DOCUMENTATION AND SCIENTIFIC INVESTIGATION ON THE 'CRUCIFIXION' BY BALLETTA IN THE CHURCH OF SANTA MARIA NOVA IN VITERBO (ITALY) CONSERVATION AND RELIGIOUS REQUIREMENTS

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Abstract

This paper reports the results of the documentation and non-invasive analysis performed on a wall painting representing the Crucifixion and attributed to Francesco d'Antonio Zacchi, also known as *Balletta*, an important 15th century artist operating in Viterbo (Italy). The wall painting is located in a chapel on the right wall of the church of Santa Maria Nova, one of the oldest churches in Viterbo with a great religious relevance for the local parishioners.

The documentation and the diagnostic analysis were performed in 2014 on the occasion of the last conservative intervention promoted by Rotary Club and founded by the Bank of Viterbo. The intervention was aimed at cleaning the wall paintings by removing the old restoration materials and the dirt and sooty layers obscuring the Crucifixion. The 2D and 3D documentation was made by digital photogrammetric and close range image systems respectively. The analysis was performed through non-invasive techniques such as: ultraviolet fluorescence digital photography, video microscope acquisitions, X-ray spectroscopy. Fourier transform infrared spectroscopy was also applied, but only on the superimposed materials that should be removed during the conservative intervention. The application of these non-invasive techniques allowed to identify the pigments used for the painting and to make hypothesis about the execution technique. Moreover the analysis highlighted the presence of non-original interventions and materials.

Keywords: wall paintings, 2D and 3D documentation, X-ray fluorescence spectroscopy, video microscope acquisition, FTIR

1. Introduction

Santa Maria Nova in Viterbo (Italy) is one of the oldest churches of the town; in fact it was certainly built in the 11th century [1]. The local tradition

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reported about the mythical origin of the church in 380 A.D., when the descendants of Hercules constructed a church named of Santa Maria Nova in the same place of the medieval church [2-3]. In 1283 an important event, considered by the believers as a miracle, occurred for the history and life of the church: a box containing the icon of the Holy Saviour was found in the place where a couple of oxen knelt down [2]. According to this religious *topos*, the church was elected as seat of the *Ars Bubulcorum* (the art of ploughmen) as testified by the presence of several terracotta tiles and wooden elements in the ceiling of the 15th century painted with the oxen.

The church of Santa Maria Nova had a great relevance for the municipality of Viterbo because it was seat of the Town Councils due to the lack of a Town's hall [4]. The rectory of Santa Maria Nova was abolished by the Pope in 1567 and the church was subjected to the jurisdiction of the cathedral of Saint Lawrence. During the centuries the church underwent various and sometimes invasive interventions that changed the original structure, for example the side chapels with the paintings were walled up in the 18th century [5]. However, at the beginning of the 20th century the Society for Conservation of Monuments in Viterbo, performed a great intervention on the church with the aim at restoring the original structure and the paintings [5-7].

The Romanesque façade of the church maintains, on the left side, a beautiful stone pulpit from which Saint Thomas Aquinos preached in 1267 [8]. The interior of the church is made of three naves divided by six couples of columns with beautiful capitals [9]. The extraordinary painted wooded ceiling was recently restored and deeply investigated on the occasion of the conservative intervention allowing for establishing new dating of the different wood elements [10]. Along the side walls of the naves, four chapels with beautiful and relevant paintings can be admired, three of which have been recently subjected to conservative intervention. The first chapel on the right side, object of the present work, shows a crucifixion with the Virgin, Saint John the Baptist, Saint Ambrose that recommends a knelt clergyman, and Saint Antony the Abbot (Figure 1). The identification of the clergyman in Nino Aldobrandini allowed for supposing a sepulchral use of the chapel, also known as Aldobrandini or Saint Ambrose chapel [9, 11].

The wall paintings of the Aldobrandini chapel were attributed to local artist Francesco d'Antonio Zacchi, also known as *Balletta*, operating in Viterbo during the 15th century [11-13]. In the arch (about 80 cm deep) seven clypei, inside decorated frames, are painted with benedictory Christ, and the saints Lawrence, Paul, John the Baptist, Michael, Peter and Stephen. In the side posts of the arch the saints Catherine of Alexandria and Barbara are painted [9].

Recently the Rotary Club of Viterbo promoted the conservation of the wall paintings in the Aldobrandini chapel with the funding of the Bank of Viterbo and the support of the Superintendence and the University of Tuscia. In fact, the bad state of preservation of the paintings required a conservative intervention aimed at removing the materials superimposed to the surface such as dirt, salt efflorescence, old restoration altered mixtures, etc. Before starting the conservation of the wall paintings, a careful documentation and some diagnostic analysis was performed in order to investigate the composition of constituent materials and to support the restoration work.

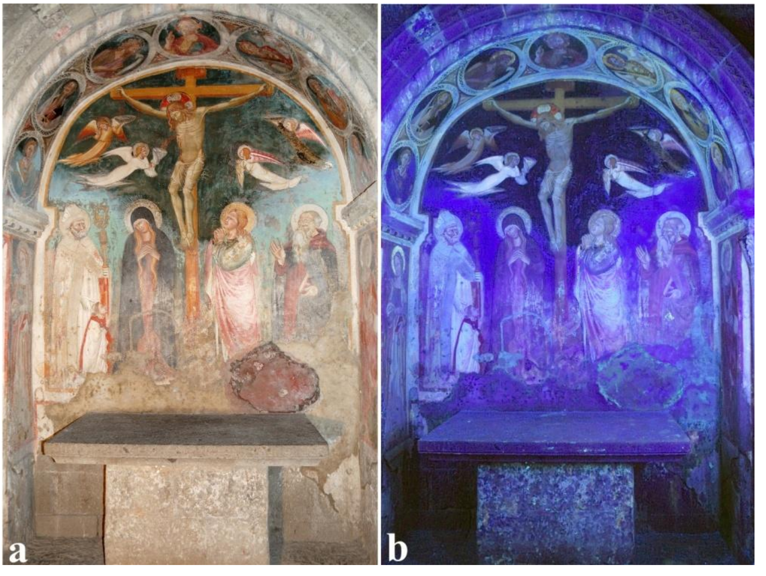

Figure 1. The crucifixion attributed to Balletta (15^{th} century), before the restoration: (a) visible light, (b) UV fluorescence.

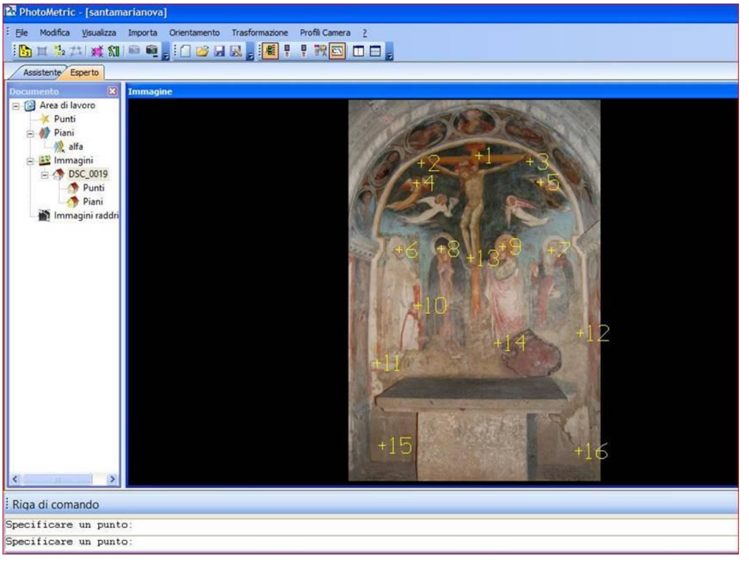

Figure 2. A screenshot of the software Photometric with the 16 control points.

2. Experimental

Ultraviolet (UV) fluorescence photographs were taken using a Nikon D90 camera and Sylvania Blacklight Blue F15W/BLB-T8 tube lamps positioned at 45° as regards the surface to be examined. In front of the camera lens, the Kodak Wratten gelatine filter 2B (light yellow, absorbing the UV radiation under 390 nm) was placed in order to block the reflected UV and to attenuate the blue dominant typical of the ultraviolet photographs.

The documentation of the painted surface was performed by digital photogrammetric system [14]. The photographic image rectification (monoscope photogrammetric survey) is based on the use of a simple photogrammetric technique performing the rectification of each image or of several images combined in a photo mosaic. The subsequent on-scale photo mosaic allows for making linear measurements in the rectified image. In the present study the software Photometric has been used for gathering the ortho-rectification and the monoscope photogrammetric survey of digital images referred to level surfaces. This software is able to transform the photographic images into orthogonal projection of the perspective objects. As consequence of the rectification, the perspective effect of the photography is almost completely removed and the object distortions produced by the photographic objectives have been limited. In order to obtain precise survey of the painting (with a sub-cm mean square deviation), a particular care was used in the photographic campaign and in the choice of the objectives for reducing the perspective distortions. To do this, a Nikon D5300 digital camera was used equipped with 50mm lens, with a resolution of 24.2 Mega Pixels. Photometric software may use two different alternative methods for image perspective correction: geometrical or analytical. In the present work, the analytical system was chosen by selecting 16 topographic control points symmetrically distributed on the entire surface of the painting (Figure 2).

The points were chosen in such way to be easily identified during the photo-mosaic dimensioning. The 16 control points were measured by the total station Topcon GPT 7005 equipped with a laser distance meter. The attachment of targets on the surface was avoided by taking advantage of details of the wall painting.

When the conservation work was concluded, a 3D survey of the entire wall painting, by close range multi image system, was performed by applying the Agisoft PhotoScan software [http://www.agisoft.ru/]. This system uses automatic methods of extraction, identification of homologous points and orienting of digital image sequences in order to automatically determine the spatial structure of a scene by starting from a sequence of images without the necessity of supplying data related to the images or to the photographic conditions. In this work, 66 images were gathered with a Nikon D5300 digital camera. The software identified 208.965 homologous points on the 66 photograms and it created a dense cloud made of 10.998.896 points and a 3D model made of 2.208.949 faces. The 3D measuring was performed on the base of the tri-dimensional coordinates previously gathered from the photogrammetric survey of the paintings.

The video microscope acquisitions were performed by a Dino Lite AM 413 system equipped with a zoom objective from 20 to 200 magnifications, directly connected to a computer for the acquisition and processing of the images.

X-ray fluorescence (XRF) spectroscopy was performed by means of a Surface Monitor instrument supplied by Assing. The XRF spectra were obtained with the following experimental conditions: Mo tube operating at 25 kV voltage and 300 μA beam current; scan time 60 s; distance 95 mm.

Fourier transform infrared (FT-IR) spectroscopy was performed by using a Nicolet Avatar 360 system. For each sample 128 scans were recorded in the 4000 to 400 cm^{-1} spectral range in diffuse reflection modality (DRIFT) with a resolution of 4 cm^{-1}. Micro-samples were ground with spectrophotometric grade KBr (1% sample in KBr) in an agate mortar. As background the spectrum of the KBr powder was used.

3. Results and discussion

The careful documentation by photogrammetric and close range multi image systems allowed for obtaining 2D and 3D digital models on which all possible information about the painting (analysis, state of preservation, conservative interventions, measurements, etc.) can be reported [15]. In fact, as stated in the European Standard EN 16095, individuals and organizations responsible for the conservation of tangible cultural heritage are required to maintain a record of its condition [16].

The photo-plane and a view of the 3D model, obtained at the end of the elaboration phase described in materials and methods, are shown in Figures 3-4. The advantage of this kind of documentation in respect to a traditional systems, based on graphical or photographic campaigns, is due to the possibility of reporting all work phases and annotations in a single file linked to the object without the necessity of having several thematic maps for the different kinds of information required [15]. Virtual reconstruction of full resolution three dimensional model, as similar as possible to its original resolution, allows a continuous and complete inspection of the object at any time and in a single file.
The UV photography of the wall paintings, compared to the visible one, gives information about the state of preservation of the surface, allowing the distinction of the restored areas (Figure 1b) [17].

The black background behind the cross, for example, seems to have no fluorescence probably due to restoration materials that don’t exhibit this property. A yellow fluorescence can be observed in the haloes and may be associated to the mixture (*missione*) used to stick the metal leaf. The white areas show a light blue fluorescence probably to the use of an organic binder to apply the pigments. The cross appears red, under UV, in the bottom part and yellow-orange in the upper part. This can be explained with the probably application of restoration materials in the upper part of the painting, especially in correspondence of the black background.

Figure 3. Ortho photo-plane obtained at the end of the elaboration process, before the restoration.

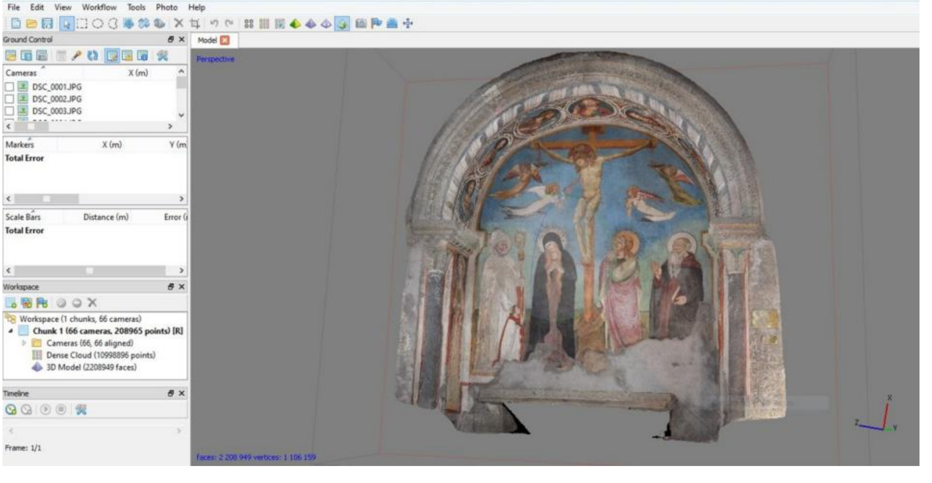

Figure 4. Screenshot of a working window from the software Photoscan. The 3D model of the chapel with the paintings can be observed, after the restoration work.

The video microscope acquisitions are useful to study in detail the morphological characteristics of the surfaces and to choice the possible sampling points, if necessary [18, 19]. In total eight points were acquired each at 2 magnifications (50x and 200x). The points were chosen in accordance with the restorers to deepen the knowledge of the surfaces in some specific areas of the paintings, in particular the dark blue background and the haloes. The acquisition from the dark blue background showed the presence of a brown layer under the blue, this last one is characterized by blue and green particles (Figure 5a).

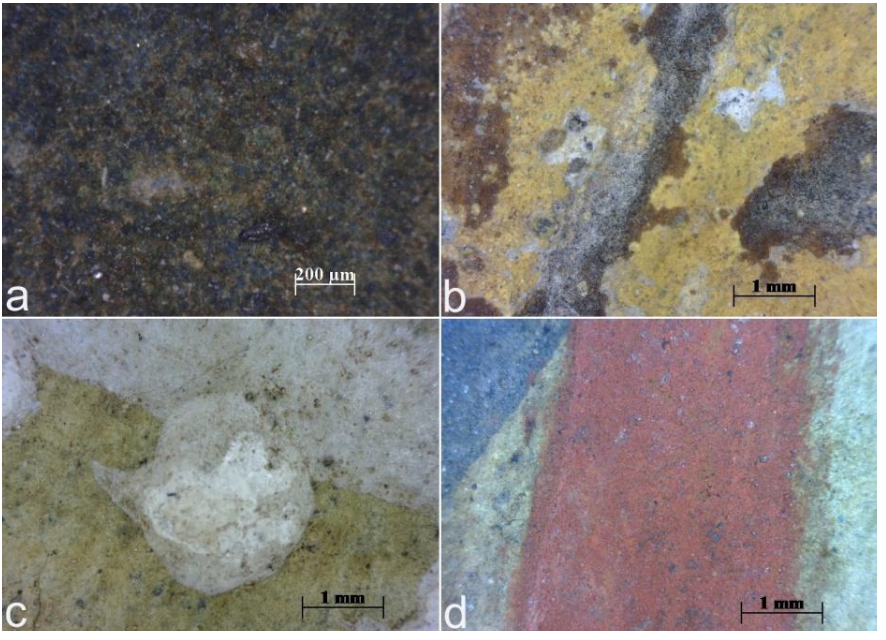

Figure 5. Some videomicroscope acquisitions of the painting: (a) dark blue background (200x), (b) the halo of Saint John the Baptist (50x), (c) a pearl in the perizoma of Christ (50x), (d) blood in the chest of Christ (50x).

The presence of blue and green grains allows supposing the use of azurite as painting pigment. Black bright grains are also visible on the surface probably associated to restoration materials. The acquisitions from the haloes highlight the presence of brown materials that can be supposed attributable to the mixture (*missione*) used to stick the metal leaf that appears almost completely lacking (Figure 5b). Video microscope acquisitions are also useful to investigate the execution technique such the colour superimposition and the details of the paintings (Figure 5c-d).

The results of the non-invasive XRF spectroscopy are summarized in Table 1.

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

Point of measurement	Ca	Fe	Cu	Hg	Pb	Sr
X1 yellow of the right Angel's garment	874	447			380	
X2 light yellow of right Angel's garment	650	325	195		579	
X3 dark yellow of right Angel's garment	784	476	146		317	
X4 blue of the background	168	248	4690			
X5 pink of the right Angel's garment	1309	119			81	
X6 pink of the right Angel's garment 2	2360	214			160	152
X7 brown of the right Angel's garment	657	100			53	
X8 white of the right Angel's garment	911	65			63	37
X9 brown area of the Saint John's garment	387	154	181		550	
X10 white on Saint John face	608	99				
X11 yellow of Saint John hair	586	297				
X12 dark area on Saint John halo	355	344	236			
X13 dark area on Saint John halo 2	466	280	95			
X14 violet of Saint Paul's clypeus	550	127				
X15 bright red of the book of Saint Paul	179	284		856		
X16 dark grey in the Saint Lawrence halo	500	160	573			
X17 dark grey in the Saint Lawrence halo 2	431	70	406			
X18 red of the blood of Christ	267	175	65	910	75	
X19 white of a pearl in Christ's perizoma	1024	140	28	113		
X20 white of left Angel's garment	1139	91	25		140	55
X21 bright red of Catherine's garment on the shoulder	144	158		673		
X22 bright red of Catherine's garment on the breast	463	537		257		
X23 yellow of the wheel in the hands of Saint Catherine	566	307				

As usual in wall paintings, calcium (Ca) is present in all examined points, sometimes associated to strontium (Sr), with higher counts in the white and pink areas, due to the use of calcium carbonate white as pigment. Iron (Fe) has also been revealed in all measured points with greatest quantities in yellow and red areas. This result points out the presence of yellow and red ochre as pigments and iron based compounds in the setting layers. In the Angel garments lead (Pb) was also detected suggesting the presence of lead based pigments (lead white and lead oxide). High counts of Pb have been found in the point X9 in a brownish part of the garment of Saint John. This finding can be related to an altered lead based pigment, probably lead white transformed in plattnerite. Mercury (Hg) was detected in the bright red areas suggesting the presence of vermilion. At last, the presence of high counts of copper (Cu) in the background of the crucifixion shows the use of azurite as pigment. Azurite was also used in other part of the paintings as in the Saint Lawrence halo. Azurite was necessarily applied by a *secco* technique due to the peculiar properties of this pigment [20-22].

FT-IR spectroscopy was applied on two micro samples taken from the black background behind the cross to obtain information useful in deciding the possible removal of this darkened area of the paintings. The archive research, in fact, highlighted that the blackened area seemed to be not present in the available historical photographs (Photographic Archive of the Federico Zeri

Foundation in Viterbo), so it can be associated to a probable alteration of restoration materials.

FT-IR spectra of the two samples are shown in Figure 6. In sample 1 spectrum, the bands of azurite can be observed (cm^{-1}: 3428, 2593, 2555, 2500, 1881, 1856, 1831, 1509, 1421, 1093, 1031, 955, 839, 818, 747) together with protein binder (bands at cm^{-1}: 3244, 2922, 1647, 1463, 1382). The sharp bands at 1324 and 771 cm^{-1} suggest the presence of oxalates.

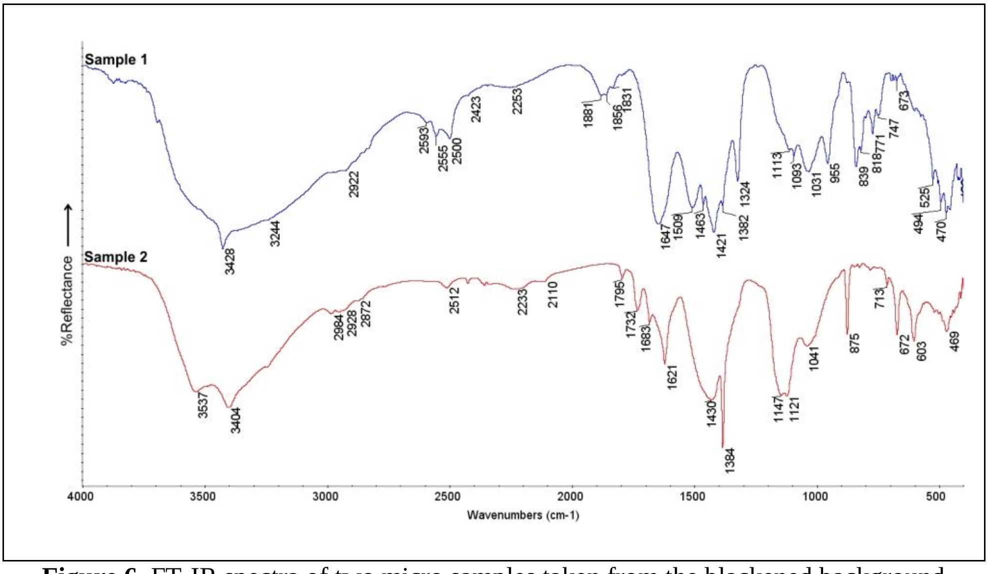

Figure 6. FT-IR spectra of two micro samples taken from the blackened background behind the cross in correspondence of the upper right angel (sample 1) and of the right arm of the cross (sample 2) respectively.

It can be supposed that sample 1 was gathered from an original area painted with azurite by *secco* technique with protein binder.

Sample 2 spectrum highlights the bands of gypsum (cm^{-1}: 3537, 3404, 2233, 2110, 1683, 1621, 1147, 1121, 672, 603 and 469), calcium carbonate (cm^{-1}: 2984, 2872, 2512, 1795, 1430, 875, 713) and synthetic resin characterized by the carbonyl band at 1732 cm^{-1}. A sharp band at 1384 cm^{-1}, associated to nitrates, can also be observed in the spectrum of sample 2.

4. Conclusions

This paper reported the main results on the study of the wall paintings by *Balletta* in the first right chapel of the church of Santa Maria Nova in Viterbo. The study was possible thanks to the conservative intervention performed in 2014 and promoted by the Rotary Club of Viterbo. The diagnostic investigation, carried out in accordance with the restorer and with the functionary of the Superintendence, demonstrated very useful to characterize the pigments, the binders especially in case of azurite that was applied by *a secco* technique, and the superimposed materials which needed to be characterize in order to decide their removal from the surfaces. This last focus is of particular relevance in the field of sacred art due to the significance of particular chromatic effect and of the final appearance of the paintings.

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References

[1] F. Orioli, *Florilegio viterbese ossia notizie diverse intorno a Viterbo e alle sue adiacenze*, Tipografia delle Belle Arti, Roma, 1855, 182-190.
[2] A. Scriattoli, *Viterbo nei suoi monumenti*, Agnesotti, Viterbo, 1988, 188-195.
[3] G. Di Sarno, *Studio diagnostico sulla crocifissione del Balletta in Santa Maria Nuova*, First Level Thesis, University of Tuscia, Viterbo, 2015, 8-17.
[4] V. Anelli and L. Pace Bonelli, *Chiesa di S. Maria Nova*, in *Il centro storico di Viterbo*, M.G. Gimma (ed.), BetaGamma, Viterbo, 2001, 95-99.
[5] A. Muñoz. Bollettino d'arte, **6** (1912) 121.
[6] P. Belli and R. Pelliccioni, *La Chiesa di S. Maria Nuova e il suo isolato*, Quatrini A. & F., Viterbo, 1991.
[7] S. Valtieri and E. Bentivoglio, *Viterbo nel Rinascimento*, GB EditoriA, Roma, 2012, 192-200.
[8] F. Bussi, *Istoria della città di Viterbo*, Bernabò e Lazzarin, Roma, 1742. Ristampa Anastatica, Bologna, 1967, 155.
[9] F. Ricci, *Viterbo, Chiesa di S. Maria Nova*, in *Conoscere per conservare, percorsi culturali e didattici nella Tuscia*, S. Rinaldi (ed.), Aracne Editrice, Roma, 2008, 93-101.
[10] M. Romagnoli and M. Togni (eds.), *Santa Maria Nuova a Viterbo. Nuove chiavi di lettura della chiesa alla luce del restauro della copertura*, Kermes Quaderni, Nardini Editore, Firenze, 2013.
[11] A.M. Corbo, Commentari, **28** (1977) 163.
[12] G. Signorelli, Bollettino Municipale, **7** (1943) 6.
[13] L. Grassi, Nuova Antologia, **77** (1955) 87.
[14] L. Lanteri and C. Vaccarella, *Survey methods and instruments of the forensic basilica pavements in ancient Ostia*, Proc. of the 5th International Congress Science and Technology for the Safeguard of Cultural Heritage in the Mediterranean Basin, Vol. I, Resources of the Territory, Rome, Valmar, 2012, 398-404.
[15] C. Pelosi, L. Calienno, D. Fodaro, E. Borrelli, A. R. Rubino, L. Sforzini and A. Lo Monaco, J. Cult. Herit., doi: 10.1016/j.culher.2015.07.004.
[16] ***, *EN 16095: Conservation of cultural property: Condition recording for movable cultural heritage. Italian Standard*, UNI, Milano, 2012.
[17] P. Baraldi and C. Pelosi, *Scientific methodology for the study of the techniques and materials of the rocky wall paintings*, Proc. of the VI International Congress on Eremistismo e Habitat Rupestre, Fondazione Centro Italiano di Studi sull'Alto Medioevo, Spoleto, 2015, in press.

[18] V. Cuozzo, A. Lo Monaco and C. Pelosi, *The Virgin of the Castle: diagnosis and conservative problems of a polychromatic wooden statue by Francesco da Valdambrino*, in *Diagnosis for the conservation and valorization of cultural heritage*, L. Campanella & C. Piccioli (eds.), Ethos, Napoli, 2013, 91-103.

[19] A. Lo Monaco, C. Giagnacovo, C. Falcucci and C. Pelosi, Eur. J. Sci. Theol., **11(2)** (2015) 73-84.

[20] R.J. Gettens and E.W. Fitzhugh, *Azurite and Blue Verditer*, in *Artists' Pigments. A Handbook of Their History and Characteristics*, Vol. 2, A. Roy (ed.), National Gallery of Art, Washington, 1993, 23-35

[21] R.J. Gettens and E.W. Fitzhugh, Stud. Conserv., **11** (1966) 54

[22] E. Mattei, D. de Vivo, A. De Santis, C. Gaetani, C. Pelosi and U. Santamaria, J. Raman Spectrosc., **39** (2007) 302.