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# HOW TO REVEAL THE INVISIBLE THE FUNDAMENTAL ROLE OF DIAGNOSTICS FOR RELIGIOUS PAINTING INVESTIGATION

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## Abstract

This paper reports the study of a little panel painting, from a private collection, which represents a landscape with figures dated back to a period between 19th and 20th century. When the painting was observed for the first time it immediately appeared evident the presence of another painting under the visible surface. This evidence was supported by the observation of small traces of colour in correspondence of lacunae of the surface painting and by the presence of an ancient wooden support. For these reasons it was decided to perform a non-invasive diagnostic campaign in order to understand the stratigraphy of the panel paintings and consequently to choose if removing the landscape. Video microscope acquisitions, infrared reflectography, ultraviolet fluorescence photography, X-ray fluorescence spectroscopy, radiography and wood characterization were selected as non-invasive and micro-invasive diagnostic techniques able to supply information useful for painting investigation and detection.
The combined use of these techniques revealed the presence of a beautiful and well-preserved painting, hidden by the landscape representation. The ancient painting shows the Virgin with the Child and Saint Catherine from Alexandria (16th century). Due to this extraordinary result, it was chosen to remove the contemporary painting and restore the old representation.

*Keywords:* panel painting, diagnostics, Picea abies, wood, analysis

## 1. Introduction

The aim of the present paper is to show how the diagnostic analysis could be crucial in decision making for painting investigation and restoration. Object of this diagnostic analysis has been a panel painting from the private collection of an antique dealer (Figure 1).

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**Figure 1.** The panel painting with the landscape. Front and back side. Dimensions: 51.5x43,5 cm.

In its original appearance, the painting, having dimensions 51.5x43.5 cm and arranged horizontally, represented a landscape with figures and it can be dated back to a period ranging from the end of 19$^{th}$ century to the beginning of the 20$^{th}$ one. The idea of this study came from the experience in the field of antique trade of artworks that often have been modified, repainted, and completely changed for various reasons. In fact, the panel painting showed some details that suggested the possible presence of a hidden representation different

from the one visible on the front side of the artwork. In particular, in correspondence of the edges and lacunae, traces of colour were visible; moreover, the wood support seemed to be much more ancient in respect to the landscape. These evidences induced to apply the potentialities of the diagnostic analysis to try to understand the stratigraphy of the hidden painting, if any, in order to evaluate the possible removal of the recent landscape painting. The diagnostic campaign was carried out by following a well-consolidated approach applied to wooden artefacts that started from the documentation step by visible and ultraviolet fluorescence (UVF) photography, and imaging techniques such as infrared reflectography, video microscope acquisitions and radiography [1-6].

The non-invasive diagnosis was completed with X-ray fluorescence (XRF) spectroscopy performed on thirteen points of the painting by no-contact portable apparatus widely tested in pigment examination [7, 8]. At last wood micro-samples were taken for laboratory analysis aimed at species characterization though microscope observation, also in this case by following a consolidated approach for wood diagnosis in artworks [9, 10]. In fact, before taking wood micro-samples, the support was carefully examined and documented in order to limit the sampling points and to gather from them the maximum information as possible [10].

## 2. Experimental

Visible and UVF photography was performed by a Nikon D40 digital camera. For obtaining UV fluorescence, the painting was irradiated with Philips PHL TUV36 lamps positioned at 45° in respect to the surface. In front of the camera lens, Kodak Wratten gelatine filter 2B and 85B were added to remove undesired component of spectrum.

Video microscope acquisitions were gathered by a Mirazoon MZ 920 portable digital instrument equipped with zoom lens ranging from 50 to 200 magnifications.

Infrared reflectography was performed through MICRO IR 20 camera, operating in the 400-1100 nm and equipped with a 12.5 mm (f 1.3) lens and IR80 visible filter. Two DigiX IR lamps were used for irradiating the painting.

Radiography was obtained by Foschi radiographic equipment under the following conditions: operating voltage 70 kV, current 50 mA. The instrument was controlled by the ARIA software.

X-ray fluorescence spectroscopy was performed by the portable equipment Surface Monitor II (Assing™). The measuring conditions were the following: Ag tube operating at 40 kV, current 76 μA, acquisition time 60 s.

Wood micro-samples were observed by Wild M420 stereomicroscope for a first macroscopic examination of xylem characteristics, identifying so the anatomical features on the three fundamental sections namely transverse, radial and tangential. Thin sections (15-20 mμ) were examined by Polivar 100 optical microscope.

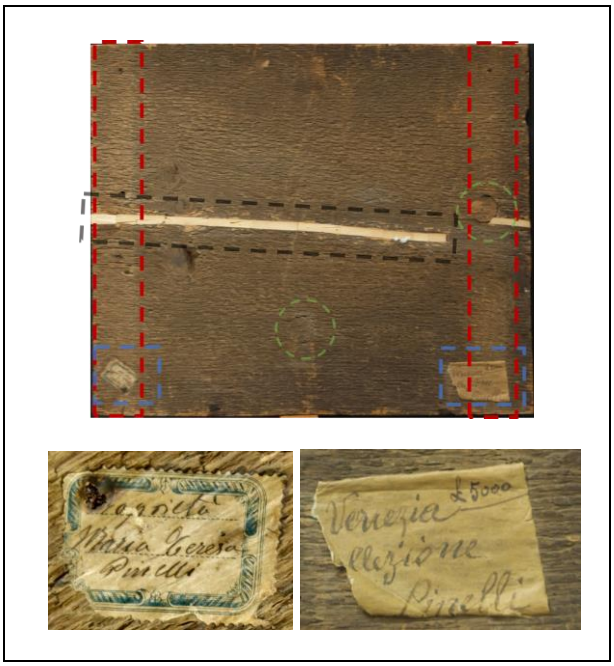


**Figure 2.** Back side of the painting that shows details of previous interventions and other information. Red line: signs of horizontal removed crossbars and nails; blue line: labels indicating property and collection; green lines: original inserts placed to repair the knotholes; dark grey line: wedge-shaped inserts applied to contrast the natural warping of the wood panel. The two labels are also shown.

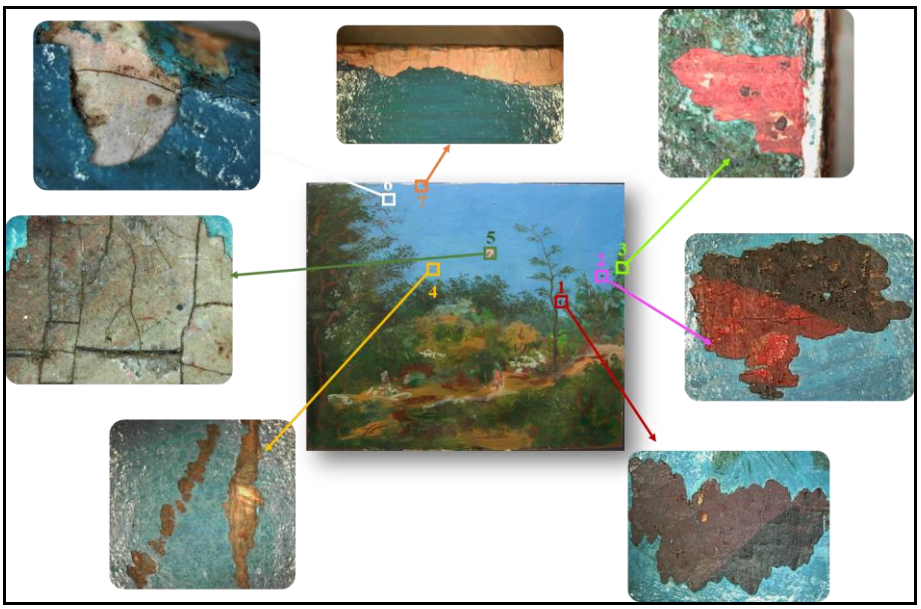


**Figure 3.** Video microscope acquisition in correspondence of lacunae in the painting layer. Point 5 corresponds to a little area where the paint was intentionally removed to better highlight the underneath colours.

## 3. Results and discussion

The preliminary careful observation of the painting surface and back support allowed detecting interesting details that deserved further investigation. Specifically, in the back side (Figure 2) the signs of previously applied crossbars are clearly visible, suggesting a possible original vertical orientation of the panel. Original inserts, used for repairing knotholes are also present and well-visible in two points of the support. Two labels can be also observed: the one on the left is referred to the property of the painting and that on the right indicates the collection.

On the front side of the panel painting, some lacunae revealed the presence of traces of colours different from those observed on the landscape. In these points the video microscope was particularly useful to obtain information about the possible presence of a hidden painting (Figure 3).

The video microscope is very useful to study in detail the morphological characteristics of the surfaces and represents a simple but highly informative instrument for a preliminary inspection of an artefact [4, 8, 11]. In total seven points were acquired at 20x magnification as shown in Figure 4. The video microscope acquisitions clearly show the presence of different colours emerging from the landscape in correspondence of lacunae: red, brown, bright red, flesh and orange hues can be observed. So, it is highly probable the existence of another painting under the visible one. The hidden painting exhibits the typical *crequelure* of oil binder, particularly visible in the point 5 that seems to belong to a flesh tone.

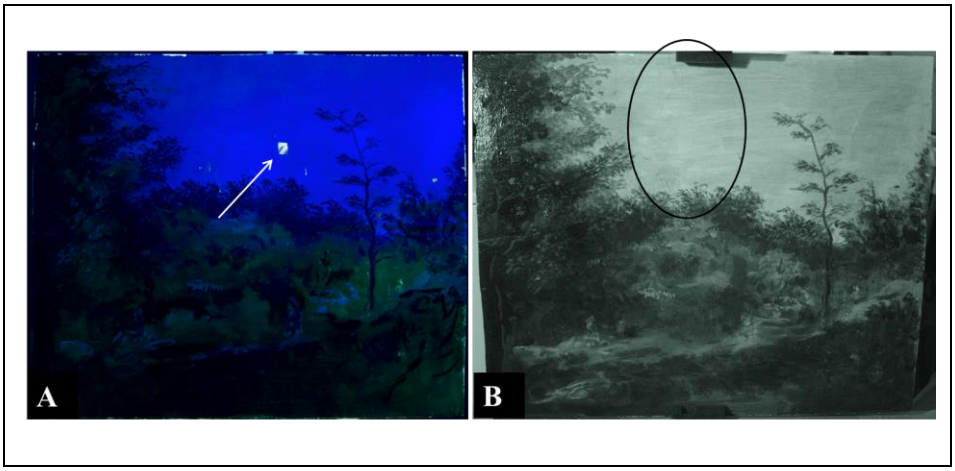


**Figure 4.** UVF (A) and IR reflectography (B) of the painting. A) the arrow indicates the fluorescence of the hidden painting in the lacuna of the sky; B) a palm is visible in the area delimited by the ellipse.

Going on in this methodological approach, UV fluorescence photography and infrared reflectography were performed: the results are shown in Figure 4A and 4B. UVF photography showed that the landscape is not characterized by any

fluorescence, whereas the hidden painting exhibits high response with this technique, further demonstrating the existence of another and more ancient painting. IR reflectography was able to reveal the presence of a probable martyrdom palm and some other lines not well defined.

These results further supported the hypothesis of the presence of a hidden painting under the landscape. But, the fundamental imaging analysis that revealed completely the hidden painting was the radiography. In fact, with this technique it was possible to 'see' the invisible, i.e. the original panel painting (Figure 5).

**Figure 5.** Radiography of the artwork showing the original painting hidden by the landscape.

The radiographic image shows all details of the painting allowing for knowing the iconography and the elements of the scene: the Virgin with the Child and Saint Catherine from Alexandria can be observed with clear definition.

To complete the analysis through non-invasive technique, X-ray spectroscopy was applied on ten points (Figure 6). The results of XRF analysis are reported in Table 1 as counts per second of each detected element.

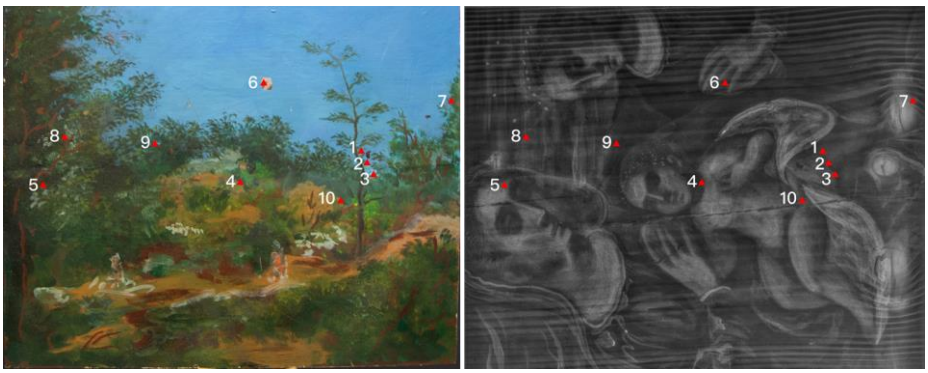


**Figure 6.** Photograph and radiography in comparison with the points of XRF analysis.

Due to the penetration capability of X-rays (about 150 µm under the surface of the painting), chemical elements of both paintings were detected by the instrument. Calcium, iron, lead and strontium were found in all examined points and they can be attributed to the original painting. The simultaneous presence of Ca and Sr suggests the use of gypsum ground layer in the original painting. Titanium, chromium and zinc can be referred to the landscape because they are elements commonly used in contemporary painting materials [13-15].

**Table 1.** Results of the XRF analysis expressed as cps (counts per seconds of the X-rays of each element).

| Point | Ca | Ti | Cr | Fe | Co | Cu | Zn | Hg | Pb | As | Sr |
|---|---|---|---|---|---|---|---|---|---|---|---|
| X1 | 1022 | 367 | 206 | 10152 | | 100 | 196 | 143 | 157 | | 201 |
| X2 | 2054 | 1308 | 685 | 3815 | | 98 | 435 | 237 | 117 | | 301 |
| X3 | 3128 | 855 | 113 | 1999 | | 83 | 159 | 1129 | 201 | | 230 |
| X4 | 1319 | 95 | 59 | 1842 | | 131 | 198 | 440 | 5115 | | 144 |
| X5 | 1429 | 174 | 91 | 4021 | | 2486 | 176 | | 2234 | | 219 |
| X6 | 76 | | | 323 | | | | 643 | 6585 | | 153 |
| X7 | 1909 | 442 | | 983 | | | | | | 3882 | 243 |
| X8 | 1417 | 333 | 94 | 3112 | 512 | | | | 1934 | 1847 | 139 |
| X9 | 1437 | 1059 | 763 | 1428 | | | 474 | | 5687 | | 101 |
| X10 | 684 | 116 | 48 | 1333 | | 193 | 159 | | 7799 | | 80 |

Mercury, arsenic and cobalt, this last element found only in one point, can be associated to the original painting and are related to pigments such as vermilion/cinnabar (HgS), orpiment/realgar (arsenic sulphides) and smalt blue (a silicate coloured by Co) respectively [16-18].

Lead and iron are also elements probably associated to the original painting being the constituent of lead white/lead yellow and iron based pigments

respectively. Lead white/lead yellow and iron based compounds are used both as painting pigments and for *imprimitura* preparation [19-21].


**Figure 7.** Photomicrographs of wood sample sections, magnification 200x: (a) tangential section: fusiform ray with resin canal; (b) radial section: ray tracheids with smooth walls, 'Picea-type 2' bordered pit of the radial tracheid as described by Bartholin [12], and visible in the area delimited by the ellipse of (b).

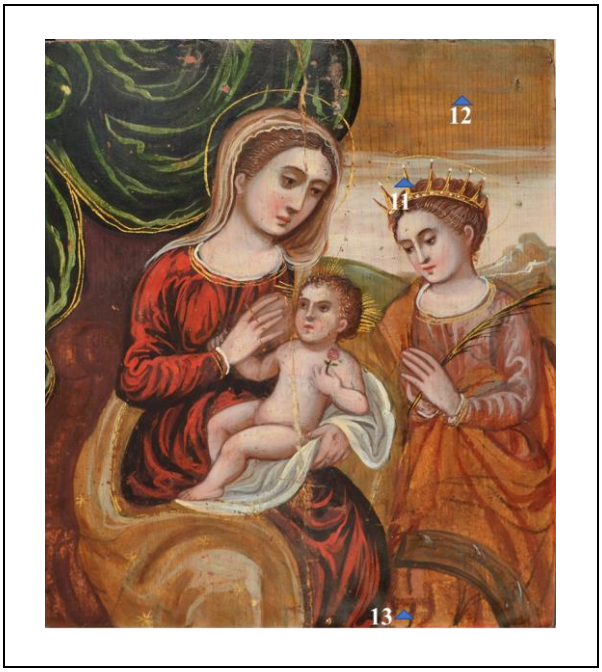


**Figure 8.** Photograph of the original painting after removal of the landscape with the points of XRF analysis.

The only element remaining doubtful is copper. In fact, this element can be associated to blue/green pigments both in ancient and contemporary artworks [22-25]. Its presence in the landscape can be associated to the green colour with higher counts in point X5 where the intensity of this hue is more evident. If we observe the radiographic image, point X5 corresponds to the Virgin and it seems strange the presence of a blue/green pigment in the flesh tone. These observations suggest that Cu is associated to pigments of the landscape.

It was also decided to analyse the support in order to characterize the wood species. From the study of the anatomical characteristics of micro-samples taken from the back of the painting (Figure 7), it was found a conifer species, as expected after the radiograph image examination (Figure 5). In particular, it is spruce (*Picea abies* Karst). The European distribution area of spruce can be recognized into three main regions: Russian-Baltic, Carpathian and Alpine area.

Due to the results of diagnostic campaign, it was decided to remove the recent painting and so to restore the original representation clearly visible in the radiographic image. A professional restorer was engaged for making the removal of the landscape and, at the end of the intervention, we can admire the original panel painting (Figure 8).

Three points were examined through XRF spectroscopy in order to confirm the presence of elements such as As and especially Co being this last one contained also in contemporary blue pigments (cobalt blue or phthalocyanine).

**Table 2.** Results of the XRF analysis expressed as cps (counts per seconds of the X-rays of each element) performed after landscape removal.

| Point | Ca | Fe | Co | Au | Hg | Pb | As | Sr |
|---|---|---|---|---|---|---|---|---|
| X11 | | 951 | | 619 | 509 | 6854 | | |
| X12 | | 987 | 1141 | | | 2319 | 2536 | 164 |
| X13 | 445 | 220 | | | | | 8959 | 226 |

The results shown in Table 2 confirmed the use of orpiment/realgar in the yellow area of Saint Catherine and in the background and the use of smalt blue in the sky. Moreover, the XRF analysis in point X11 detected the presence of gold used for the crown of Saint Catherine.

The research in the literature allowed for finding that the iconography of the painting (The Virgin Eleousa with the Child and Saint Catherine from Alexandria) can be associated with the Venetian-Cretan school operating between 15$^{th}$ and 16$^{th}$ century in Veneto region [26, 27]. The main artist of this painting School was Domínikos Theotokópoulos (Candia 1541 – Toledo 1614) better known as El Greco Madonero, in Greece, and El Cristero in Spain [28]. The use of spruce as wood species for the support of the painting is compatible with the Venetian origin of the artwork [29].

The painting, discovered in the present study, seems to belong to the Latin current of the Venetian-Cretan School [27]. The Virgin has the typical attributes found in the Venetian-Cretan panels, i.e. she is sitting on a just outlined seat; the Virgin mantle is bright red with dark shades; her veil has light yellow colour made precious through gold rims and stars. The broken bread, symbol of Eucharist, is clearly visible in the Virgin hand. The position of the Child in respect to the Virgin is typical of Orthodox iconography of Eleousa, i.e. 'the Merciful', indicating the loving pose of the Mother and that of Jesus' mercy for the faithful [30].

Saint Catherine from Alexandria is clearly identified due to the classical iconographic elements such as the martyrdom palm, the crown, the refined dresses, which suggest regal origin, and the toothed wheel symbol of the martyrdom of the saint [31, 32].

At last, the green drape and the light background with mountainous ranges in the distance are further elements typical of Venetian-Cretan school.

## 4. Conclusions

In this paper a complete diagnostic campaign on a panel painting has been reported a discussed. Diagnostics was applied as a fundamental instrument to understand the history and the stratigraphy of the painting, being it able to reveal the invisible and helping to address the restoration work. Thanks to the non-invasive investigations, carried out step-by-step with a critical and reasoned approach, it was possible to study the painting hidden by a recent landscape representation.

Video-microscope acquisitions allowed for seeing traces of colours in correspondence of lacunae of the paintings firstly suggesting the possible presence of a different painting under the landscape.

The UVF photography and IR reflectography highlighted further details supporting the hypothesis of a hidden painting, the first one revealing an intense fluorescence in the lacunae whereas the landscape had no response to UV radiation. Reflectography showed the martyrdom palms and some outlines of figures. Radiography was the decisive technique able to show the hidden painting and above all its good state of preservation. For this last reason it was decided to remove the landscape. Before doing this operation, XRF spectroscopy was also applied in order to investigate the pigments both in the original and landscape paintings. Precious pigments such as vermilion/cinnabar, smalt blue, orpiment/realgar, were supposed on the base of the detected elements, together with lead white and iron based compounds. The ground layer was made of gypsum, hypothesised on the base of the presence of calcium and strontium.

The removal of the contemporary painting revealed a beautiful and interesting artwork that, for the iconographic details and construction, has been associated to the Venetian-Cretan school operating in a period between $15^{th}$ and $16^{th}$ century in Veneto region (Italy).

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