Deltaic Ichnology: Infaunal Responses to the Dynamic Interplay of River- Discharge and Sediment Flux, Wave Energy, Storm Events, and Tidal Flux

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ABSTRACT

Analyses of deltaic successions highlight recurring ichnological patterns that reflect diverse physico-chemical stresses imposed upon infaunal organisms through the interaction of various delta front processes. Ancient deltaic successions in Canada, the United States, Australia, and Norway persistently show bioturbation intensity reductions and ichnological diversity impoverishment, compared to those of non-deltaic shorelines. Facies locally demonstrate sporadic colonization of substrates left denuded by changing environmental conditions. Ichnological suites locally display size reductions of ichnogenera and a paucity of suspension-feeding ethologies.

Such ichnological characteristics largely reflect heightened fluvial discharge, which serve to impede infaunal colonization development of stable populations. River-derived stresses are profound and diverse: increased sedimentation rates, hypopycnal-induced water turbidity, distributary flood discharges with accompanying phytodetrital pulses, freshet-produced salinity changes near the bed, hyperpycnal-induced sediment gravity flows, and fluid mud deposition all conspire to accentuate the overall depauperate nature of the ichnological assemblage.

Wave energy generally buffers these effects by dispersing suspended sediment offshore, and encouraging the thorough mixing of waters of contrasting salinity. High mud concentrations near the delta front dampen wave energy, however, limiting its effectiveness in remediating the benthic ecosystem. In wave-dominated settings, strong longshore drift also operates to extend river-derived stresses considerable distances down-drift of the distributary mouths. Where asymmetric deltas are formed, markedly different ichnological expressions are generated on either side of distributary channel mouths; updrift retaining largely shoreface-like assemblages, and down-drift acquiring markely stressed suites. Storm energy may be effective in dispersing mud and mixing waters, but also results in erosion and episodic deposition of sediment on the bed. Concomitant

precipitation induces river floods, returning fluvial-derived stresses to the delta front.

Tidal energy and its effects on infaunal suites of deltas are poorly understood. Tidal flux may trap mud plumes against the delta front elevating water turbidity. Pronounced clay flocculation associated with tidal mixing also leads to rapid deposition of thick fluid mud layers in low-lying areas, hampering or precluding colonization. Tidal energy also leads to marked changes in energy and salinity at the bed on a number of time scales.

Deltaic trace fossil suites are characterized by opportunistic structures of trophic generalists, though overwhelmingly dominated by facies-crossing deposit feeders. High water turbidity, particularly near the bed precludes most suspension-feeding behaviour, and suppresses the development of the *Skolithos* ichnofacies, even in sand-prone delta front deposits. Increased physico-chemical stress leads to greater degrees of assemblage impoverishment. Resulting ichnological characteristics record the relative significance and dynamic interplay of these different processes, both temporally and spatially on delta systems.