Nickel isotope fractionation in the soil-plant system of ultramafic environments

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Studies of nickel stable isotopes at the Earth's surface are providing valuable insights into the use of this system as a tracer of sources and biogeochemical processes. Interestingly, dissolved nickel in rivers and oceans presents a large heavy isotope enrichment (up to 1.44‰ [1]) compared to bulk silicate Earth (0±0.3‰ [2]). Weathering at the Earth's surface is thought to drive heavy isotopes into the dissolved phase, leaving the weathered material isotopically light [3]. In order to better constrain Ni isotope systematics in weathered environments, we studied soil profiles developed on ultramafic rocks in Albania and surrounding plants.

Double-spike Ni MC-ICP-MS analyses were performed on rocks, soils and soil solutions from three locations. Major and trace elements were measured in rocks and soils to constrain isotopic compositions. Almost all the soils presented lighter isotopic compositions than the parent rock (-0.6‰< $\Delta^{60}Ni_{Soil-rock}$ <-0.2‰). The magnitude of soil/rock fractionation generally correlates with the Fe/Mg ratio, and Mg-loss is responsible for the light isotope enrichment. However, the fractionation between the different horizons at any location remains low (0.1‰). Bioavailable fractions of soil solutions were recovered using DTPA extractions, and all exhibited heavy isotope enrichment (up to 0.9‰) relative to the soil. These data indeed imply that the chemical weathering process is the main control on fractionation, and the results provide further insights into the interpretation of Ni isotope systematics in surface processes.

Ni isotopes were also measured in Ni-hyperaccumulating plants that grow in these metal-rich soils. Roots exhibited heavy isotope enrichment relative to the soil. The bioavailable fractions indicate the source of heavy isotopes for the plants and provide new constraints on the soil/plant system, with no fractionation indicated during root uptake.

[1] Cameron and Vance (2014). *GCA*, **128**, 195-211 [2] Guegen *et al* (2013). *GGR*, **37**, 297-317 [3] Gall *et al* (2013). *EPSL*, **375**, 148-155