Integrated 3-D Reservoir Characterization for Oil Sands Evaluation, Development and Monitoring

Bellman, Laurie W.[1] (1) Oil Sands Imaging Inc., Calgary, AB, Canada.

The Athabasca oil sands contain more than a trillion barrels of oil within the Cretaceous McMurray Formation of northeastern Alberta.The McMurray Formation is generally considered to be a compound estuarine valley system characterized by multiple stacked channel sequences.It is bounded below by Devonian rocks at the pre-Cretaceous unconformity and above by the widespread transgressive marine shales and sands of the Wabiscaw Formation. Post oil migration, the reservoir has been subjected to structural changes caused by salt dissolution and tectonics. At the same time due to its shallow burial, fresh water infiltration has caused severe biodegradation of the oil creating the complex mixture of bitumen, gas and water present today.

So far, the preferred method of in-situ bitumen production is the Steam-Assisted-Gravity-Drainage (SAGD) process. Multiple horizontal well pairs are drilled to inject steam into the reservoir and pump out the heated, liquified oil. The objective of every oil sands operator is to minimize the steam-injected to oil-recovered ratio by maximizing the efficiency of the SAGD process. Reservoir heterogeneity has been found to have the single most significant negative effect on the efficiency of steam chamber development and overall bitumen recovery, directly influencing steam/oil ratios.

Detailed knowledge of the reservoir can therefore allow for better prediction and management of the inherent complexity of the McMurray formation. An accurate baseline reservoir characterization is also essential for subsequent time-lapse seismic analysis and comparison for production monitoring. The process described in this presentation integrates all available data to produce a detailed volume of deterministically derived facies and fluids. The workflow is illustrated using 3d seismic and well data from the Nexen/Opti Long Lake SAGD Phase 2 area near the city of Fort MacMurray, Alberta. The subsequent drilling results were compared with the predicted properties and showed that most wells matched the prediction with greater than 75% accuracy.

Portions of the facies and fluids volume can be used to populate a geo-cellular grid over a single well pair or a proposed horizontal drilling pad. After production has commenced, monitoring of steam injection and heated bitumen can be assessed by repeating the reservoir characterization process with time-lapse seismic data.