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Synrift Delta Architecture Reveals Evidence for Episodic Fault-Slip Behaviour on a Basin-Bounding Normal Fault System

We investigate the controls on coarse-grained delta progradation cycles in the Pliocene Loreto half-graben, Gulf of California. Dorsey et al (1997) argued that these cycles, with frequencies of 6250±5000y, were driven by episodic fault-controlled subsidence along the basin-bounding Loreto fault. Here we test this hypothesis by demonstrating that systematic variations in delta architecture record cyclic variations in displacement rate on the Loreto fault.

We analysed 10 delta progradational cycles, 7 of which exhibit a transition from mouth-bar to Gilbert deltas as they are traced palaeo-seaward. This transition is characterised by gradual down-transport development of foresets, which grow in height up to 35m. Foreset units thicken in a basinward direction, with initially oblique topset-foreset geometries becoming increasingly sigmoidal. Each delta is capped by a shell bed that records drowning of the delta top. This systematic transition in delta architecture records increasing water depth through time during individual cycles of progradation.

A mechanism that explains this transition is an accelerating rate of fault-controlled subsidence during each progradational cycle. During an episode of low slip rate, a shallow-water mouth-bar delta progrades across the submerged topography of the underlying cycle. As displacement rate accelerates, increasing bathymetry at the delta front leads to steepening of foresets and initiation of Gilbert deltas. Subsequent delta drowning results from sediment starvation at the shoreline at very high slip rates due to sediment trapping upstream. The observed delta architecture suggests that the long-term (>100ky) history of slip on the Loreto fault was characterised by repetitive episodes of accelerating displacement accumulation.