

25 GPaにおけるアルミナスペロフスカイト中のSiとMgの拡散 Si and Mg diffusion in aluminous perovskite at 25 GPa

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Silicate perovskite is thought to be a major constituent mineral in the lower mantle. In order to understand rheological properties of the lower mantle, it is essential to determine the diffusion rates of the slowest diffusing species which control high-temperature creep processes involving diffusion creep and climb-controlled dislocation creep. It has been reported that Si diffusion rates in MgSiO₃ perovskite and Mg-Fe interdiffusion rates in (Mg,Fe)SiO₃ perovskite are almost comparable (Yamazaki et al., 2000; Holzapfel et al. 2005). In addition, O diffusion rates in MgSiO₃ perovskite are faster than Si diffusion and Mg-Fe interdiffusion rates (Dobson et al. 2005). Thus, Si or Mg is a candidate for the rate-controlling species in perovskite. In this study, we determined Si and Mg diffusion rates simultaneously in (Mg,Fe)(Si,Al)O₃ perovskite by utilizing ²⁵Mg and ²⁹Si enriched (Mg,Fe)(Si,Al)O₃ thin film as diffusion source. Based on the result, we discuss the rate-controlling species in (Mg,Fe)(Si,Al)O₃ perovskite and rheological properties in the lower mantle.

High-temperature and high-pressure experiments were performed using a Kawai-type high-pressure apparatus. Starting material of polycrystalline (Mg,Fe)(Si,Al)O₃ perovskite was synthesized from San Carlos orthopyroxene powder at 25 GPa and 1973K. Surface of the polycrystalline perovskite was polished and then coated with ²⁵Mg and ²⁹Si enriched (Mg,Fe)(Si,Al)O₃ thin film using pulsed laser deposition (Dohmen et al. 2002). Diffusion experiments were conducted at 25 GPa and 1773-2073K. After the diffusion experiments, concentration profiles of ²⁵Mg and ²⁹Si were obtained by the depth-profiling mode using secondary ion mass spectrometry.

It was found that Si and Mg diffusion rates in (Mg,Fe)(Si,Al)O₃ perovskite are almost comparable under our experimental conditions. Thus, Si and Mg are likely to be rate-controlling species in (Mg,Fe)(Si,Al)O₃ perovskite. Si and Mg diffusion rates in (Mg,Fe)(Si,Al)O₃ perovskite could be slightly slower than previously reported Si diffusion rates in MgSiO₃ perovskite.

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