Braided River and Avulsive Depositional Systems in the McMurray Formation - LIDAR and Subsurface Data Integration at Syncrude's Aurora North Mine, Alberta

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The McMurray Fm represents a world class bitumen resource that is being developed using surface mining and in-situ recovery technologies. Reservoir quality and heterogeneity as a function of depositional environment are primary factors governing the success of these developments.

The pit exposures at the Aurora North Mine along with 380 closely spaced wells provide a database with which McMurray depositional systems can be studied from core to outcrop scale. Mine faces were captured using LIDAR scans that enhance the 3D analysis of outcrop stratigraphy. Stratigraphic interpretation was facilitated by rendering log curves as a 3D seismic volume. These data were integrated to develop predictive models for two distinct depositional systems: braided river and estuarine avulsion channel complexes.

Three major sequences are recognized within the McMurray. Braided river sands, floodplain mudstones, paleosols and coals were deposited within the basal SB100 sequence and are preserved within structural lows above the sub-Cretaceous unconformity. The overlying SB500 sequence is dominated by braided river deposits whose distribution was controlled by syndepositional structuring. Depositional remnants of SB100 paleosols are tilted along the flanks of Devonian highs.

The SB600 sequence is a 50 m thick upward-fining succession consisting of avulsion channel and bar complexes capped by coastal plain deposits. Gamma-ray motifs and grain-size trends are similar to those observed in comparably scaled point bars. However, dipmeter patterns and outcrops demonstrate large-scale cut-and-fill stratal geometries interpreted to have formed through avulsion. Compound channel fills contain early stage sand-prone sub-tidal bars and late stage mud-prone, bioturbated side-attached longitudinal bars that downlap onto the tidal bars. Mudstone clasts occur at channel boundaries and downlap surfaces. The spacing between avulsion channel remnants is aliased by the 100 m well spacing making it difficult to demonstrate the coevality of individual channels. Within any bar complex, the thickest reservoirs are located up-valley and grain size distributions fine in the down-valley direction. The avulsive down-valley alluvial architecture changes to non-avulsive channels and point bars up-valley.

The analogs developed in this study can be used to facilitate subsurface interpretation, resource characterization, assessments and reservoir modeling of similar depositional environments.