



## It's About to Get a Lot Less Salty – Comparison of a Fluvial Outcrop to Estuarine Outcrops Using UAV-Based Outcrop Modelling in the Lower Cretaceous McMurray Formation

Derek A. Hayes<sup>1</sup>, Eric R. Timmer<sup>1</sup>, Michael J. Ranger<sup>2</sup>, and Murray K. Gingras<sup>1</sup>

<sup>1</sup>University of Alberta, <sup>2</sup>Ranger Petroleum Consulting

### Summary

Despite the relatively widespread distribution of lateral accretion point-bar deposits – expressed as Inclined Heterolithic Stratification (IHS) – throughout the lower Cretaceous McMurray Formation, there remains a considerable debate regarding the physiographic location of these deposits in the fluvial-to-marine transition zone. Given the stratigraphic complexity of the McMurray Formation, outcrop studies remain the best way to characterize the large-scale depositional architecture of McMurray strata. This study uses an Unmanned Aerial Vehicle and Structure-from-Motion photogrammetry to characterize the Crooked Rapids outcrop and compare it to other McMurray Formation outcrops that show markedly different sedimentary facies and depositional architectures.

At the Crooked Rapids outcrop, one kilometer of continuously exposed McMurray Formation strata provides depositional-strike and -dip views of the key sedimentological units. The outcrop is approximately 60 meters high, comprised of four sharply bound units: (1) a lowermost limestone basement of the Waterways Formation; (2) an inclined sandstone to mudstone unit that is almost entirely sandstone to the north and becomes progressively muddier to the south; (3) a sharp-based, horizontally bedded, moderately bioturbated sandy siltstone that locally scours the unit below; and (4) horizontally bedded, bioturbated sandy mudstone. This study focuses Unit 2. Toward the north, the succession is dominantly sandstone that is characterized by metre-scale trough crossbedding with variable crossbed orientations (ranging from 250-55°). In the south, the sandstone is characterized by decimetre-scale low angle crossbedding with abundant coal fragments and organic detritus deposited in the toesets and bottomsets of the dunes. Additionally, crossbed orientations range from 10-60° and the sandstone clearly interfingers with mud-dominated deposits. Facies and architectural data support an interpretation that two fluvial point-bar deposits are preserved along with abandonment-phase mudstones in the south.

Two key observations are made at the Crooked Rapids outcrop that differ significantly from other exposures of McMurray strata: (1) it is the only locale that clearly shows IHS interdigitating with channel-thalweg sands; and (2) it is the only outcrop that is devoid of bioturbation in point-bar deposits. Additionally, some geobodies observed in other McMurray outcrops are interpreted as forward accreted compound dunes ascribed to deposition in the middle estuary, but these are not recognized at the Crooked Rapids outcrop. In most cases, owing to the presence of bioturbation and local evidence for tidal modulation, the other locales are collectively interpreted as estuary deposits. As such, this study provides a fluvial baseline for the other outcrops.