New indicator of mantle peridotite deformation history using clinopyroxene porphyroclasts

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In order to understand mantle deformation and flow, it is important to investigate actual mantle materials exposed on the Earth's surface. The Horoman peridotite complex in the Hidaka metamorphic belt, Hokkaido, Northern Japan, experienced strong deformation and is extremely fresh, providing the best research target to investigate deformation of peridotite. There are several researches on the deformation of the Horoman peridotite, such as Niida (1975) and Sawaguchi (2004). Sawaguchi (2004) particularly made extensive study and recognized several deformation zones on the basis of lattice preferred orientation of olivine, and proposed a deformation scenario of the complex. Microscopic observation and EPMA and EBSD analyses showed that clinopyroxene porphyroclasts, occupying 10% - 20% of a peridotite, was found to be a very useful indicator of deformation history.

The Horoman peridotite complex is composed mainly of plagioclase lherzolite, spinel lherzolite, and harzburgite. All rock types show strong deformation texture characterized by coarse-grained olivine aggregates (grain size: 250˜1000 micron meter) and fine-grained aggregates containing pyroxenes (grain size: 50˜250 micron meter). The latter occupies 20˜40 volume% of rocks. In this study, fine-grained aggregates composed of Cpx + Ol accompanying clinopyroxene porphyroclasts were examined. The clinopyroxene porphyroclasts accompanied fine-grained aggregates without spinel have two important features: grain size reduction in the marginal part of the porphyroclasts due to deformation and Al zoning due to pressure and temperature changes during decompression of the complex. Combination of these two kinds of information shows that clinopyroxene porphyroclasts have memory older than what olivine has and record deformation history in the spinel or even garnet stability field during the ascent of the complex. Moreover, clinopyroxene porphyroclasts have a lattice-preferred orientation (LPO) that is different from what is expected from the LPO of matrix olivine experienced in the plagioclase stability field. The clinopyroxene LPO is speculated to represent that of lithosphere before the complex started decompression.

In order to observe overall movement of detached grains from clinopyroxene porphyroclasts, misorientation analysis was made. In the result, Two different orientation of misorientation axis were found. This concentration of misorientation axis indicate rigid body rotation center on the axis. Two different orientations indicate different shear sense that had experienced the complex in the deep environment.

By analyzing fine clinopyroxene grains around porphyroclasts, shear sense involved in subgrain formation and its detachment from the host was determined, which provide a new constraint on deformation of the Horoman peridotite complex.