Shedding more light on an Oil Sand reservoir by applying integrated spectral method analysis - Case Study

Dragana Todorovic-Marinic*, David Gray, Dale Vanhooren and Greg Osiowy, Nexen Inc., Canada
dragana_todorovic-marinic@nexeninc.com
and
Paul Garossino*, Paul Gutowski and James Alison, OpenGeoSolutions Inc. Calgary, Alberta, Canada

GeoConvention 2012:Vision

Summary

Bitumen of the Lower Cretaceous McMurray Formation in north-eastern Alberta represents one of the most important hydrocarbon accumulations in the world with estimated more than 1.7 trillion barrels of oil in-place. Reservoir deposits are primarily associated with point bars and sandstone-filled channels. The reservoir is produced through steam assisted gravity drainage (SAGD), a very cost intensive operation that uses horizontal well pairs to extract bitumen. Successful SAGD relies on heat transfer through the reservoir from stem injection wells to horizontal producers at the base of the reservoir. Detailed knowledge of depositional facies, vertical and lateral distributions of potential stem-barriers (mud), net pay thickness and geometry of the reservoir are required for a successful reservoir development.

High quality 3D seismic reflection data is acquired over 120 sq km, together with extensive drill core used to guide the positioning of the SAGD horizontal well pairs. Many attempts have been made using pre-stack seismic inversion (Dumitrescu, Bellman), neural network inversion as well as seismic geomorphology (Hubbard et al) for the purpose of reservoir prediction and facies delineation with varying degrees of success. The challenge for subsurface imaging is a high degree of reservoir heterogeneity, with rapid vertical and lateral changes between reservoir and non-reservoir faces and complex fluid distributions. This complexity in reservoir characteristics results in considerable debate with respect to the geologic model. (Fustic et al).

Understanding the distribution of the sedimentary facies, which provide a direct control on bitumen distribution and recovery, is paramount for a successful development program. The goal of this paper is to investigate if an integrated spectral analysis approach can improve resolution of the geological complexities of oil sands reservoirs. In general spectral methods, such as spectral decomposition, spectral inversion and spectral discontinuity™ open the door to a non-traditional remote sensing approach to seismic interpretation, revealing heterogeneity beyond classic seismic resolution and detection. They expose stratigraphic and structural discontinuities, minimize the effects of geologic tuning due to variations in thickness and layer stacking while providing superior dip independent imaging of faults and terminations. Finally they allow a quantitative characterization of reflective boundaries and thickness of layers.

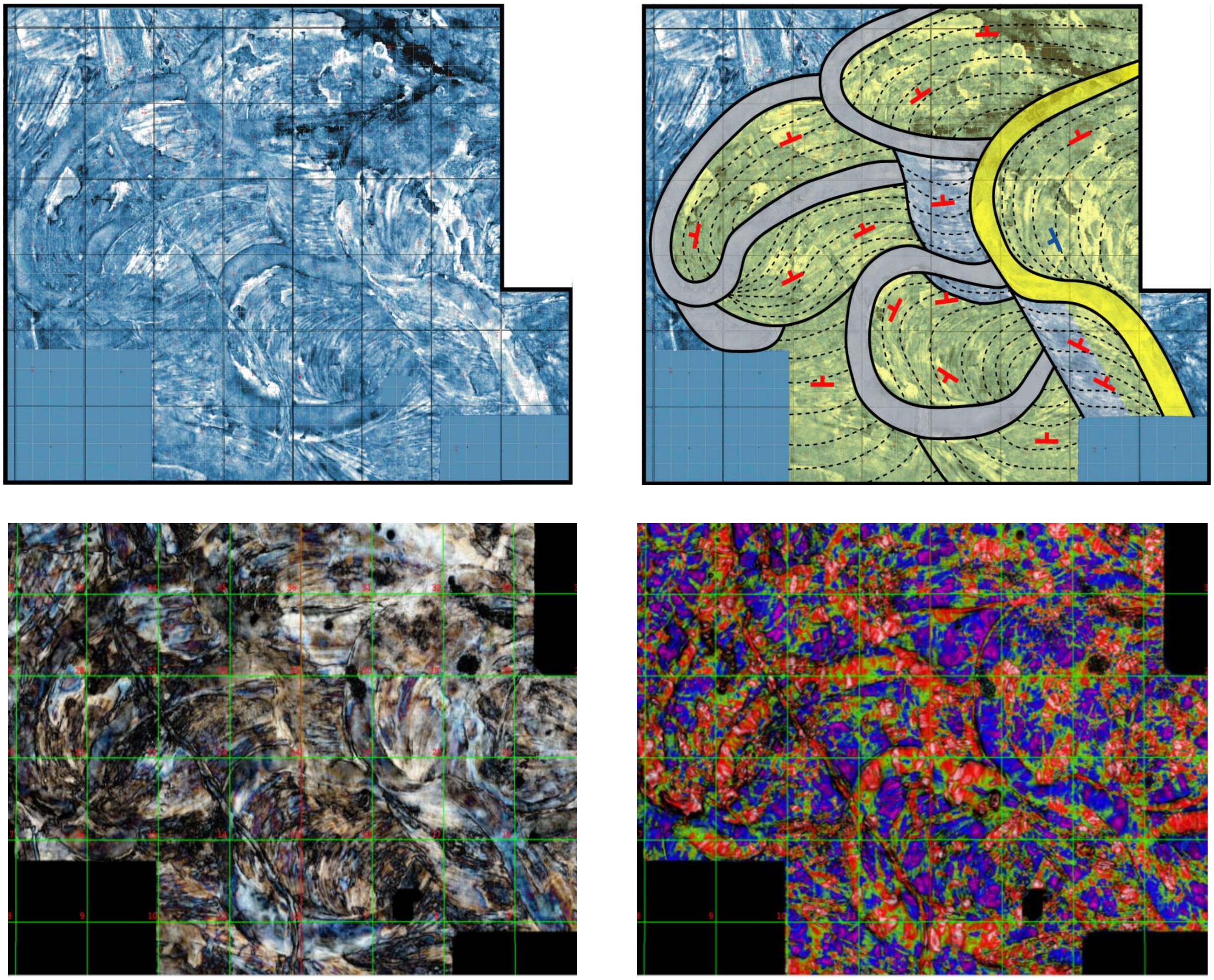

Figure: McMurray horizon slice showing reservoir architecture with stratigraphic traps (mud plugs) and stacked point bars (reservoir). Visualization and interpretation of compartments and fluids within them is greatly improved by applying integrated spectral method analysis.

Conclusions

This paper shows that applying integrated spectral analysis over our McMurray oil sand reservoir, NE Alberta, helped in redefining the interpretation of reservoir facies distribution to a great extent. Success of this method is validated and quantified by integration with extensive hard data available.

Acknowledgements

We are thankful to NEXEN Inc. for allowing us to present the results of this study. We would like to thank many geologists for discussing the sedimentology and stratigraphy of the McMurray formation.

References

Dumitrescu, C. 2008. Seismic attributes used for reservoir simulation to a heavy oil reservoir in Canada. SEG W=Expanded Abstracts, 1471-1475.

Bellman, L. 2007. Oil Sands Reservoir Characterization. A case study at Nexen/Opti Long Lake. CSEG Expanded Abstracts, 707-708.

Hubbard, S.M., Smith, G.D., Nielsen, H., Leckie, A,D., Fustic,M., Spencer, J.R., Bloom, L., 2011. Seismic geomorphology and sedimentology of a tidally influenced river deposit, lower Cretaceous Athabasca Oil Sands, Alberta, Canada. AAPG Builletin 95, 1123-1145.

Fustic, M., et al., Recognition of down-valley translation in tidally influenced meandering fluvial deposits, Athabasca Oil Sands (Createaceous) Alberta, Canada, Marine and Petroleum Geology (2011), doi10.1016/j.marpetgeo.2011.08.004

Partyka, G.A., Gridley, J.M., and Lopez, J. 1999, Interpretational Applications of Spectral Decomposition in Reservoir Characterization, The Leading Edge, vol. 18, No. 3, pg 353-360.