A review of decade-long marine geophysical studies in the Japan Trench since the 2011 Tohoku-oki earthquake

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Numerous marine geophysical studies have been conducted in the Japan Trench since a rapid response survey immediately after the 2011 Tohoku-oki earthquake. As results from those studies, spatio-temporal distribution of the large coseismic slip near the trench, the structural factors that control the slip, and the seismicity activated after the earthquake around the trench and outer rise were revealed. The rapid response marine geophysical study obtained direct evidence showing large coseismic slips (~50m) reaching the trench axis along a profile in the central part of the rupture zone. Additional bathymetry and seismic data have been acquired following the rapid response survey along the strike of the trench. Those data show that the large coseismic slip to the trench is observed in a compact region of the central part of the Japan Trench (38 ~ 39.2 N). However, no clear evidence of the slip to the trench are observed at the north and south of this area. Seismic reflection data in the trench axis as well as in the incoming plate mapped a ~50km-wide thin subducting sediment, indicating a break of continuation of pelagic-clay layer, at the northern edge of the region of the coseismic slip to the trench. Integrating those structure with the result of the IODP JFAST, the smoothly distributed clay-rich sediment in the shallow portion of the Japan Trench is interpreted as one factor fostering the large fault slip. Tsunami data form the Tohoku-oki earthquake require an additional near-trench tsunami source north of 39–40°N. A mechanism to generate such a tsunami source remains to be an un-solved question. A working hypothesis is that a broad area experienced a small uplift caused by inelastic deformation in the trench-ward toe of the overriding block or seafloor deformation due to submarine land-slid near the trench. A drastic activation of seismicity has been observed in the near trench and the outer rise region since the 2011 earthquake due to complete change of a stress field. Clear lineations of normal fault earthquakes are observed along bending related faults in the outer rise region seaward side of the large coseismic slip region. The seismicity combined with seismic reflection images shows that the bending related normal fault earthquakes have been activating along the high-angle (dip angle of ~70°) faults down to ~40km deep.

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