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ANALYTICAL CHARACTERIZATION OF ROCOCO PAINTINGS IN EGYPT: PRELIMINARY RESULTS FROM EL-GAWHARA PALACE AT CAIRO

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Abstract

El-Gawhara palace (1813–1814 AD) is situated south of the Mosque of Muhammad Ali in the Cairo Citadel. This palace is an important example of the best early 19th century rococo decorations in Egypt. The present study reports some of the results obtained from the application of different analytical techniques to characterize some rococo paintings at El-Gawhara palace at Cairo, Egypt. The characterization of the studied paintings was carried out by means of optical microscopy (OM), scanning electron microscopy equipped with an energy dispersive X-ray detector (EDS) and Fourier transform infrared spectroscopy (FT−IR). The obtained results allowed the identification of the chemical composition, structure and the painting technique employed in these paintings. This methodology reveals some useful information on some rococo paintings dating back to the 19th century in Egypt.

Keywords: *El-Gawhara palace; Cairo; Rococo paintings; Gilding; OM; BSE−EDS; FT–IR.*

Introduction

Historical background

The Gawhara Palace (Qasr al-Jawhara, also known as the Bijou Palace, but popularly referred to as The Jewel Palace), is located near the front of the main door of the Mosque of Mohamed Ali from Cairo. El-Gawhara Palace was built by Mohamed Ali Pasha in 1814 to house his administration and to receive guests and as a personal residence [1]. It was named after Gawhara Hanem the last of Mohamed Ali's wives. The palace was designed and constructed by artisans contracted from a variety of countries, including Greeks, Turks, Bulgarians and Albanians. In 1822, a fire destroyed the palace's wooden construction in a blaze that lasted for 2 days. Later, Mohamed Ali had the structure expanded and elaborated upon with the construction of a large marble fountain, columned stone terraces and porticoes, parterres of flower beds and orange groves, and even a menagerie containing a lion, two tigers and an elephant, which were a gift of the British Lord Hastings [2].

Two years later, in 1824, fire damaged again the palace after explosions of gunpowder. Mohamed Ali imported large slabs of marble from Italy to build a vestibule, staircase and corridors. There are few jewels on display here. The name actually derives from the fact that it was used as a museum for the jewels of the Khedives after the 1952 revolution. It is now opened to the public as an example of the best early 19th century Ottoman decoration and

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architecture. Its collection includes 19th century royal portraits, costumes and furnishings. It includes a small garden leading to a mosque with one of the most interesting eccentricities being the Watch Hall where was used the shape of a watch to decorate the walls. Its restored 19th century Ottoman rooms now contain royal portraits, paintings, costumes and furnishings of the period [3]. Figure 1 illustrates some of the rococo paintings found at El-Gawhara palace at Cairo, Egypt.

Rococo paintings

Rococo, also referred to as "Late Baroque", is an 18th-century artistic movement and style, which affected several aspects of the arts including painting, sculpture, architecture, interior design, decoration, literature, music and theatre [4]. The term Rococo comes from the words: *rocaille* (small stones) and *coquille* (shell). Also, the term may be interpreted as a combination of the word "barocco" (an irregularly shaped pearl, possibly the source of the word "baroque") and the French "rocaille", (a popular form of garden or interior ornamentation using shells and pebbles) and may be used to describe the refined and fanciful style that became fashionable in parts of Europe during the eighteenth century.

Fig. 1. (a) A general view of El-Gawhara palace, Cairo. (b) Some paintings show good state of preservation. (c) Cracking and detachments of paint flakes in some paintings in the palace. (d) Fading, loss of the paints and micro-cracks in the paintings.

The Rococo developed in the early part of the 18th century in Paris, France as a reaction against the grandeur, symmetry and strict regulations of the Baroque, especially that of the Palace of Versailles. Rococo art and architecture made strong usage of creamy, pastel-like colours, asymmetrical designs, curves and gold. Unlike the more politically focused Baroque, the Rococo had more playful and often witty artistic themes. Rococo style took pleasure in asymmetry, a taste that was new to European style. This practice of leaving elements unbalanced for effect is called *contraste*.

The Rococo style, which arose as a style of architectural decoration in the palaces of France in the mid-19th century, also exhibits its influence in Ottoman wood workmanship, as in every branch of Ottoman art, as ‘Turkish Rococo’ [5]. Rococo paintings were more personal and less formal. They expressed less emotions and drama than baroque paintings. Rococo paintings had delicate decorations such as flowers and shells. They showed noble subject in charming settings surrounded with pets and servants full of joy. Rococo was eventually replaced by Neoclassic art [6].

The ornamental program of El-Gawhara palace borrows heavily from European models. As a result of these influences from Occident the Ottoman Architecture, it displays some new decorations elements like Corinthian column heads, recesses and overhangs surfaces, refractions, floral motifs, gilding as baroque and rococo decorations. Generally, landscapes, urban scene, mosques, the city's major buildings, Bosphorus, a lot of towers were the main wall-paintings objects. Wall-paintings, resumed in Turkish Architecture, miniature and hand-carved decorations were together used in interior decorations [7].

Research aims

Many of the historical buildings at Old Cairo suffer from neglect and decay and no sufficient analytical data are available about the decorations applied on the walls of these buildings. Moreover, few studies have been devoted to study paintings at historical palaces in Egypt [8– 10]. For this, the main research aim of the present work was to characterize samples collected from some of the rococo paintings found at El-Gawhara palace at Cairo, Egypt. The sample characterization was performed using optical microscopy (OM), scanning electron microscopy (SEM) equipped with an energy dispersive X-ray detector (EDS), and Fourier transform infrared spectroscopy (FT–IR). This research will help in answering some questions concerning painting materials and technique used to perform rococo paintings in Egypt.

Materials and methods

Sampling

The rococo paintings at El-Gawhara palace show many deterioration forms such as cracking and complete detachment of the painted layers. Five (5) tiny samples of the detached painted layers were carefully collected and chosen for analysis. Table 1 shows the codes and descriptions of the studied samples.

Analytical methodology

Analysis of painting materials by analytical methods reveals much information about materials and development of technologies through ages. These analytical procedures should be an integral part of pre-restoration research or project. In the case of wall paintings, analytical methods routinely used are light and electron microscopy with X-ray microanalysis (SEM–EDS), and vibrational spectroscopy (Raman and IR).

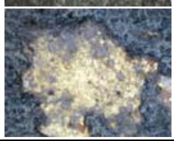
Optical examination

The microscopic examination of the paint layers was performed using a Veho VMS-004-DELUXE USB microscope. The samples were observed in both optical and reflected light under relatively low magnifications (10x to 50x).

SEM-EDS

The microstructure of the studied samples was investigated via scanning electron microscopy (in the backscattered electrons mode, BSE) by a Quanta FEG 250 scanning electron microscope (FEI, Netherlands). The magnification on the studied samples ranges from 100 to 5000x. The accelerating voltage was 20 kV. The FEI Quanta 250 is equipped with an energy-dispersive spectrometer (EDS) (an Oxford Aztec system) for elemental analysis on a microscopic scale. The Quanta line of scanning electron microscopes is versatile, high-performance instruments with three modes (high vacuum, low vacuum and ESEM) to accommodate the widest range of samples of any SEM system.

Table 1. Codes and description of the samples.

No.	Code	Description	
1	GW. 1	Dark green paint layer	
2	GW. 2	Light green paint layer	
3	GW. 3	Painted green flake	
4	GW. 10	Brown paint layer	
5	GW. 11	Gilded layer	

Infrared spectroscopy

Few grains of the paint layers were removed using a metallic scalpel and mixed with a KBr powder. After grinding, the mixture was pressed in an evacuated die in order to produce a pellet (with a diameter of about 13 mm). FT–IR spectra were collected using a Jasco 4100 FT−IR Spectrometer over a wave number range of 4000 to 400 cm^{-1} at a resolution of 4 cm^{-1}.

Results and discussion

Microstructure and microanalysis

Figure 2 shows BSE image obtained on a polished cross-section of the gilded layer (sample GW11). It was clear from the BSE image that a thin soiling layer (approx. 60 μm) is covering the gold leaf. The gold leaf is irregular and its thickness ranges from 150 to 270 μm). The third layer is the underlying reddish bole used to adhere the gold leaf sheets. This kind of gilding is usually known as '*a guazzo*' (water gilding on bole) [11], in which a layer of gesso (mainly of chalk and in many cases, gypsum and anhydrite are used in other types of water gilding) and a layer of bole are used to make the gold leaf adhere [12].

Water gilding uses fine clay, normally red bole. The bole is polished to a fine finish, coated with animal-based diluted size and allowed to dry. The bole supplies a flexible surface that allows for polishing the gold with an agate burnisher. Burnishing involves rubbing with agate stone in the shape of the surface, by pressing relatively hard to inlay the gold sheet into the bole. The surface is then wetted with water and immediately coated with gold leaf. This bole is a mixture of clays, iron oxides and organic compounds, such as oil in some cases [13, 14]. Generally, animal glue is used in bole layers in sculptures and paintings.

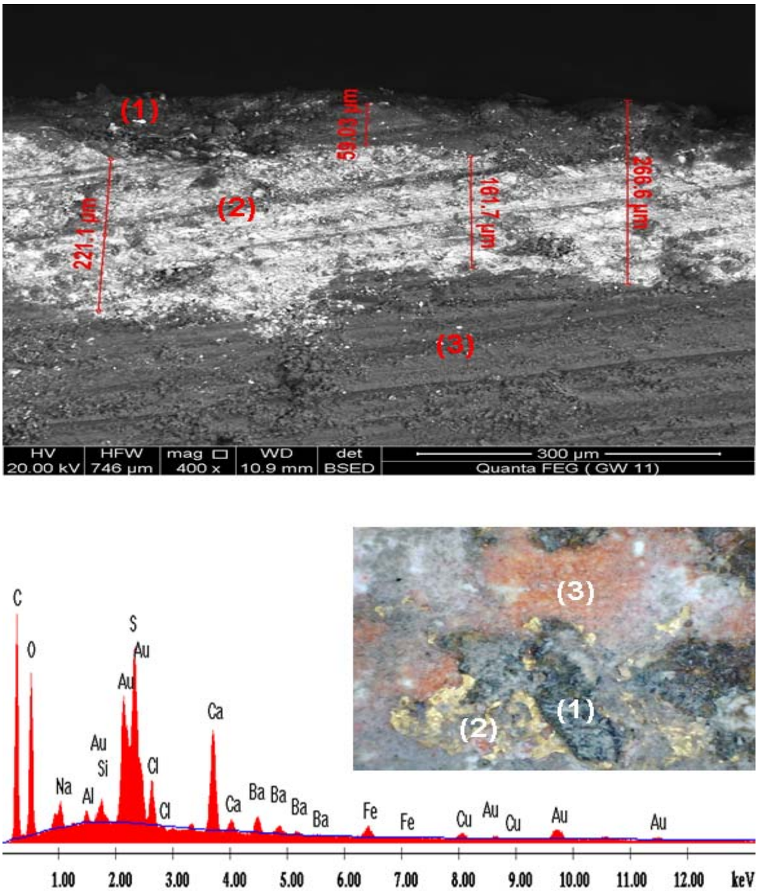


Fig. 2. (Up) BSE micrograph obtained on a cross-section of the gilded layer (sample GW. 11), 1= a soiling layer, 2= a gold leaf, 3= a bole layer for adhering the gold leaf sheets. (Down): An EDS spectrum (bulk analysis) obtained on the outer surface of the sample.

The EDS microanalysis (bulk analysis) obtained on the sample (Fig. 2 down & Table 2) shows major elements of sulphur (S) and gold (Au) with minor elements of calcium (Ca), chlorine (Cl) and sodium (Na).Traces of silicon (Si), aluminium (Al), barium (Ba), copper (Cu), arsenic (As) and iron (Fe) were also detected. The detection of gold in high concentrations with low amounts of copper suggests that an alloy of Au–Cu was used to produce the gold leaf sheets. The contribution of silicon and aluminium is attributed to the presence of aluminosilicate materials (e.g. clay minerals) from the underlying bole layer. The detection of arsenic probably attributed to arsenic sulphide (in the form of orpiment As_2S_3) which used as preparatory layer with the bole or as mordant for gilding in some areas where the gold leaf sheets are not burnished.

The detection of sulphur, barium and calcium suggests the presence of calcium and barium sulphates (barite, $BaSO_4$) which come from the plaster layers. The salt weathering affecting the site was observed through the detection of chlorine and sodium in the samples (soluble salts of sodium chloride). Another BSE image was recorded on an area of the outer surface of the gilded layer (Fig. 3) showing the well adhered thin gold leaf to the substrate below, while the EDS microanalysis shows high concentration of gold (Au, wt. 86.88 %) with traces of silver (Ag, wt. 1.32 %). The BSE image obtained on the dark green paint layer (sample

GW1) (Fig. 4) shows coarse aggregates of the pigment material. The EDS spectrum obtained on the samples (Fig. 4 down) ascertained that the green grains are green earth, since potassium (K), aluminium (Al), silicon (Si) and iron (Fe) were detected. Among mineral pigments, only green earth contains the above elements while the absence of copper (Cu) excludes the existence of malachite or atacamite

Table 2. EDS microanalysis of the gilded layer (Sample GW11).

Element	Wt %	At%
Na	1.28	1.17
Al	0.43	0.33
Si	0.70	0.52
S	7.25	4.75
Cl	1.94	1.15
Ca	5.74	3.01
Ba	3.81	0.58
Fe	1.63	0.61
Cu	1.34	0.44
Au	19.55	2.08
As	3.57	1.00

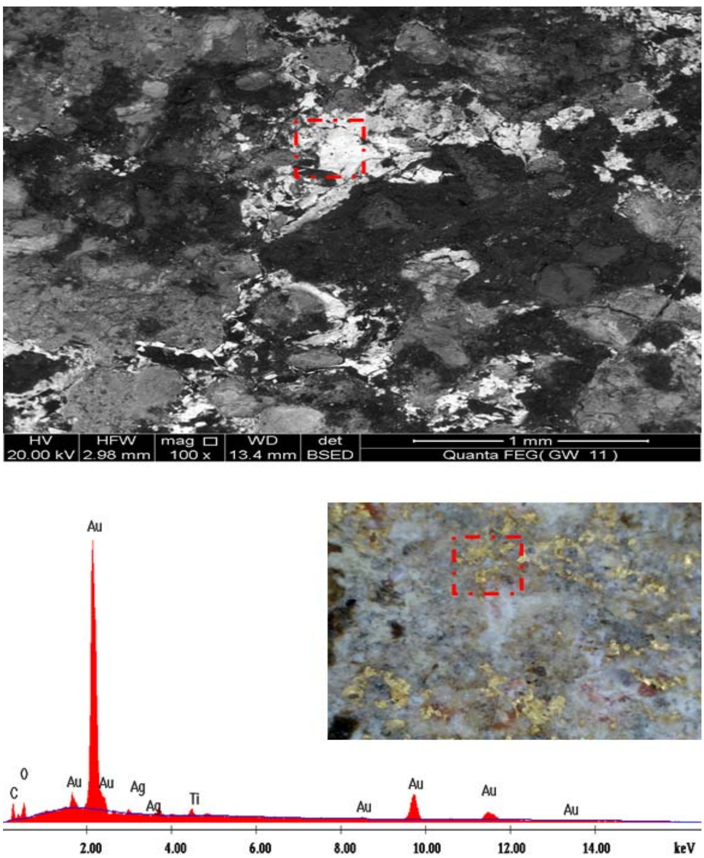


Fig. 3. (Up) BSE micrograph obtained on an area in the outer surface of the gilded layer. (Down): An EDS spectrum obtained on the sample.

Moreover, the existence of sodium (Na) detected in the EDS spectrum of the sample suggests that was used glauconite to obtain the green colour. Other elements of calcium (Ca), sulphur (S), barium (Ba) and zinc (Zn) are coming from the underling plaster layer. The BSE image obtained on the brown paint layer (GW 10) (Fig. 5) shows the fine agglomerates of the pigment material. The EDS microanalysis of the sample (Fig. 5 down) shows that calcium (Ca), sulphur (S) and iron (Fe) are the major elements found in the sample. Other elements of silicon (Si), chlorine (Cl), aluminium (Al), zinc (Zn), magnesium (Mg) and barium (Ba) were also detected. The peak of iron (wt. 5.95 %) suggests the use of iron oxides to produce the brown colour. The detection of silicon and aluminium suggests an aluminosilicate material (most probably in the form of kaolinite, $Al_2Si_2O_5(OH)_4$).

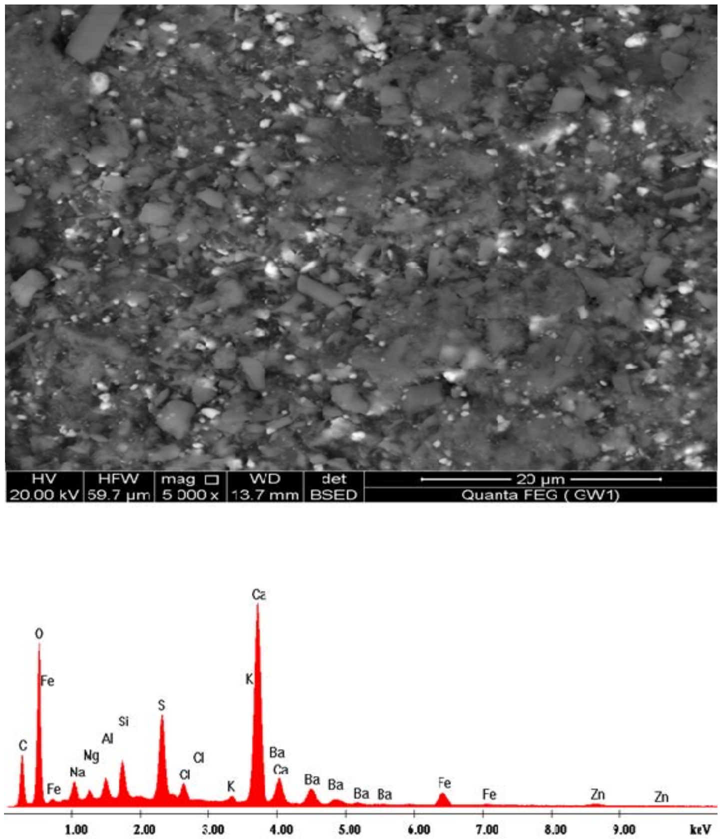
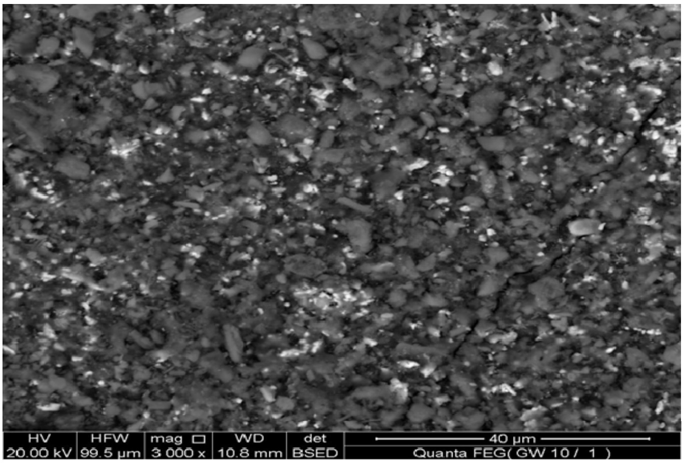


Fig. 4. (Up) BSE micrograph obtained on the outer surface of the dark green paint layer (sample GW. 1). (Down): An EDS spectrum obtained on the sample.

FT–IR results

Figure 6 displays an FT–IR spectrum collected on the dark green paint layer (sample GW1). The presence of linseed-oil is marked by C–H absorptions at 2924, 2857 and 1731 cm^{-1} and by C–O absorptions at 1282 and 1117 cm^{-1} [15]. This confirms that oil painting technique was used to decorate the walls of the palace. The characteristic bands at 1424, 873, 1791, 1514 and 705 cm^{-1} are all of calcium carbonate (chalk from the underlying layer). The FT–IR spectrum presents only the characteristic bands of aluminosilicates (Si–O–Al) at 459 and 1076 cm^{-1}.



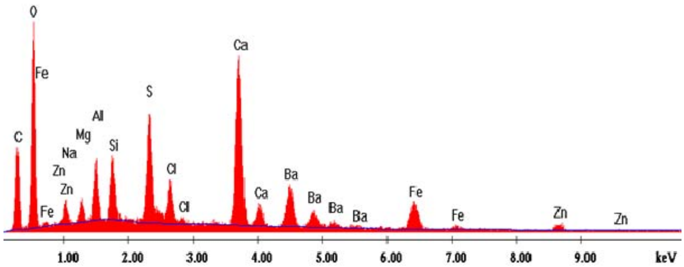


Fig. 5. (Up) BSE micrograph obtained on the outer surface of the brown paint layer (sample GW. 10). (Down): An EDS spectrum obtained on the sample.

The band at 607 cm^{-1} is probably attributed to sulphates. The band observed at 1731 cm^{-1} for carbonyl stretching which is where the carbonyl peak in drying oils, could be assigned to an oily binder (e.g. linseed oil). Linseed oil spectra look very much like the spectra of other oils (tung, etc.) so that oils must be differentiated from each other by another method such as gas-liquid chromatography.

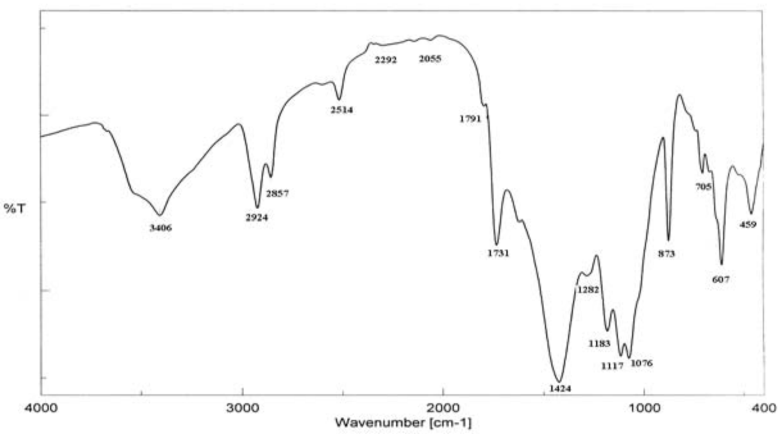


Fig. 6. The transmittance FT–IR (KBr) spectrum obtained on the dark green paint layer (sample GW. 1).

Conclusions

The application of some analytical methods such as OM, SEM–EDS and FT–IR was an attempt to answer questions concerning materials and painting technique of the rococo paintings found at El-Gawhara palace at Old Cairo, Egypt. The results showed that the chromatic palette used for decorating the walls is based mainly on earth pigments. The brown pigment was obtained from iron oxides; the green pigment was identified as green earth (specifically glauconite). The FT–IR results revealed the detection of a drying oil binder (e.g. linseed oil) which suggests that the paintings were applied by oil painting technique.

The gilding of the surfaces is based mainly on the use of gold leaf sheets of highly gold-content alloys (Au with Ag and Cu). The analysis suggests that the gilding was made by a double metal leaf, one made from Au-Cu and the other one from Au-Ag. The results showed that the gold leaf sheets were cut in the required shape and then applied on the walls and adhered on a layer of bole (reddish fine clay) using the water gilding technique. In some cases where the gold leaf sheets are not burnished, a preparatory layer of orpiment with the bole layer was used as a mordant.

The obtained results will be used in the conservation–restoration interventions regarding these paintings.

In conclusion, further investigation of additional samples is being performed and is important to improve our knowledge of the rococo paintings dating back to the 19th century in Egypt.

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