High-resolution palynological analysis of the reservoir interval in Kipper–1, Gippsland Basin.

by

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Summary

- A new detailed palynological study has been made of the Latrobe Group reservoir sections in the Kipper–1 discovery well based on assemblage counts of 60 samples, and a reconnaissance analysis or review of all other samples through the interval of interest. A summary of the results, and comparison with a similar study of the Kipper–2 well, is presented in Figure–1.

- The sequence analysed from Kipper–1 extends from the Turonian *P. mawsonii* spore-pollen Zone and *Rimosicysta* microplankton Superzone, identified in the 600 metre thick Kipper Shale, to the basal Eocene *M. diversus* spore-pollen Zone and *A. hyperacanthum* microplankton Zone identified near the top of Latrobe coarse clastics.

- Results confirm age dating and correlations presented in the original palynological report (Marshall & Partridge, 1986). However, better biostratigraphic resolution is achieved in the Paleocene *L. balmei* Zone by the identification of four new spore-pollen subzones, and within the Campanian *N. senectus* Zone, which is subdivided into Upper and Lower subzones.

- The Upper *N. senectus* Zone is identified in Kipper–1 from immediately below the volcanic unit, in a 16 metre thick sandstone and shale interval (1989 to 2005m), that is interpreted to correlate with the 32 metres of sandstone and shale (2211 to 2243m) lying between the two volcanic units in Kipper–2.

- The principal disappointment of the study was the failure to identify any further palynological subdivision of the main gas reservoir represented by the Lower *N. senectus* Zone. Unfortunately, many of the sidewall cores through this critical section yielded insufficient palynomorphs for reliable counts, and while there were plenty of good assemblages recovered from the cuttings samples no palynomorph extinction events could be identified in the cuttings that could be used to subdivide the Lower *N. senectus* Zone.

Figure–1: Palynological summary for Kipper–1 and comparison with Kipper–2

AGE	STRATIGRAPHY After Partridge 1999	KIPPER–1		KIPPER–2	
		SPORE–POLLEN ZONES or Subzones	**MICROPLANKTON ZONES**	**SPORE–POLLEN ZONES & Subzones**	**MICROPLANKTON ZONES**
EARLY EOCENE	KINGFISH FORMATION	*M. diversus* Zone 1493m	*A. hyperacanthum* 1493m	*M. diversus* Zone 1585.4–1591.5m	*A. hyperacanthum* 1585.4–1591.5m
PALEOCENE		*M. gigantis* Subzone 1506m *P. annularis* Subzone 1562.5m *P. angulatus* Subzone 1646m	*A. reburrus* Zone 1562.5m	*M. gigantis* Subzone 1603m *P. annularis* Subzone 1623.5–1742.5m *P. angulatus* Subzone 1754–1809.5m	*A. reburrus* Zone 1623.5–1809.5m
DANIAN to MAASTRICHTAIN	KATE SHALE	*T. verrucosus* Subzone 1727m	*T. evittii* Zone? 1727m	*T. verrucosus* Subzone 1871.5m	*A. circumtabulata* or older 1871.5m
		Upper *F. longus* 1733.5m	*M. druggii* Zone 1733.5m	Upper *F. longus* 1880.6–1888m	*M. druggii* Zone 1880.6m
MAASTRICHTAIN	VOLADOR FORMATION	Upper *F. longus* 1760–1840.6 Lower *F. longus* 1850†–1895†m	Age diagnostic microplankton not present	Upper *F. longus* 1944–1969 Lower *F. longus* 1982.5–2055.1m	Age diagnostic microplankton not present
CAMPANIAN to latest SANTONIAN	Missing section	*T. lilliei* Zone Not present		*T. lilliei* Zone Not present	
	UPPER VOLCANICS	Volcanics not zoned.	No palynology	Volcanics not zoned.	No palynology
	CHIMAERA FORMATION	Upper *N. senectus* 1998m	Age diagnostic MP not present	Upper *N. senectus* 2211.6–2242.1m	Age diagnostic MP not present
	LOWER VOLCANICS	Volcanics not present.		Volcanics not zoned.	No palynology
	CHIMAERA FORMATION	Lower *N. senectus* 2000†–2155m *T. apoxyexinus* 2155†–2245.5m	*C. porosa* Zone 2180†–2192	Lower *N. senectus* 2267.6–2444m *T. apoxyexinus* 2491–2595†m	*C. porosa* Zone 2491–2564
TURONIAN	KIPPER SHALE	*P. mawsonii* Zone 2295†–2862m	*Rimosicysta* Superzone 2295†–2862m	Not penetrated	Not penetrated

† = Depth limit of zone based on cuttings.

Introduction

Objectives. The primary objective of the study was to make detailed counts of palynological assemblages in samples from existing Kipper–1 slide sets with the aim of improving subdivision of the palynological succession, and in conjunction with a similar study of the Kipper–2 well provide more detailed correlation of the reservoir sections between the two wells.

The secondary objective was to resolve confusion and ambiguity in age dating of and correlation between the Kipper–1 and 2 wells reported in the palynological study by Davies & Ioannides (1999). This recent study provides significantly different zone picks and ages compared to the original palynological studies by Marshall & Partridge (1986) and Hannah (1987).

Materials. The current study is based on two separate collections of palynological slides. The earlier collection comprises the original palynological slides prepared during 1986, by the now closed Esso Australia Ltd palynological laboratory. This set consist mainly of sidewall cores and cuttings samples, and a few samples from conventional core–5 cut in Maastrichtian age sediments above the volcanics. Unfortunately, no conventional cores were cut in the reservoir section below the volcanics. The later collection consists mainly of new cuttings samples, and duplicated preparations of selected sidewall cores, processed at the Exxon Production Research Company (EPRCo) laboratories in the late 1990s. The latter samples are all from below the volcanics, and represents the bulk of the material studied by Davies & Ioannides (1999).

Basic Results. An average of 245.5 specimens per sample were counted from 60 samples (including three duplicate preparations) out of a total of 101 samples processed in Kipper–1. Palynological slides from most of the other samples were also briefly examined in the course of selecting the best samples to count. Zone interpretation on individual samples are provided in Table 1, with basic palynological data presented in Table 2, palaeoenvironmental interpretations on counted samples provided in Table 3, assemblage counts in Tables 4, and a distribution chart for selected palynomorphs provided in Tables 5.

Residue yields and concentration of palynomorphs on the slides was variable throughout the section analysed in Kipper–1 (Table 2). In general preservation of the palynomorphs was best and counting of the assemblages easiest in the younger section above the volcanics, whereas preservation was poorest and counting most time consuming in the Kipper Shale at the base of the sequence. Samples from the gas reservoir in the Chimaera Formation (*N. senectus* Zone) were also problematic to count because of the poor preservation of palynomorphs extracted from samples in the hydrocarbon column.

Limitations of Data and Method. The primary objective of making detailed of the palynological assemblages in Kipper–1 is to search for additional biostratigraphic subdivision of the palynological succession beyond that obtained from the traditional methods of palynological zonation using the first and last appearances of a relatively small number of index species. However, the comparison of assemblage counts makes many assumptions, including that: 1) the samples analysed are representative of the sequence studied, 2) the laboratory processing has not distorted or biased the assemblages on the slides, 3) preservation is comparable between the assemblages, and 4) the palynologists making the counts are consistent in both their recognition of the palynomorphs within the organic residues, and identification of species and categories that are counted. In practice each of these assumptions can be challenged and the users of the data need to be aware of the many limitations.

In reference to the first of the above points care must be especially taken in Kipper–1 with evaluating the count data from the *N. senectus* Zone covering the main gas reservoir. Over this interval from 1990 to 2155m the sidewall cores were mostly barren or low yielding and the assemblage counts needed to be made almost exclusively on cuttings. Unfortunately it is impossible to adequately evaluate how extreme is the distortion or skewing of the assemblages, due to down-hole cavings.

Concerning the second point, the palynological slides prepared in the Esso Australia laboratory have all been subjected to a technique (short-spinning) designed to eliminate organic fines, and concentrate larger, more stratigraphically important palynomorph species. This technique preferentially eliminates those palynomorphs less than about 15 mμ in diameter (eg. small acritarchs, small tricolp(or)ate pollen and fungal spores). In contrast, the palynological slides prepared in the EPRCo laboratory have been filtered or sieved into different size fractions. Inspection of the these slides revealed it was only practical to count those slides prepared from the less than 33µm fraction, which were found to have increased concentrations of small palynomorphs relative to the slides prepared in the Esso Australia laboratory (eg. compare counts of assemblages from sidewall core at 2192m, Table 4).

On the third point, poorly preserved or badly orientated palynomorphs can be difficult to identify and count. This is particularly true of samples dominated by gymnosperm pollen or fragmented dinoflagellate cysts. In Kipper–1 the spore-pollen preservation is noticeably poorest in the gas column of the reservoir where improvement in the biostratigraphy is most desired.

With respect to bias introduced by the palynologists, some evaluation of this can be obtained from the duplicate assemblage counts made on the cuttings at 2105–10m and the sidewall core at 2192m (Table 4).

Geological Comments

1. Stratigraphic terminology used in Figure–1 and mentioned in the following discussion follows a major revision of the stratigraphy of the Latrobe Group by Partridge (1999). Although detailed discussion of the new formations is clearly beyond the scope of this report the terminology is introduced in anticipation that it will be published and available in the near future.

2. At the top of the sequence studied is the thin *Apectodinium hyperacanthum* microplankton Zone at the base of the *M. diversus* Zones. This thin marine incursion, which lies within the Kingfish Formation, is a significant regional horizon across the eastern half of the offshore Gippsland Basin where it provides a important datum within the coarse clastic facies of the upper Latrobe Group.

3. The recognition of the three new palynological subzones (*P. angulatus*, *P. annularis* and *M. gigantis* Subzones) within the upper part of the *L. balmei* Zone, suggests that the Late Paleocene represents a relatively continuous or complete sequence extending into the Early Eocene. In contrast, the Early Paleocene is condensed or contains significant missing section. Based on regional data within the basin the Kate Shale is considered to extend no younger than the oldest sedimentary cycle identified in the Danian by Haq *et al.* (1987, 1988). The upper part of the Danian and probably the lower part of the Thanetian are therefore represented by the sandstone section from 1690 to 1722m in Kipper–1. As this sandstone section is unlikely to be a condensed section it undoubtedly contains one or more significant sequence boundary unconformities.

4. The Kate Shale is a new name for the distinctive regional shale, which straddles the Cretaceous/Tertiary boundary, and has an arcuate distribution across the eastern part of the Gippsland Basin. It is identified in Kipper–1 from 1722 to 1735m, and contains both Maastrichtian and basal Paleocene spore-pollen and microplankton zones. Environment of deposition is mid-shelf marine, approximately 10 km seaward of the palaeoshoreline.

5. The section between the base of the Kate Shale and top of volcanics from 1735 to 1893m is assigned to the Volador Formation (originally named by Thompson, 1986), and is interpreted to contain only Maastrichtian age microfloras of the *F. longus* Zone.

6. The late Campanian *T. lilliei* Zone is interpreted to be missing in Kipper–1 based on the absence of palynomorph assemblages containing an overlap in the ranges of the species *Tricolporites lilliei* and *Forcipites sabulosus*.

7. Compared to the accumulation rates of the sediments, the volcanic intervals in both Kipper wells are interpreted to represent relatively short time intervals. Based on more regional data, extrusion of the volcanics is interpreted to have commenced in the *N. senectus* Zone and continued into the *T. lilliei* Zone, and consequently the volcanics are indirectly dated as Campanian in age.

8. The sedimentary section below the volcanics in Kipper–1 contains the type sections of both the Chimaera Formation (from 1989 to 2279) and Kipper Shale (from 2279 to 2875m T.D.) described by Lowry and Longley (1991). The Chimaera Formation contains the upper part of the *T. apoxyexinus* and *N. senectus* Zones and is Late Santonian to Early Campanian in age. The underlying Kipper Shale represents only part of the *P. mawsonii* Zone and is interpreted as approximately middle Turonian in age.

9. In the Chimaera Formation the boundary between the Lower *N. senectus* and *T. apoxyexinus* Zones is lowered about 75 metres compared to the original palynological study by Marshall & Partridge (1986).

10. The Upper *N. senectus* Zone is either missing in Kipper–1 or represented only by the thin sand and shale section from 1990 to 2005m lying immediately under the volcanics. The latter interpretation is based on correlation of the peak abundance of the spore *Densoisporites velatus* in the

sidewall core at 1998m in Kipper–1, with the peak abundance of the same spore in the sidewall cores at 2235.6 and 2242.1m in Kipper–2. If this correlation is correct the lower volcanic unit present in Kipper–2 must pinchout somewhere between Kipper–1 and 2.

11. The bulk of the reservoir section below the volcanics in Kipper–1 is assigned to the Lower *N. senectus* Zone identified from 2005 to 2155m. Unfortunately this interval cannot be further subdivided using either species abundance or range data. The assemblage counts are almost entirely based on cuttings samples and lack any useful changes in the microfloras, while no reliable species extinction can be identified in the cutting.

12. The basal 120 metres of the Chimaera Formation in Kipper–1 is assigned to the *T. apoxyexinus* Zone and also contains the distinctive microplankton incursion assigned to the *C. porosa* Zone identified in the two sidewall cores at 2187.5m and 2192m, and possibly extending as deep as the sidewall core at 2245.5m. As the recorded assemblages are less abundant and less diverse relative to Kipper–2, the zone can be interpreted to thin or become less marine in Kipper–1. Which interpretation is correct depends on how the microplankton recorded in the sidewall core at 2245.5m in Kipper–1 are interpreted. The authors of the current study prefer to interpret this sidewall core as contaminated, which if correct would mean Kipper–1 has penetrated a slightly older portion of the Chimaera Formation relative to Kipper–2.

13. The nearly 600 metres thick section of Kipper Shale penetrated at the base of Kipper–1 is interpreted to represent an offshore or distal deep-water lacustrine facies deposited in a large palaeolake. This palaeoenvironmental interpretation is based on the presence of a distinctive suite of algal palynomorphs described by Marshall (1989) and the strong Neves effect observed in many of the spore-pollen assemblages (Table 3). The boundary between the Chimaera Formation and Kipper Shale in Kipper–1 is interpreted as either an unconformity or a fault contact, as the palynological succession suggests there is significant missing time.

Palaeoenvironments

Palaeoenvironments are assigned in Table 3 to those samples that have been counted in Kipper–1. Identification of the palaeoenvironments is based on consideration of 1) abundance, diversity and type of microplankton, 2) the way the spore-pollen composition is skewed by changes in abundances of species, and 3) sample lithologies. The various environmental categories distinguished, and their lithological and palynological characteristics, summarised in Figure 2, are derived from an empirical model developed by Partridge (1999) for the Gippsland Basin.

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*, *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 *Rimosicysta* spp. **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.	**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.

The additional comments on interpretation provided on Table 3 attempts to subdivide the categories further, particularly the non-marine environments. These are subdivided into broad vegetation categories based on the changes in abundance of the spore-pollen. Although these categories may help visualise the depositional setting of the samples they actually provide no data on the sedimentary processes that deposited the sediment.

Biostratigraphy

The spore-pollen zones identified in this study were originally described by Stover & Evans (1974) and Stover & Partridge (1973), with some of the Late Cretaceous zones subsequently modified by Helby *et al.* (1987). The microplankton zones identified are an amalgam of a Tertiary scheme originally outlined by Partridge (1975, 1976) but never published, and zones based on the Late Cretaceous microplankton assemblages described by Marshall (1988, 1989). Both these zonations schemes have been reviewed and supplemented by numerous new zones and subzones in the as yet unpublished thesis by Partridge (1999). Information from this latter work is provided in the following discussion of the zones.

Author citations for most spore-pollen species can be sourced from Helby *et al.* (1987), Dettmann (1963) or Stover & Partridge (1973), 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.

SPORE-POLLEN ZONES

***Spinizonocolpites prominatus* Subzone of the**
***Malvacipollis diversus* spore–pollen Zone.**
Sample at: 1493 metres
Age: Early Eocene.

The *M. diversus* Zone is identified in the shallowest sample examined in Kipper–1 based on the marked increase in the abundance of *Malvacipollis diversus* and the closely similar *Malvacipollis subtilis* (to 5.6% of SP count), associated with FAD (First Appearance Datum) of the mangrove pollen *Spinizonocolpites prominatus*. The short disjunct range of the latter species at the base of the *M. diversus* Zone also defines the *S. prominatus* Subzone. The pollen *S. prominatus* is absent from the succeeding *P. grandis* and *P. tuberculiformis* Subzones before reappearing again in the *M. tenuis* Subzone of the *M. diversus* Zone (Partridge, 1999). The assemblage is also characterised by high abundance of *Myrtaceidites* pollen (21%) belonging to the *M. mesonesus/parvus* species complex, and relative to the underlying *L. balmei* Zone, most gymnosperms, spores and *Nothofagidites* pollen are either less prominent or rare. The exception are the alete gymnosperms

Araucariacites australis (13%), and *Dilwynites* spp. (10%), whose increased abundance is interpreted as a Neves effect.

***Lygistepollenites balmei* spore–pollen Zone.**
Interval: 1506 to 1727 metres
Age: Paleocene.

The *L. balmei* Zone identified in Kipper–1 is approximately 220 metres thick and is characterised by the frequent to common occurrence of the eponymous species *Lygistepollenites balmei* (average 2.4%), with *Gambierina rudata* and *Australopollis obscurus* the next most consistent indicator species. The previous subdivision of the zone into the Upper and Lower *L. balmei* Zones, has recently been replaced by the recognition of four new subzones (Partridge, 1999).

The oldest of the new subdivisions is the *Tetracolporites verrucosus* Subzone, which is characterised by the consistent to common occurrence of the eponymous species. This subzone is identified from the upper part of the Kate Shale at 1727m, but possibly extends into the overlying coarsening upward sandstone from 1690 to 1722m, which lacks productive palynological samples. The succeeding *Proteacidites angulatus* Subzone defines the interval up to the LAD (Last Appearance Datum) of the eponymous species and is identified from the base of the coal measures section up to 1646m. Samples in Kipper–2 from 1754 to 1809.4m confirm that the *P. angulatus* Subzone extends down to the base of the coal measures section (Partridge & Macphail, 2000). The next youngest *Proteacidites* (al. *Propylipollis*) *annularis* Subzone, is defined by the FAD of the eponymous species. The base of this zone is poorly characterised in the assemblages from the coaly interval, and although only identified at 1562.5m the subzone probably ranges deeper. The highest *Matonisporites* (al. *Cyathidites*) *gigantis* Subzone, which is also defined by the FAD of the eponymous species, is also only represented by one sample at 1506m.

***Forcipites longus* spore–pollen Zone.**
Interval: 1733.5 to 1895 metres
Age: Maastrichtian.

The *Forcipites* (al. *Tricolpites*) *longus* Zone is ideally defined as the total range of the eponymous species. Unfortunately, this species is typically rare and therefore the base and top of the zone has always been pragmatically identified by a number of accessory index species (especially *Quadraplanus brossus* and

Proteacidites reticuloconcavus ms) with FADs and LADs that are considered coincident with those of *F. longus*. The zone has also, since the early 1980s, been subdivided into the Upper *F. longus* and Lower *F. longus* Zones. The Upper *F. longus* Zone (= *T. maastrichtiensis* Subzone) is defined at its base by the FAD of the spore *Tripunctisporis maastrichtiensis*, and is characterised by common to abundant *Gambierina* pollen. The Lower *F. longus* Zone (= *P. reticuloconcavus* Subzone) lacks the latter two criteria and generally contains higher abundances of *Nothofagidites* pollen.

In Kipper–1 the Upper *F. longus* Zone can be confidently identified as extending from the base of core–5 at 1840.6m to the sidewall core at 1733.5m, based on the combination of the common occurrence of *Gambierina* pollen, and the FAD of *T. maastrichtiensis* at the base, and LAD of *Q. brossus* at the top (Table 5). In the underlying interval from 1850 to 1895m only the cuttings samples yield useful assemblages, and as these lack *Forcipites sabulosus* (whose LAD defines the top of the underlying *T. lilliei* Zone) they are preferentially assigned to the Lower *F. longus* Zone.

***Nothofagidites senectus* spore–pollen Zone.**
Interval: 1998 to 2155 metres
Age: Early to Mid? Campanian.

The *N. senectus* Zone has traditionally been defined as the interval from the FAD of *Nothofagidites senectus* to the FAD of *Tricolporites lilliei*. However, at the base of their ranges both index species can be rare and therefore the FADs of *Forcipites sabulosus* and *Battenipollis sectilis* are used as alternate indicator species for both zones (Partridge, 1999).

In the Kipper–1 the *N. senectus* Zone is interpreted to extends from the base of the main volcanic unit to just above the top of the *C. porosa* Zone marine incursion. The eponymous species *Nothofagidites senectus* is reported as rare from the sidewall cores at 2143m and 2155m, in the palynological slides prepared at the EPRCo laboratory, and is consistently recorded in the cuttings samples down to 2155–60m. *Forcipites sabulosus* is considerably rarer than *Nothofagidites* in the lower part of the zone in Kipper–1, and unfortunately does not have a clear FAD. The reported occurrences of *F. sabulosus* in the sidewall cores at 2187.5m (in original report by Marshall & Partridge, 1986) and 2155m (in EPRCo prepared slides by Davies & Ioannides, 1999) were not confirmed during this study and are therefore recorded as questionable (Table 5). The rarity of both index species towards the base of their ranges contributes to the uncertainty as to whether the base of the *N. senectus* Zone lies within, or correlates to the base of the *Nelsoniella aceras* microplankton Zone in the Otway Basin (Helby *et al.*, 1987; Partridge, 1997). The shallowest good sample assigned to the *N. senectus* Zone in Kipper–1 is the sidewall core at 1998m which contains both *N. senectus* and *F. sabulosus* but lacks both *Tricolporites lilliei* and *Battenipollis sectilis*.

The zone can also be subdivided into a Lower *N. senectus* Zone (= *F. sabulosus* Subzone) characterised by *Forcipites sabulosus* generally being more abundant than *Nothofagidites* and an Upper *N. senectus* Zone (= *G. rudata* Subzone) characterised by *Nothofagidites* being more abundant than *F. sabulosus* and with a base defined by the FAD of *Gambierina rudata*. In Kipper–1 the Upper *N. senectus* Zone is only confidently identified from the first productive sidewall core below the volcanics at 1998m, which contains common *Nothofagidites* (7%) and the FAD of *Gambierina rudata* (reported in original report by Marshall & Partridge, 1986), but may extend down to the deeper cuttings a 2005-10m if the presence of *G. rudata* reported by Davies & Ioannides (1999) is accepted as in situ. The presence of frequent *Densoisporites velatus* (3%) in the sidewall core at 1998m makes this a distinctive assemblage which is best correlated with similar abundances of *Densoisporites velatus* in sidewall cores at 2235.6m and 2242.1m in Kipper–2. Interestingly the latter samples lie above the lower volcanic unit in Kipper–2, suggesting that the lower volcanic unit in that well pinches out between the two Kipper wells.

The Lower *N. senectus* Zone is represented by about 160 metres of section from ~2005 to 2160m in Kipper–1. This interval is also the principal gas reservoir section where a more detail palynological correlation is most needed. Sadly, most of the sidewall cores over this interval were lithologically unfavourable for palynology, with only one of the seven sidewall cores processed yielding assemblages that could be counted (Table 2). Although the cuttings samples in general give better assemblages, and eleven cuttings have been counted, the recorded assemblages display a rather constant character without any changes in abundance that can currently be identified as biostratigraphically significant. The problem with having to rely so heavily on the cuttings samples is exacerbated by the fact that there are no species extinction events that are known to occur in the Lower *N. senectus* Zone.

Tricolporites apoxyexinus **spore–pollen Zone.**
Interval: 2170 to 2245.5 metres
Age: Late Santonian.

The *T. apoxyexinus* Zone is ideally defined as the interval between the FADs of *Tricolporites apoxyexinus*, or the principal accessory species *Ornamentifera sentosa* to the FAD of *Nothofagidites senectus* based originally on our knowledge of Otway Basin sections (Helby *et al.*, 1987). However, the latest studies of the Otway Basin palynological sequence (Partridge, 1997, 1999), indicate that the pollen *T. apoxyexinus* has never been correctly identified in the Gippsland Basin, while *O. sentosa* has a significantly later FAD in the Gippsland Basin (probably within the *T. lilliei* Zone). As a consequence of these problems identification of the base of the *T. apoxyexinus* Zone in the Gippsland Basin relies on a number of secondary indicator species. The most important being the FADs of *Latrobosporites amplus*, *L. ohaiensis*, *Peninsulapollis gillii* and *Forcipites stipulatus*. While all these species have FADs within the *T. apoxyexinus* Zone identified in the Kipper–1 between cuttings at 2170–75m and sidewall core at 2245.5m, the most characteristic feature of assemblages is the frequent to common occurrence of *Proteacidites* pollen. This form-genus is used in its most broadest sense for a diverse range of small triporate pollen that represent from 2% to 10% of the spore-pollen counts in Kipper–1. In the Otway Basin the equivalent increase in the abundance of *Proteacidites* pollen occurs within the *T. apoxyexinus* Zone leading to an informal Lower/Upper subdivision of the zone.

Phyllocladidites mawsonii **spore–pollen Zone.**
Interval: 2295 to 2862 metres.
Age: Middle? Turonian.

The *P. mawsonii* Zone is identified in Kipper–1 from the Kipper Shale originally defined by Lowry & Longley (1991) as the interval from 2279 to 2875m (T.D.). The assemblages are confidently assigned to the zone based on the presence of the eponymous species *Phyllocladidites mawsonii* in 17 of 30 sidewall cores (57%) examined through the formation, and the absence of older Cenomanian index species such as *Hoegisporis uniforma*. Other diagnostic species recorded from the zone are *Appendicisporites distocarinatus* (in 10 SWCs), *Cyathidites tectifera* (in 18 SWCs), and the manuscript species *Laevigatosporites musa* (in 12 SWCs) and *Verrucosisporites admirabilis* (in 18 SWCs). A position in the middle of the *P. mawsonii* Zone is indicated by the absence of *Gleicheniidites ancorus* ms and extreme rarity of *Hoegisporis trinalis* ms. Correlation to the *L. musa* Subzone in the Otway Basin is suggested by the relative prominence of *Laevigatosporites musa* and the record of two isolated (and rather poor) specimens of *Tricolporites variverrucatus* ms at 2617m and 2862m in Kipper–1

The recorded assemblages from individual samples are typically of only moderate diversity. This partly reflects the low concentrations of palynomorphs in the palynological residues, but is also interpreted to reflect the depositional environment of the Kipper Shale, which is interpreted to be the distal lacustrine facies of a large palaeolake. Supporting this environmental interpretation is the high abundance of *Dilwynites* pollen (average 19%, maximum 65% in 21 sidewall cores) in the assemblages, which is interpreted to be the manifestation of a strong Neves effect (Partridge, 1996). These effects have been empirically observed to be associated with the most distal marine and lacustrine environments (Traverse, 1988; Partridge, 1999).

MICROPLANKTON ZONES

***Apectodinium hyperacanthum* microplankton Zone.**
Sample at: 1493 metres
Age: Early Eocene.
The *A. hyperacanthum* Zone, which is an important marker horizon across the eastern part of the offshore Gippsland Basin, is defined by the total range of the eponymous species and is identified in Kipper–1 by the occurrence of this species. Unfortunately a distinction between the species *Apectodinium hyperacanthum* and *A. homomorphum* (which both occur in the sample) was not made during the assemblage count. Accessory species include *Paralecaniella indentata* and *Glaphrocysta retiintexta*.

***Apectodinium reburrus* microplankton Acme Zone.**
Sample at: 1562.5 metres
Age: Late Paleocene.
The *A. reburrus* Acme Zone is a new name for the *Apectodinium homomorphum* Zone originally proposed by Partridge (1975, 1976). The name change is necessary as recent systematic studies have shown that the *Apectodinium* species found in the Late Paleocene is characterised by shorter spinose ornament than the type species *Apectodinium homomorphum*, and also has a distinct stratigraphic range (Partridge, 1999). In Kipper–1 the zone is only identified at 1562.5m based on rare specimens of the eponymous species recorded by Marshall & Partridge (1986).

Across the eastern half of the offshore Gippsland Basin the zone is best developed landward of the maximum seaward extent of Paleocene coals, where it is typically represented by samples containing monospecific assemblages of the eponymous species. As the zone occurs both intermittently in the coal measures section (as happens in Kipper–1 and 2), and landward of the maximum seaward limit of coal deposition, it conforms to the original precise definition of paralic environments (see Bates & Jackson, 1987). Individual samples are interpreted to represent a range of depositional settings on the lower coastal plain including coastal lagoons, coastal estuaries and nearshore interdistributary bay environments.

***Trithyrodinium evittii* microplankton Acme Zone.**
Sample at: 1727m metres
Age: Early Paleocene.

The sidewall core sample at 1727m from the upper part of the Kate Shale in Kipper–1 contains a low diversity Early Paleocene microplankton assemblage which is assigned to the *T. evittii* Acme based on the identification of the eponymous species in the original report by Marshall & Partridge (1986).

***Manumiella druggii* microplankton Subzone.**
Sample at: 1733.5 metres
Age: Late Maastrichtian.

The *M. druggii* Zone is interpreted to occur in Kipper–1 based on the presence of fragmented specimens of *Manumiella* extracted from the sidewall core at 1733.5m from the base of the Kate Shale. In the original report these fragmented specimens were reported as *Manumiella druggii*, but re-examination of the palynological slides suggests that most of the specimens are too poorly preserved to confidently assign them to any of the *Manumiella* species, and therefore only the genus is recorded on Table 5.

More detailed study of both microplankton zones recorded from the Kate Shale in Kipper–1 is desirable, but unfortunately the residues extracted from the two sidewall cores are meagre. Although cuttings could be analysed these are unlikely to provide any greater precision as the Kate Shale is only 13 metres thick (1722 to 1735m) and is likely to be represented by no more than one or two cuttings samples. Even if these were processed any microplankton assemblages obtained would undoubtedly be mixed.

***Chatangiella porosa* microplankton Zone.**
Interval: 2187.5 to 2192 metres, possibly extending to 2245.5m.
Age: Late Santonian.

The *C. porosa* Zone is defined by the total range of the eponymous species (Partridge, 1999), based on the microplankton assemblages described from Kipper–1, Tuna–4 and outcrop samples dredged from the side of the modern Bass Canyon (Marshall, 1988). The zone was also recorded from Kipper–2 by Hannah (1987), at about the same time, but this data was confidential at the time of the original description of the assemblage. This new study of Kipper–1 restricts the zone to just the two sidewall cores at 2187.5m and 2192m. Microplankton recorded from deeper cuttings are interpreted to be caved, while those species recorded from the sidewall core at 2245.5m are interpreted to be derived from mud or cuttings contamination of the sidewall core (Table 5). The assemblages are of low diversity (4 to 6 species) dominated by *Chatangiella porosa* and a probable new species of *Exochosphaeridium*. The zone is interpreted to thicken to over 70 metres in the adjacent Kipper–2 well where it is represented in sidewall cores between 2491 to 2564m (Partridge & Macphail, 2000).

***Rimosicysta* microplankton Superzone.**
Interval: 2295 to 2862 metres.
Age: Turonian.

The *Rimosicysta* Superzone is the name applied to the suite of unusual algal cysts described from the Kipper Shale by Marshall (1989). In this study the superzone is identified in cuttings and sidewall cores between 2295m and 2862m. Although assemblages have mostly of low and only rarely of moderately diversity, adequate documentation of the full diversity of the assemblages is hampered by the poor preservation of the mainly thin-walled dinoflagellate and algal cysts. In Kipper–1 the principal components of the assemblages are *Rimosicysta* spp. (almost exclusively the species *R. kipperii*), the colonial algae *Amosopollis cruciformis* (originally described as a primitive angiosperm pollen by Cookson & Balme, 1962), and small diaphanous dinoflagellate cysts which are all lumped into the genus *Luxadinium*. The latter category undoubtedly includes a number of other non-marine dinoflagellate cyst genera including *Morkallacysta* and *Saeptodinium*, but adequate documentation of this difficult group of cysts is beyond the scope of this project. Of the other distinctive components of the *Rimosicysta* Superzone, only *Wuroia corrugata* was represented by rare specimens recorded from the sidewall core at 2519.5m.

The consistent presence of the *Rimosicysta* Superzone flora throughout the Kipper Shale, associated with a strong Neves effects in the spore-pollen assemblages, is the principal palaeoecological evidence for interpreting the Kipper Shale as lacustrine sediments deposited in a large palaeolake (Partridge, 1996).

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Table 1. Interpretative Palynological Data for Kipper–1

Spl. No.	Sample Type	Depth (m)	Spore-Pollen Zone and (Subzone)	Microplankton Zone	Comments
1	SWC 104	1493.0	*M. diversus* (*S. prominatus* Subzone)	*A. hyperacanthum*	*Myrtaceidites* 21%
2	SWC 103	1506.0	Upper *L. balmei* (*M. gigantis* Subzone)		FAD of *Matonisporites gigantis*
3	SWC 100	1562.5	Upper *L. balmei* (*P. annularis* Subzone)	*A. reburrus*	FAD of *Proteacidites annularis*
4	SWC 99	1579.6	Indeterminate		Low yield / not counted
5	SWC 98	1603.0	*L. balmei*		*Nothofagidites* 30%
6	SWC 96	1646.0	Lower *L. balmei* (*P. angulatus* Subzone)		LAD of *Proteacidites angulatus*
7	SWC 92	1727.0	Lower *L. balmei* (*T. verrucosus* Subzone)	*T. evittii ?*	Moderately diverse microplankton
8	SWC 91	1733.5	Upper *F. longus*	*M. druggii*	LAD of *Quadraplanus brossus*
9	SWC 90	1743.0	Indeterminate		Barren on quick scan
10	SWC 89	1760.0	Upper *F. longus*		*Gambierina* 6%
11	Cuttings	1765–70	*F. longus*		Quick scan only / not counted
12	SWC 87	1797.0	Indeterminate		Essentially barren
13	SWC 86	1805.0	Upper *F. longus*		*Gambierina* 8%
14	Cuttings	1825–30	*F. longus*		Quick scan only / not counted
15	Core–5	1832.5	Upper *F. longus*		FAD of *Tripunctisporis maastrichtiensis*
16	Core–5	1835.0	Upper *F. longus*		*Gambierina* 2.9%
17	Core–5	1838.0	Upper *F. longus*		*Gambierina* 1.4%
18	Core–5	1839.1	Upper *F. longus*		Quick scan only / not counted
19	Core–5	1839.9	Upper *F. longus*		Quick scan only / not counted
20	Core–5	1840.6	Upper *F. longus*		*Gambierina* 2.5%
21	Cuttings	1850–55	*F. longus*		Only given quick scan
22	SWC 84	1872.0	Indeterminate		Essentially barren
23	Cuttings	1875–80	Lower *F. longus*		Minor caving in assemblage
24	Cuttings	1885–90	*F. longus*		Only given quick scan
25	Cuttings	1895–1900	Lower *F. longus*		Minor caving in assemblage
26	SWC 60	1990.0	Indeterminate		Barren
27	Cuttings	1995–2000	*N. senectus*		Only given quick scan
28	SWC 58	1998.0	Upper *N. senectus*		*Nothofagidites* 6.5%, *Densoisporites velatus* 3.3%
29	Cuttings	2000–2005	Lower *N. senectus*		*Nothofagidites* 2.6%
30	Cuttings	2005–2010	Lower *N. senectus*		*Nothofagidites* 3.1%
31	SWC 57	2008.0	*N. senectus*		Low yield / not counted
32	Cuttings	2015–20	Upper *N. senectus* ?		*Nothofagidites* 6.2% (caved?)
33	SWC 56	2025.0	Indeterminate		Barren
34	Cuttings	2040–45	Lower *N. senectus*		*Nothofagidites* 3.3%
35	Cuttings	2045–50	Indeterminate		Skewed to coarse fraction
36	Cuttings	2050–55	Lower *N. senectus*		*Nothofagidites* 2%
37	SWC 54	2052.0	Indeterminate		Essentially barren
38	Cuttings	2055-60	*N. senectus*		EPR sample / not examined
39	Cuttings	2075–80	Lower *N. senectus*		*Nothofagidites* 2.2%
40	Cuttings	2085–90	*N. senectus*		Quick scan/ not counted
41	SWC 53	2088.0	Indeterminate		Low yield / not countable
42	SWC 79	2095.0	Indeterminate		Barren / no slides prepared
43A	Cuttings	2105–10 A	Lower *N. senectus*		Angiosperm pollen 21%
43B	Cuttings	2105–10 B	Lower *N. senectus*		Angiosperm pollen <4%
44	Cuttings	2135–40	Lower *N. senectus*		Fungal spores & hyphae 24%
45	Cuttings	2140–45	Lower *N. senectus*		*Proteacidites* 3.6%
46	SWC 49	2143.0	Indeterminate		Essentially barren / not countable
47	Cuttings	2145-50	Lower *N. senectus*		*Proteacidites* 3.4%
48	SWC 47	2155.0	Lower *N. senectus*		*Proteacidites* 4.3%
49	Cuttings	2155–60	Lower *N. senectus*		*Proteacidites* 1.9%
50	Cuttings	2170–75	*T. apoxyexinus*		*Proteacidites* 2.7%
51	Cuttings	2180-85	*T. apoxyexinus*		*Proteacidites* 3.8%
52	SWC 43	2187.5	*T. apoxyexinus*	*C. porosa*	*Proteacidites* 1.2%
53A	SWC 42	2192 P	*T. apoxyexinus*	*C. porosa*	*Proteacidites* 17.7%
53B	SWC 42	2192 S	*T. apoxyexinus*	*C. porosa*	*Proteacidites* 5.5%
53C	SWC 42	2192 X	*T. apoxyexinus*	*C. porosa*	*Proteacidites* <1%
54	Cuttings	2195-200	Indeterminate		Poor sample / unreliable

Table 1. Interpretative Palynological Data for Kipper–1

Spl. No.	Sample Type	Depth (m)	Spore-Pollen Zone and (Subzone)	Microplankton Zone	Comments
55	SWC 41	2196.5	*T. apoxyexinus*		*Proteacidites* <1%
56	SWC 40	2209.5	Indeterminate		Essentially barren / not countable
57	Cuttings	2215–20	*T. apoxyexinus*		*Proteacidites* 1.2%
58	SWC 37	2234.0	*T. apoxyexinus*		*Proteacidites* 4.7%
59	Cuttings	2235-40	Indeterminate		Poor sample / unreliable
60	SWC 36	2245.5	*T. apoxyexinus*	*C. porosa* (caved ?)	*Proteacidites* 3.1%
61	Cuttings	2265-70	Indeterminate		EPR sample / not examined
62	Cuttings	2295–300	*P. mawsonii*	*Rimosicysta* Superzone	LAD of *Rimosicysta kipperii*
63	SWC 32	2296.5	*P. mawsonii*		LAD of *R. kipperii* in SWC
64	SWC 78	2307.0	Indeterminate		Low yield / not counted
65	SWC 31	2320.0	*P. mawsonii*	*Rimosicysta* Superzone	Possible *Hoegisporis trinalis* ms
66	SWC 30	2342.5	*P. mawsonii*		Abundant *Cyathidites* 34%
67	SWC 77	2357.0	Indeterminate		Low yield / not counted
68	SWC 76	2381.0	Indeterminate		Low yield / not counted
69	SWC 27	2396.0	*P. mawsonii*		Common *Dilwynites* 22%
70	SWC 75	2408.0	*P. mawsonii*		*Podocarpidites* 36%
71	SWC 74	2420.0	*P. mawsonii*	*Rimosicysta* Superzone	*Coptospora pileolus* ms present.
72	SWC 25	2442.0	Indeterminate		Low yield / not counted
73	SWC 24	2451.0	*P. mawsonii*		Low yield / not counted
74	SWC 73	2460.0	*P. mawsonii*		*Podocarpidites* 40%
75	SWC 72	2483.0	*P. mawsonii*		Low yield / not counted
76	SWC 71	2493.0	*P. mawsonii*	*Rimosicysta* Superzone	Abundant *Dilwynites* 43%
77	SWC 21	2500.0	*P. mawsonii*		Low yield / not counted
78	SWC 70	2519.5	*P. mawsonii*	*Rimosicysta* Superzone	FAD of *Wuroia corrugata*
79	SWC 19	2538.0	Indeterminate		Low yield / not counted
80	SWC 18	2559.0	*P. mawsonii*		*Amosopollis cruciformis* >9%
81	SWC 69	2581.5	*P. mawsonii*		Rare *Cicatricosisporites cuneformis*
82	SWC 16	2601.0	Indeterminate		Low yield / not counted
83	Cuttings	2605–10	Indeterminate		Low concentration / not counted
84	SWC 15	2617.0	*P. mawsonii*		Rare ?*Tricolporites variverrucatus*
85	SWC 68	2635.5	*P. mawsonii*		Low yield / not counted
86	SWC 67	2640.0	Indeterminate		Sample contaminated
87	SWC 12	2661.0	*P. mawsonii*		*Podocarpidites* 34%
88	Cuttings	2685–90	*P. mawsonii*	*Rimosicysta* Superzone	*Luxadinium* fragments >30%
89	SWC 66	2686.0	*P. mawsonii*		Low yield / not counted
90	SWC 10	2697.0	*P. mawsonii*	*Rimosicysta* Superzone	*Luxadinium* fragments >15%
91	SWC 9	2709.0	*P. mawsonii*	*Rimosicysta* Superzone	*Amosopollis cruciformis* >6%
92	SWC 65	2730.0	*P. mawsonii*		Low yield / not counted
93	Cuttings	2730-35	Indeterminate		Low yield / not counted
94	Cuttings	2735-40	*P. mawsonii*		Low yield / not counted
95	SWC 7	2756.5	*P. mawsonii*	*Rimosicysta* Superzone	*Podocarpidites* 40%
96	SWC 6	2773.0	*P. mawsonii*	*Rimosicysta* Superzone	FAD of *Australopollis obscurus*
97	SWC 64	2794.0	*P. mawsonii*	*Rimosicysta* Superzone	Poor *Hoegisporis trinalis* present in assemblage with max. *Dilwynites* 69%.
98	SWC 63	2805.0	*P. mawsonii*	*Rimosicysta* Superzone	FAD of *Rimosicysta kipperii*
99	SWC 62	2824	Indeterminate		Low yield / not counted
100	SWC 3	2839	*P. mawsonii*		FAD of poor *Rimosicysta* spp.
101	SWC 1	2862	*P. mawsonii*		FAD of *Phyllocladidites mawsonii* with probable *Tricolporites variverrucatus* ms
	T.D.	2875m			

Table 2: Basic Sample and Palynomorph Data for Kipper–1

Spl. No.	Sample Type	Depth (metres)	Lithology of SWCs after Marshall & Partridge 1986	Duplicate EAL Slides		New Exxon (EPR) Slides		SlideSet Counted	Total Count	Oper-ator	Yield	Palynomorph Concentration	Preservation
				Kero.	Oxid.	Kero.	Oxid.						
1	SWC 104	1493.0	Glauconitic sandstone	1	2			EAL	305	MKM	Low	High	Fair
2	SWC 103	1506.0	Siltstone	1				EAL	232	ADP	Low	Moderate	Fair
3	SWC 100	1562.5	Siltstone	1	2			EAL	322	MKM	Moderate	High	Good
4	SWC 99	1576.6	Sandstone	1							Very low	Very low	Poor
5	SWC 98	1603.0	Coaly shale	1				EAL	353	MKM	Low	High	Good
6	SWC 96	1646.0	Shale	1	2			EAL	358	MKM	High	High	Good
7	SWC 92	1727.0	Sandy siltstone	1	2			EAL	270	MKM	Low	Moderate	Good
8	SWC 91	1733.5	Sandy siltstone	1							Low	Very low	Poor
9	SWC 90	1743.0	Pyritic sandstone								Barren		
10	SWC 89	1760.0	Siltstone	1	2			EAL	316	MKM	Moderate	Moderate	Moderate
11	Cuttings	1765–70		1	3						High	Moderate	Good
12	SWC 87	1797.0	Sandstone	1							Very low	Very low	Poor
13	SWC 86	1805.0	Silty sandstone	1	2			EAL	317	MKM	Low	Low	Poor
14	Cuttings	1825–30		1	3						Moderate	Moderate	Fair
15	Core–5	1832.5		1	2			EAL	343	MKM	Moderate	Moderate	Good
16	Core–5	1835.0		1	2			EAL	318	MKM	Moderate	High	Good
17	Core–5	1838.0		1	2			EAL	279	MKM	Moderate	High	Fair
18	Core–5	1839.1		1	2						Moderate	Moderate	Fair
19	Core–5	1839.9		1	2						Moderate	Moderate	Fair
20	Core–5	1840.6		1	2			EAL	293	MKM	Moderate	Moderate	Poor-good
21	Cuttings	1850–55		1	3						Moderate	Moderate	Good
22	SWC 84	1872.0	White sandstone								Low	Very Low	Poor-fair
23	Cuttings	1875–80		1	3			EAL	261	MKM	Moderate	High	Fair
24	Cuttings	1885–90		1	3						Low	Moderate	Fair
25	Cuttings	1895–1900		1	3			EAL	291	MKM	Moderate	Moderate	Fair-good
26	SWC 60	1990.0	Sandstone								Barren		
27	Cuttings	1995–2000		1	2						Moderate	Moderate	Fair
28	SWC 58	1998.0	Sandstone	1				EAL	123	ADP	Low	Low	Fair-good
29	Cuttings	2000–2005		1	2			EAL	275	MKM	Moderate	Moderate	Fair-good
30	Cuttings	2005–2010				1	3	EPR	335	MKM	Moderate	Low-High	Poor-fair
31	SWC 57	2008.0	Sandstone	1	1						Low	Low	Fair
32	Cuttings	2015–20		1	2			EAL	281	MKM	Moderate	Moderate	Fair
33	SWC 56	2025.0	Sandstone	1	2	1	3				Barren-Low	Low	Fair
34	Cuttings	2040–45		1	2			EAL	224	MKM	Low	Low	Fair
35	Cuttings	2045–50		1	1						Low	Low	Fair-good
36	Cuttings	2050–55		1	2			EAL	308	MKM	Moderate	Moderate	Fair
37	SWC 54	2052.0	Silty sandstone	1		1	3				Low	Low	Poor

Table 2: Basic Sample and Palynomorph Data for Kipper–1

Spl. No.	Sample Type	Depth (metres)	Lithology of SWCs after Marshall & Partridge 1986	Duplicate EAL Slides		New Exxon (EPR) Slides		SlideSet Counted	Total Count	Oper-ator	Yield	Palynomorph Concentration	Preservation
				Kero.	Oxid.	Kero.	Oxid.						
38	Cuttings	2055-60				1	3				Moderate	Low	Poor
39	Cuttings	2075–80		1	2			EAL	253	MKM	Moderate	Low	Poor
40	Cuttings	2085–90		1	1	1	3				Low	Low	Fair
41	SWC 53	2088.0	Siltstone	1		1	3				Low	Low	Fair
42	SWC 79	2095.0	Pyritic sandstone								Barren		
43A	Cuttings	2105-10 A				1	3	EPR	288	MKM	Moderate	High	Fair
43B	Cuttings	2105-10 B		1	3			EAL	289	MKM	High	High	Fair-good
44	Cuttings	2135–40		1	3			EAL	285	MKM	High	High	Fair
45	Cuttings	2140–45		1	2			EAL	306	MKM	High	High	Fair
46	SWC 49	2143.0	Shale	1	1	1	3				Low	Low	Poor
47	Cuttings	2145-50				1	3	EPR	192	ADP	Low	Low	Poor
48	SWC 47	2155.0	Carbonaceous siltstone	1	1	1	3	EAL	312	MKM	Moderate	Moderate	Fair-good
49	Cuttings	2155–60		1	2			EAL	316	MKM	High	High	Fair
50	Cuttings	2170–75		1	2			EAL	274	MKM	High	High	Fair
51	Cuttings	2180–85		1	2			EAL	225	ADP	Moderate	Low	Poor-fair
52	SWC 43	2187.5	Carbonaceous siltstone	1	2	1	5	EAL	376	MKM	High	High	Poor-fair
53A	SWC 42	2192 P	Carbonaceous siltstone					EAL	144	ADP	Moderate	Moderate	Poor-fair
53B	SWC 42	2192 S	Carbonaceous siltstone	1	1			EAL	293	MKM	Moderate	Moderate	Poor-fair
53C	SWC 42	2192 X	Carbonaceous siltstone			1	4	EPR	305	MKM	Moderate	Moderate	Poor-fair
54	Cuttings	2195-200				1	3	EPR	35	ADP	Moderate	High	Very poor
55	SWC 41	2196.5	Carbonaceous siltstone			1	3	EPR	360	MKM	Moderate	High	Fair-good
56	SWC 40	2209.5	Shale	1		1	3				Barren-Low	Low	Poor
57	Cuttings	2215–20		1	2			EAL	273	MKM	High	High	Poor-fair
58	SWC 37	2234.0	Silty shale	1		1	3	EPR	308	MKM	Low	High	Poor-fair
59	Cuttings	2235-40				1	3				Moderate	Moderate	Poor-fair
60	SWC 36	2245.5	Sandstone	1	2	1	3	EAL	270	MKM	Moderate	Moderate	Fair-good
61	Cuttings	2265-70				1	2				Low	Low	Poor
62	Cuttings	2295-300				1	2				Moderate	Moderate	Poor
63	SWC 32	2296.5	Siltstone	1	1	1	4	Mixed	205	ADP	Moderate	Low	Poor
64	SWC 78	2307.0	Sandy siltstone	1	2						Moderate	Low	Fair
65	SWC 31	2320.0	Siltstone	1	1	1	3	EAL	214	ADP	Moderate	Low	Poor-fair
66	SWC 30	2342.5	Carbonaceous siltstone	1	1	2	6	EAL	239	ADP	Moderate	Moderate	Poor-fair
67	SWC 77	2357.0	Sandstone	1	2						Moderate	Low	Poor
68	SWC 76	2381.0	Carbonaceous sandstone	1	2						Moderate	Low	Fair
69	SWC 27	2396.0	Carbonaceous siltstone	1	1			EAL	172	ADP	Moderate	Low	Fair
70	SWC 75	2408.0	Carbonaceous siltstone	1	2			EAL	108	ADP	Moderate	Low	Fair

Table 2: Basic Sample and Palynomorph Data for Kipper–1

Spl. No.	Sample Type	Depth (metres)	Lithology of SWCs after Marshall & Partridge 1986	Duplicate EAL Slides		New Exxon (EPR) Slides		SlideSet Counted	Total Count	Oper-ator	Yield	Palynomorph Concentration	Preservation
				Kero.	Oxid.	Kero.	Oxid.						
71	SWC 74	2420.0	Carbonaceous shale	1	1			EAL	227	ADP	Moderate	Moderate	Poor
72	SWC 25	2442.0	Carbonaceous siltstone	1	1						Low	Low	Poor-fair
73	SWC 24	2451.0	Shale	1							Moderate	Low	Moderate
74	SWC 73	2460.0	Carbonaceous siltstone	1	1			EAL	139	ADP	Moderate	Low	Poor-fair
75	SWC 72	2483.0	Siltstone	1	1						Moderate	Low	Fair
76	SWC 71	2493.0	Siltstone	1	2			EAL	159	ADP	Moderate	Low	Poor-fair
77	SWC 21	2500.0	Shale	1							Low	Low	Fair
78	SWC 70	2519.0	Siltstone	1	2			EAL	223	ADP	Moderate	Moderate	Very poor
79	SWC 19	2538.0	Carbonaceous shale	1	2						Low	Low	Poor-fair
80	SWC 18	2559.0	Carbonaceous shale	1	2			EAL	240	ADP	Moderate	Moderate	Poor-fair
81	SWC 69	2581.5	Siltstone	1	1			EAL	107	ADP	Low	Low	Poor
82	SWC 16	2601.0	Carbonaceous siltstone	1	1						Low	Low	Poor-fair
83	Cuttings	2605–10		1	2						Moderate	Moderate	Poor-fair
84	SWC 15	2617.0	Carbonaceous siltstone	1	2			EAL	108	ADP	Moderate	Low	Very Poor
85	SWC 68	2635.5	White sandstone	1	2						Low	Low	Poor-fair
86	SWC 67	2640.0		1	2						High	Moderate	Poor-fair
87	SWC 12	2661.0	Calcareous siltstone	1	1			EAL	129	ADP	Moderate	Low	Poor
88	Cuttings	2685–90		1	1			EAL	194	ADP	Moderate	Moderate	Poor-fair
89	SWC 66	2686.0	Carbonaceous shale	1		1	3				Moderate	Low	Fair
90	SWC 10	2697.0	Shale	1	1			EAL	133	ADP	Moderate	Low	Fair
91	SWC 9	2709.0	Carbonaceous shale	1	2			EAL	231	ADP	Moderate	Moderate	Poor
92	SWC 65	2730.0	Carbonaceous shale	1	2						Low	Low	Fair
93	Cuttings	2730-35		1	1						Moderate	Moderate	Poor-fair
94	Cuttings	2735-40		1	1						Low	Moderate	Poor-fair
95	SWC 7	2756.5	Calcilutite ?	1	2			EAL	113	ADP	Moderate	Low	Poor-fair
96	SWC 6	2773.0	Siltstone	1	2			EAL	113	ADP	Moderate	Very Low	Poor
97	SWC 64	2794.0	Carbonaceous shale	1	1	1	3	EAL	268	ADP	High	High	Very poor
98	SWC 63	2805.0	Carbonaceous shale	1		1	3	EPR	203	ADP	Moderate	Low-High	Very poor
99	SWC 62	2824	Siltstone	1	2						Moderate	Low	Poor-fair
100	SWC 3	2839	Sandy siltstone	1	1			EAL	111	ADP	Moderate	Low	Poor-fair
101	SWC 1	2862	Sandy siltstone	1	2			EAL	218	ADP	Moderate	Low	Poor-fair
			Total Number of Slides:	89	135	27	83			**ADP**	= A.D. Partridge		
										MKM	= M.K. Macphail		

Table 3. Palaeoenvironment interpretation of individual samples.

Spl. No.	Sample Type	Depth (m)	Total MP%	Environment from palynology	Comment on Interpretation
1	SWC 104	1493.0	11%	Nearshore marine	Contains diverse microplankton assemblage of 7+ species and Neves effect with *Araucariacites/Dilwynites* >23%
2	SWC 103	1506.0	NR	Non-marine	Skewed assemblage with spores 67% — fern heath
3	SWC 100	1562.5	N/C	Paralic/Lagoonal	Lagoon/estuary surrounded by conifer/*Nothofagus*
5	SWC 98	1603.0	NR	Non-marine	Rainforest/swamp with gynmnosperms 55%, *Nothofagus*
6	SWC 96	1646.0	0.6%	Non-marine	Swampy meadow with *Australopollis obscurus* 12%
7	SWC 92	1727.0	8.5%	Nearshore marine	Moderate diversity MP assemblage in Kate Shale transgression.
8	SWC 91	1733.5	N/C	Nearshore marine	Low diversity MP assemblage in Kate Shale transgression.
10	SWC 89	1760.0	1.4%	Non-marine	Rainforest with angiosperm 44%, spores 41% and fungal spores/hyphae 9%
13	SWC 86	1805.0	1%	Non-marine	Rainforest with gymnosperms 50%, angiosperm 35%, and fungal spores/hyphae 8%
15	Core–5	1832.5	1.2%	Lacustrine?	Ephemeral lake surrounded by conifer rainforest?
16	Core–5	1835.0	0.9%	Non-marine	Conifer forest with fern understorey.
17	Core–5	1838.0	NR	Non-marine	Rainforest with *Lagarostrobus* 27%
20	Core–5	1840.6	1.0%	Lacustrine?	Rainforest/swamp with gymnosperms/conifers 47%
23	Cuttings	1875–80	2.6%	Non-marine	Rainforest/swamp with *Lagarostrobus* 40%
25	Cuttings	1895–1900	7.0%	Non-marine	Conifer forest with fern understorey.
28	SWC 58	1998.0	NR	Non-marine	Conifer/*Nothofagus* rainforest.
29	Cuttings	2000–2005	0.4%	Non-marine	Conifer/*Nothofagus* rainforest.
30	Cuttings	2005–2010	0.3%	Non-marine	Conifer/*Nothofagus* rainforest; fungal spores/hyphae 14%
32	Cuttings	2015–20	0.4%	Non-marine	Conifer/*Nothofagus* rainforest.
34	Cuttings	2040–45	0.5%	Non-marine	Araucarian rainforest; fungal spores/hyphae 11%
36	Cuttings	2050–55	0.3%	Non-marine	Conifer forest with fern understorey.
39	Cuttings	2075–80	1.3%	Non-marine	Araucarian rainforest; fungal spores/hyphae 8%
43	Cuttings	2105–10 A	~1%	Non-marine	Araucarian rainforest
44	Cuttings	2135–40	0.5%	Non-marine	Araucarian rainforest; fungal spores/hyphae 23%
45	Cuttings	2140–45	NR	Non-marine	*Podocarpus/Microcachys* shrubland to rainforest
47	Cuttings	2145-50	NR	Non-marine	*Podocarpus/Microcachys* shrubland to rainforest
48	SWC 47	2155.0	NR	Non-marine	*Podocarpus/Microcachys* shrubland to rainforest
49	Cuttings	2155–60	0.3%	Non-marine	Swampy meadow with *Australopollis obscurus* 8%; with surrounding *Podocarpus/Microcachys* shrubland/forest
50	Cuttings	2170–75	0.8%	Non-marine	Rainforest/swamp with gymnosperms 65%
51	Cuttings	2180-85	1.9%	Non-marine	Rainforest/swamp with gymnosperms 70%
52	SWC 43	2187.5	9.5%	Paralic	Low diversity MP assemblage; 2:1 marine/brackish index species. *Amospollis cruciformis* 3%
53	SWC 42	2192 P	~6%	Paralic	Low diversity MP assemblage dominated by brackish to fresh index species *Amospollis cruciformis*
55	SWC 41	2196.5	2.9%	Paralic	Lagoon/estuary surrounded by conifer forest.
57	Cuttings	2215–20	4.1%	Paralic?	Conifer forest with caved(?) microplankton.
58	SWC 37	2234.0	1.4%	Non-marine	Conifer forest/swamp with fern understorey with non-marine to brackish microplankton.
60	SWC 36	2245.5	2.3%	Non-marine	Conifer forest/swamp with mostly non-marine to brackish microplankton.
62	Cuttings	2295–300		Lacustrine	Highest occurrence of distinctive lacustrine algal microplankton suite characteristic of Kipper Shale.
63	SWC 32	2296.5	13%	Lacustrine	Mild Neves effect with *Dilwynites* pollen 16% and MP dominated by colonial algae *Amosopollis cruciformis* 4.5%
65	SWC 31	2320.0	5.7%	Lacustrine	Strong Neves effect with *Dilwynites* 24% and MP dominated by colonial algae *Amosopollis cruciformis* 4%
66	SWC 30	2342.5	4.7%	Lacustrine	Assemblage dominated by spore 62%; no Neves effect and MP assemblage monospecific with only *A. cruciformis* recorded. Possible shallower lacustrine environment?
69	SWC 27	2396.0	NR	Lacustrine	Strong Neves effect with *Dilwynites* 22%; but MP not recorded.

Table 3. Palaeoenvironment interpretation of individual samples.

Spl. No.	Sample Type	Depth (m)	Total MP%	Environment from palynology	Comment on Interpretation
70	SWC 75	2408.0	0.9%	Lacustrine	Mild Neves effect with *Dilwynites* 17%; with MP very rare.
71	SWC 74	2420.0	2.3%	Lacustrine	Strong Neves effect with *Dilwynites* 22% and MP dominated by *Rimosicysta* algal suite.
74	SWC 73	2460.0	1.5%	Lacustrine	Assemblage dominated by *Podocarpidites* 40%; no appreciable Neves effect and MP assemblage monospecific with only rare *A. cruciformis* recorded. Shallower lacustrine?
76	SWC 71	2493.0	17%	Lacustrine	Very strong Neves effect with *Dilwynites* 43%, and MP dominated by *Rimosicysta* 13%.
78	SWC 70	2519.5	24%	Lacustrine	Very strong Neves effect with *Dilwynites* 46% and diverse MP assemblage with both *Rimosicysta* and *Wuroia* present. Most distal deep-water environment?
80	SWC 18	2559.0	10%	Lacustrine	Assemblage dominated by spore 54%; little Neves effect with *Dilwynites* only 9%, and MP assemblage monospecific with only *A. cruciformis* recorded. Shallower lacustrine?
81	SWC 69	2581.5	2.8%	Lacustrine	Mild Neves effect with *Dilwynites* 12%; with MP rare.
84	SWC 15	2617.0	1%	Lacustrine	Shallower lacustrine similar to assemblage at 2460m
87	SWC 12	2661.0	3.1%	Lacustrine	Shallower lacustrine similar to above.
88	Cuttings	2685–90	45%	Lacustrine	Very strong Neves effect with *Dilwynites* 54%, and MP assemblage dominated by *Luxadinium* and *Rimosicysta*. Distal deep-water environment?
90	SWC 10	2697.0	20%	Lacustrine	Very strong Neves effect with *Dilwynites* 45%, and MP assemblage dominated by *Luxadinium*. Distal deep-water environment?
91	SWC 9	2709.0	8.7%	Lacustrine	Mild Neves effect with *Dilwynites* 19%; with MP dominated by *A. cruciformis* and *Rimosicysta*.
95	SWC 7	2756.5	1.8%	Lacustrine	Shallower lacustrine similar to assemblage at 2460m
96	SWC 6	2773.0	4.5%	Lacustrine	Mild Neves effect with *Dilwynites* 10%; with MP very rare.
97	SWC 64	2794.0	44%	Lacustrine	Very strong Neves effect with *Dilwynites* 69% and most diverse MP assemblage with *Rimosicysta* dominant. Most distal deep-water environment?
98	SWC 63	2805.0	16%	Lacustrine	Assemblage dominated by *Podocarpidites* 32%; little Neves effect with *Dilwynites* only 9%, and MP assemblage almost monospecific dominated by *Sigmopollis carbonis*. Shallow lacustrine?
100	SWC 3	2839	0.9%	Lacustrine	Shallower lacustrine similar to assemblage at 2460m
101	SWC 1	2862	2.8%	Lacustrine	Assemblage dominated by spore 68%; no Neves effect with *Dilwynites* only 5%, and MP assemblage with *A. cruciformis* and *S. carbonis*. Shallower lacustrine?
			N/C	= MP not recorded in count	
			NR	= MP not recorded in assemblage	

Table 4: Kipper–1	Percentage abundances for selected palynomorphs										
Sample Type:	SWC 104	SWC 103	SWC 100	SWC 93	SWC 96	SWC 92	SWC 89	SWC 86	Core 5	Core 5	Core 5
Depth (m):	1493	1506	1562.5	1603	1646	1727	1760	1805	1832.5	1835.0	1838.0
Operator:	MKM	ADP	MKM	MKM	MKM	MKM	MKM	MKM	MKM	MKM	MKM
Slide Set:	EAL	EAL	EAL	EAL	EAL	EAL	EAL	EAL	EAL	EAL	EAL
SPORES											
Aequitriradites spp.								0.3%			
Appendicisporites spp.											
Baculatisporites spp.	0.4%						1.1%	1.0%	1.5%	0.3%	3.2%
Camarozonosporites spp.									0.6%		
Cicatricosisporites/Ruffordispora spp.							0.4%				
Clavifera triplex		2.2%									
Coptospora spp.											
Cyatheacidites tectifera											
Cyathidites (large) >40µm	1.1%	5.6%				1.7%	1.4%	1.7%	0.6%	1.9%	0.7%
Cyathidites (small) <40µm	5.6%	10.8%	1.2%	1.1%	0.8%	2.5%	12.7%	3.8%	4.5%	5.7%	3.9%
Densoisporites velatus											
Dictyophyllidites spp.		0.4%							3.3%	1.9%	0.4%
Foraminisporis asymmetricus											
Foveogleicheniidites confossus										0.3%	
Foveosporites/Foveotriletes spp.							0.7%	0.3%	0.6%		
Gleicheniidites spp.	0.7%	28.1%	0.9%	0.3%	0.6%	1.7%	0.4%	1.0%	0.9%	0.6%	
Herkosporites/Ceratosporites spp.							0.7%	1.0%			
Hilate Spores undiff.										0.3%	
Ischyosporites/Klukisporites spp.							0.4%				
Laevigatosporites spp.	1.1%	12.1%	5.3%	2.0%	4.5%	1.7%	4.6%	1.0%	3.0%	7.3%	5.4%
Laevigatosporites musa†											
Latrobosporites spp.		0.4%					0.7%	1.0%	1.8%	2.2%	1.1%
Leptolepidites verrucatus	0.4%										
Marratisporites scabratus											
Matonisporites gigantis		4.3%									
Megaspores undiff.											
Monolete spores undiff.			0.6%				0.4%		3.3%	7.0%	1.4%
Osmundacidites wellmanii											
Peromonolites spp.											
Perotriletes spp.											
Polypodiisporites spp.				0.3%							
Retitriletes spp.							6.4%	0.3%	3.0%	1.6%	1.1%
Rugulatisporites spp.	1.1%										
Rugulatisporites mallatus											
Stereisporites antiquisporites		2.2%				0.8%	7.1%	2.1%	2.4%	0.6%	1.1%
Triletes undiff.	0.7%	0.4%				2.1%	3.2%	1.4%	2.7%	1.3%	0.7%
Triporoletes reticulatus											0.4%
Tripunctisporis maastrichtiensis							1.1%				
Verrucosisporites admirabilis†											
Verrucosisporites spp.											
Total Spores:	**11%**	**67%**	**8%**	**4%**	**6%**	**11%**	**41%**	**15%**	**28%**	**31%**	**19%**
GYMNOSPERMS undiff.		0.4%				10.5%	2.5%	8.0%	1.5%	1.3%	1.1%
Araucariacites australis	13.4%		5.9%	2.5%	10.4%	9.3%	1.4%	4.5%	25.7%	7.9%	5.4%
Corollina spp.											
Cupressacites sp.											
Cycadopites spp.			5.0%	0.8%	0.8%						
Dacrycarpites australiensis			0.6%	1.1%							
Dilwynites pusillus†											
Dilwynites spp.	10.4%		3.7%	1.4%	3.9%	1.3%	0.7%	0.3%		0.6%	
Ephedripites notensis											0.4%
Hoegisporis spp.											
Lygistepollenites balmei	0.4%	1.7%	2.2%	2.3%	2.2%	3.8%	0.4%		1.2%	0.6%	
Lygistepollenites florinii	0.7%	0.4%	4.0%	3.4%	0.8%	2.1%	0.7%	1.4%	0.6%	3.8%	2.2%
Microalatidites (P.) paleogenicus	0.4%		0.6%	0.6%					0.3%		
Microcachryidites antarcticus				0.6%	0.6%	0.8%	1.4%	2.4%	0.9%	0.3%	4.7%
Phyllocladidites eunuchus†											
Phyllocladidites mawsonii		0.4%	3.4%	9.6%	10.1%	9.3%	3.2%	16.6%	13.9%	14.6%	26.2%
Phyllocladidites reticulosaccatus/verrucosus			3.4%	4.0%	3.1%	6.3%	0.4%	1.0%	0.3%	1.3%	0.4%
Podocarpidites spp.	1.5%	2.6%	16.1%	25.5%	28.9%	12.7%	3.9%	15.2%	8.2%	17.5%	20.8%
Podosporites spp.											
Podosporites microsaccatus											
Trichotomosulcites subgranulatus	0.4%	0.4%	3.1%	3.1%	1.1%		0.7%	0.7%	0.6%	1.3%	6.5%
Vitreisporites signatus/pallidus										0.3%	
Total Gymnosperms:	**27%**	**6%**	**48%**	**55%**	**62%**	**56%**	**15%**	**50%**	**53%**	**50%**	**67%**
ANGIOSPERMS undiff.	1.1%		2.2%	1.4%	0.3%	4.6%	1.4%	1.7%	0.3%	0.3%	
Arecipites sp.	1.5%										
Asteropollis asteroides											
Australopollis obscurus				1.4%	11.5%	3.0%	0.7%	0.3%	0.9%		1.1%
Battenipollis sectilis								0.3%	0.3%		0.4%
Beaupreaidites orbiculatus										0.3%	
Cupanieidites orthoteichus	0.4%										
Dicotetradites clavatus		0.4%	0.3%		0.3%			1.0%			0.7%
Forcipites sabulosus											
Forcipites spp.								0.3%			
Gambierina rudata/edwardsii					0.3%	1.7%	6.0%	8.0%	4.8%	2.9%	1.4%
Haloragacidites harrisii (Casuarina)	6.3%	0.4%	0.9%	0.3%	0.8%						
Liliacidites spp.	0.7%		0.9%	0.3%			0.4%	1.0%		0.6%	0.4%
Malvacipollis subtilis/diversus	5.6%	1.3%	0.3%								
Myrtaceidites spp.	20.5%		0.3%								
Nothofagidites brachyspinulosus/flemingii			1.9%	0.3%				0.3%	0.3%		
Nothofagidites emarcidus		0.4%	0.9%								
Nothofagidites endurus		6.9%	20.2%	29.7%	1.4%	0.4%	0.4%	0.3%		1.0%	1.1%
Nothofagidites senectus											
Peninsulapollis gillii						1.3%	0.4%		0.6%		
Periporopollenites spp.		0.4%	5.9%	0.6%	2.2%	0.8%		0.3%			
Proteacidites spp.	6.0%	14.7%	3.4%	3.1%	5.1%	13.5%	31.1%	13.1%	5.4%	4.1%	4.3%
Proteacidites (P.) palisadus										0.3%	
Proteacidites reticuloconcavus†								0.3%		0.3%	0.4%

Table 4: Kipper–1	Percentage abundances for selected palynomorphs										
Sample Type:	SWC 104	SWC 103	SWC 100	SWC 93	SWC 96	SWC 92	SWC 89	SWC 86	Core 5	Core 5	Core 5
Depth (m):	1493	1506	1562.5	1603	1646	1727	1760	1805	1832.5	1835.0	1838.0
Operator:	MKM	ADP	MKM	MKM	MKM	MKM	MKM	MKM	MKM	MKM	MKM
Slide Set:	EAL	EAL	EAL	EAL	EAL	EAL	EAL	EAL	EAL	EAL	EAL
Pseudowinterapollis cranwelliae/wahooensis			0.3%							0.3%	
Quadraplanus brossus										0.3%	
Schizocolpus marlinensis	1.5%										
Spinizonocolpites prominatus	0.7%										
Tetracolporites verrucosus			0.3%								
Tetradites securus†								0.3%	1.2%	0.3%	0.4%
Tricolpites confessus											
Tricolpites waiparaensis										0.3%	0.4%
Tricolp(or)ites spp.	16.4%	1.7%	5.9%	4.2%	9.6%	8.0%	3.5%	6.9%	2.4%	5.7%	1.8%
Tricolporites lilliei									2.1%	2.5%	0.7%
Triporopollenites spp.	0.7%	0.9%			0.6%						0.4%
Total Angiosperms:	**62%**	**27%**	**44%**	**41%**	**32%**	**33%**	**44%**	**35%**	**18%**	**19%**	**13%**
Total Spore-Pollen	**268**	**231**	**322**	**353**	**356**	**237**	**283**	**289**	**331**	**315**	**279**
MICROPLANKTON % of MP COUNT											
Microplankton undiff.	36%				100%	32%	75%	33%		100%	
Apectodinium homomorphum	42%										
Amosopollis cruciformis	6%					9%			100%		
Chatangiella porosa											
Deflandrea spp.						41%					
Glaphrocysta retiintexta	3%										
Heterosphaeridium spp.											
Isabelidinium spp.											
Luxadinium spp.											
Manumiella spp.											
Oligosphaeridium spp.											
Paralecaniella indentata	3%										
Rimosicysta spp.								67%			
Saeptodinium spp. (non-marine dino.)											
Sigmopollis spp.											
Spinidinium/Vozzhennikovia spp.						9%					
Spiniferites spp.	9%					9%	25%				
Wuroia spp.											
Total Microplankton Count:	**33**				**2**	**22**	**4**	**3**	**4**	**3**	
Microplankton % of total SP & MP:	**11%**				**0.6%**	**8.5%**	**1.4%**	**1.0%**	**1.2%**	**0.9%**	
A. cruciformis as % of total SP & MP:	0.7%					0.8%			1.2%		
Total SP and MP COUNT:	**301**	**231**	**322**	**353**	**358**	**259**	**287**	**292**	**335**	**318**	**279**
Other Palynomorphs Count											
Botryococcus braunii											
Fungal fruiting bodies						1.1%	1.3%	0.6%			
Fungal spores/hyphae	1.3%	0.4%				2.6%	7.9%	7.3%	2.3%		
Total Fungii:	**1.3%**	**0.4%**				**3.7%**	**9.2%**	**7.9%**	**2.3%**		
Contaminants or caved — spore-pollen											
Contaminants or caved — microplankton											
Reworked Fossils						0.4%					
TOTAL COUNT:	**305**	**232**	**322**	**353**	**358**	**270**	**316**	**317**	**343**	**318**	**279**
† Manuscript species name.											

Table 4: Kipper–1

Percentage abundances for selected palynomorphs

Sample Type:	Core 5	Cts	Cts	SWC 58	Cts	Cts	Cts	Cts	Cts	Cts	Cts
Depth (m):	1840.6	1875–1880	1895–1900	1998.0	2000–2005	2005–2010	2015–2020	2040–2045	2050–2055	2075–2080	2105–2110 A
Operator:	MKM	MKM	MKM	ADP	MKM	MKM	MKM	MKM	MKM	MKM	MKM
Slide Set:	EAL	EAL	EAL	EAL	EAL	EPR	EAL	EAL	EAL	EAL	EPR
SPORES											
Aequitriradites spp.	1.4%										
Appendicisporites spp.											
Baculatisporites spp.	1.4%	0.4%	1.4%		0.4%	0.7%	1.1%	0.5%	1.0%		0.4%
Camarozonosporites spp.		1.2%	0.3%								
Cicatricosisporites/Ruffordispora spp.						0.3%					
Clavifera triplex		0.4%			1.1%				0.3%		
Coptospora spp.											
Cyatheacidites tectifera											
Cyathidites (large) >40µm	2.8%	0.8%	3.1%	2.4%	1.5%	0.3%	1.1%	2.5%	2.7%	1.7%	0.8%
Cyathidites (small) <40µm	7.3%	4.0%	7.0%	2.4%	6.0%	3.5%	2.6%	3.0%	4.7%	3.5%	3.1%
Densoisporites velatus				3.3%							
Dictyophyllidites spp.	3.1%	0.8%	3.5%		0.7%					0.4%	
Foraminisporis asymmetricus				1.6%							
Foveogleicheniidites confossus											
Foveosporites/Foveotriletes spp.							0.7%		0.3%		
Gleicheniidites spp.		2.0%	1.4%	4.1%	1.1%	2.4%	3.3%	1.0%	3.4%	0.9%	0.8%
Herkosporites/Ceratosporites spp.				3.3%							
Hilate Spores undiff.											
Ischyosporites/Klukisporites spp.											
Laevigatosporites spp.	6.3%	1.6%	19.2%	0.8%	4.9%	1.4%	2.6%	8.5%	4.7%	8.3%	3.8%
Laevigatosporites musa†											
Latrobosporites spp.	1.0%	0.8%	1.7%	0.8%							
Leptolepidites verrucatus											
Marratisporites scabratus											
Matonisporites gigantis											
Megaspores undiff.											
Monolete spores undiff.	1.7%	3.2%	1.7%		1.1%	3.8%	1.8%	3.5%	4.1%	4.8%	4.6%
Osmundacidites wellmanii											
Peromonolites spp.			0.7%								
Perotriletes spp.											
Polypodiisporites spp.											
Retitriletes spp.	0.7%	1.6%	1.7%		0.4%	0.3%	0.7%		0.3%		0.4%
Rugulatisporites spp.											
Rugulatisporites mallatus				0.8%							
Stereisporites antiquisporites	1.0%	0.4%	0.7%			0.3%	0.4%	0.5%	0.7%		
Triletes undiff.	2.4%	1.2%	2.8%	3.3%	3.0%		1.5%	4.0%	2.0%	3.5%	1.1%
Triporoletes reticulatus			0.7%								
Tripunctisporis maastrichtiensis											
Verrucosisporites admirabilis†											
Verrucosisporites spp.							0.4%		0.7%		
Total Spores:	**29%**	**19%**	**46%**	**23%**	**20%**	**13%**	**16%**	**24%**	**25%**	**23%**	**15%**
GYMNOSPERMS undiff.	2.8%	2.8%	1.4%		3.0%	2.1%	2.6%	3.5%	1.7%	1.7%	1.5%
Araucariacites australis	15.6%	4.0%	7.3%	2.4%	19.0%	14.2%	19.1%	42.2%	17.9%	30.6%	26.3%
Corollina spp.											
Cupressacites sp.					1.1%		0.4%	0.5%	2.0%	0.9%	1.1%
Cycadopites spp.						1.4%				0.4%	
Dacrycarpites australiensis		0.4%									
Dilwynites pusillus†				0.8%		1.0%	0.4%		0.7%		1.1%
Dilwynites spp.	0.3%	0.4%	0.7%	0.8%	1.1%	0.7%	1.1%	1.5%	1.7%	0.4%	1.9%
Ephedripites notensis											
Hoegisporis spp.											
Lygistepollenites balmei	0.7%		1.0%								
Lygistepollenites florinii		0.8%	3.5%	3.3%	0.7%						
Microalatidites (P.) paleogenicus											
Microcachryidites antarcticus	1.0%	6.0%	1.4%	5.7%		0.7%	1.1%	0.5%	0.7%		0.8%
Phyllocladidites eunuchus†					1.5%	1.0%	3.7%	4.0%	2.4%	3.9%	
Phyllocladidites mawsonii	13.2%	38.3%	16.1%	3.3%	1.9%	2.8%	1.1%	1.0%	4.1%	3.1%	0.4%
Phyllocladidites reticulosaccatus/verrucosus	1.4%	1.2%									
Podocarpidites spp.	11.1%	14.5%	14.7%	30.1%	29.1%	17.7%	27.2%	6.5%	20.6%	17.9%	8.8%
Podosporites spp.					1.5%		1.1%			0.4%	
Podosporites microsaccatus											
Trichotomosulcites subgranulatus	0.3%	5.2%	0.7%	4.1%	1.1%	15.3%	3.7%	3.0%	5.1%	3.9%	22.1%
Vitreisporites signatus/pallidus											
Total Gymnosperms:	**47%**	**74%**	**47%**	**50%**	**60%**	**57%**	**61%**	**63%**	**57%**	**63%**	**64%**
ANGIOSPERMS undiff.	1.4%			3.3%	1.9%	1.7%	1.8%	1.0%	0.7%	2.2%	1.9%
Arecipites sp.											
Asteropollis asteroides											
Australopollis obscurus		1.2%			0.4%	0.7%		0.5%			0.4%
Battenipollis sectilis	0.3%										
Beaupreaidites orbiculatus						0.3%					
Cupanieidites orthoteichus											
Dicotetradites clavatus	0.3%								0.3%	0.4%	
Forcipites sabulosus				1.6%			0.7%				
Forcipites spp.										0.4%	
Gambierina rudata/edwardsii	2.4%	0.4%	0.3%								0.4%
Haloragacidites harrisii (Casuarina)											
Liliacidites spp.		0.4%	0.3%			0.7%	0.4%	1.0%	0.7%		0.8%
Malvacipollis subtilis/diversus											
Myrtaceidites spp.											
Nothofagidites brachyspinulosus/flemingii											
Nothofagidites emarcidus											
Nothofagidites endurus	0.7%	0.4%	2.4%		2.6%	3.1%	5.5%	2.5%	1.0%	2.2%	
Nothofagidites senectus				6.5%			0.7%		1.0%		
Peninsulapollis gillii		0.4%		3.3%				0.5%	0.3%		
Periporopollenites spp.											
Proteacidites spp.	10.4%	2.4%	1.0%	4.9%	6.0%	8.0%	5.5%	2.0%	4.7%	4.4%	2.7%
Proteacidites (P.) palisadus	0.3%	0.4%	0.3%								
Proteacidites reticuloconcavus†											

Table 4: Kipper–1	Percentage abundances for selected palynomorphs										
Sample Type:	Core 5	Cts	Cts	SWC 58	Cts	Cts	Cts	Cts	Cts	Cts	Cts
Depth (m):	1840.6	1875–1880	1895–1900	1998.0	2000–2005	2005–2010	2015–2020	2040–2045	2050–2055	2075–2080	2105–2110 A
Operator:	MKM	MKM	MKM	ADP	MKM	MKM	MKM	MKM	MKM	MKM	MKM
Slide Set:	EAL	EAL	EAL	EAL	EAL	EPR	EAL	EAL	EAL	EAL	EPR
Pseudowinterapollis cranwelliae/wahooensis		0.8%									
Quadraplanus brossus	0.3%	0.4%									
Schizocolpus marlinensis											
Spinizonocolpites prominatus											
Tetracolporites verrucosus											
Tetradites securus†						0.3%		0.5%			0.4%
Tricolpites confessus											
Tricolpites waiparaensis										0.4%	
Tricolp(or)ites spp.	7.3%		1.0%	7.3%	8.6%	14.9%	7.7%	5.5%	9.5%	3.5%	14.5%
Tricolporites lilliei	0.7%	0.4%	1.4%								
Triporopollenites spp.		0.4%			0.4%						
Total Angiosperms:	**24%**	**8%**	**7%**	**27%**	**20%**	**30%**	**22%**	**14%**	**18%**	**14%**	**21%**
Total Spore-Pollen	**288**	**248**	**286**	**123**	**268**	**288**	**272**	**199**	**296**	**229**	**262**
MICROPLANKTON % of MP COUNT											
Microplankton undiff.	33%	29%	100%				100%	100%		67%	
Apectodinium homomorphum											
Amosopollis cruciformis	67%	43%			100%	100%			100%	33%	100%
Chatangiella porosa											
Deflandrea spp.											
Glaphrocysta retiintexta											
Heterosphaeridium spp.											
Isabelidinium spp.											
Luxadinium spp.											
Manumiella spp.		29%									
Oligosphaeridium spp.											
Paralecaniella indentata											
Rimosicysta spp.											
Saeptodinium spp. (non-marine dino.)											
Sigmopollis spp.											
Spinidinium/Vozzhennikovia spp.											
Spiniferites spp.											
Wuroia spp.											
Total Microplankton Count:	**3**	**7**	**2**		**1**	**1**	**1**	**1**	**1**	**3**	**1**
Microplankton % of total SP & MP:	**1.0%**	**2.7%**	**0.7%**		**0.4%**	**0.3%**	**0.4%**	**0.5%**	**0.3%**	**1.3%**	**0.4%**
A. cruciformis as % of total SP & MP:	0.7%	1.2%			0.4%	0.3%			0.3%	0.4%	0.4%
Total SP and MP COUNT:	**291**	**255**	**288**	**123**	**269**	**289**	**273**	**200**	**297**	**232**	**263**
Other Palynomorphs Count											
Botryococcus braunii											
Fungal fruiting bodies					0.4%	9.6%	0.4%	1.3%		1.2%	2.1%
Fungal spores/hyphae	0.7%	1.5%	0.3%		1.8%	4.2%	2.5%	9.4%	3.6%	7.1%	6.6%
Total Fungii:	**0.7%**	**1.5%**	**0.3%**		**2.2%**	**13.7%**	**2.8%**	**10.7%**	**3.6%**	**8.3%**	**8.7%**
Contaminants or caved — spore-pollen											
Contaminants or caved — microplankton		0.8%	0.7%								
Reworked Fossils											
TOTAL COUNT:	**293**	**261**	**291**	**123**	**275**	**335**	**281**	**224**	**308**	**253**	**288**
† Manuscript species name.											

Table 4: Kipper–1	Percentage abundances for selected palynomorphs										
Sample Type:	Cts	Cts	Cts	Cts	SWC 47	Cts	Cts	Cts	SWC 43	SWC 42	SWC 42
Depth (m):	2105–2110 B	2135–2140	2140–2145	2145-2150	2155.0	2155–2160	2170–2175	2180-2185	2187.5	2192 P	2192 S
Operator:	MKM	MKM	MKM	ADP	MKM	MKM	MKM	ADP	MKM	ADP	MKM
Slide Set:	EAL	EAL	EAL	EPR	EAL	EAL	EAL	EAL	EAL	EAL	EAL
SPORES											
Aequitriradites spp.		0.5%	0.3%		1.7%						0.7%
Appendicisporites spp.											
Baculatisporites spp.	0.7%		0.7%		1.7%	1.0%	1.6%	0.5%	1.5%	0.8%	1.8%
Camarozonosporites spp.											
Cicatricosisporites/Ruffordispora spp.					0.7%			0.5%		0.8%	
Clavifera triplex			0.3%					0.5%			
Coptospora spp.											
Cyatheacidites tectifera											
Cyathidites (large) >40µm		1.9%	0.7%	0.6%	3.6%	1.3%	1.6%	0.9%	0.9%	2.3%	2.9%
Cyathidites (small) <40µm	1.1%	3.2%	4.9%	4.6%	8.9%	4.9%	4.7%	4.7%	2.4%	8.5%	6.2%
Densoisporites velatus											
Dictyophyllidites spp.				2.3%			0.8%	1.9%	0.6%	3.8%	
Foraminisporis asymmetricus											
Foveogleicheniidites confossus											
Foveosporites/Foveotriletes spp.					0.7%						
Gleicheniidites spp.	1.1%		2.6%	5.2%	3.3%	5.5%	2.3%	5.7%	0.9%	3.8%	2.9%
Herkosporites/Ceratosporites spp.						0.3%		0.5%	0.6%	1.5%	0.7%
Hilate Spores undiff.			0.3%				0.4%		0.3%		0.4%
Ischyosporites/Klukisporites spp.						0.3%			0.3%		
Laevigatosporites spp.	3.6%	2.3%	6.3%	3.4%	2.0%	2.3%	10.1%	0.5%	2.4%	1.5%	2.6%
Laevigatosporites musa†											
Latrobosporites spp.		0.5%			2.6%						0.4%
Leptolepidites verrucatus					0.3%						0.4%
Marratisporites scabratus				0.6%							
Matonisporites gigantis											
Megaspores undiff.								0.5%			
Monolete spores undiff.	1.8%	3.2%	0.3%		0.7%	1.3%	3.5%		0.9%		0.7%
Osmundacidites wellmanii											
Peromonolites spp.								0.5%			
Perotriletes spp.								0.5%			
Polypodiisporites spp.											
Retitriletes spp.	0.7%	0.5%									0.7%
Rugulatisporites spp.											
Rugulatisporites mallatus											
Stereisporites antiquisporites		0.5%	1.0%	1.1%	0.7%	0.3%	0.4%	0.5%			
Triletes undiff.	0.7%	1.4%		0.6%	4.3%	1.3%	2.3%	0.5%	2.1%	8.5%	3.3%
Triporoletes reticulatus	0.7%										0.4%
Tripunctisporis maastrichtiensis											
Verrucosisporites admirabilis†											
Verrucosisporites spp.					0.7%		0.4%		0.3%		0.7%
Total Spores:	**11%**	**14%**	**17%**	**18%**	**32%**	**19%**	**28%**	**18%**	**13%**	**32%**	**25%**
GYMNOSPERMS undiff.	1.5%	4.2%	2.0%	0.6%	2.3%	1.3%	2.7%	0.5%	24.3%		8.1%
Araucariacites australis	29.5%	22.7%	6.9%		11.9%	6.5%	14.3%	5.2%	11.7%	2.3%	12.8%
Corollina spp.					0.3%					0.8%	
Cupressacites sp.	0.4%	0.5%		0.6%							
Cycadopites spp.											
Dacrycarpites australiensis											
Dilwynites pusillus†		0.5%			4.0%	1.0%	0.4%	1.9%	0.6%	3.1%	3.7%
Dilwynites spp.	1.8%	2.3%	1.3%	2.3%	3.6%	0.6%	2.3%	4.3%	5.1%	2.3%	2.6%
Ephedripites notensis											
Hoegisporis spp.											
Lygistepollenites balmei			0.3%								
Lygistepollenites florinii				0.6%	0.7%	0.6%		0.5%	0.9%		
Microalatidites (P.) paleogenicus				0.6%							
Microcachryidites antarcticus	2.5%	1.4%	1.0%	1.7%	1.0%	3.6%	0.4%	1.9%	6.3%	3.8%	2.6%
Phyllocladidites eunuchus†	2.2%	1.4%	1.6%	0.6%	2.3%	1.9%	1.9%	5.2%	0.6%		1.5%
Phyllocladidites mawsonii	6.5%	2.8%	9.5%	9.2%	9.6%	6.2%	3.5%	6.6%	1.8%	9.2%	6.6%
Phyllocladidites reticulosaccatus/verrucosus											
Podocarpidites spp.	35.3%	13.0%	28.3%	13.2%	18.5%	24.7%	35.3%	38.9%	30.3%	23.8%	21.6%
Podosporites spp.		0.5%									
Podosporites microsaccatus											
Trichotomosulcites subgranulatus	6.2%	13.0%	17.1%	23.0%	7.6%	17.2%	4.3%	2.4%	2.4%	0.8%	5.5%
Vitreisporites signatus/pallidus				0.6%				2.4%		1.5%	0.7%
Total Gymnosperms:	**86%**	**62%**	**68%**	**53%**	**62%**	**64%**	**65%**	**70%**	**84%**	**48%**	**66%**
ANGIOSPERMS undiff.		3.2%	1.3%	1.1%	0.7%	2.3%		0.9%			
Arecipites sp.											
Asteropollis asteroides			6.3%				0.4%				
Australopollis obscurus	0.7%					8.1%	1.9%	5.7%			
Battenipollis sectilis											
Beaupreaidites orbiculatus											
Cupanieidites orthoteichus											
Dicotetradites clavatus				1.7%				0.5%	0.6%		
Forcipites sabulosus											
Forcipites spp.		0.5%									0.4%
Gambierina rudata/edwardsii				0.6%							
Haloragacidites harrisii (Casuarina)											
Liliacidites spp.	0.4%	0.9%	0.3%	1.7%							0.4%
Malvacipollis subtilis/diversus											
Myrtaceidites spp.											
Nothofagidites brachyspinulosus/flemingii											
Nothofagidites emarcidus											
Nothofagidites endurus			1.0%			1.0%					
Nothofagidites senectus				8.0%				0.5%			
Peninsulapollis gillii				0.6%		0.3%		0.5%			
Periporopollenites spp.											
Proteacidites spp.	0.4%	1.4%	3.6%	3.4%	4.3%	1.9%	2.7%	3.8%	1.2%	17.7%	5.5%
Proteacidites (P.) palisadus											
Proteacidites reticuloconcavus†											

Table 4: Kipper–1	Percentage abundances for selected palynomorphs										
Sample Type:	Cts	Cts	Cts	Cts	SWC 47	Cts	Cts	Cts	SWC 43	SWC 42	SWC 42
Depth (m):	2105–2110 B	2135–2140	2140–2145	2145-2150	2155.0	2155–2160	2170–2175	2180-2185	2187.5	2192 P	2192 S
Operator:	MKM	MKM	MKM	ADP	MKM	MKM	MKM	ADP	MKM	ADP	MKM
Slide Set:	EAL	EAL	EAL	EPR	EAL	EAL	EAL	EAL	EAL	EAL	EAL
Pseudowinterapollis cranwelliae/wahooensis											
Quadraplanus brossus											
Schizocolpus marlinensis											
Spinizonocolpites prominatus											
Tetracolporites verrucosus											
Tetradites securus†			0.3%								
Tricolpites confessus				1.1%							
Tricolpites waiparaensis											
Tricolp(or)ites spp.	2.2%	16.7%	1.3%	9.8%	1.7%	4.2%	1.9%	0.5%	0.9%	2.3%	3.3%
Tricolporites lilliei											
Triporopollenites spp.		1.4%	0.3%	0.6%						0.8%	
Total Angiosperms:	**4%**	**24%**	**14%**	**29%**	**7%**	**18%**	**7%**	**12%**	**3%**	**21%**	**10%**
Total Spore-Pollen	**275**	**216**	**304**	**174**	**303**	**308**	**258**	**211**	**333**	**130**	**273**
MICROPLANKTON % of MP COUNT											
Microplankton undiff.						100%					17%
Apectodinium homomorphum											
Amosopollis cruciformis	25%						100%	75%	31%	100%	75%
Chatangiella porosa									14%		
Deflandrea spp.											
Glaphrocysta retiintexta											
Heterosphaeridium spp.									9%		
Isabelidinium spp.									46%		8%
Luxadinium spp.											
Manumiella spp.											
Oligosphaeridium spp.								25%			
Paralecaniella indentata											
Rimosicysta spp.											
Saeptodinium spp. (non-marine dino.)	75%										
Sigmopollis spp.		100%									
Spinidinium/Vozzhennikovia spp.											
Spiniferites spp.											
Wuroia spp.											
Total Microplankton Count:	**4**	**1**				**1**	**2**	**4**	**35**	**13**	**12**
Microplankton % of total SP & MP:	**1.4%**	**0.5%**				**0.3%**	**0.8%**	**1.9%**	**9.5%**	**9.1%**	**4.2%**
A. cruciformis as % of total SP & MP:	0.4%						0.8%	1.4%	3.0%	9.1%	3.2%
Total SP and MP COUNT:	**279**	**217**	**304**	**174**	**303**	**309**	**260**	**215**	**368**	**143**	**285**
Other Palynomorphs Count											
Botryococcus braunii											
Fungal fruiting bodies		1.1%				0.3%	0.4%				
Fungal spores/hyphae	3.5%	22.8%	0.3%	1.0%	1.6%	1.3%	4.7%	3.1%	2.1%		2.4%
Total Fungii:	**3.5%**	**23.9%**	**0.3%**	**1.0%**	**1.6%**	**1.6%**	**5.1%**	**3.1%**	**2.1%**		**2.4%**
Contaminants or caved — spore-pollen				6.8%		0.6%		1.3%			
Contaminants or caved — microplankton			0.3%	1.6%							
Reworked Fossils					1.3%					0.7%	0.3%
TOTAL COUNT:	**289**	**285**	**306**	**192**	**312**	**316**	**274**	**225**	**376**	**144**	**293**
† Manuscript species name.											

Table 4: Kipper–1	Percentage abundances for selected palynomorphs										
Sample Type:	SWC 42	SWC 41	Cts	SWC 37	SWC 36	SWC 32	SWC 31	SWC 30	SWC 27	SWC 75	SWC 74
Depth (m):	2192 X	2196.5	2215–2220	2234.0	2245.5	2296.5	2320	2342.5	2396	2408	2420
Operator:	MKM	MKM	MKM	MKM	MKM	ADP	ADP	ADP	ADP	ADP	ADP
Slide Set:	EPR	EPR	EAL	EPR	EAL	Mixed	EAL	EAL	EAL	EAL	EAL
SPORES											
Aequitriradites spp.		0.3%									
Appendicisporites spp.									0.6%		
Baculatisporites spp.	1.6%	1.5%	0.8%	2.5%	1.6%	1.1%		1.8%	3.0%	3.8%	1.8%
Camarozonosporites spp.											
Cicatricosisporites/Ruffordispora spp.				0.4%			1.0%	0.9%	0.6%		0.5%
Clavifera triplex		0.3%	0.4%								
Coptospora spp.						0.6%					0.5%
Cyatheacidites tectifera			0.4%				2.0%	1.3%			
Cyathidites (large) >40µm	7.1%	1.5%	1.6%	5.8%	0.8%	2.8%	4.0%	11.2%	6.0%	4.7%	2.3%
Cyathidites (small) <40µm	4.4%	8.6%	3.9%	11.3%	3.9%	16.4%	19.5%	23.3%	11.3%	16.0%	11.5%
Densoisporites velatus											
Dictyophyllidites spp.							1.5%	1.8%	3.0%		
Foraminisporis asymmetricus											0.5%
Foveogleicheniidites confossus											
Foveosporites/Foveotriletes spp.							0.5%				
Gleicheniidites spp.	1.2%	2.1%	1.2%	2.9%	1.2%	5.1%	4.0%	8.5%	4.8%	3.8%	4.6%
Herkosporites/Ceratosporites spp.	0.8%	1.2%	0.4%	0.7%			1.0%	0.9%			
Hilate Spores undiff.		0.3%			0.8%						
Ischyosporites/Klukisporites spp.											
Laevigatosporites spp.	2.0%	3.3%	2.0%	6.2%	2.3%	7.3%	1.0%	3.1%	1.2%		3.2%
Laevigatosporites musa†						0.6%				0.9%	
Latrobosporites spp.				0.4%							
Leptolepidites verrucatus											
Marratisporites scabratus						0.6%					
Matonisporites gigantis											
Megaspores undiff.											
Monolete spores undiff.	3.2%	1.2%	4.3%	2.2%	1.6%						
Osmundacidites wellmanii					0.4%	1.1%	1.5%	1.8%	1.2%	3.8%	4.6%
Peromonolites spp.						0.6%					
Perotriletes spp.											
Polypodiisporites spp.											
Retitriletes spp.	2.0%	0.3%	0.4%	1.5%	1.2%	0.6%	0.5%	0.4%	0.6%	0.9%	0.5%
Rugulatisporites spp.		0.3%			0.4%						0.9%
Rugulatisporites mallatus						1.7%	3.0%				
Stereisporites antiquisporites	1.6%	0.3%	0.4%	2.2%		1.1%			2.4%		0.5%
Triletes undiff.	1.6%	1.5%	2.3%	2.2%	2.7%	1.1%	5.5%	4.5%	5.4%	4.7%	2.8%
Triporoletes reticulatus	0.4%		0.4%				0.5%				
Tripunctisporis maastrichtiensis											
Verrucosisporites admirabilis†						4.0%	3.5%	2.2%	4.2%	0.9%	0.9%
Verrucosisporites spp.	0.4%	0.3%	0.4%		0.4%						
Total Spores:	**26%**	**23%**	**19%**	**38%**	**17%**	**45%**	**49%**	**62%**	**44%**	**40%**	**35%**
GYMNOSPERMS undiff.	12.3%	0.3%	8.6%	1.1%	3.9%			1.3%			
Araucariacites australis	21.4%	20.8%	7.8%	10.2%	14.0%	1.7%	2.0%	0.4%	1.2%	2.8%	1.4%
Corollina spp.							0.5%				
Cupressacites sp.				0.4%		0.6%					0.9%
Cycadopites spp.											
Dacrycarpites australiensis				0.4%							
Dilwynites pusillus†	0.4%	0.9%	2.0%	1.1%	3.9%	7.9%	16.5%	2.2%	6.0%	10.4%	14.3%
Dilwynites spp.	6.7%	2.4%	4.7%	2.2%	4.3%	7.9%	7.0%	1.8%	16.1%	6.6%	7.4%
Ephedripites notensis											
Hoegisporis spp.							0.5%				
Lygistepollenites balmei											
Lygistepollenites florinii	0.4%	0.3%			0.4%						
Microalatidites (P.) paleogenicus											
Microcachryidites antarcticus	4.0%	4.5%	4.7%	1.1%	5.1%	9.6%	6.5%	6.7%	4.2%	2.8%	9.7%
Phyllocladidites eunuchus†	0.8%	1.2%	0.4%	0.4%	0.8%		0.5%	0.4%			0.9%
Phyllocladidites mawsonii	0.4%	3.0%	0.8%	0.4%	0.4%		1.5%	0.9%	3.0%	1.9%	
Phyllocladidites reticulosaccatus/verrucosus											
Podocarpidites spp.	22.2%	34.1%	35.9%	12.0%	31.5%	24.3%	15.5%	21.1%	24.4%	35.8%	27.6%
Podosporites spp.						2.3%		0.9%			
Podosporites microsaccatus								1.8%	1.2%		1.4%
Trichotomosulcites subgranulatus	0.8%	6.8%	5.1%	14.5%	9.3%						
Vitreisporites signatus/pallidus							0.5%				
Total Gymnosperms:	**69%**	**74%**	**70%**	**44%**	**74%**	**54%**	**51%**	**38%**	**56%**	**60%**	**64%**
ANGIOSPERMS undiff.	0.4%	0.9%	2.7%	1.1%	1.2%	0.6%					1.4%
Arecipites sp.											
Asteropollis asteroides								0.4%			
Australopollis obscurus	0.4%	0.9%	0.4%								
Battenipollis sectilis											
Beaupreaidites orbiculatus											
Cupanieidites orthoteichus											
Dicotetradites clavatus											
Forcipites sabulosus											
Forcipites spp.				0.4%	0.8%						
Gambierina rudata/edwardsii											
Haloragacidites harrisii (Casuarina)											
Liliacidites spp.		0.3%	0.4%								
Malvacipollis subtilis/diversus											
Myrtaceidites spp.											
Nothofagidites brachyspinulosus/flemingii											
Nothofagidites emarcidus											
Nothofagidites endurus											
Nothofagidites senectus											
Peninsulapollis gillii			0.4%								
Periporopollenites spp.											
Proteacidites spp.	0.8%	0.6%	1.2%	4.7%	3.1%						
Proteacidites (P.) palisadus											
Proteacidites reticuloconcavus†											

Table 4: Kipper–1	Percentage abundances for selected palynomorphs										
Sample Type:	SWC 42	SWC 41	Cts	SWC 37	SWC 36	SWC 32	SWC 31	SWC 30	SWC 27	SWC 75	SWC 74
Depth (m):	2192 X	2196.5	2215–2220	2234.0	2245.5	2296.5	2320	2342.5	2396	2408	2420
Operator:	MKM	MKM	MKM	MKM	MKM	ADP	ADP	ADP	ADP	ADP	ADP
Slide Set:	EPR	EPR	EAL	EPR	EAL	Mixed	EAL	EAL	EAL	EAL	EAL
Pseudowinterapollis cranwelliae/wahooensis											
Quadraplanus brossus											
Schizocolpus marlinensis											
Spinizonocolpites prominatus											
Tetracolporites verrucosus											
Tetradites securus†											
Tricolpites confessus											
Tricolpites waiparaensis											
Tricolp(or)ites spp.	2.8%	0.3%	6.3%	12.0%	4.3%						
Tricolporites lilliei											
Triporopollenites spp.						0.6%					
Total Angiosperms:	**4%**	**3%**	**11%**	**18%**	**9%**	**1.1%**		**0.4%**			**1.4%**
Total Spore-Pollen	**252**	**337**	**256**	**275**	**257**	**177**	**200**	**223**	**168**	**106**	**217**
MICROPLANKTON % of MP COUNT											
Microplankton undiff.	60%	60%	9%	75%	50%	11%	17%			100%	40%
Apectodinium homomorphum											
Amosopollis cruciformis	40%	40%	55%	25%	50%	33%	75%	100%			
Chatangiella porosa			18%								
Deflandrea spp.											
Glaphrocysta retiintexta											
Heterosphaeridium spp.			9%								
Isabelidinium spp.											
Luxadinium spp.						11%					
Manumiella spp.											
Oligosphaeridium spp.			9%								
Paralecaniella indentata											
Rimosicysta spp.						7%	8%				60%
Saeptodinium spp. (non-marine dino.)											
Sigmopollis spp.						37%					
Spinidinium/Vozzhennikovia spp.											
Spiniferites spp.											
Wuroia spp.											
Total Microplankton Count:	**10**	**10**	**11**	**4**	**6**	**27**	**12**	**11**		**1**	**5**
Microplankton % of total SP & MP:	**3.8%**	**2.9%**	**4.1%**	**1.4%**	**2.3%**	**13%**	**5.7%**	**4.7%**		**0.9%**	**2.3%**
A. cruciformis as % of total SP & MP:	1.5%	1.2%	2.2%	0.4%	1.1%	4.4%	4.2%	4.7%			
Total SP and MP COUNT:	**262**	**347**	**267**	**279**	**263**	**204**	**212**	**234**	**168**	**107**	**222**
Other Palynomorphs Count											
Botryococcus braunii											
Fungal fruiting bodies	2.0%	0.3%		0.3%	0.4%						
Fungal spores/hyphae	12.1%	3.3%	2.2%	9.1%	2.2%	0.5%		1.7%	1.2%		0.4%
Total Fungii:	**14.1%**	**3.6%**	**2.2%**	**9.4%**	**2.6%**	**0.5%**		**1.7%**	**1.2%**		**0.4%**
Contaminants or caved — spore-pollen											
Contaminants or caved — microplankton											
Reworked Fossils							0.9%	0.4%	1.2%	0.9%	1.8%
TOTAL COUNT:	**305**	**360**	**273**	**308**	**270**	**205**	**214**	**239**	**172**	**108**	**227**
† Manuscript species name.											

Table 4: Kipper–1	Percentage abundances for selected palynomorphs										
Sample Type:	SWC 73	SWC 71	SWC 70	SWC 18	SWC 69	SWC 15	SWC 12	Cts	SWC 10	SWC 9	SWC 7
Depth (m):	2460	2493	2519.5	2559	2581.5	2617	2661	2685-2690	2697	2709	2756.5
Operator:	ADP	ADP	ADP	ADP	ADP	ADP	ADP	ADP	ADP	ADP	ADP
Slide Set:	EAL	EAL	EAL	EAL	EAL	EAL	EAL	EAL	EAL	EAL	EAL
SPORES											
Aequitriradites spp.											
Appendicisporites spp.								0.9%			
Baculatisporites spp.	3.8%		1.2%	2.4%	1.9%	1.0%	1.6%	0.9%	1.0%	3.3%	1.8%
Camarozonosporites spp.											
Cicatricosisporites/Ruffordispora spp.			0.6%	0.5%	3.9%	1.0%	1.6%				
Clavifera triplex											
Coptospora spp.											
Cyatheacidites tectifera	1.5%		1.2%					0.9%	1.0%		
Cyathidites (large) >40µm	2.3%	2.3%	1.2%	5.3%		2.9%	11.3%	0.9%	3.8%	1.9%	4.5%
Cyathidites (small) <40µm	13.6%	9.2%	4.9%	11.5%	14.6%	21.2%	13.7%	3.8%	10.5%	7.2%	16.4%
Densoisporites velatus											
Dictyophyllidites spp.	6.1%	0.8%	1.2%	1.4%		1.9%	3.2%	0.9%	1.9%	4.3%	2.7%
Foraminisporis asymmetricus											
Foveogleicheniidites confossus											
Foveosporites/Foveotriletes spp.											
Gleicheniidites spp.	2.3%	4.6%	3.7%	5.8%	8.7%	6.7%	6.5%	2.8%	1.9%	4.3%	3.6%
Herkosporites/Ceratosporites spp.	0.8%					1.9%	2.4%		1.0%	0.5%	9.1%
Hilate Spores undiff.											
Ischyosporites/Klukisporites spp.											
Laevigatosporites spp.	2.3%		3.1%	3.8%	3.9%	3.8%	3.2%	0.9%		2.4%	2.7%
Laevigatosporites musa†	2.3%	1.5%	0.6%	0.5%	1.0%	2.9%				1.0%	0.9%
Latrobosporites spp.											
Leptolepidites verrucatus											
Marratisporites scabratus								0.9%			
Matonisporites gigantis											
Megaspores undiff.											
Monolete spores undiff.											
Osmundacidites wellmanii	2.3%	4.6%	3.7%	4.8%	1.9%	1.9%		2.8%	1.9%	2.9%	0.9%
Peromonolites spp.											
Perotriletes spp.									1.0%		
Polypodiisporites spp.											
Retitriletes spp.	0.8%	2.3%	1.9%	2.4%				0.9%		1.0%	0.9%
Rugulatisporites spp.				2.4%			1.6%				
Rugulatisporites mallatus		0.8%									
Stereisporites antiquisporites				0.5%						0.5%	
Triletes undiff.	6.1%	4.6%	2.5%	3.8%	2.9%	7.7%	5.6%	2.8%	1.0%	1.0%	3.6%
Triporoletes reticulatus				0.5%	1.0%						
Tripunctisporis maastrichtiensis											
Verrucosisporites admirabilis†	3.0%	3.8%	2.5%	8.2%	7.8%	1.0%	2.4%	0.9%	1.0%	4.3%	
Verrucosisporites spp.											
Total Spores:	**47%**	**35%**	**28%**	**54%**	**48%**	**54%**	**53%**	**21%**	**26%**	**34%**	**47%**
GYMNOSPERMS undiff.											
Araucariacites australis		1.5%	0.6%	2.4%	1.0%	1.9%	2.4%	3.8%	1.9%	4.8%	0.9%
Corollina spp.			0.6%								0.9%
Cupressacites sp.		2.3%	2.5%	0.5%							
Cycadopites spp.											
Dacrycarpites australiensis											
Dilwynites pusillus†	4.5%	19.2%	32.7%	4.3%	5.8%			47.2%	26.7%	4.8%	0.9%
Dilwynites spp.	3.0%	23.8%	13.6%	4.8%	5.8%	5.8%	4.0%	6.6%	18.1%	13.9%	3.6%
Ephedripites notensis											
Hoegisporis spp.											
Lygistepollenites balmei											
Lygistepollenites florinii											
Microalatidites (P.) paleogenicus											
Microcachryidites antarcticus	3.0%	3.1%	3.1%	7.7%	8.7%	10.6%	5.6%	4.7%	5.7%	12.0%	6.4%
Phyllocladidites eunuchus†	0.8%	0.8%		0.5%							
Phyllocladidites mawsonii	0.8%	1.5%		1.9%		1.0%	0.8%			0.5%	
Phyllocladidites reticulosaccatus/verrucosus											
Podocarpidites spp.	40.2%	11.5%	16.7%	22.1%	25.2%	26.0%	33.9%	13.2%	19.0%	29.2%	40.0%
Podosporites spp.											
Podosporites microsaccatus	0.8%	0.8%	1.2%	1.0%	5.8%			2.8%	1.9%	0.5%	
Trichotomosulcites subgranulatus											
Vitreisporites signatus/pallidus		0.8%	0.6%	0.5%							
Total Gymnosperms:	**53%**	**65%**	**72%**	**46%**	**52%**	**45%**	**47%**	**78%**	**73%**	**66%**	**53%**
ANGIOSPERMS undiff.						1.0%		0.9%	1.0%		
Arecipites sp.											
Asteropollis asteroides											
Australopollis obscurus											
Battenipollis sectilis											
Beaupreaidites orbiculatus											
Cupanieidites orthoteichus											
Dicotetradites clavatus											
Forcipites sabulosus											
Forcipites spp.											
Gambierina rudata/edwardsii											
Haloragacidites harrisii (Casuarina)											
Liliacidites spp.				0.5%							
Malvacipollis subtilis/diversus											
Myrtaceidites spp.											
Nothofagidites brachyspinulosus/flemingii											
Nothofagidites emarcidus											
Nothofagidites endurus											
Nothofagidites senectus											
Peninsulapollis gillii											
Periporopollenites spp.											
Proteacidites spp.											
Proteacidites (P.) palisadus											
Proteacidites reticuloconcavus†											

Table 4: Kipper–1	Percentage abundances for selected palynomorphs									
Sample Type:	SWC 73	SWC 71	SWC 70	SWC 18	SWC 69	SWC 15	SWC 12	Cts	SWC 10	SWC 9	SWC 7
Depth (m):	2460	2493	2519.5	2559	2581.5	2617	2661	2685-2690	2697	2709	2756.5
Operator:	ADP	ADP	ADP	ADP	ADP	ADP	ADP	ADP	ADP	ADP	ADP
Slide Set:	EAL	EAL	EAL	EAL	EAL	EAL	EAL	EAL	EAL	EAL	EAL
Pseudowinterapollis cranwelliae/wahooensis											
Quadraplanus brossus											
Schizocolpus marlinensis											
Spinizonocolpites prominatus											
Tetracolporites verrucosus											
Tetradites securus†											
Tricolpites confessus											
Tricolpites waiparaensis											
Tricolp(or)ites spp.											
Tricolporites lilliei											
Triporopollenites spp.											
Total Angiosperms:				**0.5%**		**1.0%**		**0.9%**	**1.0%**		
Total Spore-Pollen	**132**	**130**	**162**	**208**	**103**	**104**	**124**	**106**	**105**	**209**	**110**
MICROPLANKTON % of MP COUNT											
Microplankton undiff.				9%				4%	81%		
Apectodinium homomorphum											
Amosopollis cruciformis	100%	26%	40%	91%	67%	100%	100%	7%	4%	70%	50%
Chatangiella porosa											
Deflandrea spp.											
Glaphrocysta retiintexta											
Heterosphaeridium spp.											
Isabelidinium spp.											
Luxadinium spp.								67%			
Manumiella spp.											
Oligosphaeridium spp.											
Paralecaniella indentata											
Rimosicysta spp.		74%	54%					22%	15%	30%	50%
Saeptodinium spp. (non-marine dino.)											
Sigmopollis spp.					33%						
Spinidinium/Vozzhennikovia spp.											
Spiniferites spp.											
Wuroia spp.			6%								
Total Microplankton Count:	**2**	**27**	**50**	**23**	**3**	**1**	**4**	**85**	**27**	**20**	**2**
Microplankton % of total SP & MP:	**1.5%**	**17%**	**24%**	**10%**	**2.8%**	**1.0%**	**3.1%**	**45%**	**20%**	**8.7%**	**1.8%**
A. cruciformis as % of total SP & MP:	1.5%	4.5%	9.4%	9.1%	1.9%	1.0%	3.1%	3.1%	0.8%	6.1%	0.9%
Total SP and MP COUNT:	**134**	**157**	**212**	**231**	**106**	**105**	**128**	**191**	**132**	**229**	**112**
Other Palynomorphs Count											
Botryococcus braunii											
Fungal fruiting bodies			0.4%								
Fungal spores/hyphae	3.6%		2.7%	2.5%				1.0%	0.8%	0.9%	
Total Fungii:	**3.6%**		**3.1%**	**2.5%**				**1.0%**	**0.8%**	**0.9%**	
Contaminants or caved — spore-pollen											
Contaminants or caved — microplankton											
Reworked Fossils		1.3%	1.8%	1.3%	0.9%	2.8%	0.8%	0.5%			0.9%
TOTAL COUNT:	**139**	**159**	**223**	**240**	**107**	**108**	**129**	**194**	**133**	**231**	**113**
† Manuscript species name.											

Table 4: Kipper–1	Percentage abundances for selected palynomorphs										
Sample Type:	SWC 6	SWC 64	SWC 63	SWC 3	SWC 1						
Depth (m):	2773	2794	2805	2839	2862						
Operator:	ADP	ADP	ADP	ADP	ADP						
Slide Set:	EAL	EAL	EAL	EAL	EAL						
SPORES											
Aequitriradites spp.											
Appendicisporites spp.			2.7%								
Baculatisporites spp.	4.7%	1.4%	0.7%	4.6%	3.3%						
Camarozonosporites spp.											
Cicatricosisporites/Ruffordispora spp.	0.9%		3.3%	0.9%	0.5%						
Clavifera triplex											
Coptospora spp.											
Cyatheacidites tectifera											
Cyathidites (large) >40µm	5.6%	0.7%	0.7%	6.5%	1.4%						
Cyathidites (small) <40µm	17.8%	4.8%	16.0%	17.6%	16.6%						
Densoisporites velatus											
Dictyophyllidites spp.	2.8%	2.7%		6.5%	4.3%						
Foraminisporis asymmetricus											
Foveogleicheniidites confossus											
Foveosporites/Foveotriletes spp.											
Gleicheniidites spp.	2.8%	2.0%	0.7%	10.2%	6.6%						
Herkosporites/Ceratosporites spp.	0.9%	2.0%	2.0%	0.9%							
Hilate Spores undiff.											
Ischyosporites/Klukisporites spp.											
Laevigatosporites spp.	2.8%			2.8%	6.6%						
Laevigatosporites musa†				0.9%	2.4%						
Latrobosporites spp.											
Leptolepidites verrucatus											
Marratisporites scabratus											
Matonisporites gigantis											
Megaspores undiff.			0.7%								
Monolete spores undiff.	0.9%			0.9%							
Osmundacidites wellmanii	2.8%	0.7%	1.3%	1.9%	2.4%						
Peromonolites spp.											
Perotriletes spp.			3.3%		0.5%						
Polypodiisporites spp.											
Retitriletes spp.		0.7%		0.9%							
Rugulatisporites spp.				0.9%	1.9%						
Rugulatisporites mallatus											
Stereisporites antiquisporites			1.3%		1.9%						
Triletes undiff.	6.5%			6.5%	11.8%						
Triporoletes reticulatus											
Tripunctisporis maastrichtiensis											
Verrucosisporites admirabilis†	2.8%			2.8%	8.1%						
Verrucosisporites spp.											
Total Spores:	**51%**	**15%**	**33%**	**65%**	**68%**						
GYMNOSPERMS undiff.		0.7%									
Araucariacites australis	1.9%		2.0%	0.9%	2.8%						
Corollina spp.											
Cupressacites sp.		5.4%	2.0%								
Cycadopites spp.											
Dacrycarpites australiensis											
Dilwynites pusillus†	0.9%	34.0%	2.7%	1.9%	1.9%						
Dilwynites spp.	9.3%	35.4%	6.7%	5.6%	3.3%						
Ephedripites notensis											
Hoegisporis spp.		0.7%									
Lygistepollenites balmei											
Lygistepollenites florinii											
Microalatidites (P.) paleogenicus											
Microcachryidites antarcticus	3.7%	2.7%	18.7%	2.8%	6.6%						
Phyllocladidites eunuchus†											
Phyllocladidites mawsonii	0.9%			0.9%	2.4%						
Phyllocladidites reticulosaccatus/verrucosus											
Podocarpidites spp.		6.1%	32.0%	20.4%	14.2%						
Podosporites spp.											
Podosporites microsaccatus	29.9%		1.3%	1.9%							
Trichotomosulcites subgranulatus											
Vitreisporites signatus/pallidus			1.3%								
Total Gymnosperms:	**47%**	**85%**	**67%**	**34%**	**31%**						
ANGIOSPERMS undiff.				0.9%	0.5%						
Arecipites sp.											
Asteropollis asteroides											
Australopollis obscurus	1.9%										
Battenipollis sectilis											
Beaupreaidites orbiculatus											
Cupanieidites orthoteichus											
Dicotetradites clavatus											
Forcipites sabulosus											
Forcipites spp.											
Gambierina rudata/edwardsii											
Haloragacidites harrisii (Casuarina)											
Liliacidites spp.											
Malvacipollis subtilis/diversus											
Myrtaceidites spp.											
Nothofagidites brachyspinulosus/flemingii											
Nothofagidites emarcidus											
Nothofagidites endurus											
Nothofagidites senectus											
Peninsulapollis gillii											
Periporopollenites spp.											
Proteacidites spp.											
Proteacidites (P.) palisadus											
Proteacidites reticuloconcavus†											

Table 4: Kipper–1	Percentage abundances for selected palynomorphs										
Sample Type:	SWC 6	SWC 64	SWC 63	SWC 3	SWC 1						
Depth (m):	2773	2794	2805	2839	2862						
Operator:	ADP	ADP	ADP	ADP	ADP						
Slide Set:	EAL	EAL	EAL	EAL	EAL						
Pseudowinterapollis cranwelliae/wahooensis											
Quadraplanus brossus											
Schizocolpus marlinensis											
Spinizonocolpites prominatus											
Tetracolporites verrucosus											
Tetradites securus†											
Tricolpites confessus											
Tricolpites waiparaensis											
Tricolp(or)ites spp.			0.7%								
Tricolporites lilliei											
Triporopollenites spp.											
Total Angiosperms:	**1.9%**		**0.7%**	**0.9%**	**0.5%**						
Total Spore-Pollen	**107**	**147**	**150**	**108**	**211**						
MICROPLANKTON % of MP COUNT											
Microplankton undiff.	20%	5%			33%						
Apectodinium homomorphum											
Amosopollis cruciformis	20%	12%	4%		33%						
Chatangiella porosa											
Deflandrea spp.											
Glaphrocysta retiintexta											
Heterosphaeridium spp.											
Isabelidinium spp.											
Luxadinium spp.		24%									
Manumiella spp.											
Oligosphaeridium spp.											
Paralecaniella indentata											
Rimosicysta spp.	60%	58%	7%	100%							
Saeptodinium spp. (non-marine dino.)											
Sigmopollis spp.		1%	89%		33%						
Spinidinium/Vozzhennikovia spp.											
Spiniferites spp.											
Wuroia spp.											
Total Microplankton Count:	**5**	**117**	**28**	**1**	**6**						
Microplankton % of total SP & MP:	**4.5%**	**44%**	**16%**	**0.9%**	**2.8%**						
A. cruciformis as % of total SP & MP:	0.9%	5.3%	0.6%		0.9%						
Total SP and MP COUNT:	**112**	**264**	**178**	**109**	**217**						
Other Palynomorphs Count											
Botryococcus braunii											
Fungal fruiting bodies											
Fungal spores/hyphae		1.5%	12.3%								
Total Fungii:		**1.5%**	**12.3%**								
Contaminants or caved — spore-pollen											
Contaminants or caved — microplankton											
Reworked Fossils	0.9%			1.8%	0.5%						
TOTAL COUNT:	**113**	**268**	**203**	**111**	**218**						
† Manuscript species name.											

Table 5: Kipper–1 Distribution chart for selected palynomorphs

Sample Type	Depth Metres	1 Hoegisporis trinalis ms	2 Tricolporites vanverrucatus ms	3 Verrucosisporites admirabilis ms	4 Laevigatosporites musa ms	5 Appendicisporites distocarinatus	6 Interulobites intraverrucatus	7 Cyatheacidites tectifera	8 Foraminisporis asymmetricus	9 Triporoletes reticulatus	10 Dilwynites spp.	11 Phyllocladidites mawsonii (sl)	12 Cupressacites sp.	13 Proteacidites spp.	14 Coptospora pileolus ms	15 Australopollis obscurus	16 Clavifera triplex	17 Forcipites spp.	18 Retimonocolpites peroreticulatus	19 Tricolpites confessus	20 Peninsulapollis gillii	21 Latrobosporites amplus/ohaiensis	22 Lygistopollenites florinii	23 Dicotetradites clavatus
SWC 104	1493.0										10%	X		6%		X							1%	X
SWC 103	1506.0										·	1%		15%		·	X					X	X	X
SWC 100	1562.5										4%	7%		3%		·	·					·	4%	·
SWC 99	1579.6										·	·		·		·	·				X	·	·	·
SWC 98	1603.0										1%	14%		3%		1%	·				·	·	3%	X
SWC 96	1646.0										4%	13%		5%		12%	·				·	·	1%	X
SWC 92	1727.0										1%	16%		14%		3%	·				1%	·	2%	·
SWC 91	1733.5										·	X		·		·	·				X	·	·	·
SWC 89	1760.0										1%	4%		31%		1%	·				X	·	1%	·
Cuttings	1765–70										·	·		·		·	·				·	·	X	·
SWC 86	1805.0										X	18%		13%		X	·	X		X	X	·	1%	1%
Cuttings	1825–30										·	·		·		X	·			·	·	·	·	·
Core–5	1832.5										·	14%		5%		1%	·			·	1%	·	1%	·
Core–5	1835.0										1%	16%		4%	?	·	·			·	X	·	4%	·
Core–5	1838.0										·	27%		4%		1%	·			·	·	·	2%	X
Core–5	1840.6										X	15%		11%		·	·			·	·	·	·	·
Cuttings	1850–55										·	·		·		X	·			·	·	·	X	·
SWC 84	1872.0										·	·		·		·	·			·	X	·	·	·
Cuttings	1875–80										X	40%		3%		1%	X			·	X	X	1%	·
Cuttings	1885–90										·	·		·		X	·			·	·	X	X	X
Cuttings	1895–1900									X	1%	16%		1%		X	·	X		·	·	X	4%	·
Cuttings	1995–2000								X	·	·	·		·		·	X	·		X	X	X	X	·
SWC 58	1998.0								·	·	2%	3%		5%		·	·	·		·	3%	X	3%	·
Cuttings	2000–2005								·	·	1%	2%	1%	6%		X	X	X		X	·	·	1%	·
Cuttings	2005–2010								·	·	2%	3%	·	8%		1%	·	X		X	X	·	·	·
SWC 57	2008.0								·	·	·	X	·	X		X	·	·		?	·	X	X	·
Cuttings	2015–20								·	·	2%	1%	X	6%		X	·	·		X	X	·	·	·
SWC 56	2025.0								·	·	·	·	·	·		X	·	·		·	·	·	·	·
Cuttings	2040–45								·	·	2%	1%	1%	2%		X	·	X		X	1%	·	·	·
Cuttings	2045–50								·	·	·	·	·	·		X	·	·		X	·	·	·	·
Cuttings	2050–55								·	·	2%	4%	2%	5%		·	X	·	X	·	X	·	·	X
SWC 54	2052.0								·	·	·	·	·	X		X	·	·	·	·	·	·	·	·
Cuttings	2075–80								·	·	X	3%	1%	4%		X	·	X	·	·	·	·	·	X
Cuttings	2085–90								·	·	·	X	·	X		X	·	·	·	?	·	·	·	·
SWC 53	2088.0								·	·	·	X	·	X		X	X	·	X	?	·	·	X	·
Cuttings	2105–10								·	X	2%	3%	1%	2%		X	X	X	X	?	X	·	·	·
Cuttings	2135–40								·	X	3%	3%	1%	1%		X	X	X	·	·	·	·	·	·
Cuttings	2140–45								·	·	1%	10%	·	4%		X	X	·	·	·	·	·	·	·
SWC 49	2143.0								·	·	·	·	·	X		·	·	·	·	·	·	·	·	·
Cuttings	2145-50								·	·	2%	9%	1%	3%		X	·	·	·	1%	1%	·	1%	2%
SWC 47	2155.0							X	·	·	8%	10%	X	4%		X	X	X	·	·	·	X	1%	·
Cuttings	2155–60							·	·	·	2%	6%	X	2%		8%	·	·	·	·	X	·	1%	·
Cuttings	2170–75							·	·	·	3%	4%	·	3%		2%	·	·	·	·	·	·	·	·
Cuttings	2180-85							·	·	·	6%	7%	·	4%		6%	X	·	·	·	1%	·	1%	X
SWC 43	2187.5							·	·	·	6%	2%	·	1%		X	X	X	·	X	?	?	1%	X
SWC 42	2192.0							·	·	X	5%	5%	·	8%		X	·	X	·	·	?	X	X	
Cuttings	2195-200							·	·	·	X	X	·	X		X	·	·	·	X	X			
SWC 41	2196.5					?	X	·	X	·	3%	3%	·	1%		1%	X	·	X				?	
SWC 40	2209.5						·	·	·	·	·	·	·	X		·	·	·						
Cuttings	2215–20						·	X	·	·	7%	1%	·	1%		X	·	·			CV			
SWC 37	2234.0						·	·	·	·	3%	X	X	5%		X	X	X					?	
Cuttings	2235-40						·	·	·	·	·	X	·	X		X	·	X			CV			
SWC 36	2245.5						·	·	·	·	8%	X	·	3%		X	·	1%					?	
Cuttings	2295–300						·	·	·	·	·	·	·	·	X	X	·							
SWC 32	2296.5			4%	1%	X	·	X	·	·	16%	·	1%	·	X	X	X							
SWC 78	2307.0			·	·	·	·	·	·	·	·	X	·	·	·	·								
SWC 31	2320.0	?		4%	·	X	·	2%	X	·	23%	2%	·	X	·	X								
SWC 30	2342.5			2%	·	·	·	1%	·	·	4%	1%	·	X	·									
SWC 76	2381.0			·	·	·	·	X	·	·	·	·	·	·	·									
SWC 27	2396.0			4%	·	·	·	·	·	·	22%	3%	·	·	·									
SWC 75	2408.0			1%	1%	·	·	·	·	·	17%	2%	·	·	·									
SWC 74	2420.0			1%	·	X	·	·	X	·	22%	·	1%	·	X									
SWC 24	2451.0			·	·	·	X	X	·	·	·	X	·	·										
SWC 73	2460.0			3%	2%	·	·	2%	·	·	8%	1%	·	·										
SWC 72	2483.0			·	·	X	·	X	·	·	·	·	·	·										
SWC 71	2493.0			4%	1%	·	·	X	·	·	43%	2%	2%	·										
SWC 70	2519.5			3%	1%	·	·	1%	·	·	46%	·	3%	·										
SWC 18	2559.0			8%	1%	·	·	X	X	·	9%	2%	1%	·										
SWC 69	2581.5			8%	1%	X	·	X	·	·	12%	·	·	·										
SWC 15	2617.0		X	1%	3%	·	X	·	·	·	6%	1%	·	·										
SWC 68	2635.5		·	·	·	·	·	X	·	·	·	·	·	·										
SWC 12	2661.0		·	2%	·	X	·	X	·	·	4%	1%	·	·										
Cuttings	2685–90		·	1%	·	X	X	1%	·	·	54%	X	·	·										
SWC 66	2686.0		·	·	·	X	·	X	·	·	·	X	·	·										
SWC 10	2697.0		·	1%	·	·	·	1%	·	·	45%	·	·	·										
SWC 9	2709.0		·	1%	1%	X	·	X	·	·	19%	1%	·	·										
SWC 65	2730.0		·	·	·	X	·	·	·	·	·	·	·	·										
Cuttings	2735-40		·	·	·	·	·	X	·	·	·	·	·	·										
SWC 7	2756.5		·	·	1%	·	·	·	·	·	5%	·	·	·		X								
SWC 6	2773.0		·	3%	·	·	·	·	·	·	10%	1%	·	·		2%								
SWC 64	2794.0	X	·	·	·	·	X	X	·	·	69%	X	5%	·										
SWC 63	2805.0	·	·	·	·	X	·	·	·	X	9%	·	1%	·										
SWC 3	2839	·	·	3%	1%	·	·	·	·	·	9%	1%	·	·										
SWC 1	2862	·	X	8%	2%	·	·	X	·	·	5%	2%	·	X										

Sample Type	Depth Metres	24 Nothofagidites spp.	25 Forcipites sabulosus	26 Lygistepollenites balmei	27 Densoisporites velatus	28 Gambierina spp.	29 Proteacidites (C.) palisadus	30 Tricolporites lilliei	31 Pseudowinteropollis wahooensis	32 Quadraplanus brossus	33 Forcipites longus	34 Tetracolporites verrucosus	35 Tripunctisporis maastrichtiensis	36 Battenipollis sectilis	37 Proteacidites reticuloconcavus ms	38 Proteacidites angulatus	39 Haloragacidites harrisii	40 Proteacidites (P.) annularis	41 Malvacipollis subtilis	42 Myrtaceidites mesonesus/parvus	43 Matonisporites gigantis	44 Cupanieidites orthoteichus	45 Malvacipollis diversus	46 Spinizonocolpites prominatus
SWC 104	1493.0	X		X													6%		X	21%		X	6%	X
SWC 103	1506.0	7%		2%		X											X		1%	·	X			
SWC 100	1562.5	23%		2%		X						X					1%	X	X	X				
SWC 99	1579.6	X		·		·						·					·							
SWC 98	1603.0	30%		2%		·						·	X				X							
SWC 96	1646.0	1%		2%		X						X	·			X	1%							
SWC 92	1727.0	X		4%		2%						X	X			X								
SWC 91	1733.5	·		·		X				X	X	·	·											
SWC 89	1760.0	X		X		6%	X		X	·	·	·	X											
Cuttings	1765–70	·		X		·	X		·	·	·	X	X		X									
SWC 86	1805.0	1%	?	·		8%	·		·	·	·	X	X	X	X									
Cuttings	1825–30	·		·	X	X	·		·	·	·	·	·	·	·									
Core–5	1832.5	X		1%	X	5%	·	2%	·	·	·	X	X	X	·									
Core–5	1835.0	1%		1%	X	3%	X	3%	X	X	·	·	·	·	X									
Core–5	1838.0	1%		·	·	1%	X	1%	·	·	·	·	·	X	X									
Core–5	1840.6	1%		1%	·	2%	X	1%	·	X	·	·	·	X	X									
Cuttings	1850–55	·		X	·	X	·	·	·	·	X	X	X											
SWC 84	1872.0	·		·	·	·	·	·	·	·														
Cuttings	1875–80	X		X	·	X	X	X	X	X														
Cuttings	1885–90	·		X	·	X	X	·																
Cuttings	1895–1900	2%		1%	·	X	X	1%																
Cuttings	1995–2000	·	X	·	X	·								CV										
SWC 58	1998.0	7%	2%	·	3%	X																		
Cuttings	2000–2005	3%	·	·																				
Cuttings	2005–2010	3%	?	CV		CV				CV	CV													
SWC 57	2008.0	X	·	X						CV			CV											
Cuttings	2015–20	6%	1%	·																				
SWC 56	2025.0	X	·	·		CV										CV								
Cuttings	2040–45	3%	X	·																				
Cuttings	2045–50	·	X	·	CV																			
Cuttings	2050–55	2%	X	·																				
SWC 54	2052.0	·	·	·																				
Cuttings	2075–80	2%	·	·																				
Cuttings	2085–90	X	X	·																				
SWC 53	2088.0	X	·	·											X									
Cuttings	2105–10	X	·	·		CV								CV										
Cuttings	2135–40	X	X	·																				
Cuttings	2140–45	1%	·	CV		CV																		
SWC 49	2143.0	X	·	·																				
Cuttings	2145-50	8%	·	·																				
SWC 47	2155.0	X	X	X			?																	
Cuttings	2155–60	X																						
Cuttings	2170–75																							
Cuttings	2180-85	CV																						
SWC 43	2187.5		?											CV										
SWC 42	2192.0																							
Cuttings	2195-200																							
SWC 41	2196.5																							
SWC 40	2209.5	CV																						
Cuttings	2215–20																							
SWC 37	2234.0																							
Cuttings	2235-40																							
SWC 36	2245.5																							
Cuttings	2295–300																							
SWC 32	2296.5																							
SWC 78	2307.0																							
SWC 31	2320.0																							
SWC 30	2342.5																							
SWC 76	2381.0																							
SWC 27	2396.0																							
SWC 75	2408.0																							
SWC 74	2420.0																							
SWC 24	2451.0																							
SWC 73	2460.0																							
SWC 72	2483.0																							
SWC 71	2493.0																							
SWC 70	2519.5																							
SWC 18	2559.0																							
SWC 69	2581.5																							
SWC 15	2617.0																							
SWC 68	2635.5																							
SWC 12	2661.0																							
Cuttings	2685–90																							
SWC 66	2686.0																							
SWC 10	2697.0																							
SWC 9	2709.0																							
SWC 65	2730.0																							
Cuttings	2735-40																							
SWC 7	2756.5																							
SWC 6	2773.0																							
SWC 64	2794.0																							
SWC 63	2805.0																							
SWC 3	2839																							
SWC 1	2862																							

Sample Type	Depth Metres	47 Sigmopollis carbonis	48 Amosopollis cruciformis	49 Rimosicysta spp.	50 Luxadinium spp.	51 Rimosicysta kippenii	52 Wuroia corrugatus	53 Heterosphaeridium spp.	54 Isabelidinium variabilis	55 Chatangiella porosa	56 Exochosphaeridium sp.	57 Oligosphaeridium sp.	58 Manumiella spp.	59 Deflandrea speciosus	60 Hystrichosphaeridium tubiferum	61 Trithyrodinium evittii	62 Apectodinium reburrus ms	63 Apectodinium hyperacanthum	64 Apectodinium homomorphum	65 Paralecaniella indentata	Depth Metres	Sample Type
SWC 104	1493.0		1%															X	X	X	1493.0	SWC 104
SWC 103	1506.0		·																		1506.0	SWC 103
SWC 100	1562.5		·														X				1562.5	SWC 100
SWC 99	1579.6		·																		1579.6	SWC 99
SWC 98	1603.0		·																		1603.0	SWC 98
SWC 96	1646.0		·																		1646.0	SWC 96
SWC 92	1727.0		1%											X	X	?					1727.0	SWC 92
SWC 91	1733.5		·										X								1733.5	SWC 91
SWC 89	1760.0		·																		1760.0	SWC 89
Cuttings	1765–70		X																		1765–70	Cuttings
SWC 86	1805.0		·																		1805.0	SWC 86
Cuttings	1825–30		·	?													CV				1825–30	Cuttings
Core–5	1832.5		1%																		1832.5	Core–5
Core–5	1835.0		·																		1835.0	Core–5
Core–5	1838.0		·																		1838.0	Core–5
Core–5	1840.6		1%																		1840.6	Core–5
Cuttings	1850–55		·														CV				1850–55	Cuttings
SWC 84	1872.0		·																		1872.0	SWC 84
Cuttings	1875–80		1%																		1875–80	Cuttings
Cuttings	1885–90		·																		1885–90	Cuttings
Cuttings	1895–1900		·																		1895–1900	Cuttings
Cuttings	1995–2000		·																		1995–2000	Cuttings
SWC 58	1998.0		·																		1998.0	SWC 58
Cuttings	2000–2005		X																		2000–2005	Cuttings
Cuttings	2005–2010		X																		2005–2010	Cuttings
SWC 57	2008.0		·																		2008.0	SWC 57
Cuttings	2015–20		·																		2015–20	Cuttings
SWC 56	2025.0		?																		2025.0	SWC 56
Cuttings	2040–45		·																		2040–45	Cuttings
Cuttings	2045–50		·																		2045–50	Cuttings
Cuttings	2050–55		X																		2050–55	Cuttings
SWC 54	2052.0		·																		2052.0	SWC 54
Cuttings	2075–80		X																		2075–80	Cuttings
Cuttings	2085–90		·																		2085–90	Cuttings
SWC 53	2088.0		·																		2088.0	SWC 53
Cuttings	2105–10		X																		2105–10	Cuttings
Cuttings	2135–40	X	·		?																2135–40	Cuttings
Cuttings	2140–45	·	·																		2140–45	Cuttings
SWC 49	2143.0	·	·																		2143.0	SWC 49
Cuttings	2145-50	·	·																		2145-50	Cuttings
SWC 47	2155.0	·	·																		2155.0	SWC 47
Cuttings	2155–60	·	·																		2155–60	Cuttings
Cuttings	2170–75	·	1%																		2170–75	Cuttings
Cuttings	2180-85	·	1%									X									2180-85	Cuttings
SWC 43	2187.5	·	3%	?				X	X	X	X	X									2187.5	SWC 43
SWC 42	2192.0	·	4%					·	X	X	X	·									2192.0	SWC 42
Cuttings	2195-200	·	·					·	·	X	·	·									2195-200	Cuttings
SWC 41	2196.5	·	1%	?	?			·	·	·	·	·									2196.5	SWC 41
SWC 40	2209.5	·						·	·	·	·	·									2209.5	SWC 40
Cuttings	2215–20	·	2%					X	·	X	·	X									2215–20	Cuttings
SWC 37	2234.0	·	X					·	·	·	·										2234.0	SWC 37
Cuttings	2235-40	·	·					·	·	X	X										2235-40	Cuttings
SWC 36	2245.5	·	1%					X	X												2245.5	SWC 36
Cuttings	2295–300	·	·			X															2295–300	Cuttings
SWC 32	2296.5	X	4%	X	X	X															2296.5	SWC 32
SWC 78	2307.0	·	·	·	·	·	?														2307.0	SWC 78
SWC 31	2320.0	·	4%	X	·	X															2320.0	SWC 31
SWC 30	2342.5	·	5%	·	·	·															2342.5	SWC 30
SWC 76	2381.0	·	·	·	·	·															2381.0	SWC 76
SWC 27	2396.0	·	·	·	·	·															2396.0	SWC 27
SWC 75	2408.0	·	·	·	·	·															2408.0	SWC 75
SWC 74	2420.0	·	·	X	X	·															2420.0	SWC 74
SWC 24	2451.0	·	·	·	X	·															2451.0	SWC 24
SWC 73	2460.0	·	2%	·	·	·															2460.0	SWC 73
SWC 72	2483.0	·	X	X	·	·															2483.0	SWC 72
SWC 71	2493.0	·	5%	X	·	·															2493.0	SWC 71
SWC 70	2519.5	·	9%	X	·	X	X														2519.5	SWC 70
SWC 18	2559.0	·	9%	·	X	·															2559.0	SWC 18
SWC 69	2581.5	X	2%	·	·	·															2581.5	SWC 69
SWC 15	2617.0	·	1%	·	·	·															2617.0	SWC 15
SWC 68	2635.5	·	·	·	·	·															2635.5	SWC 68
SWC 12	2661.0	·	3%	X	X	·															2661.0	SWC 12
Cuttings	2685–90	·	3%	X	X	·															2685–90	Cuttings
SWC 66	2686.0	·	X	X	X	·															2686.0	SWC 66
SWC 10	2697.0	·	1%	X	X	·															2697.0	SWC 10
SWC 9	2709.0	·	6%	X	·	X															2709.0	SWC 9
SWC 65	2730.0	·	·	·	X	·															2730.0	SWC 65
Cuttings	2735-40	·	·	·	·	·															2735-40	Cuttings
SWC 7	2756.5	·	1%	X	·	·															2756.5	SWC 7
SWC 6	2773.0	·	1%	X	·	·															2773.0	SWC 6
SWC 64	2794.0	X	5%	X	X	X															2794.0	SWC 64
SWC 63	2805.0	X	1%	X	X	X															2805.0	SWC 63
SWC 3	2839	·	·	X																	2839	SWC 3
SWC 1	2862	X	1%																		2862	SWC 1

Numbers 1 to 46 are spore-pollen species

Numbers 47 to 65 are microplankton species

LEGEND

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