I.D. 0410B/0049B

APPENDIX 6.2

PALYNOLOGICAL ANALYSIS OF BASKER-1
(GIPPSLAND BASIN, PERMIT VIC/P19)

By
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1. SUMMARY

	Dinoflagellate Zones	Spore-Pollen Zones	Age
2125m	not younger than K.EDWARDSII	not younger than P.ASPEROPOLUS	not younger than Mid EOCENE
2155-2185m	A.HYPERACANTHUM	Lower M.DIVERSUS	Late PALEOCENE/ Early EOCENE
2198m	?A.HOMOMORPHUM	Upper L.BALMEI	Late PALEOCENE
2225-2452m	Upper T.EVITTII/ Lower E.CRASSITABULATA	-	Early/Mid PALEOCENE
2495m	T.EVITTII	-	Early PALEOCENE
2551-2570m	-	T.LONGUS	MAASTRICHTIAN
2667-2673m	I.DRUGGII	T.LONGUS	"
2679-3110m	-	T.LONGUS	"
3114-3216m	-	T.LONGUS/T.LILLIEI possibly T.LONGUS	MAASTRICHTIAN/ CAMPANIAN possibly MAASTRICHTIAN
3237-3936m	-	T.LILLIEI	CAMPANIAN

SPORE COLOUR/DEGREE OF ORGANIC MATURITY (D.O.M.)/SOURCE ROCK QUALITY

Transmitted (white) light: from pale yellow (2125m) to yellow or light brown (3936m)
Incident U.V. light: from light yellow to yellow/orange.
D.O.M. from immature at 2941m to early mature at T.D.

ENVIRONMENT OF DEPOSITION (Palynofacies)

2125-2185m	marine
2198m	shoreface, slight marine influences
2210m	lagoonal? (brackish/fresh water?)
2225-2673m	marine, near source/near shore
2876-3936m	non marine (swamp, lake or fluvial deposits)

2. INTRODUCTION AND METHODS

The interval examined palynologically ranged from 2125m down to 3936m (TD is at 3992m, bdf). A total of 8 core samples, 54 sidewall cores and 8 cuttings were selected on the basis of lithology. Grey to black, fine-grained sediments (mudstones, shales) are generally richer in palynomorphs than sediments such as silts and sands deposited in higher-energy environments. Where mudstones or shale samples were not available, siltstone samples were prepared. The quality of the sidewall cores was poor to fair.

Samples were prepared in Perth by Exploration Consultants Ltd (ECL) using the "standard" technique for siliclastic sediments, i.e. hydrochloric and hydrofluoric acid treatment followed by heavy-liquid separation to remove mineral matter; controlled oxidation with nitric acid to reduce unwanted organic constituents and thus concentrate the palynomorphs; and finally washing with sodium hydroxide to remove humic acids. The resulting acid - insoluble residue was mounted in Elvacite to produce permanent microscope preparations. A slide of the non-oxidised residue was used for palynomaceral studies.

All samples yielded an organic fraction and almost all were productive, although some were too poor to be of much value. Preservation deteriorated down section and influenced specific determination of some types. Diversity of assemblages varied but was generally average to poor only, particularly in the deeper part.

The palynomorphs were recorded semi-quantitatively. To provide continuity with the work of Harris, 1983, the stratigraphic interpretation of assemblages follows the zonal characteristics given in his "Biostratigraphic Summary" (Harris, undated). The range charts in this "Summary" are largely based on published and unpublished work of Stover and Evans (1974), Stover and Partridge (1973), Partridge (1975) and Partridge (1976).

Reworked palynomorphs were found in several samples but mostly as single occurrences only. Most were Permo-Triassic and Jurassic in age. It is not clear how to classify the regular occurrences of early and mid Cretaceous spores. Although found in younger sediments than their published ranges would indicate, they may in fact not be reworked.

Contamination from the mud was present in many samples. Although all samples were carefully cleaned before preparation, a fractured or broken-up sidewall sample cannot always be fully trusted as some contamination with palynomorphs from the mud is unavoidable.

3. ANALYSIS OF ZONES

A. DINOFLAGELLATE ZONES

2125m (1 SWS): not younger than K.EDWARDSII Zone (not younger than Middle Eocene)

Chorate dinoflagellate cysts, Deflandrea spp. and several other cysts are present in this sample but could not be determined specifically. Several specimens of A.homomorphum, which has its top in the K.EDWARDSII Zone indicate however that at 2125m the section is not younger than Middle Eocene. Pollen data support this (see later, under 3B).

2155-2185m (4 SWS): A.HYPERACANTHUM Zone (Late Paleocene to Early Eocene)

Based largely on the presence of Ceratiopsis dartmooria. Other cysts present include A.homomorphum, A.hyperacanthum and Deflandrea spp. (indet.).

2198m (1 SWS):

Single specimens of Senegalinium dilwynensis and A.homomorphum would suggest the presence of the A.HOMOMORHUM Zone at this level. Although pollen data do not contradict this, the evidence is considered too flimsy for a firm opinion.

2210m:

This sample contained a number of small, thin walled dinoflagellate cysts of uncertain affinity, together with common, featureless spherical bodies, thin walled, and perhaps referable to the genus Nummus. No age could be given to this curious assemblage (see Section 5).

2225-2452m (8 SWS): Upper T.EVITTII/Lower E.CRASSITABULATA Zones (Early to Middle PALEOCENE)

The assemblages are fairly diverse and contained, a.o., Eisenackia crassitabulata, E.circumtabulata, Senegalinium dilwynensis, Palaeocystodinium sp., Palaeoperidinium pyrophorum, Ceratiopsis speciosa, Deflandrea "paleocenica", Isabelidinium bakeri, Paralecaniella indentata, Glaphyrocysta retiintexta and a number of indet. cysts.

P.pyrophorum was present in the highest sample but sporadic. It only becomes common at 2430m. This "top common occurrence" may separate an E.CRASSITABULATA Zone (2225-2352m) from a T.EVITTII Zone (2430-2495m).

2495m (1 SWS): T.EVITTII Zone (Early Paleocene)

T.evittii is common in this sample but at the same time it is the only dinoflagellate present.

2515-2665m:

This interval contained rare, mostly fragmented dinoflagellate cysts only, possibly from mud contamination.

2667-2693m (1 SWS and 3 cuttings): I.DRUGGII Zone (Late Maastrichtian)

Both Isabelidinium druggii and Eurydinium conoratum were present at 2673m. Single specimens of I.druggii were found in the other samples. The only other dinoflagellate found was Palaeocystodinium sp., several specimens at 2673m.

2676-3936m:

No dinoflagellates found.

B. SPORE POLLEN ZONES

2125m (1 SWS): not younger than P.ASPEROPOLUS Zone (not younger than Middle Eocene)

The presence of Intratriporopollenites notabilis and Proteacidites grandis indicate an age not younger than Middle Eocene.

2155-2185m (4 SWS): Lower M.DIVERSUS Zone (Late Paleocene/Early Eocene)

Verrucosisporites kopukuensis delimits the base of this interval. The top of the Lower M.DIVERSUS Zone is determined by negative evidence and, although none of the overlying zonal markers were found, the top of the interval has been defined using dinoflagellates (see 3A.).

2198m (1 SWS): Upper L.BALMEI Zone (Late Paleocene)

On the common presence of Austrolopollis obscurus. Sparse dinoflagellate evidence seems to support the Late Paleocene age.

2225-2495m (10 SWS):

Pollen evidence for the Lower L.BALMEI Zone is very poor and the Early to Mid Paleocene age given to this interval is based on dinoflagellates.

2551-3110m (1 core, 15 SWS and 8 cuttings): T.LONGUS Zone (Maastrichtian)

Top of the interval has been defined by the highest occurrence of Q.brossus and P.palisadus at 2551m, and the presence of T.lilliei and T.sectilis at 2570m.

Down to 2697m pollen assemblages are relatively poor and not diverse. No suitable samples were available between 2697 and 2876m but from then on down the number of specimens was high in most samples although diversity remained low. G.rudata was common in most samples and Nothofagidites spp. correspondingly rare although occasionally this relation was reversed. G.edwardsi, T.longus, T.lilliei, T.sectilis, G.wahooensis, Stereisporites (Tripunctisporis) sp. and S.regium, T.verrucosus, L.amplus, and Proteacidites spp. (a.o. "wahooensis", "gemmatus", "reticuloconcavus", angulatus, palisadus and amolosexinus) were among the more noteworthy types present. Several specimens of "Grapnelispora evansii" occurred at 3089 and 3110m. Stover and Partridge (in press) consider this megaspore Maastrichtian in age, based on finds around Australia and New Zealand.

3114-3216m (7 core and 4 SWS): T.LONGUS/T.LILLIEI Zone, possibly T.LONGUS Zone (Maastrichtian/Campanian, possibly Maastrichtian)

The top of the T.LILLIEI Zone is based on negative evidence, i.e. by the base occurrence of markers for the overlying T.LONGUS Zone. Unhappily, the interval under discussion is rather poor in pollen so that the absence of specific markers may be more apparent than real. One positive feature of the T.LONGUS/T.LILLIEI zonal boundary is the marked reduction up section of Nothofagiditis spp. and the corresponding increase of Gambierina. In Basker-1 this occurs at 3237m and this has therefore been taken as the top of the T.LILLIEI Zone. Additional evidence that the interval 3114-3216m could still belong to the T.LONGUS Zone comes from a single specimen of P.angulatus at 3170m. Other species found: T.lilliei, T.longus, P."reticuloconcavus", N.endurus, L.balmei, L.amplus and several Proteacidites spp.

3237-3936m (13 SWS): T.LILLIEI Zone (Campanian)

Top based on the highest occurrence of common Nothofagidites spp. relative to Gambierina. The deepest samples still contain T.sectilis and T.confessus which would seem to indicate that the base of the T.LILLIEI Zone was not reached. The following species were present: G.rudata (uncommon), N.endurus, N.senectus, Nothofagidites spp., T.lilliei, T.sectilis, T.longus (?), T.confessus, L.balmei, G.wahooensis, P.amolosexinus, P.scaboratus and Proteacidites spp. (probably unnamed). T.sabulosus was present from 3630m down.

4. SPOROMORPH COLOUR, DEGREE OF ORGANIC METAMORPHISM (D.O.M.) AND SOURCE ROCK POTENTIAL

The colour of palynomorphs changes when subjected to the increasing or prolonged temperatures such as occur during burial. These changes in colour are irreversible and therefore indicate the maximum level of maturity reached. The different stages, yellow to golden-yellow through orange and brown to black can be correlated with changes in chemical composition as hydrocarbons are generated from the organic matter (see Fuchs, 1969; Standard Legend, 23.51.10). The sporomorph colour scale is more subjective than the more commonly used vitrinite reflectance scale. Ideally, a long-ranging sporomorph type should be selected as different types of sporomorphs within the same sedimentary section show variations in colour. As observed in transmitted white light the change in colour from light yellow to golden-yellow or orange corresponds with the onset of oil generation, whereas the onset of gas generation is associated with a change in colour from orange to brown. Post-mature source rocks contain black sporomorphs and organic fragments only.

In incident ultraviolet light palynomorphs (and some palynomacerals) exhibit fluorescence colours that ~~not~~ only help in their identification but also increase and decrease according to rank. Fluorescence is maximal at the threshold of the "oil window", decreases with increasing rank and disappears at the end of the "oil window" (1-1.3% Ro, see Robert, 1981).

In Basker-1 sporomorph-colour in transmitted light ranged from pale-yellow at 2125m to yellow and yellow-orange to lightest brown at 3936m. Over the same interval fluorescence colours of sporomorphs ranged from golden yellow to yellowish-orange. Both estimates see to indicate immature conditions at 2125m, changing into early mature towards 3936m.

Palynomaceral determination was carried out on a sieved, non-oxidised preparation. The sieving (with a 10 micrometer mesh sieve) was necessary to concentrate the large palynomacerals that otherwise would be diluted by fine, amorphous organic matter. This fine fraction is undoubtedly important for source rock characterisation but its nature and origin cannot be determined by ordinary means.

In Basker-1 the total organic content after sieving in the interval 2125-2430m contained 20-30% Inertinite (hydrogen-poor, no precursor of either oil or gas), 40-50% Vitrinite (relatively hydrogen-poor) and 20-30% Liptinite (spores, pollen, dinoflagellates, cutinite, alginite, all hydrogen-rich precursors of oil and gas); the interval 2452-2673m contained 60-80% Inertinite, 20-30% Vitrinite and 5-10% Liptinite; the interval 2876-3151m contained 10-20% Inertinite, 70-90% Vitrinite and 5-10% Liptinite; and finally the interval 3170-3936m contained 20-80% Inertinite, 20-70% Vitrinite and 1-5% Liptinite.

Although no accurate figures are available, a rough estimate during preparation showed that between 2125 and 2697m total organic matter varied from 0.1 to 0.4 millilitre per 10 grams of sample, and from 2876-3936m from 0.4-6.0 millimetre per 10 grams with the higher figures on either side of about 3100m.

Both in composition and in total amount of organic matter there seems to be clear differences between Volador-1 and Basker-1, the latter being apparently richer in Inertinite and less rich in organic matter per gram of sediment. Most likely, this reflects slight differences in environment of deposition between the two wells.

Source Rock Qualities

The amount and composition of the organic matter would suggest that the best source rocks occur below about 3000m with a rather uneven distribution below about 3200m.

5. ENVIRONMENT OF DEPOSITION/PALYNOFACIES

The relationship between organic matter and grainsize of the sediments has been well-documented and is used to deduce depositional environment (palynofacies) from the type of palynomorphs and palynomacerals present.

The palynomorphs can be divided into marine organisms such as dinoflagellates and Tasmanites (both algae) and foraminiferal test linings; fresh and brackish water organisms such as Botryococcus and Acritarchs; and land derived pollen and spores (Sporomorphs).

Breakdown products of plants (woody fragments, epidermal tissues, cork cells, resin), algal and bacterial remains, animal tissue and many indeterminate organic fragments are collectively known as palynomacerals.

Although wind transport is an important aspect of the initial dispersal of sporomorphs, water transport then carries the sporomorphs and palynomacerals until they settle out of the water column. A continuous process of mechanical abrasion, biological degradation and wave and current action sorts and grades the particles during this transportation phase. Less buoyant, heavy or larger organic particles tend to characterise environments close to source while lighter, more buoyant and smaller particles are carried further afield. Very low sporomorph diversity indicates authochthonous environments (marsh, swamps); allochthonous environments are characterised by more diverse assemblages. Marine microplankton diversity increases in an offshore direction (Whitaker, 1979).

In Basker-1 the interval 2125-2185m is clearly marine: dinoflagellates are present throughout although not abundant or diverse; the presence of sporomorphs and land derived organic matter suggests a near source, near shore environment. The sample at 2198m contained only a few dinoflagellates, common sporomorphs and rich Inertinite, and may represent a shore face environment. Thin bodied leiospheres and small, thin walled dinoflagellates together with land derived organic matter would suggest that the sample at 2210m is lagoonal (brackish water). Between 2225-2673m the environment is marine, with rich and rather diverse dinoflagellate assemblages down to 2495m although, again, the presence of sporomorphs and plant tissues suggest near shore; between 2557 and 2673m fewer dinoflagellates are present and only a few species per sample; Inertinite is common and a shore face environment most likely.

The interval 2876-3936m lacks marine indicators; most samples contain medium to sometimes very large plant tissues suggesting limited water transport. "Under the tree" conditions are evident in several samples, where one pollen species outnumbers all others, eg. at 2911m (dominance of T.sectilis), 2942m (G.wahooensis) and 3123m (Dacrydium sp.). This interval is also richer in total organic matter per gram of sediment and could represent a swamp environment. Many of the other sampled intervals, especially below about 3170m, show high percentages of Inertinite alternating with samples in which the Vitrinite component dominates. A corresponding alternation between a low energy swamp environment and low to medium energy fluvial or lacustine deposits is suggested.

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SPORES AND POLLEN

AGE			REGEO CODES			ZONES *	
T	OL	L	S9	S980		P. TUBERCULATUS	
T	OL / EO	U	S9	S970	S 9707	N. ASPERUS	U
T	EO	U	S9	S970	S 9705	N. ASPERUS	M
T	EO	M	S9	S970	S 9702	N. ASPERUS	L
T	EO	M	S9	S950		P. ASPEROPOLUS	
T	EO	L	S9	S 930	S 9307	M. DIVERSUS	U
T	EO	L	S9	S 930	S 9303	M. DIVERSUS	L
T	PC	U	S9	S 920	S 9207	L. BALMEI	U
T	PC	M / L	S9	S 920	S 9203	L. BALMEI	L
K	MA		S8	S890		T. LONGUS	
K	CA		S8	S880		T. LILLIEI	
K	SA		S8	S870		N. SENECTUS	
K	CO		S8	S865		T. PACHYEXINUS	
K	TR		S8	S860		C. TRIPLEX	
K	CE		S8	S850		A. DISTOCARINATUS	
K	AB		S8	S845		T. PANNOSUS	

DINOFLAGELLATES

REGEO CODE		ZONES *
M9		
M8	M890	OPERCULODINIUM spp.
M8	M880	P. "CORIOIDES"
M8	M870	V. EXTENSA
M8	M860	D. HETEROPHLYCTA
M8	M850	W. ECHINOSUTURATUM
M8	M840	K. EDWARDSII
M8	M830	W. "THOMPSONAE"
M8	M820	W. ORNATUM
M8		
M7	M790	D. WAIPAWAENSIS
M7	M780	A. HYPERACANTHUM
M7		
M7	M760	A. HOMOMORPHUM
M7		
M7	M740	E. CRASSITABULATA
M7		
M7	M720	T. EVITTII
M7		
M6	M690	I. DRUGGII

* AFTER HARRIS (UNDATED)

SHELL-AUSTRALIA E.& P. OIL AND GAS.

GIPPSLAND BASIN

BASKER - I

BIOSTRATIGRAPHIC SCHEME

Author: EXH / 8	Date: March 1984
Report No.: SDA 525	Drawing No.: 18773