

Earthquake activity in the Pacific plate near the Japan Trench axis after the 2011 Tohoku-Oki Earthquake

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Intra-plate normal-faulting earthquakes near oceanic trenches likely associate with bending of the incoming/subducting plates. Focal mechanisms of the intra-plate normal-faulting earthquakes in trench-outer slope area suggest tensional stress at shallow depths, which may promote infiltration of seawater several tens of kilometers into the oceanic lithosphere. Recent seismic structural studies in the trench-outer slope area present seismic velocity changes in the oceanic plate approaching the trench accompanied by the development of bending-related faults cutting the oceanic crust (e.g., Fujie et al., 2013, Grevemeyer et al., 2007). However, details on hypocenter locations, especially in depths, of outer-trench normal-faulting earthquakes and relation to the crustal structures have not been well understood due to less frequent activity than inter-plate earthquakes and lack of near-field observations. After the 2011 Tohoku-Oki Earthquake (Mw 9.0), shallow normal-faulting seismicity has been active in the incoming/subducting Pacific plate near the Japan Trench (e.g., Asano et al., 2011). To investigate the stress state in the incoming/subducting Pacific plate near the trench axis and relations between earthquakes and crustal structures, we have conducted a series of ocean bottom seismograph (OBS) observations near the trench axis since the occurrence of the 2011 Tohoku-Oki earthquake. These OBS observations provide accurate hypocenter locations and focal mechanisms of earthquakes occurred in the Pacific plate. Earthquakes with a normal-faulting focal mechanism occurred at depths of shallower than 40 km beneath the outer slope of the Japan Trench. The normal-faulting earthquakes in the oceanic crust coincide with normal-faults cutting the oceanic crust and forming horst and graben structures. The hypocenter distributions and T-axes directions suggest earthquakes activity along pre-existing structures in the oceanic crust in addition to the trench-parallel normal faults. Both the pre-existing structures, such as fracture zones, and trench-parallel normal faults formed in the trench outer slope area could act as faults of the shallow normal-faulting earthquakes. Furthermore, the normal-faulting earthquakes occurred at deeper depths compared with the OBS observations before the 2011 earthquake by Hino et al. (2009). The 2011 Tohoku-Oki Earthquake likely changed the stress state in the Pacific plate. These observations suggest that stress regime in the oceanic lithosphere, which could change in temporal and spatial, and both pre-existing and newly created faults in the oceanic crust are important factor to understand the hydration of the oceanic plate prior to the subduction.

Keywords: Intra-plate earthquake, horst and graben, normal faulting, OBS