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Palynological Analysis of Iona-2 in Port Campbell Embayment Otway Basin

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INTERPRETATIVE DATA

Introduction

Eighteen sidewall cores samples and four cutting samples between 1034.5-1599m were analysed in Iona-2. The selected sidewall cores where forwarded for processing to Laola Pty Ltd in Perth in early March and an initial version of this report was submitted on 14 April. It was then decided to analyse four cuttings samples between 1292.5-1350m to improve the dating on the Waarre Formation and at the same time additional palynological slides were prepared and examined from remaining palynological residues from sidewall cores in this interval. These new preparations provided new information necessitating revision of the original report. The changes were needed once it was realised SWC-22 at 1325m was significantly contaminated, due either to drilling mud which could not be cleaned from the sample or cross-contamination during laboratory preparation. The contamination from higher in the section resulted in assignment of an erroneous younger age to this sample in the original report.

Between 6.5 to 15.8 grams (average 11.2 g) of the sidewall cores, and 10 to 24 grams (average 16.9 g) of the cuttings, were processed for palynological analysis. Residue yields vary from very low to very high while the palynomorphs are mostly present in low to moderate concentrations on the slides. Preservation of palynomorphs varies from poor to good but overall is fair. A problem with the preservation is that many of the dinoflagellates are broken which means that some species may only be represented by fragments rather than complete specimens. Spore-pollen diversity is consistently high through the Sherbrook Group averaging 33+ species per sample, but rather bimodal in the Eumeralla Formation where it is either very low (1-3 species) or moderate to high (17-38 species). Average spore-pollen diversity through the Eumeralla Formation was 19+ species per sample. Microplankton diversity is low to moderate (9-18 species) in the Sherbrook Group with an average of 12+ species, and very low in the Eumeralla Formation with and average of 2+ species per sample.

Geological ages, formations and palynological zones for the interval sampled in Iona-2 are given in Table-1. Additional interpretative data with zone identification and Confidence Ratings are recorded in Table-4, whilst basic data on residue yields, preservation and diversity are recorded on Tables-5 and 6. For the sidewall cores all species which have been identified with binomial names are tabulated on the palynomorph range charts which present the recorded assemblages on separate charts in order of highest and lowest appearances. The assemblages recorded from the cuttings samples are recorded in Appendix-1.

Geological Comments

1. The sequence sampled in Iona-2, with only minor modifications, can be readily assigned to the Mesozoic spore-pollen and microplankton zones defined by Helby, Morgan & Partridge (1987). The time interval sampled is from the Late Albian to basal Campanian.

2. The spore-pollen zone nomenclature of Helby *et al.* (1987) used in this report is a modification of an earlier zonation scheme proposed by Dettmann & Playford (1969). This earlier scheme over the interval analysed here was originally erected upon wells in the Port Campbell Embayment and is still widely used in the Otway Basin. The equivalence between the two zonation schemes, for those zones applicable to Iona-2 is as follows:

Dettmann & Playford (1969)	**Helby *et al.* (1987)**
Nothofagidites Microflora (in part only)	*N. senectus* Zone
T. pachyexinus Zone	*T. apoxyexinus* Zone
C. triplex Zone	*P. mawsonii* Zone
A. distocarinatus Zone	*A. distocarinatus* Zone
P. pannosus Zone	*P. pannosus* Zone

Explanations of the reasons for the zone name changes can be found in Helby *et al.* (1987).

3. Of the microplankton or dinoflagellate zones identified in Iona-2 the *Nelsoniella aceras* and *Isabelidinium* (al. *Deflandrea*) *cretaceum* Zones were originally established in the Otway Basin by Evans (1966), while the older *Odontochitina porifera* Zone is an Australia-wide zone defined in Helby *et al.* (1987). At the base of the marine sequence the new local *Cribroperidinium edwardsii* Acme Zone is recognised. The current preferred correlation of this zone is with all or part of the Turonian *Palaeohystrichophora infusorioides* Zone of Helby *et al.* (1987). However, as exact equivalence cannot yet be convincingly demonstrated, new terminology is preferred to avoid possible ambiguity.

4. The spore-pollen succession in Iona-2 lacks clear evidence for the presence of the *A. distocarinatus* Zone. This is supported by the ages derived from the microplankton assemblages, and is identical to the results reported by Morgan (1988) from the adjacent Iona-1.

Table-1: Palynological Summary Iona-2

<table>
<tr><th>AGE</th><th>UNIT</th><th>SPORE-POLLEN ZONES</th><th>MICROPLANKTON ZONES</th></tr>
<tr><td>CAMPANIAN</td><td rowspan="3">SKULL CREEK MUDSTONE</td><td>N. senectus
1034.5m</td><td rowspan="2">N. aceras
1034.5-1129m</td></tr>
<tr><td rowspan="5">SANTONIAN</td><td rowspan="5">T. apoxyexinus
1090-1295m</td></tr>
<tr><td rowspan="3">I. cretaceum
1161-1281m</td></tr>
<tr><td>NULLAWAARE GREENSAND</td></tr>
<tr><td rowspan="2">BELFAST MUDSTONE</td></tr>
<tr><td>O. porifera
1290-1295m</td></tr>
<tr><td>TURONIAN</td><td>WAARRE FORMATION</td><td>P. mawsonii
1303.5-1371m</td><td>C. edwardsii
1303.5-1371m</td></tr>
<tr><td>LATE ALBIAN</td><td>EUMERALLA FORMATION</td><td>P. pannosus
1402-1590m</td><td></td></tr>
</table>

5. The dinoflagellates succession in the sidewall cores is incomplete because the *Conosphaeridium striatoconus* dinoflagellate Zone was not recognised in Iona-2 although present in Iona-1 (Table-2). The possibility that the zone might be present was subsequently tested by analysis of four cuttings samples below the base of the *O. porifera* Zone. Unfortunately neither *Conosphaeridium striatoconus* nor any other index species for the zone were recorded and it is therefore concluded this zone is not present in Iona-2.

6. Between 1290m and the shallowest sample at 1034.5m the microplankton succession displays a normal sequence for the Senonian consisting of in ascending order the *O. porifera*, *I. cretaceum* and *N. aceras* Zones.

7. Table-2 provides a correlation of sidewall core samples between Iona-1 and Iona-2 with comments on the key species events used for the correlations. The striking feature is that while the *C. striatoconus* Zone is missing or not sampled in Iona-2 the overlying *O. porifera* Zone is missing or not sampled in Iona-1. The proposed correlations are based solely on the palynological data and have not been verified by electric log correlation. They do however suggest that further resolution is still possible in both wells using palynology.

Table-2: Correlation of samples between Iona-1 and Iona-2.

Spore-Pollen and (Microplankton) Zones	Iona-1 (Depths m)	Iona-2 (Depths m)	Key species datums
N. senectus (*N. aceras*)	1018-1054	1034.5	FAD for *N. senectus* and *F. sabulosus* with dinoflagellates *N. aceras* and/or *N. tuberculatus* together with questionable *X. australis*.
T. apoxyexinus (*N. aceras*)	1075.5	1090-1129	FAD of *N. aceras* without presence of *N. senectus*.
T. apoxyexinus (*I. cretaceum*)	1240-1254	1161-1281	FAD of *I. cretaceum* associated with increased dominance of *Proteacidites* spp.
T. apoxyexinus (*O. porifera*)	NOT SAMPLED	1290	FAD of *O. porifera* and FAD of *P. gillii*.
(*C. striatoconus*)	1276.5	NOT SAMPLED	FAD & LAD of *C. striatoconus* with consistent *P. mawsonii* and *C. triplex*.
P. mawsonii (*C. edwardsii*)	1287-1347.5	1303.5-1371	Total local range of *C. edwardsii* with rare but consistent *P. mawsonii* and *C. triplex*.
P. pannosus	1383-1481	1402-1590	Assemblage containing non-marine algae with FAD for *P. pannosus*.

LAD = Last Appearance Datum.
FAD = First Appearance Datum.

8. All samples analysed from the Sherbrook Group are considered to be marine based on the abundance and diversity of their contained microplankton. Abundance of microplankton expressed as a percentage varies from 6% to 32% (Table-3). The palynomorphs in the count include spores, pollen and microplankton, but exclude fungal spores and hyphae and any palynomorphs that are obviously reworked or contaminants.

Microplankton species diversity is low to moderate with between 9-18 species recorded from individual samples. As the total diversity recorded for the interval is 50+ species it is suspected the true diversity of the samples is higher than recorded being limited by low recoveries and only moderate palynomorph concentrations in individual samples. Even though the microplankton abundances of three of the four samples from Units B and D of the Waarre Formation are lower than the other samples the species diversity is consistent (Table-6). Overall, whilst the species diversity is consistently less than the diversity found in equivalent age marine rocks on the western margin of Australia, as for example recorded by Marshall (1984), it is nevertheless consistent with the style of most other marine microplankton assemblages found in the Late Cretaceous basins along the southern margin of Australia.

Table-3: Microplankton Abundance for Selected Samples.

Sample Type	Depth (m)	Microplankton Zone	Microplankton Abundance as % Relative to total Spore-pollen	Most abundant microplankton species as % of total microplankton
SWC-30	1034.5	*N. aceras*	12%	*Heterosphaeridium* spp. >40%.
SWC-29	1090	*N. aceras*	19%	*Heterosphaeridium* spp. >45%.
SWC-28	1129	*N. aceras*	25%	*Heterosphaeridium* spp. >60% *Nelsoniella aceras* 16%
SWC-26	1260	*I. cretaceum*	26%	*Heterosphaeridium* spp. >42% *Hexagonifera* spp. 25%.
SWC-25	1281	*I. cretaceum*	21%	*Heterosphaeridium* spp. >50%.
SWC-24	1290	*O. porifera*	21%	*Heterosphaeridium* spp. >52% *Odontochitina* spp. 6%.
SWC-23	1303.5	*C. edwardsii*	11%	*Spiniferites* spp. 30% *Heterosphaeridium* spp. >15%.
SWC-22	1315	*C. edwardsii*	32%	*Heterosphaeridium* spp. >35% *Odontochitina* spp. 13%
SWC-21	1353	*C. edwardsii*	11%	*Cribroperidinium edwardsii* 24%.
SWC-18	1371	*C. edwardsii*	6%	*Amosopollis cruciformis* 14%.
SWC-13	1402		5%	*Sigmopollis carbonis* 50%.
SWC-11	1412		2%	*Sigmopollis carbonis* 33%.
SWC- 8	1437.5		5%	*Sigmopollis carbonis* 70%.
SWC- 7	1457.5		4%	*Sigmopollis* spp. 90%.
SWC- 2	1590		0.5%	*Sigmopollis carbonis* 100%.

9. Buffin (1989) has proposed a depositional model for units identified in the Waarre Formation in which significant restricted marine units including back-water lagoons, swamps, tidal channels and tidal deltas are deposited behind or associated with a beach-barrier. None of the four assemblages recorded from the Waarre Formation in Iona-2 could be considered typical of these environments, which would be expected to have microplankton "blooms" consisting of the very abundant occurrence (microplankton typically >75% of total count) of one or just a few species. Instead the samples contain moderate diversity assemblages without any particular species being dominant.

10. The organic microplankton recorded from the Eumeralla Formation would generally be classed as acritarchs and are here all considered to be derived from non-marine lacustrine environments. The deposition of the Otway Group at high latitudes in the Early Cretaceous can be compared to modern deposition environments above the Arctic Circle where there are typically thousands of lakes of all sizes in the modern depositional basins as a consequence of low temperatures and low evaporation. It is easy to envisage algal cysts deposited in such lakes being reworked by fluvial processes throughout the depositional basin. These microplankton in the Otway Group have been recorded and discussed by other palynologists dating back to Evans (1966, p.31).

11. Nearly all of the samples analysed contained reworked palynomorphs. The commonest or most distinctive reworked spore-pollen are from the Permian with a minor component of distinctive Triassic spores and pollen. The Sherbrook Group contains obvious reworked Early Cretaceous spores the most distinctive of which are *Cyclosporites hughesii* and *Pilosisporites notensis*. The counts suggest the assemblages contain between 1% to 5% reworked palynomorphs. This is likely to be a conservative estimate because of the difficulty with long ranging species, which dominate all assemblages, of deciding which specimens are reworked and which insitu. Making such a distinction is only possible where there are clear differences in the maturation colour of the reworked palynomorphs.

Biostratigraphy

Zone and age determinations are based on the Australia wide spore-pollen and microplankton zonation schemes described by Helby, Morgan & Partridge (1987). As applied to the Otway Basin these schemes modified and improved on the spore-pollen zonation scheme of Dettmann & Playford (1969) and the microplankton zonation scheme of Evans (1966). An additional local microplankton association called the *Cribroperidinium edwardsii* Acme Zone is recognised in this report to better express local correlations.

Author citations for most spore-pollen species can be sourced from Helby, Morgan & Partridge (1987), Dettmann (1963) or other references cited herein. Author citations for dinoflagellates can be found in the indexes of Lentin & Williams (1985, 1989) or other references cited herein. Species names followed by "ms" are unpublished manuscript names.

Spore-Pollen Zones

***Nothofagidites senectus* Zone.**
Interval: 1034.5 metres
Age: Basal Campanian

The shallowest sample analysed is assigned to this zone on the occurrence of a single specimen of the eponymous species *N. senectus*. A position low in the zone is suggested by presence of *Forcipites* (al. *Tricolpites*) *sabulosus* with *Tricolporites apoxyexinus* but without the presence of *Gambierina rudata* (see range chart in Helby *et al.* 1987, fig. 33). Other noteworthy species are *Tricolpites waipawaensis* and *Forcipites stipulatus*. The commonest elements in the assemblage are *Proteacidites* spp. (17%) and *Podocarpidites* spp. (13%).

***Tricolporites apoxyexinus* Zone** (formerly the *Tricolpites pachyexinus* Zone).
Interval: 1090.0-1295.0 metres (200+ metres).
Age: Santonian

Of the six sidewall core samples assigned to this zone the eponymous species *T. apoxyexinus* is recorded from only three, and then usually only as a single specimen. A variety of accessory species indicative of the zone are more common. These include the first appearance datums (FADs) in this well for *Peninsulapollis gillii* (at 1290m), *Forcipites stipulatus* (1281m), *Lygistepollenites balmei* (1161m), *Camarozonosporites bullatus* (1161m, with a questionable specimen at 1303.5m), *Latrobosporites ohaiensis* (1161m) and *L. amplus* (1260m).

The species *Australopollis obscurus*, *Clavifera triplex* and *Phyllocladidites mawsonii* although known to range into older zones are consistently recorded in most samples in this zone.

On overall composition this zone can be characterised as the level in the Late Cretaceous when angiosperm pollen first became common in the assemblage counts. They range in abundance from 11% to 28% with an average of 18%. *Proteacidites* spp. and other triporate pollen are also conspicuous ranging from 4% to 16%. Thus, these assemblages readily conform to characteristic of *Proteacidites* Superzone of Helby *et al.* (1987).

The cuttings samples suggests the zone extends at least as deep as 1295m.

***Phyllocladidites mawsonii* Zone** (formerly the *Clavifera triplex* Zone).
Interval: 1303.5-1371.0 metres (68+ metres).
Age: Turonian (Coniacian absent or not sampled).

The eponymous species *P. mawsonii*, whose FAD defines the base of this zone was recorded in three of the four sidewall cores and all of the cuttings within this interval. The formerly used zone species *Clavifera triplex* was also consistently recorded in most of the samples.

Important accessory species are rare but include *Cyatheacidites tectifera* at 1353m and 1371m. This species is considered to range no older than this zone on the southern margin (Helby *et al.* 1987, fig.33). Other species are *Cicatricosisporites cuneiformis* and *C. pseudotripartitus* which are considered to range no younger than this zone by Dettmann & Playford (1969, table 9.4). *Appendicisporites distocarinatus* was also recorded from most samples and its occurrence is consistent with its range given by Helby *et al.* (1987, fig.33), but is a younger extension of the original range given by Dettmann & Playford (1969).

There are also several new species or variety previously recorded from the *P. mawsonii* Zone in the Gippsland and Bass Basins but hitherto not recorded from the Otway Basin. These include *Densoisporites muratus* ms, *Rugulatisporites admirabilis* ms, *Hoegisporis trinalis* ms, *Laevigatosporites musa* ms, *Cupressacites* sp. and *Dilwynites granulatus* (small variety).

Counts of the two assemblages show they can be characterised by frequent to abundant *Dilwynites granulatus* (3%-39%; average 21%) with frequent to common *Cupressacites* sp. (3%-10%) and *Gleicheniidites/Clavifera* spp. (6%-9%). The abundance of these three species groups clearly distinguish these samples from those assigned to the underlying *P. pannosus* Zone.

The absence of the *C. striatoconus* dinoflagellate Zone in Iona-2 suggests the upper part of the *P. mawsonii* Zone of Coniacian age may not to be present in Iona-2.

Upon initial examination the sample at 1315m was assigned to the overlying *T. apoxyexinus* Zone on the presence of the eponymous species and *Forcipites* sp. and the supporting evidence of the associated dinoflagellates. Examination of additional slides showed that these younger index species were extremely rare and the bulk of the assemblage was more similar to the other *P. mawsonii* Zone samples. It is concluded therefore that this sample has been contaminated.

Appendicisporites distocarinatus Zone.
Interval: Not recorded in Iona-2.
Age: Cenomanian.

Assemblages characteristic of this zone were not recorded in Iona-2 but may be present in the 31 metre unsampled interval between 1371-1402m. The zone was also lacking in Iona-1 where there is a similar unsampled interval of 35 metres lying between 1347.5m-1383m (Morgan 1988).

Phimopollenites pannosus Zone.
Interval: 1402.0-1599.0 metres (197+ metres).
Age: Late Albian.

Six of the seven samples from the Eumeralla Formation could be assigned to the *P. pannosus* Zone. The seventh and deepest sample in the well was virtually barren and could not be assigned to any age.

Phimopollenites pannosus was only recorded from the samples at 1457.5m and 1516.5m, while *Perotrilites jubatus* which Dettmann & Playford (1969) considers as also having its FAD within this zone was recorded in the four samples at 1412m, 1437.5m, 1457.5m and 1590m.

Other significant species recorded include *Tricolpites cooksoniae* at 1437.5m and 1457.5m, a poorly preserved specimen of *Trilobosporites purverulentus* at 1412m and a interpreted reworked specimen of *Pilosisporites notensis* at 1402m.

Overall the species diversity recorded is not high for the zone and certain species which would have been expected were either absent or very rare. These include *Coptospora paradoxa* and *Trilobosporites trioreticulosus* which were not recorded and *Crybelosporites striatus* which was only seen at 1437.5m.

Confidence in assigning all the samples to the zone is based mainly on the assemblage count. These clearly differ from the overlying *P. mawsonii* and younger Zones by the increased abundance of *Corollina* spp., *Retitriletes* spp. and spores of the *Baculatisporites/Osmundacidites* complex, and lack of any significant abundances of *Gleicheniidites* spp., *Dilwynites* spp. and *Cupressacites* sp.

The sample at 1590m was considered to be a particularly favourable lithology and duly gave a good yield. Unfortunately the spore-pollen assemblage was overwhelmingly dominated by *Baculatisporites-Osmundacidites* style spores which comprise 85% of the count, amongst which index species were very difficult to find.

A single specimen of *Amosopollis cruciformis* was recorded at 1457.5m which is flagged as a possible new downward extension of its range or alternatively evidence of downhole contamination which is indicated as possible problem with this sample (Table-5). Significant contamination was interpreted as present in the shallowest sample at 1402m which could only be assigned to this zone after counting the limited residue recovered.

Microplankton Zones

***Nelsoniella aceras* Zone.**
Interval: 1034.5-1129.0 metres (95+ metres).
Age: Late Santonian - Early Campanian.

The three samples conform to this zone by containing either *Nelsoniella aceras* or *N. tuberculata* and lacking *Xenikoon australis*. A possible specimen of the latter species was recorded in the shallowest sample but additional searching did not reveal further specimens. It is noted that Morgan (1988) also records a questionable specimen of *X. australis* at 1018m in Iona-1 but still assigns the sample to the *N. aceras* Zone.

The associated dinoflagellates disappointingly only displayed a low diversity. Of potential local correlative value is consistent present of *Heterosphaeridium evansii* ms Marshall 1984 (= *H. laterobrachius* as recorded by Morgan 1988). The LAD of *Odontochitina porifera* was also recorded for the well at 1129m.

All three assemblages are dominated by *Heterosphaeridium* spp. (Table-3).

***Isabelidinium cretaceum* Zone.**
Interval: 1161.0-1281.0 metres (120+ metres).
Age: Santonian.

Three samples with low to moderate diversity microplankton assemblages are assigned to the *I. cretaceum* Zone on the presence of the eponymous species and lack of the succeeding zone indicator. The shallowest sample is the most problematical assignment as the specimens of *I. cretaceum* recorded are like the variety illustrated by Cookson & Eisenack (1961, p.11, figs 1,2) from the Belfast No. 4 bore. This variety is larger and characteristically circumcavate rather than simply cavate at the apices like the holotype and most of the paratypes of

I. cretaceum. This sample also contains a folded specimen which could be *N. aceras*.

The assemblages are dominated by *Heterosphaeridium* spp. One significant occurrence is the first record for the Otway Basin of *Odontochitina indigena* described from the Santonian in the Gippsland Basin by Marshall (1988).

***Odontochitina porifera* Zone.**
Interval: 1290.5-1295.0 metres (25+ metres).
Age: Santonian.

The sidewall core assemblage can be characterised by abundant *Heterosphaeridium heteracanthum* with common *Odontochitina porifera* and the cuttings sample is very similar. Most specimens of *Odontochitina porifera* found in this zone and in younger samples in Iona-2 can be characterised by a constricted and non-perforate ring at the bases to both the apical and antapical horns. In this the specimens are closer to the holotype of *O. porifera* illustrated by Cookson (1956, pl.1, fig.17) rather than the specimen illustrated by Helby *et al.* (1987, fig.41C) which lack this non-perforate ring. Some specimens where the non-perforate parts of the horns become broader have been compared to *O. cribropoda* Deflandre & Cookson 1955 but no specimens were recorded which could be considered conspecific with this latter species, as originally erroneously suggested in the provisional reports.

Although both the sidewall core and cuttings contain moderate diversity assemblages none of the other recorded species can be considered age diagnostic for this zone.

***Conosphaeridium striatoconus* Zone.**
Interval: Not recorded in Iona-2.
Age: Coniacian.

Assemblages assignable to the *C. striatoconus* Zone were not found in Iona-2, but one was recorded from a single sample at 1276.5m in Iona-1 (Morgan, 1988). Although it was suggested after the initial examination of the sidewall cores that the zone may be present in the unsampled gap between samples the subsequent analysis of cuttings found no insitu or caved specimens of the eponymous species, or any other diagnostic species, suggesting strongly that the zone is not present in Iona-2.

***Cribroperidinium edwardsii* Acme Zone.**
Interval: 1303.5-1371.0 metres (68+ metres).
Age: Turonian.

The four sidewall core samples from the Waarre Formation are assigned to a new local acme zone which is characterised by the rare to common occurrence of the dinoflagellate *Cribroperidinium edwardsii*. Microplankton are considered to be present in the samples in low abundance (6% to 11%). The higher abundance at 1315m of 32% is considered to reflect the contamination of that sample with microplankton from higher in the well. Although samples are of moderate diversity, all species are either long ranging forms or species whose ranges are imprecisely known. In particular the diagnostic zone species of the standard zonation of Helby *et al.* (1987) are absent. As well as *C. edwardsii* the main elements in the assemblages comprise species of *Cyclonephelium* spp., *Odontochitina costatae* and *O. operculata*, and *Oligosphaeridium pulcherrimum* and *O. complex*. *Heterosphaeridium* spp. although present is noticeably less common than recorded from younger zones in Iona-2. Although *Palaeohystrichophora infusorioides* is recorded in three of the four samples it is certainly not prominent.

Cribroperidinium edwardsii was considered by Helby *et al.* (1987, fig.37) to have a prominent occurrence in the upper part of the *D. multispinum* Zone and through most of the *P. infusorioides* Zone and to be inconsistent above this last zone. This is currently the strongest evidence for an assignment no younger than the *P. infusorioides* Zone and hence a Turonian age. An age no older than the *P. infusorioides* Zone is based on the absence of species that become extinct in the underlying *D. multispinum* Zone yet have been recorded in basins along the southern margin rift. The most significant of these are *Pseudoceratium ludbrookiae, Litosphaeridium siphoniphorum* and *Canninginopsis denticulata*. Direct assignment of the samples to the *P. infusorioides* Zone cannot be confidently made in the absence of any prominent occurrence of the eponymous species as well as absence of other index species. The assignment of the samples to the *P. mawsonii* spore-pollen Zone also supports the Turonian age.

The sample at 1315m is considered to be contaminated with material from the *O. porifera* Zone because of the presence of the eponymous species and the related morphotype *Odontochitina* sp. cf. *O. cribropoda* and lack of younger zone indicators. Because the samples at 1290m and 1315m were both in the initial batch of four samples processed it is speculated that the sample at 1315m was cross contaminated with the shallower sample at 1290m during laboratory preparation.

Non-marine microplankton in Eumeralla Formation.
Interval: 1402.0-1599.0 metres (197+ metres).
Age: Late Albian.

Samples from the Eumeralla Formation are characterised by a limited suite of microplankton comprising *Sigmopollis carbonis*, *S. hispidus*, *Micrhystridium* sp. A of Marshall (1989) and *Veryhachium reductum*. Most of the other forms recorded over this interval can be dismissed as caved.

The most abundant cyst is *S. carbonis* which occurs in all but the barren sample at 1590m and the very low yielding sample at 1516.5m. This form has been compared to Holocene microfossil algae occurring in eutrophic and mesotrophic freshwater environments by Pals *et al.* (1980, p.407) and Srivastava (1984, p.528).

Notwithstanding that all of the above species are also recorded in overlying marine section in Iona-2 their association in the Eumeralla Formation is interpreted to indicate deposition in freshwater, most likely lacustrine environments. Abundant shallow and ephemeral lakes are to be expected in the high latitude setting suggested for deposition of the Otway Group. These types of deposits would be readily reworked by fluviatile processes to subsequently distribute the algal microfossils throughout the sedimentary section.

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Table-4: Interpretative Palynological Data for Iona-2, Otway Basin.

Sample Type	Depth (m)	Spore-Pollen Zone	CR	Microplankton Zone	CR	Comments or Key Species
SWC-30	1034.5	*N. senectus*	B1	*N. aceras*	B3	Only single specimens of *Nothofagidites senectus*, and *Nelsoniella tuberculata*.
SWC-29	1090	*T. apoxyexinus*	B1	*N. aceras*	B2	FAD *Lygistepollenites florinii*
SWC-28	1129	*T. apoxyexinus*	B4	*N. aceras*	B3	FAD *Nelsoniella aceras*.
SWC-27	1161	*T. apoxyexinus*	B1	*I. cretaceum*	B2	*Isabelidinium thomasii*. FAD *Lygistepollenites balmei*.
SWC-26	1260	*T. apoxyexinus*	B1	*I. cretaceum*	B2	*Canningia rotundata*.
SWC-25	1281	*T. apoxyexinus*	B2	*I. cretaceum*	B2	FAD *Isabelidinium cretaceum*.
SWC-24	1290	*T. apoxyexinus*	B1	*O. porifera*	B3	Abundant *Cupressacites* sp.
Cuttings	1292.5 -1295	*T. apoxyexinus*	D3	*O. porifera*	D3	*T. apoxyexinus* and *F. stipulatus* present.
SWC-23	1303.5	*P. mawsonii*	B1	*C. edwardsii*	B2	Abundant *Dilwynites granulatus* (small variety).
Cuttings	1312.5 -1315	*P. mawsonii*	D1	*C. edwardsii*		LAD *Laevigatosporites musa*.
SWC-22	1315	*P. mawsonii*	B2	*C. edwardsii*	B3	Sample contaminated with assemblage from SWC-24 at 1290m.
Cuttings	1332.5 -1335	*P. mawsonii*	D2			Frequent *P. mawsonii*.
Cuttings	1347.5 -1350	*P. mawsonii*	D2	*C. edwardsii*	D3	*Densoisporites muratus* ms present.
SWC-21	1353	*P. mawsonii*	B4	*C. edwardsii*	B2	LAD *Hoegisporis trinalis*.
SWC-18	1371	*P. mawsonii*	B1	*C. edwardsii*	B2	FAD *Phyllocladidites mawsonii*, *Clavifera triplex* and *Cribroperidinium edwardsii*.
SWC-13	1402	*P. pannosus*	B5			Low yielding contaminated sample assigned to zone on basis of assemblage count.
SWC-11	1412	*P. pannosus*	B5			Reworking conspicuous.
SWC- 8	1437.5	*P. pannosus*	B2			*Perotrilites jubatus*.
SWC- 7	1457.5	*P. pannosus*	B1			*Amosopollis cruciformis* with *P. pannosus*.
SWC- 5	1516.5	*P. pannosus*	B3			FAD *Phimopollenites pannosus*.
SWC- 2	1590	*P. pannosus*	B2			Dominated by *Baculatisporites* spp. with *P. jubatus*.
SWC- 1	1599	Indeterminate				Virtually barren.

Abbreviations:
CR = Confidence Ratings
LAD = Last Appearance Datum
FAD = First Appearance Datum

Confidence Ratings

The Confidence Ratings assigned to the zone identifications on Table-4 are quality codes used in the STRATDAT relational database being developed by the Australian Geological Survey Organisation (AGSO) as a National Database for interpretive biostratigraphic data. Their purpose is to provide a simple relative comparison of the quality of the zone assignments. The alpha and numeric components of the codes have been assigned the following meanings:

Alpha codes: Linked to sample type

- **A** Core
- **B** Sidewall core
- **C** Coal cuttings
- **D** Ditch cuttings
- **E** Junk basket
- **F** Miscellaneous/unknown
- **G** Outcrop

Numeric codes: Linked to fossil assemblage

1	**Excellent confidence:**	High diversity assemblage recorded with key zone species.
2	**Good confidence:**	Moderately diverse assemblage recorded with key zone species.
3	**Fair confidence:**	Low diversity assemblage recorded with key zone species.
4	**Poor confidence:**	Moderate to high diversity assemblage recorded without key zone species.
5	**Very low confidence:**	Low diversity assemblage recorded without key zone species.

BASIC DATA

Table 5: Basic Sample Data - Iona-2, Otway Basin

Table-6: Basic Palynomorph Data for Iona-2, Otway Basin

Appendix 1: Species Lists for Cuttings Samples.

Palynomorph Range Charts for Iona-2, Otway Basin

Chart 1: Relative Abundance by Lowest Appearance

Chart 2: Relative Abundance by Highest Appearance

Table 5: Basic Sample Data - Iona-2, Otway Basin.

SAMPLE TYPE	DEPTH (metres)	LITHOLOGY	SAMPLE WT (g)	RESIDUE YIELD
SWC 30	1034.5	Med. gry, f. gn. sandstone with laminae ~1mm, some with carbonaceous flecks <1mm.	12.1	Moderate
SWC 29	1090	Med. gry, f. gn. sandstone with laminae <1mm with 4mm layer of chocolate coloured claystone on one edge.	15.4	High
SWC 28	1129	Carbonaceous dk gry claystone with med. gry mottled sandstone.	10.6	High
SWC 27	1161	Dk gry-blk claystone with faint mottling of sandy claystone.	12.0	Very High
SWC 26	1260	Dk grn-blk glauconite (<25%) claystone.	12.9	Moderate
SWC 25	1281	Med.-dk grn-gry glauconite (<30%) claystone.	13.2	Moderate
SWC 24	1290	Med. dk gry mottled, glauc. (<20%) claystone.	7.8	High
Cuttings	1292.5-1295	Medium gry shale, very fine grained with >50% less than 1mm.	10.2	High
SWC 23	1303.5	Mottled med. gry claystone with lt. gry sandstone. Accessory mica (<2mm) and white clay or feldspar flecks.	15.8	Low
Cuttings	1312.5-1315	Claggy dk gry claystone, very f.grn. with >70% less than 1mm.	18.8	High
SWC 22	1315	Dk gry-blk homogeneous soft claystone which is contaminated by drilling mud.	8.3	High
Cuttings	1332.5-1335	Coarse grn. quartz sandstone with <5% shale fragments.	23.8	Low
Cuttings	1347.5-1350	Lt-med. gry shale & siltstone mixed with crs qtz sand (50%).	14.6	Low
SWC 21	1353	Mottled gry claystone with f. gn. micaceous sandstone. Possible glauconite, some drilling mud contamination.	11.2	High
SWC 18	1371	Faintly laminated dk gry claystone and mottled med. gry carbonaceous/micaceous sandstone. Laminae up to 11mm.	10.2	High
SWC 13	1402	Soft Lt.-med. gry mottled claystone.	9.6	Low
SWC 11	1412	Med. gry, med. grained homogeneous sandstone with white clay flecks.	12.0	Very Low
SWC 8	1437.5	Med. gry claystone with occasional laminae.	10.0	Moderate
SWC 7	1457.5	Med. gry homogeneous claystone with subconcoidal fractures. Some drilling mud contamination.	11.0	Moderate
SWC 5	1516.5	Dk gry med. gn homogeneous sandstone. Drilling mud could not be cleaned off sample.	15.2	Very Low
SWC 2	1590	Med. gry claystone with drilling mud contamination.	7.0	Moderate
SWC 1	1599	Med. grn-gry homogeneous claystone.	6.5	Very Low

Table-6: Basic Palynomorph Data for Iona-2, Otway Basin

Sample Type	Depth (m)	Palynomorph Concentration	Palynomorph Preservation	Number S-P Species*	Microplankton Abundance	Number MP Species*
SWC-30	1034.5	Moderate	Good	43+	Common	9+
SWC-29	1090	Moderate	Fair-good	37+	Common	14+
SWC-28	1129	Low	Fair-good	28+	Very Common	9+
SWC-27	1161	Moderate	Fair-good	32+	Common	9+
SWC-26	1260	Moderate	Fair-good	31+	Abundant	18+
SWC-25	1281	Moderate	Poor-good	26+	Common	14+
SWC-24	1290	Moderate	Fair	32+	Common	12+
Cuttings	1292.5-1295	Moderate	Fair-good	19+	Frequent	12+
SWC-23	1303.5	Moderate	Poor-fair	34+	Frequent	15+
Cuttings	1312.5-1315	Moderate	Fair	27+	Frequent	10+
SWC-22	1315	Low	Poor-fair	26+	Abundant	12+
Cuttings	1332.5-1335	Low	Fair	26+	Rare	4+
Cuttings	1347.5-1350	Low	Fair	23+	Rare	5+
SWC-21	1353	High	Poor-fair	36+	Common	13+
SWC-18	1371	Low	Fair	38+	Frequent	16+
SWC-13	1402	Low	Poor-fair	24+	Rare	4+
SWC-11	1412	High	Poor-fair	17+	Rare	3
SWC- 8	1437.5	High	Poor-fair	34+	Rare	2
SWC- 7	1457.5	High	Poor-fair	38+	Very rare	5
SWC- 5	1516.5	Very low	Fair	3+		
SWC- 2	1590	High	Fair-good	20+	Very rare	1
SWC- 1	1599	Very low	Very poor	1+		

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

APPENDIX 1

Species Lists for Cuttings Samples.

Cuttings at 1292.5 to 1295 metres

Spore-pollen species	
Australopollis obscurus	Rare
Baculatisporites comaumensis	Rare
Cicatricosisporites australiensis	Rare
Clavifera triplex	Frequent
Coptospora pileolus ms	Rare
Cyathidites australis	Rare
Forcipites stipulatus	Rare
Granulatisporites trisinus **RW**	Rare
Herkosporites elliottii	Rare
Latrobosporites ohaiensis	Rare
Microcachryidites antarticus	Frequent
Phyllocladidites mawsonii	Frequent
Plicatipollenites spp. **RW**	Rare
Podocarpidites/Falcisporites spp.	Rare
Proteacidites spp.	Frequent
Retitriletes austroclavatidites	Rare
Retitriletes spp.	Rare
Tricolpites spp.	Rare
Tricolporites apoxyexinus	Rare

Microplankton species	
Amosopollis cruciformis	Common
Gillinia sp.	Rare
Heterosphaeridium conjunctum	Rare
Heterosphaeridium heteracanthum	Common
Hexagonifera glabra	Frequent
Hexagonifera vermiculata	Rare
Isabelidinium cretaceum	Frequent
Micrhystridium spp.	Rare
Odontochitina costata	Rare
Odontochitina porifera	Rare
Spiniferites furcatus/ramosus	Rare

Cuttings at 1312.5 to 1315 metres.

Spore-pollen species	
Aequitriradites spinulosus	Rare
Australopollis obscurus	Frequent
Baculatisporites comaumensis	Rare
Cicatricosisporites cuneiformis	Rare
Cicatricosisporites n.sp.	Rare
Cicatricosisporites pseudotripartitus	Rare
Clavifera triplex	Rare
Cupressacites sp.	Rare
Cyathidites australis	Rare
Densoisporites velatus	Rare
Dilwynites echinatus ms	Rare
Dilwynites granulatus (small variety)	Rare
Dilwynites granulatus sensus strictus	Rare
Foraminisporis wonthaggiensis	Rare
Gleicheniidites circinidites	Rare
Haloragacidites harrisii	Rare/caved
Laevigatosporites major	Rare
Laevigatosporites musa ms	Rare
Microcachryidites antarticus	Rare
Nothofagidites emarcidus	Frequent/caved
Peninsulapollis gillii	Rare/caved
Perotrilites jubatus	Rare
Phyllocladidites mawsonii	Frequent
Plicatipollenites spp. **RW**	Rare
Podosporites microsaccatus	Rare
Proteacidites spp.	Common/mostly caved
Protohaploxypinus spp. **RW**	Rare
Retitriletes circolumenus	Rare
Retitriletes spp.	Rare
Rugulatisporites mallatus	Rare
Stereisporites antiquisporites	Rare
Stereisporites pocockii	Rare
Microplankton species	
Amosopollis cruciformis	Common
Apteodinium sp.	Rare
Chlamydophorella nyei	Rare
Heterosphaeridium heteracanthum	Common
Isabelidinium belfastense	Rare
Odontochitina operculata	Rare
Odontochitina porifera	Frequent
Oligosphaeridinium complex	Rare
Spiniferites furcatus/ramosus	Rare
Wuroia? sp.	Rare

Cuttings at 1332.5 to 1335 metres.

Spore-pollen species	
Aequitriradites spinulosus	Rare
Appendicisporites distocarinatus	Rare
Araucariacites australis	Rare
Asteropollis asteroides	Rare
Baculatisporites comaumensis	Rare
Ceratosporites equalis	Rare
Cicatricosisporites cuneiformis	Rare
Cicatricosisporites pseudotripartitus	Rare
Clavifera triplex	Rare
Cyathidites australis	Rare
Dilwynites granulatus (small variety)	Rare
Dilwynites granulatus sensus strictus	Rare
Gleicheniidites circinidites	Rare
Laevigatosporites musa ms	Rare
Laevigatosporites ovatus	Rare
Microcachryidites antarticus	Rare
Nothofagidites senectus	Rare/caved
Phyllocladidites eunuchus ms	Rare
Phyllocladidites mawsonii	Frequent
Plicatipollenites spp. **RW**	Rare
Podocarpidites/Falcisporites spp.	Rare
Podosporites microsaccatus	Rare
Proteacidites spp.	Rare
Rugulatisporites admirabilis ms	Frequent
Schizea fromensis	Rare
Stereisporites antiquisporites	Rare
Tricolporites apoxyexinus	Rare/caved
Fungal fruiting bodies	Rare
Microplankton species	
Amosopollis cruciformis	Common
Heterosphaeridium heteracanthum	Common
Isabelidinium sp. cf. I. belfastense	Rare
Isabelidinium cretaceum	Rare
Spiniferites furcatus/ramosus	Rare

Cuttings at 1347.5 to 1350 metres.

Spore-pollen species	
Aequitriradites spinulosus	Rare
Appendicisporites distocarinatus	Rare
Araucariacites australis	Rare
Australopollis obscurus	Rare
Camarozonosporites apiculatus ms	Rare/caved
Cicatricosisporites pseudotripartitus	Rare
Cupressacites sp.	Rare
Cyathidites australis	Rare
Densoisporites muratus	Rare
Dictyophyllidites spp.	Rare
Dictyotosporites speciosus	Rare
Forcipites stipulatus	Rare/caved
Gleicheniidites circinidites	Rare
Laevigatosporites ovatus	Rare
Lygistepollenites florinii	Rare
Microcachryidites antarticus	Rare
Phyllocladidites mawsonii	Rare
Podocarpidites/Falcisporites spp.	Rare
Podosporites microsaccatus	Rare
Proteacidites spp.	Rare
Rugulatisporites admirabilis ms	Rare
Stereisporites antiquisporites	Rare
Tricolporites apoxyexinus	Rare/caved
Fungal fruiting bodies	Rare
Microplankton species	
Amosopollis cruciformis	Common
Cribroperidinium edwardsii	Frequent
Heterosphaeridium heteracanthum	Frequent
Odontochitina porifera	Rare/caved
Spiniferites furcatus/ramosus	Rare