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INVESTIGATION OF A MEDIEVAL ILLUMINATED MANUSCRIPT THROUGH NON-INVASIVE TECHNIQUES

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Abstract

The so called 'Saint Thomas' Bible is a precious medieval illuminated manuscript dated back to the third quarter of the 13th century, at present stored in the Ardenti Library at Viterbo (Italy). The significance of this rare illuminated manuscript not only as codex but also as religious relic, has led to the need of studying the execution techniques and the constitutive materials especially of the two illuminated initial letters. The impossibility of carrying the Bible in a laboratory and of sampling has led to the choice of non-invasive methodologies of analysis. In particular the illuminated letters have been analysed through X-ray fluorescence spectroscopy, visible reflectance spectrophotometry, infrared reflectography, false colour infrared and ultraviolet fluorescence digital photography, video microscope acquisitions. The application of these non-invasive techniques and the analysis of the results allowed to identify the pigments used for the illuminated letters and to make hypothesis about the execution technique compared with the most important medieval treatise prescriptions on illumination. Moreover the analysis highlighted the presence of possible non-original interventions on the Bible.

Keywords: medieval, illuminated manuscript, infrared reflectography, reflectance spectrophotometry, X-ray fluorescence spectroscopy

1. Introduction

The so called 'Saint Thomas' Bible is a precious medieval illuminated manuscript (Codex m. s. II. *A*. VI. 5 of the Ardenti Library at Viterbo, Italy) dated back to the quarter of the 13th century. It was found in the choir of the Monastery of *Santa Maria in Gradi*, about 1875, during the works aimed at transforming the edifice in a prison [1, 2]. The name of this little Bible derived from the presence of Saint Thomas Aquinos in Viterbo from 1256 to 1268.

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He stayed at the Monastery of *Santa Maria in Gradi* in Viterbo where the Bible was stored and he probably looked at it [2]. So, the Bible can be considered at the same time a rare codex and a precious relic.

The codex is a parchment manuscript with initials alternately in red and blue. It is a little hand-book with dimensions 175x125x55 mm made of 325 leaves and two double-leaves in the counterguards [3, 4]. The historical and technical examination of this precious manuscript, allowed for classifying it as a renewed typology of Bible, born in Paris during the first decades of the 13th century [3]. This typology of Bible was diffused in Europe through Dominicans and Minorites and the relationships between different conventual *studia* and between conventual *studia* and the theological 'faculties' of the Paris *studium* [3].

Figure 1. Assembled images of the two investigated letters with the points of XRF analysis.

The scientific investigations were focused on two illuminated initials (Figure 1): *F*, referred to *Frater Ambrosius*, that indicates the incipit of the prologue of Saint Girolamus, and *I* of *In principio* that condenses with word and image the first book of Genesis [3].

The analysis of the constituent materials and of the stylistic features of artworks provides useful information about provenance and authentication [5]. It also provides a valid aid to a better comprehension of the usage and of the significance of the investigated objects within peoples worship traditions [6].

The extensive knowledge of the artifact obtained by scientific methodologies allows to evaluate the state of preservation and to support the conservation work methodologies [7, 8].

In the case of the Bible, the impossibility of carrying it in a laboratory and of sampling has led to the choice of non-invasive methodologies of analysis, some of which were shortly referred on the occasion of the publication of the restoration results [4, 9, 10]. In particular the illuminated letters have been analysed through X-ray fluorescence spectroscopy (XRF), reflectance spectrophotometry in the visible range, infrared reflectography, false colour infrared (IRC) and ultraviolet (UV) fluorescence digital photography, video microscope acquisitions. By combining and comparing the different non-invasive techniques, it was possible to characterize pigments, painting techniques and conservation state of the illuminated letters.

2. Experimental

The video microscope acquisitions were performed by a Keyence VH-5911 system equipped with a zoom objective from 25 to 175 magnifications.

Infrared reflectography was obtained by a modified Nikon D100 camera by placing the Kodak Wratten gelatine filter n.89B. The IRC photographs were taken using a Nikon F3 camera with a Kodak Ektachrome Infrared film, by placing, the n.12 Kodak Wratten gelatine filter n.12 coupled for time by time with the following ones: n. CC20C, n. CC30M and n. CC50M. The lighting system was made up of 2x250 Philips Photolita lamps.

UV fluorescence photographs were taken using a Nikon F70 camera and 2x160 Watt Philips MLW UV lamps positioned at 45° as regards the surface to be examined, on a Fujicolor Pro 160 C daylight colour film. In front of the camera lens a Kodak 2E Wratten gelatine filter was placed.

Visible reflectance spectrophotometry was applied by an X-Rite CA22 instrument under the following conditions: illuminant D65; standard observer 10°; geometry of measurement 45°/0°; spectral range 400-700 nm; spectral resolution 10 nm; measurement area diameter 4 mm; white reference supplied with the instrument.

The XFR analysis was carried out by a portable instrument equipped with a 5-50kV tube and a Si-PIN detector (resolution 155 eV at 5.9 keV).

3. Results and discussion

The video microscope acquisitions are useful to study the morphological characteristics of the surfaces, details of the painting techniques and possible modifications due to surface treatments [11-14]. In total nineteen points were acquired each at 4 magnifications (25x, 50x, 100x and 175x), some of which have been selected for discussion (Figure 2).

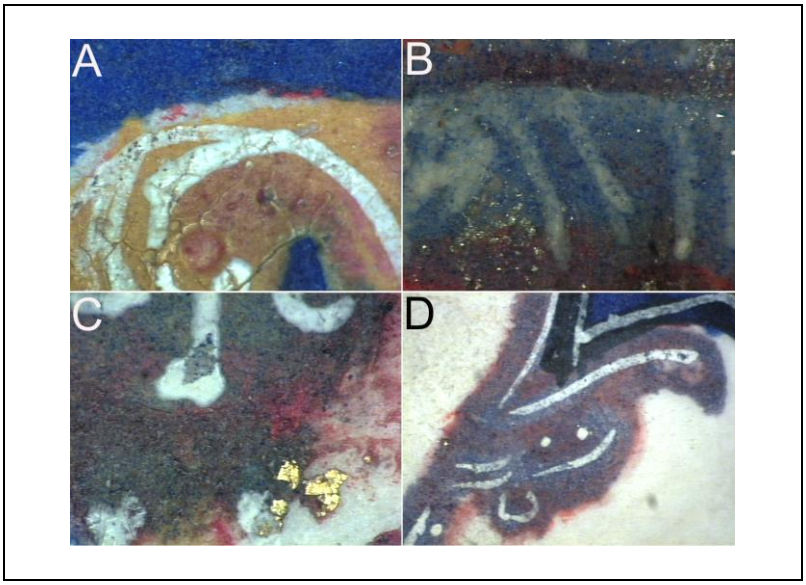

Figure 2. Videomicroscope acquisitions of details in letters *F* (A - 100x and B - 175x) and *I* (C - 175x and D - 50x). In (D) the head of *basiliscus* is shown with overlapping of blue and white colours on red base.

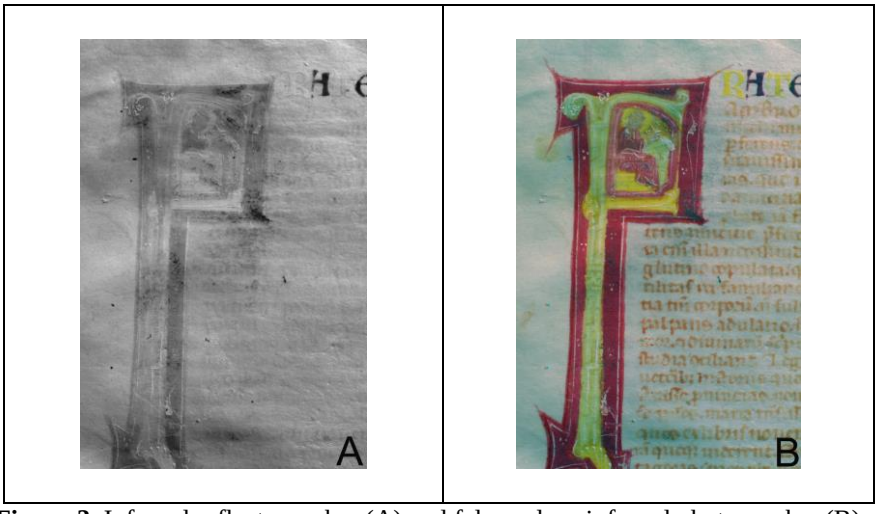

Figure 3. Infrared reflectography: (A) and false colour infrared photography, (B) of letter *F*.

The red preparatory drawing is clearly visible (Figure 2A) in correspondence of adjacent painting areas. The same red colour was used also for outlining the dark contours of the face, and of the architectural decorations.

The areas with white paintings appear characterised by black spots, visible at high magnification, and attributable to possible pigment alteration (Figure 2A). In particular, lead white could transform in dark plattnerite or lead sulphur. Generally this phenomenon occurs in wall paintings but some cases were found also in manuscripts [15-18].

Traces of gilding were also highlighted at 175x in both initials (Figures 2B and 2C). In *F*, gold was applied as powder in the garment of the saint inscribed in the letter, whereas in *I* gold was applied as leaf.

Pigment mixtures and overlapping were also highlighted in the two letters such as green/blue for the flesh tone and blue and white on red in the *basiliscus* of letter *I* (Figure 2D).

Infrared reflectography didn't reveal the presence of preparatory drawing or layer (Figure 3A), but in the visible and IRC photographs red-orange lines are clearly visible. They seem to be created in order to delimit the body of the letter.

The main results of IRC photography concerned the blue and red areas of the initials. Blue and red colours appear dark red and yellow respectively in IRC, suggesting the presence of ultramarine blue and vermilion as pigments (Figure 3B) [12].

UV fluorescence is a useful technique for analyzing the preservation state of the surface, the material losses, *pentimenti* and retouches, the presence of superimposed materials, the reading of faded paintings and so on [19-21].

In the case of the Bible, UV fluorescence photography showed the presence of non-original interventions (no or less fluorescence) and of some letters chemically or mechanically cancelled (Figure 4).

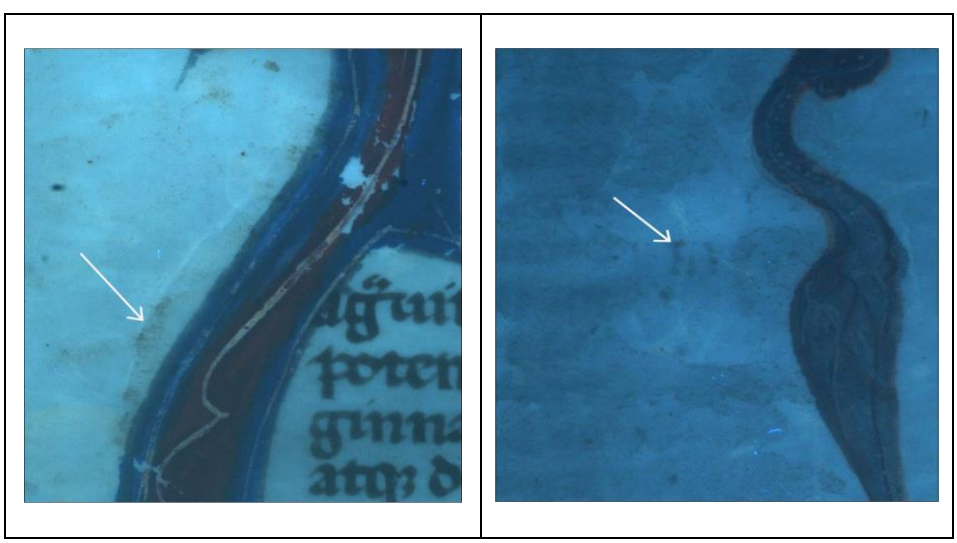

Figure 4. UV fluorescence photographs of letter *I* details. The white arrows indicate possible non-original interventions and traces of cancelled letters.

Colour measurements were particularly difficult to be obtained, due to little dimensions of the initials and so to find homogeneous area of about 4 mm in diameter. In fact, the letter *F* is about 12 cm long and 2 cm wide in the upper part; the letter *I* is about 16 cm long and 1.5 cm wide in the upper end. However, it was possible to measure the blue areas giving the typical reflectance spectrum of ultramarine blue, further confirming this precious pigment for the blue areas (Figure 5).

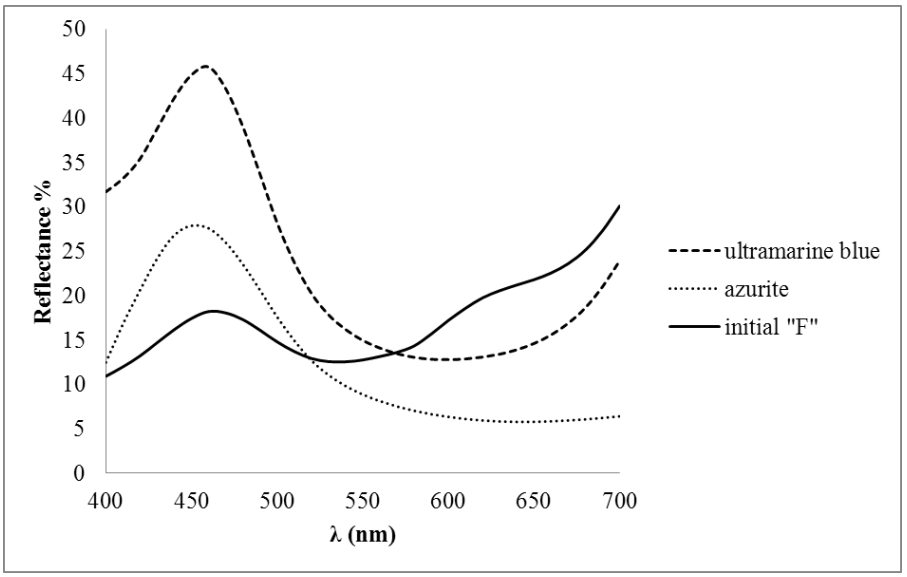

Figure 5. Reflectance spectrum in the visible range of blue colour in the letter *F* compared to reference spectra of azurite and ultramarine blue.

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

Point	Description	Fe	Sr	Hg	Pb
1	Red letters at the beginning of written text			221	249
2	Red colour in the letter *F*			302	202
3	Yellow-orange in the letter *F*	51	26	206	1589
4	Blue colour of the garment of the copyist in the letter *F*		21		274
5	Flesh colour	28		374	1545
6	*Basiliscus* tail in letter *I*		18	239	752
7	Blue colour of the background in the letter *I*	27			453

The XRF analysis, performed on colour areas (see Figure 1 for XRF points) identified in the two letters, revealed the presence of lead in all points with higher counts in the white paintings (Table 1). This result suggests the use of lead white and confirms the observation of blackened areas due to the alteration of this pigment (Figure 2A). The presence of mercury in the red paintings, together with lead, suggests the use of vermilion mixed with lead

based pigments (lead white or red lead). As expected, XRF of blue pigments gives only lead further confirming the use of ultramarine blue probable mixed with lead white.

4. Conclusions

This work would like to highlight the potentialities of the use of combined non-invasive techniques for the study of works of art. Often very sophisticated and expensive techniques are used to characterize the constitutive materials and the state of preservation of the artefacts without taking into account that they may be invasive and/or destructive for the work of art. The same information, useful for the knowledge and restoration purposes of the artefact, may be obtained with much more simple and inexpensive techniques. Moreover the techniques used in this work make possible an overall examination of the work of art in a totally non-invasive modality.

The chosen techniques allowed for detecting the use of precious pigments, especially ultramarine blue, but also vermilion, lead white and probably red lead. Ultramarine blue was confirmed by the combined use of false colour infrared photography and visible reflectance spectrophotometry. Video microscope acquisitions were useful to detect pigment alterations, such as lead white blackening, traces of gilding, and the use of a red preparatory layer.

The information gathered by diagnostic and spectroscopic techniques confirmed the precious material value of the Bible giving also useful data for the work of the conservators.

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