Seismic imaging of the subducting Philippine Sea plate

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We use the updated methods of seismic tomography to study the 3-D crustal and mantle structure of the western Pacific subduction zones. The subducting Pacific and Philippine Sea (PHS) slabs are imaged clearly. Our results show that the PHS plate has subducted aseismically down to ~460 km depth under the Japan Sea, Tsushima Strait and East China Sea. The aseismic PHS slab is visible in two areas: one is under the Japan Sea off western Honshu, and the other is under East China Sea off western Kyushu. However, the aseismic PHS slab is not visible between the two areas, where a slab window has formed. The slab window is located beneath the center of the study region where many teleseismic rays crisscross. Detailed synthetic tests were conducted, which indicate that both the aseismic PHS slab and the slab window are robust features. The slab window may be caused by the subducted Kyushu-Palau Ridge and Kinan Seamount Chain where the PHS slab may be segmented. Hot mantle upwelling is revealed in the big mantle wedge (BMW) above the Pacific slab, which may have facilitated the formation of the PHS slab window.

Our P-wave anisotropy tomography shows that the fast-velocity direction (FVD) in the subducting PHS slab beneath the Ryukyu arc is NE-SW (trench parallel), which is consistent with the spreading direction of the West Philippine Basin during its initial opening stage, suggesting that it may reflect the fossil anisotropy. Significant FVD variations with depth are revealed in the subducting Pacific slab beneath the NE Japan arc, which may be caused by slab dehydration that changed elastic properties of the slab with depth. The FVD in the mantle wedge beneath the NE Japan and Ryukyu arcs is trench normal, which reflects subduction-induced convection. Beneath the Kuril and Izu-Bonin arcs where oblique subduction occurs, the FVD in the mantle wedge is nearly normal to the moving direction of the down-going Pacific plate, suggesting that the oblique subduction together with the complex slab morphology have disturbed the mantle flow.

キーワード：フィリピン海プレート、太平洋プレート、非地震性スラブ、地震、地震波トモグラフィー
Keywords: Philippine Sea plate, Pacific plate, Aseismic slab, Earthquakes, Seismic tomography

