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Solid speciation and availability of nickel and chromium in Ni mining spoils

Sophie Raous (1), Jérémie Garnier (2), Thibaul Sterckeman (1), Guillaume Echevarria (1), Thierry Becquer (3), and Fabien Thomas (4)

(1) UMR 1120 LSE, ENSAIA-INPL-INRA, Nancy-Université, F - 54505 Vandoeuvre-lès-Nancy CEDEX, France Tel.: +33-383-596-078; fax: +33-383-595791. E-mail address: Sophie.Raous@ensaia.inpl-nancy.fr, (2) UMR 8148 IDES, Université Paris Sud XI - CNRS, Bat. 504, 91405 Orsay Cedex France, (3) UMR 210 Eco&Sols, IRD – INRA – SupAgro, 2 place Viala, Bâtiment 12, 34060 Montpellier Cedex , France, (4) Laboratoire Environnement et Minéralurgie, UMR 7569 CNRS/Nancy-Université, BP 40, 54501 Vandoeuvre-lès-Nancy Cedex, France

Nickel mining of ultramafic laterites generates different types of wastes, topsoils and ores that are too poor in Ni to be currently processed. These are mixed and stored on heaps which could be a potential source of Ni and Cr pollution. Chemical reactivity of the main metal bearing phases present in the mining spoils of Goiás (Brasil) was investigated. Principally a silicated 'saprolite' material and a Fe-oxide rich limonitic material were isolated from the wastes. Their total Ni and Cr content are high, respectively for Ni and Cr : 7,170 and 54,970 mg kg^{-1} in limonite and 12,200 and 12,650 mg kg^{-1} in saprolite. The main metal-bearing minerals, identified and localized using XRD, TEM-EDX, Raman spectroscopy and Mossbaüer spectrometry are well-crystallized minerals: goethite (75%), hematite (13%) and chromite in limonite and ferruginous smectite, talc and chromite in saprolite. Single and sequential extractions showed that the amounts of 1M KCl exchangeable Ni and Cr reached respectively 7.1% and 0.03% of total contents in saprolite. Moreover, Cr(VI) extraction by KH_2PO_4 showed that more than 2% (980 mg kg^{-1}) of total Cr was under this labile toxic form in limonite. This study allowed us to determine the main reactions controlling the Ni and Cr mobility in the spoils i.e. Ni^{2+} cationic exchange in saprolitic spoil and CrO_3^{2-} surface complexation in limonitic spoil. This study allowed us to demonstrate the need of chemical rehabilitation of mining wastes in order to avoid the dispersion of the high contents of Ni and Cr available. It constitutes the system definition needed to predict the Cr and Ni mobility in ultramafic mining spoils.