Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

SIT04-P05 Room:Poster Time:April 28 18:15-19:30

Olivine CPO in non-deformed peridotite due to topotactic replacement of antigorite

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Olivine crystallographic preferred orientation (CPO) is thought to be the main cause of seismic anisotropy in the mantle, and its formation is generally considered to be the result of plastic deformation of mantle by dislocation creep. Olivine CPO has been reproduced in laboratory deformation experiments and considerable success has been achieved in understanding the deformation conditions (e.g. stress, temperature and water content) under which different olivine CPO patterns develop. This opens the possibility of mapping conditions in the mantle using seismic anisotropy and has been the subject of considerable study. Here we report an alternative mechanism for olivine CPO without the need for deformation. This process may be important in understanding the seismic properties of mantle in convergent margins.

Metamorphic studies show peridotite in the Happo area, central Japan, formed by the dehydration of antigorite- schist related to contact metamorphism around a granite intrusion. Both field and microstructural observations suggest the olivine has not undergone strong plastic deformation. This was confirmed by TEM work that shows the olivine has very low dislocation densities and lacks low angle tilt boundaries. Such tilt boundaries are general stable even after annealing. These features show that peridotite in the Happo area formed in the absence of solid-state deformation.

The olivine of the Happo peridotite formed dominantly by the dehydration breakdown of antigorite schist. We propose that the olivine CPO formed as a result of topotactic replacement of antigorite by the newly formed olivine. EBSD measurements in samples where both antigorite and new olivine are present and in contact show a very close crystallographic relationship between the two minerals: the *a*-axes are parallel, and the *b*- and *c*-axes are perpendicular. We conclude the strong olivine CPO in the Happo area was inherited from the original CPO of the antigorite. Such a process is likely to also occur in subduction zones where serpentinite is dragged down by plate movement. Topotactic growth of olivine may be an important cause of mantle anisotropy in convergent margins.

Keywords: subduction zones, microstructure, B-type olivine CPO, antigorite, topotaxy