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Geophysical survey around the rupture zone of the 2011 off the Pacific Coast of Tohoku Earthquake by R/V KAIREI

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On March 11, 2011, the Pacific Coast of Tohoku Earthquake, occurred with a magnitude of M_j 9.0 beneath the landward slope of the Japan Trench, where large interplate thrust earthquakes are frequently generated. The magnitude of the main shock was the largest in Japan. As a result, the earthquake caused very strong vibrations, large tsunamis, and extensive damage around the Tohoku and Kanto areas. Immediately after the earthquake, we conducted a geophysical survey around the rupture zone of the earthquake using R/V Kairei of the Japan Agency for Marine-Earth Science and Technology (JAMSTEC). The operations included the deployment of ocean bottom seismographs (OBSs) [JAMSTEC, the University of Tokyo, Tohoku University], the retrieval of OBSs and ocean bottom pressure (OBP) [Tohoku University], a multi-channel seismic reflection (MCS) survey, and topography measurements by a multi-beam echo sounder. We deployed 42 OBSs for aftershock observations around the rupture zone in the offshore area from Iwate to Ibaraki prefectures. Moreover, 6 OBSs and 3 OBPs were successfully recovered. This survey is a part of the program launched following the "2011 off the Pacific coast of Tohoku Earthquake" and is assisted by a grant-in-aid for special purposes from the Ministry of Education, Culture, Sports, Science and Technology, Japan.

The MCS survey data were acquired along two lines (TH03 and TH04) in the offshore area of Miyagi prefecture and estimated at the maximum slip in the earthquake from the various analyses of some institutes. Because we carried out the survey of line TH03 in the same line as the 1999 survey (Tsuru et al., 2002), it could be possible to perform a time-lapse seismic reflection analysis using these data. However, we faced two difficulties in performing time-lapse seismic reflection analyses using these data: first, the data for the two surveys were obtained using different data acquisition systems of R/V Kairei, and second, the data quality in this survey was severely affected by the aftershocks, which were very frequent and had large magnitudes. Despite the difficulties in carrying out the time-lapse analyses, it could be possible to determine the nature of the coseismic change in the bathymetry and the crustal structure to study not only MCS data but also topographic data.

In the survey, we used an air-gun array with a spacing of 50 m. The total capacity of the array was 7800 cu.in. (130 liters; a tuned air-gun array consisting of 32 guns). The standard air pressure was 2,000 psi (approximately 14 MPa). During the operation, we towed a 444-channel hydrophone streamer cable with a 5700-m maximum offset, and the group interval was 12.5 m. The towing depth of the air-gun array and the streamer cable was maintained at 21 m below the sea surface. The sampling rate was 2 ms, and the recording length was 18 s.

In this study, we present an outline of the survey and the preliminary results of seismic reflection data and geophysical data.

Keywords: The 2011 off the Pacific Coast of Tohoku Earthquake, Ocean Bottom Seismograph, Multi-channel seismic reflection survey, Bathymetric survey, Time lapse survey, Ocean bottom pressure