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Stratigraphy, Sedimentology, and Oil Behaviour in Lithic Reservoirs: venturing into uncharted areas of the Mannville Group world class petroleum system

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Summary

Despite containing some of the largest petroleum resources in the world (1.3 TBbls) (Alberta Energy Regulator, 2019), large areas of the lower Cretaceous Mannville Group have received very little attention in published research. Most of the Mannville stratigraphy remains undifferentiated across central Alberta where only three lower units are named. In contrast, the western gas prone Deep Basin Mannville with 12 stratigraphic units and the eastern heavy oil prone Lloydminster area with 10 stratigraphic units (Hayes et al., 1994). This is likely because no significant petroleum resources were recognized. However, about 3 TBbls of light to medium gravity oils were generated in source rocks in the foredeep on the west side of the basin, migrated 100's of kilometers east, and collected in traps near the eastern border where they were degraded to heavy oil and bitumen (Higley et al., 2009; Haeseler et al., 2010). Since migration is never a 100% efficient process (Schowalter, 1979), questions must be asked about how much oil was left behind, what is its quality, what are the reservoir pathways, and why has the resource not been recognized. This study looks at the reservoir pathways that would have controlled migration. It carries the Lloydminster stratigraphy 300km west into the eastern edge of the potential source area. Several Mannville formations transition from coastal plain to marginal marine to offshore within the study area. Several shale beds correlate across the study area. There are numerous channel and marginal marine lithic sandstone reservoirs in every Mannville formation. This presentation focuses on the stratigraphy and sedimentology of the Ellerslie to Rex equivalents (Ellerslie to Glauconitic).

Theory / Method / Workflow

Over a 35 year career as a petroleum geologist, I noted indications of oil on well logs of Mannville Group sandstones in thousands of wells in central Alberta and theorized there are significant resources present. Since 2016, developing an understanding of the Mannville geology within the region has been my primary task, first in industry and now as a graduate student. A patchwork of previous projects was integrated into a contiguous study over more than 73,000 km^2 (800 Twps.). Every well penetrating the Mannville was included in single to multi-township cross-sections. Tens of thousands of wells west and north of Lloydminster were correlated. Data from production, cores, fluid analyses, and well tests were placed within the stratigraphic framework. Input from literature, well results, and conversations with dozens of colleagues were integrated to build an understanding of the Mannville reservoirs.

The present study documents geology from the previous work with some additions over an area of >20,000km^2 (270 x 75 km) west and north of Lloydminster. A network of several W-E and S-N cross-section per township and range, including about 6000 wells, was built and correlated. Log facies distribution maps for each formation are being constructed. Significant reservoir sand bodies, shale units, and the nature of their boundaries are being defined. Cores will be reviewed wherever available to confirm the nature of log correlation boundaries. Some will be sampled for

mineralogy and diagenesis information. Existing literature is being tied into the stratigraphy of this study.

Results, Observations, Conclusions

The geologic complexity in the study area is typical of the Mannville formations in the more developed Provost to Lloydminster region. The primary difference is most reservoirs are lithic sandstones with high bound water that rarely produce oil at economic rates from vertical wells. Lighter precursor oils for the bitumen deposits are present. The use of multi-lateral horizontal wells in these reservoirs is recently proving to be very successful. This study will aid in a more complete understanding of the world class Mannville petroleum system.

Acknowledgements

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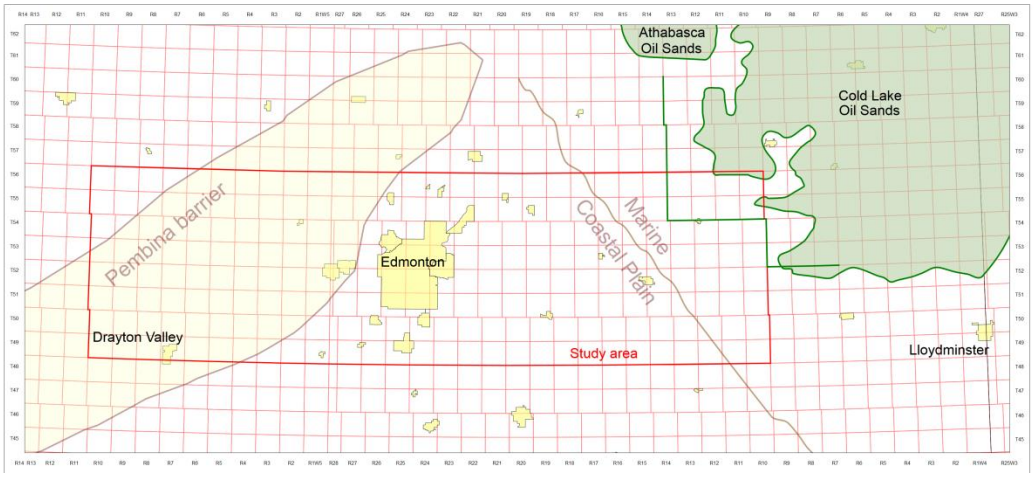

Figure 1. Study area outline in red. Geologic edges adapted from the Atlas of the Western Canada Sedimentary Basin: Chapter 19: Cretaceous Mannville Group (Hayes et al, 1994).

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