Re-evaluating Depositional Models for Shelf Shales

Janok Bhattacharya [1] and James A. MacEachern [2]
[1]Earth and Atmospheric Sciences, University of Houston, Houston, TX.
[2]Department of Earth Sciences, Simon Fraser University, Burnaby, BC, Canada.

Despite the assumption that the bulk of marine "shelf" mud is deposited by gradual fallout from suspension in quiet water, modern muddy shelves and their associated rivers show that they are dominated by hyperpycnal fluid mud. This has not been widely applied to the interpretation of ancient sedimentary shale successions. We analyze several ancient Cretaceous prodelta shelf systems and their associated river deposits. Paleodischarge estimates of trunk rivers show that they fall within the predicted limits of rivers that are capable of generating hyperpycnal plumes. The associated prodeltaic mudstones match modern hyperpycnite facies models, and suggest a correspondingly hyperpycnal character. Physical sedimentary structures include diffusely stratified beds that show both normal and inverse grading, indicating sustained flows that waxed and waned. They also display low intensities of bioturbation, which reflect the high physical and chemical stresses of hyperpycnal environments. Hyperpycnal conditions are ameliorated by the fact that these rivers were relatively small, dirty systems that drained an active orogenic belt during humid temperate to subtropical greenhouse" conditions. During sustained periods of flooding, such as during monsoons, the initial river flood may lower salinities within the inshore area, effectively "prepping" the area and allowing subsequent floods to become hyperpycnal much more easily. Although shelf slopes were too low to allow long-run-out hyperpycnal flows, the storm-dominated nature of the seaway likely allowed fluid mud to be transported for significant distances across and along the paleo-shelf. Prodelta hyperpycnites form leaner, gas-prone source rocks, prone to the generation of overpressure, versus more slowly deposited, organic-rich, anoxic laminites and condensed-section shales.