Seismic Reflection Imaging of Subduction Bending-Related Faults at Cascadia

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Abstract:
The hydration state of the downgoing Juan de Fuca (JdF) plate is important to a number of subduction processes at Cascadia, yet is poorly known. As oceanic plates subduct, faults develop at the outer rise due to flexural bending and have been shown to facilitate plate hydration near the trench. We present pre-stack time migrated (PSTM) images of two cross-plate transects offshore Oregon and Washington to characterize faulting within the Juan de Fuca Plate. Basement faulting evident from vertical offsets in the sediment section is observed as far as 200 km seaward of the deformation front, and may result from complex intraplate stresses within the JdF plate. Along the Oregon margin, bright fault plane reflections within the crust are observed beginning ~40 km seaward of the deformation front. They are sparsely spaced, form in conjugate pairs, and cut completely through the crust. We suggest they are related to plate bending. Within the same region, a set of mantle reflections, possibly originating from the continuations at depth of some of the crustal faults, extend as deep as ~6 km beneath the Moho. The waveforms of the fault plane reflections vary with depth, implying variation of the internal structure and/or pore fluid pressure within the fault zones. Along the Washington margin, densely spaced faults that may be bending-related are confined to the upper and middle crust and most of them are seaward dipping. Mantle reflections are not observed on this transect. In the lower crust, a set of dipping events is imaged, they are spaced at 1-2 km, dip ~ 30° towards the ridge and shoal into the Moho reflection. The crust in which these reflections are observed is 6-8 Ma old. Lower crustal reflections with similar characteristics are also observed in crust of same age on our Oregon transect, suggesting they are related to accretionary processes at the JdF Ridge during this time period. We conclude that different faulting patterns at Oregon and Washington margin result from along-strike variations in bending and intraplate stresses, and the pre-existing crustal structure. Localized alteration around faults is inferred at the Oregon margin.

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