Simple Shear Deformation of Perovskite+periclase Aggregate and Perovskite: Implications for the Effect of Periclase on Bulk Viscosity

FANG XU[1*], DAISUKE YAMAZAKI[1]

[1]Institute for Study of the Earth's Interior, Okayama University, Misasa, Tottori-ken 682-0193, Japan (correspondence: xufang@s.misasa.okayama-u.ac.jp; dy@misasa.okayama-u.ac.jp)

Viscosity jump in the mid-mantle depth was reported by geophysical observation (Rudolph et al., 2015). Chemical stratification is one of the candidate to cause the viscosity variation in the lower mantle. Pyrolitic lower mantle is mainly composed of perovskite (Pv, ~70 vol%) and ferro-periclase (Fp, ~20 vol.%, Ringwood, 1991), whereas perovskitic lower mantle is proposed by Murakami et al. (2012). Viscosity of Fp was considered to be two orders of magnitude lower than Pv (Yamazaki and Karato, 2001, 2002). Fp may significantly decrease the bulk rock viscosity once interconnected Fp structure was formed (Handy, 1994). To understand the effect of Fp on viscosity is the key to estimate the Pv/Fp ratio in the lower mantle.

Simple shear deformation experiments of two-layered sample composed of perovskite plus periclase aggregate (Pv+Pc) and single phase perovskite (Pv) were conducted to study the effect of Pc on the viscosity. In the experiments, two-layered samples were sandwiched together by alumina pistons and deformed simultaneously. Strain of each layer was indicated by the rotation of strain markers inserted in Pv+Pc and Pv, respectively. As the same stress and chemical condition of deformation (eg. oxygen fugacity, water fugacity), the strain contrast between Pv+Pc and Pv can quantify the viscosity contrast. This method provides direct comparison of viscosity between Pv+Pc aggregate and Pv, which can infer to the viscosity contrast in the lower mantle.

Pv+Pc and Pv aggregates were pre-synthesized from fine-grained forsterite + 5 vol.% enstatite aggregate (Koizumi et al., 2010) and MgSiO3 glass at 1800 °C for 10 hours and 1600 °C for 30 minutes, respectively, at 25 GPa in a Kawai-type multianvil apparatus. For deformation, Kawai-type 6-8 cell assembly was utilized to conduct experiment in KATD apparatus. At first, two-layered sample was compressed to ~25 GPa and annealed at 1600 °C for half hour without deformation. The recovered sample showed no deformation occurred during compression and annealing. We conclude this cell assembly is applicable for studying in simple shear deformation. In the next step, we conduct deformation experiments with large strain based on current work.