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Active topographic features on the oceanward plate of the Japan Trench near the hypocenter region of the 2011 Tohoku Ear

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The trench-outer rise earthquake near the Japan Trench occurred after the 2011 Tohoku Earthquake. Several studies pointed out high occurrence probability of trench-outer rise earthquake after the 2011 Tohoku Earthquake in near future. Trench-outer rise earthquakes occur by reactivation or creation of normal faults caused as the oceanic lithosphere approaches a subduction zone and bends into the deep-sea trench. Bending-related faults in the oceanward trench slope are ubiquitous structures of oceanic plates incoming to trenches. In general, the faults are formed parallel or subparallel to the bending axis of the incoming plate, namely the trench axis. Oceanward slopes of several trenches have bending-related structure with a strike different from the trench axes (e.g. Kobayashi et al., 1998). In these areas, abyssal hill fabric was reactivated instead of the creation of new faulting parallel to the trench axis.

The Cretaceous Pacific Plate (132-138 Ma) is subducting along the Japan Trench (Nakanishi et al. 1992). The strike of the Japan Trench changes at around 38N from about N08E in the northern part to N30 E in the southern part. The outer swell of the Japan Trench is slightly less clear compared to that of the Kuril Trench. Its crest is deeper than 5,200 m and situated about 80 km east of the Japan Trench axis. The outer swell is distinctly identified north of 37N in the Japan Trench, north of the Joban Seamounts. The outer swell is obscure around the Joban Seamounts.

The bathymetric map around the Japan Trench by Nakanishi (2011) demonstrated that most of bending-related topographic structures exist in the oceanward trench slopes deeper than 5600 m. The map also revealed that bending-related topographic structures are developed parallel to the trench axis or inherited oceanic spreading fabric. Most of bending-related topographic structures in the northern segment of the Japan Trench are subparallel to the trench axis. The bending-related topographic structures are confined to areas less than 80 km away from the trench axis. Topographic expressions of these north of 39 40N are a half graben, an asymmetric graben and ridges, which is similar to that of the western Kuril Trench. The height of bending-related topographic structures does not show any gradual trenchward increase. Some of bending-related topographic structures north of 40 N have the same strike as those of Kuril Trench. In the middle region of the northern segment between 38 50N and 39 40N, bending-related escarpments form symmetric grabens subparallel to the trench axis Gradual growing of the bending-related topographic structures is observed in this area. Trench-subparallel escarpments decrease in relief southward and a dominant set of escarpments become roughly parallel to the seafloor spreading fabrics striking at large angles to the trench axis. Between 38 N and 39 15N, several elongated escarpments have a strike perpendicular to seafloor spreading fabrics.

The sidescan images exposes numerous knolls, petit-spot volcanoes, on the Pacific Plate around 38N (Hirano et al., 2008). The knolls are covered with thin or no pelagic sediments, implying that they were formed by recent volcanism, not related with any plate boundaries.

References

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Nakanishi, M., Bending-related topographic structures of the subducting plate in the northwestern Pacific Ocean, in Accretionary prisms and convergent margin tectonics in the northwest Pacific Basin, Modern Approaches in Solid Earth Sciences, 8, edited by Y. Ogawa, R. Anma, and Y. Dilek, Springer Science+Business Media B.V., pp. 1-38, doi 10.1007/978-90-481-8885-7_1, 2011.

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