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Exploration of microstructure induced by ultra low strain rate in mantle derived olivine

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Kitamura et al. (1986) and Ando et al. (2001) found Fe concentration on dislocation core created in olivine grains of deformed alpine type peridotite. They believe that the Fe concentration occurs during dislocation creep at very low strain rate condition in the upper mantle. This phenomenon is known as Cottrell atmosphere in the material science. On the basis of this detection phenomenon, they demonstrate that the study of ultra low strain rate effect on olivine plasticity is a very important to understand the dynamics of the upper mantle.

We try to confirm whether Fe concentration on dislocation core is a common phenomenon in deformed olivine grains of mantle derived peridotite. We are now observing microstructures of three types of peridotite, namely xenoliths from basalt and kimberlite and alpine, by using optical microscopy, EPMA, EBSD, TEM, ATEM, and STEM technique.

We obtained presently the following results. The Fe concentration is detected in the alpine type peridotites collected from Uenzaru, Horoman and Oman, but not in the xenoliths of basalt collected from Takashima, Megata, Kurose and Salt Lake. Microstructural observations can explain the later result by three different possibilities: Fe concentration on dislocation core is not occurred in olivine grains 1) in whole upper mantle, 2) only in the high stress (namely high strain rate) region of the upper mantle, and 3) it diffused away due to static recovery in basaltic magma.

Reference : Ando et al. (2001) Nature, 414, 893. Jung et al. (2006) Tectonophysics, 421, 1. Kitamura et al. (1986) Proc. Japan Acad., 62, 149.

Keywords: Olivine, Cottrell Atmosphere, Dislocation Creep, Lattice Preferred Orientation