

# Paleogeographic Distribution of the Lower Cretaceous McMurray (Dina) Formation in northeastern Alberta and northwestern Saskatchewan

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The Lower Cretaceous McMurray / Dina formations are the main bitumen resource for the Athabasca Basin in Alberta and a portion of northwestern Saskatchewan. The McMurray Formation is a complex depositional system covering an extremely large area with several paleogeographic regions. Regionally, the deposit includes fluvial, fluvio-tidal, estuarine and open-bay deposits that unconformably overly Devonian carbonates.

In the northern parts of the Athabasca oilsands area, three sedimentologically and stratigraphically distinct regions have been identified: the main trunk valley, a comparably marine bay to the west and a predominantly fluvial tributary system in the east.

The main trunk valley of the McMurray Formation is represented by sand-dominated fluvio-tidal channels and tidally influenced bars dominated by Inclined Heterolithic Stratification (IHS) with tidal run-off creek / tidal-flat deposits representing various estuarine / deltaic facies associations. Cross-bedded outer estuary sands are also present. Upwards a range of brackish-water strata deposited in a locally deltaic series of embayments is generally present. The fluvio-tidal deposits predominantly fine upwards and comprise planar-tabular and trough cross bedded sandstone bed sets. The bed sets are commonly separated by thin muds, which cap the underlying bed set. Grain striping is locally observed. Trace fossils tend to be rare in the fluvio-tidal successions, but *Cylindrichnus* is rarely observed. The observed IHS deposits result from estuarine / deltaic point-bar migration. Bioturbation within these units is sparse to moderate (BI 1-4) with *Cylindrichnus*, *Gyrolithes*, *Planolites*, *Thalassinoides* and / or *Skolithos* observed as sand filled traces descending from mud bed tops. Bioturbated units capping the IHS are interpreted to represent tidal-flat deposits. Coarsening-upwards parasequences normally cap the McMurray Formation in the main trunk valley. These are variably bioturbated, locally wave-influenced and are 4 to 8m thick. Sediment supply within the main trunk valley system was likely moderate to high.

To the west, McMurray strata displays a thinly preserved succession of IHS locally, that is erosionally truncated by moderately to highly burrowed sands with commonly preserved thin mud-beds. The top of the McMurray is defined by an abrupt to erosional transition to the Wabiskaw Member of the Clearwater Formation. The IHS units likely represent estuarine sedimentation in response to transgression of the local valley and / or bay-margin deposits. The bioturbated sands represent a sand-dominated embayment that accumulated under conditions of comparably marine salinities and starved sediment supply.

Finally, the easternmost strata (*i.e.* Dina Formation) comprise sand-dominated (locally granular) fluvial deposits, likely representing the facies equivalent of the main trunk valley's Lower McMurray. The fluvial deposits can be seen as high angle planar-tabular grain-striped cross beds. Rarely small 1-2cm rip-up mud clasts and wood fragments are observed. Also observed are trough cross-bedded, fining upwards sequences displaying many reactivation surfaces

defining decimeter-scale bed sets. Higher energy transport and / or short transport is evidenced by predominantly granular / gravelly media. Although extremely rare, large insect burrow traces have been observed in these strata. Collectively, these deposits are taken to represent braided stream deposits. Notably, overbank and oxbow lake deposits have also been observed. These are recognized by fining upward bed sets of silt to mud. Rootlets are commonly preserved at the tops of bed sets and common wood and coal fragments are observed at the base of bed sets. Silts and muds are generally massive appearing, with root traces being the only recognizable trace fossils observed. Sediment supply in this region is high to extreme, coming from the very proximal Canadian Shield to the north east contributing to the presence of immature, first generation gravelly media observed.