Nickel (bio)availability in ultramafic systems from Goías, Brázil: an overlook of the soil compartments.

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The overall objective of this work is to understand and quantify the Ni availability and mobility in ultramafic soils and ecosystems of Barro Alto and Niquelândia sites, Goías State (Brázil), impacted by the mining activity. Ultramafic soils are known to have a high concentration of metals, particularly nickel and chromium, and a low content of nutrients, like N, P, K, Ca; mining activity with waste products became a relevant source of natural Ni cycle alteration. It is well known that toxicity, mobility and bioavailabilty of metals are strictly correlated to their chemical form and to their distribution in the different liquid and solid compartments. The available Ni can be present in different forms such as free or complexed metal ion, adsorbed or in exchangeable position on soil particles.

In this work we quantified Ni availability and established the link between Ni solid speciation and availability in such a specific (ultramafic) context; samples of basin and lake waters, soils, sediments, ores, wastes and sludges were investigated. Two different techniques were used in parallel to investigate Ni mobility: the Donnan Membrane Technique (DMT) (Temminghoff et al. 2000; Jouvin et al. 2009), to quantify the free-metal ion in soil-water suspensions and Isotopic Dilution (ID) to quantify the pool of isotopically exchangeable Ni, addressing the kinetic aspect of the exchange in water samples and in soil suspensions (Sivry et al. 2006).

Concerning ID, water samples and soil-water suspension solution were spiked with stable ^{61}Ni and filtered after different time steps . Isotopic ratio (^{61}Ni/^{58}Ni) were measured with a HR-ICP-MS (Thermo Element II). Total metal concentrations were measured with ICP-OES (Thermo Fisher 6200). In some cases data display an isotopically exchangeable pool of Ni (E_{Ni}) considerably higher than Ni concentration in solution: up to 407±3 µg L^{-1} E_{Ni} (after 6 days of interaction) and only 46±1 µg L^{-1} for dissolved Ni in Barro Alto samples. The experiment highlighted also the kinetic aspect of the exchanges (Sivry et al. 2011): assuming to reach the maximum E_{Ni} after 6 days of interaction, only 75% of the total E_{Ni} is reached after 2 days for samples from Barro Alto while up to 99% of E_{Ni} pool is already quantified in samples from Niquelândia.

This different behavior is directly relied to the different composition of the suspended matter in solution (bearing phases). XRD measurement performed on suspended matter (SPM) from Barro Alto site surface water clearly shows the presence of goethite and lizardite, in agreement with the geological composition of the area. On the contrary, XRD measurements on SPM from Niquelândia sites show spectra of hard interpretation which suggest the presence of colloidal species and amorphous matter. The XRD patterns of soils indicate the presence of different phases such as goethite, chromite, vermiculite and quartz in samples from Barro Alto, and lizardite, chromite, quarts and hematite in Niquelândia ones; XRF data display a content of Ni from 0.6 wt% up to 5.9 wt% in ores, from 0.1 wt% up to 3.2 wt% in sludges and from 0.02 wt% up to 3.8 wt% in soils.

Further ID and DMT experiments specifically performed on the mineral phases detected should allow to better decipher and describe their specific role on Ni mobility in ultramafic context.

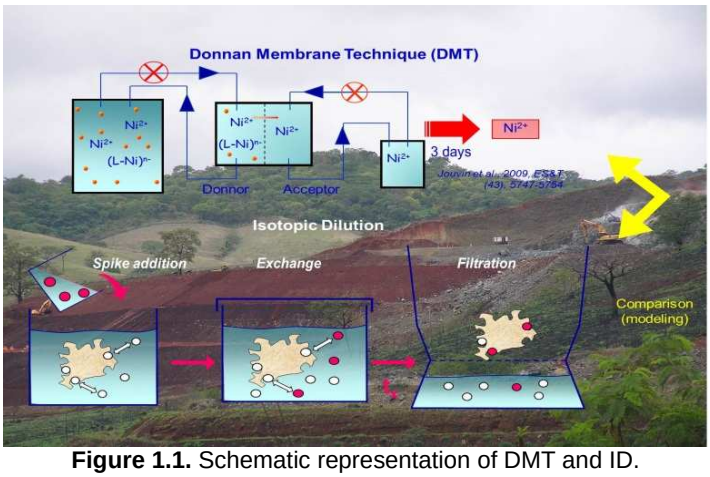

Figure 1.1. Schematic representation of DMT and ID.

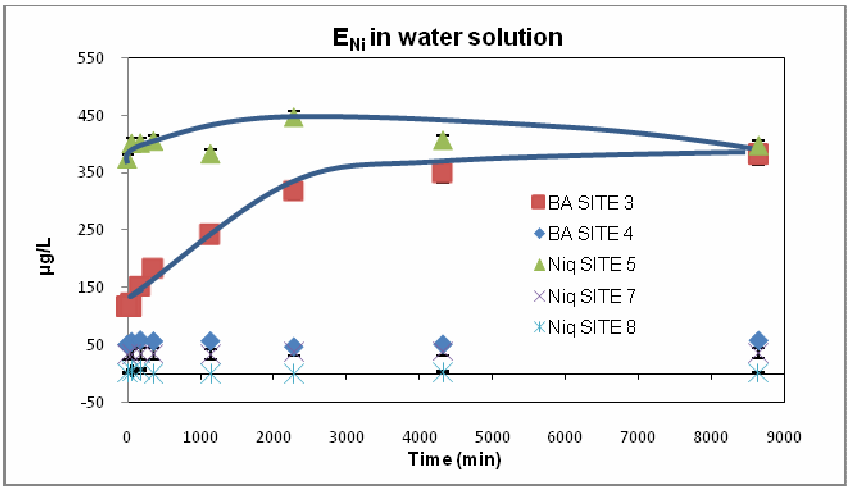

Figure 1.2. Ea Ni (µg/L) in water samples: equilibrium between liquid phase and suspended matter.

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