Feedbacks Offshore the Cascadia Margin

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A growing body of evidence from the Cascadia subduction zone in the U.S. Pacific Northwest suggests that there are significant feedbacks among the offshore upper-plate material properties, geologic and geomorphic structures, seismic shaking, sediment redistribution, and mega-thrust slip behaviors. Analyses of seafloor seismic data show that the thick accretionary wedge sediments amplify and prolong shaking by low-frequency seismic waves and attenuate high frequencies (Gomberg, 2018). This strong contrast in shaking feeds back into reshaping the sediments, by controlling where they are likely to be destabilized and redistributed by shaking. Analyses of submarine landslide morphology and numerical modeling of slope strength suggest that different feedbacks, perhaps related to shaking-induced sediment compaction, may actually make sediments stronger (ten Brink et al., 2016; Scholz et al., 2016). Understanding of these contrasting influences in turn feeds into interpretations of turbidites as proxies for paleo-earthquakes, and hazard assessments based on earthquake recurrence models derived from them; for example, regions with greater numbers of turbidites may reflect permanent features of the shaking that are more suitable to trigger failure, but may be interpreted as indicative of a greater rate of earthquakes. Abrupt strike-perpendicular changes in shaking characteristics, apparent along most of the length of the margin, coincide with sharp gradients in topography and structure along the edge of the continental shelf. This same apparent boundary along the shelf-edge also coincides with concentrations of methane bubble plumes, with gas characteristics indicative of origins within the accretionary prism. One explanation is that the shelf is bounded by faults that connect with the megathrust and act as conduits for gas extrusion, some of which may connect with the megathrust directly or indirectly. This suggests another feedback, as structural changes promote or are caused by faulting, which itself permits pore pressure changes that modify the potential for additional faulting. Taken together, the aforementioned correlations and others observed between areas of non-volcanic tremor with gravity lows, crustal faulting patterns, and marginal basins, imply feedbacks between processes along the megathrust and upper plate structure (Wells et al., 2017). To reduce the degree of speculation about some of these feedbacks, several major experiments are planned and underway. These experiments, to be summarized in this presentation, will image the margin structure with sufficient resolution to identify and characterize faults, map changes in material properties, and more, along nearly the entire length of the Cascadia margin.

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