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Deformation Microstructures of Olivine and Pyroxene in Peridotite, Spitsbergen, Svalbard and Implications for Seismic Anisotropy

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Seismic anisotropy in the upper mantle can be explained mainly by lattice preferred orientation (LPO) of olivine and pyroxene. To understand deformation mechanism and seismic anisotropy in the upper mantle under Spitsbergen, Svalbard near Arctic, deformation microstructures of olivine and pyroxene in peridotite, Spitsbergen were studied. Samples are well foliated and LPOs of olivine and pyroxene were determined using electron backscattered diffraction (EBSD) with the HKL Channel 5 software. Dislocation microstructures of olivine were observed using SEM after oxygen decoration of specimens. Water contents of olivine and pyroxene were measured using a Nicolet 6700 FTIR with Continuum FTIR Microscope. Eight specimens out of ten showed that [100] axis of olivine is aligned subparallel to the lineation and (010) plane is subparallel to the foliation, which is a type-A LPO (Jung and Karato, 2001). Two specimens showed that [100] axis of olivine is aligned subparallel to the lineation and both [010] and [001] axes are distributed in a girdle nearly perpendicular to the lineation, which is a type-D LPO. [001] axis of orthopyroxene is aligned in most cases sub-parallel to the lineation, and (100) plane is sub-parallel to the foliation. Dislocation density of olivine in the samples showing type-D LPO was higher than that in the samples showing type-A LPO. Result of FTIR study showed that both type-A and -D samples are dry. These observations are in good agreement with previous experimental study (Jung et al., 2006): samples showing type-D LPO of olivine were observed at high stress condition and both type-A and -D samples were observed in dry condition. Observations of strong LPOs and dislocations in the specimen indicate that the peridotites studied were deformed by dislocation creep. Seismic anisotropy calculated from the LPOs of olivine can be used well to explain seismic anisotropy of shear wave splitting in the lithospheric mantle under Spitsbergen, Svalbard.

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