

Comparative Analytical and Investigation Study of Wall and Oil Painting Grounds

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Summary. Some selected grounds used in wall paintings, stucco ornaments and oil paintings belonged to different periods in Egypt were analyzed and examined by different techniques such as X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR) and Scanning electron microscopy (SEM). These analysis and investigations were used to characterize their morphology and composition. The aim of research is to determine and classify the ground painting according to their differences, constituents, technique of application, morphology, decomposition and deterioration aspects in these grounds utilized in walls, stucco ornaments and canvas.

Introduction

Many researches described the application of the ground layer to the working surface for painting and decoration.⁽¹⁻⁴⁾ Polychrome played a great role in the decoration of sculpted figures. The application of ground layer to walls and stucco ornaments were quite a diffuse practice in antiquity in Egyptian, Greek, and Roman cultures. Hence, the number of layers applied, the morphology and mineralogical composition of the plaster used for the wall painting, stucco ornaments and canvas were studied. The main objective of the present experimental study is to compare the grounds utilized in wall, sculpture and altarpieces of oil paintings from different grounds available. The morphology and composition were characterized with the aim to provide useful information in further studies. Samples from some selected wall sculpture, stucco ornaments and oil painting grounds dated back to various periods were collected such as: Nefer tomb, Fig. (1) in Saqara; Giza which belonged to the old kingdom (2700-2200BC). Tal Basta stone tomb Fig. (2), located in Eastern government, from Intermediate kingdom (2160-1785BC). El Anfoshe tomb No. (2), Fig.(3) in Ras El Tin, Alexandria from Greek-Roman (323- 641BC),⁽⁵⁾ Ateka Mashhad, Fig.(4) from Fatmid period (516H- 1122AD),⁽⁶⁾ and oil paintings from Al Gizyra museum belonged to rulers of the family of Muhammad Ali Pasha on canvas.

Muhammad Ali Pasha painting Fig. (5) (ruled from 1805-1849AD), 178x270 cm, No.29. Fig.(6) Ismael Pasha painting before given the title of khedive (1863-1867AD), 73.5x59 cm, No.7/32. Khedive Ismael painting, Fig. (7), after given the title of khedive (1867-1879 AD), 270x206 cm, No.32. Sultan Hussein Kamil painting, Fig (8) (Ruled from 1914-1917 AD) 230x174 cm, No.22. King Fuad I painting, Fig (9) (ruled as a king from 1923-1936AD) 172x101 cm, No.43.

Experimental

Instrumentation and operating conditions

X-ray diffraction analyses were performed on Phillips X-ray diffraction equipment model pw/1840 with Ni filter, Cu radiation 1.54056 \AA at 40 KV, 25mA, 0.05 /sec Figs (10-18). SEM Model Phillips XL30 with accelerating Voltage 25K.V, X 420 and resolution for $50\mu \text{ m}$ was used to study the morphology and particle size of the ground samples Figs (19- 27). FTIR allows identification of the adhesive material used in oil painting grounds⁽⁷⁾ Fig (28). Chemical analysis was also carried out to confirm FTIR results.⁽⁸⁾

Results and Discussion

The old Egyptian artists used to decorate their tombs and temples. Nefer and Tal Basta stone tombs were constructed from limestone that has a very splendid carved painting relief. In these tombs the stones represent the ground layer for wall painting. Generally the ground painting layer is locating between the support and the paint layer, to provide smooth and suitable surface for the paint layer.

The obtained results by X-ray diffraction Analysis of sample (A) from Nefer tomb in Saqara are calcite CaCO_3 as major component of limestone and traces of halite NaCl as deteriorated component. Sample (B) from wall painting relief of Tal Basta in Eastern government consists mainly of calcite CaCO_3 . Sample (C) from ground painting of El Anfoshy tombs, Alexandria belonged to Graeco-roman period is

composed of gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$) as major component, quartz as minor and traces of halite NaCl. Sample (D) from the plaster ornaments in mihrab of Atteka Mashhad is a mixture of gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$) and calcite CaCO_3 .

Whereas the grounds of the selected oil paintings analyses results on canvas were as follows: Sample (E) of Muhammad Ali Pasha oil painting, consists mainly of calcium carbonate, calcite CaCO_3 and minor amounts of lead carbonate hydroxide, hydrocerussite, $\text{Pb}_3(\text{CO}_3)_2(\text{OH})_2$. Sample (F) of Ismael Pasha consists of anhydrite calcium sulfate CaSO_4 which may indicate that gypsum has been employed, and transferred to anhydrite⁽⁹⁾ due to deterioration factors such as unsuitable circumstances of storage and preservation or dryness at high temperatures.⁽¹⁰⁾ Sample (G) of khedive Ismael contains zinc oxide, zincite ZnO. Sample (H) of sultan Hussein Kamil consists of calcium carbonate, vaterite, CaCO_3 . Sample (I) of king Fuad I, includes mainly calcium carbonate, calcite CaCO_3 and little amount of iron oxide, Fe_2O_3 that transferred from red brown color to the ground layer.

Particle sizes were examined by SEM that correspond with the results obtained from the XRD analysis. Thus, the relative intensities of the diffraction peaks in the XRD patterns can be related to the degree of crystallinity. Generally speaking, the particles were small in size and represented poor crystalline appearance. Only in fig (20) showed uniformly sized prismatic or needle crystals of halite NaCl on the calcite crystals. Figs (24 -28) declared fine and deep cracks at the ground of the oil paintings of Muhammad Ali, Ismael Pasha, and king Fuad I. Moreover, definite holes through the grains of the filling materials at the oil paintings of khedive Ismael Pasha, and Sultan Hussein Kamil. Brittleness and weakness of all the oil paintings were observed. Loss in the adhesive material is due to sever mechanical deformation and aging.

Fourier transform infrared analysis (FTIR) data showed that the adhesive, which mixed with the white material of the grounds of all oil paintings, is animal glue. Chemical analysis assures the result of (FTIR) analysis.

Conclusion

According to the results of the present study, although all the painting grounds were participating in the same function represented in preparing a smooth layer for applying the paint layer, but the study assures that the technique of employing painting ground layer is different from time to time, and from material to another. Calcite was used in carved painting as main component of limestone that smoothed as a prepared ground painting for applying the paint layer. Sometimes the ground painting was consisted of a mixture of calcite, gypsum and quartz with different percentages. There are also stucco ornaments that consisted mainly of gypsum and different amounts of calcite that preparing for getting a fine layer for carving the geometrical, floral and inscription decorations. In the oil painting, also the calcite was used as a filling material mixed with animal glue as adhesive. Thus calcite is a major component of many grounds in wall painting, stucco ornaments and oil painting because it gives smooth and strength for grounds. There are also some differences among grounds that previously mentioned as, using a zinc oxide (zincite) and lead carbonate hydroxide (hydrocerussite) mixed with animal glue as a ground in oil painting only. In the case of the gypsum used as a ground layer in oil painting, it may be deteriorate due to storage at high temperatures for a long time, it will transform to anhydrite causing cracking, flaking, and separating of the ground layer. Animal glue was used as adhesive material only in preparation of oil painting ground.

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Fig.(1) Wall painting of Nefer tomb (Sample A)



Fig.(2) Wall painting of Tal Basta stone and details of sculpted figures (Sample B)



Fig.(3) Wall painting of El Anfoshe tombs (Sample C)



Fig.(4) stucco ornaments in mihrab of Ateka Mashhad (Sample D)



Fig.(5) oil painting of Muhammad Ali Pasha (Sample E)



Fig.(6) oil painting of Ismael Pasha (Sample F)

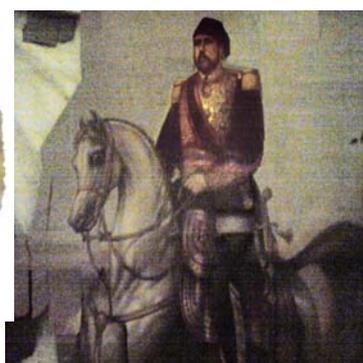


Fig.(7) oil painting of khedive Ismael Pasha (Sample G)



Fig.(8) oil painting of Sultan Hussein Kamil (Sample H)



Fig.(9) oil painting of king Fuad I (Sample I)

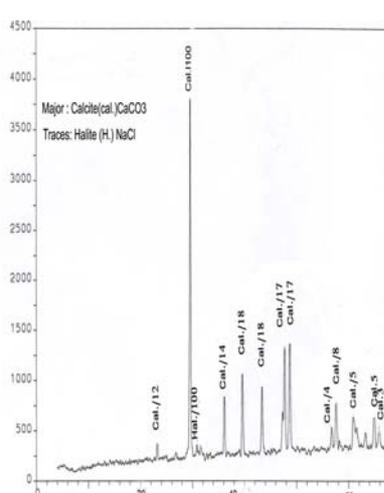


Fig.(10) (Sample A)

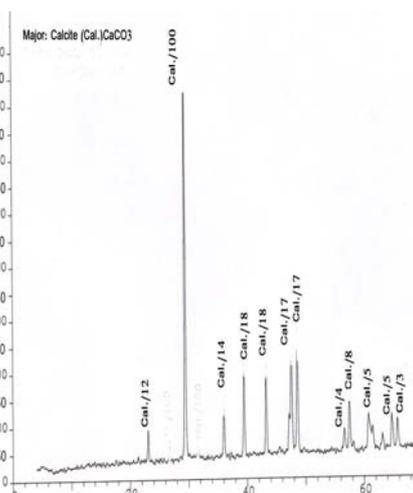


Fig.(11) (Sample B)

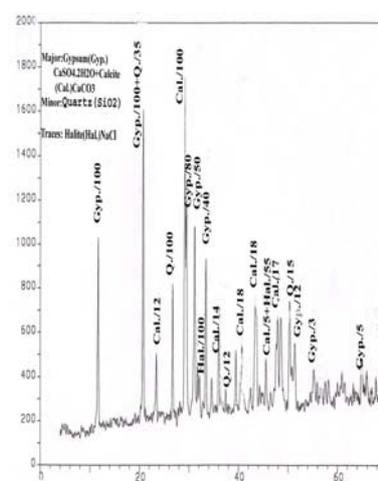


Fig.(12) (Sample C)

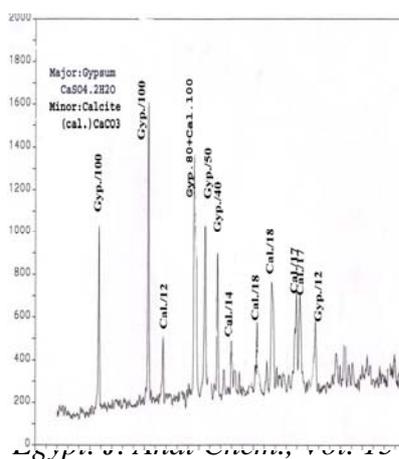


Fig.(13) (Sample D)

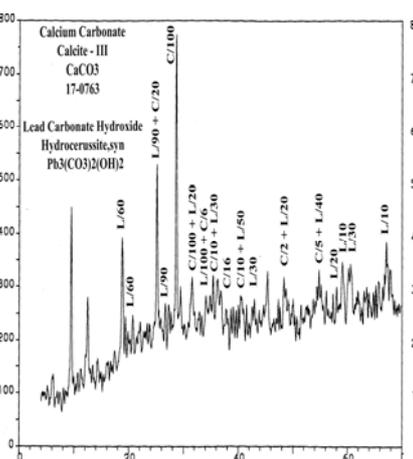


Fig.(14) (Sample E)

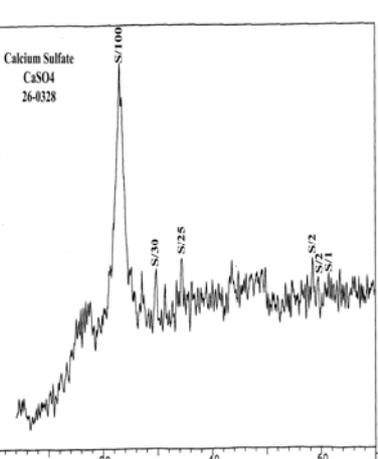


Fig.(15) (Sample F)

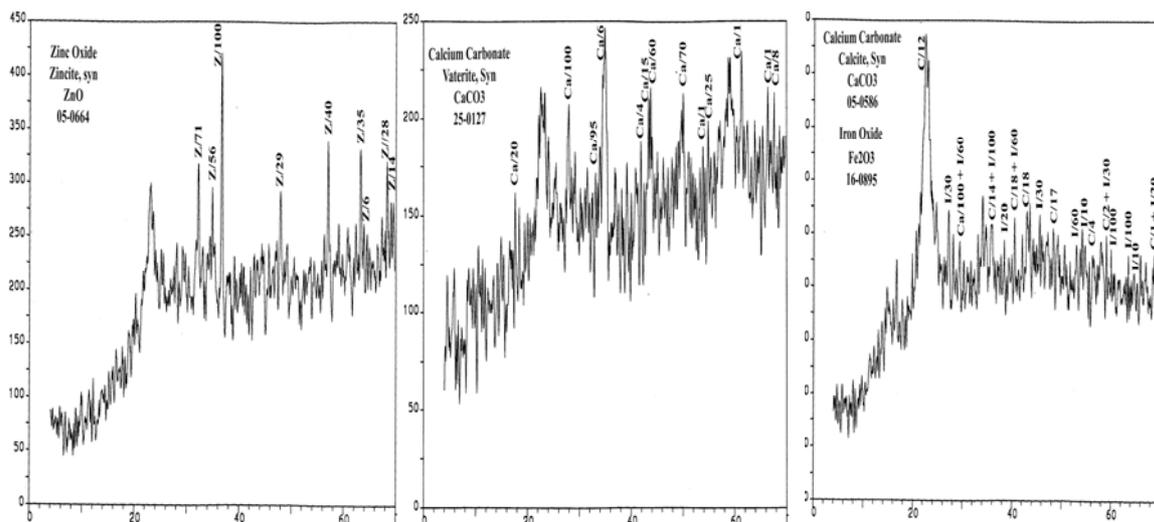


Fig.(16) (Sample G)

Fig.(17) (Sample H)

Fig.(18) (Sample I)

Figs (10- 18)

X-ray diffraction patterns of the selected ground samples used in wall paintings, plaster ornaments and oil paintings.



Fig.(19) (Sample A)

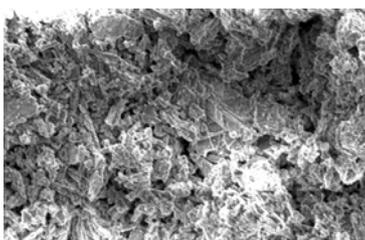


Fig.(20) (Sample B)

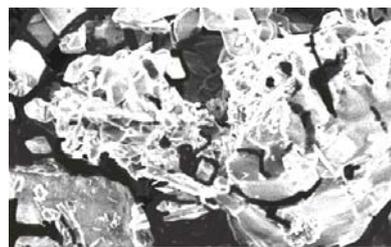


Fig.(21) (Sample C)

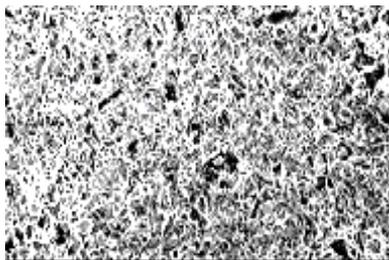


Fig.(22) (Sample D)



Fig.(23) (Sample E)

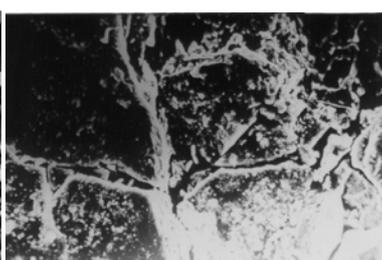


Fig.(24) (Sample F)

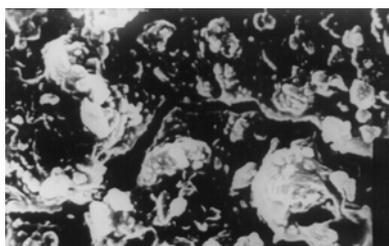


Fig.(25) (Sample G)



Fig.(26) (Sample H)

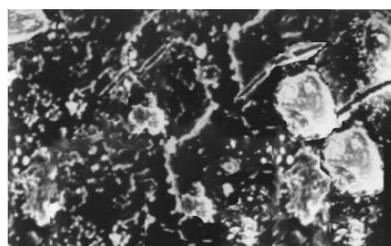


Fig.(27) (Sample I)

Figs (19 - 27)

SEM Photographs of the selected ground samples used in wall paintings, plaster ornaments and oil paintings.

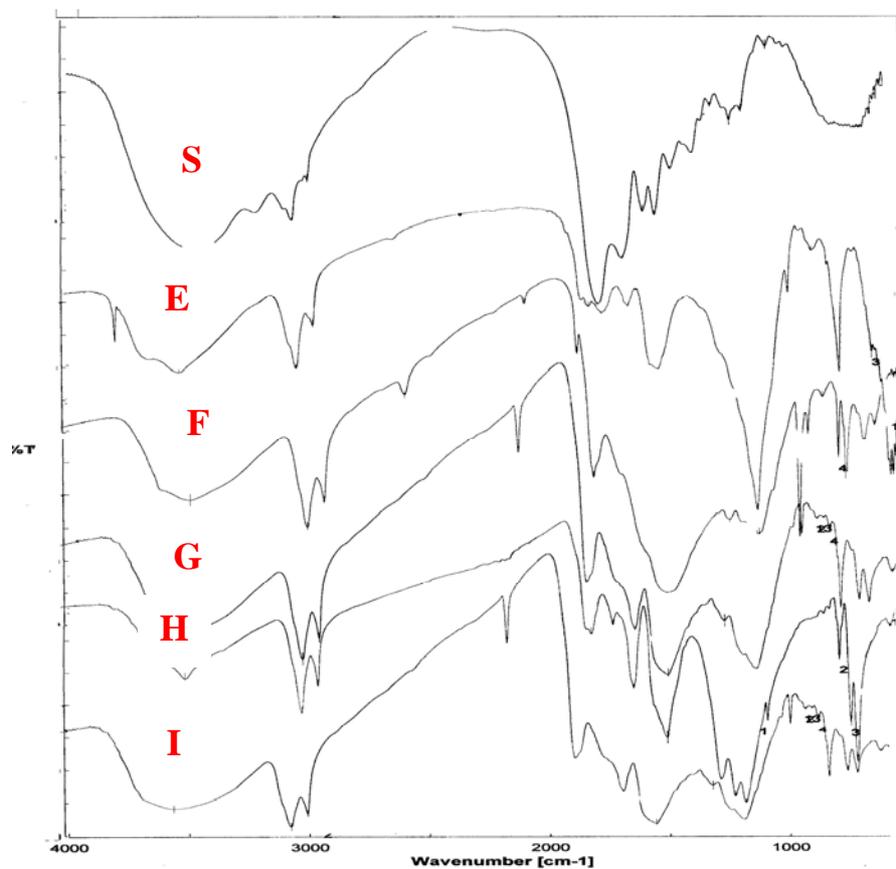


Fig. (28) FT IR. spectra patterns of the standard new animal glue (S) and adhesive material of the grounds of the selected oil paintings samples (E, F, G, H, I).