PE990076

APPENDIX 6.

BIOSTRATIGRAPHIC REPORT AND SOURCE ROCK EVALUATION

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I. ABSTRACT

Fairhope-1 was drilled to 567.5m KB in Permit PEP 98, onshore Gippsland Basin. Sidewall core samples from 179.0m to 541.5m have been examined for calcareous nannoplankton, foraminifera and palynomorphs.

DEPTH (m)	UNIT	ZONE	AGE
179	Gippsland Limestone	NN6, D	Middle Miocene
296.5-419	Gippsland Limestone	NN4-NN5, G	Early Miocene-lower Middle Miocene
454	Gippsland Limestone	H2 or younger	Latest Oligocene or younger
456	Gippsland Limestone	-	Indeterminate
532	Lakes Entrance Fm. ('lower member')	-	Indeterminate
533.6-541.5	Lakes Entrance Fm. ('lower member')	NP23-24, <u>P. tuberculatus</u>	Early-Late Oligocene

The Gippsland limestone sampled from 179m-456m was deposited in an inner neritic environment. From 533.6m to 541.5m the 'lower member' of the Lakes Entrance Formation was also deposited in a marine environment.

No significant source rocks were observed in the sampled section. Spore colours of light yellow, fluorescence of white and vitrinite reflectance of 0.29%-0.30% indicate the section penetrated by Fairhope-1 is immature.

II. INTRODUCTION

ECL Geological Laboratory was contracted by Ampol Exploration Ltd to undertake laboratory studies of sidewall core samples from the well Fairhope-1. The well is located in onshore exploration Permit PEP 98, Gippsland Basin, Victoria, and was drilled to a total depth of 567.5m KB.

Sidewall core samples from the interval 179.0 to 541.5m were analysed for calcareous nannoplankton, foraminifera, palynomorphs, source rock potential and maturity. The objective of this study was to provide biostratigraphic zonations, interpretation of depositional environment and information on hydrocarbon habitat for geological evaluation of the well section.

III. ROCK-STRATIGRAPHIC NOMENCLATURE

(A) Lakes Entrance Formation (Lower Member)

In this investigation Early-Late Oligocene glauconitic sandstone, oxidized glauconitic sandstone-siltstone and glauconitic marl, are referred to informally as the "lower member" of the Lakes Entrance Formation. The "lower member" includes the following formal onshore stratigraphic units : Colquhoun Sandstone Member, Cunninghame Greensand Member, Metung Marl Member, Giffard Sandstone Member and Seacombe Marl Member.

(B) Lakes Entrance Formation (Upper Member)

In this investigation Late Oligocene-Early Miocene marls are referred to informally as the "upper member" of the Lakes Entrance Formation.

(C) Gippsland Limestone

In Fairhope-1 Early-Middle Miocene clean skeletal limestone and calcarenites with common bryozoan fragments are referred to as the Gippsland Limestone.

IV. GEOLOGICAL COMMENTS

The mid-Oligocene disconformity recorded in both Comley-1 and Paynesville-1 is interpreted to occur at 536m in Fairhope-1 (see Figure 2). The disconformity is defined at the top of the oxidized horizon (536-537m). The oxidized horizon formed during the mid-Oligocene (Zone NP23-NP24 time). Sidewall core samples above (536m) and below (540m) the disconformity surface at 536m are NP23-NP24 in age. The sample at 536m is a glauconitic sandstone which contains an oxidized sandstone fraction. The mixed fresh glauconitic (dominant) and oxidized glauconitic fractions in the sample is consistent with its position just above the disconformity surface. The mid-Oligocene disconformity is considered to have resulted from the major global fall in sea-level at 30Ma proposed by Vail et. al. (1977). This event has resulted in a widespread Oligocene disconformity in offshore Gippsland Basin wells (unpublished data).

Lack of sample control above 532m, and the absence of in situ calcareous nannoplankton in samples at 532 and 533.6m in Fairhope-1 has restricted stratigraphic interpretation of this interval. However, log correlation with the nearby Comley-1 Well has assisted in resolving the stratigraphy of this interval. A second and younger oxidized horizon occurs between 530.5 and 534m. Sidewall core samples at 532 and 533.6m penetrated oxidized fine grained sandstone and oxidized siltstone respectively. The top of the oxidized horizon has been selected at 530.5m. The oxidized horizon has also been recognized in Comley-1 between 476 and 478m and in Paynesville-1 between 569 and 570.5m. The top of the horizon is interpreted to equate with the Late Oligocene disconformity recognized in Comley-1. This disconformity cannot be confirmed on palaeontological evidence in Fairhope-1. The thickness of the Lakes Entrance Formation ('lower member') between the Mid and Late Oligocene disconformities in Fairhope-1 is 5.5m. This is almost identical to that recorded in Comley-1 (5m) and Paynesville-1 (7m).

Log correlation with Comley-1 indicates that the 'upper member' of the lakes Entrance Formation in Fairhope-1 is probably represented by the interval 476.5m (tentative log pick) to 530.5m. Definite Gippsland Limestone consisting of bryozoan rich calcarenite was penetrated by the sidewall core sample at 456.0m.

V. MICROPALAEONTOLOGY

A total of 14 sidewall core samples from the interval 161.0-486.5m were analysed for foraminifera and calcareous nannoplankton. Calcareous microfossil species identified in the well section, interpreted zonation and depositional environment subdivision have been plotted on the micropalaeotological distribution chart (Enclosure 1).

The planktonic foraminiferal letter zonal scheme of Taylor (in prep.) and the NP-NN calcareous nannoplankton letter scheme of Martini (1971) are used in this investigation. Foraminiferal studies by Carter (1964) and Jenkins (1971), and calcareous nannoplankton investigations by Edward (1971) and Siesser (1979) have also been consulted.

(A) Calcareous Nannoplankton Biostratigraphy

i) 179m : Zone NN6 (Middle Miocene)

The presence of Cyclicargolithus floridanus (extinction at top of Zone NN6) without Sphenolithus heteromorphous (extinction at top of Zone NN5) in a moderate yielding and moderately well preserved nannofossil assemblage is indicative of Zone NN6.

ii) 296.5m : Zones NN4-NN5 (upper Early Miocene - early Middle Miocene).

The occurrence of Sphenolithus heteromorphous at 296.5m is indicative of Zones NN4 to NN5.

iii) 390.5m : Zone NN4 (upper Early Miocene)

The association of moderate numbers of Sphenolithus heteromorphous with rare S. belemnos at 390.5m indicates a position at the base of Zone NN4.

iv) 419.0-533.6m : Indeterminate

Samples 419.0-456.0m inclusive contain impoverished and poorly preserved nannofossil assemblages which are not age-diagnostic. Samples 532.0 and 533.6m are barren of calcareous nannoplankton.

v) 536.0m - 540.0m : Zones NP23-NP24 (Early/Late Oligocene boundary)

The uphole extinction of Chiasmolithus oamaruensis at 536.0m defines the top of Zone NP24 in the well. The absence of Reticulofenestra umbilica indicates that the nannofossil assemblage in the interval is no older than Zone NP23.

vi) 541.5m : Indeterminate

The nannofossil assemblage at 541.5m lacks oligocene species and appears to have caved from higher in the well.

B) Planktonic Foraminiferal Biostratigraphy

i) 179.0m : Zone D (Middle Miocene)

The association of Orbulina universa and Globigerinoides sicanus indicates that the sample at 179.0m is Zone D in age.

ii) 296.5-390.5m : Zone G or younger (Early Miocene or younger).

The occurrence of very rare specimens of Globigerinoides trilobus in a very low yielding planktonic foraminiferal assemblage indicates that the interval is assignable to Zone G or younger zones.

iii) 419.0m : Zone G (Early Miocene)

The occurrence of moderate numbers of Globigerinoides trilobus without its descendants Globigerinoides sicanus and the Praeorbulina-Orbulina group indicates that the sample at 419.0m is assignable to Zone G.

iv) 454.0m : Zone H2 or younger (latest Oligocene or younger).

The occurrence of rare specimens of Globigerina woodi woodi in a very low yielding and poorly preserved planktonic foraminiferal assemblage indicates that the sample at 454.0m is Zone H2 or younger in age.

v) 456.0-541.5m : Indeterminate

With the exception of the sample at 456.0m the interval is barren of in situ planktonic foraminifera. The sample at 456.0m contained one specimen of Catapsydrax dissimilis which is of limited biostratigraphic value. A zone F planktonic foraminiferal assemblage was noted at 538.5m but this has caved from higher in the well.

C) Environment of Deposition

i) 179.0-456.0m : Inner neritic

An inner neritic environment of deposition for the interval is indicated by the common occurrence of bryozoan fragments, very low percentage of planktonic foraminifera and the absence or rare occurrence of Euvigerina spp., Brizalina spp., and Sphaeroidina bulloides. The moderate to common occurrence of Elphidium crassatum in the upper samples at 179.0 and 296.5m is also indicative of an inner neritic environment of deposition.

ii) 536.0m and 540.0m : Marine

The samples at 536.0 and 540.0m consist of a low yielding, low diversity and abraded benthonic foraminiferal assemblage which can only be interpreted to have been deposited in a marine environment. The moderate to high abundance of calcareous nannoplankton in the samples confirms a marine environment of deposition.

VI. PALYNOLOGY

Five sidewall core samples ranging in depths from 533.6m to 541.5m from Fairhope No. 1 well were palynologically examined. The upper two samples were moderate in organic richness but rich in palynomorph contents while the lower three were rich on both accounts. The following palynostratigraphic classification is suggested according to the scheme of Stover and Partridge (1973) updated by Raine (1984) and ECL file data.

A) Palynostratigraphy

i) 533.6m-541.5m : Proteacidites tuberculatus Zone (Early Oligocene)

The interval is correlated with the Proteacidites tuberculatus Zone of Early Oligocene age due to occurrences of Cyathidites subtilis with its base in the zone, and Nothofagidites asperus with its top in the zone. Dinoflagellates support this dating in precise terms. Kallosphaeridium biarmatum occurring at 533.6m is known to be restricted to the Early Oligocene, while Deflandrea spinulosa occurring at 541.5m, and the acritarch Ascostomocystis granulatus occuring at 533.6m are not known from rocks younger than the Oligocene. Operculodinium israelianum occurring in most of the samples is not known to be older than the Oligocene.

B) Environment of Deposition

All samples treated contain abundant and diverse dinoflagellate cysts and common foraminiferal chamber-linings except the sample at 540.0m which is low in dinoflagellate cysts. The entire interval is therefore considered to have been deposited in a marine environment.

VII. SOURCE ROCK POTENTIAL AND MATURITY

Three samples at 533.6m, 536.0m and 540.0m were studied for source rock potential and organic maturity. The results are given in Tables 1A, 1B and 1C, and the methods and terms used are explained in Appendix No. 1.

All samples yielded around 1.0ml/10g organic matter which suggests a good source-rock potential. The liptinite contents and the fluorescing liptinites were, however, very poor, negating a good potential. Most of the palynomorphs were oxidised and non-fluorescing. The spore colours ranged from light yellow through yellow to light orange. The fluorescence colours were white and yellow. All these data indicate immaturity to early oil generating potentials only.

Samples from 538.5m and 541.5m were analysed for vitrinite reflectance (Appendix 2). A total of 14 and 19 determinations respectively were made and gave mean reflectances of 0.29% and 0.30% with a range of 0.22% to 0.36%, indicating the immaturity of the section.

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FIGURE 1 : SUMMARY CHART, FAIRHOPE-1

DEPTH (mkB)	LITHOLOGY *	UNIT	NANNOFOSSIL ZONE	PLANK FORAM ZONE	PALYNOLOGY ZONE	AGE	ENVIRONMENT
179.0	Calcarenite	Gippsland Limestone	NN6	B	Not studied	Middle Miocene	Inner neritic
296.5	Calcarenite		NN4-NN5	G or younger	Not studied	Upper Early Miocene - lower Middle Miocene	Inner neritic
390.5	Calcarenite		NN4	G or younger	Not studied	Upper Early Miocene	Inner neritic
419.0	Calcarenite/calcisiltite		Indeterm.	G	Not studied	Early Miocene	Inner neritic
454.0	Calcisiltite		Indeterm.	H2 or younger	Not studied	Latest Oligocene or younger	Inner neritic
456.0	Calcarenite		Indeterm.	Indeterm.	Not studied	Indeterm.	Inner neritic
---log break at 476.5m---							
Not studied		Lakes Entrance Formation ("upper member")					
---log break at 530.5m---							
#532.0	Oxidized fine grained sandstone	Lakes Entrance Formation ("lower member")	Indeterm.	Indeterm.	Not studied	Indeterm.	Indeterm.
#533.6	Oxidized siltstone		Indeterm.	Indeterm.	P. tuberculatus	Early Oligocene	+ Marine
535.0	Glauconitic sandstone/ oxidized sandstone		NP23-NP24	Indeterm.	P. tuberculatus	Early/Late Oligocene boundary	Marine
---?log break at 536.0m---							
#538.5	Glauconitic sandstone	Lakes Entrance Formation ('lower member')	Indeterm.	Indeterm.	P. tuberculatus	Early Oligocene	+ Marine
540.0	glauconitic/pyritic sandstone		NP23-NP24	Indeterm.	P. tuberculatus	Early/Late Oligocene boundary	Marine
#541.5	Slightly glauconitic/ pyritic sandstone		Indeterm.	Indeterm.	P. tuberculatus	Early Oligocene	+ Marine

* Lithology based on washed residue

\# Downhole contamination noted.

\+ Environment based on palynomorph data.

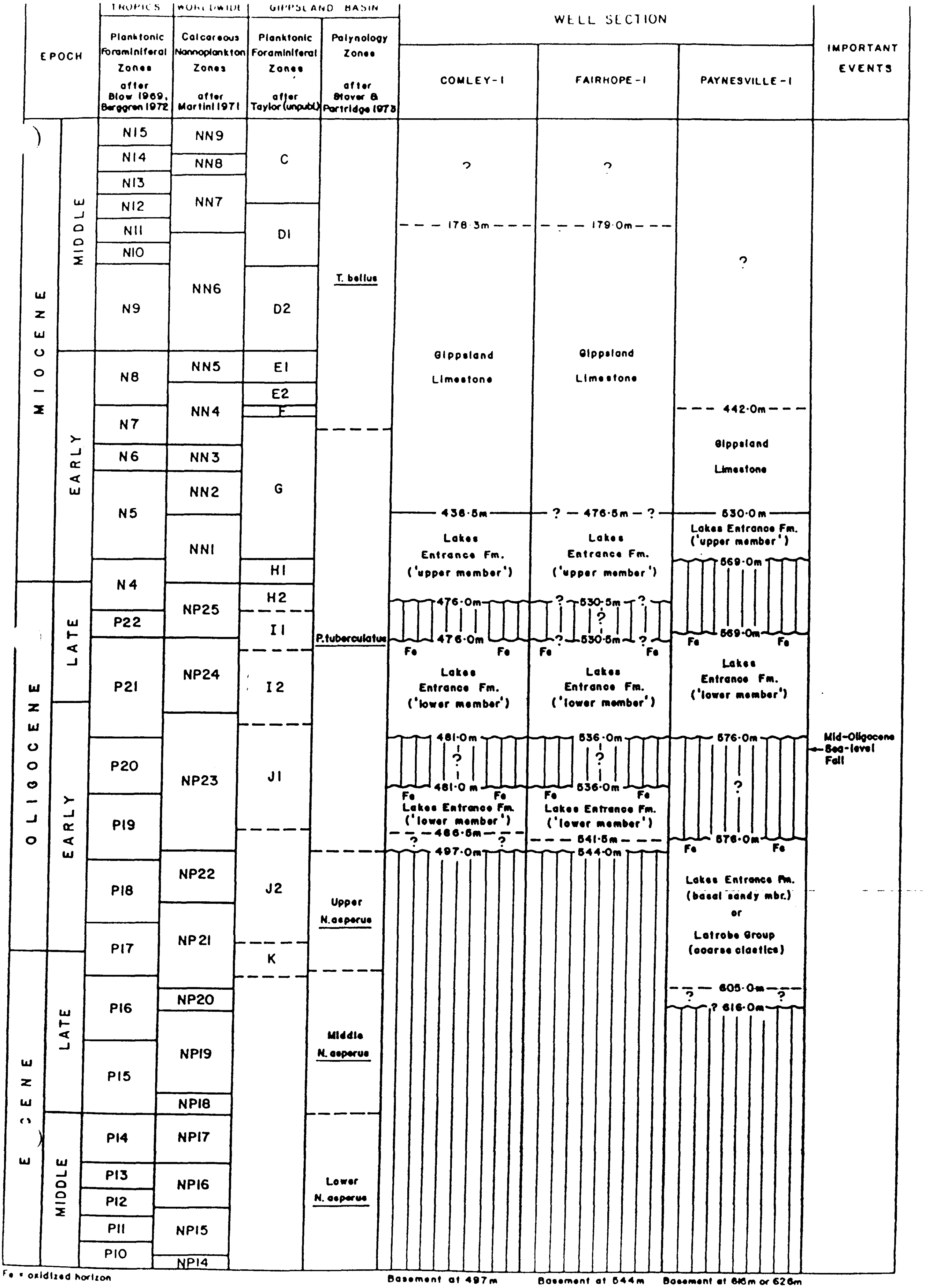

Fig. 2 Tentative chronostratigraphic correlation between Comley-1, Fairhope-1 & Paynesville-1 wells, onshore Gippsland Basin

Tentative chronostratigraphic correlation between COMLEY 1, FAIRHOPE 1 & PAYNESVILLE 1 wells, onshore Gippsland Basin - revised by Ampol Exploration Ltd

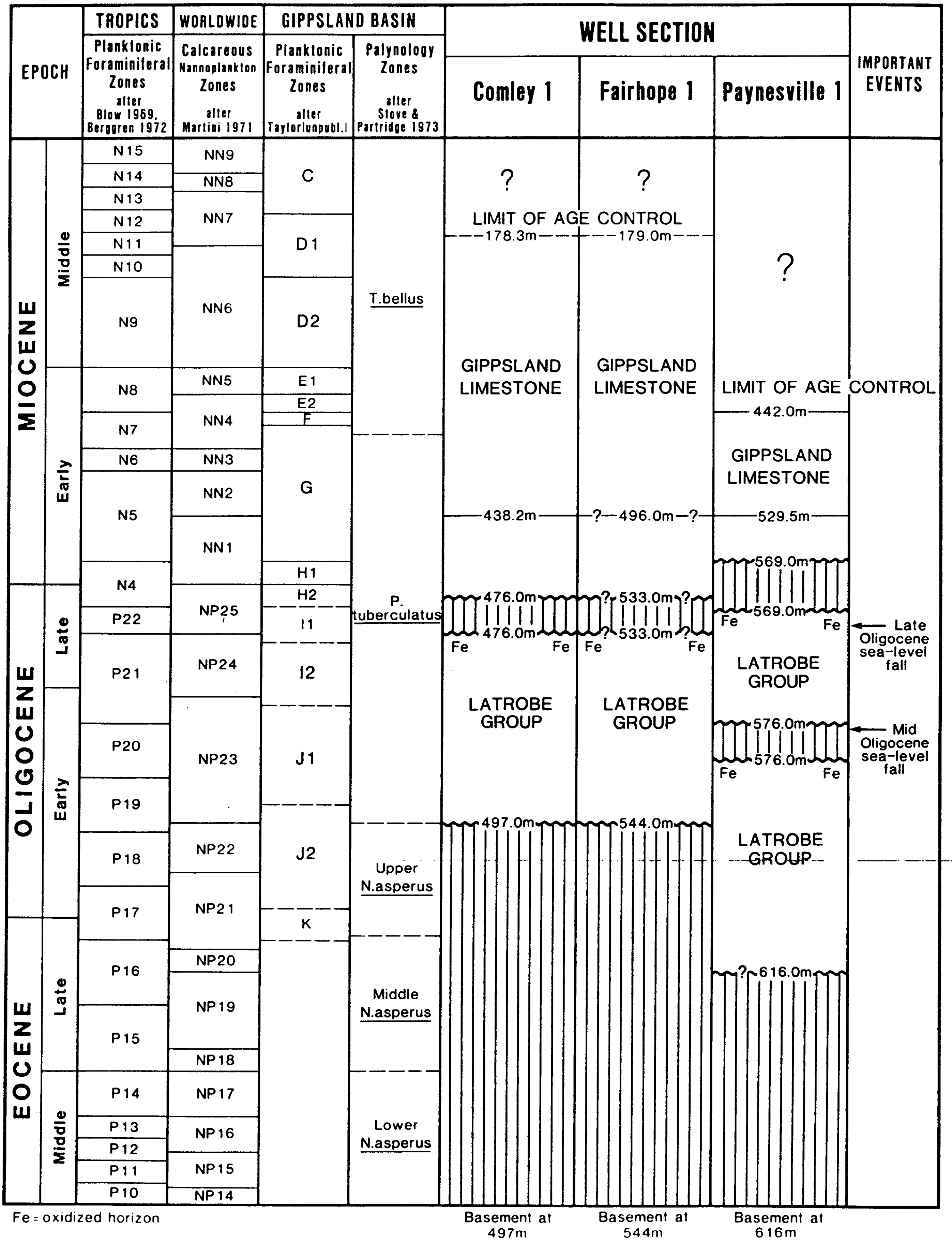

FIGURE 3

Spores and pollen recorded in Fairhope-1

KEY:

x present
c common
cf compared with

	533.6m	536.0m	538.5m	540.0m	541.5m
Alisporites varius		x		x	x
Araucariacites australis	x	x	x	x	x
Baculatisporites comaumensis	x	x			
Baculatisporites disconformis					x
Camarozonosporites bullatus					x
Camarozonosporites sherlockensis			x		
Cyathidites australis	x	x	x	x	x
Cyathidites minor	x	x	x	x	x
Cyathidites subtilis	x	x	x	x	x
Cycadopites follicularis	x				x
Dacrycarpites australiensis	x	x			x
Gleicheniidites circinidites				x	
Gleicheniidites senonicus	x		x	x	
Haloragacidites harrisii	x	x	x	x	x
Herkosporites elliottii		x	x	x	x
Laevigatosporites major	x	x		x	x
Laevigatosporites ovatus	x	x		x	x
Liliacidites bainii				x	
Lygistepollenites florinii	x	x	x	x	x
Malvacipollis subtilis			x	x	x
Microcachryidites antarcticus		x			
Myrtaceidites mesonesus				x	
Nothofagidites asperus	x	x	x	x	
Nothofagidites brachyspinulosus				x	x
Nothofagidites deminutus			x	x	
Nothofagidites emarcidus	x		x	x	x
Nothofagidites falcatus		x	x	x	x
Nothofagidites flemingii	x	x	x		
Nothofagidites goniatus				x	x
Nothofagidites heterus	x	x	x	x	x
Nothofagidites incrassatus	x	x		x	x
Nothofagidites vansteenisii	x		x	x	x
Osmundacidites wellmanii	x		x	x	
Parvisaccites catastus	x	x	x	x	x
Phyllocladidites verrucatus		x	x	x	x
Podocarpidites ellipticus	x	x	x		x
Podocarpidites microreticulatus	cf				
Propylipollis annularis					x
Propylipollis beddoesii			x		
Propylipollis latrobensis					cf
Proteacides recavus	cf		cf		
Proteacidites adenanthoides		x	cf		
Proteacidites granulatus		x		x	x
Proteacidites obscurus			x	x	x
Proteacidites pseudomoides		x			x
Proteacidites symphyonemoides			x		x
Proteacidites tuberculatus			x	cf	x
Retitriletes austroclavatidites	x	x			
Rhoipites sphaerica	x				x
Rugulatisporites mallatus	x				x
Rugulatisporites trophus				x	
Tricolporites leuros	x	x	x		
Triletes ornamentalis					x
Triletes tuberculiformis	x	x	x	x	x
Verrucosisporites cristatus	x		x		x

FIGURE 4

Dinoflagellates and acritarchs recorded in Fairhope-1

KEY:

x = present
c = common
cf = compared with

	533.6m	536.0m	538.5m	540.0m	541.5m
Alisocysta sp.		x	x		
Areosphaeridium polypetellum			cf		
Ascostomocystis granulatus	x				
Cyclonephelium-Glaphyrocysta complex	x				
Deflandrea spinulosa					x
Eatonicysta n.sp.		x	x		
Kallosphaeridium biarmatum	x				
Leiosphaeridia sp.		x	x		
Lejeunecysta paratenella					x
Lingulodinium funginum					x
Lingulodinium machaerophorum	x		x		x
Lingulodinium siculum			x	x	x
Millioudodinium sp.			x		x
Operculodinium bellulum	x	x	x	x	x
Operculodinium centrocarpum	x	x	x	x	x
Operculodinium israelianum	x	x	x		x
Operculodinium microtriainum		x	x		
Paucisphaerídium sp.			x		
Polysphaeridium subtile			x		x
Pterodinium cingulatum	x				
Selenopemphix armata		x	x		x
Selenopemphix nephroides		x			
Spiniferites membranaceous	x	x	x		
Spiniferites mirabilis	x	x	x		x
Spiniferites pachydermus		x	x		
Spiniferites ramosus gracilis	x	x	x		x
Spiniferites ramosus granomembranaceous	x				
Spiniferites ramosus multibrevis	x	x	x		x
Spiniferites ramosus ramosus	x	x	x	x	x
Spiniferites spp.	x	x		x	x

TABLE 1

Summary of the source rock and maturity data from Fairhope-1

TABLE 1A

DEPTH (m)	PALYNOLOGICAL ZONE	AGE	ENVIRONMENT OF DEPOSITION	OIL POTENTIAL	MATURITY
533.6	P. tuberculatus	Early Oligocene	Marine	Poor	Immature
536.0	P. tuberculatus	Early Oligocene	Marine	Poor	Immature
540.0	P. tuberculatus	Early Oligocene	Marine	Poor	Immature

TABLE 1B

DEPTH (m)	SAMPLE NO.	WEIGHT (g)	VOM (ml)	PRESER VÁTION (0-4)	% MICRO-PLANKTON	MICRO-PLANKTON DIVERSITY	SPORE-POLLEN DIVERSITY	PALYN YIELD (0-4)	CUT-ICLE (0-4)	HYL -OGEN (0-4)	MELAN -OGEN (0-4)	GRANULAR SAPROPEL (0-4)	AMORPHOUS SAPROPEL (0-4)
533.6	9	10	1.1	3	90	3	4	1	1	3	3	2	2
536.0	8	10	0.9	3	50	2	4	1	1	3	3	2	2
540.0	6	10	0.8	3	10	2	4	1	1	3	3	2	2

TABLE 1C

DEPTH (m)	VOM ml/10g	%SAPRO -PEL	%LIPT INITE	%FLUORESCENT LIPTINITES	VOL. FLUOR. LIPTINITES microlitres	OIL INDEX (0-4)	GAS INDEX (0-4)	SPORE COLOUR	UV LIPTINITE FLUORESCENCE COLOUR
533.6	1.10	85	5	2	22	1	2	Lt yell-Yell-Lt or	White - Yellow
536.0	0.90	85	2	1	9	1	2	Lt yell-Yell-Lt or	White - Yellow
540.0	0.80	90	2	1	8	1	2	Lt yell-Yell-Lt or	White - Yellow

APPENDIX NO.1.

Explanation of the source rock parameters recorded using palynological techniques.

INTRODUCTION

A rapid and reliable technique for estimating the abundances of the various kerogen components and relating these back to the source rock potential of the sediments has been developed.

Samples that are to be examined for palynology and source rock potential are processed using standard techniques that include acid digestion in cold HCl, cold HF and then boiling HCl. Any remaining mineral matter is removed by flotation of the organic material in a Zn2Br solution of SG 2.10. The heavy liquid is removed by washing and the volume of organic material (VOM, see below) recovered is measured in a 10ml conical centrifuge tube after spinning at 3000 rpm for 5 minutes. A measured proportion by volume of the organic residue (kerogen) is dried on a coverslip with PVA and is then mounted on to a microscope slide with a plastic resin (Elvacite or Eukit).

Counts of the various kerogen components are made on the kerogen slide using modified point-counting procedures and the results related back to the weight of rock processed. For example, a kerogen slide may represent the residue from 1/25g (0.04g) of the sediment. It has been measured that the field of view of the 20X objective on a Nikon microscope used by ECL is 1/4000 (1/4E3) of the total area of the kerogen slide. If, on average, there are 4 palynomorphs observed in each field of view when scanning the slide, then the number of palynomorphs estimated per gram of sediment is 4x25x4E3 = 4E5/g (400,000 per gram). This would be regarded as a good yield that could provide a significant contribution to the source rock potential of the sediment.

Each of the measured kerogen components usually show a wide size range that also must be taken into consideration during the counts. In an effort to reduce the subjective element of the estimates, the same microscope objective is used to count the same parameter where this is possible. It is not feasible to directly relate the measured number of particles of a particular kerogen component or their area to an estimated volume or mass for that component. However, an empirical relationship between the abundance estimates and source rock potential has been determined based on the examination of known source rock sequences. To facilate the display of the abundance data and discussion of these results, a simplified four point scale has been developed based on comparisons with source rocks from a wide variety of locations. For example, palynomorph abundances vary from less than 1000(1E3)/g in poor source rocks to more than 1000000(1E6)/g in very good source rocks.

GLOSSARY

1. PALYNOMORPH YIELD
   The estimated number of palynomorphs per gram of sediment expressed in terms of low (=1), moderate (=2), high (=3) and very high (=4) when compared with other source rocks (1=<1E3/g; 2=1E3-<3E4/g; 3=3E4-1E6/g; 4=>1E6/g; 20X Objective).

2. PRESERVATION
   Estimate of the general preservation level of the palynomorphs, recorded in terms of poor (=1), moderate or fair (=2), good (=3) and very good (=4).

3. SPORE-POLLEN AND MICROPLANKTON DIVERSITY
   The estimated number of different species in the sample expressed in terms of low (=1), moderate (=2), high (=3) and very high (=4) when compared with other source rocks (1=1-5; 2=6-15; 3=16-25; 4=>25).

4. PERCENT MICROPLANKTON
   The estimated proportion of dinoflagellates, acritarchs and other algal cysts expressed as a percentage when compared with the total palynomorph assemblage.

5. CUTICLE ABUNDANCE
   The estimated number of cuticle fragments (large and small) per gram of sediment expressed in terms of low (=1) to very high (=4) when compared with other source rocks (1=<1E2/g; 2=1E2-<3E3/g; 3=3E3-1E5/g; 4=>1E5/g; 10X Objective).

6. PERCENTAGE OF LIPTINITES
   The proportion of the unfiltered kerogen (as observed on a kerogen slide) that comprises palynomorphs (spores, pollen and algal cysts) and cuticle fragments is

estimated and expressed as a percentage of the total organic matter. Only the larger, properly identifiable liptinites can be included in this category. Finely degraded liptinites (less than 1 micron) are regarded as part of the sapropel group of macerals except when distinguishable by UV fluorescence.

7. PERCENTAGE OF FLUORESCENT LIPTINITES

The proportion of the unfiltered kerogen (as observed on a kerogen slide) that comprises fluorescing palynomorphs (spores, pollen and algal cysts) and fluorescing cuticle fragments is estimated and expressed as a percentage of the total organic matter. This includes the finely degraded liptinites that are regarded as Amorphous Sapropel (see below). Those liptinites that are unoxidised and able to auto-fluoresce are regarded as the most oil-prone fraction of the organic matter.

8. HYLOGEN ABUNDANCE

The estimated number of partially translucent woody or lignitic fragments per gram of sediment expressed in terms of low (=1) to very high (=4) when compared with other source rocks (1=<1E3/g; 2=1E3-<3E4/g; 3=3E4-1E6/g; 4=>1E6/g; 20X Objective). Broadly equivalent to vitrinite and previously referred to as fusain or fusinite.

9. MELANOGEN ABUNDANCE

The estimated number of opaque and angular woody fragments per gram of sediment expressed in terms of low (=1) to very high (=4) when compared with other source rocks (1=<1E3/g; 2=1E3-<3E4/g; 3=3E4-1E6/g; 4=>1E6/g; 20X Objective). Broadly equivalent to inertinite. As there is usually a gradation between melanogen and hylogen the two components can be difficult to distinguish,

10. GRANULAR SAPROPEL YIELD

The estimated number of clumps of granular sapropel per gram of sediment expressed in terms of low (=1) to very high (=4) when compared with other source rocks (1=<1E4/g; 2=1E4-<3E6/g; 3=3E6-1E7/g; 4=>1E7/g; 40X Objective). Granular sapropel is regarded as the very fine, fluffy, degraded and oxidised organic matter that shows no fluorescence and is usually a darker colour than the amorphous sapropel. The measurement of "clumps" of sapropel is highly subjective but provides a good order of magnitude estimate that is relatively consistent provided the sample processing is constant and the same objective is used.

11. AMORPHOUS SAPROPEL YIELD

The estimated number of clumps of amorphous sapropel per gram of sediment expressed in terms of low (=1) to very high (=4) when compared with other source rocks (1=<1E4/g; 2=1E4-<3E6/g; 3=3E6-1E7/g; 4=>1E7/g; 40X Objective). Amorphous sapropel is here regarded as weakly fluorescing, finely degraded liptinitic material. It appears to consist of fragments of palynomorphs eg. algae, and cuticles but may also include adsorbed hydrocarbons onto the organic debris, however, the particles are usually too small to be resolved by the microscope. The measurement of "clumps" of sapropel is highly subjective but provides a good order of magnitude estimate that is relatively consistent provided the sample processing is constant and the same objective is used.

12. PERCENTAGE OF SAPROPEL

The proportion of the unfiltered kerogen (as observed on a kerogen slide) that comprises sapropel, here regarded as very fine, (less than 1 micron) degraded organic matter is estimated and expressed as a percentage of the total organic matter. This includes both Granular and Amorphous Sapropel (see above).

13. SAPROPEL COLOUR

The overall colour of the dispersed organic matter and was the original parameter observed to estimate Thermal Alteration Index (TAI). Generally the most dominant colour is that of the granular sapropel which usually has a darker colour than the amorphous sapropel. Not usually recorded as it reflects both the environment of deposition and the maturation level.

14. SPORE COLOUR

The colour of the spore or pollen exines in transmitted white light. Variables that can affect the colour (apart from maturation) are the species type and exine thickness as well as any exposure to oxidising environments during and after deposition. The darkest colours of the least oxidised exines are taken as being the most significant. The change in colour from yellow to orange is regarded as indicating the onset of oil generation. Gas generation is suggested as becoming significant as the colours change to brown. Oil generation appears to cease as the spore colours approach dark brown and when they become black significant gas generation also probably ceases.

15. UV LIPTINITE FLUORESCENCE COLOUR

The dominant colour of the unoxidised liptinites (exines, cuticle and some amorphous sapropel) in reflected UV light observed with a Nikon EF-D UV330 380/4000M/420K filter combination and a 20x UV-Fluor objective. Liptinites that have been oxidised prior to deposition (mostly by recycling) show reduced intensities. The fluorescent colours observed are a complex mixture not comparable to normal colours as seen with white light. The hues range from light blue to white to light yellow with increasing maturity. The colours change to yellow at the beginning of the oil window (as here interpreted) and change to gold, dull yellow, orange and dull orange to dull red at the base of the oil window. The maturation level of sediments near the base of the oil window and deposited in an oxidising environment can be difficult to interpret.

16. VOLUME OF ORGANIC MATTER (VOM)

The measured volume of organic matter (VOM) left after removal of the mineral matter in the sample (see Introduction above) provides a rapid and reliable indication of the organic richness of the samples. From experience it has been found that the values of VOM when expressed as ml/10g approximate the %TOC determinations. Generally, <0.5 ml/10g is regarded as a poor (lean) source rock, 0.5-<2.5 ml/10g is moderate, 2.5-4.5 ml/10g is good (rich) and >4.5 ml/10g is very good (very rich). However, the abundance of unoxidised liptinites in the kerogen must also be considered in assessing the oil source rock potential of the sediments.

17. VOLUME OF FLUORESCENT LIPTINITES

The total amount of potential oil generating liptinites is calculated by multiplying the Volume of Organic Matter (VOM/10g) with the percentage of fluorescent liptinites observed in the sample (see above). The results are expressed as microlitres per gram. On an empiric basis, values greater than 200 are regarded as good source rocks.

18. OIL INDEX

An estimate of the overall abundance of liptinitic material in the kerogen expressed on a scale of 1-4 (being equivalent to poor, moderate, good and very good). This provides a broad indication of the potential of the sample to generate oil or condensate. The OIL INDEX is calculated by averaging the values for Palynomorph Abundance, Cuticle Abundance and Amorphous Sapropel Abundance (see above) and rounding the result to one digit.

19 GAS INDEX

An estimate of the overall abundance of that part of the organic matter in the kerogen that is regarded as being capable of generating gas if a high enough maturation level is reached. The estimate is expressed on a scale of 1-4 (being equivalent to poor, moderate, good and very good). The GAS INDEX is calculated by averaging the values for Palynomorph Abundance, Cuticle Abundance, Amorphous Sapropel Abundance, Granular Sapropel Abundance and Hylogen Abundance (see above) and rounding the result to one digit.

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