PALYNOLOGY AND SOURCE ROCK STUDY OF PEP 109 AND PEP 110 ONSHORE GIPPSLAND BASIN

Cluff Resources Pacific Limited
Level 5, 53 Walker Street
North Sydney NSW 2060

April, 1991

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CONTENTS

1. SUMMARY AND CONCLUSION

In order to clarify the ambiguity about the presence of Late Cretaceous Strata, equivalent to the Golden beach Formation and confirmation on presence of the Strzelecki Group Sequence in few wells, Cluff Resources Pacific submitted 23 samples for palynological study from 7 wells in the onshore Gippsland Basin, namely Burong-1, Carrs Creek-1, Dutson Downs-1, Merriman-1, Seaspray-1, North Seaspray-1 and Wellington Park-1.

Also 36 core and cutting samples from 6 wells were submitted to Amdel Core Services for geochemical analysis to determine the source potential and maturity f the Latrobe and Strzelecki Group's sediments.

On the basis of the new palynological data, a new well correlation has been made which exhibits the following:

Palaeocene sequence, the Childers Formation equivalent, is present along the north-eastern trend of Permit 109 and attenuates towards the west and over the Burong Fault Block. This sequence, however, is absent over the North Seaspray structure. Burong-1 has penetrated 50 feet of this sequence at around 4,050 feet (1,234 metres) K.B. The well has bottomed in the Strzelecki Group of Albian age (c. Paradoza zone).

Late Cretaceous sequence, the Golden Beach Formation equivalent, is present along the northeasterly trend of the coastline. This sequence, however, is absent over the Seaspray-Burong-North Seaspray Block and also on the Wellington Park structure. It is important to note that the study has confirmed the presence of the Late Cretaceous sequence in Carrs Creek-1 and Dutson Downs-1 wells, as predicted previously in our report. The study has also revealed that these wells have only penetrated the Early Cretaceous rocks at T.D.

DST tests over the Late Cretaceous (Golden Beach Formation) in Merriman-1 and Carrs Creek-1 at 5,070 feet (1,545 metres) and 4,600 feet (1,402 metres) respectively recovered water with Na Cl salinity of 15,850 ppm and 11,000 ppm, which indicates that the flushing probably has not affected the sediments of this sequence in the onshore area. This sequence was previously considered as Strzelecki Group by the operators.

The spore colours examined by the palynologist suggests that the Palaeocene rocks in the onshore area are immature to marginally mature for hydrocarbon generation, while the Late Cretaceous rocks are early mature to marginally mature. The results of the vitrinite reflectance measurements are broadly consistent with the results of the Rock-Eval Pyrolysis. However, lack of data below 5,000 feet (1,500 metres) in some of the wells and the availability of suitable samples has hampered the meaningful extrapolation of data, so that the results are not a true representation of the maturity profile in most of the wells.

The results of the extrapolation of the vitrinite reflectance have been plotted on the well correlation chart, which shows that the higher maturity gradients in the Merriman, North Seaspray and Wellington Park structures as compared to other locations may be related to the higher heat flows at these structures. The potential yield (i.e. $S_1 + S_2$) of these sediments has been calculated and indicates that the sediments of the Latrobe Group with an average of 14.63 kg hydrocarbon/tone rock have the highest source richness as compared to the Strzelecki Group with an average of 5.11 kg hydrocarbon/tone rock. The results of the potential yield for each formation have been calculated and are as follows:

Formation	$(S_1 + S_2)$ range kg/tonne	$(S_1 + S_2)$ average	kg/tonne
Latrobe Group	10.14-25.80	14.63	
Childers Formation (Palaeocene)	.15-21.82	6.77	
Golden Beach Formation (Late Cretaceous)	.76-18.45	9.60	
Strzelecki Group (Early Cretaceous)	.89-13.53	5.11	

All the sediments from Eocene to Early Cretaceous contain organic matter with the bulk composition of predominantly gas prone type III Kerogen. They consist largely of vitrinite with moderate proportions of inertinite and exinite. However, these gas prone sediments have the potential to generate liquid hydrocarbons in a significant quantity at optimum maturity.

Furthermore, light oil/condensate can be generated from the thermally labile exinite with VR=0.45% at around 2,300 metres subsea with the oil window (VR=0.7%) at around 3,600 metres subsea. Significant gas, however, can be generated from woody-herbaceous kerogen at as maturity around VR=0.6%, which corresponds approximately to 3,000 metres subsea. On the basis of these results, sediments of the Strzelecki Group are the only potential source rocks, which are mature below 2,300 metres subsea and can generate both gas and liquid hydrocarbons in the onshore area.

SAEED SHOGHI
CONSULTANT

27 March, 1991

APPENDIX 1

PALYNOLOGY OF 23 SUBSURFACE SAMPLES,

ONSHORE GIPPSLAND BASIN

BY ROGER MORGAN

PALYNOLOGY OF 23 SUBSURFACE SAMPLES,

GIPPSLAND BASIN

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FOR CLUFF RESOURCES

FEBRUARY, 1991.

PALYNOLOGY OF 23 SUBSURFACE SAMPLES,

GIPPSLAND BASIN.

BY

ROGER MORGAN

CONTENTS

I SUMMARY

The samples studied yielded the following zonal assignments.

Burong-1 :
4100 ft. (cutts) : mixed L. balmei zone (Paleocene) with minor late Cretaceous

4120 ft. (cutts) : C. paradoxa zone (late Albian)

Carrs Creek-1 :
3860 ft. (cutts), 4470 ft. (cutts) : mixed Tertiary, mostly Eocene

4570 ft. (cutts) : C. triplex zone (Coniacian-Turonian)

Dutson Downs-1 :
4590 ft. (cutts) : apparently L. balmei zone (Paleocene)

4740 ft. (cutts), 5360 ft. (cutts) : T. longus (Maastrichtian) to N. senectus (Campanian)

6020 ft. (cutts) : mixed C. triplex (Coniacian-Turonian) and C. striatus (early Albian)

Merriman-1 :
4708-14 ft. (CORE) : T. longus zone (Maastrichtian)

5057-81 ft. (CORE), 5740 ft. (cutts), 5950 ft. (cutts) : apparently all C. triplex zone (Coniacian-Turonian)

North Seaspray-1 :
3650 ft. (cutts) : C. paradoxa zone (late Albian)

3840 ft. (cutts), 4060 ft. (cutts) : C. striatus zone

(early Albian)

Seaspray-1 :
4590 ft. (cutts) : T. longus zone (Maastrichtian)

4790 ft. (cutts), 4879 ft. (cutts) : C. paradoxa zone (late Albian)

Wellington Park-1 :
3719-39 ft. (CORE) : L. balmei zone (Paleocene)

3816-19 ft. (CORE), 4550 ft. (cutts) : apparently all C. paradoxa zone (late Albian)

7380 ft. (CORE) : indeterminate mid Jurassic to mid Cretaceous

These data provide palynological confirmation for the Golden Beach Formation in Carrs Creek-1, Dutson Downs-1, and Merriman-1 and suggest its absence from the other wells. Heavy caving of the Tertiary in the cuttings samples could have masked older assemblages, however.

II INTRODUCTION

Babek Vazhebdedh of Cluff Resources submitted 23 samples for palynology from 7 Gippsland Basin wells. The study was aimed to test for the presence of late Cretaceous strata equivalent to the Golden Beach Formation, as discussedd by Lowry (1987). Raw data is presented in Appendix I.

The published palynostratigraphic framework for the Cretaceous of Australia is most recently reviewed by Helby, Morgan and Partridge (1987). Dinoflagellates had been only rarely recorded from the Cretaceous of the Gippsland Basin, although Marshall (1988) provided taxonomic study of some Santonian dinoflagellates. In unpublished work, Marshall (1987a) describes dinoflagellates from new cuttings samples in Pisces-1, Marshall (1987b) describes taxonomy and some stratigraphy of Campanian dinoflagellates and in (1987c) describes some Santonian algal cysts. These all provide clues to the Coniacian-Turonian dinoflagellate sequence, but none provides the basis for a working zonation. The zonal scheme of Helby, Morgan and Partridge is shown in figure 1.

In the Tertiary, the Gippsland zonal scheme was most recently published by Partridge (1976), but the scheme is essentially similar to that for New Zealand for which substantial new data is available in Wilson (1988). Significant new Gippsland data is available in unpublished and privately circulated material, Harris (1985), Morgan (1988) and Marshall and Partridge (1988). The zonal framework of Partridge (1976) is shown in fig. 1.

Organic maturity data was generated in the form of the Spore Colour Index. The oil and gas windows follow the general consensus of geochemical literature. The oil window corresponds to spore colours of light-mid brown (2.7) to dark brown (3.6). This would correspond to Vitrinite Reflectance values of 0.6% to 1.3%. However, factors such as detailed kerogen type, basin type, basin history and heating curves all affect precise interpretation, and analytical machine-based maturity parameters are probably more reliable.

	AGE	SPORE - POLLEN ZONES	DINOFLAGELLATE ZONES
Early Tertiary	Early Oligocene	P. tuberculatus	
	Late Eocene	upper N. asperus	P. comatum
		middle N. asperus	V. extensa
	Middle Eocene	lower N. asperus	D. heterophlycta W. echinosuturata
		P. asperopolus	W. edwardsii W. thompsonae
	Early Eocene	upper M. diversus	W. ornata W. waipawaensis
		middle M. diversus	
		lower M. diversus	W. hyperacantha
	Paleocene	upper L. balmei	A. homomorpha
		lower L. balmei	E. crassitabulata T. evittii
Late Cretaceous	Maastrichtian	T. longus	M. druggii
	Campanian	T. lillei	I.korojonense
		N. senectus	X. australis
	Santonian	T. pachyexinus	N. aceras I. cretaceum O. porifera
	Coniacian Turonian	C. triplex	C. striatoconus
	Cenomanian	A. distocarinatus	P. infusorioides
Early Cretaceous	Albian Late	P. pannosus	
	Albian Middle	upper C. paradoxa	
	Albian Early	lower C. paradoxa	
		C. striatus	
	Aptian	upper C. hughesi	
		lower C. hughesi	
	Barremian Hauterivian	F. wonthaggiensis	
	Valanginian	upper C. australiensis	
	Berriasian	lower C. australiensis	
Juras.	Tithonian	R. watherooensis	

FIGURE 1 ZONATION FRAMEWORK

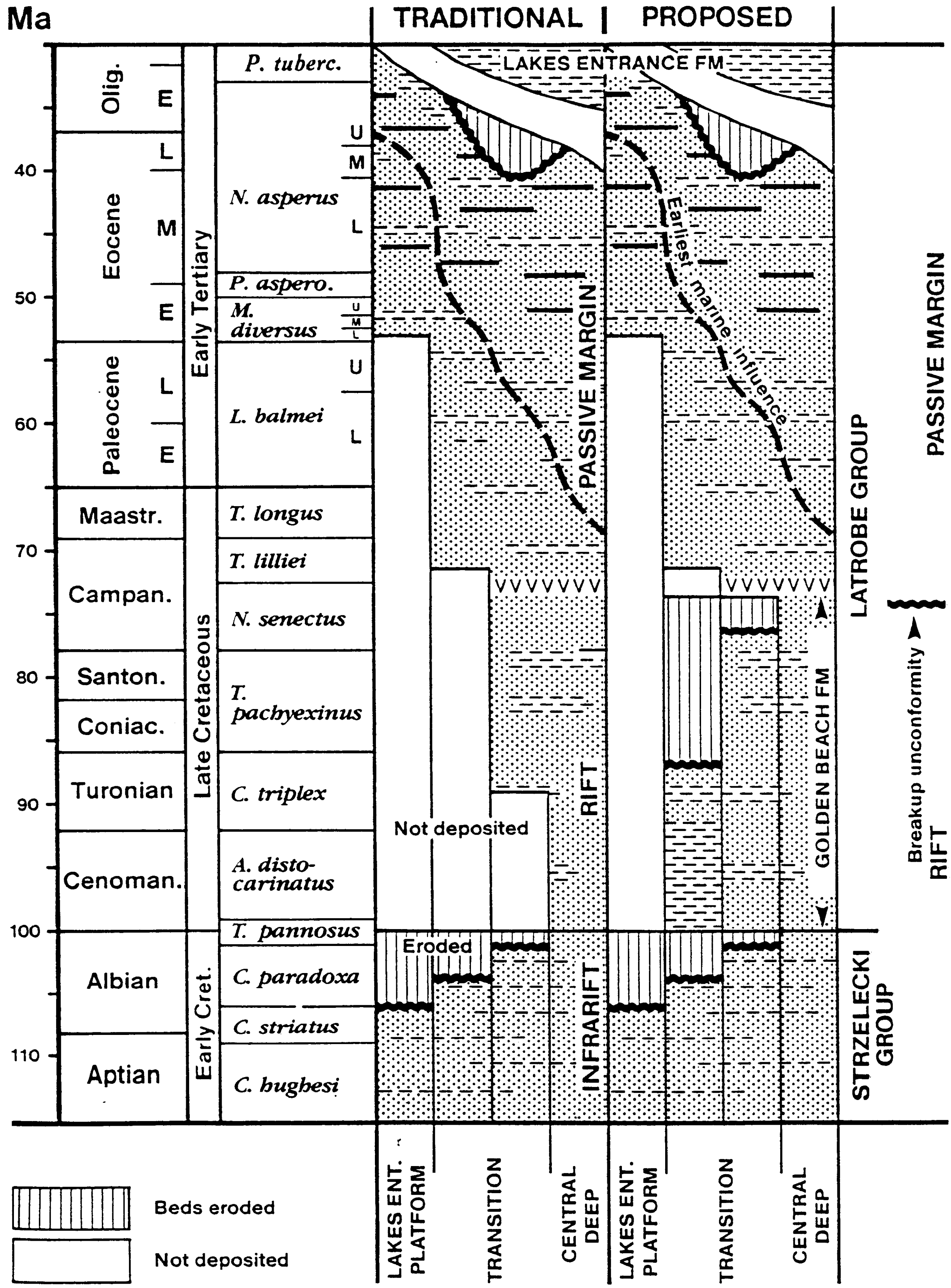

Figure 2 — Time-space diagram generalised for Cretaceous to Eocene in the offshore Gippsland Basin.

III PALYNOSTRATIGRAPHY

A. BURONG-1

- 4100 ft. (cutts) : mixed L. balmei zone and younger with minor late Cretaceous

The age is uncertain as rare Eocene restricted taxa (P. pachypolus and M. tenuis occur mixed with Paleocene and older taxa (L. balmei, G. rudata, T. verrucosus) and very rare Maastrichtian and older taxa (T. confessus). H. harrisii is dominant with frequent G. rudata and Nothofagidites spp. The most obvious interpretation is a Paleocene balmei zone assignment with minor reworked Cretaceous. However, a Maastrichtian upper longus zone assignment is also possible. Nothing older was seen.

Environments appear to be non-marine with abundant and diverse spores and pollen and no marine indicators.

Light brown spore colours suggest marginal maturity for oil generation.

- 4120 ft. (cutts) : C. paradoxa Zone

This assemblage is relatively clean, dominated by O. wellmannii and assigned on the presence of C. paradoxa and the associated spore dominated floras including Aequitriradites spp., C. australiensis, F. dailyi and T. trioreticulosus. Rare Triassic reworking was seen.

Environments are non-marine fluvial on account of the abundant and diverse spore dominated assemblage and absence of marine indicators.

Light to mid brown spore colours suggest early maturity for oil generation.

B. CARRS CREEK-1

- 3860 ft. (cutts), 4470 ft. (cutts) : mixed Tertiary, mostly Eocene

These assemblages are dominated by H. harrisii, Nothofagidites spp. and Proteacidites spp. Eocene indicators include M. diversus, M. tenuis, P. pachypolus and common N. deminatus. Nothing older than Eocene was seen, but heavy caving may be masking something older.

- 4570 ft. (cutts) : C. triplex Zone

This assemblagel is totally dominated by small Dilwynites and contains frequent P. mawsonii. More important, it contains the distinctive algal Rimosicysta spp, which are P. mawsonii zone restricted.

Non-marine environments are indicated by the absence of saline indicators, but lacustrine influence is suggested by the algal assemblage.

Light brown spore colours suggest marginal maturity for oil.

C. DUTSON DOWNS-1

- 4590 ft. (cutts) : apparently L. balmei zone

Assignment is made on L. balmei without older indicators. H. harrisii and N. emarcidus are common.

Non-marine environments are suggested by the common cuticle and diverse spores and pollen without marine indicators.

Yellow to light brown spore colours indicate immaturity for hydrocarbons.

- 4740 ft. (cutts)-5360 ft. (cutts) : apparently T. longus to N. senectus zones

These samples are almost identical with that above apart from the presence of rare Late Cretaceous forms including T. sabulosus (longus to senectus restricted). T. longus (longus restricted) and T. confessus (longus to pachyexinus restricted). It is interpreted as upper late Cretaceous with heavy Tertiary caving, but caving is so heavy that it could be older and masked.

Non-marine environments are indicated by the lack of marine indicators and the abundant cuticle and spore-pollen.

Light brown spore colours suggest marginal maturity for oil.

- 6020 ft. (cutts) : mixed C. triplex zone with C. striatus zone

The early Cretaceous striatus zone is indicated by the association of C. striatus with P. notensis without C. paradoxa. Other spores supporting the Early Cretaceous age include C. holodictyus, Aequitriradites spp., F. wonthaggiensis and Triporoletes spp. The Turonian-Coniacian triplex zone is indicated by the algal Rimosicysta and frequent P. mawsonii but are considered caved. The triplex zone must therefore occur above this point in the well. Dominant however, is the Paleocene balmei assemblage, caving very heavily.

Non-marine striatus environments are non-marine. Lacustrine triplex environments are suggested by the associations described above.

Light to mid brown spore colours suggest early maturity in the striatus zone assemblages.

D. MERRIMAN-1

- 4708-14 ft. (CORE) : upper T. longus zone

This lean and cuticle dominated assemblage is assigned at the base on oldest S. punctatus and at the top on youngest O. sentosa and frequent G. rudata, and the absence of L. balmei. Frequent forms include G. rudata and S. punctatus.

Non-marine possibly lacustrine environments are indicated by the very rare nondescript dinoflagellates in the cuticle and spore-pollen dominated assemblage.

Yellow to light brown spore colours suggest early marginal maturity for oil.

- 5057-81 ft. (CORE), 5740 ft. (cutts), 5950 ft. (cutts) : apparently all C. triplex zone

Assignment of the core is straightforward on youngest C. "pileosus" and oldest P. mawsonii. Common forms include P. mawsonii and M. antarcticus. The two cuttings samples beneath contain heavy Paleocene balmei caving, but also contain triplex zone indicators (common Dilwynites and algal Rimosicysta spp) and nothing older. They are therefore assigned to the triplex zone.

Non-marine environments with some lacustrine influence are indicated by the algal acritarchs, diverse pollen and spores and abundant cuticle.

Yellow to light brown spore colours indicate early marginal maturity for oil.

E. NORTH SEASPRAY-1

- 3650 ft. (cutts) : C. paradoxa zone

Although the assemblage is dominated by Paleocene L. balmei zone and Eocene diversus zone taxa, the rare presence of Aequitriradites spp., C. paradoxa, C. striatus, P. linearis and T. reticulatus indicate the paradoxa zone.

Non-marine environments are indicated by the abundant cuticle, dominant spore-pollen, and absence of marine indicators.

Light brown spore colours indicate marginal maturity for hydrocarbons.

- 3840 ft. (cutts), 4060 ft. (cutts) : C. striatus zone

These sample are almost identical with that above, but amongst the rare elements, markers for the paradoxa zone cannot be found. Oldest C. striatus therefore indicates the older striatus zone, although its base could be caved.

Non-marine environments and marginal maturity for oil are indicated as above.

F. SEASPRAY-1

- 4590 ft. (cutts) : probably T. longus zone

Although Paleocene L. balmei taxa dominate the sample, the rare occurrence of Cretaceous taxa such as N. senectus (longus to senectus restricted), T. verrucosus (balmei to longus restricted) and T. sectilis (longus to lillei restricted) indicate the longus zone assignment.

Non-marine environments are indicated by the absence of marine indicators and the diverse pollen and spores.

Yellow to light brown spore colours indicate early marginal maturity for oil.

- 4790 ft. (cutts), 4879 ft. (cutts) C. paradoxa zone

Although again Paeocene caving is dominant, rare Aequitriradites, C. paradoxa, C. striatus, Foraminispora spp. and Triporoletes spp. indicate the paradoxa zone.

Non-marine environments are indicated by diverse spores and pollen. The single spiny acritarch at 4879 ft. is considered caved.

Light to mid brown spore colours indicate early maturity for oil.

G. WELLINGTON PARK-1

- 3719-39 ft. (CORE) : L. balmei zone

Assignment is clearly indicated at the top by youngest L. balmei and T. verrucosus and at the base by oldest S. punctatus and T. verrucosus without older indicators. Common forms are P. mawsonii and Proteacidites spp. A single T. waiparaensis is considered reworked.

Non-marine environments are indicated by the diverse pollen and spores and absence of marine indicators.

Yellow spore colours indicate immaturity for oil generation.

- 3816-19 ft. (CORE), 4550 ft. (cutts) : apparently all C. paradoxa zone

Assignment of the core sample is straghtforward on youngest P. notensis (and the other Early Cretaceous associates) and oldest C. paradoxa. Common forms include Cyathidites and Falcisporites. Permian and Triassic reworking were seen. The cuttings at 4550 ft. contain the same assemblage but could clearly be caved into something slightly older.

Non-marine environments are indicated on the absence of saline indicators and the diverse pollen and spores.

Light to mid brown spore colours indicate early maturity for oil.

- 7380 ft. (CORE) : Jurassic-Cretaceous : indeterminate

This sample is very lean of palynomorphs and all are longranging taxa. The presence of C. dampieri, C. penolaensis and R. nodosus indicates a Middle Jurassic to mid Cretaceous age range, but more precision is not possible.

Non-marine environments are suggested, but too few palynomorphs have been seen to be confident.

Mid to dark brown spore colours indicate peak maturity for oil generation.

IV CONCLUSIONS

Clearly the current study was directed use palynology to test the log based already mapped distribution of the Golden Beach Formation. The Gippsland sequence along the northern margin usually comprises the early Cretaceous hughesi to paradoxa Strzelecki Group, a pannosus-distocarinatus unconformity corresponding to Southern Ocean breakup, an early Late Cretaceous triplex Golden Beach Formation, a pachyexinus-senectus unconformity corresponding to Tasman Sea breakup, and the lillei to asperus Latrobe Group. This is discussed in more detial in Lowry (1987) and summarized here in figure 2.

In all the cuttings samples, the younger Latrobe Group caves heavily and may confuse interpretation. Nevertheless, most wells are straight-forward.

In Burong-1, longus Latrobe Group appears to directly overlie paradoxa Strzelecki Group on an unconformity in the gap 4100 ft. to 4120 ft. The Golden Beach Formation appears to be absent.

In Carrs Creek-1, only cuttings are available, and these may mask the true situation. On the palynology, Eocene Latrobe Group appears to directly overliew triplex Golden Beach Formation, with the unconformity in the gap 4470 ft. to 4570 ft.

In Dutson Downs-1, again only cuttings are available and appear to have masked assemblages, making them appear to be deeper. The sequence appears to comprise balmei to possibly senectus Latrobe group (4590 to 5360 ft.), triplex Golden Beach Formation (somewhere in the gap 5360 to 6020 ft.) and Strzelecki Group (6020 ft.). Logs suggest Golden Beach Formation at 1442-1781m (4731-5848 ft.) (Lowry 1987) and may well be right.

In Merriman-1, longus Latrobe Group overlies triplex Golden Beach Formation with the unconformity in the gap 4714 ft. to 5057 ft. The well appears to still be in Golden Beach Formation at 5950 ft., but these cuttings could be masking something older.

In North Seaspray-1, Strzelecki Group spans the sampled interval, although balmei-diversus Latrobe Group caving is heavy.

In Seaspray-1, longus Latrobe Group directly overlies paradoxa Strzelecki Group with the unconformity in the gap 4590 ft. to 4790 ft. The Golden Beach Formation is missing.

In Wellington Park-1, balmei to possibly longus Latrobe Group directly overlies paradoxa Strzelecki Group with the unconformity in the gap 3739 to 3816 ft. The Golden Beach Formation is missing.

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PALYNOLOGICAL DATA OF 7 WELLS incl. BURONG #1, MERRIMAN #1

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CLIENT: Cluff Resources
WELL: 7 inc. Burong, Carr's Creek, Merriman, Nth Seaspray
FIELD/AREA: Gippsland Basin (Northen Margin)

ANALYST: Roger Morgan DATE: February '91
NOTES: all sample depths are in metres

RANGE CHART OF GRAPHIC ABUNDANCES BY BY GROUP: DINOS and S/POLLEN

Key to Symbols

= Very Rare
= Rare
= Few
= Common
= Abundant
? = Questionably Present
. = Not Present

▮ = Abundant

? = Questionably Present

. = Not Present

Sample	1 DEFLANDREA SPP	2 MICHRYTRIDIUM	3 OPERCULODINIUM SPP	4 RIMOSICYSTA ASPERA	5 RIMOSICYSTA EVERSA	6 SCHIZOSPORIS	7 SUBTILISPHAERA	8 AEQUITRIRADITES HISPIDUS	9 AEQUITRIRADITES SPINULOSUS	10 AEQUITRIRADITES TILCHAENESIS	11 AEQUITRIRADITES VERRUCOSUS	12 AMOSOPOLLIS CRUCIFORMIS	13 ANNULISPORITES	14 APPENDICISPORITES DISTOCARINATUS	15 ARAUCARIACITES AUSTRALIS	16 AUSTRALOPOLLIS OBSCURUS	17 BACULATISPORITES	18 BALMEISPORITES GLENELGENSIS	19 BALMEISPORITES HOLODICTYUS	20 BALMEISPORITES TRIDICTYUS	21 BANKSIEACIDITES ARCUATUS	22 CALLIALASPORITES DAMPIERI	23 CAMEROZONOSPORITES AMBIGENS	24 CAMEROZONOSPORITES SP	25 CERATOSPORITES EQUALIS	26 CICATRICOSISPORITES AUSTRALIENSIS	27 CICATRICOSISPORITES CUNEIFORMIS	28 CICATRICOSISPORITES HUGHESI	29 CLAVIFERA TRIPLEX	30 CONCAVISSIMISPORITES PENOLAENSIS	31 COPTOSPORA PARADOXA	32 COPTOSPORA PILEOSUS	33 COPTOSPORA SP
BURONG-1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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4120 CUTT	.	.	.	.	.	|	.	.	|	|	|	.	.	.	.	.	.	.	|	|	.	.	.	.	.	|	.	|	.	|	|	.	?
CARRS CREEK-1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
3850-60 CUTT	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
4460-70 CUTT	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
4560-70 CUTT	.	.	.	.	|	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	|	|	.	.	.	.	.	.	.
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4580-90 CUTT	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
4730-40 CUTT	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	|	.	.	.	.	.	.	.	|	.	.	.	.
5350-60 CUTT	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	|	.	.	.	.	.	.	.	.
6010-20 CUTT	.	.	.	.	|	.	.	.	.	|	.	.	.	.	.	.	|	|	|	.	.	.	.	.	|	|	.	.	.	.	.	|	.
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4708-14 CORE	|	.	.	.	.	.	.	.	.	.	.	.	.	.	|	.	.	.	.	.	.	.	.	.	|	.	.	.	.	.	.	.	.
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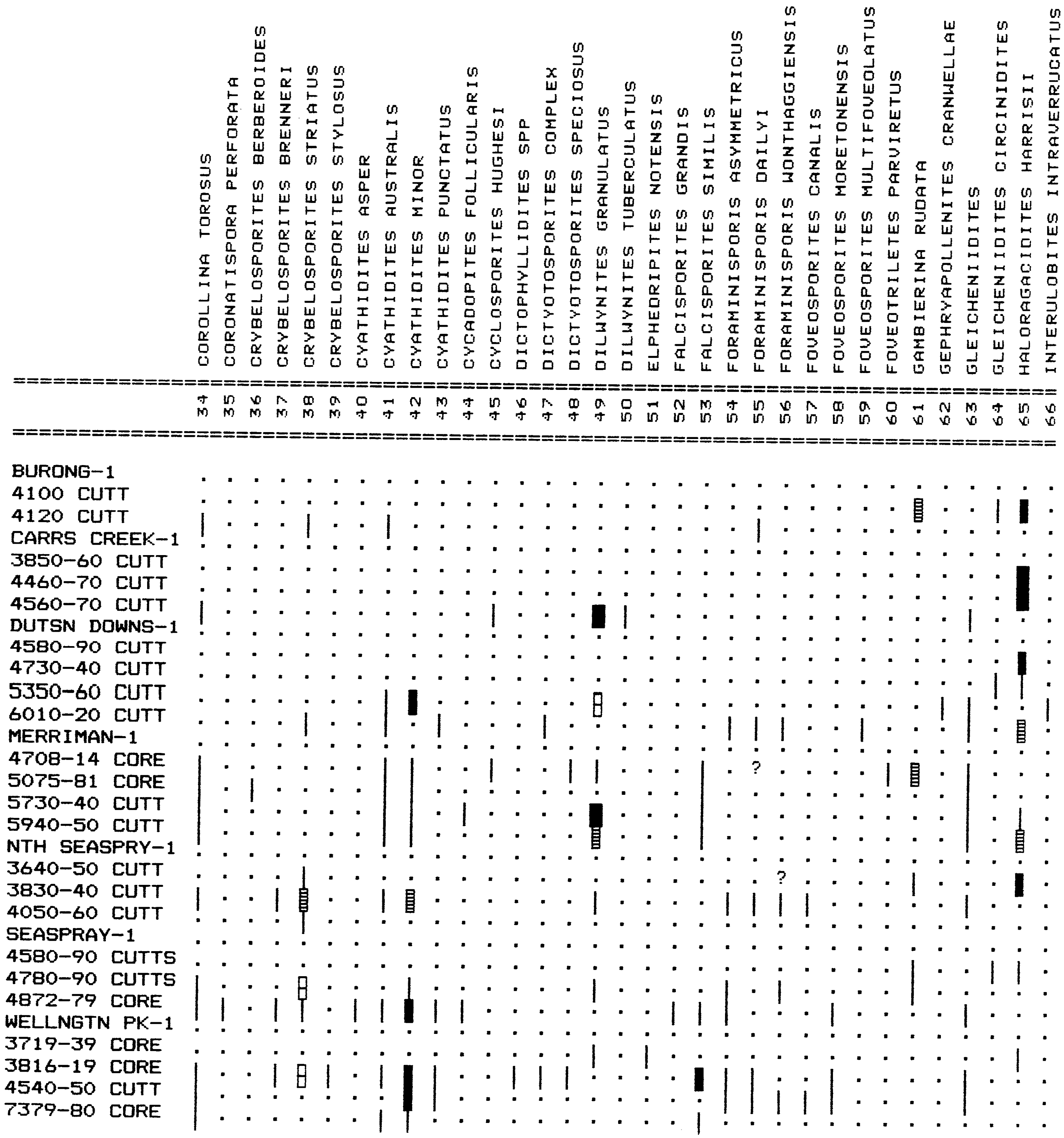
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35 CORONATISPORA PERFORATA
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37 CRYBELOSPORITES BRENNERI
38 CRYBELOSPORITES STRIATUS
39 CRYBELOSPORITES STYLOSUS
40 CYATHIDITES ASPER
41 CYATHIDITES AUSTRALIS
42 CYATHIDITES MINOR
43 CYATHIDITES PUNCTATUS
44 CYCADOPITES FOLLICULARIS
45 CYCLOSPORITES HUGHESI
46 DICTOPHYLLIDITES SPP
47 DICTYOTOSPORITES COMPLEX
48 DICTYOTOSPORITES SPECIOSUS
49 DILWYNITES GRANULATUS
50 DILWYNITES TUBERCULATUS
51 ELPHEDRIPITES NOTENSIS
52 FALCISPORITES GRANDIS
53 FALCISPORITES SIMILIS
54 FORAMINISPORIS ASYMMETRICUS
55 FORAMINISPORIS DAILYI
56 FORAMINISPORIS WONTHAGGIENSIS
57 FOVEOSPORITES CANALIS
58 FOVEOSPORITES MORETONENSIS
59 FOVEOSPORITES MULTIFOVEOLATUS
60 FOVEOTRILETES PARVIRETUS
61 GAMBIERINA RUDATA
62 GEPHRYAPOLLENITES CRANWELLAE
63 GLEICHENIIDITES
64 GLEICHENIIDITES CIRCINIDITES
65 HALORAGACIDITES HARRISII
66 INTERULOBITES INTRAVERRUCATUS
BURONG-1
4100 CUTT
4120 CUTT
CARRS CREEK-1
3850-60 CUTT
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DUTSN DOWNS-1
4580-90 CUTT
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MERRIMAN-1
4708-14 CORE
5075-81 CORE
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5940-50 CUTT
NTH SEASPRY-1
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4872-79 CORE
WELLNGTN PK-1
3719-39 CORE
3816-19 CORE
4540-50 CUTT
7379-80 CORE
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	67 KLUKISPORITES SCABERIS	68 LAEVIGATOSPORITES OVATUS	69 LATROBOSPORITES AMPLUS	70 LATROBOSPORITES CRASSUS	71 LATROBOSPORITES OHAIENSIS	72 LEPTOLEPIDITES VERRUCATUS	73 LILIACIDITES PERORETICULATUS	74 LYCOPODIACIDITES ASPERATUS	75 LYGISTEPOLLENITES BALMEI	76 LYGISTEPOLLENITES ELLIPTCUS	77 LYGISTEPOLLENITES FLORINII	78 MALVACIPOLLIS DIVERSUS	79 MALVACIPOLLIS SUBTILIS	80 MATONISPORITES COOKSONIAE	81 MICROCACHRYIDITES ANTARCTICUS	82 MYRTACEIDITES TENUIS	83 NEORAISTRICKIA	84 NOTHOFAGIDITES	85 NOTHOFAGIDITES BRACHYSPINULOSUS	86 NOTHOFAGIDITES DEMINUTUS	87 NOTHOFAGIDITES EMARCIDUS/HETERUS	88 NOTHOFAGIDITES ENDURUS	89 NOTHOFAGIDITES FALCATUS	90 NOTHOFAGIDITES FLEMINGII	91 NOTHOFAGIDITES SENECTUS	92 ORNAMENTIFERA SENTOSA	93 OSMUDACIDITES WELLMANII	94 PERIPOROPOLLENITES POLYORATUS	95 PERIPOROPOLLENITES SPP	96 PERIPOROPOLLENITES VESICUS	97 PEROTRILETES LINEARIS	98 PEROTRILETES MAJUS	99 PHIMOPOLLENITES PANNOSUS
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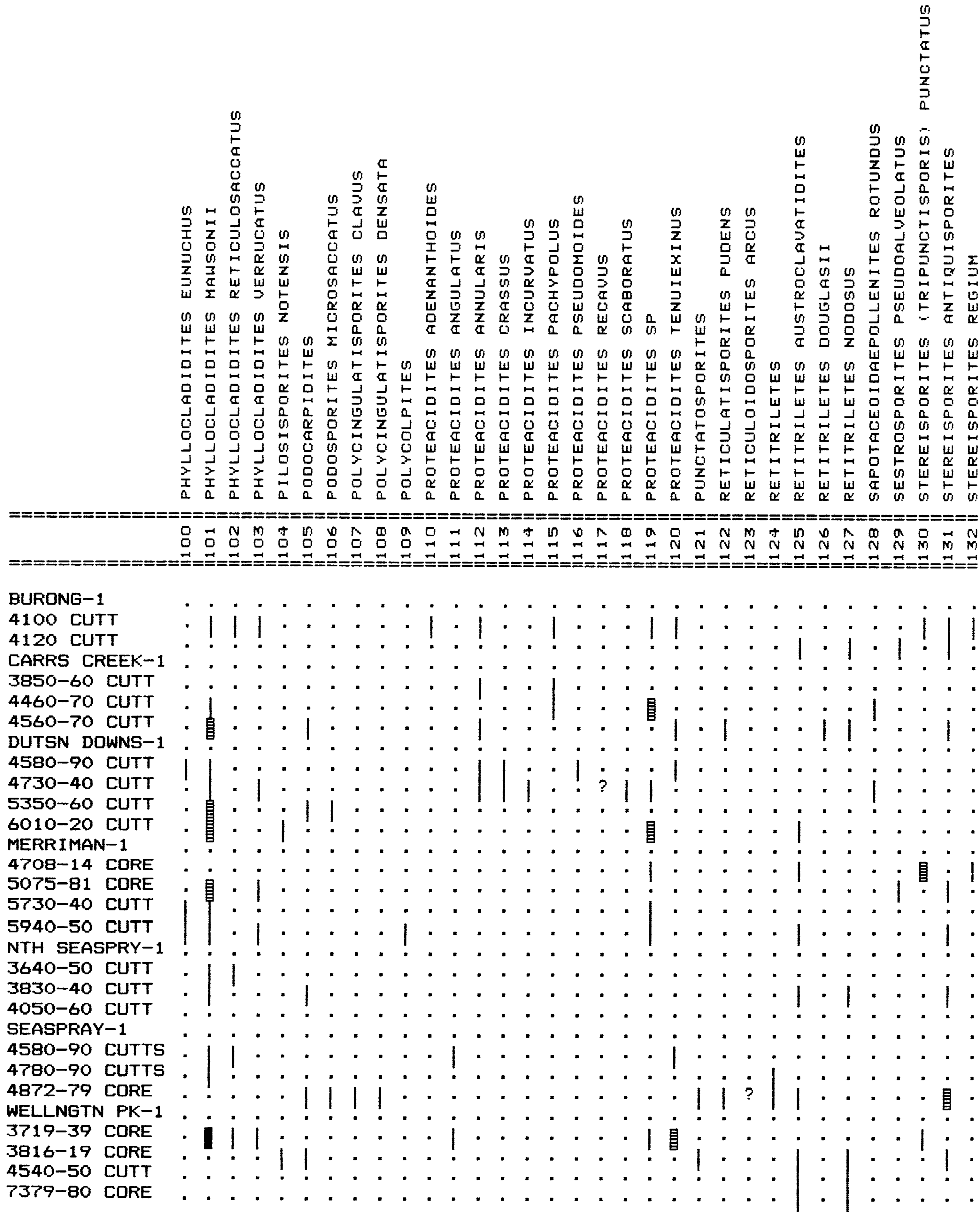

PHYLLOCLADIDITES EUNUCHUS
PHYLLOCLADIDITES MAWSONII
PHYLLOCLADIDITES RETICULOSACCATUS
PHYLLOCLADIDITES VERRUCATUS
PILOSISPORITES NOTENSIS
PODOCARPIDITES
PODOSPORITES MICROSACCATUS
POLYCINGULATISPORITES CLAVUS
POLYCINGULATISPORITES DENSATA
POLYCOLPITES
PROTEACIDITES ADENANTHOIDES
PROTEACIDITES ANGULATUS
PROTEACIDITES ANNULARIS
PROTEACIDITES CRASSUS
PROTEACIDITES INCURVATUS
PROTEACIDITES PACHYPOLUS
PROTEACIDITES PSEUDOMOIDES
PROTEACIDITES RECAVUS
PROTEACIDITES SCABORATUS
PROTEACIDITES SP
PROTEACIDITES TENUIEXINUS
PUNCTATOSPORITES
RETICULATISPORITES PUDENS
RETICULOIDOSPORITES ARCUS
RETITRILETES
RETITRILETES AUSTROCLAVATIDITES
RETITRILETES DOUGLASII
RETITRILETES NODOSUS
SAPOTACEOIDAEPOLLENITES ROTUNDUS
SESTROSPORITES PSEUDOALVEOLATUS
STEREISPORITES (TRIPUNCTISPORIS) PUNCTATUS
STEREISPORITES ANTIQUISPORITES
STEREISPORITES REGIUM
100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132
BURONG-1
4100 CUTT
4120 CUTT
CARRS CREEK-1
3850-60 CUTT
4460-70 CUTT
4560-70 CUTT
DUTSN DOWNS-1
4580-90 CUTT
4730-40 CUTT
5350-60 CUTT
6010-20 CUTT
MERRIMAN-1
4708-14 CORE
5075-81 CORE
5730-40 CUTT
5940-50 CUTT
NTH SEASPRY-1
3640-50 CUTT
3830-40 CUTT
4050-60 CUTT
SEASPRAY-1
4580-90 CUTTS
4780-90 CUTTS
4872-79 CORE
WELLNGTN PK-1
3719-39 CORE
3816-19 CORE
4540-50 CUTT
7379-80 CORE
?
?

	133 STERIESPORITES POCOKII	134 STOVERISPORITES LUNARIS	135 TETRACOLPORITES VERRUCOSUS	136 TRICOLPITES CONFESSUS	137 TRICOLPITES GILLII	138 TRICOLPITES LONGUS	139 TRICOLPITES SABULOSUS	140 TRICOLPITES SP	141 TRICOLPITES WAIPARAENSIS	142 TRICOLPORITES ANGURIUM	143 TRICOLPORITES PAENESTRIATUS	144 TRILETES	145 TRILOBOSPORITES TRIBOTRYS	146 TRILOBOSPORITES TRIORETICULOSUS	147 TRIORITES MAGNIFICUS	148 TRIPOROLETES RADIATUS	149 TRIPOROLETES RETICULATUS	150 TRIPOROLETES SIMPLEX	151 TRIPOROPOLLENITES	152 TRIPOROPOLLENITES SECTILIS	153 VELOSPORITES TRIQUETRUS	154 VITREISPORITES PALLIDUS	
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3850-60 CUTT	.	.	.	.	.	.	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	3850-60 CUTT
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APPENDIX 2

REPORT ON SOURCE ROCK STUDY ON 36 SAMPLES

FROM ONSHORE GIPPSLAND

BY AMDEL CORE SERVICES

AMDEL

CORE

SERVICES

6th March 1991

Cluff Resources Pacific Ltd
PO Box 908
NORTH SYDNEY NSW 2060

Attention: Babak Vahebzadeh

REPORT: 009/732

CLIENT REFERENCE:	Letter 8/1/91
MATERIAL:	Cuttings and Core
LOCALITY:	Onshore Gippsland Basin
WORK REQUIRED:	TOC, Rock-Eval Pyrolysis and Vitrinite Reflectance Determinations

Please direct technical enquiries regarding this work to the signatory below under whose supervision the work was carried out.

BRIAN L WATSON
Laboratory Supervisor
on behalf of Amdel Core Services Pty Ltd

1. INTRODUCTION

Thirty six core and cuttings samples from the onshore Gippsland Basin were received for geochemical analyses to determine the source richness, source maturity and source quality of these sediments.

This report is a formal presentation of the results of this work which was reported by facsimile on the 8th and 21st of February 1991 and includes an interpretation of the complete data set along with graphical displays of the data.

2. ANALYTICAL PROCEDURES

Analytical procedures used in this study are presented in Appendix 2.

3. RESULTS

TOC and Rock-Eval pyrolysis data is presented in Table 1. Figure 1 is a plot of Rock-Eval Hydrogen index versus Tmax illustrating kerogen Type and maturity. Table 2 is a summary of the Vitrinite Reflectance determinations. Histogram plots of these determinations are presented in Appendix 1. Plots of Vitrinite Reflectance versus depth are included as Figures 2-7.

4. INTERPRETATION

4.1 <u>Maturity</u>

Vitrinite Reflectance measurements (Table 2) indicate that the sediments examined in this study, are for the most part, immature for the generation of hydrocarbons. Maturities indicated by Rock-Eval pyrolysis Tmax values are broadly consistent with these indications.

The amount of Vitrinite reflectance data available for each well is of course limited by the availability of suitable samples. However, it should be noted that extrapolation of this data is limited in some cases by the spread of values with depth. The lack of data below 5,000 feet depth in Burong-1, Seaspray-1 and North Seaspray presents some difficulties in extrapolating this data to depths in excess of 8,000 feet.

The validity of the apparent change in slope in the Wellington Park-1 Reflectance versus depth plot should be further investigated. The data available indicates that the rate of change of thermal maturity changes with depth as indicated. Curved Reflectance versus depth plots are common, particularly when approaching sedimentary basement or intrusives. Vitrinite Reflectance determinations of further sediments below 6000 feet depth would be advisable to substantiate the indications of the present data set.

Extrapolation of the available Vitrinite Reflectance data indicates that the sediments intersected in these wells will be sufficiently mature for the generation of light oil/condensates from the thermally labile exinites (resinite and bituminute) below the following depths (VR threshold = 0.45%):

Well	Approximate Depth (VR = 0.45%)
Burong - 1	15,000 ft
Dutson Downs	8,000 ft
Merriman - 1	6,000 ft
North Seaspray - 1	6,500 ft
Seaspray - 1	9,500 ft
Wellington Park - 1	6,300 ft

Significant gas generation from woody - herbaceous kerogen commences at maturities corresponding to Vitrinite Reflectance values of approximately 0.6%. The available data indicates that sediments in these locations are sufficiently mature for significant gas generation below approximately:

Well	Approximate Depth (VR - 0.6%)
Burong - 1	Insufficient data
Dutson Downs - 1	12,000 - 13,000 ft
Merriman - 1	9,000 ft
North Seaspray - 1	11,000 ft
Seaspray-1	20,000 ft
Wellington Park - 1	7,300 ft

The generation of oil from exinites other than resinite and bituminite commences of maturities corresponding to a Vitrinite Reflectance of 0.7%. Extrapolation to this maturity is not possible in the majority of the wells examined in this study, however, the available data suggests that sediments intersected in the following locations are sufficiently mature for oil generation below approximately:

Well	Approximate Depth (VR = 0.7%
Merriman - 1	13,000 ft
North Seaspray - 1	13,000 - 15,000 ft
Wellington Park - 1	7,600 ft

Vitrinite Reflectance versus depth plots (Figures 2 - 7) indicate higher maturity gradients at the following locations: Merriman - 1, North Seaspray -1 and Wellington Park - 1 as compared to maturity gradients at the other locations examined (Burong - 1, Dutson Downs - 1 and Seaspray - 1). Higher maturity gradients indicate higher heat flows and should be related to the geology of the region for maximum benefit. Understanding these heat flows may lead to the identification of a region where sediments are optimally mature for hydrocarbon generation at shallower depths.

Rock-Eval production indices of greater than 0.2 indicate that the following samples contain migrated hydrocarbons:

Dutson Downs - 1	5360 feet depth
Wellington Park - 1	3650 - 7376 feet depth

4.2 Source Richness

Organic richness ranges from poor to excellent in the sediments studied (TOC = 0.18 - 49.60%; Table 1). TOC values are typically greater than 1% and are less than 1% in only eight of the thirty-six samples analysed. The absence of coal samples from Burong - 1 and Seaspray - 1 results in a data set which suggests a lower organic richness for sediments in these wells. However, these observations may be related to sampling or the availability of sample and should be further evaluated.

Source Richness for the generation of hydrocarbons also ranges from poor to excellent ($S_1 + S_2$ = 0.15 - 50.48 kg of hydrocarbons/tonne), but is generally fair to excellent (>2 kg of hydrocarbons/tonne).

4.3 Kerogen Type and Source Richness

Hydrogen Index and Tmax data (Table 1; Figure 1) indicates that these sediments contain organic matter with the bulk composition of predominantly gas prone Type III kerogen. Visual examination of the organic matter in these samples shows that whilst they consist largely of vitrinite they contain moderate proportions of both inertinite and exinite (5 - 15% of organic matter).

This data suggests that whilst these sediments are likely to be largely gas prone they do have the potential to generate significant quantities of liquid hydrocarbons on maturity.

TABLE 1

AMDEL CORE SERVICES

Rock-Eval Pyrolysis

08/02/91

Client: CLUFF RESOURCES

Basin: GIPPSLAND (ONSHORE)

Depth (ft)	T Max	S1	S2	S3	S1+S2	PI	S2/S3	PC	TOC	HI	OI
NORTH SEASPRAY-1											
1910	380	0.42	14.89	18.61	15.31	0.03	0.80	1.27	49.60	30	37
2100	385	0.83	7.66	3.28	8.49	0.10	2.33	0.70	15.60	49	21
3504	382	0.48	12.78	7.30	13.26	0.04	1.75	1.10	29.90	42	24
3690	380	0.16	3.33	3.53	3.49	0.05	0.94	0.27	11.40	29	30
3800	384	0.07	0.44	1.76	0.51	0.14	0.25	0.03	3.66	12	48
4000	401	0.06	1.70	1.18	1.76	0.03	1.44	0.14	3.01	56	39
5000	221	0.02	0.21	0.58	0.23	0.09	0.01	0.00	0.61	35	95
MERRIMAN-1											
2210									0.38		
2510	403	0.39	17.87	7.00	18.26	0.02	2.55	1.52	40.10	44	17
4350	412	0.46	10.23	2.31	10.69	0.04	4.42	0.89	11.10	92	20
4720	372	0.01	0.73	6.75	0.74	0.01	0.10	0.06	5.45	13	123
5081	339	0.01	0.75	2.36	0.76	0.01	0.31	0.06	1.45	51	162
5960	381	0.38	4.15	1.89	4.53	0.08	2.19	0.37	2.78	149	67
DUTSON DOWNS-1											
2420	380	1.03	21.01	8.17	22.04	0.12	2.35	2.07	14.60	143	61
3070	385	3.30	47.18	9.22	50.48	0.07	5.11	4.20	25.40	185	36
4210	389	0.22	4.68	1.39	4.90	0.04	3.36	0.40	3.81	122	36
4660	413	1.29	20.53	8.58	21.82	0.06	2.39	1.81	10.60	193	80
4820	390	2.68	32.46	8.98	35.14	0.08	3.61	2.92	24.20	134	37
5360	395	0.40	1.37	2.02	1.77	0.23	0.67	0.14	7.66	17	26
6110	372	0.46	4.66	1.87	5.12	0.09	2.49	0.42	1.25	372	149
BURONG-1											
2100									0.26		
2670	389	0.88	21.45	2.87	22.33	0.04	7.47	1.86	8.69	246	33
3950	406	0.14	1.82	0.42	1.96	0.07	4.33	0.16	1.33	136	31
4120	376	0.00	0.15	0.40	0.15	0.00	0.37	0.01	0.40	37	100
WELLINGTON PARK-1											
1180									0.18		
1880									0.25		
2100									0.29		
3310	230	1.13	4.92	7.80	6.05	0.19	0.63	0.50	46.70	10	16
3650	283	1.35	3.98	5.33	5.33	0.25	0.74	0.44	24.40	16	21
3830	283	2.92	10.79	6.28	13.71	0.21	1.71	1.14	31.20	34	20
7376	283	0.63	2.59	0.56	3.22	0.20	4.62	0.26	14.80	17	3
SEASPRAY-1											
4466	383	0.51	11.92	2.96	12.43	0.04	4.03	1.21	12.60	95	23
4730	380	0.21	5.02	2.43	5.23	0.04	2.07	0.31	7.49	67	32
4885	381	0.52	2.99	0.12	3.51	0.15	2.49	0.29	0.59	51	20
5000	257	0.13	0.76	0.21	0.89	0.15	3.61	0.07	0.62	122	34

KEY TO ROCK-EVAL PYROLYSIS DATA SHEET

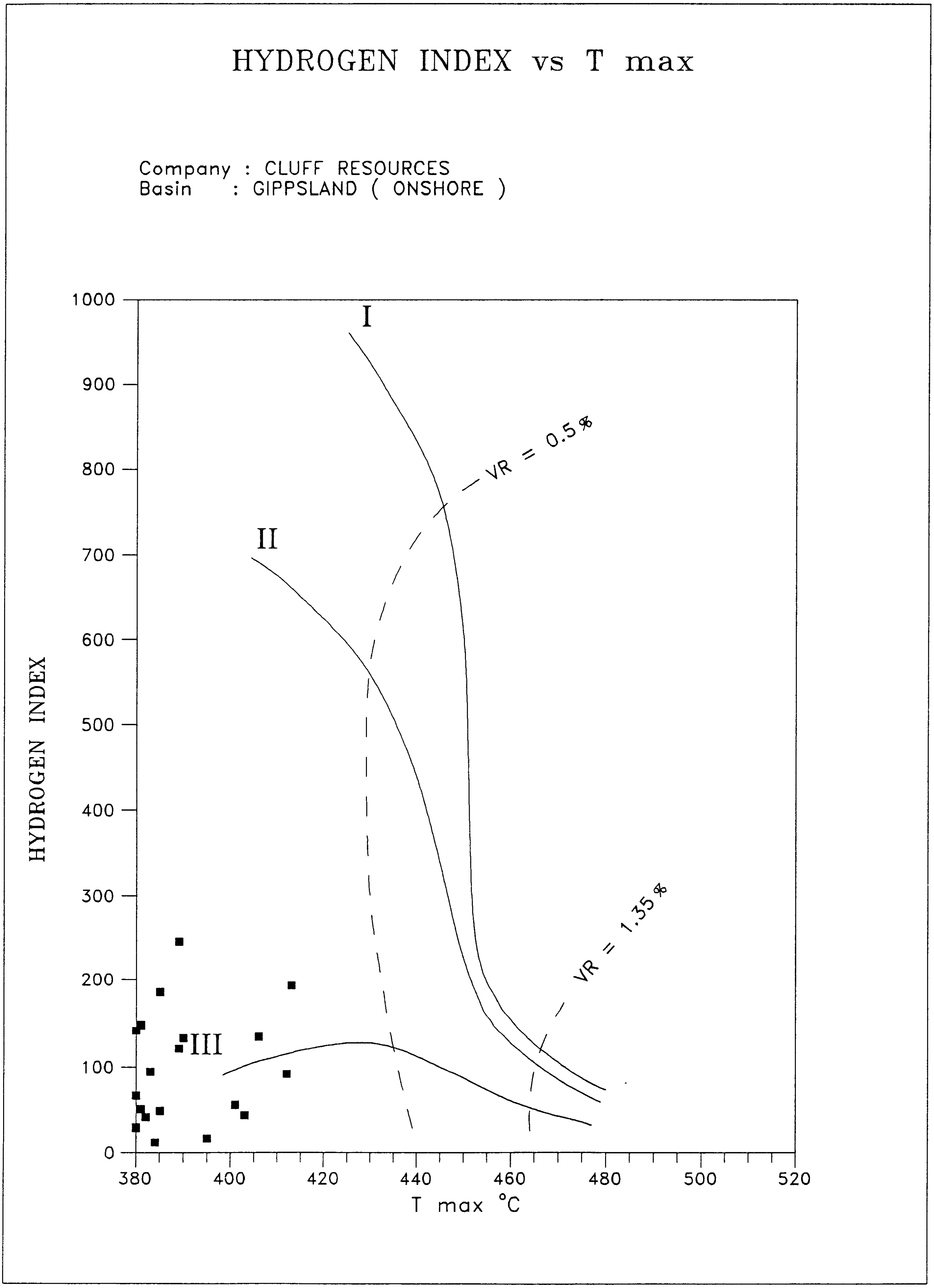
	PARAMETER	SPECIFICITY
T max	position of S_2 peak in temperature program (^{o}C)	Maturity/Kerogen type
S_1	kg hydrocarbons (extractable)/tonne rock	Kerogen type/Maturity/Migrated oil
S_2	kg hydrocarbons (kerogen pyrolysate)/tonne rock	Kerogen type/Maturity
S_3	kg CO_2 (organic)/tonne rock	Kerogen type/Maturity *
$S_1 + S_2$	Potential Yield	Organic richness/Kerogen type
PI	Production Index ($S_1/S_1 + S_2$)	Maturity/Migrated Oil
PC	Pyrolysable Carbon (wt. percent)	Organic richness/Kerogen type/Maturity
TOC	Total Organic Carbon (wt. percent)	Organic richness
HI	Hydrogen Index (mg h'c (S_2)/g TOC)	Kerogen type/Maturity
OI	Oxygen Index (mg CO_2(S_3)/g TOC)	Kerogen type/Maturity *

*Also subject to interference by CO_2 from decomposition of carbonate minerals.

TABLE 2: SUMMARY OF VITRINITE REFLECTANCE MEASUREMENTS, ON SHORE GIPPSLAND BASIN

Depth (ft)	Mean Maximum Reflectance %	Standard Deviation	Range	Number of Determinations
BURONG - 1				
2100	0.31 (0.25)	0.00	0.30-0.31	2
2670	0.26	0.03	0.19-0.33	27
3950	0.30	0.04	0.22-0.38	23
4120	0.30	0.05	0.22-0.41	13
DUTSON DOWNS - 1				
2420	0.32	0.03	0.25-0.37	16
3070	0.28	0.03	0.22-0.34	29
4210	0.35	0.04	0.28-0.41	21
4660	0.35	0.06	0.23-0.46	16
4820	0.37	0.03	0.31-0.43	25
5360	0.35	0.05	0.28-0.47	20
6110	0.44	0.06	0.34-0.53	24
MERRIMAN - 1				
2210	0.28	0.06	0.21-0.34	5
2510	0.26	0.03	0.20-0.31	31
4350	0.32	0.04	0.24-0.40	26
4720	0.39	0.02	0.33-0.45	24
5081	0.44	0.03	0.41-0.47	2
5960	0.46	0.05	0.40-0.55	12
NORTH SEASPRAY - 1				
1910	0.28	0.01	0.25-0.31	22
2100	0.29	0.02	0.26-0.33	24
3310	0.34	0.04	0.28-0.44	24
3504	0.32	0.03	0.28-0.37	24
3690	0.32	0.04	0.25-0.40	24
3800	0.33	0.03	0.25-0.40	24
4000	0.39	0.05	0.31-0.45	10
5000	0.39	0.05	0.29-0.48	16
SEASPRAY -1				
4466	0.36	0.04	0.29-0.44	22
4730	0.37	0.06	0.28-0.49	23
5000	0.37	0.02	0.33-0.41	16
WELLINGTON PARK - 1				
1880	0.36	0.07	0.27-0.50	9
3310	0.28	0.03	0.24-0.33	24
3650	0.34	0.03	0.28-0.40	16
3830	0.33	0.03	0.28-0.39	22
7376	0.63	0.07	0.46-0.77	30

FIGURE 1



HYDROGEN INDEX vs T max
Company : CLUFF RESOURCES
Basin : GIPPSLAND (ONSHORE)
HYDROGEN INDEX
1000
900
800
700
600
500
400
300
200
100
0
380
400
420
440
460
480
500
520
T max °C
I
II
III
VR = 0.5 %
VR = 1.35 %

FIGURE 2

VITRINITE REFLECTANCE VERSUS DEPTH
BURONG-1

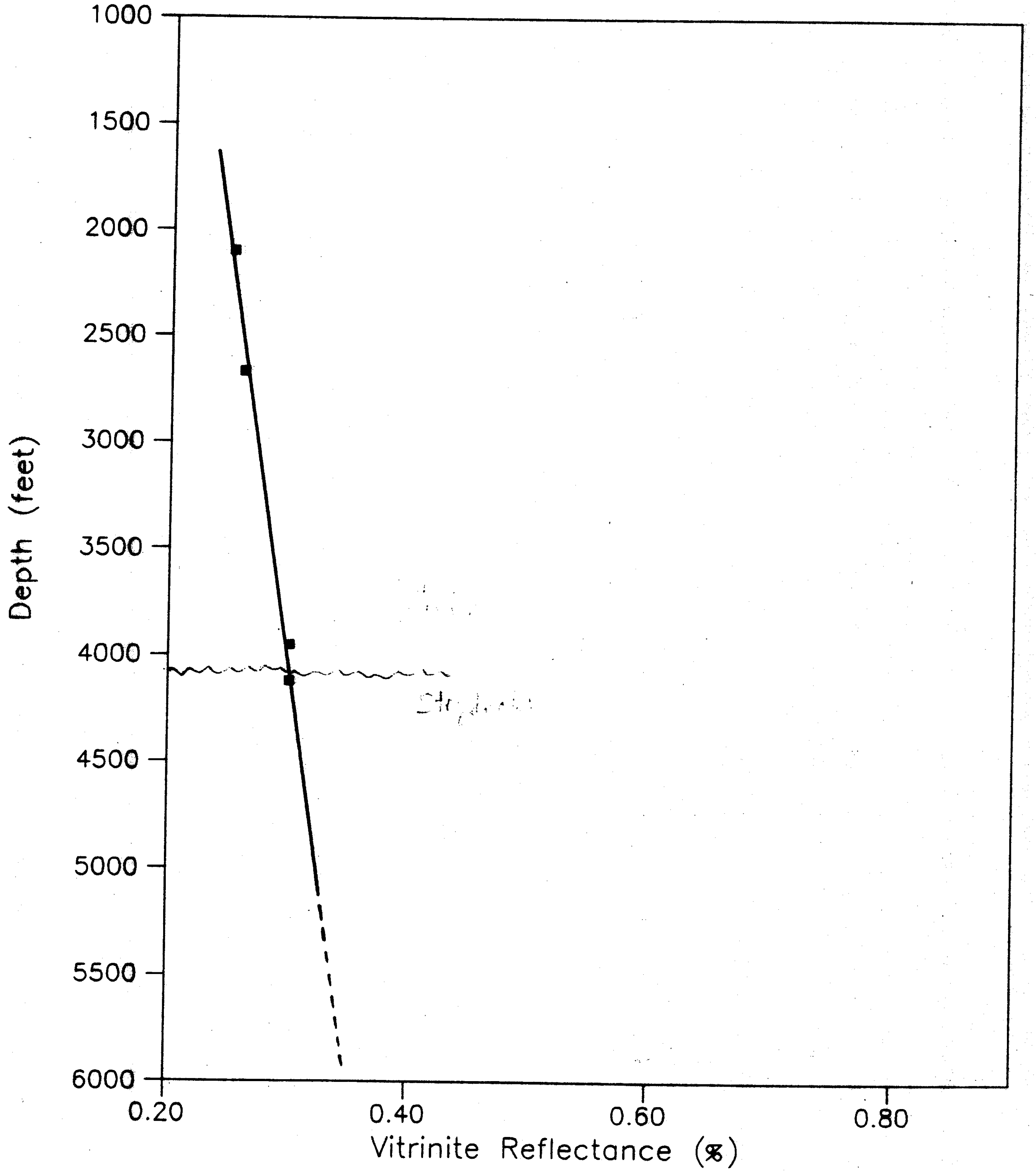


FIGURE 3

VITRINITE REFLECTANCE VERSUS DEPTH
DUTSON DOWNS-1

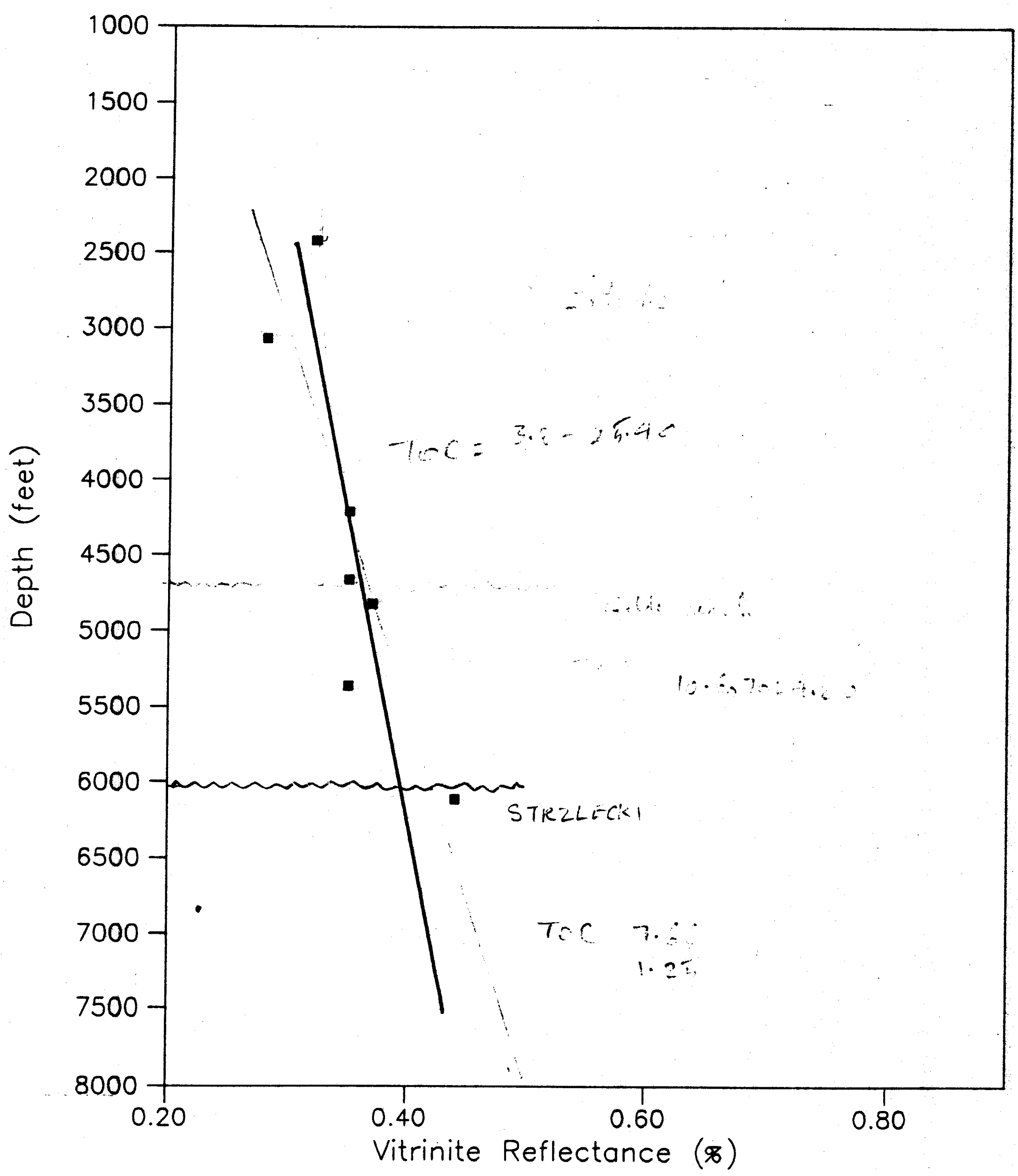
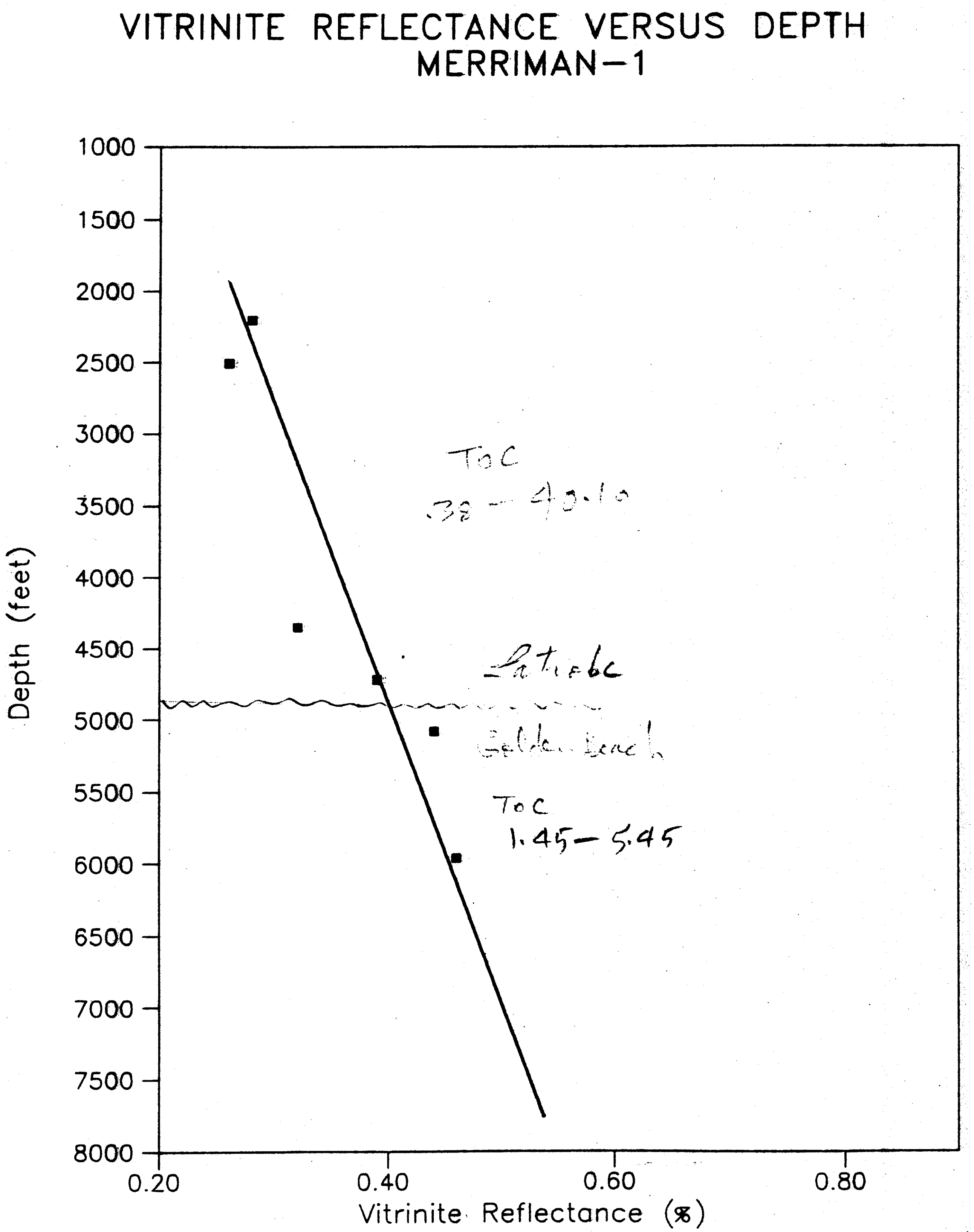


FIGURE 4



VITRINITE REFLECTANCE VERSUS DEPTH
MERRIMAN-1
Depth (feet)
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
7000
7500
8000
0.20
0.40
0.60
0.80
Vitrinite Reflectance (%)
ToC
1.45 — 5.45

FIGURE 5

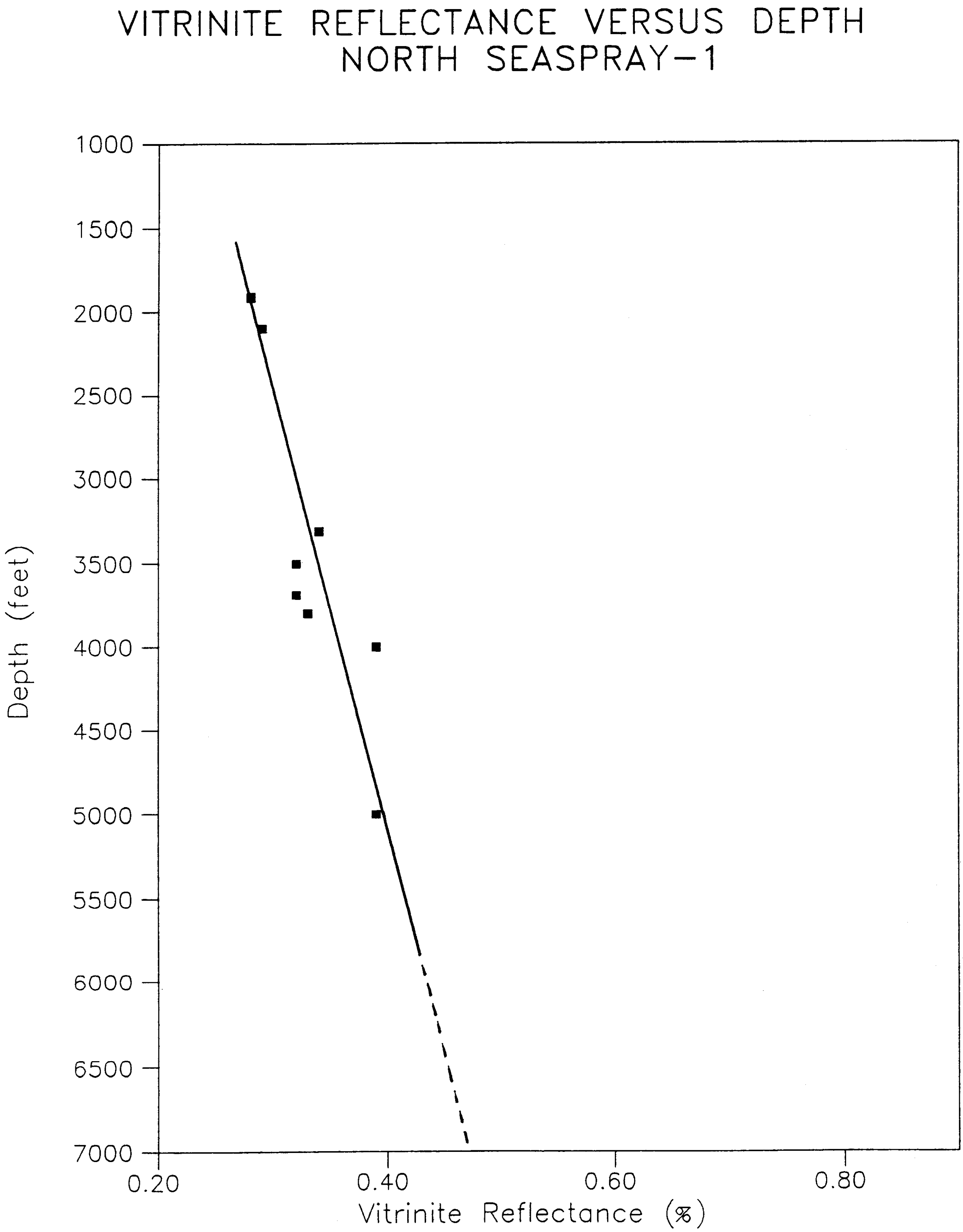

VITRINITE REFLECTANCE VERSUS DEPTH
NORTH SEASPRAY-1
Depth (feet)
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
7000
0.20
0.40
0.60
0.80
Vitrinite Reflectance (%)

FIGURE 6

VITRINITE REFLECTANCE VERSUS DEPTH SEASPRAY-1

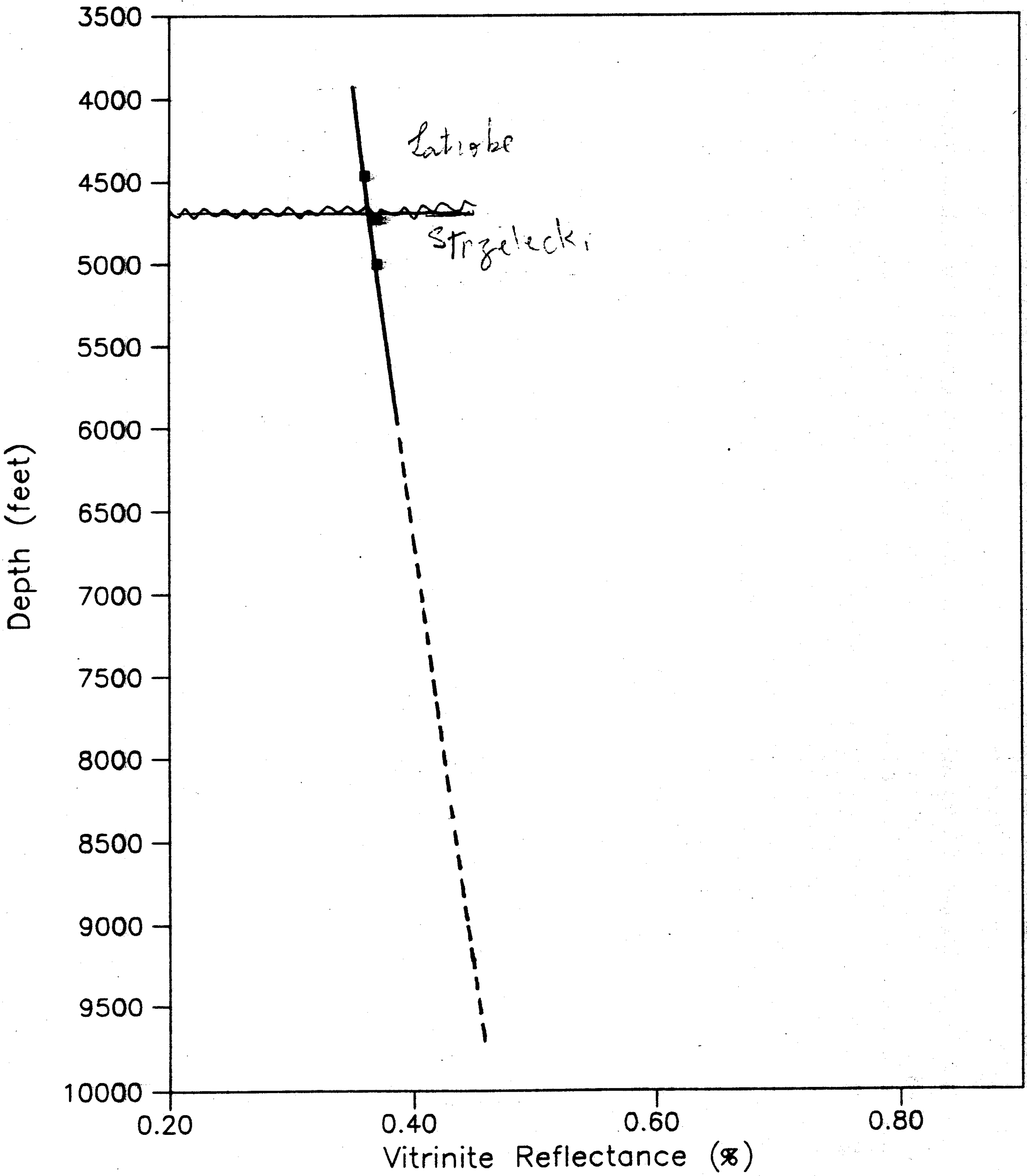
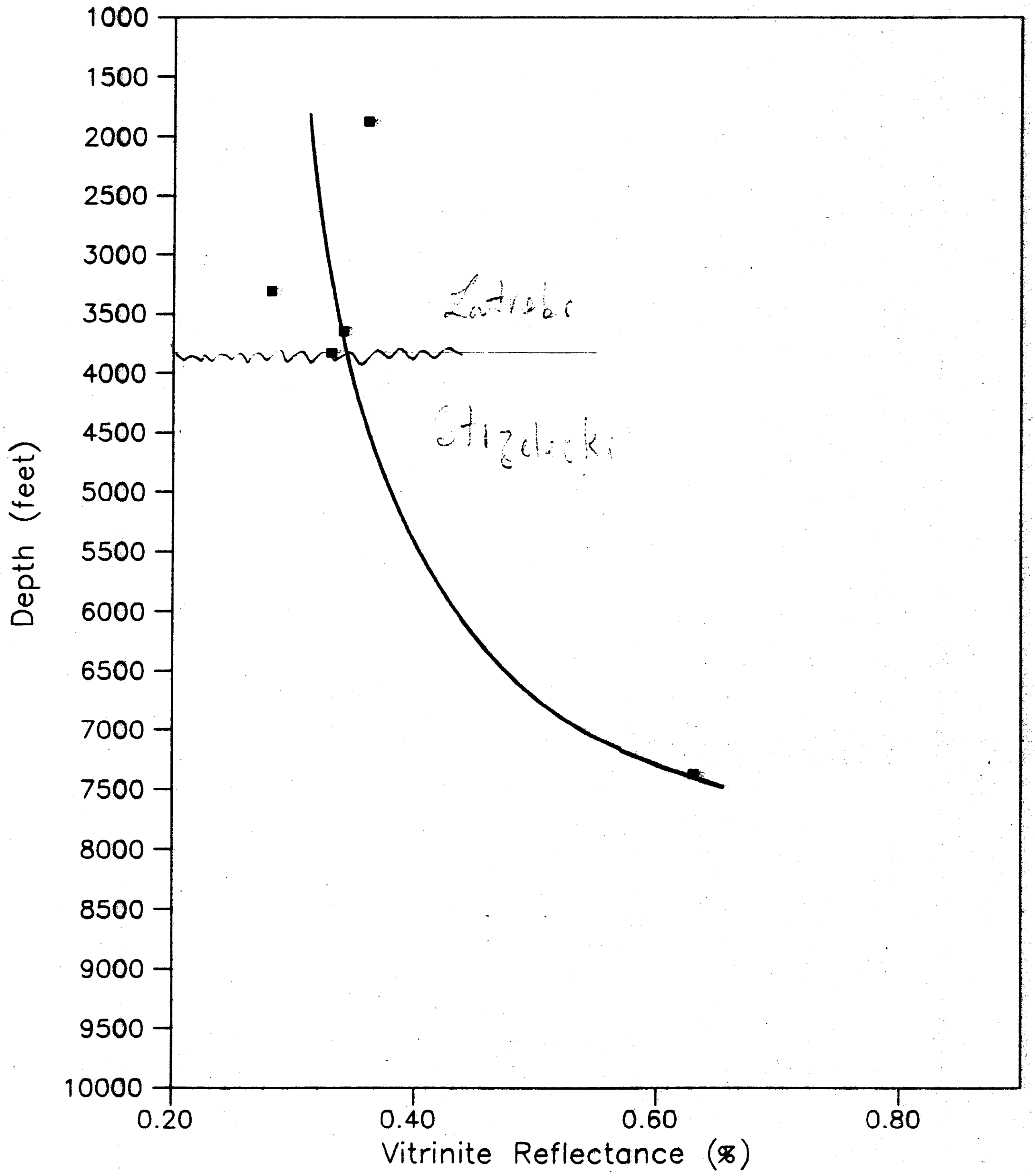


FIGURE 7

VITRINITE REFLECTANCE VERSUS DEPTH
WELLINGTON PARK-1



APPENDIX 1: HISTOGRAM

PLOTS OF VITRINITE REFLECTANCE

DETERMINATIONS, ONSHORE

GIPPSLAND BASIN

VITRINITE REFLECTANCE VALUES

Well Name: BURONG-1
Depth: 2100 ft

Sorted List

0.30
0.31

Number of values= 2

Mean of values 0.31
Standard Deviation 0.00

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

30-32 **

VITRINITE REFLECTANCE VALUES

Well Name: BURONG-1
Depth: 2670 ft

Sorted List

0.19	0.25	0.28
0.21	0.25	0.29
0.22	0.26	0.29
0.22	0.26	0.30
0.23	0.26	0.31
0.24	0.26	0.31
0.25	0.27	0.33
0.25	0.27	
0.25	0.27	
0.25	0.28	

Number of values= 27

Mean of values 0.26
Standard Deviation 0.03

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

```
19-21    **
22-24    ****
25-27    **********
28-30    ********
31-33    ***
```

VITRINITE REFLECTANCE VALUES

Well Name: BURONG-1
Depth: 3950 ft

Sorted List

0.22	0.29	0.35
0.23	0.29	0.37
0.25	0.30	0.38
0.25	0.30	
0.26	0.30	
0.27	0.31	
0.28	0.32	
0.28	0.33	
0.28	0.33	
0.29	0.35	

Number of values= 23

Mean of values 0.30
Standard Deviation 0.04

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

```
22-24    **
25-27    ***
28-30    **********
31-33    ****
34-36    **
37-39    **
```

VITRINITE REFLECTANCE VALUES

Well Name: BURONG-1
Depth: 4120 ft

Sorted List

0.22	0.33
0.24	0.38
0.25	0.41
0.26	
0.27	
0.28	
0.29	
0.30	
0.30	
0.32	

Number of values= 13

Mean of values 0.30
Standard Deviation 0.05

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

22-24	**
25-27	**
28-30	*****
31-33	**
34-36	
37-39	*
40-42	*

VITRINITE REFLECTANCE VALUES

Well Name: DUTSON DOWNS-1
Depth: 2420 ft

Sorted List

0.25	0.33
0.28	0.34
0.29	0.35
0.29	0.35
0.29	0.36
0.29	0.37
0.31	
0.31	
0.32	
0.33	

Number of values= 16

Mean of values 0.32
Standard Deviation 0.03

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

25-27	*
28-30	*****
31-33	*****
34-36	****
37-39	*

VITRINITE REFLECTANCE VALUES

Well Name: DUTSON DOWNS-1
Depth: 3070 ft

Sorted List

0.22	0.27	0.29
0.24	0.27	0.29
0.25	0.27	0.30
0.25	0.27	0.30
0.25	0.27	0.31
0.25	0.28	0.31
0.26	0.29	0.32
0.26	0.29	0.33
0.26	0.29	0.34
0.27	0.29	

Number of values= 29

Mean of values 0.28
Standard Deviation 0.03

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

22-24	**
25-27	*******
28-30	***************
31-33	
34-36	*

VITRINITE REFLECTANCE VALUES

Well Name: DUTSON DOWNS-1
Depth: 4210 ft

Sorted List

0.28	0.35	0.41
0.29	0.35	
0.29	0.36	
0.31	0.37	
0.32	0.37	
0.33	0.38	
0.33	0.38	
0.33	0.38	
0.33	0.39	
0.34	0.40	

Number of values= 21

Mean of values 0.35
Standard Deviation 0.04

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

28-30	***
31-33	******
34-36	****
37-39	******
40-42	**

VITRINITE REFLECTANCE VALUES

Well Name: DUTSON DOWNS-1
Depth: 4660 ft

Sorted List

0.23	0.37
0.28	0.37
0.28	0.41
0.29	0.43
0.33	0.44
0.33	0.46
0.33	
0.34	
0.35	
0.36	

Number of values= 16

Mean of values 0.35
Standard Deviation 0.06

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

23-25	*
26-28	
29-31	***
32-34	****
35-37	****
38-40	
41-43	**
44-46	**

VITRINITE REFLECTANCE VALUES

Well Name: DUTSON DOWNS-1
Depth: 4820 ft

Sorted List

0.31	0.37	0.40
0.33	0.37	0.40
0.33	0.37	0.41
0.33	0.37	0.41
0.34	0.37	0.43
0.34	0.37	
0.34	0.37	
0.35	0.38	
0.35	0.39	
0.36	0.40	

Number of values= 25

Mean of values 0.37
Standard Deviation 0.03

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

31-33	****
34-36	******
37-39	*********
40-42	*****
43-45	

VITRINITE REFLECTANCE VALUES

Well Name: DUTSON DOWNS-1
Depth: 5360 ft

Sorted List

0.28	0.34
0.30	0.35
0.31	0.36
0.31	0.36
0.31	0.37
0.31	0.37
0.33	0.37
0.33	0.42
0.33	0.45
0.33	0.47

Number of values= 20

Mean of values 0.35
Standard Deviation 0.05

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

28-30	**
31-33	********
34-36	****
37-39	***
40-42	*
43-45	*
46-48	*

VITRINITE REFLECTANCE VALUES

Well Name: DUTSON DOWNS-1
Depth: 6110 ft

Sorted List

0.34	0.44	0.51
0.36	0.45	0.52
0.37	0.45	0.52
0.38	0.45	0.53
0.38	0.46	
0.39	0.47	
0.39	0.48	
0.40	0.48	
0.41	0.49	
0.44	0.51	

Number of values= 24

Mean of values 0.44
Standard Deviation 0.06

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

34-36	**
37-39	*****
40-42	**
43-45	*****
46-48	****
49-51	***
52-54	***

VITRINITE REFLECTANCE VALUES

Well Name: MERRIMAN-1
Depth: 2210 ft

Sorted List

0.21
0.22
0.32
0.33
0.34

Number of values= 5

Mean of values 0.28
Standard Deviation 0.06

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

21-23	**
24-26	
27-29	
30-32	*
33-35	**

VITRINITE REFLECTANCE VALUES

Well Name: MERRIMAN-1
Depth: 2510 ft

Sorted List

0.20	0.24	0.27	0.31
0.20	0.25	0.28	
0.21	0.25	0.28	
0.23	0.25	0.28	
0.23	0.25	0.29	
0.23	0.26	0.29	
0.23	0.26	0.29	
0.24	0.26	0.29	
0.24	0.26	0.31	
0.24	0.26	0.31	

Number of values= 31

Mean of values 0.26
Standard Deviation 0.03

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

```
20-22    ***
23-25    ************
26-28    ******
29-31    ******
```

VITRINITE REFLECTANCE VALUES

Well Name: MERRIMAN-1
Depth: 4350 ft

Sorted List

0.24	0.30	0.36
0.26	0.30	0.36
0.26	0.31	0.36
0.27	0.32	0.37
0.28	0.32	0.39
0.28	0.32	0.40
0.29	0.32	
0.29	0.33	
0.29	0.34	
0.30	0.36	

Number of values= 26

Mean of values 0.32
Standard Deviation 0.04

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

```
24-26    ***
27-29    ******
30-32    ********
33-35    **
36-38    *****
39-41
```

VITRINITE REFLECTANCE VALUES

Well Name: MERRIMAN-1
Depth: 4720 ft

Sorted List

0.33	0.38	0.41
0.36	0.39	0.41
0.36	0.39	0.43
0.36	0.39	0.45
0.37	0.39	
0.37	0.39	
0.37	0.39	
0.38	0.40	
0.38	0.40	
0.38	0.40	

Number of values= 24

Mean of values 0.39
Standard Deviation 0.02

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

```
33-35    *
36-38    **********
39-41    ***********
42-44    *
45-47    *
```

VITRINITE REFLECTANCE VALUES

Well Name: MERRIMAN-1
Depth: 5081 ft

Sorted List

0.41
0.47

Number of values= 2

Mean of values 0.44
Standard Deviation 0.03

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

41-43	*
44-46	
47-49	*

VITRINITE REFLECTANCE VALUES

Well Name: MERRIMAN-1
Depth: 5960 ft

Sorted List

0.40	0.53
0.40	0.55
0.41	
0.42	
0.44	
0.44	
0.46	
0.49	
0.50	
0.51	

Number of values= 12

Mean of values 0.46
Standard Deviation 0.05

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

40-42	****
43-45	**
46-48	*
49-51	***
52-54	*
55-57	*

VITRINITE REFLECTANCE VALUES

Well Name: NORTH SEASPRAY-1
Depth: 1910 FT

Sorted List

0.25	0.28	0.31
0.26	0.29	0.31
0.27	0.29	
0.27	0.29	
0.27	0.29	
0.27	0.29	
0.28	0.29	
0.28	0.29	
0.28	0.30	
0.28	0.30	

Number of values= 22

Mean of values 0.28
Standard Deviation 0.01

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

25-27 **
28-30 ******************
31-33 **

VITRINITE REFLECTANCE VALUES

Well Name: NORTH SEASPRAY-1
Depth: 2100 ft

Sorted List

0.26	0.28	0.31
0.26	0.29	0.32
0.26	0.29	0.33
0.26	0.29	0.33
0.26	0.30	
0.26	0.30	
0.28	0.30	
0.28	0.31	
0.28	0.31	
0.28	0.31	

Number of values= 24

Mean of values 0.29
Standard Deviation 0.02

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

26-28 ******
29-31 ***************
32-34 ***

VITRINITE REFLECTANCE VALUES

Well Name: NORTH SEASPRAY-1
Depth: 3310 ft

Sorted List

0.28	0.33	0.37
0.30	0.34	0.38
0.30	0.34	0.44
0.30	0.34	0.44
0.30	0.34	
0.31	0.34	
0.31	0.35	
0.31	0.35	
0.32	0.36	
0.32	0.36	

Number of values= 24

Mean of values 0.34
Standard Deviation 0.04

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

28-30	*****
31-33	******
34-36	*********
37-39	**
40-42	
43-45	**

VITRINITE REFLECTANCE VALUES

Well Name: NORTH SEASPRAY-1
Depth: 3504 ft

Sorted List

0.28	0.32	0.35
0.28	0.32	0.36
0.29	0.32	0.37
0.30	0.33	0.37
0.30	0.33	
0.30	0.34	
0.30	0.34	
0.31	0.34	
0.31	0.35	
0.31	0.35	

Number of values= 24

Mean of values 0.32
Standard Deviation 0.03

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

28-30 *******
31-33 ********
34-36 *******
37-39 **

VITRINITE REFLECTANCE VALUES

Well Name: NORTH SEASPRAY-1
Depth: 3690 ft

Sorted List

0.25	0.31	0.37
0.28	0.31	0.40
0.28	0.31	0.40
0.28	0.32	0.40
0.29	0.32	
0.29	0.32	
0.30	0.33	
0.30	0.33	
0.30	0.34	
0.30	0.36	

Number of values= 24

Mean of values 0.32
Standard Deviation 0.04

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

25-27	*
28-30	*********
31-33	********
34-36	**
37-39	*
40-42	***

VITRINITE REFLECTANCE VALUES

Well Name: NORTH SEASPRAY-1
Depth: 3800 ft

Sorted List

0.25	0.32	0.36
0.27	0.33	0.36
0.29	0.33	0.40
0.30	0.33	0.40
0.30	0.34	
0.31	0.34	
0.31	0.34	
0.31	0.35	
0.32	0.35	
0.32	0.36	

Number of values= 24

Mean of values 0.33
Standard Deviation 0.03

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

25-27	*
28-30	****
31-33	*********
34-36	********
37-39	
40-42	**

VITRINITE REFLECTANCE VALUES

Well Name: NORTH SEASPRAY-1
Depth: 4000 ft

Sorted List

0.31
0.33
0.34
0.35
0.36
0.41
0.42
0.43
0.45
0.45

Number of values= 10

Mean of values 0.39
Standard Deviation 0.05

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

31-33	**
34-36	***
37-39	
40-42	**
43-45	***

VITRINITE REFLECTANCE VALUES

Well Name: NORTH SEASPRAY-1
Depth: 5000 ft

Sorted List

0.29	0.42
0.35	0.42
0.35	0.42
0.35	0.43
0.35	0.45
0.36	0.48
0.37	
0.38	
0.38	
0.40	

Number of values= 16

Mean of values 0.39
Standard Deviation 0.05

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

```
29-31    *
32-34
35-37    ******
38-40    ***
41-43    ****
44-46    *
47-49    *
```

VITRINITE REFLECTANCE VALUES

Well Name: SEASPRAY-1
Depth: 4466 ft

Sorted List

0.29	0.36	0.42
0.30	0.37	0.44
0.32	0.37	
0.32	0.38	
0.32	0.38	
0.33	0.39	
0.33	0.39	
0.33	0.40	
0.35	0.41	
0.36	0.41	

Number of values= 22

Mean of values 0.36
Standard Deviation 0.04

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

```
29-31    **
32-34    ******
35-37    *****
38-40    *****
41-43    ***
44-46    *
```

VITRINITE REFLECTANCE VALUES

Well Name: SEASPRAY-1
Depth: 4730 ft

Sorted List

0.28	0.34	0.44
0.29	0.34	0.48
0.29	0.37	0.49
0.30	0.37	
0.31	0.39	
0.32	0.39	
0.33	0.39	
0.33	0.43	
0.34	0.43	
0.34	0.43	

Number of values= 23

Mean of values 0.37
Standard Deviation 0.06

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

28-30	****
31-33	****
34-36	****
37-39	*****
40-42	
43-45	****
46-48	*
49-51	*

VITRINITE REFLECTANCE VALUES

Well Name: SEASPRAY-1
Depth: 5000 ft

Sorted List

0.33	0.38
0.34	0.38
0.35	0.38
0.35	0.39
0.36	0.40
0.36	0.41
0.37	
0.37	
0.37	
0.38	

Number of values= 16

Mean of values 0.37
Standard Deviation 0.02

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

33-35	****
36-38	*********
39-41	***

VITRINITE REFLECTANCE VALUES

Well Name: WELLINGTON PARK-1
Depth: 1880 FT

Sorted List

0.27
0.29
0.31
0.34
0.35
0.38
0.39
0.40
0.50

Number of values= 9

Mean of values 0.36
Standard Deviation 0.07

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

27-29	**
30-32	*
33-35	**
36-38	*
39-41	**
42-44	
45-47	
48-50	*

VITRINITE REFLECTANCE VALUES

Well Name: WELLINGTON PARK-1
Depth: 3310 ft

Sorted List

0.24	0.27	0.31
0.25	0.27	0.32
0.25	0.28	0.33
0.25	0.29	0.33
0.26	0.29	
0.26	0.29	
0.26	0.31	
0.27	0.31	
0.27	0.31	
0.27	0.31	

Number of values= 24

Mean of values 0.28
Standard Deviation 0.03

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

24-26	*******
27-29	*********
30-32	******
33-35	**

VITRINITE REFLECTANCE VALUES

Well Name: WELLINGTON PARK-1
Depth: 3650 ft

Sorted List

0.28	0.35
0.28	0.35
0.32	0.35
0.32	0.35
0.33	0.36
0.33	0.40
0.33	
0.34	
0.34	
0.34	

Number of values= 16

Mean of values 0.34
Standard Deviation 0.03

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

28-30	**
31-33	*****
34-36	********
37-39	
40-42	*

VITRINITE REFLECTANCE VALUES

Well Name: WELLINGTON PARK-1
Depth: 3830 ft

Sorted List

0.28	0.33	0.39
0.28	0.34	0.39
0.29	0.34	
0.29	0.35	
0.30	0.35	
0.30	0.36	
0.30	0.36	
0.31	0.36	
0.31	0.36	
0.32	0.38	

Number of values= 22

Mean of values 0.33
Standard Deviation 0.03

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

28-30 *******
31-33 ****
34-36 ********
37-39 ***

VITRINITE REFLECTANCE VALUES

Well Name: WELLINGTON PARK-1
Depth: 7376 ft

Sorted List

0.46	0.62	0.66
0.49	0.63	0.66
0.55	0.63	0.66
0.56	0.63	0.67
0.57	0.63	0.67
0.59	0.63	0.68
0.59	0.64	0.72
0.62	0.65	0.72
0.62	0.65	0.76
0.62	0.66	0.77

Number of values= 30

Mean of values 0.63
Standard Deviation 0.07

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

46-48	*
49-51	*
52-54	
55-57	***
58-60	**
61-63	*********
64-66	*******
67-69	*
70-72	
73-75	
76-78	**

Enclosure 1:

Cross Section - Lake Wellington Park to Merriman-1

PE801905

Enclosure 2:

Cross Section - Golden Beach 1A to Colliers Hill

PE 801908.