Palynological analysis of four cuttings samples between 1461 and 1503 metres in Judith–1, Gippsland Basin.

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INTERPRETATIVE DATA

Summary

Four new cuttings samples were collected and analysed from the Gurnard and Flounder Formations in Judith–1. The two shallower cuttings at 1461 and 1482m contain spore-pollen assigned to the Lower *N. asperus* Zone and microplankton diagnostic of the *D. heterophlycta* and *E. partridgei* Zones. The two deeper cuttings at 1494m and 1503m contain diverse spore-pollen assigned to the *P. asperopolus* Zone and the key dinoflagellate index species for the *C. thompsoniae* Zone. The exact position of the boundary between the Gurnard and Flounder Formations is uncertain but the best choices on the electric logs are at either 1483m or 1490m. The stratigraphic succession in the well is summarised in Table 1, and the zone assignments of the individual samples provided in Table 2.

Table 1: Palynological Summary for Judith–1.

AGE	STRATIGRAPHY	SPORE-POLLEN and (MICROPLANKTON) ZONES	DEPTHS mKB
RECENT to OLIGOCENE	SEASPRAY GROUP Seafloor to 1451m	*P. tuberculatus* † (*Operculodinium* Sz) †	1449 to 1451m† (1449 to 1451m†)
Middle to Late EOCENE	LATROBE GROUP Gurnard Formation 1451 to 1483m	Middle *N. asperus* † (*G. extensa*) † Lower *N. asperus* (*D. heterophlycta*) (*E. partridgei*)	1454m† (1454m†) 1461 to 1482m (1461m) (1471† to 1482m)
Early EOCENE	LATROBE GROUP Flounder Formation 1483 to 1505m	*P. asperopolus* † (*C. thompsoniae*)	1488 to 1503.5m† (1494 to 1503m)
Early EOCENE to MAASTRICHTIAN	LATROBE GROUP Halibut Subgroup 1505 to 1991m	Lower *M. diversus* † *L. balmei* † *F. longus* †	1509.5 to 1546.5m 1571.5 to 1701.5m 1764 to 1875.5m
CAMPANIAN	LATROBE GROUP Golden Beach Subgp. 1886 to 1991m	Palynology dating of SWCs uncertain.	
TURONIAN	LATROBE GROUP Emperor Subgroup 1991 to 2958mTD	*P. mawsonii* †	1993 to 2908m

† Zone picks based on review of Macphail (1982).

Introduction

The collection and analysis of four new palynological samples from Judith–1 was undertaken as part of a larger review project for Basin Oil Pty Ltd, reviewing the age dating and correlation of the Gurnard Formation in the wells Baleen–1, Flathead–1, Patricia–1, Sperm Whale–1 and Whale–1, located on the Northern Strzelecki Terrace in the offshore Gippsland Basin. The samples were collected by the author from the Victorian Department of Natural Resources & Environment on 13th September 2000, and submitted to Laola Pty Ltd in Perth for palynological processing. The prepared palynological slides were returned during the next two weeks and Provisional Report on the new analyses for Judith–1 was submitted on the 12th October.

An average of 19 grams of washed and dried cuttings were processed for each sample. Recovery of the organic residue varied from low to moderate, while the palynomorph concentrations on these slides was mostly high enabling highly diverse spore-pollen assemblages and moderate diversity microplankton assemblages to be recorded. Details of zone assignments, confidence ratings and key comments are given in Table 2, while basic sample data is provided in Table 3, and visual residues yields, palynomorph preservation and species diversity are provided in Table 4. Results of the assemblage counts are provided in Table 5, and lists of all known spore-pollen and microplankton identified are provided in Table 6. Author citations for spore-pollen species can mostly be sourced from Stover & Partridge (1973, 1982), and for the microplankton species from the indexes of Williams *et al.* (1998) and Fensome *et al.* (1990). Species names followed by “ms” or “†” are unpublished manuscript names.

Geological Discussion

The analysis of cuttings sample from Judith–1 confirms and compliments the original palynological analysis of the sidewall cores by Macphail (1990). Early to Late Eocene ages are recorded from the 54 metre thick interval of fine-grained glauconitic-rich sediments found at the top of the Latrobe Group. The basal 22 metres is assigned to the Flounder Formation, while the upper 33 metres is assigned to the Gurnard Formation, with the preferred boundary between the two formations placed at the base of a distinct gamma ray spike at ~1482 to 1483m. An alternative choice for the formation boundary is six metres lower at 1490m where there is a significant change in the character of the density/porosity logs.

Compared to the sequences analysed in Patricia–1 and the other wells located over 12 km to the NNW much of the glauconitic-rich interval in Judith–1 is older. For example, in Judith–1 the deposition of the glauconitic facies starts in the Early Eocene *P. asperopolus* Zone, and the succeeding early Middle Eocene *E. partridgei* microplankton Zone appears to be thicker and better developed. In contrast, the late Middle Eocene to Late Eocene zones are thinner. In Patricia–1, for example, the *D. heterophlycta* Zone is over 30 metres thick, but probably no more than 10 metres thick in Judith–1. The overlying Late Eocene represented by the *C. incompositum* and *G. extensa* to *S. kakanuiensis* Zones is probably no more than 10 metres thick in all wells under review, but is known to be over 25 metres thick in more westerly parts of the basin (eg. Blenny–1: Partridge, 1992). These difference in thickness of the microplankton zones within the glauconitic-rich facies can be explained by the more basinward setting of Judith–1, as it lies on the southern edge of the Strzelecki Terrace. This location was submerged earlier and remained more distal from the palaeoshoreline during the Eocene transgression of the basin.

Discussion of Assemblages

Lower *Nothofagidites asperus* spore-pollen Zone.

Interval: 1461 to 1482 metres.

Age: Middle Eocene.

The two shallower cuttings are confidently assigned to the broad *N. asperus* Zone of Stover & Partridge (1973) based on the dominance of *Nothofagidites* pollen (average 27%). An age no older than the Lower subzone is indicated by the occurrence of the index species *Nothofagidites falcatus* in both samples and *Tricolpites simatus* in the lower sample. An age no younger than the subzone is indicated by the occurrence of *Proteacidites asperopolus*, *P. pachypolus* and *P. recavus* in both samples.

***Deflandrea heterophlycta* microplankton Zone.**

Sample at: 1461 metres.

Age: late Middle Eocene.

The shallowest cuttings sample is assigned to the *D. heterophlycta* Zone based on the occurrence of the eponymous species in association with the acritarch *Paucilobimorpha inaequalis* (= *Tritonites inaequalis* Marshall & Partridge, 1988), even though the microplankton assemblage is overwhelmingly dominated by species caved from the *Operculodinium* Superzone.

***Enneadocysta partridgei* microplankton Zone.**
Sample at: 1482 metres.
Age: early Middle Eocene.
The cuttings sample at 1482m displays a marked decline in caved microplankton and is assigned to the *E. partridge* Zone based on the presence of multiple specimens of both the eponymous species and *Deflandrea flounderensis*. Supporting this assignment is the record by Macphail (1990) of *Paucilobimorpha pandus* (= *Tritonites pandus* Marshall & Partridge, 1988) in the sidewall core at 1471m, as this species ranges no younger than this zone.

The *E. partridge* Zone has previously been recorded in both palynological reports and on stratigraphic tables from the Gippsland Basin as the informal *A. australicum* Zone. The name change is necessary as *Areosphaeridium australicum* was a manuscript species that has recently been described as *Enneadocysta partridgei* by Stover & Williams (1995).

***Proteacidites asperopolus* spore-pollen Zone, and**
***Charlesdowniea thompsoniae* microplankton Zone.**
Interval: 1494 to 1503 metres.
Age: Early Eocene.
The two deeper cuttings are assigned to the *P. asperopolus* Zone on species occurrences and assemblage composition. Both samples are no older than the zone based on the presence of the eponymous species *Proteacidites asperopolus* in association with *Conbaculites apiculatus* ms, *Clavastephanocolporites meleosus* and *Sapotaceoidaepollenites rotundus*. The shallower sample is no younger than the zone based on the joint occurrence of *Intratriporopollenites notabilis*, *Myrtaceidites tenuis* and *Proteacidites ornatus*. The composition of the assemblages is also considered characteristic of the zone, by containing reduced numbers of *Nothofagidites* pollen (average 7%) and an increased abundance of *Proteacidites* pollen (average 19%). In addition the shallower sample has an abundance spike (8%) of *Proteacidites pachypolus* and *P. asperopolus* which was originally considered the most diagnostic feature of the zone (Stover & Partridge, 1973).

Although the abundant occurrence of *Spiniferites* cysts (average 28% of MP count) suggests a significant proportion of the microplankton assemblage is caved the presence of rare specimens of the distinctive *Charlesdowniea* (al. *Kisselovia*) *thompsoniae* ms confirms assignment to the *C. thompsoniae* Zone. Other

significant Early Eocene dinocysts in the assemblages are *Deflandrea dartmooria*, *D. flounderensis* and *Kenleyia* spp.

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Table 2: Interpretative data from the Judith–1 well.

Sample Type	Depth	Spore-Pollen Zone (Microplankton Zone)	CR*	Comments and Key Species Present
Cuttings	1461m	Lower *N. asperus* (*D. heterophlycta*)	D2 D2	MP 70%, but *in situ* MP <5%. Dinocysts of *Spiniferites* dominate assemblage (33% of MP count) and are mostly caved. *Nothofagidites* pollen 26%. Age based on LADs of *Proteacidites asperopolus* and *Enneadocysta partridgei*, and FAD of *Paucilobimorpha inaequalis*.
Cuttings	1482m	Lower *N. asperus* (*E. partridgei*)	D1 D2	MP 23%, but *in situ* MP <5%. *Nothofagidites* pollen 28%. Presence of common *Deflandrea flounderensis* suggests a position low in *E. partridge* Zone.
Cuttings	1494m	*P. asperopolus* (*C. thompsoniae*)	D1 D3	MP 16%, but *in situ* MP <5%. *Proteacidites pachypolus* and *P. asperopolus* 8% and total *Proteacidites* 28%, while *Nothofagidites* pollen declines to 9%. Age based on LADs of *Myrtaceidites tenuis* and *Intratripropollenites notabilis* and *Charlesdowniea thompsoniae* ms.
Cuttings	1503m	*P. asperopolus* (*C. thompsoniae*)	D1 D3	MP 6%, but *in situ* MP <3%. *H. harrisii* pollen at 17% > *Nothofagidites* pollen at 5% while total *Proteacidites* pollen 10%. Age based on FADs of *Proteacidites asperopolus* and *Charlesdowniea thompsoniae* ms.

MP %= microplankton expressed as % of combined SP & MP count.
Nothofagidites % = abundance expressed as % of SP count only.
FAD & LAD = First & Last Appearance Datums.
*CR = Confidence Ratings

*Confidence Ratings used in STRATDAT database and applied to Table 2.

Alpha codes: Linked to sample		**Numeric codes:** Linked to fossil assemblage		
A	Core	**1**	**Excellent confidence:**	High diversity assemblage recorded with key zone species.
B	Sidewall core	**2**	**Good confidence:**	Moderately diverse assemblage recorded with key zone species.
C	Coal cuttings	**3**	**Fair confidence:**	Low diversity assemblage recorded with key zone species.
D	Ditch cuttings	**4**	**Poor confidence:**	Moderate to high diversity assemblage recorded without key zone species.
E	Junk basket	**5**	**Very low confidence:**	Low diversity assemblage recorded without key zone species.

BASIC DATA

Table 3: Basic sample data on new samples processed from Judith–1.

Sample Type	Depth	Lithology	Weight (grams)
Cuttings	1461m	Greenish brown mudstone (definite top of Gurnard)	21.2
Cuttings	1482m	Brown/greenish to grey mudstone (coarse fragments)	18.5
Cuttings	1494m	Medium brown grey mudstone (coarse fragments and powder)	21.0
Cuttings	1503m	Medium grey mudstone (coarse fragments and powder)	15.6
		Average:	**19.1**

Table 4: Basic assemblage data on samples examined in Judith–1.

Sample Type	Depths	Visual Yield	Palynomorph Concentration	Preservation	No. SP Species	No. MP Species
Cuttings	1461m	Moderate	High	Fair	38+	24+
Cuttings	1482m	Low	Moderate	Poor-good	59+	27+
Cuttings	1494m	High	High	Poor-good	63+	20+
Cuttings	1503m	Moderate	High	Poor-good	50+	14+
				Averages:	**52+**	**21+**

Table 5. Judith–1 BASIC DATA on abundance of palynomorphs				
Sample Type:	**Cts**	**Cts**	**Cts**	**Cts**
Depth (m):	**1461**	**1482**	**1494**	**1503**
SPORE-POLLEN SPECIES				
Baculatisporites spp.			0.9%	0.6%
Cyathidites spp. large >40µm			0.9%	2.5%
Cyathidites spp. small <40µm	7.5%	3.4%	1.8%	6.4%
Dictyophyllidites spp.				0.6%
Gleicheniidites circinidites		2.6%	2.8%	8.3%
Laevigatosporites spp.	1.3%	0.9%	2.8%	7.6%
Peromonolites vellosus			0.9%	
Polypodiidites perverrucatus		0.9%	0.9%	
Stereisporites spp.	2.5%	0.9%		3.8%
Trilete spores undiff.	1.3%	1.7%	0.9%	1.3%
Verrucosisporites kopukuensis				0.6%
TOTAL SPORES:	**13%**	**10%**	**12%**	**32%**
GYMNOSPERMS				
Araucariacites australis	5.0%		0.9%	0.6%
Dilwynites spp.	10.0%	3.4%	3.7%	12.7%
Lygistepollenites florinii	1.3%	2.6%	2.8%	2.5%
Microcachyridites antarticus		1.7%		
Phyllocladidites mawsonii	5.0%	2.6%		
Podocarpidites spp.	11.3%	2.6%	1.8%	5.1%
Trichotomosulcites subgranulatus		0.9%		0.6%
TOTAL GYMNOSPERM POLLEN:	**33%**	**14%**	**9%**	**22%**
ANGIOSPERM pollen undiff.	1.3%	1.7%	0.9%	1.3%
Clavastephanocolporites meleosus			0.9%	
Cupanieidites orthoteichus			1.8%	0.6%
Dicotetradites clavatus		0.9%	0.9%	
Haloragacidites harrisii	7.5%	12.0%	1.8%	16.6%
Ilexpollenites spp.			1.8%	
Malvacipollis subtilis	1.3%	2.6%	4.6%	1.9%
Malvacipollis diversus				0.6%
Monosulcites waitakiensis		0.9%		
Myrtaceidites mesonesus/parvus	1.3%		0.9%	
Nothofagidites brachyspinulosus		0.9%		0.6%
Nothofagidites deminutus	1.3%	0.9%	0.9%	0.6%
Nothofagidites emarcidus/heterus	23.8%	22.2%	6.4%	2.5%
Nothofagidites flemingii		3.4%	1.8%	1.3%
Nothofagidites goniatus		0.9%		
Nothofagidites vansteenisii	1.3%			
Periporopollenites spp.				0.6%
Proteacidites asperopolus			4.6%	0.6%
Proteacidites obscurus	1.3%	1.7%		
Proteacidites pachypolus			3.7%	1.9%
Proteacidites spp.	10.0%	13.7%	20.2%	7.0%
Santalumidites cainozoicus	2.5%	0.9%	1.8%	0.6%
Sapotaceoidaepollenites rotundus			0.9%	
Tricolp(or)ates spp.	3.8%	13.7%	22.0%	9.6%
Triporopollenites simplis			2.8%	
TOTAL ANGIOSPERM POLLEN:	**55%**	**76%**	**79%**	**46%**
TOTAL SPORE-POLLEN COUNT:	**80**	**117**	**109**	**157**

Table 5. Judith–1 BASIC DATA on abundance of palynomorphs

Sample Type:	Cts	Cts	Cts	Cts
Depth (m):	**1461**	**1482**	**1494**	**1503**
MICROPLANKTON				
Dinoflagellates undiff:	9%	32%	17%	30%
Baltisphaeridium nanum (sensus lato)	3%		4%	10%
Deflandrea spp.		12%		
Enneadocysta partridgei		3%		
Fromea sp. cf. F. chytra	1%			
Kenleyia spp.				10%
Lingulodinium machaerophorum		6%		20%
Micrhystridium spp.			4%	
Nematosphaeropsis rhizoma†	2%			
Operculodinium centrocarpum	9%	9%	9%	
Paralecaniella indentata	1%			
Protoellipsodinium clavatus†	1%			
Protoellipsodinium simplex†	6%	3%		
Pyxidinopsis pontus†	1%			
Cerebrosphaera zigzag†	34%	6%	17%	10%
Spinidinium spp.			13%	
Spiniferites spp.	33%	29%	35%	20%
Systematophora placacanthum	1%			
Tectatodinium pellitum	1%			
Total MICROPLANKTON COUNT:	**190**	**34**	**23**	**10**
TOTAL SP & MP COUNT:	**270**	**151**	**132**	**167**
Microplankton as % SP + MP:	**70.4%**	**22.5%**	**17.4%**	**6.0%**
OTHER PALYNOMORPHS				
Fungal spores & hyphae	3.2%	4.4%	9.0%	2.3%
TOTAL COUNT:	**279**	**158**	**145**	**171**
† Manuscript species				

Table 6. Judith–1 BASIC DATA Palynomorph Distribution List

Sample Type:	Cts	Cts	Cts	Cts
Depth (m):	1461	1482	1494	1503
SPORE-POLLEN SPECIES				
Anacolosidites acutullus			X	X
Araucariacites australis	5%		X	X
Baculatisporites spp.		X	X	X
Beaupreaidites trigonalis†		X		
Beaupreaidites verrucosus	X			
Bluffopollis scabratus				X
Camarozonosporites heskermensis	X		X	X
Clavastephanocolporites meleosus			X	X
Conbaculites apiculatus†		X	X	X
Corollina torosa		RW		
Cupanieidites orthoteichus	X	X	2%	X
Cupanieidites reticulatus		X		
Cyatheacidites annulatus			CV	
Cyathidites palaeospora	8%	3%	2%	6%
Cyathidites splendens		X	X	X
Cyathidites subtilis	CV			
Cyathidites spp. large >40µm			X	3%
Dacrycarpidites australiensis		X		
Dicotetradites clavatus		X	X	
Dictyophyllidites arcuatus				X
Dictyophyllidites spp.				X
Dilwynites granulatus	10%	3%	4%	13%
Dilwynites tuberculatus		X		X
Diporites delicatus†			X	
Dryptopollenites semilunatus			X	
Ericipites crassiexinus	X	X		
Foveotriletes lacunosus	CV			
Gleicheniidites circinidites		3%	3%	8%
Haloragacidites harrisii	8%	12%	2%	17%
Haloragacidites trioratus			X	
Helciporites astrus		X	X	
Herkosporites elliottii		X	X	
Ilexpollenites spp.			2%	X
Intratriporopollenites notabilis			X	
Ischyosporites gremius		X	X	X
Laevigatosporites major	X	X	X	X
Laevigatosporites ovatus	X	X	3%	8%
Lygistepollenites balmei			RW	
Lygistepollenites florinii	X	3%	3%	3%
Malvacipollis diversus				X
Malvacipollis robustus†		X	X	
Malvacipollis subtilis	X	3%	5%	2%
Matonisporites ornamentalis		X	X	
Microcachyridites antarticus		2%		
Milfordia homeopunctatus		X		
Monosulcites waitakiensis		X		
Myrtaceidites mesonesus/parvus	X		X	
Myrtaceidites tenuis			X	
Myrtaceoipollenites australis				X
Nothofagidites asperus	X		X	
Nothofagidites brachyspinulosus		X	X	X
Nothofagidites deminutus	X	X	X	X
Nothofagidites emarcidus/heterus	24%	22%	6%	3%
Nothofagidites falcatus	X	X		
Nothofagidites flemingii		3%	2%	X

Table 6. Judith–1 BASIC DATA Palynomorph Distribution List

Sample Type:	Cts	Cts	Cts	Cts
Depth (m):	1461	1482	1494	1503
Nothofagidites goniatus		X		
Nothofagidites vansteenisii	X		X	X
Parvisaccites catastus				
Periporopollenites demarcatus	X	X	X	X
Peromonolites densus		X		
Peromonolites vellosus		X	X	
Phyllocladidites mawsonii	5%	3%	X	
Podocarpidites spp.	11%	3%	2%	5%
Polycolpites esobalteus		X	X	
Polypodiidites perverrucatus	X	X	X	
Pseudowinterapollis cranwellae				X
Proteacidites adenanthoides	X			
Proteacidites annularis	X	X		
Proteacidites asperopolus	X	X	5%	X
Proteacidites biornatus†			X	X
Proteacidites crassus		X		
Proteacidites grandis				X
Proteacidites incurvatus				X
Proteacidites kopiensis			X	
Proteacidites latrobensis		X		
Proteacidites obscurus	X	2%		
Proteacidites ornatus			X	
Proteacidites pachypolus	X	X	4%	2%
Proteacidites pseudomoides		X		
Proteacidites recavus	X	X		
Proteacidites reticuloscabratus			X	
Proteacidites spp.	10%	14%	20%	7%
Proteacidites xestoformis†			X	
Retitriletes spp.				X
Rugulatisporites cowrensis	CV			
Rugulatisporites mallatus		X	X	X
Santalumidites cainozoicus	3%	X	2%	X
Sapotaceoidaepollenites rotundus			X	
Stereisporites antiquisporites	3%	X		4%
Trichotomosulcites subgranulatus		X		X
Tricolp(or)ates spp.	4%	14%	22%	10%
Tricolpites incisus			X	
Tricolpites simatus		X		
Tricolporites adelaidensis		X	X	
Tricolporites leuros		X		
Tricolporites paenestriatus		X	X	
Tricolporites moultonii†			X	
Tricolporites scabratus				X
Tricolporites sphaerica	X			
Triporopollenites simplis			3%	
Tripunctisporis maastrichtiensis	X			
Verrucatosporites alienus				X
Verrucosisporites kopukuensis	X	X		X
MICROPLANKTON				
Achomosphaera spp.		X	X	
Baltisphaeridium nanum (sensus lato)	3%		4%	10%
Cerebrosphaera zigzag†	34%	6%	17%	10%
Charlesdowniea thompsoniae†			X	X
Cleistosphaeridium epacrum†		X		
Cordosphaeridium inodes		X		X
Cyclopsiella vieta	X			CV

Table 6. Judith–1 BASIC DATA Palynomorph Distribution List

Sample Type:	Cts	Cts	Cts	Cts
Depth (m):	1461	1482	1494	1503
Deflandrea antarctica/flounderensis	X	X	X	X
Deflandrea cygniformis		X		
Deflandrea dartmooria		X	X	X
Deflandrea spp.	X	12%		X
Enneadocysta partridgei	X	3%	X	
Enneadocysta sp. cf. E. arcuatum		X		
Eocladopyxis peniculata		X	X	
Fromea sp. cf. F. chytra	X			
Glaphrocysta sp. cf. G. retiintexta				X
Heteraulacacysta paxilia†		X		
Hystiocysta variata†		X		
Hystrichokolpoma rigaudiae		X		
Impagidinium dispertitum	X		X	
Impagidinium maculatum	X			
Impagidinium spp.	X	X		
Kenleyia spp.				10%
Lingulodinium machaerophorum	X	6%		20%
Lingulodinium solarum	X		X	
Melitasphaeridium choanophorum		CV		
Micrhystridium spp.		X	4%	
Nematosphaeropsis rhizoma†	2%	X		
Operculodinium centrocarpum	9%	9%	9%	X
Operculodinium tabulatum†	CV			
Paralecaniella indentata	X			
Paucilobimorpha inaequalis	X			
Phthanoperidinium delicatum†		X	X	
Phthanoperidinium eocenicum		X		
Protoellipsodinium clavatus†	CV			
Protoellipsodinium simplex†	6%	3%	CV	CV
Pyxidinopsis beta†	CV			
Pyxidinopsis pontus†	CV			CV
Schematophora speciosus	X			
Spinidinium spp.			13%	
Spiniferites spp.	33%	29%	35%	20%
Systematophora placacanthum	X			
Systematophora traphosus†		X		
Tectatodinium pellitum	X			
Tuberculodinium vancompoae	CV			
Vozzhennikova apertura/rotunda	X	X	X	
OTHER PALYNOMORPHS				
Scolecodont	X			X
† Manuscript species				
X = Present (<1%)				
CV = Caved				
RW = Reworked				
cf. = Compare with				