Structural variation in the shallowest part of the Japan Trench subduction zone and its correlation with shallow megathrust slip and tsunamigenesis

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The shallow megathrust slip to the vicinity of the trench is one of the key features of the 2011 Tohoku earthquake. Understanding the detailed structure in the shallowest portion of the Japan Trench subduction zone is indispensable to investigate the nature of the shallow slip. We have conducted seismic reflection surveys using a “compact” seismic system to map the seismic structural characters in the Japan trench axis region. Differential bathymetry estimation provided strong evidence with which to examine the shallow megathrust slip to the trench. Seismic sections in areas with large horizontal displacement estimated from differential bathymetry display folds and thrust faults, whereas ones in areas without large displacement display chaotic acoustic structures in the trench axis without any clearly imaged thrust faults or folding deformation. We suggest that the thrust faults clearly imaged in the trench axis acted as the shallowest plate boundary megathrust during the Tohoku earthquake and caused the displacement observed by the differential bathymetry. The trench axis around the 39.5˚N where the tsunami source was proposed, the seismic sections and bathymetric data indicate the past slope failures. The differential bathymetry estimates suggested no large trench-ward displacement during the Tohoku earthquake in this region. Taking into account the slope failures imaged in the seismic profiles in this region, we speculate that small-scale slope failure might have contributed to tsunamigenesis during the Tohoku earthquake. In the north of 40˚N where neither large displacement nor tsunami generation was supposed during the Tohoku earthquake. In this region, the seismic sections show a well-developed thrust-and-fold structure not only within the vicinity of the trench axis but beneath the lower landward slope 10 –20 km landward from the trench axis. This area is proposed as the tsunami source area of the 1896 Meiji Sanriku earthquake together with the area of slope failure around 39.5˚N. The Meiji Snariku earthquake and tsunami might be generated by a combination of the slope failure and thrust faults imaged.

Keywords: Japan Trench, seismic imaging, shallow megathrust slip, slope failure

