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Paleoseismograms: Can Turbidite Deposits Record Flow Unsteadiness Imparted by Earthquakes?

Details

Meeting	2012 Fall Meeting
Section	Tectonophysics
Session	The Cascadia Margin From Inside and Out I
Identifier	T22D-06
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Abstract

In paleoseismic investigations in Cascadia, Sumatra, Chile, and the Northern San Andreas Fault, we have found that it is possible to correlate individual turbidites between isolated sites using high resolution physical property data such as CT and Gamma density, P-wave velocity and magnetic susceptibility. The magnetic and density “fingerprints” of each turbidite are a reflection of grain size distributions in many lithologies. In our studies, we commonly observe “stacked” repetitions of coarse Bouma lower divisions, followed by the fining upward tail. However the long distance correlations between isolated sites and the level of detail possible are not well explained. It is difficult to explain the observation that individual events can be correlated in detail between separate channels, slope basins and onshore lakes that are not connected. To investigate this phenomenon, we have investigated several historic earthquake deposits, and have also generated turbidity currents in flume tanks to test the dynamics of transport and deposition of unsteady turbidity currents. Flume experiments commonly attempt to eliminate source heterogeneity, and assume that hydrodynamics, sediment character, and topography are the primary controls on deposition downstream. Longitudinal flow variability is rarely considered, but is predicted to have an important role in deposition (Kneller and McCaffrey, 2003), and is sometimes invoked for waxing and waning flood deposits. We question the starting assumption of no input variability, and input variable longitudinal flow regimes to simulate several common input scenarios including storm (hyperpycnal), dam breach, and long earthquake inputs. We use calibrated sediment, color coded by grain size and used photographic techniques to extract detailed grain size plots of each turbidite deposition compare to the input flow hydrograph. When compared to the input sources of the turbidity currents, we found that there is an excellent correlation between the input perturbations and the recovered grain size profiles of the deposits, reflecting considerable detail of the input source. We successfully simulated input perturbations and corresponding recovery in the deposits of single and multiple input energy peaks of varying lengths and flow hydrographs, as well as simulated hyperpycnal flows, with consistent results across a wide range of timing and and parameter scaling. Field evidence from historic earthquakes in Cascadia, Chile, the NSAF and Sumatra suggest that long earthquake shaking variability may in some cases, similarly act on unstable slopes in major fault systems, imparting a longitudinal structure to turbidity currents that can be observed in the deposit. We suspect that the shaking threshold required to overcome other influences is likely quite high, and the duration of the earthquake quite long to successfully influence the turbidity current. We also infer that if this hypothesis is correct, that ground accelerations, as opposed to liquefaction, may dominate near term co-seismic slope failures.

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