Impacts of tectonic subsidence and variable basin depth on delta lobe building as informed by the Selenga River delta, Lake Baikal, Russia

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Abstract

River delta avulsions are a primary mechanism to distribute sediment and build coastal land. Experiments show that an avulsion can generate a new delta lobe, and subsequent avulsions yield multiple lobes that amalgamate to produce a semi-circular fan deposit. For channels that are actively building lobes, a condition of sediment transport equilibrium develops, termed alluvial grade, which is characterized by material bypassing the delta topset and dispersing to the delta foreset. Previous studies have examined alluvial grade under conditions of steady subsidence and uniform basin depth. However, on tectonically active margins, deltas are affected by punctuated subsidence and lobes prograde into basins with variable depth. Both conditions disrupt alluvial grade, which in turn affects avulsion timescales and thus delta morphology. We explore these interrelated processes using measurements of delta and basin morphology based on field surveys and remote sensing collected from the Selenga Delta, which is located along the Baikal Rift Zone. Major earthquakes, affiliated with normal faulting and possessing recurrence intervals of several millennia, lower large portions of the subaerial delta several meters below mean lake level. This results in an increased regional gradient that triggers lobe-scale avulsions. Moreover, the timescale for these events is shorter than that predicted via autogenic lobe switching. Additionally, during periods tectonic quiescence, smaller channel-scale avulsions occur every 10–90 yrs, which produces sedimentation that compensationally fills embayments located between distributary channels. This process gives rise to the delta's fan-shape morphology. Stratigraphically, tectonically driven subsidence events are expected to preserve discrete sedimentary units that represent deposition and reworking associated with short-term channel avulsions. Understanding the interplay between discrete, tectonically driven subsidence events and autogenic sediment accumulation patterns of a delta prograding into a tectonically active basin will improve interpretations of stratigraphy of ancient systems.

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Abstract Text:

River delta avulsions are a primary mechanism to distribute sediment and build coastal land. Experiments show that an avulsion can generate a new delta lobe, and subsequent avulsions yield multiple lobes that amalgamate to produce a semi-circular fan deposit. For channels that are actively building lobes, a condition of sediment transport equilibrium develops, termed alluvial grade, which is characterized by material bypassing the delta topset and dispersing to the delta foreset. Previous studies have examined alluvial grade under conditions of steady subsidence and uniform basin depth. However, on tectonically active margins, deltas are affected by punctuated subsidence and lobes prograde into basins with variable depth. Both conditions disrupt alluvial grade, which in turn affects avulsion timescales and thus delta morphology. We explore these interrelated processes using measurements of delta and basin morphology based on field surveys and remote sensing collected from the Selenga Delta, which is located along the Baikal Rift Zone. Major earthquakes, affiliated with normal faulting and possessing recurrence intervals of several millennia, lower large portions of the subaerial delta several meters below mean lake level. This results in an increased regional gradient that triggers lobe-scale avulsions. Moreover, the timescale for these events is shorter than that predicted via autogenic lobe switching. Additionally, during periods tectonic quiescence, smaller channel-scale avulsions occur every 10–90 yrs, which produces sedimentation that compensationally fills embayments located between distributary channels. This process gives rise to the delta's fan-shape morphology. Stratigraphically, tectonically driven subsidence events are expected to preserve discrete sedimentary units that represent deposition and reworking associated with short-term channel avulsions. Understanding the interplay between discrete, tectonically driven subsidence events and autogenic sediment accumulation patterns of a delta prograding into a tectonically active basin will improve interpretations of stratigraphy of ancient systems.

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