Seafloor topography around the epicenter of the M7.1 November 2005 off Sanriku Earthquake

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1. Observation

The November 2005 off Sanriku Earthquake (M 7.1) occurred on Novmber 15, 2005, seaward of the Japan Trench off Sanriku. The 1933 off Sanriku Earthquake (Mj 8.1), which brought about a large tsunami, occurred seaward of the trench. Both of them are normal fault type earthquakes, and occurred in the shallow part of the Pacific plate. Fortunately a large tsunami did not occur this time; the highest observed wave height was 42 cm at Ofunato City, Miyagi Prefecture. The earthquake is still under investigation because it is the first large earthquake over M 7.0 after 1933.

We happened to observe detailed seafloor topography around the epicenter of the earthquake in October 2005 during the Hakuho-maru cruise KH-05-3 (September 27 to November 14). The survey aimed at mapping of seafloor topography around a site for geodetic monitoring based on GPS/Acoustic seafloor positioning. The site lies seaward of the Japan Trench off Sanriku, where normal faults are widely distributed. Three acoustic transponders were deployed on the relatively flat bottom, but there was no detailed topography data.

Topographic mapping was carried out by using a multi-narrow beam echo sounder of the Hakuho-maru for one night in the area 37.93 to 38.50 deg N, 144.78 to 145.10 deg E. We planned to extend the survey area farther east, but we were forced to leave the site for Onagawa Bay to escape from a low pressure.

2. Velocity correction

The multi-narrow beam echo sounding adopted a sound velocity profile obtained from a CTD observation carried out for the GPS/Acoustic seafloor positioning. However, the obtained seafloor topography had a tendency with a shallower depth near the center. Since the earthquake occurred one day after the end of the Hakuho-maru cruise, the preliminary seafloor topography was presented in the home page of the RCPEVE, Tohoku University. Nakanishi then revised the topography through a velocity correction.

3. Topography and the earthquake

There are three characteristic features in the observed topography. The first is ridge fault structures: a large slope near the western end of the survey area, a depression with a width of 3-4 km running in the N-S direction with undulations, and a depression with the same width running NW-SE. The second is topographic features indicating small volcanoes in the southern part. Extraordinary young basalts (about 6 Ma) were discovered recently near the eastern end of the outer rise (135 Ma) of the Japan Trench, and the volcanism was called petty spot (Hirano et al., 2001). Because similar young basalts were found in the outer rise to the east of our survey area (Abe et al., 2005), the newly found small topographic highs may have similar origin. The third feature is numbers of small topographic undulations running in the NE-SW direction. One of narrow depressions runs through the array of three acoustic transponders. These undulations may have resulted from deformation of the Pacific plate subduction as was proposed by Kobayashi et al. (1998).

Among the three features, the structures caused by normal faults may have higher relation with the 2005 earthquake. The problem is poor positioning of the focus of the earthquake due to the distance from land larger than 300 km. Considering the tendency that small after shocks can be better located than a large main shock, we examined the relation between the after shocks and the topographic features.