# Hydrothermal vs. meteoric redistribution of elements upon tropical weathering of ultramafic rocks

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This study reports the results of a crystal-chemistry and mass balance analysis aimed at evaluating the relative contribution of meteoric vs. hydrothermalism weathering on the redistribution of major and trace elements along a 64 m depth regolith developed in ophiolitic peridotites in New Caledonia [1].

Two categories of elements could be defined on the basis of the process responsible for their redistribution. Mg and Si occur as silicates (forsterite and enstatite) in the bedrock and are strongly leached at the first stage of meteoric weathering. Fe, Al and Cr occur as impurities in silicates and as chromites in the bedrock and are progressively moved to secondary Fe-oxides upon meteoric weathering. Mass balances indicate that these elements are almost entirely conserved in the regolith upon weathering. Mn and Co are found in Mn-oxides, of both hydrothermal and meteoric origin. Finally, Ni is transformed from Ni-bearing primary silicates (forsterite and enstatite) in the bedrock to Ni-rich hydrous silicates, in large hydrothermal veins. However, this element is also partly incorporated as impurities in secondary Fe-oxides and mass balance indicates that it is significantly leached upon meteoric weathering in the upper part of the regolith. This behavior is attributed to the progressive purification of Fe-oxides towards the surface through successive dissolution/crystallization. This work was supported by the French ANR-ECCO program.

[1] Fandeur *et al.* (2009) *GCA*, submitted.

# Temperature effect on nucleation and growth in fluid-rock interaction processes

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Fluid–rock interactions processes are highly temperature dependent from the range concerned by weathering processes (~0-25°C) up to higher temperatures of the order of 300°C in hydrothermal conditions. This is due to both thermodynamic effects on solubility and kinetic effects on nucleation and growth. It is therefore a real challenge for geochemists to be able to account for them in water–rock interaction models, particularly if one considers systems on short term compared to geological timescales. This applies for example to geothermal systems or nuclear waste storages in which the kinetic control on reactions is important, particularly in safety assessment studies.

These effects can be studied thanks to our recently developed Nanokin code [1-3] which models dissolution of primary minerals as well as the kinetics of precipitation of secondary minerals with a special care taken in accounting for the first steps of nucleation and growth.

We present the results of a set of simulations at temperatures ranging from 25 to 150°C for the two following systems :

- the competition between amorphous silica and quartz precipitation in an initially oversaturated aqueous solution;
- the alteration of a granitic rock by a dilute aqueous solution.

The results of our simulations clearly show that the increase of temperature modifies :

(1) the sequence of secondary phases which precipitate (thermodynamic effects);

(2) the dynamics of precipitation and the way aqueous solutions return to equilibrium after an intermediate oversaturation stage (kinetic effects).

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[1] B. Fritz, A. Clément, Y. Amal, and C. Noguera (2009) *GCA* **73**, 1340-1358. [2] Noguera C., Fritz B., Amal A. et Clément A. (2008) GCA **72** (12S), A687, 1 Jul 2008. Goldschmidt Conf. [3] Noguera C., Fritz B., Clement A. and Amal Y. submitted to *Chem. Geol*.