SPERM WHALE NO. 1 WELL

GIPPSLAND BASIN

Palynological Examination and Kerogen Typing of Sidewall Cores

by

W.K. Harris & C.B. Foster

PALYNOLOGICAL REPORT

Client : Hudbay Oil (Australia) Limited

Study : Sperm Whale No. 1 Well, Gippsland Basin

Aims : Determination of age and distribution of kerogen types and spore colour.

INTRODUCTION

Sixty six sidewall cores from Sperm Whale No. 1 Well drilled in the Gippsland Basin at Lat. 38°03'44"S, Long. 140°56'19"E in Vic. P-11 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 Early Cretaceous sequence.

OBSERVATIONS AND INTERPRETATION

A. Biostratigraphy

Table I summarises the biostratigraphy and age determinations for the samples studied. Tables II and III indicate the distribution of species encountered in the Early Cretaceous and Tertiary sequences, respectively. Table II list samples between 958 and 1377.1m where significant assemblages have been recorded.

Many samples from this well are barren of plant microfossils and this is mostly due to unfavourable lithologies. These are dominated by light grey to white argillaceous sandstone and claystones generally representing oxidising environments of deposition.

Where plant microfossils have been recovered they range from well preserved to very poor, but assemblages were not very diverse limiting the biostratigraphic precision. Assemblages yielding only three or four specimens have been logged as barren. These species recorded are all long ranging forms.

1. Early Cretaceous: 958 to 1302.1m

Assemblages from this section of the well were generally poorly preserved and many samples yielded only very sparse or poorly diversified assemblages. Between 1261m and 1302.1m there is little diversity in the assemblages and nothing in particular that can be used for precise biostrtigraphic assignment. The species recorded are consistent with an Early Cretaceous age but their range is often much greater.

An assemblage at 1252.9m yielded the first record of Coptospora paradoxa marking the base of the zone of Coptospora paradoxa in this well.

Assemblages above this depth are poorly diversified and contain no

TABLE I
SPERM WHALE NO. 1

SUMMARY OF PALYNOLOGICAL DATA

DEPTH	SWC	PRESERVATION	DIVERSITY	SPORE/POLLEN ZONE	CONFIDENCE LEVEL	ENRIVONMENT
806	67	good	v. low	?M. diversus	3	?Non-marine
812	66	fair	v. low	?M. diversus	3	?Non-marine
817	65	fair	v. low	?M. diversus	3	?Non-marine
821	64	barren	-	-	-	-
825	63	barren	-	-	-	-
828	62	barren	-	-	-	-
843	60	barren	-	-	-	-
846	59	good	low	L. balmei	4	
851	58	fair	low	L. balmei	4	
859	57	barren	-	-	-	-
869	56	"	-	-	-	-
877	55	"	-	-	-	-
885	54	"	-	-	-	-
896	53	"	-	-	-	-
904	52	"	-	-	-	-
917	51	"	-	-	-	-
923	50	"	-	-	-	-
932	49	"	-	-	-	-
940	48	"	-	-	-	-
948	47	"	-	-	-	-
958	46	fair	v. low	E. Cretaceous undiff.	-	-
964	45	barren	-	-	-	-
969	44	fair	v. low	?C. paradoxa	3	non marine
977	43	v. poor	v. low	?C. paradoxa	3	non marine
989	42	fair	v. low	?C. paradoxa	3	non marine
998	41	"	-	-	-	-
1010	40	"	-	-	-	-
1020	39	"	-	-	-	-
1031	38	"	-	-	-	-
1041.9	37	"	-	-	-	-
1050	36	"	-	-	-	-
1060	35	barren	-	-	-	-

DEPTH	SWC	PRESERVATION	DIVERSITY	SPORE/POLLEN ZONE	CONFIDENCE LEVEL	ENVIRONMENT
1072	34	poor	v. low	?C. paradoxa	3	non marine
1080	33	poor to v. poor	"	"	3	"
1090	32	barren	-	-	-	-
1110	30	fair	v. low	?C. paradoxa	3	non marine
1120	29	barren	-	-	-	-
1131	28	"	-	-	-	-
1142	27	"	-	-	-	-
1157	26	"	-	-	-	-
1160	31	"	-	-	-	-
1162	25	"	-	-	-	
1177	24	"	-	-	-	-
1181.9	23	"	-	-	-	-
1191.9	22	"	-	-	-	-
1207	21	v. poor	v. low	?C. paradoxa	3	non marine
1217.9	20	barren	-	-	-	-
1228	19	"	-	-	-	-
1238.1	18	"	-	-	-	-
1244.9	17	"	-	-	-	-
1252.9	16	fair	v. low	C. paradoxa	4	non marine
1261	15	poor	v. low	E. Cretaceous undiff.	-	non marine
1272.9	14	barren	-	-	-	-
1282.9	13	v. poor	v. low	E. Cretaceous undiff.	-	non marine
1292.9	12	barren	-	-	-	-
1302.1	11	fair	v. low	E. Cretaceous undiff.	-	non marine
1315	10	barren	-	-	-	-
1325	9	"	-	-	-	-
1335	8	"	-	-	-	-
1345	7	"	-	-	-	-
1355	6	"	-	-	-	-
1365	5	"	-	-	-	-
1377.1	4	"	-	-	-	-
1386.1	3	"	-	-	-	-
1400	2	"	-	-	-	-
1411.1	1	"	-	-	-	-

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 or sidewall core, good assemblage

diagnostic species. For this reason the assemblages are tentatively equated with the C. paradoxa zone.

All of the Cretaceous assemblages are of non-marine aspect.

2. Early Tertiary

Although assemblages from this section of the well were moderately well preserved the samples yielded low quantities of organic matter and assemblages of very low diversity. Nevertheless two distinct units can be recognised.

a. Lygistepollenites balmei zone: 846-851m

Two samples are correlated with this zone and assemblages are characterised by L. balmei, G. edwardsii, H. harrisii, P. reticulosaccatus and N. flemingii. The presence of the latter species suggests that the assemblage is to be correlated with the Upper L. balmei zone, however the poor diversity precludes a firm assignment to this sub-zone.

Marine dinoflagellates were recorded at 846m and indicate deposition in a marginal marine environment.

b. ?Malvacipollis diversus zone: 806-817m

Assemblages from the three productive samples from this zone again are poorly diversified but do contain M. diversus and in the youngest sample C. orthoteichus.

The sample at 806m is certainly no older than the M. diversus zone provided that none of the samples have been contaminated by drilling mud.

No marine dinoflagellates were recorded and a non-marine environment of deposition is inferred.

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 V. Only those samples which yielded spore/pollen assemblages have been examined. Spore colour is expressed as the "Thermal Alteration Index" (TAI) of Staplin (1969) according to the scale in Table IV.

TABLE IV

Thermal - Alteration Index		Organic matter/spore colour
1	none	fresh, yellow
2	slight	brownish yellow
3	moderate	brown
4	strong	black
5	severe	black and evidence of rock metamorphism.

TABLE V
SPERM WHALE NO. 1

SUMMARY OF MATURATION AND KEROGEN DATA

DEPTH	TOM	SWC NO.	PHY.	AMORPHO	HYLOGEN	MELANO.	TAI
806	v. low	67	tr.	-	tr.	100	ND
812	v. low	66	5	-	-	95	-
817	v. low	65	10	-	tr	90	ND
821	barren	64	-	-	-	-	-
825	barren	63	-	-	-	-	-
828	v. low	62	-	100	-	-	-
843	low	60	30	40	20	10	ND
846	low	59	10	80	tr.	10	1+
851	v. low	58	70	-	10	20	ND
859	barren	57	-	-	-	-	-
869	"	56	-	-	-	-	-
877	"	55	-	-	-	-	-
885	"	54	-	-	-	-	-
896	"	53	-	-	-	-	-
904	"	52	-	-	-	-	-
917	"	51	-	-	-	-	-
923	"	50	-	-	-	-	-
932	"	49	-	-	-	-	-
940	"	48	-	-	-	-	-
948	"	47	-	-	-	-	-
958	mod	46	30	-	10	60	2
964	barren	45	-	-	-	-	-
969	mod	44	30	-	10	60	2-
977	low	43	30	-	30	40	2
989	v. low	42	-	-	-	-	NA
998	barren	41	-	-	-	-	-
1010	"	40	-	-	-	-	-
1020	"	39	-	-	-	-	-
1031	"	38	-	-	-	-	-
1041.9	"	37	-	-	-	-	-
1050	"	36	-	-	-	-	-
1060	"	35	-	-	-	-	-
1072	"	34	-	-	-	-	-
1080	v. low	33	50	-	35	15	2
1090	barren	32	-	-	-	-	-
1110	low	30	40	-	30	30	2
1120	barren	29	-	-	-	-	-
1131	"	28	-	-	-	-	-
1142	"	27	-	-	-	-	-
1157	"	26	-	-	-	-	-
1160	"	31	-	-	-	-	-
1162	"	25	-	-	-	-	-
1177	"	24	-	-	-	-	-
1181.9	"	23	-	-	-	-	-
1191.9	"	22	-	-	-	-	-
1207	mod	21	95	-	-	5	2
1217.9	barren	20	-	-	-	-	-
1228	"	19	-	-	-	-	-
1238.1	"	18	-	-	-	-	-

DEPTH	TOM	SWC NO.	PHYR.	AMORPHO	HYLOGEN	MELANO	TAI
1244.9	mod	17	-	-	-	-	-
1252.9	v.low	16	-	-	-	-	ND
1261	abundant	15	65	-	30	5	2
1272.9	v.low	14	-	-	-	-	-
1282.9	v.low	13	-	-	-	-	ND
1292.9	barren	12	-	-	-	-	-
1302.1	abundant	11	95	-	-	5	2
1315	v. low	10	-	-	-	-	-
1325	v. low	9	-	-	-	-	-
1335	barren	8	-	-	-	-	-
1345	v. low	7	-	-	-	-	-
1355	barren	6	-	-	-	-	-
1365.1	"	5	-	-	-	-	-
1377.1	"	4	-	-	-	-	-
1386.1	"	3	-	-	-	-	-
1400	"	2	-	-	-	-	-
1411.1	"	1	-	-	-	-	-

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, phyrogen, 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.

1. Cretaceous Section

Kerogen types in this unit are characterised by high phyrogen towards the bottom of the well and high melanogen towards the top.

Spore colour throughout is consistent at about 2 and cannot be considered to be mature. These factors together with low to very low TOM values, imitigates against this section as a potential hydrocarbon source.

2. Tertiary Section - Eocene

This section is characterised by very low TOM's and the dominant kerogen type is melanogen in the ?M. diversus zone and amorphogen is prominent in two samples from the L. balmei zone.

Where spore colour was determined it is indicative of immaturity.

All of the evidence suggests that this section in the early Tertiary is immature and does not contain sufficient organic matter of a favourable nature to be considered as a potential source rock for the generation of hydrocarbons.

REFERENCES

Bujak, J.P., Barss, M.S., & Williams, G.L., 1977: Offshore East Canada's Organic Type and Colour and Hydrocarbon Potential. Oil Gas J., 45 (14): 198-202.

Burger, D., 1973: Spore Zonation and sedimentary history of the Neocomian, Great Artesian Basin Queensland. Spec. Publs. geol. Soc. Aust. 4: 97-118.

Dettman, M. & Playford, G., 1969: Palynology of the Australian Cretaceous: A review. IN Campbell. Ed. Stratigraphy and Paleontology: Essays in Honour of Dorothy Hill A.N.U. Press Canberra: 174-210.

Dettmann, M. & Douglas J., 1976: Lower Cretaceous Palaeontology IN Douglas et al ed. Geology of Victoria. Spec. Publs. Geol. Soc. Aust. 5: 164-176.

Partridge, A.D., 1976: The Geological Expression of Eustacy in the Early Tertiary of the Gippsland Basin. J. Aust. Petrol. Expl. Assoc., 16: 73-79.

Staplin, F.L. 1969: Sedimentary Organic Matter, Organic Metamorphism and Oil and Gas Occurrence. Bull Can. Pet. Geol., 17: 47-66.

Stover, L.E. & Partridge, A.D., 1973: Tertiary and Late Cretaceous Spores and Pollen from the Gippsland Basin, southeastern Australia. Proc. R. Soc. Vict., 85: 237-286.

W.K. Harris,

C.B. Foster,

13 January 1983

DISTRIBUTION OF CRETACEOUS SPECIES

TABLE II

SPERM WHALE #1

Depth in metres	1377.1	1365.1	1355	1345	1335	1325	1315	1302.1	1292.9	1282.9	1272.9	1261	1252.9	1244.9	1238.1	1228	1217.9	1207	1191.9	1181.9	1177	1162	1160	1157	1142	1131	1120	1110	1090	1080	1072	1060	1050	1041.9	1031	1020	1010	998	989	977	969	964	958
Spore/Pollen																																											
Baculatisporites comaumensis								X		X		X	X															X												X		X	
Cicatricosporites australiensis								X				X	X	X														X												X		X	
Osmundacidites spp.								X																																			
Podocarpidites sp.		X						X		X							X	X			X							X							X						X		
Cingutriletes clavus								X					X																												X		
Ceratosporites equalis								X																																			
Corallina sp.								?																																X	X		
Trisaccites sp.								X																																			
Cyathidites sp.								X										X												X										X		
Podosporites microsaccatus								X				X																X												X		
Cicatricosisporites sp.													X																														
Forminisporis assymetricus													X																												X		
Polypodiidites sp.													?																														
Cepatospora paradoxa													X																														
Balmeisporites holodictyus													X																														
Nodaistrickia truncata					X											X																											
Classopollis sp.																X																											
Leptolepidites verrucatus																	X											X												X		
Lycopodiumsporites sp.																												X	X				X							X		
Leiotriletes sp.																												X														
Microechryidites antarcticus																												X												X		
Aequitriradites spinulosus																												X														X
Podocarpidites ellipticus																												X	X													
Cinqutriletes clavus																												X														
Foraminisporis wonthaggiensis																												?														
Klukisporites scaberis																													X													
Neoraistrickia sp.																													X			X										X
Annulispora folliculosa																													X													
Cycadopites sp.																													X									X				
Camerozonotriletes sp.																													X									X				
Podocarpites sp.																													X									X				
Baculatisporites sp.																													X									X				
Kraeuselisporites sp.																																							X				
Cycadopites ovatus																																							X				
Stereisporites antiquasporites																																								?			
Cockcsnites variabilis																																								X			
Lundbladispora sp.																																								?			
Ceratosporites spp.																																								X			
Triletes sp. cf. T. tuberculiformis																																								X			
Cuycadopites follicularis																																								X			
Nodosus sp.																																											X
Gleicheniidites sp.																																											?
Schizosporis sp.																																											
Reworked Spores/Pollen																																											
Alisporites sp.										X																																	
Puncatisporites gretensis																										X										X							
Striatopodocarpites sp.																														X													
Aratrisporites																																				X				X			
Gabonus sp.																																						?					
Horriditriletes ramosa																																								X			
Polypodiaceoisporites tortuosus																																								Y			