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Dynamic recrystallization mechanisms of and slip systems in olivine in the Horoman peridotites

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We have examined dynamic recrystallization mechanisms of and slip systems in olivine in the Horoman peridotites, based on microstructural observations and crystallographic orientation measurements. The Horoman peridotite complex is divided into Upper Zone and Lower Zone based on constituent peridotites (Niida, 1974). Based on microstructures, the Upper Zone is further divided into Equigranular Zone and Internal Shear Zone, while the Lower Zone is further divided into Transition Zone, Porphyroclastic Zone and Basal Shear Zone (Sawaguchi, 2004). The Upper and Lower Zones ascended through the upper mantle at temperatures of 1100-1150 and 900-950 degrees in Celsius, respectively (Ozawa and Takahashi, 1995). The Internal Shear Zone was formed at the base of the Upper Zone during the juxtaposition of the Upper and Lower Zones, while the Transition Zone is a part of the Lower Zone affected by that shearing (Sawaguchi, 2004).

Microstructures and the crystallographic relationships between porphyroclasts and their adjacent grains suggest that dynamic recrystallization of olivine occurred by grain boundary migration and subgrain rotation in the Equigranular and Porphyroclastic Zones, and primarily by subgrain rotation in the Internal and Basal Shear Zones. Crystallographic preferred orientations of aggregate grains and misorientation axes of adjacent subgrains in porphyroclasts as well as in aggregate grains indicate that (010)[100], {0kl}[100] and (001)[100] have been the dominant slip systems in olivine in the Equigranular Zone, in the Internal Shear Zone and Porphyroclastic Zone, and in the Basal Shear Zone, respectively.

Different deformation temperatures between the Equigranular and Porphyroclastic Zones during their ascent in the upper mantle resulted in different dominant slip systems in olivine. Internal and Basal Shear Zones are the shear zones formed at the bases of the Equigranular and Porphyroclastic Zones, respectively. The strain rates of the former two zones have therefore been faster than the latter two zones so that slip systems dominant at relatively low temperatures have been activated in the former two zones. The dynamic recrystallization mechanism of olivine also varies with temperature and strain rate. Dynamic recrystallization primarily by subgrain rotation in the Internal Shear Zone usually occurs at lower temperatures than that by grain boundary migration and subgrain rotation as in the Porphyroclastic Zone, in spite that the deformation temperature of the former may have been higher than that of the latter. This implies that the dynamic recrystallization mechanism of olivine is more sensitive to strain rate than the slip system in olivine.