Orientation of prehistoric monuments in Britain: a reassessment

Alistair Marshall

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Images on the cover:
Front: Stone row at Down Tor, Dartmoor SX 5869: see e-FIG SR-13;
Back: Solar transit in later spring: composite figure: see e-FIGS AS-04b and c

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Abstract

This analysis considers **cues** for axial alignment, and proposes a **unified basis** for interpretation amongst **major groups of monument** of Neolithic to earlier Bronze Age date from the British Isles:

chambered tombs, timber longhouses, augmented long barrows, cursus monuments, stone rows, stone circles, standing stones, henges, pit alignments, rock art sites, linear round barrow cemeteries, and a suggested class of hypermonuments.

Additional area-studies are presented for:

Stenness (Orkney), Sligo (Ireland), Stanton Drew megalithic complex (Somerset, SW'n England), Wye-Usk area (W'n England, E'n Wales), and Brittany.

Evidence for **solar symbolism** is discussed for the period in question, and existence of a widespread and active agrarian-solar cult is proposed.

Climatic deterioration over the Atlantic margins and its pressure on the agrarian economy is suggested as the cause for widespread proliferation and elaboration of strongly axial sites with potential solar links, such as stone rows, as also seen for certain solar-related motifs of rock-art.

The **seasonal-solar** model proposed here for axial alignment recognises the prime importance of the sun amongst agrarian communities, and introduces the idea that the axis of a monument was primarily set to intersect, and interact with, those specific sectors of the passing solar transit deemed to have particular economic or funerary significance, with optimisation of contact evident.

Two main **groups of axis** are identified: the broadly W'n, typically with funerary associations, and the broadly S'n, suggested here to be more closely identified with economic concerns.

This **new model** brings the monumental axis into a *dynamic and repetitive* physical relationship with the solar transit, allowing ready opportunity for on-going expression of those social, economic, and funerary rituals annually crucial for agrarian communities.

Linkage of funerary monuments into existing monumental axes is considered to have acted to unite ancestors into rituals promoting economic well being of the community, and consequently certain sites contain integrated W'ly and S'ly axes.

This change of emphasis marks a contrast with those interpretations that are restricted to more *static, intermittent* axial coincidence with risings and settings occurring at the horizon, although additional use of these liminal events could certainly supplement the model presented here.

Problems encountered in accounting for the type of equinoctial alignment prevalent amongst chambered tombs is explained by operation of compromise between competing factors, including constraints necessarily imposed by timing of the seasonal work-cycle.

Section 01:

Introduction

01a Preliminary notes for readers:

text

References in the text to other parts of the text are given as the relevant heading in the Table of Contents, and from there reference can be made to the actual page:

example: see Table of Contents: 02a/3b
= symmetry within an axis ..corresponding page number given;

Tables: where these are very long and detailed they have been placed completely on digital media, with a reference and an outline of contents remaining within the text; certain other tables retained within the text have also been placed on disc as a copy more accessible for further use.

figures and photographs

All figures and photographs are on digital media:

e-FIGURES all maps, satellite imagery, diagrams, and graphs speciallyprepared for this volume are in separate folders, labelled for each of the major topics, with captions for each figure given inthe list of figures at the end of the text for each section;

photographs most are included in a separate folder, similarly divided by topic, and provided with captions.

01b Table of contents

Some titles, as they appear in the text, have been abbreviated for easier inclusion in this TABLE;
References in the text to other particular sections of the text are made via the TABLE OF CONTENTS below, and from here to the relevant page number listed;
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example:	02c/4ai	
explanation:	02 cues for alignment	main section
	c astronomical issues	sub-sections
	4 constellations	
	a Orion group	
	i brightness	

main sections — page

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01c Preface

Initial statement

A general review of the evidence and current state of analysis would strongly suggest the real need to **reappraise,** attempt to **rationalise,** and perhaps **integrate** the evidence for structural alignment clearly visible amongst certain types of prehistoric monument in Britain and Ireland. Such an **inclusive** approach would undertake to establish the presence of any **common theme,** rather than attempting to construct a detailed and more unified theory.

Basic problems

-the current approach to analysis is over astronomical, and a product of modern scientific thinking

Interpretation, usually presented within the field of archaeo-astronomy, is currently highly fragmented, and in many important aspects unconvincing. In further discussing the range of potential targets for alignment, the term *celestial* would be preferable to *astronomical,* avoiding any connotations of modern science suggested by the latter.

In the area of survey under consideration here, modern astronomical mind-set and technical standards are frequently applied to interpretation of the establishment and use of ancient axially structured monuments, often involving unwarranted assumptions. There are very many such cases, few of which survive closer scrutiny, fuller analysis of which would require a separate volume. However, the following selection will serve to provide particular examples over the period in question, with more detailed discussion of others undertaken in later sections of the text:

..*arbitrary linking between sites*: for instance, establishment of axial lines between local long barrows of unknown sequence, points on the Dorset Cursus, and solar-lunar setting-rising positions (Penny and Wood 1973; e-FIG CU-03; see Table of Contents: 03c/8a); such attempted linking has also been attempted for Irish passage tombs, equally flawed (Prendergast 2006; e-FIG AS_sl-01; see Table of Contents 04b/3); the suggested relationship between the Heel Stone at Stonehenge, and undated near-terminal pit-like anomalies in the nearby Great Cursus is similar, but on a smaller scale (Gaffney 2012, fig. 5/ p. 153);

..*much of the work of Thom*: from the 1960's to 1990's, on a range of megalithic monuments, is also of this type, with added development of geometries, calendric systems, and units of ancient measurement (see Table of Contents section 09: Bibliography: Thom); in one of many such examples, lunar limiting positions are imposed on a set of monuments centred at Le Grand Menhir, near Carnac, Brittany (see Table of Contents 04d/4); moving from monuments to objects, this approach culminated in a highly imaginative interpretation of the gold lozenge from Bush barrow as a solar-lunar event calculator (Thom *et al.* 1988; Ruggles 1999, fig. 8.10/ p. 140);

..*elaboration of axial lines within sites*: imposition of a detailed mesh of projected inter-post alignments for the compound attached to the cursus at Godmanchester (Cambs; TL 2570), a system now fortunately trimmed, was force-matched with various celestial risings and settings (McAvoy 2000; e-FIG CU-10 and 11; see Table of Contents: 3c/9);

..*application of modern concepts*: clearly shown by the recent fanciful interpretation of a short pit alignment of Mesolithic date as a device for synchronising lunar and solar calendars (Gaffney *et al.* 2013; e-FIG PA-02; see Table of Contents 03i/3). Here, such works as Whitrow 1989 would have been well advised for prior reading.

There appears very little in the general structural data presented in this analysis clearly to support coherent and sophisticated astronomical or calendric reference to a complex repertoire of celestial targets. However, a far more realistic case can be made in support of a widespread basis for orientational behaviour arising from economically relevant agrarian-funerary ritual and propitiation, predominantly solar, and general in its essential reference.

Certainly, in addition to this more practically economic emphasis, a complex celestial cosmology, with distinct directional elements, for which there is abundant and widespread ethnographic, historical, and archaeological evidence on a global scale, could have formed an integral part of accompanying ritual, but one not reflected in any surviving structural axis.

-a basis for interpretation more appropriate to simpler agrarian societies seems inherently more realistic

A more considered approach to interpretation is certainly required, based on the type of seasonal-economic preoccupations, and related ritual, to be expected of small-scale agrarian communities, rather than on back-projections of modern science, and its methodology.

Propitiatory rituals related to economic prosperity, and to mitigation of unfavourable seasonal conditions, with funerary aspects involving mediation of ancestors, seem to present a more credible basis for explanation of alignment than do modern constructs of eclipse prediction, solar-lunar calendric co-ordination, or abstract observation of esoteric events, such as stellar rising-setting, or lunar standstills. For the sites in this survey, these latter events, regularly invoked in the literature, and occurring as they do at near 19-year intervals, almost generational, would seem to provide a sparse and inconveniently nocturnal basis for ritual at such monuments, a poor return for their often highly labour-intensive construction, obvious social importance, and longer-term maintenance. Recourse to a supplementary range of planetary, or stellar risings and settings to explain diverse choice of axis for monuments also seems borne more of desperation than rationale, with once-proposed stellar BC astro-datings regularly shown to be at variance with those eventually determined internally for the monument by physical means.

By contrast, seasonal variation of the sun and its effects, economically important, and easily observed, would have had directly relevant consequences for agrarian communities, its cycle offering ready and regular opportunities for repetition and elaboration of ritual contact. The sun would therefore have provided a major, obvious, but not necessarily exclusive, candidate as a target for axial alignment, other astro-seasonal rhythms, and terrestrial factors, perhaps providing supplementary cues, or context.

Under this view, the monument and its axis could then assimilate communities of the living, and the dead in the case of a funerary site, the seasonal economy, and the all-important connecting solar cycle.

-a broader context for monumental orientation needs to be established

Grouped axial data from a range of different types of monument are essential to provide a background for interpretation of axial alignment, both in space, and through time. This approach would form a basis for discussion of longer-term, or more distant axial relationships, as for instance between long barrows and longhouses, or of possible axial persistence, as from long barrows to linear cemeteries of round barrows, both topics developed later in this analysis.

-arguments based on context-free appraisal of grouped monuments should outweigh those from context-rich single sites

Detailed studies and interpretation of axial alignment are often confined to particular sites, rather than addressing the broader assemblage of monuments in order to extract robust descriptors for general behaviour. Such restricted analysis can leave many of the remaining monuments in the group unexplained, or sidelined as exceptions. Any coherent model for axial orientation within a defined group must not only explain the peak trend but also, *most importantly*, the spread of values outside this: *the best working hypothesis is, after all, the one that excludes least data.*

-interpretation should be fitted to data, rather than data to preconception

Interpretation must be data-led rather than concept-driven, in the latter case when sites are repeatedly matched against an existing model, without much consideration of alternatives. A good example of this practice would be standard use of the solar-lunar standstill diagram (e-FIG AS-01) as a required backdrop for analysis, with all of the assumptions it contains, for instance the primacy of horizon-based events, and of limiting positions. Repeated attempts to invoke the various, highly infrequent positions of lunar standstill as fundamental cues for alignment, when all else seems to have failed, are discussed later in the analysis (see Table of Contents: 03d/4b and 5; 04d/4).

-when celestial cues are considered, those at the horizon should not be assumed as primary, but others at elevation also discussed

The near universal assumption in the literature that setting, or rising events at the horizon are key to explaining monumental alignment is unwarranted, and serves unduly to restrict the range of available options for interpretation. This horizon-based over-emphasis seems to arise simply because the plane of most sites, and hence the ready line of sight, accords more closely with the local horizon than with higher elevations, and also because rising-setting presents a more spectacular transition between visible and invisible, light and darkness, known and unknown. Liminal events are also embedded in the antiquarian tradition, and this persists.

-the prime importance of the direction in which a monument appears to be *facing* should not be assumed

This factor is particularly relevant to discussion of chambered tombs, where the front end usually appears larger, and more structurally developed than the rear, as for instance well seen in many long barrows. A strong case could be made (see Table of Contents: 03a/11b) for greater importance of the opposite direction in the axis, that *pointing* towards the rear, being the direction of approach towards, and potential entry of, interior axial structures, and of enhanced viewing of the monument against its background. Long barrows frequently face general E and point W'ward: under this viewpoint, rather than describing their *orientation*, perhaps use of the term *occidentation* would be more relevant.

-a more culturally-appropriate level of precision for measurement, and of latitude for interpretation of axial data is required

Structural orientations need to be determined, and compared against possible environmental cues, with a degree of precision judged not by modern criteria for scientific measurement, but by those likely to have been deemed practically sufficient and ritually appropriate by prehistoric communities.

Azimuths given to minutes of arc, which are at times quoted in axial data from prehistoric sites, usually have little basis in structural reality, given the irregular nature of axial elements such as megaliths, or little either in likely prehistoric relevance, given the technical aids available at the time of construction. Questions of suitable angular resolution can be brought into personal focus by contemplating the average adult male fist as it subtends an angle of about 8° when held at arm's length, and matching this against features on the local horizon, or against setting and rising positions of sun and moon. Uncertainty over the nature of any cue, let alone which element within it might have been the one targeted for alignment, would seem to make undue observational precision further redundant. On these grounds the need for very close correspondence to occur before a measured axis would qualify as solstitial or equinoctial, for instance, seems inappropriate, and hence use of the terms *peri-solstitial* or *peri-equinoctial* would be preferable, and more realistically inclusive.

Boundaries for modern measurements of axis may therefore need to be spread well apart before application to prehistory. A case in point from this analysis is provided by results obtained after broadening the field of outward view at recumbent stone circles, from a single central value, to include working margins (see Table of Contents: 03e/7; e-FIG SC-11 and 12).

-a major structural axis need not be related to continuing ritual

The link between structural orientation and attendant ritual should not be assumed. It is certainly possible that any such alignment might indeed have played little or no part in recurrent ritual, being more token, dedicatory, and of short-term initial relevance, set at construction, and then becoming marginal to the main activity, with a passive rather than active function (see Table of Contents: 02a/2f and g). The actual ritual intention of an axis might also be seriously misconstrued. As an example, to an uninformed observer, the E'ward orientation of Christian churches and graves in Britain and Europe might suggest sun-worship, rather than its actual symbolic reference, and active involvement of this axis in continuing liturgy might also tend to be falsely over-emphasised.

A more realistic model

Applying the conditions outlined above, and pre-empting the conclusion of this analysis, a clear case can be made for the existence of a **strong solar component** in axial targeting, with the transit as its key element, a basis likely to have persisted amongst agrarian communities over a considerable time-span, with other additional cues highly probable, but not clearly evident.

Latitude-dependent effects are apparent in axial data from well-separated areas, again suggesting a possible link between axial direction and some large-scale phenomenon, such as the solar cycle.

The high degree of variability amongst axial data would indicate that **implementation of any rule** for targeting, celestial or otherwise, was generalised, rather than consistently and strictly applied, although central tendencies are apparent, suggesting a basic pattern of behaviour.

There seems to be a **broad separation of axial emphasis** between W-NW'ly 'pointing' monuments with clear funerary associations, such as long barrows and other chambered tombs, and other generally S'ly 'pointing' monuments, such as stone rows, which have less directly funerary content, and hence were possibly more concerned with economically-based propitiation, aligning their axes away from the funerary W, and towards the sunward S. However, these latter monuments often incorporate distinctly funerary sites into their axis, thus bringing the ancestors into the process of solar targeting, to produce a more inclusive model for economically-based propitiation.

The **seasonal pattern of economic activity** might well have contributed to the alignment finally achieved by a W'ly pointing funerary monument, acting to constrain its axis further, within limits defined by the annual work-cycle. Amongst chambered tombs, as well seen in the case of long barrows, the W'n transitional zone of the solar transit at lower elevation appears important, their predominantly W-NW'ly pointing axial directions explicable in terms of interaction between the need for such W'ly solar targeting and the seasonal availability of a sufficient work force for construction to begin (the seasonal-solar model: see the note at the end of this preface);

Besides an inherent funerary interest in the W, and constraints imposed by the work-cycle, another factor is involved in a **final compromise for orientation** of the axis: the need to optimise the frequency of its exposure to the passing transit, by choice of an appropriate direction, whilst maintaining the other two conditions (competing factors: see Table of Contents 03a/13c). Such optimisation could be achieved by moving the direction of pointing further towards, even beyond due W, and this in fact seems evident from the final positions of peaks observed in frequency distributions. Such analysis indicates general avoidance of solstices, and according to the triple compromise, the peri-equinoctial distribution about the W-NW'ly peak can be explained without involving the equinox, possibly more a modern construct, than one of direct ancient application.

Such involvement of variable transit-frequency, in a process acting to increase axial exposure to passage of the sun, also seems evident amongst monuments with a distinct S'ly alignment, such as stone rows. Some of these sites have peak distributions of the axis around the peri-solstitial sectors of the transit at the SE, and SW (see Table of Contents: 02c/2e). Other rows, with even more S'ly peaks of axial alignment, lying within the permanent zone of the transit, also occur, and here exposure would be maximised to give daily repetition. If aligned close to the S'n zenith the row could also refer to the readily observed elevated vertical cycle of solar rising and sinking occurring at midday, providing a clear seasonal scale, easily visualised directly, or by shadow-casting, and very rarely taken into account as a possible cue.

The picture emerges of an active agrarian solar cult, with rituals expressed in part by orientation of key axes at many sites, and responding to environmental stress during the period in question by **structural elaboration and repetition of monuments**, as for instance seen amongst the many stone rows, and as proliferation of rupestrian rock art.

However, the model proposed here for alignment can not be described as a **theory**, in the closer sense of the term, because in the absence of clear tests for its refutation, based on strict analysis of data, it can not be readily disproved, a defining attribute for such a status (Popper 1963). For instance, the seasonal-solar model for alignment, as proposed in this analysis (see the note at the end of this preface), is certainly *capable* of explaining alignment of *any* axis, which must point towards *some* sector of the solar transit, transitional, permanent, or even where below the horizon in the null zone (see Table of Contents: 02c/2b ii; e-FIG AS-01), and in this negative sense it is automatically a unified approach.

How far this *working hypothesis* actually applies to what must have been a complex situation controlling selection of an appropriate axis is unknowable, given the number of possible variables, few of which can be determined objectively, or decisively eliminated, with discussion further complicated by the likely ancient perception of general rather than highly specific directions.

Scope of the analysis

This analysis covers major types of monument: chambered tombs, a re-defined group of augmented barrows, cursus monuments, stone rows, stone circles, standing stones, rock art, henges, linear round barrow cemeteries, pit alignments, and certain barrows of the Iron Age and their burials. Drawn from these sites, a small group of hypermonuments, distinguished by their length, is discussed separately. Importantly, environmental factors are considered as a factor influencing orientation behaviour.

Other topics within this general format also include further discussion of:

..axial trends amongst linear round barrow cemeteries as possible evidence for persistence of earlier traditions;

..deliberate choice of axis to allow illumination of tomb interiors;

..the possible axial importance of shadow casting generated by the solar transit, as suggested at certain chambered tombs, and as a possible general attribute of standing stones.

The main theme of the analysis: a brief restatement

The conclusions drawn from this analysis emerge from the **general group properties** of axial orientation amongst monuments, and hence are **data-led**, rather than concept-driven, or forced to comply with more modern abstractions, for instance astronomical. **Several trends** are apparent, each relating to a general model of agrarian ritual that is predominantly solar, with little or no convincing evidence for any involvement of the lunar cycle. The prime importance of the **solar transit** in axial orientation behaviour seems evident, although unknown factors would certainly have contributed.

Given the general solar model proposed, the importance of transit-frequency in the choice of axis is stressed, with a process of **optimisation of exposure** in operation through more S'ly placement of the axis towards the peri-solstitial margins of, and to within, the permanent zone of the transit.

Alignment appears to be of **two main types**: **S'ly**, and of suggested economic emphasis, or **W'ly** and funerary, with cases of structural and axial linkage between the two. Alignment of this second major group of monuments, chambered long and round barrows, might have involved a cooperative combination of factors: an inherent interest in the setting zone of the solar transit for funerary-ritual reasons, coupled with a timing for practical onset of major construction as determined by seasonal and agrarian work-related factors, together with the need for optimisation of exposure to the transit.

The emphasis here is that the monument was not targeted to a specific short-term cue, but brought into a more **dynamic and persistent cycle**, using the passage of the sun, in its daily and seasonal motion, to connect the visible world of the living, and its needs, with the invisible world of the ancestors, and its possible solutions. Many of the monuments considered here incorporate all three basic elements: a clear structural axis, the physical remains of ancestors, and the passing solar transit, all combined to meet an ever-present need to propitiate seasonal powers, and ensure economic well being. Aligning the site on an appropriate axis would certainly ensure at least **passive** contact that was regular, in addition to providing periodic opportunities for more **active** enactment of rituals.

The underlying **solar theme outlined here is basic** to any agricultural economy, from simple to complex, forms a recurrent background for ritual, and is supported by widespread ethnographic and historical detail: the sun moves through its journey from zenith to below the W'n horizon, through the realm of the underworld, to emerge again in the E, daily as the light-dark cycle, and seasonally as the waxing and waning of its transit. The true physical explanation for this, and its recurrent inevitability, is a modern concept: for the ancients the quantity and quality of the return would have needed to be ensured by propitiation, expressed within an inclusive *solar-agrarian-funerary* cult.

The permanent zone of the solar transit, the sector between winter solstice rise and set, defines the narrowest and lowest arc of exposure for the sun, hence resulting in the darkest, and coldest part of the year, the **critical point** of hopeful return to seasonable summer conditions (e-FIG AS-04b). It forms a seasonal minimum, and for prehistoric agrarian communities would have provided an obvious target for propitiation, in order to promote favourable development of the coming year. Such ritual, anticipating an as yet unknown year, could be called *prospective* in emphasis, whilst that at the end of the completed year *retrospective*.

Variable and deteriorating **environmental conditions**, as seem evident during the later 3rd and earlier 2nd millennia BC in far NW'n Europe, an area anyway climatically unstable, could provide a possible explanation for the elaboration and repetitive construction seen amongst certain regional groups of monument, such as stone rows, and expressed at its most extreme in the development of hypermonuments.

Such a basic solar model need by no means be exclusive of **alternatives** and secondary factors. Complex celestial cosmologies, and detailed observational knowledge of the related events that formed each annual cycle, or those seen developing over longer periods of time, either held as abstract concepts, or applied for practical and ritual purposes, might have been a feature of the communities in question during this period, if not generally, then for some specialist group. However, there is nothing from analysis of axial alignment amongst the monuments to support this.

It should be noted that use of such axial monuments might well have functioned as planned long after foundation, reflecting continuation of the same essential agrarian-economic rituals common to all periods, and especially so at such larger, more robustly constructed and conspicuous sites as:

	e-FIGS
Dorset Cursus SU 0115	CU-03 to 06;
Rudston Cursus complex TA 0969	CU-12 to 13;
Stonehenge Greater Cursus SU 1243	CU-17;
major stone rows on Dartmoor SX 63 and 65	SR-07 and 09;
Stonehenge CU 1242	HE-30-32.

The working hypotheses outlined in this analysis are combined as follows:

the seasonal-solar model	**Table of Contents**	**e-FIG**
general	03a/13a; 02b/8; 02c/2i	CO-02
axial intersection with transit	02c/2d to f	AS-09
seasonal aspects	03a/16; 02b/7	LB-36 to 41
climatic influences	02b/4; 03a/19; 03d/8g	LB-36 to 41
	05/1a	
proliferation of monuments		
general	03d/8g	
stone rows	03d	SR-01 to 33; ND-01b;
stone circles	03e	SC-01 to 13; ND-01c;
rock art	03g	RA-01 to 21; ND-01d;
letter-codes given for e-FIGS	01d	

Main theme: naming the model

The main elements of the seasonal-solar model, reflecting a combination of timing and solar target, can be summarised as follows:

terms	suggested ritual emphasis	axial targeting	examples: key monuments
seasonal	-renewal	WS	SW'n outliers at certain stone circles: see: e-FIG SC-10;
	-continued prosperity	meridian	stone rows: see e-FIG SR-05; cursus monuments: see e-FIG CU-19;
	-mediation by ancestors	W-NW'ward	long barrows; see e-FIGS LB-01 to 11;

solar the transit is suggested as the primary target for axial ritual deemed central to the agrarian economy, providing an indirect means of continued contact with, and propitiation of, influential ancestors and deities beyond the W'n horizon.

Key: WS winter solstice

01d Guide for use of digital images (e-Figures)
as supplied on digital media

Images are all presented as digital files in order to allow:

-**layering** of information within a single image;
-**synoptic presentation** of complex data;
-**selective viewing** of layers as required by the text;
-**separation of data** from interpretation;
-**further editing** of content should data change;
-**ease of transmission** and onward use;
-**use of colour throughout**;

Where relevant, details of sites have been directly overlaid onto well-rectified images of the terrain, thus enabling more **accurate plotting of sites and their axes**. Layering of published plans, from alternative surveys, or even versions from the same publication, allowed any inaccuracies in layout and orientation, of which there were many, to be remedied.

Use of satellite imagery from Google Earth and Microsoft Bing as the topographical base map in such composite images allows the general structure of many sites to be seen in useful outline, and in surprising detail for many cases, where they have been terminally eroded by agriculture, to survive only as faint crop-marks. Using such rectified images it has been possible to relocate many published features more accurately, and frequently to obtain better values for axial orientation than those previously published. Before use, such images were always checked for rectification against Ordnance Survey Explorer Series 1:25,000 maps, and the fit obtained was used to establish accuracy, adequate except for distortion in certain areas of N'n Scotland, or where cloud cover intervened, in which case these images were not used.

Use of recent direct imagery of terrain also allows the appalling state of preservation of many key sites, and their recent deterioration, to be more widely appreciated than is otherwise possible. This decline can be clearly seen, for instance, by sampling images of round barrow cemeteries, and comparing the current situation with that over past decades, to assess progressive and needless destruction, noting the general failure of those bodies responsible for their protection. Various henges, long barrows, and cursus monuments, notably the Dorset Cursus, provide further examples.

Software required and instructions for opening image files:

The file format adopted for most images is .psp (Corel Paint Shop Pro: a standard graphics package: included here with the digital media), a format which can be opened by many other applications.

A COPY OF PAINT SHOP PRO v5 IS ENCLOSED WITH THE DIGITAL MEDIA ready for rapid installation and use, together with its supplementary promotional features, which can be left unselected before download.

Layered images can be accessed as follows:

-open such files under Paint Shop Pro (v.5 and above);
-obtain the layer palette on-screen;
-move the slider in the layer palette to bring each layer up to required opacity (0 invisible; 100% opaque);
-change the order of layers by dragging the button for that layer up or down the stack, as required.

Images containing several layers can be adjusted until only the required information is obtained, this version then merged and saved as a flat image, for example in .jpg or .bmp format.

Copyright

Individual copyrights have been obtained and acknowledgements are quoted on the relevant layer of an image. Satellite images of terrain are all from Google Earth, unless otherwise stated (as for instance for Bing Maps: Microsoft Corporation).

Digital images created by the author [AJM] are released free for use by anyone without further permission, but with an acknowledgement requested. Any external copyright within them must however be separately respected.

File structure

Images are filed in Windows folders in a straightforward succession, allowing easy access from specific references in the text.

Each **SECTION** in the text has its own initialised upper-case identifier used throughout for the entire section, including its tables, references to e-figures, and to the folders that contain them: for instance LB- for the section on long barrows, or PA- for pit alignments.

e-FIGURES are given a unique number within each section, with an additional lower case letter suffix (a, b, ..) where several images should be considered together.

SECTIONS in the text	**identifier**
axis of monuments	AX
targets for alignment	TA
astronomical data	AS
long barrows	LB and other chambered tombs
augmented barrows	AB
cursus	CU
henges	HE
stone rows	SR
stone circles	SC
pit alignments	PA
round barrows	RB
rock art	RA
hyper-monuments	HY
menhirs	ME
radial post structures	RP
selected area studies	SA
Brittany	_br
Sligo	_sl
Stanton Drew	_sd
Stenness	_st
Wye-Usk	_wye
squared barrows	SQ
climate	CL
symbols	SY
ethnographic context	ET
national distributions	ND SEE THE SEPARATE NOTE FOLLOWING THIS SECTION
conclusions	CO
photographs	phot

Definition of North

In this analysis angular measurements of axes are quoted with reference to the UK, or Irish, National grid system: as °G ['degrees grid']. All mappings are also given with this grid N running vertically up the image, unless otherwise shown.

Compass directions

are abbreviated in the standard manner: N NE E SE S SW W NW

with suffixes added thus:

N	the north	noun;
N'n	north*ern*	adjectival: at the north;
N'ly	north*erly*	adjectival: *towards* the north;
N-wards	north*wards*	adverbial: *towards* the north;

Bearings are quoted where possible with the suffix °G, indicating degrees with reference to the relevant National Grid, in the case of the UK that of the Ordnance Survey. Azimuths are shown with added degree-suffix where clarity is needed.

Initialled comment specifically by the author: [AJM].

Online section: https://doi.org/10.32028/9781789697056-online

01e National distributions of sites that appear in the analysis

Comparisons between distributions of different types of monument, against the physical background, and in relation to each other, can only be achieved adequately by means of layered digital images.

Distributions of the following types of Neolithic and Bronze Age site are presented individually, and appropriately displayed against physical background for specified regions of Britain and Ireland. Plots are filed in folder ND-['NATIONAL DISTRIBUTIONS'], with sub-folders for each of the regions listed below, covering the designated types of monument, and including details of physical background:

regions

for UK-Ireland entire, and in more detail for component areas:

	file
UK-Ireland_all	01
Scotland;	02
N'n England;	03
Wales;	04
SW'n peninsula;	05
Ireland;	06

and within each of these areas, distributions of specific monuments are labelled as follows:

monuments	**file suffixed**
barrows;	a
stone rows;	b
stone circles;	c
rock art;	d

physical background

monuments are shown against the background of:

topography;
solid geology;
distribution of peat;
rainfall;
seasonal temperature.

The number of sites involved in producing these distributions are as follows (TABLE ND-01):

TABLE ND-01 Sites included in national distributions

	type of site:			
region	**barrows**	**circles**	**rows**	**rock-art**
Scotland/N'n England	13695	496	179	2162
Wales	1237	73	68	5
SW Peninsula	3042	90	194	2
Ireland	4238	255	200	345
TOTALS	**22212**	**914**	**641**	**2514**

Sources of data on monuments:

barrows: NMR: national and regional monument records for England, Wales, Scotland, and Ireland;

stone rows: NMR, Burl 1993, and supplementary data;

stone circles: NMR, Burl 1976, and supplementary data;

rock art: NMR, Beckinsall, Morris (see Bibliography, including on-line sources), plus supplementary data.

01f Glossary of terms used in the analysis

SOLAR TRANSIT:

the arc of the sun as it passes from rising in the E, through maximum elevation at the S'ly meridian, to its setting in the W, the length, duration, and elevation of the transit varying from a midwinter minimum, to a midsummer maximum;

ZONE:

permanent:

the S'ly sector of the solar transit, between midwinter sunrise and set, where no risings or settings occur, but where the sun always passes at some elevation;

null:

the N'ly sector of the transit, between midsummer sunrise and sunset, where the transit of sun never passes;

transitional:

the sectors of sky to the general E and W, lying between extremes of midsummer and midwinter rising and setting, where passage of the solar transit is a daily event;

LIMITING POSITIONS of the solar transit:

solstice:

the directions of the N'y and S'ly extremes of the transitional zone, between solar risings, or settings at midwinter and midsummer, hence marking minimum, and maximum day-length;

equinox:

the directions at due E and W, marking the mid-point of the rising and setting transitional zones of the solar transit, passed once during N'ward springtime passage of the sun (vernal equinox), and again during S'ward autumnal passage (autumnal equinox), at which point day and night are of equivalent length;

AXIS_monumental:

passive:

set rather to interact automatically with the daily solar transit, rather than necessarily requiring much further ritual intervention;

active:

established to specify a particular event, and enable its associated ritual observance;

DYNAMICS of the solar transit:

dwell time:

the time-interval during which the sun is present in a defined sector of its transit, this varying according to its direction, the season, and latitude;

transit frequency:

the number of times per year that the sun passes a defined direction, varying from zero to 365.

01g Introduction

Structural orientation has been analysed in thirteen well-defined groups of prehistoric monument from the British Isles, that broadly span the Neolithic and earlier part of the Bronze Age. Alignment of certain elements is apparent in all groups, with fairly clear trends present amongst the diversity. Although each group of monument has a somewhat different interpretation in terms of function, and spatial associations, factors common to several indicate interrelation. For instance long and round barrows lie in close proximity to many cursus sites; stone circles and round barrows form part of stone row complexes; and rock art is a feature found at many barrows, stone circles, and rows. All of the groups have funerary associations to some degree, from a far stronger primary presence at many barrow sites, through a weaker but consistent theme seen at stone circles, rows, henges, and rock art sites. Given such common ground, certain consistencies of orientation and associated basic ritual might be expected, even before analysis of data.

Basic principles are covered as follows:

-section 02a
the nature of the axis of a monument is considered;

-section 02b
possible targets for alignment of axes are discussed;

-section 02c
details of certain celestial cues for alignment are outlined;

Monuments included in the analysis:

The **thirteen groups of monument examined** are as follows, and generalised dating added, although many sites remain entirely unexplored, of unknown detailed attribution; see the Table of Contents for pagination;

section_identifier

-03a_LB: long and round barrows of Neolithic type
long and round megalithic chambered monuments and earthen long barrows; examples from Britain and Ireland analysed;

-03b_AB: elongate barrows and extended barrows
atypically elongate barrows, and related sites which appear to have been extended, or linked by linear embankment; sporadic examples from Britain analysed;

-03c_CU: cursus monuments of Neolithic type
classic elongate cursus sites, grading down in size to include smaller related cursoids, or long mortuary enclosures; examples from Britain analysed;

-03d_SR: stone rows of Neolithic to Bronze Age type
linear settings of single and multiple rows of stones ranging from very long sites down to paired megaliths; examples from Britain and Ireland analysed;

-03e_SC: stone circles of later Neolithic to earlier Bronze Age type
stone circles, and associated features such as outlying megaliths or avenues; examples from Britain and Ireland analysed;

-03f_HE: henges of later Neolithic type
circular or oval enclosures with embanked and ditched perimeters, the bank usually external, with single, several, or often double opposed entrance gaps; examples from Britain analysed;

-03g_RA: rock art sites of Neolithic to Bronze Age type
in-situ rock faces, and stones included in monuments which bear a characteristic range of abstract motifs, including cup, cup-and-ring marks, and complex channelling; examples from Britain and Ireland analysed;

-03h_RB: round barrow cemeteries of earlier Bronze age type
clusters of round barrows which contain linear arrangements of monuments; examples from S'n Britain;

-03i_PA: pit alignments of known Neolithic to Bronze Age type
sporadic dated examples from the widespread set of undated sites, many of which are probably of Iron Age date; examples from Britain analysed;

-03j_HY: hypermonuments
examples of what are termed here 'hypermonuments' on account of their size, drawn from several groups of monument, are considered separately;

-03k_HY: standing stones and menhirs
considered as providing a vertical axis capable of shadow-casting, and hence affording a further link with the solar and perhaps lunar cycles;

-03L_SQ: cemeteries of square barrows, mid-later Iron Age in date, from E'n Yorkshire
the barrows and their burials are considered together;

-03m_RP: radial structures of Neolithic to Bronze Age date
a residual group of a few monuments, formed by radiating concentric rings of posts or pits;

Several studies by area are included:

-04_SA: detailed regional studies
monuments in five selected areas are considered together: Brittany, Sligo (Ireland), Stenness (Scotland), Wye-Usk area (W'n England-Wales), and Stanton Drew (SW'n England);

Additional topics discussed are:

-05_CL climatic and environmental issues

-06_SY relevant symbolism

-07_ET ethnographic material.

Cues and targets for alignment

Section 02:

Cues for axial alignment

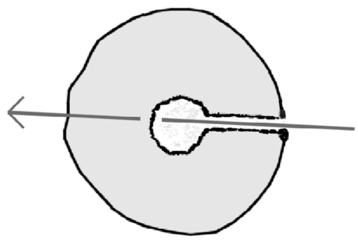
Summary:

Various topics are covered, relating to the structural axis of monuments (section 02a), and to possible targets for alignment (section 02b). Astronomical issues are discussed (section 02c), including methods for calculation of key events in the solar and lunar transits. Here, particular emphasis is placed upon the solar transit as a cue for alignment, although lunar, stellar, and planetary transits are also considered.

SEE INITIAL SECTION: Access to digital images

Section 02a:
The axis of monuments

Section identifier: AX-



the axis of a chambered tomb

Summary:

the following topics are discussed:

-problems in obtaining **viable data** on axial alignment of sites;

-**presentation** of data;

-the **nature** of structural axes.

Definition and analysis of data

Adequacy of published sources

The type of analysis presented in this general survey inevitably depends to some extent not on data directly measured, but on information from published plans, especially if sites are no longer extant, and here the reliability of directional data can be under some doubt. Unfortunately there is often clearly demonstrable inaccuracy amongst North-pointers shown on archaeological plans, as shown by comparing versions of the plan in the same publication, or by matching the plan with data from reliable sources, such as topographical maps, aerial photographs, or satellite imagery.

The graphics of many North-pointers do little to inspire confidence, with many appearing to be added as an optional afterthought, often drawn too short and ill-defined to establish a useful basal direction. Distinctions between True, Magnetic, and Grid North are also seldom stated. Directions given in text are usually not in terms of azimuth, and are often vaguely stated by quadrant or octant, without definition of this division, with adjacent quadrants often merged to give ‘general N, E, S, or W’.

This problem has been noted elsewhere as, for instance, where Burl (Burl 1981, 247-248), and Ruggles (1999, table 5.1/ p. 212) tabulate differences in measured orientations at circles. There are further examples amongst chambered tombs. For instance, the orientation in the plan of New Grange differs by some 16^{o} from that used as a basis for correlation with the azimuth of winter solstice sunrise (Patrick 1974).

Consequently data from published sources are always treated with caution in the analysis, cross-checked where possible internally, and with reference to reliable mapping, then processed appropriately before presentation. For instance, in the preliminary Europe-wide survey of barrows and long houses, highly dependent on published information, presentation of data was carried out at various stated levels of assumed error, and only robust consistencies discussed (see further details just below).

In order to avoid including poor data two procedures were adopted:

-plans of sites and areas are presented as digital images against actual topography

Wherever possible only data from primary sources are used, and this as presented against direct imagery of the landscape. In this analysis, sites and areas are mapped as a layered set of digital images (termed e-FIGURES: abbreviated throughout as e-FIGS), with rectified satellite imagery as background (Google Earth used, since widely available), this placed in register with layered Ordnance Survey coverage at 1:25k, or larger scale.

Published plans from reports and digital archives held by the National Monument Record (NMR), or regional Heritage and Environment Records (HER), have been layered over this, re-scaled to fit underlying topography and any surface indications of sites, either in relief or as crop-marks. Further relevant data from the site forms subsequent layers in e-FIGS, for instance as relating to type of site, finds, or state of preservation.

This separated layering has been done not only to obtain more reliably verified data, but also in the knowledge that information on sites and their localities may change as more detailed coverage becomes available. Such mappings are therefore presented in a format that *can* be changed, and to enable this various types of information are kept separate in layers capable of independent editing. Further technical details of the filing of images and methods of access are given in the initial section: Access to digital images.

-certain data have been subject to special processing

Since North-pointers in a great many published plans are inaccurate, with many indicating a general direction rather than a precise value, and not defined clearly as referring to grid, true, or magnetic North, special procedures have been adopted for some of the analysis.

In the case of long barrows, where many of those included in the samples no longer survive, or lie inaccessibly in areas of Europe beyond the range of extensive personal field-work, it was decided to process this batch statistically, with such sources of error in mind.

Orientations of funerary monuments, and of other relevant structures, were originally analysed using a computer program written in FORTRAN IV, running under VAX VMS, and calling external graphic routines from the GINOGRAF plotting library (CAD Centre, Cambridge) for display of the results. A more portable, self-contained version of the program has now been developed by the author.

The rationale behind the analytical section of this program involves treatment of each item of data not as a single measured angular value to be plotted directly and then analysed graphically, but as a point-value for conversion to a Gaussian or Normal Distribution of probability, centred on this stated value. The result of varying its standard deviation on the smoothness of the curve, and position of key features such as maxima and minima, is shown as an example in e-FIG LB-22.

This conversion reflects the fact that measured values are *estimates* of a notional true value, which may be difficult to determine, or may be inaccurate for a variety of reasons. This process of normalisation is repeated for each item of data in the set under analysis, by computation within the program. The final curve representing all the data is plotted after summation of the probability that accumulates, at intervals of one angular degree throughout the 360^{o} range (for instance e-FIGS LB-01 to 11).

The particular frequency of orientation that appears on the final curve at each possible orientation within this range therefore contains contributions from the individual normal distributions of adjacent values, those nearer to a specified value contributing more than those at greater separation. Converting individual values in this way enables the point-distribution of the original data to be smoothed into a continuous distribution. Since this smoothing process is based on the Normal Distribution, the level of error or uncertainty assumed to be inherent in the data can be varied at will by changing the value of its standard deviation (e-FIG LB-22).

Choice of a Normal Distribution, for the basic conversion from discrete values to probabilities centred on each of these values, seems appropriate to the nature of the data. Such a distribution might be expected to be involved if errors of random type are produced as part of the process of measuring each orientation.

Random error occurs in the choice of a single value for recording purposes. *Systematic error* [example: rounding values exclusively either up or down] derives from some inherent bias on the part of the observer to favour one particular direction in solving the problem of obtaining best-fit alignments from any structure, especially from those that are asymmetric, irregular, or fragmentary.

Such random and systematic errors in the choice of a single value for recording purposes are likely to arise from various sources:

..[..does *the drawn figure* represent the true layout of the site?];

Issues connected with the validity of the published source include the possibility of limited accuracy in recording the original orientation, during excavation for instance, and in subsequently transferring this to the published plan;

..[..was *the analyst* correct in extracting a particular value for orientation from the plan?];

Obtaining a single value of orientation from a published plan, as part of the process of data gathering, also contains inherent sources of error. In the absence of a statistically based system of decision-making this latter process is necessarily subjective. Deciding on what to adopt as the axis of an asymmetric site, or one containing component axes, can be difficult.

The above sources of random and systematic error are analytical in origin, since they are linked to measurement of data from surviving structures and derived plans. They remain entirely separate from those sources of variability linked to the selection a target by the original builders of the monument;

[..did the *builder of the monument* actually obtain valid alignment with the intended target when laying out the axis, and what were the standards for proximity, ranging from precise alignment to a more general correspondence?].

It should be noted this type of analysis assumes that errors are predominantly of random rather than of systematic type, that the value of each orientation is independent of the values of other orientations, and that all measurements are subject to equal levels of error.

The analysis in this paper is confined to generation of graphical representations for comparative visual assessment of major properties of alignment, and does not at this stage involve detailed statistical comparisons. These latter are not considered necessary to the level of discussion of the topic, or practical, given the large number of uncertainties involved in interpretation of results. If data sets were to be compared on a more quantitative basis, then in order to accommodate the continuous rotational nature of data within the 0-360^{o} cycle, the type of statistics mentioned by Fieller and O'Neil 1982 would be required.

Most frequency distributions of orientation in this general survey of alignment are presented as histograms of broader interval, in order to accommodate any items incorrectly assessed, and to avoid fragmentation of general trends that are only apparent at lower resolution.

Precision and accuracy of data

Data sets contain significant levels of uncertainty related to a range of complex variables, including the measurement itself, the level of accuracy with which the orientation might match any environmental cue, and to the precise nature of any target, whether single, compound, or absent. For instance, in discussing any possible relationship with rising or setting positions of the sun it is not known whether alignment, if at all precise, was taken against upper, mid, or lower points on the disc, generally towards a particular direction, or perhaps even notionally without reference to the observed sun.

A distinction must be made between **precision**, the degree of refinement of a physical measurement, and **accuracy**, how well that measurement represents its true or intended value (Ruggles 1999, 6-11; and as discussed above, under special processing of data).

Levels of precision in measurement and display of data for the purposes of modern analysis must also be *appropriate* to some subjective but reasonable assessment of the conditions of construction and the intentions of the builders.

For instance, prehistoric building materials such as irregular monoliths are certainly not capable of the same fine placement as a modern optical sight line. Ruggles (1999, 157) notes difficulties of measurement for axes at long barrows to within a few degrees in many cases, with degree-level precision obtainable at very few other sites, even if well preserved. Although a clear set of data obtained on a common basis is certainly required for analysis, the level of resolution for presentation of results, and their discussion, should be matched against the likely needs of ancient ritual, rather than the precepts of modern astronomy.

Indeed, if the orientation of a particular type of monument was based not on a specific target, but on a general direction, then highly precise measurement, and use of this particular value would be superfluous, and may even confuse the analysis, if taken at face value. Burl (1981) noted that over-precision of modern data collection may provide a false basis for analysis.

However detailed the measurement, the way in which it is plotted is critical to the emergence of trends within the data. A distinction must be made between the precision of primary data, and the resolution chosen for its graphical display. Plotting individualised data, as in the case of ray diagrams (e-FIG AB-24; Burl 1976, fig. 25/p. 163; Ruggles 1999, fig. 8.1/p.126), or as higher-resolution histograms (e-FIG SR-27), leads to a highly fragmented distribution. Therefore, in this analysis an interval has been routinely chosen at which any coherent structure begins to appear (e-FIG LB-22). Note the disruptive effects of over-resolution in plotting data in the case of recumbent stone circles (e-FIG SC-13), axial stone circles (e-FIG SC-12), and short stone rows (e-FIG SR-27).

Sparse data can also be amplified by relaxing constraints on the view-point for an axis: for instance, for those observations from the centre, out over the recumbent stone in recumbent stone circles (e-FIG SC-13), or by summation of arcs of viewing along multiple stone rows (e-FIG SR-17).

A degree of latitude is therefore adopted in this analysis, with measurement of azimuths to within a few degrees, and with their display as histograms at 10° intervals deemed generally sufficient.

Use of context-free data sets

Values for axial orientation can be assembled for a group of monuments as a set of **context-free** data, without reference to the precise structural and environmental conditions obtaining at each site. Such preliminary, top-down abstraction helps to define basic trends, and provide a general background for more detailed **context-rich** work at individual sites, to provide more qualified local explanation, should the need arise.

The problem with arguing on the basis of data from an individual site is that a series of exceptions emerge as a background of unexplained sites elsewhere in the group. By contrast, the approach taken in this analysis has been to stress any trends evident within the general group as a whole.

Such problems in considering single sites can be seen with regard to those relatively few monuments for which an explanation has been proposed in terms of alignment on a solstice, or limiting lunar position. New Grange and Maes Howe, for example, barrows for which closely solstitial alignments have been proposed, can be discussed as atypical exceptions to the observed trend in their general group of chambered tombs, in that they represent specialised centres of precisely tuned observation, or ritual. Alternatively, in a large group, certain axes could fall close to any defined direction by chance alone.

Similarly, the near solstitial alignment of the stone row at Cut Hill, Dartmoor (see Table of Contents: 03d/6; Greeves 2004), which is anomalous to the main trend in its area, could be viewed in the same way. As a final example: on Arran, the chambered tomb at Carn Ban (NR 991 262) has an axis of entry close to winter solstice sunset, at 230°G, compared with the solstitial azimuth 224°G at this latitude. Carn Ban is atypical of the 21 other Clyde tombs on Arran, which display a broad spread of axes, again raising the question as to whether the site is deliberately specialised in its axis, or fortuitously oriented.

In order to provide a more robust basis for general interpretation, the analysis presented in this general study is therefore strongly context-free, with further discussion of orientation based on group behaviour, rather than the situation at any particular site. This would place it in marked contrast to the approach of Thom for instance (see Thom: section: 08 Bibliography), Ruggles (1999), and Cummings (2002), where axes of sites are considered within the landscape, in relation to presence of features on the horizon, and degree of restriction of views.

Discussion of the axis

The terms **orientation** and **alignment** are generally used in this analysis, and in general published literature, as synonyms, for convenience of expression, but some distinction should perhaps be made. The term ‘orientation’ might be used to indicate disposition of a site, without necessarily implying any intention behind the choice of axis; in contrast ‘alignment’ might suggest deliberate use of a particular axis.

Definition of axis

Definition of axis is further can be further outlined in terms of lines of approach and departure, with convenient reference here to chambered tombs of Neolithic type from Britain and Ireland. The same general principles can be extended to other types of monument in the analysis.

In the case of an elongate barrow, the axis can be defined as passing longitudinally through the mid-point of the site, then through the centre of its forecourt-end. In the case of a broadly circular barrow it can be defined as that diameter which passes through the entrance/foreground area (e-FIG LB-30). Directionality is then defined in terms of pointing [approach] and facing [departure].

In this study the axis is established as the line of best visual fit, this being deemed entirely adequate for the purposes of the analysis. Possible variation amongst the majority of broadly symmetrical and regular sites is limited to a few degrees at most, well within the practical limits already imposed by irregularities of layout and structural materials. All directions are estimated in relation to Grid North, as used by the UK Ordnance Survey, and its Irish equivalent.

Symmetry within an axis

-structural symmetry
Monuments can be divided according to the structural symmetry evident between the ends of their long axis.

Symmetrical axes can be seen, for instance, at cursus sites, henges, and stone rows, where there is often little major extant structure to distinguish between directions within the axis, and here it is difficult to argue for any preferred direction being significant.

Asymmetric axes are seen, for instance, at many long barrows, where the mound may taper in plan, with any passage and chamber often at one end, and also at related circular monuments, where internal features are entered from one direction, often radial. In such cases, a distinction between opposing directions within the axis is made in this analysis between *facing* to the *front* end, and *pointing* towards the *back* end, with the latter often being the direction of taper, and/or approach/entry (e-FIG LB-30).

The conclusions reached in this analysis about significant directions within axes for different types of monument are summarised in TABLE AX-01:

TABLE AX-01 Choice of axis and specific orientation for analysis

see section	**sym**	**type of site**	**shape**	**axis**	**significant direction ?runs**	**?reason for choice**
LB	A	chambered tombs and related	long circ	longit radial	into site into site	=direction of entry note 2
AB	S	elongate barrows	long	longit	to S and W	note 1, 2
CU	S	cursus sites	long	longit	to S	note 1
SR	S	stone rows	long	longit	down-slope; to S	note 1
HE	S A	henges oe non-oe	circ	diam	to S to centre	=line of transit =direction of entry
RB	S	round barrow cemeteries	linear	longit	?to W	note 2

Key: sym(metry of axis): **A**(symmetric), **S**(ymmetric); **type of site: oe** opposed entrances**; shape: circ**(ular)**; axis: longit**(udinal); **diam**(etric); **section:** abbreviations are listed in Guide for use of digital images**.**

Note:
1 structural and topographical factors, also aspect towards the astronomically active S'n arc of the sky;
2 would accord well with funerary associations of the W'n sky.

-temporal symmetry (e-FIG AS-01; TABLE AS-01)

A particular axis can also be temporally symmetrical, or asymmetric in relation to celestial events.

Axes which link solstices are temporally asymmetric: a site oriented on winter solstice sunrise would obviously not also be aligned on sunset that day, but on summer solstice sunset some 6 months later. All lunar standstills, maximum and minimum, rising and setting are asymmetric.

The axis between the equinoxes at E and W is uniquely symmetrical however, since rising and setting events are in opposition, this only occurring transiently, axes becoming more asymmetric as the sun moves towards either solstice.

Another example of a symmetrical axis can be suggested, that between the sun at S'n zenith and an *inferred* minimum 12 hours later, below the horizon at the N, as imagined between setting and subsequent rising.

Abstract notions of direction

Whether some abstract cardinal system of direction, a modern scientific concept, operated in a manner detached from local climatic, topographical and celestial reference remains unknown. There are instances where structural elements, as for instance uprights in stone circles, occur at cardinal points, as at Long Meg (Burl 1976, 89), but such cases are relatively rare.

Alignment behaviour between regions and over time

There is no need to assume that alignment behaviour remained constant over time, and that it was homogeneous throughout each area, or between different areas. Differences in the choice of object used are certainly probable between culturally divergent areas of Europe, and changes in orientational behaviour over the considerable time span during which funerary and other monuments were being constructed might also be expected. At any given period, several alternative objects might have been used for alignment, even within the same locality, and this has, for instance, been invoked as a possible explanation for the diversity of orientation seen in the Clava group of monuments in Scotland. It has also been suggested that the alignment of Clava cairns might have changed over time, the earliest based on more obvious celestial targets, such as the settings of the sun and moon, but with cues becoming progressively more complex to accommodate increases in observational knowledge (Burl 1976, 163 and 177).

Intervals between determination of orientation at a monument and its fuller construction

The orientation of a monument is determined when its main axis is first set out on the ground, and this might have constituted a small-scale, rapidly executed, preliminary phase, detached from the main effort of construction.

Marking out could therefore be done at any time of year, with further construction continued as circumstances allowed. This separation urges caution in using any timing suggested by the axis, as for instance if directed towards a solstice or other position, to relate the effort of main-phase monument building into the agrarian cycle of activity (see Table of Contents: 03a/16b-f), since an unknown interval might have ensued.

The status of the axis

The axis selected for a monument might be expected to constitute a major factor in the direction and sequence of ritual enacted at a site, simply because of its fundamental structural importance. Such an axis would likely have exerted a continuing influence during its active lifetime, and perhaps even beyond, as for instance seen in the case of later barrows accumulating around the Dorset Cursus (see Table of Contents: 03c/8a and 03h/2i).

Types of axis

An axis can be classified in several ways: according to the **scope** of its intended action, its degree of active **involvement** in ritual at the site, and the **specific physical range** over which it remained relevant, as outlined just below:

..scope of intended usage:
whether the axis was intended to be a ritually **transient** feature, relevant only to inital establishment of the monument, or a **continuing** feature, acting as part of subsequent ritual operations;

..degree of active involvement:
an axis could have acted either ***passively***, empowering a site simply by virtue of its existence, or could have formed a continuing basis for ***active*** observance;

..range of physical relevance:
depending on its alignment, and on the target selected, an axis varies in its relationship with space and time, showing **singular,** or **general** reference;

-Scope of intended axial usage: transient or continuing

..transient usage
The axis and its cue might have been used simply to set the monument in an approved relationship with its surroundings, involving little or no direct reference, or use, thereafter. Adopting such an alignment for a site could be seen as equivalent to a foundation deposit, or some other act of consecration. It would therefore be

a mistake to assume that a site, apparently aligned on an event, from more frequent and annual, like a biennial equinox or solstice, or rare like a lunar standstill position, of over 18-year interval, ever directly utilised such a cue for regular observation, or otherwise, within recurrent ritual.

A modern parallel would be that of a medieval church, laid out using a current sunrise position as the basis for appropriate alignment to the E (Ali and Cunich 2001), but thereafter making no direct reference to the solar cycle, its ritual taking another course.

..continuing usage
On the other hand, the functioning monument might have made continued use of the cue on which its axis was targeted, as part of recurrent ritual, related to seasonal-economic, or funerary activity.

-Degree of active involvement of the axis in ritual at the site

Axial reference could have been active, for instance regularly marking the onset and duration of certain activities at the site. It might, however, have been to some extent passive, as might be imagined at a monument aligned to allow the solar transit automatically to cross its axis at certain times of the day or year, thereby creating a recurrent link between the monument and celestial sphere, independent of specific ritual enactment.

An axis aligned towards a target can therefore be considered **active** if it forms the basis for recurrent ritual, or **passive** if it serves more to empower the site by maintaining regular contact with that target and, once established, might play little further part in routine ceremonial. It is worth noting that many megalithic sites are located on remote open upland, perhaps at some distance from parent settlements, and the existence of an axis deemed to operate passively might compensate for any consequent loss of direct ritual input. For instance, it is easy to imagine those stone rows in the Dartmoor group with terminal funerary monuments (see Table of Contents: 03d/8d), their alignments often facing down-slope towards the S-SW, acting to maintain regular passive contact with passage of the S'ly sun across their line, irrespective of much further human intervention (see Table of Contents: 03a/13a).

To be efficient in this passive respect, any such axis would need to be aligned towards the permanent solar zone, or that part of the transitional zone nearer to the solstitial margins, where the transit is of more regular occurrence, and this is indeed the general trend seen for such rows, and for several other types of monument (e-FIG CL-01).

The point to be made here is that the alignment of a monument may give only a very partial view of the content of ritual enacted at the site, the axis perhaps being dedicatory, and somewhat separate from main aspects of use.

-Range of physical relevance

system proposed: here, with particular reference to the solar transit;

examples are referred to below:
..by section of the text: [section number, as given in the Table of Contents]:
..by particular e-FIGURE: {reference to a particular e-FIGURE, as listed at the end of each particular section of text, and given as a digital images in externally supplied media}:

Monumental axes can be divided into two groups, according to the degree of contact they are able to maintain with the target: **restricted,** and **general**:

..restricted
An axis fixed in the horizontal plane, such as that of a stone row, or a long barrow, are only able to intersect a passing target relatively briefly, as celestial motion brings it into temporary coincidence with the axis (speed and elevation of the solar transit: e-FIG AS-06); see Table of Contents: 03a-03L;

...limited in space, duration, and recurrence

event	immediate risings and settings;			
axis:	~horizontal;			
close axial contact	short, << 1 hour;			
specific direction	at solstices; or on a selected day	each equinox;		
annual recurrence	once [+surrounding days]..................................>			
examples amongst	chambered tombs		henges	EW'ly aligned monuments
	[03a]		[03f]	[03a]
specific	New Grange	Maes Howe	Stonehenge	Knowth
	{LB-102}	{LB-94}	{HE-32}	{LB-96}

...limited in space, and duration, less so in recurrence

event	solar transit at elevation;		
axis:	~horizontal;		
close axial contact	short, << 1 hour;		
specific direction	defined by the monumental axis	peri-meridian;	
annual recurrence	=or< daily, depending on azimuth	~daily;	
examples amongst	long barrows	stone rows, cursus	
	[03a]	[03d]	[03c]
	linear round barrow cemeteries	menhirs	
	[03h]	[03k]	

..general

A broadly defined sector of outward, horizontal viewing, such as that provided by the entrance to a burial chamber, or the aspect from a panel of rock-art, is capable of addressing a more extended duration of exposure to a cue, such as increased solar irradiation.

A vertical axis, such as that of a standing stone, although a fixed axis, is capable of even closer and more persistent contact with celestial motion, through the medium of continuous shadow-casting, as the sun, or moon, casts a moving radial axis, with duration and intensity varying according to prevailing conditions.

event	general incoming illumination;	
axis:	~horizontal; vertical for standing stones;	
close axial contact	high, during most hours of daylight;	
specific direction	not closely limited;	
annual recurrence	=or< daily, depending on azimuth;	
examples amongst	Arras culture: crouched burials	[03L];
	rock art: multi-rings, other motifs	[03g];
	?illumination of burial chambers	[03a];
	standing stones: via shadow-casting	[03k].

Directed ritual: transmission and reception

For the groups of monument considered in this general analysis, it is suggested that that their main axis might have served to establish a direct and recurrent line of intersecting contact with the circuit of the solar transit, and its re-emergent passage through the netherworld beyond the horizon, as a means for propitiation of ancestors, and natural events.

Extending this idea, it seems reasonable to suggest that any such ritual mechanism might have been a two-way process of communication, involving both transmission and reception.

Certain sites, such as chambered tombs, can perhaps be viewed in this light, as monuments providing a channel connecting these two processes. Long barrows are described in this analysis as 'pointing' towards the typically narrower end, and ‘facing’ towards the broader foreground area, with the former often the direction of physical entry to the structure, and the latter that of exit. Many such monuments are typically aligned to point W’ward, and face E’ward, hence, according to the solar model, towards the setting and rising transits of the sun respectively (e-FIGS LB-01 to 29). Such a broadly equinoctial alignment, the central tendency seen amongst the examples given, would optimise the frequency of general correspondence with joint risings and settings, hence increasing viable communication. Rotation of the axis out of this general E- to W-ly line would decrease the balance: NW-SE’ward in favour of risings, NE-SW’ward in favour of settings, assuming the ‘pointing-facing’ convention stated above. Such funerary monuments could be considered potential examples of bilateral communication.

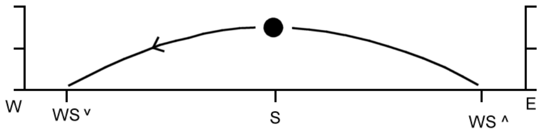
On the other hand, stone rows, with their S’ly axial emphasis (e-FIGS SR-05, 17, and 27), seem to provide a more unilateral transmissive line of ritual communication, towards the permanent zone of the solar transit, the reverse direction being towards the null zone involving no solar events (e-FIG AS-01).

One particular motif from the range commonly seen amongst rock-art in N’n Britain could also be suggestive of symbolic solar reception and transmission. Cup-marks in general, with their circular shape and concave profile, might well have represented solar symbols, any surrounding multiple rings suggesting irradiation and its benefits, adding further dynamism to the motif. At their most basic, these cups, and cupped multirings, could simply mimic the solar disc, in an attempt to invoke, or continue, clement seasonal conditions, those examples on level surfaces at least capable of holding a small additional offering. Certain of these multirings could also be receptive-transmissive, the main ring-motif receptive of solar influence, with radial channels, frequently seen, acting to redirect it in essence towards specific directions. Further details are as follows (e-FIGs RA-): general relevance 14 to 21; example of grouped motifs 03; solar exposure of panels on Tayside 10, 10a; aspect of panels 14; comparative orientation of motifs 15).

Section 02b: Possible targets for alignment

Section identifier: AS-

solar transit;



Summary:

the following topics are discussed:

-**problems of interpretation,** and possible targets for axial alignment;

-the potential of **solar and lunar cycles** as cues;

-a **seasonal-solar model** for orientational behaviour, with latitude dependent factors considered, and a specific example included; given the economic imperative within this model possible divisions of the agrarian year are considered.

Potential targets for orientation of monuments

Problems of interpretation

It is an obvious preliminary to stress that modern interpretations of how monuments were used, and how surrounding land-, or sky-scapes were perceived, may be rather different from those of their builders (Ruggles 2000, 151). General surveys of ancient, and more recent ethnographic, perception of the sky, and its role in mythology include Kelley and Milone 2005, and Ruggles 2005.

Although prehistoric and modern physical landscapes are linked by a common surviving topography on which arguments can be based, much will have changed. Since ancient cultural landscapes are known only in outline, and their survival is anyway partial, then any assessment of possible cues based on settlement pattern, or social usage is weakened. Even without these physical obstacles there are likely to be considerable conceptual differences between ancient, and modern reading of the landscape, and the potential significance of elements within it.

With regard to potential celestial targets, the physical basis for comparison is on firm ground, since change has been slight over the millennia, and all relevant aspects can be extrapolated into the past for any period in question (Haney 1994). However, potential differences in reading the sky remain (Thomas 1991, 41-47), even for singular bodies such as sun and moon, and especially for perception of more complex patterning amongst star groups, known from ethnographic sources to be considerably variable.

Even modern concepts of direction, essential though they are for extraction of analytical data, may not be entirely consistent with the prehistoric view, either in specificity, or in relationship to a cardinal system (Ruggles 2000, 141). The need for accuracy of alignment may also be more modern than ancient. For instance, in discussing any possible relationship with setting positions of the sun, it is not known whether alignment was taken precisely, or generally towards that direction, or was perhaps even notional, without reference to the observed sun.

The potential differences between prehistoric celestial observation and modern scientific astronomy are clear, the former more likely based in practical matters such as regulation of the agricultural, social, and ritual calendars, for which great accuracy, and precise external calibration are not required (Moir 1981, 222). Although monuments might be expected to reflect this agrarian attitude strongly, there may well be structural elements that could support the type of ancient astronomy as suggested, for instance, in the works of Thom and Ruggles (see Table of Contents: 09 Bibliography, respective references). These could perhaps indicate specialist activities of a minority group within prehistoric communities.

Given the number of prehistoric unknowns, and the subjective choices involved in their analysis, the best that can be done is to offer a general framework within which certain aspects of prehistoric alignment might be consistent. Discussion in terms of such a model remains somewhat different from offering a valid interpretation.

With these constraints firmly in mind, potential cues for orientation of monuments can be grouped under five main headings: random, topographical, imitative, climatic, and celestial, with any one, or a combination, operating to produce complexity within the data.

Naturally, in discussing possible targets for alignment, consistency should not be assumed. The cues used within any regional group could be varied in nature, multiple rather than single target, and could change over time.

Types of target

Random alignment

A random basis for orientation would mean that no unifying influence operated, and that alignment of monuments was not considered to be important by the builders. This might have been true for individual sites, since a considerable range of alignments exist within groups of monument. However, as one instance, it is certainly does not provide a valid explanation for the frequency distributions seen amongst long barrows (e-FIGS LB-01 to 21) in which a distinct non-randomness emerges from the general background of alignments. However, other distributions contain less well defined peaks of frequency, as for instance amongst cursus monuments, where a higher uniform background level indicates more generalised alignments throughout the range (e-FIG CU-19). Any such apparent randomness might be reduced if the target area was broadened from point to sector, for instance using the example of the sun, from a single rising, or setting at the horizon, to include the transit.

Topographical conformity

Monuments might be placed to take advantage of, and to conform with, or be more closely confined by, restricting local topography. For instance, narrow spurs might have imposed constraints on placement of long axes, or siting have been influenced by the general line of broader hilltops, factors evident in the case of many long barrows, and linear round barrow cemeteries. Particular positions might also be adopted to enhance visibility *of* a site from its immediate context, from or some significant location, as for instance the view of the monument from settlement areas, nearby routes, or at territorial boundaries. Stressing a particular view *from* the site, towards significant places, might also be important.

In general however, although some conformity with contouring of land is apparent, topography does not appear to determine orientation, since at many sites, and even for those that are relatively constricted, a number of possible alternative alignments might well have been available, but were not selected. For instance, the often quoted influence of the trend of local ridges in determination of axes amongst long barrows, as noted in the area of Cranbourne Chase, seems overstated as a controlling factor (Ruggles 1999, 89-90; Ashbee 1984; RCHME 1979, xiii; Burl 1981, 248-256). Amongst long barrows of Cotswold-Severn type, alignment towards the W-NW, and frequent conformity with ridge-lines on this axis occurs for varied topography, suggesting selection to allow, or enhance this axis (see Table of Contents: 3a/22; e-FIG LB-114 to 116). Here topographical influences seem to be secondary, perhaps operating to modify orientational behaviour somewhat, rather than providing a basic explanation for the choice of axis.

Such arguments can be advanced to explain the siting seen amongst many other groups of long barrow (TABLE LB-01). General alignment, as shown by grouped data, seems to be following non-localised cues, namely those from the wider environment, but with the other various factors involved leading to compromise. Amongst long barrows for instance, consistencies in general orientation over wide geographical areas show that the major influences that operated to direct alignment transcended those of the local area, and were European in extent, suggesting a celestial basis.

The inadequacy of topographical explanations becomes more apparent when considering circular monuments, such as passage graves. The orientation of the main passage in the Scottish group is, for instance, closely similar to the axial orientation of elongate monuments (e-FIG LB-09 and 10), and yet the essential circularity of passage graves must have freed them from many of the problems of siting encountered for inherently less compact, elongate monuments.

It seems, therefore, that there was a preferred alignment clearly in mind, with active choice of a topographically suitable site, rather than more passive acceptance of constraints imposed by what was available.

As a further example, amongst certain regional groups of henges there may be a relationship between the principal axis connecting opposing entrances and lines of transit across the region. This is seen in the Millfield basin (see Table of Contents: 03f/4a; e-FIGS HE-10 to 20), Swale-Ure area (see Table of Contents: 03f/4b; e-FIGS HE-21 to 28), and at Durrington Walls (see Table of Contents: 03f/6a; e-FIGS HE-02).

Imitative alignment

Again using long barrows as an example: if these monuments reflect the use of traditional long-house architecture, but within a funerary setting, then orientation might have been one of a range of features *borrowed* from the domestic structures (see Table of Contents: 03a/19a). Orientation is indeed similar between both types of site, with back-ends pointing W to NW'wards (compare e-FIGS LB-01 for general European long barrows with e-FIG LB-24 for Neolithic longhouses). Choice of axis amongst such houses could have been a practical response to prevailing conditions of wind and weather (Marshall 1981), or made in some direction deemed to be propitious, as discussed in more detail below. Whether orientation in these two groups of structure is related, or independent, remains a matter of speculation, and would be very difficult to argue on the basis of group statistics.

Reference to celestial cues

Use of the sun, moon, stars, and planets are considered in more detail below, with the solar transit considered of prime importance amongst the groups of monument considered in this analysis.

Skyscapes:

Celestial features of potential ritual interest can be grouped as follows, and these could have been variously incorporated into monumental axes, or used during enactment entirely without formal preservation as a structural alignment, but rather by personal, or group orientation of participants, remaining beyond the archaeological record:

type of skyscape	as	example	note
actual	currently viewable	any sky-ward view	1
conceptual	compiled by serial observation	*transits*, trajectories	2
imagined	*extrapolated*	'subterranean' solar passage	3

Actual and conceptual skyscapes have been combined to produce the solar transit as shown in e-FIGS AS-04b and c.

Notes:
Involvement of all three types of skyscape in establishment and use of an axial alignment are possible, with the following token examples:

1 the axis of a long barrow actively pointing towards a particular sunset;
2 recurrent passive axial interaction between a monument, such as a long barrow, stone row, or cursus, and the passing solar transit;
3 the axis of a long barrow possibly pointing beyond the range of solar setting towards the extrapolated transit, conceived as linking those of the setting and rising sun.

Glossary for italicised terms:	see Table of Contents
solar transit	02b/5f
extrapolated solar transit	02b/6b
axial pointing	03a/11b
passive-active interaction	02a/2g

The data in this survey can be apportioned between the three options listed just above, involving little conceptualisation beyond that for the simple transit, with evidence for any other more sophisticated reference to the skyscape lacking structurally, although entirely probable.

Use of other monuments as targets

Axial alignment might have targeted existing sites and monuments, for instance from one chambered tomb to another, or from the entrance at one henge towards another, as between Woodhenge and Durrington Walls (e-FIG H-02). Similarly, certain monuments might have been oriented towards the parent settlement, but in one area at least, the Cotswolds, where a detailed study of settlement and funerary monuments has been carried out, the evidence, such as it is, does not seem to support this (Marshall 1985; other unpublished analysis). Given the unknown nature of much of the ancient landscape any linkage is difficult to support, with few clear candidates.

One study, however has attempted to link certain Irish passage tombs into pairs, in which one monument faces another, despite being located at some distance and at higher elevation (Prendergast 2006). Closer examination of such data indicates that there is no case to support this suggestion, and a more detailed analysis is given separately (see Table of Contents: 04b).

One case where the main axis of a long barrow might have pointed towards a nearby area of occupation is outlined just below, for Belas Knap, in the Cotswold-Severn group of monuments, perhaps here linking ancestors with the welfare of the current community. How far this factor could apply elsewhere awaits far more precise data on the location of associated settlement.

Axial compromise: a case from the Cotswold-Severn group of long barrows

The axis of the long barrow at Belas Knap (Sudeley I; SP 0210 2542; e-FIG LB-70, 70a, 70b, 88) is atypically aligned, in that it points S'wards (front to rear), rather than following the more usual W-NW'ly-pointing trend seen in its regional group, and far more widely in Britain and Europe.

The area of this monument has been the subject of prospection by the author (AJM), as part of broader surveys (Marshall 1985, 2011a), and certain general features are apparent (e-FIG LB-120). An increased scatter of flint-working debris, flint artefacts, and items of domestic stonework, lies over the spine of the ridge, just to the S of the long barrow. This material suggests an area of Neolithic to earlier Bronze Age activity and settlement, utilising a defensive position on a necked promontory sited against the scarp-edge, adjacent to a useful stream valley, wooded valleys, and level cultivable land.

The long barrow itself lies some 600m to the N of this potential habitation site, and is placed hard against the edge of the scarp, following its N-S line, the topography determining the axis of the monument. This particular location is set at a discrete distance from the zone of direct habitation, and is also marginal to an area of relatively level land, ideal for cultivation, its strongly burnt sediments suggesting repeated clearance (Marshall 2011a, figs. 6-7/pp. 119-120). The barrow presents its flank towards this arable area, and would have been clearly visible throughout as an impressive feature on the skyline, less so axially from the area of settlement, perhaps deliberately. The barrow was constructed with its forecourt, further shielded from lateral view by mounded extensions, facing away from the area of settlement and agriculture, thereby maximising privacy.

It is suggested here that the axis of the barrow was determined by the need to place it discretely from the settlement, and marginally to arable areas. Its nature as a funerary monument, perhaps associated with on-going practices of excarnation and fresh burial, might have required that it was placed thus, with sensitive areas shielded, in a spot that could be readily avoided, but without encroaching on useful land, and disrupting patterns of daily work and traverse, yet close enough to be monitored generally. Choice of this particular location and orientation would have greatly reduced all such practical and ritual concerns.

A further consequence of this N-S axis was that the barrow now pointed well away from the usual W'ly axis, this latter argued in this analysis as more specifically funerary (see Table of Contents: 02b/8). However, placing chambers laterally, rather than terminally in the mound, would have overcome this problem, and in fact, apart from one possible minor chamber at the S'n end, there are two chambers in the E'n side, with one in the W'n.

The axis of the barrow would also have pointed towards the area of main settlement, and this too might have been significant, since it would have connected together the community, the ancestors, and zones of agriculture, with S'ly sectors of the solar transit of specific economic and funerary importance (see Table of Contents: 08; e-FIG CO-02).

If the model presented here for this community is valid, then it indicates clear optimisation of competing topographical, economic, and ritual factors, into a working compromise for placement and alignment of its long barrow.

The choice of axis at Belas Knap, main longitudinal axis, and subordinate transverse, does not represent any general trend evident in the Cotswold-Severn group of long barrows, and at present must be regarded as a local anomaly. Such barrow mounds, as listed in TABLE LB-17, generally point W-NW'wards, with only ten of the 59 barrows (17%) having principal axes lying within +/- 30° of due N (4 sites), or of S (6 sites). The atypical barrow complex at Bibury II (SP 1109; e-FIG LB-46) also contains a series of S'ly axes (see Table of Contents: 03a/21d). It is not known whether any of this remaining minority of monuments with 'polar axes' has lateral chambering, which would automatically bring them into the normal E-W'ly funerary alignment, from the otherwise directed N-S axis of the mound, Belas Knap being the only extant example. Even if all of this 'polar group' has lateral chambering, this sub-group with a double axis would still remain minor. The case for a distinct phenomenon is further weakened by the occurrence of laterals in W'ly pointing mounds, the chambers here then forced into a more polar direction (Swell IV, Upper Slaughter I, Brimpsfield I, Luckington (Wilts.), Pipton (Brecon), Capel Garmon (Denbs.)).

The safest conclusion here is that all chambers, terminal, or lateral, took their cue from the main W-NW'ly axis of the mound, but in those rare cases where the main axis of the barrow was forced out of normal funerary alignment by overriding factors then, in at least one case, lateral chambers could remain on that axis.

Axial combination

In addition to those simpler monuments where there is only a single axis, there are many others where several axes take different directions, perhaps acting in combination to make multiple, or repeated references to the same, or different targets, perhaps skyward. Clear examples are to be found amongst stone rows, with some cursus monuments providing comparative material.

AXIS	**type**	**example**	**linking**	**region**	**e-FIG**
simple	one axis	SR: Shovel Down F	?nil	Dartmoor	SR-12
multiple	divergent	SR: Drizzlecombe	?FM	Dartmoor	SR-08
		SR: Tormsdale	?nil	N'n Scotland	SR-25
		Lagatjar	?nil	Brittany	AS_brit-09
complex	**incorporating FMs in a single line**				
		SR: Down Tor	FM	Dartmoor	SR-13
		SR: Shovel Down B	FM	Dartmoor	SR-12
		CU: various	FMs	England	RB-282
	linking different monuments				
		direct incorporation			
		SR: Callanish	FM	Outer Hebrides	SC-02
		adjacent-contiguous			
		SR FM: Loqmariaque	FMs	Brittany	AS_brit-09
		Beaghmore	FMs	Ireland	SR-26

Key: SR stone row; **FM(s)** funerary monument(s); **CU** cursus monument.

In this analysis, the suggested target of such axes is the solar transit itself, with two of its sectors having especial significance: the sun-ward S'ly, in terms of agrarian-economic prosperity, and the setting W'n, of funerary importance. On this basis, amongst the examples given above there is a clear effort to link ancestors into the intended prosperity of the community.

The suggested combination of S'ly and W'ly axes at two major sites, the complex of cursus monuments at Rudston (TU 0969; Yorks; e-FIGS CU-12 to 14), and the megalithic complex at Loqmariaquer (Brittany; e-FIGS AS_brit-09 to 12) is shown jointly in e-FIG-CU-24.

Alternatives for targeting the solar transit

Axial targeting of the solar transit can be divided into a series of possibilities:

Point axial targeting can refer to a **single,** or **paired** event, precisely available either once **annually**, or **intermittently,** either at the **horizon,** or perhaps at **elevation,** each occurring within a specific celestial **zone of interest,** as defined by the structural axis of the monument.

Framed axial targeting refers to a range of consecutive events generated by the target in question, as bracketed within particular limits.

type	event	recur	x	target	loc	zone of interest	examples
point	single	annual	1	R/S solstice	horiz	SE/NE / SW/NW	many
			1	R/S equinox	horiz	E/W	many
		occ	-	single other	horiz specific to target		many
	paired	annual	1	R+S solstices	horiz	SE+SW / [NE+NW	GtCurs]
			1	R+S equinoxes	horiz	E + W	many
framed	mult	daily	^365	R/S transit	elev	SE-NE / SW-NW	LBs; DW
			365	- transit	elev	SW to SE	curs; st rows

Key: event: mult[iple]**; recur**[rence], **occ**[asional], **x** number of daily occurrences per year [although this can be increased if more latitude of observation is allowed], **^** =up to; **target** [solar]: **R** rising, **S** setting; **loc**[ated at]: **horiz**[on], **elev**[ation]; **zone of interest** [towards the]: **/**=or, **+** =and;

examples:

many: scattered throughout the literature, involving not only the sun, but also the moon, and specific stars;

GtCurs: such a double target has been suggested for the view from the Heel Stone at Stonehenge towards large pits, set one each at either end of the Stonehenge Greater Cursus, which lies just to the N of the henge; the paired events considered to be involved are the midsummer sunrise and sunset (Gaffney 2012, fig. 5/ p. 153);

LBs: the sample of long barrows included in this general analysis, are discussed as having been targeted on the setting solar transit (detailed discussion: see Table of Contents: 03a);

DW: it has been tentatively proposed elsewhere in this general analysis that the W'ly gap in the currently-known shaft-ring around the henge might frame the entire range of setting solar transits between midwinter and midsummer solstices (see Table of Contents: 03f/11);

curs, st rows: the predominantly S'ly orientation of cursus monuments and stone rows considered in this general analysis has been discussed as intersecting the solar transit, as recurrently available in its S'ly permanent zone (detailed discussion: see Table of Contents: 03c and 03d);

The influence of climatic factors on orientation

Continuing to use long barrows as a case in point, there are several possible explanations for the involvement of climatic influences on the choice of orientation.

It might have been necessary to orient a forecourt or entrance area away from the prevailing wind and weather, in order to shelter fires, or to protect more vulnerable items placed there as offerings, or otherwise connected with the ritual of the monument. Such objects might have included human remains, perhaps as part of a process of exposure before burial. Protection of the threshold areas of internal passages and chambers from wind-borne debris, and driven rain, would also have been important, especially whilst entrances were left open. Some evidence exists for forecourt ritual involving use of fire, digging of pits, and placement of posts, and there appears to be a tendency for finds to be concentrated around the forecourt end at many sites. Chevalier (1984) has suggested that dolmens in Languedoc and Bas Rhone tend to have their entrances on the sheltered SW'n side. However he also noted that the solar cycle might have been an important factor, since he interpreted most entrances as facing winter sunset, with some oriented towards spring or summer sunset.

However, reversal of alignment to face generally W, with consequent decrease in sheltering, as seen at some sites, and clearly in the group of Irish wedge-tombs (e-FIG LB-21) would require further explanation.

Climatic factors such as the prevailing direction of wind might therefore have influenced the orientation of such funerary monuments, but this seems unlikely to have been sufficiently uniform on a continental scale to explain similarities in their frequency distributions, although such factors might have been of local importance.

Use of celestial targets

Amongst the sites outlined in this analysis, although individual sites sometimes appear to conform with local topography, the general properties of group alignment for total samples and similarities between sub-samples at different locations, from Iberia to N'n Europe, suggest the broad influence of external phenomena common to all.

Astronomical events therefore provide the most likely targets invoked for interpretation of orientation, both in this analysis, and elsewhere (see Table of Contents: 09 Bibliography for Ruggles, Burl and Thom). However, the range of possible variables which exist make the astronomical option a complex one, and with a crowded horizon, let alone the rest of the sky, it is difficult not to point at something, especially if a bi-directional axis is considered.

The type of astronomical object involved

Possible celestial targets for alignment, in both the day- and night-time sky, are provided by sun, moon, stars, and planets. Their cycles of rising, transit, and setting vary according to seasonal cycles which are repetitive, but which undergo further fluctuations over longer time-spans. Cycles are relatively simple in the case of sun (e-FIG AS-01 to 04) and stars (e-FIG AS-14 to 16), but are more complex, with additional periodicity, for the moon (e-FIG AS-11) and planets (e-FIG AS-21 to 22). Potential celestial targets are numerous: in discussion of orientation at stone circles Burl (1976, 51) notes 46 possible alignments based on the sun and moon alone.

Points of rising and setting on the local horizon, and their directional extremes, or those of maximum elevation for a transit, are easily defined as reference points and, if sufficiently stable over time, these could have formed important temporal markers of seasonal and ritual importance.

Use of universal or site-specific targets

Considering the solar transit for example, alignments for a particular type of monument might have been made on, or towards, a discrete number of targets which occurred at specific times of year, and at fairly stable points on the horizon, targets which were of **universal** reference, standard for a stated latitude. Solstice positions at the extremities would provide obvious examples, with the equinox midway between less well defined, being a point of transition. On this basis, sites might tend to have alignments which clustered fairly tightly around one, or more, distinct directions.

Alternatively, alignment might have been directed towards a particular object or event, but one current at the time of construction, and hence **site- and time-specific**. A broader spread of alignments would result, this apparent variability masking any underlying precision of alignment, which was in fact on a distinct *but moving* astronomical event. However, if construction was restricted by season, then this would have acted to concentrate alignments, thus producing more distinct peaks in frequency distributions. This option (model: **seasonal-solar timing)** has been discussed for long barrows (see Table of Contents: 02b/8; 03a/13a and 16a-g), since it could help explain the spread nature of peaks in frequency distributions (e-FIGS LB-01 to 21).

The elevation of the astronomical object, or event, used to determine orientation

Interpretation is further complicated by considering that orientation need not have been *on* an event at, or near, the horizon, but *towards* one located elsewhere in the traverse of the object over the sky. Even if the targeted event was at the horizon, in the case of a larger object like the sun or moon, the exact orientation would depend on which part of the disk was sighted: top, centre, or base, perhaps even pre- or post- setting or rising, as first or last light. Furthermore, if an event at the *local* horizon, of elevation changing between localities, was used as a basis for alignment, then this would confer further variability on any set of data, as a S'ly deviation from the actual position on the horizon for both rising and setting bodies.

It is possible however that the alignment was intended not to intersect with a rising or setting object, but with its transit (model: **solar transit intersection**), as in the case of a W'ly axis aligned towards that of the descending sun, and even its notional onwards course below the horizon (see Table of Contents: 03/13a).

The complexity of the astronomical target

Astronomical objects used as a basis for alignment need not necessarily be singular, but could be grouped, especially if the event was nocturnal and involved constellations of stars, or planet-star associations (see Table of Contents 02c/4a; e-FIGS AS-16 to 20). In fact, alignment could have been based on even more generalised areas of the sky which acquired especial significance: for instance, towards the sunward S, or towards the generally W'n direction of sunset, both containing larger-scale patterns of celestial activity.

In contrast to much modern practice, far broader concepts such as 'towards' or 'away from' might well have been in operation, instead of closely defined direction, and a general, or token alignment on an event might have been considered sufficient (de Valera 1960).

Reference to the solar cycle, and use of limiting positions

Given the seasonal-economic importance of the solar cycle, and its likely involvement in the ritual life of agrarian communities, key solar events are prime *a priori* candidates as potential cues for orientational behaviour expressed at monuments.

The directions of sunrise and sunset on their respective E'n and W'n horizons, and the elevation of the sun at the meridian, all vary according to the time of year, within a range between limiting solstice positions for a stated latitude (e-FIG AS-01 to 04).

Such solar events are easily observed, and because of their essential annual repetition they represent stability, a feature likely to be noticed, respected, and actively propitiated by surrounding ritual in any community which depended on the success of a potentially vulnerable agricultural economy. The cyclic predictability, and constancy of the solar year would surely have provided robust symbolism for themes underlying operation of prehistoric monuments, with their interrelated communal, funerary, and economic rituals.

However, there are certain practical difficulties in determining the *precise* position of limiting solar positions without resorting to technical refinement, and anyway, the need for such precision might just not have been relevant for builders of most prehistoric monuments.

The **solstices** are very noticeable events, with prolonged periods during which the position of sunset and -rise remains in a similar direction. The duration of 'standstill periods' for S'n Britain are shown in e-FIG AS-07, and indicate the difficulty of determining the direction, and especially timing of the *exact* event by simple observation. Ruggles (1999, 32) notes that such practical problems in determining the solstice exactly could be helped by observing the position of the sun for days either side, and then extrapolating to find the actual position by division. This of course assumes that it was considered as important to determine the actual event as it would be in modern astronomical circles.

Unlike the solstices, and the sun at zenith, the **equinoxes** are not marked by any standstill, since the sun passes through them without pause. The equinox may therefore be far more a concept of modern astronomy than one of any prehistoric relevance (Ruggles 1999, 148).

However, the equinox could have been located as the midpoint between solstices, or as the only time when sunrise and sunset were opposed, and hence perhaps considered propitious in some way. The positions of solstices and equinoxes could, for instance, be found by recording the track of shadows cast from some upright marker such as a pole, or monolith. The equinox would then be discernible as a straight line lying between sets of increasingly curved tracks leading out to the solstices (e-FIG AS-10). On paper this looks more convincing than it is in practice, with location of the equinox by bisection of solstices at the horizon, using topographical reference points, being the easier option, then as now. Division by two of the interval in days between solstices would provide another option for timing the equinox, but for this the date of the exact solstitial turn-around would be needed.

The **zenith** at the meridian, and its vertical standstill positions at summer maximum, and winter minimum elevation, form other potential targets (e-FIG AS-06). The ascent and descent of the sun between these extremes provides a ready marker of seasonal change, and one, it should be noted, which is available at a more amenable time of day than dawn or dusk. The zenith, hence due S, and from this the entire cardinal system, could be determined by skyward observation as the sun climbed, and then noting the direction of maximum elevation, not easily achieved. Alternatively the zenith could be found more readily by noting the line of the shortest shadow cast daily by a vertical object (e-FIG AS-10).

The sun, as it rises during the later morning, climbs more rapidly towards its zenith, and then begins to level out, with very little change in elevation for 20° either side of the maximum. Anyone using the rising limb of the sun to gauge the zenith would see the near maximum achieved to the E of S, and may well adopt this for use, rather than waiting. Exact S could be found by bisecting this plateau around the zenith, difficult visually, since observation is sky-based and transitory, but easier if marked by the line of a shadow-cast. The *intention* to aim at this high point of the transit is therefore likely to be expressed by a range of S'ly directions that may vary quite markedly when implemented structurally. A case could therefore be made for any direction between SSE and SSW, an interval of about 40°, being a viable attempt at using an accurate zenith by a prehistoric observer.

The transit of the sun

The target for alignment might not have been a discrete celestial object but its transit. It might have been deemed sufficient if the object, here the sun, passed over the axial line of the site, providing an opportunity for ritual connection, either active, or passive (see Table of Contents: 02a/2g), when this alignment occurred, a more spectacular event when the transit was at a lower elevation.

Interpretation of axes at prehistoric monuments is almost always done with strict reference to events at the horizon, usually extreme points of the solar and lunar cycle, or dated stellar and planetary risings or settings (see section 08 bibliography: Burl, Ruggles). There are, however, occasional references to the possible importance of events above the horizon (Ruggles 1999, 151 and 154) but little effort made to develop this theme.

There are various possible reasons for this bias. Events around eye-level appear more conveniently placed for viewing from the ground surface. Appearance and disappearance of a rising or setting object can be spectacular, and the sun, or moon, can appear larger at the horizon (Ruggles 1999, 151). Transitions at rising and setting could also have provided notions of connection between celestial, terrestrial, and subterranean spheres. Apparently deliberate construction of passages and chambers at certain funerary monuments, such as New Grange, Clava, and Maes Howe (see Table of Contents: 03a/20), to take advantage of illumination at particular sunrises, may suggest that events near the horizon are generally applicable to other interpretations of alignment.

Solar shadow-casting

As well as by direct observation, the passage of sun can be noted indirectly by the position of a shadow cast by an upstanding object, linearly for position, and as a radial succession for transit. Possible use of this mechanism to mark broad divisions of the solar year is possible at certain monuments, as discussed elsewhere:

	see Table of Contents:	e-FIG	shadow casting
Callanish	03e/10a	SC-01 to 03	radial
GMB and row	04d/7	AS_brit-10	linear
Knowth	03a/20eii	LB-96 to 101	radial
menhirs	03k	ME-	radial

Reference to the lunar cycle

The moon, as the second most visible object in the sky, could also have provided an easily defined target for alignment, but one far more difficult to utilise, given the complexity of its motion. Shorter-term cycles of the moon are complex, involving rapidly changing direction, variable coincidence with darkness, and cyclic phase of moon (e-FIG AS-11). Longer term cycles, such as the 18-19 year interval between standstill positions (e-FIG AS-01), seem impracticably infrequent, and insufficiently remarkable for serious ritual use.

The moon, and its cycles, are certainly of relevance as a more detailed utility for timing, but far less as an economically determining factor than the sun, this latter with its obvious effects on productivity of the natural environment, and hence critically of agrarian activity.

Use of stellar and planetary cycles

Rising and setting of constellations, and other celestial bodies, might have provided direct targets for orientation of monuments, and have been invoked in some cases, as for stone rows and circles (Burl 1976; 1993). However, it is difficult to single out convincing cases that provide obvious, realistic candidate targets to compete with those which might be drawn from the solar and lunar cycles, especially the former.

Stellar cycles are considered in three areas of the sky: those which rise and set generally E' and W'wards, and those which do so more towards the N (e-FIG AS-15) or the S (e-FIG AS-14). These two latter areas do not present many obvious targets that seem relevant, but amongst the E-W'ward assemblage attention is drawn in this analysis to one particular set, the Orion group (see Table of Contents: 02c/4a; e-FIGS AS-16 to 19).

Planetary motions seem to lack sufficient coherence to form a basis for the types of orientation observed amongst the monuments in question (see Table of Contents: 02c/5; e-FIG AS-21 and 22).

Other considerations

Properties of data from observation of a moving solar target

Alignment of a group of monuments on limiting positions such as solstice rising and setting would be expected to produce a peak of frequencies skewed up against the inner side of the solstice position, since the sun approaches towards, and leaves from the same direction.

However, alignment on the equinox, or transit of the sun above the horizon, might tend to produce a more symmetrical peak than at the solstices, since arrival and departure are in different directions, and no turn-around of the sun is involved. Frequency distributions of orientations at long barrows are of this more symmetrical type (e-FIGS LB-01 to 04, 08 to 09, 16, 18 to 19, and 21).

Orientations beyond the solar and lunar range

The axes of some monuments, such as certain long barrows, seem to lie out of the normal near-equinoctial range, and to point towards the N'ly null zone of solar and lunar activity (e-FIGS AS-17, 92 to 93; TABLE LB-17). Certain cursus sites, henges, and stone rows also display such generally N'-S'ly orientation amongst their axes (e-FIGS CU-19, HE-39, and SR-05 respectively; also CO-01). There are many possible explanations for such marginal alignment. These sites could simply be facing the permanent zone, or be set to the null zone, or be without significant celestial reference (see definition of 'pointing' and 'facing': Table of Contents: 03a/11b).

However, in cases of deliberate reference to the null zone, the sun could still remain the intended target, if perceived as passing through an underground sector of the transit. This zone of the 'anti-zenith' might well have been considered an important turning point for the sun on its return, hence a target eminently worthy of propitiation.

Latitude-dependent factors affecting alignment of monuments

Properties of the solar cycle

Although the azimuth of the equinoxes remains constant, the interval between the solstices widens with increasing latitude with, for example, a difference of about 14° between events at the extremes of the British Isles, from S'n Wessex to Shetland (TABLE AS-01; e-FIGS 01 to 03).

A corresponding shift in peak frequency for near-solstitial alignment between samples of sites, especially those from well-separated areas, might therefore tend to support a solar basis for orientation behaviour.

However, inspection of group data for such monuments as long barrows indicates very little specific interest in the solstices, with frequency distributions spread, and usually well off-solstice (e-FIGS LB-01 to 21).

However, axial alignments of chambered tombs from Scotland could indicate a more broadly based shift in distribution consistent with latitude-dependence (see Table of Contents: 03a/16g; e-FIG LB-12;

Local onset of the seasons

The gradual progress of warmer springtime conditions across Europe can be followed in general outline by tracking the N'ly and W'ly progress of the 9°C isotherm for air temperature from winter to summer (e-FIG LB-36 and 36a; Bartholemews and Herbertson 1899, plate 5).

Isotherms summarise the main trend for changing temperature and, although useful for general discussion here, they do mask considerable temperature variation within the regions involved. The movements of modern isotherms are, for the purposes of general analysis, assumed to be broadly similar to those of the Neolithic period, given the absence of better data.

The 9°C isotherm advances fairly uniformly across W'n Europe, from S to N, at about 170 km per week, lying obliquely NW to SE over Continental areas in early local spring. As it advances, the isotherm adopts a more E-W'ly line over Britain, here bringing it more into accord with lines of latitude, simplifying joint use for assessing latitude-dependent temperature change.

Such climatic information is relevant in discussing the timing, and hence the impact, of specific seasonal activities, such as those of agriculture on available labour, and hence on the timing of construction for monuments. Such a **seasonal-solar model** is presented as one possible interpretation for the orientation of long barrows (see Table of Contents: 03a/13a).

The dates at which this springtime warming first occurs span about 3 months, from early March in N'n Iberia, to early June in the far N of Scotland, with a 6-week difference between extreme latitudes for Britain (TABLE TA-01):

TABLE TA-01 date of arrival of the 9°C isotherm at key locations in Britain, and the approximate azimuth of sunset at that time

location	**date**	**sunset (°G)**	**latitude (°N)**	**example long barrow groups and areas involved**
England:				
S	15 April	286	51	elbs; Cotswold-Severn;
N	21 April	295	54	elbs;

Scotland:

S	1 May	303	55	S'n lowlands;
N	15 May	312	58	Sutherland, Caithness, Uist;
Shetland	1 June	321	60	Orkney, Shetland.

Note: elbs: earthen long barrows

The timing for preparation, and planting of cultivated areas would therefore tend to become later with progression N, as would the corresponding period of harvest, two key periods when economic activities probably took priority over the need to establish monuments.

Periods before, and after peaks of essential agricultural activity, in local spring and late summer, might therefore have been more convenient for preparation, if not fuller construction, of major monuments. If a currently setting sun was indeed the target for alignment, then axial structures might well contain an indication of their timing, and latitude dependent effects might be detectable in data from more widely separated areas. However, it is important to stress that establishment of an axis could have been carried out at any time of year, only involving a preliminary phase requiring little input, and separated from later and main construction, perhaps itself in stages.

The seasonal-solar model of alignment for long barrows: a simplified example

In order to examine this basic model (e-FIG CO-02) more closely, it is necessary to consider a single idealised case of axial alignment.

The model

This explanation of alignment behaviour proposes that long barrows were more usually constructed to point (pointing: front to rear) towards the setting transit of the sun during the first practicable period for initial layout of the site, after completion of the main arable preparation in later spring (see Table of Contents: 03a/16). This simplified example deals with a monument with the most common W-NW'ly pointing peri-equinoctial type of axis, considers the seasonal implications of variation around this norm, and of taking either the pointing, or facing direction within it as the key aspect of ritual importance.

Test areas

Two regional areas are considered, in which major groups of long barrows are well characterised in terms of alignment: S'n England (examples: the Cotswold-Severn group; earthen long barrows), and Scotland (various Scottish groups: Henshall 1963, 1972). These two areas differ considerably in latitude and therefore in terms of seasonal temperatures, allowing regional comparison of the balance between dictates of agricultural regimes in relation to opportunities for monumental construction.

-environmental aspects

Azimuths of sunset at zero elevation have been plotted for each of these test areas over the year, subdivided according to the modern system of months, and shown against ambient monthly air temperature (TABLE TA-02; e-FIGS LB 37 to 39). Representative axes of such monuments, from 260 to 300° azimuth, have been further added to indicate their relationship with these environmental parameters: the setting sun and ambient seasonal temperature.

Modern longer-term temperature data are assumed to provide a realistic impression of broader seasonal change typical of these areas, applicable in general outline, with reasonable confidence, to extended periods of prehistory (TABLE TA-02):

TABLE TA-02 Seasonal temperature change: modern data for S'n England and Scotland

Central S'n England: mean monthly air temperatures (°C) during the 356-year period 1659 to 2014 (e-FIG LB-37 and 39):
bold type: the position of the **eq**(uinox); temperatures passing the **9°** mark, ascending and **[**descending**]**;
data: extracted from UK Meteorological Office on-line records: cent engl monthly mean\cetml1659on_dat.mht:

		eq		**9**					**eq**		**[9]**		
Jan	Feb	Mar	Apr	|	May	Jun	Jul	Aug	Sep	Oct	|	Nov	Dec
3.2	3.8	5.3	7.9	|	11.2	14.3	15.9	15.6	13.3	9.7	|	6.0	4.1

In finer detail the mean daily air temperatures (°C) during April-May for the period 1772 to 2014 (243 years) are as follows:
bold type: the onset of temperatures above 9°C during the fourth week of April;
data: extracted from UK Meteorological Office on-line records: cent engl daily mean\cetdl1772on_dat.mht:

March / weekly								
1st	4.4	4.7	4.9	4.7	4.7	4.8	4.7	
2nd	4.5	4.4	4.5	4.7	4.6	4.7	4.9	
3rd	5.3	5.5	5.4	5.7	5.8	6.0	6.0	equinox
4th	6.0	6.1	6.3	6.3	6.1	6.1	6.1	
5th	6.2	6.4	6.3					

April / weekly							
1st	6.5	6.8	6.8	6.9	7.0	7.1	7.3
2nd	7.4	7.2	7.5	7.8	7.9	7.7	7.9
3rd	8.3	8.2	8.2	8.3	8.3	8.5	**9.1**
4th	**9.2**	**9.2**	**9.2**	**8.9**	**9.0**	**8.9**	**9.1**
5th	**9.2**	**9.5**					

Scotland: mean monthly air temperatures (°C) during the 104-year period 1910 to 2013 for the entire area, also the N'n, E'n, and W'n regions (e-FIGS LB-38 and 39):
bold type: the position of the **eq**(uinox); temperatures passing the **9°** mark, ascending and **[**descending**]**;
data: extracted from UK Meteorological Office on-line records (files unspecified):

			eq			**9**				**eq**	**9**				
region	Jan	Feb	Mar	Apr	May	|	Jun	Jul	Aug	Sep	|	Oct	Nov	Dec	
all	2.4	2.5	3.8	5.8	8.6	|	**11.2**	**12.9**	**12.7**	**10.7**	|	7.9	4.6	3.0	
N	2.3	2.4	3.7	5.5	8.2	|	**10.7**	**12.3**	**12.3**	**10.3**	|	7.7	4.5	3.0	
E	1.8	2.0	3.5	5.7	8.5	|	**11.3**	**13.1**	**12.8**	**10.7**	|	7.6	4.2	2.4	
W	2.9	3.0	4.4	6.4	**9.3**	|	**11.9**	**13.4**	**13.3**	**11.3**	|	8.5	5.3	3.6	W

Data for weekly, or daily means are not readily available.

-sample axes

Three peri-equinoctial axes of pointing (pointing: front to rear) are considered: aligned at the equinox (270°), just to its S (260°), and to its N (280, 290 and 300°), covering the main peak of frequencies for most groups of long and related barrows (e-FIGS LB-37, 37a, and 38). Describing these axes here as equinoctial is done for convenience, and does not imply intention on the part of monument builders to target the equinox, a modern astronomical concept.

Discussion

Temporal relationships between these peri-equinoctial axes, the final setting sector of the solar transit below 10° elevation, and ambient temperatures for the two subject areas are shown in TABLE TA-03. Axial directions coinciding with onset of improved ambient temperature are shown in **bold type**:

TABLE TA-03 Correspondence between axes, current azimuths of sunset, and ambient temperatures for central S'n England and central Scotland

Central S'n England (52°N; 1.5°W)**:**

axis	**direction**	**date of sun at elevation 0 degrees**	**spring temp**	**date of sun at elevation 10 degrees**	**spring temp**
260	pointing	Mar 3 Oct 6	4.9	Mar 20 Sep 19	6.0
080	facing	Apr 3 Sep 5	6.8	Apr 25 Aug 14	8.9
270	pointing	Mar 21 Sep 21	6.0	Apr 6 Sep 2	7.1
090	facing	Mar 21 Sep 21	6.0	Apr 6 Sep 2	7.1
280	**pointing**	**Apr 3 Sep 5**	**6.8**	**Apr 25 Aug 14**	**8.9**
100	facing	Mar 3 Oct 6	4.9	Mar 20 Sep 19	6.0
290	**pointing**	**Apr 19 Aug 20**	**8.3**	**May 20 Jul 20**	**>9**
110	facing	Feb 16 Oct 23	<4	Mar 5 Oct 4	4.7

Central Scotland (57°N; 4°W)**:**

axis	**direction**	**date of sun at elevation 0 degrees**	**spring temp**	**date of sun at elevation 10 degrees**	**spring temp**
260	pointing	Mar 5 Oct 4	4.2	Mar 25 Sep 14	5.4
080	facing	Apr 1 Sep 8	5.8	Apr 26 Aug 13	8.2
270	pointing	Mar 21 Sep 21	5.0	Apr 8 Sep 1	6.6
090	facing	Mar 21 Sep 21	5.0	Apr 8 Sep 1	6.6
280	pointing	Apr 1 Sep 8	5.8	Apr 26 Aug 13	8.2
100	facing	Mar 5 Oct 4	4.2	Mar 25 Sep 14	5.4
290	**pointing**	**Apr 14 Aug 24**	**7.2**	**May 14 Jul 26**	**10.0**
110	facing	Feb 20 Oct 19	3.4	Mar 13 Sep 26	4.6
300	**pointing**	**May 2 aug 7**	**8.6**	**~[Jun 21 Jun 21]**	**12.4**
120	facing	Feb 5 Nov 3	2.8	Mar 1 Oct 8	3.8

Note: for central Scotland, in the absence of available daily means, spring temperatures for the stated dates have been extrapolated from the plot of monthly means given in TABLE TA-02.
Key: temp(erature).

Conclusions

In central S'n England, construction of an axis with its pointing direction towards the final setting sector of the solar transit below 10° elevation during onset of warmer conditions approaching 9°C in later April would result in an azimuth between 280 and 290°.

In Scotland, these conditions of temperature would occur a few weeks later, when this sector of the setting transit was at 290 to 300° azimuth, further to the N, and hence nearer the solstice than for S'n England.

According to this model, alignment would reflect seasonal availability of labour during mid to later spring, with detailed timing dependant on latitude, immediately following earlier discharge of essential agrarian commitments. Other than a generalised funerary and ritual interest in the W'n setting sector of the solar transit there would therefore have been no active reference to the equinox, this being an indirect consequence of seasonal activity.

The funerary axis and the seasonal-solar model of alignment: a summary

Monumental axes, those amongst the sites considered in this analysis, can be divided into two main groups:

-**W'ly pointing axes**, predominant amongst the chambered tombs discussed (see Table of Contents: 03a), and seen at other overtly funerary monuments (see Table of Contents: 03h), their axes, taken in the pointing direction (see Table of Contents: 03a/11b), capable of interacting, for limited periods, dependent on exact orientation, with the setting arc of the sun, traditionally associated with death and burial.

Such axes are seen clearly amongst long barrows, and the Cotswold-Severn group (see Table of Contents: 03a/21) forms a clear example, with well-defined axial properties peaking around 262°G in the pointing direction (e-FIG LB-16). This would correspond to a transit-frequency (see Table of Contents: 02c/2e) of about 220 days, or exposure for 60% of the year, considering all elevations, and about 80 days, or 22% for lower elevations, below 20° (e-FIG AS-09). On this basis, if the axis was largely passive (see Table of Contents: 02a/2g), then its relevance would be reduced, and strictly seasonal, as the sunset remained to the S of it. Taking the opposite, facing, direction of the axis, to the E, 082° in the above example, would give the same degree of exposure, but here to the rising transit. An argument has already been presented here for this W'ly pointing direction, that of typical axial approach and entry to the monument, ranking in ritual importance somewhat above the facing direction, the line of departure and exit.

A case has also been made for co-operation of seasonal factors, natural and social-economic, restricting the time-slot available for establishment of the axis, and hence favouring the W'n equinoctial zone (see Table of Contents: 03a/16).

Retaining the primacy of the W'ly pointing direction, it is possible to suggest that those axes left apparently stranded to the N of the solstice, out of contact with the visible leg of the transit, still remained in contact, but pointing at its supposed continuation below the horizon, towards subterranean areas more closely associated with some land of the dead.

Overall it would appear, that with various caveats, the seasonal-solar model for alignment (see Table of Contents: 01f; 03a/13a), can give a reasonable explanation of axial orientation.

To add more context to the above discussion of W'ly funerary axes, the second, contrasting, S'ly group of axes, seen amongst monuments that appear to have been not primarily funerary, is easier to explain in terms of the seasonal-solar model:

-**S'ly pointing axes are** common amongst sites that do not appear to have burial as a primary function, such as the cursus monument (see Table of Contents: 03c), and the stone row (see Table of Contents: 03d). This type of axis would have been able to interact frequently with the passing transit, since this is continuously present within the permanent zone, and almost so close to its margins (e-FIG AS-01), with alignment perhaps therefore reflecting the need to express more constant economic concerns via regular solar propitiation.

Such S'ly axes are seen clearly amongst stone rows, and the Dartmoor group (see Table of Contents: 03d/8) provides a clear example, with well-defined properties, producing a major peak around 180°G (e-FIG SR-05).

These two groups, funerary and non-funerary, are not exclusive because, in this S'ly pointing group, funerary monuments can be included within, or around, the axis as an additional element, bringing both spheres of ritual together (see Table of Contents: cursus: 03c/8 and 11; stone rows 03d/8d; stone circles 03e), thereby linking ancestors into the circuit.

Divisions of the year

Some consideration of how the year might have been divided, and of key events perhaps marked by festivals, is essential in discussing those recurrent alignments amongst monuments that might have been linked to the activity cycle of the agrarian communities which produced them. Major feasts of agriculture, or fertility, such as Beltane, and Samhain were also important with respect to the spirit world, and for honouring the dead, and hence potentially linked with aspects of funerary structure, such as alignment (Burl 1979, 83-85).

It is important to stress that the agricultural year, in terms of both practical and ritual activity, would likely have been structured around *prevailing* conditions, rather than notions of an abstract calendar, for instance, sowing when warm enough, rather than by date.

Alignment of a monument with respect to a position of the sun current at its establishment would, for instance, encode information on the timing of initial layout. Peaks in the frequency distribution for a sample of sites would indicate a preferred trend for axial direction, and hence an interval of practical opportunity for communal construction work, or time of ritual significance, perhaps marked by a seasonal festival.

Onset of construction, and fixing of alignment, might have coincided with particular times in the solar and lunar cycle, selected on a more abstract celestial basis, irrespective of other factors. They might also have marked important phases in the seasonally determined agricultural year, either times of positive activity, or slacker periods when more labour was available for larger construction projects.

In discussing how construction of monuments might have related to the competing demands of the economic year and its ritual, it is essential to draw in those surviving elements of the ancient agricultural calendar, as imperfectly known, but of long ancestry, which might be relevant.

Such a calendar might well have been primarily agrarian in its divisions, and determined by seasonal change. The timing of key activities during the agricultural year, both those which were directly economic, and those of associated ritual, might in all agrarian societies be expected to follow a strongly seasonal imperative, adapting to current conditions, rather than calendric date. Spring preparation, planting, and birth of livestock, late summer harvest, and deep winter would provide key practical divisions of the year.

The calendar might however have been less agrarian, and more astronomical, with the year divided according to regularities of the solar or lunar cycle, or a combination. For instance, a solar calendar, based on day-count between solstice positions, as observed at the horizon, or another cued by the rising and setting of stars, or constellations such as the Pleiades, would suffice. The phasing of the moon, perhaps bracketed by solstices, would have provided another basis, although more complicated.

Key alignments at megalithic sites, such as circles, or stone rows, might have served some auxiliary calendric purpose, in addition to a deeper significance for ritual and ceremony, for instance, by noting a precise solstice or equinox. Certainly, individual sites with close approximation of alignment to the local solstice do occur, this correspondence not reflected in the broader group. Cases in point include the stone row at Cut Hill (Dartmoor) (see Table of Contents: 03d/6), the cursus at Scorton (N Yorkshire) (see Table of Contents: 03c/13e), one sector of the Dorset Cursus (see Table of Contents: 03c/13b), and various alignments proposed for elements of stone circles (see Table of Contents: 03e/11f).

However, construction of such monumental settings primarily for establishment of the solstice as a calendric base-point seems unlikely, since the general position of the solstice can be well determined from other view-points, using topographical features on the local horizon as reference. The problem arises in determining *when* to start the day-count, since the sun appears not to move appreciably for a period of some days (e-FIG AS-07), and again this uncertainty would introduce variability.

Some further general background to seasonal ritual in ancient Britain is given in Hutton 1991 and 1996. Construction and use of alternative calendars are also discussed by Ruggles (1999, 83), Thorpe (1981); Thom 1967; Barclay and Harding 1999, figs 8.1/ p 279 and 8.2/ p 281).

The Celtic agrarian calendar

There is no firm basis for suggesting divisions of the year, and associated festivals, during the period prior to calendars that developed during the later Celtic period. These are recorded in early medieval literature from Ireland and W'n Britain, survived long afterwards in seasonal folk practices, and may provide some slender basis for back-projection (Burl 1976). These sources can be combined with what is known about standard seasonally defined agrarian practices to provide at least some attempt at an outline.

It is most unsafe to extrapolate in detail back in time from these earliest records and traditions, although a certain continuity of agrarian concerns and practice can be suggested over the preceding millennia. Again, on the positive side, persistence seems to be a quality inherent amongst festivals, with continuity evident over long periods, and between widely different phases of culture. For instance, several important Celtic festivals were absorbed into the Christian calendar, with change of emphasis and name, but not of timing. Much of their general content, however, continued amongst rural communities throughout the medieval period: the basic fabric of the folk calendar seems fairly indestructible.

Inscriptions on the Colligny calendar, dating to the 1st to 2nd century AD, indicate practices in later Celtic Gaul, before subsequent Roman introduction of the Julian system. This tablet indicates a complex year, highly divided, and reconciling both solar and lunar cycles. If more widely typical, and of long ancestry, then this late evidence could indicate more sophistication than might be expected for early agrarian communities.

The four major seasonal festivals known from Celtic Britain are likely to have far earlier origins. Their timing seems to have little to do with the limits of the solar cycle, either winter or summer solstices, or with vernal, and autumnal equinoxes. They fall mid-way between these events, marking what have come to be called cross-quarter days, the solar points falling on quarter days, dividing the year into four.

However, in the case of any agrarian calendar, practical consideration of local weather-dependant conditions are likely to have outweighed any more abstract notion of date. For instance, photoperiodic and temperature-related events amongst plants, such as bud-break, and flowering, would have provided a far more useful indication for the onset and development of spring conditions that were of relevance to land clearance and cultivation, and for the timing of any associated festivals. Precise weather conditions during later summer would also affect completion of the harvest, and any subsequent rituals.

The agricultural calendar that developed by the late Celtic period can be summarised as follows (TABLE TA-04):

TABLE TA-04 The Celtic calendar: basic structure

					SUN		
QD	**half QD**	**date**	**phase**	**half**	**rise**	**set**	**emphasis**
WS		dec 21	1a	D	130	230	
	Imbolc	feb 1	b	D	119	242	p
Veq		mar 21	2a	D	090	270	
	Beltane	may 1	b	**L**	065	295	p s f
SS		jun 21	3a	**L**	050	310	
	Lughnasadh	aug 1	b	**L**	060	300	a f
Aeq		sep 21	4a	**L**	090	270	
	Samhain	nov 1	b	D	114	246	a s f

Key: QD quarter day; **WS** winter solstice, **Veq** vernal equinox, **SS** summer solstice, **Aeq** autumn equinox; **phase** (numbers 1-4: the quarters, letters a and b denote the first and second halves); halves of the year: **D** the darker half, **L** the lighter half; **SUN rise and set**: approximate azimuth for S'n central England at 52°N, as an example; **emphasis** (of traditionally associated ritual): **p**(astoral), **a**(rable), **s**(pirit world), **f**(ires lit).

Four major festivals divided the year into four parts, each of approximately three months. Rather than considering the year as a single unit, it might well have fallen more naturally into darker and lighter halves, with starting dates at Beltane and Samhain.

Each of the festivals falls approximately midway between a solstice and an equinox, further dividing the four solar divisions of three months into eight. Here, the quarters are numbered 1 to 4, running from the winter solstice, and division of each is denoted by suffix ‘a’ or ‘b’ (TABLE TA-04; also e-FIG AS-19). Such a calendar would be well-organised and manageable, with a firm basis in the economy, and stable aspects of seasonal change, each festival reflecting a particular seasonal emphasis.

This combined solar-agrarian calendar could be navigated by a simple count of about 45 days for each half-quarter division. Noting the phase of the moon occurring closest to the winter solstice, and counting three lunations of about 30 days for each quarter, could also mark passage of time. In either case it is difficult to determine the exact timing of the solstice without some refinement of measurement, since the sun stands with little change over considerable days (e-FIG AS-07). Here too are further sources of variation, both for calendar, any dependent festivals, and derived solar based alignments. However, the count could be refined by reduction to a 6-monthly basis, and re-zeroing at each solstice.

Since such a calendar is calibrated against the solar transit, and this has remained relatively unchanged in its limits over millennia, then what might have operated for Celtic society could extrapolate fairly readily back towards the Neolithic.

Despite the precise dates given for these festivals, according to the modern calendar, there is no reason to suppose that this reflects their standard timing between well separated ancient communities. Lacking any national cue, such local festivals could have been celebrated over a broader range of those dates appropriate to local circumstances. If monuments were aligned to correspond with the date of any such festival then this would generate considerable variability in any larger sample. The fact that alignment, for instance on the sun, need not have been on an exact rise, or set, but on the risen, setting sun, or transit, adds yet another source of variation to be expected amongst data.

Using the series of months according to the modern calendar as a base-line, the timing of the four Celtic festivals, the timing and direction of key positions in the solar transit, of other celestial markers, and the major phases of activity in the agricultural year can be plotted together (e-FIG LB-41).

Attempts to bring key stellar events into the timing of the agrarian calendar show little obvious correspondence, for instance, seasonal rising and setting of conspicuous elements such as The Pleiades, Sirius, or Arcturus, which were often used as an agrarian reference (see Table of Contents: 02c/4a; e-FIG AS-19). The final dusk setting of the Orion group of constellations on the W’n horizon, during early to mid March, for an example-date of 3000 BC, has been suggested here as of potential significance around the vernal equinox, when increased foundation of long barrows might have occurred (e-FIG AS-18).

Further, and more detailed discussion is included with the analysis of alignment for specific types of monument, as for long barrows (see Table of Contents: 03a). However, to summarise, peaks in frequency of alignment for the monuments considered in this analysis (e-FIG CO-01) show little correspondence with the timing of these festivals in terms of the solar calendar (TABLE TA-04). Long barrows may match phases 2a-b or 3b to 4a.

In more detail the major Celtic festivals are outlined as follows:

Note: below, the azimuths of sunrise and sunset for the festivals are approximate, and are quoted for the limiting latitudes of **N’n-most Britain:** N’n Scotland (latitude 59°) and **S’n-most Britain:** for S’n-central England (latitude 52°), to provide the national range.

LATER WINTER: preparation for the agricultural year

Imbolc;
1st February; 3 months before Beltane; about midway between the winter solstice and vernal equinox (cross-quarter day: 1-2 February);

-**derivation**: Old Irish: *i mbolg* (in the belly: referring to the pregnancy of ewes);

-agrarian emphasis:
celebration of lengthening days, and early spring;
solar, return of the sun;
renewed pastoral concerns;
coming into milk of ewes;
Bede on the pagan English: in **February** cakes were offered to deities, implying some related celebration;

-activities:
lighting of fires, candles (Candlemas);
feasting; divination;

-associated deities: sacred to the fertility goddess Brighid;

-**christianised as**: the Feast of St Brighid; immediately precedes Candlemas, the feast of Purification of the Virgin;

-observed: in medieval Scotland and Ireland;

-solar cycle:
N: sunrise 125°G, sunset 235°G;
S: sunrise 119°G, sunset 242°G;

MID SPRING: full start of the lighter half of the year with its agrarian activities;

Beltane;
1st May; 3 months before Lughnasadh; about midway between the vernal equinox and summer solstice (cross-quarter day: 5-7 May);
beginning of the lighter half of the year (cf: Samhain);

-**derivation**: from Celtic deity Bel;

-agrarian emphasis: pastoral, solar, purification and a fresh start;
marked the onset of summer activities, again with solar associations, and pastoral interests; herds were sent out to summer pastures and mountain grazing;

-activities: a major fire festival, paired with Samhain, as dividing the year into summer and winter; cattle were driven between two fires; the spirit world was considered to be particularly close;

-associated deities: sacred to Bel, the god of life and death; Belenus: ancient god associated with pastoralism, 'the shining one' ?solar deity;
Bede on the pagan English: feast of Eostre in April, possibly related;

-**christianised as**: the Feast of St John the Baptist;

-observed: medieval Scotland, Ireland, and the Isle of Man, also widely in Europe;

-solar cycle:
N: sunrise 060°G, sunset 301°G;
S: sunrise 065°G, sunset 295°G;

FULL SUMMER:

Lughnasadh;
1st August; 3 months before Samhain; about midway between the summer solstice and vernal equinox (cross-quarter day);

-derivation: from the Celtic deity Lugh;

-agrarian emphasis: festival marking the beginning of the harvest period;

-activities:
lighting of fires;

-associated deities: Irish mythology: the festival was introduced by the sun god Lugh, deity of storms and lightning, as a funeral feast, and athletic event to commemorate his foster mother Tailtu, who died of exhaustion, after clearing the plains for agriculture;

-christianised as: Lammas (Anglo-Saxon: 'Loaf-mass');

-observed: medieval Scotland, Ireland, and the Isle of Man;

-solar cycle:
N: sunrise 053ºG, sunset 307ºG;
S: sunrise 060ºG, sunset 300ºG;

LATE AUTUMN: end of the agricultural year;

Samhain (Samhuin)**;** 31st October-1st November; 3 months before Imbolc; midway between the vernal equinox and winter solstice (cross-quarter day);
beginning of the dark half of the year; Samhain and Beltane are six months apart, and were important in major division of the year into light and dark;
amongst the four festivals Samhain appears to be given prime importance in the early literature, with Beltane ranking second;

-derivation:
mentioned in early Irish literature, as in the 10th century Ulster Cycle; Gaulish month *Samonios,* marking the start of winter, is possibly related (Coligny calendar); Samhain = summer's end, or assembly;

-agrarian emphasis:
marked the end of the harvest season, anticipating the onset of early winter and its problems;
pastoral celebration; cattle were brought down from a six month-long stay in higher summer pasture; autumn cull of stock;
marked the end of one pastoral year, and the start of another;

-activities: Beltane was a summer festival for the living, but still involving the spirit world; Samhain was perhaps a late autumn festival for the dead; important tribal assemblies took place, and laws were made;
a major fire festival, paired with Beltane, as dividing the year into summer and winter;
appeasement of evil spirits, solar rituals, fires; divination;
bonfires; often people and cattle walked between fires as a cleansing ritual;
rituals enacted to deter the evil spirits that came with the decline of the sun;
Bede on the pagan English: November was Blod-monath, 'blood month', when cattle were slaughtered, and perhaps sacrifices made, possibly related to Samhain-type festivals;

-associated deities:
spirits of the supernatural world became visible to men; feasts were held in their honour;
festival of the dead; divination; 'guising' occurred; portals to the spirit world opened; the supernatural emphasis is disputed by Hutton 1996;

-christianised as: Halloween; christianised as All Souls' or All Saints' Day;

-observed: widely celebrated over N'n and central Europe

-solar cycle:
N: sunrise 119°G, sunset 241°G;
S: sunrise 114°G, sunset 246°G;

Festivals associated with the solstices and equinoxes
There is very little evidence in the early medieval sources for such festivals during the later Celtic period (Hutton 1991, 177), although it is difficult to imagine that these events would have passed unmarked. Bede, commenting on the practices of the pagan English, noted that the festival **Modranicht** 'Mother Night' occurred at winter solstice, but nothing for the summer solstice or equinoxes.

-winter solstice
N: sunrise 141°G, sunset 219°G;
S: sunrise 130°G, sunset 230°G;
Bede on the pagan English: Modranicht 'Mother Night', very important festival marking the start of the year;

-vernal equinox
sunrise 090°G, sunset 270°G;
No information is available on any rituals.

-summer solstice
N: sunrise 039°G, sunset 320°G;
S: sunrise 050°G, sunset 310°G;

Midsummer's day; feast of St John the Baptist;

Lighting of fires;

not mentioned in early literature, but it was a medieval and later practice: a possible Saxon, or earlier import;

-autumn equinox
sunrise 090°G, sunset 270°G;

No information is available on any rituals.

The megalithic calendar

Attempts have been made to derive detailed calendric information, from analysis of alignment at megalithic monuments in Britain (Thom 1967, 107-117; Thom 1981). This proposed system has been open to considerable debate (Ruggles 1999), and forms no clear basis for discussion of alignment, and seasonal activity. Moir (1981, 222) criticises Thom's calendar as not being a farming calendar, but subdividing the year into nearly equal parts of 8 or 16, unrealistic for the communities involved.

Stellar motion and the agricultural calendar: Classical sources

There is much information from literary and epigraphic sources, Classical Greek and Roman, of wider relevance to agrarian activities elsewhere in W'n Europe: the problems, and preoccupations expressed there are common to all periods, and must be of long heritage.

Rather than having any importance in determining axial alignment for monuments, these stellar cues seem far more closely tied to the timing of agricultural activity, acting, along with more relevant signals from the natural world, as general indicators for the onset of various seasonal tasks, and of suitable conditions for sailing, and obviously for navigational direction.

Stars and constellations mentioned in the texts below as indicators are shown in **bold** type:

stars	**constellation**
Arcturus	Bootes
Pleiades	**Taurus**
Sirius	Canis Major
-	**Orion**
-	**Corona Boralis**

Parapegmata: seasonal calendars from ancient Greece

The παράπηγμα was a record of key appearances of stars, and constellations marking those seasonally recurring changes of weather, of key importance in determining the timing of agricultural activities, also relevant to navigation, and warfare. These calendars were compiled, and refined over many generations, with examples from the 5th century BC onwards, and appear as lists, either on parchment, or in stone and, if the latter, on open display, with moveable pegs marking progress through the sequence. Movement, and appearance of the sun, moon, stars, and planets were included, along with the solstices, and equinox. Being essentially an agrarian checklist, the parapegma differed from the calendar of the Olympiad, which provided a more national, and historical sequence of dated events.

Parapegmata place particular emphasis on first risings, and settings of particular stars, and of constellations, especially those that occurred at dusk, and pre-dawn, often including solar, and lunar cycles, with some of the more complex versions aligning them, and including eclipses, with tracking for passage of the sun through the ecliptic, and its zodiac.

Hesiod (*fl.* 750-650 BC): Works and Days:

This didactic manual describes, in poetic format, the farming year, with much supplementary advice, and information. As well as celestial markers, events in the natural world are also used to note particular times, these forming equally important seasonal markers, perhaps more so because they related more directly to actual current conditions.

The following extracts relate to star-lore, and agriculture, set in passages extended to provide context, and because they are too interesting to abbreviate further. Standard numbering of lines is given thus: [..]:

Pleiades

[380] More hands mean more work, and more increase. If your heart within you desires wealth, do these things, and work, with work, upon work. **When the Pleiades, daughters of Atlas, are rising** [*pre-dawn rising in early May*] **begin your harvest, and your ploughing when they are going to set** [*dusk setting November*]. [385] Forty nights and days they are hidden, and appear again, as the year moves round, when first you sharpen your sickle. This is the law of the plains, and of those who live near the sea, [390] and who inhabit rich country, the glens, and hollows, far from the tossing sea; strip to sow, and strip to plough, and strip to reap, if you wish to get in all Demeter's fruits in due season, and that each kind may grow in its season.

Sirius

[410] Do not put your work off until to-morrow, and the day after; for a sluggish worker does not fill his barn, nor one who puts off his work: industry makes work go well, but a man who puts off work is always at hand-grips with ruin. When the piercing power, and sultry heat of the sun abate, [415] and almighty Zeus sends the autumn rains [*October*], men's flesh comes to feel far easier, for then **the star Sirius passes over the heads of men, who are born to misery, only a little while by day, and takes greater share of night.**

Natural signs

[448] Mark, when you hear **the voice of the crane** [*mid November*], who cries year by year from the clouds above, [450] for she gives the signal for ploughing, and shows the season of rainy winter.

Winter solstice; natural signs

[479] But, if you plough the good ground **at the solstice** [*midwinter: late December*], [480] you will reap sitting, grasping a thin crop in your hand, binding the sheaves awry, dust-covered, not glad at all; so you will bring all home in a basket, and not many will admire you. Yet the will of Zeus, who holds the aegis, is different at different times; and it is hard for mortal men to tell it; [485] for if you should plough late, you may find this remedy, **when the cuckoo first calls in the leaves of the oak** [*early spring*], and makes men glad over all the boundless earth, if Zeus should send rain on the third day, and not cease, until it rises neither above an ox's hoof, nor falls short of it, [490] then the late-plougher will vie with the early. Keep all this well in mind, and fail not to mark grey spring, as it comes, and the season of rain. Pass by the smithy, and its crowded lounge in winter time, when the cold keeps men from field work.

General

[504] While it is yet **midsummer** command your slaves: 'It will not always be summer, build barns!'. Avoid the **month Lenaeon** [=Gamelion: *late January, early February*], wretched days, all of them fit to skin an ox, [505] and the frosts which are cruel when Boreas blows over the earth.

Arcturus; natural signs

[565] Sixty wintry days after the solstice, then the star **Arcturus leaves the holy stream of Ocean, and first rises brilliant at dusk** [*dusk rising in late February to early March*]. After him the shrilly wailing daughter of Pandion, the swallow, appears to men, when spring is just beginning. [570] Before she comes, prune the vines, for it is best so.

The Pleiades

[571] But when the house-carrier [snail] climbs up the plants from the earth, to escape the **Pleiades** [*high, but invisible, in the daytime, during summer*], then it is no longer the season for digging vineyards, but to whet your sickles, and rouse up your slaves. Avoid shady seats, and sleeping until dawn [575] in the harvest season, when the sun scorches the body. Then be busy, and bring home your fruits, getting up early to make your livelihood sure. For dawn takes away a third part of your work, dawn advances a man on his journey, and advances him in his work, [580] dawn which appears, and sets many men on their road, and puts yokes on many oxen.

Natural signs; Sirius

But, **when the artichoke flowers** [*June*]**, and the chirping grass-hopper sits in a tree,** and pours down his shrill song continually from under his wings, in the season of wearisome heat, [585] then goats are plumpest, and wine sweetest; women are most wanton, but men are feeblest, because **Sirius** [*pre-dawn rising July*] parches head and knees, and the skin is dry through heat.

But, at that time, let me have a shady rock, and wine of Biblis, [590] a clot of curds, and milk of drained goats, with the flesh of a heifer, fed in the woods, that has never calved, and of firstling kids; then also let me drink bright wine, sitting in the shade, when my heart is satisfied with food, and so, turning my head to face the fresh Zephyr, [595] from the ever flowing spring which pours down unfouled, thrice pour an offering of water, but make a fourth libation of wine.

Orion group of constellations: Orion, Sirius, Pleiades, Hyades; Arcturus

Set your slaves to winnow Demeter's holy grain, when **strong Orion first appears** [*pre-dawn rising in July*], on a smooth threshing-floor, in an airy place. [600] Then measure it, and store it in jars. And as soon as you have safely stored all your harvest indoors, I bid you put your bondman out of doors, and seek out a servant-girl, with no children, for a servant with a child to nurse is troublesome. And look after the dog with jagged teeth; do not grudge him his food, [605], or some time the Day-sleeper [thief] may take your goods. Bring in fodder, and litter, so as to have enough for your oxen, and mules. After that, let your men rest their poor knees, and unyoke your pair of oxen.

[609] But, when **Orion and Sirius are come into mid-heaven**, [610] **and rosy-fingered Dawn sees Arcturus** [*pre-dawn rising in earlier September*], then cut off all the grape-clusters, Perses, and bring them home. Show them to the sun for ten days, and ten nights: then cover them over for five, and on the sixth day draw off into vessels the gifts of joyful Dionysus [wine].

[615] **But, when the Pleiades, and Hyades, and strong Orion begin to set** [*pre-dawn setting late in October to early November*], then remember to plough in season: and so the completed year will fitly pass beneath the earth. But, if desire for uncomfortable sea-faring seize you, **when the Pleiades plunge into the misty sea** [*pre-dawn setting later November*], [620] to escape **Orion's** rude strength, then, truly, gales of all kinds rage. Then, keep ships no longer on the sparkling sea, but be sure to till the land as I bid you. Haul up your ship upon the land, and pack it closely with stones.

Summer solstice

[660] Such is all my experience of many-pegged ships; nevertheless, I will tell you the will of Zeus, who holds the aegis; for the Muses have taught me to sing in marvellous song. **Fifty days after the solstice** [*midsummer solstice: 21 June*], when the season of wearisome heat has come to an end, [665] is the right time for men to go sailing. Then you will not wreck your ship, nor will the sea destroy the sailors, unless Poseidon the Earth-Shaker be set upon it.

Natural signs

[678] Another time for men to go sailing is in spring, when a man first sees **leaves on the topmost shoot of a fig-tree,** as large as the foot-print that a crow makes; [680] then the sea is passable, and this is the spring sailing-time. For my part I do not praise it, for my heart does not like it. Such a sailing is snatched, and you will hardly avoid mischief.

Vergil (70-19 BC): Georgics book 1:

This didactic poem, the first of four dealing with various aspects of farming, covers the land, and its proper cultivation.

[43-99] care of the land
Come: and let your strong oxen turn the earth's rich soil,
right away, in the first months of the year,
and let the clods lie for dusty summer to bake them in full sun:
but if the earth has not been fertile, it's enough to lift it
in shallow furrows, **beneath Arcturus**
[*pre-dawn rising in early September*]:
in the first case, so that the weeds don't harm the rich crops,
in the other, so that what little moisture there is
doesn't leave the barren sand.

Likewise in alternate years let your cut fields lie fallow,
and the idle ground harden with neglect:
or sow yellow corn, **under another star**, where you
first harvested beans, rich in their quivering pods,
or a crop of slender vetch, and the fragile stalks,
and rattling stems of bitter lupin.

[204-258] Star-lore
The star of **Arcturus**
[*pre-dawn rising in early September; dusk setting early November*],
and the days of the **Kids**
[*two stars near Capella, in Auriga, skim closer to the S'n horizon during pre-dawn midwinter*],
and bright **Draco** the Serpent,
[very near the pole, never rising or setting],
are as much ours as theirs, who, sailing homeward
over stormy seas, dare Pontus, and the jaws of oyster-rich Abydos.

When **Libra** makes the hours of daytime and sleep equal
[*the sun is in this zodiacal sign at the autumnal equinox*],
and divides the world between light and shadow,
then work your oxen, men, sow barley in your fields
right to the edge of formidable winter's rains:
then it's time also to sow your crops of flax in the soil,
and Ceres' poppy, and readily bend to the plough,
while the dry ground will let you, and the clouds are high.

Sow beans in Spring: then the crumbling furrows receive you,
clover, and millet, you come to our annual attention,
when snow-white **Taurus,** with golden horns, opens the year,
[*the sun enters this zodiacal sign in later April*]
and **Sirius** sets, overcome by opposing stars.
[*setting at dusk during later April*]

But if you work the ground for harvests of wheat,
and hardy spelt, and you aim at grain alone,
first let the **Pleiades**, Atlas's daughters, set for you in the dawn,
[*pre-dawn setting in later October to earliest November*],
and let the Cretan stars of the burning Crown,
Corona Borealis, vanish, [*dusk setting in earlier November*]
before you commit the seeds required to the furrows,
or rush to entrust a year's hopes to the unwilling soil.
Many have started to do so, before **Maia's** setting,
[*Maia, one of the Pleiades, dusk setting in early November*],
but the hoped-for crop has eluded them, the husks empty.

Yet it's true, that if you sow vetch, or the humble kidney bean,
and don't ignore cultivation of Egypt's lentils,
Boötes setting will send no malign signals:
[*Arcturus, setting at dusk in early November*]
begin, and carry on sowing into the thick of the frosts.

For this purpose, the golden sun commands his **ecliptic**,
split into fixed segments, through twelve heavenly constellations.
Five zones comprise the Earth: of which one
is always bright with the glittering sun, and always burned by his flames:
round this, at the sky's ends, two stretch to left, and right,
layered with ice, and darkened by storms:
between these and the central zone, two more have been given
to weak humanity, by the grace of the gods, and a track passes
between them, on which the oblique procession of **Signs** can revolve.

Just as the world rises steeply north, towards Scythia,
and the Riphaean cliffs, it sinks down to Libya in the south.
One pole is always high above us: while the other,

under our feet, sees black Styx, and the infernal Shades.
Here, on the earth, mighty **Draco** glides in winding coils,
around, and between the two **Bears**, like a river,
the **Bears** that fear to dip beneath the ocean.
[*these are stars of the non-setting circumpolar zone of the sky*]
There, beneath the earth, they say,
either the dead of night keeps silence,
and the shadows of night's mask grow ever thicker:
or Dawn, leaving us, brings back their day,
and when the rising sun, with panting horses, first breathes on us,
there, burning **Vesper** [*the planet Venus*] lights his evening fire.

From all this we can foretell the seasons, through unsettled skies:
from this, the days for harvesting, and time for sowing,
and when it's right to set oars to the treacherous sea,
when to launch the armed fleet, or fell
the mature pine-tree in the forest.
We don't observe the **Signs** in vain, as they rise and set,
nor the year divided into its four varied seasons.

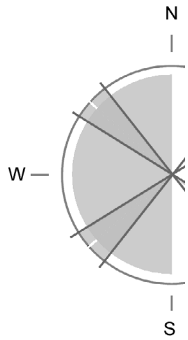
[311-334] Storms
What should I tell of autumn's storms, and **stars**,
and what men must watch for, when the daylight shortens,
and summer becomes more changeable, or when spring
pours down showers, when spiked crops bristle in the fields,
and wheat swells with sap on its green stem?

[335-350] The worship of Ceres [godess of corn and the harvest]
Fearing this, note the signs and seasons of the heavens,
to what region **Saturn's** cold planet retreats,
and into what celestial orbit **Mercury's** fire wanders.
[*the planets were thought to affect the weather according to their position amongst the constellations*]

Other entries about natural signs, and the timing of activities, occur at various points in the text.

Section 02c:
Astronomical issues

Section identifier: AS-



limiting solar and lunar positions

Summary:
the following topics are discussed:

basic calculation:
-astronomically **significant positions** in the solar and lunar cycles;
-use of astronomical **data**;
-declination, and adjustment for **elevation of sight-lines** above the horizon;

solar cycle:
-basic **properties**, with details given of latitude dependant variation over European latitudes;
-solstices and equinoxes, with three-fold **zonation** of the transit defined;
-tracking the transit by **shadow casting**;
-**intersection** between monumental axes and the solar transit, with *transit-frequency* and *dwell-time* defined;
-targeting of celestial targets at **elevation,** rather than for events strictly at the horizon;
-banding of the solar transit to enable discussion of **regional preferences** for axial alignment;
-possible **ritual associations** between monumental axes and the solar transit;

lunar cycle:
-basic **properties**, with details given of latitude dependant variation over European latitudes;
-**complexity** of the transit;
-S'n moon-**skim**;

constellations:
-the potential of the **Orion group** as a W'ly cue for alignment;
-use of **other stars** as targets;

planets:
-consideration of the four brightest planets;

Methods

Summary
Methods are outlined to calculate the direction of astronomical events suggested here as potential targets for alignment of monuments, with solar, lunar, stellar and planetary transits considered.

Calculation of astronomically significant positions within the solar and lunar cycles at defined latitudes: rising, setting, and transit

Further technical details of the astronomical background can be obtained as follows:

Thom 1967, 6-33; Thom 1971, 15-35; Hoyle 1977, 109-126; Thom and Thom 1978, 8-16; Burl 1983, 16-20; Ruggles 1999. Movement of all celestial bodies can be tracked through time using such software, such as Haney 1994, and additionally of the sun using the solar positioning facility provided by Quaschning 2005, or suncalc.org.

In this analysis, the direction of specific solar, lunar, stellar, or planetary risings and settings are expressed in terms of azimuth at zero horizon, rather than declination (methods: Ruggles 1999, 18 [general] and 22 [correction for local horizon]). Axes of monuments are also expressed as this azimuth, since for many sites this is the value most easily extracted as a common denominator in those many cases which are entirely reliant on published data of variable reliability. Inclusion of the elevation of horizons along the line of sight of monumental axes, in those cases where it is deemed relevant, is included as an angular value, again without calculating the declination of this point for the local horizon. Use of cues for alignment at the horizon is not assumed, and much of the discussion in this analysis involves considering events in general terms, and at some elevation well above the horizon, with declination hence of limited application. Use throughout of the azimuth at zero horizon is deemed sufficient for the analysis, given grouped data, and limitations on definition inherent in ancient constructional methods.

Background details on declination are as follows:

Approximate conversion between azimuth **A** and declination **D** can be achieved by the following equation:

term A B

sin **D** = sin L sin E + cos L cos E cos **A**

At zero horizon where E=0 term A drops out, since sin E=0.

Key: D(eclination); **E**(levation); **L**(atitude); **A**(zimuth);

Note:

The meridian divides the sky into E'n and W'n, and the celestial equator into N'n and S'n halves. The celestial equator is only directly overhead on the equator, otherwise lying at [90 minus the latitude] degrees, for S'n Britain about 39°.

Declination is the angular distance up or down from the celestial equator, and together with **Right Ascension**, the angular displacement E'wards from the vernal equinox, it indicates a particular location on the sky. Angular values above the celestial equator are taken as positive, and below are negative, from 0 at the equator, to 90 at the pole. A monumental axis with a particular declination can be said to intersect with the track of all celestial objects moving along that particular line of constant declination.

Solar events

-calculation of azimuths of sunrise and sunset at summer and winter solstice, marking the limits of the annual solar transit

During the year the angle of the axis of the earth rotates with respect to the plane of the earth-sun axis, from +e at the summer solstice to -e at the winter solstice, 'e' being the obliquity of the ecliptic.

At the surface of the earth this causes the azimuth of sunrise at a stated horizon to vary in a cyclical manner throughout the year, moving N' and S'ward along this horizon. It reaches a most N'ly point, the summer solstice, in late June, returning to its most S'ly, the winter solstice, in late December.

The rising sun passes through the mid-point between these extremes, at 090°, or due E, twice per year, once at the autumnal equinox, in moving from summer to winter solstice, and once at the vernal equinox, moving from winter to summer solstice.

The directions of sunset on the W'n horizon vary in a complementary manner, angular values (A) for sunrise translated to (360-A°), the equinoctial position for sunsets now being 270°, or due W.

Values of these key solar azimuths can be calculated for various latitudes as follows using the equations given in Hoyle 1977, 109-126. They correspond well with values given by Haney 1994, and other digital sources, with these preferred for more accurate values, fuller detail, and context. The application provided by suncalc.org is particularly useful for the sun, that by Haney 1994 useful for all the celestial bodies.

definition:

In this text the axes are designated as follows for convenient reference:

axis	1	NW-SE	midsummer sunset to midwinter sunrise;
	2	NE-SW	midsummer sunrise to midwinter sunset;

solstice:

summer	sunrise	$\cos^{-1}(\sin 24^o/\cos[latitude])^o$	[= **X**]
	sunset	$(360-\mathbf{X})^o$	
winter	sunrise	$(180-\mathbf{X})^o$	[= **Y**]
	sunset	$(360-\mathbf{Y})^o$	

Specific values are given in TABLE AS-01, and shown in e-FIGS AS-01 to 04.

-calculation of azimuth of sunrise for a specific day

The azimuth of sunrise **Z** at the standard horizon, at zero elevation, for a specific day can be calculated as follows:

$$\mathbf{Z} = \cos^{-1} \{(\sin \mathbf{e}/\cos \mathbf{L}).\text{sin\_rads } [2\pi\mathbf{T}/365]\}$$

where: **e** is the obliquity of the ecliptic, the angle of tilt relative to the equinoctial plane, about 23-24^o; **L** is the latitude of the site; **T** is the number of days after the vernal equinox; **sin_rads** is the sine in radians of the expression in squared brackets

Use of such simulations as Haney 1994, and other online applications, provide an easier option for such calculations.

-stability of orbits over time

The azimuth of a celestial object is the angle subtended to the observer between the N-point on a defined horizon and a point on the horizon vertically below the celestial body, measured in a clockwise direction between 0 and 360^o.

The obliquity of the ecliptic 'e', 23-24^o, the angle by which the axis of the earth is tilted in respect to the plane of its rotation around the sun, a key constant in this calculation, has not varied by more than about half a degree over the past three millennia. Penny and Wood (1973, fig. 5) note the change of ecliptic angle with time as linear, giving values of 23.45° for 2000 AD and 24.1° for 4000 BC.

Limiting positions of the solar transit are, therefore, relatively constant over the period of interest here. For instance, calculation of summer solstice sunrise at zero horizon for Stonehenge (Haney 1994) gives a stable azimuth of 051.6 between 3000BC and 2000AD.

Quoting one further published example, the direction of winter solstice sunset at the megalithic site of Kintraw, Argyllshire (NM 830 050: latitude 56.19^{o}N) is 223.03^o, as calculated by the method given in this section. This is within the range of sunset positions calculated for the early 2nd millennium BC (MacKie 1975, p. 154/ fig. 22), and those from Haney 1994.

Consequently, the azimuth of solar events, such as sunrise and sunset during the Neolithic period, are very siliar to those of the present day, certainly close enough for the purposes of this general analysis.

Lunar events

-limits for the azimuthal range of moonrise and moonset during the monthly synodic cycle, and 18-year metonic cycle

The moon orbits the earth at a mean inclination 'i' of about 5^o to the ecliptic, and the direction of moonrise or -set observed at a defined terrestrial horizon varies over a monthly **synodic cycle**, taking 29.53 days to move between its most N'ly and S'ly limits.

This synodic cycle does not remain constant from month to month, but itself changes in amplitude according to a **metonic cycle** of about 18.61 Julian years (235 lunar months). This latter cycle varies between +/-(e+i), a range of about 29^o at its outer limits, the 'major stand-stills', and between +/-(e-i), about 19^o, at its inner limits, the 'minor stand-stills'.

Note: 'e' is the obliquity of the ecliptic; **'i'** is the inclination outlined above.

Exact values of azimuths for these extremes of the lunar transit are calculated for various latitudes as follows:

MOONRISE:

maximum azimuth

most N'ly Cos^{-1}(Sin 29^o/Cos [latitude])^o [=**P**]

most S'ly (180-**P**)^o

minimum azimuth

most N'ly Cos^{-1}(Sin 19^o/Cos [latitude])^o [=**R**]

most S'ly (180-**R**)^o

MOONSET:

maximum azimuth

most N'ly (360-P)^o
most S'ly (180+P)^o

minimum azimuth

most N'ly (360-R)^o

most S'ly (180+R)^o

Specific values are given below in TABLE AS-04, and shown e-FIG AS-01.

Problems with over-specific use of astronomical data

Given the structural irregularity of prehistoric sites, and the consequent limits which must be allowed in measurement of key orientations, also the likely generalised intentions of the builders of prehistoric monuments, it seems advisable to allow a range, rather than a single position, for which risings and settings remain relevant to the axis in question.

The nature of actual targets for monumental orientation are unknown, as is the point on larger bodies, such as sun or moon, that might have been used for reference during a rising or setting: upper or lower limb, or centre. It seems more realistic to suggest that observations were not made with modern accuracy, for purposes of astronomy, but with greater latitude, sufficient to accord with ritual preoccupations.

Given such uncertainty, it has not been considered relevant in this analysis to provide precise calibration of settings and risings, by inclusion of such conditions at the horizon as refraction, or graze. More detailed background on solar and lunar cycles, and consideration of complicating factors, such as refraction, error analysis, and elevation of the horizon are given in Hoyle 1977, Appendix: pp. 109-126.

Consequently azimuths of such events are regarded not as single values, but as points within an applicable range. For instance, a singular equinoctial reference might therefore have remained acceptable over an arbitrary range of, say, 5° either side, as the sun passed and, for a solstice, over 5° of its overlapping approach and departure. This would lead from proposing a single event on a particular day as defining, to accepting a more realistic window over several, thus giving greater potential relevance for the axis.

Adjustment of solar and lunar risings and settings for topography at the local horizon

The calculations above assume a notional horizon at zero elevation, and the particular time, and azimuth, of risings and settings for a specific locality would have to be further modified according to any elevation of its horizon above zero. Relative to this zero elevation, a hill on the horizon will delay a rising, but advance a setting, displacing both to the S. In this sense, topography at the horizon must, where broadly necessary, be brought into the general discussion of risings and settings. In this study analysis of grouped data assumes a zero elevation, no longer an issue when referring axes to events higher in the transit of celestial bodies.

It is important to note that close vegetation cover, the extent of which is unknown at prehistoric sites (Ruggles 2000, 88), could have affected the visibility of the horizon, in ways far more significant than did the more distant skyline, or details of atmospheric conditions.

The solar transit: properties

Summary
This section outlines the properties of the solar transit, and the way in which they change with latitude. The solar transit is promoted as a major determinant of alignment amongst the monuments in this analysis, and a unified general model of ritual reference is suggested (see Table of Contents: 03a/13a).

Basic physical properties of the solar transit

The solar transit, passage of the sun from rising, through zenith, to setting, varies through the year, in elevation and extent, this varying further with latitude (e-FIGS AS-01 to 04).

Definitions

-limiting positions of the transit on the horizon

At the winter solstice, the sun rises at the SE, and sets at the SW, in a minimal arc. These rising and setting points move N'wards along the E'n and W'n horizon respectively during spring, in a six-monthly cycle, with a consequent increase in the arc of the solar transit, achieving a maximum at the summer solstice. Through autumn to winter this sequence is reversed, back to the minimum arc, thus completing the annual cycle.

The ***solstices*** occur when the azimuth of the setting and rising sun changes direction at the end of each 6-monthly cycle. They mark the S'n and N'n limits of these rising and setting transits, in mid-winter and mid-summer respectively, with the mid-point between solstices termed the ***equinox***, *vernal* for the springtime transit, and *autumnal* for the return leg.

Each solstitial rising is paired with its opposite solstitial setting to form an asymmetrical axis, with only the pairing between vernal and autumnal equinox a symmetrical axis (see Table of Contents: 02a/2b).

For convenient reference elsewhere in this analysis the solstitial axes can be abbreviated as follows (with **/** and **** providing visual cues for direction):

solstitial
axis 1 (/): MWset (midwinter sunset) to MSrise (midsummer sunrise);
axis 2 (\): MWrise (midwinter sunrise) to MSset (midsummer sunset).

-zonation of the transit and changes in its properties with latitude

The transit of the sun can be used to divide the horizon into four zones (e-FIG AS-01):

zone:	
transitional:	between extremes of rising and setting at the solstices on the E'n and W'n horizons respectively;
permanent:	the S'n arc of minimum transit at mid winter, within which no risings or settings occur, only transits;
maximum:	maximum transit at mid summer between sunrise and sunset;
null:	the arc at the N containing no visible solar events.

zone	**at**	**between**		**freq**	**rise/ set**
transitional					
rising	E	SSrise	WSrise	variable	variable
setting	W	SSset	WSset	variable	variable
permanent	S	WSrise	WSset	year-long	none
null	N	SSrise	SSset	none	none
maximum not	N	SSrise	SSset		

Key: freq(uency of passage of the sun over any azimuth within the zone); **SS** summer solstice; **WS** winter solstice.

zones:
The properties of these zones vary with latitude as follows over W'n Europe, with extremes of data from the Arctic Circle and Equator added in order to set this within astronomical limits (TABLE AS-01):

TABLE AS-01 THE SOLAR TRANSIT: VARIATION IN ZONATION WITH LATITUDE

		azimuth (°)				**zone width (°)**			**elevation (°)**		
		midsummer		**midwinter**							
area	**mean lat (°N)**	**rise =a**	**set =b**	**rise =c**	**set =d**	**trans =(c-a)**	**max =(b-a)**	**null/ perm/ =2a**	**min**	**eq**	**max**
Arctic Circle	65	016	344	164	196	148	328	32	2	25	48
Shetland	60	036	324	144	215	108	288	72	7	30	53
Orkney	59	038	322	142	218	104	284	79	8	31	54
	58	040	320	140	220	100	280	80	9	32	55
Grampian	57	042	318	138	222	96	276	84	10	33	56
	56	043	317	137	223	94	274	86	11	34	57
Northumbria	55	045	315	135	225	90	270	90	12	35	58
	54	046	314	134	226	88	268	92	13	36	59
North Midlands	53	048	313	133	228	85	265	96	14	37	60
Cotswold	52	049	311	131	229	82	262	98	15	38	61
Wessex	51	050	310	130	230	80	260	100	16	39	62
Dartmoor	50	051	309	129	231	78	258	102	17	40	63
Brittany	48	053	308	127	233	74	255	106	19	42	65
S'n France	45	055	305	125	235	70	250	111	22	45	68
N'n Spain	43	056	304	124	236	68	248	112	24	47	70
S'n Spain	37	059	301	121	239	62	242	118	30	53	76
Equator	0	066	294	114	246	48	228	132			

Key: **lat**(itude); **zone width**: **trans**(itional), **max**(imum), **null**, **perm**(anent), as defined above; **elevation: min**(imum at the winter solstice, **eq**(inoctial), **max**(imum at the summer solstice).

Note: the values given in Tables AS-01 and 04 are approximate to the nearest degree, and given for representative latitudes. Any more specific calculations can be made using equations given in Methods, or recourse to digital applications.

Solstices and equinoxes: the effects of latitude and longitude on azimuth and timing

The direction, date, and time of solstitial and equinoctial sunrise and set varies according to the latitude and longitude of the location in the following way:

	azimuth		**date**		**time of day**	
	lat	**long**	**lat**	**long**	**lat**	**long**
solstice	v	-	-	-	-	v
equinox	-	-	-	-	v	v

Key: v(aries according to location; **-** invariant.

The only significant relationship here is that between latitude and azimuth of solstices, with significant differences evident for the British Isles, as given in TABLE LB-01. How this might have affected alignment of long barrows, well separated by latitude, is discussed further elsewhere: see Table of Contents 03a/16g and e-FIGS LB-12, 92 and 93).

Tracking the solar transit

As well as direct observation of the transit itself, its seasonal cycle can be determined by the serial point-marking of shadows cast on the ground by some upright of suitable height and terminal definition, a gnomon (e-FIG AS-10). This method has the advantage that change can be more clearly seen, and compared with standard temporal markers.

The sun, moving clockwise from E to W, casts a serial point-shadow that curves around the N'n side of a gnomon. At the summer solstice, when the transit is at its highest, the track is closest to the gnomon, its ends curving back somewhat towards the S. At the equinox, the track runs straight across in front of the gnomon. At the winter solstice, when the transit is at its lowest, the track is furthest from the gnomon, with its ends curving away towards the N. Intervening tracks follow this splayed pattern, their spacing decreasing nearer the solstices, especially for that at midsummer. Since the sun remains around the solstices for a considerable number of days (e-FIG AS-07), such a system is more satisfactory for determination of general position than as a basis for calendric timing.

It would be possible to register such events, and any intervening points deemed important, in two ways: by marking the terminal shadow on the line N'wards from the gnomon, or on a circle around it. The former has two disadvantages: the N'ward line needs to be determined, and the spacing between points is over-close for finer definition, especially nearer to the gnomon. Use of the circle removes both of these problems. Such a system would be easily implemented, using a timber upright and portable stone markers, and is proposed here as an interpretation of the dial motif on kerb K15 at Knowth passage grave (Meath, Ireland), where it is discussed more fully in relation to that site (see Table of Contents 03a/20eii).

Axial intersection of the solar transit: transit-frequency

The number of times the sun passes over the axis of a monument during the year depends on that part of the transit towards which the axis points (e-FIG AS-09). If oriented within the S'n arc of the sky, where there are no risings or settings, then 365 transits would occur, one per day. As the axis moves E' or W'ward through the transitional zones, then this number gradually reduces to 1 at the summer rising and setting solstices, and beyond this in the null zone to the N it is obviously zero. Consequently, for any intervening axial direction there is a **transit-frequency** for the number of passes experienced, this value perhaps reflecting the potential of that orientation for use in ritual based on direct visual reference to the sun.

If the entire transit is considered over the full range of its elevation, up to 60° maximum at midsummer zenith in the S'n Britain (TABLE AS-01), then the distribution of transit-frequencies forms a single, fairly flat-topped peak (e-FIGS AS-04 and 09). However, if only lower or medium elevations are considered, say up to 20°, then the distribution forms peaks in the SW'n and NW'n quadrants. Decreasing the elevation of the transit in this way would cover events in closer correspondence with a lower line of sight towards the horizon, where more spectacular pre-setting transits over the axis would be seen.

Considering a band of elevations for the transit, rather than point events at the horizon, broadens the potential target area, from risings and settings, to include approach and departure above the line of the axis. In this particular analysis 0-30° and -20° are taken as standards for lower, and near-horizon elevation respectively (e-FIG AS-09).

Relative changes in the frequency of solar transit occur between opposing directions in an axis, as it rotates between solstice positions (e-FIG AS-09a). Considering the case of a trapezoidal long barrow as an example, the two opposing directions in its longitudinal axis can be defined as one of 'pointing' towards the narrower end, and the other of 'facing' towards the broader front end of the monument (see Table of Contents: 03a/11b). When the barrow lies E to W, along the line joining each equinox, at the mid-points between solstices on the rising and setting arcs of the solar transit, then each end of the barrow would experience the same transit-frequency, this being the number of days per year that the sun passed over its axis. Assuming that the narrower end pointed to the W, typical for such long barrows (e-FIGS LB 01-29), rotating the direction of pointing to the N, towards summer solstice sunset, would decrease the transit-frequency for this end. At the same time the direction of facing would move to the S, towards winter solstice sunrise, producing a corresponding increase in its exposure to the transit, the relationship being linear.

If increased exposure of the rear end of such barrows to the solar transit was the intention, then axes pointing generally SW'wards would be required, and if exposure of the front was more important, then barrows pointing NW'wards. Most groups of barrow have directions of pointing that cluster broadly and evenly around peak frequency at the W (examples: e-FIGS LB-08 and 16), choice of this axis resulting in fairly even exposure between ends, whether as an intended feature, or as a consequence of other factors acting to fix the axis (see Table of Contents: 03a/16).

The S'y directions within axes seen amongst stone rows (e-FIG SR-05), and cursus monuments (e-FIG CU-19), obviously result in increased values of transit-frequency, and may suggest a separate non-funerary emphasis for these groups.

Dwell-time of the sun in a particular direction: seasonal variation

The seasonal frequency of the solar transit changes for a defined axial direction, and so too does its dwell-time. The sun moves along its rising and setting limbs at a variable rate throughout the year, slowing on approach to, and departure from, the solstices in mid-winter and mid-summer, speeding up during the intervening spring and autumn, reaching a maximum at the equinoxes. For instance, sample transit speeds at the zenith given in e-FIG AS-06 for summer solstice, equinox, and winter solstice are 29, 19, and 14 degrees per hour respectively. This would result in a corresponding dwell-time of 10, 16, and 21 minutes for the sun to remain within a 5° window of observation. Sufficient duration would seem relevant to any attendant ritual.

Direct viewing of the sun therefore varies *in opportunity*, as defined by choice of axis, and *in duration* by season.

Use of near-setting or -rising positions of the sun as cues for alignment: implications for the seasonal-solar model of alignment behaviour

The azimuths for peak frequencies of alignment have been used in this analysis to provide a possible estimate of the timing of monumental construction in terms of the seasonal activity cycle.

For instance, this has been done for long barrows on the assumption that they point (front to rear) generally towards the sunset current at the time of their initial construction (see Table of Contents: 03a/13a). However, if the target area of the cue is more realistically broadened to include the descent to the setting position, then certain adjustments need to be made to suggested dates for fixing of the axis, as calculated from positions of sunset alone.

For instance, taking alignment on the lower descending limb of the setting sun around the equinox: a particular monumental axis could refer to the sunset position at a particular date, or the lower descending limb of the transit some time later for the vernal, or earlier for the autumnal transits. If the peak orientation for long barrows around due W was the result of using the equinoctial sunset as target, then use of lower setting positions would hardly have produced the bilateral spread of frequencies observed (e-FIGS LB-01 to 21).

Alignment of monuments: use of setting and near-setting directions in the solar transit

Alignment on the near-setting sun, rather than at its actual setting, might have been encouraged by the need for sufficient daylight to complete rituals, and basic layout of the axis before nightfall, perhaps an unpropitious time. For any alignments on the rising sun such considerations would, of course, not apply.

Hours of daylight remaining before twilight can be plotted for various azimuths and elevations of the sun (e-FIG AS-04). The standard definition of *civil twilight* is used here, and this occurs when the centre of the sun lies at -6° relative to zero horizon, the angular diameter of the solar disc being about 32', resulting in conditions with the brightest stars visible, and the nautical horizon still apparent.

The effects of atmospheric refraction on the apparent position of the sun, which increase with decreasing elevation, are not considered here, reaching a maximum of only about -35' at zero elevation.

If monuments were aligned towards the setting sun, consideration of such evening conditions is important. Any attendant rituals, either during, or after establishment of an axis would have required time to initiate, and bring to completion; daylight might have been important throughout, at least for obvious practical, if not ritual reasons.

Allowing two hours before twilight for constructional activity would see the sun, initially at elevation, moving over a defined range of azimuths **R,** towards setting**,** as outlined in TABLE AS-02, just below. Rather than considering only setting positions, use of this interval R is perhaps a more realistic option. Such a correction would certainly introduce yet more variability into interpretation of alignment, and its possible timing during the year.

TABLE AS-02 Azimuth and elevation for the setting sun at sample N'n and S'n latitudes

	azimuthal range R at solar elevations of (°)		
	5	7.5	10
Scotland:	**57° N**		
eq	8	12	17
SS	10	14	18
WS	14	20	26
S'n Britain:	**51° N**		
eq	6	9	13
SS	8	11	15
WS	9	14	20

Key: WS winter solstice; **SS** summer solstice; **eq** equinox.

Using S'n Britain as an example: at the equinox, use of the descending sun at 5° or 10° elevation as a target, would shift the axial foundation date by about 5 and 15 days, with respect to the solar setting calendar. At the solstices the corresponding shift would be 24 and 40 days (e-FIG AS-04), differences perhaps sufficient to influence discussion of the timing of barrow foundation in relation to the economic cycle.

For the N'ward progression of the transit towards the summer solstice the actual date-timing for an axis aimed at the *setting* sun would be later than for one setting fully at that azimuth, and for the reverse direction earlier, which for inclement N'n latitudes could confer an advantage for the timing of construction activity.

Alignments: banding for analysis of regional distributions

In the analysis of long barrows from S'n England and Scotland (see Table of Contents: 03a/25a and b), the transitional zone of the solar transit (between midwinter solstice, through the intervening equinox, to midsummer solstice) was divided into a series of three equal bands, into which axes of sites could be allocated. These, together with the null and permanent zones, enabled types of alignment to be mapped per 10km grid square for different regions, and comparison of axial trends made (e-FIG LB-92 and 93).

Using data for 52°N (central S'n England) as an example, this resulted in three bands of 41° ranging 20.5° either side of these specified points: near summer solstice, near equinoctial, and near winter solstice (bands 2-4 in TABLE AS-03). A band was allocated to the N and S of the solstices, to cover the null and permanent zones respectively (bands 1 and 5).

Initially the transitional zone of the solar transit was divided into nine equal slots, and axes were assigned according to their alignment. Various mappings were attempted, with a broader grouping of these nine slots into three bands, adopted to avoid fragmentation of the data.

band	zone of solar transit	range (°G)	az
1: null	to the N of summer solstice	332-360	
2: near-SS	transitional	291-332	311
3: near-EQ	transitional	250-291	270
4: near-WS	transitional	209-250	229
5: perm	to the S of winter solstice	180-209	

TABLE AS-03 Case study 1: sectoring of the solar transit

Key: band: SS summer solstice; **EQ** equinox; **WS** winter solstice; **perm**(anent); **az**(imuths of SS, EQ, and WS for latitude 52°N).

The solar transit: possible ritual associations

The rising of the sun from beneath the horizon, its passage across the sky, and setting below the horizon are elements that feature strongly, and widely in ancient religion (Ruggles 2005). The clearest documented, and oldest source for this journey of the sun is given in such ancient Egyptian texts as the Amduat.

These visible rising and setting sectors of the transit were in some cases linked to form a cycle, by inferred passage of the sun under the earth to reappear at rising. Variant forms of this basic idea occur widely amongst historically recorded ancient cultures, in the ethnographic record, and earlier origins are further suggested by artefactual evidence amongst various prehistoric societies, for instance those of Bronze and Iron Age Europe (see Table of Contents: 06/1, and 5 to 7).

It is possible to propose, at least in very basic outline, a fairly coherent and cross-culturally consistent ancient view of the solar cycle, relevant to the concerns of small-scale agrarian communities, and to suggest possible ritual associations. Such a unified, and simplified model may provide at least some realistic context for discussion of particular trends in axial orientation seen amongst their ritual monuments.

At its most basic, such a model would draw a clear distinction between the visible terrestrial transit and the hidden subterranean N'n arc, into which the sun disappeared, and from which it re-emerged daily. The seasonal ascent of the zenith, and the increasing extent of the circuit, fully visible at midsummer elevation, would have indicated a circular orbit, with a variably hidden section to the N, a zone not *avoided* by the sun and moon, but from which they *arose.*

The course of the solar transit could then be seen to provide a line of potential communication between these terrestrial and subterranean spheres. The symbolism of repeated solar rising and setting could also acquire connotations of birth-death-rebirth, relevant to the human and natural life-cycle, and central to the well being of the natural world, and economic sphere. Such a hidden world would be that to which the dead pass, and hence it would become the land of the ancestors, from which new life, seasonal conditions, and prosperity were determined. Such matters would require regular propitiation, the solar transit providing an all-important means of delivering it, with the moving sun itself the major vehicle.

The rising limb could have come to symbolise birth and growth, and the setting limb death and decline. Ascent and descent of the sun at the meridian could also relate to these notions, although remaining fully visible. On this basis it might be expected that funerary monuments would assume a more W'ly orientation, intersecting the transit on its downward passage, a situation certainly seen amongst long barrows (e-FIG LB-01 to 21). Sites less directly connected with burial, but more perhaps with propitiation of the ancestors and addressing economic well being, might therefore take a more S'ly line, towards more permanently visible sectors of the transit, as may be the case for cursus monuments (e-FIG CU-18 and 19), and stone rows (e-FIG SR-05).

The setting sun itself might well have been deified, and its point of setting regarded as an entrance to the underworld. Orientation towards the N'n null zone of the transit might also be expected for certain funerary monuments, since it would be the most direct line of communication with such an underworld.

An insight into the Neolithic view of the life-death cycle, that could be of more general relevance to funerary ritual, is perhaps to be seen in the Triora slab from N'n Italy, which may date from the late 4th or early 3rd millennium BC. The slab shows a tripartite carving, the upper part of which may represent the sky, with the solar disk, the central portion the earth, and the lower portion the underworld. Another carved slab from Ossimo may show the moon in the upper section, and has a central section containing spirals, interpreted as possible symbols of rebirth (Anati 1977).

The sun could be addressed by appropriate ritual at any point during the course of its transit, but to provide focus for ceremonial a line of intersection might need to be more clearly defined. Cues could be particular risings, settings, perhaps at limiting positions such as solstices, or toward the zenith as it changed elevation at the S. As well as such reference to well separated liminal events, any point on the transit deemed to be specifically relevant, or generally acceptable, could be targeted to provide more frequent opportunities for ritual intervention. The extent of intersection between axis and transit would depend on its alignment (see Table of Contents: 02c/2e; e-FIG 09).

The need for propitiation is likely to have been frequent, as a general background level, and to have increased further at key times of the natural and economic year (see Table of Contents: 02b/9), or during additional periods of stress (see Table of Contents: 05). If such ritual was recurrent, then choice of a target at the horizon which was unduly seasonally-restricted would not be helpful, as for instance those at azimuths very close to solstices, or at the equinoxes, but if the entire transit were used instead then this would broaden the currency of use.

The most efficient targets would be those within the permanent zone, from the zenith to the near-solstices, all of which see solar transits throughout the year, and allow inclusion of distinct seasonally-important limiting positions into ritual.

Visualising the solar transit at winter minimum (e-FIGS AS-04b and c)

At the winter solstice (~December 21), the arc of the solar transit is at its annual minimum, traversing the narrowest sector of the S'n horizon, and reaching its lowest elevation at the S. During this inclement period it forms the most compact target, easily encompassed within a single view (example: e-FIG AS-04b: subtending 84°), expanding laterally from then onwards until the vernal equinox (~March 21), when it subtends 180°, exceeding convenient visual range.

The course of the sun over the S'n sky, from E'ly sunrise, through S'ly meridian, to W'ly sunset, as recorded at a selected open upland location, is plotted against the backdrop of winter terrain and sky, typical of those chosen for construction of long barrows, and other axial monuments such as stone rows.

Two solar transits are shown, as directly observed, that for the winter solstice in late December [**trans WS**], where lateral range and elevation are at their minimum, closely confined to the S, and [**trans VE**], that for the period in early-mid March, approaching the vernal equinox, where the transit is considerably expanded.

Trans WS illustrates that the entire circuit is easily encompassed within a compact view, and would have formed a coherent target for propitiation, such as might be required to ensure its progressive increase from this inclement winter minimum to provide seasonal abundance. This minimal transit defines the permanent zone (see Table of Contents: 02c/2a), and is the suggested target for the S'ly group of monumental axes, such as for many stone rows (see Table of Contents: 03d), and cursus monuments (see Table of Contents: 03c).

Trans VE indicates the time when the lateral range of the transit begins to exceed the scope of a single view, and hence would have become less accessible as a defined target. It also demonstrates the setting solar transit during later winter, a suggested target for axial alignment available during onset of the more clement phase of early spring weather, when co-operative construction of larger monuments such as long barrows could more easily begin (see Table of Contents: 03a/16).

Observing the scene prompted the subjective impression that projected ritual ends could have been achieved by approximate means, with alignment general, rather than involving any need for close definition to a particular position within the transit.

The lunar transit: properties

The transit of the moon is far more complex than that of the sun, and provides a less readily accessible, and less stable target for axial orientation (e-FIG AS-11), also one of decreased economic relevance. The entire lunar construct provides a weak basis for axial alignment at monuments.

Whilst observation of the moon, its movement, and its phasing, might have played a role in general ritual and its timing, at the types of monument outlined in this analysis, there seems little valid structural evidence from axial alignment for involvement of limiting lunar positions, inherently unlikely because of their recurrence only after almost 19-year intervals.

Basic properties of the lunar transit

The moon rises in the E, moves to its zenith, then sets in the W, following a course which oscillates up to 5° either side of the track of the sun, the ecliptic, crossing it twice in one 29-day lunation, at the ascending and descending nodes, which are 180° apart. The positions of these nodes rotate slowly through the sky. The elevation of the ecliptic in the night sky, and the lunar course associated with it, varies from a maximum at midwinter to a minimum at midsummer, the opposite pattern to that of the sun. Therefore, during the summer, the moon can appear in very low transit over the S'n sky, adding moon-skim as another feature of possible ancient interest (e-FIGS AS-12 and 13).

The directions of moonrise, and moonset, along the E'n and W'n horizons respectively, vary over the cycle of the lunar month (e-FIG AS-11), and between extremes over an 18.6-year cycle (e-FIG-01). As is the case for the sun, the limiting positions of these extremes, and the width of their range vary according to latitude (e-FIG AS-03).

Limiting positions for the lunar cycle vary over almost as large a range as those of the sun, and over similar sectors of the horizon, but more rapidly, over a monthly cycle, this varying within an 18-year cycle. Compared with that of the sun, the lunar cycle is more complex, especially if phases of the moon, and nocturnal visibility are considered in addition to transit of the object (e-FIG AS-11). Ruggles (2000, 88) distinguishes between the lunar nodal cycle, with 18.6 years between standstills, and the 19-year metonic cycle, after which moon returns to the same phase on any given day.

The lunar cycle also represents the idea of seasonal productivity less well than that of the sun, and is likely to have been of far less direct and obvious economic relevance. However, the moon has been considered by some to be a key element in the construction of various megalithic monuments, which might have existed at least in part to further analyse, and utilise the lunar cycle (Thom 1967, 1971; Thom and Thom 1978; Ruggles 1999).

The existence of a lunar standstill, within a cycle of about 19 years, would only become apparent, and be confirmed as being recurrent, after systematic observation of the changing transit of the moon over a prolonged period of several generations. As with the equinox, these phenomena of longer phase may well be modern concepts, and certainly the ethnographic evidence for their widespread role in ritual is lacking (Ruggles 1999).

Even if such lunar standstills did provide a basis for prehistoric alignment, then difficulty in establishing their azimuths could have led to masking of any related monumental axis.

It seems inherently likely that the type of annual-seasonal-harvest linked ritual expected amongst prehistoric communities, small scale and agrarian, would have required regular and economically relevant cues, of a type provided by the sun, rather than the moon. Sites oriented on lunar standstills would only become re-aligned on targets after intervals too prolonged to have served recurrent ritual needs. Seasonally based agrarian ritual would require regular re-enactment, with propitiation in an annual cycle, directed towards the main driver of seasonal change. The moon, a secondary focus for ritual, not reflected by alignment, at a practical level would have provided a better basis for more detailed division of the year.

The maximum and minimum ranges of the lunar cycle (TABLE AS-04: ranges A and B respectively) increase towards more N'ly latitudes, showing a similar tendency to the limits of the solar cycle.

Similar zonation, null and transitional, can be outlined for the lunar, as for the solar transit (e-FIG AS-01).

Properties of lunar standstill positions vary with latitude as shown in TABLE AS-04:

TABLE AS-04 Extremes of azimuth for lunar rising and setting during the range of the monthly 18-19 year cycles, for defined latitudes

area and mean latitude (°N) standstill		range of azimuths (°G)								range	
		moonrise				moonset				A	B
		max to		min to		max to		min to			
		N	S	N	S	N	S	N	S		
		=a	=b	=c	=d	=a	=b	=c	=d	=(b-a)	=(d-c)
		major		minor		major		minor			
Orkney	59	020	160	051	129	340	200	309	231	140	78
	58	024	156	052	128	336	204	308	232	132	76
Grampian	57	027	153	053	127	333	207	307	233	126	74
	56	030	150	054	126	330	210	306	234	120	72
	55	032	148	055	125	328	212	305	235	116	70
	54	034	146	056	124	325	214	304	236	112	68
N Midlands	53	036	144	057	123	324	216	303	237	108	66
Cotswold	52	038	142	058	122	322	218	302	238	104	64
Wessex	51	039	141	059	121	321	219	301	239	102	62
Dartmoor	50	041	139	060	120	319	221	300	240	98	60
Brittany	48	044	136	061	119	316	224	299	241	92	58
S'n Spain	37	052	128	066	114	308	232	294	246	76	48

Note: major and **minor** refer to the lunar 'stand-still' positions, marking respectively the maximum and minimum limits of the 18-19 year cycle.
Range: the range of moonrise, or moonset, towards the E and W respectively, over the 18-19 year cycle:
A: maximum; **B:** minimum.

Complexity of the lunar transit

Lunar standstills provide fixed points in the longer-term 18-19 year cycle which appear obscure, and cover a time span which seems too lengthy to sustain interest. This complexity of the lunar transit and its component cycles can best be discussed by means of an arbitrary 14-day sample, again further demonstrating the lack of a clear basis for alignment of monuments (e-FIG AS-11).

Here, four obvious patterns of shorter-term change interact over the lunar month to provide a transit that is far more complex than that of the sun, with cycles in this example as follows:

cycle:

1: the azimuth of rising and setting varies from about 040 to 140°, and from 220 to 300° respectively;

2: the phases of the moon progress over eight clearly distinguishable stages;

3: the elevation of the moon changes between about 010 and 070°;

4: the visibility of the moon changes according to how much of its transit occurs by day, or night;

Those occasions when the moon passes low over the S'n horizon might also form a significant event for occasional observation (see this section, just below: S'n moon-skim), but again one difficult to use as a meaningful basis for alignment.

Combination of lunar and solar cycles

The zones in which risings and settings occur cover approximately the same ranges on the E'n and W'n horizons for both sun and moon (e-FIG AS-01). For the moon, those directions over which extremes of rising and setting fluctuate during the 18-19 year cycle are also centred fairly closely around each of the four solstice risings and setting positions for the sun. Such zones of combined celestial activity might have been deemed significant, although there is an 18-fold difference between the length of cycles involved.

S'n moon-skim: the minimal lunar transit between major S'n standstills

At the extremes of the lunar cycle, every 18.6 years, the moon rises and sets at its furthest N, and two weeks later, with minimum arc of elevation, at furthest S, somewhat beyond the limits for the solar cycle (e-FIG AS-01: TABLE AS-05).

In the days leading up to this minimum, the arc of the lunar transit reduces rapidly, slows in the approach to, and departure from the minimum, then increases again rapidly as the moon moves N'ward. At this S'ly extreme, the length of its transit, and its full elevation midway at due S, are at a minimum. The sequence of transits forming the lunar minimum, termed 'moon-skim', which occurred in the area of Callanish (Lewis, Scotland: 58.13°N, 6.78 °W) on 29th September 2006, is given as an example (e-FIG AS-13).

The properties of this extremely low transit vary with latitude (e-FIG AS-12). The azimuthal range for the arc of rising to setting, its maximum elevation above zero horizon at zenith, and the transit rate for moon at S'n extreme are as follows for Britain, from 50°N (England: S'n Coast) to 61°N (Shetland). Values for the solar transit at its S'n minimum in midwinter are added for comparative purposes (TABLE AS-05; e-FIG 12):

TABLE AS-05 Lunar transit at S'n extreme: properties

		England: S'n coast 50°N	**Scotland: Shetland 60°N**
moon	arc	80	20
	elev	10	0.5
	rate	12-13	
sun	arc	104	74
	elev	16.5	6.5
	rate	13-14	

Key: **arc** (between rising and setting, in degrees); **elev**(ation above zero horizon during zenith at the S); **rate** (of average transit in degrees per hour).

At more N'ly latitudes, this lunar minimum causes the transit to skim particularly closely to the horizon. Since the maximum lunar elevation varies with latitude in a linear way (e-FIG AS-12), what distinguishes a skim from higher transits is subjective. Here skims are further qualified by prefixing the maximum elevation in degrees, with those at 5° or less, occurring at latitudes above about 55°N, which includes Scotland, and the N'n coast of Ireland, being amongst the most pronounced.

Lunar skims constitute very variable phenomena:

-**recurrence**: they recur infrequently, after almost generational intervals of 18-19 years; from the event described for 2006 the next will be in 2025;

-**date**: at 18.6-year periodicity they are out of synchrony with the seasonal-solar cycle, and hence recur at different dates; the 2006 event occurred on 30th September, the 2025 event is scheduled for 16th May, 18 years and 229 days later (18.627 years);

-**visibility**: their visibility depends on the extent to which the transit occurs during sufficient darkness; less than a half of the event in 2006 occurred after sunset, however, that for 2025 will be during full darkness;

-**lunar phase**: phases of the moon vary within and between transits, and this affects visual impact; for the 2006 skim, the moon was at 6-day first quarter, but for 2025 it will be 18-day waning gibbous.

Such 2-3° skims have been noted, as perhaps of some significance, at sites with S'ly alignment, such as Callanish (Lewis) (see Table of Contents: 03e/10a; e-FIG AS-13), and amongst the multiple rows of Caithness and Sutherland (see Table of Contents: 03d/9), both located at latitude 58°N and above.

Constellations

Risings and settings of a small group of stars and constellations do not suggest a generally applicable, and robust basis for the range of axial alignment seen amongst monuments. However, such celestial events do have well-attested importance as seasonal markers, supplementing those natural cues all too evident during the changing seasons, these latter surely the primary source of timing for economic and ritual activities. Through their economic relevance, the movement of stars might have influenced alignment of some monuments indirectly.

A general map of constellations in the N'n celestial hemisphere is given in e-FIG AS-14.

Constellations show different patterns of rising and setting, according to their position in the sky relative to the limit of the local circum-polar zone, the stars within which are not seen to set. Those stars that lie just beyond its margin, such as Vega (in Lyra), can approach, and skirt the horizon at various times; those stars beyond it, such as Arcturus, and well beyond, such as Sirius, and the Orion group, show distinct seasonal patterns of rising and setting.

Precise directions of rising and setting, and the extent of trajectories that remain visible, have varied through time on a millennial scale (e-FIG AS-15).

The choice of what constitutes a constellation is very subjective, and has changed markedly over time, and between cultures. However, one particular group of stars deserves particular consideration here, as a potential marker for the E-W axis, and a possible cue for alignment in these directions, one that might have contained elements of symbolism relevant to the ritual of funerary monuments, such as long barrows (see Table of Contents: 03a). In searching the range of latitudes over the British Isles (50-58°N), for prominent stars, or star-groups, that rise and set along the E'n and W'n horizon respectively, the group corresponding to the modern constellations Canis Major-Orion-Taurus is particularly conspicuous, and contains culturally significant, ritually-suggestive elements (e-FIGS AS-16 to 20).

The Orion group

Orion and the constellations Canis Major, and Taurus flanking it, here called the 'Orion group' (e-FIG AS-14), form a conspicuous band of bright stars, with apparent magnitudes around 1 (bright) to less than 0 (very bright) (TABLE AS-06; e-FIG AS-14). The star Sirius, in Canis Major, marks one end of this band. The band continues through the highly patterned constellation of Orion at the centre, then on to the less apparent Taurus, and its star clusters, the Hyades and Pleiades, this latter a discrete, and noticeable terminal feature. Rising and setting of particular stars within this group, such as the Pleiades and Sirius, feature widely as reference points within many agricultural calendars (see Table of Contents: 02c/4a; e-FIG AS-19). Just above the Orion group lie the broadly rectangular constellations of Gemini and Auriga, which follow in setting, and extend coverage of the horizon for the entire cluster of constellations towards the NW.

The Pleiades feature prominently on the Nebra sky disk, dated to around 1600 BC, pictured together with the sun and moon, suggesting their joint importance (see Table of Contents: 06/5b). Classical sources indicate use of heliacal (near dawn) rising of the Pleiades in spring to signal the start of, and morning setting in autumn to mark the end of the farming season. They have been invoked as targets for structural alignment at prehistoric sites. For instance, Burl (1983, 179) suggests that the ENE'n row at Callanish might have been aligned on the rising of the Pleiades. A similar suggestion has been made for entrances at certain Austrian timber circles and enclosures, including Immendorf (Gibson 2005, 87-88).

The pre-dawn heliacal rising of Sirius (e-FIG AS-19) had particular calendric significance in ancient Egypt, coinciding as it did with the onset of flooding in the Nile valley, during Akhet, the first of the three four-month long seasons, and marking the start of the year. In Greece, Sirius is mentioned in the Iliad, in the Works and Days of Hesiod (7th century BC), and its dawn rising, accompanied by particular rituals, marked the onset of hot dry summer weather. Romans celebrated the heliacal setting of Sirius around April 25th by particular sacrifice to protect crops.

The setting motion of the Orion group, and its possible relevance as a cue for axial alignment of long barrows, was noted by the author [AJM] independently of the strong evidence for its involvement in ancient Egyptian funerary ritual. Evidence for Egypt has been presented, especially during the earlier Old Kingdom, by Bauval and Gilbert 1994, as a popular account. Here, the *Sahu* group of stars, from the Hyades, through Orion, to Canis Major and Sirius, can be equated with gods, notably Orion (*Sokar* as Osiris), the Hyades (as Seth), and Sirius (*Sothis* as Isis), these forming the central portion of the *Duat*, or celestial destination of the Royal Dead. Orion itself also formed one of the four standard *decans*: these were star groups rising, or culminating at highest elevation over the S'n horizon, marking hourly intervals during the night, ritually important in the ceremony of burial.

Amongst other interretations (Ruggles 2015), personification of Orion as a conspicuous humanoid figure is widely recorded, as in several Near Eastern cultures, for instance. as linked with the later Perso-Roman deity Mithras. The identification of Orion as a young man, its nearby constellations as a group of males, and the association of the Pleiades with a group of girls, is also a feature of oral traditions in Aboriginal cultures across Australia (Norris *et al.* 2012).

Brightness

All of the major stars in the Orion group are sufficiently bright to remain visible during semi-clouded conditions, or fairly bright moonlight, with the three stars forming the belt of Orion (Alnilam, Alnitak, Mintaka) continuing to appear as a distinct line under these conditions (TABLE AS-06). A league table of the brightest stars is given in Burl 2000, table 2/ p.25).

TABLE AS-06 The Orion group: visibility of stars

constellation	star(s)	apparent magnitude
Canis Major	Sirius	-1.45
Orion	Betelgeuse	0.42
	'belt stars'	1.75-2.23
	Rigel	0.18
Taurus	Aldabaran	0.85
	Hyades	0.5
	Pleiades	1.6
Gemini	Alhena	1.9
	Pollux	1.1
	Castor	1.6
Auriga	Capella	0.1

Note: belt stars: Alnitak, Alnilam (at the centre of the three), and Mintaka; the smaller the apparent magnitude, the brigher the star appears;

Directions of rising and setting

The Orion group can be seen low on the W'n horizon during the winter months, setting more or less in unison, ranged from S to N as Canis Major-Orion-Taurus (e-FIG AS-18). At this time, the three constellations rise in the E more in sequence than they do for setting, but in the opposite order (e-FIG AS-17).

Rising and setting points are constant for each year, with slow change in the long-term, seen as a gradual movement towards the S over millennia. Using Alnilam, the central belt star of Orion, as a marker, there has been a 36° shift towards the SW over the past 8 millennia, from the current near-W'ly setting (TABLE AS-07).

Taking events in 3000 BC as an arbitrary example, these constellations rise and set in different groupings (TABLE AS-07; e-FIGS AS-17 and 18):

*-**setting***: Canis Major-Orion-Taurus appear displayed together in a band along the horizon, and they set more or less in unison, to be followed at a similar elevation by Gemini-Auriga, some three hours later.

*-**rising***: compared to the more linear display during simultaneous setting, risings occur with less unity, and in more of a sequence: Auriga-Taurus followed by Gemini, then Orion, then Canis Major. The orientation of the constellations in the sky, with respect to the horizon, also differs between rising and setting, perhaps allowing different perception of constellations and interpretations of patterning.

Since these constellations are more imposing when fully displayed just above the horizon than when partly submerged, azimuths are given for such more elevated positions, as well as for risings, and settings of component stars at the horizon (TABLE AS-07; e-FIGS AS-17 and 18). The sample location is in S'n England (52°N, 2°W), and the values given are broadly representative of the British Isles up to N'n Scotland, with variation of only a few degrees of azimuth between contemporary data from extreme localities.

Taking the maximum spread of these constellations, from Sirius to Capella, they can be seen to rise and set over an 80-100° arc of the horizon, with Taurus occupying the approximate centre at around E and W (TABLE AS-07).

TABLE AS-07 The Orion group: azimuths at the E'n and W'n horizons for rising, setting, and near-horizon positions of selected stars and constellations, from 4000 BC to the present, for a sample latitude of S'n England (52°N, 2°W)

	CAN MAJ	ORION			TAURUS		GEMINI			AURIGA	R
Date	**Sirius**	**Saiph**	**Alnil**	**Bella**	**Ald**	**Plei**	**Alhena**	**Pollux**	**Castor**	**Capella**	
SETTINGS											
star at the horizon											
2000 AD	242	254	**268**	[280]	297	311	297	319	327	no set	85
1000	242	253	**266**	277	[292]	303	297	322	331	no set	89
1 BC	242	249	262	**273**	[286]	296	295	323	331	no set	89
1000	239	244	257	**267**	279	288	[291]	320	327	341	102
2000	234	238	250	260	**270**	[278]	285	314	320	325	91
3000	228	229	241	252	261	[**269**]	278	307	312	314	86
4000	219	218	232	242	252	[261]	**269**	298	302	303	84
constellation complete and just above the horizon											
2000 AD	221	241	248	255	[**272**]	286	285	281	286	318	97
1 B	220	234	242	250	260	[**274**]	286	285	290	315	95
1000	218	226	234	242	252	[266]	**282**	284	289	310	92
3000	205	205	213	220	229	[243]	265	**269**	274	290	85
RISINGS											
star at the horizon											
2000 AD	118	106	**093**	080	063	050	063	042	032	no set	
1000	118	108	**094**	083	068	056	063	037	029	no set	
1 BC	118	111	098	**087**	074	065	065	037	029	no set	
1000	121	116	103	**093**	082	[073]	069	040	034	019	102
2000	125	123	110	100	**090**	[082]	075	046	041	035	90
3000	132	131	119	109	099	[**091**]	083	053	049	047	85
4000	141	142	128	118	108	[100]	**091**	062	058	057	84
constellation complete and just above the horizon											
2000 AD	162	114	112	109	076	[**081**]	076	056	056	040	101
1 BC	158	121	120	120	[**088**]	095	076	057	057	051	107
1000	165	129	130	131	[**096**]	103	080	061	062	061	104
3000	187	149	152	156	117	[126]	**093**	075	076	078	109

Key: CAN(is) **MAJ**(or); **Alnil**(am); **Bella**(trix); **Ald**(aberan); **Plei**(ades); **R**(ange of azimuths between maximum and minimum); azimuths nearest to due E and W are shown in bold type, providing a convenient visual reference; those nearest the centre of the range R are bracketed thus [..].

Patterns of rising and setting during the year

Although the azimuths of rising and setting for the Orion group change very slowly over the centuries (TABLE AS-07; e-FIG AS-16), the time of day at which these events occur varies significantly throughout each year (e-FIG AS-19).

In order to determine the dates on which elements within the Orion group become visible, whilst rising in the early dark, and remain visible until setting in the pre-dawn twilight, precise viewing conditions during dusk and dawn have been defined for this analysis (data: from Haney 1994). The degree of darkness 1-1.5 hours after sunset, or before dawn, was deemed sufficient to allow stars to be clearly visible. This is about an hour from Nautical Twilight, as determined by Reed's Nautical Almanac, when the sun is 6-12° below zero elevation, at both dawn, and dusk (definitions of twilight: civil 0-6°, nautical 6-12°, and astronomical 12-18° below zero elevation).

Key starting and ending dates for rising and setting were determined for these conditions (e-FIG AS-20). The annual cycle was determined for arbitrary dates, 1 BC, and 3000 BC, to give an indication of longer-term change, with the former included to allow discussion in terms of the Celtic calendar (see Table of Contents: 02b/9a), which may contain structure relevant to discussion of earlier periods (e-FIG AS-19).

The Orion group is a prominent feature of the night sky during autumn and winter, with elements visibly rising and setting, making first and last appearances at dusk and pre-dawn, in a complex pattern (e-FIG AS-19).

The details for 1 BC will serve as a standard, with those for 3000 BC mentioned by comparison. In early September, the Pleiades, Orion, and Sirius (abbreviated here P, O, S) rise at dusk, but do not manage to set before daylight (e-FIG AS-19: A), until the full transit is achieved in darkness, during early November (e-FIG AS-19: B). During December and January, dark risings and settings occur variably (e-FIG AS-19: B-C), with a progressive loss of dark risings until only dark settings at dusk remain, these also overcome by daylight during mid April (e-FIG AS-19: C). The Orion group is essentially absent from the night sky during the summer months, and from early May to later August only marginal elements appear briefly during the pre-dawn (e-FIG AS-19: C-A).

Because the group sets in unison, with its elements in line, the first dawn or dusk settings, in the order P-O-S, occur over the relatively short period of a week or two (e-FIG AS-19: B, C). First dawn or dusk risings, on the other hand, since elements emerge in sequence P, O, S, are far more separated, occurring over periods of one to several months (e-FIG AS-19: x-y-z).

Changes in the daily timing, and visibility of rising, and settings over millennia

The cycle of pre-dawn and post-sunset visibility for the Orion group in 3000 BC (Neolithic) differs from that in 1 BC (later Iron Age) in two respects. Importantly, events for 3000 BC occur about a month earlier, at slightly different azimuths, and there are minor increases in the spread of P-O-S first risings and settings, this latter of minor significance.

Setting of the Orion group during the early darkness in spring is particularly conspicuous (e-FIG AS-18). In 1 BC this would have occurred during the first two weeks of April (e-FIG AS-19: C), and in 3000 BC during late February and early March. Other examples of these settings are also given in e-FIG AS-19. This may be significant in discussion of the use of such markers within the agricultural cycle (see Table of Contents: 02b/9a).

Consideration of other stars as potential targets for alignment of monuments

A general map of constellations in the N'n celestial hemisphere is given in e-FIG AS-14.

Certain types of monument, such as stone rows, recumbent stone circles, cursus monuments, and henges (e-FIG CO-01) show orientational behaviour with a distinct N-S'ly emphasis, towards areas of the sky where risings and settings are rare or absent.

Sector of the sky:

-the more N'ly sky

Polaris (apparent magnitude 2.1), at the N, provides a fixed point, either as a direct target, or as a basis for establishment of a cardinal system that includes S, E, and W. Although it appears to precess around the actual N-point, this is a very minor, and long-term effect in relation to the type of orientational behaviour considered in this analysis. Rotating around Polaris the **circumpolar, non-setting stars** also help to define a broader N'n zone.

Altair, in the constellation Aquila, is a bright star (apparent magnitude 0.8) that rises in the ESE, and sets in the WNW, and has done so, with variation of about 10° of azimuth, since 4000 BC (e-FIG AS-15).

Arcturus (apparent magnitude 0.24), in the constellation Boötes, has shown NE'ly rising, and NW'ly setting, for the past four millennia.

-the more S'ly sky

Considering the S'n horizon, few conspicuous rising and setting targets present themselves as other than fairly bland targets (e-FIG AS-15). **Antares,** in the constellation Scorpio (apparent magnitude 1.09), has become progressively more S'ly in its risings and settings, these being broadly E' and W'ward in 4000 BC, these closing to around SE and SW at present.

Vega (apparent magnitude 0), in the constellation Lyra, at the edge of the circumpolar group of stars, has remained argely visible over the last two millennia, with only brief risings or settings at the S, remaining more fully elevated above the horizon before this.

The **Orion group** of constellations has been discussed more fully above.

Stars: changing visibility in the night sky: specific examples

The appearance of stars and constellations can be considered in terms of rising, or setting events, at dusk, or dawn, and in the extent of exposure during the intervening hours of darkness (general sky-map: e-FIG AS-14).

Five examples are listed below, set at increasing distances from the celestial pole, and hence decreasing in the seasonal visibility of their trajectories: moving from Vega, at the margin of the circumpolar zone, outward to Arcturus, the Pleidades, and Orion, and finally to Sirius, near the limit of the N'n celestial hemisphere:

Vega [constellation: Lyra]

location: at the margin of the circum-polar zone of stability;
seasonal variability: low:
The circuit of **Vega** gradually approaches the S'n horizon, starting to graze it at dusk during early spring, and again at dawn during late autumn;
potential marker for activities in: springtime, and late autumn;
data: modern;
key: 1: rising at dusk; **2**: length of night-time course; **3:** rising during the pre-dawn; **G:** course grazing the horizon;

	events after dusk	**course completed during night**	**events pre-dawn**		**summary 1**	**2**	**3**
jan	near setting	sector only	first 1/4 done	J:			
feb	**setting**	sector only	first 1/3 done	F:	+		
mar	**grazing S'n horizon**	sector only	in mid course	M:	G		
apr	**grazing S'n horizon**	sector only	in mid course	A:	G		
may	risen	first 1/2	first 3/4 done	M:			
jun	well risen	mid 2/3	first 3/4 done	J:			
jul	first 1/3 done	mid 3/4	near setting	J:			
aug	in mid course	**near full**	nearer setting	A:		+	
sep	in mid course	last 1/2	setting	S:			
oct	first 3/4 done	last 1/4	**grazing S'n horizon**	O:			G
nov	near setting	last 1/4	**grazing S'n horizon**	N:			G
dec	near setting	last 1/4	rising	D:			

Arcturus [constellation: Bootes]

location: just beyond the circum-polar zone of stability;
seasonal variability: low;
Arcturus can be seen rising at dusk in early spring, and setting during the pre-dawn at the end of autumn.
potential marker for activities in: springtime, and late autumn;
historical: Greek sources: pre-dawn rising marked the end of autumn;
data: modern;
key: 1: rising at dusk; **2**: length of night-time course; **3**: rising during the pre-dawn;

	events after dusk	**course completed during night**	**events pre-dawn**		**summary**		
					1	**2**	**3**
jan	already set	first 1/3	in mid course	J:			
feb	already set	2/3	2/3 course	F:			
mar	**just rising**	2/3	3/4 course	M:	+		
apr	risen	**3/4**	just pre setting	A:		+	
may	well risen	**>3/4**	setting	M:		+	
jun	in mid course	last 1/2	already set	J:			
jul	2/3 of course done	last 1/3	already set	J:			
aug	3/4 of course done	absent	already set	A:			
sep	almost setting	absent	already set	S:			
oct	setting	absent	**rising**	O:			+
nov	already set	~absent	risen	N:			
dec	already set	first 1/3	risen	D:			

Pleiades [constellation: Taurus]

location: just beyond the circum-polar zone of stability;
seasonal variability: low;
The Pleiades rise in the pre-dawn during spring;
potential marker for activities in: springtime and early autumn;
historical: Hesiod: rising at dusk in September marked the onset of harvest time, and rising at dawn marked the end of spring, also the start of the main season for safer sailing;
data: modern;
key: 1: rising at dusk; **2**: length of night-time course; **3**: rising during the pre-dawn;

	events after dusk	**course completed during night**	**events pre-dawn**		**summary**		
					1	**2**	**3**
jan	1/4 of course done	last 3/4	already set	J:			
feb	1/2 of course done	last 1/2	already set	F:			
mar	3/4 of course done	last 1/4	already set	M:			
apr	near setting	already set	**rising**	A:			+
may	setting	already set	risen in daylight	M:	+		
jun	already set	first 1/4	risen in daylight	J:			
jul	already set	first 1/3	risen in daylight	J:			
aug	already set	first 1/2	risen in daylight	A:			
sep	**rising**	first 1/2	risen in daylight	S:	+		
oct	risen	first 3/4	risen in daylight	O:			
nov	risen	**full course**	setting	N:		+	
dec	risen	last 3/4	**nearer setting**	D:			+

Orion [specific markers used here: the three stars of the belt]

location: near the margin of the celestial sphere for the N'n Hemisphere;
seasonal variability: high:
historical: frequent association with hunting;
potential marker for activities in: clearly visible during winter and early spring, from December to April;
data: modern;
key: 1: rising at dusk; **2**: length of night-time course; **3**: rising during the pre-dawn;

	events after dusk	**course completed during night**	**events pre-dawn**		**summary 1**	**2**	**3**
jan	**just risen**	**full course**	**just set**	J:	+		
feb	1/4 of course done	3/4 of course	already set	F:			
mar	1/2 of course done	1/2 of course	already set	M:			
apr	3/4 of course done	1/4 of course	not yet risen	A:			
may	**setting**	absent	not yet risen	M:	+		
jun	already set	absent	**rising**	J:			+
jul	already set	absent	risen in daylight	J:			
aug	already set	1/4 of course	risen in daylight	A:			
sep	already set	1/3 of course	risen in daylight	S:			
oct	not yet risen	1/2 of course	risen in daylight	O:			
nov	not yet risen	3/4 of course	setting in daylight	N:			
dec	rising	**full course**	setting	D:		+	

Sirius [constellation: Canis Major]

location: at the margin of the N'n celestial hemisphere;
seasonal variability: high:
Sirius can be seen rising in the pre-dawn during mid summer;
potential marker for activities in: high summer;
historical: pre-dawn rising marked onset of mid-summer heat, and of the annual flooding of the Nile;
data: modern;
key: 1: rising at dusk; **2**: length of night-time course; **3**: rising during the pre-dawn;

	events after dusk	**course completed during night**	**events pre-dawn**		**summary 1**	**2**	**3**
jan	**rising**	**full course**	already set	J:	+	+	
feb	risen	**full course**	already set	F:		+	
mar	well risen	last 1/2	already set	M:			
apr	in mid course	last 1/3	already set	A:			
may	setting	absent	already set	M:			
jun	already set	absent	already set	J:			
jul	already set	absent	**about to rise**	J:			+
aug	already set	absent	**rising**	A:			+
sep	already set	first 1/4	risen	S:			
oct	already set	first 1/2	in mid course	O:			
nov	already set	first 3/4	setting	N:			
dec	already set	**full course**	set	D:		+	

Planets

In order to assess the potential of planetary motion as a target for alignment, directions of setting for the four brightest planets, Venus, Mars, Jupiter, and Saturn, were considered. Two separate samples were taken over 5-year periods to illustrate major features of cycles and demonstrate variability, using 2000 AD and BC as arbitrary starting points (e-FIGS AS-21 and 22).

Venus

Azimuths of setting show the full amplitude of movement along the W'n horizon between solstice positions, in a repetitive sequence, out of phase between the two sample periods illustrated. In both cases there is about a one-year interval between peaks;

Mars

Transits again show the full amplitude between solstices, but in this case do not appear comparable between the sampling periods, and have about two years between peaks;

Jupiter

The directions of setting show approximately annual minor peaks, superimposed on a longer-term fluctuation of fuller amplitude, within the inter-solstitial sector;

Saturn

Transits exhibit very slight, and approximately annual variation, within a longer-term fluctuation occupying only part of the inter-solstitial sector and, in the examples here, positioned nearer the zone of summer solstice setting;

There are distinct intervals when several planets set more or less together. **Congruent settings** of all four planets occur in the AD-sample about every two years, mid-year, especially around the zone of summer solstice setting. Such settings for the BC sample are less well defined.

These examples therefore demonstrate that planetary settings are very variable in their amplitude, periodicity, timing, and combination, moving in and out of synchrony in a complex manner over time. Although setting of some might have added significance to the direction of solstices, especially when several were involved, variability and complexity over time is such that they appear unsuitable as a clear primary cue for alignment of monuments.

e-FIGURES: combined listings and supporting information

Note: RA: data presented for a specific **R**eference **A**rea: S'n-central England at 52°N 2°W.

e-FIG
AS-
solar transit

01 Solar and lunar transits: zonation, and key points for RA
Defines standstill positions for the sun and moon, with division of the solar transit into zones.

02 Variation in the azimuth of summer solstice sunset for European latitudes
Shows movement of the solstice towards the N, with increasing latitude.

03 Properties of the solar, and lunar cycles at different European latitudes
Shows movement of solar and lunar standstill positions with changing latitude.

04 Solar transit: profiles of elevation throughout the year for S'n and N'n Britain

04a Solar transit: azimuth of sunset versus calendric date for RA

04b Visualising the solar transit at winter minimum
Positions of the sun were recorded photographically at intervals throughout the day from the stated point, and used to reconstruct the complete transit, just pre-vernal equinox, as seen in the locality. Images showing the appearance of the solar disc, taken at various times of day, have been added.

photography: area of Belas Knap long barrow (Sudeley I; Cotswold-Severn group of monuments); SP 0124; map provided as **e-FIG AS-04c**;
viewing from: SP 0149 2531;
longitude and latitude used for calculations: 51.925 N; 1.975 W;
astronomical data obtained from: suncalc.org

Trans VE: 11-12 March 2019				**Trans WS:** 21-22 December 2018		
	h GMT	**elev**	**azim**	**h GMT**	**elev**	**azim**
sunrise	0634	0	095.49	0815	0	147.17
culmination	1217;	34.38	180	1206	14.7	180
sunset	1801	0	264.44	1557	0	230.89
arc 169				arc 84		

Key: Trans(it at the) **VE** (vernal equinox), **and WS** (winter solstice)**; h GMT** hours Greenwich Mean Time; **elev**(ation in degrees); **azim**(uth);
culmination: the sun at its highest elevation; **arc**: the angular difference between sunrise and sunset.

04c Map covering the area for which solar transits are shown in e-FIG AS-04b

05 Solar transit: elevation of the zenith at solstices and equinox: variation with latitude

06 Solar transit: dynamics: elevation and speed of the sun for RA

07 Solar transit: approach and departure of the setting sun in relation to the solstice for RA

08 Solar transit: azimuths of mid points in rising and setting limbs throughout the year for RA.

Considers use of the solar limb as a target for alignment of monuments.

09 Solar transit: transit-frequency for azimuths in the setting sector throughout the year for S'n and N'n Britain
Outlines the relationship between direction of an axis and the frequency with which the sun crosses it at various elevations.

09a Solar transit: changes in the relative frequency of solar transit that occurs between opposing directions in an axis, as it rotates between solstice positions

10 Solar transit: determination of the equinox by shadow casting
Examines the possibility of determining the timing of solstices, and equinoxes by observation of shadow casting at one-eighth intervals of the half solar transit (~22 days). Selected location: Knowth passage grave (Meath, Ireland: 53.7°N, 6.5°W): undertaken for specific comparison with the dial engraving on kerb K15.

Shadows were tracked using data extracted from Haney 1994, using the azimuth and elevation of the sun as given there. The length of shadow L was calculated as L=g/tan e, where g is height of the gnomon, and e is the elevation of the sun above zero horizon.

lunar transit

11 Lunar transit: patterns of change over a sample 14-day period for RA
Demonstrating the complexity of the lunar cycle, and problems in using it as a basis for alignment.
Examining the phenomenon of moon-skim, when the lunar transit passes close to the S'n horizon, implicated as a possible factor in ritual at certain monuments, such as Callanish.

12 Lunar and solar transits of minimal elevation: variation with latitude

13 Lunar transit: S'n moon-skim at Callanish

stellar movement

14 Star map of the N'n Celestial Hemisphere

This image shows, layered onto a basic map of the night sky, the constellations visible at two-monthly intervals throughout the year.
location: latitude 51°; longitude -1.5°;
intervals: 2-monthly, on 1st January, March, May, July, September, and November;
sky viewed at: 3 hours after dusk;
data: for 2020;
-individual
Considering the brighter stars as candidates for axial alignment:

15 Stellar movement through time: examples of millennial change

-constellations
Behaviour of the Orion group might form some basis for increased awareness of the W as a significant direction for funerary alignment:

16 The Orion group: changes in setting azimuth over time for RA

17 The Orion group: rising at hourly intervals: sample sequence during 3000 BC for RA

18 The Orion group: setting at hourly intervals: sample sequence during 3000 BC for RA

19 Division of the year: patterns of rising and setting in the Orion group for RA

20 The Orion group: sample calculation for determination of events in e-FIG AS-19

Planetary orbits
The complexity of planetary orbits over time present an unstable basis for axial alignment:

21 The brightest planets: azimuths of setting for a sample period 2000-2004 AD for RA

22 The brightest planets: azimuths of setting for a sample period 2000-1994 BC for RA

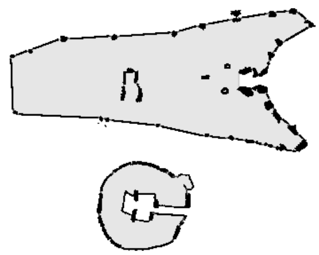
Groups of monuments in the analysis

Section 03

Axial alignment amongst particular groups of monument

Section 03a:
Analysis of the orientation of long barrows,
and other chambered tombs from the European Neolithic

Section identifier: LB-
SEE INITIAL SECTION:
Access to digital images



upper/ Blasthill (Argyll, Scotland);
lower/ Callanish_central (Lewis, Scotland)

Summary:
Analysis of a sample of 2850 long, and circular funerary monuments of Neolithic date, from different areas of W'n Europe, indicates preferred directions for the orientation of main axial elements. The range of orientation observed is broad, but shows increased frequency around W to NW for the axial direction towards the rear of the monument. Various environmental, and other cues for alignment are considered, with the solar transit likely to have been particularly significant, because of its prominence, and relevance to seasonal and economic concerns of agrarian communities.

A general model for alignment behaviour is proposed, in which three factors combine to account for the main features observed in this distribution of frequencies: onset of suitable weather, and seasonal availability of labour, with alignment of the axis tending to be towards the setting sun at those particular times. Possible links between funerary ritual and the setting solar transit are discussed.

Axial alignments fall into two main groups, the S'ly and the W'ly: many chambered tombs belong to the W'ly group, many stone rows and cursus monuments to the S'ly group.

More detailed case studies examine variation in orientation between key groups of monument in Britain, and its possible significance.

the following topics are discussed:

-aspects of axial orientation as a basis for **assessment**;

-**evolution** of alignment practice;

-analysis of orientation in **published groups**; existing interpretations;

-the **nature of the axis**: timing of construction, types of axial structure, and persistence of the axis;

-**complications** with the axis: asymmetric and composite monuments;

-**directionality** within the axis;

-general **results of analysis** for axes of long barrows, other chambered tombs, and for long and round house structures of various dates;

-a **general hypothesis**: the seasonal-solar model (e-FIG CO-02);

-the anomalous orientation of **Irish passage tombs**;

-an alternative W'ly cue for alignment: the **Orion group**;

-influence of **environmental and economic factors** on axial alignment;

-discussion of the **seasonal labour cycle**;

-the relationship between long barrows and **domestic structures**;

-choice of axis as a means for **directed illumination** of interior chambers;

-a case study: **Cotswold-Severn tombs**.

Introduction

The monuments and their orientation

Many of the Neolithic communities which developed in W'n and N'n Europe during the 4th and 3rd millennia BC are characterised by construction of often large, elaborate, and frequently megalithic funerary monuments. However, recent interpretations of function at these sites suggest that their use extended well beyond provision of essential facilities for interment, with burial rituals complex, and selective placement of human remains an integral aspect of a centre with broader cultural and territorial significance. Examples of long barrows from Scotland and England are given in e-FIGS LB-14 and 15.

There are also possible parallels between these funerary monuments and domestic architecture (e-FIG LB-23). Given the likely importance of ancestry in such communities, these monuments would have provided a ready interface between the world of the living, and that of the dead, with alignment a key link. In order to emphasise such broader interpretation, these sites are therefore considered more as funerary monuments rather than as tombs.

Since the 19th century, these monuments have been studied intensively in terms of typology and chronology. General architectural categories such as 'passage grave or tomb', 'gallery grave or tomb', and 'earthen long barrow' have been established, and these terms applied over widely separate areas (Daniel 1950, 1960; Ashbee 1984; Field 2016). Certain consistencies in orientation within, and between regional groups of funerary monument, have long been noted (TABLE LB-01). These preferred alignments have, in general, been interpreted in terms of targeting external astronomical phenomena, although marked variation in orientation within groups has often led to caution in establishing any direct correlation.

General similarities of axial orientation throughout the entire European group of funerary monuments suggest that alignment was an important factor in their construction, and perhaps one that resulted from some common ritual, involving reference to some target of continental scope. Orientation amongst these sites is generally considered to reflect deeper ritual significance, rather than any distinct calendric, or astro-observational usage.

Comparable alignment is apparent not only within structurally related groups but also between groups with differing morphology. For instance, long barrows and circular passage tombs show consistent similarities in orientation between major axial elements, despite differences in overall architecture (e-FIGS LB-30, 09 and 10).

Orientation at specific sites has often been interpreted in terms of alignment of the principal longitudinal axis with certain events in the annual solar cycle, for instance the direction of sunrise around the period of winter solstice. At certain sites it has also been suggested that passages were aligned to allow illumination of interiors at particular times of the year (see Table of Contents: 03a/2c).

However, such precise correlation with specific events at the horizon, for instance solstices or equinoxes, seems to be exceptional, since it has long been noted that group-orientation is broad and does not in general appear to be based on use of precise rules. Attempts to involve lunar standstill positions as a cue for alignment have little substance, neither within the data nor in terms of suitability as a meaningful basis for regular ritual activity (see Table of Contents: 02c/3).

There is a distinct lack of any general model for orientation amongst these monuments, with a few specific celestial targets, often unrealistic, suggested for a few sites, leaving the majority of axes unexplained. Despite studies of orientation at individual sites, and for several regional groups, such analysis has been generally lacking on a broader European scale, both amongst these barrows, and for the wider context of contemporary, and later monuments. A more comprehensive comparative study, over a range of monuments, might attempt to unify the data, examine divergence, and produce a more exact, and comprehensive basis for interpretation of more localised groupings, and single sites. This analysis, although it concentrates on samples of monuments from Britain and Ireland, does extend to consideration of data from groups of funerary monuments from Europe.

In this analysis, major features of orientation amongst funerary monuments are defined in closer numerical terms, and these data are used to examine alternative hypotheses that might specify factors influencing choice of alignment. Systematic reappraisal of monumental orientation, and its possible relationship with external astronomical, or with other environmental phenomena is important in evaluating the extent to which more abstract principles, for instance astronomical, might have been current amongst earlier prehistoric communities, and were applied as part of ritual behaviour.

Aspects of orientation for assessment

Several obvious topics relating to use of celestial events for alignment, the option which has received the most attention, present themselves for consideration:

-The extent to which limiting positions might have been used as a basis for alignment

It would be interesting to know how far limiting solar and lunar positions, such as solstices, and lunar standstills, might have provided cues for alignment (TABLES LB-01 and 04). The existence of such defined reversals of direction in the transit would be relatively easy to observe, and utilise, and could have provided ready seasonally relevant markers for monumental orientation. Such targets have been suggested for several important sites, where alignment appears to be very precisely directed towards the solstice, but these seem to be exceptions, within a much broader range (e-FIGS LB-01 to 21).

In order to allow for less precise orientational behaviour, more attuned to ritual than to astronomical-type observation, definition of the event could be broadened to include near-solstice or –standstills, as peri-solstitial.

-Use of a transitional point like the equinox as a target

Equinoctial directions represent events that are far less clear than discrete standstills, since they are a more abstract concept, and transitional in nature rather than terminal. Defined as the point midway between the solstices, the equinox is marked by no reversal in the solar transit, only by opposed rise and set, with equality of day and night.

Any interpretation of alignment, using the equinox as a basis, would require explanation in terms of more abstract astronomy, or at least calendric counting. Apparent use of the peri-equinoctial direction might however be an artefact caused by other factors arising from the seasonal-economic cycle, for instance the requirement for onset of suitable weather, and sufficient availability of labour, both acting to displace axes towards the corresponding time of year (see Table of Contents: 03a/13a; e-FIG LB-41a).

-The effect of extending the range of cues at the horizon to include those at elevation

In almost all discussion of monumental alignment it is assumed that cues were restricted to rising or setting events at the horizon (see Table of Contents: 02b/5c). This assumption is unwarranted, and may well account in large part for failure to propose any more unified basis for alignment behaviour.

Proposal of some general model for orientation

Any such model would have to explain the following:

-observed diversity between monuments within a particular group

It is not enough to offer explanations for single sites in terms of particular phenomena, such as lunar, or solar extremes, and to leave the rest of the group, otherwise structurally similar, unexplained. Particular monuments might, of course, have had specialist functions, and hence more exact astronomical alignment. However, it seems unlikely that a group of monuments, sharing many elements of construction and usage in common between widely separated areas, sites that were labour-intensive to produce, and of obvious importance in their locality, should not share some common basis for alignment.

-apparent reversals of orientational behaviour

Certain funerary monuments, single sites, and in rare cases entire regional groups, appear to express a clear reversal of the general trend, and an explanation for this too must be attempted. For example, Irish wedge tombs (e-FIG LB-21) point (front to rear) E'wards, rather than towards the more usual W'ward direction (e-FIGS LB-10, 16, and 19). Single instances of such reversal are widespread, and can be seen for instance in long barrows from the Cotswold study area (e-FIG LB-89).

-monumental alignments that appear to fall within zones where rising and setting is greatly reduced, or does not occur

There are many cases where the axis of a monument lies generally N-S, the N'n direction being the null zone where, using the sun as an example, no activity occurs, and the S'n where no events at the horizon occur, but only transits between minimum elevation at midwinter, and maximum at midsummer.

The need for comparative studies

Comparative studies are essential in order to view changes, or consistencies, in alignment behaviour amongst monuments of different type, for instance those with varying degrees of funerary emphasis. Orientation of more dedicated funerary monuments might be expected to differ from sites with a greater emphasis on ritual activity of a more seasonal and economic nature, as could be argued for cursus monuments, henges, stone rows, or stone circles.

It is known that construction of many long barrows predates the erection of stone circles, alignments, and other related megalithic structures (Burl 1976, pp. 45-54), for which a high level of geometric, and astronomical sophistication has been argued (Thom 1967, 1971, Hoyle 1977). Although they are structurally and functionally different from circles and alignments, there are cases of close association between funerary monuments and megalithic circles, which could suggest certain affinities of tradition. Sites with hybrid ring-barrow characteristics occur, for instance in the Clava group, Scotland (Burl 1976, 160-190, 213-224), and at such passage tombs as Newgrange, Ireland (Burl 1976, 33-34, 241; O'Kelly *et al.* 1983). Construction of a passage tomb within an existing megalithic ring at Callanish, Lewis, Scotland, also suggests some relationship in ritual (see Table of Contents: 03e/10a).

Analysis of orientation for groups of early funerary monument might therefore provide certain insights into the context within which later, and more elaborate megalithic structures developed, for which more advanced geometry and astronomical associations have been suggested. Conversely, it might serve to establish the existence of different spheres of ritual for each class of monument.

Evolution of alignment-practice

The evolution of trends in alignment of monuments has been widely discussed, as for instance by Burl (1983, 21-46), who suggests three main phases, the primitive (4000-3000 BC), developed (3000 to 2000 BC), and local (2000-1250 BC), outlined below:

..Primitive

Long barrows formed the dominant monumental type here, and considering the direction of facing only as prime, distinct regional traditions are outlined. Considerable variability existed, and the point is made that a range of targets, some astronomical (solar, lunar, stellar), and some topographical, might have been utilised. Certain exceptional sites, such as New Grange, and Maes Howe, appear to show sophisticated alignment on solar risings for the purpose of interior illumination (see Table of Contents: 03a/20). Anomalous alignment of Irish wedge tombs to face the W, rather than the usual E, is taken to suggest increased importance of sunset over the sunrise. Other W'ly-facing sites, later in the sequence, such as Clava cairns (see Table of Contents: 03a/5), and related recumbent stone circles (see Table of Contents: 03e/7) may reinforce this trend.

..Developed

Henge monuments appearing in this phase are noted as having many entrances aligned generally N-S, where no setting events occur (towards the null or permanent zones of the transit). Stone circles from this phase include complex geometry, with possible calendric significance, and structural reference to cardinal points.

..Local

Penetration of settlement into marginal areas during the earlier Bronze Age saw further development of local traditions amongst stone rings and rows.

The trend for alignment, suggested above by Burl, is therefore one of increasing sophistication, and of application beyond the more funerary sphere, to be found amongst the range of other monumental types that came to dominate architecture during the later Neolithic, and earlier Bronze Age. Variable, and often contradictory data suggest a complex basis for alignment, with simpler astronomical targets forming only one element.

Given the basic economic concerns shared by agricultural societies, with those of Neolithic and Bronze Age Britain no different, there should be a common strand to alignment behaviour during this period, with firm roots in agrarian practice. It remains to be seen whether alignment data can be unified around such a central theme.

Existing interpretation of orientation amongst chambered tombs

Consistencies of orientation have long been noted amongst groups of European Neolithic barrows, with emphasis usually placed on the generally E'ly direction that they face. Regional azimuths of chambered tombs in Britain, Ireland, and Brittany are given in Burl 2000, table 1/ p. 24.

Variable ranges of alignment have been noted, with several groups forming marked exceptions to the general trend, such as Irish wedge-shaped tombs, which tend to face E'ward, rather than to the more normal W'ward (e-FIG LB-21), and the Scottish Clava group, which face a S'ly direction (e-FIG LB-11). Both of these anomalous groups of monuments appear later in the sequence of chambered tombs, with suggested dates in the later 3rd millennium BC, and may indicate development of variant ritual.

In Britain and Ireland, the orientation of both chambered and unchambered tombs, round and long, has been widely discussed, examples of which follow. The emphasis is almost universally on the direction that such monuments face, rather than point (front to rear), targets are seen as events at the horizon, rather than possibly at more elevation, and involve sun, moon, stars, or planets in descending order of suggested use. Standstill positions of the sun and moon, annual for the former, at impractical 18-19 year intervals for the latter, and transitory equinoctial events are frequently invoked as cues. Much is often made of interactions between rising or setting, and distinct topographical features at the horizon. The general basis for monumental alignment is seen as exhibiting variety rather than any unity. The emphasis is frequently on what are seen as ancient astronomical interests, rather than expression of social and economic rituals.

Scotland

Henshall noted a consistent preference for facing SE'ward amongst the Shetland group, and NE-SE'ward in the Orkney-Cromarty group, the SE'n quarter in the Hebridean group, with the NE favoured in the Clyde group. A looser preference for an E'ly direction was noted in the Maes Howe group of passage tombs, with such a major site as Maes Howe itself anomalous, in that it faced SW. Considerable variability was also noted in the Balnagowan group (Henshall 1963 and 1972; Davidson and Henshall 1982, 85-86). Fraser (1983, 1988) examined 76 chambered tombs in Orkney, including analysis of visibility from monuments, and suggested observation of the sun at various times in the agricultural year.

..Clava group

The small Clava group of passage tombs, much discussed in terms of alignment, forms an exception amongst such E'ly facing sites, opening instead towards the S'n side, with a similar structural emphasis seen at related ring-cairns, and recumbent stone circles (Ruggles 1999; Bradley 2000).

Despite their SW' to S'ly facing orientation, Burl (1976, fig. 25/ p.163) noted the lack of any precise correspondence with winter solstice sunset, the closest key solar event, about 223° azimuth at latitude 57° N. It was suggested that if entrances were astronomically aligned, it must have been towards a multiplicity of celestial targets. For such later sites, a widening interest is suggested in the movements of the sun, moon and Venus, a possibility also proposed amongst related recumbent stone circles, and kerb cairns, (*ibid*, 175-179; table 7/p. 198).

In further discussion of the Clava group, Burl introduces the possibility of alignments on lunar standstill positions (1981, 257-270, fig. 7.5, 7.6/p. 261), and notes the lack of spatial segregation between sites with solar and lunar associations. Targets at the horizon are assumed, with the general importance of the moon amongst tomb groups stressed, since it was easier to observe, and its movements more easily noted than sun's slow shift along the horizon.

The immediate type-site of the group, at Clava itself, consists of a cemetery, earlier Bronze Age in date, and of later use, containing five monuments constructed along the centre of a gravel ridge, in the centuries around 2000 BC, with three barrows added later. At the Balnuaran of Clava there are two main passage tombs, with an intervening ring-cairn off-line.

Detailed work here by Bradley outlines relevant celestial alignments (2000, 122-126), and stresses the importance of solar events near the horizon in interpretation of radial alignment of passages, with midwinter sunset the most important at the site. The SW'n barrow, and that at the NE, open towards midwinter sunset, behind the hillside to their SW, with the NE'n barrow viewing sunset to the SW over its companion, precisely where its top intersects the horizon (2000, illus. 110/p. 125). At present, this view occurs fairly precisely down its passage, slightly less so if solar positions are adjusted for the time of construction.

The structure of the passage at the SW'n barrow allows broader illumination of the chamber than that seen in the NE'n barrow. Reflective interactions were noted between incoming light and the stones of passage and chamber. It was also suggested that the opposing direction, to the NE, seen in the general plan of the cemetery, the alignment from kerb cairn, to central ring cairn, to the Mains of Clava, might relate to midsummer sunrise. In view of suggested lunar links with recumbent stone circles, and other Clava cairns in the area (Burl 1981), the moon at various points in its cycle was also considered as providing targets for alignment.

In general comments on orientation amongst the wider Clava group of monuments, comprising 12 passage tombs, and 13 ring-cairns, alignments were noted as clustering around three major celestial events in the S'n sky. About a quarter of sites were seen to use midwinter sunset as a cue, a quarter towards minor S'n lunar standstill, and half targeting the major S'n standstill (TABLE AS-04; e-FIG AS-01) (Bradley 2000, 171-184, table 36/p. 181).

Movements of the moon were presented as more rapid, and easier to observe but, since standstills only occur every 18-19 years, it was noted that several generations of observation would have been needed for their appreciation. The fact that astronomy might have been only one element in choice of orientation was noted as a possible source of variation, and topographical factors were discussed as a supplementary cue (*ibid*, 2000, 182-184).

..Arran

Burl discusses monuments on Arran, and finds a link with the moon as a target for alignment, but notes variation, and difficulty in proposing a single astronomical or other basis (1981, 256).

Ireland

de Valera (1960) and Corcoran (1960) note E-W'ward orientation amongst court cairns, and suggest that general orientation facing the rising limb of the sun was the basic requirement.

Wales

Leighton (1984) notes that central rectangular chambers in round cairns were mainly aligned NW-SE.

England

Amongst the various regional groups in England, the orientation of earthen long barrows has been discussed in some detail by Ashbee (1984, 21-24 and figs. 19-22). A consistent E-SE'ly-facing orientation is noted, with minor variation apparent between regional groups, and approximately N-S'ly orientations minor, but widespread. Topography is cited as a factor influencing alignment of barrows in Cranbourne Chase, where they conform with ridges running NNW-SSE, causing divergence from the general pattern. Exceptions are also noted at certain barrows that were influenced by the axis at other adjacent structures, as at the Dorset Cursus, and Stonehenge Cursus.

Burl, in his analysis of long barrows in the Avebury area (1979, 95-97), notes that the axes of all 31 sites lie within solar limits, with earthen long barrows evenly spread facing NE to SSE, and megalithic tombs with entrances rather more between E and SSE.

Directions of facing are given thus in *ibid*, table 2/p. 96:

	NNE	NE	ENE	E	ESE	SE	SSE
totals	0	3	4	10	1	8	5

Burl suggests that such monuments, especially those on the Downs, facing autumnal sunrises, might have been constructed later in the year, when the needs of farming were less pressing, whereas many of those along the Beckhampton valley face summer and autumn risings. The direction of facing for monuments, and use of cues at the horizon are implicit here. The general nature of this alignment is emphasised, and any closer astronomical precision discounted, with significant orientation based firmly in propitiation of seasonal fertility, life, death, and the ancestors.

Burl, in further analysis of alignment at 65 long barrows on Salisbury Plain (1987, 26-29), notes that 13 face either N' or S'wards, and hence it was unlikely that the sun was a cue, and so an explanation for these is sought in the rising moon.

A W' to NW'ly orientation has also been noted amongst ditched 'long mortuary enclosures' of Neolithic type, sites with certain affinities to structures at some long barrows (Ashbee 1984).

France

Chevalier, in an extensive survey of dolmens (1984), suggests that many sites were sited with their backs into the prevailing N-NW'ly wind, and that the sun was important in cases where entrances face winter sunset, some towards spring, fewer to summer.

General

Ruggles (1999, 130) notes the difficulty in distinguishing solar from lunar cues for alignment, and suggests that each area might have offered a range of possibilities (*ibid*, 140). Arguments equating orientation with sunrise on the day of construction are not seen to be convincing where the distribution is unimodal and centred upon due E, unless generally argued that construction was concentrated in spring and/or autumn, tending to avoid times around midwinter and midsummer (*ibid*, 245, note 67). Alignments outside the solar range are thought to be explained by other non-astronomical cues (*ibid*, 130). The predominant trend for facing E-SE'ward (*ibid*, fig 8.1/p. 126), and general avoidance of the sector around due N are noted, this latter perhaps because of the absence of solar or lunar activity in that zone. Non-standard orientations mainly involve sites facing general S, and here occasional passage of the sun or moon at elevations above the horizon are suggested as sufficient motivation.

The need for better-defined data on alignment is outlined, and for analysis to take the horizon into account in order to identify risings and settings of possible astronomical targets more closely (*ibid*, 157).

Ruggles also considers that an even more general interpretation of barrow interpretation is possible, involving a symbolic division of the sky. The general N-S axis seen amongst some sites, such as cursus monuments, could have served to divide the celestial sphere into zones of rising and setting. By contrast, the E-W'ly alignment of long barrows could have acted more as a bridge to unite the two zones, by symbolising passage from rising life to setting death.

The nature of the axis at long barrows

The main alignment for an elongate barrow mound, and any internal chambering, would have been established when primary elements of the longitudinal axis were laid out at the outset of construction. In the case of circular passage-graves, elements of the main chamber, and its radial passage are likely to have appeared rapidly, at least in outline, around which the circular limit of the mound was then ranged. There is abundant evidence for such early axial structures amongst excavated barrows (e-FIG LB-31). In the case of composite monuments, such as those in which separate smaller structures appear to have been incorporated into a long mound, identification of an initial axis is more difficult, but examples of these are infrequent (see Table of Contents: 03a/10c; e-FIG LB-34).

The timing of its construction

The temporal relationship between the phase of initial layout of a monument, and that of its main construction, is important in considering seasonal and economic explanations of alignment behaviour. Any seasonal timing inferred from the direction of the axis would only be valid for the entire monument if layout was closely followed by main construction.

-Separate phasing

Initial marking-out might have constituted a transitory phase, rapidly accomplished, perhaps using small stakes, or laid stone markers, with minimal groundwork, separate from the main effort of later construction.

Such preliminaries would leave little or no trace, might have become obliterated by the main phase of construction, or may not have been revealed in the many cases of incomplete, or unsatisfactory excavation of such sites.

Separation of the phase of axial marking from subsequent major construction, by a difference of timing, would de-couple the latter from the economic model for orientation behaviour proposed for long barrows in this study (see Table of Contents: 03a/13a). This dual phasing of construction might have allowed use of some auspicious environmental cue as a basis for orientation, such as a winter sunrise or –set, at a time of year inclement, or otherwise inconvenient, for the main effort of obtaining materials and construction to begin. Most of the earliest axial structures known at long barrows are relatively slight, and could have been established rapidly in outline, under almost any conditions.

-Integral phasing

Alternatively, the main axis of the site could have been established at the same time as the main construction began, this following on with little or no pause. In this case the timing of an environmental cue can be discussed in relation to the seasonal cycle of economic activity, as part of an integrated model to explain the main trends of orientation.

Types of axial structure

At the sites discussed below there is no clear evidence to suggest other than that the initial axial structures were established when the main phase of construction began, and that hence they are of integral type.

Simple

Simple axes are defined as those involving construction of linear features of minimal post-work, or laid stone.

-earthen long barrows

The earthen long barrows at Beckhampton Road SU 0667, and South Street SU 0969 (Wilts.) provide clear examples of simple axial structures, established before mounding proper began (Smith and Evans 1968), with mounds built around a line of axial hurdling, with lateral offsets, these units perhaps prefabricated.

At Beckhampton Road (Bishops Canning 76, Wilts: SU 0666 6773), the mound was built around an axial line of stakes that supported hurdling, with offsets springing from the SE'n half, to form a series of about 20 lateral bays. The outer ends of these bays were closed by further hurdles, that delimited the sides of the barrow, and curved around to form the convex SE'n end. In the NW'n half, sporadic offsets make no coherent pattern. Once established, these bays were then filled individually with material from the side-ditches, to form the mound.

At South Street (Avebury 68, Wilts: SU 0902 6928), there was a similar structure of stakes and hurdling, with lateral bays, these infilled using turves, and chalk rubble, with a core of small sarsen boulders placed in bays near the SE'n end. A frontal capping of massive chalk was placed in position after construction of the first pair of bays, and then the sequence of filling seems to have been from SE to NW (e-FIG LB-15).

-Cotswold-Severn group of long barrows

Members of the Cotswold-Severn group of barrows provide further examples of simple axial structures.

At Hazleton North long barrow (Glos: SP 0727 1889; GLO 54), a similar longitudinal axis with lateral bays formed the initial structural element of the monument (e-FIG LB-63a), but here in stone, not timber-work (Saville 1990: construction sequence pp. 243-246, and fig. 227). The axial alignment was established as the lowest course of slabs that formed the foundation of a subsequent axial revetment, and was laid in concert with initial dumps of rubble and soil over the ground surface on the NW'n to NE'n sides, these being keyed into the axial structure. The two lateral chambers are also shown as present at this early stage, but there is no clear evidence for this, and they could be later in the sequence. The axial line was reinforced by a triangular wedge-shaped mass, including substantial slabs of quarried stone, and the cellular units of the inner cairn were then constructed.

Such axial structures occur elsewhere in the Cotswold-Severn group of barrows, as partly visible at Randwick (Glos: SP SO 8250 0690; GLO 10), and Tinkinswood (Glam: ST 0921 7331; GLA 9) (Corcoran 1969, fig. 9).

Other less definite evidence for a laid axis can be cited, as for example at Sale's Lot (Withington II, Glos: SP 0488 1576), where there is some indication of a rough spine of larger slabs for the final elongate mound (O'Neil 1966).

-timber mortuary structures

There are cases where upright axial posts, some probably supporting roofs, formed initial elements of rectangular mortuary structures of timber-, or stone-work, themselves later incorporated within a long mound (Ashbee 1984).

..primary axis maintained by the mound

...short mortuary structure, alignment maintained in the subsequent barrow
At Wayland's Smithy (Berks; SU 2808 8539; BRK 1), a small earthen long barrow (barrow I), containing a terminal mortuary structure, was followed by a trapezoidal barrow containing a terminal stone chamber (barrow II) (Atkinson 1965). Initially, in Barrow I, the primary axis was formed by a post structure, possibly a platform for exposure of bodies, followed by a ridge-roofed mortuary structure, this then being mounded over (e-FIG LB-15). Construction of barrow II followed on the same alignment after a few decades.

At Nutbane (Hants; SU 3310 4952), the initial axis was defined by a series of timber structures at the front end of the subsequently mounded barrow area. The first small building, with timber forecourt, and banked burial enclosure, were each followed by larger replacement structures before the entire area was mounded (Morgan 1959).

At Dorstone Hill one of the three long barrows contains an initial 4-post funerary chamber, later mounded (see Table of Contents: 03a/24).

...long mortuary structure, alignment maintained in the subsequent barrow
At Fussell's Lodge (Wilts; SU 192 324), the area of the initial structure, a long mortuary enclosure comprising a trapezoidal bedding-trench, with axial post pits, and associated burials, was subsequently mounded (Ashbee 1956).

At Willerby Wold (N Yorks; TA 029 760), a similar long mortuary enclosure, with a post-set facade, two axial pits, and subsequent embanked mortuary structure, was later mounded (Manby 1963).

The earliest phase at Kilham long barrow (Humberside; TA 056 674) consisted of two parallel ditches, 30-35m long, and about 1.5m wide, perhaps originally with a mound between, and oriented towards the SW (Manby 1976, fig. 19/p. 146).

..primary axis not maintained by the mound
Although the axis of an initial mortuary structure was often maintained by the subsequent long mound, exceptions occur, as at Dalladies (Kincardine; NO 645 712; KNC 8), where a rectangular mortuary structure lay obliquely across the area later covered by the long mound (Piggott 1971-1972). Another example is provided by Pitnacree (Perth; NN 928 533), where large axial posts defined the alignment of a mortuary structure that was enclosed within a horse-shoe shaped bank of stone with a roofed entrance, this later enclosed within a circular mound (Coles and Simpson 1965).

Composite

As well as such simpler axial structures within individual monuments, there are cases where closely adjacent sub-monuments, often with a variety of individual axial alignments, were later combined into a larger structure, as part of its own alignment, often different again (e-FIG LB-34). There are several clear examples where smaller, round passage-graves were later enclosed by elongate mounds, with other cases possible at sites where chambers might have existed briefly as discrete, semi-independent structures, before amalgamation into a single monument. This process has been suggested for certain chambered cairns in Scotland (Henshall 1963, 1972), and in the Cotswold-Severn group (Corcoran 1969, 89-95).

-Scotland

Cases of initial passage-type graves linked within trapezoidal, or elongate cairns occur amongst Scottish sites Henshall 1972, 249-256), as at:

Gleniron I (Wigtown; NX 186 610; WIG 1);
Gleniron II (Wigtown; NX 187 609; WIG 2);
Lang Cairn (Dunbarton; NS 458 814; DNB 3);
Clach na Tiompan (Perth; NN 829 329; PER 1);
Kindrochat (Perth; NN 723 229; PER 2);
Gort Na h'Ulaidhe (Argyll; NR 745 268; ARG 30).

For instance, at Gleniron II, an initial passage tomb appears incorporated into a long mound of different orientation (Corcoran 1963; Scott 1969, fig. 73/ p.213).

Certain heel-cairns in Shetland, and Caithness, have an earlier phase. For instance, at Vementry (Shetland; HU 294 610; SHET 45), a chamber in a circular structure is surrounded by a heel-cairn, and at Tulach an t'Sionnaich (Caithness; ND 070 619; CAT 58), there is a similar structure, but with a longer tail added.

The long mound at Glenvoidean (Isle of Bute; NR 997 705; BUT 1) (Marshall and Taylor 1976-1977) provides an interesting case for discussion of complexity in terms of axes, and component structures (see Table of Contents: 03a/10c).

-Wales

In North Wales similar cases are provided by Dyffryn Ardudwy (Merioneth; SH 5886 2284; MER 3), and several other sites (Lynch 1969, 107-48).

-Cotswold-Severn group

Amongst the Cotswold-Severn group of long barrows, there is also evidence that several monuments may represent individual chambered sites finally incorporated into long cairns (Corcoran 1969, 74-104).

Sale's Lot (Glos: SP 0488 1576; Withington II) provides a clear, excavated example of such amalgamation. Here, a passage-grave appears incorporated within a long cairn, and several other smaller chambers, towards the heavily damaged rear of the mound, might also have been included thus (O'Neil 1966).

All of these examples could indicate final expression, by the enclosing monument, of an overall axis deemed to be significant from early in the sequence of construction. In many examples the axes of the subsidiary chambers are transverse to that of the final long mound suggesting some process of axial unification, as perhaps at Belas Knap (Glos: SP 0210 2542; Sudeley I; GLO 1; e-FIG LB-70 and 70a).

Persistence of the axis

At certain sites there is apparent reinforcement of a major axis, by retaining it in subsequent phases of development:

Wayland's Smithy (Berks; SU 2808 8539; BRK 1): a small earthen long barrow with a terminal mortuary structure, and side-ditches, was followed on the same axis by a larger trapezoidal cairn, with terminal chambers, and side-ditches (Atkinson 1965).

Duffryn Ardudwy (SH 5886 2284; MER 3): a portal dolmen, with forecourt, set in a round mound, was later incorporated into a long mound, with terminal chamber, on the same axis (Powell 1963; Lynch 1969, fig. 45).

Mid Gleniron I (NX 186 610; WIG 1): two passage tombs were incorporated into a long mound, with these alignments maintained, except for an intervening chamber (Corcoran 1963; Scott 1969, fig.73**).**

The axis at Le Petit Mont (Brittany) was conserved, as the site changed from long mound to a more rounded passage tomb, with increasing access to central structures (Bradley 1998, fig. 18/p.57).

There can be a marked shift of axis when a funerary monument comes to overlie a more domestic structure. For instance, at Raigmore (Inverness; NH 6868 4549), a rectangular hut, oriented NW'ward, was later covered by a Clava-type ring cairn, with its NE'ly axis perpendicular to this. Here, a typical domestic alignment appears to have been transformed into a typical funerary one (Bradley 2000, 168-179 and illus. 133).

At Dorstone Hill, three long barrows, contiguous, and in line, closely cover timber long houses on the same axis (see Table of Contents: 03a/24).

Complications in measurement of axes

Symmetrical sites

At many laterally symmetrical sites it is fairly simple to establish, within usable limits, a single value for a defined major longitudinal axis (e-FIG LB-14, 15 and 30). For instance, at Wayland's Smithy long barrow II (Atkinson 1965), the mid-line is clear: from forecourt area, then symmetrically through a terminal chamber, and on to the rear of the long mound.

Similarly clear are the lines along the radial passages at many circular passage tombs, taken towards the central chamber, as at Barclodiad y Gawres (Powell and Daniel 1956), and Bryn Celli Ddu (Hemp 1930). However, at the many monuments that remain unexcavated, and known only as a long mound, or at sites that have been incompletely examined, what may appear to be a simple symmetrical structure, and is measured as such, could be more complex.

Asymmetric sites

In addition to a major axis, some sites incorporate other structures, often with distinctly different minor alignments (as at Belas Knap: Sudeley I SP 0225). Where a choice must be made for measurement, the priority here has been to measure the main alignment of the mound, relegating any minor components, and by averaging as appropriate. The long axis, or the radial line of passage and central chamber, would have been the first structures to have been laid out, and are hence taken to represent the fundamental alignment. However, in the case of minor structures, later incorporated into an inclusive long mound, as discussed below, this axis would not be initial in terms of implementation, but might have been planned in advance (e-FIG LB-34).

Examples serving to complicate the identification of a representative axis for an asymmetrical site include the following:

-Minor alignments at variance

There are examples where chambers and passages may be asymmetrically placed within mounds (Dowth, Meath, Ireland; O 023 738), or may themselves contain changes of alignment, as seen in the angled passage of the passage tomb at Knowth (Meath, Ireland; N 996 734).

A similar change in direction of internal structures can be seen at Hampnett II (Glos; 1042 1607; GLO 60), in the Cotswold-Severn group of long barrows. Here, a long mound contained a terminal chamber opening to the rear into a lateral cross-passage (e-FIG LB-62), the presence of an inner and outer revetment suggesting phased overall construction (Grimes 1960).

-Lateral chambering

A long mound, with no apparent chambering on the longitudinal axis, may instead have lateral chambers in the sides, set transversely to it (e-FIG LB-90). In some cases it is possible that such individual structures, set at different orientations, might have been unified by amalgamation into the major axis of a long mound (e-FIGS LB-68a, 80a, and 34).

At Ty Isaf (Brecon: SO 1820 2905; BRE 5), the possible sequence consists of a long mound, with blind forecourt, containing two lateral chambers back to back, into which a rotunda, with chamber, was added, by cutting into the mound, the long mound then enlarged by adding an outer revetment (Grimes 1939).

Pipton (Brecon; SO 1605 3729; BRE 8) consists of a long mound, with a blind forecourt, includes a lateral chamber with an angled passage, features at the back end of the mound suggesting further complexity (Savory 1956).

Belas Knap (Glos: SP 0210 2542; GLO 1) is a long mound, with blind forecourt, and lateral chambers at the sides and back-end. The possible sequence is of a primary mound containing the opposed E-W laterals, with the other subsidiary chambers also comprising semi-independent mounded structures, these then combined under a long mound, perhaps forced by existing features to place its forecourt at the N. Similar back-to back chambers can be seen at Five Wells (Derbs; SK 1238 7104; Manby 1958), and in Scotland, as at Langwell (Caithness; ND 091 222; CAT 34; Corcoran 1969, fig. 18).

At Capel Garmon (Denbigh; SH 818 543; DEN 3), a lateral passage and chamber, are set in a long mound with blind forecourt, the sequence being uncertain (Hemp 1927; Lynch 1969, fig.51).

Similar multiple alignments occur in other long barrows with lateral chambers, as at Swell IV (Glos; 1673 2637; GLO 2), Upper Slaughter I; Glos; SP 1426 2580), Brimpsfield I (Glos; SO 9114 1323; GLO 8), and Luckington (Wilts; ST 8200 8296; WIL 2), here with the long mounds pointing W'ward (front to rear), and hence the laterals N-S (Corcoran 1969, fig. 20).

-Multiple internal alignments

Measurement of alignment is also complicated by the occurrence of multiple orientations within a single monument, as for instance in various atypical passage tombs that have a series of radial passages and chambers.

Meayll Hill (Isle of Man; SC 189 676; MAN 7; Daniel 1950, fig. 23/p. 84) has six radially disposed passages, each leading to a pair of chambers, and Cerrig y Gof (Pembs: PEM 4; Daniel 1950, fig.28/p. 92,) has five such chambers, ranged around the mound.

The sub-rectangular Tumulus de La Hogue, Normandy is oriented approximately N-S, and has 12 radial passages and chambers (Dastugue 1971, fig. 3/p. 327).

-Variable alignments at the same site

There are also examples of different orientations amongst closely related monuments grouped together in barrow cemeteries, suggesting considerable variability in choice of axis. For instance, the major passage tomb at Knowth (Meath, Ireland; N 996 734; Eogan 1974, fig. 1/p. 17) has 12 smaller, satellite passage tombs, with differing axial orientations, ranged radially around it, and even the main monument itself has two passages oriented in opposing directions, 083 and 265°G. Existence of these two diametrically opposed passages suggests that here the axis of orientation was perhaps of more importance than a single direction within it.

Passage grave cemeteries at Carrowkeel (e-FIG LB-108), and Carrowmore (e-FIG SA_sl-03), also show a range of alignments of axial structures.

Such multiple alignments suggest that for certain sites consistent orientation was not a feature of overriding importance. Nevertheless, any general explanation of orientation, assuming it was purposeful, must include all variation.

Burl (1981, 248-250) notes that the variety of alignments at a single location is often difficult to explain, as in the passage tomb cemetery at Carrowkeel (Sligo, Ireland; G 753 119).

In the Cotswold Severn group, Hazleton I, and adjacent Hazleton II, have alignments front to back of 307 and 250°G respectively (Saville 1990; e-FIGS LB-63 to 63b).

Composite monuments

Multiple axes can be found at certain composite monuments, where earlier structures, either small passage-type graves, or single chambers, appear to have become combined into the later long mound of a monument (e-FIG LB-34).

In other cases, major alignments at the monument are at variance, as in the case of the augmented barrow Bryn yr Hen Bobl (Anglesey; SH 5189 6900; ANG 8), where a passage-grave type mound has a long embanked tail of different orientation (Hemp 1935; e-FIGS AB-04, LB 32).

-Glenvoidean composite long barrow; Isle of Bute, Scotland; NR 997 705 (e-FIG LB-13):

The small, composite monument at Glenvoidean conveniently summarises many of the problems in assessing the axis of a long barrow, the barrow here completely excavated (Marshall and Taylor 1976-1977). The site consists of a terminal and two lateral slab-built chambers, unkerbed, but each with some signs of individual encairnment under pitched masonry, before inclusion within a kerbed trapezoidal mound, this latter 13m long, 7m wide at front, and 4.5m at rear. This lack of more formal marginal definition may perhaps indicate no more than focal areas for initial mounding, rather than discrete passage-type sub-structures. A small round chamber was later incorporated into the E'n side of the mound.

The barrow is sited on a SW-ly facing coastal slope, and points (with its narrower end) towards due S. Six long barrows are known on Bute, four near the W'n coast, one further inland, and one on the E'n coast (Henshall 1972; Marshall 1976). Orientation is variable amongst this local sample, but sites generally point rear end to the W (e-FIG LB-13).

This site indicates the problems inherent in a context-rich approach to questions of alignment, and stresses the need to base arguments on broadly grouped axial data, rather than on individual monuments, or localised clusters.

Points worthy of consideration at Glenvoidean include the following:

..siting: It is not known how far the axis was actively determined by, or conformed passively with available terrain, and hence how much should be read into its interpretation.

..alignment: The fact that the barrow points (front to rear) towards due S could be taken as significant, with laterals opening to due E and W perhaps indicating intended cardinality, or with this just a passive by-product of the main axis. A S'ly direction could equally suggest some interest in the zenith of the solar cycle. Conversely, the N'ly facing direction of the forecourt end could suggest an interest in the null zone of the solar transit, or the polar axis of the sky. The main axis of the mound, with its terminal chamber, provides a useful general measure of orientation, but at the expense of the laterals lying across-axis. Evidence suggesting possible independent existence of locally mounded chambers would perhaps give them a greater equality of status, before final mounding fixed the prime axis.

A tapering plan for the mound could have been adopted just to emphasis the forecourt end, to economise on materials, or to provide a structurally-defined direction for launching appropriate funerary ritual.

Alignment in the local group: There is considerable variation amongst the six similar sites known on Bute, with long axes mainly W'ward pointing (front to rear). Rather than any deeper significance, this could simply reflect the practical need to shelter forecourt areas, and their principal chambers, from prevailing on-shore W'ly winds. The S'ly axis at Glenvoidan is singular here, but whether this is significant, or simply a random case is unknown.

This argument can be applied equally elsewhere, to other sites that occur close to solstice, or other key solar, or lunar positions, and for which some particular specialist importance has been suggested.

Directionality at long barrows

The relationship between forecourt, those internal structures that are directly funerary, and mounding at long barrows is important in discussing the relative significance of directions within the axis.

Structural trends

Two general trends are apparent amongst long barrows:

-The volume of the mound often greatly exceeds that needed to cover chambering and funerary areas adequately;

This disparity (Fleming 1973) is well seen, for instance, at Wayland's Smithy (Atkinson 1965), where only a small proportion of the area covered by barrow II is that allocated for the terminal chamber, and there are many similar examples (e-FIG LB-33).

Obviously, at such sites, the intention was to construct an imposing monument for more than practical disposal of the dead, perhaps with long and circular mounds reflecting domestic architecture to some degree (see Table of Contents: 03a/19a). However, the differential distribution of volume towards the fore of many mounds, and the tapering shape of their ground plans, could also indicate the particular importance of the monument *as a pointer*.

-Elaboration of the monument appears to involve increasing the volume and length of the mound rather than aggrandisement of the forecourt area;

A distinctly trapezoidal ground plan could have been adopted simply to augment the foreground area, or to emphasise the direction towards the back of the monument, or both. However, in certain cases, mounds often extend to considerable length, far in excess of functional requirements, as noted amongst augmented long barrows (see Table of Contents: 03b). This emphasis on extension of the body of the monument is in marked contrast to lesser treatment of the forecourt area, where comparable structural elaboration, beyond the provision of a modest monumental facade, is a rarity.

In discussion of orientation, of the two possible directions within the axis, that of elongation, and possible pointing, might therefore have been of particular importance in directing ritual. Outlook along the axis from the foreground, and possible entry to chambers from this direction, would have had the added advantage of directly including the monument in the field of view, in a way not done when facing outwards from the foreground, in the alternative axial direction.

Facing versus pointing

The range of variant structures seen in funerary monuments suggests that details of ritual, including those related to orientation, might have been diverse. Whatever the ritual involved, the forecourt, or broader end of the monument appears to have been a focus for activity, being structurally well-defined, and accessible, frequently allowing direct access to the internal funerary area. Higher density of artefacts, evidence for fires and other activities with possible ritual connections support this emphasis (Midgley 1985).

In most existing studies of orientation amongst long barrows there is consistent reference to the E'ly direction of *facing,* as taken from the forecourt, with sun or moon the target, being diagnostic for interpretation of axial alignment (Burl 1981, 245-248; Ashbee 1984; Ruggles 1999, 90). There are two unwarranted assumptions made in most of the literature on orientation at such sites: the emphasis given to the direction of *facing*, and the supposition that the cue for alignment was an event at the *horizon*.

If ritual was indeed directed along the main axis of these barrows, then each of the two directions within it has different potential. The notional line from the foreground **pointing** into and beyond the back of the monument is often that of access to a chambered interior, and hence to activities associated with deposition. Associated ritual carried out in this direction from the foreground would visually combine both the monument, and the aspect beyond for participants. This direction is predominantly towards the W-NW amongst long and related barrows (TABLE LB-01) which, given their function as funerary monuments, would seem appropriate, given the frequent association between the W'ly setting sun, and death (see Table of Contents: 02c/2i). The opposite line would be one of exit and display, on the return from the interior. Rituals carried out in the foreground in this direction would not involve an intervening monument, **facing** away from it.

An E-W'ly alignment could embody a symbolic dual association between the W'ly setting sun and death, and an E'ly rising sun and life or rebirth, as well supported in many early cultures, and with wide ethnographic parallels (Henshall 1963, 28-29; Burl 1976, 166). Alignment could also have been important in other ritual, perhaps in connection with vigils, or initiation ceremonies, and other *rites de passage* involving concepts of rebirth or renewal, that might have taken place at the funerary monument, whilst its interior remained accessible. Participants could, for instance, have entered at sunset in a direction towards the setting sun, and emerged at sunrise into the light of the rising sun.

Scott (1969a, 233) has suggested that the tail of the cairn might have pointed in the general direction from which the forebears of the community were assumed to have come. Carrying the dead in through the entrance, and into the chamber, might therefore have been seen as the start of the spirit's journey towards the land of the ancestors.

In terms of ritual effectiveness, both directions might have had their own merits, but it could be argued that the pointing direction might have been more potent, involving as it does all three elements in its line: the living, the dead, and the celestial sphere beyond. This direction might therefore be considered as particularly significant in the operation of the monument, and in its relationship with its broader physical setting, and it might have formed a basis for the timing of appropriate seasonal ritual enactment, as the axis realigned with any target that acted as the original cue.

An interesting parallel is given by certain Christian churches, established along an axis in a similar manner, having a basis in solar cycle, with a case made for some use of sunrise on the feast day of the particular patron (Ali and Cunich 2001). Elaboration of an external facade, and addition of towers at the W'n end of many churches belie the actual importance of the chancel-end at the E'n, often of lesser size, and external appearance. The main emphasis of ritual, here towards the E, extends beyond the monument, away from the direction of main entry, and from the most imposing end of the structure, as perhaps the case for long barrows.

Alignment of human remains

The general alignment of a monument might have been further reflected in the orientation of individual burials, or placements of human remains within it, both governed by similar ritual considerations. There are problems in obtaining adequate data on the orientation of human remains in chambered tombs, because much of the skeletal material is disarticulated, has been rearranged, or disturbed, after initial deposition, or has been inadequately recorded.

In many cases there does not appear to be a consistent alignment for burials, either in relation to the axes of the monument, or with regard to any other externally defined direction. However, there might have been be a preference at several elongate sites for alignment of certain burials in parallel with the long axis of the site, although others appear to lie along the short axis, or to have an apparently random orientation.

For instance, in the English group of earthen long barrows (Ashbee 1970, 135-153), there is little indication of a preferred alignment for human remains, a situation also seen at Fussell's Lodge, (Wilts; SU 192 324), and at Giants Hills I, Skendleby (Lincs; TF 428 711) (Ashbee 1970, figs. 35-36). However, at Nutbane (Hants; SU 330 495) some individuals were aligned along, and some across the axis of the barrow, and at Wor Barrow (Dorset; SU 012 172) several skeletons lay along the axis of the barrow.

Data from Polish barrows (Midgley 1985) suggest that the majority of burials (68% from a sample of 113) were laid out parallel to the main axis, many with the head towards the narrower end of the monument.

The situation is somewhat different in the stalled cairn at Midhowe (Orkney; HY 371 306; ORK 37), which produced evidence for 25 individuals placed on low stone benches at the margin of the chamber, including nine articulated skeletons (Henshall 1985, fig. 5.3/p.100). The cairn was oriented approximately to the NW, but only one of the surviving skeletons had its head in this direction, the remaining eight being in the opposite direction. Orientation of many such burials might have had little ritual significance, and simply conformed passively with the axial alignment of structures within the monument.

As a final example, the Neolithic wheel-grave at Hjordkaer (S'n Jutland) contained a main, central inhumation burial with head oriented to the W (269ºG), but another adjacent grave contained two inhumations on the same axis, but with heads in opposite directions. Here again the alignment of burials appears to be independent of the structure and to conform with an axis rather than a single direction (Jorgensen 1984).

Analysis of alignment amongst groups of long barrows

In order to produce basic data for an extensive area of Europe, the orientations of 2850 funerary monuments were determined, providing a representative sample from most major typological, and regional groups for which published material is available (TABLE LB-01).

Although they exhibit considerable structural diversity in their detail, for the purposes of this analysis, most sites can be assigned to one of two main types, according to the general properties of their basic ground plan (e-FIG LB-30):

-**mounds that are basically circular in plan**, and which cover a radial passage providing access from an entrance at the edge of the mound to a centralised chamber. Passage tombs and their variants, are included in this group;

-**barrows that are elongate in plan**, being either rectangular, trapezoidal, or ovate. Sites in this group frequently show clear structural differentiation between each end of the mounded area, with a tendency to concentrate internal funerary features, and external forecourt structures towards one particular 'front' end, which is often larger, resulting in a ground plan, and profile tapering to the rear. Gallery graves, and earthen long barrows are typical members of this group.

These two types of site, although they differ in detailed ground plan, are sufficiently similar in their underlying topology to be considered as equivalent in terms of axial orientation, and consequently for comparisons to be made. Although there are many variants, both types are characterised by monuments having foreground and rear areas, with axial structures entered, or approached from the front end. This axis is asymmetric (see Table of Contents: 02a/2b), and the directions within it are here referred to as 'pointing' if taken into the mound and 'facing' if outwards from it.

In order to enable data to be obtained in a uniform way, orientation was defined in a structurally-consistent manner for all sites, and was measured as the direction along the principal longitudinal axis, taken from the margin of the mound towards the centre of the structure. For rectangular and trapezoidal mounds this was from front to back, along the spine of the monument, and for circular monuments was the line of radial entry to the centre, along the passage to the chamber. This definition was made primarily as a uniform convention, internal to the analysis, to enable graphs of orientation to be plotted (e-FIGS LB-01 to 11). However, it is also proposed as being of basic importance for ritual associated with the monument, as outlined just above.

This method of axial definition is of very general application, and allows data to be obtained from a large range of sites. Data of dubious accuracy, or from sites that were too fragmentary to enable axial orientation to be determined within reasonable limits, were not included. In addition, data from the small proportion of anomalous sites that did not fall clearly into the types defined above were also excluded. For instance, elongate sites, which were entirely symmetrical between ends, such as the double court-cairns of Ireland (Corcoran, 1960; de Valera 1960), and sites for which a forecourt end could not be determined, were recorded, and analysed separately. None of these occasional omissions of anomalies affected the general properties of the working data, nor the conclusions drawn from them.

Data consisting of individual orientations were grouped according to geographical location, and type of funerary monument (TABLE LB-01), then analysed separately, or in selected combinations. Possible sources of error in published sources were addressed where relevant, by using a specifically designed computer program to manipulate data, and to produce smoothed frequency distributions, with robust maxima and minima (see Table of Contents: 02a/1a).

Results of the analysis

The results obtained by applying this smoothing function to axial data for the different groups of funerary monument (TABLE LB-01) are shown in e-FIGS LB-01 to 21. Besides barrows, a similar analysis was carried out for longhouses of Neolithic type and for other house forms from Europe as comparative studies (see Table of Contents: 03a/19).

The resulting frequency distributions display three consistent, and statistically robust graphical features that indicate general tendencies in the data. These remain invariant when levels of inherent error are changed by reprocessing under different values of the standard deviation applied to individual data points (see Table of Contents: 02a/1a; e-FIG LB-22):

-**major features** [axes taken in the direction of pointing, front to rear]:

peak 1: a minor peak of frequency occurs at about 070-080°G in some, but not all of the frequency distributions;

trough: a near-zero minimum lies between 100 and 150°G;

peak 2: the main peak occurs at about 280°G, a feature of all data sets.

These three features are seen most clearly in the case of the largest sample, the entire European data set for funerary monuments of the defined type and date (e-FIG LB-01).

Such general analysis shows that these frequency distributions are essentially unimodal, and if related to solar, or lunar cycles would refer to mainstream events in the transit, not to limiting positions (Cf: e-FIGS AS-01 and LB-01-21).

These frequency distributions view the data in a unified way, and the entire analysis approaches the question of interpretation in terms of general properties of the group, and is therefore strongly context-free (see Table of Contents: 02a/1c).

There is general consistency of such major features of orientation amongst funerary monuments sampled over considerable geographical distances, for instance from Shetland to S'n Spain, about 2800 km apart. Such general uniformity immediately suggests that some external environmental cue, or cues, operating on at least a European scale, served to co-ordinate orientation. However, beyond the peaks, the occurrence of at least some background orientations throughout the entire 0-360° range indicates that alignment reflects a general tendency, rather than any closely defined rule.

Besides the values of maxima and minima seen in the smoothed curves there are other features worthy of note:

Curves rarely show any marked **asymmetry** about the main peak, except slightly in the case of Scottish passage tombs (e-FIG LB-10), and more markedly in the case of dolmens from S'n France (e-FIG LB-05). If the seasonal model of orientation operated (see Table of Contents: 03a/13a) then such bilateral symmetry could suggest approximately equivalent preference for establishment of an axis at those times of year corresponding to each flank of the peak, during both directions of travel for the solar transit.

-**Sharpness** of the main peak varies, and this could indicate differences in strictness of orientational behaviour between areas. For instance, the peak for Scottish passage tombs (e-FIG LB-10) is sharper than for elongate barrows(e-FIG LB-09), and in England the peak for Cotswold-Severn tombs (e-FIG LB-16) is sharper than that for earthen long barrows (e-FIG LB-18). In Iberia, the peak for passage tomb is very sharp (e-FIG LB-06), far more so than that, for instance, amongst French dolmens (e-FIG LB-05).

Groups of such funerary monument consistently show a strong preference for orientation (pointing: front to rear) towards the near W (peak 2 below), a minor preference towards the near E (peak 1 below), and clear avoidance of the SE'n sector (trough 1 below). Individual results are shown as follows (TABLE LB-01):

TABLE LB-01 Groups of funerary monuments: major features of orientation

Note: only the defined direction of pointing (front to rear) within the axis is quoted here for convenience, the direction of facing is implicit, but unstated.

location	**type**		**description**	**# of sites**	**AXIS: pointing (front to rear)**			
	cir	**elon**			**peak 1**	**trough**	**peak 2**	**e-FIG LB-**
Individual regional sets of data:								
Scotland	*		passage tombs	130	-	~130	280	10
		*	gallery tombs	194	-	080-140	295	09
	*		Clava group	49	-	-	030	11
Ireland		*	wedge tombs	212	70	-	-	21
		*	court cairns	219	-	-	260	19
	*		passage tombs	62				20
		*	portal dolmens	32	-	-	280	-
N'n Europe		*	elbs	151	-	60-150	270	02
England		*	elbs	235	-	60-150	270	18
England /Wales		*	Cotswold-Severn tombs	85	-	-	265	16-17
Brittany	*	*	all types	128	-	~130	305	04
France: Languedoc	*		dolmens	241	?~80	120-190	280	05
W'n Iberia	*		passage tombs	441	-	-	286	06
S'n Iberia	*		passage tombs	241	-	-	300	06
Combined sets of data:								
EUROPE	*	*	all types	2850	~070	~140	280	01
Scotland	*	*	all types	373	-	~130	285	08
Ireland		*	all non-passage tombs	463	~072	146	260	-
France	*	*	all types	357	?~080	120-180	275	03

Note: major sources of information are listed in the appendix at the end of this section; groups are arranged in approximate order of decreasing latitude;

Key: type: cir(cular), **elon**(gate); **elbs** earthen long barrows; **#** number; **orientation: '-'** a distinct feature is absent.

Grouped data for Neolithic longhouses also consistently indicate a strong preference for orientation towards the NW (peak 2), a possible minor preference towards the near E (maximum 1), and clear avoidance of SE-SW (trough 1). Comparative data from settlements of later date are also given, where a more W'ly maximum is also seen. Individual results are shown as follows (TABLE LB-02):

TABLE LB-02 GROUPS OF DOMESTIC LONG AND ROUND HOUSES: MAJOR FEATURES OF ORIENTATION

Note: only the most W'ly direction within the axis is quoted here for convenience, the other direction is implicit, but unstated.

location	type	# of sites	AXIS: pointing (front to rear) peak 1 minor	trough	peak 2 major	e-FIG
Neolithic						
W/N Europe	L	401	?~080	120-210	325	23-24
Iron Age						
W/N Europe	L	410	020	090-180	265	25
Britain	S	267	060	120-180	255	28
Britain	R	205	110	150-210	290	29
Saxon						
Britain	L	202	015	060-180	280	26
W/N Europe	L	139				
Britain	G	173	-	-	255	27

Key: type: L long-house; **R** round-house; **S** square house; **G** grubenhaus.

Factors determining axial alignment amongst these funerary monuments

The seasonal-solar model (e-FIG CO-02);

The basis proposed for alignment behaviour at these funerary monuments can be summarised as follows:

The axis of the monument:

-**alignment**: was non-random, frequency distributions containing pronounced peaks: e-FIGS LB-01 to 21;

-**interaction with topography**:

placement of axes was **active**, conforming where possible with any compatible local topography, but with selection of terrain that fulfilled basic ritual directional criteria, rather than being constrained by it;
..various localised studies indicate that constraints were not unduly topographical: e-FIGS LB-114 to 119;
..similarities in frequency distributions between widely separated area tend to cancel out terrain as a *deciding* factor in choice of axis: e-FIGS LB-01 to 21;

-**relative importance of internal directions within the axis:**

the **important direction** within the asymmetrical axis was that which **pointed** to the rear of the monument, and generally towards the W;

..tapering and elongate monuments suggest a **clear potential** for pointing: e-FIGS LB-14 to 15, 32-33;
..such a view includes an **important direction of entry,** and extended this line on towards the W'n sky: e-FIGS LB-30, and 01;

-the target used for axial alignment was:

..universal: similarities between widely-separated groups of monument suggest that the cue for alignment was celestial, and generally available, rather than more localised, and terrestrial;
*f*requency distributions from European groups show similar maxima: e-FIGS LB-01 to 21;
..unified and solar: the basis for alignment was largely centred on interest in the sun;

the sun as the major driver of seasonal change, and hence of economic well-being, would have been central to agrarian belief-systems; any part played by other celestial bodies, such as the moon, planets, or stars is therefore likely to have been of marginal importance, as far as the axis was concerned;

-**the targeted sector was broad**: axes did not refer to a fixed event, nor to a notional direction, but generally towards a more transitory cue, here suggested as the setting solar transit, at lower elevation;

..the spread of axes beyond the peak of frequency suggests use of a broader cue, or competing factors (e-FIG LB-41a); interest in solstices appears negligible; e-FIGS LB-01 to 21;

-**precision was relatively low,** and hence more compatible with general agrarian ritual, rather than the demands of more abstract astronomical observation;

..component axes within monuments show diversity, with major axes variable and often lacking in exact structural definition; e-FIGS LB-14, 34, and 90;

-**establishment of an axis was influenced by environmental and economic constraints**:

the peri-equinoctial sector of the setting solar transit acted as a cue, as current during later spring and autumn, when weather, and available labour allowed alignment to be formalised, and more major construction projects to begin;

..this would explain the consistency of the near-W'n peak of axial frequency, without reference to a transitory equinox, an event not marked by any clear standstill, of the type seen for solstices: e-FIGS AS-01, and LB-41;

-the setting arc of the solar transit has potential for expression of funerary ritual:

this is discussed more fully elsewhere (see Table of Contents: 02c/2i).

Aspects of the seasonal-solar model (e-FIG CO-02) have also been invoked for interpretation of other types of monument in this analysis, where it has been broadened to include a less funereal axial interest, in the S'n, rather than the W'n sector of the solar transit, as discussed for stone rows (see Table of Contents: 03d/8f).

Grouping of sites

Barrow sites can be divided into three main groups, as explicable in terms of this general model:

-The majority of sites, easily explained by the model:

Most sites fall within the range of azimuths between the solstice limits for the setting solar transit in their localities (e-FIGS AS-01), and hence could use this as a cue. Others lie just beyond these limits but, allowing for laxity in applying rules for alignment, are close enough to be included.

-A minority of sites with this orientation reversed, but remaining on the standard axis:

Certain sites point (front to rear) generally E'wards, in the opposite direction to the main trend, and although relatively few they require explanation other than as anomalies.

On the frequency distribution for the entire European sample of monuments, these reversals show as a minor peak around 090^{o}G, diametrically opposed to the main peak at around 270^{o}G (e-FIG LB-01). Similar minor peaks also show up on frequency distributions for various regional groups (e-FIGS LB-03, 05, 11, and 20), and form the main peak in only one case, that of the Irish wedge-shaped tombs, which show complete reversal of the W'ly norm (e-FIG LB-21).

Such sites could be viewed as a separate group, with monuments pointing (front to rear) towards the rising sun, perhaps indicating sectarian differences amongst communities. Given the consistency of alignment amongst wedge-shaped tombs, there seems to be a unifying basis for their alignment, and so de-coupling of axial layout from some standard target such as the sun seems unlikely. Alternatively, prime importance of the normal W'ly direction, that of entry and deposition towards the W, could have been transferred to one of exit and display of contents towards the W (see Table of Contents: 03a/20e(i)).

It is interesting to consider cases of such sites that occur as exceptions amongst others of normal alignment, as in the Cotswold Severn group (e-FIG LB-89). For instance, Hazleton I (Glos; SP 0720 1882) points (front to rear) to the SE 128°G, and Hazleton II (0727 1887) to the E 076°G. At both of these adjacent monuments, forecourt areas are at the NW'n end, rather than at the more usual SE'n, and this could indicate a ritual variant in the regional group, but still retaining the standard axis. Perhaps the general axes were laid out towards sunsets, according to standard practice, as a requirement of ritual, but with forecourt areas added independently, not at the correspondingly standard end. The presence of a 'correctly' aligned axis under the site might have been considered adequate for operation of the monument, as a passive feature, independent of subsequent construction, and ritual use, (see Table of Contents: 02a/2g).

-Alignment of a few sites towards the null zone of the solar transit

A small proportion of sites aligned on more N-S'ly axes would seem to point (front to rear) towards the null zone of the solar transit at the N, where the sun never passes, and face the permanent zone of the transit to the S, where there are no risings, or settings (e-FIG AS-01). Despite the visible absence of the solar transit, such N'ly-pointing sites might have continued the intention to intercept the transit of the setting sun, but in a more abstract form, when it passed out of sight below the N'n horizon. If this extrapolated sector of the transit was viewed as actually *entering* the land of the dead then this would be entirely consistent with standard funerary ritual (see Table of Contents: 02c/2i). For instance, the major long barrow at Waylands Smithy (Berks; SU 2808 8539; BRK 1; e-FIG LB-33) points (front to rear) towards 340°G, about 29° to the N of the local solstice setting position. The Clava group of round cairns in Scotland point even closer to the N (e-FIG LB-11).

One consequence of the model is that the actual alignment selected for a barrow would have determined the *extent* to which it could access the solar transit (see Table of Contents: 02c/2e). Monuments pointing (front to rear) to the permanent zone would have year-long access, to the null zone no [visible] access, and to the transitional zone variable access, this decreasing with axial progress N'ward (see Table of Contents: 02c/2b(ii); e-FIG AS-09). Peri-equinoctial axes common amongst long barrows would experience transits for about half the year, but sunsets for shorter periods only (e-FIG AS-09a).

Factors interacting to determine the axis of a long barrow

A range of competing forces can be considered as acting to determine the final direction taken by the long axis of a notional long barrow, and five of these constraints are discussed below, for two groups of monument, well separated in latitude, and hence differing in general environment, celestial and terrestrial (e-FIG LB-41a):

Note:
-the limits of azimuth given below are for the direction of W'ly pointing, this taken towards the rear of the monument (see Table of Contents 03a/11b);

-operation of the basic seasonal-solar model for alignment is assumed (see Table of Contents 02b/8; 03a/13a; e-FIG CO-02);

area	group	central long-lat	e-FIG axis	solar transit
S'n: central S'n Britain	Cotswold-Severn	51.5; -2	LB-16	AS 04
N'n: Scotland	all long barrows	56.5; -4	LB-08	AS 04

These factors and conditions, as plotted in e-FIG LB-41a are:
1-**that the axis must meet basic ritual requirements**: by provision of some reference to the general W'n horizon, and to a sun visibly setting, this becoming a more noteworthy event below about 30° elevation;
occurring over the full transitional zone, from midwinter sunset to midsummer sunset (e-FIG AS-04):
limits_S'n area: 230-310°;
limits_N'n area: 223-317°;

2-**onset of clement weather**: initial construction would start during a period suitable for undertaking ground-work; ambient temperature >5°C; e-FIGS LB-37 to 39;
limits_S'n area: from later February [sunset at 255°, and moving N'ward]; (e-FIG AS-04a);
limits_N'n area: from later March [sunset at 275°, and moving N'ward]; (e-FIG AS-04a);

3-**availability of adequate labour**: access to a sufficient work-force, free from the urgent seasonal demands of agriculture; e-FIG LB-41;
limits_S'n area: mid April to later May [sunset at 290 to 305°];
limits_N'n area: mid May to later June [sunset at 310 to 320°];

4-**maximising repeated exposure of the monument to the passing transit;** transit-frequency changes with the azimuth selected; e-FIG AS-09;
for lower elevations of the setting sun [<30° suggested here as an upper limit] the transit shows two peaks of frequency:
S'n area: peaks at 230° and 270°;
N'n area: peaks at 220° and 270°;

5-**balancing exposure between the directions of facing and pointing for the monument**: approximate equivalence might have allowed the monument to act as a symbolic channel, more closely synchronised with a unified solar cycle of rising and setting, at least around its equinoctial midpoints (see Table of Contents: 02a/h);
limits_S'n and N'n areas: optimal and equal at 270°; this balance reducing with rotation beyond this line; e-FIG AS-09a;

Comparing the distributions of transit-frequency for the S'n and N'n groups of long barrows, as shown in e-FIG LB-41a:
the peak for the S'n (Cotswold-Severn) group is relatively sharp, with its maximum value at about 262°; the peak for the N'n (Scottish) group is far more spread, with its maximum at 285°, giving a strong difference of +23° between maxima for the two samples.

Considering each of the five factors listed above:

..similar: astronomical [factors 1, 4, and 5]: these appear little changed between the two areas: [1] a comparable range of the W'n horizon is relevant for each, with only a slightly increased interval between the solstices for the N'n group; [4] the pattern of transit-frequency is similar; and [5] the equinoctial balance point is identical;

..dissimilar: environmental [factors 2 and 3]: less favourable climatic conditions in the N'n zone compared to the S'n would have resulted in distinct environmental differences between the two areas; [2] the onset of warmer and drier weather begins later in the N; and [3] this would act to delay the start of necessary agricultural work until later in spring, and would consequently defer the availability of a communal labour force;

The *displacement* of the N'n peak of frequencies towards the N can perhaps be explained as a consequence of these environmental differences, with little contribution from astronomical factors.

The *increased spread* of this peak for the N'n group could be related to the higher variability of climatic and topographical conditions encountered over the broader latitudes of Scotland (with an extreme range of 6°: 54.5-60.5°), compared with about a degree of latitude for the S'n group, and its more uniform landscape.

Anomalous orientation of passage tombs in Ireland

Whilst the frequency distributions of axial orientation for most regional groups of chambered tombs show a clear central tendency, that for Irish passage tombs does not, and requires separate consideration of any complicating trends that might be present. The elongate court cairns of Ireland (e-FIG LB-19) peak around 260° in the pointing direction (front to rear), and similar monumental forms in Scotland peak around 290° (e-FIGS LB-09), both towards the NW. Although Irish passage tombs show some general preference for pointing towards the W the pattern is more complex, with individual peaks evident (e-FIG LB-20).

Amongst these regional groups of monuments, the set of passage tombs in Ireland is unusual in that it contains a higher proportion of clustered sites: of the 232 known and probable tombs, 141 (61%) occur in close proximity (based on totals from Prendergast 2006, fig. 2/ p. 6). Interactions between sites might therefore be sufficient to disturb the underlying trend seen more generally in the other groups, where individual monuments are more separated.

Local clusters of tombs do occur in the other Irish groups, but in far fewer cases, with lower numbers than for passage tombs, and not lying in as close proximity (TABLE LB-03):

TABLE LB-03 Ireland: examples of clustered monuments amongst non-passage tombs

type	**loc**	**site**	**~NGR**	**# sites**
portal	Donegal	Malin More	G 5083	4
wedge	Clare	Ballyganner	R 2295	5
		Ballynahown	M 1002	4
		Parknabinnia	R 2593	8

Data: O'Nuallain 1989, 115-144: combined listings of all Irish tombs;
Key: loc(ation); **#** number;

In order to address this apparent lack of coherence amongst passage tombs, the pattern of axial directions in seven key passage tomb cemeteries was examined, contexts where interactions might be evident between sites, of a type not expressed for the majority of such tombs in separate locations (TABLE LB-04):

TABLE LB-04 Passage tombs: Ireland; cemeteries sampled

					cairn			
cemetery		**NGR**	**#**	**?+**	**focus**	**id**	**axis (pointing)**	**e-FIG**
focal cairn with satellites								
Knowth	Meath	N 9973	18		yes	1	265: E'n passage	LB-96, 111
Loughcrew W	Meath	N 5777	14		yes	L	283	LB-103, 104, 107
Loughcrew E	Meath	N 5877	7		yes	T	285	LB-103, 105, 106
Carrowmore	Sligo	G 6633	32	49	yes	51	288	SA_sl-03
no focal structure								
Carrowkeel	Sligo	G 7511	14		no	-	-	LB-108
linear cemetery								
New Grange	Meath	O 0072	4-5		no	A	316	LB-102
unknown: largely destroyed								
Kilmonaster	Donegal	H 2797	8		??	A	W	LB-110
total	100							
mean			**287**					

Key: # number of tombs known to be present; **?+** possible additional tombs present; **cairn**: **focus:** barrow present in ?focal position, **id** identification number of ?focal barrow; **axis** (**pointing)**: front to rear);

The spatial patterns found in four of these cemeteries might consist of a larger focal barrow, with satellite tombs ranged around it, usually placed a short distance away. Whereas the axis of the passage-chamber at the focus consistently points in a NW'ly direction (front to rear), those of the satellites are more varied (e-FIG LB-109).

Individual cemeteries

-Knowth; Meath; N 9973; e-FIGS LB-96 and 111;
bibliography: Eogan 1974, 1984, 1986, 1994, 1998, 1997, 1997a, 2015; Prendergast and Ray 2014;

Here, the axes of satellite tombs radiate around the large central monument, their entrances generally facing it, their axes pointing (front to rear) away. Within this main mound lies an earlier, smaller passage tomb (1b), its main passage-chamber pointing (front to rear) towards the W, with a space around it unoccupied by other monuments. This tomb might have formed an original focus for the cemetery, although its status as such depends on the sequence of development at the complex, which remains unclear.

Given the spatial separation between tombs in these cemeteries, and hence the lack of connecting stratigraphy, there is little or no clear basis for any structural sequence to confirm the existence of a primary focal site with its key axis, and subsequent development of satellites with dependent alignments.

Here at Knowth however (e-FIG LB-96), there is some indication of a partial sequence (e-FIG LB-111):

direct evidence:

..the existence of a smaller initial passage tomb (1b) within the later main mound could account for the angle in the W'n passage (see Table of Contents: 03a/20f);

..later mounding over tomb 1b to form the far larger tomb 1c covered the front half of tomb 16;

..the kerb of tomb 1c appears to curve back slightly to avoid the front of tomb 13, suggesting that this latter site was already in existence;

-tomb 17 appears to encroach on the margin of tomb 16, suggesting the sequence as 16 then 17;

other factors:

..a basal turf line was noted only under tombs 1, 2, 9, 12, and 15-18, and this suggests their early establishment;

The four stage sequence developed by Cooney (2000) sees initial tombs ranged around the W'n margin of the area, supplemented by others along the N'n and S'n sides, then expansion of the main tomb 1 within the enclosed space, with final minor addition of tombs at the E (e-FIG LB-111). However, there is very little to justify this level of detail.

An alternative broader sequence is here suggested, one which incorporates existing evidence, and provides a more coherent view of possible development for the complex, as a two phase expansion of a common format:

..the initial central passage grave (1b): incorporating opposing passage chambers, broadly E-W, was established early;

..a ring of smaller tombs: with varied axes developed around tomb 1b, set at a short distance from it, leaving an open margin; pairs of such tombs occur at the N and W, with at least a single, or another duplex, at the S, and a triplex at the E, all perhaps with deliberate cardinal placement, this separate arrangement perhaps suggesting provision of facilities for separate kin groups;

..major expansion of the central mound: to over twice its diameter, bringing its edge up to the margins of the early ring of satellites;

..subsequent addition of satellites: occurred at the edge of a new exclusion zone around the main mound, again leaving sufficient intervening space; possible development of linear triplets of tombs might have occurred, with two clearer at the W, and one at the N, each maintaining broad axial consistency amongst its members; again these short linear rows of tombs could indicate segregation of usage.

The essential plan, therefore, is that of a central tomb with grouped satellites around it, set at a short distance. Whilst maintaining this general layout, the changes with time were: increased size for the focal site, and its satellites, with increase in grouping of the latter from duplex to triplex, some by expansion of earlier pairings (TABLE LB-05; e-FIG LB-111):

TABLE LB-05 Knowth (Meath, Ireland): changes in size of mounds between suggested phases

	diameter (m)		% increase		grouping of satellites						
phase	**main**	**sat**	**main**	**sat**	***labels* on e-FIG LB-111 as follows:**						
1	38	12.4	-	-	duplex	1	2	triplex	1		
2	89	14	234	113	duplex	a	**b**	triplex	**A**	B	**C**

Note: labelled groupings of satellites shown in bold type for phase 2 indicate modification of phase 1 pairings;
Key: main (mound)**; sat**(ellite mounds);

-Loughcrew; Meath; e-FIG LB-103 to 107;

..E'n cemetery; N 5877;
Again, what might be a larger focal tomb (T), its axis pointing (front to rear) W'wards, lies with satellite tombs ranged around it at a slight distance. Here however, axes do not face the focal area, but away from it.

..W'n cemetery; N 5777;
A situation similar to that at the E'n cemetery is seen here, with two potential focal tombs, T and D, each pointing (front to rear) W'wards, and with its own small set of satellites, those with known axes also pointing W'wards, with no apparent reference to any focus.

-New Grange; Meath; O 0072; e-FIG LB-102;
bibliography: O'Kelly *et al*. 1978;

Here four or five tombs form a linear cemetery, all with axes pointing (front to rear) generally N' to NW'wards, with no reference to the central area.

Two smaller passage tombs just to the W, and one, perhaps two to the E, with the main mound placed centrally, form a small linear cemetery, about 250m long (TABLE LB-06). The general axis of the line runs E-W, conspicuously along a low ridge that forms the highest ground in the locality.

TABLE LB-06 New Grange passage tomb cemetery (Meath, Ireland)

tomb	diam	kerb	pass-ch	axis (pointing)
K	20	yes	8m	N
L	20-24	yes	12m cruc	NNE
Z1	20	yes	20m cruc	336°
Z2	AP indicates possible tomb			

Key: diam(eter in m); **kerb** (present); **pass**(age)-**ch**(amber); **axis** (**pointing**: front to rear);

-Carrowkeel; Sligo; G 7511; e-FIG LB-108;

A loose scatter of tombs, none of which appear focal, exhibit axes conforming with the pronounced system of parallel NW'-SE'ly running ridges on which they lie, with some preference for pointing (front to rear) in the latter direction. Further details are given in Table of Contents: 3a/20f and e-FIG LB-108.

-Kilmonaster; Donegal; H 2797; e-FIG LB-110;

bibliography: Cody 2002, 180-181;

A possibly larger tomb, with its passage-chamber running E-W, lying at the margin of an unexplored cluster of ruinous monuments, forms a dubious focus (e-FIG LB-110).

This compact cemetery of passage-type tombs contains eight sites within an area 200 by 300m, with one outlier lying 500m to the ESE, all unexcavated, except for some early incursions, and all in terminal condition, with little mound or internal structure surviving (TABLE LB-07):

TABLE LB-07 Kilmonaster passage tomb cemetery (Donegal, Ireland)

tomb	NGR H-	diam	kerb	pass-ch	axis
A	2733 9763	23	yes	3m long	E-W
[B]	2721 9764				
[C]	272 976				
D	2718 9760			pres	
E	2717 9782	23	yes		
[F]	2720 9767	20	?yes		
[G]	2718 9781				
[?]	2710 9761	23	?yes		
J	2792 9741				

Key: diam(eter in m); **pass**(age)-**ch**(amber); **pres**[ent]; **[..]** details unsure;

There is no clear evidence for a larger focal site, as suggested at certain other such cemeteries (e-FIG LB-109), although tomb A might have been more monumental with its passage-chamber lying on an E-W axis, in common with other clearer examples of central placement.

-Carrowmore; Sligo; G 6633; e-FIG SA_sl-03;

Further details of this large cemetery are given elsewhere (see Table of Contents: 04b).

General conclusions

Increased variability amongst orientation of passage-chambers in this group of monuments may perhaps be explained in terms of weaker application of any general rules for alignment, together with regional variation, distortion caused by the influence of focal sites in cemeteries, and more passive conformity with stronger topography.

The Orion group of constellations: possible relevance of risings and settings to funerary ritual

The sun and moon rise and set conspicuously along the E'n and W'n horizons, the former body with a clear annual cycle of direct economic relevance (see Table of Contents: 02c/2), the latter showing more complex patterns of longer periodicity, and of less obvious economic application (see Table of Contents: 02c/3). Several prominent constellations also rise and set in these general directions, according to a seasonal cycle, and are hence worth discussing as potential cues for the E'-W'ly axis clearly adopted by long barrows. The Orion group of constellations, its composition and seasonal cycle, are discussed in more detail elsewhere (see Table of Contents: 02c/4a; e-FIGS AS-16 to 20).

During the winter months the Orion group can be seen clearly rising and setting in the night sky, culminating in the spring, with final settings in early darkness.

During the Neolithic period in Britain, this imposing group of constellations would have been visible while setting, just before a possible spring season, suggested on practical grounds for the onset of major labour-intensive projects, such as construction of long barrows (see Table of Contents: 03a/13a).

Taking 3000 BC as an arbitrary reference date, the W itself is marked by the setting of the three conspicuous, broadly rectangular constellations of Orion, Gemini, and Auriga, which together cross the horizon between 229 and 314° azimuth, with the Pleiades setting very close to due W (TABLE AS-07). Since it rises and sets approximately symmetrically about the E-W axis, the entire range, from Canis Major to Auriga, might have provided a target for alignment, towards the centre of this entire group. The motion of this grouping of constellations might have been of general significance in defining what we now know as the W, with patterns within it assuming particular ritual, and religious importance.

However, considering only the more restricted group based around Orion, the most imposing constellation, moves the focus of attention to the SW, and away from the peak axis for long barrow orientation. During later spring, the

Orion group set just to the S of due W in 3000 BC, with a spread of about 42° from Sirius to the Pleiades, this latter setting near due W, and remaining within 10° of this from 4000 to 2000 BC.

The peak of alignment for long barrows at around 270-290° is close to due W, with a spread either side from NW to SW (e-FIGS LB-01 to 21). Setting of the Orion group over the arc to the S of W might weaken the case for its direct use as a close target. However, this seasonal setting might have been more symbolic, in serving to stress the W as a direction of some importance for funerary ritual, rather than acting as a closer target.

On balance, the frequency distributions for alignment at long barrows seem to be more directly related to the solar cycle than to stellar events, although certain of these latter might well have been supplementary. The Orion group, rising and setting, would have been visible for a few months a year, whilst, for a site such as a funerary monument, according to the orientation adopted, dependable access to the solar transit could have been maintained for considerably longer (see Table of Contents: 02c/2e).

Determination of environmental factors important in seasonally-dependent models for monumental construction: application to long barrows

Establishment of alignment for a monument would have been one of the first stages in its construction, the timing of which might have been related to such seasonal factors as the onset of more clement spring conditions, availability of sufficient labour, and occurrence of some ritually, or economically significant period. If marking the axis was a minor preliminary, then the importance of the first two factors noted above would have been reduced.

Suitable conditions for construction, as related to weather and labour, can be defined more closely by considering onset of the more active agricultural year (e-FIG LB-41, 41a):

-**weather**: As far as weather is concerned, the transition to spring can be closely defined and tracked across Britain and Ireland in terms of the position of the 9°C isotherm, as outlined below, its onset progressively later with movement N'wards (TABLE LB-08). How far latitude-dependent factors might be reflected in regional alignment behaviour is outlined in more detail elsewhere (see Table of Contents: 03a/16g);

-**available labour**: Allocation of resources to larger co-operative construction projects during the early part of the year would have been tempered by the competing demands of essential agricultural activity;

How far the group properties of alignment can be explained in terms of targeting the setting sun during such a modified time-slot is discussed further just below.

Onset of the seasons

The gradual spread of warmer spring conditions across Europe can be followed in general outline by tracking the position attained by isotherms of 9°C for air temperature, as seen in e-FIGS LB-36 to 39. Isotherms summarise the main trend for changing temperature, and although useful for general discussion here, they do mask considerable variation of temperature within the regions involved. The seasonal movement of modern isotherms is, for the purposes of this general analysis, assumed to be broadly similar to that of the Neolithic period.

The 9°C isotherm advances fairly uniformly across W'n Europe, from S to N, at about 170 km per week, lying obliquely NW to SE over Continental areas, but adopting more of an E'-W'ly line over Britain. This coincidence brings isotherms into accord with lines of latitude, simplifying joint use of latitude-dependent temperature-change and key solar events in discussing their possible combined impact on alignment of barrows.

Dates at which this springtime warming first occurs range over about three months, from early March in N'n Iberia, to June in the far N of Scotland, with a two-month difference within Britain, from Cornwall to Shetland (TABLE LB-08).

TABLE LB-08 Date of arrival of the 9°C isotherm at key locations, and the approximate azimuth of sunset at that time

Note: data: Bartholemews and Herbertson 1899, volume 3, plate 5;

location	date	sunset: azimuth	latitude (°N)	example barrow groups involved
England:				
S'n	15 April	286	51	elbs; Cotswold-Severn
N'n	21 April	295	54	elbs;
Scotland:				
S'n	1 May	303	55	S'n lowlands;
N'n	15 May	312	58	Sutherland, Caithness, Uist;
Shetland	1 June	321	60	Orkney, Shetland;

Key: elbs: earthen long barrows;

The timing of any clearance, ploughing, and planting would, therefore, have tended to become later with progression N'ward. As a consequence, the interval proposed for construction of such monuments, suggested here as following this phase of cultivation, would also have been displaced to slightly later in the year. If the model of alignment for these monuments towards setting solar positions is correct, then any such seasonal shift in the construction period should produce clear changes in orientation between regional groups over this range of latitudes. It should be noted that arrival of the 9°C isotherm would control the *earliest* opportunity for constructional activity, rather than determining any detailed onward timing. The relationship between key events in the solar cycle, the suggested timing of limiting economic activities in spring, and peaks of barrow orientation is given in e-FIGS LB-41 and 41a.

If the tendency was to align monuments towards the setting sun during an otherwise slacker time, from later spring to early summer, as suggested by this model, those barrow groups at the N, for instance in Scotland, should show orientation distributed more towards the summer solstice than for S'n groups. This trend is indeed seen over the range of latitudes within Scotland (e-FIG LB-12), and in its comparison with a S'n group of long barrows, those from the Cotswold-Severn area (e-FIGS LB-16 and 17).

On practical grounds, onset of all such activity, agrarian and constructional, would have taken its detailed cue from the natural world, as a response to appropriate conditions in the environment, rather than from more closely calendric considerations. Any related seasonal festivals (see Table of Contents: 02b/9a) would have been timed appropriately, and hence with considerable latitude for local variation, universal synchronised celebration perhaps being a more modern concept.

A single well-placed axis could have had dual use: for instance, foundation of an axis during the slot in springtime would not only have allowed prospective sun-related rituals at that time, and also retrospective ritual during the important period of post-harvest celebration.

The seasonal labour cycle

In discussing factors acting to modify timing of monumental construction it is important to consider the agrarian cycle in more detail.

The basic cycle

The agrarian year during the prehistoric period would have followed a familiar general cycle, with details of timing dependent on local conditions. The balance between cultivation and pastoralism would of course have varied between different areas, according to local terrain and environment.

-During **spring**, cultivation would have increased in early March, with this heavier labour involving much of the basic work force, expanding during April to include more general involvement in the detailed work of sowing and weeding. In spring, the needs of sowing would be expected to predominate, with autumn planting probably a later practice. This period would also have been the one during which birth rates amongst stock caused additional pastoral responsibilities. In late April, and early May, calving and lambing would have been a preoccupation and, in later May to June, any gathering of fodder crops, such as hay might have taken place.

-**Summer** would have involved general care of crops and animals, further provisioning of the community, and maintenance of structures, with house building perhaps timed to take advantage of thatch from the autumn harvest.

-Later summer would have seen preparation for the harvest, with cereals being gathered in by early to mid September, to be followed by **autumn** straw clearance, fertilisation of the land by manuring and burning, and other preparation for the next season.

-**Winter** preoccupations would have included hunting, additional gathering of fuel, and general day-to-day survival of the community during inclement months.

Within this economic context, construction of a monumental structure, such as a barrow, would have represented a major undertaking, even for the initial stages of ground-work. In areas where the density of such monuments was relatively low, construction might have been a fairly singular event, and such provision of resources not required to be to be factored into the economic year on a regular basis, although maintenance, and operation of an established site would necessarily have continued.

The ergonomics of monumental construction

The effort involved in construction of major monuments would have been considerable, given the technology available, although this could have been carried out in stages, and have involved widespread participation. The ergonomics of such undertakings have been discussed widely. It has been estimated that construction of an earthen long barrow, such as Fussell's Lodge (Wilts; SU 192 324; Ashbee 1966), might have involved about 7000 man-hours, and a labour force of some 40 men, whilst the megalithic equivalent would have needed some 16000 man-hours and required about 100 men (Startin and Bradley 1981). These particular examples were compiled using a general ergonomic model not outlined in detail but, even without such estimates, it is all too obvious that such monuments represented a serious commitment of men, time, and materials.

Timing of construction projects

In terms of the economic cycle outlined above, there are better times for starting major construction, without compromising other economic activity, or falling foul of bad weather: post-cultivation in later spring to early summer, and post-harvest in early autumn to early winter might have been preferred.

-spring

During the first available slot the weather would have been clearing, the work-force would be more available after preparation of arable plots, plus other essential duties, and most of the year would still be available for additional work on the project, at odd times, as other activities allowed. Basic materials, such as stone from field clearance, and manageable, well-bound turf would be readily available, and could be conveniently extracted. Use of such turf in packing the cores of barrows was frequent (Ashbee 1960, 1984) and use of small sarsen boulders in primary mounding, of a type characteristic of field clearance, was noted at Wayland's Smithy, barrow I (Berks; SU 2808 8539; Atkinson 1965).

-autumn

During the second slot the weather would still be clement, the harvest, and much of the annual cycle of essential activities would be over, giving confidence and sufficient time in hand to undertake additional community projects. This would have been a favourable time for construction, of both monuments, and housing, with abundance of mature timber, and in the latter case thatch for roofing.

Interpretation of barrow alignment in terms of seasonal activity (e-FIGS LB-41 and 41a)

Peaks of alignment, taken in the direction of pointing (front to rear), typically fall just to the N of W, typically 270-290°G (TABLE LB-01). If the axis of a barrow was established (see Table of Contents: 03a/8), and initial construction carried out during either the spring or autumn slot, and alignment was made towards the setting sun at that time (see Table of Contents: 03a/13a), then this would account for these observed peaks of axial frequency. On this basis, peaks of frequency are seen as a consequence of economic activity and seasonal opportunity, rather than an abstractly intended direction towards the equinox.

On its spring passage towards the N the setting sun moves from 270°G at the vernal equinox (21 March), to 310°G at the summer solstice (21 June), with its autumnal return to the autumnal equinox at 270°G (21 September) (example: from S'n England: see TABLE AS-01).

If sunset was the target then peaks of alignment 270-290°G would correspond with later March to April for the spring slot, and later August to September for the autumn slot (e-FIG LB-37 and 38). If the near approach towards setting, rather than the setting itself, was the target, then for the spring slot the actual dates represented by the axis must be pushed slightly later, and slightly earlier for the autumn slot.

If there was a distinct increase in foundation of barrows during the later spring, or the early post-harvest period, as suggested by this model, then an association with spring, and autumn festivals is possible. These might have been precursors of the Celtic Beltane, in early May, and Lughnasa, in early August, both of which have known associations with the sun. Imbolc, in early February, would seem too early, and Samhain in later October too late to correspond (see Table of Contents: 02b/9a).

The particular periods that seem more practical for foundation of long barrows in terms of weather conditions, and temporary reprieve from more intensive agriculture, would be phases 2a-b, in later spring, and 3b-4a, in autumn (notation according to e-FIG AS-19). An earlier phase of initial construction and dedication, during a possible equinoctial festival in the pre-Beltane period, using the direction of the setting sun then current as a general guide for alignment, would have caused this ritual direction to become appropriate again during the post-harvest period for any associated festival. There may be a clear separation here between spring foundation, and autumnal post-harvest ceremonial, the two marking onset, and end of the lighter period of the year. For the general structure of the agrarian calendar proposed in this analysis, see Table of Contents: 02b/9a, and e-FIG LB-41 .

Foundation during the former phase would have had the advantage of allowing work to continue throughout the following summer and autumn, as other commitments allowed, but a start in autumn might see unfinished structures languishing over winter. Beyond this, it is difficult to argue the advantage of one seasonal slot over the other, and certainly there can be nothing from the data to distinguish them. If the stated model is valid, then all that can be said with any confidence is that there seems to have been increased foundation of barrows either side of the main phase of agrarian activity.

Such interpretation of alignment in terms of seasonal activity avoids the difficulty of involving a transient event, like the equinox, directly in determination of axes. It must be noted that these arguments are based on the central tendency for alignment, as expressed by peaks of frequency, and that there is a considerable spread of alignment at variance with this. This could reflect construction at different times of year, and alignment on that current sunset, an absence of targeting on such a cue, or involvement of other factors, such as topography, or other local features.

Minimising the outline structure required for foundation, and initial dedication of a monument (e-FIG LB-31) might have allowed this preliminary to be done under less clement conditions, during still earlier, or later months of the year, deferring fuller expansion, and completion of the monument, until weather allowed. This would de-couple alignment from the activity cycle somewhat, and introduce another possible source of variation in data. Furthermore, by using an abstract notional direction, such layout could be done at any time of year, breaking the seasonal-economic link.

Certain key events, such as seasonal ritual, and deposition, or display of remains, at a monument where the axis lay within the transitional zone of the solar transit (see Table of Contents: 02c/ 2a) might have been timed to coincide with passage of the sun over this line. The regularity with which this occurred would depend on the transit-frequency for the axis in question (see Table of Contents: 02c/ 2e). It is easy to imagine burial being made as the setting sun crossed the axis, emphasising connection between the event and the netherworld of the ancestors below the horizon (see Table of Contents: 02c/ 2i). Equally removal and display of items from the monument could be timed to coincide with the transit of the rising sun over the axis. These must remain suggestions, but not unreasonable ones.

Comparison of barrow alignment over the range of latitudes

If the seasonal-solar model of barrow alignment outlined above is correct (e-FIG CO-02) then the positions of peaks of axial frequency for groups from separate European latitudes (TABLE LB-01) should show some characteristic pattern. For the purposes of this exercise three general ranges of latitude are considered: S'n, mid, and N'n.

In the S'n range the peak alignment from Iberia, at 290°G, lies midway between the equinox and summer solstice, with that from Brittany at 305°G, slightly closer to the summer solstice, suggesting construction activity more centrally during the summer period.

For mid latitudes, earthen long barrows at 270 °G, the Cotswold-Severn group at 265°G, and the Irish court cairns at 260°G all show closer association with the equinox, and if this is the vernal, then a wave of construction activity might have followed the phase of cultivation in spring, or the autumn harvest.

In the N'n range of latitudes, a peak at 285°G for Scotland could indicate foundation of monuments slightly later in the season than for further S, with any autumnal rituals correspondingly earlier, both in line with less clement conditions, and shorter summers for the area.

This general analysis for various European groups was followed up by more detailed examination of key groups in Britain, comparing axes for earthen long barrows and Cotswold-Severn in the S, with Scottish chambered tombs in the N (see Table of Contents: 03a/25a, 25b, and 25e). In both regions, sufficiently well separated to show significant differences in the solar cycle and climate, a large number of sites were available for more precise determination of alignment.

Orientation of longhouses

Data on orientation of a sample of longhouses of Neolithic type from Europe are included in this analysis, for comparison with those from long barrows, since structural and ritual relationships between both groups have been suggested, and some common basis for alignment is at least possible. Examples of longhouses of Neolithic date from W'n and N'n Europe are shown in e-FIG LB-23, and their general orientation in e-FIG LB-24.

Examples of longhouses, rectangular and tapering, occur within, and close to Britain, for instance in N'n France, and in Brittany (Scarre 2011, 262-265), where W-NW'ly alignment is common (*ibid*, fig. 3.4/ p.49; fig. 3.6/ p.51; and fig. 9.23/ p. 263). At Pléchatel, houses A and B have clear entrance-structures at the perhaps more sheltered leeward SE'-E'n (*ibid*, fig. 9.23/ p. 263).

Relationship with long barrows

Given the broad similarity of alignment between both groups (long barrows: e-FIGS LB-01 to 21; longhouses e-FIG LB-24) it is possible that the funerary monuments might, to some extent, have been imitating that adopted amongst house structures, without reference to an independent target. Alternatively, both types of structure might have shared a common environmental cue for alignment, and this could have been practical, and weather-related, or of a more ritualised nature.

Data on orientation for other domestic structures, both long- and round-houses, from Iron Age to Saxon type are included, in order to extend the basis for discussion to possible cues common to house-types in general (e-FIGS LB-25 to 29).

Long barrows contain many architectural features that may have an origin amongst more practical domestic versions to be found in longhouses. These two types of structure, although very different in actual function, may be related through symbolism, and in aspects of external appearance, providing houses for the living, and for the dead.

Common features, such as basic rectangular, or trapezoidal plans, and details of internal division, have been used to suggest that long barrows might have represented funerary versions of longhouses, and that basic connections existed between burial ritual and the domestic sphere. That both types of structure have a similar general alignment suggests a further parallel.

Structural similarities between longhouses and long barrows are particularly evident amongst the LKB and related Neolithic cultures of central and W'n Europe. Structural parallels have been noted, and problems of interpretation widely discussed (Corcoran 1969, 77-78; Henshall 1972, 229-233; Fleming 1973; Renfrew 1976; Whittle 1977; Ashbee 1984, xxi-xlii, 49-54; Reed 1984; Petrequin 1985; Midgley 1985, 206-219; Hodder 1984, 1994; Bradley 1998, 51-67). Ruggles (1999, 125-143, fig. 8.1/p. 126) discusses the alignment of earthen long barrows and longhouses in Britain and Europe, and notes the tendency for *facing* E'-SE'ward (see Table of Contents: 03a/11b: discussion of the relative importance of directions of pointing (front to rear), and of facing in the axis).

However, there are problems in supporting a clear relationship between long barrows and longhouses in many areas. This is exemplified in Britain and Ireland where houses, and especially longhouses, of Neolithic date are relatively rare, and where many of the known house-sites, such as at Hembury (Devon), and Fengate (Norfolk) fall well outside the European tradition of longhouse construction (general survey: Darvill and Thomas 1996).

Smaller variants of European-type longhouses do occur, as at Ballynagilly, Tyrone (ApSimon 1969), Ballyglass, Mayo (O Nuallain 1972), and Crathes, Aberdeenshire (Murray *et al.* 2009), these possibly rectangular roofed buildings of single farmstead type, about 5 by 5-10m in plan. Rectangular longhouse structures sealed under barrows at Dorstone provide a further example, and a direct link at the same site (see Table of Contents: 03a/24).

Stone-built Neolithic houses from Scotland, such as at the Knap of Howar, and Skara Brae on Orkney do share certain features with megalithic tombs constructed in the same area. However, such parallels may only result from the use of common building materials, and standard techniques of construction, rather than implying any deeper connection. Near the Maes Howe tomb, the stone-built houses at Barnack (Orkney) show similar aspects of architecture and alignment, suggesting further parallels between domestic and funerary architecture (see Table of Contents: 04a.

Smaller chambered tombs in Shetland are similar in structure to local house-types, both being oval, with a main chamber entered from one end, and containing one or two recesses, or cills on each side (Calder 1962-3; Henshall 1963, pp. 151-152).

Timber mortuary houses (Ashbee 1984), as at Waylands Smithy barrow I (Atkinson 1965), Fussell's Lodge (Morgan 1959), and Gwernvale (Britnell and Savory 1984) bear a superficial similarity to early Neolithic buildings from W'n Britain and Ireland, for instance Ballynagilly and Ballyglass.

Although there are some chronological and geographical problems in establishing a well-defined relationship, it seems highly probable that funerary monuments of varied type, constructed over a millennium or more, and of wide European distribution, may well refer to an underlying tradition of domestic architecture. Such a relationship is unlikely to have been simple, entirely structural, or reflect purely functional considerations, such as the need to house the dead. Long barrows, which were house-like in external appearance, might also have been constructed as symbols of territorial assertion (Renfrew 1976), or have fulfilled other social functions within the parent community.

If long barrows and longhouses are interrelated in some way, then it is also possible that circular monuments such as passage tombs might show a similar relationship with round house forms (Hodder 1994). This suggestion is difficult to assess at present because structural evidence from the settlements that might have given rise to passage tombs is very scarce. For instance, excavations near the passage tomb cemetery at Carrowmore has produced a few oval, tent-like hut structures somewhat later than the main date of the passage tombs, and of uncertain attribution (Burenhult 1984).

Instances where houses and barrows occur in close proximity are particularly relevant to discussion of links between orientation in both types of structure. For instance, the longhouse at Ballyglass (O'Nuallain 1972) is stratified under a court cairn. The orientation of this longhouse and barrow are similar and each lie close to the NW-SE axis common for such sites (e-FIGS LB-19 and 24). The examples at Dorstone have already been mentioned, just above.

There are other examples of barrows being constructed over house-like structures, suggesting that domestic and funerary aspects of culture were firmly linked. For instance, there might have been a timber house under the barrow at Withington II (Glos; SP 0488 1576; e-FIG LB-80a), a megalithic tomb of the Cotswold-Severn group (O'Neil 1966). Two later Neolithic post-built huts, approximately circular, were stratified under round barrows at Trelysan, Powys (Britnell 1982) although in view of the intervening period this may just be coincidental reuse of the site. Timber longhouses of Neolithic date were burnt then mounded over at Dorstone Hill (Herefs; SO 326 423; see Table of Contents: 03a/24). The passage tomb at Knowth (Meath, Ireland, N 997 734) was constructed over a house site (Eogan and Roche 1994, 1997).

The construction of post circles under many round barrows of later Neolithic and earlier Bronze Age date (Ashbee 1960; Marshall 2005, 2020) may indicate token construction of a hut wall, and again assert the continuing role of house-forms in the ritual of burial.

A second type of association between huts and funerary monuments occurs where rectangular timber mortuary houses are sited close to barrows. For instance, at Tustrup (Denmark) there is one such mortuary house, with an axis approximately NE-SW (039-219°G). This structure acted as a repository for human remains, and appears contemporary with passage tombs at the site. At Ferslev (Denmark), a similar mortuary house was oriented approximately on a NW-SE'ly axis (124-304°G), which is similar to the main peak in the general distribution of axial directions (e-FIG LB-24). Such mortuary houses might perhaps have acted as intermediaries between settlement and the final repository, and may further strengthen the connection between funerary and domestic structures.

Cues for alignment

Climatic cues

-Neolithic longhouses

The general orientation of longhouses is similar in widely separated areas of Europe, as far apart as Poland and France, and this suggests that determining factors operated in a relatively uniform manner over large distances. Two such influences suggest themselves: the need to align longhouses in order to minimise the impact of prevailing weather on the timber structure, and its interior (Marshall 1981), and possible conformity with some common celestial target. The first option would have been a purely environmental response, the second reflecting domestic rituals connected with construction and use.

It certainly seems reasonable, from a practical standpoint, to suppose that climatic factors would have had at least some influence on alignment of longhouses. Their most satisfactory alignment in terms of environmental resilience would have been end-on into the prevailing wind and weather, especially that occurring during the colder and wetter winter months. Such orientation would have reduced the deleterious effects of cross-winds, which would have placed lateral stresses on the timber frame (Meyer-Christian 1976; Startin 1978), and would have reduced rapid transit of air across the short axis of the building likely to cause serious heat loss from the interior. Passage of air over a trapezoidal longhouse would have had additional effects when aligned end-on into the prevailing air-stream. In this sub-group, sloping and tapering ridged roofs would have resulted in more satisfactory circulation of air through the interior, and more effective removal of smoke through the crown of the roof, a situation with some ethnographic parallels (Marshall 1979). Consequently, trapezoidal examples are often efficiently oriented thus, with their narrower ends towards the N or NW. Within this axis, longhouses that are rectangular, but have one end distinguished by a continuous bedding trench, constructed to contain a more robust end-wall of planking, possibly as additional weather-proofing, are also frequently oriented with this end towards the same direction. There is also evidence from some sites for location of entrances at the SE, presumably the more sheltered leeward end, although in many cases clear entrance gaps do not survive.

However, for this climatic explanation of orientation to be acceptable, the direction of prevailing wind and weather during the Neolithic period in N'n and W'n Europe must have been somewhat different from that of the present day.

In those areas of Europe where such longhouses occur, at present, the most frequent direction from which summer and winter winds come is the SW'n quadrant, with most winter maxima around SW to W (e-FIG LB-42 to 43). If the NW'ly orientation of longhouses, with an axial peak around 325°, indicates the most common direction of maximum winds during the Neolithic period then a change of over 90° in wind direction must have occurred since then, for the notion of wind-determined orientation to be valid. Alternatively, longhouses might only have attempted to reduce the effects of the worst wintertime N-NW'lies, by alignment in this direction. Neither does the main peak for long barrows match this wind-maximum, although it is slightly closer than for the longhouses.

Reconstruction of winter and summer regimes of atmospheric circulation prevailing over W'n Europe from the 7th to 1st millennia BC have been attempted by Lamb (1977, 380-386, fig. 16.10). It is suggested that during the 5th to 3rd millennia, which includes the period under discussion, depressions centred in the area from Iceland to Greenland might have resulted in winter winds that came predominantly from the SW'n quadrant. However, during the Bronze Age, the British Isles might have been dominated by W'ly and NW'ly winds (Lamb 1977, 385), whereas, at present, SW'lies prevail (e-FIGS LB-42 and 43). The overall picture, with a general lack of hard data for reconstruction of such atmospheric circulation, is very vague indeed, but does not, as presented, seem to be one of highly directed surface winds coming from the NW.

However, the important factor might not have been the intensity and quantity of the prevailing wind. Since winds from the N, of which there are always some, would have been colder than those from other directions, this might have resulted in a narrower band of longhouse alignments towards this direction than would be expected from the general pattern of wind direction alone.

-other long- and round-houses

A further perspective on this problem may come from consideration of alignment in other types of house-structure in the area, of different date, and cultural context. A consistent general direction for group alignment could suggest that orientation was predominantly a practical and climatic response, rather than one determined by current ritual, unless the latter was persistent between cultures, and over time.

Orientation of rectilinear houses from Bronze Age, Iron Age, and Saxon sites were determined, and also those for circular huts of Bronze, and Iron Age date (e-FIGS LB-25 to 29; TABLE LB-02). Although circular huts can not be oriented end-on into prevailing wind in the same way as longhouses, the position of the entrance in the former may mark the leeward side, and hence indicate the prevailing direction of significant wind. Location of the entrance on the S'n, generally sunward, side would in itself have further obvious practical advantages. Detailed studies have been presented for Bronze Age circular huts on Dartmoor (Feiller and O'Neil 1982), and in Perthshire (Harris 1984).

The distributions of frequency for these later types have maxima with a more E'-W'ly trend than the sample of Neolithic longhouses, suggesting some underlying differences (TABLE LB-02). It could indicate a closer correspondence with the general W'ly air-stream typical of modern European weather, suggesting a more practically determined basis for these later groups.

-comparison of orientation between Neolithic barrows and longhouses

Neolithic longhouses of all types, rectangular and trapezoidal, show closely similar orientation, most with a peak frequency on a NW-SE'ly axis (European sample: 145-325°G; e-FIG LB-24). There is also slight indication of a minor peak around 080°G, which is similar to the minor peak seen in the pan-European data for long barrows (e-FIGS LB-01), and in certain of the regional groups, in all cases of uncertain significance.

The peak axis of orientation for Neolithic longhouses at about NW (325°G)(TABLE LB-02) appears to be close to the solstitial axis between midwinter sunrise and midsummer sunset, for the latitudes in which they occur (TABLE AS-01). This peak is some 45° to the N of that for the entire European sample of funerary monuments, which is more W'ly, at about 280°G, and potentially equinoctial (TABLE LB-01).

The spread of alignments amongst funerary monuments (e-FIG LB-01), and longhouses (e-FIG LB-24), are comparable and may indicate similar constraints.

Axial preferences in these two groups could be explained in several ways, of which the following is one suggestion:

The solstice is a limiting position, clearly apparent as a distinct annual event, and determines the line from midsummer sunset to midwinter sunrise, this axis directly available in later June. Longhouses laid out during the early post-harvest period, when appropriate materials were available, might have used this event for appropriate alignment. This would establish house-building as a mid-summer event, with the peak around the solstice indicating June and July as key months, integrating well with other aspects of the economic cycle. It would not conflict with any late summer to early autumn harvest, and would be correctly timed to benefit from the availability of harvested by-products, such as straw for thatch, and from the midsummer abundance of natural materials such as timber and turf. Starting such work at the time of the midwinter sunrise would have had obvious disadvantages.

The more equinoctial peak for funerary monuments could suggest initial definition of axial structures at a slightly different time of year, either in later spring or earlier autumn (see Table of Contents: 03a/13a). A suggested seasonal cycle of constructional activity for both longhouses and funerary monuments is shown in e-FIG LB-41.

-anthropological parallels

There are many anthropological parallels for alignment of longhouses made according to astronomical or astrological principles. The examples cited here are admittedly remote in time and space from Neolithic Europe, but they may provide some insight into the way in which, amongst small-scale societies, the house can represent, and conform with, a deeper view of the world, and its natural cycles.

For instance, in the NW'n Amazonian basin, the Tukano people build rectangular longhouses, '*malocas*', oriented with the long axis E-W, with the front door towards the E, and back door towards the W. They consider that the river of the dead flows under the house, along its main axis, and that in the evening the sun sets in the W, goes up-river, sailing against the current, until it rises again next morning in the E. The dead are buried in the centre of the house, in coffins made from canoes. This parallel is remarkable in that it incorporates the solar cycle, house alignment, and burial in the same context, a situation that may perhaps be seen again amongst longhouses and long barrows from Neolithic Europe.

As a second example, the Betsimisaraka people of E'n Madagascar construct rectangular longhouses, oriented N-S for astrological reasons, but in this case the solar cycle is not involved.

Directed illumination of interior structures at chambered tombs

Introduction

The axes of passages and chambers at some chambered tombs coincide with key sunrise, or -set positions, such as those at, or near, the solstices, or equinoxes, their interiors to become better illuminated only during the short intervals when these events occur. This phenomenon, and its status as an element of deliberate design, has been discussed widely, especially for certain Irish passage tombs (New Grange; Knowth; Dowth; Loughcrew L and T; Carrowkeel G). A similar case has been made for certain Scottish sites (Maes Howe, Orkney; Crantit, Orkney; Balnuaran of Clava, Inverness), and in Wales for Bryn Celli Ddu, Anglesey. Further details of these specific sites are given below (TABLE LB-09).

If such selective illumination was indeed an essential feature of such monuments, then alignment could have had particular ritual significance in addition to that of pointing (front to rear), and its common reference to the W'n horizon (TABLE LB-01). The case for such illumination needs, therefore, to be reassessed, in order to place these apparently opposing tendencies in context.

Five of the Irish passage tombs where cases of directed illumination have been cited are examined in closer detail: the major monuments Knowth, New Grange, and Dowth, all within the Bend of the Boyne (e-FIG LB-95, 96, and 102), the hilltop cemeteries at Loughcrew-Carnbane (e-FIG LB-103 to 105), and at Carrowkeel (e-FIG LB-108).

In reviewing the evidence for directed illumination, it has been difficult to obtain accurate, and consistent axial values for the structural elements involved, the passage and chamber. Published plans often contain inaccurate N-pointers, of unspecified type, with structural alignments appearing variable within, and between publications, as can be seen by overlaying different versions, which can also reveal frequent structural inconsistencies. There is often confusion between defining the structural outline of passages, and presenting data for the track of light itself.

Such problems have been particularly evident amongst the Irish passage tombs, where key sites are central to the discussion. Rarely do accurate data appear published, with azimuths for Knowth E'n and W'n passages, and for Loughcrew L being welcome exceptions (Prendergast 2013; Prendergast and Ray 2014).

The case against directed illumination

The extent to which directed illumination was a deliberately designed feature, or arose at random, is an open question (Patrick 1974; Ray and O'Brian 1989; Prendergast and Ray 2002), but given the small fraction of sites which exhibit this phenomenon, if real, it was certainly of restricted use. It is not possible to state with any certainty, even in the most noteworthy cases involving impressive monuments, and illumination of specifically decorated surfaces, that this was an intentional effect of the architecture at the monument, or an unintended consequence, perhaps useful.

It is argued here that structural evidence for such illumination is very sparse, varied, lacks close co-ordination with the solar event, those few candidates that are known being explicable by random alignment of passages. On present evidence, this phenomenon seems to have been, at best, a secondary effect, of minor and localised interest. It is difficult to see this transient, and weather-dependant effect, which runs contrary to the basic principles of contained entombment, as forming the mainstay of ritual.

Directed illumination, like midsummer sunrise at Stonehenge, has entered the popular imagination and literature, forming a distinct spectacle for heritage tourism at key sites, where it has been further elaborated along modern astronomical lines, oversold and, from here, more widely applied to monuments where the arguments are even more marginal.

There is a modern parallel of passing interest. At the end of May, and in mid June, the sun, low in the sky, provides a spectacular illumination of certain E'-W'ly running streets in New York, so much so that this dazzling display has become a local phenomenon dubbed 'Manhattanhenge', courtesy of the similar phenomenon at Stonehenge. This bears obliquely on directed illumination in general, as discussed here, as an example of a random, and unintended event.

-illumination by chance

Any linear passage or chamber that faces the local horizon, that is straight, unobstructed, lies within the transitional rising, or setting solar transit, and is capable of being opened at the edge of the mound, becomes more intensively illuminated by the sun, at low elevation, at some time of year.

A good case in point is provide by the E'- and W'ward facing lateral chambers at the S'ly pointing (front to rear) Cotswold-Severn long barrow at Belas Knap (Glos; Sudeley I; SP 0210 2542; e-FIG LB-70a and 90). The chamber on the W'n side in particular becomes well illuminated by the setting sun around the equinox, with no suggestion of a deliberate effect, the chamber being a few metres long and at present relatively open, allowing a short unfocused track of sunlight. Illumination of chambers on the E'n side would also occur given removal of modern woodland.

There are twelve monuments listed in TABLE LB-09 where directed illumination has been suggested, a very small proportion, around 1%, of the many hundreds of equivalent sites in Britain and Ireland where it has not. Coincidental orientation, therefore, seems a strong possibility, and in fact, many more random matches might be expected, especially around the equinoxes, given the generally W'n emphasis of axes, and allowing some tolerance in making directional comparisons. However, such scarcity of cases could be explained in terms of specialist ritual, confined to a few key sites: some but not all of the sites nominated are large, and impressive within their locality, suggesting a central function (Knowth, New Grange, Maes Howe).

For Scotland, only 13% of sites, 57 out of 439 (plans: Henshall 1963, 1972; Davidson and Henshall 1989) can be short-listed as possible candidates for directed illumination. The best of these is Maes Howe (Orkney; HY 318 127), which matches the zone of winter solstice sunset, unlike other members of its type. For instance, on Orkney, other large passage tombs, comparable to Maes Howe, such as Quanterness (Orkney 43: Henshall 1963), or Quoyness (Orkney 44: Henshall 1963), show a more normal W'ly pointing (front to rear) alignment. At these sites, directed illumination might have been possible, with the sun rising in the E'n sector, although this has not been suggested.

Amongst the Clava cairns, Balnuaran of Clava NE and SW (Inverness; NH 7544; e-FIG LB-94) appear aligned close to the winter solstice sunset, but the case here is weakened by other members of their group showing little such correspondence. These two monuments could be equally explained in terms of variability of the group around peak alignment at the SSW, a clear preference which does emerge from the plot of axial data (e-FIG LB-11).

Amongst Irish sites of all types, the situation is similar, with few clear candidates emerging, and these mainly amongst the Boyne passage tombs, a group of particularly varied orientation (e-FIG LB-20).

The mere fact that alignment of such monuments tends to peak towards the W in the pointing (front to rear) direction (e-FIGS LB-01 to 21) would automatically result in many terminal chambers, and forecourts, being illuminated facing the rising limb of the transit. This might be a secondary effect, the alignment providing conveniently leeward shelter rather than illumination.

-variation in axes

There is no consistency in choice of alignment at candidate sites, with axes as listed in TABLE LB-09 distributed as follows:

TABLE LB-09 Monuments claiming directed illumination by specific solar events

solstice		peri-equinox	other	TOTAL
winter	summer			
rise 3	1	3	1	8
set 2	1	1	2	6

No robust conclusions can be drawn from such a small sample, but there is some preference for winter solstice over summer, with rising and setting for each set about equal.

-astronomical correspondence amongst axes

The width of passages opening towards the sun is sufficient to allow a window of illumination over a short period, even for the highly directed track at New Grange (e-FIG LB-102). Such latitude of targeting is only to be expected, also reflecting architectural intention as expressed using difficult structural material, and a likely interest in broader ritual, rather than preoccupation with abstract astronomical principles.

It should be noted that, although it halves the inter-solstitial range, the equinox is a transient event, not marked by a standstill, and hence perhaps more of modern astronomical application than relevance to those who built the monuments. Any cases of directed illumination involving the equinox are therefore inherently somewhat suspect.

The transient nature of possible directed illumination should not be taken to imply restricted seasonal relevance of the alignment. For instance, illumination from the winter solstice at such sites as Maes Howe [set], and New Grange [rise] would only have been current over a matter of days. However, an alignment slightly further to the N for each site would have increased the span of events sufficiently near to the horizon to produce an effect (see Table of Contents: 02c/2e).

-questions of access to burial structures

Prolonged access to protected internal funerary structures and deposits, simply for the purposes of illumination, seems unlikely on the grounds of security for contents, both physical and ritual. Such chambers were deeply embedded in the mound, and bright illumination seems to run counter to this intention.

During the active life of a chamber, before any final sealing, periodic access could be arranged by removal of timber or stone blocking structures: blocking slabs were found over entrances at Carrowkeel (TABLE LB-14). Even with the entrance closed, partial access could have been provided through the type of higher level slit, or roof-box, suggested at some monuments: New Grange, Carrowkeel G, Crantit, and Bryn Celli Ddu, with clearer evidence at the first two sites. Such an additional slot would have allowed a point of entry for offerings and ritual contact, or some outward flow from the chamber itself, and at a very practical level a means of ventilation for the otherwise sealed interior and its decaying contents. Carved dials on, and near the roof-box at New Grange could further suggest a specific connection with illumination.

roof-box	**evidence**
New Grange	modern reconstruction casts some doubt on its original form;
Carrowkeel G	well-preserved original slot over the entrance;
Crantit	structure very slight and unconvincing;
Bryn Celli Ddu	very weak;

-rock art motifs of solar type in illuminated areas

Circular, or spiral motifs, carved on walling slabs in the illuminated areas of certain passage tombs, could indicate a further connection with the sun, although these designs are capable of different interpretation, for instance as barrows in mappings of ancient landscape (Moriarty 2010).

Such potentially solar motifs are by no means confined to illuminated target areas, but occur widely elsewhere, in chambers, passages, and on external kerbstones (e-FIGS LB-106 and 107). They are also found widely at monuments where directed illumination has not been proposed. Loughcrew L and T (Meath, Ireland) provide particular cases where directed illumination and solar motifs have been linked.

Directed illumination: insights offered by Egyptian temples

Although distant in space, time, and cultural context, consideration of the main, self-dedicated temple-shrine constructed by Ramesses II (1279-1213 BC: orthodox chronology [Kitchen]), at Abu Simbel in Egypt, allows certain relevant points to be made. Abu Simbel provides the classic case of directed illumination of an interior, in which the rising sun briefly penetrates a 60m long passage to illuminate a statue of the king against the back wall, whilst leaving Ptah, god of the underworld, seated alongside, in darkness. This event occurs twice annually, on October 22 and February 22, one or both dates possibly marking important anniversaries for the reign. The presence of a dedication to Thoth, god of wisdom in general, may support some calendric function.

Basic astronomical statistics for the main temple at Abu Simbel, and its passage are:

lat	**long**	**az**	**elev**	**dec**
22.34°N	31.63°E	100.5	+0.75	−9.6

Key: lat(itude); **long**(itude); **az**(imuth of the passage, facing outwards); **elev**(ation of the horizon faced by the passage); **dec**(lination).

Here, well defined illumination, and the known background of celestially based construction in the culture, argue for this as a deliberate feature. The fact that this was an important shrine, where such a mechanism seems appropriate, rather than a tomb, where it does not, adds to this case.

The first point to be made is that use of such specific solar illumination appears not to have been more widespread in ancient Egypt, raising the possibility of random orientation accounting for the phenomenon. Axial data for over 100 temples from upper Egypt and lower Nubia (Shaltout and Belmonte 2005, table 1) show axes throughout the range of azimuths, but with some preference for the SE'n quadrant, and its winter sunrise (Shaltout and *ibid*., ray diagram fig. 3).

Secondly, choice of axis seems to have been a compromise between the solar transit, and local terrain. An additional topographical factor in the choice of axis for many temples seems to have been the adjacent River Nile, with the need for setting monuments parallel, or facing perpendicularly towards it considered important (*ibid*., fig. 4).

However, there are a few other similar sites worthy of mention. The temple of Amun-re at Karnak, constructed by Hatshepsut (1479-1457 BC: orthodox chronolgy), is precisely aligned on winter solstice sunrise, and this would have allowed precise illumination of a statue of the god and pharaoh embracing. Her temple-shrine complex nearby at Deir-el-Bahri might also have used the rising sun in a similar manner. Again, these are temples, not tombs.

How far such well-publicised instances have affected thinking about possible illumination of passages in Neolithic chambered tombs remains an open question, but if so, it has been a distraction from more realistic interpretation of their axial trends.

General conclusions

Directed illumination can in general be explained as an occasional artefact of variable alignment, based on competing influences in cemetery construction: ritual considerations, terrain, and mitigation of impacting weather.

For instance, plotting axes of passage-chambers for key cemeteries at Knowth, Loughcrew-Carnbane, and Carrowkeel gives a clear impression of their partition amongst the sectors of the horizon (e-FIG LB-109). Resultant axes may represent a compromise between standard funerary observance of the W, influence of underlying topography, and degree of exposure at elevated locations. In these examples at least, axes become more directed towards the W and S for the two more exposed locations, Loughcrew and Carrowkeel.

-Knowth: axes for satellite cairns point outwards (front to rear) from the large central site, with all but the E'n sector represented;

topography: low, terrain fairly level;

exposure: relatively sheltered at about 50m OD;

-Loughcrew: W'ly pointing axes dominate those sites for which data are available;

topography: low, on rounded hilltops;

exposure: increased exposure at about 240-260m OD;

-Carrowkeel: S'ly pointing axes (front to rear) form the majority of the sample. The SSE'ward line of the ridges on which sites lie might have influenced choice, along with the need to place the protective rear of the monument towards the Atlantic wind and weather coming mainly from the S to W.

topography: fairly high, on narrow ridges affording quite level mid-line locations;

exposure: high exposure at 260-320m OD;

Properties of candidate monuments

Some constraints must be imposed in defining cases where deliberate and specifically timed interior illumination becomes a possibility. The properties of chambers and passages are the only relevant structures here; the form of mound is largely irrelevant.

The probability of **directed illumination** can be considered to increase where the following features of passage and chamber occur in combination (TABLE LB-09: column 'features'):

[**R**..reversal]: some **direction of facing which does not follow the normal trend,** but is peripheral, or in direct opposition to it, for instance, where chambers face the W'n, or N'n arc, rather than the more usual E'n (e-FIGS LB-01 to 21);

[**L**..length]: a **passage that is sufficiently long**, perhaps greater than 5m, and also narrow, to limit the event to a short interval of days; such focus of illumination would be greatly decreased, and the case weakened along short tracks with wider openings;

[**E**..event]: an alignment for the passage that is closely attuned to some **significant solar event,** such as a solstice, or equinox; a margin of 5° either side of this line, allowing the effect to be enjoyed over a few days, seems practical;

If intermediate solar positions, for instance those corresponding to notional festivals, such as Imbolc-, or Beltane-equivalents, are allowed (see Table of Contents: 02b/9a), and which have indeed been invoked, as for Dowth (TABLE LB-09), then anything becomes possible.

[**T**..targets]: a chamber with specific **target stones** for illumination at the back, perhaps decorated with symbols that include possible solar imagery (see Table of Contents: 06/8 c and d);

These factors can be combined to give some subjective ranking for possible instances of directed illumination amongst candidate sites. Examples from Britain and Ireland are summarised below in TABLE LB-09:

TABLE LB-09 DIRECTED ILLUMINATION: POSSIBLE EXAMPLES FROM BRITAIN AND IRELAND

site		loc	type	NGR	fac	exp	event	feature	pass	notes
SCOTLAND										
Maes Howe		Ork 36	pt	HY 318 127	216	219	WS ▼	R L E T	14	[+]
Balnuaran of	NE	Inv 9	pt	NH 757 444	214	222	WS ▼	R L e	9	+ c
Clava	SW	Inv 10	pt	NH 756 443	216	222	WS ▼	R L e	9	+ c
Crantit		Ork	-	HY 440 098	SE	142	W ▲	r	-	+ rb
Corrimony		Inv 17	pt	NH 383 303	227	223	WS ▼	R L E	11	c
Dalcross Mains		Inv 26	pt	NH 779 484	228	222	WS ▼	R L e	8	c
IRELAND										
Carrowkeel G		Sli	pt	G 753 119	319	314	SS ▼	R L	6	rb
Dowth chamber	N	Mea	pt	O 023 738	249	~241	Imb▼	R L	12	
						~245	Sam▼	R L		
	S				231	228	WS ▼	R L E	8	
Knowth	E passage	Mea	pt	N 997 734	085	090	eq ▲	R L E	36	note 1
	W inner				278	270	eq ▼	L e	27	ap
	outer				258					9
Loughcrew	T	Mea	pt	N 586 776	105	090	▲es la	L T	8	[+]
	L		pt	N 572 775	103	090	▲es la	L T	9	[+]
New Grange		Mea	pt	O 008 727	136	132	WS ▲	r L E T	24	[+] rb
Slieve Gullion		Arm	pt	J 025 203	228	230	WS ▼	R L E	8	
OTHER										
Stoney Littleton		Som	lb	ST 735 572	139	130	WS ▲	L	13	
Bryn Celli Ddu		Ang	pt	SH 508 702	052	048	SS ▲	L E	12	?rb

Key: loc(ation): **Ork**(ney), **Inv**(erness), **Arm**(agh); **Mea**(th), **Sli**(go), **Som**(erset), **Ang**(lesey);
type: **pt** passage tomb, **lb** long barrow;
NGR National Grid Reference;
fac(ing direction for the chamber and passage); **exp**(ected azimuth for the nominated **event** at zero elevation for the latitude of the site);
event: **W**(inter), **WS** winter solstice, **SS** summer solstice, **eq**(inox); **es** early spring, **la** late autumn; **Imb**(olc; early February), **Sam**(hain; early November), these latter two being Celtic festivals);
▲ rise, ▼ set;
feature(s abbreviated as **R**, **L**, **E**, or **T** that are present for the site in question and which together determine the probability of directed illumination: see details just above the table); use of lower case indicates reduction of the feature;
pass(age and chamber, combined length in metres for the track of incoming light);
notes: **+** carved motif(s), potential solar symbols, occur in the passage or chamber, marked **[+]** if they lie in the terminal target zone for illumination; **rb** roof-box present at the entrance, a potential point of entry for illumination; **ap** angled passage; **c** stone circle around the barrow.
Note 1: precise determinations of azimuths by Prendergast and Ray 2014:
E'n passage 85.13°; W'n passage/ inner 278.14°, outer 258.57°.

Alternative interpretations

The case for directed illumination being an intended effect in chambered tombs is weak and, in those instances where it might have occurred, was of probable minor importance relative to other aspects of the alignment.

-deposition and display

A more significant feature of these sites may be their non-standard alignment, which would have allowed ritual functions that might not have been typical of mainstream barrows, with their proposed W'ly direction of ritual (see Table of Contents: 03a/13a and 02c/2i).

It may be possible to reconcile major sites with radial passages which open towards the SE, such as New Grange, with an existing W'ly direction of ritual. The more usual generally W'ward *pointing* (front to rear) type of passage and chamber might have served to direct relevant items towards the setting limb of the solar transit as an act of *deposition*. Reversal of this trend, resulting in a SWward *facing* passage, as at Maes Howe, might indicate a distinct change of emphasis: stressing the importance of bringing items out of the chamber as an recurrent act of *display* and ceremonial towards the same ritually significant direction. These structures might perhaps have acted less as tombs, and more as accessible repositories for significant relics, including human remains.

Rare cases of monuments with opposed radial passages and chambers, such as Knowth (Meath, Ireland; N 996 734), or Huntersquoy (Orkney 23: Henshall 1963), might have incorporated the facility for both types of ritual.

At Knowth (e-FIG LB-96) the main mound (1c) has been interpreted as developing from a far smaller passage tomb (1b) by major extension of E' and W'ward facing passages, and expansion of the original small mound. The E'n passage is straight, ends in a cruciform chamber, and contained more cremated remains than the W'n passage, which has no developed chamber, has its extension set at an angle, and contained a smaller aggregate deposit. In both monuments, certainly in the original tomb 1b, the W'n passage seems subordinate structurally to the E'n. Here the E'n might have corresponded with the more usual W'ly direction of entry and ritual, with a depositional emphasis, with the W'n more involved with exit and display. Equally, these two chambers might just represent provision for different social groups in the area, without reference to significant alignment.

Sporadic reversals of W-ly pointing axes (front to rear), indicating diversity of practice, occur amongst most groups of chambered tombs, and examples can be seen for the Cotswold-Severn (e-FIG LB-89), and generally amongst S'n (e-FIG LB-92), and Scottish groups (e-FIG LB-93). The clearest case of group reversal can be seen amongst wedge-shaped tombs, which are distributed widely over W'n Ireland, and which point (front to rear) towards the E, and face W'ward (e-FIG LB-21). Here, if the pointing direction is taken as significant, then depositional ritual could have been directed to the rising limb of the solar transit, and if the facing direction is taken, then display ritual would have been towards the setting limb.

-Knowth site 1: alternative uses of light

Removal of strictly equinoctial, directed illumination of passage-chambers, and downplaying it as even a peri-equinoctial phenomenon (Prendergast and Ray 2014), opens other possibilities for use of the solar transit in ritual at the site. One suggestion in particular, partially supported by structural evidence, dial motifs, would allow a year-long physical and ritual link between transit and monument, also providing calendric support, sufficient for agrarian needs. The fact that this mechanism might have occurred at the largest, and most impressively decorated monument may indicate existence here of some centralised facility, although such dials could have been implemented at any site, and certainly appear fixed elsewhere as occasional carved motifs (e-FIG LB-97).

Kerbstone 15 at the site contains a dial motif on its vertical surface (e-FIG LB-98; Ruggles 1999, fig. 8.5/p. 129). Although others occur in the area (e-FIG LB-97; TABLE LB-10), here the depiction is uniquely detailed, suggesting proximity of a working original, and a close knowledge of its operation. Almost all of these carved dials appear likely to have been schematic non-functional representations.

TABLE LB-10 PASSAGE TOMBS: IRELAND: CARVED DIAL MOTIFS: PROPERTIES (E-FIGS LB-97 TO 99)

site		gnom	ap	rad	B	term	marginal field		
							circ	?cups	note
New Grange									
kerb K6	a	R	no	6		7 [1]		39	encircling in two rough rings;
	b	R	no	10		9 [7]		30	part encircling, rest disorganised;
K88	a	R	yes	4		8 [4]			field absent;
	b	R	yes	8		8		1	field absent;
roof-box		R	yes	6		8 [5]		11	encircling as a single line;
roof slab		R	yes	4		4		24	encircling as two rows;
Knowth									
site 1									
kerb K7		ur	yes	9	yes	17 [10]		45	as spokes;
kerb K15		**ur**	**yes**	**21**		**20**	**12**		**single concentric row;**
site 14		ab	yes	7		10 [4]		37	as spokes;
Patrickstown									
site X1		R	yes	12	yes	14	5-6		concentric.

Key: gnom(on): **R**(inged), **ur** unringed, **ab**(sent); **rad**(ials); **term**(inals), **[ ]** terminals located between radials; **marginal field**: **circ**(ular motif).

The prime example at Knowth, on kerb K15 (e-FIG LB-98), contains a dial in an arc of 209°, divided by 21 radials into 20 intervals of 10.1°, centred on a clear apical point. Just to the rear of this apex there is a second point, consistent with the position of a gnomon. Around the margins of the dial lie sub-rectangular motifs, perhaps indicating reference markers for shadow lines.

The layout of the dial matches that for annual, rather than daily operation, with a full scale field-layout made on a horizontal surface. A plot of changing shadow lines for the location (e-FIG LB-100) provides a seasonal pattern against which to view the features of the carved dial itself (e-FIG LB-98).

In making this comparison, several features from the physical plot suggest realism in the carved version: the gnomon is placed separately, and behind the apical point of the rays, and the arc of rays extends beyond a semicircle, giving exactly the same coverage as would solar shadow lines. The enclosed area behind the gnomon could represent a zone for viewing and operation, with the active area of the dial lying on its N'n side.

Dividing the 182-day inter-solstitial transitional zone equally into eight, giving an annual count of 16 parts (19 divisions are actually shown on the carved dial) would give the following partition of the half-year:

	WS				VE				SS
days after WS	**0**	22	**46**	67	**91**	111	**137**	156	**182**
modern dates	Dec 21	Jan 11	Feb 4	Feb 26	Mar 21	Apr 9	May 5	May 26	Jun 21

Key: WS winter solstice; **VE** vernal equinox; **SS** summer solstice;
Note: days after WS are rounded to the nearest integer.

In any implementation of such a dial, keeping the gnomon relatively short and narrow, would increase ease of use, with the resulting shadow compact and visible, even at its longest extent. For instance, a timber pole 3m in height would allow compact operation within a semicircle of 10m diameter. The shape of the moving shadow line cast by the gnomon, and position of points where it met the semicircle, would have given a clear indication of seasonal change, which could be marked by portable reference stones. Alternatively, movement could be tracked by the length of shadows cast at the meridian, although this would require establishment of a N'ward line, and would provide less spatial resolution than a more marginally-based system.

The K15 dial is more realistically interpreted as annual, rather than diurnal in scope. However, it has been suggested that rays on the K7 dial, here on a horizontal surface, might have marked 1.5 hourly intervals (Eogan 1986, 170).

With the sun at its highest elevation around midsummer, the shadow line would be nearest to the gnomon, and curve back behind it somewhat; at the equinox the line would be straight; and at the winter solstice it would be at its furthest from the gnomon, scarcely entering the circle.

Placement of a functioning sundial *adjacent* to the main mound would have been hampered by the 18 satellite mounds surrounding it, and would have detracted from its visual impact, and direct connection with the monument. The best location for such a structure would have been on the summit of the main mound, with the gnomon at its centre, providing maximum exposure to sunlight, and establishing a widely visible feature. This central location, directly over the main area of burial chambers, might have acted further to link them, and their contents, permanently to the motion of the solar transit.

Direct structural evidence for such an implemented dial is lacking, but would hardly be expected, given its ephemeral nature, and placement over the eroding summit of the mound, the most labile part of the monument. There is no trace of a monolith on the mound here, but there is some evidence for former existence of one at New Grange, perhaps moved up from the centre of the earlier stone circle when it came to be occupied by the passage tomb.

Attempts to place K15-type dials and seasonal shadow casting at the E'n and W'n entrances (Moriarty 2010, 15-26) appear unsatisfactory from a structural standpoint, and do not allow fuller expression of the diagrammatic structure in terms of content, or orientation of the implemented dial and gnomon. The two entrance areas, with their stone spreads, settings, and small monoliths seem better interpreted in terms of static display, and protection of the approach, rather than with dynamic use of light, and shadow-casting, along with directed illumination of passages.

At Knowth, much of the rock art contains elements that are capable of interpretation in terms of solar symbolism, within passage-chambers, but especially on kerbstones. Around the circuit, panels are concentrated around the S'n arc of the kerb (e-FIG LB-96), avoiding the N'n sector, which would correspond with the null zone of the transit (see Table of Contents: 02c/2b(ii)).

In addition to the detailed dial on kerb K15, and a schematic dial on K7, two other kerb-stones contain panels that might relate to depiction of the solar transit (e-FIG LB-101):

-Kerbstone K52 shows what might be passage of the sun over the land, linking with its nocturnal subterranean journey through the underworld to form a complete cycle. K52 bears, across its central field, an undulating line of 15 peaks and 15 troughs, which ends at the left in a small spiral terminal. Curving above this frieze runs an arc of four single, and three double concentric circles, joining at each end with a line of 22-23 crescentic motifs of similar size running beneath the undulation, its line partially crossed at its centre by a left handed spiral.

Attempts have been made to interpret this panel as a 29-day lunar cycle (Ruggles 1999, 129), with the moon waxing and waning between crescent and full, but there is little match between symbols and phase to support this. However, the panel might indicate a complete solar transit, both above and below the horizon, this latter represented by the undulating band. Above the horizon the orb of the sun is shown ascending and descending and, as it passes below, it becomes an attenuated symbol. The spiral in lower mid field could act to reinforce the solar imagery.

-Kerbstone K42 bears 16 circles running in a ring, that might be solar representations, reminiscent of organisation of symbols on K52, but without the undulating frieze.

Supplementary information on sites: directed illumination

Ireland

Key monuments occur at Knowth, New Grange, and Dowth, large individual sites in the Bend of the Boyne (e-FIG LB-95), the former and largest with 18 satellites. The barrow cemeteries at Carnban-Loughcrew and Carrowkeel provide other candidate sites for directed illumination.

General bibliography providing details of various sites:

O'Kelly 1973; Twohig 1981; Brennan 1994; Prendergast and Ray 2002; Moriarty 2010;

-New Grange; Meath; O 008 727; e-FIG LB-102; e-FIGS LB-95 to 101);

bibliography: Patrick 1974; O'Kelly 1982; O'Kelly *et al.* 1978, 1983; Ray and O'Brian 1989; Prendergast 1991; Stout 2002; Stout and Stout 2008;

..sequence

A stone circle containing an off-centre turf mound provided an area within which a large passage tomb was later constructed.

..site 1: the large mound

This large passage tomb, 12m high and 78m (NW-SE) by 85m (NE-SW) across, with added kerb and monumental façade, is irregularly rounded, and contains a single radial passage with cruciform chamber off-centre to the mound. Excavation and geophysical prospection have verified the absence of any second passage lying diametrically opposed on the NW in a similar paired arrangement to those at Knowth.

The passage, which slopes up at about 4° towards the interior, opens to the SE (136°G) into a recessed entrance area that contains a large decorated kerbstone. A kerb surrounds the mound and individual stones bear sporadic carved decoration, similar to those that occur on slabs in the passage and chamber. Certain of the circular motifs present are of types which have been interpreted as possible solar symbols, and on four of the stones there are representations of what may be sun dials: two each up in the roof-box area, on kerbs K6, and K88.

The passage includes a rectangular roof-box, 0.2 by 1m, placed 2m above the ground over its entrance. This feature, as currently extant, would allow a beam of light from the local sunrise, elevated to 0.85° by the distant horizon, to penetrate along the upward-sloping passage during several days either side of midwinter solstice.

..the stone circle

A stone circle, of which 12 uprights of mean height about 2m survive, with another six positions located as sockets by excavation, surrounds the mound. The best-fit circle (e-FIG LB-102) suggests a diameter of 121m, with the actual line flattened somewhat on the W'n side. A total of about 38 stones can be inferred from existing mean spacing, giving a mean angle between stones of about 9.5°. The possible existence of a central stone has been suggested, but there is no evidence for this. It is not known whether the circle was constructed before, or after the main mound, stratigraphy is inconclusive, but the precise placing of stones could indicate absence of any obstruction preventing layout from the centre.

..the turf mound

A turf mound about 35m in diameter lay within the NW'n sector of the stone circle, possibly with burial cists beneath, and was covered by the mound of the final barrow, its kerb in this area diverted outwards, to avoid the existing structure.

..surrounding structures

Two smaller satellite passage tombs lie either side of the main mound on a NW-SE'ly axis.

Excavation has been concentrated around the S'n side of the main mound, where densely packed features indicate additional construction and activity. A large ring 70m in diameter, its perimeter formed by multiple pits, skirts the foreground area, with a smaller ring just to the NW of the mound, both dating approximately to the mid 3rd millennium BC.

..current astronomical interpretations

Local data on solar and lunar transits are as follows, and these are representative for the three major sites in the area, New Grange, Knowth, and Dowth:

long-lat: 53.69°N, 6.48°W;

sun

SS		**WS**	
rise	**set**	**rise**	**set**
047.9	312.4	132.3	227.8

moon

maximum				**minimum**			
N'ly		**S'ly**		**N'ly**		**S'ly**	
rise	**set**	**rise**	**set**	**rise**	**set**	**rise**	**set**
034.5	325.5	145.5	214.5	056.8	303.2	123.2	236.6

Key: **SS** summer solstice; **WS** winter solstice.

The existing case for directed illumination at the site is supported by the axis of the passage, and by the suggested roof-box acting as a portal, but is weakened as a common feature by its general absence in the local group of related monuments, unless viewed as a specialist, or deliberately restricted function.

Attempts to force an astronomical interpretation on the stone circle do not survive closer examination. The estimated 9° angle between stones in this partially extant structure means that a great many astronomically significant directions could be accommodated by such close spacing, and if not by the stone itself, then by the interval. Differentiation in size of stones to provide specific markers remains unknown in the absence of most of the uprights. Bland interpretation as a monumentally defined space for ritual, funerary, and other activity seems the best option based on current evidence.

...the main mound: directed illumination along the passage

Around the time of the solstice, sunlight penetrates the passage, on a 24m long track, and illuminates the floor of cruciform chamber, and the base of its upright terminal slab, this latter bearing triple spiral decoration. The event occurs over the azimuth range 133.7 to 138.4, winter solstice sunrise being about 133.5 for this latitude (Patrick 1974).

However, if the properties of the roof-box were to be changed slightly, then the illumination would not occur as effectively, and there has been much modern reconstruction of masonry around this feature. A rayed circle, associated with the roof-box, may possibly be a solar symbol, perhaps referring to the effect (Ruggles 1999, 12,17,19, 129, 140). If not for illumination, then the roof-box could have served instead as a simple line of ritual communication, at times when the main entry was sealed, or more practically, as a port for ventilation of the interior.

...the circle: lines between stones

Various attempts have been made to fit stones of the circle to the axes of solar and lunar standstills, and to propose calendric functions (Prendergast 1991). This has been done using lines from known uprights, through the centre, to positions inferred on the other side of the circuit (Moriarty 2010, figure on p. 49; TABLE LB-11), or between adjacent stones (Prendergast 1991; Moriarty 2010, figure on p. 50; TABLE LB-12). In view of the unverified locations, the unknown nature of the centre, and the selective choice of a few extant stones from the notional total, this is a most unconvincing attempt to force data into a preconceived pattern (TABLE LB-11):

TABLE LB-11 New Grange: interpretation of diametric axes between stones of the circle
[see TABLE LB-13 below for revised data]

re-measured numbered stones A	B	axis °G A>B	B>A	explanation provided/ azimuth quoted				
1	[-19]	319.9	139.9	max N'n moon set	325.46	min S'n	moon rise	123.16
3	unpaired	-						
5	[-15]	359.7	179.7	due N	000	due S		180
7	unpaired	-						
9	[-11]	037.2	217.2	max N'n moon rise	034.54	max S'n	moon set	214.54
[10]	-10	048.2	228.2	SS rise	046.52	WS set		226.52
11	[-9]	056.3	236.3	min N'n moon rise	056.84	min S'n	moon set	236.64
13	unpaired	-						
[15]	[-5]	090.0	270.0	eq set	090	eq rise		270
17	unpaired	-						
[18]	-2	120.3	300.3	min N'n moon set	303.16	min S'n	moon rise	123.16
[19]	-1	129.9	309.9	WS rise	133.48	SS set		313.48
-8	unpaired	-						

Key: A and **B** provide convenient labels for columns; **[..]** stone not extant; **max**(imum), **min**(imum);
> indicates 'towards'; **WS** winter solstice; **SS** summer solstice; **eq** equinox;

Equally invalid are attempts to establish lines of sight *around* the partially known circuit as, for instance, between those stones on the S'n circuit in the foreground of the entrance (TABLE LB-12):

TABLE LB-12 New Grange: interpretation of non-diametric axes between stones of the circle

between		explanation provided/ azimuth quoted	
3	5	half dec	252
7	11	WS	315
-2	K1	eq	273
-1	K1	half dec	292
1	K1	WS	320

Key: azim(uth); **dec**(lination); **WS** winter solstice; **eq**(uinox).

Using revised plans (e-FIG LB-102) extant stones in the circle have the following azimuths from the notional central area. This again provides no convincing basis for general conclusions about any astronomically based properties of the original circle (TABLE LB-13):

TABLE LB-13 NEW GRANGE: RECALCULATED DIAMETRIC AXES BETWEEN STONES OF THE CIRCLE

	re-measured axis °G			
stone	**c ->**	**h ->**	**astronomical event**	**azimuth**
GC 1	139.7	139.5		
3	159.5	154.8		
5	**179.6**	170.5	due S	**180**
7	197.9	186.0		
9	**217.1**	202.4	max S'n moon set	**214.5**
11	234.6	216.9	~WS set	226.5
13	255.0	237.0		
17	292.2	282.0		
-1	129.2	131.3	~~min S'n moon rise	123.16
-2	120.0	**124.0**	~min S'n moon rise	**123.16**
-8	066.5	080.9		
-10	**049.0**	065.7	~SS rise	046.5

Key: c -> from the best-fit centre of the circle; **h ->** from the highest area of the final mound; **WS** winter solstice; **SS** summer solstice;

Note: bold type indicates close correspondence between axes of stones and azimuths of stated astronomical events;

Shadow casting at the site has also been weakly discussed (Prendergast 1991). For instance, although stone 1 in the circle casts a shadow around winter solstice sunrise towards kerb-stone 1 lying across the entrance, this is too diffuse to register significantly either with the spiral decoration, or the carved centre-line.

Dowth; Meath; O 023 738; e-FIGS LB-94 and 95;

bibliography: O'Kelly and O'Kelly 1983; Moriarty 2010;

This large, sub-circular, kerbed barrow is about 85m in diameter, and contains two passage-chambers, lying adjacent in the margin of the mound, on its SW'n side. The N'n structure opens towards 249°G, its passage and cruciform chamber, with annexe, providing a straight track of 12m. In the S'n structure, a passage leads on an 8m long track towards 231°G, from a rounded chamber with a small annexe. These two passage-chambers occupy a very small area of the mound, and seem marginal; whether there are more internal passages remains unknown.

Certain of the stones in passages and chambers bear motifs, some of which could be solar, and such decoration also occurs on kerbstones, with K51 presenting a line of seven such (Cf: Moriary 2010, figure on p. 63).

The N'n passage-chamber has been taken to face sunset in early November, and in early February (perhaps the dates of Samhain and Imbolc: see Table of Contents: 02b/9a), and the S'n chamber to face winter solstice sunset (Brennan 1983/1996; Ruggles 2000, 129-130). The sun illuminates chamber, passage, and decorated stones within them over these dates.

Knowth; Meath; N 997 734; e-FIGS LB-95 and 96;

bibliography: Eogan 1974, 1984, 1986, 1998; Eogan and Cleary, forthcoming 2015; Eogan and Roche 1994, 1997, 1997a; O'Kelly *et al*. 1978; Prendergast and Ray 2014;

-sequence: one passage tomb in a small cemetery was greatly expanded, with others later added around it as satellites.

-the main mound

An ovate kerbed mound, 80m by 95m, the largest in Ireland, completely excavated and restored, surrounded by 18 smaller satellite tombs, with reconstituted mounds, contains two opposing radial passages. One passage opens to the W, at 257°G, and is fairly straight for about 27m of its outer length, but is angled at 278°G for a further 9m, as it continues to its chamber, near the centre of the mound. The other passage opens to the E, at 085°G, and is straighter over its 35m length, ending in a cruciform chamber, near the centre of the mound.

The structure of the main mound, and placement of the internal art, suggests two phases of construction, termed 1b, and 1c. Phase 1b contained a cruciform chamber, and short passage at the E, with a simpler, shorter passage-chamber at the W. Both of these structures were extended greatly during phase 1c, the line at the E remaining straight, and that at the W angled from the point of expansion.

Knowth contains more decorated surfaces than any other passage tomb in Britain and Ireland, with over 250 panels on stones of chambers, passages, and including most of the 134 kerbstones.

-existing astronomical interpretations

..directed illumination

Light is able to penetrate these passages more strongly around dawn and sunset, on days around the equinox, and this has been seen as a deliberate feature (Eogan 1986, 178). More recent structural analysis, based on carefully measured data, indicates that alignment is not equinoctial, but peri-equinoctial, and that the illumination of passages and chambers is poor, even when the sunrise or -set does allow increased penetration (Prendergast and Ray 2014). The outermost sector of the angled W'ly-opening passage corresponds with sunsets about two weeks either side of the equinox, and at the equinox itself, with the sun at elevation, as it moves towards its final setting. Even under optimal conditions, illumination of the passage is imperfectly achieved, especially beyond its bend, and within the chamber. No link with the moon at its major standstill positions is apparent.

passage	az	L	=sunset on	=[eq +/- n days]	at eq =setting sun at
W'n inner	278.23	9	Apr 3 [+13]	Sep 8 [-13]	
outer	258.57	27	Mar 4 [-17]	Oct 9 [+17]	12° S of sunset, and elev 8°
E'n	085.13	35	Mar 26 [+5]	Sep 16 [-5]	

Key: azim(uth); **L**(ength of passage-chamber); **eq**(uinox).

The E'n passage and chamber was increased in length, from about 9m for the first cairn 1B, to 35m during construction of the final cairn 1C, its length, irregularities in side-walls, and kerbstone 11 at the entrance, restricting a clear line for incoming light, especially for innermost areas.

Prendergast and Ray (2014) stress that the equinox is a modern astronomical concept, perhaps of little immediate interest to such agrarian tomb-building communities, and note that in only 4 out of 122 such tombs in Ireland (3%) is equinoctial correspondence close, and here could be explained as chance. A broader ritual interest in the W is suggested as more likely.

..shadow casting around entrances

It has been suggested that standing stones in the foreground of E'n and W'n entrances cast shadows, with the sun setting, at the edge of the mound, at specific times of year, and this has been linked to concepts expressed in the dial motif on kerb K15 (Moriarty 2010).

..other effects of light

At such decorated sites, the glancing effects of sun and shadow on carved motifs might also have formed a significant effect, enhancing their relief, perhaps intentional.

..shadow casting and sundials

Kerbstone K15 bears, on its vertical face, a complex and detailed dial, consistent with annual, rather than daily use (e-FIG LB-98 to 100). K7 bears a simpler schematic dial on its upper surface (e-FIG LB-97). The entire topic of the dial on K15 has been discussed more fully, above in this section.

..other carved motifs

The panels on kerbstones K42 and K52 show rings of circles that could represent some cycle of sun or moon, as discussed above in relation to dials, and with reference to the solar transit.

Loughcrew-Carnbane; Meath; e-FIGS LB-103 to 105;

bibliography: Twohig 1981, 205-220; Prendergast 2013;

The barrows are located over a ridge running NE'-SW'ward between the Boyne-Blackwater and Shannon river systems. Three cemeteries occupy adjacent hills: Carnbane West, Carnbane East, and the Patrickstown ridge, in order of decreasing number of monuments (e-FIG LB-103). The W'n cemetery (e-FIG LB-104) contains 14 principal mounds, of which site L is prominent, although not the largest (site D), attracting its own cluster of satellite mounds. The E'n cemetery (e-FIG LB-105) is smaller, with seven mounds, loosely ranged around site T as its largest member. The Patrickstown ridge further to the E contains a few damaged sites. Those mounds with extant structure have passages pointing (front to rear) generally W'ward, although with considerable variation. Originally, there might have been 50-100 cairns in this prominently sited *necropolis*, of which some 30 sites remain as standing monuments.

Many of the stones at the barrows bear carved motifs, especially in passages and chambers, more occasionally on kerbstones, these added before, or after erection, with some revisions evident. Interpretations of panels vary, but solar symbolism, and terrain mapping (Moriarty 2010) feature strongly.

Directed illumination has been suggested at two of the main sites: L and T, with H similarly aligned, and hence possibly related:

..cairn T; N 586 775**:** A sub-circular mound, 35m in diameter, with a slightly recessed forecourt, leads to a passage and chamber. The kerb includes one massive block, The Hag's Chair, about 3m long, and 2m wide. An 8m long passage-chamber opens towards 105°, and its decorated backing stone is illuminated by the rising sun some weeks before, and after the equinox, as discussed in more detail for cairn L, similarly aligned.

..cairn L; N 572 774: A mound, about 41m in diameter, contains a radial passage that leads to an elongate, corbelled, eight-celled chamber, two of which contain basin stones, with several carved panels on side-walls. From the back of the chamber the narrow entrance gives a clear lateral view of the horizon, from 095°G to 118°G, opening along its midline towards 104°G, and providing a 9m long track for incoming light (Prendergast 2013, figs. 2, and 5). Timing for illumination at the rear of the chamber is as follows (*ibid*, table 1):

timing of illumination			**former interpretation**
limit	**midline**	**limit**	
1oct	**15oct**	7nov	Samhain: early Nov
4feb	**27feb**	11mar	Imbolc: early Feb

This more precise analysis of the chamber has replaced existing calendric interpretations in terms of Celtic festival-equivalents, with a more general role for such illumination in funerary ritual. However, the close dating of these festivals is far from clear, even for the Celtic period, let alone the Neolithic (see Table of Contents: 02b/9a). Catching the first, and last rays of the sun, at either end of the lighter part of the year, might be an appropriate compromise.

Carrowkeel; Sligo; G 753 119; e-FIGS LB-108; phot LB-01 to 02;

bibliography: MacAlister *et al.* 1912; Burenhult 1980, 1984;

Carrowkeel Mountain consists of four narrow ridges of limestone running NW-SE, separated by steep-sided valleys. Their upland tops, which rise to 314m, are fairly level, and provide exposed platforms, with wide-ranging views, on which 14 impressive cairns of Neolithic date, two cists, and a standing stone have been located, with an undated settlement of circular huts lying adjacent on lower ground (e-FIG LB-108).

In addition to early clearance and mapping work (MacAlister *et al.* 1912), the area has been under recent detailed examination (programme: Bergh; University of Ireland, Galway). The area was one of settlement, as well as burial: over 150 enclosures and hut sites lie on the exposed limestone plateau of Mullaghfarna, within the passage tomb complex, but remain of unknown association, given the lack of direct dating evidence. However, radiocarbon dating certainly indicates Neolithic and Bronze Age activity on the plateau.

The cairns are located in four groups:

group	cairns	other sites	comments
main	G **H** L **K**	two cists	clustered
E'n	O P	settlement	separate
S'n	M N	standing stone	scattered
W'n	**B** C D E **F**	scattered	

Note:
larger cairns over 20m in diameter are shown in **bold** type;

Monuments are typically circular in plan, and average 18m in diameter, their conical mounds of packed stonework surrounded in some cases by kerbs, usually single, but occasionally double. Passages, set above ground-level, and unusually high in the mound, are relatively short, averaging 5m in length, usually straight, with chambers of undifferentiated, cruciform, or transepted type, their construction often of high quality, using large slabs. No carved decoration of stonework has been reported. Only cairn G has an extant roof-box, but others are possible at partially examined, or damaged sites.

Two cairns are relevant to the question of directed illumination:

..cairn G (G 753 119; e-FIG LB-108): a typically-sized member of the main group, with a roof-box-type slot over the entrance, allowing ingress of light. When originally cleared, a covering slab blocked the entrance, as at cairn K, suggesting that the slot at G remained separate, and open. The axis of the passage-chamber faces the general direction of summer solstice sunset, allowing interior illumination.

..cairn H: also in the main group, and similar to cairn G in the axis of its passage-chamber, but this differs in lacking a roof-box, and in its angled line.

Structural **data, as currently published, are of variable quality**, and over-reliant on the 1911 report, with plans, and especially axial alignments often conflicting.

The structure of individual cairns is summarised as follows (TABLE LB-14):

In this locality summer solstice sunset at the zero horizon occurs at azimuth 312°, with axes closest to this shown in bold type:

TABLE LB-14 CARROWKEEL BARROW CEMETERY, SLIGO, IRELAND: DETAILS OF CAIRNS

cairn		**mound**			**ent**	**pass-ch**						
	alt	**diam**	**ht**	**kerb**		**hi**	**L**	**form**	**faces**	**transit**	**conf**	**note**
round:												
A	250	14	3	t				?-				
B	285	22	6	?+		yes	3	ud	342	null	+	two cists at SE
C		[]						?cru	292	trans: set	~	
D		[]						cist	SE	trans: rise	~	
F	310	26	8	?2			5	tr	000	null	+	pillar in chamber
G	290	18			/rb	yes	5	cru	325	null	~	
H		20	2			mid	9	ud	302	trans: set	~	passage angled
K	323	22	6		/	yes	7	cru	334	null	~	
L	~323	19	5									
M		8	0.6				3	cru	285	trans: rise	~	
N		[6]		t				?cru	**314**	**=SS rise**	~	
O	271	18	5			yes	2	cist	115	trans: rise	~	
P	283	10	3.5					?-				
long:									**points**			
E	36x10		2.5	t				ud	327	null	~	?portal at SSE

Note: site labels given are those of MacAlister *et al.* 1912;
axial orientations are those given in Eogan 1981;
Key: alt(itude in m); **diam**(eter in m), **[]** denotes a damaged site; **ht** height in m; **kerb: t**(races), **+** present; **ent**(rance), **/** covering slab present, **rb** roof-box extant; **pass-ch** passage-chamber: **hi** high in the mound; **L**(ength in m); **form –** absent, **ud** undifferentiated, **cru**(ciform); **transit** zone of the solar transit towards which the passage faces or points (latter: front to rear): **trans**(itional zone); **conf**(ormity with local topography: ridge-lines): ~ approximate, + strong;

-other sites:

..main group:

...just to the SE of cairn H: a cist, or dolmen, with massive capstone 1.7 by 1.2m in area, rests on four basal stones, with stonework at the sides;

...just to the E of cairn K lies a similar structure, with capstone 1.7 by 1.2m in area;

..S'n group:

midway between cairns F and M-N there is a standing stone, 2.3m high, perhaps natural;

-conclusions

The case for directed illumination in this cemetery, as elsewhere, is very weak, resting on two monuments with broadly solstitial alignment, out of 14 other sites with known axes which display varied and atypical orientation. Based on the data given in TABLE LB-14 [see: column 'faces'] the axis of the passage-chamber of cairn H is 10° to the S of the summer solstice sunset. That of cairn G, with its slot above the entrance allowing illumination, is 12° to the N of this direction.

Monuments in this cemetery are unusual in having chambers generally opening towards the N-NW'n sector, with five of the 14 facing the null zone of the solar transit. Only the axis of cairn N is close to a solstice, the summer setting. Alternatively, considering not the facing, but the pointing direction (front to rear) as the more ritually important, would align the direction of entry towards the permanent zone of the solar transit. Which option, if either, is more valid remains an open question. This upland area appears somewhat isolated, and might have developed some variant tradition of funerary ritual.

The long mound E is relevant to these two cases, since it appears to point (front to rear) just to the N of summer solstice sunset. Although not common amongst long barrows (e-FIG LB-01 to 21), this axis would at least be in general keeping with the more general W'ly direction of pointing (front to rear) at such sites.

The local ridges run NW to SE, and known axes of passage-chambers conform with this line, most in general terms, but two cairns, B and F, more strongly:

mean axis of the
nine cairns in the typical group: facing 320°
trend of the four main ridge systems: 333°

Within this topographical trend-line, the relative importance of facing the NW and pointing (front to rear) towards the SE is an open issue. No strong case can be made for deliberate protection of entrance structures, by placement on the leeward side of currently prevailing weather, which in this area is W-SW'ly.

Slieve Gullion; Armagh; J 025 203; phot LB-03;

bibliography: Collins and Wilson 1963; Smith and Pilcher 1972;

This passage tomb, located at 570m OD on the summit of Slieve Gullion, the highest monument of its type in terms of altitude in Ireland, is 30m in diameter, and 5m high, with a kerb of massive stones. This location, at higher altitude affords clear views in all directions. The passage opens to the SW (230°G), is 4.5m long, and leads to an octagonal corbelled chamber about 3.5m across, containing three blocks cut as basins. Just to the N (J 021 211) lies another cairn, smaller at 18m diameter, with a few orthostats remaining around the perimeter, covering two cists, probably of the Bronze Age and hence later in date.

The setting sun illuminates the chamber around the winter solstice.

Scotland

Maes Howe; Orkney; HY 318 127; e-FIG AS-01 and 01a; LB-94;

bibliography: Henshall 1963, 1972; MacKie 1997; Canmore HY31SW 1;

A passage tomb, some 30m in diameter, approximately contemporary with New Grange and Knowth, has its entrance facing SW'ward, with the mean axis of the inner part of the passage at 216°G, approximately in line with sunset close to the winter solstice. A passage, with a slight initial angle, leads to a corbelled cruciform chamber, with three side niches. A gap, at the top of the stone blocking of the entrance, may represent a device for illumination of passage and chamber, but other interpretations are possible (Burl 1981, 251-252; Ruggles 1999; Moir 1981). Minor undated linear decoration, of possible prehistoric date, occurs within the interior.

At Barnack, a nearby settlement of comparable date, houses share certain structural features with the Maes Howe tomb but, for the domestic sites, alignment of entrances may suggest practical illumination, and warming from the rising limb of the solar transit.

Balnuaran of Clava; Inverness; NH 7544; e-FIG LB-94;

bibliography: Bradley 2000;

Three small round cairns, part of a wider barrow cemetery, lie along a low ridge on a general NE-SW'ly line. In the main cemetery, the cairns at NE and SW are small, circular, kerbed passage-type monuments, about 15m diameter, each with a round central chamber entered by a radial passage, all within a concentric circle of spaced stones, about 37m in diameter. The intervening barrow is of similar form and size, but differs in having a central ring-feature, and no radial passage (Bradley 2000, illus. 11). Here, passage-chambers open towards the SW, close to winter solstice sunset, a 9m track allowing illumination of the innermost areas, with possible secondary effects from reflective crystalline content of stonework.

Crantit; St Ola, Orkney; HY 440 098; Canmore HY40NW 17;

A subterranean chambered tomb, constructed within a drumlin, was discovered almost intact internally, its top further enhanced by a low cairn over 25m in diameter. Any formally structured approach to the monument appears absent, and original entry was made through an opening in the roof. A stone over the entrance bears a notch, aligned on the horizon, and capable of allowing light into the rear of the chamber, with possible functions as a light-box, ventilation channel, or offering-slot. The entrance faces the SE, and would have allowed more direct passage of light from the rising arc of the sun during the winter months, before final blocking with clay and stone.

The chamber, corbelled inwards to bear roof-slabs, is about 3m across by 1m high, and includes three cells, in trefoil formation. An upright roof-supporting pillar may bear geometric, and other motifs. The unburnt remains of three individuals were found in the side-chambers: a mature woman, a young girl, and one unidentifiable in detail. Only fragments of pottery were found at the site. Cists, and one cremated deposit of Bronze Age date, were inserted into the cairn.

England and Wales

Bryn Celli Ddu; Anglesey; SH 508 702; e-FIG LB-94;

bibliography: Hemp 1930; Pitts 2006;

A sub-circular barrow, about 27m in diameter, kerbed, with a slightly recessed forecourt, contains a radial passage, ending in a polygonal chamber that lies just short of centre, all with a combined length of 11m, and facing 047°G. A carved spiral motif in the immediate entrance to the chamber may not be genuine. A slab, decorated with incisions, lay buried within the mound, near the centre of the site, behind the back wall of the chamber (Hemp 1930).

The midsummer sunrise is reported to illuminate reflective, quartz-rich stones at the back of the chamber at this passage tomb (Pitts 2006).

Stoney Littleton; Somerset; ST 735 572;

Stoney Littleton is a trapezoidal long barrow of Cotswold-Severn type, with a clear, and well constructed chamber lying on the longitudinal axis of the mound, and opening from its broader forecourt end, towards 139°G.

The barrow is located on a slight ridge that gives it some prominence when viewed laterally, especially from the SW, perhaps an active factor in its siting. The barrow faces up-slope, towards the horizon at the SE, which is at 3.6° elevation, and points (front to rear) towards the more distant horizon to the NW, here at 2.9° elevation. Local winter solstice sunrise occurs at about 130°G and, given the elevation of the horizon, this would bring the alignment into a reasonable match with sunrise in the days around the solstice.

There could have been some intended effect, illuminating the forecourt and chamber here, but a general search of the Cotswold-Severn group of long barrows for other possible candidates, around the alignment of 130°G, produces very few cases worth investigating. Seven others lie within 10° either side of this, and only two within 5°: most are unexcavated, and of unknown detail. In general therefore, there is no evidence that this effect could have been supported by architecture at these related sites.

Study area: long barrows in the N'n Cotswolds

(e-FIGS LB-44-83, 89 to 90, and 114; TABLE LB-17);

The general area and its long barrows

The area consists of a range of limestone hills running NE to SW'wards for about 70km, with its NW'n scarp edge, and highest uplands, facing the Severn-Avon valley to the NW. This highest ground declines towards the SE, over the dip-slope, as it descends towards the upper Thames valley (e-FIGS LB-89 and 114). Streams, running down the dip-slope to the Thames, form well developed valleys and ridge systems, ideal for early settlement, as indicated by the large number of long barrows of Neolithic and round barrows of Bronze Age date (Crawford 1925; O'Neil and Grinsell 1960; Saville 1980; Darvill 1982, 2003).

The number, and distribution of long barrows in the area suggest that they are the product of small groups of relatively isolated agrarian communities, operating within restricted territories, constructing barrows infrequently, at a regional average of perhaps one per decade.

Siting of barrows

Questions of siting are important for consideration of constraints on choice of axis. Trends for siting of barrows are drawn from a regional sample of 80 sites. These barrows lie most frequently on, and are approached from, level ground, and have the most open aspect towards the rear, usually the W'n end. In all cases clear topographical reference points for alignment are absent, with low relief, and bland horizons, easily cloaked by ground cover (e-FIGS LB-81 to 88).

-In relation to the **contour,** 71% are sited on level ground, 6% run up the contour, and 9% run down, in the latter two cases this taken from front to back;

-Barrows **approached** from level ground account for 47%, from approximately level 25%, and from the valley 28%;

-Siting with 'best' [as subjectively determined] **views** from the site towards the W occurs in 45% of cases, to the E in 26%, with 29% indeterminate. In 35% of cases the narrow back end of the mound points towards the 'best' view, in 10% the broader end, and in 55% the 'better' view is at variance with the axis;

-Barrows that face onto a stream **valley** account for 24% of the sample;

-Sitings where the **horizon** is easily obscured: in 43% the entire horizon is vulnerable, in 18% that at the W, and in 34% that at the E.

-Locations near the scarp, that have extensive NW'ly views, account for about 11% of sites.

Analysis of orientation (e-FIG LB-16 and 17)

The frequency distribution of alignment shows a distinct preference for pointing (front to rear) towards the W (e-FIG LB-16 and 17), and many axes conform with light local relief, as for instance a ridge-line (e-FIG LB-89 and 114). Monuments are seen as actively utilising relief, such as ridge-lines, appropriate to establishment of a previously chosen axis, rather than passively conforming to, or being constrained by topography (see Table of Contents: 03a/20).

Axes were plotted as a smoothed curve (e-FIG LB-16), and as a histogram at 10° intervals (e-FIG LB-17). Data were also plotted in terms of broader divisions of the solar transit after TABLE AS-03 (e-FIG LB-92), discussed as part of a separate case study (see Table of Contents: 03a/25a).

Using the direction of pointing (front to rear), the main peak for axes shows a calculated mean at 263.7°G with standard deviation 38.9°. The frequency distribution between these limits is, therefore, spread from 224.8° to 301.6°, at one sigma. Matching this with dates of sunset gives:

axial range	**-1 sd**	**mean**	**+1 sd**
azimuth	225	264	302
dates of sunset	WS	Mar 11	May 19
		Oct 2	Jul 26

Key: WS the approximate period of the winter solstice; **sd** standard deviation.

This range of azimuths covers the setting limb of the solar transit, and may indicate that the transit was the essential target, rather than individual sunsets within it. Distinct preference for the peri-equinoctial period may further indicate operation of seasonal factors on the timing of larger scale communal construction projects (see Table of Contents: 03a/13a, e-FIGS LB-41 and 41a).

The detailed study area: N'n Cotswolds (e-FIG LB-89)

A more detailed analysis of siting and orientation of long barrows is presented for a sample area of the N'n Cotswolds, 40km long and 25km wide, running from the main scarp-slope at the N to the lower margins of the dip-slope, along the upper Thames valley at the S (e-FIG LB-89).

The sample area includes a range of topographies representative of the broader Cotswold area, and contains 40 such long barrows (TABLE LB-17). Site-names are given according the system of O'Neil and Grinsell 1960, sites named by parish, and numbered in Roman numerals (TABLE LB-17; columns 1 and 2).

-Types of information provided in this analysis

Four sources summarise data for the barrows in this study area:

..a summary table for all sites (TABLE LB-17), that contains the following entries, by numbered columns:

1 site name;
2 National Grid Reference;
3-5 Grinsell and O'Neil 1960: dimensions of the mound;
6 Grinsell and O'Neil 1960: agricultural regime, and condition of the mound;
7 the date of any excavation carried out;
8 agricultural regime during recent decades;
9 recent condition;
10 current protection of the mound by any reserved area;
11 topography at the site, and degree to which the long axis of the barrow conforms;
12 the long axis of the mound;
13 e-FIG: locality;
14 e-FIG: any detailed geophysical survey further defining the mound and side-ditches;
15 e-FIG: any panoramic view from the barrow;

..a distribution map of the study area (e-FIG LB-89), showing all long barrows, and their orientation in relation to terrain, establishing different groupings based on the latter;

..a full set of e-FIGURES, with layered data showing each barrow in its general, and detailed locality, against contoured terrain (TABLE LB-17; column 13), with the long-axial orientation of the mound added, the former, and current surviving extent of mounds marked, and any excavated plans provided;

..panoramic views for a sample of six barrows, mainly from the study area, added in order to provide further details of outward views, and typical properties of local horizons (TABLE LB-17; column 15);

-The quality of data

Since most of the sites are known only as unexcavated field-monuments, the state of preservation of the mound is critical to adequate measurement of its longitudinal axis. Few ground plans are known in detail from excavation (TABLE LB-17; column 7), the majority of these being by early incursion, although some detailed, and seemingly accurate, plans were made (Swell IV, V, and Upper Slaughter II). More recent fuller excavations have occurred sporadically up to the 1960s (Notgrove I, Bibury II, Hampnett II, and Withington II), with a single example from the 1980s (Hazleton II). On this basis only 12.5% of this important regional group of monuments has ever been investigated in any meaningful way, despite widespread, and continuing destruction of sites by ploughing. Passive re-listing of threatened sites, and suggested measures for conservation (Saville 1980) have had no meaningful impact, beyond highlighting inadequate action, after the event.

The scale of continuing destruction of these monuments, by both marginal, and over-ploughing, can be gauged by comparing dimensions, as recorded in O'Neil and Grinsell 1960 (TABLE LB-17; columns 3-5), with the current state (TABLE LB-17; column 9). In the more detailed e-FIGURES for each site, the limits of the mound, as defined in 1923 mappings by the Ordnance Survey (lines in e-FIGURES are drawn mid-hachure from these maps), can be compared with the remains of monuments now extant from the satellite imagery included here.

Many mounds have been too badly eroded, in many cases obliterated, to allow their long axes to be established with confidence from surface remains. However, in some cases, satellite imagery allows the shape of formerly mounded areas to be seen, as denser spreads of scattered rubble, as for example at Turkdean I (e-FIG LB-76 and 76a), and here some approximation is possible.

Geophysical survey provides a rapidly obtained source for retrieval of basic structural information, and a selection of six of those carried out in the area, by the author [AJM], is provided (TABLE LB-17; column 14). Those long barrows in this area that have rock-cut ditches, and stone-built mounds, are particularly amenable to resistivity survey, with magnetic gradiometry providing only limited supplementary data. The long axis of the site is readily obtainable from the clearly defined margins of the mound, appearing as high resistance, but less so from the fill of side-ditches, of low resistance, which may be broader with blurred margins, and sometimes more in evidence on one side than the other. Side-ditches probably survive at many highly eroded sites, if only in truncated form, including those left untouched at excavated barrows (TABLE LB-17: column 4).

The current deplorable state of these nationally important monuments represents a clear absence of any meaningful, and pre-emptive strategy for their protection by the relevant authorities, English Heritage, and its predecessor. The recent allowance of some informally defined, unploughed reserves, around certain sites, many now almost terminal, or worse, would indicate a practice of allowing sites to be destroyed without investigation, and *then* protecting some of them. The only sites to have survived in fair condition, such as Withington I, Bibury I, or Swell V, have done so, not through any active protection, but because they lie passively protected in woodland, and hence not under threat from unchallenged ploughing.

Conservation of excavated barrows, as standing field monuments, after investigation, has been equally lamentable, with most mounds subsequently being totally removed, as at Hazleton II (Saville 1990). In such cases, data on axial orientation relies either on Ordnance Survey mapping, or on N-pointers of unspecified type and reliability in published plans, often at variance internally. Supplementary axial data could probably be retrieved from resistivity survey over any surviving side-ditches.

Six of the long barrows in the study area have been excavated (TABLE LB-15), of which one has been fully restored, two remain in poor state, and three have been completely obliterated, including the fullest and most recently investigated barrow at Hazleton II. At this latter site the substantial surviving mound was about 1.75m in maximum height, 50m long, and 15-20m wide (Saville 1990, fig. 5; Cf. similar dimensions from O'Neil and Grinsell 1960: height 1.8m, length 54.9m, and width 22.9m). Sudeley I (Belas Knap) was conserved and restored in the 1930s, to stand as an impressive, and much visited field monument. Notgrove I and Withington II remain as amorphous mounded areas, with little extant structure visible. The low mound of Hampnett II has been levelled. The site at Bibury II, with its highly unusual cellular construction has also been totally destroyed.

TABLE LB-15 THE COTSWOLDS: EXCAVATED LONG BARROWS IN THE STUDY AREA: LACK OF RESTORATION

column			**4**						
site	**excav**	**cont**	**ditch**	**rest**	**oblit**	**publ**	**L**	**W**	**H**
Sudeley I	1865	no	ni	full		see ref 1	51.8	18.3	3.7
Notgrove I	1935	no	ni	poor		Clifford 1936	48.8	24.4	-
Bibury II	1940	yes	ni		yes	Grimes 1960	42.6	?	0.9
Hampnett II	1941	yes	ni		yes	Grimes 1960	30.5	16.2	0.6
Withington II	1965	no	ni	none		O'Neil 1966	-	-	-
Hazleton II	1982	yes	2s		yes	Saville 1990	54.9	22.9	1.8

Key: excav(ation: final year quoted); **cont**(our survey of mound published); **ditch**(es verified): **ni** not investigated, **2s** two side-ditches verified; **rest**(oration of mound carried out); **oblit**(eration of the mound after excavation); **publ**(ished source); dimensions of the surviving mound in metres (O'Neil and Grinsell 1960): **L**(ength), **W**(idth), **H**(eight).
Ref(erence) 1: Berry 1929, 1930; Hemp 1929; Ralegh Radford 1930.

-Orientation of the monuments (e-FIG LB-16 and 17)

The main group of monuments in the detailed study area is W'ly pointing (front to rear), but with some reversals pointing E'ward, and a few which are S'ly pointing. The closely-sited pair of barrows at Hazleton I and II show such reversal and, because of their proximity, could reflect a localised trend, as may those S'ly pointing barrows evident on the lower margins of the dip-slope. There is no indication that orientation was forced by topography and, although sympathetic placement is evident, many sites run counter to the locality in seeking a generally E-W'ly axis.

The general spread of axial orientation in this selected area covers the transitional zone of the setting solar transit, and is consistent with the general pattern for the larger sample (e-FIG LB-16 and 17).

Panoramic views, provided for typical sites (e-FIGS LB-81 to 88), indicate that horizons around these long barrows are bland, with no clear features to indicate any topographical cue. These views further indicate that the presence of nearby tree cover would obscure the ground-based horizon, and hence force viewing of the transit at some elevation.

-Complexity of axes: the Bibury II monument (e-FIG LB-46)

..multiple axes

Problems in defining the axis at complex sites (see Table of Contents: 03a/10) are well seen at Bibury II (e-FIG LB-46), a monument within the area of Cotswold-Severn long barrows (e-FIG LB-89) and, although entirely atypical, is perhaps related. This site began as a corbel-roofed *tholos*-type chamber, cut into, and erected over, part of an outcrop, left standing within a large rock-cut pit. A dome of stones, similar in form to the covering structure of the chamber, but without internal features, or content, was then erected against it. A tailed cairn, containing internal compartmentalised infill, extending to the NNW, was added to the chambered structure. A similar, but less well defined tail, was added around the domed structure, to form a roughly symmetrical monument, with a possible forecourt area. Extra-revetment stonework was then added around the site, blocking the forecourt, and developing a long mound on either side of the main complex, along the same axis as the earlier tailed areas.

The site contains a range of axes, with those of the mounded elements running predominantly NNW-SSE'ward. The axis of the chamber itself cuts across this, entry being towards the NNE, although that of the combined chamber-dome, which superficially resembles a small, tapering long barrow, in plan at least, does itself conform with the former common line. This general axis does not accord well with the usual pattern for long barrows in this regional group, which point W-NW'ward (front to rear). Although the final mound could have been aligned in this direction, the earlier horned structure, and its possible forecourt, would represent a reversal, with the axis of its chamber again anomalous.

..function

The site seems best interpreted as a monument akin to the local long barrow tradition but probably providing related ritual which, although funerary, did not result in clear construction of burial structures commensurate with the size of the mounded complex, and the opportunities it provided for such facilities. The absence of skeletal material, and scarcity of finds in general at the monument, can perhaps be explained by its damaged, and looted condition but, given the extent of surviving basal stratigraphy, more might have been expected from such a detailed investigation. Except for its initial chamber, and several possible rock-cut pits, the emphasis appears to have been on construction of solid structures.

If the function of the site was less directly funerary, and more involved in economic concerns, then the SE'ly pointing (front to rear) direction of the intermediate, horned monument might indicate interest in the S'n arc of the solar transit, and in its propitiation, as might the SW'ly opening chamber. Such S'ly interests have been noted elsewhere, amongst other types of monument (e-FIG CO-01).

..anomalous chambers

The chamber, with its corbelled roof-structure, marginal ring of benching, and wall-niches, seems better suited for access and use than entirely for sealed funerary deposition. Such benching could have provided seating, or a facility for placement and display of items. Given addition of subsequent tailed structures, it is uncertain whether this chamber remained open during later phases.

A similar domed chamber occurs at Bibury V (Passmore 1934), where it lies marginal to the mound (e-FIG LB-45 and 48), and hence in a location atypical of other covered burial chambers in the area, here also opening to the

S, as at Bibury II. No contents, or definite dating evidence, were found, only a fragment of flint. At both sites, this chamber appears adjacent to the final long mound but, in the case of unexcavated Bibury V, details of any complex, as seen at Bibury II, are unknown. Comparative plans and sections are given in e-FIG LB-46a.

Properties of the two chambers are as follows (TABLE LB-16):

TABLE LB-16 THE COTSWOLDS: *THOLOS*-TYPE CHAMBERS AT BIBURY II AND V LONG BARROWS

Summary table of long barrows in the study area:

		Bibury II	Bibury V
diameter	int	1.6	1.8
(m)	ext	~2.5	3.9
height	int	1.7	1.8
(m)	ext	>2	2.2
benching	int	yes	3 ‘seats’ on N’n side
niches		2	2
opens to		207	‘S’
rock cut base		yes	yes

Key: int(ernal), **ext**(ernal).

TABLE LB-17 STUDY AREA: N’N COTSWOLDS: LONG BARROWS: PROPERTIES AND PRESERVATION

AN ADDITIONAL COPY of this table has been placed on disc in the folder TABLES_filed, for ease of further access and use;
barrows are shown in e-FIGs LB-89 and 114:
number of sites: 59:

column 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		O’Neil and Grinsell 1960 mound												
						excav	**recent ar**	**cond**	**res**	**top**	**or**		**e-FIG geo**	**pan**
long barrow	**NGR (SP-)**	**L**	**W**	**H**	**ar**									
1 Aldsworth I	1659 0972	29	20	0.9	A		A	oblit	y	r	**280**	W	44	
2 Avening I	ST 8893 9839	46	14	1.8	A		A	term		r	**~297**	**W**	-	
3 Avening II	ST 8824 9900	40	21	1.8	?		wood	good		ca	198	S	-	81
4 Avening III: ?	ST 8610 9872	32	21	0.8	?		A	term		ca	**~290**	**W**	-	
5 Bibury I	1075 0941	91	23	2.7	wood	1854	wood	good		*sd	335	N	45	
6 Bibury II	1151 0906	43	?	0.9	?	1939-40	A	oblit		L	note 1		46	
7 Bibury III	1200 1048	43	25	1.8	?		A	oblit		L	**284**	W	47	
8 Bibury V	1089 0924	?	?	?	?	1925	P	poor		L	**294**	W	48	
9 Bisley I	SO 9066 0373	85	18	0.9		?1865-75	wood	poor		*su	**279**	**W**	-	
10 Bisley II	SO 9106 0742	30	15	1.5			F	poor		st	**264**	**W**	-	
11 Bisley IV	SO 9180 0612	-	-	-	?		A	oblit		?	?		-	
12 Bourton o t Hill I	1682 3241	31	18	1.8	enc		enc	poor		r	032	N	49	
13 Bourton o t Hill II	1446 3197	[ ]					A	oblit		*su	**277**	W	50	
14 Brimpsfield I	SO 9114 1323	46	23	3.0		1880	wood	good		r	**281**	**W**	-	
15 Chalford I: ?	SO 8897 0292	21	11	1.8	?		P	poor		?	?		-	
16 Chedworth I	0452 1059	55	27	0.9	A	1856	A	poor		ca	**305**	W	51	
17 Chedworth II	0671 1228	64	?	0.7	A		A	oblit	y	L	186	S	52	82
18 Cherington I	ST 8951 9783	61	23	0.9	A		A	oblit		ca	**234**	**W**	-	
19 Coberley I	SO 9342 1737	58	30	6.1	wood		wood	good		L	**263**	**W**	-	
20 Coberley II	SO 9552 1563	41	15	2.4	?		A	fair	y	r	**261**	W	53	83
21 Cold Aston I	1434 2064	31	17	2.1	wood		A	fair		r	**303**	W	54	
22 Coln St Denis I	0680 0836	91	21	3.4	?		A	good		*sd	**255**	W	55	84
23 Coln St Denis II :?	1013 1180	80	?	?	A		A	oblit		L	340	N	-	
24 Dowdeswell I	SO 9922 1856	31	15	1.7	A		A	term		r	**270**	W	56	
25 Dunt. Abbots I	SO 9650 0659	37	27	0.9	?	1806	A	poor	y	r	**265**	W	57	
26 Dunt. Abbots I	SO 9573 0720	>28			?	1875	P	oblit		L	? **W**	W	58	
27 Dunt. Rouse I	SO 9595 0598	64	18	2.7	?	1882	A	oblit		L	**283**	W	59	
28 Edgeworth I	SO 9360 0527	49	13	0.9	?		A	poor	y	*sd	**233**	**W**	-	

29 Farmington I	1427 1254	46	23	2.6	?		P	good		L	**294**	W	60	
30 Hampnett I	0857 1587	46	23	1.1	A		A	term	y	*su	**279**	W	61	
31 Hampnett II	1042 1607	31	16	0.6	?	1940-1	A	oblit		L	**271**	W	62	
32 Hazleton I	0720 1882	50	24	0.9	A		A	poor		L	**128**	E	63	
33 Hazleton II	0727 1887	55	23	1.8	A	1979-82	A	oblit	y	L	**076**	E	63	
34 Horsley I	ST 8606 9782	37	20	1.8	?		A	poor		*su	**266**	**W**	**-**	
35 Longborough I	1735 2895	55	31	1.8	A		A	oblit		r	**307**	W	64	
36 Minchinhampton I	ST 8836 9992	-	-	-	?		wood	oblit		?	?		-	
37 Minchinhampton II	ST 8839 9972	58	24	3.7	?	1870	wood	poor		ca	**234**	**W**	**-**	
38 Minchinhampton III	ST 8540 0170	26	15	1.1	P		P	poor		L	314	N	-	
39 Miserden I	SO 9137 0908	46	23	1.8	A		AP	poor		r	343	N	-	
40 Miserden II: ?	SO 9138 0902	40	27	1.5	P		PQ	oblit		?	?		-	
41 Miserden III	SO 9300 0890	102	21	0.9	A		A	term		*su	224	S	-	
42 North Cerney I	0184 0752	56	14	1.1	wood		P	poor		*sd	**079**	E	65	
43 North Cerney II	SO 9905 0942	[ ]			Q		R	oblit	y	ca	193	S	66	
44 Northleach I	1237 1550	58	21	1.2	A		P	poor		r	**305**	W	67	86
45 Notgrove I	0957 2110	49	24		?	1934-5	P	poor	Y	r	**288**	W	68	
46 Rendcomb I :?	0269 1182	[ ]			A			poor		r	177	S	69	
47 Rodmarton I	ST 9325 9730	61	30	-		1939	enc	good		*sd	**262**	W	-	87
48 Sudeley I	0210 2542	52	18	3.7	rest	1863-5	P	rest	Y	st	172	S	70	88
49 Swell I	1352 2627	46	24	1.5	?	1874	A	poor	Y	r	**278**	W	71	
50 Swell IV	1673 2637	55	21	3.0	?wood	1874	wood	good	Y	r	**282**	W	72	
51 Swell V	1716 2652	37	12	1.5	wood	1875-6	P	fair		ca	197	S	73	
52 Swell VI	1703 2580	46	15	3.0	wood		A	poor	y	ca	**286**	W	74	
53 Temple Guiting II	1331 2879	44	18	1.2	A		A	poor	y	ca	**265**	W	75	
54 Turkdean I	1187 1668	50	17	0.5	A		A	oblit		r	**249**	W	76	
55 Upper Slaughter I	1426 2580	52	15	1.5	A	1874	A	term		r	**241**	W	77	
56 Upper Slaughter II	1433 2566	46	18	1.7	A		A	oblit		r	225	W	77	
57 Willersey I	1177 3826	46	15	1.1	A		P	term		ca	**251**	W	78	
58 Withington I	0306 1417	43	18	1.8	wood		wood	good		st	**250**	W	79	
59 Withington II	0488 1576	[ ]				1962-5	A	poor	y	*su	**306**	W	80	
barrow of the same type beyond the study area: additional panoramic views:														
Frocester I	SO 7939 0132	27	18	-	?	1937	P	rest			**253**	W		85

Note 1: Bibury II: this complex site is atypical of other long barrows in the study area, and presents no single front-to-rear direction within the axis; component axes are as follows (°G):
main mound 156-336°G; chamber and passage, direction of entry 027°G, and exit 207°G; forecourt-like area, direction of entry 136°G;.

Key:

column 1:

sites are named using the parish-based system of O'Neil and Grinsell 1960;

abbreviated site-names: Bourton **on the** Hill; **Northleach** (with Eastington); **Dunt**isbourne; the suffix **:?** signifies doubt about the status of the site as a long barrow; **Bisley** (with Lyppiatt);

renamed sites: Aston Blank 1 (O'Neil and Grinsell 1960) has been renamed Cold Aston I;

alternative site-names:

Swell IV	Poles Wood;
Swell I	Cow Common;
Withington II	Sales Lot;
Bibury I	Lamborough Banks;
Bibury II	Saltway Barn;
Hampnett II	Burn Ground;
Sudeley I	Belas Knap;

columns 3-5:

mound 1960: dimensions of the mound, as measured and published in O'Neil and Grinsell 1960, converted from feet to metres, and rounded to nearest metre, except for height, which remains in feet, **L**(ength), **W**(idth maximum), **H**(eight), **[]** site not included in that publication;

column 7:

excav: dates of incursion, or excavation at the site;

columns 6 (data: 1960) and 8 (data: current):

ar: agricultural regime: **A**(rable), **wood**(ed or scrub-land), **rest**(ored), **enc**(losed), **?** not stated in O'Neil and Grinsell 1960, **P**(asture); **Q**(uarried); **R**(oad now crosses); **F**(arm buildings);

given the arable nature of the area, much previous ploughing, certainly around the margins, and in many cases over the mound itself should be assumed;

column 9:

cond(ition of the site, relative to those best preserved in the area); **oblit**(erated), **term**(inal);

column 10:

res(erve provided, including the presumed area of the mound and 'adequate' margins): **y**(es), **Y**(es, and fenced);

column 11:

top(ographical location):

locations are graded as follows, according to conformity between the axis of the barrow and the terrain: the terrain is always in low relief, with most immediate locations approaching the level designation irrespective of placement in other categories;
-neutral
L(evel ground around the barrow);
-conforming
r(idge): axis of the barrow lying along, and conforming generally with, a weak ridge;
c(ontour): axis running **a**(long the contour);
st: along the edge of a **st**eep slope;
-non conforming
s(lope): axis running **u**(p), or **d**(own) a weak contour, with the direction taken towards the back end of the mound; *****: indicates cases where the axis does not conform with the general topography, for instance, running across, and not with the line of ridge, or contoured slope;
column 12:
or(ientation) of the long axis of the mound, from foreground towards the rear of the monument; allocation of the axis to a general group: **W**(estern), or **E**(astern reversal to the usual W'ly trend); **S**(outhern), or **N**(orthern, reversal of this latter towards the null zone of the solar transit, for this latitude azimuths 311-049). Those sites which point (front to rear) towards the transitional zones of the solar transit (azimuths at this latitude: setting 229-311, rising 049-131) are shown in **bold** type;
column 14:
geo(physical survey) carried out by the author [AJM] to provide an accurate assessment of structure and alignment; details included in the e-FIG for the site;
column 15:
pan(oramic views) from the site are provided.

Long barrows: interaction between axis and topography: comparative analysis of long barrows in the Cotswolds, mid-Wye valley, and on the Lincolnshire Wolds

The question arises as to how far the axes of long barrows conform passively to the local topography, rather than to some external target, for instance celestial. A general similarity between orientation of monuments from widely separated areas, with different landscape, suggests active general alignment on some common celestial cue, with axes adapting sympathetically to terrain as a secondary consideration. However, to examine this relationship in more detail further regional analysis is required, with a three-way comparison presented here: between barrows in sample areas of the Cotswolds, mid Wye valley, and Lincolnshire Wolds. These are areas of variant terrain, that contain monuments similar in type, and in general group properties of orientation, allowing the influence of topography to be examined in more isolation.

The study areas chosen are the Cotswolds (see Table of Contents: 03a/21), the mid-Wye valley (see Table of Contents: 04c), and Lincolnshire Wolds (see Table of Contents: 03a/22a). General properties of these areas are outlined in TABLE LB-18:

TABLE LB-18 Relationship between axes of long barrows and topography: case studies for the Cotswolds (C), Lincolnshire Wolds (LW), and mid-Wye valley (mW), with basic properties of the study areas

	C	**LW**	**mW**	**note**
area sampled: sq. km	1250	1050	806	1
substrate:	limestone	chalk	limestone	2
altitude range: m	150-300	10-140	70-700	3
axis of hills	NE-SW	NW-SE	NW-SE	
main drainage to	S-SE	S	varied	4
barrows: number	58	81	21	5
type	chambere	earthen	chambered	6
mean length [sd] :m	49 [18]	51 [18]	32 [11]	7
axis: mean [sd] to	264 [39]	298 [31]	233 [60]	8

Key: sd standard deviation;
notes:
1: only the main areas of barrow distribution are included;
2: the softer chalk substrate in **LW** forms a more rounded topography, of lower altitude range than for **C** and **mW**;
3: the sample for **C** occupies a higher range of altitudes than for **LW**;
4: the axis of the range of hills, and direction of main drainage, affects the orientation of ridge-lines;
5: the sample for **LW** contains more sites that are of less certain identification as long barrows than that for **C**. A range of elongate rectilinear ditched enclosures in the sample for **LW** may belong amongst long mortuary enclosures, rather than long barrows proper, although the dividing line is often tenuous;

6: where detailed plans are available, barrows in all areas are of broadly similar format, with rectilinear, or tapering ground plans, distinct forecourt areas, and containing axial burial structures. Differences occur, from enforced use of timber as principal building material within the area of chalk in **LW**, this latter unsuitable for suitable stonework;
7: data: for Cotswolds from O'Neil and Grinsell 1960; for Lincolnshire Wolds from Jones 1998; for mid Wye from Jones 2012 and other sources;
8: the long axes of barrows in each sample area are plotted as a histogram of frequencies at 10° intervals, with mean and standard deviation shown (e-FIG-118);

the direction of pointing (front to rear) is used for those barrows thus differentiated between ends; barrows where this is not the case are treated separately.

Further figures, graphs, and tables of data for the study areas are located as follows:

	details of sites: TABLE	**e-FIGS area map:**	**LB-data graphed:**	**for main text see: Table of Contents**
Cotswolds	LB-17	114	118	03a/21 and 22a
Lincolnshire Wolds	LB-19	116	118	03a/22a
mid Wye	AS-wye_01	115	118	04c

The study areas

-Cotswolds (see Table of Contents: 03a/21 and 22a)

The limestone hills of the Cotswolds extend from the main scarp edge forming their NW'n side, descending towards the SE over the dip-slope, towards the upper Thames valley marking their SE'n margin. Over this general area, tributaries of the upper Thames drain the dip-slope towards the SE, with the Frome, a tributary of the Severn, cutting into the NW'n margin. The majority of long barrows in this main area of the Cotswold-Severn type are distributed over the lower dip-slope, on spurs around headwater stream valleys.

-the mid Wye-Usk group (see Table of Contents: 04c)

Long barrows in this well-defined regional group, distributed in the valley and on hill slopes around the mid-Wye, were included in the analysis as an outlying extension of the main area of Cotswold-Severn type monuments, for comparative purposes, given the variant topography. Where excavated they appear comparable in plan to those in the main Cotswold-Severn area, but with the laterally chambered variant dominant.

-Lincolnshire Wolds (see Table of Contents: 03a/22a)

This area of chalk upland provides another discrete cluster of long barrows, with many well known in plan, few from excavation, but mostly from crop-marked outlines of eroded sites (Jones 1998). This sample provides good data on axial orientation, and topographical conformity, for comparison with that from the Cotswolds.

The long axes of barrows in these study areas were closely determined wherever possible from satellite imagery, with additional data supplied by aerial photography. The general set of axial data for the Lincolnshire Wolds is more complex than that for the Cotswolds. Most of the sites in the former area survive only as crop-marks, and not all have produced well-rectified plans, with a measurable axis. In addition, many sites are ovate, or rectilinear, rather than tapering, with the front end, and hence the direction of pointing, unknown. For these, it is not possible to distinguish between diametrically opposed alternatives: between pointing either to the null or permanent zones, the more usual W'ly transitional or reversal to the E'ly (e-FIG LB-116: sites plotted accordingly; compare e-FIG LB-114 for the Cotswolds). Numerical data, although partial, nevertheless provide a clear indication of general trends.

The degree of conformity between axes and topography was tabulated according to a standard format (TABLE LB-19, column 8), also used for long barrows in the Cotswolds (TABLE LB-17), and mid Wye study areas (TABLE AS_wye 01):

TABLE LB-19 Long barrows on the Lincolnshire Wolds: basic properties

AN ADDITIONAL COPY of this table has been placed on disc in folder TABLES_filed, for ease of further access

barrows: distributions are shown in e-FIG LB-116:

number of sites: 81:

column								**8**
site	**NGR TF-**	**L**	**points**	**az**	**form**	**name**	**Jones**	**top**
1 Ashby with Scremby	4379 6904	52	NNW	330	1		1	ca
2 Beelsby	1953 0162	>66	W		1		61	*sd
3 Binbrook	2198 9259	50	NW	295	1		40	r
4 Brookenby	1955 9500	74	NW	311	1		51	*su
5 Burgh on Bain	2129 8497	27	WSW	251	?1			L
6 Burgh on Bain	2185 8806	49	NW	295	?1			ca
7 Calcethorpe w Kelstern	2577 8808	50	NNW-SSE	325	2		34	*sx
8 Calcethorpe w Kelstern	2641 9238	40	NE-SW		?		39	L
9 Claxby St Andrew	4442 7198	49	WSW	257	1	Deadmen's Grave 1	7	ca
10 Claxby St Andrew	4458 7190	53	WNW-ESE	284	2	Deadmen's Grave 2	8	ca
11 Claxby St Andrew	4469 7192	36	NE-SW	226	2		9	*sx
12 Donington on Bain	2370 8215	40	SW		?			ca
13 Donington on Bain: ??	2581 8408	35	N-S	003	2			ca
14 Donington on Bain	2540 8434	33	?		?			?
15 Edlington w Wispington	2192 7134	68	NNW-SSE	326	2		15	L
16 Langton by Spilsby	3995 7195	51	SW	240	1		13	*sd
17 Langton by Spilsby	4017 7239	64	SW	218	1		12	*sd
18 Langton by Spilsby	4022 7172	72	NNW-SSE	340	2		14	ca
19 Langton by Spilsby	4015 7221	56	NN2W-SSE	335	2	Spellow Hills	11	*sx
20 Ludford: ?	2028 9025	?	?		?			?
21 Ludford	2096 8957	58	NW	303	1		36	ca
22 Ludford: ?	1878 9004	32	W	262	1		37	L
23 Maidenwell	3161 7931	52	WNW-ESE		2		27	*sx
24 Nettleton	1281 9966	40	E-W	280	2		49	*sx
25 Nettleton	1296 9802	30	NNW-SSE	336	2		48	*sx
26 Normanby le Wold	1170 9633	38	N		1		47	*sd
27 Normanby le Wold	1255 9575	75	NW	317	1		46	r
28 Normanby le Wold	1326 9674	40	?		?			?
29 Normanby le Wold	1337 9639	58	NNW	336	?1	Normanby Top		r
30 North Willingham	1826 8859	29	WSW	258	1		35	*sd
31 Riby	1715 0549	54	NW		1		62	ca
32 Scamblesby	2734 7794	42	NNW-SSE	329	2		26	*sx
33 Skendleby	4292 7088	77	NW	314	1	Giants Hill 2	3	ca
34 Skendleby	4278 7126	76	NW-SE	305	2	Giants Hill	4	ca
35 Skendleby	4287 7111	64	NW-SE	306	2	Giants Hill 1	2	ca
36 Skendleby: ?	4401 7285	>42	N-S		2		10	*sx
37 Skendleby	4257 7016	?	?		?			?
38 South Ormsby cum Ketsby	3758 7720	58	NW	318	1		25	*su
39 South Ormsby cum Ketsby	3762 7723	?	299		2			*sx
40 South Ormsby cum Ketsby	3604 7603	52	NE-SW	257	2		22	ca
41 South Ormsby cum Ketsby	3509 7513	59	NW-SE		?			*sx
42 South Thoresby	3839 7609	44	NW	307	1		21	ca
43 South Thoresby	3996 7578	50	WNW-ESE		2		20	*sx
44 South Thoresby:	3990 7390	46	N-S		2		17	ca
45 Stainton le Vale	1644 9413	50	NNW-SSE	323	2		45	*sx

46	Stainton le Vale	1513 9458	40	E-W	263	1			r
47	Stainton le Vale	1648 9322	69	NW-SE	303	2		42	ca
48	Stainton le Vale	1722 9395	44	NNW-SSE		2		44	ca
49	Stenigot	2670 8180	62	NW	303	1		28	r
50	Stenigot	2696 8157	44	NW	313	2			r
51	Swaby	3897 7715	80	S		1		23	ca
52	Swallow	1897 0109	24	NNE		1	Ash Holt	60	ca
53	Swinhope	2148 9529	50	E-W	277	2	Hoe Hill 1	52	*sx
54	Swinhope	2140 9532	?	NW-SE		?	Hoe Hill 2	53	*sx
55	Swinhope	2220 9603	47	NE-SW	273	2		55	*sx
56	Swinhope	2154 9537	>92	W	273	1		54	*sd
57	Swinhope	2088 9612	39	SSW		1	Ash Hill	56	ca
58	Tathwell	2945 8225	32	NW	288	1		29	*sd
59	Tathwell	3081 8260	28	?		2		30	?
60	Tealby	1762 9051	32	NW	282	1		38	*sd
61	Tealby	1707 9255	52	W-E	271	2		41	*sx
62	Tetford	3320 7317	44	NW-SE	316	2		16	ca
63	Thoresway	1659 9829	45	NNW	315	1		50	*su
64	Thoresway	1886 9988	48	NE-SW		2		59	ca
65	Thorganby	2054 9733	44	W		1		57	*su
66	Thorganby	2053 9823	35	E-W				?	*sx
67	Thorganby	1974 9880	98	NW-SE	316	2			*sx
68	Ulceby with Fordington	4236 7162	128	E-W		1		5	ca
69	Ulceby with Fordington	4236 7173	28	NW-SE		2		6	*sx
70	Ulceby with Fordington	4193 7471	50	?		?			?
71	Walesby	1465 9363	43	NNW-SSE		2		43	ca
72	Walesby	1496 9362	70	NW	329	1			r
73	Walmsgate	3719 7761	78	NW	307	1	Beacon Plantation	24	*su
74	Welton le Wold	2580 8680	43	NW	297	1		32	*su
75	Welton le Wold	2591 8704	43	W	275	1		33	*su
76	Welton le Wold	2635 8647	30	NE-SW		2		31	*sx
77	Welton le Wold	2610 8747	?	?		?			?
78	West Ashby	2713 7470	53	NW	319	1		18	*su
79	West Ashby	2716 7473	28	NNW-SSE	338	2		19	*sx
80	Withcall	2828 8427	?	NW-SE		?			*sx
81	Withcall	2824 8461	32	NW-SE		?			*sx

Data: Jones 1998; National Monument Record; satellite imagery: Google Earth and Bing Maps (Microsoft Corporation).
Key: L(ength in metres); **points** (from broader front to narrower rear, for tapering sites, otherwise the bi-directional axis is shown); **az**(imuth); **form: 1** trapezoidal, **2** rectilinear or oval; **Jones**: numbering after Jones 1998;
top(ographical location):
locations are graded according to the conformity of the axis of the barrow with the terrain, as follows: the terrain is always in low relief, with most sites approaching the level designation irrespective of placement in other categories;
-neutral
L(evel ground around the barrow);
-conforming
r(idge): axis of the barrow lies along and conforms generally with a weak ridge;
c(ontour): axis running **a**(long the contour); **st:** along the edge of a **st**eep slope;

-non conforming
tapering mounds with a clear back end:
su and **sd: s**(lope): axis running **u**(p), or **d**(own) a contour, with the direction taken towards the narrower, back end of the mound;
non-tapering mounds with no clear differentiation between ends:
sx:: s(lope): axis running **x** (across), not along, the slope;
*****: indicates cases where the axis does not conform with the general topography, for instance, running across and not with the line of ridge or contoured slope;

Conclusions

The relationship between axes and topography is summarised in TABLE LB-20, and e-FIG LB 118):

TABLE LB-20 Conformity between axes of long barrows and topography: case studies/ Cotswolds, mid-Wye, and Lincolnshire Wolds (LW)

		Cotswolds		LW		mid Wye	
		#	**%**	**#**	**%**	**#**	**%**
neutral	**L**	13	**24**	4	**5**	6	**35**
conforming	**r**	18	**33**	7	**9**	1	**6**
	ca	10	**18**	24	**30**	6	**35**
	st	3	**5**	0	0	0	0
sub total			**56**		**39**		**41**
non conformity	**su**	6	**11**	8	**10**	-	-
	sd	5	**9**	8	**10**	4	**23**
	sx	0	0	23	**28**		
sub total			**20**		**48**		**23**
unknown		0	0	7	**9**		
total		**55**		**81**		**17**	

-Cotswolds

In the Cotswolds **56%** of the barrows show conformity with mild terrain, with no locations constraining placement, location along weak ridges providing the major contribution. Some **24%** of the barrows utilise clearly level ground, with barrows in other categories often similarly placed. The remaining **20%** of sites have axes that display less conformity with general terrain.

Matching these results with the clear peak of W'ly alignment, shown in e-FIG LB-118, suggests that some external, non-topographical cue for the axis was the prime consideration, with those locations selected that allowed this condition to be satisfied, whilst retaining some measure of sympathetic co-ordination with terrain. Importantly, those axes here that do not conform with terrain still maintain their W'ly emphasis.

Within the sample area, six clusters of long barrows can be identified, each with fairly consistent orientation, suggesting localised traditions for alignment:

cluster	**pointing (front to rear) towards:**	**degree of conformity with terrain**
Swell	W-SW	high
Hazleton	E (reversal of normal W'ly trend)	location neutral
Hampnett	W	medium
Bibury	NW	location neutral
Duntisbourne	W	low
Avening	W-SW	high

-Lincolnshire Wolds

In the Lincolnshire Wolds **39%** of barrows conform with terrain, sites running along the contour being dominant. Barrows on level ground contribute only **5%**. Sites not conforming with topography make up **48%**, almost half of the total.

-mid-Wye area

Here, **35%** of sites are on neutral terrain, with **41%,** a similar proportion, conforming with weak topography, and a minority **23%** not conforming, a pattern resembling that observed for the main Cotswold area, supporting the conclusions drawn there.

Barrows on the Lincolnshire Wolds clearly conform less well with terrain than those from the Cotswolds and mid-Wye areas, whilst retaining a well-defined peak of orientation towards the NW, hence demonstrating the primacy of this direction over local landforms.

Differences in mean axial alignment between samples of long barrows from the Cotswolds and Lincolnshire Wolds: relevance for the seasonal-solar model of barrow construction

These two study areas contain regionally distinctive groups of long barrows that are sufficiently numerous, and well defined axially to enable a close group comparison of orientation to be made.

The sample from the Cotswolds contains 49 stone-built chambered tombs, usually tapering in plan, whilst that from the Lincolnshire Wolds consists of some 81 ditched barrows, earthen, with evidence for timber structures, apparently simpler in design, and often more ovate, or rectilinear, of which 50 have closely known axes. The samples are, therefore, broadly similar in basic layout, and in mean length of axis, with adequate numbers of sites available for analysis

Further details of the analysis are given as follows:

context	e-FIGS LB-		TABLE LB-18	
area mapping	114	116		
comparative barrow plans	44-80	117		
axes and topography	118			
climatic factors	36a			
list of sites			17	19

It is evident that, for both areas, the majority of axes fall within the transitional zone of the solar transit (see Table of Contents: 02c/2b(ii)). However, there is a significant difference between mean alignment for the samples of barrows from these two areas, the axis being more N'ly in the case of those from the Lincolnshire Wolds (TABLES LB-19 and 21). This separation could simply reflect variant practices for alignment of monuments between the two areas. Alternatively, if the setting sun was used as a W'ly target for establishment of the axis, then these mean values could provide an indication of the main season for layout, as outlined for the seasonal-solar model of barrow construction (see Table of Contents: 03a/13a; e-FIG CO-02). The Lincolnshire Wolds lie about 1.5 degrees of latitude to the N of the Cotswolds, and in a more exposed coastal location, adjacent to the North Sea. Differences in the mean axial frequency could reflect the slightly later N'n onset of suitable conditions for construction activity during spring (e-FIGS LB-36, 36a, and 39).

Axial data from barrows in these two areas, corresponding positions and dates of sunset, and related conditions of ambient temperature are given just below in TABLE LB-21:

TABLE LB-21 DIFFERENCES IN MEAN AXIAL ALIGNMENT OF LONG BARROWS IN THE COTSWOLDS AND LINCOLNSHIRE WOLDS

column		**1**	**2**	**3**	**4**	**5**	**6**		**7**	
					axis				**arrival of the modern**	
area	**set**	**lat**	**long**	**#**	**mean**	**sd**	**sset**		**9° isotherm (e-FIG LB-36)**	
Cotswolds		51.8	2.0	49 [83%]	264	39	Mar 14	(a)	Apr 15	(x)
Lincs. Wolds	A	53.3	0.1	50 [62%]	298	31	May 7	(b)	May 1	(y)
	T			26 [32%]	290	29	Apr 20	(c)		
difference	A	1.5	1.9		35		54 days	=b-a	**16 days**	=y-x
	T				27		**37 days**	=c-a		

Key:
Lincs Lincolnshire;
set: **T** axes for known trapezoidal barrows taken from broader front to narrower rear end;
A axes for the entire sample, including those sites for which identification of the front end remains unknown, quoting the W'ly direction throughout;
lat(itude: degrees N), **long**(itude: degrees W): quoting central values for each study area; **#** number of known axes in each sample, and **[n%]** this expressed as a percentage of the total of known and probable long barrows in each sampled area; **axis** (taken towards the rear of the barrow);
sset: date of sunset along the axis given in column 4, at zero horizon for the stated latitude;

According to this model, the mean alignment would represent a general tendency, with further variability introduced by use of the setting sector of the sun as a broader target, rather than any more defined point within it, such as the sunset itself.

The barrows from the Cotswolds show a general ground plan with front and rear ends clearly distinguishable, and hence the direction of rearward pointing is readily determined (e-FIGS LB-44 to 80). However, the sample from the Lincolnshire Wolds contains a significant number of ovate, or rectilinear sites, where a specific front end is not evident (e-FIG LB-117). Consequently, sites where the direction of tapering, and hence of pointing, is known have been designated as set T, with the entire sample as set A (TABLE LB-21 just above). Set T provides a clear sample, with a known NW'ly direction of pointing, with a generally W'ly direction assumed for the non-T set, for the purposes of plotting in e-FIG LB-118. Given general trends, this seems to be a reasonable interim assumption. However, the smaller, but cleaner set T is used for the purposes of this particular comparison with sites from the Cotswolds.

The angular difference between the axial means (TABLE LB-21 just above: column 4) is 27°, and this would reflect a difference of 37 days in the timing of sunset (column 6 above). However, under current climatic conditions, the two areas appear very similar in terms of changing seasonal temperatures, insufficient to warrant a delay this long in onset of construction. Monthly temperature averages from UK Meteorological Office weather stations in each area, at Waddington (Lincs; SK 9764), and Brize Norton (Oxon; SP 2907), are almost identical throughout the year (~°C: Jan 4°; Feb 4°; Mar 7°; Apr 8°; May 12°).

The 16-day delay in arrival of the 9° isotherm between the two areas (e-FIG LB-36) provides, as it stands, only about half of this 37-day difference, as projected from axial displacement. However, such isotherms represent an abstraction, and a generalisation of actual, and more detailed ground conditions, and relate to modern climate, with the possibility that conditions during the Neolithic were somewhat different, perhaps with the NE'n coastal area more inclement during the spring. Such movement of the mean axis towards the summer solstice with increasing latitude at least supports the seasonal-solar hypothesis, and agrees with the more widely separated comparison between S'n Britain and Scotland (see Table of Contents: 03a/ 25e; e-FIG LB-12). The difference between expected and observed intervals is also within reasonable limits, given the nature of the analysis. In TABLE LB-21 above, the target for axes is taken to be the sun at zero horizon: increasing this to 10° elevation increases the difference (TABLE LB-21: column 6, value c-a) still further, to 49 days.

The alternative to a climatic explanation would be to suggest variant alignment behaviour based on regional ritual preferences.

The Dorstone Hill complex; Herefs; SO 3242;

Reasons for inclusion

The linear, end-to-end placement of three long barrows on Dorstone Hill provides an opportunity to discuss intentional targeting of axes, reversal of axis, and the more general relationship between longhouse structures, here found under at least one of the barrows, and funerary monuments.

The complex

At Dorstone Hill, the line of approach to a well-defined, and defensible hilltop promontory, containing an area of Neolithic and Bronze Age activity and settlement of unknown nature, is almost completely blocked by a contiguous line of three long barrows. The barrows, when fully developed, allowed only very restricted access to the main spur along their NW'n edge. Given the highly unusual nature, and non-defensive construction of this boundary, activity over the entire hilltop might not have been of standard domestic type but, at least in part, related to ritual and funerary activity.

Further examination of the line of the amalgamated monument (e-FIG LB-119) highlights many of the problems encountered in analysis of orientation generally amongst long barrows, and stresses the need to draw robust conclusions from grouped data, rather than from specific individual, context-rich cases.

-targeting of the axis

Although the general line of barrows crosses the neck of the promontory over the shortest distance, and hence seems efficient as a boundary, it also coincides with a highly significant solstitial axis, that from summer solstice sunset to winter solstice sunrise. For the area of the site, the following solar limits at standard zero horizon can be matched against monumental axes thus:

lat-long	52.06°N;	2.98°W;
event	**azimuths**	
SSset		**310**
WSrise	**130**	
barrows:	(**p**)ointing	(**f**)acing
NW'n	107 f	287 p
central	129 p	309 f
SE'n	127 p	307 f
mean axis	121	301

Key: **pointing** (direction front to rear of the barrow), **facing** (the opposite direction); **mean axis** (between extreme ends of the line of barrows); **WS** winter solstice; **SS** summer solstice;

The correspondence between axes and solstices is therefore fairly close, especially for the central and SE'n earthen barrows, but whether this is coincidental remains unknown. The peri-equinoctial peaks for larger samples of axes amongst major groups of long barrows indicate a distinct lack of solstitial interest (TABLE LB-01; e-FIGS LB-01 to 21). This suggests that the long mounds at Dorstone, if specifically targeted, were atypical and specialised, or that the equivalence was indeed unintentional, a consequence of local topography and need for demarcation of the hinterland.

-reversal of axis

Given that the axes of long barrows normally point (front to rear) towards the W-NW (Cotswold-Severn group: e-FIG LB 16 and 17; earthen types: e-FIG LB-18), the Dorstone central, and SW'n mounds point in the opposite direction. Such reversals are noted sporadically amongst many groups (examples: Cotswold-Severn: e-FIG LB-89), with Irish wedge-shaped tombs providing a clear case of group reversal (e-FIG LB-21). The significance of this apparent reversal at Dorstone would depend in turn on resolution of the question regarding intentionality of alignment, as discussed just above. Possible interpretation of such reversal, in terms of the direction of approach and entry to a monument, is discussed elsewhere, as perhaps reflecting changed emphasis from deposition to display of its contents (see Table of Contents: 03a/20e).

The Dorstone complex lies at the edge of the mid Wye-Usk group of long barrows, this latter with affinities to the main Cotswold-Severn type (see Table of Contents: 04c). Analysis of orientation in mid Wye-Usk (e-FIG LB-115 and 118) shows distinct relaxation of the W-NW'n axial trend, in contrast to that observed for the main Cotswold-Severn area (see Table of Contents: 03a/21 and 22a; e-FIG LB-16 and 17). This might argue for a more topographically compliant explanation for axial alignment in the Wye group generally, with Dorstone as a further specific example.

Coincidental or not, the stone-built NW'n barrow at Dorstone, perhaps the final element of the line, does adopt the standard W-NW'ly pointing axis (front to rear), although here slightly more to the N than the peak frequency for the group. This provides a clear contrast with the other two earthen and timbered mounds in the line, perhaps indicating a reversion to more normal alignment-related ritual of the main group.

-longhouse and long barrow

The alignment of the mound, more definitely at Dorstone central barrow, and possibly for the other two monuments, seems predetermined by the axis of what appears to be an underlying timber longhouse. Although with likely funerary functions this latter is a different structure, one with domestic connotations, and hence introduces yet another complication for the analysis of orientation (see Table of Contents: 03a/ 17).

The NW'ly axis of the presumed longhouse at Dorstone central barrow, at around 320°, corresponds well with the peak frequency observed for a larger sample from the European Neolithic (e-FIG LB-24). Whether this latter alignment, consistent over wide areas, and also seen in house structures of other dates (e-FIGS LB-25 to 29), was a functional response to climatic conditions, or represents targeting on some other cue, is discussed more fully elsewhere (see Table of Contents: 03a/17a and 19a).

However, the longhouse at Dorstone central appears to taper towards the SE, the opposite direction to that taken by trapezoidal European examples, usually placed with narrower end to the NW, thereby possibly minimising impact from stronger winter NW'ly wind and weather, and maintaining the entrance at the more sheltered leeward end. There is no evidence for an entrance structure at Dorstone central, but from Continental parallels, on the basis of ground plan, it might be expected at the broader NW'n end, stressing this as the line of approach, as seen towards the mortuary structure at Dorstone SE'n barrow.

Supplementary information: Dorstone Hill

Dorstone Hill; Herefs; SO 3265 4240 (~centre of line); long barrows: two earthen and one stone-built;

-Location (e-FIG LB-115)

The site lies on a narrow ridge of Old Red Sandstone running NW-SE'ward, up to 3km wide, and rising to about 300m above the floodplain of the River Wye, which lies closely around its NW'n end. The Wye, flowing E'wards, defines the NE'n flank of the ridge, with the SW'n scarp formed by the River Dore, a minor tributary flowing S'ward to meet the main river further downstream. The Dorstone ridge flanks the riverine approach to the Afon Llynfi valley-Black Mountain area just to the W, and is strategically placed to control access along this sector of the Wye. The ridge is a NW'ly-running parallel outlier to the larger series forming the Black Mountains, which lie adjacent to the SW.

Transverse dissection of the main ridge at Dorstone by headwater stream valleys divides it into a series of hilltops, joined by narrow spurs. The Neolithic and Bronze Age complex on Dorstone Hill lies at about 270m OD, and is spread over the fairly level ground of a S'ly projection of the main ridge. The line of three long barrows runs conspicuously across the spur that forms the approach to the hilltop, almost blocking access. The hilltop thus enclosed is sub-rectangular, about 200m E-W and 300m N-S, and is bounded on all sides by steep slopes, except for the open N'n side, with its line of barrows.

Neolithic to Bronze Age activity, and perhaps direct settlement, is apparent from flint-work, and other debris recovered from the hilltop, including arrowheads, plus fragments of flint, and stone axes, scattered over at least seven hectares, with excavated evidence for two Bronze Age hut floors (NMR: SO34SW 18; 106120). The nature of any settlement is unknown: whether permanent or transitory, domestic, or, given the adjacent long barrows, with more funerary associations.

A substantial unexcavated bank, without any ditch apparent, cuts off a small area at the SE'n corner of the main enclosed area and, although nominally attributed to the Iron Age, it remains undated, but could certainly be earlier (SO 3271 4216; NMR: SO34SW 19; 106123).

-Long barrows (e-FIG LB-119)

Partial excavation of an embanked feature, initially considered defensive, across the neck of the promontory, has revealed three weakly tapering, ditchless long mounds of Neolithic date, serially and closely placed, on a common NW-SE'ly axis (Ray 2013; Thomas *et al*. 2015). The line of the bank, and its underlying barrows is slightly concave towards the NE, with the angle now seen to correspond with the interval between the central and NW'n barrow mounds.

The currently known properties of the barrows are as follows:

TABLE LB-22 Dorstone Hill: properties of long barrows

barrow	**L**	**Wb**	**Wn**	**axis**	**ret**	**term**	**hall**	**cists**	**ditch**	**~%**	**points**
NW'n	35	[13]	[5]	[NW:**287**]	st	no	bd	yes	no	all	SSset
central	30	7	3	[SE:**129**]	t st	no	?yes	yes	no	30	WSrise
SE'n	[38]	7	?	[SE:**127**]	t st	yes	bd	yes	no	<10	WSrise

geophysical prospection; radiocarbon dating: none noted to 2015:

Note: there are irregularities in plans provided in Thomas *et al*. 2015 [these revealed by layered presentation, and notified by AJM], sufficient to cause some uncertainty as to the axial alignments, as stated above, and shown in e-FIG LB-119). Values above in brackets **[]** are hence conjectural.

Key: L(ength of the mound in m); **W**(idth of the mound in m), **b**(roader end), **n**(arrower end); **axis** ('pointing' direction towards the narrower rear end of the mound); **ret**(aining structure to the mound, **t**[urf and timber]; **st**[one cladding]; **term**(inal chamber present at the broader end); **hall** (?burnt timber hall underlying the mound), **bd** burnt debris, including timber and daub present; **cists** (lateral, and mainly on the N'n sides of mounds); **ditch** (lateral quarry ditch[es] to the mound present); **%** (approximate extent of the mounded area excavated by 2014); **points**: the direction from broader front to narrower rear end of the mound coincides with **SS** summer solstice, **WS** winter solstice.

The main internal sequence for each of the three barrows is as follows:

..the NW'n barrow: a long stone cairn, with affinities amongst the Severn-Cotswold group, unchambered, but including small side-cists;

The long barrow at Northleach I SP 1215 (e-FIG LB-67b) provides a similar ground-plan, without obvious forecourt or chambering, but is larger. It should be noted that the overall plan of Dorstone NW has been inferred here from the preserved NE'n side, and assuming bilateral symmetry.

..possible construction of a **timber structure** of unknown type on the old ground surface is suggested by a deposit of burnt clay, and charred wood, running along the axis of the later barrow;

...revetment of the subsequent earthen core of the barrow with dry-stone work, to form a trapezoidal mound about 35m long;

This stone revetment was more substantial around the E'n third of the broader end of the mound, and its limit seems further marked by a short length of transverse internal walling. The revetment received extra buttressing at various points, possibly added later, rather than being integral. Two small stone-lined cist-chambers were constructed within the lateral stone revetment, towards the rear of the mound on its N'n side, and any others originally along the S'n side have now been lost to modern destruction of the monument.

...linking of this monument, and the two earlier earthen mounds, by further stonework to form a façade over 100m long;

..the central barrow: a long mound of earth and timber, with stone cladding;

..construction of a **rectangular timber-framed structure;**

Three pairs of posts were cut into the old ground surface, set about 2.5m apart between centres, on either side of the axis of the later barrow, as exposed by excavation only for a length of 5m. Such axial post-work could indicate the existence of an aisled timber longhouse, with other evidence for interior partitions, and timber jointing indicating its superstructure. These lines of postholes start abruptly, and run to the SE, with no evidence for a further set of posts of equivalent spacing towards the NW, only a transverse line of smaller postholes, possibly marking an end-wall. Two posts, more closely centre-set at 1.8m apart, were also found at the SE'n rear end of the later barrow and, if terminal, would indicate a building about 25m long, trapezoidal in plan, as indicated by its central posts tapering at 2.5°. The function and duration of its use remain undetermined, unsupported by finds, or by presence of skeletal material, these latter anyway poorly preserved in local sediments.

...**destruction** of timber structures by deliberate burning, followed by mounding of the resultant clay-daub-char bed, along the mid line of the later barrow;

...linear mounding of the site;

An earthen mound was established along the axis of the burnt and demolished timber structure, revetted with a double line of post-work, set in a palisade slot, this then infilled with turf, and faced with stone.

...later developments;

A sub-rectangular stone cist, inserted into the collapsed turf of the revetment on the N'n side of the mound, then sealed under its stone cladding, contained no deposit, other than a leaf-shaped arrowhead, with broken tip. Two other stone-lined cists were found, adjacent to the N'n flank of the mound. Close to the rear end of the mound, an oval pit, with a covering board of charred timber, contained fragments of rock crystal, but no other surviving deposit. Along the S'n side of the mound, and towards its rear, a series of small deposits of cremated bone may represent deliberate insertions.

..the SE'n barrow: a long mound of earth and timber with stone cladding:

...**deposition of burnt debris**, from unknown timber structures, at the partially excavated front end of the mound;

No accompanying post-holes were detected, and its relationship with the timber mortuary-type structure remains unknown.

...construction of a timber mortuary-type structure;

A sub-rectangular pit, 7.5m long, and 2.5m wide, was dug into subsoil on the axis of the later barrow, near its broader front, and was defined at each end by larger vertical timbers, set in holes 1-1.5 m across, the intervening flat-bottomed 3.5m long trough paved with rough slabs. A post at either side of the front of the mortuary-type structure might have defined an approach. The only find of note was a large polished axe, of stone possibly from Graig Llwyd (North Wales), found immediately to the W of the structure, perhaps displaced from a shallow pit nearby. Another pit, containing substantial quantities of flint and pottery, lying just to the S of the broader end of the mound, predates it, and is of uncertain relationship with the mortuary-type structure. After unknown use, the posts were dismantled, and the chamber was infilled with daub-rich sediment, this covered with a charred board, and then with turf.

...linear mounding of the site;

A linear mound of earth and turf was established within a slot-based timber revetment, this then clad with stone.

...later developments:

A cylindrical pit was dug into top of the mound, just to the SE of the mortuary-type structure. Although in truncated condition, its surviving basal sediments produced a finely, and bifacially flaked ovate knife, of flint from the Yorkshire area, plus knapping waste from its fabrication, and a polished flint axe, both items of later Neolithic type.

..gaps between the mounds

The only gap yet defined by excavation, between the ends of the central and SE'n mounds is short, at only 3m, and includes few features.

An oval pit, its contents covered with a plank, or board, and perhaps originally also covered by a small cairn, lying at the S'n margin of this inter-barrow gap, contained some cremated bone, and items of rock crystal, including a finely retouched flake. This could be a truncated burial, or cenotaph pit of a type with Beaker associations elsewhere in S'n Britain.

Any structure beyond the known ends of the line of barrows is unknown: at the NW there seems to be a sufficient gap to allow passage, before the gradient steepens, and at the SE the unexcavated mounding runs up to the edge of the slope.

Using the known length of the NW'n cairn as a standard, and applying it to the other mounds suggests the following. The central mound does not face directly onto the front of the NW'n cairn but, after a short gap, is displaced just to its NE. There is also an additional 20m of mounding beyond the SW'n monument to be accounted for by its extra length, or by another site.

-Chronology

There are no radiocarbon dates yet available for the site (to 2015), although finds from the monuments indicate an early Neolithic origin (3800-3700 BC suggested: *Thomas et al.* 2015), with secondary deposits of later Neolithic type made in extant mounds. The flint artefacts, from the pit cut into the top of the SE'n mound, date to around 2600 BC, providing an upper limit, placing the main sequence within the 4th millennium BC, and indicating persistence of interest in a long established site.

The duration of structural phases remains unknown but, in view of the degree of preservation of carbonised timber from under the central monument, the area must have been sealed by mounding without prolonged exposure of the burnt area.

In the absence of linking stratigraphy, there is no relative order for establishment of the mounds and their component structures: monuments might have been in consecutive, or serial use. The NW'n barrow, with its Severn-Cotswold parallels, is probably later than the earthen barrows, this perhaps supported by the sequence of earthen to stone chambered monument seen at Waylands Smithy (Berks; SU 2808 8539; BRK 1; Atkinson 1965).

-Function of the site

Only a small proportion of the site includes structures of direct funerary type: two small cist chambers in the NW'n mound, with a few cists and pits alongside the central and SE'n mounds. The more substantial timber chamber in the latter is of a type paralleled amongst earthen long barrows in S'n England, such as Waylands Smithy (Berks; SU 2808 8539; BRK 1; Atkinson 1965), and Haddenham (Cambs; TL 420 767; TL47NW 17; 870851; Hodder and Shand 1988; Evans and Hodder 2006).

Soil conditions in the area do not favour preservation of bone, thereby limiting direct evidence for funerary activity at the site. Fragments of cremated bone (human, or animal: nature unspecified in Thomas *et al.* 2015) do occur sporadically at the site. Apparent lack of such finds from the burnt debris under all mounds, and from the unfired 'mortuary' structure in the SW'n mound could be explained by one, or a combination of factors. Remains might have been originally absent, cremation not used for disposal, with the unburnt bone not surviving soil conditions, or material removed by scrupulous clearance, before, or after phases of destruction.

Eventual firing, and replacement of unsanitary longhouses might have been inevitable, if used for mortuary purposes over a prolonged period, especially given more permanent storage of untreated corpses. It has been suggested that such a timber longhouse structure as that proposed under the central mound might have served to hold corpses prior to final deposition in chambered tombs, several of which lie in the locality (Ray 2013).

More detailed analysis of orientation within regional groups of funerary monument

Two separate areas, S'n England and Scotland, were selected for closer analysis of variation and distribution of orientation amongst funerary monuments, for the following reasons:

-**numerous sites:** these areas contain sufficient sites to support quantitative analysis of grouped data;

-**published surveys:** data from major regional surveys are available as a background for more detailed field-work;

-**compatibility of monuments:** both areas present monuments that are of broadly similar date, and cultural affinities;

-**general survival of a basic alignment:** many sites are sufficiently well known in outline, and internal structure to allow the longitudinal axis to be measured with confidence; even for those that survive only as a long mound, it is possible to make a fair estimate, both of axis, and of front-to-rear direction within it;

-localised groupings within each area: each area contains well defined groupings, which might allow comparative studies, and indicate the possibility of localised trends in orientational behaviour;

-geographical separation: the difference in latitude between the two areas, some 6^{o} between mid points, is sufficient to cause significant changes in climate, and in properties of the solar, and lunar cycles (TABLES AS-01 and 04), this of interest in discussion of potential targets for alignment.

These three studies examine whether any more localised preferences for alignment of long barrows can be detected within each area, and how far any variation in alignment between well separated areas may be latitude-dependent.

Case study 1: long barrows in S'n England (e-FIG LB-92)

The sample area runs in a strip 100km wide, and 180km long, from the Cotswold Escarpment at the N, down to the S'n coastal strip of Dorset. The rectangular survey area is formed by the following corner points: SO 0505; SP 0505; SY 0507; SZ 0507.

The area contains five major barrow groups, mainly on areas of chalk or limestone upland, which present a range of topographies (TABLE LB-23). These barrow groups are fairly well separated by valley areas, and hence may represent discrete social units, each with its own funerary tradition. Sites are of chambered, or earthen type, and general reviews provide more basic information (Ashbee 1984; Darvill 1982, 2003).

TABLE LB-23 Case study 1: long barrow groups from S'n England

areas	**#sites total**	**axes**	**plus part of**
Cotswolds	111	90	Oxfordshire
Marlborough Down	34	28	Berkshire
Salisbury Plain	70	62	Hampshire
Cranbourne Chase	46	41	
Dorset	21	18	

Key: #sites: number of sites**; total** (number of known sites); **axes**: barrows for which axes could be determined.
The axial orientation of each site was determined from primary sources, with the particular direction noted taken as 'pointing' from front to rear, rather than as 'facing').
These data were plotted as a histogram at 10^{o} intervals, for each of the areas, to enable general viewing, and comparison. In order to examine any changes in distribution of orientations between different localities more effectively, these values were also graded according to the system of banding outlined in TABLE AS-03, with latitude taken into account, and then plotted per 5km square (e-FIG LB-92).

Although most of the barrows are presented as bulked data by this system of banding, a sample of sites within one area of the Cotswolds is presented in detail (see Table of Contents: 03a/21 and 22a).

Case study 2: barrow groups from Scotland (e-FIG LB-93)

The entire sample for Scotland

The form and distribution of barrows has been well recorded for the entire area of Scotland by Henshall (1963, 1972), with supplementary material from the Canmore database (RCHAMS), and other published sources. Long mounds are, in most cases, sufficiently well preserved to allow establishment of the long axis, and location of any forecourt end, even if unexcavated, the majority case. However, this is often more difficult for unexcavated circular mounds, but sufficient data can be retrieved to allow analysis.

For all barrow groups, the total number of sites is 341, of which 328 provide usable axial data. Analysis and presentation is the same as for Case Study 1.

Case study 3: barrow groups from N'n Scotland (e-FIG LB-91)

As a subsidiary pilot study, barrows in N'n Scotland, which show distinct localised clustering (e-FIG LB-91), were examined in more detail, to assess any differences in orientation between groupings.

Caithness contains many barrows, both long, and round, mainly with broadly coastal, and near-inland distribution, fairly well separated as local clusters in topographically different areas. These N'n, and E'n coastal locations present sites variously situated on hills, or level ground, with a range of views inland, or out to sea. The distribution of barrows suggests the existence of local communities, constructing funerary monuments in fairly well defined, and separate territories, and so has potential for detailed examination of alignment behaviour in terms of regional cohesion, or localised trends.

Although there are sufficient sites to support comparative analysis, unfortunately, most remain unexplored, of unknown internal structure and date. Although the numbers are low, the fraction of sites for which orientation can be determined does seem to suggest a general unity of orientation within the general distribution seen for all Scotland, despite localised separation, and topographical differences. This very preliminary study outlines potential for further field-investigation, rather than yielding more definitive results.

All 287 known round, and long barrows in the survey area were plotted, to define these local clusters. Orientation could be determined at only 16% of sites. Details of barrows in the defined clusters are given just below in TABLE LB-24:

TABLE LB-24 Barrow groups in Caithness: general properties

cluster	NGR ND-	#sites tot	or	%or	trend towards
Calder Mains	0557	57	16	28	WNW
Ulbster	3142	51	13	25	W
Shebster	0065	49	4	8	NW
Achingills	1561	22	7	32	NW
Kildonan	0017	21	4	19	WNW
Dunbeath	1532	13	7	54	W-NW
total		194	51	26	

Note: not all sites fall within the defined clusters; clusters are ranked in order of decreasing number of component sites.

Key: NGR (National Grid reference); **#** number; **tot**(al); **or**(ientation from foreground through the centre of the monument); **trend:** mean orientation, as observed for the few sites for which this is known.

General discussion

Regional variation and latitude-dependant effects

There is some evidence for regional preferences in alignment both for S'n England, and for Scotland (e-FIGS LB-37,37a,and 38).

-Scotland

A noticeable latitude-dependant effect seems evident amongst Scottish monuments. The latitude range for Scotland runs from 55-61°, a total of 6° from S'n Scotland to Shetland. Within this range there are differences in the properties of the solar transit (TABLE AS-01), and in the local climate, a factor of likely importance in the timing of construction (e-FIG LB-12).

The histogram of alignments taken at 1° intervals of latitude, from Shetland to the S'n Uplands shows a progressive shift in the mean for the pointing (front to rear) direction in the axis (see Table of Contents: 03a/25e). The emphasis moves from the area around the summer solstice sunset, and towards the equinox (e-FIG LB-12). If the seasonal-solar model for onset of construction applies (see Table of Contents: 03a/13a; e-FIG CO-02), then this could suggest some restriction of constructional activity in the far N to more clement summer conditions. Further S, however, the season for such work could be extended to include more of spring and autumn, their weather less predictable, but still suitable.

Furthermore, the distribution over Scotland of sites variously allocated to the five bands within the solar transit established for alignment (see TABLE AS-03) sees the centre of gravity for bands shift progressively S'wards, from band 1 towards 5, similar to the S'ward trend noted above (e-FIG LB-93).

In more detail the distribution of sites between bands is as follows:

band:

1: null zone: well represented in Shetland, Orkney, and down to the Moray Firth;

2: near-summer solstice: more sites here than in band 1; includes Shetland, Orkney, and down to the Moray Firth, with an increase in S'n Scotland;

3: near-equinox: the most numerous band; more prominent in Shetland, Orkney, the NW'n Highlands, and Outer Hebrides;

4: near-winter solstice: absent from Shetland, but some in Orkney; well represented in Caithness, and Moray; added concentrations in Strathclyde, and the S'n Uplands;

5: permanent zone: scattered in N'n Scotland, but the focus is now Strathclyde.

-S'n England

Given that the latitude range for the study area in S'n England is only about 1°, any such internal, latitude-dependent effect would not be expected, with local preference the probable reason for any variation. Sites referring to the null, or permanent zones of the solar transit are few in number, with localised distributions. Those in bands 2 and 3, associated more with the transitional zone between summer solstice and equinox, are numerous, and generally distributed, with those on the complementary sector, from equinox to winter solstice, less well represented. This distribution seems to fit in well with seasonal restriction of long barrow construction, with activity more pronounced during the spring-autumn, as suggested by the histogram for the Cotswold-Severn group (e-FIGS LB-16 and 17), on the basis of the seasonal-solar model (e-FIG CO-02). Although concentrations change between bands, there are no distinct variants characteristic of a particular locality.

In more detail the distribution of sites between bands is as follows:

1: null zone: relatively few sites; scattered, but with a noticeable increase in the area of Cranbourne Chase;

2: near-summer solstice: more sites than in band 1; well represented in the Cotswolds, a concentration in the Avebury, and S Dorset areas, a slight increase in the Cranbourne Chase area;

3: near-equinox: the most numerous band; well represented in the Cotswolds, a scatter over the Marlborough Downs, and Salisbury Plain, with local concentrations, but very few in Dorset;

4: near-winter solstice: fewer than in band 3; blocks in the S'n, and E'n Cotswolds, also the Avebury area; scattered elsewhere, but excluding the Cranbourne Chase area, and with very few in Dorset;

5: permanent zone: fewer sites than in band 4; a thin scatter in the Cotswolds, and very few elsewhere.

e-FIGURES: combined listings and supporting information

Axial orientation: long barrows and chambered tombs
Frequency distributions, for axial orientation over a range of long, and round barrows of Neolithic type, are shown, after processing of data with a statistical smoothing function (see Table of Contents: 02a/1a):
e-FIG

LB-

Europe:

01 Barrows: Europe: all chambered types: orientation: smoothed

02 Long barrows: N'n Europe: earthen type: orientation: smoothed

03 Barrows: France: all chambered types: orientation: smoothed

04 Barrows: Brittany: all chambered types: orientation: smoothed

05 Dolmens: S'n France: orientation: smoothed

06 Passage tombs: Iberia: orientation: smoothed

Scotland:

07 Barrows: Scotland: all sites: orientation: histogram

08 Barrows: Scotland: all sites: orientation: smoothed

09 Barrows: Scotland: long mounds: orientation: smoothed

10 Barrows: Scotland: round mounds: orientation: smoothed

11 Barrows: Scotland: Clava-type cairns: orientation: smoothed

12 Barrows: Scotland: variation in orientation with latitude
Variation in group orientation for chambered tombs of Neolithic type is shown for one-degree bands of latitude, from N'n to S'n Scotland, and is related to changes in solar transit over this interval.

13 Barrows: Scotland: Glenvoidean NR 9970.
This long barrow is used as an example of the problems encountered when assessing orientation at such sites, and their interpretation as part of the local group.

England:

14 Barrows: Scotland and England: examples: chambered types

15 Barrows: Scotland and England: examples: earthen types

16 Long barrows: England: Cotswold-Severn types: orientation: smoothed

17 Long barrows: England: Cotswold-Severn types: orientation: histogram

18 Long barrows: England: earthen type: orientation: smoothed

Ireland:

19 Barrows: Ireland: court cairns: orientation: smoothed

20 Barrows: Ireland: passage tombs: orientation: smoothed

21 Barrows: Ireland: wedge-shaped tombs: orientation: smoothed

methods:

22 Application of a smoothing function to frequency distributions of axial alignment for long barrows
This function allows identification of key peaks and troughs of frequency that persist, despite different conditions of processing, and changing levels of uncertainty for individualised data.

Axial orientation: house structures

Axial alignments for a range of house types, of different dates, and from various areas of Europe, are shown, to provide a basis for comparison with those of long barrows, examining the relationship between these two types of structure, and the possible origin of their axial properties.

23 Longhouses: Europe: plans of Neolithic types

24 Longhouses: Europe: Neolithic types: orientation: smoothed

25 Longhouses: Europe: Iron Age types: orientation: smoothed

26 Longhouses: Europe: Saxon types: orientation: smoothed

27 Sunken rectilinear huts: England: Saxon types: orientation: smoothed

28 Square huts: England: Iron Age types: orientation: smoothed

29 Circular huts: Britain: Bronze-Iron Age types: orientation: smoothed

General

30 Barrows: determination of axial alignment
The basis for a standard method of measurement at long and round chambered tombs.

31 Barrows: initial axial structures
Examples of those structures first established for the monument, which could have determined axial alignment at the beginning of the main sequence of construction, or as an initial detached stage.

32 Barrows: structural development of tailed areas
Examples of sites where a tailed area appears to have been added to an earlier more compact monument.

33 Long barrows: disparity between chambered and mounded areas
Examples of barrows where the mounded area forming the 'tail' greatly exceeds that required to cover the burial chamber.

34 Barrows: concatenation of individual structures within a final elongate mound
Examples of barrows where initial burial structures were combined into a composite monument, by covering all with a long mound.

35 Medieval churches: England: orientation: histogram
Long-axial orientation for a sample of churches is added here, to provide a clear example of ritualised alignment, for comparison, in terms of direction, and sharpness of axial trend, with that of long barrows.

36 Seasonal temperatures: Europe: isotherms
Spread of warmer conditions over Britain and Ireland during spring suggests the possibility of different latitude-dependent timing for construction of long barrows, as amenable working conditions moved N'ward.

36a Changing seasonal temperature and rainfall in the UK during January to May: modern records 1961-1990
This 30-year record provides at least *some* basis for contrasting the possible weather conditions occurring between samples of monuments, as for those from central S'n England, and from Scotland, during those critical spring months suggested as more amenable for construction of long barrows.
Differences would have been much reduced between the former area, and the less distant Lincolnshire Wolds, a separate comparative study, are also relevant to discussions of the seasonal-solar model: see Table of Contents: 03a/13a; e-FIG CO-02.

37 The seasonal-solar model as proposed for axial alignment amongst long barrows: a basic example from central S'n England
The relationship between stated axes, the setting sun, and conditions of ambient temperature.

38 The seasonal-solar model as proposed for axial alignment amongst long barrows: a basic example from central Scotland
The relationship between stated axes, the setting sun, and conditions of ambient temperature.

38a The seasonal-solar model of long barrow construction: peaks of axial frequency for two key groups of chambered tombs, as matched with the modern calendar, in order to illustrate seasonal differences in onset of constructional activity
Peaks of W'ly axial orientation, and their corresponding seasonal timings, are shown for two regional groups of Neolithic chambered tomb: the Cotswold-Severn long barrows at the S, and the Scottish monuments at the N of the British Isles. This relates to discussion of the seasonal-solar model of barrow construction (see Table of Contents: 02b/8), here indicating a four-week delay in onset of barrow construction for the N'n relative to the S'n group, caused by the later onset of clement weather in spring at higher latitudes.

39 Mean monthly air temperatures: comparison between central S'n England, and Scotland
These data relate to comparisons between orientation amongst long barrows in these climatically different areas, relevant to discussion of the seasonal-solar model.

40 Variation in ambient temperature and day-length, through later winter and spring, in S'n Britain
Climatic data, relevant to the onset of favourable conditions for construction of monuments.

41 Construction of long barrows, and seasonal conditions: suggested phasing
Consideration of wind direction is important in discussing functional alignment of longhouses, and their possible influence on axes of long barrows, by imitation of structure and placement.

41a Factors interacting to determine the axis of a long barrow
Axial alignment is the result of a compromise between competing factors. Data are shown for two groups, well separated in latitude, and hence in environmental conditions: S'n Britain, and Scotland.

42 Seasonal wind directions: Europe: map

43 Seasonal wind directions: Europe: graphs
Direction of prevailing winter, and summer wind, at the present day, for those selected areas of Europe in which long barrows and longhouses occur.
Each graph shows the frequency of occurrence of wind, of all intensities, from stated directions, as expressed relative to the maximum frequency on that graph. Maxima are marked on the y-axis.

country	**locality**	**data from**	
Poland	central	NOP 1978	map 25
Czechoslovakia	W'n	APCR 1958	maps IV-1 to IV-3
Germany	central	KANW 1960	pp. 3-5
Holland	central	AN 1977	plate V5
France	central	ACF 1969	plates 43-45
Ireland	central	AI 1979	p. 33
England	central	ABNI	p.32

The positions of axial maxima for Neolithic long barrows, and for longhouses from the entire European area are shown at the upper margin.

Study areas

Cotswold:

Mapping of individual long barrows in relation to terrain:
Plans of the 40 long barrows in this area, as listed in TABLE LB-17, are shown as layered images against terrain in general, and as more detailed versions:

e-FIGS LB-44 to 80 are listed in TABLE LB-17.
Panoramic views from selected sites:
Views from a sample of six long barrows, as listed in TABLE LB-17, are shown in panoramic format, to illustrate the properties of local horizons:

e-FIGS LB-81 to 88 are listed in TABLE LB-17.
Other:

89 Cotswold-Severn long barrows: topographical siting of monuments in a sample area

90 Cotswold-Severn long barrows: sites with lateral chambers
Long barrows with lateral chambers introduce other minor axes, supplementing that of the main mound.

46a Cotswold-Severn long barrows: sites with tholos-type chambers
Two cases of long barrows that contain S'ly-facing *tholos*-type chambers, structurally atypical of the group, and with possible para-funerary associations.

N'n Scotland:

91 Barrows: N'n Scotland: distribution
Distributions of barrows, showing the existence of separate sub-regional groupings for which orientation was assessed.

Scotland and S'n England:

Axial directions were divided according to banding of the transitional zone of the solar transit (TABLE AS-03), and each band was plotted to determine any trend in distribution.

92 Long barrows: study area: S'n Britain: changing patterns of orientation between regions

93 Long barrows: study area: Scotland: changing patterns of orientation between regions.

Directed illumination of passage-chambers: candidate sites

General

94 Directed illumination of passage-chambers: candidate sites
Structures are shown at a common scale and orientation.

Knowth

95 The Bend of the Boyne, Meath, Ireland: major passage tombs
The location of passage tombs at Knowth, New Grange, and Dowth are shown.

96 Knowth, Meath, Ireland: the passage tomb complex

97 Passage tombs: Ireland: carved dial motifs

98 Knowth, Meath, Ireland: kerbstone K15: dial motif

99 Knowth, Meath, Ireland: kerbstone K15: dial motif: interpretation

100 Knowth, Meath, Ireland: functional implementation of the dial from kerbstone K15
The dial motif is shown against a pattern of seasonal shadow-casting for the location.

101 Knowth, Meath, Ireland: kerbstones K42 and 52: panels possibly depicting the solar transit

New Grange

102 New Grange, Meath, Ireland: the passage tomb complex

Loughcrew

103 Loughcrew-Carnbane (Meath, Ireland): the barrow cemetery complex

104 Loughcrew-Carnbane (Meath, Ireland): the W'n barrow cemetery

105 Loughcrew-Carnbane (Meath, Ireland): the E'n barrow cemetery

106 Loughcrew-Carnbane (Meath, Ireland): E'n passage tomb cemetery: motifs in passage-chambers: distribution, frequency, and type

107 Loughcrew-Carnbane (Meath, Ireland): W'n passage tomb cemetery: motifs in passage-chambers: distribution, frequency, and type

Carrowkeel

108 Carrowkeel (Sligo, Ireland) passage tomb cemetery

General comparison

109 Orientation of passage-chambers at three passage tomb cemeteries in Ireland where directed illumination has been suggested: Loughcrew-Carnbane (Meath), Carrowkeel (Sligo), and Knowth (Meath)

Structure of cemeteries

110 Kilmonaster passage tomb cemetery (Donegal, Ireland)

111 Knowth passage tomb cemetery (Meath, Ireland): sequence of development

112 New Grange passage tomb cemetery (Meath, Ireland): general plan

Cues for alignment

113 Passage tombs: Ireland: suggested axial linking of sites

Axes and topography

114 Study area: Cotswolds: long barrows: relationship between axis and topography

115 Study area: mid-Wye valley: long barrows: relationship between axis and topography

116 Study area: Lincolnshire Wolds: long barrows: relationship between axis and topography

117 Study area: Lincolnshire Wolds: long barrows and related enclosures: plans of sites known from cropmarks, and comparison with one Cotswold-Severn long barrow as an example

118 Long barrows: Cotswold area and Lincolnshire Wolds: comparison between orientation, with analysis of topographical relationships

119 Dorstone Hill, Herefs SO 3242: the line of long barrows: outline plan

Appendix: sites producing data used in the analysis:

Funerary monuments

In view of the large number of sites involved in the analysis, individual bibliographic references are not given for data contributing to general analysis of orientation amongst various European groups. However, the following works are a brief selection of those which have provided valuable sources of information for important regional groups:

-**France:** L'Helgouach 1965; Chevalier 1984;

-**Ireland:** Corcoran 1960; de Valera 1960; de Valera and O Nuallain 1961, 1964, 1972, 1982; O Nuallain 1989; Cody 2002;

-**Poland:** Midgley 1985;

-**Scotland:** Henshall 1963, 1972;

-**Spain:** Leisner and Leisner 1943, 1956, 1959, 1965.

Domestic structures

Neolithic: longhouses

Again, specific bibliographic references are not given for individual sites, but data from the following settlements were included in the analysis:

-**Netherlands:** Geleen; Sittard;

-**Germany:** Aichbuhl; Aldenhoven; Bochum-Hiltrop; Bochum-Laer; Daseberg; Dierigsen-Ruploh; Dresden-Prohlis; Gering; Goldberg; Gudensberg; Herkheim; Hienheim; Inden Lamersdorf; Koln-Lindenthal; Langweiler; Muddersheim; Riedschachen; Sarmsheim; Zwenkau-Harth;

-**Czechoslovakia:** Bylany;

-**Hungary:** Zengvarkony;

-**Poland:** Biskupin; Brzesc Kujawski; Dobre; Dubieszowice; Konary; Krusza Zamkowa; Libenice; Mohelnice; Postoloprty;

-France: Berry-au-Bac (Aisne); Charmoy, (Yonne); Clairvaux-les-Lacs, (Jura); Cuiry-les-Chaudardes (Picardy); Cys-la-commune (Aisne); Marolles (Seine et Marne); Menneville (Picardie); Missy-sur-Aisne; Montenach (Lorraine); Montenach (Moselle); Oudrenne (Lorraine); Pertant (Aisne); Pontavert (Aisne); Reichstett (Bas Rhin); Rosires-pres-Troyes (Champagne/Ardennes); Rouffach-Gallbuhl (Haut Rhin); Sainte-Pallaye (Yonne); Villeneuve-Sainte-Germain (Aisne);

-Belgium: Blicquy; Irchonwelz;

-Ireland: Ballyglass (Co. Mayo); Ballynagilly (Co. Tyrone);

Iron Age: longhouses

-Denmark: Sarup, Odense (Funen); Bjerg A/B and Spjald (Ringkobing);

-Germany: Eschweiler-Laurensberg (Aachen);

-Netherlands: Feddersen Wierde; Flogeln, Eekholtjen, Zeijen I, Groningen; Hodde; Vorbasse; Druten-Klepperhei, Gelderland; Kethel; Rijswijk; Vreden;

-Germany: Borken (Westphalia); Soest-Ardey (Westphalia);

Iron age: circular huts

-Britain and Ireland
Mucking (Essex); Fisherwick, Tamworth (Beds.); Danebury (Hants.); Eldon's Seat, Encombe (Dorset); Thetford (Suffolk); Thorpe Thewles (Cleveland); Pennyland, Milton Keynes (Bucks.); Ashville and Hardwick, Abingdon (Oxon.); Claydon Pike (Glos.); Trevisker, St Eval (Cornwall); Garn Boduan (Caerns.); Tre'r Caeri (Caerns.); Moel y Gaer (Clwyd); Rathgall (Ireland); Dun Ailinne, Co. Kildare (Ireland);

Early medieval longhouses

-Britain
Milton Keynes; Mucking (Essex); Northampton; Thirlings (Northumberland); Catholme, Burton upon Trent (Staffs.); Chalton (Hants.); Cowdery's Down (Hants.); Raunds (Northants); Foxley, Malmesbury (Wilts); Sprouston (Roxborougshire); Yeavering (Northumbria);

-Europe
Vorbasse (Denmark); Wulfingen (Germany); Warendorf (Westphalia, Germany);

Saxon: grubenhauser

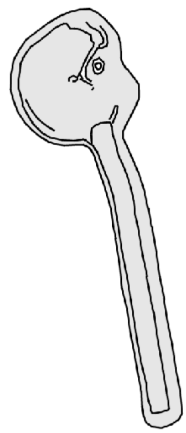
-England
Mucking (Essex); Pennyland, Milton Keynes (Bucks.);

-Europe
Speyer "Vogelgesang", Rhinepfalz (Germany); Wulfingen (Germany).

Section 03b:
The orientation of augmented long barrows in Britain

Section identifier: AB-

SEE INITIAL SECTION:
Access to digital images



Bryn yr Hen Bobl (Anglesey, Wales)

Summary:
A range of barrow sites of unusual length, that occur as a small proportion of Neolithic funerary monuments in Britain, have been reassessed to determine their characteristics more closely.

In terms of general structure, in this study they have been divided between sites that are discrete, and appear unitary, or composite in design, and those forming complexes, where an embankment links terminal components. Sites have been further grouped by length into four types: standard, elongate, extended, and super-extended, with the term 'narrow' more closely defined, where it becomes relevant for shorter members.

Although the current sample of orientations for these augmented sites is too small to generalise, they appear to show a more S'ly bias than the more W'ly orientation seen amongst typical long barrows of 'standard' length. This more S'ly alignment may be related to that seen amongst other types of monument, in which funerary areas are linked by linear features, such as certain stone rows, and cursus monuments. This S'ly trend is discussed in terms of a possible relationship with the S'n arc of the solar transit, and the implications of this in terms of ritual.

The following topics are discussed:

-**qualification of the term** 'bank barrow', with division by length and shape;

-**reclassification** of the group;

-general trends in **orientation**;

-supplementary information on **key sites.**

Introduction

There is little detailed reference material for the group of elongate, barrow-like monuments termed 'bank barrows', other than that provided by various preliminary studies of individual sites, such as those monuments associated with the Dorset Cursus, or the hybrid complex seen at Cleaven Dyke (see Table of Contents: 03b/3). General information on the group is given in Loveday 2006.

There has been very little excavation, geophysical prospection, or even reliable survey at many of these sites and, consequently, most of the information is poor, only relating to surviving form, siting, and possible relationship with surrounding monuments. General statements about internal structure, sequence, function, and affinities can not, therefore, be made, with most discussion based on the external form of undated field monuments. Basic questions remain unanswered: for instance, the nature, and relative importance of terminal structures; the nature and depositional content of mounded areas between *termini*, and the extent of any funerary function, either primary, or continuing.

There is insufficient data to discuss external relationships with other seemingly related monuments. Certain cursus sites bear comparison: some of these appear at least partially embanked, as at Scorton (>2000m long by 32m), Stanwell (3600m by 22m), and other smaller members, such as Llandegai (170m by 12m), and North Stoke (200m by 12m). Cleaven Dyke (>2.3 km long), is a case in point: this complex monument combines a long barrow, its tail-like extension, and cursus-like elements (see Table of Contents: 03b/3). Loveday (2006) envisages for the group a process of magnification, from smaller banked barrows to embanked cursuses.

The entire status of several sites as prehistoric monuments, such as the long mound at Pen Hill, and at Crickley Hill, remains open to question, with conflicting interpretation as medieval rabbit warrens, either from primary construction, or as secondary re-use (Williamson and Loveday 1988; Loveday 2006).

There is no particular regional pattern to the general distribution, although several of those more closely resembling long-barrow have been noted in Dorset (TABLE AB-01), and apparently over 40 have been listed in Scotland, with high concentrations in Tayside, Dumfries, and Galloway (Brophy 1999: but none are listed in RCHAMS Canmore database).

Problems in use of the term 'bank barrow'

The term 'bank barrow' has been used to refer to a range of monuments that are of obviously different type, and is something of a residual category. Before attempting to examine alignment, there has to be some re-assessment of sites already included in this group, and closer definition of terminology. However, since sites of this type are generally rare, then sample-size will inevitably be small, and data fragmented, hence the need for clearer structural definition amongst those sites that are known.

-definition

The English Heritage Thesaurus (English Heritage 2011) defines the term 'bank barrow' as follows, given here in a paraphrased, and re-ordered version:

..mound:
sinuous, parallel-sided, consisting of soil and stone, longer than 150m;
ratio of length to width usually >6:1;
mound usually flanked either side by ditches;
mound covers, or contains ceremonial deposits;

..type distinct from:
long mounds: which are usually <100m long;
cursus monuments: where there is an absence of substantial mounding and ditching, although some were embanked, as at Scorton and Stanwell, and which usually form a complete enclosure;

..date: mid Neolithic;

..distribution: widely over S'n Britain, with a marked concentration in Dorset;

..siting: typically along the spine of a ridge, giving a striking visual effect, but topographical locations vary, from valley to upland hilltop; generally isolated, except in the area of Long Bredy (Dorset), where three occur together.

Two main difficulties arise in current application of the term 'bank barrow' in the literature to the known set of sites, in ways that the above definition may not intend:

..inclusion of sites that are too different in basic format to lie within the same grouping. The type seems to be a residual one, into which elongate sites of barrow-like form are placed. Sites as different as the very long monument at Raeburnfoot, and the shorter more long barrow-like sites at Kingston Russell have all been described as bank barrows.

..there is distinct confusion in published material about application of the term 'bank barrow' to sites at the shorter end of the range. The lower limit of length for bank barrows, as given in the above definition is 150m, and by Loveday (2006, p. 89) as 140m. Such classification on the basis of length needs to be demonstrated more clearly, by analysis of natural division of shape, and size over the range of lengths seen amongst long barrows of all types (e-FIG AB-21 to 23).

The nature of any grouping by length also needs to be considered: whether discrete peaks of length are evident in the upper range, or whether there is simply a tailing off of the main distribution of more typical barrows. Analysis indicates that the latter is indeed the case.

Further definition of length and shape amongst long barrows

-Division of the group on the basis of length (e-FIG AB-21)

In order to clarify discussion of form, mean length was determined for a large sample of long barrows from England and Scotland (333 sites), and data presented as a histogram, at 10m intervals. This distribution shows four main groupings by length, which may act as the basis for a revised classification, and for which following specific terms are proposed:

***..standard*:** these sites occupy a distinct peak between about 10-20m and 80-90m in length, which is fairly symmetrical about a central value of about 40m;

..elongate: sites lying within a minor peak of frequency, from 90-100m to 120-130m, which either forms a tail to the main peak, or is slightly separated from it;

The following two 'groups' are not clearly defined by discrete peaks of frequency, but only by arbitary division of a tailing-off, as the distribution heads towards sporadic higher values:

*..**extended:*** a few sites lie above 150m up to 500m;

..super-extended: very few sites lie over 500m, up to a maximum of 2300m.

-Division of the group on the basis of shape (e-FIG AB-22 and 23)

The ratio between mean width and length was determined for a sample of 88 'standard' sites, and frequencies presented as a histogram. This enables the term 'narrow' to be more clearly defined in terms of some norm.

The frequency distribution obtained for this ratio is somewhat skewed, starting with ratios just above 1, rising to a maximum around 2-2.5, then falling to about 7-7.5. A larger sample might provide a distribution which is more clearly of normal Gaussian type, but treating this set of 88 values as the basis of one, it yields a mean value of 3.5, and standard deviation of 1.4.

The term 'narrow' is defined here as applicable when ratios are greater than two standard deviations above the mean, a value of 6.3, with a rounded value of 6 adopted for simplicity. A narrow site then becomes one that is 6 times longer than wide, in terms of mean dimensions. This then allows barrows of standard length to be subdivided, whereas elongate and extended barrows are automatically narrow by virtue of their extreme length.

Plotting mean length against width for the same data plotted in e-FIG AB-22 gives a scatter, for which a regression line can be calculated, one of slope 3.45, giving an idea of the centralising tendency of the distribution (e-FIG AB-23). Adding to this graph a line of slope 6, as derived just above, establishes a boundary for 'narrow' members of the standard group. There are very few cases where standard sites qualify as narrow, and these then are marginal. No tradition of long and narrow sites is therefore evident amongst the standard group, with elongate and extended barrows, appearing to be a separate development.

Redefinition of this group of long barrow-like monuments

In order to clarify discussion, the term 'bank barrow' has been abandoned in this analysis, and that general group, plus related monuments, re-ordered as follows:

Augmented barrow monuments, or complexes

The entire group of such barrows that lies beyond 'standard' length is described here as **augmented** and, within this, several divisions are made, according to length and structure, as based on best available evidence, admittedly often poor:

..composition		**example**
unitary	no component structures evident	Martins Down;
composite	different component structures present	Bryn yr hen Bobl; Long Low;

..length (e-FIG AB-21)	**max (m)**
standard	90
elongate	150
extended	500
super-extended	>

..ground plan
rectangular; tapering;

..shape, where relevant for shorter members (e-FIG AB-22 and 23)
narrow; typical;

..terminal unit involved	
long barrow	Cleaven Dyke; Auchinlaich;
round barrow	Bryn yr hen Bobl;
other	North Stoke;

..extended structures emanating from the barrow unit

unilateral	in one direction only	
	from a single barrow	Bryn yr hen Bobl;
bilateral	in opposed directions	
	from a single barrow	Maiden Castle barrow;
linking	joining two barrow-like structures	Raeburnfoot.

Three main types of augmented barrows are apparent, those that more closely resemble typical long barrows, those with added mounded tails, and terminal barrows linked by embankment (TABLE AB-01):

TABLE AB-01 Augmented barrows: provisional division into types

Note: sites are listed in order of decreasing length;
e-FIGS: references are given in Combined Listings, at the end of this section.

site	NGR	L(m)	LG	struc	shape	term	mrw	e-FIG
long barrow-like								
Auchenlaich	NN 6407	322	ext	comp		L		01
Pen Hill	ST 5648	235	ext	unit	rect		?	17
Martins Down	SY 5791	195	ext	unit	rect			14
Came Hill	SY 7085	180	ext	unit	rect			05
West Cotton	SP 9772	130	elong	unit	rect			20-20a
Heslerton: E	SE 9375	125	elong	unit	taper			11
Bassingbourne	TL 3342	120	elong	unit	rect			02-02a
Bellshiel Law	NT 8101	109	elong	unit	taper			03
Kingston Russell 2	SY 5890	106	elong	unit	rect			12
Kingston Russell 1	SY 5890	95	elong	unit	rect			12
barrows with added tails								
Cleaven Dyke	NO 1640	>2350	supext	comp		L R		06
Maiden Castle	SY 6688	546	supext	comp		L		15
Great Ayton Moor	NZ 5911	150	elong	comp		O		10
Pentridge	SU 0419	150	elong	comp		L		18-18a
Bryn yr Hen Bobl	SH 5169	125	elong	comp		R		04
Crickley Hill	SO 9216	100	elong	comp		note 1	?	07-07a
barrows linked by embankment								
Raeburnfoot	NY 2599	?2km	supext	link		R		19-19a
North Stoke	SU 6185	235	ext	link		note 2		16
Long Low	SK 1253	210	ext	link		R		13-13a
Essich Moor	NH 6438	114	elong	unit	taper			09-09a

Key: **L**(ength of mound); **LG** length-group; **struc**(ture of mound: **unit**(ary), **comp**(osite), or **link**(ing terminal structures); **shape** (of the mound: **rect**(angular), or **taper**(ing); **term**(inal structure): **L**(ong barrow), **O**(val barrow), **R**(ound barrow); **mrw** medieval rabbit warren within elongate mound.

Notes:
1: terminal: circular stone structure;
2: rounded crop-mark at the N'n end.

Two main trends within the group seem apparent:

-the need to point

The importance of this varied residual group to general discussion of orientation lies in the exaggerated linear nature of its monuments, extended well beyond the practical need to cover funerary and ritual structures.

Such funerary areas, where known, are often sited towards the broader front end of the monument, with the tail of the mound appearing relatively empty, or containing lesser chambering. Sites appear to have had more effort expended on extension of mounds to cover areas not, apparently, containing structures, than on elaboration of the forecourt, and its funerary elements.

However, it should be noted that there has been a general concentration of very partial excavation around these more obviously targetable and accessible funerary areas at the front ends of monuments, and that detailed examination of more distal areas has been far less frequent. Given the lack of investigation, the contents of such mounding, its structures, and any deposited material, primary or secondary, remains an open question. Despite this, it seems, on balance, that the tails of mounds were relatively empty, as at Bryn yr Hen Bobl, Great Ayton Moor, and Cleaven Dyke.

Rather than serving the strict need to cover internal features, this tailing of the mound appears more as an end in itself, perhaps for **aggrandisement** of lateral views towards the site, or for purposes of **establishing a significant axial direction.** Lateral aggrandisement is certainly possible at many of the sites, but elongate structures often appear rather too slight to form an effective visual, as well as physical barrier.

In formalising a particular orientation, a far shorter long mound could serve to define a particular axis, or to stress a particular direction within it, by structural differentiation between ends. The monument would 'face' this direction to the front, or 'point' towards it at the rear, as is the case for more typical long barrows (see Table of Contents: 03a). Excessive length, if added in stages could, therefore, indicate the type of repetitive activity also seen at other ritual monuments, such as stone rows, and rock art sites (see Table of Contents: 03d and 3g). Here it has been argued that such emphasis might have resulted from increased need to propitiate, during periods of environmental stress (see Table of Contents: 05). Cleaven Dyke, where the mounding is particularly long, and shows signs of periodic extension in stages, provides a clear example of progressive linear extension.

In a different group, the small, atypical, barrow-like monument at Bibury II (Grimes 1960; O'Neil and Grinsell 1960), although only about 20m long, with foreground structures adding a further 10m, showed clear signs of incremental tail-ward growth. The more rounded body of the mound contained a chamber, and short passage, with the 10m long tail developing towards the NW as a series of stone-built compartments (e-FIGS 45 and 46).

-the need to link funerary structures into an impressive alignment

At several sites, funerary structures at either end appear linked by means of intervening mounding, as for instance at Long Low, and Raeburnfoot. Such linking is seen in other types of monument, as amongst stone rows (see Table of Contents: 03d), and at cursus sites (see Table of Contents: 03c), either between components of the complex itself, or between funerary areas around, and beyond terminals.

Also relevant is concatenation of linear sets of briefly independent individual chambers, linking these by means of a long mound, as seen at certain Scottish sites (e-FIG LB-34). Here, the function of the mound was certainly to cover, and aggrandise, but might also have been to establish a general axis, unifying the different alignment of chambering at component sites. The relatively few monuments in this disparate category therefore provide a supplement to interpretation of orientation amongst other related, and more numerous groups, rather than indicating separate trends.

Analysis of orientation amongst augmented barrow monuments

Closer definition of long barrows in terms of length, and shape allows separation between monuments of 'standard', 'elongate', and 'extended' types (TABLE AB-01), with application of the term 'narrow' to certain members of the former (e-FIGS AB-22 and 23).

Since the number of sites is small, alignment has been plotted here as a ray diagram, not as a histogram, as done for other more numerous groups, such as 'standard' long barrows (e-FIG AB-24). Longitudinal axes are shown, together with any particular directions evident within them, for instance, a plan tapering front to rear, a known direction of structural growth, or some dominant aspect along the axis.

Plotting orientations for sites in both groups shows that distinct gross differences occur. Whereas axes of pointing for elongate long barrows cluster around the NW'n sector, those in the extended group show a more S'ly tendency, with more preference for the SW'n quadrant (e-FIG AB-24).

This more S'ly trend amongst extended monuments, especially those of composite form, may suggest a move away from the more W-NW'ly direction in which most long barrows 'point', with their suggested funerary interest expressed on the setting side of the solar transit (see Table of Contents: 02c/2i). Such a S'ly trend may indicate an increasing interest in the permanent S'n arc of the solar transit, still involving the body of the barrow within the line, but being less directly funerary in emphasis. This might reflect an interest in axes which intersect the course of the sun in the S'n arc, closer to the seasonally cycling zenith, as part of ritual more closely related to fertility, and the changing seasons. Similar S'ly alignments are seen amongst stone rows, another type of extended monument often linking terminal cairns, or stone circles (see Table of Contents: 03d).

Supplementary information: details of sites

Definitions: a brief restatement

Augmented barrows: the general category, including all sites longer than **standard**;

Ordered by

-maximum length: **standard** 90m, **elongate** 150m, **extended** 500m, **super-extended** >500m;

-ratio of width to length
All sites longer than standard that are included here have ratios greater than 6, and are therefore automatically defined as narrow. By virtue of its shorter length the standard group, not included here, can be divided into narrow and broader on this definition.

-structure:

unitary: with no clear sign of added features; **composite**: with auxiliary structures, such as tail-like extensions added to the original site; **linking**: where terminal funerary structures are linked by embankment.

Note:
-National Grid References refer to the mid-point of sites;
-orientations of barrows are noted as 'pointing' in the direction from front to rear, and 'facing' in the opposite direction;
-sites are listed in order of decreasing length;
-e-FIGS: references are given in TABLE AB-01 above, and in the combined listings below.

Composite barrows

Cleaven Dyke; super-extended; >2.35km long; aligned 119°G;

location: Perth and Kinross; NO 1665 4030; OS Explorer 381;

status: an embanked monument flanked by side-ditches, with affinities to both long barrows, and to cursus sites; partially excavated;

topography: located on fairly level ground, adjacent to the River Isla;

sources: Barclay *et al.* 1995; Barclay and Maxwell 1999, 1999a; Topping 1997; Barclay 1999; Canmore NO13NE 89 and NO14SE 80;

structure:
This embanked monument, with ditched perimeter, is oriented NW-SE'ward (120-300°G), and runs in a straight line from its known NW'n end for 2.35km to a point at the SW, on a slight eminence, about 1.25km from the river, where its course has been lost through erosion. The monument is considered to be a barrow-cursus hybrid.

A pair of parallel ditches, about 45-51m apart, lies 19m either side of a central bank, 1-2m high, and 9m wide, which appears to consist of conjoined dumps. The ditches run for 1820m, with a further 350m visible as a crop-mark at the SE'n end, where they appear to comprise linked segments. At certain points, including the NW'n terminal, the bank is higher, and broader (Barclay 1999, figs. 3.5/p.26, and 3.6/p.27), and throughout its length contains 2-5 deliberately constructed breaks, the course appearing straighter and more consistent over its NW'n half.

Small-scale excavation has revealed the broad, shallow and irregular section of the ditch, the internally dumped structure of the bank, and has provided evidence for onset of construction before 3600BC.

The monument was constructed from NW to SE, as a progressive project, over a considerable period, with long-term, staged repetition of small-scale effort, gaps in the banking and ditching indicating five major sectors of extension. Initially, a round Neolithic burial mound was established at the NW'n terminal, this area being subsequently extended to the SE by an 80m long barrow. Further along the SE'ward course, the side-ditches were placed further apart, to give a more cursus-like spacing. The extending monument displays a continuing commitment to the original ideas behind the axis. It has been suggested that it was aligned on hills at each end.

Maiden Castle; super-extended; 545m long; aligned E-W;

location: Dorset; SY 6692 8850; OS Explorer OL 15;

status: central ?barrow, with two mounded extensions, or a single linear development, with an E'n focus; partially excavated;

topography: sited on the low spine of a hilltop;

sources: Wheeler 1943, 86-89; Bradley 1983; NMR 452139;

structure:
A Neolithic causewayed enclosure, with doubly ditched perimeter, occupied the E'n ridge of the hill. After its abandonment, a long embankment, flanked by side-ditches, was constructed later in the Neolithic, along the spine of the main E-W'ly ridge, crossing the silted ditches of the settlement, and passing into its redundant interior.

The **side-ditches** of this long mound are parallel, with open terminals, enclosing a strip about 20m wide, and run in two straight sectors, angled towards the S: the W'n, 360m long being oriented at 096-276°, and the E'n 185m long at 114-294°, giving 545m in total length. Ditches appear similar in section throughout, about 3-4m wide, 2m deep, flat-bottomed with steep sides, and contain relatively clean silt, with no obvious sign of re-cutting.

A low **linear mound** marks most of the centre-line between the ditches. This has been sectioned by excavation, along with the ditches at one point, to reveal the original bank which, from the survival of a Neolithic gully high on its flank, would have occupied much of the enclosed strip (Wheeler 1943, plate 5/ opposite p.87). The volume of material from side-ditches would have been sufficient to form a ridged bank, 15m wide at the base, and about 1.5m high, allowing a berm of 2.5m either side [calculation by the author: AJM].

At the junction of the two linear sectors of the monument, the enclosed strip contains an indistinct, unexcavated mound, separated from the line of the more general linear bank by weak gaps, and lying on a slightly different axis: this may represent a long barrow, or some central platform.

The layout of ditches was determined by excavation of narrow multiple sections, at intervals throughout their length, with excavation in the enclosed strip concentrated near the E'n terminal, leaving most of the interior unexamined (Wheeler 1943).

At this **E'n end,** a few pits, postholes, and a hearth were located, but these formed no coherent structure. Several postholes lay along the inner edge of the S'n ditch, with one near the midline between ditches, which was also marked by a pit, and the primary burial 1, with burials 2, and 3 nearby. The pit contained significant quantities of Neolithic pottery, also shells, and fragments of animal bone.

Primary burial 1 was that of a male, 25-35 years old, unaccompanied by surviving grave-goods, complete, largely articulated, but with long-bones hacked, decapitated, and with the skull trepanned *post mortem*. Double burials 2 and 3, also sealed by the long mound, were of children 6-7 years old, crouched, placed head to toe, with a small pottery vessel present. The terminal of the S'n ditch contained five ox skulls in its lower fill.

The area of the **W'n terminal** was damaged by an Iron Age quarry ditch, obscuring any possible Neolithic features, but four postholes were located, perhaps forming part of a revetment.

There is no clear evidence for a **structural sequence** at the site, but several alternatives for the general structure of the monument are possible:

-development of mounding from a focal area, to define a ritually significant axis:

..a relatively **singular design** for the angled ditch and central mounding, the E'n terminal, with its evidence for burial and other activity, forming the front end;

This basic plan would match the general trend suggested for long barrows, with the rear of the monument stretching away towards the W, from a focal foreground area (TABLE LB-01; e-FIGS LB-01 to 21). However, burial 1 at the E'n end certainly does not suggest a standard interment of the type more typical of long barrows, and this may also be true of the double child burials 2 and 3. Sealed under a mound that was greatly in excess of any need for coverage, these appear to have been singular, dedicatory events, and there is no evidence for structures elsewhere allowing further internal access to the mound. It remains unknown to what extent the mound covers, or contains further burials.

..a **composite design,** with the possible long barrow at the junction between angled sectors forming an origin for extensions to the E and W, this latter direction being the most accentuated by virtue of its length;

The status of this separate sector of mounding, original presence of any side-ditches, and nature of any contents remain unknown. The uniform layout and nature of the ditches do not suggest two separate developments.

-construction of a protected bank, as a conspicuous feature on the local skyline, taking advantage of underlying relief, with the axial direction of little, or no importance:

The angled line of the monument seems to be a best fit to the highest ground; any attempt at straightening would have reduced lateral visibility. Sloping relief along the axis of the long mound means that the terminals are not clearly inter-visible, and only from the central zone, the area of the mound, a possible long barrow, is a more complete view achieved. There is no evidence for entrance gaps allowing lateral access to the interior through side-ditches, although this could have been achieved along the rounded spine of the central mound, or its lateral berm.

Provision of such a long structure specifically as a boundary, or some local facility for secondary burial seems unlikely.

On balance, there is little evidence to oppose the view that the greatly extended monument acted to define the direction to the W, from a foreground at the E, forming a focus for ritual that contained funerary elements, but was not involved in more routine disposal of the dead.

Auchenlaich; extended; 322m long; aligned 167°G;

location: Perthshire, Scotland; NN 6495 0730; OS Explorer 366;

status: long barrow, with a single extension; partially excavated;

topography: sited on level ground in the valley, adjacent to a small river; bounded by higher ground to the N, but more open to the S;

sources: Canmore ID 24362**;**

structure:
A stony, linear mound 322m long, averaging 11m wide, and about 0.5m high, points N'ward (353°G). It appears to contain, at its broader S'n end, a trapezoidal cairn, about 48m long, and 15m wide at the front, where it may include a deep forecourt, and 11m wide at the rear. A tail of about 270m extends from this structure, the last 20m of which contains rubble from modern field clearance. At 70m, about a quarter of the way along this tail, a chamber, apparently an original feature, opens to the W. One possible kerbstone for the mound has been identified.

Pentridge 2a/21 and 2b/22; elongate; 150m long; aligned 331°G;

location: Dorset; SU 0410 1909; OS Explorer 118;

status: long barrow, with a single extension; unexcavated;

topography: sited on level ground at the base of a hill-slope;

sources: NMR 213351; Bradley 1983;

structure:
A long barrow (designated 2a, or 21), 56m long, points NNW'ward (333°G), its higher SSE'n end 18m wide, with traces of slightly tapering side-ditches evident. The mounding continues on the same alignment beyond its SSE'n end, but separated from mound 2a by a gap of a few metres, in both mound and ditch, then continuing as a bank

(designated 2b or 22) 82m long, and evenly 21m wide, with parallel side ditches, and regular height. Mound 2b/22 has been interpreted as an extension to barrow 2a/21, rather than a separate long barrow. It has also been proposed that 2a/21 predates the adjacent cursus, with 2b added in a SSE'ly direction because the subsequent cursus prevented the more normal N'ly extension from the rear of the existing barrow 2a. There is no hard evidence to support any of this.

associated monuments: The NE'n terminal of the Dorset Cursus lies nearby; the SSE'n end of 2b/22 is supplemented by a round mound.

Great Ayton Moor; elongate; 150m long; aligned 212°G;

location: North Yorkshire; NZ 5937 1147; OS Explorer OL 26;

status: oval cairn, with a single embanked extension; partially excavated;

topography: sited on an open spur adjacent to steep down-slopes;

sources: NMR 27642; Hayes 1967;

structure:
Interpretation of this site is based on examination of damaged surface remains, and partial excavation carried out in the late 1950s. The complex contains three main elements, and may be about 150m long.

-the cairn

A rounded cairn, 16m across, possibly enclosed by a stone kerb, covers a rectangular chamber in its SW'n quadrant, about 3m to the S of centre, constructed from boulders, some burnt, and blocked by a large slab at its E'n end. The chamber is oriented NW-SE, and is approached by a metre-long dry-stone passage at its NW'n end, this latter completely filled in with large round boulders.

No post structures were found in the mound, but a pit was located that contained burnt sand and stones, with a few fragments of charcoal. The mounded area produced evidence for extensive burning. No pottery nor cremated bones were found in primary positions, but three deposits of cremated human bone, of Middle Bronze Age date, were inserted into the SE'n quadrant.

-the embanked tail

A linear cairn-bank of compacted boulders, 10m wide, runs SSW'ward (209°G) from the cairn for 137m, narrowing to 3m, and generally decreasing in height from 0.6 to 0.3m. Excavation across the tail indicated possible kerbing, and it has been suggested that the tail may post-date the cairn, but not significantly. Finds were mostly fragments of pottery, and flint chippings.

The tail is directed at a low circular mound, which is a terminal point of the alignment.

-appended enclosure

On the same general axis, and to the NE, a sub-rectangular enclosure abuts the cairn. The surviving enclosure measures about 50m from NE-SE, and is about 33m wide, its perimeter a low bank 50-70cm high that incorporates three small cairns.

The enclosed centre contained two pits, one of which included charcoal and burnt sand, the other in-filled with boulders. Finds include several unworked flints, a fragment of pottery, and a few quartz pebbles.

-function of the complex

Although the three major elements appear to have been constructed at slightly different times, the monument has been interpreted as a single unit.

The monument might have functioned as an integrated mortuary complex, with possible excarnation and cremation in the N'n enclosure, this followed by deposition of remains in the cairn. The tail might have served to channel ritual, or procession in some way, perhaps acting as a line of sight in a significant direction.

-date

Although a Neolithic origin has been suggested for the site, an extended lifetime is suggested by funerary activity of Middle Bronze Age date.

-associated monuments:

Two ring cairns lie to the E of the central cairn, and have produced cremated deposits, some with urns, all of earlier Bronze Age date.

The S'n cairn contained two pits, producing cremated deposits, a stone ball, and an abraded quartz pebble. The N'n cairn covered three such pits, and produced two stone balls, and a possible loom-weight.

Another round barrow was built against the E'n side of the embanked tail, from which stone was taken for its construction; partial excavation has not been recorded in detail. A further barrow lies to the W of the complex.

Crickley Hill; elongate; 100m long; aligned 115°G;

location: Glos; SO 9265 1605; OS Explorer OL 45;

status: cairn, and ?ritual area, with one mounded extension; partially excavated;

topography: runs along the base of a narrow, shallow natural gully, on a spur bounded by steep down-slopes;

sources: NMR 117450; Savage 1988;

structure:
A multi-phase, composite ?hut-shrine/cairn/stone circle forms the E'n terminal of a long mound of turf and topsoil, with side-ditches, about 110m long, and 12m wide, extending E'ward from it (115°G). Structure and finds were taken to indicate a later Neolithic to earlier Bronze Age date, with the hut-shrine constructed about 2500 BC, this then elaborated to a long mound, with terminal circle, before being abandoned early in the 2nd millennium BC. The site has also been suggested as an artificially constructed rabbit warren of relatively modern date (Williamson and Loveday 1988; Loveday 2006). Given the lack of published data from excavation its status remains unclear.

associated monuments: the mound lies close to the Neolithic causewayed enclosure.

Bryn yr Hen Bobl; elongate: 125m long; aligned 164°G;

location: Anglesey; SH 5189 6900; OS Explorer 263;

status: partially excavated;

topography: on a slight slope;

sources: Coflein 300180; Hemp 1935; Driver *et al.* 2000; Leivers *et al.* 2001;

structure:
A rounded mound, about 30m long, covers a near-central chamber, into which a radial passage leads towards the SSW (206°G). A dry-stone terrace, 95m long, and about 12m wide, runs SSE'ward (~164°G) from the mound, with a slight change of direction midway, and appears bonded with the internal walling of the cairn.

Various other monuments

Other sites with tailed structures have been reported, as at Broome Heath (Wainwright 1972).
Several plans in Henshall (1963, 1972) suggest addition of tails to shorter barrows:

Tulach an t'Sionnaich [Caithness 58]: 82m long; a circular cairn containing a central chamber with radial passage, all within a D-shaped cairn forming a rounded mound; from this runs a rectangular tail, which may have been an addition;

Cnoc Freiceadain [Caithness 18]; 77m long; ?circular structure, possibly with horned forecourt at one end of an elongate mound, itself horned at the other terminal.

Linked sites

Raeburnfoot; super-extended; ?2km maximum long, comprising Lamb Knowe and Tom's Knowe; aligned ~N-S;

location: Dumfries and Galloway; NY 2599 and 2598; OS Explorer 323;

status: terminal ?cairns linked by embankment; unexcavated;

sources: Canmore 67284 and 97647;

topography and **structure**:

-Lamb Knowe*;* NY 2510 9965; aligned 196°G;

A mound, 6m wide and 0.5m high, with side-ditches up to 4m wide, separated from the bank by a 3m wide berm, runs mainly straight, oriented SSW'ward (196°G), for 650m down the spine of a ridge, from below the hilltop. As the bank nears the bottom of the valley, and the river White Esk, it follows a slightly curving course. A break in the bank, about 200m from the terminal up-slope, is of uncertain interpretation. Over its SSW'n lower reaches, the bank has been levelled by cultivation, and so it is not possible to establish its full length clearly. At its NNE'n up-slope end however, the bank runs up the side of a slightly oval, barrow-like terminal, 10m by 8m, and 1.5m high, without reaching its top. The side-ditches curve around this terminal, to unite in a hairpin-shaped plan.

-Tom's Knowe; NY 2501 9810; aligned 179°G;

On the opposite side to Lamb Knowe, a bank and side-ditches run S'ward (179°G) for 255m, up the slope of a small hill flanking the river, with the ditch enclosing the mounded terminal in a hairpin-like loop, the bank not reaching the top of the mound. All of these features are similar to those seen at Lamb Knowe just to the N.

These two surviving sectors may represent the ends of a single monument 2km long, crossing the valley, with any sectors which existed on the flood-plain of the river perhaps destroyed by cultivation, and including the inevitable gap for river itself. Its line would have curved, and indeed, the truncated S'n terminal of the Lamb Knowe sector does curve towards the known alignment of the sector on Tom's Knowe. Using the main sector of bank as a line of sight, from the N'n terminal on Lamb Knowe, the S'n terminal on Tom's Knowe would be 013°G, off the main line of extant mounding.

North Stoke; extended; 235m long; aligned 195°G;

location: Oxon; SU 6112 8573; OS Explorer 171;

status: ?embanked, barrow-like monument, linking small terminal enclosures; partially excavated;

topography: sited on level ground, in the open valley adjacent to the River Thames;

sources: NMR 241773 and 1201157; Barclay *et al.* 2003;

structure:
Two parallel, linear, crop-marked ditches, 235m long, and 10m apart, oriented NNE-SSW'ward (015-195°G), enclose parch-marks that may indicate original mounding. Small structures, represented by curving gullies, lie at each end. It has been suggested that these terminal features may predate the mound that was constructed to link them.

The site has been radiocarbon dated: 3630-3340 cal BC (4672 +/- 49 BP; BM 1405; 2 sigma).

associated monuments: the immediate area contains many ring-ditches, and what may be oval barrows.

Long Low; extended; 210m long; aligned 198ºG;

location: Staffs; SK 1215 5395; OS Explorer OL24;

status: two cairns, linked by embankment; partially excavated;

topography: runs along the crest of a narrow spur;

sources: NMR 308141;

structure:
The monument survives as a 210m long embankment, 12-18m wide, oriented NNE-SSW'ward (018-198ºG), with a rounded mound at each end. The NNE'n cairn is 27m in diameter, ditch-less, and covers a central cist that contained an inhumation, and produced leaf-shaped arrowheads of Neolithic type. The SSW'n cairn is 16m in diameter, and also ditch-less. The bank that runs for 160m between *termini* ends at the centre of this cairn, meeting a short cross-wall. Cremated deposits were inserted into this cairn, and into the bank. The former cairn is interpreted as Neolithic, and the latter as of earlier Bronze Age date. The phasing of the monument is uncertain, but it might have developed from the NNE'n cairn, in a SSW'ly direction.

Unitary sites

Mounding: rectangular plan ----

Pen Hill; extended; 235m long; aligned 245ºG;

location: Somerset; ST 5652 4877; OS Explorer 141;

status: linear bank, and side-ditches; unexcavated, but some localised geophysical prospection;

topography: runs along the spine of an open hilltop;

sources: NMR 196134; Lewis 2005, 2008; Williamson and Loveday 1988; Loveday 2006.

structure:
A bank, 235m long, up to 10m wide, and surviving to 0.6m high, with flanking side-ditches 3m wide, which seem to extend around the entire mound, is oriented ENE-WSW'ward (065-245ºG).

The monument is broadly rectangular, with some hint of taper towards the W, the 120m-long E'n sector is wider, and the remaining length generally narrower, less regularly linear, and on a slightly changed orientation.

The site is similar in size and shape to known artificial rabbit warrens, of later medieval, or post-medieval date, and this has been one interpretation suggested (Williamson and Loveday 1988; Loveday 2006), but whether this the primary function, or a secondary re-use remains unknown.

Grinsell (1971) noted the site as a possible 'bank barrow', but nothing further has been done to verify the nature of this key site, beyond repeated discussion of surface remains.

Four banked structures lie on each side of the mound in question, and perpendicular to it. These additional banks appear to be more typical of warrens, and can be paralleled at nearby Dolebury (Dolebury Camp; ST 4501 5895; North Somerset; NMR ST 45NE3/ 194279), where clear examples lie within the hillfort, along with a pre-medieval field system, vermin traps, and a lodge-house for the warren (e-FIG AB-08). Another excellent example of warren-mounds can be seen in the upper Tawe valley (South Wales), to the S of the unrelated Cerrig Duon stone circle (e-FIG SC-04), some of which bear close comparison with Pen Hill, in form, and details of irregularity.

associated monuments: a long barrow lies just to the W of the 'bank barrow', slightly off its line, but aligned similarly E-W'ward. A round barrow lies just to the N, and a dispersed cluster of round barrows occupies the ridge further to the W.

Martin's Down; extended; 195m long; aligned 225ºG;

location: Dorset; SY 5716 9115; OS Explorer 117;

status: long barrow, with no structural phases evident; unexcavated;

topography: runs along the spine of a hilltop;

sources: NMR 451042; Bradley 1984;

structure:
A mound, 195m long, and 20m wide, with parallel ditches at the sides, but not the ends, points SW'ward (225ºG). A V-shaped depression in the mound, but not the side-ditches, 65m from the NE'n end, is of uncertain interpretation. The site might have been extended from a shorter long barrow, by addition of a tail.

Came Hill; extended; 180m long; aligned 291ºG; phot AB-01;

location: Dorset; SY 7030 8531; OS OL 15;

status: long barrow, with no structural phases evident; unexcavated;

topography: runs along the spine of an open hilltop;

sources: NMR 453950;

structure:
A long barrow, 180m long, 17m wide at its E'n end, 15m at the W'n end, 2m high, with side-ditches present, points WNW'ward (291ºG);

associated monuments: a round mound lies over the E'n end of the long barrow; an extensive linear round barrow cemetery extends to the W, on the same general alignment as the long barrow.

West Cotton; elongate; 130m long; aligned 261ºG;

location: Northants; SP 9755 7253; OS Explorer 224;

status: partially excavated;

topography: at the margin of a narrow river valley, flanked by low hills;

sources: Windell *et al.* 1990;

structure:
A rectangular mound of Neolithic date, 130m long, and 15m wide, partially defined by a marginal gully, and concave at the ENE'n, possible entrance end, points W'ward (261ºG), and covers an area divided into compartments by transverse lines of stakes;

associated monuments: a triple ditched round barrow, and smaller ring-ditch lie off-axis at the E'n end; a long enclosure of similar proportions lies just to the S, and is oriented SSW'ward (039-219ºG), with a separate, round turf mound and ring-ditch lying on-axis, just to the SSW.

Bassingbourne; elongate; 120m long; aligned 069-249ºG;

location: Cambs; TL 3395 4214; OS Explorer 208;

status: elongate sub-rectangular ditched enclosure, ?barrow-related; unexcavated;

topography: sited on a slight eminence, in an open valley;

sources: NMR 1336680; HER 03446;

structure:
The cropmark of an elongate enclosure 120m long, with parallel sides, and rounded ends, is oriented ESE-WSW (069-249ºG).

Kingston Russell 2; elongate; 106m long; aligned 319ºG;

location: Dorset; SY 5809 9040; OS Explorer 117;

status: long barrow; unexcavated;

topography: runs slightly down-slope, along the spine of a ridge;

sources: NMR 451076;

structure:
A mound, 106m long, 13m wide at the front end, and 12m wide at the rear, decreasing in height from 1.5m at the front, to 0.5m at the rear, with shallow side-ditches, points NW'ward (319ºG).

Bourton-on-the-Water; elongate; 100m long; aligned 160-340ºG;

location: Glos; SP 1738 2129; OS OL45;

status: elongate, sub-rectangular, ditched enclosure, ?barrow-related has been detected by magnetic gradiometry; unexcavated;

topography: sited on a level valley bottom, adjacent to the River Windrush;

sources: HER 27269;

structure: ditched enclosure 100m long, and 9.5m wide, oriented SSE-NNW'ward (160-340ºG), with a well-defined N'n terminal, showing partial continuity around the rest of the circuit. There is no evidence for, or against mounding. Although shorter, the form bears a certain similarity to the example at North Stoke.

Kingston Russell 1; elongate; 95m long; aligned 290ºG;

location: Dorset; SY 5807 9051; OS Explorer 117;

status: long barrow; unexcavated;

topography: runs along the contour, on the flank of a ridge;

sources: NMR 451071;

structure:
A mound, 95m long, 14m wide at front end, and 10m wide at the rear, decreasing in height from 2m at the front, with shallow side-ditches not continuing around the end, points NW'ward (290ºG).

Mounding: tapered plan ----

Heslerton: East; elongate, estimates of length vary: 125-140m; aligned 256ºG;

location: Humberside; SE 9385 7525; OS Explorer 300;

status: long barrow, with structural phases; partially excavated;

topography: sited on the spine of a low ridge;

sources: Stoertz 1997; Ashbee 1984; Vatcher 1965;

structure:
This badly plough-damaged site is better preserved over the W'n, tail-ward end, the mound, some 120-140m long here, surviving to about a metre high, and 20-25 metres wide, with the E'n foreground end almost obliterated by quarrying.

Partial excavation of the NE'n foreground revealed side-ditches to the mound, about 7m wide and 20m apart, estimated as tapering to about 8m at the other end. A palisade trench formed a rectangular enclosure, possibly a mortuary structure about 12m wide, and 17m long, open along the W'n side, and concave along the E'n, all fired before final closing of the barrow (Vatcher 1965). This palisade trench formed the margin of the mounded area, and sectors continue along both sides towards the rear. No human remains were recovered, although earlier reports of such exist.

Essich Moor; elongate; 114m long; aligned 002ºG;

location: Inverness; NH 6493 3830**;** OS Explorer 431;

status: composite long barrow; unexcavated;

topography: along spine of very low ridge;

sources: Henshall 1963**:** Inverness 31**;** Canmore NH63NW 14;

structure:
An irregular, elongate mound, with the narrower end to the N**,** 114m long, 28m wide at the S, tapering to 17m at the N, and waisted to 14m over the central sector, contains three oval barrow structures of Orkney-Cromarty type, each with a chamber. Originally these structures were possibly independent, but were then combined to form a single linear monument.

Bellshiel Law; elongate; 109m long; aligned 287ºG;

location: Northumberland; NT 8132 0116; OS Explorer OL 16;

status: long barrow; unexcavated;

topography: false-crested at the end of a spur;

sources: Newbigin 1936; HER 331; NMR 20919;

structure:
The barrow, 112m long and up to 2m high, is 15m across at the wider ESE'n end, tapering to 9m at the WNW'n end (288ºG).

About 18m from the E'n end of the site, the top of a large stone, perhaps the displaced cover of a cist, is set upright in the cairn, with its axis parallel to that of the barrow.

Limited excavation indicated that the sides of the cairn are roughly parallel, and regular, and established that the mound is of undivided, piled stone structure with a kerb of boulders. It failed to find side-ditches, and produced no clear evidence for more than one stage of construction, nor dating evidence. An elongate, rock-cut pit, or grave, was located at the E'n end of the mound.

e-FIGURES: combined listings and supporting information

Plans of specific sites

Note: **further details of sites are given in the section Supplementary Information.**

Twenty augmented barrows of defined types are shown in relation to local terrain, with one example of known medieval warren structures at Dolebury hillfort (Somerset) providing comparative data relevant to alternative, more modern, interpretations suggested for certain sites, otherwise thought to be barrows (Williamson and Loveday 1988):

e-FIG AB-	**site**	**NGR**	**L(m)**	**LG**	**struc**	**shape**	**term**	**mrw**
01	Auchenlaich	NN 6407	322	ext	comp		L	
02	Bassingbourne	TL 3342	120	elong	unit	rect		
03	Bellshiel Law	NT 8101	109	elong	unit	taper		
04	Bryn yr Hen Bobl	SH 5169	125	elong	comp		R	
05	Came Hill	SY 7085	180	ext	unit	rect		
06	Cleaven Dyke	NO 1640	>2350	supext	comp		L R	
07	Crickley Hill	SO 9216	100	elong	comp		note 1	?
08	Dolebury fort	ST 4558						example
09	Essich Moor	NH 6438	114	elong	unit	taper		
10	Great Ayton Moor	NZ 5911	150	elong	comp		O	
11	East Heslerton	SE 9375	125	elong	unit	taper		
12	Kingston Russell 2	SY 5890	106	elong	unit	rect		
	Kingston Russell 1	SY 5890	95	elong	unit	rect		
13	Long Low	SK 1253	210	ext	link		R	
14	Martins Down	SY 5791	195	ext	unit	rect		
15	Maiden Castle	SY 6688	546	supext	comp		L	
16	North Stoke	SU 6185	235	ext	link		note 2	
17	Pen Hill	ST 5648	235	ext	unit	rect		?
18	Pentridge	SU 0419	150	elong	comp		L	
19	Raeburnfoot	NY 2599	?2km	supext	link		R	
20	West Cotton	SP 9772	130	elong	unit	rect		

Key: L(ength of mound);
LG length-group: **elong**(ate), **ext**(ended), **superext** super-extended; **struc**(ture of the mound: **unit**(ary), **comp**(osite), or **link**(ing terminal structures); **term**(inal structure): **L**(ong barrow), **O**(val barrow), **R**(ound barrow); **shape** (of the mound): **rect**(angular) or **taper**(ing); **mrw** medieval rabbit warren, within an elongate mound.
Notes:
1: terminal: circular stone structure;
2: rounded crop-mark at the N'n end.

Other figures

AB-
Structural analysis presents a closer definition of such augmented barrows:

21 Histogram of lengths for a sample of long barrows: subdivision by length to define standard, elongate, extended, and super-extended types
Sample: 333 sites from England and Scotland.

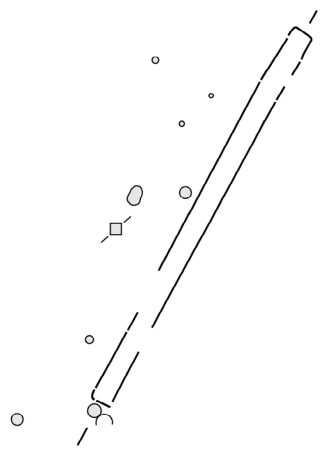
22 Histogram of the ratio between length and mean width of the mound for a sample of long barrows: calculation of a mean and standard deviation for the ratio, to enable definition of the term 'narrow'
Sample: 88 sites from England and Scotland.

23 Long barrows of ‘standard’ and ‘elongate’ type: as defined by a scattergram of mean length against width
Sample: sites from England, and Scotland.
A preliminary presentation of orientation for augmented barrows may indicate certain trends, despite the small size of sample:

24 Long barrows of ‘extended’ and ‘elongate’ type: a ray diagram indicating alignment from front to back end
Sample: sites from England and Scotland.

Section 03c:
Analysis of the orientation of cursus monuments in Britain

Section identifier: CU-
SEE INITIAL SECTION:
Access to digital images



Benson (Oxon.)

Summary:
Orientation of the longitudinal axis was determined for a sample of 143 cursus monuments from England and Scotland to produce a distribution of frequency against azimuth. General structure was evident amongst the data, with three spread peaks present: peaks 1 and 3 in near-solstitial locations, separated by peak 2 closer to the meridian.

Axial alignments in this general study fall into two main groups, the S'ly and the W'ly: many cursus monuments belong to the S'ly group, along with many stone rows.

These broad groupings of orientation are interpreted in terms of the solar transit, as suggesting ritual interest in the S'n arc of the sky. Further to this, specific targets are proposed: the seasonal ascent and descent of the sun, at the near zenith (peak 2); and the solar transit during periods of approach to, and from the winter solstices, both on its rising limb (peak 1), and on the setting (peak 3). Seasonality of construction, or at least establishment of the axis, may be indicated by peaks 1 and 3: autumn to winter.

Major cursus sites within each group are considered in more detail, with reference to the above model, and in terms of previous astronomical interpretation.

Distribution of funerary, and other monuments, in the areas around two of the longest sites, the Dorset Cursus, and the Rudston cursus-complex, are discussed in relation to function and orientation.

The following topics are also discussed for cursus monuments:

-definition, **properties**, and context;
-problems in **analysis** of axial trends;
-relation of axis to the **solar transit**;
-differences between **directions** within the axis;
-**distribution** and **association**;
-**orientation** of sites;
-**case studies**;
-existing **astronomical interpretation,** with especial reference to Godmanchester;
-relationship with the **solstitial axis**;
-association with **terminal funerary areas**;
-supplementary information on **key sites**.

Cursus monuments and their orientation

General introduction

Definition

The classic cursus monument of Neolithic date consists of an elongate rectilinear enclosure, defined by an embanked, and ditched perimeter, with entrance gaps often apparent, varying in length up to about a kilometre. Certain sites from N'n Britain have perimeters formed by pits, rather than by continuous ditching. General information on the group can be found in Harding and Barclay 1999; and Loveday 2006.

Properties

Sites vary in regularity, from straight to irregular, and many contain individual sectors, on slightly different alignments, suggesting progressive development of the monument in stages, perhaps as a seasonal activity. Some sites appear to have had a lengthy life span as permanent monuments, but in other cases refilled ditches may suggest transience.

Terminal areas appear to have formed significant elements, sometimes more massively constructed than the side-banks, and occasionally with important features within, and near them.

Interiors appear largely open, although structures such as embanking, and cross-division are known, and features such as pits, and post structures do occur.

Context

Cursus sites often lie within zones of existing monuments, such as long barrows, and may well have acted to link significant areas, the length of many over the landscape suggesting connections with the natural world, statements of land tenure, or formalisation of earlier routes. The clustering of many sites, such as round barrows, ring-ditches, and henges around cursus monuments suggests that they continued to affect the landscape around them long after construction, perhaps retaining something of their original function.

Location

Many sites occupy low-lying positions in valley areas, from those of major rivers, to those of more local streams, often lying close to the water-course.

Distribution

Cursus monuments occur in most areas of England and Scotland: the distribution for S'n Britain is shown in e-FIG CU-18.

Function

Suggested functions include processional activity, funerary ritual, and seasonal assembly, with siting in relation to rivers, and adjacent land, perhaps also providing territorial division, and control of lateral access.

Illustrated examples

The following cursus monuments are mapped within their immediate locality, with topography, and surrounding sites added (TABLE CU-01). The sites selected here are from the longest group (>1km), ranked here in decreasing length, the list restricted to those that have been unequivocally identified as cursus monuments. Further details of location are given as an Appendix: TABLE CU-14.

Key sites with axes towards SW, S, and SE, corresponding with the three weakly evident peaks of frequency in the national sample (e-FIG CU-19), have been used to illustrate the effects of variation in alignment on seasonal access to the solar transit. Sites where axes have been analysed in relation to the solar transit are noted in **bold** type, with results shown in the stated e-FIGURES and TABLES listed in TABLE CU-01. Other sites with comparable orientations are noted alongside:

TABLE CU-01 Cursus monuments: selected examples

cursus		L(km)	axis	e-FIG CU-	TABLE CU-	phot CU-	details transit
axis SW:							
Dorset	Dorset	9.9	SW	03-06	06	01-02	yes
Benson	Oxon	1.1	SW	01	-		no
axis SE:							
Dorchester on Thames	Oxon	>1.6	SE	02	05		yes
Fornham All Saints	Suffolk	>1.87	SE	09	09		yes
Scorton	N Yorks	1.68	SE		-	04	yes
axis S:							
Rudston D	N Yorks	3.9	S	12-14	11		yes
Drayton	Oxon	1.7	S	07	-	03	yes
axis W:							
Stonehenge Greater	Wilts	2.75	W	17	13	05	yes
Stonehenge Lesser	Wilts	0.4	W	RB-101	-	06	yes
Thornborough centre	N Yorks	>1.2	W	HE-08	-	0	no

Key: L length in km; **axis** general alignment, with a single direction only included here, for convenience; **details** further supplementary information on **transit**-frequency for the axis is supplied below, as stated.

The scope of this analysis, and inherent problems

The alignment, and other relevant properties, for a sample of 143 cursus monuments, and related sites, were determined from primary sources (see Table of Contents: 03c/14). In assembling these data several problems were encountered:

-Many candidate **sites remain entirely unexplored**, and even those that have been partially excavated often produce few finds to confirm their date and status. Although such sites may appear cursus-like in form, their inclusion in the group remains tentative. However, in view of classic proportions, sheer length, and relationship with other monuments, positive identification of some such sites seems highly probable. Others, at the shorter end of the spectrum, could be confused with agrarian enclosures of prehistoric, or Roman date, and some of the longer examples have been cast as possible drove-ways. Certain elongate avenue-like sites may represent an altogether separate category from the classic cursus.

-**Confident attribution is difficult** in many cases for sites which comprise short lengths of parallel ditching, with no evidence for terminal closure. In these cases the original length remains unknown, and further ranking by size is not possible.

-Known, and candidate cursus sites form a **continuum of elongate rectilinear enclosures,** over a wide range of lengths, grading down, without any clear structural division towards, and perhaps including, small sites of 'long mortuary enclosure' type. Any lower limit for the true cursus, if such exists, must be selected arbitrarily.

-There has been a general **lack of larger-scale investigation** at the majority of sites to help define use and associations. Since the function of neither cursus nor cursoid is known, then no division can be made, for instance, on the basis of funerary, or other type of inherent activity.

-**Conservation of standing remains has been extremely poor,** thus limiting the scope of detailed investigation, and analysis, to truncated ditch-fill and highly disturbed working surfaces.

Analysis of orientation at cursus sites

Despite the frequent lack of key information from cursus sites, axial orientation is one property that can be readily determined, assuming the proportion of the site known is typical of the original monument, and that the latter is indeed a cursus.

Methods

Axial orientation has been plotted as a histogram at 10º intervals (e-FIG CU-19). Here, each site has been plotted as a single unit of data, irrespective of size, for instance plotting the 9.9km long axis of the Dorset Cursus as being equivalent to that of the smallest sites, of length less than 100m. Had the lengths of all sites been known it would have been possible to weight each axis within the plot according to its length, to give a more realistic representation of the effort that went into defining a particular orientation structurally, and then to plot these in terms of frequency. Among those sites with known terminals, there appears to be no length-related difference in orientation, and so a combined data set has been used.

Results

As a preliminary stage, each site was allocated an initial axial marker, according to which opposed pair of octants it occupied (Appendix: TABLE CU-14 column 6). Cursory examination of this column indicated a preference for those octant pairs adjacent to N-S, and also a reduced frequency for those around E-W, and so provided confidence in continued analysis to define real differences. This trend is indeed seen in the final histogram, constructed from more detailed analysis (e-FIG CU-19). Axes lie throughout the range of azimuths, but three spread peaks are visible above the general background. Quoting here only the S'ly direction of the axis, for convenience, the N'ly remaining implicit, a preference is shown for the SW'n, and SE'n quadrants, more for the former than for the latter.

A sub-stratum of orientations occurs throughout the range, indicating the possibility of alignment along any axis. Above this base, three spread peaks occur, roughly equivalent in terms of the number of sites they represent. Considering the peaks in clock-wise rotation:

the peak at:

SE: lies centrally in the SE'n sector, around 135º, tailing towards the E;

S: here in a near-meridianal location, just to the W of S, and centred on about 195º;

SW: located more to the SW, around about 235º, tailing away towards the W.

Alignments and the solar transit

Considering these directions within the axis, the S'n peak is well within the *permanent* zone of the solar transit, with the SE'n and SW'n peaks lying at its margins with the *transitional* zone (see Table of Contents: 02c/2b(ii)).

These peaks may, therefore, indicate an interest in the direction of the sun at around the meridian and, fairly separately, during its approach to, and return from the solstices. This could indicate variant traditions, expressed within an overall interest in the S'n arc of the sky, one of these based the meridian, and one each on the rising, and setting limbs of the transit.

In general terms, the distribution shows no match with specific solar, or lunar risings, or settings, and no evidence for close alignment on the solstices, certainly from plotting data at 10º intervals (e-FIG CU-19), and little if considering individual data (see Table of Contents: 03c/14). An alternative general explanation for orientational behaviour can be suggested, based on the solar transit (see Table of Contents: 02c/2 and 03a/13a), one which accounts for both peaks, and the more general background distribution of frequencies.

Assuming a solar model, using the S'ly direction in the axis as an example, and considering each of these three peaks of cursus alignment, it is obvious that each peak would result in different exposure to the transit. The peak at the S would align year-long with the transit, the sun rising and falling between minimum elevation at midwinter, and maximum at midsummer, this providing an index of seasonal change. Alignments at the interface between the permanent, and transitional zones of the transit would experience more restricted exposure, depending on the precise axis, but could still use the rising and falling elevation of the transit, and the approach-departure from the solstice as seasonal markers. Alignments more central to the transitional zone, for instance to the W, would experience least exposure.

Example alignments for each of these groups, the SE'ly, S'ly, and SW'ly, with a W'ly case added for contrast, are examined in more detail below. Two conditions are included: one in which the entire set of transits, at all elevations, is considered to have been relevant, and one for lower elevations, at 10, and 20° only.

The seasonality of intersection between the axis of cursus sites within each peak, and the solar transit can be summarised in TABLE CU-02:

TABLE CU-02 Cursus sites: access to the solar transit for different key alignment groups

							exposure to the solar transit for given elevations: [tr fr]			
							to maximum transit:		**only up to 20°**	
cursus		**axis**	**az**	**TABLE CU-**	**tr freq e-FIG CU-**	**plan e-FIG CU-**	**rising**	**setting**	**rising**	**setting**
Fornham All Saints	Suffolk	SE	142	09	21	09	all	none	**NOV-FEB**	none
Dorchester-on-Thames	Oxon	SE	128	05	21	02	all	none	**OCT-FEB**	none
Rudston D	N Yorks	S	185	11	23	13	all	zeniths	none	**NOV-JAN**
Dorset	Dorset	SW	229	06	22	03	none	all	May-Jul	**OCT-FEB**
Stonehenge greater	Wilts	W	263	13	21	17	March-September		Aug-Sep	Mar-Apr

Key: axis: only the S'ly direction is quoted, for brevity; units (°G); **az**(imuth); **TABLE**: tabulated data are given in supplementary information for each site; exposure: **tr freq**: transit-frequency;
Note: seasonal exposure to the transit, rising, or setting as appropriate, for *both* directions in the axis are considered here, with winter access **capitalised,** and in **bold** type:
Here, the emphasis throughout seems to be on coverage of the non-summer months, with reference both to rising, and setting limbs, the latter slightly more in evidence, as reflected in the distribution of peaks for the national sample given in e-FIG CU-19.

Structural differentiation between directions in the axis of cursus monuments

The case for considering the S'ly direction in the axis to have been more important as a line of view towards potential targets would be considerably strengthened if backed by structural data showing a particular emphasis. There are some trends that may be relevant here, but they are far from decisive:

Topographical

Views down key cursus sites seem to have a better S'ly aspect, for instance:

Dorset — sloping to SW with good onward views;
Scorton — to SE from the edge of a hill-slope, down towards the river;
Rudston D — to S from a hill-side, down the stream valley;

Associated monuments

Funerary areas are concentrated at the S'n end of several important sites, for instance the Dorset Cursus (e-FIGS CU-map 02 and 03), Rudston (e-FIG CU-05 and 06), Scorton (e-FIG CU-15), and to the N and S of Drayton (e-FIG CU-07), suggesting their possible inclusion in a S'ly view.

Structural (Appendix: TABLE CU-14)

Within the cursus site itself, there is no consistent difference between types of terminal, nor in the positioning of entrance gaps, with few cases of their placement in either terminal for ease of local access, most appearing as lateral. Data are scarce on the distribution of activity-areas within the interiors of cursuses, or at their margins, that would be of particular relevance in discussing asymmetry of the monument.

Aspects of distribution and associations of cursus sites

Widespread consistency

Certain more localised clusters of cursus sites seem to have a characteristic alignment, and similar orientation is often shown by sites in widely separate locations, suggesting operation of some factor that was not directly related to local conditions, for instance, as seen amongst those in the upper Thames valley (e-FIG CU-18).

Topographical associations

In general, locations for siting seem relatively free from topographical constraint, indeed, such a site as the Dorset Cursus over-rides ridges and stream valleys to maintain its course (e-FIG CU-04).

Many cursus sites show close association with the valleys of streams and rivers, and it has been suggested that these monuments might have taken some directional cues from such water courses, and they have even been suggested as symbolic rivers (Brophy 1999a). In proposing a solar basis for orientation in this analysis, it has been necessary to examine this suggestion in some detail, by comparing the match between orientation of cursuses and local rivers over the entire range of known and probable sites (e-FIG CU-20).

There is an obvious problem in attempting this, because river courses can change markedly over the time-spans involved. Ancient, possibly braided courses, flowing through extensive marginal wetland, would not be the same as modern rivers, often canalised to adopt clearer courses, through a drained landscape. With this in mind, the correspondence between 148 cursus sites and their local rivers was graded, to provide general measures of conformity, from none, through low and medium, to high.

The case for river-based alignment of cursus sites seems weak, with 87% falling in categories up to medium, with only 13% rated as high. Examples of those in the high category include Rudston D (Humberside), Fornham All Saints 1 (Suffolk), and Fimber (Humberside). The Dorset Cursus, Stonehenge Greater Cursus, and the possible site at Hunsonby (Cumbria), for instance, have no association with river valleys. Other examples of non-correspondence between orientations include Maxey, Westfield, Cleaven Dyke, Wimblington, Holywood N and S, Harlow, High Catton, Hasting Hill, and Fladbury (see Table of Contents: 03c/14).

Several special spatial studies of localised clusters of cursus sites were made for various river systems to confirm these results: the Thames (at Abingdon, Wallingford, and Lechlade), and for the Warwickshire Avon (at Evesham and Warwick). The cluster of smaller cursoid monuments in the Evesham group at Fladbury has been examined in more detail as a case study (see Table of Contents: 03c/8c; e-FIGS CU-08 and 08a).

Utilisation of more open topography in valleys, rather than conformity with river flow, seems likely, cursus sites using space in river valleys to realise length, and more level siting, running along valleys, rather than transversely, thereby blocking linear access. Again, it could be argued that such sites came to occupy locations which allowed expression of some required orientation, rather than passively conforming to what was available. Rudston D provides a clear example of a cursus that appears actively to require a S'ly line, as followed by the adjacent Rudston A, despite the need to traverse difficult terrain (e-FIG CU-13).

Case studies: spatial analysis of surrounding monuments and their possible relationship with axial alignment of the cursus

Two large sites, the Dorset Cursus, and the Rudston complex, were selected to allow their relationship with wider topography, and with distributions of adjacent monuments to be more closely examined in relation to alignment.

The Dorset Cursus (see Table of Contents: 03c/8a; e-FIGS CU-03 to 06)

The Dorset Cursus contains various component sectors, of differing alignment (TABLE CU-06), runs over a varied terrain of hills and valleys, and is surrounded by unusually high numbers of barrows, all of which factors may give useful insights for interpretation of its axial orientation. Although the cursus itself originated in the earlier Neolithic, its presence as a monument, and perhaps aspects of its function, are likely to have continued well after this. The linear concentration of barrows around the cursus, extending out to some distance (e-FIS CU-05 and 06), and the concentration of barrows beyond the SW'n end, suggest deliberate inclusion of funerary areas into its general line (e-FIG RB-282). Those sites more directly within its line would have fallen into closer views along axis of the cursus, and onward towards the SW'n sky, a combination, together with the solar target, suggested here as important.

The Rudston cursus complex (see Table of Contents: 03c/8b; e-FIGS CU-12 to 14)

Although structurally less impressive than the Dorset Cursus, this complex includes major lines oriented towards the S'n to W'n quadrant, and here too there are clusters of round barrows around, and beyond terminal areas, on axial sight-lines (e-FIG RB-282).

The Fladbury group of smaller cursoid enclosures; SO 9846; Evesham, Worcs; e-FIGS CU-08 and 08a;

Six small rectangular ditched enclosures, up to about 100m long, survive as crop-marks over the level top of a gravel terrace, adjacent to the River Avon, which loops around it, about 1km away to the E and S. A single ring-ditch lies within the cluster. Four of the enclosures are aligned towards the SE'n quadrant, with the remaining two taking a more E-W'ly line.

Two points are apparent:

-there is no indication that axes take their cue from the direction of the river, the course of which is not visible from the site, less so assuming intervening ancient wetland margins;

-the sites belong to the SE'n peak of alignment, as seen in the national sample (e-FIG-19);

-these small enclosures highlight the problem of definition: there is no evidence to identify them clearly either as cursus monuments, or to place them instead amongst 'long mortuary enclosures'.

Existing astronomical interpretation: one example

In reviewing the validity of much current astronomical interpretation of sites, the cursus at Godmanchester provides an interesting case of astronomical over-analysis.

Godmanchester; Cambs; TL 2555 7092 to TL 2510 7070; enclosure NMR TL27SE 80, cursus NMR TL27SE 81; e-FIGS CU-10 and 11;

-the site

The site occupies fairly level ground, on a spread of gravel, about 500m from the River Ouse, and runs roughly in parallel with its current course. The enclosure is adjacent to higher ground at the E, with the cursus running towards the margins of the river, and its flood plain. The site, described in McAvoy 2000, and further discussed in Ruggles 1999 (fig. 8.4, p. 128), has been completely removed by gravel quarrying.

phase 1:

A trapezoidal enclosure was constructed in the early 4th millennium BC, with an inner circuit of 24 posts surrounded by a boundary ditch, 3m wide by 1m deep, and an inner bank, as detected from ditch-fill. Its long axis was aligned NE-SW'ward, with an opening at the NE'n end (McAvoy 2000, fig. 7.1/ p.52).

phase 2:

A cursus was added to the SW'n side of the enclosure, extending its axis, and broadly aligning with its NW'n ditch. Two parallel ditches, some 90m apart, about half of the width of the terminal enclosure, ran towards the SW (238°G), and were traceable for about 500m, before becoming obscured by modern building. Originally, the cursus might have terminated further towards the SW, near the course of the River Ouse, perhaps on slightly higher ground, giving it a length of about 1km. A small ring-ditch, about 9m in diameter, of typical earlier Bronze Age type (TL27SE 42), was located centrally between the ditches of the cursus. Two gaps were visible in the NW'n ditch of the cursus, near the enclosure.

Other activity, of later Neolithic and earlier Bronze Age date, occurred after the main phase of the enclosure and cursus: a transverse ditch, and a ditched compound were established within the enclosure, and pits were dug at its SW'n junction with the ditch of the cursus.

-existing astronomical interpretations

The five axes selected as astronomically significant (McAvoy 2000, fig. 7.3/ p. 54); Ruggles 1999, fig. 8.4/p. 128) are further shown in e-FIG CU-11, and labelled here for convenience as S1-3 and L1-2. The way in which the relative positions of features (perimeter of the enclosure, posts, line of cursus, and ring-ditches) change between versions of plans does not inspire confidence in the structural basis for analysis.

..three axes are indicated as solar: two of these run towards the equinoctial sunrise at due E: S1 taken between corner posts in the enclosure, S2 from a ring-ditch on the midline of the cursus to another corner post; the third axis S3, taken between the mid post at the rear of the enclosure, and a corner post, is considered solstitial, towards midsummer sunrise.

These three axes appear most unlikely, with the points selected being arbitrary, minor, and forming inconvenient view-lines, out of keeping with the general structural emphasis of the site. It would appear that here key solar axes have been fitted to the structure, rather than the latter, of itself, suggesting any more convincing axial emphasis. There is also a mismatch, in that line S3 runs to a point on the Neolithic enclosure, from a ring ditch likely to be of later date, although claimed to be of earlier importance. A key feature, the central post in the wide entrance of the enclosure, takes no part in this scheme.

..two axes are perceived as lunar, referring to rising, and setting at the minor N'n and S'n limits. Line L1 runs towards the NE, from the corner-post of an entrance in the enclosure, and along the mid-line of the cursus, passing through its central ring-ditch, and onward to the N'n minor limit of moonrise (part of the 18-year lunar cycle), the other direction taken to correspond with the S'n minor limit of moonset, at the SW. Line L2 has the same axis, but is adjacent, and in parallel, running along the line of posts that formed the NW'n side of the enclosure. Except for use of the mid-line of the cursus, these proposed axes seem an unlikely choice.

There are many alternative combinations of features possible, matching a variety of celestial events, all equally arbitrary and unlikely.

Using data on key lunar and solar events for 52°N (TABLES AS-01 and 04), the following values approximate axes at the site, with those cited as targets in the above interpretation shown in bold type:

			rise	set
solar	midsummmer		**049**	**311**
	midwinter		131	229
	equinox		**090**	**270**
lunar	limits			
	N'n	major	038	322
		minor	**058**	302
	S'n	major	142	218
		minor	122	**238**

Re-interpretation of the main axis

The only convincing axis at the site is that along the centre-line of the cursus, with the SW'n direction of particular importance, given the direction of approach, and entry to the terminal enclosure, from the nearby higher, and drier ground. The monument ran between patches of slightly higher ground, in what must have been a generally wet area, flanking the flood plain of the River Ouse, and hence its line might have been one of practical necessity, rather than a final choice from a larger range of possibilities. Approximate realisation of intent is therefore probable here, with the axial value to the SW of 238^{o}G not to be interpreted too closely.

Reference to an infrequent lunar event, occurring as it does at 18-year intervals, and in this case the minor, rather than major standstill, seems implausible in terms of its infrequency, and hence its relevance for recurrent ritual (see Table of Contents: 02c/3). Godmanchester is more convincingly placed amongst those cursus monuments that refer their axes to the peri-solstitial zone of the midwinter setting sun (see Table of Contents: 02c/2). This alignment would have allowed access to this event, and optimised interaction with the solar transit (see Table of Contents: 02c/2e). The axis of the cursus at 238^{o}G lies only 9^{o} to the N of winter solstice sunset at 229^{o}, sufficiently well within the transitional zone of the transit to ensure efficient coverage.

The relationship between alignment of cursus sites and solstitial axes

The general distribution of frequencies for axial alignment at cursus sites (e-FIG CU-19) shows three weakly-defined peaks, one just to the W of S, and one each in the vicinity of the solstitial axes, at SE and SW. The interpretation of these peaks has been discussed in more detail above, but it remains to examine more closely the two lateral peaks, that lie in the vicinity of the solstitial axes.

The apparent correspondence between axial alignment, and one, or other of the two solstitial axes has been noted for certain classic cursus sites, and suggested as potentially significant, in terms of its ritual function.

-at the **Dorset Cursus** (e-FIGS CU-03 to 06), the longest known cursus in the Britain, one of its constituent sectors (sector 2: TABLE CU-06) has been seen as intentionally aligned on the sunset at winter solstice (solstitial axis 2: NE-SW), when viewed from its NE'n end, with the effects of the event enhanced by the presence of a long barrow, set within the sight-line towards the SW. The fact that the other sectors of the monument are far less well aligned to take advantage of this event has aroused little comment;

-the cursus at **Dorchester on Thames** (e-FIGS CU-02), a smaller site at 16% of the length at the Dorset Cursus, is more consistently straight, and appears closely aligned with the other solstitial axis (1 \: NW-SE), with winter solstice sunrise frequently quoted as significant.

In order to view such sites in context, a larger sample of known, and probable cursus sites has been reviewed, to assess further possible instances of more closely solstitial orientation, and the degree of fit.

Since the azimuth of the solstitital axes varies with latitude, Britain was divided into seven bands (A-G in TABLE CU-03), each of 1 degree in latitude, and the solstitial axis was calculated for each sub-group of monuments according to the mid latitude of each band (TABLE CU-03). Pending a more closely defined sample of cursus sites, this general approach is here considered adequate, and unlikely to repay application of more detailed statistics: the conclusions as they stand below seem clear enough.

TABLE CU-03 CHANGING ALIGNMENT OF SOLSTITIAL AXES WITH LATITUDE IN THE SURVEY AREA

SOLSTITIAL AXIS (°G)

			1 (\)		**2 (/)**	
lat	**gp**	**includes area**	**MSrise-**	**MWset**	**MWrise-**	**MSset**
56-57	A	Grampian	042	222	138	318
55-56	B	Firth of Forth	043	223	137	317
54-55	C	Northumbria	045	225	135	315
53-54	D	Yorkshire	046	226	134	314
52-53	E	Midlands	047	227	133	313
51-52	F	Cotswolds	049	229	131	311
50-51	G	Wessex	050	230	130	310

Note: the azimuths above indicate a general value for each degree of latitude;
Key: lat(itude in degrees N); **gp** group label A-G for 1° intervals of latitude; **MS** mid summer; **MW** mid winter; a visual cue to the direction of the axis is given by the symbols **** and **/**.

Cursus sites that lie within 15° either side of these axes were assembled as a sub-sample, organised by length, and closeness of fit with the two solstitial axes (TABLE CU-04). Basic statistics were then extracted to examine whether any clustering of alignment could be seen, or evidence for any consistent pattern of approach to the solstice, and any preference for either of the two solstitial axes.

TABLE CU-04 CURSUS SITES WITH ALIGNMENTS CLOSE TO LOCAL SOLSTITIAL AXES: A SAMPLE

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length >1000m: **sample size 18; good fit = 5 (28%)**

Note: solstitial axes 1 (NW-SE \) and 2: NE-SW /)

cursus	**loc**	**NGR**	**L(m)**	**axis**		**NMR**	**gp**	**dif**	**fit**
SOLSTITIAL AXIS 1									
Thornborough centre	N Yorks	SE 28 78	>1196	056-236	/	SE27NE 1	C	+11	poor
				049-229				+ 4	good
Triffle	Corn	SX 33 54	?>1188	040-220	/	HER 71706	G	-10	fair
Dorset	Dorset	SU 01 15	9900	035-215	/	linear 41	G	-15	poor
				051-231				+ 1	good
				060-240				+10	fair
			all sectors:	049-229				- 1	good
SOLSTITIAL AXIS 2									
Cleaven Dyke [hybrid site]	PerKin	NO 16 40	>2350	121-301	\	NO13NE 89 NO14SE 80	A	-17	poor
Scorton	N Yorks	NZ 23 00	1676	131-311	\	HER 13271	C	- 4	good
Maxey	Cambs	TF 12 07	>2000	127-307	\		E	- 6	fair
				113-293	\	TF10NW 58		-20	poor
Fornham All Saints	Suffolk	TL 83 67	1870	165-345	\	TL86NW 11	E	+32	poor
				153-333				+20	poor
				130-310				- 3	good
				136-316				+ 3	good
Dorchester	Oxon	SU 57 95	>1600	131-311	\	SU59NE 5	F	0	good
				126-306				- 5	good

length 500-1000m: **sample size 18; good fit = 2 (11%)**

SOLSTITIAL AXIS 1

Balneaves Cottage	Angus	NO 60 49	>500	035-215	/	NO64NW 27	A	- 7	fair
High Catton	Humb	TL 71 52	>650	050-230	/	-	E	+ 3	good
Godmanchester	Camb	TL 25 71	>500	058-238	/	TL27SE 80	E	+11	poor

SOLSTITIAL AXIS 2

Alrewas and Fradley	Staffs	SK 17 14	>640	128-308	\	SK11SE 29	E	- 5	fair
Buscot 1	Oxon	SU 22 98	750	133-313	\	SU29NW 2	F	+ 2	good

length 200-500m: **sample size 41; good fit = 7 (17%)**

SOLSTITIAL AXIS 1 NMR 1043117

Sarn y Bryn Caled 1	Powys	SJ 21 04	>370	045-225	/	-	E	- 2	good
Hanworth	Norf	TG 20 36	410	038-218	/	HER 18190	E	- 9	fair
Abingdon	Oxon	SU 49 96	>390	052-232	/	SU49NE 117	F	+ 3	good
Buscot 2	Oxon	SU 21 98	>200	045-225	/	SU29NW 38	F	- 4	good
Drybridge	Ayr	NS 35 36	>220	137-317	\	NS33NE 44	B	0	good
Thornborough N	N Yorks	SE 28 78	>300	137-317	\	1043117	C	+ 2	good
Buckden 2	Cambs	TL 20 66	>470	131-311	\	TL26NW 41	E	- 2	good
Fenstanton	Cambs	TL 32 68	>371	130-310	\	TL36NW 56	E	- 3	good
Tichmarsh 1	Nhants	TL 01 79	>255	134-314	\	HER 1891	E	+ 1	good
Uttlesford 1	Essex	TL 44 30	>267	123-303	\	HER 19716	F	- 8	fair

length 100-200m: **sample size 38; good fit= 2 (5%)**

SOLSTITIAL AXIS 1

Copley Hill Farm 1	Cambs	TL 51 52	>120	043-223	/	HER 0928	E	- 4	good
Copley Hill Farm 2	Cambs	TL 51 52	>100	035-215	/	HER 09082	E	-12	poor
West Cotton	Nhants	SP 97 72	120	039-219	/	HER 5390	E	- 8	fair
Meifod	Powys	SJ 15 13	>160	043-223	/	-	E	- 4	good

SOLSTITIAL AXIS 2

Loch of Liff	Angus	NO 33 33	>150	125-305	\	NO33SW 83	A	-13	poor
Wick 2	Worcs	SO 97 45	>180	145-325	\	SO94NE 19	F	+14	poor
Fladbury 6	Worcs	SO 98 46	*160*	137-317	\	HER 33720	F	+ 6	fair

length <100m: **sample size 22; good fit= 3 (14%)**

SOLSTITIAL AXIS 2

Holm	DumfGal	NX 95 80	>85	140-320	\	NX98SE 86	B	+ 3	good
Thorganby	Lincs	TF 19 98	98	132-312	\	HER 54250	D	- 2	good
Charlton site 26	Worcs	SP 00 46	>46	135-315	\	HER 02751	E	+ 2	good
Little Wawcott	Berks	SU 39 68	>90	140-320	\	SU36NE 39	F	+ 9	fair

Note: sites in each category are listed by location, from N to S; where a cursus contains a series of sectors which differ in alignment, these are listed from N to S, and for the more complex Dorset cursus these sectors are as defined in TABLE CU-06;

Key: loc(ation)**;** **L**(ength in metres)**; axis in °G,** the symbols **/** and **** give a visual cue for the general alignment of the cursus**; gp** group labels A-G for 1° intervals of latitude (TABLE CU-03); **dif**(ference) between the axis of the cursus and that of solar axes 1 or 2 (definition: see Table of Contents: 02c/1b), with **fit** graded from good (0-5°), to fair (6-10°), to poor (>10°).

General conclusions

The distribution of frequencies expected from random orientation alone appears to account for 'solstitial alignment' at certain cursus sites

Dividing the 180° range of the S'n arc of the sky into 18 notional 10° divisions would give a 1 in 18, or about 6% probability that the axis of any site would fall within any one of these divisions by chance alone. A good fit between observed alignment and solstitial axis has been arbitrarily defined here as +/- 5°, roughly corresponding with one of these divisions for the latitude range of the sites in the sample.

Taking the two solstitial axes, the observed frequency of 'good' fit should be significantly greater than about 12%, if chance is not to be the prime candidate for explanation of sites close to these axes. There are 137 cursus sites in the total sample, with 19 instances of 'good' fit, giving a frequency of 14%, very close to this random value. Considering individual size-categories, only the longest cursus sites (>1km) have a frequency much above this random value, at 28%, with the 500-1000m group at 11%, the 200-500m group at 17%, the 100-200m group at 5%, and those shorter than 100m at 14%. The case for arguing a deliberate peri-solstitial alignment for cursus sites is therefore weak, despite close correspondence of some important members.

There is no case for exact alignment of cursus sites towards solstitial axes

If the line of a cursus was oriented on solstitial risings and settings, then this could be done in two ways. The direct target could have been the event at the time of its occurrence, or the alignment established at any time of year, by using some other topographical marker, previously established as a solstitial reference point.

Using the direct method, and assuming an intent for accuracy, it might be expected that the axis, as established on the ground, would lie *within* the range of the solar transit, on its approach to, and return from the solstice position (e-FIGS AS-01 and 07). This would give a positive value for difference in the case of setting and rising solstitial axes ('**dif**' in TABLE CU-04). Negative values for **dif** in each case would indicate an axis lying outside the solar range, beyond the solstices.

The split between positive and negative values of **dif** for axes 1 and 2 is about even, indicating scattering around the solstices, rather than alignment on positions leading up to the solstice. Such disjointed alignment is well seen in the three sectors at the Dorset Cursus.

There is nothing here to indicate accuracy of alignment, as based on direct observation of current solstitial events, or that more detailed measurement and analysis would yield a different conclusion. It seems more likely that some latitude existed, within which alignment remained valid.

It is interesting to view this 'good' fit in terms of duration for the solstitial approach and departure of the sun. Over about 24 days either side of the solstice, the direction of the sun changes little, by up to 5°, corresponding with the 'good' fit between axis of the site and solstice, as defined above in TABLE CU-04 (e-FIG CU-07), this providing considerable latitude for timing. After this plateau, the rate of transit increases markedly. Alignments with this 'close' match could, therefore, have been established over an extended winter period of about 7 weeks, from late November to mid January, assuming that direct solar observation was employed, rather than some topographical proxy.

No clear preference for alignment on one or other of the two solstitial axes is evident

Alignment of cursus sites in this sub-sample is fairly evenly divided between the sectors around solstitial axes 1 and 2 (definition: see Table of Contents: 02c/1b), with 41% around axis 1, and 59% around axis 2, this latter group taking a slight lead. In the case of the largest monuments (>1km long), the Dorset Cursus, and Thornborough N, are close to axis 1, with Dorchester, Maxey, Scorton, and Fornham All Saints around axis 2. For the Dorset Cursus, Maxey, and Fornham All Saints the match is partial, and restricted to component sectors. In only two of these sites is the alignment close to the axis ('good' fit in TABLE CU-04), and fairly consistent along the length: Dorchester and Scorton, both on axis 2. The evidence here is poor, ambiguous, and no case can be made for any preference between axes 1 and 2.

Rather than focusing on the importance of the solstice itself, alignment in this direction should be considered within a broader context. Axes aligned on the zones around solstices at the S, winter rising and setting, optimise their exposure to the solar transit, intersection occurring throughout the year, with the solar turnaround itself providing an additional feature (see Table of Contents: 02c/2e).

Association between barrows and cursus monuments

Round barrows appear consistently to the S-SW of many important cursus sites, perhaps suggesting a particular pattern of growth for these later burial areas in zones that could be viewed on-axis along the general line of the existing cursus.

This pattern is clear for the Dorset Cursus (e-FIGS CU-05 and 06), and for the Rudston complex (e-FIG CU-13), particularly for cursus D. Minor clusters of round barrows also appear near S'n terminals at Scorton (e-FIG CU-15), Fornham All Saints (e-FIG CU-09), and weakly near the W'n end at Stonehenge Lesser Cursus (e-FIG RB-101). Only at the Dorset Cursus is there similar clustering of long barrows around terminal areas, indicating an earlier involvement of funerary monuments in the line.

Evidence for differentiation between the ends of cursus monuments

In order to discuss the potential significance of different directions in the axis of these linear monuments, it is essential to review the evidence for any structural differences between terminal areas. Given the extensive damage these sites have sustained, and the lack of detailed investigation at most sites, such evidence is generally weak, and partial. There is no clear structural evidence for a consistently defined direction within the axes of cursus monuments. At certain sites, terminal structures, or topographical considerations, suggest that the cursus extends to the S as its key direction.

Features suggesting axial differentiation are of three types, summarised as follows for each site listed below:

S: structural elements at the cursus;

A: differential distribution of associated monuments;

T: topographical differences along the length of the cursus;

I: spatial interrelations between adjacent cursus sites.

Further details of sites mentioned below are given in the Appendix TABLE CU-14:

Balneaves: **[S]** a transverse division lies nearer the NE'n terminal; a change in the main axis occurs further SW'ward;

Barford Sheds: **[?A]** a possible entrance gap lies in the NW'n angle; a small C-shaped ditched enclosure, containing pits, and postholes, lies at the S'n end, but is of uncertain relationship;

Bennybeg: **[S]** a splayed timber forecourt-like frontage extends at the N'n end of the rectangular enclosure;

Benson: **[T A]** the site runs down a slight slope towards the SW; ring-ditches, an oval barrow, and a possible long barrow lie adjacent, and in weakly linear formation along the NW'n side;

Biggleswade: **[A]** three linear ring-ditches lie at the E'n end, in line with the axis of the cursus, and decreasing in size towards the E, similar to the association noted at Blairhall, and Kilmany;

Blairhall: **[S A]** a possible transverse division lies nearer the NE'n terminal; four linear ring-ditches lie on the same axis as the cursus, and adjacent to its NE'n end, decreasing in size towards the SW, similar to the association at Kilmany and Biggleswade;

Brampton: **[S A]** ring-ditches lie more concentrated towards the NW'n end; the cursus tapers towards the SE;

Broich: **[T]** the site runs down a slight slope to the S, ending in a steep scarp near the river;

Burleigh: **[T]** the site runs down a slight slope, towards good views over the sea;

Buscot: **[A]**

1: clustering of ring-ditches adjacent to the NW'n end;

2: clustering of ring-ditches adjacent to the NE'n end, with a linear trend apparent along their course towards the SW; a large ring-ditch, and other features lie just beyond the SW'n end;

Charlecote 2: **[S A]** a ring-ditch lies to the N and to the S, on same axis as the enclosure; a gap with posts in adjoining ditch terminals lies at the S'n end;

Church Lawford: **[S A]** a polygonal enclosure, with gaps, lies at the E'n end, and contains a ring of posts; a ring-ditch overlies the short 'cursus' nearer its W'n end;

Cleaven Dyke: [S T] a distinct mound lies at the NW'n end; the course makes a slight descent towards the SE along its length; **note:** this site is considered to be a cursus-'bank barrow' hybrid;

Curriestanes: **[S]** narrows from 95m at the W'n end, to 75m wide at the E'n end; a clear entrance gap lies at E'n end;

Dorchester: [A] some clustering of ring-ditches, and other monuments, may occur towards the SE'n end, but any distribution around the destroyed NW'n end remains unknown;

Dorset [S A] ***Pentridge*****:** five long barrows, and a mortuary enclosure lie near the NE'n terminal; ***Gussage*****:** two long barrows lie near the SW'n terminal; ***the whole site*****:** a concentration of round barrows lies beyond the SW'n end; extreme terminals are more monumental than the general perimeter;

Drayton St Leonard: **[A]** a long, and an oval barrow lie adjacent to the NE'n end;

Godmanchester: [A] a trapezoidal post-built enclosure lies at the NE'n end of the cursus, the final SW'ly course of which is unknown;

Hanworth: **[A]** a 'long mortuary enclosure' and two close ring-ditches lie adjacent to the SW'n end;

Hasting Hill: [A] a causewayed enclosure lies near the N'n end, and five ring-ditches run along the E'n side, nearer the S'n end;

High Catton: **[A]** a henge lies to the NE, and ring-ditches to the SW;

Hunsonby: **[A T]** a stone circle, Long Meg and Daughters, lies towards the E'n end of a possible cursus, and off-line to its N; the cursus runs slightly down-slope; the location affords a good view in a W'ly direction, over the adjacent river valley;

Kilmany: **[A]** an increase in ring-ditches is apparent at the NE'n end, including three linear ring-ditches lying on axis, and decreasing in size towards the SW, similar to the association seen at Blairhall, and Biggleswade;

Long Bredy 1: **[A T]** round barrows are clustered around the W'n end, where the NE'n end of a 'bank barrow' also lies adjacent; the site runs slightly down-slope towards the E;

Nether Exe Barton 1: **[A I]** a smaller, rectangular enclosure, Nether Exe Barton 2, and a ring-ditch lie at the SW'n end of the cursus;

Octagon Farm: **[A I]** three small, rectangular enclosures radiate to the SW from the area of a larger rectangular enclosure, lying transversely to the NE;

Old Montrose: **[A T]** ring-ditches are slightly clustered towards the WNW'n end; the ESE'n end runs more down-slope;

Ramsgate: **[A T]** a henge, and barrow group have been noted towards the N'n end; the site runs down-slope to the S;

Rudston: **[A T]**

D: N-S more ring-ditches, and a major monolith lie at the S'n end, a cluster of ring-ditches lies at the N'n terminal, and a 'long mortuary enclosure' near the N'n end;

A: N-S more ring-ditches lie at the S'n end;

C: E-W more ring-ditches lie at the W'n end;

B: E-W more ring-ditches lie at the W'n end;

Scorton: [?S A T] a distinct mound might have occupied part of the NE'n end; a distinct cluster of ring-ditches lies at the SE'n terminal; the NE'n end backs up against a hill-slope, with best aspect SE-ward to the river;

Springfield: [A S] a ring of posts lies at the NE'n end, an oval enclosure beyond the NE'n end, with a ring-ditch adjacent midway, and also at the SW'n end; more gaps in the perimeter are apparent at the NE'n end than elsewhere;

Stadhampton: **[S]** two approximately opposite gaps occur in the sides of the cursus near the NE'n end, and one possible gap at the SW'n end;

Stonehenge Greater: **[A]** linear round barrows lie along the S'n side, near the W'n end, and round barrows within the W'n end;

Stonehenge Lesser: **[A S]** the enclosure is open at the E'n end, and round barrows lie beyond, to the W;

Thornborough centre: although a possible round barrow lies near the SW'n end there is no trend evident amongst the few others in its vicinity;

Walton Green: **[A]** a round barrow lies at the SW'n end;

West Cotton: **[A I]** a long mound, and short, cursus-like enclosure splay outwards from an area at the NE, occupied by a small ring-ditch, larger ring-ditch or round barrow, and ditched enclosure; two small conjoined ring-ditches lie at the SW'n end of cursus; the long mound may have a concave entrance at the NE'n end;

Wick: **[S]** appears to narrow towards the rounded SE'n end;

Wimblington: **[A]** the longer, straight section of a curving, atypical, perhaps cursus-like monument points towards a barrow at the SE'n end;

Yatesbury Field: **[A**] ring-ditches appear more concentrated at the SW'n end.

Conclusions
Analysis of axial alignment could suggest direction of ritual towards three separate areas of the solar transit in the S'n arc of the sky: that around the zenith, and those around the two solstitial zones. These variant traditions are expressed fairly weakly, with much latitude for alternative orientation.

Although there is evidence for burial activity at certain sites, it seems likely that these monuments were essentially non-funerary, and perhaps concerned more with matters relating to economic well being, and related rituals of propitiation. The W'ly alignment seen amongst contemporary long barrows is not evident amongst cursus sites, suggesting a different emphasis. However, there is evidence for some linking of funerary monuments into the line, less for long barrows than for later aggregation of round barrows around axes, at sites still retaining some currency, perhaps as deliberate incorporation into a ritually-significant S'ly view.

There is some evidence for aggrandisement at certain sites, where sheer length, and sectoring indicate progressive elongation, in order to emphasise an axis of particular importance.

Case studies

Seven longer sites are compared in more detail: the Dorset Cursus, the cursus complex at Rudston, the Stonehenge Greater cursus (with Lesser Cursus added), the monuments at Dorchester-on-Thames, Fornham All Saints, Drayton, and Scorton. These provide a basis for more detailed analysis of orientation in terms of the solar transit, and of function, as suggested by relationships with associated monuments.

Dorchester on Thames; Oxon; SU 5795; length >1600; width 60m; axis 128-308°G; NMR SU59NE 5; e-FIGS CU-02 and 21;
bibliography: Whittle *et al.* 1992; Bradley and Chambers 1998; Loveday 1999; Barclay *et al.* 2003;

-general structure
The cursus, now heavily damaged by gravel quarrying and modern construction, can be traced for about 1600m, as a rectangular ditched enclosure, on a slightly curving line running NW-SE, partially across the neck of a bend in the river Thames. The cursus seems to be single-span, with little suggestion of component sectors. The NW'n terminal has not been located, but that at the SE survives as a crop-mark. Partial excavation has been carried out in the area of the cursus and its associated monuments.

-associated monuments
There are concentrations of sites around the cursus, including a henge, small rectilinear enclosures, and ring-ditches, some hengiform. The cursus cuts a long mortuary enclosure on a similar axis, towards its NW'n end. Dating evidence suggests construction 3510-2920 BC, and that the site provided a focus for monuments in the area for over a millennium.

At Overy, about 800m further to the SE, a large sub-rectangular enclosure, a length of double parallel ditching, and associated ring-ditches form a further complex, of uncertain relationship with the cursus, although the broad alignment of double ditching and cursus has suggested the possibility of some larger-scale structure.

-interpreting the alignment in terms of the solar transit (see Table of Contents:02c/2e; sites included are listed in TABLE CU-01)
The line of the cursus lies close to that of solstitial axis 1 (NW-SE: \), a match also seen at Scorton (e-FIG CU-15), and partially at Fornham All Saints (e-FIG CU-09).

Orientation of the site on midsummer sunset to the NW, and midwinter sunrise to the SE, has been considered particularly significant (Bradley and Chambers 1988). Ruggles (1999, 127-128) also notes alignment of the central section on midsummer sunset. However, close coincidence with solstitial axes is not seen generally in the sample of cursus sites in this analysis (e-FIG CU-19; TABLE CU-04), with no peaks of frequency around these limiting positions.

The site lies in the SE'n peak of frequency, weakly evident in analysis of alignment for the national sample (e-FIG CU-19) and, as a representative member, its corresponding seasonal access to the solar transit is examined in more detail below.

If only lower elevations of the transit are considered, then the axis would allow only the briefest precise contact with the sun, at around the stated solstices. However, including higher elevations would provide additional contact, from autumn to spring, providing a more regular basis for any solar ritual (TABLE CU-05; e-FIG CU-21).

TABLE CU-05 Dorchester cursus: correspondence between the axis and solar risings, settings, or transits

SOLAR EVENTS:

		at the horizon elevation = 0°				transits near the horizon elevation < 10° maximum				transits up to mid elevation elevation < 20° maximum			
sector	**ax**	**rise**	**DT**	**set**	**DT**	**rising**	**TF**	**setting**	**TF**	**rising**	**TF**	**setting**	**TF**
all	128	21DEC	1			7nov-7feb	92			7oct-5mar	149		
	-308	21JUN	1					none	0			none	0

all transits up to maximum elevation

		rising	**TF**	**setting**	**TF**
all	128	all year	365		
	-308			none	0

Note and Key: details as for Dorset Cursus: TABLE CU-08.

The Dorset Cursus; Dorset; SU 0115; length 9900m; width about 100m; axis 049-229°G between extreme terminals; NMR linear 41; e-FIGS CU-03 to 06; phot CU-01 to 02;
bibliography: Penny and Wood 1973; Barrett *et al*. 1991, 1991a; Ruggles 1999, plan: fig. 8.3/p. 127; Barclay and Harding 1999, plan: fig. 4.1/p. 41;

-general structure (e-FIGS CU-03 to 06; TABLE CU-06).

This, the longest cursus in the sample (TABLE CU-06), runs in a curving NE-SW'ly course, transversely over low chalk ridges, flanking headwater stream valleys of the River Allen. From the NE it crosses relatively level ground for the first 3km, thereafter crossing three stream valleys, to end at the SW on a similar level to its starting point.

Between its extreme terminals, the monument undergoes several changes of course, with component elements of various length and straightness. There is conflicting evidence as to the relative status of each side of the perimeter: the SE'n is suggested as straighter, and more continuous than the NW'n, but with a shallower ditch, where sectioned. Near the better-preserved SW'n terminal, the banks are 106m apart, typical of the width over most of the cursus.

The cursus contains one clear, intervening, transverse terminal, lying part way along its length (e-FIG CU-03 and 05; TABLE CU-06), marking a distinct component sector of the entire monument. These discontinuities of line suggest construction in stages, with at least two sub-structures, placed end to end, traditionally designated as the Pentridge and Gussage cursus monuments. Such changes may also suggest adaptation, or loss of line, while traversing more difficult topography over valley areas. The monument was also constructed in a landscape already partially settled, and cleared, and this too might well have influenced its course.

As well as providing a defined axis, its line might also have served to divide higher ground to the NW from lower areas to the SE, perhaps of some symbolic meaning, or a more practical statement of territorial division.

The entire monument consists of three main sectors, as defined by more marked changes in direction, and by presence of terminals, and each of these sectors contains further elements, marked by lesser changes (TABLE CU-06):

TABLE CU-06 Dorset cursus: structural properties

	NGR at NE'n end	az(°G)	L(km)	%tl	diff	struc	topographical
NE end							
sector *1:* ('the Pentridge cursus')							
e1	SU 0400 1920	037-217	0.3	3	-	terminal	Bockerley Down
e2	SU 0383 1900	030-210	2.4	24	-7		
e3	SU 0260 1690	035-215	0.5	5	+5	lb at NW'n side	Salisbury Plantation
e4	SU 0233 1653	044-224	0.7	7	+9		
e5	SU 0183 160	036-216	0.45	4.5	-8		
total			***4.35***	***44***			
abt		***035-215***					
sector *2:* ('the Gussage cursus')							
e6	SU 0155 1565	048-228	1.5	15	+8	terminal	Bottlebrush Down
e7	SU 0040 1455	056-236	0.9	9	+8		
e8	ST 9968 1418	040-220	0.2	2	-16	?terminal	Gussage Down
e9	ST 9953 1395	058-238	0.25	2.5	+18		Gussage Hill
total			***2.85***	***29***			
abt		***051-231***					
sector *3:*							
e10	ST 9930 1380	060-240	2.7	27	+2	lb lies across	Gussage Hill
SW end	ST 9695 1245					terminal	Thickthorn Down
total			***2.7***	***27***			
abt		***060-240***					
OVERALL LENGTH				**9.9**			

MEAN ALIGNMENT for the entire cursus: 049-229 °G, between extreme *termini.*

Key: e(lement, numbered lengths of differing alignment); **az**(imuth of the axis); **L**(ength of the sector); **%tl** percentage of the total length of the cursus); **diff** (angular difference in alignment between adjacent sectors); **struc**(tural elements of the cursus associated, **lb** long barrow; **topographical** (features nearby); **abt** alignment between terminals.

..sector 1: the NE'n Pentridge cursus

The perimeter consists of a bank, and external ditch. Excavation at the site has been at extremely small scale, and has concentrated on the side ditches. Where sectioned, these are trapezoidal, 3m wide at the top, 2m wide at the base, and 1.4m deep. The bank might have been revetted with turf and chalk blocks. Radiocarbon dates, from near the base of the ditch, lie around 3300 BC, and are in agreement with the small ceramic assemblage found. Evidence for ritual is scant, but finds of fragmented human bone from ditch may possibly suggest nearby areas for excarnation.

The NE'n terminal of the cursus is clear, and runs approximately perpendicularly to the long axis, and that at the SE, rather than being integrally closed, its end appears to run up to, and abut, the terminal of the next main sector 2, the Gussage cursus, continuing to the SW.

..sector 2: the SW'n Gussage cursus

This sector continues SW'ward from sector 1, with a change of line, from higher ground, then over a valley, to regain similar altitude in the area of the Gussage Down long barrow, which lies transversely across it, and could mark a terminal-like division, about midway. Other long barrows, lying adjacent to the extreme NE'n and SW'n terminals, align with these terminals, remaining separate from them, but the Gussage Down long barrow might have fulfilled a dual purpose. In no case has the chronological relationship between long barrows and the cursus been established, and it is unknown whether they were pre-existing, or added features. From the Gussage Down long barrow, the course of the cursus dips again over the next valley, to end on higher ground at the clearly defined SW'n terminal.

-associated monuments

Because of the unusual number of barrows, mainly round, that occur in the area of the cursus, these sites were counted, and their density plotted per kilometre square, over an extended area. The general distribution was thus determined, and its possible relationship with the line of the cursus examined (e-FIGS CU-05 and 06).

..long barrows

About 14 long barrows lie either on, near, or adjacent to the line of the cursus (TABLE CU-07; e-FIG CU-05):

TABLE CU-07 Dorset Cursus: associated long barrows

Note: barrows are numbered at the left, as shown in e-FIG CU-05; the naming of barrows follows that of Penny and Wood 1973, figs. 1 and 2; sites which are excluded from Penny and Wood's scheme of astronomical alignments are numbered thus **[..]**;

Pentridge cursus		**NGR (SU-)**	**loc**	**alig**	**note**
1	?mortuary enclosure	0416 1893	adj	perp	near the NE'n terminal;
1a	long barrow	0416 1893	adj	perp	points to the NE'n terminal;
[2]	Pentridge I	0415 1875	near	perp	
3	Pentridge IIa-b	0410 1910	adj	perp	1-2 barrows, point to the NE'n terminal;
4	Pentridge III	0393 1950	near	perp	
5	Pentridge 8	0310 1797	near	perp	
[6]	Pentridge IV	0255 1695	on	par	part of the N'n perimeter;
7	Wor Barrow	0123 1725	off	perp	
8	Gussage All Saints 12	0138 1625	off	?	Berend's Barrow: ?long or round;
Gussage Cursus		**NGR (ST)**	**loc**	**alig**	**note**
9	Gussage St Michael III	9630 1383	on	perp	?utilised as internal division;
[10]	Gussage Hill	9945 1360	off	perp	
[11]	Gussage St Michael	9930 1310	off	~perp	
12	Gussage St Michael I	9703 1240	near	perp	points to the SW'n terminal;
13	Gussage St Michael II	9718 1226	near	perp	points to the SW'n terminal;
[14]	Thickthorn	9645 1317	off	perp	

Key: loc(ation), **adj**(acent); **alig**(nment with respect to the general axis of the cursus), **par**(allel), **perp**(endicular, or otherwise angled).

Particular concentrations of long barrows occur around the extreme terminals, with individual monuments lying on, or near, the intervening line (e-FIG CU-05), in one case forming part of the perimeter, in another perhaps a partial internal division. The long axes of these barrows run perpendicular to that of the cursus, and this is a conspicuous trend.

The orientation of long barrows in the area is fairly consistently towards the W-NW, taken from front to rear, which is typical of the wider group from Britain (e-FIGS LB 01-21), and stands in marked contrast to the S'ly trend for alignment shown by cursus monuments in general (e-FIG CU-19). This could suggest a difference of emphasis between the two types of monument, with barrows aligned towards the setting limb of the sun, and cursus monuments, with far fewer direct funerary associations, more closely associated with sectors around the sunward zenith (see Table of Contents: 02c/2i and 03a/13a). This contrast is also seen amongst the few hengiform monuments in the area of the cursus, which again, typical of their group, show alignment of entrance gaps towards the S'n arc of the sky (e-FIG CU-03). The cursus seems to be linking monuments, which retain alignments typical of the funerary tradition (see Table of Contents: 02c/2I), into a fresh alignment, perhaps more closely related to seasonal and economic concerns expressed in relation to the S'n transit of the sun.

..a 'long mortuary enclosure', and long barrow; SU 0416 1893; TABLE CU-07, sites 1 and 1a; e-FIG CU-03;

Aerial photography, and geophysical survey have revealed two further monuments close to the NE'n end of the cursus, near known long barrow Pentridge 3. A rectangular ditched enclosure, 100m by 25m, and open at the E'n end, is aligned 080-260ºG. The side-ditches of what appears to be a short long barrow taper towards the N, and lie just beyond the W'n terminal of the enclosure, and in parallel with it (geophysical plan: digitaldigging.net/ Martin Green 11.12.2013). The axis of the enclosure is more W'ly pointing (front to rear) than the long barrows in its immediate vicinity, which seem to align on the terminal of the cursus. The axis of the short barrow abutting its W'n end is oriented NW-SE'ward, more in accordance with the general alignment of long barrows in the area.

..round barrows

Many round barrows occur in the vicinity of the cursus, lying in a fairly discrete linear zone, out to several kilometres around the monument, this elongate distribution, seemingly shaped by attraction to the line of the cursus (e-FIG CU-06). The distribution of these barrow sites, over the area around the cursus, shows distinct clustering around its line, laterally and especially beyond the SW'n end, both in terms of frequency, and degree of aggregation (see Table of Contents: 03h/2i). It is clear that the line of the Neolithic cursus acted as an important factor in growth of funerary areas around it during the ensuing Bronze Age, although the extent to which the cursus continued as a functioning monument, as originally intended, is unknown.

Development of the complex

There is no direct stratigraphic evidence supporting a clear structural sequence for the entire complex, arguments being based largely on spatial consideration of the field-monument. For instance, the SW'n cursus is usually quoted as being earlier than that to the NE, this suggested by the clear terminal at the NE'n end of this SW'n Gussage cursus, with the NE'n Pentridge cursus appearing to have been abutted onto this. It could equally be argued that, if the Pentridge cursus was constructed first, and expanded towards the SW, its extended line could have been revitalised by a second onward stage with clear initial terminal.

Relationships between long barrows and the cursus are also equivocal (TABLE CU-07):

-Pentridge (NW'n) cursus

This sector incorporates a long barrow in its NE'n side (Pentridge IV), perhaps providing an aiming point for the growing cursus. However, its orientation towards the SW is somewhat atypical of the group occurring around the cursus, and it might have taken its cue from the line of the cursus, or some interim sector of it, rather than using any more W'n target.

As seen at the SW'n terminal of the Gussage cursus, the long barrows adjacent to the NE'n terminal of the Pentridge cursus share the same approximate line, but the order of any imitation is unknown.

-Gussage (SW'n) cursus

Another long barrow, Gussage St Michael III, is included in the course, this time transversely, perhaps again providing an existing marker for alignment, but in neither case should this, unsupported by stratigraphic data, imply priority for the funerary monument.

The extreme SW'n terminal of the cursus is not squared, and has been thought perhaps to share the line of an adjacent existing long barrow, Gussage St Michael I, with similarly aligned II nearby, but again this relationship could be reversed.

There is certainly a spatial relationship between cursus and long barrows, and terminal banks have been discussed as emulating the form, and scale of long barrows. Whatever its detailed sequence of construction, the final cursus complex came to bridge areas in which long barrows lay, perhaps providing a symbolic line of connection, or avenue for some sort of processional use, linking key funerary areas into a significant alignment on the SW'n sky.

Alignment and function of the monument

-existing views

In discussing aspects of ritual at the site, much has been made of suggested purposeful alignments between selected elements of the cursus, surrounding monuments, and limiting solar, and lunar risings, and settings. It is worth discussing one case in more detail, that of Penny and Wood (1973), as typical of those astronomical interpretations frequently proposed for megalithic and other sites, of the type seen for instance in Thom and Thom 1990.

..Penny and Wood (1973) note as significant eight alignments (A-G), taken between points on the cursus and adjacent sites, or between these monuments: three based on solar, and five on lunar targets (table 2; fig. 13; recast in e-FIG CU-05 for this analysis):

solar: solstices
Note: long barrows are listed in TABLE CU-07.

alignments:

A: within the cursus; towards 231°; from the NW'n terminal of the Gussage cursus, running SW'ward to Gussage St Michael III long barrow;

target: mid winter solstice sunset;

F: from the cursus; towards 231°**;** from Pentridge III long barrow, running SW'ward to Wor Barrow;

target: mid winter solstice sunset

Alignment A is much quoted as visually impressive, and of singular importance for ritual at the monument, by viewing the mid winter solstice sunset. It should be noted here that the overall alignment of the cursus, as defined between the extreme *termini* at NE and SW, also approximates alignment A but, unlike the Gussage cursus, the terminals are not directly inter-visible. Any similar viewing of the solstice would, therefore, be from the NE'n terminal, towards the indirectly known area of the SW'n terminal.

G: from the cursus; towards 128°; the line formed by the extreme SW'n terminal of the monument, and two long barrows, Gussage St Michael I and II, when viewed from the terminal outwards;

target: mid winter solstice sunrise;

lunar standstills:

B: within the cursus; towards 238°, and its reverse 060°: from the Gussage St Michael III long barrow SW'ward to the extreme SW'n terminal of the monument, and the reverse direction;

targets: the most S'ly minor setting at 238°, and the minor, most N'ly rising at 060°;

C: from the cursus; towards 218°: from the extreme NE'n terminal of the monument towards Pentridge 8 barrow;

target: the most S'ly major setting;

D: from the cursus; towards 041°: from Gussage St Michael III long barrow to Gussage All Saints 12 barrow towards, and on to, Pentridge III long barrow; **target: most N'ly major rising;**

E: from the cursus; towards 218°: Pentridge III long barrow to Gussage All Saints 12 barrow;

target: most S'ly major setting.

The choice of alignments seems selective, fitting preconceptions to data, with other combinations of terminals and barrows ignored. Furthermore, proposing lines of sight between different types of site, namely points on the cursus on and barrows, these being monuments of different form, function, and properties of orientation, also seems risky, especially when the chronological relationships remain unknown. Only two of the lines are internal, and hence directly relevant to the cursus, one solar, the other lunar, and even here only involve half of it, the Gussage cursus. The other lines are wholly, or partially involved with adjacent long barrows. Various other possible alignments have been ignored, for instance, those in the NE'n half of the monument, the Pentridge cursus, and certain other long barrows have been omitted (TABLE CU-07: numbered entries shown thus [ ]).

Even including alignment A, the choice of sight-lines, and the general interpretation of any astronomical connections, seems weak, contrived to support pre-existing ideas of matching structure with liminal events at the horizon.

..Ruggles (1999: plan fig. 8.3/p. 127, also p. 128) considers the site as a possible solar and lunar observatory, dating to the earlier Neolithic, and stresses the significance of alignment A (as noted above).

The influence of existing monuments in establishing the line of the cursus is noted as a factor additional to purely astronomical considerations, as part of a pattern of influences linked to the physical and symbolic landscape, nature, the dead, and the celestial sphere. The need for orientation of cursus monuments to be assessed by data from the group, rather than from single sites is also stressed.

Possible alignment of cursus monuments on events in the solar cycle, limiting solstices, and intervening equinoxes, are seen as a possible shift away from the lunar symbolism proposed by some in earlier long barrows (Burl 1981).

..Barclay and Harding (1999, fig 4.1/p. 41) again note possible construction in two stages, the Gussage section as initial, with the Pentridge final, perhaps implying growth towards the NE, and hence some additional interest in this direction. Again, alignment of the central part on midwinter sunset is noted, without explanation of incompatible orientation amongst the other sectors.

-interpreting the alignment in terms of the solar transit (see Table of Contents: 02c/2)

The conclusions reached above seem most unsatisfactory, and are at variance with the lack of any clear general correspondence between axial alignment and limiting solar, or lunar events. For those few sites that do align fairly well with solstitial axes (for example Scorton: e-FIG CU-15 and Dorchester: e-FIG CU-02) chance appears to provide an equally convincing explanation.

A possible relationship between the Dorset Cursus and the solar cycle seems entirely plausible, but interpretations need to be broadened beyond one alignment on a single sunset-event at midwinter solstice. It seems unreasonable that such a large and important monument should have astronomical relevance briefly only once a year. The range of alignments seen amongst all sectors within the cursus complex also need to be brought into the discussion, rather than sidelined without any explanation being offered.

The site lies in the SW'n peak of frequency, as weakly evident in analysis of alignment for the national sample (e-FIG CU-19) and, as a representative member, its corresponding seasonal access to the solar transit is examined in more detail below.

The following analysis discusses the SW'ly orientation of the cursus in terms of its possible relationship with solar transits during the entire year, rather than with single events at limiting positions (TABLE CU-08; e-FIG CU-22).

This analysis of axial efficiency, as measured by the frequency of its intersection with the solar transit throughout the year, for various elevations (transit-frequency), has been carried out for four other major cursus monuments, in addition to the Dorset Cursus. Considering the general case of the entire solar transit for all elevations, the efficiency of an axis increases as it approaches the permanent zone, reaching a maximum of year-round exposure when it enters. Results for these sites have been tabulated, and appear in e-FIGS as follows:

	axis(°)	TF (days)	TABLE CU-	e-FIG CU-
Drayton N	196	365 max	-	07
Dorchester	308	365 max	-	21
Scorton	312	365 max	-	15
Stanwell	334	365 max	-	16
monuments considered in more detail:				
Dorset Cursus sector 1	**215**	**365 max**	**08**	**22**
Dorset Cursus sector 2	**231**	**365 max**	**08**	**22**
Fornham All Saints	**322**	**365 max**	**10**	**21**
Rudston A	**190**	**365 max**	**12**	**23**
Dorset Cursus sector 3	**240**	**335**	**08**	**22**
Rudston B	**248**	**254**	**12**	**23**
Stonehenge Greater	**263**	**205**	**13**	**21**
Rudston C	**274**	**161**	**12**	**23**

Key: TF transit-frequency;
Note: directions within the axis are only shown for the W'n hemisphere 180-360°G

Plotting means of azimuth for the axes of sectors 1-3 against the annual range of solar risings, settings, and transits, as calculated for the latitude and longitude of the cursus (2°W, 50.93°N, similar to those used as a basis for e-FIG AS-04, gives the data in TABLE CU-08:

TABLE CU-08 DORSET CURSUS: CORRESPONDENCE BETWEEN THE AXIS AND SOLAR RISINGS, SETTINGS, OR TRANSITS

axial intersection with SOLAR EVENTS:

		only *at* the horizon				**including transits *near* the horizon**				***up to mid elevation***			
		elevation = 0				**elevation < 10**				**elevation < 20°**			
sector	**ax**	**rise**	**TF**	**set**	**TF**	**rising**	**TF**	**setting**	**TF**	**rising**	**TF**	**setting**	**TF**
1	035	null	**0**	-		null	**0**	-		null	0	-	
	-215	-		perm	0	-		28nov-14jan	47	-		20oct-14feb	**117**
2	051	**21JUN**	**1**	-		**21JUN**	**1**	-		**21JUN**	1	-	
	-231	-		**21DEC**	**1**	-		7nov-7feb	92	-		30sep-7mar	**158**
3	060	12may	1	-		12may-	**68**	-		12may-	**68**	-	
		21jul	1			20jul				20jul			
	-240	-		20nov	1	-		10oct-14nov	**3**	-		25sep-12mar	168
		20jan	1					20jan-14feb	**25**				

for all transits *up to maximum elevation*

		rise	**TF**	**set**	**TF**
1	035	null	0	-	
	-215	-		perm	**365**
2	051	21JUN	1	-	
	-231	-		perm	**365**
3	060	12may-	68	20jan-	
	-240	21jul		14nov	**335**

combined transit-frequencies:

	TF for rising and setting			maximum TF
elevation (°)	**at 0**	**<10**	**<20**	**all**
TF for sector 1	0	47	117	365
2	2	93	159	365
3	4	128	236	335

Key: sector: details given for each sector of the cursus, if differently oriented;
ax(is of the cursus in °G; mean for all elements within the sector);
TF: transit-frequency for the sun;
null (axis points to the null zone of the transit, where solar risings and settings do not occur);
perm (axis points to the permanent zone of the transit, where the sun is always above the horizon);

Note: dates of solstice are marked in upper case.

The mean axis for the entire cursus, taken between extreme *termini*, is 049-229°, for which values relating to sector 2 approximate.

Considering risings and settings at the notional zero horizon, the axes of sectors within the cursus (TABLE CU-08) correspond with very few solar events. Only sector 2 corresponds with rising and setting solstices, sector 1 is null, and sector 3 gives a few intersections. Increasing the range of permitted intersections to include the transit at higher elevation increases the efficiency of the axis.

Viewing towards the SW, the cursus would have allowed extensive contact with the solar transit, perhaps particularly during its lower, and more spectacular elevation, as seen during critical winter months, when perhaps more actively involved in propitiating and mitigating conditions for forthcoming seasons.

Drayton; Oxon; SU 4894; total length 1700m; width 75m; axis: N'n sector 016-196°G, S'n sector 025-205°G; NMR SU49SE 83; e-FIG CU-07; phot CU-03;
bibliography: Barclay *et al.* 2003;

The cursus, adjacent to the River Thames, runs in a slightly curving course towards the SSW, from a slight rise at the N'n end, down over a stream valley, where its line is lost, and on to slightly lower ground. The overall plan is sub-rectangular, with clear terminals evident, and various gaps in the lateral perimeter suggesting access. Extensive excavation has produced much information on the perimeter, and on patterns of activity in, and around the monument.

An elongate enclosure, and oval barrow lie just to the E of the cursus, and on the same axis. A marked cluster of round barrows lies beyond the N'n end, and on area of the cursus itself there are more such ring ditches over its S'n half than the N'n.

Fornham All Saints; Suffolk; TL 8367; length >1870m; width 23-34m; axis 142-322°G; NMR TL86NW 11; e-FIGS CU-09 and 21;

-general structure (e-FIG CU-09; TABLE CU-09)

The cursus runs SSE'ward, following a low ridge of slightly higher ground flanking, and broadly parallel with an adjacent stream, just above its modern flood-plain. The cursus consists of four sectors of similar length, set in slightly different directions, to form a curving line. The N'n terminal has not been located, but that at the S survives as a clear crop-mark, with a nearby gap in the lateral perimeter suggesting an entrance. A transverse ditch, about mid-way along the cursus, in sector 3, may indicate internal division, or that the cursus is composite (TABLE CU-09).

TABLE CU-09 FORNHAM ALL SAINTS CURSUS: STRUCTURAL PROPERTIES

	NGR at NE'n end	az	L	%tl	diff	struc
NW end						
sector						
1	TL 8285 6875	164-344	>0.30	16	-	no terminal
2		153-333	0.48	25	11	
3		130-310	0.63	32	23	
4		136-316	0.53	27	6	
SE end	TL 8405 6730		terminal			
total			>1.94			
abt		**142-322**				

Key: az(imuth of the axis in °G); **L**(ength of the sector in km); **%t**(otal) **l**(ength of the cursus); **diff**(erence in alignment between adjacent sectors, in degrees); **struc**(tural elements of the cursus; **abt** alignment between terminals.

-associated monuments

A Neolithic causewayed enclosure lies just to the N of the mid-area of the cursus. No long barrows are known from the immediate vicinity, but round barrows are visible as crop-marks, a few along the S'n margin of the cursus, with a conspicuous group around the S'n terminal. This accretion of round barrows around the S'n end of cursus sites has been noted elsewhere, as at the Dorset Cursus, Rudston, and Scorton.

-function and orientation

The cursus lies on a general NW-SE'ly axis, with its component sectors introducing some variability of line. Sector 3 alone falls close to solstitial axis 1 (\: NW-SE), with the remaining two-thirds of its length at variance.

-interpreting the alignment in terms of the solar transit (see Table of Contents: 02c/2)

The axis of the site lies in the SE'n peak of frequency, weakly evident in analysis of alignment for the national sample (e-FIG CU-19) and, as a representative member, its corresponding seasonal access to the solar transit is examined in more detail below.

Considering all elevations, the SE'ly direction within the axis of the cursus would allow intersection with solar transits throughout the year, but only in the rising limb. If only lower elevations are included, then coverage of the rising limb would be limited to the deepest winter months (TABLE CU-10; e-FIG CU-21;).

TABLE CU-10 Fornham All Saints cursus: correspondence between the axis and solar risings, settings, or transits

axial intersection with SOLAR EVENTS:

		only *at* the horizon				including transits *near* the horizon				*up to mid elevation*			
		elevation = 0				**elevation < 10**				**elevation < 20°**			
sector	**ax**	**rise**	**TF**	**set**	**TF**	**rising**	**TF**	**setting**	**TF**	**rising**	**TF**	**setting**	**TF**
all	142	perm	**0**	-		28nov-	**47**	-		21oct-	120	-	
	-322	-		null	0	14jan		null	0	18feb		null	**0**

for all transits *up to maximum elevation*

		rise	TF	set	TF
all	142	perm	365	-	
	-322	-		null	**0**

combined transit-frequencies:

	TF for rising and setting			maximum TF
elevation (°)	**at 0**	**<10**	**<20**	**all**
TF for all	0	47	120	365

Note and Key: details as for the Dorset Cursus: TABLE CU-08.

Rudston complex; Humberside; TA 0969; length: Rudston D 3900m, others as outlined below; width: Rudston D 50-90m; axis 005-185°G; NMR TA06NE 48; e-FIGS CU-12 to 14; TABLE CU-11; bibliography: Dymond 1966; Stoertz 1997; Chapman 2005;

-general description

A complex of five cursus monuments (Rudston A-E) occupies the floor, and sides of a shallow N-S'ly trending stream valley, with a large monolith, possibly related, at a focal point in the valley, at the S'n end. A henge, and numerous round barrows lie within its area, and around its margins (e-FIG CU-13).

The component cursus sites range in length from 3.9km (D), to 2.7km (A), down to the shortest (E) at >0.15km. Two of the monuments, D and A, are traceable for most of their line as crop-marks, with the others known only in part. Topographically, the sites fall into two groups. Cursus D descends towards the S from higher ground at its N'n terminal, and then along the valley bottom; cursus sites A, C, and possibly B, run transversely across the valley, between hills; and to the east a minor cursoid runs along a lower hill slope.

The longest cursus in the complex (D) consists of parallel ditches, about 50-90m apart, that run in a slightly curving course, from a N'n terminal, to fade without resolution at its S'n end, in the area of the massive Rudston monolith, a feature of uncertain relationship, 7.9m high, even with its broken tip.

The second longest cursus (A) follows a similar orientation to D, and lies alongside its S'n sector, draped across the junction of the stream valley, between known *termini* on higher ground, details of any central sector lost to the stream, and its flood plain. Whether this monument was single, or contained two separate sub-units either side of the stream remains unknown. A sudden notable change in direction occurs as it ascends the slope, towards its S'n terminus.

Cursus B, and C are shorter, and run towards the SW, and W respectively, ascending from the bottom of the valley to higher ground. Cursus B has a terminus at its SW'n end, its line to the NE fading as it approaches the stream, but generally pointing towards the area of the Rudston monolith, as does cursus D. Cursus C runs between higher ground on either side of the stream valley, at the E'n end abutting, and perhaps terminating at cursus D, and appearing open to the W as it approaches a cluster of round barrows. In contrast to the other members of the group, cursus E is a very small rectangular enclosure, of a size more in accord with those of 'long mortuary enclosures'.

Very little excavation has been carried out at the complex, certainly not commensurate with its importance. Cursus A has experienced minor excavation of its ditch, and early excavation of barrows adjacent to its S'n-most end. Cursus C was examined by localised excavation, but no finds were made.

TABLE CU-11 Rudston cursus complex: structural properties

	NGR at NE'n end	az (°G)	L	%tl	diff	struc	topographical
cursus D							
e1	TA 1015 7178	011-191	0.6	15	-	terminal	Maiden's Grave Hill
e2	TA 1005 7115	007-187	1.5	38	-4		
e3	TA 0987 6975	003-183	1.8	46	-3	terminal	Rudston monolith area
total			**3.9**				
mean		**005-185**					
cursus A							
e1	TA 1035 6838	013-193	>0.7	37	-	terminal	Argam Dykes Hill
e2	TA 1015 6733	009-189	1.1	41	-4		
e3	TA 1000 6630	160-340	0.3	11	-29		
e4	TA 1005 6600	003-183	0.3	11	23	terminal	Rudston Beacon flank
total			**2.7**				
mean		**010-190**					
cursus B							
e1	TA 0932 6735	068-248	>1.3	-	-		Rudston village
	TA 0810 6688					terminal	
total			**>1.3**				
cursus C							
e1	TA 1020 6800	094-274	>1.6	-	-		Bridlington Gate
	TA 0865 6805						
total			**>1.6**				
cursus E							
e1	TA 0995 6695	065-245	>0.15	-	-		
	TA 0980 6690					terminal	
total			**>0.15**				

Note: NGRs have been extracted from a reluctant best-fit between an overlay of crop-marks from HER records, Stoertz 1997, and Ordnance Survey mapping; cursus sites are listed in order of decreasing known length;

Key: e(lement, numbered lengths of differing alignment); **az**(imuth); **L**(ength of sector in km); **%tl** percentage of the total length of the cursus); **diff**(erence in alignment between adjacent elements); **struc**(tural features of the cursus associated); **topographical** (features nearby).

-associated monuments (e-FIGS CU-12 and 13)

..long barrows

The immediate area of the Rudston complex includes no known long barrows, unlike the Dorset Cursus, which appears to link areas of long barrow construction, and also to include them in its course (e-FIG CU-05). However, there is a single possible long barrow, or mortuary enclosure, on a ridge just to the E of the N'n terminal of cursus D, and a second similar site, the Rudston barrow, on the upper hill-slope of the valley, about 1.5km W of the Rudston focus (e-FIG CU-12 and 13).

There are, however, many such long barrows scattered over the surrounding area, especially to the W, and their general W-NW'ly orientation (taken from front to rear) is typical of their group as a whole (e-FIG CU-12). Partial excavation at some of these barrows indicates a Neolithic date (examples: Manby 1963, 1976; Ashbee 1984: gazetteer). They provide an interesting contrast with the generally S-SW'ly orientation of the Rudston complex, and of the entire sample of cursus sites as a whole, a difference in polarity seen again at the Dorset Cursus (e-FIG CU-05). The long barrow could be seen as representing an orientation with more funerary connotations towards the W'n arc of the sky, with cursus monuments, sites of less directly funerary content, embodying more seasonal-economic preoccupations expressed towards the sunward S'n arc of the solar transit.

..round barrows

Round barrows, of later Neolithic and earlier Bronze Age type, are numerous in the immediate area of the cursus complex, mainly occurring in small to larger clusters. Significant groups appear on higher ground, towards the S'n to W'n ends of cursus sites A-D, with a small cluster at the N'n terminals of cursus D, and A.

Close dating for the cursus complex is generally lacking, but it is assumed to be of Neolithic construction, perhaps early in this period. Direct dating of the round barrows here is again absent in most cases, but they appear to be of typical earlier Bronze Age type, and hence would seem to represent accretion of funerary areas around the line of each cursus, as seen for the Dorset Cursus. These known clusters of round barrow could, however, mark traditional funerary areas, of earlier use. As in the case of the Dorset Cursus, the monuments at Rudston could be seen to link funerary areas into a general S'ly alignment, as also seen in the case of many stone rows, and amongst extended barrows (see Table of Contents: 03d and 03b respectively).

..henge monuments

The single henge, at Maidens Grave (TA 0967 0965), lies near the N'n end of cursus D, and displays opposed entrances, of broadly NW-SE'ly axis. This arrangement is typical of many henges of its type (e-FIG HE-39), perhaps also reflecting an interest in the S'n arc of the solar transit, and providing another contrast with the W-NW'ly emphasis seen amongst long barrows.

-function and orientation

The three main cursus sites at Rudston, D, A, and B, could be seen as marking lines of sight, and of procession, between key areas at, and around, their terminals, and as defining axial views out to other monuments, and the wider landscape (Chapman 2004).

Cursus D has a small funerary area around its N'n end, and a larger one flanking its S'n sector, with the Rudston monolith lying at its conjectural S'n end, the funerary associations of which remain unknown. Its line could be viewed from the N, and walked for the entire length, except for possible seasonal flooding over its S'n-central zone, where it runs alongside the stream.

Cursus A runs S'ward, from a similar small funerary area near its N'n terminal, crosses the stream and its flood-plain, to ascend the hill-slope towards major funerary areas. Its use as a sight-line to the S, and over these latter areas would be practical, even if direct passage along the length was impeded.

Viewing the transit of the sun, especially when lower in the sky, as it crossed the axis of the cursus, and behind associated funerary areas, might have provided a suitable context for ritual (02c/2e and 2i). If this basis is valid, then cursus sites A and D would have been aligned on the sun near its meridian at the S, with sites B and C aligned more towards the W, allowing views of the sun on its setting limb, providing combined and increased lateral coverage.

Pursuing this idea indicates that these sites might have been active at different times of year. The S'ly alignments of sites D and A would intersect solar transits throughout the year, since they lie towards the permanent zone (see Table of Contents: 02c/2e; e-FIG AS-09). However, the W'ly lines of cursus B and C would only intersect the transit for parts of the year, since the setting limb of the sun cycles past them between solstitial extremes, setting only twice on their exact line, but passing higher in the sky for longer periods (TABLE CU-12; e-FIG CU-23).

Examples of S'ly and W'ly axes, linked by a major monolith-menhir, are suggested for Rudston (TU 0969; Yorks; e-FIGS CU-12 to 14), and Loqmariaquer (Brittany; e-FIGS AS_brit-09 to 12), as jointly summarised in e-FIG CU-24.

-interpreting alignments in terms of the solar transit (see Table of Contents: 02c/2)

The site lies in the S'n peak of frequency, weakly evident in analysis of alignment for the national sample (e-FIG CU-19) and, as a representative member, its corresponding seasonal access to the solar transit is examined in more detail below.

The two longest cursus sites, D and A, being oriented to the S, are not capable of intersecting sunrise and -set, but only solar transits, and these throughout the year, near the zenith, as viewed from higher ground at their N'n ends (e-FIG CU-13). Allowing all elevations as important then there is good access, but if only elevations nearer the horizon are allowed then coverage shrinks to that for the deepest winter months, November to January. The opposite lines of cursus D and A, those towards the N would, of course, fall within the null zone of solar activity, where no transits occur.

The smaller cursus sites B, C, and E, pointing towards the SW and W, would give summer coverage, if all elevations of the transit were included. If considering only lower elevations, then this coverage divides between isolated periods either side of summer, during winter-spring, and autumn-winter. The general analysis is shown below in TABLE CU-12:

TABLE CU-12 Rudston cursus complex: correspondence between axes and solar risings, settings, or transits

axial intersection with SOLAR EVENTS:

		only *at* the horizon				**including transits *near* the horizon**				***up to mid elevation***			
		elevation = 0				**elevation < 10**				**elevation < 20 °**			
sector	**ax**	**rise**	**TF**	**set**	**TF**	**rising**	**TF**	**setting**	**TF**	**rising**	**TF**	**setting**	**TF**
oriented to S:													
D	005	null	0	-		null	0	-		null	0	-	
	-185	-		perm	0	-		null	0	-		17nov-22jan	66
A	010	null	0	-		null	0	-		null	0	-	
	-190	-		perm	0	-		perm	0	-		12nov-26jan	158
oriented to SW and W'ward:													
B	068	12apr	1	-		24apr-28may	35	-		24apr-21jun	58	-	
		14aug	1			16jul-16aug		31		21jun-16aug	56		
	-248	-		17feb	1	-		2oct-26oct	24	-		12sep-25oct	43
				25oct	1			14feb-4mar	20			14feb-2apr	49
C	94	12mar	1	-		10mar-2apr	23	-		10mar-26apr	47	-	
		2oct	1			12sep-7oct	25			14aug-2oct	49		
	-274	-		2apr	1	-		2apr-14apr	12	-		2apr-7may	35
				10sep	1			28aug-10sep	13			1aug-10sep	40

for all transits *up to maximum elevation*

		rise	TF	set	TF
D	005	null	0	-	
	-185	-		perm	**365**
A	010	null	0	-	
	-190	-		perm	**365**
B	068	24apr-	113	14feb-	254
	-248	16aug		25oct	
C	094	12mar	204	2apr-	**161**
	-274	7oct		10sep	

combined transit frequencies:

		TF for rising and setting			maximum TF
elevation (°)		**at 0**	**<10**	**<20**	**all**
TF for cursus	D	0	0	66	365
	A	0	0	75	365
	B	4	110	206	254
	C	4	73	131	161

Note and Key: details as for Dorset Cursus: TABLE CU-08.

Scorton; North Yorks; NZ 2300; length 1676m; width 32m; axis 132-312°G; NMR NZ20SW 11; e-FIG CU-15; phot CU-04;
bibliography: Topping 1982.

-general structure (e-FIG CU-15)

The cursus runs from higher ground at the base of a hill slope, over the level valley bottom, and on towards slightly higher relief at the other side, its course tangential to a bend in the river.

Some partial excavation has taken place at the N'n end (Topping 1982), and at a few other points on the circuit, but the site is known primarily from aerial photography.

This cursus, about 37m wide between parallel ditches, runs in a straight course for almost 2km, with few irregularities of line, continuing on a closely defined axis of 132-312°G. Ditches with V-shaped profile, 1m deep, and 2-3m wide, are set 32m apart. Two phases of re-cutting were evident from partial excavation near the NW'n terminal, which also indicated external pits, possibly post-bearing (Topping 1982). Smaller outer ditches may also be visible in the SE'n sector, and hence here the perimeter of the site seems double, at least in part. The possible presence of outer banking has also been suggested.

A large low mound might have lain between the ditches at the NW'n end, perhaps forming some discrete terminal structure. Possible evidence for mounding is also visible, as a band of crop-marked parching, elsewhere along the remaining length, particularly near the SE'n terminal, either indicating a deliberate feature of the monument, or the incidental up-cast from construction of the ditches. The NW'n terminal has not been located, but the SE'n terminal is clearly visible as a crop-mark. The alignment of the cursus is close to that of the solstitial axis.

-associated monuments

..barrows

There are no known long barrows in the immediate vicinity, but round barrows are conspicuously present, as a small cluster around the SE'n terminal, possibly with another at the NW'n end.

Stanwell; Surrey; TQ 0490 7600 centre; total length >3.6km; width 20m; axis: 164-344°G; NMR 932648; e-FIG CU-16; bibliography: O'Connell 1990; Framework Archeology 2006;

The rounded N'n terminal of the cursus appears as a crop-mark (TQ 0440 7778), within the braided streams of the River Colne, its tributaries flowing to the Thames some 6km to the S. The straight course of the cursus crosses these streams, continues as a crop-mark for about 2.5km, towards 164°G, reaching TQ 0516 7534, then to TQ 0545 7431, with its line located by excavation over the final 1.2km. There is no terminal at this SSE'ly point, and the cursus continues on for an undetermined distance, running under the built-up area of Stanwell, and the margins of Staines Reservoir. The site lies on an extensive spread of gravel, and its line has been damaged, or obscured, at various points by commercial extraction.

Excavation has shown that the cursus consists of two parallel U-shaped ditches, set about 20m apart, each 3.7m in maximum width, and surviving to 1.2m depth. Soil from the ditches was banked up between them, to form a low mound, no longer extant. Ditches were dug as a series of individual sectors, and a 3.5m wide gap was detected in the W'n ditch. Early Neolithic pottery, found at the base of ditches, suggests that the cursus was in use between 3600 and 3300 BC, whilst upper ditch fill contained a few abraded sherds of later Neolithic pottery.

Stonehenge Greater Cursus; SU 1243; length 2750m; width 100-150m; axis 083-263°G; NMR SU14SW 42; e-FIG CU-17; phot CU-05;
bibliography: Thomas *et al.* 2009; Pearson and Field 2011;

-general structure

The Greater Cursus is a rectangular enclosure, oriented E-W'ward in an essentially straight course, with no obvious indication of any sectoring. Its sides are not parallel, but bow outwards slightly towards the W'n end. The site runs between low ridges, over an intervening dry stream valley.

Unlike most other cursus monuments, much of its circuit survives as an earthwork bank up to 0.4m high, and 6.5m wide, with a ditch lying just beyond an intervening berm. Evidence for original entrance gaps in the perimeter is unclear, with one detected (Gaffney 2012). Small-scale excavation has revealed a flat-bottomed ditch, 1.8m wide, and up to 0.75m deep, with steep sides. Excavation of the ditch and interior at the W'n end produced few finds, indicating maintenance of general cleanliness. The ditch at the W'n terminal was deeper, at 1.6m, than the shallower ditches of the long sides, these being enlarged by re-cutting in the mid 3rd millennium BC

Construction of the cursus has been radiocarbon dated to 3630-3375 BC, and this earlier Neolithic date is supported by finds of Windmill Hill type pottery (Thomas *et al.* 2009).

-associated monuments

The cursus has a long barrow lying in parallel with, and close to, its E'n terminal. Similar associations between long barrows and terminal areas are seen elsewhere, as at the Dorset Cursus (e-FIG CU-05).

Round barrows are scattered loosely around terminal sectors, more so at the W'n end, with none known in the central sector. This concentration of later funerary activity around terminals is seen elsewhere, as at Dorset, Rudston, Scorton, and Fornham All Saints. A linear round barrow cemetery runs in parallel with the monument on its S'n flank, towards its W'n end (e-FIGS CU-05 and RB-84).

Stonehenge Lesser Cursus; SU 1043; length 400m; width 60m; axis 075-255°G; NMR SU14SW 41; e-FIG RB-101; phot CU-06;
bibliography: Richards 1990;

-general structure

The Lesser Cursus, now levelled by ploughing, is a sub-rectangular enclosure containing a transverse partition, and with its E'n end open. Limited excavation suggests that an initial, smaller, W'n sector was constructed, later enhanced by extension to the E, with this end left deliberately open. This extension was back-filled soon after construction. Radiocarbon dates from the ditches of both phases are early Neolithic, around 3630-2920 BC.

The Lesser Cursus has two extended lines of round barrows beyond its W'n end, a similar pattern to that seen at the Greater Cursus, but on a smaller scale.

-interpreting alignment in terms of the solar transit (see Table of Contents: 02c/2)

This analysis discusses orientation of the Greater cursus in terms of broader access to solar transits, rather than more specific association with rising or setting events around the equinoxes.

The axis lies beyond, and to the W of, the three peaks of frequency (SW'n, S'n, and SE'n) that are weakly evident in analysis of alignment for the national sample (e-FIG CU-19), and provides a point of comparison in terms of seasonal access to the solar transit.

Considering all elevations of the transit, alignment would allow roughly equivalent access to the rising and setting limbs during the summer months. However, if only lower elevations are considered, then coverage divides either side of full summer, into ranges for spring, and for autumn (Cf: TABLE CU-13 and e-FIG CU-21 for the similarly aligned Stonehenge Greater Cursus).

Ruggles, in discussing the solstitial alignment at the Dorset cursus (1999, 127-128) notes that not all cursus monuments are oriented on the solstitial sun, citing the E-W'ly alignment of Stonehenge Greater as falling just after the spring-, and before the autumn equinoxes.

TABLE CU-13 Stonehenge greater cursus: correspondence between the axis and solar risings, settings, or transits

axial intersection with SOLAR EVENTS:

		only *at* the horizon				including transits *near* the horizon				*up to mid elevation*			
		elevation = 0				**elevation < 10**				**elevation < 20°**			
sector	**ax**	**rise**	**TF**	**set**	**TF**	**rising**	**TF**	**setting**	**TF**	**rising**	**TF**	**setting**	**TF**
all	083	30mar	1	-		30mar	21	-		30mar-	51	-	
	--263	10sep	1	10mar	1	20apr				20may			
				2oct	1	17aug	24	-		22jul-	50		
						10sep				10sep			
								10mar-1apr	22			10mar-24sep	45
								10sep-2oct	22			20aug-2oct	42

for all transits *up to maximum elevation*

		rise	**TF**	**set**	**TF**
all	083	30mar-	0	-	
	-263	10sep		10mar-2oct	205

combined transit frequencies:

	TF for rising and setting			maximum TF
elevation (°)	**at 0**	**<10**	**<20**	**all**
TF for all	4	89	188	205

Note and Key: details as for Dorset Cursus: TABLE CU-08.

Appendix: listing of known and probable cursus monuments included in the analysis

TABLE CU-14 Cursus sites: length and alignment

This table, containing an interim sample of cursus monuments from England, Wales, and Scotland, has been placed as a text file on disc in the folder TABLES_filed, on account of its length, and the partial nature of some data.

Sites are grouped by length in the following categories:

>1000m; 500-1000m; 200-500m; 100-200m; <100m

e-FIGURES: combined listings and supporting information

Specific sites
e-FIG:
CU-

01 Cursus: Benson SU 6291

02 Cursus: Dorchester on Thames SU 5795

03 Cursus: Dorset SU 0115: distribution of barrows

04 Cursus: Dorset: topographical profile

05 Cursus: Dorset: association with long barrows
The axes of long barrows in the area contrast with that of the cursus.

06 Cursus: Dorset SU 0115: general area

07 Cursus: Drayton SU 4894

08 and 08a Cursoid group: Fladbury SO 9846

09 Cursus: Fornham All Saints TL 8367

10 Cursus: Godmanchester SU 5795

11 Cursus: Godmanchester: suggested astronomical alignments
A summary of axes proposed as astronomically significant by McAvoy 2000.

12 Cursus complex: Rudston TA 0969: the cursus complex in its regional setting
The axes of long barrows in the area contrast with that of the main cursus.

13 Cursus complex: Rudston TA 0969: the cursus complex

14 Cursus complex: Rudston TA 0969: topographical profiles

15 Cursus: Scorton NZ 2300

16 Cursus: Stanwell TQ 0476

17 Cursus: Stonehenge Greater SU 1243

General

18 Cursus monuments: S'n Britain: distribution

19 Cursus monuments: orientation: histogram

20 Cursus monuments: degree of association with rivers
The relationship between axial orientation and degree of access to the solar transit is outlined for sites aligned towards the SE, S, and SW:

21 Cursus monuments: Dorchester, Fornham All Saints, and Stonehenge greater: relationship with the solar transit

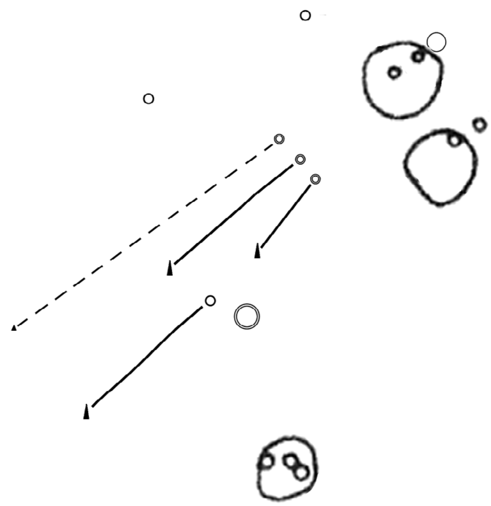
22 Cursus: Dorset: relationship with the solar transit

23 Cursus complex: Rudston: relationship with the solar transit

24 Axial combination: suggested examples
The complex of cursus monuments at Rudston (TU 0969; Yorks; e-FIGS CU-12 to 14), and the megalithic complex at Loqmariaquer (Brittany; e-FIGS AS_brit-09 to 12).

Section 03d:
Orientation of prehistoric stone rows in Britain and Ireland

Section identifier: SR-
SEE INITIAL SECTION:
Access to digital images



Drizzlecombe (Dartmoor, Devon)

Summary:

Analysis of axial alignment amongst well-defined groups of stone rows, of Neolithic to Bronze Age type, on Dartmoor, in Scotland, and in Ireland, indicates marked preferences for the S and SW, in which direction they often run down-slope. This bias is discussed in terms of ritual based on observation of the solar transit within the permanent zone. Such rows, often with barrows at, and around terminals, are seen as acting to link funerary areas into an alignment towards significant areas of the solar transit. The possibility that elaboration, and proliferation of rows was a response to challenging environmental conditions during the later Neolithic and Bronze Age is also discussed.

Axial alignments fall into two main groups, the S'ly and the W'ly: many stone rows belong to the S'ly group, whilst funerary monuments occur in the W'ly.

The following topics are considered:

-general **properties**: form, distribution, date, and function of stone rows;

-**orientation** of rows: existing interpretations;

-**study areas**: detailed analysis of all rows on Dartmoor, and multiple rows in N'n Scotland, with additional inclusion of the row-cairn complex at Beaghmore, Ireland;

-supplementary information on **key sites.**

The distribution of stone rows in Britain and Ireland

National distribution is shown in e-FIGS NAT-01b to 06b.

General form, development, and date

The definition and classification of stone rows, of later Neolithic to Bronze Age type, used here follows that of Burl 1993: ranging from pairs, through shorter 3-6 stone rows, to the longer single, and double rows, to multiple forms, both splayed, and parallel

Stone rows, especially those of commoner single, or double form, provide the ideal opportunity to examine issues of alignment since, even without any terminal structures, the majority are closely axial (cf: sinuous stone rows: e-FIG SR-33).

Only those that are sufficiently extant to allow an axial orientation to be determined with confidence are included in this analysis. Monoliths are excluded here, although many are slab-line, and hence alignable (see Table of Contents: 03k. Many such monoliths may be of similar date to rows, and might have performed a related function, but others could well have a far longer, and more recent currency, with erection for practical purposes of land tenure certainly possible.

In the absence of clearly stratified dating evidence from deposits sealed by component stones, or from firmly linked structures, such as barrows, and circles, many of these stone rows, and monoliths remain undated, except by general form, and structural affinities within the group.

Burl 1993 proposes a general typological sequence of development from:

..basic **portals and avenues** within circles (later Neolithic 3300-2000 BC);

through **detachment of avenues from circles** in the earlier Bronze Age (2300-1800 BC);

..with further development of **double,** then **single** rows during the same period;

..these shrinking to **short 3-6 stone rows** during the middle Bronze Age (1800-1200 BC);

..this sequence finally ending with construction of **pairs of stones** in the later Bronze Age (1400-1000 BC). According to this scenario the phenomenon of stone rows proper spans the period from the later Neolithic to later Bronze Age.

However, recent work at Cut Hill (Dartmoor) indicates construction there by 3000 BC, and so has pushed the origins of such rows further back into the Neolithic (Greeves 2004). Being robust features in more remote upland locations, these row-monuments are also likely to have survived for long periods of the prehistoric period in good condition, and so perhaps with their functions persisting well beyond their foundation.

Distribution

Distribution of types varies, with shorter rows of 3-6 stones having a predominantly W'n distribution, along the Atlantic seaboard, and inland, with longer single rows showing particular concentrations in the SW'n Peninsula of England (Bodmin Moor, Dartmoor, and Exmoor), Cumbria, and central-N'n Ireland. Sites with double, or triple lines account for 39% of rows on Dartmoor, and 55% on Exmoor. In Caithness-Sutherland replication of lines was more frequent, with less than 1% as double rows, and 55% as higher multiples (e-FIG SR-15 and 16).

There seems to be no readily identifiable equivalent to stone rows over areas of softer bedrock in lowland Britain, where timber would be the obvious replacement. Certain post rows of later Neolithic to Bronze Age date, as near Thornborough central henge, North Yorkshire (e-FIG PA-01), might suggest themselves as candidates. Cases of longer linear rows of stone do occur exceptionally in S'n Britain, as for instance the avenues at Avebury, with occasional cases at other stone circles, but this serves to emphasise the general absence of surviving rows. This discrepancy in distribution suggests an explanation beyond the absence of suitable rock for construction, to be found in broader cultural and environmental factors (see Table of Contents: 01/3 and e-FIGS ND-01b).

Matching distributions of rows and barrows against topography, and other environmental factors

National distributions are shown in e-FIGS NAT-01b to 06b.

In order to discuss any possible relationship between choice of orientation amongst stone rows and environmental factors, it was necessary to establish a viable distribution of such sites over Britain and Ireland. Using the listing given in Burl 1993 as a basis, frequencies were determined per 10km^2, as a first approximation, treating all types of site, from pairs to complex rows, as equivalent in the count. Given the inherent uncertainty about the dating of many sites, further resolution seemed unjustified, and likely to fragment the data. The composition of the sample of rows is given in TABLE ND-01, along with the number of barrows included, also plotted per 10km^2:

The national distribution of rows shows that a series of regional groupings is apparent. More conspicuous concentrations occur in the following areas:

-**Scotland,** around Tay, Mull, and Argyll;

-**Wales,** around Powys, Prescelly, and the River Twyi;

-the **SW'n Peninsula of England,** with notable groups on Dartmoor and Exmoor, with lesser groups on Bodmin Moor, and for Land's End;

-**Ireland,** around the upper Mourne valley, Dundalk, Connemara, and especially in Kerry, and Cork.

The distribution of rows is confined to those areas of the Highland Zone with harder rock (e-FIG ND-01b), and does not appear to penetrate the Jurassic limestone belt, running NE-SW'ly across central Britain, despite the suitability, and ready availability of much of the bedrock for erection of standing stone structures. The distribution also matches the main belt of higher rainfall that occurs along the Atlantic margin, and there is a close association between the distribution of rows and that of peat deposits developing over higher, wetter uplands, areas subject to increased environmental stress (e-FIG ND-01d).

In this particular analysis of distribution, with its lower resolution, given the absence of widespread and compatible evidence for settlement sites of the Neolithic to Bronze Age, barrow distribution has been used as a general proxy for direct settlement. Comparing the distribution of rows with that of barrows should, therefore, allow some conclusions to be made about the location of the former with respect to core settlement, and perhaps give some information relating to function, with alignment as part of the discussion.

The distribution of rows appears in many cases to extend beyond the main areas of barrow construction, out and over peripheral zones. This is well seen along the W'n seaboard of Scotland, rather than in areas of E'n Scotland, is weakly seen in Wales, and strongly again in SW'n and W'n Ireland. Here, the distribution of stone rows appears to be peripheral to main settlement, similar to the relationship noted between cup-marked stones, and main areas for barrows (e-FIG ND-01b to 06b). However, the correspondence between distributions of rows and barrows is in some cases much closer, as for the Tay, Dartmoor and Exmoor groups.

The general impression here is one of stone rows developing in areas often marginal to those of direct settlement, within less tractable upland areas, those experiencing the wetter and colder conditions of the Atlantic seaboard, and more prone to its vagaries. It may, therefore, be possible that such ritual sites functioned to mitigate challenging conditions, as further argued from interpretation of their general alignment in terms of the solar transit. Rows might also have proliferated as an intensified response to such environmental deterioration, seen not only in terms of their numbers, but also in their tendency for reduplication, and repetition of structural elements (see Table of Contents: 03d/8g).

The function of stone rows

Stone rows, the majority of which are fairly straight, appear to be defining a line of sight over the landscape, rather than acting to delimit, and separate lateral areas, for more practical territorial purposes. The case for processional use is not clear: for single rows, forming the majority, such linear access would have had to have been adjacent, rather than internal; for doubles it is possible, but many are too narrow, and have their ends blocked by terminal structures. For instance, the double row at Walkhampton, Dartmoor (SX 5612 7081) is 23m long, but only 10-30cm wide. The far shorter rows of 2-5 stones would also seem to be rather limited in terms of directing movement.

Amongst rows on Dartmoor, many rows run in a S'ly direction down-slope from higher ground, which in many cases contains funerary cairns, and which might have acted as a vantage point for viewing down the row, beyond it, and towards areas considered important. Cairn-circles, at the up-slope end of such rows, might have defined an area for sighting along the row, especially if a mound was absent, small, or platformed.

Intersection of such axial sight-lines with the transit of the sun might have been particularly important, given their general S'ly alignment (e-FIG SR-05), either towards the approach of solstitial events, or seasonal ascent and descent of the sun at the zenith, in the permanent zone (see Table of Contents: 02c/2).

Given this solar interpretation, then the type of extension, repetition, and replication seen at many rows, in areas such as Dartmoor, may suggest intensification of solar propitiation, perhaps in response to adverse environmental change, occurring during the period, along marginal areas of the NW'n Atlantic (see Table of Contents: 05).

A preview of problems: Down Tor stone row; Dartmoor; SX 5869;

The single stone row with a terminal cairn-circle on Down Tor, in the Walkham-Meavy group, provides a convenient basis for previewing associated problems, and for interpretation of alignment suggested for the broader sample (e-FIGS SR-13 and 14; phot SR-01-02;).

-restricted data

The site remains unexcavated, as is the case generally amongst stone rows on Dartmoor, and elsewhere, with dating, sequence, direction of growth, and the extent of any associated features consequently unknown. Other structures in the immediate area, namely several cairns, a pound, and boundary bank, are also unexcavated, and so can not be related. Modern re-erection of stones in the row, of uncertain extent, add to the problems of any further investigation. The data set is therefore sparse, consisting of a mean axis for the row and its terminal cairn, the relative importance of which is unknown: a cairn aggrandised by a row, or a row with an added cairn.

-the axis

The question as to the relative importance of directions within, and from, the axis is also an open issue. The row could be seen as dividing the locality laterally, or as pointing in one, or both directions. Here, the axis is asymmetrical, with the size of stones increasing in the direction generally down-slope, towards the SW, and the terminal cairn. This could be interpreted as indicating a focal viewing-area at the SW, with structural emphasis declining to the NE. It could equally suggest a viewing-area at the NE, perhaps from around the cairn upslope from the row, with larger stones making the farther terminal and monument more visible as an intermediate target, set as they are at a distance.

-the cue for alignment

The choice of one direction within the axis as primary is of fundamental importance in discussing cues, topographical or celestial. Relief at the horizon around this site is bland (e-FIG SR-13), as is the case for many others on Dartmoor, suggesting a celestial option for cues. The axis does not correspond with any positions of solar, or lunar standstill (TABLE AS-01), these latter anyway unlikely, because of their infrequency, and lack of economic relevance. Considering reference to the solar transit, the NE'ly direction would give poor exposure to the rising arc, but the SW'ly direction would ensure contact for most of the year (e-FIG AS-09).

-conclusion

The row is, therefore, interpreted as providing a line of sight from a viewing area at the NE, providing a structural connection between burial areas at each end, and the setting transit of the W'ly setting sun, with its frequent funerary associations. Such a link could have operated passively, or have been reinforced periodically by active ritual (see Table of Contents 02a/2g).

Supplementary information

Down Tor; single row; 349m long; axis 070-250°G; SX 5885 6933; terminals: at the NE a terminal stone, at the SW a stone circle containing a cairn with cist; NMR SX56NE 29, 438583; e-FIGS SR-13 and 14;

The row and circle appear well preserved because an unknown number of stones were re-erected in their original sockets in the 1890s. There are 157 stones surviving, from an estimated 174 originally placed.

The row runs for 349m, from a 1.5m high terminal stone at the NE, down-slope to its central sector, then up-slope to a terminal cairn at the SW. The size of stones increases at each end, with the largest pillar, at 2.7m high, next to the cairn at the SW, and that at the NE'n end 1.6m high. There is a slight curve to the row, 2.5m off-line towards the N at its centre.

At its SW'n terminal, the row runs to within 4m of a stone circle, 12m in diameter, containing 27 irregularly spaced stones, the tallest about 1m high, with a cairn 8m in diameter, and remains of slab cist at its centre.

Another large cairn (NMR SX56NE 31, 438589) lies in line with the row beyond its NE'n end, with another off-line just beyond the SW'n terminal. A sub-circular stone enclosure, about 43m across (SX56NE 30, 438586), lies adjacent to the NE'n end of the row and, given no evidence of hut circles, this might have been for stock. Its entrance at the E opens towards the cairn. A boundary bank runs transversely to the SW. All of these structures are of unknown date.

It has been suggested that the line from the terminal cairn towards two others, adjacent at the NW and SE, could mark solstice positions (Walker 2005).

The orientation of stone rows

The work of Burl (1993), and of Ruggles (2000), on stone rows illustrates two existing approaches to interpretation of their alignment.

Interpretation of stone rows by Burl (1993)

Burl reviews 1033 row-sites in Britain and Ireland, of which 186 (18%) were deemed have alignments considered astronomically significant, in one direction or the other, with the remaining 82%, (4 in 5!), remaining otherwise unexplained. Further statistics can be extracted as follows:

-**Stellar targets**: of the astronomically aligned fraction, 14% (26 sites) were considered likely to have been aligned on nine specific stellar targets, predominantly towards rising events, for calculated positions dated BC (TABLE SR-01):

TABLE SR-01 STELLAR TARGETS FOR ROW ALIGNMENT LISTED IN BURL 1993

star	**rising**	**setting**
Capella	6	2
Arcturus	5	
Centauri	4	
Pleiades	3	
Deneb	2	
Spica	1	
Altair	1	
Antares	1	
Vega	0	1

Note: stars are ranked in decreasing order of frequency for suggested association.

-**Solar targets**: 49% (91 sites) were considered to have a solar alignment, with the emphasis on rising positions, in the ratio 2:1 over setting, and towards winter events rather than summer, in a similar proportion. For this solar fraction, alignment at, or around the following specific events was suggested: 31% at mid winter, with rise or set about equal; 19% equinoctial, again with rise or set about equal; and 26% at mid summer, with rise greatly exceeding set.

-**Lunar targets:** 37% (69 sites) were thought to suggest lunar alignment, with emphasis on major over minor standstill risings or settings, in the ratio 2.7:1, with the ratio between rising, and setting approximately equal. Interpretations of rows as eclipse-predictors, or devices for astro-extrapolation are included for a minority of sites, especially so for multiple rows in N'n Scotland (see Table of Contents: 3d/9). Stellar, solar, or lunar interpretations are all based on rising, or setting events, at the horizon, except for one mention of orientation towards the major S'n moon in transit.

Here, we are presented with a range of mixed targets, to account for a minority of sites in the sample. There is certainly no coherent, realistic basis for ritual, which seems strange amongst monuments with many similarities of structure, associations, and siting.

Analysis of alignment amongst stone rows by Ruggles (1999)

Further data on the orientation of short stone rows is presented by Ruggles (1999, 102-111). In agreement with Burl (1993), such sites are considered to represent later development of rows during the Bronze Age, marking the possible tail-end of a sequence, with its origins amongst avenues attached to stone circles during the 3rd millennium BC.

Rows are seen as ceremonial centres, with the act of construction itself important, perhaps serving to point in some significant direction, with other functions as markers of territorial boundaries, or sacred divisions of landscape.

-Short rows in SW'n Ireland (e-FIG SR-27)

A case study is presented for such sites in SW'n Ireland (Ruggles 1999, 102-107: orientation shown in fig. 6.4/p. 106, and table 6.1/pp. 218-219; list 5 on pp. 192-195). The sites selected show a strong clustering of their alignments around a general NE-SW'ly axis.

There is little structural differentiation between opposing directions within the axis for these rows, on which to base any selection of a specific direction, as a standard for analysis, or as potentially more significant. However, some rows were noted as displaying an increase in height of stones along their length, this corresponding with some lower areas of the local horizon, possibly providing an emphasis in this direction (Ruggles 1999, fig 6.3/ p. 105).

No correlation between alignments and key solar events at the horizon were noted, such as solstitial, and equinoctial risings, and settings, but evidence for some possible association with the S'n moon was discussed.

For the SW'ly direction, there appeared to be two broad clusters of declination around lunar standstill settings, but the fit was stated as poor. By contrast, the NE'ly direction appeared to show a stronger fit with lunar events, as a single peak of declination around the limit of N'n major rising, although this was thought to be centred rather high, with much data lying beyond where the moon can ever reach. There was also a small, and unconvincing grouping, apparently around the minor lunar limit.

Despite these all too evident difficulties, Ruggles concludes (1999, 107) that, on the whole, the data seem to *strengthen* [!: AJM], the general idea of a connection between the axis of rows and the moon, and certainly to confirm the lack of any apparent correlation with the sun. He notes the absence of any simple interpretation, but that the involvement of the moon could be *tacitly assumed* [!: AJM], the precise details remaining obscure.

This seems to conflict badly with the statement elsewhere (*ibid* 1999, 103): that there would be no attempt to fit data into predetermined astronomical targets, but that any accumulation of declinations would be allowed to speak for themselves. Here however, the data seem to be forced towards a very tenuous and unsupported interpretation, in terms of lunar events at the horizon.

The critical importance of events at the horizon should not always be assumed, nor should exactness of intention amongst builders of such monuments. Attempts to provide explanations on the basis of individual axes, rather than grouped data, would also tend to obscure other more viable possibilities. It is certainly possible that combined data might fit a broader model of orientational behaviour, and ritual based on the transit of celestial objects, with the sun an obvious candidate, as suggested for rows on Dartmoor (e-FIG SR-05).

-Short rows in W'n Scotland (e-FIG SR-28)

In a study of 300 circles and rows in W'n Scotland, Ruggles (1999, 68-78) suggests some axial preference for quadrants at N and S, with avoidance of those at the E and W. It was noted that well-developed peaks of frequency occur further to the N, or S than the sun, or moon ever rises, or sets. This general survey is confirmed in detail by sites in Argyll and Mull, which show a strong preference for N'-S'ly layout (*ibid*, fig 3.5/p. 75). Again, he concludes that a pattern of low precision lunar observations might have been widespread.

In a second study (Ruggles 1999, 107-111: orientation shown in fig. 6.7/p. 109, and table 6.3/p. 221; list 6 on pp. 196-199), the axes of 20 examples analysed all lie, in general terms, within the N-S quadrants, avoiding E-W. This was seen as contrasting with the NE'-SW'ly axes of the Irish short rows, as discussed above, and was taken to suggest quartering of the horizon, based on cardinal points. It was suggested that alignment of half the sites may correspond with general moonrise or -set at the major standstill limit, although the rest showed very little association with lunar events. No distinct pattern of relief, neither hills, nor areas of increased visibility, was found in modern views along axes.

As for the Irish short rows examined, the astronomical basis for axial alignment was considered to be far from clear. Nevertheless, it was thought to suggest a real interest in those extreme directions where moonrise, or -set was only seen rarely, perhaps during a few consecutive summers, on two or three occasions in any one generation (*ibid* 1999, 109).

The further suggestion was made that these positions were so significant that a long-term watch might have been kept, with the monument perhaps acting to prevent the moon from exceeding its limits. As in the case of the Irish short rows, the data appear forced towards interpretation in terms of lunar events at the horizon, in this case rather rarely-occurring ones. These explanations appear very convoluted and contrived, in an attempt to involve the moon at all costs.

-Short rows in N'n Mull

A 'context-rich' study (see Table of Contents: 02a/1c) of seven short stone rows placed them in topographical context, and considered those broader properties of location which might have determined where the monument was sited, and with which its orientation harmonised (Ruggles 1999, 112-124). Here again a possible association with major lunar standstill was noted, but with very low precision.

Alignment of short stone rows in Scotland and Ireland: re-analysis by the author [AJM] of data presented by Ruggles (1999), as outlined above

-Ireland (e-FIG SR-27)

..analysis of alignment

Data on maximum and minimum azimuths for the long axes at 48 sites, as listed in Ruggles 1999 (list 5 on pp. 192-195), were plotted as a *cumulative frequency distribution* at 1° intervals (after summation: see the note immediately following). The *limits* of alignment for each site were used in this way, rather than a central value, in order to give a more realistic direction of general observation from within an irregular monument than would be provided by a single line. This process gave a spread of frequencies from the SSW 200°G to W 280°G, that contained two main peaks: a peak (1) around SW 224°G is skewed away towards the SSW 210°G, and a slightly smaller, and more compact peak (2), around SW 239°G is skewed away towards the WSW 250°G.

Peak 1 lies to the S of the local winter solstice sunset, and hence just within the permanent zone of the transit; it does not coincide with the S'n lunar maximum. The distribution is skewed towards the solstitial axis, tailing away to the S, perhaps suggesting preference for a direction that would provide both year-long access to the transit, together with seasonal reference to the solstitial approach and departure.

Peak 2 lies just to the N of the winter solstice sunset, and hence lies within the transitional zone of the solar transit; it does coincide with the S'n lunar minimum.

These two peaks appear separated by a distinct trough, around the winter solstice sunset but, since they are only 15° apart, this may be an artefact, likely to disappear with larger sample-size. The entire spread, including both peaks, would appear to be centred on the zone of the solstice, ranging 20° either side. The safest conclusion might, therefore, be to suggest that the near solstitial sector of the permanent zone, and of the setting transit formed the target.

Note: cumulative frequency distribution: the axial range for each site was plotted against azimuth (x-axis) and then frequency summed for all sites at each chosen interval of azimuth to give a final value (y-axis).

..changing height of stones

Most of the axes are structurally asymmetrical (see Table of Contents: 02a/2b), this caused by an increase in the height of stones towards one end, or the other (TABLE SR-02):

TABLE SR-02: short stone rows: Ireland: direction of increasing height of stones along the axis

stones graded up to general	#	%
S	22	46
N	11	23
E	3	6
ungraded	12	25

About half of the stones increase in height towards the S, with another quarter on a similar axis, but to the N. It is possible that higher stones indicate a more important direction for viewing, in which case there is some preference for the S, and this would be in broad agreement with any interest argued, from consideration of general alignment, for the S'n arc of the solar transit being the main target.

-Scotland (e-FIG SR-28)

Axial data for 27 sites, as listed in Ruggles 1999 (list 6 on pp. 196-199), was re-plotted as for the Irish examples above. The frequency distribution contains very indistinct structure: a general spread from about SE 135°G to SW 230°G, with sparse clustering between SE 135°G and S 170°G, even weaker between SSW 198°G and 214°G. All that can be said here, on the basis of this small size of sample, is that the S'ly directions within axes fall within the permanent zone of the solar transit, with a more generalised distribution than that seen for the Irish examples.

Interpretation of alignment: a recent example

At Cut Hill, Dartmoor (SX 5992 8275), a recently discovered stone row, on an elevated hill-top at 603m OD, contained six large, carefully matched granite slabs, now recumbent, but originally about 2m high, and set edge-on along the row (Greeves 2004). The row is at least 123m long, with an additional buried stone about 35m further to the NE suggesting extension of the line. In the other direction its projected line would pass within 23m of a ditched barrow, located on the highest point, 58m beyond its most SW'ly stone. Radiocarbon dating suggests construction by 3000 BC.

The row is oriented NE'-SW'ward (052-232°), close to the solstitial axis for mid-summer rise, and mid-winter set in the area, as noted for certain sites of other types such as Stonehenge, and the Dorset Cursus.

Cut Hill, therefore, lies within minor peak 2 in the general frequency distribution of orientation for Dartmoor rows, at variance with the majority of sites, which lie in the main peak 1, around the meridian (e-FIG SR-05). The intention might have been for a closely solstitial alignment, but given the number of sites in the regional sample it could be fortuitous, and is anyway atypical.

Orientation of rows on Dartmoor

Axial orientations for a sample of 64 stone rows on Dartmoor were obtained directly, or from reliably mapped sources, and these are plotted as a histogram at 10° interval (e-FIG SR-05).

The frequency distribution consists of a major, well-defined peak (1) around the meridian, with range about 160-200°G, this tailing off towards the W, but with a slight peak (2) evident around 230-240°.

The direction of slope on which sites were located, an indication of their aspect, was also determined (e-FIG SR-04). A marked tendency for construction of rows on generally S'ly-facing slopes is evident. Use of terrain with this aspect, and the measured alignment of the rows themselves may suggest general interest in the S'n sky around the meridian, with less in solstitial directions.

Summary

A review of alignments on Dartmoor, amongst short stone rows in Scotland and Ireland, and multiple row complexes in N'n Scotland, suggests the following general conclusions (TABLE SR-03):

-a case can be made for **general interest in the S'n arc of the sky,** with the solar transit in the permanent zone, and the sector of near-solstitial setting, forming targets;

-preferences appear to differ between areas, suggesting the existence of **variant traditions**;

-peaks which fall within the permanent zone of the transit may indicate sites with year-long access to the transit, those which fall at its margins having more restricted **access** (TABLE SR-03):

TABLE SR-03 Stone rows: trends in alignment with reference to the solar transit

		solar transit					
		ah		**| al**		**reg**	**e-FIG**
sample	**inc**	**perm**	**mer**	**| WSset**	**esr**	**cons**	**SR-**
Dartmoor	all		*	*		high	05
Ireland	SSR			*		high	27
Scotland	SSR	*				low	28
	mult	*			*	low	17

Key: inc(luded in sample of rows), **SSR** short stone rows, **mult**(iple rows);
solar transit: ah access high**, al** access lower**; perm**(anent zone), **mer**(idian), **WSset** winter solstice sunset, **esr** equinox to solstice, rising sector; **reg cons** regional consistency of trends.

Study area: stone rows on Dartmoor (e-FIGS SR-01 to 14)

The alignment of stone rows on Dartmoor, an area containing a particular concentration of such sites, is examined here in closer detail. This forms one of two such studies, the other being the multiple rows of N'n Scotland (see Table of Contents 03d/9).

The national distribution of stone rows for Britain and Ireland is given as a density distribution, and is shown in relation to those of stone circles, and barrows (e-FIG ND-01b to 06b). Particular concentrations of stone rows are to be seen in SW'n Ireland, E'n Scotland, and in the SW'n Peninsula of England.

Distribution of stone rows across the landscape (e-FIG SR-01)

Stone rows are located in, and around headwater stream valleys that drain radially from areas of moorland at higher altitude. Five main groups can be distinguished, with more isolated rows scattered beyond these core-areas (e-FIG SR-01; TABLE SR-04). These groups are named as follows here from the adjacent stream valley, listing clockwise from the NE. Within each group focal areas are apparent that contain more rows and, within these, individual clusters of rows can be seen in particular localities (TABLE SR-04). Further details of these groups, and their sites are given in Table of Contents: 3d/8h.

TABLE SR-04: DARTMOOR: REGIONAL GROUPINGS, FOCAL AREAS, AND COMPONENT CLUSTERS OF STONE ROWS
note: the number of sites is shown thus [n] in column 4; additional single sites are added to define the area;

column >	**1**	**2**		**3**	**4**
at	**group**	**NGR (SX-)**			**~#sites focal areas, clusters and notable rows**
|		**centre**			
NE	**TEIGN**	67	85	20	**FOCAL AREA:**
		660	859		[16]: Shovel Down-
		660	826		Assycombe Hill;
					notable row complexes:
		660	859		Shovel Down; 8 rows on similar alignment;
					local clusters:
		655	842		[4]: Fernworthy;
		654	813		[2]: Stannon;
E	**DART**	65	76	23	**FOCAL AREA:**
		644	777		[6]: Lakehead Hill-
		643	765		Bellever Tor;
					local clusters:
		644	777		[4]: Lakehead Hill;
		619	784		[2]: Higher White Tor;
		643	765		[2]: Bellever Tor;
		681	740		[2]: Yar Tor;
					single sites:
		690	808		[1]: Challacombe Down N;
		610	744		[1]: Roundhill;
		653	754		[1]: Laughter Tor;
		691	732		[1]: Sherberton Common;
		675	610		[1]: Holne Moor;
S	**ERME**	65	62	28	**FOCAL AREA:**
	-AVON	656	600		[14]: Pyles Hill;
					notable rows:
		637	660		Green Hill-Stall Moor; row >3km long;
		656	599		Piles Hill-Butterdon Hill; row 2km long;
					?local cluster:
		674	635		[?3]: Brent Moor;
					single sites:
		633	623		[1]: Stalldown Barrow;
		637	604		[1]: Burford Down;
SW	**PLYM**	57	65	19	**FOCAL AREAS:**
		592	670		[4]: Drizzlecombe;
		592	625		[5]: Penn Beacon SW-Cholwichtown Waste;
					local clusters:
		592	670		[4]: Drizzlecombe;
		598	627		[3]: Penn Beacon SW;
		555	636		[2]: Saddlesborough;
		558	620		[2]: Collard Tor;
		584	623		[2]: Cholwichtown Waste;

		576	630		[2]: Great Trowlesworthy Tor;
		577	677		[3]: Sheepstor SE;
					single site:
		564	660		[1]: Ringmoor Down;
W	**WALKHAM -MEAVY**	55	70	26	**FOCAL AREAS:**
		554	747		[6]: Merrivale;
		567	712		[10]: Walkhampton Common-Sharpitor;
					single sites:
		588	693		[1]: Down Tor E;
		530	760		[1]: Cox Tor S;
		550	788		[1]: White Tor E;
		586	790		[1]: Conies Down.
TOTAL SITES				116	

Key ~#sites: approximate number of sites.

The following sites and their localities have been mapped in detail:

group	row	e-FIG SR-
Teign	Shovel Down complex	12
Erme-Avon	Piles Hill-Butterdon Hill	06-07
	Green Hill-Stall Moor	09-10
Plym	Drizzlecombe	08
Walkham-Meavy	Down Tor	13-14

All groups contain similar numbers of sites, and extend over areas of comparable size. Within the groups, focal areas are apparent, where larger numbers of rows are concentrated; within these, localised clusters of a few rows appear sporadically, and very occasionally larger, and more complex sites occur.

The main properties of the distribution appear sufficiently well established to enable further analysis of orientation amongst rows, and its consistency within, and between groups, and their component clusters to be examined. However, there are significant additions still to be made, as shown by discovery of the row at Cut Hill (SX 5992 8275; Greeves 2004).

Location of rows on slopes (e-FIG SR-04)

Plotting, as a ray diagram at 20° intervals, the slope on which rows are located indicates a general preference for the S'n arc, with the SW'n sector slightly better represented than the SE'n. The alignment of many rows conforms generally with the down-slope direction, which might well have been chosen to allow an enhanced view from its upper end, to include the row itself, and on over areas of land and sunward sky beyond its immediate line.

Distribution of rows by altitude (e-FIG SR-03; TABLE SR-05)

Stone rows on Dartmoor are intermediate in altitude between known prehistoric settlements, and cairns (TABLE SR-05). Most of the settlements of pound-type are undated, but excavated examples have produced material of Bronze to Iron Age date, suggesting early phases, or antecedents. This inter-relationship might suggest placement of rows in areas affording slightly readier access than required for barrows, perhaps reflecting a higher social involvement in recurrent ritual. At many sites, the association is clearly close, as at Drizzlecombe where rows, settlements, and barrows lie adjacent (e-FIG SR-08). This contrasts with the distribution of rows that occurs beyond barrow areas and perhaps settlement, as seen in national distributions (e-FIG ND-01b to 06b).

TABLE SR-05 Altitudes of later prehistoric settlements, stone rows, and cairns on Dartmoor

		altitude		(m OD)
	#sites	**mean**	**sd**	
settlements	380	354	53	lower level
stone rows	116	366	62	
cairns	369	389	67	higher level

Key: # number; **sd** standard deviation;

Properties of stone rows on Dartmoor
Structural data on rows

Further general details can be obtained from Burl 1993, and the supplementary data supplied below: Table of Contents: 3d/8h.

Association of rows with other monuments (TABLE SR-06)

In addition to the classification of rows adopted by Burl 1993 (single to triple, short to long), stone rows can be further assigned to three main types, depending on their association with terminal cairns or circles, structures that can occur at the up-slope, down-slope, or at both ends (TABLE SR-06).

In this regional sample of stone rows, most sites are directly associated with terminal cairns, more frequently at the up-slope end. Given the general lack of excavation at such sites, the apparent absence of standing terminal structures at many rows may well come to be supplemented by as yet undetected buried features. At present, it seems that many rows might have acted to link such funerary areas into a clear, and ritually significant axis, with preferential placement at the upper area of observation along the row.

TABLE SR-06 Association between stone rows and cairns/stone circles on Dartmoor

structure located at	**%**
up-slope end	60
down-slope end	17
both ends	8
association uncertain	12
association complex	3
Note: sample size:	73 sites.

Cues for alignment: some existing views

There is no clear consensus as to the interpretation of orientation amongst stone rows on Dartmoor, and the nature of any specific cues. As part of a national review of stone rows, Burl (1993) noted a broad range of possibilities, including topographical, and celestial (see TABLE SR-01).

A separate, and more specific, review of 71 stone rows on Dartmoor noted that they tended to run up-slope, and concluded that the axis was largely determined by the underlying gradient of the slope, rather than by any clearly external cue (Emmett 1979). A slight bias towards the NE was seen as the result of concentration of rows in S'n and E'n Dartmoor, where this gradient is more common. In that study, irregularity of axial line, and placement of stones suggested lack of precise design, and that rows were constructed to convey a general impression.

However, cists associated with the rows on Dartmoor are seen to have a far more consistent orientation, the majority with their long axes NW'-SE'ward, although this represents a funerary tradition somewhat separate from the row itself, and local, because it is not evident in similar cases from Bodmin moor (Worth 1941, 1946, 1947).

Other reviews cite sun, moon, planets, and possible use of cardinal points, both for principal axes, and for lines offset from the row to other features (Butler 1994; Walker 2005). Little of this is convincing, and there is no agreement on any general principle to match the structural consistency of this distinctive group of monuments.

Any more rational explanation of axial trends has been further obscured by the frequent assumptions that the key direction in the axis is up-slope, and towards the general N-NE, rather than down-slope and towards the S-SW, and that potential celestial cues at the horizon, rather than at elevation were prime.

Orientation of rows (e-FIGS SR-05)

Plotting axial orientation of stone rows on Dartmoor at 10° intervals shows a spread distribution, with distinct clustering between about 150 and 210°G, peaking around 180°G. There is the suggestion of a second, far less prominent peak at 230-240°G (e-FIG SR-05). Only the S'ly direction within the axis is quoted here for clarity, although much is made of this option in discussion of the function of these sites within this general study (see Table of Contents: 02c/2i).

Orientation of rows appears fairly consistent within focal areas (e-FIG SR-02). A strong N'-S'ly tendency is apparent in the Teign group, for its Shovel Down focus, and in the Erme-Avon group, for its Green Hill-Stall Moor focus. However, a more NE'-SW'ly tendency is seen in the Erme-Avon group, for its Piles Hill-Butterdon Hill focus, the Plym group, for its Drizzlecombe focus, and in the Walkham-Meavy group, for the Merrivale and Walkhampton-Sharpitor *foci*. This may suggest some patterns of local preference, rather than the dictates of local topography.

Structural augmentation at stone row sites

An existing simple, short, singly linear row site could be augmented in five main ways, with relevant terms more closely defined below in **bold** type:

Augmentation:

INTERNAL TO THE ROW: elaboration

elongation: lengthening the row by addition of further sectors, or by joining existing rows;
replication: addition of parallel lines to form double, triple, and higher multiples;
refinement: improvement of stone-built features;

EXTERNAL TO THE ROW: amplification

repetition: addition of other rows adjacent to the site;
proliferation: construction of separate sites, spread over a wider area.

According to these criteria, the national sample of stone rows, of long, and short type can be divided as follows (TABLE SR-07; data: Burl 1993, 211-213):

TABLE SR-07 Structural augmentation amongst stone rows

type of row		**sample: national %**	**Dartmoor %**	**indicating**
short with 2-4 stones		68	0	repetition; proliferation;
long	single	17	56	elongation;
	double	7	33	replication;
	multiple	7	11	replication;
total number of sites		972	86	

Note: sites from Britain, Ireland, and Brittany are combined as the national sample; known and probable sites are included equally;

Nationally, these general statistics indicate the importance of amplification over elaboration: caused by proliferation of short rows, smaller sites, hence easier to construct, a group that accounts for two thirds of the total. The pattern reverses on Dartmoor, with amplification dominant, its main components (elongation, and replication) about equivalent.

All cases of augmentation could indicate the need to increase the potency of ritual carried on at such sites perhaps, as argued in this analysis, in response to increasing environmental stress (see Table of Contents: 05).

Examples of each type of augmentation can be seen in all of the Dartmoor groups, and the total length of almost 13km for regional row construction indicates the scale of the enterprise (TABLE SR-08).

-Elongation at row sites

Elongation can be seen well at two particular sites, each containing sectoring that may indicate staged construction, rather than unity of design and build.

Two exceptionally long rows occur in the Erme-Avon group:

-Green Hill to Stall Moor (>3km long; running N'-S'ward along a stream valley; e-FIGS SR-09 and 10);

-and the Piles Hill to Butterdon Hill row (2km long; running N'-S'ward along a ridge; e-FIGS SR-06 and 07); see Table of Contents 3d/8h for details of both.

At Green Hill-Stall Moor (e-FIG SR-09 and 10), a bowed central sector runs between straighter, similarly oriented terminal sectors at the N and S. The entire row contains five or six individual lengths, set at changing angles, and separated in several places by gaps, some of these over streamlet valleys which it crosses. These sectors may indicate stages in development of the row, but the site has not been surveyed, and excavated in sufficient detail to establish a more precise structural sequence than is evident from these general topographical observations.

At Piles Hill-Butterdon Hill (e-FIG SR-06 and 07), the row is lightly bowed to take the straightest line along the curving ridge, and includes two slight changes in direction, to form three straighter sectors. There is no direct evidence to indicate staged construction, although this is possible.

-Replication at row sites

Replication in parallel, to form a double row, is seen more frequently, but this rarely extends beyond tripling of the line. Higher multiples, some up to about 14, are confined to regional groups in N'n Scotland, and Brittany (see Table of Contents: 03d/9).

Plotting the distribution of rows shows that all types are well scattered, with doubles well represented in several major focal areas (TABLE SR-08).

-Repetition of row sites

Repetition of rows in a locality can be seen well at Shovel Down, the focal area for the Teign group, where eight rows, running on a similar N'-S'ly alignment lie across the top, and N'n slope of a low ridge (e-FIG SR-12).

An estimate of the type, scale, and rank-order of row-building activity between focal areas is given by summing known lengths of rows within each (TABLE SR-08):

TABLE SR-08 Dartmoor study area: extent of row construction in various focal areas

group	**ROWS focus**	**single**		**double**		**triple**		**hybrid**		**TOTAL**		**aug**
		#	**L(m)**	**#**	**L(m)**	**#**	**L(m)**	**#**	**L(m)**	**#**	**L(m)**	**%**
Erme-Avon	PH-BH	4	2146	3	1181	2	438	1	283	10	4048	31 * X &
	GH-SM	1	3400	1	182					2	3764	29 *
Teign	Shovel Down	4	508	5	1534					9	2042	16 * X &
Walkham-Meavy	WC-S	4	430	4	1162					8	1592	12 X &
	Merrivale	3	62	2	892					6	954	7 X &
Plym	Drizzlecombe	3	299					1	210	4	509	4 &
TOTAL		19	6845	15	4951	2	438	2	493	39	12909	100

Note: focal areas are **ranked** in decreasing order of total known row length within them;
types of **structural augmentation** are also shown, increasing in the order elongation, replication, and repetition, moving from intra- to extra-site development.

Key: focus: **PH-BH** Piles Hill-Butterdon Hill**; GH-SM** Green Hill-Stall Moor**; WC-S** Walkhampton Common-Sharpitor; # number of sites; **L**(ength); **aug** characteristic type of augmentation visible: ***** elongation, **X** replication, or **&** repetition.

Supplementary information: groups of rows on Dartmoor

Sites in the following complexes allow local consistencies of alignment to be examined in relation to topographical setting, and illustrate different types of augmentation.

Note: NMR refers to numbering by the National Monument Record.

The Teign group of stone rows (e-FIG SR-01): Shovel Down focal area;

-summary

A complex of stone rows forms a stranded N'-S'ward line, about 700m long, running over the flank of a low hill, and into the head of a shallow valley (e-FIG-12). Four single rows, in extended alignment (D, G, H, and J), form the main N'-S'ly element. Five double rows (A, B, C, E, and F) reinforce this general line. Other rows, nominated in the past, now appear to be denuded reave-walls, or other non row-type structures. The Longstone lies between rows E and F, a cairn between rows C and G, and another cairn near the junctions between rows A and B. Most of the rows have clear terminal stones.

Whilst the S'n sector of the complex runs as a single line, the N'n third consists of a fan of three rows (A, B, J-H), which converge on an area near the top of a low E'-W'ly ridge, affording more extensive views. This area contains a cairn (SX 6598 8591; NMR 443580), 7m in diameter, and 0.4m high, with a robbed cist.

The complex presents a clear case of aggrandisement, by repetition and elongation of row-elements.

-general statistics for the complex (TABLE SR-09):

TABLE SR-09 SHOVEL DOWN ROW COMPLEX: BASIC STRUCTURE

		length (m)					
row	**#**	**each**					**total**
single	4	51,	60,	169,	228		508
double	5	116,	148,	152,	169,	182	1534
total	9						2042

Note: lengths as known are used: in most cases rows are defined by terminals, but in some cases rows may extend beyond their apparent ends.

-individual rows

..Shovel Down complex: SX 6600 8600 central point; e-FIG SR-12;

row A; double; 152m long, 1.2m wide; 162-342ºG; terminals: unknown; ground runs up-slope towards the S; NMR 443524;

A double row, 155m long, with 1.2m between the original lines, runs approximately N'-S'ward, and contains 78 visible stones, with two displaced at the S'n end. The row has been robbed to leave an almost single line, containing three 8-15m wide gaps, and the wall of a reave cuts diagonally across at the S'n end (SX 6594 8602).

A probable cairn (SX 6592 8607; NMR 443622) abuts the W'n side. There are no obvious terminal features, unless the row once extended 10m further S'ward to a suggested cairn site, now unidentifiable.

row B; double; 182 long, 1.1m wide; 179-359ºG; terminals: at the S, two standing stones, and a 4-fold cairn circle; at the N, unknown; the ground runs up-slope towards the S; NMR 443524;

A double row running approximately N'-S'ward is 182m long, with 1.1m between the lines, in which remain 12 pairs of stones, 15 singles, and 11 socket-depressions, with average spacing of about 1.8m.

The S'n end of the row is aligned on, or terminates in, a cairn lying within concentric stone circles (the 'Fourfold Circle'; SX 6596 8601; NMR 443527). The row is separated from it by two massive fallen stones, one 3.5m long, and needle-shaped, similar to the Longstone, which forms the S'n terminal of row E. The other is a 2.1m long slab, with one end broadly triangular. These two stones probably stood facing each other at the end of the row, and their relationship with the cairn circle lying just beyond them is uncertain.

The cairn is about 9m in diameter, 0.4m high, has a central cist, and has been robbed. An outer circle ‘4’ now contains nine standing, and one fallen stones, with perhaps seven stones missing, and is about 9m in diameter to their inner faces. Circle ‘3’, about 6.4m in diameter, has six standing stones, is 10m in diameter, and 0.4m high. Circle ‘2’, about 4.7m in diameter, contains eight stones, and originally might have had two more. The innermost circle ‘1’, about 2.4m in diameter, has 4 stones, two of which remain standing, and possibly once had two more.

The circles now contain 29 visible stones, 0.1-0.55m high, but mainly about 0.3m. Circles ‘1’ and ‘2’ would have lain originally within the encairned area, the latter currently conforming with the top of its scarp. Circle ‘3’ now lies at the base of that scarp, and might have been peripheral. Circle ‘4’ would more certainly have been marginal, or exposed.

row C; double; 116m long, 1.5m wide; 144-324°G; terminals: at the S a cairn, at the N unknown; ground runs up-slope towards the S; NMR 443524;

A double row, 116m long, with an average distance of 1.5m between the rows, runs N’-S’ward. Most of the pairs of stones are complete, 83 stones remaining visible, with minor breaks in the line. The row is overlain, and damaged, by a reave and by a later hollow-way, 40m from the N’n end. The apparent extension of the line towards the NW, as a single stone row, is actually a denuded reave wall. The S’n end of the row terminates in a robbed cairn, 7m in diameter, and 0.4m high, containing the remains of a cist (SX 6598 8591; NMR 443580). No special feature marks the N’n end.

row D; single; 169m long; 173-353°G; terminals: at the N a possible blocking stone, at the S unknown; site approximately level; NMR 443524;

A single row, 169m long, containing 47 visible stones, lies to the E of row E, and overlaps it at its N’n end, where it curves slightly to the SW, and terminates in a supposed blocking-stone. A straight extension, 50m long, running to the N, is on a different alignment, and almost certainly represents a separate row, G. No terminal features are apparent.

row E; double; 148m long, 1m wide; 179-359°G; terminals: at the N unknown, at the S ‘The Longstone’ monolith; site approximately level; NMR 443524;

A double row, 148m long, with 1m between the lines, containing 83 stones, runs almost due N’-S’ward, to terminate in a large standing stone (‘The Longstone’; SX 6602 8567; NMR 443595). The row is fairly complete at its N’n end, but has been more extensively robbed over the S’n sector.

The Longstone, now leaning to the NE, lies between rows E and F, is 3.2m high, and 0.9m N-S, by 0.6m E-W in cross-section, currently marks the boundary between three parishes, and was documented as standing in 1240.

row F; possibly double; 169m long; 191-371°G; terminals: at the SSW ‘Three Boys’ monoliths, at the NNE ‘The Longstone’ (see row E); site approximately level; NMR 443524;

A row, 169m long, originally possibly double, continues S’ward on almost the same alignment as row E. Only three set stones now survive, but in 1858 the pits left by removal of the other stones of the double row could still be seen.

The row ends in a single standing stone, 1.7m long, 0.8m wide, and 0.3m thick, with packing stones visible at its base, leaning at 45° towards the NNE, the sole survivor of three monoliths (‘Three Boys’; SX 6603 8549; NMR 443598). The other two stones might have been taken for use as gateposts; the suggestion that they formed the supporters of a dolmen is unlikely, since the remaining stone would be unsuitable for this purpose.

row G; single; 60m long; 161-341°G; terminals: at the N a blocking stone, at the S unknown; site approximately level; NMR 443524;

A single row 60m long, containing 25 visible stones, includes two gaps, 6m and 8m wide, possibly caused by stone robbing towards the N'n end. The penultimate stone, now recumbent, at the N'n end is slab-like, larger than the norm for the row, and might have served originally as a blocking-stone.

row H; single; 51m long; 176-356ºG; terminals: unknown; the ground runs up-slope towards the S; NMR 443524;

A single row 51m long, containing 24 visible stones, includes three 5-8m wide gaps.

row J; single; 228m long; 178-358ºG; terminals: unknown; ground runs up-slope towards the S; NMR 443524;

A single row, 228m long, containing 46 stones, includes many gaps of width 3-47m throughout its length. The row most probably extended further N'ward, its line destroyed by recent mining activity, and the S'n end has probably been overlain by a reave wall. No terminal features are apparent.

The Erme-Avon group of stone rows (e-FIG SR-01):

Green Hill-Stall Moor focal area (e-FIG SR-09);

-summary

Sites include Green Hill-Stall Moor, a row of unusual length, running between terminal monuments, and containing sectors, which may indicate elongation in stages, reinforcing the generally N'-S'ly axis seen at rows elsewhere in the area, as at Brown Heath, Stalldown, and another long row at Piles Hill-Butterdon Hill.

Both of these unusually long rows, Green Hill-Stall Moor (G-S), and Piles Hill-Butterdon Hill (P-B), run generally down-slope, towards the S, and have areas at the N affording extensive views over the line. These locations could have formed more formal viewing areas down the alignment, over areas of funerary activity included in the line, as known from distribution of cairns, and on towards events in the S'n sky. The solar transit in the permanent zone (see Table of Contents: 02c/2b(ii)) would have provided an appropriate cue (see Table of Contents: 02c/2i).

-general statistics on rows in the focal area (TABLE SR-10):

TABLE SR-10 Stone rows: basic structure

		length (m)	
row	**#**	**each**	**total**
single	1	3400	3400
double	1	182	364
total	2		3764

Note: known lengths are used: in most cases rows are defined by terminals, but in some cases rows may extend beyond their apparent ends.
Key: # number of rows present;

-possible viewing areas

..Green Hill-Stall Moor (G-S)

The possible viewing area over the G-S row might have lain on the higher moor, at the known N'n terminal of the row, as marked by a round barrow, but apparently relatively empty of other sites, with few barrows, and no settlement areas extant, these latter clustering in stream valleys further to the S. The view from this reserved area, down over the line of the row, towards the S'n sky, would include settlement, and barrows along its route. Few barrows are associated along the row itself, but there is a slight clustering near the S'n end, with an onward view over a distinct cluster on Stalldown Barrow (SX 6362).

The view-shed down-slope from Green Hill towards the S, down the upper Erme valley, is further defined by lateral hills, focusing its line; the row itself, with its minor irregularities, subtends a narrow angle.

..Piles Hill-Butterdon Hill (P-B)

The P-B row lies on a spur, in contrast to G-S, which is more closely associated with the valley, but on similar N'-S'ly line. Any potential viewing area at the N appears bounded by the cross-row at Piles Hill NE, the area to N of this containing very few barrows and, as for G-S, perhaps kept deliberately empty. There is a marked clustering of barrows around the S'n end, which has the highest concentration in the area. Clusters of barrows on Butterdon Hill (SX 6558), and West Beacon (SX 6557), lie close to the line, and three more are lateral to it: Weatherdon Hill to the W (SX 6568), with Beacon Plain (SX 6659) and Ugborough Beacon (SX 6658) to the E.

The ridge would have sharpened the general view-shed down-slope towards the S, with the line possibly extending S'ward right to the end of the spur. As for G-S the row itself is closely linear, and subtends a narrow angle.

-associated settlement

..G-S

There is a distinct cluster of pound-type enclosures in the valley, around the S'n half of the row. Although of probable Iron Age, and Roman usage, in view of their ideal location, these may date to far earlier periods, and have supported settlement contemporary with establishment, and use of the row complex. The presence of settlement, as well as funerary areas, within the line of the row might have added to its potency for ritual activity.

..P-B

Settlement pounds are evident in lateral valleys flanking the P-B spur, several with their own local rows. Corringdon Ball-Brent Fore Hill contains a distinct area of settlement, stone rows, and clusters of barrows on the E'n side (SX 6661). There is a stone row on Burford Down, and adjacent settlement in the valley to the N and E (SX 6360).

The same combination of sites is seen elsewhere in the survey area (SX 65 and 66), on Black Tor (SX 6763, 6663, 6262), and Drizzlecombe (SX 5967), out of the survey area, just to the W. Other groups of known settlement, and barrows may have rows yet to be found.

-an extended row complex

The G-S row might extend further S'ward, at least nominally, if not structurally, perhaps with its line marked by the 500m long row on Stalldown Barrow (SX 632 623), which has a similar orientation, structure, and has a barrow at each end. The intervening valley need not have been an obstacle for physical continuation of the row, because other such valleys are traversed by G-S along its known route. The row on Burford Down, 2km to the SSE of Stalldown Barrow (SX 637 604), is also on a similar N'-S'ly line, but displaced 600m to the E. On a similar alignment, but displaced 2.5km to the E, the long Piles Hill-Butterdon Hill row appears as a separate complex, with all local rows emphasising a line towards the mid S'n arc of sky.

-individual rows

..Green Hill-Stall Moor; single; 3.4km long; axis 003-183°G; SX 6352 6443 to SX 6366 6779; terminals: at the N a barrow, at the S a circle; N'n end more elevated than S'n; NMR 441623; e-FIGS SR-09 and 10;

A single stone row, the longest known on Dartmoor, and in fact globally, runs N'-S'ward, on an irregular course, for 3.4km, from a cairn on Green Hill (SX 6366 6779) to a stone circle on Stall Moor (SX 6352 6443).

Six discrete sectors, of roughly equivalent length, can be distinguished, marked by changes of direction, or by gaps, which may indicate stages in construction:

sector 1: the row descends S'ward (180 °G) from the Green Hill cairn, at about 474m OD, to 450m OD, as a straight sector about 450m long, with very few extant stones;

sector 2: a straight sector, containing gaps, but with many stones intact, runs SSW'ward (187°G) at an angle to sector 1, for about 500m, down-slope to 425m OD, flanking the E'n side of an uppermost streamlet valley, with disturbance by tinning activity part-way along its course, at SX 6365 6722, and towards its end, at SX 6360 6674;

sector 3: after a gap, and change of direction to the SSE (168°G), this sector runs further down-slope for 300m, before resuming a S'ly course for a further 200m, to end near the base of a streamlet valley, at 390m OD;

sector 4: after a gap over the stream itself, a straight sector continues S'ward (180°G), flanking the W'n side of the stream valley for about 500m, until ending before an E'ward bend in the stream;

sector 5: curves SSE'ward (~204 °G) for 600m, up from one streamlet valley, over a ridge, and across the next valley, to about 385m OD;

sector 6: assumes a more S'ly, and straighter course (183°G) for 600m, to end near the stone circle on Stall Moor, at about 375m OD.

Counting from the S, sectors 6-4 contain about 613 stones, and sectors 3-1 another 187, making some 800 in total.

sector 0: a possible line running NNW'ward beyond the Green Hill terminus has been suggested, with 96 stones in its length to the depression at Blacklane Brook (SX 635 683), followed by an intermittent alignment of 21 stones to a ruined cairn on Cater's Beam (SX 633 690). However, this supposed extension, recorded by Falcon in 1905, has not been verified by more recent surveys.

Sectors 1 and 2 at the N, and 6 at the S, are close to a straight line between the two terminal sites, with the intervening central sectors bowed towards the E. Topographically, there is nothing to prevent a straight course from having been taken over this central zone. Overall straightness might have been the intention, with construction in stages, and loss of the view to *termini*, occurring over the deeper areas of valleys, contributing to loss of line. The *termini* of the row are not inter-visible, and for most of its length neither end can be seen. Viewing from the N'n terminus, the line only varies by 4° which, given the terrain and length of row, represents laudable accuracy. Sector 0, if it exists, although straight, runs on a slightly different line to sectors 1-6.

There is nothing to indicate the direction of growth for this row, whether consistently towards the N or the S, or in a more complex pattern. In general, the size of stones decreases, and the condition of the row deteriorates, as it runs N'ward. This could indicate elongation from a more substantial initial construction at the S, but may reflect differences in availability of suitable stone, or be the result of destruction by peat cutting on the open moor. A case could be made for the straight terminal sectors 1 and 6 being constructed first, with the centre added, and growth towards the S could also be argued. Without the detailed investigation that this site deserves there is little to favour any of these alternatives.

Although it shares many properties with the more usual shorter type of row, for instance, in terms of row-structure, and presence of terminal cairn and circle, since it is far longer than the norm, its importance and function might have been somewhat different. A structure this long could have acted as a practical territorial boundary, in addition to any other ritual functions. It might have divided the land over which it ran into E'n and W'n blocks, from a valley at the S, up over the highest ground, and perhaps to a valley at the N (e-FIG SR-09). Natural features bound the ovate block of land forming this locality. Crane Hill lies at the NW (SX 6269), Ryder's Hill at the NE (SX 6569), Huntingdon Warren at the SE (SX 6567), and Langcombe Hill at SW (SX 6165), with the known terminus on Green Hill row at its centre (SX 6367).

Stream valleys penetrating the block at the SW (SX 6067), S (SX 6365), and SE (SX 6666), contain numerous settlement-pounds of prehistoric type, perhaps of Iron Age, and Roman occupation, in their surviving form, but of earlier origin. These sites are situated in ideal streamside locations, likely to have supported settlement of later Neolithic to earlier Bronze Age type, contemporary with what may be the date of many rows. Rows might well have had an active life-span of use, and maintenance, well beyond the period of their construction, and could perhaps still be considered relevant against such later occupation.

The E'n and W'n groups of pounds, with burial cairns on surrounding hills, and slopes, could indicate core areas of settlement, located at the lower margin of their adjacent block of territory. The group of pounds in the stream valley of the Erme at the S may indicate a settlement area more closely associated with construction, maintenance, and operation of the long row. The Erme Pound complex lies next to the long row, with a short row amongst them, on a similar alignment to the long row.

The N'-S'ly alignment of the row might, therefore, have made practical use of a natural dividing line, for purposes of land tenure, perhaps conveniently combined with other ritual considerations.

The long row, in terms of length, with 3.4km known, and its N'-S'ly alignment, is similar to the shorter Piles Hill-Butterdon Hill row (1.9km long). This row lies about 5km to the SSE, and runs along the terminal ridge of a tongue of high ground that extends from the block of upland discussed above. Here, its predominantly ridge-top position makes it fairly convincing as a territorial boundary although, just to its N, the Piles Hill NE'n row, which cuts right across the ridge, does look more like one.

About 2km to the S of the Green Hill-Stall Moor row, the same alignment is picked up by the Staldon Row, running S'ward down-slope from the ridge of Stalldown barrow (SX 63 62). Some 1.5 km to the SSE, the same line is adopted by the row running along the ridge of Burford Down (SX 63 60). Taken together with the Piles Hill-Butterdon Hill row, this locality is dominated by such S'ly alignments, in a variety of locations, from ridge-, to valley-based, perhaps suggesting an underlying consistency of function, independent of topography.

The conclusion here may be that longer rows have additional land-tenurial functions which might have affected their alignment, but that this could be a relatively minor factor in the choice of line. It is therefore important that conclusions on alignment behaviour be drawn from group statistics rather than individual cases (e-FIG SR-05).

The Green Hill-Stall Moor row invites comparisons in terms of length and location with other linear monuments of the later Neolithic to Bronze Age (TABLE SR-11).

TABLE SR-11 The Green Hill-Stall Moor row: parallels in terms of length, alignment, and location amongst other monuments

site		**NGR**		**type**	**L(km)**	**axis (°G)**	**location**
Green Hill-Stall Moor	Devon	SX 63	65	st row	3.4	003-**183**	stream valley
Piles-Butterdon Hill	Devon	SX 65	59	st row	2.1	**185**-355	along ridge
Rudston A	N Yorks	TA 09	69	cursus	2.7	010-**190**	stream valley
Dorset Cursus	Dorset	SU 01	15	cursus	9.9	049-**229**	hills
Raeburnfoot	DumfGall	NY 25	98 -	ex bar	2	018-**198**	ridge-valley
Cleaven Dyke	Per Kin	NO 16	40	ex bar	>2.35	**121**-301	~level area

Note: **site**: **DumfGall** Dumfreis and Galloway); **PerKin** Perth and Kinross); **L**(ength); **ex**(tnded) **bar**(row); **st**(one) **row**; under '**axis**' the use of bold type indicates suggested direction of viewing during ritual use.

Terminal structures for the row: at the N, the terminal cairn on Green Hill (SX 6366 6779) is 8m in diameter, and 0.4m high, with a shallow central depression, is turf-covered, with no particular features, other than small protruding stones, and with no cist evident.

At the S, the row terminates in a stone circle on Stall Moor (SX 6352 6443), 17m in diameter, and containing 26 stones, ten in the E'n half, and 16 in the W'n half. A low round barrow lies within the circle, with a shallow trench surrounding it, and a broken stone on the surface may indicate a small standing stone, as lying displaced, or part of a cist.

..Brown Heath; double; 182m long; axis 011-191°G; SX 6411 6531-SX 6408 6515; terminals: at the N a cairn circle, at the S unknown; the ground runs up-slope to the N'n end; NMR 441705; e-FIG SR-09;

A double stone row, 182m in length, runs SSW'ward down the lower slope of a streamlet valley, from a cairn circle at its N'n, higher end, to the E'n side of a pound (SX 66 NW 50). Here it is overlain by the enclosure wall, making location of the S'n end of the row difficult. It is possible that this is the true end of the row, and that before the wall of the pound collapsed, the row and the wall were not in contact.

The row does not align with the centre of the terminal cairn at the N, but some 2m to its E. The E'n strand of the row includes more stones than the W'n part, which contains gaps. Most stones are relatively small, about 0.5m in average height, with the largest 1m tall.

Terminal structures: at the N'n end of the row (SX 6411 6531), there is a flattened stone circle of 13 stones, about 9.5m in mean diameter, surrounding a cairn 0.8m high that contains the remains of a cist. The row does not align exactly with the centre of the circle, the centres of the cairn and circle do not coincide, and the robbed cist was not central in the cairn.

At a point 27m from the centre of the cairn, the row touches what may be a hut circle (SX66NW 49). Some 137m further to the S it meets, and is partly lost in, the wall of a pound (SX66NW 50), which lies to the W.

The Piles Hill-Butterdon Hill focal area (e-FIGS SR-06 and 07)

-summary

The long row at Piles Hill-Butterdon Hill shows sectoring that suggests elongation, and strengthening of its N'-S'ly axis, as proposed for the other nearby long row at Green Hill-Stall Moor.

-general statistics on stone rows in the focal area (TABLE SR-12):

TABLE SR-12 Stone rows: basic structure

row	**#**	**length (m) each**	**total**
single	4	15, 84, 133, 2100	2332
double	3	106, 125, 950	1181
hybrid	1	single 61, double 111	283
triple	2	67, 79	438
total	10		4234

Note: known lengths are used: in most cases rows are defined by terminals, but in some cases rows may extend beyond their apparent ends.
Key: # number of rows present;

-individual rows

..Piles Hill NE; double; 950m long; rows 12-21m apart; ~088-268°G; SX 6503 6110-SX 6589 6115; terminals: possible blocking stones at the E'n, and W'n ends; the centre is higher than the terminals; NMR 442017; e-FIG SR-06;

A double alignment of stones, about 950m long, runs in a curving line E'-W'ward transversely across a ridge, and partway down its flanking slopes. Most stones have fallen, but some only partially: the row contains 139 stones, with many leaning, recumbent, or surviving as broken stumps, some bearing modern drill marks. About 30 stones are longer than 2m, with a maximum at 3m. The rows in the alignment are from 21-30m apart, and the gaps between stones vary from 3-30m. At each end the rows are closer, 12-17m apart, with fewer large gaps between stones. Some stones are slabs or boulders, but the majority are of post-type, up to 0.6m long, and square in section, with an angled top created by a single chamfer. Certain stones, as re-erected elsewhere in the area, might have come from the row. Some recumbents lie at right angles to the general axis, with no evidence of adjacent post-holes, suggesting that the row might not have been completed.

Terminal areas: at the W'n terminal there is a fairly level area, about 8m in diameter, with a scarp 0.4m high around the lower W'n half. This contains a recumbent stone, and one leaning stone, set across the axis of the row, similar to the type of blocking stone found in other rows. The E'n end of the row ends at a natural bluff, on top of which split stones, and transverse trenches indicate robbing of a possible blocking stone.

..Cantrell; part single, part double; 172m long; rows 2.1-3.7m apart; 042-222 °G; SX 6600 6078-SX 6608 6082; terminals: at the NE a cairn circle, at the SW a cairn; the ground runs up-slope to the NE; NMR 441916; e-FIG SR-06;

This stone row runs NE'ward for 172m, down the mid-slope on the flank of a ridge. The N'n sector of the row, 61m long, has its full complement of stones, and is single, with an abrupt change to double for the remaining 111m of the S'n sector. A cairn lies at the SW'n end, and at the NE'n end a retaining circle of largely fallen stones.

Terminal structures: at the NE the row ends on the remains of a cairn circle, too ruinous for estimation of diameter (SX 6609 6080). The cairn reported at the SW'n end of the row (SX 6600 6078) is no longer extant.

..Piles Hill-Butterdon Hill; single; 2100m; axis 185-355°G; SX 6543 6074-SX 6563 5880; terminals: at the N a monolith, at the S a cairn; the N'n end is higher than the S'n; NMR 442078 and 441148; e-FIG SR-06;

A single stone row runs N'-S'ward, in a lightly curving line, between two hills of similar altitude, at either end of a ridge-line, dipping over its mid section onto the flank. Although now ruinous, the row once contained an estimated 2000 stones.

Three sectors of the row can be seen, their junctions marked by changes in direction:

sector 1: a straight length, about 280m long, runs SSE'ward from the now recumbent Longstone (SX 6543 6074), to Hobajon's Cross (SX 6550 6046), appearing on a map of 1799-1800, but destroyed in 1803, when split stones were introduced into the row, allowing its re-use as a land boundary (see SX66SE 107). Ten stones, deviating by as much as 3m from a direct line, remain as earth-fast stumps up to 0.2m high: one recumbent stone is 1.2m long, and a single standing stone, 0.9m high, may be original, but has been reused as a boundary stone. Broken fragments of slab, and post-like stones cover an area of 6m by 3m, near the centre of the sector, possibly indicating debris from row-clearance. Unlike sectors 2 and 3, this initial sector runs down a S'ward-facing slope, a property of many other rows.

sector 2: this sector takes a more S'ly line, running straight for about 1050m, and contains several hundred stones, mainly 0.1-0.4m high, with few over 0.5m, forming an irregular line, fairly continuous, except for a gap of 70m on the N'n side of Hangershell cairn. In places, the line of the row is complicated by the presence of natural stone. At its N'n end, Hobajon's Cross, a probable terminal at some stage, at 1.2m is the highest stone, and may be further distinguished by the possible presence of cup-marks on its S'n face.

sector 3: the remaining line runs straight, almost due S, for about 700m. A cairn at Hangershell Rocks (SX 6564 5941) lies adjacent to the junction between sectors 2 and 3.

Terminal structures: the N'n terminal of the entire row is at the Longstone, probably once over 3m high (SX 6543 6074; SX66SE 50). Hobajon's Cross (SX 66 SE 58) might have formed the S'n terminal of an original row, represented by sector 1 of the full row. This would assume growth of the row in a S'ly direction. If sector 1 was added to existing sectors 2 and 3, then Hobajon's Cross would have formed an earlier N'n terminal.

The S'n end of the row ends at a cairn circle (SX 6563 5881; NMR 441240), on a bluff amongst other cairns. This circle of 12 stones, now recumbent, is 11m in diameter, and contains a cairn 9m in diameter, and 0.3m high, has been dug into at the centre, and now contains no cist.

The terminals are inter-visible along the length of the row, and the likely 3m height of the Longstone, as originally erected, would have further increased the prominence of the N'n terminal.

..Glasscombe Ball SW; single; 84m; axis 039-219ºG; SX 6573 6041-SX 6577 6048; terminals: at the NE a cairn, at SW a possible cairn; the ground runs up-slope to the NE; NMR 441946; e-FIG SR-06;

A single stone row runs NE-SW'ward for about 84m, obliquely over the ridge of a spur, from the centre of a cairn at the NE'n end, to a stone of doubtful significance at the SW'n end. All of the stones in the row have fallen, with 24 remaining visible, and there are gaps, with some stones probably misplaced.
Terminal structures: the cairn at the NE'n terminal is 0.6m high, now elongated to 6m by 4m NW'-SE'ward. The cairn of close-packed stones at the SW'n terminal is 4m in diameter, and 0.8m high, but may not be directly associated with the row, since it is off-alignment. Another barrow lies near the SW'n end of the row, and about 11m N of it.

..Spurrell's Cross; double; 106m long; lines about 1m apart; axis 160-340 ºG; SX 6581 5997-SX 6585 5985; terminal cairn circle; site fairly level; NMR 441145; e-FIG SR-06;

The row runs SSE'ward for 106m along a ridge-top, ending at a cairn. The row appears to have been double, and is now ruinous, with only seven stones still standing, the tallest 0.6m high, and a further six stones detectable, giving an estimate of spacing between the lines as 1m, and between stones as 0.9m.

Terminal structures: the cairn at the SSE'n end of the row (SX 6585 5985) is 12m in diameter and 0.4 metres high, with only two stones remaining of its 15m diameter retaining circle. The stone at Spurrell's Cross lies at the N'n end.

Row complex: Corringdon Ball

Here, two triple rows run parallel to a single row, and approximately towards a cairn circle. Between the two triple rows are two stones, 24m apart, their axis to the NE passing through the centre of the cairn circle. Corringdon Ball N, central, and S run NE'-SW'ward along the contour of a sloping, SE'ly-facing spur, between two streamlet valleys, the Brent Fore Hill row runs WSW'ward down the hill slope above, and The Treeland Brake row is located on the opposing NE'ly-facing slope over the ridge. Several barrows lie at the head of the slope, including a long barrow.

..Corringdon Ball N; single; 133m; ~055-235ºG; SX 6655 6112-SX 6667 6121; terminals: at the NE a terminal stone, and a cairn with retaining circle, at the SW a terminal stone; the ground runs up-slope towards the NE; NMR 441898; e-FIG SR-06;

A single row 133m long, the most N'ly of the three rows, runs NE'-SW'ward between end-stones, directly towards the centre of a cairn, the first stone of the row lying about 18m to the W of the its centre.

Terminal structures: the retaining circle of the terminal cairn is 11m in internal diameter.

..Corringdon Ball Central; multiple with three rows, divergent; 79m long, 2.1-2.7m apart; ~055-235ºG; SX 6655 6112-SX 6667 6121; terminals: at the NE a cairn with retaining circle, at the SW unknown; the ground runs up-slope towards the NE; NMR 441898; e-FIG SR-06**;**

This triple row runs towards the N'n side of the circle, and is 124m long from abreast the centre of the retaining circle.

Terminal structures: a robbed cairn (SX 6666 6120) 7m in diameter, and 0.4m high, lies within a retaining circle of diameter 11.5m. Six standing stones, and one recumbent of its retaining circle are visible on the SW'n side, the largest of which is 0.5m high, and 0.3m by 0.3m in section.

..Corringdon Ball S; multiple with three rows, divergent; 67m long, 2.4-4m apart; ~055-235ºG; SX 6655 6112-SX 6667 6121; terminals: at the NE a cairn with retaining circle, at the SW unknown; the ground runs up-slope towards the NE; NMR 441898; e-FIG SR-06;

This triple row runs towards the S'n side of the circle, and is 117m long from abreast the centre of the retaining circle.

Terminal structures: details as for Corringdon Ball Central.

..Brent Fore Hill; double; 125m long, 0.75m wide; 062-242°G; SX 6674 6126-SX 6685 6134; terminals: at the ENE a cairn, with blocking stones at both ends; the ground runs up-slope towards the ENE; NMR 441901;

A double row 81m long, containing 42 stones, of which 27 are standing, runs WSW'ward down-slope from a cairn, the centre of which is 45m further to the ENE. The up-slope, ENE'n sector of the row deviates from the rest, and so does not run precisely towards the centre of the cairn. The line of the row is crossed by two leats.

Terminal structures: each end of the row terminates in a blocking-stone. The cairn at the ENE'n end of the row (SX 6685 6134) is 13.5 metres in diameter, and 0.3 metres high, with an inner, and an outer circle of stones, 8 stones of the latter remaining.

..Treeland Brake; single; possibly about 15m long; ?~018-198 °G; SX 6718 6125-SX 6723 6139; terminals unknown; the ground runs up-slope towards the SW; NMR 442117;

A stone row estimated as 15m long, aligned NNE'-SSW'ward, containing five erect and five fallen stones, was destroyed by agricultural activity in 1977.

The Plym group of stone rows (e-FIG SR-01): Drizzlecombe focal area (e-FIG SR-08)

-summary

This group of four known, and one conjectural stone rows shows clear indications of a general plan of splayed disposition. Rows run down-slope towards the SW, down a low ridge between two streamlet valleys, from an area of cairn circles, to end at terminal stones. All rows radiate from a larger cairn, situated up-slope, that perhaps acted as a focus, and as a potential viewing area down along the lines. This fanning of separate rows is reminiscent of splaying seen within other multiple rows, such as those in Caithness and Sutherland, N'n Scotland (see Table of Contents: 3d/9).

The importance of settlement-pounds within this complex of rows is unknown, because dating evidence is generally absent. However, it is possible that there was a close association between rows, funerary monuments, and contemporary settlement at the site, the latter area providing easy viewing down lines, and over cairns, towards events in the S'n arc of the sky.

The complex represents aggrandisement of the site by repetition of rows, and by elongation of lines.

-general statistics for stone rows in the area (TABLE SR-13):

TABLE SR-13 Stone rows: basic structure

row	length (m) #	each	total
single	3	76, 77, 146	299
hybrid	1	single 70, double 70	210
total	4		509

Note: known lengths are used: in most cases rows are defined by terminals, but in some cases rows may extend beyond their apparent ends; **Key: #** number of rows present;

-individual rows

Further details of sites at Drizzlecombe (e-FIG SR-08)

..Drizzlecombe E; single; 77m; axis 043-223°G; SX 5920 6700; terminals: at the NE a cairn circle, at the SW a standing stone; NMR 438619**;**

A single stone row runs for 77m, from a cairn circle at the NE, to a large terminal stone at the SW. Its line is marked by 14 stones, of maximum height 0.8m, three of which are recumbent, and in recent years a number of boulders have been inserted into some of the gaps in the row.

Terminal structures: a cairn, of diameter 9m, and height 0.9m, lies at the NE'n end of the row, its centre offset from the line of the row by about 0.6m. Twelve stones of the retaining circle remain, 1.5m beyond the base of a mound that bears a small depression in its top. At the SW, the row ends in a terminal stone, which was recumbent in 1889, but has since been raised, and now stands 4.3m high, and edge-on to the row.

..Drizzlecombe S; partially double; 140m long, width variable; axis 050-230 °G; SX 5912 6691; terminals: at the NE a cairn circle, at the SW a standing stone; the ground runs up-slope towards the NE; NMR 438629;

This partially double stone row runs SW'ward for 140m, from a cairn at the NE, to a large terminal stone at the SW. The row contains 90 stones, 28 in one line, and 62 in the other, of which six stones are recumbent. The doubling starts at the NE'n end, and runs to about the mid-point. Some boulders have been inserted recently into the row.

Terminal structures: the cairn at the NE, bearing a central depression, has a diameter of 7m, and a height of 0.8 metres, with a retaining kerb partially extant.

The standing stone at the SW'n end is 3.2m high, 1.8 m wide and 0.4 m thick, and was recumbent in 1889, but has since been raised, to stand face-on to the row, to cover both the connecting single, and the partial doubling over the N'n half.

..Drizzlecombe Central-E; single; 146m; axis 053-233°G; SX 5920 6702; terminals: at the NE a cairn circle, at the SW a standing stone; the ground runs up-slope towards the NE; NMR 438622;

The single stone row runs SW'ward for 146m, from a cairn at the NE, to a large terminal stone at the SW. The row contains 75 uprights, and four recumbents, with a pair of additional stones at the SW, perhaps suggesting very partial doubling. A number of portable boulders have been inserted recently into some of the gaps in the row.

Terminal structures: the cairn at the NE'n end, with a diameter of 9m, up to 1m high, bears a depression in the centre, possibly the site of a cist. A surrounding circle, seven stones of which remain, lies offset from the line of the row by 1.5m. At the SW, the row ends at a standing stone, recumbent in 1889, but since raised, and standing 2.4m high, perpendicular, and edge-on to the row.

..Drizzlecombe central-W; a row has been conjectured; projected maximum length 288m; axis 055-235°G; possible terminals: at the NE, a cairn circle, at the SW, a standing stone; the ground runs up-slope towards the NE;

Based on the layout of rows E, S, and central-E, Burl (1993 fig. 26/p. 114) suggests that provision might have been made for an additional row. An isolated cairn circle at the NE'n end of the slope, and a standing stone, 1m high, on the SW'n down-slope side, may indicate the ends of a row no longer extant, or perhaps never constructed between pre-existing terminals. Such a row, 288m long, running SW'ward, would provide a symmetrical partner to the joint line of rows E and S, of equivalent length, arranged radially, either side of the shorter row Central-E.

..Drizzlecombe W; single; 76m; axis 087-267 °G; SX 591 672; terminals: at the NE, a standing stone, at the SW, a cist; the ground runs up-slope towards the NE;

Burl (1993 fig. 26/p. 114) shows a short row containing 10 stones, running SW'ward down-slope from a larger block, in line with the axis at the NE'n end, pointing towards a cist with capstone, at the SE.

The Walkham-Meavy group of stone rows (e-FIG SR-01):

Merrivale focal area (e-FIG SR-11);

-summary

Two double, and one single rows are clearly visible, with other short alignments in the area indicating further unknown complexity. The rows run down the low spine of a gently sloping hilltop, either side of a stream.

The complex represents aggrandisement by repetition of rows, and replication of row-lines. Although some minor sectors of rows lie on the more common SW'ly axis, that of the two major double rows is E'-W'ward, an orientation more common amongst funerary monuments, such as long barrows (e-FIG LB-01).

-general statistics for stone rows in the area (TABLE SR-14):

TABLE SR-14 Stone rows: basic structure

	length (m)		
row	**#**	**each**	**total**
single	3	5, 15, 42	62
double	2	182, 264	892
total	5		954

Note: known lengths are used: in most cases rows are defined by terminals, but in some cases rows may extend beyond their apparent ends.
Key: # number of rows present;

-individual rows

..Merrivale N; double; 182m long, 1m wide; 084-264°G; SX 5536 7479 to SX 5555 7482; terminals: at the ENE, a triangular blocking stone, and possible stone circle/cairn kerb, at the WSW, unknown; the ground runs up-slope towards the ENE; NMR 440056; e-FIG SR-11;

A double row runs for 182m ENE'-WSW'ward down the gentle SW'ly-facing slope of a ridge and, although it might once have extended further to the W, there is no clear evidence to support this at present. Its line is not quite parallel to the longer Merrivale centre double row just to its S, the ENE'n end being 23m N'ward of that row, and the WSW'n end 30.6m N'ward of it, making an angular difference of a few degrees.

The row contains 186 stones, and consists of randomly assorted post-, and slab-stones, the latter usually aligned along the row. The distance between the rows is fairly constant at 1.2m, and the spacing between the stones is 1.5m, closing to 1m towards the ENE'n end. Almost two thirds of the stones are under 0.2m high, but they are consistently higher in the E'n 60m sector, averaging 0.4m.

Terminal structures: at the E'n end there is a blocking stone, and beyond it a number of earth-fast and loose slabs, which may represent the remains of a kerb, or circle, about 5.6m in diameter. The blocking stone is part of the circle, along with two, or possibly three earth-fast slabs, set on-end, three recumbent slabs, and four other post-, or slab-stones, all of which are much displaced, or entirely unconnected. The stones are spaced at about 2.0m intervals, uprooted slabs are from 0.3m square to 0.4m by 0.5m, and earth-fast stones 0.1m high. There is no sign of a cairn or cist.

..Merrivale Central; double; total length 264m (134m long to the W of the central cairn circle, and 130m long to the E); 0.9m between lines; 082-262°G; SX 5530 7475 to SX 5556 7478; terminals: at the WSW, a pillar and slab, at the ENE, a triangular slab; the ground runs up-slope towards the ENE; NMR 440056; e-FIG SR-11;

The S'n-most of the two double rows runs for 264m ENE'-WSW'ward, down the gentle SW'n slope of a ridge, and is almost parallel to the N'n row, there being 25m between centre-lines at their ENE'n ends, this increasing to 32m at the WSW. A cairn circle lies within few a metres of its mid-point. The stones are of randomly assorted post-, and slab-types, the latter always well aligned with the row, except for the twin blocking stones at the W'n end, and the single blocking stone at the E'n end. Stones are spaced at about 1.6m but, for the 30m sector at the ENE, this closes to average 1m. The width between the line varies from 0.6-1.2m, narrowing towards the ENE, where the stones are consistently taller. This may reflect the increased abundance of surface rock towards the E of the area.

The central cairn (SX 5543 7477) is 4m in diameter, 0.2m high, and contains an off-centre cist, 0.7m by 0.4m by 0.3m deep, orientated N'-S'ward, of which the side-slabs remain in place. Slightly beyond the perimeter of the mound, six stones of a peristalith, or cairn circle survive, two of them 0.5m high.

Terminal structures: the WSW'n end is formed by a stone pillar, and slab, the ENE'n end by a triangular slab.

..Merrivale SW; single; 42m known length, with at least a further 60m possible; 026-206°G; SX 5539 7476-SX 5537 7472; terminal: at the NNE, a cairn, at the SSW, unknown; the ground runs up-slope towards the ENE; NMR 440357; e-FIG SR-11;

Just to the S of the two double rows, a single stone row runs SSW'ward down a shallow slope, in a slightly curving line, from a cairn at its NNE'n end (SX 5539 7476), for 42m to an upright blocking stone, set at an angle to the row, a possible terminal (SX 5537 7472). Discovery of a further stone beyond this, 0.5 by 0.4m, and up to 0.4m thick (SX 5533 7484), suggests that the row may extend further than this, at least to 60m. The row survives as six uprights, six stones just extant, and about 10-19 depressions, marking probable stone-holes; original totals have been estimated as 36, 40, or 41.

Terminal structures: at the NNE'n end of the row, a cairn (SX 5539 7476), 3m across, and 0.5m maximum high, lies slightly off-centre to the W of the row, and has been disturbed by a radial trench, revealing some indication of internal stonework. There is no obvious kerb, or cist, but a transverse slab, the terminal slab of the row, is set within the S'n side of the mound, stratigraphic relationships unknown.

..Merrivale E (after Burl 1993); single; 15m known length; ~E-W; central cairn SX 5536 7459; terminals: unknown; the site is approximately level; NMR 440047; e-FIG SR-11;

and

..Merrivale D (after Burl 1993); single; 5m known length; ~N-S; centred at SX 5536 7459; terminals: unknown; the site is approximately level; NMR 440047; e-FIG SR-11**;**

Two standing stones, 11m apart, with a disturbed cairn between them, and a number of other small, earth-fast stones, may represent the remains of a short stone row running approximately E-W, incomplete, damaged, or both. The stone at the W (SX 5536 7459), of unknown status as a terminal, or other focal element, still stands 3.2m high, supported by packing stones, and tapers up from a base 0.7 by 0.5m in section. A second stone (SX 5537 7459), 2.2m long, about 0.4m by 0.3m in section, re-erected in 1895, now lies fallen, adjacent to a depression, which may represent its socket-hole.

A cairn, about 3m in diameter, and up to 0.3m high (SX 5536 7459), disturbed by central excavation, lies between the two stones. Early plans, and excavations indicate the presence of a cairn, cist, and a circle of slabs around the menhir, now all destroyed.

Other stones in the area may indicate short row-settings. Small earth-fast stones in the area, none more than 0.3m high, may be natural. Three of these stones, just to the S of the W'ly larger stones (centred at SX 5536 7459), from 0.2m to 0.35m in height, seem aligned generally N'-S'ward towards a squarish block, near the base of the standing stone, and are similar in appearance to local row-stones, with a nearby slab set at right angles.

Walkhampton Common-Sharpitor focal area

-summary

The area contains four single, and four double rows, and represents structural aggrandisement by repetition of rows, and replication of row-lines.

-general statistics for stone rows in the focal area (TABLE SR-15):

TABLE SR-15 Stone rows: basic structure

	length (m)		
row	**#**	**each**	**total**
single	4	50, 83, 132, 165	430
double	4	37, 113, 137, 294	1162
total	8		1592

Note: known lengths are used: in most cases rows are defined by terminals, but in some cases rows may extend beyond their apparent ends.
Key: # number of sites;

-individual rows

..Black Tor NE; double; 294m long; 050-230°G; SX 5721 7155-SX 5700 7137; terminals: at the NE, a blocking slab, at the SW, a cairn; the ground runs up-slope towards the NE; NMR 440127;

A double row runs for 294m SW'ward along the contour of a spur, its N'n line almost totally merged within a substantial field boundary, the S'n line remaining just clear of it. In the S'n line, 60 stones are visible, although a few of them are only possible members of it. In the N'n row, 21-39 stones can be seen, these on average much larger than those in the S'n line. Many of the stones apparently in the N'n row may in fact have been placed during construction of the later wall. A leat crosses the alignment. Both the spacing between stones, and their height, decrease along the row towards the SW. The row is fairly straight for most of its length, but the last six stones curve away on an alignment that would barely have contacted the fringe of the mound at the SW'n end.

Terminal structures: at the NE the row ends in a substantial blocking slab 0.75m high, and 1.3 by 0.3m in section. At the SW'n end of the row there is a cairn about 9m in diameter, with a central disturbance. A cairn cemetery developed around this end of the row (SX57SE 238).

..Hartor N; double; 137m long, 2m wide; 079-259°G; SX 5771 7170-SX 5758 7168; terminals: at the ENE, a cairn, at the WSW unknown; the ground runs up-slope towards the NE; NMR 440118;

A double stone row, with more than 40 pairs of stones, runs WSW'ward for about 137m, down the lower slope of a stream valley, with about 68-92 stones remaining, mainly 0.1-0.4m high, with some up to 0.8m tall. The lower end of the row has been damaged, by cutting back the bank of the stream during mining activities, with further damage elsewhere, from a ditch cut across its line.

Terminal structures: at the upper ENE'n end of the row there is a cairn (SX 5771 7170) 9m in diameter, and 0.5m high, with evidence of an incursion at the centre, surrounded by a cairn circle of 14 stones, up to 0.9m high.

..Hartor S; single; 50m; 059-239°G; SX 5772 7169-SX 5765 7165; terminals: at the ENE, a cairn, at the WSW, unknown; the ground runs up-slope towards the ENE; NMR 440118;

A single stone row runs WSW'ward for 50m down the lower slope of a stream valley, in an irregular line, and lies just to the SE of the double row Hartor N. The row contains 18 surviving stones, mainly under 0.4m high, and probably extended further to the WSW than its currently known end. A transverse drainage ditch has damaged the line.

Terminal structures: a cairn 8m in diameter, and 0.5m, high lies at the ENE'n end of the row (SX 5772 7169).

..Sharpitor E; double; 37m long, 0.1-0.3m wide; 090-270°G; SX 5614 7078-SX 5616 7078; terminal: at the W a cairn, at the E unknown; the site is approximately level; NMR 440158;

A double stone row runs almost due E for 37m, and contains nine stones, of which six are paired, the tallest 0.5m high, with a gap between lines of about 0.25m.

Terminal structures: a cairn 7m in diameter, and about 0.3m high, with a flat top, lies with its centre 23m from the W'n end of the row (SX 5612 7081). The E'n end of the row is terminated by a reave (SX 67 SE 91), which has cut across, and obscured, any extension further W'ward.

..Sharpitor W; single; 132m; 051-231°G; SX 5506 7075-SX 5495 7067; terminals: at the NE a cairn, at the SW a standing stone; the ground runs up-slope towards the NE; NMR 440234;

A single stone row runs for 132m down-slope towards the SW, along the side of a low ridge, and contains 47 upright stones, mainly 0.1-0.3m high, mostly visible as a single line, but with occasional pairs possible. Midway along the alignment there is an edge-set stone, located next to the row.

Terminal structures: at the NE'n end of the row (SX 5506 7075) there is a low cairn, robbed at the centre, 7m in diameter, and 0.6m high, with a surround of upright stones. There is a second cairn 18m to the NE (SX57SE 105).

The row terminates at the SW'n end in an upright, post-like stone 1.2m high, the largest in the row.

..Sharpitor NE 1; double; 113m long, lines 0.4-0.7m apart; 064-244°G; SX 5576 7065-SX 5566 7061; terminals: at the ENE, a blocking stone, at the WSW, a cairn; site approximately level; NMR 440167;

A double stone row runs WSW'ward across the neck of a sloping spur, for 113m, as taken from cairn centre, and contains 43 extant stones, mainly less than 0.2m high, with seven pairs indicating a spacing between lines of 0.4-0.7m. The stones may increase in size as the row approaches the cairn. The central sector of the row is slightly higher than the terminal areas.

Terminal structures: a cairn (SX 5566 7061), about 4m in diameter, and 0.3m high, lies at the WSW'n end of the row, has lost its retaining circle, and has been dug into at the centre. The ENE'n end of the row is well defined by a pair of larger slabs, set along the lines, and is closed by a cross-set blocking stone 1.2m long (SX 5576 7065).

..Sharpitor NE 2; single; 83m; 058-238°G; SX 5577 7065-SX 5570 7061; terminals: at the ENE, unknown, at the WSW, a possible blocking stone; the ground runs up-slope towards the WSW; NMR 440366;

A single stone row runs WSW'ward across the neck of a sloping spur for 83m, at a very slight angle to the ENE'n end of the adjacent double stone row Sharpitor NE 1. The count of extant stones decreased from 30 in 1980 to 10 in 1994, indicating continuing damage to the monument. The length of the row remains uncertain, with little evidence for terminal structures. The area has been much eroded, but continuation of the row for a further 64m to the ENE would, however, lead generally towards a cairn retained by a ring of boulders and slabs, 4m in diameter, containing a slab cist, slightly off-centre, and oriented NNW'-SSE'ward (SX 5583 7068; NMR 440164).

..Leedon Tor; single; 165m; 104-284°G; SX 5654 7146-SX 5667 7143; the ground runs up-slope towards the WNW; terminal; NMR 440324;

The remains of a single stone row runs down-slope towards the ESE for 165m. The row contains 14-16 remaining stones, spaced at fairly regular 13m intervals, mainly natural blocks, with some slabs, 0.2-0.7m high, and up to 0.4 by 0.9m in cross-section, 4-5 of which are still earth-fast, the rest either lying flat, or buried.

Terminal structures: at the WNW'n up-slope end of the row lies a cairn, about 6m in diameter, and 0.5m high, robbed at the centre, with part of its retaining circle remaining, and now incorporated in the wall of a reave.

At the down-slope ESE'n end of the row there is no blocking stone, nor evidence of the original course E'ward, but towards the road there are clear indications of modern quarry pits, and a group of stones off-line at this end could have come from the row.

Case study: multiple rows in N'n Scotland (e-FIG SR-15)

Multiples stone rows containing in excess of three lines, arranged in parallel, or more usually diverging, form a conspicuous group in Caithness and Sutherland, N'n Scotland (TABLE SR-16; e-FIGS SR-15). Occasional, rather doubtful sites in the Hebrides, and Shetland, and a general absence of candidate sites elsewhere in N'n Britain, serve to emphasise this rather isolated regional grouping (e-FIG SR-16). Many sites are fragmentary, damaged by removal of individual stones, and by wholesale destruction of lines by cultivation. Despite being such an important, and unusual group of megalithic monuments, very few of the sites have been investigated, or surveyed, in sufficient preliminary detail, and key data are lacking for most. Surveys, and reviews of these sites are to be found in the following sources: Burl 1993; Thom 1971; Thom and Thom 1990; Myatt 1980, 1985, 1985a, 1988; Freer and Myatt 1982, 1983; RCAHMS: Canmore database).

Given the lack of precisely measured plans, much of the existing astronomical, and geometric analysis seems open to question, and certainly needs to be re-evaluated on the basis of rigorous survey of extant remains, supplemented by excavation to specify missing, or damaged areas. Grids imposed on rows, often ill-fitting, and extrapolated over blank areas, seem over-speculative (as in Thom 1971; Thom and Thom 1990; Myatt 1988; e-FIGS SR-22 and 24).

Sites and their localities were re-assessed from the most reliably mapped sources, key alignments determined, and details of the aspect at the site obtained (TABLE SR-16; e-FIGS SR-18).

TABLE SR-16 Multiple stone row sites in N'n Scotland

Note: rows are ranked in descending order, by number of known or probable rows.

site	#rows	L	W	p/d	dsl	axis(°G)	oct	crnN	lc	NGR
Sutherland (9 sites)										
Allt Breac;	14-15	20	14	d	[y]	mean 163	\	y	K	NC 9549 1854
Kinbrace	10	13	9-16	d	y	132-163	\	n	K	NC 827 322
Borlum;	8	26	11-19	d	l	mean 318	\	?y	D	NC 977 634O
Learable Hill S	6	20	9-18	d	y	145-168	\	y	K	NC 8928 2347
Cnoc Molach	5-7	16	4-13	d	y	170-205	|	n	K	NC 7826 3516
Dail na Drochaide	>5	10	5	p	l	N-S	|	n	N	NC 7205 5745
Borgie Bridge	5	18	10	?p	y	?016-196	|	?y	o	NC 6613 5874
Skelpick	5	30	10	?p	n	158-338	|	n	N	NC 722 574
Loch Rimsdale	4	13	3-6	d	y	160-175	|	n	K	NC 7161 3486
Caithness (15 sites)										
Hill O' Many Stanes	22	50	50-80	d	y	168-195	|	n	U	ND 2952 3840
Upper Dounreay I	13-18	35	28-37	d	l	088-132	--	n	D	ND 007 660
Dirlot	13-14	32	26-49	d	[y]	102-123	\	+	M	ND 1228 4856
Creag Breach Mhor	13	30	13-35	d	n	mean ESE	--	+	D	ND 0117 6595
Tormsdale	9	37	12-34	d	l	103-137	\	n	M	ND 1483 4974
Watenan Farm	>8	57	-34	d	[y]	190-197	|	n	U	ND 3150 4119
Loch of Yarrows	8	>42	10-12	p	-	178-182	|	y	U	ND 3129 4401
Garrywhin	7-8	59	20-35	d	[y]	199-220	|	y	U	ND 3138 4129
Clash an Dam	6-7	?	~19	?p	l	ENE-WSW	--	n	U	ND 3122 4041
Camster	6	27	10-13	d	l	?183-189	|	y	U	ND 2602 4377
Loch Watenan	4	29	?	?	l	?~N-S	|	n	U	ND 3174 4104
Broughwhin	4	33	?	d	y	SW	/	y	U	ND 3125 4096
Druim na Ceud	?	?	?	?	?	?		?	D	ND 002 661
Broughwhin Loch	?	?	?	?d	y	?S	|	?	U	ND 3130 4122
Thrumster	?	?	?	?	?	?		?	U	ND 338 452

Key: **#rows** number of rows; **L**(ength) in metres; **W**(idth) in metres; **p**(arallel)/**d**(ivergent); **dsl** rows run down-slope towards the S'n arc: **y**(es), **[y]** yes, but the slope is very slight, **l**(fairly level ground);

axis: the range of axes between outer rows, in the case of divergent sites, or the common axis in the case of parallel monuments, quoted in the S'ly direction for convenience, the other direction being implicit; **oct**(ant): axes are shown more graphically thus, according to general direction: **'|'** N-S; **'/'** NE-SW; **'--'** E-W; **'\'** SE-NW.
crnN cairn at the N'n end: **y**(es), **n**(one known), **+** more than one; **lc** **l**ocal **c**luster (see Table of Contents 03a/25c and e-FIG SR-15: **U**(lbster), **K**(ildonan), **D**(ounreay), **N**(aver), **M**(ybister).

General properties of these multiple stone rows

Despite the lack of fieldwork, much can still be said in general about the consistent properties of these multiple stone rows, without pushing the data beyond reasonable limits:

-clustering of sites (TABLE SR-17; e-FIG SR-15)

Multiple rows occur in five main clusters, with very few outliers:

TABLE SR-17 Multiple stone row sites in N'n Scotland: clustering

cluster	**~NGR**	**#**	**location**
Ulbster	ND 34	9	S'n coastal;
Kildonan	NC 82	5	strung out along the Kildonan valley, from near coastal to well inland;
Dounreay	NC 96	4	N'n coastal;
Naver	NC 75	2	Naver valley, near the N'n coast;
Mybister	ND 14	2	upper Thurso valley, well inland.

-aspect (e-FIG SR-18)

Although a few locations slope towards the N'n arc, there is a preference for the S'n arc, and especially towards the SW'n sector, with sites preferring S'-WSW'ly facing slopes, usually quite gentle;

-orientation (e-FIG SR-17)

For those sites where axial orientation has been more accurately measured, there is evidence for clustering of axes around N-S, and NW-SE, with rows usually diverging, and locations sloping down towards S'ly directions in the axis;

-number of rows (e-FIG SR-16)

There is no consistency amongst members of the group, with known row numbers varying from 4-22;

-divergence of rows

Most rows are divergent, or possibly so (62%; e-FIGS SR-21 to 25), fewer are approximately parallel (25%; e-FIGS SR-19 and 20), with 12% of unknown type;

-focal zones for convergent lines (e-FIGS SR-21 to 25)

Extrapolating convergent rows, back from their known narrower ends, indicates that they do not emanate from a single focus, but cross in a spread zone of intersection, some distance to the rear;

-internal clustering of rows (e-FIGS SR-20 to 25)

Divergent rows are rarely uniformly splayed, and often appear grouped in repeating patterns, as if indicating discrete unit-additions to the complex;

-associated monuments (e-FIG SR-20 to 23)

One, or occasionally several, cairns lie near the main site, around the axis of the rows, and towards their N'n, up-slope, usually convergent end, often lying in the zone of nominal intersection;

Multiple rows occur in the area of some of these regional barrow groups, but not in others, and this may be the result of partial fieldwork (details of barrow groups: e-FIG LB-15). Dounraeay, Ulbster, and Kildonan barrow groups have multiple rows, but Calder Mains, Achingills, and Dunbeath are apparently lacking. Such clusters of barrows certainly indicate funerary areas, and perhaps the general zone of direct settlement, although this latter relationship remains unclear.

Parallels beyond the region

The aspect and orientation of these multiple stone rows compares well with those determined for rows on Dartmoor (e-FIGS SR-02 and 04), strengthening the view that S'ly axial interest is a key component of function, and is not determined by convenient local topography. Cairns are also found in association with rows on Dartmoor, frequently in close association, at one, or both ends. Dartmoor has only a few multiple sites, containing a maximum of three rows, nothing directly comparable in scale to those in N'n Scotland, and those that are parallel do not generate focal terminal zones in the same way. At Drizzlecombe (e-FIG SR-08), individual placement of rows in a divergent pattern, running down-slope towards the SW, does seem to focus axes near a cairn beyond their up-slope ends, suggesting expression of some basic common idea here also.

At Beaghmore (Tyrone, Ulster: e-FIG SR-26), there is a fan-shaped setting of four rows, but here the rows are more widely spaced than those from N'n Scotland.

Existing astronomical interpretation

Myatt (1985) considers the relevance of the annual progression of sunrise, and –set between the extremes, at winter, and summer solstices, and that of moonrise, and –set over the 28-day lunar month, and for the 18.6-year cycle, between maximum and minimum standstill positions. Following Thom (1971), he suggests, with reservations about the quality, and limited extent of much of the data from survey, that the geometry of multiple rows, based on regularised best-fit analytical grids, might have been involved in observation of lunar risings, and settings around these liminal events. Myatt (1988, 314-315) notes that the mean azimuth of all but three rows in Sutherland and Caithness lie between rising and setting minor standstills of the moon.

The detailed involvement of certain of these multiple row complexes with the lunar cycle (Thom 1971; comments in Ruggles 1981) depends on speculative reconstruction of underlying gridded patterns for interpretation, and upon operation of a finalised structure. Burl (1993, 125) rightly points out that, rather than unitary design, extant structures often suggest progressive growth, and *ad hoc* addition. The complex might have developed from an original, central row, aligned on a barrow lying up-slope, or some otherwise significant item, to be followed by other rows, accumulating laterally, and necessarily splayed, if emanating from the prime focus. Such repetitive constructional activity, notable amongst stone rows, and certain other types of monument, is discussed separately elsewhere (see Table of Contents: 03d/8g).

Analysis of alignment at these sites

Given the small size of the sample, using a single mean value of alignment for these sites would result in a very fragmentary distribution of axial frequency. The interval of alignment displayed by each site, therefore, has been summed for all sites, over the entire range of azimuths, to produce a cumulative distribution (e-FIG SR-17). This shows a very spread distribution of alignment over the SE'n arc. Any target for this observed weak S'ly trend remains unknown, but could refer to either solar, or lunar transits, in this sector.

Observation of the SE'n rising sector of the solar transit in the permanent zone (see Table of Contents: 02c/2b(ii)), would provide a cue for ritual more relevant, and recurrent (see Table of Contents: 02c/2e), than the infrequent, and variable lunar transits to be seen around S'n major and minor standstill positions (see Table of Contents: 02c/3). Lunar skims at low elevation might have provided an incidental visual display, and such an event is shown for the Callanish area, at comparable latitude (see Table of Contents 03e/10a and 02c/3d; e-FIGS AS-12 and 13), but this seems unlikely as basic motivation for alignment behaviour.

Proposed function of these multiple stone rows

A variety of functions have been proposed for such multiple row sites, ranging from simpler ritual preoccupations, such as displaying an interest in recurrent lunar events, to analysis, and prediction of more complex phenomena, such as eclipses (Thom 1971).

However, this analysis suggests that rows might have acted to direct attention and propitiation towards the S'n sky, the transit here forming a permanent element of the annual cycle. Inclusion of funerary monuments in the line could have added particular potency, an association seen in more developed form amongst the stone rows of Dartmoor.

The type of repetitive behaviour noted for certain rows on Dartmoor (see Table of Contents: 03d/8g) can be seen to great effect here: row numbers are high, and there seems to be clear evidence for serial addition of component blocks of lines. This emphatic structural restatement could well denote a response to adverse environmental conditions (see Table of Contents: 05), in terms of increased propitiation of the permanent arc of the S'n sun (see Table of Contents: 02c/2b(ii)). The splaying of lines could also suggest general tracking, rather than more exact alignment on a single cue, with the intention of multiple axial interception of the transit increasing the dwell-time (see Table of Contents: 02c/2f; e-FIG AS-06). Such splaying is also occasionally seen in reduced form elsewhere, as at Drizzlecombe, Dartmoor (e-FIG SR-08), where a similar function is suggested.

A general interpretation in terms of the solar model (see Table of Contents: 03a/13a and 02c/2i) is therefore proposed for these rows.

Supplementary information: further details of multiple stone rows in Scotland

Note: Canmore refers to the RCAHMS online database.

SUTHERLAND

Allt Breac/ Kildonan; 14-15 rows; up to 5m long, 0.9m apart, 14m wide; slightly divergent; axis mean 163°; associated cairns: one larger to the N, one smaller at the possible focus of the rows; NC 9549 1854; OS Explorer 444; Canmore NC91NE 6; e-FIG SR-25b;

The 14-15 stone rows run SSE'ward, on a small terrace, at the base of a S'ly-facing hill slope, in a narrow E'-W'ly lying river valley, hemmed in by steep hills to the N and S. The rows are about 0.9m apart, and up to 5m long. A cairn 7m in diameter, and 1m high, lies just to the N of the rows (NC 9550 1859), but may be debris from agricultural clearance.

Plan: RCAHM-S 19llb.

Kinbrace; 10 rows; 13m long, 9-16m wide; diverging towards the SSE; axis 132-163°G, mean 148°G; associated cairns: none known; NC 827 322; OS Explorer 449; Canmore NC83SW 6; e-FIG SR-22;

Ten divergent rows run towards the SSE, down a S'ly-facing slope, at the margin of an E'-W'ly stream valley, as it slopes to the river, about 500m further S. The S'n side of this valley is more open than the steeper N'n slope on which the rows are located, affording better views. The rows contain some 80 stones, in an area about 12m square, with the largest stones in the SW'n corner, but with many of these displaced, clearance debris at the NW indicating damage.

An irregular mound, about 5m across, lying over the centre, and just beyond the known limits of rows at the NW, is of unspecified nature. The singular focus of grid lines imposed on the site-plan, for purposes of geometric, and astronomical analysis, in Burl 1993, fig. 29a/p. 126, after Freer and Myatt 1983, fig. 13, is not reflected in the extrapolated lines of actual rows, which converge in a spread zone. Observation of extreme S'ly moonrise, at a notch in the horizon, along one of these radial lines, is suggested as possible by Freer and Myatt 1983 (site 17).

Plan: Burl 1993, fig. 29a/p. 126; Freer and Myatt 1983, fig. 13).

Borlum; 8 rows; 26m long, 11-19m wide; diverging towards the SE; axis: 138-318°G; associated cairns: one possible at the NW; NC 977 634O; Explorer 449; Canmore NC96SE 94;

Eight divergent rows, containing about 52 stones, run SE'ward along the rounded top of a NW'-SE'ly lying ridge, between two small hills, this location offering more open lateral views to the NE and SW. The rows, 26m long, 11m wide at the narrower end, and 19m wide at the broader end, with a central alignment of 138-318°G, appear to converge towards a small mound of stones, some 13m distant at the NW.

Learable Hill S; 6 rows; 20m long, 9m-18m wide; diverging towards the SSE; axis 145-168°G, mean 157°G; associated cairns: one possibly just to the N, at the focus of rows; NC 8928 2347; OS Explorer 444; Canmore NC82SE 6; e-FIG SR-23;

Four main groups of rows lie together, towards the end of a spur formed by two flanking stream valleys, and are located on its level top, and gentle SW'ly slope. The area occupies part of a hill forming the W'n side of a narrow N'-S'ly river valley, which it overlooks.

The complex contains a standing stone, incised with a Christian cross (NC82SE 1), which may lie at the head of multiple rows, also a cairn circle (NC82SE 4), four groups of stone rows (NC82SE 6), and a cairn (NC 8925 2749; NC82SE 9). A scatter of other small cairns (NC82SE 16) may represent clearance of stones from cultivation. An area of settlement, including three hut circles, and a field system of about 10 hectares, occupy the S'ly-facing flank of the ridge, this being lower nearer the stream, and about 300m to the SW of the rows (NC 889 234).

The S'n complex of rows is the only one which is definitely multiple, and sufficiently clear to allow analysis. Published mappings are of uncertain accuracy (e-FIG SR-23).

-rows: N'n complex

Two irregular, and fragmentary rows, about 80m long, run WSW'-ENE'ward (NC 8922 2353-NC 8929 2357), with some indication of divergence towards the WSW'n end (248-255°G), where there are larger standing stones. The structure of this complex, and its relationship with the central-N'n complex, just to the S, is uncertain, but they seem to be separate.

Plan: Freer and Myatt 1983, item 18; Thom 1967, fig 14/ p.153.

-rows: Central-N'n complex

A fragmentary set of parallel rows (NC 8922 2352) runs E'-W'ward (096-276°G), is about 53m in total known length, and 5m across. Although fragmentary, the two S'n-most rows continue for most of the length, but the two N'n are blocked by three cairns, of uncertain stratigraphic relationship to the rows, which are spaced out over the W'n half of the complex. Possible use of these rows for calendric purposes, in conjunction with sunrise at the horizon, has been suggested by Thom (1967, 110).

Plan: Freer and Myatt 1983, fig. 14.

-rows: Central-S'n complex: the cross-inscribed stone, and its rows

A group of rows lies to the ESE of this stone. Canmore database notes three parallel rows, running WNW'-ESE'ward, and 12m in maximum length. Burl (1993: gazetteer) states that the standing stone lies at the head of a fan of 10 rows.

-rows: S'n complex

Six rows (NC 8928 2347), running down-slope to the SSE, are 20m long, diverging in this direction (145-168°G: mean 156°G), being 9m wide at the narrower NNW'n end, and 18m wide at the broader SSE'n end. The complex appears to contain three distinct double rows, their lines also slightly divergent. Several cairns lie up-slope from the rows, and one of these is near the convergent focus of the extrapolated row-lines, about 12m to the NNW of their known ends.

-cairns

Cairns are noted at the following locations:

NC 8922 2351: a cairn with kerb, 12m in diameter, containing a cist, lies about 30m to the W of the cross-inscribed stone;

NC 8926 2350: a cairn 9m in diameter;

NC 8923 2352: a kerbed cairn 6m in diameter;

Other cairns may be clearance heaps.

-cairn circle

An elliptical stone circle (NC 8918 2350), 20 by 17.5m, with a small cairn at its centre, lies 90m to the WNW of the cross-inscribed stone, and bears little obvious relation to the layout of the row complexes. The line of the central-N'n site is supposed to point to this circle.

Plans: Freer and Myatt 1983, fig. 14; Thom and Thom 1990 part 2, 304; Burl 1993, fig. 30/ p. 130.

-astronomical comment:

Central-N'n complex: the general E'-W'ly axis might refer to near equinoctial sunrise, or -set, in contrast to the more usual S'ly axis in the group, which could indicate an interest in the S'n arc of the solar transit, as seen in the S'n row complex.

Cnoc Molach/ Badanloch; 5-7 rows; 16m long, 4-13m wide; diverging to the SSW; axis 170-205°G; associated cairns: none known; NC 7826 3516; OS Explorer 448; Canmore NC73NE 11;

At least five incomplete rows, containing 18 stones of 0.6m maximum height, about 16m long, 4m wide at the narrower end, and 13m wide at the broader end, run NNE'-SSW'ward, and diverge towards the latter direction. The site lies on the SW'ly-facing flank of a small low hill, where it slopes down towards a loch, about 0.5km distant. About a third of the stones have been displaced, and the largest surviving stone is at the S'n end. The rows lie within an area of hut circles, and a field system. A cairn (NC73NE 10; NC 7825 3530), 10m in diameter, lies up-slope from the rows, within the area of the field system, but well off-line from the rows. A burnt mound, at NC 781 356, and a probable cairn, at NC 782 353, are noted by Freer and Myatt (1983; site 16).

Plan: Freer and Myatt 1983, fig. 12.

Dail na Drochaide; at least 5 rows; 10m long, 5m wide; parallel; axis N'-S'ly; associated cairns: none known; NC 7205 5745; OS Explorer 448; Canmore NC75NW 34;

A ruinous set of rows runs about N'-S'ward, on fairly level ground, at the margin of a narrow N'-S'ly river valley, confined within steep hills to the E and W. Five rows remain identifiable, within an area 10m long by 5m wide, containing 11 extant uprights. No associated mounds are apparent. The alignment would give a more open view to the S, where the valley begins to open out.

Borgie Bridge; 5 rows; 18m long, 10m wide; possibly parallel; axis ?016-196°G; associated cairns: possibly one to the N; NC 6613 5874; OS Explorer 448; Canmore NC65NE 7;

This fragmentary setting of 16 small stones, of 0.2m maximum height, contains evidence for five rows, which appear to run NNE'-SSW'ward, down a gentle S'ly-facing slope, on open ground, before the river valley becomes more constricted by hills at either side. The set of rows, about 18m long, and 10m wide, is incomplete, the area either side of the two more definite rows having been heavily disturbed, and stones removed. A mound, about 12m in diameter, possibly of natural origin, lies at the N'n end of the site. Myatt 1980 lists the site (14) as fan-shaped in plan.

Plan: Freer and Myatt 1983, fig. 10.

Skelpick; 5 rows; 31m long, 10m wide; possibly parallel; axis 158-338°G; associated cairns: none known; NC 722 574; OS Explorer 448; Canmore: nothing recorded;

The site lies on ground that slopes down very slightly towards the S, next to the current river course, at the foot of steep hills defining the W'n side of a narrow N'-S'ly river valley, as it opens out towards the S.

A fragmentary setting, about 31m long, and 10m wide, now destroyed, was recorded as comprising 11 stones, of maximum height 0.2m, plus other buried stones. It contained at least three longer extant alignments, plus others suggested by scattered stones, these irregular rows appearing to run in parallel NNW'-SSE'ward.
Plan: Freer and Myatt 1982, fig. 9.

Loch Rimsdale; 4 rows; 13m long, 3-6m wide; diverging to the SSE; axis 160-175°G; associated cairns: none known; NC 7161 3486; OS Explorer 448; Canmore NC73SW 12;

Four divergent rows, containing 41 stones, run for 12-13m, SSE'ward, down the SSE'ly-facing upper slope of a hill, are 3m wide at the narrower end, and 6m wide at the broader end, each row having a larger stone at its SSE'n end. A cairn, apparently of clearance-type, about 6m in diameter, lies just beyond the known narrower NNW'n end of the setting.
Plan: Freer and Myatt 1983, fig. 11.

CAITHNESS

Hill O' Many Stanes/ Mid Clyth; 22 rows; 50m long, 40-65m wide; diverging towards the S; axis 168-195°G, mean 182°G; associated cairns: none known; ND 2952 3840; OS Explorer 450; Canmore ND23NE 6; e-FIG SR-24;

A setting of 22 rows, now damaged and incomplete, about 50m long, containing some 200 principal earth-fast stones, and 540 smaller ones, about 40m wide at the narrower N'n end, and 65m wide at the broader S'n end, is located on a gentle ESE'ward slope, in an open landscape. The stones are fairly small, thin slabs, the largest about 1m high and wide, and about 0.45m thick, and are edge-set along the row. Basal packing stones are evident and, some evidence of these on the E'n side of the site, suggests that the rows were once even more extensive.

The rows appear to radiate from the top of a rocky knoll, nominally an ideal position for a cairn, but according to the Canmore database no trace of this has been found. However, Thom (1971, p.93), notes traces of a cairn on the knoll, together with a fallen menhir, and other short alignments of stones, producing a very fragmentary plan as the basis for his geometric, and lunar astronomical interpretation (Thom 1971; Thom and Thom 1990).

Thom (1971, 92) suggests that stones could have been set out as three separate, but related fans, on a grid of radial lines, and uniformly spaced arcs. The most N'ly radial centre would be about 125m from the base of the fan, placing it over the top of the hill, and not within view of most of the stones. Only a fraction of the stones fall on this hypothetical grid, and resultant geometry remains questionable.
Plan: Thom 1971, fig. 9.1/p. 92 and fig. 9.3/ p. 94; Thom and Thom 1990, part 2, 284, 286; Freer and Myatt 1982, fig. 1.

Upper Dounreay I; 13-18 rows; 35m long; 28-37m wide; diverging to the E; axis 088-132°G, mean 110°G; associated cairns: none known; ND 012 660; OS Explorer 451; Canmore ND06NW 3; e-FIG SR-20;

This heavily damaged complex runs E'-W'ward, along the top of a low ridge, with evidence for at least 13 fragmentary, but fairly definite rows, scattered stones suggesting the possibility of five others, all diverging towards the E. The main area of known rows is 35m in maximum length, 28m wide at the narrower W'n end, and 37m wide at the broader E'n end, but outlying stones, if forming part of the multiple row setting, could extend these dimensions considerably, towards 80m at the broader end. The plans, in Thom and Thom 1990, and Burl 1993, suggest that the main set of known lines may be grouped in multiples of parallel 3's, or 4's, suggesting no singularity of layout, in which lines converge on a common focus. The condition, and relationship of lines, beyond their current W'n ends is unknown, but two mounds of uncertain interpretation lie within this area.

Grids, laid out over the stones, have been used for geometric, and astronomical speculation. It has been suggested that, looking N'ward along the rows, the extreme N'ly moonrise, over Hoy, might have been observed from the site (Freer and Myatt 1983, site 11).

Plan: Thom and Thom 1990, part 2, p. 290; Burl 1993 fig. 29c/ p. 127; Freer and Myatt 1983, fig.8.

Upper Dounreay; ND 007 660;

Nothing is known of this site, marked by the Ordnance Survey as the 'site of stone rows', presumably destroyed by agricultural activity (Freer and Myatt 1983: site 12).

Dirlot; 13-14 rows; 32m long, 26-49m wide; diverging towards the ESE; axis 102-123°G, mean 112°G; associated cairns: three at the N'n end; ND 1228 4856; OS Explorer 450; Canmore ND14NW 6; e-FIG SR-19;

Thirteen, or fourteen irregular rows, with small stones up to 0.6m high, and 0.9-1.5m apart, occupy an area 26m wide at the narrower end, and 49m at the wider, the longest remaining row being 32m. Rows diverge towards the ESE, running down the gentle slope of a rounded knoll, in open ground, 100m from the River Thurso. The narrow end of the rows continues just over the top of the hill, and the focus of converging lines would be out of sight from most of the stones. The plan, in Thom 1971, and in Thom and Thom 1990, shows a fragmented distribution of partial lines, running from the top of the knoll, obliquely down the contour of its S'n slope. This layout is used as the basis for the grid on which further geometric, and lunar astronomical interpretation is based.

Plan: Thom 1971, fig. 9.4/p. 96; Thom and Thom 1990, part 2, fig. 9.4/p. 298; Freer and Myatt 1982, fig. 7.

Creag Breach Mhor; 13 rows; 30m long, 13-35m wide; diverging towards the ESE; axis WNW'-ESE'ward; associated cairns: several at the WNW; ND 0117 6595; OS Explorer 451; Canmore ND06NW 8;

Thirteen rows, 30m long, 13m wide at the narrower end, and 35m wide at the broader end, diverging to the ESE, lie on a narrow sloping ridge, towards the base of a NE'ly-facing hillside. The rows radiate from a group of four stones, arranged in an irregular square, of side 1.2m. A cist may lie at the focus of the rows. Two cairns, 8m in diameter (ND06NW 14), lie on the ridge beyond the narrower end of the rows, at ND 0111 6599, and ND 0113 6599. A further cairn (ND 0138 6586) lies about 250m away to the ESE, on the top of the ridge, which reduces the view from the rows along its ESE'ward axis.

Tormsdale; 9 rows; 37m long, 12-34m wide; axis: diverging to the ESE; axis 103-137°G, mean 119°G; associated cairns: none known; ND 1483 4974; OS Explorer 450; Canmore ND14NW 16; e-FIG SR-25;

A complex of nine surviving rows, several fragmentary, or with gaps, containing more than 111 stones, is located on fairly level ground, in an open area 150m from the River Thurso. The setting diverges to the ESE, maximum row-length is about 37m, width at the narrower WNW'n end about 12m, and about 34m at the broader ESE'n end. The plan in Burl 1993 shows, on the S'n side, and at the centre, what may be two groups of four rows, with different focal points at the WNW, and a very fragmentary pair at the N. A single row, 30m long, running due N'-S'ward, lies just to the S, and approaches to within 9m of the NW'n end of the multiple rows, but is of uncertain relationship.

Myatt 1985a notes the site as being 60m by 60m, but that vegetation made the full extent of stones difficult to determine. The lines of best fit for five of the rows (A-E) radiate from one point, and five of the lines (F-J) from another but, on the plan, line A has only one stone [!: AJM]. Neither focus could be determined precisely, but only as a scatter of crossing points within a relatively small area.

Plan: Burl 1993, fig. 23/p. 106; Myatt 1985a, fig. 2.

Watenan Farm; at least 8 rows; 57m long, up to 34m wide; diverging towards the S; axis 190-197°G, mean 194°G; associated cairns: none known; ND 3150 4119; OS Explorer 450; Canmore ND34SW 23;

The remains of at least eight rows (ND 31509 41193), 3-5m apart, 57m long, and up to 34m wide, lie on a gentle SSW'ly-facing slope, along a very low N'-S'ly ridge. No row is complete, only 16 stones remain, slabs set edge-on to the row, the largest 0.6m high; many stones lie prone. Burl 1993 notes the possibility of 12 divergent rows. No cairns are known in the immediate area.

The plan by Thom and Thom 1990 gives a grid 49m long, 21m wide at the narrower N'n end, and 27m wide at the broader S'n end, based on a very sparse distribution of stones, as the basis for their geometric, and lunar astronomical speculation.

Plan: Thom and Thom 1990 , part 2, 294; Mercer 1985, fig. 27; Freer and Myatt 1982, fig. 2.

Loch of Yarrows; 8 rows; >42m long, 10-12m wide; parallel; axis 178-182ºG, mean 180ºG; associated cairns: ring cairn at the N; ND 3129 4401; OS Explorer 450; Canmore ND34SW 22; e-FIG SR-25a;

Eight irregular, but parallel rows of 18-21 stones, 42m long, and with rows spaced 1.5-2.4m apart, of which six are almost complete, run on level ground almost due N'-S'ward, and parallel to the adjacent loch-side. The row is shown as 117m long by the Ordnance Survey, this additional length now destroyed by cultivation. Thom (1971), and Thom and Thom (1990) show seven rows, in a setting 39m long, 10m wide at the narrower S'n end, and 12m wide at the broader N'n end, and note reduction in length and width by cultivation. Slabs forming the rows are small, about 0.3m maximum height, and are set along the rows, with about 73 stones extant.

Myatt 1980 lists his site 8, Loch of Yarrows, as ND 313 441.

Excavation at the site in 2003 (ND 313 440) produced no diagnostic, stratified material, and concluded that the row-complex might have been built in phases. Work revealed a probable ring-cairn, 100m to the N of the rows, 18m in diameter, with phases of enlargement, and kerb construction, and of deposition in the open centre of Beaker plus later Bronze Age pottery, with deposits of cremated bone in the central stone feature dated to 1600 cal. BC.

Plan: Thom 1971 fig. 9.7/ p.98; Thom and Thom 1990, part 2, 292; Freer and Myatt 1982, figs. 4, and 5.

Garrywhin; 7-8 rows; 59m long, 20-35m wide; diverging towards the SSW; axis 199-220ºG, mean 210ºG; associated cairns: one at the NNE'n end; ND 3138 4129; OS Explorer 450; Canmore ND34SW 18; e-FIG SR-21;

A setting of 7-8 rows, about 59m in maximum length, 20m wide at the narrower NNE'n end, and 35m wide at the broader SSW'n end, descends a gentle SW'ward slope in open landscape, the lower stones running into a bog, at the foot of the slope. Rows contain 3-13 stones, set 3-4.5m apart, with the spacing appearing to increase towards the SSW. A cairn, lying at the top of the hillock, close and centrally to the known NNE'n limit of the rows (ND 31382 41291), containing a cist, and associated with Beaker pottery, is defined by a kerb, about 10m in diameter. The most prominent stones in this kerb are towards the SSW, in the direction of the rows that radiate down-slope from it. Extrapolation of row-lines to the NNE produces no clear focus, but a spread zone of intersection, quite unlike the single focus shown in Burl 1993, after Myatt 1988. A grid fitted to the stones has been used as the basis for geometric, and astronomical speculation.

Plan: Burl 1993 fig. 29b/p. 126; Myatt 1988, 288; Freer and Myatt 1982, fig. 3.

Clash an Dam; 6-7 rows; length and width unknown; possibly parallel; axis ENE'-WSW'ward; associated cairns: none known; ND 3122 4041; OS Explorer 450; Canmore ND34SW 393;

A setting of 6-7 rows, 2.5-3m apart, containing 17 stones, with no more than three per row extant, runs WSW'ward down a mild slope, on a very low ridge.

Camster; 6 rows; 27m long, 10-13m wide; diverging towards the S; axis ?183-189ºG, mean 186ºG; associated cairns: one to the N; ND 2602 4377; OS Explorer 450; Canmore ND24SE 3; e-FIG SR-25c;

Six rows, of maximum length 27m, probably intact, 10m wide at the narrower N'n end, and 13m wide at the broader S'n end, lie on a gentle N'-S'ward slope, in a very shallow N'-S'ly valley. Estimates of stones vary between 24 and 72. A cairn lies about 100m to the N of the rows (ND 2602 4390).

The plan, by Thom (1971), and by Thom and Thom (1990), shows a very fragmentary setting, with one fairly extant line supplemented by a scatter of stones, and this very sparse evidence is used as the basis for the grid on which geometric, and lunar astronomical interpretation is attempted.

Plan: Thom 1971, fig. 9.8/ p. 100; Thom and Thom 1990, part 2, p. 300; Freer and Myatt 1982, fig. 6.

Loch Watenan; 4 rows; 29m long, width unknown; possibly parallel, or divergent; axis possibly ~N'-S'ward; associated cairns: none known; ND 3174 4104; OS Explorer 450; Canmore ND34SW 118;

Scattered slabs lie generally N'-S'ward along the base of a low N'-S'ly ridge flanking Loch Watenan, running towards two upright stones at the S, about 0.6m high (Canmore database: at ND 31747 41048 and ND 31760 41503). Burl 1993 notes four rows 29m long.

Myatt 1980 gives the National Grid reference as Loch Watenan ND 318 411.

Broughwhin; 4 rows; 33m long, width unknown; diverging to the SW; axis NE'-SW'ward; associated cairns: one at the NE'n end of the rows; ND 3125 4096; OS Explorer 450; Canmore ND34SW 19;

Four rows (ND 31254 40965), 33m long, width unstated, with only 6-7 stones extant, lie on fairly level ground in an open landscape, diverging towards the SW. A cairn, 7m in diameter, and with a central cist (ND 31239 40951), lies at the head of the rows. Several stones are set edge-on, in the direction of the cairn. Other stones, to the N, NW, and SW of the cairn, may indicate other row settings, noted by Burl 1993 as two multiples, and one double.

About 55m to the W of this site, there is a single row of five upright stones, aligned along the top of the hill. Freer and Myatt (1982; site 6) note the remains of two rows of small stones at ND 311 408, set edge-on to the rows, running NNW'-SSE'ward, one containing 10 stones, and 34m long, the other of three stones, and 24m long. The status of these sites as possible multiple settings is unknown.

Plan: Mercer 1985, fig. 20.

Druim na Ceud; ND 002 661; OS Explorer 451; Canmore ND06NW 6;

An uncertain site, with no detail given in the RCAHMS Canmore database.

Broughwhin Loch; number of rows unknown; dimensions unknown; possibly divergent towards the S; axis: possibly ~N'-S'ward; associated cairns: perhaps one at the N; ND 3130 4122; OS Explorer 450; Canmore ND34SW 20;

Slight remains of rows, located on fairly level ground, in open landscape, run towards the S, only 2-3 stones remaining, the others displaced in 1911. Burl (1993) notes the rows as possibly divergent. Freer and Myatt (1982; site 4) note the presence of a ruinous cairn on a hillock, with three upright stones extant to its S, set edge-on towards the cairn, and possibly the remains of rows.

Thrumster; ND 338 452; OS Explorer 450; Canmore ND34NW 11;

A group of rows recorded in this area is no longer extant.

DUMFRIES AND GALLOWAY

Communion Stones; Skeoch Hill; NX 85913 79048; NX87NE 1; Canmore 65006; multiple stone rows, possibly of prehistoric date; e-FIG SR-25d;

Plan: Thom and Thom 1990, vol. 1, p. 215;

Five parallel rows, four distinct, the fifth destroyed, 11m long, and 1.5m apart, run upslope towards 217°. The site was used by Covenanters for religious meetings in the 17th century, commemorated by an adjacent modern obelisk. Whether these 'Communion Stones' are prehistoric, or more recent in date remains undecided. A small field of at least 14 cairns, mainly 2-3m in diameter, and up to 0.5m high (NX87NE 14) lies to the NE, centred at NX 8590 7910.

UNCERTAIN SITES

-Caithness

Torrish Burn; possibly **2 rows; 13m long; slightly divergent; axis ENE'-WSW'ward; NC 9657 1902; OS Explorer 444; Canmore NC91NE 11;**

A row of 9 stones runs down-slope ENE'-WSW'ward (mean ~102°) for 13m, from the SW'n corner of an elliptical enclosure on a slight elevation, and parallel to it, or slightly converging towards the E. A similar row of eight stones lies 1.5m away. The enclosure, which may overlie the area of the row, measures 7.5 by 3.5m, and is of unknown function, but is similar in size to a shieling.

Site: Freer and Myatt 1983 site 20.

-Sutherland

Groat's Loch; ND 31023 40658; OS Explorer 450; Canmore ND34SW 107;

A row of four small standing stones lies in small hollow to the W of Crow's Stone, 23m away (ND 3101 4063), and runs about 030-210°G. The setting may form an independent group, or be indicators on the horizon for one of five alignments to the NE, between Broughwhin and Loch Watenan (Watson 1977).

Groat's Loch; ND 311 408; OS Explorer 450; Canmore ND34SW 24;

Two rows are visible, running approximately NNW'-SSE'ward, and diverging to the N from a single stone. The W'n row of 11 stones is 34m long, and the E'n row of four stones is 24m long, ending 3m away from the W'n row. About 20m beyond the end of the W'n row, there is a single stone that may be associated. Cairn Hanach, an Orkney-Cromarty type chambered round cairn, (ND 31002 40840; ND34SW 30; 'Kenny's Cairn') lies to the W of the rows. The Ordnance Survey considered the rows to be a natural feature.

-Shetland

Giant's Stones; HU 243 805; OS Explorer 469; Canmore HU28SW 3;

Two or three standing stones have been noted

Lumbister; HU 486 962; OS Explorer 470; Canmore HU49NE 2;

Five sub-parallel rows of 250 small boulders run NE'-SW'ward, about 120m long, and with rows 20m apart. The second row from the E is crossed obliquely by a shorter row 45m long.

-Lewis

Traigh na Berie; NB 1007 3571; OS Explorer 458; Canmore NB13NW 25;

Ruinous: a possible stone row.

-Skye and Lochalsh

Raasay; NG 591 377; OS Explorer 410; Canmore NG53NE 35;

Remains of two stone rows, 30m long, run N'-S'ward in parallel, 2m apart, on a NE'ly-facing slope, amongst shielings, to the W of Hallaig Burn.

Beaghmore; Tyrone; Ulster; H 685 842; e-FIG SR-26;

This megalithic complex of rows, cairns, and circles, extends the analysis undertaken for similar sites on Dartmoor (see Table of Contents 3d/8) to include an example from a different area, one which is of known date, and position in the environmental sequence.

There is clear evidence at Beaghmore for the type of repetitive construction seen amongst several sites on Dartmoor, and amongst multiple rows from N'n Scotland, which may again indicate intensification of solar-related ritual, as a response to environmental stress (see Table of Contents: 05). Many other comparable, but less explored sites in near-coastal N'n Ireland, an area of particular Atlantic exposure (e-FIG ND-06b: Sperrin group of rows, and Mourne valley group of circles), may be of similar complexity, and serve further to reinforce these conclusions.

There is clear involvement of funerary structures in the lines established at Beaghmore, and the site seems well suited to discussion of unified ritual in terms of the solar model (see Table of Contents: 03a/13a and 02c/2i). This contrasts with existing, unconvincing attempts at precise interpretation of selected alignments here, in terms of various astronomical targets.

Structures

A complex of stone rings, stone rows, and small kerbed cairns lies on a terrace at the margin of a broad valley, packed into an area about 0.6ha in area, with the possibility of further elements lying beyond the unexcavated margins.

The partially exposed site contains four sub-complexes of closely similar structure. One to four stone rows, of varying lengths, of either larger, or smaller stones, lead in parallel, or converge slightly SW'ward, towards a small kerbed cairn, with two irregular circles of stones lying either side of, or adjacent to, this terminal area. Few stones at the site are over 50cm high. Longer rows are somewhat sinuous, and in some cases stones increase in height towards the cairns.

The circles lack further structural differentiation, except for suggestions of localised outward bowing of the ring at the SW-W, in all but one, to form a recess of unknown function. Further discussion of the site can be found in May 1953; Pilcher 1969; Burl 1976, 245-250; Thom and Thom 1990, part 1, 90-93.

Sub-complexes are renumbered here from NE to SW:

1: Two rows of larger stones, one about 8m long, the other at least 22m long, but unexcavated toward the NE, are flanked on each side by a row of smaller stones, one about 22m, and the other 11m long. The rows converge on a small kerbed cairn, about 3m in diameter, that contained a cist with stone axe. Two irregular circles of small stones, about 10-11m in diameter, flank the cairn, and may be later additions.

2: Two short rows of larger stones, about 11m long, flanked by a row of smaller stones, at least 28m long, run in parallel SW'ward, towards a small kerbed cairn, about 4m in diameter. Two irregular near-contiguous circles, of small stones, 16-17m across, flank this cairn on its S'n side, one markedly D-shaped, both perhaps later additions, with the latter circle the latest. This D-shaped circle overlies debris, and structures indicating an area of Neolithic occupation and activity.

3: A row of smaller stones, at least 30m long, leads SW'ward to a small kerbed cairn, about 3m in diameter, and is flanked in parallel by a short row of larger stones, about 6m long over its final approach. The cairn contained a cist, with skull, and cremated deposit. The cist is flanked on its W'n side by an ovate ring of larger stones, 17-20m across, which includes it within its margin. A second, small, ovate ring of stones, 6-7m across, lies just to the SSW. The interior of each of these two rings is studded with closely spaced stones, unlike others at the site, and this might have provided the basal packing for a platformed interior.

4: A row of small stones, about 2m long, runs SW'ward, to approach the margins of a clay-capped cairn, about 3m across, set without berm within a ring-ditch, and outer bank, all of maximum diameter about 9m. Two larger stones, adjacent to this row at its SW'n end, may represent part of short row, of the type seen more clearly in sub-complexes 1-3, as well as providing entrance portals for the stone ring adjoining, along the NW'n side. Two irregular rings of small stones, about 9m across, lie one each either side of the approach to the cairn, respecting the ring-ditch, and again suggesting later addition.

This sub-complex produced the following radiocarbon dates, indicating construction of elements during the earlier Bronze Age, with peat growth evident at the site by the later Bronze Age (TABLE SR-18):

TABLE SR-18 Beaghmore (Tyrone): radiocarbon dates from sub-complex 4

		uncal.		**cal. BC**		
site	**context**	**bc**		**1 sd.**	**2 sd.**	**lab #**
stone row	ground surface beneath	1605 +/-	45	1655-1560	1700-1510	UB-23
cairn:	ground surface beneath	1535	55	1600-1480	1650-1420	UB-11
	peat in ring-ditch	775	55	840-720	890-860	UB-163

Environmental issues

Environmental analysis at the site suggests early Neolithic forest clearance, for the purposes of cereal cultivation, during the 4th millennium BC, then abandonment and reversion during the earlier 3rd millennium BC, with drier heath-land conditions, and peat formation before 2000 BC, this becoming well advanced by 1000 BC. That the immediate area might have been agricultural could be indicated by what appear to be redundant field boundaries that underlie parts of sub-complexes 1 and 2. Radiocarbon dating would place development of this ritual-funerary site within a period of environmental stress, and loss of viable land (see Table of Contents: 05).

Existing astronomical interpretation

Thom suggests a more complex geometry for the layout of these irregular circles, with possible minor structural alignment on winter solstice sunrise, and on the moon at major standstill (Thom and Thom 1990, part 1, 90-93).

Burl notes a general lack of relationship of major elements with sun, moon, Venus, or the astronomical calendar (1976, 246). He suggests that the line between ring-centres in sub-complex 4 might point to midwinter sunrise, and that recessed areas in certain of the stone rings might relate to midwinter sunset, or to the transit of Venus (*ibid*, 248).

Alignment at the site

The site presents four closely similar sub-complexes, containing within them further replication of such features as rows, and stone rings, all of interest in discussion of environmental factors underlying repetitive construction at the site, and the basis for its operation as a centre for propitiatory ritual (see 03d/8g and 05).

Evidence for a detailed structural sequence is absent from the site, but it seems likely from the plan that rows with terminal cairns might have formed an initial phase, with circles being added around the terminal zones later.

It is suggested here that the rows existed to establish a significant direction of recurrent ritual towards the SW, either active, or passive (see Table of Contents: 02a/2g), forming a connection between participants, the dead, and the setting solar transit (see Table of Contents: 02c/2i). Emphasis on the SW'n, rather than the NE'n direction within the axis is based partly on analogy with the topographical setting of other row-cairn associations, for instance, those on Dartmoor (see Table of Contents: 3d/8), and in N'n Scotland (see Table of Contents: 3d/9). Certainly, such a SW'ly direction would give far better access, daily, to the transit of the sun, on its setting limb, with many instances of more vivid passage at lower elevation. Choice of the opposite direction, towards the NE, would allow only a brief period of access to the transit, during its initial rising around midsummer, with nothing for the rest of the year.

An active interest in the SW would imply the existence of viewing areas at the NE'n end of rows, but any supporting structural evidence appears absent from the fully-excavated sub-complex 4, and the NE'n terminal zones for 1-3 have not yet been exposed.

Addition of stone circles around *termini*, as a second phase of development at the site, might have acted further to enhance the importance of this SW'ly direction, providing adjuncts to the funerary monument, offering facilities for assembly, and for relevant ritual. The attraction between circle and cairn does seem somewhat stronger than between circle and row. The presence of a cairn, at the extreme SW'n end of the exposed site, possibly of increased importance, since augmented by a ring-ditch and bank, may further serve to emphasise this direction.

Assuming the priority of the SW'ly direction over the NE'ly, alignment of rows, similar between the four sub-complexes, seems to indicate a consistent interest in the sector around local (55°N, 7°W) winter solstice sunset (225°). Considering the longest rows, three are at 223° and, at two of these, this direction is repeated by flanking rows, the remaining row being an exception, at 230°. The mean for all rows, irrespective of length, is 226°.

Lunar setting standstills occur either side of this solstitial direction (S'n minimum 235°, S'n maximum 212°), and anyway seem inherently unlikely targets, because of their infrequency (see Table of Contents: 02c/3).

Circle-to-circle directions, and positions of their alcoves, are far too weakly defined, and conflicting, to present any basis for discussion of purposeful alignment.

Minilithic stone rows: the hidden sample

Stone rows, completely, or partially constructed from small, unobtrusive boulders, standing 30cm or less tall, rather than from larger conspicuous slabs, occur as a minor component of the well-established national distribution of sites (currently 44 rows out of 315: 14%). Examples are seen in regional concentrations on Dartmoor (14 sites), on Exmoor (7 sites), on Bodmin Moor (4 sites, scattered over upland Wales (11 sites), and in N'n-most mainland Scotland (6 sites) (Burl 1976; Gerrard and Simpkins [online]).

The term 'minilithic', referring to the smallness of stones relative to more standard megalithic blocks, used loosely here, needs some further definition, either in terms of estimated weight, or some measure of the manpower required to move, and place the stone.

A stone row is a minimal monument, especially if fully, or partly minilithic (see Table of Contents: 03d/11), being a simple line of stones, its axis readily established, and capable of providing a rapid ritual response if needed, for instance to deteriorating climatic conditions, or to any other social need.

Given their relative ease of construction, fragility, and the small size of component blocks, a great many more such sites might have been established, far more than are currrently known, subsequently to become destroyed, or damaged until unrecogniseable, or to remain currently undiscovered on unfrequented upland, under superficial peat and vegetation. This particular minilithic fraction might well have been far more significant than current data indicate, with such lines a regular addition to many ritual and funerary sites, as well as forming independent monuments.

Sporadic discoveries of mega-lithic rows are indeed made, where larger stones have fallen, to become hidden, as at Cut Hill, on Dartmoor (Greeves 2004), but the growth-area for the national sample is far more likely to be amongst mini-lithic rows. A case in point is provided by the well-preserved minilithic row at Bancbryn in Wales, located at the S'n margin of the W'n-most Brecon Beacons, which was only revealed when a brush-fire removed overlying vegetation. The properties of this site well illustrate the general conclusions regarding alignment, monumental associations, and possible function, drawn in this analysis from the whole national group, and point towards the need for a more intensive search for such sites.

The fact that a stone row is partially, or completely minilithic could reflect local shortage of larger stones, or preference for the relative ease of minilithic construction. Such sites form a minor sub-set of the entire sample of stone rows, with which they share many properties and, although considered here separately, there is little other than stone-size to suggest that they form a distinct type.

However, such less than fully visible monuments could indicate cases where the requirement to establish some sort of ritually valid axis, albeit small-scale, took precedence over the need for the row to make a more imposing monumental impact. Amongst longer, entirely minilithic rows (TABLE SR-23), the site at Bancbryn is alone in providing a complete example, clearly running between defined terminals.

In this analysis, stone rows are seen as allowing expression of economically important concerns for agrarian communities, with associated funerary monuments added in the general line in order to include ancestors in this process. The axis of a row is seen as linking the communities of both living and dead into a clear and recurrent relationship with the passing solar transit, through propitiation-rituals enacted as part of a solar-agrarian cult (see Table of Contents: 02c/2i). Such an axis might have directed *actively* performed ritual, or acted as a *passive* conduit (see Table of Contents: 02a/2g), its presence alone being the main factor. The axes of many stone rows (e-FIG SR-05 and 17), and of almost all minilithic rows in this sample (TABLE SR-23), point within the S'ly permanent zone of the solar transit (see Table of Contents: 02c/2a and b), thereby maximising axial exposure, since here the sun passes daily throughout the year, more conspicuously when at lowest elevation during winter (e-FIG AS-01, 04, and 04b).

If megalithic, the axis of a row might have been a conspicuous element of the landscape, and if minilithic, of very low visibility, any presence confined to the immediate locality of the monument. This latter case serves to emphasise the importance of the essence of an axis, rather than that of its wider monumental impact, and is well illustrated by the rows at Bancbryn, and at White Ladder, outlined in more detail below.

Discussion of the function of stone rows is again based here firmly, and realistically, on the essential economic concerns inherent in the small-scale agrarian communities that produced them, as a general concept, broadly applicable to all such sites, and reflecting the underlying unity of their properties over a wide geographical area. This contrasts markedly with interpretations invoking arcane astronomical targets for individual axes (TABLE SR-01), and with those explanations involving over-emphasis of their provision of vantage points that enabled specific views over horizons and landscape, local and distant, an alternative case made for Bancbryn.

One such terrain-based interpretation emphasises the fact that that the location of many rows enable vistas over, or that their axes point to, particular views of the sea (the '*sea-view hypothesis*': Gerrard and Simpkins [online]). Since many rows are located on upland in the broader coastal hinterland, this should come as no real surprise. Furthermore, an obviously distinctive view from rows, land-based, or marine, is by no means universal, and deliberate primary targeting of the sea for mere sightseeing is difficult to justify, either in terms of realistic agrarian concerns, or the effort of their construction, admittedly minimal for these slight monuments. The target suggested here is therefore celestial and solar, rather than terrestrial.

Another popular element in recent interpretations of rows has involved the suggestion that they formalised a route along which various elements of the view would pass into, and out of sight (the '*landscape-reveal hypothesis*'. Again this appears a very weak motivation for construction of a row, such personal involvement in an already familiar landscape hardly providing much of a basis for personal sensory experience, or revelation.

Certainly, rows might well have respected natural features in the landscape, as well as other broadly contemporary monuments, these perhaps forming a target for the axis in some cases, or becoming included in the axis to increase its potency.

Other explanations of minilithic rows have been offered, for instance by Gillings 2015 'arguing that far from being generalised ritual structures, or metaphorical expressions of hunting groups, the tiny stones were, instead, an integral part of a dynamic human–animal landscape of movement and pause' ..whatever this means.

Bancbryn; Carmarthenshire; SN 68936 10326; e-FIG SR-31

-summary:

Bancbryn is the most complete known example of a minilithic row, and it displays:

..a **general alignment** downslope to the **SW**, which in this analysis of stone rows is interpreted as allowing regular ritualised intersection with the setting solar transit (the seasonal-solar model: see Table of Contents: 03a/13a);

..the probability of a distinct **bipolar association with cairn fields,** these lying around each end, hence linking funerary elements into the alignment, again a feature forming part of the above model;

..and **construction by serial addition** of varied shorter sectors, indicating repetitive action, undertaken to reinforce the potency of the axis by extension, perhaps in an attempt to mitigate climatically induced pressures on the agrarian economy, by strengthening the link between economy, ancestors, and the sun, bringer of life and prosperity.

-topography:

The row runs generally SW'ward, along the top of a triangular S'-SW'ly-pointing ridge, and is located just below the summit, along its flank, at about 300m OD. This elevated location affords good panoramic views over, and well beyond, the rounded hills that form the local horizon to the S and W.

-structure:

That the site is a coherent row of stones appears to be clear, but there have been some marginal objections regarding its date, and hence to its inclusion amongst stone rows of later Neolithic to Bronze Age type, arguments now largely discounted.

A single row, of composite structure, containing 173 stones of variable, but small size, and generally about 30cm across, lying recumbent, or edge-set, runs downslope for some 717m, in a SW'ly direction (~214 °G), with a slightly sinuous course. The row can be readily divided into 19 sectors, some separated by short gaps, real, or from damage, components that appear to differ in length, alignment, and spacing of stones (TABLE SR-19). These sectors may indicate serially placed subunits, or represent individual row-lets that eventually became joined to form the final monument. The overall row therefore appears to be the result of repeated, disjointed construction, along a generally predetermined line, but of unknown sequence and direction(s) of growth. The monument appears to be a minilithic complex, rather than a single site, its wandering course the result of addition and revision, as opposed to unitary planning. The additive nature of construction at Bancbryn is also seen amongst the long stone rows of Brittany (e-FIGS SA_br 02 to 07).

TABLE SR-19 Bancbryn; Carmarthenshire: subunits forming the stone row

sector	length (m)	spacing	axis	# stones	notes
1-19	717		215.5		1
				173	2
			214 [9]		3
			214-217		4
the single sector from cairn A					
1		med	200.5	4	
gap					
first linking sector					
2		low	237.5	2	
gap					

first major alignment			
3	med	209.5	7
gap			
4	med	211.0	12
5	med + hi	213.5	13
6	low	213.5	3
gap			
7	med	207.5	4
8	med	213.0	3
9	med	205.0	2
gap			
10	low	212.5	5
second set of linking sectors			
11	high	219.5	?20
12	high	221.5	27
13	med	227.5	16
gap			
14	v low	224.0	6
gap			
second alignment			
15	med	215.5	7
gap			
16	low	207.0	4
17	med	208.0	16
18	med	205.0	7
scatter of stones beyond the terminal			
19	v low	215.5	4

notes:
1: the axis taken between terminals;
2: Gerrard *et al.* 2017, fig. 21;
3: mean [standard deviation] of all component sectors;
4: extreme tangents taken from the NE'n terminal.
key: spacing [between the stones: relative scale]: **very low**, **low**, **med**[ium], **hi**[gh]; **axis**, the mean to the nearest half degree; **#** [number of] **stones.**

The cairn (A) at the NE'n end of the row is displaced E'ward from the general alignment, and is linked to a very short and isolated sector of stones (1), which has a more S'ly orientation than the general axis. A further short sector (2), possibly fragmentary, may indicate an attempt to link this cairn into the NE'n end of the (perhaps already existing) first major alignment (sectors 3-10). In a similar manner, a second, shorter (perhaps originally separate) alignment (sectors 15-18/ ?19) is linked to the SW'n end of the first line by a gently curving series of sectors (11-14).

-associations:

The complete row has a cairn (A) loosely connected with its upper NE'n end, and a slab (possibly transverse), the largest stone, terminating its lower SW'n end, in a dual arrangement of cairn, and terminal stone seen widely amongst other stone rows as, for instance, on Dartmoor (TABLE SR-06), and in N'n Scotland (TABLE SR-16).

The immediate vicinity of the row shows a distinct concentration of cairns, their overall distribution being sympathetically linear, with a preference for location on the W'n flank of the row. There are three main cairn-fields (TABLE SR-20):

TABLE SR-20 Bancbryn: association of the stone row with cairn-fields

cairn-field	field lies to	lies close to row?	# cairns	linear elements present
NE'n	W	yes	44	no
gap	W	yes	5	no
SW'n	W	yes	43	yes
TOTAL			**92**	
E'n	E	no	24	no

key: **#** [number of] **cairns**;

The NE'n cairn-field lies about a third of the way down the row from its NE'n terminal, and is centred about 178m to its W. The SW'n cairn-field is separated from the NE'n by a gap containing few cairns, and runs along the final third of the row, closer to it than the NE'n field, being centred at about 60m to the W of the row. These two cairn-fields contain a similar number of cairns, but differ in that the SW'n field is closer to the row, and contains short lines of cairns running parallel, and also transversely to the row. The general distribution of cairns, therefore, indicates a preference for the W'n flank of the row, and a bipolar tendency, with separate attraction to terminal areas.

Twelve of these cairns lie close to the line of the row, with one, cairn A at the NW'n terminal, lying on it. There are very few cairns along the SE'n side of the row, but there is a more distant cluster, the E'n cairn-field, some 450m to the E, on a branch of the main spur.

That these cairns are prehistoric and funerary should not be assumed, although this seems at least likely for the majority. Only three have been investigated, these lying about 500m to the N of the NW'n terminal of the row, each of which was about 5m across, constructed of unstructured, loose stone, but one with a retaining kerb. Only one of these is of probable Bronze Age type, one possibly, and one is of post-Roman date. None produced any surviving burial deposits, or diagnostic finds.

-excavation:

Four small trenches, in sector 5 of the row, examined its stones, two of which were set in subsoil, and investigated the open intervals between them. There was no evidence for plough-cultivation in the natural substrate, suggesting an early date for the row, or that the area lay beyond any zone of cultivation.

-finds:

There was an absence of diagnostic artefacts, the total assemblage consisting of a few fragments of flint, including a 'thumbnail' scraper, of early Bronze Age type. The only direct dating evidence is a radiocarbon date [post-Roman: 1536 +/- 35 BP; 412-568 cal AD; 2 sigma] from beneath cairn 110471, which lies about 380m beyond the row to the N.

-scenic views

In interpretating ritual function at the complex, much has been made of the views that can be obtained along the row, and from its flanking cairn-fields, especially SW'ward to beyond the local horizon, and over the Bristol Channel, where coastal Exmoor (central bearing about 163°G) can be distantly, and variably visible. It has been noted (Gerrard et al. 2017; Gerrard [on-line]; Gerrard and Simpkins [on-line]) that the axis of the upper 300m of the row (210 °G) intersects Hartland Point, a headland in North Devon, dimly visible some 120 km distant, to the SW. The bearing of the entire row, 214 °G, lies further out to sea, closer to the island of Lundy.

Whatever the detailed bearings, and suggested targets, these topographical options seem a weak format for interpretation of general function, when compared to that based on economically-relevant propitiation involving the solar transit. Although an oblique view of Exmoor from Bancbryn might conceivably have been important, because that distant area contained other row-building communities, and hence perhaps kin-groups, it is far more difficult to explain the relevance of the Hartland Point promontary, with its general absence of stone monuments.

Bancbryn lies at the S'n margin of a local group of fifteen stone rows in the Brecon Beacons and, although minilithic, is its most prominent member in terms of length, and number of stones detected. It is also typical in terms of its generally S'ward axis (TABLE SR-21).

TABLE SR-21 Bancbryn: as a member of the local group of stone rows from the Brecon Beacons

row	lines		L(m)	sts	axis	terminals	
Bancbryn	S	SN 68936 10326	717	173	**214**	crn	st
Carreg Lwyd 1	S	SN 86516 15452	265	9	**216**	-	-
Carreg Lwyd 2	S	SN 86293 15186	4	60	**165**	-	-
Carreg Cadno	S	SN 8767 1569	19	7	**199**	-	-
Carrgeg Wen	S	SO 13284 17568	54	12	**237**	-	-
Cerrig Duon	S	SN 85151 20642	42	29	**203**	crc	-
Craig y fan ddu	M	SO 05633 18064	21	28	**205**	-	-
Maen Mawr	S	SN 85119 20642	6	3	**180**	crc	-
Nant Gwynau	S	SO 0236 1390	216	4	**106**	-	-
Nant Tarw	S	SN 81763 25873	8	3	**248**	-	-
Nant y Wern	S	SO 11848 16732	54	6	**186**	-	-
Saeth Maen NW	S	SN 83306 15399	14	7	**203**	-	-
Waun Wen 1	S	SO 02860 14400	119	3	**269**	-	-
Waun Wen 2	S	SO 02830 14240	70	3	**187**	-	-
Y Pigwn	S	SN 83273 31053	33	5	**240**	-	-

Key: lines (of stones present); **L**(ength); **sts** stones in the row; **axis** in **°G; terminals**: **crn** cairn, **crc**, circle, **st**(one).

White Ladder stone row; Exmoor; Devon-Somerset; SS 7308 3739 to SS 7336 3710; e-FIG SR 32

-summary:

This long stone row, surviving as a double line in places, although about a third of its length has been destroyed, retains enough structure to enable some general statement of its properties to be made, and to allow comparison with the row at Bancbryn (TABLE SR-22; e-FIG SR-31).

Originally, although these two rows were probably broadly comparable in length, they differ in the number of component lines, in the regularity of their construction, and in directness of course. Both axes point within the permanent zone of the solar transit, but differ in that they are well separated, one being close to the rising winter solstice, and the other to the setting. Both have undated cairn-fields, or round barrows, in their immediate vicinity, of unknown association with the rows. It may be significant that the axis of Bancbryn, the row with the most extensive cairn-fields nearby, points towards the *setting* solar transit, which often has funerary connotations.

TABLE SR-22 Comparison between basic properties of the long minilithic stone row at Bancbryn and at White Ladder

	Bancbryn [B]	**White Ladder [WL]**	**conclusions**
stranded	single	?all double	contrasting primary structure
length (m)	717	>=420	the two longest of the minilithic rows
terminals known	both	none	WL not well defined by length
monument complete ?	yes	no	
course	sinuous	straight	B ?piecemeal vs WL unitary construction
subunits present ?	yes	?no	WL appears of more unitary design
adjacent funerary area ?	yes	yes	?undated: association unknown

topography	each row runs along the contours below the summit of a hill		
axis (°G)	214	137	alignments S'ly
>PZ ?	yes	yes	year-round solar transits pass over
axis near solstitial ?	WS set-15°	WS rise+7°	separate, near solstitial events coincide
far view along axis	marine	nondescript	

key: >PZ: the axis of the row points within the permanent zone of the solar transit [definition: see Table of Contents: 02c/2a and b, also e-FIGS AS-01 and 04].

WS set: winter solstice sunset; **WS rise**: winter solstice sunrise.

-topography:

The row at White Ladder lies at about 460m OD, along the contours of the NE'n flank of an upland spur, which rises to form a small hill just to the S.

-structure:

This long minilithic stone row survives as two straight sectors, running at 137 °G, on the same axis, separated by a central ploughed zone, where the row has been destroyed. The extant NW'n sector is 67m long, and double, the SE'n sector is 205m long, only surviving as a double row in a few places, and the destroyed central section covers 147m, giving the row an original length of at least 420m. The component strands of the double row are 1-2m apart, with individual stones set at about 2m intervals.

The number of stones recorded varies between periodic re-surveys, their planning made difficult by the small size of stones, with many less than 30cm across, and these often buried. About a third of the stones recorded are small quartz blocks, the remainder being of sandstone, or slatey rock. About 160 stones have been visible during various surveys, with estimates of paired stones quoted as 19, or 55 doubles. Given a completely double row, a nominal average interval between stones of 2m, and a surviving length of 420m for the monument, this would provide an estimated 420 stones for a fully double row, sufficient to indicate significant effort of construction, even given the small size of individual stones.

The total length of the orgininal row can not be determined with certainty because it is not defined by clear terminal structures, such as a cairn at one end, and an end-slab at the other, as seen at several other rows on Exmoor, and Dartmoor. A mound has, in fact, been noted previously at the NW'n end, and a large recumbent stone near the SE'n end, but re-surveys have failed to validate these structures.

-environmental:

Pollen sampling adjacent to the stone row (extraction at Comerslade: e-FIG SR-31) suggests that the row was set within a semi-open landscape that retained significant levels of local woodland, with improvement of land evident, and accumulation of peat occurring from around 2000 cal. BC (Fyfe 2012; Exmoor HER: MEM 23810). The axis of the row itself, already minilithic, might therefore have been further obscured by local tree-growth, even when in use.

-dating evidence:

The row remains unexcavated, and has produced no direct indication of date.

-associated monuments:

..small cairns:

Mounded structures, round, or slightly oval, a few with possible traces of a surrounding bank and ditch, have been noted in the immediate area of the row. More than 30 small mounds, up to 2m across, round, or oval, some arranged linearly, have been counted, and three larger ones, 4-6m in diameter, with two showing clear traces of a ditch, and enclosing bank. The presence of white quartz in some, as seen in the stone row, suggests its use in the outer structure of these mounds. Such mounds might indicate the possible existence of funerary areas. There may be traces of other ephemeral stone settings in the immediate locality, but none forming a clear monument.

..larger round barrows:

The Five Barrows cemetery (SS 7322 3682; SS73NW 5; 35022), consisting of up to 10 round barrows, 19-35m in diameter, some ditched, lies about 400m to the S of the row, spread over the summit of the hill, on the flank of which the row is located.

A further scatter of five round barrows lies to the NW of the NE'n end of the row.

Bancbryn and White Ladder: their axial alignment compared with their local groups (e-FIG SR-32)

The S'ly axis at each of these two minilithic rows points towards the permanent zone of the solar transit, this spanning 131-229°. Bancbryn points on the setting side, post-meridian, at 214°, and White Ladder on the rising side, pre-meridian at 137°, each axis lying within about 10° of the solstice. Such marginal placement would be efficient in terms of allowing daily access to the transit, and would also enable seasonal use of the near solstice.

Despite the small size of their stones, in terms of length, these rows are the most important members of their separate local groups, in the case of Bancbryn that for the Brecon Beacons and mid-Wales, and for White Ladder that on Exmoor. How far each site is typical of its regional group, in terms of alignment, can be seen from e-FIG SR-32. Bancbryn lies within an undifferentiated spread of axial frequency, running from meridian to setting solstice. White Ladder falls on a more definite peak of frequencies, seen around the rising solstice. Both sites reflect general trends, and are well optimised, as might be expected for monuments of particular status.

Stone rows of minilithic type: a general list

Stones rows of predominantly minilithic, rather than megalithic construction are outlined in TABLE SR-23 below:

TABLE SR-23 A partial list of minilithic rows in England, Wales, and Scotland
Sites are ranked here by length, rather than by regional location, with broad division into three groups: short, intermediate, and long. Only those over 100m are considered in any detail here, and of these, two sites, Bancbryn and White Ladder have been selected for further discussion, as completed above.

row		**NGR**	**L**	**#R**	**#st**	**axis**	**trans**	**terminal one**	**other**
SHORT, possibly fragmentary: adjuncts to other monuments;									
Askham Fell Cairn	Cumb	NY 49403 21951	2.2	dbl	4	**135**	**<|>**	cn	-
Nant Gwynau	Brec	SH 87813 53452	216	sing	4	**106**		-	-
Merrivale 4	Dart	SX 55356 74586	3	sing	3	**186**	**<|>**	-	-
Cefn Gwernffrwd 2	Carm	SN 73700 49328	4.5	sing	3	**120**		circ	-
Laughter Tor 2	Dart	SX 65208 75393	8.2	dbl	10	**113**		mnd	-
Yardworthy	Dart	SX 6760 8439	9	dbl	5	**213**	**<|>**	cn	-
Tryfel Stones	Pow	SH 9699 1609	10	dbl	16	**135**	**<|>**	cn	-
Tom's Hill	Exm	SS 80197 43285	17.5	dbl	6	**158**	**<|>**	?cn	-
INTERMEDIATE LENGTH: courses usually only partially known:									
Fernworthy 2	Dart	SX 65490 84070	20.5	dbl	6	190	<|>	cn	-
Stalldown SE	Dart	SX 6375 6107	21	sing	7	**190**	**<|>**	-	-
Borlum	Caith	NC 97700 63400	22.5	mult	52	**138**	**<|>**	cn	-
Cheriton Ridge Cent.	Exe	SS 75155 43778	28	sing	7	**182**	**<|>**	-	-
Porlock Common SW	Exe	SS 84575 44654	28	dbl	11	**127**		-	-
Trecastle Mountain	Brec	SN 83273 31053	33	sing	5	**240**		-	-
Groat's Loch N	Caith	ND 31100 40800	34	dbl	15	**158**	**<|>**	-	-

Watanan E		Caith	ND 31717 42050	40	mult	8	**150**	**<|>**	cn	-
Cerrig Duon		Brec	SN 85151 20642	42	dbl	29	**203**	**<|>**	-	-
Thornworthy Common		Dart	SX 71284 43827	44	sing	16	**078**		-	-
Black Tor Avon		Dart	SX 67730 63494	56	dbl	22	**132**	**<|>**	cn	-
Carnglos		Bod	SX 1988 7737	59	sing	36	**180**	**<|>**	-	-
Merrivale 3		Dart	SX 55394 74761	60	sing	14	**206**	**<|>**	cn	pillar
Rhos y Beddau		Pow	SJ 05795 30205	60	dbl	36	**248**		circ	-
Fursehill Common 3		Exe	SS 7378 4401	66	sing	10	**135**	**<|>**	cn	-

LONG: rows with only Bancbryn fully defined in terms of its course and internal structure: cond

Y Pigwn	P	Brec	SN 83273 31053	?132	sing	5	**240**		circ	?cn
Sherberton	P	Dart	SX 63915 73272	117	dbl	34	**170**	**<|>**	**?**circ	-
Hafod y Garreg	**??**	Conw	SH 87813 53452	120	mult	150	**225**	**<|>**	-	-
Nant Gwynau	P	Brec	SO 0236 1390	?216	sing	4	**106**		-	-
WHITE LADDER	**T**	Exm	SS 73287 37111	420	dbl	164	**137**	**<|>**	**?**mnd	?pillar
BANCBRYN	**TC**	Carm	SN 68936 10326	717	sing	173	**214**	**<|>**	cn	slab
Craddock Moor	P	Bod	SX 24079 72244	244	sing	85	**210**	**<|>**	-	-

Other rows

Lanacombe 5		Exe	SS 77995 42569	?	mult	7	**158**	**<|>**	-	-
Searle's Down		Bod	SX 1769 7109	>15	sing	71	**158**	**<|>**	-	-

Key:
counties: Brec[onshire]; **Caith**[ness]; **Carm**[arthenshire]; **Conw**[ay]; **Cumb**[ria]; **Dart**[moor]; **Exm[**oor]; **Pow**[ys];
properties of rows: L[ength in metres]; **# R**: number of lines in the row: **sing**[le], **dbl** double,
m**ult**[iple]; **# st:** number of stones in the row; **axis**: direction of the axis (ºG); **trans**[it]: **<|>:** the axis points within the permanent zone of the solar transit; **terminal**: formed by a **circ**[le], **mnd** mound, or **cn** cairn;

A basic monumental format: 'axis-with-terminals'

Comparison between ground-plans of certain monuments, those made composite by addition of attached structures, indicates a common underlying theme, expressed to different degrees, and with varied components, often missing, or detached and appearing in isolation. This basic format can be described as an **axis-with-terminals**.

This structure occurs at its simplest amongst stone rows, with the **axis** formed by a single, or double row of stones, usually running fairly straight, linking terminal structures that cap each end. It is suggested here that the axis functioned to target a particular direction, by pointing, but occasionally the intention to enclose a wider view seems plausible, as in the case of multiple splayed rows. Further addition of parallel strands to the axis, to form a functional avenue, might also suggest a processional aspect.

Terminal structures can vary, but typically consist of stone circles, or kerbed cairns, with cases of larger standing stones also placed to mark the end of an axis. Occasionally, henges, and larger stone circles, can occur as terminal structures, linked by stone avenues, as seen at Stonehenge, and Avebury. Such terminal monuments are of two general types: those that are relatively inaccessible structures, such as cairns, or monoliths, as seen amongst many stone rows, and those that form potential destinations, to be approached and entered along avenues, as at Stonehenge, and Avebury.

Symmetry of the overall plan can vary, from sites with well matched structures at each end, to those with differences of size, or type between terminals, sometimes marked (TABLE SR-24):

TABLE: SR-24 A basic monumental format: 'axis-with-terminals'

linking -element	terminal structures	examples	laterality		axial function	symmetry	Table of Contents:	e-FIG
monuments:								
stone row	kerbed cairns: 2	Dartmoor	bi-	O--O O--o o--o	P	S A	03d/8d	SR-01 to 14
	: 1		uni-	O--	P	A		
	?none extant		nil	--	P	S		
avenue	stone circles/	Stonehenge	bi-	O--O	P E	A	03f/6f	HE-37
	henges	Avebury	tri-	O--O--O	P E	A	03f/2e i	
rock art:								
groove	cups	N'n Br	various		?P	S A	03g/7b	SY-03 RA-04 to 06

Key: axial function: **P** pointing, **E** enclosing; **symmetry S** symmetrical, A asymmetrical.

This basic format can also be seen, by direct transfer, or coincidentally, amongst motifs from **rock-art**, perhaps indicating some intention to represent a monumental plan, or some concept behind it. The cup mark, with a single radial groove, is the simplest such component, with various elaborations involving doubling of cup-terminals, ringing of cups, and addition of multiple radial lines, this latter perhaps suggesting parallels amongst splayed stone rows.

Karahunj: a row-complex on the Armenian plateau

The megalithic complex at Karahunj, high on the Armenian plateau, provides an ideal opportunity further to test application of the seasonal-solar model for axial alignment, as developed above for stone rows in Atlantic Europe, at a similar monument in an entirely separate area, one with environmental conditions more adverse, here at higher altitude, with snow-bound winters, and variably clement seasons. This inter-regional comparison suggests that the common economic concerns of culturally different agrarian communities found widespread and equivalent expression in such a monumental form.

Location (e-FIGS SR-33 and 34)

Karahunj [alternative name: Zarats Karer] is situated near Sisian, Syunik Province, Armenia [39.551655 N, 46.028945 E, for the centre of its main megalithic circle]. It lies about 75km to the SE of Lake Sevan, in the SE'n tongue of Armenia, at an altitude of 1770m, overlooking the headwater valley of a tributary of the River Araks, which joins with the larger River Kura, this latter draining the S'n flank of the Caucasus, to flow E'ward into the Caspian Sea.

Modern conditions of weather indicate likely general past conditions. Sisian, more sheltered in the valley just below Karahunj, 200m lower, at an elevation of 1580m, experiences an average annual rainfall of 72cm, extremes of temperature from -6 to 20^{o}C, and 73 days of snow, much lying at mean depth 12m during a prolonged winter.

The main megalithic site (eFIGS SR-3 to 6)
Note: Published plans are inaccurate, and do not match rectified satellite imagery in scale and orientation.

Karahunj, a row-complex about 310m long, suggests accumulation, addition, and modification of a general plan, rather than unitary construction, and consists of the following components:

-central features:

..an irregularly **sub-rectangular enclosure** of widely-spaced stones, about 40m SW-NE, and 33m NW-SE;

..a fragmentary **avenue** of stones about 50m long, and 10m wide, joining the enclosure from the NE;

..within the enclosure, a circular **kerbed setting,** about 18m across, set around a **cairn**, about 6m across, with ruinous chamber at its centre;

-major rows extending N' and S'ward from the central enclosure

..a sinuous **row** of often well-spaced stones extends N'ward from the enclosure for 166m, ending in a short terminal sector curving towards the E;

..a similar **row** runs S-ward for 119m, with a short terminal sector curving towards the W;

..a curving line of smaller stones, described as a '**chord**', crosses the interior of the enclosure, possibly linking the N'n and S'n rows;

-additional rows running transversely E'-W'ward across the line of the main N'n row

..two very fragmentary and irregular rows, about 100m long, appearing to funnel down from about 20m at the E, to 7m at the W, run across the N'n terminal of the main row, around a central line of about azimuth 255°;

-structures in the immediate vicinity of the main row-complex:

..circular **chambered tombs**, with one particular concentration at S'n end of the rows (e-FIG SR-37);

..many **cists** scattered over the area;

..various isolated **standing stones**, set away from the line of the row;

The basaltic megaliths forming the monument, 223 of which, standing and fallen, are registered as part of the setting, are up to 3m in height above ground, and about 80 of these contain deep holes, bored to 4-5cm diameter, some stones with several, all of undated production (eFIG SR-6).

Major alignments visible in the row-structure

The main structural axes are as follows [azimuths quoted here are only to the S'ly or W'ly direction, for convenience]:

-azimuth 180°: towards the meridian:

..the general N'-S'ward line of the rows over their main central sectors;

-azimuth 236°: towards midwinter sunset at the margin of the permanent zone of the solar transit:

..the midline of the avenue, taken on its approach to the central enclosure from the NE, then on through its central cairn-structure;

..S'n terminal sector of the S'n main row, as it veers towards a field of cairns;

-other axes, unexplained:

..N'n terminal sector: azimuth 150°.

Directional data for solstices in the immediate area

Azimuths are as follows:
mid winter sunrise: 124° sunset **236°;**
mid summer sunrise: 054° sunset 306°.

The area of settlement bounding the major rows along its E'n side

The entire row-structure curves convexly towards the W, and forms the E'n perimeter of a W'ly sloping promontory, bounded on its remaining sides by rocky slopes (e-FIG SR-35), to form a broadly rectangular enclosure, with an entire perimeter of 1.12km, and area 7.3 hectares. The interior is filled by a mesh of more open, rounded areas, edged with peripheral stone-work, all indicating densely packed settlement.

The locality shows signs of having containing a necropolis, considered as dating from the middle Bronze Age to Iron Age (20th-9th centuries BC), the settlement, at least in its extant form, being of the Hellenistic period (3rd century BC to 3rd AD), with the row-complex becoming set in a rubble bank, to act as its E'n perimeter (Avestisyan *et al.* 2002). Details of the earliest phases of the settlement remain unknown.

A possible sequence for the site

Structural sequence and chronology at the site are far from clear, given the lack of detailed investigation, and the highly robbed state of monuments.

Pending such investigation, it seems reasonable to suggest that the promontory might have provided a discrete hilltop location, perhaps deliberately isolated from more widespread habitation in the valley below, especially reserved for burial, and associated ritual, in which the row-complex played a part. The naturally defined outcrop, further closed by the row-monument, might have shielded the main necropolis, and also an area of prehistoric settlement, either of general usage, or funerary-related, and perhaps seasonal, given the wintertime inclemency of the area.

This suggested earlier settlement then continued into the Hellenistic period, the semi-redundant main megalithic structure becoming further embanked, better to define a perimeter, more notional than defensive.

Although there are other megalithic structures in the general area (e-FIG SR-34), Karahunj appears to be unique in scale, complexity, and in clearly staged construction, perhaps indicating an increased regional significance. Other fortified settlements of the historic period in the area do not have defences similar to those at Karahunj, for which reuse of an earlier row by infill of gaps has been suggested (Avestisyan *et al.* 2002; TABLE SR-25). The central tomb-like settings also appear strongly prehistoric in origin, rather than later in date.

The wider pattern of settlement

This sector of the River Araks, its surrounding slopes, and foothills, have been surveyed in outline by Avestisyan *et al.* 2002, noting various settlements, and tombs dating from the Bronze to Iron Age, also a series of fortified areas, the latest visible phases of which are designated Hellenistic to Roman, but which, as at Karahunj, may well have prehistoric origins (e-FIG SR-34; TABLE SR-25).

Interpretation of the row-complex

-existing

It has been suggested (critically summarised: Ruggles 2005; González-Garcia 2014; Simonia and Jijelava 2014) that various features of the site could have provided the means for detailed astronomical observation, with sight-lines through holes bored in the stones providing clearly defined portals for intersecting various solar, lunar, and stellar transits (e-FIG SR-38). A closer review of relationships between measured data and assumed targets, particularly their use in providing a very early origin for this phase of activity at the site in the 6th millennium BC, suggests that there is no basis for considering the site as an observatory in the astronomical sense, nor for defining its period of use. There is no consensus on any possible astronomical function for the monument, nor even for its general structure and chronology.

That the holes, around which much of this speculation centres, are artificial, and purposeful seems certain; their function is not. Possibilities extend beyond celestial targeting: for instance, they might even have served more to enhance the well-known acoustic properties of the stones, wind-driven on this exposed plateau.

-reinterpretation of the site according to the seasonal-solar model

The site, therefore, provides another failed attempt to impose modern astronomical precepts on an ancient structure, and to cast its primary function as an observatory, especially weak in this case, where so much essential data on structure, sequence, and date are missing. Certainly, this upland location would have allowed impressive sky-ward views, prompting ready celestial cues for ritual, but these have left no discernable structural trace that meets with general approval.

However, the basic layout at Karahunj *is* entirely consistent with the solar-seasonal model for axial alignment proposed elsewhere in this analysis, as applied to row-complexes as far afield from Armenia as SW'n Britain, where there is a strong tendency for *the main axis to be S'ly (*see Table of Contents: 03d/7a), where an *interest in the SW'n margin of the permanent zone* of the solar transit is evident (see Table of Contents: 02c/2a), and where *funerary structures are included in, and around the main axis* (see Table of Contents: 03d/8d). Karahunj also provides an example of a site where there is a *combination* of *axes* (see Table of Contents: 02b/3g): here that of the principal S'ly line of the rows towards the meridian of the solar transit, with the SW'ly axis of approach, and passage through the central enclosure possibly providing an additional reference to the zone of solar setting. Both axes would intersect the solar transit throughout the year, hence remaining relevant, providing an additional specific reference to the solstitial setting position, available fleetingly in midwinter. Two fragmentary rows crossing the main N'-S'ly axis at the N'n terminal may further support this W'ly reference.

There also appears to be a distinct cluster of circular tombs lying just beyond the S'n terminal of the main axis, hence suggesting inclusion of ancestors in the line, a common feature of those stone rows seen along the margin of NW'n Europe.

Although the site and its area would certainly have provided facilities for *active* observation, and ritual use of *transient* celestial phenomena of all types, the fixed structure of the monument would have allowed *recurrent* interaction with the *solar* transit, as a *passive* act of continuing propitiation, and promotion of benign seasonal conditions, without further intervention.

Details of the economy in this location are unknown, but are likely to have been strongly pastoral at these higher altitudes, a bias suggested by rock carvings in comparable areas elsewhere on the plateau, as on the slopes of Mount Ughtasar (39.6215933 N, 46.0524417 E), where wild, or domesticated animals, capriforms, and perhaps cattle are common motifs, depicted in scenes of tending, or hunting. Obviously, seasonal change is a major factor affecting productivity in both arable, and pastoral economies, one capable of finding similar expression in ritual. Terracing on the S' to SW'ly facing hill slopes, around the S'n side of the settlement, although entirely undated, might indicate areas of arable cultivation, in use from the earlier phases of the site (e-FIG SR-36), and the extent of later settlement also suggests a flourishing community, living well beyond the level of basic subsistence.

Although there are other megalithic settings in the region, the site at Karahunj appears unusual, in size, and in complexity, suggesting that the monument had a central importance beyond the immediate area, and might have acted to serve ritual, and funerary functions for a wider population, much of which was more permanently settled in the valleys below (eFIG SR-34).

It is suggested here that some of the holes cut through the stones might have provided lines of sight acting to cross-link *inwardly* with other stones, or important areas, within the monument, other holes also making *outward* reference to celestial phenomena, general, rather than as calibrated observation, both actions further strengthening ritual consistency at the site, and supporting the function of the main axes.

TABLE SR-25 Karahunj, and other sites of known and potential prehistoric date in the Sisian sector of the Armenian plateau (as plotted in e-FIG SR-34)

site	type	date	ref	latitude	longitude	alt (m)
KARAHUNJ	tombs	MB-IA	027	39.5516891	46.0289612	**1767**
Shagat	cairns	LB-?IA	016	39.5686760	45.9000092	1756
Uyts ch	tombs	IA-UR	050	39.5115585	46.0557442	1672
Aghitu	cairns	IA	073	39.5173287	46.0869706	1707
Uyts	city	MIA-R	049	39.5120697	46.0558510	1654
KARAHUNJ	city	Hel-R	024	39.5506516	46.0285721	1753
Balak	fort	ACH-R	021	39.5593605	45.9426155	1737
Shagat	fort	Hel-R	003	39.5690727	45.8976173	1769
Narinkala	fort	Hel-R	017	39.5615807	45.9201279	1715
Shakeh	fort	?date	121	39.5745239	46.0008926	1791
Shakeh	sett	R	115	39.5717621	46.0080338	1782
Narinkala	sett	EB	018	39.5611115	45.9199219	1718
Uyts	sett	EB-R	068	39.5136642	46.0565376	1597
Aghitu	fort	Hel-R	091	39.5137939	46.0808983	1588

Key: type: sett[lement]; **ref**[erence number from Avestisyan *et al.* 2002]; **alt**[itude]
Dates: EB early Bronze Age, 3rd millennium BC; **MB** middle Bronze Age, 20-16th cent. BC; **LB** later Bronze Age, 15-13th cent. BC; **IA** Iron Age, 12-9th cent. BC; **MIA** middle Iron Age, 8-7th cent. BC; **UR** Urartu, 8-7th cent. BC; **ACH** Achaemenid, 6-4th cent. BC; **Hel-R** Hellenistic-Roman, 3rd cent. BC-3rd cent. AD.

e-FIGURES: combined listings and supporting information

e-FIG SR-

Study area: Dartmoor

01 Density distribution of stone rows

02 Variation in alignment between stone rows from different localities

03 Location of cairns, stone rows, and settlement from the study area plotted against altitude

04 Aspect of slopes on which stone rows are sited

05 Alignment for all stone rows

06 Piles Hill-Butterdon Hilllong stone row: SX 6560

07 Piles Hill-Butterdon Hill long stone row: topographical profile along the row

08 Drizzlecombe stone row complex: SX 5967

09 Green Hill-Stall Moor long stone row: SX 6366

10 Green Hill-Stall Moor long stone row: topographical profile along the row

11 Merrivale stone rows: SX 5574

12 Shovel Down stone row complex: SX 6586

13 Down Tor stone row: SX 5869

14 Down Tor stone row: SX 5869

Study area: N'n Scotland

15 Density distribution of multiple stone row sites

16 Parallel replication in stone row complexes: comparative data from Dartmoor, Exmoor, Scotland, and Brittany

17 Frequency of alignment for all multiple stone row sites

18 Aspect of slope on which stone rows are sited

19 Dirlot: ND 1248

20 Upper Dounreay: ND 0166

21 Garrywhin: ND 3141

22 Kinbrace: NC 8232

23 Learable Hill S: NC 8923

24 Hill of Many Stanes: ND 2938

25 Tormsdale: ND 1449

25a Loch of Yarrows ND 3144

25b Allt Breac NC 9518

25c Camster ND 2643

Other sites

26 Beagnmore stone row complex (Tyrone, Ulster): H 6884

General

27 Alignment of short stone rows in SW'n Ireland

28 Alignment of short stone rows in W'n Scotland

Minilithic stone rows

29 Bancbryn; stone row; SN 68936 10326; Carmarthenshire

30 White Ladder; stone row; SS 73287 37111; Exmoor

31 Bancbryn [SS 6810] and White Ladder [SS 7337]; stone rows;
Comparative plans, internal structure, and relationship of the axis to the S'ly permanent zone of the solar transit.

32 Bancbryn and White Ladder: their axial alignment compared to that of their local groups

Sinuous stone rows

33 Various examples from Britain

Karahunj

34 Karahunj: general location on the Armenian plateau: oblique view

35 Karahunj: more detailed location of the row-complex, and of associated sites: oblique view

36 Karahunj: general site: oblique view

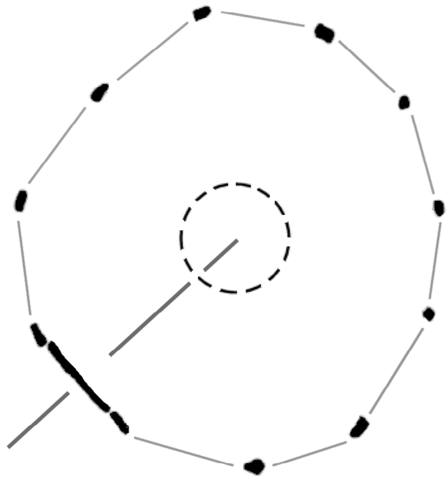
37 Karahunj: general site: vertical view

38 Karahunj: the row-complex itself: vertical view

39 Karahunj: photographs of the row-complex

Section 03e:
Structural orientation amongst stone circles in Britain

Section identifier: SC-
SEE INITIAL SECTION:
Access to digital images



Sunhoney (Aberdeen, Scotland)

Summary:
Orientable features associated internally, and externally with stone circles are discussed, and topographical aspects of location considered. Particular reference is made to recumbent stone circles, and those with distinct outlying monoliths. Callanish is analysed in some detail. Timber circles are covered briefly. Evidence is presented for possible relationships between stone circles and the S'n arc of the solar transit.

The following topics are briefly discussed:
-basic **properties** of stone circles: internal structure, circuits;
-issues of **alignment**;
-**orientable features**: topographical aspect of the location, the circle itself, associated monuments;
-supplementary information on **key sites.**

Orientation of structural elements at stone circles

General introduction

Stone circles occur widely over Britain and Ireland, with particular concentrations in NW'n Scotland, Cumbria, Dartmoor, central-N'n and SW'n Ireland (Burl 1976, fig. 1/p.9). Circles vary widely in scale, and form, and it has been argued that certain of them appear to have been set out according to a more sophisticated geometry (Burl 1976, fig. 5/p. 42); Thom 1967, 34-91; Thom and Thom 1990). Relationships between stones and surrounding topographical features have also been used to suggest deliberate astronomical alignment (Thom 1967, 1971, Thom and Thom 1978, 1990).

Circles are broadly later Neolithic to earlier Bronze Age in date, with usage likely to have continued over considerable periods subsequently (Burl 1976, fig. 6/p. 48).

Basic properties of stone circles

-interiors

Stone circles can appear more open centrally (Castlerigg, Cumbria; Merry Maidens, Cornwall), or contain other minor features, such as a standing stone (Torhouskie, Wigtownshire), particular slab settings (Stenness, Orkney), other circles (Avebury, Wiltshire), a cove (Avebury, Wiltshire), or arcs of megaliths (Stonehenge, Wiltshire).

Central areas of circles can also be occupied by funerary monuments to varying extents (Callanish, Hebrides; Esslie the Greater, Kinkardine; Brats Hill, Cumbria; Balnuaran of Clava, Inverness). Although in certain cases circles stand clear of the cairn, with an intervening margin, appearing as cairn-circles (Ringmoor, Dartmoor), they also occur as kerb-circles, more suggestive of peripheral support and retention than as a discrete structure (Ringmoor, Dartmoor; Monzie, Perth).

-the circuit

The ground plan of a stone ring can vary in shape, from more closely circular, to include irregularities, and perhaps more regular departures (flattened circle, ellipse, egg-shaped, compound: Burl 1976, fig. 5/p.42; Thom 1967, 56-83). Traditional use of the term 'circle' would perhaps, therefore, be better replaced by 'ring'.

Within the circuit of the circle, a range of features can occur, adding asymmetry. Spacing between stones can be approximately equal, or far less so, with gaps often present.

Stones may be small (Stannon, Bodmin Moor), massive (Stonehenge, and Avebury, Wiltshire; Stenness, Orkney), individually larger (Castlerigg, Cumbria), or graded in height towards a particular direction (recumbent stone circles, Aberdeenshire).

There are plain gaps in circuits, often suggestive of entrances, this sometimes confirmed by the presence of distinctive portal stones (Swinside, Cumbria; Carrigagrenane, Cork). Circuits can also contain particular settings, as in the case of a recumbent stone and its flankers, a feature diagnostic of recumbent stone circles (Midmar, and Loanhead of Daviot, Aberdeen).

Individual stones are occasionally decorated with motifs, such as cup-marks (Long Meg, Cumbria; Rothiemay, Banff).

-exteriors

Circles which occur within henges are termed 'circle-henges' (Stonehenge and Avebury, Wiltshire; Arbor Low, Derbyshire; Cairnpapple, West Lothian).

Circles are often associated, to differing degrees of certainty, with external stone structures. Avenues can lead to circles (Callanish, Hebrides), stone rows can lie adjacent (Beaghmore, Tyrone; Drizzlecombe, Dartmoor), and stone outliers can occur (Long Meg, Cumbria; Stanton Drew, Somerset; Rollright Stones, Oxfordshire). Several circles may lie adjacent (White Moss, Cumbria; Stanton Drew, Somerset; The Hurlers, Bodmin Moor; Machrie Moor, Arran; Beaghmore, Tyrone), to suggest more of a megalithic complex.

Issues of alignment

Much has been made of the ground-plans at certain circles, to suggest application of complex geometry in their design, and the existence of more standardised measures of length during the period (Thom 1967, 34-55). Still more has been made of alignments between selected stones and astronomical events, mainly solar and lunar, but also stellar, and planetary, to suggest that such sites functioned, at least in part, as celestial observatories, and that sophisticated astronomical knowledge existed, if not generally, then amongst specialists (bibliography: Thom; Ruggles 1999).

Although some alignments have higher potential for closer correlation with a specific celestial target, for instance, the main axis at Stonehenge (see Table of Contents: 03f/6f and 7c), many others thus noted appear to be far less persuasive, especially if poorly defined structurally, and involving obscure events, and exotic targets. It is easy to draw lines between standing stones, adopt a viewing point, often structurally unmarked, and invoke some basic topographical feature on the modern horizon to create an alignment, adopting only the most astronomically co-operative ones as significant, and ignoring the rest.

Such proposed alignments seem to be based almost entirely on events at the horizon, often further tuned by local topography, and with a particular point selected on larger targeted bodies, such as sun or moon, to fit a structural axis. Use of risings and settings at limiting positions dominate the literature, of the sun at solstices, and of the moon at major, and minor standstills (Ruggles 1999).

Limiting positions for the sun occur annually, are more visible (see Table of Contents: 02c/2), and are more accessible for application within recurrent ritual practice. By contrast, those for the moon, which are much less clear, and occur at far longer, almost generational, intervals (see Table of Contents: 02c/3), seem entirely unconvincing. The viewpoint in this study is as follows: that although there may be some aspects of circles, and their associated features that could indeed indicate astronomical refinement, and abstraction, these are unlikely to account for the main function of such sites. More everyday usage of appropriate targets is likely, given such pressing matters of ritual as those concerned with seasonal fertility, the economy, and relating to issues of life and death.

In this evaluation, the most robust structural features of circles have been used to discuss alignment, starting with the most basic: siting, shape, then key structural elements, both internal, and external. Much of the existing analysis appears extremely speculative, based as it is on very subjective choice of associations between features, made to fit existing preconceptions, and this has been rejected here as an approach.

Stone circles are very diverse, presumably multi-functional monuments: a single unifying ritual theme is unlikely, and certainly does not appear obvious from structural analysis. However, one strand does appear to have been significant: an interest in the S'n sky. The solar transit, and specific features within it, would seem to be an obvious candidate here, as a target for alignment, providing not just an annual coincidence with solstice or equinox, but a more regular reference to the broader transit, including changing seasonal elevation of the sun around the zenith. This mechanism is also suggested for the other types of monuments considered in this general analysis, such as cursus monuments, barrows, stone rows, and henges.

Sites discussed here in more detail include those with a characteristic, and consistent structural reference, such as that seen in the group of recumbent, and related stone circles, which may provide a clearer insight into broader trends amongst circles. Added to these sites are other individual monuments, such as Callanish, Long Meg, and others with significant outlying structure, that may provide some support for this element of interpretation.

Orientable structures at stone circles

The approach taken here has been to examine the more robust properties of stone circles and their settings, those features current between samples of sites, rather than individually. If more general aspects of function are to emerge it seems most likely to be here.

The obvious, fairly consistent directionality shown by the axes of such elongate sites as long barrows, cursus monuments, and stone rows is nowhere near as apparent amongst stone circles, which are sites of different structural emphasis, and of more compact, potentially complex layout. Outlying elements that may be associated with the basic circle, such as avenues, stone rows, and monoliths, provide a further layer of information on axial orientation.

A range of properties of circles is considered, from topographical setting, through internal structure, to associations, in an attempt to assess group consistencies (TABLE SC-01):

TABLE SC-01 STONE CIRCLES: TRENDS AMONGST DEFINED PROPERTIES

feature	trend	to~	examples include	sites outlined include
topographical setting/ restricted views	yes	S-SE		Wales
the stones in the circle itself				
shape of circles	no			
individually larger stones	no			
systematic grading of stones	yes	S	rsc kk	NW'n Scotland
recumbent stones and flankers	yes	S	rsc	NW'n Scotland
entrance features	some	S		
decorated stones	yes	S	rsc	Long Meg
structures external to the circle				
avenues	some	S		Avebury, Callanish
rows	some	S		Dartmoor
outliers	some	S		Long Meg, Monzie
the complex of associated monuments				
multiple groupings of circles	some	S		
multi-monument complexes	no			

Key: trend (observed in this analysis), **to**(wards) the stated direction, with only one direction in the axis quoted, for ease of presentation, the other is implicit): **examples: rsc** recumbent stone circles**, kk** kerb cairns.

General properties of circles, as listed in TABLE SC-01 above, are discussed in more detail as follows:

The topographical setting of circles

-general aspect

Any aspect that the location of a circle favours may well reflect preference for views of particular significance. The siting of a large sample of stone circles, from separate, and topographically different areas of Britain, was therefore determined as follows (TABLE SC-02), and plotted together (e-FIG SC-09).

In order to check whether samples of circles were comparable between regional sets, the only readily measurable common property being that of size, frequency distributions of diameter were determined for each set. These spectra were shown to be sufficiently similar to assume general equivalence, and hence that to compare aspect was practical. Circles on Dartmoor were, however, somewhat smaller than the norm.

TABLE SC-02 STONE CIRCLES: THE ASPECT OF THE LOCATION

region	sites #	number [%] .... open	weak	strong
SW'n Peninsula	71	31 [44]	20 [28]	20 [28]
Wales	70	34 [49]	15 [21]	21 [30]
Peak District	28	11 [39]	6 [21]	11 [39]
Cumbria	45	30 [67]	11 [24]	4 [9]
Grampian	151	95 [63]	31 [20]	25 [17]
TOTAL	365	201	83	81

Key: #: number; **open** location relatively level; **weak**(ly sloping); **strong**(ly sloping);

Most stone circles lie in **open,** and fairly level ground, for instance on hilltops, or spurs, keeping viewing options from the site general in aspect, without obvious directional emphasis.

Other circles, located on **slopes,** were divided into those of weak, or stronger gradient, this causing the site to face a particular direction, perhaps indicating some deliberate preference for aspect.

For all but two of the samples (Cumbria, and Grampian) numbers are split fairly evenly between open sites, and those with gradient, and for this latter property most were again about even, between weak and strong.

The frequency distribution for direction of slope amongst the total sample, plotted at 20° intervals, shows a spread peak, for those on stronger gradients, centred on the SE, addition of weaker gradients agreeing with this trend (e-FIG SC-09). Component distributions for all regional samples are also compatible with this conclusion.

-circles with restricted aspect

A few circles were seen to be in more restricted locations, for instance those in valley areas, where the range of more distant viewing, at lower altitude, from the site is channelled in a particular direction, framed by higher ground. Such sites may well be important in discussing matters of function, since presumably, even in these locations, they were still able to operate.

Five circles from Wales, lying in such locations are outlined in TABLE SC-03. These smaller circles are located in valleys that allow a more open aspect only towards the S. The sample is too small to be more specific, but this is certainly in line with the SE'ly trend for underlying slopes seen in the general sample (e-FIG SC-09).

TABLE SC-03 Stone circles: examples in restricted locations in Wales

circle	Burl#	NGR	NMRW	Exp	diam	st	ht	asp	notes
Cerrig Duon	Breck 1	SN 8511 2060	412996	12	18	22	0.6	S	avenue, nearby monolith
Ysbyty Cynfyn	Card 2	SN 752 791	-	213	?	?	?	SSW	
Rhos y Beddau	Mont 3	SJ 0577 3021	300389	255		12	0.1	SE	avenue runs E
The Circles	-	SJ 0298 2598	308783	239	?	?	?	ESE	two circles
Six Stones	Rad 5	SO 1629 5168	306107	200	18	15	0.3	SE	

Key: Burl#: the numbering used in Burl 1976, according to the system of counties operating in Wales at the time of publication; **NGR**: National Grid Reference; **NMRW**: National Monument Record for Wales; **Exp**: Ordnance Survey map Explorer Series 1:25k; **diam**(eter of circle in metres); **st**: number of stones in the circle; **ht**: maximum height of the stones in metres; **asp**(ect of location).

Of these sites, Cerrig Duon (Grimes 1963) is worth outlining in more detail (see Table of Contents: 03e/10b; e-FIG SC-04). The setting provides excellent views towards the S, framed by sides of the valley, and on towards the area of the sun at zenith, this changing in maximum elevation from winter low, to summer high.

Details of sites listed in TABLE CS-03:

Cerrig Duon

See Table of Contents: 03e/10b; e-FIG SC-04;

Ysbyty Cynfyn

The circle is situated on a low eminence, within a narrow, upper stream valley with constricted views, slightly more open towards the S, in the direction down-stream.

Six Stones

A sub-circular ring contains 15 stones, 0.3m in maximum height.

Rhos-y-Beddau

A ring contains 12 stones, all 0.1m in maximum height. An avenue, or double stone row, 49m long, 2-4m wide, and aligned ENE'-WSW'ward, lies detached, some 8m to the ENE of the ring, and is set tangentially. A possible second stone circle has been reported, 400m towards the N (Grimes 1963 120-122).

The Circles

Two stone circles are situated at the margin of a narrow, uppermost stream valley, with constricted views slightly more open towards the SE, in the direction down-stream.

Six Stones

The circle is situated in a stream-side location, in the bottom of a narrow headwater valley, with constricted views slightly more open towards the SE, in the direction down-stream.

The stones in the circle itself

-the shape of circles

Although most rings are basically circular, and irregularities seem to be of more practical origin than by design, a proportion displays an asymmetry which presents one broader, flattened side. This could be intended to broaden the frontage towards a view of particular significance, whether over features in the landscape, or sky.

Examination of a sample of 32 such sites indicates that there is no clear trend apparent, with the flattened side not favouring any particular direction.

-individually larger stones in the circle

Larger stones often appear individually placed amongst the generally smaller stones in the circuit, perhaps to mark some particular direction, when viewing outward from the interior. At Long Meg (Cumbria), for instance, those at the E and W are considerably larger, and at Swinside, and Burn Moor (Cumbria), larger stones were placed at the N and S respectively. No general trend can be seen, but it has been suggested that such larger stones could mark cardinal points (Burl 1976).

-systematic grading of stones that form the circuit of stone circles

Stones forming a circle, or kerb-circle, are sometimes graded in height towards a particular direction, and this may be fairly consistent within the regional group. There seems to be a consistent increase in the size of kerbstones towards the general S-SW amongst kerb-cairns in Scotland (Burl 1976, table 7/p. 198), and also amongst recumbent stone circles, Clava cairns, and ring-cairns in NW'n Scotland, and amongst related sites in Ireland.

Burl (1976, fig. 22/p. 138) noted that many Cornish circles have the tallest stone at the WSW (azimuth 236-254°G), and in Caithness, the tallest stone is also usually near the W. However, on North Uist it is often at the E, and in the 'west coast great circles', clustering occurs at the N, S, W, but less so at the E.

-entrance features

Many circles have informal gaps that may mark entrances, but could just be a damaged sector, and at some sites these gaps are extensive, perhaps indicating a sector of more open access. Smaller gaps, formally marked by larger flanking stones, suggest more convincing entrance structures (examples: Castlerigg, Cumbria, and axial stone circles in Ireland). A general analysis of entrance structures indicates a preference for entry, or exit, along a N'-S'ly axis, rather than E'-W'ly. Within the polar axis, entry to the N, or to the S are about even.

-recumbent stones and their flankers

Amongst the stone circles of NW'n Scotland, a characteristic recumbent stone occurs, laid horizontally in the circuit, often flanked by uprights that frame the view over the stone, out from the interior in this direction. Such recumbents lie at S-SW, and the larger of their flankers often occur on the S'-SW'n side.

Structures external to the circle

-**avenues**

Avenues of stone can run radially out from a gap in the circle, or appear to run close to it on a tangential course (Burl 1976, 1993). Callanish (e-FIGS SC-01 to 03) provides a well preserved example of circle and associated row-avenues, its cardinal layout perhaps suggesting a primary reference to the solar transit at S'n zenith, also to its rising E'n, and setting W'n limbs (see Table of Contents: 03e/10a).

-**rows**

Many of the stone rows on Dartmoor, single and double, run between kerb-circles, located at one or both terminals, including them in the alignment, with axes frequently towards the SW'n quadrant (see Table of Contents: 3d/8f).

-**outliers**

Outlying monoliths often occur near stone circles, but in the absence of linking stratigraphy it is not possible to specify their structural relationship. Even if this were possible it would not be known whether the importance of the outlier lay in viewing it from the circle, or *vice versa*. A sample of circles with recorded outliers indicates a preference for generally N'-S'ly placement, rather than E'-W'ly, with fairly clear evidence for the S'n sector being favoured. Placement of outliers to the SW of circles (e-FIG SC-10) may indicate an interest in the near solstitial horizon.

The complex of associated monuments

-multi-monument complexes which include stone circles

Stone circles sometimes occur in association with other monuments, such as cairns, and rows, as at Beaghmore, Tyrone (see Table of Contents: 3d/10; e-FIG SR-26), but in the general sample no clear trend is apparent.

-multiple groupings of stone circles

Stone circles occur fairly frequently in pairs, and more rarely in higher multiples. Analysis of a sample indicates a preference for axes between nearby circles to be generally N'-S'ly (see Table of Contents: 3e/11d). This general axis is also seen amongst linear groupings of henges (see Table of Contents: 3f/3) and, as suggested there, it may possibly indicate interest in the S'n arc of the sky. This assumes, of course, that the line of the centre-to-centre axis was the key element, in other words, the directions of pointing, rather than the axis perpendicular to it, the lateral lines of facing.

Thom and Thom (1978, 28-29: tables 3.6, 3) present a selection of nine paired circles, giving centre-to-centre azimuths, and ascribing astronomical significance to the axes as follows: three solstitial, four equinoctial, two meridianal, and three calendric. Noting the absence of prominent reference points on the horizon, they suggest that these were early types, established before accurate solar observatories, like those at Ballochroy, were being built. Burl 2000, 215-233

Recumbent and axial stone circles

NW'n Scotland contains a particular concentration of stone circles, many of which are of a characteristic type: the **recumbent stone circle (RSC)**, of which there are about 100 within an area of 4000km^2 (Ruggles 1999; Burl 1976: 74 known; Burl 2000, 215-233; Bradley 2005; Welfare 2011). The characteristic feature of these circles is a stone laid horizontally, set commonly in the S-SW'n quadrant of the circuit, often flanked by uprights, and sometimes the focus for cup-marking of surfaces (e-FIGS SC-07 and 08). Such apparent interest in the S-SW is often seen sporadically elsewhere amongst the elements of stone circles, and associated structures, for instance in the positioning of certain outlying pillars (e-FIG SC-10). It could be argued that this is just a regional variant, and hence no guide to general principles amongst stone circles, but it could provide a clearer insight into broader function within the general group.

The outward azimuths of these recumbent stones are comparable to those of the entrances at Clava cairns, and ring-cairns from the same general area (e-FIG LB-11), where there is often a similar grading up of stone-size, and attraction of cup-marking towards the SW (Burl 1976, fig. 25/p. 163). Since they are clearly differentiated structurally between their ends, such axes, from centre to recumbent are asymmetric (see Table of Contents: 02a/2b).

A related, but smaller, group of circles is found in SW'n Ireland, **axial stone circles (ASC)**, about 48 of which are known from Cork, and Kerry (e-FIG SC-11 and 12). Here, the recumbent stone is also present, but there is an additional feature, a formal entrance gap, roughly opposite.

Interpretation of alignment

Existing interpretation of alignment amongst RSCs, ASCs, and Clava cairn-circles, well illustrates the problems which arise when attempting to address sites on an individual basis, rather than collectively, and in terms of events strictly at the horizon, rather than above it. Despite the general directional trend evident amongst data, especially for RSCs, and the Clava sites, existing attempts to draw astronomical conclusions on this basis are extremely confused. Only a fraction of the alignments have been accounted for, and here only by invoking a few of the available limiting positions of annual periodicity for the sun, the 18-year cycle for the moon, and even 30-year patterns in the movement of Venus. Such theories, based on multiple targets, exclude most of the axial data. Since there is an obvious architectural link between these three groups of sites, perhaps some measure of unity in basic ritual is also to be expected. Interpretation of alignment in terms of interest in the solar transit (see Table of Contents: 02c/2) unites the data into a coherent model.

Some notes on existing interpretations are as follows:

-Burl 1976:

Burl notes the general axial preference amongst Clava cairns (*ibid*, 162-163), and RSCs (*ibid,* 175-178) in Scotland, for the SW'n quadrant, but interprets diversity in the sample as indicating multiplicity of targets, with solar, lunar, and planetary cues serving complex, and diverse ritual. For instance, amongst 30 ASCs (*ibid,* 213-224), eight were associated with moonset, four with the maximum S'n limit for Venus (a 30-year cycle [!: AJM]), three with sunset, and one equinoctial.

-Ruggles 1999:

A detailed analysis of **RSCs** from NW'n Scotland is presented (*ibid*, 91-101; fig 5.5/p. 96; table 5.1/p. 212). Individual alignments are noted as spread between about 155 and 235°G, with some evidence for general clustering over the central zone, but with individual peaks appearing spurious. Data are not thought to offer any clear and simple explanation for alignment in terms of limiting positions of sun and moon, although there is a slight peak for moonset at the minor limit. The view of the moon, as it passed over the recumbent stone, around midsummer, is considered of likely importance.

The recumbent stone is noted as providing a possible platform, over which observation could have been made from the centre of the circle, and data are closely presented from this nominal, but otherwise structurally undefined central location to the midpoint of the stone. Increased visibility of far horizons over the recumbent stone, which is usually set below the horizon, is noted.

Orientation on the winter sun, at low elevation, is considered the best potential explanation, with the tendency for cup-marks, possible solar symbols, to cluster in the area of the recumbent providing a supporting factor (*ibid*, table 5.5/p. 216). Siting of RSCs on low hills, or on slopes, and frequent orientation with respect to a single conspicuous hilltop might also have been factors in the choice of axis.

A similar analysis of **ASCs** in SW'n Ireland is also presented (*ibid*, 99-101; fig. 5.8c/p. 99, and table 5.6/p. 217; list pp. 189-191). Like those of RSCs, the orientations appear concentrated, here spread S' to W'ward, but a lack of pattern is evident. The correspondence between the axis and lower relief on the distant horizon, as detected amongst RSCs, is not seen for ASCs.

A single site at Drombeg is suggested as presenting a fairly unequivocal astronomical alignment, via a notch in the horizon (*ibid*, fig. 5.10), and on to the winter solstice sunset, but not exactly. It is suggested that, since ASCs are smaller, and more degenerate than Scottish RSCs, they may date to later in the Bronze Age, by which time the more specifically astronomical content of such sites could have been lost. It is concluded that there is no simple explanation for the alignments. Arguments that ASCs are more degenerate, and have lost the clearer trend for alignment seen amongst the related Scottish RSCs, is weighed against the careful construction, and symmetry, inherent in their design.

Re-interpretation in terms of alignment on the solar transit

There is a simpler explanation for such apparent disparity of data, this latter arising from the over exact way in which it is measured and analysed, and in the assumptions made for the basis of axial targeting.

In the data presented by Ruggles, the axial alignments for RSCs, and ASCs are measured from a notional exact centre-point for the circle, out through the mid-line of the recumbent stone, and on to the horizon, to which level they are assumed to refer. This involves four assumptions, the most reasonable being that the direction of viewing was indeed outward from inside the circle, rather than the opposite. However, the view could have been taken from almost anywhere within the circle, rather than from the exact centre, but with the best options most restricted fairly centrally, or radially to the recumbent. The centres of these circles are unmarked by extant structures, but could have been already occupied by other features obstructing the line of sight. Nor is there anything to indicate that the *centre* of the recumbent was the key intermediate marker for viewing, this could have been anywhere laterally along it, or more widely between the flankers. Neither is there any real basis for assuming that features, or events, near the horizon formed the external target for alignment.

Rather than taking such precise points, and their resultant alignments, as closely defined statements of axial intent, and interpreting them separately for each site, a more combined, and general approach is needed, to avoid this artificial fragmentation of data.

A more realistic analysis might use, not its central sight-line, but the view between the two lateral limits of the recumbent stone. The idea of a discrete, primary, centralised viewing point might also be expanded, as a defined circle around the centre, providing a limit for the area of the view-point. The azimuths from opposing margins of this central circle to the edge of an opposite recumbent would then generate a maximum zone of visual interest. This sector could then be summed for all circles, and a frequency distribution obtained that would indicate any overall preference for the direction of viewing, one with a more robust basis.

The diameters chosen here for the viewing circle around the centre of the site are one-third, and one-sixth of the diameter at the circle. Processing the combined data, as outlined above, for RSCs and ASCs, gives the following results:

..RSCs: e-FIG SC-13: a single symmetrical distribution, normal in appearance, lies between SE (130°G), and WSW (255°G), with a single peak at about SSW (200°G);

The plot in Ruggles 1999 for comparison: a spread of data over about 155-235°G, with some evidence for clustering over the centre (180-200°G), but with further individual peaks thought unconvincing;

..ASCs: e-FIG SC-12: a weakly bimodal distribution, between S (170°G), and WNW (300°G), with spread peaks around SSW (215°G), and W (270°G);

The plot in Ruggles 1999 for comparison: data spread over about 190-275°G, with some suggestion of clustering towards the limits, and thinning of data at the centre.

Approximate positions for solar and lunar events at the horizon for the latitude of RSCs and ASCs are given below in TABLE SC-04, as calculated using data from TABLES AS-01 and 04:

TABLE SC-04 RSCs AND ASCs: KEY EVENTS IN THE SOLAR AND LUNAR TRANSIT FOR THEIR LATITUDES

Note: any closer correspondence between peaks of frequency for RSCs and ASCs (e-FIGS SC-13 and 12 respectively) and limiting positions in TABLE SC-04 below is shown in **bold** type;

solar transit:

area	**mean lat (°N)**	**azimuth (°G)**				**zone: width (°)**			**elevation (°)**		
		midsummer		**midwinter**				**null/**	**min**	**eq**	**max**
		rise	**set**	**rise**	**set**	**trans**	**max**	**perm/**			
		=a	**=b**	**=c**	**=d**	**=(c-a)**	**=(b-a)**	**=2a**			
RSCs	57	042	318	138	222	96	276	84	10	33	56
ASCs	52	049	311	131	229	82	262	98	15	38	61

lunar transit:

area and mean latitude (°N)	**range of azimuths (°G)**								**range**	
	moonrise				**moonset**				**A**	**B**
	max to		**min to**		**max to**		**min to**			
	N	**S**	**N**	**S**	**N**	**S**	**N**	**S**		
	=a	**=b**	**=c**	**=d**	**=a**	**=b**	**=c**	**=d**	**=(b-a)**	**=(d-c)**
standstill	**major**		**minor**		**major**		**minor**			
RSCs 57	027	153	053	127	333	**207**	307	233	126	74
ASCs 52	038	142	058	122	322	**218**	302	238	104	64

The correspondence between peaks of alignment and the limiting positions stated above is very weak, with only maximum moonset to the S being close for RSCs, and ASCs. A weak interest in the lunar cycle remains a possibility, but only provided that the near 19-year wait was considered worth it, and that an explanation for the particular single choice made amongst the eight lunar possibilities can be offered. In nominating any particular target for alignment, there is also the spread of data lying beyond any of these peaks, to consider, and include in any explanation.

..RSCs: On this basis, and adopting the solar model (see Table of Contents 03a/13a), RSCs show a preference for the setting limb of the transit, just after the meridian, with no specific interest in winter setting solstice, but with the single peak perhaps suggesting a single tradition. The zenith, and its seasonal cycle of elevation, might have been the target of interest, with orientation towards the permanent zone of the transit allowing year-long access (see Table of Contents: 02c/2e).

..ASCs: These monuments show a weakly bimodal distribution, pointing further along the SW'n setting limb of the transit, with peaks either side of this solstice position, one in the permanent zone of the transit, the other in the transitional zone (see Table of Contents: 02c/2), perhaps indicating two variant traditions. Although access to the transit would be year-long for the former, it would be more restricted for the latter, depending on precise orientation (e-FIG LB-09). Lower elevations of the transit, during spring or autumn, perhaps with the actual equinox a coincidental concept, might have provided the basis for more seasonally-related ritual.

Given the exposed locations of these two groups of circles, and the agrarian nature of the communities which constructed them, a distinct interest in the sun would seem likely, especially during periods of environmental stress. Both groups occur in climatically exposed, and unstable areas. RSCs belong to the Grampian group of circles in NW'n Scotland (e-FIG ND-02c), hence fronting the N'n North Sea, and ASCs to the Cork group in SW'n Ireland (e-FIG ND-06c), the furthest W'n landfall on the Atlantic coast.

Circles with an outlying stone pillar to the SW

The presence of a monolith placed at the SW, just beyond the perimeter of certain stone circles, ring-cairns, and other monuments, may indicate a specific interest in this direction at such sites. Although a range of different monuments are involved, general discussion is included here, under stone circles, since this is a more consistent feature of that group, whether free-standing, or of kerbed type (e-FIG SC-10). Examples are listed in TABLE SC-05:

Table SC-05 Circles and cairns: with stone pillars at the SW

site		NGR	type	diam	az	lat	WS	ms	notes	e-FIG SC-
Carnousie House	Aber	NJ 678 505	?rec	25	214	57.5	221	206		10
Castle Dalcross	Inv	NH 780 484	pg	12	214	57.5	221	206	[179]	10
Culdoich	Inv	NH 751 437	rc	17	225	57.5	221	206		10
Easter Delfour	Inv	NH 844 085	rc	18	219	57	222	207		10
Loch nan Carraigean	Inv	NH 907 155	rc	19	225	57	222	207	[260]	none
Long Meg	Cumb	NY 571 372	sc	100	224	54.5	225	213	cm	LB-06
Miltown of Clava	Inv	NH 751 438	rc	18	227	57.5	221	206		10
Monzie	Perth	NN 882 242	kc	5	219	56.5	223	208	cm	10
mean					**221**					

Note: sites are listed in decreasing order of latitude.

Key: Inv(erness), **Aber**(deen), **Cumb**(ria); **type** (of site): **rc** ring-cairn, **rec**(umbent stone circle), **pg** passage grave, **kc** kerb cairn, **sc** stone circle; **diam**(eter, maximum in m); **az**(imuth from the centre of the site); **lat**(itude of the site, approximate), **WS** azimuth of winter solstice for that latitude; **ms** moonset, maximum S'ly for that latitude; **notes**: [..] azimuth of any further outlier, **cm** cup-marks on the outlier.

Viewed from the centre of their circles, these outliers lie close to the direction of winter solstice sunset for their latitudes, and show less correspondence with an adjacent limiting lunar position, maximum S'ly moonset, that appears consistently to the S. Further discussion of this choice of direction, in terms of access to solar transits, is given in Table of Contents: 02c/2e.

Supplementary notes on the sites in TABLE SC-05:

-Carnousie House; Aberdeen; NJ 678 505; e-FIG SC-10; possibly related to recumbent stone circles;

The site consists of two separate stone rings, the larger 25m in diameter, lying just to the S of the smaller, which is 8m in diameter. A very large boulder, 2.4 by 3.4m, once lay on the S'n arc of the larger ring. A large outlier lies just beyond the ring, at the SW (Thom and Thom 1990, 186-187).

-Castle Dalcross; Inverness; NH 780 484; e-FIG SC-10; Clava-type passage grave;

A ring of kerbstones, 12m in diameter, includes two large portal stones at the SW that once led to the now removed passage and chamber. There are two outliers beyond the kerb, the larger at the SW, and the smaller at the S.

-Culdoich; Inverness; NH 751 437; e-FIG SC-10; e-FIG SC-10; Clava-type ring-cairn;

Kerbstones, up to 1.5m high, revet a ring-cairn 17.5m in external diameter, with its infilled internal space 6.7m across. A single outlying slab, 3.7m high, some 8m away to the SW, is either a single monolith, or perhaps the remnant of a more complete original stone circle. The old ground surface within the central area was heavily impregnated with char, and cremated human bone, out to about 2m diameter; no artefacts were found (Piggott 1954).

-Easter Delfour; Inverness; NH 844 085; e-FIG SC-10; Clava-type ring-cairn;

An inner ring of kerb-stones, 7m in diameter, and an outer kerb 18m in diameter, were originally infilled between them, to form a revetted ring-bank, with an open central space. Outer kerbstones increase in size, and height towards the SW. A tapering upright slab, 2.9m high, 1.7m wide at the base, and 0.5m thick, lies 7m beyond outer kerb at the SW (219°G), with the wider face towards the cairn. Although this outlier is currently isolated, the possibility remains that it might once have formed part of an outer circle.

Existing astronomical comment: the outlier covers midwinter moonset (Thom and Thom 1990, 194-195).

-Loch nan Carraigean; Inverness; NH 907155; Clava ring-cairn;

A sub-circular outer kerb, about 19m in diameter, is concentric with a damaged inner kerb, 7m in diameter, that encloses the once open central area. Outer kerbstones are graded up towards the SW. Two fallen slabs lie in the SW'n quadrant, at the SW 2.7m long, and at the WSW 2.1m long, either isolated, or part of a vanished outer circle, about 31m in diameter (Thom and Thom 1990, 196-197).

-Long Meg; e-FIG LB-06;

For further details: See Table of Contents: 03e/10c.

-Miltown of Clava; Inverness; NH 751 438; e-FIG SC-10; Clava-type ring-cairn;

The structure and dimensions of the ring-cairn are similar to those of Easter Delfour. Partial excavation located the cremated deposit of a male, and a female. A thin slab, 3.5m high, and 2.4m wide, lies 6m beyond the outer kerb, to the SW (227°) (Thom and Thom 1990, 190-191).

-Monzie; Perth; NN 882 242; e-FIG SC-10; kerb-cairn; Burl 2000, plate 50/p. 248;

For further details: See Table of Contents: 03g/13.

Timber circles

Certain trends in alignment are also evident amongst timber circles, and possibly related pit circles, of which about 100 are known, with sites dated mainly to the 3rd and 2nd millennia BC (Gibson 2005, fig. 42/p. 63). In terms of alignment there is no general trend, but certain sites appear to show cardinal tendencies (*ibid*, 101-104, 107-115).

At Sarn y Bryn Caled (Powys), the S'n entrance in the outer circle is marked by taller posts, with possible portal structures for the central setting located at the SE (ibid, fig. 41/p. 61 and fig. 75/p. 100). At Caebetin, there are larger posts at the E and W, with a triangular stone upright at the S. At Litton Cheney, the entrance is close to due E. Avenues approach timber circles from the S at Ogden Down, Durrington Walls N, and possibly at Stonehenge. The wider aisles between the timbering are cardinal at Mount Pleasant. At Balfarg, there is a causeway at the S, and most of ceramic finds came from the S'-SE'n arc.

Gibson (*ibid*) suggests that cardinal positions could have been determined from a base line constructed between equinoctial risings, or settings of the sun. This is certainly possible, even though these events are not defined by a limiting position, as are the solstices, but were perhaps fixed by some bisection of the arc between these latter, either by eye, or by counting days. It is equally possible that the zenith of the solar transit at the S could have formed the basis for the key direction, the others following by extension, first to the N, and then bisection of this axis to provide E and W. Such cardinality, if indeed it existed, could simply be a by-product of the type of interest in the S'n arc, as also seen amongst other groups of monument.

Supplementary information on individual sites

Callanish; Lewis; Outer Hebrides; NB 213 330; NMR NB23SW 1; (e-FIGS SC-01 to 03);

A stone circle with a near-central monolith, possibly originally existing as two concentric circles, lies at the centre of four radiating row-avenues. A passage grave was inserted into the central circle, and a further cairn may lie against its outer edge.

-location

The complex is located at the S'n end of a small, sea-girt peninsula, the long axis of the site following the crest of a low ridge, this surrounded by more level ground, but overlooked by nearby upland, just to the NW. The S'n part of the complex lies closer to the shore, with the N'n part adjacent to inland areas, which offer a broader line of approach. Just to the S of the site, a rocky outcrop, towards the end of the ridge, and generally on the axis, appears discrete, and might have formed a significant natural feature, related to the complex. The central circle is on higher ground, with the row-avenues leading gently away.

It is interesting to note that, although the axis conforms with topography, this does not seem to have been considered as passive siting by those who argue sophisticated astronomical interpretations for the monument.

-structures

Apparent gaps in the row-avenues, and the very incomplete second, central ring that has been suggested, perhaps indicate partial dismantling of the monument, ancient, or more modern, or that the complex was never finished. Asymmetries in the plan, especially of row-avenues in relation to the circle, may suggest staged, and slightly disjointed construction. Only the W'n rows of the N'n, and (postulated) S'n avenues are aligned on the central pillar. The midlines of the known avenue at the N, of the partial avenue to the S, and of those lines conjectured at the E and W, do not converge on the central pillar, but on its foreground. This may be coincidental, or indicate an area of special significance, toward the centre of the area at the E of the circle, later to be occupied by the added passage grave.

However, there are certain consistencies in layout, which are worth noting in terms of alignment. Assuming all of the rows originally formed avenues, that at the N is the broadest of the four, and converges on the site, that at the S is the narrowest, with those at the E and W intermediate and equivalent. This could indicate a channelling of emphasis towards the S, with the avenue at the N providing the main line of access to central areas.

..the central circle(s)

The extant central ring of 13 stones is ovate, and some 13m by 11m, with the longer axis approximately N'-S'ly, producing a flattening of the ring along the E'n side. A near-central pillar, 4.8m high, the tallest stone on the site, lies 1.2m to the NW of centre, and became incorporated in the kerb of the inserted passage grave. A single stone at the SW may indicate an outer ring, of unknown shape, but diameter about 20m.

..the four avenues

at N: an avenue 82.3m long, and about 9m wide, tapers slightly as it approaches the circle from the N in a slight ascent. The slabs are edge-set along the axis, except for the terminal pair, set crosswise at the N'n end. There are ten stones in the W'n row, and nine in the E'n, but gaps in both may indicate further original additions. The terminal stone in the W'n row is 3.5m high, and in the E'n row is 2.4m. The stones decrease slightly in height, from terminals towards the middle section, and then increase, as they approach the conspicuously tall setting of the circle.

at S: a short row of five stones runs S'ward for 27.4m, and a single paired stone, next to the circle, may indicate the existence, or plan for, a parallel E'n row, about 4m wide. This setting leads towards the rocky knoll, some 90m away. A low, cobbled causeway led from the circle towards the start of this setting.

at E: a single row of four stones, 15.2m long, runs to the E, and is set off-centre to the circle, perhaps indicating one side of an avenue which, on the basis of symmetry, would be about 6m wide, similar to that projected at the W.

at W: a single row of four stones, 12.2m long, runs to the W, of similar potential for forming one side of an avenue as that seen on the E'n side of the circle.

..added funerary monuments

A small passage grave, of Camster Orkney-Cromarty type (Henshall 1963, 1972), about 8m in diameter, was inserted into the E'n half of the circle, utilising the central pillar, and two stones of the circle within its kerb, these latter framing the entrance. The line of entry to the passage is towards the W, typical for alignment in this group of funerary monuments (e-FIG LB-01 to 21). Although the central pillar obscures the view to the W, it might itself have formed the significant view, or the view could have been considered to have been open more in a ritual, than a physical sense.

There may also be the remains of a low cairn lying just outside the circle, at the ENE, again a probable secondary insertion.

-excavation

Excavations in the 19th century retrieved scraps of cremated bone from the chamber of the central chambered tomb, and in the 1980s Neolithic grooved ware, pottery of Hebridean type, and Beaker fragments were recovered from the site.

-astronomical interpretation

Various interpretations have been placed on alignments at the site, from antiquarian, to modern, most predicated on exact observation of sun, moon, or stars at the horizon, with the assumption that axes were closely defined, and more abstractly astronomical (Burl 1976, 148-152; Burl 1993, 231). A summary of earlier conclusions is as follows:

..Somerville, in 1913, saw the site as a deliberately despoiled astronomical observatory, with alignment of rows based on the following targets:

row	**align**	**towards**
N'n	stellar	Capella rising in December-May, 1800 BC;
W'n	solar	equinoctial sunset;
E'n	stellar	Pleiades in 1750 BC;

Key: **align**(ment);

lunar: two stones placed outside the circle, at the NE, and SW, might have been oriented towards a lunar maximum standstill;

..Hawkins (1966), again found solar and lunar connections, and considered the site to have had calendric functions:

lunar: the N'n latitude of the site would allow observation of a more noteworthy near-horizon lunar event each 18-19 years around 1500 BC;

..Thom (1967, 1971) saw the site as a lunar and stellar observatory:

row	**align**	**towards**
S'n		almost precisely meridianal, at due S;
E'n	stellar	Altair rising in 1760 BC;
N'n	stellar	faint Capella rising in 1790 BC;
N'n	lunar:	looking towards the circle, the maximum limit of setting of the moon along the slope of Mount Clisham, 26km away;

..Burl (1983, 13-15), further pointed out the conflict between proposed stellar dates, and likely dates for construction of the site, around 2400 BC, as based on Beaker pottery. The site is viewed more as a temple than observatory, with a fusion of burial, and ceremonial architecture.

..Ponting (1981, 1982, 1988, 2002), suggested lunar, and solar associations:

lunar: Ponting noted probable use of limiting positions of the S'n moonset, and the infrequent occurrence of S'n moon-skim, as targets for alignment (see Table of Contents: 2c/3d; e-FIGS AS-12 and 13). This more spectacular lunar transit, from rising to setting remaining close to the S'n horizon, as was seen in the early evening on 29 September 2006, and is projected again for 2025, was used as an example. Viewing from the N'n avenue towards the S, the moon rose in the hills to the E of the site, skimmed the horizon, at 2.5^{o} elevation, at due S, passing over the stones of the S'n row as it moved W'ward. The moon reappeared briefly amongst the stones of the circle, then set to the W of the site.

solar: midwinter and summer solstice are suggested as further targets.

..**Ruggles** (1999, 134-136, plan fig. 8.8/ p.134) noted construction of the site about 2900 BC, prior to construction of the small chambered tomb inside. An association with the moon is suggested, with the N'n avenue roughly aligned on moonset at S'n major standstill, and midsummer full moon in the years close to it. The other rows at the E, S, and W were noted as approximately cardinal, with no further conclusion drawn.

-Interpretation in terms of the solar transit

The existing lunar interpretations form a disparate, and inherently unlikely principal basis for recurrent ritual at the site, and certainly appear forced upon it by the need to consider precise events at the horizon, the stellar examples with suggested dates receiving particular criticism.

The variety of such poor candidates for alignment do not reflect the scale, importance and, despite asymmetries common amongst megalithic monuments, the general structural integrity of the site, features which should further reflect some unity of function.

The minimum, skimming transit of the moon at the S, although it might have been noticed at the site, even celebrated, seems too infrequent an event, and too unpredictable in its properties to have formed a major element in ritual (see Table of Contents: 2c/3d). Structurally, no alignments at the site correspond convincingly with lunar positions.

However, the lines of avenues to the E, S, and W, together with a preferred approach from the N, might have served to intersect with the solar transit whilst rising (E'n avenue), at near zenith (S'n avenue), and setting (W'n avenue).

..the main axes

It is suggested here that the main axes of the site reflect predominant and simple solar targets. The broader avenue at the N would have acted as an approach to the complex, and provided a view over the central circle-monolith, on down the line of the S'n row-avenue, towards the rocky outcrop, and onward to the sky at meridian. This view, from avenue or circle, would have allowed active observation of, or passively respected, the sun at zenith, ascending and descending between limiting elevations, at winter minimum, and summer maximum. This might have provided a ready basis for seasonal ritual, especially at seasonal extremes, which could be noted directly, and perhaps more closely, by shadow casting from the monolith at the centre of the ring (e-FIG AS-10), as discussed further just below.

..lateral row-avenues

Lines to the E and W could, at their most general, refer to the rising, and setting limbs of the solar transit but, more specifically, could mark rising, and setting at the equinoxes as being of particular ritual, or calendric significance. In this latter case, they could have been utilised for only a few days per year but, given a broader reference to the rising, and setting limbs of the passing transit, they would have allowed far longer currency in directing ritual (e-FIG SC-03). Even if not directly involved in personalised ritual, these lines could have allowed a more passive type of recurrent reference to the solar transit, that might have acted to increase the general potency of the complex, merely from their presence (see Table of Contents: 02a/2g).

Beyond the general relationship of the main axis to the meridian, and of lateral lines at the E, and W to equinoxes, as noted above, there is nothing to suggest an interest in solstitial axes, nor in limiting positions of the moon (TABLE SC-06).

Approximate positions for solar and lunar events at the horizon, for the latitude of the site, are given in TABLE SC-06 below, as calculated in TABLES AS-01 and 04:

Note: azimuths are rounded to the nearest degree; latitude 58°N is very close to Callanish.

TABLE SC-06 CALLANISH: KEY EVENTS IN THE SOLAR AND LUNAR TRANSIT FOR THIS LATITUDE

solar transit:

area	**mean lat (°N)**	**azimuth (°G)**				**zone: width (°)**			**elevation (°)**		
		midsummer		**midwinter**				**null/**	**min**	**eq**	**max**
		rise	**set**	**rise**	**set**	**trans**	**max**	**perm/**			
		=a	**=b**	**=c**	**=d**	**=(c-a)**	**=(b-a)**	**=2a**			
Callanish	58	040	320	140	220	100	280	80	9	32	55

lunar transit:

area and mean latitude (°N)	**range of azimuths (°G)**								**range**	
	moonrise				**moonset**				**A**	**B**
	max to		**min to**		**max to**		**min to**			
	N	**S**	**N**	**S**	**N**	**S**	**N**	**S**		
	=a	**=b**	**=c**	**=d**	**=a**	**=b**	**=c**	**=d**	**=(b-a)**	**=(d-c)**
standstill		**major**		**minor**		**major**		**minor**		
Callanish	58	024	156	052	128	336	**204**	232	132	76

Key alignments at the site are approximated as follows (e-FIG SC-03):

mid-lines of the avenues and row-avenues

N: 011-191°G; **S**: 180-000°G; **E**: 077-257°G; **W**: 088-268°G;

entry to the passage grave: 272°G;

longer axis of the central circle: 006-186°G.

-shadow casting

Given the generally meridianal axis of the site, and the suggested importance of the seasonal vertical cycling of the sun in the S'n sector of the transit, between maximum and minimum elevations, the calendric possibilities of shadow casting by monoliths might be considered. This seems a valid exercise, if only to discount it as fanciful.

Using the stated heights of the following key monoliths, and the known local elevation of the sun at zenith, for winter minimum, and summer maximum (e-FIG AS-10; TABLE SC-07) it is simple to calculate the length of shadow cast, and determine where it would fall:

s = **h**/tan **e** where **s**: length of shadow; **h**: height of monolith; **e**: elevation of the sun;

TABLE SC-07 Callanish: seasonal shadow casting

		shadow cast		
monolith	**ht**	**WS[9]**	**eq[32]**	**SS[55]**
C	4.8	30.3	7.7	3.4
Tn	3.5	22.1	5.6	2.5
Ts	2.4	15.2	3.8	1.7

Key: **C**: central pillar; **Tn** and **Ts**: the two tall terminal stones of the N'n avenue; **ht** height in metres; **WS** winter solstice; **eq**(uinox); **SS** summer solstice; **[n]** elevation of the sun in degrees, at the stated time.

The shadows cast are short, and hence sufficiently well defined terminally to be visible in strong light, even at their maximum length, during winter solstice. The two terminals would cast shadows beyond known stone structures, but that of the central pillar would correspond. Short summer shadows would fall well within the circle, at the equinox on the circle itself and, fully extended at winter solstice, would fall part way up the avenue. These extremes, then, could have been readily observed as shadows on the ground, as well as directly in the sky, perhaps with the former giving more accuracy for determination, if this was considered important.

Cerrig Duon; Brecknockshire, Wales; SN 8511 2060; Coflein 412996; e-FIG SC-04;

A stone circle, with nearby avenue, and short stone row (Grimes 1963, 183-189).

-location

The circle, and associated features, are located on the more level top of a ridge, that forms part of the W'n flank of the narrow headwater stream valley of the River Tawe, running generally S'ward nearby.

-structures

The circle is ovate, 18.3 by 16.8m, with the axis 160-340°G and, according to Thom (1967), is an egg-shaped ring of class I. The ring consists of about 20 stones, all less than 0.6m high, with spacing slightly wider at the apices, perhaps suggesting a line of transit.

Maen Mawr, a far larger upright stone, 1.8m high, and 1.5 by 0.9m in section, lies 9m to the NNE of the ring, with two smaller stones beyond it, forming a short row, aligned 004-184°G.

Just to the W of the ring, an avenue of small stones, aligned 027-207°G, tapers from about 10m, to 5m towards the SSW, as it ascends the valley side, on an easy gradient, towards the area of the circle. The W'n row is 42m long, and consists of 17 stones, all about 10cm high, and the E'n row is 25m long, containing 12 almost imperceptible stones.

Extant structures may be partially destroyed, and a group of possible cairns, to the N and S of the complex (Coflein 84489), may comprise stonework cleared from the site.

An undated standing stone, about 1km to the NNE of the circle, and on the other side of the valley, may possibly be related, forming part of an extended complex. The line of sight from this stone to the circle is 200°G, and is slightly offset to the W of the general line of the valley.

-astronomical interpretation

Existing astronomical comment on alignment at the site consists of suggesting that the short N'-S'ly alignment might have marked the rising of Arcturus in 1950 BC (Thom 1967, 101), and the general comment that it was 'more probably directional' (Burl 1976, 262).

-reinterpretation of alignment in terms of the solar transit

The plan appears to have been based on a circle over its S'n part, with an extension beyond this to the NW, possibly to include a more formal entry from the area flanking the monolith Maen Mawr.

The complex might well have taken advantage of views to the S, as framed by the valley sides, perhaps towards the solar transit as it crossed, especially when low in the sky. This aspect, towards the meridian, would have allowed convenient year-long observation of the seasonal vertical ascent and descent of the sun between limiting positions, at the winter minimum, and summer maximum, forming a ready basis for recurrent ritual (e-FIG AS-06).

Long Meg and Her Daughters; Cumbria; NY 5711 3721; NMR NY53NE 5, 12199; e-FIGS SC-05 and 06;

This large stone ring is ovate, 110m by 93m, with the N'n side flattened. The ring lies in a shallow depression, on a fairly level hilltop, the immediate ground sloping gently up towards general W, and a single outlier, Long Meg, stands on the skyline at the SW (224°G from the centre of the circle).

There are possible entrance gaps between stones at the SW, and NW. Two further slabs lie at the SW, and define a more formal entrance, outside which there are two more portal stones. Cardinal points might have been stressed in the ring by two massive blocks, placed at almost exact E, and W.

Long Meg, a single outlier 3.7m high, and about 1.2m in average width, decorated with several cup and ring motifs, lies to the SW of centre, about 23m from the SW'n entrance, and 77m from the centre of the circle.

Aubrey reported two large cairns as lying inside the ring, but these are not extant. Little Meg, a kerbed circle, lies about 600m to the ENE of the main stone circle. Stukeley noted a small stone circle, about 17m in diameter, to the SSW but, if it existed, this has not survived.

-astronomical interpretation

Long Meg might have been aligned on midwinter sunset, at about 225°G, when viewed from the centre of the ring. It has been suggested that the line at 063°G, from the ring-centre to the kerb circle at Little Meg, about 600m to the NW, lies towards May Day sunrise, providing a possible association with Beltane (see Table of Contents: 02b/9a), with no comment on the opposite direction 243°G (Thom and Thom 1990, part 1, 32-33).

-reinterpretation in terms of the solar transit

The ring is based closely on a circle over its S'n sector, but is flattened to within this notional circle along the irregular N'n side. The large blocks at the E and W are aligned 086-266°G, to provide a long axis for this partially flattened ring.

A pair of stones in the ring, close to S, may indicate an interest in the S'n arc of the sky, necessarily in solar events elevated above the local horizon, such as the seasonal movement of the sun at its zenith.

An additional marker, for the edge of the permanent zone of the transit (see Table of Contents: 02c/2), might have been provided by the monolith Long Meg. The line from the centre of the circle, notional since this latter point remains apparently unmarked structurally, to this decorated outlier, Long Meg, would coincide well with midwinter sunsets, and is almost exactly solstitial. Given the 3.7m height of the monolith, and the fall of the ground towards the circle, the line of sight to its apex would be at least 5° elevation. This might suggest that transits over the monolith, especially those of lower elevation, might have been relevant to ritual at the site. The more distant, near-zero, horizon to the W, and the River Eden, is not visible from the interior.

Such an alignment would have allowed access to the solar transit, in this SW'n sector, for the entire year, in addition to adding a specific phase of sunsets around the winter solstice. Although passage of the setting sun over the outlier might have provided timing for direct enactment of rituals at the site, it is possible that it also provided passive empowerment of the site, simply by its existence, and automatic operation as a marker of solar passage throughout the cycle (see Table of Contents: Axes/ 02a/2g).

Rothiemay recumbent stone circle; Banffshire; NJ 5508 4872; NMR NJ54NE 6; e-FIG SC-07;

The existing circle, located on the gentle SE'ly-facing slope of a spur, is about 28m in diameter, and contains five surviving stones (four uprights, about 2m high, and a rectangular recumbent block), from a possible total of 12-14, the majority of which were removed in the 19th century. The interior, and surrounding areas have been extensively cultivated.

The recumbent stone is about 4.5m long, 1.3m thick, by 1.8m high, and lies skewed across the diameter at the SW, without surviving flanking stones. The line from the centre of the circle to the mid-point of the recumbent is 222°G, near local winter solstice sunset.

The recumbent is heavily cup-marked, bearing about seven cups on the fairly level top, and 98 on its inner surface, plus six with added ring-marks. The surviving stone to the E of the recumbent has seven cup-marks on its lower outer surface.

The surviving uprights are about 2m high, and are too few to indicate any grading of height around the circuit, as often seen amongst related recumbent stone circles, but the tallest stone is on the SSE, and the shortest at the WNW, which may conform to this pattern.

Geophysical survey indicates that the surviving circle might have formed part of a concentric complex, about 33m in overall diameter, consisting of an outer circle ranged around the surviving inner circle, with a platform of stones lying within this (Aspinall 2006).

Sunhoney recumbent stone circle; Aberdeen; NJ 71592 05701; NMR NJ70NW 55; e-FIG SC-08;

This recumbent stone circle, located on a low summit, is about 25m in external diameter, and contains nine uprights, with a recumbent stone, and two flanking stones at the SW, but has undergone some restoration.

The circle is set out around a low ring-bank forming the edge of a low platform that encircles a roughly circular cairn, some 20m in diameter. Although no kerbstones are visible, the perimeter of this cairn is well defined, and extends out at the SW to meet the back of the recumbent setting. A raised inner platform, 7m in diameter, and 0.3m high, lies within the circle, probably the remains of a ring-cairn. The uprights of the outer circle are equally spaced, and are graded up in height towards the SW, with the lowest on the ESE.

There is some doubt as to the original position of the massive recumbent stone slab, which is now broken, the larger piece being 5.2m long, and 1.4m wide, lying at present with its slightly concave face upwards. It might have fallen inwards, or could still remain in its original position, with the upper decorated surface adopting a more table-like attitude. The stones flanking the recumbent, one 2.1m, and the other 2.2m high, are similar to each other in size, and shape.

There are at least 28 shallow cup-marks on the upper surface of the larger piece of the recumbent, and one on the smaller fragment lying displaced immediately to its NW, with one of the uprights in the circle also bearing cup-marks. If the recumbent lies now, as fallen, then, originally, its decorated surface might have been on the outer side of the circle.

Stone circles: orientable structures

The following table gives a partial listing of those structural features that allow an axis to be determined (TABLE SC-08):

TABLE SC-08 STONE CIRCLES: ORIENTABLE STRUCTURES

This table, containing an interim working list of orientable features associated with stone circles, has been placed as a text file on disc in the folder TABLES_filed, on account of its length, and the partial nature of some data.

Sites are grouped in the following categories:

AVENUES associated with circles;
ENTRANCE FEATURES at circles;
OTHER FEATURES extending from stone circles;
MULTIPLE GROUPINGS of stone circles;
GRADED STONES forming the circuit of stone circles;
OUTLIERS to stone circles;
STONE CIRCLES WITH PLANS OF FLATTENED RING TYPE.

e-FIGURES: combined listings and supporting information

e-FIGS SC-

Specific sites

01 Stone circles: Callanish: stone row and circle complex (Lewis, Hebrides, Scotland): NB 2133: general area

02 and 03 Stone circles: Callanish: stone row and circle complex (Lewis, Hebrides, Scotland): NB 213 330: detailed site

04 Stone circles: Cerrig Duon SN 8520

05 Stone circles: Long Meg and her Daughters: general area NY 5737

06 Stone circles: Long Meg and her Daughters: detailed site NY 5737

07 Stone circles: Rothiemay NJ 5548

08 Stone circles: Sunhoney NJ 7105

09 Stone circles: location and aspect on slopes

10 Stone circles: examples with a monolith to the SW of the circle

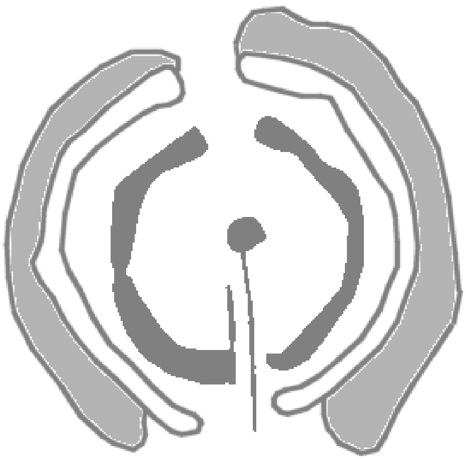
11 Stone circles: diameters of recumbent and axial types

12 Stone circles: Scotland: recumbent type: analysis of alignment from the central area to the recumbent stone

13 Stone circles: Ireland: axial type: analysis of alignment from the central area to the recumbent stone

Section 03f:
The orientation of henges and related monuments in Britain

Section identifier: HE-
SEE INITIAL SECTION:
Access to digital images



Cana (Northumbria)

Summary:
Analysis of a large sample of henges, and hengiform monuments, from Britain indicates general trends for placement of entrance gaps in their circular, or oval embanked perimeters. This is particularly so for sites with opposing gaps, where axes favour the NW'n and SE'n quadrants. The situation is less clear for the remaining henges, where the pattern is more complex.

Axial alignments for the monuments in this general analysis fall into two main groups, the S'ly and the W'ly: many henge monuments, especially those with opposing entrances, show affinities with the S'ly group, funerary monuments with the latter.

It is suggested that this NE'-SW'ly axial line might represent an important direction of S'ly access, and of viewing, across the monument, perhaps related to general observation of the solar transit across the S'n arc of the sky.

The relationship between major axes, the solar transit, and key routes across the locality are discussed for two areas: henges in the Milford Basin (Northumberland), and in the Swale-Ure valley (North Yorkshire).

the following topics are discussed:

-**general properties**, function, and grouping of henge monuments;

-**large henge enclosures**;

-closely placed, and more dispersed **linear groups** of henges, the latter including detailed study of the Milfield basin, and Swale-Ure areas;

-henges in the **area of Salisbury Plain** are considered, with Stonehenge given particular attention;

-supplementary information on **key sites.**

Introduction

General properties

A general outline of henge monuments, in terms of form, distribution, function, and date is well given in Pitts 2000; Burl 1991, 2000, and Harding 2003, with more specific details of many in Harding and Lee 1987.

For the purposes of this analysis of orientation, it is sufficient to say that henges are embanked enclosures, generally circular, or oval, displaying a range of perimeter-types, but with the ditch characteristically placed inside the bank. Entrance gaps are often single but, when double, then these are usually opposed. Sites range from smaller hengiform monuments, with affiliations amongst round barrows, to large henge enclosures, their diameters varying from 10 to 450m. A range of internal structures has been identified, including timber, and stone circles. Function appears strongly related to ritual, and there are some funerary associations, with evidence for more permanent occupation generally light, discontinuous, and of non-standard, domestic type. Distribution occurs throughout Britain, and construction is generally later Neolithic, with sites often continuing in use for extended periods. A working list of sites providing data for this analysis is given in TABLE HE-19.

Function

Evidence suggests that the function of these sites, although strongly linked with ritual activity, varies in complexion considerably over the size-range, from small enclosures with funerary associations, to very large monuments containing a variety of internal structures (TABLE HE-01). Although the form of gapped perimeter is a unifying feature, it might therefore be risky to treat axial alignment generally, as if for a more homogeneous group.

TABLE HE-01 THE SIZE RANGE OF HENGES

	typical area (ha)	**examples from**	**see**
large henge enclosures	8-21	mainly Wessex	TABLE HE-03
standard henges	1- 5	Swale-Ure catchment	Table of Contents 03f/4b
hengiforms	<1	Milfield basin	Table of Contents 03f/4a

Although the large henge enclosures stand somewhat separately, in terms of their area, the remaining smaller henges, and hengiforms, grade downward in size without clear division. The term 'standard' is used in this analysis only to distance a site from either extreme.

-the **smallest hengiform sites**, with ring-ditch broken by one, or more entrance gaps, can contain burial deposits, and timber structures, any central mounding indicating a relationship with round barrows. The diversity of features, and absence of clear evidence for an outer bank at many sites, the characteristic of a henge, makes this a somewhat residual group, merging as it does with barrows, one containing hybrid monuments;

-at other sites, **'circle-henges',** such as Stonehenge, Avebury, and Woodhenge, the interiors are dominated by internal rings of stone, or timber, and whilst retaining a funerary aspect, these would appear to be involved in broader ritual;

-the largest sites, forming a mixed group of **'large henge enclosures'** (TABLE HE-03), although less completely explored within their interiors, seem to contain more open space, in addition to discrete structures, and may, therefore, have had more of a communal function, perhaps seasonal.

Grouping

Henges can occur in relative isolation, but several discrete groupings, seen within various localities, provide a valuable opportunity to examine possible inter-relationships, and consistencies between alignments. Such clusters of henges in the Milfield basin (Northumbria), and Swale-Ure area (N Yorks.), and those in the Stonehenge area (Wilts.), have been examined here in detail. as particular Study Areas (see Table of Contents: 03f/4a, 03f/4b, and 03f/5).

A further division can be made between those henges that are dispersed over a localised area, and those few cases where several lie in close proximity (TABLE HE-02). In the latter case, instances of linear siting, triplets at Thornborough, N Yorks (e-FIG HE-08), and at Priddy, Mendip (e-FIG HE-07), introduce another, inter-henge axis for discussion.

TABLE HE-02 LOCALISED GROUPS OF HENGES

	#	dist	type	e-FIG	phot
closely grouped henges				**HE-**	**HE-**
linear		**[metres]**			
Priddy	3	50-70,350	st	07	
Thornborough	3	50	st	08	21
weak linearity					
Knowlton	3	100-150	st	09	10-11
non-linear					
Mayburgh	3	300-400	st	-	
dispersed henges					
linear		**[km]**			
Milfield basin	12	0.5-1.5	hf	10-20	
Swale-Ure area	9	<1-5	st	21-28	
non-linear					
Stonehenge area	5	1.5-3	st lhe	29	

Key: # number of sites; **dist** mean inter-henge interval, taken edge to edge, in metres for closely grouped henges, and km for dispersed groups; **type** (of henge), based on size: **lhe** large henge enclosure, **st** 'standard' type, **hf** hengiform.

Case Study: large henge enclosures

Introduction

Certain henge enclosures are far larger than the norm, at over 8ha in area, and are best grouped somewhat separately, as 'large henge enclosures', here abbreviated as **LHEs** (TABLE HE-03):

TABLE HE-03 LARGE HENGE ENCLOSURES: GENERAL PROPERTIES

		NGR	area (ha)	sh per	#	entr azim	int	ave	lrb	e-FIG HE-
Durrington Walls	Wilts	SU 1501 4375	21	so d-b	3	175, 308-128;	tcs h	1	no	02
Avebury	Wilts	SU 1026 6996	18	sc d-b	4	068-257; 332-164;	scs	2	yes	01,37
Marden	Wilts	SU 0910 5825	16	so d-b	1	353; 024; S-W open	rbs	-	yes	03
Mount Pleasant	Wilts	SY 7099 8992	10	sc d-b	4	358; 099; 138; 252;	tc rb	-	yes	04
Wauluds Bank	Beds	TL 0615 2460	8	sc b-d	?1	?345	?	-	no	05
site with possible affinities										
Duggleby	NYorks	SE 8804 6688	11	c d		?gap at S	lrb	-	yes	06

Note: henges are ranked in order of decreasing area out to the known limits of the perimeter.

Key: NGR National Grid Reference; **sh**(ape): **sc** **s**ub-**c**ircular; **so** sub oval; **per**(imeter), from inner to outer side: **b**(ank) **d**(itch); **entr**(ance gap), **#** number; **azim**(uth [°G] from the centre of the interior to the centre of the entrance, with hyphenated values marking opposed locations; **int**(erior structures): contains **sc(s)** stone circle(s), **tc(s)** timber circle(s), **rb(s)** round barrow(s), **h**(uts); **ave**(nue externally); **lbr** large round barrow associated.

Evidence suggests that LHEs, like Wauluds Bank, Durrington Walls, Marden, and Mount Pleasant, might have been established on sites of earlier, unenclosed settlements of the mid Neolithic. At all of these sites, the area that came to be enclosed, and which is not occupied by known ritual structures, is sufficiently large to have provided considerable space suitable for gatherings, for purposes of ceremonial or trade, and for temporary residence, if not for direct settlement. Each of the LHEs listed here occurs in a stream-side location, with two, Marden, and Wauluds appearing to include them in their perimeters, perhaps instead of a bank and ditch along certain sectors.

This relationship is closer for LHEs than for the group of henges as a whole, and may suggest certain advantages to transportation and economy.

Further details of function are scant, but recurrent finds of later Neolithic grooved ware may represent one manifestation of some complex of ritual that included such artefacts.

On a wider mapping, Avebury, Marden, and Stonehenge-Durrington Walls lie on a broadly N'-S'ly line, of little likely relevance to discussion of this same line for smaller regional groups, such as Milford and Swale-Ure (see Table of Contents: 03f/4a and 03f/4b respectively). It is mentioned here only to dispose of it as a probable artefact.

Large mounds of round barrow type associated with these henges

In addition to the structures over interior areas as listed in TABLE HE-04, there are a few cases of abnormally large, circular mounds associated with over half of the LHE's (details: see section: round barrow cemeteries: Table of contents: 03h/3f). These mounds may have some significance in discussing alignment at henge sites, and within the locality. The only association of more obvious significance may be the siting of Silbury Hill, due S from the henge at Avebury itself (see Table of Contents: 3f/2e(i)).

TABLE HE-04 LARGE ROUND BARROWS ASSOCIATED WITH LARGE HENGE ENCLOSURES

henge	barrow	NGR	dimensions (m)			azim	notes
			mound	ditch			
			diam	ht	od		
Avebury	Silbury Hill	SU 1002 6853	137	35	160	190	1.25km km S of henge
Marden	Hatfield Barrow	SU 0918 5820	70	7	105	069	blocks much of interior
	S'n 'barrow	SU 0901 5803	55	-	75	200	on interior: ?not a barrow
Mount Pleasant	Conquer Barrow	SY 7078 8989	30	4		263	on outer perimeter bank at E
Knowlton centre	Great Barrow	SY 0252 1028	66	6	118	-	just to the E of central henge
atypical ?related enclosure							
Duggleby		SE 8804 6688	36	6	none		at centre of enclosure

Key: dimensions: diam(eter); **ht** height; **od** outer diameter of any ditch; **azim**(uth of the barrow from the centre of the henge [°G].

None of these sites has been investigated in sufficient detail, although larger-scale excavation has been carried out at Silbury Hill, and Duggleby Howe.

Alignment at large henge enclosures (LHEs)

Certain of the LHEs (Marden, Wauluds Bank) differ in plan from the more usual circular form, although most others retain it (Avebury, Mount Pleasant, Durrington Walls). The former pair should perhaps be considered separately, in terms of placement of entrances, and potential axes of alignment based on them. In general terms there is some evidence for a N'-S'ly emphasis in the location of entrances at Wauluds Bank, and Marden, more clearly so at Mount Pleasant. However, Avebury, and Durrington Walls conform more closely with the NW'-SE'ly line common amongst smaller henges with opposing entrances. As a general conclusion, these sites appear to emphasise the N'-S'ly axis, with at least the capacity for ritual use of the S'ly view, towards the permanent zone of the solar transit.

-Avebury

This largest, and most complex LHE has two pairs of opposing entrances, opening generally S'ward to enter avenues, thus linking the site with the surrounding landscape, other monuments, and funerary areas. The S'ly arc enclosed by these avenues, with Silbury Hill on its mid-line, may be of significance in relation to ritual use of the solar transit (e-FIG HE-37).

-Mount Pleasant

This large enclosure contains evidence for two pairs of almost opposed entrance gaps, those at the N and S far clearer. The N'ly entrance opens towards the nearby river, the S'ly open down-slope, with lateral gaps in the perimeter opening along the ridge of the hill on which the site lies. The placement of these entrances appears very approximately cardinal, whether by design is unknown. The smaller, timbered, henge-like monument within the interior of the LHE was entered at the S, again supporting the importance of this general line, as seen at other henges. A large mound, the Conquer Barrow, lies outside the W'n perimeter, overlapping the outer edge of the bank.

-Marden

The axis of this incompletely ovate enclosure is N'-S'ly, and there is a clear entrance gap at the N, here with gaps in both bank, and ditch indicating a clear line of approach, entry, and view, or transit, S'ward over the interior. There is no perimeter along the S'n side, a stream forming the limit of the interior. The N'n third of the interior appears more open, with much of its central zone occupied by the large Hatfield Barrow, lying over the E'n interior, the S'n third less obstructed by the hengiform-barrow at its W'n margin. Viewing from the N'n entrance, these two monuments would frame the line running almost due S over the unenclosed S'-SW'n side, towards the meridian of the solar transit, this perhaps significant. A small cemetery of round barrows, and a hengiform monument lie beyond the henge, about 600m to the SSE of its centre, and also on this generally S'ly line, a relationship between monumental axis and terminal funerary areas seen at many other sites, such as Stonehenge (e-FIG HE-31).

-Wauluds Bank

This D-shaped LHE might have incorporated an adjacent stream as part of its perimeter, as also seen at Marden. The N'n entrance is clear, but any others remain unknown.

-Durrington Walls

The main entrances, opposed at the NW and SE, are supplemented by a minor gap at the S, opening towards that of adjacent Woodhenge. The main axial line corresponds with a slight valley within the enclosed area, and heads NW'ward towards a major ridge, likely to have been a significant route, with the SE'n gap opening towards the nearby river Avon.

-Duggleby

A platformed mound lies at the centre of an enclosure, gapped at the S, possibly providing a vantage point for views in this direction, towards the permanent sector of the solar transit, perhaps of some ritual significance. This atypical site has some affinities with henges.

Alignment of henges and large barrows

Certain LHEs have large barrows within, or near them (TABLE HE-03). Silbury Hill might have provided a significant S'ly line of sight from the LHE at Avebury, and at Duggleby the central, platformed mound might have allowed similar S'ward observation. At the other LHEs there is no pattern: at Marden the barrow lies within, and at Mount Pleasant it lies adjacent.

Details of the large henge enclosures listed in TABLE HE-03

Key: NMR National Monument Record: identifier.

Note: areas for henges are quoted for the entire site, out to the known limits of the perimeter.

Avebury; Wiltshire; sub-circular; inner ditch, outer bank; diameter 450m maximum; interior area 11.5 ha;
entrances: 4, two opposed pairs, 068-257°G, and 164-332°G; SU 1026 6996; NMR 220746; e-FIG HE-01; phot HE-01 to 04;
bibliography: Burl 1979; Malone 1994; Bewley *et al.* 1996; Gillings *et al.* 2000, 2002, 2008; Pitts 2001; Pollard 2002; David 2008;

The complex consists of a large henge enclosure, with two stone avenues and their associated terminal structures leading from it, with the large mound of Silbury Hill, a small stone circle, and enclosure sites also lying within its vicinity. Various clusters of round barrows occupy surrounding hills, and their slopes. General information about the complex can be found in Burl 1979; Malone 1994; Pollard and Reynolds 2002, with a sample of recent fieldwork in Gillings *et al.* 2008.

-the henge enclosure; *SU 1026 6996;*

The henge enclosure occupies a fairly level area, adjacent to the River Kennet, and is surrounded by a series of low hills.

..The **perimeter** was constructed in at least two stages: the initial bank was 5m wide, and 2.5m high, with some evidence for an inner ditch, and it enclosed an area similar to that defined by the extant perimeter. This bank sealed later Neolithic pottery, and developed a turf-line sufficient to indicate that an interval occurred, before enlargement of the perimeter, in its second, and final stages.

This later bank and ditch is rounded in plan, but with a straighter sector in the SW'n quadrant. Its massive ditch was very steep sided, and is estimated to have been 17m wide at the top, 10-14m deep, and separated by a 2.5m wide berm, now largely eroded away, from the external bank, this latter originally up to 6m high, and 20m wide. Ditch segments are deeper, and the bank higher, and wider when adjacent to entrance gaps. The current undulating top of the bank might have been an original feature.

The bank would have been sufficiently high to block ready views into, and out of, the interior. The embanked circuit was constructed as a series of straighter sectors, each about 50-65m long. Four entrances break this perimeter, at the NNW, ENE, SSE and WSW, three of which have been shown by excavation to be 15-20m wide, and original to the henge.

..The **interior** contains three main settings of standing sarsen stones: a circle, following the inner edge of the ditch, with two smaller circles placed more centrally, one just to the SE of centre, the other to the NW.

..The **outer circle,** about 350m in diameter, follows the inner line of the ditch, and so is likewise facetted, showing shorter straighter lengths. Its largest stones flank the NE'n, and SW'n entrances, partially blocking the view, and the route to the interior of the henge. Stones in the SW'n quadrant are some 0.5m higher, and are less regular than those in the NW'n.

..The **inner circles** are similar, being about 100m in diameter, and containing 25-30 sarsen stones. These circles survive incompletely, the NW'n circle extant over its S'n sector, and the SE'n circle over its N'n, raising the possibility that these settings might have been more open arcs.

The NW'n circle is slightly oval, with a NE'-SW'ly axis, and surrounds The Cove, a setting originally of three large slabs, ranged around three sides of a square, open towards the general NE, with the suggestion made for this facing summer solstice sunrise. Geophysical survey indicates a possible façade of small stones flanking the front of The Cove, and of outliers to the NE, SE, SW, and NW.

The SE'n circle is more circular than the NW'n, with a large stone, The Obelisk, now destroyed, formerly at its centre, this apparently a columnar pillar 2.5m in diameter, and 5.5-6m high. The remaining setting includes a smaller stone, 11m to the S, and a linear placement of nine small stones, 32m long, 15m to the W, perhaps forming a façade for the Obelisk, with possible affinities to the forecourts of long barrows.

A large **posthole** lay in the S'n entrance of the henge. Geophysical survey indicates a possible **multiple timber circle,** about 40m in diameter, adjacent to the NE'n inner stone circle, possibly its precursor, comparable to those at Durringon Walls and Mount Pleasant henges.

Crop-marks indicate a small oblong, **double ditched enclosure** in the NW'n quadrant, about 25m long, aligned E'-W'ward, and with a central pit, a site perhaps similar to the oval barrow at Radley (Oxon.).

The level of **finds,** and general detritus over the site are low, which indicates general cleanliness, and rules out more intensive domestic-style occupation, possibly reflecting the sanctity of the site, and similar to the situation at Stonehenge, but contrasting with Woodhenge, and Durrington Walls, where levels are higher. At Avebury, the SW'n sector was kept very clean, but more material, including flint, animal bone, plus some human bone, was scattered over the NW'n. Occasional ritual deposits of antler, including picks, plus animal bone, occur in the bank, ditch, and in stone holes.

-Avenues

A largely extant, and partially reconstructed avenue of standing stones, the West Kennet Avenue, runs for about 2.3km to the SE, from the SE'n entrance of the henge enclosure to the complex of stone and timber circles at The Sanctuary. Antiquarian records, and excavation, indicate the existence of a second avenue, running SW'ward from the SW'n entrance, towards Beckhampton, and on perhaps for a similar distance to that covered by the West Kennet Avenue. Structurally, both avenues appear comparable, at 15m wide, and consisting of paired, unmodified stones 1.5-3m tall, set every 20-30m. The avenues might have acted to connect significant parts of the surrounding landscape, and different monuments, to the central henge complex.

..The West Kennet Avenue; SU 1033 6973 to SU 1183 6807;

The West Kennet Avenue runs SE'ward for 2.3km, in a sinuous course, from the SE'n entrance of the henge enclosure, along the side of a dry valley, then climbing Overton Hill, to terminate at the complex of circles at The Sanctuary, and near adjacent round barrow cemeteries.

The N'n sector, adjacent to the henge, has been restored where required, with many stones re-erected, to form a line of 100 paired stones. Paired stones of different shapes have been interpreted in terms of male and female imagery. Antiquarian records suggest that a cove-like setting might have existed partway along the avenue. The azimuth of the main surviving sector is 149°G, and between end-points 141°G, both as viewed from the henge.

Just beyond the SE'n entrance at Avebury itself, the course is markedly kinked, for reasons that are not clear, but such a feature might have acted to obscure the entrance, or could represent the fragment of an earlier line. The existence of straighter sectors in its course may indicate staged construction. The avenue narrows somewhat, with broader spacing evident within lines, as it approaches its terminal at the Sanctuary.

...The Sanctuary; SU 1184 6804; (Pollard and Reynolds 2002, fig. 40/p. 107)

This complex of concentric circles, the outer 35m, and the inner 13m in diameter, lies at the SE'n terminal of the West Kennet Avenue. Its earliest phase dates to about 3000 BC, roughly contemporary with construction of the cove in the N'n inner circle at the main henge, becoming formally linked with this central enclosure when the avenue was built, about 2400 BC.

An outer stone circle, 40m in diameter, contains three larger edge-set stones, that mark its entrance from the end of the West Kennet Avenue. Two stones at the NW lie in the direction of Avebury. An inner stone circle, 14m in diameter, is concentric. Five of six post-rings, ranged around a central post, lie within its line, with one outside, at 20m diameter. These timber rings may indicate a roofed, lintelled, or open structure. The diameter of the timber rings are similar to those at other henges: Woodhenge, Durrington Walls S'n circle, and Mount Pleasant site 4.

Within the post-rings, radial gaps connect the small central space with the exterior, one line NW'-SE'ward, the other NE'-SW'ward, indicating passage-ways, diametric, and at right angles, conforming with the entrance to the outer stone circle, and the line of the avenue. Within these passages, blocking structures might have restricted access (Gibson 2005, fig. 55). The timber rings are of phased construction, and recent re-excavation indicates that posts were set, and withdrawn, on at least five occasions (Pitts 2001).

Much animal bone was scattered at the site, perhaps indicating feasting, plus significant flint-work. There appears to have been increased deposition of debris towards the rear of the monument, opposite the entrance. Deposits of artefacts were made, and a small quantity of human bone is present, but does not suggest a mortuary function for the complex.

..The Beckhampton Avenue; SU 100 699 [area] to SU 0890 6930, and perhaps on towards around SU 076 687;

This stone avenue is now largely destroyed, but evidence from field investigation, and from antiquarian records, suggests that it ran in a curving line SW'ward from the henge enclosure, along a slight valley to reach, and perhaps extend beyond The Longstones (SU 0890 6930), some 1.25km distant, the only monoliths surviving along the line.

The azimuth of the main projected sector, from Avebury to the Longstones, is 242°G, and that for the possible extension further to the SW is 245°G, taken between possible end-points, and as viewed looking away from the henge.

Excavation near the Longstones revealed evidence for a short, 10-stone length of avenue, similar in width, and in stone spacing to the West Kennet Avenue, but work failed to find any evidence for significant continuation towards the SW, as indicated in early records. The Longstones might have formed part of a cove-like setting, of the type seen in the N'n circle within the henge enclosure itself, and suggested as possible within the West Kennet Avenue. Details of broader geophysical survey are given in David 2008.

On the basis of antiquarian records, it has been suggested that the avenue might have continued beyond the Longstones, for another kilometre or so, to ascend the ridge towards West Down, an area containing small round barrow cemeteries. Such a terminal funerary area would be compatible with that seen for the West Kennet Avenue, and at many other types of monument, such as stone rows, and cursuses, where there is also a preference for placement towards the S-SW.

..finds:

Both avenues appear to have been kept quite clean of debris. However, for the West Kennet Avenue the following deposits were made:

stone-hole	
5b:	deposit of human bone;
25a:	fragment of human skull;
15b:	large fragment of later Neolithic grooved ware;
31b:	fragment of stone axe;
25b:	inhumation, possibly primary;
34—37b:	concentrations of flint debris in, and around the holes.

-other monuments in the Avebury complex

..The Beckhampton enclosure (Pollard and Reynolds 2002, fig. 34/p. 97)

The Beckhampton Avenue crosses an earlier enclosure, oval, 140m by 110m, and 45m wide, with a broad entrance gap at the E. The segmented ditch is shallow, irregular, and flat-bottomed, some 2m wide, and 1m deep, its line discontinuous, especially at the SE, and it might have had an internal bank. There are no obvious features internally.

Deposits of animal bone in the ditch, especially where it flanks the main entrance, may indicate intermittent feasting, rather than domestic occupation. Levelling of the site, and infill of the ditch with bank material, followed deposits of antler, and bone, re-cut into ditch sediment.

The enclosure may represent a late survival of the type of causewayed enclosure seen earlier in the Neolithic, and the presence of two adjacent long barrows may also be significant here.

..Silbury Hill; SU 1002 6853; (Whittle 1997; Pollard and Reynolds 2002, fig. 45/p. 119)

The large conical mound of Silbury Hill lies 1.25km to the SSW of the henge enclosure, on a bearing of 190°G from the centre of Avebury (e-FIG HE-01). The site is partially visible from the area of the henge, from the Sanctuary, and from the Beckhampton Avenue.

Various incursions into the mound indicate the following main structural phases for growth of the circular mound (TABLE HE-05):

TABLE HE-05 Silbury Hill: main structural phases

	mound (m)				ditched	
phase	**diam**	**ht**	**top**	**int struc**		**diam**
1	38	5	rounded	?	no	
2	80	20	rounded	?	yes	120
3	137	37	flat	compartmental	yes	160 max

Key: **diam**(eter); **ht** height; **int**(ernal) **struc**(ture).

phase

1: a stake-revetted, and possibly sarsen-edged mound of chalk rubble and gravel, with added turf; there is no indication of a burial, or any other central deposit; 2900-2500 BC;

2: an enlarged mound, with encircling ditch, now lying under the subsequent phase 3 mound;

3: a massive enlargement of the existing mound, reinforced with chalk revetting, and embayment; a large, irregular quarry ditch around the mound varies from 20m wide at the S, out to 150m at the W, and is over 6m deep, where sectioned; the level summit forms an elevated platform, similar in area to that of the Sanctuary;

The conical mound of the final phase was constructed as a series of stacked drums of chalk rubble, each about 5m high, decreasing in diameter with ascent, battered inwards for additional stability, and containing radial walls forming compartments, infilled with packed chalk. Sarsen stone within the mound may indicate internal stone structures, of currently unknown type. It is possible that the stacked structure included a spiral track for ascent to the level summit. Recent investigation suggests that the sides of the mound were shaped as a series of polyhedral levels, providing spiral access from the base.

The site has produced few finds, but animal bone, predominantly of cattle, has been recovered from the top of the mound, and from Neolithic levels within the ditch, perhaps indicating debris from feasting.

Current dating evidence suggests that construction probably started around 2400 BC, and a dated antler-pick from near the summit suggests that it was completed by about 2500 BC, pre-dating the avenues at Avebury by about a century.

The site belongs to a small group of very large round barrows from Wessex and Yorkshire (see Table of Contents 03f/2d), but is by far the largest member. Examples at Marden, and Mount Pleasant henges are similar in size to Silbury phases 1 and 2, but far smaller than phase 3.

It has been suggested that the final phase at Silbury Hill might have been modelled on the passage tombs of the Boyne Valley, and Brittany, traditions which had long lapsed by the time that Silbury was completed (Whittle 1997, 147–9; Thomas 2002, 217).

..Falkner's Circle (SU 1074 6943)

A small stone circle, about 36m in diameter, perhaps originally containing 10-12 stones, but with only one now surviving, lies just to the N of the West Kennet Avenue, and about a third of its length from the henge.

..West Kennet palisaded enclosures (Whittle 1997; Pollard and Reynolds 2002, fig. 42/p. 113; Gibson 2005 fig. 34/p. 49)

Two larger, ovate enclosures, defined by palisades of contiguous timbers, lie adjacent to the River Kennet, downstream from Avebury, and near the line of the West Kennet Avenue.

enclosure:

..1: sub-circular, with partly double palisade-lines 25-30m apart, enclosing about 4.2ha, and lying either side of the river; the sector to the N of the river is formed by a single palisade, and appears less continuous; the interior contains shallow scoops, and hollows, containing animal bone, mainly pig and cattle, flint-work, and later Neolithic grooved ware; finds here, and generally over the complex, do not appear to indicate routine domestic occupation, and use;

..2: an oval, defined by a single palisade, enclosing about 5.5ha; some short radial palisaded lines are visible within the perimeter, and one longer line runs externallyd to a palisaded circle at the SE; three small circulard or oval, double concentric enclosures 30-40m in diameter lie within the interior, their outer rings palisaded, the inner formed by post pits; one of these smaller sites contains a timber circle;

These enclosures are similar to others of the period, as at the Mount Pleasant henge, and Forteviot (Perth) (Gibson 2005).

Bronze Age Avebury

After completion of the main structural phases, use of the complex continued into the earlier Bronze Age. Deposits of bone, and artefacts were made in accumulating ditch silt, including careful placement of unburnt human bone in the ditch around the S'n entrance. Burnt detritus also occurs in lower secondary silts, with inclusions of animal bone, some human bone, pottery, and flint.

The inhumation of an adult female, in the ditch, was accompanied by worked flint, and a carved chalk ball. Some later Neolithic to earlier Bronze Age burials also occur at the foot of stones, with examples from the West Kennet Avenue, the Sanctuary, and the cove at the Longstones.

Dating evidence

The detailed sequence, and dating of structural elements at the site are not well understood. Finds of pottery from various contexts suggest a later Neolithic date for the main period of construction. Construction of the main earthwork, and stone circle, probably occurred between 2900 and 2600 BC.

Staged establishment of the main henge enclosure, during the first half of the 3rd millennium BC, was the main primary event in the area. During the mid to later 3rd millennium, stone settings developed within the interior, although some of these may be earlier in the sequence at the henge. Construction of the complex seems to have been strongly additive, rather than made to a single design.

The mid 3rd millennium saw addition of key monuments, such as the Sanctuary, Beckhampton enclosure, and perhaps the West Kennet enclosures, over areas that came to be crossed, in the mid to later millennium, by the West Kennet, and Beckhampton Avenues. There is evidence for staged development, and modification of these avenues.

The site at Silbury Hill was established at about the same time as the henge, but became greatly enlarged during the mid-later 3rd millennium, at the same time as monumental activity intensified in the area.

Use of the complex continued well into the earlier Bronze Age, but does not appear to have been as intense.

Further dating evidence for the complex is summarised as follows:

-henge

The earliest bank seals later Neolithic pottery, but its precise date is uncertain. The ditch of the subsequent major enlargement of the perimeter was dug 2900-2600 BC, possibly in the earlier part of this range, and coeval with Stonehenge 1.

The stone settings within the henge are difficult to date in detail, but lie within the radiocarbon range 2500-1700 BC, and hence seem broadly contemporary with other major stone settings in the area, like the avenues. OSL (optically stimulated luminescence) dating of the massive rear stone at the Cove suggests a date of around 3000 BC, which would place this feature very early in the sequence.

-avenues and associated structures

Construction of both avenues lies within the period 2600-2300 BC, and they were added to the mature henge enclosure, rather than being a feature of the initial design.

..the West Kennet Avenue is later than the area of late 4th to early 3rd millennium BC activity that it crosses, and the sector adjoining the Sanctuary belongs the to the mid 3rd millennium, or slightly later. A sherd of later Neolithic grooved ware from stone hole 5b appears to have been fresh when deposited, and several Beaker-associated burials are clearly secondary to erection of the stones.

..the Sanctuary

The site has produced later Neolithic grooved ware, and flint-work; a date for construction around 2500 BC is likely.

..West Kennet palisaded enclosures

The two main enclosures appear to have been used in succession, enclosure 1 slightly earlier, at 2500-2200 BC, with enclosure 2 at around 2200 BC.

..the Beckhampton Avenue is later than the levelled Beckhampton enclosure that it crosses.

Later Neolithic grooved ware is associated with the avenue, and construction 2650-2500 BC is probable.

..the Beckhampton enclosure

Radiocarbon dating indicates construction 2650-2500 BC, supported by later Neolithic grooved ware from the base of the ditch, suggesting that it was operational when the henge enclosure was well established.

..Silbury Hill

The mounding in phase 1 has provided a radiocarbon date of 2900-2500 BC, and construction of the phase 3 ditch produced one of 2500-2350 BC, the absence of distinct turf-lines suggesting little interval between the three phases.

Burial in the Avebury complex

There are relatively few burials known from the complex itself, with no evidence indicating use of the site for routine burial during the later Neolithic, and Bronze Age. Scatters of human bone from the interior, and from the ditch silt of the henge indicate funerary activity of some sort, either functional disposal of selected individuals, or rituals relating to use of human bone in ancestor-related rituals. Scattered bone from the Sanctuary does not support its use as a mortuary structure. Minor deposits of human bone occur in stone-holes of the West Kennet Avenue, as does a possibly primary inhumation.

An inhumation in the ditch of the henge, with minor grave-goods, is exceptional. There is evidence for occasional burial next to standing stones, as in the West Kennet Avenue, at the Sanctuary, and the cove at the Longstones. Crouched inhumation burials, with Beaker associations, occur at the base of four standing stones in the West Kennet Avenue, all male, and placed on the NE'n side of the monoliths.

Around the area of the henge there are instances of flat graves associated with, or covered by, sarsen stones, some with Beaker associations.

Development of barrow cemeteries in the area of the henge complex

Use of the area for barrow-burial was increasing by the later 3rd millennium BC, with early examples of Beaker-related inhumation, and cremation becoming the dominant rite by the mid 2nd millennium BC. The suggestion of a ring-like disposition of round barrows around the henge, perhaps indicating definition of some symbolic boundary (Woodward and Woodward 1996, fig. 2/p. 280) does not stand close scrutiny, and is discussed further elsewhere (see Table of Contents: 03h/2h).

Astronomical interpretation

Burl (1976, 329-330) discusses various solar, and lunar alignments for component structures. Ruggles (2000, 131-139) suggests that there is little convincing evidence for astronomical symbolism amongst the general layout at Avebury. In discussing coves, box-like placement of stone that occur here, and within some other circles, a possible resemblance to forecourts of chambered tombs is noted. A function in formalising an outward view has been suggested, with some tentative evidence for an interest in the moon, as opposed to the sun.

These rather limited, and unconvincing suggestions are remarkable, since the layout of the complex lends itself so readily to a solar interpretation.

Views

The varied topography of the area provides different viewing opportunities within the complex, between its elements, and outward over the surrounding area and its monuments, both from the main henge, and progressively along its avenues.

Marden; (English Heritage: Hatfield earthworks); Wiltshire; sub-ovate; inner ditch, outer bank, 500m across N-S, 350m across E-W; area 15.5ha; entrances: 1, at 353ºG from the centre; perimeter open at S to W, but there is some aerial evidence for a bank in this sector; SU 0910 5825; NMR 215179; e-FIG HE-03; phot HE-12;
bibliography: Wainwright *et al.* 1971; Field *et al.* 2009;

The site lies on low ground, just to the NE of the River Avon, now just a stream that curves around its S'n and W'n sides, some 200m away, but perhaps originally closer, and flanked by marginal wetland along this quarter, where bank and ditch appear absent.

The sub-ovate enclosure, now much reduced by ploughing, appears incompletely enclosed along its SW'n side. The remaining course is defined by a ditch, originally 2m deep, and 13.5m wide, with an external bank, now spread up to 35m wide, and 1m high, broken by a 14m wide entrance gap at the N. An apparent gap, crossed by the modern road at the NE, and a weakness in the line of bank and ditch along the central W'n side, flanking the Hatfield Barrow, could indicate other points of access. Given these three gaps, the circuit divides into four separate lengths, two each along the N'n, and the W'n sides, perhaps indicating staged construction. Excavation around the known entrance has indicated the presence of a broad, gravelled 'ceremonial' road leading towards the river (on-line release: extant 2014).

Excavated finds confirm a generally later Neolithic date for the main construction of the henge enclosure, that occupation does not appear to be of permanent, and fully domestic intensity, and that, prior to abandonment, the site was cleared of detritus. Stone-working tools, and numerous fragments of sarsen, suggest processing of stone at the site.

-structures known from the interior

..Hatfield Barrow (SU 0918 5820; NMR 215176),

A large round barrow, now almost levelled after its collapse following antiquarian and agricultural activity in 1807, occupies much of the W'n central zone of the interior. Records from the earlier 19th century suggest a height of 7m, and perhaps 70m diameter for the barrow.

Recent geophysical survey, over its ditch (Field *et al.* 2009), confirms an outermost diameter of up to 100m, and variable width up to 25m. The barrow itself, at about 70m diameter, with a central, more upstanding core, is separated from the ditch by a narrow berm.

Early excavation recovered wood ash, animal bones, and two small deposits of human bone, perhaps representing secondary inhumations.

..a monument of uncertain interpretation (SU 0901 5803; NMR 215182)

A structure that may be hengiform, or round barrow-related, survives at the SW'n margin of the main enclosure of the henge, as a sub-circular depression, 40m in diameter, surrounded by a bank some 80m in external diameter, and about 1m high, with the possibility of an entrance gap at the NNE. This depression contains a small mound, about 25m in diameter, set just off-centre, now much spread by ploughing (Field *et al.* 2009).

Recent excavation of the encircling bank located the rammed chalk floor of a later Neolithic hut, containing a sunken hearth-like feature, with some associated domestic midden debris, perhaps of specialist occupation, linked with operation of the monument.

..a circular timber structure 10.5m in diameter has been reported just inside the NE'n entrance.

-sites in the vicinity, perhaps related

A small cemetery of five ring-ditches lies beyond the main henge enclosure, about 600m to the SSE of its centre, near its main axial line. The group shows some indication of linearity along the weak N'-S'ly ridge on which it lies. A small hengiform monument (NMR 1002029), with a broad penannular ditch, 5-14m wide, and with a 12m wide gap at the NE, is located about 200m to the SE of the cemetery. A curving line of eight pits occurs just outside its entrance.

Durrington Walls: this site is included below, in the case study for the Stonehenge area.
bibliography: Wainwright and Longworth 1971; Parker-Pearson 2007.

Mount Pleasant; Dorset;
-outer enclosure; sub-oval; inner ditch, outer bank, *340-365m* across; area 9.6ha; entrances: 4, at 099, 138, 252, and 358°G; SY 7099 8992; OS Outdoor Leisure map 15; NMR 453935; e-FIG HE-04;
bibliography: Wainwright 1979, 1989;

-inner post-ring structure [site 4]; circular; only the ditch surviving; diameter 50m; area 0.2ha; entrances: 1, at 009*°G*; NMR 453935;

The site is located over the summit of the W'n-most of a linked pair of low hills, overlooking the narrow valley of the River Frome, just to its N.

The plough-eroded site is partially extant as an earthwork, and comprises a ditch, and outer bank, defining an irregular sub-oval area of external span about 350m, and area 10ha, its perimeter interrupted by four entrance gaps.

Partial excavation within the interior revealed a substantial timber structure, consisting of five concentric post circles, set within a ditch about 43m in diameter, this broken by an entrance gap at the N. Within the post-rings there is some indication of diametric passage ways running N-S, and E-W, with some evidence for blocking features, which might have restricted access, as seen at the Sanctuary, Avebury (Pollard 2005, fig. 55). In a subsequent phase, the timber structures appear to have been replaced by central cove-like setting of standing stones.

The main earthworks of the enclosure were themselves supplemented by construction of a palisade trench, enclosing an area of about 245m by 270m, within, and concentric to the inner side of the ditch, and which included two narrow entrance gaps, defined by massive post-holes.

Analysis of aerial photographs has revealed more detail, including:

..at least one additional entrance gap, in both bank and ditch, on the SW'n side;

..a possible earlier phase of enclosure marked out by pits, seen crossing this gap;

..evidence that part of the henge bank was heightened at some stage, in the E'n and SE'n sectors;

..traces of an external ditch, on the S'n and E'n sides;

..and a possible approach to the E'n entrance, from the River Frome to the NE.

Fragments of later Neolithic grooved ware were recovered from primary levels in the ditch of the henge, with Beaker sherds in later fill, and a decorated, flat bronze axe from the N'n terminal of the ditch. Evidence indicates construction of the first main phase about 2000 BC.

Around 1700 BC, the timber structure within the henge enclosure was replaced by a stone cove, open to the S, with outlying monoliths, and a strong, defensive timber palisade, with entrances at the N and W, was constructed around the hill-top, enclosing about 4ha. Associated with the palisade, and cove, were numerous Beaker sherds, and stratified pottery from the enclosure ditch indicated continued occupation of the site until about 1000 BC.

At some stage, before 1800 BC, the ditch of the enclosure was enlarged at the SW'n entrance, and the Conquer Barrow, now much disturbed, was constructed on the outer bank of the henge.

In addition to the principal excavations (Wainwright 1979), recent aerial and geophysical survey over the henge, and its immediate area, has added detail to the interior, and identified a broad linear anomaly, leading externally from the enclosure towards the river, interpreted as an avenue (Barber 2014; Linford *et al.* 2019, 2020).

-The Conquer Barrow; SY 7079 8990; NMR SY78NW 3, 453934;

This round barrow abuts the perimeter of the large henge enclosure, on its W'n side, at the highest point of the hill. Partial excavation suggests a mound, 30m in diameter, and 4m high, with a level top 7m across, located on top of the henge bank, this latter about 4m high. The barrow is surrounded, at least on its N'n and E'n sides, by a ring-ditch, with at least one causeway.

The relationship between barrow and henge enclosure is not clear. It has been argued that the barrow ditch may pre-date, or be broadly contemporary with, the ditch of the henge, and thus be later Neolithic in origin, with the extant mound perhaps representing later enhancement of a multi-phase monument, post-dating the enclosure.

Waulud's Bank; Bedfordshire; ?semi-circular; inner bank, outer ditch; 350m by 250m; area 8ha; entrances: ?1, at 345°G; TL 0615 2460; NMR 359652; e-FIG HE-05.

A moderately well preserved, semi-circular earthwork enclosure, 350m N-S by 250m E-W, about 5.5ha in area, consists of a bank, and external ditch, with a probable entrance gap at the N.

The site is located on a W'ly-facing slope, and is enclosed, on all but the W'n side, by a semi-circular bank, with traces of an outer ditch, broken at the N by a possible entrance gap. The perimeter on the W'n side might have been formed by the River Lea, its marginal wetland, and the sloping river-bank. At the NW, across the river, there is a short section of broad bank and ditch, which seems to continue the line, but does not turn S'ward to complete the formal perimeter.

Two trenches, excavated across the bank and ditch, recovered small quantities of prehistoric pottery, including later Neolithic grooved ware, from ditch fill. A small hollow, outside the ditch, was tentatively identified as a Neolithic hut. Further excavation showed that the ditch was flat-bottomed, 1.8m deep, and 9m wide, and the inner bank still stood to 0.9m high, and bore a turf revetment in front, but no entrance was located. Again, sherds of grooved ware were found in the lower ditch fill, and on the old ground surface under the bank. Many flint implements of Neolithic, and Bronze Age type have been found in, and around the enclosure.

The site is generally regarded as a large henge enclosure, on the basis of excavated data, and by analogy with similar sites at Mount Pleasant (Dorset), Marden, Durrington Walls, and Avebury (Wilts.). Reversal of the sequence of inner ditch, and outer bank, normal to most henges, is anomalous.

Atypical sites

Duggleby causewayed enclosure, and large round barrow; North Yorkshire; segmented ditch without banks; diameter 370-380m; interior area 11.3ha; two very wide opposing gaps, one probable at the S, one less so at the N, would have allowed access along a line running 148-328°G; a large round barrow lies at the centre (Duggleby Howe); SE 8866; e-FIG HE-06.
bibliography: Gibson and Bayliss 2009; Gibson 2012;

The site lies on the lower slopes of a spur forming the S'n side of an E-W stream valley.

The enclosure shows some similarities with large henge enclosures, in size, and shape, presence of larger opposed gaps for access, at the N, and S, in date, and in the presence of a very large round barrow, in this case at the centre. However, it differs in the smaller size and irregularity of its ditches, and in the absence of associated banks. Further details of the complex can be found in Gibson and Bayliss 2009; Gibson 2010, 2012.

-Duggleby Howe; round barrow without a ditch, lying central to the enclosure, diameter 38m, height 6.5m; SE 8804 6688; NMR SE86NE 2;

Initially, a series of contracted inhumations, associated with prestigious artefacts, of middle Neolithic type, were covered by a primary mound, 23m across, and 3.4m high, constructed around 3000 BC. The mound was later aggrandised substantially, when the circular enclosure was added, its surviving height still about 6m, and diameter 36 m. The profile of the mound is conical, with a platformed top, but some of this levelling could result from construction of a mill-stance over the summit.

Early excavation revealed a central grave shaft, 2.7m deep, containing an inhumation at its base (adult, ?male), and a Neolithic bowl, with other skeletons of adults, and children also present in the fill. A nearby grave contained two adult inhumations, one with a skewer-pin, and five petit tranchet derivative arrowheads, the other a rectangular, polished flint knife. Over the central pit lay an adult male skeleton, with an antler mace-head, flint axe-adze, and lozenge-shaped arrowheads. All of these burials lay under a core of earthy chalk, about 15m in diameter, which itself contained five, or more skeletons, of adults, and children. Inserted into this core, and in the chalk rubble above, lay at least 53 cremated deposits, with bone pins, and petit tranchet derivative arrowheads. This core was sealed by an envelope of sterile chalk, enlarging the diameter of the mound from 23 to 38m, and its height from 3.4 to 6.5m.

-the circular enclosure

The sequence continued with addition of a penannular ditched enclosure, about 380m across, concentric with the mound of the barrow. The causewayed ditch is 7.8-5.3m wide, and 2.8m deep, without associated banking, and its construction provided chalk rubble for expansion of the mound lying at its centre. Carbonised material from the top of primary silt gave radiocarbon dates between 2500 and 2300 BC. Associated antler picks, and flint-working debris, may link this date with continuing construction of ditch segments, later in the sequence.

The site, therefore, has a long development. The barrow might only have reached full size in around 2400 BC, almost a millennium after the burial sequence started, in the central pit grave (3555-3415 cal. BC: 1 sigma), and almost 500 years after the construction of the primary mound (2915-2840 cal. BC: 1 sigma) (Gibson and Bayless 2009; Gibson 2012).

A magnetically enhanced gully, Roman in date, running along the outer side of the enclosure ditch, follows most of the line of the enclosure, but opens up at the W to produce a wide, funnel-shaped access. The gully is circular in plan at the N, as if following some earlier line, one not clear from the known later Neolithic ditching. In contrast, the gully crosses the S'n gap in the ditch, with a straighter line, as if no marker line existed. This might suggest that the S'n sector of the enclosure was more open than along the N'n side, where some more ephemeral, partial closure has not registered in the record.

Case study: linear groups of henges

Introduction

Cases where henges of similar properties appear in very close proximity, and lie along a common axis are rare, and hence general conclusions about axial alignment are limited by small sample size (TABLE HE-06):

TABLE HE-06 LINEAR GROUPS OF HENGES: GENERAL PROPERTIES

site		NGR	#	axis	°G	sim	reg	conf	e-FIG HE-	phot HE-
Thornborough	N Yorks	SE 2879	3	NW	144-324 SE	high	high	yes	08	21
Priddy	Som	ST 5453	4	NNE	015-195 SSW	high	high	?yes	07	
linearity very weak:										
Knowlton	Dorset	SU 0210	3	NNW	160-340 SSE	low	low	no	09	10-11

Key: NGR National Grid Reference; **#** number of component henges; **axis**, best fit for all members; **sim**(ilarity in plan between component henges; **reg**(ularity of inter-henge axis); **conf**(ormity between the common inter-henge axis, and lines of intra-henge access).

The clear NW'-SE'ly inter-henge axis, as seen in the triplet at Thornborough, reflects the line of opposed entrances at each of its component henges, and is of a direction more widely seen amongst other henges with opposed entrances (e-FIG HE-39; Table of Contents: 03f/4b). This line may also be very weakly present at Knowlton, between three of the four henges, and related enclosures, but with little other regularity of line, or similarity between sites.

There is no clear evidence to indicate whether these linear groups were established as an entity, or by progressive addition of individual henges, and no evidence for any sequence in the series. In any of these cases there seems clear evidence for repetitive construction behaviour, of a type suggested amongst other monuments, such as stone rows (see Table of Contents: 03d/8g), but here on a far larger scale. The generally N'-S'ly line of the axis may also be significant, with the latter sun-ward direction being of particular emphasis, as has been suggested more widely in this analysis for other monuments with a similar disposition (e-FIG CO-01). At Priddy, a concentration of round barrows, including two impressive linear cemeteries, lying on hilltops just to the S, and near the axial line, are worthy of comment. Similar spatial relationships have been noted amongst linear monuments, and barrows elsewhere, such as at certain cursus sites (see Table of Contents: 03c/13b and 03h/2i), and at stone rows (see Table of Contents: 03d/8d and e-FIG SR-09. Such inclusion of funerary monuments within an important line of view might have been considered auspicious. However, no similar situation is evident at Thornborough.

Details of individual sites

Key: NMR National Monument Record: identifier.

Note: diameters and areas for henges are quoted for the entire site, out to the known limits of the perimeter.

Priddy; Somerset;
The site is located over the lower slopes of an E'-W'ly stream valley, between hills to the N, and S.

Four approximately circular enclosures, of similar size and structure, thought to be henges, lie adjacently on a NNE'-SSW'ly axis, except for a gap of about 350m, between circles 4 and 3, sufficient for a fifth enclosure, but of unknown content. The general centre-to-centre axis for circles 1-3 is **018-198°G**, and the best fit for circles 1-4 is **015-195°G,** since circle 4 is slightly off-line. Perimeters, and interiors have been much disturbed by agricultural, and other activities.

Although these sites have been widely discussed as henges, placement of the ditch outside the bank, in a reversal of the usual sequence at known henges, and some structural details of the perimeter, may indicate parallels amongst enclosures with more agrarian function (Tratman 1967; Lewis and Mullin 2011). However, the replication of these closely similar monuments, and their linear arrangement, do not suggest that straightforward economic factors were behind their construction. Such linear grouping is also to be found at the Thornborough henges.

Circles are listed from N to S as follows, retaining the established numbering system, 1-4:

-circle 4; circular; inner bank, outer ditch; diameter 192m; area 2.9ha; entrances: 1, at ?190ºG; ST 5420 5355; NMR 1041422;

The perimeter of this enclosure is formed by a bank, with external ditch that survives around some two-thirds of its circuit, and a single entrance has been suggested. This missing W'n sector has not been investigated by excavation, but test boring may indicate absence of defences, and suggest the site was left incompletely defined. Several mounds within the interior may be barrows. The site has produced no dating evidence.

-circle 3; circular; inner bank, outer ditch; diameter 190m; area 2.8ha; entrances: 1, at 191ºG; ST 5409 5302; NMR 1041421;

A bank up to 7m wide, and 1m high, encloses the site, with the external ditch about 5m wide, and 1m deep. There are four gaps in the circuit, but that at the SSW, facing the NNW'n entrance of Circle 2, has been suggested as original, but this has not been confirmed by excavation. No dating evidence has been recovered from the site.

-circle 2; circular; inner bank, outer ditch; diameter 184m; area 2.7ha; entrances: 1, at 016ºG; ST 5401 5279; NMR 1041413**;**

The enclosure is enclosed by a bank, up to 6m wide, and 1m high, its external ditch about 0.5m deep. The gap at the NNE has been suggested as original, but this has not been confirmed by excavation. No dating evidence has been recovered from the site.

-circle 1; circular; inner bank, outer ditch; diameter 187m; area 2.7ha; entrances: 1, at 013ºG; ST 5395 5255; NMR 1041406;

A bank, 1m high, with an external ditch about 6m wide, and 1.2m deep, define the enclosure. Partial excavation shows that bank was constructed of turf, laid over a stone core, with evidence for a line of sizeable posts on both sides, spaced 2m apart, possibly with intervening stakes. A shallow trench, about 0.15m wide, perhaps for marking out the line, runs concentrically with the ditch, and about 9.5m outside the core of the bank. Four pits underlie the spread of the terminal for the E'n bank, the larger ones interpreted as having once held stone uprights. The circuit contains several gaps, but only the NNE'n was shown by excavation to be an original feature. No dating evidence has been recovered, and no features are known in the interior. Absence of dating evidence, and the external position of the ditch, makes identification as a henge speculative.

-associated monuments

A few weakly identified round barrows may lie within Circle 4, and others in the vicinity of the enclosures. Two impressive linear round barrow cemeteries lie on hilltops about 0.5 and 1km to the S of the site (e-FIG HE-07).

Thornborough; North Yorkshire

Three sub-circular henges, of similar size, type of perimeter, and axis between opposed entrances, lie adjacently on a NW'-SE'ly axis (best fit: 144-324ºG, the central henge lies slightly off-line). Further details of the site are given in Thomas 1955; Vatcher 1960; Harding 1997a-b, 1998a-c, 2000; Goodrick and Harding 2000.

All of the monuments lie on terraced, fluvio-glacial deposits, along a slight N'-S'ward decline towards the River Ure.

-N'n henge; sub-circular; bank with inner and outer ditches; diameter 250m; area 4.9ha; entrances: 2, opposed pair at 144-324ºG; SE 2805 8005; NMR 1043117**;**

A bank forms the perimeter of the enclosure, with ditches lying on its inner, and outer sides. The outer ditch is narrower, and segmented, appears variable in width from 4-16m, and is widest around the SE'n entrance, with some evidence present for an outermost bank. The inner ditch is formed by a series of angular sectors. Two entrance gaps occur, at the NW, and SE, these 69m and 21m wide respectively.

-central henge; sub-circular; bank with inner and outer ditches; diameter 255m; area 5.1ha; entrances: 2, opposed pair at 145-325ºG; SE 2854 7946; NMR 1043119;

The perimeter bank has ditches on its inner, and outer sides, the former with squared terminals, the latter narrower, and segmented. The inner ditch is V-sectioned, 4.7-6.9m wide at the top, 1-1.3m deep, and 0.5-1.3m wide at the base. Under the bank, 13 small stake-holes, in two irregular rows, suggest a timber setting, aligned on a shallow stone-filled feature.

Two opposing entrance gaps occur, at the NW, and SE. Small-scale excavation of the inner ditch, bank, and interior produced mainly flint-work.

-S'n henge; sub-circular; bank with inner and outer ditches; diameter 239m; area 4.5ha; entrances: 2, opposed pair at 147-327ºG; SE 2895 7885; NMR-UI 1043120;

A bank forms the perimeter, with ditches on its inner, and outer sides, the former with squared terminals, the latter narrower, and segmented. Two entrance gaps occur, at the NW, and SE. Small-scale excavation of the outer ditch showed at least three phases of construction, light fencing associated with the bank, and timber uprights on the causeway of the entrance gap.

Associated monuments

-N'n henge:

..two **concentric ditches,** with internal diameter about 31m, of unknown interpretation, but possibly round barrow-related, occur as a crop-mark near the NW'n entrance;

..a short undated **pit alignment** extends NW'ward, just outside the SE'n side of the henge;

..the terminal, and sides of a **possible cursus,** aligned NW'-SE'ward, lie just to the E of the henge;

..a line of round barrows, and an undated pit alignment, lie to the E of the N'n and Central henges;

-central henge:

..a **cursus,** aligned NE'-SW'ward runs under the SE'n perimeter of the henge;

-S'n henge:

..a double **pit alignment** of Neolithic date, oriented NNW'-SSE'ward, lies just to the W of the henge, and has a round barrow near each end (e-FIG PA-01).

Knowlton; Dorset

Four sub-circular henges, of different sizes, lie close together, along a general NNW'-SSE'ly axis (best fit: 160-340ºG), and are located in the upper stream valley of the River Allen, on a low E'-W'ly ridge of gravel, across which they take a more N'-S'ly line. The henges lie within a considerable necropolis, consisting of many round barrows, which stretches generally NE' to SW'ward, along the E'n bank of the stream, the henges perhaps forming its focus (e-FIGS RB-130 to 133).

-N'n henge; sub-ovate; inner ditch, outer bank; N-S 78m, E-W 72m; area 0.56ha; entrances: 1, at 176ºG; SU 0230 1045; NMR 621827;

The plan of the enclosure, now largely destroyed by ploughing, has been recovered in more detail by magnetic gradiometry, although it remains unexcavated. The inner, ovate ditch is surrounded by a horseshoe-shaped bank, leaving a wide entrance gap open towards the S.

-The Old Churchyard; sub-circular; inner bank, outer ditch; diameter 62m; area 0.3ha; entrances: ?2, at ?050, and ?180°G; SU 0224 1037; NMR 621834;

This unexcavated enclosure, extant only as a crop-mark, further explored by magnetic gradiometry, consists of a sub-oval bank, with an outer ditch about 62m in external diameter. The location of any original entrance is uncertain, but there is a gap in the outer bank at 050°G, and perhaps signs of another at 180°G, where there may be a gap in the ditch, but not apparently in the bank.

-Church henge; sub-ovate; inner ditch, outer bank; diameter 132m; area 1.35ha; entrances: one opposed pair at 041-221°G; SU 0239 1028; NMR 621822;

This, the best preserved of the three henges, consists of a slightly oval inner ditch, about 10m wide, aligned weakly NE'-SW'ward, and contains opposed entrance gaps on this axis. An external bank, about 10m wide, and 1m high, runs in two arcs, at the NW, and SE, leaving broad gaps at the NE, and SW. The perimeter appears to have been constructed as a series of straighter sectors. A medieval church lies within the interior.

-S'n henge; ovate; inner ditch, outer bank; diameter 240m; area 4.5ha; entrances: ?1, at 203°G; SU 0246 0997; NMR 621819;

The site has been heavily ploughed along its SE'n side, and damaged by building on the NE'n. This is the largest of the henges, and is fairly regularly ovate, defined by a ditch, separated by a narrow berm from an outer bank, currently 20m wide, and 0.3m high, where it survives.

Geophysical survey has located one small entrance gap at the S, and further details of the bank and ditch. A section across the bank, and ditch, at the SE revealed possible parallel marker-gullies, each 1.5m wide, and 0.3m deep, lying 5.5m apart either side of the truncated bank, and separated from a funnel-shaped ditch 15m wide, by 5.5m deep, by a 9.5m wide berm (Gale *et al.* 2012).

An undated trackway passes the SW'n side of the henge, appearing to contain more gaps in the area of the S'n entrance, suggesting possible lateral access. Aerial photography shows that this double ditched feature extends from the Allen valley, past the S'n henge, on towards the hills, to the SE of the site.

Two large iron-rich sarsen stones have been ploughed out of the S'n henge, their exact provenance unknown, one with a design of four concentric rings pecked into its centre on one side (Lewis *et al.* 2000).

Associated monuments

A very large round barrow, the Great Barrow, lies immediately to the E of Church Henge, and rivals it in extent. The site remains unexcavated, but its margins have been delimited by geophysical prospection (see Table of Contents: 03f/2d).

-Knowlton Great Barrow; Dorset; SU 0254 1028; NMR SU01SW 106, 621861;

This large round barrow lies about 100m to the ESE of the N'n henge, its mound 41m in diameter, and 6m high, surrounded by two concentric ditches. The inner ditch is separated from the base of the mound by a 4.5m wide berm, with the outer ditch about 122m in diameter, and 11m wide. Crop-marks suggest an entrance causeway through the outer ditch, on the NE'n side. The margins of the barrow have been heavily eroded by ploughing, as has much of the surrounding complex of monuments.

Another large barrow, which lies S of the henge complex, at SU 0233 0967, measures about 40m across its extant mound, and 60m across the crop-mark of its ring-ditch.

The third largest barrow, lying at about SU 0205 0943, is represented by a ring-ditch some 50m across. Just to its N, a line of three ditched barrow mounds, now flattened, extended SSW'ward from the henges. Since they survived sufficiently to be plotted on Ordnance Survey maps they might have been more substantial than the majority of barrows in the necropolis, which are now visible only as eroded ring-ditches.

Dispersed linear groups of henges

There are two areas in N'n England which contain dispersed groups of henges, and hengiforms, sited in an approximately linear NW'-SE'ly disposition, and for which single, and double entrance gaps display lines of access in this general direction: the Milfield-Wooler plain, in Northumbria, and the Swale-Ure valley, in North Yorkshire.

In the former area, there is evidence for possible association between some of the hengiforms, and an avenue-trackway, of uncertain date, and function. In the latter area, the henges may be ranged along a natural line of transit through the area. The relationship between the S'ly trend apparent for axes at such henges, and the line of such routes, is therefore worth investigation.

Such henges may form part of a multi-monument structure, linked physically by a route of ceremonial significance, all constructed to some underlying plan, expressing the importance of a particular axis. Alternatively, such henges might simply have accumulated along a particular route, with their lines of internal access conforming more passively to an existing thoroughfare, passing generally S'ward for reasons of topography.

Case study: hengiform monuments in the Milfield basin (e-FIGS HE-10 to 20)

Summary

Many members of this close grouping of at least 12 hengiforms lie on, or near, a ditched avenue, that runs generally N'-S'ward, perhaps together indicating a formalised line of transit, across an area of some ritual significance. There is nothing to distinguish the relative importance of directions within the axis in this area, but a S'ly, sun-ward emphasis is possible, this particular line found widely amongst monuments of other types, as noted elsewhere (see Table of Contents 03d/8g).

Introduction

The Milfield-Wooler plain lies in N'n Northumbria, near the English-Scottish border, around the junction of two separate tributary systems, the Till and the Glen. These rivers then flow on NW'ward as the main River Till, to join the more substantial Tweed, which flows NE'ward to the sea, at Berwick upon Tweed (e-FIG HE-10 and 11).

The Till-Tweed valley contains significant drift deposits of gravel, overlying the Carboniferous limestone that forms bedrock for the area. The zone around the Till-Glen junction is particularly well endowed with such fertile, and tractable gravel substrate, and consequently formed an important focus for prehistoric settlement. A further attraction for the area might well have been its clear definition, with an approximately rectangular area of some 12km^2 sufficiently limited by natural features to form a coherent territory. Neolithic and Bronze Age sites are certainly well represented in the area, with a particular concentration of hengiform monuments present. This well-defined regional group of smaller hengiforms provides a clear contrast to far larger henges as, for instance, those examined in the Swale-Ure study area.

On the N'n, E'n, and S'n sides of the area, the river, and its flood plain would have provided a ready margin. The W'n side is protected by steep hill-slopes of igneous rock, which also present a further barrier beyond the river at the S. The main river valleys, extending E'-SE', W', and NW'ward from this rectangle, provide ready lines of access beyond the main area of settlement. Access to the area from the N, the most open direction of approach, is constrained by a narrowing between hill-slope and river, to form a clear N'n corridor, and such constriction is seen again for the line of access at the SW. Access to the enclosed area from the SE seems more problematic, since it would have involved crossing the river, and its flanking wetland. However, a narrowing of alluvium at central-S suggests an easier route for fording, one followed by the modern main NW'-SE'-running road, which is shadowed in part by the line of a far earlier drove-avenue, and by the line of hengiform monuments. The topography of the area seems, therefore, to provide a natural axis of potential influence on the distribution, and layout of sites and monuments, oriented generally NNW'-SSE'ward, rather than more E'-W'ward. Further details of the area, and its sites, are given in Harding 1981; Miket 1985; Harding and Lee 1987; Passmore *et al*. 2002; Passmore and Waddington 2009.

Henges and the avenue (e-FIGS HE-10 to 20)

The group of twelve small henges in the area, although badly damaged, and incompletely explored, hence affording only very partial data do, however, seem to belong amongst hengiform-barrows rather than more typical, larger, 'standard' henges, with their less dedicated funerary connections (TABLE HE-07).

Taking the distance across the outer limit of the ring-ditch as a common index of size, only three of the most definite sites are larger than 40m, and hence beyond the diameter of ditches typical for most round barrows. Five sites have clear funerary functions, with the rest unknown. Coupland, towards the N'n end of the study area, is the largest hengiform, with the smaller site at Akeld lying towards its S'n end. Flodden and Haugh, if they are indeed hengiforms, lie in the corridor approaching the study area from the N, and would complete a fairly even spacing between larger hengiforms.

Most of the hengiforms lie along the general line of access, as proposed above for transit across the area. Part of this line is more formally followed by the Milfield-Marleyknowe avenue, the traceable line of which appears to run from the vicinity of the small hengiform at Milfield S, passing through the largest at Coupland, to end just short of the small site at Marleyknowe (e-FIGS HE-12 and 18). The dating, and relationship of this avenue with the hengiforms is not well established, and its function as a ceremonial avenue, or more practically as an agrarian drove-way, is open to discussion. Better basic information on the function of the Coupland hengiform would certainly help here: if the enclosure was funerary and ritual in nature, rather than operating as a stock-enclosure the avenue could hardly have been for dedicated pastoral use.

The N'-S'ly line of hengiforms, reinforced by the positioning of their entrances, and the line of the avenue, which may, or may not be linked to them, compares well with trends in alignment seen more generally amongst similar henges (e-FIGS HE-39 and 41). This may indicate a ritual interest in the S'n sky, as discussed more fully elsewhere in this analysis (see Table of Contents: 02c/2i). However, it could simply reflect more passive conformity with a line of transit through the area, and with the general direction of the valley. Yeavering is interesting in this regard, in that the axis of its opposed entrances, in contrast to those in the main group, conforms more with the E'-W'ly side valley in which it is situated, suggesting the importance of local conditions.

TABLE HE-07 General properties of hengiforms in the area

Note: sites are ranked by size, using the external diameter of the ring-ditch, the only consistently available feature. In most cases, clear evidence for any external bank is lacking, since these features have been ploughed out.

site	**NT-**	**diam**	**shape**	**seq**	**acc**	**# entr**	**exc**	**bur**
Coupland	9433	78	ov	d b ?d	yes: 163-343	2 opp	yes	-
?Flodden	9235	59	ov	d &	no: 096-276	?2 opp	no	-
Akeld	9530	52	ov	d &	yes: 120-?300	1/?2 opp	no	-
Marleyknowe	9432	42	circ	d &	yes: 056-236,292,152	2 opp, 2 sing	no	-
?Haugh	9236	40	ov	- &	yes: 060	1	no	-
Milfield S	9333	32	ov	d &	yes: 299	1	yes	?
Ford	9337	25	?circ	d &	yes: 330 [?-150]	1 or ?2opp	?no	-
Milfield N	9334	23	circ	d &	yes: 010-190,245	2opp 1 sing	yes	?
Yeavering	9230	23	ov	d &	no: 104-284	2opp	yes	?
Ewart Park	9531	20	ov	d &	yes: 130-310	2 opp	no	-
Whitton 1	9334	10	-	-	yes -	4	yes	yes
Whitton 2	9334	9	-	-	yes: SSW	1	yes	yes

Key:
?[site name]: identification as a hengiform remains tentative;
diam(eter in metres to the outside edge of the outer ring-ditch: approximate and based on NMR data; **shape**: **ov**(ate), **circ**(ular); **seq**(uence of banks [**b**] and ditches [**d**], taken from inner to outer limit, **'&'** denotes outer elements of the perimeter are not established; **acc**(ess through entrance gap(s) generally N-S, with the axis given in °G); **# entr** number of entrances: **opp**(osed), **sing**(le); **exc**(avated); **bur**(ial activity significant): **-** unknown; **?** possible.

The settlement pattern in the study area

The main line of access is marked not only by the hengiforms, but also by round barrows, with a particular group at the S'n end of the N'n corridor, as it opens out into the study area proper. A few other barrows flank the line as it extends S'ward, and a major band of settlement lies just off-centre to the NW.

Rock art

The line of limestone hills that flanks the area along the NE contains three discrete concentrations of earth-fast rock exposures, carved with various motifs, including cups and rings. The main area of rock carving lies around NU 0131, with lesser groups some 6km to the NW, around NT 9637, and 3km to the S, around NU 0128. Although such motifs lack direct dating, there is supporting evidence from the type in general to suggest that many may be attributed to the Neolithic, and earlier Bronze Age, roughly contemporary with the period of discussion for the study area itself, its hengiforms and round barrows. It is possible that these elevated locations, with their particular chosen aspect, allowed ready graphic expression of ritual activity, by communities based on the river gravels below (see separate discussion of rock art: Table of Contents: 03g).

It is noteworthy that these concentrations of rock-cut motifs occur on the W'n side of the valley, in positions affording good views towards the S-SW'n sector, rather than occupying the hill-slopes at the E and S, with their predominantly E'ly and N'ly aspect. Rock-type may be a supplementary factor in this preference, being limestone on the E'n side, and harder igneous on the W'n. Pastoral preference for this sun-ward side of the valley might also have influenced distribution of motifs, since general activity came to be naturally concentrated here.

Key sites in the area: further details

Akeld; NT 9588 3070; HER 2140, NMR NT93SE 12; e-FIG HE-13;

An unexcavated, sub-oval, crop-marked ditch, of external diameter about 50m NE-SW, by 45m NW-SE, and about 7-10m wide, broken by two opposed entrance gaps at the NW, and SE, encloses an area about 35m in diameter. Within the ditch, and concentric with its inner edge, a ring of evenly spaced pits encloses a further ring of nine smaller pits, ranged around a central pit, possibly a grave.

Coupland; NT 9405 3308; HER 2025, NMR NT93SW 28; e-FIG HE-14;

Sited on level ground, a substantial sub-oval ditch 4-5m wide, 75m NW-SE, by 70m SW-NE in internal diameter, contains opposed 15m wide entrances, at the NNW, and SSE, one with possible gate-posts, and lies within crop-marked traces of an outer bank. Partial excavation of the henge extended to include the Milfield-Marleyknowe drove-way, or avenue (see below), defined here by two narrow side-ditches that pass through the entrances of the site. The monument has produced pottery, and radiocarbon dates from the earlier Neolithic. The nature of activities carried out at the site, the function of the drove-way, and its temporal relationship with the henge remain unclear.

Ewart Park; NT 95681 31716; HER 2153, NT93SE 25; e-FIG HE-15;

Sited on level ground, an unexcavated sub-circular ring-ditch, of maximum external diameter 20m, containing two opposed entrances gaps, wider at the NW than the SE, encloses an area 12.5-16m in diameter, and contains a large near-central pit.

Three pit alignments lie nearby, one partially excavated, and producing later Neolithic pottery (NMR NT93SE 27); also an undated sub-rectangular enclosure (NMR NT93SE 24).

Flodden Camp; NT 9237 3510; HER 1829, NMR NT93NW 22; e-FIG HE-16;

An unexcavated, sub-oval, possibly henge-like enclosure, about 55m across, sited on the slope of a spur, with opposed, everted entrances, at the E, and W, survives partly as a crop-mark, and as an earthwork. Its slighter ditch forms the innermost of several that comprise a presumed Iron Age fort, into which it might have become incorporated, but its date, function, and relationship to the fort remain debatable.

Ford; NT 9332 3716; HER 19684, NT93NW 95; e-FIG HE-17;

The N'n half of a wide, crop-marked ring-ditch, unexcavated, but probably a small hengiform monument, about 25m in external diameter, with a causeway on the N'n side, is now covered, over its S'n half by a plantation of trees. Several possible pits are visible within its interior.

Haugh; NT 9294 3655; HER 1818, NMR NT93NW 11;

A possible hengiform monument, about 40m across the ditch, with an entrance gap at the NE, remains unexcavated. An oval, crop-marked ring-ditch, externally about 45m SW-NE, by 35m NW-SE, contains a well-defined causeway at the NE. The site is unexcavated, and identification as a henge remains uncertain.

Marleyknowe; NT 9422 3226; HER 2024, NMR NT93SW 27; e-FIG HE-18;

Sited on level ground, a segmented, crop-marked, sub-circular ring-ditch, 2-6m wide, and of about 33m external diameter, appears to be divided into at least nine segments, but contains a more distinct causeway, about 5m wide, at the SW. There is some indication of an external bank, persisting as a crop-marked feature, and its possible presence may account for the deflection of the Milfield-Marleyknowe avenue, or drove-way, which turns to avoid it here by about 8m. The unexcavated interior of the henge appears to contain four large pits, in roughly rectangular arrangement.

Just beyond the henge, the Milfield-Marleyknowe avenue, or drove-way, turns sharply to the SW, and fades, perhaps marking some termination. A round barrow lies near the junction.

Milfield North; NT 9338 3490; HER 2010, NT93SE 13, e-FIG HE-19;

A small hengiform structure, about 23m across the ditch, with an inner ditch, outer bank, and outermost possible post-ring, with a N'-S'ly line of entrance gaps in the ditch, contains within it a post-ring, ranged around a group of possible grave-pits. The site has been partially excavated, its date later Neolithic to earlier Bronze Age.

Sited on level ground, the partially excavated hengiform structure consists of a roughly circular, flat-bottomed ditch, 23m in external diameter, 4-5m wide, and about 1.3m deep, and encloses an area about 15m in diameter. Opposed entrance gaps occur in the ditch, at the N and S, with a lesser gap at the SW, dividing the ditch into three segments. This ditch lies within traces of an outer bank, beyond which a ring of pits, perhaps post-bearing, formed an outer circle, about 38m in diameter.

Within the interior, and concentric with the ditch, lies a setting of 30 small, evenly-spaced pits, forming an oval, with an entrance gap at the N, just off-set from the causeway in the ditch. Although no evidence for posts in these pits was found, the structure is reminiscent of other post-rings under round barrows of earlier Bronze Age date, although, at this site, no evidence of central mounding was noted. However, the central area did produce four larger possible grave-pits. A central pit produced char, a complete pottery vessel, and perhaps evidence for a timber frame, or coffin-like structure. A second pit contained fragments of pottery, and two slabs, placed as if marking the head, and foot of a burial, of which none was found. A third pit contained an empty cist, with a cover-slab, and a fourth contained char, but no other finds.

Sherds of Neolithic, and Beaker pottery came from the ditch, and central pits, with barbed-and-tanged arrowheads also associated with the site. Radiocarbon dates from the site are suspect, for technical reasons.

Old Yeavering; NT 92842 30425; HER 2037, NT93SW 40; e-FIG HE-20;

A small hengiform monument, about 23m across the ditch, with opposed entrances at the WNW, and ESE, and with peripheral, possibly associated burial activity, has been excavated.

Situated at the edge of a low hill, an oval, flat-bottomed ditch, 3m wide, and externally about 24m NNE-SSW by 22m ESE-WNW, is broken by opposed entrances at the WNW, and ESE. The enclosed area produced no distinct features, but two pits lay just outside the WNW'n entrance, one of which was oval, and contained an undated partial, crouched inhumation. Excavated fills produced a radiocarbon date, and pottery from the Neolithic.

Pit alignment; NT 9335 3535; HER 1841, NT93NW 34; e-FIG HE-19;

Some 170m to the N of the Milfield North henge, a double row of pits, irregularly spaced, but always paired between the rows, about 90m long, and aligned E'-W'ward, produced dating evidence from excavation, comparable to that from the nearby henge, with which it could, therefore, be broadly associated.

Milfield South; NT 9396 3350; HER 2034, NT93SW 37; e-FIG HE-12;

Sited on a low knoll, an oval, segmented ditch, about 35m NE-SW by 30m NW-SE, contains a 5m wide entrance gap at the NW. The circuit was not completely excavated, and other gaps may be present. The ditch is flat-bottomed, 3.5-5m wide, and 1.5-2m deep. There is some evidence for an external bank. The partially excavated W'n-central interior featured post-stake holes, and a central pit that contained char, and a stone setting, including a cup-marked stone, with some evidence for a post present. Radiocarbon dating places the site within the later Neolithic-earlier Bronze Age.

Whitton Hill, site 1; NT 9334 3460; HER 2045, NT93SW 65; e-FIG HE-11;

A small hengiform monument, about 10m across the ditch, which contained four causeways, enclosed an area of burial activity, and has been partially excavated.

Located on a low gravel spur, a sub-circular, V-shaped ring-ditch, about 10m in diameter, and 2m wide, containing four entrance gaps, enclosed a ring of 21 pits, some of which might have held posts, with cremated human bone associated. Burial activity was noted: a larger circular stone-lined pit lay near the centre, and contained the cremated remains of a child, in an inverted urn. Two pits, possibly holding posts, stood inside the NW'n causeway, but similar features were not found at the other gaps. Finds of flint, pottery, and radiocarbon dates from partial excavation, indicate activity in the later Neolithic to earlier Bronze Age.

Whitton Hill, site 2; NT 9325 3449; e-FIG HE-11;

A U-shaped ring-ditch, about 9m in diameter, with a gap at the SSW, was partially refilled, soon after construction, and lay within a narrow outer bank. Inside the ditch, shallow pits and scoops formed a circle, within which lay a central pit. Cremated remains of at least 28 individuals came from pits, and the general scatter associated with the monument. Finds, and radiocarbon dates from partial excavation indicate activity in the later Neolithic to earlier Bronze Age.

Other ring-ditches in the area of Whitton Hill may have hengiform properties, for instance, the 20m diameter site at NT 9319 3460.

The Milfield-Marleyknowe avenue, or drove-way; from NT 9397 3386 to NT 9423 3218; HER 2039, NMR NT93SW 42, e-FIG HE-12;

This linear route, defined by broadly parallel side-ditches 10-35m apart, can be traced for 1.7km, from the Milfield gap at the N (NT 9397 3386). It passes immediately to the W of the Milfield S henge, apparently bending to skirt it, bisecting the Coupland henge, thence to just beyond the Marleyknowe hengiform at the S (NT 9423 3218), where slightly bulbous ends, a sharp turn, with a ring-ditch immediately adjacent, could indicate a distinct terminal feature. The S'n half of its course, from the Coupland henge (NT 9407 3300) S'ward, is clearer than to the N, where gaps up to 10m long appear, perhaps indicating slighter construction.

Partial excavation of the avenue suggests that its date could be broadly contemporary with the henges, but possible deflection of its course, apparently to avoid the bank at Marleyknowe henge, could indicate priority of the latter. Side-ditches are shallow, at about 1m wide, by 30cm deep, and excavation has failed to produce secure dating evidence. Neolithic dates obtained for the ditched route, similar to those for the henge at Coupland, are open to debate, but a broad contemporaneity has been suggested, with the double ditch perhaps only slightly later.

The clustering of round barrows, with hengiforms well represented, around the N'n terminal zone of the avenue, as at the Milfield N-Whitton complex, is not mirrored by extant funerary areas at the S'n limit, around Marleyknowe, with its lone accompanying ring-ditch. A rectangular crop-marked enclosure lies parallel to the avenue, near its N'n end, which may be related to long mortuary enclosures, but remains uninvestigated.

The double line of ditches forming this avenue appears rather too slight, wide, discontinuous, and irregular to have formed an effective drove-way, and seems to have been created piece-meal, with no singular plan. On this basis, perhaps interim interpretation as an avenue is the better option. The avenue narrows as it enters the Coupland henge at the N, where there seem to be two pairs of discrete pits at the entrance. The line then crosses the interior of the henge, its E'n ditch exiting cleanly through the other entrance of the henge, but its W'n ditch crossing the ditch of the henge. This may suggest that the avenue is later than the henge, but was constructed whilst the latter was still extant, and perhaps functioning.

This avenue is markedly different from other, more typical, ditched drove-ways, which appear more consistently parallel, and uniform along their length, as seen amongst local crop-marks of later prehistoric or Roman date, as for instance just to the NE of the Milfield S hengiform (e-FIG HE-12).

Case study: hengiform monuments in the Swale-Ure valley (e-FIGS HE-21 to 28)

Summary

Seven henges, of similar type, most with opposed entrances, lie spaced along a line running generally NW'-SE'ward, over higher ground between the Rivers Swale and Ure. A further two comparable henges lie, about 20km, and 40km, beyond the SE'n end of this closer line

Introduction

The Swale-Ure valley, in North Yorkshire, provides a clear example of an area where the distribution of larger henges appears generally spaced, linear, and N'-S'ly (TABLE HE-08), bearing comparison with those smaller hengiforms in the Milfield basin, Northumberland (see Table of Contents: 03f/4a). In this latter case it was suggested that hengiforms were ranged along a natural line of transit through the area, perhaps formalised in part by a long avenue, and with lines of entry, or exit, from the sites in conformity with it. Whether this general distribution followed a practical line of transit passively, or took advantage of it to express ritual concerns, remains open to discussion.

The Swale-Ure catchment slopes gradually downward from N to S, towards the confluence of rivers at Boroughbridge, whilst the land rises to the W and NE. Its drift geology is mainly characterised by terracing of fluvio-glacial gravels around the rivers, with isolated pockets of till. The soils are generally brown-earths, and sands, with gley, and stagnogley soils around the periphery of the study area, also peat formations in upland areas. The restricted area between the Rivers Swale, and Ure, channels the lines of ready transit, in a similar N'-S'ly direction to that seen in the Milfield basin.

The band of Magnesian limestone, which runs SSE'ward from the Swale-Ure interfluve, bears a dispersed linear group of eight henges along its W'n margin, plus one henge, Catterick, external to this zone, at the N (TABLE HE-08). Although cut by various rivers, including the Ure, Nidd, Wharfe, and Aire, this bedrock provides an easier generally N'-S'ward line of transit across the region, one taken by major routes, from the Roman period onward, and presumably before.

TABLE HE-08 HENGES AND OTHER LINEAR SITES IN THE SWALE-URE AREA: GENERAL PROPERTIES

Note: henges are ranked from N to S;

site	SE-	diam	shape	seq	acc	axis	# entr	exc	bur	e-FIG HE-	phot HE-
HENGES											
Catterick	2398	145	circ	b	yes:	**018**	1	part	note 1	23	
Thornborough										08	
N:	2880	250	circ	d b d	yes;	**144-324**	2 opp	part -			
central:	2879	255	circ	d b d	yes;	**145-325**	2 opp	part -			21
S:	2878	239	circ	d b d	yes;	**147-327**	2 opp	part –			

General axis along which Thornborough henges lie: 144-324ºG between N'n and S'n henges, with the central henge lying just to the N of this axis.

site	SE-	diam	shape	seq	acc	axis	# entr	exc	bur	e-FIG HE-	phot HE-
Nunwick	3274	210	circ	d b &	yes:	**172-352**	2 opp	part -		27	13
Hutton Moor	3573	252	circ	b d b d	yes:	**171-351**	2 opp	part -		25	09
Cana Barn	3671	215	circ	d b &	yes:	**173-353**	2 opp	no -		22	05
Newton Kyme	4644	>230	circ	d b d	yes:	**174-354**	2 opp	part -		26	
Ferrybridge	4724	250	circ	d b d	no :	057-237	2 opp	part -		24	08
CURSUS											
Copt Hewick	3572	minor				**165-345**				01	
Thornborough											
N:	2880	minor				**138-318**				08	
central:	2879	minor				052-232				08	
OTHER SITES											
Devil's Arrows	3966	3-stone row				**155-335**				28	07
Thornborough S	2879	double pit alignment				**019-199**				08	

Key: **diam**(eter in metres of the external edge of the outer ring-ditch: approximate and based on NMR data; **shape**: **ov**(ate), **circ**(ular); **seq**(uence of banks [**b**] and ditches [**d**], from inner to outer limit, **&** denotes that existence of outer elements in the perimeter are not certain; **acc**(ess through entrance gap(s) for henges); **axis**: those generally N-S are in bold type; **# entr** (number of entrances); **exc**(avated); **bur**(ial activity significant): - unknown; **?** possibly.
Notes:
1 A Neolithic cairn lies in the perimeter bank.

The henges here are larger, more complex, and perhaps serving more of a social than the funerary function noted amongst the Milfield hengiforms. The henge monuments from this area are amongst the largest in the British Isles, with the exception of the large henge-enclosures listed in TABLE HE-03. They are also located at wider spacing than those around Milfield, and hence axial alignment was perhaps more amenable to independent determination than for the latter, far closer sites (TABLE HE-07). Consistencies in the Swale-Ure group might, therefore, add weight to the argument for a more active, and independent choice of alignment, made for other than topographical, or imitative reasons. These well-separated henges show similarities in size, shape, order of banking and ditching that formed perimeters, and particularly in the generally N'-S'ly axis taken by their opposed entrances, this also seen in the general axis of the triplet of sites at nearby Thornborough (TABLE HE-06). The marked agreement between axes for several of the well-separated sites suggests use of some external reference. This consistent axis evident amongst the henges is also seen in other sites, of broadly comparable date, on the general line: two cursus monuments, a pit alignment, and one 3-stone row (TABLE HE-08). Round barrows are clustered in two main areas, with 20 around Hutton Moor-Cana Barn, and 8 to 11 around the Thornborough complex. Such clustering of barrows around henges has been noted elsewhere, as at Stonehenge (e-FIG HE-29 and RB-04), Avebury (e-FIGS HE-36 and RB-03), and the Priddy circles (Mendip; e-FIGS HE-07 and RB-07).

At the S'n end of the henge-line there is an imposing stone row at the Devil's Arrows, probably of similar date to the henges, but a totally different type of monument. This row was also laid out on the same general N'-S'ly axis, perhaps for reasons of common ritual, or simply conforming with some fording of the Swale, as the overland route passed by, to exit the area (e-FIG HE-28).

As would be expected, no formalised route has survived in the Swale-Ure area, as may be the case on a smaller scale with the avenue at Milfield (e-FIG HE-12), but a line which seems practical can be suggested, one that follows higher ground, and avoids obstacles of drainage (e-FIG HE-21). Given examples where avenues immediately leading from entrances have survived, as at Avebury, and Durrington Walls, it is certainly possible that similar structures existed at the Swale-Ure henges. A hint of this may be possible in the S'n entrance area at Cana henge, but here, this undated feature seems entirely localised. Such features are likely to have been relatively short, and local, of little relevance over the longer distance route.

The existence of a planned line of henges, spaced along a route of practical importance, which also conformed with a direction of particular ritual significance, seems a reasonable conclusion.

Interpretation of axial data

Distance between sites, consequent degree of inter-visibility, and conformity of the axis with the a local river valley, a key topographical feature, are given in TABLE HE-09.

TABLE HE-09 Henges in the Swale-Ure area: locational data

			RIVER					
site	**sep**	**inter**	**name**	**dist**	**conf**	**ag**	**axis °G**	**note**
Thornborough	-	-	Ure	1.3	hi	1	144	
Nunwick	5.3	none	Ure	1	hi	2	174	
Hutton Moor	3.3	none	Ure	3.5	med	2	171	
Cana	2	sl	Ure	3.2	hi	2	173	
[Devil's Arrows	6	none	Ure	0.3	no	(1)	155	3-stone row]
Newton Kyme	2.3	none	Wharfe	0.5	med	2	174	
Ferrybridge	20	none	Aire	0.5	no	-	237	

Key: sep(aration in km between one site, and that to its N); **inter**(visibility between sites, **sl**(ight)); **dist**(ance in km from the main modern river course); **conf**(ormity of axis with the general direction of the river): **hi**(gh), **med**(ium); **ag** type of axial grouping for sites, adopted for convenience in this table only, according to the line between opposed entrances); **axis** (between opposed entrances).

Whilst all of these henges show a N'-S'ly trend in the axis between their opposed entrances, those in axial group 2 show remarkable consistency, despite being well separated, and hence not inter-visible. It seems most unlikely that the direction of the regional topography, such as the course of the local river would have provided a sufficient cue for such precision, even if the modern, more canalised line were to be assumed.

The triplet of henges at Thornborough displays a common axis (here axial group 1, as outlined above) of about 144-324°G, which is fairly close to that of the solstitial axis for winter sunrise to summer sunset at this latitude, about 135-315°G. However, considering the group as a whole, this closer solstitial match could be coincidental, the safer conclusion being that the orientation is S'ly. The four henges in axial group 2 have a yet more S'ly orientation, about 171-351°G, closer to the solar zenith. Here a cue for the other limb of the axis in the N'n sky is difficult to suggest, but the solar zenith in the S'n sky forms a readily observable, consistent, and seasonally changing feature. A more detailed discussion of such use of the solar transit is given elsewhere (see Table of Contents: 02c/2i).

The conclusion reached here is that, although the major axial features of such henges might have conformed generally to local topography and lines of transit, simply for practical purposes, this seems insufficient to explain consistencies within the data, for which an external, sky-ward cue seems reasonable. Here, in general terms, this might be an interest in the S'n passage of the sun, especially the near-zenith, and in its surrounding sector, a zone of elevated vertical movement, which has no setting or rising points, and where the transit is a year-round feature (see Table of Contents: 02c/2e).

At this latitude, the permanent solar sector (see Table of Contents: 02c/2b(ii)) runs from about 135 to 225°G, and the axes of the henges fall within it. The majority of sites listed in TABLE HE-08, henges, cursuses, pit alignment, and stone row, all have S'ly axes to the E of S, which may relate to a method of approximating the position of the zenith during its final ascent. Only two of the sites listed, both of which are cursus monuments, show any closer correspondence with solstitial rising and setting lines, in this case 135-315°G (midwinter rise to midsummer set).

The single long barrow currently known in this study area, located between the Cana and Hutton henges (e-FIG HE-21), points NW'ward (front to rear). This orientation is typical amongst funerary monuments in its group (e-FIG LB-01 to 21), and provides a note of contrast with the S'ly trend seen amongst henges, and other sites mentioned above, with less funerary, and perhaps more economic associations.

Key sites in the area: further details

Note: henges are listed below from N to S.

Henges

-Catterick; North Yorkshire; perimeter: bank without ditch; maximum diameter 145m, and area 1.7ha; entrances: a double gap, at 018°G mean; SE 2304 9854; NMR SE29NW 16;

This approximately circular henge consists of a broad bank, constructed of pebbles and gravel, of internal diameter 90-100m, and externally 135-145m, its line broken by a closely spaced double entrance gap, at 018°G. No ditch appears to be present. A round cairn, 38m in diameter, of later Neolithic to earlier Bronze Age date was incorporated into the circuit at the N (Moloney *et al.* 2003).

-The Thornborough triplet of henges is outlined in more detail elsewhere (see Table of Contents: 03f/3b(ii)).

Similarities in plan with other henges in the group at Hutton Moor and Cana Barn may suggest a regional style.

-Nunwick; North Yorkshire; perimeter: inner ditch, outer bank, no trace of an outer ditch; maximum diameter 210m, and area 3.46ha; entrances: 2, 174-354°G; SE 3229 7484; NMR SE37SW 15;

A shallow, sub-circular ditch, about 14m wide, and 1.8m deep, encloses an area about 100m in diameter, and is separated from an external bank by an intervening berm, about 9m wide, the entire perimeter broken by opposed entrance gaps at the N, and S. The external diameter of the site is about 210m, with the original line of the bank spread by ploughing. Limited excavation produced neither artefacts, nor other dating evidence. The inner ditch is comparable in size to that of the central henge at Thornborough, but without any sign of an external ditch (Dymond 1963).

-Hutton Moor; North Yorkshire; perimeter: inner ditch, central bank, outer ditch; maximum diameter 252m, and area 5ha; entrances: 2, 171-351°G; SE 3526 7353; NMR SE37SE 3;

An inner, sub-circular ditch, estimated to be 10-18m wide, is surrounded by a bank, and outermost ditch, this entire circuit broken by opposed entrance gaps at the N, and S. The innermost ditch encloses an area some 93-96m in diameter, and the outermost diameter of the henge is about 240-252m, with the line of the bank spread by ploughing to 45m maximum wide. The inner ditch has been partially excavated. The outer ditch, 6-16m across, is less regular in width than the inner (Raistrick 1929).

-Cana Barn; North Yorkshire; perimeter: inner ditch, central bank, faint outer ditch; maximum diameter 215m, and area 3.6ha; entrances: 2, 173-353°G; SE 3608 7185; NMR SE37SE 4;

A ditch, currently 7-15m wide, and an outer bank, are broken by entrance gaps at the N, and S, these about 20m wide. The inner ditch encloses an area 96-99m in diameter, and that of the inner line of the bank is about 150m, with the maximum outer diameter of the henge 172-174m. The presence of an outermost ditch is uncertain. A few crop-marked pits appear within the interior. Facetting of the ditch- and bank-lines suggests staged construction. A double ditched, linear crop-mark, aligned between the two entrances, visible within the S'n half of the henge, and its entrance gap, may indicate part of an avenue.

-Newton Kyme; North Yorkshire; perimeter: inner ditch, central bank, outer ditch; maximum diameter 230m, and area 4.2ha; entrances: 2, 174-354°G; SE 4600 4490; NMR SE44NE 21;

This henge is defined by a sub-circular perimeter, consisting of innermost ditch, bank with berm either side, then outermost ditch, with a maximum external diameter of about 230m, broken by opposed entrance gaps, on an axis of 174-354°G (Harding and Lee 1987, site 211).

-Ferrybridge; West Yorkshire; perimeter: inner ditch, central bank, outer ditch; maximum diameter 250m, and area 4.9ha; entrances: 2, 057-237°G; SE 4746 2424; NMR SE42SE 31;

This broadly circular henge is defined by innermost ditch, then a bank with berms on either side, then an outermost ditch, and is about 250m in external diameter, its circuit broken by double opposed entrance gaps, with an axis of 057-237°G. A ring-ditch appears as a crop-mark, over the entire width of the berm on the SSE'n side, at SE 4748 2418. The area contains a complex of possibly related monuments (Harding and Lee 1987, site 218; Roberts 2005; Gibson 2005, fig. 20/p. 35). The henge may lie within an outer arc of short post alignments. There is a round barrow cemetery to the W-SW, beyond the SW'n entrance, around a line of access. Two timber circles lie to the SE.

Other sites

-Devil's Arrows; North Yorkshire; SE 390 665; NMR SE36NE 4; e-FIG HE-28**;**

Three large monoliths (NNW'n at SE 3906 6659; central-N'n at SE 39096 66530; SSE'n at SE 39154 66434) are set in a fairly straight line, running 155-335°G for 174m, and may represent an unfinished row. The stones, one of which might have been re-erected, are large weathered pillars, and they increase in height towards the SSE (5.5m, 6.4m, and 6.9m), with spacing 61m, and 113m, in the same direction. The central-S'n stone, set 2.4m from central-N stone, has been removed. Partial excavation at the bases of three stones revealed smaller packing stones and clay, but produced no finds (Burl 1991).

Study area: Salisbury Plain (e-FIGS HE-29 to 35)

Major programmes of survey and excavation in the area of Stonehenge and the henge at Durrington Walls include:

Stonehenge Environs Project (Cleal *et al*. 1995);
Stonehenge Riverside Project (Parker-Pearson *et al.* 2004, 2008);
Stonehenge Hidden Landscapes Project (Gaffney 2012; Gaffney *et al.* 2018, 2020).

Widespread geophysical prospection in the area has resulted in additon of a series of minor hengiforms, and barrows, mainly round, with no particular axial emphasis (Gaffney 2012, figs. 3 and 4/ pp. 151-152; Gaffney *et al.* 2018 figs. 2 and 3/ p. 3).

The study area contains the following group of henges, varying in size from large henge enclosure to hengiform (TABLE HE-10):

TABLE HE-10 Henges in the Stonehenge study area

Note: all sites are in Wiltshire; large henges are in UPPER case;

	NGR (SU-)	diam	ar	shape	perim	entr #	azim		int	ave	e-FIG HE-	phot HE-
NE-SW'ly axis												
STONEHENGE	1225 4220	115	1	c	b-d	1+	NE	045/049, 177	sc	1	29-31	
Coneybury	1302 4160	55	>0.2	so	d-b	1	ENE	070	pp	-	29	06
Amesbury 50	1148 4269	25	<1	c	d	?	NE SW	017-197	tr	-	31	
								042-222		-	RB-84	
NW-SE'ly axis												
DURRINGTON WALLS	1501 4375	520	21	so	d-b	2+	NW SE	124-304, 175	trs h	1	02	
Amesbury 9	1208 4212	22	<1	so	d	?	NW SE	152-332	tr	-	31	
other axes												
Woodhenge	1506 4337	90	0.6	c	d-b	1	NNE	025	trs	-	02	
Newhenge	142 414	?	?	?	d-b	?	?E		sc	1	30	

Key: NGR National Grid Reference; diam(eter in metres, approximate); **ar**(ea in hectares, to the outermost limits); **shape: so** sub oval; **perim**(eter)from inner to outer: **b**(ank) **d**(itch); **entr**(ance gap), **#** number, **+** denotes a minor gap is also present; **azim**(uth [°G] from the centre of the interior to the centre of the entrance, with hyphenated values marking opposed locations, and major gaps listed first; **int**(erior structures): contains **sc(s)** stone circle(s), **tr(s)** timber ring(s), **h**(uts), **pp** pits and postholes; **ave**(nue externally).

There is no overall theme for axial alignment amongst the small sample of henges in this area. Two axial trends may be evident (TABLE HE-10), some perhaps near-solstitial: NE'-SW'ly amongst half of the sites, with one major monument in opposition to this at NW'-SE'ly. Of the remaining two henges, Woodhenge appears to position its entrance towards the far larger, adjacent henge at Durrington Walls, perhaps for ease of access. Axially, these sites conform with local topography: certainly at Stonehenge, on its weak spur, at Amesbury 50, along its weak contour, perhaps at 'Newhenge' in its river valley, with only Coneybury not following the main line of its underlying ridge. It could be argued that location was selected to reflect a basic axis, rather than the converse.

However, the main axis at Durrington Walls is opposed to that in the former group, running NW-SE, perhaps reflecting the solstitial axis (TABLE HE-10). This large henge enclosure is located at the only point in this sector of the river valley that gives ready access to an important ridge-line, running NW'ward for at least 6km, and likely to have formed an important route. The enclosure itself occupies a shallow streamlet valley, with the same general alignment as the axis. It could be argued that the site was matched with this line of access, strategically sited at its final approach to the river, with little or nothing to do with limiting solstitial positions. Similar location of henges on an important S'- to SW'ly-trending route has also been suggested for the Milfield, and Swale-Ure study areas (see Table of Contents: 03f/4a and 4b respectively). Whether this line of approach to the river, via Durrington Walls, and on down the River Avon to the 'Newhenge' area, thence via the Avenue to Stonehenge, as final destination, is a valid link remains unknown (Parker-Pearson and Ramilisonina 1998).

This scheme of operation has been suggested for the two major sites, Durrington Walls, and Stonehenge, linking them within a line of funerary transit, which relates to their structural alignment. Riverside location of Durrington Walls could have allowed a formal SE'ward exit, along its main axis and, via a short avenue, onto the nearby Avon, thence S'ward to disembark in the area of 'Newhenge', and on up The Avenue, to enter Stonehenge from the SW. Such a scheme would have incorporated both solstitial directions, and others, into ritual.

Further details of individual sites

Key: NMR identifier from the National Monument Record .

Note: diameters and areas for henges are quoted for the entire site, out to the known limits of the perimeter.

Durrington Walls; Wiltshire; sub-oval; inner ditch, outer bank; diameter 516m; area 20.9ha; entrances: 3, minor single at 175°G, and paired at 124-304°G; SU 1501 4375; associated sites: Woodhenge; NMR 219364; e-FIG HE-02.

The site encloses a small, currently dry streamlet valley, sloping down to the River Avon at the SE, and lies at the lower end of a broad ridge heading NW'ward from the site towards higher ground. Further details of work at the site are given in Wainwright 1989; Wainwright and Longworth 1971; Parker-Pearson 2007, 2008; Gaffney *et al.* 2018, 2020).

-perimeter

The henge enclosure, formed by a ditch with external bank, now largely eroded by ploughing, is irregularly oval for its ditch, and appears more circular for the bank. Two opposed entrances break the perimeter, in a line crossing the site from the nearby river-bank at the SE, up towards the ridge that leads away towards the NW. A single small entrance at the S, blocked at an unknown date, would have opened towards that of nearby Woodhenge.

The ditch is 18m wide, 6m deep, with a flat bottom 6.5m wide, and the base of the bank is 30m wide. The berm between ditch and bank is of variable width, fairly narrow around most of the circuit, but widening to about 40m around the S'n entrance gap.

Geophysical prospection along the bank of the henge has indicated the existence of a C-shaped setting of large stones, representing an early structural phase (Stonehenge Hidden Landscapes Project: Gaffney *et al.* 2018, 2020).

-avenue

Partial excavation around the SE'n entrance has revealed the course of an avenue, about 170m long, and 30m wide, with parallel ditched and embanked sides, lying either side of a compacted gravel thoroughfare, about 10m wide. Halfway along the avenue there is a large pit, which probably held a timber post. This avenue leads from the river-bank, towards the SE'n entrance of the henge, and then apparently onward, internally, towards the S'n timber circle, just beyond it.

Finds of chalk, and nodules of flint, apparently in the shape of male, and female genitalia, from the gully of the avenue, an associated pit, and also from the S'n internal circle, may refer to ritual activities at the site.

-interior structures

Partial excavation, confined to a 20-40m wide N'-S'ly strip within the E'n margin of the interior, carried out ahead of proposed road construction, revealed two multi-phased, concentric timber circles, originally, either of free-standing posts, or perhaps roofed.

The S'n structure, of six concentric rings, 40m in outer diameter, was associated with an artefact-strewn platform, and a midden. The similar N'n structure was perhaps approached by a vague N'-S'ly timber avenue, and screened by a facade, or fence-line of posts, both sites being of later Neolithic date.

Recent work within the interior has revealed five hut structures; of later Neolithic date, with wooden stake-built walls, terraced into the head of the dry valley. Associated middens suggest seasonal, rather than fuller domestic occupation. Evidence may indicate thqt a larger settlement ranged around the area of the S'n circle.

Dating evidence indicates a main phase of construction during the later Neolithic: grooved ware is well represented, flint-work of this period is present, and animal bones of pig and cattle suggest seasonal feasting.

-external settlement and activity

Hut structures, pits, and platforms of rammed chalk, located in the area just beyond the SE'n entrance, suggest extra-mural settlement before, and after construction of the henge, perhaps part of a larger zone of occupation, around the site, and along the river-side.

-dating evidence

Key radiocarbon dates (TABLE HE-11) suggest construction of, and activity within the henge during the early 2nd millennium BC (Gibson 2005, fig. 28/p. 42):

TABLE HE-11 Durrington Walls: henge: radiocarbon dates

context	sample	BP	+/-	1 sd	2sd	?=Stonehenge phase (Cleal)
ground below bank	Gro-901	4584	80	2720-2550	2800-2470	2: internal timbering
near base of ditch	BM-399	3965	90	2110-1920	2200-1830	3iv: bluestone circles
N'n circle	NPL-240	3905	110	2050-1860	2140-1770	3iv: bluestone circles
S'n circle phase 2	BM-395	3900	90	2050-1860	2140-1770	3iv: bluestone circles

Note: **sd** standard deviation.

Woodhenge; Wiltshire; sub-oval; inner ditch, outer bank; diameter 90m; area 0.63ha; entrances: 1, at 025°G; SU 1506 4337; associated sites: Durrington Walls henge; NMR 219050; e-FIG HE-02;

Woodhenge, a small henge enclosure containing a multiple setting of post-rings, lies about 70m to the S of Durrington Walls, well within the ambit of this far larger site, its single entrance leading straight towards a gap in the S'n perimeter of Durrington. Further details of the site can be found in Cunnington 1929; Harding 2003; Gibson 2005.

The site is located on a low N'-S'ly ridge flanking the River Avon, just to its W.

-internal structures

Six concentric, sub-oval rings, containing 168 posts in total, with their long axis at 033-213°G, displaying further detailed radial placement, the outermost ring being 40m in diameter, may represent a roofed structure, or an open timber setting. The third ring from the centre is more substantial than the others, and might have supported a hut with a small central courtyard, or a light-well remaining open to the sky. At the centre lay the crouched inhumation of an infant, with skull split by an axe, possibly a ritual deposit, rather than a functional burial. At least five standing stones were incorporated into the timber ring-work, possibly as a later phase. This structure is similar to the N'n and S'n circles inside Durrington Walls, with further parallels: the internal ring-structure at Mount Pleasant site 4, and at the Sanctuary, on Overton Hill, Avebury.

-henge

The henge consists of a circular ditch, with external bank, broken by a single entrance at the NE. The bank was about 10m wide, with the flat-bottomed ditch up to 12m wide, and 2.4m deep, this latter containing a young adult inhumation. Construction of the henge, around 2470-2000 BC, may make it later than the internal post settings.

Grooved ware, items of carved chalk, and flint-work all indicate ritual activity of later Neolithic date. Radiocarbon dates show that the site was still in use around 1800 BC.

-function

Function is certainly ritual and, located as it is in some isolation from Durrington Walls, the site might possibly have served for preparation and processing of the dead.

-external activity

Later Neolithic rectilinear, timber structures, of 4-, and 6-posts, with associated cremated remains, at the round barrows numbered Durrington 68, and 70, located just to the S of the henges, may suggest a zone of ritual activity around both sites. The Cuckoo Stone, some 500m to the W of Woodhenge (SU 14664 43353), a sarsen boulder erected possibly before 2000 BC, together with its surrounding area of funerary activity, may be part of this generalised zone (excavated: Parker-Pearson 2008, fig. 5/ p. 157).

Newhenge complex; Wiltshire;

The site has been referred to variously, including in this text, as 'Bluestone henge', or 'Newhenge' [the designation 'Newhenge' is that given in Parker-Pearson *et al.* 2010, with the earlier stone circle at the site designated 'Newhenge circle']; it is now also listed in Pastscape as 'West Amesbury henge'.

SU 1423 4137; SU 14 SW 790; 1580342;

Neolithic stone circle, and subsequent henge; excavated as part of the Stonehenge Riverside Project (Parker-Pearson 2004, 2008); the site is located adjacent to the River Avon, in a fairly steep sided sector of its valley;

associated sites: Stonehenge Avenue, approaching nearby; e-FIG HE-30;

-Newhenge circle:

A ring of nine pits, about 10m in diameter, perhaps originally forming a circle of 21-27 monoliths, possibly of bluestone, erected about 3000-2400 BC, was eventually demolished 2469-2286 BC, and the stones removed from the site, suggested as possibly destined for re-erection at Stonehenge. These pits have a variable spacing of about a metre and above, and their bases contained imprints of former orthostats, too small to have been those of sarsens. Although some of the pits were reported as containing small chips of bluestone, their exact petrology has not been confirmed, nor matched with those from Stonehenge itself.

-Newhenge:

A henge monument, consisting of a 25m wide ditch, and external bank, with a possible entrance at the E, was constructed around the former stone circle. An antler pick in basal fill has been dated to 2470-2280 BC. There may be an entrance in the E'n side of the henge, with a deposit of antlers in the N'n terminal of its ditch. The interior of the henge was reused in the later Bronze Age. The E'n ditch of the Stonehenge Avenue runs up to the edge of the bank at the henge. It is stated that there do not appear to be any significant solar, or lunar orientations within the monument.

Coneybury; Wiltshire; ovate; inner ditch, outer bank; ditch 45 by 55m in plan; area >0.2ha; entrances: 1, at 070°G; SU 1342 4160; NMR 219462; e-FIG HE-29; phot HE-06;

The site is located on the crest of a low ridge, running SW'ward, and overlooking the valley of the River Avon.

This partially excavated monument, which survives only as an eroded crop-mark, is ovate, 45m by 55m in external dimensions, and consists of an inner ditch 5m wide, its perimeter broken by a single entrance gap at the NE (Harding and Lee 1987, 287-8; Harding 2003, fig. 7f/p. 16). Former existence of an outer bank is indicated. Structures within the interior are not clear, but consist of pits, stake-, and post-holes.

Finds, of pottery, flint-work, and animal bone, indicate activity from Neolithic to middle Bronze Age. A cremated deposit of human bone came from ditch fill.

Amesbury 50; Wiltshire; hengiform; weakly ovate; ditch, and inner post ring around a central platform; entrances: none clear; SU 1148 4269; e-FIG HE-31 and RB-84;

A weakly ovate ring, about 30m by 25m, containing eight pits, encloses another ring, of smaller post-pits, about 20m by 15m, both with a similar NE'-SW'ly axis. No clear entrance gaps are present. The centre of the site is occupied by a platform, possibly an eroded mound, about 12m in diameter. Although the plan is known from geophysical prospection (Linford *et al*. 2012) the site remains unexcavated.

Amesbury 9; Wiltshire; hengiform;

Described under the entry for Stonehenge SW'n cemetery (see Table of Contents: 03f/7e).

Stonehenge; Wiltshire; SU 1225 4240; NMR SU14SW 4; e-FIGS HE-29 to 35; phot HE-14 to 20;

Stonehenge is examined here in some detail since, although it is unparalleled in terms of location, layout, and megalithic structure, it does offer insights into the group of henges as a whole, both in terms of similarities, and especially of differences. It is also the most explored henge in the area, with much of the interior excavated, to various standards.

A broad division of henges can be made: into those that allow passage *through* the interior, termed here for convenience '**transit henges',** which have multiple entrances, often opposed, and those that do not, '**destination henges'**, which allow only unilateral entry-exit, via a single gap in the perimeter. Stonehenge belongs in the latter group, although a second minor gap does occur in its S'n perimeter. Stonehenge has a well-defined diametric axis passing through the entrance, and it is important to understand the basis for axial choice, and the relative ritual importance of directions within it.

More general detailed of the site can be obtained by reference to the following briefest selection from the very extensive range of published work: Atkinson 1960; Hawkins 1966; Blore 1995; Cleal *et a*l. 1995; Darvill *et al*. 2005; Darvill 2006; Darvill and Wainwright 2009; Darvill *et al*. 2012; Parker-Pearson 2013.

Sequence

The sequence of construction is complex, with details of the order, and dating, of key elements, open to continuing discussion. Detailed phasing, according to **Cleal** *et al.* 1995, and broader divisions, after the revised dating [abbreviated below: **RD**] (Darvill, Parker-Pearson, and Wainwright 2012) are both included to provide an index of recent change.

Before the monument (8000 BC onward)

sporadic pre-Neolithic activity is known in the area;

Mesolithic activity: 4-5 large postholes, about 1.5m in diameter, and of similar depth, spaced 10-12m apart, one possibly a natural feature, were located some 300m to the NW of Stonehenge (SU14SW 156: three of the postholes are at SU 1205 4237, 1206 4237 and 1208 4237). These holes, constructed in a wooded landscape, were set in a curving E'-W'ly line, and held posts of pine 0.45 metres in diameter, that rotted *in situ*. Charcoal, dated 7500-6000 BC, has been found at Stonehenge itself, during recent excavation, suggesting a considerable length of activity on-site.

Siting of the monument

The henge itself is situated towards the lower end of a broad ridge, that rises towards the WSW, and is located on the W'n side of a minor tributary valley flowing S'ward to the River Avon. The Cursus, and the Normanton Down round barrow cemetery occupy parallel ridges, to the N, and S respectively.

It has been suggested that the site itself might have been chosen because it lay at the end of a pair of natural periglacial ridges, which were seen to conform with a NE-SW'ly solstitial axis, considered auspicious (Parker-Pearson: on-line note extant 2012).

Stonehenge 1 (Cleal: phase 1; RD phase 1)
mid-later Neolithic:
Cleal: 2950-2900 BC;
RD: 3000–2620 BC [3100–2920 BC to 2965–2755 BC];

an initial phase, well-defined by construction of the perimeter, and the Aubrey Holes, but with entrance-related features less securely tied;
construction of the bank, and ditched perimeter of the henge, with a main entrance placed at the NE, and a minor one at the S;
portal structures of post-work, and of stone were erected just outside, and within, the main entrance;
construction of the Aubrey Holes, a ring of pits marginal to the interior;
interior structures remain unknown, but pits were dug;
evidence for burial activity in the Aubrey Holes;

-axis: phase 1 axis established;
phase 1 axis 045.8-225.8 °G;
3 axis 049.6-229.6 °G.

-perimeter: The site, which stood in open grassland, was enclosed by a circular ditch, 106m in diameter (best fit: following the mid-line), the spoil from which formed a bank along its inner side, and perhaps a small bank on the outer.

bank: A bank, 97.5m in mean diameter, and 6m wide, was established on the inner lip of the ditch. Its circuit has remained largely unexcavated. The inner positioning of the bank is somewhat unusual for henges, where the reverse order is far more common.

ditch: This was constructed in segments, which were later joined, to form an irregular circuit, steep-sided in section, and flat-bottomed, its width up to about 3.5m, and depth 1.4m. Silting was gradual, and natural, with little sign of back-filling, except at the E'n terminal of the main entrance, during phase 3i. The lower silts were clean, but then started to contain more debris, such as animal bone, and flint, as infill progressed. Cremated human bone in primary fill indicates some early funerary activity at the site.

geometry: The circle of best fit for the ditch provides a nominal centre-point, from which a radius can be added, running through the centre of the main entrance, to give a principal axis for phase 1, estimated as 225.8°G, taken here to the SW.

-entrance-related structures: A simple entrance gap, at the NE, 9.5m wide, through both ditch and bank, contains various portal structures. A smaller gap, about 5m wide, lies just at the E of S.

pits in line A: Four pits might have held posts, forming a portal structure, just beyond the entrance, its line bisected by the phase 1 axis. One pit was sealed under the bank of the phase 3i avenue.

pits D and E: These might once have held stone uprights, forming a portal structure, just within the main entrance, and lying either side of the phase 1 axis.

lines of postholes blocking the main entrance: multiple irregular lines of holes, about 1.4m apart, and 0.3m in diameter, of a size suitable for posts, run across the main entrance causeway, in roughly parallel rows, leaving more of a gap on the N'n side. Rather than a single feature, they may indicate multiple replacement of a single, gated barrier. They remain undated, but conform with the axis of phase 1, and may be from this phase, or from phase 2, where many other post-features have been assigned. Claims have been made that these timbers represent marker posts, erected for accurately establishing the point of local summer solstice sunrise, by plotting the daily approach to its limit, as viewed from the centre of the site (Ruggles 1999, fig. 8.9/p.137).

Pits for stones, along the axis outside the NE'n entrance: stones might once have been erected in pits B and C, and together with stone 97, lying adjacent to the Heel Stone, may belong to this phase. However, this line does not conform to the axis of phase 1, but lies along the mid-line of the Avenue, which is a later feature.

-the Aubrey Holes (also called X-holes: [Y- and Z-holes occur later, in phase 3]): Just within the perimeter bank, at the edge of the enclosed area, 56 pits, up to 2m in diameter (range: 0.8-1.8m), and up to about 1m deep (range: 0.6-1.1m), were dug, set at mean spacing 4.9m, to form a best-fit circle of 85m diameter.

Thirty four of these pits have been excavated (61%), and the rest have been located by probing. They appear to have been back-filled with chalk rubble soon after construction, and this fill sometimes contains further, intrusive holes, with charcoal-enriched fill.

These pits might have held posts, or stones, none of which have survived *in situ*. However, crushed chalk, at the base of a recently excavated example, with supporting evidence from archived data (2008: Stonehenge Riverside Project), may indicate traces of pressure on bedrock from overlying, weighty orthostats. The former presence of sarsens, or of bluestones, in isolated settings, or as a more complete circle, has been suggested and, if this is so, it would constitute the earliest in a sequence of monumental rings at the site.

-funerary activity: Cremated remains, recovered from the Aubrey Holes by Hawley in the 1920s, some 50,000 fragments of bone, material that was later reburied in hole 7, have been recovered for forensic analysis. Some 63 cremated deposits of human bone were located, in at least 25 of the excavated Aubrey Holes (74%), either as discrete placements, or scattered, sometimes in primary fill, but more often as later intrusions. Most deposits appeared to have been those from adult males, in the age range 25-40 years, but re-examination suggests that women, and infants were also well represented. Minor grave-goods accompanied some deposits: bone pins, and small flint rods, with a stone mace-head, and small ceramic object also found. Given the incomplete excavation of the remaining Aubrey Holes, and of ditch, bank, and external zone, any estimate of the total number, and phasing of such depositional activity remains highly conjectural.

The earliest cremated deposit, from Aubrey Hole 32, radiocarbon dated to 3030-2880 BC, indicates burial activity during the initial stages of the monument, and provides an early date for this phase of the monument. Two fragments of uncremated human skull, recovered from the ditch, have produced dates of 2890–2620 BC, and 2880–2570 BC. Two further deposits from the ditch have been dated 2930–2870 BC, and 2570–2340 BC, indicating funerary activity over a period of centuries. The latest cremated deposit has been dated to around 2300 BC, after appearance of sarsen, and bluestone structures as major features on site which, although it helps qualify the time interval, still leaves remaining detail, and total number undefined. Recent estimates suggest a total for individuals interred above 150 (Parker Pearson *et al.* 2009).

It has been suggested that the conjectural bluestones in the Aubrey Holes might have acted as grave markers, and hence that the enclosed area served as a major cemetery (Parker-Pearson: on-line). However, the frequency, and relative importance of burial amongst the activities at the monument is unknown, whether representing ancilliary activity, or acting as a prime motive for construction and use. Given the extended period of activity evident at the site, this would suggest a low average rate for such disposals, based on the current tally of individuals. This might indicate that such burial was incidental to the main activity at the site, with deposits perhaps even discouraged, or that it was selective, and determined by higher status (Parker-Pearson *et al.* 2009). Confining such burial activity to particular phases within the sequence would raise the rate of deposition somewhat, but it would still remain relatively low. Estimating the period of the Aubrey Holes, and of phase 1, as perhaps about 500 years, would give a rate of one deposit every 2-3 years. This low rate, together with the absence of known richer burials at the site, or from its immediate vicinity (see Stonehenge SW'n cemetery: Table of Contents 03f/ 7e, and more general discussion: 03h/ 2h) may support the notion of restricted burial.

-conservation of the centre-point for phase 1: Although the main axis of the site shifted slightly between phases 1 and 3, the centre-point for the basic geometry of rings, and for other key features, remains remarkable constant, strongly suggesting its intrinsic importance. Despite obstruction of the centre, by development of intervening, multiply ringed structures, and the consequent difficulty in establishing outer circles, even the outermost Y-, and Z-rings of phase 3vi remain closely based on this traditional point.

-other sites in the area:

The 'bluestone henge complex' at the river-side end of the Avenue: Establishment of the initial circle has been radiocarbon dated to 3000-2400 BC, and its dismantling to 2469-2286 BC, which would place both events within this phase (Parker-Pearson *et al*. 2006, 2010).

Stonehenge 2 (Cleal: phase 2; RD, included in phase 1)
later Neolithic:
Cleal: 2900-2400 BC;
RD: to 2620 BC;

This is something of a residual phase, containing those assorted, poorly understood post-structures that lie within the interior, which might have developed over the otherwise apparently open area enclosed by the perimeter of phase 1.

Timber structures were erected within the interior, and there was increased placement of cremated deposits of human bone at the site, part of a funerary function that continued long into phase 3;

-axis: phase 1 axis retained;
phase 1 axis 045.8 - 225.8 °G;
3 axis 049.6 - 229.6 °G.

-timber structures over the E'n interior: The pattern of postholes, as evident within the more excavated E'n half of the site, represents a combination of features from various excavations. The original pattern might well have become damaged, or obscured, by construction of later features on the site. Linear settings, some slightly curving, and irregularly rectilinear structures, appear evident, and much has been made of the passage-like structure which lines up with the smaller S'n entrance in the perimeter, but this could equally represent a detached enclosure, similar to other smaller settings beyond it, to the N. Suggestions that elements of timber circles might be present in the pattern (Gibson 2005) are difficult to support. Some postholes clearly predate the erection of the sarsen and bluestone settings of phase 3, and an early 3rd millennium BC date has been suggested for many.

-lines of posts blocking the main NE'n entrance: This feature could belong in part to phase 2, in view of similarities between its post holes and those of timber structures constructed over the interior during this phase. These entrance posts may represent some blocking structure, but it has been suggested that they could have acted as markers used during more precise determination of the summer solstitial rising, made as a basis for alignment of features on the axis of the monument (Ruggles 1999, fig. 8.9b/ p. 137).

-perimeter: The bank appears to have been deliberately reduced in height, and the ditch continued to silt up. Special deposits of antlers, partial animal skeletons, and cattle bones, some perhaps retained for centuries, were placed in the ditches.

-funerary activity: Besides those in the Aubrey Holes, deposits of cremated human bone were placed elsewhere at the site. About 30 were inserted into the fill of the outer ditch, and superficially into the bank, with a particular concentration just within the bank, at the SE, and near the entrance to the monument. Fragments of unburnt human bone have also been found in ditch fill.

-cultural affinities: Grooved ware of later Neolithic date is associated with this phase.

The sarsen and bluestone settings: phasing and dating

Phasing according to Cleal, and RD, for the sarsen and bluestone structures that now appear at the site, diverge at this point. Cleal maintains progressive addition of the various bluestone, and sarsen settings, subdividing this third phase from 3i to 3iv, whilst RD proposes a different sequence, and more unified development of the complex. In both schemes the sarsen settings provide a stable background for changing patterns of bluestone structure.

However, these details of sequence, important as they are, do not affect the basic geometry of the site, and discussion of the alignment.

-main phases for erection of bluestones and sarsens

Burl (2000, 365) notes that the range of bluestone-related lithics found at Stonehenge extends beyond that deemed sufficient for manufacture of axes, to include a third of lower grade rock.

..Cleal:
phase 3: 2550-1600 BC;
establishment of a basic circle of bluestones
i: double bluestone circle established;
addition of sarsen structures within, and around this
ii: sarsen circle and central trilithons added;
removal of existing bluestone rings
iii: a conjectural phase;
addition of new bluestone rings
iv: bluestone circle and oval were added around existing sarsen settings;
v: possible modification of existing bluestone rings;
vi: possible scheme for outermost bluestone rings, abandoned at the stage of ground-work;
..RD:

phases

establishment of the main sarsen rings, and a bluestone setting

2: 2620–2480 BC: construction of the sarsen trilithon setting as the initial structure, with a double bluestone circle outside it, and a sarsen circle outside this, the sequence of which is not clear;

addition of a minor bluestone ring

3: 2480–2280 BC: addition of an innermost bluestone circle, within the trilithon setting;

remodelling and simplification of the bluestone rings, within the continuing sarsen setting

4: 2280–2020 BC : the innermost bluestone circle, and the double bluestone circle were dismantled, and rebuilt as a bluestone oval, within the trilithons. An outer bluestone circle was added between the trilithons and the sarsen circle.

Stonehenge 3i (Cleal: phase 3i; RD phase 2);
later Neolithic;
Cleal: Stonehenge 3: all phases 2550-1600 BC;
RD: phase 2 2620–2480 BC [2760–2510 BC to 2470–2300 BC];

This phase saw transition from use of timber to that of stone for monumental structures at the site. This may not be the first phase of stone circles, if the Aubrey Holes indeed contained orthostats. There was further transport of igneous bluestone, and of sandstone sarsen to the site, over considerable distances. A double bluestone circle was erected in the Q and R holes. Monoliths were erected at the Altar Stone, Heel Stone, and at its putative companion, stone 97. The four Station Stones were added, the NE'n entrance widened, portal stones inserted, and the Avenue added.

-axis: the phase 1 axis shifts a few degrees to the E, to form a new phase 3i axis.
phase 1 axis 045.8 - 225.8 °G;
3 axis 049.6 - 229.6 °G.

-stone imported to the site: The non-sarsen stone used at the site includes over 20 igneous types: some rhyolite, but especially bluestone, this latter a spotted dolerite, which has been shown to originate from a specific outcrop in N'n Pembrokeshire, some 220km away. In the absence of evidence for local availability of glacial bluestone erratics, long distance haulage is now the preferred explanation for its presence.

Not all bluestones at Stonehenge might have been brought directly to Stonehenge from SW'n Wales, some being reused from the demolished bluestone circle at the river-side end of the Avenue, which had been established by this general period, but analysis of lithics indicates uncertainty about the relationship.

-use of bluestones at the site:

This audit (TABLE HE-12) is conveniently placed here, at the first known evidence for bluestone appearing in bulk at the site, with the proviso that any such uprights that the Aubrey Holes might have contained are an unknown variable.

TABLE HE-12 Stonehenge: bluestone: an interim audit of stones used

phase	structure	fate	#	?transfer
1	?Aubrey circle	?dismantled	<56>	reuse in phase 3i double circle
BHC	circle	dismantled	~27	reuse in 3i double circle or 3iv central ring
3i	double circle	dismantled	50-80	reuse in phase 3iv rings
3iv	circle	partly extant	[52]	reuse from phase 3i
	central ring	partly extant	[19]	?additional imports
3vi	Y-holes	lack stones	31	project abandoned
	Z-holes	lack stones	29	project abandoned

Some 40 of this conjectured total of 70 bluestones remain at the site, either standing, fallen, or as stumps, giving a survival rate of about 57%. The remainder either awaits discovery, or has been salvaged from the site for reuse elsewhere, perhaps as smaller blocks, and fragments.

Key: BHC Bluestone henge circle, at the river-side end of the Avenue; **#** number of stones originally present at Stonehenge, based on surviving uprights, and vacant holes, discounting any lintels which might have been additional; **[ ]** many potential locations for stones remain unexplored, but estimates of these are given, based on assumed repeat spacing of extant stones; < > entirely conjectural;

Movement of about 50 bluestones through the sequence, supplemented by at least a further 20 in phase 3iv, would account for all known, or projected placements, and would cover the potential requirement, apparently left unrealised, for the double ring of phase 3vi. Any extras might have formed lintels, a number of which are known to have been present at the site, as indicated by the presence of features for jointing on certain bluestones.

The bluestone circle (Parker-Pearson *et al.* 2004, 2008), located near the River Avon, at the other end of the Avenue from Stonehenge, apparently constructed during the earlier to mid 3rd millennium BC, and demolished 2469-2286 BC, contained 21-27 stones, which could have formed the supplement required at Stonehenge.

-the Station Stones (stones 91-94): Four stones of unequal size, the two remaining being of rough sarsen, were placed near the inner side of the bank, on the approximate line of the phase 1 Aubrey Holes, which they post-date. Their roughness may place their erection before the widespread use of more highly dressed sarsen at the site. They were placed at the corners of a rectangle, and two stood within small ring-ditches. The rectangle shares the same centre-point as all of the circles at the site. This might suggest that the centre was accessible as a survey point, and hence that the Station Stones predate the larger stone settings that came to obscure the centre. They may well, therefore, belong early in the sequence of larger stone construction at the monument.

..stone 91: extant, a rough boulder, 2.7m long, now fallen against the inner bank;

..stone 92: ['the S'n barrow'] this stone has now disappeared, and its ring-ditch, flattened towards the bank, cuts the fill of an Aubrey Hole. A D-shaped chalk floor, under 'the S'n barrow' could possibly indicate some small, hut-type structure;

..stone 93: extant, 1.2m high, still standing, with a more tooled finish;

..stone 94: ['the N'n barrow'] no stone remains, but the presence of a central hole has been established by probing within its circular, ring-ditched and banked perimeter;

-double bluestone circle in the Q and R holes:

Excavation along part of the circuit of the partly extant bluestone circle of phase 3iv revealed elongate slots, containing sockets for a double ring of bluestones, lying either side, in the Q (outer), and R (inner) holes. A pair of longer slots, containing four stones, marks a clear entrance zone, one slot lying either side of the phase 1 axis. A shorter slot, for three stones, lies either side of this, before the double slotting of the remaining circle was resumed. A further 18 double slots can be conjectured, on the basis of those in the known sector, suggesting the total estimate of stones as 50-80.

From basal impressions left by removed stones, each monolith has been estimated as being about 2m high, 1-1.5m wide, and 0.8m thick. Eventually, these smaller standing stones were removed, and their holes back-filled. Some of the bluestones used later at the site were shaped to fit together, some with mortice holes, or tenon pegs, suggesting that here, or at another site they might have formed an earlier, lintelled circuit.

The circle of best fit for the mid-line of the paired slots is 25.7m, that for the inner ring is 23.7m, and for the outer ring 27.2m. The double circle shares a common centre with earlier structures, but with a shift of axis of the line from centre to entrance from 045.8 (phase 1) to 049.6°G.

Radiocarbon dating, from recent excavations, places construction of this double circle between 2400 and 2200 BC.

-NE'n entrance: the NE'n causeway was widened, by infilling the ditch with material from the adjacent bank, bringing its centre into line with the entrance of the bluestone double circle, and shifting the axis of the site clockwise by about 3 degrees.

-inner portal structures: Two, or perhaps three, probably unlintelled portal stones were erected just inside the NE'n entrance at around this time, lying symmetrically with the new phase 3 axis, with only one of these, the fallen **Slaughter Stone** (stone 95), now remaining. This 28-ton sarsen upright, 6.4m long, 2.1m wide, and 1m thick, was dressed over its surfaces, and its lower end was pointed, for setting upright, but the absence of a tenon suggests an unlintelled structure. Use, or reuse, of holes D, and E for the partnering stones is likely, and would complete the triplet. Stones D and E might have been removed at some early stage, but antiquarian records indicate the possibility that these stones survived *in situ* until recently, without ancient removal. Samples of antler from hole E were radiocarbon dated to 2480–2200 BC.

Just beyond the entrance, on the axial mid-line of the avenue, stone holes B, and C indicate the former presence of monoliths, marking the final approach to the monument, and also belong to this phase, or to phase 1.

-external portal structures:

..the Heel Stone (stone 96): Although undated, this large, unworked sandstone monolith, located outside the NE'n entrance, standing 4.9m above ground, with a further 1.2m below, leaning inwards towards the stone circle, might also have been erected during phase 2. Various relationships have been suggested with another stone-hole, which lies just to its W, that for 'stone 97', any monolith here no longer extant, and hence conjectural. Any such stone 97 might have been erected earlier, with the Heel Stone added, thus forming a pair, lying across the Avenue, or stone 97 might have been relocated as a single monolith, some metres to the E, as the Heel Stone (Pitts 1982).

The Heel Stone lies within a narrow ring-ditch, about 12m in diameter, that was soon back-filled, but contained fragments of bluestone, and is overlain by the E'n bank of the Avenue.

..stone-holes B and C: These two holes lie along the mid-line of the Avenue, just outside the entrance, before reaching the Heel Stone 'pairing', and may represent additions at this stage, but their precise relationship with surrounding structures remains unknown.

..funerary activity: Deposits of cremated human bone continued to be made, until at least 2400 BC.

The Avenue:
SU 1320 4209 to SU 1228 4222; SU14SW 275;

An avenue, formed by two roughly parallel earthwork banks, each with an outer quarry ditch, runs in an angled course, for about 2.5km, from the River Avon, to the NE'n entrance at Stonehenge (TABLE HE-13).

-course

This avenued approach to Stonehenge is first detectable near the W'n bank of the River Avon, and from here it runs up-slope to higher ground, then on a more level course, taking it around headwater stream valleys, as three fairly straight sectors. These lines are progressively angled, with one turn curving, and the other sharper, from NW'ward, through W'ward, then to SW'ward for the final approach to Stonehenge. Limited excavation has taken place on the line of the Avenue, including near the Heel Stone.

TABLE HE-13 The Stonehenge Avenue: properties

sector	location	L(m)	align	ang	bend
1	leading NW'ward from the river	925	339	-	
2	the mid sector	1075	276	63	curving
3	the approach to Stonehenge	575	229	47	sharp
all		2575			

Key: L(ength); **align**(ment, moving along the Avenue towards Stonehenge); **ang**(ular change between sectors).

-structure

The Avenue varies in width, with external ditches quoted as about 34m apart near the Avon, this narrowing to about 21.5m near Stonehenge, with other mean values stated, for instance 23m. The enclosed strip is quoted as about 12m wide between internal banks. Excavation in the area of 'Newhenge', close to the Avon, records parallel ditches, about 18m apart, containing small post-holes, indicating that it held a palisade. Here, the E'n ditch runs as far as the edge of the bank at 'Newhenge', indicating an origin somewhere in its close vicinity, but with no distinct terminal structures yet apparent.

In sector 3, the Avenue appears to have been dug alongside, and conforming with, two parallel natural ridges, about 200m long, which might have defined its approach towards the earliest structures at Stonehenge.

There is no structural evidence that the Avenue included stone, or timber structures, in addition to the earthworks that define its course, beyond those stones immediately adjacent to Stonehenge itself.

-date

The Avenue lines up with the remodelled entrance gap of Cleal phase 3i, and it is perhaps to be explained as part of the same development, at least in sector 3 of the Avenue, nearest the monument. The Avenue might have been constructed according to a single plan, or in a series of stages, within this phase, or perhaps later, in Cleal phases 3ii, or iv. The existence of 'Newhenge', at the river-side end of the Avenue, certainly provided the target, or origin for its development.

Excavation indicates that the Avenue was constructed when the ditch of the henge was partially silted, and the ring-ditch around the Heel Stone more so. Chips of bluestone, and sarsen, from dressing of stones, found beneath the bank of the Avenue, suggest construction earlier than the large central stone settings.

The mid-line of the Avenue seems well matched to the radial position of the entrance gap in the double bluestone circle of Cleal phase 3i, at the centre of the site, an axis maintained in subsequent sarsen structures of Cleal phase 3iv. Radiocarbon dates of 2500–2270 BC, from ditch silt, place construction in this phase, with re-cutting around 2290–2120 BC.

-state of preservation

The course of the Avenue has been badly ploughed-out, surviving in places only as the faint crop-mark of its external ditches, except for better preservation of a short length of sector 3 as it approaches Stonehenge itself. The proportion of the entire length of the Avenue thus destroyed is about two thirds.

-function

The Avenue would have provided a formal approach to Stonehenge, for both people and goods, and in following an easier gradient seems a logical route for any heavy haulage to the site from the river.

Stonehenge 3ii (Cleal: phase 3ii; RD: continuing within phase 2);
later Neolithic;

The double bluestone circle, now redundant, was dismantled, and a sarsen circle, and central arc of trilithons were erected, the Altar Stone was perhaps erected within the sarsen setting, and there might have been work on the Avenue.

-axis: phase	3i axis retained;
phase 1 axis	045.8 - 225.8 °G;
3 axis	049.6 - 229.6 °G.

-sarsen circle: Large blocks of sarsen, a silicified sandstone, were brought to the site, perhaps quarried some distance away, on the Marlborough Downs, about 40km distant, or derived from nearer sources (West Woods, near Marlborough, Wiltshire; SU 1566; Nash *et al.* 2020). The uprights, and lintels, were prepared by dressing their surfaces, with indications of resultant working areas surviving to the N of the monument. Extensive, dense scatters of sarsen chippings have also been located immediately to the W of the Avenue, during augered survey of the area. Fragments of sarsen, with the outer cortex remaining, indicate tooling of weathered surfaces.

The uprights were tapered, with their tops, and lintels appropriately shaped, to provide mortise-and-tenoned, or tongue-and-grooved joints, and with suitable curvature added to fitted lintels.

The finished circle was 30.5m in best-fit, mid-line diameter, and consisted of thirty uprights, and lintels, with mean edge-to-edge interval of about a metre. Seventeen of the 30 original stones remain in position, eight have fallen, or are represented by fragments, and five are missing, mainly in the SW'n sector.

Each standing stone is about 4.1m high, 2.1m wide, and 1.1m thick, weighing some 25 tons. Lintel stones are about 3.2m long, 1m wide, and 0.8m thick and, as erected, their tops are about 4.9m above ground level. Their ground-set bases average 1.2m in length, resulting in an overall mean length of 5.5m, and weight of 26 tons.

-central sarsen setting: Five large trilithons, of dressed sarsen, two upright monoliths, capped by a cross-lintel, comprising ten uprights, and five lintels in all, stood linked by complex jointing, as a setting within the circle described above, forming a symmetrical horse-shoe shape, open towards the NE. Although the trilithons form this shape, their central gaps fall on a circle, the best-fit mid-line diameter for which is 16m, and this latter might have been the basis for layout.

The trilithons weigh up to 50 tons each, and range up in size, from the smallest at the NW, about 6m high, and the largest at the SW, about 7.5m high.

Although these are the most impressive elements of the megalithic complex, it has been suggested that they might have served to provide an architectural setting for the existing, and more ritually significant bluestone circles.

The uprights taper towards the top, and the lintels are curved in plan. Heights of the uprights increase from the ends of the horse-shoe towards the centre: the first, and fifth stones were originally 6m to the top of the lintel, the second, and fourth at 6.6m. The great central trilithon stood at 7.3m, one of its uprights having a total length of 9m.

A shallow mound, recently identified between stones 54 of the sarsen horse-shoe, and stone 10 of the sarsen circle, is of unknown origin.

-preparation of the sarsens:

standards of surface treatment: Recent detailed studies confirm, in greater detail, that sarsen uprights, and lintels display a range of care taken with preparation, and appearance of surfaces, both in terms of basic shaping, and in the final finish achieved (Abbot and Anderson-Whymark 2012).

In general terms, most care has been taken to ensure that the better workmanship was on view from within the interior, with the axial zone favoured, especially when viewing SW'ward along it, towards, and beyond the centre of the monument.

axial refinement: In contrast to those at the SW, uprights in the NE'n sector of the sarsen settings, on the line of approach along the axis, are more likely to be of refined trapezoidal shape, rather than the more standard, rectangular block, and to possess better prepared surfaces. Lintels in the NE'n sector also appear larger, and of higher quality than those at the SW. The only complete lintel in the SW'n sector is poorly worked. There seems to be a general lack of extant sarsen lintels, perhaps indicating that capping was not completed.

More stones that are unworked, and of lower quality, occur in the SW'n sector of the circle. From its current partial state, about a third of the circuit is missing, mainly at the SW, and it might have been left incomplete, although extensive later stone robbing, or destruction of the site, remains a distinct possibility.

internal enhancement: In the central horse-shoe shaped setting, the best surfaces of trilithons 1, 2, 4, and 5 face inwards, perhaps suggesting the importance of viewing outward. The great trilithon 3 has both faces in higher quality, possibly suggesting that equal viewing along the axis in both directions might have been significant.

Adjacent stones, 30 and 1, flanking the axial line of entry at the NE have been dressed to produce a rectangular portal, and to enable an easier line of sight. The same may be true at the other side of the setting, for stone 16, but the matching internal edge of adjacent stone 15 is missing.

-the Altar Stone (stone 80): This stone was perhaps moved to within the new oval setting, and re-erected vertically. It is the largest foreign stone at site, a dressed rectangular block, 4.9m long, 1m wide, and 0.5m thick, of micaceous sandstone, from the Old Red Sandstone series of the Milford Haven area, or from Breconshire. It now lies recumbent within the phase 3ii sarsen horse-shoe setting, perhaps covering its original stone-hole. Sarsen stone 156, of similar shape and size, lies nearby, perhaps one of a pair, with the Altar Stone once flanking the main axis of the site.

-other sites

Durrington Walls: This large henge enclosure was constructed by the River Avon, some 3km away, seasonal occupation of which might have provided a convenient base for the labour force required by developments at Stonehenge (Stonehenge Riverside project: Parker-Pearson *et al.* 2004, 2008).

Stonehenge 3iii (Cleal: phase 3iii);

An intervening phase is suggested, during which the bluestones, later reused for the phase 3iv rings at Stonehenge, formed a discrete structure, either at the site, or elsewhere, details of which remain unknown.

Stonehenge 3iv (Cleal: phase 3iv; RD phase 3);
earliest Bronze Age;
RD: 2480–2280 BC [2405–2225 BC to 2300–2100 BC];

Addition of a bluestone circle, and an oval, concentric with the sarsen settings, is assigned to this phase, the sequence, and structural details of which vary between Cleal and RD: (see introduction to phase 3 above).

The main ditch was re-cut, there was possible work on the Avenue, a Beaker period inhumation was made in the perimeter ditch ('the Stonehenge Archer'), and a large pit was dug against the central great sarsen trilithon.

-axis: the axis of phase 3i was retained.
phase 1 axis 045.8 - 225.8 °G;
3 axis 049.6 - 229.6 °G.

-bluestone circle

Bluestones, either reused, or as further imports to the site, were arranged to form an irregularly spaced circle of 23.3m diameter (best fit, mid-line), placed between the sarsen circle, and the trilithon horse-shoe. This ring survives incompletely: of an estimated 40-60 stones only six remain as upright stones, five are leaning, eight fallen, or fragmentary, and ten remain as stumps. Size and shape of slabs vary, from columnar to sub-rectangular. Except for two reused lintels that were tooled (stones 36 and 150), the majority have a less finished natural appearance than those of the bluestone horse-shoe, or of the sarsens. The irregularity of line may suggest construction after the sarsen circle of phase 3ii, since this could have obstructed accurate measurement, with the centre enclosed. Quality of workmanship also seems reduced during this phase, as reflected by instability of the new bluestone uprights. No distinguishing feature marks the presumed entrance gap, lying between stones 49 and 31, although they are set slightly within the local line of the circle.

-bluestone oval

Increased quality of stonework in this oval provides a contrast with the adjacent bluestone circle, the oval containing carefully dressed, taller pillars, about 1.8m high, and 0.6m across the section, all of dolerite. Stones are square, or rectangular in cross-section, with a slight upward taper. Six uprights remain, two are fallen, including the central pillar (stone 67), and there are three stumps. Two extant stones are 4m long, and weigh about 4 tons.

Spacing between stones indicates that 19-25 pillars stood originally, at 1.7m between centres, their inner faces forming a semicircle of 11.4m diameter (best fit, mid-line). The ends of the arc match those of the adjacent sarsen trilithon horse-shoe and, in like manner, they also increase in height towards the centre.

Some six, or seven of the stones indicate former use of the oval, as part of a structure incorporating at least two trilithons, as suggested by lintels 36, and 150. Upper surfaces have been dressed flat, and two of the pillars bear traces of a former tenon, suggesting they once stood as a trilithon, and one also bears tongue-and-groove jointing. They might have been reused from the earlier, bluestone double circle from phase 3i at Stonehenge, or were imported from elsewhere. This bluestone oval might have been truncated, to form the horse-shoe shaped setting, which has survived.

Key areas of the axis at the SE'n end of the circle and horse-shoe are covered by fallen sarsens, obscuring detailed structure.

-innermost bluestone circle

An arc of four stone holes, within the horse-shoe of sarsen trilithons, may indicate the former existence of an innermost bluestone circle, demolished at some stage. Its suggested dimensions are similar to those of the bluestone circle at the river-side end of the Avenue, and it may represent a re-erection of this demolished predecessor, although details are disputed.

-the 'Stonehenge archer'; SU 1227 4224; SU14SW 277;

A complete, supine, but partially crouched male inhumation, buried in the perimeter ditch of the henge, his chest area embedded with five arrowheads, was accompanied by a stone item, interpreted as a wrist-guard, appears to be of Beaker-period date (Evans 1984). The burial was made in an indistinct pit, cut into the top of primary silt, just to the W of the main entrance at the NW.

A date of around 2300 BC has been suggested, from an average calibrated range of 2450 to 2140 BC. Isotope analysis of the human bone indicates a probable origin for the individual in near-alpine Germany. The types of *pre-mortem* wound inflicted suggest this could have been an execution at close-quarters, and because of the context it might have been sacrificial.

Other artefact-rich Beaker burials in the area, of males interpreted as possible archers, include those at Amesbury, and at Boscombe Down, some 5km SW of the site, and across the River Avon (Fitzpatrick 2002, 2011). Together, these suggest the wider presence of higher status males in the locality, including individuals originating from some distance, since two of the males in the Amesbury burials also have an apparently Alpine origin, and Welsh connections are indicated amongst the Boscombe Bowmen.

Later in the 3rd millennium, there seems to have been a reduction in placement of cremated deposits at the site, and a possible move towards inhumation. This burial, and the undated inhumation at the centre of the site, may be part of this change.

-other evidence

Beaker sherds have been found elsewhere at the site, but mainly from unstratified contexts, indicating general activity during this later stage.

Stonehenge 3v (Cleal: phase 3v; RD phase 4);
early Bronze Age;
RD: 2280–2020 BC [2210–2030 BC to 2160–1925 BC];

Possible modification of previous bluestone rings occurred, the sequence, and structural details of which vary between Cleal and RD (see the introduction to phase 3 above).

-axis: the phase 3i axis was retained;
phase 1 axis 045.8 - 225.8 °G;
3 axis 049.6 - 229.6 °G.

-the existing bluestone horse-shoe: If the central bluestone setting of phase 3iv was originally a circular, or an oval ring, and not the extant open horse-shoe, then its NE'n sector might have been dismantled to achieve this final form, thereby matching it with the open sarsen trilithon setting. Most of the stones of the bluestone circle conform with a semicircle, stones 61 and fallen stone 72 alone converting the semi-circle into an apparent horse-shoe.

-other major sites in the area:

The henge enclosure at Durrington Walls has produced dates from early ditch silt of 2200-1830 BC, and of 2140-1770 BC (both 2 sigma) from internal post structures, and this would place establishment, and operation of the site within this phase of development at Stonehenge.

Stonehenge 3vi (Cleal: phase 3vi; RD phase 5);
early-middle Bronze Age:
Cleal: after 1600 BC;
RD: 2020–1520 BC [2010–1745 BC to 1620–1450 BC];

The Y- and Z-holes were dug for an expanded double bluestone circle around the central sarsen-bluestone setting, but this plan was abandoned. Dagger-, and axe-motifs were carved on certain of the sarsens. There was continuing activity at the site, with evidence for removal, fragmentation, and reuse of bluestone as portable artefacts. Extensive construction of round barrows took place in the area, many in discrete cemeteries.

-the Y- and Z-holes: In this latest major structural phase, two concentric rings of pits, the Y- (outer), and Z- (inner) holes, were dug, the former 31 in number, and the latter 29. The E'n half of their circuit has been excavated, revealing a double circle of stone holes, irregular in spacing, and concentric with the centre of the final sarsen setting. The best-fit, mid-line diameter for the Y-ring is 52.4m, and for the Z-ring 38.3m. An increased gap, plus slight splaying of the Z-ring, and irregularity in the Y-ring at the SE, may suggest the possibility of entrance from this direction, in marked contrast to the direction of entry from the NE seen in all previous structures.

Both Y- and Z-holes are similarly sub-rectangular in plan, about 1.8 by 1.2m, and 1m deep, steep-sided, flat bottomed, with their long axis on the line of the circle. Holes contained fragments of bluestone near the bottom, and elsewhere in the fill. A very shallow bank between the Y- and Z-holes, and one within Z-ring, may indicate spoil from original construction of the holes, or some other boundary feature.

That these rings follow final phase 3 is suggested by the apparent obstruction of the centre of the site as a base-point for establishing a precisely circular plan, and is confirmed stratigraphically by a Z-hole cutting the ramp of stone 7 in the phase 3ii sarsen circle.

These holes might have been dug for an additional bluestone double circle, a plan that was abandoned before completion. There is evidence that the holes were left open to silt up naturally.

An antler from Z-hole 29, and others from Y-hole 30, both in the NE'n circuit, probably represent ritual deposits of retained items, rather than abandoned tools, and have provided radiocarbon dates suggesting construction of the combined Y-Z circuit 1680–1520 BC.

Rock art at Stonehenge

Recent laser scanning of extant surfaces has revealed fuller detail of content and location for prehistoric carvings on the stones, as well as the extent and type of surface preparation carried out before erection (Abbot and Anderson-Whymark 2012).

Four major panels of carving at the henge contain a total of 115 certain, and probable axe heads, mostly un-hafted, and three daggers of early Bronze Age types current 1750-1500 BC. This constitutes the largest assemblage of such motifs from Britain, comprising 83% of axe carvings, and three out of six dagger carvings, as known from four other sites. Use of such motifs on cists, or on one of the kerbstones at Badbury Barrow (Dorset), where both axes and daggers occur together, link them with funerary activity, and offerings to the dead, perhaps as some type of axe cult. Cup-marks, the commonest motif from rock art sites in Britain, appear absent from Stonehenge.

Comparing these axe, and dagger motifs with metalwork of the early Bronze Age would place their appearance at Stonehenge late in the sequence, from phase 3vi onwards.

The motifs appear mainly on the E'n, and S'n sides of the monument, showing no positive association with the traditional NE'-SW'ly axis of the site, in fact perhaps the reverse, suggesting some change of axial emphasis, perhaps associated with later burial, or offering activity in their vicinity. It should be noted that rock-art on bedrock from N'n Britain, and from Ireland, shows some tendency towards facing the SE'n sector (see Table of Contents: 3g/7b).

The following motifs (TABLE HE-14) are the only ones now accepted as valid, others previously suggested now designated as natural, related to general dressing of surfaces (as for the quadrangular motif on stone 57, and the rebate on lintel 120), or as very doubtful.

TABLE HE-14 Stonehenge: rock art on the stones

struc	stone	az	face		axes	daggers
SC	3	078.3	E	ext	3	
SC	4	090.6	E	ext	59	
SC	5	101.6	E	ext	9	
			N	int	1	
SC	23	319.3	SW	betw	1	
SH	53	165.3	NW	int	42	1 ?2
			SW	betw	2	

Key: **struc**(ture): **SC** sarsen circle, **SH** sarsen horse-shoe; **stone** (its number); **az**(imuth from the centre of the henge: °G); **face** (of the stone on which the carvings occur): **ext**(ernal), **int**(ernal) to the ring, taken from the centre of the site; **betw**(een stones);

Undated

A stone reported to lie just inside bank at the SW, near Aubrey Hole 28, is in the approximate direction of midwinter sunset.

In 1926, Hawley discovered an undated burial at the centre of Stonehenge, badly disturbed by earlier digging, in a pit marked by a post, with its axis along the main NE'-SW'ly axis of the site.

Other activities at the site

Analysis of some 80,000 animal bones from the monument suggest long-distance transport and slaughter of cattle, perhaps as part of some mid-winter gathering, perhaps solstitial, during the mid 3rd millennium BC (Parker-Pearson: on-line).

General interpretations of the Stonehenge area

Models proposed fall into three groups:

-The local monument complex

A model integrating major monuments and landscape, supported by ethnographic parallels, has been suggested for the Durrington Walls-Stonehenge area during the later Neolithic, and earlier Bronze Age. The area of Durrington Walls-Woodhenge, and that of Stonehenge, might have represented complementary spheres of activity, the former, with its timber-based circles, and evidence for habitation, involving the living, and the latter, a stone-built complex with processional approach, representing the realm of the dead. Location of Stonehenge to the W of the former may contain further funerary symbolism, reflecting association of death with this direction, perhaps further stressed by important bluestone construction material imported from the far W of Wales (Parker-Pearson and Ramilisonina 1998; Parker-Pearson *et al.* 2006).

The short avenue leading to the river-side at Durrington Walls henge, and the intervening sinuous sector of the River Avon, might have linked the Durrington area to the bank-side terminal complex of the Avenue, some 6km downstream, with onward transit to Stonehenge, as final destination.

-The approach to Stonehenge

A further model has been suggested for the Avenue, in which its course, on the approach to Stonehenge, allowed more consistent, and structured views of the six local henges, and of later placements of round barrows in the area. Compared with the more direct route, involving lesser expenditure of energy, the actual three-sectored line, curving to higher ground, and around local valleys, only provides more panoramic coverage of terrain at selected spots. These occur on the King Barrow ridge, and at Stonehenge itself, from where over 200 barrows can be seen. These areas also allow a broader appreciation of the solar transit in relation to terrain and monuments. It is suggested that such considerations might have been important in the choice of route adopted (Exon *et al.* 2001)

-The site itself

The safest compromise, bland though it is, might be to call Stonehenge a multi-functional complex, acting as a regional focus of considerable importance, and longevity, upon which great effort was expended in terms of materials, and changing design.

Suggested activities suggested as taking place at Stonehenge have included, as the briefest outline:

astronomical, and calendric prediction: solstice, equinox, lunar stand-still, eclipses, and other celestial events important to contemporary ritual;
burial, and ancestor worship;

feasting, and communal gatherings;
healing;
inter-regional co-operation.

Astronomical interpretation has produced a large literature of variable credibility, including Hawkins 1966, and Hoyle 1977. Ruggles (1999, 136-139) notes the complexity of possible alignments, claims various lunar associations, and suggests that the early monument enabled communal observation of summer solstice sunrise, with later structures restricting access to a more select few.

Whatever its function, certain aspects of alignment present themselves as a key element: these seem to be predominantly solar, and it can be argued here, on clear structural grounds, related more specifically to the setting solar transit.

Alignments at the site

-Basic data

The co-ordinates for the immediate area of the site are approximated as 51° 11' (50.18°) N, and 1° 50' (1.83°) W, sufficiently accurate for practical calculation of key astronomical events.

Alignments, as shown on published plans, and as quoted in literature, all vary. Using, as a reference axis, the line between the centre of the great trilithon pair, and the mid-line of the Avenue, as it joins Stonehenge, the following values are obtained with reference to North pointers of unspecified type added to published figures (TABLE HE-15):

TABLE HE-15 Stonehenge: published values for the main axis

Note: the latter mean alignment is the one used in this analysis.

source	**azim**	**ref**	**fig**
Newall	050.0	1950	large-scale plan
Atkinson	049.3	1960	1
Hawkins	051.2	1966	first
Burl	048.5	1976	50
Cleal *et al.*	049.5	1995	various
RD (Darvill *et al.*)	050.5	2012	1
Google Earth	049.3	-	-
e-FIG HE-32	049.3	-	-
Ordnance Survey	049.0	-	-
mean	**049.6**		
phase 1 axis	045.8	- 225.8	
3 axis	**049.6**	**- 229.6**	
shift	**+3.8°**		

Key: azim(uth of the line from the centre of final stage Stonehenge, along the centre of the Avenue); **ref**(erence to published work).

Limiting positions in the solar and lunar cycles for this location are as follows:

-solstices:

The data given in TABLE AS-01 for 51° N gives the following approximate azimuths for solstitial sunrise and set:
Note: MS midsummer; **MW** midwinter;

MS rise 050 set 310
MW rise 130 set 230

Closer examination of these solar events, for the centre of the disc at zero elevation, at the precise co-ordinates of the site, gives the following values, valid for 3000 BC to the present (Haney 1994):

MS rise 051.6 set 308.5
MW rise 128.4 set 231.8

Maximum elevation of the setting sun at the site is as follows (Haney 1994):

	elevation (°) at meridian	**on main axis**
MW solstice	16	0
equinox	40	29
MS solstice	63	55

-lunar stand-stills:

The equation given in for 51° N (TABLE AS-04) provides the following approximate data for azimuths:

		rising	**setting**
maximum	N	039	321
	S	141	219
minimum	N	059	301
	S	121	239

-application of the above data to structures at Stonehenge

Major alignments at the site can be matched with these limiting positions as follows, with values in **bold type** indicating close correspondence. Only longer axes, based on robust structural data, that can be measured accurately, and which have unobstructed sight-lines, have been included:

..the main axis

The phase 3 axis corresponds well with midwinter sunset, and with midsummer sunrise, that for phase 1 somewhat less:

	azimuth		
phase 1 axis	045.8	-	225.8
3 axis	**049.6**	**-**	**229.6**
shift	**+3.8°**		
MW set			**231.8**
MS rise	**051.6**		

..the Station Stones

The long sides of the rectangular layout of the Station Stones correspond with lunar maxima of rising and setting, and the short sides with the phase 3 axis, and its solar correlates. Note that whilst stones are inter-visible along the long and short sides, the views along diagonals are obstructed by central features (TABLE HE-16):

TABLE HE-16 THE STATION STONES: ALIGNMENTS

side	**at**	**for stones**	**has azimuth** =	**at**	**for stones**	**has azimuth** =
long:	NE	94->91	**139.5**–319.5; **LmaxN^**	SW	93->92	**140.3**–320.3; **LmaxS^**
short:	NW	94->93	**051.2-231.2**; **S2**	SE	91->92	**052.3-232.3**; **S2**
diagonals:		94->92	163.5–343.5;		93->91	**117.0**–297.0; **LminS^**

Note: close correspondence with solar or lunar limits are shown in bold type;
LmaxN^ lunar maximum N'ly rise;
LmaxS^ lunar maximum S'ly rise;
S2 solstitial axis 2: / NE-SW.

..the centre point for ring structures is highly conserved over a long period of complex structural development

Centre points for the layout of stone rings, and for the rectangle of the Station Stones, plotted from phases 1 to 3, form a close scatter, lying within a few square metres, the mid-point of which can be taken as representative, and used in further calculation. Given such conservation of the centre, this point is likely to have been of considerable importance, but the area beneath it has not yet been explored by detailed modern excavation, and may well be highly disturbed anyway by superimposed structure, and by unregulated intervention. The mean centre-point has been used to define the axes of phase 1 and 3 for the site.

..the major axes undergo a slight shift to the E from phase 1 to phase 3

Although slight in angular terms (3.6°), this change is reflected in a distinct repositioning of the NE'n entrance gap, in layout of portal features, and of the Avenue, and in central ring structures. The reason for this shift might well have been a deliberate decision to comply more exactly with the solstitial axis, now that detailed internal ring structures were developing, with their requirement of more specific conditions for ritual. It is possible that this E'ward rotation may be seen in the repositioning of conjectured stone 97 to the site of the Heel Stone, although the new axis continues to pass between these two features.

The 3.6° shift in axis from phase 1 to 3 is too slight to indicate a major change in choice of any celestial target. It is not known whether change in axis at the central circle caused repositioning of the entrance, or *vice versa*.

Even though the SW'ly direction, towards the midwinter solstice sunset, might have been the prime target, the position of the summer solstice sunrise could have been used to establish the entire axis more accurately. Summer risings to the NE might have been clearer, and less obstructed by internal features than their winter alternatives. Such risings, observed from the centre of the site, would also have allowed accurate establishment of the entrance gap, a key feature in the approach to the monument.

..the phase 3 axis does not conform exactly with the solstitial line (e-FIGS HE-33 to 35)

The solstitial sun rises just to the E of the phase 3 axis, and sets just to its W.

...rising (e-FIG HE-33): Structures in the entrance area do not cover the area of rising precisely: the Heel Stone is a few degrees to the E of the phase 3 axis, and hence to the solstitial line, although it might have been part of a setting lying more satisfactorily across these axes.

Observation of solstitial events against the backdrop of structure at Stonehenge depends on the position taken by the observer, if they are to occur in register. In terms of summer solstice sunrise, correspondence would be better for a small group of observers standing on the axis in the foreground of the monument, rather than closer to the centre of the site, or to the entrance.

An approximate sunrise in the area of the entrance would have marked the event, as the sunrise approached, and lingered in this area over a series of days, before moving back towards the S. The idea of a precisely determined singular event, marked by sighting stones, seems neither practical, relevant, nor borne out by existing structure.

Summer solstice sunrise provides a limited event, since the sun is only in this NE'ly direction for a short period, with correspondingly brief opportunities for ritual activity, or contact between the site, and the solar transit. This direction is at the edge of the null zone of the solar transit (see Table of Contents: 02c/2b(ii)) and hence, except for this point of contact, the sun does not pass over, and there is no opportunity for further solar ritual.

...setting (e-FIG HE-34): By contrast however, turning attention SW'ward, to the other direction in the phase 3 axis, the possibilities for involvement of the sun in more routine ritual increase markedly, since this is the permanent zone of the transit (see Table of Contents: 02c/2b(ii) and e-FIG AS-09). This limb of the axis falls a few degrees to the S of the solstitial point, and hence could utilise the limiting position, and more generally the marginal transit, in ritual activity.

From the centre-point of the site, on the axis, within the confined arc of trilithons, the clearly setting limb of the sun could be observed on a daily basis, as it intersected the field of view. The transit would move from passing above the lintel of the trilithon at midsummer, its line sinking thereafter to within its central gap, and finally setting towards its base at midwinter, before reversing the cycle (e-FIG HE-35).

The axis of phase 3 coincides approximately with the central gap in the great third trilithon, although precise details of its position are lacking, since only one of the uprights, stone 16, remains in place, with stone 15 fallen. The clarity of outward views through central, narrow, internal gaps between trilithon pairs, and through the wider spacing between trilithons, must take into account any obstruction by uprights in the outer sarsen circle.

Broadening the viewpoint towards the SW, from a few selected individuals at the centre of the site, to a crowd in the foreground of the interior (e-FIG HE-32), or that of the entire site, would still allow observation of clear, if more general, interaction between transit and monument. The progressive S'ward setting of the sun towards the centre of the site would indicate approach to mid winter, and most significantly its retreat N'ward, the movement towards spring.

Choice of this axis, and construction of these axial features, would therefore have enabled reference to the transit *on a clearly setting course* throughout the year, the particular axis chosen optimising contact, whilst remaining close to the limiting position. An axis further to the S would also allow year-long access to the transit, but here it would not be as visibly setting, but rising and falling seasonally near zenith. Necessary involvement with the setting limb might have related to the need for clearer ritual contact with areas below the W'n horizon, *towards which the sun was heading*, a direction perhaps perceived to have been important in relation to the known funerary activity on site, and propitiation of ancestors (see Table of Contents: 02c/2i).

The increased potential of this SW'ly direction within the axis for constant reference to the sun is in marked contrast to the other axial line to the NE, which allows only brief contact with the rising sun at around the summer solstice. Whilst this latter might well have been an important feature of the ritual year, it would have been episodic, an incidental event, and seems unlikely to have formed the mainstay of recurrent ritual. Whilst the SW'ly direction of the axis stretches out from the site through the monoliths, clear, and apparently unimpeded by further structure, the NE'n limb of the axis runs back through the well-trodden area of the entrance, perhaps profaned by such access.

The SW'ly direction in the axis also leads on through what appears to be a fairly discrete burial area, lying just beyond the monument (e-FIG HE-31). Such a relationship between funerary areas and monuments is seen elsewhere, as at cursus monuments, and stone rows (see Table of Contents: 03c and 03d respectively). It could therefore be argued that the emphasis within the axis is basically unilateral, and towards the SW, a direction suggested at many other sites, including stone rows, and stone circles (see e-FIG CO-01), with a W'ward-looking funerary component.

Given the slow approach of the sun to solstice positions, and its gradual withdrawal, it is difficult to establish by simple means an astronomically-exact turning point, even today. Such precision, for the purpose of exact timing of ritual, seems implausible for agrarian communities, even at a prime site like Stonehenge, with the broader solstitial period likely to have assumed more relevance than a specific event within it. That the monument was locked into a potent cycle of observable seasonal change was probably the key factor in its design.

-suggested external astronomical links

It has been suggested, rather imaginatively, that two large pits, of unknown date and interrelationship, perhaps bearing stones, posts, or the location of fires, situated along the interior of the Stonehenge Cursus, might have marked midsummer sunrise, and sunset when viewed from an arbitrary point, the Heel Stone at Stonehenge (Gaffney 2012, fig. 5/ p. 153). These pits, it seems, could then have defined a specifically timed processional route for ceremonies at Stonehenge, on the longest day of the year (Gaffney 2012).

Stonehenge: SW'n cemeteries; general area: SU 120 420; e-FIG HE-31;

Although there is a general decrease in the number of barrows in the area of Stonehenge, those in the immediate vicinity tend to occur on its SW'n side. Here, two small, non-linear cemeteries lie further along the low ridge on which the monument is situated, but to the N of its main axis (see Table of Contents 03h/3g). The only barrows which lie close to the axis are Amesbury 10, about 300m from the henge, then Amesbury 15, and Wilsford 2, about 1km distant.

Similar axial location of funerary areas has been noted at a range of other monuments as, for instance, at the Rudston complex of cursus monuments (e-FIG CU-13), the Dorset Cursus (e-FIG CU-06), Marden henge (e-FIG HE-03), and the Piles Hill to Butterdon stone row (e-FIG SR 06). Such a relationship might have been important for axial ritual at such sites, bringing ancestors into the process.

SW'n cemetery 1: about 300m SW of Stonehenge; SU 1200 4210; SU14SW 88;
cemetery, and possible funerary processing area;

A group of small ditched enclosures lies close to the henge, a central cluster of five, with three others lying beyond its periphery. The plans of seven of these sites have been determined by geophysical prospection (Linford *et al.* 2012). Enclosures in the group differ in layout, with a range of single, and double ditched, circular, and oval sites, the location of any gaps and direction of structural axes showing no clear trend.

Although mounds have been long eroded, most of these sites appear, from known plans, and finds from early excavation, to be round barrows, of more standard form (TABLE HE-17):

TABLE HE-17 Stonehenge SW'n cemetery 1: funerary complex on the main axis: summary of properties

site	barr	bur	gg	note
round barrows:				
4	db	2I	poor	
5	db	nil	-	
6	db	I	-	
10	dd	C	-	
11	bell	C	poor	
funerary enclosures:				
7	?	nil	-	b
8	db	I	-	b
9	hf	nil	-	b
unknown nature:				
L17/ 10a	?lb	nil	-	

Key: site (Amesbury-); **barr**(ow: type): **db** ditched bowl, **hf** hengiform, **dd** double disc, **lb** long, or oval barrow; **bur**(ial: type): **I**(nhumation), **C**(remated deposit), **nil** nothing recorded; **gg** grave goods: - none retrieved; **note**: **b**(urnt material in the ditch fill is significant);

However, three of the enclosures appear potentially different, two ovate (7 and 8), and one a clear hengiform (9), all perhaps unmounded, and not primarily for burial. The inwashed ditch fill at these three sites is more magnetically enhanced than that of the adjacent enclosures, suggesting that considerable burning took place within the central area (Linford *et al.* 2012, fig. 10). The entire cluster may, therefore, represent an area of funerary processing (sites 7-9), and disposal (sites 4-6, 10-11), certainly with evidence for widespread burning, perhaps from cremation pyres. Although inhumation was noted at three of the sites, but with stratigraphy unrecorded, cremated deposits, probably under-recovered during early partial excavation, do occur at two, again without context. Similar magnetic enhancement of ditch fill was noted at another hengiform, about 1km to the NW of Stonehenge (Amesbury 50; Linford *et al.* 2012, fig. 18; e-FIG HE-31 and RB-84). This site lies at the margin of the Stonehenge Greater Cursus, W'n cemetery, where again it might have been involved in funerary processing for the local group of barrows.

Given that, in addition to more ‘standard’ barrow forms, a hengiform, and two ovate enclosures are also present, the latter three with evidence for burnt deposits, this might be better described as a funerary complex, than a straightforward cemetery. The small size of barrows, and sparse finds, do not indicate any burial of higher status here, the only larger barrow being Amesbury 11, just to the E of Stonehenge.

The complex, from what little is known, might fit against the mid to later phases at Stonehenge itself. However, no particular functional relationship is suggested for this small, perhaps self-contained, facility with regard to the widespread evidence for cremated deposits in and around the henge itself, although it might have accounted for a small proportion of them.

Note: all barrows below are numbered according to the system initiated by Grinsell.

Parish: Amesbury

4; SU 1188 4208; SU14SW 396;
ditched bowl; crop-mark, with two closely-spaced concentric ditches of overall diameter 28m; early excavation revealed a primary cremated deposit, in a cist, with a bronze awl, now lost; a large fragment of bluestone lay above the cist; two inhumations on the old ground surface, accompanied by antlers, and chips of sarsen may be secondary;
Annable and Simpson 1964, item 363;

5; SU 1197 4208; SU14SW 397;
ditched bowl; the surrounding single ditch is 3m wide, and 39m in diameter;
early excavation without result;

6; SU 1200 4211; SU14SW 398;
ditched bowl; 30m in diameter, and 0.7m high; surrounded by a double ring-ditch, the outer continuous, the inner ring with wider gaps to the NW and SE; early excavation recovered an inhumation from an ‘oblong cist’, perhaps a chalk-cut grave, corresponding with a central anomaly of low resistance;

7; SU 1201 4209; SU14SW 399;
ditched bowl; 12m in diameter, and 0.3m high; broad oval ditch 2m wide, and 20m by 15m across, aligned NNW’-SSE’ward, with one wider, and one narrower causeway at its SSE’n end; early excavation was apparently unproductive; increased magnetic enhancement of ditch fill indicates burning at the site;

8; SU 1205 4214; SU14SW 400;
ditched bowl;
mound 18m in diameter, and 0.3m high, covering a ditch, this ovate N-S, and about 10m across, irregular, with a clear gap at the E, and another less so at the SSW; increased magnetic enhancement of ditch fill indicates burning at the site; early excavation located a primary inhumation;

9; SU 1208 4212; SU14SW 401;
hengiform monument comparable to Amesbury 50: eroded mound, with diameter about 25m;
an irregularly ovate outer ditch, about 22m in external diameter, is formed by separate pits along the N’n side, and more continuous ditching along the S’n; just within this circuit, and following its shape, a ring of over 20 smaller pits, up to a metre in diameter, possibly for posts, perhaps a double line in the SW’n quadrant, encloses a more open central area; a gap in the circuit at the NW, possibly with indications of associated internal, and external structure, might indicate an entrance; magnetic enhancement of fill in the outer circuit of pits, and for the E’n half of the inner ring, indicate burning at the site; early excavation was unproductive;

10; SU 1201 4198; SU14SW 89;
disc barrow; probably with two mounds, set within a bank, and ditch, about 44m in diameter; mounds are now merged to a feature about 16m by 12m across; inner ditch weakly oval, and about 30m maximum across; traces of sectors forming a discontinuous outer ditch, about 40m across; early excavation recovered a primary cremated deposit from one of the mounds;

10a; SU 1194 4217; SU14SW 56;
low oval mound 26m long, and up to 0.3m high; orientated E'-W'ward; possibly an oval, or a long barrow without flanking ditches, but may be natural; early excavation was without result;
L17: Long (1876) shows his barrow 17 as a long barrow, and notes that nothing was found by excavators;

SW'n cemetery 2: about 800m SW of Stonehenge; SU 1155 4182; SU14SW 38;

A small eroded barrow cemetery, originally of eight bowl barrows, each of which contained a primary cremated deposit, of which five barrows have been completely removed; a long barrow is also present;

Parish: Amesbury

1; SU 1154 4185; SU14SW 431;
bowl; 23m in diameter, and 1.8 metres high, surrounded by a ditch, 4m wide, and 0.5m deep;
early excavation recovered a cremated deposit, possibly primary;

2; SU 1154 4182; SU14SW 432;
bowl; 26m in diameter, and 1.5m high; early excavation found a cremated deposit in a wooden box, placed on the original ground surface, beneath the mound;

3; SU 1156 4182; SU14SW 433;
bowl; 9m in diameter, and 0.3m high; possibly the barrow which produced the 'Stonehenge Urn', a Middle Bronze Age barrel urn, about 60cm high, containing a cremated deposit, originally placed upright, with a large triangular stone covering the mouth; alternatively, this urn might have been found in one of the destroyed line of barrows, Amesbury 107-111;
Annable and Simpson 1964, item 576;

107-111; SU 1155 4180;
a line of five barrows destroyed before 1912;

14; SU 1154 4175; SU14SW 91;
long barrow; 30m long, 15m wide, and 1.8m high, with well defined side-ditches; orientated SSE'-NNW'ward; early excavation uncovered three skeletons at the SE, perhaps primary, two with skulls cleft before burial; two crouched inhumations may be secondary;

15; SU 1150 4160; SU14SW 104; marginal to the main group:
bell; 53m in overall diameter; early excavation revealed a primary inhumation, on an elm plank, with a bronze dagger in a wooden case, also a small bronze knife-dagger, a possible beaker, and antlers, all but the initial item now lost; traces of three wooden poles were noted as extending from the primary interment to the top of the barrow;
Annable and Simpson 1964, item 351;

Other barrows in the immediate vicinity of Stonehenge

Parish: Amesbury

11; SU 1242 4217; SU14SW 90;
bell; 23m in diameter, and 3m high, with a surrounding berm 5m wide, beyond which is a ditch, 6m wide, and 0.75m deep; the overall diameter is 45m; early excavation revealed a primary cremated deposit, with bone tweezers, placed beneath an urn; fragments of bluestone were present;
Annable and Simpson 1964, item 327;

11e; SU 1125 4193 approx; SU14SW 37;
?disc; now destroyed, precise position uncertain; early excavation revealed a primary cremated deposit;

16; SU 1260 4155; SU14SW 107;
ditched bowl; mound 0.5m high, surrounded by a ditch, 14m in diameter; early excavation without meaningful detail;
-SU 1124 4216; SU14SW 515;
possible ring ditch about 12m in diameter;
-SU 1131 4177; SU14SW 182
mound, possibly a barrow;

W'n extension of the Normanton Down round barrow cemetery

A few scattered barrows lie to the W of the main linear round barrow cemetery:

Parish: Wilsford

1; SU 1111 4162; SU14SW 103;
ditched bowl; mound 13m in diameter, and 0.3m high, surrounded by a single ditch, 14m in diameter; total excavation revealed 11 burials, all at the N'n side of the mound: the original grave contained two inhumations, and a cremation, with Beaker sherds in the fill of the grave; eight further inhumations were found, all in the N'n side of the mound: seven infants, six of which were with beakers, in one case with a bone ring, and a pierced boar tusk, and another with a small urn; the crouched inhumation of a young adult was accompanied by a what may be a slate copy of a flat bronze axe.

2; SU 1138 4141; SU14SW 434;
disc; 55m in external diameter; bank 0.8m high, and ditch 0.4m deep; details of the central mound are uncertain; early incursion without result;

2a; SU 1140 4147; SU14SW 435;
bowl; mound 14m in diameter, and 0.5m high; early excavation produced a primary cremated deposit, with a bone pin, and fragments of an 'incense cup'.

Palisade trench just to the N of Stonehenge; SU 1177 4213 to SU 1279 4278; SU14SW 154; 219850; e-FIG HE-31;

A palisaded ditch, 1.4m deep, holding a continuous line of posts, runs SW'-NE'ward, on a fairly straight course for 1280m, just to the W and N of Stonehenge. The line, as followed by geophysical (Gaffney 2012, fig. 3/ p. 151, and fig. 4e/ p.152), and by aerial survey, has curving ends, and contains two gaps. At the SW it disappears among traces of a field system, probably mid to later Bronze Age in date, and at the NE it gradually converges with the course of the Avenue. The trench itself has been excavated at three points: the few artefacts recovered included Beaker sherds, Roman pottery and coins, and a chalk disc from the base of the ditch at a terminal, which also contained an adult male inhumation of Iron Age date.

Surface scatters of flint-work, and Peterborough-type pottery, may indicate associated settlement, and activity, during the early 3rd millennium BC, contemporary with the earlier phases of Stonehenge. This feature is probably of later Neolithic date, and may be broadly contemporary with Stonehenge phase 2. Its line appears to enclose the area to the N of Stonehenge, but whether for agricultural, or for ritual purposes is unknown.

Analysis of orientation for the entire sample of henges (e-FIG HE-39)

Introduction

Consistency in the positioning of entrance gaps in the circuit of certain henges suggests that this was a fundamental aspect of initial design, and that underlying axes were of considerable importance for the functioning of the monument. Many ovate henges have opposed entrances on the long axis of the oval, suggesting that entrance gaps were established early in the sequence of construction, as primary markers for layout of the perimeter.

The position of an entrance would establish the direction of immediate approach to, and exit from the site, and would exert an influence further afield, if any formal avenue were added to it externally, as seen at Stonehenge and Avebury. Opposed entrances would determine the line of transit across the interior and, as with the position of all entrances, would influence the layout of structures within the interior. These gaps, in an otherwise high bank, might also have allowed a somewhat clearer, if restricted, view from the site to its immediate extra-mural area, and beyond.

Since entrance gaps are a consistent feature that can be readily determined at most sites, including those that remain unexcavated, or have been seriously reduced by ploughing, they provide a ready format for comparing one basic aspect of orientation within the wider group. The only other axial data available are those for closely-spaced linear clusters of henges, of which there are only a few clear examples (TABLE HE-06).

Analysis

A preliminary analysis of data from the National Monument Record, giving location of entrance gaps in henges, graded only according to octant at best, suggested a distinct trend that was worth following up in more detail. Data from 303 henges showed a distinct tendency for location of gaps to face S' to NE'ward.

For the purposes of this analysis, alignment of single entrances, unmatched across the interior, is measured from the centre of the site, and outwards, through the middle of the gap, and for diametrically opposed gaps is expressed as the axis between their centres. Since no discrete categories for size could be seen amongst henges, and no trends were visible when examining alignment against size of henge, using artificial divisions, all data have been pooled, from large henge enclosures, down to small hengiforms. All gaps have been accorded equal status, with no differentiation between major, and minor. A total sample of 490 sites from England, Wales, and Scotland were included in the analysis.

Frequency distributions of azimuths for entrance gaps are presented as histograms at 10° interval, with three sets of data plotted, one each for gaps that are opposed, non-opposed, and with these sets combined (e-FIG HE-39). Data on location of entrances in the perimeter is kept separate from further discussion of relative importance of directions of entry, or exit.

-entrance gaps: opposed

Clear regional examples of this type can be seen amongst hengiforms in the Milfield basin, and amongst the larger henges in the Swale-Ure area, both in North Yorkshire (see Table of Contents: 03f/4a and 4b respectively). In S'n England, the following provide examples at larger scale: Durrington Walls, and Avebury, both in Wiltshire, the former with single opposed, the latter with double opposed entrances. According their capacity for axial transit, such sites are termed **transit henges** in this analysis, along with others that have multiple gaps in the perimeter, in contrast to **destination henges**, those with a single entrance, and no other exit from the interior.

Although all frequency distributions are well-spread, with indistinct peaks, this set of data, from those with opposed gaps, gives a somewhat clearer trend, and one which is likely to be most significant in understanding the wider group.

..peak 1

Axes from this sub-sample form a spread peak 1, within the SE'n, and NW'n quadrants, with a more discrete minor peak 2, around SW-NE. Inter-site axes for the linear groups at Thornborough, and Priddy, also the direction of opposed entrances for component henges, certainly at the former site, fall within peak 1.

Much of this spread peak would fall within the null zone of the solar transit, if the N'ly direction of the axis were taken, but well within the permanent zone, especially its rising limb, when the S'ly direction is considered. In contrast to the general absence of ready celestial targets in the N'ly direction, the S'ly would, therefore, allow year-long reference to the solar transit. Given the broad nature of the peak, there is no evidence for specific interest in the solstitial axis.

..peak 2

This peak lies within the setting limb of the solar transit, within the permanent zone, with perhaps some interest in the solstitial zone.

Assuming a solar basis, it is therefore more probable that the major axes of these henges would have allowed them to make recurrent reference to features of the solar transit, on a regular basis, rather than highly seasonal correspondence to limiting positions.

-entrance gaps: single and multiple, showing no opposition

Whereas opposed entrance gaps would constitute a primary element of design, placement of single gaps is likely to have been less formal in many cases, since a gap can simply be left in a growing ditch, or bank. Less coherence amongst data may, therefore, be expected.

Peaks indicate that gaps occur in preferred positions on the perimeter, at the near-N, at S, around E, but not at the W. Although there is no pairing between any of the gaps, those in notional opposition, at the N, and S, could reflect partial expression of this important axis. The peak at the E could indicate a facility for entry towards the W which, in view of burial functions, and barrow-like qualities seen at some hengiforms, could reflect this common emphasis of direction, also seen amongst funerary monuments (see TABLE LB-01).

-single and opposed gaps combined

Spread peaks indicate interest in the general NW'-SE'ly axis, with some dilution of the minor NE'-SW'ly trend evident amongst opposed gaps.

Comments on groups of henges and specific sites

-linear groups of henges

..closely-spaced

There are only two locations where close lines of henges occur clearly: the three sites at Thornborough (e-FIG HE-08), the four sites at Priddy (e-FIG HE-07), with a weakly linear group at Knowlton (e-FIG HE-09). This does not provide enough data for separate analysis, but nevertheless supports the evidence for a N'-S'ly trend amongst axes, as noted above for sites with opposed entrances (e-FIG HE-39).

Thornborough and Priddy form clearly linear complexes, of closely similar monuments, with Knowton providing a less linear, and uniform example. The generally N'-S'ly, inter-henge axes of these monuments fall well within the permanent zone of the solar transit, and its opposite partner, the null zone, and here again it is suggested that the S'ly direction towards the permanent zone would provide readier celestial targets.

At Thornborough, the opposed entrance gaps correspond closely with the inter-henge axis, suggesting some equivalence in terms of ritual. Construction of three such similar sites in this way would seem to be a major statement, reinforcing a direction of especial significance.

At Priddy, the locations of entrance gaps at the four henges are not well known, but on present evidence do not seem to be clearly opposed. Again, the significant investment of effort in producing this series of near-identical sites, on a clear S'ly axis, seems remarkable, and to be explained less in terms of functional need, than as reinforcement of ritual.

At Thornborough, and Priddy, there is definite unity of design amongst henges, but not at Knowlton, where sites are of unequal size, and form a far less uniform line. Nevertheless, again the axis is S'ly.

The type of repetitive construction activity seen at these sites is reminiscent of that proposed for other monuments of the period: for stone rows, amongst elongate funerary monuments, and for cursus sites (see Table of Contents: 03d, 03b, and 03c respectively).

..dispersed linear groups of henges (study areas: Milfield and Swale-Ure)

There are two areas where spaced lines of henges follow a generally N'-S'ly axis: the Milfield Basin, and the Swale-Ure valley (see Table of Contents: 03f/4a and 4b respectively). For both of these groups there is a distinct tendency for entrances of component henges also to fall on this same general axis. It is possible that this S'ly line was of more than of practical significance, passively following the accepted route across each area, and was determined not only by topographical, but also deemed appropriate as a line for henge construction, on ghd basis of other ritual considerations. Again, it is argued here that a sun-ward line to the S may well be a key element in the interpretation.

-large henge enclosures (case study above: large henge enclosures)

Although these monuments have not been segregated on the basis of their larger size from the general analysis of alignment they do merit separate comment.

..elongate oval henges incompletely enclosed at the SW

Although there are too few members to form a separate category, the two sites of Marden (e-FIG HE-03), and at Waulud's Bank (e-FIG HE-05), share certain characteristics of shape, size, and their use of river-side siting to form part of the perimeter. Both sites are, therefore, more open at the SW which, in view of the evidence for S'ly interest seen amongst many henges (e-FIG HE-39), may be of some significance in offering a more open aspect towards this direction. The line of approach to the interiors of these sites might also have been S'ly, since entrance gaps at Marden lie at the N and E, and at Waulud's Bank at the N.

..Mount Pleasant (e-FIG HE-04);

Although there are three other gaps in the perimeter, that at the N would have allowed S'ly entry to the interior of the henge. Entrance gaps in the main henge form two roughly opposed pairs, with those at the N and SE the best aligned. Here again, at this major site, at least some preference for a generally N'-S'ly axis could be argued.

The site lies on a ridge, with the N'n entrance placed up against the steeper slope of a stream valley, with the other entrances opening out onto the broader ridge that extends towards the SE, and which bears a number of round barrows. Entrances at the N, and one at the SE, were retained in the timber palisade that followed the henge, and this suggests their practical importance over the remaining pair.

A general line of access, and sight, seems possible, from the interior towards funerary areas at the SE, and via the W'n entrance to the area of the Conquer Barrow, and any associated structures.

..Durrington Walls (e-FIG HE-02);

The same possible connection between henges and overland routes, as proposed for sites in the Milfield, and Swale-Ure study areas, can be proposed here at Durrington Walls.

This large henge lies next to the river, at the bottom end of a broad ridge running NW'ward, that might have acted to channel longer-distance movement across the area. It would have provided a ready line of access towards the entrance gap at the NW. The opposing entrance at the SE is close to the course of the river, and its wetland margins, and is less amenable, when compared with that at the NW. However, this SW'n gap is supplemented by an avenue, running down to the river, that would have acted to deter lateral access. Certainly this SE'n entrance seems shielded and selective, in a way that the NW'n might not have been, at least on present evidence.

It could, therefore, be argued that these opposed entrances were well suited to movement from the ridge, to the interior, and onward to the river, of a practical and economic nature, as well as of ritual, and more funerary potential. For instance, it has been suggested that the dead, or a select fraction, might have been carried from the interior of the henge, via this short avenue, to the river, and on down-stream to the area of 'Newhenge', thence via the Stonehenge Avenue to Stonehenge itself (Parker-Pearson and Ramilisonina 1998).

The entrance in the S'n side of Durrington Walls would have afforded ready access to the N-facing entrance of Woodhenge, close by, and perhaps providing some ritual facilities deliberately segregated, possibly funerary.

..Avebury (e-FIG HE-01);

The two sets of opposed entrances at Avebury allow lines of transit across the interior, through gaps in the perimeter, at SW, and SE, then onwards in this general direction via stone avenues, along a sinuous course, towards monuments, and funerary areas on hills some distance away. There seem to be no corresponding avenues, and areas of monumental development, to the NW, and NE. The general course of each avenue, and its destination, are fairly well visible from the area of its entrance gap, suggesting that a significant sight-line might have existed.

Silbury Hill, an extremely large, round, multi-phased mound, of comparable date to the main henge, is also located almost due S of the site, and mid-way between the avenues. The lines of the avenues, therefore, act to enclose the S'n arc of the sky, with Silbury Hill set against the approximate position of the solar zenith at the meridian.

Restating the data for various lines leading from Avebury (see Table of Contents: 03f/2e(i)), towards the:

...SW: the SW'n entrance at Avebury, of azimuth from the centre 257°G, opens onto the Beckhampton avenue, the known sector of which leads away, at 242°G between currently known end-points;

...SE: the SE'n entrance at Avebury, of azimuth from the centre 164°G, forms the starting point for the West Kennet avenue, the known sector of which leads away at 141°G, between end-points;

...S: Silbury Hill lies at 190°G from the centre of Avebury.

The interval of 101° between the SW'n and SE'n lines, at 141 and 242°G, fairly effectively matches the width of the permanent zone of the solar transit (TABLE AS-01) which, at this locality, spans 99°, from about 130 to 229°G. The correspondence between the lines, and solstitial axes marking the permanent zone, is also close, each differing only by about 10°.

The primary function of these SW', and SE'ly lines, both near-solstitial, might have been to stand alone as separate markers of limiting solar positions on the S'n horizon. Alternatively, or in addition, they could have served a more secondary function, in defining the limits of the intervening permanent zone of solar transit. In this capacity, the rising and setting sun during mid-winter, rising for the West Kennet avenue, setting for Beckhampton would join the ends of the avenues. For the rest of the year, each line, and the zone between them, would experience daily passage of the solar transit.

Viewing outward from the henge, along the arc defined by the two avenues, would have provided many possible cues from the solar transit. Viewing in the other direction, from the zones at the ends of the avenues back towards the henge would only offer a very restricted range of options.

The bearing from the Overton Hill complex, back towards Avebury, is about 321°G, which would place it just within the null zone of the solar transit, to the N of solstitial axis 1 (NW-SE: \), at about 310°G. The view of summer solstice sunset, therefore, would be on the horizon, to the left of the site by about one henge-diameter. For the purposes of ancient ritual this might have been close enough to provide a background for ceremonial.

The view back to Avebury from the end of the Beckhampton avenue, whether from the possible terminal at the Longstones, or from any further extension to West Down, is at about 062°G. Solstitial axis 2 (NE-SW: /), and summer solstice sunrise, are at about 049°G, and so the avenue would align on the sun as it appeared well risen, again perhaps sufficiently close for purposes of agrarian ritual.

Returning to the question of S'ly views from Avebury itself, the midway position between the SE' and SW'ly lines of avenues would be 192°G (calculation: = 141 + [102/2]). The imposing mound of Silbury Hill, at azimuth 190°G, is at this precise midway point, giving added presence to this S'n arc. The ascent, and descent of the sun at this near meridian, between extremes of winter low-point and summer high-, would occur over the area of the mound, to provide a clear seasonal index. Depending on the viewing point, and the extent of ancient ground-cover assumed, in addition to terminal areas of avenues, the mound itself would also be visible from the Avebury area. Enlargement of the mound would have aided inter-visibility considerably.

Certain aspects of alignment at the Avebury complex may indicate a solar theme. It is also possible to suggest solar symbolism (see Table of Contents: 06/4), in terms of the circular shape of the Silbury mound, with its platformed top, and in the ground plans of rings seen at Avebury, and also those of the round barrows that surround it. Such possibilities exist for henges in general, but are of course unprovable. In the case of Avebury, a circular complex also came to lie at the end of the West Kennet avenue, with the final course, and the nature of any terminal structures for the Beckhampton avenue, as yet unknown.

Large round barrows, but none on the scale of Silbury Hill, occur at most of the large henge enclosures, and so they have been listed in this analysis (TABLE HE-04), to determine whether the relationship suggested between the henge and mound at Avebury is seen elsewhere (see Table of Contents: 03f/2d). This does not seem to be the case: the barrow at Marden lies within the enclosure, at Mount Pleasant on its W'n perimeter, and at Knowlton to the E of, and in general proximity to, all of the four henges. Only at Duggleby, an atypical site with possible henge-like qualities, is there a case to be made, and here in an association different from Avebury. The large round barrow at the centre of its circular enclosure might have provided a viewing platform for observation of the S'n sky, through a large gap in the ditched perimeter located in this direction.

..Stonehenge (e-FIGS HE-29 to 35);

The general structure of the Avebury complex, and the possible solar associations outlined above, invite comparison with the layout at Stonehenge (e-FIG HE-37). In the same way that the avenues at Avebury appear to define the limits of the permanent zone of solar transit (TABLE AS-01), it could be suggested that the Avenue at Stonehenge might have done the same. Here, sectors 1 and 3 of the Avenue align to the SE, and SW respectively, separated by the more E'-W'ly central sector 2 (TABLE HE-13). Equally, more practical considerations could be argued to explain its shape, probably more persuasively: that the Avenue had to curve, in an easy, staged line around a headwater valley, simply to avoid more difficult terrain. At Avebury, the two avenues splay, to run along more level ground either side of a hill, and again it is a question of arguing primacy, either for design, or for topographical constraint.

At Avebury, the main henge acts as a node for the two avenue-arms, only one of which, the West Kennet, is definitely known to have a ring structure as its terminal. At Stonehenge, the henge itself acts as a terminal for the Avenue, with the other end marked by the smaller Newhenge and earlier circle. The sectors of the Avenue, taken from 1 to 3, and progressing towards the W, could individually match with limiting positions, and equinox, for the setting solar transit along the W'n horizon, with obvious funerary connotations (see Table of Contents: 02c/2I; e-FIG HE-37). Taking the S'n view from the Avenue, its sectors could also have acted, symbolically, to enclose the permanent zone of the transit, with sector 2 as its base line. These two general statements of ritual intent, one W'n, one S'n, would have been supplemented by further detailed alignment at the main terminal henge itself.

Possible sub-groups

Within the general sample of henges, if there are sub-groups where the interior is approached towards the S (little evidence: e-FIG HE-39), or traversed along the general N'-S'ly line (clearer evidence: e-FIG HE-39), then examples given in e-FIG HE-40 (single entrance), and in e-FIG HE-41 (double opposed entrance) provide clear examples.

A sample of individual sites that display this axis are listed in TABLE HE-18:

TABLE HE-18 Examples of henges approached, or traversable from the N'n quadrant

			opening at °G from centre	e-FIG HE-
single entrance				
Catterick	N Yorks	SE 2304 9854	018	23
Dorchester site VI	Oxon	SU 5686 9580	007	CU-02
Gorsey Bigbury	Somerset	ST 4842 5582	000	38
Stones of Stenness	Orkney	HY 3067 1252	000	AS_st-01 and 01a
Wilsford	Wiltshire	SU 0933 5733	021	RB-04
Woodhenge	Wiltshire	SU 1506 4337	025	02
Maxey	Cambs	TF 1260 0772	E	-
double opposed entrances				
Abor Low	Derbs	SK 1603 6355	157-320	41
Avebury	Wilts	SU 1026 6996	068-257; 164-332	01
Ballymeanoch	Argyll	NR 8332 9628	017-197	-
Broomend of Crichie	Aberdeen	NJ 7792 1967	000-180	-
Bull Ring	Derbs	SK 0784 7824	000-180	-
Cana Barn	N Yorks	SE 3608 7185	173-353	22
Coupland	Nlnd	NT 9405 3307	163-343	14
Cairnpapple	W Lothian	NS 9872 7173	000-180	42
Dorchester Big Rings	Oxon	SU 5720 9537	153-333	CU-02
Durrington Walls	Wilts	SU 1501 4375	124-304; 175	02
Eggardon Hill	Dorset	SY 5468 9461	NNW-SSE	-
Ewart Park	Nlnd	NT 9569 3172	130-310	15
Hutton Moor	N Yorks	SE 3526 7353	171-351	25
Knowlton Church	Dorset	SU 0239 1028	041-221	09
Maiden's Grave	Humber	TA 0967 7063	134-314	CU-13
Milfield North	Nlnd	NT 9338 3490	010-190; 245	19
Newton Kyme	N Yorks	SE 4593 4499	174-354	26
Nunwick	N Yorks	SE 3229 7484	172-352	27
King Arthur's RT	Cumbria	NY 5233 2838	144-324	-
Round Hill	Derbs	SK 3334 2834	122-302	-
Stowe Farm	Herefs	SO 2826 4771	150-330	
Thornborough N	N Yorks	SE 2805 8005	144-324	08
Central	N Yorks	SE 2854 7946	145-325	08
S	N Yorks	SE 2895 7885	147-327	08
Willersley/ Winforton	Herefs	SO 2928 4731	130-310	-

Key: Nland Northumberland); **RT** Round Table.

Clarity of views from the interior of henges

Entrance gaps in the bank of a henge might have allowed only laterally confined outward views, near ground level, if the surrounding enclosure bank was high. A low horizon might have been obscured, but with the sky at greater elevation remaining unrestricted for the entire circuit.

Taking nominal values for the radius, and height of the perimeter bank at Avebury, and Stonehenge, would give a horizon at the perimeter elevated by less than 2°, as viewed from the centre:

	rad	ht	angle
Avebury	220	6	1.6
Stonehenge	49	?1.5	1.7

Key: rad(ius to the mid-line of the bank in metres); **ht** projected height of the bank in metres; **angle** (of elevation in degrees)

This does not take account of any further features constructed on the bank itself, such as fencing, or post-work, which further blocked the level, outward view. Obviously, the displacement would be higher for smaller sites, and with deeper ditches providing higher banks. At Stonehenge, the situation is extreme, since the megalithic rings clustered around the centre further obscure most lines of sight.

There is some evidence that entrance areas to henges might have been selectively obscured, with adjacent surviving banks often appearing to be higher (Gibson 2005, 112-116). At Avebury, a deviation in the West Kennet Avenue delays a view of the entrance until on the final approach, with two large portal stones further obscuring it. At Stonehenge, a direct view of the entrance is possible only on final approach along the Avenue, its inner, and outer sides further flanked by stone, and possibly by timber structures.

Together, this evidence might suggest that, assuming observation of celestial bodies was involved, events higher in sky, such as transits, or near-risings, or -settings, would be more amenable.

TABLE HE-19 Henges and hengiforms from England, Wales, and Scotland: a working sample: basic properties

This table, containing an interim working list of henges and hengiforms, has been placed as a text file in the folder TABLES_filed, on account of its length, and the partial nature of some data.

Outer perimeters of henges: the shaft-ring at Durrington Walls

Summary [analysis and conclusions by AJM: from data in Gaffney *et al.* 2020]

The shaft-ring at Durrington Walls, as currently-known, can be interpreted as marking the line of a serially pitted, partial boundary, perhaps also embanked, or mounded, set in two separate arcs, possibly of different structural focus, and phasing, which acted to provide outer limits for the henge, enhance the approach, and channel access into defined zones, serviced by lateral entrances.

Attempts at fitting the henge, and shaft-ring into close axial correspondence with liminal solar events at the horizon are entirely unconvincing, over reliant on general, outward viewing, from selected points. Sight-lines from the henge, or its immediate vicinity, towards the shafts are topographically obscured to varying degrees, radial inter-visibility between shafts is also weak in places, and views taken outward from shafts toward solar events are without apparent foresights, and hence without convincing linear definition by 3, or more points.

An alternative interpretation in terms of the broader solar transit is suggested here as possible but, on present evidence, a more functional non-astronomically based function for this *temenos,* and indeed for the whole henge, must remain the preferred option.

Durrington Walls henge:

Further details of the site are given elsewhere in this section on henges (see Table of Contents: 03f/6a).
The location of the site and its layout are summarised in e-FIGS HE-42 to 44.

Structural analysis of the shaft-ring (e-FIGS HE-44)

The following data on form, and structure relate to further interpretation of this shaft-ring:

-disposition

Current data indicate two separate zones in which large, spaced shafts occur, the N'n and S'n arcs. The intervening W'n sector, an area covered in detail by magnetic prospection, seems free of potential shafts; the opposing E'n sector, which lies beyond the river, has yet to be explored and, because of its separation from the W'n bank, might have been excluded from the overall circuit, the river itself forming sufficient boundary.

The henge was sited in a sheltered area, immediately fronting the river, on a self-contained SE'ly sloping hillside, and generally facing away from the known circuit of the shaft-ring, which appears to shield the henge, up against the river, forming a protected location. Had celestial interest been a priority, the henge would have been better sited on the low hill immediately to its WNW, large enough for such a major site, one with extensive views, and still retaining practical proximity to stream-heads, and the river itself.

The N'n arc of shafts follows the bottom of a small valley, which shapes much of its course, and is separated visually from the area of the henge by two low ridges, with an intervening valley. The S'n arc runs over the flanks, and lower slopes of spurs, that extend S'ward from the henge, the view of their locality from it somewhat obscured. The single shaft at the W lies behind a low hill, when viewed from the henge.

The early Neolithic causewayed enclosure at Larkhill lies at the most W'ly known limit of the N'n arc of shafts, and also on the main SE'-NW'ly axis proposed for the henge, but the two enclosures are not intervisible.

The only feature that connects these arcs to each other as a coherent shaft-ring, and to the henge itself, is a notional best-fit circle, centred on the henge, that can be fitted to them. Individual best-fit circles for each of these arcs indicate use of a different focus for each. The focus for the N'n arc is located fairly centrally within the henge itself, and this circle also approximates the line of the S'n arc.

A separate, smaller circle, of better localised fit, can be drawn for the S'n arc, its focus lying 317m to the SSW of the henge [at bearing 197° from the centre]. Either the two known arcs are separate, partially circular ring-structures, perhaps differently phased, or they form part of a larger ovate ring, incompletely known at present. Regularity of fit between arcs and individual best-fit circles might support the former alternative.

Directional data for the arcs, taken from the centre of the henge are as follows (TABLE HE-20):

TABLE HE-20 Durrington Walls: shaft-ring: directional data

arc	diam	#shafts	arc	id	azim	spacing	cored?_depth	date
N'n	2300	9	59.7	iii	310.8	-		
	area:			vi	318.6	7.8		
	420 ha			10	328.1	9.5		
				11	334.1	6.0		
				12	343.4	9.3		
				13	349.0	5.6		
				v	354.4	5.4		
				gap	.....	22.9		
				14	017.3	-		
				15	027.8	10.5		
S'n	**1450**	10	75	1	156.4	-		
	area:			i	173.1	16.7		
	170 ha			2	180.2	7.1		
				3	183.7	3.5		
				4	187.9	4.2		
				5	194.9	7.0	yes:?<>7m	MBA ?=recut
				6	200.9	6.0		
				7	209.1	8.2	yes:4.8m	
				8	220.8	11.7	yes:4.8m	later Neo
				9	231.4	10.6		
W'n	-	1	-	ii	277.8	-		

Key: diam [eter]**:** of the best-fit circle; **#**: number of shafts; **arc** the total angular sector between terminal shafts, as described from the centre of the henge; **id**: identification code for each shaft; **azim**[uth]; **spacing**: angular separation between shaft-centres; **Neo**[lithic]; **MBA** middle Bronze Age

Averaging the angular separation of the known shafts that form the N'n, and S'n arcs, using the centre of the henge as an origin, gives a mean value of 8.1° (sd 3.3). Applying this separation to estimate a maximum possible circuit, including those sectors where no shafts have yet been detected, or may never have existed, allows at least some statement of a notional maximum, here calculated as 45. Practical limits can also be set to possible completeness for the detection of further shafts, by using this mean spacing to identify those potential localities that are clearly inaccessible, as where built over, hence for which further investigation is not currently possible.

-form

Structural and magnetic similarities between shafts suggest a coherent, parent ring-structure, consisting of individual units 15-20m in diameter, each surrounded by a margin of reduced magnetic response, this perhaps indicating traces of upcast (Gaffney *et al.* 2020, figs. 2, 3, 5-8). Alignments of smaller pits, in the areas of the N'n, and S'n arcs, may suggest additional definition of the line. Three of the shafts in the S'n arc were cored: shafts 7 and 8, both with depths established at 4.8m, and shaft 5, cored to 7m, but with no definite base established.

Volumetric calculation of spoil, generated by construction of such shafts, has to be taken into account, in discussing the possible final form of this ring-structure, bearing in mind that the weathered shafts are only the truncated remnant of an original, and likely more imposing structure.

Average values of diameter, at 8.5m , and depth, at 5m, can be suggested for the original dimensions of a typical shaft, based on the weathered, mean diameter of 17m of all shafts, as detected at the surface, apparent from magnetic mapping, and by noting depths determined by coring to bedrock in two cases.

Based on these values, construction of such a shaft would have removed 308m^3 of solid bedrock, to which a 'bulking factor' must be applied, to covert it into the volume of rubble produced (multiplying factor: 1.46, as averaged from 14 values presented in civil engineering data for chalk), giving 450m^3, rubble that must be utilised, or spread.

Given a mean inter-shaft spacing of about 161m [calculated from the diameter of the larger best-fit circle, and the average 8^o angular separation between shafts], this rubble could have formed a ditchless bank about 3m wide and 2m high, linking shafts, and perhaps, for reasons of safety, enclosing them. Such added structure would convert the spaced shaft-ring into a more continuous, but not entirely defensive *temenos*, shielding the N'n and S'n approaches to the henge, channelling access into defined sectors, and generally enhancing the setting, by addition of another imposing structure. Three such concentric circuits are currently known at the henge: arcs of up to about 100 large pits, suitable for standing stones, or for timber posts, were detected beneath its bank, and following its general line (Gaffney *et al.* 2018, figs. 8-14/ pp. 8-12); these pits were covered by the bank itself, with its internal ditch; and the outer shaft-ring lies set beyond, at some distance.

The S'n arc of shafts runs E'ward up to the river, and the N'n arc also heads in the same direction towards it, but might have left access, if the gap from arc to river is real. So, on current evidence, suitable lines of less restricted access appear to have been encouraged from the W, and from the N, along approaching ridges, chanelling general traffic towards side-entrances in the S'n and NE'n perimeter of the henge, additional to that in its SE'n side, which appears to provide more restricted access to the river-bank itself.

Alternatively, spoil from each shaft could have formed a large conical mound**,** for instance, one 20m in diameter, and 4.3m high, in which case the entire arc would have constituted a ring of landmarks visible from some distance, each capable of supporting an additional structure, such as the base of a substantial vertical post. Such enhanced visibility would modify some of the constraints on outward viewing of the circuit imposed by variable terrain (Gaffney *et al.* 2020, *passim*).

Reasons as to why shafts were dug, rather than a linear ditched perimeter, with integral bank, as was done for the henge itself, might have included the following:

..a shaft would have been a more efficient means of generating clean, white chalk rubble, of a type only available at greater depth, and hence deemed suitable for a more visually arresting boundary;

..alternation of shaft and bank would have rendered the boundary feature suitably unusual, as might befit a major site with specific ritual associations;

..any bands of flint encountered during construction might have formed a useful by-product;

..depending on the season, and relative position of the water-table, the shaft could have provided a convenient, incidental source of water, in areas set at some distance from the river, as seems likely motivation for construction of the shaft-well at Wilsford 33a (Ashbee *et al.* 1962).

Current astro-archaeological 'analysis'

-basic criticism

Being within the ambit of Stonehenge, with its long-standing array of suggested astronomical associations, the henge at Durrington Walls, lately deemed a 'super-henge', has come under similar scrutiny, and pressure to yield similar results.

The most recent attempt at interpretation of Durrington Walls in terms of 'archaeo-astronomy' is presented as part of the Stonehenge Hidden Landscapes Project in the area of the henge (Yorston 2020, in Gaffney *et al.* 2020). As well as being specific to the site, this analysis provides an example of current approaches to the subject-area.

In this recent study, here under distinct criticism, certain unwarranted assumptions are made, a selection of which follow, with additional comment bracketed thus [..]:

assumptions that:

..there is *any* **celestial basis** in ritual for the alignment of extant structures, let alone those involving liminal solar events; [the sheltered location of the henge has been discussed above as being generally unfavourable to observation];

..**lunar cycles** can play no part here, it was stated, this option discarded immediately, without explanation; [it is as difficult to fit lunar events to the site, as it is to fit solar];

..observation of solstitial **rising and setting events** ***at the horizon*** were the major motive for establishment of axial alignments at the site; [axes proposed as important appear structurally minor, discordant, or unproven];

..that general **outward viewing** from various points, well beyond the henge was of key importance; [the choice of view-point appears arbitrary, and if two-point viewing of sunrise, or set is allowed, then anything becomes possible];

Certain options are not discussed in detail; these include:

..**viewing of the celestial events outward** from the interior, or immediate perimeter of the henge, concentrating on views of selected sectors of the horizon outward from the area of the shafts instead; [celestial events above the local horizon would have been well in view from the immediate henge];

..considering **lines drawn between points** in the opposing arcs of the shaft-ring as forming potential axes worth considering, if only negatively; [although there is the problem of intervisibility, such unlikely lines might have been passive in operation, rather than actively utilised (see Table of Contents 02a/2f and 2g: active and passive axes)].

In contrast to clear 'sight-lines', notional axes defined by points that are not intervisible, could be described as 'out-of-sight' lines. Shafts in the opposing N'n and S'n arcs form pairs largely of this latter type, as considered from within the henge, or from each other. The SE'-NW'ly axis across the henge also passes through the Larkhill causewayed enclosure, neither site clearly visible from the other, yet this has been considered worth noting (Gaffney *et al.* 2020). There are many other examples of such 'defective' axes in the landscape of Stonehenge-Durrington Walls, where sites remain visually separate, or are linked, often marginally, by restricted liminal views. Nevertheless, such 'out-of-sight-lines' might have been considered valid, the intention to connect even non-visually beyond the local horizon being sufficient. Churches and mosques provide a modern parallel.

..dubious data are used to substantiate precise astronomical correlations:

...a **major axis for the henge**, traditionally proposed as solstitial, runs from the well defined entrance at the SE, to another, as yet unlocated, opposing entrance, described as 'putative', but shown as an gap on plans (Gaffney *et al.* 2020, fig. 9.3), with the inner ditch in this area nevertheless remaining continuous (Gaffney 2018, figs. 14-15/ pp. 12-13). The exact details of such gaps in the circuit need to be clarified before any further analysis of an axis.

The avenue beyond the SW'n entrance, leading outward towards the river, has a published bearing of 126.5º (as measured from: Parker-Pearson *et al.* 2008, fig. 9/ p. 159), and this might give a better indication of any fuller axis.

...the **entrance of the S'n structure,** formed by concentric timber circles, has been shown in precise correspondence with the winter solstice sunrise, as adjusted for the later Neolithic, and for current local conditions of the horizon in this sector (Gaffney *et al.* 2020, fig. 9.1).

However, alignment of plans for this structure differ between published versions, and subsequently with reality (Wainwright 1971: *general area* in figs. 2, and 5; *S'n structure* in figs. 11, 12, 14, and 84; Parker-Pearson *et al.* 2008, fig 12/ p. 121; *N'n structure* in figs. 17, and 87); *general*: Gaffney *et al.* 2018, 2020, fig. 14/ p.12).

Attempts to recalibrate, and unify these published plans according to rectified satellite imagery indicate insoluble discrepancy of up to 5 degrees. Such data are not sufficiently reliable to allow the sort of correlation seen in Gaffney *et al.* 2002, fig 9.1 [S'n structure: entrance posts 22, and 23 are shown at 127º, and 137º, with the sun placed midway at 130.5º]. The problem here is that there are plans, but no definitive *plan* anchored to the National Grid.

The relevant half of the S'n structure now lies covered by the modern road, and its precise alignment can not be recovered as primary data, hence definitive analysis is not possible. The entire premise of a deliberate sight-line seems weak, because the 'axis', as it enters the post rings towards the centre, would have been occluded by timber-work, the entrance-passage is anyway set off the radius, and even if this was the true intention, it would surely have been a very minor feature of alignment, at the structure itself, and certainly for the site in general.

Furthermore, discussion of such an axis for the S'n structure alone is selective, omitting the inconvenient fact that the similar N'n post-structure shows no such solstitial alignment (Wainwright 1971, fig. 17/ p. 42). Rather, its line of timbered approach seems placed practically leeward, and facing usefully down-slope towards the S [about 189º], in spite of the fact that it would have been even better placed than the S'n structure to receive the sunrise at winter solstice, since it was located on higher ground. A further exception is provided by another enclosed post-structure, with facade and approach facing differently again, towards about 105º (Parker-Pearson *et al.* 2008, fig. 16/ p. 163).

The best that can be said here with any confidence is that for practical purposes:

..the **entire henge** was placed to occupy a conveniently sheltered, gentle SE'ly-facing slope, containing what might have been the channel of a small water-course, and was purposefully positioned close to the river, with an entrance naturally at the SE, for shortest riverine access. As well as the aspect of the slope, the narrow valley, running NW' to SE'ward across the site would have provided a natural axis, and a cue for lateral symmetry at the henge, independent of anything solar.

It is worth noting that the low hilltop immediately to the WNW of the henge seems the ideal location for a more open, and imposing site. This low hilltop has been identified as a possible general viewing point in all directions, well described as a *panopticon*, looking out towards the S, over the area of the henge, and towards the Stonehenge area, with its surrounding monuments, at some distance to the W (Parker-Pearson *et al.* 2004, fig. 6/ p. 51).

..the **S'n timber structure**, roofed, or as an open structure (Wainwright 1971, fig. 84/ p. 205), occupied the immediate interior foreground of the SE'n entrance, with its passage opening towards it, simply for ease of access, and for practical positioning on the leeward side of its circuit, to be sheltered from W'ly weather.

-points for viewing, and solar events at the horizon are proposed, with no intervening foresight to further qualify the axis at a third point:

Views from various shafts are proposed, taken directly towards solar events, and weak topographical features on the distant the horizon, with no justification for any of these elements being especially relevant to such a process;

-degrees of correspondence between proposed structural axes and solar events vary according to convenience:

-the axis for the S'n structure, and the main transverse axis for the henge are *exactly* fitted to solar events (Gaffney *et al.* 2020, fig. 9.1);

however,

-the lines of observation from the entire S'n arc of shafts is said to follow the sunrise over the horizon towards Boscombe Down;

-possible axial inter-relationships between the N'n and S'n arcs are not pursued:

A great many archaeo-astronomical interpretations involve much unrestrained ruler-work between conveniently selected points, intervisible or not, and celestial targets (Thom and others: see Table of Contents: section SC- on stone circles, *passim*). Its absence here constitutes progress. Instead, we move to general outward viewing as a valid basis for discussion.

A different interpretation

The above study (Yorlton 2020: in Gaffney *et al.* 2020) attempts to impose the familiar pattern of horizon-based solstitial limits on weakly apparent axes at the site, and on prospective views from selected view-points. The approach is also small-scale, proposing minor axes, and involving undefined views from peripheral features. Surely a super-henge, centrally placed, and a key element in the complex monumental landscape of central Wessex, would require some more ambitious celestial model as a basis for its ritual, if it had one at all.

Although equally unprovable, the following suggestion looks at what *emerges from*, rather than what can be *imposed upon* known structures, considers *events above and beyond the horizon*, and has the distinct advantage of being suitably *large-scale* for such an important henge in this core area of Wessex, rather than one over-focused on minor detail. Despite this, it remains unconvincing, in part because it depends on an absence, rather than a presence of data, namely, on a gap between features, instead of amongst fixed structural points.

In this re-appraisal, details of solar risings, and settings are not calibrated for precise local horizons, nor adjusted to the later Neolithic transit, this not considered necessary, since ancient viewing was more likely to surround the event rather than being restricted to one particular moment within it, such as first, or last, (dis)appearance, or mid-point of the solar disc, if this was indeed the target. Modern azimuths quoted at the zero horizon are considered sufficient here, as a means to highlight sectors of possible axial coincidence.

As well as retro-fitting the henge to horizon-based solstitial events, as a similar exercise, with sufficient will, it can also be made to fit the lunar cycle, to propose lunar associations: an enterprise not pursued here.

TABLE HE-21 Durrington Walls: data on solar and lunar limits

Data below are also shown in e-FIG HE-44:

Durrington Walls henge: centre
SU 1500 4372; latitude 51.1924; longitude -1.7868;

-solstice positions:
Key: SS summer solstice; **WS** winter solstice;
Data: suncalc.org; modern azimuths; all at zero horizon;

limit		time		azimuth
SS	set	21h	27 min	310.25
	rise	04	53	049.53
WS	set	16h	02 min	231.95
	rise	08	08	127.87

-lunar limits:
Data: for latitude 51°: after TABLE AS-04:

moonrise				**moonset**			
max to		min to		max to		min to	
N	S	N	S	N	S	N	S
major		minor		major		minor	
039	141	059	121	321	219	301	239

The problem with these two arcs of shafts, from the standpoint of traditional archaeo-astronomical analysis, is that, considered from the interior of the henge, even from its periphery, they are largely invisible, and anyway lie almost completely within the inter-solstitial zones: to the N, the null zone, with no solar activity, and to the S, the permanent zone, with no risings, or settings, just daily transits at elevation (see Table of Contents: 02c/2a; e-FIG AS-01). In more detail: for the 9-shaft N'n arc, all the shafts (10-17 inclusive) lie within the null zone, with only shaft 10 near the line of midsummer sunset; in the 10-shaft S'n arc, nine of the shafts (1-8 inclusive) lie within the permanent zone of the transit, and one (shaft 9) near the line of the midwinter sunset. Drawing speculative lines between shafts, therefore, becomes unproductive in terms of any horizon-based solstitial targets. However, actual inter-visibility might not have been critical to operation of the shaft-ring if these axes were passive, set to establish a celestial context for the site, rather than to provide an active venue for observation, as discussed just below.

Looking again at the two arcs, and accepting their layout as valid, the most obvious *potential* correspondence between a larger-scale shaft-ring, and the solar transit would be the gap between the current ends of the N'n, and S'n sectors, lying beyond the W'n side of the henge. Taken from the centre of the henge, shaft 9, at the W'n end of the S'n arc, lies in the direction of the midwinter sunset, and shaft iii, at the W'n end of the N'n arc, lies towards that of the midsummer sunset, the gap between them, if real, framing the transitional zone of the setting sector of the solar transit (see e-FIG AS-01), as it moves from N to S to N throughout its annual cycle.

Visibility of the shafts, or of any associated embankment, might not have been essential, because this framing need not have been a target for *direct and active* observation, even at the solstitial limits, but a background feature, once established, acting passively to lock the site permanently into the solar cycle (see Table of Contents 02a/2f and 2g: active and passive axes). Choice of framing the *W'ly setting* transit, given its frequent association with death and the ancestors, might have provided the setting for related activities that took place within the enclosure. This model has the advantage of including an arc, with lateral limits, each defined by a general three-point axis: from the interior of the henge, through the edge of a structurally-defined gap, and on to the seasonal extremes of the setting solar transit, rather than relying on a two-point system, from viewer straight to viewed. It is also a broad celestial target, as are those proposed for other monuments in this general survey (see: e-FIG CO-01).

In this key area of S'n Britain, the landscape, and its monuments, during the Neolithic period and earlier Bronze Age, have been discussed as possibly ancestral in general emphasis, with the zone around Durrington Walls more for the living, and that around Stonehenge reserved more for funerary activity, and ancestor-related rituals (Parker-Pearson *et al*. 2004, figs. 4 and 5/ pp. 49-50). If the gap in the W'n side of the shaft ring at Durrington Walls did indeed frame the W'n solar transit then, in addition to the river, and the Stonehenge Avenue, this could have provided another link between the two areas.

Shafts: ritual, functional, or both

There appears to be some concentration of potential shaft-features to the W of Durrington Walls-Stonehenge (e-FIG HE-42), and also of pond barrows, some of which at least, judging by the example of the well-shaft at Wilsford 33a, might mark the site of others (APPENDIX HE-01). The function of such shafts, probably hybrid, might range from the practical (flint mines, wells), to the ritual (funerary activity, deposition of material), and could include a range of natural features (solution hollows, tree throws), either irrelevant to human activity, or utilised, as further modified, or left unchanged. Potential examples from the area appear scattered, with some localised clustering, but nothing in scale, or layout to compare with the shaft-ring at Durrington Walls. If such individual shafts had a particular ritual significance, then drawing a ring of them around the henge might have had particular potency. Further verification of structure, and detailing of content must await excavation of other shafts.

Parallels

Other individual cases of shafts from Wessex, that have been investigated, include the following:

-Maumbury Rings; Dorset; SY 6902 8992; SY68NE 2; 451843; Bradley 1975;

a later Neolithic henge enclosed by a bank, and internal ditch; the ditch was formed by a ring of 45 shafts, each about 3m in diameter, and 9-12m in depth; fill contained antler, animal-, and human bone, flints, and carved chalk, including a phallic object; these features might have been deliberately backfilled.

-Monkton up Wimborne; Dorset; SU 0173 1475; SU01SW 94; 882592; Green 2007;

a ring of 14 widely-spaced pits surrounded a larger central pit, 10m in diameter, and 1.5m deep, with a 7m deep shaft at its edge, this latter associated with a platform, and a multiple burial; the fill of the pit contained debris, possibly associated with feasting, and that of the shaft produced special deposits, including carved stone objects; earlier Neolithic in date;

-Gussage St Michael; Dorset; SU 0017 1467; SU01SW 163; 1317487; Green and Allen 1997;

a shaft, natural, at least in part, up to 9.5m across its weathered top, was excavated to a depth of 13m, then augered for a further 12m without the bottom being reached; the shaft cut through seams of low-grade, possibly unexploited flint; the upper 3m of fill contained material of Mesolithic to earlier Bronze Age date, with clear stratification, and providing an environmental sequence; finds included pottery, and flint artefacts, with some occupational-type debris present.

e-FIGURES: combined listings and supporting information

e-FIG
Large henge enclosures:
Area-plans provide detail for five large henge enclosures, and for Duggleby, a site with possible affinities, included here for comparative purposes.

HE-

01 Henge: Avebury SU 1069

02 Henge: Durrington Walls SU 1543

03 Henge: Marden SU 0958

04 Henge: Mount Pleasant SY 7089

04a Henge: Mount Pleasant SY 7089: aerial view towards the W

05 Henge: Waulуds Bank TL 0624

06 Duggleby SE 8866

Linear groups of henges:
Two clear cases of linear siting of henge enclosures, with Knowlton less so:

HE-

07 Henge: Priddy group ST 5453

08 Henge: Thornborough group SE 2879

09 Henge: Knowlton group SU 0210

Study area: linear distributions in the Milfield basin: Northumberland
A distinctive local grouping of smaller hengiform enclosures, and a possible avenue linking them:

10 Milfield: general area

11 Milfield: detailed area

12 Milfield: avenue

13 Milfield: Akeld NT 9530

14 Milfield: Coupland NT 9433

15 Milfield: Ewart Park NT 9531

16 Milfield: Flodden NT 9235

17 Milfield: Ford NT 9337

18 Milfield: Marleyknowe NT 9432

19 Milfield: Milfield N NT 9334

20 Milfield: Old Yeavering NT 9230

Study area: linear distributions in the Swale-Ure area: N Yorkshire
A distinctive local grouping of larger henge enclosures:

21 Swale-Ure: general area

22 Swale-Ure: Cana Barn SE 3671

23 Swale-Ure: Catterick SE 2398

24 Swale-Ure: Ferrybridge SE 4724

25 Swale-Ure: Hutton Moor SE 3573

26 Swale-Ure: Newton Kyme SE 4644

27 Swale-Ure: Nunwick SE 3274

28 Swale-Ure: Devil's Arrows SE 3966
The axis of this short stone row is similar to that common amongst the henges in this group, and the site is included here for comparative purposes.

Monuments in the area around Stonehenge:

29 Stonehenge SU 1242: general area

30 Stonehenge SU 1242: locality

31 Stonehenge SU 1242: detailed area

32 Stonehenge SU 1242: plan
The sequence of structural phases, their underlying geometry, and their axes, are shown in layered format. Stonehenge area: the solar transit at the solstices:

33 Stonehenge SU 1242: summer solstice sunrise

34 Stonehenge SU 1242: winter solstice sunset

35 Stonehenge SU 1242: relationship between the axis and solar transit

Stonehenge and Avebury:

36 Henges: Avebury SU 1069 area: the surrounding distribution of round barrows and cemeteries

37 Henges: Stonehenge SU 1242 and Avebury SU 1069: comparison of the henge-avenue complexes
Basic plans of these major henges, together with their avenues might suggest definition of sectors in the S'n sky, and indicate a major role of solar rituals in their operation.

Other henges:

38 Gorsey Bigbury, Mendip ST 4855

Small henge, with an entrance at the N.

Other figures:

39 Henges: orientation: histogram
Histograms of axial orientation for various types of henge enclosure.

40 Henges with access to the interior from the N
Examples with a single entrance.

41 Henges with access to the interior from the N'n and S'n quadrants
Examples with double, opposed entrances.

Durrington Walls: the shaft-ring

42 Durrington Walls: general area

43 Durrington Wall: published plans

44 Durrington Walls: the shaft-ring

Section 03g:
Prehistoric rock-art in Britain: orientation of motifs within panels

Section identifier: RA-

SEE INITIAL SECTION:
Access to digital images

motifs at Hunterheugh (Northumbria)

Summary:
Topographical location of rock-art sites, and orientation of motifs within them, suggest a broad alignment to the SE'n and SW'n quadrants. This preference is discussed in terms of ritual based on the solar cycle. The possibility that proliferation of cup-sites during the later Neolithic, and Bronze Age was a response to challenging environmental conditions is also outlined.

The following topics relating to rock-art are discussed:

-**regional groupings**;
-**association** with barrows, stone circles, and other megalithic monuments;
-**distribution** in relation to rock-type, climatic conditions, and areas of upland peat-growth;
-the **orientation** of panels, and of individual motifs;
-**case studies** in the Cheviot area, and in Scotland;
-**supplementary information** on specific locations.
Note: the term 'art' is used here merely for brevity, and contains no deeper interpretive content.

Introduction

Areas of prehistoric rock carving occur widely in areas of Atlantic NW'n Europe, where suitable exposures of harder bedrock occur (Bradley 1997). There are many areas of N'n, and W'n Britain, and of Ireland, that have regional groups of extensively figured outcrops (e-FIG ND-01d), and these have been the subject of considerable survey, and comment (see Table of Contents: 09 Bibliography/ Morris 1964-1981; Beckinsall 1974-2009). In addition to rock-fast carvings, created in seemingly remote areas, motifs occur widely amongst megalithic monuments, such as on chambered tombs, stone circles, and stone rows, also in more portable form, on smaller stones.

Sites of rock-art are included in this general analysis because, not only do they contain elements of alignment amongst their motifs, but they also occur as additions to other types of monument, often with distinct placement, adding another element to their joint interpretation.

The motifs employed are varied and, for Britain, and Ireland, are almost entirely abstract, although figurative animal, and human representations do occur elsewhere, as in N'n Europe (Gelling and Davidson 1969), N'n France (Twohig 1981), or the Italian Alps (Fossati *et al.* 1990). Amongst British examples, concave cup-marks, some surrounded by concentric ringed channelling, simple curvi-linear elements, and longer channelling dominate the repertoire.

Collectively, for convenience, these motifs are referred to in this analysis as 'rock-art', without the term 'art' necessarily carrying any of its modern connotations. Although the function of such carving remains unknown, the consistency of motifs over wide areas suggests access to some ritually significant corpus of symbols, of more than decorative content, and local application (Walker and Smith 2008). The high recurrence of motifs at many sites suggests lower-level activity over a long period, or the type of repetitive behaviour seen in construction of other monuments during the period, as noted for augmented barrow monuments, cursus sites, stone rows, and henges (see Table of Contents: 03b to 03d and 03f). All such structural restatement might perhaps indicate intensified propitiation, under conditions of environmental stress.

In most instances absence of stratigraphic bracketing, and of clear structural associations, make these motifs difficult to date. However, their general form, and certain stylistic elements, also their occurrence on funerary structures, and stone circles, and occasional data from excavation, suggest the Neolithic and Bronze Age as a prime period for production.

In Britain, examples of sites where more precise dating evidence has been obtained include the following:

-**Fowberry**, Northumberland: motifs on rock faces in, and under the cairn (see this section: Supplementary information/ rock-art on barrows);

-**Hunterheugh Crags**, Northumberland (Waddington 2004, 2005)
At this site, an earlier phase of carving was indicated, in which simpler working of the rock-face, in discrete areas, incorporated natural undulations of the surface. Weathering of these motifs suggests that a significant interval elapsed before a second phase of working occurred, during the earlier Bronze Age, involving quarrying of the rock, damage to earlier carving, and addition of new carvings, differing in style, and complexity, made on fresh surfaces. Large slabs were quarried, and removed, to form a cleft, in which a small cist was constructed. This cist contained no bones, but any such might have been destroyed by local conditions of acidic soil. A plano-convex flint knife, of earlier Bronze Age type, came from adjacent debris. The grave was covered by a cairn that overlay some of the carvings from phase 1, and housed another stone setting, higher up, possibly a secondary insertion, but again with no surviving deposits of bone.

-Excavation around one group of panels on **Tayside** (Bradley *et al.* 2012) has provided further details of context and environment (see Table of Contents: 03g/11).

Distribution of rock-art in Britain and Ireland

In order to suggest possible functions for such rock-art, it has been necessary to establish its national distribution, and those for other types of monument, to provide a general context (see Table of Contents: 01/3).

Data from a total of 2,514 sites producing earth-fast rock-art were compiled, and plotted by 10km^2 grid squares over Britain, and Ireland. In order to enable realistic comparisons to be made between individual sets of data, distributions of other monuments, and aspects of the physical environment are presented as layered digital images (e-FIGS ND-01d to 06d).

The count used for this preliminary assessment of rock-art excludes those cases on portable stones, and is confined to examples fixed on bedrock, or large static boulders. Sites are counted as equivalent, irrespective of their complexity, which can vary from one, or a few, nondescript cups, to elaborate panels. The aim has been to produce a robust general distribution, showing any patterns of regional grouping, within which more detailed analysis could be presented, and possible relationships with environmental factors discussed. Regional groupings, and more localised clusters within them, have been named appropriately.

Regional groups and local clusters

Rock faces, and portable stones, marked with cup-, cup-and-ring, and other motifs, occur widely over the Highland Zone of Britain, with notable concentrations in Scotland, and N'n Britain, but in Ireland there are fewer, with concentrations weaker and, in the SW'n Peninsula of England, fewer still. Re-analysis of the national distribution indicates some 15 regional groupings (e-FIG ND-01d to 06d).

These 15 **regional groups,** thus established, can be broadly divided into **major**, **intermediate**, and **minor,** in terms of their intensity, and spread, as set out in TABLE RA-01. Where discrete, larger-scale concentrations within these groups have been identified, they have been termed **sub-groups**, with **clusters** appearing at the most localised level as, for instance, in the Cheviot, Argyll-Kintyre, and Galloway groups, examined in closer detail (e-FIG RA-01).

TABLE RA-01 Rock-art: regional groups

groups:	**area**	**maps:**
-major		**e-FIG RA-**
Tay	Scotland	10
Arg-Kintyre	Scotland	02
-intermediate		
Galloway	Scotland	09
Yorkshire Dales	England	
Moray	Scotland	
Grampian	Scotland	
Central Pennine	England	
Cheviot	England	11
Clyde	Scotland	
Kerry	Ireland	
-minor		
Outer Hebrides	Scotland	
North Yorkshire Moors	England	
Donegal	Ireland	
River Barrow	Ireland	
Wicklow	Ireland	

Associations of cup marks

Although motifs occur on megalithic monuments, and on the portable stones sometimes associated with them, most rock-art occurs independently, and more widely, on surfaces of open-air bedrock (e-FIGS ND-01d to 06d; see this section: Supplementary information). In addition to discussion of their inherent symbolism (see Table of Contents: 06), a more general indication for the role of this art, amongst prehistoric communities, may come from analysis of its distribution in relation to the physical background, and other types of monument, also from its particular placement on monuments. Art on monuments can be considered in terms of decorative enhancement of an existing structure, with density, symmetry, and consistency of placement providing insight into ritual function at the site, additional to the symbolic content of the motifs themselves.

Beyond their main association with natural rock-faces, applied cup-marks are a common feature linking three types of monument: standing stones, circles, and cairns, in order of increasing frequency. However, these motifs may not be contemporary with the main phase of the site itself, perhaps already existing on a stone later reused, or added as incidental *graffiti*, long after active use of the monument. If they are indeed solar symbols, then the frequency of cups could reflect the existing degree of related interest at a site, or an addition needed to establish such an association.

Funerary activity, known from such sites, increases with cup-frequency, suggesting a link between application of motifs, and burial, a further element drawing together burial, alignment, and solar symbolism. Many stone rows have very clear alignments that already suggest a highly solar basis, but stone circles, round barrows, and henges less so (see Table of Contents: 03d, 03e, 03a, and 03f respectively), these perhaps therefore requiring more reinforcement with appropriate motifs. As an extension to this process, rock faces would need the highest levels of rededication, and indeed are the location for most rock-art.

Solar links have been variously suggested for some motifs, both in their symbolism, and from location on monumental alignments (Morris 1969, 51, Gelling and Davidson 1969, 103; Simpson and Thawley 1972, 99); Burl 1974, 1976).

Under conditions of low-angled sunlight, motifs on near-horizontal surfaces, as at Achnabreck (Morris 1971), become far more apparent, and this might relate to the timing of any associated rituals, with intensification during earlier times of rising, or later setting, or generally, with the transit at lower winter elevation.

Relationship between distributions of rock-art and regional groups of barrows

In discussing the function of cup sites, it is essential to define their spatial relationship with other types of monument, and especially with areas of direct settlement.

Although many individual cases of settlement sites of the period occur, in the Highland Zone of Britain, and in Ireland, the geographical area covered by national distributions in this analysis, these are not sufficiently clear, numerous, or widespread to use as a basis for establishing a coherent general pattern. Consequently, barrow sites, monuments that are certainly widespread, and fairly clearly identifiable, have been used in this analysis as a proxy for direct settlement. This seems reasonable, at least when using national distributions of relatively low spatial resolution, with frequencies plotted per 10km grid square (e-FIGS ND). On this basis comparison can then be readily made between distributions of barrows (e-FIGS ND-01a to 06a), and rock-art (e-FIGS ND-01d to 06d).

There is, of course, the additional problem that most barrows, although of typical Neolithic, and early Bronze Age form, remain undated. However, it is here assumed that the majority counted do fall within this period, by consensus the main phase of rock-art, stone circle, and stone row construction, and give the essential elements of the distribution.

There is also the assumption that settlement and funerary zones coincide, in general terms better than might be expected for stone circles, and stone rows. These latter types, although more readily attributable to the period, are anyway fewer in number, and less universal than barrows, making their general application as a proxy difficult. A closer link between barrows and settlements might also be expected from considering problems in longer-distance transport of the dead, from the need to maintain proximity with deposited remains, and the possible role of barrows as territorial markers.

On the basis of these distributions, much rock-art clearly lies outside focal areas of barrow distribution, with varying degrees of mismatch apparent. This suggests that much of the rock-carving activity took place in areas peripheral to, or beyond, main centres of direct settlement, perhaps in marginal zones, of less economic potential, more sensitive to environmental stress and, being upland, more open to sky-ward propitiation.

-Milfield basin: The separation between areas of rock-art, and of settlement can be well seen at the local level in the Milfield basin (see Table of Contents: 03f/4a; e-FIG HE-10). Here, areas of known settlement, and a group of small hengiforms, perhaps linked by an avenue-trackway, occupy the valley, whilst the upland overlooking it to the W contains numerous carved rock-surfaces, with good SW'ly aspect.

-Scotland: In the Tay group, there are high levels of carving, well beyond the main area of barrow construction, and similar situations occur for the Argyll-Kintyre, Grampian, and Moray groups (e-FIG ND-02a and 02d). In the Galloway group, rock-art sites lie in more coastal areas, with clear separation from the main inland areas of barrow construction in the SW'n Uplands, and to the W of the promontory. In the Outer Hebrides, rock-art and barrow distributions form a reasonable match, and only a minor disparity is evident for the Clyde group of panels.

-England: The group of motifs in North Yorkshire lies over the moors, and occupy only the N'n sector of the very concentrated area of barrows that stretches S'ward from the moors, through the Vale of Pickering, to the Yorkshire Wolds. Art-groups in the Yorkshire Dales, and Central Pennines, also show significant mismatch with the main barrow areas. A reasonable fit between distributions of art-sites and barrows is, however, evident for the Cheviot group. In the Peak District, Dartmoor, and Exmoor, barrows are well represented, but there is a very low incidence of motifs where, on the basis of other environmentally and archaeologically comparable areas, these latter might have been expected.

-Ireland: Art-groups in Donegal, NE'n Ireland, and Wicklow, spread well beyond adjacent barrow groups. The major cluster of barrows in the Golden Vale area appears well separated from art-groups to the W, around coastal areas in Kerry, and to the E in the River Barrow area.

Location of motifs at individual monuments

-Barrows (see Table of Contents: 03g/13)

Association between rock-art and funerary monuments is a frequent one, motifs occurring exposed on exterior surfaces, typically on stones of the external retaining kerb, hidden internally within chambering, on grave slabs, or on stones providing buried mounding material. There appears to be no clear consistency of placement on internal slabs, but externally, positioning towards the sun-ward S is common.

-Standing stones and stone rows (see Table of Contents: 03g/14)

For the sample listed in Table of Contents: 03g/14 there is no generally consistent pattern of placement on specific faces of stones. However, for the two sites discussed in more detail, Ballymeanoch, and Kilmartin (Argyll), specifically oriented faces are decorated at each.

These sites are discussed individually:

site		**type**	**e-FIG RA-**	**Table of Contents**
Ballymeanoch	Argyll	stone row	07	03g/14
Kilmartin	Argyll	stone row	08	03g/14

-Stone circles (see Table of Contents: 03g/15)

The importance of the NE'-SW'ly axis is suggested by placement of motifs at sites such as the small kerb-circles at Monzie (e-FIG SC-10, and RA-13), Fowlis Wester W, and at the larger stone setting at Croft Moraig. At the stone circle of Long Meg and her Daughters (Cumbria; e-FIGS SC-05 and 06), a decorated outlier at the SW, similar to those at Monzie, and Fowlis Wester W, might have marked the solstitial axis. Location of motifs at other sites, such as recumbent stone circles, also stresses the importance of the S'ly direction. A distinct interest in the S'n arc is therefore generally evident.

Sites are discussed individually:

site		**type**	**e-FIG SC-**	**Table of Contents**
Long Meg	Cumbria	circle and outlier	05-06	03e/10c
Monzie	Perth	kerb-circle	10	03g/13
Rothiemay	Banff	recumbent stone circle	07	03e/10d
Sunhoney	Aberdeen	recumbent stone circle	08	03e/10e

Other suggested associations of rock-art

Other topographical associations of rock-art have been suggested (see Table of Contents: 09 Bibliography/ references for Morris and Beckensall), and these may be valid, perhaps at a local level, and as a secondary function.

-marking routes

Although rock-art might well have developed along local, and inter-regional routes, there is no clear evidence for this in distributions at any scale, from national, to entirely local. Decorated outcrops occur, in the main, well away from obvious natural lines of communication. Panels are often remote, placed at locations with wide views, suggesting that they were carved by hunters, pastoralists, or mobile grazers (Waddington 2004). Many cup sites in W'n Scotland are sited on S'ly-facing slopes, affording good views out to sea, with rock panels generally placed in a near horizontal plane (Morris and Bailey 1967, 152).

-with ore fields

It has been suggested (Morris 1967), that there might have been some association between areas of cup-marked stones and economically important deposits of copper or gold, and that the marks might have been made by early prospectors. Motifs in two ore-bearing areas were discussed, those to the N and S of the Firth of Forth (*ibid*: fig 1), and those in Argyll, and its adjoining islands (*ibid*: fig. 2). The association noted was a fairly loose one, with the proportion of sites located within six miles of ore deposits considered as possibly significant. This suggestion is not borne out at the national level by the evidence: there are significant differences between distributions of rock-art, and those deposits of copper, tin, and gold, which would have been amenable to ancient mining practice (e-FIG ND-01e). The general interpretation preferred in this analysis is that such panels represent, at least in part, localised centres of solar propitiation, in marginal areas undergoing environmental stress.

..copper was mined in Britain and Ireland during the Bronze Age from reasonably accessible deposits in
...SW'n Ireland: Ross Island, and Coad Mountain, Kerry; Cork; coastal Waterford;
...Wales: in the W at Cwmystwth, and in the N at Great Orme, and Parys Mountain;
...Cheshire: Alderney Edge (radiocarbon date 2280-1890 BC);
...Staffordshire: Ecton;
...Isle of Man (O'Brien 1996, 1997);
...other scattered deposits.

..gold was retrievable from alluvial, and shallow deposits, of the type that occur sporadically in Scotland (Lowther Hills; Wanlock Head, Dumfries and Galloway; Leadhills, South Lanarkshire), Wales (Dolaucothi; Mawddach Estuary; Pembrokeshire), the English SW'n Peninsula (Ladock and Carnon valleys), and in Ireland (Gold Mines River, Wicklow).

..tin occurs in deposits associated with certain biotites and granites, as rock-borne, primary deposits (cassiterite, and other minerals, collectively known as stannite), and as secondary placer deposits, re-deposited after erosion. Minor sources of tin occur in Ireland, and Scotland, with by far the most important in the English SW'n Peninsula (Budd *et al.* 1994; Gerrard 2000; Thorndycraft 2004).

Conclusions

Comparing national distributions of rock-art against the physical background, and against other monuments, suggests that, in many areas, it tended to develop in zones that were marginal to direct settlement, and likely to have been subject to increased environmental stress. The sheer number of panels, the S'ly trends in their aspect, and use of a limited number of motifs, many of which might have had solar connotations, could suggest a function in mitigating such natural pressures. Motifs, especially those that are cup-related, and perhaps more closely solar symbols, were also added to monuments, in part to stress particular axial directions.

Distribution of rock-art with respect to environmental factors (e-FIGS ND-01a and 01d)

Rock type

Carved rock-surfaces are, of necessity, confined to areas of suitably exposed hard strata. These occur widely throughout the Highland Zone, as in much of Scotland, Ireland, Wales, and the English SW'n Peninsula, extending S'ward through N'n England, along the spine of the Pennines. rock-art is to be found in all of these areas, but is largely absent from certain areas, the geology of which seems well suited for carving. In the English SW'n Peninsula, for instance, petroglyphs are rare on Dartmoor, Exmoor, and Bodmin Moor, either on bare rock, or on megalithic monuments. In Wales, motifs are also relatively rare, despite abundant exposures of harder sedimentary, and of igneous rock.

Rock-art sites do occur sporadically at the margin of the Lowland Zone, for instance in the belt of readily workable Jurassic limestone that runs SW'-NW'ward across midland Britain. Examples from the moors of North Yorkshire (Brown and Chappell 2005), and occasional portable stones, as in the Cotswolds (portable examples: Marshall and Morris 1983; Marshall 1985a), indicate further S'ward penetration.

Fixed rock-art therefore, largely confined within upland Britain, occurs selectively, even there, and this partial distribution seems not to be explicable in terms of inferred settlement patterns. rock-art is at its most prolific along the margins of the Atlantic seaboard, for instance in W'n Scotland, and perhaps it is amongst environmental factors in this zone, during the Neolithic and Bronze Age, that further explanation should be sought.

As a first approximation, climatic conditions prevailing in modern times provide a reasonable basis for general discussion of relative regional contrasts within Britain and Ireland, and gross differences between the environments of Highland and Lowland Zones (e-FIG ND-01). In general, rock-art sites lie in the wetter, and colder areas of N'n and W'n Britain, in a less than benign environmental zone, one that is particularly influenced by Atlantic weather systems, often changeable, and adverse.

Temperature

The predominantly N'n British distribution of rock-art coincides with the areas of coldest winter temperature, lying mainly within the 4°C isotherm for January. However, the W'n Irish groups, under the influence of the Gulf Stream, are rather less exposed, occurring within the 6-7°C isotherm for January. As far as summer temperatures are concerned, both British and Irish groups lie within the cooler isotherms of less than 15°C.

Rainfall

rock-art lies in the wetter parts of N'n and W'n Britain and Ireland, in zones where annual rainfall exceeds about 15cm per annum. The major Tay, Argyll-Kintyre, and Kerry groups all lie in the wetter zones of central-W'n Scotland, and SW'n Ireland.

Distribution of peat

The distribution of rock-art also coincides with areas containing significant deposits of peat, which have developed since the last Ice Age, and more so during the latter millennia BC, in part as a consequence of colder, and wetter conditions. Such correspondence with peat can be particularly well seen for the Tay, and Argyll-Kintyre groups of rock-art in central Scotland, the Galloway groups, and the Kerry, and Donegal groups in W'n and N'n Ireland. Growth of these peat deposits has also been accelerated by clearance, and over-exploitation of land in these areas, suggesting that such fragile marginal zones might have experienced not only environmental, but also economic pressures.

Conclusions

It is suggested, therefore, that proliferation of rock-art, and the repetitive nature of symbols, can perhaps be explained as a growing response to environmental stress, a theme preserved in their symbolism, in the S'ly orientation of many panels and their elements, and in their exposed location.

Motifs at rock-art sites: analysis of orientation

Rock-art sites: topographical aspect of panels

The siting, and aspect of earth-fast panels of rock-art in two different regions were analysed in detail: Northumbria (see Table of Contents: 09 Bibliography/ database: rock-art 1), and Eire (see Table of Contents: 09 Bibliography/ database: NMR 5)(TABLE RA-02). The mean direction of any slope on which sites were located was noted, and frequency of aspect was graphed at 20° intervals, in order to detect any trend in the orientation of panels (e-FIG RA-14).

TABLE RA-02 rock-art: topographical location of panels in Northumbria and Eire

	Eire		**Northumbria**	
	#	**%**	**#**	**%**
sample in database	256		394	
with known location	232		394	-
Eire: regional areas:				
Kerry	175		-	-
Donegal	57		-	-
Carlow-Kilkenny-Wexford	24		-	-
Siting on:				
slopes	172	**74**	215	**55**
level ground	60	26	179	45

Key: #: number of sites.

More sites lie on sloping, rather than on level ground, with the proportion higher in Eire than in Northumbria. In both areas, the aspect of cup sites is similar, predominantly towards the S'n sector, with fairly discrete peaks apparent in the SE'n, and SW'n quadrants for Northumbria, and a spread peak extending over, and beyond the SE'n quadrant for S'n Ireland (e-FIG RA-14).

This clearly indicates a general preference for panels to face the S'n arc of the sky, with an increased interest towards the SE. Such siting might have been an active choice, with clear viewing of the S'n arc required for any ritual, or other activities at the site.

Rock-art sites: orientation of motifs

In addition to analysis of general aspect amongst panels, alignment of component motifs was also examined in detail (e-FIG RA-15).

Data on rock-art sites in Northumbria were used for this analysis, since the area provides the most complete coverage available, for a well-defined regional group (databases: rock-art 1 and 2).

A set of clearly defined motifs, of common, and widespread currency, were selected for analysis of their orientation, using only those panels that included a convincing North-pointer, unfortunately not all. Related analysis of published examples from Scotland encountered similar problems with absence of North-pointers, the presence, and exact calibration of which, in many cases, could not be relied on.

For instance, in the Northumbrian sample, 66% of all panels were presented in drawn form but, of these, only 34% contained scaling, and a North pointer, sufficient to allow alignment of panel and component motifs to be noted (TABLE RA-03):

TABLE RA-03 CUP SITES IN NORTHUMBRIA: SUMMARY OF DATA AVAILABLE (DATABASE: ROCK-ART 1)

	#	**%**	**note**
all panels	1069		
drawn	705	100	all of the drawn examples;
non-portable	490	70	only rock-fast panels were included in the analysis;
directional	294	42	under half of these showed directional trends for motifs;
plus N pointer	245	**34**	only a third of the examples had a North-pointer.

Key: #: number of examples;

In plotting orientation of motifs, there is often the problem of choice: axes can be **single,** or **dual**, **symmetrical,** or **asymmetrical**.

For instance, lines of cups, and motifs which include linear channelling have two potentially significant alignments: the directions in which the lines face laterally, and those to which they point axially, giving four alternative directions, within a **dual axis**.

For motifs like cup-and-ring marks with radial grooves, the significant orientation might seem clearer, with two probable alternative directions within a **single axis**, from the centre to the periphery, or *vice versa*.

Motifs can be grouped as either **asymmetric,** if they contain one main axis with different types of terminal (motifs 1 and 2 below), or **symmetric** if the axis is not thus differentiated between ends (motif 3 below).

The selection of a particular direction, as being possibly significant, therefore involves subjective choice, somewhat modified by general consideration of the properties of other types of motif in association, disposition of the panel relative to the rock-surface, and the viewing possibilities over the landscape at the site.

In view of this problem, primary data (total number of motifs analysed: 876) are presented in two ways:

..the entire sample of each type of motif is shown diagrammatically as a palimpsest, at a common scale, orientation, and relative distance from the centre of the panel. Viewing the overall pattern gives some indication of any 'grain' in the overall alignment of motifs (e-FIGS RA-16 to 21).

..defined orientations for individual motifs are also given as histograms, plotted at 20° intervals of azimuth.

The motifs selected for this analysis are of two main types:

..**singular:** relatively simple, discrete, and occupying a confined area:
examples: **S1**: cups, cups with rings: **(a)** without radial arms, **(b)** with radial arms;
S2: penannular grooves;

..**extended:** more complex, linear, and often sinuous motifs, extending more widely over the panel:
examples:
E1: lines of cups, **(a)** unlinked, **(b)** linked;
E2: channels with terminal cups, **(a)** short, and **(b)** long channelling.

These motifs are summarised in descending order of frequency as follows:

Singular motifs

-S1b: cups, or cup-and-ring marks with radial grooves: 205 examples (e-FIGS RA-15 and 16);

[axis: single, asymmetric];
Cups, with or without surrounding, closely-spaced, concentric rings, often have one, or sometimes more, short grooves, generally less than 0.5m long, running from the centre outwards. Such radials can cut through any rings directly, or pass through a gap in each circuit.

Orientation selected as significant: from the centre of the motif, and along the radial groove, the direction of outward pointing. Alignment of radials shows a preference for the S'n arc, with a spread peak over the SE'n quadrant (e-FIG RA-15).

In the sample from Northumbria, most cup-and-ring marks have single radial, but there are some cases where several radials occur, with a range of orientations, some of which can be diametric. Such multiples seem, in general, to show a similar S'n tendency to that of the singles (TABLES RA-04 and 05).

Their histogram of orientation contains a single main peak, NE' to SE'ward, with a maximum around the E, perhaps suggesting an interest in the rising arc of the solar transit (e-FIG RA-15).

TABLE RA-04 Cup-and-ring marks from Northumbria, with multiple radials

# radials	#	%
1	176	50
2	26	7
3	6	2
0: ungapped	73	21
0: gapped	70	20
TOTAL	351	100

Key: #: number of examples;

Further details of the number and disposition of radial arms are given in TABLE RA-05:

TABLE RA-05 Number and disposition of multiple radial arms for a sample of cup-and-ring motifs from Northumbria

site	#	disposition	N-pointer	axis
Buttony 4	3	at 120°	yes	one SE'ly limb
1c	2	opposed	no	?
2	2	opposed	no	?
3	2	opposed	no	?
Whitsunbank 2	3	at 120°	yes	one SE'ly limb
Amerside Law 1	2	acute	no	?
Broomridge 1	2	opposed	yes	S-SE
Buttony 1c (3 cases)	2	opposed	no	?
Fowberry Enclosure 1	2	opposed	yes	S-SE
Fowberry excav: rock 6	2	opposed	yes	S-SE
Fowberry Park e	2	opposed	no	?
Hare Law Crags 3	2	opposed	yes	S-SW
Hunterheugh 1	2	opposed	no	?
	2	opposed	yes	~W-E
Ketley Crag Rock	3/?4	mainly perp	no	?
	2	perp	no	?
Old Berwick 1a	3	forked	no	?
	2	forked	no	?
	2	obtuse	no	?
Weetwood Cairn: kerb	3	at 120°	no	?
West Horton 3	2	opposed	yes	SW
West Lordenshaw 1a	2	opposed	no	?
West Lordenshaw 2c	2	acute	yes	S-SE
Broomridge 2	2	obtuse	yes	one S'ly limb
Chatton 5	2	opposed	yes	SE-E

Note: in the column 'axis', for brevity, only the S'ly direction has been noted, the other is implicit.
Key: **#:** number of examples; **N-pointer** (shown on the image in the database); **perp**(endicular); **excav**(ation);

-S2: penannular grooves: 150 examples (e-FIGS RA-15 and 17)

[axis: single, asymmetric]

These are small, single, curving grooves, ring-like in plan, with gaps of varying width, ranging from an open C-shape, to more closed versions. A few examples are further elaborated by short grooved extensions.

Orientation selected as significant: from the centre of the motif to the centre of the penannular gap, the direction of opening. The histogram of orientation contains a spread distribution of frequencies, with two weakly developed peaks, around E, and from S to W (e-FIG RA-15).

Extended complexes

-E1: lines of cups: 353 examples (e-FIGS RA-15)

[axis: double, symmetric]

a: unlinked: 343 examples
Linear arrangements of cups, of varying length and spacing, but without any linking groove, are a frequent feature of panels.

b: linked: 10 examples
Lines of cups, of varied length and spacing, linked by a groove. Lines of very closely spaced, contiguous cuplets also occur occasionally.

Orientation selected as significant: lateral, perpendicular to the mean axis of the groove.

The histogram of orientation shows a clear preference for the S'n arc (e-FIG RA-15).

-E2: channels and their terminal cups: 168 examples (e-FIGS RA-15 and 21)

[axis: single, symmetric/ asymmetric]

a. shorter channels: 48 examples

Short grooves, generally fairly straight, and less than about 0.5m in length, are terminated by a cup-motif at one, or usually both ends, either a plain cup, or cup-and-ring, with one terminal motif sometimes larger than the other.

b. longer channels: 81 examples

Long channels, often a metre or two in length, varying from fairly straight, to sinuous in plan, bear cups, or cup-and-ring marks at one end (asymmetric), or occasionally at both (symmetric). Longer channels, without terminal cups (39 examples), have been added to the sample here, but carefully distinguished in the analysis.

Orientation selected as significant: along the mean axis of the groove, from the terminal motif. Alignment shows a spread peak, over and beyond S-E (e-FIG RA-15). Some motifs with a larger cup at one end point from the larger to the smaller terminal towards the S'n arc of the sky.

Conclusions and interpretation

In general, although there is much variation in the alignment of the defined directions, motifs show a preference for the S'n arc, with a fraction suggesting closer interest in the SE'n quadrant. This is in agreement with the preferred aspect of the panels themselves, towards the S'n arc, as seen in data from both Northumbria and Eire (e-FIG RA-15).

This trend could indicate an interest in the area of the rising solar transit (see Table of Contents 02c/2), supported by the suggested interpretation of cups, and cup-and-ring motifs as solar symbols (see Table of Contents: 06/3).

General conclusions

Panels on level bedrock, and separate from monuments, might have provided dedicated facilities for propitiation, and offering, directed towards the S'n arc of the solar transit, with their location on marginal land, and their repetitive nature indicating a response to increased environmental pressures during the later Neolithic and Bronze Age. Given the critical importance of the sun for seasonal and economic concerns, existence of a widespread solar cult is highly likely, especially in these climatically unstable Atlantic margins.

Transference of these motifs to monuments, mainly as cup-marks, would add, or reinforce, a solar dimension, especially for sites that were not already appropriately dedicated, perhaps adding this symbolism, especially to those more involved in burial.

Study area: the Cheviot group (e-FIG RA-11)

In addition to general analysis of orientation amongst panels and motifs, several fairly well documented **regional** groups have been selected for more detailed discussion as case studies.

The Cheviot group of rock-art, as defined from national distributions (e-FIG ND-02d), contains well-documented panels, appropriate for further analysis (Beckinsall 1974, 1983, 1986, 19992, 2001; see Table of Contents: 09 Bibliography/ database: rock-art 1).

More detailed mapping of the group (e-FIG RA-11) indicates two main component areas: Cheviot N and S, which contain further more localised clusters of panels (TABLE RA-06). For the Cheviot N group, the Doddington cluster appears to be the focal area, and for Cheviot S, the Rothbury cluster.

TABLE RA-06 rock-art in the Cheviot group: groupings and clusters

sub-group	cluster	NGR	intensity
Cheviot N	Ford	NT 9836	low
	Doddington	NU 0031	medium
	Wooler	NU 0227	medium
Cheviot S	**Rothbury**	NU 0402	medium
	Wellhope	NU 1205	low
	Garleigh Moor	NU 0600	low

Note: all groupings of panels have been redefined, and renamed, for the purposes of this survey; entries for the intensity of clusters are intended to indicate general relative scaling only.

Detailed mapping of individual panels gives further data on preferred aspect, and an assessment of the complexity of panels allowed focal areas of activity to be defined more clearly.

This count of complexity involved scoring the number of motifs, together with a measure of the effort required to produce them (the method not outlined further here), and was plotted by 100m squares over individual clusters. The four clusters of higher, and similar complexity are shown in bold type below, in TABLE RA-07.

TABLE RA-07 Cup sites in the Cheviot group: scoring of complexity

cluster		NGR NU-	complexity	distrib of panels	compact distrib	association with barrows
Garleigh Moor	NE		604		yes	
	SW		1276		yes	
	all	0600	**1880**	nucleated		several
Doddington	NE		617			
	NW		180			
	SE		560			
	SW		389			
	all	0031	**1746**	dispersed	no	very low
Wellhope	E		609		yes	very low
	W		909		yes	very low
	all	1205	**1518**	nucleated		
Wooler		0227	**1436**	semi-nuc	yes	low
Ford		NT 9836	594	dispersed	no	low
Rothbury		0402	558	dispersed	no	low
Chatton Park		0729	411	dispersed	yes	very low

Key: distrib(ution);

Two of these more complex clusters within the Cheviot S sub-group were examined in more detail:

..Garleigh Moor; Beckinsall named these sites as N and E Lordenshaw;

Here, a rich spread of cup-marked rock-surfaces lies over a NE'-SW'ly ridge, on the hilltop, and on its S'-SE'ly sloping flanks. Mappings of complexity for panels suggest the existence of three centres, surrounded by zones of less intensive activity. Many of the panels show little clear sign of directionality in terms of their motifs, but where this does occur it seems to be towards the S to SE, often the down-slope direction.

..Wellhope; Beckinsall named these sites as Millstone Burn at the SW, and Snook Bank at the NE;

Two separate spreads of cup-marked rock-surfaces lie either side of a stream, over the fairly steep slopes of its valley, one with a SE'ly aspect, the other SW'ly

Each spread seems to contain an area of greater complexity on the upper slopes, surrounded by simpler, and less densely worked rock-surfaces, extending down-slope. Here again, any directionality of motifs appears to be generally towards the S and E, the aspect down-slope.

Study area: the Galloway group (e-FIG RA-09)

Two main sub-groups are visible in the Galloway group, both along the S'n coast, one overlooking the River Dee, the other the Water of Fleet (e-FIG RA-09). Both sub-groups are equivalent in extent, and intensity, with the Townhead cluster forming the focus of the Dee group, and the Kirkdale cluster that for the Fleet group (TABLE RA-08).

TABLE RA-08 rock-art in the Galloway group: groupings and clusters

sub-group	cluster	NGR (NX-)	intensity
Dee	**Townhead**	6947	high
	Borgue	6446	low
	Barharrow	6252	low
Fleet	**Kirkdale**	5154	medium
	Whiteside	5655	medium
ungrouped	Garleston	4848	low
	Sorbie	4248	low
	Montreith	3644	low

Note: all groupings of panels have been redefined and renamed, for the purposes of this survey; entries for the intensity of clusters are intended to indicate some general relative scaling only.

A S'ly aspect is visible amongst panels in each group, particularly so for the Kirkdale cluster.

Study area: the Tayside group (e-FIG RA-10, and 10a)

The broadly E'-W'ly running valley of the upper Tay, with its loch, contains a particular concentration of rock-art, running intermittently along both flanks, and extending upward from the margins of the river to the high ground overlooking it. Carved surfaces range from simple cups to complex panels, and many are loosely associated into fairly discrete clusters (TABLE RA-09; e-FIGS RA-10 and 10a).

Other types of site appropriate to the period, and indicative of more immediate settlement, such as stone circles, cairns, and standing stones, occur mainly in the lower, more amenable areas of the valley, on better land, close to the river, and increase in frequency downstream from Loch Tay. By contrast, rock-art is concentrated on the marginal hill-slopes overlooking, in areas of more pastoral potential. Such areas provide elevated, sun-ward locations, more visually connected to the surrounding landscape and sky, higher, and closer to any divine presence, ideally suited for any associated ritual activities.

There appears to be a greater concentration of motifs along the N'n side of Loch Tay, over the SE'ly-facing upper slopes, those with high sun-ward exposure (e-FIG RA-10). Further downstream from the Loch, both sides of the valley bear carved rock-surfaces, with this lateral bias reversed, greater numbers lying on the S'n side of the valley, with its NW'ly-facing hill slopes. General, rather than specifically oriented exposure to the sun might have been an important factor in creation, and operation of these carved panels. Given the seasonal range of the solar transit, both sides of the valley receive good illumination, this decreasing in extent, and intensity towards midwinter: the NW'n side especially exposed before noon, the SE'n side after.

Seasonal details for the local azimuths of the solar transit are as follows:

Loch Tay: longitude-latitude 56.5230; -4.1365;
WS rise 135, **set** 225; **SS rise** 042, **set** 320;
Key: WS winter solstice; **SS** summer solstice; **Data:** suncalc.org;

TABLE RA-09 ROCK-ART IN THE TAYSIDE GROUP: GROUPINGS AND CLUSTERS

sub-group	cluster	NGR (NN-)	intensity	aspect
S'n side	Aberfeldy	8849	medium	NE'ward
	Urlar	8346	medium	SE
	Craig Hill	8144	low	SE
	Kenmore	7945	high	NW
	Acharn	7743	high	NW-N
N'n side	Weem	8350	medium	S'ward
	Fearnan	7245	low	S-E
	Balnearn	6942	high	SE
	Machuim	6840	medium	SE
	Craggantout	6538	high	SE
	Croftvellick	6436	medium	SE
	Milton Morenish	6136	medium	SE
	Morenish	6035	medium	SE
	High Creagan	5935	low	SE

Note: all groupings of panels have been redefined, and renamed, for the purposes of this survey; entries for the intensity of clusters are intended to indicate some general relative scaling only.

In many cases the aspect of areas in which panels occur appears to conform with the general topography, following the general slope of land towards the river, panels to the S of the river facing towards the N and W, and those to the N of the river facing towards the S and E. However, some clusters, such as Urlar and Craig Hill, on the S'n bank, do not follow this general trend, but such exceptions are relatively minor.

-panels investigated by excavation

One small cluster of such decorated rocks is located on an area of S'ly facing hillslope forming part of the W'n flank of Loch Tay, centred at NN 691 428 (e-FIG RA-10a). This group was deliberately selected for excavation because of its relative isolation from known monuments, in order to provide a basis for comparison with the few other cases of excavated rock-art sites, these latter more closely associated with structures (Bradley *et al.* 2012). Four decorated rocks were examined by small-scale excavation, and two undecorated rocks were included to provide control data for interpretation of any features, and scatters adjacent to the decorated rocks.

Scatters of worked quartz and other minor lithic artefacts occurred around several of the carved rocks, these items more suggestive of debris from fabrication than votive offerings. The only possible structure was an irregular spread of rubble adjacent to one of the decorated rocks.

The results in more detail were as follows:

rock 1:

art: a multiring with central cup and radial groove, pointing toward 135°; scattered around were two cups with single rings, and 14 cuplets;

finds: one flint flake from a fissure in the rock; lithics scattered along the N'n and W'n sides, including hammerstones, an imported pebble, and a pitchstone blade;

features: an irregular and discontinuous layer of rubble on the N'n side;

rock 2:

art: a rock with a natural basin, bearing motifs; three cups with multirings, one with a radial groove pointing to 009°; seven cups with a single ring; 25 cups and cuplets;

finds: fissures in the rock produced much worked quartz;

features: none apparent;

rock 3:

art: one cup with a single ring; five cups;

finds: fragments of worked quartz were scattered around the margins;

features: none apparent;

rock 6:

art: *phase 1*: one cup with single ring, and two multirings; *phase 2*: two large cups with multirings, each with a radial groove, these pointing towards 085°, and 099°, this panel just overlapping one of the motifs from phase 1;

finds: fragments of worked quartz were found on all sides, but far fewer on the E'n;

features: none apparent;

rocks 4 and 5

uncarved: produced no artefacts, and no non-natural features;

stratified environmental material: indicates open upland pasturage;

Study area: the Argyll group (e-FIG RA-02)

Exposures bearing rock-art occur inland from the coast, mainly around the lower lying margins of the River Add, and Kilmartin Burn (e-FIG RA-02). Both of these areas form fairly discrete sub-groups, Kilmartin Burn being the more extensive, prolific in terms of panels, and with more developed clustering (TABLE RA-10).

TABLE RA-10 rock-art in the Argyll group: groupings and clusters

sub-group	**cluster**	**NGR**	**intensity**	**aspect**
Loch Awe	Fincharn	NM 9004	low	NW'ward
	Ford	NM 8603	medium	S
	Glasvaar	NM 8801	medium	NW
	Creogantairbh	NM 8500	low	NW
Kilmartin Burn	Eurach	NM 8401	low	various
	Kilmartin	NR 8298	high	NW
	Slockavullin	NR 8297	high	SE
	Baluachraig	NR 8396	low	-
River Add	Kilbride	NR 8596	low	S
	Torbhlain	NR 8694	low	-
	Kilmichael Glassary	NR 8593	low	SE
	Carnbaan	NR 8491	low	E
	Achnabrech	NR 8590	high	SW
Loch Craignish	Ormaig	NM 8202	low	W
	Barrackan	NM 7702	low	S-W
	Ardfuir	NR 7806	low	SW

Note: all groupings of panels have been redefined, and renamed, for the purposes of this survey; entries for the intensity of clusters are intended to indicate some general relative scaling only.

The siting of panels show mixed aspect, but with important clusters, such as Kilmichael Glassary, and Achnabrech, showing some preference for the S'n arc.

Supplementary information: rock-art on barrows

Motifs, mainly cup-marks, occur widely at cairns, mainly in Scotland, externally on kerbs, internally within mound material, and on cist slabs. Amongst those on fixed structural elements there is no clear evidence for any preference of direction for their aspect but, using the general directions given in the published sample listed below, the ratio between siting at S:E-W:N is 10:6:3, with the S'n quota further divisible between SW, and SE, in the ratio 6:3. This could indicate a preference for siting on the S'n side of the monument, and matches a similar trend seen amongst certain stone circles, especially those of recumbent type (see Table of Contents: 03e/7 and 10 d to e).

The prevalence of these motifs on rock-surfaces that lie separately from monuments, and trends within their orientation, suggest a general-purpose function, perhaps related to propitiation directed towards the S'n arc of the sky, and its solar transit. Their presence on monuments such as barrows, circles, and stone rows would be appropriate, in adding potency to the site, and further stressing any relevant alignment it contained. Addition to barrows appears to be largely non-directional, and perhaps it was sufficient for the motifs simply to be present. There are cases, as at Monzie (e-FIG SC-10), where motifs might have stressed a particular orthostat, in a similar manner to that seen at some stone circles, as at Long Meg (Cumbria), where the pillar at the SW is decorated.

Sample from: Britain, excluding N'n Ireland and Eire.

Key: Can: identifier in Canmore on-line database for Scottish sites; **NMR:** identifier in National Monuments Record/ English Heritage; **HER**: Historical Environment Record for the County; **Cof**: Coflein, on-line database for sites in Wales.
Note: All of the barrows listed below are round, and of later Neolithic to earlier Bronze Age type, with many producing dating evidence in support; directional information on placement of motifs is given in **bold type**.

Motifs located externally on the monument

SCOTLAND

Balnuaran of Clava; Inverness; NH 7568 4442; Can NH74SE 10;
Circle of recumbent stones, 3m in internal diameter; a stone at the **ESE** bears cup-marks, some with concentric rings.

Balnuaran of Clava centre; NH 757 444; NH74SE 50;
Ring-cairn, with cup-marks on the kerb at the **E**.

Balnuaran of Clava NE; NH 757 444; NH74SE 1;
Passage grave; cup-marks occur in the chamber, passage, and externally, on the kerb at the **N**.

Cairn Wood; Barskeoch; Dumfries and Galloway; NX 3626 6391; Can NX36SE 1;
A cairn 22m in diameter, with the remains of a kerb; a stone at the **NE'n** edge of the cairn bears a cup-mark.

Clava; Inverness; NH 757 444; (e-FIG LB-94);
Kerbed cairn, slightly oval, 4m by 4.5m externally, and defined by recumbent kerb stones; one kerb-stone at the **E** bears cup, and cup-and-ring-marking; the cairn enclosed a shallow grave, in which no burial survived; quartz fragments were present, but no other finds were made (Piggott 1954).

Culburnie; Highland; NH 4916 4180; Can NH44SE 9;
Ring-cairn, with kerb of large boulders, increasing in height towards the **S**; a ring of eight (originally nine) monoliths lies about 3m outside this kerb; cup-marks occur, possibly on three monoliths, and on three kerbstones, now considered unconvincing, except for the kerbstone at the **SSW**.

Dimmingdale; Cleeveland; NZ 6910 1199; NMR NZ61SE 14, 28389;
Barrow with a possible kerbstone at the **E;** bears 30 cup-marks.

Guiseborough; Cleeveland; NZ 624 202; NMR NZ62SW 13, 28759;
Barrow with a possible kerbstone at the **SE;** bears 19 cup-marks.

Lagmore East; Grampian; NJ 1796 3595; Can NJ13NE 10;
Probable Clava-type cairn, with a stone circle around it; a stone at the **NE** is covered with cup-marks.

Monzie; Tayside; NN 8816 2417; Can NN82SE 26; e-FIG RA-13 and SC-10;
A cairn, about 6m diameter, lies within a kerb of 10-15 contiguous stones, all less than 0.9m high, with the three largest closely set at the WSW.

An outlying slab, 2.5m long, by 1.5m wide, now fallen, lies 3m to the **SW** (**224°G** from the centre of the cairn), and bears 60 ringed cups, up to 4cm deep, on its upper face. The largest ring measures about 40cm in diameter. Two cups have radial grooves, and one dumbell-shaped motif was also noted. This slab, perhaps a former standing stone, might have been connected to the kerb cairn by a rough cobbled causeway 4.8m long and, if formerly standing, its decorated surface would have faced the cairn (Mitchell and Young 1939; Burl 1976, 197; Thom and Thom 1990, 328). A cup-marked kerbstone lies at the **E**. Excavation of the cairn suggested a pyre site at the centre, and revealed a stone cist, containing fragments of quartz, and cremated deposits of an adult and child.

Thom (Thom and Thom 1990, part 2, 328) noted a more distant outlier, 1.5m high, lying 274m away, at **305°** from the main site, and equates this line with midsummer sunset.

The view from the cairn to the outlier at **224°G** would be close to the solstitial axis (at this latitude about **222°G;** TABLE AS-01), suggesting an interest in the solar transit in the SW'n quadrant, and perhaps in particular to the sector around midwinter sunset**.**

Mulchaich; Highland; NH 5766 5679; Can NH55NE 2;
Cairn 17m in diameter, with a peristalith of boulders; one stone in the **SE'n** sector bears 15 cup-marks.

Ninewells; Tayside; NO 0757 4360; Can NO04SE 1;
Cairn 10m in diameter, with a kerb graded up in size towards the tallest stones at the **SW,** where one bears four cup-marks.

Redburn; Highland; NH 5751 6680; Can NH56NE 15;
Cairn 15m in diameter, with a kerb; one kerbstone on the **SW'n** side bears 16 cup-marks.

Tordarroch; Highland; HH 6801 3350; Can NH63SE 3;
Ring-cairn, with nine surrounding monoliths; a large prone slab on the **SW'n** side, opposite the tallest monolith, appears fallen outwards, and if so, then the cup-marks it bears were on the interior side, hence were hidden by cairn material.

Waterside; Grampian; NJ 8045 1635; Can NJ81NW 35;
A boulder, 2m to the **SE** of the cairn, bears six cup-marks on its sloping **SE'n** face.

ENGLAND and WALES

Fowberry Cairn; Northumberland; NU 0197 2784; HER 3325; e-FIG RA-12;
Round cairn, 4m in diameter, with a double kerb, infilled behind it with cobble packing, some of which bear cups, and others with more elaborate motifs; the inner kerb contains an upright slab, bearing two cups, and four other kerbstones bear cup-marks; the cairn lies amongst earth-fast boulders, with carved upper surfaces, and partly overlies some of these motifs.

Huckton Buscel 2; North Yorkshire; SE 9580 8719; NMR SE98NE 29, 65083;
Barrow, with cup-marked stones in its kerb.

Patterson's Bank; Cleveland; NZ 6214 2000; NMR NZ62SW 14, 28760;
A barrow, with one cup-marked stone at both **E,** and **S**.

Street House; Loftus, Cleveland; NZ 7365 1960; NMR NZ71NW 14, 611709;
Cup-marks occur in the kerbing of the barrow.

Weetwood Cairn; Northumberland; NU 02265 28108;
Low rounded cairn; rescue excavation has taken place at the partly-destroyed site; a kerbstone, possibly standing, or displaced, and 38 portable stones from cairn material bear cup-marks; suggested as an example of such portable stones being deliberately incorporated into cairn material, so as to be hidden from the living, and closer to the dead, perhaps serving a similar function to wreathes (see Table of Contents: 09 Bibliography/ database: rock-art 1).

Bron Llety Ifan; Gwynedd; SH 6333 1263; Cof 309761;
Cup-marked rock, situated between two cairns, with eight cup-marks on its upper surface.

Cup-marks located internally to the monument

Associated with the burial structure

SCOTLAND

-Ardmarnoch; Strathclyde; NR 9164 7265; Can NR97SW 1;
A cairn, with chamber oriented **NNE'-SSW'ward,** is divided into two compartments by septal slabs, with cup-marks on inner and outer faces.

-Dornoch; Embo Street, Highland; NH 8089 9138; Can NH89SW 1;
Cairn, 13m in diameter, covers a cist with a slab; cup-marks occur on the **underside** of this slab.

-Cairnholy I; Kirkudbright; NX 5176 5389; Can NX55SW 2;
Chambered tomb (KRK 2); cup-and-ring-marked stone placed as a loose block in the terminal axial chamber (Henshall 1972, plate 26).

-Carswell; Grampian; NJ 133 620 (approx.); Can NJ16SW 15;
Possible end-slab of a cist in a round cairn bears 37 cup-marks, distributed over both faces.

-Corrimony; Inverness; NH 383 303;
Passage grave, 15m in diameter, with surrounding stone circle 21m in diameter; a large cup-marked slab on top of the cairn might have been the capstone of a chamber.

-Culcharron; Argyll; NM 9129 3971;
Small cairn, with a kerb, its stones graded in height, had a blind entrance at the **SSW,** beyond which lay a cup-marked stone, 1.8m long, and lying parallel with the kerb (Peltenberg 1974).

-Cuninghar; Central Scotland; NS 9254 9709; Can NS99NW 1;
Cist, bearing cup-marks on its cover-slab.

-Glennan; Strathclyde; NM 8565 0117; Can NM80SE 30;
Cairn, 12m in diameter, with the exposed capstone of its cist bearing nine cup-marks on the upper side.

-Ri Cruin and Nether Largie; N Argyll;
Decorated stones were reused as Bronze Age cist slabs in these cairns (Thom and Thom 1990, 111; Simpson and Thawley 1972).

ENGLAND

-Birtley; Northumberland; NY 8854 7924; NMR NY87NE 22, 16497;
17 of the cist slabs bear cup-marks.

-Blansbury Park; North Yorkshire; SE 8141 8652; NMR SE88NW 54, 62626;
Round barrow, with inhumation grave, containing a cup-marked boulder in the fill, with another from the mound surface.

-Ford; Northumberland; NT 9390 3697; NMR NT93NW 7, 3652;
Two cremated deposits lay in hollows, covered by a cup-marked stone; any original mounding is now no longer extant.

-Guiseborough; Cleeveland; NZ 6075 1413; NMR NZ61SW 17, 28510;
Cairn with cist, its capstone bearing three cup-marks, and its **S'n** slab one cup-mark.

-Kirkwhelpington; Northumberland; NZ 0114 8470; NMR NZ08SW 6, 21119;
Barrow, with cremated deposits of an adult and child under an urn, set over a flat stone, with a cup-mark on the underside.

-Lockwood; Cleeveland; NZ 6950 1886; NMR NZ61NE 6, 28274;
Two inhumation graves, containing cup-marked stones in the fill.

-Loftus; Cleeveland; NZ 749 194; NMR NZ71NW 6, 29035;
Barrow, containing a cist burial, and cremated deposits, produced cup-marked stones, these perhaps originally loose items.

-Stamfordham; Northumberland; NZ 0774 7048; NMR NZ07SE 6, 20813;
Barrow, covering a cist with cup-marks on its cover-slab, possibly facing into the cist.

-Tregulland Barrow; Cornwall; SX 2001 8674; NMR SX28NW 11, 436213;
Barrow with cup-marked stones amongst the infill of the central grave pit.

Motifs located in mound material

SCOTLAND

-Broomton; Highland; NH 965 540 (approx.); Can NH95 14;
Cup-marked stone in cairn material.

-Creag na Larach; Tayside; NN 9786 4874; Can NN94NE 37;
Small cairn; includes a stone with one cup-mark.

-Leakin; Grampian; NJ 1645 4206; Can NJ14SE 14;
Cairn, 15m in diameter, with a block near the centre bearing 20 cup-marks.

-Ormaig Forest; Strathclyde; NM 8145 0154; Can NM80SW 101;
Stone bearing five possible cup-marks might have been used in construction of the cairn.

-Ormaig Forest; Strathclyde; NM 8143 0153; Can NM80SW 109;
Cairns, with cup-marks included in cairn material.

ENGLAND

-Addleborough; North Yorkshire; SD 9460 8812; NMR SD98NW 12, 47245;
Cairn, with several massive boulders in the interior, two with definite, and two with possible cup-marks.

-Bingley; West Yorkshire; SE 112 432; NMR SE14SW 69, 619055;
Cairn, incorporating cup-marked stones.

-Byland with Wass; North Yorkshire; SE 543 806; NMR SE58SW 16, 57336;
Over 20 cup-marked stones possibly came from cairn material.

-Fowberry Cairn; Northumberland; NU 0197 2784; HER 3325;
See the main entry above.

-Hinderwell Beacon; North Yorkshire; NZ 7933 1780; NMR NZ71NE 6, 29008;
Barrow, containing cremated deposits, produced about 300 worked stones, from the matrix of the mound, many with cup-marks.

-Tosson; Northumberland; NZ 0169 9915; NMR NZ09NW 7, 21310;
Cup-marked stone; from near the centre of the cairn.

-Weetwood Cairn; Northumberland;
See the main entry above.

-Whinney Hill; North Yorkshire; NZ 8329 1450; NMR NZ81SW 11, 29522;
A cup-marked stone lay in the matrix of the mound.

-Crick; Gwent; (Ruggles 1999, plan: fig. 8.11/p. 141);
Round barrow with kerb

Cup-marked stones at this round barrow occur on the kerb at **062°**, and **133°** from the centre, and have been interpreted as facing sunrise at midwinter, in early May, and in August. An alternative direction would, of course, be possible, with the cup marks acting as offertories whilst facing the mound, and viewing the setting sun over it. However, some doubts have been expressed about the quality of both the excavation, and its plan.

Supplementary information: rock-art on standing stones

Note: examples on stone rows and other monoliths are included, but those on stone circles are listed separately (see this section: rock-art on stone circles: just below);
directional information on placement of motifs is given in **bold type**.
Key: Can: identifier in the Canmore on-line database for Scottish sites; **NMR:** identifier in the National Monuments Record/ English Heritage;

Sample from: Briatin and Ireland;

Stone rows
The following sites bearing carved motifs are listed in Burl 1993:

ENGLAND

-Giant's Grave; Cumbria; SD 137 811; ?3-stone row;

SCOTLAND

-Auchterhouse; Angus; NO 345 392; 2-stone row;

-Balnaguard; Perth Tayside; NN 947 522; 2-stone row;

-Carragh a'Ghlinne; Jura; NR 512 664; 4 to 6-stone row;

-Clach an Tuirch; Perth Tayside; NN 725 448; 2-stone row;

-Cowden; Perth, Tayside; NN 776 205; 3-stone row;

-Cramrar; Perth Tayside; NN 723 451; 2-stone row;

-Dunamuck mid; Argyll; NR 848 924; 2-stone row;

-East Cult; Perth; NO 072 420-073 422; 2-stone row;

-Fowlis Wester SE; Perth; NN 921 240; 2-stone row;

-Kilmartin; Argyll; NR 827 979; 2-stone row;

-Kilspindie; Perth, Tayside; NO 175 248; 3-stone row;

-St Madoes Stones; Perth, Tayside; NO 197 210; 3-stone row;

IRELAND

-Barnes Lower; Donegal; C 107 245; 2-stone row;

-Milltown S; Kerry; Q 429 010; 2-stone row.

Sites additional to the above list:

SCOTLAND

-Ardach-Chaorann; Strathclyde; NR 7572 6013; Can NR76SE 3;
Slab, 2.1m high, aligned **NNW'-SSE'ward**, bears five cup-marks on its **ENE'n** face, and one on the **WSW'n** face.

-Allt Cul Corriehiam; Arran; NR 9459 2679; Can NR92NW 32;
Stone, 1.5m high; bears a cup-mark.

-Auchterhouse; Angus; NO 345 392; 2-stone row;
Stone row, aligned **NE'-SW'ward**; stones 1.5m, and 1.1m high, with the **NE'n** taller, and bearing 15 cup-marks.

-Ballymeanoch; Argyll, Strathclyde; NR 8337 9641; Can NR89NW 14;
See the detailed coverage at the end of this section.

-Balnaguard; Perth, Tayside; NN 947 522; 2-stone row;
Stone row, aligned **E'-W'ward**; stones 2.3m, and 2.5m high, with the tallest at the **E** bearing a cup-mark on its **E'n** side, and the other, to the **W,** with seven cup-marks at its base.

-Barnashalg; Strathclyde; NR 7298 8640; Can NR78NW 1;
Stone, 3.5m high, with its longer axis **NW'-SE'ward;** bears two cup-marks on its **SE'n** face, and one on the **N'n** face.

-Boltachan Burn; Tayside; NN 8471 5160; Can NN85SW 5;
Stone, 1.2m high, with nine cup-marks on the **SW'n** face, and one **on top**.

-Camus's Stone; Inverugie, Moray, Grampian; NJ 1529 6838; Can NJ16NE 24;
Standing stone, 1.5m high, with two cup-and-ring marks on the **N'n** face, and groups of cup-marks between.

-Carragh a'Ghlinne; Jura; NR 512 664; 4 to 6-stone row;
Stone row, aligned **NE'-SW'ward**; three prostrate stones 2.8, 2.4, and 1.4m high, with this latter standing at the **SW,** and bearing cup-marks.

-Clach an Tuirch; Perth, Tayside; NN 725 448; 2-stone row;
Both stones bear cup-marks.

-Clach Glas; Tayside; NN 9853 5112; Can NN95SE 5;
Stone, 2m high, oriented **N'-S'ward,** with two cup-marks on its **E'n** face.

-Clach na Croiche; Tayside; NN 9462 5211; Can NN95SW 3;
Stone 2m high, with two others 8m and 12m high now fallen, to the E, on the same due **E'-W'ly** line; seven cup-marks lie on the **S'n** face, near the base of the standing stone, with seven more strung out irregularly over the face.

-Cowden; Perth; NN 776 205;
Three-stone row, aligned **WNW'-ESE'ward**; the **ENE'n** stone bears 22 cup-marks.

-Craigberoch; Bute; NS 0745 6365; Can NS06SE 19;
Stone, 2.4m high, bears three cup-marks on its **SW'n** face.

-Craighall; Tayside; NO 1852 4827; Can NO14NE 11;
Stone, with axis lying **NNE'-SSW'ward**, 2.5m high, bears nine cup-marks near the base of its **E'n** face.

-Cramrar; Perth, Tayside; NN 723 451; 2-stone row;
Stone row, aligned **NNE'-SSW'ward**; the **NNE'n** stone bears cup-marks.

-Dunamuck mid; Argyll; NR 848 924;
Stone row, aligned **NNW'-SSE'ward**; stones 2.4m, and 3.8m high, with the **SSE'n** taller, and bearing cup-marks.

-Dunamuck S; Argyll; NR 848 923; 2-stone row;
Stone row, aligned **NW'-SE'ward**; stones 4m and 3.1m high, with the tallest at the **SE,** and bearing cup-marks.

-East Cult; Tayside; NO 0725 4216; Can NO04SE 2;
Two standing stones, aligned **E'-W'ward**; stones 2.1m, and 2.7m high, with the W'n taller; and a large flat-topped recumbent stone located 12m to E, once possibly upright, with 130-158 cup-marks on its upper surface, and three on its **E'n** face.

-Easter Broomhouse; Lothian; NT 6800 7661; Can NT67NE 21;
Stone, 2.7m high; bears three cup-marks on the **W'n** face.

-Easter Pitcorthie; Fife; NO 4975 0397; Can NO40SE 14;
Stone, 2.4m high, with main axis aligned **E'-W'ward**, and with 33 cup-marks, and two dumbbell motifs on the **S'n** face.

-Fowlis Wester SE; Perth, Tayside; NN 921 240; 2-stone row;
Stone row, aligned **WSW'-ENE'ward**, the stone at this latter end bearing six cup-marks on its **W'n** edge, and one near the **SE'n** corner.

-Glenhead; Stirling; NN 7548 0045; Can NN70SE 3;
Three stones, aligned **NNE'-SSW'ward,** in a 9m long row; a cup-mark on the central leaning stone, 2m high when upright.

-Guisachan; Inverness, Highland; NH 286 253; Can NH22NE 6;
Possible standing stone, 1.3m high, with four cups towards the base of the **NE'n** face.

-Branhunisary; Islay; Srathclyde; NR 3713 4603; Can NR34NE 21;
Stone, 2m high, with a cup-mark near the ground, on the **N'n** side.

-Kilmartin; Argyll, Strathclyde; NR 8282 9760; Can NR89NW 3;
See detailed coverage at the end of this section.

-Kilspindie; Perth; NO 175 248;
Three-stone row, aligned **E'-W'ward**; **E'n** stone bears a cup-mark with a groove.

-Lochead; Strathclyde; NS 056 836; Can NS08SE 20;
Stone; bears a cup-mark.

-Lundin; Tayside; NN 8802 5062; Can NN85SE 8;
Pair of standing stones, each facing **SSE'-NNW'ward**, 8m apart, with a cup-marked stone between.

-Macbeth's Stone; Tayside; NO 2799 4346; Can NO24SE 16;
Stone slab, 3.6m high, with its broad **E'n** face bearing at least 40 cup-marks, the **W'n** face 24, the **S'n** face two, and the **N'n** face one.

-St Madoes; Pitfour, Perth and Kinross, Tayside; NO 1972 2098; Can NO12SE 20;
Three standing stones, aligned **NNW'-SSE'ward**, the S'n-most stone now lying prostrate as a recumbent boulder; the **NNW'n** stone, 1.6m high, is heavily cup-marked on its **E'n,** and **W'n** faces.

-The Glebe Stone; Whitefield, Selkirk; NT 3526 2760; Can NT32NE 2;
Slab, 1.4m high, with broader surfaces facing **WNW'** and **ESE'ward;** bears two doubtful cup-marks on the **ESE'n** face.

-The Ringing Stone; Johnstone, Aberdeen; NJ 5790 2517; Can NJ52NE 7;
Stone, 1.5m high, with at least four cup-marks on the **WNW'n** face, and a single, possibly natural depression on the **ESE'n** face.

-The White Stone; Stirling; NN 8063 0420; Can NN80SW 3;
Stone, 3m high, with one large, and seven smaller cups on its **E'n** face.

-Torbhlaran; Strathclyde; NR 8639 9449; Can NR89SE 3;
Stone, 2.1m high, with long axis **NW'-SE'ward**, bears 30 cup-marks on the **SW'n** face, and nine cup-marks on the **NE'n** face.

-Tuilyies; Fife; NT 0291 8658; Can NT08NW 3;
Apparently not a circle, but some other type of monument; standing slab 2.4m high, aligned **NE'-SW'ward**, the lower portion of its **SE'n** face covered with cup-marks; a triangular setting of boulders, of side about 4.4m, lies immediately to the S of the slab, but bears no cup-marks.

-Westerton; Tayside; NO 5364 5210; Can NO55SW 15;
Stone, 1.4m high, and 1m broad, bears five cup-marks on top of the stone.

IRELAND

-Barnes Lower; Donegal; C 107 245; 2-stone row;
Stone row, aligned **NW'-SE'ward**; stone at the **SE** 3m high, and at the **NW** taller; **SE'n** stone bears at least 48 cup-marks, arcs, and gutters on its **E'n** face; **NW'n** stone bears eight cup-marks on its **W'n** face, and seven cup-marks on its **E'n** face.

-Milltown S; Kerry; Q 429 010; 2-stone row;
Stone row, aligned **E'-W'ward**; stone at the W 3.3m high, and at the **E** 4.4m long, with cup-marks, cup-and-ring marks, and grooves.

ENGLAND and WALES

-Bridgend; Glamorgan; SS 7021 7951; Cof 300860;
Cup-marked standing stone, 1.5m high; excavation revealed a cremated deposit at the base of packing stones.

-Giant's Grave; Cumbria; SD 1361 8110; NMR SD18SW 12, 37326;
Two standing stones, both bearing cup-marks; currently no trace of a mound, but recorded as standing on a barrow in the 18th century, or possibly part of a stone circle; **axis NE'-SW'ward**; stones 3m, and 2.4m high, with a third one reputed; taller stone at the SW; NE'n stone has cups on the 'inner' (**?SW'n**) face.

-Swinburne; Northumberland; NY 93725 74513;
Single standing stone; lies on the lower SW'n slope of a stream valley, with more open aspects to the **SE**; the **N'n** face bears four oval depressions, and 14 other cups, some small, and the **S'n** face two prominent, and 10 fainter cups.

Detailed coverage of specific sites

Ballymeanoch; Argyll, Strathclyde; NR 8337 9641; Can NR89NW 14; e-FIG RA-07;

Two near parallel alignments of standing stones, 41m apart, run NW'-SE'ward, all stones with their long axes lying in this general direction (Thom and Thom 1990, part 1, 109-111; Morris 1977, 55-56). A perforated outlier is located to the NW of the N'n end of the SW'n row. Four of the stones bear carved motifs (TABLE RA-11).

The SW'n row is undecorated, most of the art occurring on the NE'n row, further concentrated on its two central stones, with some cup-marking, and a perforation on the single outlier to the W. Distribution of motifs is, therefore, fairly symmetrical along the NE'n row. Addition of these symbols might have served to enhance the status of the larger NW'n row, and augment the significance of its S'ly line. On this row, and on the outlier, all art is on the NE'n side of slabs, and would have faced the rising sun, perhaps a consistent placement of some importance.

This relatively well-preserved site, with its higher frequency of carved motifs, allows their relationship with the alignment of stones to be discussed in more detail.

The complex contains six surviving elements:

-the NE'n row is 14.4m long, and contains four slabs of sandstone, edge-set along the row, and aligned 141-321°G, labelled A-D from the SE, increasing in height to 4.3m at the SE;

From the N the stones are detailed as follows:

D: is undecorated;

C: bears about 40 cup-marks, and two, or three cup-and-ring motifs, one with a radial groove, on its NE'n face;

B: bears 40-70 cup-marks on its NE'n face, eight with rings, and four with grooves;

A: has a cup on its NE'n side.

-the SW'n row is located roughly opposite the central stones of the NE'n row, and contains two undecorated stones E, and F, 2.3m apart, aligned 152-332°G, increasing in height towards the SE;

-the **fallen outlier G,** with its hour-glass perforation, is oriented NW'-SE'ward, lies to the NW of the N'n end of the SW'n row, and bears 17 cup-marks, and one dumbbell motif on its NE'n face. Excavation around its base, which had remained *in situ* after the upper part had broken and fallen, revealed three small patches of cremated human bone, possibly a foundation deposit (Barber 1977);

-a curved setting of stones, of uncertain interpretation and association, 6m across, lies 29m to the ESE of the SE'n end of the 4-stone row;

-linear anomalies, as detected by geophysical survey, extend from the SE'n end of the complex, with one shallow N'-S'ly ditch confirmed by excavation, but otherwise remain of unknown association and interpretation; traces of an avenue have been suggested.

TABLE RA-11 BALLYMEANOCH: PROPERTIES OF STONES FORMING THE COMPLEX

stone	ht(m)	bcs(m)	face: motifs
NE'n row: 4-stone			
N'n end			
D	2.8	1.4 x 0.5	undecorated;
C	2.8	0.9 x 0.4	**NE:** [40C and 2CR] or [~30C and 1CR] or [~40C and 2CR];
B	3.6	2.0 x 0.5	**NE:** [70C] or [~35C and 3CR] or [>70C + 13CR];
A	4.1	1.4 x 0.4	**NE:** 1C;
S'n end			
SW'n row: 2-stone			
N'n end			
F	2.7	0.8 x 0.3	undecorated;
E	3	0.6 x 0.4	undecorated;
S'n end			
outlier to the NW: fallen, excavated			
G	2.9	1.0 x 0.25	**NE:** [17C and 1DB].

Note: the count of motifs varies between published sources;
Key: **ht** height ; **bcs** basal cross section; **C** cup-mark, **CR** cup-and-ring mark; **DB** dumbbell motif.
-associated sites: The Ballymanoch group of standing stones is situated 29m to the SW of a kerb cairn (NR89NW 40), and about 130m to the NNE of Ballymeanoch henge (NR89NW 18). The large cairn at Dunchraigag stands 400m to the N, and the ditched barrow of Ballymeanoch is some 500m to the S.

-existing interpretation of alignment

Thom (Thom and Thom 1990, part 1, 109-111) suggests solar orientation for the SE'n row and, for the NW'n row, possibly a lunar target, but notes problems of choice through abundance of foresights. Thom also suggests that the hole in the outlier G might have indicated Capella, rising over high ground to the NE, but is uncertain about converse interpretations to the SW.

A more robust reinterpretation of axes, in terms of the solar transit seems evident. Both of the stone rows have a similar alignment, the NE'n row at 141-321°G, and the SW'n row at 152-332°G. These lines would be close to solstitial axis 2 (NW-SE: \) which is about 137-317°G at this latitude (TABLE AS-01) and, taking the S'ly direction within the axis as key, they would lie just within the permanent zone of the transit.

Such reference to the rising SE'n margin of the permanent zone is less common than that towards the setting SW'n margin, this latter seen amongst stone rows on Dartmoor (e-FIG SR-05), and short stone rows sampled from Ireland (e-FIG SR-27). Both zones provide access to the solar transit for the entire year, in addition to specific reference to peri-solstitial limiting positions (see Table of Contents: 02c/2e).

Against this structural background, the distribution of motifs provides additional insight, whether these symbols were graffiti, added to a standing stone, or pre-existing, and erected with it. In terms of their general distribution between stones, the increase in motifs towards the S'n part of the NE'n row is too slight to be argued as significant. However, all motifs occur on the NE'n side of slabs in this row, and on the outlier G, which would indicate viewing to the SW during fabrication, and possibly during later use, again indicating reference to the setting margin of the permanent zone of the solar transit.

Within the panels, there is no obvious pattern to the distribution of motifs on outlier G, but on stones B and C, in the NE'n row, some of the cup-marks have a weakly linear disposition (e-FIG RA-07). If the cup was indeed a solar symbol (see Table of Contents: 06/3), this line might have denoted progress of the sun along its transit. On both of these stones, any radial grooves associated with cups (see Table of Contents: 03g/7b) are pointing downwards, perhaps a reference to the setting nature of the observed transit.

Similar lines of cups occur on stones at the following sites (TABLE RA-12):

TABLE RA-12 OCCURRENCE OF LINES OF CUP-MARKS ON MONUMENTS: EXAMPLES

site		NGR	type	panel
Clava	Inver	NH 757 444	kerb cairn	level
Sunhoney	Aber	NJ 716 058	rec stone circle	level
Kilmartin	Argyll	NR 8282 9760	stone row	upright
Ballymeanoch	Argyll	NR 8337 9641	stone row	upright
Achnabrech	Argyll	NR 8557 9069	nat stone surf	level

Key: **Inver**(ness); **Aber**(deen); **rec**(umbent; **nat**(ural); **surf**(ace);

Kilmartin; Argyll, Strathclyde; NR 8282 9760; Can NR89NW 3; e-FIG 08;
A linear complex of standing stones, 74m long, aligned NNE'-SSW'ward (024-204°G), contains four elements (Thom 1971, 46-7, fig. 5.1; Morris 1977, 110-111; Thom and Thom 1990, part 1, 107-108)(TABLE RA-13):

..a pair of standing stones, at each end;

..a stone with four others arranged around it, at the mid-point;

..and a 4-stone setting 9m, to the SSW of centre;

..two outliers of uncertain association.

-The **terminal pairs** are similarly oriented, with long axes NW'-SE'ward, lying obliquely to the long axis of the monument, a direction that may be repeated in one of the diagonals in each of the rectilinear 4-, and 5-stone settings.

-NNE'n pair: The pair of standing stones at the NNE'n end, one 2.7m high, the other 2.9m, hence with the tallest at the SW, are aligned NE-SW (150-330°G), lying across the main axis of the complex. The NW'n stone bears 3-4 cup-marks on its SW'n face.

-SSW'n pair: 37m SSW'ward of the central stone there is a second pair of standing stones, aligned NW'-SE'ward (143-323°G), of equivalent height about 2.7, and 2.8m, with the marginally taller at the SE, this stone bearing three cups, on its SE'n face.

-central stone setting: a standing stone, 2.8m high, is placed within a rectangular setting of four smaller stones. The major stone bears at least 40 cup-marks on its SW'n face, some with concentric rings. A small cist lies 7m further to the SSW, on the main axis.

TABLE RA-13 KILMARTIN: PROPERTIES OF STONES FORMING THE COMPLEX

stone	ht(m)	bcs(m)	face: motifs
1.. NNE'n pair (aligned with long axes NW'-SE'ward, 150-330°G)			
K	2.9	1.0 x 0.4	SW'n: undecorated
L	2.7	1.1 x 0.4	**NW'n:** 3-4C
2.. central 5-stone group			
central upright			
F	2.8	1.0 x 0.2	**SW'n:** [20C and 3CR], or [<=20C and 3CR], or [35C/CR], or [31C and 3CR]
short flanking pair 1			
G	0.8	0.9 x 0.3	undecorated
H	0.3	0.9 x 0.2	undecorated
short flanking pair 2			
I	0.6	0.7 x 0.2	undecorated
J	1.0	0.6 x 0.2	undecorated

3..short 4-stone group			small cist mentioned here (Thom and Thom 1990, part 1, 107)
C	0.9	1.1 x 0.2	undecorated
D	0.8	1.3 x 0.2	undecorated
E	0.4	0.7 x 0.2	undecorated
-	0.5	? ?	undecorated
4.. SSW'n pair (aligned with long axes NW'-SE'ward 143-323°G)			
A	2.7	0.8 x 0.5	undecorated
B	2.8	0.8 x 0.4	**SE:** 3C
5.. outliers			
M 100m to the NW of the NE'n end; aligned NE'-SE'ward, and now leaning towards the SE;			
	1.8	0.6 x 0.3	undecorated
N stump only; 300m to the W of the SW'n end; aligned NW'-SE'ward)			
	0.8	? ?	undecorated

Key: **ht** height ; **bcs** basal cross section; **C** cup-mark, **CR** cup-and-ring mark.

Placement of motifs on the stones shows a marked preference for the SW'n face of the central monolith, and over faces of the terminal pairs, which only bear a few on their SW'n and SE'n sides. Distribution is, therefore, fairly symmetrical along the axis. Here, the art is consistently on the S'n side of slabs, and so generally towards the sun, whereas at Ballymeanoch, the NE'n faces are decorated, and hence would face the rising limb of the sun. However, despite this trend, motifs at both sites might have served more to enhance the potency of the line, with precise location a secondary issue.

-associated sites

The small stone circle at Temple Wood, located 300m to the NW of the site at Kilmartin, apparently lies open along its nearest side, and possible links with the row-complex have been suggested (Thom 1971, 46-47; Thom and Thom 1990, part 1, 107-108). The low-lying area to the S of Kilmartin is also noted as one of the most important prehistoric cemeteries in Scotland.

-existing interpretation of alignment

Both the longitudinal, and transverse axes of the rows have been matched by Thom with lunar events at the horizon. Lunar alignments have been noted along the main axis of the complex, to the SSW, and to the NW, along those of the two individual stone pairs (Thom 1971, 46-47: fig. 5.1). Thom also suggests that the position of cup-marks at the SW, W, and SE may indicate solar associations, at midwinter, and equinoctial sunsets (Thom and Thom 1990, part 1, 107-108).

However, the S'ly direction within the main axis of the site (024-204°G) would place the alignment within the permanent zone of the solar transit, whilst the other direction would be within the null zone (see Table of Contents: 02c/2b(ii)). This axis might, therefore, have referred to the near zenith, just past the meridian, and on the setting limb of the transit, in a similar manner to that proposed for other sites (e-FIG CO-01).

The paired stones lying at each end of the complex, similarly aligned, the stone at the NNE 150-330°G, and at the SSW 143-323°G, may suggest an interest in solstitial axis 1 (NW-SE: \), which at this latitude is 137-317°G (TABLE AS-01). If the S'ly direction is taken as more significant, then axes would suggest that the site provided intersection with the solar transit in this sector for the entire year, together with a passing reference to winter solstice sunrise.

Motifs are concentrated at the centre of the setting, with only a few on the stone pairs at each end. At this site, carving is on the SW'n, or SE'n faces of stones, in contrast to consistent use of the NE'n side at Ballymeanoch. The proposed line of viewing there, to the SW (see this section: just above), would need to be reversed to allow motifs on the transit-facing side to have been considered as an equivalent placement. As at Ballymeanoch, there is some linearity of cups, and a single radial groove points downward, with similar interpretation possible for both sites.

Supplementary information: rock-art on stone circles and associated cairns

Sample from: UK, not Ireland.
Note: All of the barrows listed below are round, and of later Neolithic to earlier Bronze Age type, with many producing supporting dating evidence;
directional information on placement of motifs is given in **bold type**.

Key: Can: identifier in the Canmore on-line database for Scottish sites; **NMR:** identifier in **the** National Monuments Record/ English Heritage;

Recumbent stone circles; Aberdeenshire;

Few stone circles bear motifs, except those in NE'n Scotland, here forming about 21% of the national total. Amongst the round chambered cairns of the Clava group, motifs occur mainly in the passage, or chamber, but in related ring-cairns they are located on the kerb, and circle, predominantly towards the S'n side.

In the same general area, many recumbent stone circles (RSCs) bear cup-marks. In Aberdeenshire, 15 RSCs have cup-marks on the recumbent set within the circle, or on its flanking stones. Irish axial stone circles, here without flanking stones, also have similar proportions of decorated sites as the Scottish examples.

Scottish sites include:

-**Arnhill**; Aberdeen; Grampian; NJ 531 456;

-**Auld Kirk O'Tough**; Aberdeen; Grampian; NJ 625 092;

-**Balnacraig**; Aberdeen; Grampian; NJ 603 035;

-**Balquhain**; Aberdeen; Grampian; NJ 735 241;

-**Braehead**; Aberdeen; Grampian; NJ 592 255;

-**Cothiemuir Wood**; Aberdeen; Grampian; NJ 617 198;

-**Harestain**; Banff; Grampian; NJ 664 438;

-**Innesmill**; Moray; Grampian; NJ 289 641;

-**Loanend**; Aberdeen; Grampian; NJ 604 242;

-**Nether Corskie**; Aberdeen; Grampian; NJ 749 096;

-**New Craig**; Aberdeen; Grampian; NJ 745 296;

-**Pitglassie**; Aberdeen; Grampian; NJ 686 434;

-**Potterton**; Aberdeen; Grampian; NJ 952 163;

-**Rothiemay**; Banff; Grampian; NJ 550 487;

-**St Brandan's Stanes**; Banff; Grampian; NJ 608 611;

-**Sunhoney**; Aberdeen; Grampian; NJ 716 058;

Other stone circle sites

-**Barbrook I**; Derbyshire; SK 278 755;

-**Blackfaulds A**; Perth; Tayside; NO 145 317;

-**Carse Farm II**; Perth; Tayside; NN 797 484;

-**Colen; Perth;** Tayside; NO 110 311;

4-stone settings

-**Balkemback**; Tayside; NO 382 384;

-**Carse Farm I**; Perth, Tayside; NN 802 488;

-**Cramrar**; Perth; Tayside; NN 725 455; cup-marks on **SE'n** stone;

-**Goatstones**; Northumberland; NY 829 748;

-**Four Stones**; Radnor, Powys; SO 245 607;

-**Thorax**; Banff; NJ 582 549;

Cairns

The following sites, bearing carved motifs, are listed in Burl 1976:

Passage graves:

-**Balnuaran of Clava NE**; Inverness; NH 757 444;

-**Balnuaran of Clava SW**; Inverness; NH 756 443;

-**Corrimony**; Inverness; NH 383 303;

-**Lower Lagmore**; Banff; NJ 180 359;

Ring-cairns:

-**Balnuaran of Clava centre**; Inverness; NH 757 444;

-**Bruaich**; Inverness; NH 499 414;

-**Culbirnie**; Inverness; NH 491 418;

-**Culdoich**; Inverness; NH 751 437;

-**Gask**; Inverness; NH 679 358;

-**Moncrieffe**; Perth; Tayside; NO 133 193;

-**Tordarroch**; Inverness; NH 679 334;

-**Tullochgorm**; Inverness; NH 965 214;

Other cairns:

-**Balbirnie**; Fife; NO 285 030; oval stone setting 15 by 14m, increasing in height to the S; central rectangular stone setting, with surrounding cists, one with a cup-marked stone.

Further detail on specific sites

SCOTLAND

-**Balhalgardy;** Grampian; NJ 7598 2431; Can NJ72SE 1;
Survives as a single stone, with 24 cup-marks on its **N'n** side.

-**Balluderon;** Tayside; NO 3818 3844; Can NO33NE 1;
Stone circle of two recumbent stones, and two upright boulders; the stone to the E bears 21 cups on its **E'n** side, and 16 cups on its **W'n** side.

-**Balquhain;** Grampian; NJ 7350 2408; Can NJ72SW 2;
Recumbent stone circle, 20m in diameter, with 12 stones, seven of which still remain in a semi-circle; no cup-marks occur on the recumbent stone, but there are four on the now horizontal, upper surface of the fallen flanker

lying beside the recumbent; stone A bears 15 cup-marks on its outer **W'n** face; the standing stone next to the pillar flanking the recumbent on the **SW** at **232°G** bears 25 cup-marks.

-Candle Hill; Grampian; NJ 5991 2997; Can NJ52NE 10;
Recumbent stone circle; the recumbent stone bears at least six cup-marks, at the base of the outer face, and the E'n flanker to the recumbent has three cup-marks on its outer face.

-Colen; Tayside; NO 1106 3116; Can NO13SW 19;
Recumbent stone circle, 8m in diameter, with nine stones, graded in height up towards the largest, located in the SW'n arc; the **SW'n** stone bears several possible cup-marks on its **SW'n** face, and one on its level **top**; the **W'n** stone bears 32 cup-marks on its upper surface; the recumbent stone at the **NW** bears 25 cup-marks.

-Croft Moraig; Perth; Tayside; NN 797 472;
The second structural phase consists of a central oval, about 6m by 9m, with longer axis running NNE'-SSW'ward (007-187°G), the monument more open at the S, containing eight stones, including a cup-marked stone at the **NE** (037°G). Surrounding this setting, and sharing its centre, is a kerb of rubble, about 5m by 17m, ovate along the same axis, which contains a heavily cup-marked stone, on-axis at its **S** (189°G). This kerb is open at the N, and S, suggesting access along this line (Burl 1976, fig. 35/p. 201).

-Drumfours; Aberdeen; Grampian; NJ 561 110; no details.

-Easthill; Dumfries and Galloway; NX 919 739; no details.

-Ferntower; Tayside; NN 8740 2262; Can NN82SE 4;
Possible 4-stone circle, with the W'n, S'n, and E'n corner stones surviving; one possible cup-mark lies on the upper surface of the **S'n** stone.

-Fowlis Wester E; Perth; Tayside; NN 923 249;
A pair of small oval kerb-circles lie on an E'-W'ly axis, about 20m apart, with a standing stone between them. The long axes of these ovals run towards the margin of the permanent zone of the solar transit. In the E'n ring, the long axis is reinforced by an outlier, some 10m to the NE. The kerbed oval of stones at the E is about 5m by 6m, with the long axis NE'-SW'ward (030-210°G), its stones graded up towards the W-WSW, and surrounding a small cairn, itself lying within an outer oval of stones, about 9m by 10m. A decorated stone in the kerb lies on-axis, at the **SSW** (210°G) (Burl 1976, fig.34/p.197).

-Gask; Grampian; NJ 8018 0638; Can NJ80NW 9.
Stone circle reduced to a single stone, with eight cup-marks on its **E'n** face.

-Holywell; Aberdeen; Grampian; NJ 549 270; no details.

-Howe Mill; Grampian; NJ 5804 1071; Can NJ51SE 3;
A 4-stone circle, much damaged; the largest fragment of the **E'n** stone bears six cup-marks.

-Laggangarn; Dumfries and Galloway; NX 2271; no details.

-Monzie; Perth; Tayside; NN 882 243; see Table of Contents 03g/13; e-FIG RA-13 and SC-10).

-Old Rayne; Grampian; NJ 6798 2798; Can NJ62NE 1;
Recumbent stone circle; the recumbent stone bears at least three cup-marks, and another on stone D.

-Rothiemay; Banff; Grampian; NJ 5508 4872; Can NJ54NE 6; e-FIGS SC-07;
Two stones of this damaged recumbent stone circle bear cup-marks: the heavily worked inner face of the recumbent itself at the **SW**, 222°G from the centre, with a few on the outer face of a stone in the circle itself, to the **E**. The recumbent stone bears, on its inner face, 92 small cups, plus six others with rings, and seven on the top. The recumbent lies close to the axis for winter solstice sunset in the area (TABLE AS-01). There are short

linearities amongst the cup-marks on the inner side of the recumbent, and these slope up to the W. Such lines may simply reflect the rectangular format of the block, or could perhaps indicate the transit of the sun (see this section: motifs on standing stones/ discussion of Ballymeanoch and Kilmartin). The cup-and-ring marks show no obvious pattern, or relation to the ring-less cups. The decorated surfaces of the recumbent would be visible when viewing the aspect outwards from the interior, as suggested at Ballymeanoch.

-Thorax; Grampian; NJ 5822 5495; Can NJ55SE 1;
Stone circle, 7 by 5.5m, with the most massive block at the **WSW** bearing 22 cupmarks; a partly buried stone lies 18m to the **W,** and bears three cup-marks on its upper face.

-St Brendan's Stanes; Grampian; NJ 6075 6105; Can NJ66SW 1;
Two standing stones, possibly the flankers of a recumbent stone, this latter now missing, bear two cup-marks at the base of the **W'n** pillar.

-Strathgarry; Tayside; NN 8887 6295; Can NN86SE 25;
A 4-stone setting; one cup-mark on the **S'n**-most stone, at near ground level, and facing into the circle.

-Sunhoney; Grampian; NJ 7159 0570; Can NJ70NW 55; e-FIG SC-08;
Recumbent stone circle; recumbent stone at the **SW** (230°G) bears 31 cup-marks on its upper surface, these possibly originally on the outer **S'n** face, but now displaced, with the stone now fallen inwards; one upright bears cup-marks.

-Wester Tullybannochter; Tayside; NN 7548 2247; Can NN72SE 7;
Two stones of the stone circle remain, with at least four cup-marks on the **W'n** stone.

ENGLAND

-Duddo Four Stones; Northumberland; NT 931 437; no details.

-Goatstones; Northumberland; NY 8293 7471; NMR NY87SW 16, 16849;
A 4-stone setting of short uprights, set in a 4m square, graded in height, with the tallest 0.8m high, on the WSW, and the shortest 0.4m high, at the **ESE,** with 13 cup-marks on the top; there is a low mound in the circle.

-Long Meg and Her Daughters; Cumbria; NY 5711 3721; NMR NY53NE 5, 12199; e-FIGS SC-05 and 06;
Further details of the site, and its alignments are given in Table of Contents: 03e/10c.
Long Meg, a single outlier, 3.7m high, and about 1.2m in average width, lies to the **SW** of centre, about 23m from the SW'n entrance, and 77m from the centre of the adjacent circle (Thom 1967, 151; Burl 1976, 58; Brennan 1983; Soffe and Clare 1988; Thom and Thom 1990, part 1, 32-33). The face of the outlier, closest to the circle, bears at least three motifs, an anti-clockwise spiral, and two sets of about four concentric rings, one with a cup, and a radial groove (Burl 1976, fig. 14c/p. 91). Laser scanning of the weathered surface (Diaz-Andreu 2005) indicates other fainter ring features. Whether these symbols were added before, or after erection of the stone is unknown, but they all appear to be within reach of the ground, which may support the latter option.

Brennan (1983, 188-190) observed that the sun casts spiral shadows clockwise, when moving towards midsummer, and anti-clockwise towards midwinter, suggesting that this could explain the anti-clockwise spiral of the motif on Long Meg.

The only decoration of stones known at the site occurs on the face of the monolith Long Meg, an outlier at 224°G, placed significantly close to the direction of midwinter sunsets, when viewed from the central zone of the circle. Although this would allow restricted seasonal reference to this limiting position of the sun, intersection with the setting transit is possible at other times of year (see Table of Contents: 02c/2e).

The motifs could all be interpreted as solar symbols, with the concentric rings perhaps denoting beneficial seasonal increase (see Table of Contents: 06/3). One of the ring motifs has a radial groove pointing down, in the direction that the sun would set, but this may be fortuitous (see this section, just above: similar discussion of these motifs at Ballymeanoch and Kilmartin).

Supplementary information: selected rock-art sites in Scotland and N'n England

Key: Can: identifier in Canmore on-line database for Scottish sites.

The following list outlines a few examples from the large number of known rock-fast panels, with those relevant to the general discussion given in more detail:

ARGYLL

-Achnabreck; Argyll; NR 8557 9069; Can NR89SE 2; e-FIGS RA-03 to 05;
Several rocky outcrops bear carvings, the largest of which contains complex panels, comprising varied cup-marks, cups-and-rings, chanelling, and other motifs, forming the most extensive and impressive group of such carving in Scotland (Morris 1971).

Three discrete exposures, located on ground sloping towards the SE, are described below, taken from SW to NE:

..SW'n exposure:

This largest exposure, 11m by 13m in area, on its lower slope, bears three groups of markings. Towards the lower end it is dominated by cups, with up to seven rings, these often with a radial grooves, accompanied by an extensive mesh of grooving and, close to the base, a line of four unusually large cups. At the centre of the exposure lies another group of cup-and-ring marks and, further up the outcrop, a third such cluster.

..central exposure:

At the centre of this rock-face, the smallest of the three exposures, lies an unusually large cup, with seven surrounding rings, almost 1m in overall diameter and, to its S, a cup with a quadrant of three rings. Nearby there are other multi-ringed cups, one of which has two central cup-marks, with well-defined grooves, extending S'ward from their cups, several single-ringed cups, and plain cup-marks.

..NE'n upper exposure

Cups, some with grooves, and up to six rings, more numerous plain cups, and lengths of grooving, several of which form enclosures, lie at the N'n end of the exposure. Two double, and one triple spirals, and several multiple rings without central cups, all appearing more eroded, some of which are overlain by other motifs, may represent an earlier phase of carving.

Achnabreck; Argyll; NR 85720 90655; Can NR89SE 20;
This isolated rocky outcrop lies 150m to the E of the main Achnabreck group of panels (NR89SE 2), and includes many plain cups, and at least 15 cup-and-ring marks, many with radial gutters.

Kilmichael Glassary; Argyll; NR 8579 9349; Can NR89SE 1;
The rock-face slopes towards the SE, and two parallel terraces are profusely decorated with cups, rings, and other motifs. A sheet of rock, 8m by 5m, contains over 80 cups, 15 cup-and-ring marks, and keyhole-shaped figures. An extension of the rock-sheet has been exposed by excavation to reveal at least 47 plain cups, and five cup-and-ring marks.

Four cups with keyhole-like rings occur on both the upper, and lower terraces, and three large oval marks lie on the W'n side of the lower terrace. Another outcrop, 3m by 1m, lies 4m to the W, and bears six cups, some grouped, and one cup-and-ring mark. Other outcrops in the vicinity bear cup-marks (NR89SE 17).

Kilmichael Glassary; Argyll; NR 8580 9356; Can NR89SE 17;
About 60m to the NNE of the site at Kilmichael Glassary (NR89SE 1) lies a further E'ly-facing exposure, 2m by 1m, which bears 17 plain cups, and seven cup-and-ring marks, with more examples found by excavation.

Ormaig; Argyll; NM 8222 0270; Can NM80SW 8;
Two principal groups of marks (1-2), and four lesser sets (3-6), are listed here from S to N, and lie on a SW'ly-facing slope:

(1) The lower of the two major exposures bears, on its W'n sector, at least 15 plain cups, seven cup-and-ring marks, and several lengths of grooving. On the lower part of the sheet, dense carving includes numerous plain cups, 31 cup-and-ring marks, and several channels, including a parallel group of three. Three cup-and-ring marks include a circular rosette of pits, or small cups, lying between the central cup and the surrounding ring;

(2) A short distance to the N of (1), a steeply sloping exposure of weathered and fractured rock is heavily decorated with closely spaced cups, rings, channels, a rosette-type feature, and a motif of seven short, parallel grooves;

(3) An outcrop, immediately to the W of the top of (2), bears two groups of motifs, to the E at least seven plain cups, and 12 cup-and-ring marks, and to the W six plain cup-marks, and four cup-and-ring marks;

(4) About 2m to the NNW of (3) an outcrop bears six plain cups;

(5) An outcrop 1m to the N of (4) bears five cup-and-ring marks, nine cups, three with gutters, and numerous channels;

(6) 4m to the N of (2) an outcrop bears 10 cup-marks.

TAYSIDE

-Balendune; Tayside; NN 8951 5314; Can NN85SE 10;
A rock 1m by 1.5m, and bearing at least 70 cups, lies at NN 8949 5316, on the SE'n side of an earthen tumulus, 17m in diameter.

-Braes Of Balloch; Tayside; NN 7944 4518; Can NN74NE 18;
An unusually ornate cup-and-ring marked boulder measures 1m square, and bears on its top 17 small shallow cuplets, each surrounded by up to three concentric rings, the latter mainly penannular. The slab also bears interconnecting grooves and, on its E'n edge, a series of curved lines.

-Glassie; Tayside; NN 8507 5125; Can NN85SE 3;
A rock bears 21 cups, and eight cup-and-ring marks.

-Kinigallin; Tayside; NN 7585 4709; Can NN74NE 43;
An outcrop of rock, about 4m by 3m bears, on its W'n end, 50 small cup-marks, and a groove.

-Mains Of Murthly, Tominella; Tayside; NN 8758 4907; Can NN84NE 10;
There are four cup-marked rocks in the area:
..a fragmented outcrop, 3.5m by 2m, bears seven certain, two small possible cup-marks, and what may be a large badly weathered cup;
..a boulder, 2.5m by 1.5m, bears 45 cup-marks, including one ringed, and one contiguous pair;
..a boulder, 2.0m by 1.2m, bears at least 25 cup-marks, including four ringed, and two contiguous pairs;
..a rock, 2.5m by 2m, bears one cup-and-ring mark, and three possible cup-marks.

-Pitcairn; Tayside; NN 8906 5011; Can NN85SE 4;
An outcrop, 2m by 1m, bears 27 cup-marks, and an irregular pattern of curving lines.

-Queen's Wood; Tayside; NN 7640 4291; Can NN74SE 3;
An outcrop bears 19 cups, and four cup-and-ring marks.

NORTHUMBERLAND

-Fowberry Cairn; Northumberland; NU 0197 2784; HER 3325; e-FIG RA-12;
A round kerbed cairn, 4m in diameter, excavated, partially overlies two exposures of bedrock bearing rock-cut motifs. A total of 15 such exposures lie in the immediate area, and bear a range of motifs, including cups, cups with rings, and those bearing radial grooves, channelling, and linked cups. The area slopes down towards the SW, and the cups with radial grooves show a marked tendency for the latter to point S'-SW'ward in this down-slope direction.

e-FIGURES: combined listings and supporting information

Study areas
RA-

Argyll

01 rock-art: location of study areas

02 rock-art: Argyll group: distribution of panels

03 rock-art: Argyll: Achnabrech lower: panels

04 rock-art: Argyll: Achnabrech mid: panels

05 rock-art: Argyll: Achnabrech upper: panels

06 rock-art: Argyll: Kilmichael Glassary: panel

07 rock-art: Argyll: Ballymeanoch: standing stones

08 rock-art: Argyll: Kilmartin: standing stones

Galloway

09 rock-art: Galloway group: distribution of panels

Tayside

10 rock-art: Tayside group: distribution of panels

Cheviot: N

11 rock-art: Cheviot N group: distribution of panels

12 rock-art: Fowberry cairn: panels

Other

13 Kerb cairns: Monzie NN 8824, and Clava NH 7544

Orientation of motifs

14 rock-art: aspect of panels: histogram: samples from the Cheviot, and Eire groups

15 Motifs: orientation of key types: histogram

16 Motif S1b: cups with radial grooves: overlaid examples

17 Motif S2: penannular grooves: overlaid examples

18 Motif E1a: channels with terminal cups: overlaid examples

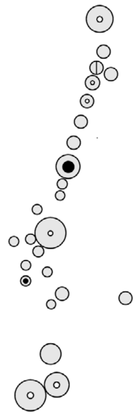
19 Motif E1b: lines of linked cups: overlaid examples

20 Motif E2a: shorter channels with terminal cups: overlaid examples

21 Motif E2b: longer channels with terminal cups: overlaid examples

Section 03h:
Linear round barrow cemeteries in S'n Britain: trends in orientation

Section identifier: RB-
SEE INITIAL SECTION: Access to digital images



Normanton Down (Wiltshire)

Summary

Analysis of alignment in linear round barrow cemeteries of earlier Bronze Age type, from seven study areas in S'n England, indicates preference for a broadly E'-W'ly axis, a trend seen especially amongst the more impressive sites. The nature of such linearity, its possible ritual basis, and its social implications are considered.

Axial alignments fall into two main groups, the S'ly (stone rows, henges), and the W'ly (long barrows, and chambered tombs of the Neolithic): the axes of certain major linear barrow cemeteries appear to conform with the W'ly group.

The following topics are discussed:

-**types** of linearity;

-**cues** for alignment;

-**trends** amongst round barrows and long barrows: comparison;

-**analysis** of linearity;

-cemeteries as **composite monuments**;

-**ranking** linearity;

-**models of growth** at linear cemeteries;

-**group assessment** of axes; basic trends at major sites;

-major coverage of cemeteries for seven **study areas** in S'n England;

-**elements** of linearity, and **dynamics** of growth;

-linearity as an expression of **social status**;

-**sub-unit structure** at cemeteries;

-significance of **directions within the axis**;

-**larger round barrows**;

-**basic trends** in orientation**;**

-supplementary information on **key sites.**

Introduction

Round barrows: types of linearity

Round barrows of later Neolithic to earlier Bronze Age type are widely distributed over S'n Britain, many singly, but also in clusters, ranging from a few, to many, from densely packed, to well spread. Such localised groupings vary in overall plan, and in the variety of barrow types represented, with individual monuments further displaying a range of internal features, rite of burial, and associated artefacts, these latter varying in type, and richness (general reviews: Ashbee 1960; Woodward 2000).

Certain clusters display various degrees of linear arrangement, either of the whole set of barrows, or amongst sub-groups of individual members. Such linearity is a widespread, and regular feature of barrow clusters possibly, in certain cases, linking individual sites together into a hyper-monument (see Table of Contents 03j). Since axes are, given fairly open topography, potentially at least, freely alignable, this being further enabled by the circularity of monuments, their properties deserve further examination for consistent regularity, and to be set amongst the range noted for other types of site, from the same general period, and area.

Various **degrees of linearity** can be seen at round barrow cemeteries, from clear axes that can be established with confidence, to cases that appear more complex, or are ill defined, including others that may simply be artefacts of placement:

..regular: At their most developed, such lines can be singular, and strongly defined, containing up to 15 near-contiguous barrows, many of which indicate once imposing monuments. Examples include Normanton Down SU 1141, and Winterbourne Crossroads SU 1941 (Wilts.), also Priddy Nine Barrows ST 5351 (Som.).

..general: The axis may appear less strictly linear, and more diffuse, becoming even broader when supplemented by peripheral barrows, some of which appear to be attempting to join the line at its sides, or ends. Examples include Cow Down SU 2251 (Wilts.).

..extended: There are cases where barrows are well spaced along what appears to be an extended line, in a manner that could reflect intentional alignment, especially when higher numbers of barrows are involved. Examples include the New King Barrows 2 complex SU 1342 (Wilts.), and West Hill SY 7084 (Dorset). Given the poor state of preservation, and exploration of many barrow sites, apparent gaps in extended lines may be real, or caused by destruction, or by non-detection of some members, perhaps more ephemeral than those that have survived.

In other cases, where well defined, shorter lines have outlying barrows set on the line, it is difficult to decide whether this is deliberate, and forms part of the line, or is not associated. Examples include barrows beyond the W'n end of The Stonehenge Cursus cemetery SU 1142 (Wilts).

..weak: In some cases linearity is far more difficult to assess, and may indeed be spurious. Examples of such lines include Everleigh SU 1856, and Codford Down ST 9742 (Wilts.).

..artefactual: In a cluster of barrows, individual sites that appear to be aligned, might have become so through chance, rather than by design, and such a process could generate potential axes in several directions, producing elements of a lattice in the plan (example: e-FIG RB-98).

Cues for linearity

In assessing directionality of axes amongst round barrows, it is essential at the outset to consider any physical constraints in the landscape that might have operated to determine, or modify their orientation.

There are many cases where linear barrow sites conform with underlying topography, sometimes strongly, as in cases sited along steep slopes, or on prominent ridges. Such locations, as well as being propitious in some way, might have served to further display the line against the horizon, in a more imposing way when viewed laterally (Woodward and Woodward 1996). However, very many other lines lie on fairly level ground, or along weak ridges, which would not have unduly restricted orientation, and which would not confer the advantages of more dramatic display on the skyline. Linear sites, such as those in the Thames valley study area (see Table of Contents: 03h/2e) illustrate the point. Still other lines lie along, or down contours, or in valley bottoms (for example: Poor Lot SY 5890, Dorset, and Lambourne Seven Barrows SU 3282, Berks.), areas with quite different properties to those of narrow elevated ridges.

Similar low-level topographical conformity is a frequent feature amongst the other types of monument considered in this general analysis, as noted for long barrows, cursus sites, and stone rows for instance. Yet, despite this, regional samples from areas of different topography show group regularities of alignment, indicating that the trend was for landforms to be chosen as suitable for construction, rather than acting to impose an orientation on the site. The approach here has been, therefore, to consider alignment amongst round barrows as a possible expression of active ritual intent, rather than as passive acceptance of terrain.

Long and round barrows: axes in common

Although there are many cases where round barrows occur in the area of an existing long barrow, there are relatively few cases where lines form up along its flanks, or its axis to the front, or rear. Examples occur at such sites as Winterbourne Crossroads SU 1041 (e-FIG RB-128 and 128a), and Milston Firs SU 1845 (e-FIG RB-108) (both Wilts.), and at Came Hill SY 6985 (Dorset; e-FIG RB-180).

Where the long barrow conforms with local topography, such as along a ridge-line, or contour, then the round barrows might also have been following terrain. Alternatively they could be continuing a tradition of axial ritual basic to the earlier monument.

Analysis of linearity

In the absence of clear differentiation along its line, the axis at a linear barrow cemetery could be described as **symmetrical** (see Table of Contents: 02a/2b). Consistent differences in external form amongst component barrows, such as unequal distribution of size, or type, would constitute asymmetry. Axes that appear **symmetrical** in terms of the surviving form of barrows may, of course, be asymmetrical in terms of other, unknown factors, such as date, burial rite, or type of grave-goods, these differing between component barrows but, in the case of unexcavated, partially excavated, or destroyed cemetery groups, these essential data are all too often lacking.

Although the longitudinal axis for long barrows is usually clearly asymmetric, having an unambiguous direction from front to rear of the monument, there is usually distinct lack of a similar standard amongst linear round barrows cemeteries.

The direction of growth of linearity would provide one such basis for asymmetry, as established using a clearly dated sequence of progressive barrow construction. However, very few sites have produced such data, even partial. In many cases, there might not have been a clear single direction of growth as, for instance, at a site where bilateral extension of the line occurred, expanding from a founder-barrow, or where there were more complex patterns of in-fill between two terminal founder-sites. In general the dynamics of cemetery growth (e-FIG RB-277) are very poorly known.

Assuming an apparently symmetrical axis at such a cemetery, there are at least five possibilities for measurement of such linearity: the entire axis, quoting both directions, either of the two directions along it from the centre, and those outwards from the two flanks. So, in terms of original intention, the line could have been meant to ‘point’, singly, or doubly, or to ‘flank’, presenting a side towards some significant direction, general, or specific. Alternatively, there might have been no such intention, the line being random, a convenient constructional device, or a passive response to underlying topography, or to other existing archaeological monuments.

Given the amount of data available on such linearity, its widespread distribution over a great variety of locations should mitigate extraneous topographical, or monumental factors, in any general analysis. A frequency distribution of orientations should, therefore, contain some indication of positive intention, detectable as any marked general deviation from randomness. However, such analysis does depend on the assumption that the basis for orientational behaviour was relatively uniform throughout the sample, and would break down if some sites 'pointed', whilst others 'flanked' in substantial proportion. For the purposes of this analysis, the bi-directional longitudinal axis was plotted as a basis for further discussion, with no differentiation of direction.

Linear placements of round barrows: status as composite monuments

Similarities in form, and regularity of placement, seen amongst round barrows in a linear cemetery could indicate more than simple *ad hoc* accretion of sites to a convenient, and traditionally accepted line. Some measure of planned development from the outset, heading towards creation of a composite monument, seems more likely at those sites that are impressive, and regular, as directed along a significant axis, by stages, over a considerable time-span, with a final presence greater than the sum of its parts.

Ranking linearity

Some method of ranking linearity needs to be adopted, as part of general description, and assessment, also for mapping changes in this property within, and between areas. Ideally, application of such a measure would require a great deal more information than is available from these cemeteries: badly conserved, poorly, and partially investigated as they all are (Table of Contents: 03h/2e to 2l). However, some such system needs to be considered, even if its application is problematic.

Actual axial lines could be scored against what might be expected in an idealised linear arrangement of barrows, involving integrity of purpose, and deliberate longer-term design.

Two main elements of linear arrangement might be considered in such a scheme: the barrows themselves, and the line on which they lie. Distributions of elements outlined below are given, where information is available, as overlays in plans for specific barrow cemeteries: for instance rite, and richness of grave goods, as given for Normanton Down SU 1141 (Wilts; e-FIG RB-111 and 111a), and Barrow Hills SU 5198 (Oxon; e-FIG RB-11).

The following features are relevant to the strength of an axis:

-external form of barrows:

..number of barrows in the line;

..size: the mean external diameter of barrows, either of the mound, or of any surrounding ditch, provides the only workable measure of size, given frequent absence of fuller structural data for poorly preserved, or investigated sites;

..type: the external form of barrows present (bowl, bell, disc, saucer, pond, and hybrids, according to the classification of Grinsell, and others (Ashbee 1960, 24), and the homogeneity of its range;

-internal content:

..uniformity of the primary rite: whether cremation, inhumation, or mixed;

..richness of grave-, or pyre-goods present: often only basic data are available, and so a more general grading, according to metal content alone, as adopted here, allows inclusion of the many sites that have been subject to early incursion, but where, although standards of excavation were poor, retrieval of significant grave goods was the prime objective, and consequently such items, and records have survived;

Richness can be graded as follows:

...rich: items of gold are present;

...moderate: gold is absent, but significant bronze is present;

...poor: bronze is absent, or forms a very minor inclusion;

...absence of surviving artefacts: this would cover placement of no items at all, or inclusion of perishable items only;

-the line on which the barrows lie

..straightness: centre-to-centre regularity of the line between barrows;

..absolute spacing between barrows: from *negative spacing* at partially overlapping sites where, for instance, ring-ditches intersect, to *zero spacing* at contiguous sites, where the edges of mounds, or ring-ditches touch, to a range of *positive spacing*, for wider intervals;

..evenness of spacing: regularity of the interval between barrows, taken here centre-to-centre rather than edge-to-edge;

The final form of a linear barrow cemetery: general properties

It is possible to score actual linear cemeteries according to these basic properties, and one tentative scheme is outlined below (TABLE RB-01). Here, maximum linearity would be obtained by a site with more than six large barrows, of similar external type, set closely, and uniformly spaced in a precise line, presenting the appearance of unified development to a distinct plan.

The choice of values used here for scoring basic properties is subjective, but seems reasonable for such preliminary discussion. Individual elements are certainly debatable: for instance, it could be argued that the effort, and intent, needed to place barrows accurately at wide spacing deserves a higher score than the considerably less difficult task of maintaining a short line.

Only those features that can be readily determined from existing field data, and from excavated records, have been included, with such internal markers as rite, and richness of burial here excluded, because so few sites have been investigated adequately. A score for the overall coherence of axial plan is included, although more to provide a general impression than as a securely quantifiable feature (TABLE RB-01). The line is considered abstractly, and not in relation to any cues from local topography, or adjacent monument, acting to guide it.

TABLE RB-01 Linear round barrow cemeteries: scoring linearity

properties of the:	from >>>				>>> to		scoring for cemeteries as listed a-d below: a	b	c	d
-barrows										
number	high	>10	>7	>5	3	low	4	3	2	1
mean diam.(m)	large	>25			<10	small	4	4	2	3
homogeneity	similar					diverse	2	2	3	3
-line										
precision	regular					irregular	4	4	3	2
interval	contiguous					wide	4	3	1	1
spacing	regular					irregular	3	2	1	1
-plan	unified					*ad hoc*	2	3	2	1
-developments around the main line: augmentation by added barrows										
flanking	few					many	1	0	1	0
terminal	few					many	3	0	0	0

SCORING was carried out according to the following system:

high	mod.	low	v.low					
4	3	2	1	>> **TOTALS**	**27**	**21**	**15**	**12**

with the cumulative score: at maximum 36, at minimum 9.

Applying this system, as a trial, to three example cemeteries, of varying linearity, from the Salisbury Plain study area, gives the following results:

	cemetery	NGR	linearity	score	e-FIG RB-
a	Normanton Down	SU 1141	major	27	111-111a
b	The Cursus W	SU 1142	significant	21	84
c	Foredown Barn	SU 0842	minor	15	92
d	Easton Down Farm	SU 2334	minor	12	90

As a general assessment, on the above basis, the degree of linearity shown at cemetery sites in the study areas (see Table of Contents: 03h/2) is generlly low, with only a few sites reaching moderate status.

Given better basic data it would be possible to map linearity in a more informative way than is possible in practice for the study areas: sites have been roughly categorised instead:

study area	TABLE RB-
Upper Thames	06
Avebury	07
Salisbury Plain	08
Dorset Cursus	11
South Dorset	12
Mendip	13
South Downs	14

Models of growth at linear cemeteries

There are four main mechanisms by which linearity might have developed at round barrow cemeteries, examples of which suggest themselves at a range of sites (e-FIG RB-277):

-simultaneous construction of barrows in the line is certainly possible, but seems inherently unlikely, although the axis might have been defined by initial, ephemeral phases of demarcation, construction, or other activity, that are no longer extant, and along which monumental construction then proceeded;

-sequential development: establishment of a row by progressive addition of barrows to extend the line, **uni-,** or **bilaterally**;

-infilling between more widely-spaced barrows, to create a row;

-accretion of barrows to an existing line, to reinforce, or generally extend it, either ;

..laterally; or **..terminally;**

This topic is discussed in more detail elsewhere (see Table of Contents: 03h/3a).

Group assessment of axes: the data

Analysis of orientation was carried out progressively in three stages:

-initial tests

In order to assess the likely productivity of more detailed investigation, a preliminary analysis of axial orientation was carried out for a sample of 237 sites, widely scattered over varied locations in S'n Britain (graph not shown, but similar to, and superseded by, the more detailed analysis given in e-FIG RB-275). Although the spread of data was broad, this preview showed a fairly well-developed peak at about E-W, indicating distinct non-randomness, and encouraged further detailed investigation. This peak seemed somewhat similar to that obtained for long barrows, over the same area, in its maximum, and spread of values (e-FIGS LB-18), perhaps indicating some common basis for funerary-related orientation behaviour, or its persistence over time.

-alignment at major linear round barrow cemeteries: the basic trend

More detailed examination of those major round barrow cemeteries, taken from the combined study areas, with the most developed linearity (listing: TABLE RB-02; see Table of Contents: 03h/2) shows that they have a distinct tendency to be aligned E'-W'ward. At these exemplars, up to 20 barrows adhere to well-defined lines, at close spacing, with others often clustering at the margins (TABLE RB-02). Here the axis is easy to define, and the trend very clear. It remained to determine whether this trend held for the broader sample of all sites, for which linearity, of less developed type, can be proposed (e-FIG RB-275).

TABLE RB-02 S'n England: major round barrow cemeteries: mean axial alignment

Note: only one direction within the axis is quoted here for convenience, the other is implicit; the mean axis is taken for those sites where there is some variation between component rows of barrows.
Key: NGR National Grid Reference; **#:** number of barrows forming the general line.

component study areas	**NGR**	**axis °G**	**#**
Mendip			
Ashen Hill	ST 5552	293	8
Nine Barrows	ST 5351	297	7
Small Down Knoll	ST 6640	266	13
Upper Thames			
Barrow Hills	SU 5198	245	12
Seven Barrows	SU 3282	300	13
Avebury			
Four Barrows	SU 2477	318	4
North Down SW	SU 0567	236	6
South Downs			
Devil's Humps	SU 8111	231	6
Devil's Jumps	SU 8217	303	6
Heyshott Down	SU 9016	303	11
Kithurst Hill	TQ 0712	271	6
South Dorset			
Five Marys	SY 7984	270	5
West Hill	SY 7084	246	9
Salisbury Plain			
The Cursus	SU 1142	270	6
Durrington Down E	SU 1144	280	10
Lake Group	SU 1040	309	16
Long Walk Plantation	SU 2439	312	5
Normanton Down	SU 1141	287	16
Silk Hill	SU 1846	283	12
New King Barrows	SU 1342	183	7
Wilsford	SU 1139	285	8
Winterbourne X-roads	SU 1040	220	21
MEAN		**273**	**9**

Study areas:

General content

Seven main study areas were selected for more detailed analysis of linearity amongst round barrow cemeteries (TABLE RB-03).

Five of these are contiguous, and provide a large sector through S'n England, from the Thames valley, to the South Coast. These study areas were each centred on: the upper Thames valley, the Avebury area, Salisbury Plain, the Dorset Cursus area, and the South Dorset ridgeway. Another, more marginal area, the Mendip Hills, was added at the W, to provide data from a different topography. Because of its similar terrain, a second, separate auxiliary area, the South Downs was also included, at the E, to provide a comparison with data from the South Dorset ridgeway.

Many mapped examples of round barrow cemeteries from the various study areas are included (e-FIGS RB-09 to 274), in order to demonstrate diversity of layout, widespread conformity with topography, and various degrees of linearity, often weak. Linearity is often more pronounced in particular cemeteries, suggestive of more impressive, higher-status burial, and for which a degree of purposeful alignment is here suggested (TABLE RB-02).

TABLE RB-03 Linear round barrow cemeteries: study areas in S'n England

study areas	NGRs for corners NW	SE	area (km)	bedrock	direction of drainage	major ridges	e-FIG RB-	major monument present
-main set								
Upper Thames	SP 0020	SU 6585	35 x 65	gravel	E-W'ward	-	02	
Avebury	ST 9090	SU 3060	30 x 40	chalk	E-W	var	03	yes: A
Salisbury Plain	ST 9060	SU 3030	30 x 40	chalk	N-S	var	04	yes: S
Dorset Cursus	ST 8030	SU 2000	30 x 40	chalk	N-S	NE-SW	05	yes: DC
S Dorset ridge	ST 5010	SY 9080	30 x 40	chalk	NW-SE	NW-SE	06	
-auxiliary								
Mendip Hills	ST 4060	ST 8060	20 x 40	lst	E-W	NW-SE	07	yes: P
South Downs	SU 7020	SZ 6095	25 x 90	chalk	N-S	E-W	08	

Key: NGR National Grid Reference; **lst** (limestone); **var**(iable); major monuments present: **A** Avebury henge and complex, **S** Stonehenge complex, **DC** Dorset Cursus, P Priddy circles.

Five of the areas are on chalk, one on limestone, and one on gravel. Areas are topographically diverse, displaying variable patterns of drainage, and of consequent ridge systems, on which barrows are frequently sited (e-FIG RB-27). There are ridge-lines and slopes set at all directions, from which to select locations for sites, as well as a great deal of open ground available.

Three of the study areas also include a major monument of Neolithic to Bronze Age date (Avebury, Stonehenge, and the Dorset Cursus), indicating the importance of each area for settlement, and for subsequent barrow construction, allowing some assessment to be made of the influence of these focal sites on patterns of barrow distribution.

Data on monuments

In order to assess their significance, it is essential to view linear round barrow cemeteries within the context of other existing barrows and monuments. The general distribution of round barrows, and of other relevant monuments was established for each study area (e-FIGS 02 to 08), using primary data from relevant National Monument, and Historic Environment Records, plus Ordnance Survey mappings.

Given the partial nature of the evidence, a more robust basis for mapping was adopted. Many round barrow sites, both as standing monuments, and as ploughed-out ring-ditches, are of uncertain attribution and, although further discoveries continue to add to the known distribution, its most general properties are unlikely to change significantly as a result. The count of long, and round barrows per square kilometre was therefore used, to establish the broader properties of barrow distribution, as a background for analysis of cemetery-type clusters.

The properties of round barrow distribution in each of the study areas have been divided into three categories (see those e-FIGURES listed in TABLE RB-03):

-**The density** of barrows was plotted at intervals of 1, 5, 10, and 15 sites per km^2, to give their general distribution, as a basis for defining discrete **major,** and **minor blocks** and, within these blocks, noting particular **focal areas** of highest concentration.

-**Areas of nucleation** within this general distribution were further defined, in which at least three barrows lie in close proximity, to suggest the existence of a distinct cemetery, rather than a zone of dispersed construction. Within this pattern, particular **clusters** of barrows were identified, their characteristics, and associations determined, with those meeting certain criteria of number, and spacing, being designated cemeteries.

-**Cases of linearity** amongst cemeteries were established, with approximate ranking noted (TABLE RB-01, and following discussion).

The general properties of each study area, in terms barrow content, are summarised in TABLE RB-04. The primacy of the three study areas covering central Wessex (Salisbury Plain, Dorset Cursus, and South Dorset) is clear from data on the mean density of round barrows (TABLE RB-04: column 11), and the percentage of significant or major linearities in the sample (*ibid*: columns 6 and 7):

TABLE RB-04 Study areas: frequency and intensity of linearity at round barrow cemeteries

Note: the main set of study areas is ranked from N to S.

column	1	2	3	4	5	6	7	8	9	10	11
	#	**#**	**#**	**#**	**%**	**%**	**%**	**rb**	**blocks**	**SA:**	**rbs/**
study area	**lb**	**rb**	**CEMS**	**lin**	**min**	**sig**	**maj**	**maj**	**min**	**km^2**	**km^2**
Upper Thames	27	1040	2	41	46	44	10	3	-	2275	0.46
Avebury	34	763	0	24	50	46	4	2	-	1200	0.64
Salisbury Plain	53	1657	**10**	**80**	14	**77**	9	1	5	1200	**1.38**
Dorset Cursus	45	1349	0	**32**	50	**50**	0	1	5	1200	**1.12**
South Dorset	21	1132	2	**58**	24	**69**	7	1	10	1200	**0.94**
Mendip	17	354	3	13	46	23	31	1	1	800	0.44
South Downs	19	785	2	8	12	63	25	2	7	2250	0.34
total sample	**216**	**7080**									

Key: **#** number of cases; **lb** long barrows; **rb** round barrows; **CEMS** major linear round barrow cemeteries; **lin**(earity): **min**(or), **sig**(nificant), **maj**(or); **SA** study area;

Linearity in the study areas: general conclusions

General analysis of linearity in the study areas (e-FIGS RB-02 to 08) suggests that it has the following properties:

-**infrequency**: linearity is a relatively uncommon feature amongst clusters of round barrows, most of which appear to be independently sited, without obvious pattern.

Many areas of extensive round barrow construction, such as the large *necropolis* at Stanton Harcourt SU 4005, Oxon. (e-FIG RB-44), and at Knowlton SU 0209, Dorset (e-FIGS RB-130 to 133), contain very few obvious linearities. Others, such as Poor Lot SY 5890, Dorset, contain linearity only in very restricted zones (e-FIG RB-197 and 197a). In such cases, linearity would perhaps be expected, by virtue of density of placement acting alone. Such absence may suggest that development of linearity was a potent symbol of power, and hence its use was restricted to important dynastic burial sites, rather than for areas of more general burial.

This restriction might be evident at the regional scale, where a single major linear barrow cemetery, lying within what might have been a discrete territory, could indicate some particular focus for a higher-ranking social group. For instance, this appears possible for certain sectors within the South Downs study area (see this section: relevant supplementary information; e-FIG RB-08).

-discrete placement: linearities appear somewhat separately located within general scatters of barrows. This is well seen at Lambourne Seven Barrows SU 3282 (Berks.) (e-FIGS RB-42 and 42a), and Poor Lot SY 5890 (Dorset) (e-FIGS RB-197 and 197a). Again, this could indicate the existence of elite areas within the general cemetery.

-unequal distribution: the level of linearity varies markedly between study areas, from relatively low ranking, and scattered, as for the Avebury area, to particularly high, and concentrated, as for Salisbury Plain. This could reflect the distribution of political power, from its centre, to more marginal areas.

Together, these features suggest that linearity may indicate a select area of burial, and associated ritual, with an especial significance, perhaps reserved for a discrete kin group, of higher status. If not only the line, and its general visibility, but also its direction was considered important, then consistency of the latter amongst these most developed sites might be expected. A convincing trend is indeed found, with a strong preference for an E'-W'ly axis (TABLE RB-02). This trend remains when the sample is extended to include all cemeteries in which some degree of linearity is present (e-FIG RB-275). That linearity and alignment are less coherent in the wider group may further indicate that these features might have been applied with some caution amongst the general community, because of their social connotations.

Summary of nucleation and linearity of barrow cemeteries

A more detailed context for linearity amongst the general distribution of round barrows is given for study areas as follows, the main set listed from N to S, with auxiliary areas following.

Study area: Upper Thames valley (e-FIG RB-02)

-nucleation: fairly equally well developed in major blocks B1-B3 of round barrow distribution;

-linearity: sporadic in all blocks; a W'ly trend is evident; only Barrow Hill in block B1 is highly linear, and the unusual presence of gold items there may well indicate higher status;

-***necropoleis***: these larger cemeteries are confined to blocks B1 and B2, with none evident further upstream;

-long barrows: alignment for many of the long, and oval barrows is poorly defined, but W'-NW'ly axes occur.

Study area: Avebury (e-FIG RB-03)

-nucleation: stronger in the main block of round barrow distribution B1, around the Avebury area, much less so in block B2, towards the NE;

-linearity: there are few well-developed linear cemeteries; a weak W'-SW'ly axial trend is evident;

-***necropoleis***: none occur in the study area;

-long barrows: these show a tendency to point (front to rear) towards the general W.

Study area: Salisbury Plain (e-FIG RB-04)

-nucleation: this is particularly high in the main block of round barrow distribution B1, with particular density developing within a 2km radius of the Stonehenge area; lesser nucleation is seen in minor blocks b1-3 towards the SE;

-linearity: the distribution of linearity follows that of nucleation, and is especially evident around Stonehenge; the general axial trend is W'-NW'ly, but in the zone around Stonehenge it has been argued that axes show some weak tendency towards a more encircling ring-like disposition (Woodward and Woodward 1996);

-***necropoleis***: none are known in the study area;

-long barrows: these show a tendency to point (front to rear) towards the W-NW.

Study area: Dorset Cursus (e-FIG RB-05)

-**nucleation**: this is very well developed in main block B1 of round barrow distribution, that lies around the line of the Dorset Cursus; a second concentration is seen in the minor block b4 in the lower lying area just to the S; nucleation elsewhere is sporadic;

-**linearity**: scattered examples occur in blocks B1 and b4, with few examples of highly linear and compact rows; a general W'-SW'ly trend for alignment is evident;

-***necropoleis***: two lesser *examples* occur in block B1, adjacent to the cursus; a large *necropolis* at Knowlton lies on lower, river-side land, to the S of the cursus, forming minor block b3;

-**long barrows**: these show a clear tendency to point (front to rear) towards the NW, contrasting with the NE'-SW'ly line of the cursus, and showing only weak agreement with the trend for local linearities amongst round barrows.

Study area: South Dorset (e-FIG RB-06)

-**nucleation**: there is a major concentration in the major block B1 of round barrow distribution, which runs along the main ridge system, but this is sporadic elsewhere;
-**linearity**: linear cemeteries, aligned generally W'-NW'ward occur, especially along the main ridge;
-***necropoleis***: the largest cemeteries of all lie in the main block of round barrow distribution: the Bronkham-Came Hill *necropolis,* and the somewhat smaller example at Poor Lot;
-**long barrows**: these occur both on, and off the main ridge, showing a similar general trend in alignment to the linear round barrow cemeteries.

Study area: Mendip (e-FIG RB-07)

-**nucleation**: there is a clear concentration amongst barrows in the main block B1 of round barrow distribution, especially within its denser areas; here too lie the main henge sites, suggesting an area of prime importance for the region;
-**linearity**: the distribution follows that for nucleation and, for denser block B1 the axial trend is W'-NW'ly, as displayed by the two most linear sites, Ashen Corner ST 5352, and Nine Barrows ST 5351, which lie near the group of four henges at Priddy;
-***necropoleis***: none are known in the study area;
-**long barrows**: where details are known these show a tendency to point (front to rear) towards the W-NW.

Study area: South Downs (e-FIGS RB-08)

-**nucleation**: for most sectors of the main ridge occurrence is scattered, but is more concentrated for the Storrington sector;

-**linearity**: there are major linear cemeteries on each of the ridge-sectors in the W'n part of the study area, suggesting the possibility of one higher status cemetery for each of what might have been a series of fairly discrete ridge-based territories:

sector	linear cemetery	
Treyford	Devil's Jumps	SU 8217;
Bignor	Heyshott Down	SU 9016;
Storrington	Kithurst Hill	TQ 0712;

Other ridge-sectors contain only sporadic minor linearities amongst barrows, and all such tend to conform with the generally E'-W'ly line of the main ridge of the Downs;

-***necropoleis***: none are known in this study area;

-**long barrows**: these occur both on, and off the main E'-W'ly ridge, this latter area containing the majority, and they all show a similar trend in alignment to the linear round barrow cemeteries.

Study area: detail: Upper Thames valley (e-FIG RB-02)

Summary

This study area includes a 70km stretch of the uppermost Thames valley, included here in order to provide data from topography different in geology, and relief from those in the five study areas located to the S, that lie on chalk down-land. Extensive spreads of gravel, flanking the upper Thames, have produced clear evidence for a range of monuments, with many round barrows, and ring-ditches occurring in localised cemetery clusters, some of which appear linear. There is no singlular monument, or feature, apart from the Thames itself, acting as a focus for the area, as is the case for the Avebury, Salisbury Plain, Dorset Cursus, and South Dorset study areas.

Three main areas of settlement, and funerary activity were detected, around junctions between the main course of the Thames and its side-tributaries, perhaps representing distinct territories. These contained the larger cemeteries, and linearity was weakly expressed at best, with few impressive cases.

General summaries of prehistoric settlement on the gravels of the mid and upper Thames valley are given in Lambrick *et al.* 2009 and Morigi *et al.* 2011. Benson and Miles 1974 give a useful general survey of monuments in the study area, based on evidence from cropmarks.

Topography

The upper Thames valley runs approximately E'-W'ward between the limestone dip-slope of the Cotswold Hills to the N, and the chalk downs of N'n Wessex at the S. Tributary streams join the main course of the Thames from either side, but especially from the N.

The area around the main river, and lower reaches of its tributaries, are densely covered by areas of gravel, and alluvium, 5-10km wide, on which much early settlement was based, utilising this better drained, and cultivable land.

Distribution of monuments

For all of the study areas the following types of monument, or a sub-set present, were plotted on distribution maps, according to the following groupings, the first two providing a context for the third, round barrows. The aim here is limited to outline identification of key areas for Neolithic to Bronze Age settlement, and activity, as a general basis for discussion.

The following sites are included:

..long barrow-related: long barrows; oval barrows; long mortuary enclosures;

..other sites: causewayed enclosures; cursus sites; henges; timber circles; stone circles;

..round barrows: all; very large mounds; cemeteries; linear groupings.

Monuments are concentrated in the zone of underlying gravel, especially in five main areas around junctions between the Thames and its side tributaries, and these are ranked here in order of decreasing content (TABLE RB-05):

TABLE RB-05 Relative abundance of monuments in focal areas around stream junctions

Thames junction with:			**monuments**						
stream	**NGR**	**area**	**lb**	**ob**	**lme**	**ce**	**cu**	**he**	**sc**
Thame	SU 5996	Dorchester	**	*	**	*	*	*	
Ock	SU 4994	Abingdon	*	*	*	*	*	*	
Leach	SU 2199	Lechlade			*	*	*	*	
Windrush	SP 4104	Stanton Harcourt		*				*	*
Evenlode	SP 4410	Cassington							

Key: lb long barrows; **ob** oval barrows; **lme** long mortuary-type enclosures; **ce** causewayed enclosures; **cu**(rsus sites); **he**(nges); **sc** stone circles; abundance: ** higher, * lower.

Long barrows

Almost all of the long barrows occur at the E'n end of the zone, mainly in the area of Dorchester and down-stream, penetrating up as far as the Abingdon area.

Other monuments

Major riverside concentrations occur around the Dorchester area, between junctions of the Rivers Thame and Ock, with lighter scatters on major spreads of gravel upstream, especially around tributary junctions. The diversity and density of monuments follows the trend set by long barrows, with the three areas upstream from Abingdon showing less of both qualities.

Round barrows

Note: for all of the study areas National Grid references for blocks are supplied, to give a general indication for the location of centre and limits;

Blocks prefixed **B**: major blocks; **b** minor blocks; **f** focal areas within blocks; **c** for distinct clusters of round barrows.

general distribution: concentrations occur around the Thame to Ock sector of the main valley, and on areas of gravel upstream along the Thames;

-block structure

Two major blocks, B1 and B2, are visible, each containing fairly discrete focal areas. A third block B3, somewhat lesser, but just eligible for this category, is less well defined in extent, and internal differentiation, and a fourth block, around the headwaters of the Thames is still more diffuse. All major blocks are approximately equivalent in area, about 20km long, and 5km wide, with their compactness, and intensity decreasing in the order B2 > B1 > B3, suggesting a major area of funerary activity in the Cherwell-Evenlode-Windrush sector, decreasing, especially upstream along the main course of the Thames.

This block-structure of funerary activity may indicate division of the valley into separate areas of settlement. The block-structure in this area is lower in intensity, and coherence than those from study areas on the chalk.

..major block: B1: SU 6093-SU 4196; Dorchester-Abingdon-Ock;

This block lies within the convoluted loops of the Thames, between junction with the Thame, extending up the side tributary of the Ock. It contains the following focal areas:

f1: SU 5895; around the Thame junction; **f2:** SU 4795; around the Ock junction; **f3:** SU 4395; in the mid-upper valley of the Ock;

..major block: B2: SP 5103-SP 3602; Cherwell-Evenlode-Windrush;

It contains the following focal areas:

f4: SP 4908; just to the W of the Cherwell junction; **f5:** SP 4510; around the Evenlode junction; **f6:** SP 4005; around the Windrush junction;

..major block: B3: SP 3600-SP2000; Bampton-Leach junction;

It contains the following focal areas:

f7: SP 3400; Bampton; **f8:** SP 2702; Clanfield; **f9:** SP 2400; Langford; **f7:** SU 2199; Lechlade;

..diffuse block; SU 2096-SP 0300:

This covers the uppermost Thames valley, and contains small focal areas.

-distribution of cemeteries

Cemetery clusters occur scattered throughout the three major blocks, with larger cemeteries more frequent in blocks B1 and B2, with this latter including the only larger *necropolis* in the area at Stanton Harcourt, ranged around its important circle-henge.

Linear cemeteries are scattered thinly throughout the general distribution of round barrows in all areas, with some concentration around the Thame to Ock sector.

Supplementary data: upper Thames valley

The following round barrow cemeteries display linearity, of which the most developed have been outlined in more detail (TABLE RB-06):

Note: site names have been standardised to the nearest place-name on Ordnance Survey Explorer 1:25k maps and, for clarity, are quoted with the abbreviated National Grid reference;

Site-names shown in **UPPER CASE** are described in more detail below under 'Details of individual sites';

non-linear cemeteries have been included for comparative purposes.

Key: conventions apply to all similar tables of supplementary data given for other study areas**:**

sitename [n] where n is the identifying number for the row, as shown in the e-FIG based plan of the site;

NGR: National Grid Reference;

cem(etery): MAJ(or cemetery);

lin(earity): general statement as to impressiveness of the row aa a linear monument: **maj**(or), **sig**(nificant), mi**n**(or);

barr: number of barrows in the stated row;

prox(imity of barrows in the row) **cont**(iguous), **clo**(se), **sp**(aced), **w**(idely spaced);

regS regularity of spacing between barrows in the row: **hi**(gh), **med**(ium), **low**;

strL straightness of the line: **hi**(gh), **med**(ium), **low**;

homB homogeneity of barrows: **hi**(gh), **med**(ium), **low**;

sub(-units) visible in the row;

alig(nment of the row in °G): only the W'n most direction in the axis is noted for convenience, the other is implicit;

dec direction of decreasing size of barrows along the row: **<** towards the W'n axis quoted in column 'alig', **>** towards the E'n axis implicit in column 'alig', **<>** in both directions along the axis; **L:** any particularly large barrow prominent in the row (see TABLE RB-17).

TABLE RB-06 LINEAR ROUND BARROW CEMETERIES IN THE UPPER THAMES STUDY AREA

e-FIG
RB-
02 ALL SITES AND MONUMENTS WITHIN THE STUDY AREA

linear cemeteries:

	cemetery		**NGR**	**cem**	**lin**	**barr**	**prox**	**regS**	**strL**	**homB**	**sub**	**alig**	**dec**
09	Abingdon Bridge		SU 5096		min	3	clo	?	?	?	no	282	
11	**BARROW HILLS**		SU 5198	MAJ	maj	12	clo	hi	med	hi	2	241	
12	Binsey	1	SU 4907		min	3	cont	med	hi	hi	no	**338**	
		2	4907		min	4	sp	low	med	med	no	**337**	
14	Buscot		2198		sig	6	sp	med	hi	med	2	238	?<
15	Cassington Mill	1	SP 4510		sig?	7	sp	low	med	?	no	**333**	
		2	SP 4510		sig	4	sp	hi	hi	?	no	303	
		3	SP 4510		sig?	6	sp	med	low	?	no	266	
		4	SP 4510		sig	4	sp	med	med	?	no	**337**	
		5	SP 4510		min	4	w	med	med	?	no	288	
16	Charney Bassett		SU 3795		min	3	sp	low	hi	low	no	18	
17	City Farm	1	SP 4311		min	3	clo	low	med	med	no	271	
		2	SP 4311		sig	3-4	cont	med	hi	low	no	**336**	**?<>**
18	Clanfield	1	SP 2802		sig?	3	cont	hi	hi	hi	no	186	
		2	SP 2802		min	3	sp	med	hi	med	no	260	
		3	SP 2802		sig	3	cont	hi	hi	med	no	246	?<
20	Corporation Farm	1	SU 4995		min	3	sp	med	med	hi	no	277	
		2	4995		min	3-4	w	low	hi	med	no	239	
21	Cote	1	SU 3400		min	4	w	hi	hi	med	no	320	
		2	3400		min	4	sp	med	hi	low	no	**331**	
22	Dorchester	1	SU 5795		sig	5-6	sp	med	med	med	no	298	
		2	5795		min	3	sp	med	hi	low	no	257	
		3	5795		min	3	w	hi	hi	hi	no	293	
23	Drayton S		SU 4893		min	6	sp	med	med	med	no	284	
24	Edgerley Farm		SP 2602		min	3	sp	med	hi	low	no	232	
25	Foxley Farm	1	SP 4208		sig	7	cont	med	med	low	no	190	?<
		2	SP 4208		sig	7	sp	hi	hi	hi	no	318	
		3	SP 4208		sig	5	cont	hi	hi	med	no	205	<
		4	SP 4208		sig	3	cont	hi	hi	low	no	225	<
		5	SP 4208		min	4	sp	med	med	hi	no	186	
26	Fullamoor Plantn		SU 5394		min	3-4	sp	med	med	med	no	242	
35	Kempsford		SU 1896		sig	3-4	cont	hi	hi	med	no	234	
37	Lechlade		SP 2100		min	3	sp	hi	med	?	no	238	
42	**SEVEN BARROWS**	1	SU 3282	MAJ	maj	5	cont	med	hi	hi	no	304	
	Lambourne	2	3282		maj	5	sp	low	hi	hi	no	295	
43	Standlake	1	SP 3804		sig	4	sp	hi	med	?	no	320	
		2	SP 3804		sig	6	w	med	hi	?	no	266	
44	Stanton Harcourt	1	SU 4005		sig	4	sp	med	med	?	no	249	
		2	4005		min	3	sp	med	hi	?	no	227	
		3	4005		maj	9	cont	med	med	?	?	270	
		4	4005		sig	4	cont	med	hi	?	no	298	

non-linear examples:

10 Appleford	SU 5393	
13 Black Bourton	SP 2803	
19 Cogges Bridge	SP 3707	
27 Garford	SU 4395	
28 Garford Field	SU 4295	
29 Grafton	SP 2601	detailed areas are shown in e-FIGS RB-30 to 32;
33 Home Farm	SP 3606	
34 Kelmscott	SU 2498	
36 Lang Down	SP 2102	
38 Little Farringdon	SP 2300	
39 Long Hanborough	SP 4214	
40 North Stoke	SU 6085	phot RB-11;
41 Northfield Farm	SU 5595	

Key: Plantn plantation.

Individual cemeteries

Barrow Hills; ....

Oxon; SU 5198; NMR SU59NW 8; e-FIG RB-11;

Summary

The cemetery consists of a single line of barrows, with some shorter sub-unit sectors evident. The barrows all appear to be of ditched bowl type. Partial excavation shows cremation as the dominant rite, with some barrows containing grave-goods of medium to high quality.

Topography: the site lies on the second (Summerton-Radley) gravel terrace of the Thames, and runs along the contour of a very gentle SE'ward-facing slope;

Barrows: 18;

-types: all ditched bowl or bell; the mounds have been eroded;

-cemetery structure: highly linear; two sub-units of five barrows each, with two linking barrows; spaced flanking barrows occur along the SE'n down-slope side;

-sequence: the ditch of barrow 4 cuts that of 3, so here at least growth seems to be towards the NE;

-special features: a possible oval barrow, and a Neolithic causewayed enclosure lie just to the E of the line;

-excavation: 10 interventions, with some fairly modern excavation;

-proportion explored: about half;

-rite: cremation predominant; no evidence for segregation;

-richness of grave-goods: some segregation of rich to moderate within the SW'n sub-unit row of the line;

-conservation: much damage;

Further details

Note: all barrows are numbered according to Benson and Miles 1974, 87-90.
The order of numbered barrows from the NE is as follows, with those in marked in **bold** type outlined in more detail below:

..barrow to the N: 17;

..N'n sub-unit of the row: 11 10 9 8 **7;**

..linking barrows: 6 5;

..S'n sub-unit of the row: 4 4a 3 2 1;

..barrows flanking the S'n side of the row: 16 15 14 13 12.

Additional detail on specific sites

-barrow 2: partial excavation 1944; Atkinson 1953;
circular ring-ditch with external diameter 32m, and that of the mound 11.5m; a central sub-rectangular pit aligned NE'-SW'ward contained the cremated deposit of a young adult ?male, with a bronze 'awl' (a triangular blade, with a rivetted handle-end), plus two truncated cones of gold foil, possibly forming halves of a gold bead-cover; further later excavation of site 2 adds little extra: Parrington 1977;

-barrow 3: partial excavation 1944; Atkinson 1953;
circular ring-ditch 31.5m in diameter, with that of the mound 21m; a central sub-rectangular pit, aligned WNW'-ESE'ward, contained an adult male inhumation, supine, with head towards WNW; a bronze knife-dagger, ?horn-handled, as grave-goods; **note**: the ditch of site 4 cuts that of site 3, so 4 appears later;

-barrow 4 and 4a: partial excavation 1944; Williams 1946;
two barrow mounds, with berms enclosed within a pear-shaped ditch, aligned NE'-SW'ward, 63m in maximum length, and 42m in maximum width; the smaller site 4a lies within the neck, and the larger site 4 within the bulbous end of the ring-ditch;

..4a: the smaller ditched area 4a is enclosed within its own sub-circular ditch, 10.5m in maximum external diameter, this mounded out to 18m diameter; a central crouched burial in an oval pit, head towards the NW, with a beaker, and three flint barbed-and-tanged arrowheads, also produced a pair of gold basket-earrings; a secondary child burial lay in the ring-ditch with no grave-goods;

..4: a larger area, mounded to 25m diameter, and separated from 4a by a shallow ditch-like depression; contained a near-central cremated deposit, with a bronze knife-dagger;

-barrow 5: partial excavation 1944; Williams 1946;
a circular ring-ditch, 44.5m in maximum diameter, with mound 20.5m in diameter; contained two shallow pits, one near the centre, and the other off-centre, containing char, and ?token cremated deposits, a flint scraper in one, and unworked flints in the other;

-barrow 6: partial excavation 1944; Williams 1946;

a circular ring-ditch, 35m in maximum diameter, contained a mound 24m in diameter, with surrounding berm; the old ground surface was apparently featureless, with no sign of burial; finds comprised a few general flints;

-barrow 7: partial excavation 1944**;** Atkinson 1953;
a sub-circular ring-ditch, 46m in external diameter; a mound, 38m in diameter, filled the interior, with no apparent berm; a near-central pit, with an adjacent burnt area, contained a partial cremated deposit, or the unsorted residue of cremation, that of a young ?female or lightly-built male;

-barrow 11: very partial excavation 1938; Leeds 1938;
a circular ring-ditch, 32m in external diameter; no details of the mound; a central pit contained a cremated deposit, with no grave goods;

-barrow 16: partial excavation 1936; Leeds 1938;
an oval area within a ring-ditch, oriented NW'-SE'ward, the latter estimated as 51m by 41m externally; no details of the mound; a central oval pit, aligned NW'-SE'ward, contained a cremated deposit, with an urn, bronze knife, awl, three amber beads, 10 shale beads, and a fragment of faience bead; food-vessels were found in the ring-ditch;

-barrow 17: partial excavation 1944; Williams 1946;
ring-ditch, 23m in external diameter; any mounding has been eroded; two pits, off-centre, contained a male burial (complete, crouched with head towards the W, and with no grave-goods), and the complete, unburnt, but disarticulated remains of a child, possibly a re-burial.

Lambourne Seven barrows; ....

Oxon; SU 3282; NMR SU38SW 10; e-FIG RB-42 and 42a; phot RB-10;

Summary

Two parallel lines of barrows lie along the contour, on the S'ly-facing slope of a small stream valley, with a few other barrows scattered over adjacent hillsides. The type of barrow in the linear cemetery is predominantly bowl. Only one barrow has been investigated, and here the rite was cremation, with grave-goods poor.

topography: on a moderate hill-slope, with the lines of barrows running along the contour, and a scatter of barrows over surrounding slopes and valley;

barrows: 13 in the linear core of the cemetery;

-types: 11 bowl, two saucer;

-cemetery structure: elongate, with two rows moderately well aligned; barrows slightly spaced, with some contiguous;

-sequence: unknown;

-special features: none;

-excavation: early excavation only;

-proportion explored: only one barrow in the row has been examined to any extent, although there are signs of incursion elsewhere;

-rite: one example of cremation in the row; cremation is the more common rite found amongst the few barrows examined elsewhere in the broader locality;

-richness of grave-goods: too few data to comment;

-conservation: much damage, especially beyond the linear sector;

The linear core of the cemetery

Note: all barrows are numbered according to Case 1956-1957:

-NE'n row: numbered NW to SE

4: saucer; early excavation, but no finds noted; **5:** bowl; no record of opening;

6, 7: bowl; **8:** bowl; two bowl barrows within a single ditch; **9:** bowl; early excavation; cist containing the cremated remains of a ?female in a collared urn; secondary crouched inhumation in the mound;

-SW'n row: numbered NW to SE

38: saucer; **10:** bowl; two bowl barrows within a single ditch; early excavation of the N'n mound noted ox and dog bones; **11:** bowl; opened but no record; **12:** bowl; **13:** disc;

Barrows beyond the rows

-to the N

1: ditched bowl, or bell barrow; primary cremated deposit, with bronze knife, awl, and pygmy cup; burial of uncertain stratigraphy; secondary collared urn, containing a cremated deposit, and a bronze knife, others with or without urns; secondary child burial;

-to the S

17: saucer barrow; two primary graves: in one, the contracted burial of a boy with beaker, two flint scrapers, and other flakes; in the same grave was an adult male burial, with a flint knife-dagger, flake, and nodule of iron pyrites; in the other grave, evidence of a child burial plus beaker;

18: bell barrow, with an addition at the S; this might have contained a secondary cist, with cremated deposit, bronze awl, shale ring, and jet amulet associated;

31: ditched bowl barrow; male burial, plus ?beaker, also a V-perforated shale button, flint knife, punch, two scrapers, flakes, and six barbed-and-tanged arrowheads.

Study area: detail: Avebury (e-FIG RB-03)

Summary

This area was selected in order to determine the distribution of round barrows, cemetery clusters, and linearity in particular, around the major henge complex at Avebury. Choice of an area for analysis located around some central monument is similar to the approach adopted for most of the other study areas.

The Avebury area was an important focus for funerary activity, and includes larger cemeteries, some with linearity, but less so, in all respects, than for the Stonehenge area.

Topography

The study area consists of the fairly narrow upper valley of the River Kennet, running E'-W'ward, with chalk uplands flanking it to the N and S. The N'n upland contains the Marlborough Downs, and Aldborough Chase, the S'n upland comprising the small Roundway Down area, at the W'n end of the larger All Cannings Down. Both areas contain strong major ridge-lines, and many minor lateral spurs, with all directions represented, but with a stronger N'-S'ly emphasis in the N'n, and E'-W'ly in the S'n.

A longer run of ridge-lines, along the S'n margin of the River Kennet valley, provides a clearer trans-regional E'-W'ly line of access, than that seen along its N'n side. The henge complex at Avebury is located near the headwater of the River Kennet, just below its last significant stream junction.

Distribution of monuments

Long barrows

Most of the 33 long barrows in the study area (88%) are scattered within an oval concentration, over the Avebury sector of the valley, and on its flanking uplands to the NE, and especially to the SW. Avebury itself lies well within this block, and towards its NE'n end. The few remaining long barrows lie well separated from the main block, and towards the NE.

Other monuments

The sites form a distinct cluster around the Avebury sector of the valley, but more closely associated with it than for long barrows. The area of the henge at Avebury appears to form a clear focus for distributions.

Round barrows

-general distribution: in a broad oval covering the Avebury area, and over flanking upland towards the NE, and SW, with most focal areas lying towards the centre;

-block structure
Two major blocks, B1 and B2, are present, the former more intense, with a few surrounding blocks qualifying as minor:

..major block: B1: SU 0563-SU 1977; Avebury:

This block, distributed over the upper Kennet valley, and its flanking ridges, is well-defined, broadly oval, about 20km long, and 10km wide, trending NE'-SW'ward, and containing the majority of round barrows. The shape and coherence of this major block clearly shows the influence of the Avebury area on the distribution of monuments.

The block contains four focal areas, f1-f4, with the same NE'-SW'ly trend as seen for the major block and, although adjacent, all of these focal areas appear separate:

f1: SU 1068; upper valley of the Kennet, and lower downland to the S of Avebury; **f2**: SU 0667; lower downland to the W of the River Kennet; **f3**: SU 1271; S'n third of Marlborough Down to the NE of Avebury; **f4**: SU 1469; lower downland along the N'n fringe of the upper Kennet, with **c1:** Clatford: the only cluster evident;

..major block: B2: SU 2971-SU 2181; Liddington-Ashbury:

This block occupies the higher ground to the N of Kennet, and to the E of the Avebury block, B1. It is less well defined than B1, and its shape is irregular, tailing off from the scarp area that flanks the tributaries of the upper Thames along the N'n margin of the study area, running S'ward, towards the Kennet. It contains fewer round barrows than block B1, and no comparable focal areas.

-distribution of cemeteries

Cemetery clusters increase somewhat towards the centre of the general distribution, with linear cemeteries scattered throughout their area;

Distinctly localised groups of round barrows were graded according to size as small, medium, or large cemeteries. Most of the cemeteries occur in the Avebury block B1, especially those of medium, and larger size.

Attempts have been made to impose further structure on the distribution of round barrows around Avebury, by suggesting two discrete ring-like dispositions of cemeteries. Here, an inner, and an outer ring range around the area of the henge, thought to be in a ritually significant manner (Woodward and Woodward 1996, fig. 2; Bradley 1998, fig. 31). The evidence clearly does not support such a pattern for the inner ring, still less for the outer. The suggestion seems to owe much to the somewhat clearer ring pattern around Stonehenge (*ibid*, fig. 6), which itself is open to doubt (see Table of Contents: 03h/2h).

Supplementary data: Avebury area

Linear round barrow cemeteries

The following round barrow cemeteries display linearity, of which the most developed have been outlined in more detail (TABLE RB-07):

Notes and Key: as given in TABLE RB-06 for the Upper Thames study area.

TABLE RB-07 Linear round barrow cemeteries in the Avebury study area

e-FIG
RB-
03 ALL SITES AND MONUMENTS WITHIN THE STUDY AREA

linear cemeteries:

	cemetery	NGR ST-	cem	lin	barr	prox	regS	strL	homB	sub	alig	dec
45	Allington	0764		min	3	sp	hi	hi	hi	no	333	
46	Avebury	1170		sig	3	sp	hi	hi	med	no	280	
47	Baydon	2677		sig	4	cont	hi	hi	hi	no	184	
49	Down Barn	0667		sig	3	cont	hi	hi	hi	no	253	
51	East Kennet	1267		min	4	sp	hi	med	?	no	187	
52	Four Barrows	2477		sig	4	cont	hi	hi	hi	no	318	
53	Fox Covert	0768		min	4	cont	hi	med	med	no	234	
54	Foxhill	2381		sig	4	cont	hi	med	mrd	no	341	<>
55	Gallops	0767		sig	3	clo	med	hi	low	no	267	
57	Gopher Wood 1	1363		min	4	clo	hi	med	med	no	315	<
	2	1363		min	3	clo	hi	hi	hi	no	221	
58	Idstone Down	2781		min	3	clo	med	low	hi	no	281	
59	Leigh Hill	2163		min	3-5	sp	hi	hi	hi	no	274	
61	Monkton Down	1272		sig	4	clo	hi	hi	hi	no	295	
62	Morgan's Hill 1	0467		sig	5	clo	hi	hi	hi	no	235	
	2	0467		sig	3-4	clo	hi	hi	hi	no	242	
63	New Town E	1163		sig	3	sp	hi	hi	hi	no	248	
65	New Town W	1163		min	3	cont	hi	med	hi	no	189	
66	North Down NE	0667		sig	3	cont	hi	hi	hi	no	253	
67	North Down SW	0567		maj?	6	cont	hi	hi	hi	no	236	
68	Overton Down	1271		sig	4	cont	med	med	hi	no	182	
69	Overton Hill	1168		min?	3-5	sp	med	med	hi	no	205	
70	Rough Hill	1372		min	4	sp	low	hi	?	no	277	
71	Wayland's Smithy	2885		min	6	sp	med	hi	?	no	233	
72	W Kennet	1168		min	4	sp	med	hi	?	no	345	
73	Windmill Hill	0871		min	3	sp	hi	hi	med	no	247	

non-linear examples:

48	Cherhill	0369
50	East Kennet	1166
56	Golf Club	0267
60	Liddington	2180
64	New Town N	1164

The area contains no linear barrow cemeteries sufficiently impressive to be described in detail here.

Study area: detail: Salisbury Plain (e-FIG RB-04)

Summary

This study area is centred on the locality of Stonehenge since, besides a range of major monuments, it contains a particular concentration of round barrows, and cemeteries, many of which are impressively linear.

The main distribution of round barrows occurs over the central zone of Salisbury Plain, on amenable land within easy access of its main river, the Avon. This denser area of barrows, some 20 by 10km, and generally aligned with the river, certainly represents a major zone of funerary activity, and probably of direct settlement. Within this main block, the area of the great henges at Stonehenge, and Durrington Walls, and of surrounding monuments, appears to act as a particular focus for barrow distribution, both round, and long, with other lesser concentrations occurring within, and beyond it. This focal area, about 5km across where most intense, is ranged towards the N

of the Stonehenge area, rather than symmetrically around it (e-FIG RB-04 and 278). There is no clear evidence for the type of circular disposition of round barrows suggested by Woodward and Woodward 1996 (see Table of Contents: 03h/2h).

Round barrow cemeteries show a distinct concentration in this main block, with larger examples prevalent, most cases of linearity occurring within the focal area at its S'n end.

Topography

Salisbury Plain is an approximately oval area of lower relief, some 20 by 15km in extent, located around a S'ly-flowing fan of tributary streams that drain to the River Avon. Along the N'n and W'n sides, but less so at the E, the margins of the area are well defined by surrounding chalk upland, heavily dissected by headwater streams, to form discrete areas of downland, and a developed structure of ridges, and their lateral spurs. The highly convoluted margins of these upland areas indicate the erosive action of a finely branched system of drainage, much of which is no longer extant at the surface. The S'n side of the area, around the confluence of the streams, provides a major break in the encircling margin of hills.

Larger stream valleys subdivide areas of downland. The Rivers Bourne, and Avon, running through the Collingbourne Kingston, and Upavon gaps, cut the NE'n, and N'n uplands. The N'n, and NW'n uplands are less completely separated by the West Lavington gap, and the River Wylye flowing through the Upton Lovell gap separates the NW'n and SW'n uplands.

Strong major ridge-lines are visible, traversing the upland, and providing ready access around the area of the Plain.

The major henges at Stonehenge, and Durrington Walls lie centrally within the Plain, about 2km from the Avon, the main river crossing the area.

Distribution of monuments

General surveys of monuments in the area, their nature, date, and state of preservation are provided by Bonney and Smith 1979, Crutchley 2000, and Komar 2010.

Long barrows

There is a major concentration in the area around Stonehenge, with more general scatters over the uplands, more prominently along the W'n margin of the Plain.

Other monuments

Monuments show clear clustering around the Stonehenge area, with major cursus, and henge sites well represented.

Round barrows

-general distribution: a major concentration covers Salisbury Plain, with focal areas around Stonehenge, and a broad general distribution over adjacent upland;

-block structure
There is one major block B1 in the study area, elongate, about 20km long, and 10km wide, covering the central sector of the Plain, over land either side of the River Avon, with a major focus in the Stonehenge area, towards its S'n end. There are minor riverine extensions of barrow distribution to the N and S, along the flanks of the Avon.

..major block: B1: SU 1033-SU 2260; Stonehenge area;

This major block contains seven focal areas, decreasing in intensity with distance from the main focus f1 at the S. The coherent shape of the block clearly shows the influence of the Stonehenge area extending outward to some distance.

focal areas:
f1: SU 1242; Stonehenge-Durrington; the major focus, covering the central zone of the Plain to the W of the River Avon; **f2**: SU 1842; Bulford; a smaller focus to the E of the River Avon, possibly extending f1; **f3**: SU 1546; Figheldean; on land around the River Avon, as it leaves the Upavon Gap; **f4**: SU 2046; Milston Down; on lower ground at the S'n margins of the NE'n upland, near a tributary of the Avon; **f5**: SU 2151; Snail Down; in the valley of the River Bourne, as it flows from the S'n margin of the NE'n upland; **f6**: SU 1856; Everleigh; on higher ground of the NE'n upland; **f7**: SU 1357; Manningford; in the upper valley of the Avon; **f8**: SU 1056; Charlton; in the upper valley of the Avon;

..minor blocks:

Along the SE'n margin of major block B1 there are four more minor blocks: **b1**: SU 1533; Winterbourne; over land on the Plain, between the lower Avon and Bourne; Blocks b2-b4 lie over higher ground on the SE'n upland, to the E of the Avon: **b2**: SU 2235; Porton Down; **b3**: SU 2538; Juniper Down; **b4**: SU 2846; Kimpton Down;

Another block lies at the W'n margin of the Plain, in the Upton Lovell gap: **b5**: ST 9242; Heytesbury;

-distribution of cemeteries

Cemetery clusters show a distinct concentration in the Stonehenge area, and to the E of the River Avon, with scattered concentrations over upland, and valley areas to the E and N. Linear cemeteries occur mainly in the Stonehenge area, and to the E of the River Avon.

Most of the larger, and more impressively linear round barrow cemeteries lie within the main block B1, around Stonehenge itself. Various attempts have been made to establish finer structure within this area, by suggesting a deliberate ring-like arrangement of barrow clusters around the immediate area of Stonehenge. A double ring has been suggested, the inner of about 1km radius, the outer 2km (Woodward and Woodward 1996, fig. 6; Bradley 1998, fig. 31). The line of these rings in relation to round barrows is shown in e-FIG RB-279, along with alternative patterns (see Table of Contents: 03h/2h).

Supplementary data: Salisbury Plain

The following round barrow cemeteries display linearity, of which the most developed have been outlined in more detail (TABLE RB-08):

Notes and Key: as given in TABLE RB-06 for the Upper Thames study area;

TABLE RB-08 LINEAR ROUND BARROW CEMETERIES IN THE STONEHENGE STUDY AREA

e-FIG
RB-
04 ALL SITES AND MONUMENTS WITHIN THE STUDY AREA
linear cemeteries:

	cemetery	**NGR**	**cem**	**lin**	**barr**	**prox**	**regS**	**strL**	**homB**	**sub**	**alig**	**det**
74	Allington Farm	SU 2137		sig	3	clo	hi	hi	hi	no	278	
75	Amesbury	SU 1841		sig?	5	clo	med	hi	?	no	269	
76	Boscombe Down W	SU 1840		sig	6	clo	med	low	hi	no	226	
77	Bulford Camp NE 1	SU 1944		sig?	5	clo	med	hi	med	no	291	
	NE 2	1944		sig?	3	clo	hi	hi	?	no	270	
78	Bulford Camp SW	1944		sig	3	w	hi	hi	med	no	277	
79	Bulford 1	SU 1742		sig	3	sp	hi	hi	hi	no	271	
	2	1742		min	6	sp	hi	low	med	no	234	
	3	1742		sig?	4	sp	hi	med	hi	no	339	
83	**COW DOWN**	**SU** 2251	MAJ	maj	12	sp	med	low	med	1	243	
113	Cursus E	SU 1343		min	7	w	low	med	hi	no	266	

84	**CURSUS W**	SU 1142	MAJ	sig	6	sp	med	hi	med	2	270	<
85	Down Farm 1	SU 1856		sig?	4	sp	hi	hi	med	no	207	
	2	SU 1856		sig?	3	sp	hi	hi	hi	no	207	
86	**DURRINGTON**											
	DOWN E 1	SU 1144	MAJ	maj?	7-8	sp	low	med	med	no	280	
	E 2	1144		sig	5	sp	med	med	hi	no	275	
87	Durrington											
	Down W 1?	SU 1044		min	3	w	hi	hi	?	no	244	
	W 2	1044		sig	3	sp	hi	hi	?	no	285	
88	Durrington											
	Down Farm	SU 1243		sig?	3	sp	hi	hi	hi	no	213	
90	Easton Down Farm	SU 2334		sig?	4	w	med	med	hi	no	196	
91	**EVERLEIGH**	SU 1856		sig	3-5	cont	hi	hi	med	no	248	>
92	Foredown Barn	SU 0842		sig	6	sp	low	hi	med	1	293	
94	Grants Firs	SU 1754		sig	3	sp	hi	hi	hi	no	274	
95	Grateley Lodge 1	SU 2440		sig?	3	cont	hi	hi	hi	no	312	
	2?	2440		min	4	w	low	med	med	no	334	
96	Halfmoon Clump	SU 1442		sig	4	sp	low	hi	low	no	354	<>
97	Idmiston Down 1	SU 2236		sig	3-4	clo	hi	med	med	no	229	
	2	2236		sig	4	clo	hi	hi	med	no	289	
98	**LAKE DOWN**	SU 1139		min	4	cont	hi	hi	hi	no	270	
99	**LAKE GROUP** 1	SU 1040	MAJ	sig	5-7	w	low	med	?	no	299	
	2	1040		sig	4	w	low	med	?	no	291	
	3	1040		sig	5	w	med	hi	?	no	**337**	
100	Larkhill	1344		sig	4	w	hi	hi	hi	no	334	
101	Little Cursus 1	SU 1043		sig?	3	w	hi	hi	?	no	238	
102	2	1043		sig	3	sp	hi	hi	?	no	283	
103	Long Walk Plantn	SU 2439		sig	5	clo	med	hi	med	no	312	>
104	Luxenburgh Plantn 1	SU 1241		sig	3	clo	med	hi	?	no	334	
	2	1241		min	4	w	med	hi	?	no	207	
105	Milston	SU 1645		sig?	3-5	w	low	hi	?	no	217	
106	Milston Down 1	SU 2046		sig	3	sp	hi	hi	low	no	279	
	2	2046		min	3	sp	med	hi	low	no	330	
107	Milston Drove	SU 2046		sig	3	sp	hi	hi	med	no	320	?<
120	**NEW KING**											
	BARROWS 1	SU 1342	MAJ	maj	6	cont	hi	hi	hi	2	184	
	2	1342		sig	6-8	w	med	med	?	2	265	
111	**NORMANTON**											
	DOWN 1	SU 1141	MAJ	maj	17	cont	hi	hi	med	2	287	
	2	1141		sig	3	cont	hi	hi	low	no	346	
112	North Hill Down	SU 1233		sig	3	cont	hi	hi	hi	no	246	
113	Old King Barrows	SU 1342		sig	6-7	sp	med	hi	med	no	225	
114	Porton Down	SU 2235		sig?	3	sp	med	med	med	no	263	
115	Rifle Ranges	SU 2045		sig?	3	sp	hi	hi	hi	no	292	
116	Seven Barrows	SU 2148		sig	4	cont	hi	hi	med	no	359	
117	**SILK HILL** 1	SU 1946	MAJ	sig	3	clo	hi	hi	med	no	329	<
	2	1946		sig	3	cont	hi	hi	low	no	278	
	3	1946		maj	8-13	clo	hi	hi	hi	no	283	
	4	1946		sig	4	clo	hi	hi	low	no	314	<
118	**SNAIL DOWN** 1	SU 2152	MAJ	sig	4-5	cont	med	med	med	no	347	<
	2	2152		sig	3	cont	hi	hi	hi	no	324	
	3	2152		sig	4	cont	hi	hi	med	no	229	> L
	4	2152		sig		cont	med	hi	med	no	252	<
	5	2152		min	5	w	low	hi	med	no	230	

119 Springbottom Farm 1	SU 1240		min	5	w	low	hi	hi	no	193	
2	1343		sig	4-5	clo	hi	hi	hi	no	204	
121 Strangways 1	SU 1343		sig	4	sp	med	med	med	no	342	?<
2	1343		sig	3	cont	hi	hi	hi	no	289	
122 Testwood Farm	SU 2735		sig	3-5	cont	hi	hi	med	?2	280	
123 The Coniger 1	SU 0742		sig	6	sp	med	med	?	no	356	
2	0742		sig?	3	sp	hi	hi	med	no	290	
124 Tytherington	ST 9141		sig	4	sp	med	hi	hi	no	197	
125 Winterbourne Stoke Down	SU 1042		sig	3	sp	hi	hi	hi	no	265	
126 West Amesbury	SU 1441		sig	3	sp	hi	hi	hi	no	299	
127 WILSFORD 1	SU 1139	MAJ	sig	7	sp	med	hi	hi	no	285	
2?	1139		min	3	cont	med	med	low	no	240	
128 WINTERBOURNE X-ROADS 1	SU 1041	MAJ	sig	3	cont	hi	hi	med	no	212	<
2	1041		maj	5	cont	med	hi	med	?3	220	
2a	1041		sig	5	cont	med	hi	low	no	223	
3	1041		sig	4	cont	med	hi	med	no	239	
4	1041		min	3	cont	hi	hi	hi	no		
129 Woodhenge 1	SU 1543		sig?	3	cont	hi	hi	hi	no	351	
2	1543		sig	4	cont	hi	hi	hi	no	332	
3	1543		sig	3	cont	hi	hi	hi	no	284	

non-linear examples:

80 Cholderton	SU 2442
81 Codford Down	ST 9742
82 Coneybury Hill	SU 1341
89 East Castle	SU 0336
93 Goat Wood	SU 1947
110 New Barn	SU 1742

other sites:

108 Milston	SU 1845
109 North Kite enclosure	SU 1140

Key: Plantn plantation.

Individual cemeteries

Cow Down; ....
Wilts; SU 2251; SU25SW 30; e-FIG RB-83;

Summary
A diffuse line of round barrows runs along the crest of a spur, becoming more linear at its SW'n end. All barrows in the core area are of bowl type, the dominant rite is cremation, and the quality of grave-goods is poor.

Topography: the site runs along the crest of a low ridge.

Barrows: 13 bowl in the linear core, with a disc barrow and a ring-ditch nearby;

-types: bowl predominates;

-cemetery structure: elongate, a mainly spaced scatter, with three smaller bowl barrows at the SW'n end, lying closely, but not contiguous; some sign of decreasing size towards the SW in the general line of the cemetery;

-sequence: unknown;

-special features: none;

-excavation: early excavation only;

-proportion explored: five incursions;

-rite: cremation predominant;

-richness of grave-goods: all poor;

-conservation: much damage;

Further details:

Note: all barrows are numbered according to the system initiated by Grinsell.
The order of barrows from the NE is as follows, with those in marked in **bold** type outlined in more detail below:
Parish: Collingbourne Ducis:
listed from W to E: **8a:** bowl; 8b: bowl; **8c:** bowl; **8d:** bowl or pond; obliterated; **9:** bowl; **10:** bowl; **11:** bowl;
these other numbered barrows also occur in the cemetery: 12-15: bowl; **16:** bowl; 17-18: bowl;

Additional detail on specific sites

Note: AS [entry number]**:** Annable and Simpson 1964;
8a: bowl; SU 2273 5142; biconical urn, in a ?secondary location (AS 553); **8c:** bowl: SU 2281 5145; urn, in ?secondary location (AS 583); **8d:** SU 2283 5149; NMR: SU25SW 184, 926314; crop-mark, 10m in diameter; **9:** SU 2289 5147; urn, in secondary location (AS 555, 571); **10:** SU 2294 5151; NMR: SU25SW 186; primary cremated deposit, in a tree-trunk coffin, with antler hammer (AS 236); **11:** SU 2301 5154; crouched child burial, with an urn; associated urn containing a cremated deposit (AS 484, 519); **16:** SU 2308 5169; primary burial with a shale bead, and handled vessel (AS 498-499).

The Stonehenge Greater Cursus: W'n round barrow cemetery; ....
Wilts; SU 1142; NMR SU 14SW 87; e-FIG RB-84;

A general line of barrows, running along a low E'-W'ly ridge, contains a marked linearity at its E'n end, comprising seven bowl barrows, and two possibly outlying barrows, with some indication for division of the line into two sub-units. Cremation is the dominant rite seen in the row, and grave-goods from low to high quality have been found.

Summary

topography:
barrows form a line along the broad spine of a weak ridge running in parallel with The Stonehenge Greater Cursus just at the N;

barrows: 22;

-types:; seven bowl, one double ?bowl, six bell, and eight indeterminate;

-cemetery structure:
two short lines, with barrows quite closely contiguous at the E'n end, with a non-linear scatter of barrows to the W, containing one larger bell barrow, of the type seen in the lines, possibly representing an outlier to W; in the more definite line, barrow size decreases towards the W;

-sequence: unknown;

-special features: The Stonehenge Greater Cursus lies just to the N;

-excavation: one modern excavation, the rest early;

-proportion explored: three interventions in the main line, and three beyond;

-rite: the known pattern suggests cremation in the lines, and inhumation in the scatter to the W;

-richness of grave-goods: rich and medium in the line, with medium to poor beyond; data sparse;

-conservation: much damage.

Further details

A general survey of the cemetery is given in Amadio and Bishop 2010.

Note: all barrows are numbered according the system initiated by Grinsell.
The order of barrows from the NE is as follows with those in marked in **bold** type outlined in more detail below:
Parish: Amesbury unless otherwise stated as **WS** Winterbourne Stoke:

..within the end of The Stonehenge Cursus: WS30: bell; **56:** bowl;

..scatter to the W of the main line, listed from W to E: 29: obliterated; **28**: obliterated; **55**: bell; **112:** obliterated; **54:** bowl; 53: bowl; **52:** bowl; **51:** bowl; **50:** bowl;

..barrows flanking the main line to the N: 158: obliterated;

..barrows flanking the main line to the S: 48a: obliterated; **115:** obliterated;

..main line listed from W to E: 49: bowl; **114:** obliterated; **48:** bell; **47:** bell; confluent with 46; **46:** bell; **45:** bell; **44 W and E:** bell or double bowl; **43:** bell.

Additional detail on specific sites

Note: Site numbering is for the Winterbourne Stoke series of round barrows; **AS** [entry number]**:** Annable and Simpson 1964;
30; SU 1101 4292; NMR: SU14SW 317**,** 870325; early excavation indicated a possible primary cremation; later excavations suggested a bell barrow, with a central mound 14m in diameter, and a berm up to 1.8m wide; the central pit contained a small quantity of cremated bone, and ash; to the W of the pit, four stake-holes, one of which might have contained a laying-out peg; on the NW'n side of the barrow, an oval-shaped hollow, with a deposit of ash and charcoal at its base, appeared to antedate the ditch; the crouched skeleton of a child was found in the primary silt of the ditch; nearby, and above, were the remains of a newly born infant;

43; SU 1202 4278; SU14SW 425, 942691; early excavation, with no record;

44; SU 1197 4278; NMR: SU14SW 426, 942696; twin bell barrow, or double bowl, surrounded by a single ring ditch;

..W'n mound: early excavation; primary cremated deposit, with six horn beads, plus an intrusive ?Roman, or Saxon burial, just below the surface of the mound;

..E'n mound: smaller than the W'n mound: early excavation; cremated deposit in a middle Bronze Age urn, of enlarged food vessel type, with a flat bronze dagger, an awl, a gold mounted amber disc, faience and amber beads, space-plates, an amber stud, beads probably of shale and ?calcite; the urn contained small friable fragments of cremated bone.

45; SU 1186 4278; NMR: SU14SW 427, 942703; early excavation; a primary cremated deposit lay close to a cist, plus char, with a few fragments of burnt bone;

46; SU 1180 4277; NMR: SU14SW 428, 942705; early excavation; primary cremated deposit, with a flat bronze dagger (AS 354);

47; SU 1177 4277; NMR: SU14SW 429, 942709; early excavation; primary cremated deposit;

48; SU 1170 4279; NMR: SU14SW 430, 942712; early excavation; primary cremated deposit, with two stone beads, an amber ring, 10 amber beads, two faience beads, and a further unspecified bead (AS 399-405);

49; SU 1152 4278; NMR: SU14SW 420, 942659; early excavation; no notable finds or structures recorded;

50; SU 1147 4267; NMR: SU14SW 421, 942661; e-FIG HE-31 and RB-84; hengiform monument, formed by a weakly ovate outer circuit of pits, about 28m externally, flanked on its inner edge by a ring of post-pits, 15-20m across, which in turn enclosed a central platform, or once-mounded area, about 12m across; no clear entrance gaps are present, although the outer pits would have allowed access along the NE'-SW'ly axis of the post-ring; detailed geophysical survey: Linford *et al.* 2012; the outer pits, and a cluster of smaller pits in the central area show increased magnetic enhancement, indicating burning over the interior (cf: Amesbury 9: see Table of Contents: 03f/7e); additional detail: a bowl barrow, about 20m in diameter, with a central oval mound, flanked by two asymmetric segmented side ditches, with opposing entrance gaps at the SW and NE; overall diameter about 41m; perhaps a hengiform monument, containing an oval ?timber structure, with a later round mound added; a small plain food vessel might have been recovered from this barrow.

51; SU 1143 4272; NMR: SU14SW 422, 942662; early excavation; primary burial with a beaker, and a sawn skull fragment; secondary burial with a pottery vessel; finds: AS 112; complete modern re-excavation (Ashbee 1978): a mound with loam core, capped by chalk, with a causewayed ditch lying beyond the berm; barrow reconstructed after the excavation; the mound contained a contracted burial, covered by a tapering board, and with a wooden, knife-like implement placed before the face, accompanied by a beaker, handled awl, flint scraper, and antler points; the mound contained several burials, with finds including beakers, antler points, fragments of bluestone, and barbed-and-tanged arrowheads; a contracted burial, with a beaker, came from the ditch silt; fragments of bluestone came from the mound, and ditch; coffin, or timber mortuary house, only partly damaged by early excavation, one burial, and trepanned skull fragment recovered; radiocarbon date of 1788 +/- 90bc (cal BC: 1880-1690 at 1 sigma; 1980-100 at 2 sigma: BM-287) from timber with the burial;

52; SU 1130 4274; NMR: SU14SW 423, 942672; early excavation; cist containing a cremated deposit;

54; SU 1117 4283; NMR: SU14SW 86, 219678; early excavation; primary burial with beaker, flint dagger, and stone hammer; two secondary burials, one with a pottery vessel, the other with a vessel, and beads of amber, and faience; finds: AS 67-69;

56; SU 1105 4291; NMR: SU14SW 31, 219513; early excavation; primary burial, with a bronze knife-dagger, and a chert pebble; two secondary burials, one of a child, and the other an adult, with a beaker: finds: AS 355

112; SU 1113 4270; NMR: SU14SW 513, 1066498; ?disc barrow, but the mounding could suggest some other form;

114; SU 1154 4277; NMR: SU14SW 551, 1119431; crop-mark, immediately adjacent to Amesbury 49, could indicate a round barrow;

115; SU 1174 4255; NMR: SU14SW 552, 1119671; segmented, or causewayed ring-ditch, possibly with an entrance at the SW; located 215m to the SSE of Amesbury 48; could be a duplicate record for Amesbury 48a;

Durrington Down E; ....
Wilts; SU 1144; e-FIG RB-86 and 86a;

Summary
A diffuse line of round barrows, mainly of bowl type contains two better-defined lines. Minor incursions indicate the presence of cremation, and poor grave-goods.

Topography: set transversely to the contour on the gentle SW'ly-facing slope of a headwater stream valley.

Barrows: 15;

-types:; 10 bowl, two disc, two saucer, one pond;

-cemetery structure: elongate, with two general lines in parallel, and with two outlying barrows just to the S;

-sequence: unknown;

-special features: none;

-excavation: poor, all early incursion;

-proportion explored: two opened;

-rite: cremation, and inhumation present, but information very partial;

-richness of grave-goods: poor but very little data;

-conservation: much damage;

Further details

Note: all barrows are numbered according to the system initiated by Grinsell for the Durrington series.
The order of barrows, from the NE, is as follows, with those in marked in **bold** type outlined in more detail below:

Parish: Durrington:

outlier to the W: 10: pond;

N'n row: 13: saucer; **14:** saucer; 15: bell; 16: bowl; 17: bowl; 17a: bowl; 23: bowl;

S'n row: 11: bowl; ?12: bowl; 18: bowl; 19: bowl; 22: bowl;

barrows to the S: 20: bell; 21: bowl; **21a:** ?type;

Additional detail on specific sites

Note: AS [entry number]**:** Annable and Simpson 1964;

11: primary cremated deposit, with urn (AS 539);

14: ?secondary burial, with a fragment of shale bead, and three pestle-shaped shale pendants (AS 274-277);

21a: SU 1182 4400; NMR: SU14SW 419, 939116; uncertain site of a possible Bronze Age round barrow, investigated by Colt Hoare, and described by him as not sepulchral; now, no physical trace of the mound remains.

Everleigh; ....
Wilts; SU 1848 5603; SU15NE 654-658; e-FIG RB-91;

Note: the numbering used here is that given in e-FIG RB-91 not the standard numbering after Grinsell.

Barrows:

1: disc; central mound, with bank and ditch; 59m overall diameter; early excavation unproductive;

2: bell; mound 24.5m diameter, 3.5m high; berm 5.5m wide; ditch 4.5m wide, 0.75m deep; early excavation; primary cremated deposit, ?male; intrusive undated skeleton;

3: bowl; site flattened by ploughing;

4: bell; early excavation; 50m overall diameter, 3.2m high; primary cremated deposit, with flat axe-dagger;

5: bowl; 13.5m diameter; early excavation unproductive.

Lake group; ....
Wilts; SU 1040; e-FIG RB-99;

Summary
Two general lines of barrows run along the contours of a shallow, SW'ly-facing headwater stream valley. Barrows are mainly of bowl type and, where investigated, cremation was the rite detected, with grave-goods of medium to higher quality encountered.

Topography: on a broad, and gently sloping spur, with most of the barrow-lines following the contours;

Barrows: 22;

-types:; 10 bowl, three bell, two disc, seven indeterminate;

-cemetery structure: two elongate groupings contain several weak lines; all barrows are fairly well spaced;

-sequence: unknown;

-special features: none;

-excavation: early incursions, with one more modern excavation;

-proportion explored: eight, about a third;

-rite: cremation seems to predominate;

-richness of grave-goods: high, medium, and low, with the two medium deposits adjacent in the same line;

-conservation: much damage;

Further details

Note: all barrows are numbered according to the system initiated by Grinsell.
The order of barrows, from the NE, is as follows, with those marked in **bold** type outlined in more detail below:

Parish: Wilsford:

45a: disc; **45b**: disc; **45c**: bowl; **46:** bowl; **42:** bell; **43:** bowl; **44**: bowl; **45**: bowl; **47:** bowl; **48**: bell; **50a**: obliterated; **50:** bell; **49:** bowl; **37**: obliterated; **38:** obliterated; SU14SW 461; **38b:** ?type ;**38a/89:** ditched ?bowl; **39:** bowl; **40:** bowl; **36f:** ?bowl; **35g**: ?obliterated; **92**: bowl; **90**: obliterated; **91**: obliterated;

Additional detail on specific sites

Note: AS [entry number]**:** Annable and Simpson 1964;

36f: SU 1076 4022; ?primary cremated deposit, with an incense cup (AS 445);

38a: (or Wilsford 89 by RCHME); SU 1077 4024; NMR: SU14SW 481, 943651; excavation more modern (Grimes 1964); small, low mound, surviving in a circular ditch, about 6m in internal diameter; a fairly central pit contained no human remains, nor finds;

38b: SU 10784023; NMR: SU14SW 479, 943522; excavation more modern (Grimes 1964); the arc of a ring-ditch was located, with a pit at the presumed centre, containing an urn, but no human remains;

39: SU 1079 4022; ?primary cremated deposit, with 20-30 identical shale beads, and a bone pin (AS 480);

40: SU 1082 4020; secondary cremated deposit, in an urn, with a bone pin; an incense cup came from the mound (AS 359, 449);

42: SU 1047 4029; primary cremated deposit, with a bronze awl, bronze dagger, stone bead, bone bead, and fragments of haematite (AS 364);

43: SU 1091 4027; primary cremated deposit, in a wooden box, with a bronze dagger, and perforated whetstone (AS 344-345);

46: SU 1105 4029; primary cremated deposit, with three segmented faience beads, two amber beads, two stone beads, and a bronze awl (AS 337-339);

47, 49 (bowl barrows), or **50** (bell barrow): the following items came from a bowl barrow, so probably not **50**: bronze awl, two miniature vessels, four gold discs, numerous amber beads, eight amber space-plates, an amber pendant, and a fragment of amber (AS 343);

91: (number by RCHME); SU 1077 4021; NMR: SU14SW 536, 1119310; possible site of a levelled barrow, or confluent barrows (Grimes 1964); crop-marks suggest two mounds, that to the SE, about 8m in diameter, recorded as SU14SW 475;

SU 1108 4002; NMR: SU14SW 705, 1366713; possible ring-ditch, about 45m in diameter.

New King Barrows; ....
Wilts; SU 1345 4222; SU14SW 111; e-FIG RB-120 and 120a;

A closely-spaced linear cemetery of impressive bowl, and bell barrows runs N'-S'ward over a low hilltop, with a more diffuse line stretching away from the area at right angles, along an adjacent ridge, the whole renamed here as the Stonehenge Cottages complex.

The two groups forming this complex might have formed a façade of barrows, facing the approach to Stonehenge along the Avenue (e-FIG RB-113). None have been excavated in any meaningful way, and ploughing has obliterated many.

Summary

Topography: located over the broad summit of a very low hill.

Barrows: 12;

-types: main group: five bowl, two bell; the group just to the W contains four indeterminate barrows; line stretching to the E: ?bowl or indeterminate;

-cemetery structure: main group: two lines of three, and four barrows, fairly closely spaced end-to-end, but on a slightly different alignment; four flanking barrows lie to the W;

-sequence: unknown;

-special features: a fairly weak, and extended line of barrows runs for 800m towards the E;

-excavation: some early incursion, and very minor modern excavation;

-proportion explored: low;

-rite: unknown;

-richness of grave-goods: unknown;

-conservation: the main N'-S'ly line is better preserved than those eroded barrows flanking to the W, and in the line running towards the E;

Further details

Note: all barrows are numbered according to the system initiated by Grinsell.

Parish: Amesbury:

-main linear group
The order of barrows from the NE is as follows, with those in marked in **bold** type outlined in more detail below: Amesbury 26-32: 4 bowl and 3 bell barrows;

..N'n line: 32: bell; **31:** bell; **30:** bowl;

..S'n line: 29: bowl; **28**: bowl; **27**: bowl; **26**: bowl;

-barrows flanking the main linear group just to its W
Amesbury 120-123: lying from SU 1337 4208 to SU 1336 4215; at least six possible round barrows are now obliterated; includes NMR SU14SW 173;

-general line to the E of the main linear group
a line of about 12 probable bowl barrows, running perpendicularly to the main group, lies either side of the Stonehenge Avenue; most members now obliterated; includes SU14SW 113 (at SU 1382 4226), SU14SW 376 (at SU 1378 4224), and SU14SW 377 (at SU 1373 4222); one barrow, excavated in 1924, revealed an empty cist, and produced many 'oddly-shaped' natural flints from low in the mound;

Additional detail on specific sites

Amesbury 26; SU14SW 362; SU 1345 4203; bell; mound 20m diameter, and about 2m high, with its summit about 6m across; the ditch appears to be two-phase;

Amesbury 27; SU14SW 363; SU 1346 4210; bell; 47m in overall diameter; mound 4.2m high, on a circular platform, defined by a partly infilled ring-ditch, 0.3m maximum depth;

Amesbury 28; SU14SW 364; SU 1346 4215; bell; about 49m in overall diameter; mound 32m diameter, and 4.4m high, with berm about 4m wide, lies on a platform 35-39m in diameter, surrounded by an incomplete ring-ditch, 8-10m wide, and 0.6m deep; the summit of the mound is about 9.5m across;

Amesbury 29; SU14SW 365; SU 1345 4221; ditched bowl; mound 40m in diameter, and 4.2m high; ditch 51m in external diameter, and 0.7m deep;

Amesbury 30; SU14SW 366; SU 1346 4228; ditched bowl; mound 41m in diameter, 3.2m high, and 9.5m across the summit; traces of a shallow ring-ditch, 54m in external diameter; superficial excavation established the absence of chalk capping of the type seen in other members of the group;

Amesbury 31; SU14SW 367; SU 1347 4233; ditched bowl; 47m in diameter, and 3.7m high, with ring ditch 0.3m deep;

Amesbury 32; SU14SW 368; SU 1348 4238; ditched bowl; 44m in diameter, and 2.6m high, with 8m wide ring-ditch;

Normanton Down; ....
Wilts; SU 1141; NMR SU14SW 39; e-FIGS RB-111 and 111a; phot RB-07;

Summary
A well developed line of mainly bowl barrows runs along the crest of a ridge. Minor incursions indicate cremation as the dominant rite, and grave-goods from low to high in quality.

Topography: located along the broad gently sloping crest of a ridge.

Barrows: 25;

-types: 16 bowl, two bell, six disc, one saucer;

-cemetery structure: elongate, with a well developed line over the E'n half, and a non-linear scatter of barrows just beyond the line, at the W;

-sequence: unknown;

-special features: what may be a sparse line of barrows stretches away at right angles, along the crest of a ridge, towards the S;

-excavation: all early incursions;

-proportion explored: 10 interventions inflicted on about half the barrows;

-rite: cremation predominant, but with inhumation known in the line, and in the W'n scatter of barrows;

-richness of grave-goods: three rich deposits in the W'n scatter of barrows, with medium and poor quality in the main line; some possible evidence for segregation;

-conservation: much damage.

Further details

Note: all barrows are numbered according to the system initiated by Grinsell.

The order of barrows, from the W, is as follows, with those in marked in **bold** type outlined in more detail below (TABLE RB-09):

TABLE RB-09 Normanton Down linear barrow cemetery: summary of finds

Key: G: barrow number after the system of Grinsell; **form** (of barrow), **lb** long barrow; **rite: C**(remation), **I**(nhumation); **pres**(ent); **bron**(ze); **non-met**(al); **gg=?:** grave-goods unknown.

G	form	rite	gold pres	bron only	non-met	gg =?	pottery	
just to the W of the main line: listed W to E								
Amesbury								
15:	bowl							
Wilsford:								
2:	disc	?				?		
2a:	bowl	?				?		
2b:	bowl	I					beaker	
3:	disc	C			*			
4:	disc	C				?		
5:	bowl	I	*					**BUSH BARROW**
6:	saucer	?				?		
7:	bowl	I	*					
in the main line: listed W to E								
8:	bell	C	*				min vess	
9:	bowl	?				?		
9a:	bowl	?				?		
10:	bowl	?				?		
13:	lb	?				?		
11:	bowl	?			*			
14:	disc	C				?		
12:	bowl	?				?		
16W:	bowl	C			*			
E:	bowl	C			*		cup (lost)	
17:	bell	?				?		
18:	bowl	?			*			
19:	bowl	I		*				
20:	disc	?				?		
21:	disc	?				?		
22:	saucer	?				?		
24:	bowl	?				?		
23:	bowl	?		*				
24a:	disc	?				?		
off-line just to the E of the main line: listed W to E								
17:	bowl	?				?		
17a:	destr	?				?		

Additional detail on specific sites

Note: AS [entry number]**:** Annable and Simpson 1964;

Amesbury 15: SU 115 416; bowl barrow, 53m in diameter, and 3.4m high; male burial, with a bronze dagger in a wooden scabbard, beaker, and deer antlers, all on a plank; a cone of timber above the corpse may indicate a mortuary hut;

Wilsford:

2b: beaker with one of two primary burials (AS 103);

3: disc barrow, 61m in diameter, with a low central mound; cremated deposit, in a circular pit, with 11 amber, six shale, and two faience beads (AS 390-395);

4: disc barrow, 58m in diameter; cremated deposit recorded;

5: Bush Barrow; bowl barrow, 15m in diameter, and 2.4m high; male burial, aligned N'-S'ward, with rich grave-goods; corpse extended (Ashbee 1960), or crouched (Lawson *et al.* 2009); a wooden shield, decorated with bronze lay near the head of the corpse; a flanged copper-alloy axe head above the shoulder; a gold lozenge, with incised ornament, on the chest; three copper-alloy daggers, one hilted, with gold pins; a perforated mace of coralline rock, near the leg, with the bone bands, and end-pieces from a wooden haft; incised gold belt-hook; small incised gold lozenge; small bronze hook; (AS 168-178, 558; Ashbee 1960, fig. 24);

6: saucer or bowl barrow;

7: bowl barrow, 27.5m in diameter, and 2.4m high; burial with shale beads, one with a gold cover, and a shale double axe-shaped pendant; amber bead, and pendants; two segments of fossil encrinite, one perforated as a ?bead; perforated gold cover cap; grape cup; collared urn at the feet; (AS 147-158);

8: bell barrow, 41m in diameter, and 3.1m high; primary cremated deposit, with five amber pendants; two flat amber pendants; amber halberd-pendant with copper-alloy blade; two gold-bound perforated amber discs; shale button with gold cover; bone pendant with applied decorated gold sheet; bronze pendant, covered with decorated sheet gold; miniature pottery cup; (AS 179-192);

9a: ?bowl barrow; SU 1184 4127; NMR: SU14SW 444, 943179; a very slight, possibly sub-circular mound, about 14 by 12m;

10: bowl barrow, plundered with no record;

13: small, ?long barrow, about 20m long, and 2.7m high; suggested to be the initial Neolithic barrow around which the cemetery spread; early incursion, with no results recorded;

11: bowl barrow, 1.8m high, with an outer bank; early incursion, with no results recorded;

14: a fine disc barrow; central cremated deposit;

16 W and E: twin bell barrows, within a single ditch; W'n mound: primary cremated deposit, with a bone belt-hook, and pendant (AS 306-307); E'n mound: primary cremated deposit, with two shale beads, three amber beads, and a small pottery vessel (AS 308-312);

17: bell barrow, opened but no record kept;

18: bowl barrow, producing a bone belt hook (AS 313);

19: bowl barrow, producing an inhumation with a bronze dagger;

23: bowl barrow, producing a perforated whetstone; bronze dagger; bronze knife-dagger; bronze crutch-headed pin; two tubular bone fragments; (AS 163-167);

S'ward of the main line of barrows

27: SU 1179 4109; bowl barrow, producing a primary cremated deposit, with a decorated bronze dagger bearing traces of a wooden sheath (AS 346);

56: SU 1210 4046; bowl barrow, producing a primary cremated deposit, in a wooden box, with a bronze dagger, bronze knife-dagger, bone pin, and bone tweezers (AS 159-162).

Silk Hill; ....
Wilts; SU 190 469; e-FIG RB-117;

Summary
Four adjacent lines of round barrows lie, and outliers cluster to form a larger complex.

Topography: on a low ridge running WNW'-ESE'ward;

Barrows: 29;

-types: 22 bowl; five bell; one pond, one saucer;

-cemetery structure: a line of round barrows runs along the crest of a ridge, with three others at the periphery;

-sequence: unknown;

-special features: none;

-excavation: poor, all early incursion;

-proportion explored: six opened;

-rite: cremation and inhumation present, but information very partial;

-richness of grave-goods: poor, but very little data;

-conservation: much damage;

Further details

Note: The first serial numbering given here is specific to the plan in e-FIG RB-117, the second (G-) according to the system initiated by Grinsell :
The order of barrows from the NE is as follows, with those in marked in **bold** type outlined in more detail below:

Parish: Milston:

1 G 5a; SU14NE 161; SU 1897 4702; bowl; 11m diameter, and less than 0.3m high;

2 G 8a; SU14NE 162; SU 1907 4704; probable disc; no central mound, and the outer bank has been obliterated at the N and W; external diameter about 24m;

3 G 13; SU14NE 163**;** SU 1913 4703; disc; about 32m in external diameter, mound no longer extant; mound 10m diameter, width of berm at the SSW 13.5m, with none at the NNE, ditch 4.5m wide, outer bank 5.5m wide; mound placed well NNE'ward of the centre;

4 G 15; SU14NE 164**;** SU 1919 4702; disc; external diameter 38m; mound 14m diameter, width of berm 7m, of ditch 3.5m, and of outer bank 4m;

5 G 14; SU14NE 160; SU 1917 4702; ditched bowl; mound slightly oval, mean diameter about 7m, height 1.5m;

6 G 2; SU14NE 121**;** SU 1853 4701; bowl; 24m diameter, and 1m high; secondary cremated deposit in a later Bronze Age barrel urn, with two smaller urns, probably also LBA, found superficially placed in the SE'n part of the mound;

7 G 2a; SU14NE 122**;** SU 1864 4699; bowl; 17m diameter, and 0.5m high;

8 G 15b; SU14NE 123; SU 1857 4695; disc; bank 0.3m high, with overall diameter 50m, the SW'n segment of which is missing; site remains visible as a slight earthwork;

9 SU14NE 227; SU 1858 4701; site of a possible round barrow;

10 SU14NE 302; SU 1863 4704; ring-ditch, 11m in diameter;

11 SU14NE 124; SU 1861 4700; bowl; 16m diameter and 0.3m high; this barrow may possibly be G 51 at SU 188 469 (SU14NE 60); early excavation revealed a primary crouched burial, with a flat bronze dagger, bearing a rivet-ornamented sheath; a secondary, urned cremated deposit was present, and above this lay another burial;

12 G 3; SU14NE 7; SU 1878 4693; bell; mound 27m in diameter, 2.7m high, with berm 4.5m wide, and overall diameter about 51m; three possibly intrusive burials;

13 G 4; SU14NE 141; SU 1896 4693; ditched bowl; 28m diameter, and 2.2m high;

14 G 5; SU14NE 142; SU 1895 4691; bowl; 25m diameter, and 1.3m high; slight ditch remained incomplete;

15 G 6; SU14NE 143; SU 1899 4690; ditched bowl; 34m diameter, and 4.2m high;

16 G 7; SU14NE 144; SU 1903 4690; ditched bowl barrow, 40m diameter, and 4.1m high; early excavation here, or at

G 3, revealed a primary cremated deposit, with a bronze dagger bearing remains of sheath, a crutch-headed pin, with twisted stem, and two perforated whetstones; intrusive burial, ?Saxon;

17 G 21b; SU14NE 148; SU 1907 4687; ditched pond; 22m in diameter; early excavation revealed a cremated deposit, in a small middle Bronze Age collared urn, fragments of a bone item resembling a whetstone, a flint flake, and a lump of iron pyrites;

18 G 8; SU14NE 147; SU 1909 4689; saucer; central platform, 21m in diameter, with little or no indication of any mound, ditch 4m wide, and 0.3m deep, external diameter 40m; early excavation revealed a primary cremated deposit some distance from the centre;

19 G 9; SU14NE 145; SU 1913 4687; ditched bowl;, 36m diameter, and 3.2m high;

20 G 9a; SU14NE 146; SU 1917 4687; bowl; 17m diameter, and 0.3m high;

21 SU14NE 352; SU 1919 4677; site of a possible round barrow;

22 G 10; SU14NE 169; SU 1921 4678; bowl; 20m diameter, and 0.8m high;

23 G 11; SU14NE 170; SU 1925 4674; bowl; 16m diameter, and 0.6m high;

24 G 12; SU14NE 172; SU 1929 4671; **the largest barrow in the cemetery;** large flat-topped mound, surrounded by a berm, elevated above the surrounding ground level, all enclosed by a bank, and external ditch; overall diameter about 70m, with mound 41m diameter, and 2m high, bank 6.5m wide and 0.6m high, ditch 5.5m diameter, and 0.5m deep; early excavation produced no signs of any burial, and the only finds were a few animal bones;

25 G 21a; SU14NE 171**;** SU 1940 4672; ditched bowl; mound 22m diameter, and 1.8m high, ditch 0.3m deep;

26 SU14NE 64; 1898 4651; slight earthwork mound, and ring-ditch;

27 G 17; SU14NE 44; SU 1920 4653; ditched bowl; 13m in diameter, mound 0.7m high, ditch 0.2m deep;

28 G 18; SU14NE 159; SU 1920 4651; bowl; 12m diameter, and 0.5m high;

29 SU14NE 187; SU 1893 4678; site of a possible round barrow.

Snail Down; ....
Wilts; SU 2152; e-FIG RB-118; phot RB-08;

Summary
A diffuse line of round barrows, mainly of bowl type contains two more regular rows. Presence of cremation, and poor grave-goods is indicated where excavation has taken place.

The broader Snail Down cemetery contains some 30 barrows, mainly bowl, but with some bell, and a few other types, ranged along the S'ly-facing, gentle slope of a small, narrow, upper stream valley.

Two general alignments of barrows are visible, set approximately perpendicularly to each other, each containing shorter constituent sub-unit rows. The primary burial rite appears to have been predominantly cremation, and the grave-goods are generally poor, with only one deposit of finer bronze-work. In addition to early incursions, and retrieval of grave-goods, the cemetery has been subject to a more systematic programme of excavation, in which 19 of the barrows were investigated to some degree, from partial and peripheral, to near complete excavation (Thomas 2005).

Topography: set transversely to the contour, on the gentle, SW'ly facing slope of a headwater stream valley.

Barrows: 15 in the central cluster;

-types: 10 bowl, two disc, two saucer, one pond;

-cemetery structure: elongate, with two general lines in parallel, and with two outlying barrows just to the S;

-sequence: unknown;

-special features: none;

-excavation: early incursion, and modern selective excavation (Thomas 2005);

-proportion explored: 19 opened;

-rite: cremation predominant;

-richness of grave-goods: generally poor;

-conservation: much damage;

Excavated barrows

Note: all cremated deposits referred to below contain predominantly, or exclusively human bone.

Key: barrow numbering: numbered sites refer to those excavated by Thomas (2005); other nomenclature for barrows is given as [parish, number] under **CK** for **C**ollingbourne **K**ingston and **CD** for **C**ollingbourne **D**ucis, after the system of Grinsell.

The approximate centre of the cemetery could be taken as barrow CK 17, at SU 2186 5207; the relative locations of other barrows are given in e-FIG RB-118.

-site 1/ CK 18: disc barrow, with a central, and an eccentric mound; The central mound covered a primary cremated deposit (?age, ?sex), placed in a pit, and contained another (?age, ?sex), at the edge of the mound, together with a copper-alloy awl. The eccentric mound also covered similar central, and peripheral cremated deposits (adult, ?male) each in a pit, without grave-goods.

-site 2/ CK 6: saucer barrow, enclosing four primary pits; excavation extensive;

pit	**cremated deposit**	**grave-goods**
central	?adult female	two pottery cups, and a copper-alloy awl;
eccentric	juvenile ?female	fragments of food vessel;
eccentric	none detected	food vessel;
eccentric	*unburnt* foetus	none.

-site 3/ CK 8: bell barrow; excavation extensive; The mound covered a primary cremated deposit (adult, ?female), possibly in an urn, from a pit near the centre of the site, and lying within an area covered by charred debris, and several long timbers, that may indicate the base of a pyre. Two secondary cremated deposits (children, ?sex), in collared urns, were placed in pits on the berm of the barrow, one with beads of faience, amber, jet, shale and stone.

-site 4/ CK 14: disc barrow with a central mound; excavation partial; Early partial excavation noted a possible cremated deposit, but no grave-goods.

-site 5/ CD 3a: a ring-ditch with an external bank enclosing a level oval area, possibly a disc barrow; excavation partial; Three primary pits at the centre contained no burials.

-site 8/ CK 13: bell barrow; the most imposing barrow in the cemetery; excavation partial; Early excavation noted burnt material that could indicate cremated remains.

-sites 10-14/ CK 12, 22, ?23, 23a, 23b : bowl barrows; excavation partial to extensive; A line of five small contiguous mounds overlies an area of Beaker settlement at the W'n end. Each barrow probably covered a burial, but only one such has been located by excavation.

-14/ CK 23b: partial excavation; the mound covered a cremated deposit (young adult, ? female), in a pit, with a flint scraper, and several urn sherds associated.

-site 15/ CD 3: bowl barrow; excavation extensive; A primary pit, containing a cremated deposit (adult, ?sex), lay off-centre within a post-ring.

-site 16/ CD 6c: pond barrow; excavation extensive; A post-ring, with a possible entrance gap at the SW, contained three pits, with token cremated deposits, one of a young child, the others indeterminate. Finds included a thin general scatter of ?earlier Bronze Age sherds, and of flint debris.

-site 17/ CK 25: bowl barrow; excavation extensive; The central area included a cremated deposit (adult male), placed in a primary pit, with a broken urn (?deliberate ritual), with evidence for an adjacent, irregular timber structure (?pyre-related, or for exposure/display of the corpse). Later, three small pits were dug into the W'n margin of the mound, one containing fragments of collared urn.

-site 18/ CK 17: bowl barrow; excavation partial plus early incursion; A pit, possibly primary, at the centre of the barrow, contained a cremated deposit in an upright collared urn.

-site 19/ CD 4: double bell barrow containing a central and off-set mound within a pear-shaped ring-ditch; excavation partial plus early incursion; Early excavation of the central mound recovered a cremated deposit in a wooden coffin (construction: plank-type, or hollowed log) together with a pottery cup (now lost), and an ogival dagger blade, a ring-headed pin, and another unspecified item, all of copper-alloy.

-site 20/ CK 12: bowl barrow, ?cenotaph type, rather than for functional burial; excavation partial, plus early incursion; early excavation noted an empty cist.

-site 21/ CK 16: bowl barrow; excavation partial, plus early incursion; no burial structures or grave-goods have been noted.

-site 22/ CD 5: bell barrow, with an additional mound on the N'n berm; excavation partial, plus early incursion; Early excavation of the main, central mound noted no burial structures or grave-goods. A secondary burial (contracted young male, wearing beads, some of shell) was inserted into a pit, dug into the margin of the central mound during the Early Bronze Age.

-CK 4: bowl barrow; early incursion only; Early excavation retrieved artefacts (?grave-goods) from a central pit: a miniature copper-alloy axe set in an antler handle, a perforated bone plate, one certain, and one possible bone pin, two bone points, and three whetstones. Bone, noted as bluish in colour, and hence possibly burnt, may indicate a cremated deposit. Alternatively, the items could form a votive deposit, not associated with burial.

The sequence of development at the site

Despite the extensive structural, and artefactual data from the cemetery, there is little on which to base a general sequence for development of the complex (Thomas 2005: discussion: pp. 306-311. Given the lack of significant stratigraphic overlap, relationships between individual barrows are absent. Six of the eleven radiocarbon dates (Thomas 2005: pp. 253-258) fall within the broad interval 2000-1750 cal BC, but together do not provide further useful detail as to how the final plan of the cemetery was achieved.

General layout of the cemetery

Despite the damage which the site has sustained, the final layout of the cemetery is clear.

-there are two main lines of barrows

The overall plan of the cemetery consists of two general lines of barrows: the **W'n,** and **E'n arms**. These are set at right angles, and run towards the SW, and SE, from a notional apex, with other barrows clustering near the lines, and a few outliers set at some distance from the main concentration. The arms diverge from a point just to the N of the largest barrow in the cemetery.

..the W'n arm, which runs along the contour, is the longest, clearest, most defined line, and contains an imposing barrow (CK 13), in a fairly central location for the entire cemetery. This arm, which contains 19 of the 30 barrows in the cemetery, ranges over a length of about 400m, and may extend a further 250m to the SW, towards the outlying barrows CK 3 and 4, the intervening 'gap' of unknown content.

This arm contains three sub-units of 3-5 barrows (rows 3-5: e-FIG RB-118), that lie on slightly different orientations, with row 4 flanked by an irregular line along its N'n side.

..the E'n arm, which runs up the contour, is shorter, less uniformly linear, and bears no flanking rows. It contains seven of the 30 barrows in the cemetery, in two shorter rows (rows 1 and 2), which are not well aligned to a common axis, and appear fairly independent.

Possible directions of growth

The barrows within some of these sub-unit rows decrease in size in a particular direction, perhaps indicating an axis of growth. In the E'n arm, row 1 decreases in size towards the NW, perhaps indicating growth from the larger, possibly founder-barrow CD 22. In the W'n arm, row 3 decreases towards the NE, away from CK 13, and row 4 towards the SW, from CK 10, towards opposite ends of the general axis of the arm, and again this may indicate the direction of development.

In this cemetery, the NE'-SW'ly axis of the longer W'n arm is perhaps the most significant, since it contains most of the barrows, and the larger members. Different alignments, as between the W'n and E'n arms, and opposite directions of apparent growth, as in rows 3 and 4, indicate some variation in the overall expansion of the cemetery. This fragmented development is also suggested by the presence of four clear sub-unit rows within the general plan, perhaps indicating provision for separate social groups. Each of the component rows could have provided a burial facility for a particular kin-group, with slightly separate placement emphasising distinct identity, this need over-riding conformity with an established and significant axis.

This idea of sequential decrease in barrow size could be perhaps tested, by comparing relative dates for barrows at the proposed end-points of the sub-unit rows. This could be done, for instance, between bell barrow CK 13 and bowl barrow CK 16 at the ends of row 3, and between CK 10 and 23b in row 4 of bowl barrows. Unfortunately relevant data are currently lacking.

Quantifying data on alignments within linear barrow cemeteries

The Snail Down cemetery well illustrates several problems in extracting data on orientation from complex sites, namely the decision as to what is to be included:

-the axis of both the main arms at this site, or only what appears to be the dominant of these, the W'n, relegating the E'n as comprising additional minor development, incidental to the main ritual theme of the layout, assuming that there was one;

-or the axis of each individual row, the data set indicating a balance, in terms of a general preference, between what appear to be conflicting directions;

-perceived directions of growth along an axis, for instance those postulated for rows that diminish in barrow size along their length, might help define directions of particular ritual interest within an axis.

A major underlying uncertainty arises from the question as to whether it is the direction of axial *pointing,* or of lateral *facing*, or in fact either, which is important, a point discussed more fully elsewhere in this study (Table of Contents: 03h/3e).

Wilsford; ....
Wilts; SU 1139; e-FIG RB-127;

Summary
A well-developed line of round barrows, running along the edge of a spur, has additional barrows flanking it to the N, and the weakly linear cemetery of Lake Down lying separately, just to the S. Barrows are mainly of bowl type, but with disc well represented, and other types in the minority. Where the rite has been determined, cremation and inhumation occur equally, with grave-goods of poor to medium quality.

Topography: on a weakly sloping ridge;

Barrows: 19;

-types: seven bowl, one bell, five disc, one saucer, one pond, four indeterminate;

-cemetery structure: a good line of closely spaced bowl barrows, with a non-linear scatter of barrows around the N and E;

-sequence: unknown;

-special features: none;

-excavation: early excavation only;

-proportion explored: four interventions;

-rite: mixed in the line, but data are very partial;

-richness of grave-goods: medium predominates in the line, but data are partial;

-conservation: much damage;

Further details

Note: all barrows are numbered according to the system initiated by Grinsell.

The order of barrows, from the NW, is as follows, with those marked in **bold** type outlined in more detail below:

Parish: Wilsford:

main line: 58 bell; 59 bowl; **60** bowl; 61 bowl; **62** bowl; **63** saucer; **64** bowl;

cluster to the E: 70 disc; 71 disc; 73a obliterated; 72 disc; **73** bowl; **65** bowl; 64a disc;

cluster to the N: 66 disc; 67 obliterated; **68** obliterated; 69 pond;

outlier to the S: 74 bowl.

Additional detail on specific sites

Note: AS [entry number]**:** Annable and Simpson 1964;

58: primary burial, with bronze items: a two-pronged object, decorated ?handle and chain of a cauldron, bronze axe; dolerite battle-axe; partly worked and polished long bone; grooved whetstone, or arrow-straightener; bone plate, with perforations; perforated antler handle; boar tusk; (AS 211-218);

60: secondary cremated deposit, with bronze dagger, whetstones, flint knife, bone mace-head, polished bone plaque (AS 267-273);

62: primary burial, with beaker (AS 135);

63: SU 1190 3976; NMR: SU13NW 103, 1110592; pond barrow, with bank and ditch, 29m in diameter, with a central depression 0.8 metres deep; no record of an excavation;

64: bowl barrow; SU 1193 3975; primary cremated deposit, with a bronze axe, perforated bone pin, and bone ring (AS 314-315);

73: NMR: SU13NW 114; ?bowl barrow, about 12m in diameter;

65: bowl; SU 1201 3974; two primary cremated deposits, with a bronze knife-dagger, and enlarged food vessel associated (AS 365, 487);

68: NMR: SU13NW 107; no details;

SU 1188 3980; NMR: SU13NW 276, 1531331; ?ring-ditch, with a very low round mound, all about 12m in diameter.

Lake Down; ....
Wilts; SU 1139; e-FIG-RB-127 and 98; phot RB-06;

Further details of this barrow cemetery are given in Komar 2010; bowl barrows predominate, but with pond barrows unusually frequent. Where determined, cremation was the rite, and the grave-goods are poor.

Summary
This very weakly linear cemetery is accompanied by other scattered barrows adjacent to the W.

Topography: on a weak spur, ranged partly along the contour, and partly transverse.

Barrows: 11;

-types: six bowl, one disc, four pond;

-cemetery structure: two weak lines, with adjacent barrows;

-sequence: unknown;

-special features: none;

-excavation: early interventions only, with confused records;

-proportion explored: three;

-rite: cremation, at one site;

-richness of grave-goods: poor, at one site;

-conservation: much damage.

Further details

Note: all barrows are numbered according to the system initiated by Grinsell.

The order of barrows from the N is as follows, with those in marked in **bold** type outlined in more detail below:

Parish: Wilsford:

main cluster: 75 bowl; 75a bowl; 76 bowl; **76a** pond; **77** pond; **77a** pond; **78** pond; 79 bowl; **80** disc; 81 bowl;

beyond to the E: 82 bowl; 83 bowl;

Additional detail on specific sites

76a: SU 1185 3932; NMR: SU13NW 132, 1119623; pond barrow with external diameter 18.5m;

77: SU 1178 3928; NMR: **SU13NW 125,** 1119544; largest pond barrow in the group; might have produced a primary cremated deposit;

77a: SU 1179 3926; NMR: **SU13NW 126,** 1119550; smallest pond barrow in the group, with external diameter 16.3m;

78: SU 1182 3926; NMR: **SU13NW 129,** 1119600; pond barrow, with external diameter 23m; might have produced a primary cremated deposit;

80: disc barrow, producing a primary cremated deposit in an urn.

Winterbourne Stoke crossroads; ....
Wilts; SU 1041; NMR SU14SW 35; e-FIG RB-128 and 128a; phot RB-09;

Summary
A well developed linear complex of round barrows runs along the crest of a ridge, dividing into two lines towards the SW'n end, and with clear grouping to sub-units throughout. Barrow form is mainly of bowl type. Cremation appears to be the dominant rite, with grave-goods of poor to medium grade encountered.

Topography: ranged along the spine of a weak ridge sloping towards the SW.

Barrows: 27;

-types:; 14 bowl, two bell, two disc, two saucer, two pond, four indeterminate, one unknown;

-cemetery structure: the main group is elongate, with four sub-lines; some evidence for decreasing size towards the SW in two of the lines; an outlying, non-linear cluster lies to the W;

-sequence: unknown;

-special features: long barrow at the S'n, down-slope end;

-excavation: early incursion only;

-proportion explored: six, about a quarter;

-rite: mixed within the lines, but with cremation predominant; no evidence for segregation of cremation and inhumation within the cemetery;

-richness of grave-goods: medium predominates in two lines; possible weak evidence for segregation;

-conservation: much damage inflicted;

Further details

Note: all barrows are numbered according to the system initiated by Grinsell.

The order of barrows, taken down-slope from the NE, is as follows, with those marked in bold type outlined in more detail below (TABLE 10):

Key: G: barrow number after the system of Grinsell; **form** (of barrow): **dest**(royed), **sauc**(er); **rite: C**(remation), **I**(nhumation); **pres**(ent); **bron**(ze); **non-met**(al); **gg=?:** grave-goods unknown.

Note: [*] indicates minor bronze

TABLE RB-10 WINTERBOURNE CROSSROADS LINEAR BARROW CEMETERY: SUMMARY OF FINDS

Note: AS [entry number]**:** Annable and Simpson 1964;
Parish: Winterbourne Stoke:

G	form	rite	gold pres	bron only	non-met	gg =?	pottery	
just to the W of the main line: listed W to E								
row 1								
14	sauc	C			*		miniature vessel	
15	sauc	C				?		
16	bowl							
row 2								
10	bowl	C					incense cup	
9	bowl	I		*			miniature vessel	
8	bowl	I		[*]			grape cup and another	
7	bowl	?				?		
6	bowl	C				?		
5	bowl	I		*			Breton urn	= **KING BARROW**
4	bell	C		*				
3a	pond	?				?		
3	bowl	C				?		

row 3					
7a	bowl				
11	bowl				
??	pond				
13	bowl	?		?	
row 4					
76	destr	?		?	
22	destr	?		?	
77	destr				
adjacent to the line: ?outlier					
2	bowl				
off-line					
16a	destr	C	*		Aldbourne cup

separate cluster to the NW
17-21b

Additional detail on specific sites

-main group

1: long barrow; **2:** bowl; cremated deposit, with small urn; **3:** bowl barrow, 23m in diameter, produced a cremated deposit; **3a:** pond barrow, 11m in diameter, overlaps bell barrow 4, and so is later than it;

4: bell barrow, 55m across, with a central mound 3.7m high; cremated deposit in traces of a wooden box, with bronze fittings, contained a bronze knife-dagger; decorated bronze dagger; bone tweezers; two fragments of sheet bronze; two bone mounts with bronze rivets; other bronze rivets; a bone pin; (AS 219-224); five burials occurred in a shallow position in the mound;

5: **King Barrow**; bowl barrow, 49m in diameter; primary burial in an elm tree-trunk coffin, head towards the NE, with a five-handled Breton-type urn, two bronze daggers, one with a wooden handle and ornamented sheath, a bronze awl with bone handle, and an item of bone (AS 263-266);

6: bowl barrow, 1.8m high, covering a cremated deposit placed beneath a mound of flints;

8: primary burial, oriented N'-S'ward, was disturbed when a cremated deposit was added to the mound; with the burial were two bone beads, a bronze awl, two whetstones, a flat pebble, two fossil shells, a fragment of stalactite, beaver incisors, a grape cup, and an incense cup (AS 300-305); bones of dog and deer came from the mound; Long (1876) mentions a ring, or bracelet of bone from his barrow 25;

9: bowl barrow, 27.5m in diameter; primary burial, in a wooden, boat-shaped coffin, together with many beads of shale and amber, a bronze dagger and awl, and a miniature pottery vessel (AS 453);

11: Long (1876) notes a cremated deposit, scattered by early excavators during a previous opening;

10: bowl barrow, producing a primary cremated deposit, with an incense cup (AS 442);

13: bowl barrow, producing a stone mace-head from mound material, and an enlarged food-vessel from a secondary cremated deposit (AS 19, 496);

Long (1876) notes this as his barrow 19, which contained a burial with head towards the W, and an urn covering a cremated deposit, lying over another burial, also the presence of two other cremated deposits, with a burnt perforated pebble associated;

14: disc barrow, 53m in diameter, comprising three small burial mounds within its ditch; cremated deposits occurred in all mounds, the central producing a miniature pottery cup, and three amber beads, with three amber beads from another of the mounds (AS 291-298);

15: disc barrow, producing a primary cremated deposit;

16a: SU 1043 4286; NMR: SU14SW 512, 1066492; ?pond barrow producing a ?primary cremated deposit, with an Aldbourne cup, and curved bone pin (AS 474).

23-24: noted by Long (1876) as 'unproductive'.

-W'n group

A non-linear cluster of barrows, lying just to the W of the main linear groups; details from Long (1876) indicate the results of earlier excavation as follows (prefix **L** for Long, followed by his barrow number):

L3: primary burial missed, but an urn containing a cremated deposit was found near the top, ?secondary;

L4-L6: simple cremated deposits;

L7: primary burial, oriented N'-S'ward, with a drinking cup at the feet, and about 4 feet above this was a child burial, with an urn;

L8: pit, containing a cremated deposit, with a drinking cup nearby;

L9: cremated deposit present.

The area around Stonehenge

The distribution of round barrows in the area around Stonehenge is of central interest, because it contains the densest cluster within the seven study groups under consideration, and also many of the most imposing linear cemeteries.

The pattern for placement of cemeteries in relation to local topography, and with regard to Stonehenge itself, has attracted considerable comment (Bender 1992; Woodward and Woodward 1996; Darvill 1997), with suggestions of a deliberate double ring-like disposition of barrows around this major henge (e-FIG RB-279, and HE-29). Under this scheme, where cemeteries are linear to any degree, they tend to face the central zone, with their long axes stressing the ring.

Some of these component cemeteries are directly inter-visible with the centre, and with each other but, for many sites, this view is obstructed to some degree, and the connection is more notional. Whether these rings arose according to some preconceived general plan, or by more passive accumulation on ring-like topography in the area, is an open question.

Further examination of the properties of cemeteries in this particular area is, therefore, relevant to discussion of the purpose of the axis at linear sites: whether to face, to point, or both (see Table of Contents: 03h/2h), and whether dispositions in this particular area were atypically forced into shape around this uniquely important henge.

It is important to determine whether such rings of cemeteries actually arise from the data, rather than from preconceived notions of structural circularity seen at Stonehenge being imposed on the wider area. This idea has been further applied to round barrow cemeteries around Avebury (Woodward and Woodward 1996), equally unconvincingly. The general relationship between certain monumental forms, circularity, and the landscape has been further discussed in Bradley 1998.

In the Stonehenge area, an examination of the distribution itself, without prompting by visual cues supplied by circular lines added to published figures (example: Woodward and Woodward 1996, fig. 6/p. 284), certainly indicates a strong case for reassessment. Separation between data and interpretation is provided in e-FIG RB-279, where layering of the image allows various patterns to be reversibly combined.

A similar examination of barrow distributions in the Avebury area (e-FIG-HE-36), where such rings have also been proposed (example: Woodward and Woodward 1996, fig. 2/p. 280), further indicates the extreme weakness of the case in this context.

The general pattern of barrows around Stonehenge (e-FIGS RB-04, and 278 to 281; HE-29 to 30)

Stonehenge lies near the base of a N'-S'ward running headwater stream valley of the Avon, now essentially dry, and occupies the end of one of a series of low ridges, formed by the marginal streamlets that further dissect its sides. The Stonehenge area is, therefore, surrounded by ridges, some conforming with the main N'-S'ly trend of the valley, others running transversely.

Adopting a top-down analysis of data, the general pattern of round barrows, plotted at lower resolution (per km^2), shows a distinct concentration around the Stonehenge-Cursus-Durrington Walls area, broadly circular, without a preferred direction, and extending out to about 3km radius (e-FIG RB-278).

A more detailed plot of barrows in this zone, by 0.25km grid squares, indicates a relative gap around Stonehenge itself, extending out to about 1.25km diameter, then a denser spread from here out to about 7.5km diameter, with some indication of peaking around 2.5km, and 4km diameter (e-FIG RB-280). Similarly broad analysis of distribution, in radial sectors within this zone of barrows, taken from its centre, at intervals of 22.5°, indicates a lesser peak around the NNE, with a larger one around the SW, perhaps indicating some axial preference in this direction (e-FIG RB-281). Major cemeteries also show some concentration in the SW'n quadrant (e-FIG RB-279 and HE-29).

Increasing resolution still further, to the level of barrow clusters, indicates that suggested arrangement of barrow cemeteries in two concentric rings with the Stonehenge area acting as a focus (Woodward and Woodward 1996, fig. 6/p. 284) does not stand closer scrutiny (e-FIG RB-279):

-an inner ring?

Barrows ranging along those ridges that form the inner skyline for Stonehenge would automatically adopt an intermittent, ring-like structure, of about 1.5km radius, with a good measure of inter-visibility between margins and centre. This would occur by virtue of their general preference for hilltop locations, as evident nationally, rather than from anything of deeper, local ritual significance. There may also be something of a chronological mismatch, since such round barrows were accumulating in the area during the later phases of Stonehenge, when it might possibly have been in some decline, hence forming less of a specific ring-inducing focus for the area. See Table of Contents: 03f/6f (Cleal: phase 3vi; early-middle Bronze Age; RD: 2020–1520 BC).

The itinerary around this suggested ring, listed below by quadrant, is as follows (e-FIG RB-279): comments are bracketed thus [..]:

SW: the Normanton Down SU 1141 cemetery runs broadly E'-W'ward along a strong ridge; [*this cemetery is perhaps better seen as associated with the area of the North Kite complex just to the S, as discussed below*];

W: there is a distinct lacuna in barrow distribution over the weak ridge; [*a clearer W'n side to the ring, where good views of the Stonehenge area are available, is therefore missing*];

NW: the Stonehenge Greater Cursus W'n cemetery SU 1142 runs E'-W'ward, along a weak ridge; [*this cemetery could be seen as conforming with the long side of The Cursus, rather than part of a larger ring-scheme*];

N: the Stonehenge Cursus runs cross-wise to the main valley; [*this monument constitutes an earlier feature, independent of linear round barrows, and can not be included with confidence in any related scheme*]

NE: a weak line of round barrows lies on a ridge, just beyond the Stonehenge Cursus; [*if intended as part of the ring, this cemetery might have been better placed along the S'n side of The Cursus, within better view of Stonehenge*];

NE: the Old and New King Barrow complex runs along the ridge forming the E'n side of the main stream valley; [*the Old and New King Barrow complex SU 1342 appears concave with respect to the approach along the Stonehenge Avenue from the SE, and might have accumulated as a façade enhancing it*];

SE: the Luxenborough Plantation SU 1241 cemetery occupies the end of a ridge.

Linearity is well developed only for the Normanton Down cemetery, and the New King Barrows, with other lines more diffuse. Most of the stated locations are broadly inter-visible, and within the general view-shed of Stonehenge.

The integrity of this inner ring is, therefore, debatable around much of its proposed circuit, and seems an artefact of topography, and of constraint along the N'n side by the existing major cursus. Gaps between cemeteries are perhaps also to be expected, on territorial grounds. The pattern could simply arise from the need to occupy suitable ridge-lines, E'-W'ly in most cases here (confirmed by the distribution for a large sample from S'n Britain: TABLE RB-02; e-FIG RB-275). One marked N'-S'ly line of barrows, along the W'n side of the proposed ring, provides an exception to this alignment, and this feature is discussed further below in relation to the Avenue at Stonehenge.

-an outer ring?

A similar itinerary around this suggested ring follows (e-FIG RB-279):

SW: Wilsford SU 1139, and Lake Group SU 1040 cemeteries lie on a ridge forming the next stream valley, to the S of the Stonehenge area;

W: Winterbourne crossroads SU 1041 cemetery occupies a spur beyond a low hill, to the W of Stonehenge; [taken together the above three cemeteries might have been more closely associated with the North Kite SU 1140 area, as discussed in more detail below];

NE: a scatter of barrows lies adjacent to the Stonehenge Lesser Cursus SU 1043; [*this minor cluster, possibly containing a very weak internal linearity, lies at the SW'n end of the cursus, in a relationship noted for other such monuments elsewhere, and explained as part of the continuing influence of the axis (e-FIG RB-101 and 282)*];

N: clusters of barrows on Durrington Downs SU 1144, and Larkhill SU 1344, lie in adjacent lateral valleys; [*these individual clusters of barrows form an unconvincing line along the N; the cemetery at Strangways SU 1343 is ignored, falling between inner and outer rings, any inclusion causing an inconvenient merging of rings on the NE'n side*];

E: Halfmoon Clump SU 1442 lies on a ridge adjacent to the River Avon. In this outer ring, only the cemetery at Winterbourne Crossroads SU 1041 is linearity impressive, others are non-linear, or contain lesser, and internal linearities. Inter-visibility between cemeteries in the ring, and the proposed central focus is generally poor to negligible.

The two rings, therefore, appear formed without due regard to the nature, and detailed location of cemeteries, strangely excluding some that do not comply, as the line is forced to obey the general model. It could be argued that cemeteries in the first general view-shed from Stonehenge were thus placed to see, and be seen from the focal area, or ended up in this manner more passively by virtue of topography. However, this is not the case for the outer ring, where most of the individual cemetery sites are marginal to, or well out of view from Stonehenge.

The ring model also ignores the predominance of the largest cemeteries, towards the SW of Stonehenge, and their apparent clustering around the North Kite valley SU 1140, as discussed further below.

If it was considered important to place important burial areas around Stonehenge as a deliberate act, then it is difficult to explain the apparent absence of impressive cemeteries in the zone *immediately around* Stonehenge, where there are relatively few barrows within about a kilometre, or more, of the henge (e-FIGS HE-29 to 31). This distancing appears similar to the situation at Avebury (e-FIG HE-36), but not around the Knowlton henge complex (e-FIG RB-130 to 131), nor the Dorset Cursus (e-FIG CU-03 and 06), where barrows are more closely associated. However, there is abundant evidence for placement of small cremated deposits at Stonehenge itself, but this would represent a separate sphere, and scale, of funerary activity; anyway, the projected annual rate of deposition is low (see Table of Contents: 03f/6f).

If viable alternative explanations can be found for key elements of this inner ring, then its existence becomes even more dubious. For instance, the linear spread of barrows in the Old and New King Barrow complex SU 1342, forming the E'n side of the ring, could have formed up to provide a façade for the line of The Avenue, as it passed through the area, on its approach to Stonehenge (e-FIG RB-113). If this was the case, then the essential aspect of the barrow complex would be outward, and to the E, rather than inward as part of the ring. Another example is provided by the affinities of the Normanton Down cemetery SU 1141 complex forming the S'n side of the ring, as discussed below.

Alternative suggestions: a more cellular pattern

The scheme based on rings appears weak, at best. Other general patterns are indeed possible and, rather than there being any overall ring structure to the distribution, emanating from Stonehenge, a pattern of localised cells can perhaps be identified (e-FIG RB-109 and 279). One at least seems to represent the data better, whilst staking no especial claim as a valid explanation: that involving the valley area of the North Kite enclosure SU 1140, to the S of Stonehenge.

The distribution of round barrows in the area might have responded to possible influences from two major monuments:

The Stonehenge Cursus

The Cursus might have made a minor contribution to the pattern, with cemeteries ranging generally around, and two closely following its line. The long barrow adjacent to its E'n end also conforms, by running in parallel.

Stonehenge

This monument will undoubtedly have exerted considerable, and widespread influence on the pattern of domestic, ritual, and funerary activity in the area, but perhaps without the over-arching ring pattern suggested for barrow cemeteries. Nor should *attraction* of cemetery sites around the monument be assumed. It is certainly possible, in view of the gap already noted in relative burial activity immediately around the henge, that the site acted rather to *distance* barrows, and especially conspicuous cemeteries. Given the evidence that Stonehenge was of national importance, usage, and a destination from long-distance then, in catering for gatherings of disparate groups, more neutral ground might have been established around it. This would have been freer from specific territorial claims, such as those suggested by imposing dynastic burial plots, marked by their linear cemeteries. Such a restriction might explain the distancing of more important cemeteries onto, and just beyond, the first general skyline, at the margin of a broadly circular exclusion zone, giving the impression of a distinct ring. Any such exclusion would not be expected to have generated further outer rings, but just that around a general inner zone.

The North Kite enclosure; SU 113 405; SU14SW 52; e-FIGS RB-109;

One such cell of barrow construction, based on the large enclosure site at North Kite, its local valley, and adjacent upland, lying to the SW of Stonehenge, could be indicated by the pattern of larger cemeteries ranged around *it*.

This lateral E'-W'ly headwater valley would have provided an excellent location for settlement: well defined, sheltered, stream-side, and adjacent to extensive upland. The North Kite enclosure, trapezoidal in plan, about 500m long, 400m wide at the broader S'n, and 140m wide at the narrower N'n end, runs down the S'n flank of this valley, enclosing about 11.7 hectares. A wider gap, lying upslope in the longer E'n side, could indicate an entrance. There have been difficulties in clearly tracing any perimeter along the broader S'n end, although a faint crop-mark can be seen.

Excavation, on the E'n perimeter, revealed a palisade slot with post-holes, and the bank on W'n side overlay later Neolithic and earlier Bronze Age pottery. The disc barrow Wilsford 45b (SU 1105 4038; SU14SW 478) partially overlies the perimeter of the enclosure. Although evidence for the date, nature, and intensity of occupation at the site is sparse, the enclosure may well be contemporary with the major phase of barrow building in the area. The site seems to have formed the focus for an extensive system of subsequent later Bronze Age boundaries, extending over the adjoining upland, and this may indicate the continuing economic importance of the locality, and the longer-term status of its occupants.

Important barrow cemeteries ring this valley: Normanton Down SU 1141 along the N'n skyline, its further linear spread lying along the perpendicular ridge forming the E'n horizon, the Wilsford SU 1139 complex along the S'n side, partly overlapping the enclosure, and the Winterbourne crossroads SU 1041 cemetery along the W. These major cemeteries are broadly visible from the area of the enclosure, with their outliers tending to be placed inside the valley margins, and hence on display from within, rather than from beyond it.

The North Kite valley complex may represent an agrarian group, of key social and economic importance in the area, with its access to resources reflected in the scale of barrow construction, and by some of the higher-status grave-goods from the locality.

Conclusion

The distribution of barrow cemeteries around the Stonehenge area could show a cellular pattern, with small groups ranged around specific monuments, and areas, as features on the skyline defining exclusion zones, or as territorial markers. These sites occupy appropriate ridge-lines and, if linear, could be seen as facing the focus of the area, in order to achieve maximum internal display, and in many important cases adopting a generally E'-W'ly axis, of possible ritual significance, as seen in the general sample (TABLE RB-02; e-FIG RB-275).

Study area: detail: Dorset Cursus (e-FIG RB-05)

Summary

This study area is centred on the Dorset Cursus, contains many round barrows, and cemetery groups, and includes the important *necropolis* at Knowlton. Linear cemeteries are present, but not to the extent found in the Stonehenge area. This study also serves to examine patterns of funerary activity around the Dorset Cursus, in terms of its continuing function, and the longer-term influence of its major axis (see Table of Contents: 03c/13b; e-FIG CU-03).

The distribution of round barrows shows an elongate concentration, along the line of the cursus, in a zone about 5km wide, and 20km long, extending beyond this at either end. This line is further emphasised by smaller concentrations flanking the SE'n side (e-FIG RB-05).

Larger cemeteries are more common in the area of the cursus, and linearities occur in most areas where barrows are concentrated.

Topography

The study area lies around the headwaters of the Rivers Stour, and Avon, which run generally S'ward from areas of chalk upland, at the N and W. This catchment area is defined along its N'n side by upland, dissected at its S'n margin by headwater valleys, and is divided into two major NE'-SW'ly running ridges by the River Ebble, a tributary of the Avon. These ridges provide clear lines of access across the area. At the SW, the valley of the River Stour, passing through the Shillingstone gap, separates the N'n upland from the W'n upland.

The Dorset Cursus runs NE'-SW'ward along the N'n margin of the catchment, and approximately parallel to the N'n block of upland, running over, and perpendicular to, the uppermost streamlet valleys.

Distribution of monuments

Long barrows

Many of the long barrows are distributed in a broad oval around the general axis of the cursus.

Other monuments

The area contains two major complexes, the Dorset Cursus (e-FIG CU-03), and the complex of henges at Knowlton (e-FIG HE-09), to its SE.

Round barrows

-general distribution: in a clear zone around the main axis of the cursus, and extending well beyond it at either end, with concentrations over upland towards the N and NE, and lesser scatters over valley areas to the SW;

-block structure

The area contains one major block B1, and five minor blocks b1-b5.

..major block: B1: SU 0519-ST 9205; Dorset Cursus;

This, the largest of the blocks, is markedly linear, and runs NE'-SW'ward along the line of the Dorset Cursus, extending well beyond its margins laterally, with a conspicuous extension beyond it to the SW. Beyond the NE'n end of the cursus, two minor blocks, b1 and b2, occur well separated, and extend the general line, as does another to the SW, b5. The elongate shape of this major block clearly shows the influence of the Dorset Cursus in determining the distribution out to some distance.

This block contains the following focal areas, which appear fairly well separated:
f1: SU 0114; Bottlebush Down; **f2:** ST 9510; Launceston Down;

..minor blocks:

Two blocks lie separately, to the NE of major block B1:
b1: SU 1623; Clearbury Down; **b2**: SU 1021; Rockborne Down;

Two more intense blocks flank major block B1, along its SE'n side:
b3: SU 0310; Knowlton; **b4**: ST 9905; King Down;

One block lies beyond the SW'n end of major block B1, extending its line:
b5: ST 8703; Blandford.

-distribution of cemeteries
Cemetery clusters are distributed closely, and axially, around the line of the cursus, with scatters over valley areas to the SE and E. Round barrow cemeteries are fairly evenly distributed throughout all blocks, with larger examples prominent in B1, b4, and with the Knowlton *necropolis* accounting for most of b3.

The distribution of linearities generally follows that of the cemeteries.

Supplementary data: Dorset Cursus area:

The following round barrow cemeteries display linearity, of which the most developed have been outlined in more detail (TABLE RB-11):

Notes and Key: as given in TABLE RB-06 for the Upper Thames study area.

TABLE RB-11 Linear round barrow cemeteries in the Dorset Cursus study area

e-FIG
RB-
05 ALL SITES AND MONUMENTS WITHIN THE STUDY AREA

Knowlton necropolis
130 general area;
131 area of Knowlton henges;
132 area at N: Wimbourne St Giles;
133 area at S; Hinton Martell;

linear cemeteries:

cemetery	NGR	lin	barr	prox	regS	strL	homB	sub	alig	dec
134 Abbeycroft Down	ST 9604	min?	4	clo	med	hi	?	no	241	
135 Ackling Dyke	SU 0116	sig	3	cont	hi	hi	low	no	227	<>
136 Badbury Rings	ST 9603	min	3-4	sp	med	hi	med	no	233	
137 Blackbush Plantn	SU 0216	sig?	4	cont	med	hi	hi	no	266	
138 Blackbush Plantn	SU 0315	sig?	4	sp	med	hi	?	no	188	
141 Charlton Down	ST 9020	sig	4	cont	hi	hi	med	no	229	
146 High Lea Hill	ST 9211	min	3-4	sp	med	hi	?	no	252	
147 Hyde Hill Plantn	ST 9410	min	3	w	med	hi	?	no	334	

149 Knoll Down	SU 0819	min	3	cont	hi	hi	low	no	201	<
150 Launceston Down	ST 9510	min	4-6	w	med	hi	?	no	270	
152 Martin Down	SU 0418	sig	3-4	cont	hi	hi	med	no	346	?<
153 Nine Yews	SU 0313	sig?	3	sp	hi	hi	hi	no	269	
154 Oakley Down 1	SU 0117	sig?	3	cont	hi	hi	hi	no	237	
2	0117	sig	3	clo	hi	med	med	no	328	
3	0117	sig?	4	cont	hi	med	low	no	307	?<>
4	0117	min	3	cont	hi	hi	med	no	199	
5	0117	min	4-5	sp	hi	med	med	no	270	
155 Old Lawn Farm	ST 9804	min	3-4	sp	med	med	med	no	339	
158 Race Down	ST 920	min	3-4	clo	med	hi	?	no	354	
159 Redmans Hill	SU 0707	min	3	w	hi	med	?	no	198	
160 Rockbourne Down W	1020	sig?	3	cont	hi	hi	med	no	226	
161 Stapleton Farm	SU 0815	min	6-10	sp	med	low	?	no	275	
162 Stoke Down	SU 0527	sig?	3	w	med	hi	?	no	358	
163 Telegraph Clump	ST 9209	sig	3	cont	med	hi	hi	no	292	
165 The Oaks	ST 9604	min	3	w	hi	hi	low	no	349	?<
166 Thornicombe	ST 8703	sig	3-5	cont	hi	med	hi	no	185	
167 Townsend Lane	SU 0519	sig	3	cont	hi	hi	hi	no	253	
169 Veny Cheese Pond	ST 9611	sig?	5-7	sp	med	hi	?	no	320	
170 Wimbourne St Giles	SU 0412	sig	3	cont	hi	hi	hi	no	291	
172 Witchampton 1	SU 0006	min	3-6	sp	low	hi	med	no	216	
2	0006	min	3	sp	hi	hi	med	no	248	
173 Wyke Down	SU 0015	min	3	cont	med	hi	hi	no	240	

non-linear examples:

139 Bockerley Down	SU 0418
140 Bowldish Pond	SU 0315
142 Collingwood Corner	ST 9110
143 Grims Ditch	SU 0618
144 Grims Lodge Farm	SU 0922
145 Gussage Down	ST 9913
148 King Down	ST 9803
151 Little Down	ST 9106
156 Old Lawn Farm S	ST 9804
157 Old Somerley	SU 1308
164 The Drive	SU 0114
168 Trow Down	ST 9721
171 Winklebury	ST 9521

Key: Plantn plantation.

The area contains no linear barrow cemeteries sufficiently impressive to be described in detail here.

Study area: detail: South Dorset ridgeway (e-FIG RB-06; phot RB-01 to 03)

Summary

Although it contains no singular monument to act as a potential focus for distribution of barrows, this area was included because the South Dorset ridgeway (SDR) appears to act in a similar manner.

Many cemetery clusters lie on, and around the ridge, often displaying linearity that conforms with its general NW'-SE'ly line. A comparison with trends for alignment in other study areas suggests that this is not passive, but arises from more active choice of location (see TABLE RB-02; e-FIG RB-39).

An area of the South Downs was included as an auxiliary study area, for comparison with South Dorset, since they both contain a similar ridge system, and significant numbers of round barrows. However, the two areas differ in the densities of round barrows they contain, the number of cemetery clusters, and in the degree of linearity developed, these features being far lower for the South Downs than for South Dorset. This difference acts to emphasise the particular importance of the SDR as a focus for funerary activity, comparable to that exerted by major monuments in the other study areas. Given active choice of this major ridgeline as a general context for burial, then the linearity shown by many of the barrow cemeteries should not be regarded as passive adherence to topography, but a more active choice, perhaps as part of a hyper-monument (see Table of Contents: 03j/3).

Topography

The study area lies around the headwaters of the generally WNW'-ESE'ward running Rivers Frome, and Trent, and is defined along its N'n and W'n sides by areas of chalk upland, into which they cut. Strong major ridge-lines occur in both areas, with many lesser lateral spurs present, showing no general preference for direction. There is no unified ridge-line crossing the region at the N which might be termed a ridgeway, but a clear trans-regional ridgeline is visible at the S, the SDR, skirting the coast, becoming more pronounced, and clearly defined as it moves NW'ward. The area downstream, around the mid-reaches of the rivers, is of more even relief, containing low spurs and ridges.

The SDR is a narrow, and fairly continuous ridge of chalk downland, about 30km long, and generally ascending towards the NW, about 290°G. It lies in a near-coastal location, offering a well-defined, and ready line of communication across the area.

Distribution of monuments

A general summary of context, dating, and association of monuments in the area is given in Royall 2011. English Heritage (English Heritage 2012), and Wessex Archaeology (Wessex Archaeology 2012), have carried out surveys, with emphasis on the state of preservation of barrows.

The SDR, considered as a unit, contains a distinct linear concentration of round barrows along its length, mainly at higher altitudes, between 150m and 200m OD. Distinct monuments near its ends may further terminally define this main band of barrows: at the NW, the bank barrow, and cursoid monuments at Martin's Down SY 5791, also the Poor Lot SY 5890 *necropolis*; at the SE, the bank barrow, and associated round barrows at Came Hill (SY 6985). The scale, and definition of the entire ridge-based complex might entitle it to be described as a super-cemetery.

In terms of sheer content of barrows, the general area appears unusual. Similar ridge systems within study areas show no such marked linear concentrations. For instance, the comparable ridge of the South Downs: e-FIG RB-08), and a scan of others elsewhere in S'n England provide no clear parallels, several showing similar topography, and geological substrate, and offering narrow ridge-lines trending generally E'-W'ward (e-FIG RB-276). Examples of the latter include the following:

..North and South Downs, flanking the Weald of Kent;
..Marlborough-Berkshire Downs, running to the N of Avebury;
..the ridge flanking Salisbury Plain, along its N'n margin, extending to the Hampshire Downs;
..Cranbourne Chase;
..North Dorset Downs;
..the Blackdown Hills.

Others, such as the Chilterns and Cotswolds have a NE'-SW'ly trend.

One particular ridge system has been singled out as a formal study area for more detailed comparison with the SDR, in order to demonstrate that this latter is indeed unusual. The W'n sector of the South Downs is closely similar in terms of topography, geology, orientation, in its near coastal location, in ease of passage, and in its spatial relationship with major areas of prehistoric settlement on the central chalk belt of S'n England. Cancelling these common factors from the equation allows the content of barrows to be compared directly: there are far more barrows, with greater expression of linearity, and a larger range of other monuments of comparable date on the SDR.

Long barrows

Almost all of the long barrows in the study area are associated with the SW'n upland, which includes the SDR, spreading back towards the SW, over lower land.

Other monuments

The general distribution of other monuments follows that of long barrows in preference for the SW'n upland, the area of the main ridgeway, but such sites as henges show a closer affinity with lower slopes, in the area of the upper Frome valley.

The area lacks a major monument acting as a focus for distributions, although the SDR acts thus as a distinctive natural feature.

Round barrows

-general distribution: on upland, and in lower valley areas, with an especial concentration over the SW'n upland.

-block structure
There is one major block, B1, in the study area, extending over the SW'n upland around the SDR, containing focal areas f1-f7. Ten other, more minor blocks, b1-b10, are scattered from NE to SE, over the lower slopes of the N'n upland, and around the mid to upper courses of the Frome-Trent catchment.

..major block: B1: SY 7384-SY 5591; SDR;
This block is roughly ovate, about 20km long, by 10km wide, and runs over, and either side of the SDR, especially to the NE, over lower ground towards the River Frome. It contains seven focal areas, mainly along the ridgeway itself:

f1: SY 5990; Poor Lot-West Hill-Big Wood; **f2**: SY 6287; Bronkham Hill; **f3**: SY 6487; Eweleaze Barn; **f4**: SY 6686; Bayard Barn; **f5**: SY 6886; Came Down; **f6**: SY 6985; Bincombe; **f7**: SY 6492; Penn Hill;

..minor blocks:
The following minor blocks occur beyond the major block B1:

b1: SY 6496; Dickley Down-Grimston Down;
N'-S'ly ridges, along the S'n margin of the N'n upland;
b2: SY 6799; Cerne Abbas-Nether Cerne;
a N'-S'ly ridge, along the S'n margin of the N'n upland;
b3: SY 6995; Cowdon Hill-Waterston ridge;
lower hills and ridges, to the N of the River Frome;
b4: SY 8095; Lord's Down-Bowcroft Hill;
low hills, along the N'n flank of the River Trent;
b5: SY 7598; Whitcombe Hill-Dewlish;
low hills and ridges, around tributary streams, to the N of the River Trent;
b6: SY 8192; Tincleton Hang-Higher Hyde Heath;
low E'-W'ly ridge and hill, just to the S of the River Trent, and parallel with it;
b7: SY 8396; Milborne St Andrew-Bloxworth Down;
low hills, between the Rivers Winterbourne and Trent;
b8: ST 8702; Charlton on the Hill-Muston Down;
low hills and ridges, between the rivers Winterbourne and Stour;
b9: ST 8003; Houghton South Down;
ridges, along the S'n margin of the N'n upland;
b10: SY 8181; Coastal;
low hills, extending the line of the SDR to the E.

-distribution of cemeteries

Round barrow cemeteries in the study area show a distinct concentration in the area of major block B1 and the SDR, extending more weakly into minor block b10, as it extends towards the coast. There is a scattering of cemeteries amongst other minor blocks. The distribution of linearities follows that of the cemeteries.

Barrows on the South Dorset Ridge: the general structure of the super-cemetery

The distribution of round barrows within the broader area of South Dorset shows a distinct concentration for some 16km along the major NW'-SE'ward running South Dorset Ridge, indicating the existence of a preferred funerary zone (e-FIG RB-174 and 174a). It is possible that a major factor in choice of this feature for intensive siting of barrows was the significance of its W'ly axis, suitable for associated funerary ritual (see Table of Contents: 02c/2i).

The distribution and status of the many round (530), and few long barrows (12), within the area of the ridge has been well established (Wessex Archaeology 2011). The main distribution of barrows follows the top of the ridge, with an additional flanking strip along its NE'n slope. Although very few sites have been adequately conserved, let alone excavated, it is at least possible to define local clusters, at various levels of resolution, although essential information on chronology, and sequence is absent. Using distributions for the entire ridge, paired barrows can be isolated, also localised clusters, from small to large, with linearity present to varying degrees, and the existence of unusually large round barrows noted (e-FIG RB-174a). These clusters can then be further grouped into larger units, that appear coherent, and spatially separate. The general basis for this broad definition, and division is clear, although in some detailed cases variants are possible, but not sufficient to affect overall conclusions.

The following features could suggest that the zone of barrows formed a distinct entity:

..terminal zones might be marked by particular monuments, lying at either end of the main line of barrows: three long barrows, a long mortuary enclosure, and two possible cursus monuments on Martins Down, at the NW (SY 5791), and two long barrows on Came Hill, at the SE (SY 7085);

..clear concentrations of barrows also mark these ends of the main funerary area, at the NW: Martins Down, and Poor Lot; at the SW: Came Hill. Another, on Bronkham Hill (SY 6286), is located midway, on the highest sector of the ridge, and features the largest round barrow in the complex (e-FIG RB-179a);

Use of the ridge as a funerary area would confer several advantages by providing:

..a natural W'-NW'ly axis, as preferred by many linear round barrow cemeteries (see TABLE RB-02 and e-FIG RB-275); even if barrows were not aligned in linear cemeteries directly conforming with the main ridge then they could still utilise the ritual potential of its natural axis by general association;

..imposing locations for siting barrows on ridge-lines, with good outward lateral views;

..ready lateral viewing towards barrows, along what must have been an important ridge-route running past them, across the region.

Supplementary data: South Dorset ridgeway:

The following round barrow cemeteries display linearity, of which the most developed have been outlined in more detail (TABLE RB-12):

Notes and Key: as given in TABLE RB-06 for the Upper Thames study area.

TABLE RB-12 Linear round barrow cemeteries in the South Dorset study area

e-FIG
RB-
06 ALL SITES AND MONUMENTS WITHIN THE STUDY AREA

174 detailed coverage of round barrows on the main ridgeway;

linear cemeteries:

	cemetery	**NGR SY-**	**cem**	**lin**	**barr**	**prox**	**regS**	**strL**	**homB**	**sub**	**alig**	**dec**
175	Ashton Farm	6687		min	4	w	med	hi	?	no	280	
176	Big Wood 1	6089		sig	7	cont	med	med	me	?2	251	
	2	6089		min	3	cont	hi	hi	low	no	232	
177	Bincombe 1	6885		sig?	3	sp	hi	hi	med	no	289	
	2	6885		sig	5	sp	hi	hi	?	no	257	
	3	6885		sig	4	sp	hi	hid	?	no	271	
178	Bincombe Barn 1	6785		sig?	4	sp	med	med	?	no	270	
	2	6785		sig?	7	sp	med	med	?	no	263	
179	Bronkham Hill 1	6187		sig	3	cont	hi	hi	hi	no	277	
	2	6287		sig	4	w	med	hi	?	no	294	
	3	6287		sig?	5	w	med	hi	?	no	312	?<>
	4	6286	MAJ	maj	9	sp	med	med	low	?	308	<> L
	5	6386		sig	3	clo	med	hi	low	no	274	>
	6	6386		sig	3	sp	hi	hi	?	no	29	?>
	7	6486		min	3	sp	low	hi	med	no	271	
	8	6586		sig	4	sp	hi	hi	?	no	283	
	9	6586		sig	4	sp	med	hi	med	no	263	
180	Came Hill 1	6985		sig?	5	w	med	med	?	no	251	
	2	6985		min	4	w	low	med	?	no	282	
	3	7085		sig	7	sp	med	hi	med	no	294	
	4	7085		sig	7	clo	med	hi	low	no	287	
181	Cripton Wood	6986		sig?	5	sp	low	med	?	no	289	
183	Downcroft Farm 1	6490		sig?	6-7	sp	hi	hi	?	no	280	
	2	6490		sig?	4	sp	hi	hi	?	no	280	
184	East Chaldon	7983		sig	3	cont	hi	hi	hi	no	257	
185	East Lulworth	8681		min	3	sp	hi	med	hi	no	305	
186	Eweleaze Barn 1	6487		sig	4	sp	med	hi	hi	no	186	
	2	6487		sig	4	cont	med	hi	hi	no	324	
187	Five Barrows	8784		sig	3	cont	hi	hi	hi	no	348	
188	Five Marys	7984		sig	5	clos	hi	hi	hi	no	270	
189	Four Barrow Hill	6587		sig	6	sp	hi	hi	hi	no	206	
190	Higher Came Farm 1	6987		sig	6	sp	hi	hi	?	no	211	
	2	6987		min	3	clo	hi	hi	?	no	187	
	3	6987		min	3	sp	hi	hi	?	no	220	
191	Highfield Plantn 1	6691		min	4	sp	low	hi	?	no	286	
	2	6691		min	4	sp	med	med	?	no	225	
194	Pavington Heath	8883		sig?	3	cont	hi	hi	low	no	212	
195	Penn Hill	6492		sig?	3	sp	hi	hi	?	no	291	
196	Plush Hill	ST 7101		min	3	sp	med	hi	?	no	249	

197	**POOR LOT**	1	5890	MAJ	sig	3	clo	med	hi	?	no	315
		2	5890		maj	9	cont	med	med	med	?3	293
		3	5890		sig	3	cont	hi	hi	hi	no	319
		4	5890		sig	3	cont	hi	hi	hi	no	318
		5	5890		maj	7-12	sp	med	hi	?	?2	266
		6	5890		sig	4	cont	hi	hi	hi	no	298
		7	5890		sig	3	cont	hi	hi	hi	no	320
		8	5890		sig	4	clo	hi	med	hi	no	222
198	Pound Farm	6799		min	4	w	low hi	?	no	191		
199	Pound Hill	6290		sig	7	sp	med	hi	med	no	291	
200	Stinsford	7192		sig?	5	sp	med	hi	?	no	305	
201	Sydling Woods		ST 6202		min	5	w med		hi	?	no	314
203	West Hill	7084		maj	9	sp	hi hi	?	no	246		
204	West Holme Heath	8884		sig?	3	sp	med	hi	med	no	270	
205	Whitcombe Barn		7086		sig	5	sp hi	hi	?	no	314	
206	White Horse	1	7184		sig	6	sp low hi		?	?2	268	
		2	7184		sig	3	sp med		hi	?	no	258
207	Whiteway	8781		min	3	sp	med	hi	?	no	251	
208	Winterbourne Kingston	8696		min	6	cont	hi med		?	no	268	

non-linear examples:

178 Bloxworth Down 8796
182 Down Wood 6886
192 Lyscombe Hill ST 7202
193 Martins Down 5791
202 Thornicombe ST 8703

Key: Plantn plantation.

Individual cemeteries

Poor Lot; ....
Dorset; SY 5890; NMR: SY59SE 57, 451192; e-FIGS RB-197 and 197a; phot RB-04;

Summary

This extensive area of round barrows, in extent and content on a par with the *necropolis* at Knowlton (Dorset: e-FIG RB-130 to 133), and at Stanton Harcourt (Oxon: e-FIG RB-44), contains scattered linearities, with the most pronounced lying in the valley, at its core. This latter area contains three rows, and associated flanking barrows, with those of bowl type predominant. Two closely spaced, triple round barrows, lying adjacent to the core area, may contain elements of earlier long barrows (Riley and Payne 2011), as may a longer mound towards the W'n end.

Further details of structure, contents, and dating await excavation.

Topography: the core area, with its linearity, lies on the terraced slope of a shallow stream valley, with its rows running along, and transverse to the contours, an unusual valley siting for a linear barrow cemetery (Cf: Lambourne Seven Barrows SU 3282, Berks; e-FIG RB-42 and 42a).

Barrows: eight in the main line, with four to five in a line at right angles, beyond the E'n end, and six scattered along the N'n side; many other round barrows occur in the wider cemetery;

-types: mainly bowl, but also bell, disc, and pond;

-cemetery structure: principal row 2: an irregular line of mainly bowl barrows, of various sizes, with scattered barrows laterally, a shorter row beyond the E'n end, and another to the NE ranged around it;

-sequence: unknown;

-special features: a long barrow may lie just to the NW of the end of row 2;

-excavation: various unrecorded incursions; two pond barrows in the broader cemetery have been excavated, but remain unpublished;

-proportion explored: negligible; early incursion evident;

-rite: unknown;

-richness of grave-goods: unknown;

-conservation: much damage.

The largest barrow in the group, at the E'n end of row 2, is a bowl barrow, 35m in diameter, with the centre dug out.

General surveys of the area have been carried out (Wessex Archaeology 2012), but only two barrows, G and F below, have been further investigated (unpublished: Atkinson 1952-1953):

barrow G; SY 5876 9068; ?pond barrow;
a ring-bank enclosed a circle of eight small pits, covered by a flint pavement, about 7m in diameter, which extended as a pathway through the entrance on the SE'n side, this latter flanked by a pair of pits; the site was recorded as a circular depression, 8.0m in diameter, and 0.5m deep.

barrow F; adjacent, unspecified location; ?pond barrow;
similar to barrow G, with a flint pavement, 7.5m by 5m, and traces of a causeway on its E'n side.

Study area: detail: Mendip (e-FIG RB-07)

Summary

This study area was included to provide, along with the upper Thames, data on round barrows from a topography, and geology different to that of areas investigated on the chalk downland of Wessex. Mendip also contains a complex of four henges at Priddy, that might have acted as a focus for barrow construction in the area, as seen around major monuments in the other study areas.

Topography

Mendip is an elongately ovate plateau of limestone hills, about 30 by 10km, running NW'-SE'ward, its edge defined by steep escarpment, this clearer in the NW'n half, and fading into lesser relief towards the SE. Its NW'n sector, designated an Area of Outstanding Natural Beauty (AONB), is higher, with much of it above 250m, whilst the SE'n half is lower, with little land above this altitude. Mendip is less defined along its SE'n side, where it merges with continuing relief.

The plateau is bounded laterally by stream valleys, along its NE'n side draining to the Avon, and Bristol Channel, here including the Rivers Chew, and Yeo, and along the SW'n side draining towards the Somerset Levels, via the Rivers Axe, and Brue-Sheppey. Headwaters of streams have formed valleys, and gorges, where they penetrate the margins of the limestone uplands.

Distribution of monuments

A general summary of context, dating, and association of monuments in the area is given in Ellis 2010.

Long barrows

About half of the sites occur around the headwaters of the River Frome, lying off-Mendip to the E, with a similar number on the higher NW'n half of the upland.

Other monuments

The linear grouping of four henge-type enclosures at Priddy ST 5352, forms the most conspicuous complex, with evidence for other non-barrow monuments scant, beyond that of the small henge at Gorsey Bigbury ST 4855. The area of the henge complex at Priddy appears to form a focus for distribution of barrows, especially round.

Round barrows

-general distribution: concentrated over the higher NW'n half of the upland, especially around the Priddy henges;

There are 286 fairly definite, and 78 doubtful examples within the AONB (Ellis 2010, distribution fig. 2).

-block structure

Round barrows are concentrated in one major block, B1, with an appended minor block b1, over the higher NW'n part of Mendip, the lower SE'n half containing a few scattered minor blocks.

..major block: B1: ST 6047-ST 4458; Priddy:

This largest block, about 20 by 5km, occupies the higher ground at the centre of Mendip, is bounded by the line of Cheddar Gorge along its NW'n side, and covers an area with more upland valleys, hence perhaps more suitable as a zone of increased settlement.

This block contains the following focal areas, with fairly weak divisions between them:
f1: ST 5352; Priddy; **f2:** ST 5151; Townsend; **f3:** ST 5154; Haydon Grange.

..minor blocks:

b1: ST 4857; Blackdown: this is about a quarter the size of major block B1, and occupies the highest ground on Mendip.

The four Priddy henge-like circles lie within the area of focal areas f1-3, within major block B1, and the smaller, single henge at Gorsey Bigbury (ApSimon *et al*. 1976) lies at the margin of minor block b1.

-distribution of cemeteries
Cemetery clusters follow the general distribution of round barrows, with linear cemeteries concentrated in the area around the henges.

Supplementary data: Mendip:
The following round barrow cemeteries display linearity, of which the most developed have been outlined in more detail (TABLE RB-13):

Notes and Key: as given in TABLE RB-06 for the Upper Thames study area.

TABLE RB-13 Linear round barrow cemeteries in the Mendip study area

e-FIG
RB-
07 ALL SITES AND MONUMENTS WITHIN THE STUDY AREA

linear cemeteries:

cemetery	NGR ST-	cem	lin	barr	prox	regS	strL	homB	sub	alig
210 Beacon Batch	4857		sig	3	clo	hi	hi	hi	-	285
211 Beacon Hill	6345		min	3	sp	med	hi	med	-	295
212 Beech Farm 1	5254		min	4	sp	low	hi	hi	no	291
2	5254		min	5	sp	low	med	hi	no	288
213 Blue Mountain Farm	5949		min	3	sp	med	hi	hi	no	302
214 Bristol Plain Farm	5051		sig	4	sp	med	hi	hi	no	301

218	**ASHEN HILL**	5352	MAJ	maj	8	con	hi	hi	hi	2	283
219	**PRIDDY NINE BARROWS**	5351	MAJ	maj	7	con	hi	hi	hi	2	306
223	**SMALL DOWN KNOLL 1**	6640	MAJ	maj	6	con	hi	hi	hi	no	277
	2	6640		maj	7-8	con	hi	hi	hi	no	255
224	The Batch	5151		min	3	w	med	hi	hi	no	313
225	Townsend Farm	5151		sig	5	con	hi	hi	hi	no	185
229	Westbury Beacon	5051		min	3	sp	med	hi	hi	no	316

non-linear examples:

209	Batts Coombe	4655
215	Clover Farm	6542
216	Pen Hill	5648
217	Pool Farm	5354
220	Priddy	5350
221	Rowberrow	5252
222	Slab House Inn	5948
226	Tynings Farm	4756

Individual cemeteries

-Priddy Ashen Hill; ....
Somerset; ST 5190 5205; NMR ST55SW 5; e-FIG RB-218;

The barrows are located along the rounded spine of a small hill. Six of the barrows form the main line, running from E to W (103-283ºG), with the last two at the E'n end forming an angled extension, from SE to NW (140-320ºG). A single barrow lies off-line nearby to the W.

Most of the bowl barrows in this cemetery are of similar size, and have been subject to antiquarian incursion. Records show that cremation was the predominant primary rite, and that grave-goods were generally poor.

The numbering of barrows given here is particular to this paper.

1: possible round barrow, now destroyed;

2: bowl barrow, 13m in diameter; small primary cremated deposit with no urn;

3: bowl barrow, 18m in diameter; primary cremated bone, and fragments of a bronze blade/knife;

4: bowl barrow, 15m in diameter; much cremated bone in an urn within a cist is probably primary;

5: bowl barrow, now sub-oval, 21 by 14m; four cremated deposits lay amongst cairn material; general finds include flint flakes and scrapers;

6: bowl barrow, 15m in diameter; cremated deposit in a cist, possibly primary, with a rivetted bronze knife, retaining fragments of its wooden sheath;

7: bowl barrow, 17m in diameter; much cremated bone in a primary position in a cist with, or possibly under, an inverted urn;

8: bowl barrow, 15m in diameter; cremated deposit, possibly primary, in a cist with beads (five amber, one perhaps faience), a possible grape cup, and a fragment of a bronze knife-dagger, possibly retaining fragments of its wooden sheath;

9: bowl barrow, 19m in diameter; primary cremated deposit, with an urn, possibly inverted; a secondary cremated deposit lay above this, and another secondary elsewhere in the mound.

-Priddy Nine Barrows; ....
Somerset; ST 5190 5145; NMR ST55SW 74; e-FIG RB-219; phot RB-12;

The barrows lie along the ridge of a low hill, and form two close, but discrete rows: a line of four barrows runs from ESE to WNW (117-297°G) and, just to the NW, a separate row of three barrows runs on a more N'ly course, from SSE to NNW (147-327°G). Beyond the NW'n end, two barrows lie off-line to the N, and one to the S.

Most of the barrows in this cemetery, similarly sized bowl barrows, and one possible disc barrow, have been subject to antiquarian incursion. Records give no general details of the primary rite, nor of grave-goods, except for barrow 3, where the rite is possibly cremation.

The numbering of barrows here is particular to this paper:

1: bowl barrow, 19m in diameter; **2**: bowl barrow, 23m in diameter; **3**: bowl barrow, 14m in diameter; ash and char present, but no details; **4**: bowl barrow, 23m in diameter; **5**: bowl barrow, now sub-oval, 25m by 28m; **6**: bowl barrow, 19m in diameter; **7**: ?disc now sub-oval 14 by 18m; **8**: bowl barrow, now sub-oval, 10m by 15m, with a ditch, giving 21m total diameter; **9**: bowl barrow, now sub-oval, 20 by 23m; **10**: bowl barrow, 16m in diameter; **11**: bowl barrow, 6m in diameter.

-Small Down; ....
Somerset; ST 665 406; NMR ST64SE 6; e-FIG RB-223;
The barrows lie along the ridge of a low hill, partly along its steeper S'n side, and form two rows. A line of seven barrows runs WSW'-ENE'ward (255-075°G), and just to its W, a second line of six takes a more W'ly course, from E to W (097-277°G), along the steep side of the hill. A single outlying barrow is located off-line, beyond the E'n end of the cemetery.

Most of the barrows show signs of incursion, and there are records of early excavation, with some details of primary cremated deposits as follows:

Note: all barrows are numbered according to the system initiated by Grinsell for the Durrington series.

Parish: Evercreech:

Context of the primary cremated deposit:

5: no urn present; flint flakes came from the excavation; **8**: on a flat stone; flint ?borer nearby; **9**: primary urn present, but no mention of bone; **10**: no urn present; **12**: in an inverted collared urn, resting on a flat stone.

Study area: detail: South Downs (e-FIG RB-08)

Summary
This area was included to provide a comparison with distributions of round barrows along the South Dorset ridgeway. Both areas are similar in their topography, containing ridges of chalk downland, trending broadly E'-W'ward, are near coastal, and are located at a similar distance from the major centres of activity in Wessex, hence similarly provincial.

Topography
The South Downs run E'-W'ward for about 90km, as a pronounced ridge of chalk downland, about 10km inland from the South Coast. A series of rivers, running S'ward, cut the ridge into shorter segments.

Distribution of monuments
Major monuments, such as causewayed enclosures, and long barrows, are concentrated towards each end of the ridge. At the W'n end, the Treyford, and Bignor ridges include about half of these sites, and at the E'n end, the areas of the Firle, Woodingdean, and Claydon ridges the remainder. Minor henges are very infrequent, and circles apparently absent.

Round barrows

-general distribution:

round barrows are distributed fairly evenly along the ridge system, with block structure corresponding to sectors of the main ridge system;

-block structure

There are two blocks B1 and B2, of equivalent area, about 5 by 15km, which just qualify as being more major:
B1: TQ 0312; Storrington; **B2:** TQ 3012; Clayton E;

There are seven minor blocks of equivalent size, about 5 by 5km;
b1: SU 7218; Treyford W; **b2**: SU 8417; Treyford centre; **b3**: SU 9612; Bignor;
b4: TQ 3806; Woodingdean; **b5**: TQ 4904; Firle; **b6**: TQ 5602; Jevington.

-distribution of cemeteries

Cemetery clusters are well represented on all sectors of the ridge, and linear cemeteries occur on most of the larger sub-ridges, but with the major linearities more frequent towards the W'n set.

Supplementary data: South Downs area:
The following round barrow cemeteries display linearity, of which the most developed have been outlined in more detail (TABLE RB-14):

Notes and Key: as given in TABLE RB-06 for the Upper Thames study area.

TABLE RB-14 Linear round barrow cemeteries in the South Downs study area

e-FIG
RB-
08 ALL SITES AND MONUMENTS WITHIN THE STUDY AREA

linear cemeteries:

cemetery	NGR	cem	lin	barr	prox	regS	strL	homB	sub	alig	dec
230 Devil's Humps	SU 8111		sig	6	clo	med	hi	med	2	231	
231 Devil's Jumps	SU 8217	MAJ	maj	7	clo	hi	hi	hi	no	303	
232 Heyshott Down	SU 9016	MAJ	maj	11	cont	med	med	med	4	303	?<
233 Kithurst Hill	TQ 0712		sig	6	sp	med	hi	hi	1	271	
235 Pashley	TV 5898		min	4	sp	low	hi	med	no	262	
237 Summer Down	TQ 2611		sig	3	sp	hi	hi	hi	no	242	
239 Westburton Hill	SU 9912		sig	5	sp	hi	hi	?	no	340	
240 Western Brow	TQ 3412		sig	6	sp	med	hi	?	no	246	

non linear examples:

228 Bepton Down	SU 8517
229 Burton Down	SU 9613
234 Manor Farm Down	SU 8816
236 Plumpton Plain	TQ 3512
238 The Peak	TQ 5800
241 Windover Hill	TQ 5403

No further details are provided for individual cemeteries, most being unexcavated.

Topics

The dynamics of linear growth at round barrow cemeteries (e-FIG RB-277)

The axis at a linear round barrow cemetery is rarely a simple line, but contains additional features reflecting various aspects of its nature, and growth, that are key to its interpretation.

Within an axial line, various sub-unit structures may be evident, resulting from unequal spacing between smaller groups, or from patterns of size, and type amongst barrows. In the absence of excavated data, analysis is necessarily confined to consideration of external form, but given internal structure, finds, and dating evidence, it could be expanded correspondingly to include other aspects of partition, in a more meaningful way.

In the case of a linear complex, there may be several lines in different relationships, and these may be associated with other non-linear clusters of barrows in different ways.

Such elements of linearity can be considered as follows (terms in bold type appear in e-FIG RB-277). First, it is essential to distinguish between **intentional,** and **incidental** linearity. In the former case linearity is the result of design, perhaps broadly applied, but in the latter case, not discussed further here, linearity can appear as an artefact, in a close cluster of barrows, as a coincidence of consecutive random placement.

Considering the **PROCESS** of intentional growth in a line of barrows: this can be **additive,** generating an coherent axis by serial siting of components. If placement is **contiguous** then growth can be **uni**-, or **bi**-directional. **Separate** and more complex patterns are possible, if different origins for growth occur within an established axis.

An alternative process to additive growth would be by **infill**, where a general axis is established, perhaps by barrows acting as end-markers, with subsequent members placed between. Additive growth could, of course, further operate within the line.

Next, considering the **FOCUS,** or origin of growth, of the cemetery: this can be **uni-focal,** producing a single line, or **multi-focal** producing several. In the latter case, several rows could be produced **in-line,** along a single axis, or if **separate,** in various dispositions with different axes: **parallel**, **angled**, or **perpendicular**.

There may be various **AUXILIARY DEVELOPMENTS** associated with the linear cemetery, such as placement of other barrows **flanking** the main axis, forming **terminal clusters**, or lying nearby as **satellite cemeteries**. A barrow, set at some distance from the main line, but on its axis, may constitute a deliberate outlier.

These elements are distributed amongst major linear cemeteries from the Study Areas as follows (TABLE RB-15):

TABLE RB-15 Round barrow cemeteries: elements of linearity: patterns of occurrence

Note: Diagrams showing cemetery structure for each of these cemeteries are given in the e-FIGS listed.

cemetery	**NGR**	**study**	**element (see list below)**													**e-FIG RB-**
		area	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	
Barrow Hills	SU 5198	U Th	?					*				*				11
Seven Barrows	SU 3282	U Th			?	?			*			*				42-42a
Cow Down	SU 2251	Salis	?										*			83
Cursus	SU 1142	Salis	*			?									?	84
Durr Down E	SU 1144	Salis	?			?				*		?			?	86-86a
Lake Group	SU 1040	Salis			?	?			?	*			*	*		99
New King Barrows	SU 1342	Salis	?			*		?			*	*			?	120-120a
Normanton Down 1	SU 1141	Salis	*	?	?	?						*	*	*	?	111-111a
Silk Hill	SU 1846	Salis	?		*	?		*		*		*		*		117

Snail Down	SU 2152	Salis	*			?					*	*			?	118
Wilsford	SU 1139	Salis	?		?		?					*	*			127
Winterbourne X-roads	SU 1040	Salis	*	?	?				*			*		*		128-128a
Poor Lot	SY 5890	S Dor		*					*			*	*	*		197-197a
Devils Jumps	SU 8217	S Dow		*								*				231
Heyshott Down	SU 9016	S Dow	*					*								232
Priddy Ashen Hill	ST 5352	Mend	?							*						218
Priddy Nine Barrows	ST 5351	Mend			?			*						?		219
Small Down Knoll	ST 6640	Mend	?					*						?		254

Key:

NGR National Grid Reference; study area: **U Th** Upper Thames, **Salis**(bury Plain); **S Dow** South Downs, **S Dors** South Dorset, **Mend**(ip);

PROCESS	**element**
additive	
contiguous	
unilateral	**1**
bilateral	**2**
separate	**3**
infill	**4**
FOCUS	
uni-focal	**5**
multi-focal	
in-line	**6**
separate	
parallel	**7**
angled	**8**
perpendicular	**9**
AUXILIARY DEVELOPMENT	
flanking barrows	**10**
terminal cluster	**11**
satellite areas	**12**
outlying barrow	**13**

Elements of linearity are numbered as follows in the TABLE above:

Analysis: an example

Cases where round barrows overlap, in a clearly excavated sequence, are too few in occurrence, and in numbers of monuments involved, to provide any general trend for directions of growth at a linear cemetery. The case of a single overlapping pair of barrows, from an axis of 12 sites at the Barrow Hills SU 5198 cemetery (Oxon.) is typical.

However, the small double linear cemetery, that developed around the forecourt area of Hampnett II SP 1016 long barrow, provides a fuller example, albeit one with axes developing under the additional influence of the existing monument (Grimes 1960; e-FIG LB-62). Here, the rows are divergent, with separate focal areas, the three N'n barrows oriented towards the NW (299°G), and the S'n three towards the SW (235°G). Both rows show growth in the axial directions just stated, with complications making this non-uniform. These barrows are small, at around 10m in diameter, their eroded state leaving no material contents. The rows do not passively follow the axis, or the sides of the long barrow, but their final plan covers the approach to its foreground. The directions of growth in the rows approximate the local solstitial axes: the N'n row 12° to the S of midsummer sunset, and the S'n row 6° to the S of midwinter sunset, covering the setting transitional zone of the solar transit. This may be significant, but on the basis of a single site, and given the probable influence of the existing long barrow in shaping the layout of the rows, it would be unwise to suggest it too strongly.

On the basis of those elements of linearity shown in e-FIG RB-277, this cemetery would be classified as follows:

N'n row: process: additive, and contiguous, from barrow A to B, unilateral towards the NW, with barrow C an unknown element; or, by infill of A and C, by intervening B;

S'n row: process: additive, and contiguous, from barrow 1, to 2, to 3, unilateral to the SE, with bilateral extension evident from 2a;

entire cemetery:
foci: multi-focal, separate, angled;
auxiliary development: none detected.

Conclusions

Linear barrow cemeteries show complexity, within, and around the general axis, with all elements listed being well represented in TABLE RB-15. Such diversity is to be expected, given likely gradual development of such cemeteries, over a considerable time-span, but certain regularities, such as sub-unit structure, or auxiliary development, might reflect further provision for different social groupings. Unfortunately, too little coherent excavation has been carried out at *any* cemetery to determine the possible dynamics of growth, and social subdivision.

A tendency for barrows to develop towards the W, within a generally E'-W'ly axis, might support a case for persistence, well beyond the Neolithic, of the type of funerary interest in this direction, as seen amongst long barrows.

Linearity as an expression of social status

Linearity in barrow cemeteries is the exception to the rule, with only about a quarter showing any degree of linear development, and with the most highly developed forming only a small fraction of this. In view of such scarcity, it is probable that the most impressive linear examples represent sites of some status, catering for an elite, perhaps reinforced by their concentration in the prime area of central Wessex:

..the clustering of developed linear barrow cemeteries (LBCs) around locally important sites, such as Stonehenge (e-FIG RB-04 and 279; HE-29 to 31), with a further minor example at the Priddy henges (e-FIG HE-07), further supports a link with status;

..the appearance of isolated LBCs in separate blocks of round barrow distribution, for all study areas, suggests widespread use within separate territories;

..the presence of sub-unit structure within some of these LBCs perhaps suggests further social division amongst burials *within* the row. Comparative study of the quality, and quantity of grave-goods could further address questions relating to status. However, such data are generally lacking, with most sites unexcavated, or poorly so, even at key cemeteries, such as Normanton Down SU 1141 (Wilts; e-FIG RB-11 and 111a), and others on Salisbury Plain;

-besides being spatially isolated, developed LBCs also seem to be absent from certain large groups of barrows, such the *necropolis* at Knowlton SU 0209 (Dorset), and at Stanton Harcourt SU 4005 (Oxon.), or at smaller clusters, such as the North Stoke complex SU 6085 (Oxon.). Minor linearities may be present, but no impressive rows, and again this absence from a more general-purpose burying ground could indicate elitism.

There are many examples of sites where linearity is confined to a clear core area within the more general cemetery. Examples include Lambourne Seven Barrows SU 3282 (Berks; e-FIG RB-42 and 42a), Poor Lot SY 5890 (Dors; e-FIG RB-197 and 197a), and in weaker form at Beacon Hill ST 6345 (Mendip; e-FIG RB-210), where a short linear triplet of barrows occupies the summit, with others spread about around it.

Sub-unit structure within LBCs

Cases where sub-unit structure is evident are listed for each of the study areas as follows:

study area	sub	TABLE RB-
Upper Thames	yes	06
Avebury	no	07
Salisbury Plain	yes	08
Dorset Cursus	no	11
S Dorset ridgeway	yes	12
Mendip	yes	13
South Downs	yes	14

Key: sub(units evident amongst sample of LBCs).

Many of the strongly linear cemeteries contain smaller component rows, typically containing up to five barrows, which may be of different type, with such sub-units set slightly apart, or on a different alignment. Examples are given in TABLE RB-16:

TABLE RB-16 LINEAR BARROW CEMETERIES: EXAMPLES OF SUB-UNIT STRUCTURE

study area	barrows in sub-units in main row	adjacent
Upper Thames		
Barrow Hills	5; 5;	?3
Lambourne Seven Barrows	6; 6;	
Stonehenge		
Normanton Down	11; 3;	
Snail Down	4; 3; 4; 5	
Winterbourne X-roads	3; 5; 3; 3; 3;	
Cow Down	3;	
Cursus W	3; 4;	
Durr Down E	4; 3;	
Silk Hill	3; 7;	3;
South Dorset ridgeway		
Poor Lot	2; 6;	4; 3;
Mendip		
Priddy Nine Barrows	3; 3; 2;	
Priddy Ashen Corner	3; 5;	

Key: any subunits are separated by a semi-colon.

Closely linear cemeteries as composite monuments

If some general plan existed for development of closely linear sites from the outset, then such cemeteries could perhaps be interpreted as **composite monuments**, expressing their own group ritual, rather than just forming an aggregation of separate units, each with its own. Given that the developing axis was a unifying factor, then rituals based on direction might have been of key importance. The predominantly E'-W'ly axis noted for strongly linear round barrow cemeteries, with its near equinoctial mean (TABLE RB-02), might relate to the transit of the sun in these directions, as noted for similar preferences shown by long barrows (e-FIGS LB-01 to 21). The discussion of the relative importance of directions within the axis is important here, as outlined in more detail just below.

In relation to structurally composite axes, it is interesting to note earlier cases, where several smaller monuments were later combined within a long mound, to form a larger elongate barrow, with examples seen amongst the chambered tombs of Scotland (e-FIG LB-34).

Significance of directions within the axis

Adopting a broadly E'-W'ly axis appears to have been a clear preference, when developing a linear barrow cemetery (LBC)(TABLE RB-02; e-FIG RB-275), with a suitable location selected to allow this, rather than necessarily more passive acceptance of existing topography.

Although this general orientational behaviour appears clear, and deliberate, it is difficult to decide which aspects of the axis might have been significant. The axis could have been developed to point in some significant direction, or alternatively to produce a more imposing frontage, facing one. Since both properties are inherent in any axis, then they might both have been significant. As well as views from the site, those towards it, as a feature in the landscape, would also have been important, and a strongly linear, and closely spaced frontage along a ridge-line would add to the impact of the monument.

Although most LBCs consist of fairly evenly sized barrows, at least in terms of surviving ground-plan, there are a few clearer cases where barrows decrease in size along the row. Given the scale of erosion amongst monuments, in many cases it is not possible to determine original size, nor to discount cases where variable diameter is the result of differential damage. Amongst the sample of such sites noted in TABLES given for study areas, there is no consistent pattern, and this is well seen at Snail Down SU 2152 (Wilts; (e-FIGS RB-118), where several sub-unit rows take different directions of decrease. If this decrease does represent a sequence, not a firm assumption by any means, such variability at the site might suggest that there was no key direction, and that provision of a more monumental lateral frontage was perhaps the objective.

Although large barrows, discussed in more detail just below (TABLE RB-17), occur sporadically in LBCs, and could sometimes possibly represent founder-monuments, most of them attract no development, to form a linear cemetery, perhaps surprisingly.

-views along the axis:

It may be entirely coincidental that axial alignment, and its lateral range, as seen amongst LBCs (TABLE RB-02; e-FIG RB-275), are comparable to those found amongst long barrows from the same general area (e-FIGS LB-18). It is at least possible that the builders of round barrows were following an earlier tradition for axes, of W'n funerary emphasis, and that the important view was along the axis. However, these two types of monument are different, in that for long barrows, the axis was established rapidly, and perhaps according to seasonal constraints on constructional activity, whilst for round barrows it developed over longer periods, although perhaps to a preconceived plan, and without similar issues of timing. Rather than a specific transient equinoctial target for LBCs, it might be more realistic to assume the notion of direction of axes towards general E-W.

It would be possible to test this aspect of alignment further, if better data were available on the direction of growth at linear sites, with evidence for specific development towards the W perhaps supporting connections with earlier ritual. The only relevant information available at present from LBCs comes from the relative size, and form of surviving barrows in the line, with the assumption unwarranted that the order ran from larger to smaller. The axis of such a tapering row might indeed have formed an effective line for direction of ritual, especially if enacted from a higher barrow at one end, viewing along the rest of the row, perhaps from the top. The taper at some LBCs might have fulfilled a similar function to that amongst many long barrows, in emphasising a particular direction. Comparing the clarity of views along different directions within the axis is unlikely to contribute much towards a decision, given that the object of interest, such as the elevated solar transit, might well have been beyond any constraints imposed by the horizon. Sequences within a clear chronological framework are absent, and even for a more completely investigated cemetery, like Snail Down, (Wilts.), the picture remains very far from clear (e-FIG RB-118; Thomas 2005).

-lateral outward views:

The outward lateral view, from a position beside, or on the row at LBCs, might have been as important for directing ritual as the view along it. Again, it is difficult to suggest evidence that might be used to distinguish which of the two lateral directions might have been important. Selection of the most open aspect, with the 'best' view, would be subject to the same qualifications mentioned for axial views above.

For an E'-W'ly axis, a case could perhaps be made for the S'ly view being of particular potential, if sun-ward rituals were operating. However, an equivalent, and equally unsupportable case could be made for a view towards the N, with its connotations of subterranean darkness, and the obvious link here with funerary ritual. A S'ly pointing interest has also been seen independently, and repeatedly, for other types of monument in this general survey, and has been interpreted as an agrarian-economic interest in the solar transit around the permanent zone (e-FIG CO-01).

Although LBCs could have been sited to face areas of significant settlement, and other monuments, this would be most unlikely to produce the consistency of axis seen for strongly linear cemeteries, as listed in TABLE RB-02. The question of round barrow distribution in the Stonehenge area, its suggested ring-structure, and viewing preferences is discussed elsewhere (see Table of Contents: 03h/2h).

-views toward the site

LBCs often seem placed as if to form a more impressive sight when viewed laterally, on the approach, or in passing. For instance, LBCs along the South Dorset ridgeway are particularly conspicuous (e-FIG RB-174 and 174a), but in general, many lines are more subdued, being placed on far lower relief, and spaced over considerable distances.

Conclusions

Considering these options together, and in the absence of much needed hard data, it seems plausible to suggest the following as a working model, necessarily bland, in which multiple factors interacted to provide a loosely applied preference. Sites were chosen for LBCs that displayed them to advantage and, conforming with existing topography, allowed them to provide aspects, and axes suitable for expression of ritual. This would be inclusive in accounting for siting, aspect, and would cover all types of line, from the impressive and compact row, to arcs of barrows extended over the wider landscape.

Larger round barrows

Most round barrows are of relatively modest size, typically from 10-20m in diameter, and with surviving heights correspondingly up to about 2m. However, there are instances of far larger barrows, with diameters above 30m, with some exceptional monuments considerably in excess of this, as for instance, in the extreme case, Silbury Hill SU 1068 (Wilts.). Where excavated, several of these barrows show clear signs of aggrandisement, by specific enlargement of the mound. Although the presence of human remains within them has been established, in several cases, the size of the mound suggests other functions, less closely related to practical needs for burial. Although a few of these barrows occur in association with linear barrow cemeteries, the remainder appear in isolation, not attracting growth of a cemetery cluster, linear, or otherwise. A short line does however extend from the large round barrow at Silk Hill, Wilts. (e-FIG RB-117). This suggests that linearity is a property restricted to more typical barrow sites, involved more closely in burial, from routine to elite, and its ritual.

Larger mounds with platformed tops could have served to provide elevated areas for enactment of ritual, made with reference to the surrounding landscape, and its monuments. If such a site was located within a linear row of barrows, the line itself could have provided a significant axial reference. Cases where larger round barrows occur close to henge enclosures, perhaps a significant association, are noted in TABLE HE-04. A formal line of ascent to a platformed summit has been proposed at Silbury Hill (Wilts.) (see Table of Contents: 03f/2b, and 2ei).

Larger barrows of this type can be listed as follows (TABLE RB-17). However, widespread damage to barrow monuments, and lack of significant survey in many cases, means that sites marginal to inclusion exist, here generally omitted, but with a few candidates included:

TABLE RB-17 Larger round barrows: a sample of sites over 30m in diameter of mound

Barrow	NGR	type	diam	ht	pt	assoc	exc	e-FIG RB-	phot RB-	note
SA: Avebury										
Marlborough College	SU 1835 6865	?	83	18	?	none		260		?=motte
Silbury Hill 3	SU 1002 6853	db	137	35	yes	none	yes	261		3; agg
SA: Salisbury Plain										
Enford	SU 1296 5170	?				none		262		
Everleigh	SU 1842 5602	bell				barrs		RB-91		
Hatfield Barrow	SU 0918 5820	?db	70	7		henge		HE-03		4
Silk Hill	SU 1929 4672	db	41	2	?	barrs		RB-117		
possibly smaller:										
?North Tidworth	SU 2070 4875	?				none		263		
SA: Dorset Cursus										
Knowlton	SY 0252 1028	db	66	6	?	henges		HE-09		
SA: South Dorset ridgeway										
Bronkham Hill sec4	SY 6267 8685	b				lbc		RB-179		
5	SY 6378 8687	b				lbc		RB-179		
?3	SY 6240 8712	b				lbc		RB-179		
Conquer Barrow	SY 7079 8990	db	34	4	7	henge		HE-04		1
Clandon area								264	05	
Clandon E	SY 6668 8928	b				barrs		265		
Clandon W	SY 6553 8900	b					yes	266		2;agg; hr
plus large mound	SY 6572 8895	?	?	?						
SA: Mendip										
Round Hill	ST 6900 5607	?				none		268		
Stock Hill	ST 5591 5008	?				none		270		?disc
Ston Easton	ST 6220 5428	?b				none		271		
Stone Barrow	ST 5112 5490	?b				none		272		
Stow Barrow	ST 5206 5354	b	37	4	?	none		273		
possibly smaller:										
Radstock	ST 6890 5435	?				none		267		
Rowberrow	ST 4492 5836	?				none		269		
Westbury Beacon	ST 5005 5076	?				none		274		
Other areas										
North Yorkshire:										
Duggleby Howe	SE 8804 6688	b	36	6	?yes	rd	yes	HE-06		Neo-eBA; agg; hr

Note: further details of dimensions have been added only for the largest, and most definite sites, other eroded candidates, of lower surviving diameter, but around the 30m mark, often cited as large barrows, can be gauged by reference to the e-FIGURES supplied;

Key: **SA**: study area; **NGR** National Grid Reference; **type** (of barrow) **b** bowl, **db** ditched bowl; **diam**(eter in metres); **ht** height in metres; **pt** platformed top to mound, with metric diameter; **assoc**(iated monuments): **lbc** linear round barrow cemetery, **barrs** scattered barrows in the immediate area, **rd** ring-ditch; **exc**(avated significantly); **note**: **Neo**(lithic), **eBA** earlier Bronze Age, **agg** serial aggrandisement of mound, **hr** human remains present; numbers refer to notes at the end of the table;

Notes:

1 see Table of Contents: 03f/2e(iv);

2 Needham and Woodward 2008; Cheetham and Gale 2010;
3 see Table of Contents: 03f/2e(i);
4 see Table of Contents: 03f/2e(ii).

Alignment of linear round barrow cemeteries: the trend shown by combined data (e-FIG 275)

Data on axial alignment for all linear round barrow cemeteries in the seven study areas (TABLE RB-03) were combined, and plotted as a histogram at 10° intervals (e-FIG RB-275). Plotting alignments for each of the study areas separately produced very similar results, but data were combined over the entire area to reduce any bias from consistent topography within the sample area. The basic distribution resisted all attempts to change it by subtraction of particular data sets.

The distribution shows a significant increase in frequency for axes between about 220 and 320°G, with a peak around 270-290°G, slightly skewed to the N of W. Although both directions within the axis are plotted in the figure, only the W'ly direction is quoted here, for convenience, the other direction is implicit. The S'ly-facing, lateral aspect of the axis has been obtained, by subtracting 90° from each of these values:

axis	**azimuth (°G)**		
	limit	**peak**	**limit**
W'ly-pointing	220	270-290	320
S'ly-facing	130	180-200	230

Location of round barrow cemeteries on, and around the axes of linear monuments

Round barrows are relevant to the analysis of structural orientation in two main ways: their occasional alignment as linear cemeteries, as discussed above, and their distribution in relation to existing monumental axes, as outlined below, where they could be displaying orientation through reuse of an existing axis.

There are cases where round barrows cluster around, or lie near, the terminal areas of linear monuments, particularly their S'n-most zones (e-FIG RB-282). Numbers of such barrows vary, from a few, to larger groups, from compact, to more diffuse spreads, and from adjacent, to more distant location. Since barrows usually lie at other points around such monuments, any particular concentration noted is usually a relative increase. Such axial placement might be more deliberate than simply being routine use of an available area, acting more to bring particular funerary areas into the line of view along the axis of the monument. It might also of acted to allow round barrows to assume some of the axial power of the nearby monument.

Certainly, in the case of many stone rows, integral inclusion of round cairns, at one, or both terminals, does occur (see Table of Contents: 03d/ 8d). There is also a clear example at the pit alignment near Thornborough S'n henge SE 2878 (e-FIG PA-01). Such cairn-terminals are also found amongst augmented barrows, but less commonly (see Table of Contents: 03b/3).

This tradition of bringing funerary areas onto important axes is clearly seen for major established monuments, with selective axial placement of later Neolithic, or Bronze Age round barrows. Obviously larger monuments, with extended axes, such as the cursus, or stone row, would provide a more suitable focus for such peripheral development, but this might also have extended to long barrows.

-distribution around longer monumental axes

The following sites appear to influence the growth of later barrow cemeteries (TABLE RB-18):

TABLE RB-18 Possible siting of cairns and round barrows on the axes of existing linear monuments

site		type	NGR	loc	e-FIG	note
cairns ?integral to the monument						
Drizzlecombe	Dartmoor	MSR	SX 5987	f	SR-08	
Down Tor	Dartmoor	SR	SX 5869	b	SR-13	
Upper Dounreay	Caithness	MSR	ND 0166	f	SR-20	
Garrwhin	Caithness	MSR	ND 3141	f	SR-21	
Kinbrace	Sutherland	MSR	ND 8232	f	SR-22	
Learable Hill	Sutherland	MSR	NC 8923	f	SR-23	
Raeburnfoot	Dumf Gall	AB	NY 2599	b	AB-19	
Long Low	Staff	AB	SK 1253	b	AB-13	
later round barrows added on the axis of a parent monument						e-FIG RB-282
Dorset Cursus	Dorset	curs	SU 0115	SW sp d	CU-03, 05, 06	1
Fornham AS	Suffolk	curs	TL 8367	SE cl n	CU-09	
Scorton	N Yorks	curs	NZ 2300	SE cl n	CU-15	
Rudston	N Yorks	curs	TA 0609	S sp d	CU-13	
Piles Hill-BH	Dartmoor	SR	SX 65	S sp d	SR-06	
Stonehenge	Wilts	henge	SU 1242	SW sp n	HE-31	

Key:
site: AS All Saints, **BH** Butterdon Hill, **Dumf**(ries and) **Gall**(oway), **Staff**(rodshire); **type** (of monument): **SR** stone row, **MSR** multiple stone row, **curs**(us);
loc(ation of cairns or barrows): **f** at the focal end of divergent rows, **b** at both ends of a row, **sp**(read of barrows), **cl**(uster of barrows), **d**(istant from monument), **n**(ear monument).

Note: 1: long barrows also cluster near both terminals of the cursus.

The **Dorset Cursus** supports two broad groupings of round barrow cemeteries, one each around, and beyond, the SW'n ends of its two component parts, the Gussage, and Pentridge sectors.

The **Fornham All Saints** cursus has a small cluster of ring-ditches immediately at its SE'n end.

The **Scorton** cursus has a similar cluster at its SE'n end.

Each component cursus of the **Rudston** complex has round barrows concentrated around, and beyond its terminals, mainly those in the S'n to W'n quadrant.

The stone row at **Piles Hill-Butterdon Hill** has a thin scatter of round cairns beyond its S'n terminal.

At **Stonehenge** a generalised spread of round barrows, and ring-ditches, lies just beyond the monument, on the SW'n side, most lying just to the N of its main axis, as provided by the line of the Avenue.

-distribution around shorter monumental axes

In order to quantify the spatial relationship between existing long barrows and later round barrows, four regional samples were examined: from the Cotswolds, the Marlborough Downs, Salisbury Plan, and South Dorset, where many such sites occur in close association. Long barrows were graded according to the number of known round barrows or ring-ditches within 0.5km, and whether these showed the possibility of any closer relationship with the axis of the monument (TABLE RB-19):

TABLE RB-19 ASSOCIATION BETWEEN LONG AND ROUND BARROWS IN THREE SAMPLE AREAS

		groups %	of	#
area	**#**	**A**	**B**	**C**
Cotswolds	81	68	23	**9**
Avebury area	27	41	56	**3**
Salisbury Plain	40	55	35	**10**
South Dorset	20	15	75	**10**

Note: defined radius **DR** around the long barrow set at 0.5km;

Key: # number of long barrows in the sample; **groups: A** no known round barrows within DR, **B** round barrows within DR, usually up to about 10, but showing no obvious relationship with the long barrow, **C** round barrows within DR appear to respect the long barrow.

This analysis clearly shows that in general, round barrows tend to avoid long barrows, and to develop in new funerary zones (groups A + B), and that where there is proximity, the former usually occur as an apparently unrelated scatter (group B). However, for a small residue of cases, around 10% for three of the four samples, some more defined spatial relationship at least seems possible (group C).

The range of spatial relationships between one, or more round barrows, and the axis of a long barrow can be considered as follows:

placement of round barrows:
supplementary:
..**lateral**: accretion along the immediate margins of the axis, with varying degrees of sympathetic alignment;
..**terminal**: location at the immediate front or rear of the axis;
..**axial**: extending the line of the axis well to the front, or rear;
..synthetic: short lines of closely spaced round barrows in the vicinity of a long barrow, similar in length and direction of its axis might indicate deliberate mimicry of the earlier structure;
..**neutral**: reasonable proximity, but no obvious relationship with the long barrow.

Particular complexes of round, and long barrows from the samples quoted in TABLE RB-19 (group C just above) have been analysed according to this system (e-FIG RB-283). In addition to the low relative frequency of group C, the examples within it show only very weak conformity between round barrows and existing axes, with patterns not suggestive of strongly intentional axial location.

Most instances involve location of single barrows near a terminal of the long barrow, with the front end often favoured. Extension along the axis is rare and weak, with Came Hill SY 7085 providing the best example. The generalised linear spread of round barrows in the foreground of the long barrow at Winterbourne cross-roads SU 1041 may well only reflect common use of the ridge-line. There are cases where a single round barrow lies at some distance from a long barrow, but on its axis, as at Northleach I SP 1215, and it is difficult to assess the possible significance of this. Augmented long barrows (see Table of Contents: 03b), by virtue of their longer axes, do not seem either consistently to attract lateral barrows, or to promote axial strings of round barrows, although Came Hill SY 7085 does both.

There is certainly no suggestion here for transference of orientation behaviour from long barrows to adjacent round barrows, and hence perhaps on to those developing as linear cemeteries in separate areas, although both groups have been shown to respect a similar direction (see Table of Contents: 03h/ 1i: TABLE RB-02).

e-FIGURES: combined listings and supporting information

Study areas: plans of barrow cemeteries
-The location of study areas within S'n England is shown as follows:

e-FIG
RB-
01 Study areas: location within S'n England.
The study areas form a continuous transect over S'n England, with two separate areas added.

-Basic plans of cemeteries, relating structural, and other layered information to current landscape, are listed under each of the seven Study Areas as follows:

A general layered map for each study area is also included at the head of each set of cemetery plans, covering distributions of long, and round barrows, and other relevant types of monument from the Neolithic-Bronze Age, within each area:

study area	TABLE RB-	area map e-FIG RB-	sites in e-FIGS RB-
Upper Thames	06	**02**	**09-44**
Avebury	07	**03**	**45-73**
Salisbury Plain	08	**04**	**74-129**
Dorset Cursus	11	**05**	**130-173**
S Dorset ridgeway	12	**06**	**174-208**
Mendip	13	**07**	**209-227**
South Downs	14	**08**	**228-241**

-More detailed analysis of structure for selected cemeteries is provided diagrammatically for each study area as follows:

cemetery	NGR	e-FIG RB-
Upper Thames:		
Barrow Hills	SU 5198	**242**
Seven Barrows	SU 3282	**252**
Salisbury Plain:		
Cow Down	SU 2251	**243**
Stonehenge Cursus W	SU 1142	**257**
Durrington Down E	SU 1144	**245**
Lake Group	SU 1040	**247**
Normanton Down	SU 1141	**248-248a**
Silk Hill	SU 1846	**253**
Snail Down	SU 2152	**255**
Wilsford	SU 1139	**258**
Winterbourne X-roads	SU 1040	**259**
South Downs:		
Devil's Jumps	SU 8217	**244**
Heyshott Down	SU 9016	**246**
South Dorset ridgeway:		
Poor Lot	SY 5890	**249**
Mendip:		
Ashen Hill	ST 5352	**250**
Nine Barrows	ST 5351	**251**
Small Down Knoll	ST 6640	**254**

Plans of larger round barrows
References to e-FIGS showing the basic plan for each of the named sites are listed in TABLE RB-17: **e-FIGS 260-274.**

Other diagrams
e-FIG:
RB-

275 Linear round barrow cemeteries from the seven study areas: orientation: histogram for the total sample
A spread peak shows the general tendency for orientation E'-W'ward.

276 S'n Britain: ridge systems
The general pattern of relief shows no bias that could account for the preferential E'-W'ly trend seen for alignment of linear round barrow cemeteries.

277 Linearity at round barrow cemeteries: basic structures, as outlined in TABLE RB-15
An outline classification is proposed for component structures within linear cemeteries that contribute to formation of their axes.

278 Distribution of round barrows around major monuments: Avebury, Stonehenge, and the Dorset Cursus
Patterns of round barrows around these locations show clear attraction to the central monument and, in the case of the highly linear Dorset Cursus, apparent reinforcement of its axis.

279 Stonehenge area: alternative patterns of distribution for round barrow cemeteries
Three alternative patterns are considered, as based on the Stonehenge Greater Cursus, Stonehenge itself, and the North Kite enclosure, as part of the discussion of possible influences on encirclement, and linearity of round barrow cemeteries in this key area.

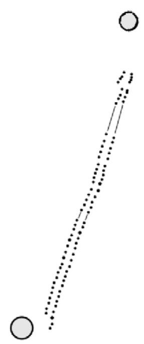
280 and 281 Stonehenge area: round barrows: variation in density of distribution with azimuth, and distance from the monument
These data supplement arguments against the existence of a ring-like disposition of round barrow cemeteries around Stonehenge.

282 Barrow cemeteries located on, and around the axes of longer linear monuments
Examples of cairns integral with stone rows, and of round barrow cemeteries that developed around the axes of certain cursus monuments, stone rows, plus the singular case at Stonehenge.

283 Barrow cemeteries located on, and around the axes of shorter linear monuments
Examples of round barrows that appear more closely associated with the axes of certain long barrows.

Section 03i:
Orientation of pit alignments in Britain

Section identifier: PA-
SEE INITIAL SECTION:
Access to digital images



Thornborough (N. Yorks.);

Summary:
Properties of certain pit alignments that are Neolithic and earlier Bronze Age in date may indicate monuments similar in function to certain broadly contemporary stone rows. Known examples of such earlier pit-based sites are too few to generalise about their alignment, occurring only sporadically amongst the largely undated, but often Iron Age to Roman assemblage.

The following topics are discussed:

-**general properties** of such pit alignments, including distribution, association, form, and dating;

-**supplementary information** on known sites of Neolithic to earlier Bronze Age date.

Introduction

Pit alignments are a distinct type of linear structure, with the capacity for deliberate alignment based on practical, or at some sites, ritual considerations. The National Monument Record for England lists 623 locations for pit alignments. Most of the excavated examples from Britain have been dated to the Iron Age, and Roman period, and seem best interpreted in terms of demarcation and division of land or, if double, perhaps as track-ways, and hence to be associated with expansion of settlement, and agriculture during this period. Many others remain unexcavated, and being of similar type, and associated with settled areas of the later prehistoric period, may well also form part of contemporary land tenure.

However, amongst the general sample, there are others that have been directly dated to the Neolithic, and earlier Bronze Age, with at least one short example of Mesolithic date, as at Warren Field (Aberdeen). Some of these earlier examples might have formed functional boundaries, but certain others have the appearance of distinct monuments of different purpose. In addition to these earlier sites, there are others which, from their proximity to barrows, may also belong here.

The form of such pit alignments, especially if these are post-bearing, invites comparison with other similarly axial monuments, such as stone rows, perhaps related in concept, but clearly differing in materials. Stone rows occur mainly in areas where hard rock is readily available, and pit alignments are found in those at some distance from such sources. This may suggest the same tradition, with its expression subject to the constraints imposed by substrate.

Distribution

Pit alignments occur mainly in valley areas, such as the Thames, those of the English Midlands, and the North, often lying on gravel spreads, but there are also examples from the chalk, and limestone uplands (Crutchley 2000, 20; Vatcher and Vatcher 1973).

Associations

Many show clear spatial association with settlement sites of Iron Age, and Roman date, and occur amongst palimpsests of crop-marks that include related enclosures and trackways (Benson and Miles 1974). There is little to suggest any clear link with ritual monuments, or any associated function as pointers, or as avenues.

Form

Alignments are mainly single, with a minority double, and very rarely in higher multiples of line. Their course varies, from straight to sinuous, or angled, and different alignments can appear to intersect.

The shape of component pits varies, from oval to round, size from small to larger, and spacing from regular to irregular. Some pits have been shown to contain post features, but other larger examples might have remained open, to form an interrupted ditch, and there are cases where a line of pits runs on as a continuous ditch. Sites where lines shadow each other may indicate sequential development, and maintenance of a specific longer-term boundary.

In addition to the simpler alignment of pits, there are more complex linear sites, of different structure, such as the type of embanked pit alignment that appears to be a regional variant, found on the moors of North Yorkshire (Lofthouse 1993).

Construction

Larger elongate pits are best seen as a means of rapidly establishing a visually, if not physically, effective boundary, with minimal effort, and such structures would have been practical from the earliest phases of land management. Their ineffectiveness as a physical boundary could imply that some more ritualised power, or measure of social agreement, backed them.

Dating

Finds are usually very sparse, and dating by artefact, or radiocarbon, may be problematic in the case of insecure stratigraphy from truncated features.

Discussion

The early group of pit alignments is not sufficiently well known to make any general statements about form, and possible function, let alone close comparisons with any other type of analogous monument, such as the stone row. However, such aligned post-pit structures could indicate the type of site in which discrete funerary structures were linked by an extended linear feature, as seen amongst stone rows (see Table of Contents: 03d), or augmented barrow monuments (see Table of Contents: 03b).

Using a better-known example, the double alignment at Thornborough S, as a standard (supplementary information; e-FIG PA-01), certain general features emerge which may be relevant to wider discussion. This site does not appear to constitute an obvious boundary feature, but its double, well-spaced sides suggest more potential as an avenue. The N'n terminal area seems blocked, rather than open, and does not provide a ready interpretation for access, but this lack of an obvious terminal entrance is no more than that found at stone rows, or cursus sites (see Table of Contents: 03d and 03c respectively). The double row here is longer, and wider, than most double stone rows, with intervals between uprights also greater.

The Thornborough site does, however, share the same general, underlying S'-SW'ly downslope, found amongst stone rows on Dartmoor (e-FIG SR-04), and there appears to be a round barrow close to each end, a feature also seen in the latter area (TABLE SR-06). Although well separated geographically, in scale, and in details of terminal structure, the complex at barrow 75, in Toterfuit-Halve Mijl cemetery (Brabant) might further suggest widespread existence of a class of S'ly alignments linked to barrows, and to other terminal structures (e-FIG PA-01). Here, a timber avenue, 35m long, runs towards the SSE, from a concentric timber circle (Gibson 2005, fig. 73/p. 96).

In contrast, a fairly consistent NW'-SE'ly alignment is found amongst the embanked pit alignments of the North Yorkshire Moors, but this is an atypical regional form. These embanked structures also show some degree of association with barrows which, on occasion, appear to overlap their margin. Whether there was any interest amongst pit alignments for alignment towards the S'n arc, or a separated preference for the SE, and SW, as seen, for instance, amongst cursus sites (e-FIG CU-19), would await analysis of a far larger sample, and a closer understanding of date, and association for this general group.

Supplementary information: pit alignments of Neolithic to earlier Bronze Age date

Clearly dated examples

Thornborough S; N Yorkshire; SE 2878 7905 to SE 2878 7905; NMR SE27NE 20; e-FIGS HE-08 and PA-01;
double pit alignment; information: http://thornborough.ncl.ac.uk

A double pit alignment runs from a clear NNE'n terminal structure, lying near the axial line between Thornborough Central and S'n henges, towards the SSW (019-199ºG) for 350m, before its onward course fades.

Excavation established a double line of 88 pits, at 5-7m intervals, forming two rows about 10-11m apart. The lines were continuous, except for a gap of about 30m in the SE'n line, where it passed closer to the N'n entrance of the S'n henge.

Plough-eroded pits in the lines were generally round in plan, and U-, or V-shaped, in profile, 0.7-3.6m across, and 0.25-1.5m deep, and produced evidence for stone packing and post pipes, suggesting that they once held timber uprights, later deliberately extracted.

The narrower NNE'n end of the alignment contains what may be a remodelled sector, and a terminal feature, comprising two parallel lines of nine slot-trenches, each 3m long, perhaps intended for contiguous posts.

The few associated finds included Neolithic to Bronze Age flint-work, and fragments of collared urn, and Deverel-Rimbury type vessels. Pottery and radiocarbon dates indicate a later Neolithic to earlier Bronze Age date. A radiocarbon date of 3385 ± 38 BP (OxA-11009, 1750-1590 cal. BC) was obtained from a small charcoal fragment in the post-pipe of one pit.

The ring-ditch of a round barrow lies near the N'n, and at the S'n end of the row, but not on its axis, and without any connecting features. Early excavation at one of these barrows produced a food vessel, and an inhumation, possibly primary.

Dishforth; West Yorkshire; SE 4722 2435; NMR SE42SE 132;
double pit alignment;

Part of a double pit alignment, aligned NNE'-SSW'ward, consisting of two parallel rows, 4.4m apart, containing about five pits, produced a radiocarbon date of 3980 ± 50 BP (cal. BC: 1 sigma: 2090-1980; 2 sigma 2140-1930)(OxA-5577).

Boroughbridge; North Yorkshire; SE 390 665 area;
two double pit alignments;

Two double alignments, about 200m to the W of the stone row at the Devil's Arrows, produced charcoal from post pipes dated to the later Neolithic:

4234 ± 80 BP (cal. BC: 1 sigma: 2370-2200; 2 sigma 2450-2120) (RCD-1596), and
4314 ± 87 BP (cal. BC: 1 sigma: 2460-2270; 2 sigma 2550-2190) (RCD-1597).

Ewart site 1; Northumberland; NT 9534 3209 to NT 9610 3162; NMR NT93SE 27;
single pit alignment;

Crop-marks of an irregular line of closely spaced pits run along the crest of a slight elevation, for about 1.1km, mainly E'-W'ward, but with a turn on its line towards the S. Two gaps are visible towards its E'n end. Eight pits were excavated, and these might have held posts. Sparse finds included later Neolithic pottery, and flint-work (Miket 1981).

Milfield; Northumberland; NT 9335 3507; NMR NT93NW 34
double pit alignment;

A double pit alignment runs E'-W'ward, terminating just to the N of the Milfield North hengiform monument (e-FIG HE-19). Excavation of the E'n-most pair of pits suggested that they once held substantial posts. Pottery, and radiocarbon dates indicate construction during the later Neolithic (Harding 1981, 115-119).

Undated examples with possible links to adjacent monuments

There are cases where visible sectors of double pit alignment appear in close relationship with ring ditches, suggesting the possibility of earlier dating as, for instance, at the following sample of locations:

site		**NGR**	**size (m)**	**axis**	**NMR**
Ryhall	Leic	TF 0370 1050	2 short	SW'-NE'ly	TF01SW 16
Harlaxton	Linc	SK 8929 3408	240x?	?	SK83SE 58
Tetford	Linc	TF 3210 7426	16x?	?	TF37SW 109
Great Witchingham	Norf	TG 096 187	>80	SW'ly from rd	TG01NE 57

Key: Leic(estershire); **Linc**(olnshire); **Norf**(olk); **rd** ring ditch.

Segmented embanked pit alignments

A series of embanked pit alignments occurs on the North Yorkshire Moors, form a regional variant, and consist of a double-banked linear earthwork, flanked on the inside by two lines of oval pits. Shorter examples are known, at around 20m long, but some are far longer, with examples up to 540m, and 710m as projected. Despite a fair degree of separation, all have a very similar NW'-SE'ly alignment, are closely associated with round barrows of Bronze Age type, and in two cases are partially overlain by these (Lofthouse 1993).

Ugthorpe Moor; NZ 7814 0990; NMR NZ70NE 9;

Two pairs of sub-oval pits, 3-4m in diameter, and up to 0.6m deep, lie symmetrically between parallel banks, 20m long, 3m wide, up to 0.8m high, and 16m apart, all running NW'-SE'ward; three Bronze Age barrows nearby may be associated;

the following alignments are similar in form and association to the above site:

Ugthorpe Moor; NZ 7797 1007; NMR NZ71SE 24;

Danby Rigg; NZ 7066 0617; NMR NZ70NW 30;

Middle Rigg; NZ 742 107; NMR NZ71SW 6.

Longer sites of similar form:

Ebberston Low Moor; SE 90585 89920 to SE 90852 89948; NMR SE98NW 5**;**
length 230m; overlain by a probable Bronze Age barrow;

Ebberston Low Moor; SE 90300 89318 to SE 90557 89845; NMR: SE98NW 10;
length 540m; appears to be the first phase for a series of other embanked pit alignments, including SE98NW 5 and 112, which pre-date a probable Bronze Age barrow;

Ebberston Low Moor; SE 90100 89460 to SE 90253 89725; NMR: SE98NW 112;
known length 310m, with a further 400m projected;

Mesolithic example

Warren Field pit alignment; Banchory, Aberdeenshire; NO 7393 9670; (e-FIG PA-02)

A complex of crop-marks includes an early Neolithic rectangular timber building, and a short pit alignment, dated to the Mesolithic. This latter consists of 16 post, or pit-features, from stake-sized, to larger post-type pits, variable in size up to about 3m across, ranged in a loose line 52m long, running NE'-SW'ward. This general line contains three conforming sectors, shorter and straighter. A fourth, very short line of stake holes, of unknown association, runs across the main line. Larger post-holes form the central zone of the line, with sizes decreasing towards the terminals. From the NE, the in-line sectors are oriented 229° (5-6 holes), 224° (3 holes), and 222° (3 holes), with a mean line at 225°: (only the SW'ly direction of the axis is noted here, for brevity).

This appears to be a multiphase structure containing at least three component lengths, re-cutting of holes suggesting a prolonged lifespan. The structure remains isolated from its more general setting, and is of unknown purpose.

However, it has been suggested, most imaginatively indeed, that this *integrated* structure acted for calendric purposes, to help reset the lunar cycle to the solar, as it drifted out of synch with the solar, by correcting mismatch, a problem of negligible importance to hunter-gatherers, and more a construct of modern conceptions of time (Gaffney *et al.* 2013).

e-FIGURES: combined listings and supporting information

e-FIG
PA-

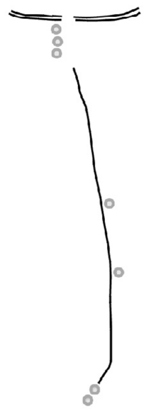
01 Pit alignment near Thornborough Central henge, North Yorkshire

02 Pit alignment at Warren Field, Aberdeenshire

Section 03j:
Hyper-monuments

Section identifier: HY-

SEE INITIAL SECTION:
Access to digital images



stone row: Piles Hill-Butterdon, Dartmoor

Summary:
Specific monuments, selected from the various groups considered in this general analysis, are discussed separately because of their extreme length.

Introduction

A group of monuments, mainly cursus sites, and stone rows, with lengths exceeding 3km, are defined here as hyper-monuments, their properties and alignment given separate attention. Any lower limit of length for this category would also be arbitrary, but 3km provides a realistic measure, with other monuments just below this also worthy of consideration (TABLE HY-01; e-FIG HY-01):

TABLE HY-01 Hyper-monuments: a range of candidates, ranked by length

complex	**NGR**	**type**	**L**	**az**	**ax**	**fm**	**st**	**e-FIG-**
hyper-monuments: length: >3km								
Dorset Cursus	SU 0014	cursus	9900	240	ps	L	yes	CU-06
Rudston D	TA 0969	cursus	3900	185	m			CU-12 to 14
Brittany PM-M	Carnac	stone rows	3690	245	ps		yes	SA_br-02 to 07
Stanwell	TQ 0574	cursus	>3630	164				CU-16
GH-SM	SX 63	stone row	3400	181	m	R		SR-09 and 10
other sites: below the 3km threshold:								
Stonehenge greater	SU 1243	cursus	2750	263	pe	L		CU-17
Cleaven Dyke	NO 1640	aug barrow	>2350	119		L	yes	AB-06
PH-Butt	SX 65	stone row	2100	178	m	R		SR-06 and 07
Raeburnfoot	NY 2599	aug barr	2000	184	m	?R		AB-19 and 19a

Key: complex: PM-M Petit Menec-Menec; **GH-SM** Green Hill-Stall Moor; **PH-Butt** Piles Hill-Butterdon Hill;
type: aug(mented); **L**(ength in metres, approximate); **az**(imuth in °G between terminal areas);
fm funerary monument(s) located at, or near the terminal(s); **ax**(is): **ps** peri-solstitial, winter setting;
m(eridional); **pe** peri-equinoctial; **st** clear evidence for stages of construction;

The sites

The Dorset Cursus, at almost 10km, is more than twice as long as its nearest rival Rudston D, and four times the length of Stanwell, and Stonehenge Greater, all cursus monuments. Cleaven Dyke is a hybrid monument, with features of both cursus and augmented barrow.

Two single stone rows stand out, Green Hill-Stall Moor (GH-SM), and Piles Hill-Butterdon Hill (PH-B), both on Dartmoor. These are single-line monuments, whereas the complex of stone rows at Petit Menec-Menec consists of five individual sites, each of multiple lines arranged linearly.

Staged construction

The sheer scale of these monuments would require that all were of staged construction. This is evident in some cases from obvious addition of major elements, such as the two component segments at the Dorset Cursus, and sectors amongst the individual row-sites at Petit Menec-Menec (PM-M), with further stages to be expected within each. Discontinuities of line, and changes in direction, as are well seen at both cursus-, and row-sites, also suggest accumulation of structural elements over time, as a continuing project. This process of progressive extension, and elaboration, of the axis strongly suggests its prime importance as a structure, and as an on-going activity.

Associated funerary monuments

In most cases barrows, long, or round, are either integral with the line, or lie close to it, linking burial sites into the axis as a component of ritual. For instance, at the Dorset Cursus, two long barrows lie within the monument, one was incorporated into the perimeter, the other across the interior, with others adjacent to extreme terminals. At GH-SM, a round cairn lies at the head of the row, and at PH-B at the S'n terminal.

The axis

The axis at the majority of these sites shows a preference for the S'n quadrant, with peri-solstitial, and meridional lines well represented (TABLE HY-01, column 5; e-FIG HY-01). The general axis has often been further reinforced by repetition of individual row-sites along its length.

Conclusions

Given their emphasis of the S'ly axial direction, it could be argued that these sites show extreme expression of solar propitiation, directed towards the permanent arc of the transit, reinforced by monumental elaboration, here as elongation, and repetition, with one case of multiple alignment at the PM-M complex.

The barrow complex along the South Dorset ridge: status as a possible hyper-monument

Those hyper-monuments, as listed above in TABLE HY-01, and shown in e-FIG HY-01, are characterised by a linear structure of repeating units, covering a considerable distance, in most cases linking specific structures of funerary, or other congregational use, all with evidence for staged construction. The linear complex of barrows along the South Dorset ridge (SDR) (e-FIGS RB 06, 174, and 174a) meets all of these four criteria, and hence deserves at least consideration as a hyper-monument, albeit separately here, in view of sheer size, and composite nature (e-FIG HY-02).

Although there is a broad distribution of round barrows over the surrounding region, the SDR bears a well defined concentration along its main ridge, especially the SE'n two thirds, including the Bronkham Hill cemetery, and on its NE'n flank, particularly towards its N'n end, and the necropolis at Poor Lot. Potential terminal areas are defined by concentrations of long barrows, and augmented barrows on the ridge: five, of which three are of longer augmented type, in the Martins-Black Down area at the NW, and two, with one augmented, in the area of Came Hill at the SE.

The entire structure suggests a topographically well defined facility for burial, and relevant ritual, as provided by the main ridge, with its prominent skyline, additional use as a regional thoroughfare, and significant W'-NW'ly orientation, this latter common amongst barrows of the Neolithic and earlier Bronze Age. If this entire ridge functioned as an integral setting for burial, one with special properties, for instance by providing a significant alignment, then it could be considered as at least a super-cemetery, at most a hyper-monument.

e-FIGURES: combined listings and supporting information

e-FIG
HY-
01 Hyper-monuments: cursus sites, stone rows, and augmented barrows of extreme length

02 The complex of barrows along the South Dorset ridge: possible status as a hyper-monument

Section 03k:
Standing stones and menhirs: monuments providing a vertical axis

Section identifier: ME-
SEE INITIAL SECTION:
Access to digital images

Merrivale, Devon SX 5555:
monolith and shadow;

Summary:
This section considers the potential of standing stones in Britain, Ireland, and Brittany as *vertical* axial structures capable of providing a further connection between monument and solar transit, through the medium of shadow-casting, a link more continuous, and dynamic than that possible for an entirely horizontal axis, such as that along a stone row.

The general distribution of more imposing stones is considered for Britain, with more detailed reference made to the menhirs of Brittany, where basic form, alignment, and associated symbolism are considered in relation to economic concerns, as expressed in the seasonal-solar model. The contrast in alignment between funerary structures in Brittany, with their typical W'ly emphasis, and the S'ly trend seen amongst its stone rows and menhirs, a correlation found widely elsewhere, is noted.

Introduction

Whereas stone rows provide an axis in the horizontal plane, only capable of intersecting the daily solar transit for a limited period, standing stones provide a structural axis in the vertical, one capable of more dynamic interaction with the transit, continuously creating a moving axial ray on the ground, by shadow-casting. Such diurnal, and perhaps nocturnal, effects are an inevitable consequence of erection, but might well have been purposeful, and an intended feature of such standing structures, allowing, either as an isolated structure, or as part of a complex, if not further dynamic engagement between monument and solar transit (see Table of Contents: 03a/20ii), then at least adding dramatic incidental effects of light and shade (e-FIG ME-13).

Definition of the terms relating to monoliths

In attempting a brief review of those monoliths that are at least capable of such an axial, shadow-casting function, some definition by appropriate height, and shape is required, since the terms 'standing stone', and 'menhir' tend to be applied loosely. For the purposes of this analysis a representative sample of monoliths from Brittany was used to provide a more defined grouping by height, establishing a mean value, and then dividing the range, on the basis of its standard deviation, into groups 0-7 (e-FIG ME-01), further applying this system also to the monoliths of Britain and Ireland.

type	monoliths >>															
	st sts				| menhirs >>											
height in m	1	-	3	-	**5**	-	7	-	9	-	11	-	13	-	15	- 17
height-group		0		1		2		3		4		5		6		7

Key: st sts standing stones; the mean value is shown in bold larger font;

The working list of monoliths from Brittany is given in TABLE ME-01, as are a selection of taller examples from Britain and Ireland:

TABLE ME-01 Monoliths: a working list of those from Brittany, Britain, and Ireland.

This table, containing an interim working list of monoliths, has been placed as a text file in the folder TABLES_filed, on account of its length, and the partial nature of some data.

Here, terms are used as follows:

monolith, all significantly vertical stones >1m high;

standing stones, those of groups 0 and 1, from 1 to 5m high;

menhirs, those of groups 2, and above, greater than 5m high, this value being the mean for Brittany;

Amongst menhirs,

..those of groups 4 and above, are designated as *elite menhirs*;

..in terms of shape, there are three categories: *slab*-, *columnar*-, and *steloid*-;

..only those stones are included that are basically columnar, not overly broad, and block-like, and at which shadow-casting would have been more marked, focused, and impressive, albeit perhaps fortuitously, one function amongst many.

Many of the examples are sufficiently tall and columnar to have cast a very clear shadow, whatever their other functions were, generating dramatic effects of light and shade, one example of which is given for Merrivale SX 5574 (e-FIG ME-13). Outliers to stone circles, Long Meg (Cumbria) (Burl 2000, plate 27/ p. 121), and Loch Buie (Mull) (Burl 2000, plate 41/ p. 196), provide other clear examples.

Date and function

The majority of such monoliths remain undated, either in absolute terms, or by association, only their general form, and any applied decoration, indicating a clear connection with other known megalithic sites of Neolithic to Bronze Age date.

Such monoliths, wherever their location, can of course date to any period, and could have served a variety of purposes, singular, or combined: from practical, such as marking boundaries; to social and funerary, indicating significant locations, as at Kerlescan, and Manio I long mounds; have served some other ritual, or calendric function; or, in combination, might have formed an axis for sighting towards some target, perceived as significant. Where many occur in a restricted area, as a distinct regional group (clusters: e-FIG ME-04), competitive territorial assertion by the communities involved might have contributed to their size, and frequency (e-FIG ME-04b). The fairly frequent steloid form of some menhirs (e-FIGS ME-06, 10 and 12), with their more flattened faces, and rounded tops, may be imitative, mimicing some particular item of ritual significance, with the axe often cited, and this is discussed further below.

In Brittany, relatively unshaped menhirs might have preceded those of more refined, and worked form. Radiocarbon dating suggests general erection 4500-4000 BC, as at the Grand Menhir, with other stratigraphy provided by fragments incorporated into chambered tombs constructed around 4200-3900 BC, as at Table des Marchands, Er

Grah, Mané Rutual, Gavrinis, Mané er Hoèk, Barnenez, and at Le Déhus (Guernsey) (general discussion: Scarre 2011, 74-79).

In many cases it is often difficult to distinguish between those monoliths that were erected for entirely practical purposes, such as demarkation, and those with a possible ritual emphasis. Those undiagnostic standing stones that are of a size beyond immediately functional limits, that lie in exposed areas, away from more recent settlement, but with areas of prehistoric activity adjacent, are more likely to be candidates for non-utilitarian interpretation. It should be noted that menhirs bearing an inscription, or Christian cross, might indicate modification of a prehistoric stone, rather than a later date for its erection.

The shape of stones, either carved or selected, could have a distinct bearing on interpretation:
Brittany: refined ?axe-like shapes for some menhirs; anthropomorphic statue-menhirs, as at Le Castel, Guernsey (Burl 2000, fig. 6.15/ p. 161);
England: opposing columnar and slab-like pairs in the West Kennet avenue at Avebury may indicate male and female forms (Burl 2000, plate 16/ p. 73).

Overtly phallic elements appear largely absent, but a pair of carved bosses near the base of the menhir at Kerloas (Brittany) may, it is thought, indicate testicles (Scarre 2011, 83).

Occurrence of monoliths within monuments, and as single structures

-within monuments

..Britain

Examples from Britain of taller standing stones incorporated as features into stone rows and circles are as follows, given in order of decreasing height:

Devil's Arrows; North Yorkshire; stone row; SE 390 665; e-FIG HE-28;
Three large monoliths, set in a fairly straight line, may represent an unfinished row: 5.5m, 6.4m, and 6.9m high, with spacing 61m and 113m, the central-S'n stone now removed;

Callanish; Lewis; Outer Hebrides; NB 213 330; NMR NB23SW 1; e-FIGS SC-01 to 03;
terminals to the N'n avenue: 2.4m, 3.5m high; central pillar in the central circle: 4.8m high;

Drizzlecombe; Devon; stone rows; SX 5920 6700; e-FIG-SR-08;
terminals to rows: 2.4m, 3.2m, and 4.3m;

Long Meg; Cumbria; outlier to a stone circle; NY 5711 3721; e-FIGS SC-05 and 06;
Large ovate stone ring with a single outlier, Long Meg, 3.7m high, at the SW;

Shovel Down; Devon; stone rows; SX 660 860; e-FIG SR-12;
The Longstone, 3.2m high, is located within the complex of stone rows;

Laughter Tor; Devon; stone row; SX 653 753;
terminal 2.6m high;

Avebury; Wilts; stone circles and avenues; a stone at the N'n entrance over 3m high (Burl 2000, plate 11/ p. 54); and the Obelisk a pillar 5.5m high (*ibid*, 321);

..Brittany

Certain of the monoliths forming alignments, especially those in the complex at Carnac, would qualify as near-menhirs (Le Ménec: 'Le Géant' at 4m high), but most are of more modest size, as for instance at Kerlescan, with stones at the NW'n end 1.5 to 2m high (Scarre 2011, fig. 5.18/ p. 127).

-as isolated stones

..Britain and Ireland

A great many standing stones, occurring in apparent isolation, as single features, or accompanied by additional minor stones, are known over areas of hard-rock substrate in upland Britain, where stone circles and rows also occur (TABLE ME-01; e-FIGS ME-02 and 03). The majority appear as simple columns, and slabs, belonging to groups 0 and 1, with group 2 weakly present, and with only a single, less accomplished instance of the steloid type, in group 3, at Rudston TA 0967 (e-FIG ME-12). The distribution of such taller stones is thin, and general, but with a localised concentration in Argyll.

..Brittany

By contrast, there is a far denser distribution of menhirs in Brittany, showing regional clustering (TABLE ME-01; e-FIG ME-04), where the steloid type is common (e-FIG ME-04), and elite examples occur (e-FIG ME-06)(general discussion: Scarre 2011, 68-102).

Menhirs in Brittany

Additional analysis of sites in Brittany is to be found in the section dealing with megalithic rows and enclosures (see Table of Contents: SA_br 04d).

Patterns of settlement and activity

In order to assess possible axial functions associated with menhirs in Brittany it is necessary to determine how they fit into the broader outline of settlement and activity in the peninsula, as established for the Neolithic and earlier Bronze Age (e-FIG ME-04).

To provide context, seven types of data were plotted, as a cumulative distribution, and are scored below as follows: '++' potentially robust, and representative; '+' less so:

data:
rock type: ++
igneous: two bands run W'-E'ward along the peninsula, either side of its central spine, more extensively at the S; fibrolite: more restricted to NW'n areas, and running W'-E'ward along the S'n coastal hinterland;

settlements: +
those that are known lie mainly along the S'n coastal zone;

chambered tombs: ++
three main groupings occur: denser along the S'n coastal area, the N'n coastal fringe, and in certain areas of the interior; signs of clustering occur within the general pattern;

enclosures: +
clear examples are confined to the general area of Carnac;

stone rows: +
a major concentration occurs in the area of Carnac, with a scattered distribution beyond;

stone axes: ++
there is a strong concentration along the S'n fringe of the peninsula, far less marked along N'n; also strong near Rennes; remarkably few are recorded around the central axe factory at Sélédin, perhaps suggesting strong export;

menhirs: ++
height greater than the 5m mean, as defined above: a scatter along the S'n coast; distinct concentrations to the W, around Brest, and Plouhinée; a scatter inland with some assortment between clusters evident;

height less than the mean: addition of this fraction strengthens the above distribution, with clusters around Carnac, Brest, Quintin, and Dinan becoming more pronounced;

elite menhirs: highlighting these largest menhirs shows a distinct scatter along the N rather than the S, but with Carnac retaining the single highest menhir, at Grand Menhir Brisé;

Clustering within the general distribution:

Fourteen main clusters of settlement and activity were detected, some capable of subdivision, and these are further grouped below according to the degree, and prevailing direction of coastal exposure. Each of these clusters is named after the modern town at its centre (e-FIG ME-04):

N'ly-facing coast; exposure: high;
Trégastel: a tight cluster of tombs, with an elite menhir;
Pontrieux: a scatter of tombs and menhirs, with some indication of subdivision at the S'n end;
Quintin: a general scatter of tombs, with menhirs well represented;
Lamballe: mainly tombs, with one larger menhir;
Dinan: a scatter of tombs, with two elite menhirs;

NW'ly-facing coast; exposure: very high, the most exposed area of the peninsula;
Brest: a marked and discrete cluster, featuring all types of data, and including two sub-groups, Lesneven and Le Conquet, approximately equivalent in terms of menhirs; separate groups of elite menhirs suggest territories;

W'ly facing coast; exposure: high;
Crozon: a small cluster localised on a minor peninsula, physically well separated from the cluster around Brest (see also e-FIG ME-04b);
Quimper: a strong distribution, on a broad peninsula, and including two sub-groups, Plouhinée, and Pont l'Abbé, with the latter, at the S'n end, the strongest, and with better menhirs;

S'ly facing coast; exposure: moderate;
Quimperlé: an undifferentiated spread along the coastal strip;
Carnac: a dense concentration of all types of data around coastal inlets, and their immediate hinterland;
Saint-Nazaire: a general spread around the lower Loire;

interior of the peninsula
Guer: a generalised spread, defined mainly by tombs;
Mur-de-Bretagne: a scatter of tombs around the axe factory at Sélédin;
Cauines: mainly a scatter of axes around the headwaters of the River Rance.

Menhirs and agrarian symbolism

As a context for discussion of the possible axial function of menhirs, it is necessary to examine the possible symbolic content of motifs carved on them, and to compare this with those panels seen on other monuments of the period (see Table of Contents: 04d/6).

The range of motifs on menhirs

Although their exact interpretation is debatable, the range of motifs carved on menhirs appears to be predominantly agrarian in nature (e-FIGS ME-07 and 08). Overt solar symbolism appears to be absent: cup-marks, although found, do not occur in the quantities seen in W'n and N'n Britain for instance, in this analysis interpreted in those areas as potential solar symbols. Distinctly human forms are generally absent, as are militaristic elements, beyond the occasional presence of axes, and the 'buckler' motif.

The generally agrarian theme of such motifs complements the S'ly elements evident in placement of many menhirs (TABLE ME-01), this latter perhaps suggesting their involvement with the S'n sector of the solar transit, as also seen amongst stone rows, and likewise indicating a sun-ward expression of economic concerns.

However, timing of the creation of such motifs, relative to erection of the menhir, remains unknown, but those that lie above the level of easy reach from ground level (e-FIG ME-07) might have more claim on being an early feature, rather than random graffiti applied later.

The distinct motifs listed just below also occur at chambered tombs, where they often appear against a background of more generalised linear-curvilinear graffiti. The number of panels known from menhirs is too low to make a close comparison, but the mix seems to be broadly similar (TABLE ME-02). However, the elaborate curving patterns that are seen in some tombs (example: Gavrinis: Shee Twohig 1981, figs. 110-121) are not found clearly on menhirs.

TABLE ME-02 Breton menhirs: frequency of carved motifs

Data: mainly from Shee Twohig 1981. Classification of motifs in this table follows this source [Cf: alternative groupings for this analysis given in TABLES SA-brit-08 and 09, e-FIGS SA_br-30 to 47;
Key: A: possible agrarian associations; **S.**: possible solar associations; **#** number of sites.

A	**S**	**motif**	**Breton tombs**		**menhirs**
			#	%	#
??		yolk, or horns	24	15.2	
		serpentiform	24	15.2	1
?		crook, or corn	20	12.7	1
		‘buckler’, ?deity	21	13.3	1
?		axe	16	10.1	2
		cross	12	7.6	
?	?	cup	11	6.9	
		U	11	6.9	
?		angle	10	6.3	
?		triangle	5	3.2	1
?		axe-plough	4	2.5	1
yes		animals	-		?2
TOTAL			158		9

Individual motifs more commonly seen on menhirs are as follows:

crooks: these appear singly, or in low multiples, usually placed vertically, with the crooks turned to left, or right; possible representations of functional crooks, as used in animal husbandry; an alternative interpretation as a standing ear of corn is supported by the panel on the back-stone within the chambered tomb at Table des Marchands (Scarre 2011 fig. 4.8/p. 78; e-FIG SA_br-36);

axes: plain axe-heads, with the cutting edge up, or down, appear more commonly than hafted examples; clear examples are found at Gavrinis, where early motifs, namely axes, crooks, buckler, and bow were later surrounded by fields of curvilinear decoration (Scarre 2011, fig 6.7/p. 146);

ards: this composite motif, with shaft, looped attachment, and head has been variously interpreted as a more elaborate type of ceremonial axe, as a plough-like implement, and as the profile of a sperm whale;

yolks: these handle-bar shaped motifs might represent a yolk for oxen, or a set of bovine horns;

animals: oxen, or caprids, are represented in a few cases.

Decorated menhirs

Further details of particular decorated menhirs are given as follows (TABLE ME-03);

TABLE ME-03 Menhirs: Brittany: decorated examples: e-FIGS ME-07 and 08;

Motifs on menhirs, many well-eroded, have not been well recorded, beyond the work of Shee Twohig 1985. Alternative descriptions, and interpretations abound.

Key: site-name; commune; department [**CDA**: Côtes-D'Armor; **Fin** Finisterre; **Morb** Morbihan; **IV** Ille-et-Villaine]; LA Loire Atlantique; longitude and latitude, as decimal, or degrees-minutes-seconds; standing height of the menhir in metres;
Note: longitude and latitude verified on Google Earth is prefixed by '='.

Prat ar Folgoat; Plouaret; CDA; =48.584506N; =3.449272; Shee Twohig 1981 (p.189, item 46, fig. 166); menhir 1.8m high; two vertical picked lines, and one horizontal line joining them;

La Pierre Longue; Le Tremblais; Saint-Sampson-Sur-Rance; CDA; 48 29 40N; 2 01 06W; Shee Twohig 1981 (p. 189, item 47; not drawn); menhir 7m high; at least five panels, all but one including a pair of 'bucklers' with squared outline, containing a cup-mark, and with a vertical projection at top centre; other motifs have been reported on its eroding surfaces, but little coherent recording is available: crosses, axes, squares, palettes, and serpentiforms have been noted;

Kermorven; Le Coquet; Saint-Renan; Fin; =48.36319N; =4.77871W; Shee Twohig 1981 (p. 189, item 48, fig. 167); menhir 1.8m high; complex carved panel, ?anthropomorphic motif;

Saint-Denec; Porspoder; Ploudalmézeau; Fin; =48.497490N; =4.750693W; Shee Twohig 1981 (p. 189, item 49, fig. 168, plate 18); standing menhirs 3.2m, 3.1m high; also one fallen menhir bearing two hafted axes in relief, midway along the stone, with two crooks also reported;

Manio; Carnac; Morb; =47.605038N; =3.051473W; Shee Twohig 1981 (p. 189, item 51, fig. 170); menhir 4.4m high; menhir stands at the E'n end of a low mound, over which the E'n sector of the Kermario alignments pass; five vertical sepentiforms occur low down on the menhir;

Le Grand Menhir; Loqmariaquer; Morb; =47 34 16.68N; =2 57 0.71W; Shee Twohig 1981 (p. 190, item 52, fig. 171); menhir 23m long, as lying fallen, ~17m high if standing; an engraved motif midway along one face has been tentatively interpreted as an axe, or axe-plough;

Table des Marchands; Loqmariaquer; Morb; =47.571630N; =2.949764W; a menhir, reassembled from one fragment incorporated into this tomb, and one each into adjacent Er Grah, and into more distant Gavrinis, indicating a total length of 15m, might once have stood in the stone row leading to Le Grand Menhir;

Scalehir; Kermaillard; Sarzeau; Morb; =47.53569N; =2.84924W; Shee Twohig 1981 (p. 190, item 53, fig. 172); menhir 5.4m long, fallen; bears 20 cup marks of varying size, at the SE'n end a panel of wavy lines, with several cup-marks; with a cross carved at the side, medieval or modern; on the under-surface, this as fallen: a rectangular figure 145 by 60cm, possibly related to 'buckler' motifs, with a semicircle, and a short line at the side; also reported: on the SW'n, SE'n and NE'n faces: each with two crooks in relief; and on the NE'n face: two arcs in relief; many cuplets, and near the base of the flat side a square with a crescent protruding from its corner;

Kermarquer; Moustoir-Ac; Morb; =47.824900N; =2.8588W; more than four crook-motifs have been reported: two on the SW'n side, and one each on the SE'n, and N'n sides, all in relief;

Guernangoué; Roudouallec; =48.145780N; =3.69348W; 4-stone row; axis NNE'-SSW'ly; only one 4.2m high stone remains standing, with another fallen, possibly bearing the engraving of an axe;

Classification of motifs

Motifs on standing stones in Brittany have been grouped by Shee Twohig 1981 (classification: fig. 3/ p. 54; occurrence: tables 4-6, pp. 55-57), and have been re-evaluated as part of this analysis (TABLE SA_br-08; e-FIGS SA-30 to 47);

Directional elements

As noted above, agrarian concerns might also be indicated by the S'ly trends evident in setting many of the menhirs with their faces turned towards the S'ly sun-ward aspect, an axial direction also noted amongst stone rows in Brittany, but contrasting with the W'ly axis predominant amongst funerary monuments in the same area (e-FIG ME-05).

Shape and quality of menhir

Larger, and more carefully worked menhirs, crafted in many cases to resemble what appears to be a fine axe-head, form an elite group that stands out against the majority of smaller, rougher slabs and columns (e-FIGS ME-06). However, this latter group of slabs still retains a general shape that prompts their discussion in terms of axe-, or adze-like implements, with the more columnar examples perhaps even representing ard-coulters, of hardened wood, or stone (e-FIGS ME-09-11). The emphasis here may well be more routinely agrarian in expression, in contrast to the more elite group of menhirs, perhaps more assertively territorial in their emphasis. For the majority of menhirs, symbolic penetration of the ground by implements of land-clearance and cultivation, indicating tenure and maintenance of economically important arable land, and prompting its continued agricultural prosperity, might be the underlying theme.

Evidence for an axe-cult

There is insufficient evidence to indicate a specific connection between menhirs and an axe cult, rather less than between menhirs and issues of land tenure, and agricultural prosperity. Although the axe was an essential item of work, and of trade, the evidence for a specific axe cult is, at present, based on sparse evidence (general discussion: Scarre 2011, 82-83; Tilley 2004,39). Brittany certainly produced axes that were fairly widely distributed over the peninsula, and were traded into NW'n France (TABLE ME-04). Axe motifs also occur on standing stones in Brittany (example: Er Lannic, e-FIG SA_br-16), but not in quantity. They also occur at stonehenge (TABLE HE-14). This contrasts with the abundance of cup-marks throughout NW'n Atlantic Europe, suggesting an alternative, and perhaps dominant solar focus for ritual, eclipsing that of the axe. Evidence is also lacking for linking the two themes together to produce a solar axe-cult, although this term often occurs in use (Burl 2000, 345-346).

Given the widespread production, economic importance, and essential need for axes in Britain, Ireland, and Brittany (TABLE ME-04) it seems surprising that there is not more evidence for use of the axe-head as a carved motif, in strong addition to the the cup-mark, or by its representation in the form of a standing stone, beyond Brittany only plain and natural shapes predominating.

TABLE ME-04 Areas of production and use of stone axes in Britain, Ireland, and Brittany

This table has been placed as a text file in the folder TABLES_filed, on account of its length, and the partial nature of some data.

The possibility of axe-cults, long lasting until the Roman period, were recognised early (Stone and Wallis 1951), the axe being associated with the sun, fertility, and land management, further supported by the existence of non-functional, and decorative axe-types (Burl 2000, 67-68), and often cited as a solar axe-cult (Burl 2000, 371).

Sporadic examples of axe-carvings occur in Britain, as for instance on the recumbent stone circle at Drombeg (Cork), persisting into the Bronze Age as carvings of flat bronze axes and halberds at Kilmartin (Argyll) (Burl 2000, 198), and at Stonehenge as carvings of bronze axes on sarsens, for instance trilithon stone 15 (Burl 2000, fig. 12/, p.123; see Table of Contents: 03f/6f; TABLE HE-14).

Axe-shaped menhirs appear to be strongly Breton, perhaps reflecting regional importance of the industry, the axe providing a vehicle for symbolism related to power, and land tenure. Only a single potential example of such an axe-shaped monolith occurs in Britain, at Rudston (e-FIG ME-12), but here, erected not in an area of axe-production, but in one of importation, and possible control of quarry-sources. Manby (1979) cites Yorkshire as providing the largest assemblage, and most concentrated distribution of Neolithic axes in the British Isles, with 2400 examples, of which 41% came from Cumbrian quarries in group 6.

Menhirs and repetitive structuring

The proliferation of stone rows along the margins of NW'n Atlantic Europe has been suggested in this general study as a response to climatic deterioration (see Table of Contents: 03d/8g; 05) and, here in Brittany, more specifically argued as a factor in development of the hyper-monumenal complex of stone rows at Kerlescan-Le Menéc (e-FIG SA_br-08; see Table of Contents: 03j). Since menhirs occur as a distinct regional type, and at relatively high density in Brittany, the same climatically-responsive process might have been operational in their proliferation. These monoliths are concentrated in coastal areas, especially along the exposed W'n coasts of Brittany (e-FIG ME-04), and there are S'ly elements in their placement (TABLE ME-01), as also seen amongst stone rows (e-FIG SR-05, 15, 27, and 28). At the same time, the distribution of menhirs shows a spacing suggestive of territorial demarcation of fertile zones, and of valuable resources within the restricted area of the peninsula (e-FIG ME-04a and 04b), distribution of a type not seen amongst the standing stones in Britain and Ireland, and in many cases menhirs assume a form perhaps embodying agrarian, and elite symbolism (e-FIG ME-06). Suffice it to say that menhirs are potentially multi-purpose, and capable of including all of these aspects.

Menhirs in Brittany: ethnographic parallels: relevant insight

Erection of menhirs appears more common in ethnographic literature than does construction of stone rows (see Table of Contents: 07). Two cases are cited here, to add relevant context to discussion of the Breton examples, and further inform interpretation.

-Indonesia

Parallels here indicate the importance of menhirs, and other megalithic forms in the social fabric, and continuing traditions of certain indigenous cultures, with function appearing more commemorative, and funerary, than territorial. Recorded instances of quarrying, traction, working, and erection of large stones indicate the sheer man-power, and social organisation involved, and stress the need for underlying economic health amongst the communities involved.

In various parts of Indonesia, megalithic construction, including erection of menhirs, survived from the pre-Islamic period well into the 19th century, and in some areas up to the present, with existing sites continuing to play a part in contemporary local culture, and with other types further developed according to current beliefs. Structures are typically involved with burial of the dead, serving to honour, commemorate, and communicate with ancestors, also as a means of preserving oral traditions (Steimer 2018). Although in many parts of Indonesia the megaliths have been abandoned, in Nias, Sumba, and Toraya these practices continue, and they still represent an integral constituent of the complex social stratification, and architectural organisation of villages (Bonatz 2002).

Indonesia provides an important context in which to examine the socio-political context of megalith building from an ethno-archaeological perspective. Using ethnographic data, Adams (2007) has developed a model that links megalith building to the status of individuals, and of groups in contexts of competition for key corporately controlled resources, relational, and socio-political power. Such a model may also be relevant to megalithic Brittany.

..Pulau Nias; a small island off the W'n coast of Sumatra, Indonesia; 1°6'S; 97°32'E; phase of megalithic construction: in traditional form until recently; e-FIG ME-14;

Ancient megaliths include menhirs, and large, flat slabs, some anthropomorphic, the former linked to male, the latter to female aspects. Such monuments were often erected to promote, or commemorate particularly prominent individuals. Megalithic construction has persisted into modern times, has been extensively recorded, and events are traditionally accompanied by large gatherings, offerings, and sacrifice of animals. Transportation of stones on wooden sledges can involve hundreds of men hauling them with ropes, for days. The largest stones form carved cap-stones for graves, these supported on stone pillars.

..Bada valley; central Sulawesi; 1°51'S; 120°15'E;

phase of megalithic construction: certainly pre-Islamic; speculative dating, millennia BC to first millennium AD and more recently; valid oral traditions are now lost; several hundred menhirs are known, some of which depict human forms with head and body, as for instance the Palindo anthropomorphic menhir, 4.5m high.

..Sumba Island; S'n Indonesia; 9°40'S; 120°E; e-FIG ME-14;

carved tombs with accompanying menhir-stele, both frequently carved with human, animal, and geometric motifs, commemorating high-ranking individuals; megalithic burial still continuing, especially around Anakalang;

-Easter Island; Polynesia; 27°7'S; 109°22'W; e-FIGS ME-15 and 16;

The erection of large monolithic figures by geographically isolated indigenous *Rapa Nui* communities on Easter Island, illustrates the importance of socially, and territorially competitive production in sustaining cultural identity. Interesting parallels with Brittany include the discrete coastal distribution of megaliths (e-FIG ME-16), the importance of directions in their placement, and cases of deliberate toppling as an act of aggression.

On Easter Island, over 900 such statue-menhirs (*mo'ai*) were constructed during the period 1250-1500 AD, as monolithic, whole-body human figures, with separate cylindrical stone head-caps, and were set on platforms (*ahu*) around the perimeter of the island. The majority of the figures faced inland, towards the communities that produced them, only seven facing out to sea, perhaps to guide, or to ward off, travellers. Their average standing height is about 4m, and weight 13 tonnes, the tallest being 10m high, and 82 tonnes, with one unfinished statue 21m long. The process of production, and erection involved considerable resources, and organisation, separate groups being involved, with access to the main quarry subdivided by clan. The final size achieved for the statue was likely to have reflected status, the process being competitive. The figures might have directly represented deified ancestors, acting as repositories of ancestral spirits, symbols of lineage, religious, and political power.

After about 1500 AD production became greatly reduced, perhaps as a consequence of religious change, and as the cult of the bird-man developed. Internecine warfare might also have contributed, with instances of statues being deliberately toppled recorded in the oral tradition. Destruction of *mo'ai* by earthquake remains a further possibility. Disturbance of communities by European contact might also have been a deciding factor. Whatever the cause of the decline, statues were still standing during the first visit by Europeans in 1722, but with only a few remaining in 1838, and none left in place by 1868.

e-FIGURES: combined listings and supporting information

e-FIG ME-

Brittany

01 Menhirs: Brittany: division by height
Menhirs are subdivided by standing height, using data from TABLE ME-01, in order to provide a more regular definition of the term 'menhir', and as a basis for plotting their regional distribution (e-FIG ME-04).

02 Taller standing stones in Britain and Ireland: distribution of examples
The scattered distribution of taller standing stones is shown against that of stone rows and circles in W'n Britain and Ireland.

03 Standing stones: Britain: examples
Taller columnar stones providing a vertical axis capable of casting significant shadows.

04 Menhirs: Brittany: distribution
The distribution of menhirs and stone rows indicates discrete clustering in key areas of settlement and activity.

04a Brittany: Crozon peninsula: distribution of megalithic rows, enclosures, and standing stones

04b Brittany: Finisterre: spacing of menhirs
This could indicate territorial demarcation.

05 Menhirs, stone rows, and barrows: Brittany: axial comparison
Azimuths of axial elements seen in these monuments are plotted, and major differences noted. The mean axis for barrows is markedly W'ly, with that for stone rows and menhirs significantly more S'ly.

06 Menhirs: elite steloid: Brittany
Examples of the most impressive, refined, steloid, axe-like forms are shown.

07 Menhirs: Brittany: engraved motifs
The range of motifs added to the faces of menhirs in engraved, or raised relief is shown.

08 Menhir: steloid: Brittany: Tremblais: engraved motifs
Further details of the eroded decoration on this menhir are given, as they survive on the stone.

09 Menhirs: Brittany: implements as prototypes
It is suggested here that menhirs might have imitated prototypes of implements important in the agrarian economy, and that this may have a bearing on aspects of their function, as related to propitiation.

10 Menhirs: Brittany: motifs: porototype: axe
The elite, and more functional type of axe presented, as possible prototypes of form amongst menhirs.

11 Menhirs: Brittany: motifs: porototype; adze and coulter
The functional axe-adze, and ard-coulter are presented as possible prototypes of form amongst menhirs.

12 Menhir: steloid: Rudston; Humberside; TA 0969
The lone example of a steloid menhir in Britain.

13 Menhirs and standing stones: shadow casting: stone rows at Merrivale (Devon; SX 5555)
The capacity of taller standing stones to cast impressive shadows, as dynamic radial features, might have acted to further integrate the monument with the movement of the solar transit.

14 Indonesia: erection of megalithic structures

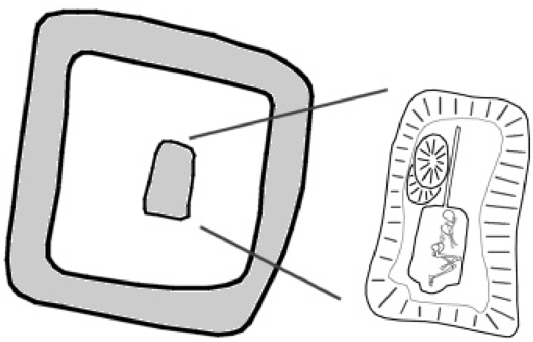
15 Easter Island: monolithic statues: examples

16 Easter Island: distribution of monolithic statues

Section 03L:
Cemeteries of the middle Iron Age in E'n Yorkshire: graves, inhumations, and squared barrows: integrated analysis of their alignment

Section identifier: SQ-

SEE INITIAL SECTION:
Access to digital images



Garton Station grave G6, Yorkshire: squared barrow, central grave-pit, and chariot burial

The problem:

Major programmes of excavation undertaken in E'n Yorkshire have provided large-scale data on the squared barrows, their burials, and extensive cemetaries, that developed as part of a distinct regional culture in the area during the mid to later Iron Age, providing a level of detail not available elsewhere in Britain. Although their basic properties have been defined, and questions of internal relationship, external affinity, and date have been addressed, no viable model for certain important aspects of burial ritual has been proposed: the issue of an cue for the distinctly non-random alignment of graves, and their inhumations remains unaddressed.

Although the basis in ritual for alignment of the grave, and its inhumation, remains entirely unknown, application of the solar model, developed during this general analysis for far earlier monuments, provides a plausible possibility, and resolves several apparent conflicts of direction.

Summary:

Analysis of a large sample of squared barrows from the regional middle Iron Age 'Arras culture' of E'n Yorkshire (Halkon 2017; Halkon *et al.* 2019) indicates consistent use of a closely-defined N'-S'ly axis for alignment of grave-pits, these constituting the primary, axially-defining element for the burial, barrow, and development of the cemetery. The close axial preference observed suggests probable use of a specific direct, or indirect, calibrating reference to the N'n circumpolar region of the night-sky, other potential cues being far less specific.

Functional use of such a primary, polar axis for graves would have automatically provided the basis for a lateral axis, to be adopted by the inhumations placed longitudinally within them, the corpse then able to face in one of two possible directions. Analysis of such burials shows distinct preference for a crouched attitude, with the whole body facing towards the E which, incidentally, or significantly, contains the rising sector of the solar transit. Also, but less frequently, bodies can face towards the W, and hence the setting sector. Facing the corpse towards the N, which would span the null zone, or towards the S, the permanent zone of the transit, was avoided, assuming that the divisions of the solar cycle are relevant here, concentrating attention instead on its more dynamic sectors, especially the rising E'n. Alternative, or additional reasons for such lateral placement are also discussed.

This axial preference indicates possible persistence, into the burial-ritual of this mid Iron Age culture, of solar transit-mediated links between the recently deceased and the long-dead ancestors, these perhaps thought to be located beyond the setting W'n horizon, ritual of a type suggested elsewhere in this study as a common theme amongst funerary monuments of the Neolithic, and earlier Bronze Age.

The dynamics of cemetery-growth are also considered, with an overall, cardinally latticed layout readily induced by the polar axis of initial grave-pits, and subsequent close packing of their overlying, axially-conforming squared

barrows. Occasional individual lines of barrows, not submerged by general growth of the cemetery, suggest serial N'ward extension, thus briefly retaining, as more open, the E'ly, and W'ly aspect of the monument, directions suggested here as ritually significant.

The final latticed, or linear appearance of monuments achieved in a cemetery of such rectilinear barrows would arise in part as a natural consequence of their overall squared geometry, and of its alignment, as dictated by the long axis preferred for the grave itself, the primary, controlling construction at the monument. Given the need to use limited space economically, once the initial alignment of barrows was established by a founder-barrow, the same trend would tend to follow on symmetrically from this, and the cemetery to self-organise around it. The mechanism of development here is classically *stigmergic* in nature: one where the result of an action promotes further similar actions, to produce what appears to be a deliberate overall design.

The clustering, or linear arrangement of round barrows (see Table of Contents: section RB-, round barrows), could also be described in such terms, with resulting accretion of monuments to form cemeteries of different format, and into specific linear groupings. Here, the stigmergy must be weaker than for squared barrows, since the circular nature of round barrows, unconstrained by straight sides, allows more latitude for alternative arrangement. That the basic mechanisms are, however, different is suggested by comparison between the linear round barrow cemetery at Arras Farm W, with the adjacent squared barrow cemetery at Arras Farm E, both shown in e-FIG SQ-05.

Introduction

Cemeteries of mid Iron Age date from E'n Yorkshire provide an opportunity to examine interrelated issues of mortuary practice and orientation, ranging from that of grave-pits and their inhumation burials, to that of their overlying, usually squared-ditched barrows, and on to the broader structure of the cemetery itself.

Several such sites, well-excavated at large scale, under modern conditions, and accessibly published (data used here: Stead 1991; TABLE SQ-01; e-FIGS SQ-02 to 03, and 06 to 10), provide sufficient data for analysis, and stand out from a background of early work in the area, which does not (TABLE SQ-02).

This study provides an opportunity to examine the relationship between alignment of monument and burial practice, aspects less approachable in the case of chambered tombs, and round barrows. Previous sections in this study, those on chambered tombs of the Neolithic (see Table of Contents: section LB-, long barrows, and related monuments), and round barrows of Bronze Age date (see Table of Contents: section RB-, linear round barrow cemeteries), did not include orientation of their human remains. Amongst the Neolithic material, data on intact inhumation seemed insufficient, and too scattered, to allow fuller analysis, concentrating here instead on interpretation of the structural alignment of the the monuments itself, with its clear axis, for which adequate large-scale data were certainly available. The same restriction applied to the Bronze Age barrows, with no axis apparent for the individual circular monument, only between them, when they occur in linear cemeteries, and none for the interred human remains, dominated by amorphous cremated deposits.

However, in the case of squared barrows from E'n Yorkshire, although separated as they are by about 1700 years from the earlier Bronze Age barrows, meaningful analysis and comparison becomes possible, because all axial elements are present in abundance: grave-pit, inhumation, squared barrow, and cemetery.

Both squared barrows and their inhumations have a readily definable axis, occur in considerable numbers, are clustered within cemetery groups spread over separate localities, and hence have potential for larger-scale comparative study.

However, given that such squared barrows are more restricted in their distribution than Neolithic and Bronze Age funerary monuments, then any conclusions drawn from these Iron Age sites are likely to reflect more of a regional variation, rather than being of general application to Britain during the mid to later Iron Age. Nevertheless, they present an interesting initial study of funerary ritual.

A few of these Iron Age graves include a chariot with the inhumation (e-FIG SQ-16), and this provides a possible link between symbolic use of vehicles, the perceived dynamic nature of the solar transit, and related aspects of mortuary practice (see Table of Contents: section SY-, symbolism). A selection of references to the chariot of the sun, taken from Latin verse of the 1st century BC, is given in Section 11 (see Table of Contents).

The many squared barrows, and occasional chariot burials, are two key elements used to define the regional 'Arras Culture' of the Yorkshire Wolds [type-site: Arras Farm: TABLE SQ-02; e-FIG SQ-05; Halkon *et al*. 2019], which shares certain features with contemporary cultures of central-N'n France, suggesting the possibility of influence, and exchange (general discussion: Stead 1961-1984, 1991; Carter *et al*. 2010, 57-58, fig. 12/ p. 56). Comparison between funerary orientation in these two distinct areas might suggest a more robust, and basic combined interpretation.

Overview

This analysis is concerned with definition and interpretation of axial alignment, rather than reviewing source-material more fully than this limited brief requires.

The approach here has been to examine the sequence of events involved in such burials, and to determine the effects of each stage upon the next, from establishment of a primary axis for the initial grave-pit, to deposition of the corpse, to framing of the squared barrow, and then to eventual generation of structure in the cemetery. Comparisons with the general layout of round barrow cemeteries of earlier Bronze Age type are kept in mind, contrasting underlying processes of growth (see Table of Contents: section RB-, round barrows).

Iron age cemeteries of 'Arras type'

-general form and content

These cemeteries are concentrated on the Yorkshire Wolds (e-FIGS SQ-01 and 18; TABLE SQ-02), and are characterised by small barrows, typically defined by a square-plan ditch, in this analysis with mean length of side calculated as 6.4m (e-FIG SQ-15). The mound at the centre, where these survive, covers an elongate primary grave pit. The burial-rite is uniformly by inhumation (Whimster 1981; Stead 1991), usually single, and crouched, accompanied by poor, or modest surviving grave-goods, such as items of personal adornment, or functional weaponry, (graded in e-FIGS SQ-06 to 10), but exceptionally by finer objects (for instance, an ornate sword in Kirkburn grave K3: Stead 1991, 64-70; fig. 125/ p. 225), and very occasionally by a chariot-cart (e-FIG SQ-16). Structural variants do occur: barrow-ditches, and grave-pits can be circular, some burials are apparently unmounded, and secondary burials of regular type can be found placed in the ring-ditch.

-layout of cemeteries

Such cemeteries occur in localised clusters (Stoertz 1997, *passim*), containing individual concentrations, most without clear overall linear tendency (e-FIGS SQ-05, 11, and 12), although component lines are often apparent internally (e-FIGS SQ-06 to 13). In terms of barrow-density, several of those examined in more detail here show very close packing over the entire area (Wetwang: e-FIG SQ-13; Danes' Graves; e-FIG SQ-11), or include packed clusters within a more generalised spread (Rudston S'n, mid, and N'n: e-FIGS SQ-06 to 10).

-inhumations

Inhumations are usually single, but occasionally occur in pairs (Rudston grave R152: Stead 1991, fig. 32/ p.39), with bodies usually crouched, or flexed, laid on one side, but also extended, in this latter case usually supine, very exceptionally prone (e-FIGS SQ-06 to 19; TABLES SQ-3 to 5; APPENDIX SQ-01). In some cases there is evidence for a coffin (Rudston grave R32: Stead 1991, fig. 30/ p.37), but usually not. In most cases burial practices seem standard, and functional, but there is occasional evidence for exceptional treatment of the body, as in the case of speared corpses (Rudston grave R94: Stead 1991, 197; possibly also R140, R152), and where bodies were laid prone, not supine (Rudston graves R138, and R182: Stead 1991, p. 202 and 208 respectively).

-orientation

The axis of grave pits is broadly 'polar' (N to S), usually with the head of the skeleton towards the N, and laid to face E'ward, but variants do occur (TABLES SQ-03 to 05).

-grave-goods

Surviving grave-goods are usually absent, or of low-grade, typically consisting of minimal personal adornment, such as a functional brooch, perhaps weapons, usually spear-heads, or tools, and very often with joints of meat, indicated by animal bone, usually sheep, or pig (see APPENDIX SQ-01). Such paucity seems general: for instance, in the cemetery at Wetwang (e-FIGS SQ-04 and 13), only about a fifth (21%: Dent 1984, 26) of the over-450 burials included any surviving grave goods, with small deposits of animal bone accounting for most of these (Brewster 1981; Dent 1982, 1983, 1985a and b, 2002; Jay and Richards 2006).

In the Rudston group of cemeterie, 78% of burials had some type of grave-goods, the majority being deposits of animal bone, or very basic personal dress-fastenings, with only 10% being of other metal-work, again all simple items (Stead 1991: table 47/ p. 176). However, some richer items do occur (examples: a sword in Kirkburn grave K3: Stead 1991, 64-70; fig. 125/ p. 225), a sword and shield at Wetwang Slack grave 98: Dent 1984), with chariot-cart burials often including basic harness-fitments.

-chariot burials

Very occasionally a grave, often placed marginally to the main area of the cemetery, contains a cart-chariot (maps: e-FIGS SQ-03 and 04; plans SQ-16). Such cases, which show a regional concentration over the Yorkshire Wolds, with scattered examples known from elsewhere in Britain, are discussed separately below.

Cemeteries included in this analysis

Those cemeteries featuring in this analysis are listed as follows, the main source of data being from those in the general area of Rudston (from Stead 1991), as re-grouped here for convenience (TABLE SQ-01; maps: e-FIGS SQ-02, 03; plans: SQ-06 to 10):

TABLE SQ-01 CEMETERIES INCLUDED IN THIS ANALYSIS

general analysis:			**#**	**#**		
cemetery	**graves: Stead 1991**	**NGR**	**graves**	**ch**	**e-FIG locn**	**SQ-detail**
Rudston N'n	BF 23-64:	TA 108 719	32	-	02	06
mid	R 190-208;	TA 094 703	20	-	02	07
	BF 1-22	TA 096 705	23	-	02	07
S'n	R 1-189	TA 093 695	190	-	02	08
Garton Station	GS 1-10	SE 982 578	11	1	03	09
Kirkburn	K 3-6	SE 984 574	5	1	03	10
total			**281**			
cemeteries illustrated for comparison:						
Arras		SE 839 418	>100	3	05	-
Danes' Graves		TA 018 633	>100	?	-	11
Scorborough		TA 019 450	>100	-	-	12, 12a
Wetwang Slack		SE 945 600	>400	4	04	13

Key: R[udston]; **BF** Burton Fleming; **#** number of; **ch**: chariot burial present; **locn** general location shown;

Criteria for selection of data used in the analysis

In order to examine any underlying pattern of growth within cemeteries, and to assess any axial correspondence between burial, grave-pit, monument, and layout of the cemetery, examples have been selected according to the following criteria:

cemeteries:

-where barrows are **not so densely packed** as to obscure any underlying sequence of accumulation, (ideally dispersed are: Rudston N'n, mid and S'n; very closely packed are: Wetwang Slack (e-FIG SQ-13), and Danes' Graves (e-FIG SQ-11));

-**not badly compromised** by early excavation, as seen for the site at Arras Farm, and others (excavation by: Stillingfleet 1846; Mortimer 1905; Greenwell 1906);

-and where a **large sample of graves is available** from a single locality, excavated, and accessibly published to a common standard (Rudston N'n, mid, and S'n, as re-grouped thus: from Stead 1991);

The high degree of damage to cemeteries from repeated ploughing, and levelling of 'obstacles' such as barrows, under a regime of industrial-scale arable cultivation (satellite imagery: e-FIGS SQ-02 to 05), precludes general access to cemeteries with much surviving superstructure. Mounds are extant for the cemeteries at Danes' Graves, where protected by woodland, and where under pasture at Scorborough (e-FIG SQ-12a).

TABLE SQ-02 Cemeteries of 'Arras type' squared barrows

General mapping: e-FIGS SQ-01 and 18;
Note: Pastscape: data from this source are listed as follows: NGR; site number; monument number;

-scattered sites and small cemeteries
Barmston; TA 159 612; TA16SE 11; 910637;
Barmston; TA 16828 60580; TA16SE 69; 1446487;
Beverley; TA 0184 3954; TA03NW 28; 79109;
Boynton; TA 1233 6749; TA16NW 52; 910826;
Burton Fleming; TA 097 707; TA07SE 17; 910766;
Cottam; SE 984 667; SE96NE 8; 64640;
Garton on the Wolds; SE 9659 5833; SE95NE 88; 1582321;
Garton on the Wolds; SE 982 578; SE95NE 56; 910820; =Garton Station (Stead 1991);
Kilham; TA 024 648; TA06SW 6; 79649;
Kirkburn; SE 9896 5745; SE95NE 67; 1308162;
Leconfield; TA 01294 45390; TA04NW 81; 1548973;
Lund; SE 944 474; SE94NW 43; 1479434;
Nafferton; TA 038 614; TA06SW 20; 1361203;
Nunburnholme; SE 8559 4751; SE84NE 55; 1619507;
Rudston; TA 096 702; TA07SE 18; 910767;
Rudston; TA 118 686; TA16NW 50; 911327;
Thwing; TA 0361 7134; TA07SW 35; 910824;
Thwing; TA 0314 7183; TA07SW 25; 910760;
Warter; SE 880 487; SE84NE 29; 910549;
Wold Newton; TA 0572 7279; TA07SE 30; 1321577;

-larger groupings
Burton Agnes; TA 127 587; TA15NW 24; 910648;
Garton on the Wolds; SE 9752 5793; SE95NE 84; 1570885;
Garton Slack; SE 956 599; SE95NE 38; 64495;
Grindale; TA 1425 7111; TA17SW 25; 910825;
Kirkburn; TA 004 565; TA05NW 32; 79342;
Scorborough; TA 0190 4502; TA04NW 6; 79187;
North Dalton; SE 9419 5150; SE95SW 39; 1570747;
Rudston; TA 099 702; TA07SE 20; 910769;
Burton Fleming; TA 094 703; TA07SE 19; 910768;

-large cemeteries
Carnaby; TA 130 625; TA16SW 10; 81304;
Garton on the Wolds; SE 9596 5908; SE95NE 59; 1171876;
Grindale; TA 148 720; TA17SW 19; 910649;
Kilham; TA 070 655; TA06NE 34; 910615;
Market Weighton; SE 929 414; SE94SW 4; 64320; [**Arras**: SE 930 413];
Nafferton, Danes' Graves; TA 018 633; TA06SW 1; 79634;
Pocklington; SE 8097 4861; SE84NW 57; 1618861;
Rudston; TA 094 695; TA06NE 36; 910763;
Wetwang Slack; SE 9460 6015; SE96SW 4; 64755;

Case study: Rudston area: the squared barrow cemeteries

General

-barrows (e-FIGS SQ-06 to 10)

mainly with squared ditches, occasionally circular; these vary in size, with a mean side calculated as 6.4m (e-FIG SQ-15); those containing a chariot-cart, at Garton Station GS6 (e-FIG SQ-09), and Kirkburn K5 (e-FIG SQ-10), are larger (e-FIG SQ-17);

-grave pits (e-FIGS SQ-06 to 10)

usually elongate, with axis N'-S'ly, that of the barrow conforming (e-FIG SQ-14);

-burials (TABLES SQ-03 to 06; APPENDIX SQ-01)

attitude of the skeleton: usually with some degree of flexure, often tightly crouched, usually placed on one side; a minority lie extended, some supine, very occasionally prone; burials of all types are usually single;

-grave goods [surviving] (APPENDIX SQ-01)

generally absent to poor, some with a few simple weapons, or tools, occasionally with finer items such as a sword, rarely with a dismantled chariot included;

Orientation

As seen in the many of the plans published for sites included in this broader analysis, their North-pointers are usually undefined as to type (grid, magnetic, true N), and rarely prove to be accurate, when checked against rectified mapping, as supplied, for instance, by the Ordnance Survey, or satellite imagery. Wherever possible, or necessary, published North-pointers are re-adjusted closer to physical reality, and plans appropriately re-aligned.

As stressed elsewhere in this work, axial directions made for purposes of ancient ritual need only have been general but, in order to gauge the degree of such generality, some close calibration of N is anyway needed, as a basis for plotting the spread as observed. The discussion of alignment amongst grave-pits which follows will illustrate this point.

Orientation of the separate structural elements: grave-pits, inhumation, squared barrow, and of chariots, if present, are outlined separately, with a combined discussion in a later section:

-grave-pits

Grave-pits are considered first, since they were the primary feature to have been constructed at the burial-site.

The longitudinal axis was determined, as accurately as possible, for a sample of 243 grave pits, as published (Stead 1991), from the cemeteries listed in TABLE SQ-01, noting only the direction within the N'n hemisphere (270-000-090°), as a convenient standard for simplified plotting on a single axis. Most of the axes of these grave-pits are 'polar', general N'-S'ly, rather than transverse, or 'equinoctial', generally E'-W'ly.

The frequency of N'ly directions for grave-pits shows a marked, well-defined, and symmetrical peak just to the W of N (e-FIG SQ-14): sample size: 176; mean 355^{o}G; sd 11; mode 353.

Note: throughout this general analysis 'degrees G' indicates with reference to N on the National Grid.

This clustering of axes would suggest use of a well-defined reference point at the N, as is well provided by the central circumpolar area of the night sky, and used, if not by direct observation at the time of grave-digging, then more likely perhaps, used to establish a convenient routine direction for N, marked by features in the landscape. Use of the meridian in the S'n sky to establish due S would result in far less accuracy, and give a far broader peak of frequency than that seen in e-FIG SQ-14. Once an axis was established for several barrows in the cemeteries, others might simply have copied this trend, the process being *stigmergic* (the term is discussed above in the summary).

-inhumations

The second stage of burial would have involved placement of the corpse in the grave, together with any grave-goods, or -furniture.

..orientation of the corpse: longitudinal, and lateral preferences

An elongate pit, thus appropriately aligned, would confer the correct bi-directional longitudinal axis on an inhumation placed within it, allowing selection from two possible directions for the head of the corpse, and a further two lateral choices for direction of whole-body facing: to one side, or the other, four if extended, and prone are included (TABLE SQ-03).

TABLE SQ-03 RUDSTON AND WETWANG SLACK: CEMETERIES: ORIENTATION OF THE SKELETON WITHIN THE GRAVE-PIT

Data: see APPENDIX SQ-01;
Axis: Stead 1991: cardinal directions are given as N-S, or E-W, usually without specific details; on this basis, further analysis is given below:
Key: NS>E: head-end =N, foot-end =S > direction of facing for the skeleton =E

In the table below, comparative data from Wetwang Slack are presented in parallel:

The cemetery at Wetwang Slack has provided a large set of data on orientation, from its 378 inhumations (Dent 1984, 24-26). As at Rudston, here too the polar axis was strongly preferred for longitudinal placement of the corpse (96% of the total sample), with head towards the N, and body facing E'ward, the most frequent combination (64% of burials on this axial combination). Use of the transverse E'-W'ly axis was insignificant, accounting for only about 4% of the total sample, with no evidence for existence of warrior graves, as discussed below (TABLE SQ-06).

Rudston cemeteries (Stead 1991)

			totals......... directions	
	#	**%**	**one**	**either**
polar:				
NS>E	118	[52]		
NS>W	2	[1]	123 [54%]	
NS>-	3	[1]		
	--------------------			168 [74%]
SN>E	8	[4]		
SN>W	37	[16]	45 [20%]	

Wetwang Slack (Dent 1984)

			totals......... directions	
	#	**%**	**one**	**either**
NS>E	241	[64]		
NS>W	65	[17]	306	[81%]

SN>E	17	[4]	58	[15%]
SN>W	41	[11]		

transverse:

EW>N	19	[8]			EW>N	6	[2]	11	[3%]
EW>S	8	[4]	34 [15%]		EW>S	5	[1]		
EW>?	7	[3]							
	--------------------			**57** [**26%**]	--------------------				
WE>N	8	[4]			WE>N	2	-	3	[1%]
WE>S	13	[6]	23 [11%]		WE>S	1	-		
WE>?	2	[1]							
total	**225[100**					**378[100]**			

The most frequent axial choices were therefore as follows:

		% of total	
		Rudston	**Wetwang Slack**
axis:	polar	74	96
head to:	N	54	81
facing:	E	56	68
and the least frequent:			
axis:	**transverse**	26	4
head to:		no distinct preference	
facing:		no distinct preference	

..orientation of the corpse according to gender

At Rudston, and Wetwang Slack, inhumations show no gender-related differences in choice of axis, head-direction, or direction of facing [values in columns 1 and 2 just below are similar], which means that equivalence can be assumed and, for the purposes of this analysis, the entire sample of graves treated as one, with no sub-division needed (TABLE SQ-04).

TABLE SQ-04 Orientation of the skeleton within the grave-pit according to gender

Data: see APPENDIX SQ-01;
Axis: Stead 1991: cardinal directions are given as N-S, or E-W without specific details; on this basis, further analysis is given below:
Note: percentages are rounded to the unit;

Rudston cemeteries (Stead 1991)									**Wetwang Slack (Dent 1984)**				
	gender						**totals**						
column:	**1**		**2**							**1**		**2**	
	M	**%**	**F**	**%**	**?**	**%**		**%**		**M**		**F**	
NS>E	41	[17]	49	[20]	28	[12]	118	[49]	NS>E	93	[25]	133	[35]
NS>W	10	[4]	6	[2]	2	[1]	18	[7]	NS>W	25	[7]	29	[8]
NS>-	2	[1]			2	[1]	4	[2]					
all NS	**53**	**[22]**	**55**	**[23]**	**32**	**[13]**	**140**	**[58]**		**118**	**[31]**	**162**	**[43]**
SN>E	3	[1]	2	[1]	4	[2]	8	[3]	SN>E	7	[2]	9	[2]
SN>W	12	[5]	16	[7]	10	[4]	38	[16]	SN>W	13	[3]	26	[7]
SN>-					1	[-]	1	[-]					
all SN	**15**	**[6]**	**18**	**[7]**	**15**	**[6]**	**48**	**[20]**		**20**	**[5]**	**35**	**[9]**

EW>N	6	[2]	9	[4]	2	[1]	17	[7]	EW>N	3	[1]	3	[1]
EW>S	5	[2]	2	[1]	1	[-]	8	[3]	EW>S	2	[1]	3	[1]
EW>?	2	[1]	3	[1]	2	[1]	7	[3]					
all EW	**13**	**[5]**	**14**	**[6]**	**5**	**[2]**	**32**	**[13]**		**5**	**[1]**	**6**	**[1]**
WE>N	4	[1]	3	[1]	1	[-]	8	[3]	WE>N	2	[1]	0	
WE>S	3	[1]	6	[2]	4	[1]	13	[5]	WE>S	1	[-]	0	
WE>?	1	[-]	1	[-]			2	[1]					
all WE	**8**	**[3]**	**10**	**[4]**	**5**	**[2]**	**23**	**[9]**		**3**		**0**	
									ALL ?	**15**	**[4]**	**13**	**[3]**
totals	**89**	**[37]**	**97**	**[40]**	**56**	**[23]**	**243**	**[100]**		**161**		**216**	
grand total:							**243**	**[100%]**				**377**	**[100%]**

..attitude of the corpse

Skeletons in burial-pits can graded by the degree of their contraction, ranging from tightly crouched, to fully extended, and by their orientation, the longitudinal axis taken as the direction of the head, and the lateral axis, that of facing for the entire body, if flexed to any degree, or of the head alone if the body was laid extended, and the head rotated (TABLE SQ-05):

TABLE SQ-05 RUDSTON AND WETWANG SLACK: CEMETERIES: SKELETONS FROM GRAVE-PITS: ORIENTATION AND ATTITUDE

--Rudston (Stead 1991)

axis			**POLAR**				**TRANSVERSE**						
head to foot		**NS**		**SN**		**EW**		**WE**					
facing		**>E**	**>W**	**>E**	**>W**	**>N**	**>S**	**>N**	**>S**				
upward side..		**R**	**L**	**L**	**R**	**L**	**R**	**R**	**L**	**sub- totals**			
column		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
crouched	M	19	6	2	9	1	-	-	-	37	**sum**	**%**	**%**
	F	30	3	2	10	5	1	-	-	51	108	45	sum
	?	12	1	3	4	-	-	-	-	0			|
													71
contracted	M	17	1	1	4	-	-	-	1	24	**sum**		|
	F	16	4	-	3	-	-	-	-	23	62	26	
	?	8	2	-	5	-	-	-	-	15			
flexed	M	11	-	-	-	2	2	2	-	17	**sum**		
	F	10	2	-	1	2	-	2	4	21	46	19	
	?	5	1	-	-	1	-	1	-	8			
sub-totals		**128**	**20**	**8**	**36**	**11**	**3**	**5**	**5**	**216**			
extended	M	-	-	-	-	3	3	2	2	10	**sum**		
	F	-	-	-	-	3	1	1	2	7	23	10	
	?	-	-	-	-	2	1	-	3	6			
TOTALS		**128**	**20**	**8**	**36**	**19**	**8**	**8**	**12**	**239**	**< GRAND TOTAL**		
%		**54**	**8**	**3**	**15**	**8**	**3**	**3**	**5**				
uppermost side:													
right		**54**			**15**		**3**	**3**		**= 75%**			
left			**8**	**3**		**8**			**5**	**= 24%**			

--Wetwang Slack (Dent 1984)

At Wetwang Slack (Dent 1984), almost all of the inhumations showed some degree of flexure, the crouched position being the most common (79% of the sample with sufficient anatomical definition), the same preference seen at Rudston. Extension of the corpse is notably absent at Wetwang Slack, as is use of an E'-W'ly axis for burials, an even further reduction than that seen at Rudston, where they both occur in combination as a minor trend associated with 'warrior'-burial, as discussed below.

Wetwang:		**%**	**note**
crouched	285	79	
+flexure	75	21	includes all degrees of flexure;
extended	1	-	
total	**361**	**100**	

Data from these major cemeteries indicate that two basic rites are present for placement of the skeleton:

..the most common: corpse crouched, or contracted; NS>E, avoiding extended placement: columns 1, 11, 12; the 'standard' rite as discussed later;

..a minor variant: extended; EW or WE>facing either side;
columns 5-8, 10, 11; widespread occurrence of weapons in this group suggests it as 'warrior' burial, again as outlined in more detail later;

-squared barrows

The third stage of construction would have been layout of the squared ditch, with its spoil used to mound the central burial-area.

Although the most common basic pattern is that of a square, there is considerable deviation from regularity, with a few cases of circular ring-ditches also occurring (e-FIG SQ-07: grave R108; SQ-08: grave R154).

Analysis of the sample of barrows in this analysis indicates a high degree of conformity between lateral side-ditches, and the long axis of grave-pits (e-FIG SQ-14), with data for mean length of side, and its mean orientation as follows:

barrows:						**e-FIG**
	units	**#**	**mean**	**sd**	**mode**	**SQ-**
side	m	163	6.4	1.8	6.1	15
axis	deg	144	356.7	10.4	350.1	14
grave-pits:						
axis	deg	176	355.3	11.4	353.0	14

Key: # number of barrows; **sd** standard deviation

-chariot burials

Cases where the inhumation is accompanied by a chariot-cart, usually semi-dismantled, are relatively rare, and since the cemeteries included in this immediate analysis have produced only two examples, their relevance is only discussed further within the national, and Continental context, as outlined in a separate section below.

Orientation of those examples within the vicinity of the study-area, and from wider Britain, are given in TABLE SQ-07, and e-FIG SQ-16.

Overview: chariot-carts in this sample were placed to follow the N'-S'ly axis of the grave, and its inhumation, with their direction of 'travel' towards the N, and corpses placed in them head to the N, hence notionally 'drawn' head-first (e-FIG SQ-16); they contrast with graves from the Paris basin, for instance, which tend to take the transverse axis, with draw-poles of any added chariots towards the E, and corpses placed in them head to the W, hence 'drawn' feet-first (e-FIG-SQ 20). The implications of these orientations are discussed later.

Squared barrow cemeteries: structured growth

The regularly squared shape of barrow ditches, the close conformity of both grave-pit and monument with a polar axis, and the need for placement of individual sites in close proximity, would have combined naturally to promote automatic development of a generally latticed structure for cemeteries (e-FIGS SQ-06 to 13).

-linear elements and packing

Within cemeteries, individual lines of barrows are often evident, clearer where packing of monuments was reduced, as at Rudston N'n, mid, and S'n (e-FIGS SQ-06 to 08), less clear where barrows have become almost contiguous, as at Wetwang Slack (e-FIG SQ-13), Danes' Graves (e-FIG SQ-11), and Scorborough (e-FIG SQ-12, 12a).

This linearity, along a polar axis, may indicate a need to keep the view towards E and W unobstructed, as part of continuing ritual observance, this becoming over-ridden as more barrows crowded into the vicinity.

A well-developed linearity at Rudston S'n cemetery (e-FIGS SQ-08) contains what may be a male founder-inhumation, placed in a larger barrow at the S'n 'terminal' (grave R84), with a series of five smaller barrows, each containing a female inhumation leading N'ward, and this may indicate a discrete unit with its sequence of growth. A second such linearity, extending from grave R82, lies immediately alongside it, to the E, but is less clearly defined.

At Garton Station the chariot burial (grave GS6) has a linear series of barrows extending N'ward, again suggesting a founder burial, and sequence (e-FIG SQ-09).

At Wetwang Slack, growth of the cemetery has been divided into four main phases (Dent 1884, fig. 2.28/ p. 82; e-FIG SQ-13a). The initial phase consisted of a small cluster of barrows developing at the intersection of two tracks, both conforming with approximate cardinal axes. From this nucleus the cemetery spread E'ward, and N'ward during phases 2 to 4, as a narrow E'-W'ly moving band, maintaining the same general alignment for its component barrows. There is little evidence from the distribution of grave-goods, or from the gender of inhumations (e-FIG SQ-13a), to suggest marked zonation of the cemetery, which appears more developed amongst those at Rudston (e-FIG SQ-06 to 08).

-barrows: distribution by size

The relative size of squared barrows is expressed with reference to the mean value established for the sample in this analysis (mean length of side 6.4m: e-FIG SQ-15).

Barrows of average size dominate the cemeteries at Rudston N'n, mid, and S'n (e-FIGS SQ-06 to 08). However, the chariot-cart burials at Kirkburn (grave K5), and Garston Station (grave GS 6), each required a larger grave-pit, and surrounding squared ditch (e-FIG SQ-17).

Squared barrow cemeteries: existence of functionally different areas

Rudston S'n cemetery provides a significant sample from a larger, unexplored unit, that spreads beyond the area excavated (Stead 1991), sufficiently extensive to distinguish any zonation of key elements, singly, or in combination: type, and gender of inhumation, quality of grave-goods, and axial properties of burial, and barrow (e-FIG SQ-08).

Distinct differences between the four main zones of the excavated area are apparent. Noticeable clusters are as follows:

Rudston S'n cemetery:

sub-area	**gender**	**non-'standard' inhumation**	**weapons in grave**	**barrows............ latticed**	**in line**
N'n	M	high	higher	yes	no
central	F	high	lower	no	yes
W'n	M	lower	low	minor	minor
S'n	F	low	low	no	weak

This stresses the obvious need to base general analysis of axial trends on a large sample of monuments.

'Standard' burial-practice: the majority of cases

Data presented in TABLES SQ-03 to 05 indicate a standard burial-practice, with some minor variation evident:

..attitude:

Pronounced flexure of the corpse was preferred, with 71% skeletons showing crouched, or contracted placement, with males and females treated equally;

..axis:

The polar N'-S'ly axis was by far most commonly adopted, with the head pointing N'ward, and the body facing E'ward, hence with its right side uppermost, this perhaps in some way also significant (see discussion below: aversion of gaze); this lateral preference is seen in the total data: 75% with the right side uppermost, 24% with the left side up.

..conformity:

As defined by these combined aspects, the degree of close conformity with the standard burial-rite (NS>E: head to foot>laterally facing) was about 50%, suggesting a fair degree of laxity in application, and the operation of personal choice. The overlying barrow, given its usually squared shape, and hence lack of a distinct single axis, without added structuring of, or on, the mound, can not have conferred some over-riding indication of ritually-significant alignment, as has been suggested for Neolithic chambered tombs (see Table of Contents: section LB-, long barrows, and related monuments), and linear round barrow cemeteries of earlier Bronze Age date (Table of Contents: section RB-, linear round barrow cemeteries).

Inhumations in the cemetery at Wetwang Slack showed the same preference for flexure of the body, head towards the N, and facing E'ward (Dent 1984, 96).

'Warrior'-burials: a numerically minor but conspicuous complement, and culturally significant

Two distinct burial rites can be identified amongst the large sample of graves from the Rudston cemeteries (e-FIGS SQ-06 to 08), characterised by the following preferences: what has been called here the 'standard' rite, as described above, accounting for the majority, but with a minority of 'warrior'-burials scattered amongst them (e-FIGS SQ-06 to 10):

			corpse				
burial	**frequency**	**axis**	**flexure**	**head_to |**	**facing |**	**side_up**	**grave-goods**
'standard'	high	polar	crouched	N	E	R	poor, no weapons
'warrior'	low	transverse	extended	E or W	S	L	poor, + weapons

Key: side_up[permost]: side of corpse placed uppermost, **R**[ight], **L**[eft];

However, for the small sample of graves from Garton Station (e-FIGS SQ-09), and Kirkburn (e-FIGS SQ-10), warrior-burials *as defined above* are absent, with weapons simply appearing in graves of 'standard' type.

Evidence for the existence of a distinct 'warrior'-burial, with defining properties (transverse axis, extended skeleton, and presence of weapons [APPENDIX SQ-02]) is summarised below, in TABLE SQ-06:

TABLE SQ-06 Warrior-graves: as defined by the relationship between axis, extension of skeleton, and presence of weaponry

--Rudston cemeteries (Stead 1991):

			skeleton				
		graves	extended		with flexure		side
axis		#	#	+weap	#	+weap	uppermost
EW	**>N**	16	8	2	8	1	L
	>S	8	5	3	3	1	R
	>?	7	7	2	0	0	?
sub-		**31**	**20**	**7**	**11**	**2**	
WE	**>N**	8	3	1	5	0	R
	>S	13	7	4	6	1	L
	>?	2	2	1	0	0	?
sub-		**23**	**12**	**6**	**11**	**1**	
totals		54	32	13	22	3	
polar		2	0	0	2	2	

Key: #: number**; weap**[onry]

--Wetwang Slack cemetery (Dent 1984):

In contrast to the Rudston N'n, mid, and S'n cemeteries only two graves at Wetwang Slack contained weapons, and only one of these constitutes a 'warrior'-burial, the other an apparent homicide (Dent 1984, 176):

burial 98 male; NS>E; with sword and ?shield;
211 female; SN>E; spearhead embedded in bone *pre mortem*;

Burial 98 could be considered more as a 'standard' N'-S'ly crouched burial with added weapons, rather than the type of E'-W'ly oriented, extended inhumation of more typical 'warrior' type, seen in greater numbers at Rudston.

conclusions:

-general

In the large sample of graves from the Rudston N'n, mid, and S'n cemeteries, only 6% [18/279] contain weapons. These are distributed disproportionately between graves with different orientation: 89% [16/18] of them in graves with a transverse [EW,WE] axis, but only 11% [2/18] in those with a polar [NS,SN] axis.

Skeletons in the axially transverse graves were most commonly placed in a preferred position, with 59% [32/54] extended, rather than flexed to any extent, and with uppermost side as follows: left 54% [29/54], right 30% [16/54], and indeterminate 17% [9/54].

-in more detail

graves on a transverse axis [EW,WE] dominate the sample, the polar axis [NS,SN] being insignificant, and hence discounted here:

considering:

..either direction within the axis:
59% [32/54] contain extended inhumations; 40% of these [13/32] include weapons;
41% [22/54] contain variously flexed inhumations; 14% of these [3/22] include weapons;

..the EW direction alone:
65% [20/31] contain extended inhumations; 35% of these [7/20] include weapons;
35% [11/31] contain variously flexed inhumations; 18% of these [2/11] include weapons;

52% face N'ward [16/31; 26% [8/31] face S'ward; 23% [7/31] are of unknown direction;
weaponry is evenly distributed between all three;

..the WE direction alone:
52% [12/23] contain extended inhumations; 50% of these [6/12] include weapons;
48% [11/23] contain variously flexed inhumations; 9% of these [1/11] include weapons;

35% [8/23] face N'ward; 57% [13/23] face S'ward; 9% [2/23] are of unknown direction;
weaponry may be slightly more abundant in graves facing S'ward;

-continental parallels:

Although the 'warrior'-graves of the 'Arras' culture show distinct differences to 'standard' graves from the same area, they do show certain similarities with broadly contemporary burials in NW'n France, for instance, generally in the Paris basin, especially in Champagne, and Marne (Baray 2003, 2016), and in the Ardennes (Cahen-Delhaye 2013/5, 38-39). In those areas, graves are often on a broadly E'-W'ly axis, with the corpse supine, and placed with head towards general W. This arrangement is further seen amongst more specialised chariot burials from the same area, as for a localised group of 19 from the Ardennes, which were aligned broadly SW'-NE'ward (Cahen-Delhaye 2013/5, fig. 15/ p.39), with the corpse placed with head towards the SW, laid longitudinally in the carriage of the chariot, the draw-pole of which pointed towards the NE (e-FIG SQ-14 and 20).

Inhumation burial during the Iron Age in S'n Britain: comparative data

Inhumation burial, the predominant rite in S'n Britain during the Iron Age, shows considerable variability in orientation of the grave, and in placement of its corpse, with regional trends, for the most part, only weakly apparent (Whimster 1977, 1981). Poorly recorded early excavation of key sites, and the general scarcity of cemeteries capable of providing large regional samples, have resulted in fragmented national data. In many cases the absence of surviving grave-goods, lack of physical dating, and continuation of traditions from the Iron Age into the Roman period introduce further uncertainty. Such graves, typically in pits, or cists that are unmarked by superstructure, are also difficult to target specifically, and are usually a by-product of general excavation.

However, the 'Arras culture' of E'n Yorkshire is exceptional in having its burials accessibly concentrated in large cemeteries of conspicuous barrows, rather than dispersed amongst smaller settlements, as is the case for much of the rest of S'n Britain. Although well-defined in this specific area, broader comparisons are more difficult on the national scale, without a common basis.

Grave-pits in E'n Yorkshire are well aligned around the N'-S'ly axis (e-FIG SQ-14), with inhumations placed longitudinally, commonly crouched, or flexed, with head towards the N, and placed on the left side to face E'ward, with no gender-related differences in practice (TABLES SQ-03 to 06). There is some deviation from this standard, but the E'-W'ly axis is avoided, and extended burial is uncommon, the two factors in combination forming a minority group of 'warrior'-burials (TABLE SQ-06).

In S'n Britain generally, among pit-, grave-, cist-, and ditch-based burials, the head of the corpse most commonly points between N and E, with the body often lying on its left side, facing broadly E'ward. Burials in the Durotrigian area of S'n Dorset tend to lie with head between NE and SE, often placed on the right side, suggesting a regional variation.

The general conclusion here must be that strict orientation played little part in the ritual of burial, with any preference expressed within broad guidelines, and some evidence for avoidance of certain directions. However, alignment amongst the graves of the 'Arras culture' of E'n Yorkshire suggests closer conformity to a standard, perhaps partly due to more supervised burial in cemeteries, where orderly placement of squared barrows was required within a restricted area.

Chariot-cart burials in Britain

-reasons for inclusion

Vehicles deposited with burials, in regularly oriented graves, as well as indicating special status of the occupant, may relate directly to their symbolic use in enabling celestial transit of the deceased beyond the grave (see Table of Contents: section SY-, on symbolism). Their alignment, relative to other features of the burial, needs to be considered: indicating either passive conformity with the shape of the grave, as an extra element, or adding some active emphasis to funerary ritual.

-introduction

Although military equestrianism is indicated, not only in the literature (Karl 2003), but also by the widespread distribution in Britain of horse-, and chariot-fittings of mid to later Iron Age date (examples: Llyn Cerrig Bach [Fox 1946]; Stanwick [Wheeler 1954]), cases of chariot-carts preserved by burial are relatively rare, those with horses present rarer still. The precise nature of the vehicle, whether as a war-chariot, as is deemed likely in many cases, or as a more functional cart, has given rise to varied reconstructions, and discussions (Fox 1946, fig. 13; Stead 1991, 29-33; Piggott 1992; Carter *et al.* 2010, fig. 13/ p.59).

In terms of numbers, the currently-known British distribution of all such burials, around 30 in all, centres on the chalk-lands of E'n Yorkshire (examples: APPENDIX SQ-02), as a feature of the 'Arras culture', so defined from finds at a cemetery in the area, at Arras Farm (e-FIGS SQ-01 and 05; Halkon *et al.* 2019). This regional culture spans the 4th to the 2nd centuries BC (Jay *et al.* 2012, 2013), is characterised by cemeteries of squarely ditched barrows, containing inhumations, generally with poor grave-goods, burials which show potential links to contemporary cultures in the Paris Basin (Stead 1991; Carter *et al.* 2010, 57-58).

Squared barrows extend from a core-area on the Yorkshire Wolds, beyond, and to the SW of the Arras group, on around the Humber estuary (Halkon and Innes 2005, fig. 10/ p.247). Outlying barrows are also known to the N of the main area, and some have produced reports of chariots, as at Pexton Moor, Cawthorn Camps, and Hunmanby (North Yorkshire).

The national distribution of chariot-cart burials is, however, growing beyond this area of Yorkshire, with recent finds from S'n Scotland (Carter *et al.* 2010), and W'n Wales (Pembrokeshire: specific data as yet unavailable) extending the range, albeit thinly. Apparent concentration of such vehicles on the Yorkshire Wolds (e-FIG SQ-18) may be in part a result of their association with squared barrows, which can survive as standing monuments, and hence form obvious targets for excavation, of which they are usually an incidental by-product. In other areas of Britain, where there was no overlying barrow to the burial, or where any ephemeral structure has not survived, many other cases may yet exist, undetected. For instance, the chariot-cart at Newbridge (Scotland) was buried in an apparently unmounded pit, and was discovered as a chance find (Carter *et al.* 2010). The isolated squared barrow at Ferry Fryston (Yorkshire) was first seen by aerial photography, then confirmed by magnetic mapping, with a strongly positive central anomaly suggesting the presence of large iron-work, typical of chariot-wheels (Boyle *et al.* 2007). A similar method of prospection was used in the Rudston area to detect chariot burials at Garton Station and Kirkburn (Stead 1991, fig. 93/ p. 160).

The major, centrally-located cemetery at Wetwang Slack (Brewster 1981; Dent 1983, 1984, 1985a and b, 2002; Hill 2001, 2002; Jay and Richards 2006; Jay *et al.* 2012) has produced over 450 burials, many of them lying under squared barrows, dates to the 3rd and early 2nd centuries BC, and includes five chariot burials from its locality. Another area of intense burial activity, around Rudston, investigated in detail by Stead (1991), and forming the basis for this analysis, has produced two such burials.

Occasionally, chariots were placed in the grave pit complete, with wheels in place, or more often semi-dismantled, with wheels removed, these then laid or stacked marginally, this latter procedure a feature of those from cemeteries of the 'Arras culture'. Indications of the carriage, and its single draw-pole often survive sufficiently well to enable the longitudinal axis of placement to be determined accurately (e-FIG SQ-16). The accompanying inhumation, where it survives, was laid in, or under, the carriage. The axis of the vehicle conforms with the longitudinal axis of the grave-pit, preferentially polar (N'-S'ly) in E'n Yorkshire (TABLE SQ-07), and in some cases its draw-pole was fitted into a slot-like extension to the main grave-pit, the wheels also semi-sunken in the floor of the grave (e-FIG SQ-16). The main pit at Newbridge (Scotland) was custom-cut to contain the vehicle, with such deeper depressions for its wheels, both of which are common features of continental chariot burials (e-FIG SQ-20).

The current exemplar of a chariot burial from the 'Arras' group is that discovered at Ferry Fryston (Yorkshire), where a relatively small, and isolated squared barrow produced an intact chariot, inhumation, and modest grave-goods, from a context well dated to the 3rd century BC, and with structural axis well-established for each of the main elements (Boyle *et al.* 2007; e-FIG SQ-16; APPENDIX SQ-02).

-general types

Chariot-cart burials can be broadly grouped as follows:

..mounded:

...the dismantled horseless series of E'n Yorkshire;

Wetwang; Garton Station, Kirkburn;

...chariots with horses present;

Pocklington (Yorkshire);

..apparently unmounded:

Newbridge (Scotland); the absence of any surviving human remains may be the result of adverse conditions for preservation in acid soil, rather than this being burial of the chariot alone;

-relative size of their barrows

It might be expected that, being more prestigious, a chariot-burial would have been marked by a larger squared barrow, well above mean size, and this is certainly the case at Garton Station and Kirkburn, but not at Ferry Fryston, which is no more than standard in plan (e-FIG SQ-17). However, large barrows can also house non-chariot burials, of entirely standard type, where surviving grave-goods are absent, or poor, suggesting lower status. Size of the barrow alone is not, therefore, the mark of chariot-burial, or even apparent status of occupant. What does appear to be diagnostic for chariot burials is the high ratio between the area of grave-pit, and that of the surrounding ditch, compared to that for standard barrows. Burial of even a semi-dismantled chariot-cart would have required a larger pit, which needed a larger quarry ditch to supply sufficient spoil for mounding of the barrow. The sample of chariot-burials is too small to establish any specific axial preference, but the alignment just to the E of N for those examples in e-FIG SQ-17 is, however, noted (TABLE SQ-07).

-dimensions of the vehicle

Averaging the data for six examples from Yorkshire given in Stead 1991, table 2/ p. 32, gives the following dimensions:

lengths: axle 1.93m, pole 3.05m, total 1.46m; **width:** of box-body 1.08m; **height:** of box-body 0.48m.

-orientation of the vehicle

Only seven cases from Britain provide reliable and accessible axial data (TABLE SQ-07; e-FIG SQ-16). Orientation of vehicles is further discussed below, in combination with that of graves and barrows).

The number of chariots listed below in TABLE SQ-07 is to small to allow any more detailed summary of orientation, other than the general axis adopted for all elements is fairly closely N'ward.

TABLE SQ-07 CHARIOT-CART BURIALS: EXAMPLES WITH PUBLISHED AXIAL DATA

site		NGR SE-	barr	axis grave	(°G) inhum	M/F	chariot	skeleton	ref
Garton Slack	Yorks	9524 6007	sq	~N	~N	M	~N	~NS>?	1
Garton Stn GS6	Yorks	9808 5777	sq	009	014	M	009 dis	NS>E;con	2
Kirkburn K5	Yorks	9837 5742	sq	033	033	M	032 dis	NS>E;cr	3
Pocklington	Yorks	810 486	sq	~N	~N	M	~N	***	8
Wetwang Slack 1	Yorks	9456 6008	sq	344	333	M	344 dis	NS>W;cr	4
2	Yorks	9456 6008	sq	348	008	F	343 dis	NS>E	4
3	Yorks	9456 6008	sq	~N	~N	M	~N	NS>E	4
Wetwang Village	Yorks	9408 5990	sq	342	168	F	340 dis	SN>W;cr	5
Ferry Fryston	Yorks	SE 469 425	sq	024	338	M	357 int	NS>E;con	7
Newbridge	Edin	NT 123 724	nil	179	none	-	181 int	none	6

Key: barr[ow present]: **sq**[uared]; **inhum**[ation]; **M** male, **F** female;
chariot: axis: = the direction of pointing for the draw-pole; **dis**[mantled chariot]; **int**[act chariot];
inhumation: axis: taken along the spine, towards the head-end; **lay-out**: head to foot > direction of facing;
skel[eton]: **cr**[ouched]; **con**[tracted];
References:
1: Brewster 1971; photograph only; **2:** Stead 1991, 29-30, fig. 26, 122; **3**: Stead 1991, 30-33, figs. 27, 127; **4**: Dent 1985 a, 2002; **5**: Dent 1985a, 2002; Dent 1985 a and b; Hill 2001, 2002; **6**: Carter *et al.* 2010; **7**: Orton 2007; Boyle *et al.* 2007; **8**: Current Archaeology Magazine 327 (2017), 347 (2019);
Note: other cases, lacking precise data are given in Appendix SQ-02;
values given for the axis are derived entirely from plans with undefined N-pointer as given there;
NGR for Wetwang is that for the centre of the cemetery;

Chariot burials in central-NW'n France

Lightly framed, two-wheeled, pole-drawn vehicles, with relevant metal fittings and horse-harness, all suggesting use as war-chariots, are found in higher-ranking burials throughout the area of Celtic La Tène culture, from Scotland in the W, to Bulgaria in the E. The usual rite was by inhumation, with both males, and females represented, and burial was often accompanied by a range of higher quality grave-goods, richer than found amongst British examples.

Four-wheeled wagons, more suited to general draught, are found in tombs distributed over E'n Alpine France, and Germany, and are Hallstatt in general date (Pare 1992; e-FIGS SQ-19 and 20). They provide a further example of transport-related symbolism in a burial-context, and have a bearing on discussion of alignment amongst the generally later La Tène chariot burials.

Two groups of chariot-burials are included here to illustrate general features:

-Ardenne-group (AG), Belgium: 19 examples: e-FIGS SQ-19 and 20; (Cahen-Delhaye 2013/5);

A localised group of 19 such chariot-burials from the Ardennes forms a coherent, localised, fully excavated sample, with alignment clearly established throughout (Cahen-Delhaye 2013/5, fig. 16/ p.42), providing a good basis for comparison with the Yorkshire group (YG).

The grave-pit is often tapered in plan, fitting the main carriage, and front end of the chariot more closely (14/19 graves), and some have an additional, narrow slot, specifically cut to contain its extended draw-pole (10/19 graves). Depressions were sometimes cut into the base of the grave, at the rear, to contain the lower half of the wheels, thus enabling a more economical vertical fit for the carriage. Similar tapering is seen in YG and beyond, as at Newbridge and Wetwang, with clear wheel-slots additional at the former site (e-FIG SQ-16).

Graves in AG are oriented broadly E'-W'ward, chariots placed with draw-pole towards the E (e-FIGS SQ-20 and 14).

Surviving skeletal material is sparse in AG, reflecting adverse ground-conditions, which precludes detailed comparison between inhumations. In terms of gender, there seems to have been more equivalence than amongst YG (note: the British sample is currently very small), with both males (8/19 graves), and females (5/19 graves) interred, 6/19 skeletons remaining indeterminate.

Orientation of the sword in burial K21 may indicate placement of the poorly preserved corpse with its head to the W, and hence to the rear of the chariot, but the sword in burial K18 is placed in the opposite direction, leaving any conclusion unresolved.

Compared to YG, grave-goods in AG are richer and more diverse, with extra weapons present to suggest 'warrior'-burial. The general dating of burials for both AG and YG is similar, spanning the 3rd to 2nd centuries BC. In YG, chariots are oriented with draw-pole towards the N, and in AG towards the E, different directions for any inferred motion.

-Bucy le Long, Aisne (BL); central-NW'n France; e-FIGS SQ-19 and 20; Pommepuy *et al.* 2009;

Among the many standard burials in this area, the grave-pits for chariot-burials appear more rectangular, and less fitted to the shape of the vehicle than those in AG. Several of these burials from BL occur centrally within a circular ring-ditch. Good preservation of skeletal material indicates clearly that corpses were laid with head towards the W, and hence the rear of the chariot, the draw-pole of which was oriented towards the E.

Many of the 'standard' burials from the area are extended supine inhumations, with head towards the NW (Lobjois 1974).

-Les Craises, Molinons (Yonne, N'n France): e-FIGS SQ-19 and 20; Baray *et al.* 2013;

This site provides an example of a chariot-burial associated with a complex squared barrow, of the general form found as simplified versions in E'n Yorkshire. The central area of this large barrow was framed by three concentric squared ditches, and accessed by an entrance gap, midway in the N'n side of the innermost ditch, the other ditches appearing unbroken (dimensions: inner 8.6 by 9.6m; central 16.8 by 17.6m; outer 39.6m by 41m). The nature of this central area was undetermined, excavation at the site being partial, but it might have contained some timber structure, perhaps sepulchral, or at least related to funerary ritual.

A partially robbed chariot burial was cut into the second of the squared ditches, midway along its unbroken S'n side, the grave-pit containing an unburnt skeleton, partial, but with key bones sufficiently in place to indicate a prone extended adult inhumation, of undetermined gender. The burial has been dated to 475-450 BC, from analysis of the finds.

Scattered minor objects of bronze, and iron included a range of small items relating to personal clothing (brooches, belt-buckle, bronze disk), horse-harness, further indicating the original presence of a chariot (iron hub- and wheel-fittings), but one of unknown nature, placement, and completeness.

Alignment at the site was as follows: ditches of the barrows, and the secondary grave-pit were all uniformly oriented at 354°, and the skeleton at 011°, on a polar N'-S'ly axis, in contrast to many from the region, which adopt the transverse E'-W'ly axis.

Alignment: general discussion

Graves, barrows, and any chariot-burials are discussed together here in combination, considering the small British sample in relation to parallels from central-NW'n France (e-FIG SQ-19).

General considerations

-orientation of the corpse:

..the ritual basis for placement

The longitudinal, and lateral axis of the body, and its degree of flexure, interact to produce a final posture. The **direction of the head, and that of facing** for the body seem of more likely importance than the converse. The **degree of flexure** of the corpse also appears significant, since it determines the postural stability of whole-body facing, while independent flexure of the head adds a further refinement.

Beyond basic anatomical description, interpretation as to motive for placement remains subjective, with only a **balance of probabilities regarding priorities** being possible. For instance, the direction of pointing for the head, and of bodily facing might seem to be the key elements. However, it is possible that they are incidental enabling factors, if the head points in a particular direction only to allow the best choice of lateral facing, and lateral facing only to allow a particular side of the body to be upward-, or downward facing, or to enable 'aversion of gaze' (see just below).

Additional to establishing the most significant aspects of placement, there is the question of suggesting some **basis for it in ritual**. A corpse placed in the foetal position could indicate readiness for rebirth in an afterlife, or simply be an affirmation of the circular nature of the human life cycle. Lesser flexure, or extension of the corpse, might simply reproduce the natural sleeping position. The range of postures seen in the sample of burials indicate a fair degree of choice as to disposition, but some of these choices can be united (see just below).

Providing some **external cue** for these directions is also entirely conjectural, but the degree of axial variation encountered indicates reference to a general one, rather than anything specific. Here the solar transit is an obvious contender, being a generalised target, relevant to themes of life and death.

..possible involvement of the solar transit (e-FIG SQ-22)

If the solar transit was indeed seen as providing a connection between the world of the living, and that of underworld-ancestors, lying beyond the W'n horizon, then facing a corpse towards its general ambit, either in its rising E'n, or setting W'n sectors, might have been thought to provide a ready line of access, with the sector active at the time of burial being the one available for facing the corpse towards the light. This process would resolve any conflict between use of opposite lateral placement of the body, being generally E'ward for burial during the morning, and W'ward for those after noon, thus uniting both alternatives in a single daytime-dependent ritual. Use of a polar axis for the grave, in this scheme, is incidental, acting only to provide a lateral E'-W'ly choice for facing.

The most common directions for facing the corpse, as shown by that sub-sample of inhumations for which detailed plans are given in Stead 1991, are seen to cluster towards horizons coinciding with those sectors of the rising solar transit that are immediately adjacent to its permanent zone, where the sun passes with frequency increasing towards the S'ly maximum (e-FIG SQ-22).

If facing the corpse towards the light at the time of burial was the rule, then certain directions would be favoured:

...**time of day** would determine general lateral direction, morning E'ward, and after noon W'ward;

...**season** would determine the degree of rotation of the corpse towards the S, winter burials being directed more S'ly, because the span of the transit reduces in this direction, towards a minimum at the winter solstice. Some increase in death-rate might also be expected in wintertime, contributing to any peak here, with Excess Winter Mortality (EWM) of 5-30% recorded for N'n latitudes in the modern era [separate study: Bowie and Jackson 2002];

..**the need for prevailing light** would mean avoidance of the N'n sector, which contains the null zone of the transit, where the sun does not pass;

..**a polar alignment** for the long axis of the grave, a regularity perhaps purely traditional, but one readily established from the circum-polar region of the night sky, would preclude facing the corpse towards the N, or S, unless the grave was wider than normal, and the corpse rotated E'-W'ward;

Interaction of these factors would tend to favour the SSE'ward-clustering frequencies of facing seen for the interim data shown in e-FIG SQ-22. Positioning the corpse on a polar axis would also have meant that the solar transit extended symmetrically over it, as the sun moved from E to W in its daily cycle, and this further daily involvement might also have been considered important, if not key. Any commemorative post-work, or totem on the mound itself, such as might mark a burial, would also interact with the transit, reinforcing its movement by shadow-casting, although there is no structural evidence whatever for this, since even surviving mounds are heavily eroded. Again, if the general passage of the transit was the important factor, whether the head of the corpse was to the N, or S, might have been a less important detail, again unifying these apparent discrepancies through a single solar mechanism.

..the need for 'aversion of gaze' (e-FIG SQ-21)

There seems to be a distinct tendency to avoid placement of the corpse so that it 'looks' out of the grave, a process termed here 'aversion of gaze'. This effect is achieved automatically for crouched inhumations placed on the side, where the angle of the head must follow that of the body, and look laterally into the earth. However, with more extended supine skeletons, the head often appears to have been turned deliberately to one side, perhaps to avert any ill-omened, outward gaze towards the living. In those few cases where a corpse was laid prone, this process would reach an extreme, the face looking strongly downward into the earth. If 'aversion of gaze' was indeed a significant factor behind choice of a direction for facing, then it would reduce the actual importance of lateral differences in facing either E'ward, or W'ward, and would also diminish the importance of any external environmental cue in making the choice.

This then could suggest one possible basis for burial ritual amongst 'standard' graves (TABLES SQ-03 to 05), with their tendency to adopt a polar N'-S'ly axis, and contain a corpse usually with head to the N, and facing E. But there remains the question of graves, and their extended burials, set on the transverse, E'-W'ly axis, which show some preference for E'ward direction of the head (57% to the E, 43% to the W), but none for direction of facing: the 'warrior' graves (TABLE SQ-06). Gaze would have been outward unless the head was rotated to the side in this way.

Seated burials from the La Tène Iron Age (Lamb 2018) clearly indicate cases where specific arrangement of attitude, and aspect for the corpse was considered essential to the particular ritual involved. Here too there is possible evidence for aversion of gaze. Known examples of these unusual burials are few in number, currently with only two from S'n Britain, three from Scotland, and eight from France, or its alpine margins.

Although a burial may be in a seated position, it should be noted that this could be incidental, simply a means of fitting a corpse economically into a confined space. Clear cases of ritualised, non-functional seating of the corpse should perhaps be confined to those graves where there was sufficient latitude for alternative postures.

Although there is considerable variation within the 'seated' group there are certain consistent features:

-only **adults** are involved, but of **variable age**, all **male** where verified;

-the preference was for burial in **pits** on the Continent, **cists** in N'n Britain, with data insufficient for S'n Britain;

-the burials usually appear **isolated,** rather than included in cemeteries;

-**single inhumation** was the norm, but there is one example of a double burial, with both seated, and non-seated individuals;

-there is an **association** of some burials with sanctuaries in France;

-**death** by natural, or un-natural means remains undecided;

-three **seated positions** are known: contorted, leaning forward, and slumped forward, all with the gaze horizontal, or downward; there is occasional evidence for binding of the corpse;

-**topographically**, certain of the burials are located in elevated locations;

-**orientation** of the body has been noted as towards nearby rivers, or other topographical features, with three facing the rising sun; cases are too few to allow conclusions about orientation by azimuth;

The seated position of such a corpse might be taken to indicate an intention to place a medium for continuing communication between the underworld, and the world of the living, more so than was possible for a burial laid horizontally in the sleeping, or resting position. Facing the seated corpse towards specific landmarks above ground has been suggested as lending support to this notion.

..including 'warrior' graves in the model

The extended supine body could also be said to have a facing direction other than upwards, that of notional rising to a seated, or standing position, as seen in far later resurrectionist ideas surrounding E'ward facing Christian burial. On this basis, bodies in these 'warrior'-graves, lying on an E'-W'ly axis, could also be considered as facing the light of the rising or setting solar transit, but starting from a supine, rather than the laterally recumbent position seen amongst 'standard' burials. Again seemingly well separated alternatives can be unified by the solar model.

..including the presence of chariots in the model

Addition of chariots to some burials, as grave-goods, introduces a further complication. As well as indicating prestige, and the status of its occupant, the presence of a chariot-cart in the grave suggests deliberate introduction of some dynamic element to the burial, perhaps related to speedy transition of the dead towards the underworld, and into the afterlife, existence of this latter destination suggested by repeated general placement of food-offerings with the corpse, presumably as sustenance for a journey.

Chariot-graves from E'n Yorkshire appear to be, in essence, 'standard' burials, with their usual polar N'-S'ly axis, and corpse with head to the N, facing E'ward, to which a vehicle has been added, in the only way it would fit, placed along the polar axis, with draw-pole to the N, whilst at the same time accommodating the most important element, the burial (e-FIG SQ-16).

The impression of the vehicle bearing the body resting within it head-first, and specifically N'ward may, therefore, be incidental, and simply the result of constraints imposed by the traditional shape of the grave. The important axis would have been that of facing for the body, all else being incidental.

Chariots in similar graves from the Continent (e-FIG SQ-20) could also be considered as fitted retrospectively to a standard grave, there generally set on an E'-W'ly, rather than a N'-S'ly axis. Here, the direction of 'travel' for the vehicle is not N'ward, but frequently generally E'ward (e-FIG SQ-14), with the corpse placed with its head towards the rear of the carriage, as if being drawn feet-first. Although supine, the direction of facing for the arising corpse could be taken as E'ward, corresponding with the direction of travel, and normal position of the driver.

Regular placement of bodies to face the rising and setting arcs of the solar transit, with their ever W'ward motion (TABLES SQ-03 to 05), in itself suggests establishment of a dynamic link, enabling transport towards the W'n horizon, a common ritualised destination for the dead.

As well as these chariot-cart burials, the theme of transport is also shown by Continental wagon-graves of the Late Bronze, and Early Iron Age Urnfield, and Hallstatt periods (Pare 1992; e-FIGS 19 and 20). Here, grave-pits are commonly on a N'ly to S'ly axis, wagons conforming with this, and inhumations are usually supine, consistently with head towards the S, with the body often placed separately from the vehicle. This generally polar axis is similar to that seen amongst graves in E'n Yorkshire, but contrasts with the transverse axis prevalent amongst those from central-N'n France, although the cultural implications of this are unclear.

e-FIGURES: combined listings and supporting information

e-FIG SQ-

General maps

Squared barrows: cemeteries:

01: general distribution in E'n Yorkshire
the fuller distribution of squared barrows extends from this core-area N'ward and to the SW around the Humber estuary;

02: Rudston: area map
showing the location of cemeteries containing squared barrow featured in this analysis;

03: Garton Station and Kirkburn: area map
location of two small, but important cemeteries producing chariot-cart burials;

04: Wetwang: area map
location of this major cemetery and adjacent features;

05: Arras Farm: area map
location of this major cemetery, the type-site for the 'Arras' culture, and the site of three known chariot burials;

Squared barrows:

-cemeteries in the analysis: detailed plans

Note: the designation of barrows as Rudston N'n, mid, and S'n is specific to this analysis not to the original report (Stead 1991);

06: Rudston N'n: after Stead 1991, fig 17/ p. 19;

07: Rudston mid: after Stead 1991, figs. 15/ p. 16, fig. 16/ p.18;

08: Rudston S'n: after Stead 1991, figs. 7-13/ pp. 9-15;

09: Garton Station; after Stead 1991, fig. 20/ p. 22;

10: Kirkburn; after Stead 1991, fig 23/ p.25;

-other cemeteries mentioned: general plans

11: Danes' Graves: early map
a major, densely packed cemetery subject to early excavation;

12: Scorborough: early map

12a:Scorborough: aerial view
a major cemetery with extant but eroded burial mounds;

13: Wetwang Slack: detailed plan
perhaps the largest known cemetery in the region, densely packed with barrows, producing four chariot-burials from the area, and its margins;

13a:Wetwang Slack: development of the cemetery
shown here in layered format;
-four main phases are proposed by Dent 1984 fig. 2.28/ p. 82;
-distribution of male and female inhumations *ibid*, fig 3/ p 97;

Graphical analysis of data from the study-area

frequency distributions:

-of alignment:

14 barrows, graves, and chariots, showing axial tendencies:
Yorkshire: squared barrows, and their grave-pits;
chariot-carts from chariot-burials;
Ardenne: chariot-carts from chariot-burials;

-of size:

15 Squared barrows: length of side
data providing a measure of average barrow size, for comparison across the sample;

Chariot burials

-Britain:

16 aligned examples from Britain;

16a chariot burial: Ferry Fryston (Yorks.)

17 relative size of barrows covering chariot-, and 'standard' burials

18 chariot-burials, and squared barrows: distribution

-Continental Europe

19 N'n France: general distribution

20 N'n France and area: examples
Ardenne; Belgium; Cahen-Delhaye 2013/5;
Bescheid; Trier-Saarburg; Verger 1995;
Bucy le Long; France; Pommepuy *et al.* 2009;
Grosbaus-Vichten; Luxembourg; Metzler 1986;
Grosseibstat; Bavaria; Pare 1992;
Moulinons; France; Baray *et al.* 2013;

Various

21 Aversion of gaze
a possible explanation for laterally-facing inhumations;

22 The solar model as a basis for orientation of burials: a sample from the group of cemeteries at Rudston (Yorkshire)
The range of the solar transit at midsummer maximum, and midwinter minimum is shown for the Rudston area. The direction of lateral facing, for a sample of 39 inhumations from the Rudston group of cemeteries, has been added, these lying on a polar axis, mainly with head towards the N, and facing E'ward, as specified in Stead 1991, 185-227.

The figure shows that there is a clear preference for the corpse to be placed facing those areas of the SE'n quadrant of the solar transit, adjacent to its permanent zone, within areas where there is an increased incidence of the rising sun passing on many days of the year.

Appendices: filed separately in folder APPENDICES_filed

Data from the study-area:

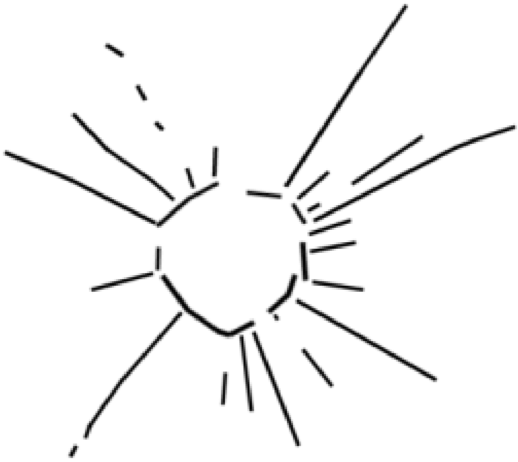
01 graves, inhumations, and grave-goods: from Stead 1991

02 chariots; interim data from various sources.

Section 03m:
Monuments formed by radiating concentric rings of posts or pits

Section identifier: RP-

SEE INITIAL SECTION:
Access to digital images



North Mains (Perthshire, Scotland)

Multi-ring, post-built structures of later Neolithic date, a few examples of which are included here in this residual group, can be divided into two types, according to the balance between concentricity, and radiality, as seen in their ring-structure (e-FIG RP-01).

The more common and well-established group:

This group is outlined here to provide a contrasting background for the second group, in which the radial structure is more pronounced, and hence has more potential for axial content:

elements:

type: post-work**, radiality** weak; **circularity** strong; **general structure was entrance-related:** yes; **central focus present:** no; **general emphasis of the structure**: non-axial, inward;

These structures are often associated with henge monuments, either as small discrete structures within them, or more rarely filling them:

site			in henge	structure	entry	reference	e-FIGS RP-
Durrington Walls	SU 1501 4375	Wilts	yes	S'n complex	irreg	Wainwright 1971	01
Mount Pleasant	SY 7099 8992	Dorset	yes	structure 4	+ 4	Wainwright 1979	01
Woodhenge	SU 1506 4337	Wilts	yes	entire interior	1	Cunnington 1929	01
The Sanctuary	SU 1184 6804	Wilts	Avebury	at end of avenue	+ 4	Cunnington 1930	01
Stanton Drew	ST 6009 6335	Som	no	main stone circle	?>2	Oswin et al 2010	01

Key: +: cruciform arrangement; **irreg**[ular]

Here the ring structure is well developed, but the radial component is weak, being largely confined to establishment of diametric, or radial passages, for entry towards the central zone, with intervening sectors of the surround infilled with spaced, but not closely aligned post-work. There is no central focus for inwardly-extrapolated radials. Here the 'emphasis' of the post-structure appears entirely inward, concerned with definition, and aggrandisement of the site itself, rather than any axial out-reach.

A poorly known, provisional grouping, currently entirely residual:

elements:

This note on these strongly radial monuments serves only to suggest the possible existence of a broader group, one that incorporates an all-round, outward array of structures, possibly providing an axial reference to the landscape, perhaps celestial as well as terrestrial, but equally unknowable. Such monuments may be 'free-standing' (Catholme 1, and 2), or exist only as a phase within a more complex structural sequence (North Mains).

type: posts, or pits; **radiality** strong; **circularity** strong; **general structure was entrance-related:** no; **central focus present:** examples of both focused, and unfocused sites are given here; **general emphasis of the structure**: outward is at least possible;

site			structure	focus	reference	e-FIGS RP-
Catholme 1	SK 1945 1670	Staffs	post-based	weak	Chapman *et al.* 2010;	01, 02
Catholme 2	SK 1968 1670	Staffs	pit-based	weak	Chapman *et al.* 2010;	01, 02
North Mains	NN 9262 1622	Perth	post-based	strong	Barclay 1983;	01, 03, and 04

The two sites at Catholme are closely adjacent, and form part of a ceremonial complex of Neolithic to earlier Bronze Age date, lying on the fertile gravels that flank the River Trent for much of its long course, here adjacent to a triple river junction (Chapman *et al.* 2010; Watters 2012; e-FIGS RP-01 and 02). North Mains lies similarly placed on gravels, again adjacent to a river junction, with a henge, and ring-ditches nearby (Barclay 1983).

Catholme 1: consists of five concentric post-rings, with an entrance gap in their NE'n sector, all surrounding an ovate central area, and maintaining a regular consecutive radiality for the entire circuit; date: radiocarbon dating indicates that the ring-ditch was re-cut around 2570–2490 BC, with later insertion of the central burial, and its Beaker pottery around 2000 BC;

Catholme 2: ('the sunburst monument'): this site is, at present incompletely defined around its outer circuit but, as currently known, consists of at least five rings of pits, arranged as 12 strong, well separated radials, all surrounding an inner, continuous, two-phase ring-ditch; date: radiocarbon dating of the post-ring indicates its construction around 2570–2470 BC;

North Mains: 17 lines of posts, as currently clearly visible, strongly radiating from a single focus within a central enclosure of unknown function, after an unknown duration as a free-standing structure, possibly of independent function, was then covered by the mound of a large round barrow;

-sequence in more detail:

from initial construction on the old ground surface to the beginning of the mounding process:

..two **central posts** were erected;

..**grooves** to E, W, and S were established, centred on one of these posts, in a T-shaped layout;

..the S'n half of a sub-circular **enclosure** was erected around this centre, 7-8m in diameter, impressions left in the mound indicating posts 2-4m tall; use of the enclosure remains undetermined, but possibly involved burial; the less substantial N'n half of the enclosure, with its entrance, was added subsequently;

..each of the three grooves came to align with a **radial fence** of stakes that extended beyond the central enclosure; other radial fences, of variable length, were erected, before any significant mounding took place, bringing the total to 17;

..a **ring-bank** was established around the periphery of the radial fences, and their intervening bays were then progressively **infilled**, the lines of decayed fences surviving as discontinuities between adjacent segments of spoil; as lower fences became covered, their line might have been extended upward, by similar structures;

-date: construction of the post-structure, and sealing under the mound took place in the later 3rd millennium BC, radiocarbon dates appearing compatible with some broad succession of phases:

2491-1958 BC (2 sd); 1855 bc +/- 100; GU-1134;
soil from the old land surface redeposited at its boundary with the turf dump of an initial phase of mounding;

2351-1925 BC;(2 sd); 1785 bc +/- 85; GU-1103;
in core material from mounding period; sherds of food vessel were also present;

2206-1744 BC; 1665 bc ± 85 (2 sd); GU-1102;
use of the hollow on top of the mound;

-general structure

This structure of radiating fences, together with the central enclosure might have formed an integral monument, or the fence-lines might have been added entirely for the purposes of compartmentalising, and stabilising subsequent mounding of the area. The detailed stratigraphic sequence is not sufficiently specific to resolve the relationship between central and outer elements, providing only a broad succession of events, with which the closely spaced series of radiocarbon dates appear to be in agreement.

However, the evidence indicates that posts originally stood up to 3m tall, and were higher for the central enclosure, and for its immediate surround, than for the periphery. The increased height of the timbered central enclosure is indicated by the plug of stony fill that formed the central mounding, its edge clearly marked by surrounding sediment (e-FIG RP-04). Whether these buried structures were extended up to, and reproduced in some way on the final surface of the mound remains unknown, but it is interesting to note evidence of activity over its central top.

Similar post-built enclosures, involving post-, and hurdled panel-work, occur under many round barrows of earlier Bronze Age date in S'n Britain, as a distinct, initial, relatively short-lived phase, often associated with burial, frequently ending in demolition, finally to become sealed under the mound (brief review: Marshall 2020). Earlier still, during the Neolithic, similar fence-work was used to divide the body, and tail of the prospective mound-area of certain long barrows, providing bays for subsequent infill (e-FIG LB-31).

There are three main options for interpretation of the final structure:

1-these radial fences might have been part of an **independent monument**, and their functions might have been axial, or otherwise related to operation of the central enclosure which, when redundant, required complete sealing by a large mound;

2-the bays between fences might then have been **secondarily utilised** in order to compartmentalise and stabilise the process of symmetrical infilling;

3-alternatively these fences might have been **added specifically,** as an aid to such mounding.

Considering the entire post structure, on balance, combination of the first two options seem best supported by the evidence.

Medicine wheels, strongly radial stone placements from the native cultures of the North American plains (see Table of Contents: 07/2d), bear a general, and superficial resemblance in plan to some sites in this residual British group, but differ in materials, and in their structural coherence, this parallel thus remaining little more than a passing curiosity. Despite the recent construction of these medicine wheels, their precise function remains uncertain, limiting any use in providing ethnographic parallels for this minor radial group, or for those partially radial monuments represented by certain multiple stone rows.

The combination between a circular central area, and surrounding radial lines, as seen structurally in these monuments, may find a possible parallel seen graphically amongst carved motifs from rock-art in Britain (see Table of Contents: 06/8e), perhaps both suggestive of solar imagery.

e-FIGURES: combined listings and supporting information

e-FIG
RP-

01 Monuments with radial post-, and pit-structures: selected examples

02 Catholme, Staffs: location of the two radial structures
sites are located on a spread of gravel near the junction of two rivers, and form part of a complex that includes a cursus, pit alignments, and ring-ditches; after: Watters 2012, fig. 14/ p.23.

03 North Mains, Perthshire: location of the barrow
the site is located on a spread of gravel near the junction of two rivers, and forms part of a complex that includes a henge, and ring-ditches;

04 North Mains, Perthshire: the succession of radial fence-lines as they continue up through the mound
the changing detailed lines of post-structures are shown as a layered succession, taken at metre intervals, from the old land surface, and up into the body of the mound that covered them; after: Barclay 1983, figs. 46-47/ pp. 200-201.

Studies in specific areas

Section 04

Detailed studies: selected areas

Summary:
In contrast to those other sections in this analysis that deal with single types of monument, for the following areas relevant monuments are briefly discussed together, to provide a few additional studies by region, or locality:

Stenness, Orkney: alignments of monuments on the isthmus at Stenness (Orkney, Scotland), an important area of settlement;

Sligo: the area around Sligo (County Sligo, Ireland) provides important data on various aspects of orientation amongst passage tombs;

Mid Wye, and Usk valleys: these river valleys contain an important group of long barrows of Cotswold-Severn type, with alignments suitable for comparative analysis;

Brittany: the Breton peninsula includes a more detailed study of the Petit Menec-Menec complex of stone rows, its alignment, and status as a hyper-monument;

Stanton Drew: this structurally well defined megalithic complex contains numerous axes suitable for combined analysis.

The range of more detailed studies

This analysis contains a series of more detailed case-, and area-studies **(case:** confined to a particular type of monument; **area**: involving different types of site within a given locality), as listed below. Those more central to the main discussion appear within the specific topic, with five others (in **bold** type below) placed here in Additional Studies (**SA**).

			study....		see
type of site	**region**	**details**	**case**	**area**	**section**
long barrows	Cotswolds	Severn-Cotswold type	*		LB
	mid-Wye Usk	**Severn-Cotswold type**		*	**SA_wye**
	Lincolnshire	earthen types	*		LB
augmented barrows	all		*		AB
chambered tombs	N'n Scotland	Caithness and Sutherland	*		LB
Ireland	Boyne valley		*		LB
Ireland	**Sligo area**			*	**SA_sl**
cursus monuments	all		*		CU
linear round barrow	S'n England	Upper Thames		*	RB
cemeteries		Avebury		*	RB
		Salisbury Plain		*	RB
		S Dorset ridgeway		*	RB
		S Downs		*	RB
		Mendip		*	RB
squared barrows	E'n Yorkshire		*		SQ
stone rows	Dartmoor		*		SR
	N'n Scotland		*		SR
	Brittany			*	**SA_br**

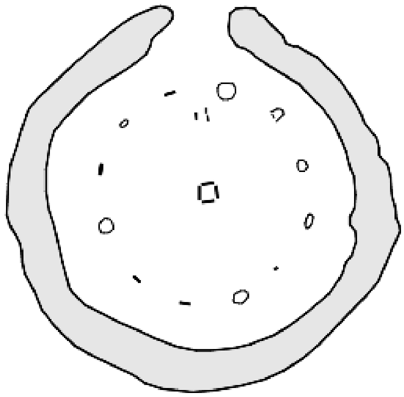
stone circles	**SW'n England**	**Stanton Drew**		*****	**SA_sd**
menhirs	Brittany		*	*	ME
rock art	Northumbria	Cheviot group	*		RA
henges	N Yorkshire	Milford basin		*	HE
		Swale-Ure area		*	HE
	Wessex	Stonehenge area		*	HE
		large henge enclosure	*		HE
		large round barrows	*		HE
various	**Orkney**	**Stenness area**		*****	**SA_st**

Key: sections: abbreviations used for sections are defined in Access to digital images (see Table of Contents: 01/2)

Section 04a:
Study area: the Stenness isthmus
(Orkney; Scotland; HY 2913 [centre])

Section identifier: SA_st-

SEE INITIAL SECTION:
Access to digital images



Stenness: Orkney: Stones of Stenness: henge

Reasons for inclusion

The Stenness isthmus in Orkney is included because of the concentration, richness, and variety of its sites, with linear topography providing an additional element when considering axial alignment. This area of Neolithic and Bronze Age settlement contains several major monuments, of different type, and provides an opportunity for comparison of alignment to be made within the general background established nationally for each.

Topography

A narrow isthmus, about 4km long, by 0.5km wide, runs NW'-SE'ly, and divides the Loch of Stenness from the Loch of Harray (phot SA_st 01). Relief is generally slight, with a ridge of higher ground running along the isthmus in its NW'n sector. Lateral vistas over lochs to the NE, and SW offer significant settings for sites, in terms of open aspect.

Although the isthmus is cut by the sea at present, near its SE'n limit, the channel is shallow and, given lower sea levels in prehistory, it might have presented less of an obstacle, or even provided a land bridge.

Sites

The isthmus, a World Heritage Area, contains an unusual concentration of sites, with far fewer in the surrounding locality. Major monuments include henges, stone circles, and other settings, barrows, chambered tombs, and settlements with well-preserved house structures, as listed below, with further details given as supplementary information. General information on the area can be obtained from Ritchie 2000.

Neolithic to Bronze Age

-settlements: Barnhouse; Wall of Stenness; other scatters of contemporary domestic debris;

-**chambered tombs,** and other larger unexcavated mounds, some ditched, may contain chambers; round mounds predominate;

..known: Maes Howe; Ring of Bookan; Sandwick; Unstan; 'Hotel Mound';

..unexcavated: Salt Knowe; Skae Frue;

-**major circle-henges:** Stones of Stenness; Ring of Brodgar; Ring of Bookan may have some affinity with henges;

-**standing stones:** Comet Stone; Barnhouse Stone; Watch Stone; Odin Stone;

-**barrows:** smaller, and predominantly circular, with some oval; mainly single, but with some instances of clustering, as around the Comet Stone, and Maes Howe; weak linearity in some cases;

-**cists:** unmounded, or originally mounded;

Conclusions

No distinct axial trend is visible amongst the range of monuments present, certainly nothing to support the type of analysis by Thom for the complex at Brodgar henge, the Comet Stone, the adjacent cairn-field, and its alignment with topographical features, in terms of significant astronomy (see below, supplementary information: Comet stone). Here, the date, and precise relationship of monuments is unknown, and the analysis anyway small-scale, and inherently unconvincing.

As well as allowing wide views of open sky towards the SW, and NE, the narrow isthmus certainly forms a distinctly oriented feature, providing a clear viewing line SE'ward along the land bridge, especially from higher ground to the NW. Sites located on this strip of land might have been drawn into this axis, and have utilised it for purposes of ritual, irrespective of their individual alignment.

Concentration of sites on such an impressive natural axis has been seen elsewhere, as on the South Dorset ridgeway, which bears significant concentrations of round barrows in a defined area (see Table of Contents: 03h/2j, and 03j/3).

The line of the isthmus would certainly have formed a natural thoroughfare, perhaps uninterrupted by the current short sea-crossing. The line between opposing entrances at The Ring of Brodgar might have conformed with, and taken advantage of, such a route, a relationship also suggested for henges in the Milfield basin (see Table of Contents: 03f/4a), and Swale-Ure area (see Table of Contents: 03f/4b). However, the direction of entry to the single entrance at the Stones of Stenness is towards the S, cutting across this topographical trend-line, and is more typical of axes at henges with opposed entrances (e-FIG SA_st-01)

Some other sites show possible conformity with the NW'-SE'ly spine of the isthmus, perhaps passively conforming with its topography. This is the case at those few barrow cemeteries with more linear disposition, such as Wasbister, and Brodgar, and the long axes of the few slab-like standing stones.

Axes within chambered tombs show no consistency, although only three are known in more detailed plan. Directions of entry at Maes Howe, and Sandwell, are generally N'ward, and at Unstan more towards the W, an axis typical of the national group (e-FIG SA_st-01), but with its elongate chamber set perpendicular to the entrance-passage. The sample is far too small to draw any more general conclusions.

The exceptionally impressive chambered tomb at Maes Howe has often been discussed in terms of more precise astronomical alignment, its passage opening towards midwinter sunset (e-FIG LB-94), thus allowing seasonal illumination of the interior (see Table of Contents: 03a/20). The direction of entry, towards the NE, is atypical of such sites (TABLE LB-01).

It is possible that these SW'ward-opening passages, the faces of undated standing stones, and the few barrow cemeteries that are more linear, could suggest a sun-ward interest in the S'n arc of the sky.

The lack of clear, and consistent orientation amongst monuments in the area may indicate considerable latitude in choice of axis, whilst retaining any essential directional aspects of ritual by other means.

Alternatively, orientation of ritual might not have been present to any extent, or not expressed clearly in structural form, but have taken place in more direct relationship with the environment, without structural mediation.

Supplementary information on individual sites

Henges

-Stones of Stenness; HY 3067 1252; Canmore HY31SW 2;
circle-henge, possibly with outlying stones (Ritchie 1978); originally containing 12 stones; only three, about 5m high, remain, with the broken stump of a fourth, about 1.8m high, set around the W'n arc of a circle 31.5m in diameter; a central, rectangular construction of supine slabs, in which a post stood off-centre, contained cremated bone, char, and sherds; these stones were set around the upper margin of a flat-topped mound, and were quarried locally, perhaps from the surrounding ditch, up to 6m wide; a circular bank, 71m in external diameter, with a single causeway at the N, lies 5.5m beyond the ditch; ploughing has all but levelled the earthworks of the henge; radiocarbon dates, and grooved ware indicate construction in the Neolithic;
outlying stones: Watch Stone HY31SW 11, Barnhouse Stone HY31SW 12, and the Odin Stone may form part of a wider complex.

-Ring of Brodgar; HY 2945 1335; Canmore HY21SE 1; phot SA_st-03;
circle-henge possibly with outlying stones; the locations of 40 stones have been identified, of which 27 are still standing, although many have been re-erected; slabs are of local Old Red Sandstone, and stand about 2m high; the especially large stones at the N, and S, might have been axial markers; the ring, about 113m in diameter, is set just inside a rock-cut ditch, 9m wide, and up to 2m deep; opposed entrances lie at the NW, and SE; an outer bank is present.

The site has been suggested as a lunar observatory, linked to three natural foresights, set on different positions of the moon (Thom 1973, 1975). The acoustic properties of such sites have been discussed by Watson and Keating 2000.

-Ring of Bookan; HY 2834 1450; Canmore HY21SE 7;
a site of uncertain interpretation; possibly a Maes Howe-type barrow, with hengiform affiliations; a circular ditch, 62m by 71m externally, 13.5m wide, and 2m deep, encloses a platformed area, 39 by 46m; the ditch is comparable in size to that of Maes Howe, but larger than those of the two locally known henges; there is no sign of a causeway, nor of an outer bank; the central area contains an irregular mound of uncertain attribution, possibly a circular, or oval barrow, perhaps chambered, oriented NE'-SW'ward, with the centre too badly damaged for ready identification; two edge-set stones, and two circular features are extant.

Chambered tombs

-Maes Howe; HY 318 127; Canmore HY31SW 1; phot SA_st-02; chambered tomb, within an oval ditch, with axis placed about NNE'-SSW'ward; the mound is 32.5m by 39m, and 7.3m high, the internal platformed area is 76.5m by 68.5m, and the ditch 90.5m by 104.5m externally; the radial passage is 11m long, and 0.9m high, and opens into to a squared terminal chamber, of side 4.6m, and 3.8m high, up to modern corbelled capping, but perhaps originally 4.6m high; the three non-passage sides of the chamber open to L-shaped sub-chambers; the passage opens towards 222°, approximately winter solstice sunset for this latitude.

-Bookan; HY 2864 1412; Canmore: HY21SE 10; Orkney-Cromarty Bookan-type chambered cairn (Davidson and Henshall 1989; Card 2005); a mound, about 16m in diameter, contains a central chamber.

-Unstan; HY 2829 1172; Canmore HY21SE 5;
Orkney-Cromarty Bookan-type chambered cairn (Davidson and Henshall 1989).

Barrows and cairns

-Salt Knowe; HY 2927 1328; Canmore HY21SE 14; oval mound, 40m NW'ward by 33m SE'ward, and 5.8m high; on the S'n edge of its top there is a cist, aligned E'-W'ward;

-Skae Frue; HY 2824 1440; Canmore HY21SE 8; circular mound, 23m in diameter, and 2.4m high, possibly mainly natural, but forming the basis for added structure; early excavation produced four inhumations;

-'Hotel Mound'; HY 3025 1165; Canmore HY31SW 24; chambered mound, surrounded by a circular ditch, 40m in external diameter;

-Bookan disc barrow; HY 2889 1371; Canmore HY21SE 3; possible disc barrow; low mound, about 15m in diameter, surrounded by a ditch, and external bank, about 6m wide, and 30m in external diameter;

-cairns; HY 280 145 area; Canmore: HY21SE 4; seven low mounds, from 4 to 10m in diameter, possibly cairns;

-cairns; HY 2859 1427: HY 2860 1422; low cairns; N'n cairn: 24m diameter; S'n cairn: 15m diameter;

-cairn; HY 2951 1348; Canmore HY21SE 11; circular mound, 19m in diameter, containing two cists;

-cairn; HY 2960 1339; oval mound, 38m NW to SE, by 26m transversely, and from 3.5m to 5.7m high; traces of horns can be seen at the S'n and E'n corners;

-cairns; HY 288 139; two contiguous ?cairns, lying E'-W'ward; HY 2887 1385; 19m diameter; HY 2888 1384; 12m diameter;

-cairn; HY 2881 1397; low cairn, 8m in diameter;

-cairn; HY 3039 1280; Canmore HY31SW 20; damaged mound, about 20m in diameter;

-cairn; HY 2946 1313; low oval mound, 9m by 12m;

-mounds near Maes Howe; HY 3175 1282; six mounds, 5-6m in diameter recorded;

-burnt mound; HY 2986 1378; low mound, 6m in diameter;

-ring-ditches; HY 291 134; Canmore HY21SE 93; two possible ring-ditches, 12m, and 6m in diameter, were detected by magnetic gradiometry;

-mound; HY 3051 1489; low mound, 11m in diameter;

-cist near Maes Howe; HY 3191 1286; Canmore HY31SW 26; cist, without mounding;

-cists; HY 302 129 area; Canmore HY31SW 25; six cists, three of which were joined end to end; Bronze Age pottery, and some bone associated;

-cists; HY 312 137 area; Canmore HY31SW 32; six cists, one with charred bone;

-cist; HY 2846 1478; Canmore HY21SE 6; ring-ditch, 15m in diameter, of uncertain association, and a larger ditch, possibly settlement-associated nearby, both detected by magnetic gradiometry.

Standing stones

-Comet Stone; HY 2963 1331; Canmore HY21SE 13; three standing stones are set on a low oval mound 14m by 13m; The Comet Stone is 1.8m high, and 76cm by 28cm in section, with its longer axis NW'-SE'ward; this axis may extend along a raised ridge on either side; two broken stumps nearby may be the remains of a mutilated 4-stone setting, or cove; cairns and cists lie nearby;

Thom proposes various lunar alignments involving other monuments, and natural features on the horizon (Thom and Thom 1978, 126-127; Thom and Thom 1990, part 2, 311-314: plan p. 313);

-Watch Stone; HY 3054 1264; Canmore HY31SW 11; standing stone; 5.6m high, and 1.5m by 0.4m in section; a second stone hole, oriented NE-SW, set at an obtuse angle, may indicate the remains of the SE'n arc of a circle;

-Stone of Odin; HY 306 126; Canmore: HY31SW 40; now destroyed; 2.4m high; pierced with a hole;

-Barnhouse Stone; HY 3127 1217; Canmore HY31SW 12; standing stone; 3.2m high, and 17cm thick, with profile expanding upwards, from 1.1m at the base, to 1.8m at about 2.4m high;

-standing stones; HY 3034 1283 and HY 3035 1283; Canmore HY31SW 10;
two standing stones set 8.2m apart; NW'n: 2.7m high, 0.4m thick, and 1m wide, set perpendicularly to the inter-stone axis; SE'n: 1.7m high, 0.4m thick, and 0.4m wide, set along this axis (135-315°G); traces of a raised cairn lie just to the S.

Settlements

-Barnhouse settlement; HY 3076 1270; Canmore HY31SW 61; a large, later Neolithic settlement, containing 10 stone-built houses, with a larger house surrounded by at least six others, set in an area about 60m by 80m, containing ditches and drains (Richards 2005); houses included a large oval building, 11m by 14m, with a side entrance, and external casing wall; outer wall 1.5m thick, and 26m in diameter, enclosing a large platformed courtyard area of clay and stone, laid around this inner structure; the internal arrangement of the house consisted of six rectangular recesses, set into the inner wall, and a hearth to the right of the entrance; a cist with cover-slab was located in a central position, directly in line with the entrance; in a second phase of construction, at least five smaller houses, of Skara Brae-Rinyo type, were constructed around the larger structure, all with a single outer wall, two opposed internal recesses, and a 'dresser'; grooved ware, flint, and stone artefacts were recovered; another settlement lies just over the water, on the main isthmus, at HY 3029 1285;

-Great Wall of Brodgar; HY 3029 1285; Canmore HY31SW 112; geophysical survey and excavation detected circular, rectangular, and linear features forming a settlement complex; later Neolithic buildings were similar to those at Barnhouse; midden deposits were associated;

-scatter of occupation debris; HY 289 144; a scatter of flint working debris and artefacts.

e-FIGURES: combined listings and supporting information

e-FIGS
SA_st-

01 Study area: Stenness area (Orkney, Scotland): general map of topography and sites

01a Study area: Stenness area (Orkney, Scotland): satellite imagery of topography and sites
This figure covers the same area as that in e-FIG SA_st 01, but shows prominent sites against terrain from satellite imagery.

Section 04b:
Study area: the Sligo area

(Sligo, Ireland; G 72 [centre])

Section identifier: SA_sl-

SEE INITIAL SECTION:
Access to digital images

Sligo: Carrowmore megalithic cemetery to Knocknarea Mountain

The Sligo peninsula and its hinterland

This study area covers a near-coastal sector around Sligo, 3km N-S, by 6 km E-W, based on the valley of the River Unshin, flowing N'ward from Lough Arrow, and its surrounding upland (e-FIG SA_sl-01). The Ox Mountains border the valley to the W, and the Kilronan-Corry Mountains to the E, with the smaller Bricklieve Mountains, and Kesh Corran, at the S. The area is rich in megalithic tombs, with the Carrowkeel cemetery on Brickleive, a smaller cluster at Kesh Corran, and a scatter up the valley, leading to a major concentration on the Sligo peninsula itself. Here, the largest such cemetery in Ireland, at Carrowmore, lies next to the imposing Knocknarea Mountain, with its major, and range of smaller cairns, probably an important elevated area of ritual activity, widely visible in the landscape.

Reasons for inclusion

This area is of interest to the analysis, for three reasons, the first two more major, and general, the third minor, and specific:

-study 1: examination of patterns of axial alignment in two major cemeteries of passage tombs, at Carrowmore, and Carrowkeel, as part of a broader explanation for the atypical orientation seen generally in this Irish group of funerary monuments. This issue is discussed more fully for the entire sample of such cemeteries elsewhere (see Table of Contents: 04/b4, and 03a/20f; e-FIG LB-20).

-study 2: use of other existing monuments as cues for axial alignment: there has been a detailed study of paired alignment amongst passage tombs, by Prendergast 2006, in which this area features importantly, providing the greatest concentration of examples (e-FIG SA_sl-01). In view of the atypical pattern of orientation seen in the general analysis presented in this study (e-FIG LB-20; Cf: more typical distribution e-FIG LB-10), this possibility needed further assessment, as a possible contributing factor.

After reassessment of data, there are major obstacles in accepting that inter-visibility formed an important factor in alignment (see just below).

-study 3: directed illumination: passage tomb G in the Carrowmore cemetery has been cited as aligned so as to allow internal illumination through its light box, and this relates to general discussion of the validity of this concept, and how it bears on questions of axial alignment (see Table of Contents: 03a/20).

The evidence that directed illumination of interiors was an intentional feature of monumental design is very weak, both for Carrowmore G, and generally, with no clear support for the primacy of the direction of facing within the monumental axis in determining ritual at the site (see: Table of Contents: 03a/20).

Use of other monuments as cues for axial alignment: study 2 above, further detail

-general discussion

In the case of many apparently isolated monuments, such as chambered tombs, there is rarely a clear case to suggest use of another monument as a cue for alignment. Where sites exist in closer proximity, or in positions allowing clear views of surrounding terrain, such sighting becomes more possible, although difficult to substantiate. Use of cues that are more universal, for instance celestial targets, seem more plausible to explain similar trends in orientation seen between monuments from widely separated areas (e-FIGS LB-01 to 21).

The presence of linked pairs of sites has, however, been suggested for specific passage tombs in Ireland (Prendergast 2006), but this particular proposal does not withstand more detailed examination,

Existing national Irish inventories of megalithic tombs indicate the following division into four structural types, with one residual category for undetermined attribution (data: *ibid*., p.3), as detailed in TABLE SA_sl-01:

TABLE SA_sl-01 IRELAND: MAIN TYPES OF CHAMBERED TOMB

	total		**revised**	**proportion of revised #:**		
type	**#**	**%**	**#**	**clustered**	**isolated**	**extant**
court	391	27	>400			
portal	174	12				
passage	**229**	**16**	**232**	**141 (61%)**	**91 (39%)**	**128 (55%)**
wedge	465	32				
unclass	189	13				
total	1448					

Key: # number; **extant** (axis of passage-chamber); **unclass**(ified)

The sample of passage tombs with extant axes, 55% of the total, was divided into five categories (*ibid*., fig. 3/ p. 7) thus (TABLE SA_sl-02):

TABLE SA_sl-02 IRELAND: PASSAGE TOMBS: CUES PROPOSED FOR AXES OF PASSAGE-CHAMBERS (ANALYSIS: PRENDERGAST 2006)

category		**#**	**%**	**note**
C	**aligned on targets:**			
1	tombs and cairns	39	**30.5**	aligned on prominent tombs and cairns, 83% of which are potential targets, set at higher altitude; little interest shown in solar declinations; no examples of tombs being reciprocally aligned;
2	solar events	21	16.4	presupposes importance of events at the horizon;
3	lunar events	4	3.1	presupposes importance of events at the horizon;
4	undetermined	60	46.9	-
5	ambiguous	4	3.1	aligned on both tomb/cairn, and solar/lunar event;
	total	128	100	

Category 1 therefore represents only 17% of the total sample (39 out of 232 monuments), a poor basis for general statements. The relationship between the horizontal, and vertical distances that separate 43 pairs of these linked sites has been extracted by the author [AJM] from the data as presented (ibid., table 1/ p. 8), and this is shown in e-FIG LB-113:

..The fact that such linking was towards a higher site was deemed important by Prendergast. However, many of the vertical separations between sites, expressed as angular elevation, are too small to have produced any clear perception that the target site was in fact higher than the point of observation. The objection would, however, be modified if the target was deemed of particular importance, for reasons other than altitude.

..In addition, many of the distances between sites are too great to allow for precise targeting of one axis on another site to be demonstrated. The lateral limits of the axis at the origin, at least several degrees, can be projected to include a considerable sector of the far horizon: as an example, the line from Carrowkeel cemetery to Knocknarea is shown +/- 2.5° (e-FIG SA_sl-01). Many of the axes of passage-chambers that are used, often structurally variable, are also poorly preserved, allowing only a more general indication of direction, and others cited do not match the proposed line of linkage well.

It might be more realistic to limit discussion of potential linking to those sites that are less than 5km apart, with a threshold for clearly visible elevation of targets being set at 2° (e-FIG LB-113). This would leave only seven sites, 3% of the total (7 out of 232).

However, there are more fundamental objections, besides technical, to this entire proposition:

..In the linked pair, the site targeted has to be in existence before the site targeting it: in no case is this known for certain and, given the imprecise nature of dating methods for this period, in a majority of cases, any sequence could not be established with any confidence. However, Prendergast (*ibid*., p. 9) argues that, having accepted the linking, then this could provide a *basis* for relative dating of sites.

..The prime importance of the direction in which the passage-chamber *faces*, its line of exit, should not be assumed. There is a considerable case to be made for considering the direction of entry into the tomb as being of more potential importance (see Table of Contents: 03a/11b).

..It would certainly have been possible to view, and enact ritual towards, or to otherwise respect, some particular target from a chambered tomb, without reference to its axis.

-the Sligo area: a more detailed examination of linked pairs of passage tombs

A particular concentration of linking is shown for sites in the hinterland of Sligo (ibid., fig. 5/ p. 10). Seven are cited as directly targeted on the large cairn at Knocknarea (see below: details of individual sites), with another two linked indirectly, via intermediate sites, as listed in TABLE SA_sl-03, and shown in e-FIG SA_sl-01 and LB-113:

TABLE SA_sl-03 SLIGO AREA: PASSAGE TOMBS: LINKED PAIRS PROPOSED BY PRENDERGAST 2006

target A: Knocknarea South (G 6260 3459; Sligo 5):

					axis			
passage tomb	**NGR G-**	**id**	**to**	**dis**	**dec**	**calD**	**meas**	**publ**
..sites directly tracking target A:								
Ardloy	7374 1660	99	5	21	30.3	**329**	**328**	
Carnaweeleen	7169 1322	97	5	23	−29.6	**147**	**156**	
Carrowkeel E	7492 1162	106	5	26	31.1	**332**	**332**	327
G	7531 1194	108	5	26	27.4	**322**	331	325
H	7530 1187	109	5	26	20.7	**307**	**331**	302
K	7534 1173	110	5	26	31.8	**334**	**331**	334
Treanmacmurtagh	7310 1218	100	5	24.5	32.3	**336**	**335**	
..sites indirectly tracking target A via adjacent sites:								
Carrowkeel D	7483 1206	105	108	0.5	-5.5	**99**	**104**	
Carrowkeel F	7494 1139	107	106	<0.5	36.2	-	**351**	
..other paired sites, not tracking target A:								
Barnashrahy	6597 3530	87	95	7.5	-25.0	**136**	143	
Barroe North	8029 1549	103	-					
Carrowmore P3	6621 3374	11	-					
P4	6624 3378	13	11	<0.5	-26.5	**139**	?225	
Carrownamadoo	7042 2957	95	-					
Geln / Croaghaun	6349 2751	93	103	20.5	-18.6	**123**	125	

Keshcorran/Murhy	7128 1263	96	-				
Knocknarea South	6260 3459	5	-				
Knocknarea South	6278 3426	7a	116	7	-34.0	**162**	195
Mullanashee/Doonmor	6094 2741	116	-				
Treanmore	7250 1213	98	96	1.5	19.1	**304**	293

Key: id(entification number, from the list of cairns in Sligo); **to**(wards the cairn, as numbered in the series for Sligo); **dist**(ance between pairs, in km); **axis: dec**(lination, given in Prendergast 2006, table 1/ p.8), **calD** azimuth calculated from **dec,** for latitude 54.04° N, **meas**(ured azimuth: using given grid references); **publ**(ished data);

There is general correspondence between axes of passage-chambers and the direction of proposed links, but certain of the distances between sites suggest problems with clearer visual linkage, as discussed above. The conspicuous Knocknarea Mountain is about 1km across, and at 26km from the Carrowkeel cemetery would subtend an angle of about 2°, which indicates the closeness of targeting required for a more convincing match.

-an alternative interpretation: the ridges on which the Carrowkeel cemetery is located also run towards Knocknarea, suggesting that, if axes of passage-chambers were conforming to some degree with basic topography, then this would create the impression of targeting the distant site. The ridges have a mean axis of 333°, and the bearing to Knocknarea is 338°.

The cemetery complex at Knocknarea-Carrowmore is of obvious regional importance, in terms of visual impact of the former mountain, and extensive nature of the latter cemetery (see: details below). That the cemetery was in existence early in the Neolithic, and hence known in the area from the outset, is suggested by radiocarbon dating evidence, albeit controversial (Burenhult 2005**;** Bergh and Hensey 2013). If the model of linkage is valid, then it seems strange that the mountain was not targeted more regularly, and widely used as a focus for axial alignment.

For instance:

..at Carrowmore:

...cairn 51, the focal tomb, points (front to rear) past the N'n flank of Knocknarea Mountain, not at its large central cairn;

...there is no specific evidence that other satellite tombs in the complex refer to Knocknarea; the sample of axial data from these is too small for any conclusion to be made;

...the court cairn at Primrosegrange, just to the SW of Knocknarea Mountain, and contemporary with the main cemetery at Carrowmore, points SW'ward, past the S'n flank of Knocknarea Mountain;

..in the wider area:

Although all 13 sites at the Carrowkeel passage tomb cemetery, in the S'n part of the study area, around Sligo, have a direct view of Knocknarea-Carrowmore to their NNW, only in four cases could an axial link be suggested (Prendergast 2006 table 1/ p. 8), as shown in TABLE SA_sl-04:

TABLE SA_sl-04 Carrowkeel passage tomb cemetery (Sligo Ireland): suggested linkage with Knocknarea, at bearing 338°G (Prendergast 2006)

	p-ch	axis	view	link	diff
Carrowkeel A	no	-	-	-	
B	yes	342	D	no	
C	yes	292	D	no	
E	yes	332	D	**yes**	**-8**
D	cist	SE	D	no	
F	yes	000	D	no	
G	yes	331	D	**yes**	**-7**
H	yes	302	D	**yes**	**-6**
K	yes	331	D	**yes**	**-7**

L	no	-	D	-
M	yes	285	d	no
N	yes	314	d	no
O	yes	115	D	no
P	no	-	D	-

Key: p-ch passage chamber: extant and axis measureable; **axis** azimuth in °G, as given in the direction of facing **: view** (to the NW, towards Knocknarea): **D** direct, **d** less clear; **link** (to Knocknarea proposed); **diff** angular difference to the bearing of Knocknarea, at 338°G.

-exposure of monuments

The general distribution of tombs in the study area indicates that passage tombs, and perhaps any areas of associated settlement, tended to occupy higher areas of upland, with court-, and wedge tombs lying closer to lowland, and better soils. This has been further demonstrated, in some detail for the area of Bricklieve Mountain (e-FIG SA_sl-01, and LB-108), in which the Carrowkeel passage tomb cemetery is located (Mount 1996). Use of more elevated locations would increase the visibility of passage tombs over surrounding areas. Such exposure might have increased any tendency to develop targeting between sites, but there is no empirical evidence for this.

-general comments

This example of unrestrained linkage between sites is similar to that suggested between long barrows around the Dorset Cursus (Penny and Wood 1973; e-FIG CU-05), this latter operating over shorter distances, and equally invalid.

Supplementary information on individual sites

Knocknarea Mountain; Sligo, Ireland; G 6260 3459; e-FIGS SA_sl-01 and 02; phot SA_sl-03; Major cairn and associated passage tombs;

This isolated and conspicuous hill, lying at the end of a small peninsula, adjacent to the sea, rises to 327m OD, and hosts, on its rounded summit, and flanks, several cairns, and provides other evidence for a considerable area of ritual activity. The E'n side of the summit is defined by an undated bank, 1km long, 2m wide, and up to 1m high, hut circles evident within it. Maeve's Cairn, at the summit, unexcavated, is the principal monument, and at 55m in diameter, and 10m high, is the largest such mound beyond the major passage tombs of the Boyne valley, far distant at the E of Ireland. Several other, smaller, damaged tombs, of passage type, occur over the summit, in a line running generally N'-S'ward: one to the N of Maeve's Cairn, one just to the S, and one on the S'n flank of the mountain. At two of the tombs, passage-chambers point (front to rear) towards the NE, a direction seen amongst several others in the area (e-FIG SA_sl-02):

Other sites:

NGR G- details
626 347: round cairn, 32m in diameter, with a cruciform chamber opening to the SE;
626 346: Maeve's Cairn: see details just above;
626 345: remains of a kerb, with the ?backstone of a chamber opening to the SE;
626 340: mound, with a cruciform chamber.

Carrowmore cemetery; Sligo, Ireland; G 6633; e-FIG SA_sl-03 and LB-109; phot SA_sl-01 to 02; Major cemetery of passage-type tombs;
bibliography: O'Nuallain, 1989, 84-91; Burenhult 1980, 1984, 1984a, 1985, 2005, reports in final preparation; Burl 2000, 78-82; Bergh and Hensey 2013;

This megalithic cemetery, the largest in Ireland, stands at the foot of Knocknarea Mountain, just to its ESE, on a low ridge of gravel. The main tomb complex, damaged by early land clearance, and by modern quarrying, covers about 0.5 km^2, and contains evidence for at least 80 individual sites, including passage tombs, boulder-kerbed dolmens, with several potential stone circles present. A court cairn is located adjacent to the main cemetery.

Tombs appear ranged around a more open oval area, about 900m N-S, and 400m maximum E-W, with tomb 51 (Listoghil), the largest monument, placed off centre in the N'n half, perhaps acting as a focal point placed on higher ground. This open distribution does not appear to be an artefact of land clearance, or selective destruction of monuments. A sparse line of several sites extends N'ward from the main complex.

Four tombs, of more typical passage-type, occur in the complex (4, 17, 27, and 51). Other monuments are characterised by central dolmens, with large capstones supported on stone uprights, surrounded by boulder-kerbs of 12-34m diameter (mean 17m), with no clear evidence for covering cairns, but in some cases for low platforms.

Radiocarbon dating places the origins of the complex in the later Mesolithic to early Neolithic, 4600-3900 BC (Burenhult 2005), although how far this relates to the megalithic structures, or to earlier activity is a subject of some debate.

The megalithic cemetery at Carrowmore is unusual, in terms of its large size relative to others in Ireland (TABLE SA_sl-05), in the form of kerbs, of burial chambers, and in its possible date, very early indeed in the Neolithic. There are 37 tombs at Carrowmore which survive sufficiently completely to be identifiable as such, of which 10 provide axial data from extant funerary areas (e-FIG SA_sl-03; TABLE SA_sl-05). The former presence of additional tombs is suggested by traces of other megalithic structures that have been reported in this heavily cleared, and quarried area. Surviving tombs conform to a general pattern. Massive boulder-kerbs are broadly comparable with perimeters of more typical later passage tombs, but the dolmen-like nature of the central burial structure, and the infrequency of a clear passage to the margin, provide points of difference, as does the scarcity of carved motifs on surfaces.

The absence of axial data from much of the cemetery, and its restriction to the N'n sector, around centrally placed tomb 51, means that general conclusions on alignment are not possible. Taking the direction of entry to the burial area of the tomb as key, as done for other chambered tombs from Britain and Ireland in this analysis, there is no consistent pattern evident. The more usual W'ly direction of approach is not in evidence here, with more of a N'ly to S'ly trend apparent. Nor is there any indication of axes targeting Knocknarea, either generally, or specifically upon the large cairn at its summit: this point is relevant to discussion of axial targeting in the area (see Table of Contents: 02b/3e). In view of the small size of the sample, any apparent trends are not to be taken as significant. Alternatively, considering the facing direction of these tombs, there is no indication that they open towards tomb 51, or even more generally onto the broader central zone. The generally linear structure of the cemetery, as an elongate open triangle, would allow ready resolution of this question, using axial data from tombs in the lateral zones of the cemetery, at the E and W, and from the S'n margin. All that can be said at present is that, in common with other such Irish passage tomb cemeteries (e-FIG LB-109; TABLE SA_sl-05), a key central tomb, with W'ly-pointing axis (front to rear), seems surrounded by satellite tombs, where alignment is less consistent.

Sites more definitely identified as tombs are listed in TABLE SA_sl-05, with many more structures located in, and around the main complex known only as unspecified stone structures (e-FIG SA_sl-03):

TABLE SA_sl-05 Carrowmore cemetery, Sligo, Ireland: properties of known tombs

tomb	mound	kerb	diam	type	bone	excav	extant	axis	note
1	yes	34 2ble	14.5	dol	cr		K		
2	yes	16			?bone		sts		
3							K ?ch		
4	plat	30	14	**pass**	cr++	**mod**	K D	**332**	
5	plat	1	34x26	dol	cr		D	**053**	
7		33 2ble	14	dol	cr	**mod**	K D	**280**	
[6]		?pres		?dol					
9		8	14	circ			K		
9a		5	23						
10		8	23	ch	unsp				
13				dol	cr		D	**~119**	
15		17 2ble	12	?dol	cr		K p		

16	plat	?3	12	dol	cr		P		
17	plat	>10	10	?**pass**	cr		sts P		
18	plat	dble	11	ch	cr		K P		
19	plat	53	23	ch	ub cr		K P		
20							sts		
21							sts		
22		dble	16	ch	unsp		K p		
[23]		pres	11	ch	unsp				
26		pres	17	cr		**mod**	K		
27			23	**pass**	ub cr	**mod**	K cc	**142**	
32		pres	15	?dol					
36		pres	21x17	?dol					
37		pres	25	ch	cr				
48		pres		dol	unsp		K d p		
49	plat	11 dble	10	ch	ub cr		K d		
51	cairn	100	35	**pass**	cr in	**mod**	K D P	**295**	**in focal location**
52	mound	pres	20	dol	cr		d	**288**	
52a				dol			K d p		
53							d	**207**	
54		pres		dol	cr				
55							K		
56	plat	pres	12	ch	cr		K ch	**353**	
57	plat	pres	18	?ch	ub		K		
58	mound		4x7	?ch			?ch		
59	mound		6x4	?ch	ub cr		ch	**025**	

Key: tomb [destroyed**]; mound** (present): **plat**(form present); **kerb**: **#** number of stones present, **2ble** double; **diam**(eter in m); **type**: **dol**(men), **pass**(age tomb), **circ**(le of kerbstones), **ch**(ambered); **bone** (human): **cr**(emated), **++** much present, **unsp**(ecified), **ub** unburnt, **in**(humation); **excav**(ation): **mod**(ern: by Burenhult);
extant: kerb present: **K** extensive**, k** fragmentary**;** dolmen at the centre), **D** good condition**, d** poor**; cc** cruciform chamber; **ch**(amber of unspecified type, in poor condition); platform mound present **P** fairly pronounced, **p** weakly evident; **sts** unstructured stonework present;
axis: direction of entry to the chamber, front to rear of the monument: numerical data given where available.

Individual sites are described in more detail as follows:

Carrowmore: tomb 51 (G 6624 3345): This site appears unique in the cemetery in three respects:

-its kerb of about 100 boulders, forming a ring 34m diameter, makes it larger than other monuments in the complex, and adds impact to its focal placement in a slightly higher area;

-unlike other dolmens in the cemetery, it contains a rectangular cist, 3.2m by 2.6m by about 1.2m high externally, roofed with a large stone slab, this bearing carved circular motifs on its underside, and also on a cill. Another small motif also occurs internally, on one of the orthostats;

-alone amongst the other tombs, it shows clear signs of a covering cairn, although low platforms are in evidence at other tombs in the cemetery.

In common with most other tombs in the complex, there is no evidence of a passage linking the central structure to the margin, although the roof-slab slopes down towards the NW, providing a smaller frontage for entry. The central area had been disturbed before modern excavation, and any funerary deposits were in evidence only as scattered unburnt, and cremated bone.

Radiocarbon dating of the mid 4th millennium BC suggests that, in its final form, it was constructed later in the sequence of tombs forming the complex, although traces of an additional boulder-built structure, and possible satellite feature, could indicate an earlier phase.

Primrose Grange (some 2km to the SW of Carrowmore; G 637 329): court tomb;
bibliography: O'Nuallain, 1989, 31; Burenhult 2005;

This small court tomb, pointing SW'ward (front to rear), was in use during the same period as the passage tombs in the Carrowmore cemetery, despite fundamental differences in tomb morphology, burial practice, and grave-goods. Radiocarbon dates, from the central chamber, lie between about 4300 and 3000 bc. The burial rite was almost entirely inhumation, with very little evidence for cremation, which appears to dominate in the other tombs at Carrowmore. The typical assemblage of antler pins, and balls of clay or stone, as seen at Carrowmore, is absent from this cairn, finds here including arrowheads of chert, mainly leaf-shaped.

e-FIGURES: combined listings and supporting information

e-FIG
SA_sl-

01 Study area: Sligo (Sligo, Ireland): general map of topography, and distribution of sites

02 Knocknarea-Carrowmore area (Sligo, Ireland): terrain, and distribution of tombs

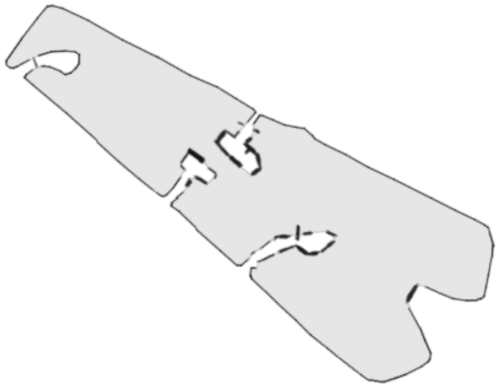
03 Carrowmore passage tomb cemetery (Sligo, Ireland): detail of the main cemetery area

Section 04c:
Study area: long barrows in the mid Wye-Usk valleys

(Herefs./ Breconshire; SO 23 [centre])

Section identifier: SA_wye-

SEE INITIAL SECTION:
Access to digital images



Mid Wye-Usk valleys: Gwernvale long barrow

Reasons for inclusion

Barrows in this topographically diverse area provide an opportunity to further examine the consistency, and topographical relationships of axial alignment, within a well-defined, localised group of monuments. Some of the sites, five out of 20 known, are clearly related to certain chambered long barrows in the Cotswolds, the core area, where analysis has also been carried out, providing a further point of comparison here, and with earthen barrows on the Lincolnshire Wolds (see Table of Contents: 03a/22a).

Although Wye-Usk forms a separate study area, the single associated figure (e-FIG LB-115) has been placed elsewhere, for convenient comparison, amongst those relating to topographical siting of barrows in the Cotswolds (e-FIG LB-114), and on the Lincolnshire Wolds (e-FIG LB-116).

Distribution of long barrows in the study area

The mid sector of the Wye valley contains a distinct concentration of chambered long barrows (e-FIG LB-115; TABLE SA_wye-01), ranged along its S'n margin, and particularly in a side valley formed by the Afon Llyn, a short tributary stream, flowing N'ward to join the main river. Here, currently known barrows are mainly distributed over the lower slopes, along the E'n side of the valley, affording a good W'ly aspect over more open views, their usual direction of pointing (front to rear). This area is that of closest approach between the major E'-W'ly running valleys of the rivers Wye, and Usk , where increased lateral tributaries have created interleaving, this zone also attracting a lesser concentration of long barrows, on the Usk-ward side.

Where more fully excavated, the barrows are clearly trapezoidal, with a recessed forecourt lying between rounded horns, and with a dummy portal at broader end; and the chambering is lateral, not terminal, a variant exemplified by a few sites in the Cotswolds, as at Sudeley I (Belas Knap; SP 0210 2542; TABLE SA_wye-02).

TABLE SA_wye-01 Long barrows in the mid Wye-Usk group: basic properties

type		barrow	NGR SO-	alt	axis	topog	
Xa	e	Dorstone Hill ce	3265 4240	260	128	L	hilltop: central;
Xb	e	Dorstone Hill SE	3265 4240	260	129	L	hilltop: central;
Xc	C	Dorstone Hill NW	3265 4240	260	298	L	hilltop: central;
X1	?	Clifford	2475 4689	70	283	L	adjacent to Wye;
X2	?	Dorstone	3325 4168	175	293	ca	upper valley slope over River Dore: SW'ly facing;
X3	?	Dorstone	3452 4130	280	?	?	upper valley slope over River Dore: SW'ly facing;
X4	C	Arthur's Stone	3189 4312	280	324	ca	edge of hilltop;
X5	?	Archenfield	2715 4202	290	?	?	uppermost valley slope: NW'ly facing;
X7	?	Pen y Wyrlod Lla	2248 3987	255	249	ca	upper valley slope: NW'ly facing;
X8	?	Little Lodge	1822 3806	140	172	*cd	near River Wye: lowest slope: S'ly facing;
X9	?	Ffostyll North	1790 3497	315	259	ca	uppermost valley slope: SW'ly facing;
X10	?	Ffostyll South	1788 3488	315	209	*cd	uppermost valley slope: SW'ly facing;
X11	C	Ty Isaf	1820 2905	260	175	ca V	spur in narrow NE'ly running valley;
X12	?	Ty Illtud	0982 2638	215	193	ca	upper slope over River Usk valley: SW'ly facing;
X13	C	Gwernvale	2103 1912	70	300	L	lowest slope in Usk valley: SW'ly facing;
X14	C	Pipton	1605 3729	150	215	r	narrow ridge on lower slope near Wye: ~level;
X16	?	Mynydd Troed	1615 2840	370	204	*cd	upper slope over River Afon Llyn: S'ly facing;
X17	[?]	Croes Llechan	1672 3626	150	?	L	lowest slope near Wye: SW'ly facing;
X18	?	Carn Goch	2122 1771	70	?	L	lowest slope near Usk: NE'ly facing;
X19	?	Maes Coch	239 378	425	?	?	valley slope in Black Mountains: SE'ly facing;
X20	C	Penywyrlod Tal	1505 3156	250	303	*cd	lower valley slope over Afon Llyn: NW'ly facing;
X21	?	Court Farm	2122 4315	80	230	L	adjacent to Wye;

Note: sites in this area have been prefixed X-; any missing X-numbers in the sequence indicate sites rejected, or in doubt, as long barrows in the initial list;

Key:
type (of plan):
e(arthen barrow) with timber structures; **C** Cotswold-Severn long barrow, tapering plan, sunken forecourt with rounded horns, and dummy portal at the broader end, chambering lateral; **?** chambering, or cists occur in the long mounds, but the general structure is unknown; **[]** site no longer extant;
barrow: abbreviations: **ce**(ntral), **Lla**(nigion), **Tal**(garth);
alt(itude in metres); axis (azimuth in °G);
topog(raphical location): **r**(idge): lying along and conforming generally with a weak ridge;
c(ontour): running **a**(long), **u**(p), or **d**(own) the contour, with the direction taken towards the back end of the mound; **L**(evel ground); **st:** at the top of a slope; **V** located in narrow valley;
*****: the site does not conform with the general topography, running across, and not with, the line of ridge, or contoured slope;

Axial orientation and topography

The predominantly W'-NW'ly direction of pointing (front to rear of the barrow) (e-FIGS LB-16 and 17), and the light constraint imposed by terrain on axial siting, seen clearly for the sample area in the Cotswolds (e-FIGS LB-89, 114, and 118), is not as evident here. The general trend for monuments, ranged along the W'-NW'ly scarp of the Black Mountains, follows the contour, and flanks the valley. This curving arc of axes can be seen from Dorstone (SO 3242), at the NE, round to Gwernvale (SO 2119), at the S. Sites based in narrow valleys, such as at Gwernvale, and Ty Isaf, are clearly placed passively along the valley, with no attempt at W'ly alignment. No compensating case can be made for resultant W'ly exposure of lateral chambers. Application of any axial rule appears very slack in this outlying area, with topographical convenience being the major determinant.

The anomalous pattern of axial orientation, noted here amongst long barrows in the Wye-Usk group, can not be explained in terms of properties particular to the laterally chambered type, which accounts for all definitely known Cotswold-Severn tombs in this area. Although axes beyond the usual W'-NW'ly direction of pointing do occur in the Wye and Cotswolds, they are not unduly characteristic of this sub-group (TABLE SA_wye-02):

TABLE SA_WYE-02 COTSWOLD-SEVERN LONG BARROWS: PROPERTIES OF MONUMENTS WITH BLIND FORECOURT-ENTRANCES, AND LATERAL INSTEAD OF TERMINAL CHAMBERS

			forecourt		chambers
barrow	**NGR**	**axis**	**form**	**portals**	**lateral**
group: main Cotswold					
Brimpsfield I	SO 9114 1323	281	s	yes	1S
Chippenham I WIL 3	ST 8773 7473	268	?d	yes	2N 1S
Hazleton II	SP 0727 1887	**076**	s	no	1N 1S
Luckington I WIL 2	ST 8200 8296	285	?d	yes	2N 2S
Nettleton I WIL 1	ST 8305 7855	275	?s	yes	4S
Minchinhampton II	ST 8839 9972	234	d	yes	1NW 1 other
Rodmarton I	ST 9325 9730	262	d	yes	2opposing
Sudeley I	SP 0210 2542	**172**	d	yes	2E 1S 1W
Swell I	SP 1352 2627	278	d	yes	1NE 1other
Swell IV	SP 1673 2637	282	d	no	1N
Swell V	SP 1716 2652	**197**	d	no	1transverse
Upper Slaughter I	SP 1426 2580	241	d	no	2NW 1S 1central
group: Wye-Usk					
Arthur's Stone	SO 3189 4312	324	d	yes	1SW
Ty Isaf	SO 1820 2905	**175**	d	yes	1W 2E
Gwernvale	SO 2103 1912	300	d	yes	1NE 2SW
Pipton	SO 1605 3729	**215**	d	yes	2NW
Penywyrlod Talgarth	SO 1505 3156	303	d	yes	2NE

Key:
axis (front to rear of the mound in °G), **bold** type indicates a direction of pointing other than the normal W'-NW'ly axis; **forecourt: form**: **s**(hallow), **d**(eep, with flanking horns); **portals** (slabs forming the dummy entrance on the axis at the broader forecourt end); **chambers lateral**: **1**(on)**S** (side) etc.

Reversal of axes from the more usual W'-NW'ly pointing, to an E'-SE'ly pointing direction is clearly seen only for the earthen barrows at Dorstone central and SE.

Supplementary information on individual sites

earthen types

Xa and Xb Dorstone central and SE: excavated
see Table of Contents: 03a/24;

unknown structure

X1 Clifford; Herefs; SO 2475 4689; SO24NW 32; 1138355; unexcavated;
an oval ditched enclosure appears as a partial crop-mark, 30m long, and 16m wide;

X2 Dorstone: Cross Lodge; Herefs; SO 3325 4168; SO34SW 20; 106126; unexcavated;
sub-rectangular stony mound; 26m long, up to 12m wide, and 2m high, with a flat top; possibly ditched; axis WNW'-ESE'ly; stone structure, possibly a chamber, at the ESE;

X3 Dorstone; SO 3452 4130; Herefs; SO34SW 8; 106094; unexcavated;
possible site of a long barrow; HER record notes no visible remains of a long barrow;

X5 Archenfield; Herefs; SO 2715 4202; SO24SE 10; 104920; unexcavated;
at least three large stones may represent a burial chamber; HER records note no visible remains of a long barrow;

X6 St Margarets; Herefs; SO 359 335 [or SO 3565 3347]; SO33SE 4; 105879;

a limestone slab, 8.4m by 2.9m, and 0.8m thick, may be the capstone of a burial chamber; an early report indicates that this was once supported on uprights, one of which might still be present, to the W of the slab;

Cotswold-Severn type barrows

Xc Dorstone NW'n mound: excavated; see Table of Contents: 03a/24;

X4 Arthur's Stone; Herefs; SO 31888 43124; SO34SW 1; 106083; excavated;
an eroded, tapering mound, with a deep forecourt, its false portal flanked by rounded horns; single passage, with angled chamber, opening to the SW'n side of the mound; burial chamber of nine orthostats, up to 1.1m high, five of which support a massive capstone, originally measuring 5.9m long by 3.7m wide, and up to 0.6m thick; entrance-passage, 0.8m wide, consisting of nine stones, runs E'-W'ward for 5m, before turning at right angles to the S for 2.9m; two upright stone slabs lie 3m to the SE of the chamber, perhaps originally supporting a lintel; traces of the mound remain, about 22m long by 19m maximum width, tapering to the NW; undisturbed kerbstones lie around the edge of the mound, at the SE; a large stone, of unknown interpretation, lies about 3m to the NW of the chamber; a drystone wall, forming an outer wall to the monument lies SE'ward of the chamber;

X13 Gwernvale; Brecon; SO 2103 1912; BRE 7; Coflein 98; excavated 1977-1978; Britnell and Savory 1984;
a well-defined, tapering mound, 46m long, 17m wide at the broader end, and 7m wide at the narrower, with a deep forecourt, flanked by rounded horns at the broader end, and with an axial stone marking the false portal; double revetment walls to the mound; one lateral chamber lies on the NE'n side, two, and fragments of a third, on the SW'n;

X14 Pipton; Brecon; SO 1605 3729; BRE 8; Coflein 93; excavated 1950; points SSW'ward;
a well-defined, tapering mound, 25m long, 12m wide at the broader end, and 7m at the narrower end, with a deep forecourt flanked by rounded horns at the broader end, and with an axial, false portal stone; two lateral chambers on the NW'n side; internal lateral walling, and other stone features suggest a multi-phase monument;

X20 Pen y Wyrlod, Talgarath; Brecon; SO 1505 3156; BRE 20; Coflein 92191; partial excavation 1972; Britnell and Savory 1984;
well-defined tapering mound, 54m long, 23m wide at the broader, and 11m at the narrower end, with a deep forecourt, flanked by rounded horns at the broader end, and with an axial stone marking a false portal; two lateral chambers lie on the NE'n side;

X11 Ty Isaf; Brecon; SO 1820 2905; BRE 5; excavated 1938; Grimes 1938;
a well-defined, tapering mound, more than 28m long, 18m wide at the broader end, and less than 12m at the original narrower end, with a deep forecourt flanked by rounded horns at the broader end, and with an axial stone marking the false portal; double revetment walls to the mound; a lateral chamber on the E'n side, and on the W'n, with another chamber-like stone setting towards the rear of the monument; a T-shaped passage-chamber, surrounded by a double revetment, within the body of the mound, suggests incorporation of an earlier passage-type tomb;

Other chambered tombs: ?Cotswold-Severn related

X18 Carn Goch; Brecon; SO 2122 1771; BRE 18; unexcavated;

X21 Court Farm; Herefs; SO 2122 4315; unexcavated;
ovate mound, 33m long, and 17m maximum wide; central cist, or chamber, with other stones of unknown structure; edge-set slabs within the mound suggest chambering, or cists;

X17 Croes Llechau; Brecon; SO 1672 3626; BRE 11; Coflein 406272;
the site of a now destroyed chambered tomb, described by Edward Lhuyd in about 1700;

X9 Ffostyll North; Brecon; SO 1790 3497; BRE 3; Coflein 306038; partial excavation 1921; an irregular tapering mound, 38m long, 15m wide at the broader end, and 8m wide at the narrower; slabs towards the front, and rear of the mound indicate cists, or chambers;

X10 Ffostyll South; Brecon; SO 1788 3488; BRE 4; Coflein 306039; partial excavation 1921-1923; a short, irregular, weakly tapering mound, 31m long, 20m wide at the broader end, and 15m at the narrower; an axial chamber without a clear passage lies near the broader end;

X8 Little Lodge; Brecon; SO 1822 3806; BRE 2; Coflein 306025; partial excavation 1928-1929; an unexcavated, irregularly tapering mound, 56m long, 20m wide at the broader end, and 11m wide at the narrower; a cist-chamber lies near the narrower end; several other axial stones indicate unknown internal structure;

X19 Maes Coch; Brecon; SO 239 378; BRE 19; no significant details;

X16 Mynydd Troed; Brecon; SO 1615 2840; BRE 10; trial excavation 1966; an irregular, ovate mound, 27m long, and 16m maximum width; fragmentary linear stone placements in the body of the mound represent unknown structure;

X7 Pen y Wyrlod, Llanigon; Brecon; SO 2248 3987; BRE 1; Coflein 92012; partial excavation 1920-1921; a tapering mound, 19m long, 11m wide at the broader end, and 7m wide at the narrower; a slab-cist lies axially, near the broader end; other stone features in the mound indicate unknown structure;

X12 Ty Illtud; Brecon; SO 0982 2638; BRE 6; unexcavated;
ovate mound, 18m long, and 8m maximum wide; central cist, or chamber, with other stones indicating unknown structure.

Localised grouping of long barrows

Dorstone ridge: X/ a-c; 2; 3; 4;

Hay on Wye area: X/ 1; 5; 7; 19; 21;

Afon Llyn valley: X/ 8; 9; 10; 11; 14; 15; 16; 17; 20;

Usk valley: X/ 12; 13; 18.

e-FIGURES: combined listings and supporting information

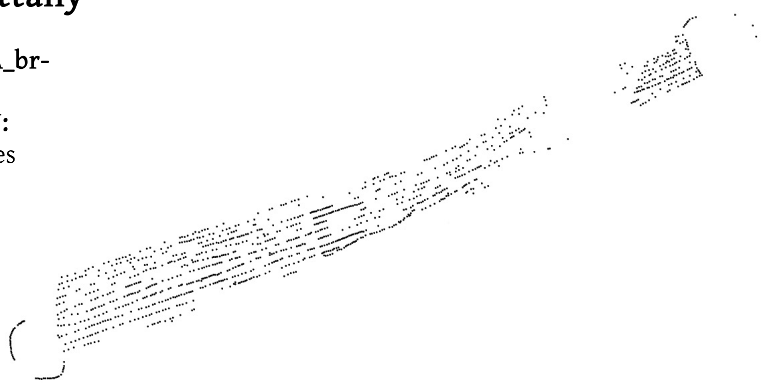
e-FIGS
LB-

115 The mid Wye-Usk group of chambered long barrows: distribution, and topographical properties

Section 04d:
Study area: Brittany

Section identifier: SA_br-

SEE INITIAL SECTION:
Access to digital images



Brittany: stone rows: Le Ménec

Summary

Stone rows, megalithic enclosures, funerary monuments, menhirs, and rock-art are discussed in terms of the seasonal-solar model for alignment, as expressing agrarian and economic concerns, by propitiation of the ancestors, via the solar transit.

Reason for inclusion

The Breton peninsula contains a remarkable set of megalithic monuments, including stone rows, several of which are long, with many lines, also cromlech-type enclosures, some associated with these rows. As with their British counterparts, the relationship between axial elements amongst these monuments, and astronomical cues, has been the subject of much speculative interpretation, and is suitable for reassessment, in line with other analyses in this study. Like much of W'n Britain, Brittany forms part of the exposed Atlantic seaboard, and general cultural affinities exist during the Neolithic and Bronze Age, allowing comparisons to be made between monuments. In this regard, the multiple stone rows are of specific interest, in relation to those lesser multiples of N'n Scotland, and the marked elaboration seen amongst certain of these Breton rows might further support, at least in part, intensified expression of a solar cult, in response to environmental pressures.

Climatic considerations

The economic stress to agrarian communities caused by environmental pressures, with consequent promotion of an existing solar cult, has been suggested elsewhere in this analysis as contributing to the proliferation of stone rows, with their S'ly sun-ward axial aspect, and to widespread use of the cup-marked solar motif in W'n areas of Britain, and Ireland. It remains to examine how far this model might relate to Brittany.

Brittany is similar to the SW'n Peninsula of England, in its topography, and in degree of exposure to changeable maritime Atlantic climate, especially along W'n and N'n coasts, with some increased shelter along the S. The density of rows, and circles in Brittany certainly fits into a regional pattern of numerical increase, W'ward towards those areas more exposed to Atlantic conditions (TABLE SR_brit-00. A progressive increase can be seen in terms of density and proportion, with more detailed changes of order possible, according to the parameter selected for ranking. Regions are placed here in increasing order, by their proportion of the total number of rows for all areas.

These broader statistics are based on a simple count of sites, treating each as equivalent, with no regard to size, and hence the contribution made by such larger complexes as those around Carnac, is underestimated. There is scope here for a more proportionate analysis.

TABLE SR_br-00 Regional densities of stone rows and circles

Note: area of land 'a' is given as the number of 10km squares;

		numbers.............								
	a	**r**	**c**	**t=**	**densities............**			**proportions**		**%...**
region	**area**	**rows**	**circles**	**r+c**	**r/a**	**c/a**	**t/a**	**r/R**	**c/C**	**t/T**
Wales	208	62	81	143	0.30	0.39	0.69	6.9	6.2	**6.5**
Brittany	340	129	49	178	0.34	0.14	0.52	14.4	3.8	**8.1**
England	1302	196	316	512	0.15	0.24	0.39	21.9	24.4	**23.4**
Scotland	788	164	508	672	0.21	0.64	0.85	18.3	39.2	**30.7**
Ireland	843	344	343	687	0.41	0.41	0.81	38.4	26.4	**31.3**
TOTALS		895 =R	1297 =C	2192 **=T**						

The area (e-FIG SA_br-01)

The Breton peninsula is about 250km long E-W, by 200km in maximum width N-S, and is broadly triangular, with its base to the E, and apex to the W. A central, more mountainous spine, of igneous rock, divides the region into N'n and S'n halves, this latter less exposed to the North Atlantic. Most of the megalithic sites lie here, away from the N'n coast, along the W'n and S'n coastal margin, and within the interior to the E. Rivers flow out from this central watershed, including the Villaine to the S, its valley containing a particular concentration of monuments.

General distribution of sites

Additional analysis of sites in Brittany is to be found in the section dealing with standing stones and menhirs (see Table of Contents: 03k).

The distribution of stone rows, megalithic enclosures, and very large menhirs, forms two fairly discrete blocks: one in S'n-W'n coastal Finistere-Morbihan, and the other inland, over central Ille-et-Vilaine (e-FIG SA_br-01). The lower relief of this more sheltered S'n coastal margin is especially suitable for settlement, and offers broad S'ly views, relevant to axial alignment.

A general plot of such sites indicates four core areas of distribution, ranked in terms of intensity as follows (TABLE SA_br 01). A more detailed mapping is given in e-FIG ME-04.

TABLE SA_br 01 Megalithic monuments in Brittany: core areas only

		rows: short			**rows: long**			
	region	**# stones**			**# lines**			**megalithic**
core area		**2**	**3**	**4-6**	**single**	**double**	**mult**	**enclosures**
Carnac	Morbihan	-	2	1	5	-	6	++
Pipriac	Ille et Villaine	2	4	5	3	2	1	+
Crozon	Finisterre	-	-	1	4	-	4	++
St Pennan	Finisterre	3	-	1	2	-	-	+

Data: after Burl 2000.
Key: rows: # number, **mult**(iple); enclosures: **++** more frequent, **+** less frequent.

Stone rows

The sample of known and possible rows in Brittany, in descending order of complexity, is as follows (Burl 1993, gazetteer 227 *et seq*.)(TABLES SA_br 02 and 06):

TABLE SA_br 02 Stone rows in Brittany: frequency of types

rows	#	%
multiple	22	16
double	4	3
single: long	36	27
4-6 stones	23	17
3 stones	27	20
2 stones	22	16
total	**134**	

Data: after Burl 2000.
Key: # number of sites.

More complex rows, from long singles, to multiple lines, form about half of the sample, with simpler, short rows the remainder. Amongst the multiple rows, there are several very large monuments, running for hundreds of metres, and containing up to 12, or more rows, as in the Petit Ménec-Ménec complex (e-FIGS SA_br-02 to 07; see Section: supplementary information just below).

Megalithic enclosures

These enclosures have been divided into three main groups, on the basis of ground plan (Burl 2000, gazetteer 395-397) (TABLES SA_br 03 and 07):

TABLE SA_br 03 Megalithic enclosures in Brittany: frequency of types

type	#	note
cromlechs	17	ovoid
horse-shoe shaped	22	large gap in circuit
rectangular	10	
total	**49**	

Key: # number of sites.

True stone circles, of the type found widely over the highland zone of Britain (Burl 1976, 2000), appear generally absent from the Breton peninsula, with this type of megalithic ring-enclosure appearing instead. These latter differ in form, and construction from true circles: they are generally large, many contain broad entrance gaps, and they appear relatively open over their interiors, with little evidence for the presence of any larger-scale burial structures. They seem more suitable for larger gatherings than do many circles, and their occasional association with stone rows, as well seen at Le Ménec (e-FIGS SA_br-06, 07, 22 and 23), may suggest mass participation in ritual.

Axial orientation of stone rows and megalithic enclosures: published work

Alignment of structural elements in relation to astronomical cues has been discussed at two levels:

-within the individual monument:

Orientation of certain structural features at stone rows, and megalithic enclosures, has suggested alignment on various solar, or lunar targets, and cardinality has been noted at some sites (TABLES SA_br 06 and 07). These suggestions are scattered, in the main poorly supported, and form no coherent view of ritual purpose for these monuments.

The statement, in an early general regional summary by Giot, expresses uncertainty about the exact nature of any astronomical basis for alignment, given the variability, and range of choice for axial data (1960, 126-127), a situation that has scarcely improved. It remains useful, in that it assumes reference to events at the horizon, here solar, summarising a major impediment to a fuller synthesis.

-larger schemes involving combinations of sites:

It has been suggested that, from various points, viewing towards the S, over the Gulf of Morbihan, using Le Grand Menhir Brisé as a fore-sight, extreme S'ly standstill positions of the lunar cycle could have been observed (TABLE SA_br 04; Thom 1978, fig 9.3/ p.100). There appears to be no reference, to N'ly directions, and lunar rise is better served than lunar set:

TABLE SA_br 04 Brittany: system of lunar observation based on Le Grand Menhir Brisé, as proposed by Thom (1978)

lunar S'n rise		**lunar S'n set**				
observed	***from:***	***via:***	***to:***	***from:***	***via:***	***to:***
minimum	Kervilor *frag rows*	6–GMB-7	~Tumiac *missing it*	locn	3–GMB-14	locn
	Le Moustoir *tumulus*	9–GMB-7	locn			
maximum	Kerran *dolmen*	4–GMB-5	Petit Mont *~tumulus*	Trevas *locn*	4–GMB-15	~Goulvarh *menhir*

Key: 6-GMB-7: 6km from the fore-sight to Grand Menhir Brisé, and 7km onwards to the more distant land-based target cited; **frag**(mentary); **tum**(ulus); **locn** location only, without any known site present;

This scheme seems to be more an imposition of the diagram of radial lunar standstills (e-FIG SA-01) onto the landscape, as a grand plan, rather than a reflection of any realistic layout of sites, and hence it is concept-, rather than data-driven.

Use of such infrequent lunar targets, spaced at over 19-year intervals, would do little to justify the monuments concerned, even as some secondary function. Furthermore, the fore-sights are a mixed group of monuments, of uncertain contemporaneity, their internal axes anyway making no distinct reference to the Grand Menhir, proposed as focal. For instance, at Kervilor, one of the fore-sights, fragmentary rows, run S'ward at 174°, with a possible transverse E'-W'ly row at 096° (Thom 1978, fig. 9.7/ p. 104). The sight lines themselves do not provide clear channels for observation, and the proposed targets, beyond that of the Grand Menhir, are weakly represented by known sites, although these latter would not be essential as third points to specify a line.

There are other, more tenable interpretations of the Grand Menhir, not involving abstract astronomical observation, for instance as a territorial marker, and symbol of power, clearly visible on the sea-ward approach to the area.

Astronomical data for the Carnac area (47.5°N; 3°W)

Azimuths for extremes of rising, and setting referred to in this discussion are as follows:

sun:	**WS**	126	rise;	234	set;	**SS**	054	rise;	306	set;		
moon:	**rise**	max	N'ly	044	min	N'ly	061	max	S'ly	136	min	S'ly 119;
	set		316				298			224		241;

Key: WS winter solstice; **SS** summer solstice;

Reassessment of axial alignment

Isolated stone rows

Although detailed information is usually lacking, and many sites are now fragmentary, or lost, axes of those stone rows listed in TABLE SA_br 06 show frequent preference for the S'n quadrant. This could suggest interest in the permanent zone of the solar transit, as noted for those better-known examples of stone rows from Dartmoor (see Table of Contents: 03d/8f).

The complex of multiple rows at Petit Ménec to Ménec

This serial complex has been selected for more detailed assessment, since it contains five closely associated sets of rows, the largest, and most impressive in the region, and has been the subject of much speculative interpretation in terms of layout, and function.

Scarre (2011, 103-134) notes the general and irregular WSW'-ESE'ly alignment of the longest row-complexes, with multiple rows accumulating serially by longitudinal, and lateral extension (*ibid*, 120-125), either side of an initial avenue linked to a terminal enclosure, as more clearly seen at Kerlescan, and Le Ménec (*ibid*, fig.5.14/ p.122). This irregularity is seen to argue against a specific astronomical basis, beyond a broad reference to sunrise and sunset. The possibility that such long lines served to divide up the landscape, as a permeable barrier, is discussed as an additional function (*ibid*, 128), but seems an unlikely reason for their construction, even minor. No basic explanation is offered for the occurrence, and scale of the repetitive elements forming these sites.

Two sets of data have been considered: those based on rectified satellite imagery (e-FIGS SA_br-02, 04, and 06), and the plans provided by Thom (1978), shown in e-FIGS SA_br-03, 05, and 07. These two sources are both in broad agreement, differing in internal detail, but for the purposes of measurement the former takes precedence.

Using the former images, the general morphology of each site was divided into zones where broad changes of layout occur. For each of these zones the orientation of currently surviving individual row-elements was noted, as a basis for general statistics, and description of form (TABLE SA_br 05):

TABLE SA_BR 05 BRITTANY: MAJOR STONE ROWS: THE PETIT MÉNEC-KERLESCAN-KERMARIO-MÉNEC COMPLEX

	form	**L**	**rows**	**me**	**#**	**axis................ mean**	**sd**	**min**	**max**	**e-FIGS SA_br sat**	**Thom**
Petit Ménec		**330**								02	03
N	F		**3**	no	5	221.8	6.4	211	230		
S	F		**7**		15	239.2	6.1	233	249		
Kerlescan	F	**250**	**~12**	2	12	272.7	6.3	260	280	02	03
Kermario	P	**1040**	**9**	no	42	239.7	4.1	233	251	04	05
zone 1					5	236.2	1.0	235	238		
2					4	234.5	1.1	233	236		
3					12	239.3	2.5	235	244		
4					6	239.5	3.0	236	244		
5					15	242.7	4.3	233	248		
Le Ménec	P	**900**	**11**	2	60	249.3	4.5	237	259	06	07
zone 1					6	243.5	3.0	238	246		
2					7	242.0	4.4	237	250		
3					47	251.1	2.4	244	259		
totals		**2520**			**134**						
mean						**244.5**					

length of the row complex between extreme NW and SE: ~3690m.

Key: form: F(an shaped layout of rows), **P**(arallel rows); **L** length of row complex in metres, excluding any terminal enclosures; **rows** maximum number of rows in the complex; **me** megalithic enclosure(s) present; **#** number of row-elements included in this analysis; **sd** standard deviation; **min**(imum); **max**(imum); **e-FIGS**: **sat** (set from satellite imagery), **Thom** (set provided by Thom 1978);

Note: zones: broad division along the length of the row-omplex where block-changes in layout appear evident, details of which are given in the relevant e-FIG.

Petit Ménec, and Kerlescan, the two N'n-most, and shortest members of the general alignment, are clearly fan-shaped, with the two larger complexes lying to the S being essentially parallel. Plotting the mean axis of row-elements against the setting solar transit indicates distinct interest in the sector just to the N of winter solstice. This peri-solstitial sector provides high transit frequency, the setting sun crossing it for most of the year (see Table of Contents: 02c/2e), and especially for the sun at lower elevation, (e-FIG SA_br-08). It is therefore suggested that this axis was chosen to optimise such contact, and that solar propitiation formed a major component of rituals carried out at each site. Aggrandisement of rows in terms of stone size, length of row, and number of rows indicates repetitive constructional activity as a major commitment to the status of the site, possibly to increase the scope for propitiation, within some agrarian-solar cult.

-a relationship with the solar transit seems evident

These major complexes show consistent reference to the SW'n quadrant, with any weak splaying of the rows in this direction subtending a fairly narrow angle, as viewed from a potential area of observation at the NE'n end. The sun would only remain S'ward, and beyond this range, as represented by the mean azimuth for the main sites of about 244°, as noted above in TABLE SA_br-05, on its close approach to, and departure from the midwinter solstice, for this latitude at 234°. The multiple rows are, therefore, aligned efficiently for the setting sun to pass over their general line of sight, remaining for some short duration within the width of the rows (see dwell times: e-FIG SA-06).

-disunity of plan suggests iterative construction

These complexes are formed as much by irregularly placed, and spaced, row-elements, as by long continuous rows, although how far such fragmentation is an original feature, or the result of differential destruction, or replacement of stones, is unknown. There appears to be no close unity of design, either at the local level within the complex, or in general, as seen, for instance, at Kermario, and Le Ménec, where a shift in layout is evident along the length. Development at these sites appears to be additive, not unitary, and certainly not reflecting the type of considered geometric layout suggested for them by Thom (1978).

-structural augmentation could indicate intensification of solar interest

These rows display all of the types of structural augmentation suggested for those on Dartmoor (see Table of Contents: 03d/8g), and in N'n Scotland (see Table of Contents: 3d/9d):

elongation	lengthening of rows; cases here from 1-2km;
replication	addition of rows in parallel or fan: here up to 12 or more rows;
repetition	occurrence of many row sites in a restricted area: as seen around Carnac;
proliferation	spread of row sites over the region; here from Finistere at the W, to Ille-et-Vilaine at the E; and to which can be added specifically for the Carnac area:
combined alignment	where the major monuments at Petit Ménec-Kerliscan-Kermario-Le Ménec form a distinct line trending SW'ward for about 3.8km, and reinforcing this general axis.

Given the proposed solar emphasis of their axes, such augmentation could be interpreted as intensive expression of a solar cult, perhaps as a response to economic pressures, under conditions of environmental deterioration (see Table of Contents: 05).

-available evidence suggests the importance of the S' to SW'n sector

These multiple rows tend to fan out weakly towards the SW, and in some cases, as at Petit Ménec, to possess a clear apex at the NE, an obvious point for observation down the rows. At nearby Kerlescan, and at Kermario, this apical area for the converging rows is not as well defined. However, at Le Ménec, the NE'n terminal, the area with potential for viewing down the rows, is occupied by a megalithic enclosure, of a size suitable for a large gathering, and because of its structural attachment here, it is possibly more integral than that located at the other end. At Kerlescan, there is no enclosure at this potential viewing end, but two lie adjacent to the SW'n terminal. Association of such enclosures with unidirectional viewing is, therefore, not clear.

However, since such penannular enclosures appear consistently open towards general E, this suggests entry from this direction, and perhaps observation towards the W, but there is little consistency amongst the broader group:

the enclosure is open towards:

N Kerlescan S;
NE Pen er Land;
E Grand Rohu, Kerbourgnec, Tossen-Keller;
SE Crucuny, Er Lannic N and S, Graniol, Kergonnan, Kerlescan N;
S ?Le Ménec NE;
SW ?Le Ménec SW;
? Kerlescan N;

Placement of the largest stones at the SW'n ends at Le Ménec, and Kermario, might indicate the need for distant areas to be seen more clearly, when viewing along the row from a distance, at the NE.

There is no evidence for the direction of growth of these row complexes, whether unilateral, bilateral, or with some degree of infill: this would be relevant to questions of viewing, and use.

-funerary associations

In the case of many rows on Dartmoor, there are kerbed cairns at one, or both ends of stone rows, suggesting deliberate linking of funerary monuments into the line of the row and any direction of SW'ly directed observation (see Table of Contents: 02c/2i). The funerary function of the terminal enclosures in Brittany remains unknown, but they appear more suitably proportioned for gatherings. Although these enclosures are not typically funerary in form, cists do occur, as at Er Lannic (Burl 2000, fig 38/ p.344), and some cairns are associated, but not in sufficient quantity to indicate intensive burial activity. Use for social gatherings, perhaps related to agrarian rituals, and solar propitiation, seems a reasonable suggestion.

If the basis for ritual at these sites was in some measure solar, then there is little from other sources in the region to suggest the existence of such a specific cult, either from artefacts, or from rock art, although for such agrarian communities this element seems highly likely.

Loqmariaquer megalithic complex: Brittany (e-FIGS SA_br-09 to 12)

-summary

This complex integrates monumental axes with different ritual emphasis into a single unit, maintaining year-long contact with the solar transit, whilst making specific reference to its different sectors, incorporating a specific reference to events around the winter solstice, and displaying potential for registering the general timing of solstices, and equinoxes. The complex consists of three extant megalithic monuments:

-the complex

..Er Grah

A terraced mound, 140m long, tapering towards the N (342°G) contains, at its N'n end, an earlier round, chambered tomb, within rectangular revetments, its radial chamber pointing W'ward (266°G). Construction and use of the monument spanned the period from the 5th millennium BC to around 3600 BC.

..Grand Menhir Brisé (GMB) and its attached row of menhirs

The GMB, now fallen, lies in the foreground of Er Grah, on its longitudinal axis, and would have measured 21.6m in total length, but standing only about 17m above ground, with an estimated weight of 330 tons, its stone sourced locally. The natural surface of the stone has been worked to form an elongate oval, with pointed tip, and chamfered base. The carving of what might be a plough lies on the upper central face, but is now much worn and lacks definition (Scarre 2011, fig. 4.3/p. 71). It has been suggested that the GMB fell, and shattered, during the earthquake of 1722, and its physical collapse has been modelled (Hill 1993).

A relatively straight row of 19 menhirs, 55m long, which is no longer extant, except for GMB, is now marked only by basal sockets, and one butt-end surviving *in situ*, would have increased in size, and height SSW'ward (200°G), along the axis of the row. The row appears to have been fairly unitary in design, with no obvious evidence for staged construction. The fate of auxiliary menhirs that once formed the row is unknown, perhaps displaced at the same time as GMB fell, becoming subsequently dispersed. Broken fragments, probably from one of these ('menhir X') were reused during the Neolithic, as capstones at nearby Er Grah (the marginally decorated top sector), Table des Merchands (decorated bottom sector, its motifs displayed in the chamber), and at the off-shore tomb of Gavrinis (the decorated middle sector, its motifs hidden from the chamber). An agrarian axe-plough motif, similar to that on GMB, together with two horned oxen, appears on this reused menhir (e-FIG SA_br-11).

..Table des Merchands

An ovate mound, about 30m across, with an outer, and inner revetment, encloses a radial passage, and chamber, this latter highly decorated on its roof-, and wall-slabs with incised motifs. A broken sector from 'menhir X', probably from the adjacent stone row, was reused as one of the capping stones, the other fitting sectors retrieved from Er Grah, and Gavrinis, with the tip possibly still missing (e-FIG SA_br-11). The theme of art at the tomb appears agrarian, since motifs on the capstone include an axe-plough, possible draught-oxen, along with what may be representations of standing crops, on the end-wall of the chamber.

-sequence

Detailed development of the complex is uncertain, but if 'menhir X' is from the row of menhirs extending from GMB, and not from another site, or was once erected elsewhere on site, then dilapidation of the GMB-row must precede the final stages of capping at the tombs.

-interpretation of axial alignment at the complex

The complex, at least in its extant form, appears to be one where S'ly axes, linked in this study more with agrarian-economic propitiation, might have operated in combination with more W'ly axes, these having a funerary emphasis, bringing rituals from these two major spheres together (summary: e-FIG CO-01). The site is therefore a prime example of combined axes, and integrated targets (see Table of Contents: 02b/5g).

The axis of GMB and its row, taken in the direction 200°G towards the largest menhir, runs towards the inner margin of the permanent zone of the solar transit (see Table of Contents: 02c/2a), close to the direction of sunset at the winter solstice, hence keeping the axis in year-round contact with passage of the transit, especially apparent when it is at lower winter-time elevation.

Examples of S'ly and W'ly axes, linked by a major monolith-menhir, are suggested for Rudston (TU 0969; Yorks; e-FIGS CU-12 to 14), and here at Loqmariaquer (Brittany; e-FIGS SA_br-09 to 12), as jointly summarised in e-FIG CU-24.

GMB latitude**:** 47.57 N; longitude 2.95 W;
permanent zone of solar transit: 125.03 (winter sunrise) to 234.50 (winter sunset); axis of the row 200°G;

When viewed from the NNE'n end of the row, the transit of the sun during the year decreases in elevation from a high point at mid summer (65°), to a low (17°) during the period of the winter solstice, intersecting the top of GMB only then (e-FIG SA_br-12). It is proposed here that the monument was thus aligned to intersect the transit throughout the year, with GMB specifically configured to register this midwinter solstitial event, using the transit at elevation, not any liminal rise, or set at the horizon.

At winter solstice, the setting sun would pass the zone around the tip of GMB, in an event lasting about an hour (e-FIG SA_br-10 and 12), and would cast a long shadow right to just beyond the terminal menhir at the NNE'n end, a potential viewpoint. At summer solstice, the shadow would fall on the third menhir (possibly 'menhir X'), and at the equinoxes on the sixth menhir, giving good separation of shadow-points, and hence workable definition of the solar year. 'Menhir X', as reconstructed from fragments, fits the elongated socket at that third position (e-FIG SA_ br-10), and like GMB, it too bears what may be agriculturally-themed mofifs. The menhirs from other positions, including socket 6, have not been found. The geometry of this model seems coherent, and reasonably convincing.

GMB, also located on the axis of Er Grah, links the row to this funerary monument, with its W'ly pointing chamber, and its long mound pointing towards the null zone of the solar transit (see Table of Contents: 02c/2i). The chamber of Table des Merchands again shows a similar W'ly axis, typically funerary.

At this site agrarian concerns, expressed to the S, appear ritually linked with acknowledgement of the importance of ancestors, expressed to the W, combining both aspects, perhaps as part of some solar cult.

An example of combined axes: Lagatjar; Crozon peninsula; Brittany (e-FIG SA_br-13)

A straight row, originally of 72 stones, up to 4m high (Devoir 1911), runs for 210m towards the SSW (216ºG). Two shorter parallel rows, each about 90m long, extend near-perpendicularly from this main row, towards the NW (exactly perpendicular would be at 306ºG), and appear joined to it: one row straight, running 311ºG, and set about a quarter of the way along from the NNE, the other more curving, running 315ºG between ends, and set at about half way. There is no sign of further enclosure along their NW'n side.

The axis of the main row (216ºG) points just within the permanent zone of the solar transit, here from about azimuth 125º (winter sunrise) to 234º (winter sunset), close to the position of winter solstice sunset, and would therefore experience passage of the transit throughout the year, as well as maintaining reasonably close contact with the solstice-event itself.

The lateral rows point just beyond the position of the summer solstice (azimuth 305) towards the margin of the null zone, where the sun does not pass. In contrast to the main axis they would not intersect the transit, only coming close around the time of the summer solstice.

It is suggested here that the main axis is of the S'ly type, typical of stone rows, and cursuses, more closely linked with agrarian-economic concerns, and that the lateral axes are a reference to the W-NW'ly axis, prevalent amongst funerary monuments, apparently token at this site in the absence of any known burial activity. Combination of axes in this way would have integrated both spheres of ritual concern.

Stone rows radiating from a focal point: two possible examples

It is possible that certain stone rows in Brittany radiated from a single point, or restricted area of observation, for viewing along them, and beyond, to encompass an arc of the sky, in a manner noted for other multiple rows (see Table of Contents: 03d/9).

At Les Alignements des Moulin (e-FIG SA_br-15; TABLE SA_br 06) three rows diverge from, or converge on, a restricted, but otherwise unmarked area. At Lampouy (e-FIG SA_br-14; TABLE SA_br 06) two rows have a menhir as a possible focus, and a third row is less closely aligned.

These radiating rows might have acted to connect with a sector of the solar transit available for most of the year, that of the E'n rising arc, and into the permanent zone (see Table of Contents: 02c/2a). The line of view would have been more visible if taken from smaller, to larger structure, from monolith, to row, hence S-SW'ly, rather than in the opposite direction.

Megalithic enclosures

One monument is worth describing in some detail, as an example of the open 'horse-shoe shaped' rings (TABLE SA_br-07), illustrating points relevant to the group, particularly that the E' to SE'ly direction of opening might serve only to present, for those gathered there, a more clement aspect, as an amenity rather than anything more astronomical, taken towards the near-mid morning sun.

Er Lannic; Morbihan; =47.567774N; =2.896573W; horse-shoe shaped stone rings;
two contiguous U-shaped settings defined by monoliths; coastal island location, now semi-submerged; partially excavated, Rouzic 1930;

Note: Many plans of this site are inaccurate, with pointers not correctly aligned. This analysis has therefore been based on rectified aerial imagery, and plans adjusted accordingly (e-FIG SA_br-16).

-structures

..N'n structure: 72m long, 54m wide, with straight sides, and rounded back, the tallest stone, 4.4m high, standing at its centre, and on the longitudinal axis, which also passes through the cove-like setting at the centre of the open side; the perimeter is approximately symmetrical about this axis, which runs at 128° from the centre of the back, to the centre of the opening; stones forming the perimeter are up to 2m high, contiguous in several places, but with a gap, perhaps original, in the centre of the N'n side; the perimeter is set in a low bank of rubble; particularly large uprights occur towards the S'n terminal; the enclosure overlies an earlier area of settlement; polished stone axes occur at the site, and are carved as motifs on the interior side of certain stones, one on the W'n side, with a simple axe, another nearby, with two shafted axes, and one axe-motif on the E'n side (Shee Twohig 1985, fig. 181); a few cup-marks also occur, on the packing of the cove, and stones of the perimeter.

..S'n structure; 66.4m long, 61m wide; more regularly curved to form a semi-circle, and better constructed than the N'n structure, using larger stones about 4m high when standing; portals are marked by very large stones; the axis from centre-rear through the mid-point of the open side is 070°;

..outliers of uncertain association:

one stone, 3m high, lies just to the N of the enclosures, and one 7m long, prostrate, more distantly to the WNW;

-sequence: it remains unknown whether the structures were contemporary, or whether the N'n replaced the S'n enclosure, as this became flooded by encroaching sea;

-status:

in terms of the area enclosed, these two sites lie towards the lower end of the range of Breton megalithic enclosures, and cromlechs (Burl 2000, table 16/ p.336; TABLE SA_br-07).

-interpretation of alignment:

..N'n enclosure: Burl (2000, 342-348) considers the inward-running line from the cove to the tallest upright at the rear to be towards the midsummer solstice sunset, and that from the [unmarked] centre of the enclosure to the [undated] 3m high outlier at the N to be towards maximum midwinter moonrise, suggesting seasonal ceremonial use at midsummer, and midwinter, with involvement of a solar axe-cult; the large stones at the S are taken to observe N'-S'ly cardinal directions, presumably by sighting from the central area of the enclosure;

..S'n enclosure: Burl (2000) quotes its major axis as 115-295°, hence possibly aligned towards May Day-Beltane sunset at the WNW; its actual axis is 070-250°, precluding this; the consistency of opening of such sites towards the SE is noted here, comparing similar cases at Crucuny, Kerbournec, and Tossen-Keler within this sub-group (TABLE SA_br-07); entry to the interior was noted as being from the E, with ritually significant viewing towards the W.

-re-interpretation:

Er Lannic provides yet another example of interpretation in terms of astronomical preconceptions rather than robust structural evidence.

The only structurally convincing axis at the site is that of the N'n enclosure, which provides the basis for its bilaterally symmetrical construction, and is near-solstitial, with nothing to argue for one particular direction of viewing. The line to the SE would take it to the margin of the permanent zone of the solar transit, allowing year-round contact between site and transit, perhaps as a passive axis, as suggested for many other sites (see Table of Contents: 02a/2g). The line to the NW would allow transient contact around summer solstice setting. There is no compelling evidence for any interest in cardinal directions, or indeed the solar transit. Linking the unmarked centre to an undated outlier through a gap in the perimeter, that might not be original, seems tenuous, especially when involving an obscure lunar standstill with 19-year periodicity. Many other lines could be drawn as, for instance, between the back-stone, and others, to connect with a range of potential targets: the terminals could be joined to produce peri-solstitial alignment: and so on.

The best that can be said: the structures open to the E, and that since the two structures are differently oriented, as are others in the broader group, close targeting of specific events might not have been a prime factor in their use, or at least one formalised in stone. Achievement of a more clement sun-ward aspect might have been the prime consideration.

Carved motifs

There is a scatter of sites producing rock art along the N'n coast, and a denser concentration along the S'n coastal margin, especially around the Carnac sector (e-FIG SA_br-01; Shee Twohig 1981, 38-75, maps 4-5/ pp. 42-43). Such art is mainly associated with the interiors of tombs (41 cases [71%]: Shee Twohig 1981), with far fewer cases occurring on menhirs (9 cases [16%]: Shee Twohig 1981), or occurs on isolated rocks in the open air (8 sites involving 15 stones [14%]: Shee Twohig 1981). Stone rows in Brittany, from pairs, up to complex multiple lines, have not attracted rock art, a general absence also seen amongst those, for instance, on Dartmoor (see Table of Contents: 3d/8h). Given the abundance of suitable surfaces, this is surprising, and seems to present a case of positive avoidance. If such monuments embodied solar rituals then perhaps this was sufficiently well established by the axis, requiring no further reinforcement by such possible solar motifs as cup-marks.

There are relatively few cases of cup-marks, which dominate many open-air panels from the Atlantic seaboard, as seen for instance in N'n, and W'n Britain (see Table of Contents: 03g/9 to 12).

Further analysis of motifs is given in TABLE SA_br 08:

TABLE SA_BR 08 BRITTANY: ANALYSIS OF CARVED MOTIFS ON STONES FROM CHAMBERED TOMBS, AND OTHER SITES IN BRITTANY, WITH ADDITIONS FROM N'W'N FRANCE

This table, containing an interim working list of rows, has been placed as a text file in the folder TABLES_filed, on account of its length, and the partial nature of some data.

Motifs were assigned what seem to be realistic interpretations (e-FIGS SA_br-30 to 47), and grouped by theme as agrarian, militaristic, solar, naturalistic, or ritual, with a residual category for indeterminate items. Instances of useful spatial associations between motifs, possibly aiding interpretation, were noted, as were cases where complex panels might be mapping actual terrain (see Table of Contents: 06/3b). The frequency of each group was noted across all sites, and this was scored, and ranked, as follows:

extract from **TABLE SA_br 08:**
grouping: assemblages of motifs have been grouped according to their general theme: agrarian [**a**], naturalistic [**n**], ?solar [**s**], militaristic [**m**], ritual [**r**], or indeterminate [**i**]; lower case indicates occurrence on panels, upper case dominance of the range;

theme	**groupings**				**TOTAL**
agrarian	**a**	24	**A**	6	30
militaristic	**m**	7	**M**	2	9
ritual	r	9			9
solar	**s**	7	**S**	1	8
indeterminate	**i**	8			8
naturalistic	**n**	5	**N**	1	6
mappings		5			5

The repertoire of motifs from tombs contains nothing overtly solar, only a range of simple geometric symbols, basic tools, and weaponry, with occasional anthropomorphic elements. This analysis indicates that agrarian themes are those most strongly represented, indicating the obvious importance of this sector, and the background concerns of the communities involved in construction, and use of such monuments. Adding naturalistic, and solar elements to agrarian would raise this level significantly.

Comparing motifs used internally within monuments, and those on outdoor surfaces (TABLE SA_br 09) indicates some differences, but the number of external panels are too few to make a valid statement:

TABLE SA_br 09 Brittany: rock art from tombs and open air surfaces

	tombs		**external**	
	#	**%**	**#**	**%**
geometric				
cups	16	6	4	16
circle	3	1		
U	11	4		
yoke	24	9		
crook	24	9	3	12
cross	12	5	2	8
angled - 7	10	4	1	4
triangle	5	2	3	12
wave	24	9	4	16
weapons				
axes: hafted	27	10	4	16
dagger-spear	15	6		
athropomorphic				
?head	60	23	4	16
breasts	28	11		
total	**259**		**25**	

Data: after Shee Twohig 1981.
Key: # number.

Supplementary information on individual sites

Petit Ménec; e-FIG SA_br-02 and 03;

The W'n terminal of the multiple rows at Petit Ménec lies about 200m to the E of the Kerlescan rows. The site appears to contain two sets of fanned rows, the N'n, and S'n, with different notional apices, merging to form a curving line about 330m long. The N'n set contains three clear lines, placed closely to form an acute fan about 216-221°, reaching about 25m wide, with the central line at 218°.

A fragmentary S'n set, of up to seven row-elements, curves SW'ward for about 330m, appearing to expand from a notional apex lying to the NE, fanning between about 236 and 244°, to a maximum width of about 50m. A final row-element, at the SW'n end, appears to align with those forming the N'n half of the Kerlescan rows, raising the possibility of some connection.

Kerlescan; e-FIGS SA_br-02 and 03; phot SA_br-03);

-rows

A set of about nine extant rows, with space for another three in the fragmentary S'n half of the monument, runs for about 250m, fanning out from a narrower E'ly end, about 50m wide, to the broader W'ly end, about 100m wide. The fan covers the range of azimuths 260-276°G, with the intervening rows ranged fairly evenly between. The rows in the N'n half of the monument form a more regular set, with surviving row-elements in the S'n half appearing to differ in layout from this plan. There is no single apex for the fan: extrapolation of the rows to the E produces a scatter of points.

-lesser enclosure

The rows terminate at the W against a clear line of megaliths, running S'ward (179°G). To the W of this, a curving circuit of stones marks the perimeter of an ovate enclosure, some 70m wide, covering most of the terminals of the rows, its S'n, and W'n sides extant, but appearing open to the N.

-greater enclosure

A large, ovate megalithic enclosure, about 200m across, lying immediately to the N of the W'n terminals of the rows, is extant over its curving S'n, and W'n sectors, appearing open to the E.

Kermario; e-FIGS SA_br 04 and 05; phot SA_br-02;

Multiple lines, of up to nine rows, run for about 1040m, and fan out slightly, towards the SW, in a weak curve. Over the fragmentary NE'n half, the rows run at about 236°, and diverge more than seen over the SW'n half, where better preserved lines, running at about 240°, are more broadly spaced and parallel, about 100m wide at the SW'n terminal. A menhir lies within the lines, near the NE'n end, but not at any apex. There are row-elements with some longitudinal consistency, but many appear as shorter lines, either originally discontinuous, or the result of more recent damage to the monument.

Le Ménec; e-FIGS SA_br-06 and 07; phot SA_br-01;

Lines of up to 11 rows run in a weak curve, for about 900m, and can be divided into three sectors. The NE'n quarter appears narrower, at about 65m wide, and runs at about 245°G, merging with a less regular zone, running at about 239°G, together making up the first half. The remaining rows, lying to the SW, fan out slightly, their axis 249°G along the mid-line, and are 100m wide at the terminal.

A fragmentary, ovate, megalithic enclosure, about 80m across, incomplete towards the S, firmly abuts the NE'n terminal of the rows, and another similar, but smaller enclosure, 80m by 65m, lies close to the S'n corner of the other end, appearing less integral with the rows. There is no evidence that any particular pair of rows formed a line of entry-exit for the enclosures, certainly nothing directly linking NE'n with SW'n.

Summary information on stone rows, and megalithic enclosures

Brittany: stone rows
Stone rows fall into six groups, examples of which are listed below (TABLE **SA_br-06**):

-multiple: rows >=3;
-double rows;
-long single rows;
-rows with 4 to 6 stones;
-rows with 3 stones;
-pairs of stones;

TABLE SA_br 06 Brittany: list of stone rows
This table, containing an interim working list of rows, has been placed as a text file in the folder TABLES_filed, on account of its length, and the partial nature of some data.

Brittany: megalithic enclosures
The enclosures are of three types, examples of which are listed below (TABLE SA_br-07):

-cromlech type; -horseshoe-shaped; -rectangular.

TABLE SA_br 07 Brittany: megalithic enclosures
This table, containing an interim working list of enclosures, has been placed as a text file in the folder TABLES_filed, on account of its length, and the partial nature of some data.

Brittany: analysis of carved motifs

This table, containing an interim working list of motifs (**TABLE SA_br 08)**, has been placed as a text file in the folder TABLES_filed, on account of its length, and the partial nature of some data.

TABLE SA_br 08 Analysis of carved motifs on stones from chambered tombs and other sites in Brittany, with additions from N'W'n France

e-FIGURES: combined listings and supporting information

e-FIGS
SA_br

Stone rows

01 Brittany: general distribution of stone rows, and related monuments

02 Brittany: Petit Ménec, and Kerlescan: stone rows: plan based on satellite imagery

03 Brittany: Petit Ménec and Kerlescan: stone rows: plan after Thom 1978

04 Brittany: Kermario: stone rows: plan based on satellite imagery

05 Brittany: Kermario: stone rows: plan after Thom 1978

06 Brittany: Le Ménec: stone rows: plan based on satellite imagery

07 Brittany: Le Ménec: stone rows: plan after Thom 1978

08 Brittany: the Petit Ménec-Ménec stone row complex: axial properties in relation to the solar transit

09 Brittany: Loqmariaquer megalithic complex: the Grand Menhir Brisé and its stone row, Er Grah chambered long mound, and Table des Merchands round chambered tomb

10 Brittany: Loqmariaquer megalithic complex: the Grand Menhir Brisé and its stone row
The position of the sun-shadow cast by the Grand Menhir along the axis of the row (020-200ºG), towards 020ºG, is shown for winter solstice, equinox, and summer solstice. The Grand Menhir has been repositioned in socket 1, as once erected, and 'menhir X', reassembled from fragments, and possibly originally from the row, has been tentatively reinserted, in socket 3.

11 Brittany: Loqmariaquer megalithic complex: surviving menhirs: the Grand Menhir Brisé, and 'menhir X', as reassembled from fragments
Surfaces bear carvings of axe, or plough-like implements, variously interpreted, and of horned oxen.

12 Brittany: Loqmariaquer megalithic complex: Grand Menhir Brisé and the solar transit
Passage of sun over the tip of the menhir at winter solstice, as viewed from the NNE'n end of the row. The apparent diameter of the sun as shown is taken as 0.53 degrees. Data: from suncalc.net.

13 Brittany: Lagatjar; Crozon Peninsula: stone rows

14 Brittany: ?radiating rows: Lampouy

15 Brittany: radiating rows: Alignements du Moulin

Megalithic enclosures

Note: details of location are given in TABLE SA_br-07.

16 Er Lannic;

17 Crucuno;

18 Crucuny;

19 Hemicycle;

20 Kebourgnec;

21 Kergonan;

22 Kerlescan S;

23 Lann Penn;

24 Ménec E;

25 Ménec W;

26 Notre Dame;

27 Tossen-Keler;

28 Le Tribunal;

29 Kerlescan N and S;

Carved motifs: themes and examples

Note: further details are given in TABLE SA_br-08.

30 animals;

31 ard;

32 axe adze;

33 body;

34 breastplate;

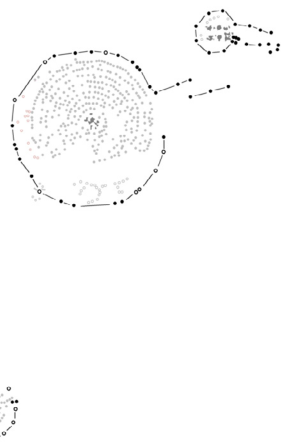
35 crooks yolks;

36 crops;
37 enclosures;
38 goddess;
39 halberds;
40 heads;
41 maps;
42 mask;
43 ploughed land;
44 shield;
45 solar cups;
46 various;
47 water plants;

Section 04e:
Study area: Stanton Drew megalithic complex

Section identifier: SA_sd-

SEE INITIAL SECTION:
Access to digital images



Stanton Drew: the main megalithic complex

Reasons for inclusion

This complex consists of a close grouping of stone circles, and associated short avenues, with other megalithic features within the immediate area. The site has been clearly defined by detailed planning, and geophysical prospection, making more precise assessment of structural axes possible.

Summary

Analysis of structural alignment within, and between the monuments in this megalithic complex indicates no reference to solar, or lunar limiting positions at, or near, the horizon.

However, consistent reference to the W'n arc of the setting solar transit would provide an alternative interpretation, one that includes all data, suggests a possible funerary function for the monuments, provides a coherent basis for ritual, and offers hypotheses testable by excavation.

Topography

The sites (e-FIGS SA_sd 01 and 02) lie on a low ridge, part of a river terrace lying at the edge of rising ground that flanks the River Chew, where its valley widens locally to form a floodplain. The main complex lies just to the S of the river, with one element, Hauteville's Quoit, lying at the edge of the valley, on the N'n side (Burl 2000, 148-149).

The general site, and its sequence of development

The complex consists of one larger stone circle, and its short avenue (**main circle**), two adjacent small satellite stone circles, one with an attached avenue (**NE'n circle),** and one apparently without **(SW'n circle**). **The Cove**, a three-stone setting, possibly the portal for a now-vanished long barrow, lies just to the SW of this main group. Individual locations are as follows:

Stanton Drew megalithic complex; Somerset; e-FIGS SA_sd 01-04:

structure	**NGR ST-**	**HER: references**
main circle	59994 63275;	ST 66SW2; 201201;
NE'n circle	60088 63345;	ST 66SW34; 1097243;
SW'n circle	59919 63070;	ST 56SE41; 1097265;
The Cove	59756 63091;	ST 56SE75; 1475186;
Hautville's Quoit	60166 63800;	ST 66SW35; 1097258;
Tynings Stones	58982 63375;	ST 56SE43; 1097273;

Key: **NGR** National Grid reference; **HER** Historic Environment Record.

Several large stones, of unknown date and association, lie beyond this main complex:

-**Hauteville's Quoit:** a large stone, set on a small ridge some 600m to the NE of the megalithic complex, was once about 4m long, but currently survives only to half this length, and although now recumbent, might once have stood upright;

-**The Tynings Stones:** two large stones, their original location uncertain, lie about 700m to the W of the complex;

-**The Tollhouse Stone**, as noted by Stukeley, no longer exists, but might have stood about 500m to the NW of the Main Circle.

The stones in the complex are of sandstone, conglomerate, and oolitic limestone, all of which are available locally.

Stones were planned, and numbered by Dymond (1896) as follows:

main circle and avenue: M 1–35;
NE'n circle and avenue: N 1–19;
SW'n circle: S 1–12;
Cove: C 1–3;

Another stone, S13, was identified by Oswin *et al.* (2009, 2010), who also noted other possible empty stone sockets, and sites of buried stone.

The complex remains unexcavated, only recently attracting any detailed geophysical investigation, and further survey. Structurally, although on the basis of parallels, the main site would fit well into a later Neolithic to earlier Bronze Age context, there is no evidence on which to base any dated sequence of development, nor to suggest general function.

The three stone circles certainly seem similar in basic concept: a stone circle encloses rings of pits, that are ranged around some discrete, pit-based structure at the centre, some, or all, of these pits perhaps once holding posts, with a formal avenue approaching the site evident in two of the three cases. Structural details differ however: the main circle is far larger than the two satellite circles, as their names would suggest, and is the only one to have an encircling ditch, of hengiform type. Common aspects of alignment are discussed separately below.

The main circle

This site consists of a single, **sub-circular ring,** about 116m in diameter, of irregularly, and widely spaced stones, 27 of which are extant. This ring lies around the inner edge of a **penannular ditch,** of mean diameter 126m, and top-width of 5-7m, with a 50m wide **entrance gap** in its NE'n circuit, and a minor 6m wide gap opposing at the SW, with evidence here for flanking timbers forming a passage. Any **bank** outside this ditch, as found at certain other circle-henges, has left no clear trace here in the geophysical mapping, perhaps because long eroded away. Five extant stones form a short **avenue,** about 50m long, and 12m wide, approaching the entrance gap, asymmetrically at the NE'n side of the stone circle.

Nine concentric rings of closely spaced pits, several hundred of which, together with additional placements, have been detected as enhanced magnetic anomalies, occupy most of the area within the main stone circle. Detailed structure over its S'n sector has been obscured by plough-damage. The inner ring is about 21m in diameter, and the outermost 91m, with intervening rings spaced fairly evenly, about 10m apart. The general structure of the ring-complex appears to be entirely concentric, with some alignment of pits between adjacent rings suggesting occasional radial lines, perhaps forming coincidentally as an artefact, rather than intentionally. There is no clear indication of radial passageways, running from edge to centre, although fewer pits in a wedge-shape sector from the ditched entrance gap, to the centre, might indicate the main line of access. The pits, possibly for free-standing, or lintelled posts, average about 1.4m across, and are spaced at about 2m intervals. The innermost ring defines a circular **central area,** containing about eight pits, that could perhaps be seen as a roughly rectangular outline, 47m by 34m, with its narrower side towards 314°G. A **marginal zone,** containing only scattered, pit-like anomalies, separates the outermost ring from the stone circle. Various possible structures are evident in this marginal zone, the clearest being an incomplete ring of such pits, about 15m in diameter, at its S'n edge, suggesting a small enclosure, perhaps with an entrance gap.

The concentric rings of pits, and the ditch, respect a common centre, but the stone circle conforms less well to circularity, and is centred separately, about 5m to the SSW of this.

The NE'n circle

An **circle** of 8 extant stones, arranged as opposing pairs, encloses a partial **ring of pits,** which in turn surround the central area. The central interior contains a **setting of four large pits**, arranged as a square, of side about 7.5m between pit centres, which aligns with the four opposed pairs of stones in the stone circle. Other pits appear to form a short passage, leading towards the W into this central structure, the same direction of approach maintained by the short stone avenue. This short **avenue,** originally of eight stones, and about 32m long, expands in width from 8m to 13m as it joins the circle. There is no evidence for a ditch around the site, but an arc of pits just beyond the N'n side of the circle might form some outer perimeter.

The SW'n circle

An irregular **circle** of 13 extant stones surrounds a platformed interior, and encloses one clear **ring of pits** around its central zone, with arcs of pits just beyond this suggesting two other rings. An irregularly rectilinear arrangement of **pit-like features,** about 9m by 5.5m, occupies the centre of the interior.

There is no evidence, as yet, for an **avenue** of stones, as seen at the other two circles. Any more complete circuit of a **ditch** also appears absent, although an arc of magnetic enhancement, and of higher resistivity, around the NW'n edge of the circle, might be a ditched segment.

Other structures

-There is a possible **setting of posts,** about 100m to the SE of the main circle. An irregular **enclosure,** about 34m by 26m, with radial divisions, is partly visible, attached to the ditch on the outer SE'n side of the main circle.

-The Cove

A setting of three stones, originally cove-like, with one slab flanked by two uprights, is of uncertain interpretation, but might well represent the portal from the forecourt of a now destroyed long barrow. Wider resistivity survey of the immediate locality indicates the possible area of a former mound, tapering towards the NNE, some 45m long, which is about the average for the Cotswold-Severn group of long barrows. The stones lie at the broader, S'n end of the suggested mound, within a wedge of lower resistance, about 15m long, and tapering from about 8m wide at this S'n end, to 4m wide at its N'n end, possibly indicating a horned forecourt. Patches of lower resistance at the periphery of the possible mound may indicate a flanking ditch, and another such area, transversely within the mound on its E'n side, could indicate a lateral chamber.

The portal structure is paralleled in the nearby Cotswold-Severn group of long barrows, at several other sites with false portals, and lateral chambering, for instance Belas Knap, and West Tump (Glos.), also Lugbury, and Luckington (Wilts.).

Axial alignment at the site

Structural basis

Structural axes at the complex can be divided according to whether they occur within individual monuments, or between them (e-FIG SA_sd 03):

-axes within monuments

Notional axes can be established between any of the individual structural elements, for instance taking stones, or internal pits separately, or between members of the combined sets, generating an even larger range of possibilities. A further set of axes becomes available if viewing is taken from some other fixed point, such as the centre of the circle, to any stated foresight. It is possible, therefore, to find an axis corresponding with, or approximating to, any celestial event. Even removing lines that are impractical, for instance, those obstructed within the crowded interiors of the three circles at this site, leaves an over-large residue of very subjective alternatives.

It is far better therefore to concentrate on axes that are major, and unequivocal, such as those of main approach, entry to, and transit across the interior of such monuments (TABLE SA_sd 01):

TABLE SA_sd 01: STANTON DREW ST 6063: MAIN AXES

site	axis line	entry to W	via	notes
within monuments				
NE	**1**	**277**	avenue	
	2	268	central structures	
MC	**1**	**250**	avenue	239-261: sparser posts within interior;
	2	**239**	gap in ditch: mid-line	lateral limits of gap 217-261
		217	*exit* via minor gap in ditch	=N lateral limit of ditch gap
SW	**1**	**243**	?portal stones	
CV	**1**	**334**	towards portals	
between monuments				
J	**1**	**199**	HQ-MC-SW	limits over site from HQ 186-234
	2	**234**	NE-MC-CV	
	e	211	NE-MC-SW edges	tangent to edges of circles

Note:
-**HQ** Hauteville's Quoit; **NE** NE'n stone circle; **MC** main circle; **SW** SW'n circle; **CV** The Cove; **J** label added to indicate the joint nature of axes;
-only the W'ly direction of axes are shown for clarity of presentation, the other is implicit;
-axial directions are given relative to National Grid N (°G);
-prominent axes are shown in **bold** type.

-axes between centres of monuments

There are two axes joining the centres of the three circles that have long been noted (Wood 1750s: Lloyd-Morgan 1887; Lockyer 1909; Thom 1967):

..axis J1 involves use of Hauteville's Quoit, a stone of unknown association, set at some distance from the main complex, which comes to be included in the axis because it too falls on the line between the centres of circles.

..axis J2 includes monuments of different types, and perhaps date, namely two circles, and a possible long barrow, but again the close fit of the line could suggest intentional alignment.

Astronomical targets for alignment

None of the more prominent, and perhaps more realistic axes proposed for the complex (TABLE SA_sd 01; e-FIGS SA_sd 03 and 04), correspond with limiting directions of solar, or lunar rising, or setting at, or very close to the horizon (Sermon in Oswin *et al*. 2010, precise corrected values for 0-3° elevation: fig. 7.8). The best that can be achieved is a very loose approximation to a few solar, or lunar positions, in a mixture of setting, and rising, with no coherent trend evident in terms of target, this forming no basis for discussion of possible ritual.

Despite this poor fit, valiant attempts have been made to shoe-horn axes into the framework of solar, and lunar setting. Thom has further suggested that axis Je, tangential to the NE'n, main, and SW'n circles, along their SE'n sides, and the parallel line between the centres of the NE'n and SW'n circles, might have targeted S'n maximum moonset, a rare and selected event, occurring only at almost generational intervals.

Reference to other celestial bodies offers no solution, and early attempts by Lockyer to involve the rising of Arcturus as a target, has no astronomical basis.

Such a mismatch between axes, and celestial targets near the horizon, could mean that orientation of monuments had no such cue, or a different one, for instance, some reverence for local topography, such as the direction of the river, and its valley.

However, this apparent absence of celestial targets for major structural axes can be readily explained as the result of constraints imposed by assuming, incorrectly, that events at, or near the horizon, especially at limiting positions in the annual cycle, formed the basis for such alignment.

The major hypothesis put forward in this analysis emphasises reference to the setting arc of the solar transit, as the key element in establishing major structural axes, especially those that determined the direction of approach, the view over the monument towards the sky beyond, and then entry to the site itself. This transit would have served to provide a continuing daily reference to the sun, as it passed over the axis, on it way towards setting, with frequency depending on the direction chosen (see e-FIG AS 09). This would have provided a readily accessible basis for ritual, notionally linking monuments to the land of the ancestors, with daily connection provided by the passing sun (see the seasonal-solar hypothesis: Table of Contents: 02b/8; 03a/13a).

Application of this model to Stanton Drew unifies the data well. Here, the direction of entry to the circles is consistently towards the W, particularly that sector of the transitional zone of the solar transit between the W'n equinox and winter solstice sunsets. Individual directions range between peri-equinoctial for axes NE1 and 2, to peri-solstitial for J2. Transits would have been available at such directions, individually, or collectively, for a large proportion of the year (e-FIGS SA_sd 03 and 04).

The Cove, if confirmed as the site of a long barrow, would most probably predate the circles, as one of the earliest elements in the megalithic complex. If axis J2 is valid, then the structure certainly seems to have been included as part of the later, and more developed layout. Its mound points towards the NNW ('pointing' is taken towards the narrower end: for discussion see Table of Contents: 03a/11b), with a far more N'ly emphasis than seen for axes at the circles. This direction too could be making more sophisticated reference to the solar transit, within the null zone, at a point extrapolated to below the NW'n horizon, more directly to any post-sunset, subterranean land of the ancestors (see discussion: Table of Contents: 02b/6b and 02c/2i).

In addition, the synoptic view over the complex, from Hauteville's Quoit, would project the site, in its entirety, towards the permanent zone of the transit, providing a year-round link for the whole complex. If the W'ly emphasis, seen for axes, indicates a strong funerary element in ritual at the complex, then such a more distant view-point might have been required for regular use, given any restricted access to the interior imposed by associated taboo.

The function of the complex

There is no clear evidence to establish a structural sequence for the complex, let alone to provide a basis for discussion of function, and existence of any particular ritual emphasis. However, several indicators point to a possible funerary function, perhaps major:

-the generally **W'ly lines of access** to monuments are in agreement with those seen, for instance, amongst Neolithic long barrows, which have a definite, but not exclusive role in processing of the dead. One such long barrow might be represented by The Cove, and be included on one of the major structural axes;

-the multiple post-rings within the main stone circle bear some similarity to **post-rings, and associated burials under round barrows** of later Neolithic and early Bronze Age date (Marshall 2020), although at Stanton Drew the number of rings is larger, and the potential timber-work more imposing;

-other such **hengiform and related structures,** with multiple post-rings, as at Woodhenge, have funerary associations;

-the **pit-based structures at the centres** of the three stone circles, especially clear in the case of the NE'n circle, suggest large timbering of the type seen at certain chambers in earthen long barrows, such as Fussells Lodge

(Wilts.), and Wayland Smithy {Berks.) (e-FIG LB-15). It is possible that timber platforms, or hut-like structures existed at these centres, in some way involved with retention, and processing of the dead;

-the **central areas of the circles, shielded from open view** by post-rings, might indeed have provided a suitable venue for exposure, or cremation, of the dead. If such areas were repeatedly used for cremation, then sediment collecting in, and around pits should be distinctly enhanced magnetically (Marshall 2011). Cursory examination of existing results from gradiometry (e-FIG SA_sd 02) may support this. Direct measurement of magnetic susceptibility would allow better assessment, but existing data (Oswin *et al.* 2009, 2010) are of little use, since taken by contact with the modern surface, not at depth (Marshall 2011a).

e-FIGURES: combined listings and supporting information

e-FIGS
SA_sd

01 Stanton Drew ST 5963: megalithic complex: the general area

02 Stanton Drew ST 5963: megalithic complex: details of the main site

03 Stanton Drew ST 5963: megalithic complex: astronomical considerations

04 Stanton Drew ST 5963: megalithic complex: analysis of the alignments

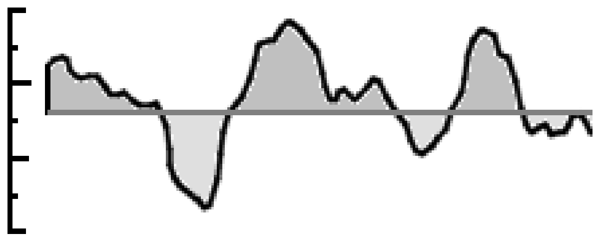
Environmental issues

Section 05

Climatic and environmental change in Britain and Ireland during the Neolithic and Bronze Age: evidence for environmental stress, and its possible role in proliferation of certain types of axially-aligned monument

Section identifier: CL-

SEE INITIAL SECTION:
Access to digital images



fluctuating palaeo-temperatures;

Summary:
Evidence is presented for climatic, and environmental deterioration over areas of upland in Atlantic Britain, and Ireland during the later Neolithic, and Bronze Age. The possible contribution of volcanism to this process is briefly outlined.

The possible economic impact of such events on small-scale agrarian communities in these areas is considered, especially in terms of it causing sufficient change in ritual emphasis to have affected construction, and alignment of monuments involved in propitiation.

The following topics are discussed:
-**replication** of certain types of monument as a response to environmental stress;
-the marked **variation of environmental conditions** over Britain and Ireland;
-**sources of evidence** for environmental change;
-the **main trend in climate** for the area during the prehistoric period, climatic zonation, and major contributors to climatic instability;
-the climatic framework suggested by the **Bond Events**;
-evidence from **alluviation**;
-a more detailed summary of **environmental change in Britain and Ireland**;
-evidence from **tree-rings**;
-the **impact of volcanic activity** on conditions in the area, summarising relevant prehistoric, historic, and modern eruptions, with especial reference to nearby Iceland; duration and abruptness of induced environmental change;
-evidence from **ice-cores**;
-the **cultural consequences** of volcanic fall-out.

Introduction

Replication of ritual monuments as a measure of environmental stress

Certain types of monument considered in this survey seem predominantly distributed in areas of the W'n seaboard of Britain and Ireland, where environmental conditions can be markedly variable over time, and are generally challenging. Weather in the zone between the main Atlantic and Continental systems, within which Britain and Ireland lie, is variable, and its patterns complex, impacting on seasonal change, and thence on agrarian economies.

Clear examples of repetitive construction can be seen amongst certain prehistoric ritual monuments, constructed in areas potentially exposed to such conditions of adverse Atlantic weather. Distributions of stone circles, stone rows, and panels of rock-art, in Ireland and Scotland, certainly show multiplication of sites within areas, and for particular localities, well beyond what might be expected as a functional minimum.

In Ireland, concentrations of such sites occur in N'n, and W'n, near-coastal areas: for circles, the Sperrin, and Cork groups (e-FIG ND-06a), and for stone rows the upper Mourne valley, and Kerry-Cork groups (e-FIG ND—06b). In England, further distinct groups occur on Dartmoor, and on Exmoor (both in Devon)(e-FIG ND-05b and 05c).

As examples of replication of structures at a single site the row-cairn-circle complexes at Beaghmore, Tyrone (e-FIG SR-26), Learable Hill, Sutherland (e-FIG SR-23), and Shovel Down, Devon (e-FIG 12) provide clear examples. Multiple rows, such as those at Drizzlecombe, Devon (e-FIG SR-08), or Merrivale, Devon (e-FIG SR-11), and those of N'n Scotland (e-FIGS SR-15 to 25) form other such cases (see Table of Contents: 03d/8h and 9f).

Sites of rock-art, very abundant over many similar areas of N'n, and W'n Britain and Ireland may also represent, in some measure, an appeal to natural forces, made as a response to environmental stress (e-FIG ND-01d). In Ireland, there are concentrations in the Kerry area of the SW'n seaboard, and in Scotland over W'n coastal areas (e-FIG ND-06d).

It is possible that the type of repetitive construction seen amongst such monuments as stone rows, circles, and sites of rock-art, both in their proliferation, and aggrandisement (see Table of Contents: 03d/8g), could represent a response to deteriorating environmental conditions. Such change might have led to intensification of those ritual practices thought to mitigate the impact on communities, and their economy. As conditions turned wetter, and colder, then some appeal to solar deities might have seemed appropriate, this reflected by further production of axial alignments that referred to relevant sectors of the solar transit. A S'ly emphasis towards the permanent zone of the solar transit (see Table of Contents: 02c/2b(ii)), or towards those sectors of the transit that linked more closely with ancestors, might be expected.

Conditions during the later Neolithic, and earlier Bronze Age seem to have been unstable over the N'n Atlantic, generally in a negative sense, especially along its NW'n margins, in areas more open to changing patterns of oceanic weather (see summaries below for Scotland and Ireland: Table of Contents 05/3a). It seems reasonable to suppose that such variability would have resulted in pressure on arable, and pastoral economies, especially if change was too rapid to have allowed more measured adaptive change.

However, establishing a clear causal link between environmental instability and proliferation of such monuments would be inherently difficult, given the relatively long time-span over which they were constructed. Demonstrating such a positive connection would be difficult; real clarity is only possible in dismissing such a link by negation, provided that events are sufficiently well defined in duration, and sequence, and hence are capable of being shown to occur out of order. Only in such cases, when the supposed effect E can be shown clearly to precede the suggested cause C, is a definite conclusion possible; if C and E are broadly contemporary, or E follows C by a short time-span, then discussion involves a balance of probabilities.

However, detailed analysis can, under such conditions, yield definite conclusions, as shown by the following case, where a suggested link between climatic downturn, and decreasing population can be dismissed.

Combined analysis of archaeological, palaeoclimatic, and chronological data for Ireland indicates that the apparent decrease in population during the 8th century BC, over the transition from late Bronze Age to early Iron Age, can not be attibuted to rapidly deteriorating climate: population began to decline a century before the climatic downturn (Armit *et al*. 2014). It is suggested, rather, that reduced levels of population might have been the result of socio-economic factors.

In more detail: a peak of human activity 1050-900 BC, was followed by a steady decline to about 800 BC, then a by sharp fall to 750 BC. A major, and rapid deterioration of climate, with wetter, and colder conditions prevailing, only occurred after this, closely dated to 800-750 BC, this forming part of the general Sub-Boreal to sub-Atlantic transition, seen widely over NW'n Europe (Swindles *et al.* 2013).

It should also be noted that proliferation of monuments, such as stone rows, even if an environmental link is indeed a valid model, need not have constituted an attempt to *mitigate* the effects of negative climatic pressures, but instead were intended to *maintain* existing generally benign conditions. Discussion of such sites as potential environmental indicators *per se* is, therefore, rather limited.

In order to assess such any such link between environmental stress and monumental construction further, it is essential to review some of the evidence for the scale, and nature of physical change during the period in question, then discuss the extent to which this might have affected prehistoric communities. Many of the monuments in question can be broadly dated, either directly or typologically to the later Neolithic, and earlier Bronze Age, and so an environmental context for the mid 3rd to mid 2nd millennia in this area, with clear comparisons between previous, and subsequent conditions, are required.

Environmental factors in the study area

The general study area in Britain and Ireland lies in the zone between Atlantic and Continental European weather systems, and hence can be affected by either, in a changing balance. Climate in this area is, therefore, variable in the short-term, and more exposed to the effects of longer-term change. The area also lies adjacent to a zone of high volcanic activity, that associated with the mid-Atlantic ridge, more fully expressed in Iceland, which introduces the possibility of another cause for deleterious environmental change.

The properties of the study area therefore render it an interesting one in which to investigate the cultural response to changing physical conditions.

Sources of evidence for climatic change

Sources of evidence for changing climate in the area of the NW'n Atlantic can be divided as follows, with considerable overlap between topics as, for instance, between data from volcanism, and from coring of polar ice. The most extensive, and reliable general context, in terms of both time, and space, comes from the physical environmental sciences, supplemented by other data from more closely archaeological sources. Evidence can be considered under the following headings:

Water-borne sedimentary deposits

-riverine

Analysis of colluvial, and alluvial deposits, can be used to determine the scale of discharge, and subsequent deposition of displaced material, and can give broad indications of the changing hydrology of river systems, with radiocarbon, and other dating of sedimentary inclusions, providing a chronological framework.
Example: Johnstone *et al.* 2006.

-marine

Analysis of sedimentary patterns in marine sediment, and the nature, and date of inclusions, allows inference about the scale, and direction of glacial discharge, and of marine circulation, to give a general picture of changing atmospheric, and oceanic conditions.
Example: Bond *et al.* 1997.

-speleothems {calcareous subterranean accretions)

The changing composition, and isotopic dating, of sections through speleothems from cave systems, can provide an important source of general information. Isotopic analysis of samples, accurately dated by the uranium-thorium method, can give proxies for much of the climate during the late Quaternary.

Aerial fall-out

-in ice-cores

Annual accumulation of snow from polar regions, its compaction, and burial as ice, gives a layered chronological sequence, unbroken in many cases since before the last Ice Age, providing a major source of environmental information.

..composition of ice

The isotopic composition of water from layers in ice-cores, for instance those of oxygen, provides information on changing temperature.

..inclusions

Gases, aerosol, and particulate material trapped within ice-cores provide data on atmospheric conditions, and the presence of ejecta can provide a marker for volcanic activity, itself an important determinant of climatic conditions. Examples: GISP programme of polar ice coring (see this section, below: ice-cores).

-in terrestrial deposits

Deposition of particulate volcanic ejecta can provide information on the extent of contemporary volcanism, its source, and date.
Example: Icelandic tephro-stratigraphy.

Palaeo-botanical sources

-tree-rings

Analysis of annual growth-rings, dated by sequence, or by radiocarbon content, indicates changing local conditions of temperature and rainfall.
Example: see this section, below: tree-rings.

-ecological

Analysis of plant material, including pollen, and molluscan shells, deposited in terrestrial, and lacustrine sediments, gives an indication of local conditions.
Example: see this section: Peat and mire deposits.

Archaeological evidence

Analysis of material relating to economic, and agricultural activity can indicate general conditions.

Overview of changing climate in W'n Europe: 4000-650 BC

Note: ky(a) kilo-years (ago).

General trends

Sufficient evidence exists to provide a general outline of changing climate during the later Neolithic, and Bronze Age in NW'n Europe, and to make broad comparisons with earlier, and later periods (example: source below: Lamb 1977). As well as information from terrestrial deposits, off-shore data, from analysis of isotopic content of polar ice, and of micro-fossil inclusions in cores of Atlantic deep-sea sediment, provide a general context for environmental conditions, and changing climate during the Holocene (10 kya to the present).

A general summary of major climate-controlling mechanisms, setting those of the N'n Hemisphere in global context, is provided by Wanner *et al.* 2008.

4000-3500 BC: the warmer phase of the climatic optimum started around 6200 BC, and peaked 4000-3500 BC; glaciers were markedly reduced in extent; tree-lines in N'n areas, including N'n England, and Scotland, were some 300m higher than at present, suggesting that wind-damage might not have been a major problem, and hence that major phases of low pressure, and cyclogenesis were fewer and weaker;

3500-3000 BC: a slight deterioration in climate might have occurred, with conditions more variable on a decadal scale; occasional cooler to colder, and wetter periods occurred, but overall it was still warmer than at present; storm-tracks were directed more towards the British Isles, and were more vigorous; heavy rain, and wind were more frequent, with summers less reliable, and runs of wet, and cool seasons; European glaciers advanced, and forests retreated from higher elevations, possibly linked to storm damage; thermophilic species of tree declined;

3000 BC: some recovery occurred after the previous downturn; major storms, and excessive rainfall were less frequent, and temperatures rose; there was an increase in forest cover over W'n upland areas;

1500-1300 BC: a sharply cooler 'neo-glacial' period is in evidence, with glaciers advancing in Alaska, and the Alps; growth in peat-bogs occurred, with cases of inundation of marginal land implying increased rainfall; temperatures were still higher than at present;

1100-900 BC: a longer-term, post-Bronze Age phase of cooling included periods of extended warmth, with more frequent dry phases of anticyclonic weather;

900-650 BC: wetter, cooler, windier, and more unsettled weather occurred in the W, with rapid growth of peat-bogs.

Although the entire W'n seaboard is subject to Atlantic weather patterns, varied terrain can produce significant local differences in climate. Bio-climatic sub-regions, differing in their exposure have, for instance, been suggested for Scotland: *hyper-oceanic* along the W'n coastal margins, *eu-oceanic* over most of the interior, and *hemi-oceanic* in areas of the NE (Birse 1971). Prehistoric communities in hyper-oceanic areas of Scotland, and Ireland might, therefore, have experienced higher levels of economic pressure, under conditions of environmental deterioration.

The Meghalayan stage of the Holocene epoch

The Meghalayan, beginning about 2200 BC, is the most recent stage of the three-fold division of the Holocene, as formally ratified by the International Commission on Stratigraphy in 2018, and is so named from key stratigraphy in caves from NE'n India that define its base-line. The stage began with a 200-year mega-drought, widespread from the E'n Mediterranean to China, and the suggested cause of major economic stress on cultures in the area. Events in the earliest Meghalayan have also been previously characterised over the same area in terms of the event 4.2 kya [kya: kilo-year ago], and in the North Atlantic as Bond Event 3, a climatic downturn. Conditions during this period are likely to have been complex, and regionally variable, with extremes coexisting, for instance, drought in one zone, and wetter, colder conditions in another.

Climatically-induced economic stress on agriculture, and other seasonal activities, have been suggested in this analysis as contributing to the proliferation of monuments with potentially solar alignment, during the later Neolithic, and earlier Bronze Age, in Britain, and NW'n Europe (see above: Table of Contents: 05/1a).

Major factors determining climate over the N'n Atlantic seaboard

The complex pattern of atmospheric, and oceanic circulation over the North Atlantic, and Arctic exerts a major influence on climate in mid sector of the Northern Hemisphere, in terms of wind-speed, and direction, the number, and track of storms, levels of precipitation, and seasonal temperature. Longer-term changes in major oceanic, and atmospheric gyres, at centurial, or millennial scales, are likely to have produced shifts in environmental conditions sufficient to have triggered significant cultural response, both in terms of economic, and ritual practice. Sustained environmental change of this type requires adaptation, whilst more sudden catastrophic events can allow rapid recovery. It is in the former option that explanations for certain patterns of monumental construction along the W'n seaboard of the Atlantic during the 3rd millennium BC should perhaps, therefore, be sought.

-the North Atlantic Oscillation (NAO)

Controlling factors include such major features as the North Atlantic Oscillation (NAO), caused by fluctuation in the difference of atmospheric pressure at sea-level between the Icelandic low, and Azores high, and which controls the strength, and direction of W'ly winds, and storm-tracks, across the North Atlantic. When the area around the Azores is at high, and that around Iceland is at low pressure, the positive NAO causes air-flow towards the W over the North Atlantic, bringing moist air over Europe, producing cool summers, and milder, wetter winters. When the pressure characteristics of these two areas are reversed, as a negative NAO, then this W'ly flow is suppressed, with overall reduction in rainfall, and temperatures more extreme in both summer, as heat-waves, and in winter, as deeper freezing. Variations in the NAO occur over decadal, and longer time-scales, with no particular periodicity.

-the Arctic Oscillation (AO)

The NAO forms part of the Arctic Oscillation (AO), which describes the changing behaviour of the circum-polar jet stream as it moves E'ward, along the top of the troposphere, at an altitude of about 10km. When Arctic pressure is low, as a positive AO, the jet stream is stronger, and more consistent in its W'ly to E'ly track, acting to confine cold air within the polar area. When pressure is high, as a negative AO, the zonal winds are weaker, with more variable track, enabling freer movement of cold polar air towards mid latitudes.

-the N'n Atlantic Drift

The N'n Atlantic Drift, branching from the Gulf Stream on its approach to Africa, and flowing NE'ward, is critical in determining temperatures in coastal waters, hence climate, and being wind-driven, it forms another factor related to atmospheric circulation.

More adverse climatic conditions during the later 3rd millennium BC might, therefore, result from increased frequency of negative NAO, and AO. The environmentally complex area of the NE'n Atlantic is sensitive to changes in oceanic circulation, and in major drivers of climatic variability, such as the NAO (Sweeney 1997).

Using climatic data from the 19th century onwards, the effects of variation seen during NAO-neutral conditions on rainfall, and on river discharge, in areas of upland N'n Britain, indicates an increased flow under strongly positive NAO, and increased possibility of drought under negative NAO (Burt and Ferranti 2012; Burt and Howden 2013).

Analysis of marine sediments in the N'n Atlantic: the Bond Events

Note: **ky(a)** kilo-years (ago);

Phases of climatic deterioration

Analysis of glacial activity, and of marine sedimentation in the N'n Atlantic, provides information on longer-term fluctuations in climate, both within this area, and on a global scale.

During the last glacial period in the N'n Hemisphere, there is evidence for some 25 short-term variations in climate, the Dansgaard-Oeschger (D-O) events, each with a period of about 1500 years, during which changes in basal temperature, and hence glacial conditions occurred.

Larger-scale shifts in climate often contain episodes of change, the onset of which may be abrupt. At orbital (10^4–10^5 years), and millennial time-scales, climate change appears as a characteristic pattern of sudden, rapid warming, each event followed by a period of slow cooling as, for instance, seen in the D-O oscillations of the last ice age (Dansgaard *et al.* 1993).

The subsequent onset of warmer, inter-glacial conditions is marked by increased complexity of climate in N'n latitudes, and there is evidence for a continuation of this cycle of longer-term fluctuation into the Holocene, with a similar periodicity, from about 12 kya, the Bond Events (Bond *et al.* 1997). The status, and relationships of Bond Events remain more debatable than those for the preceding D-O events. The cyclicity proposed for the N'n Atlantic region is 1470 +/- 500 years, exhibiting considerable latitude for variation. Most of these events do not have a uniform climatic signature, some involve periods of cooling, and others of aridification.

Eight of these Bond Events, phases of climatic deterioration, have been identified from analysis of inclusions in ice transported by rafting from the glacial margin, then released, to accumulate in Atlantic marine sediments (TABLE CL-01).

Bond Event 3 would correspond with the later Neolithic and earlier Bronze Age in Britain and Ireland.

TABLE CL-01 Bond Events: climatic fluctuations during the Holocene

Bond Event	**kya**	**BC** ***AD***	**int (ky)**	**?correlates with**	**cultural phase**
none	0.7	*1300*	0.7	Little Ice Age;	medieval
1	1.4	*600*	1.4 ?		
2	2.8	800	1.4	drought in the E'n Mediterranean and collapse of late Bronze Age cultures;	late Bronze Age
3	**4.2**	**2200**	1.7	collapse of the Akkadian empire; end of Old Kingdom Egypt; ecological change in India, Middle East, North America, including aridification; Canadian glacial advance;	**later Neolithic**
4	5.9	3900	2.2	intense aridification in N Africa, ending the Neolithic sub-pluvial; initiating migration to river valleys such as the Nile; subsequent recovery of conditions, partial at best; social conflict in Egypt and the Middle East;	early Neolithic
5	8.1	6100	1.3	sudden global cooling lasting 200-400 years, well marked in the N'n Hemisphere, as shown by ice-cores from Greenland, and N'n Atlantic marine sediments; aridification in N'n and E'n Africa, Mesopotamia, and W'n Asia	Mesolithic
6	9.4	7400	0.9	glacial activity in Norway; cooling in China;	
7	10.3	8300	0.8	?	
8	11.1	9100		transition from Younger Dryas to Boreal;	

Key: **kya**: kilo years ago; **int**(erval) between Bond Events; **cultural phase** (in NW'n Europe);
Note: although not noted as a Bond Event, the Little Ice Age, which occurred in W'n Europe during the later medieval period (see this section: Little Ice Age,) is included in the above table for comparative purposes, and because it provides an important record of the cultural and economic impact of climatic deterioration.

More detailed analysis of changing temperatures

Two curves of changing temperature over the post-glacial period can be used as a context for discussion of Bond Events:

-the master curve [MC] (e-FIG CL-01):

Temperature proxies for the last 12ky have been combined statistically to give a master curve for anomalies of temperature, in relation to a given base line (BL), using data relevant to the N'n Hemisphere.

In general, the MC shows:

..a steep rise at the end of the last glaciation, to the level of the BL, and then a fairly even plateau near the BL, during the subsequent post-glacial to present;

..this plateau is not level, but undergoes a general decline in its mean value with time, indicating that basal temperatures have been cooling steadily during this initial phase of the post-glacial;

..within this descending plateau of temperature there are some 12 peaks, fairly evenly distributed over the last 10ky, indicating instabilities.

Bond Event 3 falls about midway along this zone of instability, and corresponds with one of the deeper, and more persistent troughs. Some perspective on this variation can be gained by considering the curve of temperature over the period of the Medieval Warm Period, and the ensuing Little Ice Age, where the amplitude varies over about half a degree centigrade. The serious social, and economic consequences of this climatic downturn in medieval Europe are well described (see this section, below: Little Ice Age), and suggest that other such apparently small fluctuations in general temperature, during earlier periods, would have had similarly serious repercussions, perhaps more so, given simpler agrarian communities.

-estimates of palaeo-temperature for Greenland [GT] (e-FIG CL-02):

Again, a rise in temperature is visible at the end of the last major glaciation, followed by a period of thermal instability during the post-glacial, with peaks, and troughs, over a range of about 3°C, within which further periodicity is apparent.

Proposed Bond Events [BEs] have been superimposed on these graphs, placed at mean values of their date; the variation +/- 500 years should, however, be clearly noted. The aim here is to consider the validity, duration, and severity of BE 3, hence the entire set of BEs is discussed briefly below, from the medieval period, back through time:

-the Little Ice Age: although not a Bond Event, the LIA, a well-documented phase, has been included here, for general comparison with, and calibration of, other fluctuations, those without the benefit of supporting historical records. This period corresponds with a notable dip in the MC [master curve] over several centuries, following a clear peak for the medieval warm period [MWP]. It should be noted that the deceptively small amplitude of the temperature dip corresponds with widespread, and serious, effects on communities, well documented in the historical record.

-Bond Events [BE]: as ranked back through time

..BE 2 may correspond with a phase of lower temperatures, and instability that preceded the MWP;

..BE 3 marks onset of a localised dip in temperature. following two peaks, and also marks the start of a general decline, after which no peaks extend above the BL [base line], whereas during the preceding climatic optimum they did;

..BE 4 could indicate some possible instability within the climatic optimum;

..BE 5, and 6 each correspond with a localised trough;

..BE 7, and 8 occurred during a phase of immediately post-glacial warming.

-more detailed consideration of Bond Event 3

Events attributed to BE 3 indicate that its influence was global, and varied in content. There seems to be widespread evidence for the onset of colder climate, and reduced rainfall, over a vast area extending from Italy to Tibet.

drier conditions:

..Italy: Lake Castglione experienced drier conditions around 2200-1900 BC;

..**SE'n Europe**: there is evidence for a shift towards drier conditions between about 2200 and 2100 BC;

..**Egypt**: Aridification, including drying of lakes in the Faiyum, indicate reduction in flooding of the Nile, and of rainfall in Ethiopia, and East Africa, possibly the result of climatic cooling. Associated desertification also occurred elsewhere in the Middle East. A phase of lower floods, lasting 20-30 years, is the suggested cause of social, and political instabilities in the Egyptian Old Kingdom. This is downturn is recorded as beginning during the 94-year reign of Pepy II (Neferkare), late in the 6th Dynasty (~2246-2152 BC), and extending through the First Intermediate period (~2181–2055 BC).

..**NE'n Nigeria**: at Kajemarum Oasis, changes in airborne sedimentation indicates a pronounced shift in atmospheric circulation around 2150 BC.

..**W'n Tibet:** dry spells have been detected at Lake Sumxi.

colder-wetter-unstable conditions:

..**Iceland**: a transition from birch-, and grassland-vegetation, to that of more arctic conditions occurred in about 2150 BC;

..**Britain**: the reappearance of oak at White Moss (S'n Cheshire: SD 8703) suggests fluctuating wetness around 2190-1891 BC.

-more detailed consideration of Bond Event 4

The Neolithic sub-pluvial phase began during the 7th millennium BC, and persisted for about 2000 years, until the end of BE 4, with the return of the drier condition that prevailed before. Areas of desert increased over the Sahara, and these arid conditions have continued to the present day.

Conclusion

Bond Event 3 suggests that a general phase of climatic deterioration, and instability occurred in the N'n Atlantic area during the later Neolithic and earlier Bronze Age, causing more challenging environmental conditions than existed during the preceding, and subsequent centuries.

Evidence for alluvial activity in river valleys

Statistical analysis of radiocarbon dates from alluvial deposits has been used to provide an estimate of riverine activity for highland, and lowland Britain, arguably not a direct reflection of general rainfall, nor of discharge from catchments, but rather a measure of the changing frequency of more sudden, larger-scale flooding. This analysis provides a measure of probability for alluvial activity against time, over the period from 12,000 BC to the present, for glaciated upland, and unglaciated lowland river-catchments (Johnstone *et al.* 2006; Brown 2008, fig. 2).

The sequence of alluvial activity, as presented, shows two fairly clear blocks: a long phase of relatively stable activity from 10,000 to about 3000 BC, followed by a 4000 year phase of higher, and variable activity, more apparent in data from lowland, than from highland river-catchments (e-FIG CL-04). The transition to more flood-prone, less stable conditions occurred during the later Neolithic, from about **2800 BC**, lasting until about **1400 BC**, a period containing the colder, wetter Bond Event 3 (TABLE CL-01), similar episodes also seen in data from mires, and from ice-cores.

A return to lower levels, and more stable activity, is evident during the middle Bronze Age, lasting until about 800 BC, with a major reversion during the later Bronze Age, peaking between 800-700 BC, and lasting until about 500 BC, the colder, wetter Bond Event 2 (TABLE CL-01). These data are broadly in line with those from peat-based stratigraphy (example: Anderson *et al.* 1998), that indicate a general change to wetter, less stable conditions during the later Neolithic, with further specific episodes, as during the later Bronze Age. The evidence for more extreme patterns of weather seems fairly clear, and is supported by diverse data.

Such deterioration, and instability, would have included a general increase in rainfall, and ground water, with more frequent incidence of aberrant conditions, ranging from severe storms, and disruptive flooding, to intervening periods of drought.

Hydrological effects would have extended from problems with pastoralism, to crop damage, and soil-erosion over cleared agricultural areas would have been accelerated by increased run-off. Waterlogging of some degraded areas would have promoted sustained peat-growth, leading to abandonment of land, and changed patterns of settlement.

Fluctuating seasonal temperatures would also have affected crop-growth and development, with adverse effects perhaps mitigated by changes in agricultural practice. Less predictable conditions are also likely to have influenced ritual, especially where related to general fertility, and the seasonal cycle.

In a case study for the uplands of N'n England, recent analysis of weather records indicate that more prevalent W'ly weather systems drive air masses up over the hills, to cause a significant increase in frequent heavy rainfall during autumn, and winter (Burt and Ferranti 2011). This link between rainfall and Atlantic weather may also be relevant to the prehistoric period in question.

Stratigraphic analysis of peat and mire deposits in Britain and Ireland

At a more localised level, a range of proxy-climatic records provide terrestrial detail for specific sites and regions, their general palaeo-hydrology, plant ecology, and evidence for the degree of human impact, all relating to the complex interaction between ambient temperature, rainfall, ground-conditions, and economic exploitation.

For the highland zone of Britain, wetlands provide such data from stratigraphy of peat, and mires (distribution: e-FIG ND-01a to 01d; Montanarella *et al.* 2006), a source largely absent from the lowland zone. This latter area formed an important early centre of population, low levels of peat coverage causing difficulty in making direct inter-regional comparisons. However, data from alluvial deposits in river valleys are available for both zones, and help to redress the imbalance, with specialist methods, such as luminescence of speleothems finding increasing application.

Stratigraphic analysis of peats, and mires gives useful data on changes in flora, and in bog surface wetness [BSW], over protracted periods of the mid-later Holocene, with a framework for dating provided by radiocarbon, and by characteristic micro-inclusions of tephra, linked to specifically dated volcanic eruptions.

Such 'blanket-bogs' are extensive, and are generally formed in wetter upland areas, with human land clearance, and climatic factors aiding their growth. In contrast, 'raised bogs' are generally smaller, occurring in lower lying areas, and are natural features, where vegetation builds up in a lake. The precise relationship between BSW and general environmental conditions remains complex, and subject to debate.

Such bogs were developing during the later Holocene, with evidence for some formation around 5600 BC, but especially after about 2000 BC, particularly in the W. Individual studies (such as Anderson *et al.* 1998; Langdon *et al.* 2003; Langdon and Barber 2005) log changes in relative wetness, using various proxies. The later Neolithic to earlier Bronze Age appears to have been a time of climatic deterioration, and environmental stress, before the onset of drier periods that developed after 500 BC, as seen at such test sites as Mallachie Moss, and Ben Gorm Moss (Langdon and Barber 2005).

The general, and widespread anthropogenic clearance of primary woodland in lowland Britain, between 3000 and 1000 BC, later Neolithic to later Bronze Age, is shown by the decline in pollen from *Tilia*, a key component species of tree, with a low capacity for natural recovery, hence forming a reliable marker (Grant *et al.* 2011).

-Scotland

Case studies in central-S'n Scotland (Langdon *et al.* 2003), and N'n Scotland (Langdon and Barber 2005; Charman *et al.* 2001) appear representative of broader changes in N'n, and W'n Britain. In central-S'n Scotland there is evidence for major wet-shifts occurring at around 4600, 3850, **2500, 1850, 1500, 800**-450 **BC**, with some indication of millennial periodicity, four of these events (shown here in bold type) occurring during the later Neolithic to later Bronze Age.

Similar analysis, at five locations in N'n Scotland, indicate a major transition to wetter, cooler, peat-forming conditions between **1900** and **1500 BC**, broadly in line with data from deep-sea sediments, and from ice-cores, which further indicate colder sea-surface temperatures in the N'n Atlantic (Anderson *et al.* 1998). The onset of these wetter phases could have been relatively abrupt, occurring over a few decades. Under such conditions, blanket-peat began to develop from about **2000 BC**, most strongly in W'n areas of Scotland. Standardised comparisons between BSW for W'n, central, and E'n Scotland show regional differences, especially between N'n and S'n areas, with the clearest increase seen in the W, between about **2000** and **1500 BC**. Fluctuating conditions lasted until about 1000 BC, features seen less clearly in the central and E'n areas (e-FIG CL-05). Blanket-peats tended to develop abundantly, from about **2000 BC**, in the W of Scotland (Langdon and Barber 2005, fig. 11). Analysis of peat-deposits in Orkney indicates that temperatures dropped during the Bronze Age, and rainfall increased (Orkneyjar 2009).

..Scotland: a recent review (Tipping *et al.* 2012)

This review of changing climate in prehistoric Scotland, from 4500 to 50 BC, notes the relative speed of many transitions and, because of increased exposure of the region, highlights its potential as a valuable indicator for more general trends in the area of the N'n Atlantic. The study identifies periods of marked cultural change, and stresses the need to determine their relationship with environmental factors, testing questions of causality more rigorously, by means of better chronology, and by assessment of the capacity for agrarian societies to adapt accordingly.

The review outlines the main sequence for Scotland as follows:

5000-4000 BC ....
5400-4500: conditions were probably 1–2ºC warmer than for the period 1850-1950 AD in NW'n Europe;
~**5050**, and especially after **4750:** soils were wetter**;**
~**4700:** increased S'ward drift of icebergs from the Arctic Ocean (Bond Event 4);

4500-4100: the N'n hemisphere cooled, with lower winter temperatures;
~4350: oceanic sediments to the W of Ireland indicate the presence of drift-ice in the area (Bond Event 4)**;**
by 4450–4400: formation of dunes indicate an increase in the frequency, and intensity of W'ly winds, with conditions generally more stormy;
by **4350**: soils were drier;

4000-3000 BC ....
cultural:
4000-3600: *appearance of agriculture and characteristic Neolithic culture;*
3300-3000: *first stone circles and large round barrows were constructed;*

environmental:
after **4100–4000:** temperatures ameliorated;
after **3800:** conditions became drier, with considerably warmer air temperatures prevalent over NW'n Europe;
from ~**3700:** air temperatures fell over N'n Scandinavia; soils were wetter; **3950–3700:** recurrence of dune formation indicates unsettled conditions**;**
3400-3200: the atmospheric circulation weakened and stabilised in the N'n Atlantic area;
3200-3100: dune formation increased around Irish coasts, suggesting a return to stormier conditions;
summer temperatures fluctuated in N'n Scandinavia: falling around **3200,** and recovering around **2900**, then becoming very warm;
3200-3000: drier soils in N'n Scotland enabled growth of pine on areas of blanket-peat, with increasing wetness of soils stunting tree-growth thereafter;

3000-2000 BC ....
cultural:
3000-2700: *large palisaded enclosures appeared, with ceramic assemblages now including grooved ware;*
2700-2400: *large henge monuments, timber circles, and stone circles were constructed;*
2400-2000: *copper alloy metalwork, and Beaker pottery first appeared;*

environmental:
after **2500:** soils were wetter;
2800-2400, and after **2300:** dune formation increased ;
2500–2200: substantially wetter than average;
2200: increased ice-rafting occurred in the North Atlantic (Bond Event 3);
fluctuating levels of ground water in central and S'n Scotland: reaching a peak around **2000**, decreasing by **1500,** then rising again **1400–1300**;

2200–2100: transport of wind-blown sand increased;
2000-1000: summers in N'n Fennoscandia were warmer;
1800-1300: machair in the Outer Hebrides was frequently mobilised;
1500-1400: conditions became markedly colder;
1400-1200: dunes on the N'n Irish coast became unstable;
1400-1150 increased wetness in SW'n England provides a parallel beyond Scotland;
1150-800: drier ground-conditions developed**;**

2000-1000 BC ....
cultural:
2000-1600: *increased colonisation of upland areas;*
1600-1100: *archaeological evidence suggests that little change occurred;*
1100-800: *expansion of settlement was sustained; open, and enclosed settlements appeared; the first hillforts were constructed in N'n and W'n Britain, and in Ireland;*

environmental:
from **1600:** a strengthening of the Gulf Stream resulted in milder, and wetter winters; general reduction in seasonal contrast throughout the Bronze Age, with prevailing climatic conditions of warmer, and moister oceanic-, rather than cooler, and drier continental type;
1200-1100: unusually warm;
1050-850: transport of wind-blown sand increased, with soils drier, and possible droughts occurring in N'n Ireland;

The pattern of environmental and climatic change, as listed above, appears complex, and often disjointed, with the actual degree of instability, and its detailed time-scale difficult to assess. How far these apparently episodic events indicate abrupt change, or mask a smoother transition, relates directly to the question of likely cultural impact.

-The SW'n Peninsula of England (Devon and Cornwall)

Evidence for the environmental sequence in this area has been summarised by Wilkinson and Straker 2006. On Dartmoor, Exmoor, and Bodmin Moor, Bronze Age settlement, spanning the period 1900-950 BC, encountered a sustained period of far wetter conditions after about 1100BC, resulting in less intensive use of such marginal environments, and eventually their abandonment, by about 900 BC, a comparable sequence to that seen in other such areas of N'n and W'n Britain (Turney *et al.* 2016).

On Dartmoor, there is evidence for a marked decline in tree-cover during the later Neolithic-early Bronze Age, amidst expansion of peat-growth, this latter caused in part by an increasingly wetter climate. These changes occurred over a landscape maintained in open condition by browsing, a process which certainly began before the construction of reeves, 1300-1100 BC (Fleming 1988). On this upland a major shift to a cooler, wetter climate is inferred from about 1400 to 1250 BC coinciding with the phase of abandonment (Amesbury *et al.* 2008).

On Bodmin Moor, significant depletion of upland woodland, of hazel, birch, oak, and elm, occurred by 3400 BC, with areas remaining largely open, except for minor phases of re-colonisation by hazel. From **2910-2500 BC** there is evidence that the grass-sedge-heather flora expanded, possibly because of human clearance of trees, and scrub. As on Dartmoor, this became coupled with the development of blanket-bog, under the wetter conditions prevailing during the earlier Bronze Age, a process very clearly seen after about 1000 BC. In N'n Cornwall, by the end of the middle Bronze Age, it appears that such environmental pressures on permanent settlement and cultivation, located on moorland slopes, resulted in abandonment, these areas reverting to seasonal grazing (Johnson and Rose 1994).

Studies at the periphery of Exmoor indicate upland characterised by woodland of oak, with hazel under-storey, producing evidence for local Mesolithic, and Neolithic clearance. Riverine deposits indicate that woodland of alder occupied valleys, from 4460-4250 BC to **2280-1940 BC**, after which sedges colonised these areas, as water-tables rose.

In general, therefore, by 3000 BC, forest-cover became much reduced on the three main moors, possibly the result of changing climate, aided by human clearance. This led to formation of raised bogs, under a change to colder, and wetter conditions, these intensifying from about 1400-1200 BC (Amesbury *et al.* 2008). During the earlier Bronze Age, woodland clearance becomes apparent, from 2020 BC in the E'n part of the region, and from 1700 BC in the W'n, as a significant change occurred in the economy, towards subsistence cultivation of cereals.

-Ireland

After the Ice Age, Ireland was slowly colonised by forests, of deciduous species and pine, by 4000 BC becoming thickly forested, especially over lower lying areas. By **2500 BC** forest clearance was extensive, especially over uplands, where the forest was anyway thinner. Cleared soils became more prone to leaching, causing acidification of sediments, and depositing leached minerals as iron pan at a lower depth, thus impeding drainage, and causing waterlogging. Changes in data from analysis of pollen indicate that Ireland became cooler, and wetter about **2000 BC**. By the end of the Bronze Age, about 500 BC, clearance of lower areas increased, as higher ground became unusable, the heather, and rushes that grew on the acidic, leached soils failing to decompose, with consequent build-up of peat, causing remaining trees to become choked (Feehan and McIlveen 1997).

Analysis of pollen in sediments from the upland areas of Leean Mountain, Leitrim, NW'n Ireland (G 810 390; 417m max. OD; e-FIG AS_sl-01), has produced a sequence of environmental change, from Mesolithic, to Iron Age, that supports deterioration during the later Neolithic to earlier Bronze Age (Kytmannow *et al.* 2009). During the Mesolithic period, this area was probably forested, with the Neolithic seeing extensive clearance, resulting in development of highly managed land, supporting cereal-based agriculture, and high quality grazing, amongst controlled hazel woodland. During the later Neolithic, cereal cultivation continued, and hazel woodland eventually disappeared, with seasonal burning, to renew the quality of grazing, eventually degrading the productivity of soil, and allowing the spread of such species as heather. Cereal cultivation had ended by the Bronze Age, with a landscape, now dominated by sedges, one of greatly reduced economic value, even for general grazing. Evidence for extensive growth of cotton grass, a species tolerant of very wet ground-conditions, indicates that levels of rainfall were higher, and resultant erosion of soil from these upland surfaces is suggested by the formation of river terraces. The general sequence, therefore, is one of agricultural over-exploitation of an ecosystem, already rendered fragile by more testing climatic conditions. During the Iron Age, continued growth of heather suggests that conditions might have become drier. There is no evidence for cereal cultivation, but evidence for general burning, to renew plant cover, suggests that grazing might have continued in these marginal areas.

Combined analysis of wetland deposits, and palaeohydrology at sites across N'n Ireland, as a region perhaps representative of wider NW'n Europe, indicates no clear signal for the event 4.2 kya, as seen clearly in W'n Asia, suggesting the spatial complexity of this event (Rowland *et al.* 2014).

Palaeo-reconstruction of water-tables from two peat-lands in N'n Ireland provide a hydrological sequence from about 2500 BC to the present, and only indicate prolonged phases of drought during the later Bronze Age 1150–800 BC, the Iron Age 320 BC–150 AD, Roman period 250–470 AD, and recently 1850–2000 AD (Swindles *et al.* 2010).

Data from analysis of tree-rings

Differential growth of tree-rings provides a critical source of information on changing climate (Scuderi 1990; Fritts 1991, 2001; Jones *et al.* 1995; Baillie 1995a, 135-143), and can also be matched against the record of volcanism, as obtained from ice-cores, to help assess the environmental impact of such eruptions. The level of agreement between negative anomalies in tree-ring data, and larger volcanic events, is high for the last millennium, but becomes less certain for events during prehistory.

For instance, in the N'n Hemisphere there seems to be a clear temporal association between rings of narrower growth, or those sustaining distinct frost-damage, and large explosive volcanic eruptions. Such events are known from the historical record, and from polar ice-cores, of a scale likely to have induced marked, and extensive phases of cooling.

The implication, for climatic change, of variation in ring-width differs between species. Four common species growing in N'n Ireland include beech, and ash, as the most sensitive indicators, responding particularly well to early summer rainfall, with oak more sensitive to summer rainfall, and Scots pine to maximum temperature (Garcia-Suarez *et al.* 2009).

-W'n USA

Data from analysis of tree-rings from pines in the W'n USA (Salzer and Hughes 2007), although located at some distance from the N'n Atlantic area, may be relevant in supporting the general trend of climate in that zone, as suggested elsewhere in this section. Similarities between the regions would also highlight the general nature of such changes, their hemispheric, and perhaps global scale. This particular US-based study does suggest that the period from the 23rd to the 19th centuries BC was one of increased cold, and that, here, volcanic activity was closely linked to deterioration in climate. This phase corresponds broadly with Bond Event 3 (e-FIG CL-03).

Tabulation of those years in which the immature xylem of tree-rings was damaged by extra-cellular freezing, during the growing season, to produce 'frost-rings', indicates several episodes of low temperature during active growth. Large explosive volcanic eruptions have been implicated in the production of such frost-rings, as a result of resultant outbreaks of polar air, beyond usual limits (LaMarche and Hirschboeck 1984).

During the last three millennia BC volcanic eruptions which caused significant climatic forcing are evident around 2906-2905, 2036, 1626, 1524, 476, 425/424, 421, 406, 245, and 42 BC (TABLE CL-02). Minima of growth for tree-rings, and occurrence of frost-damaged rings, can be closely matched with signals from ice-cores, often to well within a resolution or about 5 years. During the two millennia AD, similar correlation can be seen during mid-6th, late 7th, early 10th, mid 15th, and 17th centuries AD: immediately preceding 536, 627, 687/688, 691–695, 899/900, 1201, 1288, 1458, 1602, 1641, and 1681 AD. There is also evidence that, in addition to sharper phases of cooling, these changes could be more protracted, with multiple eruptions producing a cumulative effect. Lesser eruptions, occurring at a time of environmental stress from other sources, could also produce longer-term effects.

There appears to be evidence for a phase of decreased temperature, and some increased volcanism, during the period 2200 to 2000 BC, of a type not seen since early in the third millennium. Colder, and volcanically active centuries occur sporadically after this, with the 5th century BC particularly marked.

Around 2200 BC, this later third millennium BC climatic downturn ended a relatively mild period, and is in general agreement with Bond Event 3 (TABLE CL-gen 01). Later comparisons with other Bond Events are possible: for example, cold phases from the 13th to 17th centuries AD appear to correspond with the 'Little Ice Age' in Europe (see Table of Contents: 05/9d(ii)), again with corresponding evidence for increased volcanism.

TABLE CL-02 Analysis of tree-rings: ring-width minima, and frost-ring signals for the past five millennia, from pines in the W'n USA

BC

cent	**#**	**V**	**year during which RWMs and FDRs occur**
30th	**5**	**4**	**2951, 2911, <u>2906</u>*, 2905***; (2906)
29th	**9**		2885, 2879, 2872, 2862, 2853, 2841*, 2821, 2800; (2841)
28th	3		2794, 2732*; (2731)
27th	**4**		2699, 2685, 2677, 2670
26th	0		none
25th	1	1	**2495**
24th	0		none
23rd	1	1	**<u>2294</u>**
22nd	**4**	1	2173, 2157, **2148**, 2131
21st	**6**	2	**2036***, **2035*** 2028, 2027, 2023; (2036)
20th	**6**	**6**	**1996, 1962 , 1921, 1909, 1908, 1907**
19th	3		1857, 1831; (*1815*)
18th	1		1771
17th	**6**	**3**	**1693,** 1652*, **1649, 1626*;** (1653, 1627)
16th	3	1	**1597**, 1544, 1524
15th	2		1418*; (1419)
14th	**4**		1386, 1385, 1373; (*1359*)

13th	1		(1297)
12th	**9**		1150, 1147, 1135*, 1134*, 1133, 1132; (*1187*, 1138, 1135)
11th	2		(1089, 1031)
10th	3		(973, 953, 952)
9th	3		854, 826, 811
8th	3	1	**776**; (*737*, *711*)
7th	2	1	**624**; (*655*)
6th	3	1	**586a**, (*570*, *551*)
5th	**14**	**8**	**476*, 472, 425*, 424*, 421*, 420, 419, 406*;** (480, 476, 474, 424, 422, 407)
4th	1		(355)
3rd	**8**	1	**294**, 282, 281, 280, 245*; (*275*, 244, *206*)
2nd	**7**	1	**180**; 139, 125, (*194*, *161*, 140, 123)
1st	**7**	1	61, **42***, 38, 37, 36; (*90*, 43)
AD			
cent	**#**		**years**
1st	0		none
2nd	**4**		137; (*119*, 140, *188*)
3rd	**7**		274*; (*227, 230, 251, 268,* 273, *282*)
4th	**6**		344; (*310, 337, 389, 390, 393*)
5th	**8**	1	451, **472**; (*411, 421, 438*, 469, *479, 484*)
6th	**12**	**3**	**536*, 537***, 542*, 543, 545, 547, **569**; (*522*, 532, 536, 541, *574*)
7th	**20**	**12**	**627***, 681*, **687*, 688*, 690, 691*, 692*, 693*, 694*, 695*, 696, 697, 698;** (627, *674*, 681, 684, 687, 692, 694)
8th	3	1	**743**; (*715, 789*)
9th	**8**	1	860, **899***; (*816, 822, 835, 884, 889*, 899)
10th	**9**	**3**	**900***, **902**, **903**, 990*; (*909, 934, 959, 985*, 989)
11th	**7**		(1003, 1008, 1015, 1029, 1057, 1066, 1076)
12th	**9**	1	**1114**, 1121; (*1109*, 1118, *1134*, *1139, 1142, 1171, 1190*)
13th	**12**	**4**	**1201*, 1204, 1230, 1288*,**(1200, *1225*, *1257*, *1259*, *1275, 1277, 1280*, 1287)
14th	**12**	**10**	**1332, 1334, 1336, 1342, 1348, 1349, 1350, 1355, 1357, 1360;** (1329, 1331)
15th	**18**	**12**	**1458***, **1459**, **1460**, **1461, 1462, 1464, 1466, 1468**, 1471*, **1472, 1473, 1474, 1480**, (*1443, 1453*, 1455, 1457, 1470)
16th	**5**		1578*; (*1546, 1557,* 1577, *1596*)
17th	**17**	**13**	**1602*, 1606, 1618, 1624, 1641*, 1644, 1645, 1646, 1647, 1672, 1675, 1677, 1681*;** (1601, 1640, 1680, *1699*)
18th	**8**		1702*, 1703*, 1704, 1705; (1702, *1725, 1732, 1761*)
19th	**10**	**4**	**1836, 1838, 1840, 1842;** (*1809, 1810, 1828, 1848, 1882, 1884*)
20th	2		(1941, 1965)

Note: as adapted Saltzer and Hughes 2007, table 2.
Only larger-scale perturbations have been included, for those years in which frost-rings occur at several locations.
Where the count '**#**' (number of cold-related tree-ring anomalies) is 4 and above, it is taken to indicate a colder century, and where the adjacent count '**V**' (number of corresponding large volcanic events logged in ice-cores) exceeds 3, increased volcanism is noted, both occurrences marked in **bold** type.
Key: cent(ury); **#:** number of tree-ring anomalies per century; **V** number of volcanic events per century;
years (with tree-ring anomalies): **RWM**: ring width minimum; **FDR**: frost-damaged ring;
non-bracketed **RWM**
() bracketed **FDR** (if italicised, the year appears separate (>= ± 5 years) from the stated minima for the century;
* **RWM** corresponds with **FDR** (± 1 year of RWM);
bold **RWM** corresponds with a volcanic signal in an ice-core (± 5 yr of **RWM**);
underlined exact year-match between **RWM** year, and volcanic signal from ice-cores: GISP-2 (Greenland Ice Sheet Project)

In more detail, there is also clear evidence for powerful climatically-effective eruptions, capable of causing widespread impact in, or just before, the following years (TABLE CL-03). Most of the events, up to the 15th century

AD, are from unknown locations. The events in 2036, and 1626 BC, this latter possibly from Thera, fall within the later Neolithic to earlier Bronze Age period for NW'n Europe. Modern, named eruptions are included, for comparative purposes, since both their scale, and location are known.

TABLE CL-03 Tree-ring sequences in the W'n USA: dates for anomalously narrow rings, possibly linked with large volcanic events

Note: as adapted Saltzer and Hughes 2007, table 2.
Key: VEI volcanic explosivity index.

BC	volcano	location	VEI
2906/2905	?		
2036	**?**		
1626	**?Thera ~1628 BC**	**Greece**	**6-7**
1524	?		
476	?		
425/424	?		
421	?		
406	?		
245	?		
42	?		
AD			
536	?		
627	?		
687/688	?		
691–695	?		
899/900	?		
1201	?		
1288	?		
1458	Pele	Martinique	?
1602	Huynaputina	Peru	6
1641	Parker	Phillipines	?5
1681	Tongkoko	Indonesia	?5

-Ireland

Sequences of tree-rings from Irish bog-oak have been matched, and overlapped, to provide a long chronology, spanning the past seven millennia (Pilcher *et al.* 1984), providing a firm basis for dating, and a resource for assessing environmental change.

Distinct bands of narrower rings are visible, well separated in the master sequence (Baillie 1995a, 77) (TABLE CL-04):

TABLE CL-04 Irish bog-oaks: bands of narrower rings indicating environmental impacts

decade BC	score	volcanic source	acid spike in ice-cores
4370	220	?	yes
3190	144	?	yes
1940	109		
1840	100		
1620	120	?Thera	
1140	143	?Hekla 3	yes
208	-		

AD		
540	-	?
750-900	-	

Key: score indicates the scale and prevalence of narrowing amongst rings, as explained in Baillie 1975, 77.

Such bands of narrower rings indicate serious events, with evidence from ice-cores supporting an origin in the effects of widespread volcanic fall-out.

The phase of marked narrowing, starting in 3199 BC, is closely paralleled in bristlecone pines from the W'n USA, and is reflected in data from polar ice-cores (Baillie 2011). The cause of this environmental downturn, visible on a hemispheric scale, is not at all clear, but its abruptness may indicate serious volcanism, or a cosmic impact, rather than any more general shift in climate.

The frequency of frosted tree-rings in Irish oak has been well established, back to before 5000 BC, and its relationship with volcanic eruption, and the tephro-statigraphy of ice-cores discussed (Baillie and Munroe 1988; Baillie 2000). Such sets of narrower tree-rings in N'n Ireland indicate severe environmental downturns in the area, also detected in tree-ring chronologies, and in ice-cores, from well beyond the region: major events occurred around 2354 BC, 1628 BC, 1159 BC, 208 BC, and AD 540. The atmospheric consequences of highly eruptive volcanic activity have been implicated in most of these events, with cometary impact suggested in certain cases. For instance, the event in 207 BC, corresponding with the adverse conditions recorded in Roman, and Chinese sources, might have had such an extra-terrestrial cause, as might those in 540 AD.

Such narrower tree-rings would indicate lower temperatures during the growing season, caused by prolonged winter conditions, hence late onset of spring, and could indicate a general reduction in ambient temperatures. The pattern suggests a fluctuating, but relatively high, incidence of frosting from 5000 to 3000 BC, followed by a trough, centred on about 2500 BC, with colder conditions then resuming, until a local maximum around 1500 BC (e-FIG CL-13). Onset of increased cold, coupled with higher rainfall (e-FIG CL-04), could mark an interval of climatic deterioration sufficient to have caused environmental pressure, and considerable economic stress, during a period of particular interest to this general analysis of monumental orientation.

-Sweden

Analysis of tree-rings from *Pinus sylvestris*, in near coastal N'n Sweden, and statistical comparison between variation of width amongst dated samples, and that from a set of modern standards, provides an index of changing mean summer temperature, over a 7400-year span (Grudd *et al*. 2002). Regional comparisons between sequences of tree-rings suggest that these data are representative of a larger area of N'n Europe, especially in its variability at decadal to centurial intervals. Correspondence with key phases of warmer, and colder conditions, identified over wider areas of Europe, suggests the more general relevance of results beyond Scandinavia. For instance, distinct climatic downturns, marked by longer runs of narrow tree-rings from N'n Ireland, beginning in 2354 BC, 1628 BC, 1159 BC, 208 BC, and 540 AD, correspond well with similar periods of declining temperature evident in this Swedish data.

Despite the lower size of samples, and consequent uncertainty for periods BC, several trends are apparent, with phasing marked by changing frequency of variability, and extremes of temperature summarised in e-FIG CL-15:

phase:

A: 4300-2500 BC: data from pollen, and macrofossils indicate optimal conditions for growth of pine during this period, with tree-lines extending up to higher altitude noted around 4000 BC, indicating warmer conditions during the mid to later Holocene, with temperatures about 1-2°C higher than at present;

B: 600-1BC: a phase of widely varying temperatures, with particularly high and low extremes, marks a generally cold period, corresponding with known glacial expansion, many of these at their maximum during the Holocene. This phase includes the sub-Boreal to sub-Atlantic transition, and that from Bronze Age to Iron Age in the region;

330 BC: a marked drop in summer temperatures, by 3-4ºC, may correspond with several volcanic eruptions that occurred at around this time, sufficiently large to have caused changes in weather patterns;

C: 1st century AD: corresponding with the Roman Warm Period;

D: 500-900 AD: the Dark Age cold period, including exceptionally severe summer conditions around 540 AD, as known from other markers, across wider areas of Europe;

E: 1000 AD: onset of the Medieval Warmer Period;

F: 1100 AD: onset of colder conditions, corresponding to the Little Ice Age.

Within this scheme, those events during the interval 2500-1500 BC are relevant to discussion of environmental pressures in the general study area of the W'n Atlantic seaboard, and their possible effects in terms of constructional activity.

However, the Swedish data only indicate a marked decrease in mean summer temperature after about 3000 BC, leading to a period of thermal variability, with maxima lower than during the preceding warm period A [see above]. From about 1500 to 1 BC, conditions became more stable, but remained generally below the modern base-line value.

-The duration of major volcanic events and their likely impact on patterns of narrowing and recovery of tree-rings

Against the broader pattern of climatic change, the impact of shorter environmental events, linked to volcanic activity, can be seen as a sudden reduction in width of tree-rings, sustained for some years, then followed by recovery. Amongst the Irish data, particularly relevant for the study area along the N'n Atlantic seaboard, it is interesting to consider whether such events were sufficiently long to have over-ridden the ability for shorter-term adaptation amongst communities. Events persisting for some years might have, at the least, triggered increased activity at ritual monuments, perhaps accompanied by augmentation, and fresh construction (see Table of Contents: 03d/8g).

For example, the distinct narrowing of tree-rings for years after 1628 and 1159 BC, noted at separate sites in NW'n Europe, indicates a widespread and serious environmental event of decadal impact (Baillie 1995a, 76, 82). Onset and recovery times for tree-rings during these events are as follows (TABLE CL-05):

TABLE CL-05 Tree-ring data: onset of narrowing and recovery around the events in 1628, and 1159 BC

1628 BC event:		**ring width: years until..........**	
sites		**recovery started**	**first peak**
Garry Bog	Ireland	9	13
Hasholme	England	5	7
Bronzes 9	Germany	5	8
Baumsaerge	Germany	4	8

Note: data after Baillie 1995a, fig 5.1/p.76; possibly linked to the major eruption of Thera, Aegean.

1159 BC event:			
sites			
4 bogs	N'n Ireland	18	19

Note: data after Baillie 1995a, fig 5.3/p.82; e-FIG CL-14; possibly linked to a major eruption.

Although factors affecting growth of tree-species are complex, related to levels of temperature, to hydration, and vary according to substrate, these ring-responses suggest major environmental downturns that were likely to have been of serious, if transient, economic consequence. For instance, the 1159 BC event persisted for 18 years (e-FIG CL-13 and 14), a near generational span. Fuller social recovery was also likely to have extended well beyond those dates indicated by ring-widths. However, instances of eruptive, or other environmental activity, serious enough to have suppressed tree-growth, and to register in ice-cores, seem too well separated to have caused lasting change. Adding minor episodic eruptions does not suggest environmental pressure sufficiently persistent to challenge adaptive behaviour seriously, unless part of broader persistent influences from climate, and land-use.

The environmental effects of volcanic activity

Introduction

As well as being subject to complex, and changing weather-systems over the N'n Atlantic, and Continental margin, the study area in Britain, and Ireland is also affected by fall-out from volcanic activity. As well as experiencing the global effects of large volcanic events, often remote, the area lies at the edge of a particularly active volcanic zone, with Iceland, a major centre, only some 800km to the NNW (e-FIG CL-06).

It is essential, therefore, to assess the frequency, and scale of volcanism that might have affected the general study area during the Neolithic and Bronze Age, and their likely effects. It would be especially relevant to identify any increase in eruptive activity during this period sufficient to have lead to direct, or indirect environmental stress along the NW'n margins of Britain, and Ireland.

Two primary factors appear to be implicated in variation of climate during the pre-industrial late Holocene: solar output, and volcanism, with considerable debate as to their relative importance (Free and Robock, 1999; Crowley, 2000; Shindell *et al*. 2003).

Volcanism, at any larger scale, can have an extensive impact on weather, in the short, and medium term and, over more restricted areas, particulate fall-out can cause direct environmental damage. Atmospheric effects can also result which, without the benefit of a more rational explanation of their origin, might have caused disquiet amongst those prehistoric communities observing them.

Although the more immediate environmental effects of modern eruptions are well recorded, there remain areas of uncertainty in relating episodes of volcanic activity to longer-term environmental fluctuations, such as cooler temperatures, disturbed patterns of atmospheric circulation, and stress to growth of trees (Hughes 2009; Warmkessel 2009). Further relationships with such social issues as famine, unrest, political and cultural changes are the subject of considerable debate.

The relative contribution of volcanic activity, and of changing solar radiation, to tropospheric temperatures has been assessed in detail for the Dalton Minimum, a 60-year period of low solar activity, from 1780-1830 AD, for which accurate data exist. Here, volcanic activity in 1809, 1815, 1831 and 1835, significantly decreased global mean temperatures for 2–3 years afterwards, but it was concluded that, although eruptions might have triggered the cold period from 1809, lower ambient levels of incoming radiation were responsible for maintaining it.

Although volcanism can cause changing patterns of weather, there is also evidence that the converse may also be true. Many major eruptions coincide with cooling trends, of decadal, or longer duration, that began significantly beforehand, and perhaps here changes in the depth of ice cover, coupled with changes in axis, and spin rate of the earth might trigger seismic, and volcanic activity (Rampino *et al*. 1979).

Cometary impact has been suggested as the cause of some climatic downturns, for instance when sequences of tree-rings, indicating sharp cold spells, do not correspond with evidence for volcanic activity (Baillie 2011).

The fall-out from volcanic activity affecting NW'n Europe, although occasionally serious, is likely to have been sporadic, fairly localised, and with relatively short-term effects, these within the capacity of agrarian societies to adjust. It is worth noting that subsequent, and lasting, colour-effects in the atmosphere might have been sufficiently disconcerting to elicit some supplementary ritual response (see Table of Contents 05/1a).

The atmospheric effects of explosive volcanism

-volcanic explosivity

Environmental effects of eruptions can be recorded, and modelled using various measures of severity, of which **VEI,** and **DRE** are the most frequently encountered:

VEI: the **volcanic explosivity index,** gives a measure of the volume of ejecta, and the height of column achieved;
DRE: the **dense rock equivalent,** indicates the total volume of ejecta in km^3;
DVI: the **dust veiling index** is based on the extent to which ejecta occlude the atmosphere, and on their residence-time.

VEI, the most commonly quoted measure, is a logarithmic scale from 0 (non-explosive) to 8 (mega-colossal eruption), with each unit representing a ten-fold increase in severity of eruption.

Examples of eruptions, over the range of VEI, are as follows (TABLE CL-06):

TABLE CL-06 The range of volcanic explosivity

power VEI	DRE	class	occ/ky	effects	plume (km high)	freq (yrs)	example	date
2	0.01						Tristan da Cunha	1961 AD
3	0.01	Vulcanian	868	severe	3-15	1	Cordon Caulle	1921
	0.03						Pelee	1902
4	>0.1	Pelean	421	cataclysmic	10-25	>10	Eyjafjallajokull	2010
5	>1	Plinian	166	paroxysmal	>25	>50	Mount St Helens	1980
6	18						Krakatoa	1883
	14						Laki	1783
	4						Vesuvius	79
7	150						Tambura	1816
	60						Thera	1628 BC BC
8	\2800			mega-colossal		10^4	Toba	76 kya

Key: VEI volcanic explosivity index**; DRE** dense rock equivalent**; occ/ky** estimated global occurrence per kilo-year; **freq** average global frequency per year; **ky**(**a**) kilo years (ago).

At the top end of the scale, the mega-colossal eruption of VEI 8 at Toba caldera, Sumatra, about 74 kya, of a type estimated to occur once every 10ky, is thought to have produced extreme levels of sulphurous emission, causing serious pressure on climate. Models suggest subsequent global cooling, by as much as 3-5°C, promoting an ice age (Rampino and Self 1992), or as little as about 1°C, causing a cold spell of a few centuries (Oppenheimer 2002).

-volcanic ejecta

Beyond the more localised spread of lava, and ash-fall, release of gases, and particulates from volcanic activity, into the atmosphere can have a profound influence on weather patterns. These are usually of short to medium duration, and can be effective at considerable distances from the source (Grattan *et al.* 1998; Sadler and Grattan 1999; Grattan and Pyatt 1999; Torrence and Grattan 2002).

Airborne material, altering the reflective properties of the atmosphere, can induce cooling, and its eventual deposition can damage vegetation, and soils, also animal, and human health. The effects range from global, to local in extent, and in time-scale persisting up to decades.

Major explosive eruptions can inject large quantities of sulphurous compounds into the stratosphere, which combine with water, to produce a sulphuric acid as an aerosol (Rampino and Self 1982). Injection of such material into the stratosphere changes the balance of solar radiation, by increasing absorption, and reflection of incoming shorter wave-lengths, and generally has a cooling effect on climate (Lacis *et al.* 1992; Minnis *et al.* 1993; McMormick *et al.* 1995).

Sulphurous gases released during eruptions convert to acids when in solution which, falling as rain, can do considerable damage to vegetation, over wide areas, as can fluorides, by similar means. Such acidic aerosols can remain in the atmosphere for years, and can be transported globally, far from the source, to affect weather patterns, by reflecting light, and absorbing heat, altering the duration, and properties of cloud-cover, and acting as nuclei for condensation of water.

There is clear evidence that volcanism has played a major role in forcing past global temperatures, for instance, during the climatic variability of the Little Ice Age (LIA), 1400–1850 AD (Porter, 1986; Mann et al., 1998; Crowley, 2000).

Gases emitted include carbon dioxide, hydrogen chloride and fluoride, hydrogen sulphide, and sulphur dioxide. These gases, and other particulates, provide important markers for identifying the source, and intensity of eruption, for dated horizons within ice-cores. Amongst these, sulphur of directly volcanic origin must be distinguished from other products of the complex bio-geochemical cycle of sulphur, such as that from inorganic sea-salt, and from anthropogenic sources (Mayewski *et al*. 1993; Legrand 1997).

A serial record of volcanic activity is provided by finer ejecta, and gaseous products settling over polar regions, such as Greenland, and Antarctica, to become trapped in snow, then accumulating in the growing ice-cover to form a stratified record of deposition, data to be readily retrieved from ice-cores.

The effects of volcanism: duration and abruptness of change

Many of the observed effects of modern eruptions are transient: climatic forcing lasting only a few years, until aerosols disperse, the impact on temperatures lasting for about seven years, on sea-ice for about a decade, but on oceanic circulation perhaps for a century (Oppenheimer 2011, 76).

The more noticeable effects of VEI 6 and 7 eruptions, such as those recorded for Tambura 1815, and Pinatubo 1991, lasted 1-2 years. At the extreme end of the scale, the VEI 8 eruption, indicated by the Toba event, might have caused global cooling for 6-10 years, perhaps sufficient to trigger an ice age, if conditions were already moving in this direction.

Location of volcanism

Tropical volcanoes appear to have had the biggest impact on climate, and in the past 200 years the following eruptions have all caused noticeable, and well recorded cooling, on a global scale:

Tambora	Indonesia	1815;
Krakatoa	Indonesia	1883;
Santa Maria	Guatemala	1902;
Mount Agung	Indonesia	1963;
El Chichon	Mexico	1982;
Mount Pinatubo	Philippines	1991.

Major volcanic eruptions: a global perspective

During the period 4000-1000 BC, there is geological evidence for the following volcanic eruptions, deemed to be major, in view of their calculated VEI (volcanic explosivity index) of 5-6. Those within the period of interest, the later Neolithic and Bronze Age of NW'n Europe, are shown below in **bold** type, and those with further detail given below, in **capitals** (TABLE CL-07):

Prehistoric eruptions

Major prehistoric eruptions of known date are listed below in TABLE CL-07, with those 2500-1500 BC shown in **bold** type:

TABLE CL-07 Major volcanic eruptions 4000-1000 BC

volcano	location	BC	±	VEI	DRE
Taupo/ Haroharo	New Zealand	4000	200		
Talisay	Luzon, Phillipines	3580	200		
Pinatubo	Phillipines	?3550			
Avachinsky	Kamchatka	3200	150		
VESUVIUS/ Avellino	**Italy**	**2420**	**40**	**6**	
HEKLA 4	**Iceland**	**2300**		**5**	**1.8**
Sv		**1720**			**0.5**
Long Island	**Papua New Guinea**	**2040**	**100**		
Black Peak	**Alaska**	**1900**	**150**		
HEKLA Sv	**Iceland**	**1900**			
Mount Hudson	**Chile**	**?1890**			
Mount St Helens	**Washington, USA**	**?1860**			
Veniaminof	**Alaska**	**?1750**		**6**	
ANIAKCHAK	**Alaska**	**1645**	**10**		
THERA	**Aegean Sea**	**1628**	**14**	**6-7**	**60**
Avachinsky	**Kamchatka**	**?1500**			
Taupo	New Zealand	1460	40		
Pago	Papua New Guinea	1370	100		
Avachinsky	Kamchatka	?1350			
HEKLA 3	Iceland	1135		>5	
Pinatubo	Phillipines	1050	500		

Key: **VEI**: volcanic explosivity index; **DRE**: dense rock equivalent of ejecta (km^3).

Further details of key eruptions listed above are as follows:

..Thera, Aegean Sea, Greece: 1628 BC; VEI 6-7

A major catastrophic eruption of about VEI 7, dated by analysis of tree-rings to 1628 BC, had a severe impact within the Mediterranean area, and caused a significant climatic event beyond it, in the N'n Hemisphere. Other surrounding dates within the 17th and 16th centuries BC have also been proposed for this eruption, or closely related events, based on data from tree-rings, and ice-cores (Zielinski and Germani 1998; Manning *et al.* 2002; Bronk-Ramsey *et al.* 2004; Salzer and Hughes 2007).

Evidence from radiocarbon, dendrochronology, and stratigraphy of fine ejecta from ice-cores, indicates a range of possible dates for a major eruption between 1640 and 1620 BC, with exact timing, and source of eruption subject to debate (Zielinski and Germani 1998).

Analysis of Irish oaks indicates occurrence of narrow rings for up to 20 years, corresponding with major eruptions (Baillie and Munroe 1988; Baillie 1995, 108-121). Based on absolute ring-chronology, one set, beginning in 1628 BC, was possibly caused by Thera, refining the dates 1628–1626 BC, from tree-rings in the US, and 1645 BC from fall-out in ice-cores from Greenland.

Suggesting dendrochronology as the most reliable indicator, Baillie (1990) has noted the importance of the bristlecone pine frost-event in 1627 BC, and the narrowest Irish ring-event. starting in 1628 BC, these convergent with the peak of ice-core acidity in 1645 +/- 20 BC. Using archaeological evidence from Crete, Warren (1990) has suggested a late Minoan Ia date for the eruption of Thera, certainly before late Minoan Ib, with 1555-1530 BC preferable to any date in 17th cent BC. It has also been argued, controversially, that the final major eruption occurred around 1100 BC, corresponding with the large sulphate peak in the Dye 3 ice-core from Greenland, dated to 1090 +/- 20 BC (Rohl 2007, 188-193). Added to this is the contention that ejecta from ice-cores marking the event in the 1640s have the wrong chemical signature for the Thera eruption (Zielinski and Germani 1998; Keenan 2003).

..Vesuvius, Italy: ?about 1800 BC; VEI 6

The Avellino VEI 6 eruption, which sealed the Nola Bronze Age village, has been variously dated, most estimates falling between 2000 and 1500 BC, one suggestion being of an event about 1800 BC, which followed two smaller eruptions around 3000 BC.

..Mount Aniakchak, Aleutian Mountains, Alaska: 1645 BC

A caldera formed during a major eruption in 1645 BC, and since then more than 20 eruptions have occurred, most recently in 1931.

Historic eruptions

The following eruptions have taken place during historic periods, and their effects have been more closely recorded (TABLE CL-08):

TABLE CL-08 Major volcanic eruptions: historic period: selected examples

volcano	location	AD	VEI	DRE
Katla-Eldgja	Iceland	934	6	
?Samalas	Indonesia	1257	?	40
Badarbunga	Iceland	1477	6	10
Huayaputina	Peru	1600	6	30
Laki	Iceland	1783	6	14
Tambora	Indonesia	1815	7	150
Krakatoa	Indonesia	1883	6	21
Novarupta	Alaska	1912	6	14
Pinatubo	Phillipines	1991	6	6-16

Key: **VEI**: volcanic explosivity index; **DRE**: dense rock equivalent of ejecta (km^3).

Further details of key pre-modern eruptions

-the event in 535-536 AD: source unknown: VEI 7

..volcanic or cometary

Either a cometary impact, or a super-colossal eruption of magnitude 7, possibly in South America, produced emissions, and dust-veiling, which resulted in severe winter conditions, and caused widespread environmental, and social damage, on a global scale (Tainter 1990). The effects of this dust-veiling event is seen in tree-ring chronologies (Baillie 1995, 91-107) from Siberia, widely in Europe, and from the Americas, representing the second largest signal in Greenland ice-cores during the last two millennia, exceeded only by the 1014 AD event. It has been suggested that such a major event might have been implicated in the onset of the so-called Dark Age in W'n Europe.

The evidence seems, on balance, to indicate a volcanic event (Larsen *et al.* 2008), rather than a cometary impact (Rigby *et al.* 2004; Baillie 1999). Increased earth-fall of cometary debris has been noted during the period 400-600 AD, from Chinese records. The possible role of cometary impacts in environmental, and societal change has been reviewed by Baillie, for this and other events (1999, 2005, 2006). The absence of a characteristic spike of volcanic sulphate for 535-536 AD, in the series from the ice-core shown in e-FIG CL-12, is interesting in this regard.

..point of origin

It has been suggested that a major eruption of Krakatoa in 535 AD might have caused global climatic change during the following year (Keys 1999). Layers from around this date in ice-cores, from Greenland, and Antarctica, indicate a large event, that interacted with the jet-stream, and achieved bipolar distribution, with high levels of sulphuric acid, characteristic of volcanism, but apparently the match is not exact.

The source of the eruption is not known, but its widespread effects suggest that it might have been equatorial in origin. In terms of location, and known eruptive power, Krakatoa is one strong contender, since it produces the type of viscous lava, build-up of which favours massive explosions.

Eruption at Rabaul, in the Bismark Archipelago, around 540 AD, has been estimated as VEI 6, and might have been implicated.

The eruption which formed the Lake Illopango lake, and caldera, in El Salvador, has been suggested as another possibility (Dull *et al.* 2001). A massive Plinian-type eruption (definition: TABLE CL-06), possibly the second largest in the last 200ky, spread tephra over large areas of Central America, including Nicaragua, Honduras, and in offshore areas, dated by radiocarbon to 408-536 AD, more closely to 450-545 AD. The event was equivalent to Tambora 1816, and ten times greater than Mount Pinatubo 1991, and appears to have been the most powerful in the last 1500 years. Extensive pyroclastic flows would have devastated surrounding areas, with an estimated VEI of 6.9, and with 84 km^3 of ejecta spread high into the atmosphere, leaving a caldera of 11 by 17 km in area. Regionally, such an eruption might have killed up to 100,000 people, displaced four times as many, and globally have resulted in prolonged changes to weather patterns. The data from Ilopango may provide a better fit for the 536 AD event than other contenders, such as Rabaul and Krakatoa.

..effects

In Britain the period 535-555 AD produced the worst weather of the 6th century. Mesopotamia experienced heavy snowfalls, and in Arabia flooding was followed by famine. In China, 536 AD saw heavy dust-falls, drought, and famine. For Korea, weather in 535-536 AD was the worst of that century, with massive storms and flooding, followed by drought. A pandemic, the 'Justinian Plague', which affected the Byzantine Empire in 541-42 AD might have been linked to climatic events five years earlier.

Byzantine documents of the immediate period (Michael Syriacus: 1126-1199 AD; Procopius of Caesarea: ~500-565 AD), record serious clouds of dust, causing widespread crop-failure in Europe, summer frosts, and drought. For instance, Michael Syriacus notes, admittedly long after the event, marked reduction in sunlight, and stress to crops, lasting for 18 months, from 536 AD, and again for about 9 months in 626 AD. Similarly poor weather is also noted in contemporary Chinese documents. Drought and famine might have aided the spread of bubonic plague over much of the Roman Empire, resulting in many deaths, from about 541 AD, for the next 50 years.

Sequences of tree-rings from Europe, between 536 and 551 AD, indicate years of very poor growth, seen also more widely in Sweden, Finland, North America, New Zealand, Chile, and China. Abnormally little growth of Irish oak occurred in 536 AD, and for the next seven summers, with another sharp drop in 542 AD. Width of tree-rings returned to pre-535 AD levels in the late 540s, suggesting that the climatic downturn lasted for some fifteen years (Baillie 1994). Other research suggests that the cold period began as early as AD 500, and lasted for more than 200 years (Berglund 2003). The relationship of this event to pressures on the later Roman Empire is the subject of debate.

-the eruption in 1257 AD: source unknown

Ice-cores from both the Arctic, and Antarctic contain sulphate, deposited from a massive volcanic eruption in about 1257, or 1258 AD, the largest of the historic period, and possibly of the past two, perhaps even seven millennia. This event resulted in a global volcanic winter, with very wet summers, its effects lasting for years.

Despite the inferred magnitude of its crater (10–30km across) the origin of this eruption has yet to be located (Stothers 2000; Oppenheimer 2003). A spike of sulphate, deposited in 1258, in ice at both poles, indicates an eruption somewhere within the equatorial zone. It has been estimated that at least 40km^3 DRE (dense rock equivalent) was released, in a column up to 43km high, with total destruction of Salamas volcano (Lombok Island, Indonesia) as a suggested source (Lavigne *et al.* 2013). Deposits of ash surrounding the crater, some up to 40m thick, have produced carbonised wood, dated to the 13th century AD.

Climatic data indicate boreal, and austral summer cooling in 1257–59 AD, consistent with a highly sulphurous eruption at lower latitudes in 1257 AD. Contemporary records over much of Europe, including those of Matthew Paris, and from as far afield as Japan, indicate that a stratospheric fog developed, resulting in cloudy skies. In 1258, frequent cold, and rain caused severe damage to crops, and famine throughout much of Europe, with outbreaks of plague occurring in 1258, and 1259. Another very cold winter followed in 1260–1261. Famine killed about 30% of London's population of 15,000, requiring pits for mass burial.

-eruptions linked to the onset of the 'Little Ice Age' (LIA) in Europe: later 13th century AD

There is evidence from analysis of the plant detritus in Arctic ice that volcanic eruptions might have triggered the Little Ice Age, providing more precise estimates for onset of climatic deterioration during the final decades of the 13th century (Miller 2102). It is possible that eruption of Samalas, Indonesia in 1257 contributed to the first pulse of the LIA, and eruption of Kuwae (New Hebrides), in 1452-1453, to the subsequent development of this cold phase in Europe.

These conclusions are based on radiocarbon dates from dead vegetation, emerging from rapidly melting icecaps on Baffin Island, combined with data from cores of ice, and sediment from the Arctic, and its margins, supported by simulations of interactions between sea-ice, and climate.

The Little Ice Age (Fagan 2000) appears to have begun abruptly between 1275 and 1300 AD, triggered by repeated explosive volcanism, during a 50-year episode of four massive tropical volcanic eruptions, and sustained by a self-perpetuating feedback between sea-ice and the ocean in the N'n Atlantic. This period of prolonged lower temperatures, which ended the Medieval Warm Period, was sustained by a second, sudden, cooling event, around 1450 AD, with temperatures only recovering during the 20th century.

More modern eruptions

Data from eruptions, for which direct records exist, provide accurate information on the environmental, and social effects of these events which, although they relate to modern populations, are of some qualified use as standards for similar assessment of likely impact on prehistoric communities.

The following eruptions, at the major end of the scale, illustrate global effects, albeit on modern societies, well able to compensate:

-Huaynaputina, Peru: 1600 AD; VEI 6

In Switzerland, and the Baltic area, there were bitterly cold winters in 1600–1602, and in 1601 poor grape-harvests occurred in France, Germany, and Peru. Famines occurred in Russia 1601-1603. The acid spike recorded in ice-cores from Greenland was larger than that caused by Krakatoa 1883.

-Tambora, Indonesia: 1815 AD; VEI 7; and the unlocated, possibly tropical eruption of 1809

A large volcanic eruption in 1809, unlocated, but probably tropical, of at least VEI 6, and perhaps half that of VEI 7 Tambora in 1815, deposited high levels of sulphate in ice-cores, from both the Arctic, and Antarctic. This, supplemented by Tambora 1815, might have initiated the extremely cold decade 1810-1819, the coldest for half a millennium.

Tambora experienced a large eruption in April 1815, ejecting 150 km^3 of tephra, and causing notable cooling in the N'n Hemisphere in 1816, known as the 'year without a summer', and marked by incidents of crop-failure, outbreaks of disease, and famine. Sulphurous emissions into the stratosphere reduced solar radiation, to the extent that global temperatures fell by about 1°C, for a year or two afterwards. Severe frost, and snow storms, in May and June 1816, in Eastern Canada, and New England, caused widespread crop-failure, with lake-, and river-ice observed as far S as Pennsylvania, in July and August (Oppenheimer 2003a).

-Krakatoa, Indonesia 1883 AD; VEI 6

A major eruption of Krakatoa in 1883, of VEI 6, ejected about 21 km^3 of debris, caused massive local destruction, and major tsunamis, all resulting in extensive loss of life, and in more widespread effects on climate.

-Novarupta, Alaska: 1912 AD; VEI 6

A very large eruption, lasting 60 hours, of VEI 6, occurred in 1912, expelling 13-15 km^3 of magma, resulting in 17 km^3 of airborne debris, and 11 km^3 of ash-flow tufa. This eruption was comparable to the 1991 eruption of Mount Pinatubo (Indonesia), but less than Tambora 1815 (Indonesia), or Krakatoa 1883 (Indonesia), and about 30-times less than Mount St Helens 1980 (USA).

-Mount Pinatubo, Luzon Island, Phillipines: 1991 AD; VEI 6

A major eruption in 1991 produced global effects, releasing more ejecta into the stratosphere than any eruption since that of Krakatoa in 1883. This caused severe local disruption over the following months, with the aerosols, estimated at 20 megatonnes, forming a global layer of sulphuric acid haze, reducing sunlight by more than 10%. After the eruption, the cloud persisted in the atmosphere for three years, and global temperatures fell by about 0.5°C.

Volcanic eruptions in Iceland

General

Britain and Ireland lie only about 800km SSE'ward of Iceland, the most volcanically active area in Europe (e-FIG CL-06), and certain prevailing patterns of atmospheric circulation over the NW'n Atlantic can make them particularly vulnerable to the medium-range effects of Icelandic eruptions (e-FIG CL-07). However, there are other sources of volcanic hazard in the N'n Atlantic area, and in W'n Europe, but none with the persistent activity of Iceland: the Azores (Furnas), the Canary Islands (Tenerife); Greenland (Aniakchak); Italy (Vesuvius, Campi Flegrei, and Etna), and the Aegean (Thera).

Location of volcanism

Iceland, lying on the seismically active Mid Atlantic Ridge, contains over 150 volcanoes, about 33 of which have produced known, or inferred eruptions during the Holocene (e-FIG CL-06). On average, there are about 20 significant eruptions per century. The E'n volcanic rift zone, crossing mid Iceland NE'-SW'ward, is by far the most active, accounting for 80% of verified eruptions. It contains a string of major strato-volcanoes, including the six most active in Iceland: **Grimsvotn, Hekla**, **Katla**, **Askja**, Bardarbunga–Veidivotn, and Kraftla. Those in bold type, together with Oraefajokull have, in historic times, caused 20 large explosive eruptions of VEI 5-6, to be compared with the VEI 4 event at Eyjafjallajökull of 2010, for recent reference. In Iceland, an E'n volcanic zone branches from the W'n, also running SW'ward, with the junction of the two systems occurring at an underlying volcanic hot-spot, which is key to activity in the area.

Active volcanic zones usually consist of a central volcano, and a fissure-swarm, that may extend tens of kilometres along strikes in both directions, away from the central volcano. Sixteen of the 30 known volcanic systems have been active after 870 AD. Most eruptions occur within central volcanoes, with Grímsvötn, Hekla, and Katla having the highest eruptive frequencies and, together with their associated fissure-systems, they have the highest volcanic productivity. Successive eruptions can be caused by chain-triggering, with historical evidence for this within the Katla system.

Scale of eruption

The largest explosive eruptions recorded on Iceland (VEI 6: as in the Oraefajokull eruption of 1362) occur once, or twice per millennium, and those of VEI 3 every 10–20 years. No evidence for VEI 7, or larger eruptions has been found in the geological history of Iceland (Gudmundsson *et al*. 2008).

There have been frequent large explosive, silicic eruptions during historic times, many of particularly high productivity, with estimates of ejecta for Hekla at 8km^3 for lava, and 7 km^3 for tephra, the latter rich in fluorine, and so very hazardous to grazing animals.

The most severe environmental impact recorded has been the famine of 1784–1785 AD, following eruption of Laki. Other eruptions, where contemporary sources indicate famine, include the Hekla eruptions of 1104 and 1300 AD, and famine is also suspected for the Eldgja eruption in 934 AD.

Major loss of livestock is recorded for eruptions at Hekla in 1510, 1693 and 1766–68 AD. Pre-18th century records suggest that the number of fatalities was in excess of 10,000. Certainly major loss of life is suspected for the Oraefajokull eruption in 1362.

During the medieval period, and the Little Ice Age, agrarian communities, already marginal in Iceland, reliant on subsistence farming, were well exposed to famine, if subject to undue environmental pressure. Events in medieval Iceland form reasonable parallels for discussion of comparable economies during the prehistoric period in NW'n Europe.

Although most of the more severe effects of eruption were confined to the area of Iceland itself, characteristic tephras from Hekla, and from other Icelandic volcanoes, have been recovered, at far lower densities, from well-stratified positions in British, and Irish bogs, indicating that these areas lay well within repeated ash-fall.

Column-heights of 20-30km during eruption, resulting in significant falls of fine particulates, up to a few millimetres thick, over N'n Europe, have been recorded in more recent times, about once per century. The most explosive phase of these eruptions, although usually lasting less than a day, may occur repeatedly during longer events lasting some months. Atmospheric dispersion of tephra, during aerial transport, results in ash-fall from short explosive phases being spread over some days.

Current winds, at mid-level over Iceland, flow generaly NW'ward for about 60% of the year, carrying any plume away, towards N'n Scandinavia and the Arctic (e-FIG CL-07). However, for about 30% of the time, winds are towards the SW, and hence the NW'n Atlantic seaboard, with more ideal conditions for transport obtaining for up to about half of this (Sammonds *et al.* 2011). Any past reversal in the location of dominant areas of higher, and lower pressure from their current positions could have caused increased drift of ejecta over the NW'n Atlantic seaboard (see Table of Contents: 05/4).

Much Icelandic volcanism has produced effects that are relatively local in extent. For instance, although the Badarbunga-Holuhraun eruption of August 2014 lasted six months, and released ash, and 11 megatonnes of sulphur dioxide, which spread over much of NW'n Europe, the more pronounced environmental impact was limited to the area of Iceland itself.

Frequency of volcanism

Volcanic eruptions are common in Iceland, with individual volcanic events occurring, on average, at intervals of 3–4 years, with small eruptions (<0.1 km^3 DRE) every 4–5 years, and the largest flood-basalt eruptions (>10 km^3 DRE) at 500–1000 year intervals. Localised inundation (*jokulhlaups*), caused by volcanic, or geothermal activity under glaciers, are frequent.

There are about 205 eruptions in the historical record, of which about 150 were of significant explosivity, giving an average of 20–25 eruptions per century (Sammonds *et al.* 2011).

The overall pattern of eruption in Iceland is one of decreasing frequency, and increasing size, as expressed in terms of explosivity, with volume of ejecta as follows (TABLE CL-09):

TABLE CL-09 Volcanic eruptions in Iceland: recurrence, magnitude and severity

Source: after Gudmundsson *et al.* 2008, table 2.

in terms of explosivity		in terms of lava and ejecta	
VEI	rec	**DRE (km³)**	**rec**
1	10	<0.01	5–10
2	10	0.01–0.05	5–10
3	10–20	0.05–0.1	10
4	30–50	0.1–0.5	10–20
5	100–200	0.5–1.0	50
6	500–1000	1–5	100
		5–10	500
		>10	500–1000

Key: DRE dense-rock equivalent volume; **VEI** volcanic explosivity index; **rec**(urrence, time in years)

Periodicity of eruption

Evidence suggests that in Iceland, since 1200 AD, there has been an increase in volcanic activity of variable intensity, that with a periodicity of about 130–140 years, these outbreaks separated by 50–80 year phases of reduced activity (Larsen *et al.* 1998; Larsen 2002).

These pulses of activity may be closely linked with bursts of seismic activity, acting to release accumulated strain on nearby tectonic faults, caused by rifting associated with the mid-Atlantic ridge, complicated by the activity of deep magmas, and pressure fluctuations caused by glacial melting.

There is some indication of longer-term volcanic periodicity during the post-glacial period, in data from the GISP-2 ice-core (e-FIG CL-09): see the section on ice-cores for further discussion. Other data on frequency of eruption over this period show little marked structure, although generalised, weak undulation is visible (e-FIG CL-08).

-dispersion of aerial ejecta

The extent to which particulates, and gases, are spread through the atmosphere, and the pattern of their ultimate deposition, depends both on the scale, and type of eruption, and on the prevailing directions of wind, especially at higher altitude, for which the current jet stream is a major factor. For instance, the eruption of Eyjafjallajökull in 2010 spread ash for hundreds of kilometres, from S to SE.

Historic eruptions: comparative data

Several large eruptions that have occurred during modern times in Iceland, and have been well recorded, both in terms of the eruption itself, and its effects, are included here as a possible basis for comparison with more ancient events.

-Laki, Iceland: 1783; VEI 6
volcanic zone: E'n;
fissure with over 100 craters;
very active, with violent eruptions;

Laki, a fissure-type volcano, comprising 130 craters, erupted violently in June and July 1783, the main phase of activity lasting 8 months, until early 1784. The event, a major eruption of flood-basalt, producing 15km³ of lava, also caused emissions, and ash-fall that killed more than half of the livestock in Iceland, probably as a result of fluorosis, with a quarter of the human population on the island dying from famine.

Effects of the eruption were felt in Britain, and over much of Europe, during June, and July 1784, as a dry, toxic haze, as an ash-fall, and sulphurous droplets, reducing solar radiation, to be followed by an autumn and winter of storms, and severe snow. An estimated 120 megatonnes of sulphur were emitted, from an unusually sulphur-rich magma; by comparison, the 2010 eruption of Eyjafjallajokull released about two kilotonnes of sulphur. The effects of this toxic cloud were increased by prevailing weather conditions, high pressure in the last week of June 1783 causing sulphur dioxide to sink ground-ward in the descending air column.

The lower temperatures caused by these emissions of sulphur dioxide have been linked to crop-failure, and famines elsewhere in Europe, as far afield as India, and Japan, with global deaths estimated at about 6 million. More immediate causes of death, with about 31,000 estimated from Europe, and numbers as high as 100,000 quoted, included lung-disease, and heart-failure from atmospheric pollution, this shown from contemporary records of burial as an increase during summer, in addition to a normal wintertime background of mortality.

Records for N'n Scotland indicate that, following poor harvests in 1782, this ash-fall in 1783 caused a second crop failure, resulting in severe social hardship, and abandonment of farms. This well illustrates the havoc caused when such events coincide with an already stressed marginal economy, and is certainly relevant to discussion of the possible effects of volcanism amongst prehistoric communities in these areas.

-Hekla, Iceland: 1845; VEI 4
volcanic zone: E'n;
hybrid stratovolcano and crater-row, part of a 40km long volcanic ridge;
frequent large eruptions;

Eruptions with VEI 4 have been fairly common from the 12th century AD onwards, with one more occurring more recently, in 1766. In 1845-1846 the whole island was strewn with volcanic ash, which smothered vegetation, and poisoned it for consumption by animals, resulting in the death of much livestock. An eruption of VEI 4 occurred in 1947.

Further details of specific volcanoes

-Hekla

Hekla is a volcanic ridge, rising approximately 1000m above the surrounding plateau of lava, to about 1500 m above sea-level. Eruptions of magma occur from a fissure, 5km long, over the spine of the Hekla ridge, also from short fissures on its flanks.

The past activity of Hekla is perhaps the best well known, its tephra, intermediate between highly silicic, and andesitic, being unique amongst Icelandic volcanoes. A series of major eruptions have occurred, in more recent times there have been 18 since 1100 AD, with substantial events during the prehistoric period also known (TABLE CL-10):

TABLE CL-10 Hekla: major eruptions during the prehistoric period

Data: Sverrisdottir, G. 2007, table 1; various other sources;
Note: alternative values quoted in the literature are given thus: [..].

period	eruption Hekla-	BP	~BC	14C	cal.BC	VEI	DRE	note
Mesolithic	**5**	6800	4800	5470	+- 130	0.7		
			[5050]					
			[5000]					
later Neolithic	**4**	**4260**	**2260**	**2690**	**+- 80**	**5**	**1.8**	
			2300	**2310**	**+- 20**			**note 1**
			[2345]					
			[2500]					
			2395–2279 BC					**note 2**
early Bronze Age	**Sv**	**3720**	**1720**					
		[3900]	**1900**				**0.5**	
later Bronze Age	**3**	2950	950	1120	+/- 50	5	2.2	
				1135	+/- 130			note 3
				[929	+/- 34]			
			[900]					
			AD					
Medieval-Modern period			1104				0.5	
			1158				0.15	
			1206				0.15	
			1222				0.15	
			1300				0.57	
			1341				0.15	
			1389				0.25	
			1510				0.79	
			1597				0.56	
			1636				0.2	
			1693				0.74	
			1766				1.25	

Key: [**VEI**] estimated **V**olcanic **E**xplosivity **I**ndex; [**DRE**] estimated **D**ense **R**ock **E**quivalent of ejecta (km^3).
Note: 1: date for well-stratified tephra from Irish bogs (Pilcher *et al.* 1995); **2**: **Hekla 4 tephra isochron, as quoted in palaeo-environmental analysis in Ireland by S**windles *et al.* 2010; 3: date from analysis of banding in stalactites.

Eruption of Hekla 4 during the later Neolithic resulted in deposition of much tephra in Irish bogs, and has been tentatively linked with a notable reduction in growth of Irish oaks, which started in 2354 BC. This lasted for a decade or two, and was the earliest of four extreme events that affected growth of tree-rings in the Irish record (Baillie 1995). This phase of decreased growth of trees was most pronounced at 2345 BC, with trees in Lancashire also experiencing lower growth at this time. Other tree species were also affected, with pine disappearing from most pollen spectra in Ulster just after this event.

At the cultural level, this environmental downturn has been suggested as possibly important in causing folk-movement during a period of technical innovation that saw the introduction of copper technology.

Hekla 3, during the later Bronze Age, is considered to have been one of largest Holocene eruptions (Baillie 1989), expelling about 7.3 km^3 of ejecta into the atmosphere, and leaving ash deposits up to 5m thick blanketing the surrounding area.

This eruption caused cooling of global temperatures for a few years afterwards, with local conditions often becoming colder, wetter, and more turbulent. More dramatic scenarios suggested for W'n Scotland include devastation by ash-fall, acid rain, serious storms, and masking of the sun for long periods, tree-rings suggesting 18-20 years of reduced summer. Subsequent failure of crops, and livestock would have resulted in social upheaval, mass migration to E'n Scotland, and changes in ritual activity, such as deposition of metalwork offerings in bodies of water (Moffat 2005).

Alternative studies, suggesting a less dramatic picture, have been carried out to assess the likely impact of volcanism, especially Icelandic, on ecosystems, and on prehistoric communities in N'n and W'n Britain (Grattan 1994, 1998; Grattan and Gilbertson 1994, 2000; Grattan *et al.* 1996, 1999, 2006; Dodgshon *et al.* 2000**).** At the social level, such studies stress the general economic resilience of communities, even when exposed to volcanic events of high magnitude.

-Katla
volcanic zone: E'n;
a sub-glacial strato-volcano, about 30km wide; caldera 10km in diameter, covered by 200–700m of ice; very active, with violent eruptions every 40–80 years; 16 eruptions recorded since 930 AD, and prehistoric activity known; very high sulphur dioxide emissions are likely, because of the overlying glacier causing increased explosivity when in contact with hot magma.

..Katla is the probable source of the eruption in 10,600 BP that yielded 6-7km^3 of Vedde Ash, spread from Denmark, Norway, through Scotland, and over the N'n Atlantic.

..A severe VEI 6 eruption of the 30km-long Eldgja fissure occurred in 934 AD, about twice that of Hekla 3 in intensity, and the largest known in recorded Icelandic history. This eruption lasted 3-8 years, with initial volcanic activity possibly year-long, releasing an estimated 20km^3 of ash, and 220 megatonnes of sulphur dioxide, from an extremely sulphur-rich magma. This event caused hemispheric cooling in 939-942 AD, and has been implicated in unstable weather conditions in China, and consequent famine there, with possible effects also noted in Egypt, Britain, and Scandinavia. More locally, in Iceland, ash-fall 10-20cm thick, over S'n areas, caused abandonment of Viking settlements, and movement of communities to relatively unaffected areas of upland. This provides a clear example of adaptation to adverse local conditions, of a type even more practical over those areas less affected, set at some distance from source, for instance, the W'n margins of Britain, and Ireland.

..More recently, a VEI 5 eruption occurred in 1918.

-Grimsvotn, Badarbunga, and Kverkjoll
Grimsvotn and Badarbunga are the most active of the central Icelandic volcanoes, with a history of eruption well known over last 1100 years, but almost unknown during the prehistoric period. Kverkjoll has not erupted in historic time, and little is known about its past behaviour.

However, analysis of basaltic tephras in surrounding soils, and their approximate dating by estimation of soil build-up, shows general behaviour, with two distinct peaks of activity: 5000-3000 BC, 1000 BC to 1000 AD, with others at 5000-4000 BC, 2000-1000 BC, and 1-1000 AD (Oladottir 2008).

Grímsvotn: volcanic zone: E'n;
a fissure-system, with most eruptions sub-glacial; connection with the Laki fissure; highest eruptive frequency of all the volcanoes in Iceland.

-Krafla
volcanic zone: N'n;
caldera 10km in diameter, with a 90km-long zone of fissures;
active: 29 reported eruptions in recorded history.

-Eyjafjallajökull
volcanic zone: E'n;
sub-glacial strato-volcano; crater 3-4km diameter, completely covered by an ice cap of about 100 km^2;
frequent eruption: 920 AD, 1612 AD, and again from 1821 to 1823 AD, 2010 AD.

-Oraefajokull
volcanic zone: SE'n Iceland;
strato-volcano;
A plinian eruption in 1362 AD produced 10km^3 of ejecta (2km^3 DRE), and caused large-scale fallout of rhyolitic ash, and pumice, mainly towards the ESE, causing devastating local impact, and abandonment of affected areas.

An overview of Icelandic volcanism during the later prehistoric period

Using data on evidence for volcanic activity in Iceland between 7000 BC and 1000 AD, as recorded by the Global Volcanism Program of the Smithsonian Institution, it is possible to rank volcanoes in terms of eruptive frequency, and to view general changes in volcanism over much of the later prehistoric period.

Frequency of volcanic activity, of all intensities, is given in TABLE CL-11. The most active volcano during this period is Katla, with Hekla at about a third as frequent, the other named sites appearing relatively minor by comparison.

TABLE CL-11 Icelandic volcanoes: frequency of known eruptions between 7000 BC and 1000 AD (data: Smithsonian Institution Global Volcanism Program)

Volcano	eruptions: frequency	VEI>=4	Iceland: region
Katla	108	5	S
Hekla	38	3	S
Krafla	14	1	NE
Bárdarbunga	13	1	NE
Snaefellsjökull	9		W
Torfajökull	8		S
Hengill	7		SW
Reykjanes	7		SW
Grímsvötn	6		NE
Hveravellir	5		SW
Krísuvík	5		SW
Fremrinamur	4		NE
Vestmannaeyjar	4		S
Askya	3		NE
Theistareykjarbunga	2		NE
Eyjafjallajökull	2		S
Prestahnukur	2		SW
Kverkfjöll	1		NE

Gross changes in volcanism during the prehistoric period are difficult to assess, because much of the eruptive sequence lacks precise dating, ranges often being noted in centuries, and up to a millennium in some cases. The approach adopted here has been to take more precisely stated data for Katla, the most active volcano, as being generally representative (e-FIG CL-08), then separately to add any more closely defined data from other locations, and to note any change. Data with ranges greater than about a century were excluded as unusable.

The frequency of eruption over time for Katla shows no very clear discontinuities, although there appears to be some very spread peaking over about 6000-5000 BC, around 2000 BC, 1000-500 BC, and during the later 1st millennium BC (e-FIG CL-08). Adding the other data produces very little change.

Although periodicity of volcanic activity has been suggested by recent studies, as noted above, this adds little to the search for an overall pattern.

The current evidence, using general data, and Katla as an indicator, does not support any distinct increase in Icelandic volcanism during the period 3000-1000 BC, and the pattern seems to be one of fairly continuous activity, with occasional, and non-periodic major eruptions.

Any effects of Icelandic volcanism on the N'n Atlantic seaboard, either directly in terms of ash-fall, or indirectly in terms of changed regional weather patterns, are perhaps best viewed as general background pressures, although specific, and intense episodes are certainly possible, as indicated by Laki 1783. Impact would then be enhanced if it occurred during any periods of other environmental stress, such as wetter and colder conditions, coupled with degradation of agricultural land from physical, and human causes.

Current general patterns of atmospheric circulation over the NW'n Atlantic (e-FIG CL-07) indicate prevailing winds towards the NE, that would tend to move lesser airborne ejecta away from Britain and Ireland, and out over the peri-Arctic area. Even given these conditions, larger eruptions may well overwhelm regional circulation, and spread material far more widely, both directly, and after more circuitous transport.

Further details of Icelandic volcanism are given as follows in TABLE CL-12:

TABLE CL-12 ICELANDIC VOLCANOES: DATE AND INTENSITY OF KNOWN ERUPTIONS BETWEEN 7000 BC AND 1000 AD

This table, containing an interim list of volcanic eruptions in Iceland during the prehistoric period, has been placed as a text file in the online section in the folder TABLES_filed, on account of its length, and the partial nature of some data.

Sites are grouped by geographical area as follows:
ICELAND: NE'n; S'n; SW'n; W'n.

Climate and volcanism: vulnerability of the N'n Atlantic area

The close relationship between volcanic eruption, and onset of colder phases is well shown by comparing climatic data from the Irish Annals (431–1649 AD) against dated eruptions, as identified by sulphate deposition in ice-cores, from the GISP-2 programme of drilling in Greenland (Ludlow *et al.* 2013) (e-FIG CL-11). This study supplements other such volcanic-climatic correlation, from more isolated cases of modern eruptions, for which monitored data are available, adding a longer, and more continuous sequence of impact. This period covers the Medieval Climatic Anomaly, about 900-1300 AD, and most of the Little Ice Age, about 1350-1850 AD.

These written records identify 69 cold events during this test-period, of which 37 correspond with 38 of the 48 eruptions evident from ice-cores, indicating a very significant statistical link between eruption and the onset of colder weather. The reliability of records has been established in the main, confidence increased by valid external reference, both to other well-recorded climatic downturns, and to astronomical events.

Besides this more precise correlation, made to intervals within a few years, taking the data at a more general level, there seems to be a fairly distinct association between phases of increased volcanicity and major recorded peaks of colder climate.

There are, however, some anomalies in the detail of this comparison:

-535 to 536 AD: this event, either a massive volcanic eruption, possibly of VEI 7, or caused by some cometary impact, does not feature prominently in the ice-core record as a sulphate spike;

..1257 AD: a large, unprovenanced eruption, or impact, widespread in its effects, is well marked in ice-cores, but does not appear to have triggered a written record of cold;

..the well-established onset of the Little Ice Age, after about 1350 AD, is not marked by increased frequency of recorded colder periods, but by a reduction, despite some increase in contemporary volcanism.

Although their effects may have been demonstrated, the origin of these volcanic events is not defined, whether distantly global, or more local, but a component from the Icelandic area is perhaps to be expected:

Larger eruptions include:

AD	sulphate ppb	?origin
638	(180)	
691	120	
938	130	
1175	180	
1229	110	
1257	250	tropical
1459	100	
1478	~100	
1587	100	
1604	100	
1640	110	

The effects of the 1257 AD eruption (see details elsewhere in this section), of possible tropical origin, are clear in ice-cores.

Ireland, and the entire NE'n Atlantic seaboard appear to constitute a zone that is sensitive to explosive volcanic activity, as an important influence on regional climate, and one which overrides the controlling effects of localised atmospheric circulation (e-FIG CL-07). It seems reasonable to expect that such vulnerability during the medieval period would also be seen during prehistory, perhaps greater here, since agrarian economies were less developed, and more susceptible to environmental change.

That the N'n Atlantic area appears subject to volcanic fall-out from more distant eruptions is well shown by simulation of the massive 1815 eruption of Tambora (Indonesia) (Gao *et al.* 2006). Here, airborne material, ejected at a near-equatorial location, became concentrated over mid latitudes in both N'n and S'n Hemispheres, in this case a particular concentration appearing over the N'n Atlantic area (e-FIG CL-10).

Environmental data from ice-cores

Stratified annual layers of ice, from both Arctic, and Antarctic ice-caps, are a major source of information on environmental change, and on volcanism since the last glaciation.

In the Arctic, various coring projects have provided long sequences of ice from central Greenland, principally **GISP**, the Greenland Ice-Sheet Project, and **NGRIP,** the North Greenland Ice-core Project, which started in 1999, and drilled through 3085m of ice, to end at bedrock in 2003. Data from Antarctic ice-cores supplement this, with many of the largest eruptions resulting in a bipolar deposition of debris (Castellano *et al.* 2005).

Analysis of layering in such buried ice provides environmental data on conditions current at the time of original deposition and compaction of snow. This includes data on changing ambient temperature, as given by isotopic analysis of oxygen in water, and on volcanism, from analysis of inclusions, such as tephra, and sulphurous material.

Much of the analysis has been concerned with discussion of broader issues of climatology, and volcanism, such as those involved in the onset, development, and end of the last glaciation, and matters related to discussion of global warming. There is also good coverage of change at finer time-scales, for instance from about 4000 BC, the period of the analysis in question. The record is capable of resolution to intervals of a year or so, and the ice-record remains unbroken until the present, enabling relative change to be assessed over longer periods.

It has been possible to relate acidic bands in ice-cores to major, historically known eruptions, and to identify the signatures of many others of prehistoric date, but often of unknown provenance. Sources, and properties of eruptions have been further defined, by comparative analysis of cores from different sites, and by simulation of atmospheric transport.

Although Greenland, and its ice-cores, are at some distance from more temperate areas of the N'n Hemisphere, events in the polar region are of central importance in the complex network of factors that determine patterns of weather over the N'n Atlantic area, and the adjoining seaboard.

The core from Camp Century, in Greenland, provided a record of volcanic fall-out over six millennia BC (Hammer *et al.* 1980) with major events as follows:

BC	**+/-**	
51	30	
210	30	
260	30	
1120	50	?Hekla
1390	50	
2690	80	
3150	90	
4400	100	
5400	100	

The Dye 3 core, also from Greenland, produced evidence for a significant acidic layer for 1645 +/- 20 BC, possibly marking the major eruption of Thera (Hammer *et al.* 1987).

The frequency of explosive volcanic events over the past 12ky [kilo-years], recorded as deposits of sulphate in annual rings of the GISP-2 ice-core, is summarised in e-FIG CL-09. Here, strong volcanism is evident during the post-glacial period, from about 10-7ky BC, with generally decreasing levels occurring thereafter, and this general trend might, in part, have been the result of decreased ice-load. There is some indication of millennial scale periodicity of volcanism during the subsequent post-glacial period. Low undulations of frequency occur around 6-4ky BC, then more marked maxima at about 3ky BC, and 2ky BC, with subsequent low peaks somewhat stronger around the BC-AD transition, and just before 1 and 2ky AD, but none of these approaching end-glacial levels (UMCCI 2012). Besides these low peaks of activity, at the beginning, and end of the 3rd millennium BC, there is nothing to distinguish this period as one of increased volcanic exposure: it appears little different from that during previous millennia, and generally weaker than those subsequent.

Relevant studies involving ice-cores

include the following few examples, over a range of time-spans:

-analysis of temperature change

..isotopic analysis of longer-term temperature change (Yiou *et al.* 1997);

..use of oxygen isotopes as a proxy for climate change since the last glaciation, with detail for the period 818-1985 AD, including the Little Ice Age (Stuiver *et al.* 1995);

The changing frequency of melt-years, hence of warmer conditions, through the sequence of the GISP ice-core, shows a peak around 5000 BC, and thereafter a steady decline under colder conditions, with minor peaking around 3000, and 500 BC (e-FIG CL-02). The curve of July insolation decreases steadily from 5000 BC onwards. A decline in melt-years is evident during the 3rd millennium BC, corresponding with the period of Bond Event 3, supporting the case for a climatic downturn during this period.

-evidence for volcanism from ejecta trapped within ice-cores

Information on periodicity, intensity and origin of eruptions is provided by the following sources:

..data over the last millennium (Clausen *et al.* 1995);

..volcanic sulphate for the past two millennia shows clear peaks, and possible cycles. Correlation between eruptions, and fall-out deposited in ice-cores, is well shown by processed data from the last 2ky (GISP-2 programme: Oppenheimer 2003; e-FIG CL-12). Here, certain historical eruptions are well marked, but others, several of them major, remain unidentified;

..deposition of volcanic acids over the past four millennia (Clausen *et al.* 1997);

..assessment of atmospheric circulation, and cover of oceanic ice, over the N'n Atlantic, during the past 41 millennia (Mayewski 1994);

..tephra, and aerosols for the last 110 millennia show a strong relationship between periods of increased volcanism, and periods of climatic change, over a long time-scale; at least 700 of the 850 volcanic signals detected lie between 9 and 110 kya [kilo-years ago], many with concentrations of sulphate greater than those from historical eruptions that are known to have disturbed global climate; the largest volcanic signals occur between 6 and 17 kya, during the last glaciation. and subsequent warming, with a phase of increased activity 22-35 kya, leading up to, and during, the last glacial maximum (Zielinski *et al.* 1995; 1996);

..comparative studies of sulphate, and methane sulphonate (MSA), the two major sulphurous species trapped in polar ice, provide extensive data on the last climatic cycle, distinguishing volcanic, and biogenic contributions, and clearly identifying recent eruptions at Katmai (1912), Tambora (1815), an eruption of 1807, and Laki (1783) (Legrand 1997);

..simulation of fall-out from the 1815 Tambora eruption, of VEI **7,** and deposition of sulphurous material in mid latitudes of the N'n and S'n Hemispheres, with clear impact on the N'n Atlantic area **(**Gao *et al.* 2007, fig. 9).

Data from ice-cores for the past two millennia

The pattern of volcanic fall-out in ice-cores from the Greenland ice cap (GISP-2), for the past two millennia, may provide useful comparative data for the prehistoric period. This more recent range indicates that the N'n Atlantic area has experienced a general background of lower level deposition, with well-separated pulses of more frequent activity, lasting a century or two, around 800, 1200, and after 1900 AD (e-FIG CL-12). Sporadic individual peaks from large events occur, mainly associated with these pulses. Some 110 separate events resulted in depositions greater than 10ppb of volcanic sulphate, of which 21 are greater than 50ppb [parts per billion], with only one of these outstanding, at over 300ppb. In this lattermost group, 10 spikes of sulphate have been matched to known, dated eruptions (TABLE CL-13):

TABLE CL-13 Volcanic activity for the millennia AD, as marked by sulphate deposition in GISP-2 ice-cores (e-FIG CL-12)

eruption		**AD**	**prox**	**VEI**	**DRE**	**gei**	**note**
Vesuvius	Italy	79	med	5			
Ilopango	San Salvador	~260	dist	6-7		hi	
?	?	639	?				
Eldgja	Iceland	934	loc	4	18		
Baitoushan	China	1030	dist				
?	?	~1100	?				
Kraftla	Iceland	1179	loc				
??Salamas	Indonesia	1257	dist		>40	hi	
?Kuwae	Vanuatu	1452	dist	6		hi	1

Laki	Iceland	1783-4	loc	6	14	hi
Tambora	Indonesia	1815	dist	7	150	hi
Krakatau	Indonesia	1883	dist	6	21	hi
Novarupta	Alaska	1912	dist	6	14	

Key: prox(imity to the coring site): **loc**(al to the N'n Atlantic area), **med**(ium distance), **dist**(ant); **VEI** volcanic explosivity index; **DRE** dense rock equivalent in km^3; **gei** global environmental impact: **hi**(gh).

Note: 1: eruption of the undersea volcano at Kuwae in 1452 may be linked with onset of the second phase of the European Little Ice Age.

In this identified group of events, sulphate spikes from local Icelandic eruptions appear more prominent than those from more distant sources, with the exception of the unprovenanced, but possibly tropical, 1257 AD event.

As well as positive identifications, certain anomalies also occur, for instance, the apparent absence of a sulphate spike for the widespread cooling event in 535-6 AD, possibly the result of an eruption estimated as VEI 7, and known to have caused disruption on a global scale.

Complex interpretation is further confirmed by the apparently reduced eruptive activity seen during the major cooling phase of the Little Ice Age, a phase of major environmental impact in the European area, and increased levels during the preceding medieval warm period.

If this known pattern of volcanic activity, and its recorded consequences over the last two thousand years, is typical of preceding millennia then, on its own, it does not immediately suggest the type of sustained environmental pressure likely to have produced major effects in prehistoric communities. Large eruptions, although perhaps regionally serious, appear sufficiently sporadic, and well separated in time, to have allowed any recovery, and adaptive social response to take place. Other more sustained systemic environmental factors, causing basic longer-term change in climate, may provide a more likely explanation.

Conditions of temperature in the Arctic since 7000 BC: relevant data from Greenland

Conditions of temperature in Greenland have a major influence on the climate of the N'n Atlantic area, through complex effects exerted on atmospheric, and oceanic circulation. Analysis of the water that formed the ice, and of trapped air, within cores from the GISP-2 drilling site in central Greenland has provided a detailed record of temperatures, stretching back some 9ky, to 7000 BC (e-FIG CL-16; Alley [on-line]; Kobashi *et al.* 2011). Known phasing of climatic conditions, obtained from other sources, can then be matched against this data, to examine what, if any, correlation there might be between sets of data. Matching well-documented, and more recent climatic episodes against data from such ice-cores may provide some confidence in applying this comparison further back in prehistory.

e-FIG CL-16 shows the sequence from Kobashi *et al.* 2011, extended back to 7000 BC by supplementary data from Alley [on-line], the temperatures, as given, ranging between –28 and -33°C. Highlighting peaks, and troughs, about a mean of -30.6 °C, indicates phases of relative warming, cooling, and of overall variability.

Working back from the warming conditions of present-day Greenland, the following climatic phases correlate well with the specific data on temperature from ice-cores [ICT, ice-core temperatures]. The cold phase of the Little Ice Age corresponds with a distinct trough of lower ICT, the Roman warm period with a series of peaks, the colder, and wetter period of the later Bronze Age with minor troughs, and the Bronze Age Optimum with a series of strong peaks. The later Neolithic, and earlier Bronze age correspond with a series of minor troughs of ICT, whilst the early to mid Neolithic matches a series of peaks.

Specific episodes of climate in prehistoric Britain, as suggested from hydrographic data (Brown 2008, table 1), also show some correspondence with ICT, particularly for the colder, and wetter event around 4.2 kya, during the later Neolithic to earlier Bronze Age, and for the similar event 2.6 kya, during the later Bronze Age. The particular period of interest for this analysis of possibly environmentally-sensitive monumental alignment is the former, that during which stone circles, and rows were constructed. Here the effects on the agrarian economy of a period of unstable, and deteriorating, wetter, and colder weather, over the NW'n Atlantic seaboard, especially in more marginal areas of upland Britain, and Ireland, could provide an explanation for repetitive proliferation of such monuments, in terms of their presenting some increased means of mitigation by ritual. The response here might have involved an increased ritualised interest in the economic benefits of the solar cycle, using physical axial alignments to connect the communities of the living, and of the ancestors with the sun, as an act of economic propitiation. The available data on climate during that period are consistent with such a model.

The impact of volcanism on agrarian communities of prehistoric type

Data from historical eruptions, and especially from those more recent events that have allowed fuller monitoring, provide much information on the social, and economic consequences of volcanic activity, as well as perspective on its environmental impact. Case studies of major eruptions have enabled their effects to be considered through time, space, and increasing distance from source, directly in the case of recorded events, and through simulation in the case of others. Over the medium- to long term it is not possible to separate the topic of volcanism from that of changing climate, and the two are best considered together here as closely related.

Relevant parallels from the historical record

Although volcanic events at source, whether ancient, or modern, are subject to the same physical parameters, the targeted communities have changed in terms of structure, economy, and outlook, to such an extent that it is difficult to assess impact by modern analogy.

There are, of course, historical examples that give an indication of impact on simpler agrarian communities, in already marginal areas, and precarious economic condition, and these might provide some basis for backward projection. In fact two of the most relevant parallels come from the area in question, the N'n Atlantic seaboard, albeit during the 18th century AD.

-1783: The effects of the VEI 6 Laki eruption in Iceland during 1783 caused severe disruption, both on the island, and along the Atlantic seaboard of Scotland (see Table of Contents: 05/10e), where communities were small-scale, and agrarian, in many ways comparable to those of later prehistory.

The impact of Icelandic volcanism on the society and environment of Britain and Ireland, as suggested in many studies has, however, been questioned by some analyses, which caution against an over-simplified relationship between environmental data, and volcanic events. Here, the scale of climatic change following many eruptions has been observed to be minimal, and the impact of airborne ejecta largely dependent on the vulnerability of the receptors, rather than on the scale of deposition. For instance, effectiveness of the volcanic climate-forcing mechanism has been challenged, with the concept of harsh volcanic winters, and cool volcanic summers further examined, using three of the largest eruptions of recent, and historic time: Laki (Iceland), Tambora (Indonesia), and Mount Pinatubo (Phillipines) (Grattan *et al*. 1999). It has also been argued that volcanic activity can act as a stimulus for cultural development, rather than exerting entirely negative effects (Grattan 2006).

-The Little Ice Age: 12th to 17th centuries AD: The adverse conditions of the Little Ice Age (Grove 1988; Fagan 2000), apparently volcanically induced, and maintained for several centuries, caused considerable hardship in areas of Europe. However, much of Europe at the time was semi-urbanised, the economy more regionally organised, and hence resilient, and so the basis for comparison with prehistoric communities is weaker. It does illustrate the obvious vulnerability of societies that are exposed economically through location, as along the Atlantic seaboard, or become so through inability to adapt to adverse conditions, as in medieval Europe. It is evident that small additional pressures, as might result from volcanism, can cause large-scale results.

The term 'Little Ice Age' (LIA) has become applied to the period of cooling which followed the Medieval Warm Period in W'n Europe. Estimates for starting dates vary from 1350 to 1550, with more agreement about an end around 1850. Three cold snaps have been noted, from 1650, at about 1770, and finally in 1850, with intervening warmer phases. One recent analysis suggests sudden onset of cooling between 1275 and 1300 AD, and intensification from 1430 to 1455 AD. At the beginning of the LIA, or perhaps preceding it, three years of heavy rain, beginning in 1315, caused the Great Famine of 1315-1317, and marked the onset of 500 years of climatic instability in N'n Europe.

Historical records indicate the social, and economic pressures caused by the deterioration in climate. During the LIA, harsher winters, and poor summers, with shorter growing seasons, caused episodes of repeated crop-failure, and general shortage of food throughout Europe. For instance, marginal communities of Norse in Greenland failed under these harsher conditions. Marked decline of population occurred in Iceland, although the local effects of increased volcanic fall-out on agricultural, and pastoral areas might have been a prime factor here. In the Baltic, and N'n Europe, hardship that was considerable, and widespread is recorded. The damage done by more violent events, such as storms and flooding, in coastal areas of the North Sea, and Baltic is also well attested.

Famines, regular occurrences in medieval Europe, occurred in France during the fourteenth century in 1304, 1305, 1310, 1315–1317 (the Great Famine), 1330–1334, 1349–1351, 1358–1360, 1371, 1374–1375 and 1390. In England, years of famine included 1315–1317, 1321, 1351, and 1369.

Average life expectancy declined during the period, even amongst the upper levels of society: for the English royal family in 1276 it was 35.28 years, between 1301 and 1325, during the Great Famine, it was 29.84, and between 1348 and 1375, during the Black Death, and subsequent plagues, only 17.33.

The period of the Great European Famine, one of a series of crises that struck N'n Europe early in the fourteenth century, caused serious disruption, millions of deaths, and marked an end to growth, prosperity, and increased population during the 11th to 13th centuries. Its onset coincided with the end of the Medieval Warm Period, the period 1310-1330 seeing a run of severe winters, and wet, cold summers. The medieval economy was too exposed to absorb further stress, and the famine itself began with bad weather in spring 1315, continued with crop-failures in 1316, until an improved harvest in 1317 started a fuller recovery by 1322 (Jordan 1996).

-Dark Age: the VEI 7 event of unknown origin in 535 AD (see Table of Contents: 05/9d ii) caused similar, and widespread problems, but here again, many of the targeted communities are not comparable to those of prehistoric Europe.

There are many more earlier cases where some climatic, or volcanic cause has been sought for observed cultural change, a subject of considerable debate, with examples ranging from the later Bronze Age in W'n Asia and the Mediterranean, ancient Egypt, and Mesopotamia, to the Roman empire (more popular discussions of the general topic include Keys 1999).

A recent study of central European rainfall, and temperature, based on analysis of high-resolution data from tree-rings has been used to support links between climate and socio-economic change, from about 500 BC to the medieval period (Bunten *et al.* 2011). Benign conditions appear to coincide with Roman and medieval prosperity, and increased climate variability, from about 250 to 600 AD, with the decline of the Roman Empire in the West, and with the instability of the Migration Period.

Evidence for adaptation to changing conditions in Britain and Ireland during the Neolithic and Bronze Age

There are three complexly-interacting factors in the physical environment that have direct social consequences for early communities, capable of causing environmental stress: ambient temperature, rainfall, and the viability of arable, pastoral, and other economically-important land. Issues such as over-clearance and use, subsequent erosion, and degradation of land, linked to agriculture, further complicate the contribution of climate alone to events in the sedimentary record.

Variations in climate would certainly be expected to have influenced economic productivity, social health, and levels of conflict within pre-industrial societies. However, linking environmental change with specific cultural trends, given the complexity of the systems involved, and the frequent lack of precise dating, is problematic.

Difficulties of interpretation, at a more local level, are well illustrated in SW'n England by discussion of changes in land-use on Dartmoor during the middle Bronze Age. Abandonment, or relocation of upland farming, the decline of land-division involving reaves (Fleming 1988), and their relationship with soil acidification, reversion of land to peat, and the effects of a colder-wetter period between about 1400 and 1100 BC are discussed by Amesbury *et al.* 2008.

The distinct, and well-established wetter-colder phase 2.7 kya (kya: kilo-years ago) (Bond Event 2: see Table of Contents: 05/5) has also been discussed in relation to certain trends evident during the later Bronze Age. In terms of agriculture, the deteriorating conditions appear to have resulted in adaptation, rather than marked decline. Large-scale analysis of pollen data across Britain has provided no support for wholesale change in land-use during this period, with many instances of increased agricultural activity (Dark 2006). Detailed studies in NE'n Scotland further support these conclusions (Tipping *et al.* 2008).

In Scotland, the cooler, and wetter period of the mid to later Bronze Age, 1800-800 BC, was one of general climatic deterioration, but pollen analysis in Orkney suggests that communities adapted, rather than declining markedly, and no major change in human activity was detected throughout the Bronze Age. On Hoy, spreading heath was managed by burning, then as today, and on Hoy, and South Ronaldsay human activity is evident over the entire period, with lack of pollen sprcifically associated with cereal cultivation balanced by much evidence for grazing (Orkneyjar 2009).

In the sphere of ritual, increased deposition of metalwork, as hoards, in rivers and lakes during the mid to later Bronze Age, together with a growing interest in water-based cults, may perhaps be seen as a response to adverse conditions, at least in part (Bradley 1990). As well as any contribution from environmental variation there are, however, many other possible explanations for major social and economic change during this period (Bradley 2007).

This wetter period also saw the beginning of crannog-type settlement in Ireland (Fredengren 2002), another instance of adaptive behaviour.

Adaptation of agrarian communities: a general hypothesis

Variations in climate are suggested as important factors affecting pre-industrial societies, in terms of agricultural productivity, health, and levels of conflict (Buntgen *et al.* 2011). Changing European temperatures, and rainfall, over the past 2.5ky suggest a possible correlation between wetter, warmer summers, and periods of Roman, and medieval prosperity. Increased variability, from about 250 to 600 AD, also coincides with the decline of the Roman Empire in the West, and the instability of the Migration Period. However, coincidence need not indicate cause, at least not in a simple, and direct way.

The relationship between changing climate, and levels of conflict in societies, has been quantified in some detail over a long time-span, global extent, and wide size-range for various social groups (Hsiang *et al.* 2013). This particular study suggests that deviations from average rainfall, and from mild temperatures, significantly increase the risk of conflict.

It is likely that the relatively rapid onset of climatic instability, and deterioration, as evident during the later Neolithic and earlier Bronze Age, had a significant effect on prehistoric communities in Britain, in terms of culture, economy, and ritual practice. This would have been especially marked in the more marginal, and adversely affected areas of the N'n, and W'n seaboard.

Inclement weather would have affected crops, and pastoral activities, worsened the effects of over-clearance, and over-use of land, promoting waterlogged land, soil erosion, and growth of peat. This would have progressed as a slow general deterioration, but might well have included more individually catastrophic events. Short- to medium-term pressures, such as fall-out from volcanism, might have acted as a trigger for more profound changes in the social, and economic fabric of those small-scale prehistoric communities in marginal locations, already under stress from environmental pressures.

Relevant adaptations would be expected in settlement pattern, in the economy, and in the sphere of ritual, especially that connected with fertility, and the seasonal cycle, major preoccupations of agrarian communities.

Periods of increased social, and economic pressure are also likely to have been accompanied by measures stressing possession of land, and reinforcement of territorial boundaries, and here construction of monuments is likely to have played a part in such definition.

Pressures might result in collapse, or in adaptive change, probably some combination of both, and might have been mitigated by practical changes in the economic sphere, and also in ritual activity. If changes were sufficiently gradual, then significant adaptation would be more possible, especially since communities in such marginal environments have to be adaptive by nature.

Change might be wholesale, and novel, such as relocation of settlement, or gradual, involving a shift in emphasis, economic, or ritual, in the latter case expressed by growth of practices thought to mitigate the situation by propitiation of appropriate deities, or ancestors.

This might include growth of an existing cult linked to seasonal fertility, perhaps solar in essence, and be expressed by construction, often repetitive, of sun-ward linear monuments, and as a rash of solar symbols on rock faces, again showing a similar trend for orientation.

e-FIGURES: combined listings and supporting information

Environmental change
CL-

01 Estimated variation in temperature over the N'n Hemisphere since 10,000 BC, matched against Bond Events for the N'n Atlantic area

02 Years of ice-melt since 8000 BC, as seen in ice-cores from GISP-2, matched against Bond Events for the N'n Atlantic area
Data: University of New Hampshire, USA.

03 Occurrence of frost-rings, and minima of width, since 3000 BC, for tree-rings from the N'n Hemisphere
After: Salzer and Hughes 2007.

04 Evidence for changing patterns of alluviation in lowland, and upland areas of Britain, from 6000 BC to the present
The y-axis gives a statistical measure of increased frequency of flooding.
After: Johnstone *et al.* 2006; Brown 2008, fig.2.

05 Evidence for wetter phases in Scottish peat-deposits, from 3000 BC to the present, matched against Bond Events for the N'n Atlantic area
After: Langdon and Barber 2005.

Volcanism, data from ice-cores, and tree-rings

06 Iceland: distribution of volcanically active areas

07 Currently prevailing winds over the North Atlantic, and Norwegian Sea around Iceland

08 Katla (Iceland): known eruptions since 7000 BC
Data: Global Volcanism Program of the Smithsonian Institution.

09 Frequency of volcanic eruptions from 10,000 BC to the present, as recorded by layered deposition of sulphate in ice-cores from the GISP-2 programme of drilling in Greenland
After: UMCCI 2012.

10 Tambora: simulated global deposition of sulphatic aerosols after the major eruption of 1815
After: Gao *et al.* 2006.

11 Volcanic forcing of colder spells, as recorded in the Irish annals
After: Ludlow *et al.* 2013.

12 Deposition of volcanic sulphate over the last two millennia in ice-cores from the GISP-2 programme of drilling in Greenland
After Oppenheimer 2003, fig 3.

13 Changing frequency of narrower tree-rings in Irish oaks, from 5000 BC to the present
After: Baillie 2000, fig. 10

14 Recovery of width in tree-ring from Irish bog-oak, following the environmental event of 1159 BC

15 N'n Sweden: climatic variation, as shown by data from tree-rings

16 Palaeo-temperatures in Greenland: relevance to changing climate over the N'n Atlantic
Two sets of data on ambient temperatures, obtained from ice-cores at the GISP-2 drilling-site in central Greenland (Alley 2000; Kobashi 2011), have been combined, to provide a general sequence for the past 9000 years. Known phases of changing climate during the Bronze Age in Britain, and Ireland have been matched against this sequence, to examine the context of any climatic deterioration during the later Neolithic-earlier Bronze Age, this being of possible importance in discussion of the proliferation of axial alignment amongst stone monuments.

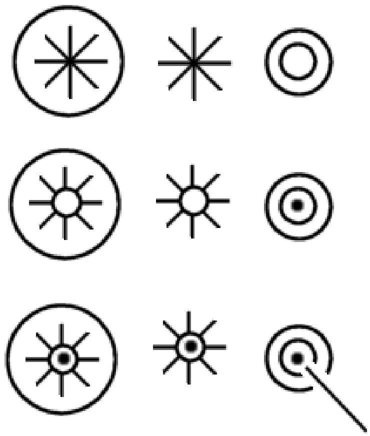
Symbolism

Section 06

A brief review of solar symbolism during the Neolithic and Bronze Age in Britain and Ireland

Section identifier: SY-

SEE INITIAL SECTION:
Access to digital images



elements of motifs

Summary:
The symbolic content of rock-carved motifs is outlined, with elements of possible solar affinity emphasised, their occurrence, and alignment on open-air panels, and on axial stone monuments further analysed. Solar symbolism amongst monuments, artefacts, and as associated with deities are also briefly outlined.

The following topics are discussed:
-**evidence** for solar symbolism;
-solar **motifs**: generic forms;
-**monuments** as solar symbols;
-relevant **artefacts**, including 'sun discs';
-solar **vehicles**;
-solar **deities**;
-**rock-art**: motifs; comparison with art at passage tombs.

Evidence for solar symbolism in ritual of the Neolithic and Bronze Age in NW'n Europe

Amongst the artefacts, and monuments of this period there is considerable physical evidence for a component that appears linked to the sun, its importance as the prime force behind seasonal change, and all that this implies for economic prosperity, firmly understood amongst agrarian communities, and reflected in well-documented ritual.

Abstract qualities of increase, and decline, inherent in the annual seasonal cycle of the sun, are also readily transferable to the human cycle of life, and death, and hence into funerary ritual, and its associated structure. Other celestial bodies, the moon being the next obvious, as well as many other features from the natural world, would also have entered the complex sphere of prehistoric belief, and practice. The sun, however, remains prime candidate as a principal deity, with any solar cult the one most likely to have been active during times of environmental hardship.

It has been suggested in this analysis that many monuments of the Neolithic and earlier Bronze Age can be interpreted as having an alignment towards the S'ly transit of the sun, as in the case of cursus sites, stone rows, stone circles, and henges (see Table of Contents: 03c, 03e, 03f respectively). Certain motifs of rock-art have also been suggested as solar symbols, and their placement on monuments to be significant in this respect (see Table of Contents: 03g).

It remains to review the evidence for such solar symbolism in more detail, in terms of two main areas of discussion, that relating to suggested content of symbols, and that covering the actual archaeological record.

Solar symbolism: generic forms

At the outset it must be clearly stated that suggestion of suitable symbolism for use by prehistoric communities in their ritual, even at its most basic, and supported by ethnographic parallels, is dangerous ground indeed, given that this is back-projection from a modern view-point. Despite these misgivings, several properties of the sun, and its seasonal cycle, certainly seem to offer themselves as obvious motifs, both for graphic art, and for architecture.

The solar disc, in static mode, might translate graphically as a simple circle, shown just in outline, or with the disc itself augmented in positive, neutral, or negative relief. A more dynamic projection of the sun might be achieved by adding further elements to the disc, and its margins: for instance, with rays indicating emission, and with rings perhaps adding further impetus, by suggesting progressive increase.

Aspects of the transit of the sun deemed worthy of depiction might have included rising, ascent, and setting, and have involved use of an arc, or some other linear feature as a motif, perhaps reinforced by one or more attached sun-symbols, to indicate origin, and duration. Stacked arcs might be used to indicate motion, the seasonal cycling of the transit from low winter, to high summer elevations.

A basic system might include the following, examples of which can be seen in the rock-art of Scotland, and Northumbria (see Table of Contents: 03g/9 to 12), and amongst the repertoire of motifs shown in e-FIGS SY-01 to 03, and 06:

..the disc itself:
static basic motif: circle;
circle : outlined only;
: filled;
positive relief;
decorated in the plain;
negative relief;
dynamic basic motif plus marginal additions;
circle : edged;
rayed;
ringed.

..the transit of the sun:
basic motifs: linear, or arc-shaped grooves, perhaps with appended sun-symbols;
lines of sun symbols.

Rock-art: possible solar motifs from Britain and Ireland

Rock-art in this area is largely restricted to the cup-based range of simpler motifs common to most areas of the Atlantic seaboard (Bradley 1997). Further elaboration of plain cups, by addition of marginal rings, and extended grooving, accounts for much of the content of most panels on rock-surfaces, and on megalithic monuments, except for the more elaborate carving found at certain chambered tombs, for instance in the Boyne valley, Ireland.

This art, predominantly rupestrian, is almost entirely non-figurative, and seems utilitarian, repetitive, and lacking in variety, certainly when compared with that from major European centres. By contrast, the repertoires found at Mont Bego (Alpes Maritimes, France), Val Camonica (Italian Alps), and in S'n Sweden are highly variable, figurative for humans, animals, and artefacts, and dynamic in content:

..Mont Bego (Alpes-Maritimes, France)

Bronze Age carvings (1800-1500 BC) evoke an agricultural, and pastoral culture, and include corniforms, harnessed animals, weapons, latticed engravings, and anthropomorphic figures (de Lumley 1984; de Lumley *et al.* 1990).

..Val Camonica (Italian Alps)

Carvings from Neolithic to Iron Age date show humans, animals, and weapons (Poggiani 1989; Fossati *et al.* 1990a, 1990b).

..S'n Sweden

A disc motif, interpreted as solar, occurs throughout the area, and persists in use from Bronze Age into Iron Age. Discs, often variously spoked, can occur in isolation, borne aloft by human figures on shipboard, or can appear with draught animals, as part of wheeled vehicles (Gelling and Davidson 1969, figs. 2-4, 6-7).

Interpretation of circular, and cup-related motifs

It is possible that many of the circular motifs utilised in rock-art of the period can be interpreted as solar symbols. Many such have undergone a second stage of development, to become wheel-like, perhaps thereby incorporating some of the dynamic qualities of the solar transit, and its frequent association with motion. In all their forms, they came to be associated, in many instances, with drawn vehicles and ships, further strengthening the idea of movement.

In Britain, and Ireland, although sharing certain elements in common, the repertoire of motifs carved in, and on chambered tombs, those of the Boyne valley in Ireland forming a notable example, differs from that on open-air, natural rock-surfaces. The latter tend to incorporate less geometric variability, with individual motifs usually simpler, and more stereotyped.

Amongst the British examples, in both traditions, the engraved circle, and its variants, can be found but, on open rock-surfaces, the repertoire is dominated by the concave cup-mark, either alone, or with added peripheral features. This might have represented a solar symbol, with added rings perhaps providing some element of dynamism, as representing radiation, and perhaps, by implication, inducing increase. Radial grooves are a common feature of single cups, and especially of cup-and-ring marks, where they appear to add some directional element to the design, this perhaps aimed towards the solar transit (e-FIG RA-15). Composite motifs, for instance those where cups feature as terminals for lengths of channelling, may perhaps indicate the arc of solar transit, and movement of the sun along it. Lines of cups might also have fulfilled the same purpose. Although a distinct possibility, interpretation of cup-marks as solar symbols remains debatable, and an extensive range of possible alternatives has been suggested (Morris 1981).

Spirals, and concentric circles, some double, have often been taken to depict eye-motifs. This imagery, and that of the sun, could have been united as a deity of nature, fertility, and renewal, clearly connected with the seasonal cycle of natural change, agriculture, and hunting. The double spiral might have represented not only the eyes of some deity, but could also have symbolised the dual nature of the rising, and setting sun.

The hollow body of the cup-mark suggests the possibility of its use as a receptacle for offerings, perhaps directed sun-ward, and there are many level locations, such as at Achnabreck, Argyll (e-FIG RA-03 to 05), where this would appear to have been a practical option. The fact that many such cups also occur on vertical slabs, typically orthostats in megalithic monuments (e-FIGS RA-07 and 08; e-FIG SC-06) need be no deterrent to this suggestion. Vertical cups might have retained smaller offerings, of more adhesive composition, might simply have been non-functional symbols, or there is the possibility that cups were carved, and used, before the slab was erected, and were perhaps dedicatory.

If these were solar symbols then the sheer quantity of them, and the repetitive nature of such motifs in the British, and Irish panels may indicate a widespread solar cult, expressing itself with some vigour, perhaps in the face of deteriorating environmental conditions. The occurrence, in certain chambered tombs, of potential solar symbols, on vertical slabs forming the ends of passages that come to be illuminated periodically by the sun, could also strengthen the case for solar imagery (see Table of Contents: 03a/20).

As well as the orientation of motifs on basically horizontal surfaces, that of symbols on vertical faces, such as on orthostats in megalithic monuments, may also be relevant in discussing the meaning of the symbolism. There seems to be a trend for ringed cups to open downwards, and for radial grooves to point in this direction as well. This could perhaps express the benevolent effects of the sun on the earth. Lines of cups also tend to run across the face, often sloping, perhaps representing the transit of the sun. Examples can be seen at Ballymeanoch (stone row: e-FIG RA-07), Kilmartin (linear stone setting: e-FIG RA-08), Sunhoney (recumbent stone circle: e-FIG SC-08), and Rothiemay (recumbent stone circle: e-FIG SC-07). Other instances of channels with cupped terminals could present an alternative version (e-FIG RA-19 and 21).

Alternative interpretation of circular motifs in rock-art: terrain-mapping and solar symbolism

In arguing a significant solar basis for interpretation of certain motifs from rock-art that occur on exposed outdoor surfaces, it is important to assess other suggestions, such as their possible function in terrain-mapping.

Certain of the more complex panels from Irish passage graves, those on kerb-stones, and in the chamber-passage, and as seen at other sites in Britain, might have utilised particular motifs to display general maps of the terrain in important areas, including those around monuments, and key natural features (Moriarty 2010). Four such cases are presented here, to examine the basis for such comparison:

..a panel from **Knowth** (cairn 14, orthostat 8) may show topography, and tombs, in the Bend of the Boyne, including Knowth, and New Grange (e-FIG SY-09). The proposed mapping covers the W'n sector of the area, with Knowth as the largest symbol, all perhaps indicating a territory, or sphere of interest;

..two panels from **Dowth** could depict part of the remaining E'n sector of this locality (e-FIG SY-10);

..panels from **Loughcrew-Carnbane** may map the E'n (e-FIG SY-12), and W'n (e-FIG SY-11) cemeteries.

The widespread examples cited by Moriarty (2010) provide persuasive evidence for possible depiction of surrounding landscapes lying within the context of the funerary monument itself, bringing the physical world into the realm of the dead. There are, however, certain reservations:

..although some motifs appear to coincide with terrain, this leaves many unaccounted for, such uncorrelated symbols perhaps suggesting grounds for further prospection, rather than rejection of a match;

..as an exercise in over-application, many other panels can be force-matched into fairly convincing correspondence with terrain;

..use of spiral, circular, and radiating motifs in such panels to denote monuments (Moriarty 2010: lexicon of motifs pp. 100-110, adapted as e-FIG SY-02), does not necessarily detract from their potential as solar symbols, if the layout of these circular sites also represented solar imagery.

Amongst the many reasons behind creating decorated surfaces, symbolic terrain-mapping, therefore, seems a likely element of contemporary iconography, together with others related to cult practice, and kinship for instance. The terrain-weighted lexicon of symbols provided by Moriarty (2010, 100-110), also includes suggested solar motifs, both for the disc itself, and for the transit.

What appear to be solar symbols occur on internal and external stone surfaces at passage tombs, especially in Ireland:

..Knowth: dials, especially that on kerbstone K15 (e-FIG LB-98);
..Knowth: rings of circular motifs: kerbstones K42, and K52 (e-FIG LB-101);
..Loughcrew T: on the stone at the rear of the chamber (e-FIG LB-106)
..Dowth: a linear set of rayed circles on kerbstone K51 (e-FIG LB-SY-10);

Here however, both externally, and especially within passage-chambers, the range, and type of symbols used, and the complexity of panels, appears different to those of most rock-art carved on exposed bedrock in open-air situations, representing major differences of intent (e-FIG SY-08). The range of motifs encountered on rocks out in the landscape tends to have more relief, with circular motifs sunken, and channelling often present (see Table of Contents: 03g). The common currency on such exposed surfaces is the simpler cup, or cup-and-ring motif, and variants, more suggestive of direct solar imagery than of terrain-based, or other conceptual mappings. The distribution here is also more sporadic, with far fewer cases of larger, complex, diverse, and highly organised panels. The proliferation of sites, and the repetition of cup-motifs also suggests some intensity, and duration of use, perhaps related to propitiation of the sun, in response to protracted deteriorating environmental conditions, as argued in this analysis (see Table of Contents: 05).

Symbolism amongst monuments

The circle appears widely as a general format amongst artefacts, and monuments, being economical in depiction of form by line, and from its potential for relevant symbolic content. Bradley (1998, 101-115) stresses its importance in cosmology, and in organisation of landscape, again perhaps, at base, representing the solar disc. As an example of the latter, the suggested circular disposition of round barrow cemeteries around Stonehenge, and Avebury is further discussed elsewhere (see Table of Contents: 03h/2h).

At a smaller scale, such symbolism might also have been expressed in monumental form. Obviously, a circular outline containing a conical mound is an ergonomically efficient option for a funerary monument, such as a Neolithic chambered tomb, or earlier Bronze Age round barrow, but it may also contain symbolic solar content. The same suggestion would also apply to stone circles, and henge enclosures (see Table of Contents: 03e, and 03f). Large round barrows, a group that can contain Silbury Hill, might indicate heightened expression of this solar theme (see Table of Contents: 03f/2b, and /2e i).

It is not possible to assign priority to any one motive for adopting a circular ground-plan, these considerations likely to have been complex, and inclusive, for both practicality, and symbolism, which could include solar imagery, or even reflect current domestic architecture. Long barrows can be set against a context of longhouses, and round barrows could be similarly related to a current tradition of round houses, both types of funerary monument being a traslation of domestic structures into the funerary sphere (see Table of Contents: 03a/17a).

Objects

Wheel-pendants

The **sun-cross,** or -**wheel**, a cross inside a circle, is a common symbol amongst artefacts from prehistoric Europe, particularly those from the Neolithic to Bronze Age, often appearing on artefacts identified as cultic items. Such votive wheels, or pendants, were offered at shrines, such as at Alesia, or thrown into rivers, such as the Seine, buried in tombs, or worn as amulets. An amber inlay from Denmark, that shows a cross-shape when held against the light, is of Bronze Age date. Ornamental pins from Switzerland, dating to the first half of the 2nd millennium BC, have circular heads incised with crosses. The wheel-motif also appears on the Gundestrup cauldron, Denmark, of later Iron Age date, and on an altar to the Roman sun-god at Lypiatt, Gloucestershire.

Sun-discs

Small discs of gold, simply decorated, and suitable for personal ornament (phot SY-01), occur as grave-goods accompanying certain burials of the earlier Bronze Age in Britain, and Ireland (Timberlake 2002, 2003, 2004). Most of these sun-discs have been discovered in Ireland, which has produced 21 of the 34 examples known. Similar discs, with simple decoration, also occur moulded in ceramic, and on the base of certain pottery vessels (Ashbee 1960, 116).

Two examples in gold are discussed below in more detail:

..Banc Tynddol; Copa Hill, Cwmystwyth Mines, Ceredigion; SN 816 756;
Excavation within an area of metallic ore-deposits, that had produced evidence for mining activity since the Bronze Age, located a shallow grave, containing a gold disc, but no other artefacts. Only very fragmentary human

remains survived, but location of the disc in the grave suggested placement over the chest area of any corpse. Overlying rubble may indicate remains of an eroded cairn (Timberlake 2002, 2003, 2004).

This disc, of gold foil, was less than 0.1mm thick, about 3.9cm in diameter, and weighed 2.51g. The hammered, and polished upper surface bore dotted, and linear decoration, impressed from the underside. The object belongs to the tradition of gold-work in primary bell-beaker cultures, and may be dated 2500-2100 BC.

Parallels are to be found in
...Ireland: unprovenanced, with 2-4 impressed circles, and two central perforations;
...Isle of Man, Kirk Andreas: decorated with impressed dots;
...Brittany: examples with dot- and linear decoration are associated with Beaker deposits;
...Britain: three examples are associated with two Beaker burials, one as a pair, and one as a single find, at Mere (Burl 2000, plate 71/ p.362), and at Farleigh Wick (Wilts.).

Similarities in style, and decoration occur on the basket-shaped ear-rings, or gold hair-tress ornaments associated with rich Beaker burials, such as that of the Amesbury Archer (Wilts.), with other examples from Kirkhaugh (Northumberland), Chibolton (Hampshire), Barrow Hills (Oxfordshire), and Boltby Scar (Yorkshire), all datable between 2500 and 1900 BC.

..Tubney Wood; Oxfordshire;

A gold sun-disc, dated to the Chalcolithic period (2450/2400-2200/2150 BC), was recovered from one of a pair of closely spaced, token, cremated burial deposits (adult,?sex, without grave-goods), lying within an area of disturbance (Simmonds 2012).

This partially crushed disc is approximately oval, measures 1.2 by 0.9cm, and bears an incised cruciform pattern of four vertical, and four horizontal lines, surrounded by an incised band around the surviving parts of the circumference. Two small perforations, 1.2mm apart, each about 0.5mm across, and located slightly off-centre, represent a means of attachment, possibly to a garment. The disc is smaller than most examples, but the decoration is characteristic. Radiocarbon dating of cremated bone provided dates of 1870-1840 cal. BC (1 sigma), or 1780-1620 cal BC (2 sigma: NZA 34865), indicating that the disc was centuries old when deposited, perhaps as an heirloom.

A pair of similar gold discs were found in a Chalcolithic context at Mere in Wiltshire, associated with a beaker, tanged copper alloy dagger, wrist-guard, bone spatula, and the unburnt, crouched skeleton of a large male, along with a second individual.

More spectacular instances of metal sun discs also occur, as for instance on the Trundholm cult vehicle (Denmark) (see just below).

The Nebra sky-disc; Mittelberg hill, Saxony-Anhalt, Germany; phot SY-02;
This disc, 32cm in diameter, is decorated with applied gold leaf, and bears on the left the sun, or full moon, on the right a waxing moon, with a star group between, and above, possibly the Pleiades. Two golden arcs were added later, along the edge, and it has been imaginatively suggested that these may mark the angle between solstices. Another arc, surrounded with multiple lines, was added towards the bottom, with interpretations ranging from a solar barge, with oars, to a rainbow. This item was buried in a cache, with bronze swords, axes, a chisel, and fragments of spiral bracelets, perhaps as a ritual deposit. The axes, and swords can be dated typologically to the mid 2nd millennium BC, and an associated radiocarbon date of 1600-1560 BC supports this.

Association of solar discs with vehicles

-carts, or chariots

There are instances amongst artefacts, and rock carvings, of what appear to be solar discs borne on vehicles, perhaps to indicate motion, and passage of the sun across the sky. Such mythology appears to have been widespread, and persisted to be outlined in Classical, and later sources.

..the Trundholm sun-chariot; West Zealand; Denmark; phot SY-03;

The cast bronze figure of a highly decorated horse stands on a bronze rod, this latter carrying a bronze disc, and supported by two four-spoked wheels, the assemblage measuring 54cm wide, 35cm high, and 29cm long. The vehicle was dismantled before its burial in a peat bog, possibly around 1400-1300 BC.

The disc is about 25cm in diameter, and consists of two bronze plates that are joined by an outer bronze ring, with a thin sheet of gold applied to one face only, this bearing impressed, and incised decoration, of concentric circles, with bands of zigzag decoration between borders. The golden side of the disc has an outer zone, that may represent rays, and also a zone with concentric circles, linked by looping bands.

If a Bronze Age date for this item is correct, then such an early example in N'n Europe of a horse-drawn vehicle, with spoked wheels is anomalous, perhaps not to be expected until the end of the Late Bronze Age, 1100-550 BC.

This model-vehicle may indicate precursors to those myths that were current in N'n Europe during the early medieval period. Here Sol, personified goddess of the Sun, rode through the sky on her chariot, pulled by the two horses, Arvak, and Alsvid. Dagr, personification of day, was also drawn by the horse Skinfaxi, on a similar course. The theme is certainly found in Classical mythology (see the end-paper), with the Greek deity Helios, and Roman Sol Invictus, riding in their chariots, and in India, as Surya riding in a chariot drawn by seven horses.

-boats

Use of a boat for solar transit might well have been an older tradition than that of the chariot, this latter a typical Indo-European device, that became current in the 2nd millennium BC.

Pits to house boats are found around some Egyptian pyramids: for instance the dismantled timbers of a fully sized, functional, 44m long boat were sealed into a stone-lined chamber, at the foot of the Great Pyramid of Khufu, at Giza, in Egypt, around 2500 BC. Drawing on well-documented mythology, this might well have been a solar barge, of a type found elsewhere in Egypt, and represented by models, and as art in tombs. Solar deities, female, as well as more prominent later males, such as Ra, and Horus, are depicted as riding in a solar barge. Ra is drawn across the heavens from E to W, then through the underworld to rise again at dawn.

In a more European context, the small curving symbol on the Nebra sky-disc could indicate a solar boat, amongst other possible interpretations. Panels of rock-art from the Nordic Bronze Age also contain what might be solar boats, in association with solar symbols (Gelling and Davidson 1969).

-ship burials from Scandinavia, although of later date, provide interesting parallels, often observe N'-NW'ward alignment, and suggest persistence of earlier traditions (Skoglund 2008). Such burials date from the later Nordic Bronze Age and into the Iron Age, from about 1700 BC to 1000 AD. These include burials within a functional timber ship, and those contained within a perimeter of stones arranged to form the outline of such a ship, as for instance the example at Blomsholm, near Strömstad, in Sweden, falls on the NW'-SE'ly solstitial axis (Sparavigna 2016).

Solar deities

Deities associated with the sun are common in mythologies throughout Europe, and Asia. The gender of solar, and lunar deities varies widely between cultures, with both being well represented, as in ancient Egypt. Although, in the later Classical mythologies of Greece and Rome the bright sun is masculine, and the darker moon feminine, earlier traditions are more variable. In Germanic mythology the sun Sunna is female, and the Moon male.

In Celtic mythology, several deities have solar attributes (Green 1989, 1991, 1992). In Ireland, Aine, goddess of love, summer, wealth, and sovereignty, was associated with the sun, and midsummer. Etain was a sun-goddess, with Lugh, and Mug Ruith also related. In Gaul, Alaunus was god of the sun, healing, and prophecy, with Taranis god of sun, sky, and thunder. Grannus was also a god associated with healing springs, and the sun.

The spoked wheel is a symbol that occurs widely throughout Celtic Europe, and appears associated with a specific deity of the sun, sky, and thunder, the 'wheel god'. This god has been further identified as Taranis, recipient of sacrifice, by the Roman author Lucan, in his poem *Pharsalia*, perhaps in some association with the other deities, Esus and Toutatis. Taranis was worshipped in Britain, Gaul, Germany, and along the Danube.

It has been suggested that depictions of the eight-spoked wheel might have had a calendric significance, representing an equivalent division of the year. The two solstices, and two equinoxes, comprising the four Albans are represented by a 4-spoked wheel, the additional four marking the fire festivals of Samhain, Brigantia, Beltane, and Lugnasadh (see Table of Contents: 02b/9a).

Large numbers of votive wheels, perhaps connected with the cult of Taranis, have been found in sanctuaries from later Iron Age Gaul, and many Celtic coins also include wheel motifs.

Symbolism in relation to monumental alignment

Solar symbolism in relation to rock-art is relevant to questions of axial alignment at monuments, and its possible relationship with the solar cycle. Such motifs in Britain and Ireland occur within, and on chambered tombs, on stone circles and alignments, and to their greatest extent over open-air rocky surfaces (see Table of Contents: 03g).

Interpretation of motifs

Since the motifs used in this area are abstract, with little detailed representational content, their close interpretation is not possible, unlike certain of those found in Iberia, and France, for instance, which provide clearer depictions of weaponry, and human, or animal forms (e-FIGS SA_br-30 to 47).

Structural analysis of motifs, and panels is certainly possible, providing general comments on their organisation, and content, but extraction of meaning is not possible, beyond certain weak generalisations, for instance, use of motifs as expressions of group identity, or ritual protection of monuments, and their contents (Twohig 1981, 140).

Various lexicons of symbols have been proposed, of which the following are a selection:

..Twohig 1981: The approach taken here is taxonomic, with little attempt at deeper interpretation of symbols. Basic motifs are assigned to 11 divisions: including circular, radial, cup-marks, linear, alternating, and angular (e-FIG SY-01);

..Moriarty 2010: Certain motifs are considered to represent features in the ancient landscape, both natural, and monumental, including individual, and grouped sites, topography, with minor inclusion of celestial events (e-FIG SY-02). This system has at least some basis for further analysis, by direct physical comparison with the surrounding landscape (Moriarty 2010). Specific cases, where content of panels from passage tombs in Ireland could relate to ancient terrain, are shown in e-FIGS SY-09 to 12. However, this interpretation is harder to apply beyond such monuments, amongst the extensive range of panels that occur on rocky open-air surfaces, where far fewer candidates present themselves, and where the repertoire of motifs is different (e-FIGS SY-07 and 08). The context also differs: on the one hand as applied to enclosed funerary sites, and on the other applied to non-monumental features, often in exposed locations that indicate no apparent connection with burial. This latter may, however, be possible, if areas of such rock-art marked zones for discrete routine disposal, or scattering of remains, well away from settlement, with motifs added to mark each event.

The underlying system proposed here, one based in solar imagery, might include division of circular, radial, and curvilinear motifs according to representation of the solar disc, and its motions (e-FIG SY-03).

..the disc itself: as a cup-mark could be seen as static, with further circles, and radials, adding augmentation, or if in spiral form indicating a more dynamic appearance;

..the solar transit: on the other hand, the transit, rising, or setting, could be indicated by lines of cups, its full cycle by a circuit, and seasonal cycles by curved arcs, or serpentiforms.

The function of panels

The repetition of basic motifs, without many attempts at coherent overall design to be seen in panels, suggests a series of individual acts, either of routine propitiation, or perhaps commemoration. The former could have some basis in the solar transit, and the weak S'ly trend for alignment of certain motifs may perhaps support this (see Table of Contents: 03g/7b; e-FIGS RA-15). The latter could be connected with disposal of human remains, perhaps cremated rather than inhumed, given the absence of much evidence for such direct burial. The lack of any distinct W'ly orientation of motifs in the analysis, as carried out in this study, might argue against any strong funerary connections.

Internal and external panels

Moving from the internal passage-chambers of tombs, to those external kerbstones that provide suitable surfaces, there is some increase in the frequency of those circular motifs with potential for solar symbolism (e-FIGS-04, 05 and 08). Certainly these do occur within such tombs, as can be seen at the Loughcrew-Carnbane W'n, and E'n cemeteries (Meath, Ireland; e-FIGS LB-106 and 107). At Knowth (Meath, Ireland), besides internal panels, there is a concentration of carving around the S'n arc of kerbing. Certain kerbstones also bear motifs that, besides their circularity, seem further to suggest solar imagery: kerbstones K15 with its sun dial (e-FIG LB-98), K42 and K52 with their possible depictions of the solar transit (e-FIG LB-101).

The passage tomb at Sess Kilgreen (Tyrone, N'n Ireland; H 612 583; Twohig 1981, 202-203) well illustrates the changing proportion of circular motifs, between panels within the chamber, and on the face of an external standing stone. Although the internal panels contain circular motifs, there is a marked increase on the outlier, and a change to those types more typical of external rock-art, cup-fields, and linear cup-marks (e-FIG SY-07).

Rock-art on passage tombs, and on external rock-surfaces

Moving beyond the monument, to completely external locations, the rock-art here uses only a fraction of the motifs associated with passage tombs (e-FIGS SY-04). Such external panels are simpler, highly repetitious, and dominated by circularity, as can be shown by sampling those of the Cheviot group (Northumberland) (e-FIG SY-05). The obvious differences in content between these two groups of panels can be seen by comparing a range of panels from each (e-FIG SY-08). This increased use of circular motifs could indicate a stronger reference to the solar transit.

Rock-art from N'n Britain: basic characteristics

The Cheviot group of rock-art, with detailed panels, extensively published as an archive (Beckinsall: see Table of Contents Bibliography 08/ rock-art, database 1), provides data typical of those from other areas of Britain, and suitable for further general analysis of motifs used.

-graphic elements

In order to address the basic symbolism behind motifs, it is essential to reduce the art first to its **basic elements**, only three of which are present, and to combine these to define **generic forms**, of which six occur (e-FIG SY-06). **Higher-order motifs** can be constructed from various combinations of elements, and forms.

..basic elements:
a: cup-mark;
b: ring;
c: channel;

..generic forms:
1: cup-groups;
2: cup surrounded by concentric ring(s);
3: cup with channelled extension;
4: rings: concentric;
5: ring with channelled extension;

6: channels: multiple, connected;

..higher-order motifs (only one example is quoted here):
2+c: cup surrounded by concentric rings crossed by one or more radial channels;

Trial classification of motifs from a sample of 110 panels, selected at random from the regional group, provided the following broad outline of basic statistics (TABLE SY-01):

Combination of elements and generic forms:

	assoc	**#**	**%**
a	C	2246	77.99
3	C ch	110	3.82
b	R	24	0.83
2	R C	298	10.35
2c	R C ch	142	4.93
5	R ch	6	0.21
c	Ch	54	1.88
TOTAL		**2880**	

Motifs containing:

cups	2654	77.24
rings	470	13.67
channels	312	9.08
TOTAL	**3436**	

multi-ringed motifs: number of rings present

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**#**	**of rings**
63.5	20.1	8.3	4.1	2.1	0.4	1.1	0.4	**%**	**of sample (total: 468)**

Key: assoc(iation); **#** number of instances; **C**(up-mark); **R**(ing); **ch**(annel);

TABLE SY-01 Cheviot group of rock-art: classification of motifs

-general properties

The following points emerge from this sample:

..only a very **limited repertoire of three basic elements** is used in panels;

..these elements are linked as a strict, and **limited set of generic forms**, with any higher-order associations again restricted to a few types;

..the **dominant theme throughout is circular,** with almost no recourse to angular, geometric patterns;

..**augmentation** is common, producing compound motifs, of multiple elements, for instance, those incorporating concentric circles;

..**complexity of motifs is generally low**: as, for instance, in the case of concentric rings, and although higher multiples are found, these are uncommon, frequency decreasing markedly after 2-ringed designs;

..the total number of motifs in the regional sample indicates **extremely repetitious activity**, especially evident from the dominance of cup-marks;

..the scattered distribution of motifs in many panels suggests a **series of individual additions,** rather than any unified design;

..**widespread use of similar motifs** between widely separated areas indicates some common basis for their establishment, beyond purely local traditions;

..there are obvious **differences in content** between this open-air rock-art and that associated with passage tombs, as for instance those from Ireland (e-FIG SY-08).

Conclusions

There is some case to be made for viewing the circular symbolism, seen frequently amongst petroglyphs, in terms of solar symbolism, although other alternatives are possible, forming what appears as a rich repertoire of motifs representing a complex set of beliefs, and associated rituals, currently not understood in any meaningful detail.

The range of predominantly circular motifs found on outdoor rocky surfaces could, therefore, indicate repeated acts of solar propitiation. Differences with the repertoire from chambered tombs may suggest little connection with funerary ritual.

e-FIGURES: combined listings and supporting information

Ordering of motifs:

01 Lexicon of petroglyphs: Irish passage tombs: classification by form:
after Twohig 1981

02 Lexicon of petroglyphs: Irish passage tombs: interpretation in terms of terrain-mapping:
after Moriarty 2010

03 Lexicon of petroglyphs proposed in this analysis: interpretation in terms of solar symbolism

Petroglyphs on tombs and outdoor rocky surfaces:

04 Petroglyphs: Irish passage tombs: relative frequency of types:
after Twohig 1981

05 Petroglyphs: rock-art: Cheviot group (Northumbria): relative frequency of types

06 Petroglyphs: rock-art: Cheviot group (Northumbria): structure of motifs

07 Sess Kilgreen (Tyrone, N'n Ireland) passage tomb: comparison between internal and external panels of rock-art

08 Panels of petroglyphs from Irish passage tombs, and from outdoor rock-surfaces in Scotland, and N'n Britain: general comparison of a selection

Use of motifs for possible terrain-mapping
The possibility that distribution of motifs on certain panels of rock-art depict significant localities has been outlined by Moriarty 2010. Examples of such proposed terrain-mapping from key Irish passage tombs are recast as follows:

09 Bend of the Boyne: W'n sector (Meath, Ireland): Knowth and its locality

10 Bend of the Boyne: E'n sector (Meath, Ireland): Dowth and adjacent monuments

11 Loughcrew-Carnbane (Meath, Ireland): W'n cemetery

12 Loughcrew-Carnbane (Meath, Ireland): E'n cemetery

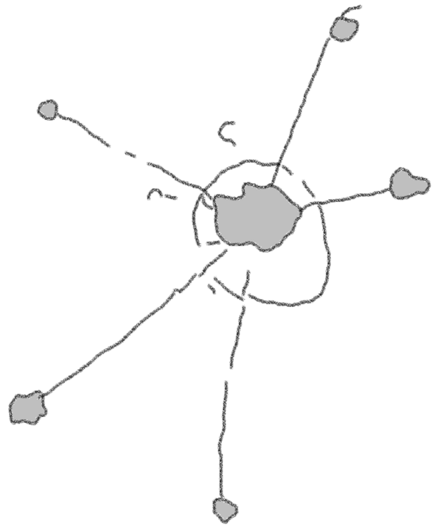
Ethnographic parallels

Section 07

An ethnographic context for stone rows

Section identifier: ET-

SEE INITIAL SECTION:
Access to digital images



Medicine-wheel: Moose Mountain, Alberta, Canada

Summary:
The main conditions for operation of the seasonal-solar model for axial alignment are outlined, as derived from those monuments in NW'n Atlantic Europe that have been considered in this analysis. Using a nominal stone row, stone circle, and their NW'n Atlantic environment as a basis, comparisons are made with those physical conditions in other areas that produced monuments of similar form, these regions differing in ambient environmental conditions, and in the types of society that produced them. This has been done in order to test the model by disproof: if monuments similar to those in the main study area were produced under markedly different conditions, then this would weaken the model.

Application of ethnographic data

-approaches

There are **two basic approaches** to the interpretation of axial alignment:

..that which **emerges from measured data alone**, reinforced by consistencies within, and between the groups analysed, and perhaps supported by other strictly archaeological material, resulting in a 'best guess' for underlying mechanisms;

..that where the analysis is **informed by textual material, or surviving ethnographic traditions**, allowing at least some integration of these sources with the structural analysis.

In the latter case this may involve **direct support**, where documented source, and structural analysis coincide geographically, and temporally, both applying to the same specific cultural example, or it may only be **indirectly informed**, where extraneous traditions open up *possibilities* for interpretation, and give pause for thought, but do not directly relate in time, or space to the case in question.

This particular analysis of monuments, that are entirely prehistoric, from the NW'n Atlantic seaboard, Neolithic to earlier Bronze Age in date, necessarily falls into the indirect category. As a supplement, however, it does attempt to draw on some traditions surviving into early European, and middle Eastern literature, but nothing more specific, and relevant is available. Indeed, the megalithic cultures of climatically marginal NW'n Europe, and the agrarian communities that produced them, have gone extinct: there are no close parallels available, comparable in terms of combined culture, architecture, and economy, for which written sources exist, either primary, or secondary.

This raises the question as to whether individual ethnographic parallels, well separated in time, and space, would add much of value to any analysis, burdened as they would be by qualification. Atttempting to draw external parallels from other, purely prehistoric contexts simply results in repetition of the problem, namely lack of non-archaeological context, if the only source is again structural analysis (for example: see the limited utility of structures at Nabta, below).

Use of weakly related ethnography only results in vague assertions, and general statements of possibility. However, these remain useful in trying to un-think modern precepts, when attempting archaeological interpretation of axial monuments, and their context, and in appreciating more fully the close connection between ancient communities, and their natural surroundings, often richly mythological, and attuned to the dynamics of the cosmos (Ruggles 2005, 2015). In this case, a round-up of relevant structures, and of surviving ethnographic customs would serve little purpose, beyond adding interest in passing: all shades of combination are likely to be found somewhere, at some time.

A far more relevant application of such data would be to apply general ethnography, in an attempt to understand why some communities built such structures, and others apparently did not, although loss of ephemeral monuments, for instance, those of timber, act to bias the archaeological record, distorting the actual evidence.

Axial structures appear sporadically in various societies, from agrarian-pastoral, to hunter-gatherer, with, and without apparent funerary, or other clear associations, and in a range of environments, many of which appear marginal, and therefore vulnerable to unstable conditions.

-testing the model

The model developed here for the megalithic cultures of NW'n Europe, which produced a rash of substantial axial monuments all along the Atlantic seaboard (Burl [1993] lists 1033 for Britain, and Ireland alone), has four main elements, which could indicate the combination of conditions required for development, and proliferation of this *particular* type of structure.

It can be suggested that production of such monuments requires:

..**small-scale communities**
critically dependent on a developed agricultural economy;

..**marginal environments**
that experience lower levels of insolation (e-FIGS ET_env-01), and are open to
the vagaries of changing patterns of weather, generally cooler and wetter;

..**suitable stone** available for construction;

..operation of a **solar cult**;

All of these conditions are met, during the Neolithic to Bronze Age, in coastal NW'n Europe, lodged as it is between ever-changing oceanic, and continental patterns of weather, where vulnerable agriculturalists might well have been routinely involved in active solar propitiation.

If the seasonal-solar model for axial alignment is correct then such developed, and extensively replicated forms of axial structure should not be as evident amongst the ethnographic data in such number, and quality, where any, or all, of the above conditions are not met. This seems broadly to be the case. Although axial stone structures, of the type outlined just below, occur widely beyond Europe, for instance in Africa, India and the Far East, Australasia, and the Americas, they are usually more sporadic, varied in form, and generally less developed in the way that is seen in NW'n Europe.

Any lack of consistency regarding these environmental, and economic parameters would weaken the solar-seasonal model proposed here as a basis for axial alignment in NW'n Europe, thereby providing a means of disproof, hence moving the model towards the status of a theory (Popper 1963).

Global patterns of temperature, rainfall, insolation, and cloud-cover are shown in e-FIGS ET_env-01 to 04, this modern data, the only type available, assumed to give at least a *general* indication of major climatic zones during the period in question. Locations having the same combination of characteristics as the NW'n European coastal zone are hard to find.

These points can be developed by reference to specific examples from a range of contexts, discussed in more detail below, with comparison scored on the basis of intrinsic monumental format, background social, and economic structures, and ontemporary ecosystem.

-case studies for comparison

Those selected are as follows (TABLE ET-01):

TABLE ET-01 Selected case studies

region	sites	type	date	society	e-FIGS ET-
S'n Egypt	Nabta playa	'alignments'	pre 3200 BC	P	ET_nab-01 to 05
India	Bysse	fields of menhirs	?Iron Age	A	ET_ind-01
	Junapani	circles	?Iron Age	A	ET_ind-02
N America	medicine-wheels	radial structures	pre-colonial	HG	ET_med-01 to 13
Australia	NSW_rows	rows	pre-colonial	HG	ET_aus-01
	Wardi Yourung	circle	pre-colonial	HG	ET_aus-02

Key: society: A agricultural; **P** pastoral; **HG** hunter-gatherer.

-basic monumental format

It is first necessary to define the relevant **monumental format for NW'n European types** as a standard for comparison [monumental format: abbreviated: **MF**].

..PLACEMENT

structures were produced mainly by separate placement of individual stones, with stone rows taken as exemplars of axial monuments;

..QUALITY OF STONEWORK

stones are megalithic, and securely ground-set, rather than minilithic, and placed (see Table of Contents: 03d/11);

..LAYOUT: geometric, rather than representational:

...in plan:

multiple stones:

linear: stone rows: acting to

align with some external target, or cue;
delimit, and separate lateral areas, as a porous barrier;
link terminal structures;
direct movement externally along the axis, or internally as an avenues;

disposition can be single and linear, or radial;
circular: stone circles: acting to define some significant area, again, with margins usually porous;
curving: arcs: hybrid functions, drawn from rows and circles;

single stones: minor, and major:
integral: defining the ends of a structure, or other key points;
isolated: marking some external point of significance, perhaps as a view-point, or a marker to target some environmental cue;

...in profile:

presence of stones, that are major, upstanding, and relatively isolated, that are capable of casting significant shadows, hence providing a means of reflecting diurnal, nocturnal, or seasonal celestial motion;

..ADDITIONS

these monuments may **contain integral, or additional** megalithic, and funerary structures, or bear carved motifs.

The stone rows and circles of NW'n Europe fall strongly into this type, exhibiting all, or most features, either as single monuments, or as a complex of several.

The points made above are discussed in further detail below, with selected examples covering hunter-gatherer, pastoral nomadic, and agrarian societies. Such excursions from NW'n Europe seem justified, more to demonstrate structural dissimilarities, and to emphasise the uniqueness of the combination of elements found in that area.

Specific case studies

[BLS]: base-line study for N'W Europe;
[MF]: monumental format, as defined below;

NW'n Europe: later Neolithic to Bronze Age

correspondence with BLS:	this is the base-line study BLS;
supporting evidence:	entirely archaeological;
monumental type:	MF**,** as defined above;
intensity of construction:	high along the Atlantic coastal margin;
stability of climate:	unstable oceanic-continental;
relative level of insolation:	low;
rainfall:	high;
economy:	agrarian, pastoral;
social groups:	more settled communities;
closely astronomical function:	evidence weak, perhaps as secondary features.

Sub-Saharan Africa

case study:	Nabta, Nubia, S'n Egypt; pre-3200 BC;
correspondence with BLS:	very low;
supporting evidence:	entirely archaeological;
monumental type:	more ephemeral than MF;
intensity of construction:	very sporadic;
stability of climate:	unstable;
relative level of insolation:	high;
rainfall:	low, and strongly seasonal;
economy:	pastoral;
social groups:	semi-nomadic, and more settled communities;
closely astronomical function	evidence absent;

-Nabta Playa; 22.508° N, 30.725° E;

..summary: The row-like content, and structural coherence of this site has been much overstated, as has the existence of an observatory, and the astronomical basis proposed for its conjectural axes. Stone structures at the site show no similarity to the BLS in form, solidity, or axial coherence, but appear to be lake-side monuments of unknown purpose placed along the ancient shore line of the playa.

..the site

Nabta Playa is a large, shallow basin ('playa'), susceptible to flooding, located in the S'n desert of Egypt, some 100km W of the Nile (e-FIGS ET_nab-01 and 02). The depression is about 7 by 10km in area, and is fed from the N by a seasonal wadi. Although now largely dry, during the period 9000-6100 BC, summer monsoon rains moved sufficiently N'ward from the tropics to cause flooding, and increased growth of vegetation, sufficient to attract seasonal cattle-herding pastoralists, during the wet season. After 7000 BC, settlements became larger, and construction of wells allowed more permanence, pottery appearing, with sheep, and goats introduced. By 6000 BC, a ceremonial centre was developing along the NW'n shore of the playa (Malville *et al.* 1998, 2008; Brophy and Rosen 2005).

After a major drought, beginning about 5500 BC, existing groups left the area, to be replaced by more organised cattle-herders, who intensified activity at the ceremonial centre, burying sacrificed cattle in chambers under **tumuli**, about 10 of which lie near the wadi, at the N'n side of the playa (e-FIG ET_nab-03). The littoral zone of the playa contains evidence for hearths, and **general activity**, with dates around 4000 BC. **Inhumation-cemeteries,** some 20km from Nabta Playa, probably housed the dead from the extended community that established the ceremonial centre and 'alignments'.

Just to the S of the animal-cemetery lies a small **stone circle**, about 4m in diameter, with opposing entrances, and an internal setting of uprights (e-FIG ET_nab-04).

Moving S'ward along the W'n shore of the playa, a linear series of knolls, formed by differential wind-erosion, bear several dozen **complex megalithic structures**, consisting of ground-set sandstone blocks, sourced locally, each up to several tons in weight, some still remaining upright (e-FIG ET_nab-05), with a preference for facing N'ward, seemingly erected during the later Neolithic, from 4600 BC, until the abandonment of the area, around 3400 BC. The largest of the complex structures (designated as 'A'), lying about 500m to the SSW of the N'n group of these row-like settings, contained buried, slightly worked, superimposed rocks, perhaps again, here, with a N'-S'ly axis. Some 24-30 megaliths, and megalithic scatters have been recorded. The most conspicuous 'lines' are at the N, this **group aligned N'-S'ward**, and at the S a group **aligned E'-W'ward** (e-FIG ET_nab-03).

The site is unusual, but there are a few other comparable structures known in the Saharan area, for instance, a stone circle in the Libian desert (Malville *et al.* 2008), and stone alignments farther to the S, in both East, and West Africa, but these latter are thought to date much later, to the Iron Age.

..astronomical constructs

Based on this scattered structural evidence (e-FIG ET_nab-03), with published mappings disparate, and of poor quality (Malville 1988, fig. 1; 2008; e-FIGS ET_nab-03 and 04), various lines have been imposed, forming these irregular placements of stones into three lines, and linking these with distant features of different type, and uncertain relationship, to produce a system of axes weakly radiating N'ward from a focus, 'like the spokes on a wheel' (Malville 2008, fig. 10).

This pattern has, in turn, been matched with movements of stars in the circumpolar group, recalibrated for the period in question: for the N'-S'ly lines, Arcturus, Sirius, α-Centauri, and Alnilam in the belt of Orion, with winter solstice sunrise also a possible target, via the E-W'ly aligned group. Further such stellar correlations have been made for the stones of the circle.

The repetitive orientation of megaliths, human burial, and those of cattle, toward the N'n regions of the sky has been taken to indicate a very early symbolic connection to the circumpolar, non-setting regions of the sky, and it is presented as the most substantial evidence for astronomical interest.

The radiating spokes of the N'-S'ly stones are in fact irregular, form more of a straggling line than radii, and upon which a system of lines, from a distant 'focus', with azimuths 024, 028, and 126, have been imposed, rather than emerging more realistically from the data. Viewing along the 'lines' from S to N has been assumed, but since the main zone of settlement, animal burials, and ready access to the area is on the N'n side of the playa, the opposite direction would be equally likely, if not more so.

Again astronomical preconceptions have been forced, on flimsy structural evidence, to justify a more sensationalised interpretation, and such lines, once assumed, have taken on a life of their own in the literature, independent of structural reality. It could be argued that the N'-S'ly line of megalithic features simply follows the W'n shore, and that the E'-W'ly line follows the S'n margin of the playa, perhaps no more than passively, facing the water.

Current solar data for the site are as follows:

	WS rise	**set**	**SS rise**	**set**
Nabta Playa	115	245	068	296

Key: WS winter solstice; **SS** summer solstice

'aligments' at Nabta, as taken from satellite imagery (e-FIG ET_nab-03) have azimuths approximately as follows:

..N'n lines: 020, 024, taken towards the N; targets, if any, unknown;
..S'n line: 117 taken towards the E, a near match with winter solstice sunrise, possibly spurious.

Australia

case studies:	megalithic sites in New South Wales; undated, but pre-colonial;
correspondence with BLS:	very low;
supporting evidence:	mainly archaeological, some oral-ethnographic;
monumental type:	more ephemeral than MF;
intensity of construction:	very sporadic;
stability of climate:	relatively stable continental type;
relative level of insolation:	high;
rainfall:	medium;
economy:	hunter-gatherer;
social groups:	mobile;
closely astronomical function:	some structural suggestion, astro-mythological.

-summary:

The rows examined bear little resemblance to the standard monumental format for stone circles [MF], being far less substantial, and less regularly aligned. The tapering circle examined has little clear reference to the W'n horizon, as suggested by its sloping sides, and its apical stone structure. The ethnographic evidence indicates that axially-connected ring-structures at ceremonial 'bora grounds' are more related to mythological mappings of the night-sky than to more closely defined movement of astronomical bodies, risings, or settings.

-general: aboriginal stone monuments in Australia

Simple monuments, and placement of stones have been constructed widely across Australia by many indigenous groups: circles, lines, standing stones, and cairns, often associated with rock-engravings, with many in locations considered sacred. These sites functioned to mark areas for gathering, and ceremony, as territorial boundaries, markers for tracks, or for other practical purposes. Such structures are generally simple (Hamacher *et al.* 2012; e-FIG ET_aus-01), constructed of relatively manageable stones, can vary in size up to hundreds of metres long, and are commonly found on higher ground, with panoramic views. Many structures are thought to correspond with cardinal directions.

The celestial patterns, and movements, in the daytime sky, but especially at night, feature strongly in aboriginal mythologies, and oral traditions indicate that they provided a context for ritual at such sites as ‘bora grounds’, and at stone rings, such as Wurdi Youang in SE’n Australia.

-Wurdi Yourung, Victoria, SE’n Australia; precise position confidential;

Wurdi Youang is a tapering ring, about 50m across the major E’-W’ly axis, constructed from rocks up to 75cm high, some with supporting stones, but none embedded deeply into the ground (Norris *et al.* 2013; e-FIG ET_aus-02). The underlying ground-surface slopes down from W to E, with a fall of about 4m. Three larger stones, about 60cm high occur at the highest point, just outside the W’n apex of the ring, and it has been suggested that they might mark solstital, and equinoctial sunsets, when viewed from the perimeter of the circle. The sides of the ring also correspond with winter-, and with summer solstice set. The site appears to be entirely aboriginal in origin, and pre-colonial in date, but no oral traditions have survived, or are presently forthcoming, about the site.

-’Bora grounds’ in SW’n Australia

Bora grounds are aboriginal Australian initiation sites, consisting of two, or occasionally three rings, defined by a stone, or earthen perimeter, their centres cleared, and stamped flat, adjacent sites linked by a pathway (Fuller *et al.* 2013). The larger circles are about 20-30m across, and were for more public access, the smaller circles, about 10-15m across, intended for a select band of initiates, and elders. The connecting track can be up to several hundred metres in length, and the direction taken along it tends to be S’ly, from the larger circle, to the smaller. Various stone placements, panels of rock-art, and occasionally long earthen mounds, can be associated with the bora grounds, and there are cases where a dolmen-like structure occurs within the smaller ring.

Initiates were introduced to the traditions of the community, and usually underwent some type of bodily modification. Oral tradition indicates that the smaller, more culturally-sensitive circle could be demolished immeditely after the ceremony, leaving only a single ring.

These sites, which show only minor variation in form, are distributed in near-coastal New South Wales, and S’n Queensland, with outliers in Victoria, N’n Queensland, and possibly S’n Australia (Fuller *et al.* 1977, fig. 1; e-FIG ET_aus-02).

Structural analysis, supported by oral tradition, indicates that the preferred alignment of the path from larger to smaller circle ran S’-SW’ward, towards a particular part of the night sky. The bora ceremony (e-FIG ET_aus-03) was an important component of indigenous culture, predominantly during August, specifically related to the pattern of stars, and darker spaces of the Milky Way. Here, the star Altair, represented a paternal creator-spirit, often called ‘Baiame’, and acted as an indicator for the ritual. Patterns of stars forming the Emu (Fuller *et al.* 1977, fig. 1), and the Rainbow Serpent, were important in local tribal mythologies, and represented a ‘sky bora’ (Fuller *et al.* 1977, fig. 3), to be emulated on earth. Correct celestial positioning of these features enabled initiation to take place.

Medicine-wheels from the American North-West

case studies:	four important examples are outlined; usage: pre-colonial;
correspondence with BLS:	low;
supporting evidence:	archaeological, and some ethnographic record;
monumental type:	more ephemeral than MF;
intensity of construction:	scattered, with a local concentration in S’n Alberta;
stability of climate:	relatively stable continental type;
relative level of insolation:	medium;
rainfall:	medium;
economy:	hunter-gatherer;
social groups:	mobile;
closely astronomical function:	poor structural evidence, astro-mythological.

-summary:

These wheel-like structures, with a circular perimeter, central cairn, and radiating spokes of placed stone, offer partial, superficial comparison with stone rows of multiply radiating type from the BLS (see Table of Contents: 03d/9). However, closer analysis indicates use of smaller, non-megalithic, placed stones, central cairns that appear inaccessible, and without funerary content, and spokes, relatively few of which are sufficiently regular, diametric, or extend sufficiently beyond the circle to form possible lines of sight.

What background ethnographic detail does suggest, however, is that these ritual sites, often located in elevated, seemingly isolated locations, were involved in enactment of tribal ceremonial, and propitiation, rather than having a pronounced function in astronomical targeting. Reference to the cosmos by participants might have been by personal enactment, and not formalised by structurally-established lines, but with certain monumental axes perhaps set passively towards cues (see Table of Contents: 02a/2g).

These monuments, and the traditions that surround them, are important to the archaeological analysis of alignment in the BLS because they stress the prime importance of natural cycles in their ritual operation, with the sun deemed important in both cases.

-general:

Native American Medicine-wheels, are divided into eight sub-types (e-FIG ET_med-02), the more complex of which consist of a central cairn, from which 'spokes' radiate out to one or more concentric circles, all constructed from placed stone of modest size. Only sub-type 2 has a formal entrance, allowing access to the centre, this also accessible in types 3, and 5, which have no perimeter circle, the other five types being more fully enclosed within a ring. Such containment of the centre may suggest that ritual was directed inward from the perimeter, rather than outward to the surrounding land-, and sky-scape.

The number of spokes varies, with 28 often reported as present, angular spacing, regularity, and radial opposition all can differ, as can length, with some spokes extending from the centre only as far as the circle, others going beyond, and still others only running outward from the outer ring. A passage-track may lead radially to the central structure. Outer circles, or cairns, may be attached to extended spokes, or occur separately around the main site. Other simple, open enclosure-type rings also occur, some over 12m in diameter, possibly used for ceremonial dance.

Alignment of certain spokes in cardinal directions is stated as common, with certain sites considered potentially complex astronomically, and thought to have been sighted on sun, moon, stars, and planets, with calendric uses, and even, by some, capable of tracking such cycles such as precession of the equinoxes, the solar, and the 19-year lunar cycles, planetary motion, acting to observe changes over millennia. Many such monuments are located at altitude, on hills, or more substantial mountains, with panoramic views, and appear to be in reserved locations (e-FIG ET_med-11).

These monuments were constructed mainly by the Plains Indians, and were associated with their religious ceremonies (Eddy 1977, 1979). These nomadic tribes, constantly following herds of buffalo, and deer, once occupied all of central North America, from Saskatchewan to Texas, and included the Sioux (Lakota, Dakota, Nakota), Cheyenne, Crow, Blackfoot, Arapaho, Cree, Shoshoni, Comanche, and Pawnee.

There is a possible link between medicine-wheels and the sun-dance (Melody 1976; film: Low 1960), the major communal ceremony held amongst the peoples of the Great Plain. This was held in late spring, or early summer, celebrated renewal of the natural world, included dance, prayer, and often rituals of endurance, requesting power, or insight from the supernatural. The circular shape, and radial layout of the wheel is similar to that of the lodge used to house the inner rituals of the sun-dance, the central pole providing a solar connection (e-FIG ET_med-12). It is not known whether a central pole was erected at wheel-monuments, and none are extant. Parallels have been drawn between the number of spokes in a medicine-wheel, often 28, and the same number of rafters in the Lakota sun-dance lodge, also the number of days in a lunar month.

Such wheels occur throughout the N'n United States, and S'n Canada, in South Dakota, Montana, Alberta, Saskatchewan, and especially Wyoming, where some 70 have been recorded (e-FIG ET_med-01). Use of such wheels persisted until European colonisation, and ancient examples are known, as for example at Majorville (Alberta, Canada), dated to 3200 BC, and with a considerable period of use evident.

-astronomical aspects:

Given many radial, but fewer clearly diametric spokes, sight-lines can be constructed across the wheel towards most parts of the horizon, and can be chosen conveniently to coincide with solstice, and equinoctial risings, and settings (e-FIG ET_med-03). Longer spokes, with terminal cairns, as at Moose Mountain, provide some fair degree of coincidence with such positions, as do those cairns of the periphery at Big Horn, but how far this is general would depend on examination of a far larger sample of sites.

Far more fanciful lines have been drawn between selected components of wheels, to coincide with certain stars, which bear little credence (e-FIG ET_med-03).

Given the emphasis of the sun-dance ceremony, it is far more likely that such wheels were principally concerned with propitiation, and invocation of powers from beyond the natural world, and with celebration of cycles, of the seasons, of life, and of the dynamic cosmos, symbolised in stone as the wheel, and in timber as the dance-lodge, and in the mind of the participant as the cycle of life (e-FIG ET_med-13). Some level of integration, perhaps not reflected structurally, with certain celestial bodies is therefore likely, but this might have a closer relation to complex, and arcane cosmic mythology, than more apparent visual astronomy.

-specific sites:

..Big Horn; Wyoming; USA; 44.8262° N, 107.9216° W; Crow, Arapaho tribal areas; e-FIGS ET_med-04 to 06;

The wheel here provides a prime example of sub-type 6 (e-FIG ET_med-02), is 24m in diameter, with 28 radial spokes reported, and includes seven cairns, one 3m in diameter at the centre, with six smaller cairns at, or near, the rim of the circle (e-FIGS ET_med-04 and 04). There is no distinct line of access to the centre apparent. No satisfactory radiocarbon dates exist for the site, but several dates for active use, from the 12th to 19th centuries AD, have been conjectured, entirely on the basis of assumed correspondence between radials, and dated astronomical events (Eddy 1974).

This wheel is located on a steep ridge (e-FIG ET_med-11), within the tribal area of the Crow, and there are oral traditions relating to its use by the Arapaho, but no claims have been made as to its original construction.

Lines from the centre to peripheral cairns coincide weakly with solstitial positions, more closely for the S'n-most pair (e-FIG ET_med-03):

Solstice positions for the site are as follows:

	WS rise	**set**	**SS rise**	**set**
Big Horn	123	237	055	305

Key: WS winter solstice; **SS** summer solstice

Pairings between the NW'n cairn and four others have been matched with stellar risings (e-FIG ET_med-03).

..Majorville; Alberta; Canada; 50.5850° N, 112.4105° W; Blackfoot tribal area; e-FIG ET_med-07;

This wheel is located on top of a hill, overlooking a deeply cut valley and large expanse of prairie (e-FIG ET_med-11), has a central cairn, 9m in diameter, set within a circle 27m in diameter, this connected to the centre by 28 radially disposed spokes, with a series of small cairns placed just beyond the circle. There is no formal line of access to the centre. Like the example at Bighorn, this site belongs to subgroup 6 (e-FIG ET_med-02), the least common type, comprising about 4% of the entire sample.

Excavation indicated a multi-phased monument, in use since about 2500 BC, with evidence of offerings, past, and present, including placement of special stones to ensure return of the migrating buffalo, which feature in Blackfoot tradition.

It has been claimed that the site was used to to observe sunrise on the winter, and summer solstices, also around the equinox, as marked by outlying lines of rock, and cairns. There is little correspondence between placement of peripheral cairns and solstice positions:

solstice positions for the site are as follows:

	WS rise	set	SS rise	set
Majorville	128	232	050	310

Key: WS winter solstice; **SS** summer solstice

..Moose Mountain; Saskatchewan; Canada: 49.7842° N, 102.4350° W; e-FIG ET_med-08;

This wheel, of sub-type 4 (e-FIG ET_med-02), is of different form to the two examples outlined above, having a smaller, ovate circle, almost filled by its central cairn, and with only five spokes, these radiating out from the cairn to well beyond the circle, themselves each ending in a small cairn. There is no distinct radial track making the centre, this still readily accessible as a viewing point.

There is little correspondence between the extended spokes and solstice positions, except perhaps the pair on the W'n side:

solstice positions for the site are as follows:

	WS rise	set	SS rise	set
Moose Mt	127	233	051	309

Key: WS winter solstice; **SS** summer solstice

..Miner's Mountain ceremonial complex; Alberta; Canada; 50.9475° N, 110.4407° W; e-FIG ET_med-09;

The complex is located along a low ridge at the edge of a bluff, within a tight horse-shoe shaped bend of the deeply cut Red Deer River (e-FIG ET_med-11). Two medicine-wheels, about 120m apart, are connected by a defined footpath, running NNE'-SSW'ward, and are surrounded by other ceremonial stone features, including rings, some D-shaped, or conjoined, and cairns.

..Wheel 1, the larger, and more elaborate of the two, is 15m in diameter, contains a central cairn, 5m across, and two small cairns, with two gaps in its circuit, one each at the E, and SE, this latter with a short passage extending from it, allowing access to the centre, its side-rows ending in small cairns. A series of spokes, up to 9m long radiate out from it, shorter on the W'n side, longer on the NE'n, ending in large stones, or small cairns.

..Wheel 2 is 15.5m in diameter, has a central cairn 5.5m across, but contains no radial spokes.

..Bull's Forehead medicine-wheel; Forks area, Red Deer River; Saskatchewan; Canada; e-FIG ET_med-10;

This wheel, with a central cairn, and a smaller cairn in its enclosing circle, is part of a complex of stone structures lying along a series of sharp ridges, overlooking the river.

India

case studies:	Bysse, Nilaskal, Junapani;
correspondence with BLS:	very low;
supporting evidence:	entirely archaeological;
monumental type:	field of spaced megaliths;
intensity of construction:	medium;
stability of climate:	moderate;

relative level of insolation:	high;
rainfall:	moderate;
economy:	agricultural;
social groups:	settled;
closely astronomical function:	no evidence.

-summary:

The field of megaliths at Bysse, is entirely different from the well structured rows seen in the BLS, and shows no axial lines, hence any astronomical associations, as have been suggested, seem unsupported by evidence. However, the circles at Junapani show clear similarities with those from the BLS, in their general layout, and in consistent positioning of cup-marked stones.

-general

Megaliths dating from before 3000 BC to about 900 AD are found in most parts of India, but especially the S, the oldest monuments being stone circles in the Afghani upper Indus valley, with sites in central India dated 1000-500 BC, with those in the S later, until about 900 BC. Apart from clearly sepulchral monuments, monoliths, avenues, and roughly gridded fields of menhirs are the main types.

Many individual megaliths are associated with burial, or were erected as memorials, but there are also larger fields of megaliths, more clearly non-sepulchral, now considered by some to contain lines of sight, cardinal organisation, and providing evidence for additional astronomical targeting (see the examples at Bysse, and Nilaskal below).

-specific sites:

..Bysse, SW'n India; 13.8292° N, 75.7167°E; e-FIG ET_ind-01;

Megaliths in S'n India are thought to have been first erected during the Neolithic (3000-1200 BC), but to be of mainly Iron Age date (500 BC-500 AD), with use continuing into the Early Historic Period (500 BC-500 AD) (Menon *et al.* 2012). Such megaliths are commonly arranged in a gridded pattern, with alignments thought to conform with cardinal directions.

A field of large megaliths at Bysse, in SE'n, near-coastal India, possibly dating from the Iron Age by association with adjacent cist-burials, are not arranged in discrete rows, but are spaced, with the vague suggestion of a latticed layout noted. Lines of sight have been inferred between stones, either between their centres, or along edges, and the conclusion drawn that these mark solstice positions, or setting points for certain stars, with shadows of several stones falling on others during days of particular significance (Vahia *et al.* 2011, fig. 9).

Two preferred axes are proposed: 142-318° (16 lines), and 172-348° (14 lines). Although the site has not been directly dated, given a nominal date of 1000 BC, important stars setting in these respective directions are Regulus, and Pollux, and then Arcturus, Vega, Deneb, and Capella.

It is concluded that the 'alignments' seem intentional, and were made for astronomical purposes, at least for the solstices, to which multiple references at the horizon are made.

Details of the solar transit at the site are as follows:

	WS rise	set	SS rise	set
Bysse	114	246	066	294

Key: WS winter solstice; **SS** summer solstice

The entire argument for astronomical targeting at this site seems extremely weak, to say the least, since it is based on alignments that are not sufficiently well supported by the stones themselves, with associations often forced between supposed pairings, spaced at some interval. Considering the pattern of megaliths without superimposed lines, there seem to be no convincing trend-lines present (e-FIG ET_ind-01).

..Nilaskal; SW'n India; 13.7737° N, 75.0208° E; some 7km S of Bysse;

The site contains over 100 stones, with long axes oriented N'-S'ward (Menon and Vahia 2011, fig. 5-7). It is suggested that many pairs were aligned towards solstitial rising, and setting points on the local horizon.

..Junapani, central N'n India; 21.1970° N, 78.9987° E; e-FIG ET_ind-02;

The locality contains a cluster of stone circles, of type common locally, of which some 150 are known, these often bearing cup-marks, lying close to river-beds, of Iron Age date (1000 BC-300 AD), and with probable tribal-territorial distribution (Vahia *et al.* 2011, fig. 2).

Cup-marks on the stones of circles tend to occur in three preferred locations on the perimeter (Vahia *et al.* 2011, fig. 6, 7): at azimuths around 118° (often cups in a gridded pattern; possibly towards winter solstice sunrise), 208° (cups in lines tangential to the circuit; possibly towards Canopus; perhaps monsoon-associated), and 334° (cups in radial lines; possibly towards Deneb, Capella, or Vega).

At Junapani (Vahia *et al.* 2011, fig. 3, 5) the circle is about 14m in diameter and has well-crafted cup-marked stones at the N, and SE of the perimeter.

e-FIGURES: combined listings and supporting information

environmental context
ET_env

01 Global distribution of temperature, rainfall, cloud-cover, and insolation
Environmental conditions for selected study areas are shown.

02 Levels of insolation in Europe

03 Levels of insolation in Africa, and the Middle East

04 Levels of insolation in North America

Nabta Playa
ET_nab

01 General location

02 General map of the playa

03 Detailed map of the site, showing stone rows, and the circle

04 Plan of the stone circle

05 Individual settings of megaliths: photographs

Australia
ET_aus

01 Distribution of bora grounds in SE'n Australia

02 Plans of stone rows from New South Wales

03 Stone circle at Wardi Yourung, Victoria

04 bora ceremony: photograph

India
ET_ind

01 Bysse: SW'n India: field of megaliths

02 Junapani; central-N'n India; stone circle

Medicine-wheels
ET_med

01 Distribution

02 Classification

03 Examples

04 Big Horn; Wyoming: aerial view

05 Big Horn; Wyoming: aerial oblique: early view

06 Big Horn; Wyoming: aerial oblique: recent view

07 Majorville; Alberta: aerial view

08 Moose Mountain; Saskatchewan: aerial view

09 Miner's mountain; Alberta: plan

10 Bull's Forehead; Saskatchewan: aerial oblique view

11 Location of selected wheels: the terrain

12 Ethnographic photographs: the sun-dance lodge

13 Art: 'Journey Wheel' by Howard Terpning
[for added atmosphere]

Other sections

Section 08
Conclusions

Section identifier: CO-
SEE INITIAL SECTION: Access to digital images

The general trends for axial alignment amongst the various groups of monument considered in this analysis are summarised in e-FIG CO-01, and the seasonal-solar model is outlined in e-FIG CO-02.

Given the variability evident amongst individual axial alignments, interpretation has been kept general, and based on **central tendencies** seen within grouped data, with the proviso that any model for underlying orientational behaviour must not only explain such peaks, but also the range of values beyond them.

Cues for alignment are likely to have been complex, with various terrestrial, and celestial factors interacting to provide direction. In view of the consistency in general axial orientation seen amongst widely distributed monuments, such as long barrows, the celestial option is favoured major, since universal.

The sun is considered to be the **principal target** for alignment amongst the monuments included in this analysis, not only at its setting, or rising, but more especially during its transit at higher elevation. Arguments for underlying and widespread *solar* cueing of monumental axes include the prominence of the sun, its seasonal, and economic importance, and the regularity of its annual cycle. Lunar targets are considered to have been minor, since the moon is highly variable in its shorter term behaviour, its periodicity between limiting positions is over-long and, compared with the sun it is of reduced economic relevance. Other targets, such as planetary, and stellar cues are discussed, mainly to discount them as prime practical alternatives.

Rather than as any expression of more abstract astronomical, or calendric principles, the basis for axial alignment of monuments seems far better explained in terms of **general rituals** surrounding agrarian economy, and funerary belief.

Two major axial trends are apparent: the W'ly amongst funerary monuments, such as long barrows, and chambered tombs of the Neolithic, and the S'ly amongst cursus monuments, stone rows, and henges, where funerary content is far less evident, and the emphasis might have been more economic, and agrarian. The West has a frequent connection with death, and the underworld of the ancestors; the sun-ward South with the economically critical seasonal cycle of the sun, moving from midwinter minimum, to midsummer maximum. Each of these general directions would have provided ritually appropriate cues for alignment of structural axes, with the solar transit providing the vehicle for direction of propitiation.

Given a link between structural alignment and economic propitiation, it might be expected that adverse **environmental pressures** from climate on arable productivity would find expression in terms of increased ritual activity, reflected in repetitive construction, and **elaboration of monuments**, as is evident amongst stone rows. There is certainly evidence for such deterioration in the NW'n Atlantic area during the later 3rd, and earlier 2nd millennia BC, the period in question, with climatic change the main agent, possibly supplemented by sporadic episodes of background volcanism.

Given the spread of alignments seen amongst the various types of monument considered here, the data are better explained as if a **broader area of the solar transit** acted as target, rather than any more localised points within it. The prevailing over-emphasis on interpretation of axial alignment in terms of highly localised events at the horizon, risings and settings, is therefore expanded to include potential use of celestial targets that are spread, moving, and at elevation.

Groups of monument can be **divided on the basis of their general axial properties** into three main types: those with peaks of frequency coincidental with the transitional, permanent, and null zones of the transit, with any clustering at the margins of the transitional zone designated peri-solstitial. W'ly, and S'ly directions within axes are deemed of particular significace, the former especially so for more directly funerary monuments, such as chambered tombs, the latter for other sites, with less of this emphasis, such as stone rows.

Transitional zone: In the case of long barrows it might have been sufficient for their axes to have referred to the setting limb of the transit, using its decline to reflect funerary function, and to establish a recurrent link with those areas below the W'n horizon that were considered to be significant in terms of the ancestors. Here, the observed clustering of axes at the peri-equinoctial W might reflect interaction between the standard needs of axial alignment and the competing constraints of seasonal, and work-related, agrarian factors.

Permanent zone: A further important relationship is possible, between other types of monument and the S'n zone of the solar transit, where the sun is always above the horizon. The S'n arc of the sky is certainly active in terms of celestial events, especially so for the solar transit, which withdraws from midsummer maximum, reducing through the transitional zone, to the minimal permanent zone at midwinter, leaving a correspondingly increasing N'ly zone of inactivity. As well as the solstices, the sun, at its zenith in the permanent zone, provides two other limiting positions, rarely considered: maximum, and minimum elevation, at midsummer, and midwinter respectively, providing a ready index of seasonal change, to be visualised directly, or indirectly via shadow-casting, and hence providing a possible target for propitiation in order to ensure continuation of the cycle.

Null zone: Axes in this direction are less easy to explain in terms of the solar model, unless by making some reference to the unseen transit, as extrapolated below the horizon, thereby appealing to the deepest areas of the underworld, perhaps connecting more directly to the spirit-world of the ancestors.

Peri-solstitial margins: Monumental axes lying close to the S'n solstices, those of winter sunrise, and –set, would have been able to maintain contact with the solar transit throughout the year, if located at the margin of the permanent zone, and for most of it, if just within the transitional zone. Such tuned alignment would maximise general axial contact, and would also include a limiting position, for possible incorporation into ritual, making very efficient combined use of the transit. On the other hand, strict alignment on positions of summer solstice rising, or setting would allow only the briefest contact, leaving the axis out of contact with the transit for most of the year.

Discussion of ethnographic parallels for construction of rows is also interesting, in determining the environmental, and cultural conditions under which such monuments tend to appear.

e-FIGURES: combined listings and supporting information

01 Axial alignment: general properties for those monuments analysed

02 The seasonal-solar model for axial alignment
The terrestrial plane, and a nominal solar transit are shown, this latter divided into its visible diurnal sector, and its 'subterranean' nocturnal passage. The terrestrial horizon is divided into sectors, as delimited by the solstices, according to the frequency that the solar transit passes within it: daily in the permanent zone, never in the null zone, and for a variable number of days, depending on the direction chosen, within the transitional zone.

The main trends of axial alignment for the major groups discussed in the analysis are marked, and an interpretation of possible intention added: a S'ly sun-ward emphasis, as for stone rows, suggesting economic concerns, and a W'ly direction, as for funerary monuments, establishing a link with the ancestors.

Section 9

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3: Wales: National Monument Record, Cardiff: Coflein: coflein.gov.uk;
4: N'n Ireland: ehsni.gov.uk/nismrsearch;
5: Eire: archaeology.ie/smrmapviewer;

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Section 10

Captions for photographs

Section identifier: phot-
SEE INITIAL SECTION: Access to digital images

e-FIGS
phot-

AB Augmented long barrows

01 Came Hill extended long barrow; Dorset; SY 7085;
Aerial view to the SW, showing the long barrow from the rear, and associated round barrows located along its flank, with their line extending beyond its foreground.

LB Long barrows and other chambered tombs

01 Carrowkeel passage tomb cemetery; Eire, Sligo; G 7411;
Aerial view of the Doonaveragh Mountain towards the S, showing Carrowkeel tomb O at the summit of the ridge, and an area of prehistoric hut circles in the foreground, at its base.

02 Carrowkeel passage tomb cemetery; Eire, Sligo; G 7411;
View towards the NW, over tomb H in the foreground, with tomb G just beyond.

03 Slieve Gullion passage tomb; N'n Ireland, Armagh; J 0220;
The view along the passage from the chamber, showing illumination from the setting sun at winter solstice.

CU Cursus

01 Dorset Cursus; Dorset SU 0115;
Aerial view towards the NW, over the NE'n end of the cursus and its associated monuments. The extended long barrow Pentridge 3 lies in the foreground, showing lateral ditching. Long barrow Pentridge 4 lies in the central background. Destruction of the once extant terminal by ploughing, and its lateral encroachment around the long barrow, should be noted as distinct failures of conservation.

02 Dorset Cursus; Dorset SU 0115;
View from Gussage Hill ST 9913, over Wyke Down SU 0015, and Bottlebush Down SU 0215, along the cursus towards its NW'n terminal, with its curving line superimposed. Penbury Knoll occupies the horizon at top right.

03 Drayton cursus; Oxon; SU 4894;
Aerial view towards the SW, over the central sector of the S'n half of the cursus, showing the linear spread of round barrows over its line.

04 Scorton cursus; N Yorks; NZ 2300;
Views of the cursus, before onset of extensive gravel-quarrying:
left: aerial view towards the NW, from the SE'n terminal, with its cluster of later round barrows;
right: aerial view towards the NW, over the midline of the cursus, in the area NZ 244 000.

05 Stonehenge greater cursus; Wilts; SU 1243;
Aerial view towards the E, along the entire cursus, from its W'n terminus, including, at centre, the linear round barrow cemetery flanking its S'n side.

06 Stonehenge lesser cursus; Wilts; SU 1043;
Aerial view towards the SE, over the entire cursus, including the cluster of round barrows at its W'n end.

07 Thornborough central cursus; N Yorks; SE 2878;
Aerial view towards the NW, over the W'n terminal of the cursus that runs under the central henge at Thornborough.

HE Henges

01 Avebury complex/ The Sanctuary; Wilts; SU 1069;
Aerial view towards the SE, over the circle-complex at The Sanctuary (SU 1184 6804), located at the SE'n terminus of the West Kennet avenue, showing their point of junction in the lower right foreground.

02 Avebury complex/ West Kennet avenue; Wilts; SU 1069;
View towards the NW, along the main surviving sector of the West Kennet avenue, around SU 107 693.

03 Avebury complex/ Silbury Hill; Wilts; SU 1069;
Aerial view over the monument, towards the SW .

04 Avebury complex/ Silbury Hill; Wilts; SU 1069;
View over the monument, towards the SW .

05 Cana henge; N Yorks; SE 3671;
Aerial views over the henge: **at left,** to the NE; **at right,** to the SE.

06 Coneybury henge; Wilts; SU 1341;
Aerial view, towards the NW.

07 Devil's Arrows stone alignment; N Yorks; SU 3966;
Views of component monoliths.

08 Ferrybridge henge; N Yorks; SE 4724;
Near-vertical aerial view over the henge, before marginal development of the highway. Grid N is at the top of the image.

09 Hutton Moor henge; N Yorks; SE 3573;
Aerial views of the henge:
at upper left: view towards the SW; **at upper right**: vertically, with Grid-N at the top of the image.

10 Knowton henges; Dorset; SU 0210;
Aerial view over the group, towards the NNE.

11 Knowlton church henge; Dorset; SU 0210;
View towards the S, over the ditch of the henge, and the medieval church at its centre.

12 Marden large henge enclosure; Wilts; SU 0958;
Aerial view, towards the NW.

13 Nunwick henge; N Yorks; SE 3229;
top left: towards the SE; **top right:** towards the SE; **bottom left:** lidar scan: ~E is at the top of the image.

14 Stonehenge; Wilts; SU 1242;
Aerial view over the henge, and curving line of the Avenue, towards the N.

15 Stonehenge; Wilts; SU 1242;
Aerial view over the henge, with the final approach of the Avenue in the foreground, towards the SW

16 Stonehenge avenue; Wilts; SU1242;
Aerial view down the final sector of the Avenue, and over the henge, towards the SW.

17 Stonehenge; Wilts; SU1242;
Aerial view over the henge, and final sector of the Avenue, towards the SW.

18 Stonehenge; Wilts; SU1242;
Aerial view over the central part of the henge, towards the SSE.

19 Stonehenge; Wilts; SU1242;
Higher-level view over the henge, from the Heel Stone, towards the SW.

20 Stonehenge; Wilts; SU1242;
Higher-level view over the henge, towards the NNW.

21 Thornborough henges; N Yorks; SE 2879;
upper left: near-vertical aerial view of the three henges: Grid N lies at the top of the image; **upper right:** aerial view of the central henge, towards the NE; **lower right:** aerial view of the S'n henge, towards the NW.

SR Stone rows

01 Stone row: Dartmoor: Down Tor SX 5885 6933;
View towards the NE, along the axis of the row, this oriented 070-250°G.

02 Stone row: Dartmoor: Down Tor SX 5885 6933;
View towards the SW, along the axis of the row, this oriented 070-250°G.

RB Round barrow cemeteries

-Dorset

01 South Dorset ridgeway; Dorset; SY 6785;
View towards the SE, from Black Down SY 613 875, over the Bronkham Hill sector of the ridgeway.

02 Southe Dorset ridgeway; Dorset; SY 6785;
Aerial view towards the S, over the Bincombe Down sector of the ridge, with its linear spread of round barrows.

03 Bronkham Hill barrow cemetery; Dorset; SY 6187;
View towards the NW, along the ridgeway, over part of 'row 4' on Bronkham Hill SY 623 872.

04 Poor Lot round barrow cemetery; Dorset; ST 5890;
Aerial view towards the SW, over the main area of the necropolis.

05 Clandon W'n large round barrow; Dorset; SY 6589;
Aerial view towards the W, over the large round barrow at upper centre.

-Salisbury Plain

06 Lake Down round barrow cemetery; Wilts; SU 1139;
Aerial views over the round barrow cemetery: **at left** to the W; **at right** to the NE;

07 Normanton Down round barrow cemetery; Wilts; SU 1141;
Aerial view, towards the SW.

08 Snail Down round barrow cemetery; Wilts; SU 2152;
Aerial view towards the N, over the cemetery, before the site was damaged by military traffic.

09 Winterbourne Crossroads round barrow cemetery; Wilts; SU 1041;
Aerial view towards the S, over the linear cemetery.

-Upper Thames

10 Lambourne round barrow cemetery; Berks; SU 3282;
Aerial view towards the NW, over the cemetery.

11 N Stoke round barrow cemetery; Oxon; SU 6085;
Aerial view towards the NE, over the round barrow cemetery, and the extended long barrow.

-Mendip

12 Priddy Nine Barrows round barrow cemetery; Mendip, Somerset; ST 5351;
Lateral view of the linear cemetery, towards the NE.

SA Stenness: study area

01 Stenness isthmus; Orkney; HY 2913;
Aerial views over the isthmus, towards the NW.

02 Maes Howe chambered tomb; Orkney; HY 3112;
Aerial view of the passage tomb, towards the NW.

03 Ring of Brodgar circle henge; Orkney; HY 2913;
Aerial view of the monument, towards the NE.

SA Sligo: study area

01 Carrowmore passage tomb cemetery; Eire, Sligo; G 8833;
Views of marginally placed passage-type tombs 1, 3, 4, 7, 13, and 57.

02 Carrowmore passage tomb cemetery; Eire, Sligo; G 8833;
Views of the centrally placed passage-type tomb 51:
left: vertical, as excavated, showing the central dolmen; N is at the top of the image;
right: view from the central dolmen, towards Knocknarea Mountain at the NW.

03 Knocknarea Mountain; Eire, Sligo; G 6234;
Views towards, and from the mountain, and of Maeve's Cairn at its summit.

SA Brittany: Petit Menec to Menec stone row complex

01 Le Menec; stone rows;

02 Kermario; stone rows;

03 Kerlescan; stone rows;
Viewing W'ward over the W'n half.

SY Symbols

01 Gold sun-disks of Bronze Age date;
at left: Banc Tynddol (Wales); **at right**: County Monaghan (Eire).

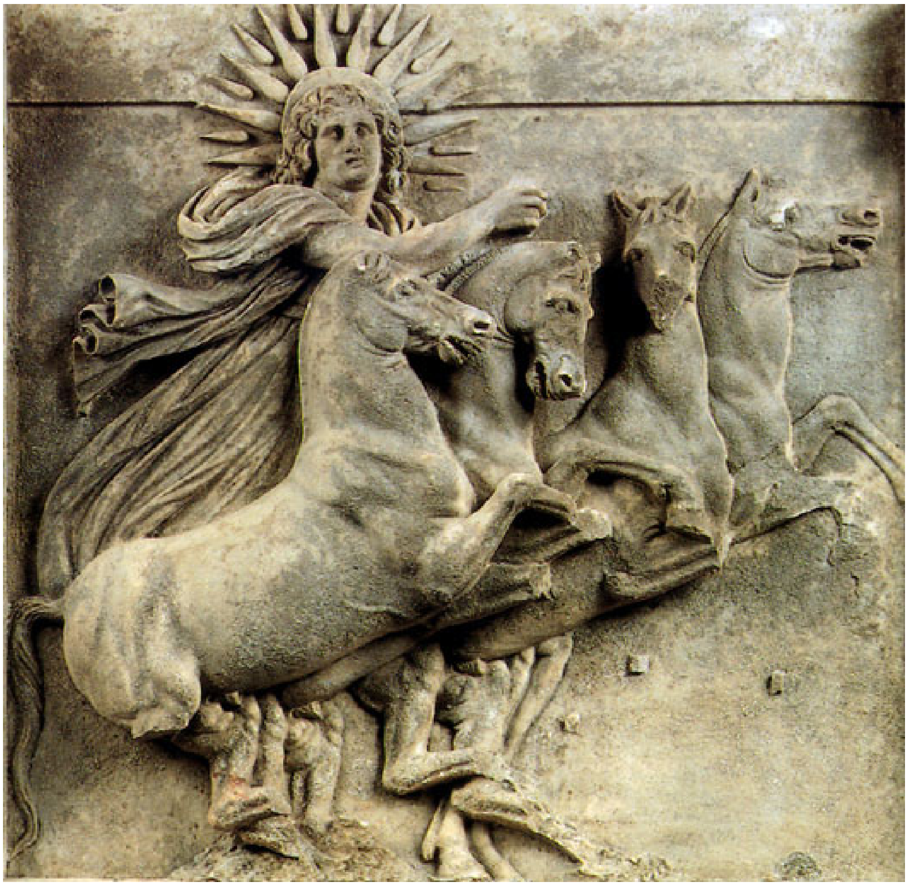
02 Nebra solar disc; Mittelberg hill, Saxony-Anhalt, Germany;
Obverse view of the disc, showing sun, moon, stars, and a curved motif of uncertain interpretation.

03 Trundholm sun chariot; West Zealand; Denmark;
Lateral views of the chariot, showing a solar disc, and horse, carried on a wheeled vehicle.

Section 11

The chariot of the sun

Images of solar motion, and celestial transport, taken from Vergil's Aeneid and Georgics, also the Carmen Saeculare of Horace, all written in the later 1st century BC, are included here to supplement the general theme of this study, and add a note of colour to the section on Celtic chariot-burials. Such literary references reflect mythology widespread and long-established throughout later prehistoric Europe.



Helios borne by horses
Ilium; Hellenistic Temple of Athena;
metope from the NW'n pediment; ~300 BC

Publius Vergilius Maro 70-19 BC

Postera vix summos spargebat lumine montes
Orta dies, cum primum alto se gurgite tollunt
Solis equi, lucemque elatis naribus efflant;
Aeneidos XII_113-115
Scarcely did the morrow shed on the mountain-tops
the beams of risen day, as the horses of the sun begin to rise
from the deep flood, and breathe light from their lifted nostrils;

Interea magnum sol circumvolvitur annum,
et glacialis hiemps Aquilonibus asperat undas.
Aeneidos III_284-285
Meanwhile, the sun rounds the great circle of the year,
and icy winter ruffles the waters with northern gales.

Expectata dies aderat, nonamque serena
Auroram Phaethontis equi iam luce vehebant;
Aeneidos V_105-106
The desired day came, and now Phaethon's coursers
bore up the ninth Dawn, clear and bright;

Et Nox atra polum bigis subvecta tenebat.
Aeneidos V_721
And now black Night arose, chariot-borne, and held the sky.
Iamque vale: torquet medios Nox humida cursus,
Et me saevus equis Oriens adflavit anhelis.
Aeneidos V_738-739
And now farewell; dank Night wheels her mid course,
and even now I feel the stern breath of the panting horses
of the East.
Hac vice sermonum roseis Aurora quadrigis
Iam medium aetherio cursu traiecerat axem;
Aeneidos VI_535-536
In this change of talk, Dawn, in her rose-coloured chariot,
had already crossed the mid axle of heaven on her celestial
course;

Iamque rubescebat radiis mare, et aethere ab alto
Aurora in roseis fulgebat lutea bigis:
Aeneidos VII_25-26
And now the sea, became red with shafts of light, and high in
heaven
yellow Dawn shone in her rosy chariot;

Iamque dies caelo concesserat, almaque curru
Noctivago Phoebe, medium pulsabat Olympeum;
Aeneidos X_215-216
And now day had faded from the sky, and gracious Phoebe
trod mid heaven in her night-wandering chariot;

Cum primum crastina
Puniceis invecta rotis Aurora rubescit...
Aeneidos XII_76-77
As soon as tomorrow's Dawn rises in the sky
blushing on her crimson wheels...

Aut redit a nobis Aurora diemque reducit,
Nosque ubi primus equis Oriens adflavit anhelis,
Illic sera rubens accendit lumina Vesper.
Georgicon I_249-251
Or Dawn, leaving us, brings back their day,
and when the rising sun, with panting horses, first breathes on us,
there, burning Vesper [*the planet Venus*] lights his evening fire.

Optima vinetis satio, cum vere rubenti
Candida venit avis longis invisa colubris,
Prima vel autumni sub frigora, cum rapidus Sol
Nondum hiemem contingit equis, iam praeterit aestas.
Georgicon II_319-322

The best season for planting vines is in the first blush of spring,
When the white bird [stork] arrives, that enemy of long snakes,
Or in autumn's first chill,
Before the horses of the swift sun touch winter,
When summer is on the wane.

Quintus Horatius Flaccus 65-8 BC

Alme sol, curru nitido diem qui
promis et celas altiusque et idem
nasceris, possis nihil urbe Roma
visere maius
Carmen Saeculare_9-12

O nurturing Sun, who with your gleaming chariot
brings forth and hides the day, and are born the same yet other,
may you see nothing greater than the city of Rome

Helios, rising, scattering the stars
Attic krater; ~430 BC

Orientation of prehistoric monuments in Britain: a reassessment **views the type of major axial alignment seen at many megalithic ritual and funerary monuments of Neolithic to Bronze Age date in Britain and Ireland, not in terms of more abstract astronomical concerns, but rather as an expression of repeated seasonal propitiation, basically solar, involving community, agrarian economy, and the ancestors in a combined attempt to mitigate variable environmental conditions. The analysis is supported by over 800 images, open-source, for unrestricted use, and available digitally.**

Alistair Marshall has a formal background in archaeology and the natural sciences, general but not exclusive interests in European prehistory, and is currently developing various projects, which include the following:
-application of remote sensing, from broader study of landscapes to detailed interpretation of ritual monuments, with related experimental work;
-structural analysis of megalithic sites, with especial reference to interpretation of axial alignment;
-investigation of broader aspects of tribal economies during the later Iron Age in Britain and NW'n Europe.

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