Multielemental and Pb, Zn Isotopic study of metal transfer processes in soils and lichens from an old mining area (São Domingos, Portugal)

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Belonging to the Iberian Pyrite Belt (Alentejo, Portugal), the São Domingos Mine (SDM) (closure in 1966) accounted for one of the most important copper-pyrite mining and refinery area of the Iberian Peninsula. Adjoining the open pit, the São Domingos village is surrounded by waste deposits (about $5x10^6$ metric ton) and an acid mine drainage system (AMD). The site offers a perfect case study for a better understanding of the metal transfer processes from the atmosphere to the critical zone in a semi-arid environment.

Elemental and multi-isotope Pb-Zn analyses have been performed on lichen samples, topsoils, unprocessed and processed ores and AMD salts collected within a 16 km^2 surface area. Cd, As, Pb, Zn, Cu and Mn are identified as the main atmospheric metal pollutants in soils and lichens, with maximum values recorded inside the village (As from 78 to 1500mg/kg). High metal enrichments are displayed in lichens over a wider area relative to soils.

Pb-Zn elemental and isotopic compositions clearly distinguish the highly contaminated soils (δ^{66}Zn=-0.69 to +0.07±0.05‰ (2SD); Zn=300-1054mg/kg; Pb=1500 to 3745mg/kg) from the geogenic soils (δ^{66}Zn=+0.10 to +0.22 ±0.04‰; Zn=23-150mg/kg; Pb=29-100mg/kg). The lowest δ^{66}Zn values are observed within the village.

Zn isotopic compositions of the lichens are only consistent with the geogenic soil signatures. At the highly contaminated spots, lichens significantly differ from the soils in δ^{66}Zn values because they reflect on one hand (1) re-suspension of unprocessed Cu-pyrite tailing deposits in the village (δ^{66}Zn: +0.05 to +0.11‰), and other hand (2) interaction with AMD salts (jarosite) in the valley (δ^{66}Zn: -0.07 to -0.05 ±0.04‰).

Elemental and Pb-Zn (Cd) isotopic multitracing approach, applied to soils and lichens, provides a sensitive tool to discriminate processes that might simultaneously occur in complex metal polluted environments.