PE990005

DISCOVERY BAY NO. 1 WELL

OTWAY BASIN

Palynological Examination and Kerogen Typing of Sidewall Cores

by

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PALYNOLOGICAL REPORT

Client : Phillips Australian Oil Company

Study : Discovery Bay No. 1 Well, Otway Basin

Aims : Determination of age and distribution of kerogen types

SUMMARY

Palynological analysis of seventy five sidewall cores from Discovery Bay No. 1 Well provide the basis for the following subdivisions:

Spore/pollen Zones

Nothofagidites asperus - 774-880m
Malvacipollis diversus - 885-1275.5m
Tricolporites lilliei - 1279.5-1838.5m
Nothofagidites senectus - 1846.5-2590m
Tricolpites pachyexinus - 2621.5-2776m

Dinoflagellate Zones

Spiniferites Assemblage - 774-786m
Apectodinium Assemblage - 891-1275.5m
Isabelidinium pellucidum - 1279.25-1719.5m
Xenikoon australis - 1749-2260m
Nelsoniella aceras - 2268.5-2738m
Isabelidinium cretaceum - 2753-2776m

A major hiatus is present between the Cretaceous and Tertiary sediments and another smaller break occurs in the early to middle Eocene.

Most of the sediments were deposited in near shore or marginal marine environments.

Kerogen analysis of the samples indicates immaturity for the entire section.

INTRODUCTION

Seventy five sidewall cores from Discovery Bay No. 1 Well drilled in the Otway Basin at Lat. 38°24'43"S, Long. 141°04'21"E in Vic. P-14 were processed by normal palynological procedures.

The basis for the biostratigraphy and consequent age determinations are based on Stover & Partridge (1973) and Partridge (1976) for the Tertiary sediments; and principally on Dettmann (1963), Dettmann & Playford (1969), with the modifications of Dettmann & Douglas (1976) and Burger (1973), for the Cretaceous sequence.

TABLE 1

DISCOVERY BAY NO. 1 WELL

SUMMARY OF PALYNOLOGICAL DATA

DEPTH	SWC NO.	PRESERVATION	DIVERSITY	SPORE POLLEN ZONE	DINOFLAGELLATES ZONE	CONFIDENCE LEVEL	ENVIRONMENT
774	41	good	low	N. asperus	Spiniferites	4	Nearshore marine
778	40	fair	low	N. asperus	Spiniferites	4	Nearshore marine
782	39	good	low	N. asperus	Spiniferites	4	Nearshore marine
786	38	good	low	N. asperus	Spiniferites	4	Nearshore marine
790	37	good	moderate	N. asperus	Spiniferites	5	Nearshore marine
854.5	26	good	moderate	N. asperus	indeterminate	5	Marginal marine
880	21	good	moderate	N. asperus	-	5	Non marine
855	20	good	moderate	M. diversus	? Apectodinium	5	Marginal marine
891	19	good	moderate	M. diversus	? Apectodinium	5	Marginal marine
906	18	good	moderate	M. diversus	? Apectodinium	5	Marginal marine
920	16	good	moderate	M. diversus	? Apectodinium	5	Marginal marine
928	15	good	moderate	M. diversus	? Apectodinium	5	Marginal marine
1013.5	13	good	moderate	M. diversus	? Apectodinium	5	Marginal marine
1026	11	good	moderate	M. diversus	? Apectodinium	5	Marginal marine
1123	9	good	moderate	M. diversus	Apectodinium	5	Marginal marine
1130	8	good	low	M. diversus	Apectodinium	4	Marginal marine
1135	7	good	moderate	M. diversus	-	5	Non marine
1150	6	good	moderate	M. diversus	-	5	Non marine
1160	5	good	moderate	M. diversus	Apectodinium	5	Marginal marine
1180	4	good	low	M. diversus	Apectodinium	4	Marginal marine
1190	3	good	moderate	M. diversus	Apectodinium	5	Marginal marine
1200	2	fair	moderate	M. diversus	Apectodinium	5	Marginal marine
1220	63	good	moderate	M. diversus	Apectodinium	5	Marginal marine
1230	62	good	moderate	M. diversus	Apectodinium	5	Marginal marine
1240	61	good	moderate	M. diversus	Apectodinium	5	Marginal marine
1270.5	60	good	moderate	M. diversus	Apectodinium	5	Marginal marine
1275.5	59	good	moderate	M. diversus	Apectodinium	5	Marginal marine
1279.5	38	fair	moderate	T. lilliei	I. pellucidum	5	Marginal marine
1297.5	55	good	moderate	T. lilliei	I. pellucidum	5	Marginal marine
1306.5	54	good	moderate	T. lilliei	I. pellucidum	5	Marginal marine
1344.5	52	good	moderate	T. lilliei	I. pellucidum	5	Marginal marine
1369.5	51	good	moderate	T. lilliei	I. pellucidum	5	Marginal marine
1400.5	50	good	moderate	T. lilliei	I. pellucidum	5	Marginal marine
1426.75	49	good	moderate	T. lilliei	I. pellucidum	5	Marginal marine
1525	47	good	moderate	T. lilliei	I. pellucidum	5	Marginal marine
1562	46	good	moderate	T. lilliei	I. pellucidum	5	Marginal marine
1594.5	45	good	moderate	T. lilliei	I. pellucidum	5	Marginal marine
1618	44	good	moderate	T. lilliei	I. pellucidum	5	Marginal marine
1687	42	good	moderate	T. lilliei	I. pellucidum	5	Marginal marine
1719.5	41	good	moderate	T. lilliei	I. pellucidum	5	Marginal marine
1749	40	good	moderate	T. lilliei	X. australis	5	Marginal marine
1796.75	39	fair	moderate	T. lilliei	X. australis	5	Marginal marine
1838.5	38	good	moderate	T. lilliei	-	5	Non-marine
1846.5	37	-	moderate	N. senectus	-	5	Non-marine
1908	36	fair	moderate	N. senectus	-	5	Non-marine
1974.5	35	-	moderate	N. senectus	X. australis	5	Marginal marine

TABLE 1 (cont)

DEPTH	SWC NO.	PRESERVATION	DIVERSITY	SPORE POLLEN ZONE	DINOFLAGELLATES ZONE	CONFIDENCE LEVEL	ENVIRONMENT
2095	33	fair	moderate	N. senectus	X. australis	5	Marginal marine
2164	31	fair	moderate	N. senectus	X. australis	5	Marginal marine
2235.5	28	fair	moderate	N. senectus	X. australis	5	Marginal marine
2260	27	fair	moderate	N. senectus	X. australis	5	Marginal marine
2268.5	26	fair	moderate	N. senectus	N. aceras	5	Marginal marine
2293	25	fair	moderate	N. senectus	N. aceras	5	Marginal marine
2345	23	fair	moderate	N. senectus	N. aceras	5	Marginal marine
2357	22	fair	moderate	N. senectus	N. aceras	5	Marginal marine
2381.5	21	fair	moderate	N. senectus	N. aceras	5	Marginal marine
2399	20	fair	moderate	N. senectus	N. aceras	5	Marginal marine
2418	19	fair	moderate	N. senectus	N. aceras	5	Marginal marine
2433	18	fair	moderate	N. senectus	N. aceras	5	Marginal marine
2485.5	17	poor	moderate	N. senectus	N. aceras	5	Marginal marine
2474.5	16	fair	moderate	N. senectus	N. aceras	5	Marginal marine
2489.5	15	fair	moderate	N. senectus	N. aceras	5	Marginal marine
2505	14	fair	moderate	N. senectus	N. aceras	5	Marginal marine
2534.75	13	fair	low	N. senectus	N. aceras	4	Marginal marine
2565	12	good	moderate	N. senectus	N. aceras	5	Marginal marine
2590	11	poor	moderate	N. senectus	N. aceras	5	Marginal marine
2621.5	9	poor	moderate	T. pachyexinus	N. aceras	5	Marginal marine
2633.5	8	poor	moderate	T. pachyexinus	N. aceras	5	Marginal marine
2649	7	good	moderate	T. pachyexinus	N. aceras	5	Marginal marine
2670	6	good	moderate	T. pachyexinus	N. aceras	5	Marginal marine
2702	5	poor	low	T. pachyexinus	N. aceras	4	Marginal marine
2738	4	poor	moderate	T. pachyexinus	N. aceras	5	Marginal marine
2753	3	poor	moderate	T. pachyexinus	I. cretaceum	5	Marginal marine
2772	2	good	moderate	T. pachyexinus	I. cretaceum	5	Marginal marine
2776	1	good	moderate	T. pachyexinus	I. cretaceum	5	Marginal marine

Confidence Levels:

1. cuttings sample, low diversity ± contaminants
2. cuttings sample, good assemblage
3. core or sidewall core, low diversity ± contaminants
4. core or sidewall core, low diversity
5. core of sidewall core, good assemblage

OBSERVATIONS AND INTERPRETATION

A. Biostratigraphy

Table I summarises the biostratigraphy and age determinations for the samples studied. Tables II to IV indicate the distribution of species identified in the Late Cretaceous and Tertiary sequences.

Preservation of the assemblages ranged from poor to good with a general improvement up sequence. All samples yielded identifiable microfossils and only few were of low diversity.

1. Late Cretaceous Spore/Pollen Zones

a. Tricolpites pachyexinus Zone: 2621.5 - 2776m

This zone is identified at T.D. by the presence of the nominate species, together with Proteacidites amolosexinus and P. scaboratus. Common species include Phimopollenites pannosus, Stereisporites viriosus and Amosopollis cruciformis.

All samples from this unit yielded marine dinoflagellates and their presence in low frequencies in a dominantly terrestrially derived assemblage indicates deposition in a marginal marine environment. The age of this zone is Coniacian to Santonian.

b. Nothofagidites senectus Zone: 1846.5 - 2590m

The initial appearance of N. senectus marks the base of this zone at 1846.5m. Stover & Partridge (1973) list several other species: viz. Gambierina rudata Tricolpites gillii and T. sabulosus in this zone in the Gippsland Basin. However in this sequence these species appear much higher in the sequence and are therefore not reliable indicators of the base of the zone. These authors also list P. amolosexinus as a species first appearing in this zone but as noted in 1(a) this species apparently occurs earlier in this Otway Basin section.

Marine dinoflagellates are persistent throughout this zone except at 1846.5 and 1908m. They indicate deposition in a marginal marine environment. The top two samples are essentially non-marine.

The age of the N. senectus Zone is largely Campanian.

c. Tricolporites lilliei Zone: 1279.5 - 1838.5m

In the Gippsland Basin the base of this zone is marked by the initial appearance of the following species:

Gephyrapollonites wahooensis
* Latroposporites amplus
* L. ohaiensis
Lygistepollenites balmei
Nothofagidites endurus
* Ornamentifera sentosa

Proteacidites palisadus
* P. scaboratus
* Tricolpites confessus
T. lilliei
Triporopollenites sectilis

The species marked * have a demonstrably longer range in this Otway Basin sequence and are therefore not reliable indicators of the base of this zone. Proteacidites palisadus has not been recognised in this section. In this well the first appearance of L. balmei and N. endurus is taken as the base of the zone. These species are then succeeded up section by G. wahooensis at 1719.5m, T. sectilis at 1618m, T. lilliei at 1562m.

The top sample in this zone contains a mixed Late Cretaceous and Early Tertiary assemblage but the latter are very rare. This can be explained by stratigraphic leakage at the unconformity surface at the top of the Late Cretaceous section. "Leaked" species are:

Haloragacidites harrisii
Nothofagidites flemingii
Sparganiaceaepollenites sp.
Herkosporites elliottii

Dinoflagellates throughout this zone, except in the bottom sample, indicate deposition in a marginal marine environment. The age of the zone is Maastrichtian.

2. Late Cretaceous Dinoflagellate Zones

The zonation adopted here is based on Evans (1966, 1971) and as adopted by Dettmann & Playford (1969).

a. Isabelidinium cretaceum Zone: 2753-2776m

This zone is defined by the first appearance of the nominate species and extends upwards to the first appearance of N. aceras. Other species which are prominent in this zone include Isabelidinium belfastensis, Hexagonifera vermiculata and Gillinia hymenophora. The age of this zone is Coniacian.

b. Nelsoniella aceras Zone: 2268.5-2738m

The base of this zone is defined by the first appearance of the nominate species and its top by the first appearance of Xenikoon australis.

However in this well there are two distinct zone where X. australis is present. The lowest is between 2663.5-2670m within the T. pachyexinus Zone and the younger assemblage begins at 2260m. Therefore, the top of the N. aceras zone as used in this report is taken at the base of the upper X. australis occurrence where it is associated with Nelsoniella tuberculata. Thus the N. aceras zone as used here includes some occurrences of X. australis. There appears to be nothing in the samples to indicate contamination and sidewall cores in this interval had very good recoveries.

The age of this zone is Campanian-Maastrichtian.

c. Xenikoon australis Zone: 1749-2260m

The definition of the base of this zone has been discussed in the foregoing section. Its top is marked by the first appearance of Isabelidinium pellucidum. Nelsoniella tuberculata and Spiniferites crassipellis are characteristic species in this zone.

d. Isabelidinium pellucidum Zone: 1279.25-1719.5m

The base of this zone is marked by the initial appearance of the nominate species. In the Otway Basin the top of the zone remains undefined. Species which may have stratigraphic significance towards the top of the zone include Alterbia cf. A. acuminata and A. acutula.

3. Early Tertiary Spore/pollen Zones

The zonal scheme adopted in this report is that used in the Gippsland Basin (Stover & Partridge 1973). An alternative scheme was proposed by Harris (1971) and a comparison of the two is presented in the following table.

TABLE VI

Comparison between Early Tertiary Spore/pollen Zones Gippsland and Otway Basins

GIPPSLAND BASIN	OTWAY BASIN
Upper Nothofagidites asperus	Sparganiaceaepollenites barungensis
Middle Nothofagidites asperus	Triorites magnificus
Lower Nothofagidites asperus	Proteacidites pachypolus
Proteacidites asperopolus	Proteacidites confragosus
Upper Malvacipollis diversus Lower Malvacipollis diversus	Cupanieidites orthoteichus
Lygistepollenites balmei	Gambierina edwardsii

a. Malvacipollis diversus Zone: 885 - 1275.5m

The base of this zone in this well is marked by the first appearance of the nominate species together with Cupanieidites orthoteichus, Dryptopollenites semilunatus and a diverse suite of Proteacidites spp. The present of D. semilunatus and Periporopollenite demarcatus would suggest that the Upper M. diversus Zone is represented. The assemblages contain a low diversity of dinoflagellates indicating deposition in a marginal marine environment. The age is Early Eocene.

b. Nothofagites asperus Zone: 774 - 880m

The base of this zone is placed at the first appearance of Nothofagidites falcatus and is succeeded in the next sample by N. asperus. The assemblages are not very diverse but are probably equivalent to the Middle N. asperus sub-zone. Dinoflagellates are prominent except in the lowest two samples and indicate deposition in a near-shore marine environment. The sequence is transgressive and is of Middle to Late Eocene age.

4. Early Tertiary Dinoflagellate Zones

There are no formal zonal schemes described from the Otway Basin and those proposed by Partridge (1976) for the Gippsland Basin are not readily identified on the data given in that paper. In addition there are problems of provincialism between the two regions. Thus two informal assemblages are recognised here.

a. Apectodinium Assemblage: 891 - 1275.5m

This assemblage is characterised by the presence of Apectodinium homomorphum, Deflandroea flounderensis, Kenleyia lophophora Deflandrea pachyceros and Muratodinium fimbriatum. Higher in the section Cassidium fragile and Rottnestia borusicca appear.

b. Spiniferites Assemblage: 774 - 786m

Species characteristic of this assemblage are Alisocysta ornata, Dyphes airiensis, Emmetrocysta urnaformis, Schemetophora speciosus, Systematophora placacantha and Deflandrea heterophlycta.

A higher subdivision of the assemblage is marked by the appearance of Dapsilidinium pseudocolligierum, Hystrichokopolma poculum and Pentadinium laticinctum. These species would suggest, in comparison with assemblages elsewhere in South Australia, that the age of these samples is latest Eocene.

TABLE II

DISCOVERY BAY NO. 1 WELL
DISTRIBUTION OF SPORES AND POLLEN

Spore/Pollen — Depth in metres	2776	2772	2753	2738	2702	2670	2649	2633.5	2621.5	2590	2565	2534.75	2505	2489.5	2474.5	2458.5	2433	2418	2399	2381.5	2357	2345	2293	2268.5	2260	2235.5	2164	2095	2047.5	1974.5	1908	1846.5	1838.5	1796.75	1749	1719.5	1687	1618	1594.5	1562	1525	1426.75	1400.5	1369.5	1344.5	1306.5	1297.25	1279.5
Appendicisporites distocarinatus	X																																														
Australopollis obscurus	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X				X				X											X
Baculatisporites comaumensis	X	X	X		X	X	X			X	X		X	X		X			X	X	X	X	X	X	X	X	X	X	X	X		X	X	X		X	X	X	X	X	X	X	X		X	X	X	
Latrobosporites amplus	X	X	X	X	X	X	X	X		X	X	X	X	X				X			X	X				X		X			X	X		X	X	X	X		X	X	X	X	X		X		X	X
Camerozonosporites sp.	X									X	X		X								X	X											X	X						X	X			X			X	X	
Ceratosporites equalis	X	X	X	X	X		X			X	X	X	X	X	X			X	X			X			X	X		X				X		X		X	X	X	X	X	X		X		X		X	
Cicatricosisporites australiensis	X	X		X			X				X	X	X	X					X	X	X													X	X	X	X	X	X						X					
Clavifera triplex	X	X	X	X		X	X	X		X	X	X	X	X				X	X	X	X	X	X		X	X	X	X				X		X		X	X	X				X	X		X	X	X	
Clevatipollenites hughesi cf.	X																																														
Cyathidites australis	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X
Leptolepidites major	X	X																																													
L. verrucatus	X				X															X			X	X																								
Lycopodiumsporites spp.	X	X	X		X	X	X				X		X	X	X				X		X	X	X	X	X	X			X	X	X			X		X	X	X	X	X	X	X	X		X		X	
Microcachryidites antarcticus	X	X	X	X	X	X	X	X		X	X	X		X	X	X	X	X		X	X	X	X	X	X	X	X		X	X			X			X		X	X	X	X	X	X				X	X
Myrtaceidites sp.	X		X																																													
Phimipollenites pannosus	X	X	X	X	X		X	X	X	X	X								X	X	X	X	X			X		X					X	X											X				X
Phyllocladidites mawsonii	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X			X	X	X		X		X
P. paleogenicus	X	X																																													
Podocarpidites sp.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X
Podosporites sp.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X
Proteacidites amolosexinus	X					X	X	X	X	X	X		X	X				X	X	X	X	X	X	X	X	X	X		X	X							X		X	X	X	X						X
P. scaboratus	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X			X	X		X	X	X				X		X
Tricolpites pachyexinus	X			X				X		X	X		X			X										X	X								X	X		X										
Balmeisporites holodictyus	X																																														
Amosopollis cruciformis		X	X				X		X				X	X				X																													
Callialasporites dampieri		X	X																																												
Dictyophyllidites sp.		X									X																																			
Falcisporites grandis		X	X	X			X			X					X							X		X		X			X	X	X		X	X	X		X	X			X	X			X		X
Gleicheniidites sp.		X	X	X	X	X	X	X	X	X	X			X		X		X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X		X	X											
Polypodiisporites sp.		X	X				X		X																																						
Stereisporites antiquasporites		X	X	X		X	X	X		X		X							X	X	X						X				X	X	X				X	X	X	X	X	X	X				X		X
S. varius		X			X	X	X				X	X	X	X			X	X	X	X	X	X	X		X	X	X					X		X		X						X						X
Tricolpites sp.		X				X													X							X								X	X														
Densosporites velatus			X																								X												X											
Vitreisporites pallidus			X										X																																	
Camerozonosporites bullatus				X						X																			X										X											
Cicatricosisporites cuneiformis				X								X																				X	X				X	X									
Corollina sp.				X		X							X	X	X																																		
Ischyosporites punctatus				X																									X																		X
Kraeuselisporites papillatus				X	X															X													X				X		X	X				X			X
Kuylisporites lunaris						X																																									
Lycopodiacidites asperatus						X																																									
Simplicepollis sp.						X																						X																		
Tricolpites gillii aff.						X			X	X									X	X								X	X			X		X	X	X		X		X	X				X		X	
Aequitriradites spinulosus							X	X																																							
Dictyotosporites complex							X																													X											
Klukisporites sp.							X																																								
Neoraistrickia truncata							X	X			X																																				

Depth in metres	2776	2772	2753	2738	2702	2670	2649	2633.5	2621.5	2590	2565	2534.75	2505	2489.5	2474.5	2458.5	2433	2418	2399	2381.5	2357	2345	2293	2268.5	2260	2235.5	2164	2095	2047.5	1974.5	1908	1846.5	1838.5	1796.75	1749	1719.5	1687	1618	1594.5	1562	1525	1426.75	1400.5	1369.5	1344.5	1306.5	1297.25	1279.5
Reticulatisporites pudens							X						X																																			
Velcsporites triquetrus							X																																									
Latrobosporites ohaiensis									X	X		X	X	X				X			X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X		X
Cicatricosisporites sp.										X													X																									
Contignisporites sp.										X																																						
Nothofagidites senectus										X	X			X													X	X	X	X	X	X	X	X	X	X	X	X										X
Triorites minor										X					X									X								X																
Crybelosporites striatus											X																																					
Laevigatosporites major											X	X																		X	X	X				X		X					X	X	X			X
Laevigatosporites ovatus													X		X		X		X	X		X			X									X			X											X
Ornamentifera sentosa													X						X				X			X								X	X	X												
aff. Ilexipollenites sp.													X	X	X		X	X	X		X																		X									
Ephedripites sp.														X																																		
Perotriletes jubatus														X																																		
Kraeuselisporites sp.															X				X																													
Proteacidites spp.						X										X				X	X		X	X	X		X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X
Pilosisporites sp.																			X																													
Cyathidites aff. splendens																				X			X			X				X		X		X										X		X		X
Tricolpites sp. aff. longus																					X	X												X		X	X	X		X	X		X		X	X	X	X
Lygistepollenites florinii												X		X								X				X	X					X	X	X		X	X	X	X	X	X		X		X			
Falcisporites similis																								X				X				X		X	X			X	X			X						
Tricolpites pachyexinus cf.																								X																								
Araucariacites australis																									X														X									
Lycopodiumsporites circolumenus																									X																							
Tricolpites sabulosus																									X	X	X	X	X	X	X	X	X	X	X		X			X	X							
Cingutriletes clavus																												X																				
Kraeuselisporites majus																												X	X			X		X	X													
Proteacidites parvus																												X							X				X				X		X	X	X	X
Tricolpites cf. confessus																													X		X			X	X	X	X	X		X	X	X	X					
Rouseisporites reticulatus																															X																	
aff. Balmeisporites sp.																																X																
Ericipites sp.																																X		X														
Proteacidites aff. similis																																	X							X	X							
Lygistepollenites balmei																																		X	X		X	X	X						X		X	X
Nothofagidites endurus																																		X	X	X	X	X	X	X	X	X		X	X	X	X	X
Matonisporites sp.																																			X													
Cyclosporites hughesi																																				X												
Gambierina rudata																																				X	X	X	X	X	X	X	X	X	X	X	X	X
Gephyrapollenites wahooensis																																				X	X										X	
Liliacidites sp.																																				X	X											
Triporopollenites spp.																																				X				X	X		X					
Gambierina edwardsii																																					X	X	X	X	X	X	X	X	X	X	X	X
Stereisporites regium																																					X	X										
Proteacidites aff. incurvatus																																					X											
Proteacidites cf. fromensis																																					X		X									
Ephedripites notensis																																						X										
Ilexpollenites anguloclavatus																																						X										
Latrobosporites crassus cf.																																						X					X					
Nothofagidites emarcidus																																						X					X		X	X	X	X
Phyllocladidites verrucosus																																						X										
Proteacidites kopiensis																																						X										
Proteacidites aff. leightonii																																						X										
Triporopollenites sectilis																																						X							X	X	X	X
Tricolpites leuros																																						X										
Gleicheniidites circinidites																																							X	X	X	X				X	X	X
Simplicepollis meridianus																																								X	X		X					X
Tricolpites lilliei																																								X								
aff. Beaupreaidites sp.																																																

Depth in metres	.76	72	2753	.738	702	2670	.649	633.5	2621.5	590	565	2534.75	2505	489.5	2474.5	2458.5	2433	2418	2399	2381.5	2357	2345	2293	2268.5	2260
Proteacidites cf. angulatus																									
Dilwynites granulatus																									
Proteacidites aff. reticuloscabratus																									
P. palisadus																									
Tricolpites reticulatus																									
Haloragacidites harrisii																									
Nothofagidites flemingii																									
Sparganiaceaepollenites sp.																									
Herkosporites elliottii																									
<u>Reworked Permian and other spores</u>																									
Granulatisporites trisinus	X												X												
Plicatipollenites sp.		X	X	X	X	X		X	X		X		X	X			X		X	X	X	X			
Horriditriletes ramosus						X																			
Limitisporites sp.							X																		
Protohaploxypinus limpidus							X																		
Apiculatisporis morbosis (Devonian)							X																		
Convolutispora sp.								X																	
Striatoabietes multistriatus								X																	
Verrucosisporites pseudoreticulatus										X															
Didecitriletes ericianus											X										X				
Protohaploxypinus sp.											X														
Verrucosisporites sp.																			X	X					
Punctatisporites sp.																			X						
Microbaculispora tentula																				X					
Microbaculispora sp.																						X			
Marsupipollenites triradiatus																									
Indotriradites sp.																									
Striate bisaccates indet.																									

Depth in metres	2235.5	2164	2095	2047.5	1974.5	1908	1846.5	1838.5	1796.75	1749	1719.5	1687	1618	1594.5	1562	1525	1426.75	1400.5	1369.5	1344.5	1306.5	1297.25	1279.5
Proteacidites cf. angulatus																							
Dilwynites granulatus																			X	X	X	X	
Proteacidites aff. reticuloscabratus																				X			X
P. palisadus																				X			
Tricolpites reticulatus																				X			
Haloragacidites harrisii																				X			X
Nothofagidites flemingii																							X
Sparganiaceaepollenites sp.																							X
Herkosporites elliottii																							X
																							X
<u>Reworked Permian and other spores</u>																							
Granulatisporites trisinus												X											
Plicatipollenites sp.	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X		X	X	X	X
Horriditriletes ramosus																							
Limitisporites sp.																							
Protohaploxypinus limpidus																							
Apiculatisporis morbosis (Devonian)																							
Convolutispora sp.																							
Striatoabietes multistriatus																							
Verrucosisporites pseudoreticulatus																	X			X			
Didecitriletes ericianus											X		X						X	X			
Protohaploxypinus sp.																							
Verrucosisporites sp.																							
Punctatisporites sp.																							
Microbaculispora tentula																							
Microbaculispora sp.																							
Marsupipollenites triradiatus				X																			
Indotriradites sp.									X														
Striate bisaccates indet.										X													
												X											

TA II

DISCOVERY BAY NO. 1 WELL
DISTRIBUTION OF CRETACEOUS DINOFLAGELLATE SPECIES

Depth in metres	2776	2772	2753	2738	2702	2670	2649	2633.5	2621.5	2590	2565	2534.75	2505	2489.5	2474.5	2458.5	2433	2418	2399	2381.5	2357	2345	2293	2268.5	2260	2235.5	2164	2095	2047.5	1974.5	1908	1846.5	1838.5	1796.75	1749	1719.5	1687	1618	1594.5	1562	1525	1426.75	1400.5	1369.5	1344.5	1306.5	1297.25	1279.5
Chatangiella aff. multispinosa	X																																															
Cleistosphaeridium sp.	X	X												X																				X														
Cyclopsiella sp.	X																																															
Gillinia hymenophora	X	X																																														
Heterosphaeridium heteracanthum	X	X	X		X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X																			?
Hexagonifera chlamydata	X	X																																														
H. glabra	X					X																																										
H. vermiculata	X		X		X	X	X	X																																								
Isabelidinium belfastensis	X	X	X																																													
I. cretacea	X	X	X			X	X	X		X																																						
Odontochitina porifera	X							X			X		X	X										X										X														
O. striatoperforata	X	X											X	X																																		
Spiniferites sp.	X																																															
Amphidiadema denticulata		X	X																																													
Chatangiella sp.		X					X																																									
Dinogymnium westralium		X																																														
Hystrichodinium sp.		X	X			X		X						X																																		
Odontochitina cribropoda		X																																														
Isabelidinium thomasii			X	X		X	X																																									
Pterospermopsis sp.			X																																													
Nelsoniella aceras				X		X		X	X	X	X	X	X	X	X	X	X	X										X		X																		
Xenikoon australis						X	X	X																	X	X	X	X	X	X																		X
Gonyaulacysta sp.							X															X																										
Oligosphaeridium sp.							X																																									
Trichodinium sp.							X													X																												
Spiniferites ramosus										X																											X	X										X
Dino. indet.												X	X						X																X	X	X	X					X	X				
Deflandrea sp. (indet).														X																																		?
Cribroperidinium cf. edwardsii														X																																		
Odontochitina sp. nov. - aff. O. perforata														X																																		
Chatangiella cf. C. tripartita														X																																		
Hystrichosphaeridium sp.															X														X											?	?							
Micrhystridium sp.																		X																														
Isabelidinium cf. korojonense																								X	X																							
Nelsoniella tuberculata																									X	X																						
Operculodinium sp.																											X	X		X																		
Spiniferites crassipellis																																		X														
Xenascus sp.																																		X														
Paralecaniella indentata																																				X	X								X			X
Isabelidinium pellucidum																																				X						X	X		X	X	X	X
Impletosphaeridium sp.																																					X	X		?	?	X	?			X		
Florentinia sp.																																								?	?							
Isabelidinium sp.																																								X	X							
Oligosphaeridium sp.																																										X						
Spinidinium sp.																																										?			X			
Isabelidinium sp. aff. cretacea																																															X	
Valensiella sp.																																															?	
Impagidinium sp.																																															X	
Alterbia acutula																																															X	X
Alterbia acuminata cf.																																																X
Spinidinium aff. macmurdoense																																																

TABLE IV

DISCOVERY BAY NO. 1 WELL
DISTRIBUTION OF EARLY TERTIARY SPORES POLLEN AND DINOFLAGELLATES

Depth in metres	1275.5	1270.5	1240	1220	1200	1190	1180	1160	1150	1135	1130	1123	1026	1013.5	928	920	906	891	885	880	854.5	786	782	778	774
Baculatisporites comaumensis	X						X					X						X							
Cupanieidites orthoteichus	X	X	X		X	X	X	X			X	X	X	X	X		X	X	X		X				
Cyathidites australis	X	X	X	X										X	X	X	X			X					
Dilwynites granulatus	X	X	X	X	X	X	X	X	X	X	X	X								X					
Dryptopollenites semilunatus	X							X	X		X								X						
Haloragacidites harrisii	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X
Lygistepollenites florinii	X	X	X	X	X	X	X		X	X	X	X		X	X	X	X		X						
Laevigatosporites ovatus	X											X													
Malvacipollis diversus	X	X	X	X	X	X		X	X	X	X		X	X	X	X	X		X	X					
Myrtaceidites parvus/mesonesus	X				X	X		X	X		X	X		X	X	X		X	X						X
Nothofagidites brachyspinulosus	X	X	X	X	X	X	X	X	X	X	X		X		X	X		X	X	X	X	X		X	
Parvisaccites catastus	X															X									
Periporopollenites polyoratus	X	X	X			X												X	X						
Podosporites sp.	X	X	X	X	X	X	X	X	X		X	X	X	X				X	X		X				
Peromonolites densus	X											X													
Phyllocladidites mawsonii	X														X	X							X		
Podocarpidites spp.	X	X	X		X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X			X	X
Polycolpites esobalteus	X				X	X							X						X		X				
Polypodiidites sp.	X	X		X																					
Proteacidites incurvatus	X				X	X		X											X						
P. leightonii	X	X	X		X	X		X				X						X		X	X				
P. ornatus	X																								
P. reticuloscabratus	X										X	X	X	X	X	X									
P. tuberculiformis	X	X																							
Stereisporites (Tripunctisporis) punctatus	X	X																							
Tricolporites scabratus	X				X	X		X	X		X	X		X											
T. microreticulatus	X		X		X	X		X																	
Araucariacites australis		X	X	X	X	X	X	X									X	X							
Alisporites similis		X																							
Clavifera triplex		X			X	X		X			X								X						
Cyathidites splendens		X																							
Microcachyridites antarcticus		X	X		X	X	X			X	X	X	X					X	X	X	X				
Proteacidites kopiensis		X	X		X	X			X			X	X	X			X	X	X		X				
P. spp.		X																		X					
Rugulatisporites mallatus		X	X									X	X												
Sapotaceoidaepollenites rotundus		X																							
Simplicepollis meridianus		X	X		X	X	X	X	X		X	X			X	X		X	X		X		X		
Tricolporites leuros		X																							
Triporopollenites gemmatus		X			X	X																			
Verrucosisporites kopukuensis		X																							
Ischyosporites gremius			X					X								X									
Myrtaceidites tenuis					X	X			X		X	X	X	X	X	X	X	X	X		X				
Proteacidites annularis			X		X	X			X	X	X	X	X						X	X	X			X	
P. crassus			X		X	X	X	X			X	X	X							X					
P. parvus			X	X							X	X											X		
Tricolpites phillipsii			X		X	X		X				X							X		X				
Tricolporites spp.			X																						

Depth in metres	1275.5	1270.5	1240	1220	1200	1190	1180	1160	1150	1135	1130	1123	1026	1013.5	928	920	906	891	885	880	854.5	786	782	778	774
T. paenestriatus			X				X	X										X							
Dacrycarpites australiensis				X																			X		
Cyathidites splendens cf.					X	X																			
Elphedripites notensis					X	X			X		X	X							X						
Ericipites crassiexinus					X	X																			
Ilexpollenites anguloclavatus					X	X	X	X	X		X		X	X											
Krauselisporites papillatus					X	X																			
Nothofagidites emaridus/heterus					X	X		X	X		X	X	X				X	X	X	X	X	X		X	
N. flemingii					X	X			X		X	X	X						X		X				
Periporopollenites demarcatus					X	X		X			X	X	X	X			X	X	X		X				
P. vesicus					X	X		X				X	X	X											
Proteacidites concretus					X		X				X		X												
P. latrobensis					X	X	X		X		X	X	X	X											
Tricolporites adelaidensis					X	X		X			X	X		X					X		X				
Beaupreaidites elegansiformis cf.						X																			
Proteacidites grandis						X																			
Falcisporites grandis							X																		
Gleicheniidites circinidites							X							X	X	X									
Anisotricolporites triplaxis								X																	
Camerozonosporites sp.								X					X												
Disulcites sp.								X																	
Intratriporopollenites notabilis								X							X	X	X				X				
I. sp. nov.								X																	
Margocolporites sp.								X				X													
Periporopollenites magnus								X					X												
Proteacidites fromensis								X					X					X							
P. obscurus														X											
Stereisporites antiquasporites								X						X											
Tricolporites prolata								X																	
T. sphaerica								X	X		X				X	X				X					
Anacolosidites luteoides											X	X													
Australopollis obscurus											X	X													
Diporate sp. nov.											X														
Gothanipollis bassensis											X														
Polypodiidites speciosus							X				X														
Proteacidites cf. rhynthius											X														
Helciporites astrus												X									X				
Herkosporites elliottii												X													
Ovoidites sp.												X													
Proteacidites tenuiexinus												X	X	X		X									
Tricolporites (sp. nov., striate)												X													
Crassiretitriletes vanraadshoovenii													X												
Polypodiaceoisporites varus													X												
P. pachypolus													X			X		X			X				
P. recavus													X												
Tricolporites geranoides													X						X						
Proteacidites tripartitus														X											
Laevigatosporites major																	X								
Proteacidites pseudomoides																		X	X	X	X				
Banksieaeidites arcuatus																			X						
Falcisporites sp.																			X						
Milfordia hypolaenoides																			X						
cf. Oenothera sp.																			X						
Peromonolites vellosus																			X						
Tricolpites incisus																			X						
T. angurium																			X	X	X				

Depth in metres	1275.5	1270.5	1240	1220	1200	1190	1180	1160	1150	1135	1130	1123	1026	1013.5	928	920	906	891	885	880	854.5	786	782	778	774
Triporopollenites delicatus																			X						
Nothofagidites falcatus																				X	X				X
Clavatipollenites sp.																					X				
Nothofagidites asperus																					X				X
Proteacidites angulatus																					X				
Tricolporites valvatus																					X				
Triporopollenites scabratus																					X				
Nothofagidites deminutus																						X			
<u>Dinoflagellates</u>																									
Apectodinium homomorphum	X	X				X	X				X	X													
Deflandrea flounderensis	X																								
Kenleyia lophophora	X															X									
Muratodinium fimbriatum	X																								
Operculodinium centrocarpum	X										X											X	X	X	X
Spiniferites ramosus	X					X	X	X			X											X	X	X	X
Thalassiphora pelagica	X	X																				X		X	
Deflandrea truncata aff.		X																							
Spiniferites sp.		X																							
Deflandrea pachyceros			X			X		X																	
Spinidinium essoi			X																						
Lingulodinium machaerophorum			X		X			X																	
Dyphes colligerum						X																			
Achomosphaera ramulifera						X	X	X														X	X		
Impletosphaeridium sp.						X		?																	
Deflandrea dilwynensis							X																		
Cordosphaeridium fibrospinosum							X																		
Rottnestia borussica							X																		
Deflandrea obliquipes								X											X						
Cleistosphaeridium sp.												X													
Cassidium fragile													X												
aff. Microdinium sp.														X											
Areosphaeridium sp.																X						X			
Hystrichokolpoma rigaudae																		X				X	X	X	
Acritarch indet.	X	X																			X				
Alisocysta ornatum																						X	X	X	
Dyphes airiensis																						X			X
Emmetrocysta urnaformis																						X	X	X	
Schematophora speciosus																						X			
Systematophora placacantha																						X	X	X	X
Deflandrea heterophlycta																						X		X	
D. leptodermata																						X			
D. phosphoritica																						X	X	X	
Phthanoperidinium comatum																						X	X	X	
Achomosphaera crassipellis																						X	X		
Impagidinium cingulatum																						X	X	X	
I. victorianum																						X			
Tectatodinium sp.																						X	X	X	
Dapsilidinium pseudocolligerum																							X		
Hystrichokolpoma poculum																							X		
Pentadinium laticinctum																							X		
Spiniferites pseudofurcatus																							X		
Cordosphaeridium inodes																								X	
Impagidinium sp.																									X

DISCUSSION

Late Cretaceous sediments in Discovery Bay No. 1 well are essentially complete from the T. pachyexinus zone through to the T. lilliei and were deposited mostly in a marginal marine environment. They correlate with the Paaratte Formation. The top of the Cretaceous is marked by an obvious unconformity with reworking and stratigraphic leakage of microfossils. Neither the Tricolpites longus nor the Paleocene Lygistepollenites balmei zones are present. The interval of uncertainty is less than 4 metres (1275.5 - 1279.5m) and strongly argues for the unconformity.

The Early Tertiary sequence represented by the marginal marine M. diversus zone correlates with the onshore Dilwyn Formation at about the level of the Princetown Member.

No Proteacidites asperopolus zone was recognised and the interval of uncertainty is less than 5m (880 - 885m). Therefore another signifant break is present in this section.

The N. asperus zone sediments are transgressive and are correlated with the Nirranda Sub-Group - Mepunga Formation and Narrawaturk Marl.

B. Kerogen Types and Spore Colouration

During routine palynological processing of sidewall cores an unoxidised kerogen sample was taken and the nature of the kerogens and spore colouration are documented in Table VII. Spore colour is expressed as the "Thermal Alteration Index" (TAI) of Staplin (1969) according to the scale in Table VI.

Total organic matter (TOM) is expressed semi-quantitatively in the scale-abundant, moderate, low, very low, barren. Samples classed as having abundant or moderate amounts of TOM would be expected to have TOC's (total organic content) greater than 1%.

In this report four classes of organic matter are recognised - amorphogen, phrogen, hylogen and melanogen and these terms are more or less synonymous with amorphous, herbaceous, woody, and coaly. For reasons as outlined by Bujak et al. (1977) the former terms are preferred because they do not have a botanical connotation. The thermal alteration index scale follows that of Staplin (1969) and as outlined by Bujak et al. (1977). At a TAI of 2+ all four types of organic material contributed to hydrocarbon generation whereas at a TAI of 2, only amorphogen forms liquid hydrocarbons. The upper boundary defining the oil window is at a TAI of approximately 3 but varies according to the organic type. Above TAI 3+ all organic types only have a potential for thermally derived methane.

Spore colouration in Discovery Bay No. 1 well ranges from values of 1 to 2 at T.D. The Tertiary sequence shows very little evidence of alteration and below the Tertiary - Cretaceous unconformity there is a very gradual increase in maturity. However all values indicate that the entire section is immature for the generation of hydrocarbons.

MATURATION LEVELS, Bujak et al. 1977

CATEGORIES	ORGANIC COMPONENTS		OIL	GAS CONDENSATE	THERMALLY DERIVED METHANE
			TAI	TAI	TAI
HYLOGEN	NON-OPAQUE FIBROUS PLANT MATERIAL OF WOODY ORIGIN }	TRACHEIDS VESSELS	>2→3 (2.5-2.9)	>2→≥3 (2.3-3.2)	2→4
PHYROGEN	NON-OPAQUE NON-WOODY ORIGIN }	SPORES POLLEN ALGAE ACRITARCHS CUTICLES	>2→3 (2.2→3)	2→<3+	>2^{-}→4
AMORPHOGEN	STRUCTURELESS ORGANIC MATTER }	FINELY DISSEMINATED or COAGULATED FLUFFY MASSES	2→<3+	2→3+	3+→5
MELANOGEN	OPAQUE ORGANIC DEBRIS		-	2+→<3	2.5-4

Notes: (1) Hylogen, Phyrogen, Melanogen 4→5: Traces of Dry Gas and Co_2

(2) Hylogen, Phyrogen, Melanogen 1→2: Biogenic methane (Marsh gas).

TAI (Thermal Alteration Index):

1+, 2-, 2 - YELLOWS
2, 2+, 3, 4 - BROWNS
4-, 5 - BLACK

TABLE VII

DISCOVERY BAY NO. 1 WELL
SUMMARY OF KEROGEN AND SPORE COLOURATION DATA

Depth	TAI	TOM	PHYRO.	AMORPHO.	HYLO.	MELANO
774	1	v. low	5	80	-	15
778	1+	v. low	10	70	-	20
782	1+	v. low	Tr.	95	-	5
786	1+	v. low	20	50	Tr.	30
790	1+	barren	-	-	-	-
854.5	1+	low	Tr.	70	Tr.	30
880	1+	moderate	10	50	10	30
885	1+	moderate	5	65	Tr.	30
891	1+	moderate	30	50	Tr.	20
906	1+	moderate	30	50	-	20
920	1	moderate	20	60	10	10
928	1+	moderate	Tr.	90	-	10
1013.5	1+	moderate	30	60	Tr.	10
1026	1+	moderate	5	85	-	10
1123	1+	low	10	80	-	10
1130	1+	moderate	5	90	-	5
1135	N.D.	moderate	20	80	Tr.	Tr.
1150	1+	moderate	10	80	10	Tr.
1160	1+	moderate	15	75	-	10
1180	1+	moderate	10	80	Tr.	10
1190	1+	moderate	10	80	Tr.	10
1200	1+	moderate	10	80	Tr.	10
1220	1+	v. low	20	10	-	70
1230	N.D.	v. low	10	-	10	80
1240	1+	low	40	40	Tr.	20
1270.5	1+	moderate	30	50	10	10
1275.5	1+	moderate	50	30	10	10
1279.5	2-	v. low	10	40	10	40
1297.25	2-	low	30	-	15	55
1306.5	2-	low	40	10	10	40
1344.5	2-	low	40	10	10	40
1369.5	2-	low	20	10	10	60
1400.5	2-	low	30	5	5	60
1426.75	2-	moderate	30	10	10	50
1525	2-	moderate	20	5	5	70
1562	2-	moderate	30	20	10	40
1594.5	2-	moderate	30	20	10	40
1618	2-	moderate	40	10	10	40
1687	2-	moderate	30	10	Tr.	60
1719.5	2-	moderate	20	5	5	70
1749	2-	moderate	20	20	10	50
1796.75	2-	moderate	30	20	Tr	4
1838.5	2	abundant	20	-	20	60
1846.5	2	moderate	30	20	10	40
1908	2	low	35	5	10	50
1974.5	2	moderate	30	10	10	50
2047.5	2	moderate	20	20	10	50
2095	2	moderate	30	10	10	50
2164	2	moderate	15	30	5	50

TABLE VII cont.

Depth	TAI	TOM	PHYRO.	AMORPHO.	HYLO.	MELANO.
2235.5	2	abundant	20	30	10	40
2260	2	moderate	20	30	15	35
2268.5	2	moderate	15	10	5	70
2293	2	moderate	20	40	10	30
2345	2	moderate	20	40	10	30
2357	2	abundant	20	30	20	30
2381.5	2	moderate	20	30	20	30
2399	2	moderate	10	30	20	40
2418	2	moderate	20	20	20	40
2433	2	moderate	20	10	10	60
2458.5	2	abundant	20	-	10	70
2474.5	2	moderate	30	-	10	60
2489.5	2	moderate	10	50	-	40
2505	2	moderate	10	50	10	20
2534.75	2	low	10	30	5	55
2565	2	low	20	15	15	20
2590	2	moderate	20	10	10	60
2621.5	2	low	30	20	20	30
2633.5	2	low	30	20	20	30
2649	2	low	30	10	20	40
2670	2	moderate	20	40	10	20
2702	2	low	30	20	10	40
2738	2	low	30	20	25	25
2753	2	moderate	15	20	Tr.	65
2772	2	low	15	10	15	60
2776	2	low	30	-	10	60

Kerogen is dominated in the Early Tertiary sequence by amorphogen which is a potential source for liquid hydrocarbons whereas the Late Cretaceous section is dominated by melanogen. The potential in this section is for the generation of gaseous hydrocarbons with some liquid fraction.

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