


## Experiment Report Form

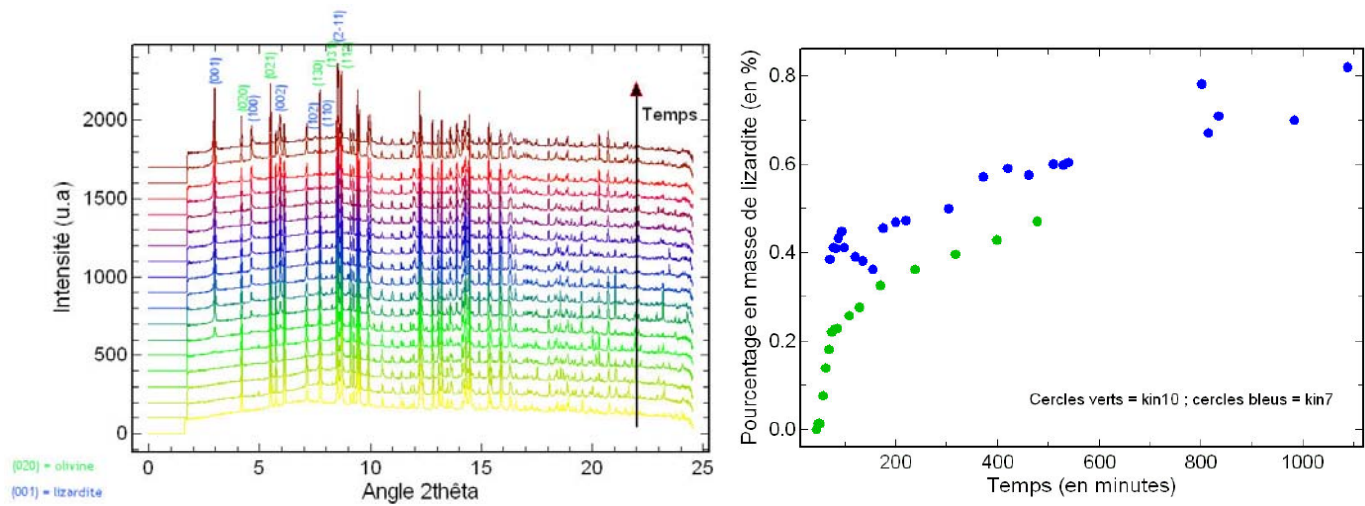
	<b>Experiment title:</b> <i>Kinetics of olivine serpentization in aluminum-bearing hydrothermal fluids</i>	<b>Experiment number:</b> HS-4586
<b>Beamline:</b> ID27	<b>Date of experiment:</b> from: 24 May 2012      to: 29 May 2012	<b>Date of report:</b>
<b>Shifts:</b> 15	<b>Local contact(s):</b> Dr Ashkan SALAMAT	<i>Received at ESRF:</i>
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### Report:

Three olivine hydration experiments has been run with an olivine single crystals and five with an olivine powder. Three additional experiments encountered problems and had been rapidly stopped (e.g. not enough water in the cell or gasket problems). They all, but one, contained 0.5M NaCl and Aluminium in the fluid and were run for 8 to 19 hours at  $T=350^{\circ}\text{C}$  and  $P=0.2\text{ GPa}$ . One have been run under the same conditions but with a carbon source ( $\text{NaHCO}_3$ ) instead of Al in order to test the effect of another abundant specie in hydrothermal systems, dissolved carbonates, on the serpentisation kinetics.

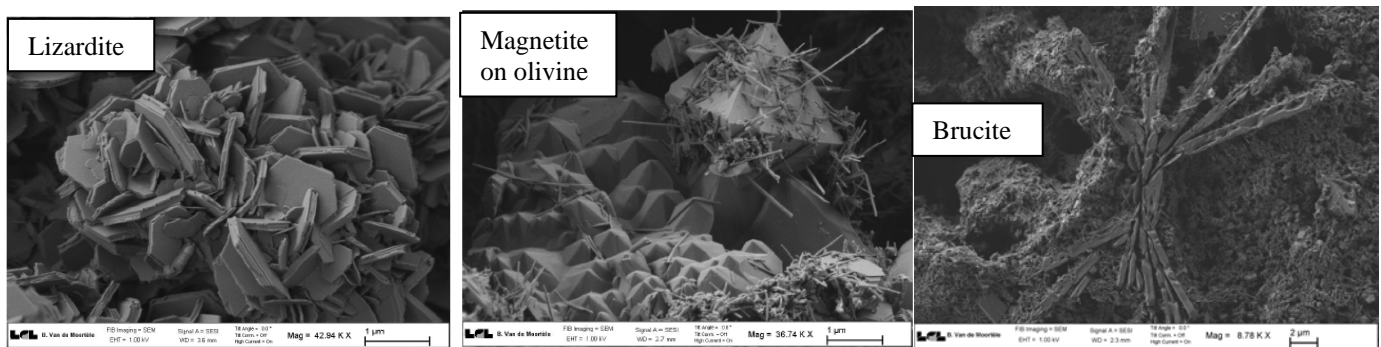
All experiments worked very well and we did not encountered technical difficulties related to the beamline. They almost all attained completion.

We have first treated the data obtained on olivine powders. Le Bail method allowed refining cell parameters of the main identified phases (olivine and serpentine). Then the Rietveld method was used to quantify the proportion of each phase as a function of reaction advancement. The method worked well and a first series of selected spectra allow to draw the evolution of the olivine to serpentine conversion as a function of time for 2 similar experiments (Kin7 and Kin10) containing 0.5M NaCl and Aluminium in the fluid (Fig. 1).



**Figure 1 :** *Left*) Evolution of XRD spectra with time for reaction Kin10. The intensity of the main lizardite peak (001) clearly increases with time while those of olivine decreases. *Right*) Evolution of the lizardite content during the reaction for 2 similar experiments. They illustrate the good reproducibility of results.

SEM characterization of sample products were also realized (Figure 2). They revealed that minor phases, brucite ( $Mg(OH)_2$  and magnetite), are also formed and are not easily detected by XRD because they only represent few percents (Fig. 2).



**Figure 2 :** SEM images of the main reaction products.

Treatment of the remaining data are being realized by Maria PENS, a student that has started her PhD in october on this subject. She has almost finished all the quantification and characterization of experiments realized on powders. They confirm the fast kinetics of olivine hydration in presence of Al and provide the first kinetics data for  $T=350^{\circ}C$  and  $P=0.2$  GPa, i.e. classical hydrothermal conditions. The first experimental test with  $NaHCO_3$  in the fluid also highlighted the efficient role of carbonate ions in solution to accelerate the alteration of olivine. In this case, serpentinisation is accompanied by carbonate precipitation.

This experimental set was really satisfactory and encouraging. Results has not been presented yet because complementary experiments are now needed. Indeed, two of the reactions started so fast that we missed the early beginning and we need to do them again to correctly extract the kinetics. We did not have the time neither to try a comparative experiment without Al which is mandatory, as well a some duplicates (notably with  $NaHCO_3$ ), to strengthen our dataset before publications. In the long term, enlarging the P-T range conditions is also of interest to investigate the wider T range of natural hydrothermalism (150 to  $400^{\circ}C$ ) and also for higher P conditions as expected in subduction zones. That's why we will ask for some new shifts on the beamline.