Lattice preferred orientation of akimotoite deformed in the D111 Kawai-type multianvil apparatus

*Longli Guan[1], Daisuke Yamazaki[1], Noriyoshi Tsujino[1]

1. Institute for Planetary Materials, Okayama University, Misasa, Japan

Seismic anisotropies are one of the key factors for understanding the mantle dynamic and have been observed near Tonga subducted slabs in the mantle transition zone and the uppermost lower mantle (mid-mantle) (e.g. Chen & Brudzinski, 2003; Vavryčuk, 2006; Nowacki et al.,2015). Spatial variation of seismic anisotropy in the Tonga subduction zone was reported by Vavryčuk. (2006). The stagnant slab above 660 km of northern segment shows that *P*-waves propagate more slowly in the direction normal to slab interface, while they propagate more slowly along the slab sinking direction in the penetrated slab below the 660 km of southern segment. The seismic anisotropy, in general, can be often caused by lattice preferred orientation (LPO) of elastically anisotropic minerals. LPO of akimotoite (ilmenite-structured (Mg, Fe) SiO_3) is plausible to interpret these seismological observations because it has a strong elastically anisotropic feature and it is one of main constituting mineral at the mantle transition zone and the uppermost lower mantle. Although pioneer works investigated the slip system of akimotoite (Cordier, 2002; Shirashi et al., 2008), it has not been fully determined yet. In this study, therefore, we conducted well-controlled deformation experiments at high pressure and temperature to observe LPO of akimotoite developed during deformation. The starting material of akimotoite aggregates was synthesized from $MgSiO_3$ glass at ~21 GPa and 1400℃, in the Kawai-type multianvil apparatus. Subsequent deformation experiments were conducted on the akimotoite aggregates at 21-23 GPa and 900-1200℃ by using high-pressure deformation apparatus, so-called D111 type apparatus, installed at Institute for Planetary Materials, Okayama University. Total strain and average strain rate were determined to be 0.08-0.19 and 2.63×10^{-5}-5.76×10^{-6} s^{-1}, respectively for the uniaxially deformed sample and 0.4-2.1 and 1.06×10^{-5} -6.03×10^{-5} s^{-1}, respectively for the sheared sample. All LPO patterns at experimental temperature ranged from 900 to 1200℃ indicate the c-axis of akimotoite is preferentially sub-parallel to the compression direction, suggesting a dominant slip plane on (0001). The variation of *P*-waves anisotropy observed in Tonga subduction zones at depths of the mid-mantle can be explained in terms of the LPO of akimotoite induced by different stress field between northern and southern slab segments. The LPOs of northern and southern slabs are mainly caused by the simple shear deformation with σ_2 perpendicular to the advance direction (slip direction) and along the slab and uniaxially compression with σ_1 parallel to the downdip direction, respectively. Our preliminary conclusion is consistent with geophysical observations (Bonnardot et al., 2009).

Keywords: akimotoite, lattice preferred orientation, mantle transition zone, subduction slabs, seismic anisotropy

