PETROFINA EXPLORATION AUSTRALIA S. A.

INTERPRETATIVE

FINA

AYU - 1

WELL COMPLETION REPORT

VOLUME - 2

<u>PETROFINA EXPLORATION AUSTRALIA S.A.</u>

WELL COMPLETION REPORT AYU-1

VOLUME II

INTERPRETATIVE DATA

GL/90/043
AH/JMQ/PhL/NG/kl
6 June 1990

WELL COMPLETION REPORT AYU-1

INTERPRETATIVE DATA

CONTENTS

LIST OF APPENDICES

LIST OF TABLES

GEOLOGICAL DISCUSSION

1. INTRODUCTION

Exploration well Ayu-1 is located in Permit VIC/P20 in the Gippsland Basin offshore Victoria, south-eastern Australia. This is the third well of a four well drilling commitment in the Permit to be fulfilled before 23 July 1990. The Joint Venture partners for the operation are:

Petrofina Exploration Australia S.A.	30%	(Operator)
Japex Gippsland Limited	30%	
Overseas Petroleum and Investment Corporation	30%	
Bridge Oil Limited	10%	

The objective of Ayu-1 was to evaluate the hydrocarbon potential of Palaeocene sandstones in a combination stratigraphic and structural trap. Ayu-1 was spudded on 30 January 1990 using the semi-submersible rig Zapata Arctic. It reached a total depth of 2750m (drillers) on 13 February 1990. No hydrocarbon zones were encountered in the target reservoirs and Ayu-1 was plugged and abandoned on 19 February 1990 as a dry well.

2. STRATIGRAPHY

Formations and seismic horizons intersected during the drilling of Ayu-1 are detailed in Table 1 and Appendix 1.

Ayu-1 penetrated 2378m of limestone, marls, calcareous claystones and siltstones of the Pliocene to Oligocene Seaspray Group which directly overlies the Latrobe Group. The base of this group has been dated by micropalaeontology to be of Late Oligocene age (Appendix 7).

The Top Latrobe unconformity was intersected at 2490m. A total of 260m of the Latrobe Group was drilled to TD at 2750m. The youngest Latrobe Group sediments are indicated by palynology (Appendix 4) to belong to the Lower L.balmei biostratigraphic zone (Palaeocene) which persists to 2705m, below which the Upper T.longus zone is present down to TD.

Palynological and micropalaeontological data indicate that the Gurnard Formation, originally predicted between 2468m and 2473m, is absent at Ayu-1, pinching out further to the east of the wellsite than originally predicted. The Palaeocene section of the Latrobe Group (L.balmei) is characterized by a basal pro-delta shale overlain by three upward coarsening regressive sandstone units with excellent reservoir characteristics. These units are interpreted as having developed within a prograding deltaic and beach environment with the lowest cycle being the most distal (Appendix 3).

The 45m thick Maastrichtian (upper T.longus) interval drilled at Ayu-1 (2705.5-2750m [TD]) consists of non-marine to marginally marine siltstones, sandstones and coals.

3. VELOCITY MODEL AND DEPTH CONVERSION

As part of a regional mapping programme for VIC/P20, the key horizons were tied to all wells in the permit, and interactively interpreted using a LANDMARK Workstation. Following interpretation of the Ayu Prospect area, the horizon and fault data for the following levels were exported to a MicroVAX system for gridding, depth conversion and contouring with the ZYCOR mapping package:

Base Lakes Entrance Formation
Top Palaeocene Unit I (Intra Palaeocene)
Near Top Maastrichtian Sequence Boundary

Depth conversion of these data specifically addressed the interval velocity heterogeneities associated with channel units within the basal Gippsland Limestone sequence. The sensitivity of the Ayu closure to velocities was evaluated by using functions of the form $\Delta t(\Delta z) = a+b(\Delta z)$ regressed from the T-Z data of VIC/P20 and available nearby wells, and by applying the SIVA technique to the CDP gathers of GF88 survey 2-D lines over the Ayu Prospect.

After comparison of these methods, the well-based technique was used to prepare the maps for the well proposal, and the SIVA results were used to support the choice of drilling location.

4. STRUCTURE

Ayu-1 was drilled to test the hydrocarbon potential of a combination stratigraphic (subcrop) and structural closure within the Palaeocene unit updip from Hermes-1. The trap model envisaged an intra-Palaeocene marine shale subcropping the Top Latrobe unconformity as forming the western flank of the closure, with seal on the eastern flank afforded by a thinly developed Gurnard Formation directly above the Latrobe unconformity on the eastern flank of the structure (Figs. 1 and 3).

The well was prognosed 132m downdip to the east of well Kingfish-6 (eastern limit of Kingfish Field) and 47m updip of Hermes-1 which was considered to have tested the very eastern limit of the Ayu closure (Fig. 3). Vertical closure was a probable 52m with a maximum potential closure of 66m.

5. RESERVOIR

Upward coarsening shallow marine sandstones with excellent reservoir characteristics were prognosed within the Palaeocene interval. Up to 200m of gross sandstone reservoirs were envisaged by the model, with a net to gross ratio of 100% over the reservoir section in closure.

6. SEAL

The seal model at Ayu-1 called for intra-Palaeocene offshore marine shales identified in the Kingfish Field and Roundhead-1 to seal the western flank of the structure; while very argillaceous glauconitic siltstones of the Gurnard Formation were expected to seal the eastern flank.

7. HYDROCARBON CHARGE

The Ayu structure was expected to share the same oil-source kitchen as the nearby Kingfish Field.

8. WELL RESULTS

Ayu-1 well results encountered the excellent Palaeocene sandstone reservoirs below the Top Latrobe as prognosed, but showed no indications of hydrocarbons (no mud gas and no fluorescence or cut). Subsequent log evaluation confirmed that these sandstones were water wet.

The VSP run in Ayu-1 confirmed that time picks for all prognosed horizons were correct. Depths prognosed for Top Lakes Entrance Formation, Base Lakes Entrance Formation and Near Top Maastrichtian were respectively 4.5m deeper (-0.3%), 22m higher (+0.9%) and 27m higher (+1.0%) than determined from electric logs following drilling.

The 27m discrepancy at the Top Maastrichtian stems more from a revision of the horizon in Hermes-1 than from a depth conversion error. The Top Latrobe, equivalent to the Top Palaeocene (Primary Objective), was found 17m deeper than prognosed, showing the crest of the Ayu structure to lie only 30m higher than at Hermes-1.

Indications therefore are that the velocities modelled by the well functions correctly compensated for the known velocity anomalies within the Gippsland Limestone.

A drilling location was selected on the crest of the closure in order to minimise any structural risk arising from inaccuracies in depth conversion. Accordingly, the well was located to the east of the mapped subcrop limit of the basal Palaeocene shale unit and did not therefore confirm the presence of a seal on the western flank of the closure (Fig. 3). The 10m of Gurnard Formation prognosed to seal the eastern flank of the structure was not found at the well. Instead, glauconitic sandy to silty claystones at the base of the Lakes Entrance Formation directly overlie the Palaeocene Sandstones.

Having intersected the entire Palaeocene interval, the well reached TD in a non-marine sequence of the Upper Maastrichtian where no hydrocarbon shows were recorded. Ayu-1 was then plugged and abandoned as a dry well.

9. SUMMARY AND CONCLUSIONS

(a) The VSP results of the well indicate the velocity and depth conversion model to be valid, confirming the presence of the Ayu closure. The reduction in structural relief by 17m greatly reduces the size of the closure as originally estimated.

(b) Palynological age dating (Appendix 4) confirms that the entire Palaeocene section was tested by Ayu-1, and that the well reached TD in the Upper T.longus biostratigraphic zone of the Upper Maastrichtian.

(c) Possible reasons for lack of any hydrocarbons within the Palaeocene sandstones are (see Fig. 2):

(i) Lack of lateral seal integrity in the intra-Palaeocene shales on the western flank of the structure.

(ii) Channelling at the crest of the structure during Top Latrobe times, affecting seal integrity along the subcrop trace.

(iii) Poor seal capability of the sandy glauconitic shales at the base of the Lakes Entrance Formation, which blanket the eastern flank of the structure.

(iv) Lack of hydrocarbon charging of the structure.

Seismic evidence indicates that possibilities (i) and/or (ii), relating to seal integrity, provide the most likely explanation for the lack of hydrocarbons at Ayu-1.

WELL DATA SUMMARY: AYU-1

Well:		Ayu-1
Permit:		VIC/P20, Gippsland Basin, Australia
Operator:		Petrofina Exploration Australia S.A.
Partners:		Japex Gippsland Limited
		Overseas Petroleum and Investment Corporation
		Bridge Oil Limited
Latitude:		38°36'35.02" S
Longitude:		148°17'02.66" E
UTM:	X =	611,800.7 E
	Y =	5,725,734.3 N
KBE:		28m
WD:		84m
Type of Rig:		Semi-Submersible
Name:		Zapata Arctic
Contractor:		Zapata Offshore Company
Objectives:		Upward coarsening upper shoreface Palaeocene Sandstones.
Spud Date:		30 January 1990
Date Reached TD:		13 February 1990
Date Plugged and Abandoned:		19 February 1990
Drilled Depth:		2750m (drillers)
		2740.5m (loggers)
Well Status:		Plugged and abandoned. Dry well.

TABLE 1

Formation and Seismic Tops, Ayu-1

Horizon	Depth (RKB)m	Depth (SS)m	TWT sec
Sea Floor/ Gippsland Limestone	112	(-84)	0.112
Lakes Entrance Fm	1740	(-1712)	1.221
Intra Lakes Entrance	2140	(-2112)	1.482
Palaeocene/Latrobe	2490	(-2462)	1.714
Maastrichtian/UK5	2705.5	(-2677.5)	1.830
Total Depth	2750	(-2722)	2.064

PE905414

This is an enclosure indicator page.
The enclosure PE905414 is enclosed within the container PE902102 at this location in this document.

The enclosure PE905414 has the following characteristics:

ITEM_BARCODE =	PE905414
CONTAINER_BARCODE =	PE902102
NAME =	Ayu 1 Geological model prior to drilling (fig 1)
BASIN =	GIPPSLAND
PERMIT =	VIC/P20
TYPE =	WELL
SUBTYPE =	DIAGRAM
DESCRIPTION =	Ayu 1 Geological Model (Prior to Drilling) (figure 1 from Volume 2)
REMARKS =	
DATE_CREATED =	
DATE_RECEIVED =	2/07/90
W_NO =	W1020
WELL_NAME =	Ayu-1
CONTRACTOR =	Petrofina Exploration Australia S.A
CLIENT_OP_CO =	Petrofina Exploration Australia S.A

(Inserted by DNRE - Vic Govt Mines Dept)

PE905415

This is an enclosure indicator page.
The enclosure PE905415 is enclosed within the container PE902102 at this location in this document.

The enclosure PE905415 has the following characteristics:

ITEM_BARCODE =	PE905415
CONTAINER_BARCODE =	PE902102
NAME =	Ayu 1 Possible reasons for lack of HC in Ayu 1
BASIN =	GIPPSLAND
PERMIT =	VIC/P20
TYPE =	WELL
SUBTYPE =	DIAGRAM
DESCRIPTION =	Ayu 1 Possible reasons for lack of hydrocarbons in Ayu Structure (figure 2, volume 2 WCR)
REMARKS =	
DATE_CREATED =	
DATE_RECEIVED =	2/07/90
W_NO =	W1020
WELL_NAME =	Ayu-1
CONTRACTOR =	Petrofina Exploration Australia S.A
CLIENT_OP_CO =	Petrofina Exploration Australia S.A

(Inserted by DNRE - Vic Govt Mines Dept)

AYU - A

TOP PALAEOCENE SANDSTONE DEPTH MAP (mss)

- (PRIMARY OBJECTIVE)

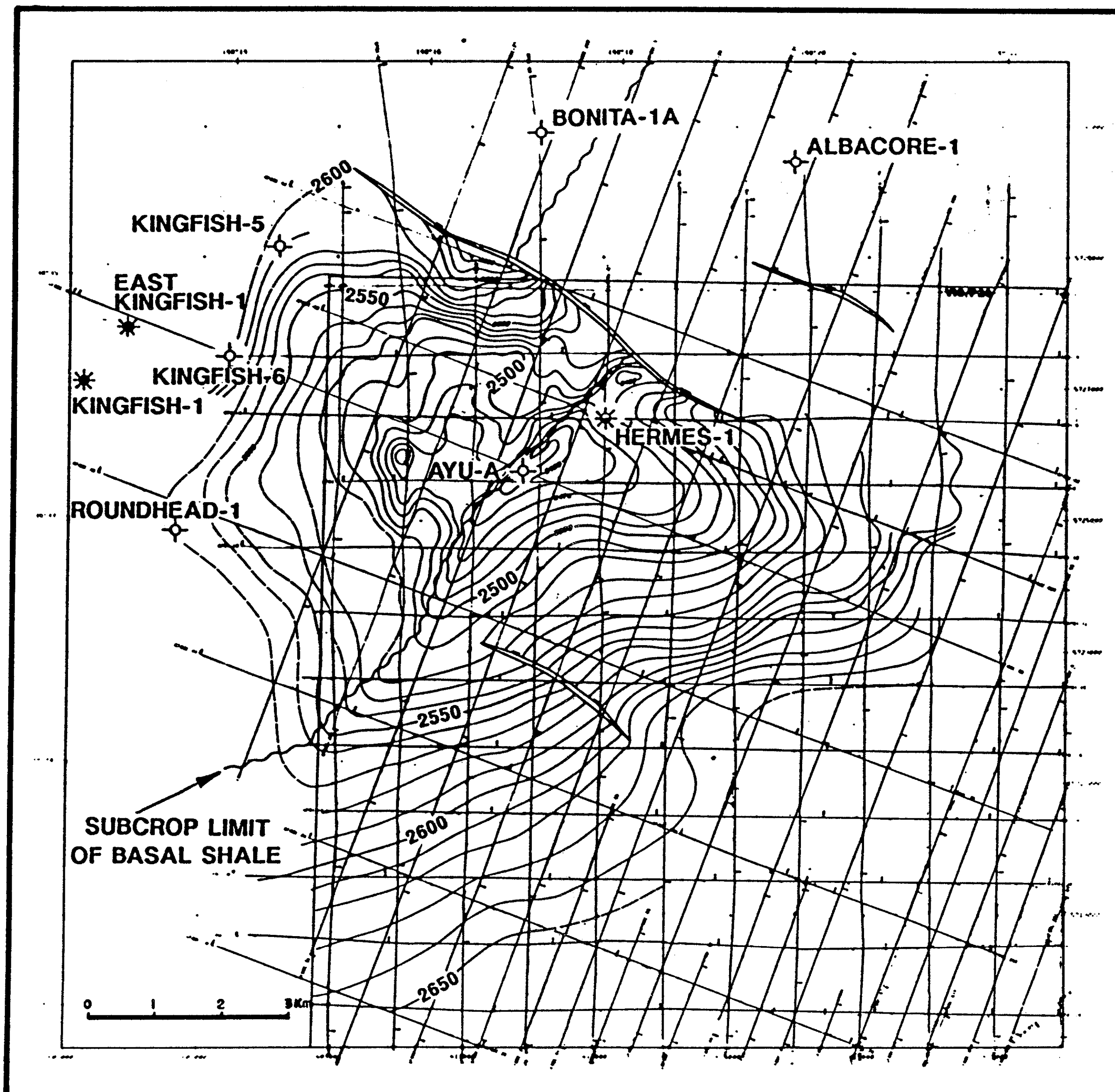


FIGURE 3

APPENDIX 1

WELL COMPLETION REPORT

AYU-1

INTERPRETATIVE DATA

APPENDIX 1

STRATIGRAPHY

PE902105

This is an enclosure indicator page.
The enclosure PE902105 is enclosed within the container PE902102 at this location in this document.

The enclosure PE902105 has the following characteristics:

ITEM_BARCODE =	PE902105
CONTAINER_BARCODE =	PE902102
NAME =	Stratigraphy Well results Ayu 1
BASIN =	GIPPSLAND
PERMIT =	
TYPE =	WELL
SUBTYPE =	DIAGRAM
DESCRIPTION =	Stratigraphy Well results Ayu 1
REMARKS =	
DATE_CREATED =	28/02/1990
DATE_RECEIVED =	02/07/1990
W_NO =	W1020
WELL_NAME =	Ayu-1
CONTRACTOR =	Petrofina exploration
CLIENT_OP_CO =	Petrofina exploration

(Inserted by DNRE - Vic Govt Mines Dept)

PE902103

This is an enclosure indicator page.
The enclosure PE902103 is enclosed within the container PE902102 at this location in this document.

The enclosure PE902103 has the following characteristics:

ITEM_BARCODE = PE902103
CONTAINER_BARCODE = PE902102
NAME = Stratigraphy & Time Curve
BASIN = GIPPSLAND
PERMIT =
TYPE = WELL
SUBTYPE = VELOCITY_CHART
DESCRIPTION = Stratigraphy & Time Curve
REMARKS =
DATE_CREATED = 28/02/1990
DATE_RECEIVED = 02/07/1990
W_NO = W1020
WELL_NAME = Ayu-1
CONTRACTOR = Petrofina exploration
CLIENT_OP_CO = Petrofina exploration

(Inserted by DNRE - Vic Govt Mines Dept)

PE902104

This is an enclosure indicator page.
The enclosure PE902104 is enclosed within the container PE902102 at this location in this document.

The enclosure PE902104 has the following characteristics:

ITEM_BARCODE = PE902104
CONTAINER_BARCODE = PE902102
NAME = Stratigraphy & Drilling time depth curve
BASIN = GIPPSLAND
PERMIT =
TYPE = WELL
SUBTYPE = VELOCITY_CHART
DESCRIPTION = Stratigraphy & Drilling time depth curve
REMARKS =
DATE_CREATED = 31/03/1990
DATE_RECEIVED = 02/07/1990
W_NO = W1020
WELL_NAME = Ayu-1
CONTRACTOR = Petrofina exploration
CLIENT_OP_CO = Petrofina exploration

(Inserted by DNRE - Vic Govt Mines Dept)

APPENDIX 2

APPENDIX 2

APPENDIX 1

LOG ANALYSIS PARAMETERS

APPENDIX 1

```
*****************************************************************
             LISTING OF ENVIRON PARAMETERS

ZONE         PALEO           WELL        AYU-1

*****************************************************************

TOP        2490.0000      (METRES) TOP OF INTERVAL
BASE       2635.0000      (METRES) BOTTOM OF INTERVAL

*****************************************************************
*********************     FLUID VALUES     ********************
*****************************************************************

RHOFR     1.00          (KG/M3 OR GR/CC)RECORDED FLUID DENSITY
SALFM    40000.         (PPM) FORMATION SALINITY (NACL)
SALMD    22000.         (PPM) MUD SALINITY (NACL)
RMM      0.2500         (OHM-M) RM
                        IF USING AN OIL BASED MUD SET TO > 100
RMMT        88.         ( F ) MEASURED TEMPERATURE FOR RM
RMFM     0.2220         (OHM-M) RMF
RMFMT       75.         ( F ) MEASURED TEMPERATURE FOR RMF
RMCM     0.3080         (OHM-M) RMC
RMCMT       70.         ( F ) MEASURED TEMPERATURE FOR RMC

*****************************************************************
****************     HOLE AND MUD VALUES     ****************
*****************************************************************

MW          9.35        (LBS/GAL) MUD WT
                         ENTER 0 MW FOR AIR FILLED HOLE
BITSIZ   12.250         (INCHES) BIT SIZE
AMST       50.0         ( F ) ANNUAL MEAN SURFACE TEMP
BHT       194.0         ( F ) BOTTOM HOLE TEMPERATURE
TD         2740.         (METRES) TOTAL DEPTH OF BOREHOLE
RSTAND    1.500         ( INCHES ) STANDOFF SETTING ON INDUCTION

*****************************************************************
*******************     LIMITING VALUES     ******************
*****************************************************************

RHOMIN    1.25          (KG/M3 OR GR/CC) MIN. VALID BULK DENSITY
DLTMIN     40.          (USEC/M OR USEC/FT) MIN. VALID SONIC ITT
DLTMAX    190.          (USEC/M OR USEC/FT) MAX. VALID SONIC ITT
PHNMAX     70.          (PERCENT) MAXIMUM VALID NEUTRON POROSITY
RUGMAX    6.00          (INCHES) MAX. RUGOSITY TO ACCEPT NEUTRON
STOMAX    3.00          (INCHES) MAX. NEUT. STANDOFF
STOMIN    0.00          (INCHES) MIN. NEUT. STANDOFF TO CORRECT
                        (SET TO STOMAX TO BYPASS STANDOFF LOGIC)
DROLIM    0.20          (KG/M3 OR GR/CC) MAXIMUM DENSITY CORRECTON
                           TO ACCEPT (+ OR -)
```

```
*****************************************************************
********   SWITCHES AND TOOL DESCRIPTIONS   *******************
*****************************************************************

[illegible]C      1          GAMMA RAY CENTERING
                                     0 = CENTERED
                                     1 = NOT CENTERED
MOPOFF      0          MOVEABLE OIL PLOT SWITCH
                                     0 = COMPUTE RXO CURVE
                                     1 = DO NOT COMPUTE RXO CURVE
RXLOG       1          SELECT RESISTIVITY FOR LITH DETERMINATION
                                     0 = USE RT AT 75 DEGREES F
                                     1 = USE RXO AT 75 DEGREES F
AUTOCA      1          NEUTRON AUTOMATIC CALIPER COMPENSATION:
                                     0 = NOT COMPENSATED
                                     1 = COMPENSATED
NSCALE    100          SET TO 100 IF THE NEUTRON IS FRACTIONAL
KSCALE    100          SET TO 100 IF THE K LOG IS FRACTIONAL

TMUD        1          TYPE OF MUD SYSTEM (0=NATURAL & 1=BARITE )

*****************************************************************
            LISTING OF CALC PARAMETERS

ZONE        PALEO          WELL        AYU-1

*****************************************************************

TOP        2490.0000     (METRES) TOP OF INTERVAL
BASE       2635.0000     (METRES) BOTTOM OF INTERVAL

*****************************************************************
*******************        MATRIX VALUES    ********************
*****************************************************************
GRMA        49.          (API) GAMMA RAY MATRIX
SPMA       -40.          (MV)  SP MATRIX (MV)
ATTMA      150.          (DB/M) ATTENUATIONOF THE MATRIX(DB/M)

DLTSS     56.00          (USEC/FT) DELTA T SANDSTONE
DLTLS     56.00          (USEC/FT) DELTA T LIMESTONE
DLTDOL    43.96          (USEC/FT) DELTA T DOLOMITE
DLTANH    50.00          (USEC/FT) DELTA T ANHYDRITE

RHOSS      2.65          (KG/M3 OR GR/CC) MATRIX DENS OF SANDSTONE
RHOLS      2.71          (KG/M3 OR GR/CC) MATRIX DENS OF LIMESTONE
RHODOL     2.87          (KG/M3 OR GR/CC) MATRIX DENS OF DOLOMITE
RHOANH     2.98          (KG/M3 OR GR/CC) MATRIX DENS OF ANHYDRITE

TPLSS      7.20          (NSEC/M) TPL OF SANDSTONE
TPLLS      9.10          (NSEC/M) TPL OF LIMESTONE
TPLDOL     8.70          (NSEC/M) TPL OF DOLOMITE
TPLANH     8.40          (NSEC/M) TPL OF ANHYDRITE

    VALUES FOR SOLO TOOLS

RHOMAB     2.65          (KG/CM OR GR/CC) MATRIX DENSITY
DLTMAB      56.          (USEC/FT) TRANSIT TIME MATRIX
[illegible]MAB     8.50          (NSEC/M) TPL MATRIX
NEUMAB        0          NEUTRON MATRIX 0=LS 1=SS 2=DOL
```

VALUES FOR COAL DETECTION

GRCOAL	180.	(API) MAXIMUM GR IN COAL.
DLTCOL	86.	(USEC/M OR USEC/FT) MINIMUM SONIC IN COAL.
UCOAL	8.00	(PPM) MINIMUM URANIUM IN COAL.
RHOCOL	2.30	(KG/M3 OR GR/CC) MAXIMUM DENSITY OF COAL.
PNCOL	27.	(PERCENT) MINIMUM LS. NEUTRON POR. IN COAL
PECOL	3.00	(BARNS/ELEC.) MAXIMUM PEF IN COAL.
COALCK	6	NUMBER OF POSITIVE COAL CHECKS NEEDED TO IDENTIFY COAL (COAL=1).

FLUID VALUES

RHOF	1.00	(KG/M3 OR GR/CC) FLUID DENSITY
DLTF	189.	(USEC/FT) TRANSIT TIME OF FLUID
RHOH	0.60	(KG/M3 OR GR/CC) HYDROCARBON DENSITY
ANEUT	1.00	NEUTRON GAS FACTOR(USUAL RANGE 1 TO 1.4) 1=HIGH DENSITY AND 1.5 LOW DENSITY
RHOMF	1.00	(KG/M3 OR GR/CC) MUD FILTRATE DENSITY
TPLH	5.00	(NSEC/M) HYDROCARBON TPL
SALMD	22000.	(PPM) MUD SALINITY
RWM	0.075	(OHM-M) RW AT MEASURED TEMPERATURE
RWMT	194.	(F) TEMPERATURE OF RW MEASUREMENT
RWBM	0.08	(OHM-M) BOUND WATER RESISTIVITY
RWBMT	194.	(F) TEMPERATURE OF RWB MEASUREMENT

SHALE AND CLAY VALUES

GRSH	135.	(API) GAMMA RAY VALUE IN SHALE
SPSH	-45.	(MV) SP VALUE IN SHALE
ATTSH	600.	(DB/M) EPT ATTENUATION IN SHALE
RHOSH	2.46	(KG/M3 OR GR/CC) MATRIX DENSITY OF SHALE
PEFSH	2.90	(BARNS/ELECTRON) PEF IN SHALE
TPLSH	9.00	(NSEC/M) TPL IN SHALE
PHINSH	27.	(PERCENT) NEUTRON LOG POROSITY OF SHALE
DLTSH	79.	(USEC/FT) TRANSIT TIME OF SHALE
RSH	8.00	(OHM-M) RESISTIVITY OF SHALE
PHIMAX	30.00	(PERCENT) MAX SHALE POROSITY IN INTERVAL

LOG CALCULATION CONSTANTS AND EXPONENTS

A	0.62	CONSTANT IN FORMATION FACTOR EQUATION
M	2.15	CEMENTATION EXPONENT
N	2.00	SATURATION EXPONENT
CP	1.10	COMPACTION FACTOR

```
*****************************************************************
*****  LIMITING VALUES FOR NET AND GROSS PAY CALCULATIONS '****
*****************************************************************

PHILIM    6.00        (PERCENT) LOWER POROSITY LIMIT
VSHLIM    0.40        (FRACTION) VOLUME OF SHALE UPPER LIMIT
SWLIM    50.00        (PERCENT) WATER SATURATION LIMIT

*****************************************************************
*********     LOG CALCULATION OPTIONS AND SWITCHES     ********
*****************************************************************

MSI            0        0=STANDARD UNITS  1=MSI
VSHCIN         3        GR TO VOL. OF SHALE CURVATURE INDEX
VSHOFF         0        0=CALC VOL. OF SHALE - 1=VOL.OF SH=0
GROFF          1        GR AS SHALE INDICATOR (0-USE ,1-NO)
KTHOFF         1        TH & K AS SHALE INDICATOR (0-USE ,1-NO)
NEUOFF         0        NEUTRON AS SHALE INDICATOR (0-USE ,1-NO)
DLTOFF         0        SONIC AS SHALE INDICATOR (0-USE ,1-NO)
ATTOFF         1        EPT AS SHALE INDICATOR (0-USE ,1-NO)
SPOFF          1        SP AS SHALE INDICATOR (0-USE ,1-NO)
PEOFF          0        USE PEF?   (0-USE ,1-NO)
MINOPT         3        MINERAL OPTION SWITCH
                        0 = COMPLEX LITHOLOGY
                        1 = SANDSTONE AND DOLOMITEONLY
                        2 = LIMESTONE AND DOLOMITE ONLY
                        3 = SANDSTONE AND SHALE ONLY (CLASSICAL)
                        4 = SANDSTONE AND SHALE ONLY (MODERN)
                        5 = SANDSTONE AND LIMESTONE ONLY

MOPOFF         0        MOVEABLE OIL PLOT SWITCH  0-USE RXO
                                                  1-NO RXO
QOPT           1        SW OPTION - 0=SW FROM PHIT AND Q
                                    1=SW FROM PHIE AND VSH
NOPRT          0        PRINT OPTION - 0=PRINT ALL VALUES
                                       1=SKIP SHALE ZONES
SWOPT          5        1 - ARCHIE; 2 - SIMANDOUX; 3 - SIMANDOUX
                        LAMINAR; 4 - V2 SIMANDOUX; 5 - INDONESIAN
                        6 - DISPERSED CLAY   7 - DUAL WATER MODEL
                        8 -  DUAL WATER Q=VSH MODEL
                        9 -  NORMALIZED WAXMAN-SMITS
                        10 - WAXMAN-SMITS
```

```
*****************************************************************
             LISTING OF ENVIRON PARAMETERS

ZONE        MAAS             WELL        AYU-1

*****************************************************************

TOP        2635.0000      (METRES) TOP OF INTERVAL
BASE       2715.0000      (METRES) BOTTOM OF INTERVAL

*****************************************************************
*********************     FLUID VALUES     ********************
*****************************************************************

RHOFR     1.00          (KG/M3 OR GR/CC)RECORDED FLUID DENSITY
SALFM    40000.         (PPM) FORMATION SALINITY (NACL)
SALMD    22000.         (PPM) MUD SALINITY (NACL)
RMM      0.2500         (OHM-M) RM
                        IF USING AN OIL BASED MUD SET TO > 100
RMMT        88.         ( F ) MEASURED TEMPERATURE FOR RM
RMFM     0.2220         (OHM-M) RMF
RMFMT       75.         ( F ) MEASURED TEMPERATURE FOR RMF
RMCM     0.3080         (OHM-M) RMC
RMCMT       70.         ( F ) MEASURED TEMPERATURE FOR RMC

*****************************************************************
*****************     HOLE AND MUD VALUES     ****************
*****************************************************************

MW         9.35         (LBS/GAL) MUD WT
                         ENTER 0 MW FOR AIR FILLED HOLE
BITSIZ   12.250         (INCHES) BIT SIZE
AMST       50.0         ( F ) ANNUAL MEAN SURFACE TEMP
BHT       194.0         ( F ) BOTTOM HOLE TEMPERATURE
TD         2740.         (METRES) TOTAL DEPTH OF BOREHOLE
RSTAND    1.500         ( INCHES ) STANDOFF SETTING ON INDUCTION

*****************************************************************
*******************     LIMITING VALUES     *******************
*****************************************************************

RHOMIN    1.25          (KG/M3 OR GR/CC) MIN. VALID BULK DENSITY
DLTMIN     40.          (USEC/FT) MIN. VALID SONIC ITT
DLTMAX    190.          (USEC/FT) MAX. VALID SONIC ITT
PHNMAX     70.          (PERCENT) MAXIMUM VALID NEUTRON POROSITY
RUGMAX    6.00          (INCHES) MAX. RUGOSITY TO ACCEPT NEUTRON
STOMAX    3.00          (INCHES) MAX. NEUT. STANDOFF
STOMIN    0.00          (INCHES) MIN. NEUT. STANDOFF TO CORRECT
                        (SET TO STOMAX TO BYPASS STANDOFF LOGIC)
DROLIM    0.20          (KG/M3 OR GR/CC) MAXIMUM DENSITY CORRECTON
                           TO ACCEPT (+ OR -)
```

****
********   SWITCHES AND TOOL DESCRIPTIONS   ******************
****

[illegible]RXC	1	GAMMA RAY CENTERING 0 = CENTERED 1 = NOT CENTERED
MOPOFF	0	MOVEABLE OIL PLOT SWITCH 0 = COMPUTE RXO CURVE 1 = DO NOT COMPUTE RXO CURVE
RXLOG	1	SELECT RESISTIVITY FOR LITH DETERMINATION 0 = USE RT AT 75 DEGREES F 1 = USE RXO AT 75 DEGREES F
AUTOCA	1	NEUTRON AUTOMATIC CALIPER COMPENSATION: 0 = NOT COMPENSATED 1 = COMPENSATED
NSCALE	100	SET TO 100 IF THE NEUTRON IS FRACTIONAL
KSCALE	100	SET TO 100 IF THE K LOG IS FRACTIONAL
TMUD	1	TYPE OF MUD SYSTEM (0=NATURAL & 1=BARITE)

****

LISTING OF CALC PARAMETERS

ZONE MAAS WELL AYU-1

****

TOP	2635.0000	(METRES) TOP OF INTERVAL
BASE	2715.0000	(METRES) BOTTOM OF INTERVAL

****
*******************   MATRIX VALUES   ********************
****

GRMA	44.	(API) GAMMA RAY MATRIX
SPMA	-40.	(MV) SP MATRIX (MV)
ATTMA	150.	(DB/M) ATTENUATIONOF THE MATRIX(DB/M)
DLTSS	55.00	(USEC/FT) DELTA T SANDSTONE
DLTLS	56.00	(USEC/FT) DELTA T LIMESTONE
DLTDOL	43.96	(USEC/FT) DELTA T DOLOMITE
DLTANH	50.00	(USEC/FT) DELTA T ANHYDRITE
RHOSS	2.65	(KG/M3 OR GR/CC) MATRIX DENS OF SANDSTONE
RHOLS	2.71	(KG/M3 OR GR/CC) MATRIX DENS OF LIMESTONE
RHODOL	2.87	(KG/M3 OR GR/CC) MATRIX DENS OF DOLOMITE
RHOANH	2.98	(KG/M3 OR GR/CC) MATRIX DENS OF ANHYDRITE
TPLSS	7.20	(NSEC/M) TPL OF SANDSTONE
TPLLS	9.10	(NSEC/M) TPL OF LIMESTONE
TPLDOL	8.70	(NSEC/M) TPL OF DOLOMITE
TPLANH	8.40	(NSEC/M) TPL OF ANHYDRITE

VALUES FOR SOLO TOOLS

RHOMAB	2.65	(KG/CM OR GR/CC) MATRIX DENSITY
DLTMAB	56.	(KG/M3 OR GR/CC) TRANSIT TIME MATRIX
T[illegible]MAB	8.50	(NSEC/M) TPL MATRIX
N[illegible]MAB	0	NEUTRON MATRIX 0=LS 1=SS 2=DOL

VALUES FOR COAL DETECTION

GRCOAL	180.	(API) MAXIMUM GR IN COAL.
DLTCOL	86.	(USEC/M OR USEC/FT) MINIMUM SONIC IN COAL.
[illegible]OAL	8.00	(PPM) MINIMUM URANIUM IN COAL.
RHOCOL	2.30	(KG/M3 OR GR/CC) MAXIMUM DENSITY OF COAL.
PNCOL	27.	(PERCENT) MINIMUM LS. NEUTRON POR. IN COAL
PECOL	3.00	(BARNS/ELEC.) MAXIMUM PEF IN COAL.
COALCK	6	NUMBER OF POSITIVE COAL CHECKS NEEDED TO IDENTIFY COAL (COAL=1).

****
********************   FLUID VALUES   ********************
****

RHOF	1.00	(KG/M3 OR GR/CC) FLUID DENSITY
DLTF	189.	(USEC/FT) TRANSIT TIME OF FLUID
RHOH	0.60	(KG/M3 OR GR/CC) HYDROCARBON DENSITY
ANEUT	1.00	NEUTRON GAS FACTOR(USUAL RANGE 1 TO 1.4) 1=HIGH DENSITY AND 1.5 LOW DENSITY
RHOMF	1.00	(KG/M3 OR GR/CC) MUD FILTRATE DENSITY
TPLH	5.00	(NSEC/M) HYDROCARBON TPL
SALMD	22000.	(PPM) MUD SALINITY
RWM	0.075	(OHM-M) RW AT MEASURED TEMPERATURE
RWMT	194.	(F) TEMPERATURE OF RW MEASUREMENT
RWBM	0.08	(OHM-M) BOUND WATER RESISTIVITY
RWBMT	194.	(F) TEMPERATURE OF RWB MEASUREMENT

****
****************   SHALE AND CLAY VALUES   ****************
****

[illegible]H	135.	(API) GAMMA RAY VALUE IN SHALE
SPSH	-45.	(MV) SP VALUE IN SHALE
ATTSH	600.	(DB/M) EPT ATTENUATION IN SHALE
RHOSH	2.45	(KG/M3 OR GR/CC) MATRIX DENSITY OF SHALE
PEFSH	2.90	(BARNS/ELECTRON) PEF IN SHALE
TPLSH	9.00	(NSEC/M) TPL IN SHALE
PHINSH	24.	(PERCENT) NEUTRON LOG POROSITY OF SHALE
DLTSH	80.	(USEC/FT) TRANSIT TIME OF SHALE
RSH	10.00	(OHM-M) RESISTIVITY OF SHALE
PHIMAX	39.00	(PERCENT) MAX SHALE POROSITY IN INTERVAL

****
*******   LOG CALCULATION CONSTANTS AND EXPONENTS   *******
****

A	0.62	CONSTANT IN FORMATION FACTOR EQUATION
M	2.15	CEMENTATION EXPONENT
N	2.00	SATURATION EXPONENT
CP	1.10	COMPACTION FACTOR

```
*****************************************************************
*****  LIMITING VALUES FOR NET AND GROSS PAY CALCULATIONS   ****
*****************************************************************

PHILIM     6.00          (PERCENT) LOWER POROSITY LIMIT
VSHLIM     0.40          (FRACTION) VOLUME OF SHALE UPPER LIMIT
SWLIM     50.00          (PERCENT) WATER SATURATION LIMIT

*****************************************************************
*********      LOG CALCULATION OPTIONS AND SWITCHES     ********
*****************************************************************

MSI           0          0=STANDARD UNITS  1=MSI
VSHCIN        3          GR TO VOL. OF SHALE CURVATURE INDEX
VSHOFF        0          0=CALC VOL. OF SHALE - 1=VOL.OF SH=0
GROFF         1          GR AS SHALE INDICATOR (0-USE ,1-NO)
KTHOFF        1          TH & K AS SHALE INDICATOR (0-USE ,1-NO)
NEUOFF        0          NEUTRON AS SHALE INDICATOR (0-USE ,1-NO)
DLTOFF        0          SONIC AS SHALE INDICATOR (0-USE ,1-NO)
ATTOFF        1          EPT AS SHALE INDICATOR (0-USE ,1-NO)
SPOFF         1          SP AS SHALE INDICATOR (0-USE ,1-NO)
PEOFF         0          USE PEF?  (0-USE ,1-NO)
MINOPT        3          MINERAL OPTION SWITCH
                         0 = COMPLEX LITHOLOGY
                         1 = SANDSTONE AND DOLOMITEONLY
                         2 = LIMESTONE AND DOLOMITE ONLY
                         3 = SANDSTONE AND SHALE ONLY (CLASSICAL)
                         4 = SANDSTONE AND SHALE ONLY (MODERN)
                         5 = SANDSTONE AND LIMESTONE ONLY

MOPOFF        0          MOVEABLE OIL PLOT SWITCH  0-USE RXO
                                                   1-NO RXO
QOPT          1          SW OPTION - 0=SW FROM PHIT AND Q
                                     1=SW FROM PHIE AND VSH
NOPRT         0          PRINT OPTION - 0=PRINT ALL VALUES
                                        1=SKIP SHALE ZONES
SWOPT         5          1 - ARCHIE; 2 - SIMANDOUX; 3 - SIMANDOUX
                         LAMINAR; 4 - V2 SIMANDOUX; 5 - INDONESIAN
                         6 - DISPERSED CLAY   7 - DUAL WATER MODEL
                         8 -  DUAL WATER Q=VSH MODEL
                         9 -  NORMALIZED WAXMAN-SMITS
                         10 - WAXMAN-SMITS
```

WELL COMPLETION REPORT

AYU-1

INTERPRETATIVE DATA

APPENDIX 2

LOG ANALYSIS OF THE LATROBE GROUP IN AYU-1

PETROFINA EXPLORATION AUSTRALIA S.A.

Log Analysis of The Latrobe Group in Ayu-1

GL/90/044

JMQ/kl

10 May 1990

CONTENTS

PAGE

LIST OF FIGURES

LIST OF TABLES

LIST OF ENCLOSURES

LIST OF APPENDICES

1. SUMMARY AND CONCLUSIONS

A total of 340m of wireline logs, covering the entire Latrobe Group at Ayu-1, have been evaluated. The analysis covers the interval from 2475m (15m above Top Latrobe Unconformity) to 2715m, the maximum depth to which the evaluation can be carried out (35m above TD).

The conclusions are:

(a) No hydrocarbons are present in any of the intersected sandstones.

(b) A total of 117.2m of excellent reservoir sandstones with average porosities of 20.8% to 21.8% were found in the interval 2490m (Top Latrobe) to 2631m. Below that depth down to 2715m, porosities decrease markedly as a result of an increase in cementation from 2631m to 2655m and an increase in shaliness from 2660m to 2715m. A total of 52.7m gross sandstone is present in both intervals with average porosities ranging from 15.2% to 18.7%.

(c) Three intervals show seal potential. The first two, from 2551m to 2560.5m and 2625.5m to 2631m, are within the Palaeocene interval, the primary objective in this well. The third seal, from 2697m to 2705m, lies at the base of the Palaeocene directly above the Maastrichtian, and like the two intra-Palaeocene units above consists of very argillaceous siltstones displaying good density-neutron separation on the logs. None of these shales coincide with structural closure at Ayu-1 and therefore do not trap any hydrocarbons, but confirm the presence of intra-Palaeocene sealing lithologies.

(d) The log analysis results are internally consistent and considered reliable in confirming that all the sandstones in the Latrobe Group are water bearing. The internal consistency of the results is mainly based on the following:

(i) The selected Rw of 0.075 ohm meter @ 195°F compares to the Rw of 0.072 ohm meter @ 185°F at Kingfish, and is further supported by Rwa computed at Ayu-1.

(ii) There is a close match between the various porosity curves.

(iii) Computed Vshale values range from 0% in the cleanest sandstones to near 100% in the most argillaceous intervals.

(iv) Ro and Rt overlie each other in zones where the Indonesian equation yields water saturation of 100%.

2. INTRODUCTION

This report presents the results of a log analysis over the Latrobe Group drilled at Ayu-1 (2490-2750m). Mud gas values in this interval were very low during drilling averaging around 0.1% C1 with minor peaks of near 1% in some tighter zones. No fluorescence or cut was detected in any of the sandstones. The aim of this evaluation was to confirm the lack of hydrocarbons in the Latrobe Group, and assess the reservoir and seal potential of this interval.

The environmental corrections on the wireline logs, and the log evaluation computations, were performed using LOGCALC 2 software from Scientific Software Intercomp. As with the previous Petrofina log analysis work performed on other VIC/P20 wells, a shaley sand model was used, with water saturations derived from the Indonesian equation.

The Latrobe Group was divided into two zones, and reservoir parameters selected separately for each. Rw is based on a formation water salinity of 40,000 ppm NaCl equivalent, which is automatically corrected for changes in temperatures with depth by the software. Results are presented in Table 1, while a summary of the reservoir parameters used in the computations are listed on Table 2. A detailed listing of the reservoir and log analysis parameters are included in Appendix 1. Enclosure 1 shows a graphic output at a 1:500 scale of the raw and environmentally corrected logs together with a Rwa trace. Enclosures 2 and 3 display the log analysis results separately on a 1:500 scale and a 1:200 scale.

3. INPUT LOGS AND LOG QUALITY

The following logs were used in the analysis:

GR	(Gamma Ray)
LLD	(Deep Laterolog)
LLS	(Shallow Laterlog)
MSFL	(Micro-spherically focussed log)
RHOB	(Bulk Density)
NPHI	(Neutron Density)
CAL	(Caliper)
DT	(Sonic Transit Time)

Hole condition as seen on the caliper log is excellent throughout. The log quality is very good down to 2625m at which point the hole rugosity, although not more than ½", markedly affects both the density and neutron logs. This is reflected in anomalously low neutron porosity readings correlating exactly with maximum DRHO corrections and maximum hole gauge (Encls. 1, 2 and 3). This anomaly is thought to be related to a standoff problem along the rugose hole section. Although the Density log is affected by this rugosity, it can still be adequately corrected by DRHO. The effect on the Neutron porosity log on the other hand is too great for this log to be used either for Vshale or porosity calculations in that section of hole.

4. METHOD

(i) The log data was loaded into LOGCALC 2 and quality controlled. Although the logs are not exactly on depth (maximum = 0.3m off depth), the effect on the computations and the resulting shoulder effects are negligible. Hence the logs have not been depth matched.

(ii) The Gamma Ray, Density and Neutron logs were borehole corrected and the deep Laterolog corrected for invasion to give a true Rt (Encls. 1 and 2).

(iii) The well was then zoned into two separate intervals (2490m-2631m and 2631m-2715m) on the basis of varying log response over the intervals.

(iv) Reservoir parameters were then selected for each zone and by means of an iterative process modified until results became internally consistent and satisfied the constraints from the wellsite data (Vshale, mineralogy, hydrocarbon shows, etc.).

5. PARAMETERS, CUTOFFS AND ANALYSIS OPTIONS

5.1 Formation Water Resistivities (Rw)

A Formation Water Salinity of 40,000 ppm NaCl equivalent was used in this analysis, yielding a Rw = 0.075 ohm metre at 195°F (bottom hole temperature). This value was determined from Rwa calculation in the cleanest sandstone intervals. Enclosure 1 shows the Rwa for the entire interval. The Rw selected for Ayu compares with Rw = 0.072 ohm meter @ 185°F for the formation water at Kingfish and a Formation Water Salinity of 45,000 ppm NaCl determined for Roundhead-1 by Esso in-house log evaluation.

5.2 Matrix and Reservoir Parameters

Selected matrix parameters for the two zones are the same, mainly 2.64 g/cc and 55 µs/ft, which are those of a typical quartz matrix. The shale parameters were selected directly from the logs, while mud properties and temperatures were taken from the log headers. Table 2 includes a list of the shale parameters for each zone.

5.3 Analysis

As for previous log evaluation in the VIC/P20 permit, a shaley sand analysis model was selected because of the complete gradation of sandstone to shale within the Latrobe Group.

For the upper zone (2490m-2630m) Vshale was calculated using the GR; Neutron-Density and Sonic-Density cross plots, with LOGCALC 2 selecting the lowest consistent Vshale from the three methods. For the lower zone where the Neutron log is unreliable only the GR and the Density-Sonic cross plot were used for calculating Vshale.

Porosities were calculated using the three standard porosity curves except below 2631m where only the Density and Sonic curves were used. The porosity curves are displayed in Enclosures 2 and 3.

The Indonesian Formula was used for water saturation determination, using the Humble parameters of a = 0.62, m = 2.15 and n = 2.

As can be seen on Enclosures 2 and 3, the Ro curve (Deep Resistivity reading in 100% water saturated rock) and the Rt curve (true measured Resistivity) lie on top of each other over all the sandstone units, and the computed Sw values are narrowly distributed around the 100% mark (Fig. 1). The Vshale curve is realistic, showing 0% opposite the cleanest sandstones and increasing to near 100% in the most shaley intervals with very few points above 100%. The Rwa curve (Encl. 1) shows that although formation water salinity might vary a little over the entire Latrobe interval, an average Rw of 0.075 ohm meter is quite acceptable. The density and sonic porosity curves closely match indicating that no anomalous mineralogy exists in these sandstones, and confirms quartz as the matrix mineral. Note that as for the other VIC/P20 wells a compaction factor of Cp = 1.1 has been used in the Tertiary section of the Latrobe Group for determining the sonic porosity.

5.4 Cutoffs

The cutoffs selected for accepting the log for computation are listed in Appendix 1.

Cutoff values used in defining gross reservoir sandstones are:

Gross Reservoir Sandstone:

Effective Porosity > 6%

Vshale < 40%

Net Reservoir Sandstone:

Effective Porosity > 6%

Vshale < 40%

Sw < 50%

6. LOG ANALYSIS RESULTS

Overall, the Latrobe Group intersected at Ayu contains 169.9m of gross reservoir sandstone, representing a 75.5% gross interval thickness ratio. The average porosities for the separate sandstone units range from 21.8% to 15.2%, while water saturations are close to 100% throughout the Latrobe Group (ranging from 99.5% to 98.3%), confirming that the sandstones are water bearing.

Reservoir quality decreases noticeably with depth with the clean and porous sandstones below the Top Latrobe Unconformity, grading down to tighter calcite cemented sandstones near the base Palaeocene (2631m-2658m). The sandstones below 2669m also display moderate reservoir qualities due to the increased shaliness.

Two argillaceous siltstone units within the Palaeocene interval (2551m-2560.5m and 2625.5m-2631m) display good shale effects on the logs and have good seal potential. A basal shale from 2697m-2705m shows excellent separation on the density and neutron logs and correlates with a similar shale at Roundhead-1 and Hermes-1, 5.2 km and 1.5 km from Ayu-1 respectively. Although none of these shales define structural closure at Ayu-1, it is clear that these are laterally extensive and therefore have an excellent seal potential on a closed structure.

FREQUENCY DISTRIBUTION OF CALCULATED WATER SATURATIONS

AYU-1 LATROBE INTERVAL 2490 - 2750m

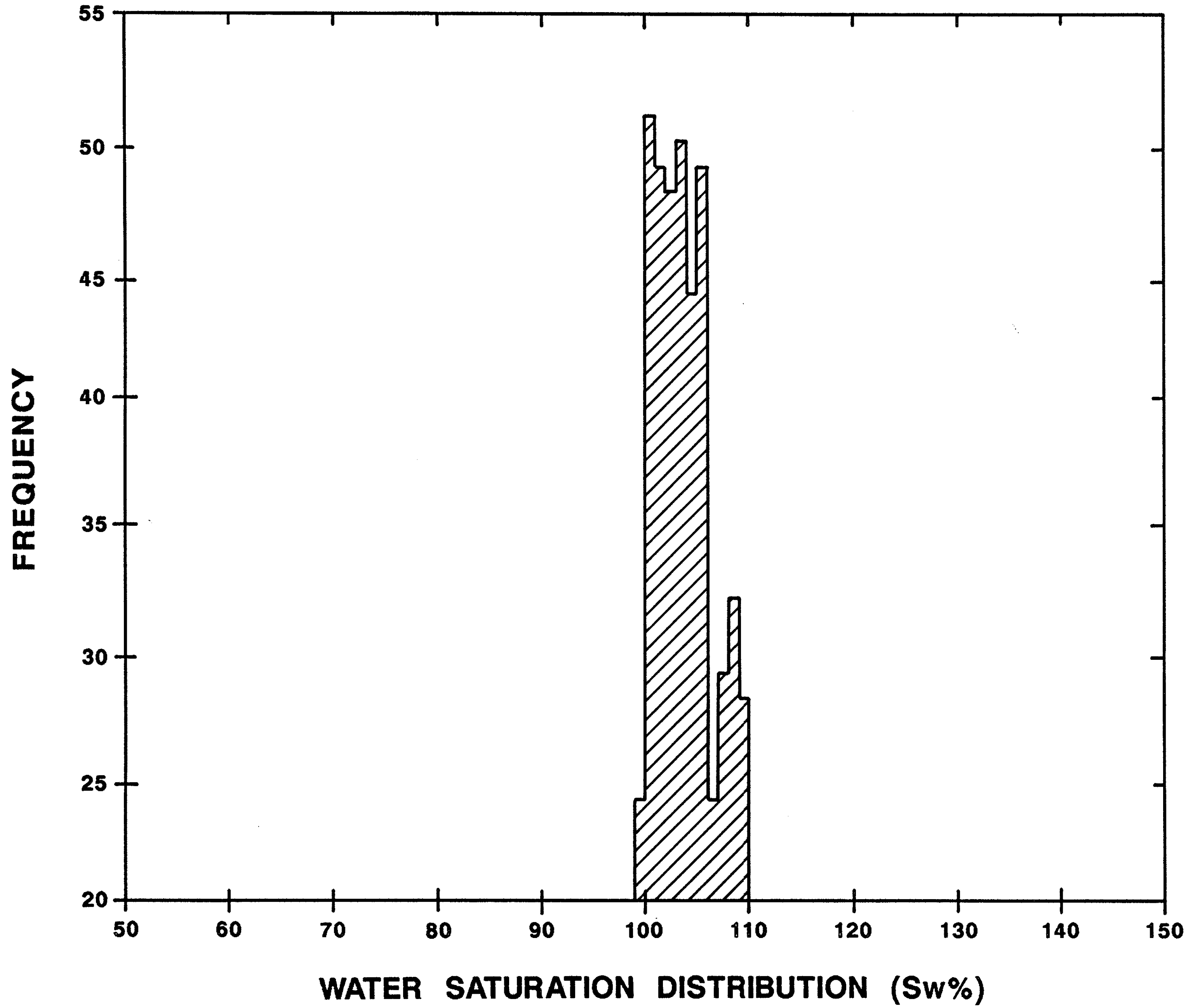


FIGURE 1

J-M. Q. 27/4/90
G 712

TABLE 1

AYU-1 SUMMARY OF LOG ANALYSIS RESULTS

ZONE	INTERVAL (m) Top	- Bottom	THICKNESS (m)	GROSS RESERVOIR THICKNESS (m)	GROSS RESERVOIR THICKNESS/GROSS INTERVAL THICKNESS	AVERAGE PHIE (%)	AVERAGE Sw (%)	NET RESERVOIR THICKNESS (m)
PALAEOCENE	2490.0	2560.5	70.5	56.7	0.80	20.8	98.7	0.0
	2560.5	2631.0	70.5	60.5	0.86	21.8	98.8	0.0
	2631.0	2669.0	38.0	30.0	0.79	16.6	98.3	0.0
	2669.0	2708.0	39.0	17.5	0.45	18.7	99.2	0.0
MAASTRICHTIAN	2708.0	2715.0	7.0	5.2	0.74	15.2	99.5	0.0

TABLE 2

AYU-1 ZONATION AND KEY RESERVOIR PARAMETERS

ZONE	INTERVAL (m) Top	Bottom	PARAMETER SET NAME	Rw @ BOTTOM OF ZONE (ohm-m)	GR Matrix (API)	GR Shale (API)	Rho Shale (g/cc)	PhiN Shale (pu)	/\t Shale (µs/ft)	Res Shale (ohm-m)	Rho Matrix (g/cc)	/\t Matrix (µs/ft)	Cp	Rho Fluid (g/cc)
PALAEOCENE	2490.0	2560.5	PALEO	0.079	49	135	2.46	27	79	8	2.65	55	1.1	1
	2560.5	2631.0	PALEO	0.077	49	135	2.46	27	79	8	2.65	55	1.1	1
	2631.0	2669.0	PALEO	0.076	44	135	2.46	27	79	8	2.65	55	1.1	1
	2669.0	2708.0	MAAS	0.076	44	135	2.45	24	80	10	2.65	55	1.1	1
MAASTRICHTIAN	2708.0	2715.0	MAAS	0.075	44	135	2.45	24	80	10	2.65	55	1.1	1

Cp = Compaction factor in the sonic porosity determination.

PE600966

This is an enclosure indicator page.
The enclosure PE600966 is enclosed within the container PE902102 at this location in this document.

The enclosure PE600966 has the following characteristics:

ITEM_BARCODE =	PE600966
CONTAINER_BARCODE =	PE902102
NAME =	Environmentally Corrected Logs
BASIN =	GIPPSLAND
PERMIT =	
TYPE =	WELL
SUBTYPE =	WELL_LOG
DESCRIPTION =	Environmentally Corrected Logs
REMARKS =	
DATE_CREATED =	28/02/1990
DATE_RECEIVED =	02/07/1990
W_NO =	W1020
WELL_NAME =	Ayu-1
CONTRACTOR =	Petrofina exploration
CLIENT_OP_CO =	Petrofina exploration

(Inserted by DNRE - Vic Govt Mines Dept)

PE600967

This is an enclosure indicator page.
The enclosure PE600967 is enclosed within the container PE902102 at this location in this document.

The enclosure PE600967 has the following characteristics:

ITEM_BARCODE = PE600967
CONTAINER_BARCODE = PE902102
NAME = Shaly Sand Interpretation
BASIN = GIPPSLAND
PERMIT =
TYPE = WELL
SUBTYPE = WELL_LOG
DESCRIPTION = Shaly Sand Interpretation
REMARKS =
DATE_CREATED = 28/02/1990
DATE_RECEIVED = 02/07/1990
W_NO = W1020
WELL_NAME = Ayu-1
CONTRACTOR = Petrofina exploration
CLIENT_OP_CO = Petrofina exploration

(Inserted by DNRE - Vic Govt Mines Dept)

PE600968

This is an enclosure indicator page.
The enclosure PE600968 is enclosed within the container PE902102 at this location in this document.

The enclosure PE600968 has the following characteristics:

ITEM_BARCODE =	PE600968
CONTAINER_BARCODE =	PE902102
NAME =	Shaly Sand Interpretation
BASIN =	GIPPSLAND
PERMIT =	
TYPE =	WELL
SUBTYPE =	WELL_LOG
DESCRIPTION =	Shaly Sand Interpretation
REMARKS =	
DATE_CREATED =	28/02/1990
DATE_RECEIVED =	02/07/1990
W_NO =	W1020
WELL_NAME =	Ayu-1
CONTRACTOR =	Petrofina exploration
CLIENT_OP_CO =	Petrofina exploration

(Inserted by DNRE - Vic Govt Mines Dept)

APPENDIX
3

APPENDIX 3

WELL COMPLETION REPORT

AYU-1

INTERPRETATIVE DATA

A P P E N D I X 3

SEDIMENTOLOGICAL INTERPRETATION

PETROFINA EXPLORATION AUSTRALIA S.A.

Sedimentological Interpretation of the Latrobe Group in Ayu-1

GL/89/049
PhL/kl
25 May 1990

CONTENTS **PAGE**

LIST OF FIGURES

LIST OF ENCLOSURES

LIST OF TABLES

SUMMARY AND CONCLUSIONS

1. The sedimentary facies encountered in the Palaeocene sequence at Ayu-1 are a combination of prograding deltaic units and stacked beach sandstones. Facies within the Maastrichtian are restricted to non-marine deposits.

2. The Palaeocene Unit I is characterised by a basal 8m thick pro-delta shale overlain by a 270m thick sequence of well developed sandstones deposited as three regressive units within a prograding deltaic and beach environment.

3. Three prograding cycles have been recognised in the Palaeocene Unit I, with the lowest cycle being in the most distal position, while the Palaeocene shows an overall regressive depositional history.

1. INTRODUCTION

A detailed sedimentological study of the Latrobe Group has been carried out at Ayu-1. The section studied is from 2490m (Top Latrobe Group) to 2750m (TD), a thickness of 260m.

All available wireline logs were used in this study, including the MSD processed dipmeter log. Results from sidewall cores, cuttings descriptions and palynological results were also integrated in this work. The interpretation has been compiled as a sedimentological log (Encl. 1), incorporating the composite log, the MSD dipmeter log (tadpoles and SHDT resistivity traces), and the sedimentary interpretations.

The Latrobe Group intersected by the well can be divided into two distinct facies associations:
(a) a series of three deltaic sequences in the Palaeocene interval, and
(b) non-marine coastal plain sediments in the underlying Maastrichtian.

2. LATROBE GROUP SEDIMENTARY INTERPRETATION

Four main depositional environments have been identified in the Latrobe Group in VIC/P20. These are shallow marine, deltaic, and lower and upper coastal plain environments (Questiaux and Tringham, 1988/1989). Figure 1 schematically illustrates a typical log for the four depositional environments and their sub-environments, while Table 1 summarises their main diagnostic features.

3. WELL INTERPRETATION RESULTS

3.1 2750m (TD) - 2705m (Top Maastrichtian)

The Maastrichtian section (Upper T.longus zone) penetrated in Ayu-1 is characterised by siltstone deposited in a lower coastal plain environment with possible marine influence near the top (based on palynological data).

Depositional dips are low with scattered azimuths probably reflecting a high degree of bioturbation in this interval.

3.2 2705m - 2490m (Palaeocene)

This thick Palaeocene interval corresponds to the lower L.balmei zone, equivalent to the Palaeocene Unit I defined in Roundhead-1. Both log and palynological evidence show that, as prognosed, the Palaeocene Unit II present in Roundhead-1 was not intersected in this well.

The basal Palaeocene Unit I transgressive sequence is represented in Ayu-1 by an 8m thick pro-delta shale between 2697m and 2705m, characterized by excellent separation on the density neutron logs. These shales were deposited as two separate units, with each unit displaying a blue pattern to the north-east. The dipmeter indicates a palaeo slope of $\pm 6^\circ$ to the ENE which is not present in the underlying Maastrichtian sediments, reflecting an angular unconformity between the Maastrichtian and Palaeocene sequences.

From the basal shales, sediments coarsen rapidly upwards into three regressive units of siltstones and massive sandstones, separated by two sharp transgressive events at 2560m and 2633m. These sediments are interpreted as having been deposited in a delta front environment with strong marine influence, resulting in the deposition of stacked beach ridges within each cycle. The sandstones within these beach ridges are well winnowed, giving them excellent reservoir characteristics.

Each cycle is further characterised by high angle foresets (up to 30°) deposited on a palaeo slope dipping $\pm 8°$ to the ESE, in turn overlain by low angle topsets (maximum 10°).

In the first cycle the foresets are mainly developed in siltstones grading upwards to sandstone in the topsets. The sedimentary dips show a bimodal distribution with an azimuth of deltaic progradation of 75° East and a longshore current direction of 15° East. This somewhat more argillaceous cycle may have been deposited in a more distal position than the two overlying cycles.

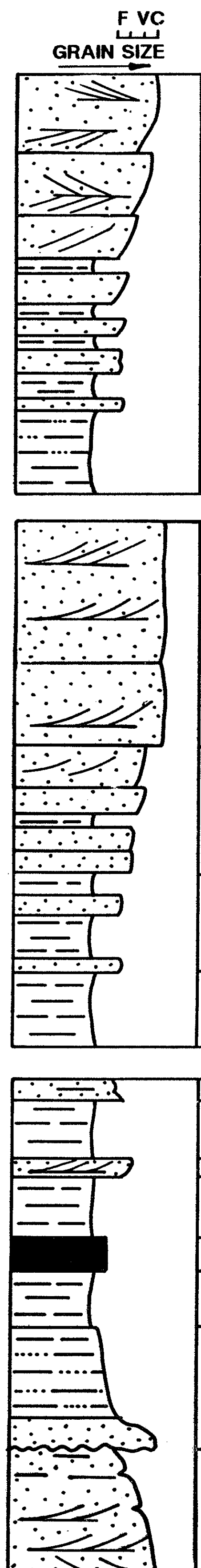
In the upper two cycles, foreset and bottomset azimuths within the sandstones are unimodal, trending 110° East ($\pm 15°$), reflecting a waning of longshore drift.

4. REFERENCES

QUESTIAUX, J.M. and TRINGHAM, M.E., 1988.
A Sedimentological Interpretation of the Latrobe Group in Wells of the VIC/P20 Area. Petrofina Exploration Australia S.A., Unpublished Report.

FIGURE 1

LATROBE DEPOSITIONAL ENVIRONMENTS



LITHOLOGY	SUB-ENVIRONMENT	ENVIRONMENT
	UPPER SHOREFACE	SHALLOW MARINE
	LOWER SHOREFACE	
	OFFSHORE	
	STREAM MOUTH BAR	DELTA
	UPPER DELTA FRONT	
	LOWER DELTA FRONT	
	PRO-DELTA	
	CREVASSE SPLAY	LOWER COASTAL PLAIN
	FLOOD PLAIN	
	CREVASSE SPLAY	
	FLOOD PLAIN	
	MARSH	
	FLOOD PLAIN	
	CHANNEL FILL	
	POINT BAR	

G 729

TABLE 1

SUMMARY OF SEDIMENTARY ENVIRONMENTS

MAIN ENVIRONMENT	SUB-ENVIRONMENT	LITHOLOGY	DIAGNOSTIC FEATURES AND LOG RESPONSE	DIAGNOSTIC SEDIMENTARY STRUCTURES	GEODIP/CLUSTER TRENDS
SHALLOW MARINE	UPPER SHOREFACE	Sandstone (med-crse)	Massive Bedding c.u. Cycles	Trough Cross-Bedding	Blue and Red Patterns Diverse Trends
	LOWER SHOREFACE	Sandstone (f-crse) Siltstone Shale	Interbedded c.u. Cycles	Hummocky Cross-Bedding	As Above
	OFFSHORE	Siltstone Shale	Thin Bedded Siltstones Thick Shales	Ripples Bioturbation	Green Pattern
DELTA	STREAM MOUTH BAR	Sandstone (med-crse)	Blocky Log Pattern Massive Bedding c.u. Cycles	Sharp Bases Trough Cross-Bedding	Blue and Red Patterns Unimodal Trends
	UPPER DELTA FRONT	Sandstone (f-med) Siltstone	Interbedded c.u. Cycles	Trough Cross-Bedding Parallel Lamination	As Above
	LOWER DELTA FRONT	Sandstone (f) Siltstone Shale	Interbedded c.u. Cycles Individ. Sandstones f.u.	Ripples Parallel Lamination	Green Pattern
	PRO-DELTA	Siltstone Shale	Thin Bedded Siltstone Thick Shales	Ripples Bioturbation	Green Pattern
LOWER COASTAL PLAIN	FLOOD PLAIN	Shale (coaly) Siltstone		Parallel Lamination Root Bioturbation	Green Pattern
	MARSH	Coal Shale (coaly)	High Resistivity & Sonic Low Density		None
	CREVASSE SPLAY	Sandstone (f-med) Siltstone	c.u. or f.u. Cycles Thin Bedded, Spikey	Trough Cross-Bedding	Blue or Red Patterns Unimodal Trends
	CHANNEL FILL	Shale Siltstone Sandstone (v.crse-f)	f.u. Cycles	Sharp Erosional Base Trough Cross-Bedding in Sandstone	Red Pattern Diverse Trends
	POINT BAR	Siltstone Sandstone (v.crse-f)	f.u. Cycles	Sharp Erosional Base Trough Cross-Bedding	Red and Blue Trends Diverse Trends

PE600969

This is an enclosure indicator page.
The enclosure PE600969 is enclosed within the container PE902102 at this location in this document.

The enclosure PE600969 has the following characteristics:

ITEM_BARCODE =	PE600969
CONTAINER_BARCODE =	PE902102
NAME =	Sedimentary Interpretation Log
BASIN =	GIPPSLAND
PERMIT =	
TYPE =	WELL
SUBTYPE =	WELL_LOG
DESCRIPTION =	Sedimentary Interpretation Log
REMARKS =	
DATE_CREATED =	31/05/1990
DATE_RECEIVED =	02/07/1990
W_NO =	W1020
WELL_NAME =	Ayu-1
CONTRACTOR =	Petrofina exploration
CLIENT_OP_CO =	Petrofina exploration

(Inserted by DNRE - Vic Govt Mines Dept)

APPENDIX 4

APPENDIX 4

WELL COMPLETION REPORT

AYU-1

INTERPRETATIVE DATA

APPENDIX 4

PALYNOLOGY AND GEOLOGICAL IMPLICATIONS

PALYNOLOGY OF PETROFINA AYU-1, GIPPSLAND BASIN, AUSTRALIA

BY

ROGER MORGAN
BOX 161
MAITLAND 5573
SOUTH AUSTRALIA
PH (088) 322795
FAX (088) 322658
REF:DW.GIPP.AYU1

for PETROFINA EXPLORATION AUSTRALIA SA

APRIL 1990

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
			W. echinosuturata
		P. asperopolus	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. lillei	I.korojonense
		N. senectus	X. australis
	Santonian	T. pachyexinus	N. aceras
			I. cretaceum
			O. porifera
	Coniacian	C. triplex	
	Turonian		C. striatoconus
			P. infusorioides
	Cenomanian	A. distocarinatus	
Early Cretaceous	Albian Late	P. pannosus	
	Albian Middle	upper C. paradoxa	
		lower C. paradoxa	
	Albian Early	C. striatus	
	Aptian	upper C. hughesi	
		lower C. hughesi	
	Barremian	F. wonthaggiensis	
	Hauterivian		
	Valanginian	upper C. australiensis	
	Berriasian	lower C. australiensis	
Juras.	Tithonian	R. watherooensis	

FIGURE 1 ZONATION FRAMEWORK

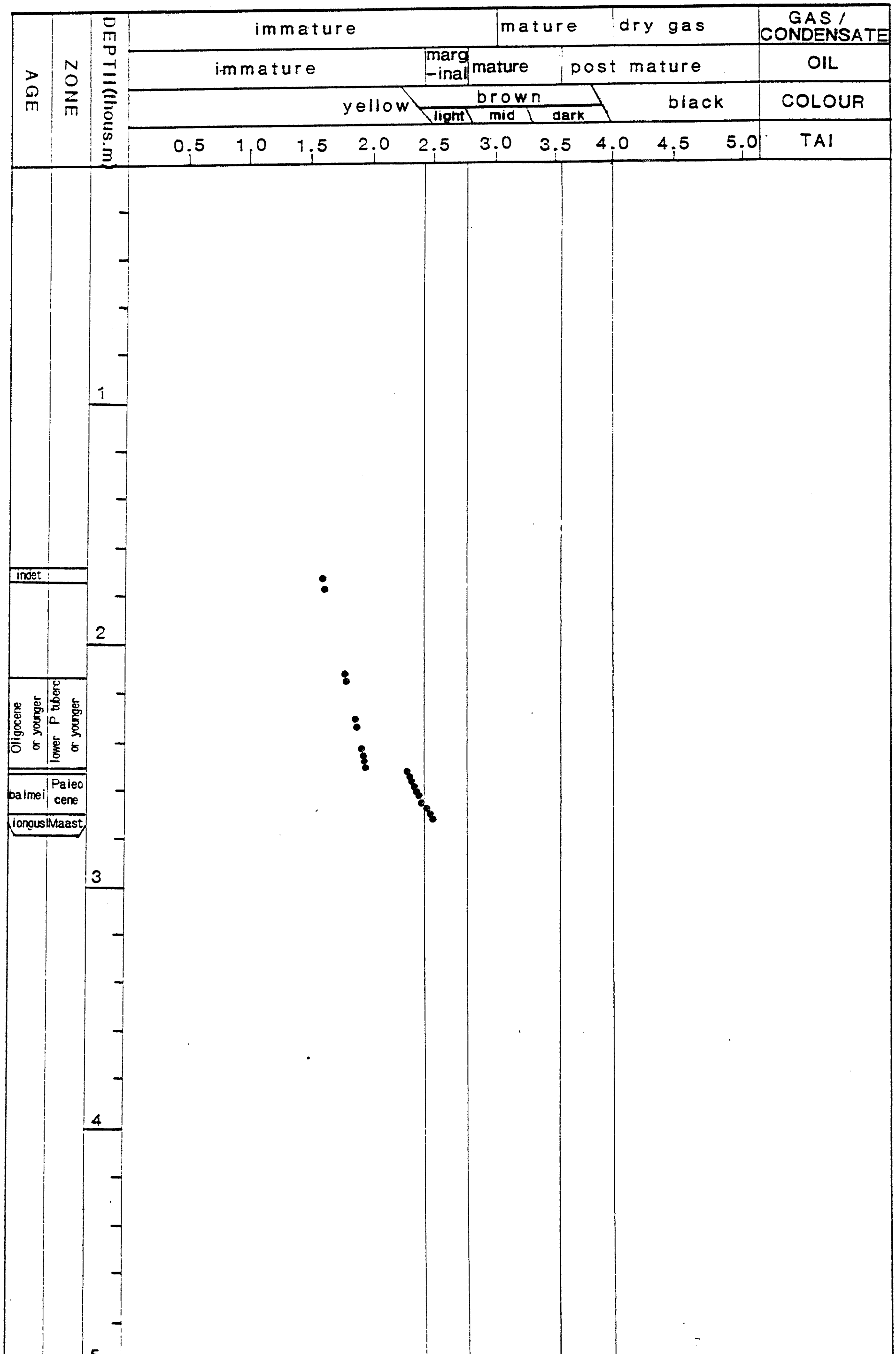


FIGURE 2 MATURITY PROFILE AYU 1

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.

Pages 12-15 have not been located. Information similar to this missing section ('Correlation with Roundhead-1') can be found in Section 5 of the attachment 'Ayu-1 Post Drilling Appraisal Report' (PE903115).

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

Helby, R.J., Morgan, R.P., and Partridge A.D., (1987) A palynological Zonation of the Australian Mesozoic Australas. Assoc. Palaeont.,. Mem. 4

Marshall, N.G. (1988) A Santonian dinoflagellate assemblage from the Gippsland Basin, Southeastern Australia Australas, Assoc, Palaentols. Mem. 5, 195-213

Marshall, N.G. and Partridge A.D. (1988) The Eocene acritarch Tritonites gen. nov. and the age of the Marlin Channel, Gippsland Basin, Southeastern Australia Australas. Assoc. Palaentols. Mem. 5, 239-257

Morgan, R.P. (1988) Petrofina Gippsland Cretaceous palynology project report 7 : regional synthesis unpubl. rpt. for Petrofina

Partridge A.D. (1976) The Geological Expression of Eustacy in the Early Tertiary of the Gippsland Basin Aust. Pet. Explor. Assoc. J., 16 : 73-79

AYU#1

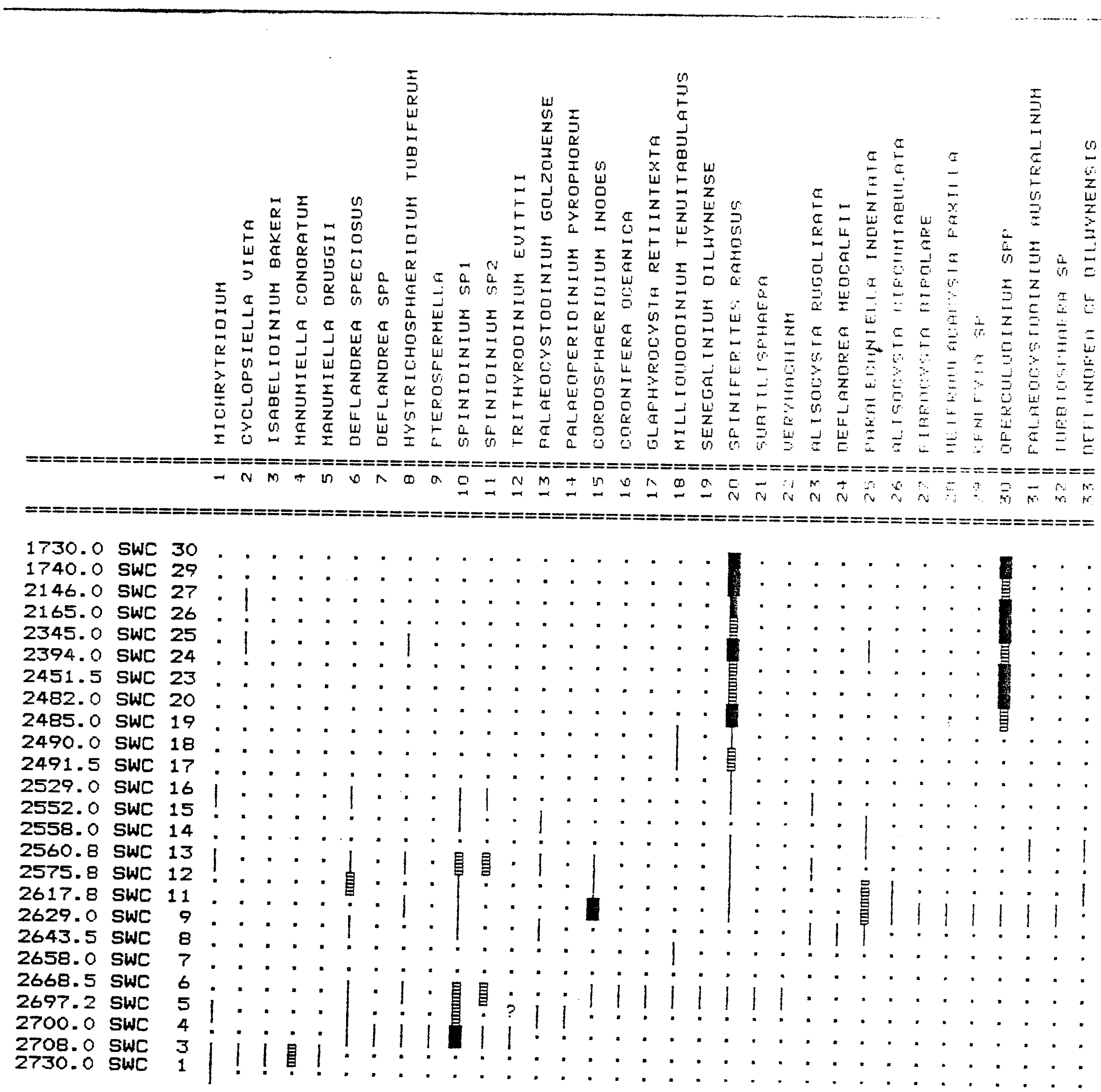
ROGER MORGAN : PALYNOLOGY CONSULTANT
BOX 161, MAITLAND, SOUTH AUSTRALIA, 5573
PHONE (088) 322795 FAX (088) 322658

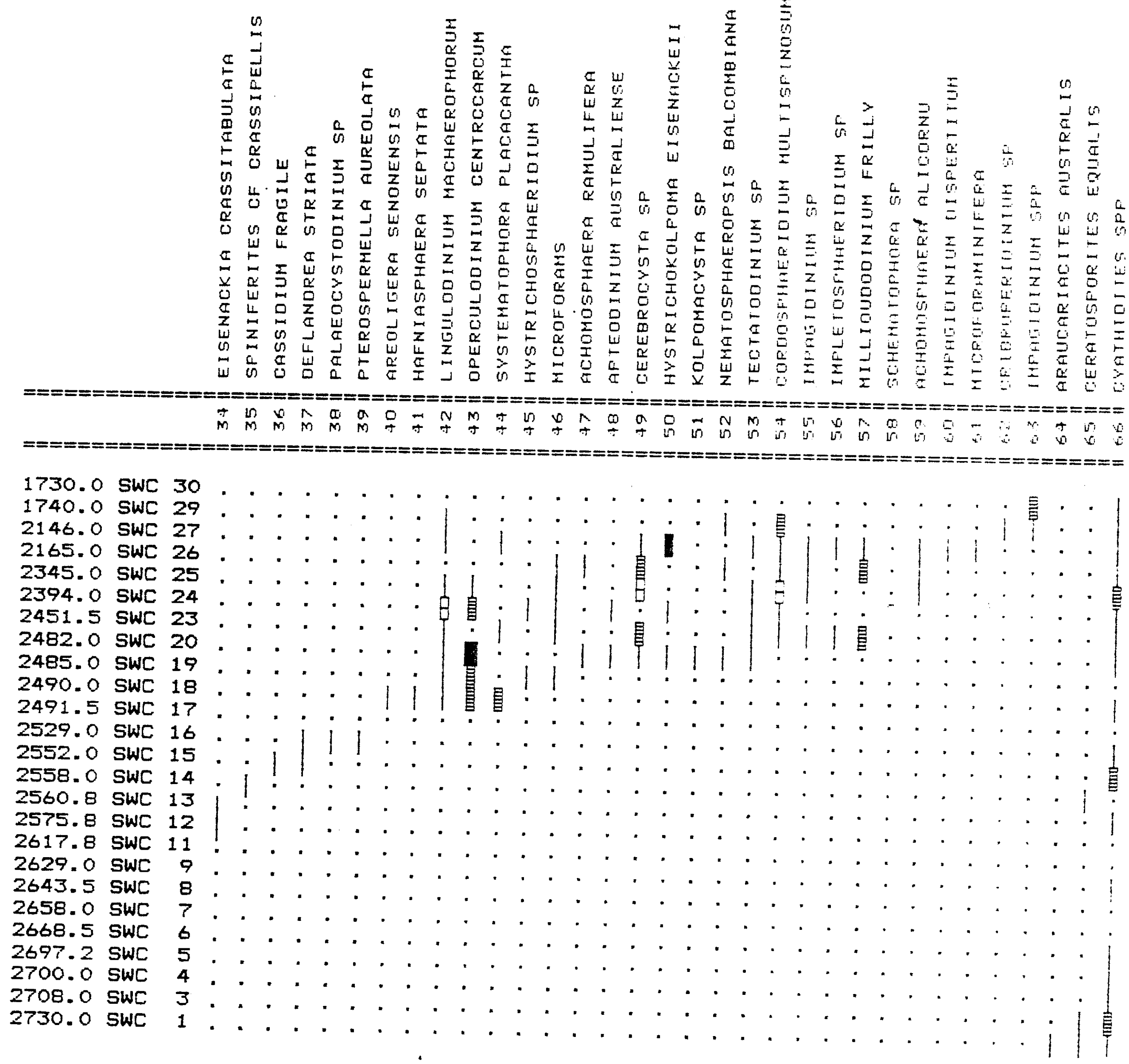
CLIENT:
WELL: AYU#1
FIELD/AREA:
SECTION: TOWNSHIP: RANGE:
COUNTY: STATE:
KB ELEVATION: TOTAL DEPTH:
ANALYST: ROGER MORGAN DATE: APRIL 90
NOTES: ALL DEPTHS IN METRES

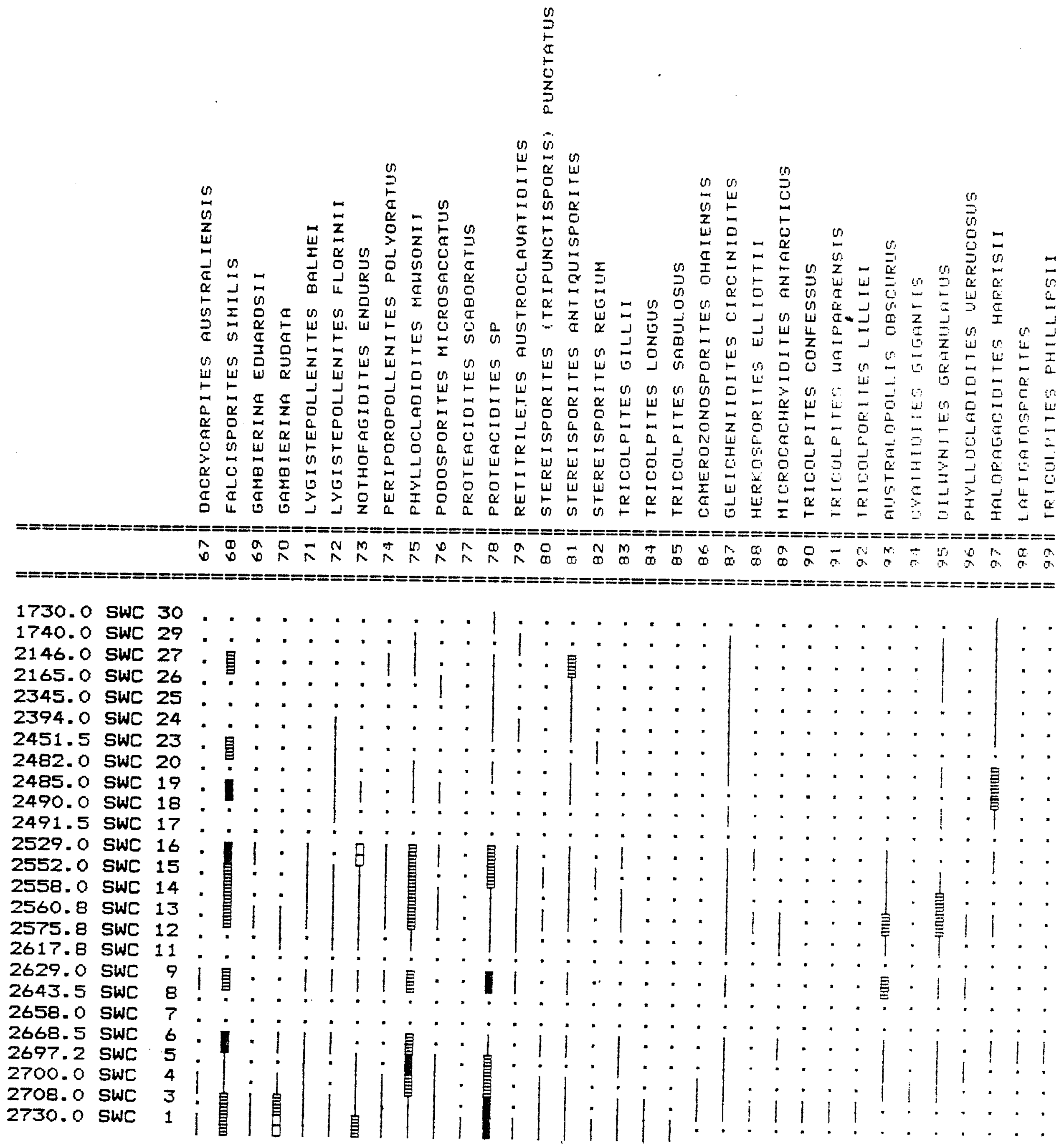
RANGE CHART OF GRAPHIC ABUNDANCES BY LOWEST APPEARANCE: Dino, S/P

Key to Symbols

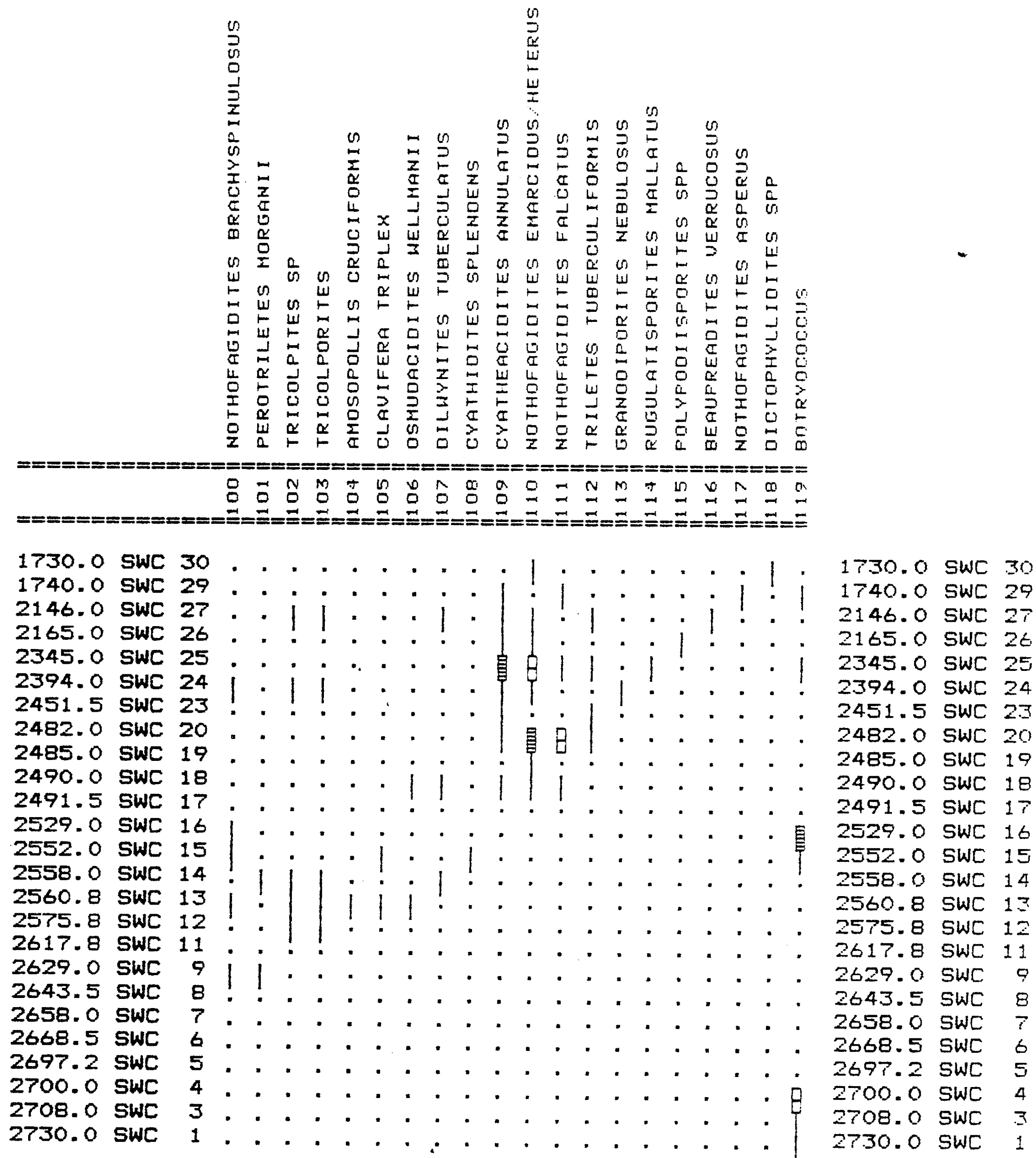
= Very Rare
= Rare
= Few
= Common
= Abundant
? = Questionably Present
. = Not Present


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
16 CORONIFERA OCEANICA
17 GLAPHYROCYSTA RETIINTEXTA
18 MILLIOUDODINIUM TENUITABULATUS
19 SENEGALINIUM DILWYNENSE
20 SPINIFERITES RAMOSUS
21 SURTILISPHAERA
22 VERYHACHIUM
23 ALISOCYSTA RUGOLIRATA
24 DEFLANDREA MEDCALFII
25 PARALECANIELLA INDENTATA
26 ALISOCYSTA CIRCUMTABULATA
27 FIBROCYSTA BIPOLARE
28 HETEROAULACACYSTA PAXILLA
29 KENLEYIA SP
30 OPERCULODINIUM SPP
31 PALAEOCYSTODINIUM AUSTRALINUM
32 TURBIOSPHAERA SP
33 DEFLANDREA CF DILWYNENSIS
1730.0 SWC 30
1740.0 SWC 29
2146.0 SWC 27
2165.0 SWC 26
2345.0 SWC 25
2394.0 SWC 24
2451.5 SWC 23
2482.0 SWC 20
2485.0 SWC 19
2490.0 SWC 18
2491.5 SWC 17
2529.0 SWC 16
2552.0 SWC 15
2558.0 SWC 14
2560.8 SWC 13
2575.8 SWC 12
2617.8 SWC 11
2629.0 SWC 9
2643.5 SWC 8
2658.0 SWC 7
2668.5 SWC 6
2697.2 SWC 5
2700.0 SWC 4
2708.0 SWC 3
2730.0 SWC 1
?


34 EISENACKIA CRASSITABULATA
35 SPINIFERITES CF CRASSIPELLIS
36 CASSIDIUM FRAGILE
37 DEFLANDREA STRIATA
38 PALAEOCYSTODINIUM SP
39 PTEROSPERMELLA AUREOLATA
40 AREOLIGERA SENONENSIS
41 HAFNIASPHAERA SEPTATA
42 LINGULODINIUM MACHAEROPHORUM
43 OPERCULODINIUM CENTROCARPUM
44 SYSTEMATOPHORA PLACACANTHA
45 HYSTRICHOSPHAERIDIUM SP
46 MICROFORAMS
47 ACHOMOSPHAERA RAMULIFERA
48 APTEODINIUM AUSTRALIENSE
49 CEREBROCYSTA SP
50 HYSTRICHOKOLPOMA EISENACKEII
51 KOLPOMACYSTA SP
52 NEMATOSPHAEROPSIS BALCOMBIANA
53 TECTATODINIUM SP
54 CORDOSPHAERIDIUM MULTISPINOSUM
55 IMPAGIDINIUM SP
56 IMPLETOSPHAERIDIUM SP
57 MILLIOUDODINIUM FRILLY
58 SCHEMATOPHORA SP
59 ACHOMOSPHAERA ALICORNU
60 IMPAGIDINIUM DISPERTITUM
61 MICROFORAMINIFERA
62 CRIBROPERIDINIUM SP
63 IMPAGIDINIUM SPP
64 ARAUCARIACITES AUSTRALIS
65 CERATOSPORITES EQUALIS
66 CYATHIDITES SPP
1730.0 SWC 30
1740.0 SWC 29
2146.0 SWC 27
2165.0 SWC 26
2345.0 SWC 25
2394.0 SWC 24
2451.5 SWC 23
2482.0 SWC 20
2485.0 SWC 19
2490.0 SWC 18
2491.5 SWC 17
2529.0 SWC 16
2552.0 SWC 15
2558.0 SWC 14
2560.8 SWC 13
2575.8 SWC 12
2617.8 SWC 11
2629.0 SWC 9
2643.5 SWC 8
2658.0 SWC 7
2668.5 SWC 6
2697.2 SWC 5
2700.0 SWC 4
2708.0 SWC 3
2730.0 SWC 1



67 DACRYCARPITES AUSTRALIENSIS
68 FALCISPORITES SIMILIS
69 GAMBIERINA EDWARDSII
70 GAMBIERINA RUDATA
71 LYGISTEPOLLENITES BALMEI
72 LYGISTEPOLLENITES FLORINII
73 NOTHOFAGIDITES ENDURUS
74 PERIPOROPOLLENITES POLYORATUS
75 PHYLLOCLADIDITES MAWSONII
76 PODOSPORITES MICROSACCATUS
77 PROTEACIDITES SCABORATUS
78 PROTEACIDITES SP
79 RETITRILETES AUSTROCLAVATIDITES
80 STEREISPORITES (TRIPUNCTISPORIS) PUNCTATUS
81 STEREISPORITES ANTIQUISPORITES
82 STEREISPORITES REGIUM
83 TRICOLPITES GILLII
84 TRICOLPITES LONGUS
85 TRICOLPITES SABULOSUS
86 CAMEROZONOSPORITES OHAIENSIS
87 GLEICHENIIDITES CIRCINIDITES
88 HERKOSPORITES ELLIOTTII
89 MICROCACHRYIDITES ANTARCTICUS
90 TRICOLPITES CONFESSUS
91 TRICOLPITES WAIPARAENSIS
92 TRICOLPORITES LILLIEI
93 AUSTRALOPOLLIS OBSCURUS
94 CYATHIDITES GIGANTIS
95 DILWYNITES GRANULATUS
96 PHYLLOCLADIDITES VERRUCOSUS
97 HALORAGACIDITES HARRISII
98 LAEVIGATOSPORITES
99 TRICOLPITES PHILLIPSII
1730.0 SWC 30
1740.0 SWC 29
2146.0 SWC 27
2165.0 SWC 26
2345.0 SWC 25
2394.0 SWC 24
2451.5 SWC 23
2482.0 SWC 20
2485.0 SWC 19
2490.0 SWC 18
2491.5 SWC 17
2529.0 SWC 16
2552.0 SWC 15
2558.0 SWC 14
2560.8 SWC 13
2575.8 SWC 12
2617.8 SWC 11
2629.0 SWC 9
2643.5 SWC 8
2658.0 SWC 7
2668.5 SWC 6
2697.2 SWC 5
2700.0 SWC 4
2708.0 SWC 3
2730.0 SWC 1


100 NOTHOFAGIDITES BRACHYSPINULOSUS
101 PEROTRILETES MORGANII
102 TRICOLPITES SP
103 TRICOLPORITES
104 AMOSOPOLLIS CRUCIFORMIS
105 CLAVIFERA TRIPLEX
106 OSMUNDACIDITES WELLMANII
107 DILWYNITES TUBERCULATUS
108 CYATHIDITES SPLENDENS
109 CYATHEACIDITES ANNULATUS
110 NOTHOFAGIDITES EMARCIDUS/HETERUS
111 NOTHOFAGIDITES FALCATUS
112 TRILETES TUBERCULIFORMIS
113 GRANODIPORITES NEBULOSUS
114 RUGULATISPORITES MALLATUS
115 POLYPODIISPORITES SPP
116 BEAUPREADITES VERRUCOSUS
117 NOTHOFAGIDITES ASPERUS
118 DICTOPHYLLIDITES SPP
119 BOTRYOCOCCUS
1730.0 SWC 30
1740.0 SWC 29
2146.0 SWC 27
2165.0 SWC 26
2345.0 SWC 25
2394.0 SWC 24
2451.5 SWC 23
2482.0 SWC 20
2485.0 SWC 19
2490.0 SWC 18
2491.5 SWC 17
2529.0 SWC 16
2552.0 SWC 15
2558.0 SWC 14
2560.8 SWC 13
2575.8 SWC 12
2617.8 SWC 11
2629.0 SWC 9
2643.5 SWC 8
2658.0 SWC 7
2668.5 SWC 6
2697.2 SWC 5
2700.0 SWC 4
2708.0 SWC 3
2730.0 SWC 1
1730.0 SWC 30
1740.0 SWC 29
2146.0 SWC 27
2165.0 SWC 26
2345.0 SWC 25
2394.0 SWC 24
2451.5 SWC 23
2482.0 SWC 20
2485.0 SWC 19
2490.0 SWC 18
2491.5 SWC 17
2529.0 SWC 16
2552.0 SWC 15
2558.0 SWC 14
2560.8 SWC 13
2575.8 SWC 12
2617.8 SWC 11
2629.0 SWC 9
2643.5 SWC 8
2658.0 SWC 7
2668.5 SWC 6
2697.2 SWC 5
2700.0 SWC 4
2708.0 SWC 3
2730.0 SWC 1

SPECIES LOCATION INDEX

Index numbers are the columns in which species appear.

INDEX NUMBER	SPECIES
59	ACHOMOSPHAERA ALICORNU
47	ACHOMOSPHAERA RAMULIFERA
26	ALISOCYSTA CIRCUMTABULATA
23	ALISOCYSTA RUGOLIRATA
104	AMOSOPOLLIS CRUCIFORMIS
48	APTEODINIUM AUSTRALIENSE
64	ARAUCARIACITES AUSTRALIS
40	AREOLIGERA SENONENSIS
93	AUSTRALOPOLLIS OBSCURUS
116	BEAUPREADITES VERRUCOSUS
119	BOTRYOCOCCUS
86	CAMEROZONOSPORITES OHAIENSIS
36	CASSIDIUM FRAGILE
65	CERATOSPORITES EQUALIS
49	CEREBROCYSTA SP
105	CLAVIFERA TRIPLEX
15	CORDOSPHAERIDIUM INODES
54	CORDOSPHAERIDIUM MULTISPINOSUM
16	CORONIFERA OCEANICA
62	CRIBROPERIDINIUM SP
109	CYATHEACIDITES ANNULATUS
94	CYATHIDITES GIGANTIS
108	CYATHIDITES SPLENDENS
66	CYATHIDITES SPP
2	CYCLOPSIELLA VIETA
67	DACRYCARPITES AUSTRALIENSIS
33	DEFLANDREA CF DILWYNENSIS
24	DEFLANDREA MEDCALFII
6	DEFLANDREA SPECIOSUS
7	DEFLANDREA SPP
37	DEFLANDREA STRIATA
118	DICTOPHYLLIDITES SPP
95	DILWYNITES GRANULATUS
107	DILWYNITES TUBERCULATUS
34	EISENACKIA CRASSITABULATA
68	FALCISPORITES SIMILIS
27	FIBROCYSTA BIPOLARE
69	GAMBIERINA EDWARDSII
70	GAMBIERINA RUDATA
17	GLAPHYROCYSTA RETIINTEXTA
87	GLEICHENIIDITES CIRCINIDITES
113	GRANODIPORITES NEBULOSUS
41	HAFNIASPHAERA SEPTATA
97	HALORAGACIDITES HARRISII
88	HERKOSPORITES ELLIOTTII
28	HETERAULACACYSTA PAXILLA
50	HYSTRICHOKOLPOMA EISENACKEII
45	HYSTRICHOSPHAERIDIUM SP
8	HYSTRICHOSPHAERIDIUM TUBIFERUM
60	IMPAGIDINIUM DISPERTITUM
55	IMPAGIDINIUM SP
63	IMPAGIDINIUM SPP
56	IMPLETOSPHAERIDIUM SP
3	ISABELIDINIUM BAKERI
29	KENLEYIA SP
51	KOLPOMACYSTA SP
98	LAEIGATOSPORITES
42	LINGULODINIUM MACHAEROPHORUM
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

APPENDIX 5

APPENDIX 5

WELL COMPLETION REPORT

AYU-1

INTERPRETATIVE DATA

A P P E N D I X   5

GEOCHEMISTRY

AMDEL CORE SERVICES

5 April 1990

Petrofina Exploration Australia SA
Level 2
476 St Kilda Road
MELBOURNE VIC 3004

Attention: Nick Grollman/Jean-Marie Questiaux

REPORT: 009/210

CLIENT REFERENCE: Fax from N Grollman 16/2/90

MATERIAL: Cuttings Samples

LOCALITY: Ayu -1

WORK REQUIRED: Source Rock Analysis

Please direct technical enquiries regarding this work to Brian L Watson (Adelaide) under whose supervision the work was carried out.

Dr Brian G Steveson
Manager Australasia
on behalf of Amdel Core Services Pty Ltd

C O N T E N T S

LIST OF TABLES

LIST OF FIGURES

1. INTRODUCTION

Rock-Eval pyrolysis, total organic carbon (TOC) and organic petrology analyses were requested on cuttings samples from Ayu -1, Vic-P-20 Gippsland Basin.

These analyses were requested to determine the maturity, source richness and source quality of the sedimentary section intersected in the Ayu -1 location. This report is a formal presentation of data reported by facsimile on 23rd March and 5th April 1990.

2. ANALYTICAL PROCEDURES

Analytical procedures used in this study are provided in Appendix 1.

3. RESULTS

Analytical data are presented in this report as follows:

	Table	Figure	Appendix
TOC and Rock-Eval data	1	1	-
Vitrinite Reflectance data	2	2	2
Descriptions of dispersed organic matter	3-5	-	-

4. INTERPRETATION

4.1 Maturity

Hydrogen Index and Tmax data (Table 1) indicate that the sediments intersected in the Ayu -1 location are immature for the generation of hydrocarbons (VR_{equiv} = 0.3-0.4%). Measured Vitrinite Reflectance values have a slightly different range (VR = 0.28-0.54%) and indicate that sediments below 2450 metres depth are sufficiently mature for the generation of oil from the thermally labile exinites resinite and bituminite (VR threshold = 0.45%). The higher measured Vitrinite Reflectance in comparison to the equivalent Vitrinite Reflectance (indicated by the Rock-Eval Hydrogen Index and Tmax data) is due to the presence of caved cuttings which were identified by organic petrology and not included in the measured values.

Extrapolation of the measured Vitrinite Reflectance data indicates that:

- sediments below ~3100 metres depth are sufficiently mature for the generation of gas from woody herbaceous kerogen (VR threshold = 0.6% (Monnier et al, 1983)

- sediments below approximately 3500 metres depth are sufficiently mature for the generation of oil from exinites other than that resinite and bituminite (VR >0.7%; Connan and Cassou, 1980).

Rock-Eval production indicies are also maturation dependent but show no clear trend of increasing with increasing depth. These values are also sensitive to the presence of migrated hydrocarbons. However, none of the samples analysed have production indicies which are indicative of the presence of migrated hydrocarbons.

4.2 Organic and Source Richness

Organic richness is uniformly poor in the majority of the sediments examined (TOC = 0.03-0.41%). However, some samples in the 2680-2740 metres depth interval have higher TOC values (0.90-10.50%) indicative of poor to excellent organic richness.

Source richness for the generation of hydrocarbons varies from poor to excellent in the samples examined (S_1 + S_2 = 0.07-32.32 kg of hydrocarbons/tonne). Samples with the best source richness also have the best organic richness and occur in the 2680-2740 metres depth interval (S_1 + S_2 = 2.42-32.32 kg of hydrocarbons/tonne). These sediments have fair to excellent source richness.

Organic petrology of these samples shows that the samples analysed below 2680 metres depth contain caved cuttings. Therefore these observations should be substantiated by either lithological descriptions of core (if available) or identification of coal bands from electric logs. This may be particularly important as the sample with the highest organic and source richness contains a high proportion of caved coals.

4.3 Kerogen Type and Source Quality

Rock-Eval hydrogen index and Tmax data indicate the sediments intersected in the Ayu -1 location contain organic matter which has bulk compositions ranging from that of Type IV to Type II-III kerogen. Organic petrology data shows that this organic matter consists largely of inertinite. Percentages of exinite and vitrinite range from low to moderate (exinite <5-15% of DOM; vitrinite <5-50% of DOM; Table 3). Exinite however is generally quite oxidised and has therefore probably lost much of its oil generative potential.

Samples with the best quality organic matter correspond to those intervals which have the best organic and source richness (ie sediments in the 2680-2740 metres depth interval). This relationship is probably due to variations in the degree of oxicity of the environment of deposition of these sediments. As the environment becomes less oxic, conditions become more favourable for the preservation of organic matter and the organic matter preserved becomes less oxidised.

Organic matter in the caved coals from the 2740 metres depth sample show little evidence of oxidation.

5. CONCLUSIONS

1. Vitrinite Reflectance measurements indicate that the sediments intersected in the Ayu -1 location are sufficiently mature for:

    - the generation of light oil from the thermally labile exinites (resinite and bituminite) below 2450 metres depth

- significant gas generation below ~3100 metres depth (VR threshold = 0.6%)

- the generation of oil from exinites other than resinite and bituminite below ~3500 metres depth.

2. Organic richness, source richness for the generation of hydrocarbons and source quality are uniformly poor over much of Ayu -1 sedimentary section studied. Sediments from 2680 and 2720-2740 metres depth have fair organic richness and fair to excellent source richness. These samples also contain better quality organic matter which has the bulk composition of Type II-III kerogen and is less oxidised than the other intervals examined. However, a high proportion of the coals present in the 2740 metres depth sample have caved from a stratigraphically higher unit.

TABLE 1

AMDEL CORE SERVICES

Rock-Eval Pyrolysis 23/03/90

Client: PETROFINA EXPLORATION AUSTRALIA S.A.

Well: AYU-1

Depth (m)	T Max	S1	S2	S3	S1+S2	PI	S2/S3	PC	TOC	HI	OI
2400									0.34		
2410	432	0.01	0.06	0.48	0.07	0.14	0.13	0.00	0.41	15	116
2415									0.34		
2420									0.34		
2430	420	0.05	0.29	0.35	0.34	0.15	0.83	0.02	0.33	85	106
2440									0.34		
2450	422	0.01	0.11	0.34	0.12	0.08	0.32	0.01	0.31	35	110
2460									0.32		
2470									0.23		
2480									0.14		
2490									0.11		
2500									0.07		
2510									0.08		
2520									0.15		
2530									0.05		
2540									0.09		
2550									0.18		
2560									0.15		
2570									0.18		
2580									0.03		
2590									0.06		
2600									0.04		
2610									0.09		
2620									0.08		
2630									0.05		
2640									0.07		
2650									0.23		
2670									0.17		
2680	425	0.14	2.28	0.73	2.42	0.06	3.13	0.20	0.90	253	81
2690	420	0.05	0.44	0.45	0.49	0.10	0.98	0.04	0.41	107	109
2700									0.15		
2710	424	0.07	0.53	0.49	0.60	0.12	1.09	0.05	0.40	132	122
2720	424	0.21	2.92	1.24	3.13	0.07	2.35	0.26	1.32	221	94
2730	424	0.12	2.35	0.80	2.47	0.05	2.93	0.20	0.90	261	89
2740	422	1.71	30.61	7.77	32.32	0.05	3.94	2.69	10.50	291	74

TABLE 2

SUMMARY OF VITRINITE REFLECTANCE MEASUREMENT, AYU -1

Depth (m)	Mean Maximum Reflectance	Standard Deviation	Range	Number of Determinations
1700	0.28	0.04	0.20 - 0.33	6
1750	0.31	0.06	0.24 - 0.43	10
1800	0.34	0.05	0.23 - 0.41	16
1850	0.33	0.03	0.24 - 0.40	17
1900	0.33	0.03	0.28 - 0.40	15
1950	-	-	-	-
2000	0.32	0.01	0.32 - 0.33	3
2050	0.35	0.04	0.30 - 0.40	5
2100	0.41	0.06	0.30 - 0.47	6
2150	0.45	0.02	0.43 - 0.47	2
2200	-	-	-	-
2250	0.39	0.05	0.32 - 0.48	9
2300	0.41	0.04	0.36 - 0.45	2
2350	-	-	-	-
2410	0.44	0.02	0.42 - 0.46	2
2450	0.45	0.04	0.41 - 0.55	8
2470	0.49	0.03	0.45 - 0.54	8
2550	-	-	-	-
2600	0.47	0.01	0.46 - 0.48	3
2660	0.47	0.01	0.45 - 0.49	3
2680	0.49	0.11	0.39 - 0.67	4
2740	0.54	0.04	0.39 - 0.54	4

TABLE 3

PERCENTAGE OF VITRINITE, INERTINITE AND EXINITE IN

DISPERSED ORGANIC MATTER

Depth	Percentage of Vitrinite	Percentage of Inertinite	Percentage of Exinite
1700	5-10	75-80	15
1750	5	80	15
1800	<5	90	5-10
1850	<5	90	5-10
1900	10	80-85	5-10
1950	10	80-85	5-10
2000	<5	85-90	5-10
2050	5-10	85	5-10
2100	<5	90	5
2150	<5	90	5
2200	<5	90	5
2250	<5	90	5
2300	<5	90	5
2350	<5	90	5
2410	<5	90	5
2450	<5	90	<5
2470	<5	85	10
2550	<5	85	10
2600	<5	85	10
2660	<5	90	5
2680	<5	90	5
2740	50	35-40	10-15

TABLE 4

ORGANIC MATTER TYPE AND ABUNDANCE, AYU -1

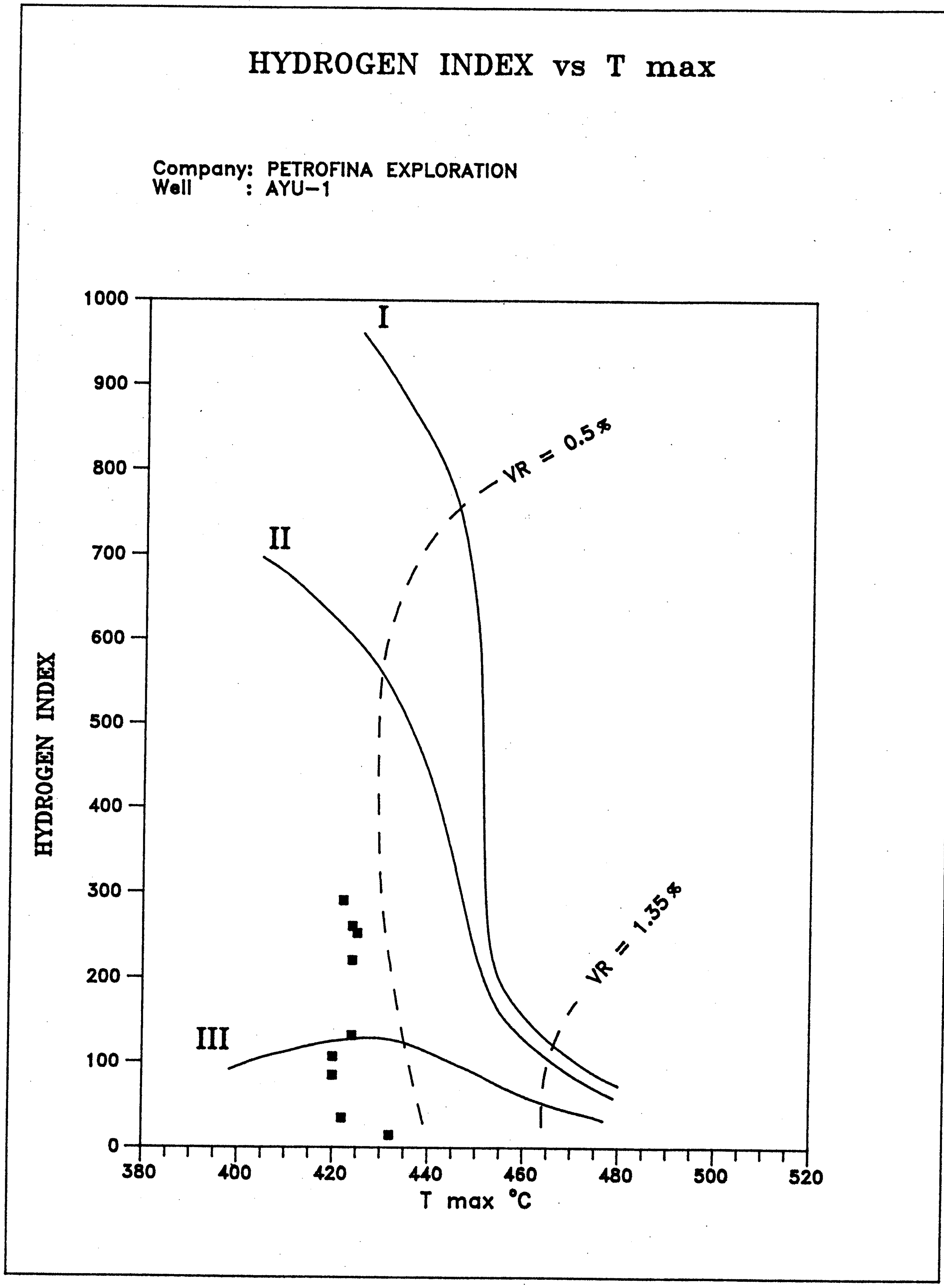
Depth (m)	Estimated DOM	Volume of Exinites	Exinite Macerals
1700	<0.5	Ra-Vr	lama, lipto, phyto, bmite, ??oil
1750	<0.5	Ra-Vr	lipto, lama, bmite, phyto
1800	~0.5	Ra-Vr	lipto, lama
1850	~0.5	Ra-Vr	lipto, phyto
1900	~0.5	Ra-Vr	lipto
1950	<0.5	Ra-Vr	lipto, lama
2000	~0.5	Ra-Vr	lipto
2050	~0.5	Ra	lipto, lama, phyto
2100	<0.5	Ra	lipto, phyto
2150	<0.5	Vr	lipto, phyto
2200	<0.5	Vr	lipto
2250	<0.5	Vr	lipto
2300	<0.5	Vr	lipto, lama
2350	<0.5	Vr	lipto, phyto
2410	~0.5	Vr	lipto, spo
2450	<0.5	Vr	lipto
2470	<0.5	Vr	lipto
2550	<0.5	Vr	lipto, cut
2600	<0.5	Vr-Tr	lipto
2660	<0.5	Vr-Tr	lipto
2680	<0.5	Vr	lipto, spo, phyto
2740	3-5	Ra	spo, cut, lipto, res, phyto

TABLE 5

EXINITE MACERAL ABUNDANCE AND FLUORESCENCE CHARACTERISTICS, AYU -1

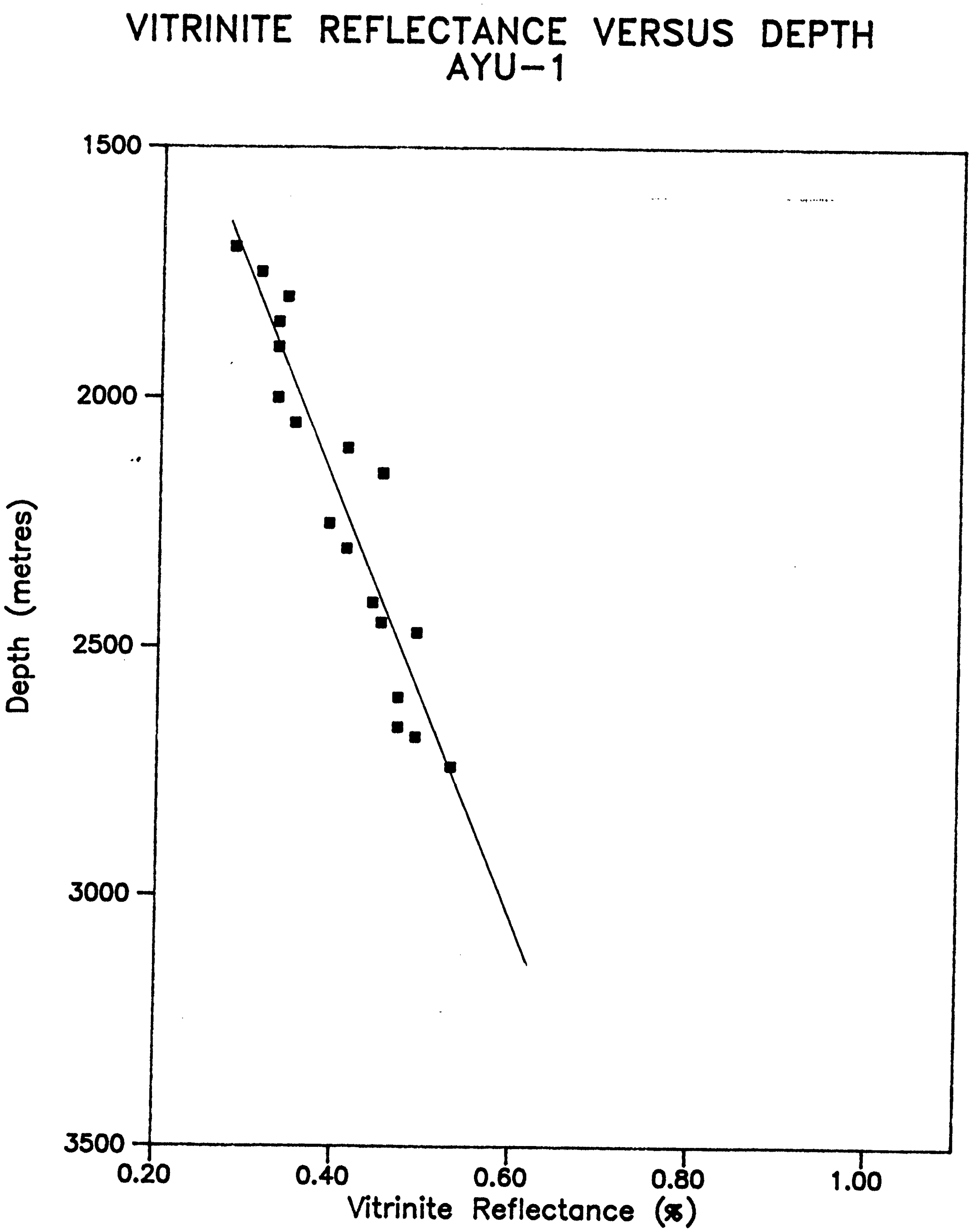
Depth (m)	Exinite Macerals	Lithology/Comments
1700	lama(Vr;mO-dB), lipto(Vr;mY-mO), phyto(Vr-Tr;iY-dO), bmite(Vr-Tr;mO) ??oil(Tr;iY)	Carbonate rich silty shale; some exinite is oxidised
1750	lipto(Vr;mY-mO), lama(Vr-Tr;mY), bmite (Vr-Tr;mO-dO),phyto(Tr;mY)	Shale; exinite as above
1800	lipto(Ra-Vr;mY-mO),lama(Vr;mO-dB)	Shale; exinite as above
1850	lipto(Ra-Vr;mY-dO),phyto(Tr;mY-mO)	Shale; exinite as above
1900	lipto(Ra-Vr;mY-dB)	Shale; exinite is oxidised
1950	lipto(Vr-mY-dB),lama(Tr;mY-mO)	Shale; exinite as above
2000	lipto(Ra-Vr;mO-dB)	Shale; exinite as above
2050	lipto(Ra;mO-dO),lama(Vr;mO-dO), phyto(Tr;mO-dO)	Shale; exinite as above
2100	lipto(Ra-Vr;mY-dO),phyto(Tr;mY)	Shale; exinite as above
2150	lipto(Vr;mY-dO),phyto(Tr;iY)	Shale; exinite as above
2200	lipto(Vr;mY-dB)	Shale; exinite as above
2250	lipto(Vr;mO-dB)	Shale; exinite as above
2300	lipto(Vr;mY-dB), lama(Tr;mO)	Shale; some exinite is oxidised
2350	lipto(Vr;mY-dB), phyto(Tr;dO-dB)	Shale; most exinite is oxidised
2410	lipto(Vr;dO-dB), spo(Tr;mO)	Shale; exinite is oxidised
2450	lipto(Vr;dO-dB)	Shale; exinite as above
2470	lipto(Vr;dO)	Shale; exinite as above
2550	lipto(Vr;dO-dB), cut(Tr;mO)	Chiefly sandstone, <5% shale; most exinite is oxidised
2600	lipto(Vr-Tr;dO)	Chiefly sandstone, ~5% shale; exinite as above
2660	lipto(Vr-Tr;dO)	Chiefly sandstone, ~5% shale; exinite as above
2680	lipto(Vr;mO-dO), spo(Tr;mO) phyto(Tr;mO)	Chiefly sandstone, ~5% shale, exinite as above
2740	spo(Ra;mO), cut(Ra;mO), lipto (Ra;mO-dO), res(Vr;iYG-iG),phyto (Tr;iY)	Chiefly sandstone, ~5% coal and shale. Coals are cavings

FIGURE 1



HYDROGEN INDEX vs T max
Company: PETROFINA EXPLORATION
Well : AYU-1
I
II
III
VR = 0.5%
VR = 1.35%
HYDROGEN INDEX
T max °C
1000
900
800
700
600
500
400
300
200
100
0
380
400
420
440
460
480
500
520

FIGURE 2



VITRINITE REFLECTANCE VERSUS DEPTH
AYU-1
1500
2000
2500
3000
3500
Depth (metres)
0.20
0.40
0.60
0.80
1.00
Vitrinite Reflectance (%)

APPENDIX 1

ANALYTICAL PROCEDURES

1. Total Organic Carbon (TOC)

Total organic carbon was determined by digestion of a known weight (≈0.2 g) of powdered rock in HCl to remove carbonates, followed by combustion in oxygen in the induction furnace of a Leco IR-12 Carbon Determinator and measurement of the resultant CO_2 by infra-red detection.

2. Rock-Eval Pyrolysis

A 100 mg portion of powdered rock was analysed by the Rock-Eval pyrolysis technique (Girdel IFP-Fina Mark 2 instrument; operating mode, Cycle 1).

3. Organic Petrology

Representative portions of the cuttings samples crushed (to -14+35 BSS mesh) were obtained with a sample splitter and then mounted in cold setting Glasscraft resin using a 2.5 cm diameter mould. Each block was ground flat using diamond impregnated laps and carborundum paper. The surface was then polished with aluminium oxide and finally magnesium oxide.

Reflectance measurements on vitrinite phytoclasts, were made with a Leitz MPV1.1 microphotometer fitted to a Leitz Ortholux microscope and calibrated against synthetic standards. All measurements were taken using oil immersion (n = 1.518) and incident monochromatic light (wavelength 546 nm) at a temperature at 24±°C. Fluorescence observations were made on the same microscope utilising a 3 mm BG3 excitation filter, a TK400 dichroic mirror and a K510 suppression filter.

APPENDIX 2

HISTOGRAM PLOTS OF VITRINITE REFLECTANCE MEASUREMENTS

VITRINITE REFLECTANCE VALUES

Well Name: AYU-1
Depth: 1700 m

Sorted List

0.20
0.26
0.28
0.28
0.32
0.33

Number of values= 6

Mean of values 0.28
Standard Deviation 0.04

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

20-22	*
23-25	
26-28	*
29-31	**
32-34	**

VITRINITE REFLECTANCE VALUES

Well Name: AYU-1
Depth: 1750 m

Sorted List

0.24
0.25
0.25
0.27
0.28
0.30
0.31
0.33
0.39
0.43

Number of values= 10

Mean of values 0.31
Standard Deviation 0.06

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

24-26	***
27-29	**
30-32	**
33-35	*
36-38	
39-41	*
42-44	*

VITRINITE REFLECTANCE VALUES

Well Name: AYU-1
Depth: 1800 m

Sorted List

0.23	0.35
0.30	0.35
0.30	0.37
0.30	0.40
0.30	0.41
0.32	0.41
0.33	
0.33	
0.33	
0.33	

Number of values= 16

Mean of values 0.34
Standard Deviation 0.05

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

23-25	*
26-28	
29-31	****
32-34	*****
35-37	***
38-40	*
41-43	**

VITRINITE REFLECTANCE VALUES

Well Name: AYU-1
Depth: 1850 m

Sorted List

0.24	0.34
0.30	0.35
0.31	0.35
0.31	0.35
0.32	0.35
0.32	0.35
0.32	0.40
0.32	
0.33	
0.34	

Number of values= 17

Mean of values 0.33
Standard Deviation 0.03

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

24-26	*
27-29	
30-32	*******
33-35	********
36-38	
39-41	*

VITRINITE REFLECTANCE VALUES

Well Name: AYU-1
Depth: 1900 m

Sorted List

0.28	0.35
0.31	0.35
0.31	0.37
0.31	0.37
0.31	0.40
0.31	
0.33	
0.33	
0.33	
0.34	

Number of values= 15

Mean of values 0.33
Standard Deviation 0.03

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

28-30	*
31-33	********
34-36	***
37-39	**
40-42	*

VITRINITE REFLECTANCE VALUES

Well Name: AYU-1
Depth: 2000 m

Sorted List

0.32
0.32
0.33

Number of values= 3

Mean of values 0.32
Standard Deviation 0.00

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

32-34 ***

VITRINITE REFLECTANCE VALUES

Well Name:	AYU-1
Depth:	2050 m

Sorted List

0.30
0.32
0.35
0.37
0.40

Number of values=	5
Mean of values	0.35
Standard Deviation	0.04

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

30-32	**
33-35	*
36-38	*
39-41	*

VITRINITE REFLECTANCE VALUES

Well Name: AYU-1
Depth: 2100 m

Sorted List

0.30
0.38
0.38
0.43
0.47
0.47

Number of values= 6

Mean of values 0.41
Standard Deviation 0.06

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

30-32	*
33-35	
36-38	**
39-41	
42-44	*
45-47	**

VITRINITE REFLECTANCE VALUES

Well Name: AYU-1
Depth: 2150 m

Sorted List

0.43
0.47

Number of values= 2

Mean of values 0.45
Standard Deviation 0.02

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

43-45 *
46-48 *

VITRINITE REFLECTANCE VALUES

Well Name: AYU-1
Depth: 2250 m

Sorted List

0.32
0.33
0.34
0.37
0.39
0.40
0.43
0.43
0.48

Number of values= 9

Mean of values 0.39
Standard Deviation 0.05

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

32-34	***
35-37	*
38-40	**
41-43	**
44-46	
47-49	*

VITRINITE REFLECTANCE VALUES

Well Name: AYU-1
Depth: 2300 m

Sorted List

0.36
0.45

Number of values= 2

Mean of values 0.41
Standard Deviation 0.04

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

36-38	*
39-41	
42-44	
45-47	*

VITRINITE REFLECTANCE VALUES

Well Name: AYU-1
Depth: 2410 m

Sorted List

0.42
0.44
0.46

Number of values= 3

Mean of values 0.44
Standard Deviation 0.02

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

```
42-44    **
45-47    *
```

VITRINITE REFLECTANCE VALUES

Well Name: AYU-1
Depth: 2450 m

Sorted List

0.41
0.42
0.43
0.43
0.44
0.44
0.44
0.55

Number of values= 8

Mean of values 0.45
Standard Deviation 0.04

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

41-43	****
44-46	***
47-49	
50-52	
53-55	

VITRINITE REFLECTANCE VALUES

Well Name: AYU-1
Depth: 2470 m

Sorted List

0.45
0.45
0.46
0.49
0.50
0.50
0.51
0.54

Number of values= 8

Mean of values 0.49
Standard Deviation 0.03

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

45-47	***
48-50	***
51-53	*
54-56	*

VITRINITE REFLECTANCE VALUES

Well Name:	AYU-1
Depth:	2680 m

Sorted List

0.39
0.41
0.47
0.67

Number of values=	4
Mean of values	0.49
Standard Deviation	0.11

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

39-41	**
42-44	
45-47	*
48-50	
51-53	
54-56	
57-59	
60-62	
63-65	
66-68	*

VITRINITE REFLECTANCE VALUES

Well Name: AYU-1
Depth: 2600 m

Sorted List

0.46
0.47
0.48

Number of values= 3

Mean of values 0.47
Standard Deviation 0.01

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

46-48 ***

VITRINITE REFLECTANCE VALUES

Well Name:	AYU-1
Depth:	2660 m

Sorted List

0.45
0.47
0.49

Number of values=	3
Mean of values	0.47
Standard Deviation	0.02

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

45-47	**
48-50	*

AYU-1

GEOCHEMISTRY REPORT

SUMMARY AND CONCLUSIONS

Rock Eval pyrolysis analysis was performed on 35 samples covering the interval 2400m to 2740m (TD = 2750m). Vitrinite reflectance measurements and visual maceral type determination was performed over a further 22 samples equally spaced over the interval 1700m to 2740m. Geothermal gradient and Pyrolysis results are summarized on Figures 1, 2 and 3.

Conclusions are:

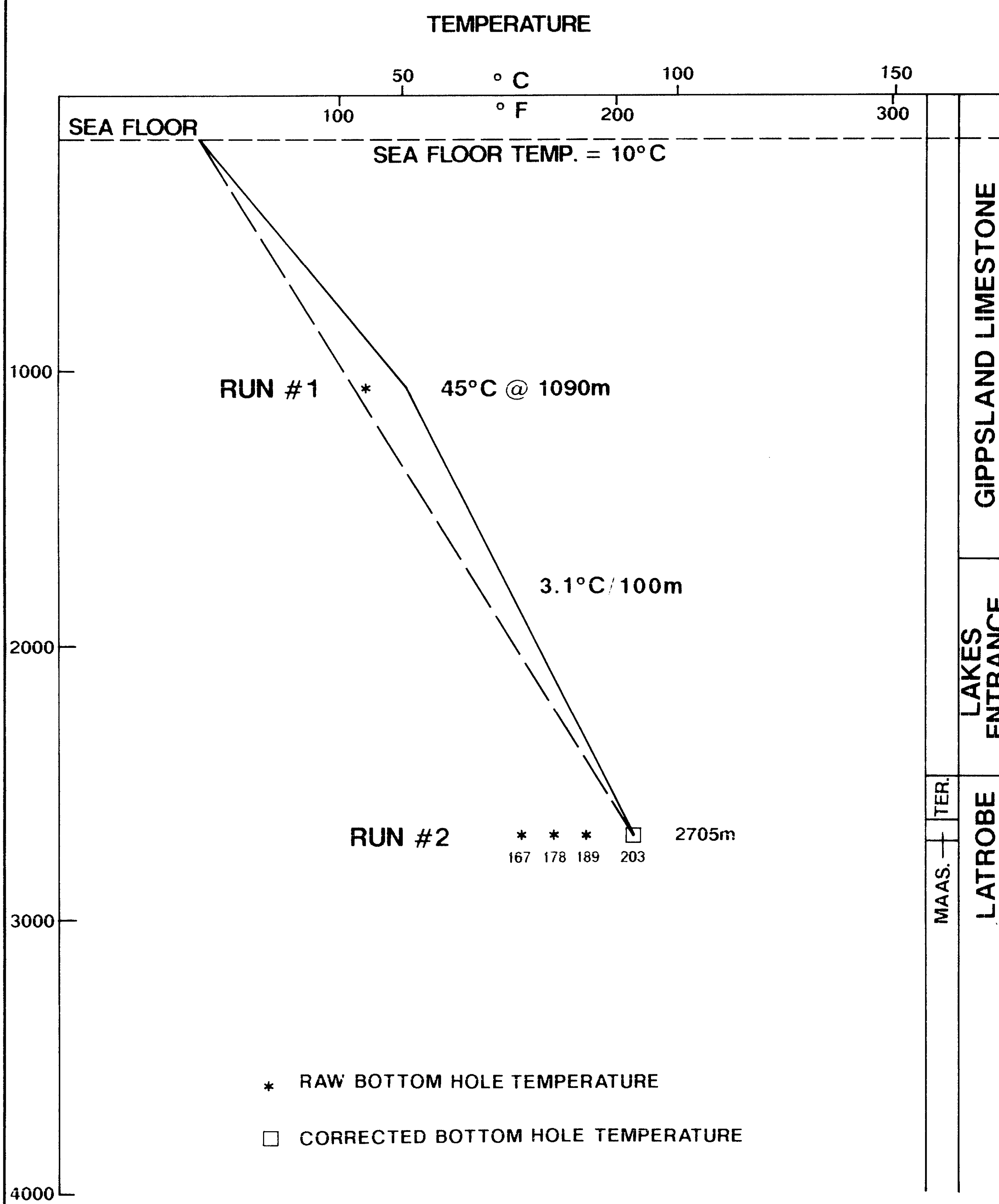
1. The geothermal gradient is high at 3.1°C/100m (Fig. 1), comparable to Hermes-1 where the gradient was 2.9°C/100m over the equivalent interval.

2. The source rock richness based on TOC, S1 and S2 parameters is very poor except for the coaly sequence near Top Maastrichtian in the basal 25m of the well (Figs. 1 and 2) where the source rock can be described as good to very good quality.

3. Based on the Production Index (PI); Tmax and Vitrinite Reflectance levels, all potential source rocks intersected at Ayu-1 are immature (Figs. 2 and 3).

4. Source rock types range from essentially type IV to a mixture of type II and type III organic matter, with inertinite the predominant maceral material.

AYU-1 TEMPERATURE/DEPTH



J-M. Q. MARCH 1990

FIGURE 1

G 667

PE902106

This is an enclosure indicator page.
The enclosure PE902106 is enclosed within the container PE902102 at this location in this document.

The enclosure PE902106 has the following characteristics:

ITEM_BARCODE =	PE902106
CONTAINER_BARCODE =	PE902102
NAME =	Stratigraphy & Pyrolysis Data
BASIN =	GIPPSLAND
PERMIT =	
TYPE =	WELL
SUBTYPE =	DIAGRAM
DESCRIPTION =	Stratigraphy & Pyrolysis Data
REMARKS =	
DATE_CREATED =	31/05/1990
DATE_RECEIVED =	02/07/1990
W_NO =	W1020
WELL_NAME =	Ayu-1
CONTRACTOR =	Petrofina exploration
CLIENT_OP_CO =	Petrofina exploration

(Inserted by DNRE - Vic Govt Mines Dept)

PE902107

This is an enclosure indicator page.
The enclosure PE902107 is enclosed within the container PE902102 at this location in this document.

The enclosure PE902107 has the following characteristics:

ITEM_BARCODE =	PE902107
CONTAINER_BARCODE =	PE902102
NAME =	Geochemsitry & Maturity of the Latrobe group
BASIN =	GIPPSLAND
PERMIT =	
TYPE =	WELL
SUBTYPE =	DIAGRAM
DESCRIPTION =	Geochemsitry & Maturity of the Latrobe group
REMARKS =	
DATE_CREATED =	31/05/1990
DATE_RECEIVED =	02/07/1990
W_NO =	W1020
WELL_NAME =	Ayu-1
CONTRACTOR =	Petrofina exploration
CLIENT_OP_CO =	Petrofina exploration

(Inserted by DNRE - Vic Govt Mines Dept)

APPENDIX
6

WELL COMPLETION REPORT

AYU-1

INTERPRETATIVE DATA

A P P E N D I X 6

COMPOSITE LOG

PE600971

This is an enclosure indicator page.
The enclosure PE600971 is enclosed within the container PE902102 at this location in this document.

The enclosure PE600971 has the following characteristics:

ITEM_BARCODE =	PE600971
CONTAINER_BARCODE =	PE902102
NAME =	Composite Well log
BASIN =	GIPPSLAND
PERMIT =	
TYPE =	WELL
SUBTYPE =	COMPOSITE_LOG
DESCRIPTION =	Composite Well log
REMARKS =	
DATE_CREATED =	19/02/1990
DATE_RECEIVED =	02/07/1990
W_NO =	W1020
WELL_NAME =	Ayu-1
CONTRACTOR =	Petrofina exploration
CLIENT_OP_CO =	Petrofina exploration

(Inserted by DNRE - Vic Govt Mines Dept)

APPENDIX 7

WELL COMPLETION REPORT

AYU-1

INTERPRETATIVE DATA

A P P E N D I X 7

MICROPALAEONTOLOGY

MICROPALAEONTOLOGICAL REPORT ON THE
PETROFINA EXPLORATION AUSTRALIA S.A.
AYU-1 WELL
GIPPSLAND BASIN, AUSTRALIA

M. Apthorpe
Apthorpe Palaeontology Pty Ltd
35 Bailey Street,
TRIGG, WA, 6029

21 May 1990

CONTENTS

1. INTRODUCTION.

A total of 32 samples comprising 19 ditch cuttings and 13 sidewall cores from the Ayu-1 well were submitted for micropalaeontological examination by Petrofina Exploration Australia S.A.

Most of the carbonate sequence comprises Miocene deep water sediments. Down to 1400m the sequence appears to have been a normal, outer shelf to uppermost slope depositional regime. From 1450 to 1730m impoverished faunas in a hard calcisiltite, with some evidence of size sorting, suggest the possibility of a canyon fill or slump deposit of Late Miocene age. Beneath this, a normal marine Middle Miocene sequence was deposited in upper bathyal water depths. Similar water depths are inferred for the Early Miocene section between approximately 2000m and 2394m. An interval of deep water sediments of Late Oligocene age makes up the base of the carbonate section. The thickness of Late Oligocene present is somewhere between 9 and 95 metres. Unfortunately a critical sidewall core at 2451.5m is either mislabelled, or else sampled a lump of younger sediment in the borehole wall, because this sample is clearly out of sequence. Given the absence of other sidewall cores at around this depth, the top of the Oligocene cannot be placed more closely.

The zonation used, that of D.J.Taylor for the Gippsland Basin (see, for example, Taylor: 1966, 1983), is the same as that used in previous well reports on Angler-1 and Anemone-1.

2. LIST OF SAMPLES EXAMINED.

DC = ditch cutting; SWC = sidewall core. All depths in metres below rotary table.

DC 1250
DC 1300
DC 1350
DC 1400
DC 1450
DC 1500
DC 1550
DC 1650
DC 1700
SWC 1730
SWC 1740
DC 1800
DC 1850
DC 1900
DC 1950
DC 2000
DC 2050
DC 2100
SWC 2146
SWC 2165
DC 2200
DC 2250
DC 2300
SWC 2345
SWC 2394
SWC 2451.5 out of sequence
SWC 2482
SWC 2485
SWC 2490

SWC 2491
SWC 2527
SWC 2552

3. NATURE AND AGE SIGNIFICANCE OF THE FORAMINIFERAL ASSEMBLAGES.

1250 - 1350 metres : probably Zone B-2 : Late Miocene.

The moderately hard calcisiltite present in ditch cuttings in this interval has released some fauna, but most specimens are of benthonic habitat, and are not age indicators. Evidence of the age is derived from the presence of *Globorotalia conoidea*, the age of which is dominantly Late Miocene (although occasionally reported from the Early Pliocene, according to Jenkins, 1986). *Globorotalia conomiozea* and *Globorotalia miotumida* are both found in the ditch cutting at 1250m. In Taylor's letter zonation for Gippsland, these species do not overlap, but their presence together here is probably due to caving. The presence of *G. miotumida* indicates an age at least as old as Zone B-2. *Turborotalia acostaensis acostaensis*, although very rare, suggests that the age is no older than B-2. The presence of *Globorotalia lenguaensis* in the ditch cutting at 1300m tends to confirm a B-2 determination.

The varied benthos is dominated by *Uvigerina peregrina* and *U. bassensis*, particularly in the highest sample. Other genera common in the interval are *Lenticulina*, *Cibicides*, *Florilus subturgidus* and *Sphaeroidina bulloides*. The depositional environment suggested is outer shelf to shelf/slope break.

1400 - 1700 metres : undifferentiated Zone B-2 / Zone C : Late to topmost Middle Miocene.

This interval contains impoverished planktonic faunas with almost no index species. The presence of *Globorotalia miotumida* and *G. lenguaensis* in the top 50m suggests a Zone B-2 age, but *Turborotalia acostaensis* was not found, and the zone could be as old as C. Below 1500m planktonic specimens are extremely rare (and in one sample absent) and between 1550 and 1650m the age is indeterminable. At 1700m a small amount of planktonic fauna is present in a predominantly benthonic assemblage. The presence of *Globorotalia miotumida* and *G. scitula*, in the absence of older species, suggests an age of undifferentiated Zone B-2 to C down to this depth.

At 1730 metres : probably Zone B-2 : probably Late Miocene.

The highest sidewall core in the well is a hard calcisiltite with a substantial number of minute-sized foraminifera released from the matrix, but with most of the adult-sized specimens embedded in the rock matrix, or damaged when broken out. As a result, there are few specimens available on which to base an age determination. The age rests on the presence of *Globorotalia miotumida* and a single specimen of *Turborotalia* cf. *acostaensis*, providing slender evidence for a B-2 determination. As the sample lies at the base of a major, fairly uniform section of calcisiltites, the age is obviously critical for much of the interval above.

The suggestion of size sorting seen in this sample, plus the impoverished character of the faunas seen above, despite occasional indications of deep water, suggests that the whole sequence between 1450 and 1730m may be a canyon fill deposit, or at least composed of slumped and rapidly re-deposited shelf sediment.

At 1740 metres : low in Zone C : Middle Miocene.

Electric log evidence suggests that this sample is part of a different sequence from the sidewall core ten metres above. This is confirmed by the differences in lithology and the much richer fauna seen in this sample. The genus *Globorotalia* is abundant. *G. miotumida* and *G. scitula* are both common, suggesting an age no older than the base of Zone C. *G. conica* is moderately abundant. Taylor defines the top of Zone D-1 on the highest appearance of this species, and overlaps the ranges of *G. conica* and *G. miotumida* only at the boundary of the zones; but Jenkins (1986) reports that in New Zealand the ranges of the two species overlap within the *G. mayeri* zone (roughly the equivalent of Gippsland Zone C). *G. peripheroronda* and *Praeorbulina glomerosa circularis* both range up into the basal part of Zone C. Consequently an age very low in Zone C is suggested.

The depositional environment is interpreted as normal marine, upper bathyal depths, based on the presence of *Vulvulina pennatula*, *Karreriella bradyi* and very rare *Planulina wuellerstorfi* in a diverse assemblage.

1800 - 1850 metres : Zone D-1 : Middle Miocene.

These ditch cuttings contain an abundant fauna in a grey calcisiltite which has been partially metamorphosed by drill-bit friction. The abundance of *Globorotalia scitula* and *G. miotumida* superficially suggests Zone C. However the presence of Globorotalia miozea plus a moderate number of G. peripheroacuta indicate Zone D-1. The presence of G. miotumida is presumed to be the result of caving. Globoquadrina larmeui and Globorotalia panda make their highest appearance in the sample at 1800m.

The benthonic assemblages of both samples are very diverse. Significant for environmental interpretation is the presence at 1850m of Planulina wuellerstorfi, Osangularia bengalensis, Sigmoilopsis schlumbergeri and Karreriella bradyi. The latter sample is clearly of upper bathyal (=upper slope) facies.

1900 - 1950 metres : Zone D or E-1 : Middle Miocene.

The differentiation of Zones D and E, by means of ditch cuttings in which caving is suspected, is difficult if not impossible. The boundary between D-2 and E-1 is defined on the evolutionary appearance of Orbulina universa, an event which is readily obscured by the caving of the species from strata higher in the borehole. Nonetheless, the decline in numbers of the species around this level does suggest that the boundary lies somewhere in this interval. The ditch cutting at 1900m contains, among other species, Globorotalia peripheroacuta and G. praefohsi, indicative of a Zone D determination. Suggestive of a older, Zone E-1 determination is the absence of Orbulina universa and the presence of Praeorbulina glomerosa glomerosa. The sample at 1950m contains an abundant planktonic fauna, including many minute specimens, but a lack of diversity is evident. Globorotalia praefohsi and G. peripheroacuta are absent. However, the sample contains four specimens of Orbulina universa, so that the sample could be either of basal Zone D age, or could contain minor caving from higher in the sequence (not necessarily from Zone D). Orbulina suturalis is moderately common, and Praeorbulina spp. rare, suggesting again the possibility of a Zone E-1 age.

Benthonic specimens are very rare in both samples. The presence of Vulvulina pennatula in one and Osangularia cf. bengalensis in the other suggests at least outer shelf or upper slope depths.

At 2000 metres : Zone E : astride Middle / Early Miocene boundary.

This ditch cutting contains abundant planktonic specimens, particularly small specimens of Globigerina spp. Also present are large Globorotalia spp. caved from Zones B and C. The presence of rare Praeorbulina glomerosa curva, P. glomerosa glomerosa and P. glomerosa circularis, absence of Orbulina universa, and presence of only two specimens of O. suturalis may suggest an E-2 age determination. (Zone E-2 occupies the topmost 0.5 million years of the Early Miocene; Zone E-1 occupies the basal 0.5 million years of the Middle Miocene). The absence of sidewall core control means that the presence or absence of in situ Orbulina suturalis cannot be verified to differentiate E-1 from E-2. As for the interval discussed above, the benthonic part of the assemblage is very rare. However, a few specimens of Karreriella bradyi and Martinotiella communis suggest that the environment was upper bathyal.

2050 - ?2146 metres : probably Zone F : Early Miocene.

The ditch cutting at 2050m contains a moderate amount of planktonic fauna, including fairly common

Globigerinoides trilobus, in a moderately hard calcisiltite. The sample lacks Praeorbulina spp., and contains almost no Orbulina suturalis (which may well be caved). The presence of very rare Globigerinoides cf. sicanus suggests a Zone F determination, particularly in view of the abundance of other Globigerinoides spp. Downhole caving from at least Zones B and C is evident. The depositional environment appears to be essentially the same as for the sample above. The ditch cutting at 2100m contains common Globigerinoides trilobus and an absence of Globigerinoides sicanus, suggesting a Zone G rather than F determination. (Zone G is characterised by the earliest appearances of long-ranging "background" species in the planktonic fauna, including Globigerinoides trilobus and Globorotalia miozea miozea. Consequently caving from younger zones tends to obscure the character of the in situ fauna, which lacks distinctive species of its own). Caving of Globorotalia spp. from higher zones continues to be conspicuous. The depositional environment is as for the sample above.

The sidewall core at 2146m contains very rare specimens critical for age determination at this level. While Globigerina spp. are abundant, Globigerinoides trilobus and G. sicanus were found as only one specimen of each, a situation highly atypical of Zone F. Globorotalia miozea is common, indicating an age of Zone G or younger. The sidewall core may be at the base of Zone F, but the presence of Globorotalia cf. praefohsi and the rarity of the Globigerinoides trilobus group are anomalous. The presence of Planulina wuellerstorfi indicates bathyal depths.

2165 - approximately 2200 metres : Zone G : Early Miocene.

The sidewall core at 2165 contains a planktonic assemblage dominated by small forms, mostly *Globigerina angustiumbilicata*, *G. ciperoensis* and *G. juvenilis*. *Globigerinoides quadrilobatus* is common and *G. trilobus* present in some numbers. A moderate number of *Globorotalia miozea*, *G. praemenardii* and *Turborotalia siakensis* are also present, and the assemblage appears to be a normal Zone G one. Benthos are rare. Species such as *Osangularia* cf. *bengalensis*, *Sigmoilopsis schlumbergeri*, *Glomospira charoides* and cassidulinids suggest shelf edge to upper bathyal water depths.

The ditch cutting at 2200m is totally planktonic dominated, but the effect of caving makes the presence of *Globigerinoides trilobus*, *G. quadrilobatus* and *Globorotalia miozea* not definitive for a Zone G determination, although suggestive of such. The presence of one specimen of *Globorotalia kugleri* provides slender evidence for the top of the next zone, H-1. The sample may be at, or just below the boundary, of Zones G and H-1. The very rare benthos again contains *Planulina* cf. *wuellerstorfi* and *Karreriella bradyi*, suggesting depths of at least upper bathyal.

Approximately 2200 - 2394 metres : Zone H : Early Miocene.

The ditch cutting at 2200m has been discussed above. The cutting at 2250m contains an abundance of planktonic specimens, many very small in size. The presence of extremely rare *Globorotalia kugleri* leads to the Zone H-1 determination. *Globorotalia zealandica* is also present, a distribution consistent with the lowest occurrence of the species in Selene-1. Caving is a conspicuous feature of the planktonic assemblage in this sample. The cutting at 2300m is less caved. It lacks G. kugleri, but the presence of Globoquadrina dehiscens s.s. in some numbers indicates that the age is still within Zone H-1. The rare benthonic specimens continue to suggest upper bathyal water depths.

Sidewall core samples at 2345m and 2394m indicate a Zone H-2 age, based on the presence of Globigerina woodi and Globoquadrina cf. dehiscens, in a fauna lacking Globigerinoides (except G. cf. primordius). The assemblage is dominated by small Globigerina spp. Catapsydrax dissimilis is conspicuous among the larger species. Very rare specimens of Globorotalia cf. mendacis occur at 2394m. The benthonic assemblage in both samples contains a number of arenaceous species and fragments. The presence of Bathysiphon sp., Cyclammina sp., Haplophragmoides sp., Karreriella bradyi, Ammodiscus sp., and cassidulinids may well indicate slope water depths, with some shelf species moved downslope.

At 2451.5 metres : Zone F : Early Miocene : sidewall core OUT OF SEQUENCE.

The presence of a sidewall core containing common Globorotalia miozea, Globigerinoides trilobus and excellent specimens of Globigerinoides sicanus indicates (in the absence of Praeorbulina and Orbulina spp.) a Zone F determination. This is clearly younger than the four sidewall cores between 2146 and 2394m. The only reasonable explanation is either that the core was mislabelled when unloaded, or that the sidewall core gun sampled a fragment of Zone F sediment wedged in the borehole wall.

2482 - 2490 metres : Zone I-1 : Late Oligocene.

Faunas in these sidewall cores contain an abundance of planktonic specimens, mostly small. The presence of specimens of Globoquadrina cf. dehiscens (in the absence of younger species) is indicative of a late Zone I-1 age. Good specimens of Globigerina euapertura are also suggestive of a Zone I determination. Globigerina cf. woodi is represented by only one specimen. Other species of Globigerina are numerous, but all are long-ranging. Nonetheless, the assemblages are typical of the Late Oligocene in Gippsland. The sidewall core sample at 2485m is a limestone with abundant broken specimens, and is contaminated with a trace of younger fauna. The presence of one specimen of Pseudohastigerina micra is anomalous. The species has a range of Eocene to Early Oligocene; but no other evidence for an Early Oligocene age was found, either in this sample or the one below. Furthermore, P. micra appears to have seldom, if ever, been recorded from Gippsland wells, so the presence of a single specimen here remains unexplained.

The sample at 2490m, which is the deepest sample to contain foraminifera in any numbers, is assigned to Zone I-1 on the basis of Globoquadrina cf. dehiscens, and on the absence of Early Oligocene indicators such as Globigerina angiporoides. The presence of Karreriella bradyi, Cyclammina sp., Osangularia bengalensis, Recurvoides sp. and Vulvulina pennatula in a fairly diverse benthos is interpreted to indicate upper bathyal water depths. The contrast with the facies interpreted for the sample one metre below, strongly suggests a disconformity between the two sidewall cores.

At 2491 metres : age indeterminable.

This glauconitic quartz sand was found to contain very rare specimens of Cyclammina sp. This may well be the same form recorded by Taylor as Haplophragmoides cf. incisa from the Gurnard Fm. in Selene-1 (Taylor, 1983). The correct generic placement of arenaceous specimens with cancellate wall structure has been a matter of controversy (see Taylor, 1965; Ludbrook, 1977). All authors who have examined the Early Tertiary "Cyclammina faunas" of southern Australia appear to be in agreement with their shallow-water depositional environment, as suggested by other arenaceous and calcareous species which are sporadically present in some sequences, and by the lithofacies. Taylor (1983a,b) has suggested estuarine and marsh environments for samples comparable to the sidewall core at 2491m. Although the name Cyclammina sp. is retained here on the basis of the wall-structure (which is indistinguishable from that of bathyal specimens higher in the Ayu-1 sequence), the interpretation of a marginal marine facies, as suggested by Taylor, seems a valid one.

2527 - 2552 metres : age indeterminable : barren.

Two sandy sidewall cores were barren of foraminifera or other obvious marine indicators.

4. REFERENCES.

Jenkins, D.G. (1986) : Southern mid-latitude Paleocene to Holocene planktic foraminifera: p.263-282 in : Bolli,H.M. and Saunders,J.B. (eds.), Plankton Stratigraphy. Cambridge University Press.

Jenkins, D.G. (1960) : Planktonic foraminifera from the Lakes Entrance oil shaft, Victoria, Australia. Micropaleontology, v.6, no.4, pp.345-371.

Ludbrook, N.H. (1977) : Early Tertiary Cyclammina and Haplophragmoides (Foraminiferida: Lituolidae) in Southern Australia. Transactions Royal Society of South Australia, v.101, pt.7, pp.165-198.

Taylor, D.J. (1966) : Esso Gippsland Shelf No.1 : the mid-Tertiary foraminiferal sequence. Commonwealth of Australia, Bureau of Mineral Resources, Geology and Geophysics. Publications Petroleum Search Subsidy Acts Australia, no.76, pp.31-46.

Taylor, D.J. (1983) : Stratigraphy of the foraminiferal sequence in Selene #1, Gippsland Basin. Appendix No.7 in Selene-1 well completion report. Phillips Australian Oil Company, unpublished report.

TABLE 1 : TIME STRATIGRAPHIC SUBDIVISION OF THE INTERVAL 1250-2490M, AYU-1.

DEPTH (M)	ZONE	AGE	ENVIRONMENT
1250-1350	probably B-2	Late Miocene	Outer shelf to shelf/slope break
1400-1700	Undiff.B-2/C	Late Mioc. to topmost Middle Mioc.	?Canyon fill or slump?
At 1730	Probably B-2	Probably Late Miocene	" " " "
At 1740	Low Zone C	Middle Miocene	Upper bathyal
1800-1850	D-1	Middle Miocene	Upper bathyal
1900-1950	D or E-1	Middle Miocene	Outer shelf or upper slope
At 2000	E	Middle/Early Miocene boundary	Upper bathyal
2050-?2146	Probably F	Early Miocene	Upper bathyal
2165-approx.2200	G	Early Miocene	Upper bathyal
approx.2200-2394	H	Early Miocene	Upper bathyal
At 2451.5	(F)	(Early Miocene - OUT OF SEQUENCE)	(Upper bathyal)
2482-2490	I-1	Late Oligocene	Upper bathyal
2491	-	age indeterminable-almost barren	?
2527-2552	-	" " -barren	?

PE900772

This is an enclosure indicator page.
The enclosure PE900772 is enclosed within the container PE902102 at this location in this document.

The enclosure PE900772 has the following characteristics:

```
     ITEM_BARCODE = PE900772
CONTAINER_BARCODE = PE902102
             NAME = Ayu 1 Planktonic Forams
            BASIN = GIPPSLAND
           PERMIT = VIC/P20
             TYPE = WELL
          SUBTYPE = DIAGRAM
      DESCRIPTION = Ayu 1 Planktonic Forams. Enclosure from
                    appendix 7 of WCR volume 2.
          REMARKS =
     DATE_CREATED =
    DATE_RECEIVED = 2/07/90
             W_NO = W1020
        WELL_NAME = Ayu-1
       CONTRACTOR =
     CLIENT_OP_CO = Petrofina Exploration Australia S.A.
```

(Inserted by DNRE - Vic Govt Mines Dept)

PE900773

This is an enclosure indicator page.
The enclosure PE900773 is enclosed within the container PE902102 at this location in this document.

The enclosure PE900773 has the following characteristics:

ITEM_BARCODE =	PE900773
CONTAINER_BARCODE =	PE902102
NAME =	Ayu 1 Planktonic Forams
BASIN =	GIPPSLAND
PERMIT =	VIC/P20
TYPE =	WELL
SUBTYPE =	DIAGRAM
DESCRIPTION =	Ayu 1 Planktonic Forams. Enclosure from appendix 7 of WCR volume 2.
REMARKS =	
DATE_CREATED =	
DATE_RECEIVED =	2/07/90
W_NO =	W1020
WELL_NAME =	Ayu-1
CONTRACTOR =	
CLIENT_OP_CO =	Petrofina Exploration Australia S.A.

(Inserted by DNRE - Vic Govt Mines Dept)