3-D structure and seismogenesis in the East Japan forearc derived from S-net data

*Dapeng Zhao[1], Y. Hua[1], G. Toyokuni[1], Z. Yu[1]

1. Tohoku University

So far we have used the Kiban network data of suboceanic events relocated with sP depth phases to study the 3-D P and S wave velocity structure of the source zone of the 2011 Mw 9.0 Tohoku-oki earthquake (Zhao et al., 2011; Huang & Zhao, 2013; Liu & Zhao, 2018). Significant structural heterogeneities are revealed in the Tohoku megathrust zone, which are correlated with the distribution and rupture processes of the large megathrust earthquakes (M > 7.0). However, the structure near the Japan Trench is still not very clear. Recently, we study the 3-D velocity structure of the entire forearc region off Eastern Japan using data recorded by both the permanent OBS network (S-net) and the Kiban seismic network on the land area (Hua & Zhao et al., 2020; Yu & Zhao, 2020). We used a large number of arrival-time data of local earthquakes during June 2002 to December 2018 recorded at 480 permanent stations of the Kiban seismic network and 120 OBS stations of the S-net. To conduct tomographic imaging of the East Japan arc, we selected many well-located local events that occurred beneath the Kiban seismic network and many suboceanic events that were recorded and located by the S-net. From the high-quality vertical-component seismograms recorded by the S-net, we picked P-wave arrival times generated by the local offshore events. The picking accuracy of the arrival times is estimated to be 0.05-0.15 s. Only arrival times of the events with well-located hypocenters (uncertainty < 3 km) are used in the tomographic inversion. The tomographic method of Zhao et al. (1992, 2011) is used to determine a high-resolution 3-D velocity model of the East Japan forearc. The well-determined geometries of the Conrad and Moho discontinuities and the upper boundary of the subducting Pacific slab are considered in the velocity model. The general pattern of the obtained tomographic model is similar to that of previous models (Zhao et al., 2011; Liu and Zhao, 2018), but our new model reveals a low-velocity (low-V) anomaly near the Japan Trench off Miyagi and Sanriku. The mainshock hypocenter of the great 2011 Tohoku-oki earthquake is located at the boundary between a down-dip high-velocity anomaly and the up-dip low-V anomaly. The slow anomaly at the shallow depths near the Japan Trench may reflect low-rigidity materials that are close to the free surface, resulting in large slips, weak high-frequency radiation, and the high tsunami on March 11, 2011. Our new tomographic model can explain not only the large slips near the trench but also weak high-frequency radiation from the shallow rupture areas.

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