

# Outcrop and Subsurface Reservoir Characterization of the Duvernay Formation in the East Shale Basin: Using Traditional Methods to Tackle New Challenges

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## Summary

Organic-rich mudstone reservoirs are intrinsically heterogeneous at all scales –from mm-to-km–. In the subsurface, the expression of this heterogeneity often causes variations in drilling and stimulation efficiencies, consequently affecting the well productivity. To analyze the range of spatial variability and to assist the validation of subsurface stratigraphic models, outcrops provide an inexpensive alternative to capturing reservoir architectural information while bridging the scale gap between seismic and borehole data.

In this presentation, we examine outcrop strata equivalent to the Late Devonian Duvernay Formation, and illustrate the utility of combining traditional field geology with modern techniques to extract spatial information relevant for subsurface applications. The studied outcrop features a ‘seismic-scale’ exposure of the transition between a carbonate buildup and its surrounding organic-rich basinal deposits. Collected data from the outcrop comprise facies descriptions, UAV –drone– photogrammetry, hand-held spectral gamma ray, thin section petrography, and geochemical analysis (XRD, XRF, TOC), which then were compared with drill cores of the Duvernay Fm. of the East Shale Basin.

Observations resulting from this outcrop to subsurface comparison reveal that the Duvernay strata is stacked into ‘small-scale cycles’ or parasequences superimposed onto transgressive-highstand cycles mainly controlled by bathymetric barriers placed by the adjacent reefs. The transgressive system tract reveals backstepping aggradational buildup margins that caused bottom-water stagnation and seasonal oxygen deficiency in the adjacent basin, this is represented in the organic-rich fine-grained deposits interbedded with bioturbated horizons. During the highstand system tract, with relative sea level rising but at a slower rate, sediment production rates in the buildups gradually exceeded the rate of creation of accommodation space; as a result, reef-derived strata progrades -outbuilding- into basinal settings, this is represented in the reef tongues and intraformational coarse breccias interbedded with deeper organic-rich mudstones. The repetition of this pattern (i.e., transgression-to-highstand) produces sharp alternations between background and redeposited strata, which herein is illustrated by a model of reciprocal sedimentation.