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Structural changes within the subducting oceanic plate around the outer rise region

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The subducting oceanic plate and the water within it play important roles in seismic and volcanic activities in the island arc. Bending related faulting in the outer rise region is considered to be one of the major mechanisms of the water penetration and hydration of the incoming plate. However, detailed structural changes in the outer rise region have been not well resolved.

In 2009, for revealing seismic structure and its variation around the outer rise, we conducted a reflection and refraction seismic survey along a 500-km long survey line (A2) in the northwestern Pacific region, which is perpendicular to the Kuril trench. The Vp (P-wave velocity) and Vs (S-wave velocity) structure models along line A2 clearly show that the seismic velocities within the oceanic crust gradually decrease toward the trench axis beneath the outer rise and Vp/Vs within the upper crust becomes higher near the trench axis, suggesting high water content within the upper part of oceanic crust. These structural changes begins just at the south end of the outer rise, implying that the bending related faulting at the outer rise is responsible for the variation in the seismic velocity and water content within the incoming plate.

In 2010, for confirming these structural features and revealing the seismic anisotropy, we conducted another reflection and refraction seismic survey along two trench parallel survey lines, R1 and P1. R1 is located at the outer slope of the Kuril trench and P1 is located at the south of the outer rise. Both lines perpendicularly cross the line A2. We deployed 45 OBSs along R1 and P1 at a spacing of 6km, and fired a 7800 cu. in. tuned airgun array of R/V Kairei at a regular spacing of 0.2km. During the airgun shots, we towed a 444-channel, 6km long, hydrophone streamer cable and obtained multi-channel seismic (MCS) reflection data. The quality of the OBS and MCS seismic record section is good. We can observe clear refractions from the oceanic mantle (Pn) with apparent velocity of about 8.0km/sec, which is significantly lower than that of line A2.

We modelled Vp and Vs structure models by using both OBS and MCS traveltimes. Above the oceanic Moho, seismic velocity models of the trench parallel lines R1 and P1 are well consistent with that of A2, supporting the structural features observed along line A2. On the other hand, just below the oceanic Moho, we observed remarkable seismic velocity difference between the trench parallel direction and perpendicular direction, indicating that the significant anisotropy within the oceanic mantle.

Keywords: oceanic plate, outer rise, anisotropy, seismic velocity structure, Ocean Bottom Seismometer, wide-angle seismic survey