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Urgent aftershock observation of the 2011 Tohoku earthquake using ocean bottom seismometer network

Masanao Shinohara[1*], Tomoaki Yamada[1], Kazuo Nakahigashi[1], Shin'ichi Sakai[1], Kimihiro Mochizuki[1], Kenji Uehira[2], Yoshihiro Ito[3], Ryosuke Azuma[4], Yuka Kaiho[5], Tetsuo No[5], Hajime Shiobara[1], Ryota Hino[3], Yoshio Murai[4], Hiroshi Yakiwara[6], Toshinori Sato[7], Yuya Machida[1], Takashi Shinbo[1], Takehi Isse[1], Hiroki Miyamachi[6], Koichiro Obana[5], Narumi Takahashi[5], Shuichi Kodaira[5], Yoshiyuki Kaneda[5], Kenji Hirata[8], Sumio Yoshikawa[8], Kazushige Obara[1], Takaya Iwasaki[1], Naoshi Hirata[1]

[1]ERI., Univ. Tokyo, [2]ISV, Kyushu Univ., [3]Sci., Tohoku Univ., [4]ISV, Hokkaido Univ., [5]JAMSTEC, [6]Sci., Kagoshima Univ., [7]Sci., Chiba Univ., [8]MRI, JMA

The 2011 off the Pacific coast of Tohoku earthquake occurred offshore of northeast Japan region on March 11, 2011. Knowledge of precise aftershock distribution is inevitably important to understand the generation mechanism of this large earthquake. In addition, this kind of information provides useful constraints for studies of rupture in such wide source region. In order to study the aftershock activity of this event, we started deployment of seventy-three ocean bottom seismometers (OBSs) four days after the mainshock. Consequently, we observed the aftershocks at 121 sites including the pre-installed OBS sites in total. Deployed OBSs after the mainshock are being recovered after one-month observation. The observation area is 500 km x 200 km and has a high aftershock activity, which is estimated from the land seismic network. The spatial interval of OBS is approximately 25 km to cover the whole source region. We use various types of the digital recording OBS system. Most of OBSs have both vertical and horizontal velocity sensitive electro-magnetic geophones with a natural frequency of 4.5 Hz. This 4.5Hz OBS are equipped with a glass sphere pressure vessel with the recording period of 1-3 months. Some OBSs use three-component velocity sensitive electro-magnetic geophones with a natural frequency of 1 Hz. The 1Hz OBS uses glass sphere or titanium sphere as a pressure vessel. The others use broadband seismic sensor or accelerometer as a seismic sensor. The OBS with titanium sphere pressure vessel has the longest recording period of 1 year. The resolution of the A/D conversion is 16 bits or 24 bits. Accurate timing is provided by a precise crystal oscillator. All the OBSs are of a pop-up type with an acoustic release system. The recovered OBS position at the sea floor was estimated by using acoustic ranging and ship GPS positions.

In south of the source region, thirty-four long-term OBSs (LT-OBSs) had been deployed before the occurrence of the mainshock, and we recovered three LT-OBSs to clarify the depth distribution of aftershocks. Using the data of OBSs, 99 aftershocks were located. Most of the aftershocks were located in a depth range of 5 - 30 km and concentrate in the plate boundary region. In addition, aftershocks occurred within the subducting oceanic crust and the 6.2-km/s layer of the landward plate. No aftershocks were found in the mantle of the subducting plate. From the results of previous seismic survey using OBSs and controlled sources, the subducting Philippine sea plate is estimated to be contact with the subducting Pacific plate. The southern end of the seismic activity region of the aftershocks corresponds to the region of two subducting plate contact. We infer that the propagation of the rupture during the mainshock sequence was terminated at the contact point with two subducting oceanic plate.

Keywords: The 2011 Tohoku earthquake, aftershock, subduction, ocean bottom seismometer