Chromium mobility in ultramafic areas: an isotopic study

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Ultramafic rocks may display high chromium (Cr) concentrations, which could be naturally leached to surface and groundwater. However, mining and metallurgical activities may considerably increase the amount of both Cr(III) and Cr(VI) released into the environment, the later being highly soluble in water, bioavailable and toxic. In the present study, a nickel and a chromium mining areas were studied in Goiás State, Brazil (Barro Alto, BA and Crominía, CA, respectively) in order to compare the potential release of Cr, its pathway from solids to surface and ground waters, and the associated isotopic compositions in those matrices. The chemically and isotopically exchangeable pool of Cr(VI) ($E_{Cr(VI)}$) was significant in BA ores with values up to 104.09 ± 7.70 mg kg^{-1}. In soils, the $E_{Cr(VI)}$ in the deep soils (160 cm) was up to 30 and 8 fold higher than in the surface in BA and CA (up to 21.14 ± 2.17 mg kg^{-1} and 6.66 ± 1.05 mg kg^{-1}, respectively). This was accompanied by an increase of $\delta^{53}Cr$ in BA and CA, which varied from -0.28 ± 0.01‰ to -0.05 ± 0.01‰ and from -0.70 ± 0.01‰ to 0.21 ± 0.02‰, respectively. In addition, extracted Cr(VI) (0.1 M KH_2PO_4) displayed positively fractionated $\delta^{53}Cr$ (1.69 ± 0.03 ‰) in the same range of isotopic compositions measured in the fresh waters. These results suggest that in weathered materials, Cr is mainly release as the toxic Cr(VI) specie, which availability increases from the soil profile to the ores and mining residues. The differences observed in the Cr isotopic composition suggest that $\delta^{53}Cr$ could be used as a tracer of Cr leaching in environmental studies.