INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY STUDIES IN HERITAGE RESEARCH

(P. ISSN: 2785-9614)
(O. ISSN: 2785-9622)

VOLUME 7, ISSUE 2, 2024, 101 –119.
DOI 10.21608/IJMSHR.2025.335148.1033

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THE ROLE OF CONSERVATION PROCESSES IN REVEALING AND DISPLAYING OF BLAZONS AND DECORATIVE PATTERNS ON LEAD-BRASS GRILLES IN THE MOSQUE OF AMIR QAJMAS AL-ISHAQI, CAIRO- EGYPT

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ABSTRACT

The Prince Qajmas Al-Ishaqi Mosque, known as Abu Hariba Mosque, contains windows with metal grilles covered with thick layers of corrosion and dust that completely hide their features. Various investigations and analyses were conducted on these grilles to identify their components and the corrosion compounds that cover their surfaces. Stereomicroscope, metallographic, scanning electron microscope, X- Ray diffraction and EDX unit were used. Examinations show that the surface layers consist of clay minerals, quartz and corrosion products in various colours. The mineral composition of the samples was determined by X –Ray Diffraction Analysis. The analysis revealed the presence of cuprite, malachite, atacamite, and paratacamite as Corrosion products, in addition to quartz and kaolinite. The grilles were made by casting from a lead - brass alloy, which is an alloy consisting of copper and zinc in addition to lead. The various conservation processes, including mechanical and chemical cleaning, resulted in the discovery and display of the blazon of Prince Qajmas Al-Ishaqi, the founder of the mosque, as well as various decorations. The outer surface was also protected by applying protective layers to preserve these windows with metal grilles from deterioration again using a solution of Paraloid B 82 dissolved in toluene at a concentration of 3%. The current study seeks to uncover the conservation processes that were carried out in revealing and displaying of blazons and decorative patterns on lead-brass grilles in the Prince Qajmas Al-Ishaqi Mosque in Cairo, Egypt.

مُلخص

يحتوي مسجد الأمير قجماس الإسحاقي المعروف بمسجد أبي حريبة على نوافذ ذات مصبعات معدنية مُغطاة بطبقات سميكة من التآكل والغبار تخفي معالمها تماماً. ولقد أُجريت الفحوص والتحاليل المُختلفة على هذه المصبعات للتعرف على مكوناتها ومركبات التآكل التي تُغطي سطحها. ولقد تم استخدام الميكروسكوبات المجسم والميتالوجي والإلكتروني الماسح وجهاز حيود الأشعة السينية ووحدة EDX. أظهرت الفحوص أن الطبقات السطحية تتكون من معادن الطين والكوارتز ومنتجات التآكل بألوان مختلفة. وقد تم تحديد التركيب المعدني للعينات بواسطة تحليل حيود الأشعة السينية. كشف التحليل عن وجود معادن الكوبريت والملاكيت والأتاكاميت والباراتاكاميت كمنتجات تآكل بالإضافة إلى معدني الكوارتز والكاولينيت. تم تصنيع المصبعات بطريقة السباكة من سبيكة النحاس الأصفر الرصاصي، وهي سبيكة تتكون من النحاس والزنك بالإضافة إلى الرصاص. ولقد أسفرت عمليات الترميم المختلفة، بما في ذلك التنظيف الميكانيكي والكيميائي عن كشف وعرض رنك الأمير قجماس الإسحاقي مُنشئ المسجد، بالإضافة إلى زخارف مختلفة، كما تم حماية السطح الخارجي بوضع طبقات واقية للحفاظ على هذه النوافذ ذات المصبعات المعدنية من التلف مرة أخرى باستخدام محلول الباراليويد ب ٨٢ المُذاب في الطولوين بتركيز ٣%. وتسعى الدراسة الحالية لإماطة اللثام عن عمليات الصيانة والترميم التي تم إجراءها للكشف عن الشعارات والأنماط الزخرفية على شبكات النحاس والرصاص في مسجد الأمير قجماس الإسحاقي بالقاهرة – مصر.

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DOI 10.21608/IJMSHR.2025.335148.1033

KEYWORDS
Qajmas Al-Ishaqi Mosque; Lead-Brass Alloy; Grilles; Blazon; Conservation.

كلمات دلالية (مُفتاحية)

مسجد قجماس الإسحاقي؛ سبيكة البراس الرصاصي؛ مصبعات؛ رنك؛ صيانة.

INTRODUCTION

The Qajmas Al-Ishaqi Mosque is known as the "Abu Hariba Mosque". The mosque is located on Al-Darb Al-Ahmar Street.[1] It was built by Prince Saif Al-Din Qajmas Al-Ishaqi Al-Zahiri, one of the Circassian Mamluk princes. He added a dome, a fountain, a Madrasa, and a water basin to it.[2] It was built between 885 AH and 886 AH, during the reign of Sultan Al-Ashraf Qaitbay. [3] Qajmas Al-Ishaqi Mosque is located in historic Cairo. [4] Historic Cairo is one of the cities characterized by the presence of various industrial activities that result in air pollution.[5] It spreads air pollutants, the most important of which are solid suspensions and hydrocarbons resulting from car exhausts and various means of transportation. [6] There is also a large percentage of polluting gases such as sulfur oxides, nitrogen oxides, and chlorine gas, as well as high levels of carbon dioxide gas in addition to oxygen gas. [7] The presence of these polluting gases, along with atmospheric humidity, leads to the formation of various corrosion compounds such as cuprite, malachite, azurite, atacamite, paratacamite, and others.[8] This is considered the main reason for the corrosion and deterioration of metal grilles in mosques in Cairo, including the Prince Qajmas Al-Ishaqi Mosque and other archaeological and heritage structures[9] , ***Fig. (1), (a-b).***

[1]) O'Kane, Bernard (2016). The Mosques of Egypt. Cairo: The American University in Cairo Press, pp. 66–70.

[2]) Williams, Caroline (2018). Islamic Monuments in Cairo: The Practical Guide (7th. Ed.). Cairo: The American University in Cairo Press,pp.18-23.

[3]) Bloom, J., (2012), Mamluk Art and Architectural History, A Review Article, Middle East Documentation Center, The University of Chicago, p. 31.

[4]) Gallin, P., (2017), Mamluk Art Objects in Their Architectural Context, Faculty of Middle Eastern Studies, Boston College University Libraries,pp.124-137.

5) Chang (T.), et al., (2019). The role of Sn on the long-term atmospheric corrosion of binary Cu-Sn bronze alloys in architecture. Corros Sci 149,p.78.

[6]) Khoder, M.I. (2007). " levels of volatile organic compounds in the atmosphere of Greater Cairo". Atmospheric Environment (Air Pollution Research Department, National Research Centre, Dokki, Giza) 41 (3), pp.554-566.

[7]) Cole, I. S. (2000). Mechanisms of atmospheric corrosion in tropical environments. ASTM STP 1399. In: S. W. Dean, G. Hernandez-Duque Delgadillo & J. B. Bushman (Eds.), American Society of Testing and Materials. West Conshohocken, PA, pp.48-59.

[8]) Kucera, V., Tidblad, J. (2005). Comparison of environmental parameters and their effects on atmospheric corrosion in Europe and in South Asia and Africa. Proc. 16th Int. Corrosion Congress, Beijing, pp.26-29.

[9]) Brimblecombe, P., (2003). The effects of air pollution on the built environment. Imperial College Press, London, pp.33-37.

Dense layers of solid suspensions, dust, and corrosion compounds form on metal grilles, distorting their appearance and hiding their features and the various decorative and archaeological elements they may contain.[1] In the Mamluk era, an artistic phenomenon spread widely in Mamluk era buildings, whether in mosques, fountains etc., which is metal grilles. [2] They were made of bronze or brass alloy and sometimes iron. The main purpose of using metal grilles was to cover windows and provide protection, such as using them to protect doors inlaid with gold, such as the door of the mausoleum of Sultan Hassan Madrasa.[3] Metal grilles took different decorative forms to reduce the intensity of repetition in their use by creating cubes, small balls, or simplified polygons in the areas where the grilles intersect, which form a decorative aspect in addition to their structural function in strengthening those metal networks [4].The metal grilles with ribbed sticks or stems that intersect in the form of beveled ribbed balls, which is the style used for the metal grilles in the mosque of Prince Qajmas Al-Ishaqi are made through the following steps, ***Fig. (2)***.

The beveled ribbed balls that carry the shape of the Prince Qajmas Al-Ishaqi blazon are prepared in the required size from brass using the casting method, and a hollow part is made on both sides that resembles a circular ring so that it fits the diameter of the ends of the vertical and horizontal sticks that will be used as metal grilles.[5] The horizontal and vertical ribbed sticks of appropriate lengths that carry casting style decorations are also prepared from brass alloy.[6] Traditional sand casting was used, and it was taken into consideration that the thickness or diameter of the horizontal and vertical sticks be less than the end diameter of the beveled ribbed balls. [7] The grilles network is fixed by inserting the ends of the horizontal and vertical sticks into the hollow end rings of the beveled ribbed balls that carry the blazons and riveting them. Thus, the metal

1) Saiz-Jimenez, C., (Ed.), (2004). Air pollution and cultural heritage. A.A. Balkema Publishers, Taylor & Francis Group plc, London,pp.115-118.

2) Williams, Caroline (2018). Islamic Monuments in Cairo: The Practical Guide (7th ed.). Cairo: The American University in Cairo Press,pp.18-23.

3) Gallin, P., (2017), Mamluk Art Objects in Their Architectural Context, Faculty of Middle Eastern Studies, Boston College University Libraries, pp.124-137.

4) Peruski, J., (2014). The supposed dissipation of figural imagery in Mamluk art:, a study of Mamluk iconography, American University in Cairo AUC Knowledge Fountain,pp.73-77.

5) Nabil Ali Youssef, (2010). Encyclopedia of Islamic Metal Artifacts: Egypt from Before the Islamic Conquest until the End of the Mamluk Era, Vol.2, 1st Edition, Dar Al Fikr Al Arabi, Cairo,pp.140-146.

6) Bloom, J., (2012). Mamluk Art and Architectural History: A Review Article, Middle East Documentation Center, The University of Chicago , p. 31.

7) Hodges,H., (1998). " Islamic Metalwork of Sixteenth Century AD", Ltd, London, p.44.

DOI 10.21608/IJMSHR.2025.335148.1033

grilles window is made without any welding processes.[1] This research aims to study the deterioration of the metal grilles in the Qajmas Al-Ishaqi Mosque and to reveal and uncover the decorative elements and the blazons of Prince Qajmas al-Ishaqi executed on the surfaces of the metal grilles by carrying out treatment and conservation processes with the aim of revealing these decorations and blazons, preserving them and protecting them from deterioration again.

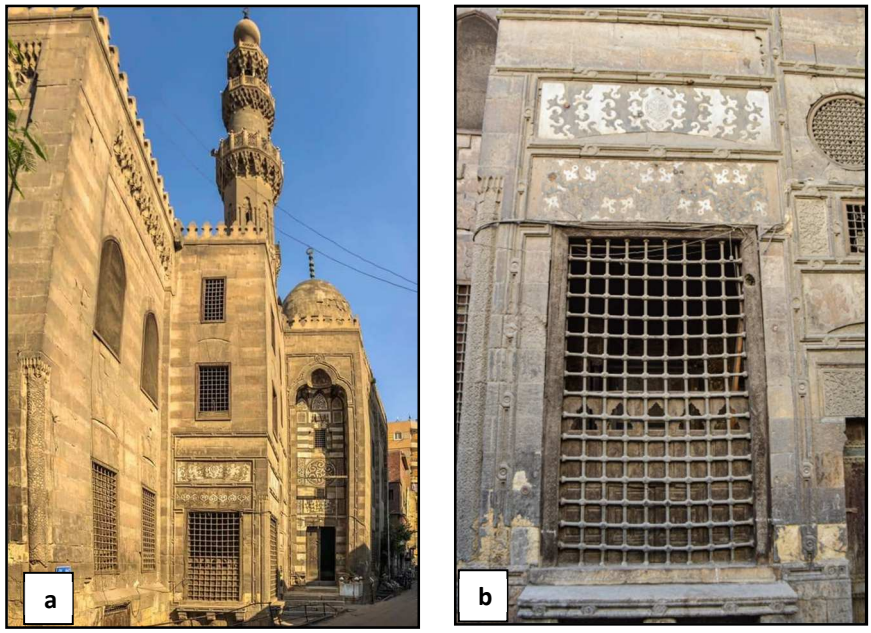

Fig. (1), (a - b): shows the mosque of Prince Qajmas Al-Ishaqi and the grilles of the Sabil widow.

Fig. (2): shows one of the metal grilles in the mosque of Prince Qajmas Al-Ishaqi, and the rank of Prince Qajmas Al-Ishaqi appears on it after the surface layers that were hiding it were removed by mechanical cleaning.

[1]) Nabil Ali Youssef, (2010). Encyclopedia of Islamic Metal Artifacts. Egypt from Before the Islamic Conquest until the End of the Mamluk Era,pp.140-146.

1. MATERIALS AND METHODS

The grilles of the fountain window attached to the Qajmas Al-Ishaqi Mosque were selected for various examinations and analyses. The aim was to determine their components and the corrosion compounds formed on their surfaces. Then, treatment and conservation processes were carried out on them to reveal the decorations on their surfaces and the blazons of Prince Qajmas Al-Ishaqi. The digital recording of the fountain window grilles was done using the AutoCAD program on the computer, as shown in ***Fig. (3)*** and ***Fig. (4)***.

Samples of the grilles were examined using a stereomicroscope. Leica S9i, Stereozoom microscope was used (Stereozoom microscope with zoom magnification changer for incident light with integrated MC190 HD 10MP full HD digital video camera system). An OLYMPUS BX51M metallographic microscope was used to identify the microstructure of the grilles alloy and manufacturing technique of the grilles; a small sample was fixed in cross-section and embedded in epoxy resin. Grinding and polishing processes were carried out then, the sample was impregnated with diamond paste to achieve a fine polish.

The analysis was used with the EDX unit attached to the scanning electron microscope to identify the elements in the samples taken from the surface of the grilles. SEM micrographs and EDX spectra of the selected samples were obtained by using a JSM-6380 LA instrument equipped with a Link EDX operating up to 30 kV. X-ray diffraction analysis was used to identify the components of the grilles and the corrosion compounds. X-ray diffractometer model Philips PW1840 was used.

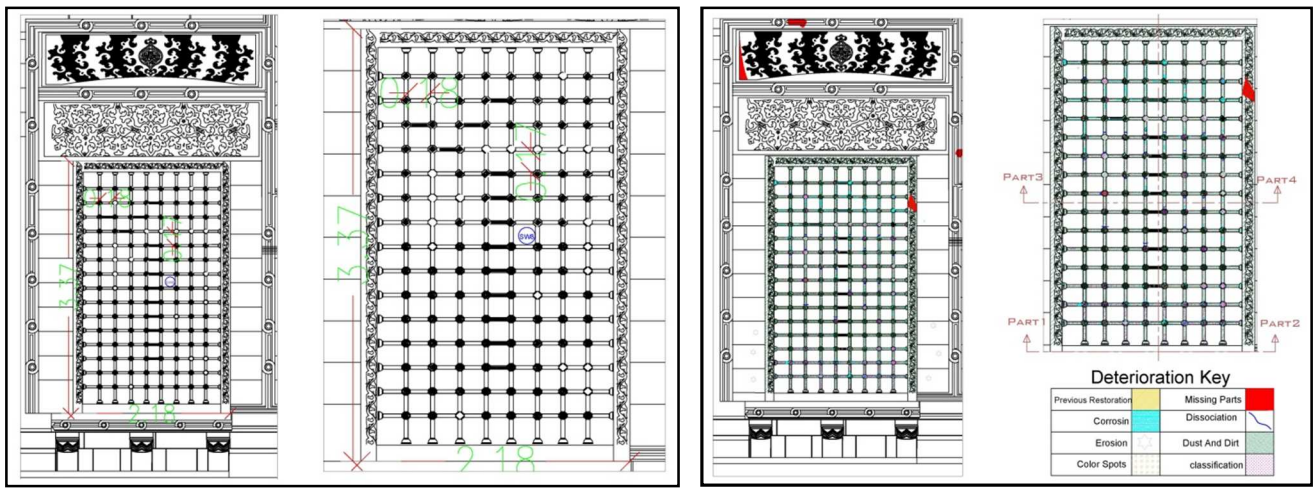

Fig. (3): shows a digital recording by computer using AutoCAD of the grilles of the fountain window attached to the Prince Qajmas Al-Ishaqi Mosque, showing the various deterioration phenomena.

DOI 10.21608/IJMSHR.2025.335148.1033

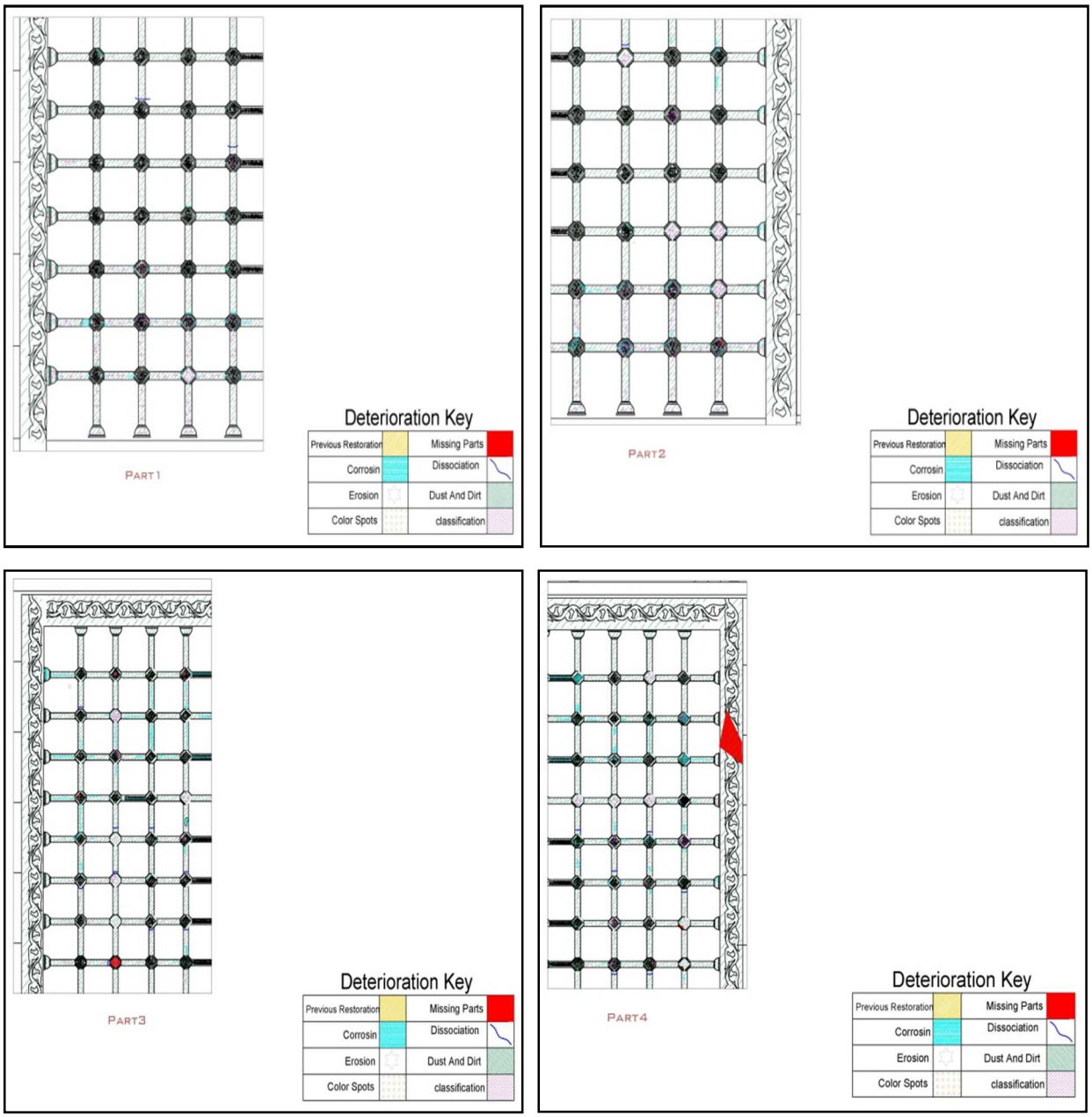

Fig. (4): shows details of the grilles of the fountain window of the Prince Qajmas Al-Ishaqi Mosque executed using AutoCAD, showing the various deterioration phenomena.

2. RESULTS

2.1. Examination by Stereo microscope

Samples of the grilles of the Qajmas Al-Ishaqi Mosque's fountain were examined using a stereo microscope. The examination revealed the presence of calcifications and dark layers mixed with green corrosion layers on the surface of the grilles. Pits and roughness were also found on the surface in some places on the surface of the grille samples. ***Fig. (5), a-d***, Shows the results of the grilles examination.

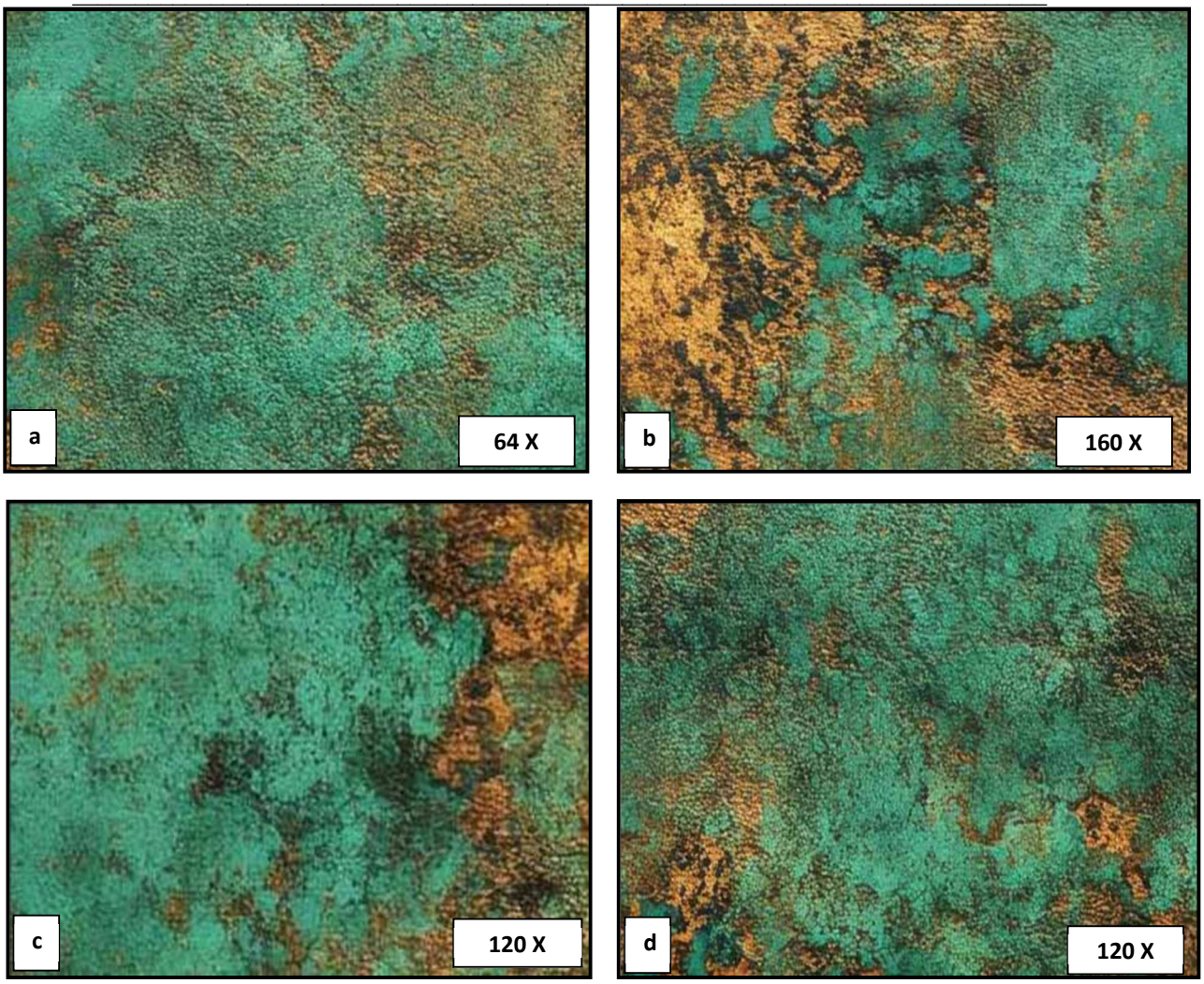

Fig. (5), (a, b, c and d): A stereomicroscopic examination of samples of the grilles of the fountain of the Prince Qajmas Al-Ishaqi Mosque. It shows layers of green corrosion mixed with other dark grains of dust and calcifications. The surface of the grilles is visible from underneath.

2.2. Examination by Metallographic Microscope

Samples of the grilles were examined using a metallugraphic microscope and the examination revealed the presence of the basic elements that make up the triple alloy, which are copper, zinc and lead. The examination revealed that the two basic elements of the alloy are copper and zinc with a small percentage of lead, making it a lead-brass alloy. The microstructure of the leaded brasses contain discrete lead particles primarily in the grain boundaries or inter-dendritic regions. Lead is practically insoluble in solid copper and is present in the cast and wrought materials as discrete particles that appear dark in the structure, ***Fig. (6), a,b.***

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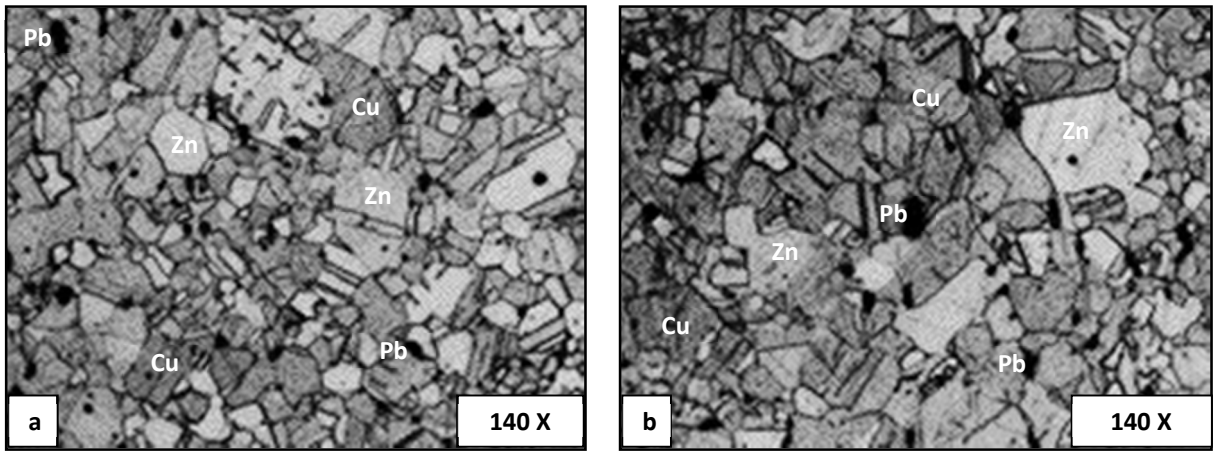

Fig. (6),(a-b): Shows a metallugraphic microscope examination of a sample of the grilles of the Sabil window in the Mosque of Prince Qajmas al-Ishaqi, it shows the three metals that make up the alloy: copper, zinc and lead. The shape of the grains also shows that the grilles were made using the casting method.

2.3. Examination by Scanning Electron Microscope (SEM)

Samples of the grilles were examined using a scanning electron microscope to identify their different morphological and surface characteristics. As well as the extent of their homogeneity or heterogeneity, Examination of the samples with a scanning electron microscope revealed surface erosion and roughness, and consequently the loss of a portion of the surface's smoothness due to the erosion that occurred. Some holes and gaps also appeared. The examination result is shown in ***Fig. (7), a, b***.

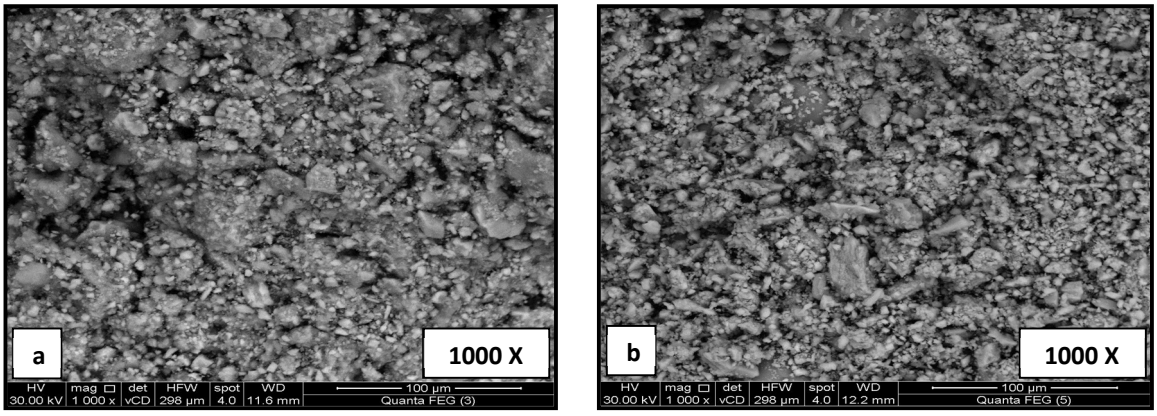

Fig. (7) , (a-b): Scanning electron microscopy examination of the samples from the grilles. The examination revealed roughness in the surface of the grilles and the presence of dense layers of calcification and corrosion between them, gaps and pits in a heterogeneous texture with the presence of sunken and corroded areas.

2.4. Elemental Analysis by EDX Unit

Samples from the surface components of the grilles were analyzed by the (EDX) unit attached to the scanning electron microscope (SEM). It showed that, the presence of Cu, Zn, Pb, Si and other elements. Ratios of elements have been found and the results are complete shown in ***Figs. (8), (9)***.

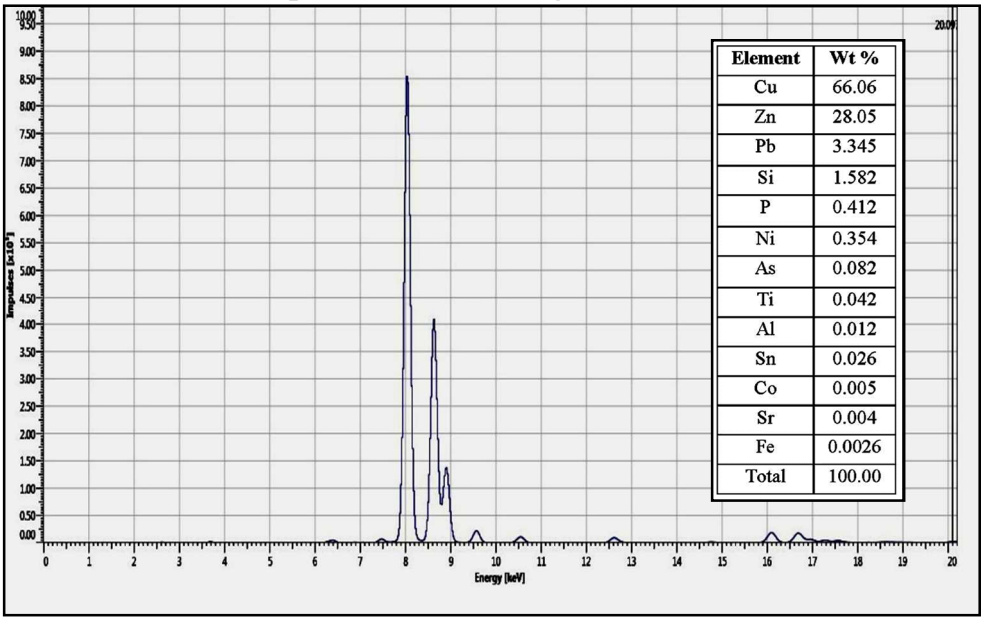

Fig. (8): Shows EDX pattern of a sample from the grilles and the percentages of elements present in the sample.

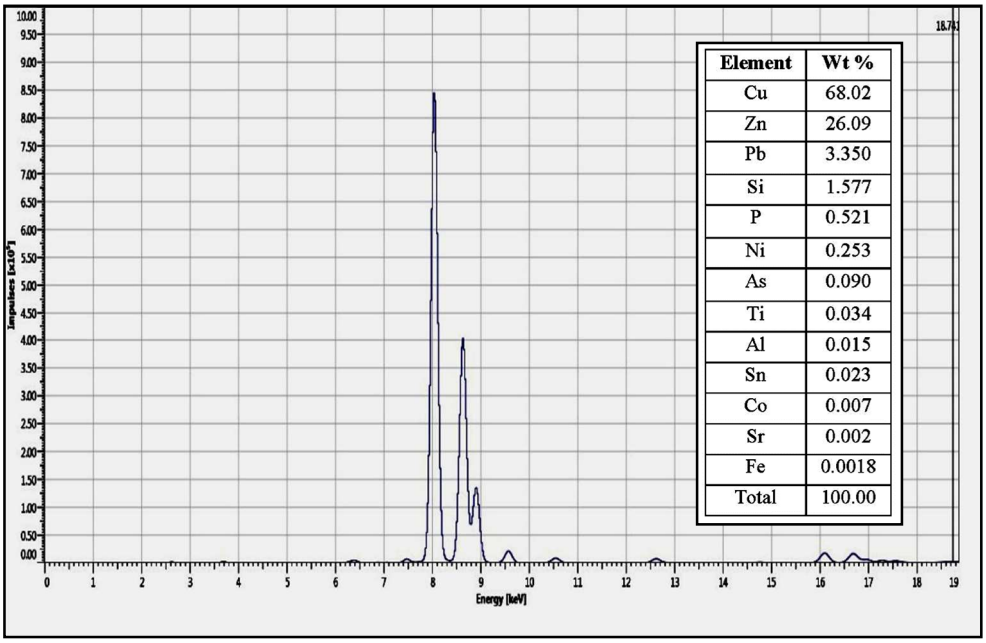

Fig. (9): Shows EDX pattern of another sample from the grilles and the percentages of elements present in the sample.

DOI 10.21608/IJMSHR.2025.335148.1033

2 .5. X –Ray Diffraction Analysis

X-ray analysis of samples from the surface of the grilles. The surface layers of the grilles represent the effect of deterioration due to atmospheric pollution in the presence of moisture and the interaction of the metal surface of the grilles with the surrounding non-metals and the formation of corrosion products compounds mixed with calcifications and solid particles. It shows the presence of the cuprite, malachite,quartz, kaolinite, atacamite and paracamite., the results are shown in ***Figs. (10), (11)***.

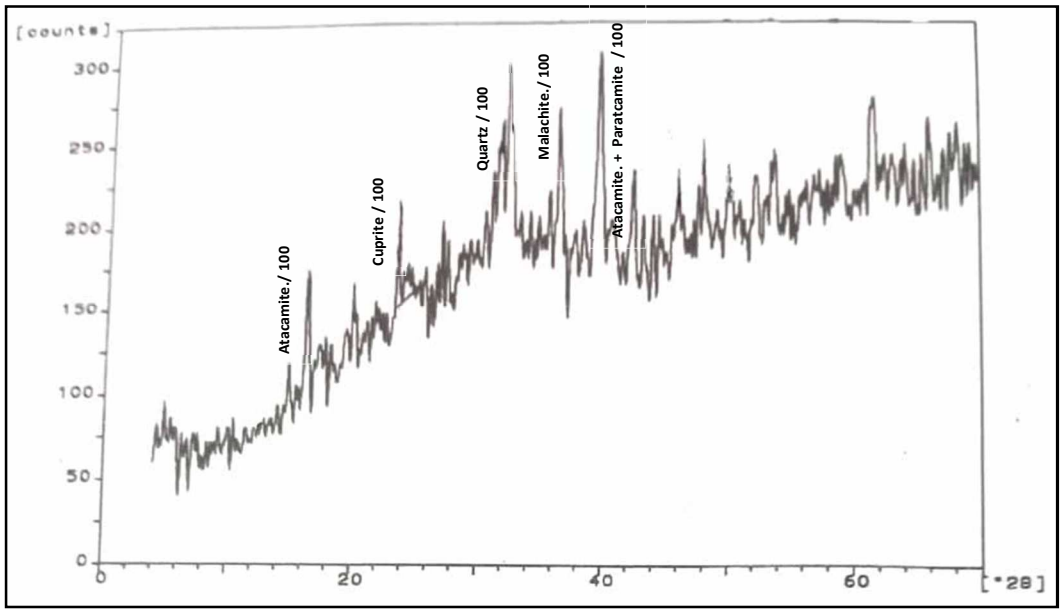

Fig. (10): XRD pattern of a sample from the grilles.

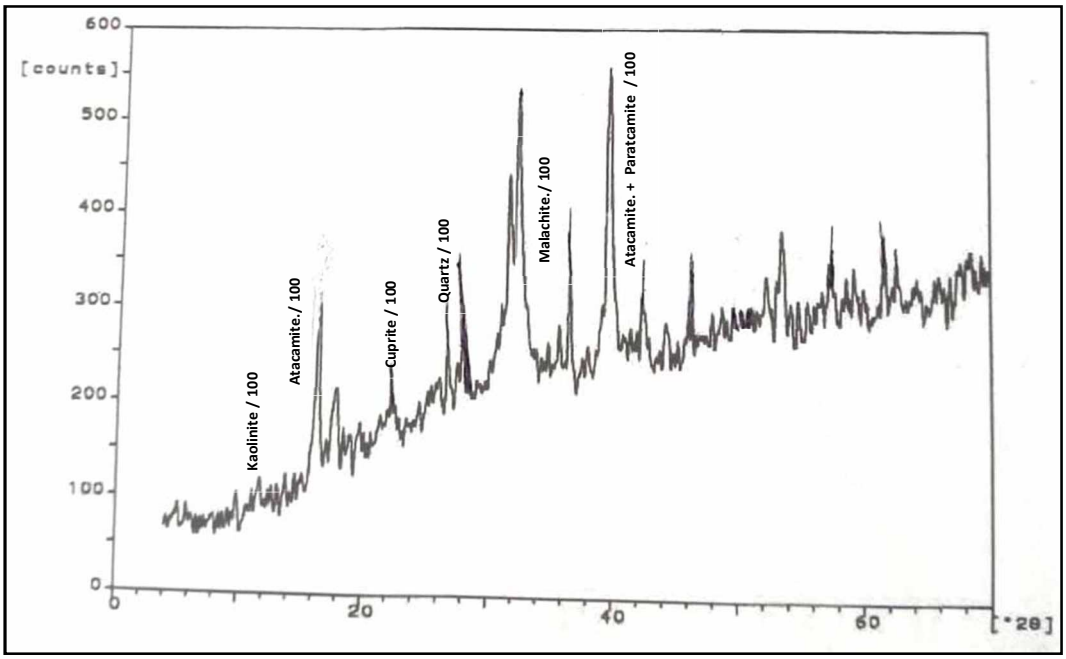

Fig. (11): XRD pattern of another sample from the grilles.

3. Conservation Processes of the grilles of the Sabil window of the Prince Qajmas Al-Ishaqi Mosque

The treatment and conservation processes of the grilles were carried out to treat it from deterioration, ***Fig. (12), a-f***. It depends on the results of the examination and analysis.[1] The presence of thick layers of dust, suspended particles and corrosion compounds on the surfaces of the grilles concealed the decorations and blazons of Prince Qajmas Al-Ishaqi, the builder of the mosque underneath. In order to reveal and expose these decorations and blazons, treatment and conservation processes were carried out. Treatment processes began with mechanical cleaning using hand tools that included scalpels, metal needles and fine chisels.[2] The thick layers of suspended particles and calcifications were removed mechanically.[3] Since the decorations and the blazons were engraved in sunken engravings, sediments and calcifications were found in these sunken areas, which made it difficult to remove them completely with hand tools, therefore, [4]the use of mechanical cleaning was followed by chemical cleaning to complete the detection and exposure of the decorations and the blazons beneath the thick layers of corrosion and calcifications.[5]

Chemical cleaning of the surfaces of the grilles was carried out first using 5% sodium hexaphosphate solution to remove the dense scales and suspended particles on the surface.[6] Then the corrosion layers were removed using a Rochelle salt solution with rough and soft brushes to facilitate the removal of corrosion compounds, especially from between the decorative cavities and sunken blazon shapes of Prince Qajmas Al-Ishaqi executed using the casting

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[1]) Oudbashi, O., (2015). From Excavation to Preservation: Preventive Conservation Approaches in Archaeological Bronze Collections. In La Conservation-Restauration des Métaux Archéologiques: des Premiers soins à la Conservation Durable. Ed. S. Clerbois. Institut Du Patrimoinr Wallon, pp.29-36.

[2]) Petiti, C. et al, (2020), Effects of cleaning procedures on the long-term corrosion behavior of bronze artifacts of the cultural heritage in outdoor environment, Environmental Science and Pollution Research, pp.49-54.

3) Saleh M. Saleh and Ragab Abu ElHassan, (2022). Preliminary Study of the Armored Door at Al-Zaher Barqūq's Mosque, Condition Assessment, and Previous Conservation Campaigns, Egyptian Journal of Chemistry, Vol. 65, pp. 669-685.

[4]) Gehan Adel Mahmoud , et al, (2022), Corrosion Characteristics and conservation of Ancient Egyptian Bronze Osiris Statuette from Al-Arish Museum, Egyptian Journal Archaeological and Restoration Studies (EJARS), Vol. 12. No.1, pp.2-15.

[5]) Lucchi,E., (2020). " Environmental Risk Management for Museums in Historic Buildings through an Innovative Approach: A Case Study of the Pinacoteca di Brera in Milan (Italy)" Sustainability, VOL12,Isseu,5155, pp.154-161.

[6]) Degrigny, C., (2007). 'Examination and conservation of historical and archaeological metal artifacts: a European overview. In: Dillmann GB, Piccardo P, Matthiesen H (eds) Conservation of metallic heritage artifacts. Investigation, conservation and prediction for longterm behaviour. Cambridge, Wood head publishing, pp.23-26.

DOI 10.21608/IJMSHR.2025.335148.1033

method.[1]Then chemical cleaning was carried out using a sodium sesquicarbonate solution, and the parts cleaned using chemical solutions were thoroughly rinsed with pure water [2]. The chloride compounds were removed using localized electrochemical reduction by placing zinc powder in these pits or holes with formic acid in a concentration of 5%. The released hydrogen reduces these compounds into soluble compounds. To preserve the grilles and protect them from being deteriorated again, a protective layer was applied to their surfaces using a solution of Paraloid B82 dissolved in toluene at a concentration of 3%.[3]

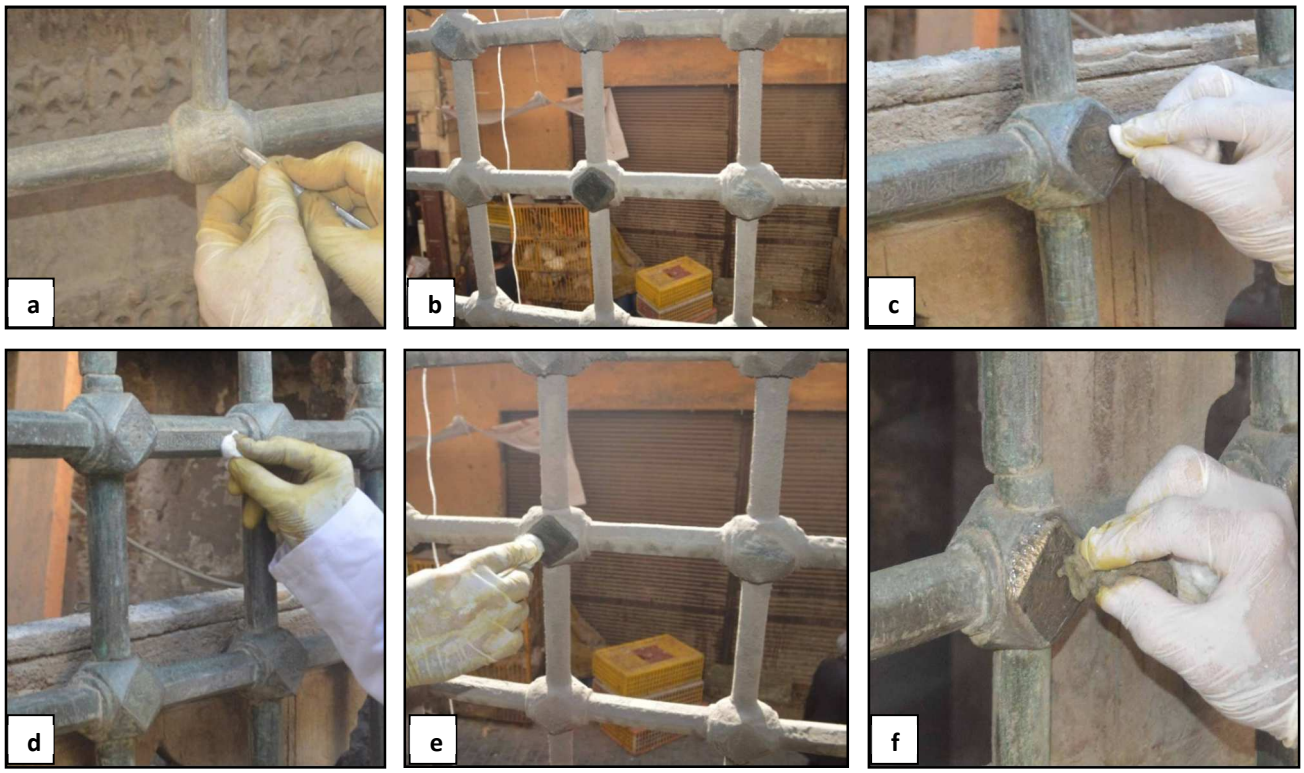

Fig. (12), (a-f): Shows the treatment and conservation processes of the grilles of the fountain window of the Prince Qajmas Al-Ishaqi Mosque.

4. Discussion

The ancient buildings include various arts, including metalwork. For example, metal grilles were used to cover windows.[4] The grilles were made of many

[1])Bertholon, R. (2007). Archaeological Metal Artefacts and Conservation Issues: Long-term Corrosion Studies, In Corrosion of Metallic Heritage Artefacts: Investigation, Conservation and Prediction for Long-Term Behaviour. ed. P. Dillmann, G. Béranger, P. Piccardo and H. Matthiesen. 31-40. European Federation of Corrosion Publication 48, Cambridge: Wood head Publishing,pp.17-22.

[2]) Turner-Walker,G., (2008)." A Practical Guide to the Care and Conservation of Metals " Xi Wang Art and Design Agency, Taiwan, pp.29.

[3]) Knotkova, D., and Kreislova, K., (2007). Atmospheric Corrosion and Conservation of Copper and Bronze, Environmental Science, WIT Transactions on State-of-the-art in Science and Engineering, pp.84-89.

[4]) Gallin, P., (2017). Mamluk Art Objects in Their Architectural Context, Faculty of Middle Eastern Studies, Boston College University Libraries,pp.124-137.

metals and alloys, the most important of which are bronze and brass. The Mosque of Prince Qajmas Al-Ishaqi, which dates back to the Mamluk era, contained metal grilles.[1] Air pollution in Cairo, where the Qajmas Al-Ishaqi Mosque is located, led to the presence of dense layers of suspended solids, dust and calcifications. In addition to the presence of dense layers of green corrosion due to air pollution gases such as sulfur oxides, as well as presence of carbon dioxide and oxygen.[2] With the presence of humidity from its various sources, the most important of which are condensation water, water vapor and rainwater.[3] By examining samples of grilles using a stereo microscope, it was found that there was roughness on the surface and the mixture of suspended solids with dense layers of green corrosion.[4]

The thickness of the corrosion layers varied from one place to another. It was also noted that layers of corrosion and various calcifications mixed with it adhered to a large percentage on the surface of the grilles. On the other hand, the grilles were examined using a scanning electron microscope, where surface corrosion and roughness were observed as a result of pitting and holes on the surface due to the formation of various corrosion compounds. [5] It was also noted that layers of corrosion and various calcifications mixed with it adhered to a large percentage on the surface of the grilles.[6] On the other hand, the grilles were examined using a scanning electron microscope, where surface corrosion and roughness were observed as a result of pitting and digging on the surface due to the formation of various corrosion compounds.[7] By analyzing samples of the grilles using the EDX unit attached to the scanning electron microscope, the grilles in the Prince Qajmas Al-Ishaqi Mosque were made of a lead - brass alloy

[1]) Anna,B., (2010). "Three Medieval Islamic Brasses and the Egyptian Tradition of Inlaid Metalwork", Ahona, pp.25-28.
[2]) FitzGerald, K.P., Nairn, J., Skennerton,G., & Atrens, A., (2006). Atmospheric corrosion of copper and the color, structure and composition of natural patinas on copper. Corros Sci 48, pp.2480–2509.
[3]) Abd-Elhadya, M., Mohammed,A., &Salem, Y., (2016). " Comparison among the best and widely compounds used to copper artefacts protect at atmospheric environment", Architecture, Arts Magazine, pp.26-38.
[4]) Yussri Salem, (2022). Casting, gilding and corrosion mechanisms in two gilded hollow bronze statues from ancient Egypt, Journal of Archaeological Science: Reports, p.43.
[5]) Oudbashi, O., Hasanpour,A., and Davami,P., (2016). Investigation on corrosion stratigraphy and morphology in some Iron Age bronze alloys vessels by OM, XRD and SEM–EDS methods, Applied Physics, 122, p.262.
[6]) Gehan Adel Mahmoud , et al, (2020). Deterioration and Conservation of an Assyrian Bronze Kneading Bowl, SHEDET, Annual Peer - reviewed Journal of the Faculty of Archaeology, Fayoum University, Article 14, Volume 7, Issue 7, pp.250-262.
[7]) Roberge,P.R., (2008). "Corrosion engineering; Principles and Practice" Mc GrawHill publisher.

DOI 10.21608/IJMSHR.2025.335148.1033

consisting mainly of copper, zinc and lead in addition to small percentages of silicon and other elements.[1]

The addition of lead to the alloy is due to giving it the required flexibility and softness so that the decorations and blazons of Prince Qajmas Al-Ishaqi appear on the surfaces of the grilles.[2] On the other hand, the presence of silicon indicates the presence of fine sand grains mixed with corrosion compounds, as well as the possibility of the presence of clay minerals, which consist of two basic elements: silicon and aluminum, and both elements appeared in the analysis result.[3] This was confirmed by the appearance of kaolinite as one of the clay minerals in the results of X-ray diffraction analysis. Other elements also appeared in the analysis results in very small percentages, such as nickel, phosphorus, titanium and iron. The grilles were also analyzed using X-ray diffraction, which revealed the presence of lead- brass alloy corrosion compounds, which included cuprite, malachite, atacamite and paracamite. [4]These are compounds of copper oxides, carbonates and chlorides, which are formed by non-metals present in the atmosphere surrounding the grilles, which include oxygen, carbon dioxide and chlorine ions.[5]

Lead brass alloys are used for their high formability by casting and atmospheric corrosion resistance. The formability by casting of brass is increased by the addition of lead. The lead brasses have excellent workability, good strength and corrosion resistance. Lead can be added to any brass to increase workability and provide pressure tightness by sealing the shrinkage pores. The treatment and conservation processes were carried out on the grilles, which included mechanical and chemical cleaning, which helped to reveal the various decorations on the surfaces of the grilles, as well as the shapes of the blazons of Prince Qajmas al-Ishaqi, which represent very great historical, archaeological and artistic value [6] ***Fig. (13)***. The blazons of Prince Qajmas al-Ishaqi, the founder of the mosque, were discovered, executed in the casting style on the

[1]) Hubbard, F., (2001). 2000 Years of Copper & Zinc and Brass , Revised Edition , Oxford.
[2]) Oudbashi, O., (2015). Multianalytical study of corrosion layers in some archaeological copper alloy artefacts, Surface and Interface Analysis 47, pp.1133-1147.
[3]) Knotkova, D., and Kreislova, K., (2007). Atmospheric Corrosion and Conservation of Copper and Bronze, in "Environmental Deterioration of Materials", WIT Transactions on State of the Art in Science and Engineering, WIT Press, Vol. 28.
[4]) Gehan Adel Mahmoud , et al, (2021). Manufacturing Technique and Conservation Treatment of a Unique Gilt-Bronze Statuette Excavated through Restoration of the Step Pyramid, Saqara, The European Journal of Materials Science and Engineering (EJMSE), Vol. 6, Issue 4,pp.176-191.
[5]) Ingo, G.M., (2019). Surface Studies of the Coatings and Metallic Features of Uncommon High Tin Bronze Artifacts from Ancient Italian Tombs in Abruzzo (Central Italy), Applied Surface Science, 470.
[6])Manal A. Mahera, &Yussri Salemb, (2021). An Unusual Corrosion Product, Kobyashevite, From Ancient Egyptian Copper Artifacts:Technical Note, Egyptian Journal of Chemistry,Vol. 64, No.1, p.11.

surfaces of the metal grilles. The blazon of Prince Qajmas al-Ishaqi is a circle divided into three sections, the widest of which is the middle section, called the shatb. The upper section is occupied by a drawing of the baujah sign, and the middle section occupies a cup with an inkwell, which is a writing tool, on its sides are two horns of gunpowder. The lower section contains a small cup [1]. ***Figs. (14), (15)***.

Fig. (13): Shows the grilles of the Sabil window of the Prince Qajmas Al-Ishaqi Mosque after the treatment and conservation processes, and displaying the blazon of Prince Qajmas Al-Ishaqi on the surfaces of the grilles.

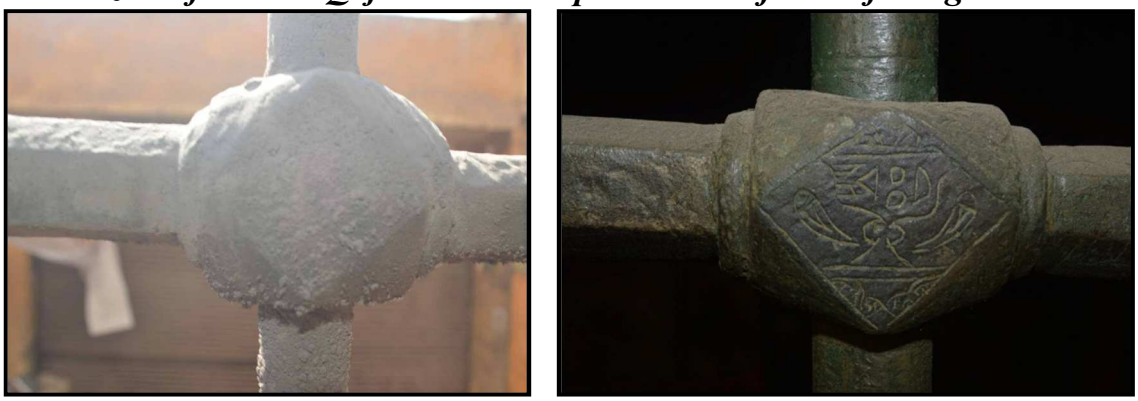

Fig. (14): Shows the blazon of Prince Qajmas Al-Ishaqi on the surfaces of the grilles before and after treatment and conservation processes.

[1]) Nabil Ali Youssef, (2010). Encyclopedia of Islamic Metal Artifacts, Egypt from Before the Islamic Conquest until the End of the Mamluk Era,pp.140-146.

DOI 10.21608/IJMSHR.2025.335148.1033

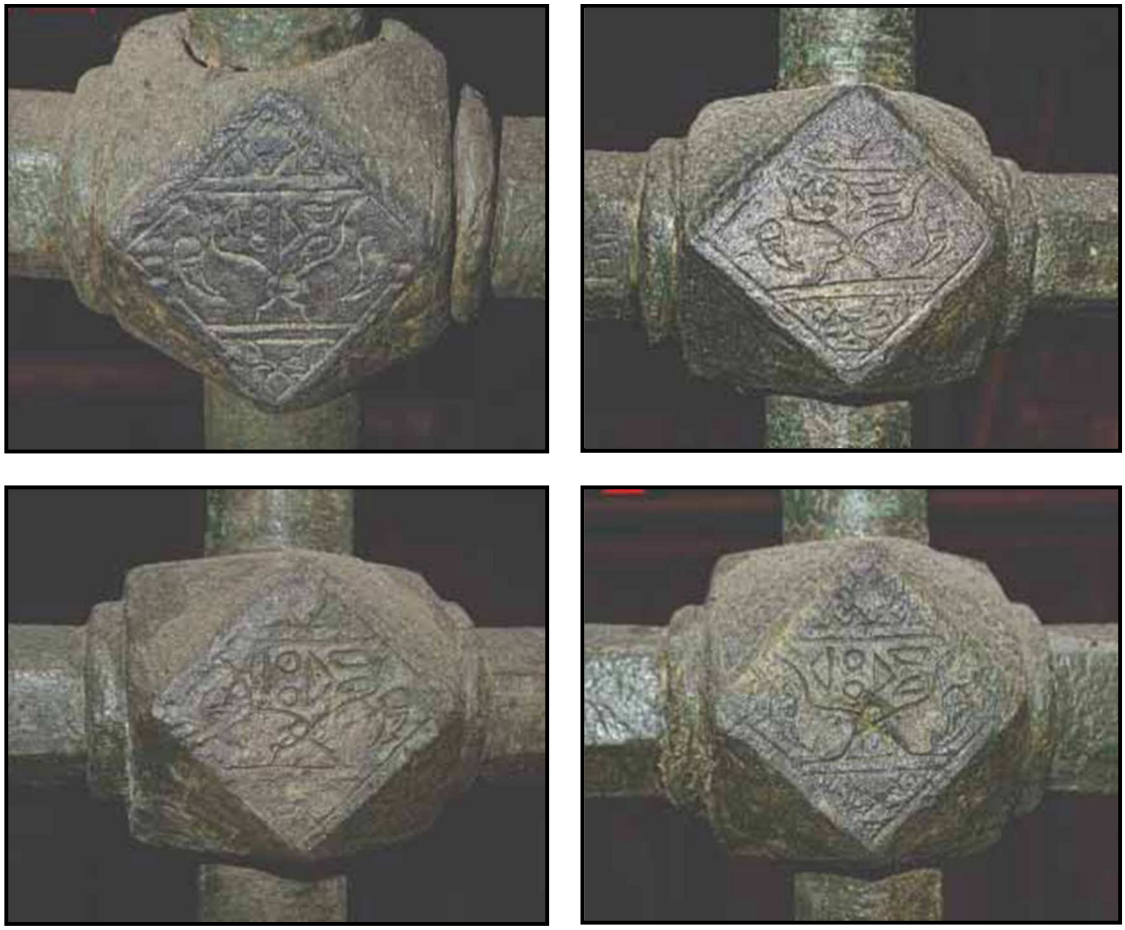

Fig. (15): Shows the blazon of Prince Qajmas Al-Ishaqi, which was discovered and displayed on the surfaces of the grilles after treatment and conservation processes.

5. Conclusion

Metal grilles were widely used in historic buildings, including mosques, to cover windows. There are examples of them that contain decorations. One of these mosques is the Mosque of Prince Qajmas Al-Ishaqi from the Mamluk era. Parts of these decorations appeared under dense layers of fine sand grains mixed with solid particles and calcifications, in addition to the presence of layers of green corrosion. The results of the analysis of the elements that make up the grilles proved that they were made of a lead - brass alloy composed mainly of copper and zinc in addition to lead. The corrosion products also contained cuprite, malachite, atacamite, and paratacamite compounds. Mechanical and chemical cleaning of the grilles revealed the decorations on their surfaces, as well as the blazons of Prince Qajmas Al-Ishaqi, which are of great and varied value. To preserve the appearance of the grilles and the decorations and blazons on them, a surface protective layer of Paraloid B82 dissolved in toluene at a concentration of 3% was applied.

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DOI 10.21608/IJMSHR.2025.335148.1033

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RECEIVED: NOVEMBER 22, 2024
ACCEPTED: DECEMBER 26, 2024