Outcrop-Core Correlation of Channel and Non-Channel Facies, McMurray Formation, Fort MacKay Area, NE Alberta

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ABSTRACT

Detailed sedimentological and stratigraphic analysis of outcrops along the MacKay River (11), the Ells River (11), Dover River (2) along with lithofacies analysis of 26 cores facilitated detailed reservoir-facies scale mapping and outcrop-core correlation within the McMurray Formation in the Fort MacKay area of northeast Alberta.

Units within the Lower McMurray, interpreted as part of a fluvial lowstand systems tract, include braided channel-and-bar sands and mudstone intraclast breccias. More laterally extensive basal water-sands occur within paleolows along the pre-Cretaceous unconformity. Thick mudstones from overbank and abandoned channel complexes are preserved on paleotopographic carbonate highs within interfluve areas between the main channel complexes. Locally, exposed in outcrop along the MacKay River, are thick coaly mudstones that were deposited within flooded paleo-karstic lows along the pre-Cretaceous unconformity. Regionally, coals are common at the top of the Lower McMurray, representing widespread swamps that developed in response to the initiation of the transgressive systems tract. In outcrop and core, there are indications of a disconformity or unconformity at the top of the Lower McMurray.

The overlying Upper McMurray succession is a transgressive system tract that contains rich bitumen reservoirs, hosted primarily within estuarine channel-and-point bar complexes that are often stacked above one another. These vary from thick stacked estuarine channel sands with practically no shale breaks, as in the "Amphitheatre" section at Fort MacKay, to point bar sands with well defined lateral accretion geometry, seen in the subsurface and confirmed with dip-meter data. Off-channel equivalents are commonly coarsening-upward units, interpreted as representing progradational delta-front or estuarine bay-fill deposits.

In places it is useful to divide the Upper McMurray into a lower, transgressive, estuarine-channel succession (“Middle McMurray”) and an upper, more widespread, high-stand, coastal-plain succession. Both regionally, and to some degree on the local ("lease") scale, the lower estuarine and upper coastal plain successions are time-equivalent facies tracts. The upper coastal plain outcrops and core show laterally-continuous tidal flat, shoreline and splay units of the Upper McMurray, that are exposed in outcrops along the Ells River. Here tidal flat sediments and upward-coarsening splay and bay fill deposits are common; the amount of wave influence increases upsection; and laterally continuous coal markers occur near the top of the McMurray Formation.

The Lower McMurray amalgamated braided fluvial channel-and-bar complexes have very good to excellent porosity and permeability, often forming sheet sands within bedrock-confined paleovalley fills. The permeability of these Lower McMurray sands averages 8.6 darcies and is commonly up to 12 to 13 darcies. Local basal water sands may be interconnected along the bases of the main paleovalley fills; outside the main valley trends, these basal water-sands are more localized.

The Upper McMurray amalgamated estuarine meandering channel-and-bar complexes have somewhat lower porosity and permeability, in comparison with the underlying fluvial reservoirs of the Lower McMurray. Average permeability in the Middle McMurray sands is 6.5 darcies. Additionally, baffles to flow occur as mudstone-intraclast breccias, and a mudddy inclined heterolithic stratification that is juxtaposed with the channel sands. Within the Upper McMurray in the Ells River thin locally extensive (hundreds of metres to several kilometers) crevasse splay sheet sands and tidal channel-flat sediments are good, thin, small scale reservoirs within otherwise non-productive fine grained and coaly coastal plain sediments.

Deer Creek Energy is operating a thermal recovery pilot in the sands of the Lower McMurray within 1.5 km of the Ells River Valley, near the confluence between Joslyn Creek and the Ells River. Here, the Lower McMurray sands are at a depth of 100 m while the Upper McMurray sands outcrop at surface within the valley of the Ells River.

Detailed lithofacies mapping, outcrop-core correlation, and isopachs of reservoir versus non-reservoir facies demonstrate the need for this detailed sedimentological analysis for potential in-situ schemes for production of bitumen from the heterogenous McMurray reservoirs.