下部マントル条件下におけるMORBとパイロライト物質の多相粒成長実験

Differences in grain growth kinetics between MORB and pyrolitic materials under lower mantle conditions: preliminary results

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Convective mixing and persistence of chemical heterogeneities such as subducting slabs in the lower mantle largely depends on their density and viscosity contrasts. In contrast to detailed studies on the density, those on the viscosity of deep slab materials have been limited so far due to difficulties of direct quantitative deformation experiments. Previous studies suggest that both MORB and peridotite regions of deep slabs across the upper and lower mantle boundary cause significant grain-size reduction through the post-spinel and post-garnet transformations, respectively, resulting that the grain-size sensitive creep becomes dominant as the deformation mechanism (e.g., Kubo et al., PEPI2008; EPSL2009; AGU2011). Therefore, the grain growth is an important process controlling the viscosity of slab materials in the lower mantle. Here we report preliminary results on grain growth experiments of MORB and pyrolitic materials under lower mantle conditions.
Each material consists of 3-4 phases after the transformations; those are Mg-perovskite, Ca-perovskite, stishovite, and aluminous phase in MORB, and Mg-perovskite, Ca-perovskite, and ferropericlase (+majoritic garnet at the top of the lower mantle) in pyrolite. We conducted grain growth experiments in these assemblages using a Kawai-type multi-anvil apparatus at ~25-28 GPa, 1873-2373K, and for 1-600 min. SEM observations of recovered samples revealed that these assemblages exhibit relatively homogeneous equi-granular texture except for the short-duration annealing in the pyrolitic material. At the present stage, the average grain size was measured without distinction among phases in the case of MORB material, whereas the grain size in each phase was measured for the pyrolitic material. Preliminary analysis on the grain growth data indicates that the grain growth exponent is about 3.5 for both the MORB material and the major phase of Mg-perovskite in the pyrolitic material, suggesting that the grain growth kinetics in these multi-phase assemblages are controlled by an Ostwald ripening process. The grain size in the MORB material is smaller than that in the pyrolitic material, which corresponds to the difference of 100-150K in temperature. The difference in grain size evolution may lead to the viscosity contrast between MORB and pyrolitic materials in the lower mantle, however further detailed studies are needed to assess this issue.

