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Downdip and along-strike variations in the properties of the Alaska megathrust from active-source seismic imaging

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Abstract:
Downdip and along-strike changes in slip behavior at subduction zones are often attributed to changes in the properties of the megathrust. Here we review information on the subduction megathrust offshore of the Alaska Peninsula from MCS reflection and wide-angle seismic data acquired in 2011 during the Alaska Langseth Experiment to Understand the megaThrust (ALEUT) program, and compare them with constraints from other data and experiments. This region encompasses the full spectrum of coupling: 1) the weakly coupled Shumagin Gap; 2) the Semidi segment, which last ruptured in the 1938 M8.2 event, appears to be locked at present, and 3) the western Kodiak asperity, which marked the western extent of the 1964 M9.2 rupture and also appears to be locked.
Our data reveal substantial along-strike variations in incoming sediment thickness and plate structure and along-strike and downdip variations in megathrust reflection characteristics. Over 1 km of sediment is observed on the incoming oceanic plate in the Semidi segment prior to subduction, and a relatively thick and continuous layer interpreted as subducted sediment can be imaged at the plate boundary here up to ~50 km from the trench . In the Shumagin Gap, where the incoming sediment section is half as thick and more pervasively faulted at the outer rise, a subducting sediment layer is also observed but it is thinner, less continuous and is not observed to continue as far from the trench. ,Although the Semidi segment is capable of producing great earthquakes, the comparatively thick sediment here may contribute to the relative paucity of seismicity compared with adjacent segments. At greater depths, simple and bright reflections are generally observed at depths of ~12-25 km, ~40-100 km from the trench, within the center of the estimated locked zone. The character changes where the megathrust appears to intersect the forearc mantle wedge to a wide (~2 km thick), bright band of reflections and may arise from a change in deformation style, distribution of fluids, and/or plate boundary properties. Although the overall patterns in reflection characteristics are consistent between profiles across different segments, this transition in reflection characteristics occurs at larger distances from the trench within the Semidi segment than in the Shumagin Gap.

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