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Stacking patterns and depositional processes of turbidites in a shallow-water basin, Upper Middle Montney Formation, Alberta

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Summary

The sedimentological processes of deep-water (i.e. turbidite) and shallow-water depositional systems are often considered in isolation by discrete communities of researchers. Accordingly, knowledge transfer between these communities is somewhat limited and paradigms of deep versus shallow marine systems are commonplace. For idealised basin-margin systems with thick slopes separating the shelf and wave-base from basin-floor such models may be easily applied. However, in shallow and low-gradient systems the wave-base may be at or proximal to the basin-floor over large areas. Thus, turbidity currents in such settings are susceptible to oscillatory flow components, affecting their depositional processes and products. However, relatively few studies document the detailed architectures of turbidite deposits in shallow basins, and discussions of depositional processes are typically presented in the context of shoreface and tempestite models.

The Lower Triassic Montney Formation consists predominantly of siltstone with subordinate sandstone, interpreted to have been deposited within shoreface-to-offshore environments within a relatively shallow sea. Previous descriptions of turbidites within the Upper Middle Montney have documented stratal architectures consisting of basin-floor and base-of-slope turbidite systems. Their facies are characterized by pervasive hummock-like bedforms indicating combined flow, and recent observations of hybrid beds suggesting that cohesive and rheologically complicated flows were common in these systems. We utilize sedimentary logs from sixteen cores recovering stratigraphy from the Elmworth area, supplemented by well-log correlations, to constrain the stratigraphic architecture of an Upper Middle Montney turbidite system and spatial and temporal changes in depositional processes within the study area.

The unique combination of classical turbidite facies and combined flow bedforms, and their inferred positions within the lobes are contrasted with established models from deep-water and paralic systems to characterize submarine fans deposited in shallow-water basins. Through detailed process-based facies analysis six main facies associations are identified: 1) ‘background’ mudstone deposits; 2) outer lobe fringe; 3) frontal lobe fringe; 4) lobe off-axis; 5) lobe axis; and 6) ‘clinothem’ deposits. Correlations between adjacent wells suggest these facies change laterally in response to compensational lobe stacking patterns, and pinchout of the submarine fan against the Southern Peace River Leduc Paleohigh. These findings have implications for: 1) the development and re-evaluation of geological models in the Montney Formation; and 2) prediction of spatial facies distribution from 1D and 2D datasets.