Long-term inheritance of Pb in soils of former mining sites: the Peisey-Nancroix Pb-Ag mine (1644-1866, French Alps)

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The Pb-Ag district of Peisey-Nancroix (northern French Alps) is an excellent target to study the long-term environmental impacts (> 150 years) of former mining activity and inheritance of trace metal dispersal in the critical zone, considering that every steps of the mining cycle, from ore extraction to ore processing, were located on a few hectares site that has been unmodified since mine closure in 1866 (no reclamation). The extraction of 22 000 t Pb and 53 t Ag produced significant amounts of waste deposits that have been abandonned to weathering for several hundred years.

A cross-disciplinary study has been conducted using several proxies (ore, slags, abiotic and microbioal compartments of soils) in order to (i) characterize present-day contamination on the mining site, (ii) determine the speciation and bioavailability of lead in soils, and (iii) evaluate the effect of trace metals on microbial communities functioning.

Topsoils are significantly enriched to extremely enriched in Pb, and locally in As, Sb and Cu compared to the local geological background. Soils developed on top of abandonned slags contain up to 3.4% Pb, 1695 ppm Zn, 381 ppm Sb and 168 ppm Cu. DRX analyses indicate that abandoned Pb-rich sulphide ores and slags have been altered into cerussite and Pb-adsorbed iron oxides, thus contributing to Pb dispersal in soils. Leaching tests show that, apart for the metallurgical soils, the amount of leacheable lead is perfectly correlated to the soils lead content. Microbial activity (extracellular enzymes involved in organic matter decomposition and nutrient recycling) is shown to decline with increasing Pb content of topsoils, providing evidence that mining activity still impacts the ecosystem more than 150 years after mine closure.