

CSPG Distinguished Lecture

Dr. Lindsay Dunn, Athabasca Oil Corp, Calgary, Alberta

Fifty Shades of Grey: From Pore to Seismic an Integrated Workflow Identifying Sweet Spots in the Liquids Rich Duvernay Formation Kaybob, Alberta, Canada.

The Devonian Duvernay Formation is fast becoming one of the most active liquids-rich shale plays in North America. The play fairway extends over some 400 km from the Kaybob sub basin in the north to the Willesden Green Basin in the south. In the Kaybob region, the play has rapidly moved from an early exploration phase that began in late 2010, to commercial multi-well pad development. With this evolution companies are actively evaluating and high grading their acreage integrating all aspects of geosciences from pore, to core, to log, to microseismic and ultimately to seismic scale.

Sedimentological and sequence stratigraphic work flows provide the starting point for developing a predictive geological and subsequently geophysical models delineating rock quality to reservoir quality relationships. Relative amounts of total organic carbon, biogenic silica, carbonate, and clay have a first order control on reservoir quality in the Duvernay and vary systematically (Dunn *et al.*, 2013). The Duvernay can be classified into three end-member rock types that display decreasing reservoir quality from highly siliceous organic rich mudstones, argillaceous organic rich mudstones down to non-reservoir carbonates. The geographic and stratigraphic distributions of these lithofacies are controlled by the basin bathymetry and morphology (Fig. 1). (Dunn and Hummenjuk 2014a).

Key petrophysical attributes differentiate the three main rock types within the Kaybob study area. Cross plotting of Young's modulus and Poisson's ratio logs indicated that the siliceous organic rich mudstone, argillaceous organic rich mudstone and carbonate lithologies are distinctly clustered. Utilizing a 3D seismic volume within the study area, these same petrophysical attributes can be generated through AVO inversion producing a Poisson's ratio and a Young's modulus volume (Dunn and Hummenjuk 2014b). In the absence of horizontal logs X-Ray Florence (XRF) on cuttings calibrated to core has proven to be a fast, cheap and accurate tool to quantify rock properties along the well bore. Rock mechanical properties extracted along the well bore from the 3D volume show an excellent correlation to those calculated from XRF.

These integrated data sets have been used to place frac stages and show a good correlation between lithology, fracture treatment parameters and micro-seismic events. The results of this workflow enhances our understanding of the heterogeneity of the reservoir and how it relates to production and is being used to high grade acreage extracting maximizing net present value.

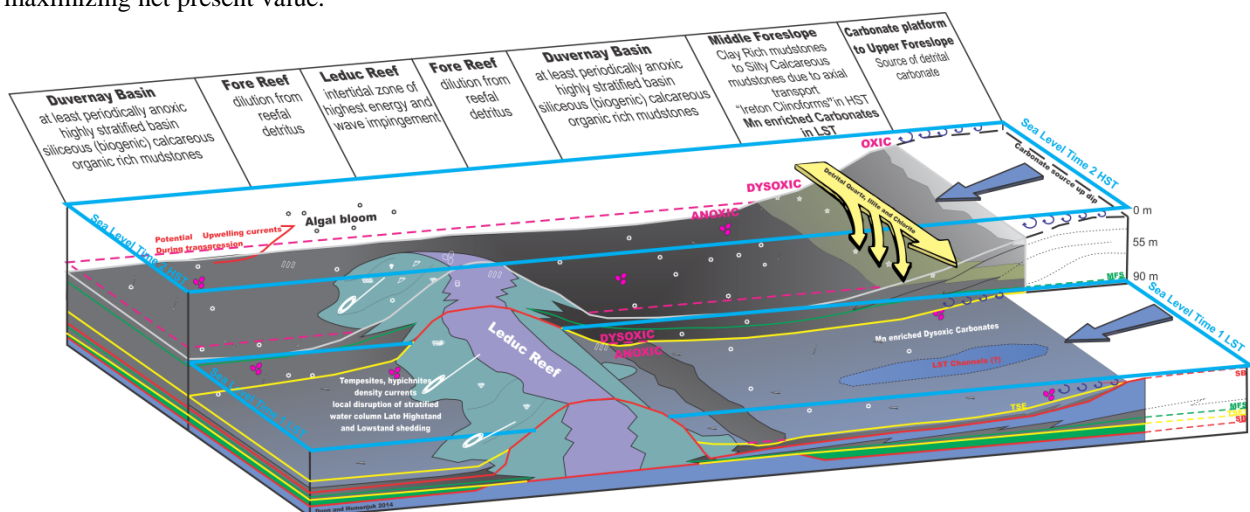


Figure 1: Integrated Duvernay Depositional and Sequence Stratigraphic Model for the Kaybob Area. Axial transport of clastic detritus and estimated water depths as per Stoakes (1980).

Acknowledgements:

The authors would like to thank Athabasca Oil Corp for permission to present this ongoing work. We would also like to acknowledge Seitel Canada Ltd, Core Labs and XRF Solutions for permission to show the data.

References

- Dunn L. A., Gordon K. and Houle M. 2013. Fifty Shades of Grey: Utilizing “Conventional” Sedimentology and Sequence Stratigraphy to unlock rock quality to reservoir quality relationships in the liquids rich Duvernay Shale play, Kaybob Alberta, Canada. Canadian Society of Petroleum Geologists Annual Convention Calgary, Alberta, 6-10 May program with abstracts.
- Dunn L. A and Humenjuk J. A. 2014a. Fifty Shades Darker: Integrating Sedimentology, Sequence Stratigraphy, Chemostratigraphy and Geophysics to Identify Sweet Spots the Liquids-Rich Duvernay Shale Play, Kaybob Alberta. Canadian Society of Petroleum Geologists Annual Convention Calgary, Alberta 12-16 May program with abstracts.
- Dunn L. A. and Humenjuk J. A. 2014b. The Duvernay Formation: Integrating Sedimentology, Sequence Stratigraphy and Geophysics to Identify Sweet Spots in a Liquids-Rich Shale Play, Kaybob Alberta. Unconventional Resources Technology Conference Denver, Colorado, 25-27 August program with abstracts.
- Stoakes, F.A. 1980. Nature and Control of Shale Basin Fill and its Effect on Reef Growth and Termination: Upper Devonian Duvernay and Ireton Formations of Alberta, Canada. Bulletin of Canadian Petroleum Geology vol 28. No 3 p 345-410.

Biography

Dr. Lindsay Dunn began her geoscience career at Edinburgh University in Scotland obtaining her BSc. She subsequently obtained an MSc from the University of New Brunswick and a PhD from the University of Calgary. Upon graduating she has worked for various exploration and production companies in Calgary specializing in unconventional sedimentology and stratigraphy. For the last five years she has worked for Athabasca Oil Corporation and is currently the Geoscience Manager for the Light Oil Division responsible for the exploration and development of their Montney and Duvernay assets. Lindsay's interests include unconventional reservoir characterization and well optimization utilizing sedimentological and stratigraphic principles. She was the recipient of the CSPG Link Award in 2015 for best technical presentation at a Society luncheon. When she is not working Lindsay likes to spend her time with her family in the beautiful Canadian Rocky Mountains.