PALYNOLOGY OF WEAVER SQUID-1

BASS BASIN, AUSTRALIA

BY

ROGER MORGAN

for BRIDGE OIL

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442002

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CONTENTS PAGE

I SUMMARY

1820 m. (cutts)-1985 m. (cutts) : middle N. asperus Zone : middle to late Eocene : nearshore marine : immature

2030-45 m. (cutts) : lower N. asperus Zone : middle Eocene : marginally marine : mature

2110 m. (cutts)-2380 m. (cutts) : indeterminate : probably post-mature due to local heating

2440 m. (cutts)-2660 m. (cutts) : middle M. diversus Zone : early Eocene : apparently marginally marine : immature

2735-50 m. (cutts) : lower M. diversus Zone : early Eocene : non-marine : marginally mature

2845 m. (cutts)-2890 m. (cutts) : upper L. balmei Zone : Paleocene : non-marine : marginally mature

II INTRODUCTION

Following the drilling of Chat-1 by Bridge Oil in early 1986, some problems of correlation arose with an older well, Weaver Squid-1. Herman Huizinga arranged for Phil Lawry of Kimberley Oil to send 14 unwashed composite cuttings samples for analysis. The principal results were conveyed by telephone after initial rapid analysis. This report details the results following a more careful and thorough examination.

Palynomorph occurrence data are shown on Appendix I and form the basis for the assignment of the samples to five spore-pollen units of late Paleocene to late Eocene age. The zonation is that of Stover and Evans (1973) and Stover and Partridge (1973) set up in the Gippsland Basin and modified for the Bass Basin by Partridge (1973).

No formal dinoflagellate zonation has been published for the Gippsland or Bass Basins, although Harris (1985) has recently published some dinoflagellate zones for part of the Eocene of the St. Vincent and Otway Basins. Partridge (1976) published a table showing zone names in the Gippsland Basin but charts defining these zones were never published. Neither of these zonations are entirely relevant, but elements of them are discussed herein.

Maturity data was generated in the form of Spore Colour Index, and is plotted on Figure 1 Maturity Profile of Weaver Squid-1. The oil and gas generations windows on Figure 1 follow the general concensus 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%.

Geochemists, however, have not reached universal agreement on these values, and argue variations based on kerogen type, basin type and even basin history. The maturity interpretation is thus open to reinterpretation using the basic colour observations as raw data. However, the range of interpretation philosophies is not great, and would probably not move the oil window by more than 200 metres.

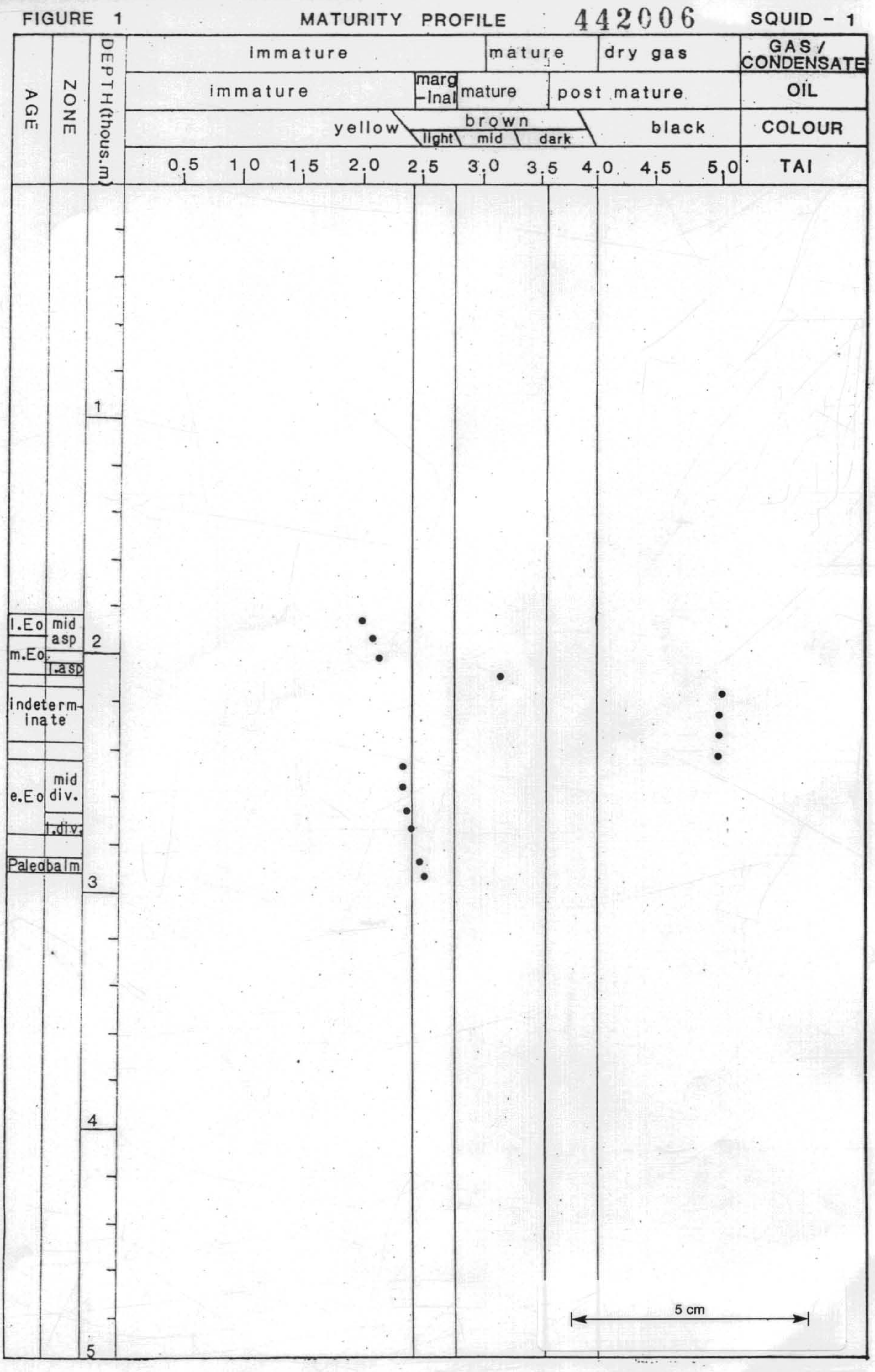
FIGURE 1
MATURITY PROFILE
442006
SQUID - 1
immature
mature
dry gas
GAS / CONDENSATE
immature
marg -inal
mature
post mature
OIL
yellow
brown
light
mid
dark
black
COLOUR
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
TAI
AGE
ZONE
DEPTH (thous. m)
1
2
3
4
5
l.Eo
mid asp
m.Eo
l.asp
indeterminate
e.Eo
mid div.
l.div.
Paleo
balm
5 cm

III PALYNOSTRATIGRAPHY

A. 1820 m. (cutts)-1985 m. (cutts) : middle N. asperus Zone

This interval is assigned to the middle to late Eocene middle Nothofagidites asperus Zone at the top on the youngest occurrences of Triorites magnificus, supported by those of Beaupreadites verrucosus, Proteacidites crassus, P. incurvatus, P. kopiensis, P. leightonii, Santalumidites cainozoicus, Triporopollenites ambiguus. The interval base is defined by the oldest occurrence of Triorites magnificus. Reworking of older taxa is minor and includes Myrtaceidites tenuis. As the base of the interval is taken on an oldest occurrence in cuttings, the interval base may be picked here slightly too low, due to caving.

Age significant dinoflagellates include Alisocysta ornata at 1970-85m (cuttings), confirming the middle N. asperus assignment. The presence of relatively common dinoflagellates, and the oldest occurrences of Phthanoperidinium comatum, (presumed caved at 2210-25 m. below) Areosphaeridium multicornatum (caved at 2530-45 m.) and Deflandrea phosphoritica are broad support for the assignment.

Nearshore marine environments are indicated by the presence of significant (5%) to common (20%) dinoflagellates showing moderate diversity (about 15 species). Large numbers of diverse pollen and spores and intermittently common cuticle suggest reasonable proximity to shore.

Pollen and spores are colourless to light yellow and are therefore immature for hydrocarbon generation.

B. 2030-45 m. (cutts) : lower N. asperus Zone

Assignment to the lower Nothofagidites asperus Zone of middle Eocene age is indicated at the top by the absence of younger indicators and at the base by the oldest occurrence of common Nothofagidites spp. including N. deminutus, N. falcatus and N. vansteenisii (although are intermittently caved below), and the absence of older indicators. The presence of Proteacidites rugulatus confirms the assignment. No age significant dinoflagellates were seen.

Marginally marine environments are indicated by the very scarce very low diversity dinoflagellates amongst dominant and diverse pollen and spores.

The spores and pollen are mostly mid brown indicating maturity for oil generation and marginal maturity for gas/condensate. A minority of grains show lighter colours back to pale yellow or colourless, and are presumed caved from higher in the well.

C. 2110 m. (cutts)-2380 m. (cutts) : indeterminate

These four samples are almost barren of palynomorphs. They contain abundant inertinite fragments and the rare spores and pollen show a wide range of colours from dark brown (fully mature) to colourless (immature). Considering their scarcity, they are probably all caved from above, with the "in situ" assemblage destroyed by very high maturity. Vulcanicity during deposition, or subsequent igneous intrusion, are likely causes.

D. 2440 m. (cutts)-2660 m. (cutts) : middle M. diversus Zone

Assignment to the middle Malvacipollis diversus is indicated at the top by the absence of younger indicators and confirmed by the youngest occurrence of Tricolpites gillii at 2645-60 m. (cutts). At the base, the oldest occurrences of Proteacidites clarus and P. ornatus occur. The oldest occurrences of Polycolpites esobalteus and Proteacidites leightonii at 2530-45 ft. (cuttings) confirm the interval base. Obvious caving at 2530-45m (cuttings) includes Proteacidites asperopolus and Nothofagidites deminutus. As the interval base is taken on oldest occurrences in cuttings, it may be picked slightly too low, if significant caving is present.

Environments are probably marginally marine, as rare dinoflagellates were seen in all samples. However, none were age diagnostic of the early Eocene, and some were obviously caved (Areosphaeridium multicornutum at 2530-45 m.). If all the dinoflagellates are caved, environments could be non-marine. Pollen and spores are dominant and diverse.

Yellow/brown spore colours indicate immaturity for any hydrocarbon generation, in contrast to the higher maturities seen above.

E. 2735-50 m. (cutts) : lower M. diversus Zone

Assignment to the early Eocene lower Malvacipollis diversus Zone is indicated at the top by the youngest occurrence of Cyathidites gigantis, and confirmed by the oldest occurrences discussed above. The interval base is defined by the oldest occurrences of Intratriporopollenites notabilis, Malvacipollis diversus and Cupaneidites orthoteichus and the absence of older indicators. Obvious caving into this sample includes Anacolosidites acutullus and Periporopollenites vesicus. A single specimen of probable Lygistepollenites balmei is considered reworking, although it suggests assignment of the sample to the underlying zone.

Non-marine environments are indicated by the common and diverse pollen and spores and absence of dinoflagellates.

Yellow/brown to light brown spore colours indicate marginal maturity for generation of oil, and immaturity for gas/condensate.

F. 2845 m. (cutts)-2890 m. (cutts) : upper L. balmei Zone

Assignment to the upper Lygistepollenites balmei Zone of late Paleocene age is indicated at the top by the youngest occurrences of Gambierina rudata and Lygistepollenites balmei, and the oldest occurrences discussed above. The base is defined by the oldest occurrences of Proteacidites grandis and Cyathidites gigantis. Rare specimens of Tricolpites confessus occur in both samples suggesting penetration of the Maastrichtian T. longus Zone, but are now considered reworked in view of the consistent occurrence of L. balmei. If the interval was as old as T. longus, then P. grandis and C. gigantis would be considered caved. Sidewall cores might resolve the uncertainty.

Non-marine environments are suggested by the common and diverse pollen and spores and absence of dinoflagellates.

Yellow to light brown spore colours indicate marginal maturity for generation of oil and immaturity for gas condensate.

IV CONCLUSIONS

A. The studied section comprises a probably continuous sequence spanning the late Paleocene to late Eocene (represented by the upper L. balmei to middle N. asperus Zones). Some boundaries may be picked slightly too low, as the work is entirely based on cuttings. Although the late early Eocene to early Middle Eocene interval (upper M. diversus and P. asperopolus Zones) was not identified, it is likely to be present but post-mature within the indeterminate interval 2100-2400 m.. Intrusive or extrusive volcanics are a likely cause for the post-mature interval.

B. The section generally is not mature for oil generation (with the exception of the post-mature and partly mature interval discussed above), and this may be the chief reason for the failure of Squid-1. Any hydrocarbons that might have been reservoired would have needed long migration pathways. In this area, older and deeper section (such as the Early Cretaceous) is likely to be mature and therefore a better target.

C. Correlation with Chat-1 is straightforward although obviously Squid-1 did not penetrate section as old as the T.D. of Chat-1. In particular, the top L. balmei correlation is firmly based, as the boundary is easily and reliably recognised in these two wells and throughout the basin.

V REFERENCES

Harris, W.K. (1985) Middle to Late Eocene Depositional Cycles and Dinoflagellate Zones in Southern Australia Spec. Publ., S. Aust. Dept. Mines and Energy 5 : 133-144

Partridge, A.D. (1973) Revision of the Spore-pollen Zonation in the Bass Basin Esso unpubl. palaeo. rept. 1973/74

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APPENDIX I

PALYNOMORPH RANGE DATA

- SPORES AND POLLEN
- MICROPLANKTON

SQUID #1 S/P

442014

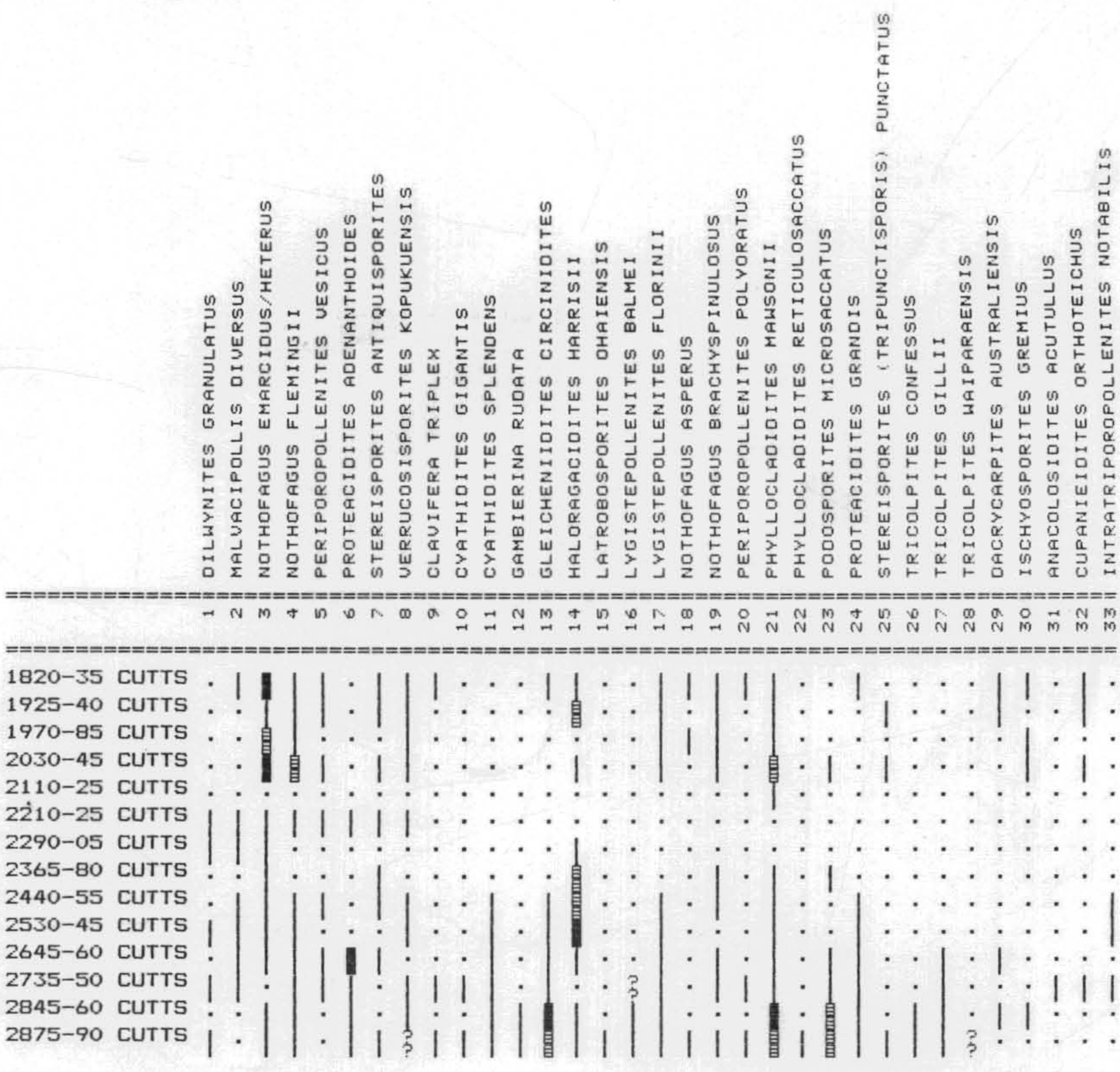
DESCRIPTION:

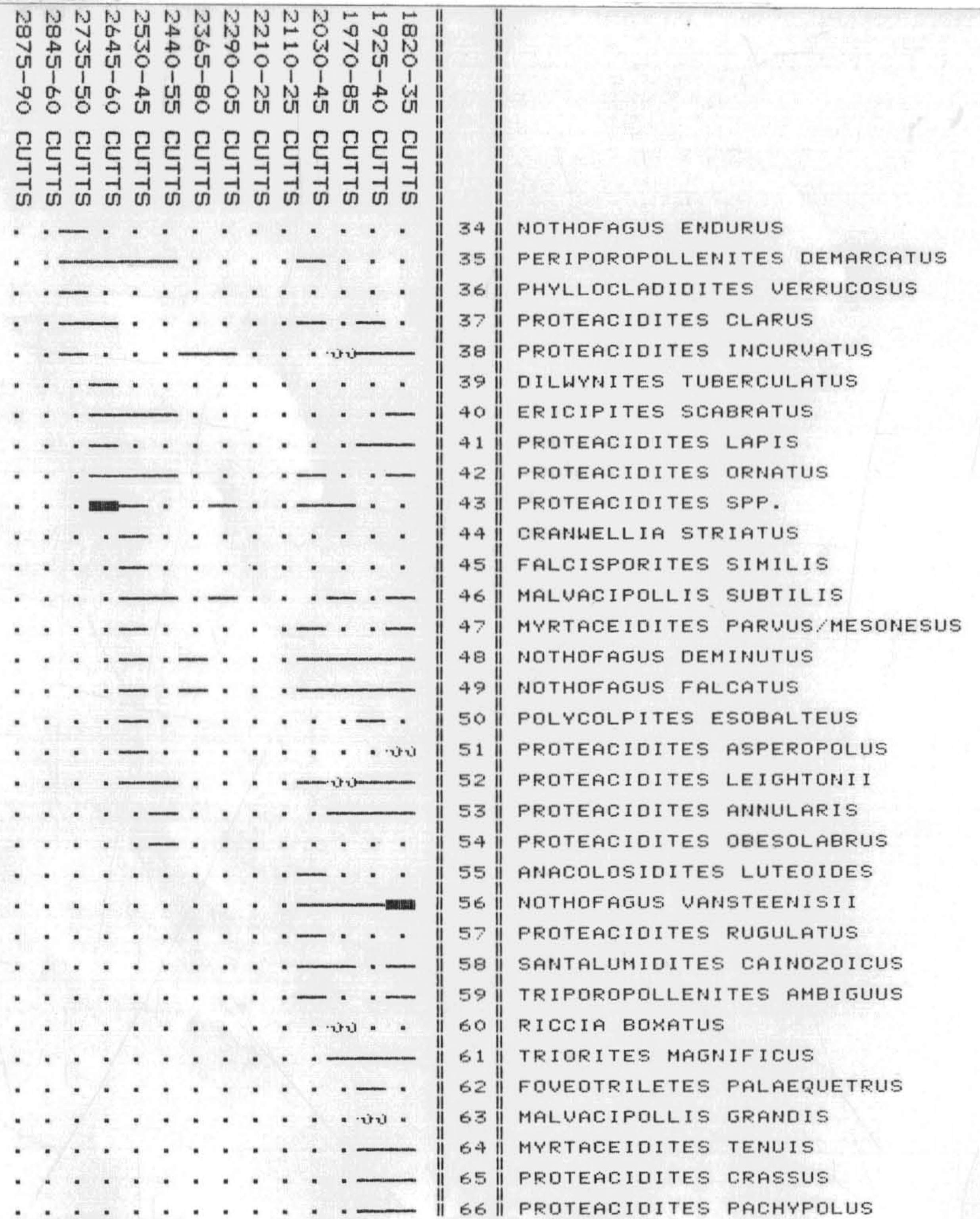
ALL SAMPLE DEPTHS ARE IN METRES.

CHECKLIST OF GRAPHIC ABUNDANCE BY LOWEST APPEARANCE

= Abundant
= Common
= Few
= Rare
= Very Rare

? = Questionably Present
. = Not Present





1820-35 CUTTS
1925-40 CUTTS
1970-85 CUTTS
2030-45 CUTTS
2110-25 CUTTS
2210-25 CUTTS
2290-05 CUTTS
2365-80 CUTTS
2440-55 CUTTS
2530-45 CUTTS
2645-60 CUTTS
2735-50 CUTTS
2845-60 CUTTS
2875-90 CUTTS
34 NOTHOFAGUS ENDURUS
35 PERIPOROPOLLENITES DEMARCATUS
36 PHYLLOCLADIDITES VERRUCOSUS
37 PROTEACIDITES CLARUS
38 PROTEACIDITES INCURVATUS
39 DILWYNITES TUBERCULATUS
40 ERICIPITES SCABRATUS
41 PROTEACIDITES LAPIS
42 PROTEACIDITES ORNATUS
43 PROTEACIDITES SPP.
44 CRANWELLIA STRIATUS
45 FALCISPORITES SIMILIS
46 MALVACIPOLLIS SUBTILIS
47 MYRTACEIDITES PARVUS/MESONESUS
48 NOTHOFAGUS DEMINUTUS
49 NOTHOFAGUS FALCATUS
50 POLYCOLPITES ESOBALTEUS
51 PROTEACIDITES ASPEROPOLUS
52 PROTEACIDITES LEIGHTONII
53 PROTEACIDITES ANNULARIS
54 PROTEACIDITES OBESOLABRUS
55 ANACOLOSIDITES LUTEOIDES
56 NOTHOFAGUS VANSTEENISII
57 PROTEACIDITES RUGULATUS
58 SANTALUMIDITES CAINOZOICUS
59 TRIPOROPOLLENITES AMBIGUUS
60 RICCIA BOXATUS
61 TRIORITES MAGNIFICUS
62 FOVEOTRILETES PALAEQUETRUS
63 MALVACIPOLLIS GRANDIS
64 MYRTACEIDITES TENUIS
65 PROTEACIDITES CRASSUS
66 PROTEACIDITES PACHYPOLUS

442015

	67 BEAUPREAIDITES VERRUCOSUS	68 LATROBOSPORITES CRASSUS	69 MYRTACEIDITES VERRUCOSUS	70 PROTEACIDITES KOPIENSIS	71 PROTEACIDITES RECTOMARGINIS
1820-35 CUTTS	|	|	|	|	|
1925-40 CUTTS	.	.	.	.	.
1970-85 CUTTS	.	.	.	.	.
2030-45 CUTTS	.	.	.	.	.
2110-25 CUTTS	.	.	.	.	.
2210-25 CUTTS	.	.	.	.	.
2290-05 CUTTS	.	.	.	.	.
2365-80 CUTTS	.	.	.	.	.
2440-55 CUTTS	.	.	.	.	.
2530-45 CUTTS	.	.	.	.	.
2645-60 CUTTS	.	.	.	.	.
2735-50 CUTTS	.	.	.	.	.
2845-60 CUTTS	.	.	.	.	.
2875-90 CUTTS	.	.	.	.	.

SPECIES LOCATION INDEX

Index numbers are the columns in which species appear.

INDEX NUMBER	SPECIES
31	ANACOLOSIDITES ACUTULLUS
55	ANACOLOSIDITES LUTEOIDES
67	BEAUPREAIDITES VERRUCOSUS
9	CLAVIFERA TRIPLEX
44	CRANWELLIA STRIATUS
32	CUPANIEIDITES ORTHOTEICHUS
10	CYATHIDITES GIGANTIS
11	CYATHIDITES SPLENDENS
29	DACRYCARPITES AUSTRALIENSIS
1	DILWYNITES GRANULATUS
39	DILWYNITES TUBERCULATUS
40	ERICIPITES SCABRATUS
45	FALCISPORITES SIMILIS
62	FOVEOTRILETES PALAEQUETRUS
12	GAMBIERINA RUDATA
13	GLEICHENIIDITES CIRCINIDITES
14	HALORAGACIDITES HARRISII
33	INTRATRIPOROPOLLENITES NOTABILIS
30	ISCHYOSPORITES GREMIUS
68	LATROBOSPORITES CRASSUS
15	LATROBOSPORITES OHAIENSIS
16	LYGISTEPOLLENITES BALMEI
17	LYGISTEPOLLENITES FLORINII
2	MALVACIPOLLIS DIVERSUS
63	MALVACIPOLLIS GRANDIS
46	MALVACIPOLLIS SUBTILIS
47	MYRTACEIDITES PARVUS/MESONESUS
64	MYRTACEIDITES TENUIS
69	MYRTACEIDITES VERRUCOSUS
18	NOTHOFAGUS ASPERUS
19	NOTHOFAGUS BRACHYSPINULOSUS

442018

2	MALVACIPOLLIS DIVERSUS
63	MALVACIPOLLIS GRANDIS
46	MALVACIPOLLIS SUBTILIS
47	MYRTACEIDITES PARVUS/MESONESUS
64	MYRTACEIDITES TENUIS
69	MYRTACEIDITES VERRUCOSUS
18	NOTHOFAGUS ASPERUS
19	NOTHOFAGUS BRACHYSPINULOSUS
48	NOTHOFAGUS DEMINUTUS
3	NOTHOFAGUS EMARCIDUS/HETERUS
34	NOTHOFAGUS ENDURUS
49	NOTHOFAGUS FALCATUS
4	NOTHOFAGUS FLEMINGII
56	NOTHOFAGUS VANSTEENISII
35	PERIPOROPOLLENITES DEMARCATUS
20	PERIPOROPOLLENITES POLYORATUS
5	PERIPOROPOLLENITES VESICUS
21	PHYLLOCLADIDITES MAWSONII
22	PHYLLOCLADIDITES RETICULOSACCATUS
36	PHYLLOCLADIDITES VERRUCOSUS
23	PODOSPORITES MICROSACCATUS
50	POLYCOLPITES ESOBALTEUS
6	PROTEACIDITES ADENANTHOIDES
53	PROTEACIDITES ANNULARIS
51	PROTEACIDITES ASPEROPOLUS
37	PROTEACIDITES CLARUS
65	PROTEACIDITES CRASSUS
24	PROTEACIDITES GRANDIS
38	PROTEACIDITES INCURVATUS
70	PROTEACIDITES KOPIENSIS
41	PROTEACIDITES LAPIS
52	PROTEACIDITES LEIGHTONII
54	PROTEACIDITES OBESOLABRUS
42	PROTEACIDITES ORNATUS
66	PROTEACIDITES PACHYPOLUS
71	PROTEACIDITES RECTOMARGINIS
57	PROTEACIDITES RUGULATUS
43	PROTEACIDITES SPP.
60	RICCIA BOXATUS
58	SANTALUMIDITES CAINOZOICUS
25	STEREISPORITES (TRIPUNCTISPORIS) PUNCTATUS
7	STEREISPORITES ANTIQUISPORITES
26	TRICOLPITES CONFESSUS
27	TRICOLPITES GILLII
28	TRICOLPITES WAIPARAENSIS
61	TRIORITES MAGNIFICUS
59	TRIPOROPOLLENITES AMBIGUUS
8	VERRUCOSISPORITES KOPUKUENSIS

SQUID #1 DINOS

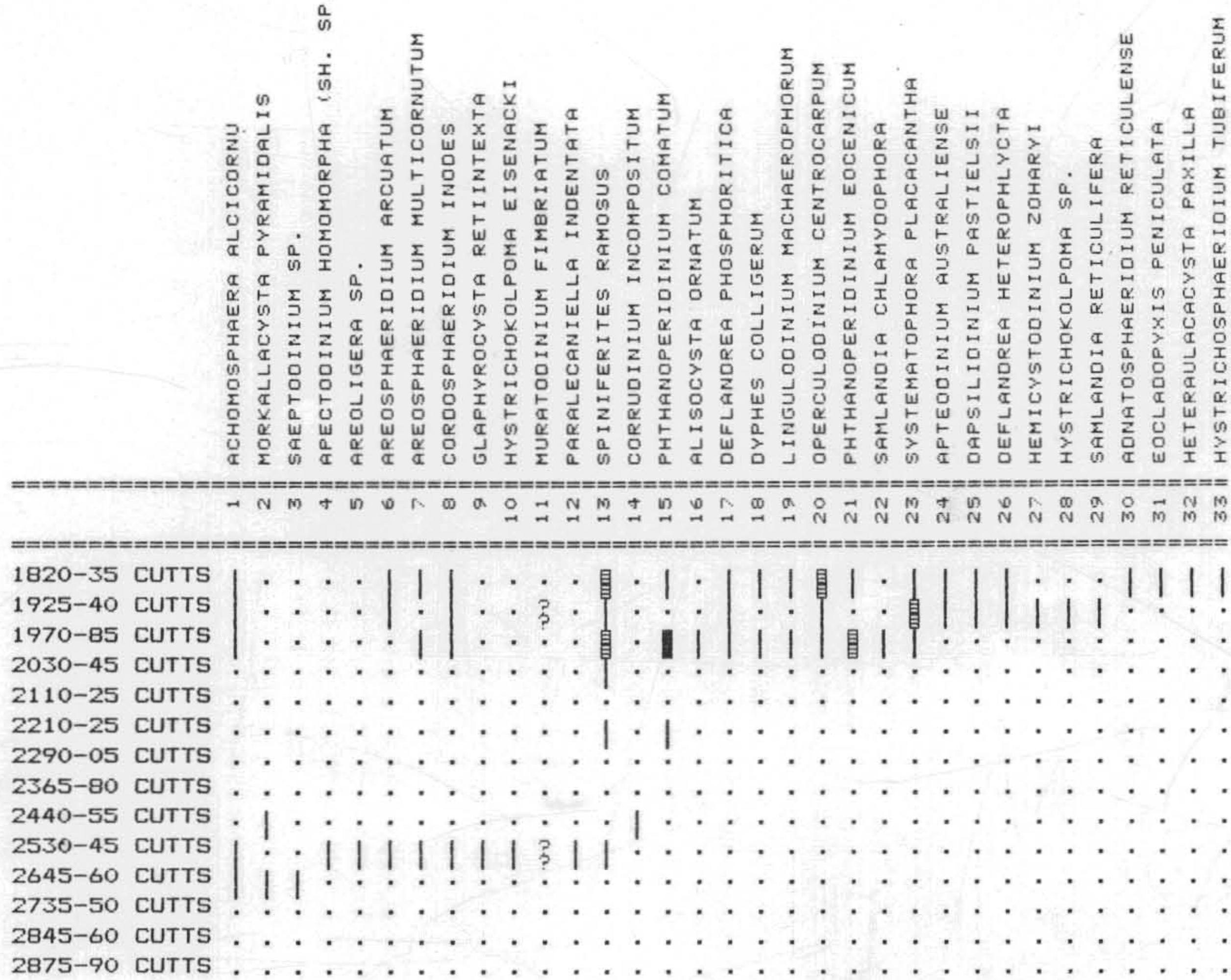
442019

DESCRIPTION:

ALL SAMPLE DEPTHS ARE IN METRES.

CHECKLIST OF GRAPHIC ABUNDANCE BY LOWEST APPEARANCE

= Abundant
= Common
= Few
= Rare
= Very Rare
? = Questionably Present
. = Not Present



	34 IMPAGIDINIUM SP.	35 THALASSIPHORA PELIGICA
1820-35 CUTTS	|	|
1925-40 CUTTS	.	.
1970-85 CUTTS	.	.
2030-45 CUTTS	.	.
2110-25 CUTTS	.	.
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2440-55 CUTTS	.	.
2530-45 CUTTS	.	.
2645-60 CUTTS	.	.
2735-50 CUTTS	.	.
2845-60 CUTTS	.	.
2875-90 CUTTS	.	.

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Index numbers are the columns in which species appear.

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30	ADNATOSPHAERIDIUM RETICULENSE
16	ALISOCYSTA ORNATUM
4	APECTODINIUM HOMOMORPHA (SH. SP.)
24	APTEODINIUM AUSTRALIENSE
5	AREOLIGERA SP.
6	AREOSPHAERIDIUM ARCUATUM
7	AREOSPHAERIDIUM MULTICORNUTUM
8	CORDOSPHAERIDIUM INODES
14	CORRUDINIUM INCOMPOSITUM
25	DAPSILIDINIUM PASTIELSII
26	DEFLANDREA HETEROPHLYCTA
17	DEFLANDREA PHOSPHORITICA
18	DYPHES COLLIGERUM
31	EOCLADOPYXIS PENICULATA
9	GLAPHYROCYSTA RETIINTEXTA
27	HEMICYSTODINIUM ZOHARYI
32	HETERAULACACYSTA PAXILLA
10	HYSTRICHOKOLPOMA EISENACKI
28	HYSTRICHOKOLPOMA SP.
33	HYSTRICHOSPHAERIDIUM TUBIFERUM
34	IMPAGIDINIUM SP.
19	LINGULODINIUM MACHAEROPHORUM
2	MORKALLACYSTA PYRAMIDALIS
11	MURATODINIUM FIMBRIATUM
20	OPERCULODINIUM CENTROCARPUM
12	PARALECANIELLA INDENTATA
15	PHTHANOPERIDINIUM COMATUM
21	PHTHANOPERIDINIUM EOCENICUM
3	SAEPTODINIUM SP.
22	SAMLANDIA CHLAMYDOPHORA
29	SAMLANDIA RETICULIFERA
13	SPINIFERITES RAMOSUS
23	SYSTEMATOPHORA PLACACANTHA
35	THALASSIPHORA PELIGICA