INTERPRETATIVE DATA

Reconnaissance palynological analysis of interval 3008 to 4440m in Breaksea Reef-1, offshore Otway Basin, South Australia.

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Summary

Reconnaissance palynological analyses have been performed on 26 samples from the Breaksea Reef-1 well comprising a mixture of new cuttings collected between 4026 and 4440m, and new palynological slides prepared from surviving palynological residues from sidewall cores and cuttings between 3008 and 4178.2m analysed in the original palynological study. The recorded palynomorphs consist of moderate diversity spore-pollen assemblages mostly lacking key index species associated with moderately abundant but low diversity microplankton assemblages, which also mostly lack the critical index species.

Based on samples analysed the spore-pollen succession is subdivided into the *Tricolporites apoxyexinus* Zone from 3008 to 3145m, and the broad *Phyllocladidites mawsonii* Zone from 3216.1 to 4440m. Within the latter the *Clavifera vultuosus* Subzone is identified from 3310 to 3613.1m, the *Gleicheniidites ancorus* Subzone from 2775 to 3868m and the *Laevigatosporites musa* Subzone tentatively identified in the deepest sample examined at 4440m. The microplankton succession is subdivided into the *Odontochitina porifera* Zone identified at 3008m (and extending to 3120.1m based on the original data), the *Conosphaeridium striatoconum* Zone identified from 3310 to 3613.1m, and the broad *Palaeohystrichophora infusorioides* Zone identified from 3630 to 4440m. Within the latter the *Kiokansium polypes* Subzone is weakly identified from 4026 to 4179m, with possible *Isabelidinium evexus* Subzone tentatively identified at 4440m.

The palynological zonation suggests the portion of the well analysed represents the middle part of the Sherbrook Group. The shallower mudstones are correlated with Unit B of the Belfast Mudstone (from ~3002 to ~3200m), and the Morum Formation (from ~3200 to 3638m). The distinctive sandstones between 3638 and 3673m are correlated with the Banoon Member. The deeper mudstones from 3673m to 4468mTD are correlated with Flaxman Formation, grading imperceptibly into the Waarre Formation. Sediments equivalent in age to the Flaxman Formation extend as least as deep as 4179m. Below this over the remaining ~290 metres penetrated by the well the quality of the palynological assemblages decline markedly. Rare index species typical of the Waarre Formation are first recorded in cuttings at 4350m, 4410m and 4440m suggesting that Unit C of that formation may have been penetrated by TD. This evidence is very weak as the critical species recorded are all known to range into the overlying Flaxman Formation in other wells.

Table 1. Palynological and Stratigraphic Summary of Breaksea Reef-1.

Age	Spore-Pollen Zones/Subzones (Microplankton Zones/Subzones)	Depths	Stratigraphic Equivalence
Santonian	*Tricolporites apoxyexinus* Zone (*Odontochitina porifera* Zone)	3008 to 3145m (3008 to 3120.1m)	Belfast Mudstone Unit B
Coniacian	*Phyllocladidites mawsonii* Zone *Clavifera vultuosus* Subzone (*Conosphaeridium striatoconum* Zone)	3216.1 to 3630m 3310 to 3613.1m (3310 to 3613.1m)	Morum Formation or Unit A of Belfast Mudstone
mid to Late Turonian	*Phyllocladidites mawsonii* Zone (*Palaeohystrichophora infusorioides* Zone)	3641.1 to 3677m (3641.1 to 3677m)	Banoon Member of Flaxman Formation
mid to Late Turonian	*Phyllocladidites mawsonii* Zone *Gleicheniidites ancorus* Subzone (*Palaeohystrichophora infusorioides* Zone) (*Kiokansium polypes* Subzone)	3775 to 4179m 3775 to 3868m (3775 to 4179m) (4026 to 4179m)	Flaxman Formation undifferentiated
mid to Late Turonian	*Phyllocladidites mawsonii* Zone *Laevigatosporites musa* Subzone (*Isabelidinium evexus* Subzone)	4413 to 4440m 4440m (4440m)	Waarre Formation Unit C

Introduction

This new palynological study of the offshore Breaksea Reef-1 well was undertaken for Essential Petroleum Resources Limited with the objective of improving the age dating and correlation of the bottom ~1500 metres penetrated in the well by the analysis of new samples and the examination of new palynological slides prepared from old palynological residues.

The Breaksea Reef-1 well was drilled between 22 December 1983 and 28 May 1984 by Ultramar Australia Inc to a TD of 4468m, in the South Australian portion of the Otway Basin. The nearest wells penetrating equivalent stratigraphic section to that being investigated are the onshore Mount Salt-1 well directly to the north, Normanby-1 to the east and Argonaut-1A to the west. In the Well Completion Report by Ultramar Australia (1984) the well is interpreted to have drilled through a 1360 metre thick interval of the Belfast Mudstone between 3002 and 4362m, before penetrating a 142 metre thick "sandy" interval assigned to a composite Flaxman/Waarre Formation between 4326 and 4468mTD. Age dating and confirmation of the stratigraphic assignment of the latter interval has proved problematic as even though the section was penetrated in all three Sidetrack holes no electric logs were obtained deeper than 4289m, while the deepest sidewall core recovered and analysed was at 4178.2m some 148 metres shallower than the picked top of the Waarre Formation.

Relevant previous palynological work from the bottom half of Breaksea Reef-1 consists solely of the original study by Morgan (1984) who analysed 40 sidewall cores and 8 cuttings samples over the interval of interest. Although this original palynological data is consistent with the conclusions in the Well Completion Report the data cannot be reinterpreted in terms of the new palynological subzones and revised stratigraphic terminology for the Sherbrook Group developed over the last decade by this author because many important new species were not reported. In addition, the recorded microplankton assemblages are of low diversity and consist predominantly of long-ranging species, while the only abundance data available is based on visual estimates rather than assemblage counts. Further complicating any revisions of the well is the apparent loss of many of the original palynological slides examined by Morgan (1984). Although these slides were returned to the operator, they were never subsequently relinquished and are now missing and therefore are not available for restudy. Fortunately however, some of the original palynological residues have been located and from these residues new palynological slides been prepared by the Palynology Facility at Santos Ltd. From this new set of slides 18 sidewall cores and one cuttings sample between 3008 and 4178.2m have been examined for this study. As there were no slides or residues available from the bottom 290 metres penetrated in the well an additional seven (7) new cuttings samples were collected and processed between 4026 and 4440m. In total 26 samples are examined for this study.

Materials and Methods

As this new study of Breaksea Reef-1 has been commission at a specified budget the approach taken has been to examine and report on the samples at a qualitative reconnaissance level. The assemblages were only counted to a level necessary to determine the abundances of marine microplankton and the colonial algae *Amosopollis cruciformis* relative to the abundance of terrestrial spore-pollen in the assemblages.

The new cuttings samples were collected from the PIRSA Core Store in Adelaide by Dr Sally Phillips and the laboratory processing undertaken by Core Laboratories Pty Ltd in Perth. The initial results of were provided in three Provisional Reports issued between the 15th November and 12th December 2005. Final zone interpretations of both the new slides analysed, and all other available palynological samples in the interval being reviewed are provided in Table 2, while the species distribution data is provided on the accompanying StrataBugs™ range chart. Early drafts of both

Table 2 and the Range Chart were previously provided on the 5th and 6th December respectively. Basic assemblage data comprising the visual organic residues yields, the concentration and preservation of the palynomorphs observed on the slides, and the number of species of spore-pollen and microplankton recorded from the new slides analysed are provided in Table 3.

The distribution of the palynomorphs identified in the samples are displayed on the accompanying StrataBugs™ range chart. This displays the presence of the palynomorph species recorded in the samples joined by stratigraphic range bars. The palynomorphs recorded are also split between different categories. The terrestrial spore and pollen are divided between spores, gymnosperm pollen and angiosperm pollen, which are plotted in separate panels. This is followed by a panel showing the total count of marine microplankton and the colonial algae *Amosopollis cruciformis* displayed as a graph of percentages relative to the combined spore-pollen and microplankton count. The next three panels record the occurrence of the individual species of Microplankton, various Other palynomorphs, and Reworked (RW) palynomorphs. The species are plotted within the panels according to their deepest or oldest occurrences, or in alphabetical order. The following codes or abbreviations apply to the individual species occurrences and abundances on the range chart:

Numbers	=	Abundance expressed as percentage
C	=	Caved species
R	=	Reworked species
?	=	Questionable identification of species.

Author citations for the recorded spore-pollen species can be sourced from papers by Dettmann (1963), Dettmann & Playford (1968), Helby *et al.* (1987) and Stover & Partridge (1973), while the author citations for the microplankton species can be sourced from the indexes for dinocysts and other organic-walled microplankton prepared by Fensome *et al.* (1990) and Williams *et al.* (1998). Manuscript species names and combinations are indicated by “sp. nov.” or “comb. nov.” on the range chart, and “ms” after their binomials names in the text and tables.

Geological Discussion

The palynological assemblages recorded and the zonation proposed for the samples examined in Breaksea Reef-1 establish that the interval from 3008 to 4440m extends from the middle part of the Belfast Mudstone to possibly into the top of the Waarre Formation. The suggested age range is mid-Santonian to mid-Turonian.

The most significant new information generated by the study is the identification of the important *Conosphaeridium striatoconum* microplankton Zone between 3310 to 3613.1m. The eponymous species and principal marker for this zone was **not** reported in the original study by Morgan (1984), but has been found in the new slides prepared from the remaining organic-residues from several of the sidewall cores analysed in that initial study. The discovery of this zone marker is extremely important as it confirms the identification of the Morum Formation in Breaksea Reef-1 as originally suggested by Partridge (2001; fig.9).[1]

Palynological confirmation of the Morum Formation, which correlates to a generally highly condensed section at the base of the Belfast Mudstone in the type area of the Port Campbell

[1] In Partridge (1999) the Morum Formation was originally identified as lying between ~3000 and 3638m and this pick as carried over onto Figure 9 in Partridge (2001). This new palynological investigation suggests a more restricted distribution for the formation between ~3200 and 3638m. Precise placement of the top of the formation on the electric logs remains uncertain owing to complications caused by the TD of the 12-1/4 inch hole at 3192m, and the shoe for the 9-5/8 inch casing slightly shallower at 3178m. The overlying section from 3002 to ~3200m, based on superposition and the presence of the *Odontochitina porifera* Zone is now correlated with Unit B of the Belfast Mudstone.

Embayment, also provides a new interpretation of the so-called "***intra-Belfast sands***" identified between 3638 and 3673m in Breaksea Reef-1 on Figure 5.28 in Morton & Drexel (1995). These sands must now be reinterpreted as lying at the **base** of the Belfast Mudstone, and in terms of the revised stratigraphy advocated by Partridge (2001) they would be equivalent to the Banoon Member at the top of the Flaxman Formation.[2]

The underlying thick 'shaly' interval from 3673m to at least the bottom of the good electric logs at ~4160m based on the law of superposition must therefore belong to the remainder of the Flaxman Formation. Although the new palynological analysis supports this interpretation the results are poor, as the interpretation is based on a combination of weak species occurrence data and a reliance on negative evidence**:** the absence of younger or older zone index species. The key index species found which confirm that this interval is equivalent to the bulk of the Flaxman Formation are the oldest occurrence of the spore *Gleicheniidites ancorus* ms found at 3868m, and the dinocyst *Kiokansium polypes* whose youngest occurrence is found in the new cuttings at 4026m. In the thinner and highly condensed sections of the Flaxman Formation found in the Port Campbell Embayment these two species have overlapping ranges and are found in assemblages containing much greater diversity and much higher abundances of marine microplankton.

The reason why there are such unusual low diversities and low abundances of microplankton (aside from the colonial algae *Amosopollis cruciformis* which averages 12%) throughout this thick marine shale section in Breaksea Reef-1 is best explained by the very high rate of deposition. For the Flaxman Formation the deposition rate for these compacted sediments is between 500 to 1000 metres per million years depending on which chronometric time scale is used. The high magnitude of this rate is important as it is an empirical observation developed of the author that when deposition rates exceed ~300 metres per million years in thick siliciclastic successions (for compacted sediments), both the abundance and diversity of marine microplankton decline markedly due to dilution from the influx of terrestrially derived organic-matter. The rational behind this is that unless we are dealing with carbonates or marine volcano-clastics lithologies **all** fine-grained sediments originate from the weathering and erosion of subaerially exposed terrestrial rocks, and the clays are then transported to and are ultimately preferentially deposited in the most distal offshore environments, be they lacustrine or marine. Terrestrial palynomorphs which are silt-size but clay-weight get entrained in such sediment and are deposited with the finer siliciclastics. Total organic carbon of these high deposition rate siliciclastic sediments typically averages <1% and the total concentration of the spore-pollen is in the order of one part per ten thousand. In contrast, the incorporation of marine palynomorphs into marine siliciclastic sediments follows a different pattern. Microplankton cyst[3] originate from single-celled organisms living in the water column and on geological time scales can be assumed to be sedimentary particles that have a depositional rate that is relatively constant proportional to time. Under this criteria, assuming all other factors are equal, the abundance of microplankton should be proportional to depositional rate, with higher abundances in the more condensed sections, and with diluted low microplankton abundances at times of high influx of terrestrial derived sediments with their entrained constant average density of

[2] Although age or stratigraphic equivalence to the Banoon Member is established there are significant differences in the lithology and depositional environment of the member between Breaksea Reef-1 and the onshore Port Campbell Embayment (eg. Kelly & Partridge, 1997). A better comparison can probably be made with the uppermost gas reservoir sand in the Minerva field, which is also correlated with the Banoon Member but has a different depositional facies compared to the type section.

[3] The majority of microplankton cysts are interpreted as a "resting stage" in the life-cycle of dinoflagellates and other single-celled organisms which are initiated on either a regular seasonal periodicity or in response to adverse environmental conditions which would have a more irregular periodicity.

terrestrial spores and pollen.[4] The principal exception to the above general observation is when unusual or exceptional environmental circumstances allow the development of "blooms" of one or more algal types. A good example is the exceptional abundance of the colonial algae *Botryococcus braunii* in the Upper Jurassic (Kimmeridgian) source interval in the North Sea sedimentary succession, which was clearly the result of a very unusual environmental circumstances.

Over the bottom ~300 metres penetrated in Breaksea Reef-1 (from the cuttings at 4179m to TD at 4468m) the quality of the palynological assemblages is extremely poor, in both the original study by Morgan (1984) and the new cuttings processed for this report. In his original study Morgan (1984) records **single occurrences** of the dinocyst *Palaeoperidinium cretaceum* in cuttings at 4350m,[5] and the dinocyst *Cribroperidinium edwardsii* and spore *Appendicisporites distocarinatus* in cuttings at 4410m.[6] In this study the deepest of the new cuttings at 4440m[7] contains **single occurrences** of the dinocyst *Isabelidinium evexus* ms and the spore *Laevigatosporites ovatus* ms. All these species can be considered "typical" of the Waarre Formation but each have been recorded in the younger Flaxman Formation, either as reworked specimens or as rare extensions to their usual stratigraphic ranges. It is noteworthy however that none of these species has been recorded any shallower in Breaksea Reef-1, and therefore they cannot be dismissed as caved from higher in the well. This observation is valid irrespective of the uncertainty as to which Sidetrack hole the individual samples were collected from (see footnotes). In summary, the most reasonable conclusion to be drawn from this limited palynological data is that somewhere between 4300 and 4400m the Breaksea Reef-1 well penetrates the top of the Waarre Formation.

At the top of the interval being studied, above the 9-5/8 inch casing shoe at 3178m, the assemblages recorded herein from the sidewall core at 3008m and cuttings at 3145m, and those reported by Morgan (1984) from adjacent sidewall cores, confirm that the section belongs to the *Tricolporites apoxyexinus* spore-pollen Zone and the *Odontochitina porifera* microplankton Zone, and thus can be correlated to Unit B of Belfast Mudstone as recognised in the Port Campbell Embayment by Partridge (2001).

Biostratigraphy

The samples analysed in Breaksea Reef-1 are classified according to the Australian standard spore-pollen and microplankton zonation schemes originally defined in Helby *et al.* (1987), and subsequently modified by Partridge (1999 and 2001, fig.2). A recent summary of these zonation schemes can also be found in Partridge & Dettmann (2003).

Tricolporites apoxyexinus **spore-pollen Zone**
Interval: 3008 to 3175.1 metres, and
Odontochitina porifera **microplankton Zone**
Interval: 3008 to 3120.1 metres
Age: Santonian.

The two samples examined at 3008 and 3145m display surprisingly little difference in their gross spore-pollen compositions compared to the bulk of the samples from the older *P mawsonii* Zone in that they are dominated by common to abundant bisaccate pollen of *Podocarpidites* spp. and spores

[4] The long-standing traditional empirical observation in the palynological literature that there is a general increase in microplankton cyst abundance proportional to distance from the shoreline, currently does not acknowledge that part of the increased abundance needs to be attributed to a decline in deposition rates proportional to distance from shoreline.
[5] Cuttings at 4350m could have come from either Sidetrack-1, Sidetrack-2 or Sidetrack-3.
[6] Cuttings at 4410m could have come from either Sidetrack-2 or Sidetrack-3.
[7] Cuttings at 4440m can only have come from Sidetrack-3.

of *Cyathidites* spp. and *Gleicheniidites circinidites*. They are however assigned to the *T. apoxyexinus* Zone based on the rare presence of secondary index species, represented by *Forcipites* sp. at 3008m and *Latrobosporites amplus*, *Tricolpites confessus* and frequent *Proteacidites* pollen in the cuttings at 3145m. Supporting these identifications are the previous records in Morgan (1984) of the FAD (First Appearance Datum) of *Latrobosporites ohaiensis* in the deeper SWC at 3175.1m and the FADs of the primary zone index species *Ornamentifera sentosa* and *Tricolpites pachyexinus* (sic) in the SWC at 3120.1m. It is not certain whether the last species is identical to the subsequently described eponymous species *Tricolporites apoxyexinus* Partridge 1987 or a mis-identification of *Tricolpites confessus*, but either way it is consistent with the zone identification.

The shallowest sample examined at 3008m can also be assigned to the equivalent *O. porifera* microplankton Zone based on the presence of the eponymous species in association with dinocysts of the *Chatangiella tripartita* to *Amphidiadema rectangularis* morphological complex. This zone also extends to the deeper SWCs at 3075.1 and 3120.1m based on the identification of *Odontochitina porifera* in these samples by Morgan (1984).

***Phyllocladidites mawsonii* spore-pollen Zone**
Interval: 3216.1 to 4467 metres,
Age: Turonian to Coniacian.

All the samples analysed broadly conform to the *P. mawsonii* Zone in that they contain either or both the eponymous species *Phyllocladidites mawsonii* (in 17 out of 24 samples) and the former index species *Clavifera triplex* (in 15 out of 24 samples), and lack both the key index species and gross assemblage characteristics of the older Otway Group (eg. absence of *Coptospora paradoxa* and any abundance of *Ruffordiaspora australiensis* and *Baculatisporites/Osmundacidites* spores), and the younger *Tricolporites apoxyexinus* Zone (eg. absence of younger eponymous species and secondary criteria like presence of *Tricolpites confessus* and the increased abundance of *Proteacidites* pollen). Three of the four subzones within the parent zone are also identified, and are discussed in descending stratigraphic order below:

***Clavifera vultuosus* spore-pollen Subzone and**
***Conosphaeridium striatoconum* microplankton Zone**
Interval: 3310 to 3613.1 metres
Age: Coniacian.

This spore-pollen subzone and the parallel microplankton zone are both identified by the rare occurrence of the respective eponymous species *Clavifera vultuosus* ms and *Conosphaeridium striatoconum* in the shallowest and deepest samples examined from the interval. The spore-pollen assemblages are characterised by common *Gleicheniidites circinidites*, while the deepest sample at 3613.1m also has common *Cupressacites* sp. pollen. The latter is regarded as a characteristic feature of assemblages from or adjacent to the Banoon Member (Kelly & Partridge, 1997). In the top sample examined at 3310m the presence of *Latrobosporites amplus* and *Phyllocladidites verrucosus* represent unusual and unexpected older extension of the ranges of these two species, while the occurrence of *Appendicisporites tricornus* is a surprisingly late record of this species. Other microplankton index species recorded are the incoming of good *Trithyrodinium* spp. and a single specimen of *Isabelidinium balmei* recorded at 3613.1m. The microplankton assemblages are dominated by common to abundant *Amosopollis cruciformis* and mostly are of low diversity averaging less than 5 species per sample.

Gleicheniidites ancorus **spore-pollen Subzone**
Interval: 2775 to 3868 metres
Age: Mid Turonian to early Coniacian.

Ideally the base of this subzone is identified by the oldest occurrence of consistent *Gleicheniidites ancorus* ms, and an increase in the consistency of occurrence and abundances of *Phyllocladidites mawsonii* and *Clavifera triplex*. Although the latter criteria applies to most of the deeper samples analysed the identification of the subzone is restricted to just those samples containing the eponymous species. The subzone would normally be expected to extend into the sandstone unit between 3638 and 3673m, which is correlated with the Banoon Member, but sadly the assemblages recorded from the new slides prepared from the sidewall core at 3641.1m contain a very poor assemblage, while the other samples at 3638m and 3640.1m analysed by Morgan (1984) are essentially barren.

Laevigatosporites musa **spore-pollen Subzone**
Cuttings at: 4440 metres
Age: Mid Turonian.

The deepest cuttings examined is assigned to this subzone based on the occurrence of a single specimen of the eponymous species *Laevigatosporites musa* ms. The associated presence of the spores *Stoverisporites microverrucatus* and *Verrucosisporites admirabilis* ms are consistent with the subzone assignment, while the apparent anomalous occurrence of *Gleicheniidites ancorus* ms is interpreted as caved. The assemblage is dominated by non-descript bisaccate pollen and *Cyathidites* spores.

Palaeohystrichophora infusorioides **microplankton Zone**
Interval: 3630 to 4467 metres
Age: Turonian to early Coniacian.

The formal definition of this zone by Helby *et al.* (1987; p.62) is the stratigraphic interval from the LAD (Last Appearance Datum) of *Pseudoceratium ludbrookiae* to the FAD of *Conosphaeridium striatoconum* and as such in Breaksea Reef-1 applies to all samples below the FAD of the latter species at 3613.1m. Sadly, the recorded diversity in all the samples is very low with an average of just 5 species per sample and an overall diversity recorded on the range chart of 23 species. The two subzones tentatively identified are discussed in descending stratigraphic order below:

Kiokansium polypes **microplankton Subzone**
Interval: 4026 to 4179 metres
Age: Mid to Late Turonian.

The top of the subzone is placed at the LAD of *Kiokansium polypes* in the new cuttings at 4179m while the base of the subzone extends at least to the new cuttings at 4179m based on the presence of the eponymous species associated with common *Amosopollis cruciformis* and frequent *Heterosphaeridium* spp. Unfortunately, *Valensiella griphus* the marker species for the base of the subzone was only found at 4413m, where based on the style of preservation, it is interpreted to be caved. Overall the microplankton content of the sidewall cores analysed through the thick and shaly Flaxman Formation is very poor, and the best hope of further improving the current results would be to collect and analyse additional cuttings samples.

***Isabelidinium evexus* microplankton Subzone, or younger**
Cuttings at: 4440 metres
Age: Mid Turonian.

The deepest cuttings analysed is tentatively assigned to this subzone based on the presence of a single specimen of the eponymous species *Isabelidinium evexus*. Unfortunately, the other microplankton recorded are not diagnostic of this subzone, and the presence of *Conosphaeridium striatoconum* and *Trithyrodinium* spp. is clear evidence that the samples is also contaminated by cavings. The best interpretation that can be given to the sample is to say that it is no older than the *I. evexus* Subzone.

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Table 2. Interpretative palynological assemblage data for Breaksea Reef-1.

Depth metres	Sample Type	Hole	Code	Spore-Pollen Zone	CR	Microplankton Zone	CR	Comments & Key species	Ana-lyst	MMP%	AC%	No. SP Species	No. MP Species
3008.0	SWC 5	BR1	A	*T. apoxyexinus* Zone	B5	*O. porifera* Zone	B3	FAD of *Chatangiella tripartita*	ADP	15%	13%	34	10
3075.1	SWC 4	BR1	C	*T. apoxyexinus* Zone	B3	*O. porifera* Zone	B3	*Odontochitina porifera* present	RM			18	14
3120.1	SWC 3	BR1	C	*T. apoxyexinus* Zone	B2	*O. porifera* Zone	B3	FADs of *Tricolporites pachyexinus, Ornamentifera sentosa* and dinocyst *Odontochitina porifera*	RM			19	6
3145.0	Cuttings	BR1	A	*T. apoxyexinus* Zone	D3	Indeterminate		LAD of *Verrucosisporites admirabilis* ms and FAD of *Tricolpites confessus*	ADP	4%	4%	38	3
3175.1	SWC 2	BR1	C	*T. apoxyexinus* Zone	B4	Indeterminate		*Latrobosporites ohiensis* present	RM			18	9
3190.1	SWC 1	BR1	C	Indeterminate		Indeterminate		No significant species recorded	RM			14	9
3194.0	SWC 52	ST1	C	BARREN		BARREN		Barren of palynomorphs	RM			NR	NR
3216.1	SWC 50	ST1	A	*P. mawsonii* undiff.	B5	Indeterminate		LAD of *Appendicisporites* sp.	ADP	<3%	<2%	34	2
3245.0	SWC 49	ST1	B	Indeterminate		Indeterminate		No significant species recorded	RM			17	7
3276.0	SWC 48	ST1	B	Indeterminate		Indeterminate		No significant species recorded	RM			17	7
3310.0	SWC 47	ST1	A	*C. vultuosus* Subzone	B2	*C. striatoconum* Zone	B3	LAD of *Conosphaeridium striatoconum* FAD of *Latrobosporites amplus*	ADP	<1%	14%	42	6
3328.0	SWC 46	ST1	B	*T. apoxyexinus* Zone	B4	Indeterminate		FAD of *Latrobosporites ohiensis*	RM			16	3
3351.0	SWC 45	ST1	B	*P. mawsonii* undiff.	B5	Indeterminate		Not re-examined	RM			15	2
3381.0	SWC 44	ST1	B	*P. mawsonii* undiff.	B5	Indeterminate		Not re-examined	RM			18	1
3460.0	SWC 43	ST1	B	*P. mawsonii* undiff.	B5	Indeterminate		Not re-examined	RM			11	4
3477.0	SWC 42	ST1	B	*P. mawsonii* undiff.	B5	Indeterminate		Not re-examined	RM			13	5
3494.0	SWC 41	ST1	B	*P. mawsonii* undiff.	B5	Indeterminate		Not re-examined	RM			17	4
3516.0	SWC 40	ST1	B	*P. mawsonii* undiff.	B5	Indeterminate		Not re-examined	RM			11	7
3543.1	SWC 39	ST1	A	*C. vultuosus* Subzone	B5	*C. striatoconum* Zone	B3	*Conosphaeridium striatoconum* present	ADP	<1%	11%	30	4
3570.0	†SWC 38	ST1	B	*P. mawsonii* undiff.	B5	Indeterminate		Not re-examined	RM			14	4
3589.0	SWC 37	ST1	A	*C. vultuosus* Subzone	B5	*C. striatoconum* Zone	B3	*Conosphaeridium striatoconum* present	ADP	12%	21%	35	9
3613.1	SWC 36	ST1	A	*C. vultuosus* Subzone	B3	*C. striatoconum* Zone	B3	FADs of *Conosphaeridium striatoconum, Isabelidinium balmei* and *Clavifera vultuosus* ms	ADP	2%	17%	41	6
3630.0	SWC 35	ST1	A	*P. mawsonii* undiff.	B4	*P. infusorioides* undiff.	B4	FAD of *Ilexpollenites primus* ms	ADP	5%	17%	29	9
3638.0	SWC 34	ST1	C	Indeterminate		Indeterminate		No significant species recorded	RM			4	2
3640.1	SWC 33	ST1	C	Effectively BARREN		BARREN		No significant species recorded	RM			1	NR
3641.1	SWC 32	ST1	A	*P. mawsonii* undiff.	B4	*P. infusorioides* undiff.	B4	Poor assemblage from sandstone	ADP	2%	4%	25	2
3677.0	SWC 26	ST1	A	*P. mawsonii* undiff.	B5	*P. infusorioides* undiff.	B5	Poor assemblage from sandstone	ADP	NR	<4%	16	1
3693.0	†SWC 25	ST1	B	*P. mawsonii* undiff.	B5	Indeterminate		Not re-examined	RM			13	2
3736.0	SWC 23	ST1	B	*P. mawsonii* undiff.	B5	Indeterminate		Not re-examined	RM			11	1
3751.0	†SWC 22	ST1	B	*P. mawsonii* undiff.	B5	Indeterminate		Not re-examined	RM			14	2

Table 2. Interpretative palynological assemblage data for Breaksea Reef-1.

Depth metres	Sample Type	Hole	Code	Spore-Pollen Zone	CR	Microplankton Zone	CR	Comments & Key species	Ana-lyst	MMP%	AC%	No. SP Species	No. MP Species
3775.0	SWC 21	ST1	A	*G. ancorus* Subzone	B3	*P. infusorioides* undiff.	B4	Frequent *Gleicheniidites ancorus* ms	ADP	12%	18%	31	9
3799.1	SWC 20	ST1	B	*P. mawsonii* undiff.	B5	Indeterminate		Not re-examined	RM			9	1
3829.0	†SWC 19	ST1	A	*G. ancorus* Subzone	B2	*P. infusorioides* undiff.	B5	*Gleicheniidites ancorus* ms present	ADP	4%	7%	29	6
3868.0	†SWC 17	ST1	B	*G. ancorus* Subzone	B3	Indeterminate		FAD of *Gleicheniidites ancorus* ms	ADP	3%	27%	28	4
3886.0	†SWC 16	ST1	A	*P. mawsonii* undiff.	B4	*P. infusorioides* undiff.	B5	Poor assemblage	ADP	<1%	<5%	31	3
3987.0	†SWC 11	ST1	A	*P. mawsonii* undiff.	B4	*P. infusorioides* undiff.	B5	Poor assemblage	ADP	18%	<1%	32	4
4026.0	NEW Ctts	?	A	*P. mawsonii* undiff.	B4	*K. polypes* Subzone	B3	LAD of *Kiokansium polypes*	ADP	17%	28%	25	7
4027.1	SWC 9	ST1	A	*P. mawsonii* undiff.	B4	*P. infusorioides* undiff.	B4	Poor assemblage	ADP	12%	16%	32	7
4053.0	†SWC 8	ST1	B	*P. mawsonii* undiff.	B5	Indeterminate		*Cyclonephelium distinctum* common?	RM			11	7
4070.5	SWC 7	ST1	A	*P. mawsonii* undiff.	B4	*K. polypes* Subzone	B3	Depth 4075m in SWC descriptions	ADP	19%	11%	25	7
4173.0	SWC 3	ST1	A	*P. mawsonii* undiff.	B4	*P. infusorioides* undiff.	B4	Poor assemblage	ADP	8%	<4%	19	6
4178.2	SWC 2	ST1	A	*P. mawsonii* undiff.	B4	*P. infusorioides* undiff.	B4	FAD of *Phyllocladidites mawsonii* in	ADP	8%	9%	24	9
4179.0	NEW Ctts	?	A	*P. mawsonii* undiff.	D4	*K. polypes* Subzone	D5	FAD of common *Amosopollis cruciformis*	ADP	8%	18%	20	6
4290.0	Cuttings	?	C	*P. mawsonii* undiff.	D4	*P. infusorioides* undiff.	D4	No significant species recorded	RM			14	11
4311.0	NEW Ctts	ST2	A	*P. mawsonii* undiff.	D5	BARREN		Very lean <10 specimens per slide	ADP	NR	NR	7	NR
4320.0	Cuttings	?	C	*P. mawsonii* undiff.	D4	*P. infusorioides* undiff.	D4	No significant species recorded	RM			11	6
4323.0	NEW Ctts	?	A	Indeterminate		Indeterminate		Very lean <10 specimens per slide	ADP	NR	NR	8	2
4350.0	Cuttings	?	C	*P. mawsonii* undiff.	D4	*P. infusorioides* undiff.	D4	*Paleoperidinium cretaceum* present	RM			8	5
4380.0	Cuttings	?	C	*P. mawsonii* undiff.	D4	*P. infusorioides* undiff.	D4	No significant species recorded	RM			10	7
4395.0	NEW Ctts	ST3	A	Indeterminate		Indeterminate		Very lean <10 specimens per slide	ADP	NR	NR	5	1
4410.0	Cuttings	ST3	C	*P. mawsonii* undiff.	D4	*P. infusorioides* undiff.	D4	LADs of *Cribroperidinium edwardsii* and *Appendicisporites distocarinatus*	RM			8	10
4413.0	NEW Ctts	ST3	A	*P. mawsonii* undiff.		Indeterminate		Caved *Valensiella griphus* present	ADP	NR	NR	9	2
4440.0	NEW Ctts	ST3	A	*L. musa* Subzone	D3	*I. evexus* Subzone or younger	D3	FADs of *Laevigatosporites musa* ms, *Isabelidinium evexus* ms & *K. polypes*	ADP	16%	<5%	24	13
4440.0	Cuttings	ST3	C	*P. mawsonii* undiff.	D4	*P. infusorioides* undiff.	D4	No significant species recorded	RM			6	8
4467.0	Cuttings	ST3	C	*P. mawsonii* undiff.	D4	*P. infusorioides* undiff.	D4	FAD of common *Heterosphaeridium* spp.	RM			8	6

CODES and ABBREVIATIONS

A = New samples and slides examined.
B = New slides NOT examined.
C = No slides available.
†SWC = NOT recorded in SWC descriptions

BR1 = Original Hole
ST1 = Sidetrack-1
ST2 = Sidetrack-2
ST3 = Sidetrack-3
? = Unknown hole

CR = Confidence Ratings
MMP% = Marine Miroplankton Percentage
AC% = *Amosopollis cruciformis* Percentage
FAD = First Appearance Datum
LAD = Last Appearance Datum

ADP = Analyst Alan D Partridge
RM = Analyst Roger Morgan

Confidence Ratings (CR) applying to Table 2.

Alpha Code Linked to Sample	Numeric Code Linked to Palynomorph Assemblage
A = Core	1 = Excellent confidence: High diversity assemblage **plus** key zone species.
B = Sidewall core	2 = Good confidence: Moderately diverse assemblage **plus** key zone species.
C = Coal cuttings	3 = Fair confidence: Low diversity assemblage **plus** key zone species.
D = Ditch cuttings	4 = Poor confidence: Moderate to high diversity **minus** key zone species.
J = Junk basket	5 = Very low confidence: Low diversity assemblage **minus** key zone species.

Table 3. Basic palynological sample and assemblage data for Breaksea Reef-1.

Depth metres	Sample Type	Visual Yield	Palynomorph Concentration	Palynomorph Preservation	No. SP Species	No. MP Species
3008.0	SWC 5	Low	Low	Poor-Fair	34	10
3145.0	Cuttings	Moderate	Moderate	Poor-Fair	38	3
3216.1	SWC 50	Moderate	Moderate	Fair	34	2
3310.0	SWC 47	Moderate	Moderate	Poor-Fair	42	6
3543.1	SWC 39	Moderate	Low	Poor-Fair	30	4
3589.0	SWC 37	Moderate	Moderate	Poor	35	9
3613.1	SWC 36	Moderate	High	Poor-Fair	41	6
3630.0	SWC 35	Moderate	Low	Poor-Fair	29	9
3641.1	SWC 32	Low	Very Low	Very Poor	25	2
3677.0	SWC 26	Low	Low	Poor	16	1
3775.0	SWC 21	Moderate	Moderate	Poor	31	9
3829.0	†SWC 19	Moderate	Moderate	Poor	29	6
3868.0	†SWC 17	Low	Low	Very Poor	28	4
3886.0	†SWC 16	Low	Low	Poor	31	3
3987.0	†SWC 11	Moderate	Moderate	Poor	32	4
4026.0	NEW Cuttings	Moderate	Moderate	Very Poor	25	7
4027.1	SWC 9	Moderate	Moderate	Poor	32	7
4070.5	SWC 7	Moderate	Low	Poor	25	7
4173.0	SWC 3	Moderate	Low	Poor	19	6
4178.2	SWC 2	Low	Low	Poor	24	9
4179.0	NEW Cuttings	Moderate	Low	Poor	20	6
4311.0	NEW Cuttings	Moderate	Very Low	Very Poor	7	NR
4323.0	NEW Cuttings	Moderate	Very Low	Very Poor	8	2
4395.0	NEW Cuttings	Low	Very Low	Very Poor	5	1
4413.0	NEW Cuttings	Moderate	Very Low	Very Poor	9	2
4440.0	NEW Cuttings	High	Low	Very Poor	24	13

†SWC = NOT recorded in SWC descriptions (presumably not paid for).

Well Name : Breaksea Reef-1

Operator : Ultramar
Well Code : BREAKSEAREEF-1
Lat/Long : 38° 9' 0.00"S 140°36' 0.00"E
Interval : 3000m - 4500m
Scale : 1:4000
Chart date: 28 February 2006

Spudded : 22 December 1983
Completed : 28 May 1984
INTERPRETATIVE Range Chart
Sample interval 3308 to 4440m
Microscope analysis by Alan D. Partridge

Breaksea Reef-1

Biostrata Pty Ltd
AUSTRALIA

Attachment to Biostrata Report 2006/02A