Geophysical Research Abstracts
Vol. 14, EGU2012-6673, 2012
EGU General Assembly 2012

Investigation of Philippine Garnierites: a close look on their mineralogy, geochemistry, morphology, and nature of nickel association

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The Philippines hosts several nickel-laterite deposits from the weathering of ultramafic sections of its ophiolites and ophiolite complexes, distributed from north to south of the archipelago. It is within two of these deposits that garnierites, hydrous nickel magnesium silicates, were collected and characterized in detail for their mineralogy, morphology, chemistry, nickel association, and spectral bands. X-ray diffraction (XRD) analyses, with corresponding X-ray fluorescence data, show that the garnierites from a mining area in Surigao (Southern Philippines) are mostly species of the serpentine group while samples from Zambales (Northern Philippines) are made up of falcondoite, species of pyrophyllite-talc, serpentine, chlorite, or an intimate mixture of these minerals. Electron micrographs reveal a variety of morphological forms: rod-shaped, platy or foliated, scaly, and fibrous. Three spectral regions have been observed using IR spectroscopy: 3700 cm-1-3400 cm-1 absorption bands associated with –OH stretching vibration region, 950 cm-1-900 cm-1 bands associated with the Si-O-Si stretching vibration region, and the 650 cm-1-600 cm-1 bands which are associated with either Si-O bending or –OH liberation. Noted nickel concentration in Philippine garnierites reach up to 20%. Sequential extraction results show that more than 90% of the nickel in garnierites is concentrated via substitution rather than adsorption. No significant correlation between nickel and other trace elements, except for cobalt, is observed from trace element analysis conducted using inductively-coupled plasma mass spectrometry (ICP-MS).