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Chemical Composition for the Provenance of Archaeological Silver Artifacts

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Silver played a central economic and social role in ancient societies, yet reconstructing its production pathways and circulation remains challenging due to extensive recycling and alloying. While provenance studies have traditionally emphasized isotopic signatures, this study highlights the critical role of chemical composition and its integration with lead isotope analysis (LIA) for identifying the provenance and alloying histories of archaeological silver artifacts. Two complementary analytical approaches are presented.

The first approach combines elemental concentrations with lead isotope ratios for groups of artifacts that share comparable archaeological histories, contexts and trajectories (e.g., hoards). These results are evaluated against a geochemical mixing model that simulates the contribution of up to three isotopic end members to the measured compositions, allowing assessment of metal mixing practices.

The second approach focuses exclusively on chemical composition, comparing artifacts to one another to identify groups with similar alloying and trace-element characteristics. This analysis is based on elemental ratios rather than absolute concentrations. Multidimensional scaling (MDS) is used to generate a two-dimensional compositional map in which spatial proximity reflects chemical similarity and separation reflects distinct compositional histories.

Both models are applied to multiple datasets, demonstrating how compositional patterning and isotopic information together can clarify both the provenance of silver and the complexities of metallurgical mixing. The results underscore the importance of integrating chemical composition with isotopic data in archaeo-metallurgical studies and highlight the potential of composition-driven approaches for improving interpretations of ancient metal circulation.