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Exchangeability of Cr(III)/Cr(VI) in ultramafic systems: Elucidating the role of colloidal carrying phases to the mobility of chromium

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Chromium is known as one of the most (eco)toxic heavy metals, that can raise severe ecological and environmental issues. To gain a profound insight into the toxicity of Cr in soils and waters, a better understanding of its availability and mobility is substantial, rather than only quantifying its total amount. In the natural environment, chromium mostly occurs in ultramafic systems and either as trivalent (Cr(III)) or hexavalent (Cr(VI)) states. Chromium availability and mobility are regulated by bearing and scavenging mineral or organic phases from soils and surface waters. In order to figure out the role of Cr(III) and Cr(VI) carrying phases on the availability and mobility of Cr in soil, we used the Stable Isotopic Exchange Kinetics (SIEK) approach, which is an efficient method to determine the size and reactivity of the exchangeable pool of Cr (E_{Cr}), as it was previously performed for Ni by our group (Zelano et. al. 2016a and 2016b). We focused the study on ultramafic soils in New Caledonia which are characterized by elevated Cr contents, here from 10 000 to 25 000 mg kg^{-1}. The SIEK experiments highlight that the total exchangeable amount is higher for $E_{Cr(III)}$ than for $E_{Cr(VI)}$, in most soil samples, ranging from 156 to 240 mg kg^{-1}, which indicates that exchangeable Cr is mainly in its less toxic Cr(III) form in these samples. The relative exchangeable pools ($E_{Cr(III)}$ %) reach 30% after 10 min and 97% after 3 days. The mineralogical composition of the soil samples determined by X-ray diffraction (XRD) consists of goethite, hematite, chromite and spinel. SIEK analyses for Cr(III) and Cr(VI) on these mineral phases allows to describe the proportion and kinetics of exchanges ($E_{Cr(III)}$, $E_{Cr(VI)}$, $k_{Cr(III)}$ and $k_{Cr(VI)}$) associated to each scavenger of Cr in these soil samples. Quantifying the specific contribution of each carrying phases to the exchangeable pools of Cr(III) and Cr(VI) will allow the accurate understanding of Cr mobility in these ultramafic soils.