Diffusion of hydrogen in wadsleyite

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Water plays an important role in geodynamic processes in the Earth's interior. For example, water affects the physical properties of the Earth's materials, such as elastic velocity, viscosity, plastic deformation, diffusion, and electrical conductivity.

The diffusivity of hydrogen in mantle minerals affects a distribution and circulation of water in Earth's interior. The diffusion rate of hydrogen in olivine has been measured at high pressure in the past, but no data exist in the wadsleyite, which is a major constituent mineral in the mantle transition zone. So we tried to determine the diffusion rate of hydrogen in beta-phase of Mg2SiO4.

We examined the kinetics of hydrogen diffusion in wadsleyite by measuring the O-H distribution in polycrystals annealed under hydrothermal conditions. Diffusion experiments were conducted at 17GPa and 1073-1273K. A 3000-ton multi-anvil high-pressure apparatus was used, with a 5mm truncation edge length on the tungsten carbide anvils. The concentration of OH were determined by Fourier Transform infrared spectrometer.

In this research, the diffusion experiments was conducted using two methods. One is that wadsleyite was surrounded by NaCl + Mg(OH)2 powder which was used as the hydrogen source. Another is that dry and hydrous wadsleyite were used as the diffusion couple. The determined value of diffusion coefficients was 1*10^-11 m2/s-2*10^-10 m2/s, and about 2*10^-13 m2/s-3*10^-12 m2/s, respectively.