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Geologic overview: setting the stage what makes the Duvernay tick at the Reservoir level

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Summary

The Duvernay Formation in the portion of west Central Alberta covered by the collective operations of the FCOG was first described by Imperial Oil in 1950 as a world class source rock. The Duvernay has been typed as the source formation for a prolific percentage of conventional, light, sweet oil that has been discovered in the basin. According to the AER the Duvernay Formation has sourced an estimated 443 TCF of natural gas and 61.7 billion barrels of oil. As the Duvernay began to be exploited as a reservoir the member organizations of FCOG began to systematically collect data to allow for a more complete and reservoir focussed description of the Formation. 25 cores, hundreds of wells with specialty logs and core studies were conducted in the initial vertical data point wells. The collection and analysis of data continued into the horizontal drilling phase with additional data such as image logs and permanent fiber optic installations. Data collection continues and is now dominated by production, reservoir and micro-seismic information.

The Devonian-age Duvernay Formation (Frasnian, c. 380 Ma) is a regionally extensive, organic and quartz-rich, marine mudstone deposited in variably oxygenated conditions. Stratigraphically, the Duvernay is bounded by the younger Ireton shale above, older Beaverhill Lake group (Waterways Shale & Swan Hills Reefs) below and laterally by age-equivalent Leduc reefs (Figure 1). These reef structures have been suggested to exert a major influence on Duvernay deposition representing both one of the primary sources of matrix/framework material and restricting circulation in the basin allowing for the preservation of organic matter (Stasiuk & Fowler, 2004; Knapp et al. 2017).

Theory / Method / Workflow

Critical play elements evaluated for mapping in the Duvernay include: (i) net reservoir thickness; (ii) pressure; (iii) gas to oil ratio (GOR); (iv) PVT/API well trends and (v) hydrogen sulphide (H2S) prediction. This talk will focus on how describing the interplay of these elements has led industry to focus on specific areas of the play.

The Duvernay reservoir can be split into several zones, starting with “C” at the bottom and “A” at the top. These two units represent the primary reservoir zones of the Duvernay, being composed primarily of organic-rich, quartz-bearing mudstones. The Duvernay “B”, located between the “A” and the “C” is of variable thickness and consists of a tight carbonate, generally not considered to be contributing to production. Landing zone strategies in Fox Creek have varied by operator and region, but in general consider several aspects of hydrocarbon deliverability in liquids-rich

unconventional systems for optimization of well placement. The primary considerations for well placement are reservoir quality and heterogeneity to optimize drilling and completion performance.

Results, Observations, Conclusions

Technical understanding of the Duvernay has evolved rapidly in recent years, with learnings from industry sharing groups providing opportunities to increase production (e.g. improved completion designs) and realize significant cost savings. This has resulted in further areas of the Duvernay being accelerated to development. Understanding of how geological properties (e.g. net pay, gas/oil ratio, pressure) do and do not influence production has allowed for high grading sweet spots of the play and focus efforts on core areas, while allowing less favorable areas to be further appraised. This talk will share insights regarding variations in rock properties both spatially and vertically through the formation. These learnings are critical not just for the Duvernay itself but have implications for understanding source rocks in a broader context.

Novel/Additive Information

Members of the FCOG have a broad-based data trade arrangement, allowing each member to obtain area wide information to integrate into their respective operations. Analysis of the data, estimated at hundreds of terabytes, has allowed for the development of a robust reservoir and basin models, it has allowed us to define “what makes the Formation work at the reservoir level”.

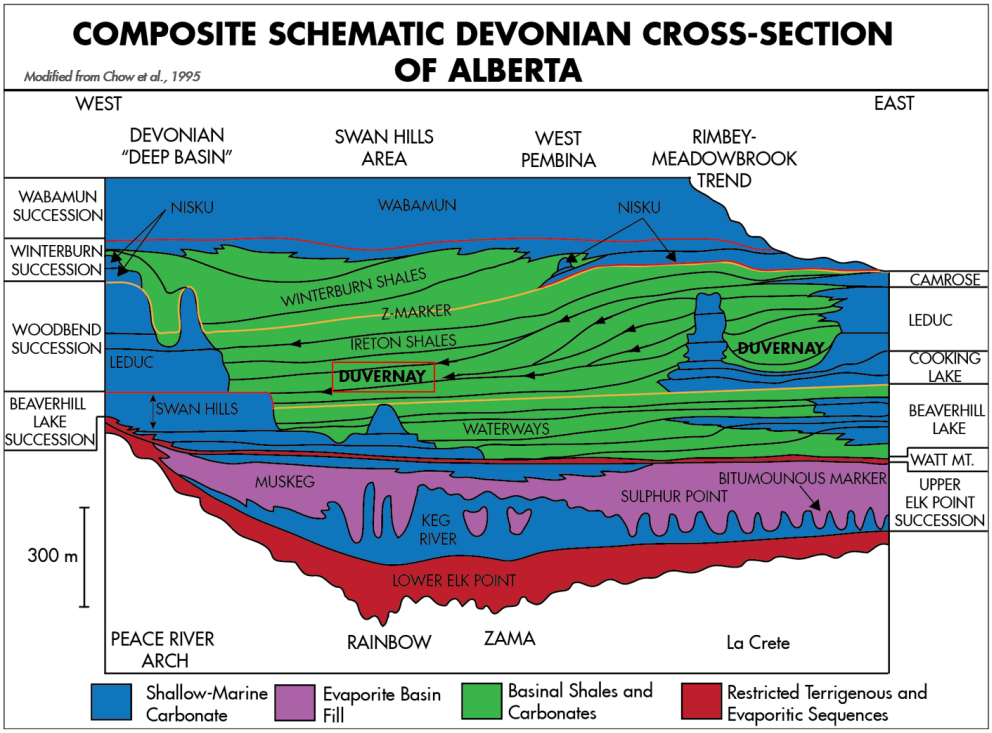

Figure 1: Composite Schematic Devonian Cross-Section of Alberta (from Chow et. al., 1995)

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