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Subsurface Reactive Transport Modelling of the Lateritic Ni mineralization in New Caledonia: A coupled Thermo-Hydro-Geochemical Approach

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This research proposes a subsurface reactive geochemical transport modelling of the development of a nickel laterite profile in New Caledonia over the past few million years. Such a regolith formation from ultramafic bedrock was not yet modelled and gives new profound insights into the Ni vertical mobility, its retention processes in a soil profile and relative enrichment, that are still poorly studied. The downward progression of the lateritization front is allowed by the leaching of the soluble elements (Si, Mg and Ni) through drainage system, represented by porous column of peridotite. Particular emphasis is placed on the detailed understanding of Ni redistribution as a function of time and depth triggered by Ni-bearing silicate precipitation (i.e. garnierite) and by sorption or recrystallization process with goethite.
Current work consists of the following models: i) 1-D calculations that are done at 25oC with the code PHREEQC associated with the llnl thermodynamic database and ii) 2-D model that handles coupled thermo-hydro-chemical processes and is calculated on the interface Comsol-Phreeqc (iCP, Nardi et al., 2014). The impact of i) fluid flow in fractures and ii) recharge rate along with iii) hydraulic and iv) geothermal gradients are considered here. While the first model gives profound insights into the vertical mobility of metals upon the formation of laterite (Myagkiy et al, submitted), the latter one additionally allows to describe heterogeneities of mineralizing distributions due to the influence of preferential pathways (fractures), convective flows and lateral transfers. Our long-term 1-D simulations (10 Ma) clearly demonstrate that the Ni enrichment and thickening of iron-rich zone are governed by the vertical progression of the pH front. At the same time 2-D modelling shows reactivation of Ni from oxide zone and it subsequent redistribution and concentration in saprolite. Such a model appears to be of importance in attempt of explanation Ni mineralization processes, revealing the main keys to understanding the trace elements mobility in ultramafic environment.

Myagkiy A, Truche L, Cathelineau M, Golfier F. “Revealing the conditions of Ni mineralization in laterite profile of New Caledonia: insights from reactive geochemical transport modelling” Preprint submitted to Chemical Geology (September 28, 2016).

Nardi A, Idiart A, Trinchero P, de Vries LM, and Molinero J. “Interface COMSOL-PHREEQC (iCP), an efficient numerical framework for the solution of coupled multiphysics and geochemistry.”Computers & Geosciences 69 (2014): 10-21.