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Deformation experiments at the lower mantle condition using Kawai-type apparatus for triaxial deformation (KAT-D)

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Knowledge of rheological property of mantle constituent minerals is important for understanding of material behavior in the Earth's deep interior. The Earth's lower mantle consists of ~77 vol% Mg-rich perovskite, ~16 vol% ferropericlasite and ~8 vol% Ca-rich perovskite in pyrolite mantle (e.g. Irifune et al., 1994). In spite of its small proportion (~16 vol%), there is a chance that ferropericlasite dominates the lower mantle rheology because ferropericlasite is significantly softer than Mg-perovskite (e.g. Yamazaki and Karato, 2001). The deformation induced microstructure is one of the most important factors which control viscosity of the rheologically heterogeneous aggregate. However, no experimental study has been conducted on the deformation microstructure of the lower mantle material due to difficulty in deformation experiments at high-pressure and high-temperature.

The Kawai-type apparatus for triaxial deformation (KATD) installed at Magma Factory, Tokyo Institute of Technology is a modification of cubic-type Kawai-type multi-anvil apparatus with top and bottom differential rams. In this study, we conducted deformation experiments of (Mg,Fe)SiO₃-perovskite at the lower mantle conditions (25 GPa, 1873 K) using KATD apparatus and WC second stage anvils with truncation edge length of 2 mm. Presintered of (Mg,Fe)SiO₃- orthopyroxene aggregates were used as starting material of deformation experiments. A strain of ~30% was observed in the deformation experiments. Deformation experiments up to the top of lower mantle condition (25 GPa, 1873 K) using KATD became possible.

Keywords: Deformation experiments, Lower mantle, Perovskite, Kawai-type apparatus for triaxial deformation