EUROPEAN SYNCHROTRON RADIATION FACILITY
INSTALLATION EUROPEENNE DE RAYONNEMENT SYNCHROTRON

Experiment Report Form

ESRF	**Experiment title:** ***Kinetics of peridotite serpentinization approaching complex natural chemistry with plagioclase and calcite***	**Experiment number**: ES-336
Beamline: ID27	**Date of experiment**: from: 27 Nov. 2015 to: 2 Dec. 2015	**Date of report**:
Shifts: 15	**Local contact(s)**: Dr Mohamed Mezouar	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

*Steve PEUBLE, LGL, UMR 5276, ENS et Univ. Lyon 1

*Muriel ANDREANI, LGL, UMR 5276, ENS et Univ. Lyon 1

*Isabelle DANIEL, LGL, UMR 5276, ENS et Univ. Lyon 1

*Jean-Philippe PERRILLAT, LGL, UMR 5276, ENS et Univ. Lyon 1

*Hervé CARDON, LGL, UMR 5276, ENS et Univ. Lyon 1

Report:

Previous experiments [1, 2: Exp. HS-4586 and ES-91] highlighted the role of Al and (bi)carbonates ions on the alteration kinetics of olivine under oceanic hydothermal conditions (200-350°C, 200 MPa). The first main objective of the present experiments was to test more realistic sources of Al and (bi)carbonates using minerals typical of the oceanic lithosphere, plagioclase and calcite respectively, mixed with olivine or peridotites powders. The second objective was to explore the effect of those elements at higher P-T conditions (450°C, 2 GPa) representative of subduction zones where the oceanic lithosphere can interact with sediments, also riched in Al and (bi)carbonates sources.

We have run a total of 10 experiments with minerals in a 0.5 M NaCl solution.
One experiment was conducted at 340°C - 2 GPa with olivine and corundum to directly address the effect of P compared to previous data [1] at lower P (200 MPa). Then experiments were run with the new mineral mixtures (olivine + calcite or plagioclase): two at 200°C-200 MPa, two at 340°C-200 MPa and three at 340°C-2 GPa. Two experiments were run with a peridotite at 340°C- 2 GPa. The effect of higher T could not be addressed because of time limitation.

As in previous experiments [1, 2], data were treated using Le Bail method to refine cell parameters of the main identified phases. Then the Rietveld method was used to quantify the proportion of each phase as a function of reaction advancement.

Results show the formation of a wide range of mineral phases depending on the initial mixture but serpentine is always the dominant one. The most efficient reactions were the one run with olivine and plagioclase that displayed fast conversion to serpentine and amphibole (Fig. 1) which is similar to what is observed at olivine-plagioclase contacts in natural systems. This confirm that Al effect is valid over a wide range of P conditions and whatever the source of Al. The kinetics is not much increased with pressure in the 200 MPa – 2 GPa range. XRD data also shows the formation of metastable intermediate phases forming very fast at the beginning of some reactions that then evolves over time. Data are still under processing.
Another unexpected result was the very fast transformation of a peridotite at 2 GPa with pyroxene and few spinel as the sources of Al. This opens news perspectives on the kinetics of mantle serpentinization in subduction zone for which data are still lacking. This will be the objective of a future project.

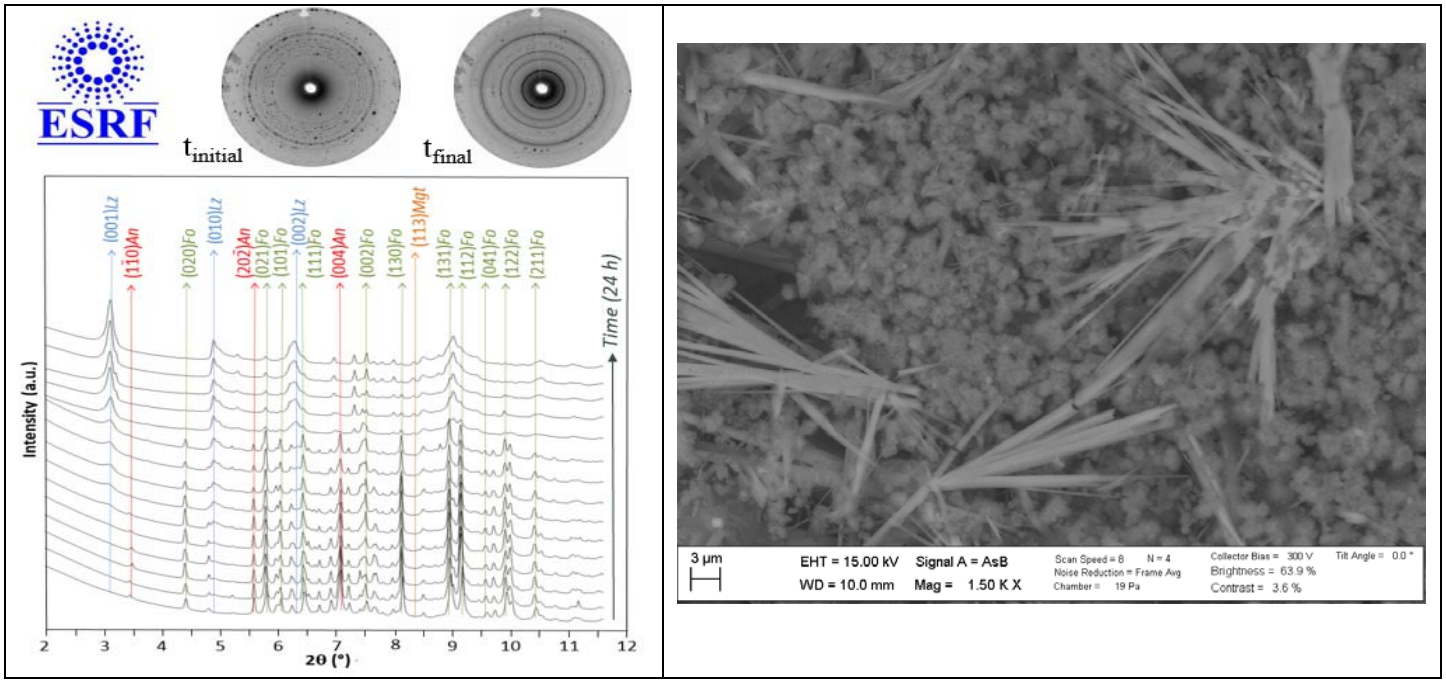

Figure 1: On the left, XRD spectra obtained during the experiment carried out with olivine and anorthite at 340°C – 200 MPa. On the right, SEM image showing the formation of serpentine associated with amphibole.

References:

[1] Pens M., Andreani M., Daniel I., Perrillat J-P., Cardon H., 2016. Contrasted effect of aluminum on the serpentinization rate of olivine and orthopyroxene under hydrothermal conditions. Chemical Geology, 441, 256-264.
[2] Pens M., Etude expérimentale de l'altération hydrothermale des roches ultrabasiques, PhD thesis, Université Claude Bernard Lyon 1, defended on July 11th 2016. Supervised by I. Daniel and M. Andreani.