Silicon diffusivity in ringwoodite at high pressure

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Atomic diffusion is the rate-limiting step in many kinetic processes including mantle rheology, electrical conductivity, and homogenization of chemical heterogeneities. (Mg, Fe)2SiO4 ringwoodite is a high-pressure polymorph of olivine and one of the major constituent minerals between 520 km and 660 km depth in the mantle transition zone.

In this study, we conducted Si diffusion experiments of (Mg, Fe)2SiO4 ringwoodite in order to understand the rheological properties of Earth's mantle, because Si is found to be the slowest diffusing species which may control plastic deformation in silicate minerals.

High-pressure experiments were performed using a kawai-type multi-anvil apparatus installed at Tohoku University. The starting material of polycrystalline ringwoodite was synthesized at 20 GPa and 1473-1673 K from San Carols olivine. The surface of the polycrystalline ringwoodite was polished with diamond paste and then coated with a 29Si enriched SiO2 thin film. Oxygen fugacity was set by the Ni-NiO buffer. Diffusion annealing experiments were conducted at 20 GPa and 1473-1673 K. After diffusion experiments, concentration profiles of 29Si were measured by the depth profiling method using secondary ion mass spectrometry (SIMS) installed at Kyusyu University.