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Along-trench variation of the water contents within the incoming plate offshore north-eastern Japan

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The dehydration process and the expelled water from the subducting oceanic plate are expected to affect various subduction zone processes, including the arc volcanism, generation of the intermediate-depth earthquakes and the regional variation in the seismic coupling of plate interface. To better understand these subduction zone dynamics, it is essential to clarify the amount of water that is being subducted within the incoming oceanic plate into the subduction zone.

In the northern Japan trench subduction zone, a number of great interplate earthquakes, such as the 2011 Mw 9.0 Tohoku-oki earthquakes, have repeatedly occurred. However, the distribution of rupture zones of these interplate earthquakes shows distinct regional variations. It has been suggested that the along-trench variation in the distribution of large interplate earthquakes are well correlated with the along-trench variation in the outer trench seafloor roughness. Recently, seismic structure studies in the middle and south America trench have suggested that the seafloor roughness including seamounts and bending-related faulting is closely associated with the oceanic plate hydration. Thus, there is a possibility that the along-trench variation of the large interplate earthquakes in the northern Japan trench subduction zone is associated with the amount of water that is being subducted within the incoming plate.

In 2010, to clarify the regional variation in the seismic structure and regional variation in the amount of water containing within the incoming plate, we conducted an extensive wide-angle seismic reflection and refraction survey along a trench-parallel profile using OBS and air-guns. We obtained P-wave and S-wave velocity structure models by traveltime inversion techniques and a seismic reflection section by Prestack depth migration. All the obtained seismic structure models including Vp/Vs show significant along-trench variations. As expected, in the region where the seafloor bathymetry is rough (between 38 and 39 degrees north), seismic velocities within the oceanic crust and oceanic mantle are low and Vp/Vs is high. This suggests that water infiltration and/or the hydration of the incoming oceanic plate is high in the region where the seafloor is rough, and indicates that the amount of water that is being subducted within the incoming plate varies significantly along trench axis in this region.

Keywords: outer rise, seismic velocity, water contents, hydration, wide-angle seismic survey, OBS