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Behavior of major and trace elements upon weathering of peridotites in New Caledonia : A possible site on ultramafic rocks for the Critical Zone Exploration Network (CZEN) ?

Farid Juillot (1), D. Fandeur (1), E. Fritsch (1), G. Morin (1), J.P. Ambrosi (2), L. Olivi (3), A. Cognigni (3), J.L. Hazemann (4), O. Proux (4), S. Webb (5), G.E. Brown Jr. (5,6)

(1) Institut de Minéralogie et de Physique des Milieux Condensés (IMPMC), UMR CNRS 7590, Université Pierre et Marie Curie – Université Denis Diderot - IPGP, 75015 Paris, France, (2) Centre Européen de Recherche et d'Enseignement en Géosciences de l'Environnement (CEREGE), UMR CNRS 6635, Université Paul Cézanne – Université de Provence, 13545 Aix en Provence, France, (3) ELETTRA, Sincrotrone Trieste -Area Science Park, 34012 Basovizza, Italy, (4) European Synchrotron Radiation Facility, FAME Beamline, BP 220, F-38043 Grenoble, France, (5) Stanford Synchrotron Radiation Lightsource, 2575 Sand Hill Road, Menlo Park, California, 94025, USA, (6) Department of Geological & Environmental Sciences, Stanford University, Stanford CA 94305-2115, USA

Ultramafic rocks cover about 1% of the continental surfaces and are related to ophiolitic bodies formed near convergent plate boundaries (Coleman, 1977). The most typical ultramafic rocks are dunite and harzburgite, which are composed of easily weatherable ferromagnesian mineral species (olivines and pyroxenes), but also of more resistant spinels (chromite and magnetite). Oceanic serpentinization of these ultramafic rocks usually lead to partial transformation of these initial mineral assemblages by forming hydrous layer silicates such as serpentine (lizardite, chrysotile and antigorite) talc, chlorite and actinolite (Malpas, 1992). It also lead to the formation of highly sheared textures, which favor meteoric weathering through preferential water flows. Compared to their crystalline rock counterpart that covers most of the continental surfaces, these ultramafic rocks mainly differ by their lower SiO_2, Al_2O_3 and K_2O contents (less than 50%, 10% and 1%, respectively) and, on the opposite, much higher MgO content (more than 18%). Moreover, they commonly have higher concentrations in FeO and other trace elements, such as Ni, Cr, Mn and Co. Weathering of these rocks is then at the origin of major geochemical anomalies on continental surfaces, especially when they occur in tropical and subtropical regions.

Such conditions are encountered in New Caledonia where one third of the surface is covered with peridotites (mainly harzburgite with small amounts of dunite) obducted about 35 millions years ago during large tectonic events in the Southwest Pacific at the Late Eocene (Cluzel et al., 2001). Tropical weathering of these ultramafic rocks lead to the development of thick lateritic regoliths where almost all Mg and Si have been leached out and Fe, Mn, Ni, Cr and Co have been relatively concentrated. In these oxisols, Ni, Cr and Co can exhibit concentration up to several wt%, which make them good candidates for ore mining (New Caledonia is the third Ni producer in the world). However, these high concentration of potentially toxic elements can represent a serious hazard for the environmental quality of the Caledonian ecosystem which is a '' biodiversity hotspot" (Myers, 2000), which emphasize the strong need for characterizing the natural cycling of these elements upon weathering of ultramafic rocks.

To reach this goal, we have studied the mineralogical distribution, crystal-chemistry and mass balance modelling of major (Si, Mg, Al, Fe, Mn) and trace elements (Ni, Cr and Co) in the freely-drained weathering profile developed in the serpentinized harzburgites of Mt Koniambo (West Coast of New Caledonia). Results show that both hydrothermal and meteoric processes contributed to the vertical differentiation of this freely drained weathering profiles in serpentinized ultramafic rocks. Finally, they also emphasize the importance of both redox reactions and interactions with Mn- and Fe-oxyhydroxydes (Fandeur et al., 2009a; 2009b) to explain the opposite behavior observed between very mobile Ni and almost immobile Cr (Fandeur et al., 2010).

These results bring new insights on the geochemical behavior of trace elements upon weathering of ultramafic rocks under tropical conditions leading to the formation of supergene ore deposits. They also emphasize the interest of

such a weathering site on ultramafic rocks under tropical climate to complemente the reference sites of the Critical Zone Exploration Network (CZEN).

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