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S-wave velocity structure tomography beneath the Japanes islands

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The Japanese islands are located in the subduction zone of the Philippine Sea and Pacific plates, and their underground structures should be very complicated. Many studies have been carried out on the velocity structure, but most of them were dedicated to the P-wave velocity structure. The studies on the S-wave velocity structure were limited to regional analyses, because the quality of S-wave traveltime data is also limited. Recently, the nation-wide seismic array was expanded and the number of stations with three-component seismometers increased. The problems in the S-wave data have been solved accordingly. These data were compiled in the Annual Seismological Bulletins of the Japan Meteorological Agency (JMA). We here estimate the 3-D S-wave velocity structure beneath the Japanese islands using them. We will study with the S-wave velocity structure in the crust and upper mantle, and image the Philippine Sea slab in the structure.

We set a target for tomography on the region of 28-45N and 128-145E. In October 1997, the JMA array was unified with the arrays by national universities, the National Research Institute for Earth Science and Disaster Prevention (NIED), JAMSTEC and so on. This unification resulted in 967 stations in the target area. We select 4666 earthquakes, with 59138 S-wave traveltimes, and 112776 P-wave traveltimes.

In this study, the analysis is carried out on the basis of the method of Zhao et al. (1992). For tracing rays, we adopt the pseudo-bending method by Koketsu and Sekine (1998), because of its computational efficiency and stability. We introduced the Conrad, Moho and upper boundary of the Pacific plate as discontinuities. Although we fix the Conrad and the upper boundary of the Pacific plate (UBPP) to the model of by Zhao et al. (1992) and Zhao and Hasegawa (1993), respectively, we determine the topography of the Moho using the method of Afnimar and Koketsu (2002). As an initial velocity model for the tomography, we suppose Vs=3.4 km/s, Vp=6.0 km/s in the upper crust, Vs=3.7 km/s, Vp=6.7 km/s in the lower crust. We use the model by Jeffreys and Bullen (1940) in deeper parts than the Moho discontinuity. The velocity from UBPP to a depth of 85km is 4% higher than that in other parts. The checkerboard resolution test is carried for apprasing the results of the tomography.

In the resultant S-wave velocity structure, low-velocity zones extend continuously along the volcanic fronts of the northeastern Japan, Izu-Ogasawara arcs at a depth of 40km, suggesting that melt does not exist only under volcanos. In southwestern Japan, low-velocity zones are also recovered along the volcanic front at a depth of 25km. In the vertical cross section of northeastern Japan, the low-velocity zones extend from near the top of the upper mantle under the volcano to the lower west. A similar distribution of the low-velocity zones is also found in Nakajima et al. (2001), where the P and S-wave velocity structures in the Tohoku region was estimated from data observed by a dense array. In central and southwestern Japan, the vertical cross section of the derived structure shows a high-velocity zone subducting to the northwest. These zones should correspond to the Philippine Sea slab.