Nickel isotope fractionation in the soil to hyper-accumulating plant system

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Nickel stable isotopes are a promising non-traditional stable isotope system for understanding the Ni biogeochemical cycle, especially in contaminated or highly enriched environmental compartments such as ultramafic contexts. Ni hyperaccumulating plant species (e.g. *Alyssum murale*) growing in ultramafic soils can concentrate up to several weight percent in leaves and may be used in phytoremediation or phytomining. In addition to its insensitivity to redox-processes, nickel homeostasis in hyperaccumulating plants is poorly understood. In this work, we used Ni stable isotopes to document the isotopic fractionation range during accumulation processes from soil to Ni-hyperaccumulating plant species in a field investigation.

Sampling was carried out in Albania at four different sites and included the collection of several hyperaccumulating plant species as well as tolerant ones. Using two-step chemistry to isolate Ni and the double-spiking technique to correct for instrumental mass fractionation, we recorded Ni concentrations and Ni isotope compositions along the continuum of ultramafic rock, soil (different horizons), litter, roots, stems, leaves and flowers. In typical Ni-rich soil, root and litter concentrations ranged between 1-3 g kg^{-1} dry matter. Nickel accumulation increased to 3-6 g kg^{-1} in stems and reached up to 20 g kg^{-1} in leaves. In contrast, tolerant species present Ni concentrations in leaves within the 0.1 g kg^{-1} range.

Preliminary results in hyper-accumulator plant samples did not reveal large extent of isotope fractionation between roots and leaves (0.2‰). Further investigation is ongoing to confirm these results and evaluate the entire soils plants variations.

Dusts from metal smelters in Africa: Mineralogy, leaching and contaminant bioaccessibility

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Dry climate and strong winds are believed to be responsible for dispersal of contaminated dust particles in areas affected by mining, mineral processing and smelting [1]. We evaluated the solid speciation, leachability and potential bioaccessibility of metals (Co, Cu, Pb, Zn) and As in fly ashes and slag dusts originating from the metal mining and smelting areas of Zambia (the Copperbelt Province) and Namibia (the Tsumeb area). Dusts were highly enriched in inorganic contaminants (up to 273 g Cu/kg, 8.9 g Co/kg, 39 g Pb/kg, 21 g Zn/kg and 437 g As/kg). Based on XRD, SEM, EPMA and HRTEM investigations, major contaminant-bearing phases were cuprospinel ($CuFe_2O_4$), chalcanthite ($CuSO_4.5H_2O$), delafossite ($CuFeO_2$), arsenolite (As_2O_3) and minor galena (PbS), anglesite ($PbSO_4$), sphalerite (ZnS) and elemental Cu [2, 3]. The pH-static leaching tests indicated that contaminants were released from the fly ash mostly at low pH [2, 3], corresponding to conditions found in laterite soils from this area. We also adopted *in vitro* methods based on simulated gastric fluid (SGF) and simulated lung fluid (SLF). The maximum bioaccessibilities in SLF were relatively low (Co 16%, Cu 2%, Zn 1.2%, As 2.9%), whereas values higher than 20% were obtained for SGF (Co 80%, Cu 50%, Zn 77%, As 83%). The obtained data indicate that a severe health risk related to smelter dust ingestion/inhalation should be taken into account in these areas. This study was supported by the Czech Science Foundation (projects no. 13-17501S and P210/12/1413) and IGCP project no. 594.

[1] Ettler *et al.*. (2012) *J. Geochem. Explor.* **113**, 68-75. [2] Vítková *et al.*. (2011) *Appl. Geochem.* **26**, S263-S266. [3] Vítková *et al.*. (2013) *Appl. Geochem.* **29**, 117-125.

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