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The use of Miscellaneous Scientific Methods in Characterization and Analyzing the Gilding Cartonnage Tape for the Late Period.

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Abstract

The purpose of this research is to examine and identify the colors, media, and ground layer used in the late era of the ancient Egyptian civilization by analyzing the gilded cartonnage tape based on the use of various examinations and analyzes, such as the use of optical microscopy, stereo microscope and scanning electron microscope (SEM) in examining samples of cartonnage and its damage. Using x-ray diffraction (XRD), scanning electron microscope with EDX and infrared (FTIR) to analysis the cartonnage tape.

The piece is gilding cartonnage tape dating back to the a late-era, that suffered from some problems such as cracks in the ground and pigment layer, Separate of linen layers of each other's investigate by optical, stereo, scan microscope. The results show that ground layer consists of two layers, the first one is composed of calcite ($CaCO_3$) with small amounts of quartz (SiO_2). sThe second one composed of calcite, gypsum and quartz. Silver and gold in the gilding layer and cuprorivaite, wollastonite and SiO_2 content in blue color.

Keywords: Cartonnage , tape , gilding, ground layer, pigment ,SEM , XRD, FTIR, Stereo

1. Introduction.

The ancient Egyptians believed in the idea of resurrection and immortality after death therefore, they gave a great importance to preserve the bodies of their dead through mummification, and this interest was not limited to the embalming, but also they manufactured coffins, were these coffins resemble the deceased in order to the spirit recognize the flesh, from this point, the shapes had been evolved to represent the image of the deceased among, these materials are cartonnage.(**(Francoise, D. 1997)**. Cartonnage was represented in forms of masks and boards then developed to become bodies and Spells were drawn on these bodies to protect the deceased in the afterlife, and cartonnage forms continued to Greco Roman period. **(Adams C., 1996).** The cartonnnage is a special cover which the mummy was wrapped with **(Scott., 2009**), or it is a burial tool of the deceased placed on his body inside the coffin, such as canopies and pottery **(Grajetzk, 2003)**, which is dedicated to Save and decorate the mummy **(Teete ,2003).**

Cartonnage coverings are characterized with it's different types and manufacturing materials **(Scott., 2004**) It's cheap, soft, light weight and easy to make from other coffins which made of wood and stones, so it was the most popular alternative for individuals.(**Taylor,1992)**The cartonnage masks are an identical picture of the deceased man**(Walker 1997)**, since the ancient Egyptians generally believed that the man will maintain his image which he had before death , especially his youthful image**(Abdul Rahim,1992**). So, cartonnage is a guide to "recognize" the BA (ba is a soul that leaves the body on the day of death to visit the other world whatever form it chooses to recognize the body) **(Paterson, 1999).** Cartonage is a magical burial tool that carries information and burial texts such as the

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name of the deceased, male or female by the decorations and colors painted on it **(Walker, 1997).** Cartonnage was developed over the different ages, appeared in the late of ancient state and first intermediate period (2160 B.C**) (Scott, 2009**) It was considered an important new innovation, as it was a mask made above the linen layer that was molding, it developed to be layers of linen covered with gesso layer then colors and in some rich masks was gilded (**Freed,1999)**, In the middle state, the cartonnage evolved in shape and materials. For the shape, **(Taylor ,1997)** the mask elongated and reached the shoulder also covered the skull from the back and the beard was added (**Gerner ,2002)**. For the material ancient Egyptians used the flax which is glued together with animal glue, and a layer of gypsum to form a three-dimensional cartonnage **(Taylor,1989).** Cartonnage has seen a great popularity during the period of Ptolemaic rule in Egypt, continued until it reached the Greek and Roman ages. It also had very large changes in the ancient Egyptian ages, whether in the materials, shapes, or decoration **(Françoise,1997)** In this age, cartonnage is made from several layers of compressed papyrus rather than the different flax layers, so they call it "Papier mache" in modern ages. This papyrus gives the material its usual hardness**. (Moehler,1989)** In the Greek-Roman era there were new adjustments to the art of cartonnage, like cartonnage pieces was disappeared to be replaced by the full cartonnage. In other cases, the mask is elongate to form a colored pectrol, The body was formed like it were sculpted, women wore geometric dresses, and men wore shirts with sleeves and coats, this was a representation in their daily life(**Françoise,1997).** The cartonnage consists of many traditional materials which used by ancient Egyptians in all its industries. This material consists of several layers, the fist layer was support which consist of several layers of linen to give strength and stiffness to the cartonnage **(Lansing,1940)** Then papyrus was used instead of linen in the Ptolemaic era (322 B.C. _ 313 AD) Where pieces of papyrus were used and written on them also sometimes they were as distinctive as a waste paper **(Hunt,1988)** . The second layer is preparation layer. The preparation layer which used in the cartonnage are variable. It is sometimes **c**omposed of white material and the bottom layer is made of treated vegetarian coarse fibers like straw and above it is two layers of clay and then a smooth layer is made of gesso **(Jonson,1995**), Aleksilew, B., mentioned that the Ground Putty of cartonage contains of wet clay of alumonya silicate often mixed with carbon black **(Aleksilew, ,2001**). Most of the floors in the cartonnage were two layers,1-Rough layer 2-fine layer (**Scott, 2003)** The third layer is either colored or gilded**,** the cartonnags covers were mostly wonderful multicolored and often have mostly white or gray background. The main colors of the design are red, green, blue, and black, is used for small details (**Scott,2004)** As for media the ancient Egyptians knew a number of natural materials that they used with the preparation layer, colored materials and the support. Ancient Egyptians used one of these materials for various purposes **(Jay,1994),** but the artist knew how to differentiate between the appropriate concentrations for each purpose and used these materials to maintain their works to remain for a long time. The ancient Egyptian used one or several types of medium in one work also in one layer, such as the colored layer. **(Scott, 2003)**

The study aimed to identify the layers and the pigments of cartonnage tape at the atfih Storeroom, Egypt, as well as the chemical alterations caused by the burial environment. Different techniques, such as the scanning electron microscopy (SEM), Attenuated total reflectance- Fourier transform infrared (FTIR) spectroscopy and X-ray diffraction (XRD) were used in the present study.

2. Materials and methods.

2.1. Sampling.

The study examined and analyzed some fragment from the gilded cartonnge tape dating back to the late period in a store in Atfih. It is 40 cm long and 5cm wide. It is gilded cartonnage tape divided with four rectangles the first and the third is white the second is blue and the fourth is gilded. These rectangles are set with black line. In the gilded layer found writing with black line, this is cartridge with the name of the deceased It is content:

di b m3c hrw ms

ib S m3c hrw

Translate Ja Ip honest Sound Son of Ib Is honest sound.

The significance of this tape is that it bears the name of the deceased. This tape is placed on the mummy and carries its name so that the soul can recognize the body on the Day of Resurrection.

2.2. Visual observation by the digital camera.

This method was used to record and document the cartonnage, showing the decorations and the

degradation of each piece separately by using Nikon Coolpix S10 digital camera focal (length: 6.3mm and resolution: 6 megapixels).

2.3. Documentation by drawing.

AutoCAD programme was used to draw cartonnage parts by shooting with a digital camera and sitting a drawing scale inside the image to adjust the measurement while drawing the image. During the shooting process, the angles of the image are adjusted, and then placed inside the AutoCAD program. This method is effective to document the decorations and damage of each piece separately.

2.4. Light microscope:

The optical microscope was used to study cross section of color and gilded cartonnage layer and recognize the shape , skiness, and arrange this layer Kind of light microscope which uses: Leitz ortho plane model 96 with ore lens (X320).

2.5. Stereo microscope.

Device specifications,model: C-2000 stereo microscope,type: Germany,company:Carl Zeiss magnification 3.2 and light 2.5 .

2.6. Investigation by Scaning electrom microscope.

Scanning electron microscopy coupled with dispersive energy -Detector (SEM–EDS). Using SEM Model Quanta 250 FEG (Field Emission Gun.

2.7. X-ray diffraction.

X-ray diffraction was used to identify the concentration of materials in the formof vehicles. and not in the form of elements and is considered (of the ways other than the damage of the archaeological material) **(Heling, 2012)**. This method used in the cartonnage(study subject) on the sample of ground, colored and gilding layer. Operating conditions such as:X-ray diffraction (XRD) analysis was performed using an automated (philips type:PW1840) diffractometer equipment with Cu Kα radiation source and at a step size angle of 0.02°, scan rate of 2° in 2unit,and a scan from 10° to 70°.

2.8. SEM(scanning electron microscope)with EDX.

SEM with EDX uses in quantitative and adequate degradation of materials of inorganic composition of the archaeological material, this method has been used to identify the components of the cartonnage. .

2.9 Fourier Transform Infra Red(FTIR).

FTIR is display for the analysis of organic substances (binding media)and non-organic materials. Providing information can be identified through the functional links of each compound and the distinctive links of each compound that can be easily identified through C=O.8COOH,CHO,CH_3OH **(Wilfried, &schreiner 2010**).

3. Results and disscussion

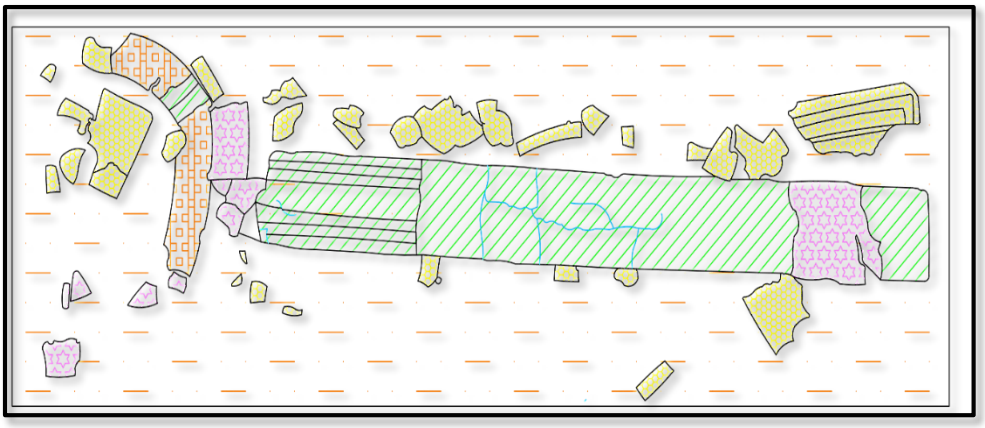
3.1. Visual observation by the digital camera.

Visual observation is the first step for conservation to examine the object by the naked eye and the digital camera. photographing process is done before and after restoration to record and document the object and show the decorations in it, in addition to clarifying the manifestations of damage to each piece separately. The visual observation indicated the accumulation of dust and dirt in the surface of cartonnage tape, Cracks in gilded and painted layer, Breaking and detachment layers of cartonnage and gilded layer which break from the tape, which might be due to thermal degradation or biological infestation, Holes caused by insect damage in the paper support, Paper support (previous study) degradation, yellowish and exposure to insect damage. (figure 1,3)

3.2. Documentation by drawing.

This method is effective to document the decorations and damage of each piece separately. The deterioration in the samples are presence of dust on the surface of tape, Flake of gilded layer and pigment, Loss of parts of cartonnage, Cracks of the layers of cartonnage, Detachment of the pigment layer from the tape, previous restoration, Insect damage in the support. (figure 2)

Figure 1.The gilded cartonnage tape.



Dust.	Separated layers from the surface.	Cracks in the surface.
Previous restoration.	Flake of gilded layer.	Detachment of layer.

Figure 2. Documentation by drawing cartonnage tape by auto CAD. programe and showing the appearance damage on it.

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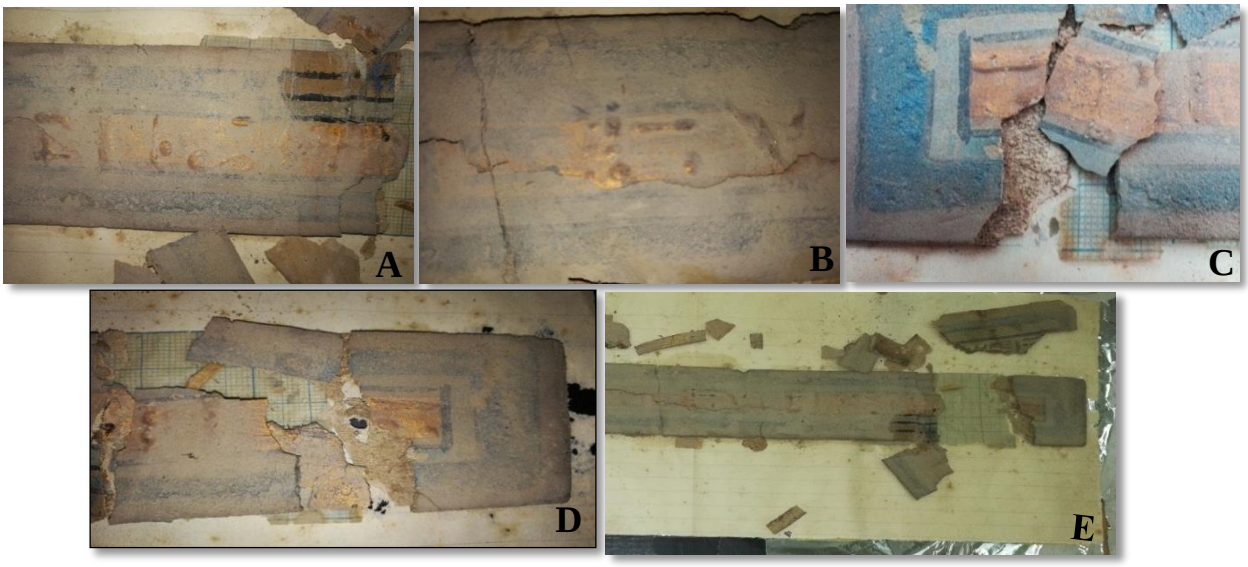


Figure 3. The mapping of the damaging cartonnage.

Notes. A) Accumulation of dust and dirt in the surface of cartonnage tape. B) Cracks in gilded and painted layer. C) Breaking and detachment layers of cartonnage and gilded layer which break from the tape. D) Holes caused by insect damage in the paper support. E) Paper support (previous study) degradation, yellowish and exposure to insect damage.

3.3. Light microscope.

Investigation microscopies of cartonnage indicated to the cartonnage suffers from debility, layers of dust on surface and hides the pigment, gilding layer and details of surface, Cracks in the ground and pigment layer,Separate of linen layers of each others see.

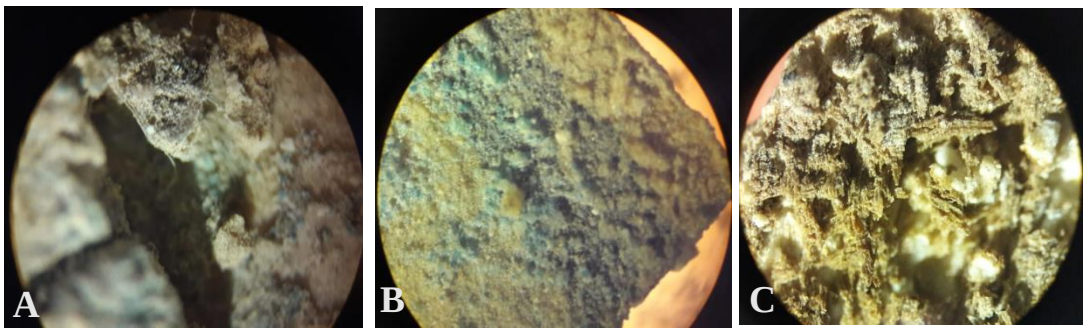


Figure 5. Deterioration of layers.

Notes:A) Cracks, separate, loses in ground layer and some turn into them of powder. B) The artist's inaccuracy during coloring where areas have color clusters and other areas that do not exist. C) Presence of salts in the linen layer.

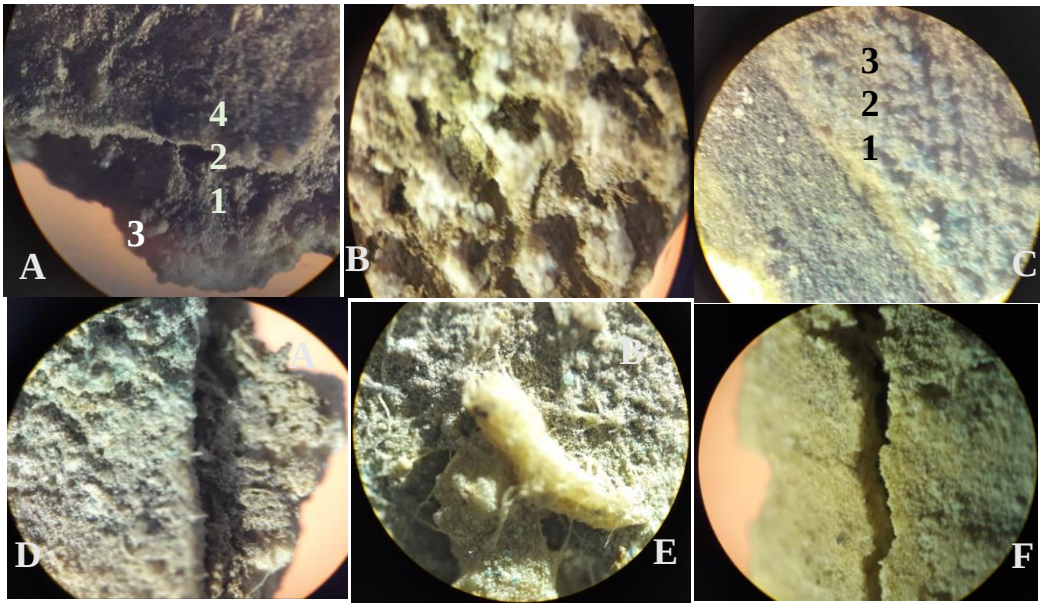


Figure 4. The samples under light microscope.

Notes: A) Cross section of sample of cartonnge shows cartonnage layer in order 1- layer of coarse plaster. 2 - Two layers of linen 3- ground layer. 4-Pigment layer. B) Ground layer of coarse plaster. C. pigment layer. 1- black color. 2- White. color. 3- blue color. D) Separate in linen layer. E) Pieces of Animal glue in the surface. F) loses in pigment layer and cracks in the ground layer.

3.4. Stereo microscope.

The examination by stereo microscope showed the damage in the linen, losing, Flaking, disfigurement by paste some linen layer in the surface and Efflorescence of salts in the surface, this is due to the presence of cartonnage in agricultural soil or soil containing high salt content. Stereo microscope showed the microscopy revealed the weakness, cracks and disintegration of the ground layer, the gilding layer has cracks, efflorescence salts in the surface and paste the linen layers over the gilding layer. In some area the gilding layer was completely destroyed might be due to a change in temperature and humidity levels. This piece has been previously restored, by making a paper support for it to be assembled on and protect it from breakage and damage.

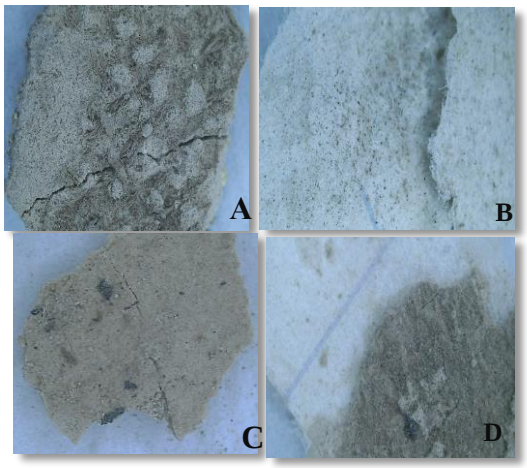


Figure (6). The degradation in the linen layer and ground layer.

Notes: A. losing of the linen layer, cracks in the ground layer and Weaknesses. B. Separate in linen layer. C. cracks and chromatic change in gesso layer. D. support). Previous restoration (paste cartonnage tape on the paper.

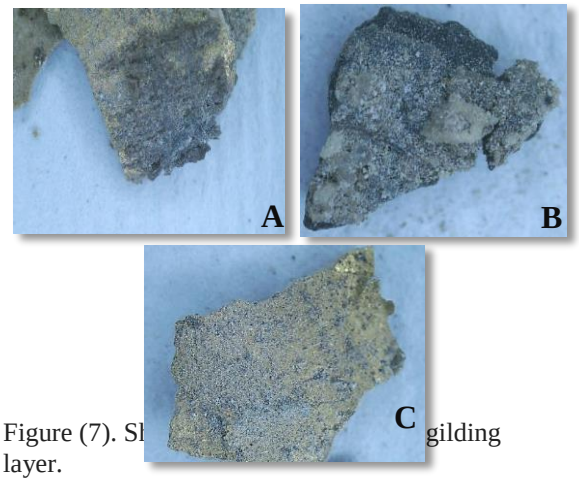


Figure (7). Sl gilding layer.

Notes. A. Paste the linen layers over the gilding layer. B. Efflorescence of salts in the surface and Paste cartonnage layers over each other, C. Separating, flaking, cracks in gilding Layer.

3.5. Investigation by Scaning electrom microscope.

The examination by SEM showed that component of cartonnage layer whether colored or gilded samples and arrange these components on top of each other which is: 1) gesso layer this layer is rough layer. 2) line layer which soaked by animal glue, this layer could be two layers of linen or more. 3) A soft layer of gesso. 4)colored layer or gilding layer. Each layer was examined separately, therefore the extent of weakness, spacing between the granules of the gesso and the presence of glue granules between them in addition to the presence of cracks and lost in some places.

SEM showed linen was soaked by animal glue, weakness and showed colored, gilding layer. The gilding layer is a very thin gold leaf on the surface and we see the separations between them and the ground layer, the cracks and the layer of colors we find a gap between the granules, the loss in some areas and cracks. We see some deterioration in the layer such as salts; it was crystals found in the gesso and inside the linen layers. This subject is displaying to fungi damage. The mycelium of some living organisms are located around the linen fibers, and within the grains of color.

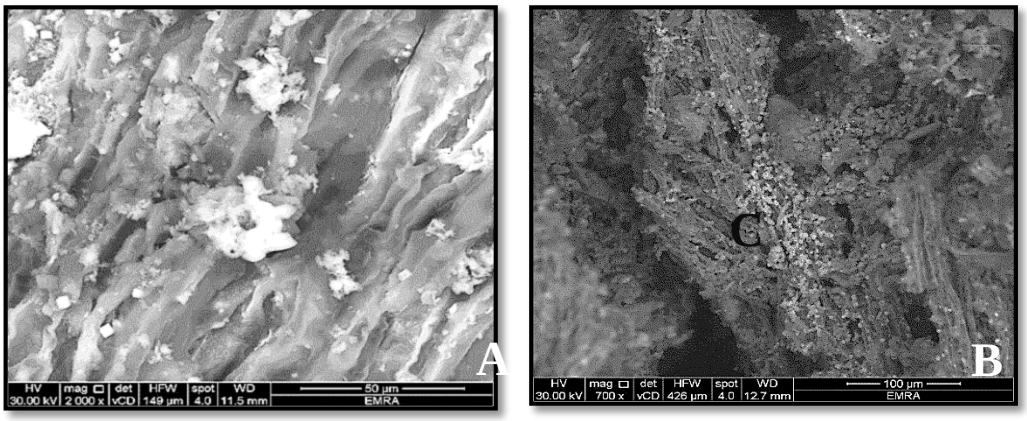


Figure (8) showed a degradation in linen textile.

Notes. A) Linen fiber, which Adhesives by animal glue salt granules scattered within the layer. B) Losing in support and Weaknesses in linen covered with gesso.

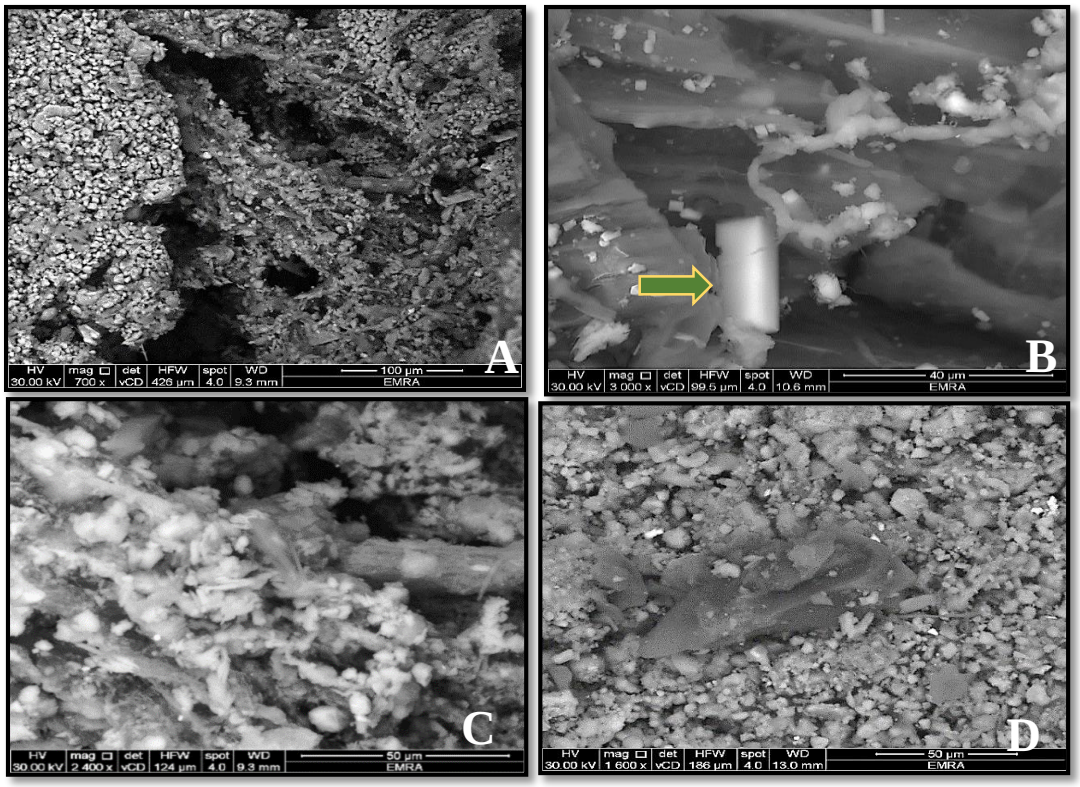


Figure (9). Showed a degradation in plaster layer.

Notes: A) Spacing in minerals of granules layer. B) Gesso layer with linen and found salts polarized, Salts crystallized found within the granules of the ground cartonnage C) Gesso layer with salts, mycelium of fungi, and loss of gesso layer. D) Glue grains, salt granules scattered within the layer.

3.6.X-ray diffraction.

XRD results showed the mineralogical composition of the samples of the cartonnage and the ground layers from the apron and sandal area.

Sample 1 show blue sample consist of quartz, calcite, orthoclase. This is component of ground layer, but proportion of quartz is large than calcite this refer to this layer is groase layer and that is not a perfect part. In addition to presence of orthoclase, that is traces in calcite. Blue pigment in sample is Cuprorivaite that is the basic component of Egyptian blue. It consists of some minerals (cuprorivaite + minor Cu wollastonite + SiO_2 + glass), and it was found on all painted decoration **(Bianchetti, et.al 2000).** Halite, which find in the sample that proportion, is 7% this is refer to the presence of percentage salts in the cartonnage, this is due to the presence of cartonnage in salt soils.

Sample 2 is yellow color its content of Quartz, Calcite, Goethite, Orthoclase and Halite, this refer to that the ground consists of quartz and calcite. Yellow pigment is goethite, in addition to presence of salts in the sample.

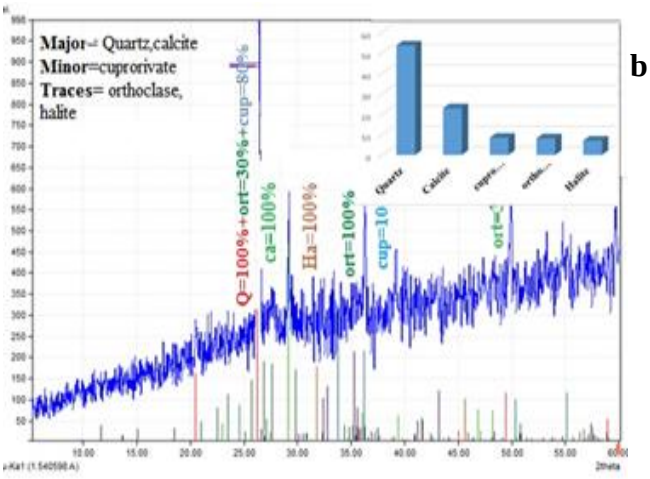
Sample 3 is white color its contents of Gypsum, Calcite, Zincite, Titanium oxide and Halite. In this sample the artist added gypsum, this is likely to be used as a filler instead of quartz to make a very fine layer or to give white color. White pigment, it found two types of metals that give white color namely Zincite, Titanium oxide. This type of minerals is the most uses in white color in addition to halite.

Sample 4 is black color, its contents of Calcite, Gypsum, Quartz, Hydroxylaptite, and Halite. Presence of calcite, gypsum and quartz is content of fine ground layer. black pigment consists of hydroxylapitite, it is called bone black It is the result of placing the bones of a cell inside closed containers and then boiling them with water to slip fats and gelatins materials. It is given a color to black slanted blue and contains 10% phosphate calcium, 6% calcium carbonate. **(Merwin 1990).**

Figure (10). XRD spectra of blue(b) and yellow(y) sample of cartonnage tape.

Minerals	Chemical name	Chemical composition	Con. in sample	Number of card
Quartz	Silicon oxide	Sio_2	53.5%	46-1045
Calcite	Calcium carbonate	$CaCo_3$	22.8%	05-0586
Cuprorivaite	Copper calcium silicate	$CaCuSi_3O_{10}$	8.4%	12-0512
Orthoclase	Potassium Aluminum silicate	$KAlSi_3O_4$	8%	09-0462
Halite	Sodium chloride	Nacl	7%	05-0628

Minerals	Chemical name	Chemical composition	Con. in sample	Number of cards
Quartz	Silicon oxide	Sio_2	48.2%	46-1045
Calcite	Calcium carbonate	$CaCo_3$	9.98%	05-0586
Goethite	Iron oxide hydroxide	Feo(OH)	16.9%	17-0536
Orthoclase	Potassium Aluminum silicate	$KAlSi_3O_4$	10.3%	09-0462
Halite	Sodium chloride	Nacl	14.4%	05-0628



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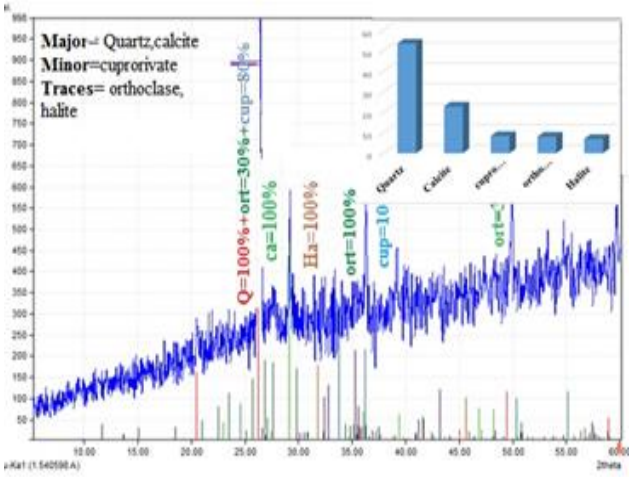

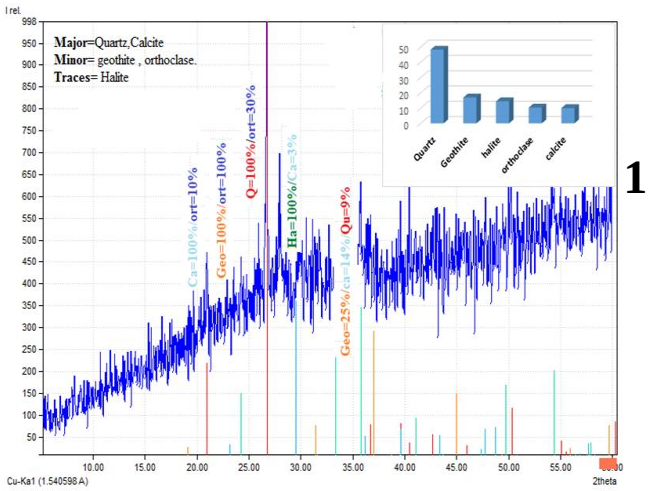

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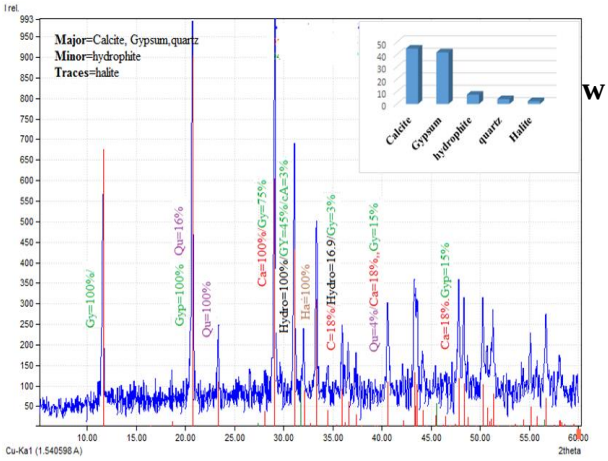
y

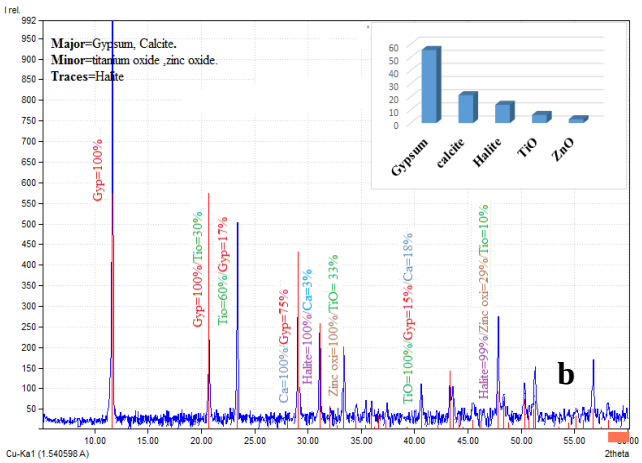
Figure 11. XRD spectra of white(w) and black(bl) sample of cartonnage tape.

Minerals	Chemical name	Chemical composition	Con. in sample	Number of cards
Gypsum	Calcium sulfate hydrate	$Caso_4.2H_2o$	55.6%	33-0311
Calcite	Calcium carbonate	$CaCo_3$	21. 2%	05-0586
	Titanium oxide	TiO	6.9%	09-0240
Zincite	Zinc oxide	Zno	5.3%	05-0664
Halite	Sodium chloride	Nacl	2.82%	05-0628

Minerals	Chemical name	Chemical composition	Con. in sample	Number of cards
Calcite	Calcium carbonate	$CaCo_3$	44. 8%	05-0586
Gypsum	Calcium sulfate hydrate	$Caso_4.2H2o$	41.7%	33-0311
Quartz	Silicon oxide	Sio_2	3.9%	46-1045
Hydroxy laptite	Black bone	$Ca_3(po_4)_3$	7.5%	9-432
Halite	Sodium chloride	NaCl	2.24%	05-0628



w



b

3.7 Scanning Electron Microscopy Coupled with Energy Dispersive X-Ray Detector (SEM-EDX)

The SEM- EDX analysis of sample (1) were showed the presence Fe, o, is yellow color Fe (OH) (goethite) and elements Ca,C,O is Calcite $CaCO_3$, Si,O is quartz (Sio_2).This is the composition of ground layer and small amount of K,Al this is Orthoclase $KAlSi_3O_4$ The occurrence of Na and Cl are indicative of the existence of halite (NaCl) and some traces like Mg this is refer to dust it the sample. Sample (2) were showed the presence Au, Ag. is Gilding layer consists of Au, Ag. it's an alloy of gold and silver. Ca, C, O and Si, these results showed that the ground layer Calcite $CaCO_3$. And quartz Sio_3. Na, Cl These elements refer to salts NaCl. Fe, o, is yellow color Fe (OH) (goethite). Fe, OH, Al , The presence of aluminum oxide and iron hydroxide like the ground layer of gilding layer which clay and alpole materials and magnesium oxide are from dust.Sample (3) is gilding sample which showed the presence of of Au Ag this is gold leaf, an alloy of gold and silver. The occurrence of Ca, C, O, indicate to ground layer which consist of Calcite $CaCO_3$ and Si,O is quartz (Sio_2).Sample (4) is blue sample which showed in SEM-EDX is Ca, Cu, Si, O this result indicate to the presence of Egyptian blue cuprorivaite $CaCuSi_3O_{10}$, small amount of K,Al this is Orthoclase $KAlSi_3O_4$ The occurrence of Na and Cl are indicative of the existence of halite (NaCl) and some traces like Mg this is refer to dust it the sample. Sample (5) is ground layer which showed in SEM-EDX is Ca, C, O, indicate to ground layer which consist of Calcite $CaCO_3$ and Si,O is quartz (Sio_2). small amount of K,Al this is Orthoclase $KAlSi_3O_4$ The occurrence of Na and Cl are indicative of the existence of halite (NaCl) and some traces like Mg this is refer to dust it the sample .

Elements	Wt%
C	35.45
O	31.25
Na	2.26
Mg	1.20
Al	2.04
Si	4.66
S	5.31
Cl	2.09
K	0.54
Ca	13.65
Fe	1.55

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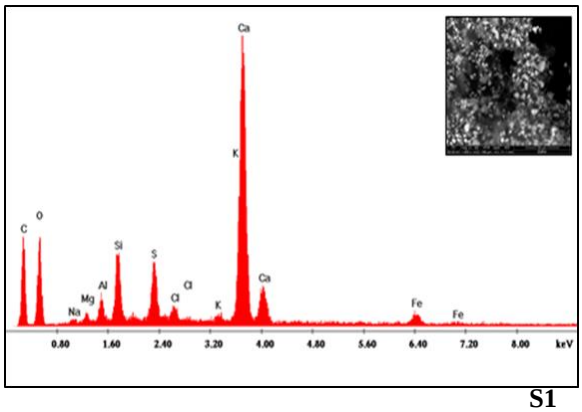
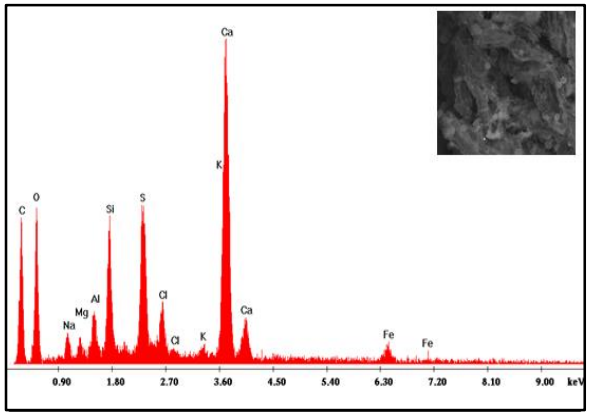
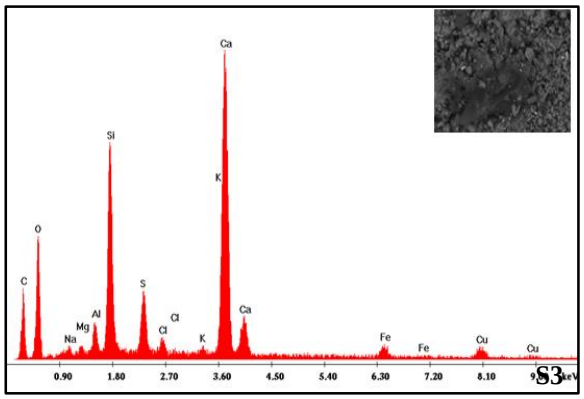


S1

Elements	Wt%
C	31.69
O	34.77
Na	0.79
Mg	0.91
Al	1.59
Si	4.28
S	3.11
Cl	0.88
K	0.48
Ca	19.73
Fe	1.77

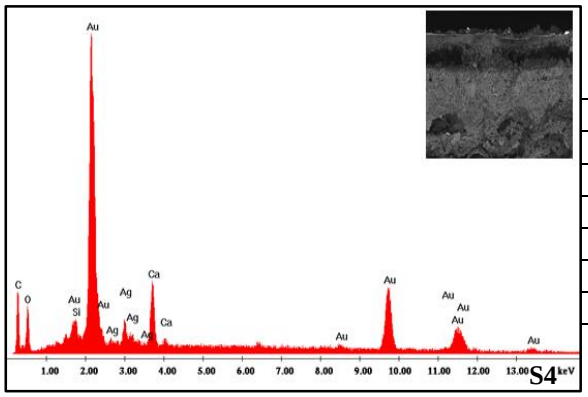


Elements	Wt%
C	35.47
O	31.98
Na	1.58
Mg	0.86
Al	1.64
Si	3.21
S	5.07
Cl	2.41
Ag	0.65
Ca	11.67
Fe	1.12
Au	4.34



S3

Elements	Wt%
C	23.78
O	35.29
Na	1.07
Mg	0.69
Al	1.80
Si	10.94
S	3.01
Cl	0.82
K	0.41
Ca	18.19
Fe	1.63
Cu	2.36

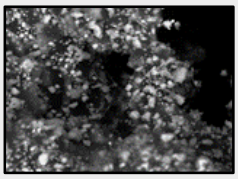
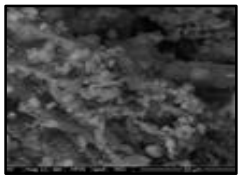
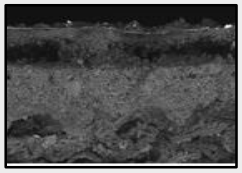
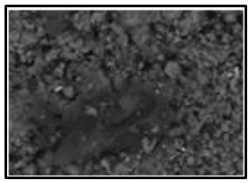
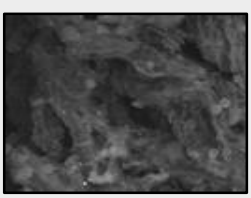


S4

Elements	Wt%
C	20.55
O	14.72
Si	1.05
Ag	5.29
Ca	5.83
Au	52.56

Figure 12. SEM-EDX (S1). elements of yellow, ground layer and salt. (S2) elements of ground layer, and gilding. (S3) elements of gilding layer. (S4) elements of blue pigment. (S5) elements of ground layer.

Table 1. Results the analysis to some fragments of the Cartonnage by SEM.EDX.

Sample	Elements	Explanation	Chemical formula
Sample 1 	Ca, C, O, Si, Fe Traces K, Al, Na, Cl, Mg	Indicated the ground layer consist of calcite, quartz and orthoclase. pigment is goethite, and halite. Mg, Al The presence of aluminum oxide and magnesium oxide are from dust.	**Calcite** $CaCo_3$, **Quartz** Sio_2, **Goethite** FeO(OH), **Orthoclase** $KAlSi_3O_4$, **Halite** Nacl.
Sample 2 	Ca, C, O, Si, Fe, Au, Ag Traces K, Al, Na, Cl, Mg	Indicated the ground layer consist of calcite, quartz and orthoclase. Gilding layer consists of Au, Ag. it's an alloy of gold and silver pigment is goethite, and halite. Fe, OH, Al, The presence of aluminum oxide and iron hydroxide like the ground layer of gilding layer which clay and alpole materials. Mg, the presence of magnesium oxide are from dust.	**Calcite** $CaCo_3$, **Quartz** Sio_2, **Goethite** Feo(OH),**Orthoclase** $KAlSi_3O_4$, **Halite** Nacl, Gilding layer
Samples 3 	Ca, C, O, Si, Au, Ag,	Indicated the ground layer consist of calcite, quartz. Gilding layer consists of Au, Ag. it's an alloy of gold and silver.	**Gilding layer , Calcite** CaCo3, **Quartz** Sio_2, gilding layer . .
Sample 4 	Ca, C, O, Cu, Si Traces K, Al, Na, Cl, Mg, S, Fe.	Indicated the ground layer consist of calcite, quartz. Blue pigment is Egyptian blue and the content of it is Cuprorivaite. Mg, Al The presence of aluminum oxide and magnesium oxide are from dust.	**Calcite** $CaCo_3$, **Quart** Sio_2, **Cuprorivaite** $CaCuSi_3O_{10}$, **Orthoclase** $KAlSi3O_4$, **Halite,** Nacl
Sample 5 	Ca, C, O, Si, K, Al, Na, Cl, Mg ,S.	Indicated the ground layer consist of calcite, quartz and orthoclase. Mg, Al the presence of aluminum oxide and magnesium oxide are from dust.	**Calcite** $CaCo_3$, **Quartz** Sio_2, Orthoclase $KAlSi_3O_4$, **Halite** Nacl.

3.8 Fourier Transform Infra Red (FTIR).

FTIR analysis results (Sample 1.) confirmed that the first ground layer of cartonnage tap gave a strong signal gave a strong signal at 3279cm-1 and 2871 cm-1 attributed to N-H stretching band and C-H groups stretching band and 1645 to C=O cm^{-1} 1480 CH bending respectively characterization the animal glue. 1435 cm^{-1} 796cm-1 CO_2 cm^{-1} characterization the Calcite (Calcium carbonate ($CaCO_3$) C=O .1102 (Silica(Sio_2).

Sample 2. from the linen layer of cartonnage tape gave a strong signal gave a strong signal at 3404cm-1 and 3088 cm-1 attributed to N-H stretching band and C-H groups stretching band and 1645 to C=O cm^{-1} 14 CH bending respectively characterization the animal glue.

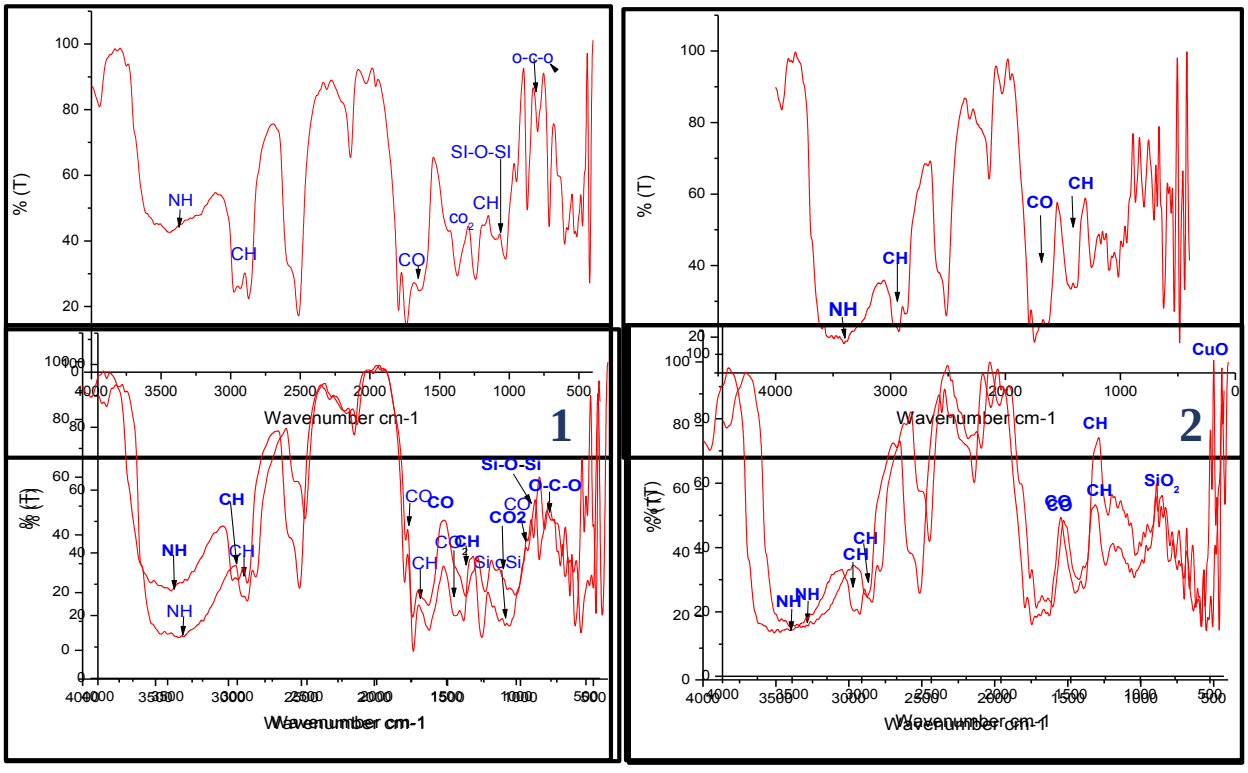
Sample 3. from the second ground layer of cartonnage tap gave a strong signal gave a strong signal at 3386 cm-1 and 2962 cm-1 attributed to N-H stretching band and C-H groups stretching band and 1624 to C=O cm^{-1} 1441 CH bending respectively characterization the animal glue. 1441 cm^{-1} 875 cm-1 CO_2 cm^{-1} characterization the Calcite (Calcium carbonate ($CaCO_3$) C=O .1049 (Silica Sio_2).

Sample 4. from the blue color of cartonnage tap gave a strong signal gave a strong signal at 3386 cm-1 and 2962 cm-1 attributed to N-H stretching band and C-H groups stretching band and 1628 to C=O cm^{-1} 1440 CH bending respectively characterization the animal glue. 485 cm^{1} 1104 cm-1 CuO Sio2 cm^{-1} characterization the Egyptian blue ($CaCuSi_3O_{10}$).

Sample 5. from the black color of cartonnage tape gave a strong signal a strong gave signal at 3404 cm-1 and 2965 cm-1 attributed to N-H stretching band and C-H groups stretching band and 1625 to C=O cm^{-1} 1450 CH bending respectively characterization the animal glue.

Sample 6. from the white color of cartonnage tap gave a strong signal at 3393 cm^{-1} and a 2965 cm^{-1} attributed to N-H stretching band and C-H groups stretching band and 1629 to C=O cm^{-1} 1445 CH bending respectively characterization the animal glue. 1373 cm^{-1} 870 cm-1 CO_2 cm^{-1} characterization the Calcite (Calcium carbonate ($CaCO_3$)C=O1088 (Silica Sio_2).

Figure 10. FTIR spectra of the sample of cartonnage tape to identification of binding media and layers of ground.



Notes 1) FTIR spectra of the first ground layer sample of binding media and layers of ground.

2) FTIR spectra of the binding media in linen layer. 3) FTIR spectra of the second ground layer of plaster. 4) FTIR spectra of the blue color sample 5) FTIR spectra of the white color .6) FTIR spectra of the black color.

4- Conclusion.

The present study provided a number of valuable data about cartonnage during the late Period depending on the analytical techniques of all layers of the cartonnage tape.

The piece is gilding cartonnage tape dating back to the a late-era, it is 40 cm long and 5cm wide. The cartonnage tape suffered from some problems that it has presence of dust on the surface of tape, Flake of gilded layer and pigment, Loss of parts of cartonnage., Cracks of the layers of cartonnage., Detachment of the pigment layer from the tape, un suitable restoration, Insect damage in the support.

Investigation light microscopies of tape indicated to suffers from debility, layers of dust on surface and hides the pigment, gilding layer and details of surface, cracks in the ground and pigment layer, Separate of linen layers of each other's. Stereo microscope of tap appear losing of the linen layer, cracks in the ground layer and Weaknesses. Efflorescence of salts in the surface, Paste the linen layers over the gilding layer, scanning electron microscope of tape samples show each layer was examined separately, therefore the extent of weakness, spacing between the granules of the gesso due to the loss of the bonding material (its ability to stick), and also weakness between the granules. The results confirmed that ground layer consists of two layers, the first one is inner coarse ground layer is composed of calcite ($CaCO_3$) with small amounts of quartz (SiO_2). The fine ground layer that was used under the pigments directly was also composed of calcite, gypsum and quartz. The gilding layer content of Au and Ag. The blue color was cuprorivaite, wollastonite and SiO_2, yellow color its content of Quartz, Calcite, Goethite, Orthoclase. white color was Gypsum, Calcite, Zincite, Titanium oxide and black color was Calcite, Gypsum, Quartz and Hydroxyapatite. The presence salts in the sample, this is due to the presence of the cartonnage tape inside groundwater soil that contains a percentage of salts. The binding media in the ground layer and pigment layer confirmed that is animal glue. Moreover, the presence of the gypsum in the second layers of ground layer to be fine layer to draw and color. Finally, the identification of the composition of ancient layers' services to know art historical information, the methods and materials which described in common or exceptional for a particular period.

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