Transition in crystallographic preferred orientation of akimotoite and its application to seismic anisotropy of the Tonga slab

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Akimotoite, the ilmenite structured MgSiO3, is the major constituent of the harzburgite layer of subducting slabs, and it is likely to be the most anisotropic mineral in the mantle transition zone. Therefore, the deformation-induced crystallographic preferred orientation (CPO) of akimotoite provides important information on seismic anisotropy in the mantle transition zone. Plastic deformation experiments of MgSiO3 polycrystalline ilmenite (akimotoite) at high pressures and temperatures were carried out at confining pressure of 20 to 22 GPa, temperature of 1273-1573 K using a Kawai-type multi-anvil apparatus installed at Tohoku University. The sample was sandwiched between alumina pistons, which induced high differential stresses inserted in the furnace assembly. Two- type- modified assemblies, uni-axial compression geometry and simple shear geometry were used for the deformation experiment. Crystallographic orientations of deformed ilmenite grains were measured by the electron backscatter diffraction (EBSD) technique at Chiba University.

We observed a transition in crystallographic preferred orientation pattern of akimotoite with temperature. A c-axis maximum parallel to the compression direction develops at higher temperatures (T=1473-1573 K), while c-axes are oriented parallel to the shear direction at the lowest temperature (T=1273 K). This change in CPO of akimotoite may be due to a change in dominant slip system with temperature. Seismic anisotropy of deformed MgSiO3 polycrystalline ilmenite calculated from the crystallographic orientation data is very strong. Furthermore, the difference in P-wave seismic anisotropy between the northern and southern segments of the Tonga slab reported previously in the mantle transition zone depth may be attributed to the difference in CPO patterns of akimotoite with temperature. This CPO transition may greatly improve our understanding of the regional variations in seismic anisotropy in different slabs