



**HAL**  
open science

## Formation of hydrothermal corrugations during ultramafic rocks weathering

Laurent Guillou-Frottier, Anicet Beauvais, Robert Wyns, Laurent Bailly, Thierry Augé, Anne-Sophie Audion

### ► To cite this version:

Laurent Guillou-Frottier, Anicet Beauvais, Robert Wyns, Laurent Bailly, Thierry Augé, et al.. Formation of hydrothermal corrugations during ultramafic rocks weathering. Aquifères de socle : le point sur les concepts et les applications opérationnelles, Vingtièmes journées techniques du Comité Français d'Hydrogéologie de l'Association Internationale des Hydrogéologues, Jun 2015, La Roche sur Yon, France. hal-01120470

HAL Id: hal-01120470

<https://brgm.hal.science/hal-01120470>

Submitted on 25 Feb 2015

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution - NonCommercial - NoDerivatives 4.0 International License

## Formation de corrugations hydrothermales lors de l'altération des roches ultramafiques

**Laurent GUILLOU-FROTTIER<sup>(1)</sup>, Anicet BEAUVAIS<sup>(2)</sup>, Robert WYNS<sup>(1)</sup>, Laurent  
BAILLY<sup>(1)</sup>, Thierry AUGÉ<sup>(1)</sup>, Anne-Sophie AUDION<sup>(3)</sup>**

(1) BRGM, ISTO, UMR 7327, Orléans ; (2) Aix-Marseille Université, CEREGE (IRD, CNRS), Aix-en-Provence ; (3) Variscan mines, Orléans  
l.guillou-frottier@brgm.fr

Préférence pour :  Présentation orale,  Poster,  Sans préférence

During shallow subsurface (< 200 m depth) weathering processes, temperatures may reach several tens of °C as a result of exothermic chemical reactions, such as hydration of olivine in ultramafic rocks or chloritization of biotite in granitic rocks. These mineralogical transformations enhance mineral fracturing, and the growth of fracture networks leads to further reactions and increases the permeability. The subsequent deepening of the weathering front creates new reactions, thus self-maintaining the weathering process over several million years (Myr). For more than 20 Myr, the peridotite massifs of New Caledonia have undergone intense weathering that has produced thick lateritic weathering mantles. The observable undulations of the weathering front and the protrusions of unweathered peridotite, from several meters to several tens of meters high, attest to a corrugated bedrock topography, which may result from inhomogeneous fluid circulation patterns within the coarse, permeable and porous (30-50%) saprolite layer. Combined together, the excess heat (up to  $\approx 100^\circ\text{C}$ ) and high permeability ( $10^{-14}$  to  $2 \times 10^{-13} \text{ m}^2$ ) within lateritic weathering mantles could potentially trigger hydrothermal convection (buoyancy-driven flow). This was numerically modeled by accounting for temperature-dependent fluid density and viscosity, and for time-dependent and spatially varying parameters simulating the deepening of the weathering front. Modeling the transient evolution of the thermal and flow velocity fields over 10 Myr reveals that hydrothermal convection can be triggered in the weathering lateritic mantles of New Caledonia, even on sloped surfaces where topography-driven flow prevails. Convective cells develop above the weathering front, and the amplitudes of thermal undulations are enhanced when feedback mechanisms between permeability and temperature are accounted for. The models also allow definition of the most probable zones of mineralization and reveal two-dimensional corrugations below which weathering is no longer efficient.