Regional Context
- Northeastern Alberta
  - Township 92 - Range 9 west of the 4th meridian
  - 57°N 112°W
  - 3km east of Fort McMurray

Study Area
- 4.8 km upriver from the Athabasca River
- Continuous outcrop exposure along meander bends
- 13 logged sections: 10 strike sections, 3 dip sections

Objectives
- Differentiate the middle McMurray Formation of the steepbank area into facies
- Identify the sedimentological, architectural and ichnological characteristics of each facies
- Determine the geometrical relationships between each facies in three dimensions
- Determine the depositional conditions responsible for each facies
- Integrate facies into a facies model

Middle McMurray Facies Model Integration

Facies Analysis of Tidal Fluvial Point Bar Deposits
Middle McMurray Formation - Steepbank River, Alberta
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Depositional Environments
- Tidal Flats
- Flood Bar Channel
- Tidal Bar (BT)
- Channel Base

Middle McMurray Facies (with distinctions)

Facies 1 - Medial (Rhizomorphs, mud crust, polymictic sediments)

Facies 2
- Discontinuous Coarse Member
- Scant to locally abundant mud drapes on coarse members
- Bioturbation typically associated with fine member, but can occur top down into coarse beds
- Facies 3 typically overlies Facies 1 gradationally - the contact is defined by transition from abundant cross beds to ripples

Facies 3
- Bioturbation very limited
- Low species diversity
- Sparse tidal indicators
- Limited bioturbation (BI = 0 - 2) including traces of Cylindrichnus
- Burrows are commonly associated with mud beds, but also are present in sand beds
- Facies 4 typically overlies Facies 2 gradationally - the contact is defined by transition from abundant cross beds to ripples

Facies 4
- Bioturbation intense
- High species diversity
- Many tidal indicators
- Facies 5 is commonly associated with Facies 4

Facies 5
- Highly bioturbated, discontinuous coarse member
- Bidirectional asymmetrical ripples (bedding highlighted by red lines)
- Cylindrichnus Planolites burrows located in toeset; note the mud layer above burrows (each rectangle is 4 cm long)
- Subangular (1-4 cm diameters) mud clasts, occur as discontinous layers- 1-7 cm thick
- Variable bioturbation (BI = 0 - 4) including abundant traces of Cylindrichnus, and minor Planolites

Facies 6
- Discontinuous coarse member beds
- Windblown sand domes, or crescentic structures
- Sharp to locally gradationally based (normally graded from coarse member)
- Internal scour surfaces truncate inclined surfaces with steeper dips; convoluted bedding occurs
- Intense bioturbation (BI > 4)
- How original mud layers have been destroyed by bioturbation
- Burrows are common within the uppermost 5 -10 m of the facies
- Large scale cross beds to ripples
- Subangular (1-4 cm diameters) mud clasts, occur as discontinous layers- 1-7 cm thick
- Variable bioturbation (BI = 0 - 4) including abundant traces of Cylindrichus, and minor Planolites

Facies 7
- Bioturbation highly concentrated within the fine grained member - original structures may be obliterated
- Top down bioturbation into coarse members is common
- Local coarse member bioturbation occurs within the coarse member
- Predominantly fine grained (granules)
- Bioturbation is concentrated within the fine grained member - original structures may be obliterated
- Facies 8 is commonly associated with Facies 7

Facies 8
- Large scale cross beds (scale rod is 1.5 m long)
- Mud drapes on asymmetrical ripple sets
- Bidirectional asymmetrical ripples (bedding highlighted by red lines)
- Cylindrichnus Planolites burrows located in toeset; note the mud layer above burrows (each rectangle is 4 cm long)
- Subangular (1-4 cm diameters) mud clasts, occur as discontinous layers- 1-7 cm thick
- Variable bioturbation (BI = 0 - 4) including abundant traces of Cylindrichus, and minor Planolites

Facies 9
- Large scale cross beds (scale rod is 1.5 m long)
- Mud drapes on asymmetrical ripple sets
- Bidirectional asymmetrical ripples (bedding highlighted by red lines)
- Cylindrichus Planolites burrows located in toeset; note the mud layer above burrows (each rectangle is 4 cm long)
- Subangular (1-4 cm diameters) mud clasts, occur as discontinous layers- 1-7 cm thick
- Variable bioturbation (BI = 0 - 4) including abundant traces of Cylindrichus, and minor Planolites

When using a facies model, one must recall that they are a distillation of numerous examples to produce a "typical" set of depositional elements for an environment. This explains the discrepancy between the model and the case specific middle McMurray Formation.

Furthermore, tidal flat point bars form along a continuum in a spectrum from fully tidal to completely tidal. This complicates the formulation of a depositional model since there is a progressive longitudinal change in the relative strength of tidal and fluvial currents within the system. The middle McMurray and its associated facies are interpreted to occur in a more proximal location and to be more fluvially dominated than the model shown.

This proximal interpretation is indicated by:
- No fluid-mud layers are present; such layers form in the turbidity maximum zone.
- There are four slack-water mud drapes on ripples which suggest that the water was relatively calm.
- Low species diversity of bioturbation, which is expected by the presence of low-salinity slackwater.
- Sparse tidal indicators such as tidal ripples, which indicates that there is limited tidal influence.
- The cyclic alternation of sand and mud is too thick to be deposited during a single tidal cycle and must indicate another type of periodicity, possibly seasonal cyclic.