Geometry of the subducting Philippine Sea Plate beneath central Japan and formation of the slab window

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The geometry of the subducting Philippine Sea (PHS) Plate has been determined using hypocenter distribution, converted seismic waves, passive seismic exploration, receiver function analysis, seismic tomography, and other inversion methods. As a result, its existence has been traced to a depth of about 400 km beneath off the coast of the Japan Sea side of Chugoku region. However, the lateral extent of the subducted PHS Plate beneath northern part of central Japan is smaller than that expected from the geological evidence. Therefore, the size of the plate may be underestimated. We target the northern part of central Japan and investigate the geometry of the PHS Plate beneath this region.

We first determined the three-dimensional seismic velocity structure in central Japan using the seismic tomography method (Zhao et al., 1992), which uses the travel time of P and S waves. The results reveal a series of high velocity anomalies in the southwest- northeast direction from below Wakasa Bay to below the Noto Peninsula. Since the resolution of this area is sufficient, we interpret this series of high velocity anomalies as the PHS Plate. On the other hand, the high velocity anomaly is not imaged continuously along a profile parallel to the subduction direction, which passes through from Kanto to the Noto Peninsula. This suggests that the PHS Plate does not locally exist in the area below the Hokuriku region, or that it shows a low-velocity anomaly rather than a high-velocity anomaly.

Beneath the northern part of central Japan, the Pacific (PAC) Plate is subducting under the subducting PHS Plate. Therefore, these two plates may be colliding and affecting the subducting PHS Plate. Thus, we performed a two-dimensional simulation (Yoshioka et al., 2015) of oceanic plate subductions to understand the tectonics of the subducting PHS Plate due to collision with the PAC Plate. The results show that the colliding of the two slabs may lead a tear of the PHS Plate, which is caused by the velocity difference between the two slabs.

The combined results of seismic tomography and subduction simulations suggest that the PHS Plate beneath the Hokuriku region is tearing and thus does not show high-velocity anomaly in the slab tear. The tear may have started from the eastmost part of the PHS Plate as a physical interaction with the underlying PAC Plate and migrated westward with time. Therefore, although the PHS Plate has been subducting at least as far as the Noto Peninsula, it is thought to be forming a V-shaped slab window beneath the Hokuriku region.

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