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Deciphering the record of short-term base-level changes in Gilbert-type deltas

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The geometrical relationship of fluvial topset to subaqueous foreset in a Gilbert-type delta may be 'sigmoidal' (transitional) or 'oblique' (erosional), which is generally attributed – respectively – to a rise or fall of the delta shoreline's time-distance trajectory and considered to reflect base-level changes. However, since every episode of a base-level fall forces the fluvial distributary system to cut down, the delta-brink sigmoidal signature of a preceding base-level rise tends to be removed. The geometrical record of short-term base-level changes in a Gilbert-type delta thus tends to be obliterated by fluvial erosion. The issue addressed in this presentation is whether the fully-preserved foreset to bottomset deposits may serve as a key for deciphering the base-level history of an ancient Gilbert-type delta.

Outcrop studies of Plio–Pleistocene Gilbert-type deltas at the southern margin of the Corinth Rift, Greece, reveal a genetic relationship between the delta-brink morphodynamics controlled by base level behaviour and the processes of subaqueous sediment dispersal on the delta slope and in its foot zone. The component facies are deposits of turbidity currents (whether slope-derived brief surges or longer-duration hyperpycnal flows), cohesionless debrisflows and loose-gravel debrisfalls. The development of sigmoidal delta-brink architecture appears to be accompanied by deposition of a debrite-dominated facies assemblage (DFA) of delta foreset beds, thought to form when the aggrading delta front tends to store sediment and undergoes discrete gravitational collapses. Development of oblique delta-brink architecture is accompanied by deposition of a turbidite-dominated facies assemblage (TFA) of foreset beds, which is thought to form when the delta-front accommodation decreases and the sediment carried by hyperpycnal effluent largely bypasses the front. The alternation of TFA and DFA facies assemblages in delta foreset is thus attributed to changes in delta-front accommodation driven by short-term base-level changes, with some accompanying inevitable 'noise' in the facies record due to the system autogenic variability and regional climatic fluctuations.

Comparison of delta coeval foreset and toeset/bottomset deposits in a delta shows further a reverse pattern of reciprocal changes in facies assemblages, with the TFA assemblage of foreset deposits passing downdip into a DFA assemblage of delta-foot deposits, and the DFA assemblage of foreset deposits passing downdip into a TFA assemblage. This reverse reciprocal alternation of TFA and DFA facies assemblages is attributed to the delta-slope own morphodynamics. When the delta slope is dominated by deposition of debrisflows, only the most diluted turbulent flows and chute bypassing turbidity currents are reaching the delta-foot zone. When the delta slope is dominated by turbiditic sedimentation, larger chutes and gullies form – triggering and conveying debrisflows to the foot zone.

These case studies as a whole shed a new light on the varying pattern of subaqueous sediment dispersal processes in an evolving Gilbert-type deltaic system and point to an the attractive possibility of the recognition of a 'hidden' record of base-level changes on the basis of detailed facies analysis.