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Subduction of the southern Kuril Trench convergent plate margin: Re-processing of multichannel seismic reflection data

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There is two end members for convergent plate margin systems: accretion and non-accretion. At accretionary convergent plate margins, large-volume accretionary prisms have developed. Non-accretionary convergent plate margins lack large-volume accretionary prisms at toes of forearc slopes. Tectonic erosion at some non-accretionary margins removes forearc material from the overriding landward plate during subduction of an oceanic plate. Particularly, basal erosion occurs farther landward along the base of the upper plate, and is inferred from general margin subsidence during convergence (von Huene and Lallemand, 1990). However, tectonic erosion, particularly basal erosion, is difficult to identify, because evidence of it is removed by erosion itself. Therefore, the mechanisms of non-accretionary margins are much less understood than those of accretionary convergent plate margins.

The Kuril trench convergent plate margin is known as one of the non-accretionary convergent plate margins, where several large earthquakes have occurred. The southern Kuril trench is characterized by oblique subduction of the Pacific plate beneath the North American plate. Subducting Pacific plate is deformed by normal faults, and horst and graben structure is developed.

In 1992, multichannel seismic reflection (MCS) data across the southern Kuril trench were collected during R/V Hakuho-maru KH-92-3 cruise (Ariie and Suyehiro, 1992). MCS data were acquired using a 24-channel streamer of 1200 m length and 37 l air gun seismic source. The seismic source was fired every 50 m. Our MCS data re-processing included common mid-point (CMP) sorting, deconvolution, velocity analysis, band-pass filtering, normal move-out (NMO) correction, 12-fold CMP stacking, and Kirchhoff time migration. Seismic velocities were analyzed every 2.5 km using full CMP gathers. To obtain improved velocity models, we used a recent instantaneous phase technique (Tsuji et al., 2007).

Re-processed MCS profile across the southern Kuril trench delineates sub-seafloor geological structures from the subducting Pacific plate to the upper forearc slope. Subducted Pacific plate is clearly imaged at least 60 km from the trench axis, and it is deformed by normal faults that form horst and graben structure. Development of a sedimentary basin with normal fault deformations can be recognized in the upper forearc slope, which indicates subsidence of the basin. The deformed sedimentary basin includes two unconformities, and this suggests that the basin has subsided intermittently. Moreover, normal faults in the basin reach to the seafloor, and this suggests the fault deformations are active at present. In order to explain these structural features, particularly basin subsidence, we have to consider the vertical movement of the forearc upper slope. Possible interpretation is mass removal at the base of overriding plate caused by basal erosion (e.g., von Huene et al., 2004). In this case, downward mass transfer of the base of overriding plate with subducting plate occurs, and forearc subsidence is induced to compensate the mass removal. To test this possibility using marine geological and geophysical data including MCS, we can delineate the non-accretionary type subduction tectonics in the southern Kuril trench.