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Integrated Geoscience Workflow for Drilling Optimization and Enhanced Oil-sand Production

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Summary

The oil-sand reservoirs in Northern Alberta are known as challenging and extremely complex with strong vertical and lateral variability, high porosity, and shallow depth. To effectively manage these in-situ and time-lapse projects, geoscientists and engineers must work together, using a shared language, and knowledge of the subsurface and production processes to increase production.

In this presentation, we will discuss case studies where the usage of integrated geoscience workflow, utilizing core, well and seismic data, contributed to solve key problems.

The workflow starts with a comprehensive petrophysical analysis and continue with seismic inversion technique that include either simultaneous prestack inversion for PP seismic data, or joint PP-PS prestack inversion for multicomponent seismic data. Prestack inversion is essential for oil-sand reservoirs as P-wave velocities do not show significant variations and density is the only elastic property that affects seismic reflectivity amplitudes. By inverting high-resolution AVO seismic data, reliable density estimates are obtained. The inversion process can be further improved by carefully aligning well-to-seismic data, accurately estimating the wavelet/group of wavelets, and developing a better low-frequency model. Our workflow also includes neural network analysis for density and resistivity (proxy for saturation), as well as Bayesian facies analysis, providing valuable information for sand/shale interpretation.

The seismic results from this workflow have been used for drilling optimization and enhanced oil-sand production.

The first case study is an in-situ oil-sands reservoir where resistivity and density seismic volumes were estimated, solving problems such as pay characterization, correct flank water mapping and accurate identification of high versus low oil saturation in zones with high salinity bitumen sand.

The second case study is from a time-lapse project where rock physics models and joint PP-PS inversion were used to estimate the probabilities of different stages in the production cycle of an oil-sands reservoir located in the Athabasca Basin of Alberta, Canada. The seismically derived elastic properties were used for imaging steam chamber extension, fluid saturation changes, the extension of warmed bitumen (future production zones), and temperature distribution within the reservoir.