



**Palynological Analysis of
Wallaby Creek-2,
Port Campbell Embayment,
Otway Basin.**

by

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INTERPRETATIVE DATA

Introduction

Fifteen sidewall cores and two core samples were analysed in Wallaby Creek-2 over a short 208 metres interval extending from 1392m at the top of the Belfast Mudstone to 1599.5m within the Eumeralla Formation. The palynological zones and ages identified and their correlations to formations or units identified in the well are summarised in Table 1 below. Additional interpretative data with zone identification and Confidence Ratings are recorded in Table 3, whilst basic data on sidewall core lithologies, sample quantity and quality, residue yields, preservation and diversity are recorded on Tables 4 and 5. All species which have been identified with binomial names are tabulated on a composite range chart for both spore-pollen and microplankton which presents the recorded assemblages in order of lowest appearances.

Table-1: Palynological Summary Wallaby Creek-2.

AGE	UNIT	SPORE-POLLEN ZONES	MICROPLANKTON ZONES (SUBZONES)
SANTONIAN	BELFAST MUDSTONE 1391-1479m	<i>T. apoxyexinus</i> 1392.0-1475.0m	<i>I. cretaceum</i> 1392.0-1475.0m
TURONIAN	WAARRE FORMATION UNIT C 1479-1486m	Indeterminate	Indeterminate
	WAARRE FORMATION UNITS A/B 1486-1528m	<i>P. mawsonii</i> 1495.0-1523.5m	<i>P. trifusortoides</i> 1495.0-1510.0m (<i>C. edwardsii</i>) 1501.0-1510.0m
LATE ALBIAN	EUMERALLA FORMATION 1528-1745m (T.D.)	<i>P. pannosus</i> 1531.87-1589.5m	No zones present.

Between 4 to 12.4 grams (average 8 g) of the sidewall cores and an average of 16.5 grams of the core samples were processed by Laola Pty Ltd in Perth. Moderated to high residue yields were extracted from most samples. Kerogen slides were prepared with filtered and unfiltered fractions, and where sufficient residue was recovered, separate oxidised slides were prepared from fractions concentrated from the residues using 8 and 15 micron filters. Palynomorph concentrations on the palynological slides varied from low to high throughout the sequence without a

) notable trend or pattern (Table 5). Palynomorph preservation was poor to fair and only very occasionally good.

Overall spore-pollen diversity was high averaging 27+ species per sample with the exception of the low yielding sample at 1519m, the barren sample at 1599.5m, and contaminated sample at 1481.5m (Table 5). Microplankton were common to abundant in all samples from the Belfast Mudstone, but were inconsistently abundant varying from very rare to common in the Waarre Formation and were very rare in the Eumeralla Formation. Microplankton species diversity was low to moderate averaging overall less than 10 species per sample.

Geological Comments

1. The section analysed in Wallaby Creek-2 consists of three distinct ages separated by two significant unconformities. The oldest unit analysed in the well is of Late Albian age (*P. pannosus* Zone) and is assigned to the Eumeralla Formation. This is overlain unconformably by the lower part of the *P. mawsonii* Zone which is considered to be early to middle Turonian in age. As with other wells in the Port Campbell Embayment, Cenomanian age strata is missing at the unconformity. In Wallaby Creek-2 there is less than a 9-metre sampling gap in the palynological control across this unconformity. The youngest unit analysed in the well is a suite of Santonian age samples assigned to the *T. apoxyextnus* and *I. cretaceum* Zones from the shaly unit identified as the Belfast Mudstone. An unconformity picked at 1480m separates the Belfast Mudstone from the highest sand in the underlying Waarre Formation. Missing at the unconformity in terms of the microplankton zones are the uppermost part of the *P. infusortoides* Zone and all of the younger *C. striatoconus* and *O. porifera* Zones. Across this unconformity there is a sampling gap of only 20 metres, including the 6 metre sand between 1480-1486m. The only sample considered prospective from this sand (at 1481.5m) proved on processing to be contaminated by obvious Tertiary and Maastrichtian palynomorphs and could not be assigned with confidence to any zone.
2. In terms of the nomenclature proposed by Buffin (1989), missing in Wallaby Creek-2 relative to other wells analysed in the Port Campbell Embayment over the past year is the upper part of Unit C (ie. that part of the *P. mawsonii* Zone above the highest occurrence of *Hoegtsports trinaltis* ms), all of Unit D and the basal part of the Belfast Mudstone containing the *C. striatoconus* and *O. porifera* microplankton Zones. In total the unconformity has a duration of as much as 5 million years. Considering that the missing section has been recorded in Langley-1 to the southeast

and Vaughan-1 and Dunbar-1 to the north west the unconformity in Wallaby Creek-2 is more likely to be erosional rather than non-depositional.

3. Marine microplankton were recorded from four of the five samples from in the Waarre Formation and all samples from the overlying Belfast Mudstone. Microplankton abundance data presented on the table below was obtained from counts made on the slides prepared using an 8 micron filter cloth. The microplankton abundances and diversity in the Waarre are more similar to the Vaughan-1 and Dunbar-1 wells rather than the Langley-1 well (Partridge 1994b, 1995a, b) and are best interpreted to reflect near-shore, but fluctuating marine conditions. The consistently higher abundances and diversity in the overlying Belfast Mudstone are interpreted to represent a more continuous open marine environment.

Table-2: Selected Microplankton Abundances in Wallaby Creek-2.

SAMPLE TYPE	DEPTH (Metres)	Microplankton Zone and (Subzone)	Microplankton Abundance as % Relative to total Spore-pollen and Microplankton Count	Most abundant microplankton species as % of total Microplankton Count
SWC 24	1392.0	<i>I. cretaceum</i>	11%	<i>Heterosphaeridium</i> spp. >40%.
SWC 23	1415.0	<i>I. cretaceum</i>	33%	<i>Heterosphaeridium</i> spp. >70%.
SWC 22	1437.5	<i>I. cretaceum</i>	25%	<i>Heterosphaeridium</i> spp. >70%.
SWC 20	1461.5	<i>I. cretaceum</i>	33%	<i>Heterosphaeridium</i> spp. >50%. <i>Amosopollis cruciformis</i> >25%.
SWC 19	1470.0	<i>I. cretaceum</i>	43%	<i>Amosopollis cruciformis</i> >35% <i>Heterosphaeridium</i> spp. >15%.
SWC 18	1475.0	<i>I. cretaceum</i>	25%	<i>Heterosphaeridium</i> spp. >40%. <i>Amosopollis cruciformis</i> >25%.
SWC 14	1495.0	<i>P. infusorioides</i>	7%	No species dominant in low count.
SWC 13	1501.0	(<i>C. edwardsii</i>)	<4%	No species dominant in low count.
SWC 10	1510.0	(<i>C. edwardsii</i>)	8%	No species dominant in low count.
SWC 7	1523.5	Indeterminate	<1%	Microplankton very rare.

4. The identification of the *C. edwardsii* Acme at 1501m and 1510m, based on multiple specimens of *Cribroperidinium edwardsii* in the somewhat restricted microplankton assemblages, suggests the shaly interval between 1486-1518m is best interpreted as belonging to Unit B of the Waarre. This makes both Units A and C very thin in Wallaby Creek-2.

Biostratigraphy

The zone and age determinations are based on the Australia wide Mesozoic spore-pollen and microplankton zonation schemes described by Helby, Morgan & Partridge (1987). Author citations for most spore-pollen species can be sourced from Helby, Morgan & Partridge (1987), Dettmann (1963), Stover & Partridge (1973) or other references cited herein, whilst author citations for dinoflagellates can be found in the index of Lentini & Williams (1993). Species names followed by "ms" are unpublished manuscript names.

***Tricolporites apoxyexinus* spore-pollen Zone and**

***Isabelidium cretaceum* microplankton Zone.**

Interval: 1392.0-1475.0 metres. (83+ metres)

Age: Santonian.

The seven shallowest samples analysed are assigned to the *T. apoxyexinus* Zone on the presence of good specimens of *Ornamentifera sentosa* at 1415m, 1437.5m and 1475m; *Latrobosporites amplus* at 1415m and 1437.5m; *Peninsulapollis gillii* at 1415m and *Forcipites* spp. at 1392m and 1437.5m. The eponymous species was not recorded and as index species for the zone are very rare only low confidence ratings have been assigned to most samples. Average diversity was 27+ species per sample with most samples characterised by abundances of the gymnosperm pollen *Podocarpidites* spp. (5% to 17%) and the *Araucariacites/Dilwynites* group (11% to 20%) and occasional high abundances of *Gleicheniidites* spp. (14% at 1437.5m and 19% at 1475m). There is also a marked increase in abundance of angiosperm pollen going up section from <1% at 1475m and 4% at 1470m to >27% in the two shallowest samples. The increase in angiosperm abundances is mostly small morphological nondescript triporate and tricolpate pollen. Peak abundance of *Proteacidites* spp. was 16% at 1415m and *Australopollis obscurus* was 5% at 1392m. A single specimen of *Nothofagidites senectus* was recorded at 1415m suggesting the younger zone of this name, but as this species is not recorded below the Skull Creek Mudstone in other wells it is best treated as contamination until consistent occurrences as old as this can be documented in other sections.

The samples are also assigned to the *I. cretaceum* Zone on the presence of a variety of *Isabelidium* species. Most frequent is *Isabelidium belfastense* occurring in all samples between 1415m to 1475m. The eponymous species *I. cretaceum* was only confidently identified at 1453m and 1470m while *I. thomasi* was recorded between 1415m to 1470m. Important accessory species include *Chatangiella victoriensis*, *Odontochitina cribropoda* and *O. porifera*. Most

assemblages are dominated by *Heterosphaeridium heteracanthum* although the deepest three samples also have significant abundances of the enigmatic algal cyst *Amosopollis cruciformis*. The shallowest sample also contains *Isabelidium rotundatum* ms whose oldest occurrence defines a possible useful upper subdivision of the *I. cretaceum* Zone. On a strict zone definition the deepest sample at 1475m should also be assigned to the *O. portifera* Zone on the absence of *I. cretaceum* but was retained within the younger zone based on the frequent occurrence of *I. belfastense*.

***Phyllocladidites mawsonii* spore-pollen Zone**

(formerly the *Clavifera triplex* Zone).

Interval: 1495.0-1523.5 metres (28+ metres).

Age: Turonian

The four samples assigned to the *P. mawsonii* Zone are all assigned to the lower part of the zone based on the range of *Hoegisporis trinalis* ms. The fifth sample over this interval at 1519m probably also belongs to this zone but unfortunately the palynomorphs were so rare it was impossible to record a diagnostic assemblage.

The deepest sample at 1523.5m contains the eponymous species *Phyllocladidites mawsonii*, associated with the new species *Dilwynites pusillus* ms and *Rugulatisporites admirabilis* ms which are not currently known to range below this zone. Also present is *Appendicisporites distocarinatus* which can range older.

The three samples between 1495-1510m are all characterised by *Hoegisporis trinalis* ms and also contain *D. pusillus* ms, *R. admirabilis* ms and *A. distocarinatus*. The oldest occurrences of *Laevigatosporites musa* ms and *Foveogleichenitidites confossus* in the shallowest sample are potentially important FADs for future subdivision of this interval.

The assemblages are dominated by the spores *Cyathidites* spp. and *Gleichenitidites circinidites* and the gymnosperm pollen of the *Araucariacites/Dilwynites* species complex and *Podocarpidites* spp. Angiosperm pollen are rare in all samples.

The sample at 1481.5m upon preparation for processing was found to consist of a medium to dark brown claystone, carbonaceous in part, irregularly mixed with coarse grained quartz sandstone. It was mostly the claystone fraction that was submitted for processing although this could not be adequately separated or cleaned in the soft and crumbly sample. The assemblage recorded consisted of spores, pollen and microplankton also recorded in the overlying Belfast Mudstone mixed with palynomorph species indicative of Maastrichtian and Tertiary ages.

The former species are shown as caved on the range chart while a selection of the latter are listed below. The preferred interpretation is that the entire assemblage is caved and therefore not representative of the age of the sand between 1480-1406m.

Maastrichtian Species:

Forcipites longus
Manumiella sp. cf. *M. druggii*
Proteacidites otwayensis ms

Tertiary Species:

Aglaoreidia qualumis
Haloragacidites harrisii
Nothofagidites emarcidus / heterus
Operculodinium centrocarpum
Podocarpidites exiguus
Protoellipsodinium simplex ms
Rudolphisporis rudolphi

***Palaeohystrichophora infusorioides* microplankton Zone.**

Interval: 1495.0-1510.0 metres (15+ metres).

***Cribooperidinium edwardsii* Subzone.**

Interval: 1501.0-1510.0 metres

Age: Turonian.

The identification of the *P. infusorioides* Zone follows the recent analysis and arguments in Partridge (1994a, b, c; 1995a, b). The zone is identified by the similarity of the assemblages to those recovered in other wells in the Port Campbell Embayment. The assemblages recorded from Wallaby Creek-2 are not in themselves diagnostic as only long ranging species were recorded. The shallowest sample at 1495m has a moderate diversity but no particular species dominates. It does however contain the oldest occurrence of *Heterosphaeridium* represented by fragmented specimens. The sample at 1501m has both low diversity and low abundance of microplankton but does contain *Cribooperidinium edwardsii* and is therefore considered to lie at the top of the acme of this species. In the sample at 1510m *Palaeoperidinium cretaceum* is the most conspicuous species in the 15 μ m filtered slides with *Cyclonephellium compactum* and *C. edwardsii* the next most frequent. The last is considered to be sufficiently abundant to constitute the *C. edwardsii* Acme.

The sample at 1523.5m is also considered marine as it contains *Palaeoperidinium cretaceum* but the record of just this single species does not justify any zone assignment.

***Phimopollenites pannosus* spore-pollen Zone.**

Interval: 1531.87 to 1589.5 metres (68+ metres).

Age: Late Albian.

The sidewall core sample at 1589.5m and deepest sample from this zone contained an assemblage dominated by laevigate trilete spores referred to *Cyathidites* spp. with an abundance of 31% and bisaccate gymnosperm pollen referred to *Podocarpidites* with an abundance of 22%. The assemblage also contained common *Corollina torosa* with an abundance of 5% as is typical of this zone sampled in other recent wells. Of the rare microplankton recorded *Michrhystridium* sp. A, Marshall 1989 and *Sigmopollis carbonis* have previously been recorded from this zone but the single specimen of *Sentusidinium aptiense* (Burger 1980) observed has not previously been reported from this zone and is best interpreted as either down-hole or laboratory contamination until it can be documented in other sections or samples in the Eumeralla Formation.

The two conventional core samples were both from carbonaceous laminae in massive feldspathic sandstone and (not surprisingly) were dominated by high yields of structured terrestrial kerogen (also referred to as woody or herbaceous kerogen) in which spore-pollen were very rare to moderately abundant. Both samples contained the typical bland assemblages characteristic of the Eumeralla Formation. The shallowest sample is no younger than the *P. pannosus* Zone on common occurrence of *C. torosa* while the deeper contained frequent specimens of the eponymous species. The rare microplankton recorded in the latter are more likely to be derived from mud pellets in sandstone rather than the carbonaceous laminae (see Table-4).

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Table-3: Interpretative Palynological Data for Wallaby Creek-2.

Sample Type	Depth (m)	Spore-pollen Zone	*CR	Microplankton Zones and (Subzones)	*CR	Comments and Key Species
SWC 24	1392.0	<i>T. apoxyextrus</i>	B4	<i>I. cretaceum</i>	B4	<i>Proteacidites</i> spp. >10% FAD of <i>Isabelidinium rotundatum</i> ms.
SWC 23	1415.0	<i>T. apoxyextrus</i>	B1	<i>I. cretaceum</i>	B4	<i>Proteacidites</i> spp. 16%. Presence of <i>Nothofagidites senectus</i> interpreted as down-hole contamination.
SWC 22	1437.5	<i>T. apoxyextrus</i>	B2	<i>I. cretaceum</i>	B3	<i>Proteacidites</i> spp. 12% with <i>Ornamentifera sentosa</i> and <i>Isabelidinium belfastense</i> .
SWC 21	1453.0	<i>T. apoxyextrus</i>	B4	<i>I. cretaceum</i>	B3	<i>Isabelidinium cretaceum</i> sensus strictus with <i>I. belfastense</i> and <i>I. thomasi</i> present.
SWC 20	1461.5	<i>T. apoxyextrus</i>	B4	<i>I. cretaceum</i>	B4	<i>Proteacidites</i> spp. >7% with <i>I. belfastense</i> .
SWC 19	1470.0	<i>T. apoxyextrus</i>	B4	<i>I. cretaceum</i>	B3	FAD of <i>Isabelidinium cretaceum</i> .
SWC 18	1475.0	<i>T. apoxyextrus</i>	B2	<i>I. cretaceum</i>	B4	FADs of <i>O. sentosa</i> and <i>I. belfastense</i> .
SWC 17	1481.5	Indeterminate		Indeterminate		Sample contaminated by Tertiary and Maastrichtian palynomorphs suggesting carbonaceous claystone fraction in broken SWC is all downhole contamination.
SWC 14	1495.0	<i>P. mawsonii</i>	B1	<i>P. infusorioides</i>	B2	LADs of <i>Hoegtsports trinalis</i> ms, <i>Appendicisporites distocarinatus</i> and dinoflagellate <i>Klokanstium polypes</i> .
SWC 13	1501.0	<i>P. mawsonii</i>	B1	<i>P. infusorioides</i> (<i>C. edwardsii</i>)	B3	LAD of <i>Cribroperidinium edwardsii</i> .
SWC 10	1510.0	<i>P. mawsonii</i>	B1	<i>P. infusorioides</i> (<i>C. edwardsii</i>)	B2	FADs of <i>H. trinalis</i> and <i>C. edwardsii</i>
SWC 8	1519.0	Indeterminate				Palynomorphs very rare
SWC 7	1523.5	<i>P. mawsonii</i>	B3			FADs of <i>Phyllocladidites mawsonii</i> , <i>Appendicisporites distocarinatus</i> and <i>Rugulatisporites admirabilis</i> ms. Microplankton very rare.
CORE-2	1531.87-1531.94	<i>P. pannosus</i> or older	A4			Common <i>Corollina torosa</i> .
CORE-2	1545.11-1545.17	<i>P. pannosus</i>	A1			Frequent <i>Pimopollenites pannosus</i> . Rare microplankton considered to be from mud pellets.
SWC 3	1589.5	<i>P. pannosus</i>	B1			FAD in well of <i>Pimopollenites pannosus</i> with <i>Corollina torosa</i> 5%.
SWC 2	1599.5	Barren				Greenish grey claystone was barren of palynomorphs.

*CR = Confidence Ratings
LAD = Last Appearance Datum
FAD = First Appearance Datum

Confidence Ratings

The Confidence Ratings assigned to the zone identifications on Table-3 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-4: Basic Sample Data - Wallaby Creek-2.

Sample Type	Depth (m)	Rec (cm)	Lithology	Sample Wt (g)	Residue Yield
SWC 24	1392.0	3.5	Dark brown-black siltstone with 2mm laminae of white siltstone. Well cleaned.	10.8	High
SWC 23	1415.0	3.0	Dark brown- black claystone - soft. mud penetrated. Poorly cleaned	8.0	Low
SWC 22	1437.5	3.0	Dark brown-black pyritic claystone. Firm - well cleaned.	10.9	High
SWC 21	1453.0	3.8	Dark brown claystone slightly calcareous with trace of glauconite. Soft - moderately well cleaned.	10.3	High
SWC 20	1461.5	4.1	Dark brown claystone. slightly calcareous with trace micromica. Well cleaned.	8.9	High
SWC 19	1470.0	2.5	Dark brown claystone. Firm - well cleaned.	9.5	High
SWC 18	1475.0	3.5	Medium dark brown claystone. faintly mottled. Well cleaned.	12.4	High
SWC 17	1481.5	2.8	Medium-dark brown claystone intermixed with coarse sandstone. Poorly cleaned.	5.8	Moderate
SWC 14	1495.0	3.5	Interlaminated dark brown claystone and light brown-tan sandstone. Laminae irregular 1-5mm. Well cleaned	9.0	High
SWC 13	1501.0	1.8	Tan fine-medium sandstone with dark brown claystone laminae up to 3mm. Well cleaned.	4.1	Moderate
SWC 10	1510.0	1.4	Dark grey-brown fissile claystone. Moderately well cleaned.	4.3	High
SWC 8	1519.0	<2.0	Light brown fine grained sandstone with carbonaceous claystone to coal. Sample broken - poorly cleaned.	4.7	Moderate
SWC 7	1523.5	<2.0	Light brown fine grained sandstone interlaminated with dark brown claystone. Laminae <2mm. Poorly cleaned	6.4	Moderate
CORE-2	1531.87-1531.94		Medium grey, fine-medium grey feldspathic sandstone with thin lamination of carbonaceous fragments up to 3mm diameter	16.6	High
CORE-2	1545.11-1545.17		Medium grey coarse grained feldspathic sandstone with a bedding surface containing carbonaceous fragments up to 20mm long overlain by pebble size mud pellets.	16.3	High
SWC 3	1589.5	3.5	Light-medium grey siltstone with faint lamination. Well cleaned.	12.0	High
SWC 2	1599.5	<1.7	Green grey claystone. Well cleaned.	4.0	Very low

Table-5: Basic Palynomorph Data for Wallaby Creek-2.

Sample Type	Depth (m)	Palynomorph Concentration	Palynomorph Preservation	No. S-P spp*	Microplankton Abundance	No. MP Species*
SWC 24	1392.0	Moderate	Poor-fair	35+	Common	19+
SWC 23	1415.0	Low	Fair-good	34+	Abundant	15+
SWC 22	1437.5	Moderate	Poor-good	27+	Abundant	12+
SWC 21	1453.0	High	Poor-good	21+	Abundant	11+
SWC 20	1461.5	Low	Poor-fair	20+	Abundant	6+
SWC 19	1470.0	Moderate	Poor-good	21+	Abundant	9+
SWC 18	1475.0	Moderate	Poor-good	33+	Abundant	12+
SWC 17	1481.5	Low	Poor-good	12+	Frequent	5+
SWC 14	1495.0	Moderate	Poor-fair	35+	Common	14+
SWC 13	1501.0	Low	Poor-fair	30+	Frequent	5+
SWC 10	1510.0	High	Poor-good	29+	Common	15+
SWC 8	1519.0	Very low	Poor	8+	NR	
SWC 7	1523.5	Very low	Poor-good	25+	Very rare	1+
CORE-2	1531.87- 1531.94	Low	Fair	18+	NR	
CORE-2	1545.11- 1545.17	Moderate	Fair	23+	Very rare	2
SWC 3	1589.5	High	Poor-fair	36+	Very rare	3+
SWC 2	1599.5	Barren				

***Diversity:** Very low = 1-5 species
 Low = 6-10 species
 Moderate = 11-25 species
 High = 26-74 species
 Very high = 75+ species
 NR = Not recorded in sample