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High pressure experiments on water solubility in olivine and orthopyroxene: study on the effect of iron and aluminum

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Trace amounts of hydrogen dissolved as defects in nominally anhydrous minerals in the mantle are believed to play a key role in physical and chemical processes in the Earth's upper mantle. Indeed, the presence of water in the mantle drastically affects diffusion, electrical conductivity or viscosity. That is why estimation of water storage in mantle phases and solubility mechanisms are important in order to understand all these phenomena. Experimental data on water solubilities are available for upper mantle minerals such as olivine, pyroxene and garnet. However, all these studies were performed in simplified systems. The aim of this study is to constrain water solubility in a system representative of the upper mantle mineralogy. Moreover, the role of Fe and Al, on the water solubility of orthopyroxene and olivine are investigated.

The solubility of water in coexisting orthopyroxene and olivine was investigated by simultaneously synthesizing the two phases at high pressure and high temperature in a multi-anvil press. Experiments were performed under water-saturated conditions in the MSH systems with Fe and Al at 2.5, 5 and 7.5 GPa and temperatures between 1175 and 1400°C. Integrated OH absorbances were determined using polarized infrared spectroscopy on doubly polished thin sections of randomly oriented crystals.

Preliminary results show that water solubility in orthopyroxene increases with pressure and decreases with temperature at 7.5GPa, like in olivine. These data give water partition coefficients between orthopyroxene and olivine in the range 0.2 to 0.3 for experiments at high pressure which are 10 times lower than Grant et al. (2006) partitions coefficients obtained at low pressure. Moreover it seems that H incorporation in orthopyroxene is controlled by water fugacity rather than by the incorporation of Al, especially at high pressure.

Key words: hydrogen incorporation, mantle, high-pressure, IR spectroscopy