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Report:

Solidification of the magma ocean is a major differentiation event of the planet that set the initial conditions for modern mantle dynamism and contributed to the existence of deep primordial chemical reservoirs. Constraining magma ocean evolution is therefore necessary to understand today geochemical reservoirs. Several magma ocean crystallization models have been proposed based on experimental and theoretical studies (Solomatov, 2000; de Koker and Stixrude, 2009; Labrosse et al., 2007) and resolution of these competing scenarios now awaits additional experiments. In particular, accurate knowledge the mantle solidus is needed in order to estimate the depth of the onset of the magma-ocean crystallization and therefore, the evolution of the mantle. The objective of our project was to investigate the role of volatiles on the solidus and the crystallization sequences of the primitive mantle. It is well known that volatiles, such as H_2O and CO_2, affect mantle melting relationships, transport of major and trace elements, as well as its rheological and physical properties (Dasgupta and Hirschmann, 2010; Hirschmann, 2006; Ghosh et al., 2009; Kono et al., 2014); however few studies have focused on the role of these volatiles on the cristallization of a primitive mantle.

In this report, we present preliminary results from an X-ray diffraction study carried out on ID27 at high-pressure and high-temperature, using the state-of-the-art double-sided laser heating system through diamond anvil cells available at ID-27. We measured the solidus temperature of two volatile-bearing composition of a primitive mantle up to 60 GPa (~1500 km).

Two different composition of starting material were synthesized at the Laboratoire Magmas et Volcans (Clermont-Ferand) before experiments. These starting materials consisted of a chondritic composition (Mcdonougha, 1995) enriched in either CO_2 (0.2 wt% CO_2) either CO_2 and H_2O (0.2 wt% CO_2; 1 wt% H_2O). Powdered sample were loaded in between two layers of KCl discs which served as pressure medium and pressure calibration (Dewaele et al., 2012). Such pressure transmitting medium usually provides an optimal insulation of diamonds during sample laser-heating and thus significantly reduce thermal gradients.

Samples were first pressurized to a target pressure and then heated progressively while XRD patterns were collected continously. Rapid change in the XRD peak intensities have been used as a criteria for the determination of the solidus temperature corresponding to the melt/re-crystallization of the grains in the sample : at sub-solidus conditions, the relative peak intensities were very compatible with those theoretically expected based on atomic topologies, which hence revealed an equilibrated microstructure. No significant changes were observed on further heating until the sample behaviour changed abruptly: all the diffraction peaks from the sample suddenly underwent major changes of their intensities with time.

Experimental solidus temperature determined during this beamtime are reported in Figure 1 for the two compositions. Our results are in good agreement with previous studies on the solidus of CO_2-bearing peridotite (Litasov et al., 2010) and H_2O-bearing peridotite (Ghosh et al., 2009).

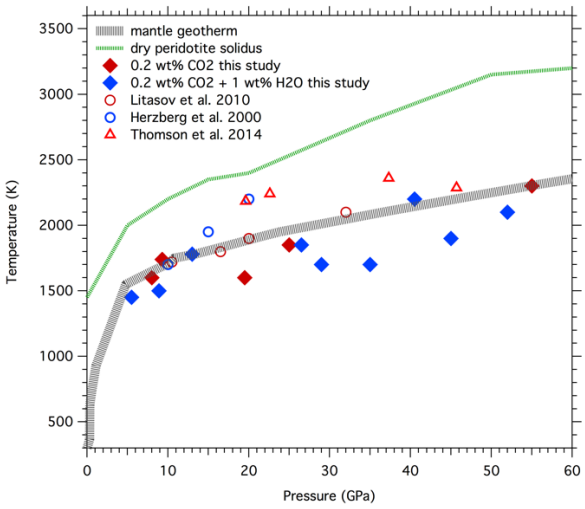

Figure 1: Solidus temperature measured for chondritic material enriched with 0.2 wt% CO_2 (in red) and 0.2 wt% CO_2 + 1 wt % H_2O (in blue)

Determination of the phase assemblage in equilibirum with the melt on the solidus by analyses of the XRD pattern collected upon melting is still in progress. In addition, *ex situ* analyses are yet to be performed on the recovered samples by infrared spectroscopy in order to determine the H_2O and CO_2 content in the quench phases ad further transmission electron microscopy analyses.

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