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Alteration of the New Caledonia ophiolite: Mineralogical and geochemical investigations

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The New Caledonia ophiolite is one of the largest ophiolite in the world (500 km long, 50 km wide and 2 km thick). Emplaced during the Eocene, it consists of a large continuous massif occurring in the south of the island and of few smaller isolated klippes located along the west coast. The peridotites are mostly harzburgites, except in the northernmost massifs where lherzolites also occur. The entire ophiolite is affected by strong serpentinization whose intensity decreases from bottom to top of the massifs. Since its complete obduction (at $\sim$ 34 Ma), the ophiolite has experienced strong weathering due to tropical conditions. This alteration is expressed as laterization affecting both the fresh and moderately serpentinized peridotites of the upper part of the massif. The lower part of the massif does not seem affected by this weathering, but previous studies showed that the serpentinites located at the base of the massif have an anomalous chemical composition relative to the others.

This study focuses on the determination of the processes responsible of (a) the chemical variability of the serpentinites and (b) the formation of new mineral phases. To answer these questions, we used different analytical techniques: we used Raman spectrometry to identify the mineral phases (including the serpentine polymorphs) present in the basal sequence of the ophiolite; we developed an original method, based on micro-beam X-ray fluorescence (μ-XRF) mapping on macroscopic samples to characterize the relationship between mineral phases in finely-divided mineral assemblages; and finally we measured major and rare earth element compositions of serpentinite, peridotite and laterite to evaluate the chemical exchanges between the different parts of the ophiolitic sequence.

Our results demonstrate that the chemical and mineralogical transformations of the basal serpentinite are directly linked to the laterization process occuring at the top of the ophiolite. Laterization leads to leaching of silica, magnesium and rare-earth elements; these elements are transported by percolation of meteoric fluids to the bottom of the ophiolitic sequence where they accumulate and reprecipitate by supersaturation. This is where new phases such as magnesite and amorphous silica are formed. At the top of the sequence, the leaching process leads to the concentration in the laterites of transition metals of economical interests such as iron and nickel.