INTERNATIONAL JOURNAL OF CONSERVATION SCIENCE
ISSN: 2067-533X Volume 9, Issue 3, July-September 2018: 429-438 www.ijcs.uaic.ro

NEW APPROACH FOR THE STUDY OF WALL PAINTINGS IN ABU EL LEAF MONASTERY, FAYOUM OASIS, EGYPT

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Abstract

The Abu El Leaf Monastery, also known as Deir Abu Lifa, is considered one of the most important and famous monasteries in Fayoum Oasis, Egypt. It is located about two kilometers north of Quasr Al-Sagha Palace and about thirteen kilometers from Lake Qarun, one hundred kilometers from the capital of Egypt. The Abu El Leaf Monastery was mentioned and founded by St. Panoukhius about 687 A.D. Dir Abu El Leaf monastery was used almost from seventh to ninth centuries. It was seen as a safe haven for Christians seeking safety from religious persecution. The monastery is quite rudimentary, its entrance is cut into the mountain and consists of small caves carved into cliff sides that can be difficult to reach. It has seven rooms containing some wall paintings and structures painted with some remains of pigments. Here we reported the investigations and analyses of the materials and techniques of the wall paintings in The Abu El Leaf Monastery using analytical techniques such as: Polarized light microscopy (PLM), X ray diffraction (XRD), scanning electron microscopy energy dispersive X-ray spectroscopy (SEM–EDS) and Fourier Transform Infrared Spectroscopy (FTIR). Earth materials such as iron oxides based on hematite and goethite were the main findings, black carbon was also identified. The analyses of samples from different locations of The Abu El Leaf Monastery with XRD analysis indicated the presence of calcite, anhydrite, gypsum in the ground layer, and calcite in the plaster one. The pigments were identified by close visual investigation which showed that the paint layer was a very thin one, and that some parts were in very bad conditions such as some missing parts and some fallen others. Arabic Gum as organic binding medium suggests that tempera technique was used in The Abu El Leaf Monastery in Fayoum Oases.

Keywords*: Wall paintings; Analysis; Conservation; Investigation; Pigments; Coptic; Monastery; Egypt.*

Introduction

Fayoum Governorate which has a unique cultural and archaeological heritage is called Minor Egypt because it includes a collection of monuments dating back to different historical periods [1-3]. It includes a collection of Pharaonic, Roman, Greek, Coptic and many Islamic monuments. It has a long history, which goes back to millions of years. It has begun in the stone age before there was a civilization and had a prominent position in the Middle Kingdom and the Twelfth Dynasty was important during the Greek, Roman and Coptic time [4-5] (Fig. 1).

Deir Abu Lifa is one of the most important Coptic monuments in Fayoum Oasis which includes seven rooms and there are a group of murals that adorn two of these rooms [6] (Fig. 2). Deir Abu Lifa or Abu Lifa is also known as Abu Banukhm or St. Panoukhius. The entrance to the monastery is cut into the mountain. Inscriptions date the monastery to as early as 687 [7].

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The Abu El Leaf units have been built using a large, sloping and slanted sandstone blocks that contain different layers of corals and other marine invertebrates, that often close with a layer of limestone so-called limestone bare [8].

Deir Abu Lifa consists of seven rooms with wall paintings, most of which are lost and can be seen in two rooms (Fig. 2).

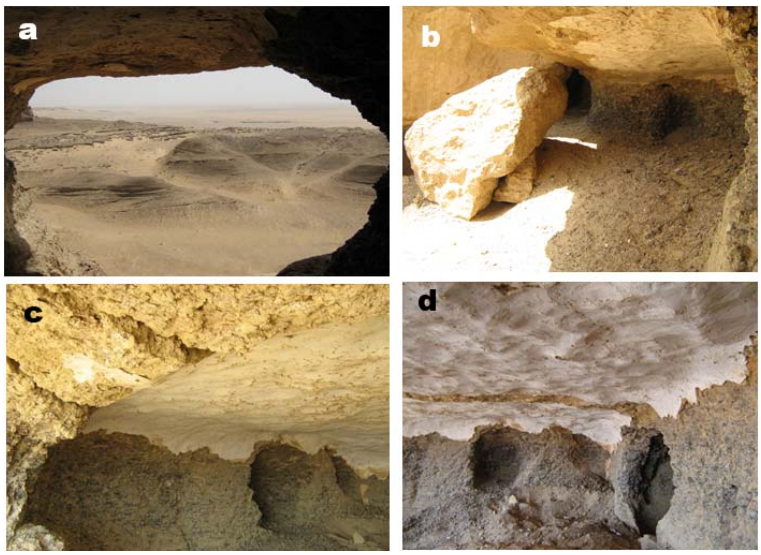

Fig. 1. Entrances of Abu Lifa Monastery (Coptic monument):
a. and b. Main entrances; c. and d. entrances of seven rooms (caves) with wall paintings.

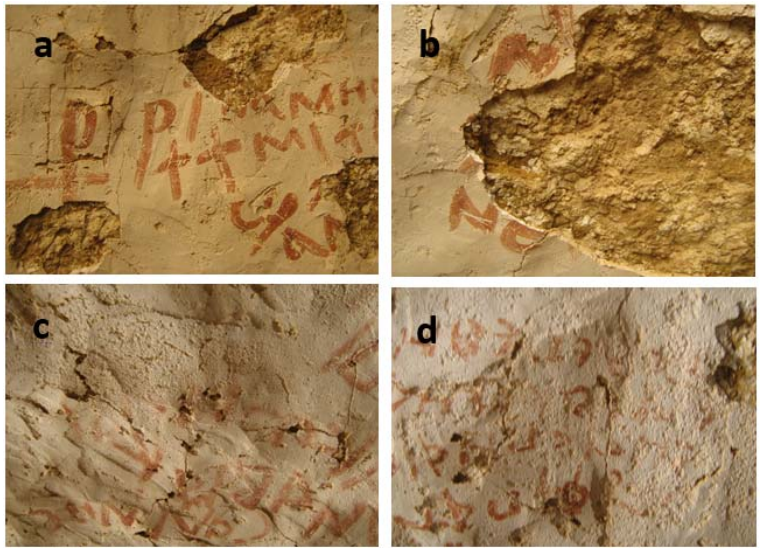

Fig. 2. Wall paintings of Abu Lifa Monastery:
a. and b. Remains of wall paintings illustrate the deterioration of the situation, the collapse of some and the loss of the others; c. and d. Remains of the Coptic writings of the mural paintings

The research aims to document and record the Abu Lifa Monastery as well as examine and analyze the various wall paintings such as pigments, colored materials. The preparation

ground and the organic media were used as well as the wall painting support. The examination and analysis are of utmost importance and necessity, especially before the restoration, maintenance and conservation. We also need to put the monastery on the archaeological map and tourism in Fayoum and Egypt [9-11].

However, access to the entrance of the monastery is difficult and it needs to climb the rock vertically. After reaching the monastery above, we will see seven rooms in the cave. The lower parts on the walls and surfaces have been damaged by human contact and by the use during the services of the Copts of Egypt only to escape the religious persecution or worship. Many of these parts were loss and have fallen, and the parts that were covered by the blinds are strongly affected by the loss of paint materials and the splinters. It is worth mentioning that this area is characterized by high temperatures and that the temperature in that period was very high. The dry state in the local environment and around causes some deterioration such as the destruction of wall paintings in the ceilings or their fall (Fig. 2).

While the Deir Abu Lifa suffers from different deterioration factors, it is worth mentioning that the wall paintings in the monastery or the monastery itself have not undergone any restoration before and there are many other damage factors which caused much surface deterioration such as the loss of some colored surfaces or falling surfaces. We fear that in the near future we will not find and will not see any documents for all the paintings from there. Therefore, the examination and analysis must be followed by restoration and maintenance to save it from the natural deterioration factors [12-15].

It should be noted that there are some historical studies only about those murals long ago, but there have been no previous studies of murals and coloring materials and organic media association of those colors and no attempts were made to carry out any studies on the restoration work or preservation of murals in the monastery.

Therefore, the aim of this study is to contribute to a better understanding of the materials used as well as techniques for the implementation of these phases. It is well known that the results of these analyze and tests will greatly assist in the future conservation and restoration operations of the monastery in general and the murals in the monastery in particular [16-18].

There is an urgent need for such a study because of the suffering of these murals and the cultural heritage of the Monastery, which suffers from a very serious deterioration that threatens a total loss of that monument.The monastery is threatened with total disappearance, not only because of multiple damage factors, but also in the absence of repairs, maintenance and protection. These reforms require those results that will help to understand the nature of the components of the murals, and then choose the most suitable methods and materials for restoration and preservation [19] (Fig. 2).

Technical studies of Abu Lifa Monastery wall paintings are done, but highly needed as this world cultural heritage is threatened due to limited treatment and conservation works in those places. Here the documentation of the materials and techniques is therefore aimed to stem this loss, as well as to provide some information for future restoration and historical studies.

The documentations and recording of the written letters and shapes are belonging to Coptic period in Egypt. Analysis and investigation showed that red color comes from iron oxide, yellow pigments from iron oxide hydroxide, black from carbon, white from gypsum. Ground preparation consisted of gypsum, calcite and anhydrite was found too. The support which used the mountain stone was a lime stone.

Experimental

Optical Microscopy

The tests were performed using a polarized optical microscope (POM) on the prepared samples, which were examined and studied by the Wild M8 stereomicroscope, with the Olympus BX51 optical microscope and directed with the recording of the image camera [20].

The samples previously prepared by the cross-section were painted with a well prepared and special arrangement where the thickness of the sample was approximately 1mm and was immersed in the liquid melodent resin. After the hardening, doubling and drying process of the samples submerged in the resin, followed by fine-tuning them with soft polishing tablets to get a flat surface, smoothing and exposing the cross-section of the surface color to a good surface, the cross-sectional surface becomes smoother and more complex. [21].

X-Ray diffraction (XRD)

Samples were prepared for the analysis group by X-ray diffraction analysis using X-ray diffraction model of P/1840 with Ni-filter, with copper radiation 1.54056° at 40°C, 25mA, 0.05/sec. by High-precision graphite monochromator and rotating sample holder and relative detector.

It is worth mentioning that the prepared samples for analysis are very simple, were not subjected to grinding and were analyzed in the solid state without grinding for the purpose of preservation and survival [23-25].

The measurements were made for the previously prepared samples without grinding or powder, but were prepared for analysis directly with X-ray diffraction pattern as intact samples that were not destroyed, in the range of $0° < 2\theta < 70°$ with a step of 0.02°. It is worth mentioning that The Rigaku unit was operated at 40kV, 35mA, for 22 minutes as a fixed time.

Fourier transforms infrared spectroscopy (FTIR).

The analysis was carried out by the infrared absorption (Fourier transform infrared spectroscopy - FTIR) method on the samples which were prepared for this type of spectral analysis [26-27]. The analysis was performed using a Perkin Elmer Spectrum. The readings were measured and recorded in the 4000-400 cm^{-1} region to identify the existing and sample materials. Fourier transform infrared spectroscopy analysis technique was applied to identify and to determine the organic functional groups present in the samples [28-29].

Some samples were analyzed to identify the organic materials that were used in painted layers, plaster and ground preparation layers with FTIR that showed that arabic gum was used as organic medium in the three layers and red pigment was hematite, plaster layer was calcite with a few amounts of gypsum and anhydrite, ground preparation layers consisted of calcite with a little of gypsum and anhydrite, that means tempera technique was used in wall paintings in Abu Lifa Monastery.

Scanning Electron Microscopy investigations (SEM-EDS)

A set of samples were prepared to be used in the analysis and testing using Scanning Electron Microscopy coupled with energy dispersive X-ray spectrometry SEM-EDS, which indicated that calcite is a main component in the plaster layer [30].

The operating system of the device has been set up on an operating system. A Philips XL30 instrument with an INCA Oxford spectrometer package and with an LaB6 source with an EDAX/DX4 detector at a working distance of 10mm, working with an accelerating voltage of 20kV; a spot size of 4.7 to 5.3 (INCA conventional units) and the process time of work was 5s, corresponding to a detector dead time of 25-40%, and an acquisition time of 75s [31].

Results

Optical Microscopy Analysis

Cross section investigation provided information both about the number of painted layers and their sequence and thickness, and the size of pigment grains. Then, the mounted cross-sections were studied with Mac Microscopy, then with Scanning electron microscope (SEM), where energy dispersive spectroscopy (SEM-EDS) was used to characterize the elements present in the different layers. OM images were taken with a Leica DMR microscope equipped with a Leica DC300 digital camera [22].

The examination of the prepared samples under the optical microscope gives strong indications about the nature of the materials in the structure as well as their shape and the current state, as well as the number of layers in the wall imaging and the thickness of those layers, current situation and the manifestations of damage. Investigation of the samples indicated some information and techniques such as a Coptic applied his painted layer over two layers, putting preparation ground layer on the surface of mountain cave, preparing the surface with white plaster layer and then applying his pigments.

Some techniques as we can see from investigation with cross section for some samples like red showed that red pigments or red color was a very thin layer and it is applied over plaster layer and that red one was not continuous because the surface was not flat. The yellow sample was investigated and showed that the yellow pigment granules are very small lines. The black one showed that a black pigment is very thin and smooth and seems to be a soot carbon rather than wood or ivory or animal or manganese because it is a very thin layer and continuous line with a smooth surface without minerals of crystals or shapes of animals (Fig. 3).

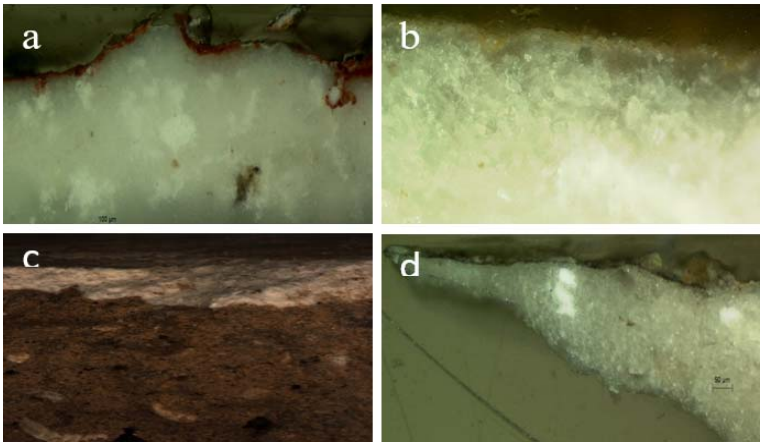

Fig. 3. Cross section investigation:
a. red sample; b. orange sample with a thick layer of orange paint;
c. sample showed the structures of wall paintings such as ground, plaster and painted layer;
d. black sample showed a very thin layer and smooth line

XRD analysis

XRD analysis indicated that plaster layer consisted of Calcite ($CaCO_3$) as a main component with presences of gypsum, and there was anhydrite found causing a high degree of temperature in that place which can reach to 50°C on day time (Fig. 4).

Ground Preparation Layers: were a mixture of Calcite with Gypsum and Quartz. The first preparation layer and the second one have similar compositions.

For the Plaster Layer, XRD analysis identified that it consists in calcite, anhydrite and gypsum. XRD carried out for red painted layer showed that hematite was the main component as a red pigment. Yellow painted analysis was carried out with XRD analysis which indicated that goethite with calcite were the main components as yellow pigment. Orange painted layer was a mixed from hematite with goethite. And the last one, black painted or black pigment was a carbon.

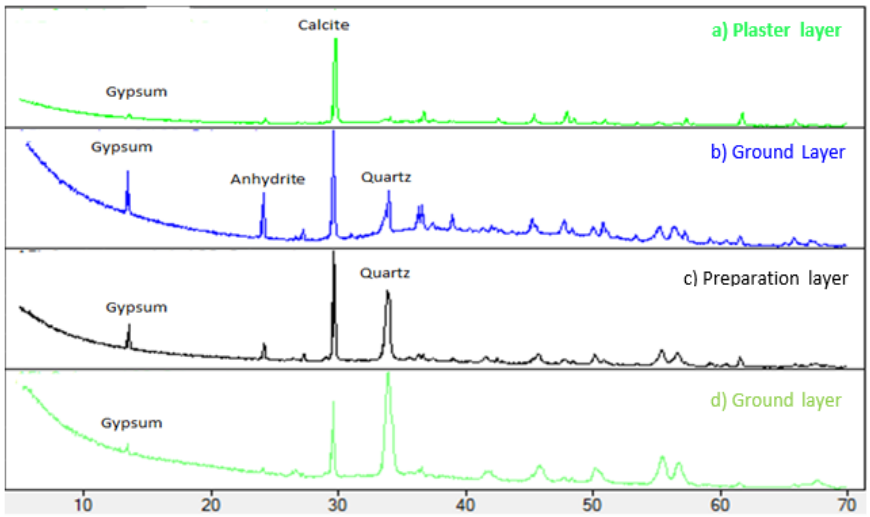

Fig. 4. XRD analysis Spectra:
a. Plaster layer consisted of Calcite as a main component with presences of Gypsum;
b. Ground layer were a mixed of Calcite with Gypsum, Quartz and Anhydrite;
c. Preparation layer or in the second one its similar in their compositions;
d. Ground layer with Quartz and Gypsum

FTIR analysis

A comparison between the basic sample of arabic gum and the various archaeological samples from the wall paintings of the monastery shows the great similarity between the archeological samples and the sample of the arabic gum, as well as the availability of strong signs and indications of the presence of effective organic groups of arabic gum in the analyzed samples (Fig. 5).

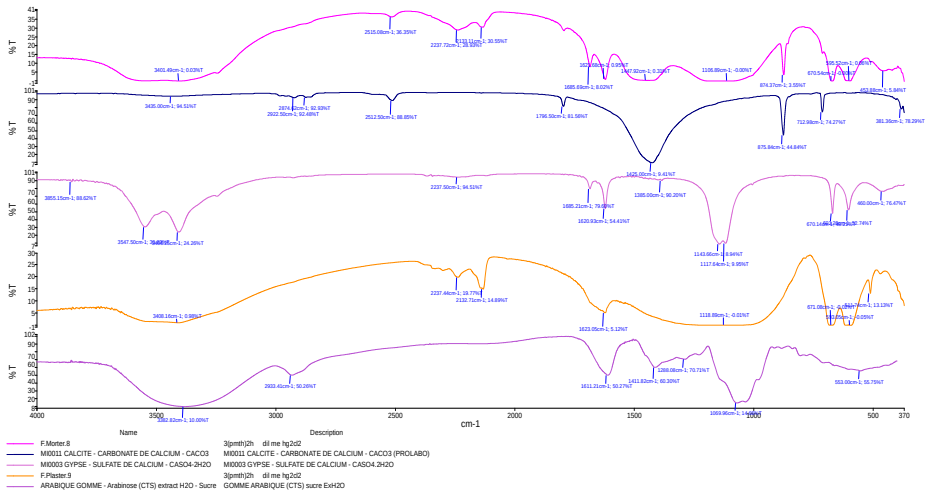

Fig. 5. FTIR Spectrum investigation showed that Arabic gum was used as organic medium in the three layers and red pigments was hematite, plaster layer was Calcite with a few amounts of Gypsum and Anhydrite, ground preparation layers consisted of Calcite with a little of Gypsum and Anhydrite

SEM images (Fig. 6), by backscattered electrons (BSE), showed some information about the current state of the painting layers in Abu Lifa Monastery such as orange painted layer which is a very thin layer in very bad condition. It was applied above a white layer of calcite. That preparation layer was in a bad state, with a lot of cracks and holes and seems to be very dry and fragile.

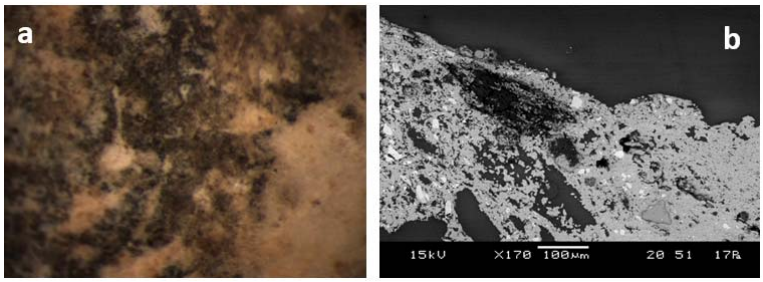

Fig. 6. a) Optical microscopy investigation showed Black Painted
b) Scanning Electron Microscopy showed the decay in the sample.

Plaster layer: it is a non-thick white layer made up of Calcite, with damages as it appears on it or in some places, including separation or disintegration [32- 33]. Black sample under investigation and analysis by optical Microscope and SEM showed that carbon black was a very thin one (Fig.6). Orange and yellow painted layer, under optical microscope and SEM, showed that yellow paint was a thick layer applied on a white plaster from Calcite (Fig. 7), fallowed by a preparation layer of calcite and gypsum which suffer from drying (Fig. 8).

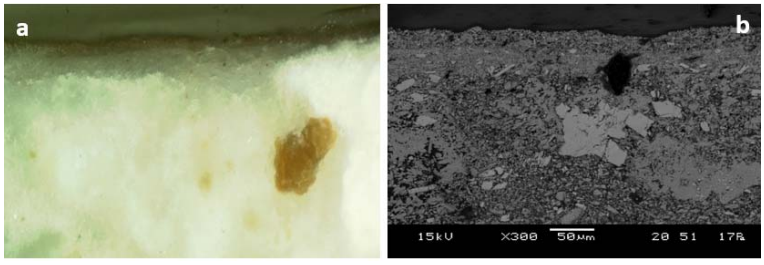

Fig. 7. Microphotographs of cross section and SEM:
a. orange sample showed a thick orange line;
b. orange one showed a thick layer of pigment and plaster layer then ground layer

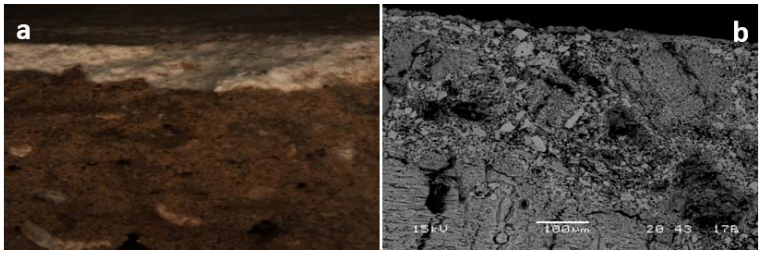

Fig. 8. Microphotographs obtained through optical microscopy and scanning electron microscopy:
a. yellow Painted Layer from Deir Abu Lifa (OM);.b. showed the multi layers of wall paintings (SEM)

Red painted layer analysis carried out with OM and SEM showed that red pigment was a thick layer that suffered from drying and there were some separation and losing in some places and it was applied above a white plaster layer from Calcite (Fig. 9).

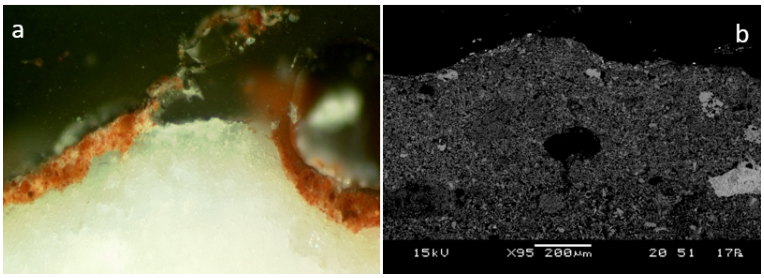

Fig. 9. Microphotographs of cross section and SEM:
a. Red sample; b. red one showed the decay in the ground preparation layer.

Discussions

By studying, examining and analyzing the wall painting components of Deir Abu Lifa in Fayoum, the study of the current state of the monastery shows the following: the use of a very thin layer of materials for coloring, which was used with an organic medium - Arabic gum, as a link element between the grains of the color and the surface. Plaster was a weak white color layer composed of Calcite and both layers of color. There were many separated, lost and fractured parts due to the high temperature in that area, which caused the losing of wall paintings, constrained and weakened the organic medium. The images of the preparation from different places show that they are severely dehydrated. The coloring is composed of Hematite as a coloration agent for red color, calcite for white color, carbon for black color, Goethite with Hematite for orange color.

Conclusions

Based on the above results and very important information about the nature of the components of the wall paintings in Abu Lifa in Fayoum Oasis, and the severe damages, there is a risk of losing the rest of the wall paintings from monastery's rooms together with the information contained and writings dating back to the Coptic period from the seventh century to ninth century AD.

The process of recording the monastery and the components of the site, the area, the number of rooms, caves and the contained paintings, also with their registration and documentation, became necessary.

The project also includes the restoration of the monastery including all the protection and maintenance measures. It is located on the Coptic tourist map of Fayoum as one of the oldest and most important Coptic monasteries.

The restoration project should include cleaning works, reinforcement works for the coloring and painting layers, the preparation floors, the re-assembling of the roofs and walls, as well as the completion and strengthening of all of these components.

The project of restoration and maintenance of wall paintings at Deir Abu Lifa in Fayoum Oasis will be the second step of this research, based on all the important information that resulted from the study, examination and analysis, as an initial step in order to save this monastery and its heritage, the writings, murals and colors.

Acknowledgments

The author would like to thank Jean Marc Vallee from Marseille institute (LRMH), France, and also to Dr. Hamada Sadik from Fayoum University.

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Received: October 03, 2017
Accepted: August 08, 2018