EVALUATION OF ORGANIC FACIES OF THE VERRILL CANYON FORMATION SABLE SUBBASIN, SCOTIAN SHELF

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ABSTRACT

Thirty organic-rich sediment samples from five wells (Alma F-67, Glenelg J-48, S. W. Banquereau F-34, Intrepid L-80, and Thebaud P-84) from Scotian Basin were analyzed by organic petrography and Rock-Eval pyrolysis to evaluate the organic facies and source-rock potential of these sediments. Twenty-eight samples from first three wells are from the distal basinal Verrill Canyon Formation, two other samples from Intrepid L-80 and Thebaud P-84 are from the Mississauga Formation (near-shore facies equivalent of distal Verrill Canyon Formation).

The distal Verrill Canyon Formation sediments from Alma F-67, S. W. Banquereau F-34, and Glenelg J-48 are composed of marine or mixed organic matter forming Kerogen Type IIA and IIA-IIB oil-prone source rocks. Anoxic events are possibly controlled by upwelling. Variability in organic facies suggests the presence of multiple source rocks for the generation of crude oil, condensate, and gas in the Sable Subbasin and surrounding areas.

The presence of abundant solid bitumen in a matured and overmature source rock possibly suggests the time of overpressuring and peak oil generation is related; oil could not be migrated and remained within the source rock (example: S. W. Banquereau F-34), because of overpressuring.

Presence of strong fluorescence in alginite and bitumen in the overmature or within the boundary of mature and overmature zone suggest possible extention of oil window in the overmature zone because of overpressuring.

TABLE OF CONTENTS

INTRODUCTION

Administrative Aspect

This research project was requested on January 19, 1990 by the Supply & Services, Canada at the initiation and formulation of the Atlantic Geoscience Centre, Geological Survey of Canada, Dartmouth, Nova Scotia. In compliance with that request, I submitted the proposal on January 29, 1990. The proposal was accepted on February 6, 1990 by telephone from SSC, Dartmouth, Nova Scotia. The research work was started from February 7, 1990.

According to the contract, Canada Nova Scotia Offshore Petroleum Board (CNSOPB), Halifax, Nova Scotia, on my request, permitted me to collect thirty sediment samples (twenty-seven unwashed cuttings and three conventional cores) from five wells (Alma F-67, Glenelg J-48, S. W. Banquereau F-34, Intrepid L-80, and Thebaud P-84) of the Scotian Basin from the CNSOPB-COGLA Repository at the Bedford Institute of Oceanography at Dartmouth, Nova Scotia. Samples were selected mainly from the deeper part of the wells especially from the Verrill Canyon Formation in consultation with the Scientific Authority, John A. Wade of the Atlantic Geoscience Centre. According to this contract, a part of the samples after washing and hand-picking were handed over to the Palynology Section of the Atlantic Geoscience Centre for kerogen isolation and smear slide preparation; a part of the samples were sent to ISPG, Geological Survey of Canada, Calgary, Alberta for Rock-Eval pyrolysis.

Research Aspect

In the Scotian Basin, studies of hydrocarbon generation, migration, and accumulation using organic geochemical and petrological parameters have been published since 1975 (Bujak et al, 1977; Cassou et al., 1977; Purcell et al., 1977; Rashid and Mc Alary, 1977; Powell and Snowdon, 1979; Powell, 1982; Kendell and Altebaumer, 1985; Grant et al, 1986). In order to resolve some of the unsolved problems on the organic facies and source-rock potential of various organic-rich sediments, two research projects were recently been initiated by Basin Analysis Subdivision of the Atlantic Geoscience Centre, Geological Survey of Canada, Dartmouth, Nova Scotia (Mukhopadhyay and Birk, 1989; Mukhopadhyay, 1989). These studies clearly defined some of the short term partial anoxic events, source-rock potential, and a possible oil-source rock correlation in the Sable Subbasin and surrounding areas using organic petrography, Rock-Eval pyrolysis, elemental analysis, gas chromatography, and stable carbon isotopes. However, these studies did not incorporate the study on the basinal shale facies of the Verrill Canyon Formation. Powell (1982) defined that Verrill Canyon Formation is the main source of liquid hydrocarbons in the Scotian Basin by studying some shale samples which he thought as the basinal shale facies of the Verrill Canyon Formation. However, paradoxically, his studied samples were not actually from the basinal facies of the Verrill Canyon Formation. These samples are from the Missisauga Formation (near-shore equivalent of Verrill Canyon basinal facies) possibly of pro-delta facies. Accordingly, Powell (1982) concluded that "organic matter in the Verrill Canyon Formation is of Terrestrial origin (Type III) and is largely gas-prone except in the northern part of the Sable Subbasin, where it has potential for associated condensate and minor amounts of oil". Recent evaluation of seismic stratigraphy by Wade and MacLean (1990) recognized that thick black shales of the basinal Verrill Canyon Formation are significantly represented in three boreholes such as Alma F-67 (between 3112 to 5054m), Glenelg J-48 (depths between 4613 to 5148m), and S. W. Banquereau F-34 (depths between 4980 to 6309m).

This research project was therefore initiated for better evaluation of the organic facies and source-rock potential of the basinal Verrill Canyon Formation and their relation with hydrocarbon generation, maturation, migration, overpressuring, and future evaluation of the oil/gas-source rock correlation in the Scotian Basin. In order to better evaluation of Powell's (1982) work, two of his analyzed samples from boreholes Intrepid L-80 and Thebaud P-84 were analyzed by organic petrography and Rock-Eval pyrolysis.

SAMPLES, LITHOLOGY, AND STRATIGRAPHY

Figure 1 shows the location of these five wells Alma F-67, Glenelg J-48, S. W. Banquereau F-34, Intrepid L-80, and Thebaud P-84. All wells (except S. W. Banquereau F-34) are within the Sable Subbasin or within the fringe of Sable Subbasin. Figure 2 represents the generalized stratigraphy and their relative ages from the Scotian Basin (after Wade and MacLean, 1990). All the samples from Alma F-67, Glenelg J-48, and S., W. Banquereau F-34 are from the Verrill Canyon Formation (age: Bajocian to Barremian, Fig. 2) and the two other samples from Intrepid L-80 and Thebaud P-84 are from the Missisauga Formation (age: Tithonian to Barremian, Fig. 2). Out of thirty selected samples, nine of them (unwashed cuttings) were chosen from Alma F-67 (depths between 4500 to 5040m), eleven (8 unwashed cuttings and three conventional cores) were from Glenelg J-48 (depths between 4620 to 5235m), and eight (all unwashed cuttings) were from S. W. Banquereau F-34 (depths between 5720 and 6309m), and two unwashed cuttings from borehole Intrepid L-80 (depth: 4087m) and Thebaud P-84 (depth: 4045m). All cuttings samples were selected after scrutinizing the washed cuttings samples.

All selected samples are dark gray to greenish gray shale with minor amounts of siltstone and sandstone. Most of the samples (except depths 4940, 5160, 5180.7, 5186.7, and 5187m) from borehole

Glenelg J-48 are contaminated with some amounts of cavings, fibre, plastic, and mica. Some of them cou cleaned properly in spite of proper hand-picking. Mr samples from borehole Alma F-67 (except 4975 and 5040m) and free from any contamination. Because of lack of precis data by palynology or micropaleontology, no exact age wa incorporated with any of these samples.

All samples were washed using -200 mesh sieve with water and sunlight detergent, because both Alma F-67 and Glenelg J-48 were drilled with oil-base drilling mud. These samples were later dried, hand-picked as far as possible, and crushed to -20mesh for the whole rock preparation, -40 mesh for kerogen isolation, and -60 mesh for Rock-Eval pyrolysis.

ANALYTICAL METHODS

Kerogen isolation was done by the palynology section of the Atlantic Geoscience Centre according to Barss and Williams (1973). For maceral point counting, three types of organic matter preparations (kerogen smear slide, whole rock polished pellet, and kerogen polished pellet) were made using transmitted white light for the smear slides, incident white light for both types of polished plugs (whole rock and kerogen), and incident blue-light (fluorescence) for all three preparations. Two polished thin sections were prepared by Paul Lake, AGC from the two core samples of Glenelg J-48.

The maceral terminology used in this report are taken from Stach et al., (1982), Mukhopadhyay et al., (1985), and Mukhopadhyay (1989). A detail of these terminologies are given in Mukhopadhyay and Birk (1989). Equivalent terms of various maceral types are taken from Teichmuller and Ottenjann (1977), Teichmuller (1986), van Gijzel (1981), Senftle et al., (1986), and Hutton (1987). Vitrinite reflectance data are taken from Avery (personal communication) and Avery (1989).

Cleaned whole cuttings and hand-picked cuttings were sent to the geochemistry division of ISPG, Geological Survey of Canada, Calgary, Alberta according to the contract. The Rock-Eval pyrolysis data used here are of ISPG, GSC, Calgary, Alberta. The parameters for various plots using Rock-Eval pyrolysis data are taken from Espitalie et al., (1985).

RESULTS AND DISCUSSIONS

Maceral Composition

Table 1 illustrates the maceral composition (in volume %) and fluorescence characteristics of amorphous liptinite and exinite or alginite related to depths from the five analyzed wells. The footnote in Table 1 illustrates the nature of each sample and possible synonyms of various macerals and possible hydrocarbon potential; special marks were shown for core samples or contaminated samples.

Most of the samples from Glenelg J-48, S. W. Banquereau F-34, and Thebaud P-84 wells show formation of abundant secondary macerals (semi-inert or inert from liptinites> these types of macerals are defined earlier (Mukhopadhyay and Wade, submitted; Dow et al., 1988; Mukhopadhyay et al., 1985). Original macerals were identified from the morphology of the secondary macerals by using white light in smear slide or polished kerogen/whole rock plugs.

Most of the samples from Alma F-67, are not much affected by maturation effect, becuase not much of secondary macerals are generated from the liptinites. Most of the liptinites preserve some amount of fluorescence at least up to 4785m. All samples contain more than 70% amorphous liptinites. The morphology of the these amorphous liptinites differentiate between amorphous liptinite I, IIA (Fig. 3a and 3b), and IIB showing relict structures of tasmanites, dinoflagellates/coccoliths, and exinite as discussed in Mukhopadhyay (1989). The small clusters and fine grained nature of the amorphous liptinite IIA in Alma F-67 (above 4785m) indicates deeper water facies, which are morphologically similar to the deep water black shales from Tyrrhenian Sea (Mukhopadhyay, 1990) or Angola Basin (Rullkotter et al., 1984). Most of these amorphous liptinites show dark brown fluorescence. Some of the amorphous liptinite IIA and framboidal pyrite show oxidation features. Below 4785m, the bitumen and mineral-bituminous groundmass show yellowish brown fluorescence, although the amorphous liptinite IIA is nonfluorescent. Samples at 4975 and 5040m show abundant lignite and other contamination possibly from the drilling mud additives. The amorphous liptinite IIA below 4825m shows different morphological features than the upper section; they form large brown clusters (in transmitted light) of fluffy amorphous material having coarser texture and often show relict structures of dinoflagellates. Samples 4975 and 5040m contain abundant vitrinite diluting the marine amorphous liptinite. Most of these samples contain some amount of bitumen, which often show brown fluorescence.

Except two samples (4855 and 4940m), all other samples in the borehole Glenelg J-48, contain abundant population of vitrinite, exinite, and inertinite (Fig. 3c). The samples 4855 and 4940m contains abundant amorphous liptinite IIA (Fig. 3d). Some of them show abundant semi-inert macerals like granular vitrinite (Fig. 3d) (Mukhopadhyay et al., 1985). Three core samples from Glenelg J-48 contains a high percentages two forms of alginite (alginite = telalginite and particulate liptinite A = lamalginite). Most of these alginite is transformed partially to meta-alginite (Fig. 3e). However, the alginite in sample 5186.7 shows orange fluorescence in both polished thin section and whole rock pellet, which is not normal considering its maturity. Except the core samples and the sample at 4940m, all samples contain abundant lignite and other contaminations. Maceral analysis was done excluding these contaminants.

Similar to Glenelg J-48, most samples from S. W. Banquereau F-34 (except samples at 5945 and 6205m) contain abundant vitrinite, exinite, and inertinite. Most of these samples have a mixed assemblage of macerals. Sample 5945m contain some fragments of tasmanite algae. Most of the amorphous liptinite IIA form large clusters of fluffy materials similar to the samples from the lower part of Glenelg J-48 indicating shallow marine origin. All samples contain abundant bitumen. These bitumens are either occur parallel to the alignment of minerals (Fig. 3f) or occur as large block associated with amorphous liptinite IIA (Fig. 3g). All these bitumens show orange brown fluorescence. Most of the amorphous liptinite IIA is nonfluorescent or show dark brown fluorescence, however, did not generate much of secondary macerals like that of Glenelg J-48. The fluorescence of amorphous liptinite and bitumen is anomalous to the vitrinite reflectance of these samples.

Sample from Intrepid L-80 contains a total mixture of vitrinite, inertinite, exinite, and amorphous liptinite (both IIA and IIB); these macerals are nonfluorescent.

Sample from Thebaud P-84 shows similarity with some of the amorphous liptinite-rich samples of Glenelg J-48. Amorphous liptinites show generation of secondary macerals like granular vitrinite or clustered micrinite (Fig. 3h) (Mukhopadhyay et al., 1985).

Vitrinite Reflectance

Alma F-67 samples did not have any vitrinite reflectance data, because this contract was restricted to maceral composition and no data on vitrinite reflectance was available from AGC. However, fluorescence data of amorphous liptinite IIA and solid bitumen suggest that all these samples are within 1.30% Ro.

Table 3 shows the vitrinite reflectance data from the boreholes Glenelg J-48 and S. W. Banquereau F-34. Accordingly, all samples from Glenelg J-48 lie within 1.15 to 1.88 Ro (mature to overmature zone). However, fluorescence of alginite and solid bitumen in the core samples suggest extention of liquid hydrocarbon generation or abnormality in vitrinite reflectance due to overpressuring.

Rock-Eval Pyrolysis

Table 2 illustrates the Rock-Eval pyrolysis data of thirty samples. One sample from Glenelg J-48 (5115 m) were analyzed twice; one of which is pure hand-picked shale and the other whole washed cuttings.

Table 2 shows that all samples contain more than 1% TOC. The anomalous high TOC content (24.83%) of sample 5115m (Glenelg J-48) and samples 4855, 4975, and 5040m from Alma F-67 supports that at least a part of the this TOC is derived from contamination, as suggested from maceral composition data. Uncontaminated samples of high TOC in S. W. Banquereau F-34 well suggest the influence of solid bitumen in TOC.

Most of the samples in Alma F-67 are within classical Kerogen Type II-III in a hydrogen index (HI) versus oxygen index (OI) diagram (Espitalie et al, 1985) (Fig. 4). Some of the samples are close to Kerogen Type II. According to the amounts of TOC, HI, and S2, these samples are potential oil source rocks. High production indices of these samples indicate significant generation of bitumen from the source rock or contaminated with base oils (Alma F-67 was drilled with oil-base drilling mud).

All samples from Glenelg J-48 in the HI versus OI diagram are Kerogen Type III (Fig. 4). However, high Tmax values of the core samples suggest advanced maturity related low S2 values. High production indices of all samples also support the maturity data. Low Tmax values in some samples suggest effect of contamination.

In S. W. Banquereau F-34, most samples lie within Kerogen II and III similar to Alma F-67 in a HI versus OI diagram. Some of the samples (5945, 6035, 6205, and 6260m) have high TOC and S2, suggesting presence of possible oil source rocks. The low Tmax values compared to vitrinite reflectance in most of the samples, suggest the influence of solid bitumen. Solid bitumens possibly affect the production index values of these samples, which are relatively low compared to vitrinite reflectance.

According to the amount of HI, OI, and S2, both samples from Intrepid L-80 and Thebaud P-84 lie in Type III kerogen maturation path. The low Tmax value for Thebaud P-84 sample indicates influence of bitumen. High production index suggests either presence of allochthonous bitumen or advanced maturation with Type II kerogen.

ORGANIC FACIES AND SOURCE-ROCK POTENTIAL

Table 3 shows the variation of organic facies as related to the volume % of maceral affinity association and their associated petrographic criteria.

Based on organic petrographic criteria, most of the analyzed sediments from Alma F-67 well contain mainly marine organic matter and mostly deposited in a partially anoxic environment. Except sample at 5040m, all samples are either Kerogen Type IIA or IIA-IIB (classical Type II) oil-prone source-rock. Petrographic criteria (abundance of vitrinite and inertinite) indicates that sample at 5040m (Alma F-67) is not a typical oil-source rock as indicated by Rock-Eval pyrolysis and the elevated TOC and HI are possibly derived from contamination. According to the nature of the organic matter from the analyzed samples, sediments above 4825m are derived from a partially deep marine depositional environment, whereas the samples below 4825m are originated in a shallow marine environemnt; depletion of oxygen is possibly caused by upwelling. In most cases, petrographic data corroborate Rock-Eval pyrolysis data. Fig. 4 from Rock-Eval pyrolysis shows the gradual increase in Tmax values and decrease in production indices suggesting indication of maturation profile for similar kerogen type and depletion of hydrocarbons from the source rock because of possible migration.

On the other hand, most of the analyzed sediments from Glenelg J-48 are of Kerogen Type III or IIB (non source rock for normal crude oil). Two samples (4855 and 4940m) are of Kerogen Type IIA derived mainly from the biodegradation of marine organic matter (deposited in an upwelling region with oxygen depletion) forming typical oil source rock. The morphology of the organic matter in the upper part of the section (above 4940m) are suggestive of deep marine origin. However, except sample 4855m and 4940m, other three samples are deposited in a partially oxidizing environment which destroyed marine organic matters. Organic matter in sediments below 5115m, are mainly of mixed origin possibly deposited in a shallow marine environment. A typical oil-source rock could not be formed in these sediments, because of lack of preserved marine organic matter. Lack of correlation between petrographic and Rock-Eval pyrolysis data was possibly affected by contamination and maturation.

The nature of the morphology of the organic matter and framboidal pyrite in all samples from S. W. Banquereau F-34, suggested that all sediments are deposited in a partially sheltered environment. However, formation of oil-source rock was controlled by the amount of terrestrial organic matter input possibly triggered by the discharge of rivers in a shallow marine environment. Two samples (5945 and 6205m) are composed of marine organic matter forming Kerogen Type IIA oil source rock. Two other samples contain mainly mixed organic matter forming a less effective oil source rock (Type IIA-IIB). All other samples are nonsource rock for generation of normal crude oil. The low correlation between petrographic data and Rock-Eval pyrolysis are possibly controlled by the advanced maturation. Abundant bitumen and bitumen fluorescence at this maturity possibly indicate either presence of allochthonous bitumen or precipitation of bitumen from the oil because of overpressuring.

Intrepid L-80 sample contain abundant terrestrial input forming a typical Kerogen Type III organic matter, although this sediment was deposited in a partially anoxic environment. The abundance of amorphous liptinite and the morphology of the organic matter in sample from Thebaud P-84 suggest presence of a possible Kerogen Type IIA-IIB oil source rock. The low correlation of of organic petrography and Rock-Eval pyrolysis is possibly controlled by early generation and expulsion of hydrocarbons from this source rock.

SUMMARY AND CONCLUSIONS

1. Contrary to Powell (1982), most of the distal Verrill Canyon Formation sediments in Alma F-67, S. W. Banquereau F-34, and two samples from Glenelg J-48, are composed of marine or mixed organic matter forming IIA or IIA-IIB oil-prone source rocks. Anoxic events preserving these source rocks are possibly controlled by upwelling. Some of the source rocks recognized by Powell (1982) as distal Verrill Canyon Formation are actually equivalent to prodelta facies of Mississauga Formation similar to S. Venture O-59 well (Mukhopadhyay and Birk, 1989; Mukhopadhyay and Wade, submitted); these rocks are mainly condensate and gas source rocks. The implication of this present source rock data possibly indicate presence of more oil-saturated Cretaceous reservoir south of Sable Subbasin.

2. As postulated in our earlier studies, variability in organic facies suggests the presence of multiple source rocks for crude oil, condensate, and gas generation in the deeper part of the Sable Subbasin and surrounding areas.

3. The variation of maturity in similar depth from wells Alma F-67 and Glenelg J-48, suggests the influence of time in organic maturation; Alma F-67 possibly contains younger sediments at similar depth than that of Glenelg J-48.

4. The presence of abundant solid bitumen in a matured and overmature source rock possibly suggests the time of overpressuring and peak oil generation is related; oil could not be migrated and remained within the source rock (example: S. W. Banquereau F-34) because of overpressuring. Presence of fluorescent bitumen also corroborate this theory.

5. Presence of strong fluorescence in alginite and bitumen in the overmature or boundary of mature and overmature zone suggest possible extention of oil window in the overmature zone because of overpressuring. Overpressuring on the other hand accelerated vitrinite reflectance, possibly because of different reaction kinetics.

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LIST OF TABLES AND FIGURES

Tables

Figures

Table 1: Maceral Composition of shale samples from borehole Alma F-67, Scotian Shelf

SAMPLE ID (m)	Vit.	Int.	Exin.	Res.	Part. Lip.A	Amorphous Liptinite I	IIA	IIB	Amorp. OM	Alg.	Lpdet	Bitumen	Fluorescence Exin/Amor.Lip
4500	4.0	3.2	0.2	0.0	1.4	0.0	85.0	0.4	0.0	2.2	0.8	2.8	dark brown
4560	10.6	4.6	0.4	0.0	2.2	10.2	60.8	2.8	0.2	2.6	2.6	3.0	dark brown
4625	8.8	3.0	0.0	0.0	1.8	0.0	71.0	10.8	0.2	1.0	2.0	1.4	dark brown
4725	10.0	5.6	0.4	0.0	1.8	10.0	51.0	18.8	0.0	1.0	0.2	1.2	orange
4785	5.0	3.8	0.0	0.4	0.0	0.4	73.8	15.2	0.0	1.2	0.2	0.0	nonfluorescent
4825	12.6	1.2	0.2	0.0	0.2	0.0	72.0	11.2	0.0	2.0	0.2	0.4	nonfluorescent
4885	7.6	1.4	0.2	0.0	0.0	6.2	79.6	1.0	0.0	2.2	0.2	1.6	nonfluorescent
4975#	27.6	1.6	0.8	0.0	0.4	8.8	53.0	1.8	0.2	1.6	0.0	4.2	nonfluorescent

Vit. = Vitrinite
Int. = Inertinite
Exin. = Exinite
Res. = Resinite

Part. Lip A = Lamalginite
Amorphous Liptinite I, IIA = Sapropelinite I & IIA
Amorphous Liptinite IIB = Sapropelinite IIB
Amorp. OM = Amorphous Organic Matter = Humosapropelinite (mixture of humic & liptinitic matrix)

Alg. = Alginite = Telalginite
Lpdet. = Liptodetrinite
Bit. = Bitumen

= Contamination; + = Low O.M; c = core

Sapropelinite = Bituminite = Amorphinite; Particulate Liptinite A = Acritarch, dinfl. clast = lamalginite

Amorph. Liptinite I/IIA = Oil; Amorphous Liptinite IIB = Condensate + Oil; Amorphous Org. Matter = Gas + Condensate

Table 1: Maceral Composition of shale samples from borehole Alma F-67, Scotian Shelf

SAMPLE ID (m)	Vit.	Int.	Exin.	Res.	Part. Lip.A	Amorphous Liptinite I	IIA	IIB	Amorp. OM	Alg.	Lpdet	Bitumen	Fluorescence Exin/Amor.Lip
5040#	36.6	11.0	2.6	0.0	0.4	0.0	40.2	2.6	1.0	0.6	0.8	4.2	nonfluorescent

Vit. = Vitrinite
Int. = Inertinite
Exin. = Exinite
Res. = Resinite
Part. Lip A = Lamalginite
Amorphous Liptinite I, IIA = Sapropelinite I & IIA
Amorphous Liptinite IIB = Sapropelinite IIB
Amorp. OM = Amorphous Organic Matter = Humosapropelinite (mixture of humic & liptinitic matrix)
Alg. = Alginite = Telalginite
Lpdet. = Liptodetrinite
Bit. = Bitumen

= Contamination; + = Low O.M; c = core

Sapropelinite = Bituminite = Amorphinite; Particulate Liptinite A = Acritarch, dinfl. clast = lamalginite

Amorph. Liptinite I/IIA = Oil; Amorphous Liptinite IIB = Condensate + Oil; Amorphous Org. Matter = Gas + Condensate

Table 1: Maceral Composition of shale samples from borehole Glenelg J - 48, Scotian Shelf

SAMPLE ID (m)	Vit.	Int.	Exin.	Res.	Part. Lip.A	Amorphous Liptinite I	IIA	IIB	Amorp. OM	Alg.	Lpdet	Bitumen	Fluorescence Exin/Amor.Lip
4620#	45.4	17.6	10.6	1.8	6.6	0.2	6.8	6.0	0.4	1.2	2.4	1.0	orange
4655#	58.4	15.8	9.0	0.8	3.6	0.0	1.6	7.6	0.2	0.2	1.6	1.2	nonfluorescent
4745#	52.8	11.0	10.8	1.0	3.2	0.0	4.2	14.4	0.2	0.0	1.0	1.4	dark brown
4855#	11.0	5.0	1.0	0.0	0.4	0.4	74.6	2.8	0.0	3.6	0.0	1.2	dark brown to nonfluorescent
4940	5.4	2.2	0.2	0.0	0.0	1.0	84.8	2.2	0.0	2.4	0.0	1.8	diffuse orange
5115#	65.0	4.0	10.4	1.0	0.6	0.2	10.4	6.6	0.0	0.8	0.4	0.6	nonfluorescent
5160	44.8	14.8	14.4	0.4	1.4	0.0	2.8	19.2	0.2	1.0	0.4	0.6	bit. = yellow nonfluorescent
5180.8(c)	30.0	13.2	16.4	0.2	11.0	0.0	3.2	16.4	0.0	6.4	2.8	0.4	bit. = yellow orange

Vit. = Vitrinite
Int. = Inertinite
Exin. = Exinite
Res. = Resinite

Part. Lip A = Lamalginite
Alg. = Alginite = Telalginite
Amorphous Liptinite I, IIA = Sapropelinite I & IIA
Lpdet. = Liptodetrinite
Amorphous Liptinite IIB = Sapropelinite IIB
Bit. = Bitumen
Amorp. OM = Amorphous Organic Matter = Humosapropelinite (mixture of humic & liptinitic matrix)

= Contamination; + = Low O.M; c = core

Sapropelinite = Bituminite = Amorphinite; Particulate Liptinite A = Acritarch, dinfl. clast = lamalginite

Amorph. Liptinite I/IIA = Oil; Amorphous Liptinite IIB = Condensate + Oil; Amorphous Org. Matter = Gas + Condensate

Table 1: Maceral Composition of shale samples from borehole Glenelg J-48, Scotian Shelf

SAMPLE ID (m)	Vit.	Int.	Exin.	Res.	Part. Lip.A	Amorphous Liptinite I	IIA	IIB	Amorp. OM	Alg.	Lpdet	Bitumen	Fluorescence Exin/Amor.Lip
5186.7(c)	30.8	11.2	23.0	0.2	7.2	0.0	0.0	5.0	0.0	9.2	12.2	1.2	min.bit.gr=yel alg.=orange
5187(c)	49.6	8.4	16.4	0.0	6.0	0.2	10.2	2.2	0.0	4.8	1.2	1.0	non fl. to red
5235#	39.6	8.4	16.8	0.6	4.2	0.0	15.4	9.6	0.4	1.8	2.4	0.8	nonfluorescent

Vit. = Vitrinite
Int. = Inertinite
Exin. = Exinite
Res. = Resinite

Part. Lip A = Lamalginite   Alg. = Alginite = Telalginite
Amorphous Liptinite I, IIA = Sapropelinite I & IIA   Lpdet. = Liptodetrinite
Amorphous Liptinite IIB = Sapropelinite IIB   Bit. = Bitumen
Amorp. OM = Amorphous Organic Matter = Humosapropelinite (mixture of humic & liptinitic matrix)

= Contamination; + = Low O.M; c = core

Sapropelinite = Bituminite = Amorphinite; Particulate Liptinite A = Acritarch, dinfl. clast = lamalginite

Amorph. Liptinite I/IIA = Oil; Amorphous Liptinite IIB = Condensate + Oil; Amorphous Org. Matter = Gas + Condensate

Table 1: Maceral Composition of shale samples from borehole S. W. Banquereau F-34, Scotian Shelf

SAMPLE ID (m)	Vit.	Int.	Exin.	Res.	Part. Lip.A	Amorphous Liptinite I	IIA	IIB	Amorp. OM	Alg.	Lpdet	Bitumen	Fluorescence Exin/Amor.Lip
5720	16.8	5.2	1.8	0.0	3.0	2.2	30.8	28.0	0.0	5.4	2.0	4.8	dark brown
5840	19.2	9.2	9.6	0.0	9.4	0.0	25.4	13.4	0.0	1.2	10.0	2.6	nonfluorescent
5945	8.8	5.8	0.4	0.0	3.6	0.0	68.8	0.6	0.0	0.4	2.8	8.8	nonfluorescent
6035#	27.6	6.4	7.0	0.2	9.0	0.0	26.8	10.6	0.0	0.6	4.2	7.6	nonfluorescent
6145	22.8	3.4	7.6	0.0	4.4	0.0	30.2	26.8	0.2	0.4	2.2	2.0	bit.=yellow nonfluorescent
6205	14.2	1.4	1.4	0.0	4.8	0.0	65.0	1.4	0.0	0.2	1.4	10.2	dark brown
6260	24.8	2.6	3.4	0.0	1.2	0.0	43.0	5.4	0.0	0.2	5.6	13.8	bit.=brown nonfluorescent
6309	25.0	3.4	6.2	0.0	3.2	0.0	29.8	14.4	0.4	1.2	5.4	11.0	nonfluorescent

Vit. = Vitrinite   Part. Lip A = Lamalginite   Alg. = Alginite = Telalginite
Int. = Inertinite   Amorphous Liptinite I, IIA = Sapropelinite I & IIA   Lpdet. = Liptodetrinite
Exin. = Exinite   Amorphous Liptinite IIB = Sapropelinite IIB   Bit. = Bitumen
Res. = Resinite   Amorp. OM = Amorphous Organic Matter = Humosapropelinite (mixture of humic & liptinitic matrix)

= Contamination; + = Low O.M; c = core

Sapropelinite = Bituminite = Amorphinite; Particulate Liptinite A = Acritarch, dinfl. clast = lamalginite

Amorph. Liptinite I/IIA = Oil; Amorphous Liptinite IIB = Condensate + Oil; Amorphous Org. Matter = Gas + Condensate

Table 1: Maceral Composition of shale samples from borehole Intrepid L-80, Scotian Shelf

SAMPLE ID (m)	Vit.	Int.	Exin.	Res.	Part. Lip.A	Amorphous Liptinite I	IIA	IIB	Amorp. OM	Alg.	Lpdet	Bitumen	Fluorescence Exin/Amor.Lip
4087#	48.8	12.6	17.6	0.4	2.2	0.0	6.6	6.0	0.2	0.6	1.8	3.2	nonfluorescent

Vit. = Vitrinite
Int. = Inertinite
Exin. = Exinite
Res. = Resinite

Part. Lip A = Lamalginite
Amorphous Liptinite I, IIA = Sapropelinite I & IIA
Amorphous Liptinite IIB = Sapropelinite IIB
Amorp. OM = Amorphous Organic Matter = Humosapropelinite (mixture of humic & liptinitic matrix)

Alg. = Alginite = Telalginite
Lpdet. = Liptodetrinite
Bit. = Bitumen

= Contamination; + = Low O.M; c = core

Sapropelinite = Bituminite = Amorphinite; Particulate Liptinite A = Acritarch, dinfl. clast = lamalginite

Amorph. Liptinite I/IIA = Oil; Amorphous Liptinite IIB = Condensate + Oil; Amorphous Org. Matter = Gas + Condensate

Table 1: Maceral Composition of shale samples from borehole Thebaud P-84, Scotian Shelf

SAMPLE ID (m)	Vit.	Int.	Exin.	Res.	Part. Lip.A	Amorphous Liptinite I	IIA	IIB	Amorp. OM	Alg.	Lpdet	Bitumen	Fluorescence Exin/Amor.Lip
4045	10.0	4.6	6.4	0.4	1.2	0.0	63.2	11.2	0.0	0.4	0.8	1.8	red brown-non

Vit. = Vitrinite
Int. = Inertinite
Exin. = Exinite
Res. = Resinite

Part. Lip A = Lamalginite
Amorphous Liptinite I, IIA = Sapropelinite I & IIA
Amorphous Liptinite IIB = Sapropelinite IIB
Amorp. OM = Amorphous Organic Matter = Humosapropelinite (mixture of humic & liptinitic matrix)

Alg. = Alginite = Telalginite
Lpdet. = Liptodetrinite
Bit. = Bitumen

= Contamination; + = Low O.M; c = core

Sapropelinite = Bituminite = Amorphinite; Particulate Liptinite A = Acritarch, dinfl. clast = lamalginite

Amorph. Liptinite I/IIA = Oil; Amorphous Liptinite IIB = Condensate + Oil; Amorphous Org. Matter = Gas + Condensate

Table 2: Rock-Eval pyrolysis data

Well No.	Sample depth (m)	TOC (wt %)	S_1	S_2	S3	S_2/S_3	PI	HI	OI	T_{max} (°C)
Alma F-67	4500	2.87	6.33	10.25	1.90	5.39	0.38	357	66	427
	4560	3.06	5.89	11.93	2.02	5.90	0.33	389	66	430
	4625	3.56	6.21	12.40	2.00	6.20	0.33	348	56	435
	4725	3.20	5.72	11.68	1.96	5.95	0.33	365	51	434
	4785	3.51	5.26	12.10	1.68	7.20	0.30	344	47	437
	4825	3.35	5.25	13.56	1.73	7.84	0.28	405	51	441
	4885	3.51	4.92	14.82	1.78	8.32	0.25	422	50	440
	4975	4.16	8.39	21.29	2.11	10.09	0.28	511	50	442
	5040	5.23	8.20	26.92	2.48	10.85	0.23	514	47	445
Glenelg J-48	4620	1.34	0.82	0.72	1.27	0.56	0.53	53	94	443
	4655	1.92	0.95	0.80	1.52	0.52	0.55	41	79	440
	4745	1.64	0.98	0.96	1.92	0.50	0.51	58	117	438
	4855	8.35	1.25	4.16	6.83	0.60	0.23	49	81	435
	4940	3.43	1.07	1.48	2.23	0.66	0.42	43	65	440
	5115 (h)	2.52	1.89	1.99	2.09	0.95	0.49	78	82	447
	5115 (w)	24.43	3.38	28.60	19.26	1.48	0.11	117	78	440
	5160	2.14	1.82	2.42	1.70	1.42	0.43	113	79	432
	5180.8 (c)	1.88	0.37	1.05	1.39	0.75	0.26	55	73	539
	5186.7 (c)	2.10	0.34	0.65	0.92	0.70	0.35	30	43	537
	5187	1.79	0.25	0.45	0.78	0.57	0.35	25	43	467
	5235	4.54	4.58	5.43	6.50	0.83	0.46	119	143	375
S.W.Banquereau F-34	5720	1.92	0.96	1.92	2.54	0.75	0.33	100	132	432
	5840	1.56	0.39	1.47	1.67	0.89	0.21	94	107	440
	5945	2.48	1.02	4.30	3.06	1.40	0.19	173	123	440
	6035	2.00	1.57	5.13	1.57	3.26	0.23	256	78	432
	6145	1.39	0.38	1.37	1.06	1.29	0.22	98	76	431
	6205	3.91	1.03	13.75	2.18	6.30	0.07	351	55	433
	6260	4.46	1.14	12.84	2.43	5.28	0.08	352	56	435
	6309	2.55	0.66	5.47	1.44	4.49	0.09	253	56	435
Intrepid L-80	4087	1.26	0.27	0.69	0.97	0.71	0.28	54	76	461
Thebaud P-84	4045	1.12	[illegible]	0.41	1.62	0.25	0.73	36	143	420

h = hand-picked shale; w = whole cuttings; c = core

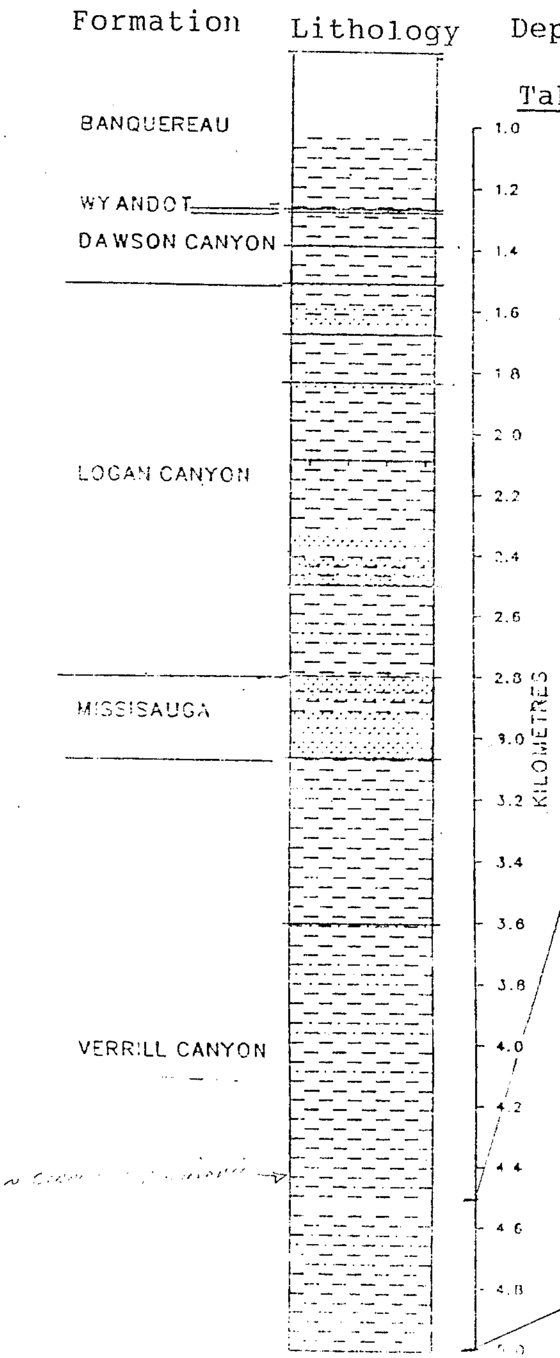
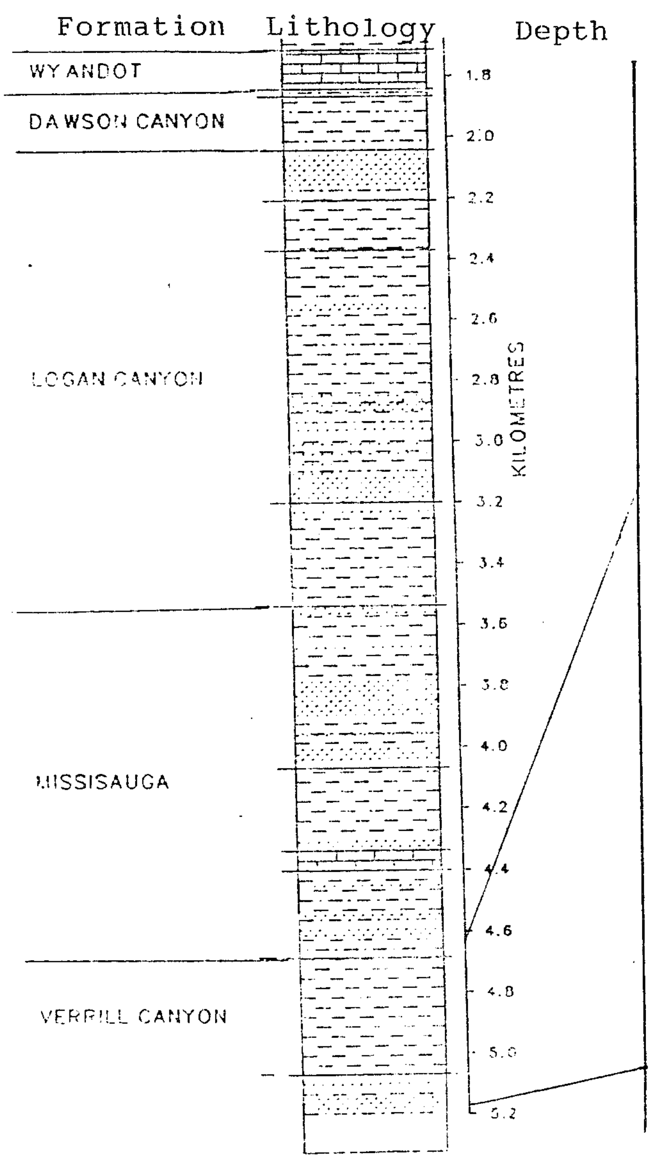


Table 3. Variation of organic facies (volume % of maceral affinity association) and their associated petrographic criteria, kerogen type, and their inferred oil/gas potential related to stratigraphy & from borehole Alma F-67

Depth (m)	Vitrinite Refl. R_o	Vitrinite Refl. Std. Dev.	Organic Facies Distribution (vol. %)# 1	2	3	4	5	6	Other Petrogr. Criteria: Oxidation Level (Environment)	Other Petrogr. Criteria: Organic Input	Kerogen Type	Oil/Gas Potential
4500			2.3	88.9	1.2	0.2	4.1	3.3	Part. anoxic (deep marine)	Marine	IIA	Oil
4560			13.2	64.9	5.7	0.4	11.1	4.7	Part. anoxic (deep marine)	Mainly marine	IIA-IIB	Oil/Cond.
4625			1.0	73.8	13.1	0.0	9.1	3.0	Part. anoxic (deep marine)	Mainly marine	IIA-IIB	Oil/Cond.
4725			11.1	53.5	19.2	0.4	10.1	5.7	Part. anoxic (deep marine)	Mainly marine	IIA-IIB	Oil/Cond.
4785			1.6	73.8	15.4	0.4	5.0	3.8	Part. anoxic (deep marine)	Mainly marine	IIA-IIB	Oil/Cond.
4825			2.0	72.4	11.5	0.2	12.7	1.2	Part. anoxic (shallow mar.)	Mainly marine	IIA-IIB	Oil/Cond.
4885			8.5	81.0	1.2	0.2	7.7	1.4	Part. anoxic (shallow mar.)	Marine	IIA	Oil
4975			10.9	55.7	1.9	0.8	29.0	1.7	Part. anoxic (shallow mar.)	Mixed	IIA-IIB	Oil/Cond.
5040			0.6	42.5	3.5	2.7	39.2	11.5	Part. anoxic (shallow mar.)	Mixed	IIB	Cond/Gas

organic facies distribution in volume % in bitumen-free basis.
Shallow mar. = shallow marine; environment = possible depositional environment derived from Organic Petrography.

Table 3. Variation of organic facies (volume % of maceral affinity assiciation and their associated petrographic criteria, kerogen type, and their inferred oil/gas potential related to lithology, stratigraphy of borehole Glenelg J-48.

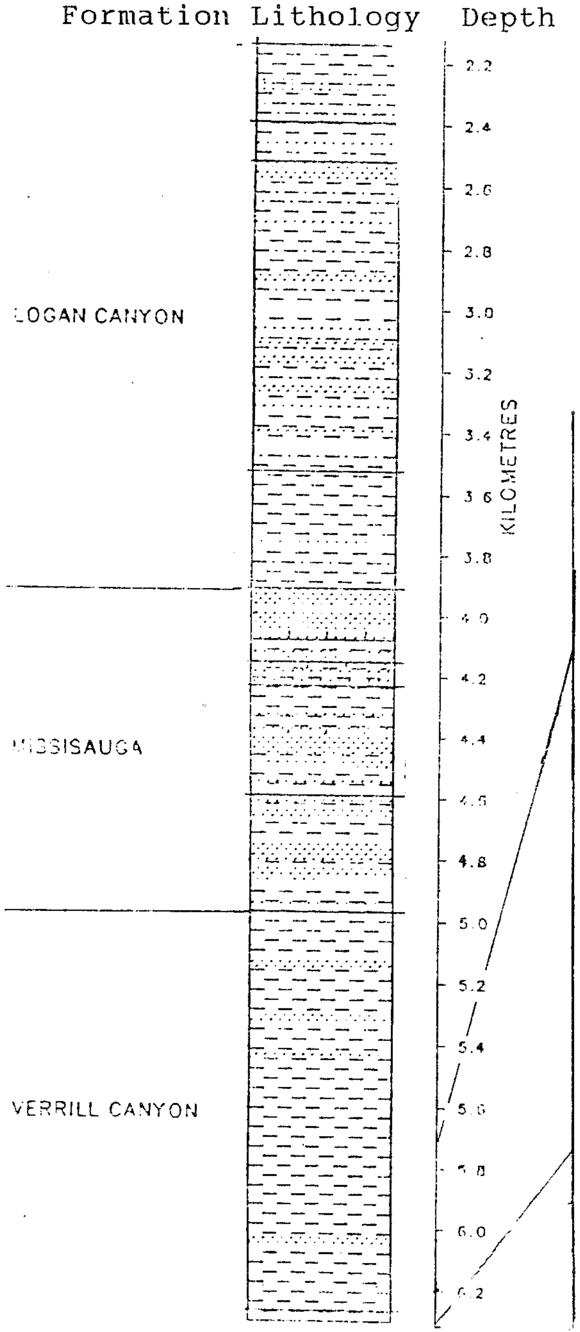


Depth (m)	Vitrinite Refl. R_o	Std. Dev.	Organic Facies Distribution (vol. %)# 1	2	3	4	5	6	Other Petrogr. Criteria: Oxidation Level (Environment)	Organic Input	Kerogen Type	Oil/Gas Potential
4620	1.15 (mature)		1.4	13.5	8.5	12.5	46.3	17.8	Part. oxic (deep marin)	Terrest.	III	Gas
4655			0.2	5.3	9.3	9.9	59.4	16.0	Part. oxic (deep marine)	Terrest.	III	Gas
4745	1.20 (mature)	0.10	-	7.5	15.6	12.0	53.8	11.1	Part. oxic (deep marine)	Terrest.	III	Gas
4855	1.30 (mature)		4.0	75.9	2.8	1.0	11.2	5.1	Part. anoxic (deep marine)	Marine	IIA	Oil
4940	1.40 (mature)		3.5	86.4	2.2	0.2	5.5	2.2	Part. anoxic (deep marine)	Marine	IIA	Oil
5115	1.70 (overmature)		1.0	11.1	7.0	11.5	65.4	4.0	Part. oxic (shal.marine)	Terrest.	III	Gas
5160	1.87 (overmature)		1.0	4.2	19.7	14.9	45.3	14.9	Part. Oxic (shal.marine)	Terrest.	III	Gas
5180.8	1.87 (overmature)		6.4	14.2	19.3	16.7	30.1	13.3	Part. anoxic (shal.marine)	Mixed	IIB	Cond/Gas
5186.7	1.87 (overmature)		9.3	7.3	17.4	23.5	31.2	11.3	Part. anoxic (shal.marine)	Mixed	IIB	Cond/Gas
5187	1.87 (overmature)		5.0	16.4	3.4	16.6	50.1	8.5	Part. anoxic (shal.marine)	Mixed	IIB	Cond/Gas
5235	1.88		1.8	19.8	12.1	17.5	40.3	8.5	Part. oxic	Mixed	III	Gas

#organic facies distribution in volume % in bitumen-free basis

shal. marine = shallow marine; environment = possible depositional environment derived from Organic Petrography

Part. oxic/anoxic = partially oxic/anoxic



<u>Table3</u>. Variation of organic facies (volume % of maceral affinity association) and their associated petrographic criteria, kerogen type, and their inferred oil/gas potential related to stratigraphy, lithology of borehole S. W. Banquereau F-34

Depth (m)	Vitrinite Refl. R_o	Std. Dev.	Organic Facies Distribution (vol. %)# 1	2	3	4	5	6	Other Petrogr. Criteria: Oxidation Level (Environment)	Organic Input	Kerogen Type	Oil/Gas Potential
5720	2.04 (overmature)	0.07	8.0	35.5	31.5	1.9	17.6	5.5	Part. anoxic (shal.marine)	Mixed	IIA-IIB	Oil/Cond
5840	2.20 (overmature)		1.2	35.1	24.0	9.8	19.7	9.4	Part. anoxic (shal.marine)	Mixed	IIB	Cond/Gas
5945	2.43 (overmature)	0.09	0.4	79.4	3.7	0.4	9.7	6.4	Part. anoxic (shal.marine)	Marine	IIA	Oil
6035			0.6	38.7	16.0	7.8	30.0	6.9	Part. oxic (shal.marine)	Mixed	III	Gas
6145			0.4	35.3	29.6	7.8	23.5	3.4	Part. anoxic (shal.marine)	Mixed	IIB	Cond/Gas
6205	2.83 (overmature)	0.03	0.2	77.7	3.1	1.6	15.8	1.6	Part. anoxic (shal.marine)	Marine	IIA	Oil
6260			0.2	51.3	12.8	3.9	28.8	3.0	Part. anoxic (shal.marine)	Mixed	IIA - IIB	Oil/Cond
6305	2.64 (overmature)	0.05	1.3	37.2	22.2	7.0	28.5	3.8	Part. anoxic (shal.marine)	Mixed	IIB	Cond/Gas

#organic facies distribution in volume % in bitumen-free basis
shal. marine = shallow marine; environment = possible depositional environment derived from Organic Petrography
Part. oxic/anoxic = partially oxic/anoxic

Table 3: Organic facies distribution and their associated petrographic criteria, kerogen type, and inferred oil/gas potential of borehole Intrepid L-80

Depth (m)	Vitrinite Refl. R_o	Vitrinite Refl. Std. Dev.	Organic Facies Distribution (vol. %)# 1	2	3	4	5	6	Other Petrogr. Criteria: Oxidation Level (Environment)	Organic Input	Kerogen Type	Oil/Gas Potential
4087			0.6	9.1	8.1	17.8	51.3	13.1	Part. anoxic (prodelta)	Terrest.	III	Gas

#organic facies distribution in volume % in bitumen-free basis
shal. marine = shallow marine; environment = possible depositional environment derived from Organic Petrography
Part. oxic/anoxic = partially oxic/anoxic

Table 3. Organic facies distribution and their associated petrographic criteria, kerogen type, and inferred oil/gas potential of borehole Thebaud P-84

Depth (m)	Vitrinite Refl. R_o	Std. Dev.	Organic Facies Distribution (vol. %)# 1	2	3	4	5	6	Other Petrogr. Criteria: Oxidation Level (Environment)	Organic Input	Kerogen Type	Oil/Gas Potential
4045			0.4	65.6	12.2	6.9	10.2	4.7	Part. anoxic (shal.marine)	Mixed	IIA - IIB	Cond/Gas

#organic facies distribution in volume % in bitumen-free basis
shal. marine = shallow marine; environment = possible depositional environment derived from Organic Petrography
Part. oxic/anoxic = partially oxic/anoxic

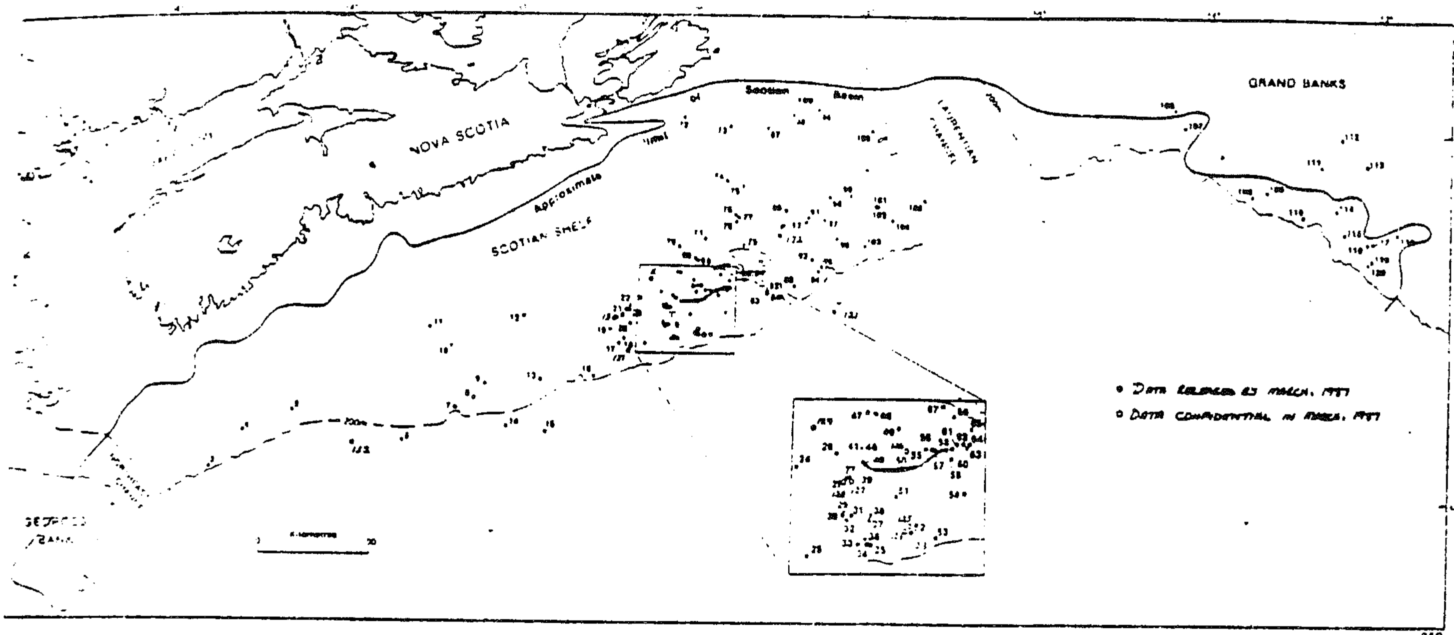


Table 5.2a

No.	Wells – Name	Status
1.	Chinampas N-37	P & A
2.	Cape Spencer No. 1	P & A
3.	Bonnet P-23	P & A
4.	Mohawk B-93	P & A
5.	Montagnais I-94	P & A
6.	Albatross B-13	P & A
7.	Mohican I-100	P & A
8.	Moheida P-15	P & A
9.	Glooscap C-63	P & A
10.	Naskapi N-30	P & A
11.	Sambro I-29	P & A
12.	Ojibwa E-07	P & A
13.	Oneida O-25	P & A
14.	Acadia K-62	P & A
15.	Shubenacadie H-100	P & A
16.	Evangeline H-98	P & A
17.	Alma K-85	Del. G
18.	Alma F-67 *	DISC. G
19.	Demascota G-32	P & A
20.	Cree E-35	P & A
21.	Cohasset A-52	Del. O
22.	Cohasset P-42	P & A
23.	Cohasset D-42	DISC. O
24.	Cohasset L-97	P & A
25.	Wenonah J-75	P & A
26.	Migrant N-20	P & A
27.	Thebaud P-84	DISC. G,C
28.	Thebaud I-94	Del. G,C
29.	Onondaga B-96	P & A
30.	Onondaga O-95	P & A
31.	Onondaga F-75	P & A
32.	Onondaga E-84	DISC. G
33.	Glenelg E-58 and E-58A	Del. G
34.	Glenelg J-48 *	DISC. G
35.	Glenelg H-38	P & A
36.	Glenelg N-49	Del. G
37.	Marmora C-34	P & A
38.	Marmora P-35	P & A
39.	Sable Island O-47	DISC. G
40.	Sable Island E-48	DISC. G,C,O
41.	Sable Island H-58	Del. G,C,O
42.	Sable Island 2H-58	Del. G,C,O
43.	Sable Island 3H-58	Del. G,O
44.	Sable Island 4H-58	Del. G,O
45.	Sable Island 5H-58	Del. G,C,O
46.	Sable Island 6H-58	P & A
47.	Penobscot B-41	P & A
48.	Penobscot L-30	P & A
49.	South Desbarres O-76	P & A
50.	Sable Island C-67	P & A
51.	Intrepid L-80	DISC. G
52.	Triumph P-50	P & A
53.	Chebucto G-90	DISC. G
54.	Eagle D-21	DISC. G
55.	Olympia A-12	DISC. G,C
56.	West Venture N-91	DISC. G
57.	West Venture B-92	P & A
58.	West Venture C-62	DISC. G,C
59.	South Venture O-59	DISC. G,C
60.	Venture B-52	Del. G,C
61.	Venture B-43	Del. G,C
62.	Venture D-23	DISC. G,C
63.	Venture H-22	Del. G,C
64.	Venture B-13	Del. G,C
65.	Arcadia J-16	DISC. G,C
66.	Citnalta I-59	DISC. G,C
67.	Uniacke G-72	DISC. G,C
68.	Abenaki J-56	P & A
69.	Abenaki L-57	P & A
70.	Dover A-43	P & A
71.	Iroquois J-17	P & A
72.	Eurydice P-36	P & A
73.	Fox I-22	P & A
74.	Erie D-26	P & A
75.	Wyandot E-53	P & A
76.	Mic Mac D-89	P & A
77.	Mic Mac J-77	P & A
78.	Mic Mac H-86	P & A
79.	Missisauga H-54	P & A
80.	Bluenose C-47	P & A
81.	Bluenose 2G-47	P & A
82.	Primrose F-41	P & A
83.	Primrose N-50	DISC. G,O
84.	Primrose A-41	P & A
85.	Southwest Banquereau F-34	P & A
86.	Tuscarora D-61	P & A
87.	Crow F-52	P & A
88.	Argo F-38	P & A
89.	Hercules G-15	P & A
90.	Jason C-20	P & A
91.	Chippewa G-67	P & A
92.	Chippewa L-75	P & A
93.	Sauk A-57	P & A
94.	Banquereau C-21	DISC. C
95.	North Banquereau I-13	P & A
96.	Louisbourg J-47	P & A
97.	Huron P-96	P & A
98.	West Esperanto B-78	P & A
99.	Esperanto K-78	P & A
100.	Adventure F-80	P & A
101.	Hesper P-52	P & A
102.	Hesper I-52	P & A
103.	South Griffin J-13	P & A
104.	Sachem D-76	P & A
105.	Dauntless D-35	P & A
106.	Hermine E-94	P & A
107.	Emerillon C-56	P & A
108.	Puffin B-90	P & A
109.	Kittiwake P-11	P & A
110.	Tern A-68	P & A
111.	Petrel A-62	P & A
112.	Gannet O-54	P & A
113.	Merganser I-60	P & A
114.	Shearwater J-20	P & A
115.	Brant P-87	P & A
116.	Gull F-72	P & A
117.	Tors Cove D-52	P & A
118.	Mallard M-45	P & A
119.	Heron H-73	P & A
120.	Heron J-72	P & A
121.	Tantallon M-41	P & A
122.	Peskowesk A-99	P & A
123.	West Chebucto K-20	Conf.
124.	North Triumph B-52	Del. G
125.	North Triumph G-43	DISC. G
126.	West Olympia O-51	Conf.
127.	Thebaud C-74	Del. G
128.	Thebaud I-93	Del. G
129.	Kegeshook G-67	P & A
130.	Panuke B-90	DISC. O
131.	Merigomish C-52	P & A
132.	Shelburne G-29	P & A

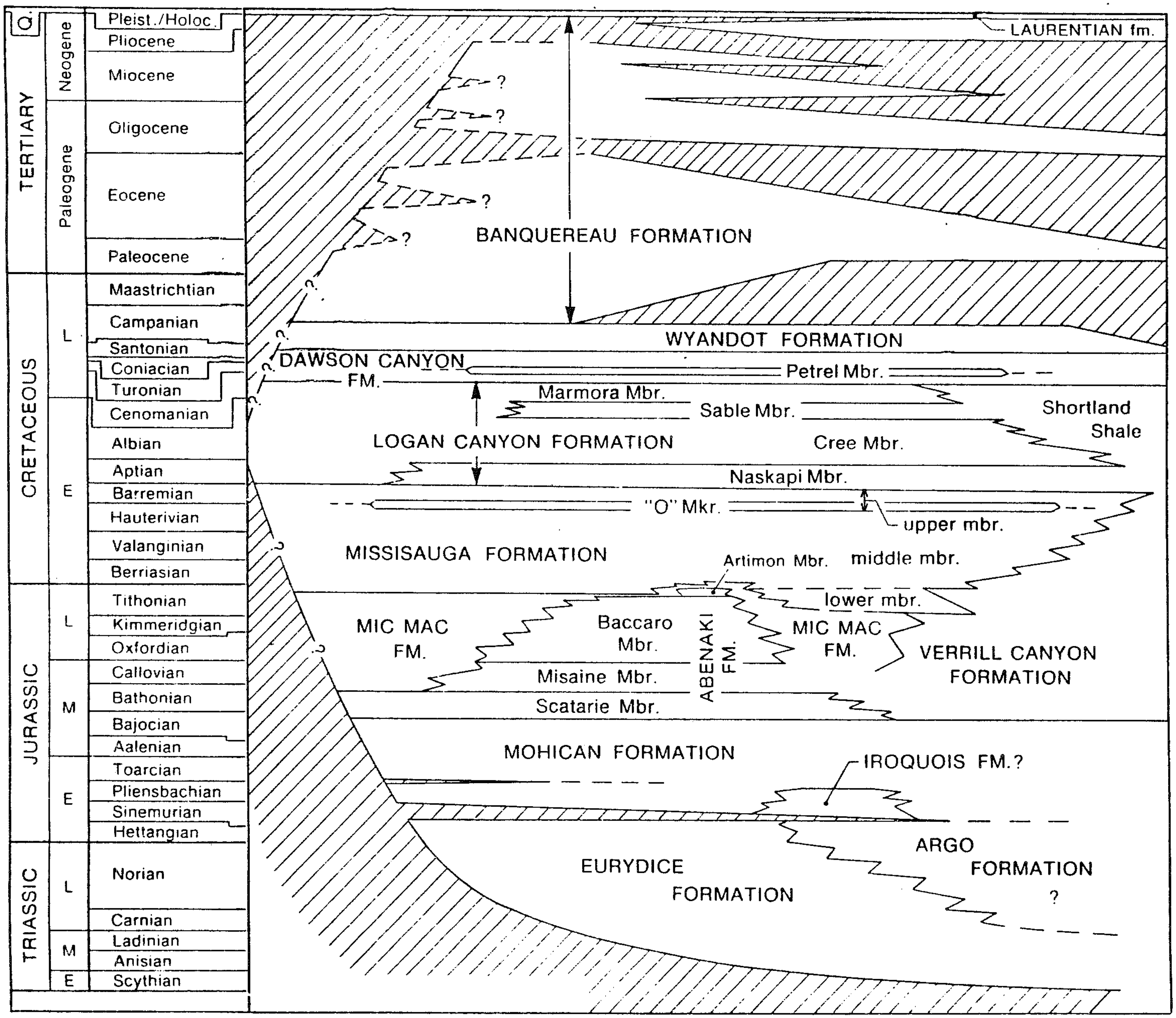
P & A = plugged and abandoned
Del. = delineation well
DISC = discovery well
G = gas
C = condensate
O = oil

Table 5.2b

No.	Wells – Name
68.	Abenaki J-56
69.	Abenaki L-57
14.	Acadia K-62
100.	Adventure F-80
6.	Albatross B-13
18.	Alma F-67 * *
17.	Alma K-85
65.	Arcadia J-16
88.	Argo F-38
94.	Banquereau C-21
80.	Bluenose C-47
81.	Bluenose 2G-47
3.	Bonnet P-23
115.	Brant P-87
2.	Cape Spencer No. 1
53.	Chebucto G-90
1.	Chinampas N-37
91.	Chippewa G-67
92.	Chippewa L-75
21.	Cohasset A-52
23.	Cohasset D-42
24.	Cohasset L-97
22.	Cohasset P-42
20.	Cree E-35
66.	Citnalta I-59
87.	Crow F-52
105.	Dauntless D-35
19.	Demascota G-32
70.	Dover A-43
54.	Eagle D-21
107.	Emerillon C-56
74.	Erie D-26
99.	Esperanto K-78
72.	Eurydice P-36
16.	Evangeline H-98
73.	Fox I-22
112.	Gannet O-54
33.	Glenelg E-58 and E-58A
35.	Glenelg H-38
34.	Glenelg J-48 *
36.	Glenelg N-49
9.	Glooscap C-63
116.	Gull F-72
89.	Hercules G-15
106.	Hermine E-94
119.	Heron H-73
120.	Heron J-72
102.	Hesper I-52
101.	Hesper P-52
97.	Huron P-96
51.	Intrepid L-80 *
71.	Iroquois J-17
90.	Jason C-20
129.	Kegeshook G-67
109.	Kittiwake P-11
96.	Louisbourg J-47
118.	Mallard M-45
37.	Marmora C-34
38.	Marmora P-35
113.	Merganser I-60
131.	Merigomish C-52
76.	Mic Mac D-89
78.	Mic Mac H-86
77.	Mic Mac J-77
26.	Migrant N-20
79.	Missisauga H-54
4.	Mohawk B-93
8.	Moheida P-15
7.	Mohican I-100
5.	Montagnais I-94
10.	Naskapi N-30
95.	North Banquereau I-13
124.	North Triumph B-52
125.	North Triumph G-43
12.	Ojibwa E-07
55.	Olympia A-12
13.	Oneida O-25
29.	Onondaga B-96
32.	Onondaga E-84
31.	Onondaga F-75
30.	Onondaga O-95
130.	Panuke B-90
47.	Penobscot B-41
48.	Penobscot L-30
122.	Peskowesk A-99
111.	Petrel A-62
84.	Primrose A-41
82.	Primrose F-41
83.	Primrose N-50
108.	Puffin B-90
50.	Sable Island C-67
40.	Sable Island E-48
41.	Sable Island H-58
39.	Sable Island O-47
42.	Sable Island 2H-58
43.	Sable Island 3H-58
44.	Sable Island 4H-58
45.	Sable Island 5H-58
46.	Sable Island 6H-58
104.	Sachem D-76
11.	Sambro I-29
93.	Sauk A-57
114.	Shearwater J-20
132.	Shelburne G-29
15.	Shubenacadie H-100
49.	South Desbarres O-76
103.	South Griffin J-13
59.	South Venture O-59
85.	Southwest Banquereau F-34 *
121.	Tantallon M-41
110.	Tern A-68
127.	Thebaud C-74
125.	Thebaud I-93
28.	Thebaud I-94
27.	Thebaud P-84 *
117.	Tors Cove D-52
52.	Triumph P-50
86.	Tuscarora D-61
67.	Uniacke G-72
64.	Venture B-13
61.	Venture B-43
60.	Venture B-52
62.	Venture D-23
63.	Venture H-22
25.	Wenonah J-75
123.	West Chebucto K-20
98.	West Esperanto B-78
126.	West Olympia O-51
57.	West Venture B-92
58.	West Venture C-62
56.	West Venture N-91
75.	Wyandot E-53

* = Studied boreholes

Figure 1


Q.
TERTIARY
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Paleogene
Pleist./Holoc.
Pliocene
Miocene
Oligocene
Eocene
Paleocene
CRETACEOUS
L
E
Maastrichtian
Campanian
Santonian
Coniacian
Turonian
Cenomanian
Albian
Aptian
Barremian
Hauterivian
Valanginian
Berriasian
JURASSIC
L
M
E
Tithonian
Kimmeridgian
Oxfordian
Callovian
Bathonian
Bajocian
Aalenian
Toarcian
Pliensbachian
Sinemurian
Hettangian
TRIASSIC
L
M
E
Norian
Carnian
Ladinian
Anisian
Scythian
LAURENTIAN fm.
BANQUEREAU FORMATION
WYANDOT FORMATION
DAWSON CANYON FM.
Petrel Mbr.
Marmora Mbr.
Sable Mbr.
Shortland Shale
LOGAN CANYON FORMATION
Cree Mbr.
Naskapi Mbr.
"O" Mkr.
upper mbr.
MISSISAUGA FORMATION
Artimon Mbr.
middle mbr.
lower mbr.
MIC MAC FM.
Baccaro Mbr.
ABENAKI FM.
MIC MAC FM.
VERRILL CANYON FORMATION
Misaine Mbr.
Scatarie Mbr.
MOHICAN FORMATION
IROQUOIS FM.?
ARGO FORMATION
?
EURYDICE FORMATION

Figure 2

Fig. 3. Photomicrographs

All photographs are in white reflected light. Magnification X500.

a. Amorphous liptinite IIA and pyrite; polished kerogen concentrate. Alma F-67, depth 4625m

b. Amorphous liptinite IIA and mineral bituminous groundmass and pyrite; polished whole rock. Alma F-67, depth 5040m

c. Vitrinite, meta-sporinite, and amorphous liptinite IIB, and pyrite; polished kerogen concentrate. Glenelg J-48, depth 4620m.

d. Amorphous IIA changed to granular vitrinite, amorphous liptinite IIA without change, mineral-bituminous groundmass and pyrite; polished whole rock. Glenelg J-48, depth 4940m.

e. Meta-alginite, vitrinite, inertinite, rank-sporinite,and pyrite; polished kerogen concentrate. Glenelg J-48, depth 5180.7m.

f. Mineral-bituminous groundmass with amorphous liptinite IIA, solid bitumen, and pyrite; polished whole rock. S. W. Banquereau F-34, depth 6260m.

g. Large solid-bitumen with amorphous liptinite IIA, pyrite, and other minerals. polished whole rock, depth 6309m, S. W. Banquereau F-34.

h. Clustered micrinite (secondary maceral) from amorphous liptinite IIA and pyrite; polished kerogen concentrate. Thebaud P-84, depth 4045m.

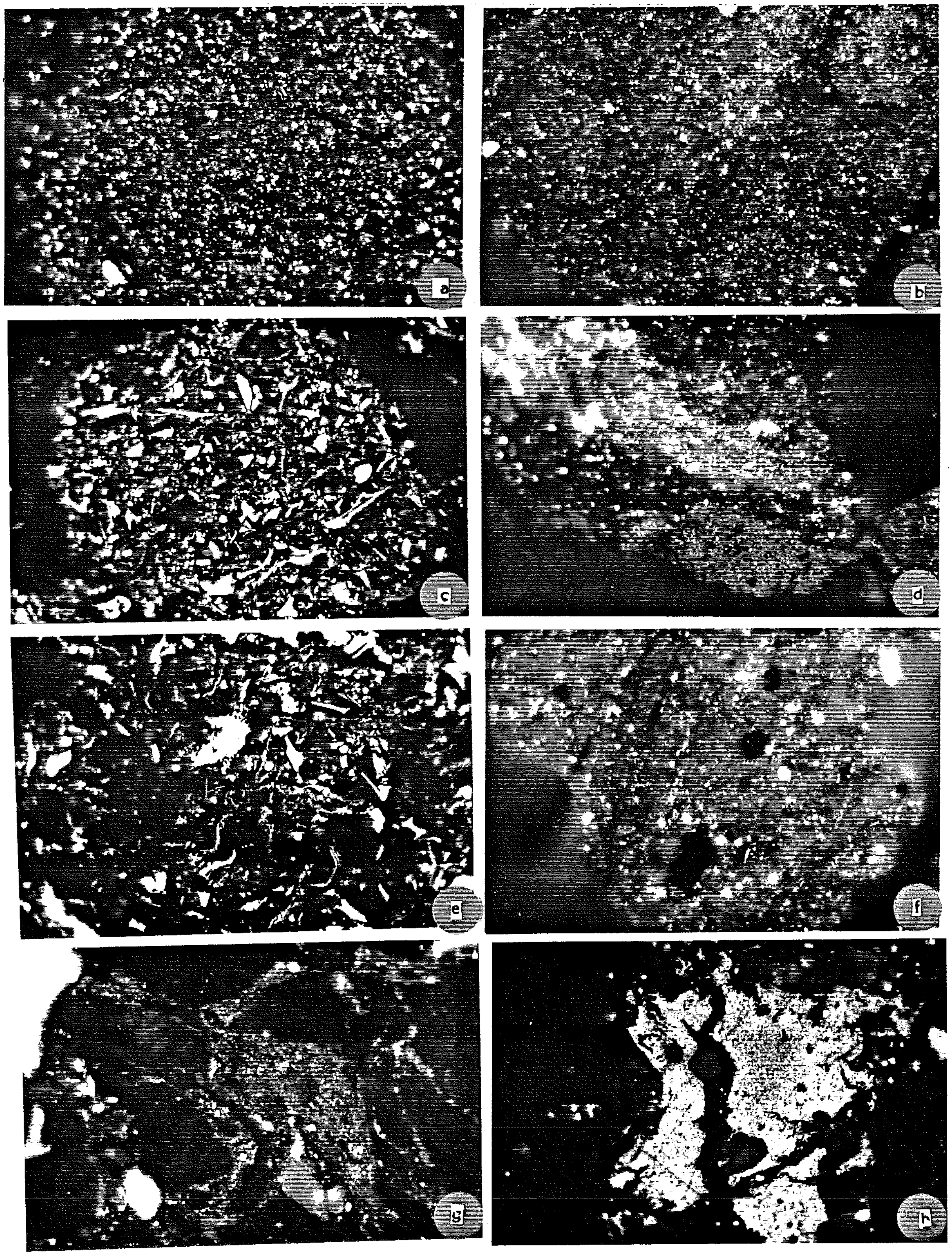


Figure 3

Fig. 4. Rock-Eval pyrolysis parameters from borehole Alma F-67

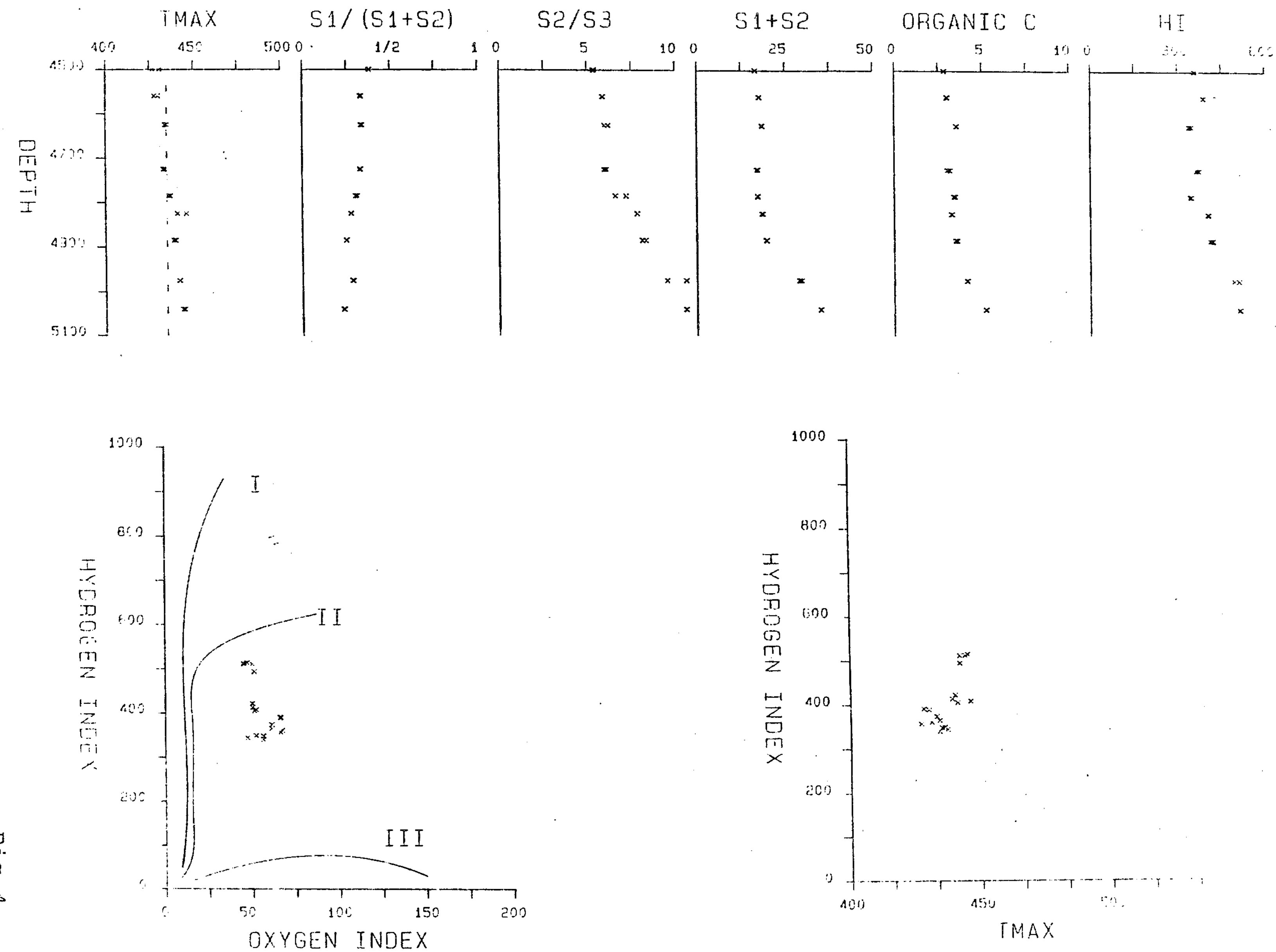


Fig.4

Fig. 4. Rock-Eval pyrolysis parameters from borehole Glenelg J-48

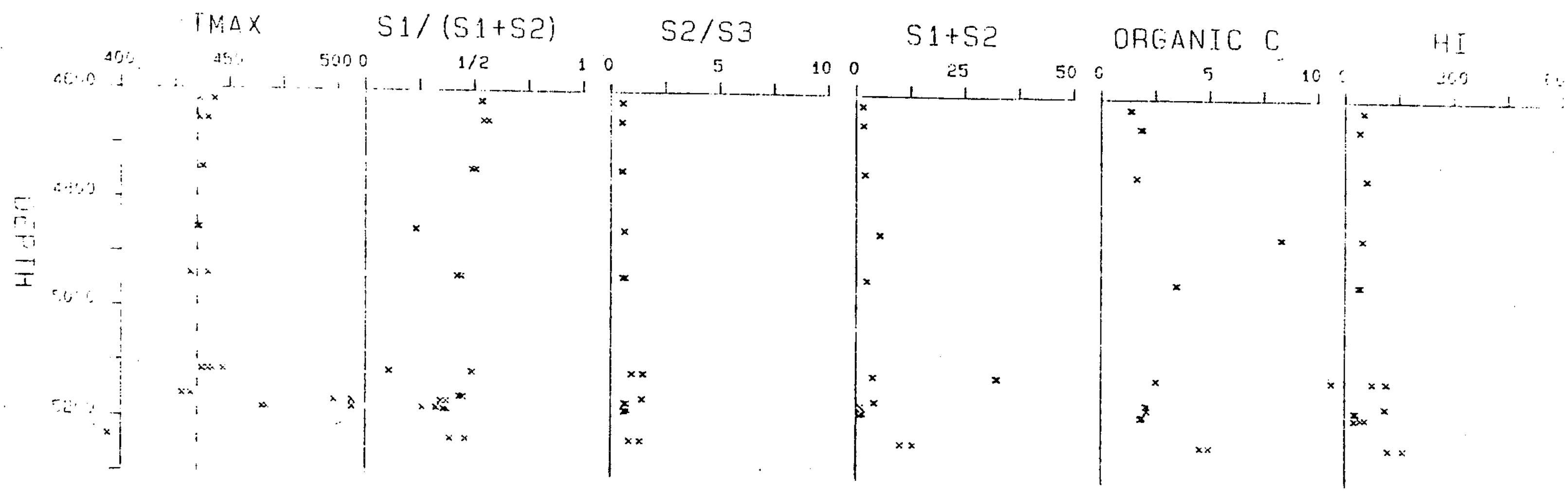


Fig. 4

Fig. 4 . Rock-Eval pyrolysis parameters from borehole Glenelg J-48

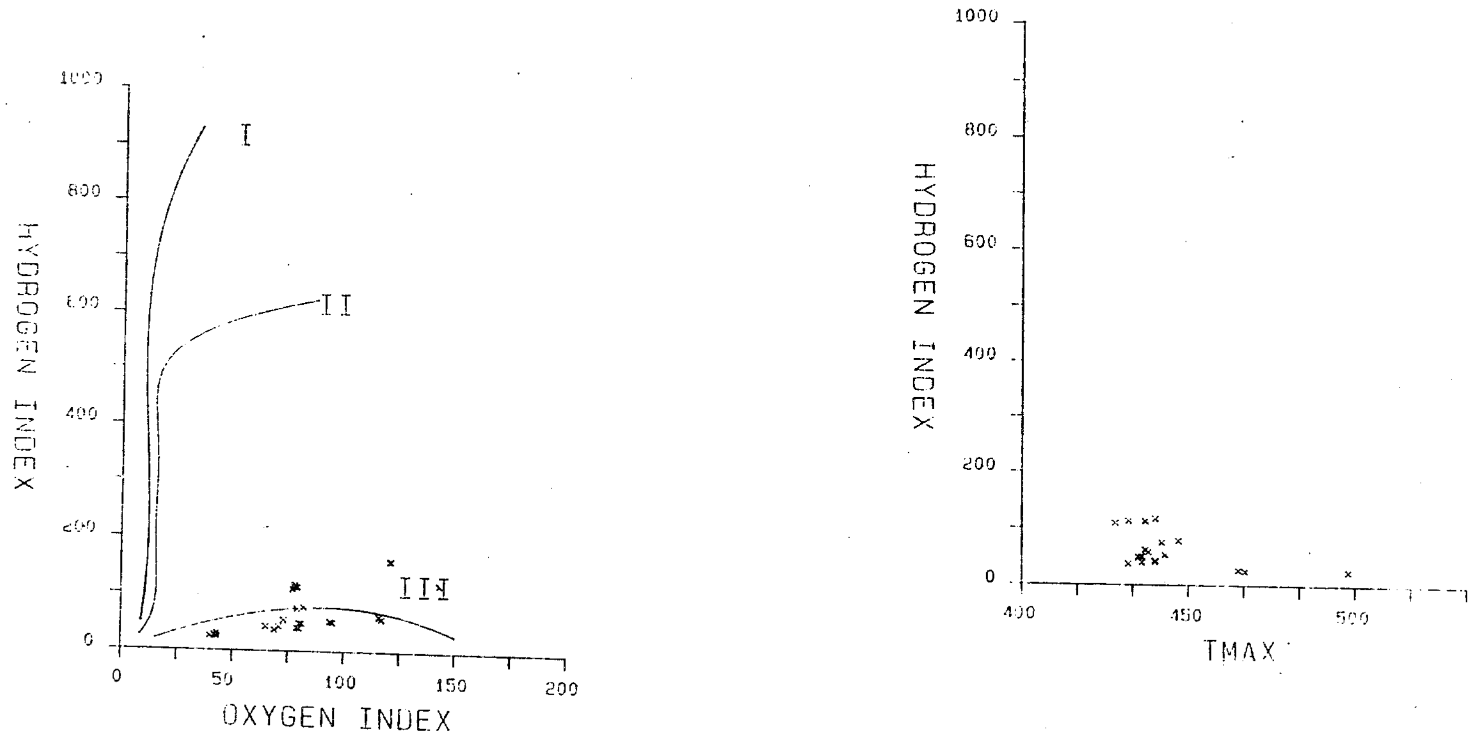
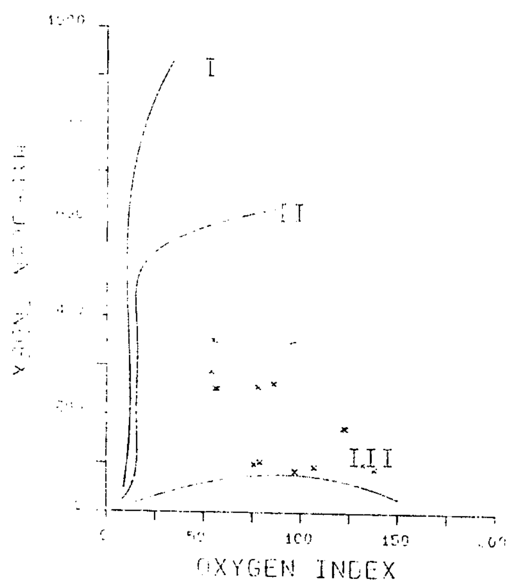


Fig.4

Fig. 4. Rock-Eval pyrolysis parameters from borehole S. W. Banquereau F-34



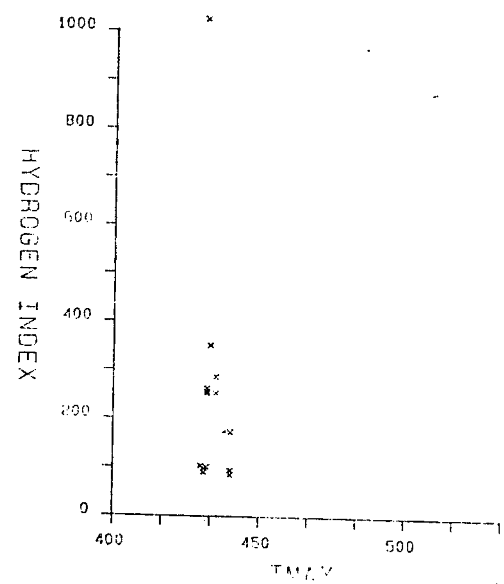


Fig. 4 . Rock-Eval pyrolysis parameters from borehole S. W. Banquereau F-34

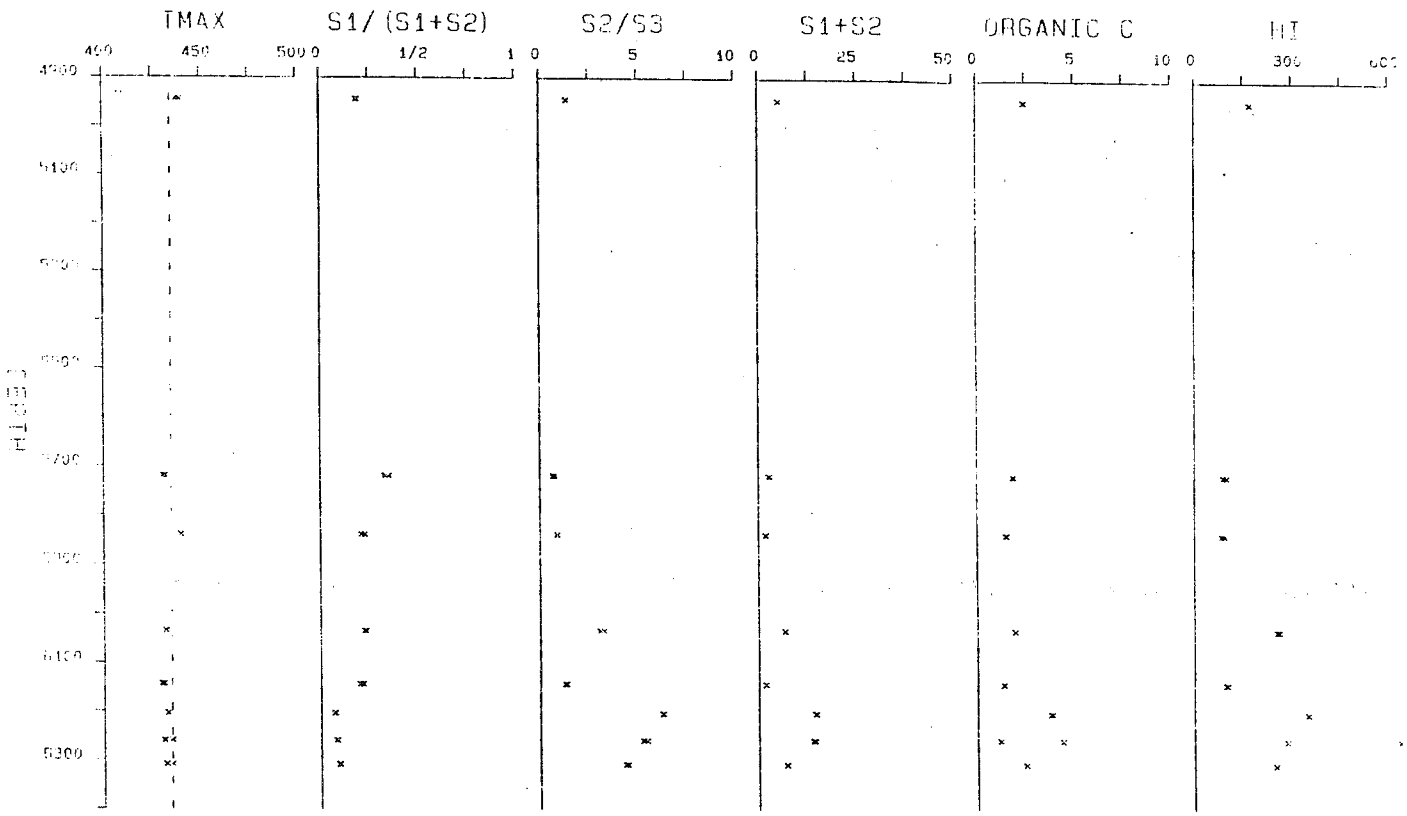


Fig. 4