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3D geomodeling and applications in Oil Sands reservoirs and Tight Oil reservoirs

Weishan Ren
RWS Geomodeling Ltd.
Ben Hollands
PTTEP CANADA Limited

Summary

Geomodeling has been applied in many different types of reservoirs, in this talk we will focus on oil sands reservoirs and tight oil reservoirs. Two cases studies are presented.

The oil sands reservoir in general has dense wells and a large amount of data, which includes well logs, core data, 3D and 4D seismic data, and a well-established geological concept model. A good practice is to construct a 3D geological model by integrating all the available information and honoring the information in the model with respect to its accountability or degree of accuracy. The 3D model should reflect as much as possible what we already know. Furthermore, it should quantitively show aspects of what we still do not know, i.e. the geological uncertainty.

A 3D geological model was constructed (Figure 1) over the Mariana Thornbury in Situ oil sands Project Area (ISPA). The main reservoir in the ISPA is comprised of stacked sandy channels and point bar successions deposited during middle McMurray time. The south to north trending channels are sometimes directly in contact with the lower McMurray sands, forming deep and narrow bitumen saturated sands, the SAGD recoverable pay. Multiple sources of data were incorporated into the geomodeling process with involvement of different people in the G&G team. Lithofacies, porosity, water saturation, horizontal and vertical permeability were modeled. Best practices for oil sands reservoir modeling workflows were implemented.

The heterogeneities of the oil sands reservoir were captured in the model, and the Drainage Area (DA) based static simulation models were delivered for Steam Assisted Gravity Drainage (SAGD) reservoir simulation studies. From the static models, OOIP and other volumetric calculations were performed. Net sand proportion and net connectivity can be generated for reservoir evaluation. Uncertainty and sensitivity analysis were also implemented. Besides these normal applications, the geomodel was further used to determine and optimize the layout of the SAGD drainage areas and pad patterns. Vertical placement of horizontal wells can be optimized as needed.

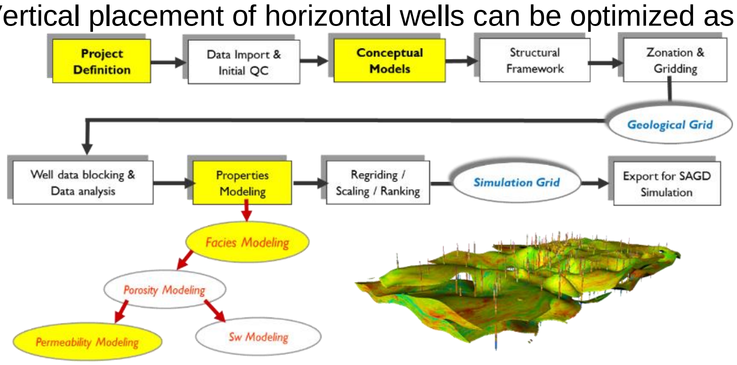

Figure 1. Workflow diagram for an oilsands geological modeling case.

The tight oil reservoirs generally do not have as much data when compared with oil sands reservoirs. It is common that a 3D geomodel is constructed from a few wells with basic logs, core measurements and analysis, and sometimes 2D seismic lines. The conceptual geological model requires strong subject matter expertise as input for the local geology and many references from analog studies. The trend model becomes critical in the 3D geological modeling processes. In this case, trends needed to be carefully generated from available hard data while incorporating the soft information from the geologist's interpretation. Given the sparse data which is preferentially sampled, i.e, most wells drilled in high pay areas, and the typically skewed distributions of porosity values, data analysis and modeling must be handled with care. Otherwise, the 3D models are biased.

A 3D model was built for the Cardium formation in central Alberta (Figure 2). Common practices for tight oil reservoir modeling workflows were implemented. Lithofacies, porosity, water saturation, horizontal and vertical permeability were modeled. The 3D geomodels were used as input static models for reservoir simulations and studies. The near wellbore lithofacies models were extracted to help the hydraulic fracture design. Vertical placements of horizontal wells were optimized using the 3D model.

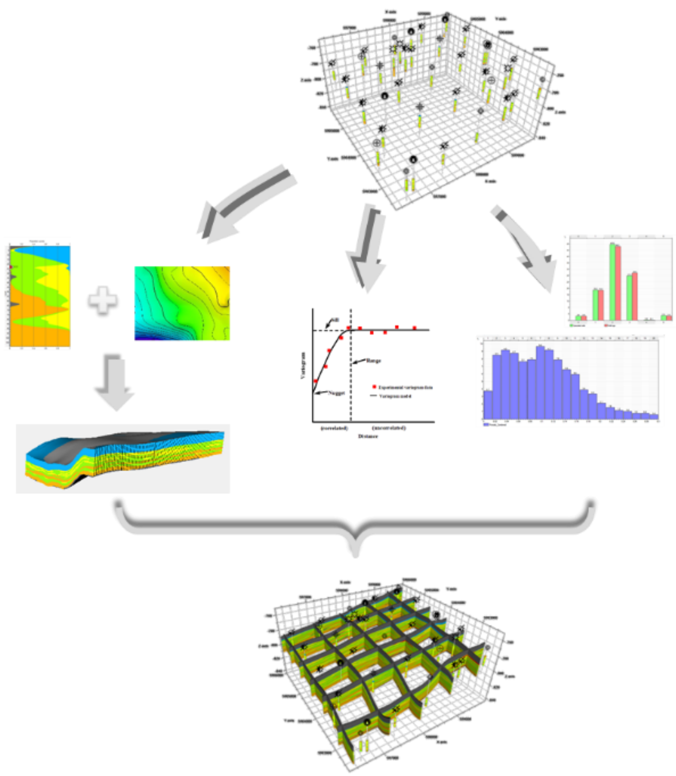

Figure 2. Workflow diagram for a tight Cardium geological model.

Acknowledgements

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