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Serpentinization of sintered olivine during seawater percolation experiments

Linda Luquot (1), Muriel Andreani (2), Marguerite Godard (1), Philippe Gouze (1), and Benoit Gibert (1)

(1) Université Montpellier 2 - CNRS, Laboratoire Géosciences Montpellier UMR5243, Montpellier, France , (2) Université Claude Bernard Lyon 1, Laboratoire des Sciences de la Terre de Lyon, UMR5570, Villeurbanne, France

Hydration of the mantle lithosphere exposed along detachment faults at slow-spreading ridges leads to strong modification of rock rheological, geophysical and geochemical properties, and to the emission of large amounts of H_2 and CH_4, and of complex carbon molecules that support primitive ecosystems. The sustainability and efficiency of this hydration process, serpentinisation, and of associated reactions, requires penetration and renewal of fluids at the mineral-fluid interface. However, precipitation of material along flow paths will affect porosity and permeability that, in turn, will have feedbacks effects on the reactions. It is thus necessary to investigate the sustainability of flow paths, and the evolution of reaction rates for a dynamic system under representative conditions. We investigate these processes by percolation experiments carried out under P, T representative conditions, using the ICARE Microlab experimental bench. We present the preliminary results of seawater percolation within samples of sintered San Carlos olivine. The experiments were carried out under a confined pressure of 190 bars and a temperature of 190˚C and water flow was set at a constant specific discharge of 0.06 ml/h.. The experiments were performed at very slow flow rate to be more representative of natural systems. ICARE Microlab allows measuring continuously the permeability changes during the percolation experiment and sampling the brine at the outlet of the sample.

After 20 days of experiments, poorly crystallized serpentine and iron oxide formed within the micro-cracks while permeability strongly decreases. Such rapid precipitation of serpentine results in clogging of fluid paths. The chemical composition of the outlet fluid is dominated by Si and is depleted in Mg relative to stoechiometric dissolution of olivine during the whole experiment suggesting that brucite possibly formed. SEM and AEM/TEM are used to characterize the reactive interfaces and the neoformed materials.