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Realistic geological modeling of Mariana Thornbury Oil Sands reservoir

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Summary

A fine-scale 3D geological model over the Mariana Thornbury in Situ Project Area (ISPA) has been constructed. The purpose of this model is to capture heterogeneities of the oil sands reservoir and to provide realistic simulation models for Steam Assisted Gravity Drainage (SAGD) simulation study. The best practices of oil sands modeling have been implemented.

In the SAGD process, the development of steam chamber and the movement of oil are greatly affected by reservoir heterogeneities at different levels. Large scale structures and heterogeneities were framed in the geological model with an extensive A2 mudstone layer as caprock, and the B and C complex channel systems as bitumen zone in McMurray formation. For the small scale heterogeneities, IHS facies or mud layers were modeled with geostatistical modeling approach to form buffers or barriers depending on their thickness and lateral continuity. A facies model is critical to capture the heterogeneities. All petrophysical properties were modeled subsequently with the constraint of facies model. The modeled petrophysical properties include effective porosity, effective water saturation, shale volume, horizontal permeability, and vertical permeability.

Vertical permeability is the most important parameter for SAGD simulation. With unconsolidated sands, it is common in oil sands reservoirs that petrophysical properties exhibit distinguished distributions in different facies. Porosity and permeability must be modeled by facies to realistically reflect such different distributions. Vertical permeability modeling was further improved by using regression analysis for each facies instead of a constant Kv/Kh ratio. An additional study of modeling permeability using image logs was conducted with University of Alberta.

Conclusions

In constructing a realistic 3D geomodel, appropriate integration of multiple sources of data is the key. This geomodeling project has utilized well data, seismic data, geological conceptual models, and trend models. Geostatistical modeling methods were used for data integration with a good handle of different data scales and different data qualities. 100 realizations were generated for each parameter to access the associated geological uncertainty.

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