POLISH CONSERVATORS-RESTORERS IN ZHOVKVA CASTLE, UKRAINE

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Zhovkva Castle (Western Ukraine) together with the city of Zhovka was founded in 1597 by Stanislaw Zolkiewski. At the end of the 17th century, his great-grandson Jan Sobieski, the future king of Poland, made the Zhovkva Castle his official residence. In 2011, Polish conservators-restorers discovered wall paintings that presumably are contemporary to Zolkiewski. Accompanied by thorough material studies (OM, petrographic study, SEM/EDS/WDS, FTIR, μ-XRD, nano-LC-ESI-Q-TOF), a detailed digital documentation, including the orthophotographs, and some emergency conservation works have been performed. The painter's palette consisted of calcite, white lead, massicot, red lead, vermillion, malachite and an expensive smalt with high concentration of cobalt. In blue areas, casein binder was identified, while in the red ones – egg and animal glue. To date the wall-paintings, a 14C method was applied and a stylistic analysis has been performed. Art historical and archival studies helped to interpret properly the results of instrumental analysis.

POLŠTÍ KONZERVÁTOŘI-RESTAURÁTOŘI NA ZÁMKU ZHOVKVA NA UKRAJINĚ Zámek Zhovkva (západní Ukrajina) byl založen společně s městem Zhovka v roce 1594 Stanislavem Zoliewskim. Jeho pravnuk Jan Sobieski, budoucí polský král v druhé polovině 17. století, ustanovil zámek Zhovkva jako své oficiální sídlo. Muzeum paláce krále Jana III. ve Wilanówě, s finanční podporou Ministerstva kultury a národního dědictví, se také zapojilo do průzkumu. V roce 2011 objevili polští konzervátoři-restaurátoři malby na zdi, které pravděpodobně pocházejí z dob Stanislava Zoliewského. Společně s průzkumem materiálu (pigmentů a pojiv pomocí OM, SEM/EDS, FTIR, XRD, MALDI-TOF) byla provedena podrobná digitální dokumentace včetně ortofotografií a některé restaurátorské práce. Na objevené nástěnné malby byla doposud aplikovaná metoda C14. Na příkladu Zhovkva chceme ukázat, že instrumentální analýza může sloužit jako přesvědčivá odpověď, ale zároveň chceme poukázat na další otázky, které by mohly být vyřešeny historiky umění.

1. INTRODUCTION

Zhovkva Castle is situated in Western Ukraine, 40 km from the Polish border and 30 km from Lviv. The castle was founded together with the city of Zhovka around 1597 by a nobleman and military commander of Polish-Lithuanian Commonwealth, Stanislaw Zolkiewski (1547–1620). He was following the example of his predecessor, friend and teacher, Jan Zamoyski (1542–1605) who in 1580 founded the city of Zamosc. Both cities were situated in Red Ruthenia at a distance of 100 km from each other, both were built by Italian architects (Zamosc by Bernardo Morando, Zhovkva by Paul the Lucky) and were supposed to illustrate the Renaissance concept of ideal city. Red Ruthenia was a voivodeship of the Crown of the Kingdom of Poland until the First Partition of Poland in 1772, when it fell under the Habsburg rule. After the World War I Zhovkva together with Lviv became part of the Second Republic of Poland. As a result of Yalta Conference in 1945, Zhovkva was incorporated into the Ukrainian Soviet Socialist Republic. Since 1991, when Ukraine declared its independence, the Polish Ministry of Culture and National Heritage has supported the research and conservation works in Zhovkva considering Zhovkva Castle and the impressive Collegiate Church of St. Lawrence part of Polish heritage abroad.

Fig. 1 *South-eastern wing of the Zhovkva Castle. View from the courtyard side. Arched passage. Phot. W. Holnicki*

Fig. 2 *North-western wing of the Zhovkva Castle – the palace with piano nobile. View from the courtyard side. Phot. W. Holnicki*

In 2011 the Museum of King John III's Palace at Wilanow (Warsaw) launched a research project on Zhovkva Castle. Jan III, king of Poland 1674–1696, called by the Turks after the victory in the Battle of Vienna 1683 "Lion of Lechistan", was in fact the great-grandson of Stanislas Zolkiewski. He spend in Zhovkva his childhood and in late 17th century made the Zhovkva Castle his official residence. Wilanow Palace was his summer residence in Warsaw built in 1677 for his French wife Marie Casimire Louise de la Grange d'Arquien. One of the goals of the project was to look for material traces of the King or some common points in the decoration of Zhovkva Castle and Wilanow Palace as there was a hypothesis that the same workshops could work in both residencies. The history of Zhovkva Castle is as dramatic as the history of the Ukrainian state. It was several times rebuild adapting it to the shifts in fashion and taste. The big refurbishment works were linked with the change of owners. Some of these changes are described in the inventories which served us as an archival source of information [Mojecki et al., 2012].

As a warrior, Stanislas Zolkiewski gave the building quite an austere look of a simple castle with a rectangular ground plan and four wings enclosing an inner courtyard. Sobieski added it more splendour and a hint of oriental accent, as he brought some Turkish trophies from the Battle of Vienna. He introduced wooden parquets instead of the cold stone. He filled up the walls covered with cordovans and upholstery with paintings. The next important owner, Micha[3] Kazimierz Radziwi[33] *Rybeñko* (1702–1762), was behind the biggest changes in the palace wing and the rooms' layout inside the building. One of the staircases was walled up. New stuccoes were made and the *piano nobile* acquired a rococo appearance. His Italian architect, Antonio Castello, designed a new portico to the seventeenth century *loggia*. The death of Rybeñko in 1762 marks the decline of the castle. His sons run up huge debts and the castle had to be auctioned off in 1787. The last two owners didn't invest much in the property. At the beginning of the 19th century a solemn ball in honour of Napoleon Bonaparte was organised here. It was the last moment of its grandeur. In the second half of the 19th century the castle fell into disuse and some of its parts (stone elements, bricks) were dismantled and sold out. In order to rescue the remains, the Austrian government and the local commune bought it. In 1915, a heavy fire consumed the roof. After some refurbishment works, a municipal grammar school was established in the building. It also hosted other institutions, such as: district court, prefect and army. Nowadays, it is the seat of the state Historic-Architectural Reserve in Zhovkva.

2. GOALS OF THE PROJECT

The goal of the project was to verify if, despite its chequered history, there were any old paint layers or artefacts left in the castle of Zhovka. We were also supposed to find out whether there could be any similarities between the decoration of Zhovkva Castle and Wilanow Palace, another royal residence of Sobieski. Once the paintings were discovered, a detailed study of the materials used had to be performed. Assessment of the discovered decoration included the general evaluation of its possible dating and relative significance, and the ideological program. In addition to *in situ* analysis of the complex sequence of layers, laboratory analysis of pigments, binders and plasters, a C14 analysis was executed. We cooperated with an art historian who was responsible for the stylistic evaluation. The necessary conservation works were performed. The final step was a thorough documentation of discovered paintings, inclu-ding the orthophotographs. Our foremost concern was to preserve and make the discovered heritage available to the Polish citizens.

3. OVERVIEW OF ACTIVITIES IN ZHOVKVA

3.1. Preliminary research (2012) In 2012, Polish conservators-restorers were invited to Zhovkva Castle for a research. The poor preservation state the side wings didn't offer much hope for finding anything that would bear great historical significance. Some parts of the building, such as the façade and inscriptions on the window frames, in which we were particularly interested, where difficult to access as putting scaffoldings was not an option. After a few risky attempts, we understood that a thorough investigation had not been possible in these places. Therefore we concentrated on the interiors of the main part of the castle – its palace and especially the *piano nobile*. After the preliminary examination and visual inspection, we identified areas of interest and executed over 100 'test windows' in the chosen nine rooms in order to build up a better understanding of the situation, and identify areas requiring more detailed investigations. Old paint layers were discovered in five rooms of the palace (rooms I-IV, see Fig. 3). The attempts to uncover old decoration in the main dining room (room I) were not successful as the flakes of old paint had a very bad adhesion to the lime layers on original plaster and a good adhesion to the 19th and 20th century paint layers. Persisting in uncovering the painting would cause them an irrevocable loss. Moreover, from the inventories, we knew that the walls were originally covered with cordovans, so that the coloured decoration had to be dated to the end of 18th century at the earliest. We limited our scope of work in this room to the documentation of the multiple phases of decoration. In the other rooms of *piano nobile,* not much has been found on the eye-level as the plasters kept being exchanged on regular basis. The examination of cross-sections with optical and electron microscopy confirmed that we had to do mostly with 20th century paint layers. However, in the vicinity of lime mortar and stucco chimneypiece and in the upper part of the rooms we could see some remnants of friezes partly hidden beneath later covering layers. These areas were chosen as the main goal of the research in the second stage of the project.

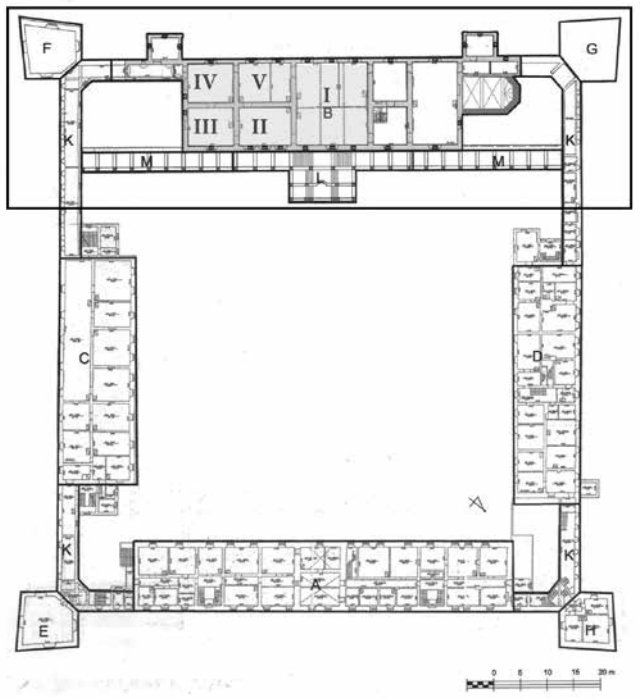

Fig. 3 *Reconstructed plan of the first floor of the castle (1671)[1]. The numbers I–IV refer to the investigated rooms discussed in the article*

Fig. 4 *Photo of the lime mortar* chimneypiece *in the room II. Test windows in the* chimneypiece *with well preserved fragments of the decoration. Phot. W. Holnicki*

The lime mortar chimneypieces were built in the 18th century. At that time the ceilings were lowered and the nails, which were holding the structure of the new ceilings, were hammered into the upper part of the painted 17th century frieze. Although it suffered from permanent and irreparable damage, this operation it from being covered with new plasters. The lower part of the friezes has been practically removed. Only some remnants survived in the typical hard to reach places, such as corners, where the likelihood of surviving historic decoration is always assumed to be high. Since during the construction of the new steal roof truss in the 20th century, the ceilings in the palace were damaged, we could see some fragments of the paint layer. These small areas of painted decoration went completely unnoticed by the current users of the building. It is mainly because, due to the poor state of preservation, this part of the castle is not visited.

In two rooms (rooms II and V), the decorative band looked very similar (the composition, colours and ornaments). Additionally, we discovered some remainss of paint on an old mortar in the place where a thin partition separating two rooms was touching perpendicularly the wall on which we found the decoration. It was the proof that originally these two rooms formed one space. Furthermore, as we could see that the original plaster and paint layer was visible behind the chimneypieces and from one of the inventories[2] we knew that the chimneypieces were already there in 1743, we could date the paint layer for the period before. The same could be said about the adjacent room (room III) in which we could see a more austere painted frieze with panoplies. And in the fourth room (room IV) that hosted the fourth chimneypiece, we discovered a monochromatic light blue layer with an illegible red ornament.

3.2. Informed choice of conservation strategy: full uncovering of the frieze (2013) The discovery of historic wall paintings does not always mean that they should be fully uncovered. We had to consider all pros and cons. Indeed, the terrible state of the building would be a factor against uncovering as we weren't able to provide appropriate conditions for the exposure of the painting in the future. In order to restore them, the castle would need huge amount of money. The factor which advocated for uncovering was first of all the aesthetic and historic value of the paintings. This discovery may actually help in raising funds. Uncovering and documenting seemed the only way to ensure the survival of the paintings. Covered with dust, easy to remove remnants could easily disappear in the big refurbishment works planned for the future.

In the third stage of the research conducted in 2013 we concentrated on careful uncovering and examination of the decorative frieze in the four rooms of the *piano nobile*. The goal was to assume its extent and protect it from any further subsequent deterioration. In two rooms (rooms II and V) we uncovered one frieze with medallions kept by allegories, and cartouches in green-red colours on the dark blue background painted on one layer of lime wash. In the adjacent room (room III) we uncovered pink-grey ornament with panoplies laying on several (up to nine) layers of lime wash. And finally in the last room (room V) we uncovered light blue monochrome layer with some remains of red ornament. All these paint decorations were found on a very smooth but wavy plaster. The heavily keying not only has affected the legibility of the decoration, but it also made the edges extremely vulnerable. Because of the poor state of the building, the leaking roof and the constantly changing temperature and humidity levels, this stage of the project was particularly important.

3.3. Conservation treatment (2013) In order to insure survival of the paintings, the necessity of an emergency intervention was evident. The edges of uncovered fragments had to be protected and sealed with the mortar. The preliminary simple non-destructive examination involving knocking to identify hollow areas was used to assess the presence of voids. In many cases it wasn't necessary to drill the application holes as it was possible to introduce the grout through the holes in the upper edge of the plasters. The preparation of the application holes consisted of cleaning from dust and debris trough aspiration, pre-wetting with water and alcohol, pre-consolidation with Haftfest water-based polymer dispersion (in the ratio 1 : 10 with water) and Primal™ AC33 (in the ratio 1:3 with water). For the final consolidation, two kinds of commercial grouts were used : PLM M and AI. PLM M was used in order to reinforce the structure of the wall, while PLM AL, known for its low molecular weight, was used to reattach the vulnerable fragments of wall painting. The surface of the paint layer was cleaned mechanically with surgical scalpels, wishab sponge, and erasers. Often, it was necessary to proceed with a pre-consolidation of powdering paint with Haftfest.

3.4. The last phase: uncovering, documenting and recovering (2014)

In 2013, in order to assess the scope of the painting and especially the bottom part we executed test windows in the lime mortar chimneypieces. The preservation of the paint layer in this place turned out to be much better. The layers of gypsum protected it from the influence of external conditions. Still the lime mortar chimneypieces are of historical value as they were executed in 18th century. The last phase consisted of dismantling the chimneypieces and executing a thorough recording of the findings. The original plan was to recover the paintings and reinstall the dismantled pieces of chimneys. Due to the decision of the owner of the castle, the dismantled pieces were described, documented and put together in the storage rooms of the museum. The museum is now working on a project of a new exhibition and the chimneys will probably be moved in order to show the discovered paintings: the portraits of a man and a strapwork ornament. This last element of our puzzle was indeed necessary to produce good documentation, including orthophotographs, with all the gathered information, and studies, accessible on the internet website. The database is already built and the website is to be launched in the near future.

4. DETAILED STUDY OF THE PAINTINGS

4.1. Material studies In order to diminish the damage caused by sampling we collected the material from the frieze and also from a couple of other elements, such as the dislodged pieces of the old cornice that were with and the flakes of the removed layers of paints.

4.1.1. Experimental methods

For the purpose of identifying materials, several analytical methods were employed, e.g. optical microscopy, SEM/EDS, FTIR, XRD, petrographic study, ***nano-LC-ESI-Q-TOF, radiocarbon analysis.***

Sample preparation

The samples for stratigraphic studies were embedded in a polyester resin, Neukadur PE 45, and polished. For the purpose of carrying out observation in transmitted light, slides with pigments were prepared using a resin with refractive index 1.66. Authors: A. Borkowski, MSc.; S. Pawełkowicz, MA

Optical microscopy

Studies of cross-sections and slides were performed with Leica DM4000 m equipped with Leica camera DFC295 and Olympus CX41 with Olympus camera UC30. Author: S. Pawełkowicz, MA

Petrographic study

Thin sections of ca. 30 µm were executed using epoxy resin with refractive index 1.54. The observations were performed with the help of polarised light microscope Zeiss Axiolab, with a digital camera Canon G2. Author: W. Bartz, Ph.D.

SEM-EDS-WDS

The morphology and elemental composition were determined with Jeol electron microscope JSM-6520 with EDS and WDS detectors from Oxford Instruments. The spectra were analysed with INCA software. In order to avoid charging, the samples analysed with WDS were coated with carbon. Quantitative analyses with WDS were executed after a preliminary standardization. For the EDS semi-quantitative no standardization has been performed. Author: Eng. P. Svora, Ph.D.

FTIR

The measurements were executed with Thermo Nicolet 6700 FT-IR spectrometer, equipped with ATR (diamond crystal, single bounce beam path, 45° incident angle) (PIKE GladiATR) and MTC/A detector. Spectra, averaged over 32 scans, were taken in the range 4000-600 cm^{-1} at a spectral resolution of 4 cm^{-1}. ATR correction was performed. Author: J. Bagniuk, MSc.

Nano-LC-ESI-Q-TOF

Analýza byla prováděna pomocí UHPLC Dionex Ultimate3000 RSLC nano (Dionex, Německoy) s hmotnostním spektrometrem s dvojitým analyzátorem ESI-Q-TOF Maxis Impact (Bruker Daltonics, Německo). Peaklisty byly ze změřených dat extrahovány programem Data Analysis 4.1 (Bruker Daltonics, Německo). Jednotlivé proteinové fragmenty byly identifikovány softwarem Mascot verze 2.4.01 (Matrix Science, Velká Británie) vyhledáváním v databázi SwissProt. Author: S. Kučkova, Dr.

μ-XRD

X-ray micro-diffraction data was collected with the PANalytical X' Pert PRO diffractometer equipped with a conventional X-ray tube (Co Kα radiation with the wavelength 1.7890 Å, 40 kV, 30 mA, point focus), a glass collimating mono-capillary with an exit diameter of 0.1 mm and a multichannel position sensitive detector (X' Celerator) with an anti-scatter shield. Diffraction patterns were recorded in the 2θ interval from 4° to 80° with a step of 0.0334° and counting time of 2,200 s per step. Qualitative-phase analysis was performed with HighScorePlus software package (PANalytical, version 2.2.5) and JCPDS PDF-2 database. Author: P. Bezdicka, RNDr. Dr.

C14

The radiocarbon dating was performed in the Radiocarbon Laboratory of the Institute of Physics, Silesian University of Technology. Author: prof. A. Pazdur.

4.2. Results and discussion

Plasters

The petrographic studies of thin sections confirmed similarity of plasters on which we found the painted decoration in all four rooms. The plaster was composed of two layers: the coarser *arriccio* and the thin layer of approximately 3 mm of *intonaco*. Quantitative analysis through point counting was performed, the volumetric proportion of aggregate, binder and void space was determined. In the *arriccio* the quantity of calcium carbonate was estimated to be approximately 60 %, while in the *intonaco* 80 %. In the plaster, we were also able to find charcoal, some pieces of wood, and some straw. No proteinaceous additive has been detected.

Green-red-dark blue frieze

The painted decoration is laying on a lime wash without any additive of proteinaceous binder. As for the pigments used, malachite, smalt, vermillion, red and white lead were identified. In one of the samples we found some yellow grains which could be presumably massicot.

Two kinds of proteinaceous binders were detected in the paint layer. In the sample taken from the dark blue background, milk proteins were identified, which might come from casein tempera. While in the sample taken from the pink area, egg and collagen proteins where identified – indicating that an egg or glue tempera paint might have been used. The use of binders explains the state of preservation of the paint layer. While the background is well visible, the red-green ornaments survived in far worse condition. Casein tempera is much more resistant than egg or glue tempera. This could be caused by the creation of calcium caseinates that are responsible for the hardening. Harder layer has better mechanical properties, less cracks, so that there is less surface for oxidation, condensation of water vapours and consequently for microbiological activity[3]. The use of a different binder for the background and different for the ornaments could be explained by the fact that casein is less susceptible to turn yellow than egg or glue binder. As the background was blue, it could significantly influence the final appearance of the painting. It is quite known that for blue pigment casein binder was used [Colombini et al., 2009]. As for the ornaments, the final effect was achieved through superposition of many layers of paint. We could still see very thin lines in the finishing layer. Application of thin (glue) tempera on the surface painted with fat (egg) tempera could be helpful to achieve very precise lines.

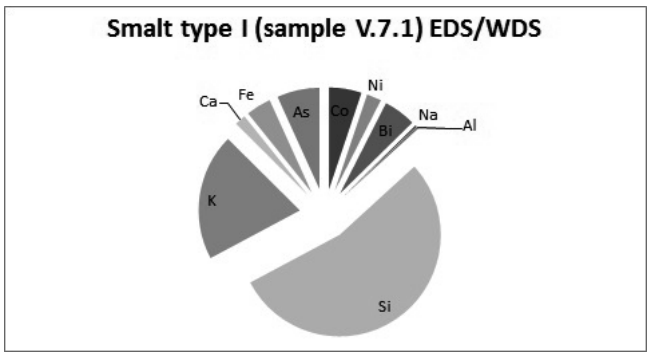

Fig. 5 *Averaged elemental composition of the dark blue smalt from EDS/WDS measurements*

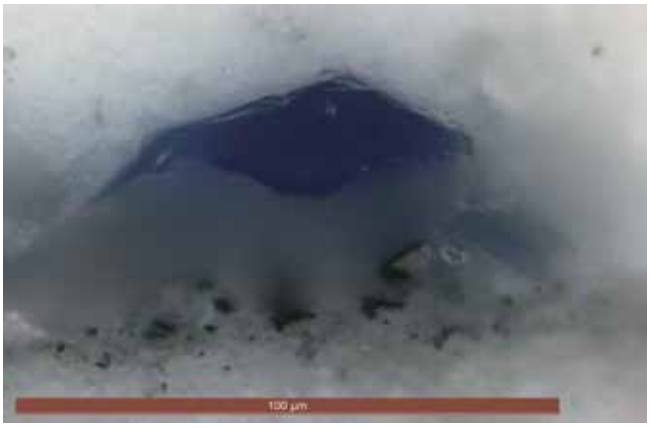

Fig. 6 *Microscopic photography of dark blue smalt. Phot. S. Pawełkowicz*

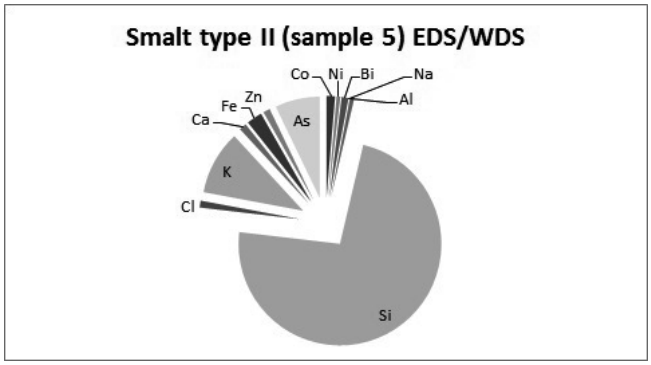

Fig. 7 *Averaged elemental composition of the light blue smalt from EDS/WDS measurements*

Fig. 8 *Microscopic photography of light blue smalt. Phot. S. Pawełkowicz.*

Pink-grey frieze

The pink paint layer is lying on several layers of lime wash – up to nine. This means that it cannot be traced back to the same period as is not contemporary with the green-red-dark blue frieze. The palette is rather limited, and composed of: red earth, charcoal and lime white. The binders' analysis showed two possible proteinaceous binders: casein and collagen.

Light blue frieze

The light blue paint layer is composed of smalt and lime wash. Some red earth was detected in the remnants of an ornament. Egg proteins were identified as a binder.

Study of smalt

Smalt was identified in two different rooms (rooms II and V *versus* room IV), in two different paintings. The elemental composition of the pigments was however completely different. Different ratios or absence of trace element might indicate the origin of the raw material used or methods of production. In the dark blue smalt, with a colour that nearly looked like ultramarine, less silica, more cobalt, and intensive peaks from bismuth and nickel were detected. While the light blue particles contained minor quantities of cobalt, zinc and nickel, whereby bismuth was only detectable with WDS detector. In the dark blue smalt the average quantity of cobalt was 5.23 % (WDS) and 5.66 % (with EDS), while in light blue 1.84 % (WDS) and 1. 52% (EDS).

Smalt is a synthetic cobalt and potassium containing silicate glass which was extensively used in all types of artwork. In Europe, smalt was originally used by glassmakers to produce blue-coloured glass. The oldest evidence of smalt used as the painting pigment can be traced back to as early as the mid-14th century [Richter, 2004].The peak of its use in painting dates back to 16th–18th century [Mühlethaler and Thissen, 1993]. The discovery of Prussian blue in the early 18th century made smalt gradually disappear from painters´ palettes.

To produce smalt, cobalt oxide, obtained by roasting the original ore, and sand or quartz were melted together with the addition of potash (K_2CO_3). The mixture of cobalt oxide and quartz was called *zaffre*. According to Mühlethaler and Thissen (1993) the most common raw material used for smalt production was the mineral obsoletely called *smaltite* (Co, Fe, Ni)As_{3-2}, an As-deficient *skutterudite*. In the 17th and 18th centuries associated minerals *erythrite* $(Co, Ni)_3(AsO_4)_2.8H_2O$ and *cobaltite* CoAsS were probably also in use (Mühlethaler and Thissen, 1993).

Smalt production was mostly concentrated close to available raw materials. Cobalt ores occur in several regions in Europe – England, Spain, Sweden and Germany (Saxony). Saxony is reported to have been the main source of cobalt for smalt pigment in the past even though the pigment itself was produced on a large scale also in England and the Netherlands [Kirkby et al., 2009].

Tracing the provenance of smalt pigment in an artwork would be quite challenging as all the above mentioned raw materials often contain similar elements as impurities. In many deposits common impurities in skutterudite can be: Ag, Bi, Cu, Fe, Pb, S, Zn. Cobaltite frequently contains: Cu, Fe, Ni, Pb and Sb. It is therefore difficult to distinguish elements typical for specific localities or regions. Ratios of elements can also change during ore processing (e.g. volatilisation of As during ore roasting which was an intentional process), pigment production (different hues of smalt available in the market were achieved by varying cobalt oxide to sand/quartz ratio in the zaffre [Richter, 2004]) or as a result of degradation processes. Nevertheless according to Richter [2004] cobaltite and smaltite from Saxony, Bohemia, Schwarzwald and Hessen is rich in arsenic. Riederer [1968] noticed some areal differences. Na- and Ag containing smalts were found only in paintings of Dutch and German provenance, while Italian paintings did not include smalt containing these elements. Yet, he admitted that the number of analysed samples is too low to generalise.

Basing on this literature research, we might assume that the smalt from Zhovkva Castle could be linked with Italian production rather than German or Dutch, as no silver was detected. More detailed studies should be done to make such an attribution reliable and sound. A thorough investigation on the subject of smalt production is needed. The only fact that we can state is that big quantity of cobalt in the dark blue smalt meant it was a very expensive material.

A comparative study was executed with two large scale easel paintings painted in 1684–1693 [Petrus, 2012] in Zhovka Castle by an Italian painter, Martino Altomonte, for King Jan III. The smalt from Altomonte paintings showed no resemblance to the expensive pigment from the green-red-dark blue frieze in rooms II and V. Moreover, the green pigment used by Altomonte was not malachite, as was the case of the painted frieze, but green earth [Szpor et al., 2013]. Because the pigments were expensive, they were often ordered by the commissioner. We could assume that if any big painting works were taking place in the palace, the whole workshops could presumably use the same pigments. This is not always true, as the expensive pigments could be reserved only for the most representative paintings. It was also confirmed that one painter could use two kinds of smalt in one painting: a cheaper one for undercoats and a more expensive one for the finishing layers. Nevertheless, this study was a further argument that the green-red-dark blue frieze in rooms II and V was probably not contemporary with the Altomonte paintings, so it would have been created before the rule of Jan III. In order to confirm it, we executed C14 analysis.

C14

Three samples of organic material from the plasters were analysed to estimate the age through the decay of carbon 14 isotope. These were: one straw, one burnt piece of wood, and probably a reed that we took for a straw. Unfortunately, a botanical study wasn't performed before the samples were sent to the Radiocarbon Laboratory. Anyway, the results for all three samples indicated a date before the Jan III's rule, so before 1674. Of course, these were the dates of the organic additives of the plasters and not the dates the paintings were made. As the result of radiocarbon dating, we received some ranges of calendar age. Historical and art historical studies helped us to choose the most relevant results. With regard to the burnt wood the estimated ranges of calendar age, with 68.2 % confidence were 1442–1466, so long before the construction of the castle (1594 at the earliest). Probably, this piece of wood wasn't coming from the external rings of a tree, and this could be the source of an error. With the straw sample the result was much more probable: 1544–1601 (ranges of calendar age with 68.2 % confidence level), and 1482–1642 (ranges of calendar age with 95.4 % confidence level). In case of the reed or straw sample, the statistically less probable result turned out to be the most probable from the point of view of the art history and the history of the castle. Ranges of calendar age with 95.4 % confidence level were: 1442–1512 (85.4 %) and 1601–1617 (10%). Even though we didn't receive a simple answer to our question about the age of the painting, the radiocarbon dating permitted us to date back, at least the plasters, to the time before the rule of Jan III.

4.3. Study of analogies in art history A thorough study of the style and motives of the green-red-dark blue frieze was performed by an art historian. Certain designs, colour combinations and decorative motifs can be linked to specific historical periods and therefore may clarify the dating much more precisely than material studies. Some attempts to reconstruct the frieze were made after the first stage of the project in 2012, and in 2013, after full uncovering.

The frieze presented a decorative scheme composed of up to sixteen portraits busts in medallions kept by human figures, separated by ornaments and cartouches. Based on the inventory from 1671, we may suppose that the frieze dates back to the period before 1671, as probably at that time the wall dividing rooms II and V was already there [Bernatowicz, 2009; Pawełkowicz, 2013]. Due to the poor state of the painting it was impossible to see who was actually portrayed. However, the study of analogies and of the history of the castle gave us some hints.

As for Polish territory, some analogical friezes, painted by Hans Durer (1530) and Dionizy Stuba (1536), exist in the Wawel Castle in Cracow. Such friezes featured ancient emperors copied from old medals along with rulers and ancestors. Not many of these portrait galleries survived. Some are known only from the descriptions. There is one particularly interesting description that is worth mentioning, it comes from the fourth wedding of Jan Zamoyski, teacher and friend of Zolkiewski,

which took place in 1592 in the dining room of the Zamoyski Palace in Zamosc. Moreover, the author of the text, Szymon Szymonowic, was also a friend of Zolkiewski, so Zolkiewski had to know it. The text was published in 1604 in Lviv under the title *Imagines diaetae Zamoscianae*. The muse of history, Clio, describes the decoration of the room and mentions the faces of eminent and noble men. According to the text, the painted frieze in Zamoyski Palace featured portraits of military commanders, King Stephen Báthory, and Pope Sixtus V. The portraits were situated just below the coffered ceiling, exactly as we think it was in Zhovka Castle. Therefore, we formed a hypothesis that the painted frieze at Zhovkva palace could have been made as part of occasional decoration for the wedding of Zofia, Zolkiewski's daughter and grandmother of the King Jan III. We know from archival documents that this ceremony took place in the palace in 1605 [Bernatowicz, 2009]. In this case, we could expect that members of the family of the married couple were portrayed in the medallions. The analysis of ornaments and stylistic features shows that the painting could have been created in the 1620's at the latest. Another important event was the death of Zolkiewski in 1620. This would mean that we should expect commemorative portraits.

The workshop working in Zhovkva could use iconographic model prints from illustrated numismatic books, such as *„Illustrium imagines"* of Andrea Fulvio (1517), *„Elogia virorum bellica virtute illustrium"* of Paolo Giovio (1554), *„Prontuario de le medaglie le più illustri et fulgenti huomini et donne…"* of Guillaume Rouille (1553), *„Vivae omnium fexe imperatorum imagines"* of Hubert Goltz (1557). Some ornaments and particularly mannerist scrollworks edging the cartouche evoke the etchings of the Flemish printmaker Hans Vredeman de Vries found in *"Grottesco in diversche manieren; Icones duodecim Caesarum Roma ex Antiquissimis monumentis in Gratiam artificum elegantissime ex Ornatae"* (1565–1569). The allegorical figures evoke Girolamo Ruscelli *„Le imprese illustri…"* (1572–1583).

According to the stylistic analysis the motives from the frieze should be linked more with Dutch or Northern European schools. Allegories keep-

Fig. 9 *Fragment of the frieze in room V uncovered in 2013. Phot. W. Holnicki*

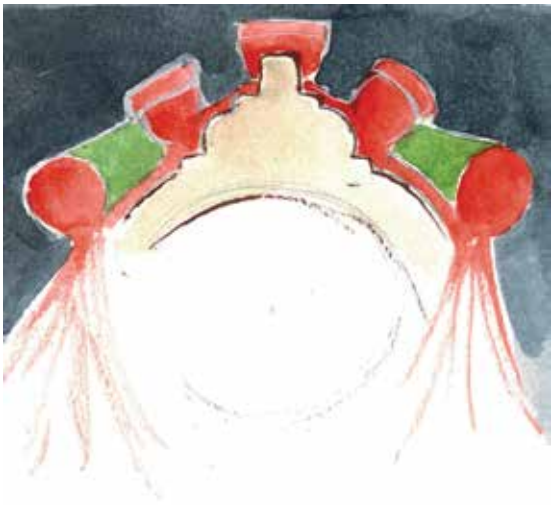

Fig. 10 *Coloured reconstruction of the medallion after the first stage of the project in 2012. Author: S. Pawełkowicz*

Fig. 11 *Uncovered frieze in room II. State from 2013. Test windows in the* chimneypiece. *Phot. W. Holnicki*

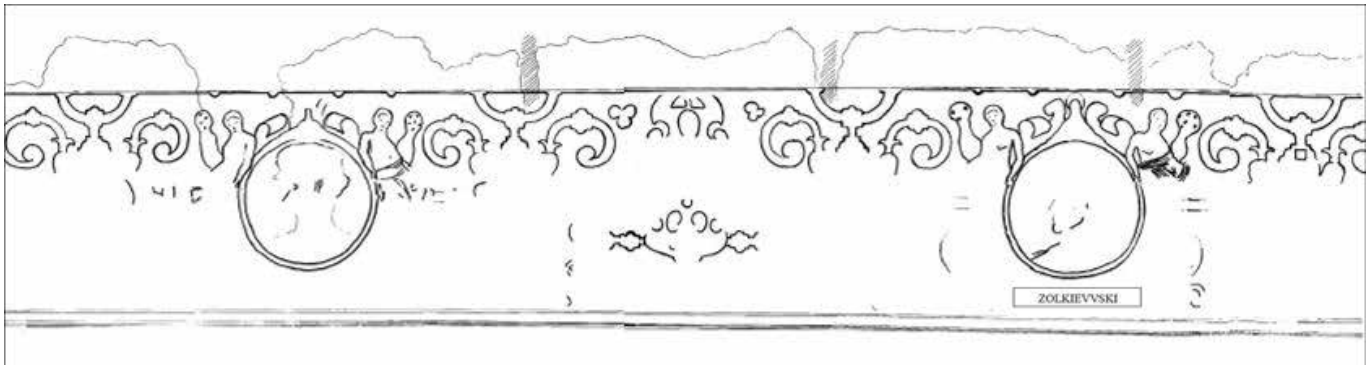

Fig. 12 *Reconstruction of the frieze with portraits after full uncovering in 2013. Author: M. Witkowski*

ing the medallions with portraits are the only Italian element. Nevertheless, all these elements could be used by a local workshop as they were accessible through the books. We should probably look for the answer in a detailed study of Lviv painters' guild. It is worth mentioning that such cartouche edged with scrollworks and portraits inside are present in the decoration of the Zhovkva church, but also in Lviv's architecture, so any future search for analogies should include studies of ornaments of the Lviv's buildings. Another important source of information about the workshops operating in Zhovkva are the archives in Belarus. As for a long time, the castle belonged to the Radziwill family, a lot of artefacts and documents were transported to the main seat of the family in Nesvizh, now in Belarus. Archival research is planned for the coming seasons.

5. CONCLUSIONS

Zhovkva Castle's walls, despite their bad preservation state, kept for beautiful examples of wall paintings. Having porformed stylistic analysis, analysis of inventories, radiocarbon dating and comparative material studies we believe that the min mannerist style frieze (green-red-dark blue) had to be created long before Jan III's rule, and probably dates back to the very beginning of the castle's history. One of the very possible dates would be 1605 – the wedding of Zolkiewski daughter. Unfortunately, we still know very little about the author of the paintings although we managed to study his palette, technique of painting and printed sources of motives that could serve him as inspiration. The Northern European influences are definately more pronounced than the Southern ones, but both are present. This would mean that the author could be an educated and highly skilled local painter. A very specific and expensive set of pigments was used along with smalt with high concentration of cobalt (over 5%). This means that the room had to serve as a representative space.

The pink-grey frieze in the adjacent room III with panoplies had to be created long after the mannerist frieze. Because of the subject, it could have probably been made during the times of King Jan III. Nevertheless, further studies are necessary. Certainly, room III had to be the lord's space, presumably the sleeping-room.

The Zhovkva Castle project is a perfect example of a cross-disciplinary collaboration between scientists. The project shows that instrumental analysis require proper contextualisation, and should be supported by art historical and archival studies.

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NOTE

[1] Zhovkva Castle. First floor. Scheme of the castle buildings based on measurements performed in 2000 with the reconstruction of destroyed part elaborated on the basis of the inventory made in 1762 by T. Bernatowicz, graphic design by A. Zak. Source: T. Bernatowicz, 2009.

[2] *Inwentarz traktu żółkiewskiego... z 1743*. In: T. Bernatowicz, 2009.

[3] S. Kuckova, private communication.

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