Shallow velocity structure of the Alaska Peninsula subduction zone and implications for controls on seismic behavior

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Abstract:
Downdip and along-strike variations in the seismic behavior of subduction zone megathrust faults are thought to be strongly controlled by changes in the material properties along the plate boundary. Roughness and hydration of the incoming plate, fluid pressure and lithology in the subducting sediment channel are likely to control the distribution of shallower rupture. Here, we focus on the subduction zone offshore of the Alaska Peninsula. In 2011, the ALEUT program acquired deep penetration multichannel seismic (MCS) reflection and ocean bottom seismometer (OBS) data across the apparently freely sliding Shumagin Gap, the locked Semidi segment that last ruptured in 1938 M8.2 earthquake, and the locked western Kodiak asperity, which ruptured in the 1964 M9.2 earthquake.
Seismic reflection data from the ALEUT cruise reveal significant variability in the thickness of sediment on the incoming plate and entering the trench, and the roughness and degree of hydration of the incoming plate. Oceanic crust entering the trench in the Shumagin gap is rugged with extensive faults and only a thin layer of sediment (<0.5 km thick). Farther east in the Semidi segment, the subducting plate has a smoother surface with thicker sediments (~1 km thick) and less faulting/hydration. To better constrain the properties of the accretionary prism and shallow part of the plate boundary, we are undertaking travel time tomography using reflection/refraction phases in OBS and MCS data, and constraints on the interface geometry from MCS images to estimate the detailed shallow velocity structure, with particular focus on properties within the shallow subduction channel. We observe refractions and reflections in OBS data from the shallow part of the subduction zone in both the Shumagin Gap and Semidi segment, including reflections off the top and base of what appears to be a layer of subducting sediment, which can be used for this work. We plan to present initial models of the shallow part of the subduction zone from both segments and discuss comparisons between the two.

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