Diffusion of hydrogen in ringwoodite

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Water affects the various physical properties of the constituent minerals in the Earth's interior, such as electrical conductivity, melting temperature, and viscosity. Therefore, it is important to understand the distribution and circulation of water in the Earth's interior. It is possible to discuss the topics by examining the hydrogen diffusion in mantle minerals.

In the past, the diffusion rate of hydrogen has been measured for the upper mantle minerals, such as olivine and diopside, but no data exist for ringwoodite which is a major constituent minerals in the mantle transition zone. Therefore we performed the diffusion experiments of hydrogen in ringwoodite polycrystals with the composition of Mg_2SiO_4.

Anhydrous ringwoodite polycrystals were synthesized first for the diffusion experiments. The diffusion experiments were performed with ringwoodite surrounded by NaCl+Mg(OH)2 powder which was used as the hydrogen source at 21GPa and 900-1300C, and at 19GPa and 900-1100C. A 1000-ton multi anvil high-pressure apparatus was used for operation of the Kawai type apparatus on the tungsten carbide anvils with a 3.5 mm truncated edge length. The water content was determined by a Fourier Transform infrared spectrometer(FTIR).

At 21GPa and 900-1300C, diffusion of hydrogen could not be measured perhaps due to stability of brucite in the conditions. The diffusion coefficients at 19GPa and 1000-1100C were determined to be approximately $7.6*10^{(-12)}$-$1.2*10^{(-11)}$ m2/s and the activation energy was 66kJ/mol.The diffusion coefficiens determined here may represent the self diffusion coefficients of metal vacancy.

Magnitude of diffusion coefficients and activation energy implies that water is heterogeneously distributed in the mantle transition zone. Therefore, it is thought that physical properties, such as electric conducitivity and melting temperature, could vary in the transition zone depending on the geologocal settings.