

Diffractometric analysis as a toll for an early-Byzantine stone tesserae origin, on the example of a mosaic from the Basilica in Chhim (Lebanon).

Anna Julia Tomkowska (Academy of Fine Arts in Warsaw, Inter-Academy Institute of Conservation and Restoration of Works of Art). anna.tomkowska@cybis.asp.waw.pl

Michał Ruzzkowski (Institute of Mineralogy, Geochemistry and Petrology of the Faculty of Geology of the University of Warsaw).

The hypothesis about the local origins of raw material in historical structures has often been formulated in archaeological research, and later confirmed by many teams thanks to the use of modern analytical techniques. This hypothesis became the basis for the interdisciplinary research conducted at the Chhim archaeological site. As of 1996, the Polish Center of Mediterranean Archeology has carried out an archeological mission at the site of the village of Chhim. In the first year of excavations, an early-Byzantine basilica decorated with a floor mosaic was found. Based on the Greek inscription discovered at the site, the mosaic was dated to AD 498.

In 2015, an interdisciplinary team of young scientists was established to support mission activities in Chhim. The team's aim was to search for the local rock deposits from which material could have been obtained for the architectural structures. Primarily, the focus was on determining the provenance of the material for tesserae production. The tessellatum decorative layer was made of 9 pre-separated tesserae types. Observations of the colorful mosaic surface have shown that the tessellatum layer was made using 5 different types of stone and 4 types of ceramic. A geological field survey was done in the Chhim area with the aim of achieving an understanding of the geological structure and sequence of sedimentation. During fieldworks, a large tesserae group and numerous stone samples were collected and prepared for XRD analyses. All the samples were transported to laboratories in Poland.

The tesserae samples were tested in the (X-ray laboratory at the Institute of Mineralogy, Geochemistry and Petrology), while the samples of rocks were analyzed in the laboratories of the Inter-Academy Institute of Conservation and Restoration of Works of Art of the Warsaw Academy of Fine Arts. Geological samples were tested on a SmartLab Rigaku device and archaeological samples on an X'Pert PRO MPD device. SmartLab Rigaku is a high-resolution X-ray diffractometer. The system incorporates a high-resolution θ/θ closed loop goniometer drive system, cross beam optics (CBO), an in-plane scattering arm, and an optional 9.0 kW rotating anode generator. Databases of mineral substances of PDF 4 and PDF4+ data are attached to each set of devices. The X-ray laboratory at the Institute of Mineralogy, Geochemistry and Petrology of the Faculty of Geology of the University of Warsaw is equipped with a modern powder X-ray diffractometer "X'Pert PRO MPD (manufacturer PANalytical BV – The Netherlands)" on Bragg-Brentano geometry in the θ - 2θ system with the possibility of transmission tests and application capillaries (DSH). The diffractometer configuration allows for the study of samples with a complex mineral composition in the field of geological and archeometric sciences. The high resolution of the camera (0.001 degree 2θ) and Johansson's X-ray monochromator enables performing crystallographic works. The possibility of changing the geometry of the diffractometer to DSH allows for the identification of small amounts of material. The laboratory is also equipped with an EDXRF apparatus providing additional information on the chemical composition of the analyzed samples.

As a result of comparative analyzes carried out using the XRD technique, it was found that the material for the production of stone tesserae originated from quarries and rock deposits located at a short distance from the village of Chhim. In addition, thanks to the exact location of the rock sampling places, local material beds were marked on geological drawings. This interdisciplinary research project undertaken by Polish scientists has the first such advanced program regarding the origins of rock material for the production of mosaics from Lebanon. The information obtained during the research has significantly extended our knowledge in the field of production techniques in local mosaic workshops operating in Lebanon during the late Roman period.