Massive and Planar Laminated Sandstone, High- and Low-Density Turbidity Currents: New Insights Into Deep Marine Processes And Deposits

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ABSTRACT

Like in the 1970s, investigation of deep-marine sedimentary environments has returned to the forefront of geological investigation. With this resurgence has been the resurrection of a number of nagging and still unresolved questions, including the origin of massive sandstone and its relationship, if any, with upper regime plane bed. In order to interpret massive beds, but also a variety of other structureless (i.e. lack of traction structures), but graded beds, researchers have recently turned to the poorly understood influence of sediment concentration on the transport and deposition from sediment-gravity flows. With this new "enlightenment" has come the birth of the terms high- and low-density turbidity currents. In large part these terms, and accordingly their distinction, is based on the earlier work of Bagnold, who suggested that as sediment concentration exceeded ~10% fluid turbulence would be negatively affected (i.e. damped). Based on that idea, much of the recent geological literature interprets beds containing stratification (i.e. traction transport deposition) to be indicative of deposition from "low-density" turbidity currents, and by default those beds lacking such structures to have been deposited directly from suspension, or more commonly from "high-density" turbidity currents.

Recent experiments and observations of strata in the deep-marine part of the Neoproterozoic Windermere Supergroup by this author, suggest that stratified, specifically planar-laminated, sand can be deposited by "quasi steady" flows far in excess of 10% sediment concentration by volume. In the experiments stratification was eliminated only when a hydraulic jump was formed, and as a consequence the bed extensively reworked and then explaced from a rapidly collapsing, shearing, dewatering quick bed. As a consequence, the utility of the terms high- and low-density turbidity currents, as presently defined, is questionable, and the importance of hydraulic jumps in the stratigraphic record has been largely overlooked.

The experimental data and ancient outcrop examples suggest that local(?) stratal characteristics of off-channel interbedded sandstone and mudstone successions are significantly affected by these depositional processes. Although seemingly "academic", off-channel/channel-margin strata are an important play type and prolific hydrocarbon producer in a number of sedimentary basins around the world, and as such, a better understanding of their depositional mechanisms, and accordingly reservoir quality distribution, is essential.