MATERIAL INVESTIGATION OF THE LATE GOTHIC POLYCHROMY OF THE NATIVITY RELIEF FROM THE CORONA SANCTAE MARIAE MONASTERY IN TŘEBAŘOV IN MORAVIA

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Abstract

The paper deals with the results of material research of the superb monumental relief depicting the Nativity of Christ from the National Gallery in Prague. It represents an important artwork originating in the first quarter of the 16th century in the renowned workshop in Olomouc. The Master active there was presumably trained in the famous workshop of Jacob Beinhart in Wrocław. According to the art-historical research, the two studios may conceivably have had an intensive mutual cultural influence. It is possible that certain specifics in the material composition of pigments were adopted by the Olomouc Master from the Beinhart workshop.

The thorough restoration of the relief revealed the original late Gothic polychrome. Extensive laboratory examinations of the micro-samples were executed by means of optical microscopy, Scanning Electron Microscopy and X-ray Microanalysis, Micro Raman Spectroscopy and Gas Chromatography - Mass Spectrometry. The combination of methods gave a comprehensive overview of the polychrome technology, materials specific to the turn of the 15th and 16th centuries and also of the method of polychrome layering and specification of the artists' procedures within the framework of workshops. The most significant benefits of the study include confirmation of use of fluorite as an artistic pigment within the workshop as well as knowledge of metal coating technology with the subsequent use of coloured glaze layers. The analyses of binders in layers were also taken into account. The presented facts are the result of the interdisciplinary collaboration of art historian, conservator and chemist.

Introduction

The monumental relief of the *Nativity of Christ* from the collections of the National Gallery in Prague comes from the former Augustinian monastery of Corona Sanctae Mariae in Třebařov near Krasíkov in Moravia (Fig. 1).[1] In the context of late Gothic sculpture in Moravia this is an unusually interesting work, which originated in the first quarter of the 16th century in the important Olomouc workshop linked not only with Bishop Jan Thurzo and his court, but also with the person of the educated and Italian-oriented humanist Ladislav of Boskovice, on whose estate the majority of works from the workshop have been preserved. The Master active in Olomouc at this time was probably trained in Wrocław under Jacob Beinhart, who led a large workshop here in 1483─1525. According to the conclusions of art-historical research there was intensive mutual cultural exchange between the two workshops. In addition to this there were lively commercial links between Olomouc and Wrocław at this time, supported both by the Olomouc Bishop Stanislav Thurzo and by the Bishop of Wrocław, Jan Thurzo, his brother.

The high artistic quality of the relief of the *Nativity of Christ* was only revealed in the course of its thorough restoration in the years 2005-2011, within the framework of which extensive material investigation of the polychromy was also undertaken.[2] The conclusions were subsequently compared with the results of research on the polychromy of related works from the workshop of the Master of the Olomouc Madonnas and the circle of the Wrocław workshop of Jacob Beinhart.

Figure 1. The Nativity Relief from the Corona Sanctae Mariae Monastery in Třebařov. Photo©2014 National Gallery in Prague.

Around 1510 there was produced in the Olomouc workshop, among other things, the sculpture of the *Madonna of Hradčany Kobeřice*, which from the art-historical viewpoint represents the closest possible comparison with the relief of the *Nativity of Christ* (Fig. 2). The two works are linked by several similar formal traits, such as the emphasising of the muscles of the neck, similar facial types or the lock of hair filling the space between the shoulder and the neck, as well as the layout of the drapery. The tiny, precisely carved statue of the *Saint Virgin from Uhelná* (around 1510) is the only sculpture on the territory of the Czech Republic very closely connected to the works of the workshop of Jacob Beinhart of Wrocław,[3] with which the stylistic genesis of the Master of the Olomouc Madonnas is linked. The sculpture might be part of the decoration of the private chapel of the chateau in Javorník, serving occasionally as the bishop's residence. The Bishop of Wrocław, Jan Thurzo, completed its reconstruction at the beginning of the 16th century.

Figure 2. Virgin Mary of the Nativity Relief (a), Madonna from Hradčany Kobeřice (b) and St Virgin from Uhelná (c), details. Photo©2014 National Gallery in Prague.

The aim of the material research work was to contribute to the clarification of interesting technological peculiarities and customs of the two workshops and also to specify more closely the artistic relations between Olomouc and Wroclaw. The material research was carried out in two stages. A considerable part of the first stage concentrated on investigation of the relief of the *Nativity of Christ*, where it was possible to collect micro-samples within the framework of the restoration process. The second stage was based on comparative research of the *Madonna from Hradčany Kobeřice*, where the emphasis was on non-invasive analytical techniques and the collecting of micro-samples had to be considerably restricted. On the sculpture of the *Saint Virgin from Uhelná* only local fragments of secondary more recent polychromy were documented and it was not possible to compare the colour finish of the surface on the basis of the material substance.

Experimental

For the study of the chemical and mineralogical composition of the paint layers use was made of the techniques of optical microscopy, X-ray fluorescence analysis[4] and SEM/EDS element analysis. Molecular analysis was done using Raman micro-spectroscopy (MRS).[5] Analysis was performed on the individual pigment grains or in the cross-sections using the mapping mode for the identification of individual components presented in the colour layers. Binding components were analysed by the method of infrared spectroscopy with Fourier transformation (FTIR) and the method of gas chromatography with mass spectroscopy (GC-MS).

Macro-photographic documentation was performed with USB microscope AM4113ZT Dino-Lite Premier, polarized light, 1.3 Mega pixel, magnification 50×, 200×. The photos were processed in the program Dino-Capture 2.0 version 1.5.1.F.

Non-invasive element analyses were carried out using a portable X-ray fluorescence (XRF), Niton XL3t Thermo Scientific. This XRF system includes an X-ray tube with a silver target and it was operated at a voltage of 35 kV. The diameter of the investigated area was approximately 3 mm. The time of one analysis was 20-30 s. The analyses were carried out by Tomáš Čechák of the Czech Technical University in Prague, Faculty of Nuclear Sciences and Physical Engineering.

Micro-samples of the polychrome were fixed in methyl-methacrylate resin (ClaroCit, Spofacryl). After hardening the cross-sections were gradually dry-ground and polished with the abrasive material silicium carbide SiC.

Consideration of the stratigraphy was carried out on a polarising microscope Eclipse 600 Nikon in reflected and intersecting light, on a dark field and after excitation by UV light, Hg lamp, UV filter 330-380 nm and 450-490 nm. Usual magnification was 200-750×. Morphological traits of individual pigments on prepared sections were examined in intersecting polarised light in parallel (PPL) and crossed (XPL) nicols.

Standard analysis of the element composition on the sections was carried out on a scanning electron microscope with energy-dispersing detector (SEM/EDX) on the instrument JEOL JXA 50A/EDAX in the Geological Institute of the Czech Academy of Sciences. The analysis took place in a high vacuum, acceleration voltage 20 kV, BSE detector. Polished cross-section was prepared by applying a graphite coating.

Raman spectroscopy (MRS) was carried out on the layers of polychrome on the spectrometer DXR Raman Microscope from the firm of Thermo Scientific in combination with an Olympus confocal microscope with lenses 10×, 20×, 50× and 100×. Measurement took place in the range of 3300-50 cm^{-1}, using an NIR laser 780 nm and a green laser 532 nm. Spectra were evaluated in the Omnic 9 programme and compared with the spectra library.

Molecular analysis of binder materials was carried out by the FTIR method using a Bruker UFS 66v/S spectrometer with a Hyperion microscope. Miroslava Novotná of the Institute of Chemical Technology in Prague carried out analysis directly on the sections.

Gas chromatography-mass spectrometry (GC-MS) analyses were performed on a 6890N gas chromatograph connected to a quadrupole mass spectrometer, model 5973N (both Agilent

Technologies, USA) at the Conservation Science Department, Kunsthistorisches Museum Vienna. The samples were tested for the presence of proteins as well as lipids and resins. Analyses of proteinaceous materials are based on an acidic hydrolysis (6M HCl) of proteins to liberate amino acids, followed by the derivatisation (with MTBSTFA silylation reagent in pyridine – pyridine hydrochloride mixture) and quantitative determination of amino acids as their silyl derivatives. The procedure for analyses of lipids and resins is based on the esterification of fatty acids or resinous acids by methylation reagent Meth-Prep II and the determination of their relative ratios to identify particular lipids or resins, respectively.[6]

Results and discussion

The research concentrated in particular on the identification of the original historical materials and techniques and on seeking identical correlation traits of polychromes carried out on all the works investigated.

One of the main benefits was the comparison of the construction of the flesh painting. Both on the relief of the *Nativity of Christ*, and on the *Madonna from Hradčany Kobeřice* the stratigraphy and morphology of the pigments used in the original polychrome of the flesh area are identical in character. On the chalk ground, which is separated from the colour layers by an organic insulating layer, lies an almost pure white layer of lead white in which fine and very tiny particles of vermilion are dispersed. This resulted in a soft matt tone of the light-coloured flesh. The faces of the Madonnas are painted with a stronger pink colour mixture, containing a greater amount of vermilion and with local use of blue azurite. A stronger tone is used in a graduated manner on the faces of the Virgin Mary, Jesus and other figures on the relief. In the over-paintings of the *Madonna from Hradčany Koběřice* lead white and vermilion were also identified, but the particles are considerably larger and coarser.[7]

Figure 3. Detail, cross-section and macro-photo of the gilding of the drapery: a) Virgin Mary of the Nativity Relief, b) Madonna from Hradčany Kobeřice. Photo©2014 National Gallery in Prague.

Considerable similarities occur on the gilding of both carvings, which is carried out in gold leaf on a red-orange bole. The bole has a very warm tone, achieved by the combination of the clays and ochres used, ranging from red to a warm yellow shade (Fig. 3). MRS showed, apart from the clays, the admixture of natural anatase (TiO_2). The Virgin Mary on the relief of the *Nativity of Christ* has a robe decorated with a floral motif executed in carbon black on a yellow layer containing lead-tin yellow (type I),[8] whereas the dress of the *Madonna from Hradčany Kobeřice* is gilded. Metal applied to both parts of clothing (dress and cloak) in the same manner is not typical, more often the colour of the clothing differs.

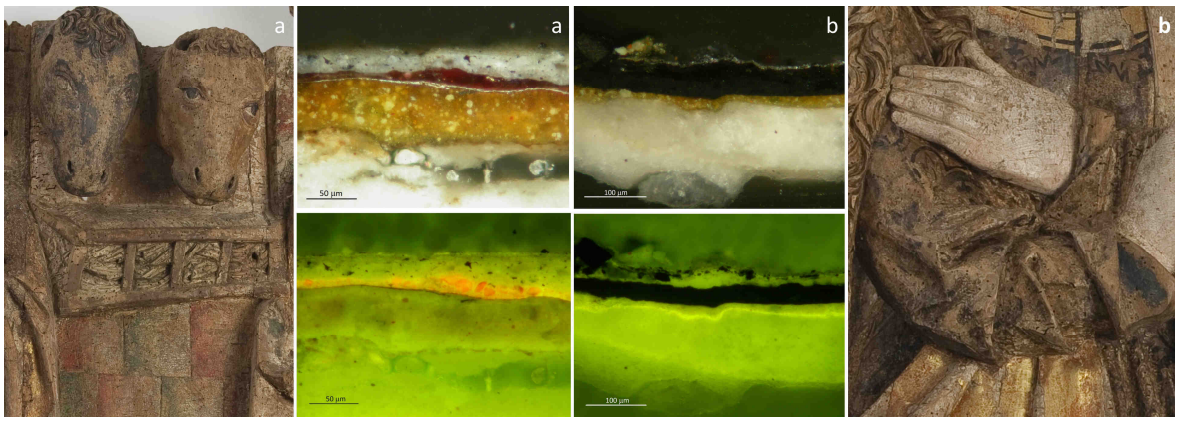

Figure 4. The Nativity Relief: a) detail and samples from the silvering of the background of the stable. Cross-section showing silver on mordant, which has a warm yellow shade and red coloured glazes containing red lake with admixture of vermilion; b) detail and cross-section of the robe decorated with a floral motif showing layer containing lead-tin yellow (type I) and final black layer. Photo©2014 National Gallery in Prague.

The colour shaping of the background of the stable beneath the manger on the relief of the *Nativity* is created by a different technique. On the surface of the carving representing the wall the silvering is applied on a chalk ground and insulation with leaf silver on mordant, which has a warm yellow shade. The silvered bricks were then shaded with coloured glazes, alternating red and green, creating a chessboard pattern (Fig. 4). In the red glazes the FTIR analysis identified red lake, probably carmine with a small admixture of vermilion. The mordant, like the polychrome of the Virgin Mary's clothing, contains lead-tin yellow (type I). The binder of the pigments on the relief of the *Nativity of Christ* in the coloured layers of mordant and on the clothing of the Virgin Mary was confirmed to be dominantly oil. GC-MS analysis showed the presence of walnut oil (P/S~2.2) with a marginal admixture of pine resin and beeswax. A combination of oil and resin is the binder of the layers for the mordant plating, which is already described in written historical sources and was commonly used in paintings in medieval art practice.[9] The source of the beeswax and probably also the partly present pine resin is more likely later secondary layers. Before restoration the entire relief was covered with a thick layer of dark fixing material containing resin and glue components.

Evidence of the workshop practice of the time is the use of purple fluorite (CaF_2), which was identified on the *Nativity relief* in the under-painting beneath the strong azurite layer on the reverse of the cloak of the Virgin Mary (Fig. 5). On our territory around 1500 and especially in the first quarter of the 16th century knowledge of the processing of fluorite as an additional pigment was a common part of workshop (painting) practice.[10] The use of this compact layer of purple fluorite mixed with a small amount of calcite is specific to the construction of polychromy on statues and reliefs.[11] The use of purple fluorite in the technique used for panel paintings has a different character.[12] The sequence of the individual layers and the subsequent combination of their colour effect could delicately and specifically influence the actual colour impression of the top layer of azurite. The effect of the pigment is influenced to a considerable extent by the colouring of the original mineral used and its subsequent preparation. Within the artistic techniques the most used for colour was dark-purple fluorite known as antozonite.[13] The mineralogical characteristics of fluorite vary according to where it is found. Important deposits within the framework of the Central European region were mainly in Germany.[14] Purple fluorite also occurs on the territory of the Czech Lands; formerly in connection with historical mining it was localised in the mines in Jáchymov, where mining did not begin, however, until after 1520.[15] MRS analysis shows the most probable similarity in particular with the purple fluorite from the area of Wölsendorf in Bavaria.

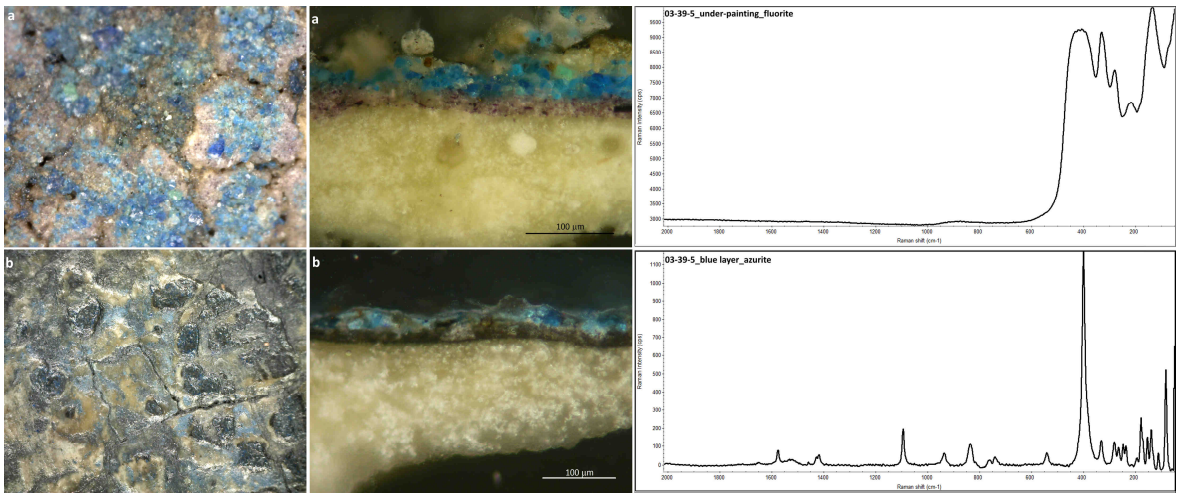

Figure 5. Macro-photos and cross-sections of samples taken from the reverse of the cloak of Virgin Mary: a) The Nativity Relief, the purple fluorite (CaF2) in the under-painting beneath the strong azurite layer. b) Madonna from Hradčany Kobeřice. The blue layer of azurite is based on a grey layer of black mixed with chalk. Raman spectra, purple fluorite of under-painting layers and azurite. Photo©2014 National Gallery in Prague.

Investigation of the binding components of the fluorite and azurite demonstrated the use in particular of egg proteins. Fig. 6a shows the chromatographic profile of amino acids confirming the presence of an egg-based medium with high percentage of leucine, serine and aspartic acid. In addition, a slight contamination with animal glue from the ground layer indicated by glycine and hydroxyproline is also visible. The presence of glycerol is attributed to lipids, which were subsequently analysed as depicted in Fig 6b. Confirmation of cholesterol besides the presence of fatty acids (P/S~3) is typical for egg. The increased amount of azelaic acid (A/P~0.25) declares that, apart from the esters of fatty acids from the egg yolk, there is also a smaller quantity of oil binder present. Furthermore, diterpenes such as dehydroabietic acid (DHA) and 7-oxo-DHA and their oxidation products were recorded, which represents pine resin (*Pinus* species).[16] This finding of a different basis of binding components compared with the finding on the clothing of the Virgin Mary is fully in keeping with the mineralogical properties of fluorite, which thanks to its low refraction index (n=1.433) has very low covering ability in binders on the basis of oils (linseed oil: n=1.484, walnut oil: n=1.4692). To increase the covering ability it was necessary to use a protein-based binder, which increased the covering ability and the colour strength and thus had a greater impact on the resulting colours.

On the reverse side of the cloak of the *Madonna from Hradčany Kobeřice* the use of the same technique was not confirmed. Here, on the contrary, the construction of the layers is very classical and more typical of the whole Gothic period, where the blue layer of azurite is based on a grey layer of black mixed with chalk.

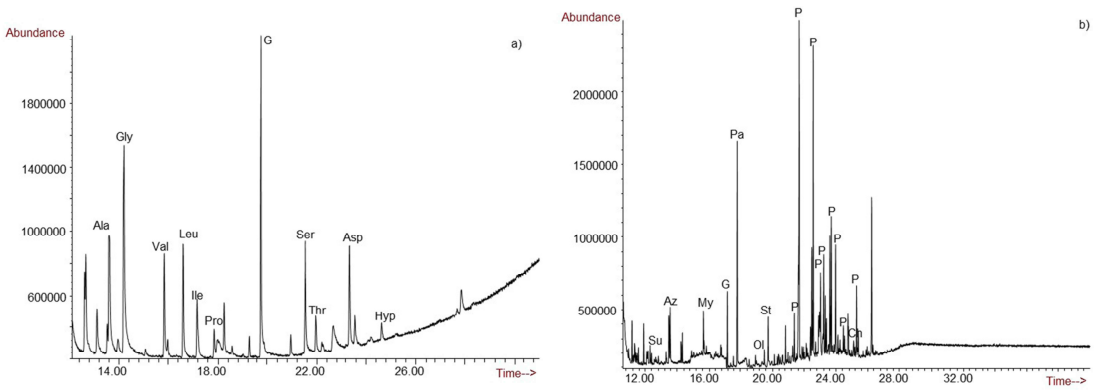

Figure 6. TIC chromatograms of blue paint layer after hydrolysis (a) and after methylation (b) Note: amino acids (Ala...alanine, Gly...glycine, Val...valine, Leu...leucine, Ile…isoleucine, Pro…proline, Ser…serine, Thr…threonine, Asp…Aspartic acid, Hyp…hydroxyproline); G…glycerol; fatty acids (Su…suberic acid, Az…azelaic acid, Pa…palmitic acid, Ol…oleic acid, St…stearic acid); Ch…cholesterol, P…pine resin diterpenes.

Conclusions

The combination of the investigative methods used brought forward valuable information sources on the polychrome technique, including knowledge of the materials specific to the period of the second half of the 15th century and first half of the 16th century, the method of the layering of polychromy and knowledge of specific workshop procedures. Among the most important achievements of this research is the identification of the same execution of the polychromy of the flesh areas and the gilding on the relief of the *Nativity of Christ* and the sculpture of the *Madonna from Hradčany Kobeřice*. One of the basic workshop specifics is the use of purple fluorite in the under-painting on the reverse of the cloak of the Virgin Mary on the relief of the *Nativity of Christ*. Its use may have been influenced either by the arrival of foreign masters working on prestigious orders of court and bourgeois culture, or else some local masters may have become acquainted with the use of fluorite during their travels. It seems most probable that the source of the fluorite was the area of Wölsendorf in Bavaria. In workshop operation the requirements for a varying range of binders were also taken into account. On the basis of the properties of individual pigments the binder components were used specifically for different mixtures of pigments and techniques of execution (such as gilding).

The sophisticated execution of the polychromy on the relief of *Christ's Nativity* is evidence of developing painting techniques and the contemporary popularity of distinctive treatment of polychromy. The whole range of colours and the use of the contrast of the delicate pale skin tones and warm areas of gilding and polychrome painting on parts of the clothing and on the background reflect the high demands made on the resulting aesthetic quality of execution. The delicate colouring of glazes enabled the graduated perception of plated surfaces, colour intensification and augmentation of the carving of the relief. The notes presented can also create a wider base for comparative studies of historical late Gothic technologies of polychrome sculptures originating in the cultural-historical contexts of Central Europe.

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