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変形蛇紋岩中のアンチゴライトの配列

Alignment of Antigorite Crystals in Deformed Serpentinized Peridotites

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Serpentines play key roles in subduction zone processes including transportation of water, seismogenesis, exhumation of high-pressure rocks, etc. Geophysical mapping of serpentinized regions in the mantle wedge leads to further understanding of these processes. Seismic properties of serpentinized peridotites are critical to interpretation of seismological observations. Antigorite is a major form of serpentine, which is stable to higher temperatures. Its elasticity and orientation govern seismic properties of high-temperature serpentinized peridotites. The single-crystal elastic properties were recently revealed via Brillouin scattering technique (Bezacier et al., 2009). It has thus become possible to calculate seismic velocities in a serpentinized peridotite with given mineral composition and orientation. What controls the orientation of antigorite crystals? Combining previous studies and our petrofabric examination, we propose a model of alignment of antigorite crystals.

Controlling factors should change with the volume fraction of antigorite. At an early stage of serpentinization, where antigorite is a minor component in volume, pre-existing fabric of olivine controls orientation of antigorite crystals. Boudier et al. (2009) pointed out the topotactic relationships between antigorite and olivine. The olivine fabric determines the geometry of fluid pathways, in which antigorite crystals form. Planar defects created during deformation and potential slip planes (010) of olivine are likely to be intruded by hydrous fluids. Antigorite c-axes are aligned normal to these planes.

Our observation on serpentinized peridotites from Happo and Higashi-Akaishi shows that most of antigorite grains form continuous zones parallel or subparallel to the foliation. It is the case even at the antigorite volume fraction of 10%, where antigorite cannot govern bulk deformation. Antigorite grains seem to fill veins, into which hydrous fluids intrude.

CPO data of olivine and antigorite confirms the topotactic relationships suggested by Boudier et al. (2009). The concentration of antigorite c-axes is observed parallel to olivine a-axes or b-axes in Happo samples, where olivine a-axes are aligned normal to the foliation. In Higashi-Akaishi samples, antigorite c-axes are mostly aligned normal to the foliation. This might reflect the previous fabric of olivine. Olivine b-axes are aligned normal to the foliation and c-axes parallel to the lineation in antigorite-free peridotites. Antigorite c-axes might develop parallel to olivine b-axes.

The alignment of antigorite b-axes might be also inherited from olivine fabric. Antigorite b-axes are mostly aligned parallel to the lineation. Olivine c-axes are parallel to the lineation in Happo samples and antigorite-free peridotites from Higashi-Akaishi. We suggest a new topotactic relationship between antigorite and olivine; <010>atg // <001>ol. This is also seen in samples of Boudier et al. (2009)

Progressive deformation and serpentinization should change the alignment of antigorite crystals. Petrofabric examination on Happo samples suggests that antigorite grains are rotated and aligned parallel to the foliation during deformation and serpentinization.

At a late stage of serpentinization, where antigorite grains control bulk deformation, the deformation of antigorite crystals should control their alignment. Katayama et al. (2009) conducted deformation experiments of an antigorite rock, and found that a- and c-axes are aligned parallel to the flow direction and normal to the shear plane, respectively. Antigorite (001) is a potential slip plane, and the a-axis direction is the most probable slip direction.

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