Three-dimensional seismic velocity structure in the off-Miyagi and off-Fukushima fore-arc region

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The Japan Trench is a plate convergent zone where the Pacific Plate is subducting below the NE Japan arc. Interplate coupling along the plate interface is estimated to be strong by a backslip modeling of the land GPS observation in the middle to southern part of the arc (Suwa et al., 2006). However, the middle part (the off-Miyagi region) and the southern part (the off-Fukushima region) show different characteristics of the interplate seismic activity. In the off Miyagi region, the large earthquakes (greater than M 7) with thrust mechanisms have occurred at an interval of about 40 years, and an interplate earthquake of M 7.2 occurred in this region on 16 August 2005. In the off-Fukushima region, few large interplate earthquakes have occurred while the background microseismicity is very high.

In 2005, we deployed 51 OBSs in the off-Miyagi and off-Fukushima regions to observe the interplate seismicity, including the 2005 off-Miyagi earthquake (M7.2) and its aftershocks. Using the OBSs data with those of the onshore seismic stations, we performed a 3D seismic tomography in order to clarify whether there are some differences in the seismic velocity structures between the off-Miyagi and the off-Fukushima regions, corresponding to the differences in the seismic activity.

In our results, the subducting oceanic crust and the mantle wedge of the overriding plate were imaged as the landward dipping low velocity (Vp: ˜7.0 km/s, Vs: ˜4.0km/s) layer and the high velocity (Vp: ˜8.0 km/s, Vs: ˜4.5km/s) layer above it, respectively. Most of the earthquakes were relocated along the plate boundary, including the mainshock and the aftershocks of 2005 earthquake. Comparing spatial extents of the rupture areas of the 1978 and 2005 earthquakes and the velocity variation in the mantle wedge, we found that the location of high Vp anomaly corresponds to the rupture areas of the large interplate earthquakes. This suggests that the heterogeneity of the upper plate delimits the extent of the rupture area of large interplate earthquakes. The Vp in the mantle wedge of the off-Fukushima region is slower than that in the off-Miyagi region. Previous airgun-OBS experiment studies indicated that there is a low Vp (˜7.5 km/s) area at the toe of the mantle wedge in the off-Fukushima (Miura et al., 2003), while the Vp of the mantle wedge in the off-Miyagi is high (˜8.0 km/s) (Ito et al., 2005, Miura et al., 2005). The Vp variation in the mantle wedge imaged by the present seismic tomography is consistent with their results.