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Osmium isotope analysis as an innovative tool for provenancing ancient iron-based metals

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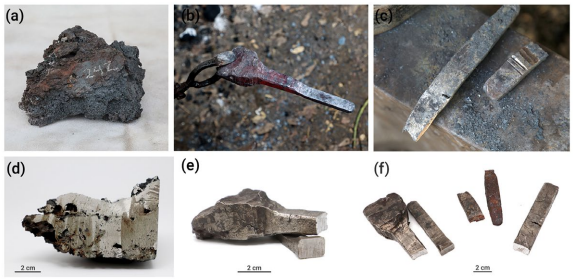

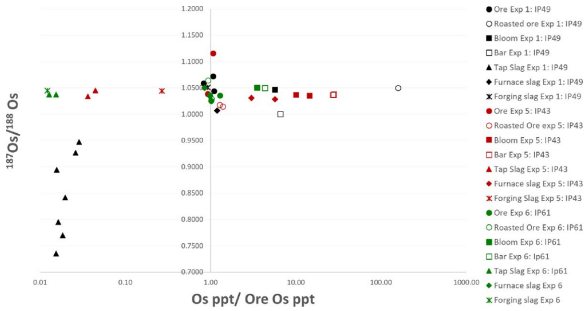

The introduction of iron metal use for utilitarian purposes such as the production of agricultural tools and weapons is considered one of the most intriguing technological developments in human evolution. In the southern Levant this started at the end of the late Bronze Age and culminated during the full Iron Age (late 12th to early 10th C. BCE), with the introduction of Bloomery iron smelting. However, despite the growing number of archaeological and metallurgical research over the past few decades, archaeological evidence for ore exploitation is scarce and the question of provenance remains unanswered.

In general, the provenancing of metals heavily relies on the application of geochemical analysis, accompanied by the compilation of a database of geological ore sources in order to shed light on social, political and economic aspects of past societies.

The use of osmium isotopes has been previously suggested for the provenancing of iron. Its highly siderophile geochemical nature of Os, results in an enrichment in the metallic phase during metal production, thus renders it an excellent tracer in archeometallurgical studies of iron production and use.

This suggestion was further studied by a set of systematic, bloomery iron-smelting experiments utilizing selected rich iron ores from the Negev region in southern modern Israel. Attempts were successful, and three iron blooms were produced and further worked to form a bar ingot. The 187Os/188Os ratio measured for the ores, blooms and metal produced in the experiments show that the 187Os/188Os ratio is preserved from ore to metal, with no isotopic fractionation. In addition, enrichment/depletion of osmium content was observed in the transition from ore to metal and from ore to slag. This observation has potential significance for our ability to differentiate between the various processes and sheds light on the suitability of various production remains for this method, which emerges as a robust and promising tool for the provenancing of archaeological ferrous metals. The ability to compare a metal product to its ore source is therefore highly instrumental in reconstructing significant aspects of ancient society and economy.