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Depositional Dynamics of a Highstand Prodeltaic System in the Pennsylvanian Minturn Formation of the Central Colorado Basin: Deposits of Wave-Influenced Turbidity Currents

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A detailed study of prodeltaic facies in the Pennsylvanian Minturn Formation in north-central Colorado provides insight into the general nature of fan-delta deposition, as well as reconstruction of paleogeographic and paleoclimatic conditions within a tectonically active cratonic basin. The Minturn is a thick succession with a complex stratigraphic architecture of alluvial, fluvial, and deltaic lithofacies that were deposited in the Central Colorado Basin of the Ancestral Rockies. An ~20- to 35-m-thick, regionally extensive, unconformity-bounded prodelta unit was deposited during a significant eustatic rise that temporarily interrupted coarse-grained fluvial–deltaic deposition. The unit consists of dark-green shale and sandstone event beds with tool marks that were produced by abundant plant debris. The sandstone event beds are graded, and contain stratification consistent with deposition from turbidity currents. However, in the proximal prodeltaic deposits there is evidence for combined unidirectional and oscillatory flow (i.e., asymmetric hummocky cross stratification (HCS), quasi-planar lamination, and combined-flow ripple stratification). In this case, the combined flows consisted of turbidity currents and storm-generated surface gravity waves in relatively shallow water. Some event beds, mostly in distal localities, contain reverse-to-normal grading and sequences of sedimentary structures that indicate deposition from waxing to waning flows. We interpret the majority of these event beds as a record of deposition from hyperpycnal flows, i.e., turbidity currents generated directly from highly concentrated river plumes, which accelerated and decelerated in response to a rising and falling flood discharge. A hyperpycnal interpretation is supported by the presence of abundant plant fossils in the turbidite beds that are typical of middle to high elevation habitats, which are absent in underlying and overlying shoreline and marginal marine deposits that have a separate floral assemblage.

Paleohydraulic calculations indicate that deposition of the HCS beds requires a fetch of at least 75 km to generate the necessary wave periods. Given the position of the CCB in the lee of the ancestral Front Range relative to the prevailing trade winds, and the narrow seaway to the south, storms either tracked across the Cordilleran seaway from the west or formed in situ within the CCB. The former hypothesis is consistent with paleoclimate models that propose the development of summer monsoonal circulation patterns over western equatorial Pangea during the late Paleozoic, and regional observations of eastward eolian bedform migration directions.

Back to the [RMS-SEPM Luncheon Abstract Archive](#)