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Preliminary findings from a non-invasive and micro-invasive multi-analytical study of the painting "Posa della Prima Pietra" by Ismaele Teglio Milla (1853)

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***Abstract* – A preliminary investigation into the painting technique and colour palette used in the "Posa della Prima Pietra" canvas by Ismaele Teglio Milla (1853) was carried out in this study. The main goal was to evaluate the presence of preparatory drawings or *pentimenti* and to spectroscopically characterize the materials used in the artwork. For these purposes, a micro- and non-invasive multi-analytical approach was employed using the following techniques: Multi-Spectral Imaging (MSI), portable X-Ray Fluorescence (XRF), Scanning Electron Microscopy with Energy Dispersive X-ray spectroscopy (SEM-EDX), Attenuated Total Reflection Fourier-Transform Infrared spectroscopy (ATR-FTIR) and Visible Reflectance Spectroscopy (Vis-RS). The results highlighted several *pentimenti* and other changes made by the artist, along with the identification of most of the colour palette and the components of the preparatory layer.**

I. INTRODUCTION

The "Posa della Prima Pietra" is an oil painting on canvas made by Ismaele Teglio Milla, apprentice of the well-known Milanese artist Francesco Hayez. The artwork was initially presented at the *Grande Concorso* of Brera in 1853, and since then it has become part of the collection of the Academy of Fine Arts of Brera where it is still preserved inside its *Quadreria* today [1][2].

The artwork represents the laying of the foundation stone of the then Ospedale Maggiore in the city centre of Milan. The building, later known as "Ca' Granda", served as a public hospital until the XX century. After the end of the Second World War, it was repurposed to house the Rectorate of the University of Milan. Hence, the painting carries an important historic and symbolic significance for the University of Milan [3]. It is worth remembering that in 2024 the University of Milan celebrated the 100th anniversary of its foundation, further enhancing the importance of this work's valorisation.

Due to a non-optimal conservation, the artwork presents several structural damages such as holes and cuts in the canvas. Therefore, restoration work has been recently carried out. Before the restoration, a diagnostic investigation using a non-invasive and micro-invasive multi-analytical approach was carried out, and the results are outlined in this study. The main focus was to evaluate the possible presence of sketches or *pentimenti* and to characterize the materials and pigments used on the canvas.

II. EXPERIMENTAL

The painting "Posa della Prima Pietra" (Fig. 1) captures the ceremonial laying of the foundation stone for Milan's new Ospedale Maggiore, held on 1st April, 1456, by Francesco I Sforza, Duke of Milan [1]. At the centre of the composition, the duke is shown lifting the foundation stone of the building from a red velvet cushion held by a kneeling page boy. Beside him stands Bianca Maria Visconti, his wife, elegantly dressed in a white gown adorned with golden accents. Carlo Gabriele Sforza, Archbishop of Milan and Francesco's stepbrother, is also present blessing the event while wearing the traditional ecclesiastical attire of the time, including a mitre. Atop the scaffoldings some workers are depicted, along with a figure believed to be Filarete, the architect responsible for the construction of the site. This figure is holding the blueprint of the building. Finally, in the foreground and behind the main characters, there is a crowd of people attending the public event, while the religious building of the Basilica di San Nazaro in Brolo is recognizable in the background [2].

Fig. 1. "Posa della Prima Pietra", Ismaele Teglio Milla (1853), oil on canvas (175 × 235 cm). Quadreria of the Academy of Fine Arts of Brera, Milan (Italy).

Several non-invasive and micro-invasive techniques were used to study the artwork. Multispectral imaging (MSI) measurements were carried out using a multispectral camera with a 20.3-megapixel APS-C CMOS sensor, 28 mm f/2.8 lens and a set of sources and optical filters. Different sources were used during investigations, such as a visible fluorescence lamp for acquisition of the visible spectrum; and a Visible/IR halogen lamp for Infrared Reflectography (IRR). Also, different sets of filters were applied to obtain the different spectra, including a UV&IR Cut "hot mirror" filter for acquisition of the visible spectrum; and a high-pass 850 nm filter for IR Reflectography.

Visible reflectance spectroscopy (Vis-RS) analyses were performed using of a Konica Minolta CM 2300d portable spectrophotometer in the range 400 – 700 nm.

X-Ray Fluorescence measurements were performed with a SciAps X-50 Handheld XRF Analyzer equipped with an X-ray tube with Rh anode (40 kV, 200 µA, 4 W) and a 20 mm^2 SDD detector with 135 eV resolution at the 5.95 Mn K_α spectral line.

SEM-EDX analyses were performed on micro fragments (4 samples) using a Hitachi TM-4000 instrument equipped with backscattered electron (BSE) and secondary electron (SE) detectors and an Oxford-AztecOne EDX microprobe. The analyses were carried out under low vacuum conditions in charge reduction mode, which enabled image acquisition without the need for sample metallization. Thanks to its high spatial resolution, the instrument allowed detailed investigation of surface morphology and the acquisition of false-color EDX elemental maps, providing insights into the spatial distribution of elements in the various samples.

Finally, ATR-FTIR spectra were obtained with a Nicolet iS10 – Thermo Fisher Scientific (Waltham, USA) instrument coupled with an ATR accessory equipped with a germanium crystal. The instrument mounts a He-Ne Ever-Glo laser. The infrared spectra were registered between 400 – 4000 cm^{-1} with a spectral resolution of 4 cm^{-1} and 32 scans of accumulations.

III. RESULTS

Multispectral Imaging (MSI) is a powerful tool for the analysis of artworks. It is a simple, low-cost and non-invasive imaging technique, representing an asset for the identification of details invisible to the naked eye and for the preliminary characterization of pigments.

In the present study, infrared reflectography was employed in the spectral range of 850-1100 nm to investigate the possible presence of *pentimenti* and preparatory drawings beneath the surface of the painting. The first *pentimento* was identified on the figure of Francesco Sforza (Fig. 2), who was originally depicted wearing the characteristic ducal hat, later concealed by the wall of the Basilica. The reason behind this choice remains unclear, especially since Francesco was already Duke of Milan at the time of the depicted event. Moreover, IRR revealed other minor *pentimenti* such as a reworking of the main character's shoulder, an accentuation of the drapery of his robe, and the removal of several figures in the background.

The same technique also allowed to identify *pentimenti* on the left side of the painting (Fig. 3). Notably, the profile of the Archbishop of Milan was resized from the original sketch. Additionally, the ornamental cross on his robe, absent in the preparatory drawing, was directly painted directly with a brush suggesting that the addition was made during the painting process.

Moreover, IR images revealed decorative details in the damask sleeve of the man kneeling before the archbishop. Indeed, the sleeve appears less defined in the visible image (Fig. 4). Moreover, the configuration of the figure's left hand differs between the two imaging modalities: in the IR scan, the hand is visible only up to the knuckles, while in the final painting, the fingers are fully extended and clearly defined.

IRR imaging also revealed a phrase written on the frame of the canvas: "DEL SIG. ISMAELE TEGLIO MILLA MILANESE" ("Of Mr. Ismaele Teglio Milla from Milan"), referring to the painter's name and birthplace (Fig. 5). Currently, the sentence is only faintly readable since it was later covered by a golden paint layer.

Fig. 2. Comparison between the visible image (on the left) and the IRR image (on the right) of the painting focused on the figure of Francesco I Sforza.

Fig. 3. Comparison between the visible image (on the left) and the IRR image (on the right) of the painting focused Carlo Gabriele Sforza, Archbishop of Milan.

Fig. 4. Comparison between the visible image (on the left) and the IRR image (on the right) of the painting focused on the hands of the man kneeling in the foreground, in front of the Archbishop.

Fig. 5. Comparison between the visible image (above) and the IRR image (below) of the artwork's frame.

IRR acquisitions were also performed to obtain false-colour images (both IRRG and IRGB) in post-production, to be used for pigment identification [4]. This approach requires the comparison with a series of reference pigments, which were photographed in the same conditions and underwent the same post-production editing. Colour charts (Kremer Pigment GmbH) were selected for this purpose [5]. The results of these investigations show that most of the red pigments present on the canvas were identified as cinnabar. Similarly, the pink colour of the lady's dress on the right seems to be a mixture of cinnabar with some other pigments (Fig. 6).

Vis-RS analyses were also carried out to investigate the artist's colour palette. These results highlighted the presence of cinnabar, as indicated by MSI, and other red pigments such as red earths (Fig. 6Fig. 7). Indeed, the spectra and relative first derivatives show the presence of red earth used to colour the woman's dress. Instead, cinnabar was identified as the pigment used to colour the cushion, once again thanks to the superposition of the spectra and the first derivatives (Fig. 7, c and d).

Fig. 6. Visible image (on the left), IRRG false-colour image (in the centre) and IRGB false-colour image (on the right) of the group of people on the right side with cinnabar (10620 Kremer Pigments) acquisitions in the same conditions as reference (in top right corners).

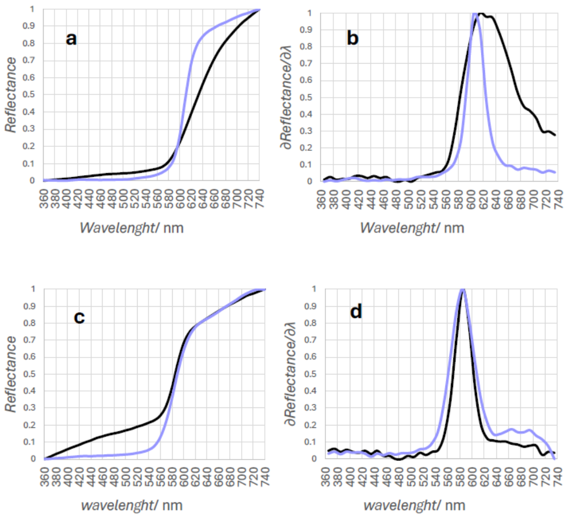

*Fig. 7. Vis-RS spectrum acquired on the lady's dress (**a**, black line) and on a reference of red earth (**a**, blue line) and their respective first derivatives (**b**); Vis-RS spectrum acquired on the cushion (**c**, black line) and on a reference of cinnabar (**c**, blue line) and their respective first derivatives (**d**).*

XRF analyses were also used to investigate the pigments used in the painting. The use of smalt pigment was ruled out by the absence of cobalt. Instead, the presence of iron was detected in several blue spots (Fig. 8, points 1220 and 1227), which could be associated with the use of Prussian Blue. Moreover, two red areas (Fig. 8, points 1219 and 1222) were characterized by the presence of mercury, indicating once again the use of cinnabar/vermillion. XRF results were also used to investigate the preparatory layers, which are based on a calcium mineral, with barium white and lead in the ground layer.

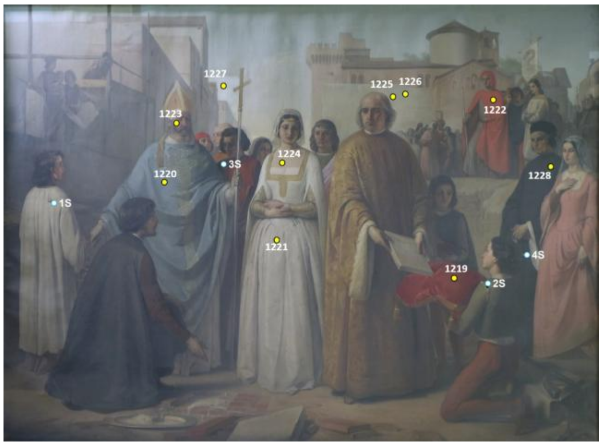

Fig. 8. The painting with the indication of the points where XRF analyses were performed (in yellow) and the points from which micro-samples were collected (in light blue).

Moving on, the analyses performed using SEM-EDX and ATR-FTIR were carried out on some micro-fragments collected from pre-existing *lacunae* in the artwork prior to the restoration intervention (Fig. 8, points indicated as 1S – 4S).

SEM-EDX analyses were carried out on both the front and back surfaces of the samples. The front-side analyses allowed the identification of the main elemental components present in the pigments. While these results are representative only of the specific areas analysed, they may provide significant insights into the artist's palette.

The consistent detection of lead across all samples suggests that the ground layer of the canvas was prepared with a lead-based composition. This hypothesis is further supported by the homogenous elemental composition of the back surface of all samples, in which high concentrations of barium and lead, followed by sulphur, were detected. These results contribute to a better understanding of the ground layer, which appears to be primarily composed of barium sulphate (barium white) and basic lead carbonate (lead white or *biacca*). This type of ground preparation was typically employed by the painter Francesco Hayez [6] and, consequently, also by Ismaele Teglio Milla, who was one of his pupils.

Moreover, the white sample 1S shows the presence of lead (once again attributable to lead white) and calcium, the latter suggesting the use of calcite as an additional white pigment. In the green sample 2S, a notable feature is also the detection of iron, which may indicate the use of a green earth. Instead, the red sample 3S shows the presence of mercury and sulfur, confirming the use of cinnabar/vermillion as the red pigment, in accordance with what previously highlighted by MSI and XRF analyses. Finally, in the black sample 4S, no specific chromophores were observed, except for iron, which may suggest the presence of iron oxides.

Tab. 1. Main elements detected in the micro-fragments with EDX analysis together with the main signals obtained in FT-IR spectra.

Sample	**Colour**	**Main elements front (SEM-EDX)**	**Main elements back (SEM-EDX)**	**Bands (ATR-FTIR) [cm^{-1}]**
1S	White	Pb, S, Ca, Cl	Ba, Pb, S	2920, 2852 C-H 1530 carboxylate 3534, 3398, 1622, 1109, 670 gypsum 1391,1039, 874, 852, 767 carbonates (lead white)
2S	Green	Pb, Fe, Ca, Cl	Ba, Pb, S	2923, 2852 C-H 1527 carboxylate 1730 C=O 3534, 1730, 1397, 1042, 678 lead white 1397, 1042, 833, 678 cerussite 1166, 980, 631 barium white 792, 779 quartz
3S	Red	Pb, Ca, Fe, Ba, Hg, S, Al	Ba, Pb, S	2923, 2852 C-H 1539 carboxylate 3240, 1403, 874, 678 carbonates (white lead) 1622, 1315 calcium oxalate 1163, 985, 631 barium white 1033, 779 silicates
4S	Black	Pb, Ca, Fe, Cl, S, Si	Ba, Pb, S	2913, 2847 C-H 1536 carboxylate 3240, 1397, 871, 678 carbonates (white lead) 1628, 1316 calcium oxalate 1026 silicates

Finally, ATR-FTIR analyses revealed the presence of organic components in all samples, attributable to the binding medium used to apply the pigment to the canvas, as indicated by absorption bands centered around 2920 and 2850 cm^{-1}. Furthermore, degradation products were also identified in all samples thanks to IR investigations. The presence of carboxylates, common organic salts formed as products of degradation, was highlighted by the 1530 cm^{-1} band [7][8]. Moreover, cerussite was identified by the diagnostic band centered at 833 cm^{-1} (typical of cerussite and not of basic lead carbonate) indicating once again the presence of degradation products [8].

Instead, investigations on sample 1S show the characteristic bands of both gypsum and lead white, which is consistent with the results of EDX analysis. Samples 2S and 3S share the presence of silicates, lead white, and barium white, the latter identified by its characteristic bands centered approximately at 1163, 985, and 631 cm^{-1}. These FTIR spectra once again support the results obtained by SEM-EDX, which highlighted the presence of barium.

Interestingly, in samples 3S and 4S, calcium oxalates were also detected, as indicated by absorption bands at 1622 and 1315 cm^{-1}. These are known degradation products frequently found on artworks exposed to fluctuating humidity and suboptimal conservation conditions [9].

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