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Identification of Materials Used in Roman Over-Paintings in Cross Section at the Luxor Temple

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Abstract: The present work aims to study the characteristics of the Roman over-paintings at the Luxor temple is considered one of the famous and important archaeological temples in Egypt. For this purpose, samples were collected from fallen fragments of Roman fresco in Luxor temple. the samples were in cross section which was identified by using Binocular and SEM-EDX in order to identify the different layers and Identification of materials. In the case of the Roman over-paintings at the Luxor temple consist of the coarse plaster “arriccio” composed mainly of Quartz , gypsum and calcium carbonate. On the other hand, The fine plaster “intonaco” composed of calcite, quartz, gypsum. The paint layer consent mainly of (Lime) calcium carbonate traces of gypsum. On the other hand the probably the Coptic artist used the technique of “Secco Fresco” in Roman over painting at Luxor temple.

Keywords: Over painting ; SEM-EDX ; Investigation; Roman mural painting.

1. Introduction

The Roman over-paintings dating back to the late 3rd century were applied on Pharaonic walls built during the reign of Amenhotep III (1402–1364 BC) at Luxor temple [1]. the technique of over-painting is found in several sites of upper Egypt. This research in two directions The first, samples were collected from fallen fragments of Roman fresco in Luxor temple which was prepared in cross-sections observation in both PLM (BM) and SEM-EDX. The second direction, to scientific observation using two techniques: The first, surface observation in Binocular and SEM. The second, preparation cross-sections observation in both BM and SEM.

Investigation of Cross-Section through different techniques and analysis as PLM and SEM-EDS were carried out to provide us important information about roman over-painting such as structure, characteristics, thickness, shapes, number of layers, materials and technique used in Roman over-painting, Luxor temple. The cross-section investigations identified three different layers was applied on the surface of the Pharaonic wall. The surface of the Pharaonic wall preparation from different tools, the signs of the tools has shown on the surface of Pharaonic walls. After that, putting preparation coarse layer on the surface of the Pharaonic wall, then preparing the surface by hatching of the layer then applying his fine plaster which composed of calcium carbonate (lime) and a trace of gypsum, finally Coptic artist applying the pigments Fig.1.

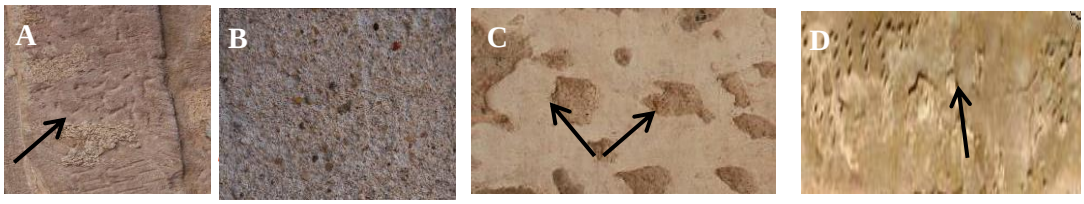

Fig. 1 Showing layers prepration of roman over-painting, Luxor temple:

(a) Signs of the tools on Pharaonic walls before application coarse plaster, (b) The coarse plaster "arriccio" rich in the quartz calcium carbonate, gypsum and feldspars (c) Hatching of the plaster before application of the layer of plaster, (d) The fine plaster "intonaco" based mainly on calcium carbonates and traces of gypsum (lime)

2. Experimental Setup

2.1 Materials

Epoxy Number 27-751 and the hardener, Sandpaper sizes (800, 1000, 2400 and 4000) were used to preparation of the samples.

2.2. Samples Preparation:

The samples to be used for Cross-Section were divided into small pieces, then embedded in epoxy (Number 27-751, mix the epoxy and the hardener in a 100: 2 mL ratio). after the completely hardener and drying the epoxy, the samples were ground and polished by using sandpaper sizes (800: 4000) with wet-type sandpaper to get smooth and good surface Fig. 2. The samples surface was observed by BM each time. the other sides of the sample were polished then, the prepared samples were observed using the BM and SEM.

Fig. 2 Showing The preparation of the cross-section steps for microscopic observations

3. Observation

The surface observation study was carried out using two methods, these are:

3.1 : Observation by BM:

The surfaces of the Roman fresco were an investigation by BM (Olympus BX53).

3.2 : Observation by SEM-EDX:

The surfaces of the Roman frescoes were observed using SEM (JEOL/JSM-6010LA). The Accel. Volt. was 20 kV and Spot size was 50. the observation was carried out in (SEI) and analysis was in mode (BSE).

4. Experimental Results

4.1. Observation by PLM (BMM):

The cross-section is advantageous for the following reasons: (a) Not need experience and inexpensive. (b) Stored for a long time in the normal conditions. (c) Extremely important for over-painting technique and evaluate the quality of the used materials. (d) Useful in determining the structure and characteristics, thickness, shapes, number of layers. (E) Evaluation of the current

situation of mural painting [2]. Observation by PLM used to examine and study of the structural roman over-painting Figures.3.4.5.

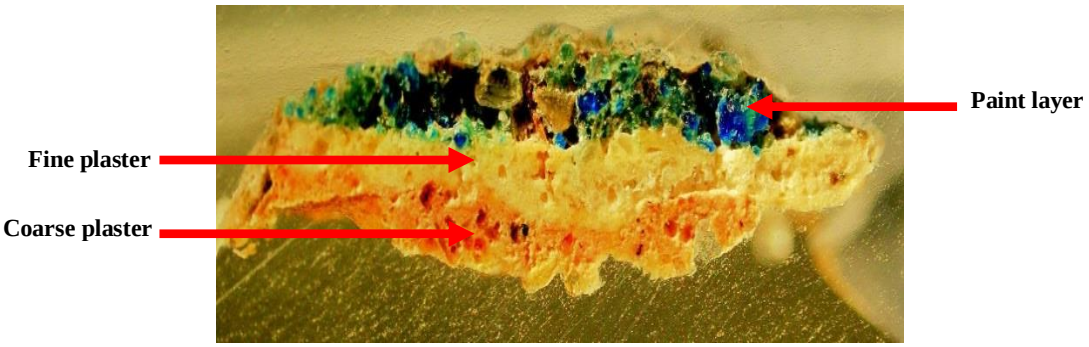

Fig.3 Photomicrograph of cross-section image showing the structures of roman over-painting of three layers from the bottom to top: coarse plaster, fine plaster and paint layer under normal light under PLM (BMM).

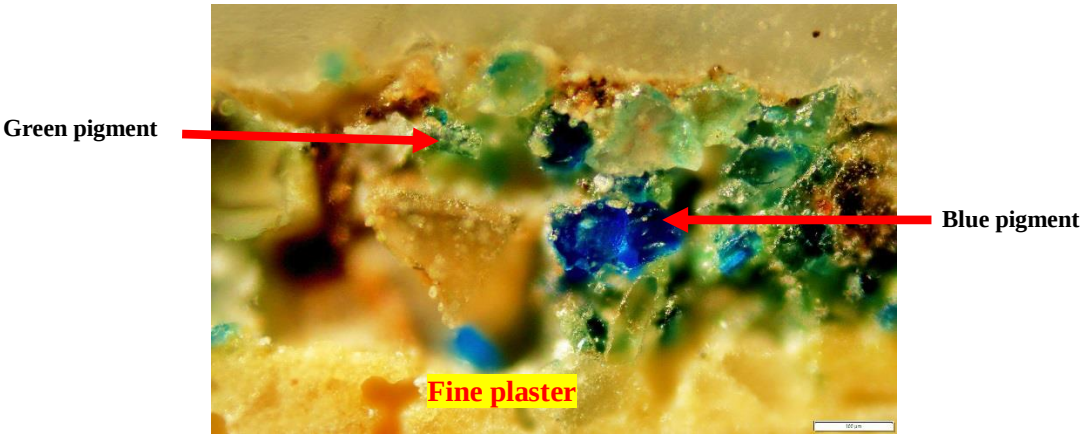

Fig. 4 Photomicrograph of cross-section image showing the structures of roman over-painting of the fine plaster and pigment layer (blue and green) under normal light under PLM (BMM).

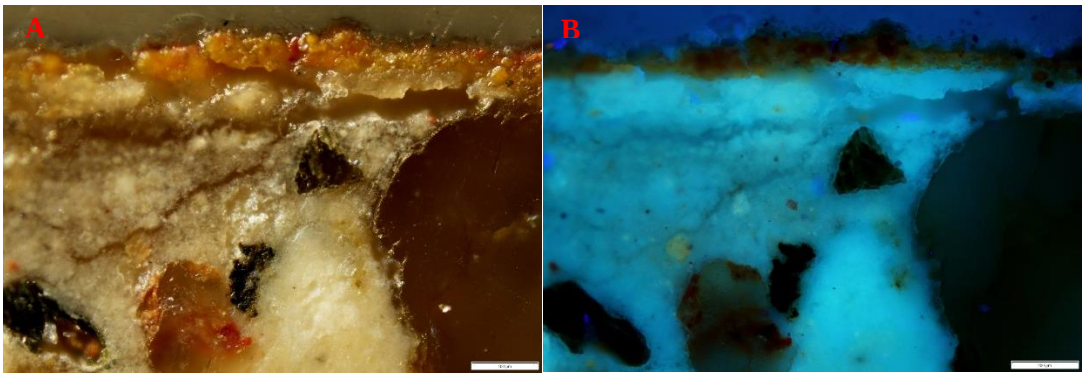

Fig.5 Photomicrograph of Cross-section image showing the yellow paint layer (a) under light under PLM (BMM, (b) under UV light

4.2. Observation and analysis by SEM-EDX:

The structure observation of the Roman fresco in Luxor temple were observed using SEM was carried out in (SEI) and analysis was in mode (BSE). SEM images Fig. 6 showed the cross-section investigation identified three different layers was applied on the surface of the pharaonic wall the temple[3,4].

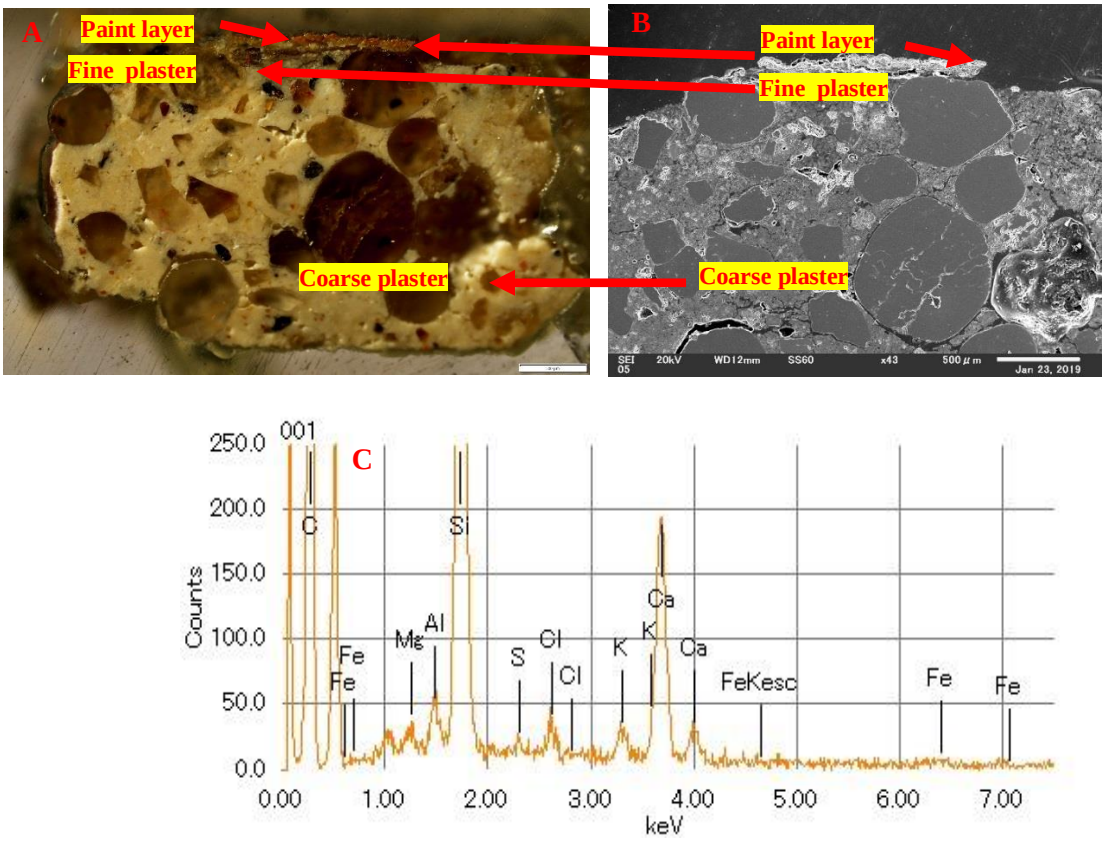

Fig. 6 Observation of Cross section of sample under PLM and SEM: Photomicrograph of cross-section image (a) under PLM showing yellow Paint layer; (b) SEM image of cross-section showing the multi-layers of roman over-painting of coarse plaster, fine plaster and paint layer under (SEM) ; (c) the EDS analysis obtained the same sample

EDX analysis suggests:

1- The coarse plaster of the arriccio differs throughout the walls in the amount of Quartz (silicon Si), Calcite (Ca), aluminium (Al), and K-feldspar.

2- The second layer of finer, smoother plaster of the intonaco, based mainly on calcim carbonates and gypsum.

3- The third layer of yellow pigment composition of Quartz, Calcite and iron oxide indicate the yellow pigment goethite (α-FeOOH) [5,6]. Figures 7, 8.

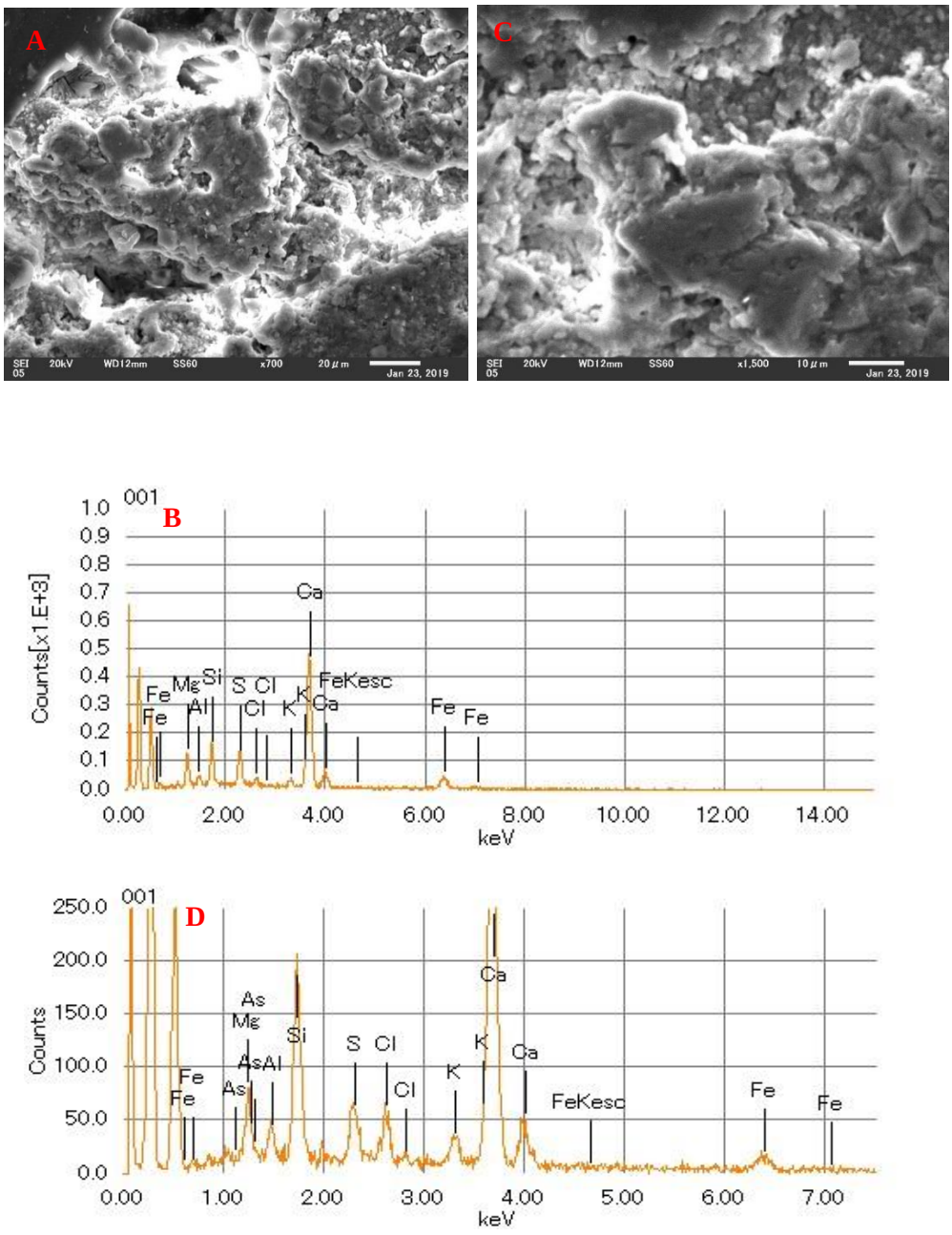

Fig. 7 SEM image (a) showing yellow Paint layer, (c) is detail of the previous image X1500 ; and (b),(d) EDX analysis representatitve the paint layer including iron oxide indicate the yellow pigment goethite (α-FeOOH).

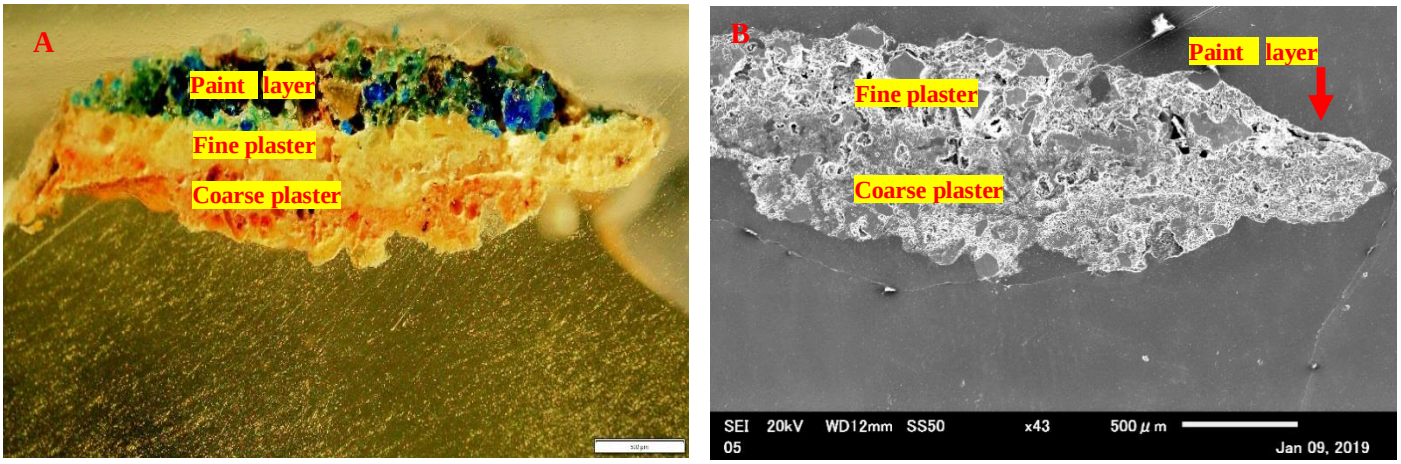

Fig. 8 Photomicrograph of Cross section of the sample under PLM (a) and SEM image (b) of the sample showing the three layers applied over sandstone the main material of the pharaonic wall in Luxor temple

The cross-section investigation identified three different layers was applied on the surface of the pharaonic wall the temple: from the bottom to the top, the coarse plaster of the arriccio differs throughout of the surfaces of the samples in terms of the quantity of quartz and in shapes and the second layer of finer, smoother plaster of the intonaco, the major of the composed of calcium carbonates. the third layer of pigment [3,5,7].

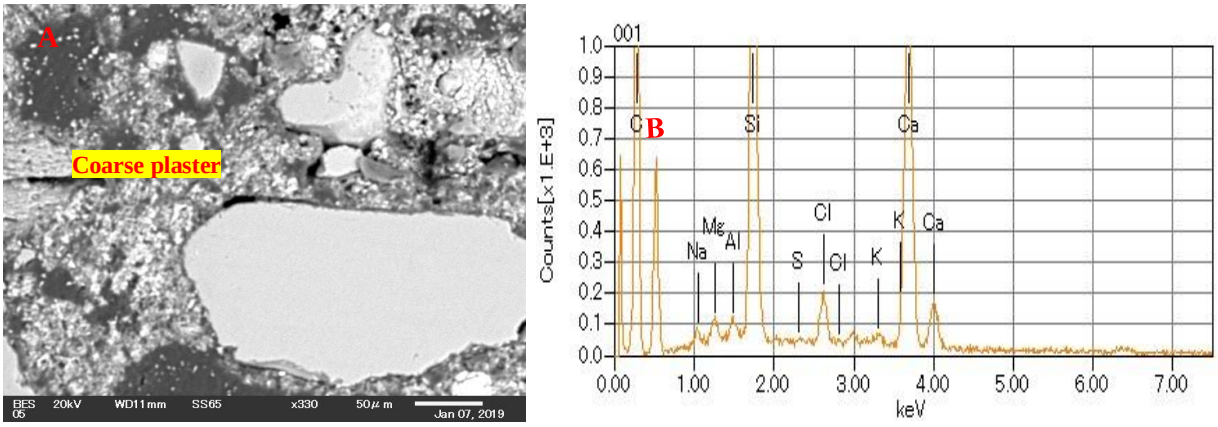

Fig. 9 SEM image (a) was carried out in (BES) showing Coarse plaster, and (b) the EDS analysis obtained the same sample was in mode (BSE).

Coarse plaster based mainly on Quartz, K feldspars, calcium carbonate, sodium chloride and gypsum. The matrix is composed of fine particles to large particles are well visible, they have angular shape and their size goes from small to very large, squared or round is visible at the bottom of the section, large particles are also diffused in the whole layer. They have different size and shape [6].

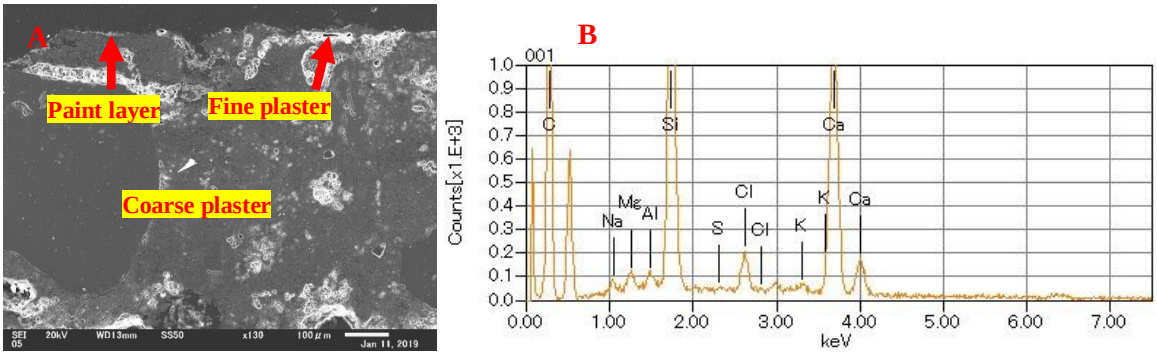

Fig.10 SEM image (a) of Cross section of the sample identified three different layers from roman -over paintig from the bottom to the top, the coarse plaster ,the second layer of fine plaster of the intonaco, based mainly on calcium carbonates. the third layer of pigment; (b) the EDS obtained the same sample

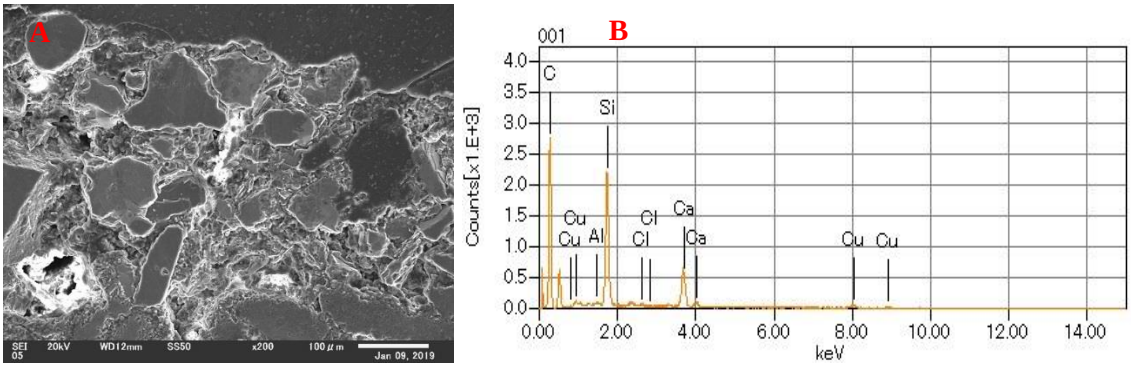

Fig. 11 SEM image (a) of paint layer of the sample identified the blue pigment of the fine plaster ; (b) the EDS obtained the same sample showing Si, Cu, Ca and Cl as the major ions contained in this layer, The elements of the sample was in agreement with cuprorivaite (CuCaSi4O10) The blue pigment is artificial pigment called Egyptian blue.

5. Conclusions

The stratigraphic structure of the paint layers by investigation by PLM and SEM-EDS. The cross-section investigations identified three different layers was applied on the surface of the pharaonic wall the temple: from the bottom to the top: The coarse plaster “arriccio” composed mainly of Quartz the major component which were in different size goes from small to large and different in shape from angular to around on the other hand, traces of gypsum, calcium carbonate, aluminosilicate and feldspars. On the other hand, The fine plaster “intonaco” composed of calcite, quartz, traces of gypsum. The paint layer consent mainly of (Lime) calcium carbonate traces of gypsum. The thin layer of yellow pigment layer composition of Calcite, Quartz and iron oxide EDS analysis showing Fe peak indicate the yellow pigment goethite (α-FeOOH). The paint layer of Blue pigment of the sample identified the Egyptian blue pigment of the fine plaster. the EDS analysis obtained the same sample showing Si, Cu, Ca and Cl as the major ions contained in this layer, The elements of the sample was in agreement with Cuprorivaite ($CuCaSi_4O_{10}$) The blue pigment is artificial pigment called Egyptian blue. The investigation and EDS analysis of the cross-section of the paint layers of the samples showed Execution technique containing calcium carbonates and traces of gypsum that suggests the Coptic artist applying his pigments on dry plaster (Lime and gypsum)"secco fresco" NOT fresh

plaster "buon fresco" (Lime) so the probably the Coptic artist used the technique of a secco fresco. The results obtained will be of importance to use it in the future work to conservation and restoration of Roman fresco over-painting.

Acknowledgments

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Reference

[1] Jill, K., 1976. " Luxor A Guide to Ancient Thebes", Second edition, London.

[2] Dilruba, S., and Fumio, O., 2011. " Surface Coating Technique of Northern Black Polished Ware by the Microscopic Analysis" , Ancient Asia Volume, P.58.

[3] Ahmed, S., Ying, Z., Moustaph, H.,Muhammet, T., Mamoun, M. and Abdusalam, U. 2016. "Studies on the Deterioration of Coptic Mural Paintings in the Monastery of Martyrs and the Luxor Temple" International Journal of Conservation Science, Volume 7, Issue 2, 493-500.

[4] Ahmed, S., Sayed Hemeda, Moustaph, H.,Muhammet, T., Mamoun, M. and Abdusalam, U. 2019. "CT Scanning and MATLAB Calculations for Preservation of Coptic Mural Paintings in Historic Egyptian Monasteries", Scientific Reports 9(1):3903.

[5] Ahmed, A., Hussein, M., and Atef, B. 2013. " Analytical study of Coptic wall paintings in Egypt, El-Bagawat necropolis,Kharga Oasis: a case study" Periodico di Mineralogia, 82, 1, 25-40.

[6] Basem, G., Mona, A., and Hussein, M. 2015. " Identification of the Byzantine Encaustic Mural Painting in Egypt " Mediterranean Archaeology and Archaeometry, Volume 15, No 2, pp. 243-256.

[7] Moussa, A., Kantiranis, N., Voudouris, K., Stratis ,J., Ali ,M., Christaras ,V., 2009, "Diagnosis of weathered Coptic wall paintings in the Wadi El Natrun region", Egypt, Journal of Cultural Heritage, 10(1), pp. 152-157.