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Interplay of Structure and Sediment Supply May Influence Subduction Zone Rupture Patches and Propagation

Details

Meeting	2007 Fall Meeting
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Session	Megathrust Slip and Forearc Structure II
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Abstract

The question of whether there are universal controls on the genesis and maintenance of large slip and moment patches along strike on subduction megathrusts has proved remarkably elusive, in part due to the short temporal records we have of these great events around the globe. Many events this century are poorly constrained, and many subduction zones only have one or a few events available for comparison. Long historical records and good structural constraints have made Nankai a leading case for basin centered asperities, yet the recent Sumatra Mw 9.2 rupture models show that slip and moment for the most part avoided basins and was centered under structural highs. In Cascadia, both deformation and tsunami models clearly fit the respective subsidence and runup data better if slip in past events was centered under or did not avoid these highs as opposed to basin centered model. Onshore and offshore paleoseismic evidence from 38 Cascadia earthquakes strongly suggest that structural segmentation plays a role only along the southernmost margin. These data do not provide information on moment or slip distribution, but do effectively constrain rupture lengths. Rupture lengths constrained by the paleoseismic data show that there is no Holocene segmentation for the northern margin, and that southern segments may be controlled by some of the obvious structural boundaries such as the Blanco Fracture zone, and outer arc uplifts and forearc basins. Where resolution is adequate, these data also suggest that ruptures die out into the basins and are linked multi-segment ruptures of structural uplifts, similar to that observed in the 2004 and 2005 earthquakes from Sumatra where outer arc uplifts may mark segment boundaries, high slip patches and initiation points for great earthquakes. The difference between the rupture modes observed for Nankai and Sumatra, and suggested here for Cascadia may be linked to the sediment supply for these systems. Cascadia and Sumatra are both systems where massive submarine fans are accreting to the margin in their northern regions, with incoming sections of 3-4 km thickness that taper southward. These thick sections promote high fluid pressure, but also tend to smooth the plate interface with respect to structures in both the downgoing and upper plates. A smooth plate interface has long been thought to promote long ruptures and high moment release, and so we suspect 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. By comparison, the relatively thin sediment supply at Nankai may allow these structural boundaries to play a greater role in rupture propagation and moment release. The smaller southern Cascadia ruptures are also consistent with this model, with structural control taking precedence as the sediment supply thins southward.

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