Study on the double-planed shallow seismic zone in the NE Japan forearc region by land-based and ocean bottom seismic network

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Double-planed deep seismic zone can be clearly observed within the Pacific slab beneath the NE Japan arc. Predominant focal mechanisms of the upper and lower plane earthquakes are down-dip compressional and down-dip extensional fault types, respectively (Hasegawa et al., 1978; Umino and Hasegawa, 1975). Recently, the double-planed shallow seismic zone has been found in the NE Japan forearc region by the precise distribution of hypocenters relocated with the time delay of the near-filed sP depth phase (Shantha et al., 2009). Focal mechanisms of some relatively large earthquakes in the double-planed shallow seismic zone have been determined from P-wave initial motion data recorded only land-based seismic networks; they show that the upper and lower plane earthquakes are normal faulting type and thrust faulting type, respectively (Shantha et al., 2009). However, it is not so easy to determine focal mechanisms of the lower plane earthquakes of the double-planed shallow seismic zone owing to two reasons: 1) The seismicity of lower plane events is lower than that of the upper plane ones; 2) Station coverage on the focal sphere is considerably poor if only land-based seismic networks could be used for estimation of focal mechanisms. In this study, we tried to investigate the focal mechanisms of the lower-plane events of the double-planed shallow seismic zone using both land-based and ocean bottom seismic network data.

We determined focal mechanisms of earthquakes whose focal depths were determined by sP phase but no focal mechanisms were estimated by Shantha et al.(2009). Those focal mechanisms are determined by P-wave initial motions. P-wave initial motions observed by not only the land-based seismic networks (Tohoku University, Hirosaki University, Hokkaido University, University of Tokyo, JMA and NIED Hi-net), but also ocean bottom cable seismic stations off Kamaishi (University of Tokyo) and temporary ocean bottom seismic networks off Miyagi (Tohoku University, University of Tokyo and JMA) are used in this study. The most suitable focal mechanisms are determined by using the grid search algorithm (Ito et al., 2005).

As a result, four lower-plane event focal mechanisms could be precisely determined. It is clear that ocean bottom seismic networks are very useful for constraining the focal mechanisms of offshore earthquake, especially determining their rakes. All of the focal mechanisms show thrust faulting type. The feature of these focal mechanism is very consistent with that of Shantha et al.(2009). This result suggests that the earthquake-generating stress field in the double-planed shallow and deep seismic zone in the NE Japan arc can be explained by the bending-unbending model of the subducting Pacific plate.

In future, we will investigate the seismotectonics of forearc regions in the NE Japan in long term and broad area by combining both the land-based seismic stations and ocean bottom seismic networks.