W931. NORMANBY-1.

# PALYNOLOGY OF BP NORMANBY-1,

# OTWAY BASIN, AUSTRALIA

BY

ROGER MORGAN

FOR BP AUSTRALIA

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# I SUMMARY


710m (cutts)-915m (cutts) : upper M. diversus Zone : Early Eocene : marginal marine to nearshore marine : immature

950m (cutts)-1115m (cutts) : middle M. diversus Zone : Early Eocene : non-marine to very marginal marine : immature

1150m (cutts)-1280m (cutts) : lower M. diversus Zone : Early Eocene : non-marine to very marginal marine : immature

L. balmei Zone (Paleocene) absent by hiatus

1285m (cutts)-1515m (cutts) : T. longus Zone (to possible part T. lillei Zone) (1285m, cutts, to 1320m, cutts, M. druggii Dinoflagellate Zone) : Maastrichtian : non-marine to very marginal marine : marginally mature

1550m (cutts)-1595m (cutts) : T. lillei Zone : Maastrichtian to Campanian : non-marine to very marginal marine : marginally mature

1630m (cutts) (1685.09m, swc)-1885m (cutts) (1720.59m, swc) : N. senectus Zone (1630m, cutts to 1845m, cutts (1720.59m, swc) X. australis Dinoflagellate Zone) : Campanian : marginal marine : marginally mature

1923m (swc)-2639.5m (swc) : T. pachyexinus Zone (2087.92m, swc, to 2417.51m, swc, I. cretaceum Dinoflagellate Zone) : Santonian-Coniacian : nearshore to marginal marine : marginally mature above 2300m, mature below.

2672.8m (swc)-2989.5m (swc) : C. triplex Zone : Turonian : nearshore marine to marginal marine : mature

3035m (swc)-3288m (swc) : A. distocarinatus Zone (2047m, swc, to 3197m, swc, P. infusorioides Dinoflagellate Zone) : Cenomanian : nearshore to marginal marine above 3200m, brackish beneath : mature

## II INTRODUCTION

One hundred and three samples are reported herein, comprising thirty cuttings samples in the top hole, above the available sidewall cores, sixty seven sidewall cores and a further six cuttings samples infilling sample gaps. During the later stages of drilling, several cuttings samples were examined to help in the T.D. decision. Of these, only the deepest has been included in this report, as it is deeper than the available sidewall cores. It, and the other downhole cuttings samples were subject to some downhole contamination, and since the sidewall core data now supercedes this earlier data, it has not been included.

Palynomorph occurrence data are shown in Appendix-1 and are the basis for the assignment of the samples to nine major units of Cenomanian to Early Eocene age, with a Paleocene hiatus.

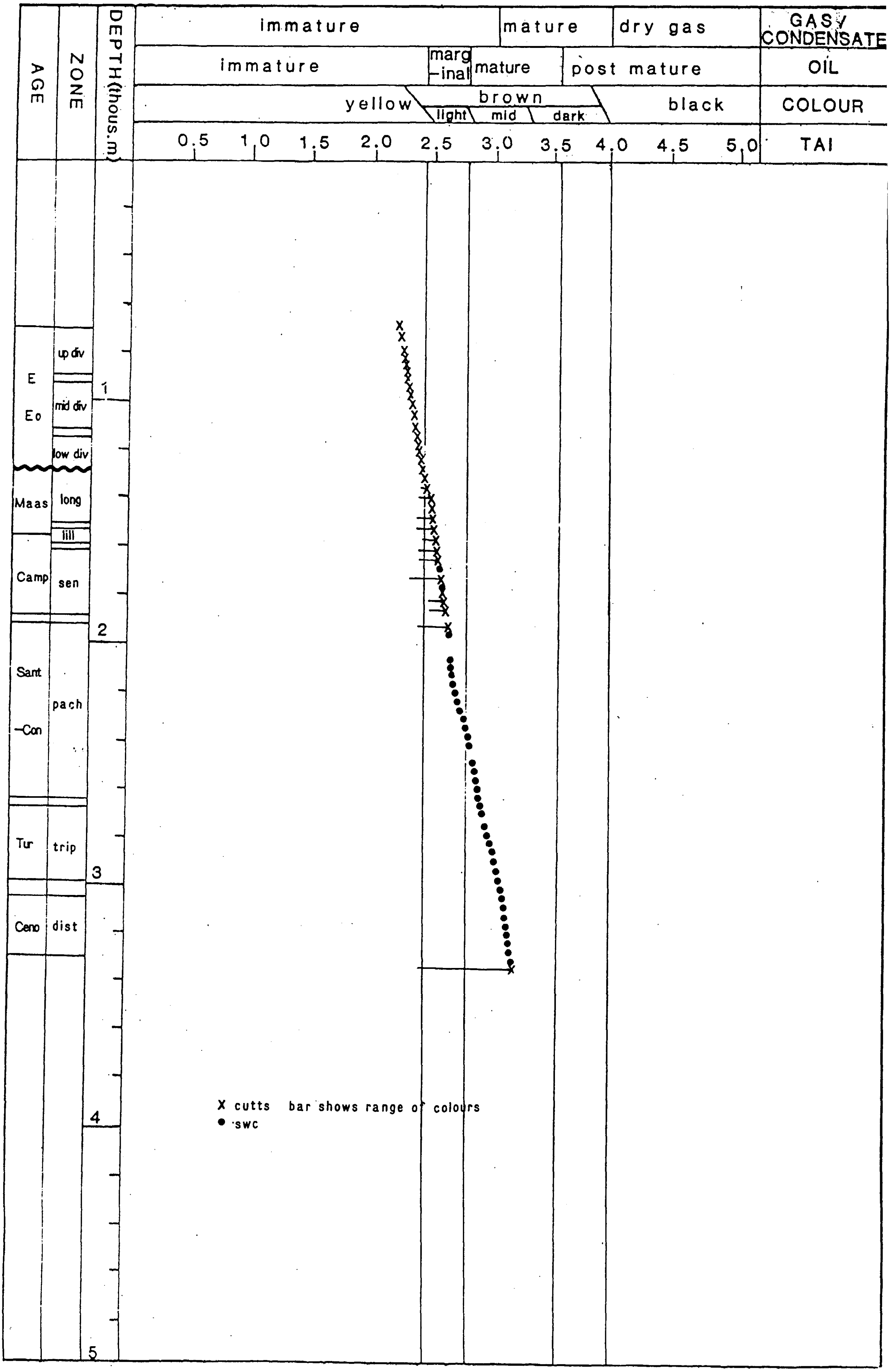
The Spore-Pollen zonation used in the Cretaceous is that most recently summarised and modified by Helby, Morgan and Partridge (in press) but drawing on extensive earlier work by Dettman and Playford (1969) and Stover and Evans (1973) and Stover and Partridge (1973). The Tertiary Spore-Pollen zonation is that of Stover and Evans (1973) and Stover and Partridge (1973) as modified by Partridge (1973).

The Cretaceous Dinoflagellate Zonation is also recently revised by Helby, Morgan and Partridge (in press), drawing on earlier work principally of Evans (1966). No formal dinoflagellate zonation has been published for the entire Lower Tertiary, although Harris (1985) has recently published some dinoflagellate zones for part of the Eocene of the St. Vincent and Otway Basins. Partridge (1976) published a table showing zone names in the

Gippsland Basin but charts defining these zones were never published. Very few Tertiary dinoflagellates were seen in Normanby-1, and the samples are not assigned to any of the published zones, although aspects of them are published herein.

Maturity data was generated in the form of T.A.I. (Thermal Alteration Index) and is plotted on Figure 1 - Maturity Profile, Normanby-1. The oil and gas windows on Figure 1 follow the general consensus of geochemical literature, but may differ from some individual company usage. The oil window corresponds to spore colours of light-mid brown (TAI of 2.7) to dark brown (3.6). This would correspond approximately to Vitrinite Reflectance of 0.6% to 1.3%. Geochemists, however, have not reached universal agreement on these values, and argue variations based on kerogen type, basin type and basin history. The maturity interpretations are thus open to reinterpretation, using the basic colour observations as raw data. However, the range of interpretation philosophies is not great, and would probably not move the oil window by more than several hundred metres.

FIGURE 1 MATURITY PROFILE, NORMANBY 1



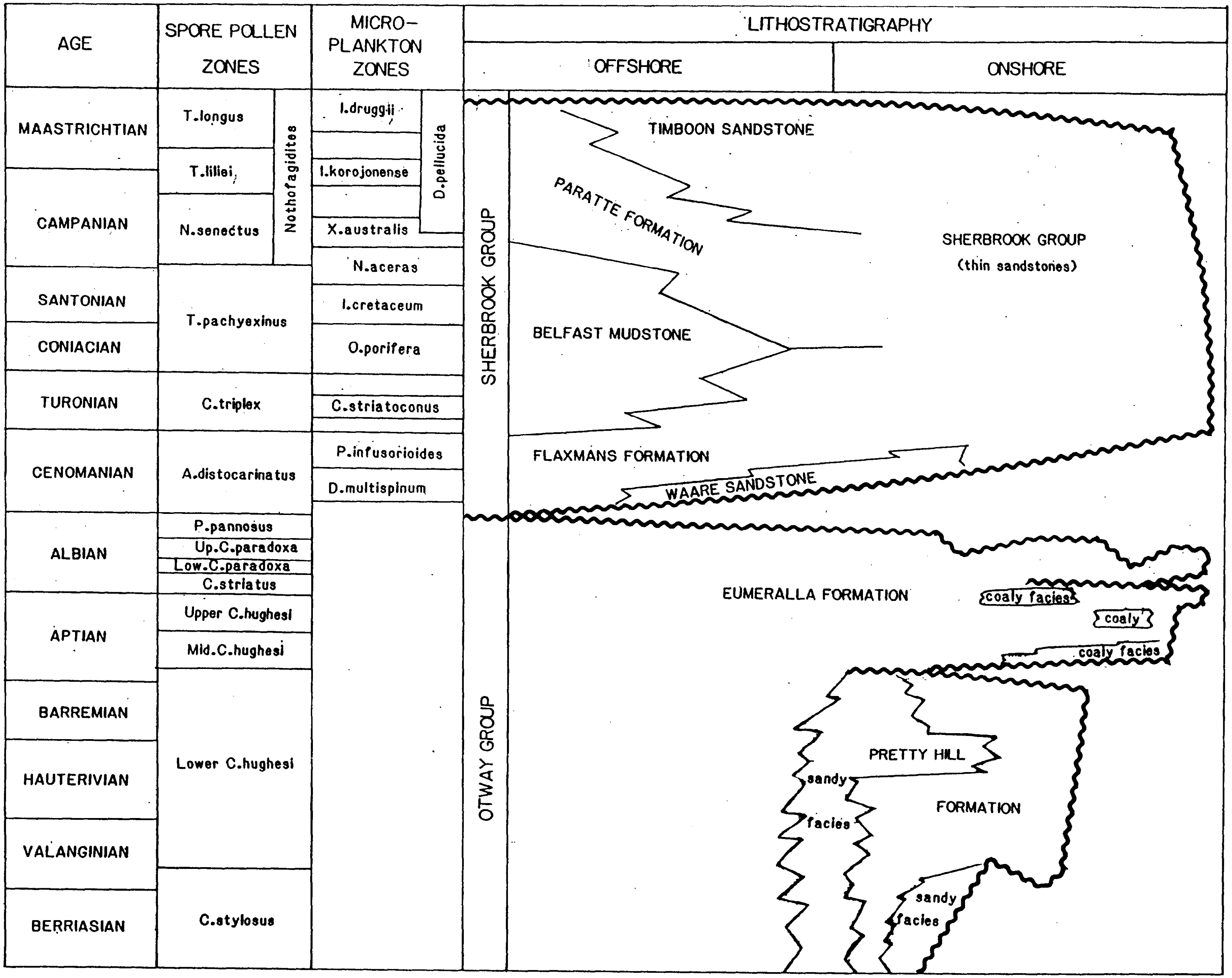



FIGURE 2 CRETACEOUS REGIONAL FRAMEWORK, OTWAY BASIN

## III PALYNOSTRATIGRAPHY

### A. 710m (cutts)-915m (cutts) : upper M. diversus Zone

This interval is assigned to the upper Malvacipollis diversus Zone at the top on the absence of younger indicators (most notably Proteacidites asperopolus) and at the base on the oldest occurrence of Proteacidites pachypolus considered to be "in place". The youngest occurrence of Myrtaceidites tenuis at 710-20m (cutts) confirms that the interval top can be no younger than the P. asperopolus Zone. As the interval base is picked on an oldest occurrence in cuttings, there is some uncertainty regarding its exact location. It could be slightly shallower if P. pachypolus is caved at 910-15m (cutts) or it could be slightly deeper if M. tenuis at 990-95m is in place (not caved as presumed herein). Greater precision is not possible in these cuttings.

Age diagnostic dinoflagellates were seen in several samples, but some are considered caved. The presence of Homotriblium tasmaniense throughout the interval 710-875m (all cutts) indicates assignment to the upper M. diversus or P. asperopolus Zones and so confirms the spore-pollen assignment. In the upper two samples (710-20m, 750-55m, both cutts) age diagnostic dinoflagellates include Systematophora placacantha, Deflandrea phosphoritica and Schematophora speciosa, all indicating younger Spore-Pollen Zones (Lower N. asperus or younger). These are incompatible with the other data, and so are presumed caved.

Marginal marine conditions at the base, deepening to nearshore marine conditions above, are indicated. The assemblages are very lean, cuticle rich, and dominated by spores and pollen. Below 790m, the dinoflagellates are known to be in place, are very scarce (absent from 910-15m) and of very low diversity. Marginal marine conditions are therefore indicated. Above 755m, dinoflagellates are of moderate diversity, comprise 10-20% of palynomorphs, but are at least partly caved. Nearshore marine environments are therefore indicated.

Yellow spore colours indicate immaturity for hydrocarbons.

B. 950m (cutts)-1115m (cutts) : middle M. diversus Zone

This interval is assigned to the middle Malvacipollis diversus Zone at the top on the youngest occurrence of Tricolpites gillii (and the oldest P. pachypolus, discussed above), and at the base on the oldest occurrences of Triporopollenites ambiguus and Proteacidites clarus considered to be in place. Other oldest occurrences supporting the assignment include Liliacidites lanceolatus, Proteaceacidites kopiensis and P. leightonii (1070-75m) and Bankseidites arcuatus and Proteacidites obesolabrus (1030-50m). Uncertainty concerning the zone top is discussed above, and some uncertainty exists concerning the zone base (as it is picked largely from oldest occurrences in cuttings). However, mid M. diversus and younger elements are much more scarce below this point. The presence of Cyathidites gigantis at 1030-50m (cutts) is considered reworked, although it would suggest the top of the lower M. diversus Zone, if in place. Minor downhole caving is clearly evident, including Proteacidites rugulatus at 950-55m and probably Myrtaceidites tenuis at 990-95m.

Age diagnostic dinoflagellates were not seen.

Non-marine environments at the base are succeeded by very marginal marine environments above. At the base (1070-1115m, cutts), cuticle is dominant, pollen is diverse and in place dinoflagellates are absent, indicating non-marine conditions. Above this (950-1050m, cutts) cuticle is common, pollen and spores are dominant and diverse, and dinoflagellates are very scarce and of very low diversity, indicating very marginal marine conditions.

Yellow spore colours indicate immaturity for hydrocarbon generation.

C. 1150m (cutts)-1280m (cutts) : lower M. diversus Zone

Assignment to the lower Malvacipollis diversus Zone is indicated the the top by the youngest occurrence in place of Cyathidites gigantis (the single shallower specimen is considered reworked), and the oldest occurrences "in place" of the species mentioned above. These species do occur beneath this point, but are much less frequent and are considered caved. The youngest occurrence of Australopollis obscurus also occurs near this point (at 1100-15m, cutts) and supports the boundary placement. There is thus some uncertainty regarding the placement of this boundary, but given the available cuttings samples, it cannot be located with more confidence. The interval base is defined by the absence of older indicators, and is supported by the presence of Cupaneidites orthoteichus and Malvacipollis diversus down to the base. These species, however, could be partly caved. Given the nature of the lower boundary, it is picked here with high confidence. Minor obvious caving and minor Permian reworking were seen in several samples.

Age diagnostic dinoflagellates were not seen.

Environments were probably non-marine to very marginal marine, Dinoflagellates were either absent (1150-55m) or extremely scarce. Those seen include some obviously reworked from the Cretaceous (Exochosphaeridium phragmites at 1200-05m), non-age diagnostic forms which might be in place or might be caved (most samples) and the probably freshwater lacustrine Morkallacysta pyramidalis (1250-55). In addition, the freshwater alga Botryococcus is seen in several samples. Large cuticle fragments are common and diverse pollen and spores are seen in most samples with Gleicheniidites, Proteacidites and Haloragacidites harrisii the most common forms.

Spore colours of yellow to yellow/light brown indicate immaturity for hydrocarbon generation.

D. L. balmei Zone not seen.

The Paleocene Lygistepollenites balmei Zone is easily recognised by the youngest occurrence of Gambierina rudata and Lygistepollenites balmei, with the latter species consistently present throughout the zone, but quite rare in older zones. L. balmei was not consistently seen in this well. The obvious conclusion is that the Paleocene L. balmei Zone is absent through hiatus in the sample gap 1280m to 1285m, although given the sandy lithologies, it could be slightly higher.

E. 1285m (cutts)-1515m (cutts) : T. longus Zone (to possibly part T. lillei Zone).

This interval is assigned to the Tricolpites longus Zone at the top on the youngest occurrences of Gambierina rudata and G. edwardsii in the absence of L. balmei (1285-95 ft, cutts), supported by youngest Triporopollenites sectilis (1300-05m), Tricolpites confessus and Tetracolporites verrucosus (1315-20m, cutts), Tricolpites waipawaensis (1390-95m) and Tricolporites lillei (1430-35m, cutts). The top is therefore picked with precision. The interval base is picked on the oldest occurrence of Tetracolporites verrucosus, supported by oldest Stereisporites (Tripunctisporis) punctatus. However, these are oldest occurrences in cuttings, and so may be picked too low through caving. If so, then the lowest part of this interval may belong to the T. lillei Zone but be unrecognized due to the cuttings nature of the available samples. Support for this possibility might be provided by the very thin section assigned to the T. lillei Zone, and the oldest T. sectilis at 1510-15m, cutts and youngest T. pachyexinus at 1550-55m (both usually intra T. lillei Zone events). Without sidewall cores, precision on this lower boundary cannot be improved. Minor Permian and Triassic reworking is intermittently seen through this interval.

Age diagnostic dinoflagellates include Manumiella coronata (1285m-1305m, both cutts) and Eisenackia crassitabulata (1315-20m, cutts), indicating assignment of that interval (1285-1320m) to the upper part of the Manumiella druggii Dinoflagellate Zone, correlative with the uppermost part of the T. longus Spore-Pollen Zone.

Environments are non-marine to very marginally marine. Dinoflagellates and acritarchs are always very scarce and of very low diversity, but are present in every sample. They may be entirely caved into some samples, however, as many are obviously caved (Impagidinium maculatum at 1390-95m, Eocladopyxis peniculata at 1325-30m) and some samples contain only longranging forms which may be caved. Pollen and spores, and occasionally large cuticle fragments, are dominant in all samples. Environments are obviously only barely marine if at all, except in the upper interval (1285-1320m), where convincing in place marginal marine dinoflagellate assemblages were seen.

Spore colours range from obviously caved yellow species, with the yellow/brown to light brown majority indicating marginal maturity for oil, but immaturity for gas/condensate.

F. 1550m (cutts)-1595m (cutts) : T. lillei Zone

This interval is assigned to the Tricolporites lillei Zone at the top on the absence of younger indicators. This boundary may be too low, as discussed above. The interval base is picked on the absence of older dinoflagellate indicators discussed below, and supported by the oldest T. lillei at 1550-55m. The lower boundary is thus considered to be firmly based. Minor Permian reworking was seen.

Age diagnostic dinoflagellates were not seen, other than to support a general Late Cretaceous age.

Environments are non-marine to very marginally marine with dinoflagellates extremely scarce, of very low diversity, and possibly all caved. Pollen, spores and cuticle are dominant.

Spore colours of light brown indicate marginal maturity for oil and immaturity for gas/condensate.

G. 1630m (cutts) (1685.09m, swc)-1885m (cutts) (1720.59m, swc) : N. senectus Zone

This interval is assigned at the top on dinoflagellate data, supported by the oldest occurrence of T. lillei, as discussed above. This boundary is considered reliable. Caving of younger Zone indicators is seen, within the interval including T. sectilis (1630-35m and 1760-65m), T. verrucosus (1685-90m and 1880-85m) and T. waipawaensis (1800-05m). The scarcity of these, and their absence from the sidewall cores, indicate their caved nature. The interval base is defined by the oldest Nothofagidites senectus, supported by N. endurus. This pick is probably slightly too low due to caving, as N. senectus, N. endurus and Tricolpites sabulosus (the latter normally restricted to the upper N. senectus to mid T. longus Zones) all occur consistently down into the basal cuttings sample, but are absent from the sidewall cores beneath. All three are present in the sidewall core at 1720.59m, and so the upper N. senectus Zone must extend at least down to that point, with the lower N. senectus Zone part or all of the interval 1760-1885m (entirely cuttings). Minor Permian and Triassic reworking occur in the interval.

Age diagnostic dinoflagellates are rarely present. The interval 1630m (cutts)-1845 m (cutts) (1720.7m, swc) contains Xenikoon australis and so is assigned to the X. australis Dinoflagellate Zone (correlative with the upper two thirds of the N. senectus Spore-Pollen Zone). The interval top is an extinction in cuttings and so is considered reliable. It is suported by youngest Nelsoniella aceras at 1685-90m (cutts). The interval base is an oldest occurrence in cuttings and so may be slightly caved, although it can be no shallower than the sidewall core at 1720.57m. The interval 1878.99 (swc)-1885m (cutts) beneath the X. australis Zone, lacks diagnostic dinoflagellates and is not assigned to any dinoflagellate zone. Trithyrodinium spp. occur consistently to the interval top but not beyond it, and may have biostratigraphic potential.

Environments are marginal marine. Dinoflagellates are consistently very rare (1-3%) and of very low diversity (1-5 species) or even absent (1670-75m, cutts). Large cuticle fragments are frequently dominant, with common and diverse pollen and spores.

Spores colours of light brown indicate marginal maturity for oil, and immaturity for gas/condensate.

H. 1923m (swc)-2639.5m (swc) : T. pachyexinus Zone

Assignment of this interval is indicated at the top by the absence of younger indicators, and this boundary could be slightly higher, as discussed above. The interval base is defined by the oldest occurrence of Tricolporites pachyexinus and is supported by the oldest occurrences of Camarozonosporites bullatus (2601.1m, swc) and Ornamentifera sentosa (2417.51m, swc). Within the interval, oldest Tricolpites gillii (2332.98m, swc), youngest Amosopollis cruciformis (2379.03m, swc) and oldest Tricolpites confessus (2417.5m, swc) all suggest subdivision of the interval into upper and lower subzones. The usual pick is oldest T. confessus, indicating an upper T. pachyexinus subzone at 1923m (swc) to 2417.5m (swc) and a lower T. pachyexinus subzone at 2476m (swc) to 2639.5m (swc). T. pachyexinus is consistently present in the upper subzone, but scarce and inconsistent in the lower subzone. The base of this interval is therefore less precise than the top. Amosopollis cruciformis is consistent to common in the lower subzone, and rare to absent above. Rare Permian reworking occurs intermittently throughout.

Age diagnostic dinoflagellates are intermittently present. An I. cretaceum Dinoflagellate Zone can be recognised at 2087.92m (swc) to 2417.51m (swc). The interval top is defined by youngest Isabelidinium belfastense, supported by youngest Amphidiadema denticulata (2147.64m, swc) and youngest Chatangiella victoriensis (2251.46m, swc). The interval base is defined by oldest Isabelidinium cretaceum. The I. cretaceum Dinoflagellate Zone is usually correlative with the middle part of the T. pachyexinus Spore-Pollen Zone. The intervals above and below the I. cretaceum Zone lack diagnostic taxa and cannot be assigned to any Dinoflagellate Zone. Trithyrodinium spp. do not occur below 2524.38m (swc) and may have biostratigraphic potential.

Nearshore to marginal marine environments are indicated. Dinoflagellates are always present, but are usually rare (1-2% of palynomorphs) and of very low diversity (1-3 species). Intermittently, however, dinoflagellates comprise 3-7% of palynomorphs with low to moderate diversity (5-7 species). Spores and pollen are always dominant, and cuticle can be quite common.

Spore colours above about 2300m are light brown, indicating marginal maturity for oil and immaturity for gas/condensate. Below 2300m, spore colours are light to mid brown, indicating maturity for oil and marginal maturity for gas/condensate.

I. 2372.8m (swc)-2989.5m (swc) : C. triplex Zone

The interval top is indicated by the lack of younger indicators discussed above, and the base is indicated by the oldest occurrence of Clavifera triplex, supported by oldest Phyllocladidites mawsonii and Cyatheacidites tectifera at 2935m (swc) and oldest consistent Australopollis obscurus at 2952m (swc). Appendicisporites distocarinatus occurs consistently up to 2952m (swc) and inconsistently up to 2601.06m (swc). Minor Cretaceous and Triassic reworking was inconsistently seen.

The dinoflagellates seen were not age diagnostic. Chatangiella has its oldest occurrence at 2918m (swc).

Nearshore marine to marginal marine environments are seen. Above about 2800m, dinoflagellates comprise 5 to 10% of palynomorphs, with moderate diversity (5-10 species). Below 2800m, dinoflagellate contents are less (1-3%) with low to moderate diversity (1-10 species). The deeper interval is considered to be marginal marine, and the shallower one nearshore marine.

Spore colours are light to mid brown above about 2800m, indicating early maturity for oil and marginal maturity for gas/condensate. Below 2800m, mid brown spore colours indicate maturity for oil, and early maturity for gas/condensate.

J. 3035m (swc)-3288m (swc) : A. distocarinatus Zone

Assignment is indicated at the top by the absence of younger indicators supported by dinoflagellate data, and at the base by the absence of older indicators, supported by the presence of consistent Appendicisporites distocarinatus throughout, and Amosopollis cruciformis down to 3098.5m (swc). Balmeisporites holodictyus has its youngest occurrence at 3220m (swc). Minor reworking from the Early Cretaceous, Triassic and Permian was intermittently seen.

Age diagnostic dinoflagellates suggest assignment of the interval 3047m (swc)-3197m (swc) to the P. infusorioides Dinoflagellate Zone (correlative with the upper A. distocarinatus Spore-Pollen Zone). The interval top is indicated by youngest Dinopterygium tuberculatum and consistent Cribroperidinium edwardsii, supported by youngest Microdinium ornatum at 3087m (swc). The interval base is marked by oldest C. edwardsii without older indicators. Cauca sp. has its youngest occurrence at 3176.5m (swc). The sample at 3200m is too lean for confident assignment, although the presence of Heterosphaeridium heteracanthum suggest that it belongs in the P. infusorioides Zone. The interval beneath (3217m, swc to 3288m, swc) lacks age diagnostic dinoflagellates. The deepest sample (3300m, cutts) contains dinoflagellates which are considered caved.

Environments are brackish in a lower interval (3217-3288m) deepening to alternating marginal marine and nearshore marine above (3035m, swc-3200m, swc). In the lower interval, all microplankton are very scarce (1% or less) and comprise an undescribed Cauca sp. and spiny acritarchs (Micrhystridium and Veryhachium) in most samples, with occassional very rare dinoflagellates. Only one sampple (3220 ft, swc) lacks any marine indicators. Freshwater lacustrine acritarchs (Pediastrum, Schizosporis) are rarely seen. Large cuticle fragments are intermittently common. In the upper interval, dinoflagellates are more common and diverse. Diversity is generally moderate (5-15 species) but can be as low as 3 or as high as 20. Dinoflagellate content is also highly variable, with half the samples having 1-2% dinoflagellates and half having 5-30% dinoflagellates with occasional contents to 50%. There is little overall trend, with marginal marine assemblages interbedded with nearshore marine ones. The highest dinoflagellate contents are at 3144m (swc)-3121.5m (swc).

Spore colours are mid brown, indicating full maturity for oil, and early maturity for gas/condensate.

## IV GEOLOGY

A. The palynological breakdown is entirely consistent with the logs and the regional geology.

1. The Waare Sandstone interval (3084-3300) contains most of the A. distocarinatus Zone. The topmost part (3084-3112m) contains few sands, and could be assigned to the Flaxmans Formation. Environmentally, there is a clear subdivision which occurs between the samples at 3200m and 3217m. This may coincide with base of the good sand at about 3207m.

   Above this, in the marginal marine to nearshore marine section, sands are more common, and thicker, and it includes the best blocky sands. In the more shaley section, there is a slight tendency to coarsening upwards. Beaches, submarine bars or even barriers are possible. The majority of the section is shale dominated, and more typical of the Flaxmans Formation elsewhere. However, at least the major sands between 3112 and 3143m must be assigned to the Waare Sandstone.

   Below 3207m, in the brackish section, sands are minor and thin (with the single exception at 3291-96m). Estuaries, back barrier lagoons and brackish lakes are likely environments, with the sands probably beaches and subaqueous bars and channels. The sequence is generally accepted as comprising a sequential transgression, with shoreline environments progressively inundated.

   Palynologically, the Otway Group has not been penetrated and there is thus some potential for further sand beneath the drilled section. Given the environments, however, the potential may be minor. Comparison with other wells which do penetrate the Otway Group, such as Lake Bonney-1 and Burrungule-1, show that the best sands may be towards the top of the Waare Sandstone interval.

2. The Belfast Formation interval (2400-3084m) spans the uppermost A. distocarinatus Zone, entire C. triplex Zone, and the lowermost T. pachyexinus Zone. Environments are generally nearshore marine, and sand-free. They are generally accepted as being nearshore prodelta shales.

3. The Paratte Formation interval (1485-2400m) spans most of the T. pachyexinus Zone, whole N. senectus and T. lillei Zones, and possibly the basal T. longus Zone. The mixed sandstone and shale lithologies show marked long coarsening upward cycles particularly near the base where shales are dominant. Towards the top, as sandstone becomes more common, this trend is less obvious, and the sands tend to be more blocky. Environments are marine throughout, but shallow from nearshore marine at the base, to very marginally marine/non-marine at the top. The older sands probably represent submarine bars passing upwards to beaches and estuarine to deltaic channel sands. The sequence is gennerally accepted as comprising a prograding delta front passing into delta top.

4. The Curdies Formation (= Timboon Sandstone) interval (1275-1485m) contains the T. longus Zone, and its top corresponds to the terminal Cretaceous hiatus. The thick blocky sandstones are typical of the formation which is generally accepted as representing stacked channels in a

delta top sequence. Some fining upward and some coarsening upward sequences are seen and may represent point bar and shoaling bars respectively. Palynologically, environments are non-marine to very marginally marine. The topmost interval (1275-1320m) which contains significantly more dinoflagellates, also corresponds to an interval of very high gamma response shale.

5. Following the Paleocene hiatus, the Dilwyn Formation interval (717.5-1275m) contains the Early Eocene lower, middle and upper M. diversus Zones. The Pember Mudstone Member at the base (1213-1275m) is either freshwater or very marginally marine, and a lacustrine (freshwater or brackish) environment seems likely. The rest of the Dilwyn Formation is shale dominated at the base, with generally thin and minor sands, and a tendency for coarsening upward into the major sands. Towards the top, sands are much thicker and more common, with a strong tendency to coarsen upward. Palynologically, environments are non-marine (to possibly very marginally marine at the base) passing upward into marginally marine and finally nearshore marine environments. The sequence may this represent subaqueous sandy bars, shoals and beaches moving through initialy muddy freshwater lakes, then estuarine to nearshore lagoons and brackish lakes and finally the nearshore marine shoreface.

6. Overlying these clastic sequences, further transgression produced progressively more marine deposition, and the establishment of the carbonate regime. No evidence exists for the presence of the P. asperopolus Zone even in cavings, and it may be that the Early Eocene upper M.

*diversus* Zone in the Dilwyn Formation is disconformably overlain by the late Middle Eocene lower *N. asperus* Zone in the Nirranda Group. In the absence of sidewall core control, this possibility cannot be tested.

## V CONCLUSIONS

1. Normanby-1 was a valid test of the primary objective, the Waare Sandstone, although the target was significantly low to prognosis. It demonstrated the presence of reservoir at this location.

2. It did not drill out of the Waare Sandstone, and therefore there is potential for further undrilled sand.

3. It did not penetrate the Otway Group, and therefore the secondary objective of Eumeralla Formation sands were not tested.

4. The section drilled was consistent with regional knowledge but has made a valuable contribution by providing good palaeontological and environmental control in the Waare Sandstone.

5. The drilled section penetrated 1000m of rocks mature for oil, but barely reached peak mature section. Only the basal 400m were mature for gas/condensate, and this section was only early mature.

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# APPENDIX I

## PALYNOMORPH DISTRIBUTION CHARTS

- SPORES AND POLLEN
- DINOFLAGELLATES

# NORMANBY #1 S/P

DESCRIPTION:

PALYNOLOGICAL INTERPRETATION OF DATA GENERATED BY BP AUSTRALIA - JULY 1986.
... ROGER MORGAN

CHECKLIST OF GRAPHIC ABUNDANCE BY LOWEST APPEARANCE

= Abundant
= Common
= Few
= Rare
= Very Rare

? = Questionably Present
. = Not Present

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# NORMANBY #1 DINOS

DESCRIPTION:

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ALL SAMPLE DEPTHS ARE IN METRES. ......ROGER MORGAN.

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