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The analysis of mural painting „The Crucifiction" in St. John the Baptist and St. John the Evangelist basilica in Toruń

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1. Introduction

St. John the Baptist and St. John the Evangelist church in Toruń had been errected in several stages. During the second half of 13th century the rectangular chancel was built, and at the turn of that century the works at the three-aisled body of the basilica started. Further works were continued during 14th and 15th centuries. The church gained its final shape in 15th century.

Mural painting, being the subject of our analysis is located on the second pier, separating the north aisle from the nave. First traces indicating the presence of polychrome have been discovered in July 2007, when the side altar of the Holy Cross (dated 1739) was dismantled, due to the planned transfer to conservation atelier for further treatment.

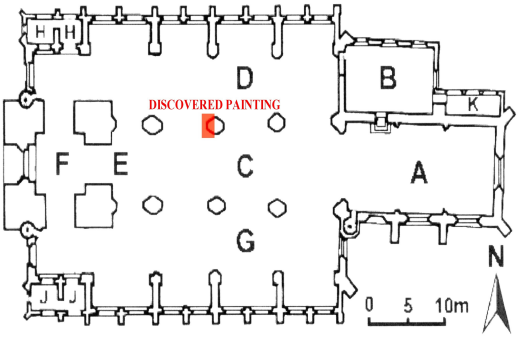

***Fig. 1**. Location of the mural in the church-plot. A - Chancel, B - Vestry, C - Nave, D - North aisle, G - South aisle, J - South porch, H - North porch.*

***Fig.2.** Side altar of the Holly Cross, 1739 with a painting "Deposition" 1640, behind which the analysed mural painting was discovered.*

2. Investigations of the object

The analysis of mural painting was executed on commission of the District Conservation Office in October 2007. The analysis aimed for establishing the state of preservation of the artefact and it comprised: localisation of structural anomalies of the painting (delaminating plasters and lime-wash layers), identification of the materials used and revealing the composition of the painting covered with lime-wash. The non-destructive analyses were made with the use of different bands of electromagnetic radiation. The UV reflectography was employed, UV-fluorescence, VIS, coloured infra-red, near infra-red and thermographic analysis. The non-destructive methods were complemented with micro-chemical analyses and instrumental analyses: gas-chromatography GC, X-ray fluorescence XRF and infrared spectroscopy FTIR.

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Fig.3. *Fragments of composition visible in lacunae of lime-wash covering the painting. Image in visible light, scattered.*

The most complete information on the condition of painting has been obtained by thermographic analysis conducted with the use of both active and passive techniques. They allowed to reveal the areas of thermal anomalies caused by local dalamination of plaster and lime-wash layers to various extent (Fig.4.). The area, in which the plaster is considerably well bound with lime-wash was identified. The analysis of thermographs allowed also for revealing the brick-bond of the support (Fig.5).

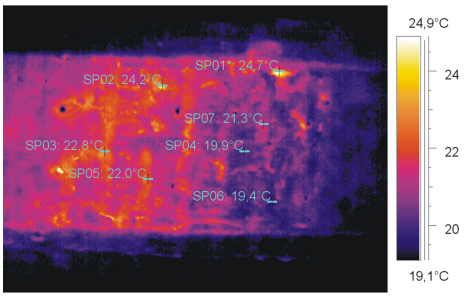

Fig.4. *Thermograph of the polychrome The measurement was taken during heating the surface of the wall with halogen lamps. The temperature range of the taken measurement amounted (24.9 – 19.1 °C) and the range of radiation wavelength 7.5 - 14μ. The measurement parameters: the artefact emission factor 0.80; air temperature 15°C, Rh in vicinity 50% ; distance 3m; transmission 1.00. The highest temperatures (24.7 and 24.2°C) mark the areas of strong delamination of lime-wash. Medium temperatures (22.8, 22.0 and 21.3°C), have been recorded in areas of blisters within the plaster structure. The highest temperatures correspond with stronger delamination. The lowest temperatures , between 19.9 and 19,4°C indicate the areas, where the plaster is considerably well bound with lime-wash.*

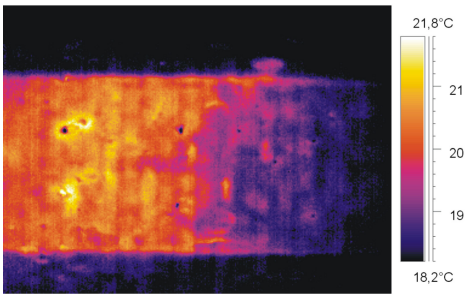

Fig.4. *Thermograph of the polychrome The measurement taken during cooling of the wall. The temperature range of the taken measurement amounted (21.8 – 18.2 °C) and the range of radiation wavelength 7.5 - 14μ. The measurement parameters: the artefact emission factor 0.80; air temperature 15°C, Rh in vicinity 50%; distance 3m; transmission 1.00. The recorder thermograph revealed the bond of the brick support, the regularity of which has been disturbed by some (more separated) blisters within the plaster.*

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The analyses with dynamic thermography (the method of heat-wave with the Fourier analysis of the images) allowed to locate the areas of a composite system of delaminations, in which the delaminating lime-wash covers the blistered plaster. This technique allowed also to reveal the places in which only the dalaminating lime-wash appeared. The analysis revealed both the blisters in plaster in the areas of exposed paint layer and in the areas of plaster covered with well-adhering lime-wash.

The quality of thermal image, allowing for visualisation of underlying paint layer is highly influenced by numerous anomalies appearing in the structure of polychrome. Those are: blisters within the plaster (of diverse extent of delamination); the so called systems of double (superimposing) dalamination of plaster and lime-wash; blisters in lime-wash and areas of separation and crumbling of lime-wash. Additional disturbances are introduced by the exposed parts of polychrome, injuries in areas of halos and local differences in the thickness of lime-wash. Those factors deform the image of revealed composition.

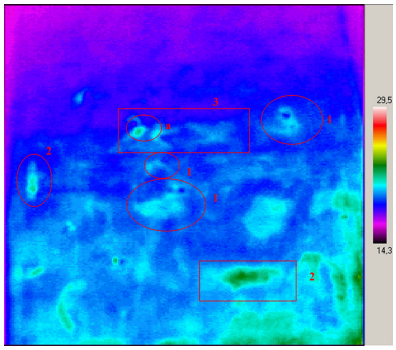

Fig. 6. *Thermograph of the upper part of the painting. The analyses allowed to locate the areas – appearing on various depth – where double delamination occurred: the blister of lime-wash on the blister in plaster (1). The areas of delaminating lime-wash were identified (2) and the dalamination of plaster and lime-wash layers (a) surrounding the injury (3).*

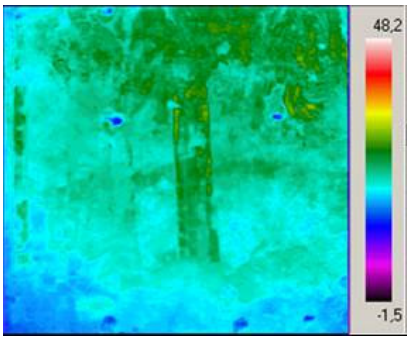

Fig.7. *Thermograph of the lower part of analysed painting.*

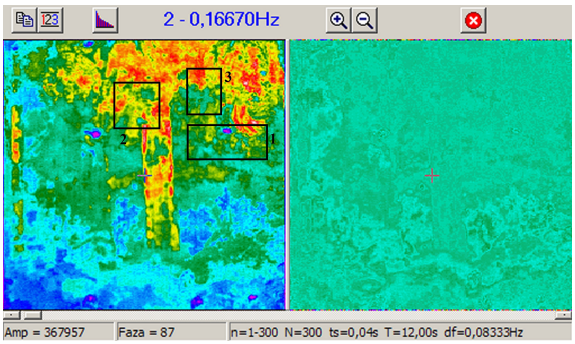

Fig. 8. *The transformed thermographic signal - Fast Fourier Transformation. The distribution of amplitude on the right (amplitudogram) and the phase-shifting on the left (phase plot). In result of this analysis one receives the information on differentiation of the inner structure of painting. Using this technique the range of large delamination of plaster in the area of exposed blue paint layer (1) was revealed. Also the wide-spread blisters in plaster in the left part of the painting (2) were identified as well as blisters in the area between the cross and the figure in the right side of composition (3).*

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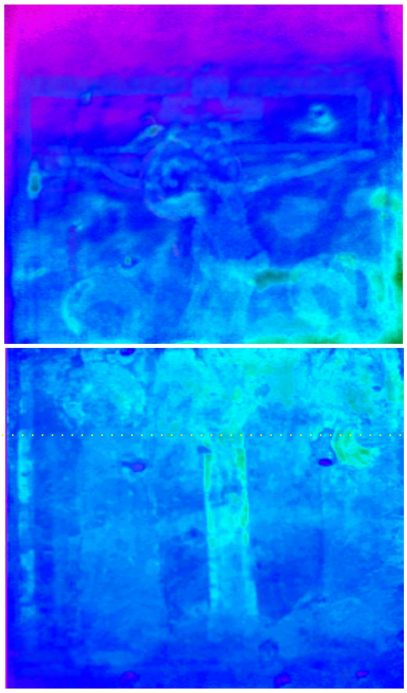

Fig.9. *Termograph partly revealing the outlines of the upper part of composition.*
The quality of thermal image, allowing for visualisation of underlying paint layer is highly influenced by numerous anomalies appearing in the structure of polychrome. Those are: (1) blisters within the plaster (of diverse extent of delamination); (2) the so called systems of double (superimposing) dalamination of plaster and lime-wash; (3) blisters in lime-wash and areas of separation and crumbling of lime-wash. Additional disturbances are introduced by the exposed parts of polychrome, injuries in areas of halos and local differences in the thickness of lime-wash.

Fig.10. *Photograph of the mural painting in St. John the Baptist and St. John the Evangelist basilica in Toruń, taken after the conservators have removed the lime-wash layer. Condition in November 2007.*

Good results in revealing the outlines of composition have been obtained thanks to developing the suitable research methodology. The analysed images were recorded with the use of synchronic thermography (*lock-in*). Out of the particular sequences (300, 1000) 80 contrast images (single frames) were selected. The characteristics of obtained images have been processed to normalise the colours using the Paint Shop Pro 7 software. Then using the Combine Z5 software the obtained bitmaps of the artefact have been combined in various sequences (for instance 45 – 50 frames) into a final image. Basing on the conducted analyses the outlines of composition were revealed. (Fig. 9, 10).

The achieved results allowed to reveal the outlines of composition prior to removing the lime-wash layers concealing the painting.

3. Summary

Reconstructed composition of the painting, being the outcome of executed thermographic analyses using the method of heat-wave combined with Fourier image analysis and the rightly developed algorithm for computer image processing in considerable extent corresponds with the above presented (Fog. 10) original painted composition, exposed by the conservators.

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