Palynological analysis of cuttings from 1317 to 1452 metres in Wombat-3, onshore Gippsland Basin.

by

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INTERPRETATIVE DATA

Summary

Palynological analysis has been performed on eight cuttings samples over the interval 1317 to 1452m in Wombat-3. The four shallowest assemblages from 1317 to 1338m, although badly contaminated by caved Eocene and Oligocene palynomorphs, contain key index species of the Paleocene *Lygistepollenites balmei* Zone, with the two deeper samples at 1332 to 1338m possibly extending into the slightly older latest Maastrichtian Upper *Forcipites longus* Zone. Irrespective of the precise age the four samples are representative of the Barracouta Formation of the Halibut Subgroup. The assemblages from the next pair of samples at 1356 and 1358m, although also contaminated, contain rare index species of the Turonian portion of the *Phyllocladidites mawsonii* Zone, and are representative of the Emperor Subgroup. Finally, the two deepest samples contain very poor assemblages, with the sample at 1376m essentially barren, while the sample at 1452m contains mostly long ranging species. Although no zone assignment can be specified for either assemblage they most likely come from the Strzelecki Group based on their stratigraphic position.

Introduction

The eight cuttings samples analysed from the Wombat-3 well drilled by Lakes Oil N.L. were submitted in two batches of four samples each between 6th and 22nd October 2004. All samples were forwarded to the palynological processing facilities of Core Laboratories Australia Pty Ltd (formerly operated by Laola Pty Ltd) in Perth, for laboratory processing and slide preparation. The first batch, submitted as unwashed cuttings, were given routine palynological processing without any special pre-treatment, and unfortunately initially yielded palynological residues and slides which were found to be unworkable at the microscope when returned to the author on 15th October. In the second batch, the samples were pre-treated in an attempt to remove some of the obvious caved lithologies, and this approach gave much better results. At the same time the first batch of cuttings were given additional oxidation and workable slides were also obtained from these samples. All slides from the second round of processing were returned to the author for microscope analysis on the 24th November, and a Provisional Report giving the initial zone and age determinations on all eight samples was issued on the 25th November.

The final zones and ages assigned to the samples, zone confidence ratings, and zone identification criteria for each of the samples are summarised on Table 1. Basic sample data on lithologies and weights of sample processed, and organic yields obtained are provided on Table 2. The visual organic residues yields from the samples varies from very low to moderate, with the concentration of palynomorph on most slides only moderate, while the preservation of the fossils is mostly poor (Table 3). The recorded spore-pollen diversity varies from very low to high averaging 25+ species per sample, whereas the recorded microplankton diversity is typically low averaging only two species per sample. The distribution of the palynomorphs identified in the samples are displayed on the accompanying StrataBugs™ range chart. Author citations for most of the recorded spore-pollen species can be sourced from the papers by Dettmann (1963), Helby *et al.* (1987) or Stover & Partridge (1973), while the author citations for the microplankton species can be sourced from the indexes for dinocysts and other organic-walled microplankton prepared by Fensome *et al.* (1990)

and Williams *et al.* (1998). Manuscript species names and combinations are indicated by "sp. nov." or "comb. nov." on the range chart and "ms" after their binomials names in the text and tables.

Processing Methods: The first batch of four samples were received as unwashed cuttings in clear plastic bags. They were observed to consist of a wet, sticky, black mud and were submitted for routine palynological processing without requesting any pre-treatment or washing. As a consequence of this oversight the initial results proved to be disappointing. The slides produces were observed to contain abundant "chunky" opaque kerogen but very few palynomorphs, and unfortunately could not be age dated. The poor results were due to the presence in the samples of an abundance of coal caved from the shallower Eocene section at the top of the Latrobe Group, exacerbated by insufficient oxidation and poor alkali treatment of the extracted organic residues.

The second batch of four samples were received as washed cuttings and were observed to contain significant amounts of caved Eocene coal, as well as Oligocene marl caved from the Lakes Entrance Formation (Table 2). Because of the amount of caved material special pre-treatment washing was requested for these samples. This consisted of an initial dilute acid (HCl) wash to breakup and remove the marl, followed by removal of the caved coal by density separation using carbon tetrachloride. Although the organic residue yields extracted from the samples were ultimately low, much better slides were produced, and these contained moderate concentrations of palynomorphs. Age datable assemblages were obtained even though caved palynomorphs still constitute a large proportion of the recorded assemblages. The remaining organic residues from the first batch of samples were also given additional oxidation and alkali treatment to also produce better slides. The assemblages recorded on the range chart from these samples are derived from this second set of slides.

Discussion of Results

The four shallowest cuttings samples analysed in Wombat-3 between 1317 and 1338m contain similar moderate diversity assemblages composed of a mixture of caved Eocene and Oligocene palynomorphs and rare index species of the Paleocene *Lygistepollenites balmei* Zone. The caved component could however be significantly higher than the average 50% estimated from the assemblage count as all the long-ranging species are assumed to come from the Paleocene zone. The higher pair of samples at 1317 to 1320m are assigned the higher confidence ratings and cannot be younger than the *L. balmei* Zone. The bottom pair of sample at 1332 to 1338m are assigned lower confidence ratings, because they could belong to underlying latest Maastrichtian Upper *Forcipites longus* Zone, which was found in the Wombat-1 and 2 wells at comparable depths (Partridge, 2004a-b). Irrespective of their zone assignments all four samples lie within either the Barracouta or Yarram formations (Hocking, 1976, 1988). These two formation have recently been included in the Halibut Subgroup by Partridge (1999) and Bernecker & Partridge (2001).

The next pair of cuttings samples at 1356 to 1358m show an increase in gymnosperm pollen and corresponding decline in angiosperm pollen. The samples also contain the shallowest occurrences of index species of the *Phyllocladidites mawsonii* spore-pollen Zone and *Rimosicysta* microplankton Superzone, and thus confirm the presence of section belong to the Emperor Subgroup of Partridge (1999) and Bernecker & Partridge (2001). The presence of *Hoegisporis trinalis* ms at 1356m is diagnostic of the lower part of the zone and a Turonian age. The few *in situ* microplankton recorded indicate that at least part of the section is of lacustrine facies equivalent to the Kipper Shale.

The two deepest samples analysed both gave very poor assemblages. The shallower at 1376m was effectively barren, while the deeper at 1452m contained only long ranging and caved species and could not be assigned to a zone. However, based on the presence of the spore *Ruffordiaspora australiensis* and comparison with the palynological results from Wombat-1 and 2 it is most likely that both samples come from the Early Cretaceous Strzelecki Group.

In summary, the palynological succession over the interval analysed in Wombat-3 consists of an indeterminate thickness of Paleocene to possible latest Maastrichtian section of the Halibut Subgroup, overlying a thin section of Turonian age Emperor Subgroup, which in turn rests on the Strzelecki Group. There is no evidence in the palynological assemblages of any section belonging to the Santonian to Campanian age Golden Beach Subgroup, which is equivalent to the upper part of the former "Golden Beach Group" of Lowry & Longley (1991).

Palynological Assemblages and Zones

***Lygistepollenites balmei* spore-pollen Zone to**
possible Upper *Forcipites longus* spore-pollen Zone
Interval: 1317 to 1338 metres
Age: Paleocene to ?Late Maastrichtian.

All four assemblages can be no younger than the *L. balmei* Zone based on the consistent presents of the eponymous species *Lygistepollenites balmei* (<1% to >10% of *in situ* spore-pollen), associated with *Gambierina rudata* (at 1317m, 1320m and 1338m) and *Australopollis obscurus* (common at 1320m and 1338m). All three species are traditionally considered not to range above this zone, but do range down into older zones. The bottom pair of samples at 1332m and 1338m may however be slightly older and belong to the Upper *F. longus* Zone based on the frequent occurrence of *Stereisporites antiquasporites* at 1338m. This latter species being also prominent in the sample from the same depth in Wombat-1 (Partridge, 2004a). Supporting the possible presence of this old zone is the questionable identification of *Battenipollis sectilis* and presence of *Tripunctisporis maastrichtiensis* in the deeper sample at 1338m. The assemblages in the four samples are all dominated by angiosperm pollen but this in part is a distortion due to the amount of caved pollen in the assemblages.

***Phyllocladidites mawsonii* spore-pollen Zone**
Interval: 1356 to 1358 metres
Age: Turonian.

The two adjacent cuttings samples are assigned to the *P. mawsonii* Zone based on the dominance of gymnosperm pollen (>60% of *in situ* spore pollen) and presence of single or rare specimens of the index species *Hoegisporis trinalis* ms, *Coptospora pileolus* ms and *Verrucosisporites admirabilis* ms which are typical of this zone. The most distinctive of the gymnosperm pollen are the increase in frequency of *Dilwynites granulatus* and *D. pusillus* ms and highest occurrence of common *Corollina torosa*. The presence of Permian reworking at 1358m is also considered more typical of the *P. mawsonii* Zone, compared to younger zones.

Supporting the spore-pollen data are the presence of rare specimens of fresh to brackish water microplankton, the most important of which are *Rimosicysta* sp., *Amosopollis cruciformis* and *Micrhystridium* sp. A. Taken together these are most typical of the lacustrine Kipper Shale and the *Rimosicysta* Superzone, based on the assemblages described by Marshall (1989). Overall the Wombat-3 assemblages are much less diverse than those recorded from Wombat-1 (Partridge, 2004a) owing to the poorer quality of the samples.

Early Cretaceous Assemblages?

The two cuttings samples at 1376 and 1452m cannot confidently be given either an age or zone assignment as they contain too few palynomorphs, and those that are recorded are mostly long-ranging or caved species and therefore not diagnostic. The only possible diagnostic species recorded is a single specimen of the spore *Ruffordiaspora australiensis* at 1452m. This species has a fairly consistent range from the base of the Cretaceous to around the top of the Albian (*R. australiensis* to *P. pannosus* Zones), but is by comparison relatively rare and inconsistent in the Late Cretaceous of the succeeding Emperor and Golden Beach subgroups. Its occurrence is therefore weak evidence that the Strzelecki Group has been penetrated at the bottom of Wombat-3.

Eocene to Oligocene Assemblages

All of the cuttings are also contaminated to a more or lesser extent by 1) spore-pollen of Eocene age, mostly derived from coal caved from near the top of the Latrobe Group, and 2) dinocysts of mainly Oligocene age, derived from marl caved from the Lakes Entrance Formation. The most abundant and consistent of the caved spore-pollen species are *Haloragacidites harrisii*, *Nothofagidites emarcidus/heterus*, *N. deminutus*, *Lygistepollenites florinii*, *Phyllocladidites mawsonii* plus a variety of *Proteacidites* species, while the most frequent dinocysts found are *Spiniferites* spp., *Lingulodinium machaerophorum* and *Operculodinium centrocarpum*. Amongst the common types are rarer index species including *Myrtaceidites tenuis*, *Proteacidites pachypolus*, *Triorites magnificus* and the dinocyst *Gippslandica extensa*. In combination these caved palynomorphs confirm the presence of the *Proteacidites asperopolus*, Lower and Middle *Nothofagidites asperus* spore-pollen zones and *Operculodinium* dinocyst Superzone higher in the well.

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Description of Range Chart.

The range chart accompanying this report was prepared using the StrataBugs™ program and displays the palynomorph species in the samples proportional to their depth in the well. The palynomorphs recorded are split into different categories, with the spores, gymnosperm pollen and angiosperm pollen plotted in separate panels with the abundance of individual species calculated as a percentage of the total Spore-Pollen sum. This is followed by the panel labelled Caved which records the abundance of Eocene and younger palynomorphs as a percentage of total palynomorphs. The Microplankton and Other palynomorphs are next plotted as separate panels, with abundances expressed as a percentage of the total Spore-Pollen plus Microplankton sum or Spore-Pollen plus Others sum. Finally, Permian and Triassic species in the assemblages are plotted in panel labelled Reworked. Within the panels the species are plotted according to their highest or youngest occurrence or alphabetical. The following codes or abbreviations apply to the individual species occurrences and abundances on the range chart:

Numbers	=	Abundance expressed as percentage
+	=	Species outside of count
C	=	Caved species
R	=	Reworked species
?	=	Questionable identification of species.

INTERPRETATIVE DATA

Table 1: Interpretative palynological data for Wombat-3, onshore Gippsland Basin.

Sample Type	Depth metres	Spore-Pollen Zone Age/Stage	CR*	Comments and Key Species Present
Cuttings[1]	1317m	*Lygistepollenites balmei* SP Zone **Paleocene**	D3	Shallowest occurrences of *Lygistepollenites balmei* and *Gambierina rudata* confirm sample is no younger than zone. Caved specimens constitute >40% of assemblage.
Cuttings[2]	1320m	*L. balmei* SP Zone **Paleocene**	D3	*Lygistepollenites balmei* at >10% of ***in situ*** fossils. Caved specimens represent >45% of total count.
Cuttings[1]	1332m	Probable *L. balmei* Zone **Paleocene**	D5	Caved specimens increase to >70% of total count potentially obscuring any older age than *L. balmei* Zone.
Cuttings[2]	1338m	*L. balmei* to possible Upper *F. longus* SP Zone **Paleocene**	D5	*Stereisporites antiquasporites* at 7% suggests older zone assignment based on comparison to this zone in Wombat-1. Caved fossils constitute a minimum of 30% of total count, but could be much higher if species from *L. balmei* Zone are also caved.
Cuttings[2]	1356m	*P. mawsonii* SP Zone *H. trinalis* SP Subzone **Turonian**	D3	Shallowest occurrences of *Hoegisporis trinalis* ms, *Verrucosisporites admirabilis* ms, and algal *Rimosicysta* sp. confirms Upper Cretaceous age.
Cuttings[1]	1358m	*P. mawsonii* SP Zone **Turonian**	D3	Overall assemblage composition and presence of *Coptospora pileolus* ms confirms zone assignment.
Cuttings[1]	1376m	Indeterminate sample		Essentially BARREN with less than 5 specimens
Cuttings[2]	1452m	Zone indeterminate but probably **Early Cretaceous**		Low yield with <70 specimens on available slides. Presence of spore *Ruffordiaspora australiensis* favours assignment of sample to Strzelecki Group.

Cuttings[1] = First set processed
Cuttings[2] = Second set processed

FAD & LAD = First & Last Appearance Datums
MP = Microplankton
SP = Spore-pollen

*Confidence Ratings used in STRATDAT database and applied to Table 1.

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 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 without key zone species.
E	Junk basket	**5**	**Very low confidence:**	Low diversity assemblage without key zone species.

BASIC DATA

Table 2: Basic sample data for Wombat-2, onshore Gippsland Basin.

Sample Type	Depth	Lithology	Wt gms	VOM	Org. Yield
Cuttings[1]	1317m	Unwashed cutting — lithology not recorded.	12.2	0.4	0.03
Cuttings[2]	1320m	Light grey marl >75%, coal >10%, remaining lithologies indeterminate in unwashed clumps.	10.7	0.5	0.05
Cuttings[1]	1332m	Unwashed cutting — lithology not recorded.	13.1	0.5	0.04
Cuttings[2]	1338m	Light grey marl >30%, coal >30%, other lithologies include cemented quartz sandstone with white clay matrix.	10.7	0.4	0.04
Cuttings[2]	1356m	Medium grey mudstone >50%, coal mostly in large caved pieces >30%; remaining lithologies mostly indeterminate but includes some sandstone	10.5	0.4	0.04
Cuttings[1]	1358m	Unwashed cutting — lithology not recorded.	13.5	0.9	0.07
Cuttings[1]	1376m	Unwashed cutting — lithology not recorded.	13.2	0.2	0.02
Cuttings[2]	1452m	Medium grey lithic sandstone 90%, and medium grey shale mostly in large shards 5-15 mm long	13.0	0.4	0.03

Cuttings[1] = First set processed
Cuttings[2] = Second set processed

Wt = Weight of sample processed in grams.
VOM = Volume of wet organic residues in cubic centimetres.
Org. Yield = Organic Yield — VOM divided by Wt.

Table 3: Basic assemblage data for Wombat-2, onshore Gippsland Basin.

Sample Type	Depth	Visual Yield	Palynomorph Concentration	Preservation	No. SP Species	No. MP Species
Cuttings[1]	1317m	Moderate	Moderate	Poor-Fair	25+	2+
Cuttings[2]	1320m	Moderate	Moderate	Poor-Fair	24+	3+
Cuttings[1]	1332m	Low	Moderate	Poor-Fair	28+	3+
Cuttings[2]	1338m	Low	Moderate	Poor	29+	2+
Cuttings[2]	1356m	Low	Moderate	Poor	30+	5+
Cuttings[1]	1358m	Moderate	Moderate	Poor	41+	4+
Cuttings[1]	1376m	Very Low	Very Low	Poor	2+	
Cuttings[2]	1452m	Low	Very Low	Poor	21+	
				Averages:	**25+**	**2+**

Cuttings[1] = First set processed
Cuttings[2] = Second set processed

Well Name : Wombat-3

Operator : Lakes Oil NL   Spudded : 23 September 2004

Completed: 28 October 2004

Lat/Long : 38°21' 28.00"S 147° 8' 57.00"E

Interval : 1200m - 1700m   Palynological Range Chart

Scale : 1:2000   Sample Interval 1317 to 1452m

Chart date: 22 December 2004   Microscope analysis by Alan D. Partridge

Wombat-3

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AUSTRALIA

Attachment to Biostrata Report 2004/13A