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Traceability of materials in ancient works of art through isotope analysis: Unveiling provenance and trade networks in cultural heritage

ULIANA NAUMENKO[1,2], WOLFRAM KLOPPMANN[1], ALEKSANDRA LIPINSKA[3] AND MARIA O. NAUMENKO-DÈZES[4]

[1]BRGM (French Geological Survey)
[2]Institute of Geological Sciences of National Academy of Sciences of Ukraine
[3]University of Cologne
[4]BRGM

Determining the origin of alabaster used in sculptures is crucial for restoration research, trade route reconstruction, and for understanding the historical material use. Despite its importance, Ukraine's alabaster heritage remains poorly documented, with references mostly found in studies of stonemasonry, folk crafts, and archaeology. However, from the 14th to 17th centuries, the stone industry flourished in Galicia, historical region that nowadays stretches from south-eastern Poland and western Ukraine, and alabaster was a highly valued raw material for sculptors and architects. The region, geologically part of the Precarpathian Trough, hosts Badenian gypsum formations with alabaster deposits, which were used in artistic traditions.

As part of the international multidisciplinary project Materi-A-Net (https://materi-a-net.uni-koeln.de/en/the-project/), which explores cross-border Franco-German cultural networks through the exchange of raw alabaster and alabaster artworks between 1350–1650, this research extended its focus to Ukraine and Poland [1], where alabaster played a significant role in medieval and early modern sculpture. To investigate its historical use, 24 alabaster samples were collected from historical quarries in the Western part of Ukraine. Additionally, a comprehensive catalogue documenting alabaster architectural and artistic objects in various states of preservation was compiled, providing valuable insights into the region's artistic heritage.

The study focused on determining the $^{87}Sr/^{86}Sr$, $d^{34}S$, and $d^{18}O$ isotopic fingerprints [2] in samples from historical quarries as well as medieval and Renaissance alabaster sculptures from Lviv, Krakow and other cities of Ukraine and Poland. Analyses at the BRGM (France) revealed that while Ukrainian alabaster exhibits strontium isotopic similarities with Italian sources, it differs significantly in oxygen and sulphur isotopes. These distinct isotopic signatures allow clear differentiation from alabaster found in other European regions.

The results contribute to a pan-European alabaster provenance database, aiding in the identification of historical raw material sources and providing insights into cultural and trade connections between Ukraine and Europe. This research also supports conservation efforts by offering a scientific basis for the authentication and restoration of alabaster artworks.

[1] Lipińska A. et al. (2024) *36e congrès du Comité International d'Histoire de l'Art CIHA*, Lyon, June 23 to 28, 2024. [2] Kloppmann W. et al. (2017) *PNAS*, **114**, 11856–11860.