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Plastic flow and CPO of the Oshima peridotite mass as a remnant of upper mantle

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The Oshima peridotite mass is the lower part of the Yakuno ophiolite in SW Japan. The Oshima peridotite mass was studied by Ishiwatari (1985a,b), but it is needed for its crystallographic fabric and mode of plastic flow remains to be investigated. The purpose of this study is to clarify the process of the microstructure development together with Crystal Preferred Orientation (CPO) of olivine in the upper mantle.

The Oshima peridotite body is located north of Kyoto, which shows circular in shape with an area of 5*3 km2. This body consists dominantly of dunite and harzburgite. Peridotites have suffered from strong serpentinization. Therefore, we selected 20 fresh samples to study the microstructures precisely.

We analyzed microstructures and CPO of olivine in all samples using thin sections cut perpendicular to the foliation and parallel to the lineation (i.e. XZ-section). The results show that CPO of olivine was formed by (0kl)[001] slip system, and that peridotites studied here display various microstructures from coarse grained texture(0.7-1.0mm) to elongated porphyroclastic texture(1.0mm-). Olivine (0kl)[001] slip system and elongated porphyroclastic texture can be inferred to be formed by the upper mantle flow at relative low temperature (1000-1100C) (Nicolas and Poirier, 1976).

In order to characterize the CPOs, we determined the fabric strength and orientation distribution density of the principal crystallographic axes (J index and M index; e.g., Mainprice et al., 2000; Michibayashi and Mainprice, 2004; Stemer et al., 2005). Tommasi et al. (2000) and Skemer et al. (2005) obtained relationship between J- and M-index and strain. According to their study, as the strain increases, the value of J- and M-index also increases. In the Oshima mass, the lower part of this body has a larger value of J- and M-index than the upper part of one. This evidence suggests that the lower part of this body has a high strain magnitude.

In this study, we proposed new method indicating the process of CPO development during mantle deformation. Within a given thin section, we determine for each olivine grain 2 angles:

(1) Angle between slip axis of each olivine grain and sample lineation.

(2) Misorientation axis between adjacent olivine grains.

The angle difference between axis and lineation is controlled by lattice rotation due to dislocation creep (Sevillano et al., 1976). On the other hand, the misorientation angle with neighboring grains governed by the local deformation involving recrystallization and dislocation climb.

From these 2 variables, we can build fabric distribution diagrams for any sample which we compared to the J-index of the some samples. We showed that as the J-index increase (= fabrics get stronger), the fabric distribution diagrams also tends to concentrate on given values.

This study enables to study together dislocation glide and recrystallization, which both contribute to CPO development.