Shear deformation on post-spinel

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Earth’s lower mantle is mainly composed of ferro-periclase and bridgmanite. The viscosity of ferro-periclase is considered to be 2-3 orders of magnitude lower than that of bridgmanite. Such large discrepancy in viscosity may cause the significant effect of microstructure of the aggregate of bridgmanite and ferro-periclase on bulk viscosity. For example, bulk viscosity is low when the interconnected weak layer structure is formed, whereas bulk viscosity is as high as the viscosity of bridgmanite when the load bearing framework structure is formed [1].

Microstructural evolution from the load bearing framework structure to the interconnected weak layer structure in post-spinel phase (mixture of bridgmanite and ferro-periclase) during deformation was previously reported based on the rotational Drickamer apparatus [2]. This results suggests the important viscosity reduction during deformation in the lower mantle. We therefore considered that more detailed and precise experiments are necessary to discuss the lower mantle rheology quantitatively.

Deformation experiments under the lower mantle conditions can be conducted by using D111-type deformation Kawai-type high pressure apparatus. This apparatus was previously installed at UCL followed by PF-AR and Misasa. In this study, we use these apparatus for the deformation on post-spinel phase.

Starting material for deformation experiment was well-sintered aggregate of bridgmanite and ferro-periclase synthesized at 24 GPa and 1873 K. For the simple shear deformation, we used 45 degree cut design. In in-situ X-ray experiments at PF-AR, we used tapered and coned anvils for X-ray paths. On the other hand, in “quench” experiments at Misasa, we used a simple cubic anvils (TEL=2.0 mm). All deformation experiments were performed with constant D-rams displacement rate.
We deformed sample up to shear strain of ~0.8 with the 0.4 mm displacements of D-rams. SEM observation on the recovered sample by SEM shows that there is no significant evolution in microstructure, indicating that viscosity reduction is not expected with shear deformation to gamma~1. [1] D. Yamazaki, S. Karato: Am. Mineral., **86**, 385 (2001). [2] J. Girard et al.: Science, **351**, 144 (2016).

