人工震源構造調査で明らかとなった，2011年東北地震北限域における地震前後のプレート境界反射波振幅の変化

Amplitude changes of the seismic reflected phases from the plate interface before and after the 2011 Tohoku earthquake around its northern limit region as revealed by active seismic surveys

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Seismicity along the Japan Trench off the northeastern part of Japan is not uniformly distributed, but it shows spatial variation. In fact, there have been identified aseismic areas off Miyagi prefecture around 39°N, 143°E. In order to investigate the origin of this variation in seismicity around this region, seismic surveys were conducted in 1996 and 2001. P-wave velocity structures were obtained along along-strike and along-dip profiles using data of the 1996 survey. Fujie et al. (2002) identified amplitude variation in reflected phases from the plate interface along the along-strike profile, and compared their amplitudes with the seismicity. They observed good anti-correlation between the amplitude and the seismicity such that large amplitude reflections were observed within seismically inactive regions. Spatial distribution of large amplitude reflections from the plate interface around the region was then revealed by Mochizuki et al. (2005), and the good anti-correlation between the amplitude and seismicity was confirmed. They also revealed that such reflection amplitudes increase as the plate interface becomes deeper. By qualitatively reproducing reflection amplitudes by numerical simulations, they concluded that there exists a thin low P-wave velocity layer over the subducting oceanic plate. They proposed abundant fluid must exist along the plate interface as the origin of such low P-wave velocity.
In 2011, the devastating Tohoku earthquake occurred along the Japan Trench with its fault dimensions reaching 500 km along-strike and 200 km along dip. A number of models for its rupture region have been proposed, and all share the common northern limit of the co-seismic slip at around 39°N where considerable contrast of seismicity exists. In order to investigate if physical properties along the plate interface may have changed in response to the rupture propagation, we conducted a seismic survey in 2013. In order to directly compare the observed waveforms with those obtained in 2001 survey, we deployed ocean bottom seismometers (OBSs) at the same station locations along the same along-strike profiles.
We estimated P-wave velocity structures using data of the 2013 survey. At first, we constructed 1-D V-p structures to about 2km depth beneath the seafloor for each OBS station by applying the

analysis method. Then, we conducted forward modeling of 2-D Vp structures by referring to the 1-D V-p structures so that the models explain travel times of shallow P-wave arrivals. Finally we obtained 2-D Vp structures by travel-time inversion. The depth of the plate interface was simultaneously estimated by including arrival-time picks of the plate interface reflected phases. We compared amplitudes of the reflected arrivals from the plate interface between the 2001 and 2013 surveys. Because the type of OBSs are mutually different between the surveys even at the same station sites, and the source signature of the airgun array was also different, we normalized amplitudes of reflected arrivals from the plate interface by the first arrival refracted waves. The amplitudes of the reflected waves from the plate interface appeared decreased within the seismically quiet region where abundant fluids had existed along the plate interface, whereas they were increased within the seismically active region. We propose a possible explanation that fluids migrated from the aseismic (fluid abundant) region to the other regions in response to the rupture propagation during the Tohoku earthquake.
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