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- Meetings
- Sections
- Index Terms
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# Sumatra and Cascadia: Parallels Explored

## Details

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|---|---|
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## Abstract

The 2004 Sumatra-Andaman Mw9.2 earthquake has spawned superficial parallels between the Sumatra and Cascadia convergent margins in terms of rupture length and tsunami generation, however the parallels go deeper than these simple parameters. The accretionary wedges of both systems are fed by large accreting submarine fans at their northern ends, sourcing sediments from remote continental interiors. The Astoria and Nitinat fans, accreting in northern Cascadia taper to the north and south, while the Nicobar and Bengal fans taper southward, interrupted by the 90E Ridge. The Washington Cascadia margin is the type example of landward/mixed vergence most likely induced by high fluid pressures which may approach lithostatic as evidenced by wedge taper and mud volcanoes. The fluid pressures are a result of rapid deposition of the Pleistocene fans, and tectonic accretion. The landward/mixed vergence regions are broader, with more open and coherent folds. Similarly, the accreting Bengal/Nicobar fan appears to result in a landward/mixed vergence wedge off northern Sumatra, the Nicobars and the Andamans (though limited data show a steeper narrower wedge off the Andamans, broadening toward Myanmar). Fold trends are also more coherent, and fold style more open. In Cascadia, the regional trend is interrupted by local vergence changes linked to local backstop configuration. In both systems, landward/mixed vergence gives way to the south where the accreting fan section thins, the wedge transitions to seaward vergence and a steeper narrower wedge, though the controls on vergence may also include backstop shape, lithology and other factors. The landward/mixed vergent regions in both systems are characterized by broader more coherent fold/basin trends. Rupture models from seismology and geodesy suggest that slip was concentrated toward the rear of the outer arc high in the 2004 Sumatran earthquake, tapering both seaward into the outer wedge, and landward into the forearc basin. In Cascadia, geodetic data cannot resolve the offshore position of significant coupling. Seismic reflection data however show that a stress change from margin normal compression to margin parallel compression can be mapped from Pliocene to Holocene structures underlying the continental shelf. This boundary parallels the rear of the outer arc high 10-20 km arcward, similar to the structure-slip relationship observed in Sumatra. This abrupt stress change is suggestive of the long term position of downdip interplate coupling, and consistent with stress indicators on shorter timescales such as borehole breakouts. Along strike, the stress gradient extends further arcward adjacent to highly deformed submarine banks, and trends seaward between these uplifts, suggestive of a classic asperity model. In Sumatra, the three slip patches common to most slip models are associated with potentially analogous structures in the Andaman and Nicobar Islands, and the northern part of the uplift that includes Simeulue Island. Enough data do not yet exist off Sumatra to map a stress transition similar to Cascadia, however existing data and slip models for Sumatra are at least consistent with the Cascadia data. Paleoseismic evidence from Cascadia and the 2004 and 2005 earthquakes from Sumatra suggest outer arc high uplifts may mark segment boundaries, and in the case of Sumatra, initiation points for great earthquakes.

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