An investigation of fault zone hydrogeology in subducting plates

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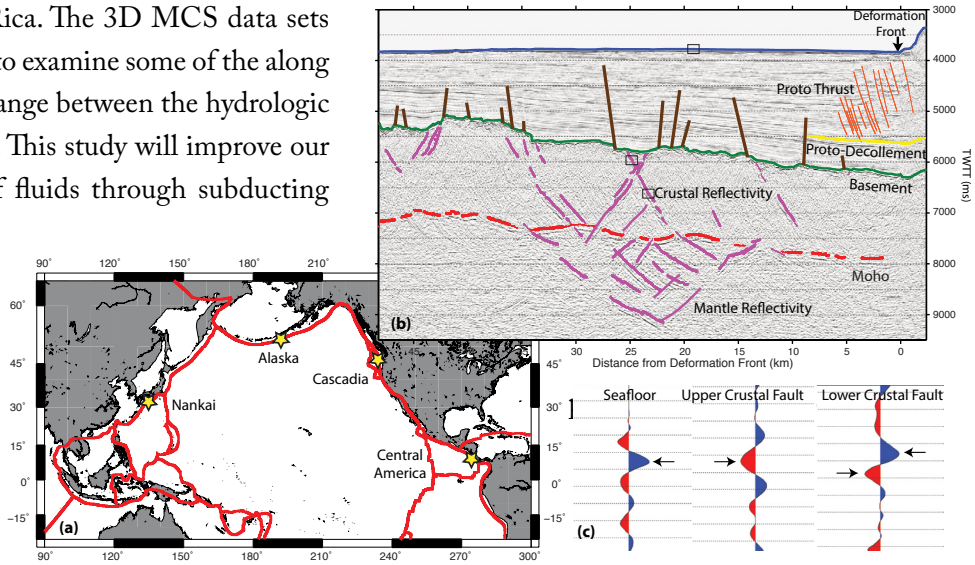
Faults in the oceanic plate facilitate plate hydration near the trench and provide pathways for fluid migration during subduction. However, the internal structure and hydraulic conductivity of these faults and their variation over time and space have not been examined and quantified. In this recently awarded project, we will investigate the structure and fluid content in the faults within representative segments of the subducting plate using existing multichannel seismic (MCS) data (see Fig.). We will conduct amplitude preserved prestack-depth migration, 2D waveform modeling of fault plane reflections, and fluid flow modeling on the 2D MCS data at Nicaragua, Cascadia, Nankai (offshore southwestern Japan), and Alaska to explore the limits on the fluid content of the fault zones in the oceanic plate seaward of the trench. From these results we will quantitatively assess the hydration state of incoming plate at different subduction zones. We will also conduct seismic attribute analysis of the decollement, near-basement sediment, and basement crustal rocks, and carry out waveform modeling of the faults in the downgoing plate beneath the trench and the slope at Nankai and Costa Rica. The 3D MCS data sets from these two sites will allow us to examine some of the along strike variability in the fluid exchange between the hydrologic systems of upper and lower plate. This study will improve our understanding of the transfer of fluids through subducting plate faults both seaward and landward of the trench, and will provide constraints for future investigations in plate hydration and dehydration zones.



(a) Locations of the four subduction zones: Cascadia, Nankai, Central America, and Alaska (marked by yellow stars) that are to be examined in this study. (b) Prestack-time migrated multichannel seismic image of the incoming Juan de Fuca plate seaward of Cascadia Subduction Zone with interpretation. Seafloor, top of the oceanic crust, and Moho are shown as blue, green, and red lines; Normal faults, protothrust faults, and protodecollement in the sediment section are shown as brown, orange, and yellow lines. Crustal and mantle reflections that are interpreted as fault plane reflections are shown in magenta lines (from Han et al., submitted.) (c) Waveform of the reflections of seafloor, upper crustal fault, and lower crustal fault in the black rectangles of (b).

References

Han, S., Carbotte, S.M., Canales, J.P., Carton, H., Nedimović, M., Gibson, J., Horning, G. Seismic reflection imaging of the Juan de Fuca plate from ridge to trench: new constraints on fault evolution and crustal structure prior to subduction. submitted to, J. Geophys. Res