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Report:

Bridgmanite ($MgSiO_3$-perovskite) is the main component of the Earth's lower mantle, and thus it's a key mineral for the interpretation of mantle geophysics. The interpretation of the seismic data (one-dimensional profile as well as tomographic data) in terms of chemical composition, mineralogy and temperature requires the knowledge of the elastic behaviour of the deep Earth minerals at relevant pressure and temperature conditions.

Over the last decades XRD studies on bridgmanite focused on the effect on the EoS of minor and trace element substitutions, mainly Al and Fe [1], but no data have been reported on the influence of water content on the physical properties of this phase. Effects of hydration on the elastic properties can be very significant, as for instance reported for lower mantle minerals [e.g. 2]. Actually, the presence of volatile elements in the Earth's mantle is testified by natural Nominally Anhydrous Minerals (NAMs) like pyroxene, olivine, ringwoodite [3]. Volatiles (mainly H_2O) strongly influence the geophysical properties of the mantle. The water saturation conditions of NAMs and the water partitioning coefficients among the mantle phases may have dramatically consequence on the distribution and release of water in the mantle. Bridgmanite is expected to have low content of water, but water preferentially enter into Mg-pure bridgmanite over postperovskite by a factor about 5: 1 [4].

In this proposal we aimed at measuring the structural evolution of Mg-pure bridgmanite at pressure conditions directly relevant for the lower mantle and to constrain the influence of water incorporation on the PVT EoS.

Test on bridgmanite crystals:

Samples of bridgmanite of less than 100 microns as maximum size were tested in-house by single-crystal XRD (at Dept. of Physics and Geology UniPg using a Xcalibur Rigaku diffractometer and at IMPMC, Paris, using a Xcalibur2 Rigaku diffractomer) showing an exceptional crystallinity and no evidence of twinning. Crystals having the highest crystallinity were subsequently measured by FTIR spectroscopy at IMPMC in Paris.
Crystals of different water content, from anhydrous to ca. 140 ppm, were then crushed to obtain samples of size suitable with DAC constraints (~15 micron thickness) to reach target pressures up to 60 GPa. The crushed crystals were tested again for crystallinity at ID27 before loading the DACs for the SC-XRD experiments. Not all the crushed crystals preserved a good crystallinity and thus not all were suitable for the experiments.

HP Experiments:
Three membrane-type DACs, equipped with Re gaskets and 250-150 μm culets diamonds, were loaded with so-prepared crystals, neon gas as pressure transmitting medium, and a gold chip as pressure calibrant.
<u>Exp.1</u>: A first attempt to load a DAC with two crystals (one anhydrous and one hydrous samples) failed at low pressure (ca. 2 GPa) due to an anomalous shrinking of the gasket hole, which also affected the crystallinity of the crystals.
<u>Exp. 2</u>: a DAC loading with a hydrous crystal was successful. We measured single-crystal data collections (single scans and ω-rotation of about 40°degree) up to 53GPa. Single scan were collected each 0.5 GPa and data collections each 2 GPa. Detailed data analysis is currently ongoing.

HP-HT Experiments:
Two membrane-type DACs, equipped with Re gaskets and 250-150 μm culets diamonds, were loaded for the HP-HT experiments. KCl disks were used as thermal insulator, pressure transmitting medium, and pressure calibrant. A ring made of boron-doped diamond (BDD) was used as heater in the DAC as Mg-pure end-member does not directly couple with YAG laser.
<u>Exp. 1</u>: Anhydrous sample. Before start heating we increased pressure up to 43 GPa, and tested the laser heating. We then probed the sample along an isotherm at 1800 K, first increasing pressure up to 57 GPa, and then on downloading, collecting data at steps of 1 GPa or less. Detailed data analysis is currently ongoing.

<u>Exp. 2</u>: Hydrous sample. Before start heating we increased pressure up to 31 GPa, and tested the laser heating. This time we could not succeeded to have a correct coupling and stable heating and after some attempts of heating at 58 GPa the experiment failed.

References: [1] G Fiquet et al., Application of inelastic x-ray scattering to the measurements of acoustic wave velocities in geophysical materials. 2004 Phys. Earth Planet. Inter. 143–144, 5; [2] SD Jacobsen et al., Effects of hydration on the elastic properties of olivine, 2008 Geophys. Res. Lett. 35, L14303; [3] N Bolfan-Casanova, et al, Water partitioning between nominally anhydrous minerals in the MgO-SiO2-H2O system up to 24 GPa: Implications for the distribu- tion of water in the Earth's mantle, 2000 Earth Planet. Sci. Lett. 182, 209; [4] JP Towsend et al., Water partitioning between bridgmanite and postperovskite in the lowermost mantle. 2016 Earth Planet. Sci. Lett. 454, 20