Modification of sequential extraction method for better understanding of host phases in high grade Ni laterite ores

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Ni laterite deposits, currently the major sources of Ni ores, are formed by chemically weathering of ultramafic rocks in tropical to sub-tropical climates. Regardless of the significance in the mineral exploration and processing, host phases of Ni in Ni laterite ores are not readily identifiable by conventional mineralogical analyses due to possible presence of amorphous weathering products. Although sequential extraction methods have been primarily used to identify host phases of various elements in soils, application of sequential extraction to Ni laterite ores may be problematic because of the different physicochemical properties, for example, high Fe contents. Therefore, we aimed to modify a sequential extraction method first developed by Geological Survey of Canada (mGSC method [1]), which has been used for tropical soils, for Ni laterite ores. Then, using the method, we investigated chemical states of Ni in different types of Ni laterite ore deposits, namely a hydrous Mg silicate deposit at Petea Hill in Soroako mine, Indonesia [2], and a hybrid deposit of hydrous Mg silicate and clay silicate types in Tagaung Taung mine, Myanmar [3]. We were particularly focused on modification of extraction for ion exchangeable as well as iron (hydr)oxides phases.
Best selective extraction of Ni for ion exchangeable as well as iron (hydr)oxides phases from the laterite and saprolite samples was achieved by using ammonium acetate and sodium dithionite/citrate (DCB method), respectively. Although DCB method was repeated three times to increase recovery of Fe from (hydr)oxides, subsequent analysis for the residual phases shows minimal dissolution of silicate phases for almost all the samples but lower saprolite samples from Petea Hill. The modified sequential extraction applied to the whole weathering profiles demonstrated that Ni was mainly present in the crystal structure of silicate minerals in the saprolite layers at both Petea Hill and Tagaung Taung. The results are consistent with previous XRD and EPMA analyses suggesting secondary serpentine and smectite as the primary host minerals for Ni in the saprolite layer at Petea Hill and Tagaung Taung, respectively [2, 3]. Extraction of ion exchangeable phases from saprolite samples at Tagaung Taung suggests that Mg^{2+} is the major interlayer cation in the smectite. Although these silicate minerals are the main Ni hosts in the saprolite layers at both weathering profiles, the sequential extraction results also suggest that significant fractions (up to ~20%) of Ni were hosted by low crystalline Fe oxides in the saprolite layers. This is supported by EXAFS spectra obtained from the lower saprolite samples where Ni is highly concentrated. These results imply that Fe oxides may also concentrate Ni in the saprolite layer and play important roles in the Ni enrichment processes in both deposits.

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