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

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Isotopic multitracing approach has been conducted in an old mining area for a better understanding of the metal transfer processes in a semi-arid environment.
Belonging to the Iberian Pyrite Belt (Alentejo, Portugal), the São Domingos Mine (SDM) accounted for one of the most important copper-pyrite mining and refinery area of the Iberian Peninsula until its closure in 1966. In the neighbourhood of the São Domingos village, about 5x106 metric ton of waste deposits and an acid mine drainage system (AMD) are observed.
Elemental and multi-isotope Zn-Cd analyses were performed on lichen samples, topsoils, unprocessed and processed ores and AMD salts collected within a 16 km2 surface area.
As, Cd, Pb, Zn, Cu and Mn are identified as main atmospheric metal pollutants in soils and lichens, with maximum values recorded inside the village (As from 78 to 1500mg/kg). Lichens display higher enrichments over a wider area relative to soils.
Elemental and Zn isotopic compositions of the soils samples clearly distinguish highly contaminated soils (d66Zn=-0.69±0.03 to +0.07±0.05? (2SD); Zn from 300 to 1054mg/kg; Pb from 1500 to 3745mg/kg) from geogenic soils (d66Zn=+0.10±0.05 to +0.22±0.04? ; Zn from 23 to 150mg/kg; Pb from 29 to 100mg/kg). The lowest d66Zn values are observed in the village.
d66Zn values of the lichens are only consistent with the soil isotopic signatures at the geogenic soil sites. At the highly contaminated spots, lichens significantly differ from the soils because either (1) in the village, lichen d66Zn values (+0.05±0.01 to +0.11±0.02?) reflect re-suspension of unprocessed Cu-pyrite tailings, or (2) in the valley, the lichen d66Zn values (-0.07±0.03 to -0.05 ±0.04?) reflect Zn fractionation by interaction with AMD salts (jarosite).
Preliminary d114Cd data in soils show enrichment in light Cd isotopes, which suggests a strong effect of Cd adsorption on Fe-Mn oxi-hydroxides in regosols.
Zn-Cd isotopic multitracers applied to soils and lichens constitute a sensitive approach to discriminate processes that might simultaneously occur in complex metal polluted environments.