

Complex investigation of the 12th-century wall painting in Pskov Mirozhsky Monastery by complementary physical and chemical methods

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Mirozhsky Monastery is the 12th-century Russian Orthodox monastery complex in Pskov, Russia. Murals of its Christ's Transfiguration Cathedral are unique monument of ancient Russian art. The integrity of frescoes complex is the most complete among the monumental painting of the 12th century. The history of the study and restoration of Christ's Transfiguration Cathedra goes back more than 150 years. During the XX century, murals have undergone all the stages of the formation of restoration science. Despite the fact that the monument was always in the cross hairs of researchers, some of the ancient paintings are still hidden under a layer of renovation, and restoration work has not been completed. A comprehensive scientific study of the monument is of great importance not only to analyze how murals were performed, but also to understand what mark have been left by the materials used by restorers throughout the 20th century, and predict the consequences.

To achieve veracious results a complex of four physical and chemical methods was used: X-ray fluorescence analysis (XRF), optical microscopy (OM), Fourier transform infrared spectroscopy (FTIR) and spot qualitative test microanalysis.

More than 180 spectral data were collect directly in the cathedral using portable XRF spectrometer Tracer 5i (Bruker). The elemental composition of more than 80 pigments plaster bases and mortars has been determined. The analysis of the elemental composition revealed the main pigments used. They are yellow and red ocher, green earth, lapis lazuli, lime white, red lead and others.

Seven samples were examined with optical microscope Polam-215 (Lomo) to determine the number of used pigments or to detect several layers of painting. So, the main component of green color is glauconite. The required hue was achieved with small additions of goethite, lapis lazuli and malachite. The burgundy color was obtained using a composition of hematite and lapis lazuli.

About twenty samples were analyzed using FTIR spectrometer Invenio-R (Bruker) to define the type of organic binders. To concentrate the micro-content of organic substances, water and chloroform solutions were prepared which make it possible to extract polar and non-polar substances, respectively. For painting of different centuries various organic binders have been identified, such as casein, egg white, egg yolk, oil. Vegetable glue based on polysaccharides/ carbohydrates was found in various plaster samples.

Spot test microanalysis based on different anions qualitative reaction was performed. Sulfates and carbonates were found, but nitrates were not detected.

Also of great importance is a comprehensive study of the scientific study of the monument, not only in order to analyze how the paintings were made, but also what mark the materials used by the restorers have left during the 20th century, and to predict the consequences.