

NEW RESEARCH ON MATERIALS USED IN THE PAINTING OF ICONS ON GLASS IN TRANSYLVANIA IN THE XIX CENTURY

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Abstract

In Transylvania, glass icon is, by excellence, the art of peasants' artists. The painting of icons on glass has used the following types of materials: glass as support, pigments and dyes, organic binders, other additives, gold leaf and several species of wood for frames and for the back of icon. In the practice of Transylvanian art of glass icon the iconographic model have a Byzantine origin. The gilding technique using gold leafs is common for all glass-paintings workshops of Transylvania and cannot be found in other parts of the Central European glass paintings. Preparation of color and the application of local tones were made by the more experienced members of the family, and the most skilled made the drawings, writing and application of bright spots. Retouching and application of the gold leaf were made only by the head of the workshop. Our research focuses on the binders used in applying gold and silver leaf for either the icon's background, the halos, the golden thrones, the ornamentation of garments or to highlight a symbol - the cross, chalice, the earth globe kept by Jesus Pantocrator. A set of tests was developed to establish the presence of chemical elements that give us information about pictorial materials used by icons painters from the late nineteenth century.

Keywords: *Glass painting; Silver leaf; Brass powder; Colored soils; Conservation state*

Introduction

Glass painting technique came to Transylvania in the first half of the eighteenth century, with the trade of townspeople with specific Catholic religious cult objects produced in centers from Germany, Bohemia, Slovakia [1, 2]. They did not have any customs difficulties in introducing their products to local Transylvanian commodity markets. Penetration and spread of glass painting in Transylvania was possible due to socio-political context determined by the onset of Habsburg rule over Transylvania in 1699, followed by pooling part of the Orthodox Church with the Catholic Church, whose result was the United Church and Greek Catholic (1701) [3-5].

The profound changes of political, social and mentality brought about important changes in religious and secular life, with direct consequences in terms of artistic expression. Enrolling in the Austro-Hungarian Empire, Transylvania had a double influence on the Romanian people; on the one hand, it interfered with the movement of the lines of their art forms and culture of Central Europe, but being oppressed people, they had to opt for more modest means of artistic expression, making the most of them however [3-5].

In Transylvania, glass icon is, by excellence, an expression of peasants' artistic skills. Glass painting technique is relatively simple, but has some big drawbacks: that the painting is

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done in reverse order, so paint layers are applied from behind and the order is reversed. Another difficulty is due to the impossibility of retouching, and poor adhesion to glass color and, finally, that glass icons cannot be restored as easily as the ones painted on wood or painted in the secco technique [6-12].

The icons on glass are composite objects, made up of a variety of materials: glass, pigments, binders, additives, gold or silver leaf, wood and sometimes, paper, newspapers, tow, dry hay or metal. These materials have different properties and are exposed to various degradations mechanisms [13-16].

Romanian icon painters used as a support for painting, glass produced in glassware workshops of Transylvania. In workshops called “glăjării” two methods were used for the preparation of glass, depending on the raw materials used: a bottle obtained from quartz sand, limestone, and potash; other glass obtained from quartz sand, limestone and soda (this technology began to be used in the eighteenth century). Glass based on potash have a slightly yellow tint due to the iron oxide contained in the ashes of potash and cleansing sand, raw materials available in Transylvania, which differed greatly from those of Central European centers. White glass, colorless, was extremely rare in Transylvania [3-5].

Manufacturing the glass by blowing the pipe was the most common process used. Flat glass is obtained, free of air bubbles and Knot, because it could not maintain a constant high temperatures. Transgression and manual stretching of the surface area of pulp produced inequalities in the form of waves, creating a beautiful sparkle of glass, of tilt uniform plans that refract light in different angles. One reason for the beauty of Transylvanian glass icons is precisely this imperfection of glass, its surface shiny wavy and produce an optical phenomenon that gives depth complex nuances, resulting in vibrant colors. Glass was trampled flat by hand until the late nineteenth century, after which in the early twentieth century, icon painters began to use, as support for their painting, glass of industrial origin [7].

Glass was cut into small pieces, of various sizes to be transported more easily. The size of the glass plates used for icons was not standardized. Various sizes were used by different craftsmen in different centers or even in the same box, in different time periods. In centers¹ as Nicula, Gherla, amidst poor, less developed, icons were lower than in the developing of Șcheii Brașovului, as the price of glass hung heavily in the total cost of the icon [3-5].

Overview of the stages of painting on glass

The peasants were painters and they used family members as helpers in their workshops. Among them there is a distribution of labor so that operations that did not require artistic talent or special technical skills (grinding and sieving pigments, rubbing them with a pestle, preparation of adhesives, materials for paints and additives, binders and manufacture frames) were executed by family members with less experience or training. Preparation and application color local nuances were made by more experienced family members and those who most skilled and made drawings, writing and application of bright spots. Retouching and application of gold leaf were made only by the head of the workshop. In the workshops with high production, colors were applied simultaneously on several icons, to save time and materials [4, 5, 7].

Preparing the glass support for painting is achieved by removing fat with a solution that was obtained by scalding ash (lye), after which the glass was rinsed with clean water, and then dry to be painted. Many of the causes flaking layers painted on some icons are due to imperfect glass cleaning before painting [7, 9-15].

The design was copied, usually after a model was sketched (or made by free hand), being drawn in pencil, ink, ink, tempera black or red. In some cases the artist would copy or engrave prints from xylography in religious books (Fig. 1). Some craftsmen were drawing from

¹ See ANNEX - Glass painting areal centers

imagination or taking details of some models or engravings, so as to create their own compositions.



Fig. 1. Our Lady of Sorrows, drawing from the nineteenth century.²

When copying a model, artist's contribution began with the removal or introduction of details, figures or ornaments arranged in a way not to spoil the composition; the aim was to convert each image into a unique piece. This led to more distant representation from the original drawings on a variety of icons to the same subject painted by the same artist, even when they were mass produced. Some talented painters rarely used designs, being able to paint new compositions. The models were created, borrowed, copied, restored and inherited.

Pictorial materials used for icon painting on glass

Pigments used for painting icons on glass were obtained either from the sedimentary rock deposits or from other painters workshops or bought from merchants.

Raw materials from natural resources (iron salts, hydroxides and oxides of manganese and copper, cinnabar, kaolin, chalk, etc.) were cleaned, ground, sifted and washed in the peasant workshops by less qualified family members. In Romania they knew and practiced some preparation technologies described in other parts of the world but with local innovations to give excellent pigments, the whiteness of white lime or lead to synthetic cinnabar or copper acetate green [7-15].

In addition to the inorganic pigments certain organic dyes obtained from infusion or decoction of the plants were used. Some exceptional chromatic harmonies were made using colors made of organic dyes. Unfortunately, with time, they become chalky and earthy, showing their poor quality. Some icons made in the center of Laz-Sebeș are enough colorful parties only works with organic paint faded and disappeared, while only colored with inorganic pigments parties maintained their brilliance as the first day [7].

In the late nineteenth century and early twentieth century, in painting centers from Valea Sebeșului, gold leaf was replaced by bronze white or yellow. Sometimes, especially the painters of Țara Oltului, replaced the background with a sheet of silver leaf.

² Picture taken from <http://galerie.liternet.ro/mtr/#f>, 18/01/2014.

In Făgăraș centers, such as Țara Bârsei, Șcheii Brașovului organic dyes are rarely used and today extraordinary color sense peasants can be admired in icons made by them (Fig. 2).



Fig. 2. Icons on glass, beginning of the XIX-th century, Anonymous, Laz/Șcheii Brașovului, Brâncoveanu Monastery Museum, Sâmbăta de Sus, Brașov: a. Crucifixion of the Lord, b. Deisis, Icon on glass, 19. aug. 1865, c. Saint Haralambos, d. Mother of God "Lactans" (Galactophylissa), e. Saint George

At first, glass icons were painted with tempera. Colors were bought in pieces and beaten. Pigments is obtained by fine grinding of minerals in the mortar, and then dispersed in an emulsion of animal glue, egg yolk and small amounts of ox gall and vinegar. The vinegar is added to the binders for coagulation and color preservation. In other times, only the oil was contained in the emulsion added with ethyl lead as desiccant. The proportions in which they were held by mixing these ingredients iconographer experience.

Ion Mușlea [4], in his woodcuts *Icons on glass in Transylvania Romanian peasants* show their regret that they lost valuable information related to terminology and technical preparation of colors in peasant workshops: “An interesting terminology and chromatic technique could popular be collected from painters. But 30 years ago I have found only fragments, of which: black rub it with glue and «brandy spirit», otherwise not «extinguished». «Ink glue», is made from «chinuruș» (black) with some egg yolk and «wood glue juice». In the past, most durable painting was made from egg whites. Other colors are rubbed with oil («firniș»). In Valea Sebeșului «tempera, shellac, coparlac» is more use. The colors were, of course, mixed with each other, in certain doses, to achieve deliberate

shades. Like a character out pink cheek, posing in white and red. To get a lighter green, first we put yellow, then I gave the green again. The terms « bluish-grey shadows » are known”.

Brushes were bought in shops, while they were homemade blueprint for every iconographer of cat hair.

After finishing their preparation the colors were laid on the table, in a lot of small bottles, tin cans or lids. Then a glass plate of a certain size and a pattern of the same size were taken. The model would be placed on the table; the artist would put the glass over it and began to paint. First, it drew the contours and copied the model under glass. Colors were made by painters as they felt or how they were taught by their parents, respecting a certain order: first the white contours of clothes, then their folds and afterwards the figures characters. Once the colors were dried, the clothes were filled in with oil color, employed also for achieving the background.

In the vast majority of production of Transylvanian glass icons it can be found the gold background with a lavish and surreal effect that creates a transcendental space, graduating sized bodies relative to landscape or architectural elements, it detaching them and dematerializing everything that is mundane.

In the peasants glass painting’s of Transylvania, gold leaf was used either for backgrounds, the halos, the golden thrones, the ornamentation garments or to highlight a religious symbol - the cross, the Chalice, Christ Pantocrator keeping the globe.

Using gold leaf is common to all centers of Transylvania and cannot be found in other Central European glass paintings centers [16-25].

Finally, the painting was covered with a protective layer made of a mixture of linseed oil and turpentine. Its role was to allow setting better the colors and to protect the pictorial layer against moisture and also to intensify the colors.

The icons frames were often made of fir. Plum, maple, oak and walnut woods were also used. The frames were made by the village carpenter, but sometimes they were even worked by the icon painter. Frame size was adjusted to that of glass, and their width varied between 1.5 cm and 12 cm.

Some frames of icons from Șcheii Brașovului Centre were decorated with stains in tempera or oil colors, with a protection role (Fig. 3a), painted flowers on their frames, others have geometric motifs (Fig. 3b) and by drawing a comb of lines in wavy brown (Fig. 3c).



Fig. 3. Frames decorated with stains in tempera or oil colors from Icon on glass Șcheii Brașovului, Brâncoveanu Monastery Museum, Sâmbăta de Sus, Brașov: a. Detail of Emanuel in Chalice, b. Detail of Saint Haralambos (Fig. 2b), c. Detail of Saint George (Fig. 2e)

The main colors were gray, black, dark blue, purple, brown, some centers having a color preferences (for example, by the end of the nineteenth century, in the center Nicula, the frames were painted in blue with red stripes, in Iernăuți centre all the frames were only given with stains).

On the back of the frame is applied plywood or a thin wooden board's cover, to protect and strengthen frame icon (Fig. 4).



Fig. 4. Plywood on the back of the frame and overs planks placed vertically or horizontally. The covers of icons Șcheii Brașovului, Brâncoveanu Monastery warehouse, Sâmbăta de Sus, Brașov

Experimental Part

The analytical methodology adopted here studied the pictorial materials (composition and microstructural morphology) of the glass icon of the *Virgin Coronation* and other glass icons made in the late nineteenth century in the painting center of Făgăraș.

Materials

In study take a icons of *Virgin's Coronation* was performed by renowned iconographer Ioan Pop of Făgăraș, in 1862 an some fragments for other old glass icons. Currently, the glass icon is in Brâncoveanu Monastery Museum, from Sâmbăta de Sus, Brașov county (Fig. 5).



Fig. 5. Virgin Coronation, Icon on glass, 1862, Ioan Pop de Făgăraș, Brâncoveanu Monastery Museum, Sâmbăta de Sus, Brașov: a. front, b. verso

Photos presented in figure 5 below were made before the restoration icon. Delaminated pigment fragments from the glass icon painting were taken for laboratory analysis.

Between painting and wood cover, was put paper and tow, to ensure greater protection (Fig. 6).



Fig. 6. Open cover allow to see the paper covering the back of the painting

Analytical techniques

The analytical protocol made use of Axio Imager Carl Zeiss Alm optical microscope at 100X magnification, attached to an AXIOCAM digital camera and using specialized software and scanning electron microscope (SEM), model VEGA II LSH, manufactured by Czech TESCAN, coupled with an EDX detector type QUANTAX QX2, manufactured by BRUKER/ROENTEC Germany. Sample analysis by SEM-EDS was performed at 2500X magnification between 200 and with an accelerating voltage of 30 kV, and the pressure was less than 1×10^{-2} Pa. The topographic and elemental mapping images were obtained using secondary (SE) and backscattered (BSE) electrons.

Results and discussion

The EDX analysis of pigments and paper support on the back icon Coronation Virgin, made on glass, were identified following chemical elements (Table 1):

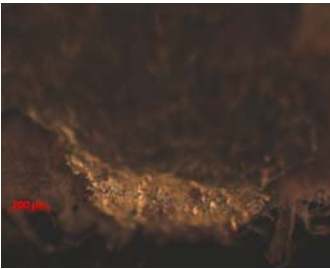
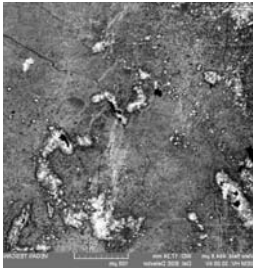
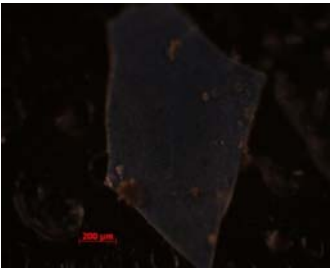
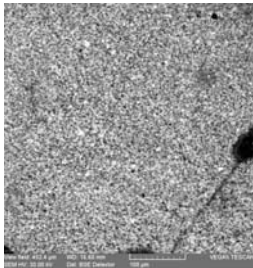

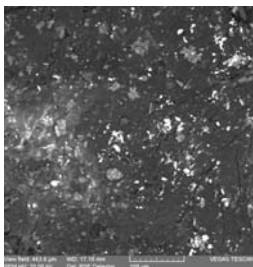

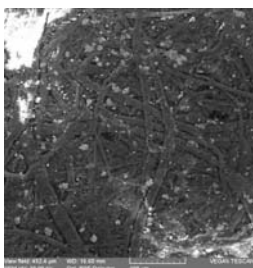
- Ag, Au, Cu, Si, Al, K, C, O gold leaf;
- Si, Al, Na, Pb, S, C, O blue;
- Si, Al, Fe, Ca, Cl, Ag, Cu, Pb, C, O Black;
- Si, Al, Fe, Ca, Mg, K, Cl, Cu, S, C, O paper.

Table 1. Elemental composition of the pigments used in icon painting Virgin Coronation and paper to protect the back of the icon

Sample	Elemental composition - weight percent														
	Si	Al	Fe	Ca	Mg	Na	K	Cl	Ag	Au	Cu	Pb	S	C	O
Gold	1.161	1.601	-	-	-	-	2.075	1.651	30.633	5.310	0.926	-	-	4.838	51.805
Blue	2.546	2.341	-	-	-	2.249	-	-	-	-	-	22.759	1.200	17.923	50.982
Black	2.165	1.444	0.923	1.271	-	-	-	0.657	2.307	-	0.538	2.845	-	15.926	71.924
Paper support	2.935	2.069	1.117	0.470	0.334	-	0.385	0.176	-	-	0.333	-	0.365	15.084	76.732

Based on elemental composition (Table 1) and morphology pigments (Table 2) were established painterly material types. Thus: gold foil is silver and is alloyed with gold and copper; blue pigment ultramarine blue is based ($3\text{Na}_2\text{O} \cdot 3\text{Al}_2\text{O}_3 \cdot 6\text{SiO}_2 \cdot 3\text{Na}_2\text{S}$) and white lead ($2\text{PbCO}_3 \cdot \text{Pb}(\text{OH})_2$); It contains black pigment ultramarine and black charcoal and paper is cellulose support (stationer) contaminated with elements of pigments used in the painting of icons on glass.

Table 2. SEM and OM images of analyze pigments for *Virgin Coronation* icon and paper to protect the back of the icon

The pigment	Method of analysis		The chemical composition in according with Table 1
	Optical microscopy (OM)	Scanning electronic microscopy (SEM)	
Golden			Silver leaf, alloyed with gold and copper
Blue			Ultramarine and lead white
Black			Ultramarine black coal
Paper			The old paper is contaminated with some elements of the composition of pigments

For comparative discussion it taken a set of samples from some glass icons made late nineteenth century to which these chemicals were identified (Table 3):

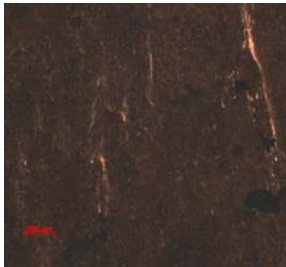
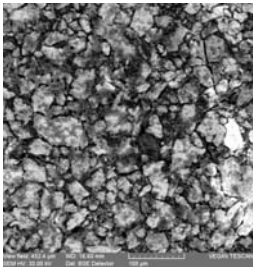
- Si, Al, Fe, Zn, Ca, Mg, Cu, Cl, K, P, S, Mn, C, O - gold;
- Si, Al, Fe, Zn, Ca, K, S, C, O - blue;
- Si, Zn, Na, K, S, B, C, O - pink beige;
- Si, Al, Fe, Zn, Ca, Mg, I, K, S, B, C, O - yellow;
- Si, Al, Fe, Zn, Ca, K, S, Ba, Cd, Co, O - violet;
- Si, Al, Fe, Zn, Ca, Cu, Na, P, Pb, C, O - orange;
- Si, Al, As, Hg, C, O - red;
- Si, Al, Fe, Zn, Ca, Mg, Na, K, P, S, B, C, A - green.

Table 3. Elemental composition of the pigments used in the painting of icons on glass made at the end of XIX-th century

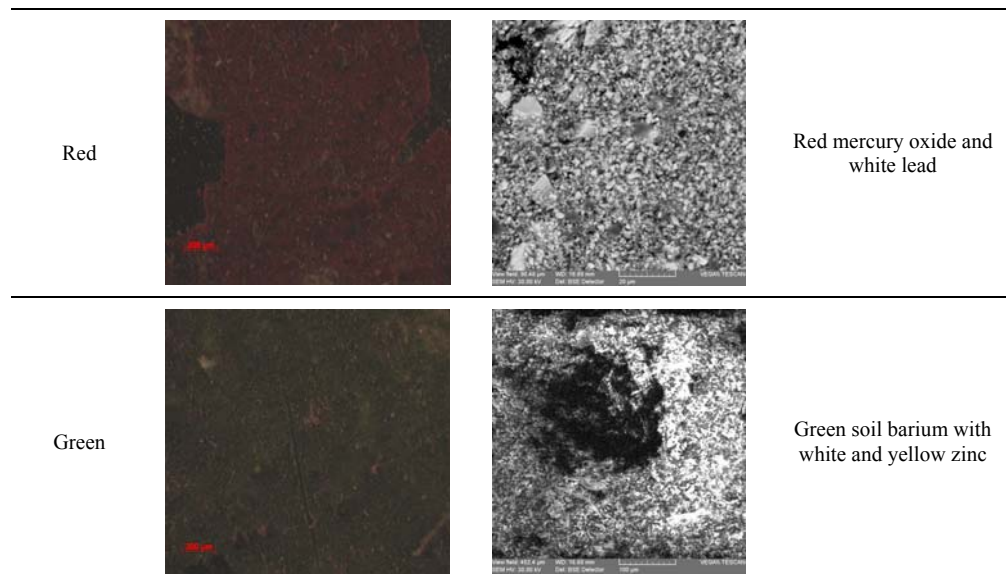
Sample	Elemental composition - weight percent																					
	Si	Al	Fe	Zn	Ca	Mg	Cu	Cl	Na	As	K	P	S	Ba	Cd	Co	Pb	Hg	Mn	C	O	
Golden	2.43	3.08	0.39	7.62	1.08	0.94	26.63	0.76	-	-	0.41	0.45	1.67	-	-	-	-	-	0.34	11.29	42.92	
Blue	0.90	0.62	3.60	27.54	0.52	-	-	-	-	-	0.78	-	-0.90	-	-	-	-	-	-	-	14.72	50.43
Pink beige	0.45	-	-	36.97	-	-	-	-	0.09	-	1.42	-	4.10	14.13	-	-	-	-	-	-	10.59	32.26
Yellow	3.71	1.93	0.68	0.58	2.57	0.32	-	-	-	1.08	0.63	-	5.83	11.46	-	-	-	-	-	-	10.99	60.23
Violet	2.06	3.71	1.09	7.15	2.09	-	-	-	-	-	0.42	-	4.09	12.35	3.80	1.54	-	-	-	-	-	61.69
Orange	0.30	0.30	0.29	0.51	0.46	-	0.52	0.28	-	-	0.02	-	-	-	-	-	38.29	-	-	-	15.33	43.71
Red	0.79	1.01	-	-	0.59	-	-	-	-	-	-	-	-	-	-	-	-	30.57	-	-	18.48	48.56
Green	3.01	1.91	0.55	1.64	1.71	0.79	-	0.50	-	0.55	0.42	2.49	4.39	-	-	-	-	-	-	-	15.60	66.43

Based on elemental composition (Table 3) and morphology pigments of other icons studied for comparison (Table 4) were established pictorial main types of materials used. Thus: bronze powder pigment is golden brass copper based zinc and containing colored soils; blue pigment is based ultramarine blue ($3\text{Na}_2\text{O} \cdot 3\text{Al}_2\text{O}_3 \cdot 6\text{SiO}_2 \cdot 3\text{Na}_2\text{S}$), lead white - Whitewash ($2\text{PbCO}_3 \cdot \text{Pb}(\text{OH})_2$) and yellow zinc - chromate and zinc phosphate ($\text{ZnCrO}_4 \cdot \text{Zn}_3(\text{PO}_4)_2$); pink - beige contains barium (BaSO_4) and yellow zinc ($\text{ZnCrO}_4 \cdot \text{Zn}_3(\text{PO}_4)_2$); yellow - yellow iron oxide ($\text{FeO} \cdot \text{H}_2\text{O}$) and white barium (BaSO_4); violet - blue enamel mixed with red iron oxide (Fe_2O_3) and white barium (BaSO_4); orange - red iron oxide (Fe_2O_3) mixed with white lead ($2\text{PbCO}_3 \cdot \text{Pb}(\text{OH})_2$); red - red mercury oxide (HgO) with white lead ($2\text{PbCO}_3 \cdot \text{Pb}(\text{OH})_2$); green - green ground (Cr_2O_3) with white barium (BaSO_4) and yellow zinc ($\text{ZnCrO}_4 \cdot \text{Zn}_3(\text{PO}_4)_2$).

Table 4. SEM and OM images of analyze pigments for some icons on glass made at the end of XIX-th century

The pigment	Method of analysis		The chemical composition of pigments in according with Table 3
	Optical Microscopy (OM)	Scanning electronic microscopy (SEM)	
Golden			Bronze copper based on zinc and colored soils

Blue			Ultramarine mixed with zinc white and yellow zinc
Pink beige			White barium and zinc yellow
Yellow			Yellow iron oxide and barium white
Violet			Blue enamel mixed with red iron oxide and barium white
Orange			Red iron oxide and white lead



Conclusion

In the nineteenth century glass icons were painted with colors tempera, made by finely grinding the pigments or various colored soils, which were then mixed with an emulsion based adhesive animal, egg yolk or small amounts of iron ox and vinegar. At other times, only the oil contained in the emulsion and lead acetate with a role of desiccant.

The proportions in which the ingredients were mixed experience held iconographer.

Although the technique of painting on glass has been taken over by other nations, Romanian icon painters developed it according to their own artistic traditions, bringing it to unknown heights recognized by researchers worldwide. Their originality and style are impressive unit and shown in choosing colors instinct speaks perfect artisans, who have left their mark on Romanian folk art.

The study revealed the main pigments used in icon in the study by comparison with other pigments used glass icons of the nineteenth century.

Acknowledgements

This work was supported by Laboratory of Scientific Investigation and Cultural Heritage Conservation ARHEOINVEST Interdisciplinary Platform, „A.I.Cuza” University of Iasi, Romania and Restoration Center of glass icons *Brâncoveanu* Monastery, Sâmbăta de Sus, Braşov county, Romania.

References

- [1] A. Kalinova, *Malovane Nebe – Obrazy na skle ze sbirek Etnografickeho ustavu Moravskeho Muzea*, Moravske zemske museum, Brno, 2009.

- [2] * * *, **Glas – Glanz – Farbe, Vielfalt barocker Hinterglaskunst im Europa des 17. und 18. Jahrhunderts**, Schloßmuseum Murnau, 1997.
- [3] M. Mihalcu, M.D. Leonida, **Din tainele iconarilor români de altădată**, Ed. Eikon, Cluj-Napoca, 2009.
- [4] I. Muşlea, **Icoanele pe sticlă și xilogravurile țăranilor români din Transilvania**, Ed. „Grai și Suflet – Cultura Națională”, București, 1995.
- [5] S.T. Rosca, *The Transylvanian Glass Icon Themes*, **PhD. Thesis**, Babes-Bolyai University of Cluj-Napoca, 2008, p. 544.
- [6] L. Uspensky, **The Icon Theology**, Anastasia Publishing House, București, 1994.
- [7] I. Bratu, C. Marutoiu, Z. Moldovan, V.C. Marutoiu, L. Trosan, D.T. Pop, I.C.A. Sandu, *Scientific Investigation of the Saint Elijah's Icon from Drăguș village, Brașov County for its preservation and restoration*, **Revista de Chimie** (Bucharest), **66**(10), 2015, pp. 1628-1631.
- [8] A. Baci, Z. Moldovan, I. Bratu, O.F. Marutoiu, I. Kacsó, I. Glajar, A. Hernanz, C. Marutoiu, *Comparative Study of the Painting Materials of a Series of Orthodox Icons on Wooden and Glass Support from Transylvania*, **Current Analytical Chemistry**, **6**(1), 2010, pp. 53-59.
- [9] R.A. Cristache, I.C.A. Sandu, A.M. Budu, V. Vasilache, I. Sandu, *Multi-analytical Study of an Ancient Icon on Wooden Panel*, **Revista de Chimie** (Bucharest), **66**(3), 2015, pp. 348-352.
- [10] S. Hrdlickova Kuckova, M.C. Krizkova, C.L.C. Pereira, R. Hynek, O. Lavrova, T. Busani, L.C. Branco, I.C.A. Sandu, *Assessment of Green Cleaning Effectiveness on Polychrome Surfaces by MALDI-TOF Mass Spectrometry and Microscopic Imaging* **Microscopy Research and Technique**, **77**(8), 2014, pp. 574-585.
- [11] I. Bratu, Z. Moldovan, I. Kacsó, C. Marutoiu, L. Trosan, V.C. Marutoiu, *A Transylvanian Diptych Wooden Icon: Wooden Support and Painting Materials Investigations*, **Revista de Chimie** (Bucharest), **64**(5), 2013, pp. 524-528.
- [12] I. Bratu, C. Marutoiu, L. Trosan, Z. Moldovan, I. Kacsó, D. Toader, *Complex Investigation of Component Materials of Triptych Icon "Mother of God" from the Patrimony of Ethnographic Museum of Transylvania*, **Revue Roumaine de Chimie**, **59**(11-12), 2014, pp. 1003-1008.
- [13] S. Kuckova, I.C.A. Sandu, M. Crhova, R. Hynek, I. Fogas, S. Schafer, *Protein identification and localization using mass spectrometry and staining tests in cross-sections of polychrome samples*, **Journal of Cultural Heritage**, **14**, 2013, pp. 31-37.
- [14] C. Marutoiu, I. Bratu, A.M. Budu, O.F. Marutoiu, C. Neamtu, C. Tanaselia, I. Kacsó, I.C.A. Sandu, *Evaluation of Conservation State by Analysis of Imperial Gates' Constituent Materials Belonging to a Aschileu Mic Wooden Church, Cluj County*, **Revista de Chimie** (Bucharest), **66**(7), 2015, pp. 992-996.
- [15] C. Pereira, T. Busani, L.C. Branco, I. Joosten, I.C.A. Sandu, *Nondestructive Characterization and Enzyme Cleaning of Painted Surfaces: Assessment from the Macro to Nano Level*, **Microscopy and Microanalysis**, **19**(6), 2013, pp. 1632-1644.

- [16] I.C.A. Sandu, S. Bracci, M. Loberfaro, I. Sandu, *Integrated Methodology for the Evaluation of Cleaning Effectiveness in Two Russian Icons (16th-17th Centuries)*, **Microscopy Research and Technique**, **73**(8), 2010, pp. 752-760.
- [17] I.C.A. Sandu, L.U. Afonso, E. Murta, M.H. de Sa, *Gilding Techniques in Religious Art Between East and West, 14th -18th Centuries*, **International Journal of Conservation Science**, **1**(1), 2010, pp. 47-62.
- [18] I.C.A.Sandu, T. Busani, M.H. de Sa, *The surface behavior of gilding layer imitations on polychrome artefacts of cultural heritage*, **Surface and Interface Analysis**, **43**(8)SI, 2010, pp. 1171-1181.
- [19] I.C.A. Sandu, H.M. de Sa, M.C. Pereira, *Ancient 'gilded' art objects from European cultural heritage: a review on different scales of characterization*, **Surface and Interface Analysis**, **43**(8) (SI), 2011, pp. 1134-1151.
- [20] I.C.A. Sandu, E. Murta, R. Veiga, V.S.F. Muralha, M. Pereira, S. Kuckova, T. Busani, *An innovative, interdisciplinary, and multi-technique study of gilding and painting techniques in the decoration of the main altarpiece of Miranda do Douro Cathedral (XVII-XVIIIth centuries, Portugal)*, **Microscopy Research and Technique**, **76**(7), 2013, pp. 733-743.
- [21] I.C.A. Sandu, S. Bracci, I. Sandu, M. Loberfaro, *Integrated Analytical Study for the Authentication of Five Russian Icons (XVI-XVII centuries)*, **Microscopy Research and Technique**, **72**(10), 2009, pp. 755-765.
- [22] C. Marutoiu, S.P. Grapini, A. Baci, M. Miclaus, V.C. Marutoiu, S. Dreve, I. Kacso, I. Bratu, *Scientific Investigations of a 16th Century Stall Belonging to the Evangelic Church in Bistrita, Bistrita-Nasaud County, Romania*, **Journal of Spectroscopy**, 2013, Article ID 957456, <http://dx.doi.org/10.1155/2013/957456>.
- [23] C. Marutoiu, I. Bratu, A. Trifa, M. Botis, V.C. Marutoiu, *FTIR Analysis of Painting Materials from the Church Saint Paraschiva, of Poienile Izei, Maramures, Romania*, **International Journal of Conservation Science**, **2**(1), 2011, pp. 29-35.
- [24] R.A. Cristache, I.C.A. Sandu, A.E. Simionescu, V. Vasilache, A.M. Budu, I. Sandu, *Multi-analytical Study of the Paint Layers Used in Authentication of Icon from XIXth Century*, **Revista de Chimie** (Bucharest), **66**(7), 2015, pp. 1034-1037.
- [25] Z.I. Glavcheva, D.Y. Yancheva, Y.K. Kancheva, E.A. Velcheva, B.A. Stamboliyska, *Development of FTIR spectra database of reference art and archaeological materials*, **Bulgarian Chemical Communication**, **46**(SI A), 2014, pp. 164-169.

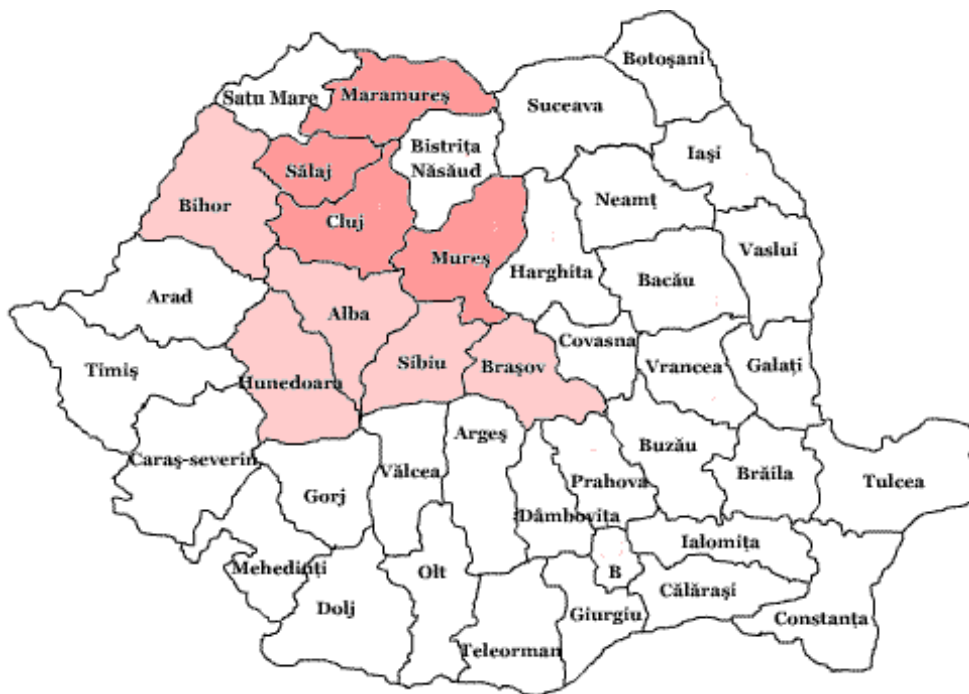
Received: July, 28, 2015

Accepted: September, 14, 2015

ANNEX

The centers of glass painting in Transylvania - Romania

1. Cluj county – villages: Nicula, Hăjdate, Gherla;
2. Mureș county – villages: Iernuțeni;
3. Alba county – villages: Laz, Lancrăm, Săsciori, Sebeș, Rahău, Maierii Albei Iulia;
4. Sibiu county – villages: Mărginimea Sibiului (Săliște, Vale), Arpașul de Sus, Rășinari, Cârțișoara, Țara Oltului;
5. Brașov county – villages: Țara Bârsei (Șcheii Brașovului, Săcele), Țara Făgărașului;
6. Hunedoara county – villages: Hațeg, Sibișel;
7. Sălaj county – village Căpâlna;
8. Maramureș county;
9. Bihor county.



The Romanian map with the studied centers in Transylvania.