Seismicity and its relation to the bending-related faults in the incoming Pacific Plate along the Japan Trench

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After the 2011 Tohoku-Oki earthquake (Mw 9.0), many M7-class normal-faulting earthquakes occurred in the trench-outer rise region seaward of the largest co-seismic slip area during the 2011 Tohoku-Oki earthquake. Outer-rise normal-faulting earthquakes likely relate to the normal-faults, which cut the oceanic crust and form the horst and graben structures. However, relationships between the outer-rise seismicity and crustal structures are not clearly understood from the observations using land seismic network since the outer-rise area is far away from the coast. After the 2011 Tohoku-Oki earthquake, we have conducted repeated ocean bottom seismograph (OBS) observations in the trench-outer rise region along the Japan Trench. Based on the OBS observations, shallow seismicity within the oceanic crust coincides with the seafloor topographic lineation. Their orientations are both parallel and oblique to the trench axis. The trench-parallel topographic lineation is related to the horst and graben structures formed in the trench outer-rise region prior to the subduction. On the other hand, the topographic lineation oblique to the trench axis is almost parallel to the magnetic anomalies. The seismicity along the topographic lineation oblique to the trench axis suggests reactivation of the pre-existing structures formed at the mid oceanic ridge. The results of the OBS observations indicate both pre-existing and newly created faults within the oceanic plate have actively deformed in the trench-outer rise region. Furthermore, close-up OBS observations in a westward dipping normal fault detected concentrated seismicity west of the fault escarpment on the seafloor. Although we could not obtain a clear image of the normal fault within the oceanic crust in the outer-rise of the Japan Trench through seismic reflection surveys, the seismicity could provide some information of the fault geometry within the crust.

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