Palynological analysis of the interval 1629 to 2425 metres in Minerva–1, Otway Basin.

by

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Summary

In this report relinquished palynological slides from 51 samples (23 sidewall core, 4 core and 24 cuttings) are analysed or reviewed from Minerva–1, over a ~800 metre interval from 1629 to 2425 metres. The well bottoms in the Eumeralla Formation and this unit is overlain after a substantial unconformity by the Waarre Formation, which in turn is overlain after lesser time breaks by the Flaxman Formation and Belfast Mudstone. The identification of the new Banoon Member at the top of the Flaxman Formation is confirmed by a distinctive *Cupressacites* pollen spike. A summary of the identified palynological zones, their ages, and the suggested correlation of the section analysed to the revised stratigraphy of the Sherbrook Group (Figure 1) is provide below:

Table–1: Palynological summary for Minerva–1

AGE	EQUIVALENT LITHOLOGICAL UNIT	SPORE–POLLEN ZONES & Subzones	MICROPLANKTON ZONES & Subzones
SANTONIAN to CONIACIAN	BELFAST MUDSTONE 1309–1648m	*P. mawsonii* Zone 1629–1647m	*C. striatoconus* Zone 1629–1647m
CONIACIAN to TURONIAN	BANOON MEMBER 1648–1673m	*P. mawsonii* Zone 1660m *Cupressacites* spike 1660m	*P. infusorioides* Zone 1660m
TURONIAN	FLAXMAN FORMATION 1673–1816m	*P. mawsonii* Zone 1690–1805m *G. ancorus* Subzone 1690–1790m	*P. infusorioides* 1690–1805m *K. polypes* Subzone 1690–1805m
TURONIAN	WAARRE FORMATION 1816m–2293m Subdivided into Unit Cb 1816–1944m Unit Ca 1944–2080m Unit B ?2080–2135m Unit A ?2135–2293m	*P. mawsonii* Zone 1837.3–2157.5m *L. musa* Subzone 1837.3–1872.5m *H. trinalis* Subzone 1943†–2157.5m	*P. infusorioides* Zone 1838.1–2132m *I. evexus* Subzone 1839.7m *Heterosphaeridium* Acme 2035m *C. edwardsii* Subzone 2084†–2105†m
ALBIAN	EUMERALLA FORMATION 2293–2425m T.D.	*C. paradoxa* 2294–2408m	Not zoned.

† Depth from cuttings sample.

Identification of the informal lithological subdivisions within the Waarre Formation is based on a combination of log character and the correlations of the palynological zones to wells in the Port Campbell Embayment. On current understanding of the palynological sequence the Waarre Formation is interpreted to represent a continuous succession and does not contain any significant time breaks or unconformities

Detailed interpretative data on all samples, including zone identifications, zone confidence ratings and environmental interpretations are recorded in Table 2, whilst basic data on sidewall core lithologies, number of palynological slides relinquished, visual residue yields, palynomorph preservation and species diversity are presented in Table 3. Counts of selected samples are recorded in Table 4, and distribution of selected palynomorphs are presented in Table 5.

Materials and Methods

The study is based on relinquished palynological slides borrowed from the Department of Natural Resources and Environment. Additional relinquished palynological slides were also available for another 27 sidewall cores and five cuttings sample between 563m and 1616m covering a section of Coniacian to Eocene in age, but these were not reviewed as part of this study. The Basic Data range chart prepared by Dr Roger Morgan in July 1992, and included in the Well Completion Report was available during the study, but not the final interpretative written report.

Based on the number of palynological slides in the relinquishment collection, residue yields were mainly high through the formations of the Sherbrook Group, but variable from low to high in the underlying Eumeralla Formation of the Otway Group. Concentration of palynomorphs on the slides is also variable with the concentration varying with different processing techniques applied to the samples. The latter also affects the preservation with many samples being over oxidised, although other samples are poorly preserved due to microscopic pyrite pitting of the palynomorphs (Table 3). Spore-pollen diversity is mainly moderate to high, while microplankton diversity is mostly low to moderate down to ~2150m and very low or absent below that depth. The majority of the 24 cuttings samples through the section analysed were only given a cursory examination.

The assemblage abundances given on Table 4 were counted under a x40 objective, and although providing a good approximation of the abundance of the major species groups they cannot be considered accurate to better than about ±2%. On tables and in text the abundance of spore-pollen species is always expressed as a percentage of the spore-pollen count. In contrast, the microplankton abundances are generally expressed as percentage of combined spore-pollen and microplankton count (eg. Table 2). However in the discussion of the microplankton zones abundance of individual genera and species are given as percentages of just the microplankton count (see Table 4).

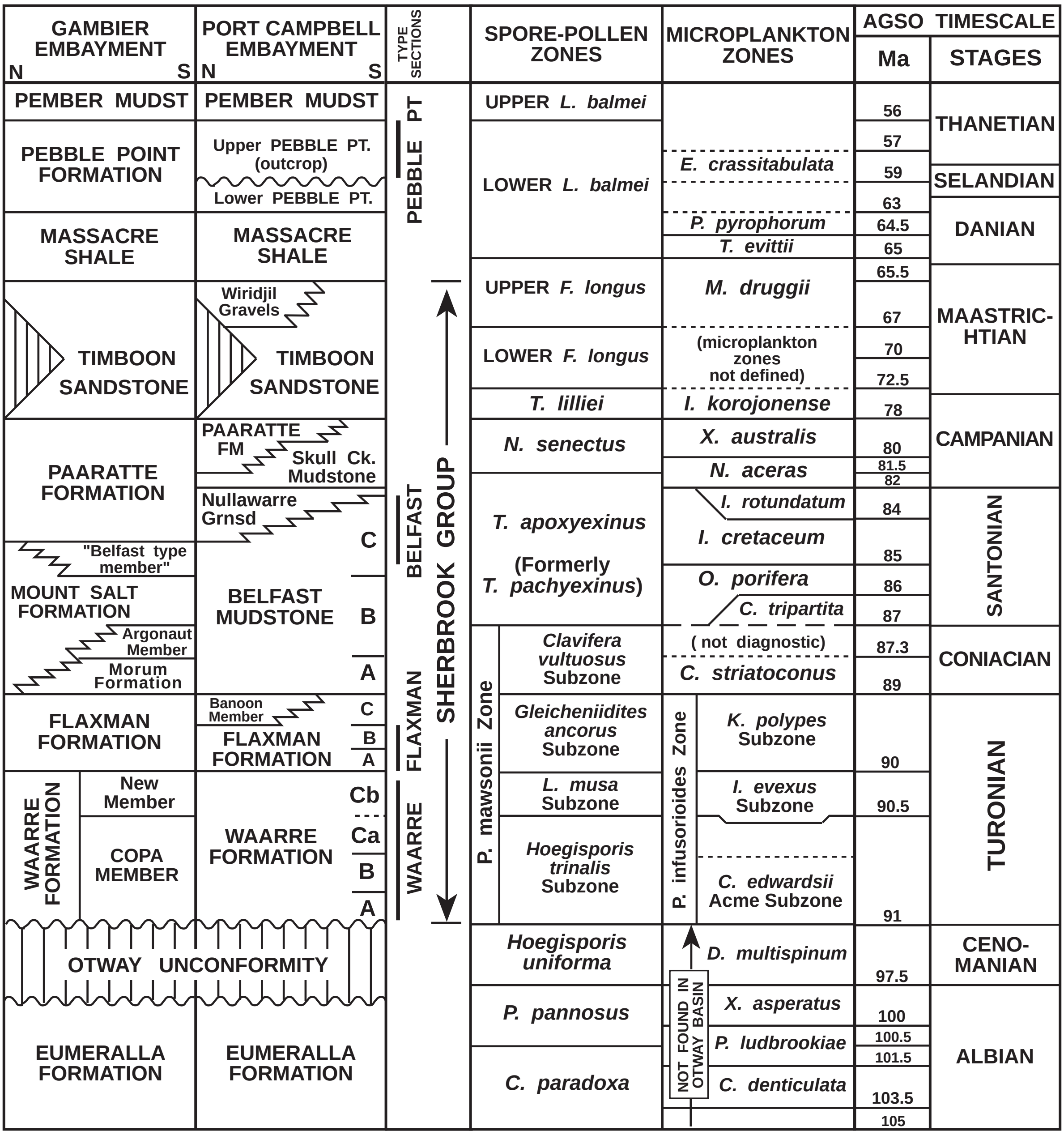

Figure 1. Revised Sherbrook Group stratigraphy, palynological biostratigraphy and proposed correlation to international stages and AGSO chronometric timescale (Young & Laurie, 1996).

Palaeoenvironments

The palaeoenvironments assigned to the samples are based on consideration of **1)** abundance, diversity and type of microplankton, **2)** the way the spore-pollen composition is skewed by changes in abundance of different species, and **3)** the lithology of the samples. The various environmental categories distinguished and their lithological and palynological characteristics are summarised in Figure 2.

ENVIRONMENT	**TYPICAL LITHOLOGIES**	**CHARACTERISTICS OF PALYNOLOGICAL ASSEMBLAGES**
NON-MARINE — including marsh, overbank, fluviatile and alluvial environments	**Coals** and **carbonaceous mudstones**	**Microplankton** absent to extremely rare, all non-marine species. **Spore-pollen** assemblages skewed with high abundances of certain species. Diagnostic species include gymnosperm pollen: *Phyllocladidites mawsonii, P. eunuchus, Trichotomosulcites subgranulatus* and spores: *Gleicheniidites* spp., *Cyathidites* spp. *Cicatricosisporites* spp., and *Ruffordiaspora* spp.
LACUSTRINE — mostly moderately long-standing fresh-water lakes on coastal plain. Ephemeral lakes mostly lack microplankton.	**Mudstones** to **siltstones** — massive or laminated	**Microplankton** diversity low (1 to 3 species), abundance usually low, but if high normally dominated by single species. Characteristic species: *Amosopollis cruciformis*, *Sigmopollis carbonis* and *Micrhystridium* sp. A. **Spore-pollen** assemblages less skewed but in large palaeolakes can show Neves effect characterised by abundance of *Dilwynites* spp.
PARALIC — marine incursions extending landward of palaeoshoreline. Includes coastal lagoons, estuaries and interdistributary bays. But only lagoons have unique microplankton and algae.	**Mudstones** to **sandstones** — laminated, mottled (burrowed), carbonaceous, pyritic.	**Microplankton** diversity low to moderate (3 to ~8 species), abundance low to moderate (1% to ~10%). Characterised by marine, brackish and cosmopolitan forms. Typical species include: *Amosopollis cruciformis, Heterosphaeridium* spp., *Cribroperidinium edwardsii* and algae *Botryococcus braunii*. **Spore-pollen** assemblages typically homogenous.
NEARSHORE MARINE — or proximal marine immediately offshore from palaeoshoreline.	**Mudstones** to **sandstones** — laminated, pyritic, burrowed, slightly calcareous, rare glauconite, but still carbonaceous.	**Microplankton** diversity low to moderate (>3 to <12 species), abundance moderate (>5% to <30%). Contains most marine species often associated with an abundance of forms washed out of the paralic environments. **Spore-pollen** assemblages typically homogenous.
OFFSHORE MARINE — or distal marine equivalent to middle and outer neritic environments.	**Mudstones** to **sandstones** — glauconitic, pyritic, calcareous, sparsely carbonaceous.	**Microplankton** diversity increases to >10 species and abundance >10%, with abundances of species often variable between samples. **Spore-pollen** assemblages generally show distinct Neves effect with abundance of *Dilwynites* pollen.
OCEANIC MARINE — outer shelf to slope environments.	**Mudstones** — often glauconitic, calcareous, pyritic.	**Microplankton** diversity >15 or 20 species and abundance >30%, with abundances of species often variable between samples. **Spore-pollen** often poorly preserved, with consequent increased prominence of more robust spores. Neves effect still present in better preserved assemblages.

Figure 2. Empirical model for palaeoenvironments in Sherbrook Group.

Biostratigraphy

The zone and age determinations are based on the Australia wide Mesozoic spore-pollen and microplankton zonation schemes described by Helby *et al.* (1987), with finer resolution provided by the subzones outlined in Figure 1. The latter are based on extensive unpublished work in the onshore Port Campbell Embayment (eg. Partridge, 1994, 1997, 1999). Identification of zones is determined from the presence/absence of key species recorded in Table 5, supported by the changes in assemblage composition recorded by the abundance data in Table 4. Preparation of a comprehensive range chart showing distribution of all species recorded was not commissioned as part of this review study.

Author citations for most spore-pollen species can be sourced from Helby *et al.* (1987), Dettmann (1963), Stover & Partridge (1973) or other references cited herein, whilst author citations for dinoflagellates can be found in the index of Williams *et al.* (1998). Species names followed by "ms" are unpublished manuscript names.

Phyllocladidites mawsonii **spore–pollen Zone**
Interval: 1629 to 2157.5 metres.
Age: Turonian–Coniacian.
This zone was identified in 30 samples over a ~500 metres interval, with the eponymous species *Phyllocladidites mawsonii* recorded from 15, and *Clavifera triplex*, the original index species, recorded from 16 out of the 21 core and sidewall core samples. Half of the 30 samples have been assigned to the *H. trinalis*, *L. musa* and *G. ancorus* Subzones established in the Port Campbell Embayment (Partridge, 1997, 1999). The shallowest three samples examined are dominated by microplankton (average >40%) and unfortunately lack key spore-pollen index species of the subzones. Of these the deepest at 1660m contains abundant *Cupressacites* pollen (20%). In the onshore Port Campbell Embayment an equivalent spike in the abundance of *Cupressacites* pollen is identified within the Banoon Member at the boundary between the *G. ancorus* and *C. vultuosus* Subzones (Partridge, 1999)

All samples from the Belfast Mudstone and Flaxman Formation are from marine environments, while in contrast about half of the core and sidewall core samples from the Waarre Formation are from non-marine or paralic environments. Independent support for the Turonian to Coniacian age is provided by the associated marine microplankton in the samples which are assigned to the *C. striatoconum* Zone (from 1629–1647m) and new subzones of the *P. infusorioides* Zone (between 1660 and 2105m). Further details of the assemblages from the *P. mawsonii* Zone are provided under the discussion of the subzones.

***Gleicheniidites ancorus* spore–pollen Subzone**
Interval: 1690–1790 metres.
Age: Late Turonian.

The *G. ancorus* Subzone was originally defined as the interval between the FAD[1] of *Gleicheniidites ancorus* ms, and the FAD of *Clavifera vultuosus*. However, in La Bella–1, and now in Minerva–1 rare specimens of the eponymous species are recorded from the underlying *L. musa* Subzone, and therefore the defining criterion has been changed to the first consistent appearance of *G. ancorus*. The assemblages from the *G. ancorus* Zone in Minerva–1 are dominated by gymnosperms (average 75%) with the alete *Dilwynites* pollen (average 27%) and the bisaccate *Podocarpidites* pollen (average 27%) equally prominent, and *Cupressacites* pollen (average 8%) a conspicuous accessory. The spores are dominated by genera *Cyathidites* (average 9%) and *Gleicheniidites/Clavifera* (average ~4%), while angiosperm pollen generally don't register in the count. The environment of deposition is interpreted as distal marine based on the *Dilwynites* pollen abundance, which is interpreted as diagnostic of a Neves effect (Traverse, 1988).

***Laevigatosporites musa* spore–pollen Subzone**
Interval: 1837.3–1872.5 metres.
Age: Mid? Turonian.

The *L. musa* Subzone was originally defined as the interval between the LAD[2] for *Hoegisporis trinalis* ms, and the last consistent appearance of *Laevigatosporites musa* ms, which is usually before the FAD for *Gleicheniidites ancorus* ms. However, additional analyses of samples from the top of the Waarre Formation in the Iona and Mylor fields in the onshore Port Campbell Embayment, and the recent reviews of the offshore wells Eric the Red–1, Loch Ard–1 and La Bella–1 has extended the range of *Hoegisporis trinalis* ms to nearer the top of the Waarre Formation and potentially through the entire *L. musa* Subzone. Consequent on these findings the base of the *L. musa* Subzone is identified on alternative

[1] FAD = First Appearance Datum
[2] LAD = Last Appearance Datum

criteria, consisting of the FAD of *Tricolporites variverrucatus* ms (recorded in the core samples from 1839.7–1840.3m) and an increase in prominence of the eponymous species. Within the *L. musa* Subzone is also found the oldest occurrences of significant abundances (>10% of total SP and MP count) of the colonial algae *Amosopollis cruciformis*, and this event in Minerva–1 occurs at 1872.5m.

While the assemblages from the *L. musa* Subzone continue to be dominated by gymnosperm pollen (average 62%) there is considerably more variability in abundances of particular species or count categories compared to the overlying *G. ancorus* Subzone, which is from the environmentally homogeneous Flaxman Formation. The variability is interpreted to reflect fluctuating environments. For example the core sample at 1837.3m (which most likely belongs to the *L. musa* Subzone even though it lacks the index species) is dominated by *Trichotomosulcites subgranulatus* (62%) and is interpreted to represent a peat swamp. In contrast, the core sample at 1839.7m with the highest marine microplankton abundance (17%) and diversity (10+ species), associated with a moderate Neves effect (*Dilwynites* pollen 12%) is the most marine sample in the subzone and is interpreted to represent deposition in an interdistributary bay or coastal lagoon. The assemblage composition of the other samples in the subzone fall between these environmental end members.

Hoegisporis trinalis **spore–pollen Subzone**
Interval: 1943 to 2157.5 metres.
Age: Early? Turonian.

Ideally the *H. trinalis* Subzone is identified as the interval from the LAD of Cenomanian species *Hoegisporis uniforma* to the FAD of *Tricolporites variverrucatus* ms. However, as the latter species is rare in Minerva–1 the top of the subzone is placed below the increase in abundance of *Amosopollis cruciformis* recorded from 1872.5m. The eponymous species is recorded in about half of the samples and a couple of the cuttings assemblages, with its absence in the other samples interpreted to reflect limited searching of the palynological slides at the microscope. The other main characteristic of this subzone are the prominent occurrences of the spores *Appendicisporites distocarinatus* and *Verrucosisporites admirabilis* ms, and the rare presence of *Interulobites intraverrucatus*.

In contrast to the overlying subzones the assemblages are dominated by spores (average 60%) with *Cyathidites* (average 21%), *Gleicheniidites* (average 14%) and *Laevigatosporites* (average 9%) the most prominent. Exceptionally high abundances of *Gleicheniidites* (54% at 1947.5m) and *Laevigatosporites* (49% at 2157.5m) being interpreted as diagnostic of non-marine assemblages. When these skewed assemblages are amalgamated with the observed variability of microplankton abundances in other samples through the subzone the environment of deposition is interpreted as fluctuating from nearshore marine to paralic to non-marine.

Coptospora paradoxa **spore–pollen Zone**
Interval: 2294 to 2408 metres.
Age: Albian.
Samples from the bottom ~130 metres in the well were mostly only given a cursory examination, but are confidently assigned to the *C. paradoxa* Zone on the presence of the eponymous species and the consistent presence of *Crybelosporites striatus*. Only the shallowest and deepest productive sidewall cores in the interval were counted with the latter containing an unusual abundance of *Perotrilites jubatus* (46%). Environment of deposition is non-marine, although rare lacustrine microplankton are present.

Conosphaeridium striatoconum **microplankton Zone.**
Interval: 1629 to 1647 metres.
Age: Coniacian.
The FAD of *Conosphaeridium tubulosum* recorded by Roger Morgan in the lower sidewall core and the FAD of *Isabelidinium balmei* recorded herein from the upper sidewall core confirm the presence of this zone. The microplankton are abundant (53% of combined SP + MP count) and their assemblages are dominated by *Amosopollis cruciformis* (>50%) and *Heterosphaeridium* spp. (>25%).

Palaeohystrichophora infusorioides **microplankton Zone.**
Interval: 1660 to 2132 metres.
Age: Turonian.
The microplankton recorded through most of the *P. mawsonii* Zone are consistent with the *P. infusorioides* Zone. Individually, none of the samples contain a sufficiently diverse microplankton assemblage to provide confident assignment to the zone, but the composite assemblage, from all samples through the interval, is

entirely consistent with this zone as identified in other wells throughout the Otway Basin. The identification of the *K. polypes*, *I. evexus* and *C. edwardsii* Acme Subzones is based solely on a few key species.

Kiokansium polypes **microplankton Subzone.**
Interval: 1660m to 1805 metres.
Age: Late Turonian.

The *K. polypes* Subzone is identified in seven samples from the Flaxman Formation based on the overlap in the ranges of *Kiokansium polypes* and *Valensiella griphus,* with the latter recorded in the three deeper sidewall cores in the interval. The microplankton are abundant (33% of combined SP + MP count) with the assemblages dominated by *Heterosphaeridium* spp. and *Amosopollis cruciformis,* both averaging ~25% of the microplankton count.

Isabelidinium evexus **microplankton Subzone.**
Sample at: 1839.7 metres.
Age: Mid? Turonian.

Only one core sample was assigned to the subzone on the presence of the eponymous species *Isabelidinium evexus* ms, however the interval 1838.1 to 1872.5m could also be interpreted as belonging to the subzone on the prominent presence of the colonial algae *Amosopollis cruciformis* (Table 5).

Heterosphaeridium **microplankton Acme**
Sample at: 2035 metres.
Age: Early? Turonian.

Heterosphaeridium is present in significant abundance (15% of combined SP+ MP count) in the sidewall core at 2035m, and this abundance is believed to represent a potential marker horizon between the *I. evexus* and *C. edwardsii* Subzones. A similar abundance peak has been identified in La Bella–1 at 2232m.

Cribroperidinium edwardsii **microplankton Acme Subzone.**
Interval: 2084 to 2105 metres.
Age: Early? Turonian.

The *C. edwardsii* Acme Subzone was established for marine dinoflagellate assemblages found in the lower part of the Waarre Formation, which are of relatively low diversity and low abundance, yet contain a dominance of the eponymous species (Partridge, 1994). In Minerva–1, *Cribroperidinium edwardsii* is only recorded from two sidewall cores at 2089m and 2101m and is only abundant in the deeper sidewall core (24% of MP count). The wider occurrence of the zone species in the cuttings suggests however that the subzone may be thicker, and may even extend as deep as the sidewall core at 2123m, the effective base of the marine microplankton succession.

Conclusions and Recommendations

This new palynological study of Minerva–1 has confirmed the presence of the Albian *C. paradoxa* Zone in the Eumeralla Formation, and established that the palynological sequence in the lower Sherbrook Group can be assigned to the new spore-pollen and microplankton subzones developed in the Port Campbell Embayment, and that good correlations are possible with the lithological units established in the Port Campbell Embayment (Table 1).

Notwithstanding, the generally good age breakdown and lithological correlations established in Minerva–1, further improvement could still be achieved by processing the following additional sidewall cores that have not yet been analysed for palynology:

Sample Type	Depth	Lithology
SWC 82	1650m	Argillaceous calcareous sandstone
SWC 81	1653m	Glauconitic sandstone grading to claystone
SWC 78	1670m	Sandstone interlaminated with claystone
SWC 73	1785m	Argillaceous siltstone
SWC 71	1814m	Silty claystone
SWC 67	1915m	Sandstone interlaminated with coaly claystone
SWC 66	1944.5m	Sandstone interlaminated with silty claystone
SWC 62	1982m	Sandstone interlaminated with coal
SWC 61	1996m	Sandstone interlaminated with claystone
SWC 53	2066m	Interlaminated sandstone/claystone
SWC 125	2129.5m	Claystone
SWC 121	2215m	Claystone

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Confidence Ratings

The Confidence Ratings assigned to the zone identifications on Table 2 are quality codes used in the STRATDAT relational database 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.

Table 2: Interpretative Palynological Data for Minerva–1

Sample Type	Depth (metres)	Spore-Pollen Zone (or Subzone)	CR	Microplankton Zone (or Subzone)	CR	Marine MP%	Ac%	Total MP%	Environment from palynology	Comments & Key Species Present
SWC 84	1629	*P. mawsonii*	B2	*C. striatoconum*	B4	24%	24%	48%	Marine/offshore	FAD of *Isabelidinium balmei*
SWC 83	1647	*P. mawsonii*	B2	*C. striatoconum*	B4	28%	30%	58%	Marine/offshore	FAD of *Conosphaeridium tubulosum* recorded by Roger Morgan.
SWC 80	1660	*P. mawsonii*	B2	*P. infusorioides*	B4	4%	22%	26%	Marine/offshore	*Cupressacites* pollen spike of 20%.
SWC 77	1690	*G. ancorus*	B2	*K. polypes*	B3	22%	18%	40%	Marine/offshore	LAD of *Kiokansium polypes.*
Cuttings	1699	*G. ancorus*	D4	*K. polypes*	D4		X		Marine	*Gleicheniidites ancorus* recorded in quick scan.
SWC 76	1723	*G. ancorus*	B2	*K. polypes*	B3	23%	2%	25%	Marine/offshore	Strong Neves effect with *Dilwynites* 33%.
SWC 75	1747	*G. ancorus*	B1	*K. polypes*	B2	9%	0.6%	10%	Marine/offshore	LADs of *Appendicisporites distocarinatus* and *Valensiella griphus. Dilwynites* 32%
SWC 74	1766	*G. ancorus*	B2	*K. polypes*		16%	12%	28%	Marine/offshore	Strong Neves effect with *Dilwynites* 32%.
Cuttings	1790	*G. ancorus*	D3	*K. polypes*	D3		X		Marine/offshore	Presence of *Conosphaeridium striatoconum* interpreted as caved.
SWC 72	1805	*P. mawsonii*	B3	*K. polypes*	B2	47%	16%	63%	Marine/offshore	FAD of *Valensiella griphus.*
Cuttings	1817–20	Indeterminate		Indeterminate			X		Indeterminate	*Conosphaeridium striatoconum* recorded by R. Morgan interpreted as caved.
Core	1837.3	*L. musa*	A5				NR		Non-marine Marsh	Skewed assemblage dominated by *Trichomonosulcites subgranulatus* 62%
Core	1838.1	*L. musa*	A4	*P. infusorioides*	A5	5%	23%	28%	Marine/nearshore to Paralic	LAD of *Laevigatosporites musa* ms
Core	1839.7	*L. musa*	A2	*I. evexus*	A3	17%	8%	25%	Marine/nearshore to Paralic	*Tricolporites variverrucatus* ms and *Isabelidinium evexus* ms both present.
Core	1840.3	*L. musa*	A1	*P. infusorioides*	A5	10%	18%	28%	Marine/nearshore to Paralic	FAD of *Tricolporites variverrucatus* ms
SWC 69	1872.5	*L. musa*	B4	*P. infusorioides*	A5	3%	16%	19%	Marine/nearshore to Paralic	LAD of definite *Hoegisporis trinalis* ms.
Cuttings	1886–89	*P. mawsonii*	D5	*P. infusorioides*	D5		X		Indeterminate	Quick scan only.
Cuttings	1910–16	Indeterminate		Indeterminate			X		Indeterminate	Caved palynomorphs conspicuous in quick scan.

Table 2: Interpretative Palynological Data for Minerva–1

Sample Type	Depth (metres)	Spore-Pollen Zone (or Subzone)	CR	Microplankton Zone (or Subzone)	CR	Marine MP%	Ac%	Total MP%	Environment from palynology	Comments & Key Species Present
Cuttings	1943–49	*H. trinalis*	D2	Indeterminate		3%	4%	7%	Non-marine to Paralic	Mixed/partly caved assemblage with *Gleicheniidites* 17%
SWC 65	1947.5	*P. mawsonii*	B2	Indeterminate			NR		Non-marine Marsh	COAL with restricted assemblage dominated by *Gleicheniidites* 54%.
Cuttings	1997–03	Indeterminate		Indeterminate			X		Indeterminate	Significant cavings noted in quick scan.
Cuttings	2021–27	Indeterminate		Indeterminate			X		Indeterminate	Poor preparation — given quick scan only/nothing significant recorded.
SWC 57	2035	*P. mawsonii*	B2	*Heterosphaeridium Acme*	B2	30%	NR	30%	Marine/offshore	*Heterosphaeridium* 15% of combined SP + MP count.
SWC 54	2061	*H. trinalis*	B2	*P. infusorioides*	B2	10%	NR	10%	Marine/nearshore	FAD of *Phyllocladidites mawsonii.*
Cuttings	2084	*P. mawsonii*	D2	*C. edwardsii Acme*	D3		X		Marine/nearshore to Paralic	LAD of consistent *Cribroperidinium edwardsii* recorded by R. Morgan.
SWC 49	2089	*P. mawsonii*	B2	*C. edwardsii Acme*	B3	6%	NR	6%	Non-marine to Paralic	FAD of consistent *C. edwardsii* in SWC recorded by R. Morgan.
Cuttings	2093	*P. mawsonii*	D2	*C. edwardsii Acme*	D3		X		Marine/nearshore to Paralic	Quick scan only.
SWC 47	2101	*H. trinalis*	B4	*C. edwardsii Acme*	B2	24%	1%	25%	Marine/nearshore	FAD in SWCs of *Cribroperidinium edwardsii* representing 6% of combined SP + MP count.
Cuttings	2102	*P. mawsonii*	D4	*C. edwardsii Acme*	D3		X		Indeterminate	Quick scan only.
Cuttings	2105	*P. mawsonii*	D4	*C. edwardsii Acme*	D3		X		Indeterminate	*Cribroperidinium edwardsii* recorded on quick scan.
Cuttings	2117	*P. mawsonii*	D4				NR		Indeterminate	Quick scan only.
SWC 126	2123	*H. trinalis*	B1	*P. infusorioides*	B5	4%	NR	4%	Non-marine to Paralic	FAD of *Laevigatosporites musa* ms
SWC 124	2142	*H. trinalis*	B1			<1%	NR	<1%	Non-marine to Paralic	FADs in SWCs of *Hoegisporis trinalis* ms and *Appendicisporites distocarinatus.*
Cuttings	2150	Indeterminate							Indeterminate	Quick scan only.
SWC 123	2157.5	*H. trinalis*	B5						Non-marine Marsh	Coal assemblage with *Laevigatosporites* 48% including probable FAD of *L. musa* ms.

Table 2: Interpretative Palynological Data for Minerva–1

Sample Type	Depth (metres)	Spore-Pollen Zone (or Subzone)	CR	Microplankton Zone (or Subzone)	CR	Marine MP%	Ac%	Total MP%	Environment from palynology	Comments & Key Species Present
Cuttings	2180	Indeterminate							Indeterminate	Quick scan only.
SWC 122	2212.5	Indeterminate							Indeterminate	Effectively BARREN
Cuttings	2222	Indeterminate							Indeterminate	Quick scan only.
Cuttings	2261	Indeterminate							Indeterminate	Poor preparation — slides contain significant undissolved mineral matter.
Cuttings	2270	Indeterminate							Indeterminate	Quick scan only.
SWC 117	2294	*C. paradoxa*	B1						Non-marine	LAD of *Coptospora paradoxa*
Cuttings	2318	Indeterminate							Indeterminate	Quick scan only — poor preparation dominated by undissolved mineral matter.
SWC 122	2321	*C. paradoxa*	B1						Non-marine	*Coptospora paradoxa* present.
Cuttings	2324	*C. paradoxa*	D1						Non-marine	Quick scan only — *Coptospora paradoxa* present
Cuttings	2333	*C. paradoxa*	D4						Non-marine	Quick scan only.
Cuttings	2354	Indeterminate							Non-marine	Quick scan only.
SWC 111	2360	Indeterminate							Non-marine	Nothing significant on quick scan.
SWC 109	2392.5	*C. paradoxa*	B4						Non-marine	Assemblage dominated by abundant *Perotrilites jubatus* 46%.
Cuttings	2408	*C. paradoxa*	D4						Non-marine	Quick scan only.
SWC 108	2412	Indeterminate							Indeterminate	Sample BARREN
Cuttings	2425	Indeterminate							Indeterminate	Quick scan only — slides contain significant undissolved mineral matter.

CR = Confidence Rating
NR = Not recorded

MP% = Microplankton
Ac% = *Amosopollis cruciformis* %
X = Present in assemblage but not recorded in count.

LAD = Last Appearance Datum
FAD = First Appearance Datum

Table 3: Basic Sample and Palynomorph Data for Minerva–1

Sample Type	Depth (metres)	Lithology	Kerogen slides	Oxidised slides	Visual Yield	Palynomorph Concentration	Preservation	No. SP Species	No. MP Species
SWC 84	1629	SILTSTONE, argillaceous, medium grey, rare carbonaceous matter.	1	4	Moderate	Low	Poor	27	13
SWC 83	1647	CLAYSTONE, silty, dark greenish grey, rare very fine glauconite grains.	1	3	Moderate	Low	Poor (pyrite pitted)	28	12
SWC 80	1660	SANDSTONE, medium grey, grading to arenaceous claystone in darker patches, rare carbonaceous flecks, pyrite &	1	4	Moderate	Moderate	Poor (over oxidised)	34	8
SWC 77	1690	SILTSTONE, argillaceous, dark grey, rare disseminated carbonaceous flecks and coaly fragments.	1	5	High	Moderate	Poor	26	12
Cuttings	1699			4	High	Moderate to high	Poor-fair	18*	20+
SWC 76	1723	CLAYSTONE, silty, medium/dark grey, trace glauconite grains.	1	5	High	Moderate	Poor (pyrite pitted)	30	17
SWC 75	1747	CLAYSTONE, medium greyish green, rare glauconite grains, grading to argillaceous siltstone.	1	4	Moderate	Moderate	Poor-fair	31	16
SWC 74	1766	SILTSTONE, argillaceous, brownish grey, rare disseminated carbonaceous flecks.	1	5	High	Moderate	Poor	29	18
Cuttings	1790			5	High	High	Poor-fair	19	20*
SWC 72	1805	CLAYSTONE, silty, brownish grey, traces of coarse quartz grains, carbonaceous flecks and microcrystalline pyrite.	1	5	High	High	Very poor	29	25
Cuttings	1817–20			5	High	Moderate to high	Poor-fair	20*	25*
Core	1837.3			9	Very high	Moderate	Poor	17	
Core	1838.1		1	4	High	Moderate	Very poor	23	6
Core	1839.7		1	4	Moderate	Low	Very poor	26	10
Core	1840.3			10	High	Low to moderate	Very poor	34	9
SWC 69	1872.5	CLAYSTONE, silty, dark brownish grey, trace carbon- aceous fragments, rare microcrystalline pyrite.	1	6	High	High	Poor (over oxidised)	33	9
Cuttings	1886–89			3	High	Moderate	Poor-fair	22*	9*
Cuttings	1910–16			3	Moderate	Moderate	Poor-fair	26*	15*

Table 3: Basic Sample and Palynomorph Data for Minerva–1

Sample Type	Depth (metres)	Lithology	Kerogen slides	Oxidised slides	Visual Yield	Palynomorph Concentration	Preservation	No. SP Species	No. MP Species
Cuttings	1943–49			3	High	Moderate	Poor-fair	27	5
SWC 65	1947.5	COAL, black, vitreous, brittle, grades to carbonaceous claystone dark brownish grey, rare pyrite nodules.	1	6	High	High	Poor	23	
Cuttings	1997–03			7	High	Moderate	Poor-fair	20*	11*
Cuttings	2021–27			5	Moderate	Low to moderate	Poor	25*	9*
SWC 57	2035	CLAYSTONE, silty brownish grey, coally and carbonaceous fragments, interlaminated on a mm scale with light grey, very	1	6	High	Moderate to high	Poor-fair	31	20
SWC 54	2061	CLAYSTONE, silty, medium brown, with thin ~2mm discontinuous laminae of off-white, medium grained kaolinitic	1	6	High	High	Fair	42	18
Cuttings	2084			4	Moderate	Low to high	Poor	24*	13*
SWC 49	2089	SANDSTONE, medium grey, laminated grading to arenaceous claystone 40%.	1	9	High	Low	Poor-fair	25	3
Cuttings	2093			4	High	Moderate	Poor	25*	13*
SWC 47	2101	CLAYSTONE, silty, brownish grey, trace fine glauconite grains, grading to argillaceous siltstone.	1	6	High	High	Poor-fair	28	14
Cuttings	2102			4	High	Moderate	Poor-fair	19*	10*
Cuttings	2105			4	High	Low to high	Poor-fair	20*	9*
Cuttings	2117			7	High	Low to high	Poor–fair	30*	2*
SWC 126	2123	CLAYSTONE, dark grey, trace carbonaceous flecks, interbedded with sandstone, light grey, very fine grained.	1	6	High	High	Poor-fair	37	9
SWC 124	2142	CLAYSTONE, medium dark grey, trace silt, interlaminated with sandstone, light grey, very fine grained.	2	5	High	Moderate	Poor–fair	31	2
Cuttings	2150			4	High	Low to moderate	Poor	19*	
SWC 123	2157.5	COAL, black subvitreous blocky fracture.	1	5	High	Very low	Poor-good	17	
Cuttings	2180			5	High	Low	Poor	26*	1*

Table 3: Basic Sample and Palynomorph Data for Minerva–1

Sample Type	Depth (metres)	Lithology	Kerogen slides	Oxidised slides	Visual Yield	Palynomorph Concentration	Preservation	No. SP Species	No. MP Species
SWC 122	2212.5	CLAYSTONE, medium grey, common silt, occasional carbonaceous flecks.	1	1 + B	Very low	Very low	Poor	3*	
Cuttings	2222			4	Moderate	Low	Poor	21*	5*
Cuttings	2261			2	Low	Low	Poor	14*	1*
Cuttings	2270			5	High	Low	Poor	18*	1*
SWC 117	2294	CLAYSTONE, medium grey, trace silt, rare carbonaceous flecks.	1	3	Moderate	Moderate	Fair	28	1
Cuttings	2318			3	Low	Low	Poor	12*	1*
SWC 114	2321	CLAYSTONE, massive medium grey, slightly mottled, common hard silica cement.	1	2	Moderate	Moderate	Poor-fair	27*	4*
Cuttings	2324			5	High	Moderate	Poor-fair	30*	
Cuttings	2333			5	High	Moderate	Poor-fair	27*	
Cuttings	2354			2	Low	Moderate	Poor-fair	18*	1*
SWC 111	2360	CLAYSTONE, light grey, firm, contains 20% silt to very fine grained sand.	1	2	Moderate	Low	Poor-fair	17*	1*
SWC 109	2392.5	CLAYSTONE, medium grey, moderately hard, subfissile, rare carbonaceous flecks.	1	5	High	Moderate-High	Fair	23	3*
Cuttings	2408			6	High	Low	Poor-fair	31*	1*
SWC 108	2412	CLAYSTONE, grey to dark green, hard, with est. 40% medium to coarse sand composed of quartz (40%), lithics (30%),		1 + B	Very low	Barren			
Cuttings	2425			2	Low	Low	Poor	19*	
		Total slides:	**25**	**234**			**Averages:**	**24.6**	**9.6**

NB. Lithologies not available for cuttings or core samples.
B in "Oxidised slides" column = Blank slide in relinquishment slide set.
Asterisks in "No. Species" column = Number of species recorded by Roger Morgan in original report.

Table 4: Minerva–1

Abundance Chart for selected palynomorphs.

Sample Type	SWC 84	SWC 83	SWC 80	SWC 77	SWC 76	SWC 75	SWC 4	SWC 72
Depth (m)	1629.0	1647.0	1660.0	1690.0	1723.0	1747.0	1766.0	1805.0
SPORES								
Appendicisporites spp.		1.6%				0.7%		
Baculatisporites spp.	1.0%			1.9%			1.9%	
Cicatricosisporites spp.			0.9%	2.8%	3.4%		1.9%	
Clavifera triplex	1.0%	1.6%	1.7%		0.9%	1.4%		
Crybelosporites striatus								
Cyathidites (large) >40µm	1.0%	4.8%		2.8%	2.6%	0.7%	1.9%	
Cyathidites (small) <40µm	10.9%	14.3%	7.8%	6.5%	5.1%	7.0%	9.4%	8.3%
Dictyophyllidites spp.	5.9%	4.8%	4.3%	1.9%		1.4%	1.9%	6.7%
Foraminisporis asymmetricus								
Gleicheniidites spp.	5.0%	3.2%	10.3%	4.7%	5.1%	4.9%	2.8%	3.3%
Herkosporites/Ceratosporites spp.			2.6%	2.8%		0.7%		3.3%
Laevigatosporites spp.	1.0%		0.9%	1.9%			0.9%	1.7%
Laevigatosporites musa †								
Osmundacidites wellmanii	1.0%			0.9%		2.8%		
Peromonolites spp.								
Perotrilites spp.								
Retitriletes spp.	1.0%		0.9%		0.9%	1.4%	0.9%	1.7%
Rugulatisporites/Verrucosisporites spp.					0.9%			
Stereisporites spp.				0.9%				
Triletes undiff.	4.0%	7.9%	2.6%	2.8%	1.7%	4.2%	1.9%	3.3%
Triporoletes reticulatus								
Total Spores	**32%**	**38%**	**32%**	**30%**	**21%**	**25%**	**24%**	**28%**
GYMNOSPERMS								
Araucariacites australis	4.0%	6.3%		1.9%	2.6%	1.4%	2.8%	
Corollin a spp.							1.9%	
Cupressacites sp.	1.0%	4.8%	19.8%	10.3%	6.8%	10.5%	4.7%	1.7%
Dilwynites pusillus †	11.9%	1.6%	1.7%	7.5%	12.0%	6.3%	15.1%	
Dilwynites spp.	3.0%	4.8%	6.9%	4.7%	21.4%	25.9%	17.0%	10.0%
Hoegisporis trinalis †								
Microcachryidites antarcticus	10.9%	4.8%	7.8%	13.1%	12.8%	5.6%	3.8%	25.0%
Phyllocladidites eunuchus †								
Phyllocladidites mawsonii	2.0%	3.2%	1.7%			2.1%		
Podocarpidites spp.	34.7%	33.3%	27.6%	31.8%	22.2%	22.4%	30.2%	35.0%
Trichotomosulcites subgranulatus	1.0%		1.7%		1.7%	0.7%	0.9%	
Vitreisporites signatus		1.6%	0.9%	0.9%				
Total Gymnosperms:	**68%**	**60%**	**68%**	**70%**	**79%**	**75%**	**76%**	**72%**
ANGIOSPERMS undiff.								
Australopollis obscurus								
Liliacidites spp.								
Tricolpites/Tricolporites spp.		1.6%						
Total Angiosperms:		1.6%						
Total Spore-Pollen Count:	**101**	**63**	**116**	**107**	**117**	**143**	**106**	**60**

Table 4: Minerva–1 — Abundance Chart for selected palynomorphs.

Sample Type	SWC 84	SWC 83	SWC 80	SWC 77	SWC 76	SWC 75	SWC 4	SWC 72
Depth (m)	1629.0	1647.0	1660.0	1690.0	1723.0	1747.0	1766.0	1805.0
MICROPLANKTON % of MP COUNT								
Microplankton undiff.	6%	18%	5%	18%	10%	38%	33%	10%
Amosopollis cruciformis	51%	52%	85%	45%	8%	6%	43%	26%
Chlamydophorella nyei								1%
Cleistosphaeridium ancoriferum								3%
Cribroperidinium edwardsii								
Cribroperidinium spp.					3%			
Cyclophelium spp.								
Heterosphaeridium spp.	38%	15%	3%	27%	50%	25%	10%	22%
Isabelidinium balmei	1%							
Kallosphaeridium spp.								32%
Kiokansium polypes				1%	5%	6%		1%
Odontochitina spp.								3%
Oligosphaeridium spp.								
Palaeohystrichophora infusorioides	2%	9%		4%	3%	6%	5%	
Palambages spp.					3%			
Pterospermella spp.								
Spiniferites spp.	2%	5%	8%	4%	5%	19%	7%	1%
Trithyrodinium spp.		1%			15%		2%	
Valensiella griphus								1%
Veryhachium spp.								
Total Microplankton Count:	**95**	**88**	**40**	**71**	**40**	**16**	**42**	**100**
Microplankton % of total SP & MP	48%	58%	26%	40%	25%	10%	28%	63%
A. cruciformis as % of total SP & MP	24%	30%	22%	18%	2%	0.6%	12%	16%
Total SP and MP COUNT:	**196**	**151**	**156**	**178**	**157**	**159**	**148**	**160**
Other Palynomorphs Count								
Botryococcus braunii	0.5%							0.6%
Fungal fruiting bodies							0.7%	
Fungal spores/hyphae		0.7%				0.6%		
Reworked Fossils	0.5%		0.6%			0.6%		
TOTAL COUNT:	**198**	**152**	**157**	**178**	**157**	**161**	**149**	**161**
† manuscript name								

Table 4: Minerva–1 Abundance Chart for selected palynomorphs.

Sample Type	Core	Core	Core	Core	SWC 69	Cuttings	SWC 65	SWC 57
Depth (m)	1837.3	1838.1	1839.7	1840.3	1872.5	1943–49	1947.5	2035.0
SPORES								
Appendicisporites spp.				1.0%	2.9%			
Baculatisporites spp.		1.0%				1.8%		
Cicatricosisporites spp.		1.0%	0.9%	1.0%	1.0%			0.9%
Clavifera triplex					1.0%			1.8%
Crybelosporites striatus								
Cyathidites (large) >40µm	1.3%	6.0%	1.8%	1.9%	1.0%	2.7%		4.6%
Cyathidites (small) <40µm	4.7%	13.0%	17.7%	4.8%	10.5%	9.0%	5.9%	28.4%
Dictyophyllidites spp.		2.0%	0.9%	10.5%	4.8%	5.4%	2.7%	3.7%
Foraminisporis asymmetricus								
Gleicheniidites spp.	8.7%	5.0%	10.6%	12.4%	1.9%	18.0%	53.8%	2.8%
Herkosporites/Ceratosporites spp.		1.0%			1.0%			
Laevigatosporites spp.		1.0%	0.9%			6.3%	2.7%	2.8%
Laevigatosporites musa †		1.0%	0.9%	1.0%			1.1%	2.8%
Osmundacidites wellmanii	2.7%	2.0%		1.9%	1.0%			1.8%
Peromonolites spp.							2.2%	
Perotrilites spp.								
Retitriletes spp.					1.0%	1.8%		
Rugulatisporites/Verrucosisporites spp.		2.0%	0.9%			0.9%		0.9%
Stereisporites spp.				1.0%	1.9%	2.7%	1.1%	
Triletes undiff.		2.0%	0.9%	6.7%	5.7%	3.6%	0.5%	1.8%
Triporoletes reticulatus								0.9%
Total Spores	**17%**	**37%**	**35%**	**42%**	**33%**	**52%**	**70%**	**53%**
GYMNOSPERMS								
Araucariacites australis		5.0%	1.8%	1.0%	4.8%	2.7%		2.8%
*Corollin*a spp.								
Cupressacites sp.			3.5%	1.9%				
Dilwynites pusillus †		3.0%	3.5%	3.8%	1.0%	2.7%		9.2%
Dilwynites spp.		4.0%	8.8%	4.8%	2.9%	2.7%	0.5%	4.6%
Hoegisporis trinalis †				1.0%	1.0%	2.7%		
Microcachryidites antarcticus	2.0%	15.0%	6.2%	13.3%	17.1%	7.2%	1.1%	1.8%
Phyllocladidites eunuchus †	2.0%		0.9%	2.9%				
Phyllocladidites mawsonii					1.0%	0.9%		0.9%
Podocarpidites spp.	16.7%	15.0%	16.8%	18.1%	38.1%	23.4%	23.1%	14.7%
Trichotomosulcites subgranulatus	62.0%	10.0%	21.2%	5.7%	1.0%	5.4%	4.3%	11.9%
Vitreisporites signatus								
Total Gymnosperms:	**83%**	**52%**	**63%**	**52%**	**67%**	**48%**	**29%**	**46%**
ANGIOSPERMS undiff.				1.9%			1.1%	
Australopollis obscurus		4.0%						
Liliacidites spp.		1.0%	0.9%	1.9%				
Tricolpites/Tricolporites spp.		6.0%	0.9%	1.9%				0.9%
Total Angiosperms:		11%	1.8%	5.7%			1.1%	0.9%
Total Spore-Pollen Count:	**150**	**100**	**113**	**105**	**105**	**111**	**186**	**109**

Table 4: Minerva–1 **Abundance Chart for selected palynomorphs.**

Sample Type	Core	Core	Core	Core	SWC 69	Cuttings	SWC 65	SWC 57
Depth (m)	1837.3	1838.1	1839.7	1840.3	1872.5	1943–49	1947.5	2035.0
MICROPLANKTON % of MP COUNT								
Microplankton undiff.		8%	5%	5%	8%	25%		19%
Amosopollis cruciformis		82%	32%	63%	88%	63%		
Chlamydophorella nyei								6%
Cleistosphaeridium ancoriferum								
Cribroperidinium edwardsii								
Cribroperidinium spp.								
Cyclophelium spp.				5%				
Heterosphaeridium spp.		5%	58%	22%		13%		51%
Isabelidinium balmei								
Kallosphaeridium spp.								
Kiokansium polypes				2%	4%			6%
Odontochitina spp.			3%					
Oligosphaeridium spp.		5%	3%	2%				13%
Palaeohystrichophora infusorioides								
Palambages spp.								
Pterospermella spp.								
Spiniferites spp.								4%
Trithyrodinium spp.								
Valensiella griphus								
Veryhachium spp.								
Total Microplankton Count:		**39**	**38**	**41**	**24**	**8**		**47**
Microplankton % of total SP & MP		28%	25%	28%	19%	6.7%		30%
A. cruciformis as % of total SP & MP		23%	8%	18%	16%	4%		
Total SP and MP COUNT:	**150**	**139**	**151**	**146**	**129**	**119**	**186**	**156**
Other Palynomorphs Count								
Botryococcus braunii								
Fungal fruiting bodies		0.7%	1.3%		1.5%			
Fungal spores/hyphae	2.0%	3.4%		3.3%		3.9%		
Reworked Fossils						2.4%		
TOTAL COUNT:	**153**	**145**	**153**	**151**	**131**	**127**	**186**	**156**
† manuscript name								

Table 4: Minerva–1 Abundance Chart for selected palynomorphs.

Sample Type	SWC 54	SWC 49	SWC 47	SWC 126	SWC 124	SWC 123	SWC 117	SWC 109
Depth (m)	2061.0	2089.0	2101.0	2123.0	2142.0	2157.5	2294.0	2392.5
SPORES	0.5%							
Appendicisporites spp.	1.0%		2.5%	1.5%	0.6%			
Baculatisporites spp.				1.0%			2.6%	
Cicatricosisporites spp.	4.7%	2.3%	2.5%	3.1%			0.6%	6.5%
Clavifera triplex								
Crybelosporites striatus								0.6%
Cyathidites (large) >40µm	3.1%	9.1%	6.2%	4.1%	5.2%		14.3%	12.9%
Cyathidites (small) <40µm	18.2%	27.3%	31.1%	23.2%	13.5%	4.9%	10.4%	18.7%
Dictyophyllidites spp.	5.2%	2.3%	2.5%	0.5%	2.6%		3.2%	0.6%
Foraminisporis asymmetricus								2.6%
Gleicheniidites spp.	3.6%	13.6%	6.8%	3.6%	3.9%	22.3%		0.6%
Herkosporites/Ceratosporites spp.			1.9%					0.6%
Laevigatosporites spp.	4.7%	2.3%	1.9%	3.6%	1.9%	47.6%		
Laevigatosporites musa †	1.6%			0.5%		1.0%		
Osmundacidites wellmanii	0.5%		1.2%	0.5%	5.2%		6.5%	1.9%
Peromonolites spp.					0.6%	2.9%		
Perotrilites spp.			0.6%		0.6%			46.5%
Retitriletes spp.	1.6%	2.3%	1.2%	3.1%	2.6%		1.9%	
Rugulatisporites/Verrucosisporites spp.	0.5%	2.3%	0.6%	1.5%	1.9%			
Stereisporites spp.		2.3%				4.9%	0.6%	
Triletes undiff.	2.6%	6.8%	6.8%	6.2%	6.5%	1.0%	6.5%	2.6%
Triporoletes reticulatus								0.6%
Total Spores	**48%**	**70%**	**66%**	**53%**	**45%**	**84%**	**47%**	**95%**
GYMNOSPERMS								
Araucariacites australis	14.1%	4.5%	1.2%	5.2%	5.8%	1.9%	4.5%	
Corollin a spp.				1.0%	1.9%			
Cupressacites sp.	0.5%		1.2%		0.6%			0.6%
Dilwynites pusillus †	2.1%		5.6%	0.5%	14.2%			
Dilwynites spp.	0.5%	2.3%		1.0%	1.3%			
Hoegisporis trinalis †	2.1%		1.9%	0.5%	0.6%			
Microcachryidites antarcticus	14.1%	2.3%	4.3%	12.4%	5.2%	1.0%	9.1%	1.9%
Phyllocladidites eunuchus †	1.0%				1.3%			
Phyllocladidites mawsonii					0.6%			
Podocarpidites spp.	10.9%	20.5%	18.0%	25.8%	21.3%	11.7%	37.7%	1.9%
Trichotomosulcites subgranulatus	4.7%		1.9%	0.5%	1.9%	1.0%	1.9%	0.6%
Vitreisporites signatus				0.5%				
Total Gymnosperms:	**50%**	**30%**	**34%**	**47%**	**55%**	**16%**	**53%**	**5%**
ANGIOSPERMS undiff.								
Australopollis obscurus								
Liliacidites spp.	1.6%							
Tricolpites/Tricolporites spp.	0.5%							
Total Angiosperms:	2.1%							
Total Spore-Pollen Count:	**192**	**44**	**161**	**194**	**155**	**103**	**154**	**155**

Table 4: Minerva–1 **Abundance Chart for selected palynomorphs.**

Sample Type	SWC 54	SWC 49	SWC 47	SWC 126	SWC 124	SWC 123	SWC 117	SWC 109
Depth (m)	2061.0	2089.0	2101.0	2123.0	2142.0	2157.5	2294.0	2392.5
MICROPLANKTON % of MP COUNT								
Microplankton undiff.	38%		24%	63%	100%			
Amosopollis cruciformis			4%					
Chlamydophorella nyei	5%		28%					
Cleistosphaeridium ancoriferum								
Cribroperidinium edwardsii			24%					
Cribroperidinium spp.								
Cyclophelium spp.				25%				
Heterosphaeridium spp.	24%	100%	11%					
Isabelidinium balmei								
Kallosphaeridium spp.								
Kiokansium polypes	5%		2%					
Odontochitina spp.				13%				
Oligosphaeridium spp.			6%					
Palaeohystrichophora infusorioides								
Palambages spp.								
Pterospermella spp.	24%							
Spiniferites spp.			2%					
Trithyrodinium spp.								
Valensiella griphus								
Veryhachium spp.	5%							
Total Microplankton Count:	**21**	**3**	**54**	**8**	**1**			
Microplankton % of total SP & MP	10%	6%	25%	4%	1%			
A. cruciformis as % of total SP & MP			0.9%					
Total SP and MP COUNT:	**213**	**47**	**215**	**202**	**156**	**103**	**154**	**155**
Other Palynomorphs Count								
Botryococcus braunii					1.2%			0.6%
Fungal fruiting bodies								
Fungal spores/hyphae								
Reworked Fossils		2.1%		1.0%	3.1%		0.6%	
TOTAL COUNT:	**213**	**48**	**215**	**204**	**163**	**103**	**155**	**156**
† manuscript name								

Table 5: Stratigraphic distribution of key index palynomorphs in Minerva–1.

Sample Type	Depth (metres)	1 Crybelosporites striatus	2 Coptospora paradoxa	3 Laevigatosporites musa ms	4 Phyllocladidites eunuchus ms	5 Camerozonosporites australiense	6 Hoegisporis trinalis ms	7 Appendicisporites distocarinatus	8 Verrucosisporites admirabilis ms	9 Cyatheacidites tectifera	10 Cupressacites sp.	11 Dilwynites spp.	12 Phyllocladidites mawsonii	13 Clavifera triplex	14 Interulobites intraverrucatus	15 Cicatricosisporites cuneformis	16 Proteacidites spp.	17 Coptospora pileolus ms	18 Tricolporites variverrucatus ms	19 Gleichenidites ancorus ms
SWC 84	1629										1%	15%	2%	1%			•	X		X
SWC 83	1647									X	5%	6%	X	2%			X	•		•
SWC 80	1660				X	X				X	20%	9%	2%	2%			X	•		X
SWC 77	1690				•	•				X	10%	12%	X	X			•	•		X
SWC 76	1723		W		•	•			1%	•	7%	33%	•	1%		X	•	X		X
SWC 75	1747				•	•		1%	•	•	11%	32%	2%	1%		•	•	•		X
SWC 74	1766				•	•		•	X	•	5%	32%	X	X		•	•	•		X
SWC 72	1805	W			•	•		X	•	•	2%	10%	•	X		•	•	•		•
Core	1837.3				2%	•		•	•	•	•	•	X	X		•	•	•		•
Core	1838.1			1%	X	•		•	2%	•	•	7%	X	•		•	•	•		•
Core	1839.7			1%	1%	•		•	•	•	4%	12%	X	•		•	•	•	X	X
Core	1840.3			1%	3%	•	1%	1%	•	X	2%	9%	•	X		X	•	•	1%	
SWC 69	1872.5			•	X	•	1%	3%	X	X	•	4%	1%	1%		•	•	•		
Cuttings	1943–49			X	•	X	3%	•	1%	•	•	5%	1%	•		•	X	•		
SWC 65	1947.5			1%	X	X	•	•	•	•	•	X	X	X		•	X	•		
SWC 57	2035			3%	X	•	•	X	1%	•	X	14%	1%	2%	X	•	•	•		
SWC 54	2061			2%	1%	X	2%	1%	1%	•	1%	3%	X	X	X	1%	•	X		
SWC 49	2089	W		•	X	•	•	X	2%	•	•	2%	•	•	•	•	•			
SWC 47	2101			•	•	•	2%	3%	1%	•	1%	6%	•	X	•	X	X			
SWC 126	2123			1%	•	2%	1%	2%	2%	•	•	2%	•	•	X	X				
SWC 124	2142			•	1%	X	1%	1%	2%	X	1%	15%	1%	X						
SWC 123	2157.5			1%	X	X														
SWC 117	2294	X	X																	
SWC 122	2321	1%	X																	
SWC 109	2392.5	1%	X																	

Numbers 1 to 19 are spore-pollen species.

Sample Type	Depth (metres)	20 Paleoperidinium cretaceum	21 Cyclonephelium compactum	22 Odontochitina operculata/costatae	23 Heterosphaeridium spp.	24 Cribroperidinium edwardsii	25 Kiokansium polypes	26 Oligosphaeridium spp.	27 Amosopollis cruciformis	28 Palaeohystrichophora infusorioides	29 Isabelidinium evexus ms	30 Valensiella griphus	31 Trithyrodinium spp.	32 Actinotheca aphroditae	33 Conosphaeridium tubulosum	34 Isabelidinium balmei
SWC 84	1629			X	18%				24%	1%			X			X
SWC 83	1647			•	9%			X	30%	5%			X	X	X	
SWC 80	1660			X	X			•	22%	X			•			
SWC 77	1690			•	11%		X	X	18%	2%			•			
SWC 76	1723		X	X	13%		X	X	2%	X			4%			
SWC 75	1747		•	•	3%		X	X	1%	X		X	•			
SWC 74	1766		•	X	3%		X	X	12%	1%		X	X			
SWC 72	1805		X	2%	14%		X	•	16%	•		X				
Core	1837.3		•	•	•		•	•	•	•						
Core	1838.1		•	X	1%		•	X	23%	•						
Core	1839.7	?	•	X	15%		•	X	8%	•	X					
Core	1840.3		•	•	6%		X	X	18%	•						
SWC 69	1872.5		X	X	X		X	•	16%	X						
Cuttings	1943–49	?	•	X	1%		•	•	4%	•						
SWC 65	1947.5		•	•	•		•	•	•	•						
SWC 57	2035	X	•	X	15%		2%	4%	•	X						
SWC 54	2061	X	•	X	2%		X	X	•							
SWC 49	2089	•	•	•	X	X	•	•	•							
SWC 47	2101	•	•	•	3%	6%	X	1%	1%							
SWC 126	2123	X	1%	X	X											
SWC 124	2142															
SWC 123	2157.5															
SWC 117	2294															
SWC 122	2321															
SWC 109	2392.5															

Numbers 20 to 34 are microplankton species

LEGEND

1% = Percentage abundance
X = Present but <1% of count
? = Questionable identification or occurrence
W = Reworked species occurrence
• = Not recorded in sample within species range