BALEEN NO. 1 WELL

Palynological Examination and Kerogen Typing of Sidewall Cores

by

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PALYNOLOGICAL REPORT

Client : Hudbay Oil (Australia) Ltd.

Study : Baleen No. 1 Well, Gippsland Basin.

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

INTRODUCTION

Thirty nine sidewall cores from Baleen No. 1 Well drilled in the Gippsland Basin at Lat. 38°0'36.63"S, Long. 148°28'8.4"E in Vic. P-11 were processed by normal palynological procedures.

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

OBSERVATIONS AND INTERPRETATION

A. Biostratigraphy

Table 1 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.

Several 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 are generally well preserved but assemblages were often not very diverse limiting the biostratigraphic precision.

1. Early Cretaceous 709 to 1014m

Assemblages from this section of the well were generally well preserved but many samples yielded only very sparse or poorly diversified assemblages. Between 878m and 1014.1m there is little diversity in the assemblages and ~~nothing in particular~~ that can be used for precise biostratigraphic assignment. The species recorded are consistent with an Early Cretaceous age but their range is often much greater.

An assemblage at 840.1m records the first appearance of Coptospora paradoxa marking the base of the zone of Coptospora paradoxa. The assemblages at this point became more diversified although low yields predominate. Between 745 and 795m yields are low and assemblages are poorly diversified. The Coptospora paradoxa asemblage reappears at 723m and the top of the Cretaceous section appears to still in this zone at 709m.

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TABLE 1

SUMMARY OF BIOSTRATIGRAPHY AND AGE

DEPTH IN METRES	BIOSTRATIGRAPHIC UNIT	AGE
640	Late N. asperus	Late Eocene
646	Late N. asperus	Late Eocene
651	Late N. asperus	Late Eocene
658	Middle-Late N. asperus	Late Eocene
659	Middle-Late N. asperus	Late Eocene
672	Middle-Late N. asperus	Late Eocene
675	Middle-Late N. asperus	Late Eocene
678	Middle-Late N. asperus	Late Eocene
680	Middle-Late N. asperus	Late Eocene
683	Middle-Late N. asperus	Late Eocene
685	Middle-Late N. asperus	Late Eocene
688	Middle-Late N. asperus	Late Eocene
690	Middle-Late N. asperus	Late Eocene
693	No older Middle N. asperus	?Late Eocene
698	No older Middle N. asperus	?Late Eocene
709	Coptospora paradoxa	Albian
723	Coptospora paradoxa	Albian
735	Barren	-
745	Indeterminate	Early Cretaceous
751	Indeterminate	Early Cretaceous
765	Indeterminate	Early Cretaceous
774	Indeterminate	Early Cretaceous
784	Barren	-
795	Indeterminate	Early Cretaceous
817.9	Coptospora paradoxa	Albian
830	Coptospora paradoxa	Albian
840	Coptospora paradoxa	Albian
855	Barren	-
878	Indeterminate	Early Cretaceous
918	Indeterminate	Early Cretaceous
927	Indeterminate	Early Cretaceous
941	Indeterminate	Early Cretaceous
946.9	Indeterminate	Early Cretaceous
958	Indeterminate	Early Cretaceous
967	Indeterminate	Early Cretaceous
973	Indeterminate	Early Cretaceous
982	Indeterminate	Early Cretaceous
998	Indeterminate	Early Cretaceous
1014.1	Indeterminate	Early Cretaceous

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TABLE II

DISTRIBUTION OF CRETACEOUS SPECIES

Depth in metres	1014.1m	998	982	973	967	958	946.9	941	927	918	878	840.1	830	817.9	795	774	765	751	745	723	709
Baculatisporites comaumensis	X											X	X	X	X		X		X	X	X
Classopollis sp.	X																			X	
Cyathidites australis	X		X	X		X	X	X	X	X	X	X	X	X		X	X	X	X	X	X
Gleicheniidites	X																				
Kraeuselisporites sp.	X																				
Podocarpidites	X	X	X			X	X		X		X	X	X	X	X	X	X	X	X		X
Ceratosporites equalis		X		X				X	X					X						X	
Falcisporites australis			X	X	X				X	X		X		X	X			X		X	X
Ginkgocyadophytus sp.			X							X				X			X			X	
Lycopodiumsporites austroclavatidites				X	X				X				X	X						X	X
Microcachryidites antarcticus									X		X	X		X						X	X
Sestrosporites pseudoalveolatus									X												
Stereisporites antiquasporites									X		X	X	X	X		X					
Aequitriradites spinulosus												X	X							X	
Coptospora paradoxa												X		X							
Balmeisporites holodictyus												X									
Cicatricosisporites australiensis													X	X							
Neoraistrickia truncata													X								
Araucariacites australis														X							
Crybelosporites striatus														X						X	X
Dictyophyllidites mortoni														X						X	
Foveosporites canalis														X							
Foraminisporis sp.														X							
Pilosisporites grandis														X							
Podosporites microsaccatus														X							X
Stereisporites pocockii														X		X				X	
Cingutriletes clavus																X				X	
Cicatricosisporites ludbrooki																				X	
Densoisporites velatus																				X	
Leptolepidites major																				X	
L. verrucatus																				X	
Podosporites																				X	
Vitreisporites pallidus																				X	
Aratrisporites sp.																				X	
Foraminisporis dailyi aff.																					X
Gleicheniidites circinidites																					X

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TABLE III

DISTRIBUTION OF TERTIARY SPECIES

Depth in metres	698	693	690	688	685	683	680	678	675	672	659	658	651	646	640
Baculatisporites comaumensis	X						X				X	X		X	
Baculatisporites disconformis	X														
Cupanieidites orthoteichus	X	X						X	X						
Cyathidites splendens aff.	X														
C. australis	X	X				X	X	X	X	X	X	X		X	
Gleicheniidites circinidites	X						X								X
Haloragacidites harrisii	X	X	X	X	X	X	X	X	X		X	X	X		X
Haloragacidites sp.	X														
Helciporites astrus	X														
Hystrichosphaeridium sp.	X														
Kuylisporites waterbolki	X								X						
Laevigatosporites major	X														
Lygistepollenites florinii	X	X				X		X	X				X		
Malvacipollis diversus	X	X				X	X		X		X	X	X		
Myrtaceidites parvus/mesonesus	X		X				X		X						
Nothofagidites brachyspinulosus	X	X				X	X	X		X	X				
Nothofagidites emarcidus/heterus	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Nothofagidites falcatus	X		X			X			X		X				X
Nothofagidites flemingii	X						X		X		X		X	X	
Phyllocladidites mawsonii	X	X	X	X	X	X	X		X	X	X	X	X	X	
Podocarpidites sp	X	X	X				X	X	X		X	X			X
Proteacidites parvus	X	X													
Rugulatisporites mallatus aff.	X					X		X							
R. trophus	X														
Sapotaceoidaepollenites rotundus	X											X			
Simplicepollis meridianus	X					X		X							
Spinidinium sp.	X		X								X				
Triletes tuberculiformis	X		X								X				
Tricolporites geranoides aff.	X														
Verrucosisporites cristatus	X					X									
Dacrycarpites australiensis		X													
Lycopodiumsporites sp.		X													
Matonisporites ornamentalis		X										X			X
Microcachyridites antarcticus		X												X	
Parvisaccites catastus		X													X
Periporopollenites demarcatus		X									X				
Periporopollenites vesicus		X	X												
Podosporites microsaccatus		X													
Proteacidites latrobensis		X													
Paralecaniella indentata		X		X				X				X			
Operculodinium sp.		X					X								
Deflandrea phosphoritica		X													
Corrudinium incompositum		X													
Proteacidites pachypolus		X				X	X		X						
Santalumidites cainozoicus		X				X	X			X					

Depth in metres	698	693	690	688	685	683	680	678	675	672	659	658	651	646	640
Stereisporites (Tripunctisporis) punctatus		X													
Thalassiphora pelagica			X												
Deflandrea heterophylycta			X												
Operculodinium centrocarpum			X									X	X	X	X
Proteacidites sp				X			X			X		X			X
Laevigatosporites ovatus						X						X			
Tricolpites thomasii						X	X				X				
Verrucosisporites kopukuensis						X			X	X					
Gonyaulacoid cyst						X									
Dryptopollenites semilunatus							X								
Nothofagidites deminutus							X			X	X			X	
Proteacidites annularis							X								
Tricolpites phillipsii							X		X						
Cyclopsiella sp.							X								
Spiniferites adelaidensis							X								
Spiniferites ramosus							X				X		X	X	X
Areosphaeridium sp.							X	X					X	X	
Proteacidites adenanthoides								X							
Phthanoperidinium comatum								X							
Krauselisporites sp.									X						
Proteacidites incurvatus									X						
Tricolporites adelaidensis									X					X	
Tricolporites sphaerica									X						
Dictyophyllidites sp.										X					X
Proteacidites obscurus											X				
Araucariacites australis												X			
Stereisporites antiquasporites												X			
Tricolporites sp.												X			
Spiniferites spp.												X			
Impagidinium victorianum												X	X		
Spiniferites pseudofurcatus												X			
Vozzhennikovia extensa												X			
Impletosphaeridium sp.													X		
Hystrichokolpoma rigaudae														X	
Areosphaeridium pectineforme														X	X
Herkosporites elliottii															X
Camarozonosporites sp.															X
Nothofagidites asperus															X

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

2. Eocene 640 to 698m

Although assemblages from this section of the well were well preserved the samples yielded in general very low quantities of organic matter with concomittant poor diversity.

Notwithstanding these features all assemblages can be assigned to the Nothofagidites asperus zone and some refinement can be made within this. Assemblages from 698 and 693m are certainly no older than Middle N. asperus zone but could be younger. The low diversity of Proteacidites spp. would tend to favour the younger age but with low diversity assemblages this assignment may be questioned. Dinoflagellates are uncommon in the sample at 698m but indicate some marine influence. Dinoflagellate assemblages become more diverse at 693m and the remainder of the samples to 640m have an increasingly stronger marine influence attesting to marine transgression in the Late Eocene.

The age of samples up to 658m is Late Eocene but their low yields and poor diversity precludes more precise biostratigraphic determination. The general appearance of the assemblages however would favour to younger assignment. From 651 - 640m the assemblages are more confidently assigned to the Late N. asperus zone from dinoflagellate evidence which includes the dominance of Spiniferites spp. and Areosphaeridium pectiniforme. The very common occurrence of dinoflagellates in these samples is indicative of open marine probably near shore sedimentation.

There would appear to be no significant breaks in the Eocene section of the well and the entire sequence was deposited under the influence of a late Eocene transgression.

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.

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 than1%.

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 connatation. 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 contribute to hydrocarbon generation whereas at a TAI of 2, only amorphogenforms liquid hydrocarbons. The upper boundary defining the oil window is at a TAI ofapproximately 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 throughout this unit are characterised by high melanogen with only one exception (e.g. 878m) where amorphogen becomes a significant component. If this section was mature for the genration of hydrocarbons if would yield dominantly gas with minor amounts of condensate.

Spore colour throughout is consistant at about 2 and cannot be considered to be mature especially when the kerogens are dominated by melanogen. 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 amorphogen which appears as finely divided organic matter.

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 matterof a favourable nature to be considered as a potential source rock for the generation of hydrocarbons.

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TABLE V

DISTRIBUTION OF KEROGEN TYPES AND SPORE COLOUR

DEPTH (m)	TAI	TOM	PHYROGEN %	AMOR. %	HYLOGEN %	MELANOGEN %
640	-	very low	*Tr	95		5
646	-	very low		95	Tr	5
651	**N.D.	very low		90	Tr	10
658	N.D.	very low		60	Tr	40
659	N.D.	very low		90	Tr	10
672	N.D.	very low		60	Tr	40
675	N.D.	very low	Tr	90	Tr	10
678	1+	very low	5	70	5	25
680	N.D.	very low	5	80	Tr	15
683	1+	very low	25	40	5	30
685	1+	very low	Tr	60	Tr	40
688	1+	very low	Tr	70	Tr	30
690	1+	very low	Tr	60	Tr	40
693	1+	very low	Tr	70	Tr	30
698	1+	low	Tr	60	Tr	40
709.0	2	very low	10	-	10	80
723	2+	very low	30	-	10	60
735	N.D.	very low	-	-	-	100
745	N.D.	very low	10	-	Tr	90
751	N.D.	very low	5	-	Tr	95
765	N.D.	very low	5	-	Tr	95
774	2	very low	5	-	Tr	95
784	N.D.	barren	-	-	-	100
795	2	very low	10	Tr	10	80
817.9	2	low	30	Tr	20	50
830	2	very low	20	-	10	70
840.1	2	low	25	-	15	50
855	N.D.	barren	-	-	-	-
878	2+	very low	10	60	Tr	30
918	2	low	5	-	5	90
927	2	low	15	-	5	80
941	N.D.	very low	10	-	Tr	90
946	2+	very low	10	-	Tr	90
958	N.D.	very low	5	-	Tr	95
956	2	very low	10	-	Tr	90
973.0	N.D.	low	20	Tr	10	70
982	N.D.	low	5	-	5	90
998	2-	low	30	-	10	60
1014	N.D.	very low	5	-	5	90

* Tr indicates "trace"

** N.D. indicates "not determined"

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