Object Based Modeling - A New Approach for McMurray Formation Visualization and Reservoir Characterization

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The McMurray Formation is characterized by rapid vertical and lateral lithology changes and associated petrophysical properties. In addition to rock heterogeneities, bitumen, water and gas display a wide range of organizational orders even between closely spaced wells. Bitumen composition is also very heterogeneous, commonly showing order-of-magnitude differences in viscosity within a single reservoir column.

Correlation of lithofacies between closely drilled wells using the conventional statistical 3D modeling approach, commonly leads to inaccurate models for oil sands reservoir development purposes. An alternative modeling approach is to map laterally correlatable large scale depositional elements commonly named "geobodies."

Recent technological advances in seismic and well logging allow for modifications to existing depositional concepts, and provide a better understanding of controls on the spatial distribution of fluids. Modified depositional concepts suggest a range of large scale depositional elements from an ancient meandering river system, which formed highly compartmentalized reservoirs. In addition, advances in reservoir geochemistry improve understanding of biodegradation intensity in different parts of the reservoir. Fluid distribution and bitumen molecular data suggest that each compartment behaves as an independent “bioreactor”. Interplay of biodegradation and intra-reservoir fluid-mixing processes controlled by driving mechanisms and host-rock properties in each compartment are responsible for the fluid heterogeneities observed in McMurray Formation reservoirs.

The above findings about the origin and controls on rock and fluid properties provide the ability to predict, map, and model rock and fluid heterogeneities. The workflow shown in this study demonstrates the necessity to integrate a range of collected data types.
The mapping and modeling process consists of several steps:

- Geobody interpretation and correlation between cross-sections to create 3D surfaces (geobody envelops);
- Spatial distribution and population studies for petrophysical and fluid properties are performed for each geobody individually, honoring its own specifications;
- Simulation of petrophysical and fluid properties within each geobody.

In comparison with standard workflows, the geobody mapping and modeling approach provides the ability to reduce uncertainties and improve the ability to visualize, simulate, and analyze results in a geological context. Depending on the model complexity, this approach can be challenging in terms of workflow management. Implications for reservoir development include:

(i) better placement and optimization of the number of horizontal wells;
(ii) production history matching in a geological context;
(iii) more realistic production optimization studies;
(iv) reduced exploration and production costs and maximized recoveries.

Feedback suggests that the 3D geobody model is more realistic than the 3D model created by the conventional approach. Uncertainties related to input values are significantly reduced.

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