Hidden, Unknown, Unexpected: Unlocking Provenance, Technology and Degradation in Painted Artworks by X-ray Powder Diffraction

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Painted artworks and other decorated heritage objects preserve complex material histories in which crystalline phases often record the origin of raw materials, technological practice or subsequent degradation processes. Owing to its high structural specificity, X-ray powder diffraction (XRPD) holds a distinctive place among analytical methods in heritage science, enabling identification of crystalline compounds in heterogeneous microsamples and, in selected cases, also directly on objects by non-invasive analysis. This lecture will demonstrate how XRPD can reveal important new information on provenance, technology and degradation in painted artworks and related cultural heritage materials.

Three groups of case studies will be presented. The first one shows how identification of clay minerals and associated phases in preparatory grounds can support provenance studies and help distinguish regionally specific materials [1]. The second one demonstrates the potential of non-invasive XRPD for the study of ancient ceramic vessels, where phase analysis of black gloss and decorative layers provides insight into manufacturing technology and firing conditions without sampling (Fig. 1) [2]. The third one focuses on miniature portraits, in which XRPD detects crystalline degradation products, including metal carboxylates formed through pigment–binder interactions, and thus contributes to the understanding of deterioration mechanisms relevant to conservation [3-4].

Together, these examples highlight XRPD as more than a phase-identification method: they show its value in uncovering otherwise hidden information about the material history of artworks. Linking provenance, technology and degradation, XRPD emerges as an important bridge between crystallography, materials science and heritage research.



Figure 1. *XRPD analysis of a Late Apulian plate (4th century BCE, collection of the Faculty of Arts, Charles University in Prague, Czech Republic)*

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