TI: Paleohydraulic Interpretations of Wave-Modified Hyperpycnal Flow Deposits

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AB: A variety of paleohydraulic calculations are presented in order to reconstruct the depositional dynamics of sandstone beds formed by hyperpycnal flows that were superimposed by oscillatory currents. These event beds are part of a ~20 to 35-m-thick, unconformity-bound unit of prodeltaic sandstone and shale from the Pennsylvanian Minturn Formation of central Colorado. The hyperpycnites are turbiditic in character and display a wide range of sedimentary sole marks and internal stratification sequences. The beds contain abundant remains of the plant fossil Walchia, which is absent in marginal marine and shoreline deposits, but is known to have grown in upland areas. These fossils were thus carried by floods and then bypassed the shoreline as hyperpycnal flows to the prodelta region. Deeply gouged sole marks made by plant material attest to deposition from sediment-charged hyperpycnal flows. Distal beds contain evidence for both waxing and waning flow in the form of reverse-to-normal grading and beds with rippled bases and tops and parallel laminated centers. These are interpreted as a record of the hydrographic response to flood events, namely increasing and decreasing discharge. Proximal deposits contain internal sedimentary structures that reflect deposition under the influence of both excess weight forces and oscillatory flow. These include small- and large-scale hummocky cross-stratification (HCS), gutter casts, and combined-flow ripples. Based on the median grain size of associated fluvial dune deposits, and the shields number for the stability of dunes, we calculate the minimum diameter that could have been suspended in the fluvial channels as approximately 0.2 mm. The grain size of the turbidite beds ranges from silt to very fine sand (0.004 mm – 0.25 mm), and thus the fluvial channels would have been competent to suspend the sediment composing the turbidite beds, which is consistent with the hyperpycnal flow interpretation. Paleohydraulic calculations of the concentration of suspended sediment in the turbidity currents indicate that the turbidity would have exceeded the threshold necessary for a freshwater plume to plunge through seawater. Estimates of deposition rate and ripple migration rate were used to calculate a range of possible flow durations, and these indicate a timescale consistent with a river floods. Structural, sedimentological, and stratigraphic data indicate a paleogeography with high topographic relief adjacent to a marine basin. Our calculations indicate that the HCS formed under large waves that required a fetch of at least 75 km. Cyclonic storms would have been unlikely to create these waves because at the equatorial latitudes of the Central Colorado Basin (CCB), the Coriolis force would have been minimal. The storms were most likely convective and generated within the CCB. They likely stalled against the high elevations of the Ancestral Rocky Mountains and created floods that evolved into hyperpycnal flow that were affected by strong storm-generated waves