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1 Transfer kinetics of cadmium from naturally enriched rocks to Lupinus albus

V. Matera (1), R.C. Le Bayon (2), R. Quezada (1), Gobat J-M (2) and K. Föllmi (1)

(1) Laboratory of Geochemistry Sedimentology and Mineralogy, Geological Institute, Neuchâtel University, CH-2009 Neuchâtel, Switzerland (virginie.matera@unine.ch / Fax: +41 32 718 26 01), (2) Laboratory Soil & Vegetation, Botanical Institute, Neuchâtel University, CH-2009 Neuchâtel, Switzerland

Carbonate substrata from the Swiss and French Jura Mountains, which are anomalously enriched in cadmium (Cd) ($>$0.5 mg·kg^{-1}; Bajocian and Oxfordian in age), were found to be responsible for high concentrations of this highly toxic trace element in the associated soils (Dubois et al., 2002). The identified Cd concentrations may exceed the Swiss official tolerance guideline concentration for non-polluted soils (established at 0.8 mg•kg^{-1}; Osol, 1998) by one order of magnitude.

We study rock-soil-plant interactions with regards to the transfer of cadmium (Cd) using a specific experimental set-up (called "microcosms") under controlled temperature, light and humidity conditions. As part of a multi-proxy investigation, in which we study the plant response to stressful conditions, a model plant (white lupine; *Lupinus albus*) was chosen because of its specificity of forming special root structures when growing in soils with limited concentrations of phosphorus. These so-called 'cluster roots' excrete large amounts of organic acids, which acidify the rhizosphere soil. In these conditions, the solubility of heavy metals such as Cd is greatly enhanced by the formation of metallorganic complexes leading to a faster diffusion into the roots.

The microcosms were filled with a Cd-depleted soil (Cd content = 0.23 mg·kg^{-1}). 12 polished slices of naturally Cd-enriched carbonate rocks were placed in the soil column. Four lupine seeds (*Lupinus albus*) were sown in each microcosm. Two time

modalities are studied: one-year and three-year experiment duration. Here, only the one-year modality results are presented. Aerial parts are collected every two months and new lupine seeds are sown again. Cd concentrations in the model plant are measured in roots and aerial parts separately.

The soil chemistry is studied by analyses of total and bioavailable Cd, trace metals and major elements. Physicochemical properties of soil samples are determined. SEM-EDS analyses are used in order to precise surface weathering effects by roots contacts on rock slices.

The preliminary results in plants reveal an accumulation of Cd in cluster roots (about 0.70 mg.kg^{-1}). Cd complexation by excreted organics acids facilitates its solubilization and its further absorption by roots. Cd accumulation in the aerial biomass seems to be quite negligible after 1-year culture. Nevertheless, it is still difficult to establish a kinetic of Cd transfer due to the short time of experimentation and variations in biomass during the cycle of lupine. On the other hand, observations of rock slices by SEM reveal direct root contacts with the Cd-enriched carbonates which seem to induce a surface alteration. Thus, the local weathering on the Cd-enriched rock slices by activity of roots reveals a risk of Cd mobilization and direct uptake by plants on the long term.

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References:

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