

Comparative Regional Rock Properties/Trends and Oddities seen in the Duvernay Formation

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Summary

Geologists have known about the Duvernay Formation since the mid-20th Century. Firstly, as the source rock for the prolific conventional oil and gas discoveries in the Leduc and Swan Hills carbonate complexes. Now the Duvernay is seen in a much different light – as a shale oil/gas play – a phenomenon that seems to have taken over the world in terms of oil and gas exploration. Fall 2009 saw the beginnings of the Duvernay land sale rush, with a 300% increase in area sold with Duvernay rights (Low, 2012). From 2011 to present, detailed core and petrophysical analysis is being conducted in order to characterize this play (Low, 2012). A number of horizontal wells have now been completed and are producing, showing promising liquid-rich potential.

Core Laboratories has been at the forefront of developing shale plays around the world, including the Duvernay Formation. The Integrated Reservoirs Solutions (IRS) group has put together a Duvernay Consortium with a total of 13 working participants with a vested interest in geologically understanding this reservoir. To date we have 39 cores submitted to the consortium which have been extensively sampled and analyzed, detailing key reservoir attributes and providing a basis for understanding the quality and/or productivity of any given well. Reservoir quality within shale reservoirs depends on a number of attributes including organic richness (TOC and vitrinite reflectance), lithology (brittleness as a function of quartz vs. carbonate content); reservoir thickness (net shale); effective porosity and permeability and pressure gradients (Low, 2012).

The study area covers the main liquids-rich fairway extending from the Kaybob area in the north down through to Pembina and Willesden Green fields in the south. Dividing the study area into three zones (north, central and south) trending NW – SE, provides a comparative look at the key reservoir rock properties in main areas of interest. The Duvernay ranges in thickness from 20-80 m, with the thickest accumulations in the Kaybob and Wild River Sub-Basins and thinning towards the south. Pressure gradients confirm that the formation is overpressured, ranging from 0.6 psi/ft to 0.9 psi/ft, and increase with depth.

Organic richness is often the first parameter used when starting to evaluate a new shale play. Comparing the average weight% TOC values in each of the three areas, it was not surprising to find that the northern area (Kaybob, Waskahigan fields) showed the highest averages, closely followed by the central and southern regions. What was a surprise was the total and hydrocarbon-filled porosity results, which showed the opposite trend; with much higher porosity seen in southern regions (Willesden Green, Ferrier fields). Water saturations were also slightly

higher in the northern regions compared to southern and central regions, the lowest being in the Edson area. This is likely attributed to the proximity to the Leduc reef complexes where water saturations are typically high. Mineral composition distribution, specifically quartz, carbonate and clay content are important when evaluating the “fracability” of the shale, with average quartz content highest in the northern region and lower in southern and central regions. The opposite trend is seen for both the carbonate and clay models with higher averages in the southern area.

A number of oddities were also noted in some of the described cores. A concentration of barite rosettes and nodules was seen in the southern Willesden Green area. Not a complete surprise, as diagenetic barite commonly forms primarily under dysoxic conditions not unlike the conditions in which the Duvernay was deposited (Griffith, 2012). Anhydrite was also identified both in thin section work and core. Anhydrite fracture-fill and smaller nodules were seen largely associated with carbonate concretions and nodular/bioturbated limestone beds. Lastly, a fluid sensitivity test highlighted the effect of kerogen content on higher clay samples. Siliceous shales with higher kerogen content showed a lesser affinity to swell and mechanical breakdown when exposed to various completion fluids.

When comparing the areas of interest in the Duvernay Formation, they each have similar but unique rock property traits when looking at the overall regional picture. Each operator has a different set of criteria in which to evaluate the reservoir, as not one property typically has precedence over the other. Ultimately, it will be the future production rates that will distinguish the most and least productive areas.

References

Griffith, E.M., and Paytan, A., (2012). Barite in the ocean – occurrence, geochemistry and palaeoceanographic applications. *Sedimentology*, vol. 59, issue 6, p. 1817-1835.

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