Deep-Water Siliciclastic-Carbonate Sedimentation in the Windermere Turbidite System, Canada: Influence of Sea-Level, Sediment Supply and Composition

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At the Castle Creek study area deep-marine strata of the Windermere turbidite system consist of a few km-thick succession of basin-floor overlain by passive-continental-margin slope deposits. Strata are siliciclastic, although a thick, regionally-extensive deep-water carbonate unit, informally termed the First Isaac Carbonate (FIC), is an exception. Stratigraphic, architectural and petrographic analyses of a continuous, approximately 700 m-thick section, provide insight into the large-scale evolution of this deep-water system, which allow to constrain similar depositional system models. Major vertical changes in the succession appear to have been driven mostly by long-term (possibly third-order) fluctuations of relative sea level (RSL), which accordingly affected sediment supply and sediment composition.

The gradual upward change from deep-water siliciclastic to carbonate strata of the FIC coincides with a change from sand-dominated lobe to mudstone-dominated slope deposits, feldspathic- and subfeldspathic-rich sandstone to hybrid sandstone and conglomerate with abundant carbonate clasts interbedded with quartzose sandstone, and an increase in the thickness of fine-grained turbidites and mass-transport deposits. These changes were most likely related to a major fall followed by rise of RSL that substantially reduced the flux of feldspar-rich sediment into the basin, but increased the flux and frequency of mud- and carbonate-rich gravity flows. During and after the RSL rise, carbonate was produced on an areally expanded shelf and delivered to the basin by fine-grained turbidity currents. Upward these strata become increasingly more interbedded with repetitive, meter-scale sequences of mixed siliciclastic-carbonate turbidites, that show an organized tripartite pattern consisting of an erosive based, planar and single-set dune- cross-stratified quartz arenite overlain by fine-grained upper-division siliciclastic turbidites, overlain by fine-grained calciturbidites. These sequences represent shallow, broad scour fills wherein sediment caliber, sedimentary structures and mineralogy is controlled by the axis to margin position within the scours.

The resumption of feldspar-rich siliciclastic deposition is indicated by a 110 m-thick, channel-levee system that incised into the underlying carbonate strata. The basal bounding surface represents a major lowstand of RSL when large volumes of immature clastic sediment were supplied from the updip hinterland.