High-resolution palynological analysis of the reservoir interval in Kipper–2, 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–2 step-out well on the Kipper gas field based on assemblage counts of 56 samples, and a reconnaissance analysis or review of all additional samples in the intervals of interest. A summary of the results, and a comparison with a similar study in Kipper–1 is presented in Figure–1.

- ❖ The sequence analysed from Kipper–2 ranges from the Late Santonian *T. apoxyexinus* spore-pollen Zone and *C. porosa* microplankton Zone 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 (Hannah, 1987), 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 considered to be restricted to the interval from 2211 to 2243m lying between the two volcanic units in Kipper–2. This interval is interpreted to correlate to a 16 metre interval from 1989 to 2005m, lying below the volcanic unit in Kipper–1.

- ❖ The principal disappointment of the study was the failure to identify any further palynological subdivision of the gas reservoir section belonging to the Lower *N. senectus* Zone. Although this interval is adequately covered with samples from conventional cores and a few sidewall cores the detailed assemblage counts did not uncover any biostratigraphically useful changes in the microfloras, nor were any new species been identified with useful first appearances or extinctions within the zone.

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

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

† = 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–2 slide sets with the aim of improving subdivision of the palynological succession, and in conjunction with a similar study of the Kipper–1 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 suggested significantly different zone picks and ages compared to the original palynological studies by Marshall & Partridge (1986) and Hannah (1987).

Materials. The study is based on two vintages of palynological slides. The earlier is the original palynological slides prepared during 1987, by the now closed Esso Australia Ltd palynological laboratory. This set consist of 48 sidewall cores samples and only four conventional core samples that had been collected at the well-site. The remainder of the cores had been waxed-sealed for reservoir analysis, and did not become available for detailed palynological sampling until a considerable period after the original palynological report had been submitted. The later collection comprises 16 additional core samples, 9 reprocessed sidewall core samples and six cuttings samples, prepared 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 278 specimens per sample were counted from 56 samples out of the 69 samples processed in Kipper–2. 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 are 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 mostly moderate to high throughout the section analysed in Kipper–2, with the notable exception of the interval ~2340 to 2430 metres where both the sidewall and conventional cores gave low yields and low concentration of palynomorphs on the slides (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 declined to mostly fair to poor below the volcanics.

Limitations of Data and Method. The primary objective of making detailed of the palynological assemblages in Kipper–2 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 comparison of the count data through the *N. senectus* Zone between Kipper–1 and 2. In Kipper–1 mostly cuttings have been counted and these counts may incorporate a significant number of caved palynomorphs, whereas from the equivalent section in Kipper–2 the assemblage counts are made on conventional and sidewall core samples.

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 in Kipper–1; Partridge & Macphail, 2000).

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–2, as 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 samples in Kipper–1 (Partridge & Macphail, 2000).

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. The top of the sequence examined 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 1810 to 1870m in Kipper–2. 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–2 from 1870 to 1890m, 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 1890 to 2071m 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–2 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 thin sedimentary interval from 2211 to 2243m intercalated between the volcanics in Kipper–2 contains Upper *N. senectus* Zone microfloras, and is assigned to the Chimaera Formation of Lowry and Longley (1991). This section is either missing in Kipper–1 or represented only by the thin sand and shale section from 1990 to 2005m immediately underlying the volcanics in that well. The latter interpretation is based on correlation of the peak abundance of the spore *Densoisporites velatus* in Kipper–2 at 2235.6 to 2242.1m, with the peak abundance of this spore in Kipper–1 from the sidewall core at 1995m.

9. The sediments from 2266 to 2600m (T.D.) underlying the lower volcanics in Kipper–2 are also assigned to the Chimaera Formation. In this section the boundary between the Lower *N. senectus* and *T. apoxyexinus* Zone is lowered

about 150 metres compared to the original palynological study by Hannah (1987). Unfortunately, further palynological subdivision of the thickened Lower *N. senectus* Zone, which represents the main gas reservoir section below the volcanics, was not achieved. The assemblage count display no marked changes in the gross composition of the microfloras, and no new extinctions or first appearances of species were identified.

10. The basal 150 metres in Kipper–2 is assigned to the *T. apoxyexinus* Zone and also contains the distinctive microplankton incursion assigned to the *C. porosa* Zone identified between 2491 and 2564m. This zone in Kipper–2 has both higher microplankton abundance and diversity compared to Kipper–1, where the zone is only well expressed in the sidewall cores at 2187.5m and 2192m. Two alternative correlations are possible. Either the zone thins to less than 10 metres in Kipper–1 or the section is about the same thickness in both wells, but considerably less marine in Kipper–1.

Palaeoenvironments

Palaeoenvironments are assigned in Table 3 to those samples that have been counted in Kipper–2. 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.

The additional comments on interpretation provided on Table 3 attempt 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.

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.

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). 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 on the identification of the zones in the Kipper wells.

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.**
Interval: 1585.4 to 1591.4 metres
Age: Early Eocene.

The *M. diversus* Zone is identified in the two shallowest sample examined in Kipper–2 based on the marked increase in the abundance of *Malvacipollis diversus* and the closely similar *Malvacipollis subtilis* (average 8% 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. *Spinizonocolpites prominatus* is not found in the succeeding *P. grandis* and *P. tuberculiformis* Subzones but reappears again in the *M. tenuis* Subzone of the *M. diversus* Zone (Partridge, 1999).

The two assemblages are characterised by high abundances of *Myrtaceidites* pollen (average 35%) belonging to the *M. mesonesus/parvus* species complex and absence of the distinctive index species *Lygistepollenites balmei* and *Gambierina rudata* diagnostic of the immediately underlying *L. balmei* Zone. Relative to this older zone both spores (average 5%) and gymnosperms (average 12%) are less prominent, while *Nothofagidites* pollen is very rare.

***Lygistepollenites balmei* spore–pollen Zone.**
Interval: 1603 to 1871.5 metres
Age: Paleocene.

The *L. balmei* Zone identified in Kipper–2 is approximately ~270 metres thick, and is characterised by the frequent to common occurrence of the eponymous species *Lygistepollenites balmei* (average 5%), 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 1871.5m, but possibly extends into the overlying coarsening upward sandstone from 1810 to 1870m, which lacks productive palynological samples. The following *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 from 1754 to 1809.4m. The next youngest *Proteacidites* (al. *Propylipollis*) *annularis* Subzone, is defined by the FAD (First Appearance Datum) of the eponymous species, and is identified from 1623.5m to 1742.5m. The highest *Matonisporites* (al. *Cyathidites*) *gigantis* Subzone, which is also defined by the FAD of the eponymous species, is represented by the sidewall core at 1603m.

***Forcipites longus* spore–pollen Zone.**
Interval: 1880.6 to 2055.1 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 (eg. *Proteacidites reticuloconcavus* ms) with FADs and LADs that are considered coincident with those of *F. longus* (see Stover & Partridge, 1973, Helby *et al.*, 1987). The zone has also, since the early 1980s, been informally 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–2 the Upper *F. longus* Zone is confidently identified in sidewall cores between 1880.6 and 1969m based on the abundance of *Gambierina* pollen (average 6%), supported by the FAD of *T. maastrichtiensis* slightly shallower at 1954m, and LAD of *P. reticuloconcavus* ms at the top of the zone at 1880.6m (Table 5). The Lower *F. longus* Zone is identified between 1999m and 2055.1m based on the presence of *P. reticuloconcavus* ms (FAD at 2030m) and absence of *Forcipites sabulosus*.

Nothofagidites senectus **spore–pollen Zone.**
Interval: 2211.6 to 2444 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 boundaries (Partridge, 1999).

In Kipper–2 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 deepest pick for zone is the sidewall core at 2444m which contains the FAD of reliable *F. sabulosus*, with the FAD for *N. senectus* occurring slightly shallower in conventional core–9 at 2436.41m (Table 5). Although both species are recorded in deeper samples these occurrences are either questionable identifications or are interpreted to represent caved specimens. The shallowest good samples assigned to the *N. senectus* Zone in Kipper–2 are those from conventional core–1 from 2216.18 to 2221.42m, which contains both *N. senectus* and *F. sabulosus* but lack *Tricolporites lilliei* and *Battenipollis sectilis*. Although *Tricolporites lilliei* is reported by Davies & Ioannides (1999) from the one sample processed from conventional core–2 at 2222.06m, the specimen they coordinated could not be located and therefore is interpreted as questionable.

The zone can also be subdivided into a Lower *N. senectus* Zone (= *F. sabulosus* Subzone) characterised by *Forcipites sabulosus* being more abundant than *Nothofagidites* and a 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*. The Upper *N. senectus* Zone in Kipper–2 is best represented by samples from conventional core–1 from 2216.18 to 2221.42m, which contain common *Nothofagidites* pollen (5% to 17%) and extremely rare *Gambierina rudata*. The latter species was not recorded in the counts but is reported in the assemblage lists of Davies & Ioannides (1999). In addition, the sample from core–2 at 2222.06m and cuttings at 2230-35m are assigned to the Upper *N. senectus* Zone on the common occurrence of *Nothofagidites* (8% of SP count), while the two sidewall cores at 2235.6m and 2242.1m are tentatively assigned to the subzone on the frequent occurrence of the spore *Densoisporites velatus*. The latter species is characteristic of the Upper *N. senectus* Zone identified in Kipper–1 (Partridge & Macphail, 2000).

The Lower *N. senectus* Zone is represented by approximately 200 metres of section from 2267.6 to 2444m in Kipper–2. Twenty-six samples have been processed for palynology through the interval and nineteen samples were counted (Table 2). The remaining seven samples are either barren or gave only meagre yields. Overall the assemblages show changes in abundance of a few species (or species categories) of spores and gymnosperm pollen known to have much longer ranges, that extend significantly beyond this subzone. Most conspicuous are the categories *Cyathidites* spp. (<3% to 43%, average 13%), *Laevigatosporites* spp. (<1% to 35%, average 9%), *Podocarpidites* spp. (<2% to 34%, average 16%), *Trichotomosulcites subgranulatus* (<1% to 35%, average 15%), and *Phyllocladidites mawsonii* (<1% to 7%, average 2%). Amongst the angiosperm pollen only the small tricolpate and tricolporate pollen are consistently common (<1% to >40%, average 12%), with the next most frequent pollen being the broad category of *Proteacidites* spp. (<1% to 22%, average 4%). The index species *Nothofagidites* spp. and *Forcipites sabulosus* are only sporadically frequent and both average less than 1% of the assemblages. It was hoped that the increase in prominence of both these species would provide a useful biostratigraphic horizon, but a comparison of their occurrences in both Kipper–1 and 2 has found no consistency in their distribution and abundance. In conclusion, although the assemblages from the Lower *N. senectus* Zone have now been documented in considerable detail no further palynological subdivision can be identified through this important reservoir section.

***Tricolporites apoxyexinus* spore–pollen Zone.**

Interval: 2461 to 2595 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 are recorded within the *T. apoxyexinus* Zone identified in the Kipper–2, the most characteristic feature of assemblages is instead 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 comprise from 2% to 13% (average 7%) of the spore-pollen count. 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.

The assemblages in Kipper–2 are dominated by gymnosperm pollen (average 63%) with spores (average 21%) only slightly more abundant than angiosperm pollen (16%). Bisaccate pollen assigned to *Podocarpidites* (14% to 46%, average 27%) generally dominate the assemblages, with *Dilwynites* spp. (average 10%) and *Trichotomosulcites subgranulatus* (average 9%) the next most common, and *Cyathidites* spp. (average 8%) the most abundant spores. Amongst the angiosperms pollen *Proteacidites* spp. (average 7%) are more prominent than tricolpates/tricolporates (average 6%).

MICROPLANKTON ZONES

***Apectodinium hyperacanthum* microplankton Zone.**

Interval: 1585.4 to 1591.4 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 two Kipper–2 by the occurrence of this species in two sidewall cores over an interval of 6 metre. In the shallower sample *Apectodinium homomorphum* is twice as abundant as *A. hyperacanthum* with few other microplankton species present, while the deeper sample contains a more diverse assemblage dominated by *Paralecaniella indentata* with only rare specimens of *A. hyperacanthum*.

Apectodinium reburrus **microplankton Acme Zone.**
Interval: 1623.5 to 1809.5 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. In Kipper–2 the zone is identified by the occurrence of mostly monospecific assemblages of the eponymous species, which ranges in abundance from 1% to 53% of the combined SP + MP count. As all samples are interbedded within a coal measures section of the Latrobe Group they are interpreted to represent depositional settings ranging from coastal lagoons, coastal estuaries to nearshore interdistributary bay environments. As all these environments are landward of the maximum seaward limit of coal deposition during the Late Paleocene they also conform to the original definition of paralic environments (see Bates & Jackson, 1987).

Alisocysta circumtabulata **microplankton Zones or older.**
Sample at: 1871.5m
Age: Early Paleocene.

The sidewall core sample at 1871.5m from the upper part of the Kate Shale in and Kipper–2 contains an abundant (46%) and moderated diversity microplankton assemblages dominated by the species *Glaphyrocysta retiintexta, Deflandrea speciosus* and *Hystrichosphaeridium tubiferum*. The presence of *Alisocysta circumtabulata* favours assignment of the sample to the *A. circumtabulata* Zone the youngest of three Early Paleocene microplankton zones, but does not preclude assignment to the slightly older *Palaeoperidinium pyrophorum* Zone. The possibility that the sample might belong to the basal Paleocene *Trithyrodinium* *evittii* Acme Zone is considered unlikely in the absence of any abundance of that eponymous species.

***Manumiella druggii* microplankton Subzone.**
Sample at: 1880.6 metres
Age: Late Maastrichtian.
The eponymous species *Manumiella druggii* was recorded in the original palynological report by Hannah (1987) from the sidewall core at 1880.6m recovered from the middle of the Kate Shale, but the species was not confirmed during the assemblage count. On log character the slightly deeper sidewall core at 1888m is also interpreted to lie within the Kate Shale but appears to lack microplankton. Additional study of microplankton assemblages from the Kate Shale interval from 1870 to 1890m in Kipper–2 could be made using cuttings, even though the assemblages extracted from this thin interval most likely will be mixed.

***Chatangiella porosa* microplankton Zone.**
Interval: 2491 to 2564 metres
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.

The zone is best developed in Kipper–2 where it is identified in sidewall cores over a 73 metre interval from 2491 to 2564m (Table 5). The assemblages are of moderate diversity (12 to 20 species) dominated by *Chatangiella porosa* and a probable new species of *Exochosphaeridium*. The zone is interpreted to thin to only 5 metres thick in Kipper–1 were it is confidently recorded only in the two sidewall cores at 2187.5m and 2192m (Partridge & Macphail, 2000).

References

BATES, R.L. & JACKSON, J.A., editors, 1987. *Glossary of Geology. Third Edition.* American Geological Institute, Alexandria, Virginia, p.1-788.

DAVIES, T.D. & IOANNIDES, N.S., 1999. Re-evaluation of palynological ages for the Kipper Field, Gippsland Basin, Australia. *Exxon Exploration Company, Technology Biostratigraphy Report, Geological Services Division EEC.16A.BIO.99*, p.1–50.

DETTMANN, M.E., 1963. Upper Mesozoic microfloras from southeastern Australia. *Proceedings Royal Society of Victoria, vol.77*, pt.1, p.1–148, pl.1-27.

HANNAH, M.J., 1987. Palynological Analysis of Kipper-2, Gippsland Basin. *Esso Australia Ltd Palaeontological Report 1987/10*, 16p, 2 charts (September).

HAQ, B.U., HARDENBOL, J. & VAIL, P., 1987. Chronology of fluctuating sea levels since Triassic. *Science 235*, p.1156–1167.

HAQ, B.U., HARDENBOL, J. & VAIL, P., 1988. Mesozoic and Cenozoic chronostratigraphy and cycles of sea-level change. **In** *Sea-level changes: An integrated approach*, C.K. Wilgus, B.S. Hastings, C.G.St.C. Kendall, H.W. Posamentier, C.A. Ross & J.C. Van Wagoner, editors, *SEPM Special Publication No. 42*, p.71–108.

HELBY, R., MORGAN, R. & PARTRIDGE, A.D., 1987. A palynological zonation of the Australian Mesozoic. *Memoir Association Australasian Palaeontologists 4*, p.1–94.

LOWRY, D.C. & LONGLEY, I.M., 1991. A new model for Mid-Cretaceous structural history of the northern Gippsland Basin. *The APEA Journal, vol.31*, pt.1, p.143–153.

MARSHALL, N.G., 1988. A Santonian dinoflagellate assemblage from the Gippsland Basin, Southeastern Australia. *Association of Australasian Palaeontologists Memoir 5*, p.195-215.

MARSHALL, N.G. & PARTRIDGE, A.D., 1986. Palynological Analysis of Kipper-1, Gippsland Basin. *Esso Australia Ltd Palaeontological Report 1986/18*, 21p, 3 charts (September).

PARTRIDGE, A.D., 1975. Palynological zonal scheme for the Tertiary of the Bass Strait Basin (Introducing Paleogene Dinoflagellate Zones and Late Neogene Spore-Pollen Zones). *Geological Society of Australia (Victorian Division) Symposium on the Geology of Bass Strait and Environs, Melbourne*, November, 1975. *Esso Australia Ltd Palaeontological Report 1975/17* (unpubl.).

PARTRIDGE, A.D., 1976. The geological expression of eustacy in the early Tertiary of the Gippsland Basin. *The APEA Journal, vol.16*, pt.1, p.73–79.

PARTRIDGE, A.D., 1990. Palynological analysis of Admiral–1, Gippsland Basin. *Esso Aust. Ltd. Palaeontological Report 1990/14*, p.1–31 (unpubl.).

PARTRIDGE, A.D., 1997. New Upper Cretaceous palynology of the Sherbrook Group, Otway Basin. **In** *Victorian Supplement, PESA News* April/May, p.9.

PARTRIDGE, A.D., 1999. Late Cretaceous to Tertiary geological evolution of the Gippsland Basin, Victoria. PhD thesis, La Trobe University, Bundoora, Victoria, p.i-xxix, p.1–439, 165 figs, 9 pls (unpubl.).

PARTRIDGE, A.D. & MACPHAIL, M.K., 2000. High-resolution palynological analysis of the reservoir interval in Kipper–1, Gippsland Basin. *Biostrata Report 2000/8*, p.1–38.

STOVER, L.E. & EVANS, P.R., 1974 [imprint 1973]. Upper Cretaceous–Eocene spore-pollen zonation, offshore Gippsland Basin, Australia. **In** *Mesozoic and Cainozoic palynology: Essays in honour of Isabel Cookson*. J.E. Glover & G. Playford, editors, *Geological Society of Australia Special Publication 4*, p.55-72, pls 1-4.

STOVER, L.E. & PARTRIDGE, A.D., 1973. Tertiary and late Cretaceous spores and pollen from the Gippsland Basin, southeastern Australia. *Proceedings Royal Society Victoria 85,* p.237–286.

THOMPSON, B.R., 1986. The Gippsland Basin—Development and Stratigraphy. **In** *Second South-Eastern Australia Oil Exploration Symposium*, R.C. Glenie, editor, Technical papers presented at PESA Symposium, 14–15 November, 1985, Melbourne, p.57-64.

WILLIAMS, G.L., LENTIN, J.K. & FENSOME, R.A., 1998. The Lentin and Williams index of fossil dinoflagellates 1998 edition. *American Association of Stratigraphic Palynologists, Contributions Series, no. 34*, p.1–817.

Table 1: Interpretative Palynological Data for Kipper–2

Spl. No.	Sample Type	Depth (metres)	Spore-Pollen Zone or (Subzone)	Microplankton Zone	Comment
1	SWC 51	1585.4	*M. diversus* (*S. prominatus* Subzone)	*A. hyperacanthum*	FAD of *Apectodinium homomorphum* with *Myrtaceidites* 28%
2	SWC 50	1591.4	*M. diversus* (*S. prominatus* Subzone)	*A. hyperacanthum*	FAD of *Apectodinium hyperacanthum* with *Myrtaceidites* 44%
3	SWC 59	1603.0	Upper *L. balmei* (*M. gigantis* Subzone)		FAD of *Matonisporites gigantis*
4	SWC 48	1623.5	Upper *L. balmei*	*A. reburrus*	*Apectodinium reburrus* ms 1.6% of combined SP+MP count, and *Araucariacidites/Dilwynites* pollen 24%
5	SWC 47	1652.5	Upper *L. balmei* (*P. annularis* Subzone)	*A. reburrus*	FAD of *Proteacidites annularis* with *Apectodinium reburrus ms* 4%
6	SWC 46	1675.5	Indeterminate		Dominated by caved Olig/Miocene MP
7	SWC 44	1699.5	Upper *L. balmei*	*A. reburrus*	*Araucariacidites/Dilwynites* pollen 29%
8	SWC 42	1742.5	Upper *L. balmei* (*P. annularis* Subzone)	*A. reburrus*	FAD of *Propylipollis annularis* with *Araucariacidites/Dilwynites* pollen 15%
9	SWC 41	1754.0	Lower *L. balmei* (*P. angulatus* Subzone)		LAD of *Proteacidites angulatus*
10	SWC 39	1809.5	Lower *L. balmei* (*P. angulatus* Subzone)	*A. reburrus*	FAD of *A. reburrus* ms representing 53% of combined SP+MP count
11	SWC 38	1871.5	Lower *L. balmei* (*T. verrucosus* Subzone)	*A. circumtabulata* or older	LAD of *Alisocysta circumtabulata*
12	SWC 37	1880.6	Upper *F. longus*	*M. druggii*	LAD of *Proteacidites reticuloconcavus* ms
13	SWC 36	1888.0	Upper *F. longus*		*Gambierina* 9.7%
14	SWC 35	1899.5	Indeterminate		Essentially barren on quick scan
15	SWC 33	1944.0	Upper *F. longus*		Coal sample with *Gambierina* <2%
16	SWC 33	1954.0	Upper *F. longus*		FAD of *Tripunctisporis maastrichtiensis*
17	SWC 31	1969.0	Upper *F. longus*		*Gambierina* 6.6%
18	SWC 30	1982.5	*F. longus*		Low concentration / not counted
19	SWC 29	1999.0	Lower *F. longus*		*Grapnelispora evansii* present.
20	SWC 28	2015.5	Lower *F. longus*		FAD of *Forcipites longus*
21	SWC 27	2030.0	Lower *F. longus*		FAD of *Proteacidites reticuloconcavus* ms
22	SWC 26	2041.5	Lower *F. longus*		*Nothofagidites* pollen <2%
23	SWC 25	2055.1	Lower *F. longus*		Some contamination present
24	SWC ?	2192.0	*N. senectus ?*		EPR sample, type unknown, depth near base of volcanic unit, assemblage most similar to those from below volcanics.
25	SWC 21	2211.6	Indeterminate		Low concentration / not counted
26	Core 1	2216.18	Upper *N. senectus*		*Nothofagidites* pollen 5%
27	Core 1	2221.42	Upper *N. senectus*		*Nothofagidites* pollen 17%
28	Core 2	2222.06	Upper *N. senectus*		*Nothofagidites* pollen 8%
29	Cuttings	2230-35	Upper *N. senectus*		>10% assemblage caved
30	SWC 20	2235.6	Upper? *N. senectus*		*Nothofagidites* pollen 4% *Densoisporites velatus* 5%
31	SWC 19	2242.1	Upper? *N. senectus*		*Nothofagidites* pollen 1.3% *Densoisporites velatus* 2.7%
32	SWC 16	2267.6	Lower *N. senectus*		*Forcipites sabulosus* 2.7% *Nothofagidites* 4.4%
33	Cuttings	2280-85	*N. senectus*		>10% assemblage caved
34	Core 3	2287.0	Indeterminate		Quick scan only / contaminated
35	Core 3	2290.35	*N. senectus*		Poor sample — badly clumped
36	Core 3	2292.6	Lower *N. senectus*		*Forcipites sabulosus* 8%
37	Cuttings	2295-300	Indeterminate		Low yield / not counted
38	Core 5	2313.68	Lower *N. senectus*		*Forcipites sabulosus* 0.3%
39	Core 5	2315.53	Lower *N. senectus*		*Forcipites sabulosus* 1.8%
40	Core 6	2320.84	Indeterminate		Poor sample — badly clumped
41	Core 6	2325.18	Indeterminate		Fungal spore & hyphae 53%
42	Core 6	2330.0	Lower *N. senectus*		*Forcipites sabulosus* 1.8%

Table 1: Interpretative Palynological Data for Kipper–2

Spl. No.	Sample Type	Depth (metres)	Spore-Pollen Zone or (Subzone)	Microplankton Zone	Comment
43	Core 7	2339.48	*N. senectus*		Dominated by gymnosperm pollen 74%
44	Core 8	2344.46	Indeterminate		Essentially barren / not counted
45	Core 8	2346.05	Indeterminate		Essentially barren / not counted
46	SWC 15	2364.0	Indeterminate		Essentially barren / not counted
47	SWC 14	2385.0	*N. senectus*		Low yielding sample
48	Cuttings	2390-95	*N. senectus*		Assemblage substantially caved
49	SWC 13	2403.6	Indeterminate		Essentially barren
50	SWC 12	2413.5	Indeterminate		Barren
51	Core 9	2430.48	Indeterminate		*Laevigatosporites* 36%
52	Core 9	2433.03	Lower *N. senectus*		Reliable presence of *Forcipites sabulosus*
53	Core 9	2434.66	Indeterminate		Skewed assemblage
54	Core 9	2436.41	Lower *N. senectus*		FAD of *Nothofagidites*
55	Core 9	2437.92	*N. senectus*		*Proteacidites* 5%
56	Core 9	2439.0	*N. senectus*		*Proteacidites* 22%
57	SWC 11	2444.0	Lower *N. senectus*		FAD of *Forcipites sabulosus*
58	SWC 10	2461.0	*T. apoxyexinus*		LAD of *Exochosphaeridium* n.sp. with *Proteacidites* 13%
59	SWC 9	2475.0	Indeterminate		Low yielding sample
60	SWC 8	2491.0	*T. apoxyexinus*	*C. porosa*	LAD of *Chatangiella porosa* with *Proteacidites* 8%
61	Cuttings	2495-500	*T. apoxyexinus*		*Proteacidites* 4%
62	SWC 7	2503.5	*T. apoxyexinus*	*C. porosa*	*Proteacidites* 11%
63	SWC 6	2517.0	*T. apoxyexinus*	*C. porosa*	*Proteacidites* 2.4%
64	SWC 5	2528.5	*T. apoxyexinus*	*C. porosa*	*Proteacidites* 11%
65	SWC 4	2544.1	*T. apoxyexinus*	*C. porosa*	FAD of *Chatangiella porosa* with *Proteacidites* 6%
66	SWC 3	2564.0	*T. apoxyexinus*	*C. porosa*	*Proteacidites* 4%
67	SWC 2	2580.1	*T. apoxyexinus*		*Proteacidites* 9%
68	SWC 1	2590.1	Indeterminate		Low yielding sample
69	Cuttings	2595-600	*T. apoxyexinus*	*C. porosa* (caved?)	Assemblage substantially caved.
	T.D.	2600m			

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

Spl. No.	Sample Type	Depth (metres)	Duplicate EAL Slides		New Exxon (EPR) Slides		SlideSet Counted	Total Count	Oper-ator	Visual Yields	Palynomorph Concentrations	Preservation
			Kero.	Oxid.	Kero.	Oxid.						
1	SWC 51	1585.4	1	2			EAL	282	ADP	Low	Moderate	Fair
2	SWC 50	1591.4	1	1			EAL	276	ADP	Low	Moderate	Fair-good
3	SWC 59	1603.0	1	2			EAL	346	MKM	Moderate	High	Fair
4	SWC 48	1623.5	1	2			EAL	355	MKM	High	High	Good
5	SWC 47	1652.5	1	2			EAL	354	MKM	Moderate	High	Fair
6	SWC 46	1675.5	1	2						Very Low	Very Low	Fair-good
7	SWC 44	1699.5	1	2			EAL	308	MKM	High	High	Good
8	SWC 42	1742.5	1	2			EAL	302	MKM	High	High	Good
9	SWC 41	1754.0	1	2			EAL	253	ADP	High	High	Fair-good
10	SWC 39	1809.5	1	2			EAL	296	MKM	High	High	Fair-good
11	SWC 38	1871.5	1	2			EAL	208	ADP	Moderate	Moderate	Poor-fair
12	SWC 37	1880.6	1	2			EAL	358	MKM	High	High	Fair
13	SWC 36	1888.0	1	2			EAL	217	ADP	Moderate	Moderate	Good
14	SWC 35	1899.5	1	2						Very Low	Very Low	Poor-fair
15	SWC 33	1944.0	1	2			EAL	284	MKM	Moderate	High	Fair-good
16	SWC 33	1954.0	1	2			EAL	284	MKM	Moderate	High	Fair
17	SWC 31	1969.0	1	3			EAL	290	MKM	High	High	Good
18	SWC 30	1982.5	1	2						Low	Low	Fair
19	SWC 29	1999.0	1	2			EAL	291	MKM	Moderate	Moderate	Good
20	SWC 28	2015.5	1	2			EAL	308	MKM	High	High	Fair
21	SWC 27	2030.0	1	2			EAL	292	MKM	Moderate	Moderate	Fair
22	SWC 26	2041.5	1	2			EAL	311	MKM	Moderate	High	Fair-good
23	SWC 25	2055.1	1	2			EAL	357	MKM	High	High	Fair
24	SWC ?	2192.0				1	EPR	213	ADP	Low	High	Fair
25	SWC 21	2211.6	1	1						Low	Low	Fair
26	Core 1	2216.18			1	4	EPR	285	MKM	Moderate	High	Poor-good
27	Core 1	2221.42			1	2	EPR	164	ADP	Moderate	Moderate	Poor (over oxid.)

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

Spl. No.	Sample Type	Depth (metres)	Duplicate EAL Slides		New Exxon (EPR) Slides		SlideSet Counted	Total Count	Oper-ator	Visual Yields	Palynomorph Concentrations	Preservation
			Kero.	Oxid.	Kero.	Oxid.						
28	Core 2	2222.06			1	2	EPR	287	MKM	Moderate	High	Fair
29	Cuttings	2230-35			1	2	EPR	283	MKM	Moderate	High	Poor-fair
30	SWC 20	2235.6	1	3			EAL	293	ADP	High	High	Fair-Good
31	SWC 19	2242.1	1	2			EAL	296	ADP	Moderate	Moderate	Poor-fair
32	SWC 16	2267.6	1	2			EAL	303	ADP	Moderate	Moderate	Fair-Good
33	Cuttings	2280-85			1	2	EPR	298	MKM	Moderate	Moderate	Poor-fair
34	Core 3	2287.0	1	2						Moderate	Moderate	Poor-fair
35	Core 3	2290.35			1	1	EPR	257	MKM	Low	Moderate	Poor (clumped)
36	Core 3	2292.6	1	2			EAL	281	ADP	Moderate	Moderate	Poor
37	Cuttings	2295-300			1	2				Low	Low	Poor-fair
38	Core 5	2313.68			1	1	EPR	333	MKM	Moderate	High	Fair
39	Core 5	2315.53	2	3			EAL	278	ADP	High	High	Fair
40	Core 6	2320.84			1	1	EPR	262	MKM	Moderate	High	Poor (clumped)
41	Core 6	2325.18			1	2	EPR	316	MKM	Moderate	High	Poor (fragmented)
42	Core 6	2330.0	1	2			EAL	280	ADP	High	Very High	Fair-Good
43	Core 7	2339.48			1	3	ERP	335	MKM	Moderate	High	Poor-fair
44	Core 8	2344.46			1	1				Very Low	Barren	Poor
45	Core 8	2346.05			1	1				Very Low	Barren	Poor
46	SWC 15	2364.0	1	2						Very Low	Barren	Poor
47	SWC 14	2385.0	1	2			EAL	119	ADP	Moderate	Very Low	Fair
48	Cuttings	2390-95			1	2	EPR	297	MKM	Moderate	High	Poor (clumped)
49	SWC 13	2403.6	1	2						Very Low	Very Low	Poor
50	SWC 12	2413.5								Very Low	Barren	Poor
51	Core 9	2430.48			1	2	EPR	283	MKM	Moderate	High	Poor
52	Core 9	2433.03			1	2	EPR	214	ADP	Moderate	High	Poor (over oxid.)
53	Core 9	2434.66			1	2	EPR	303	MKM	High	High	Poor
54	Core 9	2436.41			1	2	EPR	355	MKM	High	High	Poor

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

Spl. No.	Sample Type	Depth (metres)	Duplicate EAL Slides		New Exxon (EPR) Slides		SlideSet Counted	Total Count	Oper-ator	Visual Yields	Palynomorph Concentrations	Preservation
			Kero.	Oxid.	Kero.	Oxid.						
55	Core 9	2437.92			1	2	EPR	302	MKM	High	High	Poor
56	Core 9	2439.0	2	4			EAL	242	ADP	Moderate	Moderate	Fair
57	SWC 11	2444.0	1	2			EAL	212	ADP	Moderate	Low	Fair
58	SWC 10	2461.0	1	2	1	2	EAL	251	ADP	Moderate	Low	Fair
59	SWC 9	2475.0	1	2						Low	Low	Poor-fair
60	SWC 8	2491.0	1	2	1	2	EAL	164	ADP	Moderate	Moderate	Fair
61	Cuttings	2495-500			1	2	EPR	335	MKM	High	High	Poor (clumped)
62	SWC 7	2503.5	1	2	1	2	EAL	304	ADP	Moderate	Low	Poor
63	SWC 6	2517.0	1	2	1	2	EAL	272	ADP	High	High	Poor-fair
64	SWC 5	2528.5	1	2	1	2	EAL	273	ADP	Moderate	Moderate	Fair
65	SWC 4	2544.1	1	2	1	2	EAL	317	ADP	Moderate	Moderate	Poor (pyrite pitted)
66	SWC 3	2564.0	1	2	1	2	EPR	333	MKM	Low	Moderate	Poor (pyrite pitted)
67	SWC 2	2580.1	1	2	1	2	EPR	155	ADP	Moderate	Low	Poor
68	SWC 1	2590.1	1	2						Low	Low	Poor-fair
69	Cuttings	2595-600	1	2	1	2	EPR	127	ADP	Moderate	Low	Poor (over oxid.)
		Total No. Slides:	49	97	29	57			**ADP**	= A.D. Partridge		
									MKM	= M.K. Macphail		

Table 3: Palaeoenvironmental interpretation of individual samples.

Spl. No.	Sample Type	Depth (metres)	Total MP%	Environment from Palynology	Comments on Interpretation
1	SWC 51	1585.4	29%	Nearshore marine	Abundant microplankton in moderate diversity assemblage.
2	SWC 50	1591.4	25%	Nearshore marine	Abundant microplankton in low diversity assemblage.
3	SWC 59	1603.0	0.3%	Non-marine	Spores dominant 31% — fern heath or understorey to conifer forest.
4	SWC 48	1623.5	1.6%	Paralic to Nearshore marine	Lagoon/estuary to interdistributary bay — SP assemblage shows Neves effect with *Araucariacites/Dilwynites* pollen 22%
5	SWC 47	1652.5	6.3%	Paralic	Lagoon/estuary surrounded by conifer/*Nothofagus* rainforest.
7	SWC 44	1699.5	1.3%	Paralic to Nearshore marine	Lagoon/estuary to interdistributary bay — SP assemblage shows Neves effect with *Araucariacites/Dilwynites* pollen 29%
8	SWC 42	1742.5	5.4%	Paralic	Lagoon/estuary surrounded by conifer/*Nothofagus* rainforest.
9	SWC 41	1754.0	0.2%	Non-marine	Swampy meadow with *Australopollis obscurus* 20%
10	SWC 39	1809.5	57%	Paralic	Lagoon or estuary with abundant *Apectodinium reburrus* ms representing 53% of combined SP + MP count.
11	SWC 38	1871.5	46.0%	Nearshore marine	Moderately diversity MP assemblage from near top of Kate Shale transgression.
12	SWC 37	1880.6	0.3%	Nearshore marine	Low diversity MP assemblage from near base of Kate Shale transgression.
13	SWC 36	1888.0	NR	Non-marine	Angiosperm heath or shrubland with *Proteacidites* 49%, and *Gambierina* 10%
15	SWC 33	1944.0	NR	Non-marine	*Podocarpus/Microcachys* shrubland to rainforest
16	SWC 33	1954.0	NR	Non-marine	Conifer/angiosperm shrubland to rainforest.
17	SWC 31	1969.0	0.7%	Non-marine	Angiosperm heath or shrubland with *Proteacidites* 16%, and *Gambierina* 7% surrounded by conifer rainforest.
19	SWC 29	1999.0	0.7%	Non-marine	Angiosperm heath or shrubland with *Proteacidites* 15%, surrounded by conifer/*Nothofagus* rainforest.
20	SWC 28	2015.5	0.7%	Non-marine	Angiosperm heath or shrubland with *Proteacidites* 26%, surrounded by conifer/*Nothofagus* rainforest.
21	SWC 27	2030.0	1.0%	Non-marine	*Podocarpus/Microcachys* shrubland to rainforest
22	SWC 26	2041.5	4.7%	Lacustrine	Local fresh-water lake with colonial algae *Amosopollis cruciformis* 5% surrounded by conifer rainforest.
23	SWC 25	2055.1	0.5%	Non-marine	Local/ephemeral fresh-water lake within conifer shrubland to rainforest.
24	SWC ?	2192.0	NR	Non-marine	*Podocarpus/Microcachys* rainforest; fungal spores/hyphae 32%
26	Core 1	2216.18	NR	Non-marine	Angiosperm shrubland to rainforest with tricolpate angiosperms 71%, and *Nothofagus* 17%.
27	Core 1	2221.42	NR	Non-marine	Conifer/*Nothofagus* rainforest.
28	Core 2	2222.06	0.3%	Non-marine	Conifer/*Nothofagus* rainforest.
29	Cuttings	2230-35	5.7%	Non-marine	Conifer/*Nothofagus* rainforest; microplankton probably caved.
30	SWC 20	2235.6	NR	Non-marine	Conifer/*Nothofagus* rainforest.
31	SWC 19	2242.1	NR	Non-marine	Skewed assemblage with spores 72% — fern heath
32	SWC 16	2267.6	NR	Non-marine	*Podocarpus/Microcachys* rainforest; fungal spores/hyphae 3%
33	Cuttings	2280-85	8.6%	Non-marine	*Podocarpus/Microcachys* rainforest; high *Nothofagus* and MP abundances interpreted to represent caved elements.
35	Core 3	2290.35	4.1%	Lacustrine	Ephemeral lake surrounded by conifer rainforest?
36	Core 3	2292.6	0.4%	Non-marine	Fern heath (spores 49%) surrounded by *Podocarpus/Microcachys* rainforest
38	Core 5	2313.68	NR	Non-marine	*Sphagnum* marsh or bog with spore *Stereisporites antiquisporites* representing 56% of SP count.
39	Core 5	2315.53	NR	Non-marine	Fern heath (spores 56%) surrounded by *Podocarpus/Microcachys* rainforest
40	Core 6	2320.84	NR	Non-marine	*Podocarpus/Microcachys* rainforest

Table 3: Palaeoenvironmental interpretation of individual samples.

Spl. No.	Sample Type	Depth (metres)	Total MP%	Environment from Palynology	Comments on Interpretation
41	Core 6	2325.18	NR	Non-marine	Angiosperm shrubland to rainforest with tricolpate angiosperms 40% of SP count, and fungal spores/hyphae 52% of total count.
42	Core 6	2330.0	NR	Non-marine	Fern heath (spores 56%) surrounded by *Podocarpus/Microcachys* rainforest
43	Core 7	2339.48	NR	Non-marine	*Podocarpus/Microcachys* rainforest; fungal spores/hyphae 4%
47	SWC 14	2385.0	NR	Non-marine	Skewed assemblage with spores 73% — fern heath
48	Cuttings	2390-95	1.0%	Non-marine	*Podocarpus/Microcachys* rainforest
51	Core 9	2430.48	NR	Non-marine	Fern heath (spores 61%) surrounded by *Podocarpus/Microcachys* rainforest
52	Core 9	2433.03	1.4%	Non-marine	Swamp or ephemeral lake within *Podocarpus/Microcachys* rainforest
53	Core 9	2434.66	0.3%	Non-marine	Swamp or ephemeral lake within *Podocarpus/Microcachys* rainforest
54	Core 9	2436.41	NR	Non-marine	*Podocarpus/Microcachys* rainforest with fern understorey.
55	Core 9	2437.92	0.7%	Non-marine	Swamp or ephemeral lake within Angiosperm/*Podocarpus/ Microcachys* rainforest
56	Core 9	2439.0	NR	Non-marine	Angiosperm heath to shrubland Proteaceous angiosperm pollen 22%, surrounded by rainforest.
57	SWC 11	2444.0	NR	Non-marine	Conifer (*Podocarpus)* rainforest with angiosperm (Proteaceae) and fern understorey?
58	SWC 10	2461.0	1.2%	Paralic?	Shallowest marine MP mixed with SP assemblage interpreted to represent conifer rainforest with angiosperm and fern understorey.
60	SWC 8	2491.0	4.3%	Paralic	Marine MP mixed with lower coastal plain rainforest assemblage.
61	Cuttings	2495-500	0.3%	Non-marine?	*Podocarpus/Microcachys* rainforest with fern/angiosperm understorey. Assemblage substantially caved?
62	SWC 7	2503.5	18%	Paralic	Probable lagoon or estuary with moderately diverse and abundant MP assemblage from *C. porosa* Zone incursion surrounded by rainforest.
63	SWC 6	2517.0	24%	Paralic	Lagoon or estuary with most abundant and diverse MP assemblage from *C. porosa* Zone incursion, surrounded by rainforest.
64	SWC 5	2528.5	12%	Paralic to Nearshore marine	Diverse (9+ species) moderately abundant MP in *C. porosa* Zone incursion with *Dilwynites* pollen 13% representative of mild Neves effect.
65	SWC 4	2544.1	33%	Nearshore marine	Peak of flooding event of *C. porosa* Zone incursion based on abundance and diversity (8+ species) of MP and presence of distinct Neves effect represented by maximum *Dilwynites* pollen abundance of 17%.
66	SWC 3	2564.0	3.4%	Paralic?	Fresh-water lagoon based on dominance of non-marine MP *Sigmopollis carbonis* , mixed with SP assemblage interpreted as derived largely from conifer rainforest.
67	SWC 2	2580.1	2.7%	Paralic?	Generally a poor sample with SP assemblage representative of conifer rainforest, and MP most likely caved.
69	Cuttings	2595-600	6.3%	Indeterminate	Mixed assemblages of conifer rainforest spore-pollen and paralic microplankton that are interpreted as most likely caved.
			NR	= MP not recorded in count	

Table 4: Kipper–2	Percentage abundances for selected palynomorphs.									
Sample Type:	SWC 51	SWC 50	SWC 49	SWC 48	SWC 47	SWC 44	SWC 42	SWC 41	SWC 39	SWC 38
Depth (m):	1585.5	1591.4	1603	1623.5	1652.5	1699.5	1742.5	1754	1809.5	1871.5
Operator:	ADP	ADP	MKM	MKM	MKM	MKM	MKM	ADP	MKM	ADP
SPORES										
Aequitriradites spp.										
Baculatisporites spp.				0.6%		1.0%		0.8%		
Camarozonosporites heskermensis										
Cicatricosisporites/Ruffordiaspora spp.										
Clavifera triplex			0.3%	0.3%						
Clavifera vultuosus†										
Coptospora pileolus†										
Cyathidites (large) >40µm		2.5%	4.3%	1.2%		0.3%	0.7%	1.6%		1.8%
Cyathidites (small) <40µm	3.2%	2.0%	6.4%	2.7%	1.2%	2.0%	0.7%	4.0%	1.6%	
Densoisporites velatus										
Dictyophyllidites spp.								0.4%		
Foveotriletes/Foveosporites spp.						0.3%				
Gleicheniidites spp.			5.5%	2.1%	0.3%	3.0%	0.3%	2.8%		3.6%
Herkosporites/Ceratosporites sp.								0.8%		1.8%
Ischyosporites spp.			0.3%	0.6%						
Laevigatosporites spp.	3.2%	2.0%	9.5%		1.5%	3.6%	1.4%	1.2%	2.3%	0.9%
Latrobosporites spp.				1.5%		0.3%				0.9%
Marratisporites scabratus										
Monolete Spores undiff.		0.5%	0.6%			0.3%	0.3%	0.4%	0.8%	
Osmundacidites wellmanii										
Peromonolites spp.	0.5%		0.9%					0.8%		
Perotrilites spp.										
Polypodiisporites spp.			1.5%		0.3%					
Retitriletes spp.			0.3%		0.3%					
Rugulatisporites spp.			0.3%							
Stereisporites antiquisporites			0.6%	0.3%		0.3%	0.3%			
Stereisporites regium										
Triletes undiff.		1.5%	0.9%			0.7%	0.3%	2.4%		
Triporoletes reticulatus										
Tripunctisporis maastrichtiensis										
Verrucosisporites kopukuensis				0.6%						
Total Spores:	**7%**	**8%**	**31%**	**10%**	**4%**	**12%**	**4%**	**15%**	**5%**	**9%**
GYMNOSPERMS undiff.			0.6%	0.3%	0.9%		2.4%			
Araucariacites australis		0.5%	3.1%	9.3%	2.4%	10.5%	3.8%		2.3%	
Corollina spp.										
Cupressacites sp.				0.3%		1.0%		0.8%		
Cycadopites spp.			0.3%							
Dilwynites pusillus†										
Dilwynites spp.	5.8%	5.0%		13.1%	2.1%	18.8%	11.5%	3.2%		1.8%
Lygistepollenites balmei			5.2%	6.3%	1.2%	7.9%	6.3%	6.0%	2.3%	3.6%
Lygistepollenites florinii	1.6%		0.9%	4.2%	5.7%	3.6%	3.8%		6.3%	0.9%
Microalatidites (P.) paleogenicus					0.3%	0.3%				
Microcachryidites antarcticus		0.5%	0.3%	1.8%	0.3%	0.7%	0.7%	0.4%	2.3%	0.9%
Phyllocladidites eunuchus†										
Phyllocladidites mawsonii			2.4%	2.7%	10.0%	9.9%	13.3%	4.8%	22.7%	8.9%
Phyllocladidites reticulosaccatus/verrucosus			0.9%		0.3%	0.7%	1.0%	0.4%	1.6%	0.9%
Podocarpidites spp.	7.9%	3.5%	9.2%	23.0%	10.6%	15.5%	19.2%	13.7%	14.1%	33.0%
Trichotomosulcites subgranulatus			0.3%	1.2%	0.3%	1.6%	1.4%	4.4%	0.8%	2.7%
Vitreisporites signatus/pallidus										
Total Gymnosperms:	**15%**	**9%**	**23%**	**62%**	**34%**	**70%**	**64%**	**34%**	**52%**	**53%**
ANGIOSPERMS undiff.	6.3%	5.0%	1.8%	0.6%	1.8%	0.7%	1.0%	1.2%	3.1%	1.8%
Australopollis obscurus		0.5%		6.9%	0.9%		0.3%	20.1%		
Battenipollis sectilis										
Beaupreaidites orbiculatus										
Cupanieidites orthoteichus	2.1%									
Dicotetradites clavatus	0.5%	0.5%	0.9%	0.9%	2.4%		0.7%	0.4%		
Forcipites longus										
Forcipites sabulosus										
Forcipites spp.										
Gambierina rudata/edwardsii			0.6%		0.6%	0.3%	0.3%			
Haloragacidites harrisii (=Casuarina)	2.1%	2.0%	3.1%	0.9%	6.0%	0.7%			0.8%	
Ilexpollenites spp.			0.3%		0.6%			0.4%	0.8%	1.8%
Liliacidites spp.					1.2%	0.7%	0.7%			0.9%
Malvacipollis subtilis/diversus	5.8%	11.9%		0.3%						
Myrtaceidites parvus/mesonesus	28.0%	44.3%								
Nothofagidites brachyspinulosus/flemingii			1.8%	2.1%	1.5%	0.3%	0.3%	0.4%		
Nothofagidites emarcidus/heterus			0.3%			0.3%		2.4%		
Nothofagidites endurus			10.7%	4.8%	8.2%	4.3%	3.8%	4.0%	0.8%	
Nothofagidites senectus										
Peninsulapollis gillii							0.3%	0.4%		8.9%
Periporopollenites spp.	1.1%		8.9%	4.8%	11.8%	2.3%	8.4%	2.8%	3.1%	
Pseudowinterapollis cranwellae/wahooensis			0.3%				0.3%			
Proteacidites spp.	5.8%	4.0%	11.9%	2.1%	13.6%	2.6%	7.7%	9.6%	8.6%	16.1%
Proteacidites angulatus								0.4%	8.6%	
Proteacidites obscurus				0.3%	0.9%					
Proteacidites (C.) palisadus										
Proteacidites reticuloconcavus†										
Spinizonocolpites prominatus	0.5%									
Tetracolp(or)ites spp.				0.3%	0.3%	0.3%				

Table 4: Kipper–2	Percentage abundances for selected palynomorphs.									
Sample Type:	SWC 51	SWC 50	SWC 49	SWC 48	SWC 47	SWC 44	SWC 42	SWC 41	SWC 39	SWC 38
Depth (m):	1585.5	1591.4	1603	1623.5	1652.5	1699.5	1742.5	1754	1809.5	1871.5
Operator:	ADP	ADP	MKM	MKM	MKM	MKM	MKM	ADP	MKM	ADP
Tetracolporites verrucosus								0.4%		1.8%
Tetradites securus†										
Tricolpites confessus										
Tricolpites waipawaensis										
Tricolpites/Tricolporites spp.	12.2%	11.4%	0.9%	4.2%	9.4%	5.3%	8.0%	8.4%	17.2%	6.3%
Tricolporites lilliei										
Triporopollenites spp.	13.2%	2.5%	3.7%		3.0%					0.9%
Total Angiosperms:	**78%**	**82%**	**45%**	**28%**	**62%**	**18%**	**32%**	**51%**	**43%**	**38%**
Total Spore-Pollen:	**189**	**201**	**327**	**335**	**331**	**304**	**286**	**249**	**128**	**112**
MICROPLANKTON % of MP COUNT										
Microplankton undiff.	6%	50%	100%		9%		6%	100%	4%	35%
Alisocysta circumtabulata										1%
Amosopollis cruciformis										
Apectodinium homomorphum	64%									
Apectodinium hyperacanthum	30%	1%								
Apectodinium reburrus†				100%	59%	100%	19%		92%	
Chatangiella porosa										
Circulisporites parvus										
Cribroperidinium sp.										
Deflandrea spp.					14%		75%		1%	10%
Dinogymnium spp.										
Exochosphaeridium n.sp.										2%
Glaphrocysta spp.										22%
Heterosphaeridium spp.										
Hystrichosphaeridium tubiferum										8%
Isabelidinium spp.										
Kenleyia spp.		3%								
Manumiella spp.										
Micrystridium sp. A										
Oligosphaeridium spp.										
Palambages spp.										1%
Paralecaniella indentata		46%							3%	6%
Saeptodinium spp. (non-marine dino.)										
Senegalinium dilwynense										4%
Sigmopollis carbonis										
Spinidinium/Vozzhennikovia spp.					9%					5%
Spiniferites spp.					9%					4%
Trithyrodinium spp.										
Xenascus spp.										
Total Microplankton Count:	**77**	**68**	**1**	**5**	**22**	**4**	**16**	**1**	**165**	**96**
Microplankton % of total SP & MP:	28.9%	25.3%	0.3%	1.5%	6.2%	1.3%	5.3%	0.4%	56.3%	46.2%
A. cruciformis as % of total SP & MP:										
Total SP and MP COUNT:	**266**	**269**	**328**	**340**	**353**	**308**	**302**	**250**	**293**	**208**
Other Palynomorphs Count										
Botryococcus braunii										
Fungal fruiting bodies					0.3%					
Fungal spores & hyphae	5.7%	2.5%		1.7%	0.3%			1.2%	1.0%	
Total Fungii:	5.7%	2.5%		1.7%	0.6%			1.2%	1.0%	
Contaminants or caved — spore-pollen										
Contaminants or caved — microplankton										
Reworked Fossils										
TOTAL COUNT:	**282**	**276**	**328**	**346**	**355**	**308**	**302**	**253**	**296**	**208**
† Manuscript species name.										

Table 4: Kipper–2	Percentage abundances for selected palynomorphs.									
Sample Type:	SWC 37	SWC 36	SWC 33	SWC 32	SWC 31	SWC 29	SWC 28	SWC 27	SWC 26	SWC 25
Depth (m):	1880.6	1888	1944	1954	1969	1999	2015.5	2030	2041.5	2055.1
Operator:	MKM	ADP	MKM	MKM	MKM	MKM	MKM	MKM	MKM	MKM
SPORES										
Aequitriradites spp.									0.3%	0.6%
Baculatisporites spp.	2.6%	0.9%	2.9%	1.8%	2.5%	1.7%	1.0%	0.3%	1.0%	0.6%
Camarozonosporites heskermensis									0.7%	
Cicatricosisporites/Ruffordiaspora spp.										0.3%
Clavifera triplex			0.4%	0.7%				0.7%		
Clavifera vultuosus†										
Coptospora pileolus†										
Cyathidites (large) >40µm		1.4%	0.7%	2.6%	2.1%	3.1%	1.0%	0.7%	2.4%	1.4%
Cyathidites (small) <40µm	3.1%	3.2%	4.0%	5.1%	5.3%	3.1%	3.0%	2.8%	5.8%	2.5%
Densoisporites velatus										0.8%
Dictyophyllidites spp.								0.7%	0.7%	
Foveotriletes/Foveosporites spp.				0.4%	0.4%					
Gleicheniidites spp.	2.3%		0.4%	3.3%	0.7%	0.7%	0.3%	0.7%	2.7%	3.1%
Herkosporites/Ceratosporites sp.		2.3%				0.7%	0.7%	0.3%	1.4%	1.4%
Ischyosporites spp.						0.3%				
Laevigatosporites spp.	5.1%	2.8%	5.8%	5.5%	6.7%	5.9%	4.0%	5.9%	6.4%	8.5%
Latrobosporites spp.	0.6%	2.3%	1.1%	0.7%	0.7%	0.3%	0.3%	2.4%	0.3%	1.7%
Marratisporites scabratus										
Monolete Spores undiff.	0.3%	0.5%	0.7%	0.4%	0.4%	0.7%	0.7%		0.3%	0.6%
Osmundacidites wellmanii										
Peromonolites spp.				0.4%						0.3%
Perotrilites spp.										
Polypodiisporites spp.								0.3%		
Retitriletes spp.	0.3%	0.9%	0.4%	0.7%	0.4%	0.7%	1.3%	2.1%	1.4%	2.3%
Rugulatisporites spp.			0.4%							0.3%
Stereisporites antiquisporites	1.1%	0.9%	8.7%	4.4%	2.5%	0.7%	0.7%	2.1%	1.0%	0.3%
Stereisporites regium				0.7%						
Triletes undiff.	0.6%	2.8%	0.4%	0.7%	0.4%			1.0%	0.7%	3.4%
Triporoletes reticulatus										0.8%
Tripunctisporis maastrichtiensis		2.3%	0.4%	0.4%						
Verrucosisporites kopukuensis										
Total Spores:	**16%**	**20%**	**26%**	**28%**	**22%**	**18%**	**13%**	**20%**	**25%**	**29%**
GYMNOSPERMS undiff.	2.3%		1.1%	1.8%	1.8%	1.0%	1.7%	1.7%	1.7%	1.4%
Araucariacites australis	6.0%	0.9%	5.5%	12.5%	7.8%	16.0%	3.7%	15.6%	11.9%	4.8%
Corollina spp.				0.7%						
Cupressacites sp.	0.9%						0.3%			
Cycadopites spp.										
Dilwynites pusillus†										
Dilwynites spp.	0.6%			0.7%	0.7%	0.3%	0.7%	0.7%		0.3%
Lygistepollenites balmei		2.3%	0.7%				0.3%		0.3%	0.3%
Lygistepollenites florinii	0.6%		5.8%	1.8%	0.7%	1.0%	0.3%	1.4%	0.7%	9.1%
Microalatidites (P.) paleogenicus		0.5%					0.3%			
Microcachryidites antarcticus	0.6%	0.5%	5.1%	1.8%	0.7%	0.3%	1.0%	2.1%	1.4%	5.4%
Phyllocladidites eunuchus†										
Phyllocladidites mawsonii	14.8%	4.2%	6.9%	5.9%	6.0%	6.6%	9.6%	11.4%	7.1%	5.4%
Phyllocladidites reticulosaccatus/verrucosus	1.1%	0.5%	1.5%	1.1%		1.4%	4.0%	0.3%	3.7%	0.8%
Podocarpidites spp.	16.8%	1.4%	23.6%	12.1%	16.7%	15.0%	11.3%	9.0%	31.5%	15.9%
Trichotomosulcites subgranulatus	0.9%	0.9%	16.0%	5.9%	8.9%	3.1%	2.3%	11.8%	1.0%	2.0%
Vitreisporites signatus/pallidus										
Total Gymnosperms:	**44%**	**11%**	**66%**	**44%**	**43%**	**45%**	**36%**	**54%**	**59%**	**45%**
ANGIOSPERMS undiff.	2.6%	2.8%	0.7%	1.8%	0.7%	1.4%	0.7%	1.0%	0.7%	0.6%
Australopollis obscurus	6.0%		0.4%				0.3%	0.3%		
Battenipollis sectilis		1.4%			0.4%	0.7%	2.7%	0.3%		
Beaupreaidites orbiculatus	0.3%			0.4%						
Cupanieidites orthoteichus										
Dicotetradites clavatus	1.1%			0.4%	1.1%					0.3%
Forcipites longus	1.1%					1.4%	0.3%			
Forcipites sabulosus										
Forcipites spp.										
Gambierina rudata/edwardsii		9.7%	1.8%	5.1%	7.1%	1.4%	1.3%			
Haloragacidites harrisii (=Casuarina)										
Ilexpollenites spp.	0.3%									
Liliacidites spp.	0.9%		1.1%		0.4%		0.7%	1.0%		0.3%
Malvacipollis subtilis/diversus										
Myrtaceidites parvus/mesonesus										
Nothofagidites brachyspinulosus/flemingii										
Nothofagidites emarcidus/heterus										
Nothofagidites endurus				1.1%	2.1%	6.6%	4.7%	2.8%	1.7%	0.6%
Nothofagidites senectus						0.3%	0.3%	1.4%		0.3%
Peninsulapollis gillii	1.1%	3.2%	0.4%	0.7%	0.7%	0.3%	2.0%	1.0%	0.7%	
Periporopollenites spp.	2.0%			0.7%	0.7%	2.1%	0.7%	1.4%	0.7%	0.6%
Pseudowinterapollis cranwellae/wahooensis						0.3%				0.3%
Proteacidites spp.	15.1%	47.2%	2.2%	11.4%	15.6%	14.6%	25.6%	10.0%	8.8%	9.9%
Proteacidites angulatus										
Proteacidites obscurus										
Proteacidites (C.) palisadus		1.4%					0.7%		0.3%	
Proteacidites reticuloconcavus†	0.6%	0.5%	0.4%							
Spinizonocolpites prominatus										
Tetracolp(or)ites spp.										

Table 4: Kipper–2	Percentage abundances for selected palynomorphs.									
Sample Type:	SWC 37	SWC 36	SWC 33	SWC 32	SWC 31	SWC 29	SWC 28	SWC 27	SWC 26	SWC 25
Depth (m):	1880.6	1888	1944	1954	1969	1999	2015.5	2030	2041.5	2055.1
Operator:	MKM	ADP	MKM	MKM	MKM	MKM	MKM	MKM	MKM	MKM
Tetracolporites verrucosus			0.7%	0.7%		0.3%				
Tetradites securus†	0.6%	0.9%					1.0%	0.7%	2.0%	0.3%
Tricolpites confessus										
Tricolpites waipawaensis					1.1%	0.3%	0.7%	0.3%		
Tricolpites/Tricolporites spp.	8.2%	0.5%		4.8%	5.0%	6.6%	9.6%	4.5%	0.7%	9.3%
Tricolporites lilliei						0.3%	0.3%	0.7%		3.4%
Triporopollenites spp.		0.9%		0.4%				0.3%		
Total Angiosperms:	**40%**	**69%**	**8%**	**28%**	**35%**	**37%**	**51%**	**26%**	**16%**	**26%**
Total Spore-Pollen:	**352**	**216**	**275**	**272**	**282**	**287**	**301**	**289**	**295**	**353**
MICROPLANKTON % of MP COUNT										
Microplankton undiff.					100%			100%		
Alisocysta circumtabulata										
Amosopollis cruciformis	100%					50%			100%	100%
Apectodinium homomorphum										
Apectodinium hyperacanthum										
Apectodinium reburrus†										
Chatangiella porosa										
Circulisporites parvus										
Cribroperidinium sp.										
Deflandrea spp.										
Dinogymnium spp.										
Exochosphaeridium n.sp.										
Glaphrocysta spp.										
Heterosphaeridium spp.										
Hystrichosphaeridium tubiferum										
Isabelidinium spp.										
Kenleyia spp.										
Manumiella spp.						50%				
Micrystridium sp. A										
Oligosphaeridium spp.										
Palambages spp.										
Paralecaniella indentata										
Saeptodinium spp. (non-marine dino.)							100%			
Senegalinium dilwynense										
Sigmopollis carbonis										
Spinidinium/Vozzhennikovia spp.										
Spiniferites spp.										
Trithyrodinium spp.										
Xenascus spp.										
Total Microplankton Count:	**1**				**2**	**2**	**2**	**3**	**14**	**2**
Microplankton % of total SP & MP:	0.3%				0.7%	0.7%	0.7%	1.0%	4.5%	0.6%
A. cruciformis as % of total SP & MP:	0.3%					0.3%			4.5%	0.6%
Total SP and MP COUNT:	**353**	**216**	**275**	**272**	**284**	**289**	**303**	**292**	**309**	**355**
Other Palynomorphs Count										
Botryococcus braunii										
Fungal fruiting bodies			0.4%	0.4%	0.3%		0.6%		0.3%	
Fungal spores & hyphae	1.4%	0.5%	2.8%	3.5%	1.7%	0.7%	1.0%		0.3%	0.6%
Total Fungii:	1.4%	0.5%	3.2%	3.9%	2.1%	0.7%	1.6%		0.6%	0.6%
Contaminants or caved — spore-pollen				0.4%						
Contaminants or caved — microplankton										
Reworked Fossils										
TOTAL COUNT:	**358**	**217**	**284**	**284**	**290**	**291**	**308**	**292**	**311**	**357**
† Manuscript species name.										

Table 4: Kipper–2

Percentage abundances for selected palynomorphs.

Sample Type:	SWC ?	Core-1	Core-1	Core-2	Cts	SWC 20	SWC 19	SWC 16	Cts	Core-3
Depth (m):	2192	2216.18	2221.42	2222.06	2230–2235	2235.6	2242.1	2267.6	2280–2285	2290.35
Operator:	ADP	MKM	ADP	MKM	MKM	ADP	ADP	ADP	MKM	MKM
SPORES										
Aequitriradites spp.						0.3%	0.3%	1.3%		
Baculatisporites spp.	0.7%	0.4%	0.6%			0.3%			0.8%	
Camarozonosporites heskermensis										
Cicatricosisporites/Ruffordiaspora spp.						0.3%	0.7%	0.3%		0.4%
Clavifera triplex										
Clavifera vultuosus†								0.7%		
Coptospora pileolus†								0.7%		0.4%
Cyathidites (large) >40µm		2.1%		0.4%		0.7%	0.7%	0.7%		1.7%
Cyathidites (small) <40µm	6.9%	1.8%	9.8%	2.1%	2.4%	5.1%	11.8%	6.0%	4.7%	7.7%
Densoisporites velatus						5.1%	2.7%	0.3%		
Dictyophyllidites spp.	0.7%					2.0%	0.7%	1.7%		
Foveotriletes/Foveosporites spp.										
Gleicheniidites spp.	2.1%	0.7%	4.9%	0.4%	6.3%	15.4%	14.9%	3.4%	1.6%	0.4%
Herkosporites/Ceratosporites sp.	2.1%					0.3%			0.4%	
Ischyosporites spp.										
Laevigatosporites spp.	4.9%	4.9%	3.0%	1.4%	3.9%	6.8%	36.1%	6.4%	3.1%	6.0%
Latrobosporites spp.			0.6%			0.3%	0.3%			
Marratisporites scabratus						0.7%				
Monolete Spores undiff.		2.1%		0.4%	2.0%				1.9%	3.0%
Osmundacidites wellmanii	1.4%					1.4%	0.3%			
Peromonolites spp.										
Perotrilites spp.								0.3%		
Polypodiisporites spp.										
Retitriletes spp.	1.4%	0.4%		0.4%	0.4%		0.3%	1.3%	0.4%	0.9%
Rugulatisporites spp.										
Stereisporites antiquisporites			3.0%	0.4%	0.8%		0.3%		0.4%	
Stereisporites regium										
Triletes undiff.	0.7%	1.4%	1.2%	1.1%	0.8%	0.3%	2.0%	0.7%	0.8%	4.3%
Triporoletes reticulatus							0.3%	0.7%		
Tripunctisporis maastrichtiensis										
Verrucosisporites kopukuensis										
Total Spores:	**21%**	**14%**	**23%**	**6%**	**17%**	**39%**	**72%**	**24%**	**14%**	**25%**
GYMNOSPERMS undiff.				1.1%	0.4%				1.2%	2.6%
Araucariacites australis	3.5%	2.8%	3.0%	16.8%	3.1%	1.7%	0.3%	2.3%	4.7%	7.2%
Corollina spp.										
Cupressacites sp.	1.4%		0.6%		0.4%			3.4%	0.4%	
Cycadopites spp.										
Dilwynites pusillus†		0.7%	3.7%			0.3%		1.3%		1.7%
Dilwynites spp.	8.3%	1.8%	1.2%	1.8%				1.0%	1.6%	1.3%
Lygistepollenites balmei										
Lygistepollenites florinii		0.4%		0.7%	0.4%	1.0%		1.0%	0.8%	0.9%
Microalatidites (P.) paleogenicus			0.6%			0.7%			0.8%	
Microcachryidites antarcticus	4.2%		1.8%	1.1%	1.2%	3.1%	1.0%	5.0%	1.9%	1.3%
Phyllocladidites eunuchus†					0.8%	4.4%	0.7%	1.3%		
Phyllocladidites mawsonii	2.8%		1.8%	3.2%	3.5%	8.9%	1.0%	5.7%	2.7%	1.7%
Phyllocladidites reticulosaccatus/verrucosus										
Podocarpidites spp.	27.8%	0.7%	12.2%	23.9%	21.3%	20.1%	7.4%	17.1%	12.5%	11.5%
Trichotomosulcites subgranulatus	25.7%	0.4%	14.6%	14.0%	19.7%	12.3%	1.0%	8.7%	13.2%	8.5%
Vitreisporites signatus/pallidus							0.7%	0.3%		0.4%
Total Gymnosperms:	**74%**	**7%**	**40%**	**62%**	**51%**	**53%**	**12%**	**47%**	**40%**	**37%**
ANGIOSPERMS undiff.		1.1%	2.4%	2.1%	1.6%	0.3%		2.0%	2.3%	0.4%
Australopollis obscurus				0.4%	4.3%				0.8%	
Battenipollis sectilis										
Beaupreaidites orbiculatus										
Cupanieidites orthoteichus										
Dicotetradites clavatus				0.4%	0.8%		2.7%	2.7%		
Forcipites longus										
Forcipites sabulosus	0.7%					1.4%	4.4%	2.7%	0.4%	
Forcipites spp.							0.7%	0.7%		
Gambierina rudata/edwardsii										
Haloragacidites harrisii (=Casuarina)										
Ilexpollenites spp.										
Liliacidites spp.			2.4%			0.3%		0.7%	0.8%	0.9%
Malvacipollis subtilis/diversus										
Myrtaceidites parvus/mesonesus										
Nothofagidites brachyspinulosus/flemingii										
Nothofagidites emarcidus/heterus										
Nothofagidites endurus								0.3%		
Nothofagidites senectus		4.9%	17.1%	7.7%	8.3%	4.1%	1.4%	4.0%	5.8%	
Peninsulapollis gillii		0.7%	1.8%	0.4%	0.4%	1.4%	2.4%	3.0%	0.4%	
Periporopollenites spp.		0.4%								
Pseudowinterapollis cranwellae/wahooensis									0.4%	
Proteacidites spp.	2.8%	1.1%	6.1%	2.8%	3.5%	0.7%	3.7%	3.4%	8.2%	3.4%
Proteacidites angulatus										
Proteacidites obscurus										
Proteacidites (C.) palisadus										
Proteacidites reticuloconcavus†										
Spinizonocolpites prominatus										
Tetracolp(or)ites spp.								0.3%		

Table 4: Kipper–2	Percentage abundances for selected palynomorphs.									
Sample Type:	SWC ?	Core-1	Core-1	Core-2	Cts	SWC 20	SWC 19	SWC 16	Cts	Core-3
Depth (m):	2192	2216.18	2221.42	2222.06	2230–2235	2235.6	2242.1	2267.6	2280–2285	2290.35
Operator:	ADP	MKM	ADP	MKM	MKM	ADP	ADP	ADP	MKM	MKM
Tetracolporites verrucosus										
Tetradites securus†										
Tricolpites confessus			0.6%				0.3%	4.4%		
Tricolpites waipawaensis										
Tricolpites/Tricolporites spp.	2.1%	71.4%	4.9%	16.8%	13.4%		0.7%	4.0%	26.1%	32.3%
Tricolporites lilliei										
Triporopollenites spp.			1.8%	0.7%	0.4%				1.2%	1.3%
Total Angiosperms:	**6%**	**80%**	**37%**	**31%**	**33%**	**8%**	**16%**	**28%**	**46%**	**38%**
Total Spore-Pollen:	**144**	**283**	**164**	**285**	**254**	**293**	**296**	**298**	**257**	**235**
MICROPLANKTON % of MP COUNT										
Microplankton undiff.				100%						18%
Alisocysta circumtabulata										
Amosopollis cruciformis										64%
Apectodinium homomorphum										
Apectodinium hyperacanthum										
Apectodinium reburrus†										
Chatangiella porosa										
Circulisporites parvus										
Cribroperidinium sp.										
Deflandrea spp.										
Dinogymnium spp.										
Exochosphaeridium n.sp.										
Glaphrocysta spp.										
Heterosphaeridium spp.										9%
Hystrichosphaeridium tubiferum										
Isabelidinium spp.										
Kenleyia spp.										
Manumiella spp.										
Micrystridium sp. A										
Oligosphaeridium spp.										
Palambages spp.										
Paralecaniella indentata										
Saeptodinium spp. (non-marine dino.)										
Senegalinium dilwynense										
Sigmopollis carbonis										
Spinidinium/Vozzhennikovia spp.										
Spiniferites spp.										9%
Trithyrodinium spp.										
Xenascus spp.										
Total Microplankton Count:				**1**						**11**
Microplankton % of total SP & MP:				0.3%						4.5%
A. cruciformis as % of total SP & MP:										2.8%
Total SP and MP COUNT:	**144**	**283**	**164**	**286**	**254**	**293**	**296**	**298**	**257**	**246**
Other Palynomorphs Count										
Botryococcus braunii										
Fungal fruiting bodies	0.5%									
Fungal spores & hyphae	31.9%	0.7%		0.3%	1.1%			1.7%	1.3%	4.3%
Total Fungii:	32.4%	0.7%		0.3%	1.1%			1.7%	1.3%	4.3%
Contaminants or caved — spore-pollen					3.5%				4.0%	
Contaminants or caved — microplankton					5.7%				8.4%	
Reworked Fossils										
TOTAL COUNT:	**213**	**285**	**164**	**287**	**283**	**293**	**296**	**303**	**298**	**257**
† Manuscript species name.										

Table 4: Kipper–2	Percentage abundances for selected palynomorphs.									
Sample Type:	Core-3	Core-5	Core-5	Core-5	Core-6	Core-6	Core-7	SWC 14	Cts	Core-9
Depth (m):	2292.6-2293.0	2313.68	2315.53	2320.84	2325.18	2330	2339.48	2385	2390–2395	2430.48
Operator:	ADP	MKM	ADP	MKM	MKM	ADP	MKM	ADP	MKM	MKM
SPORES										
Aequitriradites spp.			0.7%							
Baculatisporites spp.		0.3%	0.4%	0.8%	2.0%	0.7%	2.8%	0.9%	1.0%	
Camarozonosporites heskermensis										
Cicatricosisporites/Ruffordiaspora spp.								0.9%		
Clavifera triplex	0.7%									
Clavifera vultuosus†										
Coptospora pileolus†										
Cyathidites (large) >40µm		3.7%		6.9%	1.3%		2.5%	30.6%	1.0%	1.8%
Cyathidites (small) <40µm	14.3%	6.1%	31.4%	5.0%	3.3%	43.2%	1.2%	12.6%	1.7%	7.8%
Densoisporites velatus								0.9%		
Dictyophyllidites spp.	1.8%	0.6%	0.4%	0.4%		1.8%		0.9%		
Foveotriletes/Foveosporites spp.					0.7%					
Gleicheniidites spp.	17.9%	0.3%	1.1%	0.8%	0.7%	2.5%	3.7%	0.9%	2.8%	0.7%
Herkosporites/Ceratosporites sp.					0.7%	0.4%		3.6%	0.3%	
Ischyosporites spp.		0.3%								2.5%
Laevigatosporites spp.	13.6%	9.1%	13.7%	11.5%	4.0%	6.4%		7.2%	3.1%	35.6%
Latrobosporites spp.							4.3%	2.7%		
Marratisporites scabratus			7.2%							
Monolete Spores undiff.		2.4%		1.5%	2.0%		1.5%		1.7%	1.1%
Osmundacidites wellmanii			0.4%	0.4%						
Peromonolites spp.										
Perotrilites spp.										
Polypodiisporites spp.										
Retitriletes spp.		0.6%	0.4%	0.8%				5.4%		1.1%
Rugulatisporites spp.									0.3%	
Stereisporites antiquisporites		56.1%	0.4%		1.3%		0.6%		0.3%	
Stereisporites regium										
Triletes undiff.	0.7%	1.8%		1.5%	0.7%	0.7%	1.2%	6.3%	1.4%	10.7%
Triporoletes reticulatus										
Tripunctisporis maastrichtiensis										
Verrucosisporites kopukuensis										
Total Spores:	**49%**	**81%**	**56%**	**30%**	**17%**	**56%**	**18%**	**73%**	**14%**	**61%**
GYMNOSPERMS undiff.		0.6%		1.2%	4.0%		0.6%			0.7%
Araucariacites australis		4.3%	1.4%	5.4%	8.6%	0.4%	9.3%		4.5%	1.8%
Corollina spp.										
Cupressacites sp.							0.3%		0.3%	
Cycadopites spp.										
Dilwynites pusillus†		0.3%	1.4%			3.6%	0.3%		1.4%	
Dilwynites spp.			0.7%	0.4%			0.6%		0.3%	
Lygistepollenites balmei										
Lygistepollenites florinii		0.3%								
Microalatidites (P.) paleogenicus										
Microcachryidites antarcticus	1.8%		0.4%		0.7%	0.4%	0.9%		1.7%	0.4%
Phyllocladidites eunuchus†	1.1%			0.4%	1.3%		0.3%		1.4%	0.4%
Phyllocladidites mawsonii	0.7%		2.2%		6.0%	1.1%	3.4%	0.9%	1.0%	0.4%
Phyllocladidites reticulosaccatus/verrucosus									0.3%	
Podocarpidites spp.	16.8%	1.8%	8.7%	16.2%	6.6%	13.2%	30.0%	17.1%	25.9%	12.8%
Trichotomosulcites subgranulatus	11.1%	2.1%	13.0%	26.2%	9.9%	18.9%	27.9%	0.9%	28.7%	5.0%
Vitreisporites signatus/pallidus	0.7%		1.1%							
Total Gymnosperms:	**32%**	**9%**	**29%**	**50%**	**37%**	**38%**	**74%**	**19%**	**66%**	**21%**
ANGIOSPERMS undiff.		0.3%	1.1%	0.4%	1.3%		1.9%		0.7%	0.4%
Australopollis obscurus							0.3%		0.3%	
Battenipollis sectilis										
Beaupreaidites orbiculatus										
Cupanieidites orthoteichus										
Dicotetradites clavatus			0.4%							
Forcipites longus										
Forcipites sabulosus	8.2%	0.3%	1.8%			2.9%				
Forcipites spp.										
Gambierina rudata/edwardsii										
Haloragacidites harrisii (=Casuarina)										
Ilexpollenites spp.										
Liliacidites spp.	0.4%	0.3%		0.8%	1.3%				0.3%	
Malvacipollis subtilis/diversus										
Myrtaceidites parvus/mesonesus										
Nothofagidites brachyspinulosus/flemingii										
Nothofagidites emarcidus/heterus										
Nothofagidites endurus										
Nothofagidites senectus									2.1%	
Peninsulapollis gillii		0.3%	0.7%						0.3%	
Periporopollenites spp.				0.4%						
Pseudowinterapollis cranwellae/wahooensis			0.4%							
Proteacidites spp.	1.8%	3.7%	2.5%	4.6%	2.0%	0.4%	0.3%	8.1%	1.4%	2.1%
Proteacidites angulatus										
Proteacidites obscurus										
Proteacidites (C.) palisadus										
Proteacidites reticuloconcavus†										
Spinizonocolpites prominatus										
Tetracolp(or)ites spp.	2.5%									

Table 4: Kipper–2	Percentage abundances for selected palynomorphs.									
Sample Type:	Core-3	Core-5	Core-5	Core-5	Core-6	Core-6	Core-7	SWC 14	Cts	Core-9
Depth (m):	2292.6-2293.0	2313.68	2315.53	2320.84	2325.18	2330	2339.48	2385	2390–2395	2430.48
Operator:	ADP	MKM	ADP	MKM	MKM	ADP	MKM	ADP	MKM	MKM
Tetracolporites verrucosus										
Tetradites securus†										
Tricolpites confessus							0.9%		0.3%	
Tricolpites waipawaensis										
Tricolpites/Tricolporites spp.	6.1%	4.0%	8.3%	14.2%	40.4%	3.6%	5.0%		14.7%	14.9%
Tricolporites lilliei										
Triporopollenites spp.		0.3%		0.4%	1.3%					
Total Angiosperms:	**19%**	**9%**	**15%**	**21%**	**46%**	**7%**	**8%**	**8%**	**20%**	**17%**
Total Spore-Pollen:	**280**	**328**	**277**	**260**	**151**	**280**	**323**	**111**	**286**	**281**
MICROPLANKTON % of MP COUNT										
Microplankton undiff.									67%	
Alisocysta circumtabulata										
Amosopollis cruciformis										
Apectodinium homomorphum										
Apectodinium hyperacanthum										
Apectodinium reburrus†										
Chatangiella porosa										
Circulisporites parvus	100%								33%	
Cribroperidinium sp.										
Deflandrea spp.										
Dinogymnium spp.										
Exochosphaeridium n.sp.										
Glaphrocysta spp.										
Heterosphaeridium spp.										
Hystrichosphaeridium tubiferum										
Isabelidinium spp.										
Kenleyia spp.										
Manumiella spp.										
Micrystridium sp. A										
Oligosphaeridium spp.										
Palambages spp.										
Paralecaniella indentata										
Saeptodinium spp. (non-marine dino.)										
Senegalinium dilwynense										
Sigmopollis carbonis										
Spinidinium/Vozzhennikovia spp.										
Spiniferites spp.										
Trithyrodinium spp.										
Xenascus spp.										
Total Microplankton Count:	**1**								**3**	
Microplankton % of total SP & MP:	0.4%								1.0%	
A. cruciformis as % of total SP & MP:										
Total SP and MP COUNT:	**281**	**328**	**277**	**260**	**151**	**280**	**323**	**111**	**289**	**281**
Other Palynomorphs Count										
Botryococcus braunii										
Fungal fruiting bodies					0.6%					
Fungal spores & hyphae		1.5%	0.4%	0.8%	51.6%		3.6%		2.7%	0.7%
Total Fungii:		1.5%	0.4%	0.8%	52.2%		3.6%		2.7%	0.7%
Contaminants or caved — spore-pollen										
Contaminants or caved — microplankton										
Reworked Fossils								6.7%		
TOTAL COUNT:	**281**	**333**	**278**	**262**	**316**	**280**	**335**	**119**	**297**	**283**
† Manuscript species name.										

Table 4: Kipper–2	Percentage abundances for selected palynomorphs.									
Sample Type:	Core-9	Core-9	Core-9	Core-9	Core-9	SWC 11	SWC 10	SWC 8	Cts	SWC 7
Depth (m):	2433.03	2434.66	2436.41	2437.92	2439	2444	2461	2491	2495–2500	2503.5
Operator:	ADP	MKM	MKM	MKM	ADP	ADP	ADP	ADP	MKM	ADP
SPORES										
Aequitriradites spp.										0.4%
Baculatisporites spp.	0.5%	1.0%	0.9%	0.7%	1.2%	0.5%			1.3%	0.4%
Camarozonosporites heskermensis					0.8%	1.0%		1.3%		
Cicatricosisporites/Ruffordiaspora spp.					0.4%	0.5%	0.4%			
Clavifera triplex								2.6%		1.2%
Clavifera vultuosus†										
Coptospora pileolus†										
Cyathidites (large) >40µm		1.7%	0.6%	0.7%	6.6%	3.9%	3.3%	2.6%	1.6%	1.2%
Cyathidites (small) <40µm	7.2%	7.0%	2.0%	7.1%	12.9%	5.8%	7.5%	6.5%	3.9%	5.7%
Densoisporites velatus								0.6%		
Dictyophyllidites spp.	0.5%		0.3%	0.3%	1.7%	1.5%	0.8%			1.6%
Foveotriletes/Foveosporites spp.										
Gleicheniidites spp.	1.9%		8.0%	2.0%	2.5%	2.4%	1.7%	8.4%	0.7%	2.4%
Herkosporites/Ceratosporites sp.	0.5%			0.3%	2.1%	0.5%	1.2%			0.8%
Ischyosporites spp.			0.6%	0.3%						
Laevigatosporites spp.	7.7%	17.8%	11.7%	9.5%	3.3%	3.4%	0.8%	1.3%	7.6%	1.6%
Latrobosporites spp.			0.3%			0.5%		0.6%		0.4%
Marratisporites scabratus	0.5%				0.4%		0.4%			0.4%
Monolete Spores undiff.			3.7%						1.3%	
Osmundacidites wellmanii	1.4%				1.7%	1.0%		1.3%		0.8%
Peromonolites spp.										
Perotrilites spp.					1.2%		0.4%	0.6%		0.4%
Polypodiisporites spp.										
Retitriletes spp.		1.0%	0.9%	0.3%	2.5%	2.4%	1.7%	1.3%	0.7%	1.2%
Rugulatisporites spp.										
Stereisporites antiquisporites	0.5%	5.0%	1.1%	1.4%	0.4%		0.4%		1.0%	0.4%
Stereisporites regium										
Triletes undiff.	0.5%	2.0%	1.7%	2.7%	1.2%	1.0%	1.7%	3.9%	5.6%	0.8%
Triporoletes reticulatus						0.5%	0.8%			0.4%
Tripunctisporis maastrichtiensis										
Verrucosisporites kopukuensis										
Total Spores:	**21%**	**36%**	**32%**	**25%**	**39%**	**25%**	**21%**	**31%**	**24%**	**20%**
GYMNOSPERMS undiff.		0.3%	0.9%	1.0%	0.4%				1.6%	
Araucariacites australis		4.4%	0.9%	14.9%	2.9%	3.4%	8.3%	1.3%	8.2%	1.6%
Corollina spp.					0.4%					
Cupressacites sp.	0.5%					0.5%	1.7%	0.6%	0.3%	2.0%
Cycadopites spp.	1.9%		0.6%							
Dilwynites pusillus†	5.3%	6.4%	1.1%	3.7%	5.4%	2.9%	2.5%	6.5%	2.0%	7.3%
Dilwynites spp.	1.4%	2.3%		2.0%		3.4%	1.7%	0.6%	4.9%	1.6%
Lygistepollenites balmei										
Lygistepollenites florinii										
Microalatidites (P.) paleogenicus					0.4%					
Microcachryidites antarcticus			0.3%	2.4%	1.7%	6.8%	3.3%	3.2%	0.3%	6.1%
Phyllocladidites eunuchus†			0.3%				1.7%	0.6%	0.3%	
Phyllocladidites mawsonii	1.4%	1.0%	2.3%	1.0%	2.1%	6.8%	2.1%	15.5%	2.0%	4.0%
Phyllocladidites reticulosaccatus/verrucosus				1.4%						
Podocarpidites spp.	21.3%	4.0%	22.8%	9.8%	14.5%	34.0%	32.0%	23.2%	14.1%	37.7%
Trichotomosulcites subgranulatus	29.5%	24.5%	34.5%	17.6%	3.3%	3.9%	7.9%	3.2%	20.4%	4.9%
Vitreisporites signatus/pallidus					1.2%			0.6%		0.4%
Total Gymnosperms:	**61%**	**43%**	**64%**	**54%**	**32%**	**62%**	**61%**	**55%**	**54%**	**66%**
ANGIOSPERMS undiff.	0.5%	1.3%	0.3%	1.0%	0.4%		0.8%	1.9%	0.7%	1.6%
Australopollis obscurus				0.3%		0.5%				
Battenipollis sectilis										
Beaupreaidites orbiculatus										
Cupanieidites orthoteichus										
Dicotetradites clavatus										
Forcipites longus										
Forcipites sabulosus	1.0%					0.5%	0.4%			
Forcipites spp.					2.9%			1.3%		
Gambierina rudata/edwardsii										
Haloragacidites harrisii (=Casuarina)										
Ilexpollenites spp.										
Liliacidites spp.	1.0%	2.0%	1.1%	0.3%	0.4%				0.7%	
Malvacipollis subtilis/diversus										
Myrtaceidites parvus/mesonesus										
Nothofagidites brachyspinulosus/flemingii										
Nothofagidites emarcidus/heterus										
Nothofagidites endurus										
Nothofagidites senectus			0.3%						0.3%	
Peninsulapollis gillii	1.4%				2.1%		0.8%			0.4%
Periporopollenites spp.										
Pseudowinterapollis cranwellae/wahooensis										
Proteacidites spp.		0.7%		5.1%	21.6%	11.2%	12.9%	7.7%	4.3%	10.5%
Proteacidites angulatus										
Proteacidites obscurus										
Proteacidites (C.) palisadus										
Proteacidites reticuloconcavus†										
Spinizonocolpites prominatus										
Tetracolp(or)ites spp.										0.4%

Table 4: Kipper–2	Percentage abundances for selected palynomorphs.									
Sample Type:	Core-9	Core-9	Core-9	Core-9	Core-9	SWC 11	SWC 10	SWC 8	Cts	SWC 7
Depth (m):	2433.03	2434.66	2436.41	2437.92	2439	2444	2461	2491	2495–2500	2503.5
Operator:	ADP	MKM	MKM	MKM	ADP	ADP	ADP	ADP	MKM	ADP
Tetracolporites verrucosus										
Tetradites securus†										
Tricolpites confessus		0.3%								
Tricolpites waipawaensis										
Tricolpites/Tricolporites spp.	13.5%	17.1%	3.1%	13.5%	0.8%	1.5%	2.5%	2.6%	15.8%	0.8%
Tricolporites lilliei										
Triporopollenites spp.				0.7%	0.4%		0.4%		0.3%	0.4%
Total Angiosperms:	**17%**	**21%**	**5%**	**21%**	**29%**	**14%**	**18%**	**14%**	**22%**	**14%**
Total Spore-Pollen:	**207**	**298**	**351**	**296**	**241**	**206**	**241**	**155**	**304**	**247**
MICROPLANKTON % of MP COUNT										
Microplankton undiff.								29%	100%	28%
Alisocysta circumtabulata										
Amosopollis cruciformis		100%					67%	43%		2%
Apectodinium homomorphum										
Apectodinium hyperacanthum										
Apectodinium reburrus†										
Chatangiella porosa								14%		23%
Circulisporites parvus	33%									
Cribroperidinium sp.										
Deflandrea spp.										
Dinogymnium spp.										
Exochosphaeridium n.sp.							33%	14%		9%
Glaphrocysta spp.										
Heterosphaeridium spp.										
Hystrichosphaeridium tubiferum										
Isabelidinium spp.										2%
Kenleyia spp.										
Manumiella spp.										
Micrystridium sp. A										2%
Oligosphaeridium spp.										
Palambages spp.										4%
Paralecaniella indentata										
Saeptodinium spp. (non-marine dino.)										
Senegalinium dilwynense										
Sigmopollis carbonis	67%			100%						
Spinidinium/Vozzhennikovia spp.										28%
Spiniferites spp.										2%
Trithyrodinium spp.										
Xenascus spp.										
Total Microplankton Count:	**3**	**1**		**2**			**3**	**7**	**1**	**53**
Microplankton % of total SP & MP:	1.4%	0.3%		0.7%			1.2%	4.3%	0.3%	17.7%
A. cruciformis as % of total SP & MP:		0.3%					0.8%	1.9%		0.3%
Total SP and MP COUNT:	**210**	**299**	**351**	**298**	**241**	**206**	**244**	**162**	**305**	**300**
Other Palynomorphs Count										
Botryococcus braunii										
Fungal fruiting bodies				0.3%					0.3%	
Fungal spores & hyphae	1.9%	1.3%	1.1%	1.0%	0.4%	1.9%	2.4%		8.7%	0.7%
Total Fungii:	1.9%	1.3%	1.1%	1.3%	0.4%	1.9%	2.4%		9.0%	0.7%
Contaminants or caved — spore-pollen										
Contaminants or caved — microplankton										
Reworked Fossils						0.9%	0.4%	1.2%		0.7%
TOTAL COUNT:	**214**	**303**	**355**	**302**	**242**	**212**	**251**	**164**	**335**	**304**
† Manuscript species name.										

Table 4: Kipper–2	Percentage abundances for selected palynomorphs.					
Sample Type:	SWC 6	SWC 5	SWC 4	SWC 3	SWC 2	Cts
Depth (m):	2517	2528.5	2544.1	2564	2580.1	2595-2600
Operator:	ADP	ADP	ADP	MKM	ADP	ADP
SPORES						
Aequitriradites spp.						1.7%
Baculatisporites spp.	0.5%	0.4%		0.3%	0.7%	
Camarozonosporites heskermensis		0.4%				
Cicatricosisporites/Ruffordiaspora spp.		0.4%	0.5%			0.8%
Clavifera triplex	1.0%					
Clavifera vultuosus†						
Coptospora pileolus†						
Cyathidites (large) >40µm	0.5%	0.4%	0.5%	1.0%	4.2%	1.7%
Cyathidites (small) <40µm	7.8%	5.0%	2.9%	1.6%	11.1%	9.2%
Densoisporites velatus						
Dictyophyllidites spp.	1.9%	0.4%			0.7%	0.8%
Foveotriletes/Foveosporites spp.						
Gleicheniidites spp.	14.1%	6.3%	0.5%	1.3%	3.5%	1.7%
Herkosporites/Ceratosporites sp.	0.5%	0.8%	0.5%			
Ischyosporites spp.						
Laevigatosporites spp.	1.0%	1.7%		8.7%	2.8%	
Latrobosporites spp.						
Marratisporites scabratus						
Monolete Spores undiff.				3.8%		
Osmundacidites wellmanii		0.8%	0.5%			0.8%
Peromonolites spp.						
Perotrilites spp.						
Polypodiisporites spp.						
Retitriletes spp.	0.5%		0.5%		0.7%	0.8%
Rugulatisporites spp.						
Stereisporites antiquisporites					0.7%	1.7%
Stereisporites regium						
Triletes undiff.	0.5%	0.8%	1.4%	1.6%	2.1%	
Triporoletes reticulatus			0.5%		0.7%	
Tripunctisporis maastrichtiensis						
Verrucosisporites kopukuensis						
Total Spores:	**28%**	**18%**	**8%**	**18%**	**27%**	**19%**
GYMNOSPERMS undiff.				2.9%		
Araucariacites australis	1.5%	0.8%	1.4%	10.6%	2.1%	1.7%
Corollina spp.			0.5%			
Cupressacites sp.	3.4%	6.3%	4.3%	1.0%	2.8%	
Cycadopites spp.	0.5%					
Dilwynites pusillus†	6.3%	9.7%	14.4%	8.3%	2.1%	5.9%
Dilwynites spp.	1.0%	3.4%	2.4%	6.1%	6.9%	6.7%
Lygistepollenites balmei						
Lygistepollenites florinii				0.6%		
Microalatidites (P.) paleogenicus	1.5%	0.4%				
Microcachryidites antarcticus	12.6%	6.7%	10.5%	1.0%	4.9%	4.2%
Phyllocladidites eunuchus†		0.8%		0.6%		
Phyllocladidites mawsonii	3.9%	3.8%	1.0%	0.3%	1.4%	
Phyllocladidites reticulosaccatus/verrucosus						
Podocarpidites spp.	20.4%	26.1%	45.5%	15.4%	27.1%	31.1%
Trichotomosulcites subgranulatus	14.1%	6.3%	3.8%	12.2%	6.3%	15.1%
Vitreisporites signatus/pallidus	0.5%		1.9%			1.7%
Total Gymnosperms:	**66%**	**64%**	**86%**	**59%**	**53%**	**66%**
ANGIOSPERMS undiff.		0.4%		1.0%	2.1%	
Australopollis obscurus	1.9%	1.3%	0.5%		0.7%	0.8%
Battenipollis sectilis						
Beaupreaidites orbiculatus						
Cupanieidites orthoteichus						
Dicotetradites clavatus						
Forcipites longus						
Forcipites sabulosus						
Forcipites spp.		0.4%				1.7%
Gambierina rudata/edwardsii						
Haloragacidites harrisii (=Casuarina)						
Ilexpollenites spp.						
Liliacidites spp.	0.5%			0.3%	0.7%	0.8%
Malvacipollis subtilis/diversus						
Myrtaceidites parvus/mesonesus						
Nothofagidites brachyspinulosus/flemingii						
Nothofagidites emarcidus/heterus						
Nothofagidites endurus						
Nothofagidites senectus						
Peninsulapollis gillii		2.5%	0.5%		2.1%	
Periporopollenites spp.						
Pseudowinterapollis cranwellae/wahooensis						
Proteacidites spp.	2.4%	10.9%	5.7%	3.5%	9.0%	1.7%
Proteacidites angulatus						
Proteacidites obscurus						
Proteacidites (C.) palisadus						
Proteacidites reticuloconcavus†						
Spinizonocolpites prominatus						
Tetracolp(or)ites spp.						

Table 4: Kipper–2	Percentage abundances for selected palynomorphs.									
Sample Type:	SWC 6	SWC 5	SWC 4	SWC 3	SWC 2	Cts				
Depth (m):	2517	2528.5	2544.1	2564	2580.1	2595-2600				
Operator:	ADP	ADP	ADP	MKM	ADP	ADP				
Tetracolporites verrucosus										
Tetradites securus†										
Tricolpites confessus										
Tricolpites waipawaensis										
Tricolpites/Tricolporites spp.	1.5%	1.7%		17.3%	4.2%	8.4%				
Tricolporites lilliei										
Triporopollenites spp.		0.8%		0.6%	0.7%	0.8%				
Total Angiosperms:	**6%**	**18%**	**7%**	**23%**	**19%**	**14%**				
Total Spore-Pollen:	**206**	**238**	**209**	**312**	**144**	**119**				
MICROPLANKTON % of MP COUNT										
Microplankton undiff.	14%	25%	13%		100%	88%				
Alisocysta circumtabulata										
Amosopollis cruciformis		13%	1%							
Apectodinium homomorphum										
Apectodinium hyperacanthum										
Apectodinium reburrus†										
Chatangiella porosa	71%	41%	21%			13%				
Circulisporites parvus				9%						
Cribroperidinium sp.	2%		4%							
Deflandrea spp.										
Dinogymnium spp.	2%									
Exochosphaeridium n.sp.	5%	3%	28%							
Glaphrocysta spp.										
Heterosphaeridium spp.				9%						
Hystrichosphaeridium tubiferum										
Isabelidinium spp.	2%	3%	3%							
Kenleyia spp.										
Manumiella spp.										
Micrystridium sp. A										
Oligosphaeridium spp.	2%		28%							
Palambages spp.		6%	2%							
Paralecaniella indentata										
Saeptodinium spp. (non-marine dino.)										
Senegalinium dilwynense										
Sigmopollis carbonis				82%						
Spinidinium/Vozzhennikovia spp.										
Spiniferites spp.		6%								
Trithyrodinium spp.	3%	3%								
Xenascus spp.	2%									
Total Microplankton Count:	**66**	**32**	**104**	**11**	**4**	**8**				
Microplankton % of total SP & MP:	24.3%	11.9%	33.2%	3.4%	2.7%	6.3%				
A. cruciformis as % of total SP & MP:		1.5%	0.3%							
Total SP and MP COUNT:	**272**	**270**	**313**	**323**	**148**	**127**				
Other Palynomorphs Count										
Botryococcus braunii										
Fungal fruiting bodies										
Fungal spores & hyphae		0.4%	1.3%	3.0%	2.6%					
Total Fungii:		0.4%	1.3%	3.0%	2.6%					
Contaminants or caved — spore-pollen										
Contaminants or caved — microplankton										
Reworked Fossils		0.7%			1.9%					
TOTAL COUNT:	**272**	**273**	**317**	**333**	**155**	**127**				
† Manuscript species name.										

Table 5: Kipper–2 Distribution chart for selected palynomorphs

Sample Type	Depth (metres)	1 Foraminisporis asymmetricus	2 Triporoletes reticulatus	3 Forcipites spp.	4 Coptospora pileolus ms	5 Peninsulapollis gillii	6 Cupressacites sp.	7 Australopollis obscurus	8 Proteacidites spp.	9 Dilwynites spp.	10 Phyllocladidites mawsonii	11 Clavifera triplex	12 Lygistepollenites florinii	13 Retimonocolpites peroreticulatus	14 Latrobosporites amplus/ohaiensis	15 Tricolpites confessus	16 Densoisporites velatus	17 Lygistepollenites balmei	18 Forcipites sabulosus	19 Nothofagidites spp.	20 Tricolpites waiparaensis
SWC 51	1585.5								6%	6%	X		2%								
SWC 50	1591.4							1%	4%	5%	·		·								
SWC 59	1603.0							·	12%	X	3%		1%					5%		13%	
SWC 48	1623.5						X	7%	2%	13%	3%	X	4%		X			6%		7%	
SWC 47	1652.5					X	·	1%	14%	2%	10%	X	6%		·	?		1%		10%	
SWC 44	1699.5					X	1%	·	3%	19%	11%	·	4%		·			8%		5%	
SWC 42	1742.5					X	·	X	8%	12%	14%	X	4%		·		X	6%		4%	
SWC 41	1754.0					X	1%	20%	10%	3%	5%	X	X		·			6%		7%	
SWC 39	1809.5					X	·	·	9%	X	24%	·	6%		·			2%		1%	
SWC 38	1871.5					9%	·	·	16%	2%	10%	·	1%		·			4%		·	
SWC 37	1880.6					1%	1%	6%	15%	1%	16%	·	1%		·			·		·	
SWC 36	1888.0					3%	·	·	47%	X	5%	·	·		X			2%		·	
SWC 33	1944.0					X	·	X	2%	X	8%	·	6%		X			1%		·	
SWC 33	1954.0					1%	·	·	11%	1%	7%	X	2%		X			·		1%	
SWC 31	1969.0					1%	·	·	16%	1%	6%	·	1%		X			·		2%	
SWC 30	1982.5					·	·	·	·	·	·	·	·		·			·		·	
SWC 29	1999.0					X	·	·	15%	X	8%	·	1%		X			·		7%	
SWC 28	2015.5					2%	X	X	26%	1%	14%	·	X		X			X		5%	
SWC 27	2030.0					1%	·	X	10%	1%	12%	·	1%		X			·		4%	X
SWC 26	2041.5					1%	·	·	9%	X	11%	·	1%		X			X		2%	·
SWC 25	2055.1					·	·	·	10%	X	6%	·	9%		X		1%	X		1%	X
SWC ?	2192.0					·	1%	·	3%	8%	3%	·	·		·		·	·	1%	·	·
SWC 21	2211.6					X	·	·	X	X	X	·	·		X	X	·	·	·	X	·
Core 1	2216.18				X	1%	·	·	1%	3%	·	·	X	X	·	X	·	·	X	5%	X
Core 1	2221.42			X	·	2%	1%	X	6%	5%	2%	·	·	X	·	1%	·	·	·	17%	·
Core 2	2222.06			·	·	X	X	X	3%	2%	3%	·	1%	X	·	X	·	·	·	8%	·
Cuttings	2230-35			·	·	X	X	4%	4%	·	4%	·	X	·	·	·	X	·	·	8%	X
SWC 20	2235.6			X	·	1%	·	X	1%	X	9%	X	1%	·	X	X	5%	·	1%	4%	·
SWC 19	2242.1		X	1%	·	2%	·	·	4%	·	1%	·	·	·	X	X	3%	·	4%	1%	·
SWC 16	2267.6		X	1%	X	3%	3%	·	3%	2%	6%	X	1%	X	X	4%	X	·	3%	4%	·
Cuttings	2280-85		·	·	·	X	X	1%	8%	2%	3%	·	1%	·	X	·	·	·	X	6%	X
Core 3	2287.0		·	·	·	X	·	·	·	X	X	·	·	·	·	·	·	·	·	X	·
Core 3	2290.35		·	·	·	·	·	X	3%	3%	2%	·	1%	·	·	·	·	·	·	·	?
Core 3	2292.6		·	·	·	X	·	·	2%	·	1%	X	·	·	·	X	·	·	8%	X	·
Cuttings	2295-300		·	·	·	·	·	X	X	·	·	·	·	·	·	X	·	·	·	X	·
Core 5	2313.68		·	·	·	X	·	·	4%	X	·	·	X	·	·	X	·	·	X	·	·
Core 5	2315.53		·	X	·	1%	·	X	3%	2%	2%	X	·	X	·	X	·	·	2%	X	·
Core 6	2320.84		·	·	·	·	·	X	5%	X	X	·	·	·	·	·	·	·	·	·	·
Core 6	2325.18		·	·	·	X	·	X	2%	·	6%	·	·	·	·	X	·	·	·	·	·
Core 6	2330.0		·	·	·	X	·	·	X	4%	1%	·	·	·	·	X	·	·	3%	·	·
Core 7	2339.48		·	·	·	X	X	X	X	1%	3%	·	·	·	X	X	·	·	·	X	X
Core 8	2346.05		·	·	·	·	·	X	·	·	·	·	·	·	·	·	·	·	·	·	
SWC 14	2385.0		·	·	·	·	·	·	8%	·	1%	·	·	·	X	·	1%	·	·	·	
Cuttings	2390-95		·	X	·	X	X	·	1%	2%	1%	·	·	·	·	X	·	·	X	2%	
Core 9	2430.48		·	X	·	X	·	X	2%	·	X	·	·	·	X	?	·	·	·	·	
Core 9	2433.03		·	X	·	1%	1%	X	X	7%	1%	·	·	X	·	X	·	·	1%	·	
Core 9	2434.66		·	X	·	X	·	X	1%	9%	1%	·	·	·	X	X	·	·	X	X	
Core 9	2436.41		·	·	·	·	·	·	X	1%	2%	X	·	·	·	?	·	·	·	X	
Core 9	2437.92		·	X	·	X	·	X	5%	6%	2%	X	·	·	X	X	·	·	·		
Core 9	2439.0		·	3%	·	2%	·	·	22%	5%	2%	·	·	·	·	·	·	·	·		
SWC 11	2444.0		X	·	·	·	1%	X	11%	6%	7%	·	·	·	X	·	·	·	X		
SWC 10	2461.0		X	X	X	1%	2%	X	13%	4%	2%	X	·	·	·	?	·	·	?		
SWC 9	2475.0		·	·	·	X	·	·	·	·	X	·	·	·	·	·	·	X			
SWC 8	2491.0		·	1%	X	·	1%	X	8%	7%	16%	X	X	·	X	?	1%		?		
Cuttings	2495-500		·	X	·	·	X	·	4%	7%	2%	·	·	·	X	?	·			CV	
SWC 7	2503.5	X	X	·	·	X	2%	X	11%	9%	4%	X	·	·	X	?	X				
SWC 6	2517.0	·	·	X	·	X	3%	2%	2%	7%	4%	X	·	·	X	X					
SWC 5	2528.5	X	·	X	·	3%	6%	1%	11%	13%	4%	X	·	·	X	?					
SWC 4	2544.1	·	X	X	·	1%	4%	1%	6%	17%	1%	·	·	X	X						
SWC 3	2564.0	·	·	·	·	·	1%	X	4%	14%	X	X	1%								
SWC 2	2580.1	X	X	·	·	2%	3%	1%	9%	9%	1%										
SWC 1	2590.1	·	·	·	·	X	·	·	·	·	·										
Cuttings	2595-600	↓	↓	2%	↓	X	↓	1%	2%	13%	X					?					

Sample Type	Depth (metres)	21 Pseudowinterapollis wahooensis	22 Dicotetradites clavatus	23 Gambierina spp.	24 Tricolporites lilliei	25 Proteacidites (C.) palisadus	26 Battenipollis sectilis	27 Proteacidites reticuloconcavus ms	28 Grapnelispora evansii	29 Forcipites longus	30 Tripunctisporis maastrichtiensis	31 Tetracolporites verrucosus	32 Haloragacidites harrisii	33 Proteacidites angulatus	34 Proteacidites (P.) annularis	35 Malvacipollis subtilis	36 Matonisporites gigantis	37 Malvacipollis diversus	38 Myrtaceidites mesonesus/parvus	39 Spinizonocolpites prominatus	40 Cupanieidites orthoteichus
SWC 51	1585.5		1%										2%			1%		5%	28%	1%	2%
SWC 50	1591.4		1%										2%			2%		9%	44%	X	
SWC 59	1603.0		1%	1%							X		3%			·	X				
SWC 48	1623.5		1%	·							·		1%			X					
SWC 47	1652.5		2%	1%							·		6%		X	X					
SWC 44	1699.5		·	X							·		1%		·						
SWC 42	1742.5		1%	X							·		X		X						
SWC 41	1754.0		X	·							·		·	X							
SWC 39	1809.5		X	X							·		1%	9%							
SWC 38	1871.5		·	X							·	X									
SWC 37	1880.6		1%	10%				X			X										
SWC 36	1888.0		·	X			1%	X			2%										
SWC 33	1944.0		·	2%			·	·			X										
SWC 33	1954.0	X	X	5%			·	·			X										
SWC 31	1969.0	·	1%	7%		X	X	X													
SWC 30	1982.5	·	·	X		·	·	·		X			CV								
SWC 29	1999.0	·	·	1%	X	X	1%	X	X												
SWC 28	2015.5	·	X	1%	X	·	3%	X													
SWC 27	2030.0	·	·	·	1%	·	X	X													
SWC 26	2041.5	·	·	·	·	X															
SWC 25	2055.1	X	X	·	3%								CV								
SWC ?	2192.0	·	·	·																	
SWC 21	2211.6	·	·	X																	
Core 1	2216.18	X	·	X												CV					
Core 1	2221.42	X	·	X																	
Core 2	2222.06	·	X		CV																
Cuttings	2230-35	·	1%	X									CV	CV		CV					
SWC 20	2235.6	·	·	?																	
SWC 19	2242.1	·	3%																		
SWC 16	2267.6	·	3%																		
Cuttings	2280-85	X	·	CV									CV	CV							
Core 3	2287.0	·	·	?																	
Core 3	2290.35	·	·																		
Core 3	2292.6	·	·																		
Cuttings	2295-300	·	·										CV								
Core 5	2313.68	·	·	?	CV																
Core 5	2315.53	X	X	?																	
Core 6	2320.84	·																			
Core 6	2325.18	·																			
Core 6	2330.0	X																			
Core 7	2339.48																				
Core 8	2346.05																				
SWC 14	2385.0																				
Cuttings	2390-95			CV			CV						CV								
Core 9	2430.48												CV								
Core 9	2433.03																				
Core 9	2434.66												CV								
Core 9	2436.41												CV								
Core 9	2437.92					?					CV										
Core 9	2439.0																				
SWC 11	2444.0																				
SWC 10	2461.0																				
SWC 9	2475.0																				
SWC 8	2491.0																				
Cuttings	2495-500																				
SWC 7	2503.5																				
SWC 6	2517.0																				
SWC 5	2528.5																				
SWC 4	2544.1																				
SWC 3	2564.0																				
SWC 2	2580.1																				
SWC 1	2590.1																				
Cuttings	2595-600																				

Numbers 1 to 40 are spore-pollen species

Sample Type	Depth (metres)	41 Chatangiella victoriensis	42 Heterosphaeridium spp.	43 Palambages sp.	44 Chatangiella porosa	45 Isabelidinium variabilis	46 Trithyrodinium sp. (diaphanous)	47 Palaeohystrichophora infusorioides	48 Trithyrodinium suspectum	49 Cribroperidinium sp.	50 Oligosphaeridium sp.	51 Dinogymnium spp.	52 Exochosphaeridium sp.	53 Amosopollis cruciformis	54 Xenascus sp.	55 Vozzhennikovia sp.A Marshall	56 Sigmopollis carbonis	57 Circulosporites parvus	58 Manumiella spp.	59 Deflandrea speciosus	60 Hystrichosphaeridium tubiferum	61 Senegalinium dilwynense	62 Glaphrocysta retiintexta	63 Alisocysta circumtabulata	64 Paralecaniella indentata	65 Apectodinium reburrus ms	66 Apectodinium hyperacanthum	67 Apectodinium homomorphum	Depth (metres)	Sample Type
SWC 51	1585.5																										9%	19%	1585.5	SWC 51
SWC 50	1591.4																								12%		X		1591.4	SWC 50
SWC 59	1603.0																								·				1603.0	SWC 59
SWC 48	1623.5																								·	2%			1623.5	SWC 48
SWC 47	1652.5																								·	4%			1652.5	SWC 47
SWC 44	1699.5																								·	1%			1699.5	SWC 44
SWC 42	1742.5																					?			·	1%			1742.5	SWC 42
SWC 41	1754.0																								·	·			1754.0	SWC 41
SWC 39	1809.5																								·	53%			1809.5	SWC 39
SWC 38	1871.5																			5%	4%	2%	10%	X	3%				1871.5	SWC 38
SWC 37	1880.6													X					X										1880.6	SWC 37
SWC 36	1888.0													·															1888.0	SWC 36
SWC 33	1944.0													·															1944.0	SWC 33
SWC 33	1954.0													·															1954.0	SWC 33
SWC 31	1969.0													·															1969.0	SWC 31
SWC 30	1982.5													·															1982.5	SWC 30
SWC 29	1999.0													X															1999.0	SWC 29
SWC 28	2015.5													·															2015.5	SWC 28
SWC 27	2030.0													·															2030.0	SWC 27
SWC 26	2041.5													5%															2041.5	SWC 26
SWC 25	2055.1													1%															2055.1	SWC 25
SWC ?	2192.0													·															2192.0	SWC ?
SWC 21	2211.6													·															2211.6	SWC 21
Core 1	2216.18													·															2216.18	Core 1
Core 1	2221.42				?									·															2221.42	Core 1
Core 2	2222.06				?									·															2222.06	Core 2
Cuttings	2230-35													·												CV			2230-35	Cuttings
SWC 20	2235.6													·															2235.6	SWC 20
SWC 19	2242.1													·															2242.1	SWC 19
SWC 16	2267.6													·															2267.6	SWC 16
Cuttings	2280-85													·												CV			2280-85	Cuttings
Core 3	2287.0													·															2287.0	Core 3
Core 3	2290.35													3%															2290.35	Core 3
Core 3	2292.6													·				X											2292.6	Core 3
Cuttings	2295-300													·				·								CV			2295-300	Cuttings
Core 5	2313.68													·				·											2313.68	Core 5
Core 5	2315.53													·				·											2315.53	Core 5
Core 6	2320.84													·				·								CV			2320.84	Core 6
Core 6	2325.18													·				·											2325.18	Core 6
Core 6	2330.0													·				·											2330.0	Core 6
Core 7	2339.48												?	·				·											2339.48	Core 7
Core 8	2346.05													·				·											2346.05	Core 8
SWC 14	2385.0													·				·											2385.0	SWC 14
Cuttings	2390-95													·				X											2390-95	Cuttings
Core 9	2430.48													·				·											2430.48	Core 9
Core 9	2433.03													·			X	X											2433.03	Core 9
Core 9	2434.66													X			·												2434.66	Core 9
Core 9	2436.41													·			·												2436.41	Core 9
Core 9	2437.92													·			X												2437.92	Core 9
Core 9	2439.0													·															2439.0	Core 9
SWC 11	2444.0													·															2444.0	SWC 11
SWC 10	2461.0												X	1%															2461.0	SWC 10
SWC 9	2475.0												·	·															2475.0	SWC 9
SWC 8	2491.0	?			X	X	X	?			X		X	2%	?														2491.0	SWC 8
Cuttings	2495-500				X	·	·				·		·	·															2495-500	Cuttings
SWC 7	2503.5			X	4%	·	X				X		2%	X		5%													2503.5	SWC 7
SWC 6	2517.0			X	17%	X	X		X	X	X	X	1%	X	X														2517.0	SWC 6
SWC 5	2528.5		X	X	5%	X	X		·	·	X	·	X	2%															2528.5	SWC 5
SWC 4	2544.1	?	·	X	7%	1%	X		X	1%	9%	X	9%	X															2544.1	SWC 4
SWC 3	2564.0	X	·	X	X	X	X	X	X	X	X																		2564.0	SWC 3
SWC 2	2580.1	·	·	·	·	·	X																						2580.1	SWC 2
SWC 1	2590.1	·	·	·	·	·																							2590.1	SWC 1
Cuttings	2595-600	X	X	X	X	X																							2595-600	Cuttings

Numbers 41 to 67 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