Shale Gas Opportunities in Southern Ontario – an Update

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48th Annual OPI Conference and Trade Show
Sarnia, Ontario
Acknowledgements

- Oil, Gas and Salt Resources Library
- Staff of Petroleum Resources Centre, MNR
- Tony Hamblin, GSC – Open File Report 5384
Regional Geological Setting and Shale Gas Plays

Antrim Production
2.7 tcf

Michigan Basin

Marcellus Play Area

Utica Play

New Albany Shale

Illinois Basin

Ohio Shale
2.6 tcf

Appalachian Basin
Potential gas shales in Ontario

Same plays as in NE U.S. and Quebec

Best potential in:
- U. Devonian Kettle Point Fm (Antrim shale equivalent)
- M. Devonian Marcellus Formation
- U. Ordovician Blue Mountain Formation and Collingwood shale (Utica equivalents)

- Gas shows, no current production
- Unexplored (only one shale gas exploratory well)
- Large prospective areas
Potential Gas Shales in Southern Ontario - outcrop
Blue Mountain / Collingwood (Utica)

- **Collingwood**
  - Calcareous shale; average thickness 4 to 6 m, max 12 m
  - TOC: 1 to 11%, marginally mature to mature
  - Depth to top: outcrop - 175 m
  - 25,000 km²
  - Attempts to extract oil in 1860’s

- **Blue Mountain Formation**
  - Unsubdivided Georgian Bay-Blue Mountain Formation in subsurface
  - Non-calcareous shale approximately 75 m thick
  - Lowermost 2 to 50 m is black organic-rich with up to 3 % TOC
  - Depth to top: outcrop - 1000 m
  - 70,000 km²
Blue Mountain / Collingwood

TOP: 804.3 m

BOTTOM: 850.6 m
Collingwood subcrop / outcrop

Churcher et al, 1991
OFR 5817
Georgian Bay-Blue Mountain Structure

- Michigan
- Lake Huron
- Ontario
- Lake Ontario
- New York
- Lake Erie

C.I. = 50 m
Georgian Bay-Blue Mountain Isopach

C.I. = 50 m
Georgian Bay-Blue Mountain Gas Shows

Ontario

Lake Ontario

Michigan

New York

Lake Erie

C.I. = 50 m
Blue Mountain black shales

black shale
1000-1055 m
Maturity Studies

• Obermajer, Fowler & Snowdon, AAPG 1999

• Core, cuttings, outcrop

• Most samples are mature, in oil window

• Increase in maturity to southeast (Repetski et al, 2008)

• Lack of samples in southeast where shales are thickest – gas window?
Marcellus Shale

- No surface outcrop, subcrop beneath glacial drift
- Max 12 m thick beneath Lake Erie
- TOC: 1 to 11%
- Depth to top: subcrop to 225 m
- 4700 km², mostly beneath Lake Erie
- Marginally mature
Marcellus Formation

No outcrop at surface
Marcellus shale subcrop

Michigan

Lake Huron

Ontario

Lake Erie
## Subsurface Paleozoic Stratigraphic Chart

### Subsurface Paleozoic Stratigraphic Chart

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<th>Age</th>
<th>Windsor-Essex</th>
<th>London area</th>
<th>Niagara Peninsula</th>
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### Key Locations
- **Kettle Point**
- **Marcellus**
- **Blue Mountain + Collingwood**

### Legend
- Clastics
- Carbonates
- Evaporites
- Shales
Kettle Point Formation

• Subcrop beneath glacial drift – only 3 outcrops
• Max 105 m thick, average 28 m
• TOC: 3 to 15%
• Depth to top: outcrop to 143 m
• 9500 km², 50% beneath Lake Erie
• Thermally immature
• Numerous gas shows in petroleum wells and water wells
• Production in late 1800’s near Ridgetown for street lighting
• One exploratory well: OSN Gore of Chatham, Chatham 7-16-IV in 2006 – reported as plugged & abandoned with gas show
Kettle Point Formation
Kettle Point Isopach

Michigan

Ontario

Lake Huron

Lake Erie

New York

C.I. = 20 m
Gas Shows in Hamilton Group

Michigan

Lake Huron

Ontario

Lake Erie

Hamilton Group

Subcrop
Gas Shows in Drift

Michigan

Lake Huron

Ontario

New York
Natural Gas in Groundwater “Contact Aquifer”

Gas in “contact aquifer”

Top of bedrock
All Gas Shows associated with Kettle Point

- Gas shows in Hamilton Gp.
- Gas shows in water wells
- Gas shows in drift
Biogenic or Thermogenic?

• No direct evidence for any of the Ontario shales
• Natural gas in drift and bedrock over prospective shales is associated with fresh water and may be biogenic
• Shallow, low temperature
• Antrim shale in Michigan is at least in part biogenic
• Best potential for thermogenic gas may be in the deeper thermally mature Blue Mountain / Collingwood shales
Summary

- Shale gas potential in Kettle Point, Marcellus, and Blue Mountain / Collingwood formations
- Large prospective areas
- Thermally immature to mature
- Favourable depths and thicknesses
- Natural gas shows reported – large number in Kettle Point formation
- Gas is there - Can it be commercially recovered?
- Research project initiated by Ontario Geological Survey in 2009 – Catherine Béland-Otis
Ontario Bedrock Geology

Lake Huron
Lake Erie
Lake Ontario

Algonquin Arch
Findlay
Frontenac Arch
Arch Michigan Basin
Appalachian Basin
Chatham Sag

BEDROCK GEOLOGY
Precambrian
Lower Devonian
Middle and Lower Silurian
Middle Devonian
Middle Ordovician
Upper Ordovician
Upper Silurian
Upper Devonian
All Gas shows associated with Kettle Point

Michigan

Lake Huron

Ontario

Lake Erie

- Gas shows in Kettle Point
- Gas shows in Hamilton Gp.
- Gas shows in water wells
- Gas shows in drift
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Stratigraphic Correlations

Antrim Shale
MICHIGAN BASIN

Kettle Point Formation
MICHIGAN AND APPALACHIAN BASINS

400

Ohio Shale
APPALACHIAN BASIN

Bedford Shale

Ellsworth Shale

Kettle Point

Chagrin Mbr

Upper Submember

Middle Submember

Lower Submember

Huron Member

OLENTANGY FM.