Abstract

A significant land posting and bidding event has occurred in Canada's north near the Arctic Circle. During the 2011-2012 period over 1 million hectares (2.5 million acres) were licensed in a region within the Northwest Territories of Canada called the Central Mackenzie Valley (CMV). A combined 624 Million dollars (CDN) were pledged as work commitments for unconventional oil shale exploration.

Within the CMV a well-developed and extensive Paleozoic basin had seen significant exploration for conventional oil and gas resources. While exploring this basin two highly prospective Mid to Upper Devonian organic rich shales were delineated at depths of 100 to over 2400 m. One of these shales has been identified by rock geochemistry as the source rock for the giant conventional Norman Wells Oil field (greater than 300MMBbls recoverable).

These shales, the Canol Formation and Bluefish Member, have excellent total porosity (8% to more than 16%), high total organic carbon (6% and greater), very low clay content, high silica content and low bound water, all of which makes them excellent candidates for oil shale development using horizontal wells and multi-staged fracture technology. The main target on the MGM's operated exploration licenses is the Canol Shale with its thickness up to 130 m. This paper will discuss the geological, geochemical, and geophysical characteristics of the two shale sections and present some preliminary results from a 2012 vertical well drilling, coring and testing program.

Selected Website

Geological, Geochemical and Geophysical Characteristics of the Devonian Oil Shales in Central Mackenzie Valley, NWT, Canada

Enachescu, M.E*., Price, P.R., Hogg, J.R., Kierulf, F., Cooper, M.F.J. & Springer, A.C.
MGM Energy Corp

Pittsburgh, Pa, 22 May 2012
Content

• Introduction
• Regional Geological Setting
• Organic Geochemistry and Petrography
• Seismic Characteristics of Devonian Shales
• Regional Canol Profile and Map
• East MacKay I-78
• Conclusions
Introduction

$630 MM for work programs on over 1.5 MM acres was committed 2011-12
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- 270 MMbbls produced from a Recoverable Resources of over 300 MMbbls (NEB)
- Known source rock of excellent quality

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A 39,400 bopd pipeline, operated by Enbridge from Norman Wells to to Zama (870 Km) is running at about 20% capacity

$630 MM for work programs on over 1.5 MM acres was committed 2011-12
Up to Now, Only Winter Operation Feasible!
Central Mackenzie Valley
Regional Geological Setting

- Northern extension of the WCSB
- Paleozoic continental margin basin
  - Platformal/Reefal carbonates
  - Evaporites
  - Clastics
- Unconformably overlain by a Cretaceous foreland basin
  - Clastics and Coals
- Evolution includes repeated episodes of extension, transtension and compression
  - Platformal in the east through simple monoclines to a fold and overthrust belt in the west
Reef and Basinal Stratigraphy

Canol 100+ m

Hare Indian Fm

Bluefish Mbr

Hume Fm

Basin Reef Basin
Regional Geology, Ramparts Reef and Shale Basin

Base Cretaceous

U. Imperial

L. Imperial

Top Canol

Ramparts Reef (Key Scarp)

Rampart Platform

Canol

Hare Indian

Devonian

Cambrian

Saline Rv Marker

Pre-Cambrian Basement

B-46

Canol

2 km

NW

SE
Presenter’s notes: **Stratigraphy from bottom up:**

**Hume** – last of a long succession of platformal carbonates and local evaporitic basins that began in the lower Devonian; composed of limestone/dolomite: may locally be a potential conventional reservoir, locally porous, locally vuggy, massive, nodular, fossiliferous, argillaceous; locally reefal and/or dolomitized

**Bluefish** - represents a marine transgression of the previous stable platform; – first of 2 such drowning events; composed of a bituminous highly organic black shale; occasional thin limestone interbeds potential source rock

**Hare Indian** – Shale generally thin-bedded, calcareous, micaceous with minor thin limestones; generally low TOC and tight

**Ramparts Platform** – not present everywhere;

**Canol** – Shale - Second major flooding event; Dark grey to black, organic rich, bituminous, yellow and rusty-brown weathering, siliceous, thin-bedded, fissile and predominantly non-calcareous shales; may locally contain paper thin black chert beds; may contain ironstone nodules at discrete stratigraphic intervals; in outcrop may have bright yellow sulphide and white mineral coatings at scattered intervals.

**Lower Imperial** – Predominantly marine shale with occasional interbedded marine siltstones and sandstones; major sandstone (Canyon SS) locally developed - tight fine to medium-grained sandstones and sandy shales
Paleogeographic Setting
Middle Devonian Time (385 Ma)

Adapted from figure on Colorado Plateau Geosystems, Inc. website after Blakey, R.C. March 2011
Presenter’s notes: Now take you on a bit of a geological field trip
We will look at 4 key wells in basin (from south to north) and Travel ~124kms from south to the north
1) Start at I-77 (on EL 466) then go to
2) K-71 (on EL 474)..... 15 kms from I-77 then go to
3) K-03 (on EL 470)..... 58 kms from I-77 (43 kms from K-71) and finally go to
4) F-27 (on EL 475)..... 124 kms from I-77 (67 kms from K-03)
I Want to show how:
a) correlatable lower Imperial to Hume section is
b) How consistent along strike the thicknesses and other parameters are within the Canol and Bluefish
Canol (1870.2 to 1965.5mMD)
- Thickness 95.3m
- Net Pay 59.3m
- Avg \( \Phi_T \) 13.9%
- Avg Sw 20.9%
- Avg VSh 21.9%
- Avg \( \text{TOC}_{\text{calc}} \) 6.9%

Bluefish (1986.1 to 2006.5mMD)
- Thickness 20.4m
- Net Pay 11.4m
- Avg Avg \( \Phi_T \) 10.2%
- Avg Sw 35.3%
- Avg Vsh 29.8%
- Avg \( \text{TOC}_{\text{calc}} \) 4.1%
### Petrophysical Summary

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Canol</th>
<th>Bluefish</th>
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<tbody>
<tr>
<td>Depth (m)</td>
<td>Subcrop to 2000</td>
<td>Subcrop to 2200</td>
</tr>
<tr>
<td>Thickness (m)</td>
<td>0 to 180</td>
<td>0 to 25</td>
</tr>
<tr>
<td></td>
<td>Avg Basinal 70</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Avg on Reef 20</td>
<td></td>
</tr>
<tr>
<td>Vsh (%)</td>
<td>15 to 29</td>
<td>14 to 35</td>
</tr>
<tr>
<td></td>
<td>Avg 20</td>
<td>Avg 25</td>
</tr>
<tr>
<td>Net Pay (m)</td>
<td>50 to 100</td>
<td>0.5 to 18</td>
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<tr>
<td></td>
<td>Avg Basinal 75</td>
<td>Avg 12</td>
</tr>
<tr>
<td>Total Porosity (%)</td>
<td>8 to 18%</td>
<td>8 to 17</td>
</tr>
<tr>
<td></td>
<td>Avg 12</td>
<td>Avg 11</td>
</tr>
<tr>
<td>Sw (%)</td>
<td>15 to 25</td>
<td>15 to 25</td>
</tr>
<tr>
<td>TOC (%)</td>
<td>6 to 24</td>
<td>4 to 10</td>
</tr>
<tr>
<td></td>
<td>Avg 8</td>
<td>Avg 6</td>
</tr>
</tbody>
</table>

Presenter’s notes: Examined 18 wells in basin … here is the summary of the data
Organic Geochemistry

Canol Fm. %TOC (max)
(based on Rock-Eval results from well cores and cuttings)

Legend
- Excellent TOC (>4.00%)
- Wells With Data
- Recent Exploration Wells (confidential)
- Wells With Suspect Data (excluded)
- Existing Oil Pipeline

30 Kilometers
Organic Geochemistry
Canol and Bluefish Shale parameters compare favourably with proven shale resource plays:

- **Organic Richness:** High TOC, excellent shale oil potential – Canol (3 to 27% in CMV; avg 6 to 8%)
- **Kerogen Type:** Liquid prone
- **Maturity:** Liquid window over most of the blocks
Assembled a regional coverage
Various data vintages 1970s to 2000s
Irregular grid
Tied to 24 wells
Variable datum
Some reprocessed
Poor to excellent data quality
K-71 Synthetic Seismogram

EL 474

89.7 m

19.0 m

Canol

Hare Indian

Bluefish
K-71 Synthetic Seismogram

EL 474

89.7 m

19.0 m
Seismic Section Through K-71
Seismic Section Through K-71
Canol Depth Map

Depth conversion of the Canol Time Structure using the time horizon and over 20 well Canol tops
NW-SE Devonian Cross-section

Hoosier Ridge
EL 475

Kee Scarp
Ramparts Platform
Hare Indian
Hume
Bluefish

Norman Wells

Kee Scarp

East Mackay
ELs 466 & 474

Canol
NW-SE Devonian Cross-section

Hoosier Ridge
EL 475

Kee Scarp
Hare Indian
Canol
Kee Scarp

Norman Wells

Kee Scarp
Ramparts Platform

East Mackay
ELs 466 & 474

Bluefish
Hume
Canol
MGM and Shell East MacKay I-78

Why Drill I-78?

- Located in EL 466
- Vertical Well approved
- Deeper and thick Canol within fault bounded syncline
- Offset East MacKay I-77
- Intersection of seismic lines
- Good seismic data quality
- Coring and logging will allow further research of seismic, geo-mechanical and reservoir properties of Devonian shales
Shale Oil Play in EL 466, CMV

- I-55
- I-77
- I-78

- Base Cretaceous Unc
- Imperial
- Canol
- Hume
- Saline Rv Mkr
- Proterozoic Unc
- Cretaceous
- L. Paleozoic

1.9 Km

Line 105

Line 145

SE
SE
S
S

Machine: PREC-DWCHLS1
Dataset: ScanLB105.Scanned.0
Dataset: 145.QI scanned STK.0

Dataset Information
User: menachescu
Date: Friday December 14, 2012 - 10:04 AM
Display Parameters
Trace Scaling: 20.000 Traces/Inch
Line Scaling: 20.000 Lines/Inch
Time Scaling: 5.000 Inches/Second
Trace Excursion: 1.000 Traces
Trace Clipping: 9.000 Traces
Scale Mode: File RMS
Direction: Left to Right
Polarity: Normal
Wiggle Style: Variable Density
Shale Oil Play in EL 466, CMV
East Mackay I-78

- Drilled to total depth
- Seismically prognosed tops came in ± 5m
- Cored Canol-Hare Indian-Blue Fish-Hume interval
- Full suite of wire line logs including Dipole Sonic
- Fracture stimulation of Canol and Bluefish using a clear mineral oil
- Confirmed presence of free hydrocarbons
- Shut-in for pressure build-up
Conclusions

• Canol and Bluefish Shales in NWT, Canada are excellent candidates for oil production based on petrophysical and geochemical data.

• The prospective Canol shale oil play was seismically mapped in a large area including portions of MGM ELs.

• Light oil was produced from the I-78 vertical well.

• Canol and Bluefish cored section in I-78 should allow for a better calibration of seismic data and the study of seismic attributes vs shale properties.

• A new unconventional oil play will emerge with important consequences for the NWT’s and Canada’s economy if post-drill analysis of Devonian Shales bring positive results.