GeoConvention
Calgary • Canada • March 7-11 2016
OPTIMIZING RESOURCES

Direct Reservoir Characterization with a High-Density High-Resolution 3D Seismic survey – a Canadian oil sands case history.

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Introduction

This case history showcases a 7km^2 High-Density High-Resolution 3D seismic survey (HDHR3D) that was acquired as a pilot project aimed at determining the imaging improvement associated with a high field effort. Due to shallow depth and low impedance contrast with overlying shale, the detectability and imaging of the McMurray reservoir in the project area is relatively poor on legacy 3D seismic data. The main objectives of this project were to improve the mapping of reservoir architecture as well as investigate the potential for direct reservoir and fluid detection in order to influence future drilling locations and reservoir forecasting models.

Methodology

Numerous papers have been published in the literature regarding the extraction of the rock properties of the oil sands reservoirs (Batzle et al., 2006, Kato et al,2011, Kato et al, 2008, Gray et al., 2004). Prior to the seismic interpretation, local dipole sonic data were analyzed to determine the rock-physics response of the McMurray formation. These data indicated that the McMurray reservoir response was governed by grain-to-grain contacts, much like conventional clastic reservoirs. Bitumen saturation had little effect on the petro-elastic behavior of the rock. Synthetic gathers showed that sand to shale interfaces within the McMurray pay were characterized by a Class 2 AVO response.

As expected, the high field effort considerably improved the imaging of the subsurface structure and stratigraphy. The rugose unconformity at the top of the Devonian was well imaged and overlying thin coal beds could be mapped. The predicted Class 2 AVO response was found to be present in the HDHR3D data (as in Gray, 2011) and the ultra-far angle stack proved to be a useful volume for discriminating reservoir from the overlying shale. Net reservoir thickness maps based on this volume closely matched the existing well control, providing a method for optimizing core hole locations. Discrimination of sands and muds also provided insight in the McMurray reservoir architecture. Numerous previously unmapped steeply dipping mud baffles were found between well control. The steep dip of the baffles meant that an unrealistic density of core holes would be required to properly characterize the reservoir. The optimum solution appeared to be a combination of core holes and HDHR3D seismic data.

Conclusions

- Understanding the rock physics is a key first step to seismic interpretation but quality shear data can be difficult to come by in slow formations like the McMurray.

- Oil sands are not a slurry but instead behave much like a conventional sandstone and can be directly detected using AVO.

- The HDHR3D provided much improved imaging of the subsurface structure and reservoir architecture, allowed the mapping of top gas and coal beds as well as discrimination of sand from mud.

- The HDHR3D pilot project showed that seismic has a role to play in delineation and development of oil sands projects.

Acknowledgements

We would like to thank the following people and organizations: Suncor Energy Inc. for the permission to publish these results, Andres Altosaar and Hossein Aghabarati for fruitful discussions.

Disclaimer

References

- Heavy oils—seismic properties, *Batzle et al., TLE, 2006*
- Rock physics modeling of heavy-oil saturated, poorly consolidated sands, *Kato et al, SEGJ Symposium, 2011*
- Elastic property changes in a bitumen reservoir during steam injection, *Kato et al, TLE, 2008*
- Examination of wide-angle, multi-component, AVO attributes for prediction of shale in heavy oil sands: A case study from the Long Lake Project, Alberta, Canada *Gray et al. SEG Convention, 2004.*
- Oilsands: Not Your Average Seismic Data, *David Gray, Recovery – 2011 CSPG CSEG CWLS Convention*