TIDAL INLET VARIABILITY IN THE MISSISSIPPI RIVER DELTA PLAIN

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ABSTRACT

Stratigraphic sequences of deltaic and shallow marine origin commonly contain sand bodies transgressively overlying lower delta plain and delta front deposits. Although generally ascribed to barriers formed during the destructive phase of the delta cycle, most of this sand is probably of tidal inlet origin because of the high preservation potential for sediment deposited below the base of the retreating shoreface in deep migratory tidal channels and their associated tidal deltas. To facilitate the identification of such units, this paper reviews the temporal evolution of the inlet sand bodies found along the rapidly transgressive shoreline of the abandoned Holocene Mississippi River deltas. This study also reveals that tide dominance or wave dominance of a coastline is not simply a function of tidal range and wave height; it depends largely on the tidal prism, an inlet parameter which in Louisiana changes rapidly over time.

Three distinct stages can be identified in the evolutionary sequence of Louisiana tidal inlets: (1) wave-dominated inlets with flood-tidal deltas, (2) tide-dominated inlets with large ebb deltas, and (3) wide, "transitional" inlets with sand bodies confined to the throat section.

Stage 1. Tidal inlets ranging in age from 50 to a few hundred years are associated with flanking barrier systems attached to erosional deltaic headlands. The barriers enclose restricted interdistributary bays. Small inlets occur at the entrance to abandoned distributary channels within the headland section proper. The tidal prism being exchanged through either of these inlet types is small; the morphology of the inlets and adjacent coastline is wave-dominated, and most of the inlet sand is associated with a flood-tidal delta. The inlets are generally shallow.

Stage 2. The Holocene Mississippi River deltas are subject to rapid subsidence and consequent local sea-level rise. One gauge at Grand Isle indicates a sea-level rise of 30 cm (12 in.) over the past 20 years; however, the long term average is somewhat less. Subsidence leads to an expression of backbarrier open water environments, an increase in tidal prism, and an evolution of the inlet into a tide-dominated morphology with a deep main channel and large ebb-tidal delta. The recent evolution of Pass Abel and Quatre Bayou Pass represents the transition from wave dominance to tide dominance. Sand bodies developed in stage 2 inlets have the greatest preservation potential because they generally lie below the base of the retreating shoreface.

Stage 3. Further subsidence generally leads to the development of an open sound permitting efficient tidal exchange with the gulf along the sound margin (Chandeleur Sound). As a consequence, the inlets play only a minor role in the tidal exchange pattern. At this stage, the inlet sand bodies evolve along two distinctly different paths, apparently controlled by sediment supply. Barriers with adequate coarse sediment produce many small well-defined inlets with large flood-tidal deltas (washover fans) and transient post-storm ebb deltas. The island shore is distinctly wave dominated. Along coastal segments where coarse sediment is scarce, one finds rapid island deterioration, shoaling of the inlet channel, and reworking of the ebb-tidal deltas into a "transitional" configuration with the sand tied up in throat section shoals.

As the inlets migrate during the transgression, they leave behind on the continental shelf tidal sand bodies with a landward succession of facies changing from those characteristic of wave dominance, into tide dominance, and back again to "transitional" or wave-dominated inlets.

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