VERSITA

ACTA CHEMICA IASI, **21_2**, 71-82 (2013)

DOI: 10.2478/achi-2013-0007

Study of Archeometric Characteristics of a Panel Painted Icon Form XIXth Century

Raluca A. Cristache,[1*] Ion Sandu,[1,2] Viorica Vasilache,[1,2] Oana Cristache[1]

[1]*„Al. I. Cuza" University of Iasi, ARHEOINVEST Platform, Blvd. Carol I 11, 700506, Iasi, Romania*

[2]*Romanian Inventors Forum, Str Sf. Petru Movila 3, L11, III/3, 700089, Iasi, Romania*

Abstract: This study presents a physicochemical analysis on the orthodox icon "The grieving Mother" from XIXth century. The icon is made by an anonymus painter, in tempera pigments, on a lime wood support, *Tillia cordata.* God's Mother is represented from one side, only the bust, with the head down, framed by a white border. The predominant colors of the icon are ultramarine blue, ocher, red-brown, with silver leaf. The edges of the panel were painted with tempera pigments as the border. On the right edge an inscription in blue ink, can be seen, but is unreadable. The painting layer has gaps, fissures, detachments, dirt, degraded and scaly varnish. The panel is made from a single board, transversally cut, without crossbeams. The study is based on the identification of some archeometric characteristics of the wood panel and of the pigment layer. To determin painting materials and the conservation state, Fourier Transform Infrared

* R.A. Cristache, *e-mail*: raluca_cristache@yahoo.com

Spectroscopy (Micro-FTIR) and Scanning Electron Microscope coupled with Energy Dispersive X-ray spectroscopy (SEM-EDX) were employed. Using this methods we identify the pigments used and the state of degradation of the panel. The FTIR spectrum analysis showed that the pigment layer contains schellac varnish, ultramarine blue and dust, a conclusion supported by SEM-EDX analysis.

Keywords: icon, pigments, Optical Microscopy, Micro-FTIR, SEM-EDX.

Introduction

Over time the human artistic expression takes different forms; man expressing his life through drawings, paintings, sculptures, furniture, places of worship and palaces. The modern man tries hard to preserve all evidence of its existence and evolution. For this, science blends with art trying to provide explanations and solutions for the preservation and restoration of cultural heritage.

One of the most expressive and personal art forms is religious painting. In this study we present the analysis of some archaeometric characteristics by microscopic investigation techniques (MO), electron (SEM-EDX)[1] and infrared (micro-FTIR)[2] of a nineteenth-century Byzantine icon. The icon "Mother of Sorrows" is executed by an anonymous painter, in tempera with yolk, on linden wood, with no knowlegde on its origin, the artist's signature or date. Our study aims to identify the pigments and the making techniques used, so in the end the icon can be preserved, restored, dated and authenticated.

The icon "The grieving Mother", is known in Romania as "Lady of Rohia", is painted in a neobyzantine style, with egg tempera[3] in dark colors, the image focusing on Her face. Virgin Mary is depicted in half profile, with head bowed and eyes facing down, the image comprising only head and

bust figure. The face is painted with shades of golden ocher, white and red, and there is a ray halo around her head[4]. The cloak that covers Her is dark blue, the background beeing darker brown, gradient, light-colored around the halo (Figure 1)[5]. The Blue pigment used is proably natural ultramarine, used in antiquity and synthesized in 1823[9].

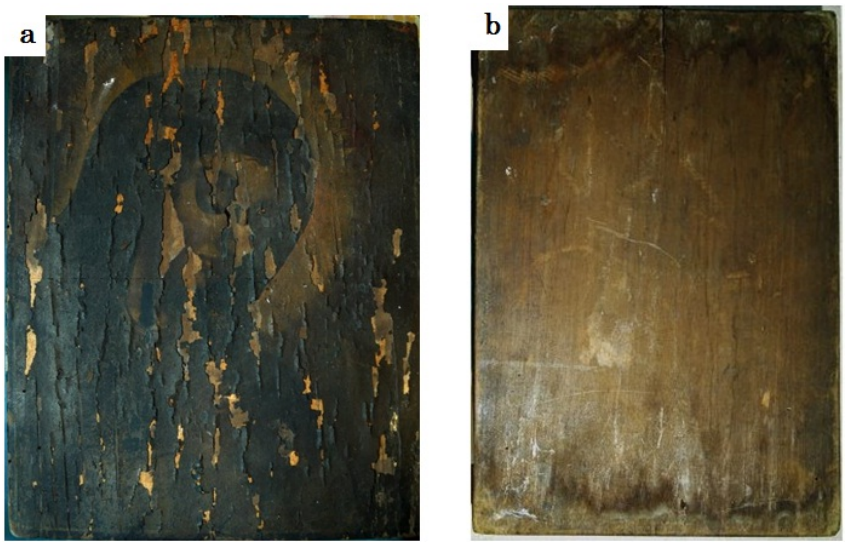

Figure 1. The icon "Lady of Sorrows", a - front, b – back.

From the point of view of the conservation state of the paint layer is very weakened, 60%, beeing separated from the support, and about 25% are gaps around which the paint layer is roof detached. The varnish is cracked and very thin, sometimes absent, and under the painting layer no ground is present. There are also 8 hatching holes from the borring insects. The panel is well preserved with low bending, showing cracks caused by wood movement in time and scratches and bluntness in corners. In the upper edge is inserted a nail with a hanger of flax or hemp.

Experimental

For the experimental analyzes, 4 samples were taken from the paint layer, fragments already detached from the halo (Figure 2a), the face (Figure 2b), the cloak (Figure 2c) and background (Figure 2d)[6].

First all samples were analyzed by light microscopy by reflection CARL ZEISS AXIO IMAGER A1m, with attached camera AXIOCAM, images being enhanced between 50x and 500x. To identify the chemical elements , we have used an electron microscope (SEM-EDX), model VEGA II LSH, made by TESCAN Czech Republic, coupled with an X-ray spectrometer QUANTAX QX2, produced by BRULER/PROENTEC Germany. FT-IR spectra were recorded with a FT-IR spectrometer coupled with a microscope HYPERION 1000, both from Brüker Optic Equipment, Germany.

Figure 2. Areas from which samples were taken for analysis:
a - halo, b - face, c - cloak and d – background.

Results and discussions

Optical microscope analysis has found new information about the varnish, pigments, metal leaf and primer used by the painter. The samples were enhanced from 50x to 500x, and observed under a microscope in reflection mode[7].

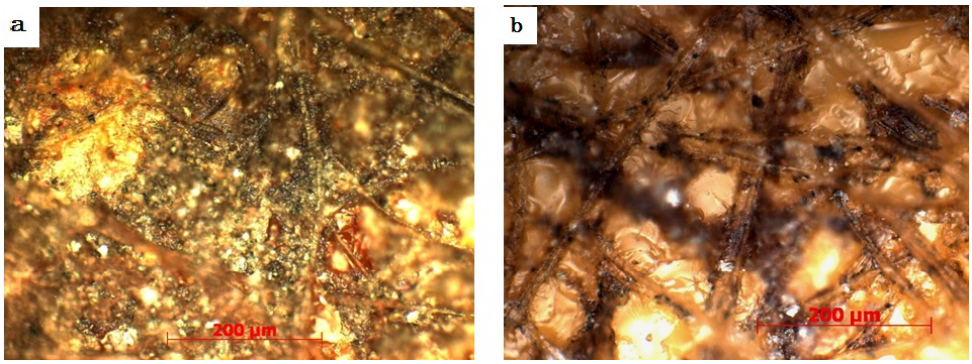

Figure 3. Images obtained from OM: a - halo detail b - face detail.

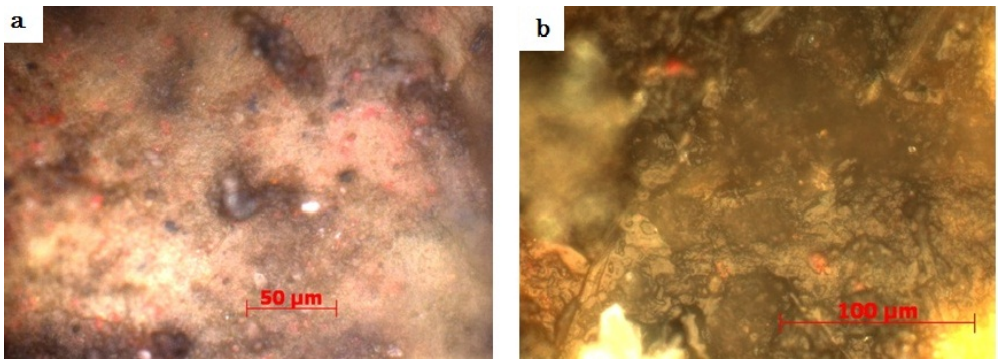

Figure 4. Images obtained from OM: a - background detail, b - cloak detail.

At a magnification of 200x, the sample from the halo area of (Figure 3a), was observed a thin layer of varnish, non-cracked, with long rays formed in the drying process star-shaped. Also the varnish has clogged dust. Under the varnish was observed the metallic leaf with high gloss, yellow in color, placed on a layer of dark pigment which has traces of red pigment. Under the thicker layer of varnish from the face (Figure 3 b), it can be seen a light colored pigment, white with ocher. The film color of the cloak and the background were enlarged by 400x, so we were able to see in the background detail, a mixture of ocher pigment, red and brown (Figure 4a), this time the varnish being much better stretched. In the detail of the cloak (Figure 4b), in an area with partially varnish, a dark color was seen, possible blue, brown, mixed with particles of red.

The SEM-EDX analysis of all 4 samples collected from the paint layer of the icon, have not detected the presence of ground. Concerning the

painting technique used in Romanian schools of iconography, on the wood panel is stretched a canvas with animal glue, covered after with layers of ground. The canvas and ground being absent, the painting was done directly on the wood surface treated with animal glue, therefore severe damages with large losses of substance occurs during the time.

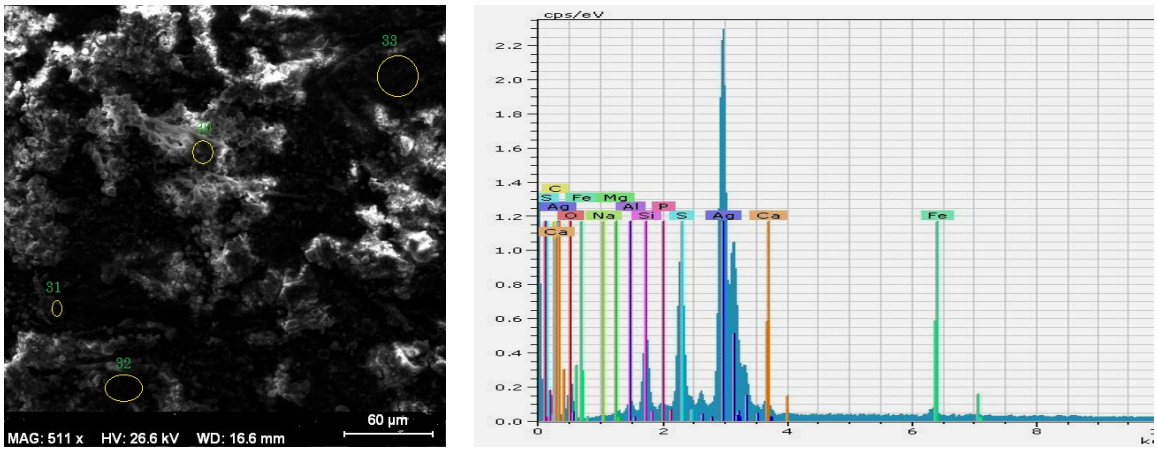

Figure 5. SEM micrograph, BSE, 500x enhancement, EDX spectrum, halo area.

A very important detail of the icon construction is the usage of metal leaf at the Virgin Mary's halo. Since the halo rays are visible only under a microscope and appear to be in gold leaf, EDX spectrum shows that it is actually silver leaf (Figure 5) covered with varnish.

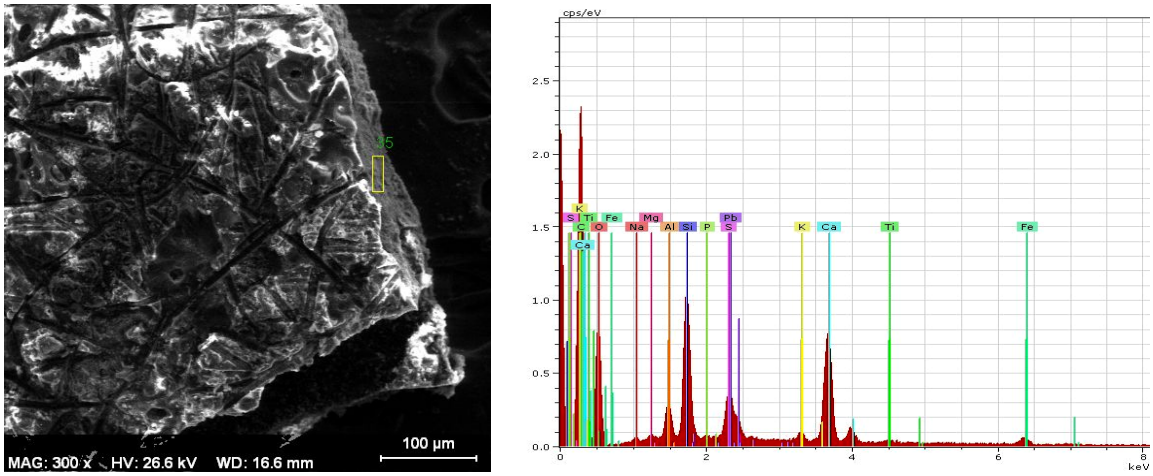

Figure 6. SEM micrograph, BSE, 500x enhancement, EDX spectrum, face area.

Certain chemicals such as Si, Ca, Al, P, Fe, K, Mg, Na, Ti, Cr, and Zn have been detected in all samples analyzed, demonstrating the use of natural earth pigments. These include ocher, red iron, green earth, and natural sienna or burned sienna. Therefore, on the icons background (Figure 7) a mixture of green earth[8] $K[(Al,FeIII),(FeII,Mg)](AlSi_3,Si_4)O_{10}(OH)_2$ and carbon black was used. The red pigment in the halo is minium Pb_3O_4 which darkened, through the action of light (Figure 5). The face of Virgin Mary was painted mostly in a mixture of white and ocher CO_3Pb lead and massicot PbO, Fe_2O_3 +4 H_2O (Figure 6)[9].

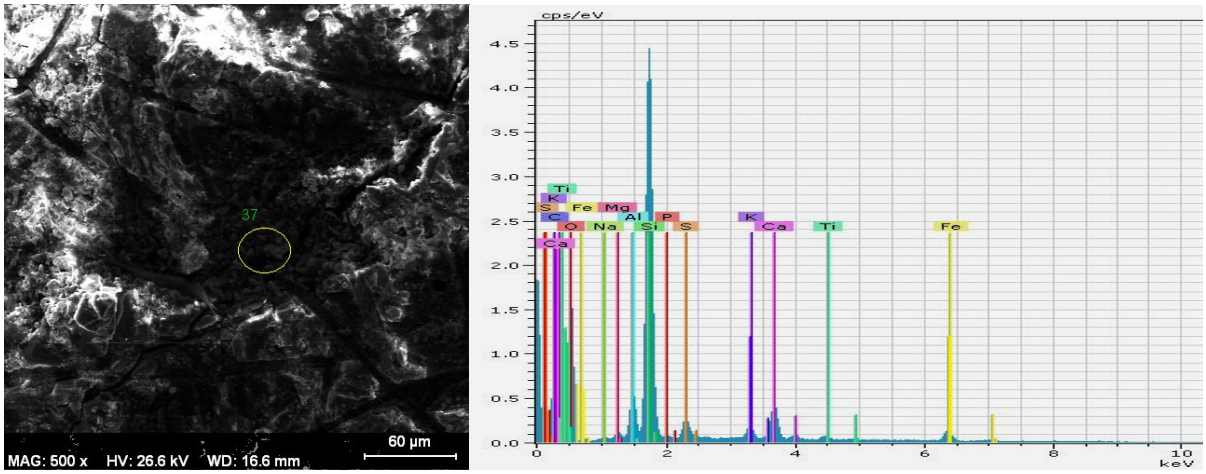

Figure 7. SEM micrograph, BSE, 500x enhancement, EDX spectrum, background area.

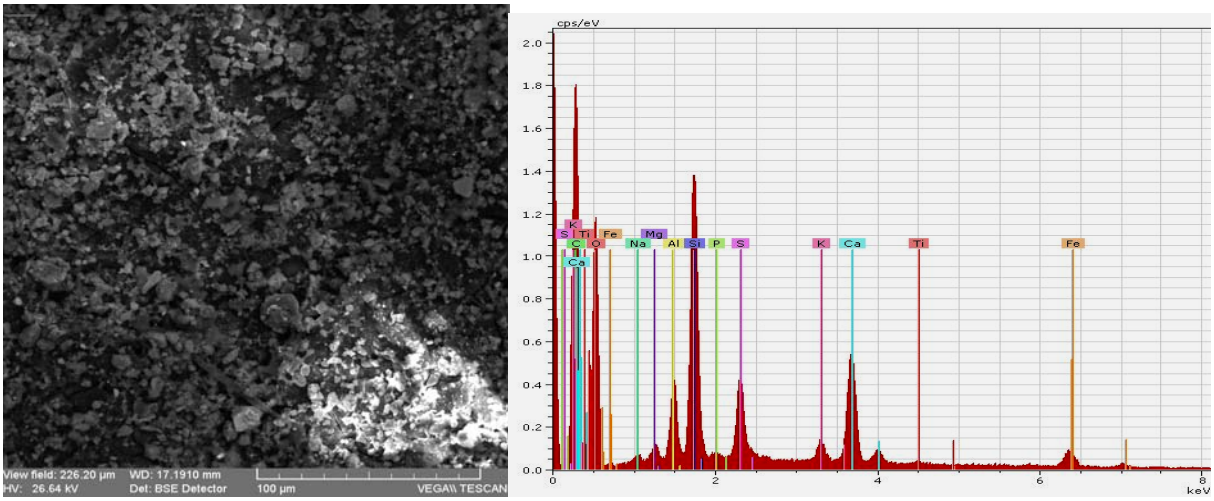

Figure 8. SEM micrograph, BSE, 500x enhancement, EDX spectrum, cloak area.

EDX analysis of the the cloak (Figure 8) detected the corresponding

elements $Na_3CaAl_3Si_3O_{12}$ S_{10} of natural ultramarine blue, made of the lapis lazuli gemstone. There also detected the earth pigments and carbon black.

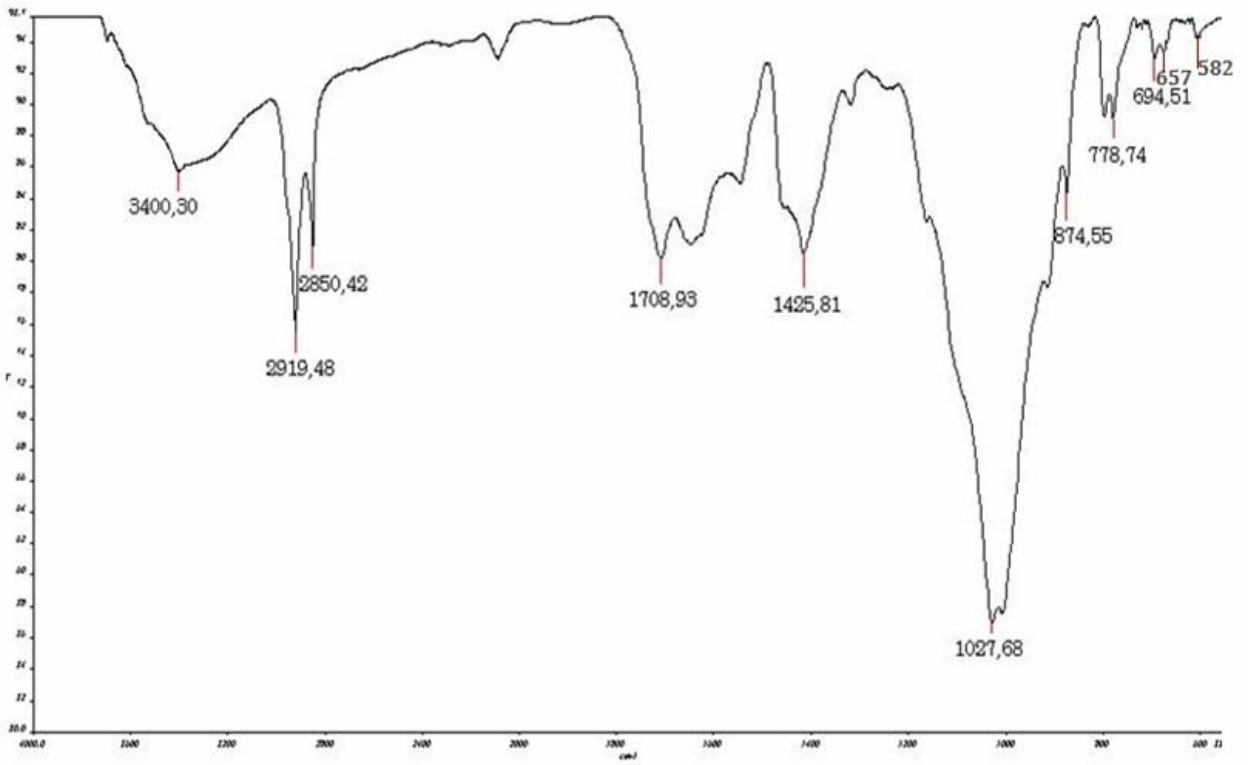

Figure 9. Micro-FTIR spectrum of the paint layer.

The FTIR spectrum analysis of the cloak (Figure 9) indicates that the paint layer contains ultramarine blue, dust and schellac. The bands that appear in the IR spectrum can be attributed, in accordance with the script of the data sampling and as in the literature[10, 11], so a very weak band and the slit 694, 657, 582cm^{-1} is specific ultramarine pigment[12]. This can be seen by comparison with the witness spectrum of ultramarine blue (figure 10). Specific bands appear well resolved, sharp at 778, 874, 1415cm^{-1} which were assigned to calcium carbonate existing in earth pigments[13]. Medium and broad bands appear at 1027, 1708, 3400cm^{-1} and were assigned according to the state of the object. Peaks at 2850cm^{-1} and 2919cm^{-1} are corresponding to an organic matter, schellac[6] and1027, 3400cm^{-1} bands being characteristic for the adherent dust to the paint layer.

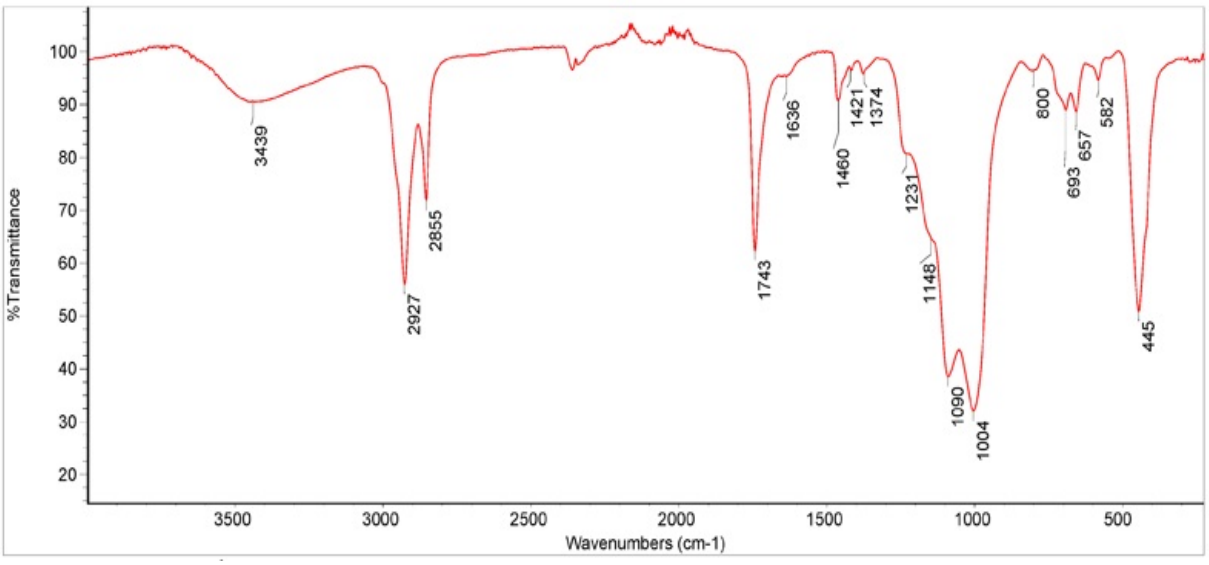

Figure 10. Micro-FTIR reference spectrum of the ultramarine blue with linseed oil[14].

According to the literature8, the chemical difference in terms between synthetic and natural ultramarine blue, it is almost absent, but this can be precisely done by analyzing pigment particles. Thus synthetic ultramarine, unlike the natural has spherical particles. As it can be seen in Figure 8, the particles of the used pigment have different sizes, with sharp edges, demonstrating the presence of natural and precious ultramarine pigment.

Conclusions

In this study we analyzed several archaeometric features as pigments used and some details of the work technique for the "The grieving Mother" icon. We determined that the used varnish is Schellac, a weak varnish, very thin and scaly. The pigments used in the painting of the studied icon are natural mineral earth colors; ocher, iron red, green earth, sienna, and white lead, massicot and minium. The presence of ultramarine blue and lapis lazuli pigment, were observed. Another important detail identified was the use of silver foil with varnish for halo-shaped rays.

According to the evidence found, the icon "The grieving Mother" is a valuable icon, which although is Orthodox, it doesn't have the particularities of Romanian iconographic school, having characteristics of the Western paintings at that time.

Acknowledgements

This work was made possible also with the financial support of the Project POSDRU/86/1.2/S/62307.

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