

Hyperpycnal Versus Hypopycnal River Plumes and the Origin of Shelf Mud

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Many sedimentological textbooks assume that most marine “shelf” mud is deposited by fallout from suspension in quiet water. Work on modern active muddy shelves, such as Papua New Guinea and the Amazon Shelf, show that sediment is mostly supplied from rivers plumes that may be hyperpycnal or hypopycnal. These concepts have not been widely applied to the interpretation of ancient sedimentary systems, such as the Cretaceous Western Interior Seaway of North America.

Comparison of the paleohydraulics of Cretaceous trunk river systems suggest that these systems frequently went hyperpycnal. Associated flood deposits show extremely high sedimentation rates of up to 1 m per year. High sedimentation rates are indicated by an abundance of normally graded siltstone beds, climbing ripples, and soft-sediment deformation. Associated high stresses result in a lack of infaunal burrowing, a lack of suspension feeders, and an abundance of fugichnia. Associated sandstones show well-developed Bouma sequences, suggesting hyperpycnal sandy-river-flood deposits, or over-thick HCS beds, caused by storm-wave reworking of flood deposits.

Mudstones associated with hypopycnal conditions show far higher abundance and diversity of ichnofauna. Where the shelf experiences neither hypopycnal nor hyperpycnal processes, carbonate productivity tends to increase, resulting in increased carbonate content forming units like the Austin Chalk. In contrast, shale-dominated “shelf” mudstones have a strong pro-deltaic overprint.