Quebec's Horizontal New Play for Light Oil in the Gaspe Peninsula: Reprocessed 2-D Seismic Reveals Complex Structures that could be Significant Fields*

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Abstract

The search for commercial quantities of light oil in the Gaspe Peninsula looks promising along trend with the 2014 announced oil discovery in Galt Field. This discovery required horizontal drilling to maximize the wellbore contact with natural fractures and porosity in the previously uncommercial, Devonian-aged, Forillon Formation. Horizontal drilling is the key to commercial oil production in the Gaspe area. Thousands of acres along trend of the Galt Field discovery require a re-assessment as to horizontal drilling and exploration potential. This presentation will show where new discoveries could be found in central Gaspe Peninsula, based on reprocessed 2D pre-stack PSTM seismic lines, and surface and subsurface integration of geologic data. Mundiregina Resources Canada reprocessed 2008 2D lines in 2014-2015 and achieved an improvement in data quality. Reprocessed lines now image large thrusted anticlines and synclines in central Gaspe. Interpretation of the reprocessed seismic lines will be presented. The Gaspe area Silurian and Devonian rocks were deformed into an Appalachian-style thrust belt during the Acadian Orogeny. Tectonic forces included syn-sedimentary, listric, faulting during the Silurian, and thrusting and strike-slip movement during the Middle Devonian. Carbonate and siliciclastic rocks experienced hydrothermal fluids along faults and fractures during structural movement, enhancing porosity. Ordovician source rocks charged the overlying Silurian and Devonian section. A key piece of well data for the area is the Mont Alexandre #1 well (2009) which penetrated the Forillon Formation along trend with Galt Field. The key elements of productive Forillon reservoirs, including hydrothermal dolomite in natural fractures, are demonstrated to exist in surface outcrops along trend to Galt Field, and over an extensive area of the central Gaspe Peninsula. Older wells in the central Gaspe were shallow, vertical wells. Light oil potential was left undiscovered by abandoning these old wells.
Quebec's Horizontal New Play for Light Oil in the Gaspe Peninsula:

Reprocessed 2D Seismic Reveals Complex Structures That Could Be Significant Fields

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AAPG ACE Calgary 2016
Quebec, Canada
A new light oil frontier

Great source rocks!!

Light Oil (condensate) discoveries

Thick oil columns

Undrilled fairways and large structures
Appalachian Fold Belt

Notice that the Gaspe Peninsula is the northern-most expression of the U.S. Appalachian fold belt.
Upcoming Lease Opportunities

Leases frozen since 2008 are likely to go out for bid again. Quebec Government will ask leaseholders to pay more. Current operators can’t keep all their acreage.
Location of Discoveries & Deepwater Ports

Port Daniel
Port Bonaventure
People think this is a gas play, but it's not!

Proven Commercial Oil

Source rocks are in the oil window
Junex Oil Discovery - Galt Field

- Canadian junior oil company, owns majority of field
- 557 MMBO in place, 71 MMBO Recoverable unrisked prospective oil
- Modern horizontal drilling using their own rigs
- Galt #4 horizontal well, drilled in 2014, yielded 7200 barrels light sweet oil at 100-300 bbl/day.
- Successful DST of oil in the Galt #5 (8200 ft test)
- Large 3D processed in November 2015.
Junex Oil Discovery - Galt Field

- Devonian-age low porosity reservoirs exploited by modern horizontal drilling using their own rigs

- Structural trap is a complicated strike-slip flower structure. 3D was required for well placement.
Horizontal Drilling is the key to Gaspe production

It's important to intersect natural fractures
Geologic Setting

Drilling History
1860-present

Stratigraphic Column:
Canada and the US
Gaspe is a Continuation of U.S. Paleozoic Trends
Trend of Paleozoic Fields

Trend of Paleozoic fields
Cambrian, Ordovician, Silurian-Devonian
## Ordovician to Devonian Rocks

### Stratigraphic Column

<table>
<thead>
<tr>
<th></th>
<th>NEW YORK USA</th>
<th>GASPE CANADA</th>
<th>SOURCE RX</th>
<th>RESERVOIR</th>
<th>Tectonic Events</th>
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<tbody>
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<td></td>
<td></td>
<td>sandstone</td>
<td>Stronger impact</td>
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<td>Catskill shales Tully Limestone</td>
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<td>MARCELLUS SHALE</td>
<td>Battery Point Sands</td>
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<td>Indian Cove Lmst</td>
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<td>Pabos Shale</td>
<td>MACASTY SHALE</td>
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<td>?? Equivalent??</td>
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<tr>
<td>Potdsoam Sandstone</td>
<td>Metamorphosed Cambrian</td>
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</tbody>
</table>

**Tectonic Events:**
- 350 -- Alleghenian
- 352 -- Acadian Orogeny
- 441 -- Taconic Orogeny
Gaspe Drilling History

1836- first reports of seeping oil in Gaspe Peninsula
1860- first shallow drill holes
1897- first oil collected
1990-2000- Government-encouraged increase in drilling
2014- Horizontal technology brought in
2009-present - commercial oil production

200 WELLS IN GASPE
WELLS DRILLED BY DECADE

Most recent
23% of wells in Gaspe have oil and gas shows
Oil Seeps at the Surface near large undrilled structures
Two Source Rocks Charging the Section
Reservoir Rocks in Gaspe

Middle-Lower Devonian host rocks are low porosity limestones (2-6%) interbedded with silt.

Silurian reservoirs include the Sayabec Fm which has >10% porosity.

High porosity hydrothermal dolomite found in fractures.

High Permeability Reefal Bioherms.
Field observations

Fortin Group Facies B: Siltstone, ±calcareous, high fissibility.
Facies C: Sandstone, ±homogeneous.
Facies D: Polymict conglomerat, well to poorly sorted.
Junex Lemaire H-Q, Galt No 3 Well

Hydrothermal dolomite

Hydrothermal breccia at 2248 mkb
- saddle dolomite, barite
- oil and gas shows

~ 415 barrels of oil
recovered in 2004 and 2005
(200 mcf/day of gas, Galt No 1)

Photo provided by J.-S. Marcil
Recent well results

Mundiregina Resources
Mont-Alexandre #1 (2008)
Well log correlation

MT ALEXANDER WELL #1

50 KM

GALT 1 WELL

True Forillon thickness about 650 meters (2132 ft) corrected for 45 Degree Steep dips while drilling

6/21/2016
Structural Geology and Seismic Lines

Fault bend folds
Surface Geological Map of Gaspe

- Middle Devonian
- Lower Devonian
- Ordovician

Features:
- 25 mile long anticlinal fold belt
- 20 kilometers
- 12 miles

Geological Features:
- Metamorphosed Cambrian-Ordovician
- Middle-Lower Devonian Fm fold belt
- Anticline
- Syncline
- Silurian fold belt
- Ordovician
Devonian-age Strike Slip Faulting
Central Gaspe fold belt
Interpreted Stratigraphy
From Seismic Character

Middle Devonian
Lower Devonian
Silurian
Ordovician ??
Utica Shale ??
Cambrian ??
Flattened on the Silurian

Silurian
Ordovician ??
Utica Shale ??
Cambrian ??
Flattened on the Detachment
Champlain Prospect - Reprocessed 2D Seismic Segment

Shickshock Sud Fault
Causapscal Fault
Grand Pabos Fault

Surface oil shows

2014 Reprocessed Segment

HUMBER ZONE
SHICKSHOCK-SUD FAULT
CAUSAPSCAL FAULT
GRAND-PABOS FAULT

SOUTH

Shoreline
PLATFORM

0 km
10 km
67,000 acres
30 miles long
Conclusions

- Light Oil Play - not a gas play
- Source rocks are Marcellus and Utica age equivalents
- Old straight holes poorly evaluated the light oil play
- New 2014-15 horizontal drilling at Galt field applied transformative technology
- Large undrilled structures
- Acreage will likely be coming available in future bid rounds