Uncertainty in turbidite correlations along the Cascadia Subduction Zone

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An influential reconstruction of Cascadia earthquakes builds on tenous evidence for synchronous shaking. The synchroneity has been inferred by correlating deep-sea turbidites with one another (http://pubs.usgs.gov/pp/pp1661f/). The correlated deposits record turbidity currents that likely evolved from other kinds of subaqueous mass movements. The stratigraphic correlations reportedly distinguish between long ruptures and series of shorter ones; the greater the extent of turbidite correlation along the plate boundary, the longer the inferred fault rupture. The correlations have been interpreted as exact enough to show whether the initial mass movements began during the same few minutes in areas hundreds of kilometers apart. A recent review of these findings focuses on deep-sea channels that head offshore Washington (http://pubs.usgs.gov/of/2012/1043/). Two of the points reviewed: (1) Sensitivity of Cascadia Channel turbidites to the extent of fault rupture beneath its tributary canyons. The Juan de Fuca tributaries head mainly in submarine canyons offshore northern Washington, while the combined Quinault, Grays, and Willapa tributaries head offshore southern Washington. It has been assumed that flows from north and south, if initiated at the same time, were both large enough to merge at the head of Cascadia Channel and to continue together for hundreds of kilometers downstream. This so-called confluence test is often cited as evidence that 13 fault ruptures of the past 7,500-7,800 years extended along the full length of the Washington coast. But the test is confounded by uncertainties in proximal turbidite counts, flow paths, and relative sizes of flows. (2) Ability of individual sandy layers within a turbidite to mimic the series of strong-motion pulses during an earthquake. According to the reconstruction: (a) A series of ground-motion pulses during an earthquake produces a series of sediment pulses in a turbidity current. (b) The sediment pulses yield a sequence of sandy layers. (c) The sandy sequence correlates among core sites hundreds of kilometers apart along the length of the subduction zone. (d) This stratigraphic similarity, evidenced mainly by logs of density and magnetic susceptibility, enables a full-length rupture of magnitude 9 to be distinguished geologically from a series of shorter ruptures. Open questions include: Do the density and magnetic signatures of a sandy sequence have enough complexity in shape and reproducibility among adjacent cores to justify long-distance correlation of individual sandy layers? Do the initial mass movements respond less to individual pulses than to cumulative shaking, and do they commonly begin or continue after the mainshock has finished? Are the pulses of shaking likely to vary along strike, as in strong-motion records from the 2010 Maule and 2011 Tohoku earthquakes? An unknown fraction of the so-called full-length ruptures represents series of shorter ruptures, and solitary short ruptures may sometimes break the plate boundary offshore southern British Columbia and northern Washington.