

Hypocenter distribution around the 2011 Tohoku-Oki earthquake by using Ocean Bottom Seismographic data

SUZUKI, Kensuke^{1*}, HINO Ryota¹, ITO Yoshihiro¹, YAMAMOTO Yojiro², SUZUKI Syuichi¹, Fujimoto Hiromi¹, SHINO-HARA Masanao³, ABE Masao⁴, KAWAHARADA Yoshiharu⁴, HASEGAWA Yohei⁴, KANEDA Yoshiyuki²

¹Tohoku University, ²JAMSTEC, ³ERI, University of Tokyo, ⁴Japan Metrological Agency

A megathrust earthquake (M9.0), the 2011 off the Pacific coast of Tohoku earthquake (the 2011 Tohoku-Oki earthquake), occurred on Mar. 11, 2011 along the Japan Trench subduction zone. Its hypocenter and the area of major moment release are located in the Miyagi-Oki region, middle part of the Japan Trench area, where large interplate earthquake (~M7.5) have repeatedly occurred at about 40 years intervals. Since 2002, we have repeatedly deployed and retrieved pop-up type Ocean Bottom Seismometers (OBSs) to monitor the seismicity in the region. By this OBS network, we could observe a sequence of the foreshocks, the mainshock and aftershocks of the 2011 Tohoku-Oki earthquake in their close vicinity.

Suzuki et al. (2011) relocated these hypocenters by using OBSs data. Although OBSs deployed in the area observed the series of earthquakes and their data provided with improved image of the hypocenter distribution, they relocated only aftershocks with more than M-3.5 because vast number of earthquakes after the mainshock made it difficult to process the earthquakes with less than M-3.5. To investigate more detailed seismicity pattern, we relocated hypocenters of aftershocks with M-2.0~3.5 in addition to the their data set. In the first step of hypocenter determination, we calculated hypocenter positions by using 1D seismic velocity structure with applying station corrections for the OBS arrival time data and used those as the initial hypocenters in the second step. In the second step, we calculated hypocenters by using 3D seismic velocity structure estimated by Yamamoto et al. (2011) for a more detailed hypocenter determination.

The mainshock hypocenter was relocated slightly westward from that reported by JMA and near the intersection between the plate boundary and the Moho of the overriding plate. The foreshock seismicity mainly occurred on the trenchward side of the mainshock hypocenter, where the Pacific slab contacts the island arc crust. The foreshocks were initially activated at the up-dip limit of the seismogenic zone ~30 km trenchward of the largest foreshock (M 7.3, two days before the mainshock). After the M-7.3 earthquake, intense interplate seismicity accompanied by epicenters migrating toward the mainshock hypocenter was observed. The focal depth distribution changed drastically in response to the M-9 mainshock. Earthquakes along the plate boundary were almost extinct in the area of huge coseismic slip, whereas earthquakes off the boundary increased in population in both the upper and the lower plates.

Keywords: Tohoku-Oki earthquake, OBS, hypocenter distribution, foreshock, aftershock