Distribution of earthquakes around the subducted seamount off Ibaraki in response to the largest Mw7.8 aftershock of the 2011 Tohoku-oki earhtquake

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M7 class earthquakes have repeatedly occurred ~100 km offshore of the Ibaraki prefecture at fairly constant time interval of 20 years. It has been revealed that there exists a subducted seamount up-dip of the source region of such repeating M7 earthquakes (Mochizuki et al., 2008). Therefore, the seamount itself does not appear to be an asperity of the large earthquakes.

The region coincides with the southern limit of the fault region of the 2011 Tohoku-oki earthquake, where its largest aftershock with Mw7.8 occurred 30 minutes after the main shock. Spatio-temporal distribution of seismicity following such large earthquakes provides important information for understanding changes of the state of the stress caused by such a large fault slip and mechanisms of earthquake generation in relation to the topographic features of the plate interface.

We collected one-year long seismic data using ocean bottom seismometers equipped with 3-component 1 Hz velocity sensors. Data were recorded at a 200 Hz sampling frequency. We installed a dense OBS array using 35 instruments around the subduction front of the subducted seamount at a spatial interval of ~6 km for about a year from October, 2010, through September, 2011. In the middle of the observation period, the 2011 Tohoku-oki earthquake and its largest aftershock occurred. The epicenter of the largest after shock is located only ~30 km to the west (donw-dip) of the array, and its rupture propagated up-dip toward the seamount. Recent studies on its rupture propagation (Honda et al., 2013; Kubo et al., 2013) revealed that the rupture stopped before it reached the subducted seamount so that its rupture area occupies the area in subduction front of the seamount. In spite of such severe situation for seismic observation, we successfully recovered data from 31 stations.

More than 20000 earthquakes around the OBS array were recorded. Visual identification and manual picking of P and S arrivals through the records of ~30 stations are unrealistic. Therefore, we applied an automatic picking method that we developed by referring to Grigoli et al. (2014). The observed waveforms were converted to characteristic functions that have high sensitivity to arrivals of seismic phases. Having 3-D seismic velocity structure around the region that has been compiled by referring to the existing seismic profiles, the characteristic functions were migrated according to the travel times from the stations to the grid points in the structure volume, and then they were stacked. We determined the hypocenter of each event by finding the maximum stacked value among the grid points.

The resulted distribution of the earthquakes shows two primary layers of seismicity. The upper layer may represent distribution of small scale faults above the seamount. We found seismically quiet region in front of the subducted seamount that appears consistent with the rupture area of the largest aftershock.

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