Bed Self-Similarity in Deep Marine Levees: Evidence of Rhythmic Pulsing in Turbidity Currents?

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Abstract

Deep-marine levees are areally extensive features that commonly extend up to a few tens of kilometers beyond the margins of the coeval channel and characteristically experience high rates of sedimentation. In addition, levees have near-continuous depositional records and high preservation potential of individual events, unlike channels, whose complex depositional histories are often dominated by periods of erosion and bypass. Despite their size and volumetric prominence in the deep-marine sedimentary record, levees have received much less research attention compared to the adjacent channels - an artifact of generally poor exposure in the ancient rock record and widely-spaced control points in the modern. At the Castle Creek study area in B.C., Canada, levee deposits of the Neoproterozoic Windermere Supergroup are glacially polished and completely exposed. This allows for detailed examination and description of lateral and vertical lithological variation and stratal geometries, which is critical to understanding and modelling depositional processes and reservoir geometry and continuity. Strata are dominated by Tcde turbidites that can be subdivided into three types based on the make-up of the Tc division: multi-set, single-set, or starved ripples. These then form sharply bounded bedsets that range from 10-250 cm and comprise 5-30 beds, all of which are of a single ripple type with similar thickness, grain size, and sand-to-mud ratio. The self-similarity of beds within each bedset suggests systematic and recurring pulses or surges with similar flow conditions that overspilled the channel margin and spread over the levee. Moreover, it suggests that more than one bed may be deposited from a single channelized flow event, and that a single bedset may represent deposition during a single channelized flow event. Also, pulses were not only of relatively high

energy but also of sufficiently low frequency to allow for the accumulation of a Tde layer at the top of each bed and at least partial consolidation of the underlying bed. The self-similarity and systematic organization observed in levee deposits of the Windermere Supergroup must be related to an internal mechanism inherent to turbidity currents that results in episodic fluctuations in flow conditions, although details of the physical mechanism remain unknown. This study seeks to better understand this internal mechanism and its role in depositional trends across a wider range of deep marine environments.

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