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COLOUR AND CULTURE IN ANCIENT JUDAISM STUDY OF THE MURAL PAINTINGS PRESERVED IN THE ARCHAEOLOGICAL SITE OF MAGDALA, 1st CENTURY CE (LOWER GALILEE)

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Abstract

The city of Magdala hosts one of the few synagogues constructed in ancient Israel during the first century AD and the first to be discovered in the region of Galilee. Its three most outstanding artistic manifestations are the Magdala Stone, whose iconographic motifs are said to represent the Second Temple and make it unique, the mosaic on the floor of the sacred enclosure, and the mural, surviving only partially. In our last field campaigns (2017-2018), we conducted physical-chemical analyses of these remains to identify the materials and manufacturing techniques that were used in their construction. From the results of these analyses we have been able to research economic, social and cultural issues pertaining to the society that lived in this Lower Galilean city at the beginning of the Christian era. We used a combination of microscopic, spectroscopic, chromatographic and other techniques to develop a physical-chemical characterization of the colours preserved on the walls of the synagogue. To interpret our results, we have taken into account the specialized bibliography as well as primary historical sources such as the 'Mishnah' and 'Antiquities of the Jews' by Flavius Josephus.

Keywords: synagogue, mural painting, ancient Israel, Jewish, culture

1. Introduction

In August 2009, archaeologists from the Israel Antiquities Authority, Dina AvShalom-Gorni and Arfan Najjar, discovered the Magdala synagogue (Figure

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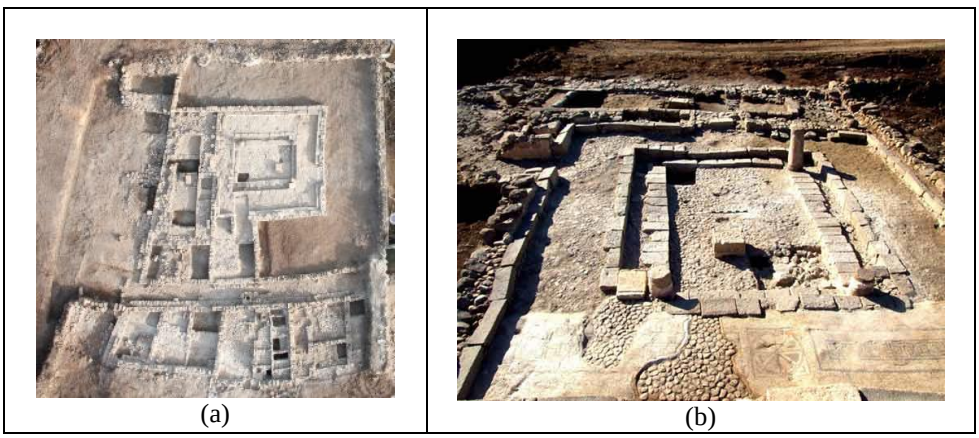
1a). It is the seventh synagogue corresponding to the first century and the only one that has been discovered so far on the banks of the Kinneret for that period. After 5 years of work, the archaeologists of the IAA have identified three stages of construction of the building - the remains of an old building, dating from the middle of the 1st century BC. The original idea of the inhabitants of the Magdala settlement was not to build a synagogue, it is until the third moment that they reuse spaces and architectural elements of other buildings to have a meeting place for the assembly.



(a) (b)

Figure 1. Magdala synagogue: (a) aerial view, (b) side west view.

Figure 2. A mosaic floor discovered at the eastern part of the synagogue corridor. Note that the main iconographic motif is a rosette.

The synagogue is located at the northern end of the settlement and is accessed by a street with an east-west direction. The main access to the building is from the south, towards the area identified as a market. Architecturally, the building has the characteristic spaces of a synagogue: to the west, a room that has been defined as reading and teaching area (later known, 2nd century AD as Beth Midrahs). The access to this room is from the west, but it is also possible to enter through the interior of the building. It also has a lobby and the central room for the assembly reunions (Figure 1b). Recent analyses of the archaeological

materials discovered within the synagogue indicate that it may have been abandoned at a time before the Great Revolt against the Romans, at 67 CE. If this is confirmed, it would be the only building in the Magdala settlement that will not have a continuous occupation until the 2nd century AD.

Figure 3. A detail of the mural painting preserved on a wall of the reading room, west side.

Figure 4. The stone of Magdala, detail of the iconographic motifs. Note the presence of the Menorah or seven-arm candelabra.

The elements that make this synagogue considered the most important discovery in the last 50 years of Biblical Archaeology are:

1. The east room with an unfinished mosaic floor, probably by the effect of the Revolt. This mosaic represents a rosette in the centre flanked on each side by a belt adorned with a black 'teselas' meander pattern (Figure 2).
2. Mural painting that covered the walls of the main access to the south of the building, the walls of the meeting room and the columns, which conserved dark red, mustard yellow and blue panels placed inside black and white frames (Figure 3).

3. The 'Magdala Stone' that was discovered in the centre of the floor of the assembly meeting room, is a rectangular block of limestone from the Galilee region; This stone has five sides decorated in relief, on one of its faces (south-facing) (Figure 4) is represented by a menorah (candelabrum) flanked on both sides by amphorae and columns. It is very likely that the stone represents the Second Temple, a kind of model, since it also has other elements such as oil lamps, bread offering and a rosette in the centre of the upper face.

There is no doubt that, together with the mosaic, the remains of mural paintings preserved in the Magdala synagogue are the other artistic manifestation of greater value in this ancient historical building. In antiquity, mural painting was a common artistic manifestation in both civil and religious architecture, especially in territories that had close connections to the Roman Republic and Roman Empire before and after the first century AD Galilee (the ancient Israel), and more specifically Magdala, are examples of such a territory. Here, local inhabitants would draw fish from the Sea of Galilee, known in ancient times as Lake Tiberias. After cleaning and salting the fish, they would export it by sea to Rome. The Romans called their fish 'taricho', which is why Magdala became known by the Romans at that time as Tariquea. This close connection with Rome suggested several interesting hypotheses for our archaeometric study of the Magdala synagogue mural painting. In turn, these led us to establish the following five objectives: (1) Analyse whether the preparations for the mural were carried out in accordance with the triple stratigraphy (*arriccio, intonaco, intonachino*) described by Vitruvius in his *Ten Books on Architecture* [1]; (2) identify whether clay silicates are present in these preparations. Clay silicates may also indicate Roman influence because of the important role of clays in polishing these preparatory strata and the final pictorial film that produces the strong surface luminosity characteristic of all four styles of Roman mural painting; (3) characterize the technique that was used to create the murals of the Magdala synagogue to determine whether they were executed in the secco or fresco manner. This will also indicate whether Roman artistic traditions exerted a direct influence; (4) detect the presence of local or non-local traditions from Rome or any of Rome's conquered territories in the colour palette at the Magdala synagogue; (5) identify elements that could indicate different influences in the mural paintings of the Magdala synagogue, e.g. Hebrew culture or Rome influence or others, such as from Egypt or Ancient Middle East.

2. Experimental

All colours preserved in the remains of the mural painting at the Magdala synagogue were analysed in the present study. Samples from each detected colour hue were taken for analysis. These comprised four hues of yellow, one hue of blue, one of white, two blacks, two types of ochre, five hues of red, and one green (Table 1). These chromatic typologies were identified *in situ* by means of ultraviolet-visible (UV-Vis) spectrophotometry. A multi-technical approach was

used to identify the materials of plasters, pigments and binders used in the wall paintings.

Light optical microscope (LM), through Leica E24HD model, was used to study the samples' surface and stratigraphy. In order to obtain sample cross sections, they were embedded in transparent epoxy resin with catalyst in a 5% solution.

Table 1. Examined colour samples and obtained results.

Sample number	Colour	Sample typology	Results
MG-1a	Yellow	Collapsed wall painting sample	Yellow ochre
MG-1b	Yellow	Collapsed wall painting sample	Yellow ochre
MG-1c	Yellow	Collapsed wall painting sample	Yellow ochre
MG-1d	Yellow	Sample from the eastern section	Yellow ochre
MG-2a	Blue	Sample taken on the mural	Egyptian Blue
MG-3a	White	Collapsed wall painting sample	Calcium carbonate
MG-5a	Black	Collapsed wall painting sample	Carbon Black
MG-5b	Black	Collapsed wall painting sample	Carbon Black
MG-6a	Brown	Collapsed wall painting sample	Red earth
MG-6b	Brown	Collapsed wall painting sample	Red earth
MG-7a	Red	Collapsed wall painting sample	Red earth
MG-7b	Red	Collapsed wall painting sample	Red earth
MG-7c	Red	Collapsed wall painting sample	Red earth
MG-7d	Red	Collapsed wall painting sample	Red earth
MG-7e	Red	Sample from the eastern section	Red earth
MG-8a	Green	Sample taken on the mural	Malachite

A CM-700d portable spectrophotometer was used with the objective of obtaining the exact measurements of each color, and to make proposals for preventive conservation later.

Scanning electron microscopy with energy dispersive X-ray spectroscopy (SEM-EDX) was used to characterize the inorganic fraction of pigments and plasters. Scientific examination of the samples was conducted using a JEOL scanning electron microscope (JSM 6300 model) with a Link-Oxford-Isis microanalysis system operating at a voltage of 10-20 kV between cathode and anode. We used the ZAF method to correct inter-elemental effects in the semi-quantitative analysis.

X-Ray Powder Diffraction (XRPD) was conducted on randomly oriented samples after grinding the powder samples in an agate mortar. A Bruker D8 Advance system, operating in θ:θ mode was used as follows: generator setting 40 kV, 40 mA, Cu anode (Cu-Kα = 1.5418Å), Ni filter, 2θ range 5-80°, step size 0.01°, and scan speed 0.5° min^{-1}. Qualitative phase determination was conducted using QualX2.0 software [2] and the correlated COD database [3]. Quantitative Phase Analysis (QPA) was conducted using Quanto software.

Attenuated total reflection Fourier transform infrared spectroscopy (ATR-FTIR) was applied for identifying organic and inorganic materials. The analysis was performed using Vertex 70 equipment, with an FR-DTGS detector coated for temperature stabilization.

Gas Chromatography-Mass Spectrometry (GC-MS) has been used to characterise organic substances. Agilent 6890N was employed for GC analysis. The chromatograph was coupled to an HP 5973 mass detector. The column used was an HP-5MS (5% phenyl and 95% polydimethylsiloxane). The oven temperature programme was 60-220°C, with temperature increasing at a rate of 1°C/min and being held at 220°C for 3 min. The injector temperature was 250°C, the injection volume was 1 μL (95:5), and the inlet pressure was 7.96 psi. The carrier gas was He. The interface temperature was 280°C. The ionization temperature for the mass detector was 230°C. To identify possible organic components, we used the GC-MS database (NIST library, version 2002).

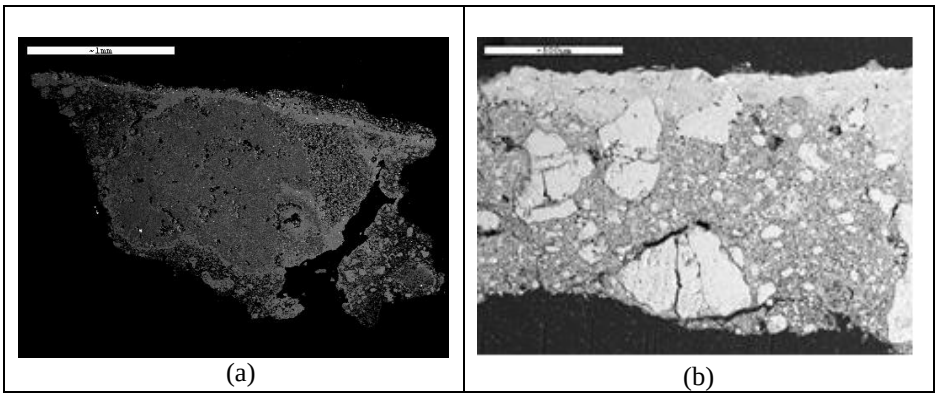
3. Results and discussion

Only two ground layers were detected in the mural paintings of the Magdala synagogue. The first one was applied directly on the wall surface. This thick layer, whose components are irregular in appearance, was possibly intended to remain well-adhered to the architectural surface. The second layer, a thin pictorial plaster, was applied on top of this ground mortar. The greater homogeneity of the components of this preparatory layer enabled the pictorial film to be applied extensively. The clear line of separation between these two layers, as revealed by SEM (Figure 5), suggests that the plaster was applied over dried ground mortar. It is also possible that different workers applied the two types of mortar. In fact, in the ancient world, ground mortars were usually prepared by the same specialists who manufactured the architectural elements, i.e. the masonry experts, while the pictorial plasters were prepared and applied by the painters. The clear separation between the mortar and plaster of the mural painting at the Magdala synagogue, which is also visible by LM, seems to suggest that two different specialists worked on the two different layers. SEM-EDX and XRPD spectra showed that the compositions of both levels are essentially based on calcium carbonate ($CaCO_3$) (Figure 6).

More recently, we have carried out comparative studies by ATR-FTIR between the composition of the preparation bases of the Magdala synagogue wall painting and the stuccoes that were used between the 1st and 2nd centuries CE to cover other architectures of the settlement.

As can be seen in the ATR-FTIR spectra, the similarity is evident, especially by the widespread use of carbonated lime microcrystalline matrices. In other words, all plaster samples have similar IR spectra, in number and band position, although the absolute absorbance values differ from one another, which can be explained by the lack of homogeneity. The spectra obtained for the analysed samples are shown in Figure 7. The assignment of the main bands, which are marked in red in the figure (1798 cm^{-1}, 1420 cm^{-1}, 872 cm^{-1} and 712

cm^{-1}) indicate the presence of calcium carbonate as main component. Bands are also visible around 1030 cm^{-1}, and in some cases at 776 cm^{-1} and 796 cm^{-1}, compatibles with the presence of silicates.



(a) (b)

Figure 5. Images by SEM from the samples: (a) MG-3a and (b) MG-6a, which show us the separation between the mortar and the *intonaco*.

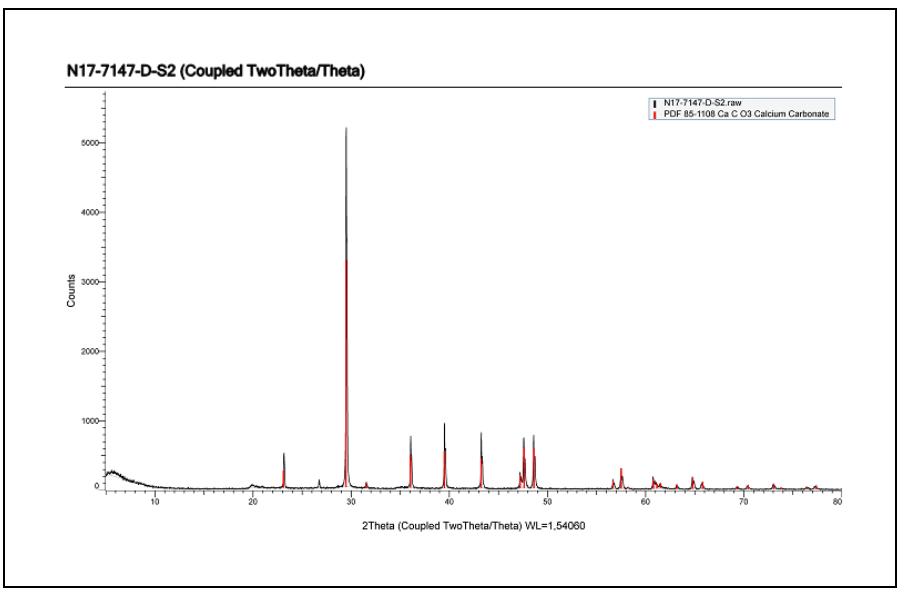


Figure 6. Calcite: the component of the underlying stucco.

This is the case of the sample 'Stucco 15', for which these bands are of greater intensity, as can be seen in the Figure 8. These small differences in the architectural stucco of Magdala have opened a new line of research in the archaeological project, focused on lime technology. For this, it will be necessary to apply new analysis techniques that will allow us to identify with greater rigor the components or manufacturing processes that caused these small variants, and interpret them correctly. The reasons for this could be technical, but also of others nature (symbolic or cultural). In this sense, an approach to the Jewish Law

through Torah and Mishnah informs us about the great importance that matters related to purity had in ancient Judaism. The use of some muds or others in the architectural coatings of a Jewish city of the first century must have been conditioned by the function of these built spaces.

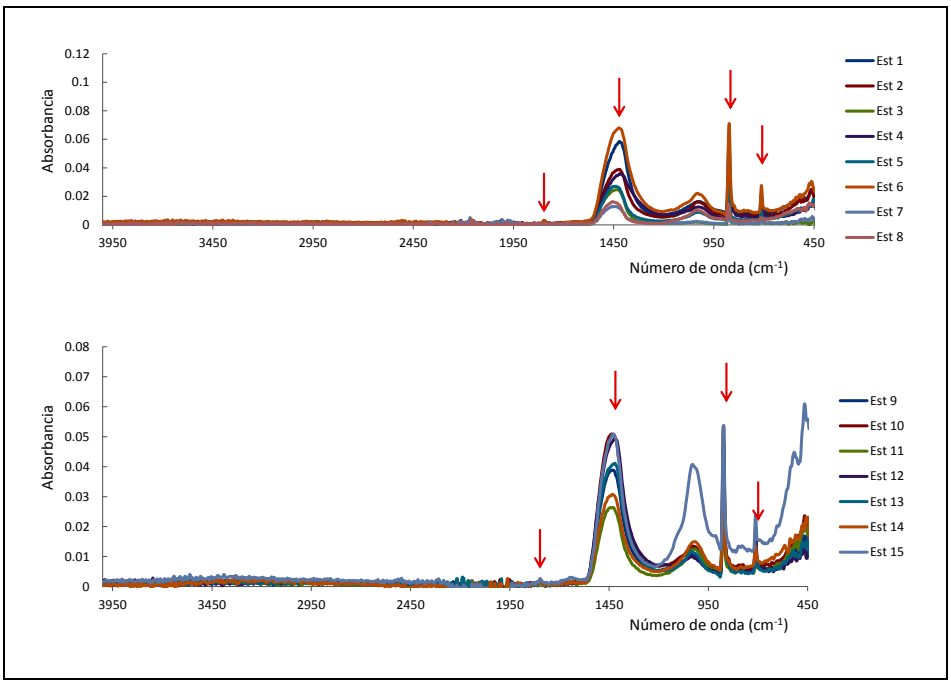


Figure 7. ATR-FTIR spectra of the samples from the synagogue wall painting (stucco 1) and architectural elements. The great similarity between them can be observed, due to the generalized use of calcium carbonate as the main component (red arrows).

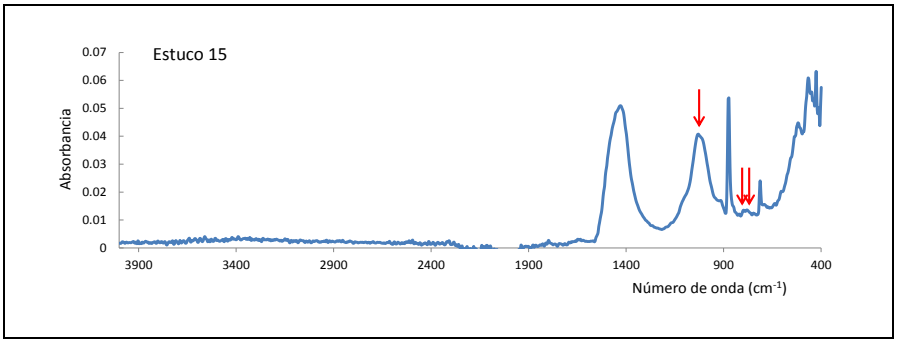


Figure 8. ATR-FTIR spectrum of sample 15 showing the presence of clay silicates (red arrows).

In the case of the synagogue wall painting preparations, there is no doubt of its complete calcareous nature. This purity distinguishes them from the preparations used for Roman mural paintings, that according to Vitruvius [1] and to the results of analyses of numerous Ancient Roman wall paintings, were

constituted by calcium carbonate mixed with volcanic stone (pozzolana) and clay silicates [4-6]. With regard to our first two objectives, therefore, the materials and manufacturing technique used for the preparations at the Magdala synagogue undoubtedly have a strong link to the cultural identity based on a compositional purity that probably could be found in Jewish law.

The absence of organic additives from animal or vegetable sources, according to the results of GC-MS and ATR-FTIR, seems to indicate that the colours of the synagogue's mural painting were applied when the calcareous plaster was still wet (fresco technique). This technique enabled the colours to settle without the need for organic binders whose fluid state (like blood) could be contrary to the precepts of purity established and respected by the Jewish law. For this reason, the use of fresco technique was popular in Jewish mural painting. Further studies will be carried out in ancient Israel with the aim to verify this assertion.

No organics-based colours were identified in the mural painting of Magdala synagogue. Such colours were often used in Roman period - third and fourth Pompeian style - which corresponds to the first century BCE, i.e. the same period in which the Magdala synagogue was constructed. In the mural of ancient Tarichea there is no evidence of organic pigments from *Isatis tinctoria* or woad (blue), *Rubia tinctoria* or madder (red), *Croscus sativus L.* or saffron (red), and *Purpura murex* (red/violet), which are often found in Roman mural paintings and in contemporary written sources such as Pliny's *Natural History* [7].

As shown in Table 1, the entire colour palette of the Magdala synagogue mural painting comprises mineral colours of local origin. Magdala is surrounded by mountains with deposits of calcite, hematite and red and ochre earths of diverse composition. These were not pigments imported from abroad, but could be obtained easily be obtained easily and at low cost in the area in the area. We know, on the other hand, that some of these iron-based pigments were widely used in the daily life of ancient Mediterranean cultures, including Hebrew society, and this should have facilitated its consumption among the inhabitants of these cities of Lower Galilee of the first century. In this sense, for example, it was common to use hematite and other red earth to prepare cosmetics, such us lipsticks that containing these pigments mixed with some oil, especially olive oil, also available in the region. Another daily use of these iron-based pigments in these same cultures was medicinal. Hippocratic and Galenic medicine, of Greek and Roman origin respectively, prevailed in all these cultures. And so, and according to the 'Theory of Moods' formulated by Galeno, the colours could be used for healing purposes, being able to return the lost balance to the body due to the excess or lack of any of those moods. An example of this is found in the red hematite, prescribed since Greek times to treat diseases caused by blood loss, including the ailments of women due to menstruation. Other red earth also served the same purpose, among them the Land of Lemnos, whose distribution was widespread throughout the ancient Mediterranean in that first century, including Lower Galilee. Every year the priestesses of the Temple of Diana prepared this red earth at the goddess's sanctuary on the Island of Lemnos, as described by

Pliny and Galen in their respective treatises [8]. Both authors refer to the significant use of this red pigment in three different contexts: painting, ritual and medicine. The medicinal use of the pigment included, for instance, the treatment of epilepsy, known as the 'sacred disease' ever since it was thus coined in the *Corpus Hippocraticum*, given the association that was established in Ancient Greece between this malady, the Moon and the goddess Diana [9]. Consequently, the local pigments identified in the Magdala synagogue were colouring materials of local origin at low cost, whose applications in art and other activities of daily life are more than verified in cultures such as Hebrew, spread throughout the ancient Mediterranean. In fact, they are products that were purchased raw by the inhabitants of Magdala in the city market, according to the physical-chemical analyses that we are doing in the coloured balls that have been found in this area of the settlement, very close, otherwise, to the synagogue, which will be the subject of another publication.

For the range of warm pigments (reds and yellows), iron-based colours predominate, mostly clay silicates (Figure 8). Such pigments are able to endure all kinds of milling processes from the gentlest to the most aggressive without losing their initial hue. They can also be applied using any pictorial technique, including fresco, which could affect other pigments often used in Roman mural paintings during the first century AD, such as mercury sulphide, or vermilion (HgS). In one sample, Egyptian blue was detected, an ancient pigment obtained by firing a copper compound with silica, calcium carbonate and a flux agent at a temperature between 850 and 1050ºC [10]. This pigment was perfectly suited to be used in a fresco technique. Egyptian blue reached the cultures of the Aegean during ancient times. Commonly used in Greek paintings since the time of Alexander the Great (4^{th} century BCE), it was known by the artists of ancient Rome long before Egypt was annexed to the Republic in 30 BCE. Its preparation and use spread to every province in the Empire including, as we have been able to verify, Lower Galilee.

4. Conclusions

The scientific investigation of the mural painting materials from the ancient synagogue of Magdala, constructed in the first century CE, it was found that different materials and techniques, commonly used in Roman mural paintings, were detected. The use of these materials and techniques may be explained by the need to find greater compositional purity in accordance with the precepts of Jewish law. On the other hand, both the painting technique (fresco) and the colour palette employed in the synagogue are related to those used in mural painting in Rome and Roman provinces during the first century CE. The fact that Egyptian blue was a component of the palette used for the mural painting at the Magdala synagogue, shows that the economic history of the colours in Magdala was open to cultural connections beyond the Galilee of the Second Temple period. The identification of malachite among the colours that were used in the mural painting makes it possible that the Egyptian blue pigment was being manufactured by specialists from Magdala or the region. If so, that means that the colour

technology in the ancient Migdal was highly developed, because the painters knew how to manufacture an artificial pigment like this. This meant not only knowing the components of the recipe, but also aspects as relevant as the type of oven necessary for the preparation of this pictorial material, temperature or cooking time.

It is possible to verify this hypothesis, or the other, concerning the importation of this colour from Rome, the finding of Egyptian blue in Magdala proves that the history of artistic materials in the ancient world establishes ties of union between cultures, religious beliefs, and very diverse social practices and rituals.

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