Integration
geoConvention 2013
geoscience engineering partnership

Origin, Prediction, and 3D Object Based Modeling of Rock and Fluid Properties in Compartmentalized McMurray Formation Reservoirs

Milovan Fustic*
NEXEN Inc.
milovan_fustic@nexeninc.com

and

Dany Cadiou
Paradigm Inc.

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.

Recent technological advances in seismic and geophysical 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:

- Geobodies (rock and fluid bodies) delineation in cross-section views
- Geobodies connection between cross-sections to create 3D surfaces
- Spatial distribution and population studies for petrophysical and fluid properties are performed for each geobody individually, honoring its own specifications.

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) conducting production allocation studies using molecular markers

(iii) more realistic production optimization studies

(iv) production history matching in a geological context

(v) reduced exploration and production costs and maximized recoveries are inferred.

The geobody study approach would also be beneficial for mapping and modeling depositional units to optimize water management and future CO2 storage initiatives.