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Regional variations in the nature of the incoming plate and its implication to the subduction zone

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The megathrust earthquakes like the 2011 Tohoku earthquake are caused by the interaction between the overlying plate and the subducting oceanic plate, indicating that the properties of the subducing oceanic plate, such as their geometry, thermal state, lithology, and water content, have a potential to controll the megathrust earthquakes. Of these properties, water content (degree of hydration) is highly influential because water transported by the incoming plate lowers the temperature of the subduction zone, promotes forearc metamorphism. Moreover, the presence of water and hydrated materials like serpentine can affect interplate seismic coupling on the plate interface. Accordingly, the regional variations in the degree of the hydration within the incoming plate might have strong influences on the regional variations in the interplate earthquakes.

To reveal the regional variations in the nature of the incoming oceanic plate and its evolution owing to bending-related faulting near the trench axis, we conducted extensive controlled-source seismic surveys in the trench-outer rise region off northeastern Japan arc. We confirmed the systematic changes in seismic velocities owing to the bending-realated faulting, suggesting the water content within the incoming oceanic plate increases toward the trench accompanied by the development of bending-related fractures. In addition, we found along-trench variations in the seismic structure of the incoming oceanic plate; lower seismic velocities and higher Vp/Vs ration around the ancient fracture zones associated with ridge propagation. This observation suggests that the ancient scar on the oceanic plate influences along-trench variations in the current water amount transported by the oceanic plate. If we extend the ancient fracture zone toward the forearc region, it corresponds to an area of weak interplate coupling, characterized by low Vp and high Vp/Vs ratio around the depth of the plate interface. Our observations suggest that the bending-related faulting promotes the hydration of the incoming oneanic plate but the along-trench variations in the water content might be controlled by the existence of the ancient fracture zone despite.