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Development of olivine crystal preferred orientations in the Oshima peridotite mass

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Observation of seismic anisotropy in the mantle is a powerful tool in order to identify the mantle dynamics. The anisotropy is mainly governed by the crystal preferred orientations (CPOs) of olivine. However the characterizing the relation between the intensity of CPOs and strain magnitude of the mantle flow quantitatively has not always succeeded yet. Consequently, it should be required to understand the formation mechanism of olivine CPOs development with strain increasing.

The Oshima peridotite mass belongs to the lower part of the Yakuno ophiolite in SW Japan. This mass consists predominantly of dunite and harzburgite deformed in the upper mantle conditions. The peridotites commonly display a coarse grained granoblastic texture and rarely porphyroclastic one. Analysis of olivine CPOs are carried out by an EBSD both in dunites and harzburgites and the results showed that olivine CPOs were formed by (0kl)[100] or (010)[100] slip system.

In order to characterize the CPOs, we first determined the fabric strength and orientation distribution density of principal crystallographic axes of olivine in peridotite samples. Furthermore, we investigated two kinds of angles to study the CPOs development process during mantle deformation. As follows:

(1) The angle difference between [100] and the axis of grains

(2) The misorientation angle between adjacent grains

The angle (1) should be controlled by a lattice rotation due to dislocation glide and the angle (2) is the governed by grain boundary migration and dislocation glide of individual grains. These two angles are also associated with deformation increment.

In order to research the CPOs development during mantle deformation, we constructed the fabric distribution diagram of deformed mantle rocks. The fabric distribution diagram shows the changes in angles of (1) and (2), and the patterns shape concentrate with fabric strength increasing. This diagram enables us to treat the dislocation glide increment controlled by Schmidt factor and the rotation effect due to resistive force of nearest neighboring grain deformation at the same time, which both contribute to the CPOs development.

The Oshima peridotite mass has a various degree of deformation structure such as grain size, aspect ratio of olivine and fabric strength (J-index and M-index). According to the spatial distribution of those values in the Oshima peridotite mass, it is revealed that the development of olivine CPOs and the occurrence of hundreds meter shear zone. These hundreds meter scale mantle shear zones with same coarse grained textures have not been reported. The complex CPOs patterns in hundreds meter shear zones within the Oshima peridotite mass reveal that the mantle flows in various scale heterogeneity and is largely influenced by micro-scale deformation processes.