



Non-Destructive Investigations on Four Paintings by the Master of Castelsardo. A Collaboration Between ENEA and University of Cagliari

An agreement between ENEA and University of Cagliari gave the chance of studying the materials and the technique used by Maestro di Castelsardo, the major artistic figure working in Sardinia during the end of the XV and the early XVI century. The application of non-destructive techniques (x-ray fluorescence, x radiography and near infrared reflectography) to investigate four paintings by Maestro di Castelsardo gave the possibility to characterize the pigments and the constructive technique used by the painter. Some hypotheses on the latter could be formulated by the authors of this article thanks to the comparison of the data obtained

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The collaboration agreement between ENEA, the *Dipartimento di Ingegneria Meccanica, Chimica e dei Materiali (DIMCM)* – University of Cagliari – and the *Soprintendenza per i Beni Architettonici, Paesaggistici, Storici, Artistici ed Etnoantropologici (BAPPSAE) per le Province di Sassari e Nuoro* provided the opportunity

to create a multidisciplinary team working on Cultural Heritage materials. This agreement permitted us to draw up a project concerning diagnostic tasks to preserve and protect the artistic heritage, in order to promote specific exchanges of experience and knowledge, and to focus on the study of materials and artifacts. Such agreement has also allowed us to give young Sardinian people the chance to get new job opportunities, increasing cultural growth. The above mentioned collaboration agreement provides the basis for further collaborations, with the involvement of other partners like, for example, the *Consiglio Nazionale delle Ricerche*, particularly the *Istituto di Geologia Ambientale e Geoingegneria (IGAG-CNR)* in Cagliari, already actively involved in diagnostics on Cultural Heritage, in collaboration with the DIMCM. The present collaboration allowed to investigate on works by the Master of Castelsardo, the most important

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painter working in Sardinia at the end of the XV and the early XVI century.

The *Retablo di Castelsardo* is a work of fundamental importance for the development of art history in Sardinia between the XV and the XVI century. From this retablo three panels (representing the *Madonna with the Child and Angels*, the *Trinity*, *Saint Michael the Archangel*), and part from the *pradella* with *The Apostles Philip, Bartholomew, Mathias and Mathew* survive. The project, with the execution of diagnostic investigations, was introductory to the restoration and involved the study of three of these four panel paintings.

The anonymous author probably had Catalan origins and moved to Sardinia in the last decade of the XV

century, and he is commonly known as the Master of Castelsardo in relation to precisely this *retablo*, originating probably from the Franciscan convent of Santa Maria delle Grazie and now in the cathedral of Sant'Antonio in Castelsardo and in the adjacent Museo Diocesano. The artist was active in Spain, Sardinia and Corsica, and his oeuvre is characterised by strong spatial definition, inside a three-dimensional space, but still having a vague perspective [1-11].

The panels with the *Trinity* (Fig. 1) and *Saint Michael the Archangel* (Fig. 2) retain their original supports, with little additions on the bottom, while the painting representing the *Four Apostles* (Fig. 3) was transferred onto a new wooden support.

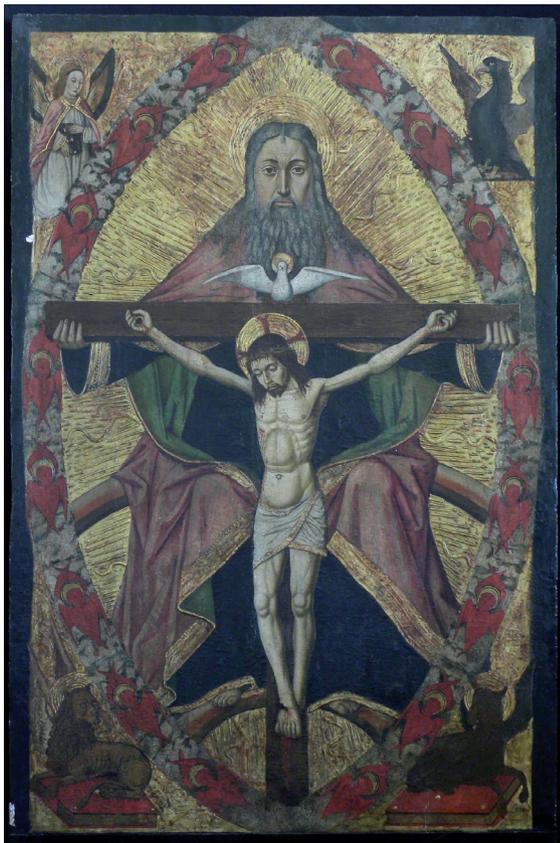
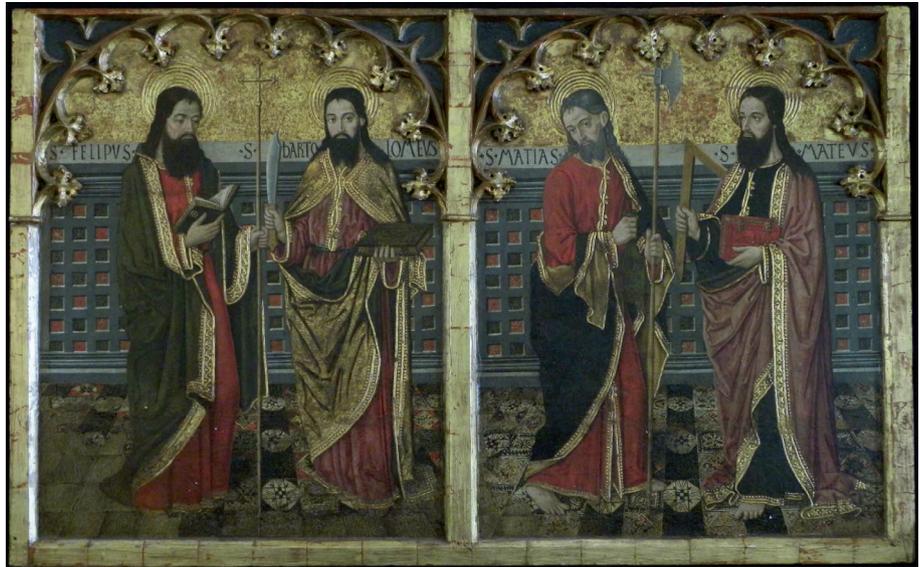


FIGURE 1 Master of Castelsardo, *Trinity*, Castelsardo, Museo Diocesano
Source: Archivio fotografico della Soprintendenza per i Beni Architettonici, Paesaggistici, Storici, Artistici ed Etnoantropologici per le province di Sassari e Nuoro



FIGURE 2 Master of Castelsardo, *Saint Michael the Archangel*, Castelsardo, Museo Diocesano
Source: Archivio fotografico della Soprintendenza per i Beni Architettonici, Paesaggistici, Storici, Artistici ed Etnoantropologici per le province di Sassari e Nuoro

FIGURE 3 Master of Castelsardo, Four Apostles, Castelsardo, Museo Diocesano
 Source: Archivio fotografico della Soprintendenza per i Beni Architettonici, Paesaggistici, Storici, Artistici ed Etnoantropologici per le province di Sassari e Nuoro



The diagnostic campaign was carried out in July 2011, in the Studio Abacus in Cagliari. In order to compare the findings from the dismembered *Retablo di Castelsardo* with other paintings attributed to the Master, a small panel representing an *Angel with tambourine* from the *Retablo della Porziuncola* (post 1492) in the Pinacoteca Nazionale in Cagliari was also examined.

Infrared Reflectography

The study of the underdrawing – including in this term the preparatory drawing, pentimenti, signatures, graphic prospective designs, dates, chromatic codes lying under the surface of the pictorial layer – has been carried out with infrared reflectography (IRR). This is an optical technique that, through a detector sensitive in the IR region (from 0.7 to 2.2 micron), acquires reflectograms (images in black and white) of the back-scattered infrared radiation from the painting, which is illuminated by two lamps with IR light.

A standard CCD camera¹ was used for this, with a spectral range between 0.7 and 1.2 microns; and two 250 Watt Nitraphot-S lamps as well as Photoshop software (to construct a mosaic with all the acquired images) were used.

IR reflectography was performed on the panels with

the *Trinity*, *Saint Michael the Archangel*, *Four Apostles*, and also on the small panel representing an *Angel with tambourine*.

The overall results showed affinities in the studied paintings in the use of broad lines applied to reinforce the profiles of all the figures, as well as in every detail in the paintings. Indeed, the possibility of investigating paintings by the same author offers the opportunity of understanding the characteristic preparatory technique used by the painter in realizing his work.

In the *Trinity*, there are only a few light traces of preparatory drawing, and they are only visible in some areas: the profile of the *mandorla*, the fingers, the nose and the loincloth of Christ. In all other areas, profiles are reinforced with a liquid medium, using a brush, with strong lines. Beneath the red mantle of God-the-Father, which is painted using a transparent pigment, probably an organic lake pigment, many lines are visible, forming almost a sketch, modeling the knees. A slight *pentimento*, looking like a correction, is visible in Christ's hands, which are smaller in visible light.

An interesting particular is visible in the right knee of God-the-Father: a word, which could be deciphered as *ocra*. Due to the thinness of the pictorial layer, this word is also visible to the naked eye. The color painted

on the knee does not correspond to the beige colour that the word indicates.

Beneath the paint surface of *Saint Michael the Archangel*, the outlining of all the figures with intense dark lines painted with a brush is detectable. Only in the face of the Saint, are the lines thin. In the internal part of the mantle, the lines are hatched to show the pleats of the mantle. In the lower part of the drapery a circular line, which corresponds to nothing on the surface of the painting, can be seen clearly. This line may have been drawn as an aid to drafting the composition, perhaps to indicate the length of the skirt.

There is a slight *pentimento* in the right hand, in which a correction to the knuckles is well visible. And a stronger one (or an evident change carried out during a restoration) has been detected in both shoes: in the earlier version the shoes were decorated, instead now they are entirely red without any kind of drawing.

In the *Four Apostles* all the outlines have been broadly delineated with a brush. Only in the anatomic particulars (eyes, nose, mouth), are the lines thin.

A significant detail has been discovered on the panel: two words have been detected. The first one is under the red tunic of Saint Matthias (Fig. 4), and it can be interpreted as the word *vermell*, the Catalan term for red. The second one, under the drapery of Saint



FIGURE 4 Four Apostles, detail of the red drapery of Saint Matthias with the color notation “vermell”, IR reflectography
Source: ENEA

Bartholomew, is illegible. These chromatic indications can be interpreted either as a code for someone else within the studio who was to paint the red drapery, or else as a kind of reminder to the artist himself.

On the small panel of the *Angel with tambourine* from the *Retablo della Porziuncola*, the same pictorial technique with broad lines used to reinforce the outlines has been detected. There are many losses in the paint layer in this panel.

Radiography

Only the three panel paintings from the *Retablo of Castelsardo* were radiographed. An x-ray generator ART-GIL, Agfa D7Pb films 30x40 cm wide, Agfa Structurix G 135 for the photographic processing, and Agfa Structurix G 335 as fixing bath were used. The current at the filament of the x-ray generator tube was 5.0 mA and 40 kV the voltage; the distance from the film to the x-ray generator was 100 cm; the exposure time was 60 seconds.

The radiographs make it possible to study in detail the types of joins in the planks, the non-original crossbars, the presence of nails (both original and non-original), the screws, and the wood inserts (the result of past restorations).

The surface of the three painting supports was lined with a rather coarse weave canvas which does not cover all the surface of the paintings, but ends a few centimetres shorter than the original borders of the panels.

The greater thickness of the preparatory layers in the gilded decorations in the haloes, the drapery and the backgrounds, is easily read in the radiographs. It was noted that the collar and the upper part of the central vertical band of the armour of the gilded areas in *Saint Michael the Archangel* are not in relief, as are other details of the same armour, but were applied directly onto the dark blue paint of the armour, which indicates variations during execution.

In the two panels representing the figures painted on a larger scale (the *Trinity* and *Saint Michael the Archangel*), the figures are defined in a different manner. In the flesh areas, the initial chiaroscuro of the volumes defines the shapes and the figures as

geometric volumes; this is due to the richness in lead white, and to the strong radiopacity of the pigment. This plastic research is one of most peculiar aspects of the Master of Castelsardo, and it can be related to the influence of the works of Antonello da Messina.

In the *Trinity*, precisely in the green reverse of God-the-Father's cloak, the paint shows the characteristic *craquelure* resulting from the presence of excess oil binding medium.

The colours of the two largest figures in the *Trinity* do not match, hence in order to avoid a wet-in-wet application of the paint, the resulting separation lines were not eliminated by the finishing layers, and the forms enhanced with dark lines. In the radiographs, the strongest of these *contours* are evident, delineating the arms of Christ, but are not so visible to the naked eye because of the poor contrast between the dark colours. In addition, in the area of the armpits (and the left one in particular), these en reserve outlines increase both in area and take on shape, defining the shadow area. In contrast, the smaller details are not defined by such en reserve contours, but are painted directly over larger areas of different colour. For instance, Christ's hair is painted over the flesh tones of the neck and the shoulders.

The only pentimenti identified on the radiographs of the *Trinity*, are of no great importance. They involve the fingers of God-the-Father, which are slightly longer in their final version, and a series of radio-opaque round areas in the red cloak, about six centimetres distant from the gilded embroidery border of the cloak. They seem to define a different initial decoration on the cloak, which was executed only on the left side of the painting.

In *Saint Michael the Archangel*, the radiographs (Fig. 5) show very different images from what is visible for the wings. Losses in the paint of the first version attest that the change was not due to an original *pentimento*, but to a later intervention. In fact, the version readable on the radiographs is comparable with the *painted* wings of the angels of other paintings ascribed to the Master of Castelsardo. Indeed, they are never entirely covered by gold or silver leaf, but are bi-chromatic and have an elongated and tapered shape, whereas the later version on this painting is not painted, but



FIGURE 5 Saint Michael the Archangel, radiographic image
Source: ENEA

has a surface decorated with reliefs and incisions. In addition, the use of silver leaf, covered with a yellow varnish glaze (*mecca*) simulating gilding, was detected on these wings but was never detected on other details in this painting nor in the other three paintings by the same artist previously analysed. This confirms that the later version of the wings is the result of a spurious reconstruction.

As an example of the empirical perspective used by the Master of Castelsardo, in the panel representing *Four Apostles* one can see that the floor was initially set with horizontal bands carried out with broad brush strokes, while the tile borders in perspective were incised. The light appearance of these incisions in the radiographs seems to attest that they were incised

before the horizontal definition of the floor, as they were filled with the lead white containing film. In this painting, only a few variations were detected on the radiographs, and these of no great importance and only in the area corresponding to Matthias' right ankle, where the initial composition shows a series of folds not present in the final version.

XRF Analysis²

The results obtained involved all layers down to the support. The panels were prepared with a calcium rich compound (gypsum), characterised by the presence of iron and strontium impurities, generally detected on the paintings previously investigated. The strontium impurities are due to strontium sulphate (celestine).

For all of the four paintings investigated, the iron rich pigment (bole) used for the preparatory layers for the gilding contains titanium and manganese impurities.

The original palette is composed by lead white, copper-based blue and green pigments, lead tin yellow, brown red-orange and yellow iron-based pigments, cinnabar/vermillion (mercury sulphide), red lakes and, only in the *Angel with tambourine*, minium.

Generally, the quantity of copper is higher in blue areas than in green ones.

Lead-tin yellow is generally used in combination with copper-based pigments in the green areas, or iron-based pigments in the yellow areas, with tin increasing in light tones and iron increasing in dark tones.

Red areas are characterised by the use of cinnabar (the brighter ones), or of organic lake pigments (the less saturated ones, from pink to dark red).

Flesh tones contain lead white, iron based pigments (earths and/or ochres), and small amounts of cinnabar/vermillion and lead tin yellow. Copper-based pigments were added to the composition of shadow areas. Obviously, in Christ's skin in the *Trinity*, the quantity of iron present is lower and mercury is absent, as it is the complexion of a dead man which is represented. Other exceptions are present in results from the panel representing *Four Apostles*, where lead tin yellow was detected only in the cheeks of Saint Matthias and Saint Philip, and no copper based pigments were used for shadowing the flesh tones. This latter peculiarity

characterises also the flesh tones of the *Angel with tambourine*.

Brown areas were painted with iron based pigments, sometimes darkened with the addition of copper-based pigments.

The modern pigments used in past restorations were also investigated. Titanium, zinc, and barium whites were both found in different areas, and combined together in one area. The presence of three different modern white pigments must be related to the *stratification* of different restorations and/or, perhaps, also to the use of some of these modern white pigments as extenders in industrial colours. In the latter hypothesis, the presence of one of these three elements should in some cases be related to the unintentional choice of the restorer. The presence of chromium was detected in yellow, green, grey-greenish and dark blue areas. Cadmium yellow was identified in brown and grey-greenish areas. Moreover, a mixture of zinc and barium whites with Prussian blue, even not ever in constant proportions, was detected in some areas of the panel representing the *Four Apostles*, which in the past was transferred onto a new support.

More interesting are the findings concerning the metallic decorations in the paintings representing the *Trinity* and *Saint Michael the Archangel*.

In the *Trinity*, the gold leaf used for the *mandorla* for Christ's halo and for the background is very thick, if compared with the gold leaf employed in other contemporary paintings executed in Italy and analysed in the past. A further typology of gildings was found in the Cherubs' halos, where both gold and silver were detected. From XRF data only, it is impossible to verify whether these elements are alloyed together or beaten in a double leaf (*Zwischgold*). However, the intentionality in the use of gold, and gold-silver leaf is evident.

On *Saint Michael the Archangel*, both gold leaf and silver leaf were detected. Generally, and in this painting, gold leaf is very thick and it was used on the background and in the decorations of the armour. Silver leaf was used for the chainmail, for the greaves, for the sword and for the umbo of the shield, whereas gold leaf was used for the borders.

In the old spurious reconstruction of the wings of Saint

Michael, identified during the present diagnostic campaign, silver leaf was used but as a surrogate for gold, as it is covered by a transparent yellow varnish glaze (*mecca*). Furthermore, over the *mecca*, there is polychrome decoration with semitransparent paint layers simulating feathers. This decoration was executed using organic pigments for dark yellow and red colours, and diluted copper-based pigment as blue colour.

Conclusions

The results described above, represent the first published information on the most important artist working in Sardinia between the XV and the XVI century. Some of his particularities, such as the volumetric enhancement of the figures and his use of empirical perspective were documented analytically. Even if his palette is quite limited in terms of the most important pigments available to artists during this period, a highly developed use of metal leaf was documented, aimed at achieving rich and differentiated appearance. Very interesting is the use of colour notations, a well documented practice in Spanish contemporary workshops [12-14]. Also important, for further studies on this artist, was the identification of a later reconstruction of the wings of *Saint Michael the Archangel*, which was not known prior to the present investigation.

Recently, a micro-sampling has been carried out on the investigated paintings; their analysis is still ongoing and will provide further details about the artist's palette and technique. In the future, we hope to investigate, under this collaboration agreement, other paintings by this important artist as well as works by contemporary artists, in order to include the results of the present study in a wider and more representative context.

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Notes

1. Apparatus NIR DIGI 1200 from OptoLab Milan.
2. For information about this analysis technique and the operative conditions adopted see, in this issue, the paragraph "XRF analysis" in the paper *Correlation between XRF data and pigment radiopacity*, pp. 144-145.

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