Shale Gas, Oil Shale, Coal, Potash and MVT in Southwestern Manitoba
2009 Update

by James Bamburak and Michelle Nicolas
Manitoba Geological Survey

Presentation to Manitoba Mineral Society
April 1, 2009
Shale Gas

- Michelle Nicolas is undertaking a multi-year shale gas study.
- Shallow Cretaceous shale gas, with up to 276 kPa (40 lbs.) of naturally compressed pressure, known for over 100 years in Manitoba.
- Used intermittently for local lighting, heating and cooking.
Shale Gas

Gas well ignited in 2003, near Notre Dame de Lourdes, by the local landowner, Normand Bosc.

Composition of gas:

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>methane (CH₄)</td>
<td>81.87 %</td>
</tr>
<tr>
<td>nitrogen (N₂)</td>
<td>16.79 %</td>
</tr>
<tr>
<td>oxygen (O₂)</td>
<td>0.460 %</td>
</tr>
<tr>
<td>carbon dioxide (CO₂)</td>
<td>0.37 %</td>
</tr>
<tr>
<td>ethane (C₂H₆)</td>
<td>0.219 %</td>
</tr>
<tr>
<td>argon (Ar)</td>
<td>0.151 %</td>
</tr>
<tr>
<td>helium (He)</td>
<td>0.1350 %</td>
</tr>
<tr>
<td>propane (C₃H₈)</td>
<td>0.0038 %</td>
</tr>
</tbody>
</table>
Shale Gas

- Well situated near edge of Manitoba Escarpment.
- Source of gas believed to be porous siltstone bed within Boyne Member of Carlile Formation; or possibly the deeper Favel Formation.
- Gas recharges in well 24 hours after ignition.

May, 2004

June, 2006

Oct., 2006

Sept., 2008
Shale Gas

- Two gas wells located in Pembina River valley, near Manitou.
- One well drilled by Federal Dept. of the Interior in 1906/07.
Shale Gas

- Target of drilling was source of oil floating on the river; but in July 1907, high pressure pocket of natural gas struck at depth of about 58 m.
- Oil was not found to a depth of about 167 m; and the well abandoned Nov. 1907.
- Shown at left, is Percy Lea (local landowner), who equipped the well with a small storage tank, pressure gauge and regulator; and who periodically ignites the gas for interested parties.

Sept., 2008
Shale Gas

- Another near-by gas well has been fitted with a larger storage tank.
- Stored gas is used on special occasions for barbecues.

Tastes better with MB natural gas

<table>
<thead>
<tr>
<th>Gas Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>methane (CH₄)</td>
<td>89.69 %</td>
</tr>
<tr>
<td>nitrogen (N₂)</td>
<td>9.34 %</td>
</tr>
<tr>
<td>oxygen (O₂)</td>
<td>0.375 %</td>
</tr>
<tr>
<td>ethane (C₂H₆)</td>
<td>0.260 %</td>
</tr>
<tr>
<td>carbon dioxide (CO₂)</td>
<td>0.180 %</td>
</tr>
<tr>
<td>argon (Ar)</td>
<td>0.0896 %</td>
</tr>
<tr>
<td>helium (He)</td>
<td>0.0379 %</td>
</tr>
<tr>
<td>propane (C₃H₈)</td>
<td>0.0171 %</td>
</tr>
<tr>
<td>iso-butane (C₄H₁₀)</td>
<td>0.0063 %</td>
</tr>
</tbody>
</table>
Shale Gas

- From 1941-1953, 4.7 million m$^3$ of shale gas produced at Kamsack, Saskatchewan (Yurkowski, 2006).
- Gas recovered from 8 wells that penetrated the Boyne Member of the Carlile Formation and the Pembina Member of the Pierre Formation, at a depth of 60 m.
- Used to heat the town.

![Map of Kamsack Gas Wells, Notre de Lourdes Gas Well, and Manitou Gas Wells.](image)
• Boyne Member of the Carlile Formation is continuous from the Kamsack area of Saskatchewan into southwestern Manitoba, as shown on the isopach map and cross-section.

Figure Credit: “Oil Shales in Saskatchewan” prepared by Melinda Yurkowski, Petroleum Geology Branch and Bruce Wilhelm, Energy Development and Climate Change of Saskatchewan Industry and Resources, 2007.
Shale Gas

**Something to think about**

**Distance from Manitou gas wells to Kamsack, about 600 km.**

If, source of the biogenic? gas is continuous 2 m thick siltstone bed in the Boyne Member of the Carlile Formation.

And, assuming 2% porosity over a width of 50 km.

Then, there is a conservative contingent & prospective resource estimate of 1200 million m$^3$ of shale gas to be present, mainly in Manitoba.
Oil Shale

- Cretaceous oil shale, capable of yielding oil upon heating, was also noted along the Manitoba Escarpment over 100 years ago.
- Scoriaceous clinker present in Swan River valley gravel pits; and Valley River burnt shale outcrops, northwest of Dauphin.
Oil Shale

Pasquia Hills, Saskatchewan

- Six companies involved in oil shale evaluation, mainly on the north flank of the Pasquia Hills.
  - Goldnev Resources Inc.
  - Oilsands Quest Inc.
  - Source Petroleum Inc.
  - Norwest
  - Outrider Energy Ltd.
  - Nobel Hydrocarbons Alta Ltd.

Yurkowski & Wilhem (2007)
Goldnev Resources Inc. (2008)

- **Goldnev Resources Inc.**
  - In 2007, one drillhole penetrated 22 m of oil shale, beneath 7 m of overburden.
  - Lab results indicated 9 million m$^3$ of oil could be recovered from oil shale averaging 61 litres/tonne over an area of 256 ha.

- **Oilsands Quest Inc.**
  - 2.4 billion barrel oil resource grading 7.8% kerogen by weight in 45 m thick zone, averaging 35 litres/tonne, beneath 21 m of overburden.
Oil Shale

Shale sampled along the Manitoba Escarpment by Kovac (1984):

- Average TOC of shale = 6%.
- Average petroleum potential = 30 kg/tonne = 30.2 litres/tonne.
- Favel Formation slightly richer than Boyne Member of the Carlile Formation.
- Richness increases slightly northwestward along the Escarpment.

However, conclusions based on:
- Limited number of samples
- Combining several formations
- Including float samples
- And, including relatively thin carbonate units (having low TOC and low petroleum potential).
Oil Shale Sampling by Kovac (1984)

Total Organic Carbon (TOC %)/Petroleum Potential (kg/t)

- **Pasquia Hills**
  - 7.61/34.76 – 15 samples

- **Porcupine Hills**
  - 7.19/35.18 – 3 samples

- **Duck Mountain**
  - 6.81/30.93 – 11 samples

- **Riding Mountain**
  - 5.92/30.23 – 5 samples

- **Pembina Mountain**
  - 5.18/16.65 – 3 samples
Oil Shale

- Purple dots shown in Phase 1 of Shale Gas Study indicate number of sites where Cretaceous bedrock samples collected this summer. Many of these samples will be used for TOC/Petroleum Potential evaluation.
- Contact Michelle Nicolas for further information
Paleocene lignite coal was produced in the Turtle Mountain area of Manitoba in the 1940s; but was found to be difficult to extract, at a profit, from wet erratically distributed coal seams.
Coal

Saskatchewan Discovery

Discovery of Durango Coal Seam in Pasquia River basin April, 2008.

• Two coreholes, 1.6 km apart, intersected a flat-lying coal seam with clay partings in the Cretaceous Manville Formation, averaging 32.8 m thick, at average depth of 79 m.

• Results of 213 drillcore analyses, carried out during the summer, confirmed good quality thermal coal ranging from sub-bituminous C to bituminous C in rank.

• Average calorific value stated to be generally higher than Alberta thermal coal fields and Powder River basin major producers.

Goldsource Mines Inc. (2008)
Coal

In Manitoba

- Cretaceous sub-bituminous coal resources may extend eastward across the provincial boundary (as the Manville equivalent Swan River Formation) north of the Porcupine Hills, into Manitoba (shown in dark yellow on map).

- Quarry Exploration Permits have been taken out by a number of parties in west-central Manitoba:
  - Jon R. MacNeill
  - Greencastle Resources Ltd.
  - Nucoal Energy Corp.
  - Minera Pacific Inc.
  - Silver Fields Resources Inc.
  - Westcan Uranium Corp.
Coal

**Pine River Coal**

- Two shallow shafts and test holes sunk into lignite occurrence on north bank of Pine River, 22 km northeast of the village of Pine River in 1937.
- Second attempt to mine the coal made in 1948 and 1949 by Silico Pine River Coal Occurrence Limited. Small lignite pile, measuring 4 m in height over an area 15 m in diameter, bulldozed from a pit south of the river.
- 9 m thick lignite seam was also reported in water well drilled near local school in the village of Pine River. Drilling by the MGS in 1978 did not prove up the seam.
- Contact for further information – Jim Bamburak.
Potash
(10 producing mines in Sask.)
Potash

- Two potash deposits outlined, at depth, within the Devonian Prairie Evaporite, west of Russell and St. Lazare, Manitoba.
- Both deposits contain several hundred million tonnes of ore, averaging more than 20% K₂O (as sylvite).
- Additional deposit potential may be present in the vicinity of the known deposits and southward to the US border, but exploration must recognize Petroleum resource concerns.
- Contact for further information – Michelle Nicolas

Bamburak, 2007
Potash

Potash

Prairie Evaporite

Upper Salt (or Leonard Salt)

Dawson Bay Formation

2nd Red Beds

Belle Plaine Potash Member*

Salt VI

Pink Panther Potash Bed

Salt V

White Bear Potash Member

Salt IV

Esterhazy Potash Member

Potash Mining Level

Salt III

Marker - Anhydrite

Salt IIb

Salt IIa

Shell Lake Anhydrite

Salt I

Basal Anhydrite

Winnipegosis

* Not always present

Manitoba Potash Project
Seven companies are involved in potash exploration in Manitoba, stretching from Roblin south to the US border:

- Manitoba Potash Corporation – PL1-87, with non-compliant probable mineable ore reserves of 164.7 million tonnes grading 24.5% K₂O (as sylvite) at a depth of 852 m.

- Agrium Inc. – QP-154, with non-compliant estimated mineable reserves 168.7 million tonnes averaging 21.7% K₂O (as sylvite).

- Dahrouge Geological Consulting Ltd. – QP-173.

- Geo Minerals Ltd. – QP-197.

- W.S. Ferreira Ltd. – QP-167, 168.

- 5736235 Manitoba Ltd. – QP-202.

- Western Potash Corp. – QP-170 to 172, 174-176, 180.
• In 2004, the first Mississippi Valley-type (MVT) mineralization to be discovered in Manitoba was found within a corehole (DDH No. 3).

• The hole was drilled into Silurian Interlake Group dolomite east of Pemmican Island in the north basin of Lake Winnipegosis by Klyne Exploration.

• It should also be noted that argillaceous Devonian Ashern Formation was found in DDH No. 1.
The mineralized veinlet hosted by Silurian Interlake Group dolomite in DDH No. 3 comprised a 15 cm interval grading 4.59% Zn, 0.41% Pb, 0.014% Cu, 10.4% Fe and 14.05% S.
Mineralization was also deposited as euhedral crystals, botryoidal masses, and snake-like tube structures within brecciated dolomite country rock.
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Geothermally-altered drillcore, with observed saddle dolomite, in Duck Bay corehole M-1-07 (shown above) and in Paradise Beach corehole M-6-76, drilled 75-100 km away from Pemmican Island, show that regional heating and alteration was pervasive throughout west-central and Interlake areas of Manitoba.
Geothermally-altered Silurian and Devonian outcrops (with argillic alteration, sparry and recrystallized dolomite) have also been noted on the east shore of Lake Winnipegosis, across from Duck Bay by Doug Berk (previously with the Department), who provided the following photos.
The Pemmican Island Zn-Pb Discovery has characteristics common with Upper Mississippi Valley-type (UMV) mineralization, such as a comparable lead isotope ratio.
But, West-central Manitoba also has many features that are similar to Pine Point mining district:

- hydrothermally-altered karst within dolomite
- above a major reactivated Precambrian basement structure
- below argillaceous secondary caprock
- at the edge of the Western Canada Sedimentary Basin.
• Banded marcasite mineralization lining the walls of cavities within the brecciated dolomite is polymetallic; as shown by the two divergent trend lines in the above plot of %Ni vs %As from electron microprobe analysis, and by visual examination.
• This suggests that the sulphide mineralization was deposited during several mineralizing events.
Additional drilling of transient electromagnetic conductors, within a broad weak magnetic anomaly, is required to locate the source of mineralization found in the 2004 Discovery Hole.
Manitoba’s Future Mineral Commodities

- Shale Gas
- Oil Shale
- Coal
- Potash
- MVT