TECHNICAL ANALYSIS REPORT

Conservation of the Northern Lobe of the Sanctuary. Microstratigraphic analysis on cross section and Spectrophotometry analysis (FT-IR) aimed to study the plasters, the preparatory and the pictorial layers. Identification and absolute dating of the wood.

Domenicco Poggi, Artelab s.r.l

Conservation and Documentation of the Wall Paintings at the Red Monastery, Sohag.

Sub-grant No. EAC-13-2007

Fall Mission: October 28, 2007 – December 20, 2007

The Egyptian Antiquities Conservation Project (EAC)
USAID Agreement No. 263-A-00-04-00018-00

Awarded to

THE AMERICAN RESEARCH CENTER IN EGYPT (ARCE)

Address: 8700 Crownhill Blvd. Suite 507, San Antonio, TX 78209 Tel: (210) 821-7000

by the

USAID Program Office of Productive Sector Development / Office of the Environment
USAID / Egypt

March 2008

In collaboration with the United States Agency for International Development and the
Egyptian Ministry of State for Antiquities

Index

1. Materials and Methods ……..……..… P 3

2. Analytical sheets of the samples

Sample no. 1 ..... P 5

Sample no. 4 ..... P 9

Sample no. 5 ..... P 15

Sample no. 9 ..... P 18

Sample no. 11 ..... P 20

Sample no. 12 ..... P 23

Sample no. 14 ..... P 25

Ns. rif. Y – 55

Spett. Luigi De Cesaris, *via Federico Cassitto n. 100 00134 Roma*

Aim: Microstratigraphyc analyses on cross section and Spectrophotometry analysis (FT-IR) aimed to study the plasters, the preparatory and the pictorial layers. Identification and absolute dating of the wood.

The specimens were provided by the customer

1. Materials and Methods

The specimens taken by the restorers were initially characterized and selected for the subsequent more thorough stereo-microscopic tests. The most representative or more interesting specimens were then submitted to specific testing. In particular:

- chemical and mineralogical tests using infrared spectrophotometry (FTIR: Fourier Trasform Infrared), performed on specimens as are and on extracts in organic solvents;
- microstratigraphic analyses on polished sections plus microchemical and histochemical tests;
- stereo-microscopic tests plus microchemical tests;
- absolute dating using the radiocarbon (^{14}C) method and relevant correction by means of calibration using dendrochronology;
- morphoanatomic studies using light microscopy for identifying the wood. In seguito, i più rappresentativi o quelli più interessanti, sono stati sottoposti ad analisi di approfondimento.

The number and type of tests performed were aimed at achieving the main goals of the investigations in this stage of the study, namely:

- define the technique used in producing the red pictorial layer attributable to stage three in the execution (specimen n° 1 taken from the transept);
- confirm by FTIR that a mortar without gypsum was used for the second stage plaster (specimen n° 1);
- characterize and compare the plasters taken from the transept, North wall (above the monochrome cross to the left of the knight), and from the court-yard, south-west corner (inside the south-looking window) – specimens n° 4 and 5;
- identify initially the layers contained in a specimen taken from the transept near the velarium fringe in the North recess, roughly indicating its composition;
- provide an absolute date for a wood element of the transept (high DIATONO);
- identify the wood used for producing an element of the transept (low *diatono*[1]);

[1] The two wood specimens examined initially under the stereo-microscope, highlighted similar morphological and textural characteristics. Of the two specimens, the one taken from the lower *diatono*, was very small in size such as not to ensure a sufficiently correct dating by the technique being used [liquid scintillation counting (LSC) for β^- multichannel spectrometry]. Hence this specimen was used for the morphoanatomic test aimed at identifying the wood; the other specimen taken from the upper diatono, was used for absolute dating using the radiocarbon (^{14}C) method and corrected by calibration with dendrochronology .

- identify the presence, in any, of lead pigments in the superficial layers of two specimens taken from the transept, respectively from the velarium fringe of the North recess and from the horse of the 'Medieval knight'.

The tests were carried out in compliance with the UNI – Normal recommendations, where possible, and with the indications provided by the scientific publications published by national and international institutes that operate in the field of cultural heritage conservation: ICR, ICCROM, ICOM, ASTM.

The results of these investigations are given in detail in the analysis sheets, in which ample photographic documentation is also provided for each sample.

Roma 11/03/08 Geol. Domenico Poggi

2. Analytical sheets of the samples

Sample no. 1

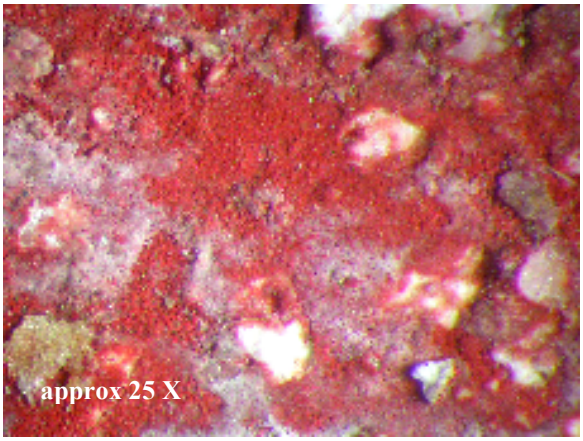
Description accompanying the specimen

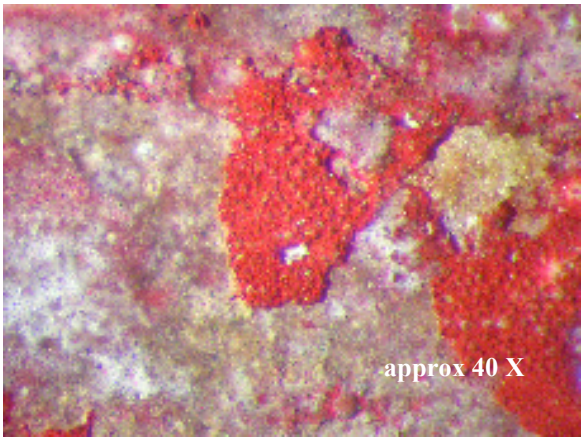
"Very resistant red of the transept near the recess".

Preliminary stereo-microscopic examination

The specimen consists of a millimeter sized flake (approximately 17 x 12 x 2-3 mm thickness) including the following layers listed bottom-up:

1) white primer;
2) plaster consisting of lime, siliceous sand and few plant fibers;
3) white lime-based color (preparatory layer);
4) red pictorial layer;
5) traces of a whitish layer (probably the white wash of stage IV). Indeed coats 1-4 seem to have been placed in stage III.





Stereomicroscope, reflected light

Indeed the two pictures illustrate just as many details of the specimen surface. Some tens of milligrams of material of the red pictorial layer were taken selectively using a microtome with a rounded-shaped blade under stereo-microscopic control. The harvested material was then submitted to FTIR spectrophotometry (see below).

Infrared spectrophotometric analysis (FT-IR)

Preparation of the sample - Methods used for selecting the specimen and techniques used

The material, taken mainly from the red pictorial layer, was finely ground using an agata mortar. The powder was then mixed with KBR and then analyzed using a Shimadzu 8400 – S FT-IR spectrophotometer (DRIFT method).

After interpreting the IR spectrum obtained, the possible organic compounds present in the specimen were selectively extracted both using bidistilled water and by means of a 1:1 acetone-Xylene mixture. The extracts, dried in a kiln at 60 °C after mixing with KBR, were again analyzed by means of FTIR spectrophotometry using the same equipment and methodology described above.

Results

- *Unprocessed specimen (as is)*

The study of the IR spectrum obtained from the analysis (see next page) indicates that the sample consists of the following components, listed according to relative abundance:

- *calcium carbonate*, *calcite* phase ($CaCO_3$);
- *calcium sulphate (gypsum)* present both as *hemhydrated phase* ($CaSO_4.0.5H_2O$) and as *bi-hydrated phase (*$CaSO_4.2H_2O$);
- *calcium oxalates* present undoubtedly as *hemhydrated phase* (*whewellite*: $CaC_2O_4.0.5H_2O$) and, probably, also as bihydrated phase (*weddellite*: $CaC_2O_4.2H_2O$);
- probably *phyllosilicates* (*clayey* and/or *micaceous minerals*) attributable to (red ochre) '*terra*' used as pigment;

The *organic substances*, that are almost absent, are indicated by the presence of a single, very 'weak', band at 2985 cm-1.

Finally, there is a small doubt as to the possible presence of calcium phosphate (apatite) that can be more easily identified using X Ray Diffraction.

Extract in bi-distilled water

The FTIR spectrum obtained from the analysis of the extract in water (at around 60 °C) shows various similarities with the results obtained from the analysis of extracts in water of animal glue or jelly, recorded in the same testing conditions. It is possible therefore that the sample may contain protein substances of this type albeit altered and mineralized in calcium oxalates.

In the IR spectrum, effects relative to *hemihydrated gypsum* and *nitrates* (minimum amounts) are also observed.

In the following pages you can see the specimen spectrum compared with that obtained using rabbit glue.

Extract in the acetone-xylene mixture

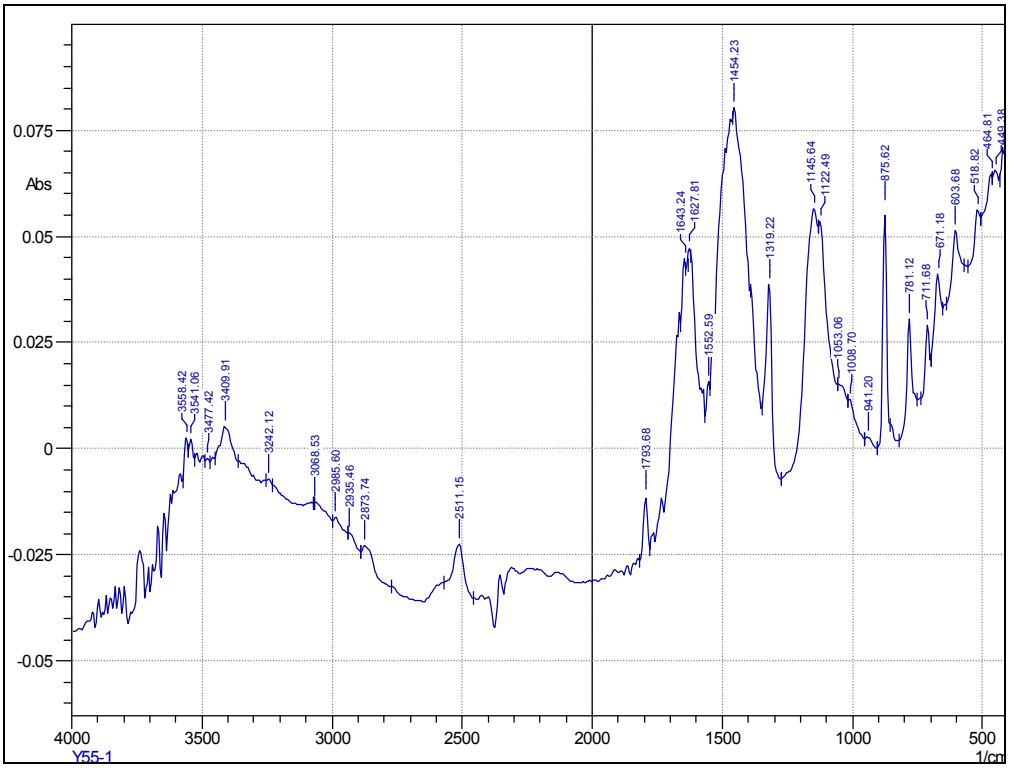
The spectrum obtained from the analysis of the extract in the 1:1 acetone-xylene solvent mixture indicated that the specimen currently contains no lipids or insoluble proteins in water (egg yolk – oils). Indeed the absorption bands of the ester group are absent; also the effects relative to the CH groups are virtually absent.

Remarks and interpretation of analytical results

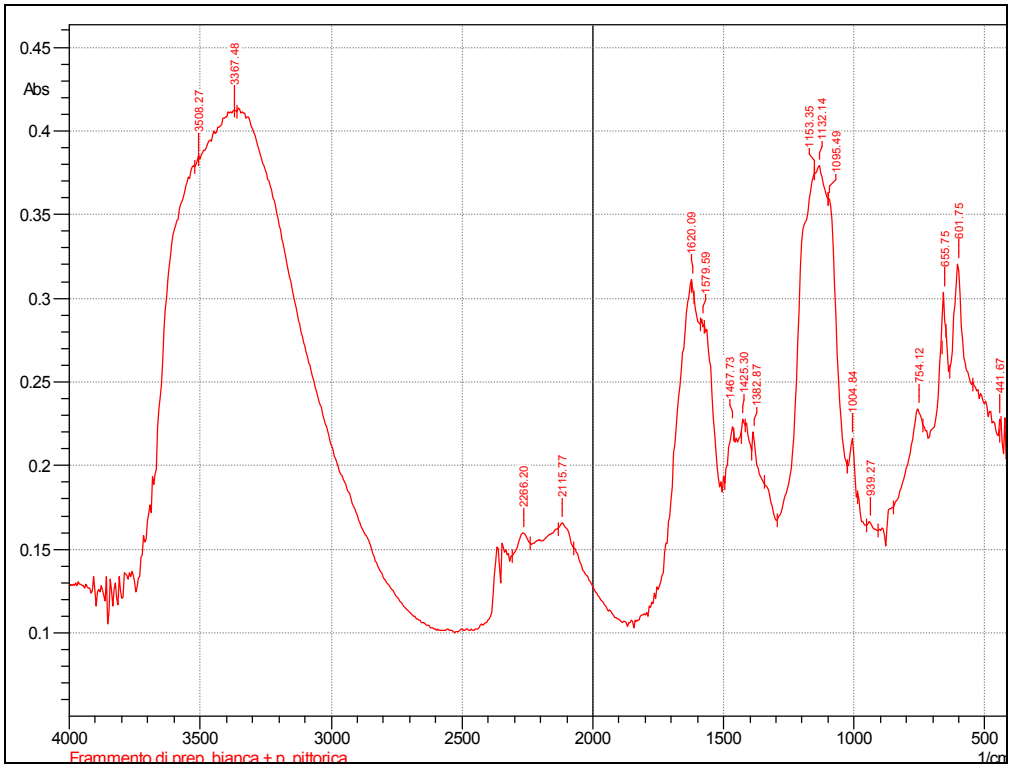
The results obtained from the interpretation of the three FTIR spectra indicate that the original binder has almost totally 'become mineralized' into *calcium oxalates (whewellite* and

perhaps also *weddellite)*. Some cues indicate that perhaps animal glues or jellies were used as binders for the pictorial layer, whereas no effect attributable to the presence of egg or oil was detected. However, precisely because of the strong alteration and mineralization into calcium oxalate of the medium, in order to have a final confirmation of the presence of animal glues or jelly, it is recommended that high pressure liquid chromatography (HPLC) and gas-chromatography (GS) tests be carried out.

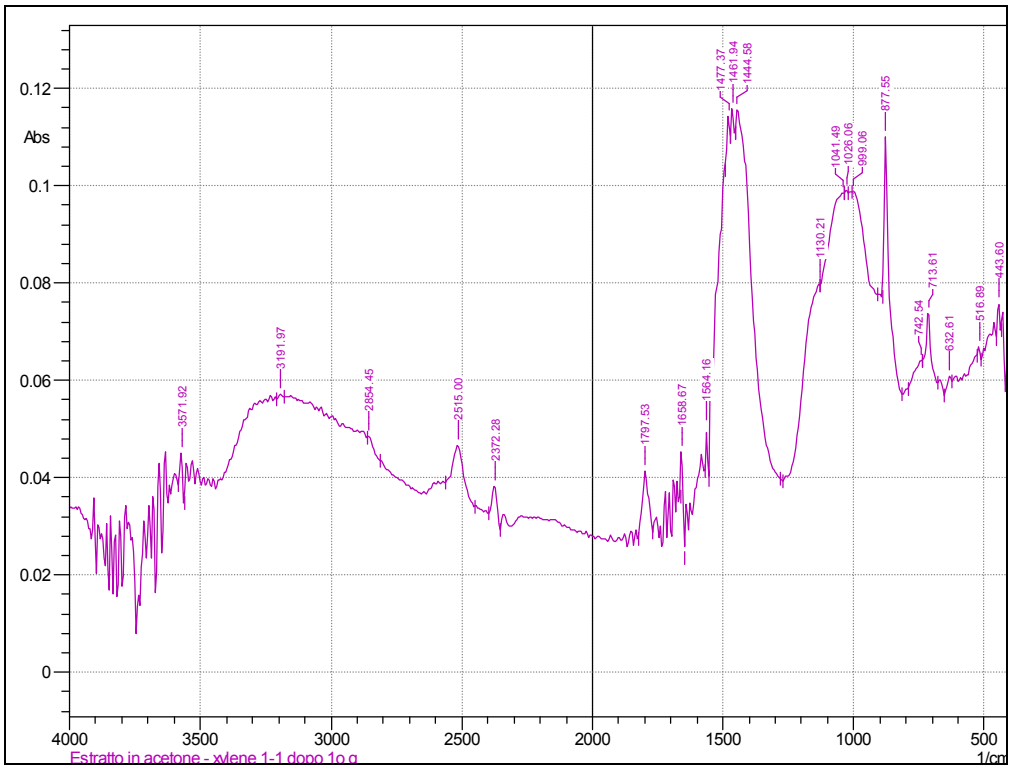
The presence of gypsum in the pictorial film is striking, while it is virtually absent in the plaster and in the underlying preparatory layers. Gypsum is also absent in the white wash relative to stage IV, a layer that is present in the fragments above the red pictorial layer which is being analyzed, and which consists of calcite, albeit within the limits of observations using the polarizing microscope on thin sections (see the 2004 Artelab report)



Sample Y55-1. Spectrum of the sample 'as is'



Sample Y55-1. Spectrum of the extract in water at around 60 °C.



Sample Y55-1. Spectrum of the 1:1 acetone - xylene extract

Sample no. 4

Description accompanying the specimen

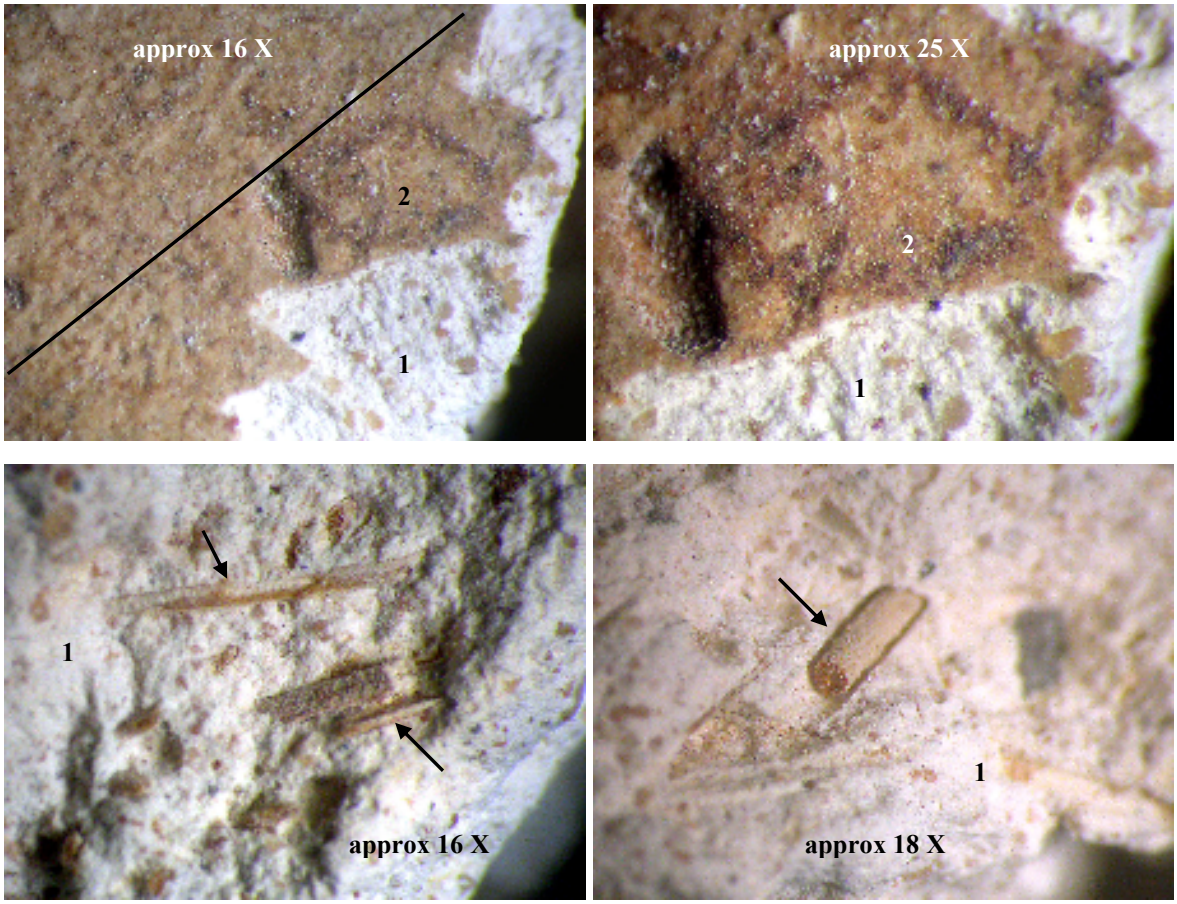
"Plaster of the North-facing wall of the transept (above the monochrome cross to the left of the knight)".

Picture of the point of sampling provided by Luigi de Cesaris

Preliminary stereo-microscopic examination

The sample consists of some plaster fragments measuring at the most 20 x 24 x 28 mm^3) characterized by an accurately polished surface. At the present time it is covered by a thin brownish layer that may be referred to a protein binder based coat (see the results of the microstratigraphic tests).

The mortar was produced with lime, abundant plant fibers and, very likely, sand.



Stereomicroscope, reflected light.

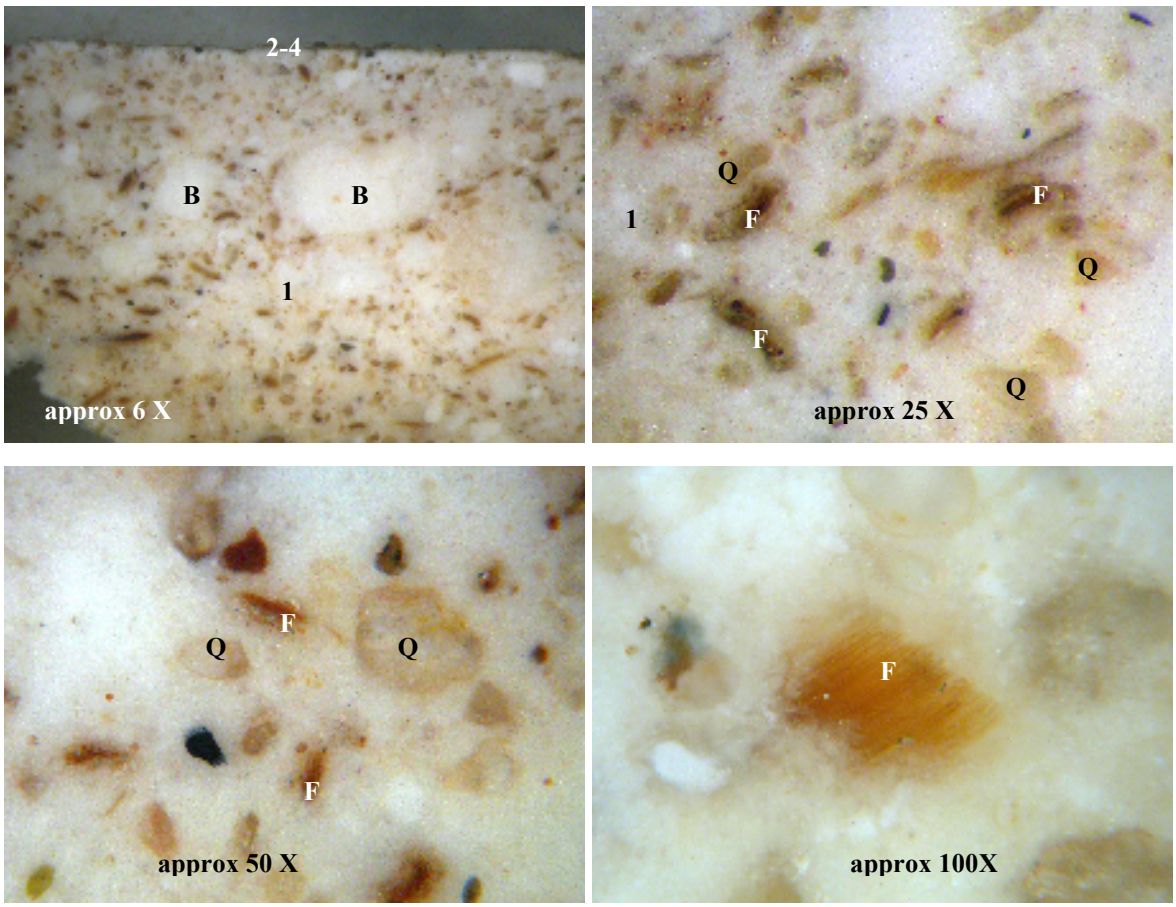
The two top pictures, taken at different magnifications, illustrate a superficial portion of the specimen. On top of the plaster (n° 1), consisting of lime, essentially siliceous sand and plant fibers, a layer of light brown color (n° 2) attributable essentially to a protein-based layer is visible.

The two lower 'photographs' describe details of the mortar, highlighting the morphology of the plant fibers included inside (arrows). Presumably, rather rich in lignin, they have a yellow-brownish color and an aspect which is compatible with that of the fibers obtained from the stalks of annual plants (cereal hay, flax, hemp, etc. [2]).

The black segment, visible in the upper photograph on the left, approximately indicates the shear line of the polished cross-section prepared for the microstratigraphic examination described below.

[2] However for a precise identification a morphoanatomic analysis by an expert is needed.

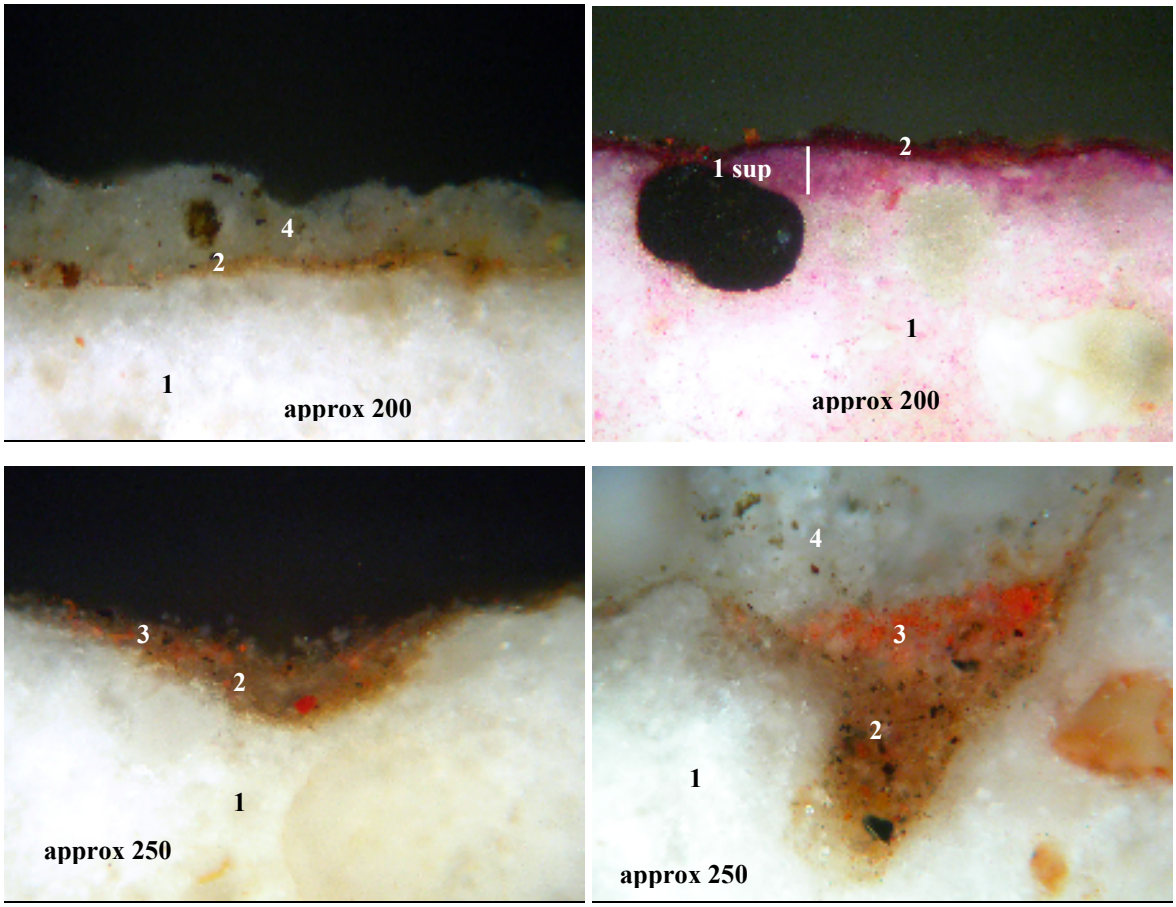
Microstratigraphyc analyses on cross section with microchemical and histochemical tests
Analytical sheet written according to the Doc Normal 12/83



Cross section, reflected light

The four pictures at increasing magnification from bottom to top accurately describe the structure of the plaster (n° 1). The characteristics of the thin finishing layers (layers 2 and 3) and their stratigraphic relationship with the plaster are documented in the large magnification pictures shown on the next page.

The letters have the following meanings: B: micro-fissured lumps of lime ('bottaccioli'); F: plant fibers; Q: quartz granules.



Cross section, reflected light

The upper left-hand picture describes a small superficial portion of the section where, above the plaster (n° 1), there is the 'terra'-based light brown layer (2) and carbon black dispersed in a protein medium (based on animal glues), as well as residues of the grayish layer containing hydraulic binders (4). The latter may be attributed to splashes or dripping of the cement mortar used in the recent restoration of the cupola

The upper right-hand picture, taken after the test with fuchsine, aimed at identifying the protein substances (in particular animal glues and/or jelly) is evidence of the positive outcome of the test both in coat n° 2 and in the superficial portion of the plaster (1-sup). Indeed, the latter may have absorbed the protein binder in coat n° 2.

In the two lower pictures, traces of a red pictorial layer are visible (n° 3) based on red ochre-hematite dispersed in an organic binder probably of protein origin. This coat could have been applied on top of the light brown layer (n° 2) at the same time, probably with the function of providing a dark background on which the various motifs would then be depicted.

The following pages provide a more detailed description of the individual coats.

1) Plaster deriving from a mortar of slaked lime, essentially quartzitic sand and plant fibers obtained from stalks (*hay*) [3]

Thickness: varies from about 8.0 to about 11 mm.

Grain-size of the aggregate: between 0.05 mm and 1.0 mm

Sizes of the plant fibers (hay): generally between about 0.2 and 1.0 mm (the size interval refers only to the fibers observed in the cross-section).

Sizes of the siliceous sand granules: between the grain-size of very coarse silt (0.05 mm) and the grain size of a coarse sand (1.0 mm). In any case, the latter is to be taken as a limit value which is far larger than the size of most granules.

Degree of uniformity of the grain sizes (*grade*): good.

Estimate of the original binder/aggregate volume ratio: 1:2 - 1:3.

Characteristics of the mix
Air-hardening mortar obtained by mixing plant fibers with slaked lime, and a siliceous, mostly quartzitic sand, characterized by a high degree of uniformity (both in terms of size and nature of the granules). As occurs with any mortar containing also plant fibers, it is difficult to evaluate the amounts of the various components; the sand, however, seems to have been added in larger amounts than the plant fibers.
In the mix there appear to be various lumps of binder characterized by high internal porosity due to microfissures ('bottaccioli'), varying in size between 1.0 and 4.0 mm.
On the whole the binder has average porosity (estimated to be around 30-35%), determined by the presence of minute 'bubbles', and uniformly distributed micro-fissures.
The plaster was accurately smoothed and pressed with an ad hoc device.

- *Type of contact between layers*: clean-cut, with good adhesion.

2) Discontinuous fragments of a 'terre' based light brown coat and opaque particles attributable to carbon black dispersed in a protein medium, probably having an animal glue base.
This could be a layer applied to constitute a dark background against which pictorial motifs could be depicted.

Thickness: Generally between 0.02 and about 0.05 mm. In some points, where there are small superficial irregularities in the plaster, it can be as much as 0.18 mm thick.

Among the histochemical tests carried out on sections, only the fuchsine test provided positive results ([4]).

- *Type of contact between layers:* not well defined, with good adhesion.

---

[3] Layers are described from bottom-up.

[4] The following tests were carried out on the layers present in the section being examined: Fuchsine: highlights protein substances, in particular animal glue; Starch Black for identifying proteins, in particular egg proteins; Sudan Black for identifying lipids in the liquid phase (oils, egg yolk); saponifiable substances (oils, waxes and other saponifiables); polysaccharides; Arabic gum, honey, sugars.

3) Traces of a red pictorial layer based on ochre red –hematite dispersed in an organic binder that was probably of protein origin

Thickness: maximum 0.05 mm.

Even though the histomechical tests carried out on the sections did not provide definite results, the layer does seem to contain an organic binder of possible protein origin. In many cases, the pictorial layers applied on the wall with an egg-based binder do not provide definite results through the histochemical and microchemical tests.

- *Type of contact between layers*: not well defined, with good adhesion.

4) Fragments of a greyish layer based on hydraulic binders

These are probably splashes or drippings of cement mortar used in the recent restoration of the cupola.

Thickness: varies from about 0.06 to about 0.16 mm

The presence of hydraulic binders is signaled inside the mortar by the presence of brown, amorphous looking masses which include polygonal shaped colorless elements. These are the typical more-or-less-hydrated calcium silico-aluminates, produced by the hydraulic binders when they set.

Sparse silica granules are also present in the mortar fragments.

Note

The microchemical test for identifying the lead indicates the presence of traces of this element. Its concentration therefore is not large enough to suggest that lead pigments were used in the pictorial film

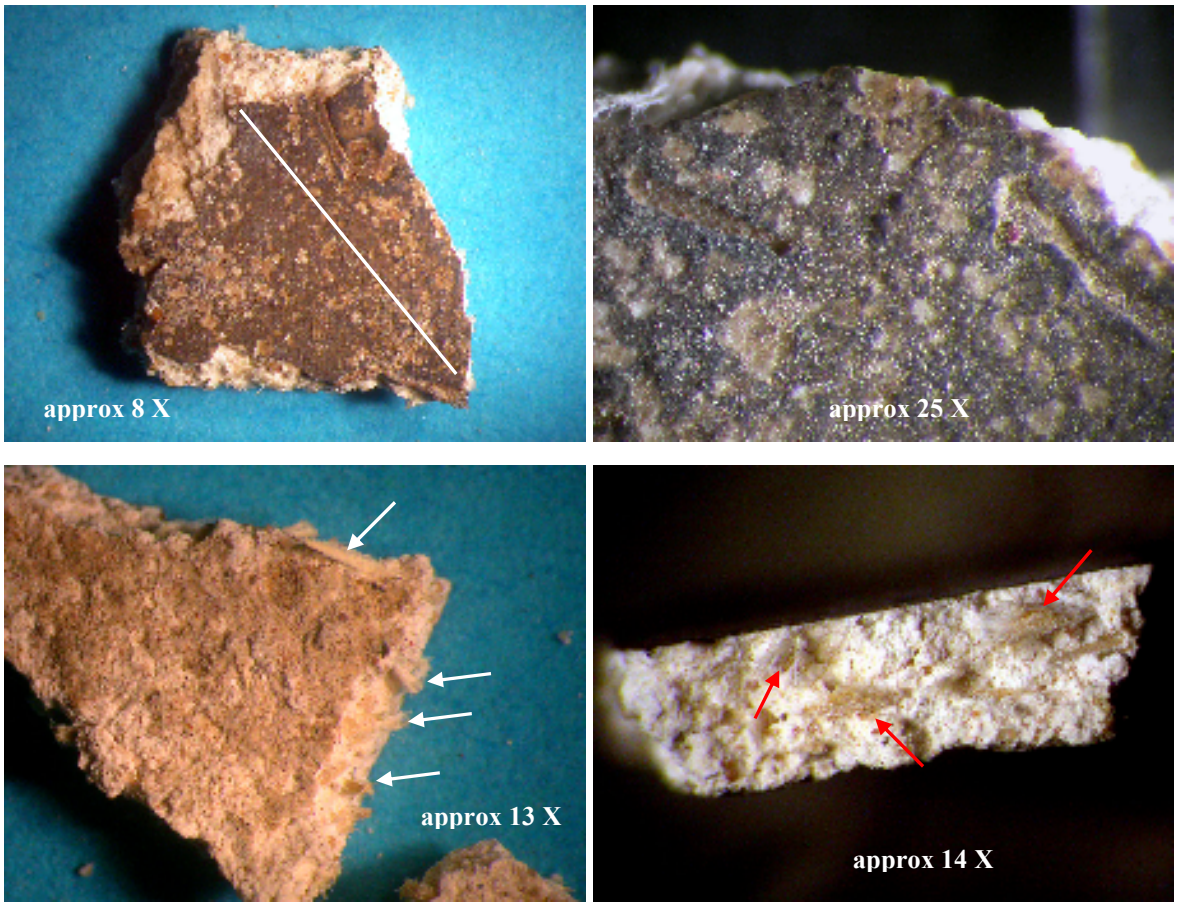
Sample no 5

Description accompanying the specimen

"Plaster of the South-West corner of the court yard, internal side of the South window".

Preliminary stereo-microscopic examination

The sample includes some centimeter-sized fragments (maximum sizes: 14 x 10 x 2 mm^3) of a thin plaster consisting of lime, straw and probably sand, accurately smoothed at the surface. At present it is covered by a thin brownish layer presumably due to the deposition of particulates of black smoke produced by lamps, fixed by organic substances (e.g. wax) applied for protection purposes.

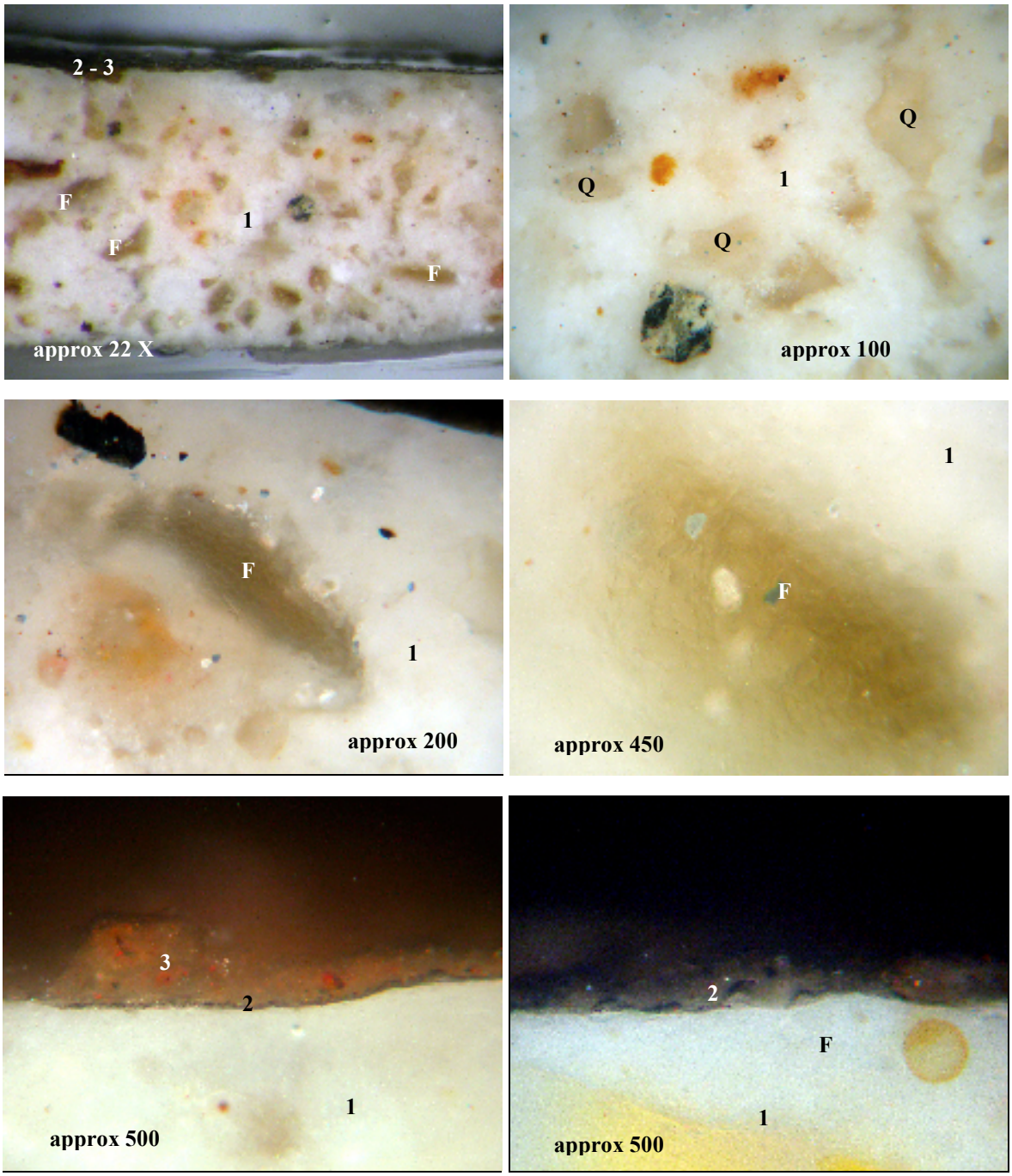


Stereomicroscope, reflected light.

The two upper pictures represent details from the external surface of the specimen characterized by the presence of a carbon particulate layer consisting of black smoke, probably covered by organic substances (e.g. wax).
The two lower pictures instead respectively illustrate the lower face of the plaster (left) and the cross-section of the fragment. The arrows indicate the light-colored plant fibers present in the mortar. These are unprocessed textile fibers (e.g. cotton).
The White segment, visible in the upper photograph on the left, approximately indicates the shear line of the polished cross-section prepared for the microstratigraphic examination described below.

Microstratigraphyc analyses on cross section with microchemical and histochemical tests

Analytical sheet written according to the Doc Normal 12/83



Cross section, reflected light

The two upper pictures, at relatively low magnification, describe the structure of the plaster (n° 1) obtained with slaked lime, mainly quartzitic siliceous sand (Q) and unprocessed textile fibers (F).

The latter are better documented in the two central pictures, while the layers overlying the plaster are represented in the two strongly magnified lower pictures. In direct contact with the mortar: a think blackish layer (n° 2) consisting of minute carbon particles that can be referred essentially to small aggregates of black smoke produced by lighting systems (e.g. lamps) or by votive candles. Then comes a thin discontinuous layer of brownish color as a whole (n° 3) attributable to a fixative consisting of organic substances.

1) Plaster deriving from a layer of mortar made with slaked lime, essentially quartzitic sand and unprocessed textile fibers

Thickness: varies from about 1.3 to about 2.2 mm.

Grain-size of the aggregate: between 0.05 mm and 1.25 mm.

Sizes of the plant fibers (hay): generally between 0.35 and 1.25 mm. The size range refers only to the fibers observed in the section.

Sizes of the siliceous sand granules Dimensioni dei granuli di sabbia silicea: between that of a very coarse silt (0.05 mm) and that of an average sand (0.5 mm).

Degree of uniformity of the grain sizes (*grade*): good.

Estimate of the original binder/aggregate volume ratio: 1:2.

Characteristics of the mix

Air-hardening mortar obtained by mixing slaked lime, a highly uniform mostly quartzitic siliceous sand (uniform in size and type of granules) and unprocessed textile fibers (for instance cotton). As occurs with all the mortars containing plant fibers, it is difficult to estimate the relative amount of the various components; however, the ratio between the sand and the plant fibers seems to be close to 1.
On the whole the binder has average porosity (estimated to be around 30-35%), caused by the presence of uniformly diffused small "bubbles" and micro-fissures.
The plaster appears to have been carefully smoothed and pressed with an ad hoc device.

Remarks

The plaster of this sample is different from that of specimen n° 4 essentially for the nature of the plant fibers in the mix. This difference does not necessarily indicate a different age of the plasters. Indeed it might indicate a different choice of materials in dependence of the different strength to be attributed to the mortar. The addition of textile fibers stronger than hay in the mortar of specimen n° 5, applied in millimetric layers, certainly ensured greater cohesion of the plaster.

- *Type of contact between layers*: clean-cut with good adhesion.

2) Thin blackish layer consists of minute carbon particles that are essentially small aggregates of lampblack produced by the lighting systems (e.g. lamps) or votive lamps

Thickness: less than 0.005 mm.

- *Type of contact between layers*: clean-cut with good adhesion.

3) Thin and discontinuous brownish layer attributable to a fixative based on organic substances

Thickness: generally around 0.03 – 0.05 mm.

Characterized by a translucent aspect with inclusions of few ochre particles and fewer carbon particles. Even though the histochemical tests carried out on sections have not provided clear-cut results, the layer is deemed to contain an organic binder, presumably wax.

Very fine lamp black carbon particles located on the surface of the layer, and partially included inside the layer

Sample no 9

Description accompanying the specimen

"White (lead-based?) pigment. Velarium fringe of the recess in the North transept".

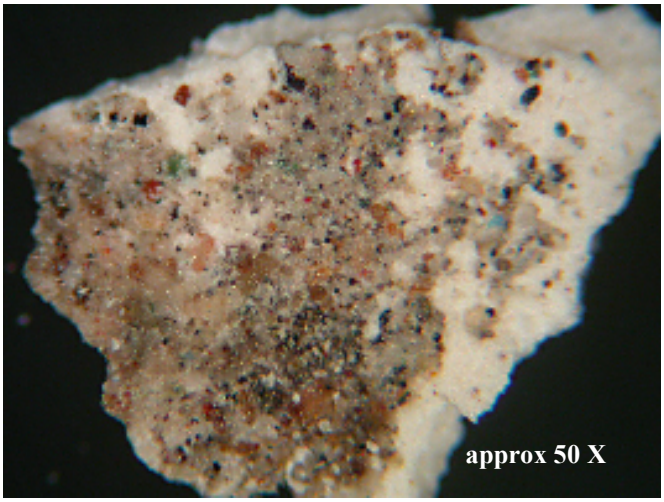
Preliminary stereo-microscopic examination with microchemical tests

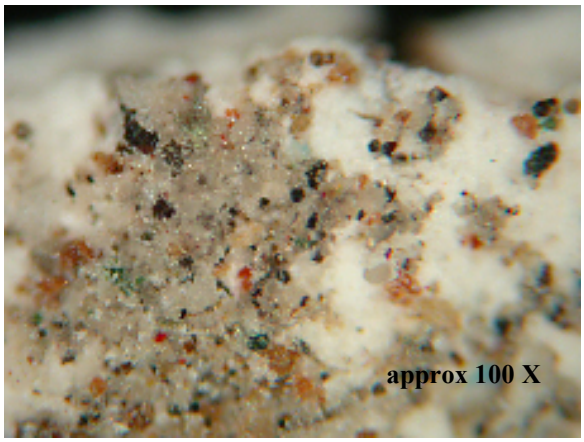
The sample consists of many sub-millimeter sized scales consisting of the following layers:

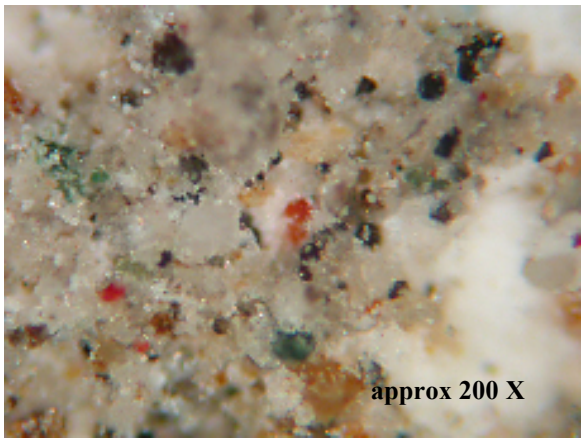
1) white lime-based layer characterized by various globular pores without evident fissures. The microchemical test with HCl 1N provided an empirical confirmation of the presence of carbonates and, hence, of carbonated lime. However it cannot be ruled out that internally there may also be other compounds (e.g. gypsum);
2) thin translucent layer from colorless to whitish color, insoluble in the short term and in cold conditions in HCl 2N. It might consist of gypsum.
3) dark grey layer, with some voids, characterized by a granular aspect. This consists of:
   - many blackish particles with (mainly) globular and elongated forms;
   - various dark green particles, globular in form, and with an opaque-"terra" aspect;
   - many roundish granules, from colorless to whitish to brown-reddish in color. They seem to be siliceous sand granules. This latter layer could be the residue of a pictorial layer that has almost entirely been eroded, mixed with particulates deposited on the surface and consisting of sand and pigments taken from other pictorial layers([5]);

The microchemical test for identifying the lead, carried out on a small fragment including all the above-mentioned layers, suggested that the sample does not contain this element (or contains it in amounts below a few parts per million). Therefore the layers do not contain lead pigments like white lead.

[5] Hypothesis to be checked by performing more thorough tests and accurate in situ observations.







Stereomicroscope, reflected light.

The three pictures, taken at increasing magnitudes (from top to bottom and from left to right) illustrate just as many aspects of the superficial portion of the specimen.

The presence of granules of different colors and different types suggest that the layer may represent the remains of a pictorial layer that has almost entirely been eroded mixed with particulates deposited on the surface throughout time

Sample no. 11

Description accompanying the specimen

"Transept, upper *diatono* wood".

Preliminary description of the sample

Centimeter-sized flake of a brown-reddish wood approximately having the following maximum sizes: 24 x 14 x 11 mm^3. The weight of the specimen, measured with a precision analytical scale (four decimal numbers), is 695 mg (0.695 g). The two main sides of the flakes are characterized respectively by a brown film (due to wax or other treatments based on organic substances) and by a grey layer which may perhaps be an 'terra particulate' (powder). The brown film adheres firmly to the wood and is resistant to scratches.
The wood, which is rather hard and tough, is not affected by insect-induced bio-changes.

Objectives of the laboratory tests
Absolute dating of the wood.

Type of analyses performed
Absolute dating using the radiocarbon (^{14}C) method and relative correction by means of calibration with dendrochronology.

International acronym of the laboratory
Rome (uniroma1).

Absolute dating with the radiocarbon (^{14}C) method and relative correction by means of calibration using dendrochronology

<u>Preliminary mechanical and chemical decontamination treatment</u>

The aim of 'decontamination' is to remove the chemical forms of carbon that are extraneous to the wood to be dated, forms that could also have been acquired by the material in the course of its history. In particular, reference is being made to treatments applied for aesthetic reasons or for conservation of the wood. Moreover, it is very important to remove from the specimen also dusts or particulates deposited on the surface or that have penetrated inside the wood.

The sample was at first submitted to mechanical removal of both the brown film and the grey layer by microtome under stereo-microscopic control. Then the following chemical decontamination protocol was applied:
- sequential leaching with HCl – NaOH – HCl;
- thermal washing with distilled water up to attenuation of the Cl- Chloride ion-;
- drying in a kiln at 110 °C;
- selective extraction in Soxhelt.

Method for measuring the ^{14}C content

Radiometric method consisting in the measurement of the beta particles issued in a unit of time by the radioactive decay of the ^{14}C contained in the specimen.

Instrumentation and method used

Liquid scintillation count (LSC) β^- multichannel spectrometry.

By using this technique, all the carbon in the sample (^{12}C + ^{13}C + ^{14}C) were usefully transformed into benzene which, was then funneled into a liquid scintillation detector connected with other three similar detectors that are part of the instrumentation. Then simultaneous measurements were taken of the activity of the β particle issued by the sample, by the oxalic acid international standard (MRS by N. Bureau of Standard Washington), by the cellulose sample of known age, distributed by the Interantional Atomic Agency (IAEA, Vienna) and by the 'backgound'. A detector surrounds the sample-standard system and hence made it possible to measure and subtract the environmental radiations from the 'background' (radiations due to cosmic rays or other accidental sources; "anti-coincidence systems").

The data obtained were processed statistically and, hence, after correction for the $\delta^{13}C$, they were used for calculating the age of conventional radiocarbon (^{14}C).

Conventional (^{14}C) age

Rome-2000, wood **845 +/- 40yr BP**.

By international convention, the ^{14}C age is expressed in years from the present time, where present time has been set at 1950. The term +/- expresses the error of the measurement.

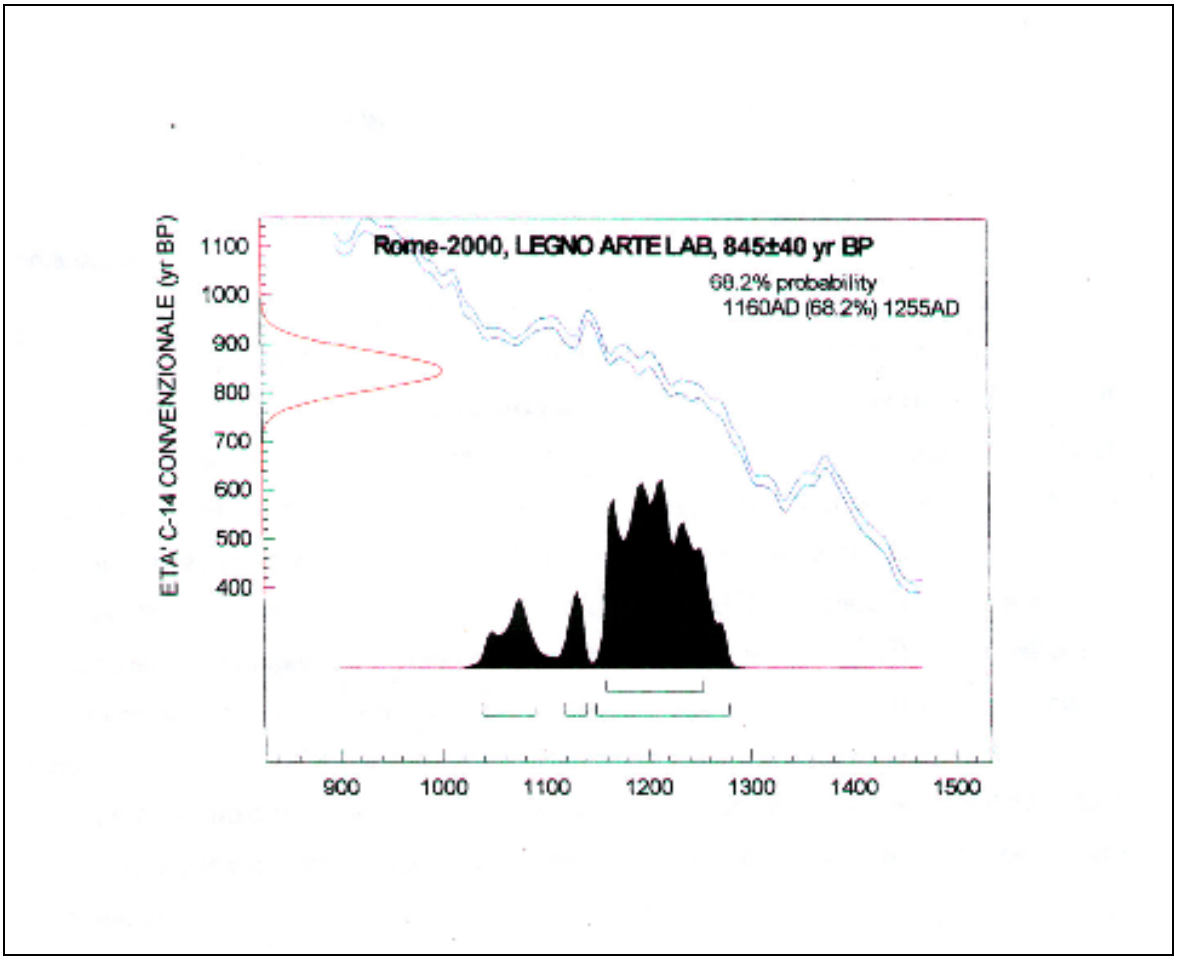
Calibrated ^{14}C age

The real age of the sample (calendar date) is different from the ^{14}C conventional age because of the lack of constancy over time of the concentration of ^{14}C in the atmosphere. In order to establish the actual calendar date of the specimen under study (or rather a range of dates), it is necessary to correct the conventional age. This correction was made by using the data made available by dendrochronology by means of a calibration curve (INTCAL '98). A full discussion of the method and, in general, of dating using ^{14}C is reported in: "Hedges R.E.M. (2000), 'Radiocarbon Dating', in Modern Analytical Methods in Art and Archeology, New York, Wiley".

Calibration of conventional radiocarbon age, shown in graphic form on the next page, provided the following result:

Rome-2000, wood **1160 – 1255 cal AD**.

The calendar age of the wood fragment is therefore included between the second half of the 12th century and the first half of the 13th century after Christ. The 1160-1255 interval represents the measurement error that is not offset by the calibration. It is worth confirming, in relation to elementary statistical considerations, that all the dates included in the 1160-1255 interval have the same probability of corresponding to the true age of the specimen. It is moreover pointed out that the measured and calibrated age (1160-1255 AD) refers to the age of the tree, used to produce the item, when it was felled.



Graphic representation of the result of the calibration of the conventional C-14 age measured for the wood sample (ARTELAB Rome – 2000). The pair of curves traced in blue ("calibration curve"), obtained from dendrochronological tests, show C-14 fluctuations in the atmosphere during the time period of interest here.

Sample no. 12

Description accompanying the specimen

"Transept, low *diatono* wood".

Preliminary description of the sample

Centimeter-sized fragment of brown-reddish wood having approximately the following maximum sizes 25 x 6 x 7 mm^3. The weight of the sample, determined using a precision analytical scale (four decimal figures) is 286 mg (0.286 g).

Objectives of the laboratory tests

Identification of the wood.

Type of analyses performed

Morphoanatomic analysis targeted to identifying the wood

Morphoanatomic analysis targeted to identifying the wood

Methodology

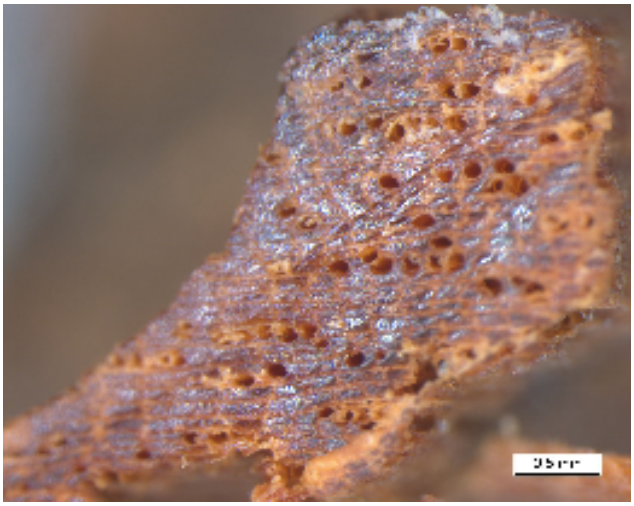
By using the sampled fragment and by using a microtome, three sections along orthogonal planes with respect to each other were prepared. In particular, one section was obtained by cutting the fragment transversally to the orientation of the fibers, whereas the other two were obtained from the longitudinal planes.
The definition of the wood species was achieved by observing the microscopic preparations of the three fundamental sections and the relative comparisons with appropriate references (texts, publications and data bases of the laboratory)

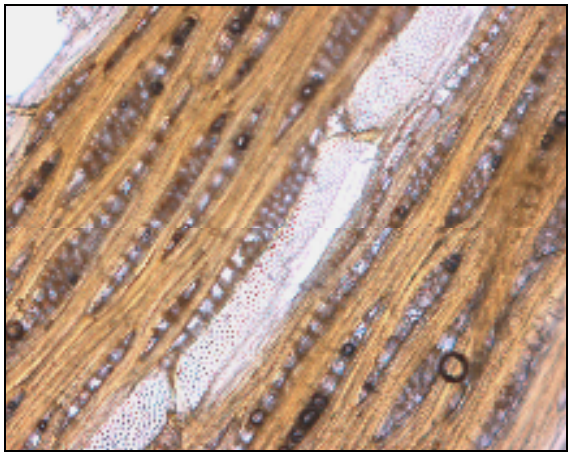
Morphoanatomical characteristics (refer to the pictures on the following page)

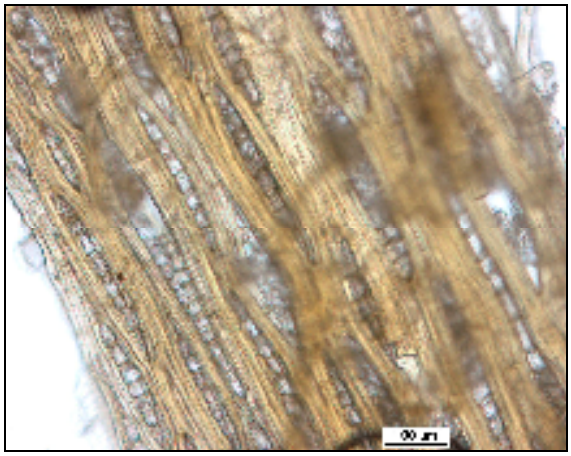
Heteroxile wood with single or twin, uniformly distributed, small pores – around 100 microns. Presence of paratracheal parenchyma. Simple perforations and absence of spiral thickenings, mainly double-treble (bi-tri) seriated heterogenous rays.

Identification

Possible identification with a mimosas leguminous plant of the *Acacia* species. Cfr. H. Schweingruber, Anatomy of European woods, WSL Stuttgart 1990.







On the top: *Transverse section.* The two lower 'photographs' illustrate t*angential section*

Sample no. 14

Description accompanying the specimen

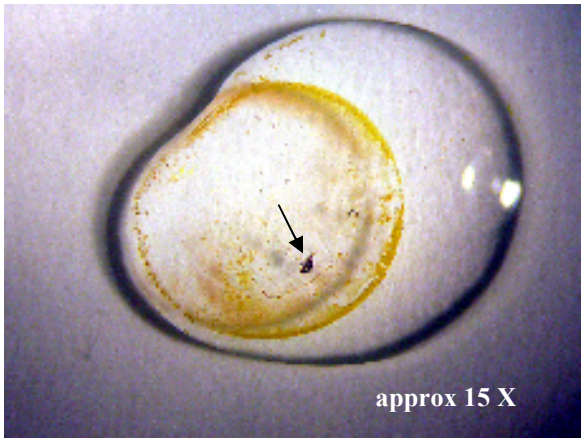
"Transept, horse, Medieval knight. Pictorial layer currently black-violet due presumably to the 'color-change' of white lead transformed into lead oxides

Preliminary stereo-microscopic examination with microchemical tests

The specimen consists of some milligrams of powdery material which on the whole is dark grey.

The microchemical test for identifying the lead ([6]) suggests that the powdery material contains a high amount of this chemical element.

Hence the assumption made by the restorers, concerning the possible presence of white lead transformed into lead oxides at the sampling site, is confirmed.



Stereomicroscope, reflected light.

The picture highlights the positive result of the test for identifying lead, with the production of a conspicuous gold-yellow color. The arrow indicates the larger sized fragment present in the specimen.

6 Test carried out according to the indications contained in the *DIMOS: Course on the maintenance of Wall Paintings – Mosaics – Stuccos; Part I: Execution Techniques – Constitutive Materials, Module 3: Binders, Fixatives, Pigments: Recognition Methods. Istituto Centrale del Restauro, 1978 Roma.*