Palynological analysis of new core and cuttings samples from the Latrobe Group in Flathead–1, Gippsland Basin.

by

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INTERPRETATIVE DATA

Summary

Two cuttings samples from the Gurnard Formation and one sample from each of the top three conventional cores were analysed over a 36 metre interval from 442 to 478m in Flathead–1. The cuttings samples confirm the Gurnard Formation contains spore-pollen assemblages from both the Lower and Middle *N. asperus* Zones, and ranges in age from Middle to Late Eocene. Although both samples also contained Eocene microplankton only those recorded in the deeper sample are diagnostic, being assigned to the late Middle Eocene *D. heterophlycta* Zone. The core samples confirm the presence of non-marine sediments belonging to the Early Eocene *P. asperopolus* Zone in a thin section of Latrobe Group coarse clastics intercalated between the base of the Gurnard Formation and Strzelecki Group. The top of the last unit being no older than the Mid to Late Albian *C. paradoxa* Zone. 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 Flathead–1.

AGE	UNIT/FACIES	SPORE-POLLEN ZONES (MICROPLANKTON ZONES)	DEPTHS mKB
RECENT to Late OLIGOCENE	SEASPRAY GROUP Seafloor to 447.5m	No palynology dating.	
Middle to Late EOCENE	LATROBE GROUP Gurnard Formation 447.5 to 470m	Middle *N. asperus* Lower *N. asperus* *(D. heterophlycta)*	442–448m 460–462m (455–462m†)
EOCENE?	LATROBE GROUP Undiff. coarse clastics 470 to 476.5m	*P. asperopolus*	472–473m
Middle to Late ALBIAN	STRZELECKI GROUP 476.5 to 1065.5mTD	*C. paradoxa* *C. striatus* or younger	478 to 517m† 1063 to 1065m†

† Zone picks based on earlier reports.

Introduction

The collection and analysis of five new palynological samples from Flathead–1 was undertaken as part of a larger review project for Basin Oil Pty Ltd, revising the age dating and correlation of the Gurnard Formation in the wells Baleen–1, Judith–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 (DNR&E) 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 Reports on the new analyses for Flathead–1 were submitted on the 25th September and 3rd October.

Collection of the cuttings samples through the Gurnard Formation in Flathead–1 was hampered by the extremely limited amount of washed and dried cuttings per sample held by the DNR&E. It was therefore necessary to collect a composite of two 10 ft intervals to obtain sufficient sample for palynological processing, yet still leave material for reference. Although the yield from the <10 grams of cuttings processed was low, the concentrations of palynomorphs on the slides were high. A different set of problems applied to conventional cores 1 to 3. These three cores had low recoveries due to difficulties encountered coring the conglomeratic Latrobe coarse clastics. The portion of the cores held by the DNR&E consisted of a mixture of sand, pebbles and rock fragments jumbled together in plastic sleeves. The best that could done was to collect the most favourable looking lithologies for palynological analysis and assign the depth intervals of the cores to the samples. Results of the analyses were also mixed with both unreliable and good palynomorph assemblages recovered.

Details of all zone assignments, confidence ratings and key comments are given in Table 2, while the basic sample data is provided in Table 3, and visual residues yields, preservation of palynomorphs and recorded species diversity provided in Table 4. Distribution and abundances of the principal spore-pollen and microplankton species identified are listed alphabetically in Tables 5 and 6. Author citations for spore-pollen species are mostly sourced from Stover & Partridge (1973, 1982) and Dettmann (1963), 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 new samples confirm the results of earlier studies of Flathead–1 and provide better documentation, but do not significantly change the ages assigned to the sequence in the earliest reports (Evans & Mulholland, 1969; Stover, 1970). The top cuttings sample is confidently assigned to the *N. asperus* Zone, but could belong to either the Lower or Middle subdivisions. The associated microplankton are mostly caved and do not provide further resolution. The deeper cuttings at 460–63m is more confidently assigned to the Lower *N. asperus* and *D. heterophlycta* Zones.

Assemblages from the samples from cores 1 and 2 are contaminated by North American Tertiary pollen types derived from a North American lignite commonly used as a drilling mud additive in many early wells to overcome lost circulation. Notwithstanding this complication, the assemblage from core 2 at 472–473m contains a spore-pollen assemblage that is confidently assigned to the *P. asperopolus* Zone, confirming the earlier age date for the coarse clastics section. Similar ages are found near the top of the Latrobe Group coarse clastics in Patricia–1 and Sperm Whale–1 (Partridge, 2000a-b).

The sample from core 3 contains a rich Early Cretaceous spore-pollen assemblage that is no older than the *C. striatus* Zone. However, a younger *C. paradoxa* Zone assignment is accepted for the top of the Strzelecki Group derived from earlier studies.

Significant numbers of reworked fossils from the Paleocene *L. balmei* Zone are recorded from the deeper cuttings at 460–63m, but their source is speculative. In contrast to the results from other wells there was no evidence of caved fossils in the cuttings to indicate the presence of the *F. leos* microplankton Zone higher in the well.

Discussion of Assemblages

***Nothofagidites asperus* spore-pollen Zone.**
Interval: 442 to 463 metres (1450 to 1530 feet).
Age: Middle to Late Eocene.
Although the two small cuttings samples gave low yields both contained high diversity spore-pollen assemblages and moderate diversity microplankton assemblages. The dominance of *Nothofagidites* pollen (average 37%), including the

index species *Nothofagidites falcatus* confirms assignment of both samples to the broad *N. asperus* Zone. The presence of *Anacolosidites sectus* (provided the single specimen is not caved) assigns the shallower sample to the Middle *N. asperus* Zone, while the presence *Proteacidites grandis* and the tentative identification of *Proteacidites reflexus* assigns the deeper sample to the Lower *N. asperus* Zone.

The dominance of *Spiniferites* (average 55% of MP count) in both samples suggests the bulk of the microplankton are caved from the Oligocene to Miocene *Operculodinium* Superzone. However, the deeper sample can also be assigned to the Middle Eocene *D. heterophlycta* Zone, based on the LADs of the eponymous species *Deflandrea heterophlycta* (represented by an endocyst) and *Enneadocysta partridgei*. Unfortunately, although the shallower cutting sample contains Eocene microplankton species they are not zone diagnostic. The early report by Stover (1970) provides little additional information but interesting does record *Diphyes colligerum* in the sidewall core shot at 462m (1516 ft). This species was only recorded from a single core sample at 725.8m in the more comprehensively sampled Patricia–1 well (Partridge, 2000a).

Indeterminate sample — Core 1 at 471–472m (1545–49 feet).
The palynomorph assemblage extracted from the light brown to tan coloured fine-grained sandstone collected from core 1 was dominated by North American Tertiary spore-pollen derived from a lignite based drilling mud additive. The few Australian species recorded are not age diagnostic and are probably contaminants.

***Proteacidites asperopolus* spore-pollen Zone.**
Sample from core 2 at: 472 and 473 metres (1549–52 feet).
Age: Early Eocene.
The sample of light brown fine-grained sandstone from core 2 contained a moderately diverse non-marine spore-pollen assemblages that can be confidently assigned to the *P. asperopolus* Zone based on the FADs of the eponymous species *Proteacidites asperopolus* and *Conbaculites apiculatus* ms, both of which do not range below the zone. Although the palynomorph yield was too low to effectively count the assemblage the presence of *Haloragacidites harrisii* pollen in greater numbers than *Nothofagidites* pollen confirms an age no younger than the zone.

***Coptospora paradoxa* spore-pollen Zone.**

Sample from core–3 at: 1567–70 feet (478–479metres).

Age: Mid to Late Albian.

The assemblage extracted from a mudstone sample collected from the top of core 3 is dominated by bisaccate gymnosperm pollen referred to *Podocarpidites* (34%) and smooth trilete spores referred to *Cyathidites* (21%) and *Stereisporites antiquisporites* (11%), and clearly is of Early Cretaceous age on its gross composition. The presence of rare specimens of *Crybelosporites striatus* and absence of younger zone index species confirms an age no older than the Albian *C. striatus* Zone. However, based on the record of the spore *Coptospora paradoxa* in the deeper core 6 between 506.5 and 517m (1662–1696 ft) in the unpublished reports by both Shell Company Australia Ltd (1985) and W.J, Paley (undated), recorded in the Petroleum Data Package of Victorian Biostratigraphy (issued by the Victorian Department of Natural Resources and Environment) it is likely the top of the Strzelecki Group is no older than the Mid to Late Albian *C. paradoxa* Zone.

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Table 2: Interpretative data from Flathead–1 well.

Sample Type	Depth	Spore-Pollen Zone (Microplankton Zone)	CR*	Comments and Key Species Present
Cuttings	1450–70 ft 442–448m	Middle or Lower *N. asperus*	D4	MP 27% with est. >50% assemblage caved. LAD of *Proteacidites pachypolus* FAD of *Anacolosidites luteoides*.
Cuttings	1510–20 ft 460–463m	Lower *N. asperus* (*D. heterophlycta*)	D1 D3	MP 13% with est. ~25% assemblage caved. LADs of dinocysts *Enneadocysta partridgei* and *Deflandrea heterophlycta* and pollen *Proteacidites grandis*.
Core 1	1545–49 ft 471–472m	Indeterminate		Light brown/tan sandstone contains abundant North American spores and pollen derived from lignite drilling mud additive and only rare long-ranging spore-pollen from the Australian Tertiary.
Core 2	1549–52 ft 472–473m	*Proteacidites asperopolus*	A1 A4	Light brown fine-grained sandstone with sulfur coloured blushes gave a low yield of palynomorphs with *Haloragacidites harrisii* pollen > *Nothofagidites* pollen and including key index species *Proteacidites asperopolus* and *Conbaculites apiculatus* ms. Assemblage also contained abundant contaminants from North American lignite mud additive. No marine microplankton recorded.
Core 3	1567–70 ft 478–479m	*C. striatus* or younger	D1	Early Cretaceous assemblage from Strzelecki Group containing *Crybelosporites striatus* and no younger index species.

MP %= microplankton expressed as % of combined SP & MP count.
Nothofagidites % = abundance expressed as % of SP count only.
LAD & FAD = Last & First 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 for new samples from Flathead–1.

Sample Type	Depth	Lithology	Weight (grams)
Cuttings	1450–70 ft 442–448m	Greenish grey mudstone (glauconite) — composite sample	9.3
Cuttings	1510–20 ft 460–463m	Medium grey brown glauconitic sandstone	8.3
Core 1	1545–49 ft 471–472m	Light brown/tan fine-grained sandstone loose (large quartz pebbles not sampled).	19.1
Core 2	1549–52 ft 472–473m	Light brown fine grained sandstone with sulfur blushes (loose in plastic sleeve)	17.6
Core 3	1567–70 ft 478–479m	Light grey glauconitic? mudstone (loose in plastic core sleeve)	15.4
		Average:	**13.9**

Table 4: Basic assemblage data on new samples from Flathead–1.

Sample Type	Depths	Visual Yield	Palynomorph Concentration	Preservation	No. SP Species	No. MP Species
Cuttings	1450–70 ft 442–448m	Very Low	High	Poor-good	47+	18+
Cuttings	1510–20 ft 460–463m	Low	High	Poor-good	64+	15+
Core 1	1545–49 ft 471–472m	Very Low	Low	Poor-good	9+	1+
Core 2	1549–52 ft 472–473m	Low	Low	Good	26+	1+
Core 3	1567–70 ft 478–479m	High	High	Fair	26+	2+
				Averages:	34+	7+

Table 5. Flathead–1 Palynomorphs species list and abundances.

Sample Type	Cts	Cts	Core 1	Core 2
Depth (ft)	1450-1470	1510-1520	1545-49	1549-52
Depth (m)	442-448	460-463.3	471-72	472-73
SPORE-POLLEN as % of SP count				
Anacolosidites sectus	X			
Araucariacites australis	1.9%	1.8%		
Australopollis obscurus		3%/RW		RW
Baculatisporites spp.	X	X	X	X
Banksieacidites elongatus		X		
Beaupreaidites trigonalis†	X			
Beaupreaidites verrucosus		X		
Clavifera triplex		X		
Conbaculites apiculatus†				X
Cupanieidites orthoteichus	X	0.6%		X
Cyatheacidites annulatus		CV		
Cyathidites palaeospora	2.5%	1.8%	X	X
Cyathidites splendens	0.6%	X		X
Dicotetradites clavatus		X		
Dictyophyllidites arcuatus	1.3%			
Dilwynites granulatus	1.9%	3%		
Dilwynites tuberculatus	X	X	X	X
Dryptopollenites semilunatus	X			
Ericipites crassiexinus		X		
Foveotriletes balteus		X		
Foveotriletes lacunosus	CV			
Gambierina rudata	RW	RW		
Gleicheniidites circinidites	1.9%	4.1%		X
Haloragacidites harrisii	10.2%	10.1%		Common
Haloragacidites haloragoides	CV			
Haloragacidites trioratus	X	X		
Helciporites astrus				X
Ischyosporites irregularis†		X		
Laevigatosporites major	X	X		
Laevigatosporites ovatus		3%	X	Few
Lygistepollenites balmei		0.6%/RW		
Lygistepollenites florinii	1.3%	2.4%		X
Malvacipollis subtilis	1.9%	1.2%		
Microcachryidites antarcticus	0.6%		X	
Monolites alveolatus	0.6%	0.6%		
Myrtaceidites mesonesus/parvus		0.6%		
Nothofagidites asperus		X		
Nothofagidites brachyspinulosus	X	X		
Nothofagidites deminutus	2.5%			X
Nothofagidites emarcidus/heterus	36%	31%	X	Few
Nothofagidites falcatus	X	X		

Table 5. Flathead–1 Palynomorphs species list and abundances.

Sample Type	Cts	Cts	Core 1	Core 2
Depth (ft)	1450-1470	1510-1520	1545-49	1549-52
Depth (m)	442-448	460-463.3	471-72	472-73
SPORE-POLLEN as % of SP count				
Nothofagidites flemingii	3.2%	0.6%		X
Nothofagidites falcatus	X	X		
Nothofagidites flemingii	3.2%	0.6%		X
Nothofagidites goniatus	X	X		
Nothofagidites vansteenisii	X			
Periporopollenites demarcatus	0.6%	X		
Peromonolites vellosus		X		
Phyllocladidites mawsonii	8.9%	7.1%		X
Podocarpidites spp.	5.7%	8.3%	X	X
Proteacidites adenanthoides	X	X		
Proteacidites alveolatus		X		
Proteacidites annularis		0.6%		
Proteacidites asperopolus				X
Proteacidites crassus		X		
Proteacidites grandis		X		X
Proteacidites latrobensis				X
Proteacidites leightonii	X	X		X
Proteacidites obscurus	X	1.2%		
Proteacidites pachypolus	0.6%	0.6%		X
Proteacidites reflexus		cf.		
Proteacidites tenuiexinus	X			
Proteacidites spp.	10.2%	5.3%	X	
Pseudowinterapollis couperi	X			
Retitriletes spp.		X		
Rugulatisporites mallatus		X		
Santalumidites cainozoicus		0.6%		
Stereisporites antiquisporites	1.9%	1.2%	X	X
Tetracolporites textus†	RW			
Trichotomosulcites subgranulatus	0.6%	0.6%		
Tricolp(or)ates spp.	2.5%	4.7%		
Tricolpites simatus	0.6%	X		X
Tricolporites adelaidensis	X	X		
Tricolporites paenestriatus	X	0.6%		
Trilete spores undiff.	0.6%	2.4%		
Tripunctisporis maastrichtiensis	X	1.2%		
Verrucatosporites alienus		X		
Verrucosisporites kopukensis	X	X		
Total Spores:	10%	14%		
Total Gymnosperm pollen:	21%	24%		
Total Angiosperm pollen:	69%	62%		
Total spore-pollen count:	**157**	**169**		

Table 5. Flathead–1 Palynomorphs species list and abundances.

Sample Type	Cts	Cts	Core 1	Core 2
Depth (ft)	**1450-1470**	**1510-1520**	**1545-49**	**1549-52**
Depth (m)	**442-448**	**460-463.3**	**471-72**	**472-73**
MICROPLANKTON as % of MP count				
Dinoflagellates undiff:	20%	5%		
Cyclopsiella vieta	X			
Dapsilidinium pseudocolligerum	2%			
Deflandrea cygniformis		X		
Deflandrea heterophlycta		X		
Deflandrea spp.	X			
Enneadocysta partridgei	2%	5%		
Eocladopyxis peniculata	X			
Heteraulacacysta paxilla†	X			
Hystrichokolpoma rigaudiae	X	X		
Lingulodinium machaerophorum	X	X		
Melhitasphaeridium choanophorum	CV	CV		
Nematosphaeropsis rhizoma†		CV		
Operculodinium centrocarpum	20%	11%	CV	
Paralecaniella indentata	X	X		
Phthanoperidinium comatum	4%			
Protoellipsodinium simplex†	2%	CV		
Pyxidinopsis pontus†		5%		
Rottnestia borussica		X		
Spinidinium essoi	X			
Spinidinium macmurdoense	X	X		
Spiniferites spp.	44%	68%		
Tectatodinium marlum†	X			
Vozzhennikovia apertura/rotunda	6%	5%		
Microplankton as % SP + MP:	**25.6%**	**10.1%**		
OTHER PALYNOMORPHS as % of total count				
Botryococcus braunii	0.5%			
Fungal spores & hyphae	2.3%	10.9%		X
Total palynomorph count:	**218**	**211**		

Table 6. Flathead–1 Palynomorphs species list and abundances.

	Sample Type	Core 3
	Depth (feet):	**1567–1570**
	Depth (metres):	**477.6–478.5**
SPORE-POLLEN SPECIES as % of SP count.		
Aequitriradidites spinulosus		X
Araucariacites australis		7.9%
Baculatisporites spp.		2.6%
Ceratosporites equalis		0.7%
Cicatricosisporites/Ruffordiaspora spp.		1.3%
Corollina torosa		2.6%
Crybelosporites striatus		0.7%
Cyathidites australis		4.6%
Cyathidites minor		15.9%
Cycadopites nitidus		1.3%
Foraminisporis asymmetricus		X
Horriditriletes ramosa/taylori		X
Marattisporites scabratus		0.7%
Microcachryidites antarcticus		7.9%
Osmundacidites wellmanii		4.0%
Podocarpidites spp.		33.8%
Polycingulatisporites clavus		X
Reticulatisporites pudens		X
Retitriletes austroclavatidites		X
Retitriletes nodosus		X
Retitriletes spp.		2.6%
Ruffordiaspora australiensis		X
Stereisporites antiquisporites		10.6%
Stereisporites pocockii		X
Trichotomosulcites subgranulatus		0.7%
Triporoletes reticulatus		X
Trilete spores undiff.		2.0%
	Total Spores:	45.7%
	Total Gymnosperm Pollen:	54.3%
	TOTAL spore-pollen count:	151
MICROPLANKTON		
Sigmopollis carbonis		X
Sigmopollis hispidus		X
	Microplankton Count:	1
	TOTAL SP & MP count:	152
	Microplankton as % SP + MP:	0.7%
OTHER PALYNOMORPHS as % of total count		
Fungal spores & hyphae		1.9%
	TOTAL palynomorph count:	155

† Manuscript Species
X = Present (<1%)
CV = Caved
RW = Reworked
cf. = Compare with