Oil Shale

East Favel outcrop

- ***Cretaceous Morden Member of the Carlile Formation*** (McNeil and Caldwell, 1981, Outcrop Section 63) in the south-central portion of 3-30-35-25W1 in NTS 63C3SE. The disturbed outcrop is exposed on west bank of East Favel River, approximately 6.4 km south of Minitonas, Manitoba. The East Favel River drains the northern flank of Duck Mountain.

According to Wallace and Greer (1927), it appears that the oil shale at the site has been burning since 1917. McNeil and Caldwell (1981, Outcrop Section 63) noted a hydrogen sulphide odour when they visited the site about 1975.

- Mid July 2011, Jeff Vermette of Manitoba Conservation received a call from a farmer in the RM of Minitonas (Steve Natyna) who reported that he has a large ground fire on his property along the East Favel River. It is burning at the base of the river bank. Jeff visited the area on July 22nd and discovered the ground fire which is on the west side of the river. "What is strange about this particular fire is that it is burning in the shale and there is a very strong odour of sulphur coming from the ground/smoke. Around the edges of the ground fire is a yellowish crust (I imagine this is result of the sulphur). The farmer stated that the old timers in the area stated that in this same area and back in the 1960's the same thing occurred and that this whole bank was extremely hot. They claim that there is coal and possibly natural gas pockets in this area" (J. Vermette, written communication , 2011).

- Upstream and downstream from the burning shale site, the Cretaceous outcrops are undisturbed horizontally bedded pyrite-bearing non-calcareous shale (***Morden Member of the Carlilie Formation***) and underlying calcareous oil shale (***Assiniboine Member of the Favel Formation***) with beds of argillaceous limestone (Marco Calcarenite). The presence of oil shale along the Manitoba Escarpment was documented by Kovac (1984), see figure below showing sampling results.

- The burnt reddish brown shale (clinker), seen at the East Favel site, is the usual colour that Morden Member dark grey shale acquires upon heating to kiln temperatures (1030°C), as was done at the Leary brick plant in southern Manitoba from 1947 to 1952 (Bannatyne, 1970, p. 44-47). The oxidation of pyrite, (FeS_2) upon heating of the Morden Member shale results in the formation of H_2S and SO_2 gas and Fe-oxide and Fe-oxyhydroxide minerals. Some of the H_2S reacts with groundwater to form sulphuric acid (H_2SO_4). Some of the SO_2 precipitates as native sulphur crystals, which can be seen on the tree roots in the photos. Heating of the underlying calcareous oil shale and impure limestone results in the calcining of the calcium carbonate ($CaCO_3$) to lime (CaO). The reaction of the SO_2 and CaO then forms calcium sulphate (CaSO4.H2O), also known as gypsum.This process is utilized by the Mining Industry for flue-gas desulphurization, which is used to reduce SO_2 emissions from the roasting of sulphides during base metal extraction from ore. According to Graf (2008), the formation of sulphates can cause strata to become incompetent, causing landslides, slumping and erosion. Another consequence of the chemical process of the oxidation of pyrite is the production of ferricrete, an iron-oxide cemented conglomerate at the base of the outcrop (shown in the photos), where iron-rich solutions, leached from the shale by H_2SO_4, mix with local groundwater under highly oxidizing conditions to precipitate hematite and goethite (Lueth et al., 2006).

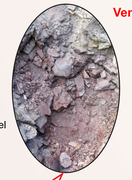
Similar burning shale has been video documented in Blue Bridge, Ohio (outside Monroeville) on You Tube on the Internet(stevenjw70; http://www.youtube.com/watch?v=74wfXOkp32o). An explanation for the burning was also provided on the Internet site: "The shale began burning due to spontaneous combustion of the mineral pyrite which is abundant in the shale. As pyrite weathers and oxidizes it undergoes chemical reactions which, if enough heat from this process is trapped, can combust the sulfur atoms in the pyrite. Then the fire is maintained by the oil content in the shale."

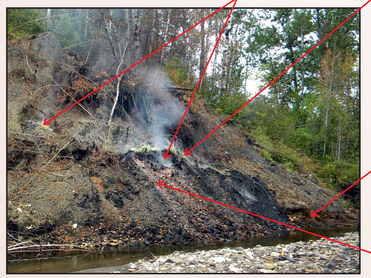
In the Swan River Valley, at least two gravel pits (Hubble Creek and Renwer) contain scoriaceous clasts of burnt shale, as documented by Gaywood and Nielsen (1994) and Bamburak and Nielsen (1996), respectively (see photo below). The clasts were probably first glacially transported from a pre-Quaternary or Interglacial burn site; and then in the case of the Hubble Creek clasts, they were subsequently exposed to fluvial and/or beach transport.

As indicated below, another site of burnt shale is present in Manitoba (south of the Swan River Valley) along the Valley River north of Ashville, shown in photo below (Bannatyne and McCabe, 1970). All of the above occurrences strongly suggest that burning of oil shale is (was) much more common in Manitoba than is usually perceived.

- MGS visited the site at the end of August and found the site to be smouldering and quite hot, smoky and smelly, after exposing some of the underlying bedrock, below the slumped overburden. Photos were taken and samples collected, some for analysis.

"Normal" Morden Member outcrop (2011-08-30) 0.3km upstream of burning shale site (above) contrated with disturbed, slumped appearance of the latter (to the right) (2011-07-20).





Burning shale outcrop along East Favel River on the northern flank of Duck Mountain.
(Photo: courtesy of Jeff Vermette, Manitoba Conservation, 2011-07-22)

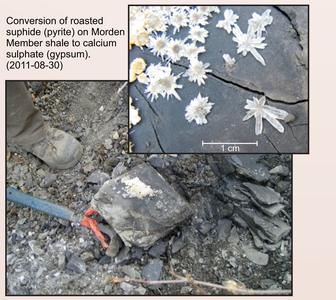
Vent

Native Sulphur Precipitate

Ferricrete

Burnt Shale

Ric Syme, Director MGS," stirring the flame" at site and Jim Bamburak photographing the exposed vent (2011-08-30).



Conversion of roasted suphide (pyrite) on Morden Member shale to calcium sulphate (gypsum). (2011-08-30)

Hubbell Creek gravel pit

- Matile and Nielsen (1994) noted numerous scoriaceous clasts (IMG 5495, lower) in a gravel pit in SW2-20-37-28W1, 0.4 km east of Hubbell Creek and 14 km northwest of Swan river. The clasts range in size from 2 to 19 cm in diameter and are rounded to subrounded. They are light weight, high vesicular and red, brown or black. The glass-walled vesicles are hollow and their fragile nature suggested limited transport from a local source, possibly on the south side of the Porcupine Hills. One of the samples was 40Ar/39Ar age dated as 470 ±50 Ka.

Renwer gravel pit

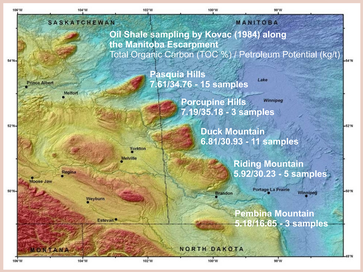
- Angular scoriaceous clinker clasts (IMG 5495, upper) have been noted in the Renwer Pit in ls10, Sec. 11, Twp. 36, Rge. 24W1) in the RM of Minitonas that suggest that the burning has also occurred during previous inter-glacial episodes during the past million years; and that the advancing ice-sheets transported the burnt shale (Bamburak and Nielsen, 1996). At least 31 samples were collected in the pit by Bamburak and Nielsen; with the largest breccias fragment having a length of 29 cm, width of 21 cm and a thickness of 17 cm.

Sclater River outcrop

- ***Cretaceous Favel Formation (Assiniboine Member overlying Keld Member).*** (McNeil and Caldwell, 1981, Outcrop Section 64) in the north-central portion of 14-15-34-23W1, NTS 62N15NE. Outcrop is well exposed on north bank of Sclater River, approximately 2.1 km west of Sclater, Manitoba. The Sclater River drains the northeastern flank of Duck Mountain.
- Petroleum smell from freshly broken shale and an oil slick was noted on the water from shale falling into the stream.

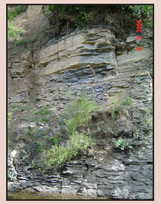
Valley River outcrop

- ***Cretaceous Favel Formation overlying Ashville Shale.*** (McCabe and Bannatyne, 1970, Stop 13) in 13-35-25-21W1, NTS 62N1NW. Outcrop forms a cliff face on the east side of the Valley River, about 4 km north of Ashville, Manitoba. The Valley River forms part of the drainage basin between Duck Mountain to north and Riding Mountain to the south.
- The outcrop consists of 6.7m of Cretaceous Ashville and Favel formations; both units show highly abnormal appearance. The upper 2.4 m consist of grey thin-bedded fissile speckled calcareous shales of the Favel Formation which are "weathered" to light buff and pink; several thin white to greenish and purplish bentonitic (?) beds are present. The bottom 4.3 m are Ashville Formation consisting of non-calcareous slabby to fissile shale which is quite brightly colored shades of pink to buff, greyish red, yellow, and purplish red; one patch of black shale is present. This may represent a "burned" section of highly oxidized Ashville and Favel beds. The black shale probably represents an unoxidized remnant of the normal black petroliferous Ashville shale.



Upper angular clast is from the **Renwer gravel pit** (Bamburak and Nicolas,1996) in 10-11-36-24W1. Lower four rounded clasts are from the **Hubbell Creek gravel pit** (Matile and Nielsen, 1994).

Burnt shale outcrop present along Valley River on the southern flankof Duck Mountain 4km NE of Ashville(13-35-25-21W1). Photo taken on MGS field trip in 2004-09-08.



Oil shale and impure limestone along **Sclater River** on the east flank of Duck Mountain in 14-15-24-23W1 (2004-09-08).

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Shale Gas

Manitoba

Manitou area

- Two capped gas wells, with about 276 kPa pressure, are situated in the south half of Section 23, Twp. 2, Rge. 9W1, about 13 km south of Manitou. One of the wells has produced shallow shale gas since it was drilled into the Boyne Member in 1907. The other well was drilled around 1933. Both wells were ignited by a local landowner, Percy Lea during two water and gas well sampling visits in September and October, 2009. The 1933 well feeds a small storage tank and a natural gas barbeque, which is used to cook food on special occasions.
- Another two gas occurrences are present, a short distance to the west, in a former and current domestic farm water well in 2-22-2-9W1 (Robert E. Lea-Grenier) into Morden Shale.
- Gas shows were also reported in the 1930s from Cretaceous shale in petroleum test wells drilled in NE13-2-10W1 (Lisgar No. 1) and 8-26-2-9W1 (1931-32, Commonwealth Manitou No. 2, Hagyard Farm).

1907 Manitou gas well (SE 23-2-9W1)

September 24, 2008 - Percy Lea flaring the "Gas Jet" well.

Normand and Guy Bosc water well (1-30-7-8W1)

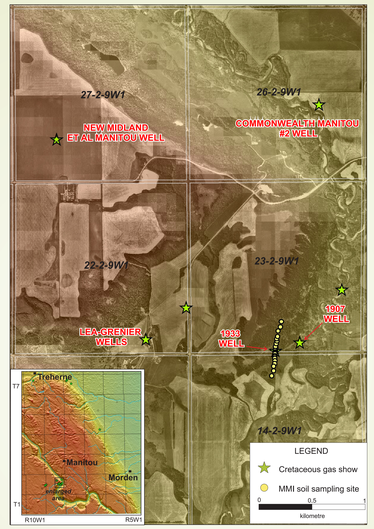
September 9, 2004 - Normand Bosc flaring the well.

September 23, 2008 - Normand and Guy Bosc flaring the well for onlookers.

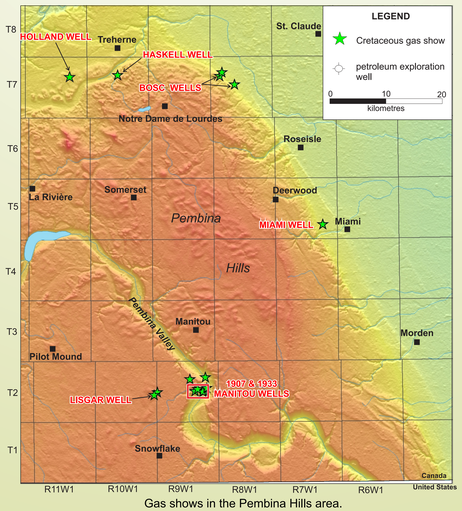
Notre Dame de Lourdes area

- A gas source, identified along the Manitoba Escarpment, 6 km north-northeast of Notre Dame de Lourdes in SW¼ 21-7-8W1, was utilized in the past for household consumption. The gas was obtained on the farm of Frank Bosc at a depth of 170 feet in 1919 and was used to light one kitchen light for at least 6 years (Wallace and Greer, 1927, p. 71; Howard, 1935).
- Another natural gas source is situated within a water well located on the farm of Normand and Guy Bosc in 1-30-7-8W1. The well, drilled in 1936, produces a weak petroleum smelling gas with 221 kilopascals (kPa) pressure that burns for at least 0.5 hours when ignited. After ignition the gas pressure drops to 21 kPa, but the well recharges in 12 hours when the valve is closed. A short video of the well being ignited can be viewed on the Internet at:
http://www.gov.mb.ca/stem/mrd/geo/willistontgi/downloads.html
Field Trip Gas Well Demonstration Quicktime mov file (7.4 MB) or MPG file (15.4 MB). Carlile (formerly Niobrara) Formation bedrock is exposed at two locations, a short distance to the southeast and to the southwest of the well. The exposures are at about the same elevation as the top of the well. The 52 m deep well likely penetrated the Favel Formation, which is an oil shale. According to Normand Bosc, poor quality drinking water has been encountered in all wells drilled in Section 30.

Lea Family at 1907 Manitou oil well drill site in Pembina Valley in SE23-2-9W1. Gas was found and was subsequently ignited; and the well became known as the "Gas Jet" which could be seen 13km to the north in Manitou.



Gas shows in the Manitou area. Yellow dots show MMI sampling transect, (Fedikow et al., 2009).



Gas shows in the Pembina Hills area.

Treherne area

- Wallace (1925, p. 35) reported that as of 1925 Mr. Rannard had been using Manitoba natural gas for domestic lighting purposes on his farm in the Treherne area for many years. However, according to the Treherne Area History Committee (1976, p. 180), natural gas was struck in 1913 in a water well drilled on the same farm located in NE28-7-10W1, which had been acquired from Mr. Rannard by Ezra C. Haskill. In 1927, Wallace and Greer (1927, p. 71) stated that the gas, obtained at a depth of 150 feet on the Haskill farm, had been used for 15 years for kitchen and dining room lighting, and occasionally for cooking.
- Wallace and Greer also indicated that an oil well was drilled to a depth of 250 feet in the SE corner of the same quarter section in 1926, but the drilling ceased when financial difficulties arose. Similar views of the 1926 drillsite were printed by Wallace and Greer (1927, p. 36) and the Treherne Area History Committee (1976, p. 180). The drill stem from the 1926 drilling was left in the ground for many years, but the portion sticking out above ground was removed about 10 years ago after it was struck by a farm implement.

1933 Manitou gas well (SW23-2-9W1)

September 24, 2008 - Barbeque underway at well site.

October 9, 2008 - Percy Lea tending the barbeque.

June 16, 2009 - Percy Lea and Michelle Nicolas tending the barbeque.

Miami area

- Gas was found within a water well at a depth of 120 feet in 1912, 3 km west of Miami, in 11-5-7W1 (Kerr, 1949, p. 67).

Holland area

- Gas was found within a water well (NE26-7-11W1) at a depth of 150 feet in 1905? in "Niobrara Limestone" and was used for 30 years for heating and lighting purposes (Howard, 1935).

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