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Geomorphologic analysis of the co-seismic deformation of the seabed in the tsunami source area of the Tohoku Earthquake

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Abstract

The 2011 off the Pacific coast of Tohoku Earthquake happened on March 11, 2011, generated huge tsunamis and caused many fatalities and missing in the Hokkaido, Tohoku and Kanto regions.

According to Japan Agency for Marine-earth Science and Technology, JAMSTEC, seabed topography in off the coast of Tohoku deformed at the giant earthquake event by active faults along the Japan Trench.

We identify a series of faults from bathymetric data obtained before and after the giant event. Bathymetric data after the earthquake had acquired by KH11-7 cruise of the JAMSTEC R/V Hakuho-maru and YK11-E06 cruise of the JAMSTEC R/V Yokosuka in 2011, and the data before earthquake were acquired and compiled by Japan Coast Guard.

By deciphering and comparing the coseismic deformation of the seabed in both map view and vertical sections, we confirmed the location and attitude of the active faults that caused great slip at the shallow tip of the plate boundary.

The resultant slip model corresponds to the relationship of seabed topography with tsunamigenic displacement in the tsunami source region.

The rises located in the center of the trench bottom are asymmetric in profile, the landward side dips gentle and the seaward side is steeper. They are chained almost north-southerly, in the trench floor from 38o02' to 38o05'N, about 5.5 km.

Examined the correspondence between the results of geomorphlogical analysis and the slip distribution models, the distribution of asymmetric ridges formed by the earthquake is ristricted in the area 143o57'˜144o03E', and 38o00'˜38o07'N and almost coincide with large displacement area in slip distribution model in Iinuma et al.(2011).

The trench floor west of the anticlinal ridges and the lower landward trenchslope display apparent uplift by about 50 m, while no significant change was detected in the seaward.

From this we can consider that, the asymmetric ridge is caused by reverse faulting of the plate interface, and the layers of trench floor sediment were deformed in a style of detachment fold.

The fault scarps distributed on the landward trench-slope before the earthquake were disappeared after the earthquake. This is because the hanging wall of a spray fault might be raised to caused the giant tsunami.

In the landward trench-slope many new landslides and fault scarps were formed. Numbers of small landslides appeared along the fault scarps. Some of them are accompanied by sedimentary terraces.

Consequently, we estimated the trench floor and the landward trench-slope were uplifted and displaced seaward by the coseismic slippages of the decollement surface and splay faults during the giant earthquake. Such seafloor deformation conformed by this study might explain the reason of the sharp peak wavelet of the giant tsunami.

Those changes in seafloor topography due to large slip of the decollement surface and the splay faults during the earthquake, we may provide one of criteria in screening of slip distribution models.

Keywords: Off Tohoku Earthquake, Geomorphological Change, Morphological survey, The KH11-07 Cruise, Japan Trench, Seafloor Faults

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