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Upper Mannville Formations in Leduc-Woodbend Area of Alberta

Unconventional Oil within Conventional Rock Developed with Unconventional Techniques

Sean Kostenuk[1], Dino Zelantini[1], Rob Brown[2]
1. Blackspur Oil Corp.
2. RGB Consultants Ltd.

Summary

Significant hydrocarbon reserves exist within early Cretaceous lithic sand reservoirs of the Upper Mannville Group in the Leduc–Woodbend field southwest of Edmonton. The field is unique compared to conventional heavy oil reservoirs (>20% porosity, >100mD permeability, <1000m TVD) in that it contains;

- heavy oil with a density >925kg/m^3
- API gravity <20° (aer.ca; neb-one.gc.ca,)
- abnormally deep depths of ~1300m TVD
- low total porosity and permeability of 9-15% and 0.02-10mD

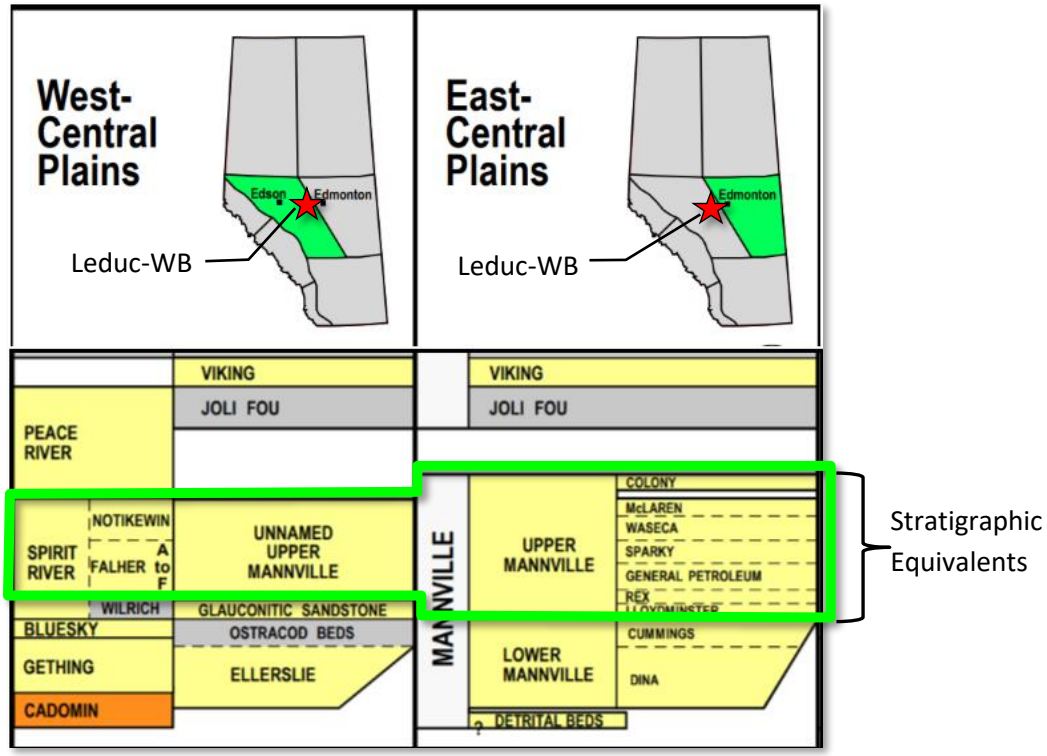
Upper Mannville deposits (Sparky & Rex Formation equivalents) in the field exhibit estuarine to fluvial continental depositional signatures, reflective of valley systems that were periodically inundated by flooding events. Sedimentological and petrological data derived from two recently cored Sparky intervals has been integrated with petrophysics and geophysics to aid geological mapping and resource delineation. Horizontal wells utilizing tailored completion and production techniques are now targeting these hybrid conventional/unconventional Upper Mannville reservoirs in the Leduc-Woodbend strike area, exploiting a resource estimated to exceed 2 billion barrels (OOIP)[1].

[1] Blackspur Oil Estimate

Introduction

Upper Mannville (Sparky) lithic sands in the Leduc-Woodbend area consist of stacked, fluvial channels recording valley-fill deposition in an estuarine coastal plain, periodically inundated by continental to nearshore storm flood events. Valley-fill sand bodies extend over several townships, ranging from 5-30m in thickness and exhibit porosity and permeability up to 18% and 10mD. Secondary porosity following lithic grain and clay clast disaggregation and/or dissolution is an effective porosity type likely associated with a porosity occluding mesogenetic to telogenetic ferroan dolomite cementation phase. Microporous clay grains, clasts and intergranular clays derived from disaggregated lithic grains result in higher bound water.

Figure 1: Table Of Formations Showing Stratigraphic Equivalents



These Upper Mannville reservoirs were largely ignored during the 1960's and into the mid 1990's as focus was on deeper, more prolific, light oil bearing conventional formations such as the Leduc, Nisku and Lower Mannville formations. However, technological advances in drilling and completion techniques piqued interest in these up-hole, less porous and permeable hydrocarbon-bearing lithic sands, and enabled some operators to successfully test, prove and produce oil.

In the mid 1980's and 1990's, two operators tested these Upper Mannville sands. Although they proved the existence of hydrocarbon, they were deemed un-economic as the production rates declined very quickly. Vertical well 102/16-33-049-01W5 drilled in 1985 by Penn West Petroleum was completed and placed on production and in 1998, operator Probe Exploration assembled an aggressive drill program drilling ~50 vertical and deviated wells targeting these lithic sands. These wells had average initial production rates of ~30 barrels per day oil and declined to ~10 barrels in just 6 months. To the operators surprise, oil from the Upper Mannville was heavy, viscous and difficult to produce, unlike the existing Lower Mannvile oil reservoirs. The conventional drilling, completion and production methods applied to the Upper Mannville lithic sands proved unsuccessful.

Advancements in unconventional drilling and completions such as horizontal wells combined with multi-stage fracking, led to a new wave of development for these lithic sandstone reservoirs. In 2009, Rondo Petroleum drilled, completed and produced two short length, frac'd horizontal wells. Again, these wells had high decline rates and were deemed un-economic. The short length 600m lateral sections combined with low frac intensity completions of only 6 fracs per well, and heavy, viscous oil were contributing factors.

As unconventional completion techniques rapidly evolved, Blackspur Oil was the next to attempt to produce economic heavy oil from the Upper Mannville lithic sand reservoirs. In 2014, Blackspur drilled the first 1 mile horizontal well utilizing an increased frac intensity completion resulting in increased initial oil production. Since 2014, Blackspur Oil has drilled ten horizontal wells within the Sparky Formation and continues to achieve increased production rates with favourable economics through the fine tuning of its drilling, completion and production techniques. Recent wells have average initial production rates of >250 barrels of oil per day.

Core data from the vertical well 100/16-05-050-01W5 drilled in 2017, is one of the few cores available from the Upper Mannville, Sparky and Rex Formations in the area. Core data alongside detailed stratigraphic correlation work is used to describe the paleoenvironment and assist with geological mapping. The data shows lithic sediments containing up to 13% porosity and 3mD permeability (Figure 2 & 3). Fluid analysis data show heavy viscous oil within the range of 14-20 API and 2,000cp viscosity at 20°C (Core Laboratories oil analysis).

Figure 2: 100/16-05-050-01W5 Lithological Ternary Plot

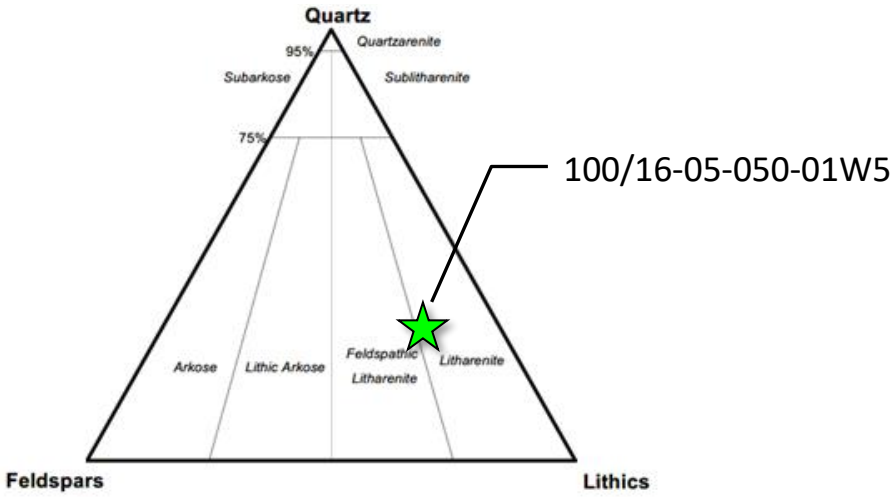
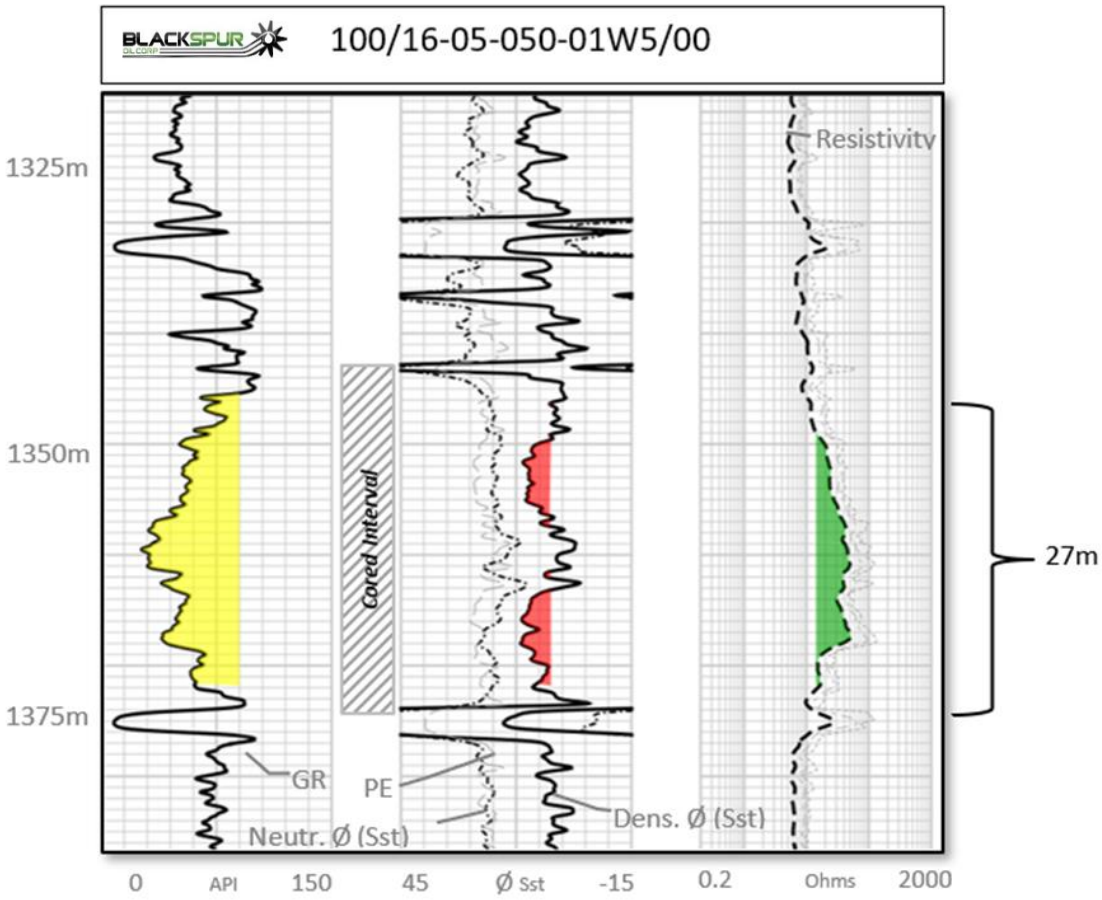


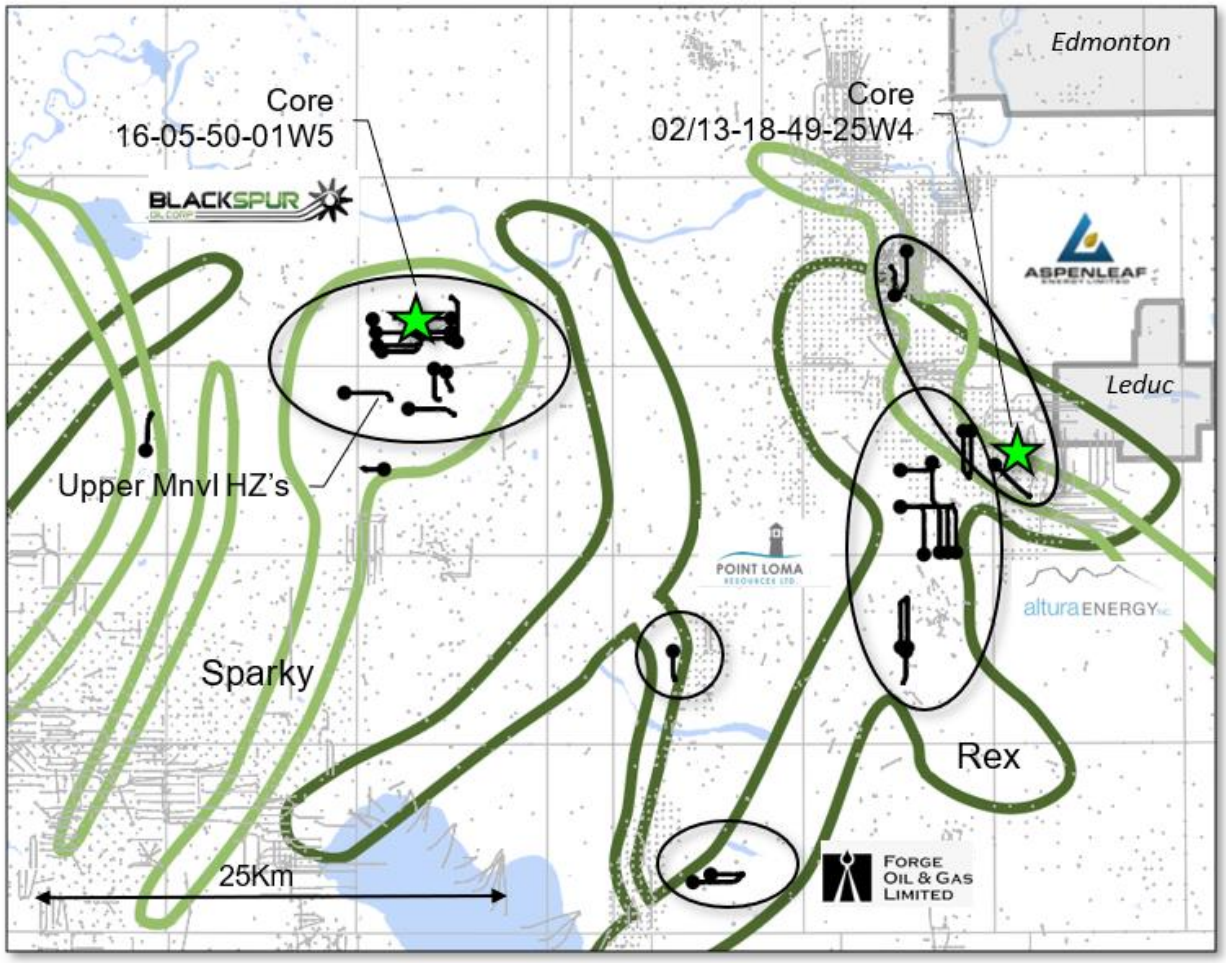
Figure 3: 100/16-05-050-01W5 Open-Hole Log Data & Cored Interval



The Upper Mannville reservoirs in the Leduc-Woodbend field are unique in that they contain heavy oil at abnormally deep depths (~1300m TVD) and low porosity/permeability when compared to most conventional heavy oil reservoirs. The combination of the permeability and the heavy oil create for a pseudo-unconventional play and is the reasoning for the delayed development.

Today, operators such as Altura Energy, Aspen Leaf Energy (formerly NEP), Forge Oil & Gas, Point Loma Resources and Blackspur Oil Corp. have been actively drilling horizontal wells targeting Upper Mannville reservoirs in the Leduc-Woodbend area (Figure 4). Since 2014, production from these tight sands has increased to > 3,000 boed (70% oil) as of January 2019 (GeoScout).

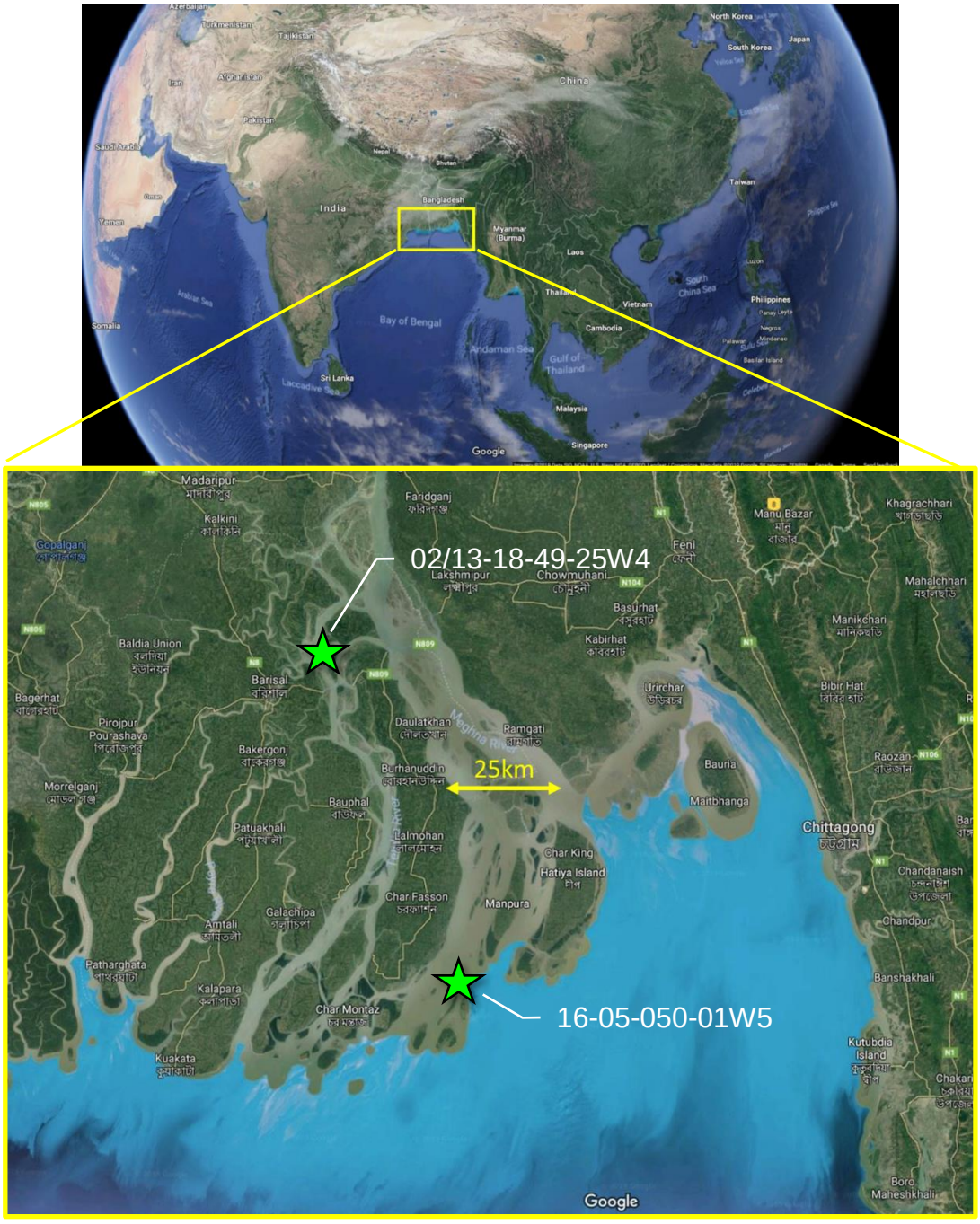
Figure 4: Upper Manville Sands Depositional Trend Illustration including Operators and HZ Mannville Wells



Modern Day Example

Upper Mannville coastal plain analog in the modern day Bay of Bengal including depositional environment interpretations of the 100/16-05-050-01W5 and 102/13-18-049-26W4 wells. (Figure 5).

Figure 5: Modern Day Depositional Environment Example: Bay of Bengal, India/Bangladesh



Conclusions

The Upper Mannville sands in the Leduc Woodbend area form conventional reservoirs that contain significant unconventional heavy oil reserves. These reserves were once deemed uneconomic due to production challenges and thus have remained under-explored and under-developed. Technological advancements applied to these sands are unlocking incremental resource resulting in improved production rates and economics. Continued development and technological improvements may further improve the recovery and economics of these Upper Mannville lithic sands which may significantly increase heavy oil production from the area.

References

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