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New Biostratigraphic Subdivision and Paleoecology of the Upper Cretaceous West Tuna R Reservoir, Gippsland Basin, Australia

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EXECUTIVE SUMMARY

- Palynology and kerogen analyses of three West Tuna well R reservoir provide: 1) a new detailed biostratigraphic subdivision of the *T. lilliei* reservoir section, 2) biostratigraphic events that have local and potentially regional correlatable value, 3) paleoenvironmental interpretations to better constrain sequence stratigraphic interpretations, facies models, and paleogeographic reconstructions.

- Seven local and potentially regionally correlatable biozones are identified versus one zone previously.

- Palynozone are defined on downhole occurrences, where possible, but they also are characterized by influxes and base occurrences, as well as trends in overall assemblage composition.

- The youngest sediments analyzed from 2391 m in Tuna-4, 2373.6 m in West Tuna W-8, and 2370 mSS TVD in West Tuna W-32 are Lower Maastrichtian and attributable to the West Tuna palynozone Mb 1.

- The sections above c.2495 m in Tuna-4, above c.2482 m in West Tuna W-8, and above c.2489 m in West Tuna W32 are tentatively assignable to the Lower Maastrichtian palynozones Mb 1, 2 and most of Mb 3.

- The oldest sediments analyzed at 2794 m (swc) in Tuna-4 are broadly assigned to the Middle-Lower Campanian palynozone Mc. The oldest sediments studied in West Tuna W-8 at 2641.5 m (swc) and 2651.9 m (swc), and in West Tuna W-32 at 2604-2609 m (cuttings) and 2619-1624 m (cuttings) are assigned to the Middle Campanian Mb 7 West Tuna zone.

- The palynological assemblages indicate deposition of the Upper Campanian-Lower Maastrichtian R reservoir sediments in a nonmarine setting fluctuating from a humid to somewhat less humid, cool to warm temperate climate.

- No positive evidence of marine or brackish influence, such as acritarchs or dinoflagellates, was found in intervals previously interpreted as supra-tidal to tidal channel from a sedimentological study of the cores.

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INTRODUCTION

At the request of Esso Australia Ltd. (Dave Moreton), we examined samples from the West Tuna field R reservoir interval, Gippsland Basin, Australia. This study presents results of biostratigraphic analyses of core and sidewall cores from Tuna-4, sidewall cores from West Tuna W-8, and ditch cuttings from West Tuna W-32. The stratigraphic section studied comprises the Late Cretaceous Latrobe Group and Golden Beach Group from the base of Tuna-4. The stratigraphic breakdown for each well over this interval is summarized on pages 3 and 4, and discussed in detail in Biostratigraphic Discussion section beginning on page 6.

The purpose of the study was:

- to provide a palynologic and biofacies evaluation of the studied intervals,
- to determine if it is possible to further subdivide the Lower Cretaceous *T. lilliei* zone,
- to identify both potentially regionally correlative and local (subzonal) biostratigraphic events from the Lower Cretaceous R reservoir interval, and
- to provide paleoenvironmental interpretations to better constrain sequence stratigraphic interpretations, facies models, and paleogeographic reconstructions.

The results of this study are based on analyses of more than 200 palynology and kerogen slides from thirteen core and twelve sidewall core samples from Tuna-4, seventeen sidewall cores from West Tuna W-8, and seventeen ditch cuttings samples from West Tuna W-32.

The identification of correlatable biostratigraphic zones forms the basis of the stratigraphic interpretations of these wells. Where possible these palynozone are defined on downhole occurrences, but they also are characterized by influxes and base occurrences, as well as trends in overall assemblage composition. Each unit is defined as the stratigraphic interval between two distinctive biostratigraphic events. The key biostratigraphic events that define the palynozones are given in the Biostratigraphic Discussion section. The age interpretations for this Late Cretaceous section are approximate, as little independent information has been obtained to correlate the Gippsland spore-pollen, and are those shown on the Cenozoic an Mesozoic Sequence Chronostratigraphic Framework cycle chart (Hardenbol and others, in press).

The age and paleoenvironmental interpretations are based on comparisons with materials from Askin (1990); Burger (1990); Churchhill (1973); Davies (1995A); Dettman and Jarzen (1990a, 1990b, 1991, 1996); Dettman, Pocknall and others (1990); Germeraad and others (1968); Hardenbol and others (1996); Helby and others (1987); Macphail (1985); Partridge (1973, 1976, 1988); Powell (1992); Stover (1972); Stover and Evans (1973); Stover and Partridge (1971, 1973, 1984); and Wilson (1984, 1988).

Interpretations of paleoecology were made based on observed changes in the spore-pollen (S/P) assemblages and biofacies from kerogen slides. Appendix A following the references, gives a sample-by-sample listing of the distribution of important species. Relative abundance abbreviations used are: EA - extremely abundant; VA - very abundant; A - abundant; C - common; F - few; R - rare; and VR - very rare. Other abbreviations used are: SP - spores and pollen, D - dinoflagellates, A - acritarchs; F - foraminifera.

BIOSTRATIGRAPHIC ZONATION

TUNA-4

Age	Palynozone	Depth (mSS TVD)
Lower Maastrichtian	Mb 1a Mb 1b	2391 m 2405 m
	Unassigned (no samples provided)	2405-2443.5 m
Lower Maastrichtian-Upper Campanian	Mb 3	2443.5 m
Upper Campanian	Mb 4 Unassigned	2510.5 m 2516.3 m
	Mb 5	2528.8 m
Upper-Middle? Campanian	Unassigned (?Mb 6) Mb 6b	2584 m 2613 m
Middle Campanian	Mb 7 Unassigned (poor preserv., sparse fossils)	2641 m 2709-2778 m
Middle-Lower Campanian	Mc	2794 m

WEST TUNA W-8

Age	Palynozone	Depth (mSS TVD)
Lower Maastrichtian	Mb 1a Mb 1b Mb 2	2373.6 m 2408.7 m 2423.1 m
Lower Maastrichtian-Upper Campanian	Mb 3	2433 m
Upper Campanian	Mb 4 Mb 5	2501.3 m 2527.4 m
Upper-Middle? Campanian	Mb 5/6 (undiff.)	2570.7 m
Upper-Middle? Campanian	Mb 6a Mb 6b	2584.3 m 2598.1 m
Middle Campanian	Mb 7	2641.5 m

WEST TUNA W-32

Age	Palynozone	Depth (mSS TVD)
Lower Maastrichtian	Mb 1a	2370 m
	Mb 1b	2399 m
	Mb 2	2419 m
Lower Maastrichtian-Upper Campanian	Mb 3	2449 m
	Unassigned	2475 m
	Mb 3?	2490 m
Upper Campanian	Mb 4/5	2505 m
	Mb 5	2514 m
	Unassigned (Mb 5?)	2529 m
Upper-Middle? Campanian	Mb 6	2549 m
	Unassigned	2569 m
	Mb 6?	2579 m
Middle Campanian	Mb 7?	2604 m

GEOLOGICAL SUMMARY

TUNA-4

The basalmost Tuna-4 sample analyses was at 2794 mSS TVD, within the upper part of the Golden Beach Group of Middle Campanian age. These sediments are recorded up to about 2711 m where they are overlain by volcanics. Deposition occurred in a nonmarine, fluvial setting.

In absence of biostratigraphic evidence, but based on assemblage zones and sequence stratigraphic analyses, the Middle / Upper Campanian boundary is provisionally placed at the log break at about 2603 m (or alternatively at about 2586 m). The Upper Campanian - Lower Maastrichtian Latrobe Group sediments continue in a nonmarine, fluvial environments with deposition dominated by braided fluvial sandstones.

The Campanian / Maastrichtian boundary is placed at about 2495 m.

A sedimentological study (P.E. Patterson, EPR, pers. comm.) suggests that sediments in Tuna-4 from parts of cores 6 and 9 represent sedimentary environments in a supra-tidal to tidal channel setting. Our investigation of samples from core 9 from 2534.7 to 2537.9 m, which is interpreted as supra-tidal to tidal channel, reveals no positive evidence of marine or brackish influence, such as acritarchs or dinoflagellates, to support a tidal interpretation. Also, the general composition of the palynomorphs in this section are similar to those intervals attributed to a nonmarine depositional environment.

WEST TUNA W-8

The basalmost sample analyzed from this well was within the Latrobe Group of Middle Campanian age. Deposition of these sediments occurred in a nonmarine, fluvial setting, with deposition dominated by braided, fluvial sandstone.

Based on assemblage zones and sequence stratigraphic analyses, the Middle / Upper Campanian boundary is provisionally placed at the log break at about 2589 m (alternatively at c.2584 m).

The Campanian / Maastrichtian boundary is placed at about 2482 m.

WEST TUNA W-32

The basalmost sample analyzed from West Tuna W-32 was of Middle Campanian age in the Latrobe Group. Deposition of the studied section occurred in a nonmarine, fluvial setting, with deposition dominated by braided, fluvial sandstone.

Based on assemblage zones and sequence stratigraphic analyses, the Middle / Upper Campanian boundary is provisionally placed at the log break at about 2580 m (alternatively at c.2552 m).

The Campanian / Maastrichtian boundary is placed at about 2489 m.

BIOSTRATIGRAPHIC DISCUSSION

This section describes the results of the biostratigraphic analyses and highlights those event that are of local or potentially regional correlatable value. The zones assigned in this report are newly developed in the West Tuna field and may have limited utility outside the area.

TUNA-4

Interval: **2391-2405 mSS TVD**

Age: **Lower Maastrichtian**

Interval zones:

2391m - palynozone Mb 1a
2405m - palynozone Mb 1b

Palynology:

- palynozone Mb 1 is divided into two subzones.

- the highest sample analyzed at 2391 m is assigned to the Lower Maastrichtian subzone Mb 1a (within the Upper *T. lilliei*). It contains *Gambierina rudata* of Stover and Partridge, 1973, *Triporopollenites sectilis, Tetracolporites verrucosus, Nothofagidites* spp., *Stereisporites* spp., and *Proteacidites* spp. (Appendix A).

- a shift in the palynomorph assemblage indicates penetration of subzone Mb 1b at 2405 m.

- palynoflora suggest that the depositional environment is interpreted as humid and cool temperate.

- zone Mb 1 is recorded from the Tuna-4, as well as from West Tuna W-8 and West Tuna W-32 in the section above the reservoir package and above EAL's 'TLILLPKNEW' surface.

- Palynozone Mb 2 was not identified in Tuna-4. Zone Mb 2 is recorded from West Tuna W-8 and West Tuna W-32 in the section just below EAL's 'TLILLPKNEW' surface.

No samples are provided from 2405-2443.5 m, which may account for the absence of Mb 2.

Interval: **2443.5-2498.6 mSS TVD**

Age: **Lower part of Lower Maastrichtian - upper part of Upper Campanian**

Interval age and zones:

2443.5m - palynozone Mb 3

Palynology:

- the palynomorph assemblage at 2443.5 m is placed in the Lower Maastrichtian-Upper Campanian, palynozone Mb 3.

- taxa recorded consistent with this age, include *Nothofagidites* spp., *Aequitriradites* spp., *Tetracolporites verrucosus,* cf. *Quadraplanus brossus*, *Proteacidites* spp, *Stereisporites* spp., *Tricolpites gillii*, and *Tricolpites confessus* (Appendix A).

- the depositional setting of this interval is considered to be somewhat cooler and perhaps a little less moist than the overlying zone. There is an increase in numbers of the moisture-loving species from about 2485.4 m, suggesting an increase in moisture toward the base of this zone.

- the log break at about 2495 m, near the base of this zone, may correlate with the flooding event (about 72 Ma) of the CAM 10 sequence shown on the Cenozoic-Mesozoic cycle chart of Hardenbol and others (in press).

- zone Mb 3 is recorded from the Tuna-4, as well as from West Tuna W-8 and West Tuna W-32 in the section from just above or near the top of R-200 down to just above the top R-200 surface.

Interval: **2510.5-2514.6 mSS TVD**

Age: **Upper Campanian**

Interval age and zones:

2510.5m - zone Mb 4

Palynology:

- the two SWC samples from 2510-5-2514.6 m are assigned to the Upper Campanian zone Mb 4.

- taxa present that support this zonal assignment are *Cyathidites* spp., *Proteacidites* spp., *Nothofagidites* spp., *Phyllocladidites* spp., *Tricolpites confessus*, *Tricolpites gillii*, *Gambierina edwardsii,* and *Stereisporites* spp. (Appendix A).

- the palynoflora is indicative of a cool, humid environment of deposition.

- zone Mb-4 is recorded in Tuna-4 and West Tuna W-8, and possibly in West Tuna W-32 in the upper part of R-300 reservoir sandstone.

Interval: **2516.3-2517 mSS TVD**

Age: **Upper Campanian, based on age of overlying and underlying strata**

Interval age and zones:

2516.3m - Unassigned (undifferentiated palynozone Mb 4/5/6)

Palynology:

- spore-pollen are sparse in this interval. There are relatively common *Cyathidites* spp., as well as rare *Proteacidites* spp. and a few trilete spores (Appendix A).

Interval: **2528.8-2537.9 mSS TVD**

Age: **Upper Campanian**

Interval age and zones:

2528.8m - palynozone Mb 5

Palynology:

- a palynofacies change occurs at 2528.8 m and marks the top of the Upper Campanian palynozone Mb 5.

- taxa recorded include common *Cyathidites* spp., a few *Stereisporites* spp., and frequent to common *Phyllocladidites* spp., *Proteacidites* spp., *Nothofagidites* spp., and *Tricolporites lilliei* (Appendix A). Amorphous kerogen is relatively common.

- the palynoflora indicates that the depositional environment was humid, but probably slightly warmer than above..

- zone Mb 5 is identified in Tuna-4 just above the Seis R-350 surface and in West Tuna W-8 from just above the Seis R-350 surface down to just above the R-350 surface. Mb 5 possibly occurs in West Tuna W32 from R-350 to possibly just above the R-300 Base surface.

Interval: **2584 mSS TVD**

Age: **Upper-Middle? Campanian, based on age of overlying and underlying strata**

Interval age and zones:

2584m - Unassigned (palynozone Mb 6?)

Palynology:

- spore-pollen are rare in this sample and no zonal events are recognized (Appendix A).

Interval: **2613-2621 mSS TVD**

Age: **Upper - Middle? Campanian**

Interval age and zones:

2613m - palynozone Mb 6

Palynology:

- the palynoflora recorded in this interval is characteristic of the Upper-Middle? Campanian, palynozone Mb 6.

- taxa recorded are *Nothofagidites* spp., *Proteacidites* spp., *Phyllocladidites* spp., trilete spores, *Tricolpites gillii, Tricolpites confessus*, *Tricolpites pachyexinus,* cf. *Tricolporites lilliei* and *Australopollis obscurus* (Appendix A).

- the increase in number of moisture-loving species and the increase in cool, humid indicators, suggest that the depositional environment was perhaps a littler wetter and slightly cooler than above.

- the spore-coloration index, or thermal alteration index (TAI) measured from kerogen slides, in SWC sample 2613-2621 m is 2.3. This is approximately equivalent to a LOM of 9.5 (Appendix A).

- zone Mb 6 is identified in Tuna-4 between top R-500 and the Seis R-500 surface, and between the top R-500 and R-350 Base surfaces in West Tuna W-8 and West Tuna W-32. The top of this zone in Tuna-4 may continue up to just beneath the R-350 Base surface.

Interval: **2641-2662 mSS TVD**

Age: **Middle Campanian**

Interval age and zones:

2641m - zone Mb 7

Palynology:

- the assemblage in this interval is indicative of palynozone Mb 7.

- taxa recorded consistent with this zonal assignment include fern spores, including *Cyathidites* spp., *Phyllocladidites* spp., frequent *Nothofagidites* spp., rare *Stereisporites* spp., *Proteacidites* spp., *Tricolpites confessus*, and *Tricolpites gillii* (Appendix A).

- the depositional setting is interpreted as cool, but slightly drier than above.

- the thermal alteration index (TAI) of SWC sample 2641 m is 2.6-2.8 (equivalent to LOM of approximately 11) and that of SWC 2662 m is 2.3-2.5 (LOM of about 10-10.5) (Appendix A).

- zone Mb 7 is identified in Tuna-4, as well as in West Tuna W-8 and West Tuna W-32, within the R-500 sandstone.

Interval: **2709-2778 mSS TVD**

Age: **Unassigned**

Interval age and zones:

2709m - Unassigned

Palynology:

- spore-pollen are rare in this interval and no zonal events are recognized.

Interval: **2794 mSS TVD**

Age: **Middle - Lower Campanian**

Interval age and zones:

2794m - undiff. palynozone Mc

Palynology:

- this sample is placed in the Middle-Lower Campanian palynozone Mc (~equivalent to Upper *N. senectus* zone).

- taxa recorded include *Nothofagidites senectus*, *Tricolpites confessus, Tricolpites gillii, Proteacidites* spp., *Australopollis obscurus*, *Phyllocladidites* spp., and fern spores (Appendix A).

- the palynoflora suggests the depositional setting for this interval is cool and moderately humid.

- the TAI of SWC sample 2794 m is 2.2-2.3 (equivalent to LOM of approximately 9.5-10) (Appendix A).

WEST TUNA W-8

Interval: **2372.6-2408.7 mSS TVD**

Age: **Lower Maastrichtian**

Interval age and zones:

2373.6m - palynozone Mb 1a
2408.7m - palynozone Mb 1b

Palynology:

- palynozone Mb 1 is divided into two subzones.

- the highest SWC sample analyzed at 2373.6 m is placed in the Lower Maastrichtian subzone Mb 1a (within the Upper *T. lilliei*). Taxa present are rare *Gambierina rudata* of Stover and Partridge, 1973, *Triporopollenites sectilis, Proteacidites* spp., *Nothofagidites* spp., *Stereisporites* spp. and *Proteacidites* spp. (Appendix A).

- the slight change in the spore/pollen assemblage indicates that the sample at 2408.7 m is in subzone Mb 1b.

- the palynoflora suggests that the depositional environment was humid and cool temperate, but may have been slight warmer toward the base of this zone.

Interval: **2423.1 mSS TVD**

Age: **Lower Maastrichtian**

Interval age and zones:

2423.1 - palynozone Mb 2

Palynology:

- the SWC sample at SWC 2423.1 m is characteristic of the Lower Maastrichtian palynozone Mb 2.

- taxa recorded in this interval are *Stereisporites* spp., *Nothofagidites* spp., *Tricolpites confessus, Tricolpites gillii, Tricolporites lilliei,* and *Tricolporopollenites sectilis* (Appendix A).

- palynoflora suggest the depositional setting was warmer and perhaps slightly drier than above.

Interval: **2433-2486.1 mSS TVD**

Age: **Lower part of Lower Maastrichtian - upper part of Upper Campanian**

Interval age and zones:

2433m - palynozone Mb 3

Palynology:

- taxa present indicate a Lower Maastrichtian-Upper Campanian zone Mb 3 age at 2433 m. Species noted are *Nothofagidites* spp., *Proteacidites* spp., *Stereisporites* spp., *Quadraplanus brossus, Tricolpites confessus,* and *Tricolpites gillii* (Appendix A).

- the depositional setting of this interval was cooler and perhaps a little less moist than the overlying zone. Toward the base of this zone palynoflora suggest that there may be a slight increase in moisture.

- the log break at about 2485 m near the base of this zone may correlate with the flooding event (at about 72 Ma) of the CAM 10 sequence shown on the current cycle chart of Hardenbol and others (in press).

Interval: **2501.3-2514.5 mSS TVD**

Age: **Upper Campanian**

Interval age and zones:

2501.3m - palynozone Mb 4

Palynology:

- the samples at 2501.3 m is assigned to the Upper Campanian palynozone Mb 4.

- taxa present in this interval that supports this zonal assignment are *Proteacidites* spp, fern spores, *Nothofagidites* spp., *Phyllocladidites* spp. *Tricolporites lilliei, Tricolpites confessus, Tricolpites gillii, Aequitriradites* spp., and *Stereisporites* spp. (Appendix A).

- the palynoflora indicate a cool, humid depositional setting.

Interval: **2527.4-2549.3 mSS TVD**

Age: **Upper Campanian**

Interval age and zones:

2527.4m - palynozone Mb 5

Palynology:

- the top of the Upper Campanian palynozone Mb 5 is placed at 2527.4 m.

- amorphous kerogen is relatively common, and taxa recorded in this interval include *Nothofagidites* spp., *Proteacidites* spp. *Gambierina rudata* of Stover and Partridge 1973, fern spores, *Stereisporites* spp., and *Phyllocladidites* spp. (Appendix A).

- the depositional environment is interpreted as humid, but slightly warmer than above.

Interval: **2570.7 mSS TVD**

Age: **Upper - Middle? Campanian**

Interval age and zones:

2570.7m - palynozone Mb 5/6

Palynology:

- the sample at 2570.7 m contains a mixed assemblage and is broadly placed in Palynozone 5/6.

- taxa recorded are *Proteacidites* spp., *Tricolpites gillii*, *Nothofagidites* spp., fern spores, cf. *Tricolporites lilliei*, and *Phyllocladidites* spp. (Appendix A).

- palynoflora suggest that the depositional environment was perhaps warm temperate and only moderately humid.

Interval: **2584.3-2612.5 mSS TVD**

Age: **Upper - Middle? Campanian**

Interval age and zones:

2584.3m - palynozone Mb 6a
2598.1m - palynozone Mb 6b

Palynology:

- palynozone Mb 6 is subdivided into two subzones.

- the palynomorph assemblage indicates that samples 2584.3 m is in the Upper-Middle? Campanian subzone Mb 6a.

- taxa recorded at this level include *Proteacidites* spp., Phyllocladidites spp., *Cyathidites* spp., *Stereisporites* spp., *Tricolpites gillii* and *Araucariacites* spp (Appendix A).

- a change in the assemblage at 2598.1 indicates penetration of the Upper-Middle? Campanian, subzone Mb 6b.

- the depositional environment is interpreted as perhaps slightly more humid and cooler than above.

Interval: **2641.5-2651.9? mSS TVD**

Age: **Middle Campanian**

Interval age and zones

2641.5m - palynozone Mb 7

Palynology:

- the samples in this interval contains a palynomorph assemblage characteristic of zone Mb 7.

- taxa recorded from this interval consistent with this zonal assignment are fern spores, including *Cyathidites* spp., *Phyllocladidites* spp., *Nothofagidites* spp., *Stereisporites* spp., *Proteacidites* spp., and *Tricolpites* cf. *confessus*.

- the depositional setting for this interval is interpreted as cool, but slightly drier than above.

- the TAI of SWC sample 2641 m is 2.6-2.8 (equivalent to LOM of approximately 11) and that of SWC 2662 m is 2.3-2.5 (LOM of about 10-10.5).

WEST TUNA W-32

Results of analysis for West Tuna W32 are based on cuttings samples. Some samples contain frequent caving and cause uncertainty in placement of zone.

Interval: **2370-2395 mSS TVD (cuttings samples)**

Age: **Lower Maastrichtian**

Interval age and zones:

2370m - palynozone Mb 1a
2399m - palynozone Mb 1b

Palynology:

- palynozone Mb 1 is divided into two subzones.

- the highest cuttings sample analyzed at 2370-2374 m is placed in the Lower Maastrichtian, subzone Mb 1a (within the Upper *T. lilliei*). It contains a few *Gambierina rudata* of Stover and Partridge, 1973 (some of which are considered to be caved), *Haloragacidites harrisii* (caved?), *Stereisporites (Tripunctisporis)* sp., *Proteacidites spp., Nothofagidites* spp., *Tricolpites gillii,* and *Stereisporites* spp. (Appendix A).

- a change in the palynoflora at 2399 m indicates penetration of the Lower Maastrichtian subzone Mb 1b. Taxa recorded in this interval include *Proteacidites* spp., *Nothofagidites* spp., and *Stereisporites* spp., as well as *Tricolpites confessus, Tricolporites lilliei,* and *Triporopollenites sectilis* (Appendix A).

- palynoflora suggest that the climate was humid, cool temperate, and that if may have been slight warmer toward the base of this zone.

Interval: **2419-2424 mSS TVD**

Age: **Lower Maastrichtian**

Interval age and zones:

2419m - palynozone Mb 2

Palynology:

- the marked change in the palynomorph assemblage indicates that this interval is in the Lower Maastrichtian palynozone Mb 2.

- taxa recorded consistent with the Mb 2 zone are *Stereisporites* spp., *Nothofagidites* spp., *Tricolpites confessus, Tricolpites gillii, Tricolporites lilliei, Tricolpites longus*, and *Tetracolporites verrucosus.*

- the depositional setting is interpreted to be perhaps slightly drier and warmer than above.

Interval: **2449-2475 (2505?) mSS TVD**

Age: **Lower part of Lower Maastrichtian - upper part of Upper Campanian**

Interval age and zones:

2449m - palynozone Mb 3

Palynology:

- the spore/pollen assemblage in cuttings sample 2449 m indicates a Lower Maastrichtian-Upper Campanian, palynozone Mb 3. Taxa present include *Nothofagidites* spp., *Proteacidites* spp., *Stereisporites* spp., and *Aequitriradites* sp. (Appendix A)

- cuttings sample 2475-2485 m contains cf. *Quadraplanus brossus* and cuttings sample 2490-2505 m contains *Tetracolporites verrucosus.* Cavings occur frequently in samples from this well.

- other taxa recorded are *Tricolpites confessus, Tricolpites pachyexinus, Tricolpites gillii, Tricolporites lilliei,* cf. *Tricolpites longus*, and *Stereisporites* spp.

- the depositional setting of this interval in interpreted to be cooler and perhaps a little less moist than the overlying zone.

- the log break at about 2493 m, near the base of this zone, may correlate with the flooding event (about 72 Ma) of the CAM 10 sequence shown on the cycle chart of Hardenbol and others (in press).

Interval: **2505-2510 mSS TVD**

Age: **Upper Campanian**

Interval age and zones:

2505m - palynozones Mb 4/5, undifferentiated

Palynology:

- cuttings sample 2505-2510 m contains a mixed assemblage with cavings, so the interval can only be placed broadly in Mb 4/5.

- taxa present include *Proteacidites* spp., *Nothofagidites* spp., *Tricolporites lilliei, Cyathidites* spp. and other trilete fern spores, *Tricolpites confessus, Tricolpites gillii*, and *Stereisporites* spp. (Appendix A). Amorphous kerogen is relatively frequent.

- the palynoflora present suggest a relatively warm temperate, humid depositional setting.

Interval: **2514 (-2534?) mSS TVD**

Age: **Upper Campanian**

Interval age and zones:

2514m - palynozone Mb 5

Palynology:

- cuttings sample 2514-2524 m is placed in the Upper Campanian, palynozone Mb 5. It contains relatively common amorphous kerogen, rare *Nothofagidites* spp., and a few trilete fern spores, *Gambierina rudata* of Stover and Partridge 1973, *Stereisporites* spp., and *Phyllocladidites* spp. Also present are very rare *Tetracolporites verrucosus* occur, which are (presumed) caved.

- the depositional setting is interpreted as humid, warm temperate.

Interval: **2549-2594 mSS TVD**

Age: **Upper - Middle? Campanian**

Interval age and zones:

2549m - palynozone Mb 6

2569m - palynozone unassigned)
2579m - palynozone Mb 6?

Palynology:

- the cuttings sample at 2549-2564 m is assigned to zone Mb 6. Taxa present include *Proteacidites* spp., *Cyathidites* spp., *Nothofagidites* spp., *Tricolpites confessus, Tricolpites gillii, Gambierina rudata,* fern spores, and *Phyllocladidites* spp. However, downhole cavings are frequent to common and cause some uncertainty in the zonal assignment.

- taxa recorded at 2569-2574 m are rare and include *Tricolpites gillii, Proteacidites* spp. and *Nothofagidites* spp., and *Phyllocladidites* spp., and *Cyathidites* spp (Appendix).

- palynoflora suggest that the depositional environment was perhaps warm temperate and humid.

Interval: **2604-2624 mSS TVD**

Age: **Middle Campanian**

Interval age and zones:

2604m - Prob. palynozone Mb 7

Palynology:

- sample 2604 m contains a palynomorph assemblage characteristic of palynozone Mb 7.

- taxa recorded from this interval consistent with this zonal assignment include *Cyathidites* spp., *Phyllocladidites* spp., *Nothofagidites* spp. rare *Stereisporites* spp., *Proteacidites* spp., *Tricolpites confessus* (Appendix A).

- because of cavings and poor recovery, the depositional setting for this interval is tentatively interpreted as warm temperate, but slightly drier than above.

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APPENDIX A

BIOSTRATIGRAPHY AND PALEOENVIRONMENTAL DATA

TUNA-4

Palynozone Mb 1 (Lower Maastrichtian)
(2391-2405 mSS TVD)

2391mSS TVD

Paleoenvironment: Nonmarine **(subzone Mb 1a)**
Kerogen: 8-10% amorph; 80-85% woody/coaly; 5-10% biodeg terr; 1-2% herbac.;2-3% S/P
Spore/pollen (C-A); Dinoflagellates (barren); Pyrite (F-R?)
Tricolpites confessus (SP) (R)
cf. Tricolpites pachyexinus (SP) (VR)
Tricolpites gillii (SP) (VR)
Gambierina rudata (SP) (VR)
Proteacidites spp. (SP) (C)
Nothofagidites spp. (SP) (F)
Nothofagidites cf. endurus (SP) (VR-R) -102.5/12
Tetracolporites verrucosus (SP) (VR)
Araucariacites spp. (SP) (R-F)
Phyllocladidites spp. (SP) (F)
Phyllocladidites mawsonii (SP) (R)
Phyllocladidites microsaccatus (SP) (R-F)
Stereisporites antiquasporites (SP) (F)
Trilete spores ornamented (SP) (R)
Gleicheniidites spp. (SP) (VR)
Ceratosporites sp. (SP) (VR)
Laevigatosporites spp. (SP) (VR)

2405m

Paleoenvironment: Nonmarine **(subzone Mb 1b**
Kerogen: <1% amorph; 90-95% woody/coaly (dk); 5% biodeg terr.;2-3% S/P
Spore/pollen (C); Dinoflagellates (barren); Pyrite (VR?); poor preserv.
Tricolpites confessus (SP) (VR)
Tricolpites gillii (SP) (VR)
Tricolporites cf. lilliei (SP) (T. longus-T. lilliei) (VR)
Gambierina rudata (SP) (VR)
Proteacidites spp. (SP) (C-F)
Proteacidites interactus (SP) (VR)
Nothofagidites spp. (SP) (R)
Nothofagidites cf. endurus (SP) (VR)
Nothofagidites cf. senectus (SP) (VR)
Australopollis obscurus (SP) (R-VR)
Araucariacites spp. (SP) (R)
Phyllocladidites spp. (SP) (F)
Phyllocladidites mawsonii (SP) (R)
Phyllocladidites microsaccatus (SP) (R-F)
Stereisporites antiquasporites (SP) (R)
Trilete spores ornamented (SP) (R)
Cyathidites spp. (SP) (VR)
Laevigatosporites spp. (SP) (VR)

No sample provided from shale-prone section just below TL PK N surface

Palynozone Mb 3 (lower part of Lower Maastrichtian-upper part of Upper Campanian)
(2443.5-2498.6 mSS TVD)

2443.5m

Paleoenvironment: Nonmarine
Kerogen: <1% amorph; 90-92% woody/coaly (dk); 5% biodeg terr.; 3-5% S/P
Spore/pollen (C); Dinoflagellates (barren); Pyrite (VR?)
Tricolpites confessus (SP) (VR)
Tricolpites gillii (SP) (R-F)
Tricolporites cf. lilliei (SP) (T. longus-T. lilliei) (R)
Proteacidites spp. (SP) (F-C)
Proteacidites adenanthoides (SP) (base N. senectus) (ER)
Nothofagidites spp. (SP) (F)
Nothofagidites cf. endurus (SP) (R)
Nothofagidites cf. senectus (SP) (VR)
Tetracolporites verrucosus (SP) (base Upper T. lilliei) (VR)
Gephyrapollenites wahooensis (SP) (L.L.balmei-T. lilliei) (VR)
Australopollis obscurus (SP) (R)
Araucariacites spp. (SP) (R)
Phyllocladidites spp. (SP) (C-F)
Phyllocladidites mawsonii (SP) (F)
Phyllocladidites microsaccatus (SP) (R-F)
Lygistepollenites cf. balmei (SP) (VR)
Stereisporites antiquasporites (SP) (ER)
Trilete spores ornamented (SP) (F-C)
Lycopodiumsporites spp. (SP) (F)
Gleicheniidites spp. (SP) (VR)
Ceratosporites sp. (SP) (VR)
Camarozonosporites spp. (SP) (VR)
Baculatisporites spp. (SP) (VR)
Latrobosporites cf. ohaiensis (SP) (VR)
Cyathidites spp. (SP) (VR)
Laevigatosporites spp. (SP) (VR)

2447m

Paleoenvironment: Nonmarine
Kerogen: 1% amorph; 90-92% woody/coaly (dk); 5% biodeg terr.; 3-5% S/P
Spore/pollen (C); Dinoflagellates (barren); Pyrite (VR?)
Tricolpites confessus (SP) (F)
cf. Tricolpites pachyexinus (SP) (R)
Tricolpites gillii (SP) (R)
Proteacidites spp. (SP) (F)
cf. Proteacidites amolosexinus (SP) (VR)
Nothofagidites spp. (SP) (F-C)
Nothofagidites cf. endurus (SP) (R)
Nothofagidites cf. senectus (SP) (R)
Tetracolporites verrucosus (SP) (base Upper T. lilliei) (VR)
Australopollis obscurus (SP) (R)
Araucariacites spp. (SP) (R-VR)
Phyllocladidites spp. (SP) (C-A)
Phyllocladidites mawsonii (SP) (F)
Phyllocladidites microsaccatus (SP) (C)
Stereisporites antiquasporites (SP) (R)
Stereisporites regium (SP) (VR)
Trilete spores ornamented (SP (R)
Lycopodiumsporites spp. (SP) (VR)
Gleicheniidites spp. (SP) (VR)
Cyathidites spp. (SP) (VR)
Laevigatosporites spp. (SP) (VR)

2469.4 m

Paleoenvironment: Nonmarine
Kerogen: 3-5% amorph; 88-92% woody/coaly; 3-5% biodeg terr; 2-3% S/P
Spore/pollen (C-A); Dinoflagellates (barren); Pyrite (F?)
Tricolpites confessus (SP) (VR)
Tricolpites gillii (SP) (F-R)
Tricolpites longus (SP) (VR) +99.8/13
Tricolporites lilliei (SP) (T. longus-T. lilliei) (VR-R) +95/6
Tricolporopollenites (Cranwellopollis) cf. apiculatus (SP) (VR)
Gambierina rudata (SP) (VR)
Gambierina edwardsii (SP) (base Upper T. lilliei) (VR-R) +90/18.5
Australopollis obscurus (SP) (R)
Proteacidites spp. (SP) (F-C)

cf. Proteacidites angulata (SP) (VR, aved?)
Proteacidites adenanthoides (SP) (VR)
cf. Proteacidites amolosexinus (SP) (VR)
Proteacidites cf. palisadus (SP) (VR)
Nothofagidites spp. (SP) (F-R)
Nothofagidites cf. senectus (SP) (R)
Nothofagidites cf. endurus (SP) (VR)
cf. Tetracolporites verrucosus (SP) (base Upper T. lilliei) (VR)
Araucariacites spp. (SP) (R-F)
Phyllocladidites spp. (SP) (F)
Phyllocladidites mawsonii (SP) (R-F)
Phyllocladidites microsaccatus (SP) (F)
Lygistepollenites balmei (SP) (VR)
Stereisporites antiquasporites (SP) (R)
cf. Stereisporites regium (SP) (VR)
Trilete spores ornamented (SP) (R-F)
Gleicheniidites spp. (SP) (R)
Camarozonosporites spp. (SP) (VR)
Latrobosporites ohaiensis (SP) (VR)
Lycopodiumsporites spp. (SP) (R-F)
Ceratosporites sp. (SP) (VR)
Cyathidites spp. (SP) (R)
Laevigatosporites spp. (SP) (R-F)
Aequitriradites sp. (SP) (top in zone Mb 3)(VR)

2471-2472.9m

Paleoenvironment: Nonmarine
Kerogen: 2-3% amorph; 88-92% woody/coaly; 5-10% biodeg terr; 3-5% S/P
Spore/pollen (C-A); Dinoflagellates (barren); Pyrite (R-F?)
Tricolpites confessus (SP) (VR)
Tricolpites gillii (SP) (R)
Tricolpites longus (SP) (VR)
Triporopollenites sectilis (SP) (base consistent Upper T. lilliei) (VR-R)
Gambierina rudata (SP) (F-R)
Gambierina edwardsii (SP) (base Upper T. lilliei) (VR)
Australopollis obscurus (SP) (VR)
Proteacidites spp. (SP) (C)
cf. Proteacidites angulata (SP) (base in U. T. lilliei) (VR, caved?)
Proteacidites adenanthoides (SP) (base N. senectus) (VR)
Nothofagidites spp. (SP) (F)
Nothofagidites cf. senectus (SP) (R-F)
Nothofagidites cf. endurus (SP) (VR)
Tetracolporites verrucosus (SP) (base Upper T. lilliei) (VR)
Araucariacites spp. (SP) (R-F)
Phyllocladidites spp. (SP) (F)
Phyllocladidites mawsonii (SP) (R-F)
Phyllocladidites microsaccatus (SP) (F)
Stereisporites antiquasporites (SP) (R)
Trilete spores ornamented (SP) (R-F)
Camarozonosporites spp. (SP) (VR)
cf. Latrobosporites ohaiensis (SP) (VR)
Lycopodiumsporites spp. (SP) (R-F)
Cyathidites spp. (SP) (R)
Aequitriradites sp. (SP) (VR)

2485.4-2485.7m

Paleoenvironment: Nonmarine
Kerogen: 2-3% amorph; 85-90% woody/coaly; 5-10% biodeg terr; 5-10% S/P
Spore/pollen (A); Dinoflagellates (barren); Pyrite (R-F?)
Grapnelispora evansii (SP) (T. longus-?uppermost T. lilliei) (ER) k97/10
Tricolpites confessus (SP) (VR)
Tricopities waiparaensis (SP) (VR)
Tricolpites gillii (SP) (R)
cf. Tricolpites reticulatus (SP) (VR)
Tricolporites lilliei (SP) (T. longus-T. lilliei) (VR-R)
cf. Quadraplanus brossus (SP) (base in Upper T. lilliei) (ER, distorted T. verrucosus??)
Gambierina rudata (SP) (R)
Australopollis obscurus (SP) (VR)
Proteacidites spp. (SP) (C)
Proteacidites sp. G of Dettmann & Jarzen, 1996 (SP) (VR)
Nothofagidites spp. (SP) (C)
Nothofagidites cf. senectus (SP) (F)

Nothofagidites cf. endurus (SP) (VR)
Tetracolporites verrucosus (SP) (base Upper T. lilliei) (VR)
Araucariacites spp. (SP) (R-F)
Phyllocladidites spp. (SP) (F)
Phyllocladidites mawsonii (SP) (R)
Phyllocladidites microsaccatus (SP) (F)
Lygistepollenites balmei (SP) (VR)
Stereisporites antiquasporites (SP) (R)
Trilete spores ornamented (SP) (R)
Gleicheniidites spp. (SP) (VR)
Camarozonosporites spp. (SP) (VR)
Lycopodiumsporites spp. (SP) (R)
Ceratosporites sp. (SP) (VR)
Cyathidites spp. (SP) (R-F)
Laevigatosporites spp. (SP) (R-F)
cf. Aequitriradites sp. (SP) (VR)

2488.5m

Paleoenvironment: Nonmarine
Kerogen: <1% amorph; 90-92% woody/coaly; 5% biodeg terr; 5-10% S/P
Spore/pollen (A); Dinoflagellates (barren); Pyrite (R?)
Tricolpites confessus (SP) (VR)
Tricopities waiparaensis (SP) (VR)
Tricolpites gillii (SP) (F)
Tricolporites lilliei (SP) (T. longus-T. lilliei) (VR)
cf. Gambierina rudata (SP) (VR)
Proteacidites spp. (SP) (C)
cf. Proteacidites amolosexinus (SP) (VR)
Gephyrapollenites wahooensis (SP) (L.L.balmei-T. lilliei) (VR)
Nothofagidites spp. (SP) (C-A)
Nothofagidites cf. senectus (SP) (F)
Nothofagidites cf. endurus (SP) (VR-R)
Phyllocladidites spp. (SP) (C)
Phyllocladidites mawsonii (SP) (R)
Phyllocladidites microsaccatus (SP) (F-C)
Stereisporites antiquasporites (SP) (R)
Trilete spores ornamented (SP) (R)
Gleicheniidites spp. (SP) (VR)
Camarozonosporites spp. (SP) (VR)
Lycopodiumsporites spp. (SP) (VR)
Ceratosporites sp. (SP) (VR)
Cyathidites spp. (SP) (R-F)
Laevigatosporites spp. (SP) (R)
Aequitriradites sp. (pustulate/spinose) (SP) (F)

2489.1-2490.6m

Paleoenvironment: Nonmarine
Kerogen: <1% amorph; 90-92% woody/coaly; 5% biodeg terr; 5-10% S/P
Spore/pollen (A); Dinoflagellates (barren); Pyrite (F?)
Liliacidites-type (SP) (VR)
Tricolpites confessus (SP) (VR)
Tricolpites pachyexinus (SP) (T. longus-T. lilliei) (VR)
Tricopities waiparaensis (SP) (VR)
Tricolpites gillii (SP) (F)
Tricolporites lilliei (SP) (T. longus-T. lilliei) (VR)
Triporopollenites sectilis (SP) (base consistent Upper T. lilliei) (VR)
cf. Gambierina rudata (SP) (VR)
Gambierina edwardsii (SP) (base Upper T. lilliei) (VR)
Proteacidites spp. (SP) (C)
cf. Proteacidites angulata (SP) (base in U. T. lilliei) (VR, caved?)
Proteacidites amolosexinus (SP) (VR)
Gephyrapollenites wahooensis (SP, tropical-temperate indicator) (L.L.balmei-T. lilliei) (VR)
Nothofagidites spp. (SP) (C-A)
Nothofagidites cf. senectus (SP) (F)
Phyllocladidites spp. (SP) (C)
Phyllocladidites mawsonii (SP) (R)
Phyllocladidites microsaccatus (SP) (F-C)
Lygistepollenites spp. (SP) (VR)
Stereisporites antiquasporites (SP) (R-F)
Trilete spores ornamented (SP) (F)
Gleicheniidites spp. (SP) (VR)
Camarozonosporites spp. (SP) (VR)

Baculatisporites spp. (SP) (VR)
Ceratosporites sp. (SP) (R-F)
Cyathidites spp. (SP) (R-F)
Laevigatosporites spp. (SP) (R)
cf. Aequitriradites sp. (SP) (VR)
Aequitriradites sp. (pustulate/spinose) (SP) (F)

2496.6-2499.6m

Paleoenvironment: Nonmarine (likely corresponds close to the ~72 Ma max. flooding of the CAM 10 sequence)
Kerogen: <1% amorph; 90-92% woody/coaly; 5% biodeg terr; 5-10% S/P
Spore/pollen (A); Dinoflagellates (barren); Pyrite (VR?)
Monocolpites sp. (SP) (VR)
Tricolpites confessus (SP) (R-F)
cf. Tricopities waiparaensis (SP) (VR)
Tricolpites gillii (SP) (R)
Tricolporites lilliei (SP) (T. longus-T. lilliei) (VR) -95.5/9.7*
Gambierina rudata (SP) (VR)
Australopollis obscurus (SP) (VR)
Proteacidites spp. (SP) (C)
Proteacidites adenanthoides (SP) (base N. senectus) (VR)
Proteacidites amolosexinus (SP) (VR)
Gephyrapollenites wahooensis (SP) (L.L.balmei-T. lilliei) (VR)
Nothofagidites spp. (SP) (C-F)
Nothofagidites cf. senectus (SP) (R)
Nothofagidites cf. endurus (SP) (VR-R)
Tetracolporites verrucosus (SP) (base Upper T. lilliei) (VR, last downhole occurrence)
Araucariacites spp. (SP) (R)
Phyllocladidites spp. (SP) (C-A)
Phyllocladidites mawsonii (SP) (R)
Phyllocladidites microsaccatus (SP) (C-A)
Stereisporites antiquasporites (SP) (R-F)
Trilete spores ornamented (SP) (F)
Gleicheniidites spp. (SP) (R-F)
Camarozonosporites spp. (SP) (VR)
Lycopodiumsporites spp. (SP) (VR)
Baculatisporites spp. (SP) (VR)
Ceratosporites sp. (SP) (F)
Cyathidites spp. (SP) (F-R)
Laevigatosporites spp. (SP) (R)

Palynozone Mb 4 (Upper Campanian)
(2510.5-2514.6 mSS TVD)

2510.5-2510.9m

Paleoenvironment: Nonmarine **(subzone Mb 4a?)**
Kerogen: 1% amorph; 92-95% woody/coaly; 2% biodeg terr; 3-5% S/P
Spore/pollen (C-F); Dinoflagellates (barren); Pyrite (VR?)
Tricolpites confessus (SP) (R-F)
Tricolpites gillii (SP) (R)
Gambierina rudata (SP) (VR)
Australopollis obscurus (SP) (R)
Proteacidites spp. (SP) (C)
Nothofagidites spp. (SP) (F-C)
Nothofagidites cf. senectus (SP) (R)
Araucariacites spp. (SP) (R)
Phyllocladidites spp. (SP) (F)
Phyllocladidites mawsonii (SP) (R)
Phyllocladidites microsaccatus (SP) (F)
Stereisporites antiquasporites (SP) (R-F)
Trilete spores ornamented (SP) (F)
Gleicheniidites spp. (SP) (R)
Camarozonosporites spp. (SP) (VR)
Lycopodiumsporites spp. (SP) (VR)
Cyathidites spp. (SP) (F)
Laevigatosporites spp. (SP) (R)

2514.6m

Paleoenvironment: Nonmarine **(subzone Mb 4b?)**
Kerogen: <1% amorph; 42-45% woody/coaly; 1-2% biodeg terr; 55% S/P
Spore/pollen (EA); Dinoflagellates (barren); Pyrite (VR?)
Tricolpites confessus (SP) (R)
Tricolpites gillii (SP) (VR)
Gambierina rudata (SP) (VR)

Gambierina edwardsii (SP) (base ~Upper T. lilliei) (VR, last downhole occurrence)
Australopollis obscurus (SP) (VR)
Proteacidites spp. (SP) (F)
Nothofagidites spp. (SP) (F-C)
Nothofagidites cf. senectus (SP) (R)
Phyllocladidites spp. (SP) (F)
Phyllocladidites mawsonii (SP) (R)
Phyllocladidites microsaccatus (SP) (F)
Stereisporites antiquasporites (SP) (F-C)
Trilete spores ornamented (SP) (C-A)
Gleicheniidites spp. (SP) (F-C)
Camarozonosporites spp. (SP) (R)
Lycopodiumsporites spp. (SP) (VR)
Baculatisporites spp. (SP) (VR)
Ceratosporites sp. (SP) (R)
Cyathidites spp. (SP) (F)
Laevigatosporites spp. (SP) (R)
cf. Aequitriradites sp. (SP) (VR)
Aequitriradites sp. (pustulate/spinose) (SP) (VR)

Indeterminate
(2516.3-2517 mSS TVD)

2516.3-2517m

Paleoenvironment: Nonmarine
Kerogen: 95-98% woody/coaly (dk); 3-5% S/P
Spore/pollen (R-F); Dinoflagellates (barren)
Proteacidites spp. (SP) (R)
Corollina (Classopollis) spp. (SP) (VR-R)
cf. Chomotrilites spp. (SP) (VR)
Trilete spores ornamented (SP) (F-R)
Lycopodiumsporites spp. (SP) (R)
Cyathidites spp. (SP) (C-A)

Palynozone Mb 5 (~=top of Lower T. lilliei) (Upper Campanian)
(2528.8-2537.9 mSS TVD, base prob. not sampled)

2528.8-2529.6m

Paleoenvironment: Nonmarine
Kerogen: 8-10% amorph; 80% woody/coaly; 10-15% biodeg terr; 3-5% S/P
Spore/pollen (C); Dinoflagellates (barren); Pyrite (R-F?); HC stringers (R-F)
Tricolpites confessus (SP) (R)
Tricolpites gillii (SP) (VR)
cf. Tricolpites reticulatus (SP) (VR)
cf. Tricolporites lilliei (SP) (T. longus-T. lilliei) (VR)
Proteacidites spp. (SP) (F)
Nothofagidites spp. (SP) (R-F)
Nothofagidites cf. senectus (SP) (VR)
Nothofagidites cf. endurus (SP) (VR-R)
Araucariacites spp. (SP) (R)
Phyllocladidites spp. (SP) (C)
Phyllocladidites mawsonii (SP) (R)
Phyllocladidites microsaccatus (SP) (C)
Stereisporites antiquasporites (SP) (F-R)
Trilete spores ornamented (SP) (C-F)
Gleicheniidites spp. (SP) (F)
Camarozonosporites spp. (SP) (R)
Lycopodiumsporites spp. (SP) (VR)
Baculatisporites spp. (SP) (VR)
Cyathidites spp. (SP) (F)
Laevigatosporites spp. (SP) (R)

2531.7m

Paleoenvironment: Nonmarine
Kerogen: 15-20% amorph (BT?); 45-50% woody/coaly; 20-25% biodeg terr; 1-2% S/P
Spore/pollen (C); Dinoflagellates (barren); Pyrite (C?)
cf. Tricolpites confessus (SP) (R)
Tricolpities waiparaensis (SP) (VR)
Tricolpites gillii (SP) (VR)
Australopollis obscurus (SP) (VR)
Proteacidites spp. (SP) (F)
Proteacidites amolosexinus (SP) (VR)
Nothofagidites spp. (SP) (R)

Nothofagidites cf. senectus (SP) (VR)
Nothofagidites cf. endurus (SP) (VR)
Araucariacites spp. (SP) (R)
Phyllocladidites spp. (SP) (F)
Phyllocladidites mawsonii (SP) (VR)
Phyllocladidites microsaccatus (SP) (R)
Stereisporites antiquasporites (SP) (R-F)
Trilete spores ornamented (SP) (F)
Gleicheniidites spp. (SP) (F-C)
Lycopodiumsporites spp. (SP) (VR)
Baculatisporites spp. (SP) (VR)
Ceratosporites sp. (SP) (R)
Cyathidites spp. (SP) (F)
Laevigatosporites spp. (SP) (R)
Aequitriradites sp. (pustulate/spinose) (SP) (VR)

2534.7m

Paleoenvironment: Nonmarine
Kerogen: 95% woody/coaly (dk); 1% S/P
Spore/pollen (F); Dinoflagellates (barren); Pyrite (?); HC stringers (VR); poor pres.
Tricolpites confessus (SP) (R)
Tricolpities waiparaensis (SP) (VR)
Tricolpites gillii (SP) (VR)
Proteacidites spp. (SP) (F)
Nothofagidites spp. (SP) (R)
Nothofagidites cf. senectus (SP) (VR)
Araucariacites spp. (SP) (R)
Phyllocladidites spp. (SP) (F)
Phyllocladidites microsaccatus (SP) (R)
Stereisporites antiquasporites (SP) (VR)
cf. Stereisporites regium (SP) (VR)
Trilete spores ornamented (SP) (F)
Camarozonosporites spp. (SP) (F)
Lycopodiumsporites spp. (SP) (VR)
Baculatisporites spp. (SP) (VR)
Ceratosporites sp. (SP) (VR)
Cyathidites spp. (SP) (F)
Aequitriradites sp. (pustulate/spinose) (SP) (R)

2535.3-2535.8m

Paleoenvironment: Nonmarine
Kerogen: 3-5% amorph (BT?); 85-90% woody/coaly (dk); 10-15% biodeg terr; 1-2% S/P
Spore/pollen (C-A); Dinoflagellates (barren); Pyrite (C-F?); HC stringers (R); poor pres.
Tricolpites confessus (SP) (VR)
Tricolpities waiparaensis (SP) (VR)
Tricolpites gillii (SP) (R)
Tricolporites lilliei (SP) (T. longus-T. lilliei) (VR) -96/5*
cf. Triporopollenites sectilis (SP) (base consistent Upper T. lilliei) (VR)
Gambierina rudata (SP) (R)
cf. Gambierina edwardsii (SP) (base Upper T. lilliei) (VR)
Proteacidites spp. (SP, moisture loving) (C-A)
Proteacidites adenanthoides (SP) (base N. senectus) (VR-R)
Proteacidites amolosexinus (SP) (VR)
cf.. Proteacidites cf. palisadus (SP) (T. longus-U. T. lilliei (-L. T. lilliei)) (VR)
Gephyrapollenites wahooensis (SP, tropical-temperate indicator) (L.L.balmei-T. lilliei) (VR) -94.5/15.8
Nothofagidites spp. (SP) (R)
Nothofagidites cf. senectus (SP) (VR)
Nothofagidites cf. endurus (SP) (VR)
Araucariacites spp. (SP) (R)
Phyllocladidites spp. (SP) (F)
Phyllocladidites mawsonii (SP) (VR)
Phyllocladidites microsaccatus (SP) (R)
Stereisporites antiquasporites (SP, moisture loving) (VR-R)
Trilete spores ornamented (SP, moisture loving) (F)
Camarozonosporites spp. (SP) (R)
Lycopodiumsporites spp. (SP) (VR)
Ceratosporites sp. (SP) (VR)
Cyathidites spp. (SP) (F)
Aequitriradites sp. (pustulate/spinose) (SP) (R-F)

2537.9m

Paleoenvironment: Nonmarine
Kerogen: 3-5% amorph (BT?); 85-90% woody/coaly (dk); 10-15% biodeg terr; 1-2% S/P

Spore/pollen (C-A); Dinoflagellates (barren); Pyrite (F-C?); HC stringers (R)
Tricolpities waiparaensis (SP) (base T. lilliei)(VR)
Tricolpites gillii (SP) (R-F)
cf. Tricolpites longus (SP) (VR)
Tricolporites lilliei (SP) (T. longus-T. lilliei) (VR)
Gambierina rudata (SP) (R)
Australopollis obscurus (SP) (VR)
Proteacidites spp. (SP, moisture loving) (C-A)
Proteacidites adenanthoides (SP) (base N. senectus) (VR)
Proteacidites amolosexinus (SP) (VR)
Proteacidites sp. G of Dettmann & Jarzen, 1996 (SP) (T.longus-N.senectus) (VR)
Nothofagidites spp. (SP) (R)
Nothofagidites cf. senectus (SP) (VR)
Araucariacites spp. (SP) (R)
Phyllocladidites spp. (SP) (F)
Phyllocladidites mawsonii (SP) (VR)
Phyllocladidites microsaccatus (SP) (R)
Lygistepollenites spp. (SP) (VR)
Stereisporites antiquasporites (SP, moisture loving) (R)
cf. Stereisporites regium (SP) (VR)
Trilete spores ornamented (SP, moisture loving) (R-F)
Gleicheniidites spp. (SP) (R)
Camarozonosporites spp. (SP) (R)
Lycopodiumsporites spp. (SP) (VR)
Ceratosporites sp. (SP) (VR)
Cyathidites spp. (SP) (R-F)
Laevigatosporites spp. (SP) (R)
Aequitriradites sp. (pustulate/spinose) (SP) (VR)

Indeterminate (poss. Palynozone Mb 6) (Upper-Middle? Campanian)
(2584 mSS TVD)

2584m

Paleoenvironment: Nonmarine **(subzone Mb 6a?)**
Kerogen: <1% amorph; 92-96% woody/coaly (dk); 3-5% biodeg terr; <1% S/P
Spore/pollen (R) ; Dinoflagellates (barren); Pyrite (?)
Australopollis obscurus (SP) (VR)
Phyllocladidites spp. (SP) (R)
Phyllocladidites microsaccatus (SP) (R)
Cyathidites spp. (SP) (R-VR)

Palynozone Mb 6 (Upper-Middle? Campanian)
(2613-2621 mSS TVD)

2613-2621m

Paleoenvironment: Nonmarine **(subzone Mb 6b)**
Kerogen: <1% amorph; 85-88% woody/coaly (dk); 10% biodeg terr; 3-5% S/P; TAI 2.3
Spore/pollen (C-A); Dinoflagellates (barren); Pyrite (?)
Tricolpites confessus (SP) (R, influx)
Tricolpites pachyexinus (SP) (T. longus-T. lilliei) (VR)
Tricolpites gillii (SP) (R-F)
cf. Tricolporites lilliei (SP) (T. longus-T. lilliei) (ER)
Australopollis obscurus (SP) (R)
Proteacidites spp. (SP) (R)
Beaupreaidites orbiculatus (SP) (N. senectus-T. longus) (VR) k100.5/13
Nothofagidites spp. (SP) (F-C)
Nothofagidites cf. senectus (SP) (R)
Nothofagidites cf. endurus (SP) (R)
Australopollis obscurus (SP) (VR)
Araucariacites spp. (SP) (R-F)
Phyllocladidites spp. (SP) (F-R)
Phyllocladidites mawsonii (SP) (VR)
Phyllocladidites microsaccatus (SP) (R)
Stereisporites antiquasporites (SP) (R)
Trilete spores ornamented (SP) (F)
Gleicheniidites spp. (SP) (VR)
Camarozonosporites spp. (SP) (VR)
Lycopodiumsporites spp. (SP) (VR)
Baculatisporites spp. (SP) (VR)
Ceratosporites sp. (SP) (R)
Cyathidites spp. (SP) (R-VR)
Laevigatosporites spp. (SP) (R)

cf. Aequitriradites sp. (SP) (VR)

Palynozone Mb 7 (Middle Campanian)
(2641-2662 mSS TVD)

2641m

Paleoenvironment: Nonmarine
Kerogen: 1-2% amorph; 90-93% woody/coaly (dk); 5-8% biodeg terr; 2-3% S/P; increase in maturation (TAI 2.6-2.8)
Spore/pollen (C-A); Dinoflagellates (barren); Pyrite (RF?); poor preserv.
Tricolpites confessus (SP) (VR)
Proteacidites spp. (SP) (R)
Nothofagidites spp. (SP) (F)
Araucariacites spp. (SP) (R)
Phyllocladidites spp. (SP) (F)
Phyllocladidites mawsonii (SP) (VR)
Phyllocladidites microsaccatus (SP) (R)
Stereisporites antiquasporites (SP) (R-VR)
Trilete spores ornamented (SP) (R)
Circatricosisporites spp. (S) (VR-R)
Lycopodiumsporites spp. (SP) (VR)
Baculatisporites spp. (SP) (VR)
Ceratosporites sp. (SP) (VR)
Cyathidites spp. (SP) (VR)
Laevigatosporites spp. (SP) (VR)

2662m

Paleoenvironment: Nonmarine
Kerogen: 8-10+% amorph; 75-85% woody/coaly (dk); 3-5% biodeg terr; <1% S/P; (TAI 2.3-2.5)
Spore/pollen (C-A); Dinoflagellates (barren); Pyrite (R-F?); poor preserv.
Tricolpites gillii (SP) (VR)
Australopollis obscurus (SP) (VR)
Proteacidites spp. (SP) (R-VR)
Nothofagidites spp. (SP) (F-R)
Araucariacites spp. (SP) (VR)
Phyllocladidites spp. (SP) (F)
Phyllocladidites mawsonii (SP) (VR)
Phyllocladidites microsaccatus (SP) (R)
Trilete spores ornamented (SP) (R)
Lycopodiumsporites spp. (SP) (VR)
Baculatisporites spp. (SP) (VR)
Ceratosporites sp. (SP) (VR)
Cyathidites spp. (SP) (VR)
Laevigatosporites spp. (SP) (VR)

Section beneath volcanics

Indeterminate (poor preservation, sparse fossils)
(2709-2778 mSS TVD)

2709m

Paleoenvironment: Prob. Nonmarine **(just below volcanics)**
Kerogen: % amorph; 95-97% woody/coaly (dk); <1% biodeg terr; <1% S/P; (TAI ?)
Spore/pollen (R); Dinoflagellates (barren); poor preserv.
Dino (Ovoidinium/Chatangiella) mud contam? /15
Tricolpites confessus (SP) (VR)
Australopollis obscurus (SP) (VR)
Proteacidites spp. (SP) (VR)
Phyllocladidites spp. (SP) (R)
Phyllocladidites microsaccatus (SP) (VR-R)
Corollina (Classopollis) spp. (SP) (T. lilliei and lower; prob. contamination) (VR)

2743m

Paleoenvironment: Prob. Nonmarine
Kerogen: organic matter very sparse
Spore/pollen (nearly barren); Dinoflagellates (barren); Pyrite (F-C?)

2759m

Paleoenvironment: Nonmarine
Kerogen: <1% amorph; 95% woody/coaly (dk); <1% biodeg terr; 3-5% S/P
Spore/pollen (C); Dinoflagellates (barren); poor preserv.
Proteacidites spp. (SP) (VR)
Araucariacites spp. (SP) (R)
Trilete spores ornamented (SP) (F-C)
Gleicheniidites spp. (SP) (R)
cf. Latrobosporites ohaiensis (SP) (VR)
Circatricosisporites spp. (S) (VR)
Lycopodiumsporites sp. (SP) (F)
Baculatisporites spp. (SP) (VR)
Cyathidites spp. (SP) (VR)
Laevigatosporites spp. (SP) (R)

2778m

Paleoenvironment: Nonmarine
Kerogen: 1% amorph; 92-95% woody/coaly (dk); 1-2% biodeg terr; <1% S/P
Spore/pollen (R-VR); Dinoflagellates (barren); poor preserv.
Tricolpites sp. (SP) (VR)
Proteacidites spp. (SP) (VR)
Nothofagidites spp. (SP) (VR)
Nothofagidites cf. senectus (SP) (VR)
Gleicheniidites spp. (SP) (VR)

Prob. Palynozone Mc 1 (~=top N. senectus) (Middle-Lower Campanian)
(2794 mSS TVD)

2794m

Paleoenvironment: Nonmarine
Kerogen: 1-2% amorph; 90-92% woody/coaly; 1-2% biodeg terr; 3-4% S/P; **TAI 2.2-2.3 (LOM 9.5)**
Spore/pollen (C); Dinoflagellates (barren); poor preserv.
Tricolpites confessus (SP) (R-F)
Tricolpites gillii (SP) (VR)
Australopollis obscurus (SP) (VR)
Proteacidites spp. (SP) (VR-R)
Nothofagidites spp. (SP) (F, influx)
Nothofagidites cf. senectus (SP) (R-F)
Araucariacites spp. (SP) (R)
Phyllocladidites spp. (SP) (C)
Phyllocladidites mawsonii (SP) (VR)
Phyllocladidites microsaccatus (SP) (R)
Trilete spores ornamented (SP) (R-F)
Lycopodiumsporites spp. (SP) (R)
cf. Aequitriradites sp. (SP) (VR)

WEST TUNA W-8

Palynozone Mb 1 (Lower Maastrichtian)
(2372.6-2408.7 mSS TVD)

2373.6 m

Paleoenvironment: Nonmarine **(subzone Mb 1a)**
Kerogen: 90-95% woody/coaly; 2-3% herbac.;5-10% S/P
Spore/pollen (C-A); Dinoflagellates (barren); Pyrite (?)
Dinocysts undiff. (VR)
Tricolpites confessus (SP) (R)
cf. Tricolpites pachyexinus (SP) (VR) 90.2/6
Tricolpites gillii (SP) (F)
Tricolporites lilliei (SP) (VR)
cf. Triporopollenites sectilis (SP) (VR) 97/14
Gambierina rudata (SP) (VR)
Proteacidites spp. (SP) (C)
Nothofagidites spp. (SP) (F)
Nothofagidites cf. senectus (SP) (R)
Nothofagidites cf. endurus (SP) (F)
Phyllocladidites spp. (SP) (F-C)
Phyllocladidites mawsonii (SP) (F)
Phyllocladidites microsaccatus (SP) (R)
Lygistepollenites cf. balmei
Stereisporites antiquasporites (SP) (C)
Stereisporites regium (SP) (R)
Trilete spores ornamented (SP) (F-C)
Gleicheniidites spp. (SP) (R)
Camarozonosporites spp. (SP) (R)
Latrobosporites ohaiensis (SP) (R)
Lycopodiumsporites spp. (SP) (R)
Baculatisporites spp. (SP) (R-F)
Laevigatosporites spp. (SP) (R)

2408.7 m

Paleoenvironment: Nonmarine **(subzone Mb 1b)**
Kerogen: 95-98% woody/coaly; % amorphous; 1-2% S/P
Spore/pollen (F); Dinoflagellates (barren); preservation
Dinocysts undiff. (ER)
Tricolpites spp. (SP) (R-VR)
Tricolpites gillii (SP) (R)
Gambierina rudata (SP) (VR)
Proteacidites spp. (SP) (F-R)
Nothofagidites spp. (SP) (VR-R)
Nothofagidites cf. endurus (SP) (VR)
?Gephyrapollenites sp. (SP) (close to T. longus/T. lilliei boundary) (ER, fragment)
Phyllocladidites spp. (SP) (R)
Phyllocladidites mawsonii (SP) (R)
Stereisporites antiquasporites (SP) (C)
Stereisporites regium (SP) (R)
Trilete spores ornamented (SP) (F)
Camarozonosporites spp. (SP) (R)
Ceratosporites equalis/Herkosporites spp. (SP) VR)
Cyathidites spp. (R)
Laevigatosporites spp. (SP) (R)
cf. Verrucatosporites spp. (SP) (VR)

Palynozone Mb 2 (Lower Maastrichtian)
(2423.1 mSS TVD)

2423.1 m

Paleoenvironment: Nonmarine
Kerogen: 95% woody/coaly; 2-3% herbac; 2-3% S/P
Spore/pollen (C); Dinoflagellates (barren); Pyrite (?)
Liliacidites spp. (SP) (VR)
Tricolpites spp. (SP) (R-VR)
Tricolpites confessus (SP) (VR)
Tricolpites gillii (SP) (R-F)
Tricolporites lilliei (SP) (VR)
Triporopollenites sectilis (SP) (VR)
Proteacidites spp. (SP) (F)
Proteacidites interactus (SP) (T. longus-Upper T. lilliei) (VR)

Proteacidites cf. amolosexinus (SP) (T. longus-Upper T. lilliei) (VR)
Proteacidites palisadus (SP) (lower T. longus-t. lilliei(VR)
Nothofagidites spp. (SP) (VR)
Australopollis obscurus (SP) (VR) 90/8
Cycadopites sp. (SP) (VR)
Araucariacites spp. (SP) (VR)
Phyllocladidites spp. (SP) (F-C)
Phyllocladidites mawsonii (SP) (F)
Stereisporites antiquasporites (SP) (R)
Stereisporites regium (SP) (R)
Trilete spores ornamented (SP) (R-F)
Gleicheniidites spp. (SP) (R)
Clavifera spp. (SP) (R)
Latrobosporites ohaiensis (SP) (R)
Lycopodiumsporites spp. (SP) (R)
Laevigatosporites spp. (SP) (R)
Verrucatosporites spp. (SP) (VR)

Palynozone Mb 3 (lower part of Lower Maastrichtian-upper part of Upper Campanian) (2433-2486.1 mSS TVD)

2433 m

Paleoenvironment: Nonmarine
Kerogen: 95% woody/coaly; 2-5% herbac.; 3-5% S/P
Spore/pollen (C-A); Dinoflagellates (barren)
Glaphyrocysta sp. (D) (ER, mud contamination/)
Liliacidites spp. (SP) (VR)
Tricolpites gillii (SP) (R)
cf. Tricolpites longus (SP) (ER, broken)
Gambierina rudata (SP) (VR)
Proteacidites spp. (SP) (C)
Proteacidites cf. reticulconcavus (SP) (T. longus-Upper T. lilliei) (VR) 88.9/12
Proteacidites cf. angulata (SP) (VR) h99/5.6
Nothofagidites spp. (SP) (C, marked increase, infllux)
Nothofagidites cf. senectus (SP) (F)
Nothofagidites falcatus (SP) (ER, contamination) 95.4/6
Phyllocladidites spp. (SP) (F-C)
Phyllocladidites mawsonii (SP) (F)
Lygistepollenites spp. (SP) (VR)
Stereisporites antiquasporites (SP) (R-VR)
Stereisporites regium (SP) (VR)
Trilete spores ornamented (SP) (F-R)
Latrobosporites ohaiensis (SP) (R)
Cyathidites spp. (R)
Laevigatosporites spp. (SP) (R)

2464.8-2469.2 m

Paleoenvironment: Nonmarine
Kerogen: <1% amorph; 95% woody/coaly; 2-5% herbac.; 1-2% S/P
Spore/pollen (C-A); Dinoflagellates (barren); Pyrite (); preservation
Tricolpites confessus (SP) (VR)
Tricolpites gillii (SP) (R)
Proteacidites spp. (SP) (C-F)
Nothofagidites spp. (SP) (C-F)
Nothofagidites cf. senectus (SP) (F)
Nothofagidites cf. endurus (SP) (VR)
Quadraplanus brossus (SP) (VR)
Stereisporites antiquasporites (SP) (R)
Trilete spores ornamented (SP) (R)
Clavifera spp. (SP) (VR)
Camarozonosporites spp. (SP) (VR)

2477.2 m

Paleoenvironment: Nonmarine
Kerogen: 95% woody/coaly; 2-5% herbac.; 1% S/P
Spore/pollen (C-A); Dinoflagellates (barren); Pyrite (?F); preservation
Liliacidites spp. (SP) (VR)
Tricolpites spp. (SP) (F-R)
Tricolpites confessus (SP) (R) 97.2/19.5; 89/19.7*
Tricolpites 'microreticulatus' (SP) (VR) k93/16
Tricolpites cf. pachyexinus (SP) (VR) 91.8/20.8
Tricolpites gillii (SP) (R-VR)

Tricolporites lilliei (SP) (VR) 88.8/22.1
Gambierina spp. (SP) (VR)
Proteacidites spp. (SP) (F-C)
Nothofagidites spp. (SP) (F)
Nothofagidites cf. senectus (SP) (R)
Phyllocladidites spp. (SP) (F)
Stereisporites antiquasporites (SP) (R)
Trilete spores ornamented (SP) (R)
Gleicheniidites spp. (SP) (R)
Camarozonosporites spp. (SP) (VR)
Cyathidites spp. (SP) (R)
Laevigatosporites spp. (SP) (R)
Verrucatosporites spp. (SP) (VR)

2483.6-2486.1 m

Paleoenvironment: Nonmarine (likely corresponds close to the ~72 Ma max. flooding of the CAM 10 sequence)
Kerogen: 90-95% woody/coaly; 2-5% herbac.; 2-3% S/P
Spore/pollen (A); Dinoflagellates (barren); Pyrite (?); fair-poor preservation
Tricolpites spp. (SP) (VR)
Tricolpites gillii (SP) (VR)
Tricolporites lilliei (SP) (VR) 94.2/14
Tetracolporites verrucosus (SP) (base in Zone Mb 3) (ER, broken)
Gambierina rudata (SP) (VR)
Proteacidites spp. (SP) (C)
Nothofagidites spp. (SP) (C-A)
Nothofagidites cf. senectus (SP) (R)
Nothofagidites cf. endurus (SP) (VR)
Ephedripites/Gnetaceae spp. (SP) (VR) 96.9/19.3
Phyllocladidites spp. (SP) (C)
Phyllocladidites mawsonii (SP) (R)
Phyllocladidites microsaccatus (SP) (F-C)
Stereisporites antiquasporites (SP) (VR)
Trilete spores ornamented (SP) (R)
Clavifera spp. (SP) (VR)
Ornamentifera sentosa (SP) (VR) +101/12.5
Camarozonosporites spp. (SP) (VR)
Lycopodiumsporites spp. (SP) (R)
Ceratosporites equalis/Herkosporites spp. (SP) (VR)
Cyathidites spp. (SP) (R)
Laevigatosporites spp. (SP) (R)

Palynozone Mb 4 (Upper Campanian)
(2501.3-2514.5 mSS TVD)

2501.3 m

Paleoenvironment: Prob. Nonmarine
Kerogen: 85-90% woody/coaly; ?1-2% amorphous; 8-10% bio deg terrest; 2-3% herbac.; 3-5% S/P*
Spore/pollen (C-A); Dinoflagellates (barren-ER); HC streamers (F); preservation fair-poor
Paleocystodinium sp. large (~225u long) (D) (ER, contamination?)
Tricolpites spp. (SP) (VR)
Tricolpites cf. pachyexinus (SP) (VR) 89.9/8.6
Tricolpites gillii (SP) (R)
Tricolporites lilliei (SP) (VR-R) 98.8/9.2
Tricolpites remarkensis (SP) (Lower T. longus-T. lilliei) (VR) k101.1/13.9
Gambierina rudata (SP) (VR) 94.6/7.1*
Proteacidites spp. (SP) (C-A)
Nothofagidites spp. (SP) (C-A)
Nothofagidites cf. senectus (SP) (R-F)
Gephyrapollenites wahooensis 27u (SP) (L. L. balmei-T. lilliei) (VR) 98.4/7.2
Phyllocladidites spp. (SP) (F-C)
Phyllocladidites mawsonii (SP) (R)
Phyllocladidites microsaccatus (SP) (F)
Lygistepollenites spp. (SP) (VR)
Stereisporites antiquasporites (SP) (VR)
Stereisporites regium (SP) (VR)
Trilete spores ornamented (SP) (R-F)
Gleicheniidites spp. (SP) (R)
Camarozonosporites spp. (SP) (VR)
Latrobosporites ohaiensis (SP) (R)
Lycopodiumsporites spp. (SP) (R)
Ceratosporites equalis (SP) (VR)

Cyathidites spp. (R)
Laevigatosporites spp. (SP) (R)

2514.5 m

Paleoenvironment: Nonmarine
Kerogen: 85-90% woody/coaly; ?1-2% amorphous; 8-10% bio deg terrest; 2-3% herbac.; 3-5% S/P
Spore/pollen (C-A); Dinoflagellates (barren); HC streamers (F); preservation poor
Tricolpites spp. (SP) (VR)
Tricolpites cf. confessus (SP) (VR)
Tricolpites gillii (SP) (R)
Tetracolpites sp. (SP) (VR)
Gambierina rudata (SP) (VR)
Proteacidites spp. (SP) (C)
Nothofagidites spp. (SP) (C)
Nothofagidites cf. senectus (SP) (R)
Phyllocladidites spp. (SP) (F-C)
Phyllocladidites mawsonii (SP) (R)
Phyllocladidites microsaccatus (SP) (R-F)
Stereisporites antiquasporites (SP) (VR)
Trilete spores ornamented (SP) (F-R)
Gleicheniidites spp. (SP) (R)
Lycopodiumsporites spp. (SP) (R)
Aequitriradites sp. (SP) (VR)
Cyathidites spp. (SP) (R)
Laevigatosporites spp. (SP) (R)
Verrucatosporites spp. (SP) (VR)

Palynozone Mb 5 (~=top of Lower T. lilliei) (Upper Campanian)
(2527.4-2549.3 mSS TVD)

2527.4 m

Paleoenvironment: Nonmarine (warmer, decr. moisture toward zonal base) (prob. corresponds with Lower T. lilliei)
Kerogen: 80-85% woody/coaly; 2-5% amorph (incr.) ; 2-5% bio deg terr; 2-5% herbac.; 1-2% S/P
Spore/pollen (C-A); Dinoflagellates (barren); Pyrite (?F); HC streamers (R); preservation poor-fair
Tricolpites confessus (SP) (VR)
Tricolpites gillii (SP) (R)
Gambierina rudata (SP) (VR)
Proteacidites spp. (SP) (F-C)
Nothofagidites spp. (SP) (F)
Nothofagidites cf. senectus (SP) (R)
Phyllocladidites spp. (SP) (F-C)
Phyllocladidites mawsonii (SP) (R)
Phyllocladidites microsaccatus (SP) (F-C)
Stereisporites antiquasporites (SP) (VR-R)
Stereisporites regium (SP) (VR)
Trilete spores ornamented (SP) (R-F)
Camarozonosporites spp. (SP) (VR)
Latrobosporites (L. L. balmei-T. lilliei) ohaiensis (SP) (VR)
Latrobosporites (T. longus-T. lilliei) amplus (SP) (VR)
Aequitriradites sp. (SP) (VR)
Cyathidites spp. (SP) (R)
Laevigatosporites spp. (SP) (R)

2532.4 m

Paleoenvironment: Nonmarine (Unassigned)
Kerogen: 90-95% woody/coaly; 5-8% amorphous (F-C)
Spore/pollen (nearly barren); Dinoflagellates (barren)

2549.3 m

Paleoenvironment: Nonmarine
Kerogen: 85-90% woody/coaly; ?6-8% amorphous*; 5-10% bio deg terres; 1-2% S/P
Spore/pollen (C); Dinoflagellates (barren); Pyrite (?F); preservation poor-fair
Tricolpites spp. (SP) (VR)
Gambierina spp. (SP) (VR)
Proteacidites spp. (SP) (F)
Nothofagidites spp. (SP) (R-F)
Nothofagidites cf. senectus (SP) (R)
Australopollis obscurus (SP) (VR)
Simplicipollis meridianus (SP) (M. N. asperus-U. T. lilliei) (ER)
Phyllocladidites spp. (SP) (C)
Phyllocladidites mawsonii (SP) (R)
Phyllocladidites microsaccatus (SP) (F)
Lygistepollenites spp. (SP) (R)
Trilete spores ornamented (SP) (R-F)

Latrobosporites (L. L. balmei-T. lilliei) ohaiensis (SP) (VR)
Baculatisporites spp. (SP) (R)
Cyathidites spp. (SP) (R)
Fungal spores striate (R)

Palynozone Mb 5/6 Undifferentiated (Upper-Middle? Campanian)
(2570.7 mSS TVD)

2570.7 m

Paleoenvironment: Nonmarine
Kerogen: 85-90% woody/coaly; ?6-8% amorphous; 5-10% bio deg terrest; % herbac.; 1-2% S/P
Spore/pollen (C); Dinoflagellates (barren); Pyrite (?F); HC streamers (R-F); preservation poor-fair
Tricolpites spp. (SP) (VR)
Tricolpites gillii (SP) (VR)
Tricolporites cf. lilliei (SP) (VR-R)
Proteacidites spp. (SP) (R-F)
Proteacidites vulgaris (SP) (VR) 105.5/20.1
Nothofagidites spp. (SP) (R-F)
Araucariacites spp. (SP) (VR)
Phyllocladidites spp. (SP) (C)
Phyllocladidites mawsonii (SP) (R)
Phyllocladidites microsaccatus (SP) (F)
Lygistepollenites spp. (SP) (R)
Trilete spores ornamented (SP) (VR-R)
Camarozonosporites spp. (SP) (VR)
Lycopodiumsporites spp. (SP) (VR)
Aequitriradites sp. (SP) (VR)
Cyathidites spp. (SP) (R)
Laevigatosporites spp. (SP) (R)

Palynozone Mb 6 (Upper-Middle? Campanian)
((?2570.7-) 2584.3-2612.5 mSS TVD)

2584.3 m

Paleoenvironment: Nonmarine **(subzone Mb 6a)**
Kerogen: 95% woody/coaly (dk); <1% amorphous; % bio deg terrest; % herbac.; 1% S/P
Spore/pollen (F) ; Dinoflagellates (barren); preservation very poor
Tricolpites gillii (SP) (VR)
Proteacidites spp. (SP) (R)
Nothofagidites spp. (SP) (VR)
Araucariacites spp. (SP) (VR)
Phyllocladidites spp. (SP) (VR)
Corollina sp. (SP) (VR, reworked?) 103/16; 93.2/13.9
Stereisporites antiquasporites (SP) (VR)
Lycopodiumsporites spp. (SP) (VR)
Cyathidites spp. (SP) (F)
Circatricosisporites spp. (SP) (VR)

2598.1 m

Paleoenvironment: Nonmarine **(subzone Mb 6b)**
Kerogen: 85-90% woody/coaly (dk); 4-8% amorphous; 8-10% bio deg terrest; % herbac.; 1-2% S/P
Spore/pollen (C-A) ; Dinoflagellates (barren); Pyrite (?F); preservation poor-fair
Liliacidites spp. (SP) (VR-R)
Tricolpites spp. (SP) (R)
Tricolpites confessus (SP) (R) k101.5/14.7
Tricolpites gillii (SP) (VR)
Gambierina rudata (SP) (VR)
Proteacidites spp. (SP) (R)
Nothofagidites spp. (SP) (F)
Nothofagidites senectus (SP) (R) k100.4/14.8
Nothofagidites cf. endurus (SP) (R)
Australopollis obscurus (SP) (VR)
Ericipites psilatus (SP) (VR)
Araucariacites australis (SP) (R)
Phyllocladidites spp. (SP) (F)
Phyllocladidites mawsonii (SP) (R)
Phyllocladidites microsaccatus (SP) (F)
Stereisporites regium (SP) (VR)
Trilete spores ornamented (SP) (R-F)
Gleicheniidites spp. (SP) (VR)
Lycopodiumsporites spp. (SP) (VR)
Baculatisporites spp. (SP) (R)
Ceratosporites equalis/Herkosporites spp. (SP) (VR)

Aequitriradites sp. (SP) (VR)
Cyathidites spp. (SP) (C)
Laevigatosporites spp. (SP) (R)

2608.5-2612.5 m

Paleoenvironment: **(subzone Mb 6b)**
Kerogen: 95% woody/coaly (dk); 2-3% amorphous; % bio deg terrest; % herbac.; 1% S/P
Spore/pollen (F); Dinoflagellates (nearly barren); preservation very poor
Dinocysts undiff. (Glaphyocystat-type) (ER, fragment, contamination?)
Tricolpites spp. (SP) (R)
Tricolpites confessus (SP) (R-F) k;
Tricolpites gillii (SP) (R)
Gambierina cf. rudata (SP) (VR)
Proteacidites spp. (SP) (F-R)
Nothofagidites spp. (SP) (F)
Nothofagidites senectus (SP) (R)
Araucariacites spp. (SP) (R)
Araucariacites cf. australis (SP) (F)
Phyllocladidites spp. (SP) (R)
Phyllocladidites microsaccatus (SP) (VR-R)
Trilete spores ornamented (SP) (F)
Camarozonosporites spp. (SP) (R)
Latrobosporites (L. L. balmei-T. lilliei) ohaiensis (SP) (VR)
Lycopodiumsporites spp. (SP) (VR)
Baculatisporites spp. (SP) (R-F)
Aequitriradites sp. (SP) (VR)
Cyathidites spp. (SP) (C)
Laevigatosporites spp. (SP) (R)
Verrucatosporites spp. (SP) (VR)

Palynozone Mb 7 (Middle Campanian)
(2641.5-2651.9? mSS TVD)

2641.5 m

Paleoenvironment: Nonmarine
Kerogen: 85-90% woody/coaly (dk); 3-5% amorphous; 8-10% bio deg terrest; % herbac.; 1% S/P
Spore/pollen (C); Dinoflagellates (nearly barren); Pyrite (?F); preservation very poor-poor
TAI: 2.4-2.5 (LOM 10.0-10.5)
Dinocysts undiff. (ER, contamination?) 105.4/12.4
Tricolpites spp. (SP) (VR-R)
Tilieaceae-type (SP) (VR, contamination?)
Gambierina spp. (SP) (VR)
Proteacidites spp. (SP) (F-C)
Nothofagidites spp. (SP) (R-F)
Araucariacites spp. (SP) (VR)
Phyllocladidites spp. (SP) (F-C)
Phyllocladidites mawsonii (SP) (VR)
Phyllocladidites microsaccatus (SP) (VR-R)
Trilete spores (SP) (R)
Lycopodiumsporites spp. (SP) (VR-R)
Laevigatosporites spp. (SP) (R)

2651.9 m

Paleoenvironment: Nonmarine
Kerogen: 95% woody/coaly (dk); 1-2% amorphous; 1-2% bio deg terrest; % herbac.; <1% S/P
Spore/pollen (R); Dinoflagellates (barren); Pyrite (?R); preservation very poor-fair
?Glaphyrocysta sp. (D) (ER, piece, mud contamination?)
Proteacidites spp. (SP) (VR?, very poor pres.)
Tetracolpites sp. (SP) (VR)
Nothofagidites spp. (SP) (VR)
Nothofagidites cf. senectus (SP) (VR) 94.6/18.7
Phyllocladidites spp. (SP) (R-F)
Phyllocladidites microsaccatus (SP) (VR-R)
Trilete spores (SP) (ER)
Cyathidites spp. (SP) (R)

WEST TUNA W-32

Palynozone Mb 1 (Lower Maastrichtian)
(2370-2419 mSS TVD)

2370-2374m

Paleoenvironment: Nonmarine **(subzone Mb 1a)**
Kerogen: 1-2% amorph; 85-90% woody/coaly; 5-10% biodeg terr; 1-2% herbac.;1-2% S/P
Spore/pollen (C-A); Dinoflagellates (ER, caved?); Pyrite (?)
Dinocysts undiff. (VR) +b
cf. Glaphyrocysta-type sp. (D) (ER, caved?) +a 95.5/11.5
?Isabelidinium spp. (D) (ER, broken) +a 103.8/3.4
Tricolpites confessus (SP) (VR)
cf. Tricolpites pachyexinus (SP) (VR)
Tricolpites gillii (SP) (R)
Tricolpites reticulatus/scabratus (SP) (VR) +97.7/9
cf. Tricolporites lilliei (SP) (VR)
Triporopollenites sectilis (SP) (base consistent U. T. lilliei) (VR) 106.4/10
Gambierina rudata (SP) (F)
Gambierina cf. edwardsii (SP) (base Upper T. lilliei) (VR) k99.5/12.6;-b 105.5/10*
Haloragacidites harrisii (SP) (base Upper T. longus) (VR, caved?)
Proteacidites spp. (SP) (C)
Proteacidites interactus/crassus (SP) (T. longus/-Upper T. lillie (-Lwr T. lilliei)) (VR) -b 102/4.5
Proteacidites sp. G of Dettmann & Jarzen, 1996 (SP) () (VR) -b 91/12
Quadraplanus brossus (SP) (VR) +a 100.6/9.4
Nothofagidites spp. (SP) (VR-R)
Nothofagidites cf. endurus (SP) (VR) -b 98/12.2;96.7/11.9
Phyllocladidites spp. (SP) (F-C)
Phyllocladidites mawsonii (SP) (F)
Phyllocladidites microsaccatus (SP) (R)
Lygistepollenites cf. balmei
Stereisporites antiquasporites (SP) (F)
Stereisporites regium (SP) (R)
Stereisporites (Tripunctisporis) sp. (SP) (generally no lower than T. longus; caved?) (ER)
Trilete spores ornamented (SP) (F)
Gleicheniidites spp. (SP) (VR)
Latrobosporites ohaiensis (SP) (R)
Lycopodiumsporites spp. (SP) (VR)
Baculatisporites spp. (SP) (R)
Cyathidites spp. (SP) (VR)
Laevigatosporites spp. (SP) (VR)

2390-2395m

Paleoenvironment: Nonmarine **(subzone Mb 1a)**
Kerogen: 1% amorph; 85-90% woody/coaly; 5-10% biodeg terr; 1-2% herbac.;2-5% S/P
Spore/pollen (C-A); Dinoflagellates (barren); Pyrite (?)
cf. Tricolpites confessus (SP) (VR)
Tricolpites gillii (SP) (R)
Triporopollenites sectilis (SP) (base consistent Upper T. lilliei) (R)
Gambierina rudata (SP) (F)
Gambierina cf. edwardsii (SP) (base Upper T. lilliei) (VR)
Australopollis obscurus (SP) (VR)
Proteacidites spp. (SP) (C)
Proteacidites adenanthoides (SP) (VR)
Nothofagidites spp. (SP) (R-F)
Nothofagidites cf. senectus (SP) (R)
Nothofagidites cf. endurus (SP) (VR)
Tetracolporites verrucosus (SP) (base Upper T. lilliei) (VR)
Araucariacites spp. (SP) (R-F)
Phyllocladidites spp. (SP) (F-C)
Phyllocladidites mawsonii (SP) (F)
Phyllocladidites microsaccatus (SP) (R)
Stereisporites antiquasporites (SP) (F)
Stereisporites regium (SP) (VR)
Stereisporites (Tripunctisporis) sp. (SP) (generally no lower than T. longus; caved?) (ER) -a96/11
Trilete spores ornamented (SP) (F)
Ornamentifera sentosa (SP) (T. longus-Upper N. senectus (VR)
Latrobosporites ohaiensis (SP) (R)
Ceratosporites sp. (SP) (VR)
Cyathidites spp. (SP) (R)
Laevigatosporites spp. (SP) (R)

2399-2404m

Paleoenvironment: Nonmarine **(subzone Mb 1b)**
Kerogen: <1% amorph; 90-95% woody/coaly; 2-3% biodeg terr; 1-2% S/P
Spore/pollen (C-A); Dinoflagellates (barren); Pyrite (F?); rare Eocene contam (M. tenuis)
cf. Tricolpites confessus (SP) (VR)
Tricolpites gillii (SP) (ER)
Gambierina rudata (SP) (VR)
Australopollis obscurus (SP) (R-F)
Proteacidites spp. (SP) (F)
cf. Proteacidites adenanthoides (SP) (VR)
Nothofagidites spp. (SP) (VR-R, some contam?)
?Tetracolporites verrucosus (SP) (base Upper T. lilliei) (VR)
cf. Ephedripites spp. (SP) (VR)
Araucariacites spp. (SP) (R-F)
Phyllocladidites spp. (SP) (C)
Phyllocladidites mawsonii (SP) (F-C)
Phyllocladidites microsaccatus (SP) (R)
Stereisporites antiquasporites (SP) (F-C)
Trilete spores ornamented (SP) (R)
Latrobosporites ohaiensis (SP) (R)
Lycopodiumsporites spp. (SP) (VR)
Cyathidites spp. (SP) (R)
Laevigatosporites spp. (SP) (R)

2409-2419m

Paleoenvironment: Nonmarine **(subzone Mb 1b)**
Kerogen: <1% amorph; 95% woody/coaly; 2-3% biodeg terr; 1% S/P
Spore/pollen (C-A); Dinoflagellates (barren); Pyrite (?);
cf. Tricolpites confessus (SP) (VR)
Tricopities waiparaensis (SP) (VR) -b 92.3/19
cf. Tricolporites lilliei (SP) (VR)
cf. Gambierina rudata (SP) (VR)
Australopollis obscurus (SP) (R)
Proteacidites spp. (SP) (F-C)
Nothofagidites spp. (SP) (VR)
?Tetracolporites verrucosus (SP) (base Upper T. lilliei) (VR) -b 92.9/16.1
Araucariacites spp. (SP) (R)
Phyllocladidites spp. (SP) (C)
Phyllocladidites mawsonii (SP) (F-C)
Phyllocladidites microsaccatus (SP) (R)
Lygistepollenites spp.
Stereisporites antiquasporites (SP) (F)
Stereisporites regium (SP) (VR)
Trilete spores ornamented (SP) (R-F)
Gleicheniidites spp. (SP) (VR)
Camarozonosporites spp. (SP) (VR)
Latrobosporites ohaiensis (SP) (R)
Lycopodiumsporites spp. (SP) (VR)
Rugulatispoites sp. (SP) (VR)
Cyathidites spp. (SP) (R)
Laevigatosporites spp. (SP) (R)

Palynozone Mb 2 (Lower Maastrichtian)
(2419-2424 mSS TVD)

2419-2424m

Paleoenvironment: Nonmarine
Kerogen: 1-2% amorph; 88-90% woody/coaly; 8-10% biodeg terr; 2-3% S/P
Spore/pollen (C-A); Dinoflagellates (barren); Pyrite (F-C?)
Dinocysts undiff. (VR) +a 92.8/17.5 (caved?, Operculo.)
cf. Tricolpites confessus (SP) (VR)
Tricopities waiparaensis (SP) (VR-R)
Tricolpites gillii (SP) (R-F)
Tricolpites reticulatus/scabratus (SP) (VR)
Tricolpites longus (SP) (VR) -a 94.2/10
Tricolporites lilliei (SP) (VR) -b 91.8/15.2
?Gambierina rudata (SP) (VR)
Haloragacidites harrisii (SP) (base Upper T. longus) (ER, caved?)
Australopollis obscurus (SP) (R)
Proteacidites spp. (SP) (C)
Proteacidites cf. adenanthoides (SP) (VR)
Proteacidites amolosexinus (S) (VR)
cf. Proteacidites sp. G of Dettmann & Jarzen, 1996 (SP) () (VR)

Nothofagidites spp. (SP) (VR)
Nothofagidites cf. senectus (SP) (ER)
Nothofagidites cf. endurus (SP) (VR)
Tetracolporites verrucosus (SP) (base Upper T. lilliei) (VR) -b 95.7/9.3
Araucariacites spp. (SP) (R)
Phyllocladidites spp. (SP) (F)
Phyllocladidites mawsonii (SP) (R-F)
Phyllocladidites microsaccatus (SP) (R)
Stereisporites antiquasporites (SP) (VR-R)
Trilete spores ornamented (SP) (R-F)
Gleicheniidites spp. (SP) (VR)
Camarozonosporites spp. (SP) (VR)
Lycopodiumsporites spp. (SP) (VR)
Cyathidites spp. (SP) (R)
?Aequitriradites sp. (pustulate) (SP) (ER, ?reworked in Ss lithology of sample) 104/12.7

Palynozone Mb 3 (lower part of Lower Maastrichtian-upper part of Upper Campanian) (2449-2475 (2505?) mSS TVD)

2449-2459m

Paleoenvironment: Nonmarine
Kerogen: 5% amorph; 85-90% woody/coaly; 3-5% biodeg terr; 1% S/P
Spore/pollen (C-A); Dinoflagellates (~barren); Pyrite (C?); Eocene cavings, *P. pachypolus*
Glaphyrocysta sp. (D) (ER, caved?) +a 99/13
Tricolpites confessus (SP) (R-F?)
Tricolpites pachyexinus (SP) (VR) 92.5/12*
Tricopities waiparaensis (SP) (VR)
Tricolpites gillii (SP) (VR)
cf. Tricolpites reticulatus/scabratus (SP) (VR)
cf. Tricolpites longus (SP) (VR) +b 97.8/7.5
Tricolporites lilliei (SP) (T. longus-T. lilliei) (VR-R) +b 99.813
Australopollis obscurus (SP) (R)
Proteacidites spp. (SP) (F)
Proteacidites adenanthoides (SP) (VR) +b 104/7.4
Proteacidites palisadus (SP) (VR)
cf. Quadraplanus brossus (SP) (base in Upper T. lilliei) (VR)
Gephyrapollenites wahooensis (SP) (L.L.balmei-T. lilliei) (VR) +b 89.9/9.9
Nothofagidites spp. (SP) (R)
Nothofagidites cf. senectus (SP) (VR) -b88/12.9
Nothofagidites cf. endurus (SP) (VR) 86/14
Araucariacites spp. (SP) (R)
Phyllocladidites spp. (SP) (F)
Phyllocladidites mawsonii (SP) (R-F)
Phyllocladidites microsaccatus (SP) (F)
Lygistepollenites spp. (SP) (VR)
Stereisporites antiquasporites (SP) (VR)
Trilete spores ornamented (SP) (R)
Gleicheniidites spp. (SP) (VR)
Clavifera trplex (SP) (VR)
Camarozonosporites spp. (SP) (VR)
Lycopodiumsporites spp. (SP) (R-F)
Cyathidites spp. (SP) (R)
Aequitriradites sp. (rugulate) (SP) (VR, top within zone)

2465-2475m

Paleoenvironment: Nonmarine
Kerogen: 2-3% amorph; 88-95% woody/coaly; 2-5% biodeg terr; 2-3% S/P
Spore/pollen (C-A); Dinoflagellates (barren); Pyrite (C?)
Tricolpites confessus (SP) (R)
Tricolpites pachyexinus (SP) (T. longus-T. lilliei) (VR)
Tricolpites gillii (SP) (R)
Tricolporopollenites (Cranwellopollis) cf. apiculatus (SP) (T. longus in Otway Basin) (VR) +b 97.6/8
?Gambierina rudata (SP) (VR)
Australopollis obscurus (SP) (R)
Proteacidites spp. (SP) (F)
Proteacidites interactus (SP) (T. longus-Upper T. lilliei) (VR)
Proteacidites adenanthoides (SP) (base N. senectus) (VR-R)
cf. Proteacidites amolosexinus (SP) (VR-R)
Proteacidites palisadus (SP) (VR)
cf. Quadraplanus brossus (SP) (base in Upper T. lilliei) (VR)
Nothofagidites spp. (SP) (VR-R)
Nothofagidites cf. senectus (SP) (R)

Nothofagidites cf. endurus (SP) (VR)
Araucariacites spp. (SP) (R)
Phyllocladidites spp. (SP) (F)
Phyllocladidites mawsonii (SP) (R-F)
Phyllocladidites microsaccatus (SP) (R)
Stereisporites antiquasporites (SP) (VR)
Stereisporites regium (SP) (VR)
Trilete spores ornamented (SP) (F)
Gleicheniidites spp. (SP) (VR)
Ceratosporites sp. (SP) (VR)
Camarozonosporites spp. (SP) (R)
?Latrobosporites ohaiensis (SP) (R)
Lycopodiumsporites spp. (SP) (R-F)
Cyathidites spp. (SP) (R)
Laevigatosporites spp. (SP) (R)

2475-2485m

Paleoenvironment: Nonmarine **(Probably Mb 3; Uncertainty due to frequent cavings)**
Kerogen: 5% amorph; 85-90% woody/coaly; 2-5% biodeg terr; 3-5% S/P
Spore/pollen (C-A); Dinoflagellates (~barren); Pyrite (C-A?); freq cavings
Glaphyrocysta sp. (D) (ER, caved?)
Tricolpites confessus (SP) (VR)
Tricolpites gillii (SP) (R)
Australopollis obscurus (SP) (R)
Proteacidites spp. (SP) (F)
Proteacidites adenanthoides (SP) (base N. senectus) (VR-R)
cf. Proteacidites amolosexinus (SP) (VR)
cf. Quadraplanus brossus (SP) (base in Upper T. lilliei) (VR)
Nothofagidites spp. (SP) (R)
Nothofagidites cf. senectus (SP) (VR)
Araucariacites spp. (SP) (R)
Phyllocladidites spp. (SP) (F)
Phyllocladidites mawsonii (SP) (R-F)
Phyllocladidites microsaccatus (SP) (R)
Stereisporites antiquasporites (SP) (R-F?)
Trilete spores ornamented (SP) (R)
Lycopodiumsporites spp. (SP) (R)
Ceratosporites sp. (SP) (VR)
Cyathidites spp. (SP) (R)
Laevigatosporites spp. (SP) (R)

2490-2505m

Paleoenvironment: Nonmarine **(mixed assemblage, cavings, Probably Mb 3)**
Kerogen: 3-5% amorph; 90-92% woody/coaly; 2% biodeg terr; 2-3% S/P
Tricolpites gillii (SP) (VR)
cf. Tricolpites reticulatus/scabratus (SP) (VR)
?Gambierina rudata (SP) (VR)
Australopollis obscurus (SP) (VR)
Proteacidites spp. (SP) (F)
Proteacidites angulata (SP) (base in U. T. lilliei) (VR)
Proteacidites adenanthoides (SP) (base N. senectus) (VR-R)
Proteacidites palisadus (SP) (T. longus-U. T. lilliei (-L. T. lilliei)) (VR-R) -b 94.2/12.7
Nothofagidites spp. (SP) (VR-R)
Nothofagidites cf. senectus (SP) (VR)
Tetracolporites verrucosus (SP) (base Upper T. lilliei) (VR, last certain downhole occurrence) -95/15.2
Chomotriletes spp. (SP) (VR)
Araucariacites spp. (SP) (R)
Phyllocladidites spp. (SP) (F)
Phyllocladidites mawsonii (SP) (R-F)
Phyllocladidites microsaccatus (SP) (R)
Stereisporites antiquasporites (SP) (R)
Trilete spores ornamented (SP) (R-F)
Gleicheniidites spp. (SP) (VR)
Camarozonosporites spp. (SP) (R)
Lycopodiumsporites spp. (SP) (R)
Cyathidites spp. (SP) (R)
Laevigatosporites spp. (SP) (VR)

Palynozone Mb 4/5 (Upper Campanian)
(2505-2510 mSS TVD)

2505-2510m

Paleoenvironment: Nonmarine **(mixed assemblage)**

Kerogen: 10-15% amorph (zone 5); 82-88% woody/coaly; 2% biodeg terr; 1-2% S/P
Spore/pollen (C-A); Dinoflagellates (~barren); Pyrite (C-A?)
Glaphyrocysta sp. (D) (ER, fragment; caved?)
Tricolpites confessus (SP) (VR)
Tricolpites gillii (SP) (VR)
Tricolporites lilliei (SP) (T. longus-T. lilliei) (VR-R) b 96.7/6.5 (zone 4)
Gambierina rudata (SP) (VR)
Australopollis obscurus (SP) (VR)
Proteacidites spp. (SP) (F) (zone 5)
Proteacidites palisadus (SP) (T. longus-U. T. lilliei (-L. T. lilliei)) (VR-R)
Nothofagidites spp. (SP) (VR) (zone 5)
Nothofagidites cf. senectus (SP) (VR)
?Tetracolporites verrucosus (SP) (base Upper T. lilliei) (ER)
Phyllocladidites spp. (SP) (F)
Phyllocladidites mawsonii (SP) (R-F)
Phyllocladidites microsaccatus (SP) (R)
Stereisporites antiquasporites (SP) (F)
Stereisporites regium (SP) (VR)
Trilete spores ornamented (SP) (R)
Gleicheniidites spp. (SP) (VR)
Camarozonosporites spp. (SP) (R)
Cyathidites spp. (SP) (R) (zone 4)
Laevigatosporites spp. (SP) (R-F)

Palynozone Mb 5 (~=top of Lower T. lilliei) (Upper Campanian)
(2514 (-2534?) mSS TVD)

2514-2524m

Paleoenvironment: Nonmarine
Kerogen: 3-5% amorph*; 85-90% woody/coaly; 5-8% biodeg terr; 3-5% S/P
Spore/pollen (C-A); Dinoflagellates (barren); Pyrite (F-C)
?Microforaminifera test (ER, broken, caved?) -b 87.9/11.4
Tricolpites confessus (SP) (VR)
Tricolpites gillii (SP) (VR)
Gambierina rudata (SP) (VR)
Australopollis obscurus (SP) (VR)
Proteacidites spp. (SP) (F)
Proteacidites adenanthoides (SP) (base N. senectus) (VR-R)
Proteacidites cf. palisadus (SP) (T. longus-U. T. lilliei (-L. T. lilliei)) (VR)
Nothofagidites spp. (SP) (VR)
Nothofagidites cf. senectus (SP) (VR) -91.8/5.9
Nothofagidites cf. endurus (SP) (VR)
Tetracolporites verrucosus (SP) (base Upper T. lilliei) (VR-R)
Araucariacites spp. (SP) (R)
Phyllocladidites spp. (SP) (F-C)
Phyllocladidites mawsonii (SP) (F)
Phyllocladidites microsaccatus (SP) (F)
Stereisporites antiquasporites (SP) (R)
Stereisporites regium (SP) (VR)
Trilete spores ornamented (SP) (C)
Gleicheniidites spp. (SP) (F)
Clavifera triplex (SP) (VR)
Camarozonosporites spp. (SP) (R)
Lycopodiumsporites spp. (SP) (R)
Ceratosporites sp. (SP) (VR)
Cyathidites spp. (SP) (R)
Laevigatosporites spp. (SP) (R)
Aequitriradites sp. (pustulate) (SP) (VR)

Unassigned
(2529-2534 mSS TVD)

2529-2534m

Paleoenvironment: Nonmarine **(Unassigned, prob. in Mb 5)**
Kerogen: 2-3% amorph; 90-95% woody/coaly; 5-8% biodeg terr; <1% S/P
Spore/pollen (R-F); Dinoflagellates (barren); Pyrite (C-A?)
Proteacidites spp. (SP) (R)
Lewalanipollis senectus (Triorites) (SP) (VR) -94/9.2
Nothofagidites spp. (SP) (VR)
Nothofagidites cf. endurus (SP) (VR)
Trilete spores ornamented (SP) (R-F)
Camarozonosporites spp. (SP) (R)

Latrobosporites ohaiensis (SP) (VR, broken)
Lycopodiumsporites spp. (SP) (VR)
Cyathidites spp. (SP) (R)

Palynozone Mb 6 (Upper-Middle? Campanian)
(2549-2564 mSS TVD)

2549-2564m

Paleoenvironment: Nonmarine **(subzone Mb 6)**
Kerogen: 5% amorph; 88-90% woody/coaly; 5-8% biodeg terr; 1-2% S/P
Spore/pollen (F); Dinoflagellates (barren); Pyrite (R-F?)
Tricopities waiparaensis (SP) (VR)
Tricolpites gillii (SP) (VR)
Australopollis obscurus (SP) (VR)
Proteacidites spp. (SP) (R)
Nothofagidites cf. senectus (SP) (VR)
Araucariacites spp. (SP) (R)
Phyllocladidites spp. (SP) (F)
Phyllocladidites mawsonii (SP) (R)
Phyllocladidites microsaccatus (SP) (R)
Lygistepollenites cf. balmei
Stereisporites antiquasporites (SP) (R)
cf. Stereisporites regium (SP) (VR)
Trilete spores ornamented (SP) (F)
Gleicheniidites spp. (SP) (R)
cf. Clavifera triplex (SP) (VR)
Camarozonosporites spp. (SP) (R)
Lycopodiumsporites spp. (SP) (R)
Cyathidites spp. (SP) (F)
Laevigatosporites spp. (SP) (F)

Unassigned
(2569-2574 mSS TVD)

2569-2574m

Paleoenvironment: Nonmarine **(Unassigned, sparse fossils)**
Kerogen: 1-2% amorph; 90-95% woody/coaly; 5% biodeg terr; <1% S/P
Spore/pollen (R); Dinoflagellates (ER); Pyrite (F-C?)
Dinocysts undiff. (VR) +98/8 (caved?, Operculo.)
Proteacidites spp. (SP) (VR)
Nothofagidites spp. (SP) (VR)
Nothofagidites cf. endurus (SP) (VR)
Phyllocladidites spp. (SP) (F-R)
Phyllocladidites mawsonii (SP) (R)
Trilete spores ornamented (SP) (R)
Gleicheniidites spp. (SP) (R)
Latrobosporites ohaiensis (SP) (VR)
Lycopodiumsporites spp. (SP) (R)
Cyathidites spp. (SP) (R)
Laevigatosporites spp. (SP) (R)
Aequitriradites sp. (pustulate/spinose) (SP) (VR)

Prob. Palynozone Mb 6 (Upper-Middle? Campanian)
(2579-2594 mSS TVD)

2579-2594m

Paleoenvironment: Nonmarine **(prob. Mb 6)**
Kerogen: 3-5% amorph; 88-90% woody/coaly; 5% biodeg terr; 2-3% S/P
Spore/pollen (F); Dinoflagellates (VR-R, cavings); Pyrite (C-A?); cavings (F-C)
Dinocysts undiff. (VR) +100.3/19.5 (caved?, Operculo.); +95.3/15.2
Spiniferites spp. (D) (VR) +97.6/22.2; Leptodinium-type sp. (D) (VR) +104/19
Wetzeliella/Apectodinium sp. (D) (VR, caved) +99.2/19.1
Tricolpites confessus (SP) (VR)
Tricolpites gillii (SP) (VR-R)
Gambierina rudata (SP) (VR)
Haloragacidites harrisii (SP) (base Upper T. longus) (VR, pink, caved?)
Australopollis obscurus (SP) (F, some prob. caved, stain)
Proteacidites spp. (SP) (R)
cf. Proteacidites angulata (SP) (base in U. T. lilliei) (VR, caved?)
Proteacidites cf. palisadus (SP) (T. longus-U. T. lilliei (-L. T. lilliei)) (VR)
Nothofagidites spp. (SP) (VR)
Nothofagidites cf. senectus (SP) (VR)
Nothofagidites cf. endurus (SP) (VR)

Tetracolporites verrucosus (SP) (base Upper T. lilliei) (VR, caved?)
Araucariacites spp. (SP) (R-F)
Phyllocladidites spp. (SP) (F-R)
Phyllocladidites mawsonii (SP) (R)
Phyllocladidites microsaccatus (SP) (R)
Lygistepollenites cf. balmei (SP) (VR)
Stereisporites antiquasporites (SP) (R-F)
Gleicheniidites spp. (SP) (R)
Lycopodiumsporites spp. (SP) (R)
Cyathidites spp. (SP) (R-F)
Laevigatosporites spp. (SP) (R)
Aequitriradites sp. (pustulate/spinose) (SP) (VR)

Prob. Palynozone Mb 7 (Middle Campanian)
(2604-2624 mSS TVD)

2604-2609m

Paleoenvironment: Nonmarine
Kerogen: 15% amorph; 70-85% woody/coaly; 5% biodeg terr; 1% S/P
Spore/pollen (F-C, caved?); Dinoflagellates (barren); Pyrite (C?)
Tricolpites confessus (SP) (VR)
Proteacidites spp. (SP) (VR)
Australopollis obscurus (SP) (C, ?caved)
cf. Tetracolporites verrucosus (SP) (base Upper T. lilliei) (VR, caved?)
Phyllocladidites spp. (SP) (F)
Phyllocladidites mawsonii (SP) (F)
Phyllocladidites microsaccatus (SP) (C)
Lygistepollenites balmei (SP) (R)
Cedripites type (SP) (VR) -97.8/15
Stereisporites antiquasporites (SP) (VR-R)
Trilete spores ornamented (SP) (R-F)
Gleicheniidites spp. (SP) (R)
Camarozonosporites spp. (SP) (VR)
Baculatisporites spp. (SP) (R-F)
Cyathidites spp. (SP) (R)
Laevigatosporites spp. (SP) (R)

2619-2624m

Paleoenvironment: Nonmarine
Kerogen: 10% amorph; 75-85% woody/coaly; 5% biodeg terr; 1% S/P
Spore/pollen (F); Dinoflagellates (barren); Pyrite (C?)
Australopollis obscurus (SP) (F, caved?)
Proteacidites spp. (SP) (VR)
Protacidites cf. cooksoniae/ornatus/grandis (SP) (VR, piece) -104/16
cf. Proteacidites angulata (SP) (base in U. T. lilliei) (VR, aved?)
Nothofagidites spp. (SP) (VR)
Phyllocladidites spp. (SP) (R)
Phyllocladidites microsaccatus (SP) (R)
Lygistepollenites spp. (SP) (VR)
Lygistepollenites balmei (SP) (VR)
Trilete spores ornamented (SP) (R-F)
Camarozonosporites spp. (SP) (VR)
Baculatisporites spp. (SP) (R-F)
Gleicheniidites spp. (SP) (R-F)
Lycopodiumsporites spp. (SP) (R)
Cyathidites spp. (SP) (R)
Laevigatosporites spp. (SP) (F)

2730-2735m Paleoenvironment: Nonmarine **(Sequence M)**

Kerogen: 10% amorph; 75-85% woody/coaly; 5% biodeg terr; 1% S/P
Spore/pollen (); Dinoflagellates (barren); Pyrite (C?)
?Microforaminifera test (ER, broken, caved?) -b 87.9/11.4
Dinocysts undiff. (VR) +100.3/19.5 (caved?, Operculo.); +95.3/15.2
Spiniferites spp. (D) (VR) +97.6/22.2
Leptodinium-type sp. (D) (VR) +104/19
Wetzeliella/Apectodinium sp. (D) (VR, caved) +99.2/19.1
Glaphyrocysta sp. (D) (ER, fragment; caved?)
?Isabelidinium spp. (D) (ER,broken) +a 103.8/3.4
Tricolpites confessus (SP) (VR)
Tricolpites pachyexinus (SP) (T. longus-T. lilliei) (VR)
Tricopities waiparaensis (SP) (VR)
Tricolpites gillii (SP) (VR)
cf. Tricolpites reticulatus/scabratus (SP) (VR)
cf. Tricolpites longus (SP) (VR) +b 97.8/7.5
Tricolporites lilliei (SP) (T. longus-T. lilliei) (VR-R) b 96.7/6.5
Triporopollenites sectilis (SP) (base consistent Upper T. lilliei) (R)
Tricolporopollenites (Cranwellopollis) cf. apiculatus (SP) (T. longus in Otway Basin) (VR) +b 97.6/8
Gambierina rudata (SP) (VR)
Gambierina cf. edwardsii (SP) (base Upper T. lilliei) (VR)
Haloragacidites harrisii (SP) (base Upper T. longus) (ER, caved?)
Australopollis obscurus (SP) (F)
Proteacidites spp. (SP) (VR)
Protacidites cf. cooksoniae/ornatus/grandis (SP) (VR, piece) -104/16
cf. Proteacidites angulata (SP) (base in U. T. lilliei) (VR, aved?)
Proteacidites interactus/crassus (SP) (T. longus/-Upper T. lilliei (-Lwr T. lilliei)) (VR)
Proteacidites interactus (SP) (T. longus-Upper T. lilliei) (VR)
Proteacidites adenanthoides (SP) (base N. senectus) (VR-R)
cf. Proteacidites amolosexinus (SP) (VR)
Proteacidites cf. palisadus (SP) (T. longus-U. T. lilliei (-L. T. lilliei)) (VR)
Proteacidites sp. G of Dettmann & Jarzen, 1996 (SP) () (VR)
Lewalanipollis senectus (Triorites) (SP) (VR) -94/9.2
cf. Quadraplanus brossus (SP) (base in Upper T. lilliei) (VR)
Gephyrapollenites wahooensis (SP) (L.L.balmei-T. lilliei) (VR) +b 89.9/9.9
Nothofagidites spp. (SP) (VR)
Nothofagidites cf. senectus (SP) (VR)
Nothofagidites cf. endurus (SP) (VR)
cf. Tetracolporites verrucosus (SP) (base Upper T. lilliei) (VR, caved?)
Chomo. spp. (SP) (VR)
Ephedripites spp. (SP) (VR)
Araucariacites spp. (SP) (R)
Phyllocladidites spp. (SP) (F)
Phyllocladidites mawsonii (SP) (F)
Phyllocladidites microsaccatus (SP) (F)
Lygistepollenites spp. (SP) (VR)
Lygistepollenites balmei (SP) (VR)
Cedripites type (SP) (VR) -97.8/15
Stereisporites antiquasporites (SP) (R)
cf. Stereisporites regium (SP) (VR)
Stereisporites (Tripunctisporis) sp. (SP) (generally no lower than T. longus; caved?) (ER) -a96/11
Trilete spores ornamented (SP) (R)
Ornamentifera sentosa (SP) (T. longus-Upper N. senectus (VR)
Gleicheniidites spp. (SP) (R)
cf. Clavifera triplex (SP) (VR)
Camarozonosporites spp. (SP) (R)
Latrobosporites ohaiensis (SP) (VR)
Lycopodiumsporites spp. (SP) (R)
Baculatisporites spp. (SP) (R-F)
Ceratosporites sp. (SP) (VR)
Rugulatisporites sp. (SP) (VR)
Cyathidites spp. (SP) (R)
Laevigatosporites spp. (SP) (R)
Aequitriradites sp. (pustulate/spinose) (SP) (VR)
Aequitriradites sp. (rugulate) (SP) (VR)