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TECHNIQUE OF THE MURAL PAINTINGS OF THE HOSPITAL CHURCH IN HOREZU MONASTERY

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Abstract

This paper deals with the technique of mural paintings which cover the interior wall of the Hospital Church (hereafter Bolniţa) of Horezu Monastery in Romania, constructed in the last years of the 17th century. The original paintings being better conserved, Bolniţa of Horezu is one of the least modified parts in the whole monastery complex, inscribed as Romanian world heritage property of UNESCO. These mural paintings basically followed the medieval texts of painting technique, known to us through Theophilus or Dionysios, which mentioned thin and fewer painting layers with earthen pigments.
Close observation and chemical analysis of the painting have shown that the painting techniques of Bolniţa are classified in three types (*Buon fresco, Mezzo fresco, Secco*), and that the way of their application was quite consistent. It is significant for the conservation of the art that this high and universal standard of medieval painting technique had been maintained for centuries in the area of cultural mixture which might have effected on the field of the mural painting in wider cultural context. On the other hand, some particular decorations on the traditional frescoes were observed, especially in the west part of Bolniţa.
The mural painting of Bolniţa gives an interesting example of consistency in medieval painting technique. This study clarified three types of painting techniques in Bolniţa on the basis of identification of inorganic materials, including are materials for the mural painting such as silver foil.

Keywords: mural painting, hospital church, Horezu monastery, Romania

1. Introduction

Hospital churches were originally small chapels attached to the sanatorium of Orthodox monasteries. Those chapels, erected for aged or sick monks, became independent churches under the Principality of Wallachia (1330-1859).With the diffusion of advanced medicine, the sanatorium itself became an independent medical institution, while hospital churches remained as modest religious attachment to the monastery. Being used by particular monks as solitary place for the last period of life, hospital churches had been left aside

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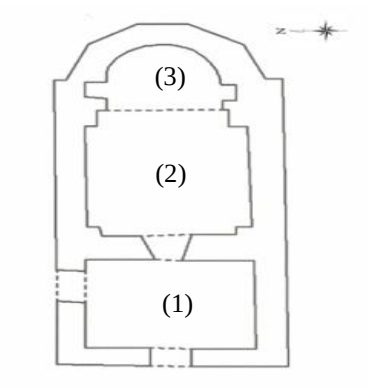
from occasional renovations or decorative interventions in later periods. As consequence, their original paintings by chance were preserved well and Bolniţa of Horezu is an outstanding example of such quiet history (Figure 1).

(a)



(b)

Figure1. (a) Horezu hospital church and (b) its ground plan where (1) is the porch, (2) is the naos and (3) is the altar.

The entire interior surface of Bolniţa was decorated with a series of mural paintings which, on the basis of painting technique, can be classified into three groups: *Buonfresco,* the pigment was diluted into water and applied on mortar before its drying; *Mezzofresco,* the pigment was mixed with slaked lime and diluted into lime water and applied on either wet or dried wall; and *Secco,* the pigment was mixed with binding media, watered in diluent and applied on dried wall. Although these three types of painting techniques have long been known among painters, scientific studies and relevant analytical information have been quite limited, especially relating to the distinction of those three techniques in examples of mural paintings during late-medieval era in Balkan.

This study aims at clarifying scientific difference between these three painting techniques, and analyzing inorganic materials used for mural paintings in Bolniţa. On the basis of chronological and historical studies of art, this study has been developed to the wider comparative research of survey and chemical analysis of inorganic materials, including five hospital churches (Cozia, Polovragi, Bistriţa, Ostrov, Brâncoveni) and seven other churches constructed under Wallachian rule.

2. Research methodology

Buon fresco, Mezzo fresco and *Secco* have long been known as common techniques shared by painters since Medieval times, scientific studies and relevant analytical information have been limited. This study aims at describing the difference of these three traditional techniques on the basis of chemical analysis.

Table1. Samples taken from original paintings.

No.	Sample	Monastery	Church	Sampling dates	Sampling point	Notes/results of analysis (listed from deeper layer)
1.	H1B	Horezu	Hospital	2011/07/27	south wall	blue of sky/azurite on carbon black
2.	H2G					green of ground/terraverde on iron-oxide-red
3.	H2A				west wall	black of votive family's cloth/yellow ochre, minium + iron-oxide-red, silver foil, carbon black, silver foil, carbon black
4.	H2B					blue of decorative pattern/smalt
5.	H3B				north wall	blue of decorative pattern/smalt
6.	H1W			2012/03/15	west wall	black of votive family's cloth/yellow ochre, minium + iron-oxide-red, silver foil, carbon black
7.	H2W					black of inscription frame/yellow ochre, minium + iron-oxide-red, silver foil, carbon black
8.	H3W					white of inscription frame/iron-oxide-red
9.	H4W					gray of inscription frame/yellow ochre, minium + iron-oxide-red, silver foil, carbon black
10.	H5W					green of ground/yellow ochre + carbon black
11.	H1N				north wall	black of saint's cloth/iron-oxide-red + little cinnabar, minium
12.	H2N					black of saint's cloth/iron-oxide-red + little cinnabar, minium
13.	H1S				south wall	gold of saint's cloth/yellow ochre, minium, gold leaf
14.	H2S					gold of star/carbon black, iron-oxide-red, gold leaf
15.	H3S					green of saint's cloth/iron-oxide-red, azurite + malachite
16.	N1S					gold of star/carbon black, iron-oxide-red, gold leaf
1.	C1S	Cozia	Hospital	2012/03/17	south wall	green of ground/yellow ochre, carbon black, terraverde
2.	C2S					yellow of shoes of saint/yellow ochre, lead-tin-yellow + lime white
3.	C3S					red of ground/carbon black, iron-oxide-red
4.	C4S					gold of aureola/yellow ochre, iron-oxide-.red + minium, gold leaf
5.	C1W				west wall	gold of votive family's cloth/smalt + carbon black, minium + lead-tin-yellow, gold leaf
6.	C2W					green of ground/terraverde or silicate
7.	C3W					blue of sky/carbon black + smalt
8.	C4W					light green of founder's robe/lead-tin-yellow + terraverde
9.	C5W					blue of founder's robe/terraverde, smalt
10.	C6W					gold of founder's cloth/terraverde, minium + lead-tin-yellow, gold leaf
1.	N1S	Horezu	Saint Apostles	2011/07/27	south wall	blue of background/yellow ochre, carbon black, smalt
2.	N2S				north wall	blue of decorative pattern/yellow ochre, smalt
1.	O1W	Polovragi	Hospital	2012/03/19	west wall	yellow of saint's cloth/yellow ochre, lead-tin-yellow
2.	O2W					yellow of saint's cloth/yellow ochre + lime white

Two preparatory works, on site and in laboratory, were conducted in order to understand better the scientific differences between these types of painting preparation: (i) detailed observations on site with 2D and 3D documentation of mural paintings of Bolniţa of Horezu and other comparison

churches were performed, and (ii) samples which hypothetically and approximately correspond in chemical composition to the three original techniques were prepared. The component ratios of calcium and pigment of these laboratory-made samples were compared with those of original samples.

In order to clarify the type of pigments and techniques applied in the original paintings, it was important to detect and identify the elements contained in the original samples by XRF (X-ray Fluorescence analyser) and EPMA (Electron Probe X-Ray Micro Analyzer). The latter (EPMA) gave the percentage of the elements contained in each layer of relevant techniques. Then, the chemical combination of identified elements was determined by XRD (X-ray Diffraction analyzer) and MDG (X-ray Micro Diffract Goniometer), which enabled to clarify the chemical compounds used as pigments in the original paintings. The SEM images gave precise data of elements distribution on each layer. Through the comparison with data obtained from laboratory-made samples, the original techniques can reasonably be classified into *Buon fresco*, *Mezzo fresco*, and *Secco*, by comparing SEM image data of the original with those of samples made by the head author.

The basis of this research was the following hypothesis: techniques were applied in the sequence of time, one after the other, and the overlapped layers certainly differ in calcium content, which may be effectively detected by EPMA.

Table 2. Component of laboratory-made samples.

Sample	Technique	Paint			Notes
		Pigment	Binder	Diluent	
T1	buon-fresco	terraverde burned ochre yellow ochre lead-tin-yellow		water	
T2	mezzo-fresco		slaked lime	lime water	applied on wet mortar
T3					applied on dried mortar
T4	secco		animal glue	water	glue 10%
T5			casein+ammonia water		casein: 28% ammonia water: water = 1:10:0.2
T6			casein+slaked lime		casein: slaked lime: water = 1:10:0.5
T7			casein+borax		casein: borax: water = 1:10:0.2
T8				lime water	
T9					reference

Optical imaging survey as visual documentation was carried out applying the following instruments: 3D-scanner (Riegl VZ400), Digital camera (Nikon D700/Ricoh GXR), and Portable Microscope (Sugitoh). After close observation on-site and on-the-spot analysis by XRF, some samples were taken from Bolniţa of Horezu and other churches (Saints Apostles' church of Horezu, Bolniţa of Cozia and Polovragi) and compared, using EPMA and XRD techniques. In total, thirty original samples were taken (Table 1), all of which were analysed by EPMA and XRD, while, according to the necessity of further analysis, six original samples were put under MDG.

In the laboratory twenty-seven new samples were made by applying the three techniques: *Buon fresco* - one sample, *Mezzo fresco* - two samples, one on wet mortar, and the other on dried mortar, and *Secco* technique - five samples prepared by using different kind of binding media (since organic materials of

original painting have not yet been identified). One sample was left without any pigment layer, as a reference data. Table 2 gives 9 types (T1-T9) of laboratory-made samples for each colour (terraverde, burned ochre, yellow ochre and lead-tin-yellow), the total number of samples being thirty six.

3. Results

Analyses of laboratory-made samples clearly showed that the three types of painting techniques differ from each other in composition of calcium (main component of mortar) and pigment component (Figure 2). In *Buon fresco* sample, calcium is not detected in the pigment layer, though a thin but clear layer of calcium is observed on the topmost surface, which may properly be regarded as transparent calcite layer. Samples of *Mezzo fresco* technique, show calcium content in whole layers, which means that the pigment was sufficiently mixed with calcium before its application. In samples of *Secco* technique, calcium is not observed in the pigment layer or on the surface of the sample, the pigment layer being totally separated from the supporting layer. An additional careful observation on the pigment components shows a difference in density which comes from the difference of painting procedure along the sequence of time. *Buon fresco* sample shows highest detection and *Secco* technique follows to it, while pigment layer of *Mezzo fresco* technique is low in density and it is even difficult to identify the layer itself.

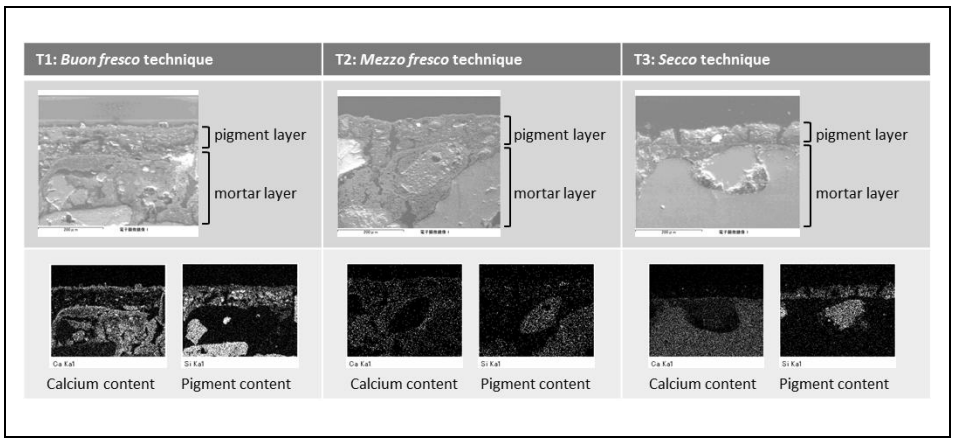


Figure 2. Back scattered electron images and element mapping images of three painting techniques.

Following these results, the samples taken from original paintings are analysed in the same way, and the results of the analysis are compared with those of laboratory-made samples. Through comparative consideration it has clearly been shown that all samples have *Buon fresco* layer in the deepest part, which can be considered as an underdrawing, painted before its wall dry. And after *Buon fresco* layer, an actual colouring or a fine decorating layer comes over it, from *Mezzo fresco* to *Secco* painting, painting on completely dried mortar

without being tied to time. The *Mezzo fresco* technique generally shows better adhesion applying on wet mortar, though it seems that in late Medieval times, slaked lime is used simply as a white colour, without taking due consideration of the wall condition.

Table 3 shows inorganic materials used for mural painting in Bolniţa. The mural paintings of Bolniţa were painted mostly by creating layers of single pigments, and there are only few layers of mixed pigments: carbon black and yellow ochre, and red underlayer of metallic foils. In comparison churches, there are other mix layers: lead-tin-yellow and green earth; smalt and carbon black.

Table 3. Materials used for mural painting.

	Horezu	**Comparison churches**
Blue	Smalt Azurite	Smalt
Red	Iron-oxide-red Minium	Iron-oxide-red Minium
Yellow	Yellow ochre	Yellow ochre Lead-tin-yellow
Green	Green earth Malachite	Green earth Malachite
White	Calcium hydroxide	Calcium-hydroxide
Black	Carbon black	Carbon black
Metallic foil	Gold leaf Silver foil	Gold leaf

Lead-tin-yellow was detected in two comparison hospital churches and probably used in some other churches as well, which were examined for comparative studies. In decoration of clothes in naos or porch in those two hospital churches, the brilliant lemon yellow coloured lead-tin-yellow was used for all three types of painting techniques. Lead-tin yellow, made by heating the mixture of lead and tin oxide, has high-coatability and is resistant against both acid and alkaline. With this reason, it has been frequently used during late-Medieval times, though, the pigment has not yet been identified in churches of Horezu monastery including Bolniţa, and the only yellow colour detected was yellow ochre. In all churches analysed in this study, yellow ochre was observed in the first layer of painting layer in almost whole part of the wall, which indicated that the pigment was used not only as a yellow colour decoration but also as main pigment for *Buon-fresco* underdrawing.

The main pigment for blue colour was smalt in all examples observed in this study. No exception was confirmed. Estimating 10 mol of all oxygen, oxide weights % of the elements detected were calculated by EPMA. The result is shown in Table 4. Modern smalt (Zecchi and Kremer product) were also analysed in comparison. Smalt of Cozia and Horezu contained impurities which derived from original minerals of cobalt such as Smaltite. The existence of impurities is the biggest difference from modern industrialized smalt [1]. Between the smalt of Cozia and Horezu, there was a clear difference in

production process: smalt of Horezu is a so called cobalt glass coloured with cobalt oxide, while that of Cozia is a soda glass which contains sodium instead of potassium and colouring with cobalt. Cozia smalt contained more arsenic as impurities than Horezu. The lead oxide contained in Cozia smalt gives its property as lead glass as well.

Table 4. Composition of smalt.

Sample	SiO_2	K_2O	CoO	As_2O_3	Fe_2O_3	Oxide of Al, Ca, Ni, Bi
Horezu 1	73.2-75.0	12.9-15.0	1.8-2.2	1.8-3.1	2.3-2.4	0.6-1.4 (Na_2O:0.7-0.9)
Horezu 2	76.3-77.3	13.3-13.4	1.4-1.5	1.4-2.3	1.4-1.5	0.5-1.4 (Na_2O: 0.3)
Cozia 1	57.2-66.4	0.6-1.0	5.5-6.7	11.8-13.7	3.5-4.2	0.1-5.3 (Na_2O:5.9-7.3, PbO: 0.9-3.0)
Cozia 2	54.9-60.5	0.5-0.9	4.9-6.2	9.5-13.1	3.2-3.5	0.3-1.4 (Na_2O: 8.4-14.5, PbO: 7.9-10.0)
Zecchi	76.4-81.3	7.0-14.7	8.7-11.4	-	-	-
Kremer	69.1-74.6	15.5-17.1	9.2-13.7	-	-	-

The iron-oxide-red was most extensively used as red pigment. The minium was preferred for folds of clothes, detail decoration and ornaments of nobles specifically painted in the naos. Minium was frequently applied for underlayer of metallic foils as well, mixed with iron-oxide-red or lead-tin-yellow. The colour of the red underlayer seems to have had relation with the iconography of the decoration: stars and aureole should have bluish red underlayer, using iron-oxide-red as main pigment; crowns, clothes or other fine decorations should be backed up with yellowish red underlayer, using minium as main pigment, and sometimes mixed with lead-tin-yellow. No lead-tin-yellow was detected in all samples from Horezu churches. In contrast, in samples from Cozia and Polovragi, we found that lead-tin-yellow was often mixed with minium as an underlayer of metallic foils of votive images. The brilliant minium colour was rationally chosen not to be used for surface decoration. It was well known from the medieval time that the minium was not suitable for the mural painting, as they found that minium decorated surface had been turned black of lead dioxide without exception. In addition, very little amount of cinnabar in the layer of minium was found, detected in the clothes of saints painted in the nave of Bolniţa, though it is not clear if it was used consciously or not.

Silver foil decoration was found only in Horezu (Bolniţa and Saint Apostles church). This decorative method is particularly characteristic in Bolniţa (Figure 3), as whole part of clothes of votive family and patrons are covered with silver foil, extending to the entire lower part of the western wall of the naos. Although today we see all these silver foils oxidized and weared in black, the joint lines of foils are still visible. Through microscope, unoxidized silver foils are clearly observed and SEM analysis proved that those parts have one or two layers of silver foil (Figure 4).The SEM images also proved that the surface of silver foils is chlorinated, the reason of which is yet to be studied.

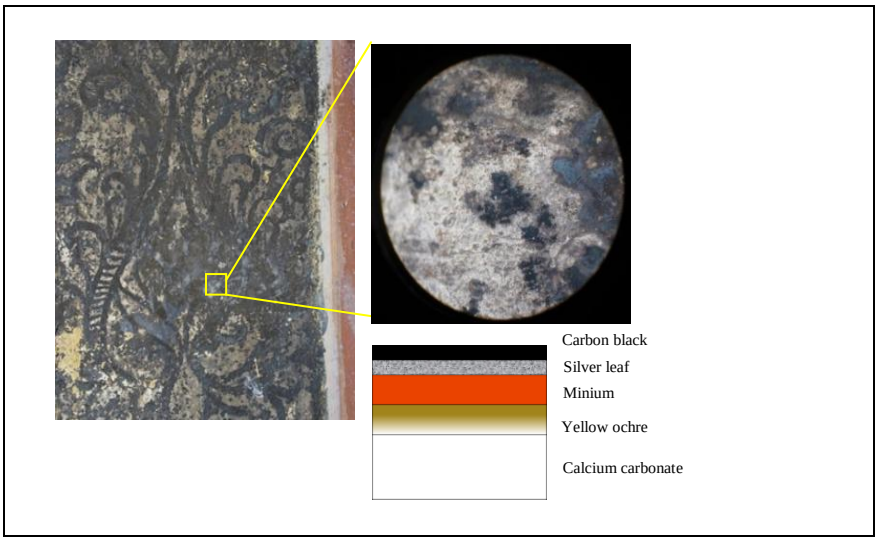


Figure 3. Detailed view of the votive image, where unoxidized remains of the silver foil decoration are still observed.

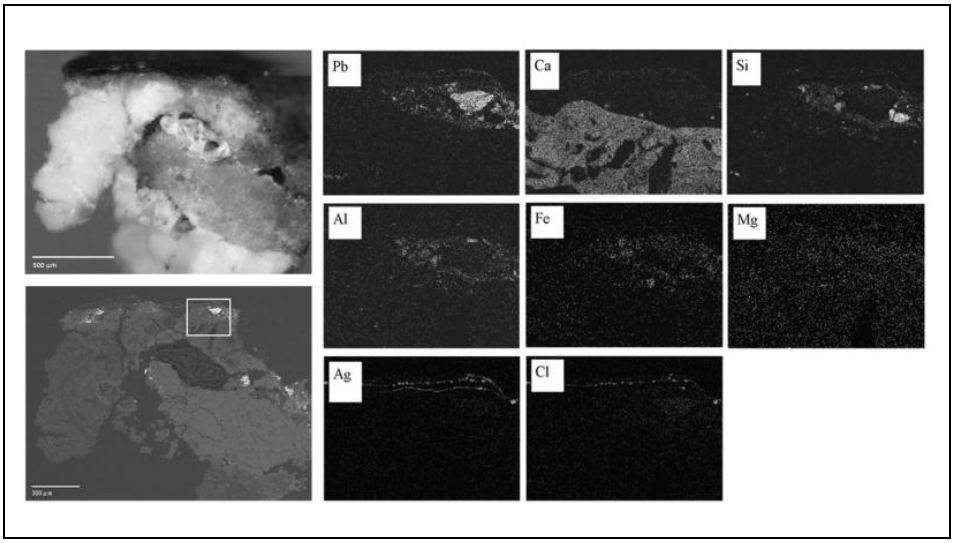


Figure 4. Optical microscope image and back scattered electron image of silver foil decoration, with 8 elements mapped separately on the right. The mapping of Ag gives the proof of silver strata.

The colour of the underlayer of the foil is not so dark as usually is in case of silver foils. Instead, it was observed a mixed red layer of minium and iron-oxide-red. The silver foils bear a decoration of fine pattern of carbon black which is not often seen on mural paintings. We know that medieval masters had already mentioned the defect of silver foils which are not suitable to be used in mural paintings because of discolouring oxidation. Despite of this common knowledge from medieval times, the silver foil decoration was selected and put

in practice in Horezu, probably because painters in charge had no other choice to depict founders and nobles used to be decorated in an exceptional gorgeous way. We may logically presume that certain economic problem went on during the construction of the monastery.

Comparing four churches built in the Horezu complex, we observe the votive image in the first one, Main church, was decorated with plenty of gold leaves, while Bolniţa and Saint Apostles' church were left decorated less gold leaves, silver foil and partially with fine patterns of iron-oxide-red, smalt and malachite for clothes. In the last one, Saint Stefan's church, the greater part was decorated with fine pattern of inorganic pigments. As far as the aureole is concerned, yellow ochre as the imitation of gold became more commonly used in the later examples. Beside the possibility of economical depression along with the construction, we may well suppose a probable transition of technique and style, which may be corroborated by the fact that the clothes of saints and nobles had already plentifully been decorated with fine patterns of inorganic materials or lime white even in older examples in Serbia or in Macedonia.

4. Conclusion

On the cultural crossroads of Western and Eastern Europe of the medieval age, relatively stable principality of Wallachia inherited and integrated Roman artistic-cultural tradition and Greek spirit of Orthodox Church. Mural paintings decorating Wallachian churches were basically painted as follows: *Buon fresco* for the first pigment layer, and then *Mezzo fresco* and/or *Secco* techniques for detail colouring layer, all in reasonable and consistent way. The decoration was as modest and simple as possible in the Altar, using only few pigments known from older times, while in the porch and naos, the decoration became more vivid and challenging, using minium as fine decoration or making from three to six layers with single pigments. Analysis on lead-tin-yellow or smalt pigment has shown that each monastery or painter's group had different recipes in producing pigments. Application of silver foil and distinction of red underlayers of metallic foil were quite unique in technique of mural paintings in Horezu.

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References

[1] J. Miyata, Annual Report of Art Restoration Studio, **21(15)** (2001) 12.