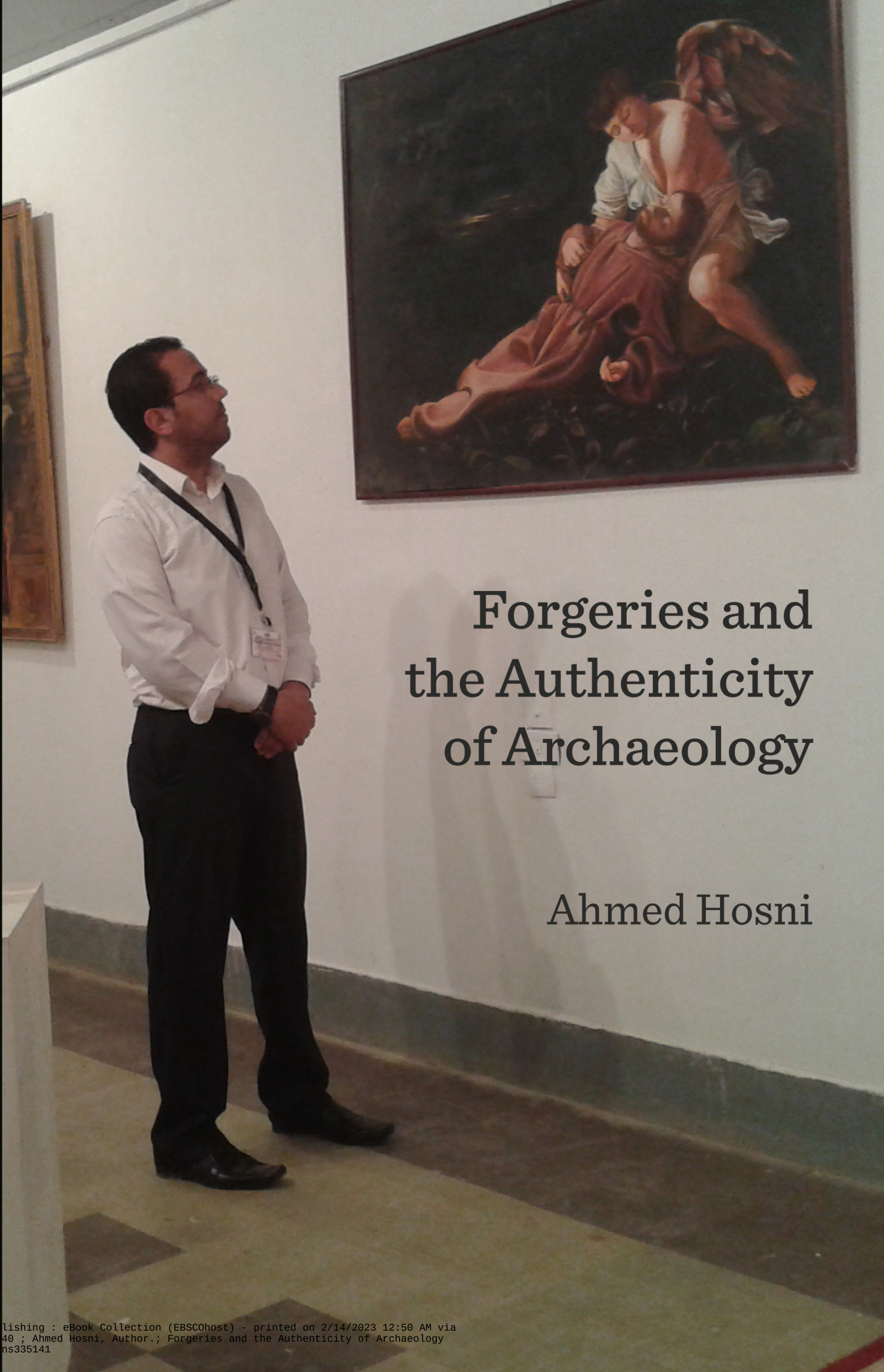

Forgeries and the Authenticity of Archaeology

Ahmed Hosni

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By

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Cambridge Scholars Publishing

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To my beloved daughter Makah,

I look forward to seeing you have achieved the ambitions and wishes you wanted, and that the day you are proud of your father will come.

Your loving Father,
Ahmed Hosni

Between the dream and the reality is the attempt, and between the attempt and the certainty, there is patience, as knowledge needs a dream, effort, and patience, I reject the word 'impossible', and I always replace it with the words 'we can'. With this book, we can confront those who are trying to fake and forge heritage, as preserving heritage is our goal, and it is what we have inherited from our professors.

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FOREWORD

These steps towards the detection of forgery of monuments are a shining light in the darkness of the crime of fake and forgery of archaeology.

Minya University, 2021

Introduction

The modern technological revolution has resulted in amazing developments in life fields, especially in those which serve the recording processes and artistic industries, such as printing methods and the casting of models and statues. However, the other side of this development is bad use or criminal thought. These are called crimes of a scientific nature, so the processes of forgery and fakery, despite their existence throughout time, are furthered by technological development, which gives them a wide area in which to manipulate and obliterate heritage.

Forgery is a distortion of artistic achievement and of history. The problem of forgery in art not only affects contemporary society, but also affects the course of events in history.

The tradition of artistic work is as old as civilization. Forgery appeared in ancient Pharaonic times, where the names of some kings were obliterated from sculptural and architectural works of art, and other Pharaohs' names engraved, as a means of plagiarism.

In the era of the Romans, some secondary artists made work and attributed it to major artists, by forging the signatures of the work of that era. In Islamic times, writers and copiers did the same, forging the signatures of great writers in unknown works.

The truth is, that trading in copy artworks is a legitimate matter, unless it turns into deceiving others and selling them as real antiquities, which has spread in many countries of the world and has become a profitable industry which is practiced professionally.

Here, in this work, the detection of forgery and fake antiquities is presented in two main axes:

The first axis: The forgery and fake of organic monuments represented in manuscripts.

The second axis: The forgery and fake of inorganic monuments represented in metals.

The forgery and faking of organic monuments represented in manuscripts, is presented in three elements. The first element is paper manuscripts, used as a general example of manuscripts, because paper is distinguished by the comprehensiveness of its characteristics. Therefore, our mission was the recognition of the paper, to classify, document, and authenticate it, so we could classify and put every work in its correct place in terms of value. This was our main duty, as researchers who are interested in archaeology and restoration. The second element is a presentation of the methods of forgery and the faking of manuscripts, and how to use traditional and modern methods, although impressive development in technology makes them more difficult, which presents us with a difficult confrontation. As for the third and last element, it is a presentation of methods for detecting the forgery and faking of manuscripts.

The second section of content talks about the inorganic monuments represented in metals. These are presented in this book in three sections:

The methods used in the faking of metals.
The detection of the authenticity of metals.
An applied example of fake metals detection.

Ultimately, in this book, we have tried to present a simple, structured, scientific, method of detecting organic and inorganic monuments, and we give two examples of raw materials representing both. Then it is possible to generalize the rest of the archaeological materials using the same methodology so that specialists in the field can benefit from it.

The Author

Acknowledgements

It was not easy, and the road wasn't paved to begin with, but steadfastness, perseverance, and continuous work were the real supporters, along with the support and confidence of those around me and from those close to me who know how difficult our work is. I especially thank and appreciate Professor **Wafika Noshi** at Cairo University, Professor **Tarik Nazel**, Dr. **Al-Quds** at Minya University and **Mrs. Victoria Barry** for reviewing the work. In the end I also thank everyone who contributed advice to bring out the work in a distinct form.

The Author

List of Abbreviations

2.5D	**Two and Half Dimension**
3D	**Three Dimension**
AAS	**Atomic Absorption Spectroscopy**
AD	**After Date**
AH	**After Hegira**
BC	**Before Date**
C14	**Carbon Fourteen**
CT	**Computed Tomography**
FTIR	**Fourier Transform Raman Red**
HDV	**Hardness Vickers Scale**
IR	**Infrared**
OM	**Optical Microscope**
RS	**Raman Spectroscopy**
SEM	**Scanning Electron Microscopy**
TL	**Thermoluminescence**
UV	**Ultraviolet**
VSC	**Video Scan Comparator**
XRD	**X-ray Diffraction**
XRF	**X-ray Fluorescence**

Key Words: Archaeology, Manuscript, Documents, Metal, Forgery, Fake, Authenticity, Dating, Restoration, Conservation

Chapter One

Types of Forgery and Faking

The Concepts of Forgery

1. Forgery:

A work intended for complete deception to create the illusion that it is an original work of historical and artistic value. It is a complete, forged, copy of a found original, or a completely forged work which has no original.

2. The Fake:

An original work that has undergone some change to show it has historical and artistic value. This work may be original, but it is worthless, so it is being 'faked' in order to give it value. This may involve, say, the adding of blood to a manuscript and assigning these drops to a famous historical figure, or adding the fake signature of a known figure to a work of no value, the purpose of which is deception.

3. The Fabrication, or Pastiche:

This is an artificial work, created by assembling original or non-original pieces, and attaching them to the original copy. The truth is, that they are not connected, and have no relation to each other, but this compilation gives them an artistic and historical value. For example, appending a pen and a leather bag to a manuscript with value, so the pen and bag are affiliated to the artistic and historical value of the manuscript. Whether they are original, or authentic, or not, it is intended to deceive.

4. The Word 'False':

The word 'false' is used in the sense that it has a good and positive role, such as using materials for decoration, such as attaching a decorated wooden box to an original manuscript to decorate it, but it may come to have a bad and negative role, such as the wrong characterization of the manuscript on a card which describes the shown work in museums.

5. Fraud:

This relates to the fake signatures of property contracts, arguments, and documents, with the intent to commit fraud, and the theft of money and property. There are many manuscripts with fake signatures that were intended to fraud.

6. Copy, or Reproduction:

The making of copies identical to the original work, for the educational study of students.

7. The Genuine Object:

This is the original version that has been proven by scientific evidence.

8. The Concept of 'Forgery' and 'Fake' in the Arabic Language:

(i) Forgery:

In a dictionary of the Arab tongue, a forgery is a decorative lie. To forge is to adorn by a lie, and a forged act is an act disguised with a lie. From it, also comes a forgery of something which resembles the truth. In the Dictionary of Al-Waset, he forged his signature, i.e. he imitated it.

(ii) Fake:

In the dictionary of the Arab tongue, a fake of a thing, means it has deceived. According to the Dictionary of Al-Waset, money is a trick, meaning that it appears fake, and deceives. From the above, the concept of forgery is more comprehensive and broader than merely 'fake'. The word 'forgery' includes everything that contradicts the truth by simulating it completely, while a 'fake' is a partial change intended to deceive and defraud.

9. Forgery as a Legal and Technical Crime:

(i) The legal crime of forgery and fake:

This involves a breach of public and private interests. The threat to private interest endangers an individual's ownership, whether of a manuscript or a document, while the threat to the public interest is the damage to our heritage, which includes economic and historical damage punishable by law. In the past, crimes of forgery and fake mainly involved fake money, which in ancient law, was considered one of the most serious crimes. The Roman legislators punished currency forgers working outside the mint, even if the currency was of the same standard and weight.

(ii) The technical offence of forgery and fake:

This is a crime of corruption of aesthetic taste, and includes the distortion of the work, or heritage piece of historical beauty. Beside the loss of sensual value and heritage, science, and history, the responsibility is borne by dealers in antiquities and copyists.

10. Forgery and Fake of Organic and Inorganic Archaeology:

(i) Organic archaeology:

This involves materials that contain carbon in their composition. Museum collections include many of these materials, which include wood, textiles, oil paintings, leather, paper, parchment, papyrus, ivory, bone, and feathers. In this work, we use the paper manuscript as an appropriate example to explain the fake of organic antiquities.

(ii) Inorganic archaeology:

These are materials that are stiffer than organic materials, and are represented by stones, rocks, metal, glass, pottery, ceramics, mortar layers, and construction. In our work, we have taken a sample of metal to explain the faking of inorganic archaeology.

Types of Forging and Faking of Organic Archaeology: Manuscripts and Documents

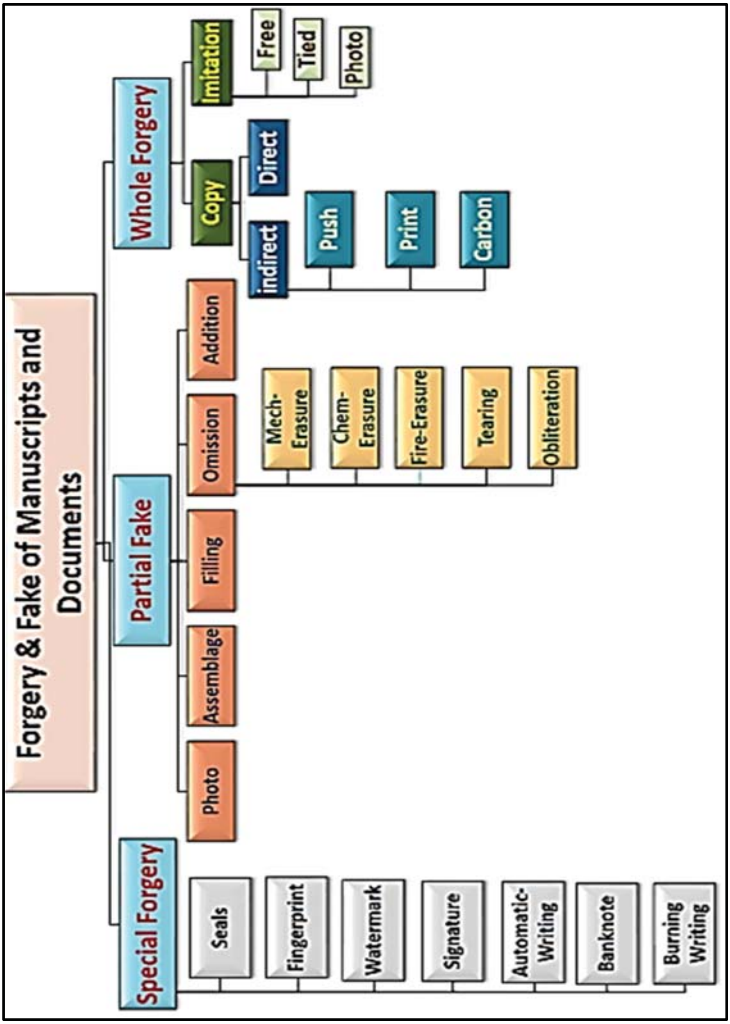

Table 1-1: Types of forgery and fakes of manuscripts and documents, by author.

1- Whole Forgery

A. Imitation

Imitation is divided into:

i. **Free Hand:** Replication several times until the imitator reaches a form approximating the script, and the presence of the original document is not required.
ii. **Tied:** The original document is required in order for the counterfeiting process to take place, step-by-step.
iii. **Photo:** By photographing the manuscript or document, and then imitating it.

Characteristics of the imitation:

The presence of pauses that may be evident at the beginning of writing, and with the linear formations, as well as syllables with thick and unnatural endings, due to the slow hand when imitating the original.

B. Copy:

(i) Direct Copy: The forgery is carried by direct imitation of the original manuscript or document, by placing the original document on the glass box with lighting from underneath through a glass panel of the box.

Properties of a direct copy:

The forged manuscript and document are free from the effects of pressure, and there is a noticeable slowdown of handwriting during forgery by imitation, with skip marks in the stop and cracks strokes of the pens.

(ii) Indirect Copy: Here the intermediary factor is used.

* **Push:** Using a solid object to press the document to show the words on a white paper below it.

Properties of push:

Abnormal strokes appear, as the writing material penetrates deep into the paper fibers. The effects of the tool used in the pressure are parallel to the strokes of the pen in the case of using solid pointed objects, thus the presence of sunken pressure shows on the face of the document, and there may be prominent holes in the back of the document, which may also appear in the face of the document, in the case of needle tools.

*** Print:**

Media printing: Using transparent paper, or a soft medium such as boiled potatoes, for print. Using transparent paper may leave traces of graphite from the use of a pencil, but in the case of a soft medium, like a pre-boiled potato, a boiled egg, or a piece of rubber or soap, with any volatile medium, the fingerprint is transferred from an authentic document, then transferred again from the soft medium to the manuscript to be forged.

Properties of Media Printing:

It is free from the effects of natural pressure and imprecision of the dimensions of the word. Where the imprint is transmitted by comparing it with the original word, the words appear faded, with erosion at the edges of the letters of the word or fingerprint.

*** Carbon:**

Using carbon paper or graphite filings or a charcoal pen in showing the words or signatures in the manuscript on another white paper. This method is characterized by the fact that the carbon strokes are not natural in their path of rewriting, and the forger may neglect some points. In addition, strokes of letters may not be clear.

Properties of carbon:

The slowness and lack of fluency of the writing hand, and the presence of carbon traces parallel to the strokes of letters, especially in complex formations, in addition to the ink density and pressure near strokes and the ends of letters.

2- Partial Fakes

i. Addition:

Words are added, a line, or a point or letter is added directly to the word itself, in order to change the meaning at the beginning and end of the manuscript, in order to change the title, introduction, ending, name of the author, or the date of its publication.

Properties of addition:

The use of more than one writing method besides the original, so the writing will be different, as there are differences between the writing method, the words, and the added meanings, which differ in their context from the original meaning of the manuscript and the document.

ii. Omission:

This is an attempt to remove the writing, or hide it from the naked eye with the following tools:

* **Mech-Erasure:** Mechanical erasure at the surface of the paper to delete some of the words, letters, or points.

Most often, this method involves removing the surface layer of the paper containing the writing to be erased, which also results in the removal of the layer of polish and torn surface fibers using the erasure tools. This is done using an eraser, or a sharp object, and the fakers may then resort to smoothing the surface by pressing on the surface of the paper, after placing it on a plate of glass, and then returning the fibers to their normal position. However, this is not hidden on the manuscript surface.

* **Chem-Erasure and Laser:** Chemical erasure aims to remove writing by means of special chemical solutions that affect the colored materials contained in the document, interacting with them and analyzing them into colorless materials which the naked eye does not perceive in ordinary light.

Solutions may be alkaline materials, organic acids, or reducing materials, which are the most common and widespread. The use of lasers in laser erasure often does not leave traces visible to the naked eye. Finally, the effects of chemical erasure and laser can be identified when examining the surface paper with invisible rays, such as ultraviolet, infrared or ultrasound.

***Fire-Erasure:** Burning a manuscript or document to conceal information or to get rid of an important document by using fire.

The burnt manuscript can be preserved and read if it is dealt with quickly by specialists, but if the burning is severe, it is possible to lose the manuscript and document for ever.

***Tearing:** Shredding parts of the document to hide something. If the shredded parts are still present, it is possible to deal with the shredded manuscript or document by re-assembly.

Obliteration: Striking out and blurring the words to be hidden, whether by visible obliteration by ink, or invisible obliteration with colors similar to the color of the paper.

* **Filling: I**nserting a point, letter, number, or word, between letters and words in the text. This padding may also be by adding an entire sheet of paper to the manuscript or document to change the facts.

* **Assemblage:** Compiling several parts of different documents to create a complete document.

Where it was customary for the author to write in more than one scientific branch in one volume, the forgers dismantle the volume and assemble each individual part for the purpose of increasing profits. These forgers may also attribute one of these the branches to other writers.

* **Photo:** Photocopying certain parts of the manuscript or document especially the signatures, and then using them to make a template identical to the original.

After filming, these document parts are entered into a computer and worked on using electronic programs to create a forgery. Then an ageing process is simulated using various materials such as tea, chickpea glue water, or wet straw, to match the shape of the manuscript or original document.

3- Special Forgery

(Seals, Fingerprints, Watermarks, Handwriting, Signature, Automatic Writing, Banknotes, and Burning Writing).

3.1 Seals:

Seals were used in the form of clay seals with a primitive design in the Egyptian civilization three thousand years ago. Then, the seals evolved and were made of ivory, bone, or clay, with geometric shapes, or in the form of birds with the name of the king, the minister, one of the princes, or one of the common people inscribed on them. In the Mesopotamian civilization, the cylindrical seal was designed, which dates back to the year 2300 BC. With that, the ancient purpose of the seals was for correspondence, trade exchange, and proof of ownership.

(i) Manufacture of fake seals:

This involves checking the seals and photographing them, then making a template for the stamp by chemical, manual, or laser engraving. The template is completely identical to the image transferred from the original stamp.

(ii) Attributes of valid seals:

- The presence of pressure traces representing the outer frame of the seal imprint.
- Written formations, whether words or numbers, are specific and clear.
- Deposition of the stamping material on both sides of the writing strokes, and around the outer frame.

(iii) Properties of seals:

They are of a substance which has a special viscosity and is composed of a suitable dye material mixed with glycerin, to which some volatile substances are added, such as alcohol which is poured onto the felt until it is completely saturated to help distribute the dye on the surface of the sealing mold.

(iv) Methods of forging the fingerprints of seals:

The forger resorts to one of the following methods in the process of transferring and forging seals:

The seal imprint is hand-drawn, similar to the original. In addition to studying and following the steps of the drawing of the external frame, its dimensions, words, and distances, this method will be devoid of the pressure effects that are seen in the fingerprints of the seals taken from the solid molds.

Making a similar seal: No one is capable of making a similar seal, therefore there will be differences between them in terms of letter positions, syllables, numbers, and spaces.

Transferring the seal imprint from one sheet to another: There is more than one way to do this, such as using a soft object like a boiled egg, the palm of the hand, or even using a plaster cast, but in the imprint of the forged seal, we notice the loss of pressure, the flattening of the fingerprint, the difference in its dimensions, and the regularity of the distribution of the colored material in the footprint, where no deposition is seen on the sides of the writing strokes.

Transferring the fingerprint by using carbon paper: It is evident in this method that the seal imprint is free from pressure and the appearance of carbon traces, although in the modern era there are types of carbon paper that do not leave a trace. Where transparent carbon paper is used, the fingerprint is taken by a pencil, and in this method, the graphite of the carbon is deposited with a compression footprint.

(v) Protection of seals:

When making seals, two frames are taken into account for the outer perimeter of the seal fingerprint, which is zigzag-shaped, to be an obstacle to the forger. There are precise letters in the outer frame to the side of the seal, and a distinctive mark in the seal is taken into account, which is a ‘secret’ mark that only the owners of the seal know. Recently, a substance which is fluorescent under ultraviolet rays, and that the naked eye does not see, has been added, which is used to take a fingerprint, and thus the authenticity of the seal can be recognized.

Fig 1: Prophet Muhammad Seal on Metallic Ring. The Era of the Beginning of the Emergence of Islam. (Photo: ShutterStock Images).

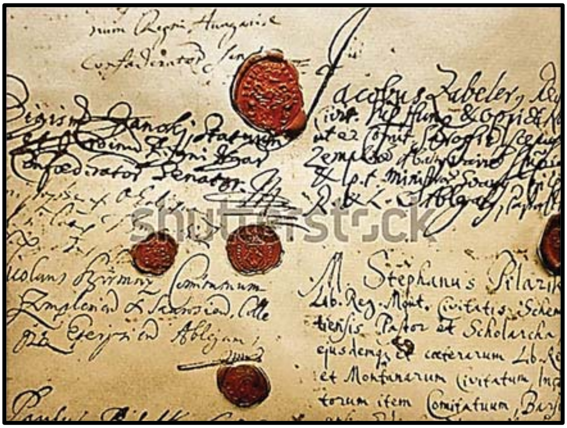

Fig 2: Original Seal, Ancient Manuscript (Fragment of the Real Ancient (A.D.1707) Manuscript with Red Wax Seals) (Photo: ShutterStock Images).

Fig 3: Forged seals. Shown here is the imprecision and the presence of ink precipitation on the sides of the seal (Photo: author)

3.2 Fingerprints:

These are the prominent lines, surrounded by different lines, which take various shapes on the skin of the fingertips from the inside. These lines leave their mark on everything that they touch, especially on smooth surfaces. The handprint is a unique, subjective, characteristic which God Almighty has honored us with, and the formation of fingerprints begins in the fetus from the third month of gestation. It is completed in the sixth month of pregnancy and does not undergo any further change except growth and enlargement. The uniqueness of the human fingerprint was discovered by the Czech anatomist Jan Evangelista Purkinje in 1823, who found that the fine lines on the fingertips differ from one person to another. Studies continued until fingerprinting became a stand-alone science, and what is now known as an ‘electronic fingerprint’ was created using computers and subsequently used to prove the ownership of the fingerprint. Forging the fingerprint is done by cross-cutting with transparent paper or a wet medium.

(i) Features of Fingerprints

- They are stable for life, and do not change with the passage of time.
- No two people have matching fingerprints.

(ii) How to take a fingerprint:

- Cobia pen: the thumbprint is colored after applying it to water, then fingerprinted.
- Dyeing: This uses colored pigments in molds.
- Soot: In the past, soot was taken from a flame of kerosene, which was known as the ‘jazz bulb’. The finger was exposed to the soot flying from this bulb, and fingerprinted with it.

(iii) Types of fingerprint:

Curves: These take the form of curves on one side of the fingerprint, with ripples in lines at the centre, including simple curves, and tent curves.

Slopes: On the right hand, the fingerprint lines descend towards the thumb, and on the left hand the fingerprint lines descend towards the little finger.

Circles: These are the circles in the fingerprint, including types known as normal, central, or double.

(iv) Problems of taking a fingerprint when examining and comparing two fingerprints:

- Not choosing the right ink for a good comparison.
- Increasing the number of inks on the fingerprint, which leads to smudging and blurring.
- Excessive pressure on the fingerprint and slipping of the fingers leads to blurring of lines.
- Uncertainty that the finger is clean, which deposits unwanted plankton in the fingerprint.
- Not enough ink is used, which causes very light and dull edges.

(v) The relationship of fingerprints to the forging of manuscripts:

Fingerprints are taken from manuscripts or pens kept in museums, and there is a comparison of the signature with the fingerprint on the documents, which determines ownership. During disputes over manuscripts and documents, the fingerprints are compared by specialists in the museum, and fingerprints are recorded using the electronic fingerprint method. This is taken as in the traditional fingerprint, but without using ink, through a special scanner device which stores the fingerprint and imprint of the palm of the hand. This device is an integrated work unit which includes fingerprinting, checking, and comparison.

Fig 4: Electronic Fingerprint. (Photo: ShutterStock Images).

3.3 Watermarks:

These are transparent marks in paper made during the pulp manufacture, with a design that can be seen in when the paper is looked at against the light. It is a technique used to form a pattern or mark, which is made by wires woven into the surface of a mold that is made by hand or in a rotating cylinder in case of the machine-made paper. The thickness of the wire forms a space similar to wet tissue during its shaping, so when it dries, the pattern is easily visible.

The beginning of the emergence of watermarks was in Europe after the paper industry arrived from the Arab and Islamic world, and the paper industry in the West witnessed tremendous development and rapid spread. This led to the need for a method to distinguish each manufacturer separately, so European paper makers invented watermarks which depended on the idea of bending some copper wire in the paper-making mold, into a specific shape or design that includes the initials of the name of the manufacturer, or the name of the factory itself. Thus the watermark appeared for the first time in the 13th century as a personal or commercial mark for paper makers and their factories. The oldest form of watermark was found in a document in Bologna in 1282 AD; the mark was a Greek cross with four small circles at its edges and a circle in the middle.

The method of designing watermarks differs according to the paper industry itself, as their design expresses a special stage through which the process of manufacturing paper passes, thus, it appears that there are fundamental differences in the method of design of watermarks with respect to manual or automatic paper.

(i) The differences between watermarks in manual and automatic paper manufacturing:

The watermark in manual paper: The nature of handmade paper-making molds inspired the idea of designing watermarks, and this was evident after the copper wires forming the surface of the mold replaced the bamboo chips which had traditionally been used in making oriental paper. This had a printed effect on the paper, in the form of lines which could be distinguished clearly upon exposure to light. With the passage of time, and the development of the industry, the effects of the lines resulting from copper wires inspired the idea of bending some of those wires so that they would form a certain shape or design. This became the watermark that expresses a specific logo of the manufacturer or factory in which the paper was produced. The watermark in manual paper is made by installing it at the bottom of the mold, which will appear on the paper when casting. However, with frequent use, the wires of the watermark can break and therefore it is necessary to replace them every six months.

The watermark in automatic paper: The method of designing watermarks in machine-made paper differs from that in manual paper making. The invention of the paper-making machine in 1789 AD, at the hands of Nicholas Lewis, led to fundamental differences in the steps involved in making paper, and to a change in the method used to design watermarks. They were no longer fixed in the mold, as was the case in manual paper-making, but became placed in rollers dedicated to this purpose. The rollers were added in 1825 AD by John and Christopher Fies. When the paper pulp passes under the cylinders, the watermark is printed easily, so the design in automatic paper is made. The roller dedicated to this purpose is known as the Dandy Roll, which is a hollow cylinder surrounded by copper discs, and covered with a body of thin strings of fabric.

Watermarks were among the later techniques used in the manufacture of paper which spread through manuscripts written late in the 14th century. The paper industry moved from the Arab factories to Andalusia in the 8th century, (Gregorian) and from there to Europe, through the Italian factories, and thus, Europe began to register watermarks in the paper produced from their factories in order to distinguish between European paper and Arabic paper. The first European watermark was in the form of an Ox.

From the Italian factories, the watermark spread to all European factories, and became widespread, indicating which factory the paper had come from. It was transmitted to the Islamic world in the 15th century. The first watermark in paper factories in the Islamic world consisted of narrow, two-dimensional waterlines, and appeared in the book *Explanation to Explain Al-Jami Al-Sahih*, by Ibn Al-Muqin, in 1415. The Ottoman Empire used the three crescents sign to denote the Ottoman Empire.

The watermark plays an important role in determining the size of the paper, because it is usually placed exactly in the middle of each half sheet. From this, a fixed location for the marks within each size of book is determined. Each sheet of paper has two halves, and the paper contains two marks, one for the watermark and the other for the name of the manufacturer.

Finally, in order to fake a watermark, the forgers press it in while it is wet, until it interferes with the manuscript surface, and then the mark pattern is painted with a greasy or waxy substance, or an oil medium, to simulate the aging.

Fig 5: Addition of Watermark in Fabiano Factory. (Photo: ShutterStock Images).

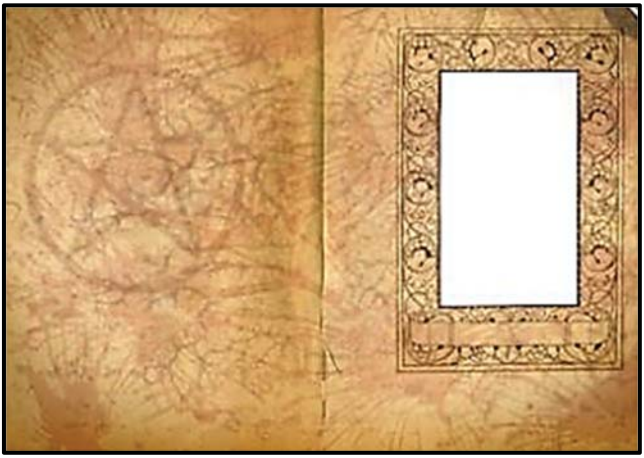

Fig 6: A Star-shaped Watermark in One of the Manuscripts. (Photo: ShutterStock Images).

3.4 Handwriting, Signature, and Special Examination:

A signature is a type of handwriting that is defined as the linear formations in which the human hand runs. The fingers and muscles of the hand and the eye share an important role, and all this is under the supervision of the mind. The scientific basis on which a manuscript is based is handwriting, which is divided into natural writing, and abnormal writing. Natural writing is writing that comes from the writing hand without any pressure, so the writing flows easily, and the hand directs the line as it wants. Natural writing, is influenced by factors such as writing standing up, sitting down, or moving, and the writer's psychological state and the sequence of his thoughts. Non-natural writing achieves the goal of imitating and simulating the writing and signature of a person in order to obtain benefit through forgery.

3.4.1 Handwriting:

Handwriting has components: writing surface, writing instruments, and inks, and knowing the properties of these components has an important role in detecting manuscript forgery.

(i) Writing surface:

The materials on which writing is written have varied and differed over time, and each era has an intellectual and cultural level which is reflected in the lives of those who live in it. The most widespread of these materials are cuneiform clay plates, stone plates, burnt pottery pieces, wax plates, bones, metals, leathers, papyrus, and paper.

Paper was first invented by the Chinese in the year 105 AD, and it was transmitted to the Arabs through the Chinese captives in their battles with the Arabs. Many of these prisoners were proficient in making paper, and the first Arab paper factory was established in Samarkand in 751 AD. Then the industry moved to Baghdad, and after that, the industry spread very quickly throughout the Islamic world from the Levant and Palestine to Egypt and the Maghreb, and from there to Andalusia and the rest of Europe. The manual method was used until the first machine was invented, and the industry improved significantly. The factories produced excellent types of paper after the order issued by the Caliph Harun al-Rashid that people should not write except in the Kaghed which was the reason for the spread of paper.

(ii) Methods of industrial aging of paper followed by forgers:

- Painting with a solution of old hay soaked in water.
- Painting with a tea solution, or a solution obtained from boiling walnut shells with starch in hot water.
- Exposing the fake manuscript to smoke rising from burning wood (soot).
- Exposing the fake manuscript to a heat source (kerosene flame).
- Curling the paper, parting, tearing, and dusting it (with sand or dirt).
- Making some holes to suggest insect infestation.
- Creating grease spots.

(iii) Writing tools:

The writing tools of manuscripts are represented by the pen. The names for pens have varied in the past, so we find Yorae, Morkam, and Kalm = Pen, while the latter is the most common, due to its derivation from 'pruning' (cutting and straightening), and the types of pens: reed, wood, bone, feather, and modern pens (pencils and ballpoint pens).

Pens in the past:

The bamboo pen is made of bamboo or reed, thus sometimes it is called the reed pen. The qualities of the reed pen are to be solid and not thick or thin in diameter, to be shaped without the knots of reeds, straight, not twisted, and flat. The bamboo pen must be completely dry. Its length should not exceed 14 - 20cm, and its thickness ranges from 0.5cm to 1cm.

- The wood pen is made from the thin branches of trees.
- The bone pen is made from thin bones as well as from the bones of large fish, after the tips have been sharpened.
- The feather pen is made from colored bird feathers, especially the tail feathers and those from the edges of the wings. Many pens of this type are still used today in Arabic calligraphy.

Modern pens:

e-pencils have been known since the 16th century, and were initially made from lead, or one of its alloys. When graphite (soft charcoal) was discovered, in 1560, the lead was replaced by graphite, and these pens are distinguished by being chemically inert. The marks remain on the surface of the leaf and do not penetrate into the paper, but over time they begin to fall off and gradually disappear.

Ink pens and colored pigments:

The Cobia Pen represents the beginning of the emergence of colored pigment pens, after the year 1870. They were made of graphite, in addition to a colored dye (such as blue, red, green, black), dissolved in water for the penetration of writing into the paper fibers, giving them a distinctive color and the ease of transferring the writing to another surface. However, the disadvantages of writing with these pens are that they do not last long, and fade with the passage of time after constant exposure to light.

Liquid ink pens with a fibrous tip hold the ink in a container. The pen has a separate fibrous tip and was produced at the beginning of the 20th century.

The ballpoint pen (ball pen) first appeared in 1939, and is still in use today. It is a ball-point pen with a dry extension, and one of the characteristics of using it is the difficulty of erasing the writing. The pen is also associated with the amount of ink. If the ink runs out, the pen becomes unusable.

Contemporary pens are used in the contemporary era in addition to of many types of ballpoint pen. Felt pens were introduced in the early 1970s, and the pen industry continued and developed. Among these we find gel pens, phosphorescent pens, and many others.

Inks:

In the past, ink generally consisted of three main components, namely:

Pigment prepared from organic and inorganic sources (vegetable, mineral or animal). Vegetable sources included pomegranate peel, mustard, and henna. Mineral sources included Malachite, aspidag ceruse, basic lead carbonate, and blue vitriol. Vitriol is copper sulfate, and is known to Arab chemists as sulfate salts. Animal sources included the red cochineal dye extracted from an insect named *Dactylopius Coccus*.

The carrier broker (vehicle):

This is the solvent solution for inks or coloring materials, whether oil or water.

Chemical Additives:

These are the binder materials, and control the degree of fluidity of inks and pigments. They include driers, such as cobalt and manganese, which accelerate the dehydration process, extenders, such as barium sulfate, which are inorganic materials, and responsible for the ease of spreading inks, and antioxidants, which work on keeping the ink for a long time without it being affected by the factors of damage and keeping it in good condition for a long time before use. The appropriate temperature for ink to remain unchanged is between 15 and 65°C, and the point of a complete collapse of the ink is at a temperature of 150°C.

Examples of inks used in handwriting are: carbon, black iron, red, green, blue, gold and yellow, and white and silver.

3.4.2 Signatures:

Signatures are part of handwriting, and are on documents for interaction between humans. The signature is usually at the foot of the document.

The validity of the signature is divided into: a valid signature, which takes all forms of natural writing in terms of the individual characteristics of handwriting; an incorrect signature, which is written by the owner of the document, but disturbances appear in the font, indicating that the signee was under pressure; and a forged signature, which, when examined proves to be completely different.

Types of signature include: the spelling signature (natural), where the full name used for writing is written; the integrated signature (e.g on forms) which is a written formation chosen and practised by the signature holder with which his name is reduced, and which may be used in important and repeat work; and an abbreviated signature (such as on a Visa card), which often does not contain letters and is used in the daily work of conducting business.

Types of font used in handwriting among the ancient Arabs:

Arabic calligraphy is of two types (epigraphy or calligraphy), and played an important role in documenting manuscripts and ensuring the correctness of tracing their lineage to their authors. The origin of Arabic calligraphy goes back to the kingdom of the Nabataeans, who lived on the trade route between southern Arabia and the countries of the Mediterranean. The Nabataeans came into contact with the Aramaeans, they attended their civilization and used their language in the affairs of their lives. They derived lines from their calligraphy, and they converted the Arabic language, through the Nabati script, into written Nabati Arabic. That was in the late 2nd century, and the writing in Nabati script continued for nearly three centuries.

Nabataean calligraphy was derived from the Aramaic script, and then moved to the northern Arabs, but with sophisticated writing it extended to Mecca, so the Nabataean script was developed into a Makki script in the pre-Islamic era before the advent of Islam. Characteristics of the Nabati script include: linking letters together, with the exception of letters that are not linked to what follows, such as **(ر)** and **(و);** the letters are free of dots; the use of shapes of some letters at the beginning of the words, which contradict their forms if they appear as the last word, such as **(هـ)** and **(ب);** some letters are not written, like the extended (أ), as **(ثلاثة = ثلت) (عام = عم),** and the feminine (ة) is not written with the (ة), but rather it is written in the simplified form **(ت)**, such as **(سنة = سنت)**.

Makki and Madani calligraphy: Nabataean calligraphy moved, with its characteristics, to Meccan calligraphy and spread in Mecca before Islam. With the advent of Islam, and its move to Medina, writing spread, and there were many writers. The Makki calligraphy moved to the Madani calligraphy in a more elaborate development, and so it can be said that the first Arabic script was the Makki calligraphy and the second was the Madani calligraphy. They are distinguished by the curvature of the winding to the right of the hand, and they are inclined, rather than straight. It is known that the Qur'ans of Othman were written in Madani calligraphy.

Rounded calligraphy spread in the 1st century. Its characteristics include: the 'H' **(أ)** is tilted slightly from the top to the right while maintaining the height of the tails of **(أ)** to the right and the top, while trying to straighten **(أ)** and being free of flatness. The correspondence of the Messenger (PBUH) to the Kings inviting them to Islam was done with this calligraphy.

Dry calligraphy appeared after the 1st century and is characterized by bold letters which tend to be straight. It was often used in stone inscriptions. It is also characterized by the use of right geometric angles.

The Hijaz calligraphy is a diagonal calligraphy which was taken by the people of the Hijaz from Al-Hurrah and Anbar, and appeared between the 2nd century and the 8th century. The forms of the letters of the Hijaz script were developed mainly for the writing of the Noble Qur'an. However, the

Hijaz script style prevailed to be used in all writing, and the Hijaz script was built on what the Arabs call the Jazm calligraphy. The Hijaz calligraphy takes two forms. The first is the Dry calligraphy, and we can say that the Hijaz calligraphy is considered as one of the first examples of this. It is distinguished by its geometrical character and sharp angles, as it was an attempt to impart a sublime characteristic, and it was used in the writing of the Noble Qur'an. The second form is the soft calligraphy, which was used to represent the writing of transactions with curved strokes, until it emerged from the Hijaz calligraphy, after which, it became the Kufic calligraphy.

Kufic Calligraphy appeared after the founding of Kufa, and with the spread of Islam, the calligraphy was widely used, and was a means of copying The Qur'an. It is distinguished by the straightness of its letters and its right angles, and was issued in the 3rd century.

Copying 'Naskh' Calligraphy:

This is a developed script for Madani calligraphy, but with the advent of the Kufic calligraphy, the Naskhi calligraphy was neglected, until the 6th century, when the Naskhi calligraphy was issued for writing Qur'ans, correspondence, and literature, due to the ease of writing in it, unlike the Kufic calligraphy, which needed to be careful and accurate. It was called Naskh (copying) relative to the copyists, and they preferred it to the rest of the calligraphy.

Characteristics:

2- Its letters are small and their lengths close.
b- Full clarity of the writing letters.
c- The presence of protrusions for the letters (س) and (ش).

The 'Third Al-thuluth' Calligraphy:

Its first appearance was at the beginning of the 4th century, and the name (Al- Thuluth) refers to the Thuluth pen, which is a wide pen with twenty-four hairs. This calligraphy is written with a wide pen of the Naskhi calligraphy. Its letters tend to be large, so it is preferred for writing headings and side headings.

Al-raqea Calligraphy:

This is calligraphy derived from the Naskhi calligraphy, written with a short pen, which helps to speed up and accomplish writing in a shorter time than writing in the Naskh calligraphy. It was evident in the 13th century, and its letters evolved until they combined simplicity and beauty.

Characteristics:

2- Most of the letters in it are simple in shape, devoid of teeth **(س and ش)**.
b- The two points are reduced to a slash, and the three points turned into a small triangle.

Diwani Calligraphy:

This is the calligraphy that specialized in the official writing of the office of the Ottoman Empire in the 9th century, and it was used until the 16th century. It has many branches, including Al-Gali Diwani.

Characteristics:

2- Its letters are a mixture between the script (Thuluth) and (Naskh).
b- It is distinguished by its beautifully decorated letters with arches.

Andalusian and Cyrene Calligraphy:

The Arabic calligraphy spread in northern Africa after the spread of Islam, beginning in Kairouan in the **1st** century Hijri. It was called the Kairouanese Script, and it was derived from the Madani calligraphy, while the Andalusian calligraphy become a calligraphy developed from the Kairouan calligraphy.

Characteristics:

2- **(أ)** is drawn with a semi-round head on the inside with a flat tip down.
b- **(ل)** was drawn with a semi-round head.
c- **(ص)** was drawn without a prominent tooth.

Persian Calligraphy:

It is a font derived from the Naskhi script in the 5th century, and it has two types of scripts; the Ta'liq line and the Nasta'liq line (The name refers to that between Naskh and Commentary).

Persian calligraphy is characterized by its flexibility, ease, and smoothness, in drawing, and independence of letters.

IV-Study of the process of matching and submitting signatures and unnatural handwriting:

1-Line quality: This means whether the line is flowing, erratic, or shaky.

2-Distance: This means that the space between the words is equal or crowded.

3-Continuity: This means if the writing continues, or if the writer raises his hand from the places where writing begins and ends.

4-Linking letters: This means linking letters in an ideal and natural way, without any imitation and trembling in the line, or noticeable missing letters, as well as noting the shape of knots and structures and placing points on letters such as **(ـة ، ك ، ت ، هـ).**

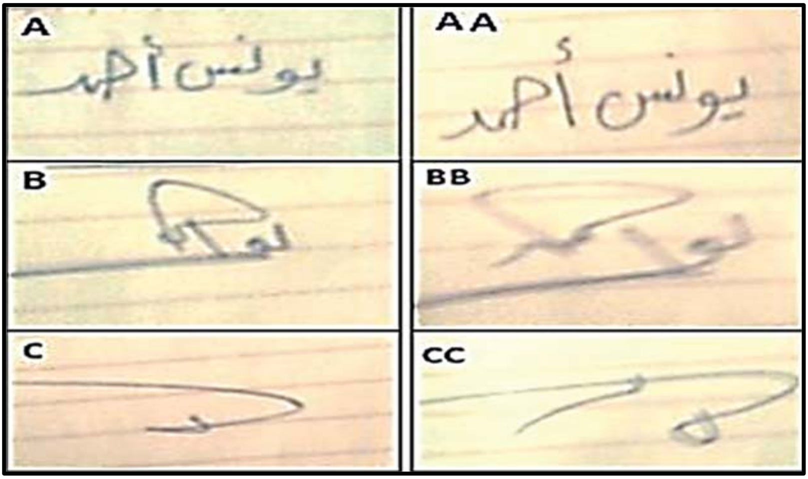

Fig 7: Where (A): signature of signature spelling, (AA) signature of forged spelling. Where (B): form signature, (BB) forged form signature. Where (C): is the visa signature, (CC) the forged visa signature. (Photo: author)

V-Comparison based on individual handwriting:

Each individual has an independent individuality when writing, which is called the theory of individualism, and the theory of uniqueness progresses as follows:

1-Alphabet: Each individual has his own independent and unique alphabet of meanings and words based on his cultures, environment, and the surrounding environment, and the individual's own profession has a major role in the distinctive writing performance of the individual.

2-The Singular Calligraphy: This is what the individual has acquired from his alphabet, his profession, his culture, and his personal uniqueness. All this appears in the form of his writing uniqueness.

VI-Matching Models:

These are samples submitted in handwriting and are either original samples (documented and preserved) or written samples (made by experts on the subjects of forgery cases, or the accused in them). Matching samples are taken in a calm atmosphere, away from any pressure of the clerk, and are by dictation only, taking into account the state of writing (standing or sitting), as well as writing materials such as paper and tools.

VII-Results of matching:

1-The results of the simulation are shown in the following figures:

2- **The difference:** this confirms the forgery process.

b- Similarity: It clarifies that there is some relationship between the owner of the original manuscript and those who want to imitate it. This relationship is similar to a family one, such as father and son, or people from one school or place.

c- The agreement: This is the agreement that all the public features and special features were written by the owner of the matching.

d- Matching: This is the complete agreement on all the public and private characteristics, which confirms that the author is the same as the owner of the manuscript.

2-The results of the comparison are presented in the following forms:

2- Normal writing + full agreement with forms = valid signature.

b- Normal writing + total disagreement with forms = incorrect signature.

c- Unnatural writing + apparent similarity + disagreement with models = a forged signature by theoretical imitation.

d- Abnormal writing + discrepancy with forms = incorrect signature.

e- Unnatural writing + appearance similarity + disagreement with patterns + match = transcription forged signature

f- Unnatural writing + visual similarity + disagreement with models + intermediary effects + match = a forged signature with medium.

In conclusion, the signature and handwriting are treated as a fingerprint, so that one person cannot write something twice with the same match, even if his signature matches. If two signatures are identical, one of them is forged, but there is other evidence that is taken when proving the lineage of the signature, such as stops and pen-raising, and the beginnings and ends of the letters.

34.3-Special Examination for Signatures and Handwriting:

Examination of the handwriting, especially signatures, depends on the physiological and behavioral characteristics of the individual, thus one person has contradictions when re-signing and it depends on the psychological state, surrounding circumstances, physical condition, time, age and the place where the signature was made.

I-Types of Forging Signatures and Handwriting:

1-Random Forgery: This is rudimentary forgery that does not take into account the appearance of the original signature, but rather depends on writing the name of the signatory only.

2-Simple Forgery: This is an attempt to mimic a simple signature.

3-Skilled Forgery: This is the tradition of signing professionally, taking into account the proportions, strokes, and stops in writing the signature.

II-Methods for detection of forged signatures and handwriting, using the following steps:

1-The existence of a standard font for the original line owner (standard):
The standard font is clear, establishing whether the letters of the forged words are actually present in the standard font.

2-Manual analysis: This is done by making tables, diagrams, and engineering measurements manually.

3-Automated analysis: This uses examination devices such as microscopes.

III-The automatic analysis steps are as follows:

1-Image Acquisition:

Storing the digital copy and original of the signatures to be examined in the computer.

2-Pre-processing the two images:

This stage makes the signature in a standard, ready-made way, to extract the differences:

a- Reducing crowding caused by images, and noise reduction by filtering and removing unwanted portions resulting from the scan.

b- Resizing images**,** by cropping the image, then enlarging or reducing it until a suitable size of signature is reached.

c- Setting themes for pictures by converting the image color to grayscale, standardizing the brightness of the images, and unifying the size of the line thickness by zooming in or out to match the images together.

d- Clutter removal by removing any black points unrelated to signatures.

e- Net – this involves placing signatures in a grid cell for easy identification of beginnings, ends, and strokes, and to place parentheses and curves.

IV-Difference Results:

The differences between two signatures are extracted in three stages:

1-General differences:

By looking at signatures with a comprehensive overview, and limiting the signature image to key points, such as the ratio of the signature's height from the horizontal line, the signature area and its size, the geometric shapes in which the signature is made, and the movement and direction of each letter in the signature.

2-Special differences:

By studying part of the signature and comparing it to part of the subject to be examined.

3-Accuracy differences:

By choosing just one letter, studying it, and comparing the two signatures.

3.5. Automatic writing:

This is the writing resulting from the use of a machine, whether it is a typewriter which began to be used in 1714 AD, or a computer, that began to be used in 1946 AD and spread its use around the world beginning in the 1980s. Experiments have shown that each printer or typewriter has its own fingerprint, which can be treated as a signature or handwriting. The type of printer or typewriter, can be compared, with the knowledge that the lines arising from printing or from computer printers, fax machines, and others, have special features which distinguish each type and each model. Each machine is unique as a result of development and printers can be identified as follows:

1-Laser printers: can be differentiated by the fullness of the ink, the scattering of granules around the letters, the clarity of the stroke and its strong luminosity, the difference in the granules around the stroke when examined under magnification, the clarity of the contact angles of the letters, where the linear stroke is broken at the bending positions.

2-Inkjet printers: These have the presence of points or clusters within the print, and not in the rest of the face of the paper, so the linear stroke is not affected in the bending sites; the outline is in one or two directions of the stroke.

3-Dot matrix printers: Differences can be noticed in the presence of a degree of pressure in the stroke; the letters appear in the form of dots, when printing more thickly, the stroke and its edges are in the form of a zigzag ladder, thus the spread of clusters and granules around the letters leave pressure traces in the center of the printed letters, while there is a lack of influence of the stroke in the places of bending, on the back of the paper.

The bottom line is, that each printer has its own advantages and is recognizable to within 10 percent.

3.6. Banknotes:

1-Methods of Forgery and Fake Paper Currency:

I-Forgery:

1-Manual drawing by direct transfer.

2-Copy, where the lip is used with carbon or transparent paper.

3-Photography, and then imitating photographs by drawing, or copying.

4-Electronic scanning (computer) and color copying, using Photoshop and drawing programs deployed on the computer, then making color copies through laser printers.

II-Fake:

1-Erasure or Addition:

In erasure, a number or name is changed, then what the faker wants is added, including addition to the value of currency by adding numbers.

2-Assembly:

Where there is torn currency or missing parts, the appropriate parts are assembled from each other to produce complete currency.

2-Examining paper currency:

- I- **Checking the color of the paper:** From this we know whether the color of the currency paper is natural or artificial.
- II- **Examination of the texture:** Here we notice that the feel of the fake currency paper is smoother.
- III- **Dimensions measurement:** by referring to the approved standard dimensions and comparing the dimensions.
- IV- **Examination of the visible means of security:** such as metallic strings and silk wires.
- V- **Examining drawings, writing and decorations:** Comparing decorations, drawings and writings with the original, and seeing if there is anything that draws attention and raises doubts.
- VI- **Checking the different printing media:** to find out whether the print quality is different from, or similar to, the approved standard printers.

VII- **Examination of signatures:** to compare them with approved standard signatures.
VIII- **Glow paper under ultraviolet rays:** to see fluorescent materials that fluoresce and glow under UV rays.
IX- **Examining the invisible security means under the rays and microscope:** to see the invisible security means agreed upon.
X- **Examination of the watermark:** The watermark may be a form, graphic, or symbolic image.
XI- **Examining the currency paper, face and back:** to notice any difference on either side of the currency paper.
XII- **Check the safety thread:** to ensure its presence and compare it with the standard thread.
XIII-**Checking multi-colored inks:** to record any difference present.
XIV-**Examining the three-dimensional image (the hologram):** and matching it with the standard image.

3-Means of guarantee in paper currencies:

I- Confidentiality of installing the paper pulp.
II- Confidentiality of the composition of colors and inks.
III- The multiplicity of printing methods (cavernous and prominent).
IV- Overlapping lines of drawings and decorations.
V- Watermark (dirt, linear, double, and glowing).
VI- Guarantee thread (metallic, printed, flared, visible, and hidden).
VII- Silk bristles.
VIII- Filaments and glowing rings.
IX- Glowing secret inks.
X- Magnetic inks.
XI- Hologramatic images.
XII- Micro writing (fine writing).
XIII-Hidden pictures.
XIV-Concentric circles.
XV- Letters and numbers are in groups.
XVI-Signatures.
XVII-Integrated images of the face and back.
XVIII-Integration of decorations in length and width, on the front and back.
XIX-Noticing intentional mistakes.

3.7. Burnt Writing:

This is writing that has been completely or partially burnt and is dealt with using precautionary measures:

1-Preventing air currents that could break and damage the paper.

2-Close-up examination of the burnt manuscript.

3-Attempting to flatten the paper on a glass plate in a basin with the help of a soft brush, or trying to flatten with fingers after softening the manuscript with a dilute solution of adhesive material. The softening may be done with steam, then the manuscript is placed between two glass plates and left for two weeks without moving or shaking, so the burnt writing appears white on a black surface. It is visualized through photography, and infrared imaging may be used to show the burnt writing, especially where the manuscripts are written in pencil, because the carbon material appears opaque in front of the infrared rays, while the paper appears more transparent. The burning paper is treated with an oil that has the property of fluorescence, and absorbs it, so the paper is saturated with oil until it reaches the ink. It can then be imaged using ultraviolet rays, depending on the contrast between the two degrees of brilliance of the ink and the paper when exposed to ultraviolet rays.

We find difficulties in reading burnt writing made with a pencil because it turns into illegible ashes, and it is also difficult to read a manuscript in which the writing is written on both sides, but in the case of colored inks which consist of metallic pigments that resist heat dissolution, and manuscripts written by a typewriter, it is a great possibility The speed of damage increases when the temperature rises.

Conclusion:

Means of general protection against forgery and fake for paper currencies, documents and manuscripts:

1- **Protection against erasure:** the use of papers bearing specifications against automatic or chemical erasure, as these papers react as soon as they come into contact with chemical wiping materials.
2- **Watermarking:** High-tech watermarking increases the protection of documents, manuscripts and fiat currencies.
3- **Warranty wire:** This is a metal or plastic line located vertically and integrated into the paper.

4- **Silk filaments:** These are small pieces of silk threads not exceeding a few millimeters in length and have multiple colors that can be seen by the closer eye.
5- **Microscopic printing:** This is a very accurate print that can be seen with magnifying lenses but not seen with the naked eye. It is also protected against forgery and imaging.
6- **Secret notice:** This is a kind of protection made by inserting a graphic or slogan with secret inks that you can only see by examination using ultraviolet rays.
7- **Holograms:** The image can be seen through holograms from all directions. They were used for the first time in 1972 AD.

Types of Forging and Faking of Inorganic Archaeology: Metals

Faking metalwork began in ancient times, almost by accident. Rather, the fakes were replicas of previous work, especially in the Greek and Roman eras, which are the most imitated eras. Models of classical statues were copied, and art forgery was common in archaeology. In the Middle Ages, the production of more forged pieces, especially with regard to religious matters, extended to include seals on metal pieces. However, in the modern era, technology played a major role in the production of many copies in addition to the superb craftsmanship of modern technology until the point in the modern era where the number of fake items which enter the global market every year is 25,000, and faking has become a major source of income for many.

As Jonathan Richardson[1] says: "Falsification of art is the most terrible crime, and indicates that after the comparison between the original works and the fake works, the clear differences between them appear".

Characteristics of the formation of metals through the ages in Egypt:

The Characteristics Formation of Metals in Pharaonic:

Aged Copper was the most widely used metal in ancient Egypt, and daily tools were made of it. Bronze was created by chance from mixing copper

[1] -Polanyi, K. 2007, 69.
Jonathan Richardson: An English art critic who published a comprehensive essay on art involving art falsification in 1719 and is the first person to develop art criticism as he followed the theory of the Enlightenment at the beginning of the 18th century.

and tin. It became common during the Middle Ages and increased its spread in the modern state. Tin was imported to craft bronze from the islands of Crete and Cyprus, as the medium, and then the alloy of copper and zinc was used to cast the brass. Meteoritic (cyan) iron contains a percentage of nickel ranging between 3:11%. Nickel is characteristic of cyan iron, after iron was extracted from other iron ores and smelted with carbon. In order to reach a high enough temperature to extract metals from their natural ores, the ancient Egyptians built special shrines that were protected by coal. Metals were melted, to be purified in a crucible over the fire. Workers in the era of the the Old Kingdom used to blow into the fire to achieve the melting point of the metal. This required a number of workers to take turns. Later, bellows were used to facilitate the blowing process. These consisted of a shallow earthenware dish covered with leather.

When the metal was extracted, it was usually prepared in the form of blocks, and then thinned using a stone hammer. To make specific pieces, the metal was cut into the required shapes, then bent and held together. To get rid of impurities, the metal was rubbed with hard stones after cutting, until the impurities disappeared and the surface was polished. One method of shaping was by hammering, where the metal was placed on a round anvil, and fixed in place by one worker, while another hammered on it. Another method of shaping, was by smelting and casting in molds of lost wax. Copper casting has been known since prehistoric times, but in a primitive way that does not exceed the casting of hammer heads and hammers. Copper casting methods have since advanced and become part of an artistic process that is practiced with extreme precision. The ancient Egyptians knew the use of welding, as is shown by the example of a copper jug from the Fourth Dynasty (2723-2563 BC), where the method of hammering was used in the manufacture of the body of the jug. As for the mouth of the jug, it was poured separately and then fixed onto the body of the jug by welding with silver. The makers realized the secrets of the methods of copper metal to create the necessary hardness for the edges of the chisels and knives, and they knew that the succession of hammering and exaggeration might lead to the metal becoming brittle, so they resorted to exposing it to a temperature not exceeding (700 °C), which returned to its softness, in what is known as the annealing process.

The Characteristics of the Formation of Metals in the Roman Age:

The Roman government's control over all materials and industries remained as it was in the Ptolemaic era, but in a lighter way. The Roman government regulated every step of industrial work and supervised its implementation.

Cottage industries had been established in Egypt for a long time, and expanded and spread in cities. The most famous centers were the city of Tell Basta (now in the Eastern governorate), Heliopolis (now in Shams), and the city of Nokratis (in the Beheira governorate) next to the city of Alexandria. The industries and metal formation in Alexandria were the resources on which the state relied, and taxes were imposed on all metal products until the Egyptians fleeing the industry. Roman art in Egypt kept pace with European society in the Middle Ages, and was metaphysical and symbolic at the same time.

As for art, it was considered a tool for ecclesiastical education at that time, which required the work of artists to be made in the light of Christian spiritual content. Priests set up workshops in the temple precincts and benefited by selling their products. The Coptic artists were able to extract copper and iron and make alloys suitable for casting in molds until they gained wide fame in the metal industry. Egypt was able to meet the needs of its handicrafts for practical use in daily life and also for religious purposes. The proportion of zinc ore in the manufacture of brass ingots may have reached 35%, and lead was also added to brass ingots to facilitate casting. It was also usual to hammer iron in the early periods of the 2nd and 3rd centuries AD, to make swords, scales and locks, using cauldrons to heat the iron and shape it. The Coptic artists used influences dating back to Sasanian origins, such as in making the heads of statues in the form of human heads and birds, and sometimes referring to Ptolemaic origins, such as the use of some mythical animal shapes such as centaurs. The artists also borrowed ancient Egyptian elements, such as the use of the ankh sign, or life forms of ancient Egyptian deities. The Coptics had many executive skills related to shaping metal chips, such as pressing, drilling, cuffing, perforation, and the using the effects of surface oxidation. They were interested in forming and crafting metals using Christian religious and spiritual symbols, whether in the form of crosses or drawings of angels or saints, as well as making crutches from precious metals, such as the care stick, known in Coptic as Shabbut. This is carried by the Pope or the bishop, and indicates his responsibility for serving his parishioners. It represents the staff on which Moses the Prophet leant. Other symbols are the metal crown, which remind us of the crown of thorns found in holy drawings, as well as the cross made of bronze or silver, which is the cross of blessing and is used in baptism ceremonies. Metal artifacts in this era were very popular, so we find Egyptian copper vessels from the 5th century AD in European kingdoms up to the borders of Scandinavia. From this, we conclude that this industry has reached such precision and fame that the Western kingdoms scrambled to master it. It is worth mentioning that the Coptic artist mastered the decoration of metal pots by engraving them with prominent or sunken drawings, or by making delicate statues of human shapes, crosses, or birds, which we often see on copper and bronze pots. In the Roman era, industries were divided into special industries for the wealthy, and industries for the general public, which were called folk art. The latter had its own importance and was made for large-scale production for export to foreign markets under the rule of the Romans after the arts lost the protection and encouragement of the royal palace. Archaeological excavations in Memphis revealed in this era used new industrial methods for mass production by using molds in making large numbers of copper and bronze statues of various sizes, and modern excavations prove the wide spread of these artefacts, and the like, among the members of the upper class in the empire. Because art was divided between the emperors and the general public, it was the fine art of the emperors and the wealthy of society, who brought valuable metal statues from Rome, which worked on the weaknesses of the local art which had begun to appear throughout the state. The distinction of the Roman Coptic artists in Egypt was in dealing with popular subjects with a predominantly religious element and adapting them through metalworks to suit spiritual beliefs. There were metal industries necessary for everyday life and for internal local consumption, which was on a large scale. These metal industries continued, and were left in the hands of the people, away from the monopoly of the state, which satisfied itself with imposing taxes on these industries.

The Characteristic Formations of Metals in Islamic Ages

After the Islamic conquest of Egypt, Amr ibn al-Aas was given safety for the Coptics, protecting themselves, their money, their churches and their trade, and they continued to manufacture metals, endowed with this profession because the Arabs were preoccupied with the affairs of the country and governance. Fustat was the first Islamic capital at the time, including factories known as foundries, and called copper or iron foundries for the purpose of manufacturing weapons and military machinery, in addition to household tools and metal artifacts. Some historians have indicated that these foundries were in Fustat. Dar al-Nahhas was found near Suwaqa Maatouq, and the Copper Market near the Amr Ibn al-Aas Mosque. The market included a group of shops selling household appliances among other things. Supplies were made of copper, in addition to the work of iron makers and other craftsmen. The Egyptian capital, Fustat, was rich with many craftsmen in its paths and alleys, bearing the names of crafts, such as Darb al-Hadden and Zaqaq al-Nahhasin. In addition to Fustat, Alexandria retained what it was famous for after the Islamic conquest. Metal artifacts had been exported to Constantinople since the Roman and Byzantine periods, and the cities of Fayoum and Bahnasa continued to produce pots. After the Islamic conquest, the weights and symbols bore the names of the princes and caliphs, whether the Umayyads or the Abbasids, and there is no doubt that the Islamic era was poor in metal artifacts. This does not mean that the early Muslims did not use weapons, dirhams, dinars, metal pots and ornaments, but what was found in the ruins and treasures was mostly not made by the first Muslims, but was hereditary, so we find the caliphs and princes looted from the precious artifacts and relics of the Sassanid civilization after they destroyed their owners (636 AD) and seized the throne of Kasri. The abundance of mines, as well as skilled craftsmen in their civilization ensured that the metal industry continued with the same methods used in the Sassanid era, in the general form of metal industry and metal ores used from copper, alloys of bronze, brass, and iron, during the beginning of the Islamic era, especially in the countries of Iraq and Iran. However, the differences in the decorations and human drawings began to fade, and so did the use of animal drawings, for ideological reasons. The production of brass in the Islamic ages spread, due to its light weight and ease of formation, and this continued in the artistic style until that tradition disappeared with the Mamluk state. The date of the product as well as the name of the manufacturer of the piece was often seen next to the place of manufacture, but often, when we find pieces that are not marked with those details, we can compare the decorations and the shapes to estimate the time period or recognise the artistic style of the unidentified pieces. However, this comparison method is not sufficient to know the exact time period, so it is necessary to study the different techniques in casting and forming, and the materials used, including raw materials and tools, as well as studying the interaction between the Islamic world and other surrounding cultures. Although metallic zinc was known at the beginning of the 16th century AD, the understanding of how to melt zinc ores to produce metallic zinc came relatively late, because the boiling of zinc leads to the evaporation of zinc, which needs to be condensed, although there is no evidence that the Muslim artist used metallic zinc to produce brass alloy instead of a bronze ingot. This is not surprising, because tin was not available in the Middle East, unlike zinc ores that were available during Islamic times in the form of (zinc sulfide ZnS) and (zinc carbonate $ZnCO_3$). Zinc was used with the presence of copper to give brass alloy and the brass industry technology was inherited from previous civilizations such as the Byzantines. There are some contemporary descriptions from the Islamic era, such as smelting zinc oxide with copper. To do this, zinc sulfide must be converted into zinc oxide by roasting sulfide, which leads to the process of sublimation and oxidation of zinc. This technique served brass by making it free of impurities. To get rid of impurities during the roasting process, the iron content has to be very low, making it easier to pour and lighter. Jugs made of brass were the most widely manufactured and widely used utensils. Long handles were made for the jugs in the form of an animal or a bird. We have come across metal artifacts in Egypt dating back to the early Islamic era, including jugs of different shapes which often have long handles, and a spout in the form of an animal or a bird. These are considered masterpieces, and represent a link between the Sassanid and Islamic styles.

Forgery Methods of Metal:

There are two methods of forgery, manual and automatic:

Manual Forgery is done by using hammering and annealing methods without the intervention of machines. Whole pieces are produced manually with dates or references which transform them from modern pieces to original and historical pieces, which are then given chronological obsolescence by methods such as burying for a short period in moist soil, or adding some chemical compounds which help with rapid aging.

Automatic Forgery is the method used by forgers to capture and copy details with automatic tools. Automatic Forgery is divided into cold forming, hot forming, and electrical reduction.

Forgery with Cold Forming:

As in coin minting, the forgery in this method is by the following steps:

1- Preparing the metal so that its length is relatively large.
2- Passing the metal between the rolls.
3- The rolls exert large pressure forces that reduce the thickness and area of the metal.
4- The metal comes out from the other side with a new thickness.
5- The forger cuts the metal according to the piece to be forged.
6- This method is usually used to forge coins.
7- The forger presses the cut pieces using a mold printed with the shape to be printed.
8- The forger performs good pressing and removes appendages with a solid scraper.

Forgery with Hot Forming (Casting):

Casting is one of the oldest known methods for producing an accurate copy of most alloys, thus the method of forging by casting can be divided into sand mold, metal mold, lost wax mold, wood mold, and plaster cast.

Sand Mold:

Forgery by casting into a sand mold is less dangerous than many forging operations, as it is an easy process. Sand molds are inexpensive and easy to manufacture, and are intended for tourism marketing or academic study and not to deceive experts or those working with museums and artists.

Method of forgery using a sand mold:

A mold is created in two halves which are filled with fine sand and mixed with wet clay. The item to be copied is immersed in the sand on each side and a channel is cut across the casting area from edge to the edge. This is known as the casting channel, and when the two halves are held together, a mold is created. Molten metal is poured into the casting channel, and left to cool down, taking the form for which the mold is made. After the freezing process is completed, the forged piece is extracted from the mold. After casting and removing the appendages, the piece is cleaned with appropriate acids, which makes it softer, however over-washing and acid-cleaning make the piece brighter and more lustrous, which hides the value of age, so it appears at once, that it is fake.

The metal mold:

Many common versions of cutting are made in molds of metal, such as iron and aluminum, They are made of two parts that fit together so easily that molten metal can be poured through the casting channel and take the shape in the mold.

The advantages of casting in metal molds compared to casting in sand molds:

(i) Metal molds can be reused for casting many times, thus increasing production. It is possible to produce thousands of forged pieces from a single metal mold.

(ii) Sand molds leave sand particles on the surface of the fake product.

Defects in metal molds:

(i) There is a casting channel that appears after casting and is difficult to remove.
(ii) There is a mold line usually visible around the edge of the metal copy after casting, and this line needs to be removed.
(iii) It is more difficult to obtain a match between the parts of the metal mold.
(iv) Large amounts of metal come out between the two parts of the mold, leaving excess metal on the mold lines.
(v) An additional problem is that the metal molds that are usually used are cold, and when casting, the molten metal may solidify quickly due to the temperature of the mold before it is completely filled with molten metal. This leads to incomplete casting, which makes casting with copper metal somewhat unsuitable. This method, therefore, uses tin, lead, and zinc, to reduce the speed of hardening.

Lost Wax Molds:

Wax die forging is the most dangerous type, and it requires more advanced equipment than sand mold forging. This method is usually used by jewelers, so the equipment is readily available. Forgery by casting with lost wax has two methods:

First Method:

1- The copied pieces are formed from clay, and then a mold made of thin rubber or silicone. The rubber is placed over the clay copy to capture the details very accurately, and then the wax mold is made around the rubber. The rubber mold lasts a long time, with accurately captured details, thus it can be used to make several copies which are identical to the original.
2- The wax is applied once, or in the form of consecutive blocks, then the wax layer is covered with a layer of gypsum as a wall and an external mask.
3- A tube is placed vertically (creating a casting channel) and is also used to remove the wax after melting.
4- The mold is placed in the hot oven and melts through the tube, leaving a cavity in the exact shape of the copy.
5- While the mold is still hot, the molten metal is poured down the casting channel to fill the cavity and make an accurate copy.

Second Method:

By using centrifugal force instead of heating in the oven, the rotation of the mold forces the metal to be more compact and concentrated in the mold, which leads to the best detail in the shape. Upon completion, the rotation of the mold will stop, so the fake work can be removed and separated from the mold.

Advantages of wax die forging:

- **(i)** Ease of saving wax, and its cheapness.
- **(ii)** The fake copies are easily removed from the wax without leaving any traces.
- **(iii)** The casting quality using the wax mold is great, and the casting effects are invisible.
- **(iv)** The casting channels are much thinner and narrower than the sand mold channels, therefore, their traces can be removed without leaving a mark. However, with experience it is possible to detect the casting channel.
- **(v)** The casting quality varies according to the different tools, and good tools give good surfaces free from casting defects.

The Wooden Mold:

Common woods used in casting processes for the purpose of faking metal monuments include fir, white pine, and mahogany. The wood needs to be dry and stored for a long time, with straight, integrated fibers, narrow pores and with a relatively low expansion coefficient. Thus large models, for example, are made of fir, while small models are made of walnut. Mahogany wood is used for repeated patterns, because it does not swell, shrink, or warp, and despite its hardness, it is soft enough to carve and shape.

The Gypsum Mold:

This is used in models that are repeated in the range of 5 and 6 copies, provided the integrity of the mold is preserved, and it gives good patterns. Gypsum is a material that expands when frozen and has high compressive strength.

Electrical Reduction:

It is possible to make an electrical reduction to give original color and shape to a fake piece made of clay. Then a metallic deposit is introduced by electrical conduction, which is called the reduction process.

Problems that occur in the electrostatic transcription process:

(i) The piece is divided into two halves, which are welded by a suitable alloy, however it is difficult to fit the two halves together completely, which presents evidence of forgery on the edge of the piece, on the line where the two halves meet.
(ii) The presence of the two halves makes controlling the weight difficult, so we rarely achieve the correct weight compared to the original.
(iii) The deposition is not disguised as a valuable artefact.
(iv) Air bubbles are trapped between the mud and the sedimentation, due to the presence of moisture in the clay, which leads to the presence of small bumps on the fake piece.
(v) Another problem is caused when the fake piece is withdrawn by sedimentation from the clay, however, this leaves irregular depressions, which distort the fake piece.

Fig 8: Fake Gold Athena Coin with Casting Channel. (Photo: Shutterstock Images).

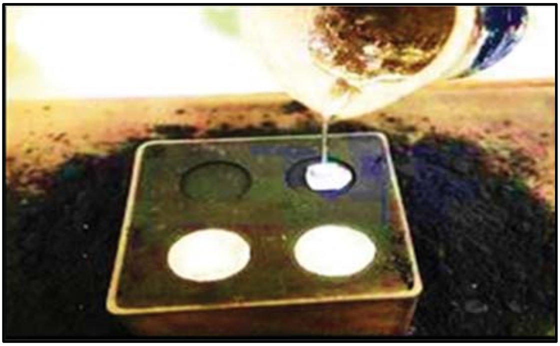

Fig 9: Faking Coins by Sand Mold. (Photo: Shutterstock Images).

Conclusion:

Despite the previous problems, amazing detail can be captured by electrical reduction, but in general, this method is rarely used due to the difficulty in concealing the edge lines. Few museums still make this method a purpose of academic study.

All the previous methods still have a problem with the casting channel. Despite attempts to remove them, the effects of the casting channel appear by analysis and careful examination. This is usually the biggest problem in forgery, and with the method of lost wax, specifically.

CHAPTER TWO

METHODS OF DETECTING FORGERY AND THE FAKING OF ARCHAEOLOGY

Organic Archaeology (manuscripts and documents)

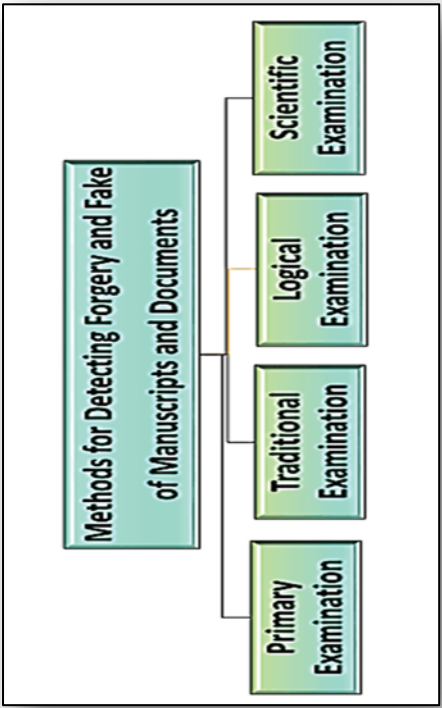

Table 2-1: Methods of Detecting Forgery and the Faking of Manuscripts and Documents, by author.

1-Primary Examination

A-Knowing the manuscript - text, explanation, and footnote.

B-Trying to read the manuscript to know the topic.

C-Extracting all the names, places, chapters, and dates, that the examiner encounters, or texts taken from other books, for comparison them with another manuscript.

D-Knowing the author and the name of the book.

E- Uncovering Suspicions - this method depends on guessing, such as guessing the title of the book through indexes or the author's guessing by the subject.

2-Traditional Examination

A-Checking the paper type

B-Checking the locations of the assembly holes of a manuscript (is the hole old or new? Was a pin or thread used?).

C-Putting small brackets around words that attract attention, and on extra pictures from the manuscript.

D-Noticing the extent to which the right border of the text is parallel to the left border, and whether or not the margin distances are regular.

E-Noticing the direction of the calligraphy and the direction of the words (are they ascending, descending, or straight?), or the words which are attached, noting the places of modification.

F-Noticing the adjacent letters (is the size normal, increased, or is there a difference?).

G-Noticing when the pen is raised and stopped, and when calligraphy begins and ends? Are they the same or different?

H-Noting verbal touches, where they are drawn at the bottom of each part of the letters, where this calligraphy is straight, and separates more or less in the word, to show the differences between the original and forged text.

I-Noting the diameters of the corners, distortion of the edges, the decoration, stop signs and numbering.

J-Examination of the page numbers (is there a change in the numbers?).

3-Logical Examination

Historic Analysis: a historical knowledge of events and places and the history of rulers and authors, with knowledge of the historical development of the paper industry, the use of inks, decorations, gilding and watermarks, as well as the historical development of calligraphy.

Critique Analysis: (Internal criticism, external criticism, natural aging criticism):

(i) Internal criticism: by studying the contents of the manuscript to assess whether or not the scientific content applies to the truth, as well as knowing the author's style, whether he or she continued in the same manner, throughout the whole manuscript, and whether there are places of deletion or amendment.

(ii) External criticism: The shape and thickness of the external manuscript, the method of binding used and placing the title, to assess whether all of it is in line with the historical period of the manuscript and where it was copied.

(iii) Natural aging criticism: by noting and recording the following:

The spread of holes and cutting, the shape of these holes, and the fragmentation and brittleness of the heels and side casings.

The spread of color chemicals and biological spots on the pages and leather covers.

Thread sticking, dissolution of cellulose fibers and their appearance as cotton filaments.

The erosion of the paper under the letters written in iron inks, and the fossilization of manuscripts.

Decay of inks and colors, change of paper color and paper loss of elasticity.

4-Scientific Examination

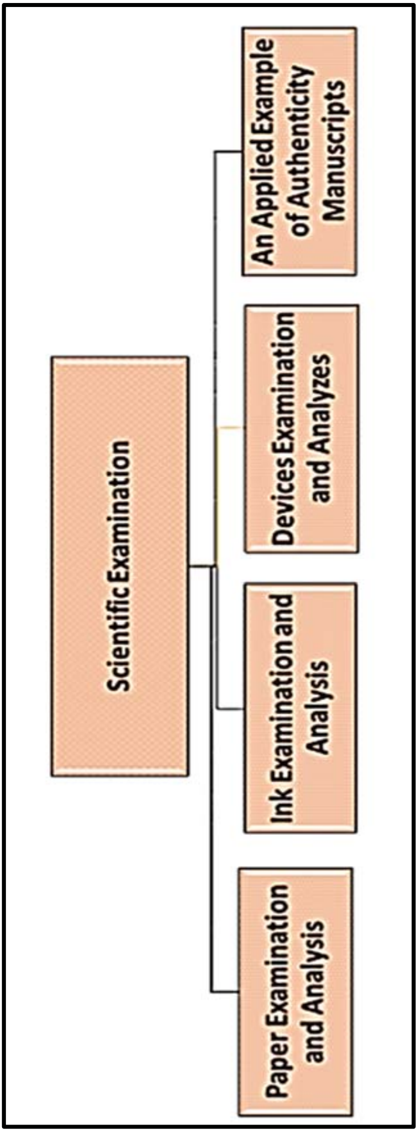

Table 2-2: Scientific examination, by author.

A The Examination and Analysis of Paper:

1-The Examination:

Optical Examination:

Examining the dimensions and surface appearance of the paper, such as the degree of whiteness.

Microscopic examination:

(i) To understand the shape of paper manufacture and the type of fibers, using a scanning microscope or a polarizing microscope (SEM/PLM) and a stereomicroscope.

(ii) To find out the shape of watermarks, and layers that are not visible to the naked eye by imaging using ultraviolet (UV) rays, infrared (IR), or radiography, and after that, referring to the catalogues and atlases to match it, such as watermarks.

2-The Analysis:

To know the composition and components of the inner paper compounds, using methods such as XRD/XRF Raman.

3- The Use of Reagents for the Paper added Material Detectors:

Detection of lignin concentration or its absence:

Paper made from **wood** contains a high percentage of lignin.

(i) Use of Aniline Sulfate: by dissolving 1g of aniline sulfate in 50 cm^3 of distilled water and adding one drop of sulfuric acid, then putting a drop of the previously prepared solution on the paper to be tested. The presence of lignin gives a color (yellow).

(ii) Use of Fluoroglycinol: by dissolving 2g of fluoroglycinol in 50 cm^3 of pure alcohol, and adding two drops of previously prepared fluoroglycinol solution, then one drop of concentrated hydrochloric acid. A red color appears indicating the presence of lignin.

Detection of alum using aluminum: by dissolving 0.05g of aluminum in 5cm^3 of distilled water, and adding a drop of the previously prepared solution, the appearance of a bright red color indicates the presence of the aluminum compound inside the composition of the alum.

Detection of rosin:

Using a concentrated solution of sugar, a drop of this solution is placed and then left for a while. Then a drop of concentrated sulfuric acid is added, and the appearance of a scarlet color indicates the presence of rosin.

Detection of Starch:

Prepare a solution by dissolving 1g of potassium iodide in $10cm^3$ of distilled water, then dissolve 0.3g of iodine into it. Then 90 cm^3 of distilled water is added. If starch is present, a dark blue color appears.

Detection of Gelatin:

By adding 1mm of copper sulfate with hydrogen peroxide in a tube a foam will appear. When the foam subsides, the tube is placed in a boiling water bath and during that, 1mm of sulfuric acid is added. The tube is left in the water bath for five minutes, and then it is left to cool down, before some drops are distilled onto the paper from this reagent. In the presence of lignin the paper sample is colored pink.

B-The Examination and Analysis of Ink:

1-Optical Examination:

Using the naked eye or magnifying lenses to observe the shape of the inks.

2-Microscopic examination:

Using microscopes such as the Stereo/Polarizer which may be accompanied by dual-color filters to identify the nature of pigments and inks.

3-Ray Examination:

Infrared and **UV** rays to illustrate obliteration, chamfering, and modification processes.

4-Devices to differentiate between old and modern inks:

Such a Video Comparative Device VSC6000, or Laser.

5-Analysis of ink:

As analysis to identify ink compounds and pigments by means of FTIR / ED-X, or using a chromatography device.

C- Examples of Devices Used to Detect Forgery:

1-Macrophotography
2-Stereotactic examination (3D).
3-Radiography (CT + 3D):
4-Examination with video comparator (VSC_{6000}).
5-Examination and authenticity by Tearing.
6-Colorimeter.
7-Scanning Electron Microscopy (SEM + EDX).
8-Infrared (IR)
9-Ultraviolet (UV) rays.
10-X-ray - Radiation diffraction (XRD) + (XRF).
11- Raman
12- Radiocarbon.

1-Macrophotography:

This method relies on photographing accurate details of the monuments in a specific location to clarify these details further. This method is applied in all the museums of the world, with the aim of documenting and preserving the archaeology from forgery, in the safest confidential places, for reference when needed.

Fig 10: Close-up of a manuscript written in Spanish which is part of the Palafoxiana Library stock. This library was built in 1646 and the microphotography point is indicated by a red circle. (Photo: Shutterstock Images).

2-Stereoscopic Examination (3D):

The method that has been recently introduced in detecting technical falsifications is known as Digital Authentication, through which the image is divided into bands, and each band is analyzed by optical projection and color sensitivity, before the waves are analyzed so that they are divided into low frequency and high frequency for comparison. If there is an external part, it will appear as a frequency which is different from the rest. This difference appears in the terrain of the image, in nanometric detail, such as surface roughness or a clear change in image stability, a difference in the distribution of ink on the surface or the shape of ink particles, and it also appears as a chromatic aberration from the difference in wavelength in paper and ink, in the case of extraneous fake words. There are two methods for digital fake detection:

Active Detection:

Making digital comparisons between authentic and forged documents and manuscripts. This is most important for signatures and watermarks.

(i) Signatures: a kind of mathematical diagram is created, such as the retina, in an area of around

16 x 16 pixels. This retina surrounds the fake and original signatures, making a comparison, and then extracting a unique feature from the thickness of the signature, the shape of the pen stroke, or the beginnings and ends of the stops.

(ii) Watermarks: The watermark is verified by entering the original mark next to the fake one, making a grid comparison, and recording the differences.

(iii) Passive Detection: This method does not require the presence of the original piece or signatures, and this is an advantage. The counterfeit piece is completely scanned by digital imaging and recorded if there is manipulation, extraneous words, color appearances, or a different distribution of ink particles**.**

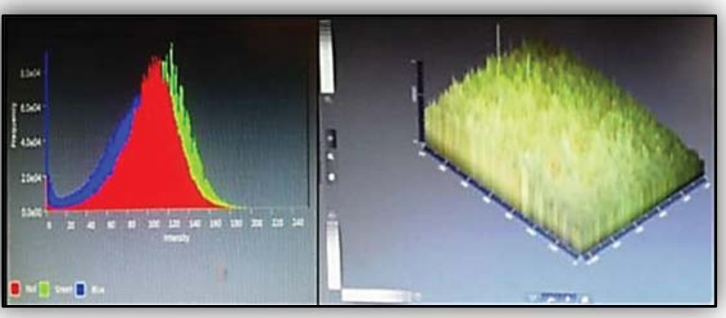

Fig 11: Digital Authenticity. (Photo: the author)

Radiography (CT + 3D):

X-ray imaging is a non-destructive examination that provides us with information about the internal content of the manuscript or monuments, called radiographic imaging (CT), and, with technological development, we have obtained a full stereoscopic vision at an angle of 360° after adding the 3D imaging technique, so the X-rays fall and penetrate the four directions of the piece, but unevenly, as the radiation is intensely directed in the facing direction, the beam intensity decreases in the other directions, and the writing appears in the following dimensions: 0.1 x 4 x $4cm^3$.

Using the examination method according to the ALARA Standard, the book or manuscript is placed in front of the scanner (CT) so that the outer cover is perpendicular to the axis of rotation (Z) so that the radiation reaches the largest possible area.

Advantages of radiography in detecting manuscript forgery:

- **(i)** There are mobile types that can be used on-site and in museums.
- **(ii)** To show the writing which is attached to manuscripts, which is difficult for us to dislodge between the pages.
- **(iii)** It is used to show the internal content of unopened manuscripts.
- **(iv)** It is used with burnt manuscripts to recognize letters and words that are not clear to the eye.
- **(v)** It is used to distinguish between lines and writing after embossing letters, especially if the letters were written with metal compounds, which makes it easier for us to know the distribution of ink particles.

Disadvantages of radiography in detecting manuscript forgery:

The biggest disadvantage of radiographic imaging is the radiation energy that increases the speed of the accelerated aging of cellulose. To eliminate the risk of this, a reduction of the radiation energy is achieved by reducing the amount of radiation according to the standard method (ALARA).

Fig 12: Museum of Natural History, Austria: X-ray of skeleton on the computer screen with various analyzing tools. (Photo: Shutterstock Images).

The Video Spectral Comparator 6000 (VSC_{6000}):

This device contains different light sources for examination, and it is used as a screening tool to verify the authenticity of a manuscript and documents. It contains a computer, and a basic unit, which has a high-resolution camera with a sensitivity of 360:1100 Nanometer, and various light sources, optical filters, and a lighting panel. Placing the sample on the lighting panel can illuminate the document from below, thus the images and information are transferred to the computer connected to it.

Light sources that depend on the VSC:

(i) An incandescent LED filament lamp.
(ii) Infrared IR source.
(iii) A source for the emission of ultraviolet **UV** rays.
(iv) A source of regular light, which is used as a flash.

The device works on two sides:

(i) The first way is by placing a reference file that contains a large number of colors and pigments dating back to the same time as the original manuscript or document. The colors and pigments are photographed and examined from the unknown manuscript or document, and a comparison is made with the reference dyes, with a confirmatory analysis done using SEM + EDS to confirm correct results.

(ii) The second way is a direct comparison, by placing the image of the original document next to the image of the forged document, performing photographic checks using different lighting sources, and showing the contrast and monitoring the differences. However, if the fake document is a single document without an origin, it is examined, the discrepancy is monitored, and the areas of deletion or addition are shown as in the examination, by a photograph (UV and IR).

Fig 13: The Video Spectral Comparator. (Photo: the author)

Checking for tearing with a Top-Hat transform program:

Examining rips and paper damage is indicative of authenticity, because natural tearing from the effect of time is unique, and different from intentional tearing. The word ‘crack’ means a tear that occurs in the paper, or in the pigments, used in manuscripts or documents. This is studied by examining the normal image using the Top-Hat Transform program, and from this examination, a histogram is drawn showing the beginning and end of the crack, the extent of its connection with the paper fibers, and the extent to which the colors are related to each other. It will be clear whether the crack or tearing is natural or intentional from the shape, the connection, and the strength, of the fibers together, as well as the strength of colors and their bonding. The causes of tearing in paper and dyes are aging, drought, and mechanical factors, and the tearing shape is irregular because the pressure and drought on the paper and dyes works on the evaporation of the water content inside them, which leads to dehydration, irregular cracks and peeling. Finally, this leads to fragmentation, tearing, and distortion of the manuscript form.

Fig 14: Ancient Manuscript with Tearing. (Photo: Shutterstock Images).

Top-hat Transform:

The digital morphology of images is processed by Top-Hat Transform. Small elements and details from the images are presented in black and white, where the white parts represent small cracks which are glossy, and the black parts are the rest of the image. It is possible to control the image in terms of area, tools, and lighting, through the program settings, which helps to detect tears, the extent of the fibers correlation with each other, whether the ruptures by time are natural or artificial, and the types of cracks in the paper and colored manuscripts, such as:

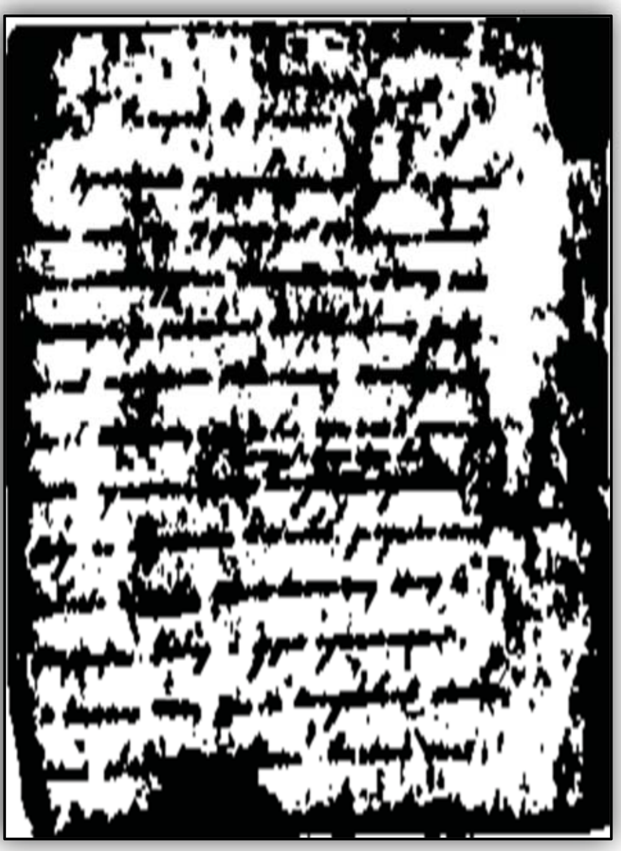

Fig 15: Image Captured of an Old Manuscript with a Program. (Photo: the author)

6-Colorimeter:

I-How the device works:

Color is produced by light waves that are reflected from the material and affect the eye, giving the feeling of color, depending on the type of light absorbed or reflected, and on the material's ability to absorb and reflect light.

The color contrast device works to accurately estimate and measure the size and quantity of a substance in a solution, and each color has an internationally agreed quantitative measurement, so the material to be measured is converted into a color by mixing it with one or several other materials, so that the color degree and its density are proportional to the concentration of the substance that we are measuring, For example, if the concentration of the substance increases, the concentration and intensity of the color increases, and vice versa.

A colorimeter measures the degree of color, based on a law by which the degree of concentration of a substance can be obtained using a standard solution, which is prepared by dissolving a known weight of the substance to be measured in a known volume of distilled water, so it gives a constant reading. The standard solution has a fundamental role in the process of calculating the concentration of the substance in the sample, allowing the device to compare two different spectra.

II-Installing a Colorimeter:

The installation requires the following:

- A light source, such as a tungsten bulb for regular light, or hydrogen bulb for ultraviolet rays.
- Optical filters.
- Monochromatision.
- A glass prism or a reflector that diffuses light.
- Photomultiplier.
- Cuvette bowl.
- Photo Cell.

III- Reading the result:

This can be done in two ways:

1- The reading is based on the scale and index of the device. In this reading there are two gradients, one for transmission and the other for absorption.
2- A digital reading, which is on a digital counter that is pre-set through the device's control panel to determine the reading system.

IV-The method:

The amount of light absorbed or reflected is calculated depending on the thickness of the colored solution, or the path of the light through the solution, according to Lambert's Law:

$$\frac{RT}{RS} = \frac{CT}{CS}$$
$$CT = \frac{RT}{RS} = CS = 1000V$$

Where:

CT is the sample whose concentration is to be measured.
CS is the standard sample.
RT is the reading for the sample,
RS is the reading for the standard sample,
V is the intensity of sample concentration.

A: Blank is used to set the colorimeter, and distilled water is used as Planck's solution
B: The wavelength assigned to the reading is defined as Wavelength.
C: Set the device to zero with the required solution.
D: Take into account the cleanliness of the cuvette container before and after use, and that the content of the solution in it is 1mm.
E: Ensure that there are no bubbles in the solution.
F: Close the cuvette location securely.

Fig 16: Colorimeter Device. (Photo: the author)

7-SEM+EDS or ED-X

Scanning Electron Microscopy + Energy Dispersive "X-ray" Spectroscopy:

The scanning electron microscope works by inducing a current of electrons with high energy of 0.5: 40 K-Volts, so the current collides with the sample being studied, and the image of the sample is clearly and accurately reflected up to a distance of 10 nanometers. The electron microscope is characterized by the fact that the samples do not need Preparation much. This problem can be solved by adding some acetone to the sample to reduce its energy without clumping, because the scanning electron microscope is used to photograph the structural composition of the sample with a high-definition technique and with high magnification power. The sample is coated with gold for 30 seconds to improve the surface condition of the sample.

The EDS unit, which is a unit of chemical analysis of elements in very precise areas, is attached to the analysis by SEM + EDS which helps in distinguishing between the original and the fake manuscript by studying the history of the manuscript’s era, and the technology used to make the pulp, and linking the historically used compounds with the elements of the present sample to be analyzed.

Fig 17: Scanning Electron Microscopy. (Photo: Shutterstock Images).

8-Infrared (IR):

Infrared Examination (IR Spectrometry):

Introduction to Infrared:

Infrared is a type of electromagnetic spectrum. The electromagnetic spectrum is a collection of waves and particles with individual wavelengths, and the spectrum is divided into seven sections, arranged according to decreasing wavelength and increasing energy and frequency. Infrared radiation was discovered when experiments were conducted to measure the difference in temperature between the colors in the visible spectrum. Devices were placed to measure the temperature in the light path for all the colors of the visible spectrum, and the increase in temperature when moving from blue to red was noted.

Characteristics of Infrared:

One of the most important things that we rely on in the use of infrared imaging is to examine manuscripts and documents by their ability to absorb and reflect rays. Material that absorbs a large amount of the rays falling on it and reflects little, shows as dark, or black, while material that absorbs little from the rays and reflects the largest amount of them, shows as light (white or grey). Thus, infrared imaging succeeds in detecting forgery, whether by addition or erasure forging. In cases of detecting forgery by erasing, the chemicals used in the abrasion will remove the color of the ink, leaving traces of ink and pressure. The writing remains, and due to the ability of infrared rays to penetrate the surface layer of the paper body, the original writing appears opaque in front of the infrared rays, while the fake addition is detected through the contrast of the infrared absorption by modern ink. Old ink is different, and the image appearing in front of the infrared rays is different in terms of the degree of contrast between dark and light.

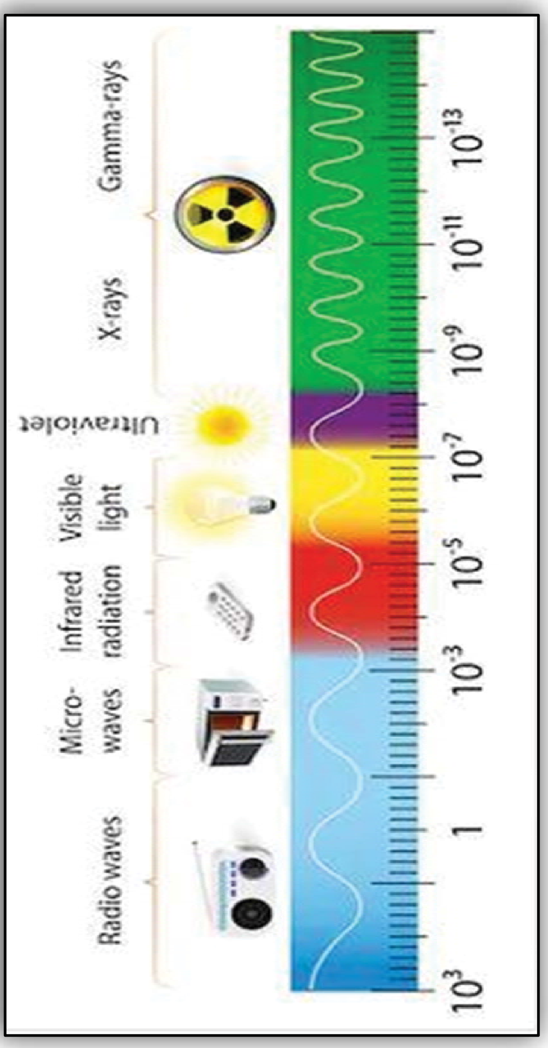

Fig 18: The Electromagnetic Spectrum Vector Diagram. (Photo: Shutterstock Images).

Fig 19: Examine and Photograph an Oil Painting using Infrared at St. Petersburg Museum. (Photo: Shutterstock Images).

Infrared analysis (FTIR):

This is a non-destructive method for demonstrating the chemical properties of manuscript and document surfaces, analyzing a sample ranging from 1-4cm.

FTIR spectroscopy is used to determine the functional groups of cellulose and colors in each sample, and to detect the vibration and imbalance of the functional groups. These differences help to identify natural or industrial aging, in addition to determining the chemical composition of the additives used during the preparation of the paper pulp. The additives in the manufacture of paper, and the percentage of Lignin determine the method of making the pulp, and whether it is made from chemical or semi-chemical pulp.

Fig 20: Using Infrared Analysis in St. Petersburg Museum. (Photo: Shutterstock Images).

8- Ultraviolet (UV) Rays:

The Use of Ultraviolet Rays in Analysis:

This is used with caution, due to its destructive damage to the plot and sample, so it is only used to distinguish pigment compounds by means of UV Transmission and reflection spectra.

Ultraviolet rays are widely used in the analysis of heritage pieces, and this method was used in the late 1970s to study the history of artworks, especially color changes and identification of pigments on artistic surfaces. This method has developed a lot in recent times, and equipment became portable. Thus the scope of use expanded, even close to the infrared area (2500 nanometers). The most information is obtained from an analysis is by blue, green, white, red, and most yellow dyes, but black pigments are not distinct except in the iron oxide range. The most important advantage of UV analysis is that it is very fast and can obtain high spectrum quality in less than 10 seconds, which allows for large surveys of individual works or entire groups in a relatively in a short time. The tools are not limited in size or shape, and the qualitative interpretation of the spectra is relatively easy, even where components, such as pigments drawn on paper, are mixed and complex.

The Use of Ultraviolet Rays in Examinations:

This is to show the layers that are not visible to the naked eye, using UV Spectrometry, which is one of the most important methods of detecting forgery, especially in cases of forgery by deleting or adding.

Ultraviolet shows deleted writing, and identifies added writing as follows:

Either (i) the deleted original writing shines and appears white on a dark surface if the reaction of the original ink with the removal solution results in a new substance that has the property of fluorescence; or (ii) the writing appears as a dark color on a white or grey surface. The reason for this is that the original ink disappears permanently as a result of chemical treatment, where the action of the removal of materials except for traces of ink compounds, which often contain iron or carbon, remain latent in the body of the paper that the writing is on. Because these compounds absorb, and do not reflect, ultraviolet rays, they appear black. As for the surface of the paper, it will definitely reflect the rays in white, and this is the reason why writing appears as a dark color on a white surface.

In the case of added writing, ultraviolet rays show a clear contrast between the extent of old and modern ink's brilliance, and record it. The strength and intensity of fluorescent or phosphorescent fluorescence are affected by ink's age or freshness.

Three factors affecting the reflected or fluorescent rays during the examination of manuscripts:

- **(i)** The chemical composition of the ink, and the property of its brilliance against ultraviolet rays.
- **(ii)** The chemical composition of the removing ink or abrasive material when there are deleted words, and the properties of its shine in front of ultraviolet rays.
- **(iii)** The characteristics of the paper and whether it is fluorescent in front of ultraviolet rays, or if it absorbs them and appears dark in image.

The Way Ultraviolet (UV) Rays Work in an Examination:

In the electromagnetic wave chain, ultraviolet rays occupy the region that follows the ultraviolet rays, and are shorter in the range between 1000 and 4000 Angstrom, where visible rays fall between the field of view between 4000 and 7000 Angstrom. Ultraviolet rays have energy, and this energy, if it falls on a substance, takes one of the following forms:

- **(i)** The substance absorbs it and turns it into thermal energy;
- **(ii)** The material absorbs it, and it is reflected again in the form of visible shine, which may be fluorescence and phosphorescence.
- **(iii)** It is absorbed by the material and then reflected in the form of invisible ultraviolet rays. Then the wavelengths of the reflected waves are less than 3900 Angstrom.

Ultraviolet Imaging Method:

Ultraviolet imaging can be done in two ways:

- **(i)** Fluorescent or phosphorescent photography.
- **(ii)** Imaging the rays reflected in the form of ultraviolet rays.

Fluorescent or Fluorescent Fluorescence Photography:

In order to record the fluorescent and phosphorescent phenomena in photographs, a method must be found to absorb visible rays (fluorescence), and an optical filter is placed in front of the radiation source. One of the characteristics of the filter is to absorb visible rays and allow only ultraviolet rays to pass through. The resulting image is then recorded by the ultraviolet rays from the surface of the material.

Imaging the Reflected Rays in the form of Ultraviolet Rays:

Ultraviolet rays are reflected from the surface of the material in the form of invisible rays also in the UV range. In order to record the reflected image, the steps are identical to imaging fluorescent or phosphorescence, by placing a filter that absorbs the visible rays and allows the ultraviolet rays to pass through. The image reflected from the surface of the material is recorded, by the ultraviolet rays.

- **(i)** Before photography, the manuscript must be exposed to ultraviolet rays for a period of not less than ten minutes.
- **(ii)** In order for the light source to rise in temperature, it emits the largest amount of ultraviolet energy, and this heat has an effect on the extent of fluorescence appearing in the hidden writing, as the brilliance increases with the increase in temperature.
- **(iii)** The heat of the source, and the energy produced by the ultraviolet rays, may cause the re-appearance of the disappeared writing immediately. The reason for this is that the heat causes chemical changes to emerge on the paper, helping the disappeared writing, to re-appear without resorting to photography and filters.

The longer exposure period creates greater penetration of radiation, and a greater chance of stirring the ink.

Fig 21: Examination of the Currency under Ultraviolet Rays. (Photo: Shutterstock Images).

9- X-Ray:

X-Ray is a non-destructive chemical analysis, the purpose of which is to identify the basic elements and defective elements of paper and ink. From a knowledge of the elements and compounds we can understand the industry technology used to prepare the paper pulp or ink compounds, and compare originals with forgery samples by knowing the elemental composition, and using an X-ray device consisting of source, detector, and analysis tools.

Two Types of Analysis Using X-Rays:

X-ray diffraction (XRD):

This is used to identify the basic chemical compounds and impurities involved in paper and ink making and is considered a primary analysis.

X-ray fluorescence (XRF):

The use of XRF is simple, inexpensive, and portable, including portable devices, and can be set up on-site. One of its most important advantages is that it is used with dyes, in addition to its use with paper and other effects. This method depends on identifying the basic and defective elements in a specific area of the trace, using the device connected to a computer. The area becomes a fingerprint, without taking a sample, and its results are kept in complete confidentiality. When the pieces are transported to exhibitions, and then returned, it ensures that the area that was identified from before, shows the same elements after conducting the analysis. If the same elements appear, the piece is considered original, but if the elements are found to be different, this means that the object has been replaced, and that it is forged. The basic rule in using X-ray fluorescence analysis is to excite the sample with X-rays from the source. The sample will absorb this high energy, which generates energy, in the form of fluorescence. Each chemical element has a special luminescence, and by measuring the intensity of fluorescence, we can identify the elements.

Some Problems with XRF Elemental Measurement:

- **(i)** If the sample surface contains coarse grains, there will be a negative effect on the measurement, and the measurement from the original will be inaccurate.
- **(ii)** Identifying elements using XRF is difficult when complex chemical compounds are present.

(iii) The measurement depends mainly on the source of radiation and the detector. The starting radiation energy, coming out of the source, may be unsuitable for the sample, and may make the measurement inaccurate.

Fig 22: X-ray Device. (Photo: Shutterstock Images).

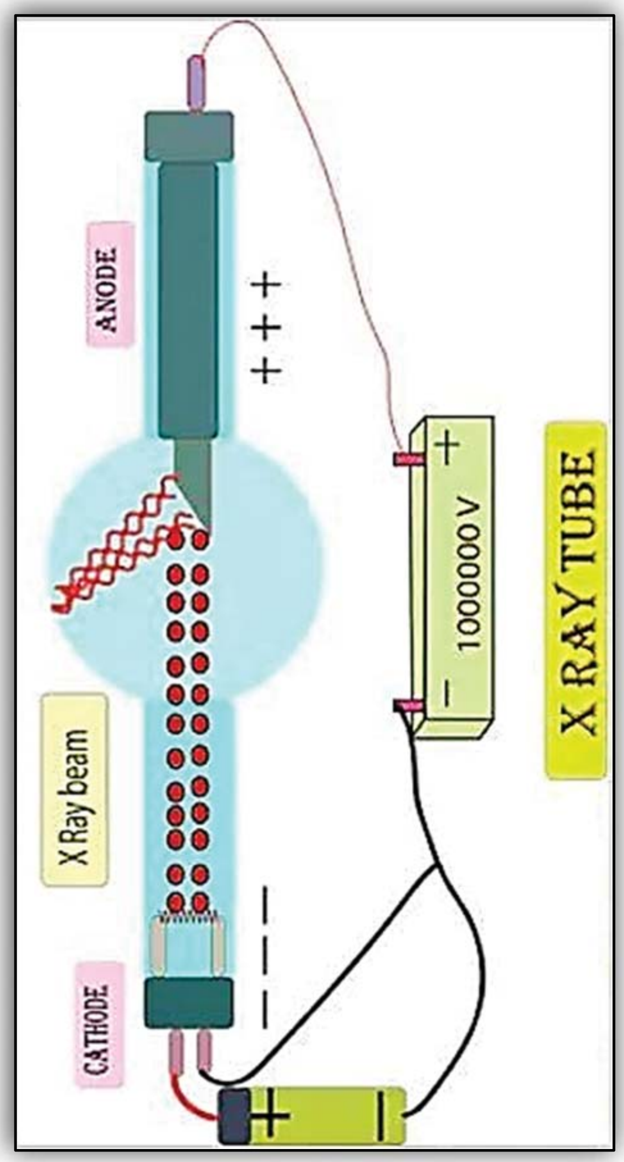

Fig 23: X-ray tube, X-ray Machine Work. (Photo: Shutterstock Images).

10-Micro-Raman:

This is an analysis that deals with the study of low-frequency molecular vibration patterns, and depends on the scattering of light on molecules, stimulating them to rotate and vibrate. Then the material to be studied is exposed to the radiation of monochromatic light, focused on the components of inks and paper, and compared, to detect forgery between the elemental composition of the fake piece and the original. Known information about the compounds used historically in industrial technology in the era of the manuscript, is used, and the analysis is recorded starting from 50_X /100_X magnification on an area of about 25 mic/meter, which is a useful analysis of artwork, especially paper.

The most important features of Micro-Raman analysis are fast results, relatively low cost, and the fact that it is non-destructive of the sample.

Key defects of Micro-Raman analysis are that it does not give results with some dyes, due to media that may not respond to the Raman signal, and are not recognized. Therefore it is recommended to complete these analyses with one of the other types of analysis, such as XRF.

Fig 24: Portable Raman Device. (Photo by: Shutter Stock Images).

11-Radiocarbon (C_{14}):

Radiocarbon was discovered in 1934, by Grosse. The first person to start using radiocarbon as a measure was Willard Libby, who determined the half-life of radiocarbon, using wood samples known to be 11,100 years old (from tree rings). The half-life was calculated at 5730 + 40 years, and the process was repeated on wooden samples from the graves of Djoser (2800 BD) from the third family, according to the hypothesis of the Egyptian civilization. They found that it is approximately half the concentration of radiocarbon in wood. Radiocarbon provides the utmost accuracy and error does not exceed 10%.

Carbon$_{14}$ is considered unstable because the number of protons is not equal to the number of neutrons, and it has high energy, so it is called radiocarbon, which has a half-life. This is the age required for the amount of radioactivity to halved (5730 + 40), and it is a source of B rays, that decompose over time at a constant rate. After 5730 years have passed, these would have decomposed by half, and this is what call a half-life. This, actively, is the basis on which Carbon$_{14}$ depends when determining age.

Radioactive Carbon$_{14}$ is formed in the upper layers of the atmosphere within 12 minutes. It combines with Oxygen, a component of Carbon Dioxide, which contains an atom of Carbon$_{14}$, and this atom is the one that begins its cycle in living organisms through plants, which absorb it by photosynthesis. Carbon$_{14}$ appears in the composition of organic materials in the plant, and is transferred from plants to humans and animals, through eating. Animals eat plants and take in Carbon$_{14}$, and Carbon$_{14}$ is transferred to humans in the same ratio. When a person dies, he stops storing radiocarbon, so there is no addition to his body, which is considered to be ‘moment zero’. However, the radiocarbon that he stored during his life is not stable, and begins to decompose, and its percentage decreases with the passage of time at a constant rate until it fades completely at 70,000 years. This is the maximum time for the use of Carbon$_{14}$ as a measure, and the history of radiocarbon by radioactive decay of Carbon$_{14}$ is the so-called isotope.

A radioactive isotope is formed when cosmic radiation collides with a core (Nitrogen) in the cosmic air; this collision produces radioactive C_{14}. Then the radioactive isotope is absorbed by plant tissues during the process of photosynthesis. The analysis of radiocarbon depends on the principle of half-life, so radiocarbon has a life. At a certain point the radiocarbon begins to decompose at a constant rate. Because of its continuous decomposition, depending on the principle of half-life in which the amount of radiation decreases to half its value in each period until the number of periods reaches five periods, after which the radiocarbon and red color fade out in the chart showing the amount of remaining radiation after each period, the radiocarbon analysis gives a numerical record of the date of the manuscript.

Factors that affect this Radiological Analysis:

- **(i)** Defects in the sample.
- **(ii)** Continuous radioactive exchange of the sample with cosmic radiation.
- **(iii)** Not separating the elements and mixing the radiocarbon sources and analyzing them together, such as analyzing the radiocarbon resulting from a paper manuscript and a leather cover, which requires analyzing each source separately.
- **(iv)** A comprehensive knowledge of the history and environmental site of the source of the piece must be studied, and the history of the piece itself must be studied, taking into account exposure of the piece to theft, fire, or wrongful restoration.
- **(v)** Noting that there are many types of radiological analysis, and each piece takes what suits it from the analysis. For example, with manuscripts suitable for radiocarbon analysis and not suitable for thermal flash analysis, thermal flash (TL) is a type of optical measurement of the energy which is suitable for inorganic materials containing silica, that retain and store heat before burial.

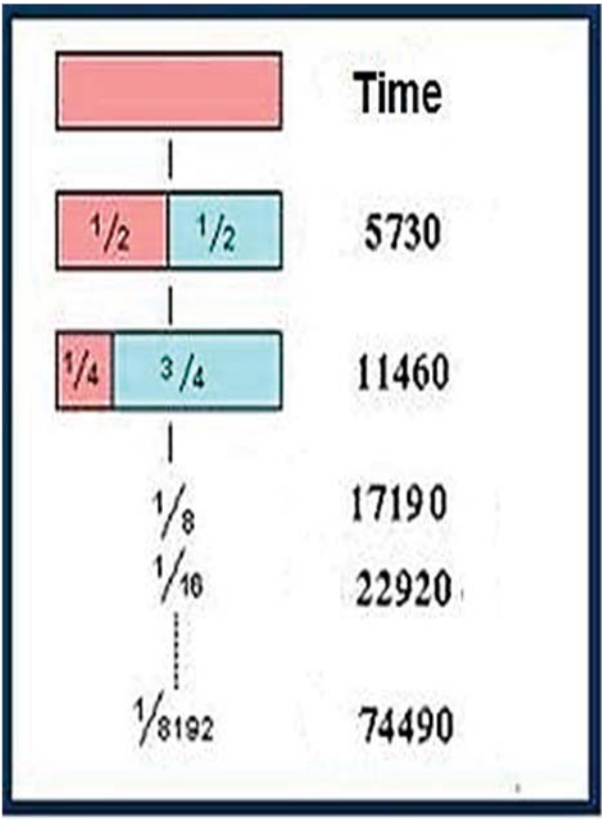

Fig 25: C_{14} Diagram. (Photo: the author)

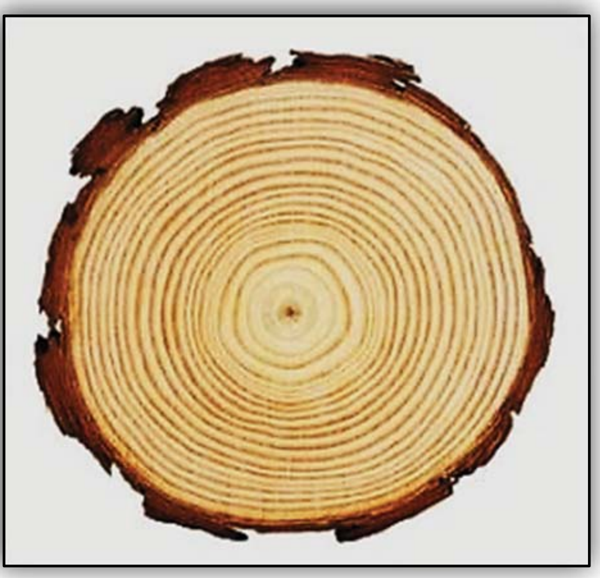

Fig 26: Old Tree Rings. (Photo: Shutterstock Images).

Inorganic Archaeology (Metals)

The forger resorts to technology, and uses 3D technology to do so. This is applied to molds, which leads to the quality of forging and the quality of detail on the faked copies, It is necessary to study all the methods that lead to the forgery used in the modern era so that we can confront the rapid development of forgery.

Forming and Working of Metals:

Forming metals in the past was intended to change the metal from one form to another, using manufacturing processes, and without removing a part or layer of the metal. However, if the shape is changed by removing a layer of the metal, the manufacturing processes are called metalworking operations. In the past, metal formation processes were listed as follows:

Hot metal forming processes and includes two types:

(i) Hot molding in the liquid state (casting), and hot forming in the solid state.
(ii) Metal cold forming operations.
(iii) Metalworking.

Hot metal forming processes in liquid state (smelting and casting):

Casting is the process of forming a metal object by melting the metal and pouring it into a cavity made in a mold, so the metal takes the shape of the cavity after it solidifies, and the shape of the cast is determined by the shape of the cavity of the mold.

Smelting of the metal was done in one, or several, crucibles, according to the required quantity, and the stoves were ignited with coal, which came from many and wide areas in the Eastern Desert and Sinai in ancient Egypt. The temperature in the crucibles reached about 982°C.

The discovery that metals were melted and cast in molds was one of the important steps towards understanding the civilization that was made by the first humans 4000 years ago. Early casting was with colored metals such as Malachite and Azurite, then, after this period copper was smelted. At first it was poured into simple open molds of stone, wood, or often clay, to produce simple tools where the required shapes were cut out of a plastic clay mold and printed on it. Then it was dried and burned to become a clay mold, and after the casting and cooling process, the resulting form of casting took place with some finishing touches and leveling. This method allowed the two sides of the tool to be formed.

Then followed the use of molds consisting of two parts, and cast figures for simple human or animal statues were natural or symbolic, to satisfy many of the deities associated with the first religions.

The ancient Egyptians introduced a new technique in the casting process, which is the lost wax technique. This required a skilled craftsman, perhaps a sculptor, who made a model of the wax required to work, which was covered with a layer of child or child mixed with sand, lime, or gum. Then this formation was placed in the oven in order to make the layer solid, and to melt the internal wax. The mold remained solid by the burning of the child, preserving all the details of the model formed from the wax. Then the molten metal is poured into the child, and the mold becomes cold and full of molten metal. The pottery mold was broken, and then a process of cleaning and polishing was done for the formed pieces. This method was used in the manufacture of jewelry, amulets, and valuables.

With the passage of time, the ancient Egyptians acquired extensive experience in shaping, and an example of this was shown by the two special statues of Bibi the First (One of the kings of the Sixth Dynasty) which are the two oldest known metal statues in ancient Egypt. The casting used the lost wax technique, for the feet and arms, while other parts of the statues used the technique of hammering and welding.

The ancient Egyptians were the ones who laid the foundation for the technique of casting metals, Small statues were usually cast solid, while the larger ones, like the hollow cat statue made of bronze, were hollow.

Fig 27: Melting Wax for Use in Casting (18th Dynasty). (Photo: the author)

Types of Molds Used in Metal Casting:

- **(i)** Open molds are based on sand. The required shape is made as a prominent or recessed carving, then molten metal is poured over the open mold, and after freezing, the sand can be separated from the metal shape, but the molds are dead.
- **(ii)** Closed molds have become famous for the production of repeated products. The mold is in two halves. Each half carries half details of the desired shape, hollowed from the inside to receive the molten metal The two halves are joined together leaving a hole for the

molding, then the molten metal is poured inside, and after freezing it is broken. These molds were often made from clay, whether they were to be used with the lost wax technique or sand-based casting.

Hot forming in the solid state:

The ability of solid metals to accept plastic formations is one of the important mechanical properties in ancient industries, as this property allows for change in the metal and its transformation from one form to another without the need to melt it. The plastic formation occurs when the metal is subjected to a stress that exceeds the melting point.

Hot forming is done at a higher temperature than the crystallization temperature of the metal, while cold forming is done at a lower temperature than the recrystallization temperature, and is usually done at normal temperature. The hot forming processes of metals represent the first step towards changing the shapes of the metal blocks. These processes occur with the metal in a plastic change, and within a specific range of temperatures. This range varies according to the metal being formed. The metal is not burnt or overheated, which could lead to cracks in the metal during the forming process.

The difference between hot forming and cold forming:

Cold forming works to give the metal certain mechanical properties, including increase in the hardness of the metal, increased metal resistance, and the creation of surface formations. The change caused by cold forming is limited, to a large extent due to the stress that occurs in it as a result of this formation, which in turn leads to hardening of the metal. This is called forming hardening, and it can be removed by what is known as fermentation.

Types of hot forming in the solid state:

1: Forging:

This refers to the process of cutting metals into sheets after they are subjected to temperature so that they can be easily formed. There are two types of blacksmithing:

(i) Forge forming, limited to expanding the piece and squaring or lengthening it.

(ii) Forging the molds by placing the panels on pre-prepared molds in shape and size, and cutting the panels with sharp machines to take the same shape as the mold, in order to obtain repeated production of the artifacts.

2: Soldering (welding):

Welding is meant to connect one metal to another which has a lower melting point. This is done by placing the parties to be joined together tightly next to each other. Then the welding material is placed over the joining point, and the heat is directed at the Centre until the welding material is melted and spreads across the part connecting the two metals. Metal joining and welding operations are considered to be among the processes necessary to complete the various forming operations, where the work pieces can be assembled and their parts joined. This is because it is sometimes difficult to form the work from one piece, and in this case, each piece is executed separately. Through the joining operations, rigidity is increased, but the joining operations can also be used in ornamental forms, such as rivets, in different shapes, and in various distributions.

Welding is the process of metallic bonding by means of the forces of attraction between the atoms. Before this bonding occurs, the oxides and impurities between the surfaces of the tension must be removed, and smelting aids such as Natron salt or Silica sand should be used to remove the oxide layer and form a liquid slag floating on the surface. The molten metal in the welding area blocks it from air pollutants.

3: Gilding:

The ancient Egyptians used gold for ornamental purposes, and then concluded that it was possible to convert gold into thin sheets of paper. This led to the application of gilding to the surface of the metal in order to improve the appearance and enhance its value. They also used adhesives for the application of gilding and mechanical methods, but these methods are still considered cold forming. The advantages of gilding include that the metallic surface gains an attractive appearance, it protects the metal from weather factors such as moisture and oxidation, it gives a smooth surface, and its color does not change over time.

Fig 28: Manufacture of Jewelry, Pendants, and the Gilding Process in the 18th Dynasty. (Photo: the author)

4: Enamel:

Enamel is a glassy substance that melts and adheres to the surface of the metal at a high temperature. The use of heat makes this a type of hot forming, and it is associated with metal ornaments and artifacts. It has attractive colors and multiple color grades. Enamel is a transparent material that has no color, but if metal oxides are added to it when melting, different colors appear which differ according to the oxide and the amount present. Enamel is solid, soft, or a medium between hard and soft, depending on the amount of silica and the time required for smelting. The greater the degree of the hardness of the enamel the greater the reduction in the degree of its influence by atmospheric factors. The ancient Egyptians reached a great degree of skill in applying glass coatings by melting crushed quartz with salt of Natron, a process which developed in the era of the Greeks, so the ancient Egyptians worked in Greek times on melting glass material between metal barriers. This method became the first application of enamel known as enclosed enamel (Cloisonné). The Egyptian artists in the Greek era excelled in the use of colors in enamel, especially blue and white, to color themes such as flowers, animals and decorative plants on metal.

In the 9th century in the Roman era, Constantinople became a center for the dissemination of this art, and enamel was applied to gold pieces. The enamel colors were transparent, or translucent, and separated from each other by golden ribbons. Engraved enamel was also applied.

Topics in Islamic art were concerned with plant elements, geometric shapes, and Arabic lines, and enamel was applied with a distinctive Islamic character. Most of the decorative household items were applied with enamel technology.

There is a type of enamel decoration called Niello, which is used after the decorations are engraved on the outer surface of the metal These decorations are in the form of deep cracks filled with black enamel, which are put into the oven to burn until the enamel material is fixed inside the cracks.

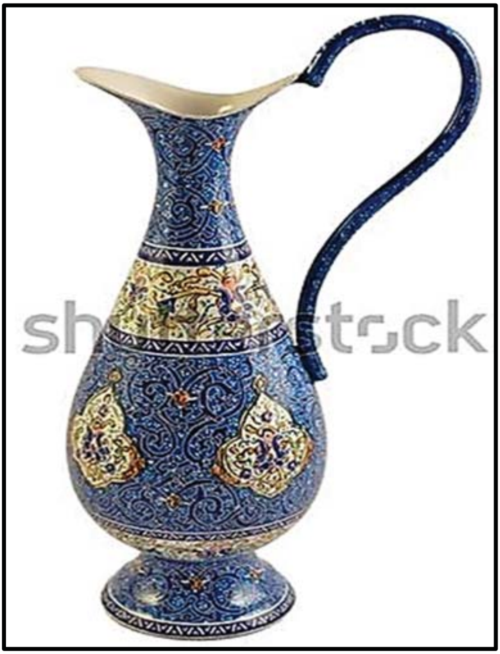

Fig 29: Ancient Enamel Jug. (Photo: Shutterstock Images).

Metal cold forming operations.

The shape of the metal or alloy is changed under the influence of the forces imposed on the formation to take the required shape and size until it reaches the plasticity limit. This is the maximum effort that the metal can bear under the influence of forming stress without returning to its original shape after the stress has been removed.

The change in the shape of the metal should be limited so that the cold forming strain does not lead to the hardening of the metal in what is known as strain hardening. This results in cracks or fractures in the metal, where the metal loses its plasticity property, and it is impossible to continue forming on it cold, except after a procedure called annealing, or the fermentation process. This is done at temperatures lower than the recrystallization temperature, and cold forming is used when there is a need to impart the metal with certain properties in terms of dimensions and size, using special, accurate equipment.

Hammering:

This is the first process of preparing metal sheets after smelting and refining the metal or alloy and taking them into spherical shapes, where the manufacturer flattens them with contiguous strokes from the inside or outside and in all directions using hand hammers (mallets) or iron gouaches with wooden legs. This creates a convex shape, and the hammered metal is then levelled using flat or flat-faced hammers, and in many cases double-sided hammers, where one side is convex and the other level. This is done by placing the metal on a wood anvil or an iron anvil, where a worker fixes it in position while another worker knocks it, using a metal or stone hammer tool, in all directions. The efficiency of the forging process in different directions depends on the chemical composition and the physical properties of the mineral, which includes the homogeneity of its grains and mineral crystals, and on this basis, the metal or alloy containing fine grains has a high resistance to hammering stress and higher durability than metals with large grains, or metal impurities. Therefore, bismuth and antimony are considered to be minerals that impede the process of forming by these methods, as they are found in metal compounds with brittle membranes on the surfaces of the grain boundaries, even in very few percentages, not exceeding 0.2%. Metals are formed in this way by applying local compressive forces to them with hand hammers. In ancient Egypt, work was done by rubbing the surface of the metal with a fine stone, then with leather, wood, or hematite fragments. Steel files were also used to smooth the metal surface.

Metalworking:

Metal artifacts are obtained in the final form by removing the appendices in the metalwork (called Rish), using tools and a number of pieces. Metalworking operations with hand tools such as files depend on the physical strength and individual skill, due to the effort required.

Metal workability is a characteristic of the properties of metals, so the ability of the metal to work is difficult to represent in numbers, unlike other properties such as hardness, due to the difference in the working characteristic from other properties. Workability means the ease in removing the metal appendages in addition to the ability to impart an acceptable surface to the occupied metal. It is possible to say that a metal has good workability if a portion of the metal can be easily removed in some way, and the new surface produced after removal is good.

A-Factors that fall into the operation:

Hardness of operating equipment and work piece

The cut ability is the cut-off limit for the operation kit to penetrate inside the work piece. This depends on the hardness of the materials and the operating equipment. If the hardness of the work piece material is higher than the hardness of the operating or cutting tool, the operation process with this equipment becomes impossible, and vice versa.

Grain size occupied:

The size of the worked interlayer granules affects the operability, because the large particle size reduces the forces required for the operation and, as a result, the cutting depth can be increased.

Cutting temperature:

Low temperature generated in the cutting area causes a good and smooth surface to be worked out, because it reduces the possibility of welding between the cutting edge and the work which is expected at high temperatures. This affects the smoothness of the surface after the end of the operation process, and accordingly, coolant fluids are used in order to reduce the temperature in the cutting area.

Defects in the work piece:

The presence of sand and slag inside the work piece, as a result of an impure plumbing process, affects the cutting edge of the working tools and leads to their rapid damage, due to their high hardness. Often there are gas gaps inside the work piece, which cause the cutting equipment to vibrate due to a difference in the forces affecting the cutter. This leads to a reduction in the quality and smoothness of the work surface, and to the potential breakage of the cutting edge of the operating equipment.

B-Workability of metals:

There is no identification of digital operability, or its difference between one metal and another, but between one process and another on the same metal, in addition to the effect of previous operations that were performed on the metal earlier, such as plumbing, or heat treatment, and the method of its formation.

Ferrous metals:

The higher the carbon percentage, the less steel is able to accept work. Wrought iron is the most workable type in the past.

Non-ferrous metals:

These usually show better workability than ferrous materials, but magnesium and aluminum alloys reduce the workability of the metal, and brass alloy has good workability, especially if it has a lead content.

There are two methods of examination and analysis in the study of the forging of metal artefacts:

1-Method of Visual Examination

By using a more subjective method known as style analysis, which is considered as a form of documentation and depends on the expert eye and visual examination by art historians and restoration experts. This method is used initially, to find and recognize clear evidence to determine whether a piece is fake or authentic. This is done by: an eye examination, examination using a digital camera and computer, or examination using microscopes and various examination devices.

Method (Visual Examination)

Optical investigation is done as follows:

Visual Investigation:

To find out signs of vowels and ornamentation using eyes or magnifying lenses.

Forming Marks and Decoration:

Dating and revealing the authenticity of metal pieces by inferring the operating and decoration marks, after visual examination, recognizing the operating signs that indicate the manufacturing and decoration methods that were used to produce the piece, and comparing this information with historically documented samples.

The art of decoration on metals is intended to make formations that combine the functional and aesthetic aspects of a piece at the same time. Egypt is considered one of the first countries to use the art of decoration on metals, but it flourished and advanced greatly in the Mamluk era, which is known as the golden age of decoration, for the number of decorative pieces produced. As a guide to the date of a piece, it must go through the forming and operating stages that produce marks on coins of the time.

Different types of molding and decoration:

In addition to forming and embossing by welding, gilding, enameling, drilling, grooving, printing, hollowing, punching, veneering, and inlaying with precious stones, there are other types of forming and decoration methods:

Decorating by hammering methods: This is done using a hammer with certain types of hard pens, where the manufacturer prepares the decorations and hammers on them so that they appear prominent or deep as needed. This used in the formation of vessels.

Mold decoration: This is done by making metal molds on which the decorations are executed prominently. The purpose is to make deep decorations on the surface of the metal piece, and molds are used during the preparation before the piece is completely dry, so that its outer surface is subject to decoration.

Addition decoration: This is intended to add other parts to the surface of antiques, which may be of the same type of metal or another type. Thin strings are affixed to the outside of the piece before it is completely dry.

The waist: This is expansion of pots and jugs at the edge of the base.

Straightening: Treating the twisting or rippling that occurs during the formation of pots is done by knocking on a piece of iron, called the flower of straightening, or by using a hammer, or, in the case of straightening thick pieces, by heating before straightening, which is divided into two types:

by hammering or by heating.

Repousee: The aim of this method is to highlight and show the decorative units and scenes painted on the metal surface so that it resembles what is called relief.

Sandblasting: The craftsman uses different hard pens to draw round, square, straight, or perpendicular points. This method is distinguished by the fact that it enriches the artwork aesthetically, because it shows the contrast of the rough-touch effect that results from the edges of the different sanding pens and the soft-touch domed drawings.

Common decorative items on metal artefacts:

Among the most decorative elements painted on metal products are various plant and geometric motifs, such as the lotus flower and the prominent formations of pharaonic gods and kings. Drawings of ducks flying with their wings in the air, were widely used in the era of the Sultans from the Qalawun family, due to the meaning of the word *Qalawun* (flying ducks). In addition to the presence of Arabic writing on the represented metals in the Kufic and Naskh scripts, and behind the growth in the art of metalworking, a large number of craftsmen and artists, and even some of their products featuring the signatures of their makers, have reached us. The artistic inscriptions on the products have spiritual connotations, some verses and prayers on are written on metal artefacts, and specific drawings (animals) are made for the purpose of extinguishing an aesthetic pigment, and highlighting their shine as a method.

C-Visual Examinations on a Coins:

Correct coin manufacture:

Coins are made of alloys bearing different percentages of metals depending on the material value of the coin, and these alloys are manufactured with a mixture of different types of other metals to improve their properties.

The alloy required for casting coins is required to have attained a high degree of hardness and ability to withstand natural weather factors, so that the writing and decorative inscriptions or drawings characteristic of it do not erode, guaranteeing the longest period of time for circulation. Therefore, the chemical proportions of the components of the coin alloy are clear evidence of coin authenticity

Study the stages of forging coins:

There is a difference in the method of work between the manufacture of forged coins by using a fused alloy and the method of work in the manufacture of original coins using cold pressing in the role of minting money. It is rare to find that the forger has followed the method of forging by minting. It is a method used regardless of the quality of the raw materials of the alloy, and depends on manufacturing by cold forming, by pressing alloy sheets between two steel molds very strongly to ensure that the engraving and writing appear prominently on the correct coin. It is difficult to use this method, because it requires high material capabilities that may be difficult for the social, artistic, intellectual, and economic level of the forger to provide.

Therefore, it is expected that coins will be forged by the hot forming (casting) method. Alloys are prepared to be poured into specially prepared molds. It is rare for the counterfeiter to use a mold of metal; molds are usually made of sand or gypsum. On one side of the mold, there is a negative image. The other side bears upside-down negative images. When they are put together, this space is filled with molten metal, and the molten ingot is entered through a casting channel, which shows in the examination. There must be ventilation holes in the casting channel in order for the distraction to escape, as the presence of air bubbles is one of the forms of forging.

Results of studying the stages of forged coins and determining the signs of forging:

There is a casting channel that appears during the examination.

There are traces of air bubbles that distort the coins.

There are sidelines indicating that the coin was cast with molds.

Lack of smoothness on the surface of the coin due to the use of sand or gypsum blocks.

The difference in the chemical composition of the alloy metals between the original and the fake.

The color of the coin, and the difference in color between the authentic and the forged.

The feel of the coin and any type of manufacturing method.

Weight and resonance.

Scratch ability, hardness, and thickness.

Determine the entrance to the casting channel.

Determination of the outlet of the ventilation duct, which appears irregular in shape.

Standardizations of die lines, with different distances between them, and the depth of digging varies in these distances and the locations of mineral appendages (reich).

Identifying the effects of the joining of the two molds sides. These lines appear in the form of a circular line that divides the lines of the template into two parts.

Fig 30: Fake Roman Coin with Casting Channel. (Photo: Shutterstock Images).

2-Method of Analysis

Various analysis devices are used in this method to find out if any artworks have been synthesized and to confirm that these works are not original, by using Carbon-14 and radioactive elements to determine the age of the effect. However, this method is useful for iron only.

1-Carbon-14 and Radioactive Elements:

Radioactivity:

Radioactivity is used to give specific lifetimes to minerals, which are referred to as 'absolute ages'. Isotope analysis examines the distribution of stable isotopes with chemical components, and in art, stable isotopes are analyzed in the components that enter into the manufacture of products, so isotopes are already present in the composition of ores. If analyzed, radioactive isotopes, such as zircon and chromium, serve to differentiate between the fake and the original because the visual similarity between the authentic and the fake pieces may lead to visual confusion.

Conditions for using radioactive decay in determining absolute ages:

The dating of the mineral depends on the following conditions:

That the metal to be dated contains atoms of one of the radioactive isotopes.

That the quantities of the remaining parent and the nascent counterpart are measurable.

That the half-life period is known precisely for the element to be analyzed.

The absence of any analogues in the mineral at the beginning of its crystallization, and if there is a quantity of it in the metal, the possibility must be available to determine the initial quantity of this incipient.

2-Techniques for estimating the age of radioactive metals:

The uranium-lead method:

This is one of the most successful methods used to determine the ages of metals, because minerals which contain uranium and lead have a tight crystalline structure, most notably Zircon ($ZrSiO_4$) zirconium silicate. Through this method, it is possible to put uranium in the place of zircon, due to the convergence of the sizes of these two elements at the same time, and the big difference between the sizes of zircon and lead. This means that zircon does not contain lead when crystallized. Zircon has a strong crystal structure, which makes it resistant to weathering processes, so it is better than other minerals in preserving its parent counterpart. Its crystal remains closed to the loss or gain of its parent isotope, and after uranium substitution, we can measure the half-life of uranium and then determine the age of the metal.

Lead oxide:

Radioactive lead, which is called white lead, can be used to detect the artefact. If the age reaches 2000 years it enters into the metal, casting small proportions of radioactive lead. Because of its radioactivity, it is used to determine the age of the metal.

Carbon$_{14}$ method: The use of carbon$_{14}$ to determine the age of metals:

Carbon$_{14}$ is used to determine the age of the metal artwork, as after a certain point of time, (C_{14}) begins to decay at a constant rate, which causes a continuous decrease in the presence of radiocarbon. The age of some works of art can be determined by the amount of remaining carbon.

This technique is relatively useful, because it works to destroy a large number of materials inside the artefacts, and it is also used with iron in metallic effects, because it contains the percentage of carbon, using the ancients' charcoal during the iron preparations for plumbing.

The relation of carbon$_{14}$ to history:

Carbon$_{14}$ dating often conflicts with the historical speculations found in literature references, and these references contain comprehensive historical information as well as a history of the surrounding environment of the relic.

When comparing the literary chronology with dating by carbon$_{14}$, we often find that C_{14} dating gives two centuries beyond the text, which confirms the opposition of C_{14} dating to the literary chronology, and therefore the radioactivity of carbon is used in conjunction with archaeological historical sequencing, with error ratio in place as a preventive measure. For the Egyptian civilization, it possessed a uniquely challenging situation among civilizations thanks to the literary-historical constructive sequence, which gave radiocarbon dating a close relationship with Egyptology, working on the proportions of a particular metal piece in a certain period and determining this historical period with precision. If the traces are of organic origin, they can be dated by $carbon_{14}$ which is based on the fact that all organic matter which is less than 2,500 years old contains $carbon_{14}$, which is lost at a steady rate.

48 Papyrus sheets, as well as Coptic books that contain literature, and more than 500,000 pages of ancient manuscripts, were discovered in the Monastery of Saint Catherine on Mount Sinai. Among them, what could be the oldest copy of the New Testament in the Greek language was discovered, written on deerskin.

$Carbon_{14}$ device in the history of metals (iron):

The carbon extraction system was developed using an oven with a flow of oxygen to completely oxidize iron and carbon, followed by a series of steps to purify the combustion gas resulting from the use of CO_2. The product was collected by cracking CO_2 in a quartz tube, and several tests were conducted to develop the ability to extract radiocarbon. Iron was burned, with CuxO as a donor of oxygen, in the quartz tube to extract the radiocarbon on which the date was based, as well as by preparing samples of iron dating back to before the year 700 AD, and then cleaned of rust mechanically, before being cut into small pieces, or ground with acetone, in order to remove any greasy coating, and placed in a tube of quartz. The quartz tubes had to be cleaned before use, then we put about 0.5: 1g Cu_xO over the samples in an oven, at a temperature of about 900°C for five hours.

Radiocarbon is extracted from iron when the temperature reaches 1000°C, for a period ranging between 10 and 36 hours as a maximum, as carbon dioxide is collected in a filling tube. The half-life period in $carbon_{14}$ begins after about 5730 years.

Radiocarbon extraction from an iron sample depends on:

- **a-** The size of the particles present in the sample.
- **b-** The temperature being between 1000 and 1050°C.
- **c-** The exposure time ranging from 10 to 24 hours.
- **d-** Excess oxygen after combustion of iron with Cu_xO, and we note that the amount of oxygen has a clear effect on the productivity of carbon, which requires an appropriate surplus of oxygen.

The radiocarbon content inside the sample is at the following levels:

From 1% to 3% is high content, 0.5% is medium content, 0.2% is low content.

C_{14} is known from 16,000 to 33,000 years ago, and it is also known that the oldest iron tools date back to about 800 BC, some 7,530 years, and half the amount of radiation is lost, to reach to $\frac{1}{8192}$ after 74,490 years, which is a very small amount.

B-Devices:

Double induction plasma, pomegranate, atomic absorption, X-ray fluorescence, and scanning electron microscopes can be used in order to know the manufacturing techniques and chemical ratios, and compare them with the techniques used on similar original pieces.

The proportions of chemical elements as well as industry techniques can be found and compared with similar historical mineral effects, documented using the following devices:

- Use of bulk double induction plasma.
- Raman Spectroscopy (RS).
- Use of atomic absorption.
- Atomic Absorption Spectrometry (AAS).
- Using the Imaging Scanning Electron Microscope (SEM).
- Use of X-Ray Fluorescence (XRF).

3-Using the physical properties

Such as hardness properties to know the extent of change in hardness resulting from the originality and age of the metal piece.

A-Detection of authenticity through properties:

Learning about the types of hardness gauges used:

Mohs scale:

This divides the hardness of the metal into ten fixed degrees (1- 10), where each degree represents the hardness of a particular metal. However, the gradient in this measurement is not fixed, it is relative hardness, meaning that the difference between a metal of hardness 3, and another metal of hardness 4, does not equal the difference between metal of hardness 9, and a metal whose hardness is 10. The difference between the degrees 9 - 10 is greater than the difference between the degrees of 3 - 4.

Determine the hardness of the metal as follows:

The approximate extent of the hardness of the metal is determined by trying to scratch it with a nail, which can scratch metal of hardness up to 2.5. If it does not scratch, a copper coin can be used, which will scratch metal of hardness of 3.5, then a piece of glass which scratches a hardness of 5.5, then a knife blade which scratches up to 6.5.

If the unknown metal is scratched by any of the previous tools, the hardness of the unknown metal can be precisely determined, and converges according to the Mohs scale of hardness.

The degree of hardness affects the change in the composition of the metal by the presence of impurities and weathering processes. Therefore, a hardness test is required for modern scratched surfaces, and the color of the scratch (the color of the powder) must be checked to see which of the two metals is the one scratched, as the metal used in scratching may be the scratched metal, and not the subject of the test.

The scratch characteristic is a constant, unlike the scratching powder, which is basically powder. The scratch cannot be easily erased, so the length of the scratch should be as short as possible, not more than a quarter of a centimeter, so as not to distort the metal sample.

Most metals have a hardness of less than 6, so a simple gouge with a measuring tool, such as a nail, until we reach the knife, will do the trick and make it easy to establish the hardness of the metal.

B-Vickers method for measuring HDv hardness:

In this method, a square pyramid of diamonds is used with a vertical angle between the two opposite surfaces (136°), where the sample is polished and placed in the specified place on the device, and then a specific load of a fixed amount is applied to the pyramid until it penetrates the surface of the metal. After the displacement of the load is measured, the average diameter of the trace that is it is in a rhombus or square shape.

Fig 31: Hardness Testing. (Photo: Shutterstock Images).

CHAPTER THREE

APPLIED SAMPLES

Organic archaeology: An applied example of an authentic manuscript

Fig 32: The Applied Manuscript. (Photo: the author)

1-Documention of the Applied Manuscript

The archaeological description of the manuscript:

This is a manuscript from the Islamic era (The Thirty Parts of the Holy Qur'an) in *thuluth* script. The copyist is unknown, the dimensions of the manuscript are 23 x 33cm, and the number of the manuscript pages is 28. The cover is made of cloth supported by cardboard and cotton fibers dyed in a dark grey color, As for the manuscript, it is joined together with triple stitches. It has no tongue and is written with liquid oxide inks. The red ink was used in writing the names of the Surahs, and defining the pictures and ornaments drawn on some of the words and the inner frame of the page, and the entire body of the manuscript was written in black, while the blue ink was used to make the outer frame of the page only. The manifestations of the manuscript damage are some tearing, loss, dirt, and melting of some inks, and there is also a loss of sewing and stitches to assemble the manuscript paper, and the end of the edges of the manuscript completely.

B- Documentation by Photography:

Photographic by Camera:

Digital image (DIS) Samsung ES9 - Wide Angle 27MM - Optical Zoom 4X.

From photography and visual examination, the following appeared:

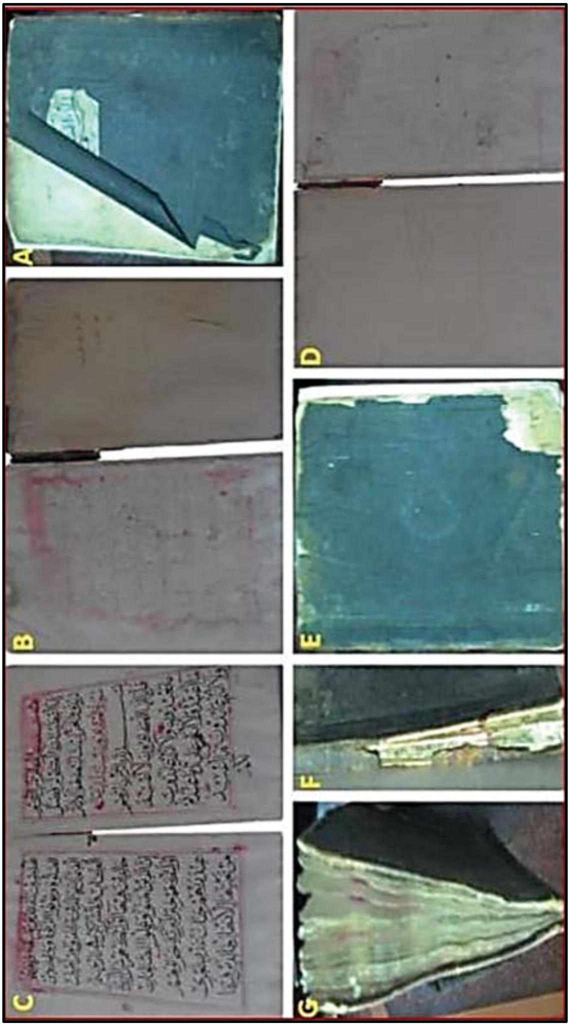

Fig 33: Parts of Applied Manuscript. (Photo: the author)

The front cover of the manuscript appears to be a fabric cover supported with torn and lost cardboard.

The first and second pages of the manuscript appear melting red, and there is human damage from writings identifying the *Qur'an.* In the middle of the manuscript it is clear that the writings were written in three types of ink (red, blue and black), there is dirt and there are greasy spots in the paper, and the inks have suffered from moisture that has melted the red ink. The ink melting problems persist to the last and penultimate pages of the manuscript. On the back cover of the manuscript there is an area of loss in the cover fabric. The leather manuscript heel is significantly degraded from loss and fracture, and the supporting suture is also missing, but the shape of the edges of the manuscript is largely intact.

2-Visual examination, where the following appeared:

Fig 34: Parts of Applied Manuscript. (Photo: the author)

The yellow arrow indicates an error that the typist has made by typing the wrong word, crossing it out, and indicating in red that this word was written wrongly. The yellow arrow indicates human damage (writing in pencil) on the margin of the manuscript. The red arrow represents the line of the original manuscript script, and the two black arrows indicate a different line that tries to imitate the manuscript's original manuscript, while the yellow arrow shows the dryness shown in the manuscript cover. The yellow arrow indicates an error that the copyist made where he forgot a word **(طعام)** in the verse, and when he retrieved it and found that the space was not enough for it, it was placed in the margin. The yellow arrow indicates red lines that the copyist made, and after checking and checking, it became clear that the red lines were essential and all the words are above all the letters, which indicates that the script, while preparing the paper for writing, might have tried some red pens on the paper. The paper itself completes the *surah* and the *Qur'anic* portion, which led to all the letters being raised in black and skipped in color (the lines of experimentation in red). The yellow arrow indicates the modification made by the copyist by adding the letter **(و)** in red, and considering the original black **(م)** **(و)** to make the word **(وما بناها)**. It is clear that the copyist forgot the letter **(م)** and wrote **(وابناها)**.

2-Methods of Authenticity and Detecting Forgery of the Applied Manuscript

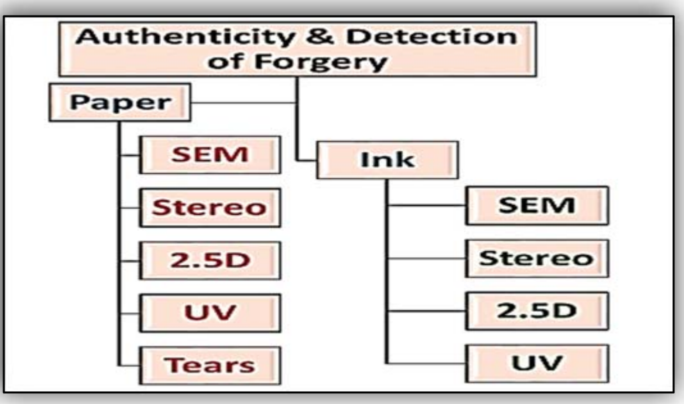

Table 3-1, Types of detection of forgery and fake manuscripts and documents, by author.

A-Paper:

Detecting the apparent forgery is based on the superficial comparison between the original manuscript and the forged sample, and the comparison of the surface appearance of the paper by observing the apparent differences between the applied manuscript and the forged sample through the following:

Using SEM:

The applied manuscript and the forged sample were examined and compared using a scanning electron microscope (SEM) in the laboratory of the Egyptian General Authority for Mineral Resources at the Ministry of Petroleum.

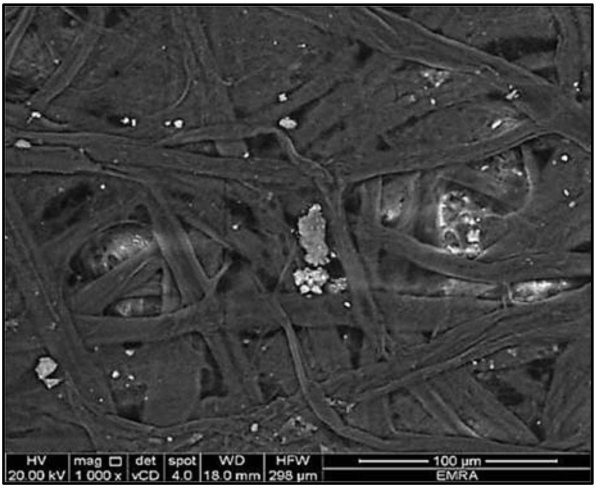

Fig 35: Forged Manuscript. (Photo: the author)

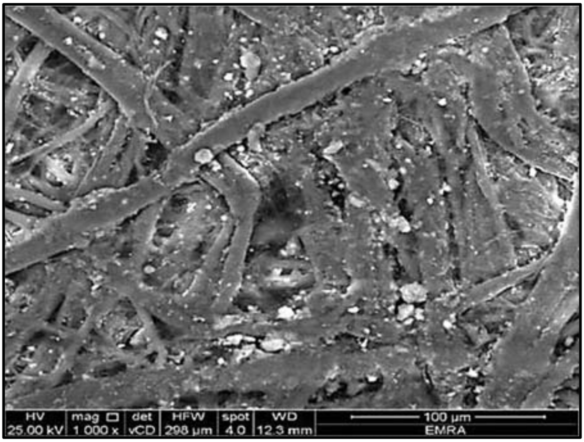

Fig 36: Applied Manuscript. (Photo: the author)

From the comparison, it was found that the applied manuscript fibers were spread by the penetrating dust grains causing white spots along the fibers, and this is not present in the forged sample. From this examination we conclude that (SEM) can be employed in the detection of paper where the fibers are very weak or full of interfering dirt, unlike sample materials. The imitation has dirt spread on the surface, and we note a number of differences:

i) The applied sample is brighter than the fake sample, which is predominantly dark.
ii) The fibers in the applied sample are very weak compared to the forged ones.
iii) Grains of dust and dirt intertwine between the fibers in the applied sample, more than in the forged one.

Stereo Microscope:

A stereo microscope (Zeiss Stemi 508) was used in the laboratory of the Department of Restoration - Faculty of Fine Arts - Minya University, in comparison between the applied manuscript and the forged sample.

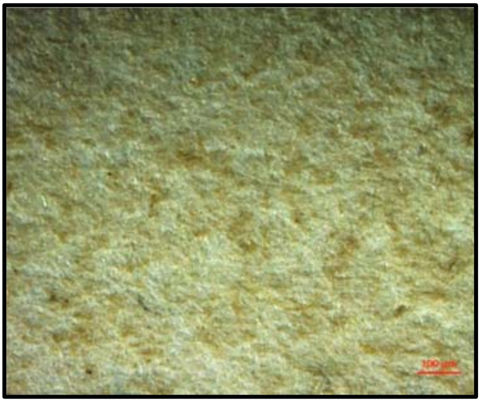

Fig 37: Applied Manuscript. (Photo: the author)

Fig 38: Forged Manuscript. (Photo: the author)

The microscopic examination shows that the surface of the forged sample is smooth, flat, and coherent, unlike the applied manuscript sample, which has an uneven surface, due to its continuous influence by surrounding environmental factors. Historical paper has three-dimensional features, causing unevenness.

3- (2.5) D:

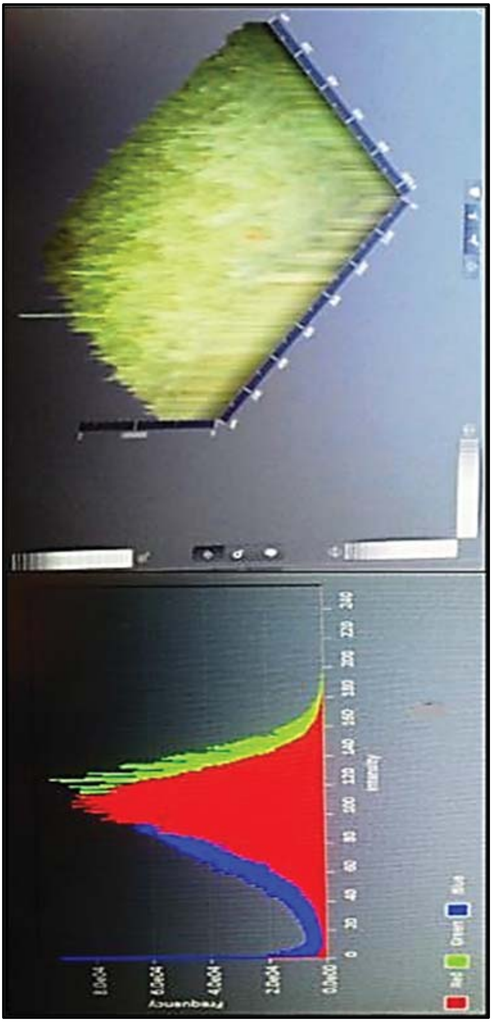

Fig 39: Applied Manuscript. (Photo: the author)

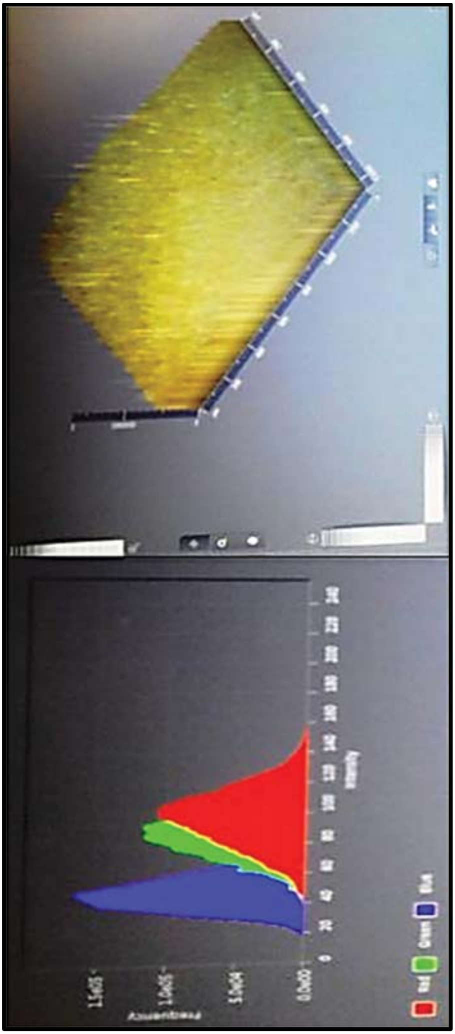

Fig 40: Forged Manuscript. (Photo: the author)

Technique (2.5 D) shows that the difference in the topography of the applied manuscript surface, is that it is uneven, in contrast to the forged sample, in addition to the obvious difference in the sensitivity of light absorption. The forged sample still retains the reflection of the bulk of the incident light, it absorbed little, due to its flat surface, and each of the three light bands appear separately.

UV was used to examine and compare the applied and forged manuscript paper, using camera imaging with G8W UV illumination - Vis 254 Sterilizer Ultraviolet - Model SBS, in the laboratory of the Department of Restoration - Faculty of Fine Arts - Minya University.

Fig 41: Applied Manuscript. (Photo: the author)

Fig 42: Forged Manuscript. (Photo: the author)

From the comparison, it became clear that chemical and biological color spots had spread in the applied manuscript naturally, and were not contrived with the change of color of the applied manuscript. This is in contrast to the forged sample which does not show that, besides the appearance of watermarks and underlining lines in the applied manuscript.

Inspection of (Holes and Tearing) Using Light Table, Imaging Scan Images in Top-Hat Transform:

A light table was used in the Department of Restoration - College of Fine Arts - Minia University, in imaging between the applied manuscript and the forged sample, and then examined by Top-hat Transform to find the difference between the holes and tearing in the two samples.

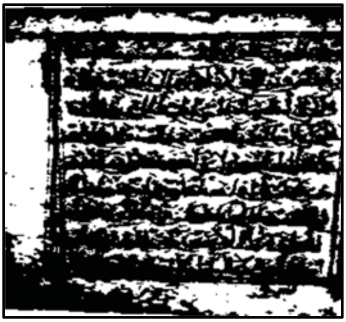

Fig 43 Applied Manuscript. (Photo: the author)

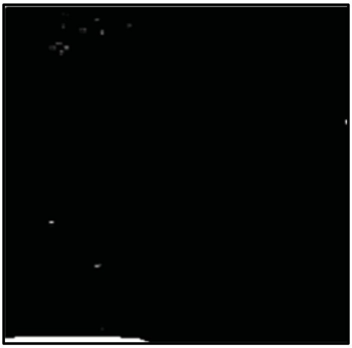

Fig 44: Forged Manuscript. (Photo: the author)

The comparison shows that there is no noticeable difference between the natural holes in the applied manuscript and the fabricated holes in the forged sample, but the noticeable differences in tearing or natural loss in the applied manuscript from the forged sample are the regularity and dynamic, in contrast to the abrasion or the artificial rupture.

B-Ink:

Comparing the inks by monitoring the apparent differences between them in the applied manuscript and the forged sample by means of the following:

1-SEM:

Inks of the applied manuscript and the forged sample were examined and compared, using a scanning electron microscope (SEM) in the laboratory of the Egyptian General Authority for Mineral Resources at the Ministry of Petroleum -Egypt, as follows:

1-Blue Ink:

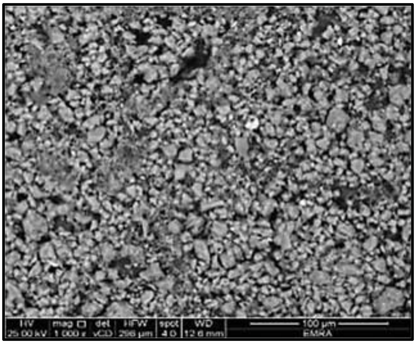

Fig 45: Applied Manuscript. (Photo: the author)

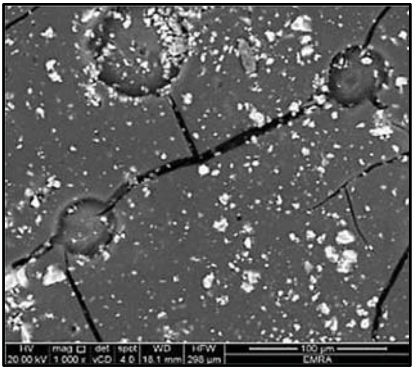

Fig 46: Forged Manuscript. (Photo: the author)

The comparison shows the weak cohesion of the blue ink in the applied manuscript and the separation of its particles into granules, leads to poor coverage, unlike its presence in the forged sample. We found that it still retained its particles with the beginning of cracks and separations.

II-Red Ink:

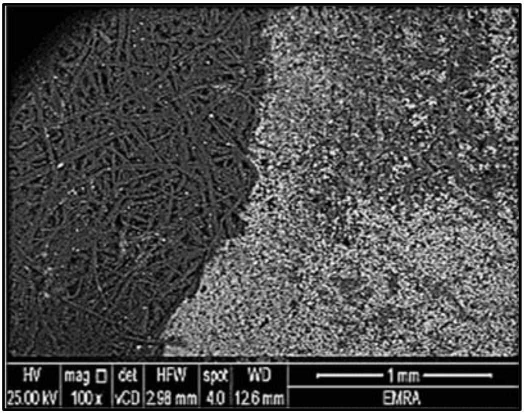

Fig 47: Applied Manuscript. (Photo: the author)

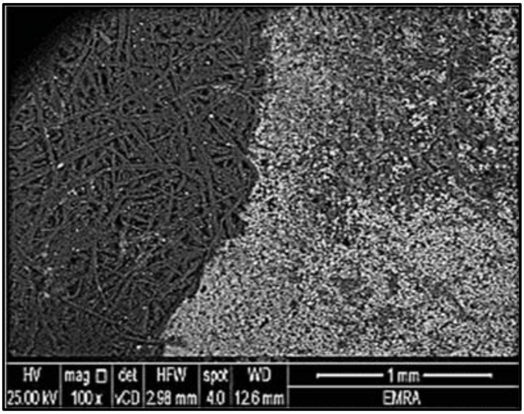

Fig 48: Forged Manuscript. (Photo: the author)

The red ink in the applied manuscript has weak coverage, and is fast melting. It has spread to the surface of the paper. In the forged sample, there is poor coverage and the occurrence of cracks in the color surface in the form of bristles, and cracks due to the rapid drying of the red color, unlike the old red inks, which, because they are well-milled and integrated with the fibers, do not crack quickly.

III-Black Ink:

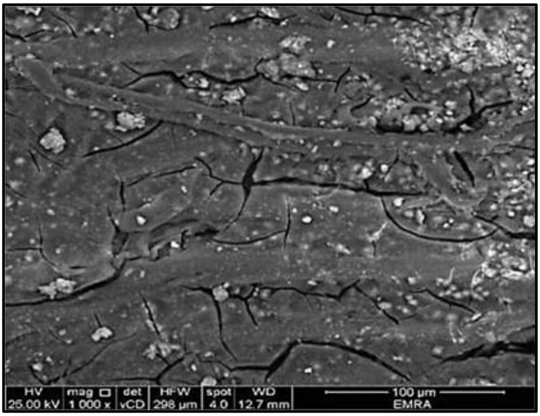

Fig 49: Applied Manuscript. (Photo: the author)

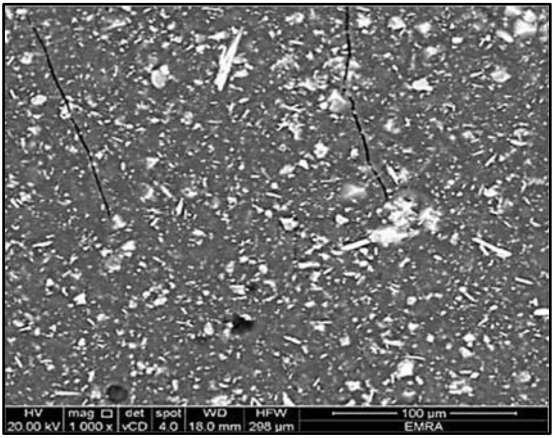

Fig 50: Forged Manuscript. (Photo: the author)

From the comparison, it was found that the black ink in the applied sample still maintains the strength of coverage despite the presence of cracks to dry the ink with the passage of time, and the forged sample is more covered, denser, and coherent. There is a cluster of dust in the forged sample that clearly shows the flatness of the surface.

2-Stereo Microscope:

The stereo microscope (Zeiss Stemi 508) was used in the laboratory of the Department of Restoration - Faculty of Fine Arts - Minya University in comparison between the inks of the applied manuscript and the forged sample.

I-Blue Ink:

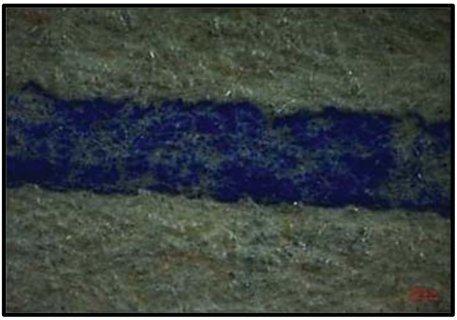

Fig 51: Applied Manuscript. (Photo: the author)

Fig 52: Forged Manuscript. (Photo: the author)

The comparison shows the weak consistency of the blue ink in the applied manuscript and the separation of its particles into granules, which leads to poor coverage, unlike its presence in the forged sample. It can also be said that the modern imitation ink is more covered than the old one.

II-Red Ink:

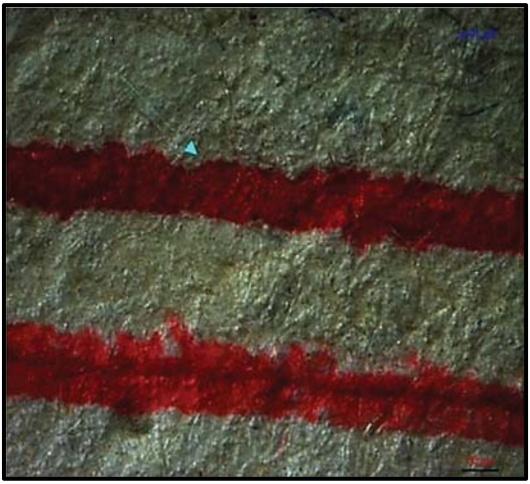

Fig 53: Applied Manuscript. (Photo: the author)

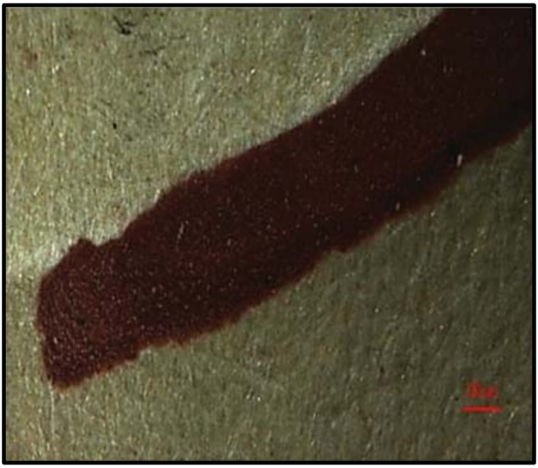

Fig 54: Forged Manuscript. (Photo: the author)

The comparison shows poor coverage and melting of the red ink with the applied manuscript and it has spread to the paper surface, in contrast to the forged sample.

III-Black Ink:

Fig 55: Applied Manuscript. (Photo: the author)

Fig 56: Forged Manuscript. (Photo: the author)

From the comparison, it was found that the black ink still maintains the strength of coverage with the presence of shiny places, and this is present in the forged sample, but in abundance, and it is caused by iron sulfate, the main component of the black ink.

3- (2.5) D:

This work was done with a stereo microscope in the laboratory of the Department of Restoration - Faculty of Fine Arts - Minia University:

1-Blue Ink:

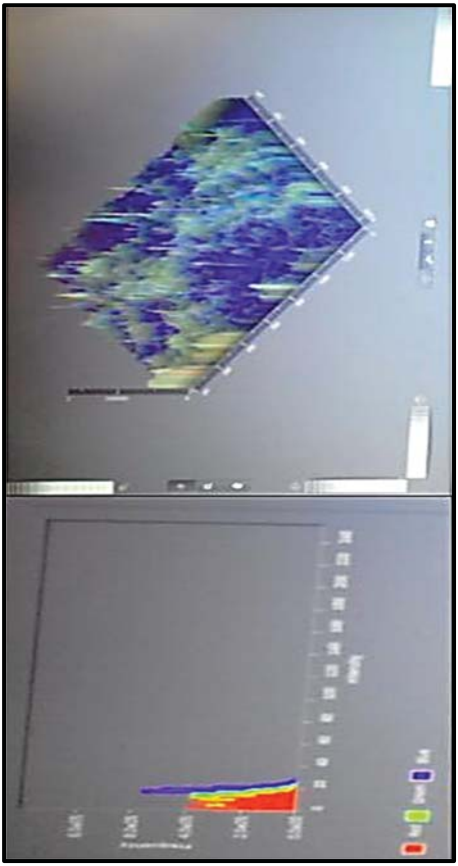

Fig 57: Applied Manuscript. (Photo: the author)

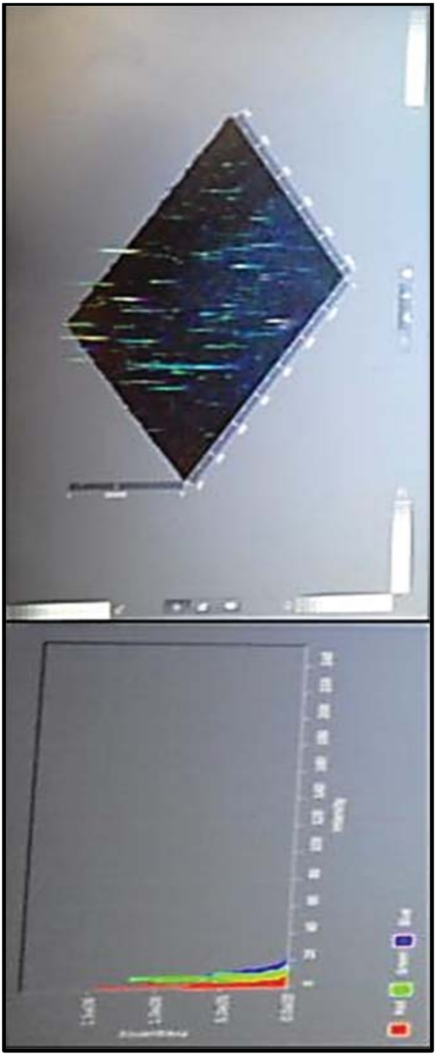

Fig 58: Forged Manuscript. (Photo: the author)

The comparison showed:

1- The consistency of the blue ink in the applied manuscript was weak, so it spread incoherently on the surface and distributed separate grains, in contrast to the blue ink in the forged document, which showed the color coherently.
2- The apparent difference in the sensitivity of the applied spectrum to the blue color, so the difference in the applied manuscript's lower ability to absorb the blue spectrum from the forged sample resulted in an increase in the blue spectrum of the applied manuscript compared with the forged sample.
3- Note that the reflection of the red color is predominant in old samples.

2-Red Ink:

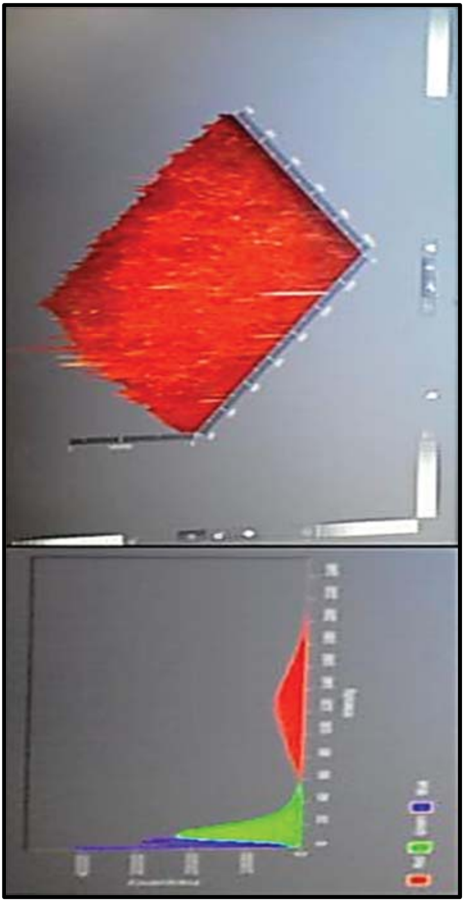

Fig 59: Applied Manuscript. (Photo: the author)

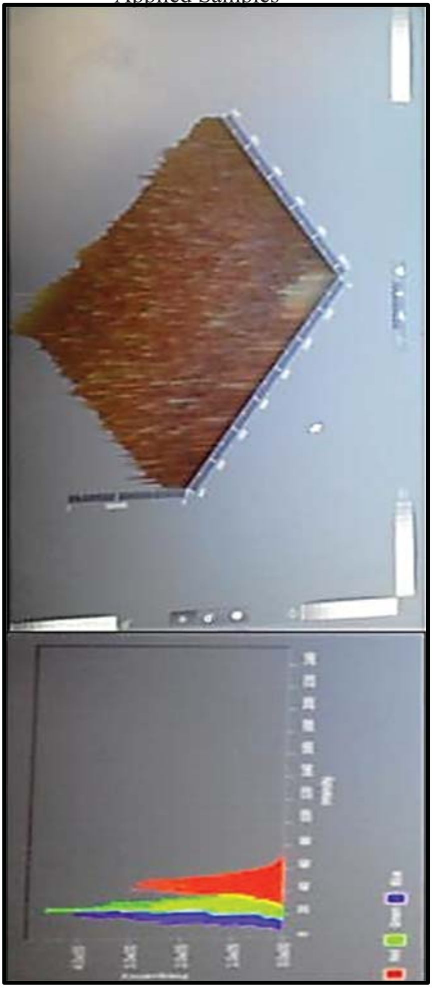

Fig 60: Forged Manuscript. (Photo: the author)

The comparison showed that the red ink melted in the applied manuscript, so it spread widely on the surface, unlike the red ink in the forged sample, which showed consistency of color, but the strength of the coverage of both is of higher severity.

3-Black Ink:

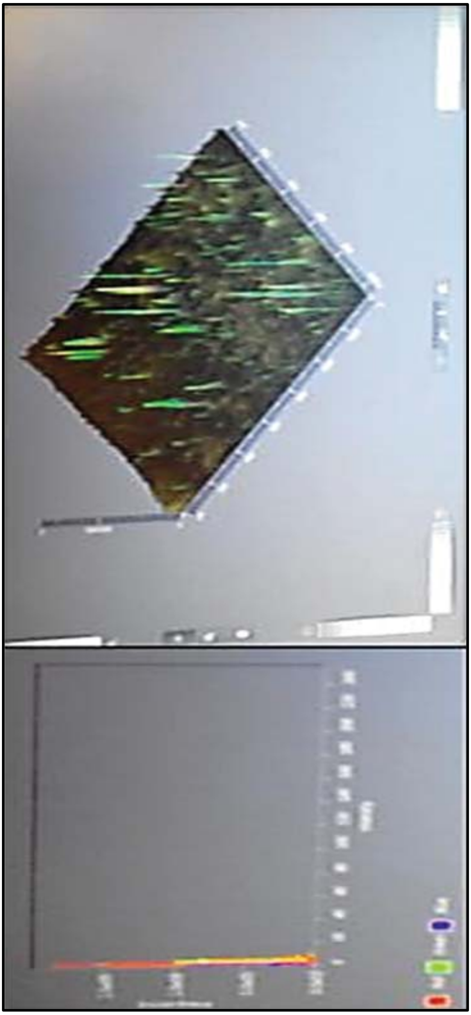

Fig 61: Applied Manuscript. (Photo: the author)

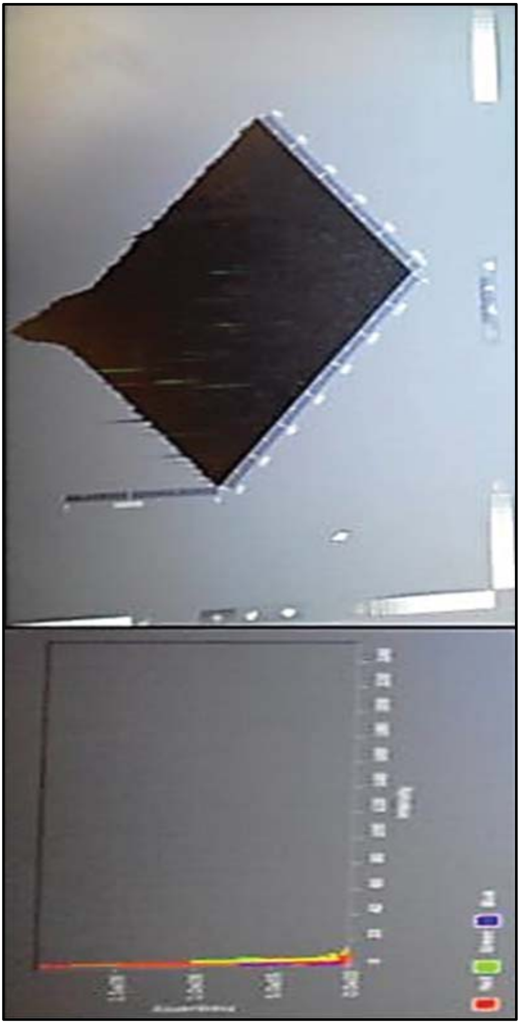

Fig 62: Forged Manuscript. (Photo: the author)

The comparison showed great similarity between the applied manuscript and the forged sample in strength of cover, although the grain distribution of the black ink in the applied manuscript was less correlated than the black ink in the forged sample.

4-UV:

The inks of the applied manuscript and the forged sample were examined and compared using camera imaging with UV illumination at the Laboratory of the Department of Restoration - College of Fine Arts - Minia University (Sterilizer Ultraviolet - Model SBS - G 8W - Vis 254).

1-Blue Ink:

Fig 63: Applied Manuscript. (Photo: the author)

Fig 64: Forged Manuscript. (Photo: the author)

The comparison confirms that the blue ink in the applied manuscript has a weaker coverage than the blue ink used in the forged sample.

2-Red Ink:

Fig 65: Applied Manuscript. (Photo: the author)

Fig 66: Forged Manuscript. (Photo: the author)

The comparison indicates that the red ink in the applied manuscript is dissolved in the paper as the red arrows indicate, and in the forged sample we find the beginning of melting and weakness of color, which indicates that the nature of the red color used in the application and the forgery is not stable and is vulnerable to attack by moisture.

3-Black Ink:

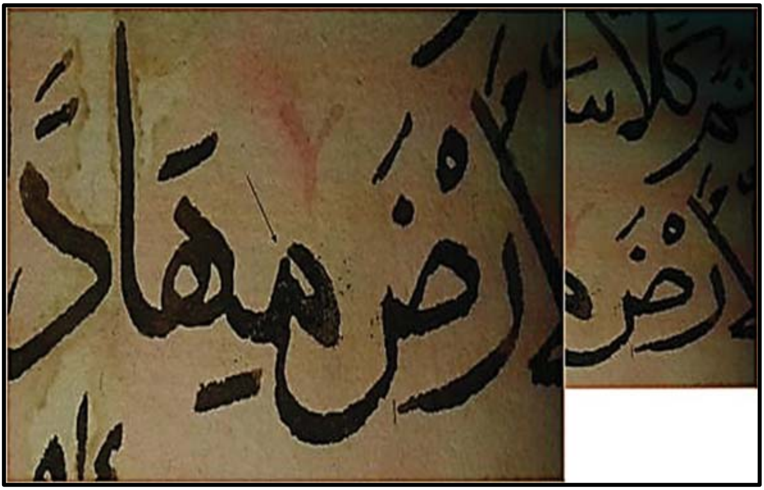

Fig 67: Applied Manuscript. (Photo: the author)

Fig 68: Forged Manuscript. (Photo: the author)

The comparison indicates that the black ink in the applied manuscript has a high covering power and is chemically coherent to a large extent, as indicated by the black arrow in the forged sample.

3-Results

A-The Results of the Paper Check:

Device	Applied manuscript paper	Forged sample paper	Explanation
SEM	The fibers of the applied manuscript are dispersed by dust grains that penetrate and cause white spots all over the applied manuscript surface.	There are no particles of dust penetrated.	The manuscript was exposed to dust for a long period of time, so enabled it to penetrate.
Stereo	The surface of the applied manuscript is uneven and spread out with folds.	The surface of the sample is smoother, flatter and more even.	An unevenness of the applied manuscript due to the continuous exposure of its surface to moisture and then it's drying, which leads to periodic expansion and contraction resulting in folds in the surface of the old applied paper.
2.5D	The applied manuscript surface is uneven, and the light band appears as a	The sample surface is flat, and the three light bands are shown separately.	The uneven surface of the applied manuscript due to the drought it was subjected to, As for the appearance of the applied manuscript in one area, it absorbed much of the incident light and reflected little

	single beam in the red band.		to the topography of its uneven surface, The light bands appeared as one band in the spectral field of the red color, unlike the forged sample in all ranges
U.V	Non-disaggregated natural spread of chemical and biological color spots with applied manuscript color change along with the appearance of watermarks and underlines.	It doesn't show all of that in spots, underlines, or watermarks.	Spread of stains in the applied manuscript due to their continuous exposure to biological and chemical damage due to non-observance of the rules of conservation and scientific maintenance.
Tearing	Note the regularity and normal dynamic process in normal tearing.	A fabricated tear leaves behind an irregular cut.	Natural tearing eroded the allowable area to be cut, so the natural wear without a dividing boundary, as opposed to a fabricated rupture whose boundary is the end of the shear and cut.
Paper Comparison: 2.5D scan is the best used: The fake can overcome dust penetration, stains and tearing, but light bands are difficult for the forger.			

Table 3-2, The Results of the Paper Check, by author

B-The Results of Examining the Inks:

the device	Red ink	Black ink	Blue ink
SEM & Stereo Microscope	In the applied manuscript, the ink surface was poorly covered and cracked, unlike the forged sample ink. Interpretation: The ink melting in the applied manuscript due to its continuous absorption of moisture and then its drying, which led to the cracks because there is a dual tendency to a chemical reaction with water and this happens slowly over time.	It still retains the strength of coverage and cohesion and there is a sheen of dirt and dust that appears more in the forged sample. Interpretation: Because the iron ink is largely stable in contrast to the red ink, besides its density and specific weight is higher, which increases the covering strength, and the appearance of more dust in the forged sample is normal for its flatness.	In the applied manuscript, the blue ink separates into particles, which leads to poor coverage, as well as the forged sample, but to a lesser extent. Interpretation: synthetic ultramarine, which began in its use from 1814 A.D. tendency to dryness and loses all water content, separating and turning into granules leads to poor coverage and that is clearly shown in the manuscript.

2.5D	The red ink spread more widely over the applied manuscript surface than the forged sample, and the light absorption range was higher for the forged sample than the applied manuscript. Interpretation: The ink spreads widely in the applied manuscript due to its greater solubility than the forged sample, and the wide melting effect makes the absorption of lightless and the reflection more, so the absorption range of the forged sample appears to be higher than that of the applied manuscript.	There is great similarity between the distribution of black ink particles between the applied manuscript and the forged sample Interpretation: for the stability of the iron ink in both the applied manuscript and the forged sample.	In the applied manuscript, the blue ink was dispersed inconsistently over the surface and by distributing separate pellets in contrast to the forged sample. Interpretation: The blue ink completely lost the water content, so it spread inconsistently from the ultramarine in the forged sample that still retained the water content.

UV	It appears more soluble in the applied manuscript than the forged sample Interpretation: For its tendency as a binary compound to interact continuously with moisture and the time factor makes it more than the forged sample.	In the applied manuscript and forged sample, they appear flat with high cohesion and coverage. Interpretation: due to their chemical stability and high specificity.	Coverage by applied manuscript is weaker than for fake sample. Interpretation: for its complete transformation of granules in the applied sample.
Best device for checking the surface appearance of inks: 2.5D Difficult to fabricate optical absorption on a fake.			

Table 3-3, The Results of Examining the Inks, by author

2. Inorganic archaeology: An applied example of authentic metals

1. Documentation of the Applied Metals

A-Copper Vase:

Fig 69: Copper Vase. (Photo: the author)

This is a copper vase (No.1280) in the holdings hall of the Agricultural Museum in Cairo. It is a vase made of brass alloy used as a decorative tool, and consists of two parts; the upper part (the neck of the vase) and the lower part (the body of the vase) and the height of the whole vase in two parts reaches almost 40cm. As for the upper part (the neck of the vase), it reaches a length of 10cm and is in the form of a widening cylinder at the mouth with a diameter of 15cm, and then narrows towards the body, to reach 12cm. The neck of the vase was executed by forming (a type of cold forming and decoration in well-known Islamic art. The decoration takes the Arabic alphabet in Kufic script). The body of the vase takes a conical shape, widening from the top. Its diameter is approximately 24cm, gradually decreasing to 10cm at the base. The height of the vase's body is about 30cm.

The decoration on the body of the vase was executed using the grooving technique to depict exquisite geometric and botanical shapes, which is what Islamic art is famous for.

The weight of the vase is 4.5kg, and the vase is covered with a layer of rust, as indicated by the analysis used in the study.

B-Iron Helmet:

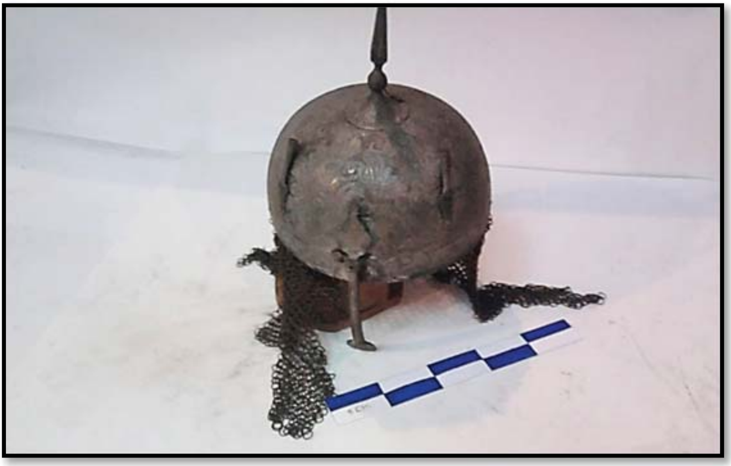

Fig 70: Iron Helmet. (Photo: the author)

This is an iron helmet (No.64) in the Museum of Applied Arts in Cairo, which was used as a tool of war and a head guard, It is a half-oval shape with a diameter at the base of approximately 20cm. In the middle of the upper surface of the helmet there is a small, 10cm, iron column. The helmet is made by welding and riveting with nails, and it also has an iron nose protector, which is 12cm long and 2cm wide at both ends. At the end of the base of the helmet there are chains of iron rings in a semicircular shape fixed by direct connections, and there are small spaces in the base of the helmet prepared for this. It was used In Islamic times.

The helmet is decorated with Persian drawing, which was prevalent in the manufacture of helmets during the rule of the Ayyub and Mamluk, and it was manufactured in the region of Khorasan. The weight of the helmet is approximately 1kg.

2. Detection of Authenticity Using Metal Properties

One of the characteristics of metals is the occurrence of chemical changes accompanied by physical changes, and through this, it is possible to evaluate a set of special characteristics that change with the change of time, place of origin, and production techniques. Based on the material conditions, art historians can classify the chronology, so the originality of a metal effect is the product of social and cultural influences, and the conditions of its origin and production.

A-The purpose of the study:

We studied the effect of aging on hardness and tensile strength using a Vickers scale, by measuring the hardness of a sample and taking 10 readings. All measurements were made in an exemplary manner, and the samples were carefully prepared so that they were perfectly thin. It was observed that an accidental change in hardness was observed, and the kinds of aging were as follows:

1- Natural aging: After pouring and cooling, and normal aging at room temperature.
2- Industrial obsolescence: The obsolescence is artificial, and made by human intervention.
3- Aging in chronological order: With the passage of a large period of time, the presence of natural influences such as soil characteristics if the piece is buried.

Aging affects the mechanical properties of the alloys in hardness, where the thermal treatments for aging affect the density, size and distribution of the alloy stiffness.

B-Examination and Analysis of the Selected Pieces under Study:

i) USB Optical Microscope:

To get acquainted with the external shape of the samples we took pictures when enlarging by 200x using USB OM:

Fig 71: Original Vase. (Photo: the author)

Fig 72: Original Helmet. (Photo: the author)

ii) Scanning Electron Microscope:

All images were taken at 2000x magnification using an SEM/EDX microscope. This is to determine the chemical composition in the original pieces, as well as to determine the percentage of each element in them to make imitation copies with identical chemical composition to the original selected pieces, so that we could compare between the original and selected pieces and determine the difference and reveal the authenticity between them.

The authentic copper vase:

Four different points were chosen for the alloy to be sampled, examined and analyzed using a scanning electron microscope, It was found that the main component of the sample is copper with zinc, which indicates that the metal in question is an alloy (brass). Therefore zinc carbonate was used in casting the alloy.

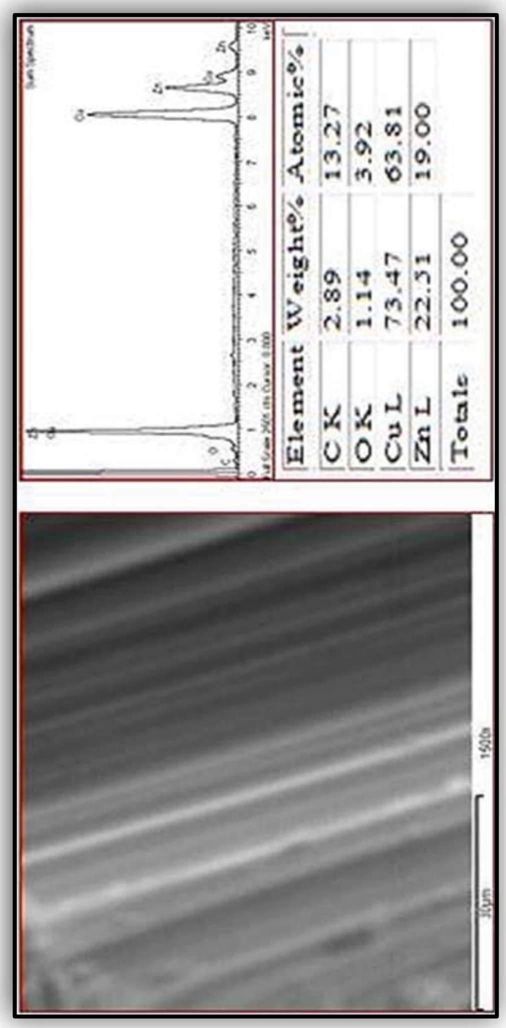

Fig 73: Examination of the Pure Copper Sample No. (Zero) with a Scanning Electron Microscope SEM. (Photo: the author)

The first point contains 73% copper, 2.9% added carbon with zinc (zinc carbonate), and 1.14% of oxygen.

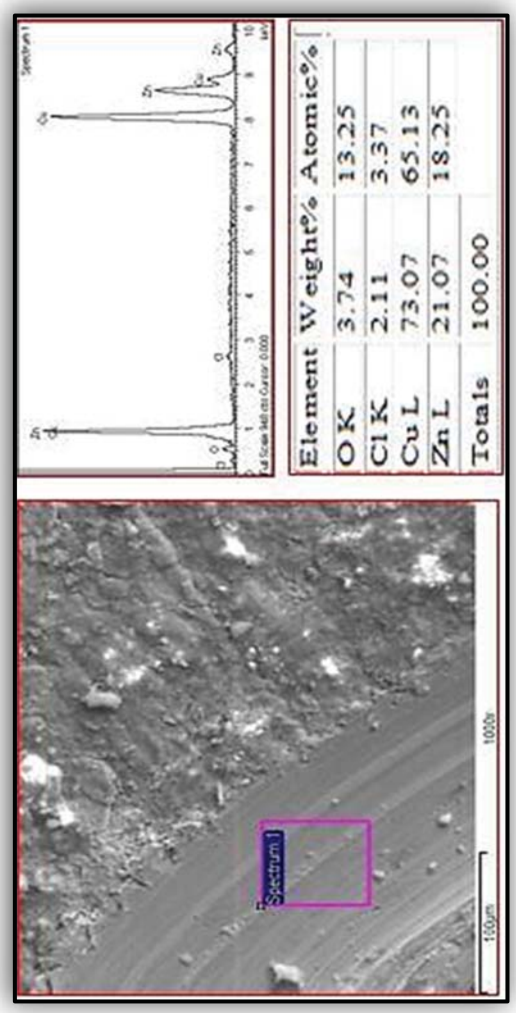

Fig 74: Examination of the Pure Copper Sample No. (1) with a Scanning Electron Microscope SEM (Photo: the author)

The second point contains 73% copper, 2.11% chlorine as a rust compound 2.11%, and 3.7% oxygen.

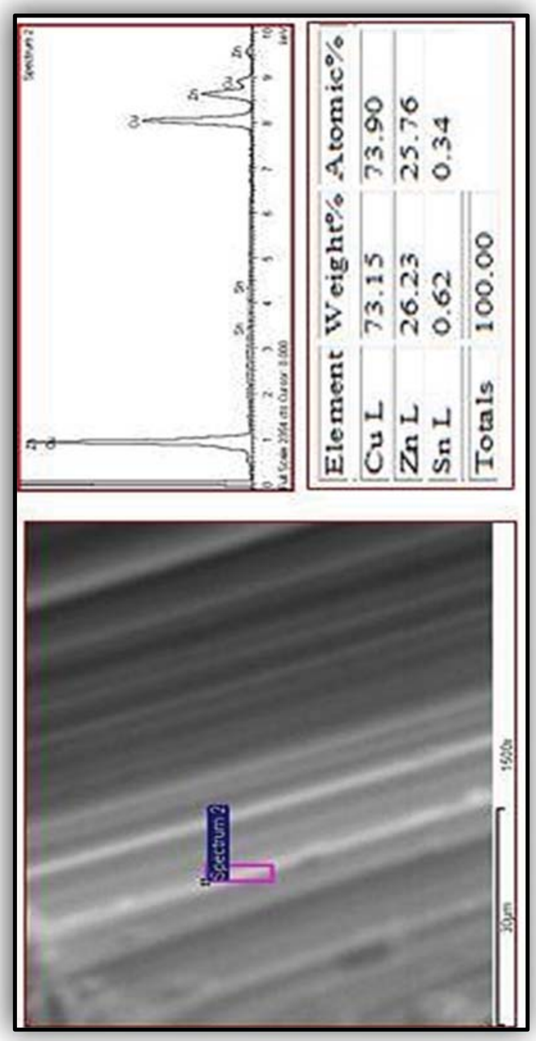

Fig 75: Examination of the Pure Copper Sample No. (2) with a Scanning Electron Microscope SEM. (Photo: the author)

The third point contains 73% copper, 26.33% zinc, and a very small percentage (0.6%) of tin as an impurity.

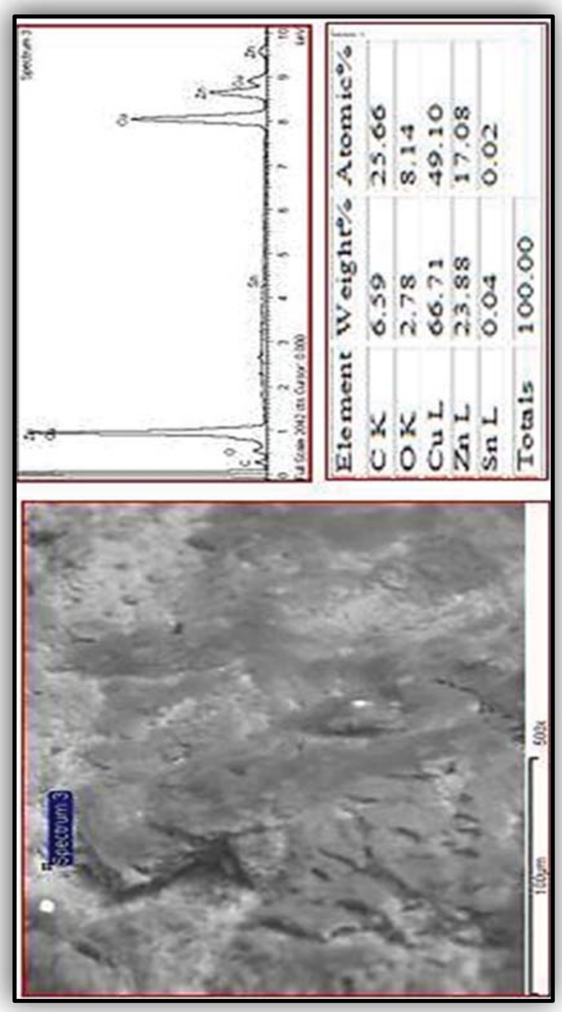

Fig 76: Examination of the Pure Copper Sample No. (3) with a Scanning Electron Microscope SEM. (Photo: the author)

The fourth point contains 66.7 % copper, and 23.9% zinc, in addition to a percentage of carbon of about 6.5%, added with zinc (zinc carbonate), a percentage of oxygen (2.78%), as well as a percentage of very few impurities of tin, of 0.04%.

Accordingly, 73% copper metal and 21% zinc were chosen to be the two main components for casting the replica of the vase, noting that the percentage of copper is 73% in the presence of other additives, but may rise slightly in the absence of other additives, ranging between 73-78%.

The Authentic Iron Helmet:

Two points were taken on the sample, and it became clear after the analysis that the metal is an alloy of iron and chromium, alongside a percentage of carbon, in addition to some impurities of silicon and calcium, and the presence of a corrosion compound of sulfate.

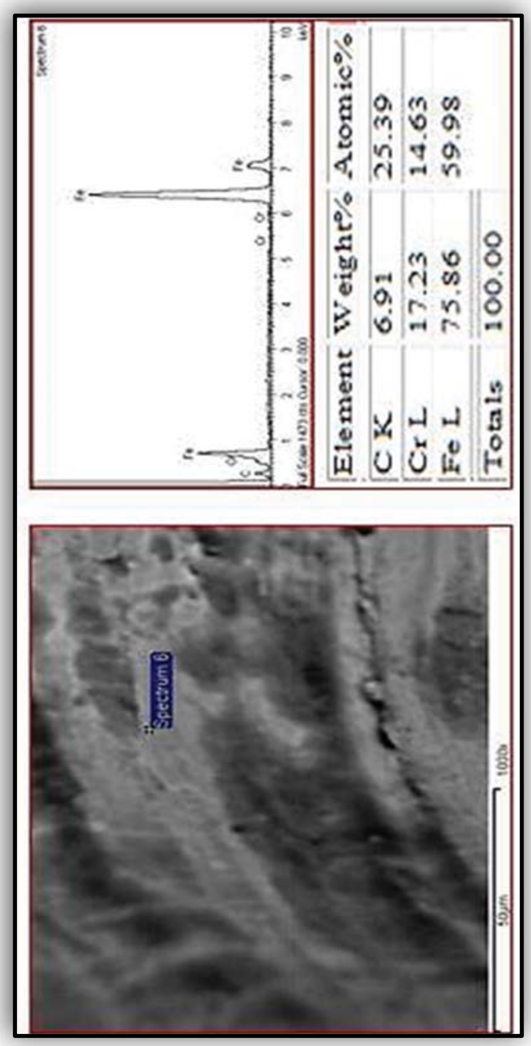

Fig 77: Examination of the Pure Iron sample No. (1) with a Scanning Electron Microscope SEM. (Photo: the author)

The first point: It was clear from the results of the analysis with the EDX unit that iron is the main component of the alloy with a percentage of 75.8%, in addition to 17% chromium, and 6.9% carbon added into the casting.

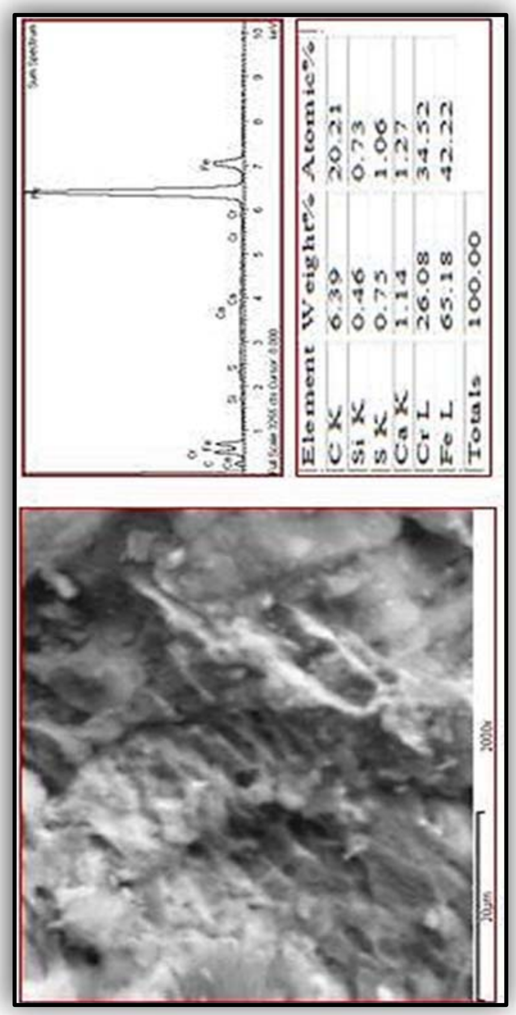

Fig 78: Examination of the Pure Iron sample No. (2) with a Scanning Electron Microscope SEM. (Photo: the author)

The second point contains 65.18% iron as a basic component, along with 26.08% chromium, in addition to 6.4% carbon added in an industry, 0.4% silicon as a sediment due to Egypt's desert soil, and a percentage of calcium deposits from the soil of 1.14%. We also found 0.75% of sulfur compound as corrosion. From that, based on the analysis of the scanning electron microscope, the chemical percentage of the elements that cast the imitation iron helmet was chosen to match the original, consisting of 65% iron, next to 26% chrome and 4% carbon.

iii) X-Ray:

For this, we used the X-Ray diffraction analyzer with a cathode tube of copper anode with an intensity of 40kV/volt, a strength of 55mm/amp, a wavelength of 1.54.18 Å/A angstrom, and a starting angle of 2θ = 4.

Samples were taken from the inner surface of the selected pieces to include rust compounds and according to the X-ray diffraction pattern.

By studying the results of the analysis in the X-Ray table, the following was found:

The Original Copper Vase Sample:

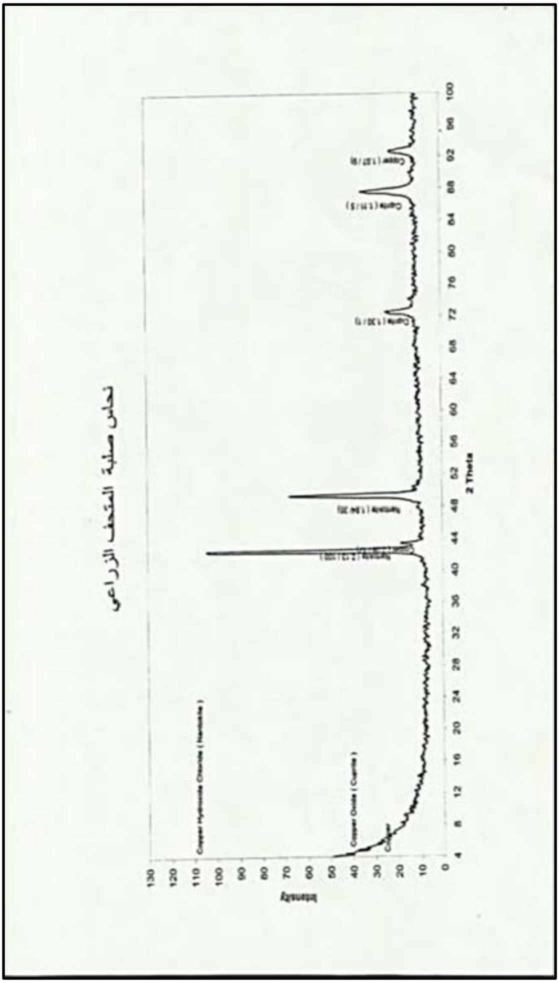

Fig 79: Analysis of the Pure Copper Sample with X-Ray. (Photo: the author)

Copper Hydroxide Chloride

$Cu_2Cl_2 (OH)_3$ and card number 15-0694.

Copper (Cu) with card number 01-1241.

-Copper Oxide (Cuprite) Cu_2O

Card number 0667-05.

The X-ray diffraction pattern of the authentic copper vase (No.1280).

The agricultural museum contains nantokite rust, along with cuprite.

The Original Iron Helmet:

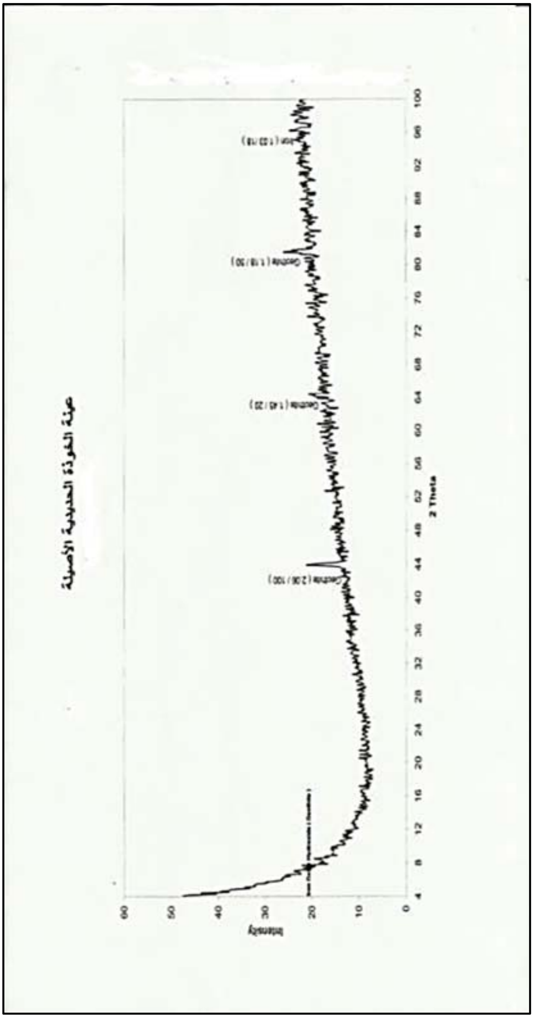

Fig 80: Analysis of the Pure Iron Sample with X-Ray. (Photo: the author)

Iron Oxide Hydroxide (Goethite):

Fe_2O_3 (H_2O), with card number 02-0281.

Iron (Fe), with card number 06-0696.

The X-ray diffraction pattern for the Iron Helmet (No.64).

Museum of Applied Arts containing compounds (Fe).

Goethite (basic iron oxide), as well as the rust compounds.

C-Making a Model Matching the Selected Pieces:

Brass vase and iron helmet:

According to the analysis, a simulated model was made for the copper vase, and another for the iron helmet, and the casting was done in the Metallurgical Research Center in Tabin - Helwan- Egypt. The steps were as follows:

- **i)** Making a gypsum mold identical to the shape of the vase.
- **ii)** Making a wooden mold (Ornic) so that we can take the imprint of the mold in the casting through sand.
- **iii)** Taking the fingerprint in the sand for the wooden block.
- **(iv)** Preparing the sand mold.
- **(v)** Casting into the sand mold.
- **(vi)** Taking out and operating the metal model, which is the subject of study.

Fig 81: The Wooden Ornic. (Photo: the author)

Fig 82: Sand Fingerprint of Wooden Ornic. (Photo: the author)

Fig 83: Sand Fingerprint. (Photo: the author)

Fig 84: Drying Process of Sand Mold. (Photo: the author)

Fig 85: Melting Metal in a Melting Crucible. (Photo: the author)

Fig 86: Follow-up to the Smelting Process by the Author. (Photo: the author)

Fig 87: The Process of Taking out the Molten Metal. (Photo: the author)

Fig 88: Sand Blocks are placed near the Molten Metal. (Photo: the author)

Fig 89: Preparing the Casting Channel in the Sand Mold. (Photo: the author)

Fig 90: Follow-up to Ready the Molds for Casting by the Author. (Photo: the author)

Fig 91: The Process of Taking out the Molten Metal. (Photo: the author)

Fig 92: Transferring the Molten Metal towards the Sand Molds. (Photo: the author)

Fig 93: The Process of Casting Metal into Sand Molds. (Photo: the author)

Fig 94: Casting Process Finished. (Photo: the author)

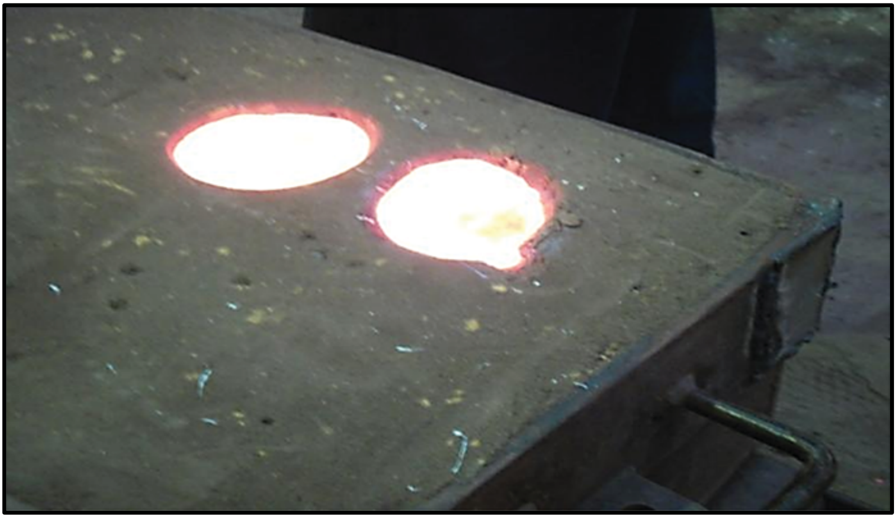

Fig 95: Copying Inside Sand Molds. (Photo: the author)

Fig 96: Casting Additional Experimental Samples. (Photo: the author)

Fig 97: The Fake Copper Vase After Casting. (Photo: the author)

Fig 98: The Fake Iron Helmet After Casting. (Photo: the author)

D-Examinations and Analyzes on Forgery Models:

USB Optical Microscope:

To get acquainted with the external shape of the samples, images were taken at 200x magnification using USB OM.

Forged Vase:

Fig 99: Forged Vase. (Photo: the author)

Forged Helmet:

Fig 100: Original Helmet. (Photo: the author

Scanning Electron Microscope (SEM / EDX).

This is to ensure that the replicas match the original copies closely so that the comparison is fair.

The forged copper vase:

Four different points were chosen for examination and analysis using a scanning electron microscope. This confirmed that the copper vase sample contained the basic elements that were previously determined with the same approximate chemical proportions based on the analysis of the original sample of the vase, and these elements are copper and zinc.

The First Point: 78% Copper.

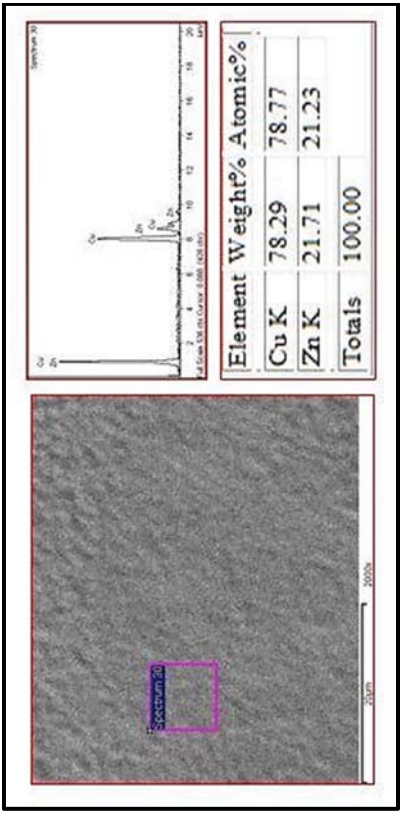

Fig 101: Examination of the Forged Copper Sample No**. (0)** with a Scanning Electron Microscope SEM. (Photo: the author)

The Second Point: 78% Copper.

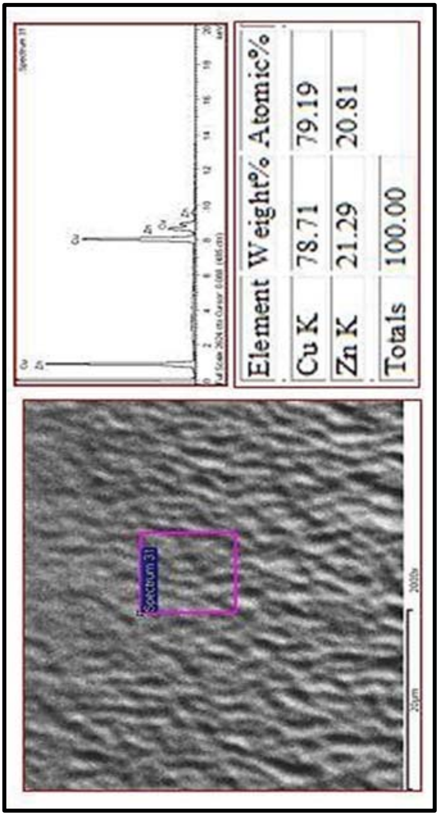

Fig 102: Examination of the Forged Copper Sample No. (1) with a Scanning Electron Microscope SEM. (Photo: the author)

The Third Point: 77% Copper and 22% Zinc.

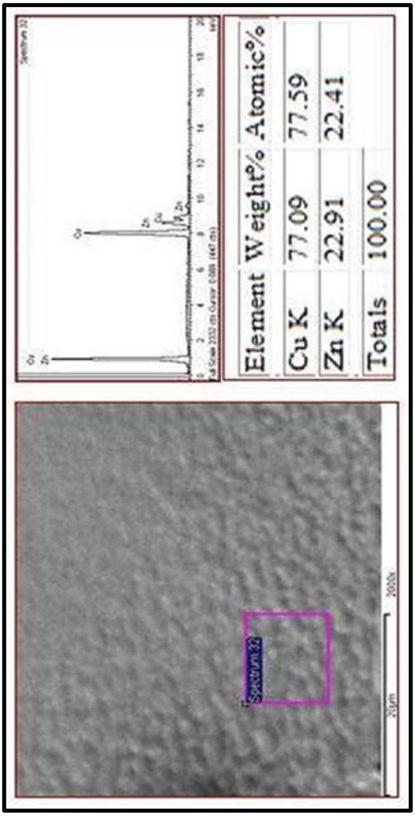

Fig 103: Examination of the Forged Copper Sample No. (2) with a Scanning Electron Microscope SEM. (Photo: the author)

The Fourth Point: 79% Copper and 20% Zinc.

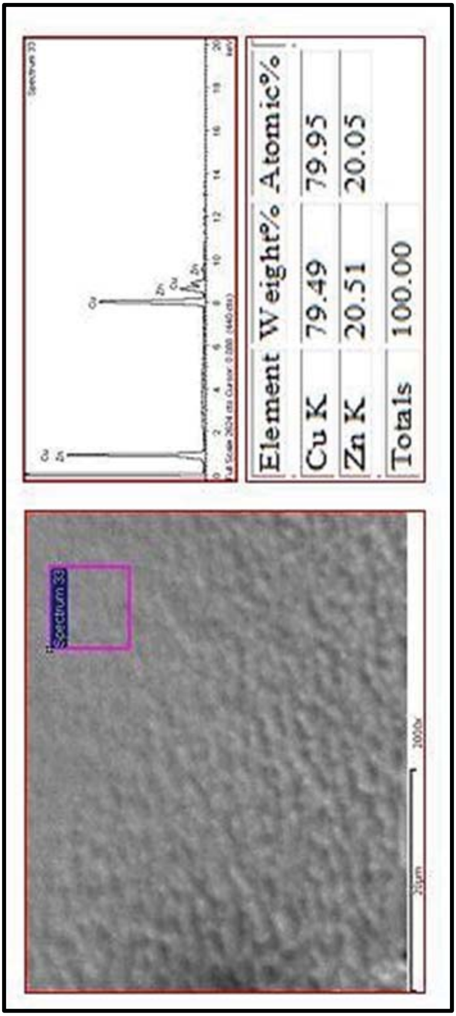

Fig 104: Examination of the Forged Copper Sample No. **(3)** with a Scanning Electron Microscope SEM. (Photo: the author)

Hence, the casting achieved the required percentage to make a copy of the copper vase, which is 78% copper and 21% zinc, which is a brass alloy.

Forged Iron Helmet:

Two points were taken from the iron helmet sample and examined with a scanning electron microscope to ensure that the chemical proportions of the forged iron helmet match the chemical ratios of the authentic iron helmet.

The two points contained:

The First Point: 82% iron as a basic component and 17% chromium.

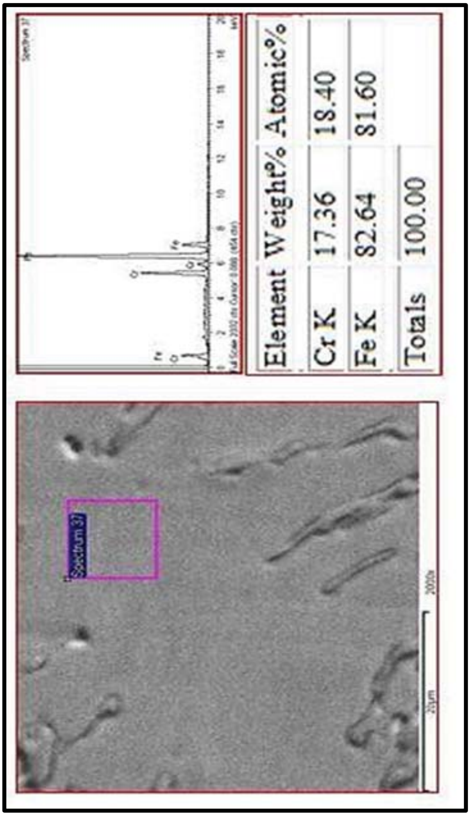

Fig 105: Examination of the Forged Iron Sample No. (1) with a Scanning Electron Microscope SEM (Photo: the author)

The Second Point: 65% iron as the main alloy component, along with 26% chromium along with carbon.

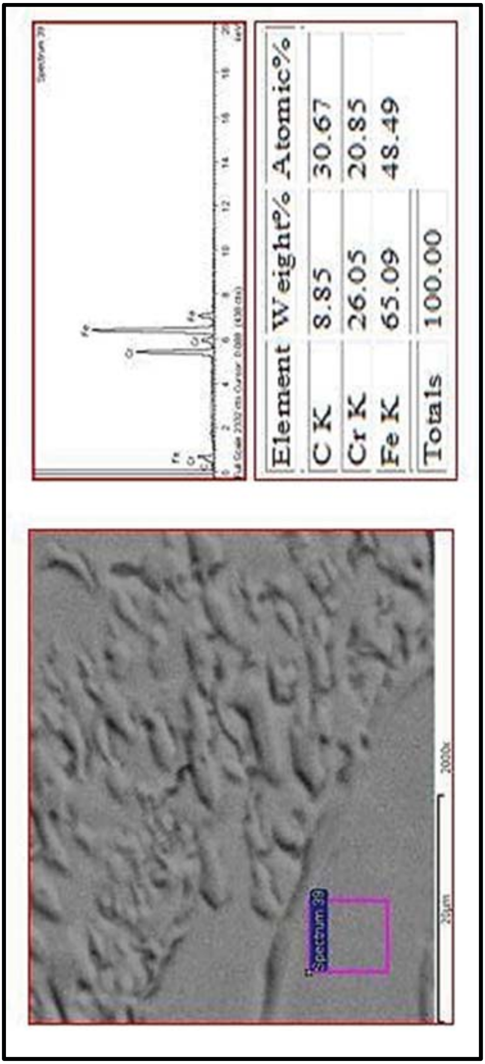

Fig 106: Examination of the Forged Iron Sample No. (2) with a Scanning Electron Microscope SEM. (Photo: the author)

From that, the imitation iron alloy from which the imitation iron helmet was made has achieved the required proportions of iron 65%, chromium 26%, and carbon higher than 4%, which leads to the results of the comparison subject of study being fair and with a high degree of accuracy.

Using X-Ray:

A sample of the forged vase, and a sample of the forged iron helmet were examined by X-Ray diffraction in order to gain knowledge of the corrosion compounds that result from exposure of the sample to outside air, especially the existence of a time distance between casting the imitation sample and the X-Ray examination. This time distance allows the alloy to form and it is useful in knowing the types of corrosion that affect the metal traces that have the same chemical composition.

Forged Copper Vase:

The following appeared under the x-ray of the forged brass vase sample:

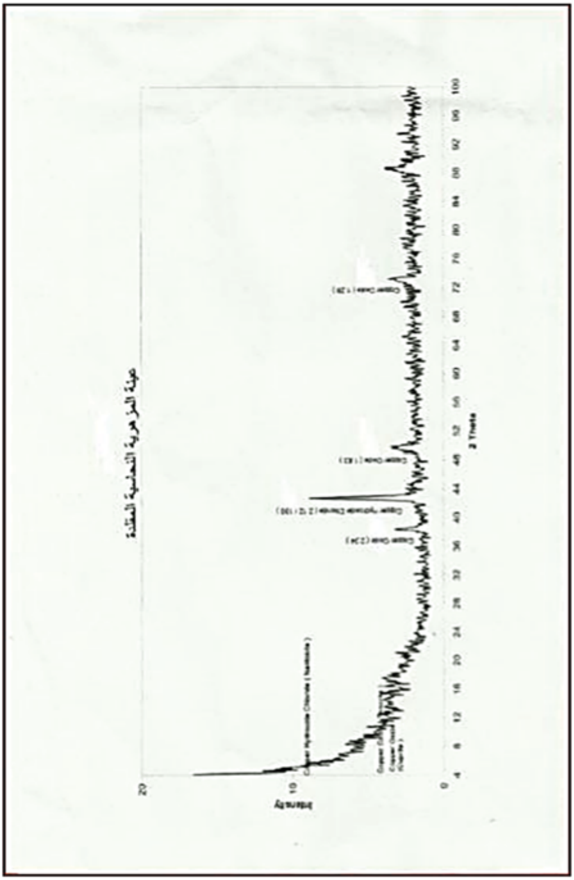

Fig 107: Analysis of the Forged Vase Sample with X-Ray. (Photo: the author)

Copper chloride corrosion compounds (Nantokite).
Copper oxide (Tenorite).
Copper oxide (Cuprite).

Forged Iron Helmet:

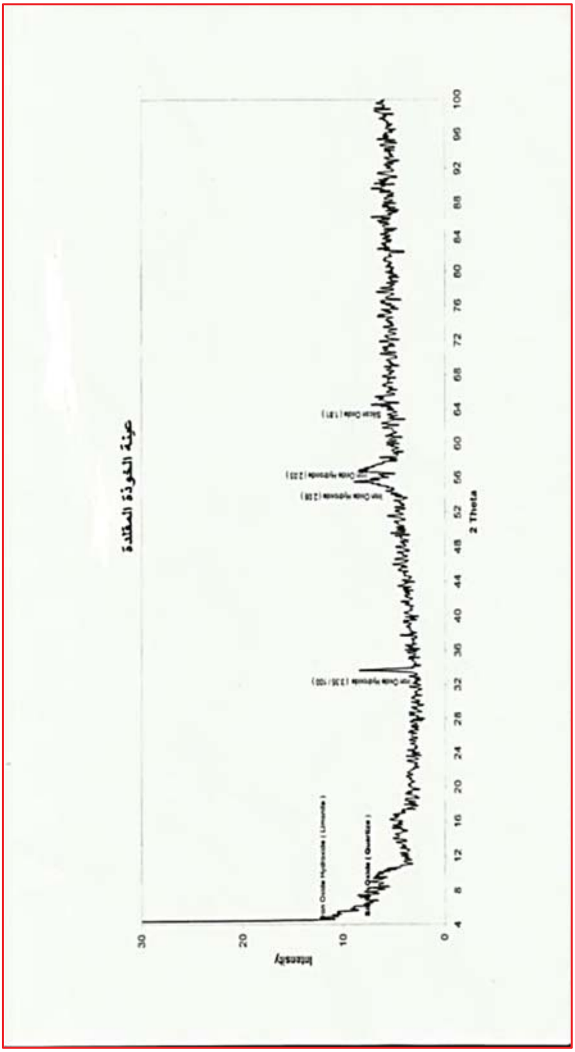

Fig 108: Analysis of the Forged Helmet Sample with X-Ray. (Photo: the author)

Iron Oxide Hydroxide compounds (Limonite) with Card number 1266-34
Silicon Dioxide (Quartize) with card number 116-33

E-Comparing the Selected Authentic Objects against the Forgery Objects:

The comparison was done using two methods:

(i) Metallographic Microscopy to identify the difference in the surface appearance of the original and the forgery. Through this examination it is possible to determine the shape and size of the mineral crystals and grains that show what the mineral has been subjected to from the different forming processes that affect the size, shape and distribution of metal grains.

The sample was prepared for examination by placing it in a mold of Araldite (the transparent type is preferred) so that the surface of the sample was at top of the mold, which facilitated the preparation of the surface for examination. First, the surface was polished well to remove various suspensions and compounds until the surface was detected. Different degrees of sandpaper, or polishing wheels covered with wool can be used. These rotate in horizontal planes and place the surface of the metal vertically, which facilitates the process of polishing. Then the metal was rinsed with water and dried with alcohol to remove traces of water. Finally it was dried with hot air, followed by what is called differential corrosion (etching). In the case of copper, Nitric acid 25% + distilled Water 75% is used, and in the case of iron, 25% Nitric Acid + 75% Ethyl Alcohol. The sample was prepared for examination under different degrees of magnification, and all images were taken in 200_X (micro) magnification.

Fig 109: Process of Polishing Using Polishing Wheels. (Photo: the author)

Fig 110: Copper Sample under a Metallographic Microscope. (Photo: the author)

1-The Authentic Copper Vase:

Fig 111: Authentic Copper Vase Under a Metallographic Microscope. (Photo: the author)

The Forged Copper Vase:

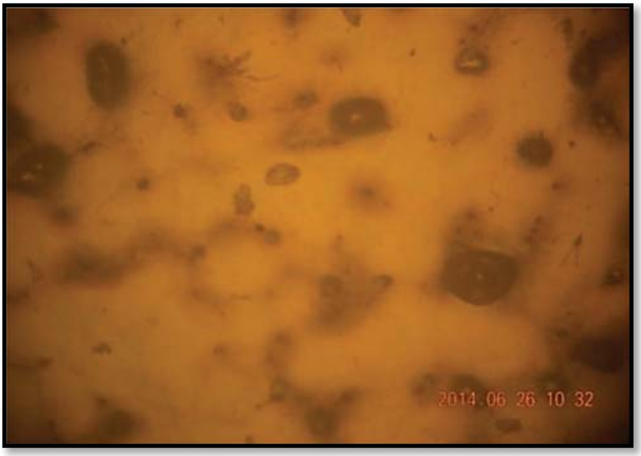

Fig 112: The Forged Copper Vase under a Metallographic Microscope. (Photo: the author)

The Authentic Iron Helmet:

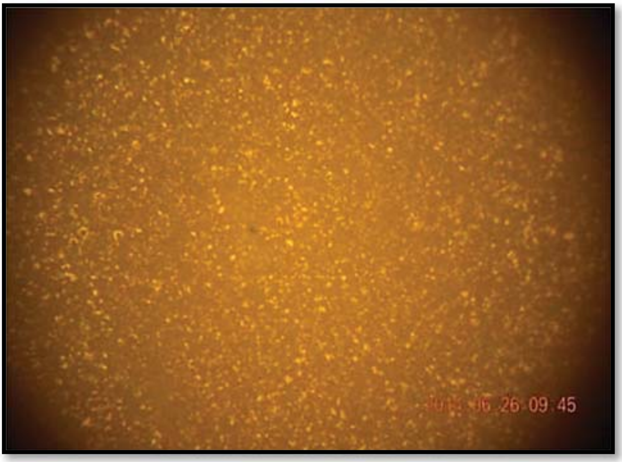

Fig 113: The Authentic Iron Helmet under a Metallographic Microscope. (Photo: the author)

The Forged Iron Helmet:

Fig 114: The Forged Iron Helmet under a Metallographic Microscope. (Photo: the author)

Hardness Using the Vickers scale (HDv):

A 5kg measurement was used on the Vickers scale, and there is a big difference between reading the hardness scale of the original and imitation samples, whether for the copper vase or the iron helmet.

Fig 115: Iron Sample under a Hardness Scale. (Photo: the author)

The Copper Vase:

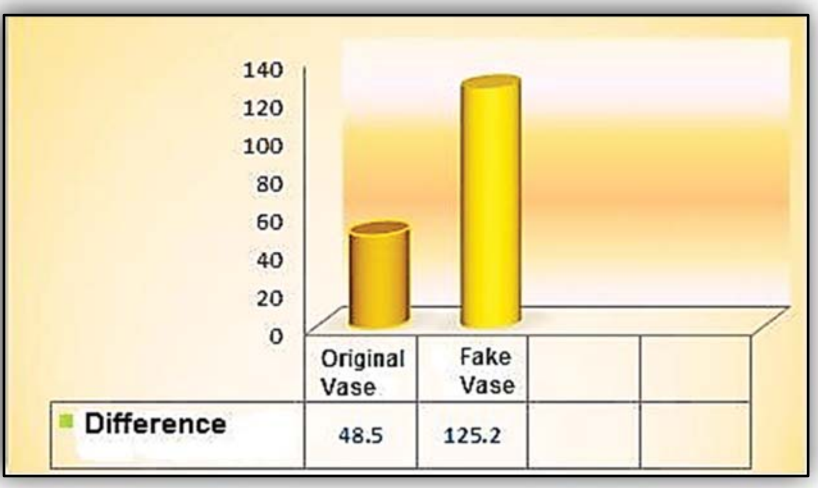

Chart (1) of Copper Sample under a Hardness Scale. (Photo: the author)

The Iron Helmet:

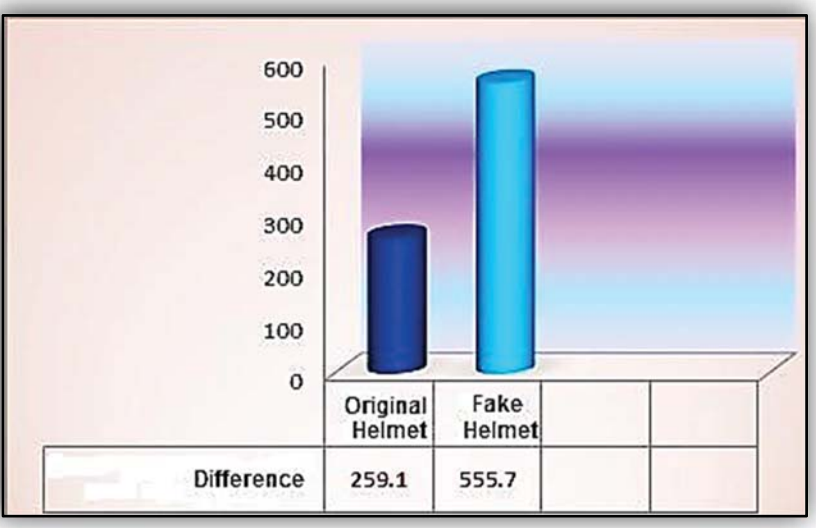

Chart (2) of Iron Sample under a Hardness Scale. (Photo: the author)

It is evident from charts (1) and (2) that there is a difference between the hardness of the original vase and the forged vase by a large amount, as the measurement of the hardness of the original vase was 48.5 Vickers, and the measure of the hardness of the forged vase was 125.2 Vickers. The original helmet measured 259.1 Vickers and the forged helmet measured 555.7 Vickers, which confirms the difference in hardness between the original and the fake.

3. Dating Applied Samples to Using the Method of Hardness and Metallographic Microscope

Dating with Two Methods: 1-Using Decorations:

i) The copper vase in the Agricultural Museum-Egypt:

By comparing the decorations with the decorations of different eras, Arabic letters in Kufic script were found, which indicates that the piece belongs to the Islamic eras.

Comparing the decorations within the Islamic period, we found that they refer to the decorations of the Mamluk period in Egypt.

ii) The iron helmet in the Museum of Applied Arts-Egypt:

By comparing the decorations with the decorations of different eras, we found modified plant motifs which began to be used in the Islamic era, suggesting that the piece dates back to the Islamic eras.

We noted that the drawings are in the Persian style, which entered Islamic art after the arrival of Islam in Khorasan. Concrete weapons were brought to Egypt during the Mamluk era in the Tatar wars, so the helmet dates back to the Mamluk era in Egypt as well.

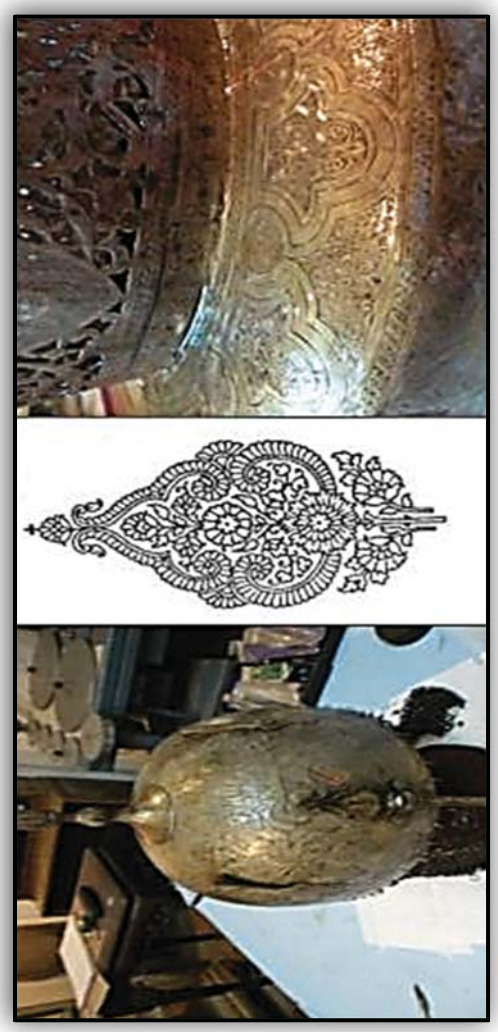

Fig 116: Comparison of the Decorations on the Copper Vase and the Iron Helmet. (Photo: the author)

2-Using Chemical Composition:

This is a comparison between the percentage of chemical composition of the elements in the alloy of pieces chosen for the study, and the percentage of casting the same alloy over the ages. The results are as follows:

i) The Copper Vase in the Agricultural Museum-Egypt:

Depending on the chemical analysis of the elements using a scanning electron microscope, we found that the alloy has copper and zinc as basic components, with an approximate ratio of 75: 78% for copper, and approximately 21 for zinc, which produces what is known as a brass alloy. By looking for the chemical composition ratios over the ages, we found that this ratio corresponds to the Islamic eras. The technique of roasting zinc sulfide or zinc carbonate was developed by Islamic artists. Zinc sulfide sublimates into zinc oxide, and we found that this leaves zinc that is almost free of impurities and iron content. There is also a percentage of oxygen, which indicates that the user is zinc oxide, and this is what we found after analysis with a scanning electron microscope. The approximate proportion of zinc from this era is between 17% and 30% in brass, which corresponds to the proportion of zinc in the applied copper vase, which is approximately 21%.

ii) The Iron Helmet in the Museum of Applied Arts-Egypt:

Using the scanning electron microscope, we found that the alloy is 65% iron, 26% chromium, and has carbon higher than 4%, which corresponds to the manufacture of armor, iron swords and helmets in Iraq and Persia at the end of the Ayyub era and the beginning of the Mamluk era.

4-Results of the comparison between the original archaeological samples and the forged samples.

1. The Comparison between the Original Copper Vase and the Forged Copper Vase in Physical Properties:

i) Microstructure:

We found the presence of impurity elements and corrosion compounds attached to the alloy over time in very small proportions in the microstructure of the ancient copper vase. However, elements such as tin, carbon, and chlorine, beside copper and zinc, did not appear except by careful analysis using scanning electron microscopy. We found that the shape and size of the crystals and metal grains have taken sizes and colors due to the multiplicity present in the crystalline and chemical composition of the alloy whose components appeared only in careful analysis. This makes the shape and size of the crystals different from the microstructure of the imitation alloy, which shows the granular appearance and the microstructure of two types only in two colors (the yellow of copper and the brown of zinc). Therefore, the forger cannot recreate this precise crystal structure, so he has to manufacture a brass alloy consisting of copper and zinc only. This is what supports our ability to reveal the authenticity of metallic traces, and to clarify the difference between the authentic and the fake.

ii) Hardness Test:

The hardness test shows the striking difference between the hardness of the original copper vase and the hardness of the forged copper vase, which was recorded on a scale (Vickers) over 5kg after recording three different readings. The average hardness reading was 48.5 Vickers, compared to the hardness of the forged copper vase, which was 125.2 Vickers. This is a distracting difference, meaning that the hardness of the newly-made copper metal is more than twice the hardness of the archaeological metal, which explains the effects of the temporal factors that weaken the hardness of the copper metal and cause it to be temporarily obsolete. Thus we can differentiate between the authentic and the forged.

2: The Comparison between the Authentic Iron Helmet and the Forged Iron Helmet in Physical Properties:

i) Microstructure:

We found a difference between the shape and size of the crystals and metal grains in the original and forged iron samples. We found that the crystals of the elements consisting of iron, chromium and carbon in the forged sample had a link and harmony between them, such that the crystals appeared in a simple form of repeated crystalline units in shape, size and color. This was in contrast to the archaeological sample where the crystals are in the form of very small, scattered balls, which is attributed to the lack of strong connection between the crystals and the presence of pores between them, as well as to the presence of more than one element in the original alloy which only appeared in the careful analysis beside iron, carbon and chromium. After careful analysis using a scanning electron microscope we found elements (silicon and sulfur and calcium), which is what the counterfeiter cannot accurately determine when casting the counterfeit piece. This confirms our ability to distinguish between the authentic and the fake in the metal.

ii) Hardness Test:

The hardness of the archaeological original iron sample on a scale (Vickers) over 5kg, and after recording three different readings, the average reading of the hardness scale was 259.1 Vickers, and the average reading of the forged iron sample was 555.7 Vickers, meaning that the hardness of the forged iron sample is more than twice the hardness of the archaeological sample. Therefore, the results of the hardness test of the iron sample are in agreement with the results of the hardness of the copper sample. This confirms that the passage of time weakens the hardness of the metallic trace, and this helps us reveal the authenticity of the metal effects.

Conclusion:

We have reviewed the subject of forgery and faking of organic and inorganic archaeology, in this book. We began with organic manuscripts and documents and tried, as far as possible, to provide comprehensiveness so that everyone who researches in this science finds it valuable. We explained meanings and concepts that may not have been used before, such as the definitive meaning of the concepts of forgery and fakes, the difference between them, and the meanings of erasure and special forgery. We concluded by working with applied performance, as a practical and scientific example of studying authenticity and detecting forgery and fakes, which is a practical illustration for the reader as to how to deal with devices while detecting forging and authenticity. Some points in the research are summarized as follows:

1. There is a difference between the meanings and terms of forgery:

Forgery: A complete work intended to deceive and mislead that it is an original work of historical and artistic value.

Fake: a genuine work that has undergone some change to show it to be of historical and artistic value.

Copy: This is identical to the original work and its educational purpose.

2. Types of forgery are as follows:

Forgery: includes whole forgery, copy, and imitation.

Partial fake: is addition, omission, filling, assemblage, and photo.

Special forgery: has been named in our private work because it is fraud that occurs by stalking, the purpose of which is crime and fraud, and includes seals, fingerprints, watermarks, signatures and handwriting, automatic writing, banknotes, and burned writing.

3. The methods of detecting forgery, including the following checks and analyses:

Initial examinations: This is an initial examination of the manuscript to see if there is evidence in the manuscript through which it can be identified, such as names of authors, addresses, places.

Traditional examinations: by placing brackets on words that draw attention, noting the diameter of the corners, distortion of the edges, decorations, endowments, and punctuation.

Logical examinations: with the following criticism:

i) Historical criticism: After knowledge of events, their locations and their arrangement, as well as the people that appear in the manuscript and their roles, and with special knowledge of the dates relating to the first appearances of any part of the manuscript's components historically, such as the beginning of the use of watermarks or script.

ii) Artistic criticism: This takes two directions, the first of which is internal artistic criticism with knowledge of the writer's style, and whether there is a difference in the style of calligraphy throughout the manuscript, and the second of which is external artistic criticism, including the formal criticism of the manuscript in terms of binding, title and gilding, and whether it is consistent with the same period to which the manuscript belongs.

iii) Criticism of natural aging: by examining natural aging in terms of the spread of holes, chemical and biological color spots, sticking of pages, corrosion of paper and fading of inks.

Scientific examinations: using different examination and analysis devices such as infrared, x-ray, video comparative device, and 3D imaging.

4. An applied performance on a manuscript to authenticate it, and detect forgery: We used some new devices to examine the manuscript, and we were able to employ 2.5D technology to detect forgery. We published this experience independently in one of the important international journals in this field.

THE USE OF DIGITAL TECHNOLOGY (2.5D) IN THE AUTHENTICITY OF A MANUSCRIPT FROM THE ISLAMIC ERA

The importance of 2.5D technology lies in its success with checking paper, checking inks, and ease of handling, and the most important aspect is that it is a non-destructive examination of samples. From that, we adhere to the power of science to chase the forgers and refute their actions and refute them (God Almighty wills). Given the modernity of the field, and despite its great importance in preserving the heritage, we have made some important recommendations that I hope, God willing, will be met and fulfilled.

We finished our work with metal as inorganic archaeology, using the hardness of the alloy and the difference in the surface appearance of the microstructure of the samples.

After using metallographic microscope imaging of samples to clarify the difference in the surface appearance of the microstructure, which gave us a positive result, and demonstrated that there is a big difference between the surface appearance of the original archaeological sample and the modern forged sample, and after using the Vickers Scale at 5kg to test for hardness, we found that there is a difference between the hardness of the original piece and the fake.

These results confirm that inherent effects have a special imprint in physical properties and this ‘fingerprint’ can be relied upon in detecting authenticity, reducing counterfeiting, and setting up barriers to stop fakers. Authenticity was revealed in an easy and safe way, without resorting to damage. Besides this, the detection devices that we used are available in laboratories.

Recommendations

1- The use of 2.5D imaging techniques to compare the surface appearance of organic and inorganic archaeology when detecting forgery and authenticity is recommended.

2- Using a metallographic microscope, and hardness scale techniques, to compare the surface appearance of inorganic archaeology when detecting forgery and authenticity is recommended.

3- Generalizing the trend towards the periodic maintenance of manuscripts in private libraries is recommended. Communicating with the owners of these libraries to facilitate their documentation so as not to lose anything of our heritage is also recommended.

4- Intensive courses should be held to link the field of Arabic manuscript verification with the field of authenticity and detecting the forgery of archaeological manuscripts, in order to popularize the use and exchange of information between the two fields.

5- It is recommended that the Ministry of Higher Education should communicate with the Ministry of Industry in order to create a bridge between universities and factories (such as paper factories), to allow the training of graduates, students and researchers. Also that there should be periodic scientific visits so that there is no gap between theoretical and practical study.

6- It is recommended that academics should study the restoration and maintenance of archaeology within the Forensic Medicine Authority to deal with archaeological forgery, This is because the forensic authority deals with archaeology by seizure, and there is no specialist who studies the nature of the manuscript or archaeology to deal professionally and professionally with the seized archaeology. Initial maintenance is recommended to preserve them, and then to conduct non-destructive checks to authenticate them and detect forgery.

7- It is recommended that research in the field of detecting counterfeiting should continue until it reaches the law and rules of work in detecting the authenticity of all kinds of archaeological materials.

8- It is suggested that the science of archaeological authenticity and detecting forgery as an academic course should be taught in universities within colleges and institutes specializing in the field of restoration of archaeology, so that we can produce distinguished generations who are able to distinguish between the original and the fake.

GLOSSARY

Archaeology: The science that deals with the study of ancient civilizations.

Organic Archaeology: A material whose chemical composition contains the element carbon.

Inorganic Archaeology: A material whose chemical composition does not include the element carbon.

Manuscript: All written by hand.

Document: Handwritten document recording correspondence or private property.

Metal: A chemical element that is a good conductor of heat and electricity.

Forgery: A work intended for complete deception to create the illusion that it is an original work of historical and artistic value. It is a complete, forged, copy of a found original, or a completely forged work, and has no original.

Fake: An original work that has undergone some change to show it has historical and artistic value, This work may be original, but it is worthless.

The Fabricator or Pastiche: An artificial work of assembling original or non-original pieces and attaching them to the original copy, while the truth is that they are not interconnected and have no relation to each other. This compilation gives them an artistic and historical value.

The False: The word ‘false’ is used in the sense that it has a good and positive role, such as using the materials for decoration, such as attaching a decorated wooden box to an original manuscript to decorate it, although it may come to mean that it has a bad and negative role.

Fraud: This includes fake signatures of property contracts, arguments and documents intended to defraud and steal money and property. There are many manuscripts with fake signatures that were intended to defraud.

Copy/Reproduction: Making copies identical to the original work for educational study for students.

Genuine Object: This is the original version that has been proven by scientific evidence.

Authentication: Study of the work to explain if it is original or fake.

Dating: Studying the object to explain its age.

Imitation: Replication several times until the imitator reaches the form approximating the script.

Addition: Where a line, a point, or a letter is added directly to the word itself in order to change the meaning, or at the beginning and end of the manuscript.

Omission: An attempt to remove the writing or hide it from the naked eye.

Tearing: Shredding parts of the document to hide something.

Obliteration: Striking out and blurring the words to be hidden.

Filling: Inserting a point, letter, number, or word, between letters and words in the text to fake.

Assemblage: Compiling several parts of different documents to be make a complete document.

Burned Writing: Writings that have been completely or partially burned.

Casting: Pouring the molten metal into the mold to make art.

Sand Mold: A mold made of sand used to create identical models.

References

1- Aamb. M. 2011. "Use of the Video Spectral Comparator 6000: as a Non-Destructive Method for Pigment Identification – An Experiment" Graduating Thesis BA/Sc., Department of Conservation, Institute of Cultural, University of Gothenburg, Sweden.
2- Abdel-Maksoud. G. 2011. "Analytical Techniques Used for the Evaluation of a 19th Century Quran Manuscript Conditions". *Measurement* 44.
3- Adler. C., Haak. W. et al. 2011. "Survival and Recovery of DNA from Ancient Teeth and Bones" *Journal of Archaeological Science* 38.
4- Ali.N., and Fakhri. I. 2017. "Detection and Restoration of Cracked Digitized Painting and Manuscripts Using Image Processing – A Survey" *International Journal on Perceptive and Cognitive Computing*, Vol.3.
5- Anal. M. 2016. "UV-Visible Reflectance Spectrophotometry in Cultural Heritage" *Royal Society of Chemistry*, Vol l8.
6- Badke. D. 2002 "Watermarks" MS diss., University of Victoria Lydgate.
7- Bicchieri. M., Monti. M., Piantanida. G., and Sodo. A. 2013. "Non-Destructive Spectroscopic Investigation on Historic Yemenite Scriptorial Fragments: Evidence of Different Degradation and Recipes for Iron Tannic Inks" *Anal Bioanal Chem*.
8- Bloom, J. 2001. "Radiocarbon Dating, Aramco World" *Live Science*, Vol 50.
9- Clark. W. 2001. "Photography by Infra-red". Live science, Vol 50.
10-Clarke.M., 2013. "The Analysis of Medieval European Manuscripts" *Studies in Conservation*.
11-Crodack.P. 2009. *Scientific Investigation of Copies: Fakes and Forgeries* Elsevier Ltd.
12- Dongya. Y., and Kathy. W. 2005. "Contamination Controls when Preparing Archaeological Remains for Ancient DNA Analysis" *Journal of Archaeological Science* 32.
13-Doumenq. P., Mille. G., and Carvalho. M. 2015. "Conservation of Moroccan Manuscript Papers Aged 150-200 and 800 YEARS, Analysis by Infrared Spectroscopy (ATR-FTIR), X-Ray Diffraction (XRD), and Scanning Electron Microscopy Energy Dispersive Spectrometry (SEM-EDS)" *Spectrochimica Acta* Part A.

14-Duran. A., Franquelo. M., Centeno. M., Espejo. T. and Rodriquez. L. 2011. "Forgery Detection on an Arabic Illuminated Manuscript by Micro – Raman and X-ray Fluorescence Spectroscopy" *Journal of Raman Spectroscopy*.

15-El-youssef.M. 2013. "The Extraction and Classification of Craquelure Patterns for Geographical Analysis of Fine Art" Master's diss., Applied Science, Department of Electrical and Computer Engineering, Faculty of Graduate Studies, University of Windsor, Canada.

16-Gambaro. A., Ganzela. R., Fantin. M., Cappelletto. E., Piazza. R., and Cairns.W., 2009. "Study of 19^{th} Century Inks from Archives in the Palazzo Ducale (Venice, Italy) Using Various Analytical Techniques Micro" *Chemical Journal* 91.

17-Garhawal.S. and Shukla. N. 2013. "A Study on Handwritten Signature Verification Approaches" *International Journal of Advanced Research in Computer Engineering & Technology*, Vol.2.

18-Hassan.R.R.A. 2015. "A 'Tafsir Alkhazen' Manuscript, a Century 17 AD Technical Study" *International Journal of Conservation Science*, Vol 6.

19-Hisako.S., et al. 2019. "Estimation of Birth Year by Radiocarbon Dating of Tooth Enamel" *Journal of Forensic*.

20-Hofman. C., Rick. T., Fleischer. C., and Maldonado. J., 2015 *Conservation Archaeogenomics: Ancient DNA and Biodiversity in the Anthropocene*, Cell Press.

21-Huber. R., and Headrick. A. 1999. *Handwriting Identification Facts and Fundamentals* CRC Press, New York.

22-Hugo. R., Civan. P., et al. 2012. "Ancient DNA in Archaeological Wheat Grains: Preservation Conditions and the Study of Pre-Hispanic Agriculture on the Island of Gran Canaria (Spain)" *Journal of Archaeological Science* 39.

23-Hyuk. S., and Tappert. C., 2002. *Automatic Detection of Handwriting Forgery* Paca University Press.

24-Irvin. S. 2007. "Forgery and Corruption of Aesthetic Understanding" *Canadian Journal of Philosophy* 37.

25-Janssens. K., et al. 2000. "Use of Microscopic for Non-destructive Analysis in Art and Archaeometry" *X-Ray Spectrum* 29.

26-Jones. M. 1990. *Fake: the Arts of Deception* University of California Press, Berkeley.

27-Julio. M., Gondko. K. et al. 2016. "A Multi-Technique Approach for Detecting and Evaluating Material Inconsistencies in Historical Banknotes" *Forensic Science International* 266.

28-Kostadinovska.M. 2015. *Implementation of Methods for Examination of Paper Based Library Materials* National and University Library VBH.

29-Kumpova. I., Vavrik. D. and Vopalensky. M. 2018. “Reading Closed Historical Manuscripts Using Dual–Source Dual-Energy X-Ray Tomography” *Conference on Industrial Computed Tomography*, Wels, Austria iCT.

30-Kusko.H., and Schwab.R. 1987. *Historical Analysis by X-Ray* Elsevier Science.

31-Larsen.R., Coluzzi. N., and Cosentino. A. 2016. “Free XRF Spectroscopy Database of Pigments Checker” *International Journal of Conservation Science*, Vol.7.

32-Layton.J. 2017. *What Is Infrared* Wise Geek Press.

33-Leising.C. 2010. *Paper Surface Roughness Using 3D* NANOVEA.

34-Manso.M., and Carvalho. M. 2009. “Application of Spectroscopic for the Study of Paper Documents: A Survey” *Spectrochimica Acta* Part B. 69.

35-Mark.A. 2016. “UV-Visible-NIR Reflectance Spectrophotometry in Cultural Heritage” *Royal Society of Chemistry*, Vol.8.

36-Martini.M., and Sibilia E. 2001. *Radiation in Archaeometry - Archaeological Dating* Elsevier Science Ltd.

37-Mchugh.M., Difrancesco. G., Gencarelli. J. and Debenham. C. 2010. *Art Forgeries and their Detection* Neutron Ltd.

38-Mulligan.C. 2006. “Anthropological Applications of Ancient DNA: Problems and Prospects” *American Antiquity*, Vol 71.

39-Munger.S., Knabb. K., et al. 2014. “High-Precision Radiocarbon Dating and Historical Biblical Archaeology in Southern Jordan” *National Academy of Sciences*.

40-Musilek.L., Cechak. T., and Trojek. T. 2012. “X-Ray Fluorescence in Investigations of Cultural Relics and Archaeological Finds” *Applied Radiation and Isotopes* Vol 70.

41-Neff.A. 2010. *Rewriting History: Forgeries as Crimes against our Cultural Heritage* Routledge Library & Archival Security.

42-Nervo.M., Buscagilia. P., Giudice. A., et al. 2016. “The Importance of Tomography Studying Wooden Artefacts: A Comparison with Radiography in the Case of a Coffin Lid from Ancient Egypt” *International Journal of Conservation Science*, Vol 7.

43-Plofker.K. 2017. “A Response to the Bodleian Library's Radiocarbon Dating” *History of Science.*

44- Polanyi, K. 2007. *Enlightenment Theory* Viking Penguin, New York.

45-Poulakakis. N., Tselikas. A., et al. 2007. "Ancient DNA and the Genetic Signature of Ancient Greek Manuscripts" *Journal of Archaeological Science* 34.

46-Poulakakis. N., Tselikas. A., Bitsakis. I., Mylonas. M., and Lymberakis. P. 2007. "Ancient DNA and the Genetic Signature of Ancient Greek Manuscripts". *Journal of Archaeological Science*.

47-Remi.C., Prevost. L., and Anquetil. E. 2015. "Drawing Handwriting Processing Analysis: New Advance and Challenges" HAL Archives – Ouvertes.

48-Rosenstein.C. 2007. *Chemical Analysis of Plating Solutions*. Elsevier Sciences.

49-Rowland. J., Brock. F., et al. 2012. *Synchronizing Radiocarbon Dating and Egyptian Historical Chronology by Improved Sample Selection.* Antiquity Publications Ltd.

50-Shwetha.B., and Sathyanarayana. V. 2017 "Digital Image Forgery Detection Techniques" *ACCENTS*, Vol 2.

51-Singh. P., Sethy. P., et al. 2015. "Digital Image Forgery Detection Using Correlation Coefficients" *International Journal of Computer Applications*, Vol 129.

52-Stephen. P., Clarrk. H., Cheryl. A. et al. 2017. "Identification by Raman Microscopy and Visible Reflectance Spectroscopy of Pigments on an Icelandic Manuscript" *Studies in Conservation* 40.

53-Trafela. T., Strlic. M., et al. 2007. "Nondestructive Analysis and Dating of Historical Paper Based on IR Spectroscopy and Chemo Metric Data Evaluation" *Anal Chem* 79.

54-Varshney. V. 2007. *Project Report: Crack Detection and Removal from Old Painting and Manuscripts* Oklahoma Press.

55-Verhoeven. G. 2008. "Imaging the Invisible Using Modified Digital Still Cameras for Straightforward and Low-cost Archaeological Near-Infrared Photography" *Journal of Archaeological Science* 35.

IN THE END

We find the importance of research in finding a safe, scientific method to uncover the forgery & fake of the archaeological monument, thus reducing fakes and preserving our heritage. Therefore, this book, which introduces new methods for detecting forgery, deserves attention and development in the world of archaeology, and these methods are presented in a simple scientific form that is understandable to every reader.

>>

*My work is in the cultural studies field, especially in the conservation of archaeology and the detection of faking in archaeology, As you will see from this book, my skills and experience are matched to the ideas I offer. Of particular relevance is my **10** years' experience working in archaeological conservation, and my university certificates in the field. I am aware of readers' taste for the topic, and how to present a topic with an impetus that gives rise to new and useful scientific reputation, and it would be an honour to be part of a respected team of publishers.*

*I have a **PhD** in the conservation and restoration of archaeology and my achievements include:*

*1-Article "using some examination and analysis devices for authenticity of manuscript, American journal of science, engineering and technology "**AJSET** "**Vol.6**, No.2, **2021**.*

*2-Reviewer for an international journal in "Archaeological Discovery **(AD)**", Scientific Research **(SCIRP)**, Wuhan, China, **2020**.*

*3-Reviewer for an International journal in "International Journal of Archeology **(IJA)**", Science Publishing Group **(Science PG)**, New York, USA, **2020**.*

*4-Article "The use of digital technology **2.5D** in the authenticity of a manuscript from Islamic era, Egyptian journal of archaeological and restoration Studies "**EJARS** " Vol.10, No.1, **2020**.*

*5-Nomination for the award of the best doctoral thesis at Minya University, Egypt, **2020**.*

*6-Patent candidacy from the Egyptian Academy of Scientific Research, Egypt, **2019**.*