APPENDIX-1

PALYNOLOGICAL ANALYSIS OF SAWBELLY-1
GIPPSLAND BASIN.

by

A.D. PARTRIDGE
ESSO AUSTRALIA LTD.

Esso Australia Ltd.
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INTRODUCTION

Twenty-nine sidewall core samples were processed from Sawbelly-1 and examined for spores, pollen and microplankton. Although oxidized organic residue yields were mostly high the palynomorph concentrations were mostly moderate to low. Consequentially only moderate spores and pollen diversities were recorded from the majority of samples. Average diversity was 20.2 species per sample. A few samples from the Early Eocene section did, however, contain high diversity assemblages. Low spore-pollen diversity correlates directly to the poorer preserved samples. Microplankton, principally dinoflagellates cysts, were present in about two-thirds of the samples with the most diverse assemblages being identified from the Gurnard Formation. Microplankton diversity is mainly low. Preservation of all palynomorphs was mostly poor.

Lithological units and palynological zones from base of Lakes Entrance Formation to T.D. are given in the following summary. Interpretative data with indentification of zones and confidence ratings are recorded in Table-1 and basic data on residue yields, preservation and diversity are recorded in Table-2. All species which can be identified with binomial names are tabulated on the accompanying range chart.

PALYNOLOGICAL SUMMARY OF SAWBELLY-1

AGE	UNIT/FACIES	SPORE-POLLEN ZONES (Dinoflagellate Zones)	DEPTH RANGE (mKB)
Oligocene	Lakes Entrance	*P. tuberculatus*	1976.0-1983.0
	1984.0m		
Late Eocene	Latrobe Group (Gurnard Fm.)	Middle *N. asperus*	1989.0-1994.0
		(*G. extensa*)	(1989.0)
		(*C. incompositum*)	(1994.0)
Middle Eocene		Lower *N. asperus*	2000.0
	2015.5m		
Middle Eocene	Latrobe Group (Transition Beds)	Lower *N. asperus*	2023.0
	2037.0m		
Early Eocene	Latrobe Group	*P. asperopolus*	2041.0-2116.8
Early Eocene	(Coarse clastic facies)	Upper *M. diversus*	2144.7-2223.0
Early Eocene		Middle *M. diversus*	2275.0-2331.0
Early Eocene		Lower *M. diversus*	2417.0-2438.0
		(*A. hyperacanthum*)	(2438.0)
Paleocene		*L. balmei*	2531.0-2639.5
		(*A. homomorphum*)	(2531.0)
Paleocene		Lower *L. balmei*	2838.0-3022.5
	T.D. 3069.5m		

GEOLOGICAL COMMENTS

1. The deepest palynological samples in Sawbelly-1, although poorly preserved and containing only meager assemblages, indicate that the well at total depth is still with in the Paleocene Lower *L. balmei* Zone. These deepest assemblages do not contain either *T. longus* Zone indicator species or the abundance of *Gambierina rudata* which is so characteristic of the top of the latter zone. Similarly no key dinoflagellates were recorded. On this evidence it is therefore suggested that no equivalents to the T-1 Shale which straddle the Cretaceous/Tertiary boundary were reached in Sawbelly-1.

2. In the Conger-1 palynological report the Latrobe Group was sudivided into informal lithological units (Partridge, 1989). The equivalent units in Sawbelly-1 are as follows:

UNIT	SAWBELLY-1 Depth	SAWBELLY-1 Thickness	CONGER-1 Depth	CONGER-1 Thickness
Gurnard Formation	1984m	31.5m	1814m	17m
Transition beds	2015.5m	21.5m	1831m	13m
Upper Sands	2037m	201m	1844m	181m
Coal Measures	2238m	41m	2025m	30m
Top Coastal Plain facies	2279m	601m	2279m	555m
Lower Sands	2880m	188m+	2610m	269m
Bottom Coastal Plain facies	NA		2879m	91m+

NA = Not Penetrated

3. The top of the Gurnard Formation in Sawbelly-1 is picked at the sharp increase on the gamma-ray log at 1984m which also corresponds to an increased separation between the neutron porosity and bulk density logs compared to the overlying Lakes Entrance Formation. The base of the Gurnard Formation is picked at 2015.5m corresponding to a reduction on the gamma-ray log and a decrease in

the separation between the neutron porosity and bulk density logs. The sidewall cores through this 31.5 metre thick unit all contain glauconite. As thus delimited it is equivalent to the Gurnard Formation as recognised in Conger-1 between 1814-1831m (Partridge, 1989), but only equivalent to Unit A of the Gurnard Formation in Swordfish-1 between 1998.9-2030.0m (6558-6660ft) of Partridge (1977). The microplankton assemblages present in the samples suggest that only part of the Lower and Middle *N. asperus* Zones are represented.

The unit between 2015.5-2037m is considered to represent "Transition Beds" between the Gurnard Formation with glauconite and the undifferentiated coarse reservoir facies of the Latrobe Group. These Transition Beds are characterised by lower gamma-ray log response and moderate but variable separation between the neutron porosity and bulk density logs. The lithology of the single sidewall recovered from this unit at 2023m was a iron stained silty sandstone suggestive of a oxidised "Gurnard facies". It contained a poor Lower *N. asperus* age flora. This unit is considered equivalent to the Transition beds in Conger-1 between 1831-1844m (see Partridge, 1977), and the lower Unit B of the Gurnard Formation in Swordfish-1 between 2030.0-2045.2m (6660-6710ft).

BIOSTRATIGRAPHY

Zone and age-determinations have been made using criteria proposed by Stover & Partridge (1973, 1982), Helby *et al.* (1987) and unpublished observations made on Gippsland Basin wells drilled by Esso Australia Ltd.

Author citations for most spore-pollen species can be sourced from Stover & Partridge (1973, 1982), Helby *et al.* (1987) and Dettmann & Jarzen (1988) or other references cited herein. Species names followed by "ms" are unpublished manuscript names. Author citations for dinoflagellates can be found in Lentin & Williams (1985, 1989).

Lower *Lygistepollenites balmei* Zone: 2838.0-3022.5 metres Paleocene.

The five samples assigned to this zone are all poorly preserved, and mainly as a consequence of this palynomorph concentrations are low. Key zone species are therefore rare and it proved difficult to estimate the relative abundance of the principal species in the assemblages. The absence of either species typical of the *T. longus* Zone, or any abundance of *Gambierina rudata*, are the main reasons for assigning the two deepest sidewall cores to the Lower *L. balmei* Zone, albeit with low confidence ratings. The sidewall core at 2977.0m is the deepest high confidence pick for the base of the zone based on the presence of *Proteacidites angulatus*. Other significant species are the common occurrence of *Australopollis obscurus* at 2860.0m, and the presence of fragmented specimens of dinoflagellate *Glaphrocysta retiintexta* at 2838.0m.

Lygistepollenites balmei Zone: 2531.0-2629.5 metres Paleocene.
and
Apectodinium homomorphum Zone: 2531.0 metres Paleocene.

The two samples in this interval although confidently *L. balmei* Zone in age cannot be definitively assigned to either the Upper or Lower subdivisions because of the lack of key spore-pollen species. The rare presence of the dinoflagellate *Apectodinium homomorphum* (short spined variety) in the shallower sample suggest that it most likely represents the Upper subdivision based on association of this dinoflagellate with key spore-pollen species of the Upper subdivision in other wells.

Lower *Malvacipollis diversus* Zone: 2417.0-2438.0 metres Early Eocene.
and
Apectodinium hyperacanthum Zone: 2438.0 metres Early Eocene.

The base of the zone is picked on an abundance of *Malvacipollis diversus* and the FADs (First Appearance Datums) of the spores *Crassiretitriletes vanraadshoovenii* and *Polypodiaceoisporites varus* ms, and the palm pollen *Spinozonocolpites prominatus*. These latter three species are all considered to be derived from plants growing in mangrove environments. Also present is a species of *Spinozonocolpites* characterised by gemmate rather than baculate ornament which has previously only been recorded in Australia from the Tertiary of northern Australia (eg. species recorded as *Gemmamonocolpites* sp. by Hekel 1972, pl.3, fig.23). The shallower samples assigned to the zone are all characterised by frequent *Proteacidites grandis* but rely on the of absence of key species characteristic of the next younger zone for their assignment to the Lower subzone. A rare but significant species is *Myrtaceoipollenites australis* Harris 1965, recorded from the sample at 2417.0m.

The deepest sample, at 2438.0m, also contains a microplankton assemblage referable to the *Apectodinium hyperacanthum* Zone. The key indicators for the zone are the eponymous species and *Fibrocysta bipolare*. The diversity of the assemblage is considerably higher than recorded, but unfortunately most of the species are too poorly preserved to be properly identified. The shallowest sample, at 2417.0m, also contained dinoflagellates but again poor preservation hampered full identification of the assemblage.

Middle *Malvacipollis diversus* Zone: 2331.0-2275.0 metres Early Eocene.

This interval is assigned to the Middle subdivision of the *M. diversus* Zone based on the FAD of *Proteacidites tuberculiformis* in the deepest sample. Other species whose usual FADs are in this zone are *Polycolpites esobalteus* identified at 2331.0m and 2275.0m and *Proteacidites nasus* Truswell & Owen 1988 identified at 2301.0m. The shallowest sample also contains the dinoflagellates association of common *Homotryblium tasmaniense* with abundant *Apectodinium longispinosum* which is generally considered typical of the younger Upper *M. diversus* and *P. asperopolus* Zones. However, after considerable searching neither of the key species *Proteacidites pachypolus* or *Myrtaceidites tenuis* could be found.

Upper *Malvacipollis diversus* Zone: 2144.7-2223.0 metres Early Eocene.

The base of this zone is picked at the FAD of *Poteacidites pachypolus* at 2223.0m. The other key species used to indicate the base of this zone is *Myrtaceidites tenuis* whose FAD occurs in the shallowest sample at 2144.7m. The base of the *P. pachypolus* abundance or Acme is in the middle sample at 2156.0m. Abundant specimens of the dinoflagellate *Apectodinium longispinosum* also characterise the shallowest sample.

Proteacidites asperopolus Zone: 2041.0-2116.8 metres Early Eocene.

The lower boundary of this zone is placed at the FADs for *Conbaculites apiculatus* and *Sapotaceoidaepollenites rotundus*, below the FAD for *Proteacidites asperopolus* in the next deepest sample at 2066.8m. The upper boundary is placed at the LAD (Last Appearance Datum) for *Myrtaceidites tenuis*. Unlike in the adjacent Conger-1 well (Partridge, 1989) the *P. pachypolus* abundance or Acme does not extend to the top of the zone but is characteristic of the deeper two samples. Of considerable interest is the generally rare index species for the zone *Bombacacidites bombaxoides* at 2116.8m, *Clavastephanocolporites meleosus* ms at 2066.8m, and *Triporopollenites simplis* Truswell & Owen 1988 (= *Triporopollenites spinosus* ms) at 2041.0m and 2066.8m. Other interesting species in the samples, but of no zone significance, are the records of single specimens of the fresh-water megaspore *Azolla* sp. at 2116.8m, the distinctive pollen *Anisotricolporites triplaxis* at 2041.0m and a closely related species *Anisotricolporites* sp. cf. *A. truncatus* Pocknall & Mildenhall 1984, at 2066.8m.

The only significant dinoflagellate in the zone is the occurrence of rare specimens of *Apectodinium longispinosum* in the deepest sample.

Lower *Nothofagidites asperus* Zone: 2000.0-2023.0 metres Middle Eocene.

The base of the zone is picked at 2023.0m on the increase in abundance of *Nothofagidites* spp. above the LAD of *M. tenuis*. However, in the absence of key indicator species known to first occur in the Lower *N. asperus* Zone only a low confidence rating can be assigned to the sample. The shallower sample at 2000.0m although clearly no older than this zone based on the

FAD of *Nothofagidites falcatus* is also only given a low confidence rating because the associated microplankton assemblage has closer similarities to assemblages from the Middle rather than Lower subdivision of the *N. asperus* Zone. The dinoflagellates suggesting a younger age are the frequent to common occurrence of the species *Operculodinium centrocarpum*, *Phthanoperidinium comatum* and *Areosphaeridium* sp. cf. *A. capricornum*. Given the presence of the last species it is noted that no specimens which could be confidently identified as *Areosphaeridium australicum* ms (= *Areosphaeridium* sp. cf. *A. diktyoplokus* of Marshall & Partridge 1987) could be found in any of the palynological slides.

Middle *Nothofagidites asperus* Zone: 1989.0-1994.0 metres Late Eocene.

Two samples are assigned to this zone on their microplankton content as the associated spores and pollen while supportive are not particularly diagnostic of the zone. Key dinoflagellate species are *Corrudinium incompositum* and *Areosphaeridium capricornum* at 1994.0m and *Gippslandica extensa* associated with abundant *Tectactodinium marlum* ms at 1989.0m.

The *Gippslandica extensa* Zone was informally proposed (as the *Deflandrea extensa* Zone) in Partridge (1976). It is typically characterised by abundances of the nominated species in "coastal plain" environments, and is best developed in wells to the west and north of the Sawbelly-1 location. However, *G. extensa* is not characteristic of the coeval "shelfal marine" environments of the Gurnard Formation developed to the east and south of the Sawbelly-1 location and therefore the *Corrudinium incompositum* Zone has been used as an alternative name. The *G. extensa* and *C. incompositum* Zones have therefore been treated as time equivalent but representative of different environments. The occurrence of the *G. extensa* Zone above the *C. incompositum* Zone in Sawbelly-1 suggest the alternative interpretation that the "typical" development of the *G.extensa* Zone lies above the *C. incompositum* Zone.

Proteacidites tuberculatus Zone: 1976.0-1983.0 metres Oligocene.

The two samples are confidently assigned to the *P. tuberculatus* Zone based on the occurrence of the spore *Cyatheacidites annulatus* in both samples. Both assemblages are dominated by dinoflagellates consistent with the open marine environment of the Lakes Entrance Formation. Of particular interest is the first record in Australia of the unique dinoflagellate

Evittosphaerula paratabulata Manum 1979 from the sample at 1983.0m. This dinoflagellate cyst is characterised by consisting solely of a parasutural network of wall material whose strands define a standard gonyaulacaecean paratabulation. The stratigraphic range of this species given in Manum (1979) is late Middle Oligocene to Early Miocene.

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TABLE-1: INTERPRETATIVE PALYNOLOGICAL DATA SAWBELLY-1, GIPPSLAND BASIN

SAMPLE TYPE	DEPTH (metres)	SPORE-POLLEN ZONE	DINOFLAGELLATE ZONE	CONFIDENCE RATING	COMMENT
SWC 60	1976.0	*P. tuberculatus*		1	
SWC 59	1983.0	*P. tuberculatus*		0	*Evittosphaerula paratabulata* present.
SWC 58	1989.0	Middle *N. asperus*	*G. extensa*	2	Abundant *Tectatodinium marlum* ms.
SWC 57	1994.0	Middle *N. asperus*	*C. incompositum*	1	
SWC 56	2000.0	Lower *N. asperus*		2	
SWC 54	2011.0	Indeterminate			
SWC 53	2023.0	Lower *N. asperus*		2	LAD *Proteacidites asperopolus*
SWC 52	2041.0	*P. asperopolus*		1	LAD *Myrtaceidites tenuis*.
SWC 51	2066.8	*P. asperopolus*		1	*Clavastephanocolporites meleosus* ms present.
SWC 49	2116.8	*P. asperopolus*	(*A. longispinosum*)	1	*Bombacacidites bombaxoides* present.
SWC 48	2144.7	Upper *M. diversus*	(*A. longispinosum*)	2	Fossils badly pyrite pitted.
SWC 47	2156.0	Upper *M. diversus*		1	Base *Proteacidites pachypolus* Acme.
SWC 46	2223.0	Upper *M. diversus*		1	
SWC 43	2275.0	Middle *M. diversus*	(*A. longispinosum*)	2	Fossils badly pyrite pitted.
SWC 42	2301.0	Middle *M. diversus*	(*A. longispinosum*)	2	
SWC 41	2309.0	Indeterminate			Most fossils probably contaminants.
SWC 40	2331.0	Middle *M. diversus*		1	FAD *Proteacidites tuberculifomis*.
SWC 35	2417.0	Lower *M. diversus*		2	*Mytaceoipollenites australis* present.
SWC 34	2423.0	Lower *M. diversus*		1	
SWC 33	2431.0	Indeterimate			Virtually barren.
SWC 32	2438.0	Lower *M. diversus*	*A. hyperacanthum*	0	
SWC 29	2531.0	*L. balmei*	*A. homomorphum*	1	
SWC 25	2639.5	*L. balmei*		1	
SWC 16	2822.0	Indeterminate			
SWC 15	2838.0	Lower *L. balmei*	(*G. retiintexta*)	2	
SWC 14	2860.0	Lower *L. balmei*		1	
SWC 5	2977.0	Lower *L. balmei*		1	*Proteacidites angulatus* present.
SWC 2	3008.0	Lower *L. balmei*		2	
SWC 1	3022.5	Lower *L. balmei*		2	

LAD - Last Appearance Datum
FAD - First Appearance Datum

PALYNOLOGY DATA SHEET

BASIN: GIPPSLAND ELEVATION: KB: +21.0m GL: -63.0m

WELL NAME: SAWBELLY-1 TOTAL DEPTH: 3068m

AGE	PALYNOLOGICAL ZONES	HIGHEST DATA Preferred Depth	Rtg	Alternate Depth	Rtg	Two Way Time	LOWEST DATA Preferred Depth	Rtg	Alternate Depth	Rtg	Two Way Time
NEOGENE	*T. pleistocenicus*										
NEOGENE	*M. lipsis*										
NEOGENE	*C. bifurcatus*										
NEOGENE	*T. bellus*										
NEOGENE	*P. tuberculatus*	1976	1				1983	0			
PALEOGENE	Upper *N. asperus*										
PALEOGENE	Mid *N. asperus*	1989	2				1994	1			
PALEOGENE	Lower *N. asperus*	2000	2				2023	2			
PALEOGENE	*P. asperopolus*	2041	1				2116.8	1			
PALEOGENE	Upper *M. diversus*	2144.7	2	2156	1		2223	1			
PALEOGENE	Mid *M. diversus*	2275	2				2331	1			
PALEOGENE	Lower *M. diversus*	2417	2	2423	1		2438	0			
PALEOGENE	Upper *L. balmei*										
PALEOGENE	Lower *L. balmei*	2838	2	2860	1		3022.5	2	2977	1	
LATE CRETACEOUS	Upper *T. longus*										
LATE CRETACEOUS	Lower *T. longus*										
LATE CRETACEOUS	*T. lilliei*										
LATE CRETACEOUS	*N. senectus*										
LATE CRETACEOUS	*T. apoxyexinus*										
LATE CRETACEOUS	*P. mawsonii*										
LATE CRETACEOUS	*A. distocarinatus*										
EARLY CRET.	*P. pannosus*										
EARLY CRET.	*C. paradoxa*										
EARLY CRET.	*C. striatus*										
EARLY CRET.	*C. hughesi*										
EARLY CRET.	*F. wonthaggiensis*										
EARLY CRET.	*C. australiensis*										

COMMENTS: Dinoflagellate Zones: *G. extensa* 1989m; *C. incompositum* 1994m; *A. hyperacanthum* 2438m; *A. homomorphum* 2531m; Top sample from *L. balmei* Zone is at 2531m; but assignment to Upper or Lower subdivision is not possible. All depths in metres.

CONFIDENCE RATING:
- 0: SWC or Core, Excellent Confidence, assemblage with zone species of spores, pollen and microplankton.
- 1: SWC or Core, Good Confidence, assemblage with zone species of spores and pollen or microplankton.
- 2: SWC or Core, Poor Confidence, assemblage with non-diagnostic spores, pollen and/or microplankton.
- 3: Cuttings, Fair Confidence, assemblage with zone species of either spores and pollen or microplankton, or both.
- 4: Cuttings, No Confidence, assemblage with non-diagnostic spores, pollen and/or microplankton.

NOTE: If an entry is given a 3 or 4 confidence rating, an alternative depth with a better confidence rating should be entered, if possible. If a sample cannot be assigned to one particular zone, then no entry should be made, unless a range of zones is given where the highest possible limit will appear in one zone and the lowest possible limit in another.

DATA RECORDED BY: A.D. Partridge DATE: June 1990.

DATA REVISED BY: DATE:

BASIC DATA

TABLE-2: BASIC DATA

RANGE CHART

TABLE-2: BASIC PALYNOLOGICAL DATA SAWBELLY-1, GIPPSLAND BASIN

SAMPLE TYPE	DEPTH (metres)	LAB. NO.	LITHOLOGY	RESIDUE YIELD	PALYNOMORPH CONCENTRATION	PRESERVATION	NO. OF S-P SPECIES*	MICROPLANKTON ABUNDANCE	NO. SPECIES*
SWC 60	1976.0	78352 H	Calcareous claystone	Very low	Low	Poor-good	9+	Low	4+
SWC 59	1983.0	78352 G	Calcareous claystone	Moderate	Moderate	Poor-good	15+	Moderate	8+
SWC 58	1989.0	78352 F	Glauconitic claystone	Low	Moderate	Poor-fair	21+	Moderate	4+
SWC 57	1994.0	78352 E	Glauconitic claystone	Moderate	Low	Fair	13+	Moderate	9+
SWC 56	2000.0	78352 D	Calc. quartz sst. (tr. glauc.)	Low	Moderate	Poor-fair	26+	Moderate	8+
SWC 54	2011.0	78352 B	Glauconitic sandstone	Very low	Barren				
SWC 53	2023.0	78352 A	Oxidised brown sandstone	Low	High	Good	38+	Low	5+
SWC 52	2041.0	78351 Z	Mottled sandstone	High	Modertae	Fair-good	34+	Very low	2+
SWC 51	2066.8	78351 Y	Carbonaceous sandstone	Moderate	High	Good	57+		
SWC 49	2116.8	78351 W	Mottled sandstone	High	High	Good	36+	Moderate	5+
SWC 48	2144.7	78351 V	Laminated siltstone	High	Moderate	Poor-fair	19+	Moderate	1
SWC 47	2156.0	78351 U	Chocolate brown mudstone	High	High	Fair	26+		
SWC 46	2223.0	78351 T	Medium brown siltstone	High	Very low	Poor-fair	7+		
SWC 43	2275.0	78351 Q	Micaceous/carbonaceous sltst	High	Moderate	Poor	23+	Moderate	5+
SWC 42	2301.0	78351 P	Interbedded sst./siltst.	High	Moderate	Poor-fair	30+	Low	1
SWC 41	2309.0	78351 O	White-light grey sandstone	Low	Low	Fair	11+		
SWC 40	2331.0	78351 N	Siltstone	High	Moderate	Fair	32+		
SWC 35	2417.0	78351 I	Carbonaceous sandstone	Low	Moderate	Poor-good	28+	Very low	3
SWC 34	2423.0	78351 H	Massive pyritic mudstone	High	Moderate	Poor	20+	Low	3+
SWC 33	2431.0	78351 G	Very fine grained sandstone	Very low	Very low	Fair	3		
SWC 32	2438.0	78351 F	Massive mudstone	High	High	Poor-fair	20+	Abundant	6+
SWC 29	2531.0	78351 C	Interbedded sst./siltst.	High	Low	Poor	13+	Low	1
SWC 25	2639.5	78350 Y	Massive mudstone	High	Low	Poor	20+		
SWC 16	2822.0	78350 P	Siltstone	High	Very low	Poor	2+	Very low	1
SWC 15	2838.0	78350 O	Very fine grained sandstone	High	Very low	Very poor	7+	Low	2
SWC 14	2860.0	78350 N	Carbonaceous mudstone	High	Moderate	Poor-fair	13+		
SWC 5	2977.0	78350 R	Siltstone	High	Low	Very poor	18+		
SWC 2	3008.0	78350 B	Carbonaceous siltstone	High	Low	Very poor	13+		
SWC 1	3022.5	78350 A	Carbonaceous siltstone	High	Low	Very poor	12+		

* Diversity:
Very Low - 1- 5 species
Low - 6-10 species
Moderate - 11-25 species
High - 26-74 species
Very High - 75+ species

(ADP279)