Lattice preferred orientation of akimotoite and its implication to seismic anisotropy in the Earth’s mantle

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Seismic anisotropy has profound implications for understanding the dynamic process of the Earth’s deep interior and it has been observed in the lower mantle transition zone (MTZ). The seismic anisotropy can be often caused by lattice preferred orientation (LPO) of elastically anisotropic minerals. The origin of the observed anisotropy is still unclear and debated as the dominant minerals in the lower MTZ, ringwoodite and majorite, are nearly isotropic. Akimotoite (ilmenite-structured (Mg, Fe) SiO_3) has a strong elastically anisotropic feature and it is one of the main constituting minerals at the cold region of the lower MTZ. Therefore, the LPO of akimotoite plausibly contributes to the seismological observations of anisotropy. To investigate the LPO of akimotoite developed during deformation, the well-controlled uniaxial and shear deformation experiments on the akimotoite aggregates were conducted at 21-23 GPa and 900-1300℃ by using D111 Kawai-type multianvil apparatus. Maximum strains of uniaxial and shear deformation experiments are 0.23 and 2.1, respectively. The most dominant slip system of akimotoite would be <11-20> (0001) with no change of slip system between 900-1300℃ based on LPO patterns of deformed akimotoite aggregate. Our present results indicate that: (i) The observed strong V_{SH} (or V_{SV}) azimuthal anisotropy with azimuthally isotropic V_{SV} (or V_{SH}) can be explained by the horizontal (or vertical) deformation of akimotoite, and (ii) The V_{SH} faster polarization anisotropy observed near the stagnant slabs above the 660 km discontinuity and the slabs penetrating across the 660 km discontinuity with shallow dips (dip angle is no more than 45˚) can be explained by the horizontal deformation of akimotoite and the V_{SV} faster polarization anisotropy observed near the slabs steeply penetrating across the 660 km discontinuity (dip angle is larger than 45˚), in contrast, can be explained by the vertical deformation of akimotoite.

Keywords: akimotoite, Lattice preferred orientation, seismic anisotropy , subducting slabs, mantle transition zone

