Olivine fabric development during Newtonian (diffusion creep) corner flow.

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Lattice-preferred orientation (LPO) is produced by the alignment of anisotropic minerals (e.g., olivine) and is regarded as the main reason for seismic anisotropy observed in the upper mantle. There are several mechanisms suggested for the LPO development (e.g., dislocation creep, dislocation-accommodated diffusion creep and diffusion creep) and our group has shown it develops during diffusion creep which is sensitive to the parameter of temperature as the mechanism of which involves grain rotation and preferential grain boundary sliding on low-index grain boundaries of tabular shaped olivine that occurs at higher temperatures (>0.92 Ts) (Miyazaki et al. 2013; Maruyama and Hiraga 2017 a and b).

To investigate the application of the LPO development during diffusion creep to various tectonic settings including mid-ocean ridges (MOR) where corner flow is introduced by the association of upwelling mantle flow and plate-driven motion, we did channel angular pressing shear deformation experiments called ECAP (Equal-Channel Angular Pressing) test. To conduct deformation experiments under diffusion creep in the laboratory, we synthesized fine-grained (~1 μm) forsterite + diopside specimen (Koizumi et al. 2010). Experimental temperatures were high enough to develop tabular-shaped forsterite grains (T > 0.92Ts). After experiments, we analyzed the LPO development and its evolution along a streamline of corner-flow. The forsterite grains away from the corner-flow region show relatively random fabric (J ~ 1.47), while it gets increasing along the streamline and gets maximum (J ~4.96) with indicating A-type LPO at the end of the corner-flow. The development of LPO is characterized by continuous rotation and clustering of forsterite a-axes along the streamline. From marker analysis, most of the strain was achieved during the corner flow, which also has been suggested by several studies of numerical modeling of mantle flow beneath MOR (e.g., Mckenzie. 1979).

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