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Tracing copper supply networks in the Middle Elamite period: a lead isotope study of artifacts and ingots from Haft Tappeh, southwestern Iran

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This study presents the results of lead isotope analysis (LIA) of copper-based artifacts and ingots from the Middle Elamite (mid–second millennium BCE) archaeological site of Haft Tappeh in southwestern Iran. The assemblage includes tools, ornaments, production debris, and raw metal ingots recovered from well-defined workshop and metallurgical contexts. Previous analytical research at the site demonstrated the working of both unalloyed copper and tin bronze, providing a robust technological background for the present provenance study. The primary objective of this research is to investigate the origin of the copper employed at Haft Tappeh and to assess patterns of metal procurement during a period of increasing socio-political complexity in Elam. Lead isotope ratios were measured for 41 artifacts and ingots and compared with isotopic data for copper ore deposits from the Iranian Plateau and surrounding regions. The results identify two principal isotopic groupings and a single outlier within the assemblage, indicating the exploitation of multiple copper sources. With the exception of one ingot, all samples exhibit isotopic affinities consistent with ore fields on the Iranian Plateau. The close isotopic correspondence between some of the ingots and finished artifacts further indicates that Haft Tappeh functioned not only as a consumer site but also as a center for metal processing and redistribution. By integrating lead isotope data with archaeological context and technological observations, this study demonstrates that copper procurement at Haft Tappeh was embedded within broader networks of production and exchange operating across the ancient Near East during the second millennium BCE. These findings contribute to ongoing debates on Late Bronze Age–Early Iron Age metallurgy and underscore the effectiveness of LIA for reconstructing supply strategies and economic foundations of early complex societies.