Numerical Model of the Development of the Secondary Nickel Ores (New Caledonia): Towards Understanding the Lateritic Ni mineralization

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The New Caledonia is one of the world's largest sources of nickel from laterites, formed on olivine-rich ultramafic rocks. Lower Ni concentrations are present at the top of the limonite zone, throughout which they are increasing and peaking in the saprolite. Knowledge of the elements mobility and its controlling factors appears to be a key point to understanding the Ni mineralization and zoning in laterites.

The lateritic soil development due to meteoric water flow was modelled using reactive transport in PHREEQC. Dissolution of olivine in the column was assumed to be kinetically controlled, while dissolution/precipitation of secondary minerals (ferrihydrite, gibbsite, Mg talc-like, Ni talc-like, Mg sepiolite, Ni sepiolite, quartz, saponite) are considered to occur according to local equilibrium. Ni mineralization was considered as due to both sorption of Ni on ferrihydrite charged surfaces and precipitation of Ni-bearing minerals.

The Ni deposits are moving by the action of ground water and governed by migration of pH front. Whilst the iron has been oxidized, the nickel remains divalent and is somewhat mobile, more so than iron, less so than magnesium. Transport of Ni is retarded compared to water migration by sorption and precipitation of Ni-bearing silicates, which are being functions of pH and Ni concentration. Subsequent decrease of pH due to dissolution of olivine leads to both decrease of a charge of oxide surfaces and dissolution of previously formed silicates. It causes release of previously sorbed on ferrihydrite as well as precipitated in form silicates Ni into porewater and following redeposition beneath, under the form of Ni-silicates or re-adsorption. This redistribution of Ni in between iron oxi-hydroxides and silicates defines the Ni laterite mineralization and is closely tied to hydrology of the weathering profile. Thus, the calculations were performed for two different residence times of solution in a cell, leading to either advection- or reaction-dominated flow regime and, consequently, difference in thickness and Ni content of goethite. This kind of studies is thus to be considered as a useful tool to improve the understanding of Ni-zoning and different factors governing the process of lateritization of ultrabasic rocks.