Northern Petroleum

Virgo Technical Update

23rd October 2014
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Project summary

- Northern Petroleum has established a 30,000 acre land position in the Virgo area of NW Alberta to undertake a field re-development project.
- The area is prospective for light oil from Devonian Keg River vuggy carbonate reefs — approximately 1,500m depth.
- The recovery factor in the Virgo reefs is lower than analogue Keg River reefs to the south in the Rainbow area.
- Production to date has been through bottom aquifer drive.
- There has been lower recovery at Virgo from poor sweep efficiency at the reef edge due to reduced vertical permeability within heterolithic strata.
- Trapped oil at the reef edge is an attractive development target and well results prove its existence — additionally, vuggy carbonate reefs remain prolific, even at the reef edge.
- Well placed development locations have demonstrated high oil productivity.
- Recent well results have highlighted the importance of seismic interpretation to locate wells in a ‘sweet spot’ between the core and edge of the reefs.
The Virgo area

Virgo is located in a remote Boreal forested wilderness setting, 500 miles northwest of Edmonton, Alberta.
The area is prospective for oil and gas in several formations at Cretaceous and Devonian Levels.

- Upper Keg River formation has been prolific for oil with over 110 MMSTB produced to date in the area of the Northern’s land position.
- Up hole zones include the Sulphur and Slave Point formations — these tend to contain non-associated sour gas (although oil is also present).
- Oil is present in the Muskeg formation and the Muskwa Shale is prospective for oil and wet gas.

### Oil Pools

<table>
<thead>
<tr>
<th>Formation</th>
<th>Pool Count</th>
<th>Average STOIIP MMSTB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jean Marie</td>
<td>1</td>
<td>2.1</td>
</tr>
<tr>
<td>Slave Point</td>
<td>3</td>
<td>0.1</td>
</tr>
<tr>
<td>Sulphur Point</td>
<td>11</td>
<td>0.3</td>
</tr>
<tr>
<td>Muskeg</td>
<td>64</td>
<td>0.9</td>
</tr>
<tr>
<td>Keg River</td>
<td>416</td>
<td>1.5</td>
</tr>
</tbody>
</table>

### Non-Associated Gas Pools

<table>
<thead>
<tr>
<th>Formation</th>
<th>Pool Count</th>
<th>Average GIIP (BCF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bluesky (Cret.)</td>
<td>1</td>
<td>9.9</td>
</tr>
<tr>
<td>Slave Point</td>
<td>171</td>
<td>0.9</td>
</tr>
<tr>
<td>Sulphur Point</td>
<td>128</td>
<td>0.6</td>
</tr>
<tr>
<td>Muskeg</td>
<td>2</td>
<td>0.3</td>
</tr>
<tr>
<td>Keg River</td>
<td>23</td>
<td>0.6</td>
</tr>
</tbody>
</table>

Pool count in the 576 square mile region around company lands. Does not include co-mingled pools nor associated/solution gas volumes.
The Company participated in eight Crown land sales in 2013 and 2014

Acquired just under 30,000 acres for a total of Cdn2.9 million

The Company has obtained mineral rights covering 118 full or partial Keg River reefs

It is estimated that these reefs did contain 108 MMSTB of original oil in place based on the Alberta Energy Regulator’s (AER) estimate

The average recovery factor on these reefs is 18%
The area benefits from extensive infrastructure which was constructed between 1968 and the present day.

Good road infrastructure and proximal tie-in locations significantly reduce the cost of entry.
The company has purchased and interpreted over 50 sq km of 3D seismic.

Just under 30% of the land position is now covered.
# Keg River Formation at Virgo

## Average KR Reef properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Porosity</td>
<td>8%</td>
</tr>
<tr>
<td>Water Saturation</td>
<td>15%</td>
</tr>
<tr>
<td>Net Pay</td>
<td>35m</td>
</tr>
<tr>
<td>Radius</td>
<td>250m</td>
</tr>
<tr>
<td>$K_h$ (air)</td>
<td>100mD</td>
</tr>
<tr>
<td>Oil Gravity</td>
<td>32-40 API</td>
</tr>
<tr>
<td>Reservoir Temperature</td>
<td>75 °C</td>
</tr>
<tr>
<td>Original Solution Gas Oil Ratio</td>
<td>200-450 scf/STB</td>
</tr>
<tr>
<td>Initial Pressure</td>
<td>150 Bara (2200 PSIA)</td>
</tr>
</tbody>
</table>
Primary gas in the Keg River Formation

- The Keg River formation deepens to the West and is sourced from later basinal Keg River equivalent strata
- The increased maturity of the source rock leads to higher API gravity oils and additional gas generation
- Oil API gravity increases to the west (from 32 to 40 API), the saturation pressure increases and primary gas caps begin to develop
- Lands were deliberately targeted which did not have primary gas caps
Production performance in Keg River Reefs

- Displacement of oil by water within swept areas of the reef can achieve recovery factors between 45 – 65%

- To the south of Virgo, in the Rainbow area, recovery factors in the Keg River are much higher and demonstrate little un-swept pore volume

- This is due to many more wells / reef and larger reef size

- Why is the recovery factor at Virgo half as high and where is the un-swept pore volume?
Production performance in Keg River Pinnacle Reefs

The core of the reef tends to be homogenous and vertically continuous — whereas, the reef edge tends to be heterolithic and have vertical barriers to flow.

These vertical barriers at the reef edge can trap oil resulting in low recovery factors where well penetration counts are low.

When the reef is produced, aquifer support from the base sweeps oil from the core of the reef towards the production well until the well waters out.

After an extended shut-in, some oil migrates from the reef edge back to the core of the reef and some oil remains trapped at the reef edge.

This is not coning, it is low areal sweep efficiency.
Production performance in Keg River Pinnacle Reefs

Displacement (original well in reef)

- Primary production performance from original wells tends to show extended low water cut production followed by sharp water breakthrough — consistent with piston like displacement of oil by water
- The live oil viscosity varies from below 1 to 3 cP — good mobility ratio for the displacement of oil by water — again consistent with piston like displacement
- This suggests that coning is not occurring to a material degree and that un-swept pore volume results from geological factors rather than fluid dynamics

Drive

- Generally, under primary production, the reefs were produced with perforations near the top of the structure
- Drive energy came, predominately, from bottom aquifer drive
- Displacement is gravity stabilised
A series of horizontal sidetrack wells were drilled in the area between 1995 – 2005
- They were singularly unsuccessful at increasing recovery factor from the reefs
- Conventional horizontal wells are advantageous to suppress coning
- Due to oil being trapped by vertical layering at the reef edge, horizontal wells do not increase sweep

In 2001
100/15-23 Sidetrack (05 Event)
Produces 500 STB before watering out

In 2014
102/15-23 Vertical
Tests >1300 STB/D dry oil at the reef edge

Water, which has already displaced oil from the core of the reef will water out the heel of the horizontal well almost immediately. No additional oil will be captured from the heterolithic strata at the reef edge
## Phase 1B results (Oct 2014)

<table>
<thead>
<tr>
<th>Well and Objective</th>
<th>Drilling Result</th>
<th>Production Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>102/15-23</td>
<td>14m net oil pay</td>
<td>Well flowed at over 1,300 STB/D on test. Waiting on delivery of separator package.</td>
</tr>
<tr>
<td>100/14-23</td>
<td>4m net oil pay</td>
<td>Well swabbed 20 STB/D and pump run. Waiting on delivery of separator package.</td>
</tr>
<tr>
<td>100/01-27</td>
<td>0m net oil pay</td>
<td>MDT showed Keg River to be swept</td>
</tr>
</tbody>
</table>

[Map showing well locations]
Demonstrated un-swept oil at the reef edge and significant oil deliverability
Keg River reef was clearly oil saturated at 102/15-23 with a total of 14m of net pay interpreted based on the wireline logs.

Un-swept oil has been encountered in a heterolithic sequence at least 32m below the top of the Keg River perforated in the original producer, 350m away.

This well clearly indicates that significant un-swept oil is present at the reef edge.
MDT pressure show good overpressure, consistent with a significant gross hydrocarbon column and demonstrating the reef to be at original pressure

This suggests that the perforated interval may not be in hydrostatic equilibrium with the swept interval
The well cleaned up quickly and showed excellent deliverability with a productivity index of approximately 2.9 STB/D/Psi

The flow test was conducted over exactly 72 hours and was divided into the flow periods shown above

The average rate during the 12 hour high rate flow period was 1,313 STB/D against a ½” choke with 300 to 400 psi tubing head pressure

- **Perforated Interval** 1499.4 – 1508.8mMD
- **Net Perforated Pay** 9.2m
- **PHIE** 0.074
102/15-23 production and pressure history
production from 102/15-23 expected to be between 300 – 400 stb/d after tie-in
  - positions the well in the top 2% of flowing oil wells in alberta in terms of production rate
- only 12% of wells in the province flow to surface with the rest requiring artificial lift
Encountered poorly developed, but oil saturated reservoir
Completed for production
Keg River expression on the overlying Slave Point

- A thorough review of the 14-23 result has highlighted the importance of the muted expression of the Keg River structure on the overlying Slave Point surface
- This will improve our ability to discriminate between subtle Keg River tops and Muskeg on-lap on the reefs
Encountered high quality reservoir, but swept by original producer
## Well Results Phase 1A

<table>
<thead>
<tr>
<th>Well and Objective</th>
<th>Drilling Result</th>
<th>Production Result</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>14-22</strong>&lt;br&gt;Re-entry&lt;br&gt;Test for migration of oil after extended shut-in</td>
<td>Successfully re-entered&lt;br&gt;Up-hole zones cemented&lt;br&gt;Well swab tested and pump run</td>
<td>Well on test 02/04/2014&lt;br&gt;Produced over 3000 STB oil at an average water cut of 63%&lt;br&gt;Peak daily rate 100 STB/D and current rate 35 STB/D oil</td>
</tr>
<tr>
<td><strong>13-33</strong>&lt;br&gt;Infill well into previously produced reef&lt;br&gt;Test for un-swept oil at reef edge</td>
<td>Drilled and encountered 15m gross oil column in the Keg River formation&lt;br&gt;Produced dry oil on MDT test&lt;br&gt;Ran liner across Keg River and perforated&lt;br&gt;Well swab tested and pump run</td>
<td>Well on test 16/04/2014&lt;br&gt;Produced over 11,300 STB oil at an average water cut of 36%&lt;br&gt;Peak daily rate 260 STB/D and current rate 50 STB/D oil</td>
</tr>
<tr>
<td><strong>16-19</strong>&lt;br&gt;Exploration well into undrilled reef&lt;br&gt;Test new structure</td>
<td>Drilled and encountered 22m gross oil column in the Keg River formation&lt;br&gt;Produced dry oil on MDT test&lt;br&gt;Completed open hole with inflatable packer above oil water contact&lt;br&gt;Produced at high water cut after Inflatable packer failure&lt;br&gt;Liner cemented in place and perforated. Well flowing dry oil</td>
<td>Well on test 14/04/2014&lt;br&gt;Produced over 8,700 STB oil&lt;br&gt;The well continues to produce dry oil&lt;br/Peak daily rate 140 STB/D and current rate 70 STB/D oil</td>
</tr>
</tbody>
</table>
Virgo type curve and economics

Update on assumptions

- IP rates are higher than originally planned
- DCET costs should reduce with larger well programmes and lessons learnt
- Variable opex will significantly reduce if water separation and disposal facilities are built
- Fixed opex will reduce through synergies of scale
- Metrics are robust using a life of well $85 flat
- Payback within a year

<table>
<thead>
<tr>
<th>Cost (US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drill and complete</td>
</tr>
<tr>
<td>Equip and tie in</td>
</tr>
</tbody>
</table>

Forecast production and recovery

- IP30 (bbls/d) 150
- Year 1 decline 33%
- Estimated economic reserves (bbls) 125,000

Economics (using $85 WTI flat)

- Operating net back per barrel $37
- Payback (months) 10
- IRR 63%
- PV10 $2.09m

Note: assume well tied in upon completion

October 2014
Potential from existing land position

Virgo notional development plan

- AER STOIPP and recovery factors suggest that there are at least 12 reefs with the capacity for a minimum of three additional wells
  - minimum well recovery at 125 MSTB
  - at least 17 reefs which with capacity for a single producer
- Estimated that existing land position can support 64 wells
  - providing for 8,000,000 incremental oil recovery
- Sufficient for the Virgo asset to grow, organically, to 3,000 – 5,000 STB/D.

Key points for successful development

- New wells will increase recovery factors by targeting unswept areas of reefs
- Well locations will be optimised with increased understanding of edge reef environment
- Well evaluation and completion improved through application of formation tester data acquisition and interpretation