Fluids, melts and minerals in Pannonian peridotites - Quantitative petrography using synchrotron X-ray microtomography

L. CREON[12], V. ROUCHON[1*], E. ROSENBERG[1], S. YOUSSEF[1], F. GUYOT[2], CS. SZABO[3], P. TAFFOREAU[4] AND E. BOLLER[4]

[1]IFP Energies nouvelles, Rueil-Malmaison, France (*correspondence: virgile.rouchon@ifpen.fr)
[2]Sorbonne Universités-MNHN-IMPMC, Paris, France
[3]LRG, ELTE, Budapest, Hungary
[4]ESRF, Grenoble, France

Petrographic observations are often restricted to the examination of polished sample surfaces. Various limitations of 2D observations, such as preparation artefacts or sample anisotropy preclude the quantitative 3D description of rock samples. X-ray micro-tomography allows for the in-situ, non-destructive 3D density structure imaging of solids. Although the sub-micron level of investigation has been developped more than a decade ago, its potential for petrological applications has not yet been fully investigated.

With the objective to quantify the distribution of fluids and melts in mantle xenolites from the Pannonian Basin, we examined a set of 11 distinct lherzolitic peridoties at the ID19 beamline of the European Synchrotron Research Facility (ESRF) in Grenoble, France. A monochromatic 30 keV X-ray beam was applied on peridotite plugs (p=4mm, L=10-20mm), allowing for an average spatial resolution of 1.2 μm, with a 14-bit grey-level resolution. Image filtering, 3D reconstruction and segmentation were performed using the ImageJ® and Avizo® softwares.

The density resolution allowed to segmentate the volumes occupied by the different crystalline phases, glass and fluids, and to quantify their volumic proportions and render their morphological distributions. Modal 3D mineralogical compositions were calculated, together with glass/mineral and fluid/glass abundance ratios. Measured densities of glasses are in good agrement with chemical compositions measured by electron microprobe. The crosscuting between gas vesicle-rich magma veins at grain boundaries and trails of secondary fluid inclusions (FI) allowed for establishing their cogeneticity. Fluid inclusion size histograms and their distribution between minerals were computed. Independent CO_2 density measurement in FI using Raman spectroscopy allowed for calculating an undegassed CO_2 concentration of the different melts between 0.11 wt.% ± 0.02 and 0.47 wt.% ± 0.02, and to discuss magmatic C-fluxes from the mantle to the Pannonian lithosphere.