

## High-precision Pb and Ag isotope analysis of galenas from Spain: new insights into silver ore exploitation in Roman times

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First considered a luxury commodity, silver became the metal of choice for coin minting in the Mediterranean from the 7<sup>th</sup> century BC onwards. Silver-bearing galena (PbS) is commonly thought to have been a major source of silver in the Antiquity. Galena was smelted under reducing conditions to obtain lead bullion from which silver was purified by cupellation under oxidizing conditions. Since Phoenician until Roman times, the Iberian Peninsula was intensively exploited for its silver resources [e.g. 1]. The present study uses Pb and Ag isotopes [2] to explore the dynamics of Roman silver exploitation in Iberia.

We measured the Pb and Ag isotopic compositions of 64 galenas from several Iberian mining districts previously shown to have been exploited in ancient times. After separation by ion-exchange chromatography, Pb and Ag isotope compositions were measured by multi-collection inductively coupled plasma mass spectrometry at ENS Lyon [2]. The isotopic signature of the Iberian ores were compared to those of Roman silver coins to identify potential provenance links.

The comparison of uncorrelated Pb and Ag isotopic compositions between silver coins and galenas excludes most known galena deposits as significant sources of Roman silver. Instead, we suggest that galena was mined for lead, which subsequently was used to extract silver from other so far unidentified Pb-depleted ores. This interpretation is in accordance with the example of Phoenician and Roman silver smelting in Rio-Tinto (Huelva province, SW Spain), where lead was imported from other regions to extract silver from local Ag-rich jarosite [3]. The present work lays the foundation for a systematic tracing approach for ancient silver by combining Pb and Ag isotope analyses.

[1] Domergue, C., 2008. *Les mines antiques. La production des métaux aux époques grecque et romaine*, Paris, A. et J. Picard, 240 p.

[2] Milot, J., Malod-Dognin, C., Blichert-Toft, J., Télouk, P., Albarède, F., 2021. Sampling and combined Pb and Ag isotopic analysis of ancient silver coins and ores. *Chemical Geology* 564, 120028.

[3] Anguilano, L., Rehren, T., Müller, W., Rothenberg, B., 2010. The importance of lead in the silver production at Riotinto (Spain), *ArchéoSciences*, 34, 269-276.