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Mud transport processes across a Cretaceous ramp in a rapidly-subsiding foredeep: Albian-Cenomanian of NE British Columbia

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Introduction

Albian-Cenomanian strata of the upper part of the Fort St John Group (Hasler, Goodrich and Cruiser formations), were deposited on a low-gradient, storm-dominated muddy ramp. Exposures are located on both the proximal (west) and distal (east) portions of this ramp. Nearshore sandstone with abundant hummocky and swaley cross-stratification grades seaward over 30-40 km in siltstone and silty claystone that in the field present both ‘rubbly’ and ‘laminated’ fabrics, suggestive of greater and lesser degrees of bioturbation. The key question is: by what process or processes was this muddy sediment transported several hundred km seaward?

Method and result

The un-cemented and weakly-compacted mudstone in the study interval requires a special sampling and preparation technique in order to extract sedimentary and paleoflow data. Oriented samples from each of the main mudstone facies were taken in steel boxes, which, after slow drying, were impregnated with liquid resin and then dry-sawn in three planes to yield thin slabs that were mounted on over-size glass slides and ground to ~25 µ. Prepared in this manner, it is evident that the mudstone preserves a wealth of facies detail. Microscopic examination shows that individual depositional events (beds) are of sub-millimetre to millimetre scale, and are defined by scoured surfaces overlain by a lag of silt grains that may be molded into very low-amplitude symmetrical or combined-flow ripples. Alternatively, a basal silt layer grades up into clay-rich sediment. Thin section and SEM examination shows that, in many instances, individual clay flakes are packaged into aggregate grains 5-20 µ in diameter (i.e. fine to medium silt-size). Within individual beds, 4 main microfacies can be distinguished: 1) siliceous silt, 2) siliceous silt interlaminated with clay aggregates on a 5-20 µ scale; 3) silt-streaked mud and 4) clay-rich mud. Microfacies in organic rich facies are organized in normally-graded beds (1-2 mm thick) consists of siliceous silt interlaminated with clay aggregates followed by clay-rich mud, that suggest deposition from decelerating combined flows. Whereas more silt-rich facies are organized in sharp-based normally-graded beds (3-6 mm thick) consist of silt to silt-streaked mud followed by clay-rich mud. This resembles deposits from decelerating wave-supported density flows (e.g. Macquaker 2010). Must deposition appears to have taken place from decelerating storm-driven geostrophic flows. Available evidence from the orientation of silt micro-ripples suggests transport towards SW-SE direction (i.e. sub-parallel relative to the contemporaneous shoreline).

Conclusions

Thin-section observation of oriented samples of offshore mudstone reveals a wealth of micro-scale sedimentary structures that provide evidence of vigorous, storm-related scouring and resuspension of sediment on the sea floor, at distances of at least 50-90 km from shore. Sharp-based graded beds of silt and clay, wave-formed ripples, micro-gutter casts all indicate advective transport of muddy sediment by combined flows in water that was probably significantly less than 100 m deep. Clay particles were packaged into silt-sized aggregate grains that probably reflect repeated cycles of burial, chemical and biological aggregation, and re-erosion by storms. Available evidence from silt micro-ripples suggests transport sub-parallel relative to the contemporaneous shoreline.

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