Shale Gas and Oil in Canada: Current Development and Exploration Targets in a North America Context*

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Editor’s note: Please refer to a related article by the author; it is entitled “Lower Paleozoic Shale Gas and Shale Oil Potential in Eastern Canada: Geological Settings and Characteristics of the Upper Ordovician Shales,” Search and Discovery Article #80242 (2012).

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Abstract

Over the last few years, development of shale gas and oil has significantly changed the energy outlook of North America. From years of slow decline in production volume of conventional resources, the input of unconventional hydrocarbons has positively impacted on the overall energy independence to foreign sources. The development of shale gas and oil in the US has been hectic in the last decade or so; conversely, Canada, given its large reserves of conventional hydrocarbons has been lagging behind. Recent evaluations from Canadian industry and government regulators indicate the potential presence of over 1500 TCF of gas-in-place. Production from Devonian and Triassic shale gas and Devonian-Carboniferous shale oil in western Canada is now rapidly ramping up.

The Geological Survey of Canada (GSC) research on source rocks of conventional hydrocarbon systems led to identification of potential shale targets for oil and gas. In eastern Canada, fundamental research and pre-production drilling and completion have identified the Upper Ordovician and Carboniferous shales as the next targets to be developed for their natural gas potential. Lesser known Middle Ordovician and Devonian shales are longer-term potential targets for resource appraisal.

From Ohio in the US to the Gulf of St. Lawrence in eastern Canada, the regional Upper Ordovician Utica Shale has various thermal maturation domains and preliminary results indicate that large areas have oil potential (Ohio and Anticosti Island). Further to the east, Lower Ordovician shales of the Green Point Formation in western Newfoundland are tested for their oil potential.

For decades, fundamental research of the GSC has been concerned with all aspects of conventional hydrocarbon systems; new research projects on the unconventional systems are now being developed in response to the increasing demand of geoscience data. On-going activities range from development of resource-reserves evaluation to geoscience approaches for continuous accumulations, evolution of pore space in diverse types of organic matter during burial, methodology for assessing geological integrity of shale cap-rock, and new chemostratigraphic approaches for sweet spots identification.
Moreover, in response to societal concerns on groundwater and environmental matters, research on water management issues and the potential for induced seismicity from well completion techniques are in progress.

**Selected References**


**Selected Websites**


http://photos.state.gov/libraries/usoecd/19452/pdfs/DrNewell-EIA-Administrator-Shale-Gas-Presentation-June212011.pdf
SHALE GAS AND OIL IN CANADA: CURRENT DEVELOPMENT AND EXPLORATION TARGETS IN A NORTH AMERICAN CONTEXT

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Geological Survey of Canada - Quebec Division
Outline of the presentation

1. Shale gas and oil, the situation in North America

2. Research projects of Natural Resources Canada
   - Resource characterization and evaluation
   - Environmental - hazard potential impacts

3. Defining the shale unconventional potential in eastern Canada frontier basins.

4. Conclusions
Shale gas / tight oil in the US
Towards energy independence
Shale gas production in USA

2.0 Tcf/y

Source: EIA
US natural gas 25 years outlook

Source: EIA, Annual Energy Outlook 2011
Oil production in the USA
Stopping the decline

Source: U.S. Energy Information Administration
A new era; from conventional to tight oil
Shale gas / tight oil in Canada

A late start, but rapidly picking up
Montney 700

Planned LNG terminals

Shale Gas
Projected Natural Gas In Place

1700 Tcf
Shale gas production in Canada

Supply limited market: LNG import projects built

3 Bcf/d

Shale gas era begins

Inversing the trend
And Canadian tight (shale) oil plays

North American shale plays
(as of March 2011)
A recent significant increase in tight oil production
Current research by Natural Resources Canada

Focusing on geological and environmental issues
Montney

1700 Tcf

Groundwater studies
Induced seismicity study
Resource evaluation studies
Cap rock integrity studies

Planned LNG terminals

Projected Natural Gas In Place
Early definition of gas and oil potential of Ordovician shales in eastern Canada
Upper Ordovician Black shales
Mid- to Late Ordovician

Formation of a tectonic foreland basin

Miall and Blakey, 2008
Seismic reflection and subsurface understanding
Seismic reflection and subsurface understanding
Lorraine
(> 1000 m)

Utica
(50 - 300 m)

Trenton
(250 - 300 m)

Burrows
Ostracodes, cephalopods, Trilobites, chitinozoans, Little to NO pyrite

Cyclic micrite beds
Depth to the top of the Utica Shale

- Exploration wells (60)
- 2800 Rock Eval
- 300 Ro analyses
- 500 XRD

< 800 m

1200 - 2500 m

Yamaska Fault

Logan’s Line
Thickness of the Utica Shale

- Ave. = 105 m
- Ave. = 220 m
- Ave. = 640 m

Yamaska Fault
Logan’s Line
Total Organic Carbon (TOC)

- Logans Line
- Yamaska Fault

- Over 2%
- 1 – 1.5%
- Best hz well: 12 MMSCF/d

Distribution équivalente – COT

Canada
Utica Formation Thermal Maturation

HYDROCARBON GENERATION STAGES

- Oil
- Condensate
- Dry gas
- Anchizone
- Epizone

Lithologic contacts

Faults

Normal

Thrust
Mineralogy - X-Ray Diffraction

Quartz + Feldspars

- Lorraine
- Upper Utica
- Lower Utica
- Trenton

Calcite

Clays
A new potential target
Shale oil in Upper Ordovician shales on Anticosti Island

<table>
<thead>
<tr>
<th>AGE</th>
<th>FORMATION</th>
<th>LITHOLOGY</th>
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<tbody>
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<td>Jupiter</td>
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<tr>
<td>= Utica</td>
<td>Macasty</td>
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<td>Black River</td>
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<td>Pre-Cambrian</td>
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From Corridor Resources
Geological and thermal settings
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<th>Property</th>
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<tbody>
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<tr>
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<td>Carbonate content</td>
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<td>TOC</td>
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<td>Kerogen type</td>
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<td>Porosity</td>
<td>2.4-5.1% average 3.6%</td>
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<tr>
<td>Permeability</td>
<td>200 to 740 nD average 480 nD</td>
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<td>Oil saturation</td>
<td>27%</td>
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<tr>
<td>API gravity</td>
<td>35°</td>
</tr>
</tbody>
</table>

*From Corridor Resources, 2011*
A new potential target
Shale oil in Upper Ordovician shales on Anticosti Island

P50 estimate of OIIP: 45 BBO

From Corridor Resources, 2011
Conclusions...

Shale gas and tight oil are changing the hydrocarbon markets in North America.

Production from unconventional reservoirs is rapidly picking up in Canada, stopping the multi-year production decline.

Natural Resources Canada is currently carrying out fundamental research on resource evaluation / characterization as well as on potential environmental impacts on groundwater and risk of induced seismic activities in producing fields and frontier areas.
... Conclusions

1. The Upper Ordovician black shales in Quebec consist of the Utica and Macasty calcareous shales.

2. The Utica Shale has been successfully fractured in southern Quebec with the best IP of 12 MMcf/d

3. OGIP estimates range between 120 to 140 Tcf (P50)

4. The Macasty has not been tested yet; preliminary technical data indicate that the calcareous shale is oil saturated and in the oil window

5. Preliminary OOIP estimate is 45 BBO (P50)
Thank you!

Utica Shale along the Jacques Cartier River
30 km southwest of Quebec City