

Si diffusion in single crystal of MgSiO₃ perovskite

Junshan Xu^{1*}, Daisuke Yamazaki², Tomoo Katsura³, Xiaoping Wu¹, Patrick Remmert⁴, Hisayoshi Yurimoto⁵, Sumit Chakraborty⁵

¹Univ Sci & Technol China, ²Inst Study Earths Interior, Okayama Univ, ³Bayerisches Geoinstitut, ⁴Ruhr Universität Bochum, ⁵Hokkaido University

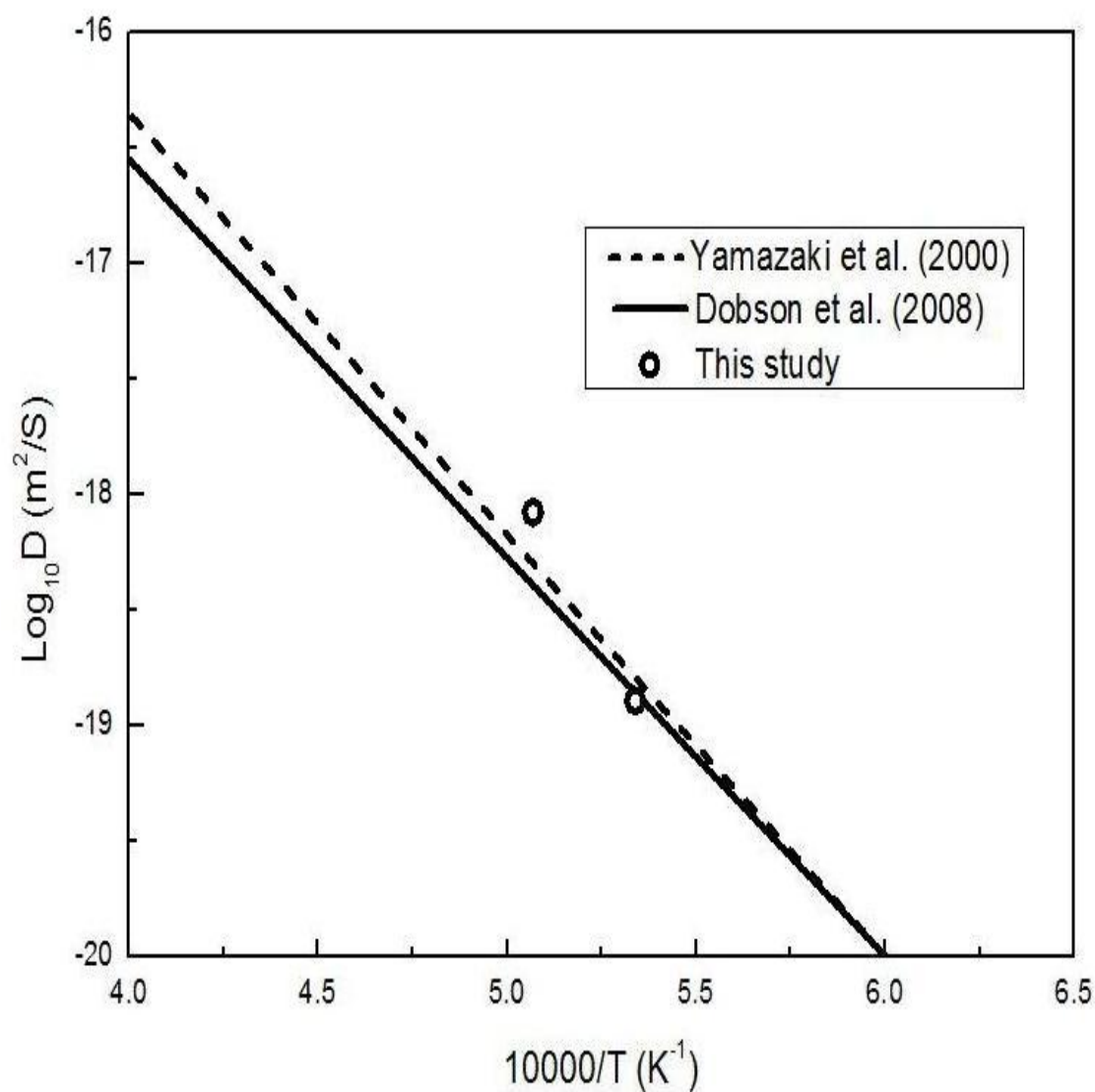


Fig.1 Diffusion coefficients in MgSiO₃ perovskite at 25

Diffusion creep (Nabarro-Herring or Coble creep) may dominate in the most part of lower mantle (Karato et al., 1995). In most silicates, silicon is the slowest diffusing species, and therefore, the diffusion of silicon is likely to control the viscosity of the lower mantle (Houlier et al., 1990; Bejina and Jaoul, 1996). In the earth's lower mantle, magnesium silicate perovskite is the dominant material and it may exceed 85% of the volume (Stixrude et al., 1992). Therefore, measurement of Si diffusion coefficient is important for understanding the dynamics of the lower mantle. Yamazaki et al. (2000) and Dobson et al. (2008) investigated Si diffusivity in MgSiO_3 perovskite using polycrystalline samples. In this study, Si self-diffusion coefficients in single crystals of MgSiO_3 perovskite were measured under lower mantle conditions.

Single crystals were synthesized at the conditions of 25 GPa and 1500 degree C using Kawai-type multi-anvil high-pressure apparatus, orientated by precession X-ray camera and ^{29}Si enriched layer was coated by pulsed laser deposition (PLD) on polished surface. Diffusion annealing experiments were conducted at pressure of 25 GPa and temperatures from 1400 degree C to 1800 degree C. The diffusion profiles were obtained by secondary ion mass spectrometry (SIMS).

The diffusion coefficients are identical within error to previous results. There is no significant different for Si diffusion in single crystal of perovskite from polycrystal perovskite (Fig.1). The results agree with the conclusion that the effective diffusion of silicon in perovskite is almost represented by the lattice diffusion if the grain size is larger than a few tens micrometers (Yamazaki et al., 2000). In addition, there seem to be no significant orientation dependence.

Keywords: Si diffusion, perovskite, lower mantle