Seismic structure and seismotectonics of the East Japan forearc derived from seafloor S-net data

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A permanent seafloor seismic network (S-net) consisting of 150 stations has been recently installed in the East Japan forearc and the outer-rise area under the Pacific Ocean, which provides an unprecedented opportunity to investigate the detailed forearc structure and initial stage of plate subduction. Using P-wave arrival-time data of local suboceanic events recorded by the seafloor S-net, *Yu and Zhao* (2020) determined P-wave velocity (Vp) tomography off Hokkaido, *Hua et al.* (2020) obtained Vp tomography off Tohoku, and *Wang et al.* (2022) investigated 3-D Vp anisotropic structure off Tohoku. However, the 3-D S-wave velocity (Vs) structure of the forearc region has not been investigated using the S-net data, except for *Matsubara et al*. (2019). In this work, we use a large number of P and S wave arrival times of local earthquakes beneath the Pacific Ocean and land areas recorded by both the S-net and the land-based Kiban seismic network to investigate the 3-D Vp and Vs structures of the East Japan forearc. Geometries of the subducting Pacific slab boundary and the Conrad and Moho discontinuities under the forearc are refined by referring to results of previous studies including active-source seismic soundings and seismicity located by the S-net. The obtained Vp and Vs images are quite similar to each other, suggesting that they reflect robust features of the 3-D seismic structure. The subducting Pacific slab exhibits high velocities, whereas significant low-velocity (low-V) anomalies are revealed in the overlying Okhotsk plate beneath the forearc, which may reflect accretionary materials containing abundant fluids. The subducting oceanic crust atop the Pacific slab is revealed clearly as a thin low-V layer extending from the trench axis down to ~100 km depth under the volcanic front. Our results of earthquake relocation using the 3-D velocity model indicate that the double seismic zone in the subducting Pacific slab occurs from the outer-rise area east of the Japan trench down to ~180 km depth under the eastern margin of the Japan Sea. The occurrence and focal mechanisms of the double seismic zone are caused by slab deformation during its subduction, such as slab bending or unbending, as well as other processes including hydration, dehydration, compositional variations, and phase changes in the subducting slab. Significant lateral variations of velocity structure are also revealed in the interplate megathrust zone, which show correlations with the distribution of large interplate earthquakes. These results shed new light on the seismic structure and subduction dynamics of the forearc region (*Zhao et al*., 2022).

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