Effect of O2 on water solubility in minerals around the 410 km discontinuity: Analysis using Raman spectroscopy

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Abstract

The top of the transition zone of Earth's mantle (410-670 km) is marked by the olivine – wadsleyite phase transition. Olivine and wadsleyite are nominally anhydrous minerals (NAMs), but both may contain various amounts of water as hydroxyl. As a point defect, OH may play an important role on the physical and melting properties of the mantle around the 410 km discontinuity.
Our approach is to study the water partition between the different minerals in pyrolytic composition under water-saturated conditions. As oxygen fugacity is a key parameter on fluid speciation, it has been buffered in the experiments with the use of metal-oxide mixtures covering a wide range of redox conditions (Fe-FeO, Ni-NiO, and Re-ReO2). All the experiments were performed at the LMV, in a Kawai-type multi-anvil press around 13 GPa, between 1200 and 1400∘C, in double sealed capsules to prevent fluid loss. Samples have been analyzed with SEM and electron microprobe to study the minerals composition, and Raman spectroscopy for the water content (Bolfan-Casanova et al., 2014) (a).

The small grain size (50μm average for olivine and wadsleyite), the high water content, and the impossibility to get a proper double polishing due to samples fragility render the use of FTIR extremely difficult. Raman spectroscopy allowed us an easy mineral identification even on small grains ($< 5\mu$m), and has been used for water quantification. Standards with known water concentration were used to build a correlation with the integrated intensity of the water bands of wadsleyite of various composition (Fo89 and Fo100). The correlation used for olivine and clinoenstatite are from Bolfan-Casanova et al. (2014) (a).

Preliminary results show a wide range of water contents, mainly increasing with O2, and decreasing with increasing temperature. We will also discuss the positive impact of the measurements dispersion for each sample phases on the final estimation precision, as crystal orientation has a strong effect on peaks intensities in Raman spectra.
(a) Bolfan-Casanova N., Montagnac G. and Reynard B. (2014) Measurement of water contents in olivine using Raman spectroscopy. American Mineralogist 99, 149-156.

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