Microstructural observations of naturally deformed peridotite showing B-type LPO

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Recent deformation experiments suggest that slip systems of olivine vary systematically with temperature, stress and water content. Mizukami et al. (2004) reported a B-type LPO pattern formed by [001](010) slip system in the Higashi-akaishi peridotite body occurred within Sanbagawa metamorphic belt. This LPO is known to be developed during deformation under wet condition. In order to understand how conditions develop B-type LPO in the upper mantle, we observed microstructures of this peridotite with optical microscopy, electron back-scatter diffraction method (EBSD), fourier transform infrared spectroscopy (FTIR) and transmission electron microscopy (TEM).

We observed two samples. One of them (D1) was deformed at higher temperature rather than 800 C and ca. 2 GPa pressure conditions. The other (D2) was deformed after D1 stage under increasing pressure from 2 GPa to 3 GPa at ca. 800 C.

The results obtained through this research are following: 1) The average grain sizes of the olivines constituted D1 and D2 are ca. 390 micrometers and ca. 100 micrometers, respectively. Using grain size piezometer, these sizes indicate equivalent stresses are ca. 20 MPa - ca. 40 MPa and ca. 40 MPa - ca. 100 MPa, respectively. 2) We measured LPO of D1 and D2 by EBSD method. LPO of D1 shows a typical pattern formed by axial shortening, which suggests that the active slip system are [100](010) or [001](010). On the other hand, LPO of D2 shows a typical pattern formed by [001](010) slip system. 3) We measured water content incorporated into crystal structure of olivine by FTIR method. The average water contents measured in D1 and D2 are 615 ppmH/Si and 703 ppmH/Si, respectively. 4) We observed dislocation microstructures by TEM and measured dislocation densities in the olivine grains. The result is 6.8 X 10^6 /cm^2 and 2.1 X 10^7 /cm^2 in D1 and D2, respectively. Using dislocation density piezometer, these values indicate equivalent stresses are ca. 30 MPa and ca. 50 MPa, respectively.

The comparison of the results obtained here and previous deformation experiments may introduce the following possibilities. 1) The lowest stress activating [001](010) slip system decreases with decreasing deformational temperature. 2) The water incorporated into the crystal structure of olivine of D1 and/or D2 diffused after the cessation of deformation.