Hydration of the incoming oceanic plate owing to the bending-related faulting and its regional variation

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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 arc volcanism, generation of intermediate depth earthquakes and tremors, seismic coupling of plate interface, and thermal structure. Accordingly, the regional variations in the degree of the hydration within the incoming plate might have strong influences on the regional variations in the subduction zone processes.

Recent seismic and electromagnetic observations in the trench-outer rise region around the world suggest that plate bending-related faults just prior to subduction have a potential to promote water infiltration and raise the degree of hydration in the incoming oceanic plate.

To evaluate the impact of the bending-related faulting on the water amount within the incoming oceanic plate, we have conducted extensive active source seismic surveys in the northwestern Pacific margin. Obtained seismic velocity models show gradual reduction in seismic velocities and gradual increase in Vp/Vs ratio (Poisson's ratio) toward the trench axis accompanied by the development of bending-related faults, suggesting that water content (degree of hydration) within the oceanic plate increases toward the trench axis owing to the plate bending-related faulting.

However, the development of the bending-related faults, in other words, the development of the horst and graben structure, shows remarkable regional variations here. On the whole, the throw of the bending faults is much larger in the outer rise of Japan trench than that in the Kuril trench. As expected, changes in seismic velocities are more significant in the Japan trench than that in the Kuril trench. This can be explained by the differences in the angle between the strike of the paleo-spreading ridge and the strike of the trench axis. In addition, we observed low seismic velocities and high Vp/Vs ratio in the vicinity of the ancient fracture zone associated with ridge propagation. These observations imply that the amount of water transported by the oceanic plate into the subduction zone is dependent on both of the ancient activities near the paleo-spreading ridge and of the present activities near the oceanic trench.