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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.

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Abstract

The Duvernay Formation of Alberta is a mudrock reservoir that produces oil and gas from mature to overmature oil-prone source rocks. What makes the Duvernay Formation particularly attractive as a "shale" play like its American cousin the Eagle Ford Formation is its ability to produce significant volumes of liquids due to it's over pressured nature. The highest reservoir quality within the Duvernay is developed in high total organic carbon (TOC), siliceous mudstones. A strong positive correlation between silica content and TOC in the siliceous mudstones indicates a biogenic rather than detrital source for much of the silica and produces a higher modulus, brittle rock amenable to fracture stimulation (Dunn *et al*., 2012). A strong positive correlation between increased reservoir quality and TOC indicates an organo-porosity system analogous to the Barnett and Marcellus (Dunn *et al*., 2012).

Contrary to many people's perception these "basinal" source rock deposits are inherently heterogeneous due to the dynamic nature of their depositional environment. Variations in primary productivity, bottom water energy, rates/process of sediment accumulation and redox conditions, result in a complex depositional system (May and Anderson, 2011). Relative amounts of TOC, biogenic silica, clay, and carbonate control reservoir quality in the Duvernay vary systematically. "Conventional" Sedimentology and Sequence Stratigraphic work flows provide the framework to develop a predictive model deciphering rock quality to reservoir quality relationships both vertically and laterally.

In the study area the Duvernay is underlain by the Majeau Lake Formation and overlain by the Ireton Formation representing a single 2nd order depositional cycle (Switzer *et al*., 1994), with the Duvernay Formation deposited during the late Transgressive Systems Tract (TST) early Regressive Systems Tract (RST). High resolution macroscopic core descriptions are integrated with lab analyses and petrophysics to develop a higher order sequence stratigraphic framework in the Kaybob Study area.

The underling Majeau Lake Formation and Duvernay Formation succession comprises at least four 3rd order transgressive-regressive cycles (T-R) superimposed on the 2nd order systems tract (Fig. 1). Within an individual T-R cycle the mudstone becomes increasingly rich in organics and biogenic silica through the transgressive systems tract and progressively diluted by extra-basinal clay and carbonate detritus through the overlying regressive systems tract.

This sequence stratigraphic model has been integrated with the Duvernay Depositional Model (Fig 2.) and can be used not only to high grade geographic areas but can also be used to pick optimum horizontal drilling targets and/or completion zones in order to maximize production rates.

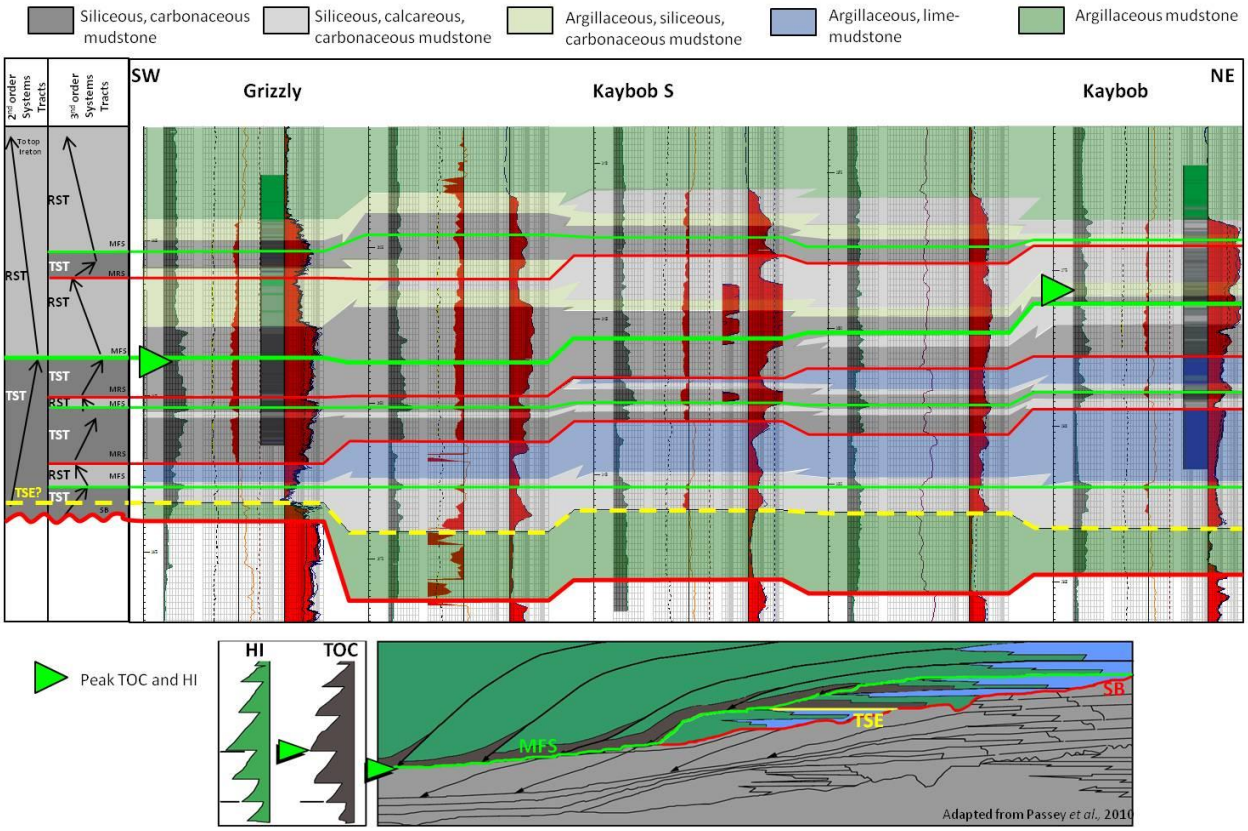

Figure 1. Proposed Sequence Stratigraphic model for the Duvernay Formation Kaybob, Alberta Canada.

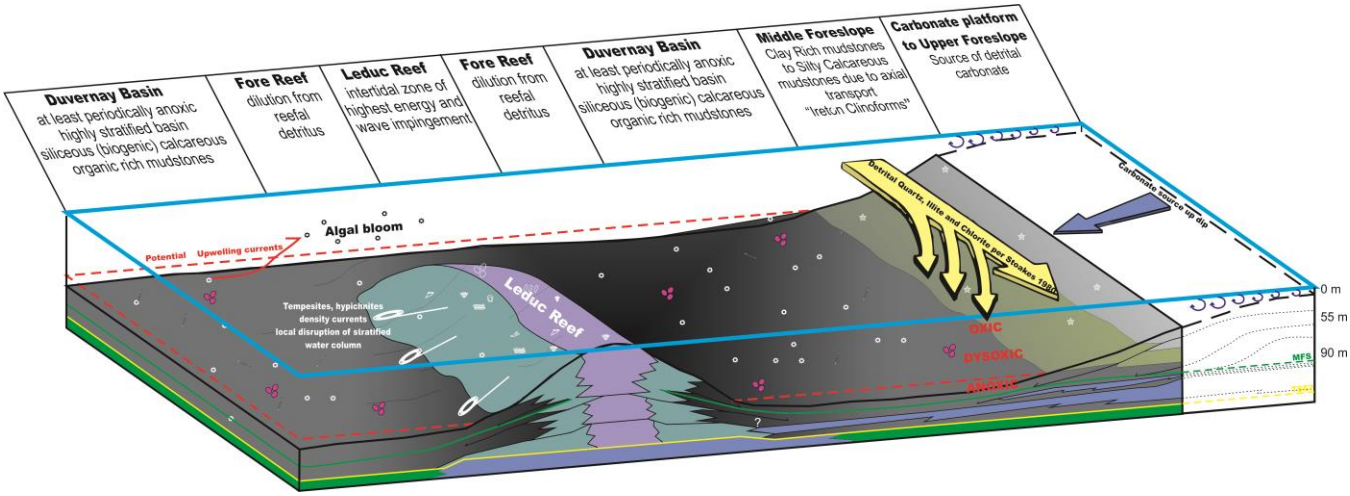

Figure 2. Integrated Duvernay Depositional and Sequence Stratigraphic Model for the Kaybob Area. Axial transport of clastic detritus material and estimated water depths as per Stoakes (1980).

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