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Bending-related Topographic Structures of the subducting plate in the Northwestern Pacific Ocean

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Elongated topographic structures associated with bending of the subducting oceanic plate along the western Kuril, Japan and Izu-Ogasawara trenches, were investigated using available multibeam bathymetric data.

The outer rise earthquake occurred just in the same day after the 2011 Tohoku Earthquake. Several studies pointed out high occurrence probability of outer rise earthquake near Japan Trench after the 2011 Tohoku Earthquake. The outer rise earthquake may generate tsunami even if its magnitude were not so large. Faults associated with outer rise earthquakes are observed in the oceanward trench slope. Bending-related faults are ubiquitous structures of oceanic plates incoming to trenches. In general, the faults are thought to be formed parallel or subparallel to the bending axis of the incoming plate, namely the trench axis, in most trenches. Oceanward slopes of several trenches have bending-related structure with a strike different from the trench axes (Masson, 1991; Kobayashi et al., 1998; Ranero et al., 2003). In these areas, abyssal hill fabrics made parallel to spreading centers by activity of normal faults were reactivated instead of the creation of new faulting parallel to the trench axes.

The Mesozoic Pacific Plate is subducting along the Kuril, Japan, Izu-Ogasawara, and Mariana trenches (Nakanishi et al. 1992). Kobayashi et al. (1998) investigated the bending-related structures of the oceanward trench slope of the western Kuril and northern Japan trenches using the bathymetric data obtained by the multibeam echo-sounder, SeaBeam. They concluded that the abyssal hill fabrics are revalidated when abyssal hill fabrics trend within 30 degree of trench axes.

To examine controlling factors for strikes of bending-related structures, it is indispensable to describe oceanic spreading fabrics and to identify magnetic anomaly lineations. The oceanic spreading fabrics consist of inherited abyssal hill fabrics and other preexisting weak zones related to seafloor spreading process, which are fracture zones, non-transform offsets, and so on. Magnetic anomaly lineations on the Pacific Plate incoming to trenches east of Japan were identified by Nakanishi et al. (1989; 1999). The curved lineation was identified at the Japan Trench near 38 N (Nakanishi et al., 1989, 1991), but was not assigned an age. No lineations were identified very near the trench axis of the Izu-Ogasawara Trench (Nakanishi et al., 1989). In these areas, it is difficult to examine controlling factors for strikes of bending-related structures.

The new bathymetric map demonstrated that most of bending-related topographic structures exist in the oceanward trench slopes deeper than 5600 m. The map revealed that bending-related topographic structures are developed parallel to the trench axis or inherited seafloor spreading fabrics. Detailed identification of magnetic anomalies near the Japan Trench revealed curved lineations and discontinuity of lineations associated with propagation ridges. Comparison between the detailed bathymetric and magnetic anomaly lineation maps elucidated that abyssal hill fabrics were reactivated where the angle between abyssal hill fabrics and trench axis is less than about 30 degree. The topographic expression of bending-related structures are classified into two types according to whether new faults develop parallel to the trench axis or inherited seafloor spreading fabrics reactivate.

Reference: 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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