

Sedimentological Calibration of Geomorphologic Elements Imaged Seismically in the McMurray Formation, Alberta, Canada: Characterizing a Complex Tidally-Influenced Fluvial Depositional System

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The stratigraphic architecture of the McMurray Formation is complex and variable, a function of numerous factors associated with the original depositional setting in the Western Canada Sedimentary Basin. Seismic time slices extracted from a high-quality 3-D seismic volume at Long Lake reveal a montage of depositional elements attributed to a tidally-influenced fluvial environment, including point bars, counter point bars, abandoned channel reaches or oxbow lakes, and sandstone-filled channels. The channel was 400-600 m wide and >30 m deep, as constrained by seismic and well data.

Point bars constitute the majority of the depositional elements present, characterized by a dominance of bitumen-saturated sandstone with siltstone layers variably abundant. The component inclined heterolithic stratification (IHS) was deposited as the point bars migrated laterally or translated downstream, to the northwest at ~335° on average. Counter point bars, which are deposited towards the distal end of some point bars, are readily identified in seismic images by their uniquely concave-downstream oriented scroll patterns (by contrast, point bar scrolls are ubiquitously oriented convex downstream). These depositional elements are characterized by IHS dominated by siltstone. The net/gross of counter point bar deposits is <0.4 whereas it is up to 0.98 for point bar deposits. Abandoned channel fills are composed of siltstone strata up to 36 m thick, which provide a mold of the channels that were responsible for deposition of the units studied. Sandstone-filled channels are also important locally, particularly as reservoir targets, as they consist of nearly 100% sandstone over their >35 m thickness.

The point bar and counter point bar units studied comprise upwards fining stratal packages that record the lateral migration of the channel system. Evidence for erosive currents, including mudstone-clast breccia and trough cross-stratified sandstone, dominate the bases of the packages. IHS is characteristic upwards, with bed-scale evidence for marine processes including physical sedimentary structures generated by tides, and ichnological and palynological components indicative of brackish-water. The combination of evidence for active channel migration associated with fluvial-style geomorphological elements and bed-scale evidence for marine processes, suggests that the environment of deposition for the McMurray Formation in the area studied was a tidally-influenced fluvial setting.