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# Palynological analysis of cuttings samples from the Sherbrook Group in Lindon-1, Otway Basin.

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# INTERPRETATIVE DATA

## Introduction

Eight new cuttings samples are analysed in Lindon-1 with seven samples from the Sherbrook Group and one sample from the Eumeralla Formation. This new data is integrated with previous work by Archer (1984a, b) and Morgan (1986) and a synthesised interpretation of the palynological zones and ages identified and their correlations to formations and new units identified in the well summarised in Table-1 below. This is followed by discussion of methods, geological comments and basis of zone picks. 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. All species which have been identified with binomial names are tabulated on Tables-5 & 6.

**Table-1: Palynological Summary for Sherbrook Group in Lindon-1.**

| AGE | UNIT | SPORE-POLLEN ZONES | MICROPLANKTON ZONES (SUBZONES) |
|---|---|---|---|
| PALEOCENE | PEBBLE POINT FORMATION 915-938m | Not sampled | Not sampled |
| DANIAN to MAASTRICHTIAN | K/T Boundary Shale 938-950m | Indeterminate | *M. druggii* 945m |
| MAASTRICHTIAN | TIMBOON SAND 950-990m | Not sampled | Not sampled |
| EARLY CAMPANIAN to SANTONIAN | PAARATTE FORMATION 990-1199m | *N. senectus* 990-1015m<br>*T. apoxyexinus* 1070-1155m | *N. aceras* 1015-1070m |
| SANTONIAN | BELFAST MUDSTONE 1199-1226m | *T. apoxyexinus* 1200-1223.1m | *I. cretaceum* 1200-1210m |
| ? SANTONIAN | Unnamed sand 1226-1232m | Not sampled | Not sampled |
| ALBIAN | EUMERALLA FORMATION 1232+ m | *P. pannosus* 1235m | No zones defined. |

T.D. 3011m

## Materials and Methods

Between 10 to 24 grams (average 15.7 g) of the cuttings were collected by the author then forwarded to Laola Pty Ltd in Perth for processing. 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 were mostly moderate, while palynomorph preservation was generally good.

Overall spore-pollen diversity was high averaging 32+ species per sample (Table-4). Microplankton abundance and diversity was low, averaging 8+ species per sample. The microplankton abundance data presented in Table-2 was obtained from counts made on slides prepared using 8microns filter cloth.

The earliest palynological analysis of Lindon-1 consists of two brief reports by Archer (1984a, b) in which six sidewall cores and two cuttings samples were analysed between 1206.8–3005m. Only the shallowest two samples were from the basal 30 metres of the Sherbrook Group. Because only limited species assemblages were recorded by Archer *(oc. cit.)* the confidence in the age picks is low. Subsequently, Morgan (1986) re-examined Archer's material and analysed 17 new samples (most of which seem to have been cuttings), over the same interval of 1206.8–3005m. Only four sidewall cores were examined from the Sherbrook Group. Morgan discusses his interpretation of the samples but only lists the key species supporting his zone picks. Unfortunately, in the copy of Morgan's report made available for review there were no species lists for the individual samples, so it was not possible to confirm or challenge Morgan's interpretations.

## Geological Comments

1. The deepest cutting at 1235m gave a very good *P. pannosus* Zone assemblage with only minimal contamination by cavings. The top of the Eumeralla Formation can therefore be confidently picked at the break on the gamma, resistivity and bulk density logs at ~1232m. The uncertainty in the exact depth is solely due to the small scale of the logs used to pick the formation tops.

2. There is no evidence in the cuttings of palynomorph species diagnostic of the Waarre, Flaxman or Morum Formations (the last is a new

formation containing the *C. striatoconus* Zone). Instead the caved element at 1235m suggest the Eumeralla Formation is overlain by the *T. apoxyexinus* and *I. cretaceum* Zones. The thin sand between 1226–1232m which has previously been identified as belonging to the Waarre Formation is now considered to be a new unit laterally equivalent to the Belfast Mudstone.

3. The shale unit from 1199-1226m can be confidently confirmed as age equivalent to the type section of the Belfast Mudstone as it contains the *T. apoxyexinus* spore-pollen and *I. cretaceum* microplankton Zones. Although the cuttings (at 1200m) in this interval contains *Nelsoniella aceras* this species, on the balance of evidence, is considered to be caved. The *I. cretaceum* Zone is also confirmed by the dinoflagellates *Amphidiadema denticulata* and *Isabelidinium cretaceum* recorded in the sidewall core at 1206.5m (Archer, 1984a).

4. The interval 990-1199m is confirmed as belonging to the broad concept of the Paaratte Formation. It contains both the *T. apoxyexinus* and *N. senectus* spore-pollen Zones while the *N. aceras* microplankton Zone was identified in the samples at 1015m and 1070m. More tenuously it is suggested that the more sandy interval between 1085–1199m can be correlated to the Nullawarre Greensand and the more shaly interval between 990-1085m to the Skull Creek Mudstone. These latter correlations are based on the association of the *N. aceras* Zone with the Skull Creek Mudstone in the Port Campbell Embayment, and the absence of the *X. australis* Zone in Lindon-1.

5. The absence of index species diagnostic of the *T. lilliei* or Lower *T. longus* spore-pollen Zones and *X. australis* and *I. korojonense* microplankton Zones in any of the cuttings is evidence to suggest a major unconformity is present at ~990m, at which most of Campanian and Early to Middle Maastrichtian is missing (ie. ~15 million years). The sandy section above this unconformity between 950–990m would then equate to part of the Timboon Sand. As the gamma log over this section shows two sands separated by a shaly spike it may even contain two sequences and another unconformity. For instance the interval 965–990m could be interpreted as the Timboon Sand while the overlying sand between 950–965m could be equivalent to the Wiridjil Gravel of Tickell *et al.* (1992, p.15). Unfortunately inspection of the cuttings samples over the interval 950–990m revealed no samples suitable for palynological analysis to test these speculations.

6. The palynological assemblage from cuttings at 945m confirms the shale between ~938–950m is the Cretaceous/Tertiary boundary shale recognised in the Port Campbell Embayment (Partridge, 1994). Although the spore-pollen assemblage is not diagnostic, being overwhelmed by caved specimens, the key dinoflagellates *Manumiella conorata, M. seelandica* and *Palaeoperidinium pyrophorum* and were recorded.

7. Dinoflagellate abundances (Table-2) in the cuttings samples analysed are consistently below 10% of the total palynomorph count. This includes the shallowest sample at 945m which is believed to be biased by a significant caved component in the assemblage count. Excluding the deepest sample at 1235m which is from the fluviatile Eumeralla Formation, all samples are considered marine, although more proximal to the Late Cretaceous shoreline than wells to the south.

## 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.

*Manumiella druggii* microplankton Zone.
Interval: 945 metres.
Age: basal Danian to Early Maastrichtian.
The shallowest occurrence of common *Manumiella conorata* associated with rare specimens of *M. seelandica* is the basis for identification of the *M. druggii* Zone. Both species are considered typical of microplankton assemblages from the near the base of the Cretaceous/Tertiary boundary shale. *Palaeoperidinium pyrophorum, Tubiosphaera filosa* and *Paralecaniella indentata* are also known from the Cretaceous/Tertiary boundary shale, but the remaining species representing approximately 50% of all microplankton recorded in the count are considered to be caved.

The associated spore-pollen in this sample are not considered diagnostic. The presence of *Malvacipollis* spp. ~4%; *Haloragacidites harrisii* ~4%; *Intratriporopollenites notabilis* and *Proteacidites nasus* Truswell & Owen, 1988, indicate significant caving from the Pember Mudstone above 915m.

No index species characteristic of the Upper *T. lcugus* Zone were identified to support the identification of the *M. druggii* Zone.

*Nothofagidites senectus* spore-pollen Zone
Interval: 990–1015 metres.
Age: Early Campanian.
The combined occurrence in both samples of *Nothofagidites* spp. and *Forcipites sabulosus* is the basis for identification of this zone. *Nothofagidites senectus* was recorded in the deeper sample and *N. endurus* in the shallower. In both samples *Protencidites* spp. at [illegible]% is the dominant pollen in the assemblages.

*Nelsoniella aceras* microplankton Zone.
Interval: 1015–1070 metres.
Age: Late Santonian to Early Campanian.
The two samples are confidently assigned to the *N. aceras* Zone on the presence of the eponymous species in assemblages dominated by *Heterosphaeridium* spp. Other microplankton species recorded are longer ranging or caved.

In the overlying sample at 990m the recorded microplankton are caved or non-diagnostic except for *Heterosphaeridium heteracanthum* and the manuscript species *Anthosphaeridium bullatum*. The latter was described from the Perth Basin by Marshall (1985) where it is found in the *N. aceras* Zone and lower part of the overlying *N. australis* Zone. Its short range is strong supporting evidence for a major unconformity and missing section at the log break at 990m.

*Tricolporites apoxyexinus* spore-pollen Zone
Interval: 1070–1223.1 metres.
Age: Santonian.
The base of the *T. apoxyexinus* Zone is identified on the oldest occurrence of *Ornamentifera sentosa* in the sidewall core at 1223.1m (Morgan, 1986) and cuttings at 1210m. The top is identified on the absence of younger index species. The spore-pollen assemblage counts are dominated by *Gleicheniidites circiniditcs*, *Podocarpidites* spp. and *Proteacidites* spp. The high and increasing abundance of *Proteacidites* spp. from 4% at 1210m to 15% at 1200m, culminating in a high 22% in the shallowest sample at 1070m is considered typical of the upper part of this zone.

*Isabelidinium cretaceum* microplankton Zone.
Interval: 1200–1210 metres.
Age: Santonian.
The microplankton component whilst not abundant contains the index species *Isabelidinium cretaceum, I. belfastense* and *I. thomasii* (Table-5). The assemblage recorded by Archer (1984a) from the sidewall core at 1206.5m with both *I. cretaceum* and *Amphidiadema denticulata* confirms the assignment. The next shallowest cuttings sample at 1155m cannot be confidently assigned to a microplankton zone.

*Phimopollenites pannosus* spore-pollen Zone.
Interval: 1235 metres.
Age: Late Albian.
The one sample analysed from the Eumeralla Formation was an excellent representation of the *P. pannosus* Zone and contained an unusually high abundance of eponymous species (*Phimopollenites pannosus* @ 22%). Other index species recorded were *Coptospora paradoxa* and *Pilosisporites grandis* whilst high abundances of *Cicatricosisporites/Ruffordiaspora* spp. at ~7%; *Foraminisporis asymmetricus* at ~3%; *Marattisporites scabratus* at >8%; and *Microcachryidites antarcticus* at 13% make the composition of the assemblage quite distinct from the cuttings samples from the overlying Sherbrook Group. Except for the fresh water algal cysts *Schizosporis reticulatus, Sigmopollis carbonis* and *S. hispidus* the recorded microplankton are interpreted as caved.

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**Table-2: Interpretative Palynological Data for Lindon-1, Otway Basin.**

| Sample Type | Depths | Spore Pollen Zone (Microplankton Zone) | CR* | Comments and Key Species Present |
|---|---|---|---|---|
| Cuttings | 945m | *(M. druggii)* | D3 | Microplankton 12%.<br>*Proteacidites* spp. 21%.<br>Common *Manumiella* including index species *M. conoratum* and *M. seelandica*.<br>*Palaeoperidinium pyrophorum* also present but probably caved. |
| Cuttings | 990m | *N. senectus* | D2 | Microplankton ~6%.<br>*Amosopollis cruciformis* <1%.<br>*Proteacidites* spp. 20%.<br>The occurrence of the distinctive dinoflagellate *Anthosphaeridium bullatum* ms described from Perth Basin confirms an age no younger than early Campanian or the *X. australis* Zone. |
| Cuttings | 1015m | *N. senectus*<br>*(N. aceras)* | D1<br>D2 | Microplankton <4%.<br>*Amosopollis cruciformis* <1%.<br>*Proteacidites* spp. 18%.<br>Zone picked on frequent *Forcipites sabulosus*, LAD of *Nelsoniella aceras* and absence of younger index species. |
| Cuttings | 1070m | *T. apoxyexinus*<br>*(N. aceras)* | D2<br>D2 | Microplankton 6%.<br>*Proteacidites* spp. 22%.<br>Zone pick on oldest occurrence of dinoflagellates *Nelsoniella aceras* and *Odontochitina porifera* and absence of younger *Xenikoon australis* |
| Cuttings | 1155m | *T. apoxyexinus* | D2 | Microplankton 7%.<br>*Proteacidites* spp. >17%.<br>Significant tertiary caving present. |
| Cuttings | 1200m | *T. apoxyexinus*<br>*(I. cretaceum)* | D4<br>D3 | Microplankton <3%.<br>*Amosopollis cruciformis* <1%.<br>*Proteacidites* spp. 15%.<br>Mixed assemblage with index species *Nothofagidites senectus* and dinoflagellate *Nelsoniella aceras* interpreted as caved. |
| Cuttings | 1210m | *T. apoxyexinus*<br>*(I. cretaceum)* | D1<br>D2 | Microplankton 7%.<br>*Amosopollis cruciformis* 9%.<br>*Proteacidites* spp. ~4%.<br>A diverse assemblage was recovered with no species indicative of section older than Belfast Mudstone. |
| Cuttings | 1235m | *P. pannosus* | D1 | Microplankton <2%.<br>Well preserved and highly diverse assemblage characterised by abundant *Pimopollenites pannosus* at ~22%.<br>Microplankton are non-marine types and calculated abundance excludes obvious caved species. |

*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 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 as[illegible]blage recorded with ke[illegible] 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-3: Basic Sample Data—Lindon-1, Otway Basin.**

| SAMPLE TYPE | DEPTH (Metres) | LITHOLOGY | SAMPLE WT (g) | RESIDUE YIELD |
|---|---|---|---|---|
| Cuttings | 945.0 | Sandstone 50%; siltstone/shale 50%. | 24.0 | High |
| Cuttings | 990.0 | Quartz sandstone 60%; siltstone/shale 40% | 20.7 | Moderate |
| Cuttings | 1015.0 | Quartz sandstone 50%; siltstone/shale 50% | 15.8 | Moderate |
| Cuttings | 1070.0 | Dark grey mudstone >90%. | 15.7 | High |
| Cuttings | 1155.0 | Dark grey mudstone >90%. | 13.2 | Moderate |
| Cuttings | 1200.0 | Mudstone/shale 35%, sandstone 65% including yellow quartz. | 10.2 | Moderate |
| Cuttings | 1210.0 | Mudstone/siltstone 90%; sandstone 10%. | 11.5 | High |
| Cuttings | 1235.0 | Felspar 80%; sandstone 20%. | 14.4 | High |

**Table-4: Basic Palynomorph Data for Lindon-1, Otway Basin.**

| SAMPLE TYPE | DEPTH (Metres) | Palynomorph Concentration | Palynomorph Preservation | Number S-P Species* | Microplankton Abundance | Number MP Species* |
|---|---|---|---|---|---|---|
| Cuttings | 945.0 | Moderate | Fair-good | 21+ | Common 12% | 7+ |
| Cuttings | 990.0 | Moderate | Good | 25+ | Common 6% | 5+ |
| Cuttings | 1015.0 | Moderate | Fair-good | 39+ | Frequent <4% | 8+ |
| Cuttings | 1070.0 | Moderate | Poor-good | 32+ | Common 6% | 10+ |
| Cuttings | 1155.0 | Moderate | Fair-good | 31+ | Common 7% | 7+ |
| Cuttings | 1200.0 | High | Fair-good | 34+ | Frequent <3% | 12+ |
| Cuttings | 1210.0 | Moderate | Fair | 34+ | Abundant 26% | 13+ |
| Cuttings | 1235.0 | High | Good | 45% | Rare <2% | 3+ |

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

Note: Spore-pollen and Microplankton diversity excludes reworked and obvious caved species in samples.

## Legend for Tables-5 & 6

| | | |
|---|---|---|
| RW | = | Reworked |
| A | = | Abundant |
| C | = | Common |
| F | = | Frequent |
| X | = | Rare to present |
| Caved | = | Specimens caved from higher in well |

## Table-5: Lindon-1 — Range Chart for Spore-Pollen

| SPECIES/SAMPLES | 945 m | 990 m | 1015 m | 1070 m | 1155 m | 1200 m | 1210 m | 1235 m |
|---|---|---|---|---|---|---|---|---|
| **SPORE-POLLEN SPECIES** | | | | | | | | |
| AEQUITRIRADITES spp. | | | | | | | #### | #### |
| Aequitriradites n.sp. | | | | | | | | X |
| Aequitriradites spinulosus | | | X | | X | | X | X |
| Aequitriradites tilchaensis | | | | | | | | X |
| Aequitriradites verrucosus | | | | | | | | X |
| Anacolosidites acutullus | | | | | | caved | | |
| Annulispora folliculosa RW | | | | | | RW | | |
| Araucariacites australis* | #### | X | X | X | | #### | #### | #### |
| Arcellites n.sp. | | | X | | | | | |
| Asteropollis asteroides | | | | | | | X | |
| Australopollis obscurus | | #### | #### | #### | X | #### | #### | aved |
| BACULATISPORITES spp. | #### | #### | #### | #### | | #### | | #### |
| Balmeisporites glenelgensis | | | X | X | X | X | X | |
| Balmeisporites holodictyus | | | | | | | | X |
| Callialasporites dampieri | | | | RW | | | | |
| Ceratosporites equalis | | | X | | | | #### | #### |
| CICATRICOSISPORITES spp. | | | #### | #### | | | #### | #### |
| Cicatricosisporites australien | RW | RW | | | | | | X |
| Cicatricosisporites cuneiformis | | | | | X | | | X |
| Cicatricosisporites pseudotripartitus | | | | | X | | | X |
| Cicatricosisporites rhodanos ms | | | | | | | | X |
| Clavatipollenites hughesii | | | | | | | | X |
| Clavifera triplex | | X | #### | X | | #### | #### | X |
| Clavifera vultuosus ms | | | X | | | X | | |
| Coptospora paradoxa | | | | | | | | X |
| Corollina torosa | | | | | #### | | #### | #### |
| Crybelosporites striatus | RW | | | | | | | #### |
| Cupanieidites orthoteichus | | | | caved | | | | |
| Cupressacites sp. | | | | X | #### | #### | #### | #### |
| Cyatheacidites annulatus | | caved | | | | | | |
| Cyathidites asper | | | | | | | | X |
| Cyathidites australis (>40μm) | #### | #### | X | #### | #### | #### | #### | #### |
| Cyathidites minor (<40μm) | #### | #### | #### | #### | #### | #### | #### | #### |
| Cyathidites punctatus | | | | X | X | | | |
| Cyathidites splendens | X | X | ave | aved | | | | |
| Densoisporites velatus | | | | | X | | | |
| Dicotetradites clavatus | #### | #### | #### | | | X | | |
| DICTYOPHYLLIDITES spp. | | #### | #### | #### | #### | #### | #### | |
| Dictyophyllidites crenatus | | | | | | X | | X |
| Dictyotosporites speciosus | | | RW | | | RW | | |
| Dilwynites granulatus | #### | #### | #### | #### | #### | #### | #### | |
| Dilwynites pusillus ms (sm.va | | | | | #### | | #### | aved |
| Dilwynites tuberculatus | X | X | X | X | X | X | X | |
| Dryptopollenites semilunatus | X | ave | aved | | | | | |
| Dulhuntyispora spp. RW | | | | | RW | | | |
| Ephedripites notensis | | | X | | | | | |
| Foraminisporis asymmetricu | | | | | | | | #### |
| FORCIPITES spp. | | #### | #### | #### | | | | |

## Table-5: Lindon-1 — Range Chart for Spore-Pollen

| SPECIES/SAMPLES | 945 m | 990 m | 1015 m | 1070 m | 1155 m | 1200 m | 1210 m | 1235 m |
|---|---|---|---|---|---|---|---|---|
| Forcipites l ngus | | aved | | | | | | |
| Forcipites sabulosus | | X | X | | | X | | |
| Foveogleicheniidites confossus | | | | | | X | | |
| Gambierina rudata | #### | ave | | | | ave | | |
| Gleicheniidites circinidites | #### | #### | #### | #### | #### | #### | #### | #### |
| Granulatisporites trisinus RW | | | RW | | | | | |
| Haloragacidites harrisii | aved | | cave | ave | ave | aved | | |
| Herkosporites elliottii* | X | | X | | X | | X | |
| Ilexpollenites primus ms | | | | | | X | | |
| Intratriporopollenites notabil | aved | | | | | | | |
| Laevigatosporites spp. | #### | #### | #### | #### | #### | #### | #### | #### |
| Latrobosporites amplus | | X | X | X | | | | |
| Latrobosporites ohaiensis | | | X | | | X | | |
| Leptolepidites verrucosus | | | | X | | | | |
| LILIACIDITES spp. | | | | | X | | | |
| Lygistepollenites balmei | | | | X | aved | | | |
| Lygistepollenites florinii | #### | #### | X | #### | #### | #### | #### | |
| Malvacipollis diversus | ave | aved | | cave | aved | | | |
| Malvacipollis subtilis | ave | ave | aved | | | caved | | |
| Marratisporites scabratus | | | | | #### | #### | #### | #### |
| Matonisporites cooksoniae | | | | | | | | X |
| Microbaculispora spp. RW | | | | X | | | | |
| Microcachryidites antarcticus | | #### | #### | #### | #### | #### | #### | #### |
| Myrtaceidites parvus/meson | aved | | caved | | | | | |
| Neoraistrickia truncata | | | | | | | | X |
| Nothofagidites endurus | | X | | | | | | |
| Nothofagidites senectus | | | X | | | X | | |
| Ornamentifera sentosa | | | | X | | | X | |
| Osmundacidites wellmanii | | | #### | #### | | | #### | #### |
| Peninsulapollis gillii | #### | #### | X | | | | | |
| PEROMONOLITES spp. | #### | | | | | ave | | |
| Peromonolites densus | X | X | | | | | | |
| Peromonolites vellosus | | | caved | | | | | |
| Perotrilites jubatus | | | | | X | | | |
| Perotrilites majus | | X | | | | | | |
| Phimopollenites pannosus | | | | | | | | #### |
| Phyllocladidites eunuchus m | | | | | | | #### | |
| Phyllocladidites mawsonii | #### | #### | #### | #### | X | #### | #### | |
| Pilosisporites grandis | | | | | | | | X |
| Pilosisporites notensis RW | | | RW | | | | | |
| Plicatipollenites spp. RW | | | RW | RW | RW | RW | RW | |
| PODOCARPIDITES spp. | #### | #### | #### | #### | #### | #### | #### | #### |
| Podosporites microsaccatus | #### | #### | #### | #### | #### | #### | #### | #### |
| PROTEACIDITES spp. | #### | #### | #### | #### | #### | #### | #### | |
| Proteacidites adenanthoides | aved | | caved | | | caved | | |
| Proteacidites amolosexinus | | | | | | | | |
| Proteacidites annularis | aved | | | cave | aved | | | |
| Proteacidites grandis | | | | caved | | caved | | |
| Proteacidites incurvatus | | | | | | caved | | |
| Proteacidites nasus | aved | | | | caved | | | |

## Table-5: Lindon-1 — Range Chart for Spore-Pollen

| SPECIES/SAMPLES | 945 m | 990 m | 1015 m | 1070 m | 1155 m | 1200 m | 1210 m | 1235 m |
|---|---|---|---|---|---|---|---|---|
| Proteacidites ornatus | | | | | | caved | | |
| Protohaploxypinus spp. RW | | | | | | | RW | |
| Pseudoreticulatispora pseudoreticulata | | | | RW | | | | RW |
| RETITRILETES spp. | | | X | #### | #### | #### | X | #### |
| Retitriletes austroclavatidites | | | X | | | | X | X |
| Retitriletes eminulus | | | | X | | | | |
| Retitriletes nodosus | | | | | | X | | X |
| Rotverrusporites stellatus | X | | caved | | | | | |
| Rugulatisporites mallatus | | X | X | | X | | X | |
| STEREISPORITES spp. | #### | #### | #### | #### | #### | #### | #### | #### |
| Stereisporites (Tripunctispori | X | | | cave | aved | | | |
| Stereisporites antiquisporite | X | X | | X | X | X | X | X |
| Stereisporites viriosus | | | | X | | | | |
| Striatoabieites multistriatus | RW | | | | | RW | | |
| TRICOLPITES/TRICOLPORIT | #### | #### | #### | #### | #### | #### | | #### |
| Tricolpites confessus | | | 3 | | X | | | |
| Tricolpites phillipsii | X | | | | caved | | | |
| Tricolpites walparaensis | | X | | | | | | |
| TRILETES undiff. | #### | #### | #### | #### | #### | #### | #### | #### |
| Trilobosporites trioreticulosus | | | | | | | | X |
| Triporoletes laevigatus | | | | | | | | X |
| Triporoletes radiatus | | | | | | | | #### |
| Triporoletes reticulatus | X | | | X | | X | X | X |
| Triporoletes simplex | | | | | | | | X |
| TRIPOROPOLLENITES spp. | #### | | #### | #### | #### | #### | | |
| Verrucosisporites kopukuens | X | X | | | | caved | | |
| Vitreisporites pallidus | | | X | | | X | X | X |
| | | | | | | | | |
| COUNT SPORE-POLLEN (in s | 98 | 113 | 134 | 144 | 104 | 116 | 105 | 236 |
| | | | | | | | | |
| SPORES as % of S-P | 31% | 25% | 22% | 35% | 27% | 30% | 39% | 47% |
| ANGIOSPERM POLLEN as % o | 27% | 40% | 39% | 28% | 43% | 40% | 52% | 32% |
| GYMNOSPERM POLLEN as % | 43% | 35% | 39% | 37% | 30% | 30% | 9% | 22% |
| | | | | | | | | |
| Spore/Pollen as % of TOTAL | 66% | 68% | 89% | 83% | 72% | 80% | 70% | 96% |
| | | | | | | | | |
| MICROPLANKTON undiffere | 8% | 4% | 3% | 5% | 6% | #### | 16% | #### |
| Amosopollis cruciformis | | #### | #### | | | #### | 9% | |
| COUNT MICROPLANKTON (i | 8% | 5% | 3% | 5% | 6% | 2% | 25% | #### |
| | | | | | | | | |
| Fungal hyphae | 3% | 7% | #### | 5% | #### | 2% | #### | 2% |
| Fungal spores | 7% | 8% | 5% | 2% | #### | | 2% | |
| Fruiting bodies | | X | X | X | X | | X | X |
| | | | | | | | | |
| REWORKED Spore-Pollen | | | #### | #### | #### | 2% | 3% | |
| CAVED PALYNOMORPHS | 15% | 13% | #### | 5% | 19% | 14% | | #### |
| | | | | | | | | |
| TOTAL COUNT - ALL PALYNO | 149 | 167 | 150 | 174 | 144 | 145 | 151 | 246 |

## Table-6: Lindon-1 — Range Chart for Microplankt

| SPECIES/SAMPLES | 945 m | 990 m | 1015 m | 1070 m | 1155 m | 1200 m | 1210 m | 1235 m |
|---|---|---|---|---|---|---|---|---|
| **DINOFLAGELLATE SPECIES** | | | | | | | | |
| Anthosphaeridium bullatum ms | | X | | | | | | |
| APECTODINIUM sp. | | cave | aved | | caved | | | |
| Apectodinium homomorph | ave | ave | ave | aved | | | | |
| Canningia bassensis | | | | X | | | | |
| Cleistophaeridium ancoriferum | | | | | | X | | |
| Cordosphaeridium sp. | X | | | | | caved | | |
| CRIBROPERIDINIUM spp. | | | X | | | | | |
| Cyclonephelium distinctum | | | | | | | X | |
| Deflandrea medcalfi | aved? | | | | | | | |
| Deflandrea obliquipes (long horn) | | cave | ave | aved | | | | |
| Exochosphaeridium phragmites s.l. | | | | X | | | | |
| HETEROSPHAERIDIUM spp. | | X | X | A | A | C | A | ave |
| Heterosphaeridium evansii ms | | | | X | X | | | |
| Heterosphaeridium heteracanthum | | | X | X | X | X | A | |
| ISABELIDINIUM spp. | | X | | X | | | X | |
| Isabelidinium belfastense | | | | | | | X | ave |
| Isabelidinium cooksoniae(?) | | | | | | | X | ave |
| Isabelidinium cretaceum | | | X | | | X | C | |
| Isabelidinium rectangularis | | | | | | | X | |
| Isabelidinium thomasii | | | | | | cf. | X | |
| Kiokansium polypes | | | | | | cf. | | |
| MANUMIELLA spp. | | | | | caved | | | |
| Manumiella conorata | X | aved | | | | caved | | |
| Manumiella seelandica* | X | | | | | | | |
| Nelsoniella aceras | | | X | X | | F | | cave |
| Odontochitina costata | | | X | X | | | X | |
| Odontochitina porifera | | | | X | X | X | X | |
| Palaeohystrichophora infusorioides* | | | | | X | | | |
| Palaeoperidinium pyrophor | X | | | | | | | |
| Palaeostomocystis reticulata | | | | | | X | | |
| Paralecaniella indentata* | X | | | X | | X | | |
| SPINIDINIUM spp. | | | | | | X | | |
| SPINIFERITES spp. | X | X | X | X | C | X | | |
| Systematophora placacant | aved | | | | | | | |
| TRITHYRODINIUM spp. | | | | | X | X | | |
| Trithyrodinium vermiculata | | | | X | X | | | |
| Tubiosphaera filosa | X | | | | | | | |
| ALGAL SPECIES | | | | | | | | |
| Amosopollis cruciformis | | | X | | | X | A | |
| Circulisporites parvus | | | | | | | X | |
| MICRHYSTRIDIUM spp. | | X | | | | X | | X |
| Schizosporis reticulatus | | | | | | | | X |
| Sigmopollis carbonis | | | | | | | | X |
| Sigmopollis hispidus | | | | | | | | X |
| MICROFORAMINIFERAL LINERS | | | | X | X | | | |