

Crystal chemistry and concentration process of nickel in New Caledonia laterite

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In the lateritic profiles developed on ultramafic rock, nickel is concentrated preferentially in the saprolite horizons, towards the bottom of the profile, close to the bed rock. Paradoxically, nickel is therefore concentrated in zones presenting the first stages of supergene alteration. From a multi-scale approach based on microscopic and chemical imaging, geochemistry and spectroscopy, we propose here to shed light on the sequences of Ni enrichment in the saprolite facies [1].

Cross-checking this information first makes it possible to propose a mineralogical model describing the main nickel-bearing phase in these lateritic horizons. From molecular modeling, the proposed model is based on a “talc-like” nano-phase in which nickel forms clusters at the atomic scale in the octahedral layers. This model reconciles the various observations, which have led to difficulties in properly characterizing this phase for decades, such as a very low crystallinity, water/hydroxyl contents often strongly overestimated in chemical analyses, and an interplanar spacing greater than that of talc.

Secondly, based on in-situ iron redox data and the hydroxyde solubility of the different species as a function of pH, we propose a model of nickel trapping in the saprolite facies. While bedrock dissolution operates, the enrichment sequence consists of, i) in-situ serpentinization into lizardite, using pre-existing “oceanic” lizardite network veins, ii) polygonal serpentine formation with Ni contents of about 5 wt%, iii) a succession of talc-like phases first presenting Ni contents of ~20 wt%, then replaced by another phase with ~36 wt% Ni. An increase in Fe(III)/Fe(total) ratios from ~0.5 to ~0.95 is observed in this mineral sequence, reflecting a local increase in oxygen fugacity with increasing weathering degree and therefore a progressive opening of the mineralized veins to the external environment. Finally, the cross-checking of the solubility curves of Mg and Si hydroxides within the saprolite facies allow us to propose that the main driving force responsible for the over-concentration of nickel, in this buffer zone of the laterite profile, is the strong local pH gradient.

[1] Muñoz et al. (2019), *Journal of Geochemical Exploration*, 198, 82-99.

