Palynological analysis of cuttings samples from the Sherbrook Group in Najaba 1a, Otway Basin.

by Alan D. Partridge
Biostrata Pty Ltd
A.C.N. 053 800 945

Petroleum Development Unpublished Report 1997/08

by Alan D. Partridge

INTERPRETATIVE DATA
....
1
Summary
....
1
Table-1: Palynology of Sherbrook Group in Najaba-1A.
....
1
Materials and Methods
....
2

INTERPRETATIVE DATA

Summary

Sixteen cuttings samples were analysed in Najaba-1A with the focus of the palynological investigation concentrated on the Sherbrook Group. Only one sample was analysed from the older Eumeralla Formation. This new data is integrated with previous work by Dettmann (1986) and a synthesised interpretation of the palynological zones, their ages and correlations to established and possible new stratigraphic units summarised in the following table:

Table-1: Palynology of Sherbrook Group in Najaba-1A.

AGE	UNIT	SPORE-POLLEN ZONES	MICROPLANKTON ZONES (SUBZONES)
PALEOCENE	PEBBLE POINT FORMATION 1405-1455m	Not sampled	Not sampled
DANIAN to MAASTRICHTIAN	K/T Boundary Shale 1455-1465m	Indeterminate	*P. pyrophorum* to *M. druggii* 1465m
MAASTRICHTIAN	TIMBOON SAND 1465-1762m	Undiff. *T. longus* 1490-1496*m Lower *T. longus* 1525m	*M. druggii* 1490-1496*m
EARLY CAMPANIAN to SANTONIAN	PAARATTE FORMATION and MOUNT SALT FORMATION 1762-2645m	*N. senectus* 1765m *T. apoxyexinus* 1875-2305m *T. apoxyexinus* to *P. mawsonii* 2390-2520m	? *X. australis* 1765m *I. cretaceum* 1980m *O. porifera* 2186.5*-2390m
CONIACIAN to TURONIAN	Equivalent to MORUM and FLAXMAN FORMATIONS 2645-2805m	*P. mawsonii* 2651*-2780m	Indeterminate
TURONIAN	Equivalent to FLAXMAN and/or WAARRE FORMATION 2805-2855m	*P. mawsonii* 2805*-2820m	Indeterminate
ALBIAN	EUMERALLA FORMATION 2855-3420m T.D.	*C. paradoxa* 2870-2887*m	No zones defined.

N.B. Depths marked with asterisks are re-interpretations of data in Dettmann (1986)

Additional interpretative data on each of the new samples with zone identification and Confidence Ratings are recorded in Table-2, whilst basic data on cuttings lithologies, sample quantities, residue yields, preservation and diversity are recorded on Tables-3 and4. As the cuttings samples are badly contaminated with caved species only the most abundant and stratigraphically significant species are recorded on Tables-5 & 6.

Materials and Methods

Between 12 to 56 grams (average 20.6 g) of the cuttings were collected by the author then forwarded to Laola Pty Ltd in Perth for processing. 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. The palynomorph abundance data presented in Table-5 was obtained from counts made on slides prepared using an 8microns filter cloth.

Disappointingly, although moderate to high residue yields were extracted from most samples, the palynomorph concentrations were low on the palynological slides and palynomorph preservation was overall poor. This is reflected in the uncertainty in a number of the zone picks and low confidence ratings. Surprisingly, recorded spore-pollen diversity was still quite high averaging 29+ species per sample (Table4). However, key zone index species were relatively rare. Similarly, while microplankton abundance on average was common, diversity was low averaging 5+ species per sample, and the key index species were rare and difficult to find.

Similar assemblages appear to have been obtained from the six sidewall cores examined by Dettmann (1986) through the Sherbrook Group, as her recorded assemblages are dominated by long range species with index species of both spore-pollen and microplankton seemingly rare or inconsistent in their occurrence.

Geological Comments

1. The deepest cuttings at 2870m gave a good or typical Eumeralla Formation assemblage which is assigned to the *C. paradoxa* Zone as was also the sidewall core at 2887m examined by Dettmann (1986). The assemblage examined was poorly preserved so it is possible that the top of the Eumeralla Formation could be as young as the *P. pannosus* Zone.

2. The basal sample from the Sherbrook Group at 2820m clearly belongs to the *P. mawsonii* Zone and this is confirmed by the assemblage recorded from the sidewall core at 2805m by Dettmann (1986). Index species for the Waarre Formation such as *Appendicisporites distocarinatus* and other mostly undescribed spores and pollen and associated microplankton such as *Cribroperidinum edwardsii* have not been found by either study suggesting from the age equivalent section to the Waarre Formation is not present at the Najaba-1A locality. This interpretation is somewhat tentative as the *P. mawsonii* Zone is now known to range to the base of the Waarre Formation in the type area of the Port Campbell Embayment and assemblages from Najaba-1A are quite poor being dominated by long ranging species and lacking the new index species which have enabled subdivision of the *P. mawsonii* Zone.

3. The shaly interval between 2645-2805m which has been referred to the Belfast Mudstone in the well completion report is here considered to be equivalent to the informal Morum Formation or to be equivalent to both the Morum and Flaxman Formations. The correlation is based on overall composition of the spore-pollen assemblages as the key dinoflagellates (see Partridge, 1996a) characteristic of these formations were not recorded in Najaba-1A.

4. The time equivalent to the base of the type section of the Belfast Mudstone is considered to be represented by the sample at 1980m which contain the *I. cretaceum* Zone dinoflagellates as well as the first appearance of a substantial increase in *Proteacidites* pollen. This latter feature is characteristic of the spore-pollen assemblages from the type locality of the Belfast Mudstone in Port Campbell-1. It is therefore suggested that the slightly more shaly section on the gamma logs between 1960-2045m in Najaba-1A may reflect the marine incursion associated with the type Belfast Mudstone. This interpretation is supported by the fact that the highest abundance of marine dinoflagellates in Najaba-1A is recorded in this interval at 1980m.

5. Accepting the palynological correlation that the base of the Belfast Mudstone lies at about 2045m an alternative lithological interpretation is suggested for the thick section between ~1520m to 2645m which is currently referred to as undifferentiated Paaratte Formation in the well completion report. Following the nomenclature for the Sherbrook Group in the western Otway Basin proposed by

Reynolds *et al.* (1966) the section above 1980m is assigned to the Paaratte Formation while the section down to 2645m is assigned to the Mount Salt Formation.

6. Relative to the sequence penetrated in the Port Campbell Embayment the interval represented by the *O. porifera* Zone and the underlying indeterminate *T. apoxyexinus/P. mawsonii* Zone interval down to 2645m have thickened considerably. The time equivalent of this 450+ metres thick section is less than 25 metres in the well sampled Langley-1 well (Partridge, 1994) and similar thicknesses are known from other wells in the Port Campbell Embayment. The maximum thickness in the Port Campbell Embayment probably occurs in the Port Campbell-2 well were it is 190+ metres thick. Unfortunately insufficient palynological control is available in this latter well to provide a upper limit to the unit or a precise thickness.

7. The upper Paaratte section between ~1762m to 950m in Najaba-1A is interesting in that the *N. aceras* and *X. australis* Zones are poorly developed and relatively thin. In this Najaba-1A resembles wells in South Australian where these zones are thin, rather than, wells in the offshore Victorian portion of the basin or in the Port Campbell Embayment where these zones are quite thick (Partridge, 1996b).

8. The pick for the base of the Timboon Sand at 1762m was taken from on the electric log supplied by the Department of Energy and Minerals Victoria. This boundary, on the available palynological control, would lie within Campanian and therefore approximate the base of the Timboon Sand as used over most of the Port Campbell Embayment. A shallower log break evident on the gamma log at about 1520m, with an even more sandy section above, would in turn equates to another unconformity or sequence boundary within the *T. longus* Zone and is of Mid-Maastrichtian age. This break is correlated with the major Mid-Maastrichtian unconformity recognised on the North West Shelf by Apthorpe (1979).

9. The Cretaceous/Tertiary boundary shale interprated to lie between 1455–1465m is poorly developed on the logs available from Najaba-1A, but its presence is strongly suggested by the palynology of the cuttings at 1465m. However, the sidewall core at 1460.5m within this shale is confusing because the palynological assemblage recorded by Dettmann (1986) is more typical of the overlying Pebble Point

Formation. To explain this anomaly it is suggested there may be reworking at the top of the Cretaceous/Tertiary boundary shale.

10. The total microplankton percentage quoted on Tables4 & 5 includes all dinoflagellate, acritarchs and algal cysts. On Table-2 the enigmatic algal cyst *Amosopollis cruciformis* is provided as a separate percentage. It has a abundance of ³10% between 2190-2655m whilst the rest of the microplankton which are marine dinoflagellates only have abundances between 2% to 7%. This higher abundance of *Amosopollis cruciformis* relative to the marine dinoflagellates is interpreted as reflecting a more proximal deposition environment and probably more brackish salinity.

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 Lentin & Williams (1993). Species names followed by "ms" are unpublished manuscript names.

***Palaeoperidinium pyrophorum* to**
***Manumiella druggii* microplankton Zones.**
Interval: 1465–1496 metres.
Age: basal Danian to Early Maastrichtian.
The shallowest occurrence of *Palaeoperidinium pyrophorum* and *Manumiella druggii* and/or *M. conorata* define the tops of their respective zones and their occurrence together in the cuttings sample at 1465m is considered typical of the Cretaceous/Tertiary boundary shale in the Otway Basin. The *M. druggii* Zone also extends below the boundary shale and is recorded in cuttings at 1490m and sidewall core at 1496m where it is associated with good *T. longus* Zone spore-pollen assemblages. Unfortunately the spore-pollen assemblage in the cuttings at 1465m cannot be considered reliable as it is dominated by species caved from the overlying Pember Mudstone.

***Tricolpites longus* spore-pollen Zone.**
Interval: 1490–1525 metres.
Age: Maastrichtian.
The shallowest cuttings is dominated by spore-pollen caved from the Pember Mudstone with only the index species *Battenipollis sectilis* recorded. The zone assignment is however clearly supported by the good

assemblage recorded from the sidewall core at 1496m which contains the index species *Forcipites* (al. *Tricolpites*) *longus*, *F. sabulosus*, *Tricolporites lilliei*, as well as *B. sectilis* (Dettmann, 1986). In absence of any abundance data it is not known if this latter sample belongs to the Upper subzone. The deeper cuttings at 1525m contains a much better assemblage with numerous Late Cretaceous index species. It is no older than the *T. longus* Zone based on the presence of the eponymous species and *Tetracolporites verrucosus*, and is assigned to the Lower subzone based on the absence of *Stereisporites* (*Tripunctisporis*) spp.

Nothofagidites senectus spore-pollen Zone
Sample at: 1765 metres.
Age: Early Campanian.
The top of the *N. senectus* Zone is picked at 1765m on the common presence of the eponymous species associated with common *Forcipites sabulosus* and absence of younger index species. *Nothofagidites senectus* was also recorded in the two cuttings at 2190m and 2305m, but based on the associated spore-pollen and microplankton assemblage in these samples, and absence of *N. senectus* in the sidewall core analysed by Dettmann (1986) at 2186.5m, these two deeper records are considered to be caved. The associated microplankton in the sample are non-diagnostic except for a single partly obscured specimen tentatively identified as *Xenikoon australis*.

Tricolporites apoxyexinus spore-pollen Zone
Interval: 1875–2305 metres.
Age: Santonian.
The base of the *T. apoxyexinus* Zone is identified on the oldest occurrences in the cuttings of *Latrobosporites amplus* at 2305m and *Ornamentifera sentosa* at 2190m. A much higher confidence base to the zone can be assigned to the sidewall core at 2186.5m which also contains *O. sentosa* as well as the eponymous species *Tricolporites apoxyexinus* (Dettmann, 1986). The common occurrence of *Proteacidites* spp. in the counts in the shallower cuttings at 1875m and 1980m is consistent with the upper part of the *T. apoxyexinus* Zone based on work in the Port Campbell Embayment (Partridge, 1996a). The top of the zone is picked at the sample below the deepest in situ occurrence of *N. senectus.*

The three cuttings samples between 2390–2520m lack diagnostic species which would allow confident assignment to either the *T. apoxyexinus* or *P. mawsonii* Zones. However, the common occurrence of *Cupressacites* sp.

and presence of *Clavifera vultuosus* ms indicates the interval is no older than the upper third of the *P. mawsonii* Zone.

Isabelidinium cretaceum microplankton Zone.
Sample at: 1980 metres.
Age: Santonian.
This moderate diversity assemblage dominated by *Heterosphaeridium* spp. and containing *Isabelidinium belfastense* and *Hexagonifera glabra* and *Trithyrodinium vermiculata* can be assigned to the *I. cretaceum* Zone even in the absence of the eponymous species.

Odontochitina porifera microplankton Zone.
Interval: 2190–2390 metres.
Age: Santonian.
The *O. porifera* Zone in Najaba-1A is identified on presence of *Chatangiella tripartita* and absence of younger index species. The other species in the low diversity assemblages recorded are long ranging and are not considered diagnostic.

Phyllocladidites mawsonii spore-pollen Zone
Interval: 2655–2820 metres.
Age: Coniacian–Turonian.
This interval contains relatively non-descript assemblages which are assigned to the *P. mawsonii* Zone based on the shallowest occurrence of *Rugulatisporites admirabilis* ms at 2655m and oldest occurrence of *Phyllocladidites mawsonii* at 2820m. The assemblages appear to be younger than the Waarre Formation based on the absence of characteristic species found in that unit such as *Appendicisporites distocarinatus* and the manuscript species *Hoegisporis trinalis, Laevigatosporites musa* and *Densoisporites muratus.* Little confidence however can be given to this latter observation because of low concentration of palynomorphs and overall poor preservation.

Coptospora paradoxa spore-pollen Zone.
Interval: 2870–2887 metres.
Age: Late Albian.
This interval is assigned to the *C. paradoxa* Zone on the presence of *Pilosisporites grandis* and *Perotrilites majus* in the deepest cuttings examined at 2870m and the presence of the eponymous species in the sidewall core at 2887m examined by Dettmann (1986). The cuttings assemblage is dominated by *Cyathidites* spp. (35%) and *Podocarpidites* spp. (19%) with the common occurrence of *Cicatricosisporites* spp. (8%) and is considered typical of the Eumeralla Formation. The in situ microplankton recorded are all fresh water types.

References

APTHORPE, M.C., 1979. Depositional history of the Upper Cretaceous of the North-West Shelf, based on foraminifera. *APEA J. 19*(1), 74–89.

DETTMANN, M.E., 1963. Upper Mesozoic microfloras from southeastern Australia. *Proc. R. Soc. Vict. 77*, 1–148.

DETTMANN, M.E., 1986. Biostratigraphy, Palaeoenvironment, and Hydrocarbon source potential of Najaba No.1, 1311m–3400m (Early Cretaceous—Early Tertiary) Otway Basin. Prepared for Beach Petroleum N.L. August 1986. 7p. Tables 1–3.

HELBY, R., MORGAN, R. & PARTRIDGE, A.D., 1987. A palynological zonation of the Australian Mesozoic. *Mem. Ass. Australas. Palaeontols 4,*1–94.

LENTIN, J.K. & WILLIAMS, G.L., 1993. Fossil Dinoflagellates: Index to genera and species, 1993 Edition. *AASP Contribution Series No. 28,*1–856.

PARTRIDGE, A.D., 1994. Palynological analysis of Langley-1, Port Campbell Embayment, Otway Basin. *Biostrata Report 1994/11*, 1–28.

PARTRIDGE, A.D., 1996a. Palynological review of the type sections of the Belfast Mudstone Flaxman and Waarre Formations in the Port Campbell Embaymen[illegible] Basin. *Biostrata Report 1996/1*

PARTRI[illegible] A.[illegible] [illegible]96b. Review of palaeontology data and preparation of STR[illegible]T datums for selected Otway Basin wells. *Biostrata Report 19*[illegible] (in preparation)

REYNOLDS, M.A., EVANS, P.R., BRYAN, R. & HAWKINS, P.J., 1966. The stratigraphic nomenclature of Cretaceous rocks in the Otway Basin. *Australian Oil & Gas Jour. 13*(3), 26–33

STOVER, L.E. & PARTRIDGE, A.D., 1973. Tertiary and late Cretaceous spores and pollen from the Gippsland Basin, southeastern Australia. *Proc. R. Soc. Vict. 85,*237–286.

Table-2: Interpretative Palynological Data for Najaba-1A, Otway Basin.

Sample	Depth Metres	Spore-Pollen Zone (Microplankton Zones and Subzone)	*CR	Comments and Key Species Present
Cuttings	1465	(*P. pyrophorum* and *M. druggii*)	D2	Microplankton 20%. Key index species of both zones present in heavily caved assemblage.
Cuttings	1490	*T. longus* (*M. druggii*)	D4 D3	Microplankton 20%. Frequent *Manumiella conorata* in heavily caved assemblage.
Cuttings	1525	Lower *T. longus*	D1	Microplankton <1% [illegible]Ds for *Forcipites longus* and *Tetracolpotites verrucosus*
Cuttings	1685-90	Indeterminate		Very low yield sample without key species.
Cuttings	1765	*N. senectus* ? *X. australis*	D2 D5	Microplankton ~2%. *Nothofagidites senectus* 9% *Proteacidites* spp. 17% Possible *Xenikoon australis* recorded.
Cuttings	1875	*T. apoxyexinus*	D2	Microplankton ~2% *Proteacidites* spp. 7%.
Cuttings	1980	*T. apoxyexinus* (*I. cretaceum*)	D4 D4	Microplankton 24%. *Amosopollis cruciformis* 6% *Proteacidites* spp. 8%. *Heterosphaeridium heteracanthum* dominates microplankton.
Cuttings	2190	*T. apoxyexinus* (*O. porifera*)	D2 D4	Microplankton ~7%. *Amosopollis cruciformis* ~10% *Proteacidites* spp. <1% LAD of *Chatangiella tripartita*,
Cuttings	2305	*T. apoxyexinus*	D4	Microplankton ~6%. *Amosopollis cruciformis* 11.5%. *Nothofagidites senectus* is considered caved.
Cuttings	2390	*T. apoxyexinus* to *P. mawsonii* (*O. porifera*)	D3	Microplankton ~2%. *Amosopollis cruciformis* 12% FAD of *Chatangiella tripartita*,
Cuttings	2470	*T. apoxyexinus* to *P. mawsonii*		Microplankton ~2%. *Amosopollis cruciformis* 16%.
Cuttings	2520	*T. apoxyexinus* to *P. mawsonii*		Microplankton 5%. *Amosopollis cruciformis* 12%.
Cuttings	2655	*P. mawsonii*	D4	Microplankton ~2%. *Amosopollis cruciformis* 10%. LAD *Rugulatisporites admirabilis*
Cuttings	2780	*P. mawsonii*	D4	Microplankton <10%. *Amosopollis cruciformis* <2%.
Cuttings	2820	*P. mawsonii*	D2	Microplankton ~4%. *Amosopollis cruciformis* ~2%.
Cuttings	2870	*C. paradoxa*	D4	Microplankton caved and <1%. Spore-pollen characteristic of Eumeralla Formation.

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

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.

FASIC DATA

Table–3: Basic Sample Data—Najaba-1A, Otway Basin.

SAMPLE TYPE	DEPTH (Metres)	LITHOLOGY	SAMPLE WT (g)	RESIDUE YIELD
Cuttings	1465.0	80% red-brown & clear quartz sandstone; 20% siltstone/shale.	27.8	Low
Cuttings	1490.0	70% sandstone; 30% siltstone/shale.	20.0	Low
Cuttings	1525.0	65% shale/siltstone; 35% quartz sandstone.	14.2	High
Cuttings	1685–90	Composite of two 5m cuttings intervalscomprising: >90% quartz sandstone with <10% shale/siltstone.	56.6	Low
Cuttings	1765.0	70% shale; ~30% sandstone.	12.3	High
Cuttings	1875.0	60% shale; 40% light grey fine grained sandstone.	17.5	High
Cuttings	1980.0	70% medium grey shale/siltstone; 30% cemented fine grained sandstone.	15.0	High
Cuttings	2190.0	30% shale medium grey; 70% cemented light grey fine-medium sandstone.	15.7	Moderate
Cuttings	2305.0	40% medium grey shale. 60% fine-coarse sandston	18.7	Moderate
Cuttings	2390.0	95% medium grey mudstone; <5% sandstone.	12.5	High
Cuttings	2470.0	95% medium grey shale/siltstone; <5% sandstone.	24.0	High
Cuttings	2520.0	>95% light grey mudstone; <5% sandstone.	21.9	High
Cuttings	2655.0	85% medium grey shale; 15% fine-medium quartz sandstone and siltstone.	18.5	High
Cuttings	2760.0	>95% dark grey shale; <5% sandstone.	14.5	High
Cuttings	2820.0	75% dark grey shale; 15% siltstone; 10% sandstone	21.5	High
Cuttings	2870.0	70% light-medium shale; 30% fine light grey sandstone.	19.9	Moderate
		Average weight	20.7	

Table–4: Basic Palynomorph Data for Najaba–1A, Otway Basin.

SAMPLE TYPE	DEPTH (Metres)	Palynomorph Concentration	Palynomorph Preservation	Number S-P Species*	Microplankton Abundance	Number MP Species*
Cuttings	1465.0	High	Poor-good	33+	Common 14%–20%	11+
Cuttings	1490.0	High	Good	27+	Common 19%	6+
Cuttings	1525.0	Moderate	Poor	42+	Rare <1%	2+
Cuttings	1685–90	Low	Poor–fair	11+	Not recorded	
Cuttings	1765.0	Low	Poor–fair	27+	Rare ~2%	2+
Cuttings	1875.0	Moderate	Poor–fair	36+	Rare ~2%	2+
Cuttings	1980.0	Low	Fair	38+	Abundant 23%	12+
Cuttings	2190.0	Moderate	Fair	31+	Common 17%	11+
Cuttings	2305.0	Low	Poor	33+	Common 17%	4+
Cuttings	2390.0	Low	Poor–fair	22+	Common 13%	5+
Cuttings	2470.0	Low	Poor	33+	Common 16%	4+
Cuttings	2520.0	Low	Poor	26+	Common 17%	4+
Cuttings	2655.0	Low	Poor	28+	Common 11%	5+
Cuttings	2780.0	Very low	Very poor	22+	Common 15%	5+
Cuttings	2820.0	Very low	Very poor	20+	Common 12%	3+
Cuttings	2870.0	High	Poor	43+	Rare <1%	6+
			Average Diversity:	29+		5+

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

Note: Spore-pollen and Microplankton diversity excludes reworked Permian species and some of the caved species in samples.

Table-5: Najaba-1A—Range and Abundance Chart for selected palynomorphs.

F CUTTINGS INTERVAL	1465m	1490m	1525m	1685m	1765m	1875m	1980m	2190m	2305m	2390m	2470m	2520m	2655m	2780m	2820m	2870m
SPORES																
Aequitriradites spp.							X	X							1%	5%
Baculatisporites spp.	###		2%		3%	6%	3%	1%	2%	5%	2%	4%	3%	12%	6%	8%
Biretisporites sp.	5%	###														
Cicatricosisporites spp.	RW				2%	X	X	X	X	X	X	3%	2%	X	2%	8%
Clavifera triplex			####		###	2%	X	5%	X	4%	2%	X			X	
Cyathidites (large) >40μ	5%	2%	2%		###	9%	###	6%	X	###	1%	5%	4%	7%	6%	19%
Cyathidites (small) <40μ	5%	###	####	###	5%	X	9%	6%	4%	3%	5%	6%	6%	8%	5%	16%
Dictyophyllidites spp.					###		###	1%	6%	2%	3%	2%	5%	1%	X	
Gleicheniidites spp.	9%	3%	6%	8%	4%	5%	9%	9%	###	###	9%	9%	###	5%	2%	5%
Herkosporites elliotti			X		X	2%	3%	X	3%	2%	###	###	1%			
Laevigatosporites spp.	4%	5%	2%		1%	###	###	3%	X	4%	3%	###	X	1%	1%	
Latrobosporites amplus/			2%			X	X	X	4%							
Marratisporites scabratu							###						1%			
Osmundacidites spp.					###	X			###	1%	2%	###	2%	1%	1%	4%
Retitriletes spp.					###	X	###	X	4%	1%	X	###	X	4%	2%	3%
Stereisporites spp.	2%		14%	###	###	X	2%	1%	2%	3%	###	4%	X	1%		####
Triletes undiff.	###	###	8%	8%	5%	4%	9%	5%	8%	6%	5%	8%	3%	3%	3%	9%
Triporoletes reticulatus					###											####
Total Spores	###	###	37%	###	###	###	###	###	###	###	###	###	###	42%	29%	78%
GYMNOSPERMS																
Araucariacites australis	X		3%	4%	3%	###	###	3%	2%	4%	2%	3%	1%	5%	13%	
Classopollis spp.		RW							###	X				3%	X	####
Cupressacites sp.					###	4%	2%	7%	6%	4%	9%	6%	4%	3%	1%	
Dilwynites pusillus ms					###		###		3%		2%		2%	4%	3%	
Dilwynites spp.	6%	7%	2%	4%	4%	5%	6%	6%	4%	8%	5%	6%	9%	4%	18%	
Lygistepollenites balmei	X		####					1%								
Lygistepollenites florinii	###	2%	2%													
Microcachryidites antar	###	###	2%		4%	###	###	8%	4%	X	5%	7%	8%	7%	5%	2%
Phyllocladidites mawson	5%	2%	3%	4%	3%	9%	###	X	2%	X	###	4%	3%	2%	1%	
Podocarpidites spp.	6%	2%	9%	###	###	###	###	###	###	###	###	###	###	28%	27%	19%
Podosporites microsacca		###	6%		9%	###	8%	9%	4%	2%	5%	4%	7%	1%	2%	####
Vitreisporites signatus					###		###	1%	###	1%	2%	X		1%	1%	

Table–5: Najaba-1A—Range and Abundance Chart for selected palynomorphs.

F CUTTINGS INTERVAL	1465m	1490m	1525m	1685m	1765m	1875m	1980m	2190m	2305m	2390m	2470m	2520m	2655m	2780m	2820m	2870m
Total Gymnosperms	###	###	26%	###	###	###	###	###	###	###	###	###	###	57%	70%	22%
ANGIOSPERMS undiff.	###	###	3%	8%			###									
Australopollis obscurus					###	8%	###	2%	###	3%	2%	###	1%	1%		
Dicotetradites clavatus	2%	###	X	4%								X				
Forcipites spp.					###	2%	###	X								
Gambierina rudata	2%	4%	5%		###											
Haloragacidites harrisii	2%	3%														
Malvacipolls spp.	###	###	####													
Nothofagidites spp.			3%	4%	5%			1%								
Peninsulapollis gillii	2%	###	####			X										
Proteacidites spp.	###	###	17%	4%	###	7%	8%	X	###	1%	###	###	1%		1%	
Spinizonocolpites promi	X	8%														
Tricolpites/Tricolporites	###	3%	8%		###	4%	2%	1%	2%	1%	2%	2%	1%			
Triporopollenites spp.		###	####		###	###	###									
Total Angiosperms	###	###	38%	###	###	###	###	4%	4%	5%	4%	4%	3%	1%	1%	
Total Spore-Pollen	110	119	120	26	154	111	150	102	114	105	129	113	104	103	101	108
Fungal spores	###	2%	1%	6%	3%	###	2%		2%	4%	###	###	2%	1%	1%	
Fungal hyphae	4%			6%	3%	4%	4%	2%	###	2%	2%	###	[illegible]	7%	2%	X
Fungal fruiting bodies	2%			3%				X		X			X			
Total Fungii	###	2%	1%	###	7%	5%	6%	2%	3%	6%	2%	3%	6%	7%	3%	
Reworked Fossils	2%	###	####		2%	###	###	1%	2%	4%	1%	###	1%	####	2%	2%
DINOFLAGELLATES und	###	9%			###	###	###	2%	###	1%	###	3%	1%	4%	2%	####
Chatangiella spp.								X		1%						
Deflandrea obliquipes	X	###														
Heterosphaeridium spp.						###	###	5%	4%	1%	###	###		1%	2%	
Kenleyia spp.	X	4%	X													
Manumiella spp.	X	5%														
Nummus spp.			####					X		X		###	1%	7%		
Odontochitina spp.							###		###							

Table–5: Najaba-1A—Range and Abundance Chart for selected palynomorphs.

F CUTTINGS INTERVAL	1465m	1490m	1525m	1685m	1765m	1875m	1980m	2190m	23[illegible]m	2390m	2470m	2520m	2655m	2780m	2820m	2870m
Paralecaniella indentata	###															
Amosopollis cruciformis	X	X			###	X	3%	###	###	###	###	###	9%	3%	7%	
Total Microplankton	###	###	####		2%	2%	###	###	###	###	###	###	###	15%	12%	####
TOTAL COUNT	162	154	123	31	173	120	211	126	145	136	161	143	127	134	121	111

X = PRESENT RW = REWORKED SPECIMENS

Table–6: Najaba-1A—Range Chart for selected palynomorphs

P OF CUTTINGS INTERVAL	1465m	1490m	1525m	1685m	1765m	1875m	1980m	2190m	2305m	2390m	2470m	2520m	2655m	2780m	2820m	2870m
SPORES																
Aequitriradites spinulosus							X	X							X	X
Aequitriradites verrucosus																X
Asteropollis asteroides							X	X								
Balmeisporites holodictyus																X
Battenipollis sectilis		X				CV										
Camarozonosporites austra	X				X							X				
Camarozonosporites horren			X													
Cicatricosisporites australiensis						X	X	X			X		X		X	X
Cicatricosisporites cuniformis						X	cf									
Cicatricosisporites hughesii																X
Cicatricosisporites pseudotripartitus												X				
Clavifera vultuosus ms								X		X	X	X				
Contignisporites cooksoniae																X
Corallina jardinae									X							
Crybelosporites striatus						W						W				X
Cyathidites asper																X
Cyclosporites hughesii					W							W				X
Densoisporites vellatus			X			X	X			X						
Dilwynites echinatus ms							X	X								
Foraminisporis asymmetricus						W								X		X
Forcipites longus			X													
Forcipites sabulosus					X											
Foveogleicheniidites confossus									X	X		X	X			
Gambierina rudata	X		X					CV								
Ischyosporites crateris																X
Latrobosporites amplus			X		X	X	X		X							
Latrobosporites ohaiensis						X	X	X								
Leptolepidites verrucosus					W											X
Nothofagidites endurus				X												
Nothofagidites senectus					X			C	V							
Ornamentifera sentosa			X			X	X	X								
Peromonolites bowenii			X													
Perotrilites jubatus								X							X	
Perotrilites majus					X	X	X		X				X	X		X
Perotrilites opekii						cf				X	X	X				
Phyllocladidites verrucosus					X											
Pilosisporites grandis																X
Proteacidites clinei ms			X													
Proteacidites otwayensis ms			X	X												
Pseudowinterapollis wahooensis			X	X												
Rogalskisporites cicatricosus																X
Rugulatisporites admirabilis ms													X			
Rugulatisporites mallatus	X					X							X			
Stereisporites (Tripunctisp	X															
Stereisporites regium			X													
Stereisporites viriosus						X	X									
Tetracolporites verrucosus			X													
Tetradopollis securus ms			X													
Tricolpites confessus					X											
Tricolpites walparaensis			X													
Tricolporites lilliei			X													
Trilobosporites trioreticulosus												W				X

Table–6: Najaba-1A—Range Chart for selected palynomorphs

P OF CUTTINGS INTERVAL	1465m	1490m	1525m	1685m	1765m	1875m	1980m	2190m	2305m	2390m	2470m	2520m	2655m	2780m	2820m	2870m
MICROPLANKTON																
Achomosphaera septata	X	X														
Ampidiadema rectangularis								X								
Callaoisphaeridium asymmetricum							X									
Chatangiella tripartita								X		X						
Chatangiella victoriensis								X								
Cleistosphaeridium sp.			X													
Cyclonephelium distinctum								X	X		X					
Gillinia hymenophora								X								
Glaphyrocysta pastiellii	X	X														
Heterosphaeridium evansii ms						X	X	X								
Heterosphaeridium heteracanthum							X	X	X	X	X	X	X	X	X	
Hexagonifera glabra							X									
Isabelidinium belfastense							X	cf								
Manumiella conorata	X	X														
Manumiella druggii	X															
Micrhystridium sp. A, Marshall 1989																X
Odontochitina costata							X	X	X				X			
Odontochitina cribropoda							X									
Odontochitina porifera							X									
Palaeohystrichophora infusorioides												X				
Palaeoperidinium pyrophor	X															
Schizosporis reticulatus																X
Sigmopollis carbonis																X
Sigmopollis hispidus																X
Spiniferites spp.							X	X		X			X		X	
Trithyrodinium spp.							X				X			X		
Trithyrodinium vermiculata							X									
Xenascus spp.										X						
Xenikoon australis					cf											

ABBREVIATIONS

X = Present
W = Reworked
CV = Caved
cf = Compared with