

Sedimentology and Architecture of Point Bar Deposits, Cretaceous McMurray Formation, Alberta: Cyclic Sedimentation and Heterogeneity Prediction

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The Cretaceous McMurray Formation is the most volumetrically important bitumen-bearing unit of Alberta's Athabasca Oil Sands deposit. Point bar deposits account for a significant proportion of the subsurface reservoir, and are characterized by bedded, sandstone-dominated strata with a net:gross that, in ideal cases, may approach 1.0. The steam assisted gravity drainage (SAGD) process is the most common means of extracting bitumen in the study area; this method is sensitive to interbedded siltstone beds, which are locally common in the formation. The objectives of this study are to sedimentologically and statistically assess the spatial distribution of siltstone beds, which act as barriers to fluid flow and are detrimental to the transmission of steam through the reservoir and subsequent bitumen recovery.

The dimensions of the channel examined, ~30 m deep and 500 m wide, are well constrained by 3-D seismic data, cores and wireline logs from ~100 wells spaced approximately 400 m apart. Individual point bars in the study area are on the order of 10 km². Statistical analysis of wireline logs using correlograms, Fourier transforms and wavelet transforms demonstrate cyclicities of varying strengths in both gamma ray and density porosity logs over wavelengths ranging from 1-10 m in the spectra. The origin of these well-defined cycles are most likely attributable to: (1) seasonal shifts in point bar sedimentation; (2) inter-annual climatic variations (e.g., El-Niño Southern Oscillations) with periods of 7 years or less; or (3) depositional fluctuation related to celestial sunspot cycles (~11 year period).

Depositional cyclicity is most pronounced in the muddy portions of point bars, including: (1) distal, downstream areas, including counter point bars, and (2) the youngest scrolls, which were commonly associated with the early phase of channel abandonment. Sedimentological heterogeneity within sandstone-dominated point bar deposits of the McMurray Formation greatly can impact heavy oil recovery. Thus, validating the strength and location of depositional cyclicity provides a measure of predictability in a complex reservoir system.