Cascadia Segmentation: Sediment supply, structural influences, and a pinchout of the locked interface

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Onshore and offshore paleoseismic evidence from 41 Cascadia earthquakes strongly suggest that segmentation plays a significant role in Cascadia, and may have multiple sources. Southern segments may be controlled by obvious structural boundaries such as the Blanco Fracture zone, and two subducting pseudo faults. Along the northern margin, where segmentation is not apparent, significant basement structure is masked by thicker sediment supply, supporting a primary control by sediment thickness on the subducting plate. In Cascadia, massive submarine fans are accreting to the along the northern margin in their northern regions, with incoming sections of 3-4 km thickness that taper southward. These thick sections smooth the plate interface with respect to structures in both the downgoing and upper plates, likely promoting long ruptures. We suspect, supported by paleoseismic data, that northern Cascadia and northern Sumatra may be prone to large ruptures due to the masking of other structures by large influxes of sediment on the subducting plate.

One segment boundary in Cascadia appears not to be related to sediment supply, but may linked to a narrowing of the locked interface in map view. The Cascadia forearc is composed of an Eocene-Pliocene accretionary complex, outboard of which lies a Pleistocene-Holocene wedge of low taper, mixed vergence, and high pore fluid pressure. The young wedge is widest off Washington and northernmost Oregon, tapering both north and south. Mixed vergence, open folds, mud volcanoes and backstop parallel trends indicate poor coupling of the young wedge that is easily mapped from surface data. The long-term average downdip limit of significant coupling appears to be consistent with thermal, geodetic, and structural evidence of a transition from arc normal to arc parallel contraction. An average boundary consistent with these disparate data suggest significant heterogeneity in along-strike width and or magnitude of coupling. A seaward swing of the downdip locked zone, combined with a landward position of the updip limit may create a “pinchout” in central Oregon, where we observe a paleoseismic segment boundary.