

SMP045-21

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マントル無水鉱物間の水の分配：高圧実験とFT-IR分析

Water partitioning between nominally anhydrous mantle minerals: experimental study with FT-IR analysis

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Water affects physical property of minerals, such as elemental diffusion rates, melting points, etc. Even a small amount of water plays a key role in mantle rheology, so the presence of water is very important in understanding the earth dynamics. Although the solubility of hydrogen in minerals, such as olivine has been well studied, experiments those determine water partitioning between coexisting mantle minerals are still limited.

In order to investigate the partitioning of water between nominally anhydrous minerals in mantle phases, we performed high-temperature and high-pressure experiments using Kawai-type multi-anvil apparatus (SPI-1000, SAKURA-2500) and piston-cylinder apparatus at the Magma Factory, Tokyo Institute of Technology. Starting materials are olivine, orthopyroxene and clinopyroxene separated from a spinel peridotite (KLB-1). Powdered minerals were set in Au or Au₇₅Pd₂₅ capsules to form monomineralic layers with more than 200 micron meters in thickness each. Trace amount of moisture was added by breathing in some capsules. Otherwise, water was not added. Experimental conditions were that equivalent at the topmost mantle and that at mantle transition zone. The topmost mantle conditions are pressures of 1-2 GPa and temperatures of 1200-1300C. The mantle transition zone condition is 17 GPa and 1650C. The water contents were obtained from a vacuum type Fourier transform infrared spectroscopy (JASCO-FT-IR6100). Detection limit in the IR spectra in 3000-4000 cm⁻¹ is typically less than 1 ppm due to very low background.

In all experiments at the topmost mantle conditions, $D_{(opx/oliv)}$ and $D_{(cpx/oliv)}$ are 10-30. These partition coefficients are much smaller than those reported by Grant et al., (2007) who analyzed coexisting minerals in mantle xenoliths. The difference might be explained by excess hydrogen solubility in our experimental olivine by oxidation effect. Alternatively, the difference might be due to the hydrogen loss in mantle xenolith olivines during transportation. $D_{(cpx/opx)}$ in our experiments are 2-4 which are in excellent agreement with those values in mantle xenoliths.

In some run products oxygen fugacity was controlled by NNO buffer. In unbuffered runs, however, oxygen fugacity becomes much higher than NNO due to absorption of iron into Au₇₅Pd₂₅ capsule. In the oxidized samples, IR spectra of clinopyroxene, orthopyroxene and especially olivine showed 3700cm⁻¹ band. This band is similar to those in talc and serpentine but neither is stable at our experimental conditions. It is suggested that the IR spectra at 3700cm⁻¹ are due to OH stretching vibration without hydrogen bonding. The excess hydrogen may be OH in defects coupled with Fe³⁺ formed by oxidation.

At the mantle transition zone condition, we obtained $D_{(maj/wads)}$ to be 1.6. The fact that majorite garnet contains greater amount of water than coexisting wadsleyite seems surprising, because wadsleyite is known to be one of the major reservoir of water in the Earth's transition zone. However, the same tendency was already experimentally reported in MgO-SiO₂-H₂O system by Bolfan-Casanova et al. (2000). Because our partition data were obtained in very low water concentration level (usually less than 100ppm) concentration dependence of the partition coefficients must be studied in future works.

Keywords: water, anhydrous mineral, FT-IR, partitioning, mantle