Cr-Al spinel as deformation indicator for the upper mantle peridotite

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Cr-Al spinel is a minor phase in peridotite, but is present in almost all peridotites. The morphological and chemical features of spinel show significant diversity on various scales. Spinel has been regarded as a good petrogenetic indicator of magmatic processes such as melting conditions in the upper mantle (Irvine, 1965,1967; Dick and Bullen, 1984; Arai,1992,1994). Moreover, spinel morphology and arrangement are interpreted to be related to deformation and used as a key information to know deformation mechanism (Nicolas and Poirier, 1976). Spinel usually occurrs in aggregate forming lineation, which is interpreted as subparllel to flow direction of peridotite. The obliquity between the lineation and olivine LPO (Lattice Preferred Orientation) is used to determine shear sense. However, formation process of the lineation and spinel morphology in the upper mantle have not been fully understood yet. Purpose of this study is to examine spinel lattice orientation and Cr-Al zoning to develop a spinel deformation indicator for mantle peridotites. In this presentation, we will show usefulness of the deformation indicator on the basis of observation made in the Horoman peridotite complex.

The Horoman peridotite complex is divided into two portions, Uppwe Zone and Lower Zone. We compared spinel morphology, lattice orientation, and Cr-Al zoning in harzburgite samples from the two zones. Spinel morphology were quantified by using roundness parameter, similar to degree of roundness proposed by Mastumoto and Arai (2001). Spinel morphology of the Lower Zone is more irregular with common occurrence of apparent inclusions of olivine or orthpyroxene. Lattice orientation was measured by using a SEM-EBSD system. Spinel from the Upper Zone is fairly consistent in terms of lattice orientation in each grain. By contrast, spinel from the Lower Zone consists of several grains locally showing subgrain structure. Cr-Al zoning was mapped by using EPMA. Cr/Al ratio in a spinel grain from the Upper Zone is fairly homogeneous with minor concentric zoning, whereas that from the Lower Zone shows significant heterogeneity characterized by the coexistence of both Cr and Al maximum on the grain surface.

Polyclistalline spinel grains from the Lower Zone recorded both dislocation creep forming subgrains and diffusion creep forming Cr-Al zoning. Coupling such recorded deformation of spinel and olivine LPO, we examine a possibility of non-linear shear stress distribution in deformation of the Lower Zone.