EUROPEAN SYNCHROTRON RADIATION FACILITY

INSTALLATION EUROPEENNE DE RAYONNEMENT SYNCHROTRON

Experiment Report Form

	Experiment title: High-pressure, large strain deformations mechanisms of serpentinized peridotite using synchrotron X-Ray diffraction and imaging	**Experiment number**: 558
Beamline: ID06LVP	**Date of experiment**: from: 30 Jun 2017 to: 04 Jul 2017	**Date of report**: 5/03/2023
Shifts: 12	**Local contact(s)**: Wilson Crichton	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

Dr Nadege Hilairet, (CNRS- Univ. Lille)*, Pr Sébastien Merkel (Univ. Lille, France)*, Alex Bellanger (Univ. Lille, IUT)*, Paul Raterron (CNRS, Univ. Lille)

This series of experiments investigated deformation of aggregates relevant for subduction zones dynamics. The samples were proxies for serpentinized peridotites made of mixed powders of olivine and serpentine. These series were a follow up to ES-201 during which we carried out deformation in axisymmetric compression.

The aim was to define, at high pressure, the conditions under which the peridotites evolves in a regime dominated by the strongest mineral (olivine) in the “load bearing frame regime”, or in a regime dominated by the rheology of the weakest phase, the “interconnected weak layer” regime [1]. Two parameters had to be studied 1) the effect of the volumetric fraction of weakest phase, serpentine, on the and stress partitionning between phases and aggregate rheology (ES201) 2) the effect of strain on the rock crystal preferred orientation and on the flow stress – indeed the more the aggregate is strain, the more the weakest phase can become interconnected and take up the deformation (ES-558).

The first series ES-201 investigated topic (1), the effect of the serpentine fraction, with four compositions: olivine with 5%, 10%, 15% and 50% serpentine. The results have been reported multiple times in conferences, by oral presentations at European Geophysical Union meeting 2017 and 2019 (invited) among others. A manuscript has been submitted in spring 2022 to Journal of Goephysical Research - Solid Earth,

however we are still dealing with the revisions that requested additional microscopy, and it should be re-submitted this spring 2023.

For the present series ES-558 on topic (2), polycrystalline aggregates, either cores or hot-pressed powder of 90% vol. olivine and 10% serpentine, were deformed in the large volume press, in simple shear instead of pure shear in order to investigage larger strains. The stress partitionning between the two phases as a function of time (and deformation) were investigated in-situ under HP and HT, using monochromatic X-Ray diffraction (XRD).

The following table lists the experiments carried out :

Run number	Press load (bar)	Furnace power (W)	deformation	Composition*
PER1	20	70	yes	Cored sample
PER2	25	70	Blow-out	Cored sample
PER3	25	75	yes	Cored sample
PER4	30	85	Blow-out	Powder
PER5	30	No furnace	-	Powder
PER6	30	85	yes	Powder

We had quite a low success rate this beamtime with 50% failed, due to a problem of confining medium (the B-epoxy cubes were failing due to insufficient induration).
The last run PER6 worked best, and the lattice strain analysis from the XRD (olivine only shown) is given Fig.1 as an example.

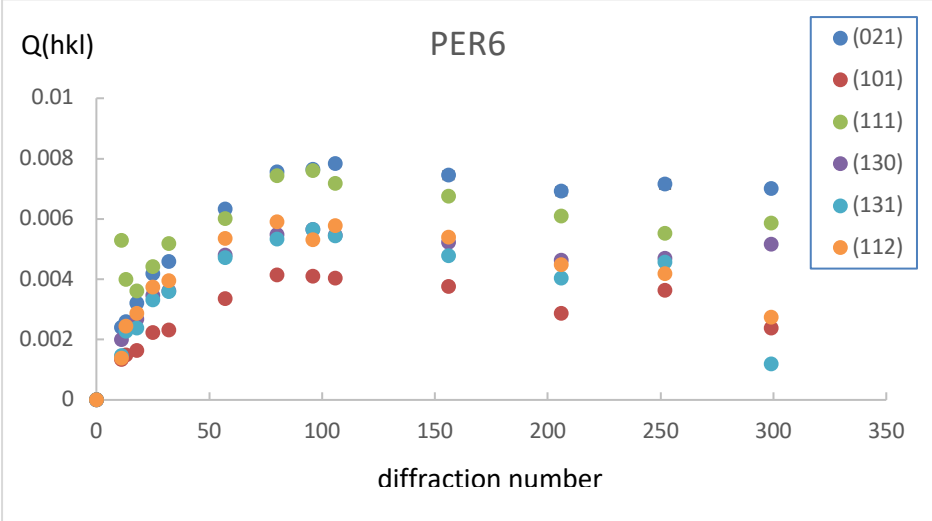

Fig.1 Lattice strain as a function of diffraction number
(nb. the error bars for Q(hkl) are smaller or same size as symbols)

It is difficult to publish this dataset by itself with only three runs. We intend therefore to publish these mechnical data together with results from experiments on the hot pressed powders, using in-situ absorption contrast tomography to image strain partitionning realized at the psiché beamline at SOLEIL (e.g. Mandolini et al,. AGU FM presentation 2020 and 2021).

Reference: [1] Handy, Journal of Structural Geology, 1994