Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.19460

Multi-isotope (Pb, Sb) approach to trace metallic contaminant sources at an historical mining and metallurgical site

MAGALI ROSSI[1], FLORIANE GUILLEVIC[1], ELÉONORE RESONGLES[2], RÉMI FREYDIER[2], COLIN FERRARI[3], CÉCILE QUANTIN[4], GAEL MONVOISIN[5], JEROME POULENARD[6] AND FABIEN ARNAUD[6]

[1]EDYTEM, Université Savoie Mont-Blanc

[2]HydroSciences Montpellier, Université de Montpellier, CNRS, IRD

[3]Hydrosciences Montpellier, Université de Montpellier, CNRS, IRD

[4]GEOPS, Université Paris-Saclay, CNRS, France

[5]Université Paris-Saclay, CNRS, GEOPS

[6]Université Savoie Mont Blanc

Presenting Author: magali.rossi@univ-smb.fr

The extraction and processing of ore is among the most environmentally harmful anthropogenic activities. It produces large volumes of wastes enriched in potentially toxic elements (PTE), which alteration and weathering may result in PTE dispersal in terrestrial and aquatic ecosystems. This study couples the Pb and Sb isotopic systems to characterize the contamination sources and transfer processes of PTE in the setting of an abandoned Pb-Ag mine. If Pb isotopes are commonly used to identify mining/smelting contaminations, Sb isotopes have never been studied in a metallurgical context, although they are likely subjected to fractionation during pyrometallurgy, and could provide a good tracer of the contamination sources (metallurgical wastes vs ore-bearing rocks).

This study focuses on the Pb-Ag mine of Peisey-Nancroix (NW French Alps, 1550 m a.s.l.), which was operated from 1734 to 1866, producing 21 500 t of Pb and 53 t of Ag. Smelting occurred on site from 1745 to 1834. The abandoned mine wastes and slags remain enriched in Pb (≤ 7.1 wt. % and ≤ 10.8 wt. %, respectively) and in Sb (≤ 137 $mg.kg^{-1}$ and ≤ 3000 $mg.kg^{-1}$, respectively). Pb-Sb isotope ratios were measured in 4 ore-bearing wastes and 4 metallurgical wastes (2 slags; 2 stack residues), 3 soil profiles (0-80 cm, n=4-6 per profile), stream sediments from the main river (n=4) and from dewatering galleries (n=4).

The $^{206}Pb/^{207}Pb$ and $^{208}Pb/^{206}Pb$ ratios of the ore-bearing rocks, slags and stacks residues are similar, in the range 1.1712-1.1734 and 2.0930-2.0962 respectively, confirming the absence of Pb fractionation during pyrometallurgy. Opposite, the $\delta^{123}Sb$ values of the ore-bearing rocks (from -0.28 to 0.10 ‰) differ from those of the slags and stack residues (0.62-0.79 ‰). These results show that an apparent fractionation of about +0.87 ‰ occurred during smelting between ores and slags, so that Sb isotopes could be a good tracer of the contamination sources in metallurgical contexts. Coupling of Pb-Sb isotopes on environmental samples shows (i) that remobilization of the ore from dewatering waters still contaminate the stream sediments, and (ii) that all soils are contaminated by both the slags and the ore.