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Seismo-turbidite Sedimentology: Implications for Active Tectonic Margin Stratigraphy and Sediment Facies Patterns

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Abstract:

Earthquakes generate mass transport deposits (MTDs); megaturbidites (MTD overlain by coeval turbidite); multi-pulsed, stacked, and mud homogenite seismo-turbidites; tsunamites; and seiche deposits. The strongest (Mw 9) earthquake shaking signatures appear to create multi-pulsed individual turbidites, where the number and character of multiple coarse-grained pulses for correlative turbidites generally remain constant both upstream and downstream in different channel systems. Multiple turbidite pulses, that correlate with multiple ruptures shown in seismograms of historic earthquakes (e.g. Chile 1960, Sumatra 2004 and Japan 2011), support this hypothesis. The weaker (Mw = or < 8) (e.g. northern California San Andreas) earthquakes generate dominantly upstream simple fining-up (uni-pulsed) turbidites in single tributary canyons and channels; however, downstream stacked turbidites result from synchronously triggered multiple turbidity currents that deposit in channels below confluences of the tributaries. Proven tsunamites, which result from tsunami waves sweeping onshore and shallow water debris into deeper water, are a fine-grained turbidite cap over other seismo-turbidites. In contrast, MTDs and seismo-turbidites result from slope failures. Multiple great earthquakes cause seismic strengthening of slope sediment, which results in minor MTDs in basin floor turbidite system deposits (e.g. maximum run-out distances of MTDs across basin floors along active margins are up to an order of magnitude less than on passive margins). In contrast, the MTDs and turbidites are equally intermixed in turbidite systems of passive margins (e.g. Gulf of Mexico). In confined basin settings, earthquake triggering results in a common facies pattern of coeval megaturbidites in proximal settings, thick stacked turbidites downstream, and ponded muddy homogenite turbidites in basin or sub-basin centers, sometimes with a cap of seiche deposits showing bi-directional flow patterns.