3D seismic velocity structure and seismicity around the rupture area of the 1978 Miyagi-Oki earthquake revealed by OBS observation

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Along the subduction plate boundary off-Miyagi, middle part of the Japan Trench area, M 7 class interplate earthquakes occur repeatedly at intervals of about forty years. Twenty-six years has already passed since the occurrence of the most recent earthquake, the 1978 Miyagi-Oki earthquake (M 7.4), and the Japanese government evaluated that the next large earthquake may occur within 20 years from now with over 80 % possibility. We started a series of ocean bottom seismographic (OBS) observations in September 2002 in order to clarify the spatio-temporal distribution of seismicity around the area where the next large earthquake is supposed to occur.

We perform a 3D seismic tomography to clarify both the velocity structure and detailed hypocenter distribution in the off-Miyagi area by combining the OBS data with those of the land seismic network. Owing to the OBS data, the accuracies of focal depths were greatly improved and the most of the hypocenters were relocated along a landward dipping plane. The plane corresponds to the boundary between the overriding continental mantle (Vp ~ 8.0km/s) and the subducting oceanic crust (Vp ~ 7.0km/s) in the obtained velocity structure model, indicating that most of the relocated earthquakes occur along the plate boundary. The dip angle of the plate boundary as imaged by the hypocenter distribution shows significant difference between the north and south of the study area; the dip angle in the southern part is shallower than that in northern part.

Besides the interplate seismicity, it becomes clear that there is a significant seismicity in the overriding land plate. In the focal area of the Miyagi-Oki earthquake, Takagi et al (1980) pointed out that the intraplate seismicity had been diminished for about one year, before the occurrence of the 1978 Miyagi-Oki earthquake. The present study clarify that the range of the intraplate seismic activity is limited just above or in the up-dip side of the asperity of the 1978 Miyagi-Oki earthquake (Yamanaka and Kikuchi, 2004).

The intraplate seismicity in the overriding land plate is reported in the Tokai region, the middle part of Japan, where the occurrence of another large interplate earthquake is apprehended. In the Tokai region, the range of the intraplate seismicity is thought to be corresponding to the area of strong interplate coupling (Matsuura and Kato, 1999). A numerical simulation using the rate-and-state dependent friction law demonstrated that the quiescence of the intraplate earthquakes can be caused by the aseismic slip preceding a large interplate earthquake (Kato et al., 1997). Takagi et al (1980) might detect the temporal change of the seismicity in the vicinity of the asperity, which we found by the present study, prior to the occurrence of the 1978 event.