Variation in water content in olivine in the Horoman peridotites and its effects on crystal plastic deformation of olivine

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We have examined variation in water content in olivine in the Horoman peridotites and its effects on crystal plastic deformation of olivine, based on the results of FT-IR microspectroscopy, grain-size analyses and crystallographic orientation measurements. The Horoman peridotite complex is divided into Upper Zone and Lower Zone based on constituent peridotites. 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. The Upper and Lower Zones ascended through the upper mantle at estimated temperatures of 1040-1100 and 930-970 degrees C, respectively. 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.

FT-IR microspectroscopy data indicate that water contents in olivine grains in the Upper Zone peridotites are relatively low, whereas those in the Lower Zone peridotites are relatively high. The relationship between olivine grain size and water content in olivine indicates that grain-size reduction of olivine proceeded at water-poor conditions in the Upper Zone, whereas at water-rich conditions in the Lower Zone. Water contents in olivine grains in the Basal Shear Zone higher than those in the Porphyroclastic Zone suggest water infiltration during the formation of the Basal Shear Zone.

Following the classification by Jung and Karato (2001) and Katayama et al. (2004), A-type, E-type, D-type and E-type crystallographic-preferred orientations (CPOs) are developed in olivine in the Equigranular Zone, Internal Shear Zone, Porphyroclastic Shear Zone and Basal Shear Zone, respectively. The variation in olivine CPO among these four zones can be systematically explained if the CPO developed in olivine changes from E-type through D-type to A-type with increasing temperature, decreasing strain rate or increasing water content. If so, then at a given strain rate, A-type, D-type and E-type olivine CPOs would be developed at relatively high temperatures or water contents, at relatively moderate temperatures or water contents, and at relatively low temperatures or water contents, respectively. E-type olivine CPOs are developed in the Internal and Basal Shear Zones deformed at similar high strain rates, because water contents were low in the former zone and high in the latter zone. Likewise, A-type and D-type olivine CPOs are developed in the Equigranular and Porphyroclastic Zones, respectively, deformed at similar low strain rates, because water contents were low in the former zone and moderate in the latter zone. On the other hand, at a given temperature, A-type, D-type and E-type olivine CPOs would be developed at relatively low strain rates or high water contents, at relatively moderate strain rates or water contents, and at relatively high strain rates or low water contents, respectively. A-type and E-type olivine CPOs are developed in the Equigranular and Internal Shear Zones, respectively, deformed at similar high temperatures and water-poor conditions, because strain rates were low in the former zone and high in the latter zone. Likewise, D-type and E-type olivine CPOs are developed in the Porphyroclastic and Basal Shear Zones, respectively, deformed at similar low temperatures, because water contents were moderate in the former zone while strain rates were high in the latter zone.