How to get into deep water: sand transport seaward of early Cretaceous deltas in the Scotian Basin

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In early Cretaceous time, high-energy braided rivers deposited complex deltas on the Scotian shelf. The manner in which sand was transferred from these deltaic systems to deep water is important for identifying exploration targets on the deep-water continental margin. We have logged conventional core from the Tantallon M-41, Thebaud I-93, Thebaud 3, Thebaud 5, and North Triumph G-43 wells, emphasizing sedimentological features that indicate either hyperpycnal river-mouth flow or prodeltaic slumping of sandy facies. The relative importance of slump-derived and hyperpycnal turbidity currents is critical for predicting sand distribution in deep water. Slump-derived turbidity currents generally evolve into highly turbulent flows that deposit only on low gradients of $<0.2°$ on the basin floor. More concentrated hyperpycnal flows may deposit on higher gradients of 0.4°, and will thus give thick sand deposits more proximally.

In the wells studied, hyperpycnal flow facies in conventional cores with deltaic and shelf facies are found stratigraphically below major channel sandstones. They show abrupt alternations of granule conglomerate, fine sandstone, and mudstone. In prodeltaic (shoreface) environments, sharp-based laminated to cross-laminated fine sandstone beds with abundant wood fragments or mudstone chips are also interpreted as the products of hyperpycnal flows. They can be distinguished from storm-resuspended sandstone beds by their better sorting and lack of reworked shelly fossils.

In conventional cores from prodeltaic settings, large slide blocks, tens of metres thick involve a wide range of primary sedimentological facies. These facies are recognized as allochthonous by the presence of a basal foliated mudstone and variably deformed contacts between sediment blocks, some of which include spaced shear zones. Preserved facies are predominantly shale-prone: we speculate that failure of sand-prone successions could have generated sandy turbidity currents. Prodeltaic slopes in many cases developed at growth faults on the shelf, so that failure would not have transferred sediment to the continental slope.

In the Tantallon M-41 well on the present continental slope, conventional core from the Middle Missisauga Formation shows overbank turbidites with characteristic sparse bioturbation, Bouma Tb-c sequences, and fading ripples. In some sandstones, abundant woody fragments, sorted mudstone chips, and transported siderite nodules suggest a source from river discharge. Reverse grading at the base of some sandstone beds suggests hyperpycnal flow.

Present data is insufficient to fully evaluate the relative importance of slump-derived turbidity currents and hyperpycnal turbidity currents in sand transport to deep water in the early Cretaceous. There is evidence that both types of current were present. The widespread evidence of hyperpycnal flow deposits interbedded with shelf sediments strongly suggests that some hyperpycnal flows reached deep water and like modern hyperpycnal flows could have deposited sand in relatively proximal settings.