ORGANIC PETROLOGY OF SAMPLES OF OIL SHALE FROM MANITOBA.

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INTRODUCTION

Four samples of oil shale from an Upper Cretaceous sequence in southern Manitoba were received from the Department of Energy and Mines, Manitoba Samples were requested in order to obtain data on the included organic matter.

Representative portions of each sample were taken and mounted in cold setting ASTIC resin in such a way that surfaces both perpendicular and parallel to bedding could be polished for petrographic examination The surface of the block selected for polishing was ground flat using carborundum impregnated laps and carborundum papers, polished with chromium sesquioxide and finally magnesium oxide

Reflectance measurements on humic matter were taken using a Leitz MPV1 microphotometer and galvonometer scale fitted to a Leitz Ortholux microscope and calibrated against synthetic garnet and spinel standards of 0 42%, 0 92% and 1 72% reflectance All measurements were taken in oil immersion (n = 1 518) using incident monochromatic light with wavelength of 546 nm and at a temperature of 23±1° C Fluorescence observations were made using a Leitz Orthoplan microscope utilizing a 3mm BG3 excitation filter, a TK400 dichroic mirror and a K490 suppression filter Table 1 summarizes fluorescence colours and abbreviations used in sample descriptions

Maceral analyses were calculated from point count data collected with a Swift automatic point counter 500 data points were counted for each sample using a grid with 0 05 mm between adjacent points and 0 2 mm between traverses

RESULTS

Reflectance data is given in Table 2 and maceral analyses are presented in Table 3 The volume of each component is given to the nearest 1%

Petrographic Descriptions

Boyne Member, Vermilion River Formation
103 m (339 ft)

Laminated, dark brown shale with coarser pale brown to grey lenses and laminae.

Organic matter comprises dinoflagellates/acritarchs (G to GY), lenses of non-fluorescing humic matter, ?cutinite (O) and liptodetrinite (Y, O) occurring both within lenses of humic matter and in the mineral-rich layers. Brown to dark brown bitumen (Y), mostly massive, rarely granular Rare resinite (Y) occurring in aggregates.

Mineral matter mostly fine-grained Quartz, mica and lithic fragments common in coarser layers. Pyrite, ubiquitous, fine-grained anhedral in mineral-rich layers and infilling larger thin-walled dinoflagellates/acritarchs

Boyne Member, Vermilion River

118 m (386 ft)

Massive grey siltstone.

Abundant humic matter with abundant to rare included liptodetrinite (Y) and small phytoplankton (G, GY) In many humic layers approximately 80% of the layer is liptodetrinite Larger dinoflagellates/ acritarchs (G) and spores (Y) in mineral-rich layers

Mineral matter mostly fine-grained with rare quartz. Minor anhedral pyrite, rare ?kaolinite pods and carbonate

Favel Formation

77 m (253 ft)

Massive dark grey shale.

Organic matter comprises lenses and rarely layers of granular to massive humic matter with minor included liptodetrinite (Y) and small phytoplankton. Rare dinoflagellates/ acritarchs (G, GY) in mineral-rich layers Liptodetrinite (Y, B).

Mineral matter comprises anhedral and euhedral carbonate (pale orange fluorescence). Rare forams.

Favel Formation

96 m (316 ft)

Dark grey claystone interlaminated with grey siltstone Laminae to 5 mm.

Fine-grained layers have abundant small lenses of humic matter with rare liptodetrinite (Y). Rare dinoflagellates/acritarchs (G, GY) in mineral-rich layers. Pods of bitumen (Y).

Coarse-grained layers with larger pods of humic matter with liptodetrinite (Y) and small dinoflagellates/acritarchs (G, GY). Rare dinoflagellates/acritarchs in mineral rich layers.

Anhedral and euhedral carbonate (pale orange fluorescence) common in coarse-grained layers, rare or absent in fine-grained layers. Anhedral pyrite ubiquitous. Forams abundant in coarse-grained layers, rare in fine-grained layers.

DISCUSSION

Reflectance Data

Only two samples gave reflectance measurements and these were on small ?inertodetrinite and so few in number that any calculated mean maximum reflectance would only be approximate.

Organic Matter

All samples contain abundant lenses and layers of humic matter with included liptodetrinite and small phytoplankton which are not the same type as the larger dinoflagellates/acritarchs which occur in the mineral-rich layers. Samples from the Favel Formation have fewer discrete dinoflagellates/acritarchs in the mineral-rich layers than samples from the Vermilion River Formation In the former, the dinoflagellates/acritarchs are smaller, processes are commonly fewer and of a simpler form. The bifurcate and trifurcate branching which is common in diniflagellates from the latter is also absent in the former. Spores with reticulate surfaces and spores with a large single wing are also present in samples from the Vermilion River Formation but not those from the Favel Formation.

Forams in samples from the Favel Formation commonly have several chambers.

Oil shales interbedded with limestone in the Cretaceous Toolebuc Formation of Queensland (Australia) contain both humic matter of the form which occurs in the Manitoba samples, foraminifera and dinoflagellates/acritarchs The acritarch Veryhachium has been recognised in the Toolebuc oil shales (Hutton et al , 1980) but was not recognised in the Manitoba samples. Microplankton as well as macrofossils, both vertebrate and invertebrate forms, indicate a shallow marine environment for the Toolebuc Formation. The presence of dinoflagellates/acritarchs in the Favel and Vermilion River Formation indicate a marine environment during deposition.

In the Toolebuc Formation massive oil shales and thinly interlaminated oil shale and carbonate layers occur The carbonate rarely possesses the orange fluorescence which is characteristic of the carbonate in the Favel Formation

The term "mixed oil shale" has been applied to oil shales from the Toolebuc Formation (Hutton, 1981), and it is probably that oil shales from the Toarcien sequence of the Paris Basin and the Kimmeridge Clay, Oxford Clay and Blue Lias from the United Kingdom belong to this group as well The oil shales from the Cretaceous sequence of southern Manitoba has similar characteristics and could be called a mixed oil shale

The origin of the lenses and layers of humic matter in both the Toolebuc oil shale and the Manitoba oil shales is not known. It has been suggested that the lenses of humic matter in the Toolebuc Formation may represent accumulations of larger algae such as seagrass and other large algal forms Alternatively the lenses may have originated from humic matter derived from higher plants Liptodetrinite and phytoplankton are ubiquitous throughout the lenses This suggests that the humic matter was not deposited as a particle but accumulated as phytoplankton sank to the bottom Minor to significant amounts of the humic matter in each lens, as well as liptodetrinite and phytoplankton, fluoresce Thus during pyrolysis shale oil is probably produced from the humic matter as well as from the exinite macerals.

CONCLUSIONS

1 Oil shales from the Favel and Vermilion Creek Formations of Manitoba are mixed oil shales containing exinite comprising dinoflagellates, acritarchs, liptodetrinite and sporinite. These oil shales have many features in common with oil shales from the Toolebuc Formation of Australia

2 Humic matter of unknown affinity occurs in lenses and layers throughout the samples but is most abundant in the Favel Formation

3. Foraminifera and fluorescing carbonate are present in the Favel Formation

4 A marine environment during deposition is indicated by microflora such as dinoflagellates but the occurrence of sporinite indicates an input of terrestrial plant matter.

REFERENCES

HUTTON, A C , 1981 - Classification of Australian Oil Shales. 51st ANZAAS Congress 10 p.

HUTTON, A C , KANTSLER, A J , COOK, A C , and McKIRDY, D.M , 1980 - Organic matter in oil shales. A P.E A , Vol 20, p.44-67

Table 1 Fluorescence Colours and Abbreviations

PG - pale green
G - green
GY - greenish yellow
Y - yellow
BY - bright yellow
YO - yellowish orange
O - orange
PO - pale orange
PB - pale brown
B - brown

Table 2 Reflectance data for oil shales from Manitoba

Sample	Depth (m)	Range (%)	Number of Readings
Arco 3	103	0 76-2 60	3
Arco 2	96	0 54-2 60	5

Table 3 Maceral Analyses for Samples of Oil Shale from Manitoba

Location	Core Hole	Depth (m)	Formation	Percentage				
				Phyto-plankton	Humic Matter	Foraminifera	Pyrite	Other Mineral Matter
2-9-6-8 WPM	Arco 3	103	Boyne Member Vermilion River	1	13		<1	87
2-9-6-8 WPM	Arco 3	118	Boyne Member Vermilion River	1	17		<1	81
16-11-18-11 WPM	Arco 2	77	Favel	1	20		<1	78
16-11-18-11 WPM	Arco 2	96	Favel*	1	24	<1	tr	75
			Favel#	<1	16	6	<1	77

tr -<1 count per 500

1 - 2 to 4 counts per 500

* fine-grained layer

\# Coarse-grained layer

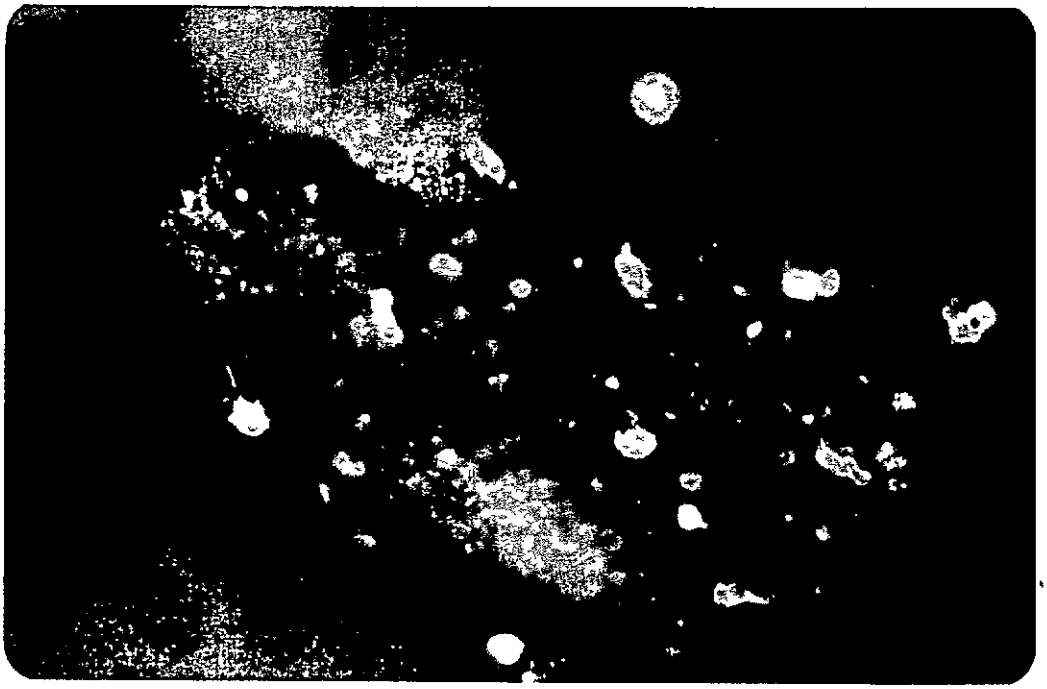

Plate 1 Arco No 2 Favel Formation, 253 ft

Fine-grained fluorescing organic matter with dinoflagellates/ acritachs
Parallel Section Field width = 0 36 mm, fluorescence mode

Plate 2 Arco No 2, Favel Formation, 316 ft

Bitumen with non-fluorescing granular organic matter and small phytoplankton
Parallel Section Field width = 0 28 mm, fluorescence mode

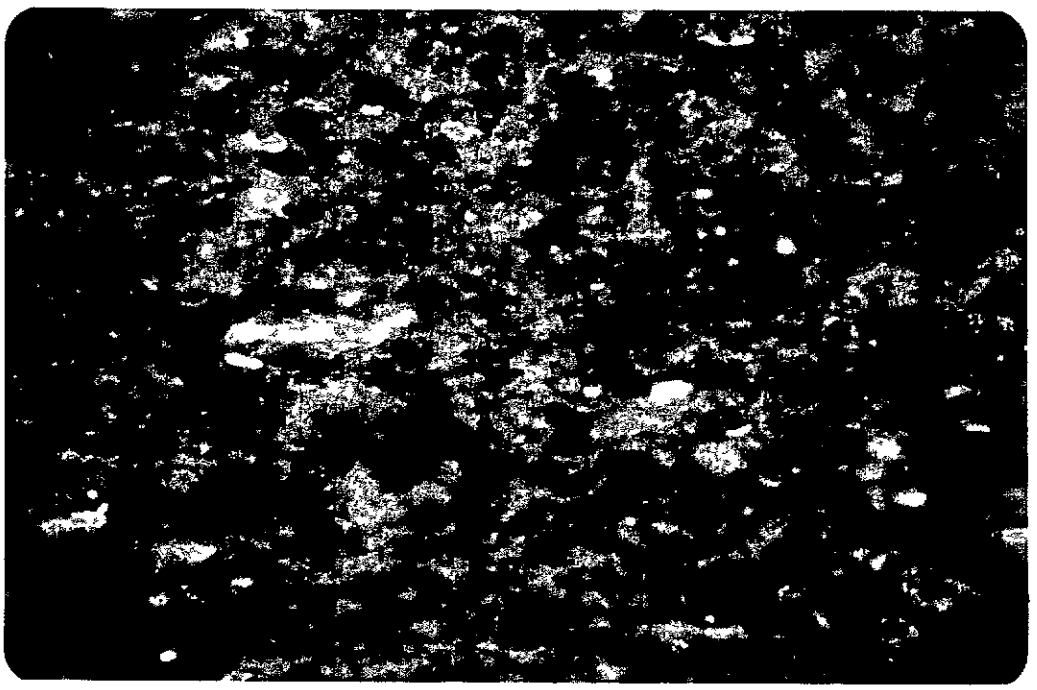

Plate 3 Arco No2. Favel Formation, 316 ft

Small lenses of non-fluorescing organic matter, dinoflagellates (centre left) and liptodetrinite.
Field width = 0 28 mm, fluorescence mode

Plate 4. Arco No 3, Vermilion River Formation (Boyne Member) 339 ft

Dinoflagellates/acritarchs, liptodetrinite and minor non-fluorescing organic matter
Field width = 0 28 mm, fluorescence mode

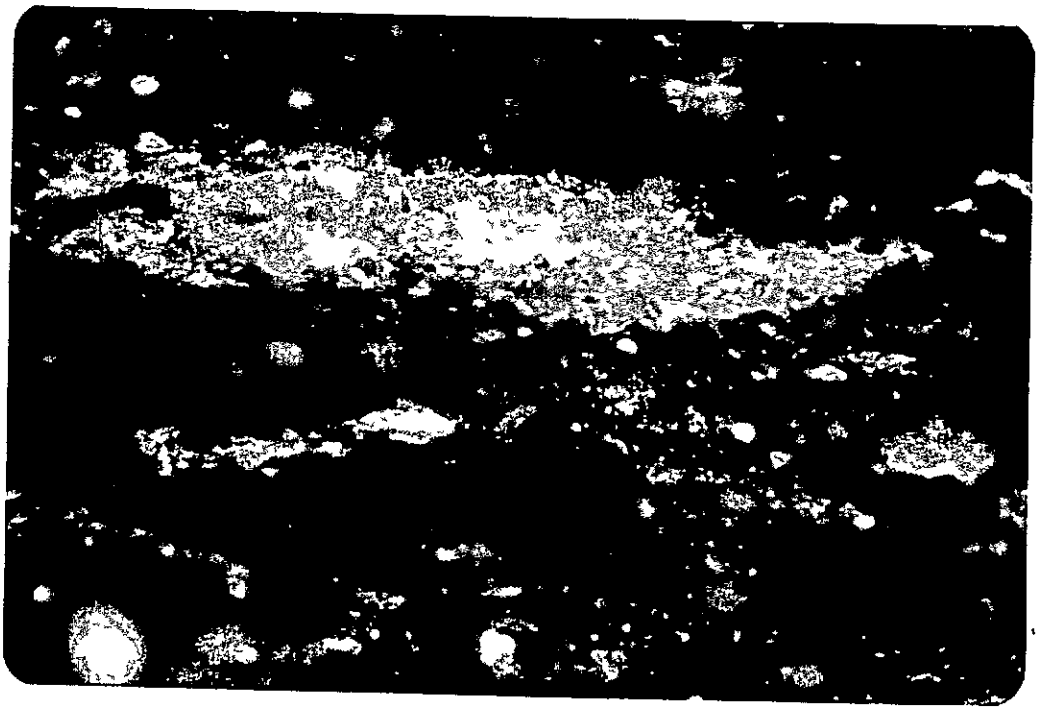

Plate 5 Arco No 3, Vermilion River Formation (Boyne Member), 386 ft
Fluorescing and non-fluorescing granular organic matter, dinoflagellates/acritarchs and liptodetrinite
Field width = 0 28 mm, fluorescence mode

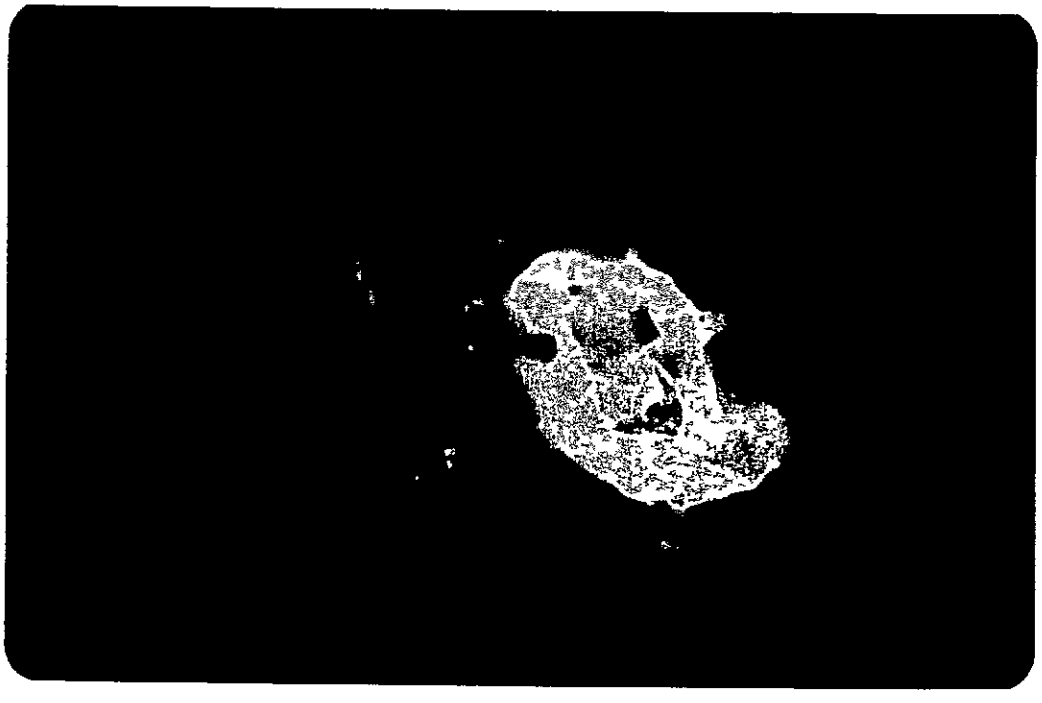

Plate 6 Arco No 3, Vermilion River Formation (Boyne Member), 386 ft
Dinoflagellate
Field width = 0 18 mm, fluorescence mode