Prospect To Reserves: De–Risking Unconventional Plays

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Mike Morgan, P. Eng.
Major Concepts

• To be of economic interest, a reservoir must be capable of flowing hydrocarbons to a well and the well must be capable of producing those hydrocarbons.

• A production test is the only “proof” for the “pudding”.

• The only exception is a mining operation... and there are very few hydrocarbon mining operations.

• But even mining operations require drilling delineation wells.

• There has never been, and likely never will be, a replacement for drilling and flowing to surface.

• In short, shareholders want you as the operator to prove to them the full value of the asset they own. This means you need to drill and test smartly.
What is an Unconventional Play?

- Anything that is not yet routine!
- Less glibly…
  - Geographically large
  - Requires thousands or tens of thousands of wells
  - Requires stimulation
  - Uneconomic at least 5 – 10 years ago
  - The net pay is hard to determine
  - Sustained development requirements: maybe decades of drilling
- Due to the high number of wells, reproducibility is key.
- Reservoir quality is never uniform.
- Not all resource plays are new!
Triassic Sediments in the WCSB

Panek 2000
Shallow Gas

![Graph showing the relationship between Total Gas Rate (MMcf/day) and Number of Producing Wells from 1960 to 2010. The graph displays a significant increase in both metrics after 1980.](Slide 5)
Shallow Gas 1960s
Shallow Gas 1970s
Shallow Gas 1980s
Shallow Gas 1990s
Shallow Gas Early 2000s
Shallow Gas Late 2000s
Looking at one of Canada’s original resource plays, we can see that 25 years of technology have incrementally added EUR, but have not fundamentally changed the picture.
Shallow Gas Geostatistics
### Play–Wide Drilling Timetable

<table>
<thead>
<tr>
<th>Well Count</th>
<th>Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>1–2</td>
<td>Discovery!</td>
</tr>
<tr>
<td>5–10</td>
<td>Confirm geological extent and test possibility of profit</td>
</tr>
<tr>
<td>25–50</td>
<td>Determine economic hydrocarbon price</td>
</tr>
<tr>
<td>50–100</td>
<td>Build “resource” level confidence, area by area</td>
</tr>
<tr>
<td>200–500</td>
<td>Build “reserve” level confidence, area by area</td>
</tr>
<tr>
<td>500+</td>
<td>Development, area by area</td>
</tr>
</tbody>
</table>
## Company Drilling Timetable

<table>
<thead>
<tr>
<th>Well Count</th>
<th>Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>1–2</td>
<td>Must have flowing hydrocarbons</td>
</tr>
<tr>
<td>5–10</td>
<td>Drill farther away and hope to get flowing hydrocarbons</td>
</tr>
<tr>
<td>10–25</td>
<td>Drill near the good wells to confirm economics</td>
</tr>
<tr>
<td>25–50</td>
<td>If you have success, push the distance limits. If you can build a variogram, jump to that distance as it’s the biggest reserves/resource ROI.</td>
</tr>
<tr>
<td>50–150</td>
<td>Continue drilling to demonstrate to regulators (and the investing public) that the results are economically viable and repeatable</td>
</tr>
<tr>
<td>200+</td>
<td>Land base is converted to “reserves” and developed, if still economic</td>
</tr>
</tbody>
</table>
Beaverhill Lake

Graph showing the total oil rate (bbl/day) and the number of producing wells from 1960 to 2010.
Beaverhill Lake 1960s
Beaverhill Lake 1970s
Beaverhill Lake 1980s
Beaverhill Lake 1990s
Beaverhill Lake Early 2000s
Beaverhill Lake Late 2000s
Beaverhill Lake EUR/mi²
Montney Drilling Up To 1990
Montney Drilling Up To 2000
Montney Drilling Up To 2005
Montney Drilling Up To 2008
Montney Drilling Up To 2010
Montney Drilling Up To 2012
Montney Liquids Yields
Montney Gas Geostatistics

Upper Montney
Declustered Average Rates (2011)

Lower Montney
Declustered Average Rates (2011)
Montney Contingent Resource
Montney Prob. Reserves (purple)
Montney Proved Reserves (green)
Major Conclusions

- The appropriate correlation/booking distance is play dependant.
- Major resource plays may require tens of thousands of wells and decades to fully develop.
- Development may suddenly halt due to external forces, as seen in the shallow gas example.
- Development may restart due to changing conditions, as seen in the Beaverhill Lake example.
- The size of the resources is known early on, the economic value isn’t. Smart operators will concentrate on delineating the expected economic outcome… and making sure they don’t miss anything!
- This will require a moderately large drilling and testing program, spaced at the appropriate correlation distance.
Contact Us

Keith Braaten
1–403–266–9515
kbraaten@gljpc.com

Jodi Anhorn
1–403–266–9479
janhorn@gljpc.com

Len Herchen
1–403–266–9507
lherchen@gljpc.com

Mike Morgan
1–403–266–9437
mmorgan@gljpc.com