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Leaching and plant uptake of toxic metals in abandoned mine tailings in the Cave del Predil (I) mining site and Rio del Lago valley

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Mining of Zn and Pb metal ores, mainly blende (ZnS) and galena (PbS), in Cave del Predil (I) valley from 1800 to 1991 produced a huge amount of tailings (estimated about 20 •10^6 m^3). Such tailings had been prevalently accumulated close to the Rio del Lago creek or used to reshape the excavation area. These tailings are rich in toxic metals (i.e. Pb, Zn, Tl) under different chemical and mineralogical forms (sulphide, sulphate, carbonate, etc.), representing a potential health risk to the local ecosystem. The gradual oxidation of sulfide minerals tend to mobilize these toxic metals, that in part are retained due to the calcareous nature of rock, but they are partially leached to the trans-boundary Slizza/Gailitz creek.

Phytocapping represents a promising strategy to reduce the dispersion of contaminants into the air as dust particles and to groundwater, but the establishment of a permanent vegetation is strongly unpaired by the toxicity of this substrate. Immobilization techniques, using abundant, rather inexpensive, natural and/or industrial by-products, may offer an effective alternative to conventional methods to reduce the metals mobility and bio-availability.

The aims of this study are to assess: (i) the effect of metal immobilization treatments on mine tailings and (ii) the uptake and translocation of Pb, Zn and Tl in the metalliferous plant species Biscutella laevigata (L.) and Silene vulgaris (L.).

The mobility of toxic metals has been evaluated either in batch extractions (synthetic rain, TCLP) or by leaching columns in the native mine tailings and in tailings treated by different amendments (zero-valent Fe, Fe(II)+digestate, biochar).

The plants were collected respectively upstream (2 stations) and downstream (5 stations) the mining site in the sediment banks of Slizza/Gailitz creek. In each stations, six specimens were sampled for each species. In addition, at each plant collection point, a composite bulk soil and rhizospheric soil sample was excavated along the 0–20 cm profile. Plant specimens were divided into two fractions: root apparatus and aboveground biomass. The soil and plant samples were oven-dried and acid-digested in a microwave oven. Total Cu, Fe, Ni, Pb, Tl and Zn contents in the extracts were determined by ICP-MS. The bioavailable metal fraction of Cd, Pb, Tl and Zn was determined by selective extractants.

Addition of Zero-valent Fe showed the strongest decrease of leached metals trough the soil columns, whereas the addition of Fe(II)+digestate strongly increased the concentration of metals in leachates, probably because of the acidification caused by Fe oxidation/precipitation.

Biscutella laevigata and Silene vulgaris are metal tolerant species. Pb concentration in B. laevigata ranged between 0.01-669 and 0.01-234 mg kg^{-1}, respectively in roots and shoots. In the same fractions of S. vulgaris Pb ranged between 0.01-891 and 0.01-208 mg kg^{-1}. As for Zn, root and shoot concentration in B. laevigata were 13.4-1461 and 20.6-3390 mg kg^{-1} respectively, whereas in S. vulgaris 2.36-1829 and 17.2-1590 mg kg^{-1}. The response of metal uptake and accumulation in plant species grown in treated mine tailings are currently under observation.