PALYNOLOGY OF PETROFINA AYU-1, GIPPSLAND BASIN, AUSTRALIA

BY

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for PETROFINA EXPLORATION AUSTRALIA SA

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PALYNOLOGY OF PETROFINA AYU-1

CONTENTS

I SUMMARY

1730m (swc) - 1740m (swc) : age indeterminate : offshore marine : immature

2146m (swc) - 2490m (swc) : lower P. tuberculatus Zone or younger : Early Oligocene or younger : offshore marine : immature : very lean, especially at 2482m and below.

2491.5m (swc) : barren and indeterminate

2529.0m - 2558m (swc) : lower L. balmei Zone (not assignable to any dinoflagellate Zone) : Paleocene : nearshore to marginally marine : immature

2560.8m (swc) - 2575.8m (swc) : lower L. balmei Zone (E. crassitabulata Dinoflagellate Zone) : nearshore marine : immature

2617.8m (swc) - 2697.2m (swc) : lower L. balmei Zone (not assignable to any dinoflagellate Zone) : nearshore to offshore marine : marginally mature for oil

2700m (swc) : lower L. balmei Zone (T. evittii Dinoflagellate Zone) : offshore marine : marginally mature : Paleocene

2708m (swc) : upper T. longus Zone (M. druggii Dinoflagellate Zone) : nearshore marine : marginally mature : Maastrichtian

2730m (swc) : upper T. longus Zone (not assignable to any dinoflagellate Zone) : brackish : marginally mature : Maastrichtian

II INTRODUCTION

Twenty five samples were submitted by Nick Grollmann of Petrofina for palynology. Raw data is presented in Appendix I.

The palynostratigraphic framework for the Cretaceous is most recently reviewed by Helby, Morgan and Partridge (1987). In the Tertiary, the zonal scheme was most recently published by Partridge (1976), but significant new data exists in privately circulated studies, in Harris (1985), Morgan (1988), and in Marshall and Partridge (1988). The zonal scheme used here is shown in Fig. 1 and is a combination of Helby, Morgan and Partridge (1987) and Partridge (1976). The data is easily discussed against this framework.

Organic maturity data was generated in the form of the Spore Colour Index and plotted on Fig. 2. The oil and gas windows follow the general consensus of geochemical literature. The oil window corresponds to spore colours of light-mid brown (2.7) to dark brown (3.6). This would correspond to Vitrinite Reflectance values of 0.6% to 1.3%. Howeve, factors such as detailed kerogen type, basin type, basin history and heating curves all affect precise interpretation, and analytical machine-based maturity parameters are probably more reliable.

	AGE		SPORE - POLLEN ZONES	DINOFLAGELLATE ZONES
Early Tertiary	Early Oligocene		P. tuberculatus	
	Late Eocene		upper N. asperus	P. comatum
			middle N. asperus	V. extensa
	Middle Eocene		lower N. asperus	D. heterophlycta
			P. asperopolus	W. echinosuturata
				W. edwardsii
				W. thompsonae
	Early Eocene		upper M. diversus	W. ornata
				W. waipawaensis
			middle M. diversus	
			lower M. diversus	W. hyperacantha
	Paleocene		upper L. balmei	A. homomorpha
			lower L. balmei	E. crassitabulata
				T. evittii
Late Cretaceous	Maastrichtian		T. longus	M. druggii
	Campanian		T. lilliei	I.korojonense
			N. senectus	X. australis
	Santonian		T. pachyexinus	N. aceras
				I. cretaceum
				O. porifera
	Coniacian		C. triplex	
	Turonian			C. striatoconus
	Cenomanian		A. distocarinatus	P. infusorioides
Early Cretaceous	Albian	Late	P. pannosus	
		Middle	upper C. paradoxa	
			lower C. paradoxa	
		Early	C. striatus	
	Aptian		upper C. hughesi	
			lower C. hughesi	
	Barremian		F. wonthaggiensis	
	Hauterivian			
	Valanginian		upper C. australiensis	
	Berriasian		lower C. australiensis	
Jurassic	Tithonian		R. watherooensis	

FIGURE 1 ZONATION FRAMEWORK

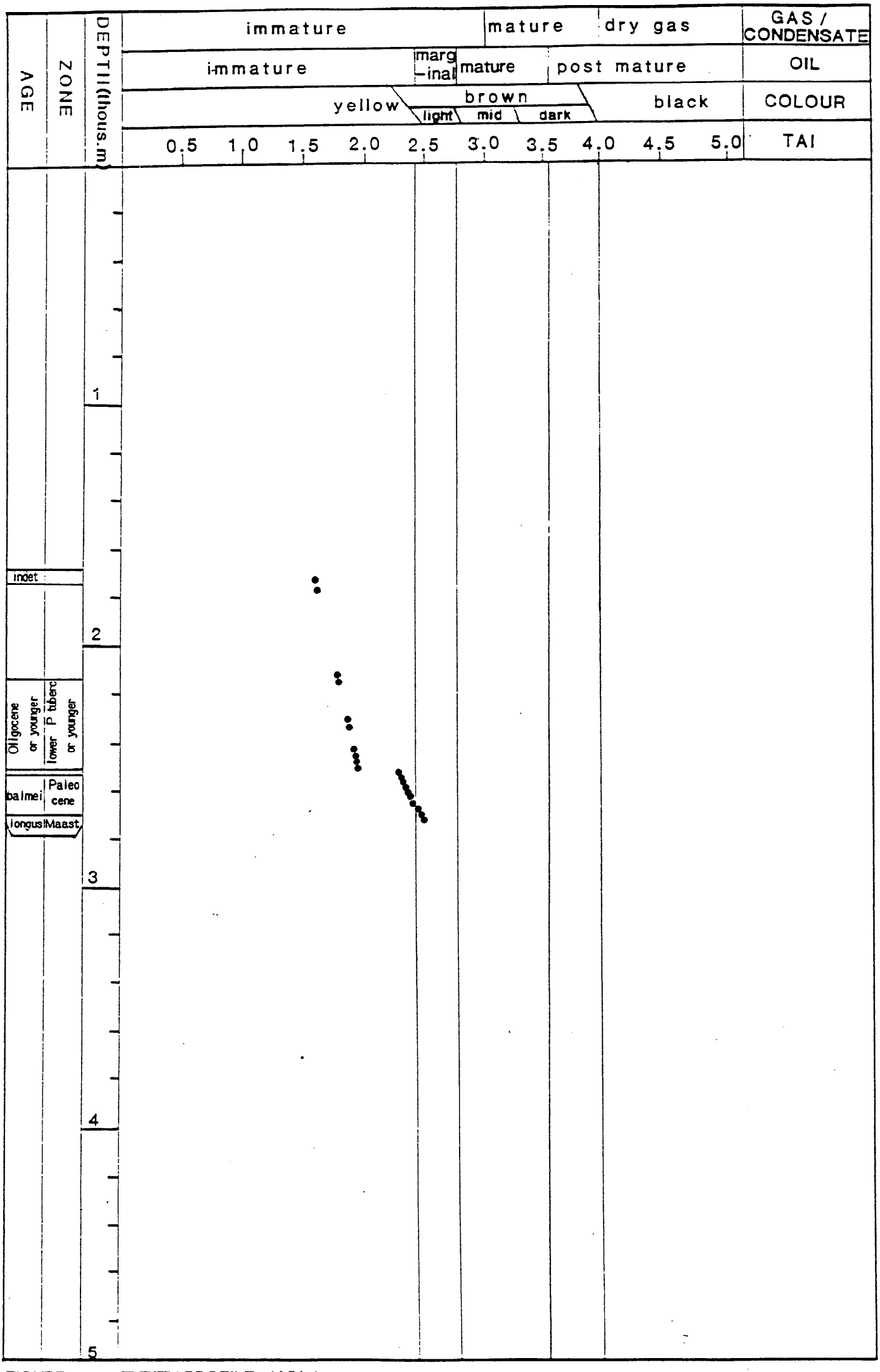

FIGURE 2 MATURITY PROFILE AYU 1

III PALYNOSTRATIGRAPHY

A 1730m (swc) - 1740m (swc) : indeterminate

These two samples are extremely lean and contain too few age diagnostic taxa for zonal assignment. Cyatheacidites annulatus occurs at 1740m, but its total range is Oligocene to Pliocene. Nothofagidites and Cyathidites are present but rare.

Dinoflagellates dominate both samples, comprising 80% and 95% of palynomorphs. Diversity is low, with Operculodinium spp and Spiniferites ramosus abundant, and age diagnostic taxa absent.

Environments are clearly offshore marine, with the abundant but low diversity dinoflagellates dominant.

Colourless palynomorphs indicate immaturity for hydrocarbon generation.

B 2146m (swc) - 2490m (swc) : lower P. tuberculatus Zone or younger

Assignment to the lower part of the Proteacidites tuberculatus Zone is indicated at the base by oldest Cyatheacidites annulatus, and at the top by youngest Beaupreadites verrucosus, confirmed by youngest Granodiporites nebulosus at 2394m. These are, however, single specimens, and if they are reworked, the samples can be assigned no more precisely than to the Oligocene to Pliocene. Hopefully, micropalaeontology will provide more definite ages. All samples are quite lean, with Falcisporites, Stercesporites, Cyathidites, Cyatheacidites, Haloragacidites harrisii and Nothofagidites intermittently frequent. Diversity is quite low.

Dinoflagellates dominate all samples, comprising 80 to 90% of palynomorphs. Operculodinium spp dominate with Spiniferites, Systematophora, Cerebrocysta and an undescribed Millioudodinium "frilly" intermittently common. Lingulodinium machaerophorum and Cordosphaeridium are present in many samples. These features are consistent with assignment to the P. tuberculatus or younger spore-pollen zones.

Offshore marine environments are indicated by the dominance of low diversity dinoflagellates over the subordinate and low diversity spores and pollen.

These features are normally seen in the Lakes Entrance Formation.

Colourless to light yellow spore colours indicate immaturity for hydrocarbon generation.

C 2491.5m (swc) : indeterminate
This sample was almost completely barren, containing only minor scattered inertinite and a single specimen of the dinoflagellate Spiniferites ramosus. Marine environments are therefore indicated, and the colourless palynomorph indicates immaturity for hydrocarbon generation.

D 2529m (swc) - 2558m (swc) : lower L. balmei Zone (no dinoflagellate zone)
Assignment to the lower part of the Lygistepollenites balmei Zone is indicated at the top by youngest Gambierina edwardsii and Lygistepollenites balmei without younger indicators, and at the base by oldest L. balmei without older indicators.

Dinoflagellates are very rare in this interval, and

forms diagnostic of the established dinoflagellate zones were absent. Spinidinium spp, Deflandrea speciosa and Palaeocystodinium are the most consistent taxa.

Nearshore to marginally marine environments are indicated by the very low dinoflagellate content (1 to 5%) and their low diversity. Dominance of moderately diverse spores and pollen and common plant debris especially cuticle, confirm these palaeoenvironments.

These features are normally seen in the upper Latrobe Group, significantly below its youngest top. Notably, the upper L. balmei Zone and its correlative A. homomorphum Dinoflagellate Zone were not seen.

Yellow spore colours indicate immaturity for hydrocarbons. D. speciosa and Palaeocystodinium spp show their characteristically darker colours, but are not considered representative of the assemblage as a whole.

E 2560.8m (swc) - 2575.8m (swc) : lower L. balmei Zone (E. crassitabulata Dinoflagellate Zone).

The presence of L. balmei and G. rudata without younger or older markers indicates the spore-pollen zonal assignment. Falcisporites, Dilwynites, Phyllocladidites mawsonii and Australopollis obscurus are frequent forms in moderate diversity assemblages.

Eisenackia crassitabulata is rare but present in both samples and indicates the zonal assignment. Otherwise, the two samples are quite different. The shallower one contains rare dinoflagellates (10% of palynomorphs) moderate diversity, common Spinidinium spp and includes

oldest Alisocysta rugolirata. The deeper one contains dominant microplankton (70% of palynomorphs), low diversity, and common D. speciosa and Paralecaniella indentata, and contains youngest Alisocysta circumtabulata.

Nearshore marine environments are indicated by the low to moderate diversity microplankton, despite the high content at 2575.8m. The moderate diversity spores and pollen support this interpretation.

These features are normally seen in the upper Latrobe Group.

Yellow to yellow-brown spore colours indicate immaturity for hydrocarbons, although D. speciosa displays its usual anomolous darker colour.

F 2617.8m (swc) - 2697.2m (swc) : lower L. balmei Zone (no Dinoflagellate Zone)

Stratigraphic position and the intermittent continued presence of G. rudata and L. balmei indicates the zonal assignment of these extremely lean samples. In the better yielding samples, A. obscurus, F. similis, P. mawsonii and Proteacidites spp are the most common forms.

Dinoflagellates are also scarce in the lean samples of this interval, and markers of the formal zones were absent. Spinidinium spp dominate the lower two samples (2668.5 and 2697.2m) while the upper sample (2617.8m) is dominated by Cordosphaeridium spp. Alisocysta circumtabulata accurs in the top sample and Palaeoperidinium pyrophorum occurs in the basal one.

Environments are all marine, but proximity to shoreline is not constant throughout the interval. At the base, moderate dinoflagellate content (50% of palynomorphs) and low diversity suggest nearshore conditions. The middle part of the section (2643.5-2658m) is virtually barren due to the clean sandstone lithologies. At the top, a nearshore sample at 2629m (low dinoflagellate content 5% and diversity with dominant and diverse spores and pollen) pass to offshore environments (high dinoflagellate content 95% and moderate diversity with no spore pollen in a very lean sample).

These features are normally seen in the Paleocene part of the Latrobe Group.

Yellow to yellow-brown spore colours indicate immaturity for hydrocarbon generation

G 2700m (swc) : Lower L. balmei Zone (T. evittii Dinoflagellate Zone)
Spore-pollen zonal assignment is based on the continued presence of G. rudata and L. balmei without older indicators. Proteacidites spp and P. mawsonii are frequent in a moderate diversity assemblage.

Dinoflagellates dominate the assemblage (80%), with Spinidinium spp the most common and the presence of Trithyrodinium evittii indicates the Dinoflagellate zonal assignment.

Offshore marine environments are indicated by the dominance of moderately diverse dinoflagellates, and the subordinate moderately diverse spores and pollen. Amorphous sapropel and Pterospermella spp suggest anoxic bottom conditions.

These features are normally seen in a shale peak at the base of the Paleocene part of the Latrobe Group.

Light brown spore colours indicate marginal maturity for oil, but immaturity for gas/condensate.

H 2708m (swc) : upper T. longus Zone (M. druggii Dinoflagellate Zone)
Assignment to the upper part of the Tricolpites longus Zone is indicated at the top by youngest Tricolpites confessus, T. longus, T. waiparaensis and Tricolporites lillei, and at the base by oldest Tripunctisporis punctatus and frequent G. rudata. Overall, Proteacidites is dominant, with frequent Cyathidites and G. rudata.

Dinoflagellates include Manumiella druggii and M. conorata which indicate assignment to the M. druggii Dinoflagellate Zone. In a low diversity assemblage, M. conoratum is the most common.

Nearshore marine environments are indicated by the low content (25% of palynomorphs) and diversity of dinoflagellates, and the common and diverse spores and pollen.

These features are normally seen in a thin shale peak at the top of the Maastrichtian part of the Latrobe Group.

Light brown spore colours indicate marginal maturity for oil but immaturity for gas/condensate.

I 2730m (swc) : upper T. longus Zone (no Dinoflagellate Zone)
Spore-pollen zonal assignment is based in the continued

range overlap of T. punctatus with T. longus. G. rudata continues to be more frequent than Nothofagidites endurus. Proteacidites spp dominate the assemblage. No age diagnostic microplankton were seen.

Brackish marine environments are indicated by the very rare spiny acritarchs seen amongst the dominant and diverse spores and pollen. The freshwater alga Botryococcus indicates some lacustrine influence.

These features are normally seen a little below the top Maastrichtian part of the Latrobe Group.

Light brown spore colours indicate marginal maturity for oil, but immaturity for gas/condensate.

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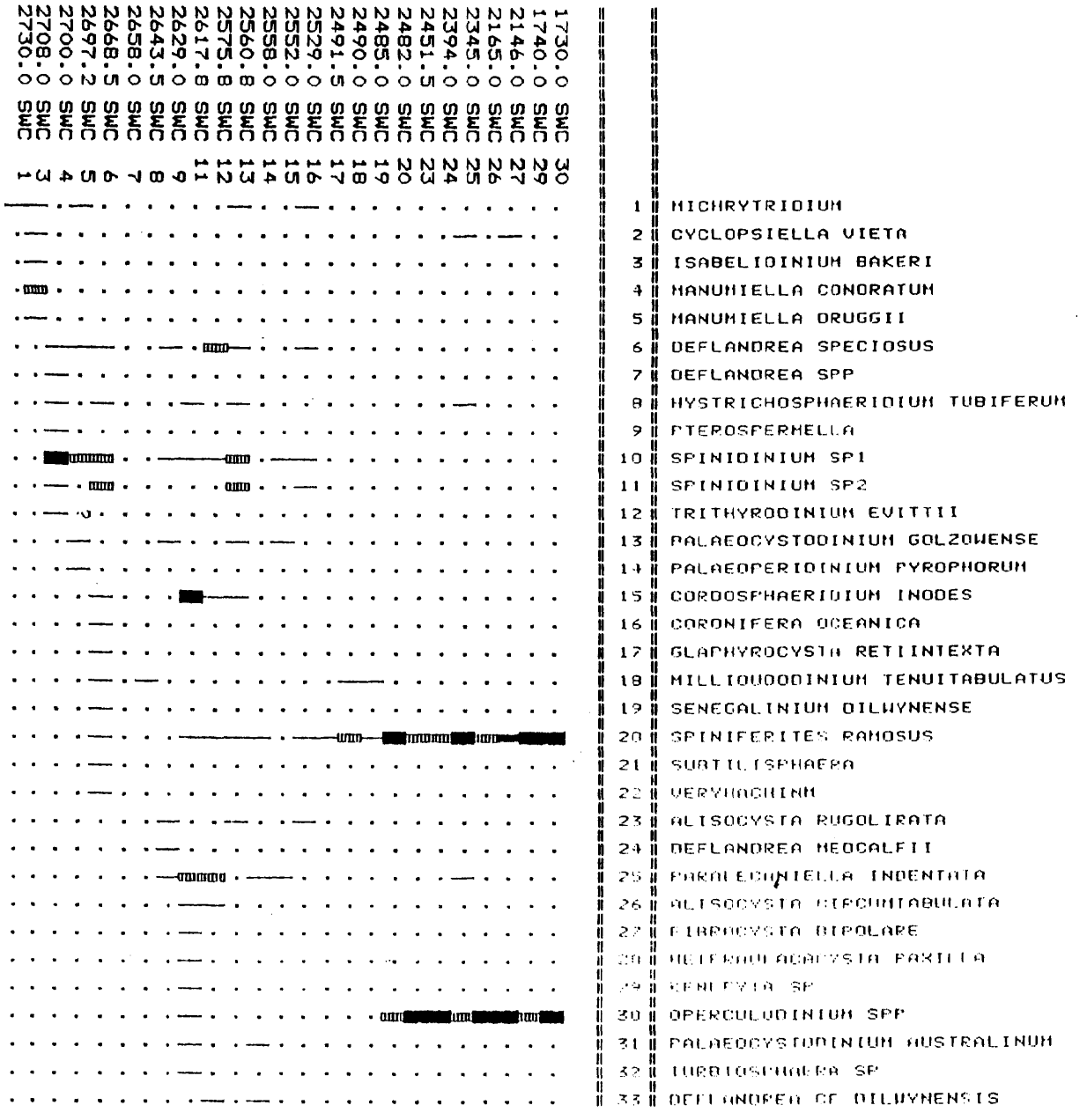
COUNTY: _____ STATE: _____
KB ELEVATION: _____ TOTAL DEPTH: _____
ANALYST: ROGER MORGAN DATE : APRIL 90
NOTES: ALL DEPTHS IN METRES

RANGE CHART OF GRAPHIC ABUNDANCES BY LOWEST APPEARANCE: Dino, S/P

Key to Symbols

| = Very Rare
▯ = Rare
▮ = Few
▮ = Common
▮ = Abundant
? = Questionably Present
. = Not Present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2658.0 SWC 7
2668.5 SWC 6
2697.2 SWC 5
2700.0 SWC 4
2708.0 SWC 3
2730.0 SWC 1
1 MICHRYTRIDIUM
2 CYCLOPSIELLA VIETA
3 ISABELIDINIUM BAKERI
4 MANUMIELLA CONORATUM
5 MANUMIELLA DRUGGII
6 DEFLANDREA SPECIOSUS
7 DEFLANDREA SPP
8 HYSTRICHOSPHAERIDIUM TUBIFERUM
9 PTEROSPERMELLA
10 SPINIDINIUM SP1
11 SPINIDINIUM SP2
12 TRITHYRODINIUM EVITTII
13 PALAEOCYSTODINIUM GOLZOWENSE
14 PALAEOPERIDINIUM PYROPHORUM
15 CORDOSPHAERIDIUM INODES
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17 GLAPHYROCYSTA RETIINTEXTA
18 MILLIOUDODINIUM TENUITABULATUS
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20 SPINIFERITES RAMOSUS
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22 VERYHACHIUM
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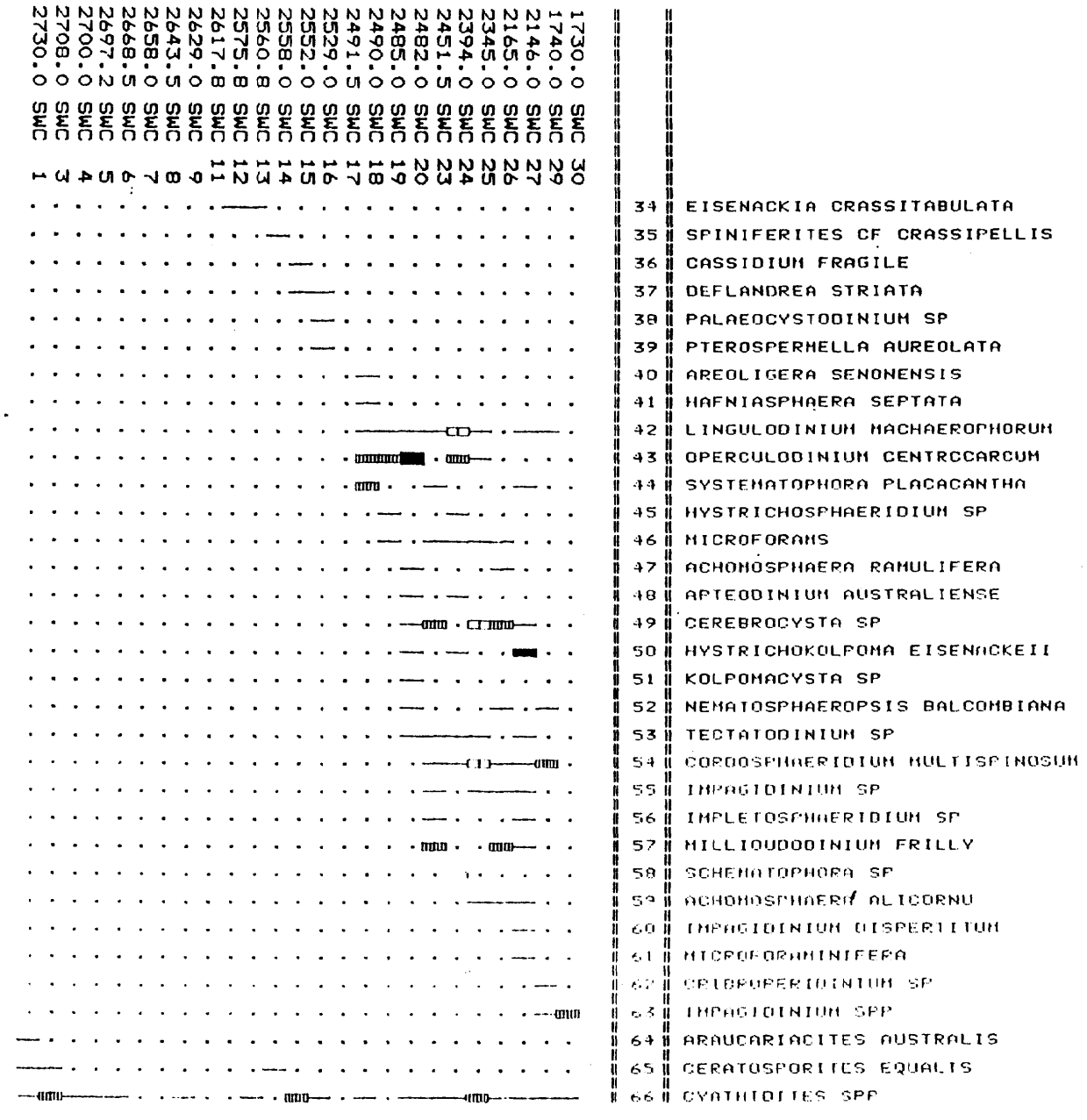
24 DEFLANDREA NEOCALFII
25 PARALECANIELLA INDENTATA
26 ALISOCYSTA CIRCUMTABULATA
27 FIBROCYSTA BIPOLARE
28 HETERAULACACYSTA PAXILLA
29 CENEPYIA SP
30 OPERCULODINIUM SPP
31 PALAEOCYSTODINIUM AUSTRALINUM
32 TURBIOSPHAERA SP
33 DEFLANDREA CF OILWYNENSIS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56 IMPLETOSPHAERIDIUM SP
57 MILLIOUDODINIUM FRILLY
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59 ACHOMOSPHAERA ALICORNU
60 IMPAGIDINIUM DISPERITUM
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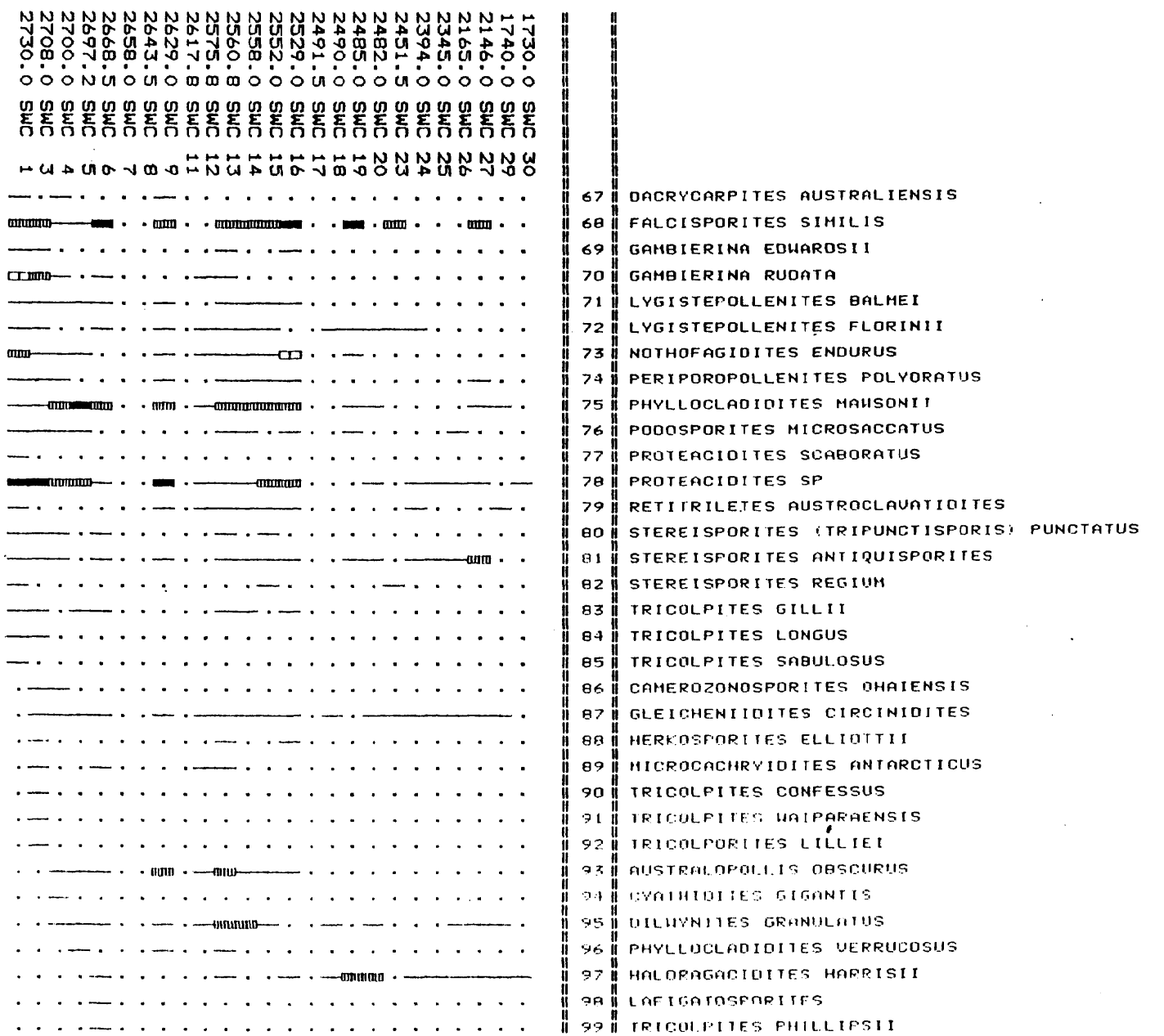
62 CRIBROPERIDINIUM SP
63 IMPAGIDINIUM SPP
64 ARAUCARIACITES AUSTRALIS
65 CERATOSPORITES EQUALIS
66 CYATHIDITES SPP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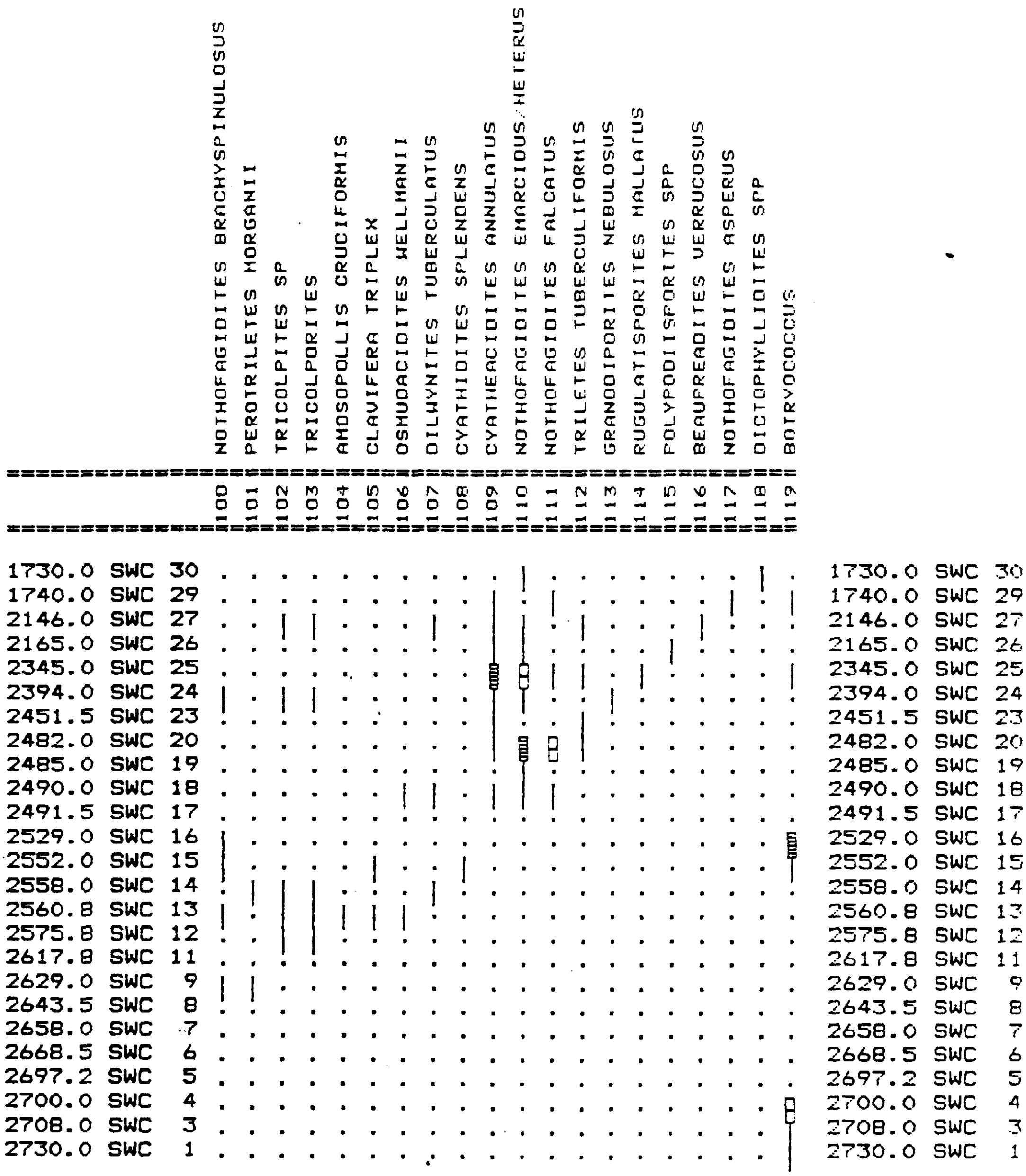

NOTHOFAGIDITES BRACHYSPINULOSUS
PEROTRILETES MORGANII
TRICOLPITES SP
TRICOLPORITES
AMOSOPOLLIS CRUCIFORMIS
CLAVIFERA TRIPLEX
OSMUDACIDITES WELLMANII
DILWYNITES TUBERCULATUS
CYATHIDITES SPLENDENS
CYATHEACIDITES ANNULATUS
NOTHOFAGIDITES EMARCIDUS/HETERUS
NOTHOFAGIDITES FALCATUS
TRILETES TUBERCULIFORMIS
GRANODIPORITES NEBULOSUS
RUGULATISPORITES MALLATUS
POLYPODIISPORITES SPP
BEAUPREADITES VERRUCOSUS
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BOTRYOCOCCUS
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71	LYGISTEPOLLENITES BALMEI
72	LYGISTEPOLLENITES FLORINII
4	MANUMIELLA CONORATUM
5	MANUMIELLA DRUGGII
1	MICHRYTRIDIUM

89	MICROCACHRYIDITES ANTARCTICUS
61	MICROFORAMINIFERA
46	MICROFORAMS
57	MILLIOUDODINIUM FRILLY
18	MILLIOUDODINIUM TENUITABULATUS
52	NEMATOSPHAEROPSIS BALCOMBIANA
117	NOTHOFAGIDITES ASPERUS
100	NOTHOFAGIDITES BRACHYSPINULOSUS
110	NOTHOFAGIDITES EMARCIDUS/HETERUS
73	NOTHOFAGIDITES ENDURUS
111	NOTHOFAGIDITES FALCATUS
43	OPERCULODINIUM CENTRCCARCUM
30	OPERCULODINIUM SPP
106	OSMUDACIDITES WELLMANII
31	PALAEOCYSTODINIUM AUSTRALINUM
13	PALAEOCYSTODINIUM GOLZOWENSE
38	PALAEOCYSTODINIUM SP
14	PALAEOPERIDINIUM PYROPHORUM
25	PARALECANIELLA INDENTATA
74	PERIPOROPOLLENITES POLYORATUS
101	PEROTRILETES MORGANII
75	PHYLLOCLADIDITES MAWSONII
96	PHYLLOCLADIDITES VERRUCOSUS
76	PODOSPORITES MICROSACCATUS
115	POLYPODIISPORITES SPP
77	PROTEACIDITES SCABORATUS
78	PROTEACIDITES SP
9	PTEROSPERMELLA
39	PTEROSPERMELLA AUREOLATA
79	RETITRILETES AUSTROCLAVATIDITES
114	RUGULATISPORITES MALLATUS
58	SCHEMATOPHORA SP
19	SENEGALINIUM DILWYNENSE
10	SPINIDINIUM SP1
11	SPINIDINIUM SP2
35	SPINIFERITES CF CRASSIPELLIS
20	SPINIFERITES RAMOSUS
80	STEREISPORITES (TRIPUNCTISPORIS) PUNCTATUS
81	STEREISPORITES ANTIQUISPORITES
82	STEREISPORITES REGIUM
21	SUBTILISPHAERA
44	SYSTEMATOPHORA PLACACANTHA
53	TECTATODINIUM SP
90	TRICOLPITES CONFESSUS
83	TRICOLPITES GILLII
84	TRICOLPITES LONGUS
99	TRICOLPITES PHILLIPSII
85	TRICOLPITES SABULOSUS
102	TRICOLPITES SP
91	TRICOLPITES WAIPARAENSIS
103	TRICOLPORITES
92	TRICOLPORITES LILLIEI
112	TRILETES TUBERCULIFORMIS
12	TRITHYRODINIUM EVITTII
32	TURBIOSPHAERA SP
22	VERYHACHINM