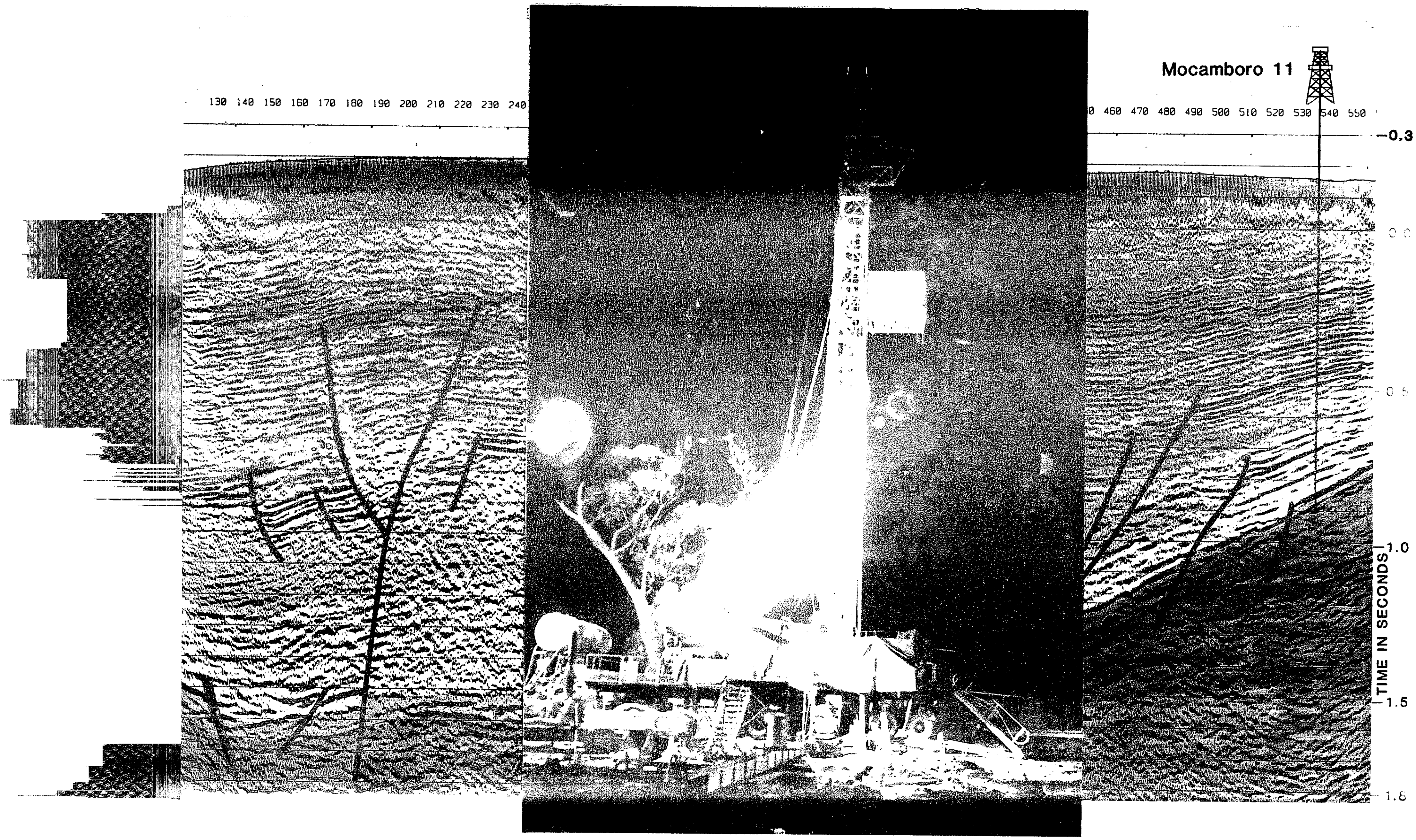
Mocamboro No. 11

Well Completion Report



Geological Survey of Victoria
Basin Studies

Department of Manufacturing and Industry Development

VOL. I: TEXT & APPENDICES

1991

GEOLOGICAL SURVEY OF VICTORIA

BASIN STUDIES

Mocamboro 11

Well completion report

Unpublished report No.1991/65

Volume 1
Text and appendices

Department of
Manufacturing
and Industry
Development

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APPENDICES

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ENCLOSURES

BASIN STUDIES SECTION - DEEP WELL SUMMARY REPORT - DMID WELL

Well Name: Mocamboro 11 Basin: Otway Conseq No.: 21/90/1

Status: Plugged and abandoned Rig: Emsco GB 250 THB

Date Commenced: 11/6/90 Completed: 3/9/90 Total Depth: 1435.04m

Elevation (GL): 145m Parish No.: 3132

Location: AMG Sheet: Coleraine Number 7222 Zone: 54

Easting: 544100 Northing: 5821450

Latitude: 37° 48' 8.4"S Longitude: 141° 30' 2.8"E

Seismic: SP 535 Line CR88-01

Engineering Data: (Casing, Plugs, completion details)

Hole Size		Casing		Plugs & Grouting
381mm	0 - 123.14m	273mm	0-121.37m	0 - 50m
251mm	123.14 - 650.61m			91 - 150m
216mm	650.61 - 1435.04m			932 - 1001m

All depths from ground level

Geophysical Logs: Logged by BPB Wireline Services - 12/9/90

Gamma Ray
Compensated Neutron
Spontaneous Potential
Laterolog Deep
Laterolog Shallow
Laterolog Micro
Compensated Sonic
Micro Normal
Micro Inverse
Caliper

BHT 68° C after 12 hrs
69° C after 18 hrs

Cuttings: 3m intervals from 0 - 1428m.
Cores: 40 Conventional, 48 Sidewall cores.
Formation Testing: None
Palynology See Appendix 9

STRATIGRAPHY:	Depth intersected (m)	Thickness (m)	R.L. (m)
Eumeralla	0	967.5	140
Heathfield Sand Member	362	8	-222
unnamed sand unit	587	5	-447
Pretty Hill Formation	967.5	406.5	-827.5
Sand/Shale Unit	967.5	197.5	-827.5
Sand Unit	1165.0	209	-1025
Palaeozoic Basement	1374	61+	-1234

2 WELL HISTORY

2.1 Location (See Figures 1 & 2)

Co-ordinates:	Latitude 37° 48' 8.4" Longitude 141° 30° 2.8"
	Easting 544100 Northing 5821450
	Zone 54
Geophysical Control:	Shot Point: 535 Seismic Line: CR88-01
Property Description:	County of Normanby
	Parish of Mocamboro
	Shire of Glenelg
Property Owner:	Noel Hobbs

2.2 General Data

Well Name:	Mocamboro #11
Operator:	Geological Survey of Victoria
Elevation:	Ground Level 145m ASL (Unless otherwise stated all depths refer to ground level).
Total Depth:	Driller 1435m Wireline logger 1432m
Drilling Commencement:	11 June 1990 @ 0830 hrs.
Rig Released:	15 September 1990 @ 1600hrs
Total Depth Reached:	3rd September @ 0200 hrs.
Status:	Plugged and abandoned.

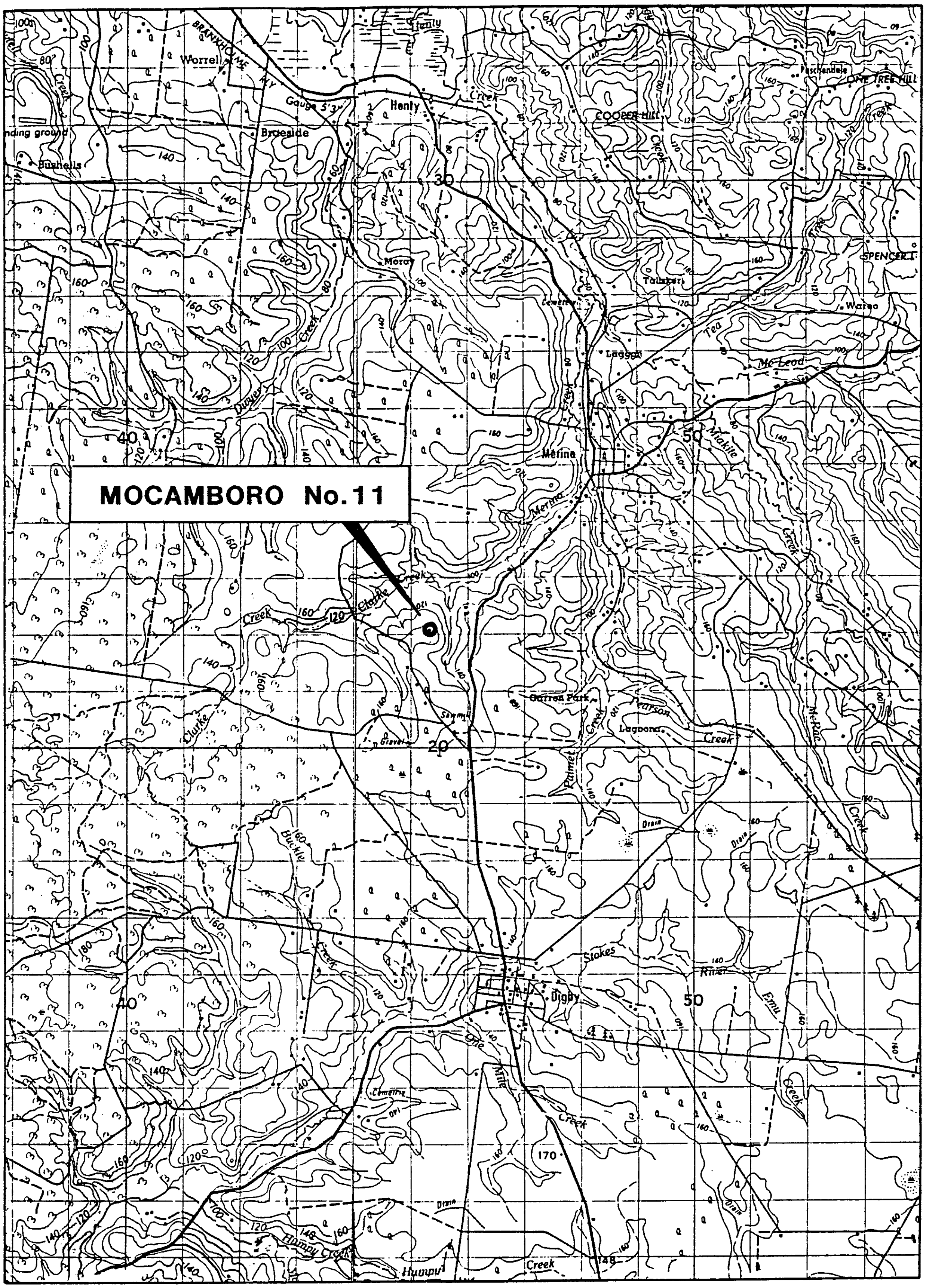

FIGURE 1 – MOCAMBORO No.11
TOPOGRAPHIC LOCATION MAP

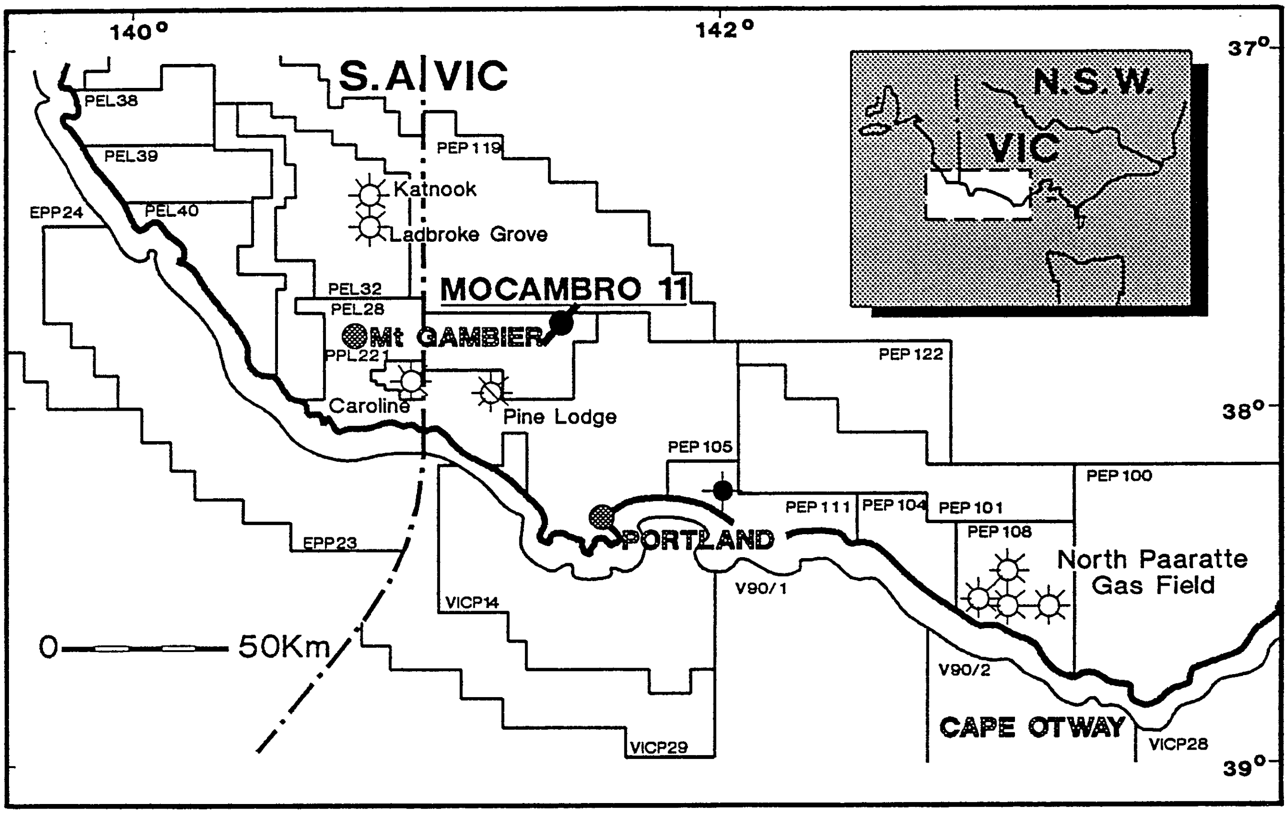

FIGURE 2 – OTWAY BASIN PERMIT MAP

2.3 Drilling Data: (See also appendix 1)

2.3.1 Drilling Contractor

Department of Manufacturing and Industry Development,
Drilling Unit

2.3.2 Drilling Rig

DMID Rig 21
Rig specifications are included as appendix 1

2.3.3 Casing and Cementing Details

A 16" Conductor Pipe was set at 2m before rig up.

Surface Casing

Size: $10\,^{3}/_{4}$"

Depth: 121.37m

Cement: 216 Sacks class A neat.

Cement Plugs

Plug No 1

Interval: 1001.0 - 931.0m

Cement: 80 Sacks Class "A" neat

Method: Balanced

Tested: Tagged at 931m

Plug No 2

Interval: 150 - 91.0m

Cement: 101 Sacks Class "A" neat.

Method: Balanced

Tested: No.

Plug No 3

Interval: 50.0m - Surface

Cement: 84 sacks class "A" neat

2.3.4 Drilling Fluid

The drilling fluid programme was designed by Baroid Australia Pty Ltd. The programme was structured to accommodate the operating schedule of the rig and the anticipated long period of open hole conditions, while being relatively easy to monitor and maintain by site personnel.

The hole was spudded using a prehydrated bentonite spud mud flocculated with lime. Drilling and coring to casing point were completed without complications.

After drilling out the casing cement, a Potassium Chloride - Bentonite - C.M.C mud system was used to drill to total depth. Tight hole conditions were experienced at 725 metres, 1000 metres, and several times from 1160 to 1200 metres. These problems were overcome by reaming.

The wireline logging and sidewall coring programme was completed without complication, as was the velocity survey. The caliper log indicates significant washout in the Eumeralla Formation, particularly above 350 metres. Considering the long period of open hole conditions the level of washout was acceptable. Below the Eumeralla the hole remained in gauge.

2.3.5 Water Supply

Rig water was drawn from a creek some 400 m from the rig. Regular rainfall ensured a continuous supply of fresh, good quality water.

2.4 Formation Sampling

2.4.1 Cuttings

Cuttings samples were collected at three metre intervals from surface to total depth. Each sample was washed, dried and stored in labelled polythene bags. These samples are stored in the DMID core laboratory, Port Melbourne. Descriptions of these samples are included as appendix 4.

2.4.2 Cores

(i) Forty conventional cores were cut, the intervals and recoveries are listed below, core descriptions are presented in Appendix 5.

CORE NO.	INTERVAL (m)	RECOVERY (%)
1	9.78 - 12.78	100
2	25.86 - 28.75	100
3	60.78 - 61.78	100
4	61.78 - 67.78	75
5	96.79 - 102.99	94
6	115.14 - 117.14	100
7	213.44 - 214.36	100
8	307.52 - 313.44	92
9	324.52 - 328.52	97

CORE NO.	INTERVAL (m)	RECOVERY (%)
10	577.23 - 578.48	10
11	613.67 - 618.14	95
12	650.61 - 653.01	100
13	705.11 - 706.26	90
14	741.27 - 745.01	76
15	759.31 - 763.26	10
16	777.80 - 783.65	92
17	783.65 - 784.95	10
18	814.32 - 816.82	100
19	832.58 - 835.43	100
20	850.97 - 853.47	97
21	869.42 - 871.47	95
22	905.87 - 907.62	70
23	942.57 - 944.02	70
24	979.05 - 985.00	90
25	997.26 -1000.36	95
26	1015.65 -1021.40	90
27	1033.92 -1037.92	19
28	1061.12 -1066.67	77
29	1088.58 -1090.68	100
30	1125.21 -1129.86	29
31	1161.75 -1166.10	76
32	1197.94 -1199.94	55
33	1233.46 -1235.74	50
34	1252.69 -1258.84	73
35	1271.08 -1276.03	60
36	1289.54 -1294.69	63
37	1316.97 -1322.97	79
38	1390.20 -1393.45	44
39	1427.19 -1431.94	4
40	1431.94 -1435.04	10

These cores are held in the DMID core laboratory, Port Melbourne.

(ii) Forty-eight sidewall cores were attempted of which forty-three were recovered. Depths and recoveries are detailed below. Sidewall core descriptions are presented in Appendix 5.

Core No.	Depth (m)	Recovery (mm)	Core No.	Depth (m)	Recovery (mm)
1	1380	25	25	792	35
2	1346	30	26	769.5	40
3	1311.5	NR	27	750.5	38
4	1304.5	38	28	734.5	31
5	1241	40	29	727	28
6	1169	NR	30	695	30
7	1164	34	31	680.5	32
8	1119.5	30	32	667.5	30
9	1081.5	26	33	644	40
10	1060	30	34	626	40
11	1041	25	35	609	41
12	1030	30	36	605	39
13	1022	30	37	590	40
14	1006	23	38	582.5	41
15	969.5	NR	39	580	38
16	965	20	40	569	33
17	933	20	41	550	41
18	904	31	42	517	30
19	890	30	43	455	15
20	877	15	44	414	27
21	861	20	45	367	NR
22	842	20	46	365	NR
23	823	20	47	360	28
24	808	23	48	159	38

Note: NR: No Recovery

2.4.3. Testing

No formation testing was carried out on this well.

2.4.4 Sample Analyses

2.4.4.1 Palynology

Twenty-five samples were submitted for palynological analysis. These samples are listed below.

SAMPLE	DEPTH	RECOVERY
(1) Core No.1	9.78 - 12.78m	100%
(2) Core No.2	25.86 - 28.75m	100%
(3) Core No.5	96.79 - 102.99m	94%
(4) Core No.7	213.44 - 214.36m	100%
(5) Core No.9	324.52 - 328.52m	79%
(6) SWC No.47	360.0m	28mm
(7) SWC No.44	414.0m	27mm
(8) SWC No.41	550.0m	41mm
(9) Core No.10	577.23 - 578.48m	10%
(10) SWC No.37	590.0m	40mm
(11) SWC No.35	609.0m	41mm
(12) Core No.11	613.67 - 618.14m	95%
(13) SWC No.32	667.5m	30mm
(14) Core No.13	705.11 - 706.26m	90%
(15) Core No.16	777.80 - 783.65m	92%
(16) Core No.19	832.58 - 835.43m	100%
(17) Core No.22	905.87 - 907.62m	70%
(18) SWC No.16	965.0m	20mm
(19) Core No.24	979.05 - 985.00m	90%
(20) Core No.25	997.26 - 1000.36m	95%
(21) Core No.28	1061.12 - 1066.67m	77%
(22) Core No.31	1161.75 - 1166.10m	76%
(23) Core No.34	1252.69 - 1258.84m	73%
(24) Core No.37	1316.97 - 1322.97m	79%
(25) SWC No.2	1346.0m	30mm

The results of palynology are included as Appendix 9

2.4.4.2 Source Rock Analysis

Thirty-three samples were submitted for source rock analysis. These samples are listed below.

SAMPLE	DEPTH	V	RE	EXT
(1) Core No.4	61.78 - 67.78m Rec. 75%		x	
(2) Core No.5	96.79 - 102.99m Rec. 94%	x	x	
(3) SWC No.48	159.0m Rec. 38mm	x	x	
(4) Core No.7	213.44 - 214.36m Rec. 100%	x	x	
(5) Cuttings	260.0m	x		
(6) Core No.8	307.52 - 313.44m Rec. 92%	x	x	
(7) Cuttings	350m	x	x	
(8) Cuttings	400m	x	x	
(9) Cuttings	426 - 429m coal	x	x	
(10) Cuttings	465m	x	x	
(11) Cuttings	500m	x	x	
(12) SWC No.41	550.0m	x	x	
(13) SWC No.39	580.0m Rec. 38mm			x
(14) SWC No.38	582.5m Rec. 41mm	x	x	x
(15) SWC No.36	605.0m Rec. 39mm	x	x	
(16) SWC No.34	626.0m Rec. 40mm	x	x	
(17) SWC No.32	667.5m (Coal sample)	x	x	
(18) Core No.13	705.11 - 706.26m Rec. 90%	x	x	
(19) Core No.15	759.31 - 763.26m Rec. 10%	x	x	
(20) SWC No.25	792.0m Rec. 35mm	x	x	
(21) SWC No.24	808.0m Rec. 23mm	x	x	
(22) SWC No.21	861.0m Rec. 20mm	x	x	
(23) SWC No.19	890.0m Rec. 30mm		x	
(24) SWC No.17	933.0m Rec. 20mm	x	x	
(25) Core No.25	997.26 - 1000.36m Rec. 95%	x		
(26) Core No.28	1061.12 - 1066.67m Rec. 77%	x		
(27) Core No.31	1161.75 - 1166.10m Rec. 76%	x		
(28) Core No.32	1197.94 - 1199.94m Rec. 55%			x
(29) SWC No.5	1241.0m Rec. 40mm			x
(30) Core No.36	1289.54 - 1294.69m Rec. 63%			x
(31) SWC No.4	1304.5m Rec. 38mm			x
(32) Core No.37	1316.97 - 1322.97m Rec. 79%			x
(33) SWC No.2	1346.0m Rec. 30mm	x		

V: Vitrinite Reflectance
RE: Rock Eval-Pyrolysis
EXT: Hydrocarbon Extraction
The results of source rock analyses are included as appendix 7.

2.4.4.3. Porosity and Permeability analysis

Twenty-one core samples were collected by E. Alexander of the South Australian Department of Mines and Energy. These samples are listed below and results of the analyses are included as Appendix 10.

Sample	Depth (m)
1	984.96
2	983.40
3	982.78
4	982.40
5	981.98
6	981.70
7	981.50
8	980.96
9	980.50
10	1021.10
11	1020.28
12	1019.27
13	1018.25
14	1017.45
15	1017.10
16	1016.38
17	1066.64
18	1065.90
19	1065.05
20	1064.15
21	1063.50

2.5 Logging and Surveys

2.5.1 Mud Logging

A DMID mobile laboratory was used. The unit was equipped with a binocular microscope, a UV sample examination box and a sample drying oven. The gas detection equipment was a gas alarm with a lower threshold of 1000ppm. The system collected sample directly from the flow line without a conventional gas trap or agitator. No gas was detected by this equipment. The mud log is included as enclosure 2.

2.5.2 Wireline logging

Wireline logging was carried out by BPB Wireline Services using a standard truck-mounted unit. One logging suite consisting of the following logs was carried out at total depth.

Suite 1	Interval (m)
Dual laterolog/microlog/ microlaterolog/gamma ray compensated sonic/Caliper	1432.0 - 120.0m
Compensated Density	1432-120
Compensated Neutron/ Gamma Ray/Caliper	1432-Surface
SWC	2 guns (48 cores)
Quick look interpretation	1428-100

2.5.3 Deviation Surveys

Deviation Surveys were conducted regularly with the following results.

Depth (m)	Deviation (Deg)
109	0
565	1
637	2 5/8
693	2
730	2
808	3
861	3
1002	3
1112	1.5
1420	2.5

2.5.4 Velocity Survey

A velocity survey was carried out by Velocity Data Pty Ltd. The data are included as Appendix 6.

3 RESULTS OF DRILLING

3.1 Stratigraphy

The following stratigraphic intervals have been determined using wireline log interpretation, palynology and core and cuttings analysis. (Unless otherwise stated all depths refer to G.L.)

Formation	Depth (m)	Thickness (m)	Elevation S.L. (m)
Eumeralla	Surface	967.5	+.140.0
Heathfield Sand Member	362.0	8.0	-222.0
Intra-Eumeralla Sand Unit	587.0	5.0	-447.0
Pretty Hill	967.5	406.5	-827.5
Sand/Shale Unit	967.0	197.5	-827.5
Sand Unit	1165.0	209.0	-1025.0
PALAEOZOIC BASEMENT	**1374.0**	**61.0+**	**-1234.0**
Total Depth (Driller)	1435.0		-1295.0
Total Depth (Logger)	1432.0		-1292.0

3.2 Lithological Description

3.2.1. Eumeralla Formation (Surface - 967.5m)

Surface to 366m.

Claystone, light grey to brownish grey and greenish grey, common to abundant fine sand throughout, occasional coaly flecks, and fragments, occasional to rare pyrite, slightly silty in parts, very soft to moderately firm, slightly calcareous in parts; from 60 to 130m becoming predominantly Sandstone, medium grey to light brownish grey and occasionally greenish grey, very fine to fine-grained arkose, moderately to well sorted, very angular to sub-angular and occasionally sub-rounded, calcite-cemented in parts, common to abundant silty to argillaceous matrix, trace to common pyrite, occasional to common mica, trace of coal, predominantly unconsolidated; from 130m Claystone, medium grey to medium dark grey, trace to occasional fine sand, slightly silty in parts, slightly micaceous, soft to moderately firm, sub- blocky in parts, non- calcareous.

Heathfield Sand Member 362.0-370.0m

Sandstone,medium light grey to medium grey, coarse to very coarse-grained quartz, common medium grains, poor to moderately sorted, angular to sub-angular, sparse silty matrix, common lithic and feldspathic grains, non-calcareous, unconsolidated.

Eumeralla Formation 370.0-587.0m

Claystone, light grey to medium dark grey, occasionally greenish grey, common very fine to fine quartz sand, occasional lithic and feldspathic grains, silty in parts, trace to common coaly fragments and laminae, occasional to common calcite cement in sand fraction and discrete calcite fragments, trace to common pyrite, trace of mica, soft to moderately firm, sub-blocky in parts, interbedded with Sandstone, very light grey to light grey, predominantly very fine to fine-grained, commonly quartz, occasional intervals up to very

MOCAMBORO No.11

PROGNOSED AND ACTUAL STRATIGRAPHY

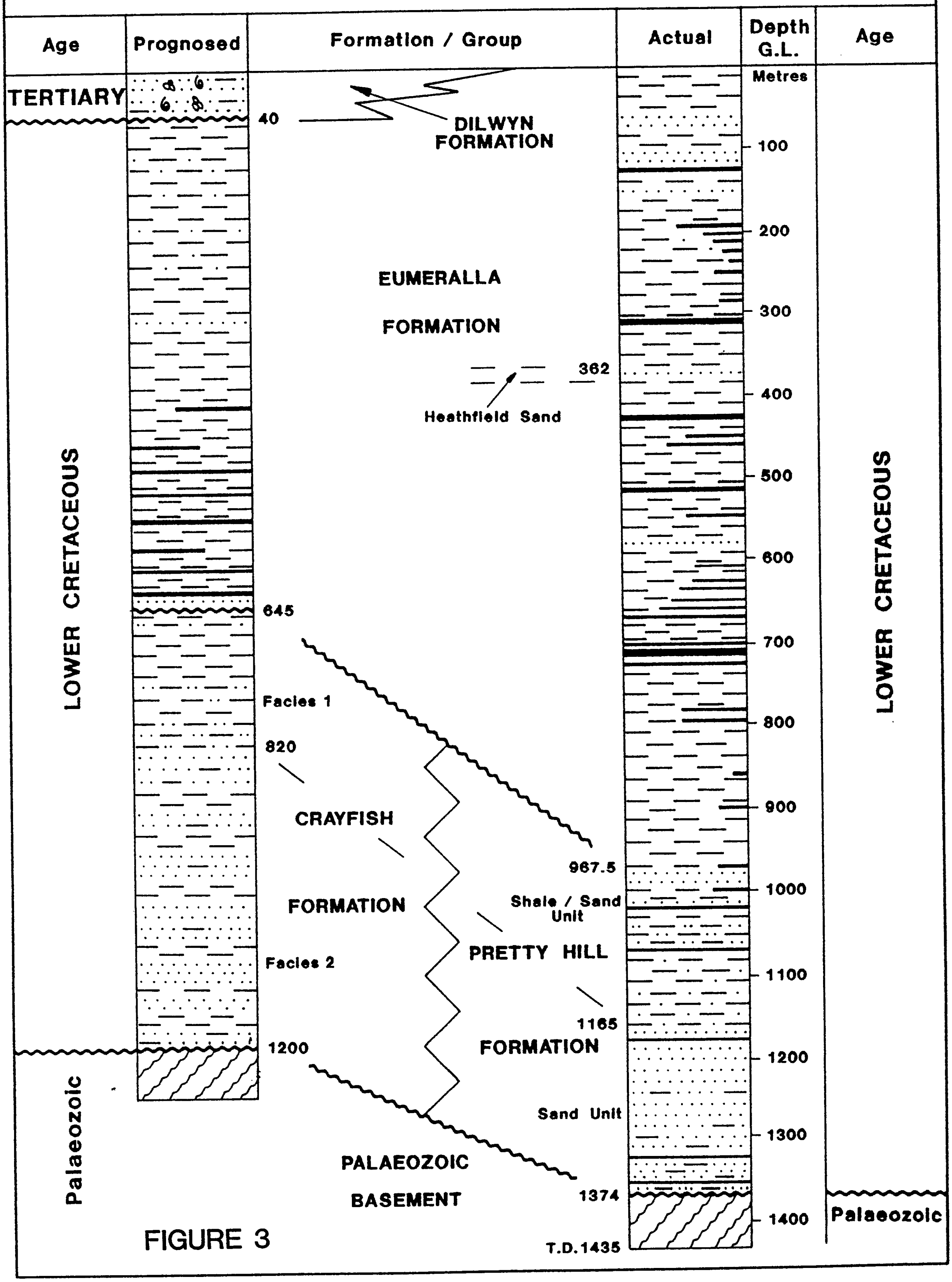

FIGURE 3

coarse-grained, common lithic and feldspathic grains which become more prevalent with depth, moderately to well sorted, angular to sub-angular and occasionally very angular, common silty to argillaceous matrix, trace to abundant calcite cement which is patchy in parts, trace of pyrite, trace of mica, poor visual porosity; grading in parts to Siltstone, medium light grey to medium dark grey, commonly sandy, occasional calcite cement, occasional to common coaly fragments, trace of pyrite in parts, soft to moderately firm, non calcareous. The interval has several bands of Coal, black, sub-vitreous lustre, blocky, soft to moderately firm, trace of medium to coarse quartz sand, slightly silty.

Intra-Eumeralla Sand Unit 587.0-592.0m

Sandstone, medium light grey to light grey. Occasionally very light grey, very fine to fine-grained, occasionally medium-grained, well to very well sorted, angular to sub-angular, predominantly quartz with common to abundant lithic and feldspathic grains, becoming more arkosic with depth, abundant calcite cement, trace of argillaceous matrix in parts, trace of mica and coal, poor visual porosity, moderately hard.

Eumeralla Formation 592.0-967.5m

Claystone, very light grey to medium grey, occasionally greenish grey, common interbedded fine-grained arkosic sand, silty in parts, trace to common coaly flecks and laminae, occasional calcite fragments, trace of pyrite, non-calcareous; common Sandstone, very light grey to light grey, very fine to fine-grained, arkosic, predominantly well sorted, very angular to angular, occasionally sub-angular, trace to abundant calcite cement, argillaceous matrix in parts, trace to common coaly flecks and occasional laminae, moderately firm to very firm, poor visual porosity; grading to Siltstone, medium light grey to medium dark grey and occasionally greenish grey, common carbonaceous flecks, trace of mica, trace of pyrite, trace to common fragments of very fine to fine-grained arkosic sandstone which is calcite-cemented in parts, moderately hard, non-calcareous; the interval has several bands of Coal, greyish black to brownish black, brittle, blocky to sub-blocky, occasional sub-conchoidal fracture, non-calcareous.

3.2.2. Pretty Hill Formation 967.5 - 1374.0m

Sand/Shale Unit 967.5 - 1165.0m

Sandstone, very light grey to light grey, clear to translucent and occasionally milky, very fine to medium-grained, occasionally coarse and very coarse grains, moderately to very well sorted, occasionally poorly sorted, sorting decreases with increasing grain size, sub-rounded to rounded, occasionally sub-angular to angular, common to abundant calcite cement, occasionally trace to rare, traces of silica cement in parts, silty and argillaceous matrix in parts, occasional light pink and red garnets, coaly fragments and laminae in parts, micaceous in parts, common lithic and feldspathic grains throughout,

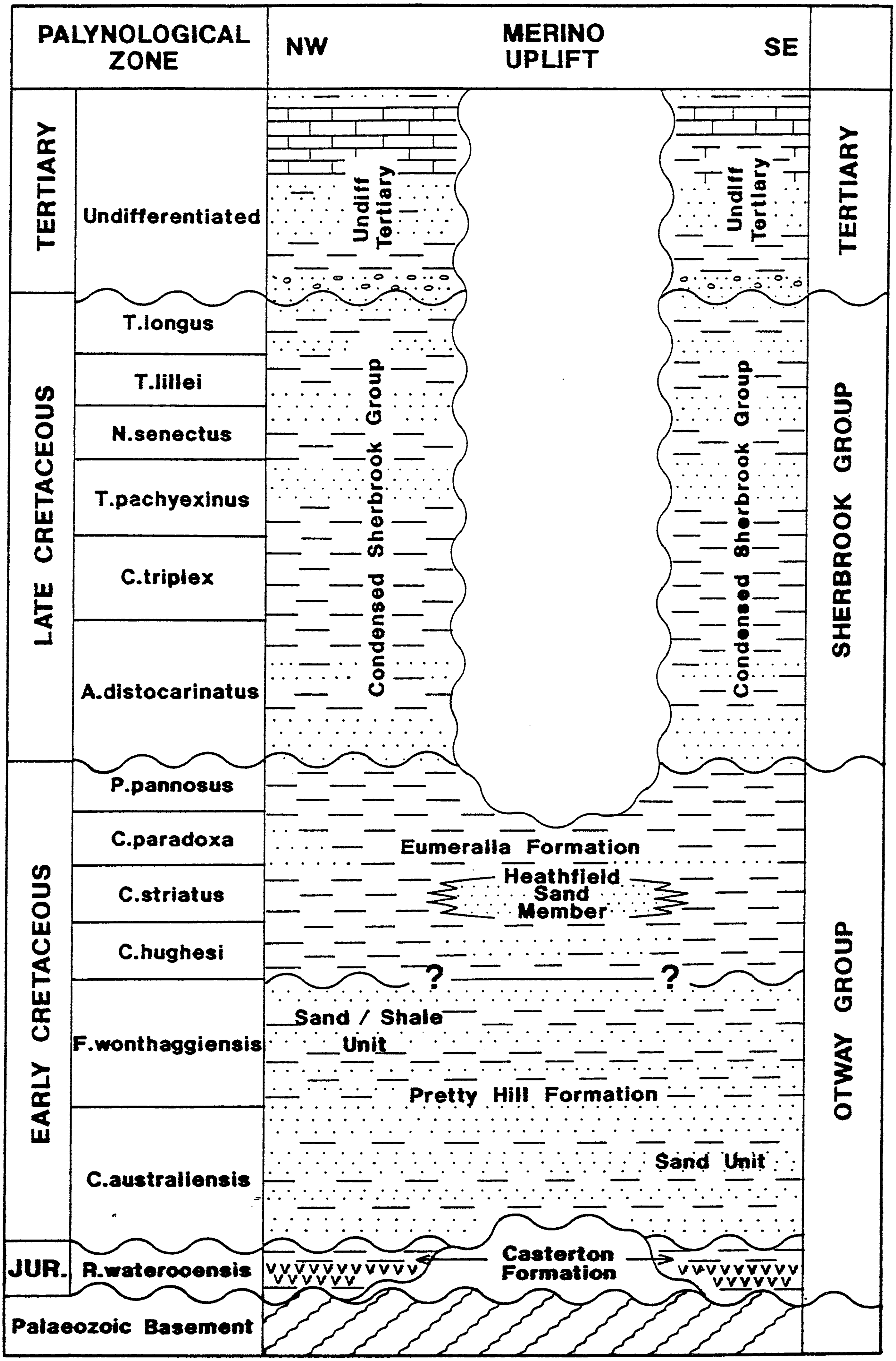

FIGURE 4 – SUGGESTED STRATIGRAPHIC TABLE FOR MERINO UPLIFT AND ENVIRONS

trace micaceous in parts, unconsolidated to firm, poor to occasionally moderate visual porosity; interbedded Siltstone, light grey to medium dark grey, grading to very fine sandstone in parts, abundant fragments of very fine-grained lithic sandstone, occasional medium to coarse quartz, blocky to sub-blocky, sub-fissile in parts, moderately firm to occasionally soft; in parts grading to a Claystone, greenish grey to brownish grey, carbonaceous in parts, soft to moderately firm.

Sand Unit **1165.0 - 1374.0m**

Sandstone, clear to translucent and occasionally milky quartz, predominantly medium to coarse and occasionally very coarse-grained, occasionally fine-grained, moderately to well sorted, sub-angular to rounded, common silica cement discernible as quartz overgrowths in part, strong calcite cement in parts, occasional pyrite cement, trace of kaolinitic matrix in parts, abundant light pink to red garnets, occasional coaly fragments and laminae, rare to occasional lithic and feldspathic grains, firm to moderately hard, poor to generally moderate and occasionally good visual porosity; occasional Siltstone, dark grey to greenish grey, moderately firm to firm, non calcareous; occasional Claystone, brownish grey, carbonaceous, soft to moderately firm, non-calcareous.

3.2.3. PALAEOZOIC 1374.0m - T.D.

Claystone, light greyish green to greenish grey, occasionally brownish grey, micromicaceous, fissile in parts, phyllitic, abundant lithic fragments including mica schist, moderately firm to firm, non-calcareous; common fragments of Sandstone, light greyish green, fine to medium-grained, common coarse to very coarse grains, moderately sorted, sub-rounded, abundant silica cement, abundant calcite cement, rare pyrite, moderately hard.

3.3 Hydrocarbon Indications

3.3.1 Drilling Fluid Gas Readings

The gas detection equipment used was an Analytical Logging Inc. model AZHW gas detector. The unit has a lower detection threshold of 1000ppm. The system collected sample directly from the flowline without a conventional gas trap or agitator.

No gas was detected with this system. Many attempts to have this system register anything at all were unsuccessful. Initially a standard calcium carbide "bomb" lag check was unsuccessfully tried. This was followed by using larger quantities of carbide and then by pouring the carbide directly into the top of the conductor pipe. All to no avail.

It is concluded that the gas detector was not operational and that cuttings gas, if any were present, was not recorded.

3.3.2 Sample Fluorescence

Trichlorethane cut hydrocarbon fluorescence was first noted in a sandstone cuttings sample from the interval 690 to 693 metres. After further drilling and testing of samples it was realised that hydrocarbon fluorescence was more likely to be observed if the samples being tested were dried first. It was also noted that fluorescence was more likely to be observed in siltstone, claystone and coal samples rather than sandstone.

Where hydrocarbon fluorescence was observed in sandstone samples, there was generally, with some exceptions, some component of claystone or less commonly coal in the sample.

There was some variance in the methods of different testers but the most commonly achieved result was attained from the crush cut procedure. One notable exception was an 18cm interval in core No.37, at approximately 1322.8 metres depth, where an instant strong cut was achieved. Other methods which achieved results were straight cut and also the pouring of the crushed and dissolved sample onto filter paper.

A dried sample of the drilling fluid also yielded hydrocarbon fluorescence when tested. The possibility of fluorescing drilling fluid additives was discounted after discussions with a drilling fluid engineer, and it was concluded that the fluorescence was derived from formation material which had become suspended in the drilling fluid.

A comprehensive testing program of all core material achieved some fluorescence from all but the basement cores. The fluorescence colours ranged from yellow to yellowish white through greenish white to bluish white. It was generally observed as a sometimes delayed, increasing glow after solvent application, culminating with a stronger residue ring after solvent evaporation. Hydrocarbon fluorescence without the aid of trichlorethane solvent was not observed.

A summary of the core testing program is presented below.

MOCAMBORO 11 CORE TESTING

Trichloroethane Cut Fluorescence Under UV Light

Core No	Cut	Crush Cut
1A	nil	Slight trace green
1B	nil	Trace green
1C	nil	nil
1D	nil	nil
2A	nil	nil
2B	nil	Slight trace green
2C	nil	Very weak green
2D	nil	nil

Core No.	Cut	Crush Cut
3	Trace green	Strong green/white
4A	Trace orange/brown	Weak green
4B	nil	Very weak green
4C	Trace green	Trace green
4D	Weak/moderate green	Trace green
4E	nil	Trace green
4F	nil	Slight trace green
5A	nil	Trace green
5B	nil	Weak green/white
5C	nil	Weak green/white
5D	nil	Weak green/white
5E	nil	nil
5F	Slight trace green/white	Weak green/white
5G	Trace green/white	Weak green/white
6A	nil	Trace green/white
6B	nil	Weak green/white
6C	nil	nil
7A	Slight trace green/white	Slight trace green/white
7B	Slight trace green/white	Moderate green/white
8A	Slight trace green/white	Very weak green/white
8B	Slight trace green/white	Moderate green/white
8C	nil	Weak green/white
8D	Slight trace green/white	Weak green/white
8E	Moderate green/white	Moderate green/white
8F	Slight trace green/white	Moderate green/white
8G	nil	Weak green/white
9A	Slight trace green/white	Weak green/white
9B	Slight trace green/white	Weak green/white
9C	Slight trace green/white	Weak green/white
9D	Slight trace green/white	Weak green/white

Core No.	Cut	Crush Cut
9E	nil	Slight trace green/white
10	Slight trace green/white	Moderate green/white
11A	Slight trace green/white	Moderate green/white
11B	Slight trace green/white	Moderate green/white
11C	Slight trace green/white	Moderate green/white
11D	Slight trace green/white	Moderate green/white
11E	nil	Weak green/white
11F	Weak/moderate green/white	Strong green/white
12A	nil	Moderate green/white
12B	Trace green/white	Moderate/strong green/white
12C	Weak blue/white	Strong blue/white
13A	nil	Weak/moderate green/white
13B	nil	Moderate green/white
14A	nil	Weak/moderate green/white
14B	Slight trace green/white	Moderate green/white
14C	Slight trace green/white	Moderate green/white
14D	Slight trace green/white	Weak green/white
15	nil	Weak green/white
16A	nil	Moderate green/white
16B	nil	Moderate green/white
16C	nil	Moderate green/white
16D	nil	Moderate green/white
16E	Very slight trace	Weak green/white
16F	nil	Moderate green/white
16G	nil	Weak green/white
17	nil	Weak green/white
18A	nil	Very weak green/white
18B	Slight trace green/white	Moderate green/white
18C	nil	Weak greenish white
19A	nil	Moderate green/white

Core No.	Cut	Crush cut
19B	nil	Moderate green/white
19C	nil	Moderate green/white
19D	nil	Weak green/white
20A	nil	Very weak green/white
20B	Weak green/white	Strong green/white
20C	Trace green/white	Strong green/white
21A	nil	Moderate green/white
21B	nil	Weak green/white
21C	nil	Weak green/white
22A	nil	nil
22B	nil	Strong green/white
23	nil	Moderate green/white
24A	nil	nil
24B	nil	Slight trace green/white
24C	nil	Faint green/white
24D	nil	Faint green/white
24E	nil	Faint green/white
24F	nil	Faint green/white
25A	Trace green/white	Moderate green/white
25B	Weak green/white	Moderate green/white
25C	nil	Moderate green/white
26A	nil	Trace green/white
26B	nil	Moderate green/white
26C	nil	Faint green/white
26D	nil	Faint green/white
26E	Strong green/white	Strong green/white
27F	nil	Faint green/white
26G	nil	Faint green/white
27	nil	Weak green/white
28A	Trace green/white	Strong green/white
28B	nil	Trace green/white

Core No.	Cut	Crush cut
28C	Trace green/white	Strong green/white
28D	Trace green/white	Moderate green/white
28E	Weak green/white	Weak green/white
28F	Trace green/white	Weak green/white
29A	Weak green/white	Strong green/white
29B	nil	Faint green/white
29C	nil	Strong green/white
30A	Faint green/white	Faint green/white
30B	No sample	strong blue/white
31A	nil	nil
31B	nil	nil
31C	Faint green/white	Faint green/white
31D	Faint green/white	Faint green/white
32A	Weak green/white	Strong green/white
32B	nil	nil
33	nil	nil
34A	Moderate blue white	Strong blue/white
34B	Weak green/white	Moderate green/white
34C	Weak green/white	Weak green/white
34D	Trace green/white	Moderate green/white
34E	nil	nil
35A	nil	
35B	Trace green/white	Strong green/white
35C	nil	Faint green/white
35D	nil	Faint green/white
36A	Trace green/white	Strong green/white

Core No.	Cut	Crush Cut
36B	nil	nil
36C	Moderate green/white	Strong green/white
36D	Weak green/white	Moderate green/white
37A	Moderate green/white	Moderate green/white
37B	nil	nil
37C	nil	Trace green/white
37D	Trace green/white	Strong green/white
37E	Faint green/white	Strong yellow/green
37F	Strong blue/white	Very strong blue/white
38	nil	nil
39	nil	nil
40	nil	nil

4. GEOLOGY

The Mocamboro 11 stratigraphic well was primarily drilled to:-

a) clarify part of the stratigraphic nomenclature of the Otway Basin;

b) achieve a better understanding of the structural complexity of the Merino Uplift, which may consequently elucidate some aspects of the tectonic history of the basin;

c) evaluate the reservoir potential of the sandstone of the Pretty Hill Formation;

d) evaluate the source potential of the Eumeralla Formation, and;

e) generally evaluate the hydrocarbon prospectivity of the area.

The drilling results passed well beyond expectations and contributed greatly to the understanding of the area. The following interpretations are based on the findings of this well.

4.1 STRATIGRAPHIC NOMENCLATURE

4.1.1 Eumeralla Formation

The well was spudded in the Eumeralla Formation and terminated in Palaeozoic basement. The palynological results (see appendix 9) indicate that a thin interval of upper Coptospora paradoxa Zone of Middle Albian age was penetrated at the top of the hole. The first indication of lower C. paradoxa zone was noted at 103 m depth. Sediments of the Late Albian Phimopollenites pannosus Zone have either been eroded and or not deposited.

The Heathfield Sand Member of the Eumeralla Formation which was encountered at 362.0 metres depth, appears to be of Cybelosporites striatus Zone or older. This porous and permeable quartzose sand reservoir appears to be restricted to the southeastern end of Penola Trough. The absence of this member in the McEachern No. 1 petroleum well could indicate an even more restricted environment of deposition. A point bar sand of a meandering stream could be represented by this unit.

An intra-Eumeralla sand unit was encountered between 587.0 and 597.0 metres. This unit is a lithic sandstone distinctly different from the Heathfield Sand Member. No other sand members of the Eumeralla Formation are recognisable in the Victorian portion of the Otway Basin. Any sand unit of reasonable thickness which has been encountered in this formation has restricted lateral extent and cannot be confidently correlated. This clearly indicates that the majority of sand units (if not all) within the Eumeralla Formation are lenticular with extremely limited extent.

4.1.2 Pretty Hill Formation

The entire Pretty Hill Formation at this location was penetrated by the Mocomboro 11 stratigraphic well. The formation consists of the following units:-

Sand/Shale unit	197.5m thick
Sand unit	209.0m thick

No other recognisable sub-division was identified in this formation.

4.1.2.1 Sand/Shale Unit

This unit consists of sandstone, claystone and minor siltstone. The sand:shale ratio could be as high as 1:1 in places or much lower elsewhere. This unit was found to lie within the upper Foraminisporis wonthaggiensis Zone of late Neocomian age. However, its lower portion is pollen-lean and its age indeterminate. The sandstone portion of this unit proved to be of good reservoir quality (See 4.3.3.1).

4.1.2.2 Sand Unit

This unit consists of more than of 90% of good to very good reservoir quality sandstone with minor beds of siltstone and claystone. Palynology results on the deepest sample (SWC @ 1346.0m) in this interval indicate upper Crybelosporites australiensis Zone of early Neocomian age. No deeper sample was successfully dated to determine whether the lower C. australiensis Zone is present or a basement high prevented its deposition.

4.1.3 Discussion

The stratigraphic nomenclature of the Lower Cretaceous Otway Group of the Otway Basin has been recently reviewed by Kopsen & Scholefield (1990) and further revised by Morton (1990). Figures 5 and 6 show their respective proposed stratigraphic tables.

Before drilling the Mocamboro 11 stratigraphic well, it was prognosed that two facies of the Crayfish Formation were present at this location. It was also assumed that these were laterally equivalent, one being a sandy facies named the Pretty Hill Facies and the other more shaly with very little or no reservoir potential named the Geltwood Beach Facies. In this classification, which was based partially on seismic interpretation, the Pretty Hill and Geltwood Beach formations were downgraded to facies status and the name Crayfish formation assumed to encompass all the sediments sandwiched between the base of the Eumeralla Formation and the top of the Casterton Formation and/or the Palaeozoic basement.

Recent basin studies carried out by the Geological Survey of Victoria, as well as results from the Mocamboro 11 stratigraphic well have revealed that the above classification is not appropriate. Furthermore, the stratigraphic nomenclature used by the South Australian Department of Mines and Energy, (Morton, 1990) does not agree with that of Mocamboro 11 or elsewhere in the Victorian portion of the Otway Basin.

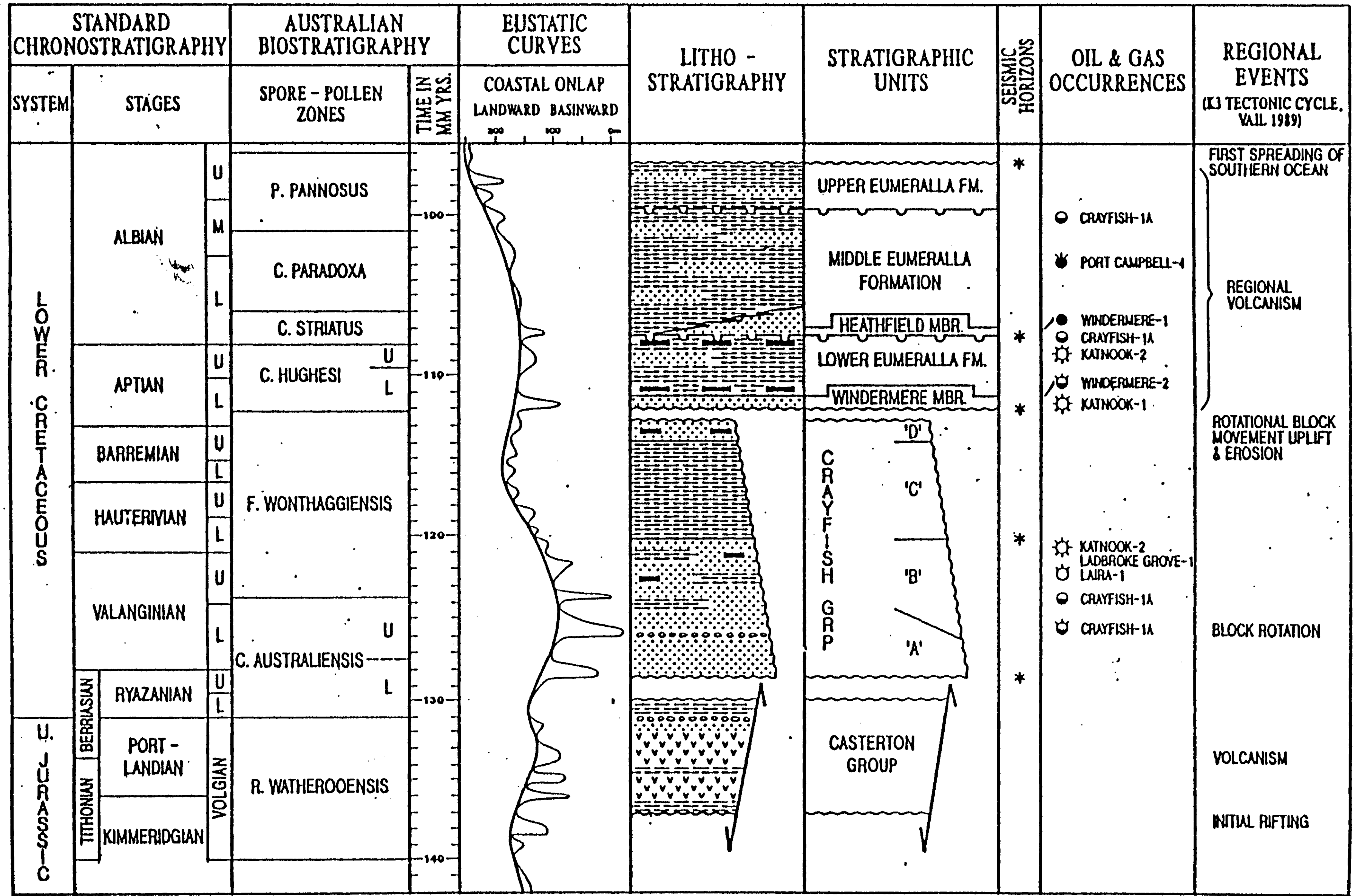

FIGURE 5 – STRATIGRAPHIC NOMENCLATURE OF OTWAY BASIN (AFTER KOPSEN & SCHOLEFIELD, 1990)

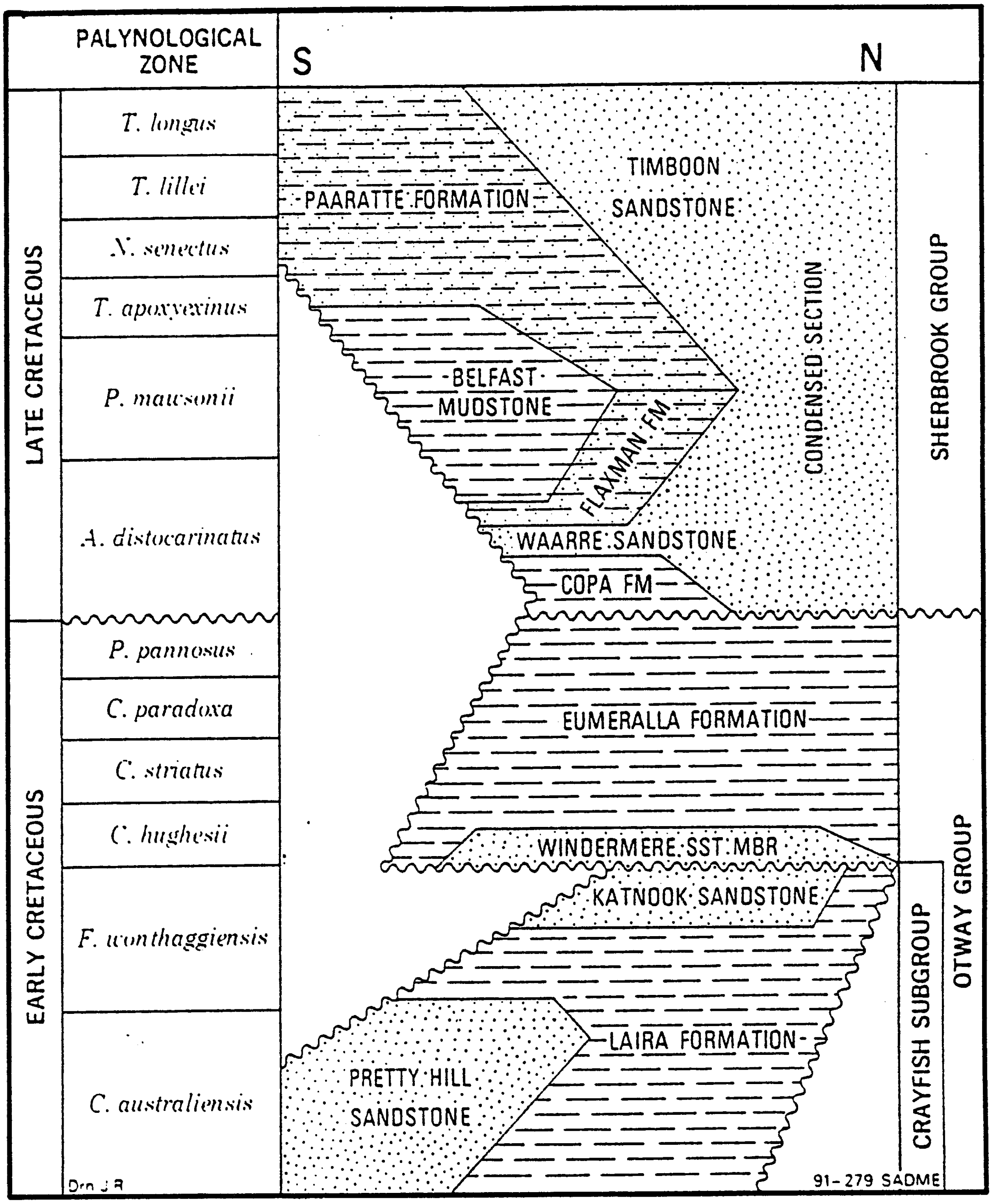

FIGURE 6 – STRATIGRAPHIC NOMENCLATURE OF THE OTWAY BASIN (AFTER MORTON, 1991)

The Windemere Sandstone Member of the Eumeralla Formation, first suggested by Kopsen and Scholefield (1990) and later confirmed by Morton (1990) is not present at Mocamboro 11. Its presence is also doubtful in some other wells drilled in the Otway Basin. However, as discussed earlier, any sand unit within the Eumeralla Formation is lenticular and has limited extent. This is also true with the intra Eumeralla sand unit encountered in Mocamboro 11 over the interval 587 - 597 metres. This unit has not been recognised by Kopsen & Scholefield (1990) and Morton (1990).

The sediments underlying the Eumeralla Formation and overlying the Casterton Formation and/or Palaeozoic basement were called the Crayfish Group by Kopsen and Scholefield (1990). This was later renamed the Crayfish Subgroup by Morton (1990). The stratigraphic nomenclature used by Kopsen and Scholefield has been modified by Morton. Under Morton's classification the Crayfish Subgroup consists of the Pretty Hill Sandstone at the base overlain by the Laira Formation which is in turn overlain by the Katnook Sandstone (Figure 6).

This nomenclature generally does not fit either the Mocamboro 11 stratigraphy, or the stratigraphy of any other part of the Otway Basin in Victoria. The Katnook Sandstone appears to be present only on the central and northern margin of the Penola Trough. No well drilled in Victoria has penetrated a stratigraphically equivalent sand unit.

The Laira Formation and the Pretty Hill Sandstone of the Morton nomenclature in some ways resemble the Sand/Shale and Sand units of the Pretty Hill Formation recognised in Mocamboro 11. However, the diachronous nature of the Laira Formation (which ranges from lower C.australiensis to upper F.wonthaggiensis Zones) is somewhat different from that of the Sand/Shale Unit.

As a detailed investigation of the stratigraphic nomenclature of the Lower Cretaceous Otway Group is beyond the scope of this report, no further discussion on this subject will be attempted. Based on the drilling and recent basin studies results however, the use of the term Pretty Hill Formation is proposed. This unit occurs over the interval 967.5 - 1374.0 metres and consists of:-

Sand unit between 1165.0 and 1374.0 metres
Sand/Shale unit between 967.5 and 1165.0 metres

Figure 4 shows the stratigraphic table of the area.

4.2 TECTONICS

It has recently been suggested that both the Penola and Ardonachie troughs were an integrated part of the late Jurassic - early Cretaceous aborted rift of the Otway Basin (Pettiffer et al., 1991). The aborted rift has later been subjected to segmentation by a series of en echelon northeasterly trending highs.

The Merino Uplift is believed to be one of these highs. Although it trends northeasterly, a north-northwesterly trending feature links into its northern end and creates a peculiar and confusing picture. It is here asserted that the latter is a Palaeozoic trend independent of the Mesozoic Merino Uplift and that their proximity is purely coincidental.

Based on the results of drilling, it is possible to assume that a low relief basement high was present at this location at the early stage of rift development within the aborted rift. The late Jurassic Casterton Formation, which is usually present within the central part of the aborted rift, is absent in this well. That, together with the pinch out nature of the well location (Figure 7), may well support this hypothesis. Furthermore, the lower C.australiensis Zone was not proven to be present at this location. This is further evidence supporting the presence of the high.

The next major rift could have occurred towards the end of Early Cretaceous time. Relatively steeply dipping seismic reflectors elsewhere may suggest a minor unconformity, however there is no evidence of an unconformity between the Eumeralla and Pretty Hill formations at this location. This assertion is supported by the palynological results. The absence of the entire P. pannossus Zone at the top of the Lower Cretaceous Eumeralla Formation in Mocamboro 11 can be attributed to either a lack of deposition and/or erosion. In either case a relatively major uplift can be inferred. However, if non-deposition due to uplift is the case, the timing of the movement is more likely to be at the end of Early Cretaceous time. Should erosion be the cause of this absence the problem becomes more complex.

The absence of the Upper Cretaceous can be attributed to uplift but there is no evidence present to support the idea. It is not unreasonable to suggest, however, that the location was high-standing during Late Cretaceous time, hence the absence of Sherbrook Group sediments.

During the early Tertiary the Otway Basin has undergone major tectonism. This includes the final stage of separation of the Australian continent from Antarctica, regional lateral shear and local compressional regimes. The major uplift of the Otway Ranges is believed to have occurred during this period. It is also believed that the Merino Uplift and Warrnambool High were uplifted simultaneously. This is possibly the most significant movement in the Merino Uplift as the timing appears to be adequate for structuring before hydrocarbon migration and entrapment.

Although several movements on the Merino Uplift have progressively shallowed the sediments, the potential of the source rock maturity has not been downgraded. It is believed that earlier movements were minor and have left the potential source rock at a depth suitable for maturation processing. It is probable that the major movement in the early Tertiary was responsible for the greatest part of the uplift. This is believed to be later than generation and expulsion time.

4.3 RESERVOIR POTENTIAL

4.3.1. Heathfield Sand Member

The Heathfield Sand Member of the Eumeralla Formation is the shallowest potential reservoir encountered in the Mocamboro 11 stratigraphic well. It consists of generally unconsolidated coarse quartzose sands which are porous and permeable.

The unit has proved to be a good reservoir in several wells drilled in this area, with between 27% and 29% porosity and excellent permeability confirmed by drill stem testing.

Drill stem test No. 2 in the Heathfield No. 1 well recovered 122 metres of gas cut muddy salt water and 1085 metres of gas cut salt water. Drill stem test No. 3 in the Tullich No. 1 well recovered 457 metres of gas cut salt water. Samples from both tests contained 72% to 79% hydrocarbon content gas.

Despite all these promising facts, the Heathfield Sand Member should not be regarded as a primary objective because it has limited distribution and it lacks recognisable seismic character.

4.3.2 Intra-Eumeralla Sand

There are other sand units within the Eumeralla Formation. They are generally thin, possibly discontinuous and have much poorer reservoir characteristics than the Heathfield Sand Member. These sands are fine grained and extremely tight. The thickest intra-Eumeralla sand encountered in Mocomboro 11 was over the interval 587.0 to 597.0 metres. This sand was found to be strongly calcite cemented.

The reservoir potential of these sands, although limited, should not be overlooked as

a) they are well placed within the most active source rock;

b) a small amount of oil has been recovered from these sands in some wells, e.g. Port Campbell No. 4 and Windemere No. 1; and

c) major gas shows have been recorded from a stack of these sand units in Katnook No. 1.

4.3.3 Pretty Hill Formation

The sandstone of the Pretty Hill Formation is the principal reservoir in the Katnook Gas Field and the Ladbroke Grove No. 1 gas discovery well. It is also the host of oil and gas shows in a number of wells drilled in the South Australian and Victorian portions of the Otway Basin. It is probably the most significant reservoir in the onshore Otway Basin.

4.3.3.1 Sand Shale Unit

The sandstone of this unit consists of generally medium to coarse quartz grains with porosity up to 27.4% and permeability as high as 980 millidarcies (see appendices 7 and 10 and Enclosure V). As this unit consists of sand-shale interbeds, each shale section provides adequate seal for an underlying sand, creating a number of potential plays within a closed structure.

4.3.3.2 Sand Unit

This unit consists of up to 90% sandstone with the same reservoir quality as the sandstones in the overlying unit. In places however, particularly at the top, the sandstone is cleaner, coarser and has higher porosity and permeability. The only drawback is the fact that there is no thick shale interval to provide a seal for an individual sand body, and hence the lack of potential stack plays.

4.4 SOURCE ROCK

Two major geochemistry studies have been carried out on core samples from the Mocamboro 11 stratigraphic well. One was conducted by AMDEL as part of the Geological Survey of Victoria's commitment to this well (Appendix 7). The second was part of a research study in the Department of Geology and Geophysics of the University of Adelaide (Appendix 8). Analyses relevant to the definition of source rock potential have been carried out, including vitrinite reflectance and maceral analysis, Rock-eval pyrolysis, hydrocarbon extraction, and gas chromatography - mass spectrometry and aromatic maturity data on extracted residual oil.

4.4.1 Vitrinite Reflectance and Source Rock Maturity

A total of thirty core and cuttings samples between 64.2 and 1346.0 metres have been used for vitrinite reflectance measurements. The Amdel work determined Rvmax = 0.5% at around 3500 metres. The Adelaide University study, however, asserts that Rvmax = 0.5% has been reached at around 700 metres (figures 8 & 9). In either case it is reasonable to assume that the onset of liquid hydrocarbon generation should be reached at around 1200 metres (Rvmax = 0.55%).

The above studies suggest that the sedimentary sequence in this area has reached sufficient maturity to generate:

a) light oil/condensate below 800 metres
b) a significant amount of gas below 1600 metres
c) oil below 2100 metres

Amdel also suggests that some core samples, from which residual oil has been extracted, contain migrated hydrocarbons. This clearly indicates that the sedimentary sequence in this area, particularly the Eumeralla Formation, is an active source rock which is mature and has generated a significant volume of hydrocarbons. Furthermore, the expelled hydrocarbons have migrated to potential reservoir rocks.

Although the Total Organic Carbon (T.O.C.) content of the samples analysed is generally low, certain intervals, particularly those containing coals, have T.O.C. levels as high as 35.0% (figure 10) The Rock-Eval pyrolysis results reveal that samples with high T.O.C. content have excellent $S_1 + S_2$ values which indicate source richness (See appendix 7).

4.4.2 Source Quality and Genetic Affinity

The Rock-Eval study illustrates that the samples examined generally contain organic matter with composition ranging from Type III to Type IV kerogen. Samples with rich T.O.C., however, have organic matter which has a bulk composition of Type II - III kerogen.

Available data suggest a terrestrial source affinity for the hydrocarbons extracted from the core samples. This is evident from the Pristane/n-heptadecane, phytane/n-octadecane ratios. Shales of both the Eumeralla and Pretty Hill formations are believed to represent a fluviatile environment of deposition. Therefore the potential source rock lies within the fine grained sediments of these two formations. The Eumeralla Formation is considered to be the major source rock.

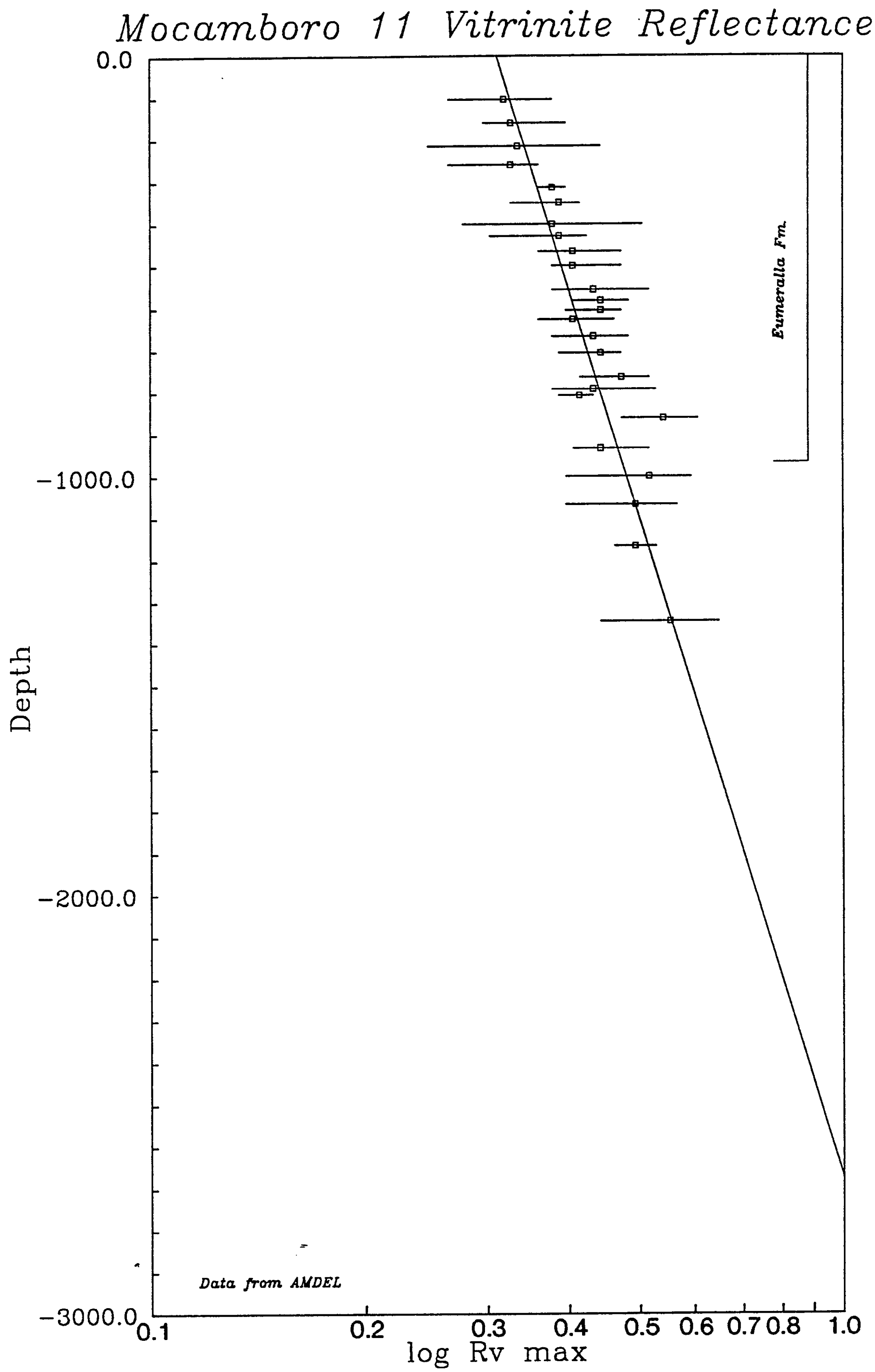

FIGURE 8 – VITRINITE REFLECTANCE PROFILE (AMDEL DATA)

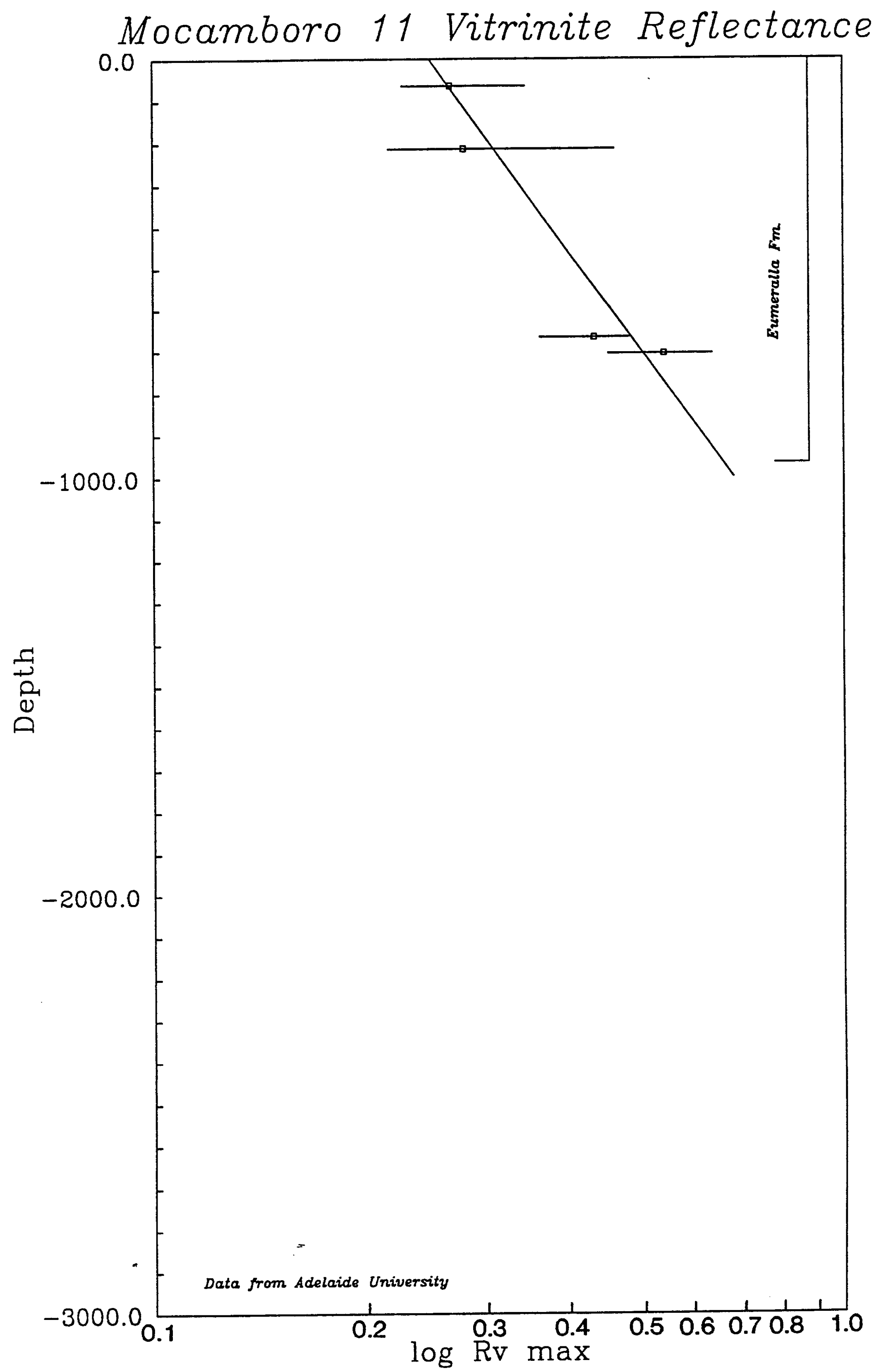

FIGURE 9 – VITRINITE REFLECTANCE PROFILE (ADELAIDE UNIV. DATA)

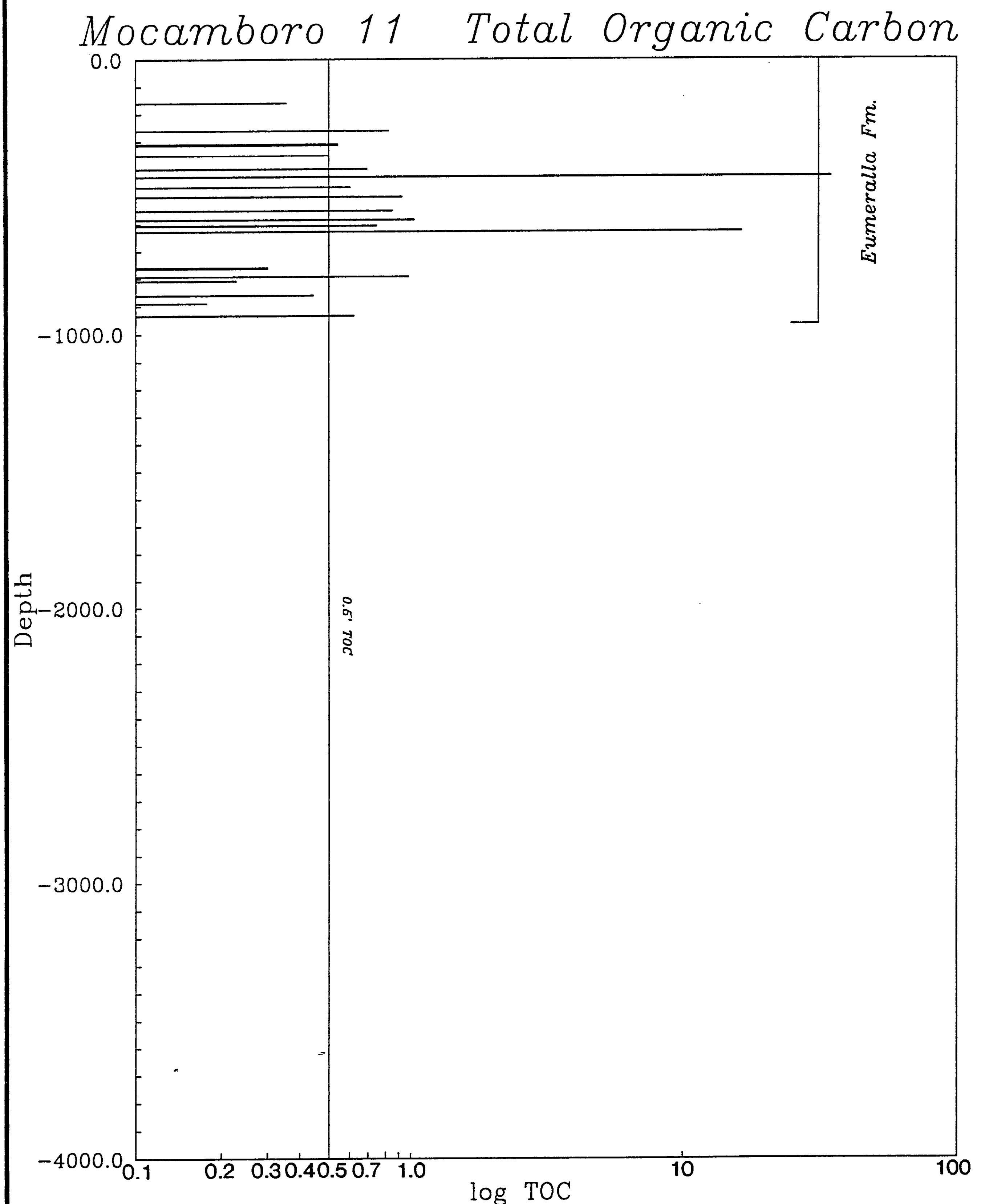

FIGURE 10 – TOTAL ORGANIC CARBON CONTENT (T.O.C.)

PE906577

This is an enclosure indicator page.
The enclosure PE906577 is enclosed within the container PE906578 at this location in this document.

The enclosure PE906577 has the following characteristics:

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            BASIN = OTWAY
           PERMIT = PEP118
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          SUBTYPE = SECTION
      DESCRIPTION = Seismic Section (interpreted) CR88-01,
                    showing Mocamboro-11
          REMARKS =
     DATE_CREATED = 31/12/1991
    DATE_RECEIVED = 31/12/1991
             W_NO = W1032A
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       CONTRACTOR =
     CLIENT_OP_CO = GSV
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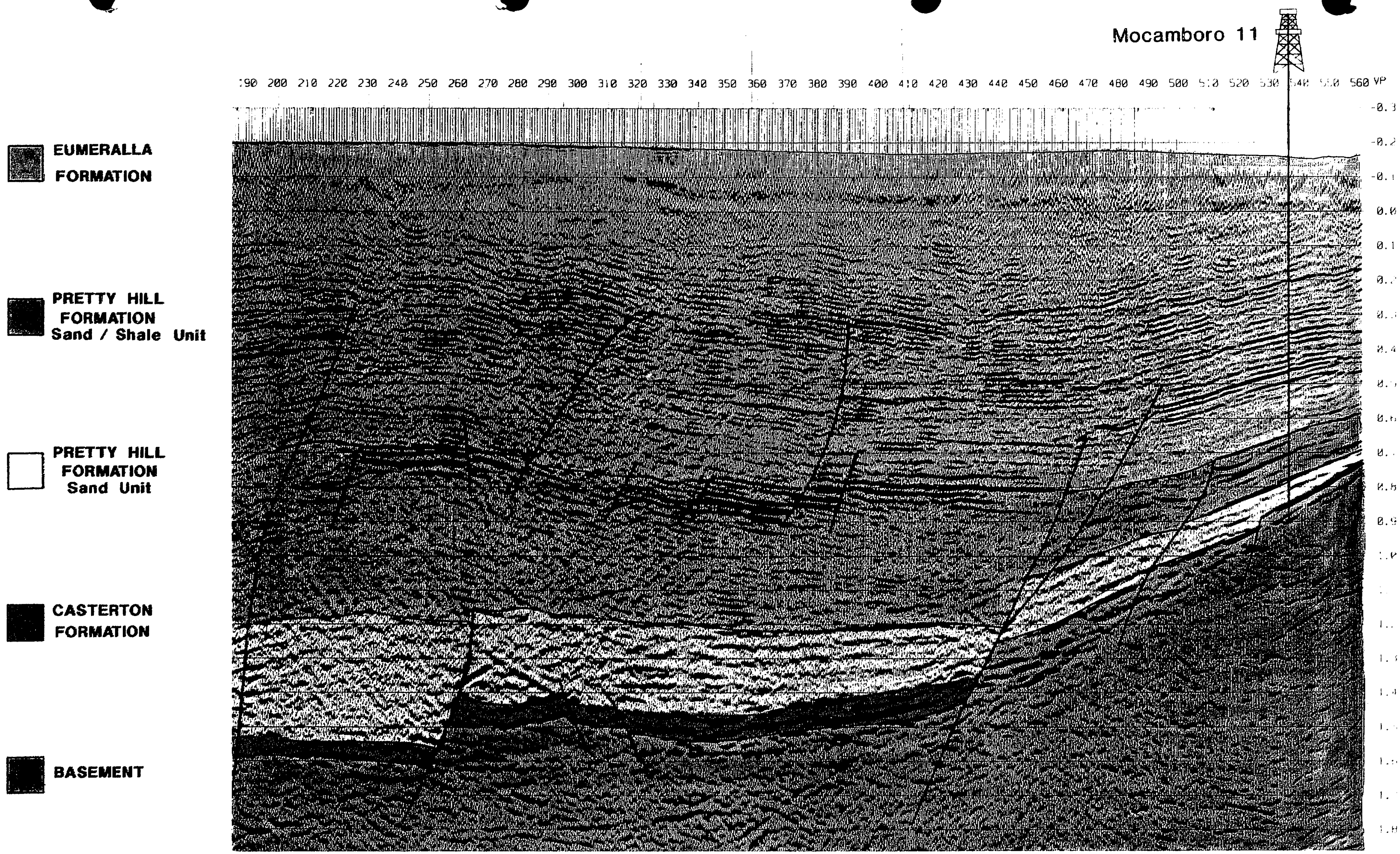
(Inserted by DNRE - Vic Govt Mines Dept)



SEISMIC LINE CR88-01 SHOWING THE LOCATION OF MOCAMBORO No.11 STRATIGRAPHIC WELL

(SEISMIC LINE COURTESY OF BEACH PETROLEUM N.L.)

DEPT. NAT. RES & ENV
PE906577

FIGURE No. 7

5. CONTRIBUTIONS TO THE HYDROCARBON PROSPECTIVITY OF THE AREA

Many instances of hydrocarbon fluorescence were encountered while drilling, from 500 metres to the top of the Palaeozoic basement. Most of this fluorescence was observed in non-reservoir rocks, that is in claystones and siltstones. This is attributed to in situ generation in which no migration has occurred. Other occurrences of fluorescence were observed in the reservoir sands, some of which were later determined to be migrated hydrocarbons. The residual oil extracted from the three bottom samples was determined to have been generated from a more mature part of the basin. The calculated vitrinite reflectance values for these extracts (VRCcalc = 0.98 - 1.05%) would place the mature source rock at a depth of approximately 3100 - 3700 metres.

Figure 7 shows the seismic line on which the Mocamboro 11 stratigraphic well is located. The interpretation of this line indicates that the top of basement is shallower than 3000 metres. Available data suggest that a basement depth of more than 3000 metres, in which potential source rock is available, may be a considerable distance from the Mocamboro No. 11 location.

No migration is expected from the north. Migration from the northwest and southeast may be possible. The nearest kitchens for the migrated hydrocarbons are the Penola and Ardonachie troughs. Any migration from the south could be from the Homerton Platform (See Enclosure IV) which is the possible source of oil found at Lindon No. 1.

It can now be concluded that the Merino Uplift is surrounded by three hydrocarbon generating provinces. With the exception of the Ardonachie Trough, where no exploration well has been drilled, the provinces are proved to contain mature sediments and to have generated hydrocarbons. The Merino Uplift itself has marginally mature source rock and the proven capability of generating considerable amounts of gas and oil, as discussed earlier.

The results of drilling have also proven the presence of several potential reservoirs with adequate seals for each one. Further, the structural configuration of the Merino Uplift has provided excellent opportunity for the creation of different types of plays, including pinch outs, rollovers, faulted anticlines as well as fault dependent blocks.

In summary, the drilling of the Mocamboro 11 stratigraphic well has either recognised or confirmed all the ingredients required for a successful hydrocarbon prospect. These are:

- the presence of mature source rock
- the generation of hydrocarbon
- the migration of hydrocarbon
- the presence of potential reservoir
- the presence of potential plays.

A thorough remapping and/or further seismic survey are required to delineate mature plays.

REFERENCES

DOUGLAS, J.G., & FERGUSON, J.A. (Eds)), 1988 - Geology of Victoria. Geological Society of Australia, Melbourne.

GLENIE, R.C. (Ed.) 1995 - Second South-eastern Australia Oil Exploration Symposium. PESA, Melbourne.

KOPSEN, E., & SCHOLEFIELD, T., 1990 - Prospectivity of the Otway Supergroup in the central and western Otway Basin. APEA Journal 30 (1), 263-79.

PETTEIFER, G., TABASSI, A., & SIMONS, B., 1991 - A new look at the structural trends in the onshore Otway Basin, victoria, using image processing of geophysical data. APEA Journal, 31 (1), 213-228.

MORTON, J.G.D., 1990. Revisions to stratigraphic nomenclature of the Otway Basin, South Australia. Quarterly Notes, Geological Survey of South Australia, 116.

WOPFNER, H., & DOUGLAS, J. G. (Eds), 1971 - The Otway Basin of South-eastern Australia. Special Bulletin of Geological Surveys of South Australia and Victoria.

APPENDIX 1

APPENDIX 1

DETAILS OF DRILLING PLANT

Department of
Manufacturing
and Industry
Development

In reply
please quote
Reference No.

RIG 21

SPECIFICATIONS

RIG 21

SPECIFICATIONS

EMSCO GB-250-THB TRAILER MOUNTED DRILLING RIG AS DESCRIBED BELOW, COMPLETE WITH EMSCO GB CATHEADS, CATHEAD CONTROLS AND FLOOR MOUNTING TYPE ROPE ROLLER, HYDROMATIC BRAKE PACKAGE POWERED. BY -

ONE GENERAL MOTORS TWIN - 6-71 MODEL 12103 TORQUE CONVERTER DIESEL ENGINE
AND WITH 97 FT. L.C. MOORE DUAL TRAILER MOUNTED CANTILEVER DRILLING MAST.

DRAWWORKS

WINCH DRUM:	16" dia. x 40" long, plain
BRAKE RIMS:	7-3/4" face x 38" diameter Enclosed water cooling system
BRAKE:	Type "J" with 350 degree arc of contact
SHAFTS:	Drummshaft max. dia. 6-1/4" Cathead shaft max. dia. 4-13/16" Rotary Countershaft max. dia. 4-1/4"
CLUTCHES:	Drum disc type Emsco C-227 Rotary, disc type Emsco C-314 Transmission low, Spline, air controlled Transmission high, Spline, air controlled Transmission reverse, Spline, air controlled
CHAIN:	Drum drive 1-1/2" double Cathead Shaft Drive 1-1/2" double Engine, 1" quadruple Reverse 1-1/2" double Rotary 2" or No. 3 single Hydrotarder 1-1/2" double
CONTROLS:	Driller's control console includes all operating control except engine power take-off clutch.

Battery Charging Generator
I Beam Front Supports and Base
Governor, includes Throttle
Control set at 1600 RPM full
load.
Fan.
Air Cleaner and Air Inlet Housing
without Shutdown
Wisconsin Gasoline starting Engine
600MM Injector

MAST

97' Lee C. Moore Dual Trailer Mounted Cantilever Drilling Mast No. 27217, static hook load capacity 180,000lbs.(equivalent to standard Derrick Capacity of 300,000 lbs.), 2'7-1/2" wide x 4'0" top 8'5" clear width at base between front legs, horizontally retracting top section, reversible crown block consisting of five 30" OD Manganese steel roller bearing working sheaves grooved for 1-1/8" diameter line and one 30" OD Manganese steel roller bearing sandline sheave grooved for 5/8" diameter line, all on 5-1/2" diameter shafts, and equipped with line guards, racking finger capacity of 7200' of 4-1/2" diameter drill pipe; 15" diameter swinging catline sheave; welded ladder; crown safety platform; tong counterweights complete; fifth wheel hoist and inverted fifth wheel for adjusting mast elevation to enable making connections; semi-trailer mast base complete with two supporting screw jacks.

ROTARY TABLE

Emsco Type P-17-1/2" -44" Rotary Machine with completely enclosed rectangular fabriform case, manual locks, sealed rotary mechanism, split table bushing and hook for 6" conventional type drill stem bushing. (LESS: Drive sprocket and Drill Stem Bushing)

SWIVEL

Emsco type L-140 Swivel complete with female Thread gooseneck, cartridge type washpipe packing, sleeve or coupling thread protectors and bail bumper, including 2 1/4" ID Washpipe and 96387-C sleeve couplings, 6-5/8" API L.H.Pin 19".

KELLY

Emsco 4-1/4" x 40' overall length 37' working length 6-5/8" API Reg. L.H. box top and 3-1/2" API Reg. Pin bottom connection, steel kelly.

TRAVELLING BLOCK

Emsco type R-30-3-H100 Hydra-hook Travelling block with 3-30" dia. Roller Bearing Forged Sheaves. Sheaves grooved for 1-1/8" wire line. Sheaves Rolled Forged Steel, mounted on Double Race Tapered Bearings; Rope Grooves Flame-hardened; Roller Steel Side Plates; Reversible Sheave Bearing Lubrication Cartridge Oil-Bath Lubrication for Main Bearings, Main Springs and Plunger, Locking Mechanism (8 equally spaced positions). (Total rated capacity 100 tons).

MUD PUMP UNIT

Unitized Gardner Denver 7-1/4" x 12 Model FZ-FXZ Power Slush Pump driven by General Motors 6-71 Model 12107 Torque converter-Diesel Engine complete with standard accessories. Unit to be Trailer Mounted complete with necessary sprockets, chains, chain guards, 3 member light steel skid, and manifold fittings, including 0-3000lbs. pressure gauge, shear relief valve, 3" Cameron valves on mud lines, wing unions, suction hose. Trailer, Hobbsmodel 74105.

APPENDIX 2

APPENDIX 2

SUMMARY OF WELLSITE OPERATION

SUMMARY OF WELL SITE OPERATION

A conductor was set before the rig arrived at the site. The well was spudded with an $8^1/_2$ inch tricone bit and drilled to 133 metres. Six cores were cut over this interval. The hole was then reamed with a $12^1/_4$ inch bit to 129 metres, with a $15^1/_4$ inch bit to 123 metres.

$10^3/_4$ inch casing was then run with the casing shoe set at 121.37 metres. The casing was then cemented with 216 sacks of cement. The cement was drilled out and drilling continued to 324 metres using a $9^7/_8$ PDC bit. Two further cores were taken over this interval.

Several days rig time were lost at 143 metres depth due to mud pump problems and torque converter failure on the rig. After cutting a core at 324 metres drilling continued with tricone $9^7/_8$ inch bits, to a depth of 650 metres. Two further cores were cut over this interval.

After cutting a core at 650 metres, drilling continued to 1390 metres using $8^1/_2$ tricone bits. A further twenty five cores were cut over this interval. After cutting a core at 1390 metres drilling continued to total depth using $7^7/_8$ inch tricone bits. Two further cores were cut.

Before logging, the $7^7/_8$ inch hole was reamed out to $8^1/_2$ inches. The hole was successfully logged by both BPB Wireline Services and the DMID logging unit. Two guns of sidewall cores were also shot by BPB Wireline Services. A velocity survey was successfully carried out by Velocity Data Pty. Ltd.

The well was then plugged and abandoned, and the rig released.

APPENDIX 3

APPENDIX
3

DRILLING FLUID RECAP

DRILLING FLUID RECAP

The drilling fluid programme for this well was provided by Baroid Australia Pty. Ltd. It was designed to provide an uncomplicated yet effective mud system while taking into account the anticipated geology, the likely well duration, the coring programme and the rig crew work practices.

The mud system was to be maintained and monitored by the rig crew since there would be no drilling fluid engineer at the site. Assistance was available from the site geologist who was also responsible for monitoring the chloride levels in the mud. Baroid Australia personnel were available for telephone consultation and visited the site on several occasions.

The programme proved effective and easy to operate. Minor problems were readily rectified. A copy of the drilling fluid programme is included in this appendix.

Due to the method of operation of this rig and the extended duration of the well, no conventional drilling fluid recap has been prepared.

Geological Survey of Victoria

DEPARTMENT OF INDUSTRY AND ECONOMIC PLANNING

MOCAMBORO #11
STRATIGRAPHIC WELL

MUD PROGRAM

Prepared by: Manfred Olejniczak

Baroid Australia Pty. Ltd./NL Industries, inc.

MAY 1990

D.I.E.P. MOCAMBORO NO. 11

INTRODUCTION

The aim of this mud programme is to provide an uncomplicated, yet highly effective mud system which takes into account the well geology, the likely duration of 2-3 months, the rig crew work practices and the extensive coring programme.

The 12 1/4" hole should be simply and quickly drilled using a lime flocculated bentonite spud mud.

The 8 1/2" hole has a long open hole section from 120m to the expected T.D. of 1250m and will be open for a long time. To give good long term hole stability a potassium chloride polymer mud system would be the ideal. A 3-4% by WT of solution potassium chloride concentration should be adequate, particularly as the lower part of the well is predominantly sandy. It is recommended that this concentration is maintained all the way to the well T.D., for optimum hole stability. To enable such a mud system to be easily run by rig personnel who may not be familiar with it, I have compromised, to recommend a C.M.C. - Bentonite based potassium chloride mud. This has several advantages as follows :

(a) C.M.C. (Hi-Viscosity), and C.M.C. (Low Viscosity) are readily available products which the rig crew may already be familiar with.

(b) C.M.C. is not that readily attacked by bacteria (Ferments), so should survive the shut down periods, and tolerate the long well duration.

(c) C.M.C. (Hi-Viscosity) in particular, responds to increasing solids or clay content by increasing viscosity, and vice versa. This will enable monitoring of the viscosity to indicate whether solids content should be reduced by dilution, or mud clay content should be raised by adding prehydrated bentonite.

The mud should be able to be adequately run based on regular checks of only mud weight, viscosity and water loss. Additional checks of pH, filtrate hardness and salinity would be helpful.

Note that the effectiveness of this mud system depends very largely on maintaining constant levels of potassium chloride. Also any bentonite cannot be added directly to the mud system as it is basically a salt water mud but has to be premixed in fresh water.

For these reasons all additions to the mud system should come out of the premixing tank only. No water should be added directly to the mud system. The concentrations of materials being premixed can be progressively changed to slowly and gradually change the mud properties.

During premixing the potassium chloride should always be added last, as bentonite must be mixed in fresh water, and the C.M.C. also mixes better in fresh water. Between batches of premix the tank should be pumped out as low as possible to remove as much of the salty premix as possible before the next lot of fresh water is added. Also if bentonite is being used in the premix it should be vigorously mixed for at least one hour, before adding the potassium chloride.

To minimise chances of fermentation becoming a problem during the long duration of the well it is advisable to regularly add a low concentration of a bacteriacide to the premix, as indicated in the recipes later.

<u>12 1/4" HOLE</u> : SURFACE TO 120 m

Spud in the well with a moderately thick prehydrated bentonite spud mud, made by mixing 1/4 ppb caustic soda and 20-25 ppb bentonite in freshwater. Keep the initial mud volume as low as possible as bentonite additions won't be necessary once the Eumeralla Formation is encountered.

Try to maintain a funnel viscosity of 40-45 seconds while drilling the surface sands by adding small amounts of lime through the mixing hopper, to increase the viscosity. Maintain circulating mud volume with water. Adding the lime should enable the original mud volume to be stretched sufficiently to get through the surface sands.

While drilling the surface sands it is preferable to keep the circulating rate low and rely on the mud viscosity for hole cleaning. I would recommend no more than 500 gpm (410 Imp.gpm). This will help minimise hole washout and sand instability.

Once the top of the Eumeralla Formation is reached maintain the mud volume with water additions only, and add small amounts of lime through the mixing hopper to maintain a mud viscosity between 32-36 seconds only. Keeping the viscosity lower will help to minimise clay cuttings sticking together downhole and forming a mud ring. If the mud viscosity rises above 38 seconds while drilling the Eumeralla Formation, it is advisable to increase the water dilution rate, and dump excess mud volume from the sand trap. It is preferable not to add any caustic soda in this section, as this increases clay hydration and stickiness of cuttings and the hole.

I would recommend a slightly higher circulating rate of 550-600 gpm (460-500 Imp gpm), with three 16/32" nozzles in the bit, to give a nozzle velocity of 300-325 ft/sec, while drilling with a conventional bit. This is still a reasonably low nozzle velocity and should still give a good gauge hole.

Immediately prior to, or at the 9 5/8" casing depth, raise the mud viscosity to 40-45 seconds by adding more lime through the mixing hopper, to give better hole cleaning.

Circulate the hole clean for 1/2 hour, then run a wiper trip back to surface to check for tight hole or fill on running back to bottom. If there are no problems circulate the hole clean for another 1/2 hour and then run the 9 5/8" casing.

8 1/2" HOLE : 120m to 1250m T.D.

After cementing the 9 5/8" casing, dump the old mud from the 12 1/4" hole and fill the mud tanks with fresh water. Then drill out the cement and casing shoe with water only.

Continue drilling Eumeralla Formation mixing 1 ppb of C.M.C. (Hi-Vis), and then 15 ppb potassium chloride into the circulating mud system. This will produce a basic potassium chloride mud with a low viscosity. This mud system should be maintained all the way through the Eumeralla Formation by premixing new mud in a separate mixing tank as follows in this order.

FRESH WATER
1 ppb C.M.C. (Hi-Vis)
15 ppb POTASSIUM CHLORIDE
1/2 LITRE BARACIDE BACTERIACIDE OR EQUIVALENT

The pH of the mud system should be controlled to about 9.0, with small amounts of caustic soda mixed in water trickled into the circulating mud system.

Viscosity of the mud system will stay low while mud weight, solids content and clay content remain low. As drilling continues and these parameters rise the viscosity will correspondingly rise as well. Limit the mud viscosity to a maximum of 40 seconds and the mud weight to 9.3 ppg by dumping excess mud and diluting with new premix mud.

Ensure that the potassium chloride concentration of the mud system remains stable, by not adding any water directly to the mud system, only through the premix tank.

Should the hole show signs of being tight or sticky raise the potassium chloride concentration to 4% by using 20 ppb in the premix instead of 15 ppb.

I would recommend a mud circulating rate of 300 gpm (250 Imp gpm) with three 12/32" nozzles giving a nozzle velocity of 300 ft/sec.

Again this is a reasonably low nozzle velocity which will minimise hole washout.

As drilling continues out of the Eumeralla Formation into the Crayfish Formation the formations will become progressively sandier, with higher permeability requiring improved mud water loss control. So from this point on additional C.M.C. (Lo-Vis) at about 2 ppb should be added to the premix mud, to reduce the circulating mud water loss to 8-10 cc's.

Also to improve hole cleaning and wall cake formation in the sands, the mud viscosity should be raised to 38-40 seconds. To raise the mud viscosity begin including bentonite in the premix mud recipe as follows :

FRESHWATER
1 ppb C.M.C. (Hi-Vis)
2 ppb C.M.C. (Lo-Vis)
12 ppb BENTONITE
ALLOW TO MIX AT LEAST 1 HOUR BEFORE ADDING
15 ppb POTASSIUM CHLORIDE

Continue using this recipe until the mud viscosity exceeds 40 seconds then delete the bentonite from the recipe till the viscosity falls back down.

Again limit the mud weight to 9.3 to 9.4 ppg maximum by dumping and diluting with new premix mud. Run all solids control equipment available throughout the duration of the well. I would recommend using B60 over B80 mesh shaker screens on a double deck shaker for the 8 1/2" hole if possible. If not a B40 over B60 combination will have to do.

Occasional checks of mud filtrate hardness, with soda ash added to keep this below 200 mg/l would assist in getting better mud viscosity and water loss control.

At the well T.D. it may be advisable to raise the mud viscosity a little more to between 42-45 seconds to improve hole cleaning while circulating out the well prior to logging.

SUMMARY OF ANTICIPATED MUD PROPERTIES

1. 12 1/4" HOLE   Prehydrated Bentonite Spud Mud Flocculated

With lime

Mud Weight	Less than 9.3 ppg
Viscosity	40 - 45 seconds (32-36 in eumeralla formation)
Water Loss	No Control
pH	9.5 to 10.5
Chlorides	Negligible (Fresh water)

2. 8 1/2" HOLE   3 - 4% Potassium Chloride - Bentonite - C.M.C. Mud

a. Through Eumeralla Formation

Mud Weight	Less than 9.3 ppg
Viscosity	34 - 40 Seconds
Water Loss	15 - 20 cc's
pH	9.0
Chlorides	15,000 - 20,000 mg/l
Hardness	Less than 200 mg/l

b. Through Crayfish Formation

Mud Weight	Less than 9.3 ppg
Viscosity	38 - 40 Seconds
Water Loss	8 - 10 cc's
pH	9.0
Chlorides	15,000 mg/l
Hardness	Less than 200 mg/l

ANTICIPATED MUD CONSUMPTION

1. 12 1/4" HOLE (Assuming 200 bbl mixed to spud with)

Bentonite	-	40 sxs	(100 lb)
Caustic Soda	-	1 sxs	(25 kg)
Lime	-	5 sxs	(25 kg)

2. 8 1/2" HOLE (Assuming 2500 bbl mud mixed)

Potassium Chloride (50kg)	-	340 sxs
C.M.C. (HV) (25kg)	-	45 sxs
C.M.C. (LV) (25kg)	-	45 sxs
Bentonite (100lb)	-	150 sxs
Caustic Soda (25kg)	-	15 sxs
Baracide (30kg)	-	1 can

APPENDIX 4

APPENDIX 4

SAMPLE DESCRIPTIONS

MOCAMBORO #11 CUTTINGS SUMMARY

Logged by C Menhennitt

3-6m Claystone:	Light brown to moderate reddish brown, common clear and translucent coarse quartz grains which are sub angular to sub rounded, trace of pyrite, discrete calcite grains and occasional fragments of calcite cemented very fine grained brownish grey sandstone, traces of limonite, rare coaly fragments, soft to moderately firm, calcareous in parts.
6-9m Sandstone:	Very light grey, very fine grained quartz, silty in parts, occasional medium to coarse quartz grain, moderately to well sorted, sub angular, ferruginous cement in parts, common claystone fragments, common lithic fragments, trace of limonite, trace of mica, trace of pyrite, unconsolidated, non calcareous.
9.78-12.78m	Core #1. Recovery 100%.
12-15m Claystone:	Light grey to brownish grey, occasionally greenish grey, ferruginous in parts, common very fine sand, trace of coarse sand, trace of calcite, trace of pyrite, rare lithic fragments and calcite cemented fine ferruginous sand, very soft to soft.
15-18m Claystone:	Medium light grey to medium grey, slightly ferruginous and silty parts, trace of coaly fragments and very fine sand, rare pyrite and coarse quartz grains, soft to very soft, non calcareous.
18-21m Sandstone:	Medium light grey to medium grey, very fine to fine grained, predominantly quartz, abundant lithic and feldspathic grains, well sorted, rounded to sub rounded occasional coarse quartz grains, coal fragments, argillaceous matrix, argillaceous fragments, possible calcareous fossil fragment, rare pyrite, rare mica, soft to unconsolidated, non calcareous.
21-24m Claystone:	Medium light grey to greenish grey, abundant very fine to fine arkosic sand, occasional coarse quartz grain, sand is generally unconsolidated but has argillaceous matrix and calcite cement in parts, fossil fragments, rare calcite fragment, trace of coaly fragments, trace of mica, rare pyrite, soft to very soft, very slightly calcareous.
25.86.28.75m	Core #2. Recovery 100%.
30-33m Sandstone:	Light grey to medium light grey, fine to very fine grained, grading to coarse silt in parts, predominantly quartz with abundant lithic grains, well to moderately sorted, angular to sub angular, rare coarse grained quartz, rare pyrite, common mica, common coaly fragments, rare calcite cement, soft to unconsolidated, slightly calcareous.

33-36m Claystone:	Medium light grey to greenish grey, trace of very fine sand, trace of pyrite, traces of coaly flecks, and fragments, soft to moderately firm, non calcareous.
36-39m Claystone:	Medium light grey to greenish grey, abundant very fine sand, trace of pyrite, rare coarse quartz grain, common lithic grains, rare discrete calcite fragments, soft, non calcareous.
39-42m Claystone:	Medium light grey to light brownish grey, common coaly fragments, common very fine sand, slightly silty in parts, soft to moderately firm, non calcareous.
42-45m Claystone:	As for 39-42m
45-48m Claystone:	Medium light grey to light brownish grey, rare coaly flecks, silty in parts, rare pyrite, rare arkosic sandstone fragments, moderately firm to firm, calcareous.
48-51m Claystone:	Light grey to occasionally light brownish grey, trace of pyrite, trace of coarse quartz grains, commonly silty, trace of coaly flecks and laminae, rare coal fragments, fossil fragment, trace of mica, abundant fine to very fine sand, fragments of calcite and calcite cemented sand throughout, soft to occasionally moderately firm.
51-54m Claystone:	Greenish grey to light brownish grey, trace of coaly flecks, common very fine sand, soft to moderately firm, slightly calcareous.
54-57m Claystone:	Medium light grey to medium dark grey occasionally greenish grey, abundant very fine predominantly quartz sand with common lithics, trace of pyrite, trace of mica, occasional coal fragments, rare coarse to very coarse quartz grains, slightly silty in parts, possible fossil fragments, occasional calcite grains and fragments of calcite cemented sandstone, predominantly soft to occasionally moderately firm, slightly calcareous.
57-60m Claystone:	Medium light grey to occasionally greenish grey, common fine grained sand, rare coarse quartz grain, trace of coaly fragments, silty in parts, soft, slightly calcareous.
60.78-61.78m	Core #3. Recovery 100%.
61.78-67.78m	Core #4. Recovery 75%.
66-69m Sandstone:	Light grey to light brownish grey very fine to fine grained, arkosic, very well sorted, angular to subrounded, calcite cemented in parts, trace of pyrite, occasional mica, occasional coaly fragments, no fluorescence.

69-72m Sandstone:	As for 66-69m.
72-75m Sandstone	As for 66-69m.
75-78m Sandstone:	Light grey to medium light grey, very fine to fine grained, occasional medium grain, predominantly quartz, abundant lithic and feldspathic grains, larger grains are quartz, moderately to well sorted, predominantly unconsolidated, calcite cement in parts, abundant claystone, common pyrite, common mica, trace of coal, slightly calcareous.
78-81m Sandstone:	As for 75-78m.
81-84m Sandstone:	As for 75-78m.
84-87m Sandstone:	As for 75-78m.
87-90m Claystone:	Light grey to light brownish grey, common coaly fragments, commonly silty, trace of pyrite, rare calcite fragments, trace of very fine sand, soft, non calcareous.
90-93m Claystone:	Light grey to occasionally light brownish grey, common fine to very fine sand, rare coarse quartz grain, trace of mica, occasional coarse calcite grains, trace of coal, soft, slightly calcareous.
93-96m Claystone:	Medium grey, occasionally greenish grey, trace of fine sand, soft to moderately firm in parts, non calcareous.
96.78-102.99m	Core #5. Recovery 94%.
102-105m Sandstone:	Medium light grey to medium grey, occasionally greenish grey, arkosic, fine to occasionally sub angular, trace of calcite cement, trace coal, trace of pyrite, common mica, predominantly unconsolidated, slightly argillaceous matrix in parts, no fluorescence.
105-108m Sandstone:	As for 102-105m
108-111m Claystone:	Medium light grey to medium grey, occasional brownish grey, abundant fine arkosic sand, trace of coal, trace of pyrite, rare coarse quartz grain, soft to occasionally moderately firm, non calcareous.
111-114m Sandstone:	Medium light grey to medium grey, arkosic, very fine to fine grained, well sorted, angular to sub rounded, traces of calcite cement, very argillaceous in parts, trace of pyrite, trace of coal, unconsolidated, no fluorescence.
114-117m Sandstone:	Medium grey to medium dark grey, medium grained quartz, moderately well sorted, sub angular to sub rounded, silty to argillaceous matrix, soft, calcareous.

115.14-117.14m	Core #6. Recovery 100%.
117-120m Sandstone:	As for 114-117m.
120-123m Sandstone:	As for 114-117m.
123-126m Sandstone:	Medium dark grey, medium grained quartz, moderately sorted, sub angular to angular, silty to argillaceous matrix, soft, slightly calcareous.
126-129m Sandstone:	Medium dark grey, fine to predominantly medium grained quartz, moderately well sorted, angular to sub angular, very silty to argillaceous matrix, common coaly fragments, soft to unconsolidated, non calcareous.
129-132m Sandstone:	As for 126-129m.
132-135m Claystone:	Medium grey, trace of medium sand, slightly micaceous, firm, non calcareous.
135-138 Claystone:	Medium grey, occasional coarse angular quartz grains, slightly micaceous, firm to soft, non calcareous.
138-141m Claystone:	As for 135-138m.
141-144m Claystone:	Medium dark grey to dark grey, minor carbonaceous fragments, soft to firm in parts, non calcareous.
144-147m Claystone:	As for 144-147m.
147-150m Sandstone:	Medium dark grey, fine to medium grained quartz, moderately to well sorted, angular to sub angular, very argillaceous matrix, soft, calcareous.
150-153m Claystone:	Medium grey to medium dark grey, trace of fine quartz sand, soft to moderately firm, non calcareous.
153-156m Claystone:	Medium grey to medium dark grey, common to abundant fine to medium quartz sand, soft to moderately firm, calcareous.
156-159m Claystone:	Medium dark grey, occasional medium quartz grain, soft to moderately firm, non calcareous.
159-162m claystone	As for 156-159m.
162-165m Claystone:	As for 156-159m.
165-168m Claystone:	Medium grey to medium dark grey, soft to moderately firm, sub blocky, non calcareous.
168-171m Claystone:	Medium grey to medium dark grey, silty in parts, trace of medium quartz sand, soft to moderately firm, sub blocky, non calcareous.
174-177m Claystone:	Medium grey to medium dark grey, silty in parts, trace of fine sand, rare coaly fragments, soft non calcareous.

177-180m Claystone:	As for 174-177m.
180-183m Siltstone:	Medium dark grey, argillaceous, common fine to medium sand, soft to moderately firm, calcareous.
183-186m Claystone:	Medium grey to medium dark grey, trace of fine quartz sand, soft to moderately firm, sub blocky, non calcareous.
186-189m Claystone:	Medium grey to medium dark grey, soft to moderately firm, sub blocky to blocky, non calcareous.
189-192m Claystone	Medium grey to medium dark grey, very soft, non calcareous.
192-195m Claystone:	As for 189-192m.
195-198 Claystone:	As for 189-192m.
198-201m claystone:	Medium dark grey, micaceous, common fine to very fine sand, grading to silt in parts, soft, non calcareous.
201-204 Claystone:	Medium dark grey, trace to common coaly fragments, trace of fine sand, soft, non calcareous.
204-207m Claystone:	As for 201-204m.
207-210m Claystone:	Medium grey to medium dark grey, slightly micaceous, rare coaly fragments, soft, sub blocky, non calcareous.
210-213m Claystone:	As for 207-210m
213.44-214.36m	Core #7 recovery 100%
213-216m Claystone:	Medium dark grey, slightly micaceous, trace of fine sand, trace of coaly fragments, soft, slightly calcareous.
216-219m Claystone:	Medium dark grey to dark grey, soft, sub blocky, non calcareous.
219-222m Claystone:	As for 216-219m.
222-225m Claystone:	As for 216-219m.
225-228m Claystone:	Medium grey, slightly silty in parts, trace of fine sand, soft, non calcareous.
228-231m Claystone:	As for 225-228m.
231-234m Claystone:	Medium grey to medium dark grey, slightly micaceous, trace of fine sand, soft to moderately firm, sub blocky, non calcareous.
234-237m Claystone:	As for 231-234m.
237-240m Claystone:	Medium grey, trace of fine to medium sand, soft, non calcareous.

240-243m Claystone:	Medium grey, slightly silty in parts, soft to moderately firm, sub blocky, non calcareous.
243-246m Claystone:	Medium grey, soft to very soft, non calcareous.
246-249m Claystone:	Medium grey to medium dark grey, slightly micaceous, slightly silty, soft to moderately firm, sub blocky, non calcareous.
249-252 Claystone:	As for 246-249m.
252-255m Claystone:	Medium dark grey, slightly micaceous, trace of very fine sand, soft to moderately firm, non calcareous.
255-258m Claystone:	Medium dark grey, slightly micaceous, trace of very fine sand, soft to moderately firm, sub blocky, non calcareous.
258-261m Claystone:	As for 255-258m.
261-264m Claystone:	Medium dark grey, slightly silty, very soft, non calcareous.
264-267m Claystone:	Medium grey to medium dark grey.
267-270m Claystone:	Medium grey to medium dark grey, slightly silty, trace of fine sand, soft to moderately firm, sub blocky, non calcareous.
270-273m Claystone:	As for 267-270m.
273-276m Claystone:	As for 267-270m.
276-279m Claystone:	As for 267-270m.
279-282m Claystone:	Medium grey to medium dark grey, slightly silty, trace of fine sand, slightly micaceous, soft to moderately firm, non calcareous.
282-285m Claystone:	As for 279-282m.
285-288m Claystone:	As for 279-282m.
288-291m Claystone:	As for 279-282m.
291-294m Claystone:	Medium grey to medium dark grey, slightly silty, soft, non calcareous.
294-297m Claystone:	As for 291-294m.
297-300m Claystone:	As for 291-294m.
300-303m Claystone:	As for 291-294m.
303-306m Claystone:	As for 291-294m.
306-309m Claystone:	As for 291-294m.
307.52-313.44	Core #8 recovery 92%.

315-318m Claystone:	Medium dark grey, slightly silty, soft, non calcareous.
318-321m Claystone:	Medium grey to medium dark grey, slightly silty, slightly micaceous, trace of very fine sand, soft, non calcareous.
321-324m Claystone:	As for 318-321m
324.52--328.52m	Core #9 Recovery 97%.
330-333m Claystone:	Medium grey to medium dark grey, silty in parts, slightly micaceous, soft to moderately firm, sub blocky, non calcareous.
333-336m Claystone:	Medium dark grey to dark grey, slightly silty, trace of fine sand, sub blocky, moderately firm, non calcareous.
336-339 Claystone:	Medium dark grey, slightly silty, trace of fine sand, slightly micaceous, soft to moderately firm, non calcareous.
339-342m Claystone:	Medium dark grey, trace to common silt, trace of fine sand, firm to moderately firm, sub blocky, non calcareous.
342-345m Claystone:	Medium grey to medium dark grey, slightly silty, trace of fine sand, soft to very soft, non calcareous.
345-348m claystone:	Medium dark grey, silty, trace of fine sand, soft to moderately firm, sub blocky non calcareous.
348-351m Claystone:	As for 345-348m.
351-354m Claystone:	As for 345-348m.
354-357m claystone:	As for 345-348m.
357-360m claystone:	Medium dark grey, very silty to slightly sandy in parts, trace of coaly fragments, soft to moderately firm, sub blocky, non calcareous.
360-363m Claystone:	As for 357-360m.
363-366m Claystone:	Medium grey to medium dark grey, slightly silty, trace of fine to very fine sand, soft, non calcareous.
366-369m Sandstone:	Medium light grey to medium grey, coarse to very coarse grained, common medium grains, arkosic, poorly to moderately sorted, angular to sub angular, common feldspathic grains and rock fragments, coarse silty matrix, unconsolidated, non calcareous, good visual porosity.
369-372 Sandstone:	As for 366-369m.

372-375 Siltstone:	Medium dark grey, common to abundant sand grains as above, trace of pyrite, soft to moderately firm, sub blocky, non calcareous.
375-378m Claystone:	Medium grey to medium dark grey, slightly silty, trace of pyrite, soft to moderately firm, trace of sand as above, non calcareous.
378-381m claystone:	Medium grey to medium dark grey, slightly silty, soft, non calcareous.
381-384m Claystone:	Medium dark grey, slightly silty, firm, sub blocky to blocky, non calcareous.
384-387m Claystone:	Medium grey to medium dark grey, slightly silty, trace of fine sand, slightly micaceous, soft to moderately firm, non calcareous.
387-390m Sandstone:	Medium dark grey, predominantly fine grained, occasional medium to coarse grain, well sorted, feldspathic, rock fragments, argillaceous to silty matrix in parts, predominantly hard and no porosity due to calcite cement.
390-393m Claystone:	Medium dark grey, trace to common fine sand, trace of mica, trace of coal, soft, non calcareous.
393-396 Claystone:	Medium grey to medium dark grey, slightly silty, trace of mica, soft, non calcareous.
396-399m Claystone:	As for 393-396m.
399-402m Claystone:	Medium grey to medium dark grey, silty, trace of fine to very fine sand, trace of mica, soft, sub blocky in parts, non calcareous.
402-405m Claystone:	As for 399-402m.
405-408m Claystone:	As for 399-402m.
408-411m Claystone:	Medium dark grey, slightly silty, soft to moderately firm, sub blocky, non calcareous.
411-414m Claystone:	As for 408-411m.
414-417m Claystone:	As for 408-411m.
417-420m Claystone:	Medium dark grey, slightly silty, trace of very fine sand, trace of coal, soft to moderately firm, sub blocky to blocky, non calcareous.
420-423m Claystone:	As for 417-420m.
423-426m claystone:	Medium dark grey, slightly silty, trace of very fine sand, trace of coal, soft to moderately firm, sub blocky non calcareous.
426-429m Coal:	Black, sub vitreous lustre, blocky, soft to moderately firm, trace of medium to coarse quartz sand, non calcareous.

429-432 Claystone:	Medium grey to medium dark grey, slightly silty, soft, non calcareous.
432-435m Claystone:	As for 422-432m.
435-438m Sandstone:	Light grey to medium light grey, very fine grained, feldspathic, predominantly quartz, well sorted, angular to very angular, coaly fragments, traces of calcite cement, slightly argillaceous in parts, soft to firm, poor visual porosity.
438-441m Sandstone:	As for 435-438m.
441-444m Sandstone:	As for 435-438m.
444-447m Siltstone:	Light grey to medium light grey, occasionally medium dark grey to brownish grey, occasional coaly fragments, common very fine sand, calcite cement in parts, soft to moderately firm, calcareous.
447-450m Sandstone:	Light grey to medium light grey, very fine grained, predominantly quartz, feldspathic grains, common silty matrix, well sorted, sub angular to angular, occasional calcite cement, unconsolidated.
450-453m Claystone:	Medium grey to medium dark grey, slightly silty in parts, trace of very fine sand, occasional coaly fragments, soft to moderately firm, non calcareous.
453-456m Claystone:	As for 450-453m.
456-459m Claystone:	medium grey to medium dark grey, commonly silty, trace of very fine sand, occasional coaly fragments, soft to very soft, non calcareous.
459-462m Claystone:	As for 456-459m.
462-465m Sandstone:	Light grey to medium light grey, very fine grained quartz, very well sorted, angular to sub angular, silty matrix, abundant calcite cement, trace of pyrite, trace to common coaly fragments, soft to firm in cemented parts, poor visual porosity.
465-468m Siltstone:	Medium light grey to medium dark grey, occasionally dark grey, abundant very fine grained quartz sand which is calcite cemented in parts, common coaly fragments, trace of pyrite, becoming very sandy in parts, soft to moderately firm, non calcareous in siltstone.
468-471m Siltstone:	As for 465-468m.
471-474m Claystone:	Medium grey to medium dark grey, silty in parts, common coaly fragments, slightly micaceous, common fragments of calcite cemented very fine sand, soft to moderately firm, claystone is now calcareous.

474-477m Sandstone:	Light grey to medium light grey, very fine grained, becoming silty in parts, very well sorted, angular to sub angular, very silty to argillaceous matrix, calcite cement in parts, trace to common coaly fragments, soft to moderately firm in parts, slightly calcareous.
477-480m Claystone:	Medium grey to medium dark grey, silty in parts, common very fine quartz sand, trace of coaly fragments, trace of pyrite, predominantly soft, non calcareous.
480-483m Claystone:	As for 477-480m.
483-486m Sandstone:	Very light grey to light grey, very fine to fine grained quartz, trace of calcite cement, argillaceous matrix in parts, common claystone, trace of pyrite, common coaly fragments, soft to moderately firm, predominantly non calcareous.
486-489m Sandstone:	Very light grey to light grey, very fine to coarse grained quartz, poor to moderately sorted, very angular to angular, calcite cement in finer grained sand, common pyrite, rare to trace of coaly fragments, occasional feldspathic grain, unconsolidated, good visual porosity.
489-492m Sandstone:	Very light grey to light grey, very fine to occasionally fine grained quartz, occasional feldspathic and lithic grains, well sorted, sub angular to sub rounded, trace of mica, trace of pyrite, common coaly fragments, silty to argillaceous in parts, calcite cement in parts, soft to firm, calcareous in parts, poor visual porosity.
492-495m Claystone:	Very light grey to light grey, commonly silty and sandy, common coaly fragments, soft to moderately firm, calcite cement in sandstone fragments.
495-498m Siltstone:	Medium grey to medium dark grey, argillaceous and sandy in parts, common coaly fragments, trace of pyrite, soft to moderately firm, trace of calcareous cement in fine sands.
498-501m Siltstone:	As for 495-498m.
501-504m Siltstone:	As for 495-498m.
504-507m Siltstone:	As for 495-498m.
507-510m Claystone:	Medium light grey to medium grey, common fine to very fine quartz sand, trace of coaly fragments, trace of calcite cement in sands, silty in parts, soft to moderately firm, non calcareous.
510-513m Sandstone:	Very light grey to light grey, very fine to fine grained quartz, occasional coarse grain, trace to common coaly fragments, trace of mica, common calcite cement, silty and argillaceous matrix in parts, soft to moderately firm in parts, poor visual porosity.

513-516m Claystone:	Medium light grey to medium grey, common very fine to fine sand, silty in parts, trace of coaly fragments, trace of calcite cement in sands, soft to moderately firm, non calcareous.
516-519m Claystone:	As for 513-516m.
519-522m Sandstone:	Very light grey to medium light grey, very fine to fine grained quartz, well sorted, angular to sub angular, common silty to argillaceous matrix, common coaly fragments, trace of pyrite, common calcite cement, soft to firm, poor visual porosity.
522-525m Claystone:	Light grey to medium grey, common fine sand and silt, common coal, calcite in sands, common coaly laminae, soft to moderately firm.
525-528m Claystone:	Light grey to medium grey, common sand, trace to common fine coaly fragments and laminae, trace of pyrite, calcite cement and lithic fragments in sandstone pieces, soft to moderately firm, claystone is non calcareous.
528-531m sandstone:	Very light grey to light grey, very fine to fine grained, occasional medium grain, feldspathic, lithic fragments, rare pyrite, silty to argillaceous matrix and laminae in parts, abundant calcite cement, trace of mica, firm to moderately firm, poor visual porosity. Weak to moderate cut and moderate crush cut yellowish white fluorescence.
531-534m Sandstone:	Very light grey to light grey, fine to occasionally medium grained, predominantly quartz, common feldspathic and lithic grains, trace of pyrite, trace of mica, well sorted, calcite cement, slightly silty in parts, moderately firm, very angular to angular, moderate visual porosity. Weak yellowish white cut and crush cut fluorescence.
534-537m Sandstone:	As for 531-534m.
537-540m Claystone:	Light grey to medium grey, common fine sand, trace to common coaly fragments and laminae, trace of pyrite and calcite cement in sands, becoming silty in parts, predominantly soft to occasionally moderately firm, non calcareous in claystone. Weak to moderate cut and strong crush cut yellowish white fluorescence.
540-543m Claystone:	As for 537-540m.
543-546m Sandstone:	Very light grey to light grey, very fine to fine to occasionally medium grained, well sorted, angular to sub angular, feldspathic and lithic grains, trace of mica, trace of pyrite, abundant calcite cement, firm, poor to moderate visual porosity. Slight cut and moderate to strong crush cut yellowish white fluorescence.

546-549m Claystone:	Medium light grey to medium grey, common fine to very fine sand, common coaly fragments and laminae, silty in parts, slightly micaceous, moderately firm, non calcareous. Slight cut and moderate to strong crush cut yellowish white fluorescence.
549-552m Claystone:	As for 546-549m.
552-555m Claystone:	As for 546-549m with around 40% fragments of calcite cemented fine sandstone.
	Sandstone: Very light grey, fine grained, feldspathic and lithic grains, well sorted, angular to sub angular, common calcite cement, argillaceous matrix in parts, trace of pyrite, moderately firm, poor visual porosity.
555-558m Siltstone:	Medium grey to medium dark grey, grading to very fine sand in parts, slightly argillaceous in parts, common coaly fragments, trace of mica, traces of calcite cemented fine sand, rare pyrite, moderately firm, sub blocky, now calcareous. Slight cut and strong crush cut greenish white fluorescence.
558-561m Siltstone:	As for 555-558m.
561-564m Coal:	Black, slightly silty in parts, dull to sub vitreous, blocky, firm, common fine sand, common siltstone as for 555-558m. Weak cut and strong crush cut greenish white fluorescence.
564-567m Sandstone:	Very light grey to light grey, fine to very fine grained grading to siltstone, feldspathic, lithic grains, common coaly fragments, well sorted, sub angular to angular, abundant calcite fragments and calcite cement, trace of pyrite, trace of mica, firm to moderately firm, poor visual porosity. Slight cut and strong crush cut greenish white fluorescence.
567-570m Claystone:	Very light grey to medium light grey, becoming silty and sandy in parts, common coaly fragments and pyrite, common calcite cemented fine sand fragments and discrete calcite pieces, soft to moderately firm, calcareous. Slight cut and strong crush cut greenish white fluorescence.
570-573m Claystone:	Medium light grey to medium grey, becoming silty and very sandy in parts, trace to common coaly fragments and laminae, trace of pyrite and mica, occasional calcite fragments, very soft to moderately firm, sub blocky in parts, predominantly non calcareous. Slight cut and strong crush cut greenish white fluorescence.
573-576m Claystone:	As for 570-573m.
577.23-578.48m	Core #10. Recovery 10%.

576-579m Sandstone:	Very light grey to light grey, very fine to fine grained, well sorted, angular to very angular, feldspathic, lithic grains, abundant calcite and calcite cement, common pyrite, traces of mica, common siltstone and claystone fragments with carbonaceous laminae, occasional coaly fragment, firm poor visual porosity. Weak yellowish white cut and strong greenish white crush cut fluorescence.
579-582m Claystone:	Medium light grey to medium grey, occasional to common fine sand, traces of coal, rare pyrite, occasional fragments of cemented lithic sand, sandstone fragments are calcareous, soft to occasionally moderately firm, claystone is non calcareous. Trace of bluish yellow cut and moderate greenish white crush cut fluorescence.
582-585m Claystone:	As for 579-582m
585-588m Claystone:	Medium light grey to medium grey, occasionally medium dark grey, common fragments of very fine grained lithic sandstone which is calcite cemented in parts, minor unconsolidated very fine sand, trace of coaly fragments, very soft to soft and occasionally moderately firm, claystone is non calcareous. Very weak cut and strong crush cut greenish white fluorescence.
588-591m Sandstone:	Light grey to medium light grey, very fine to fine grained, occasional medium grain, well to very well sorted, angular to sub angular, predominantly quartz grains with common lithic and feldspathic grains, trace of mica, trace of coal, argillaceous matrix in parts, abundant calcite cement, unconsolidated to moderately hard in cemented sections, moderate to poor visual porosity. Trace of cut and moderate crush cut greenish white fluorescence.
591-594m sandstone:	As for 588-591m.
594-597m Sandstone:	Very light grey to light grey, very fine to fine grained, predominantly lithic and feldspathic grains, well sorted, angular to very angular, trace of mica, rare coaly fragments and pyrite, abundant calcite cement, moderately hard, very calcareous, nil visual porosity, nil fluorescence. Trace of cut and strong crush cut greenish white fluorescence.
597-600m Sandstone:	Very light grey to light grey, very fine to fine grained, predominantly lithic and feldspathic grains, well sorted, angular to sub angular, trace of mica, trace of coaly fragments, rare pyrite, abundant calcite cement, argillaceous matrix in parts, unconsolidated to moderately hard, very calcareous poor visual porosity, nil fluorescence. Faint cut and moderate greenish white crush cut fluorescence.
600-603m Claystone:	Medium light grey to medium grey, slightly silty in parts, trace of coaly fragments, occasionally very

	fine sand, soft, non calcareous. Trace cut and strong crush cut greenish white fluorescence.
603-606m Claystone:	As for 600-603m.
606-609m Claystone:	As for 600-603m.
609-612m Claystone:	As for 600-603m.
613.67-618.14m	Core #11. Recovery 95%.
618-621m Claystone:	Medium light grey to greenish grey, up to 40% cemented very fine to fine lithic sandstone, cement commonly calcite, trace to common coaly fragments in both claystone and sandstone, trace of mica, soft to moderately firm, calcareous in sandstone. Weak greenish white cut and crush cut fluorescence.
621-624m Claystone:	As for 618-621m.
624-627m Claystone:	Medium light grey to greenish grey, predominantly greenish grey, trace to occasional coaly fragments, occasional calcite cemented fine sand, soft to moderately firm, non calcareous. Weak yellowish crush cut fluorescence with a moderate to strong yellowish white residue ring.
627-630m Claystone:	Medium light grey to occasionally greenish grey, silty in parts, traces of coaly laminae and coal fragments, common fragments of calcite cemented very fine sand and silt, firm to moderately firm, occasionally soft, calcareous.
Fluorescence 627-666m	Weak yellowish crush cut fluorescence which leaves a moderate to strong yellowish white fluorescence residue ring.
630-633m Claystone:	As for 627-630m with interbedded sandstone: very light grey to light grey, very fine to fine grained quartz, occasional to rare coarse grain, well sorted, angular to very angular, common lithic and feldspathic fragments, common to abundant calcite cement, argillaceous matrix in parts, traces of coal, unconsolidated to moderately firm, calcareous in parts, nil visual porosity, nil fluorescence.
633-636m sandstone:	Very light grey to light grey, very fine to fine grained quartz, abundant lithic and feldspathic grains, well sorted, angular to very angular, common to abundant calcite cement, argillaceous matrix in parts, traces of coal and mica, abundant light grey claystone, unconsolidated in parts, commonly moderately firm, nil visual porosity, nil fluorescence.
636-639m Claystone:	Very light grey to light grey, occasionally greenish grey, trace to common coaly fragments, trace of pyrite, slightly silty in parts, soft to moderately firm in parts, common calcite cemented fine to very fine sand.

639-642 Claystone:	Very light grey to greenish grey and greyish black to brownish black, trace of coaly fragments, occasional coarse to very coarse sub rounded quartz grains, trace of pyrite, trace calcite cemented fine sand, soft to moderately firm.
642-645m Claystone:	As for 639-642m.
645-648m Claystone:	Light grey to medium light grey, occasionally greenish grey and grey black, common coal, trace of pyrite, traces of mica, trace to common calcite cemented very fine to fine sand, soft to moderately firm, slightly calcareous.
650.61-653.01m	Core #12. Recovery 100%.
654-657m Claystone:	Medium light grey to greenish grey, up to 40% very fine to fine arkosic sand, commonly calcite cemented, claystone is silty in parts, trace of coaly fragments, rare pyrite, possible rare pink garnets, common unconsolidated fine sand, moderately firm, very calcareous.
657-660 Claystone:	Medium light grey to medium grey, occasionally medium dark grey, silty in parts, common fragments of very fine sand with calcite cement, rare very coarse quartz grain, trace of coaly fragments, soft to moderately firm.
660-663m Claystone:	As for 657-660m.
663-666 Claystone:	As for 657-660m.
666-669m Claystone:	Medium light grey to medium grey, occasionally dark grey, silty in parts, occasional to common coaly flecks and laminae, trace of pyrite, common large coal fragments, up to 40% fragments of very fine sandstones, commonly calcite cemented, soft to moderately firm, slightly calcareous.
669-672m Claystone:	As for 666-669m.
672-675m Claystone:	As for 666-669m.
675-678m Claystone:	Very light grey to light grey, trace coaly flecks and laminae, slightly silty in parts, common calcite fragments, trace blocky coal fragments, soft to moderately firm, slightly calcareous.
678-681m Claystone:	Light grey to medium light grey, occasionally greenish grey, occasional brownish grey siltstone fragments, trace coaly flecks and laminae, occasional discrete calcite fragments and fragments of calcite cemented fine to very fine askosic sandstone, soft to moderately firm, slightly calcareous.
681-684m Claystone:	Light grey to medium light grey, occasionally greenish grey, occasional brownish grey siltstone

	fragments, common unconsolidated very fine to fine sand, trace of pyrite, abundant calcite and calcite cemented sand fragments, coaly flecks and laminae, soft to moderately firm, calcareous.
684-687m Claystone:	As for 681-684m.
687-690m Claystone:	Light grey to medium grey, occasionally greenish grey, commonly silty, common coaly flecks and fragments, trace of pyrite, green claystone is now silty, abundant loose fine sand, calcite cemented fine sand, trace of non calcareous sandstone fragments with argillaceous matrix, common calcite fragments, soft to moderately firm, claystone is now calcareous.
690-693m sandstone:	Very light grey to light grey, fine to very fine grained quartz grading to silt in parts, well sorted, very angular to angular, abundant calcite cement, trace of mica, common lithic grains, common feldspathic grains, common fragments of grey and greenish grey claystone, occasional brownish grey siltstone fragments, soft to moderately hard, poor visual porosity, no fluorescence, very weak yellowish crush cut residue.
693-696m Claystone:	Light brownish grey to greenish grey, occasionally medium light grey, common coaly flecks and fragments, abundant fragments of very light grey calcite cemented fine sandstone, common loose fine sand grains which are predominantly quartz but have common lithic and feldspathic grains, soft to moderately firm, claystone is non calcareous.
696-699m Claystone:	As for 693-696m.
699-702m Sandstone:	Light grey to light greenish grey, predominantly quartz with common lithic and feldspathic grains, fine grained, very well sorted, abundant very light grey consolidating matrix, common calcite cement, common coaly fragments, possible light pink garnets, common mica, trace chlorite, occasional light grey and light brownish grey claystone fragments, occasional light brown calcite fragments, friable, no visual porosity, very weak whitish fluorescent residue on filter paper, very weak crush cut, pale yellow.
702-705m Sandstone:	As for 699-702m with occasional dark brownish grey claystone.
705.11-706.26m	Core #13. Recovery 90%.
705-708m Claystone:	Medium light grey to light brownish grey, occasionally brownish black, occasional coal fragments, slightly silty in parts, occasional fragment of light grey arkosic sandstone, trace of loose fine sand, rare calcite fragments, minor coaly flecks in claystone fragments, soft to moderately firm.

708-711m Coal:	Greyish black to black, brittle, blocky to sub conchoidal fracture, non calcareous, no cut, weak crush cut, weak pale yellow residual ring in spot tray.
711-714m Claystone:	Medium grey to light grey, occasionally brownish grey and brownish black, trace of coaly flecks and fragments, rare fragments of calcite cemented sandstone, soft to moderately firm, occasionally firm, non calcareous.
714-717m Claystone:	As for 711-714m.
717-720m Claystone:	Medium light grey to medium grey, occasional brownish grey, common coaly flecks and laminae, occasional coal fragment, abundant calcite cemented fine grained lithic sandstone, soft to moderately firm, non calcareous.
720-723m Claystone:	Medium grey to medium light grey, occasionally brownish grey, common coal fragments, flecks and laminae, abundant calcite cemented fine sandstone, trace of pyrite, slightly silty in parts, soft to firm, calcareous.
723-726m Claystone:	Light grey to medium light grey, minor brownish grey, trace of pyrite, trace of coal, abundant loose and calcite cemented fine sand, silty in parts, predominantly moderately firm to occasionally soft, claystone is non calcareous.
726-729m Coal:	Greyish black to brownish black, brittle, sub blocky to blocky, occasional sub conchoidal fracture, non calcareous, no cut or crush cut.
729-732m Claystone:	Medium grey to brownish grey, common coal flecks, fragments and laminae, trace of pyrite, abundant fragments of calcite cemented fine sandstone, silty in parts, moderately firm, non calcareous.
732-735m Sandstone:	Very light grey to medium light grey, fine to predominantly very fine grained, arkosic, well sorted, sub angular to sub rounded, abundant calcite cement, trace of pyrite, common coal fragments, common to abundant siltstone and claystone fragments, moderately firm to firm, no visual porosity, no fluorescence, weak fluorescent crush cut residue on filter paper.
735-738m Sandstone:	As for 732-735m.
738-741 Claystone:	Medium light grey to greenish grey, slightly silty in parts, trace of pyrite, common fragments of calcite cemented fine grained arkosic sandstone, rare coarse to very coarse quartz grains, common coal fragments, soft to moderately firm, claystone is non calcareous.
741.27-745.01m	Core #14. Recovery 76%.

747-750m Claystone:	Medium light grey to medium dark grey, occasionally greenish grey, becoming silty in parts, abundant fragments of fine sandstone, some with calcite cement, trace of coal, trace of mica, trace of pyrite, soft to moderately firm, claystone is non calcareous.
750-753m Sandstone:	Very light grey to light grey, arkosic, very fine to fine grained, well sorted, angular to sub angular, predominantly calcite cemented, trace of pyrite, trace of mica, common to abundant medium light grey to medium grey siltstone and claystone fragments which have common coaly flecks, rare very coarse quartz grain, coal cavings, no visual porosity, no fluorescence.

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753-756m Siltstone:	Very light grey to medium grey, arkosic, very fine grained, up to very fine sand size, calcite cement, mica, few soil fragments which are strongly oriented, no visual porosity, no fluorescence.
756-759m Siltstone:	Very light grey to medium light grey, arkosic, with minor very fine to fine sand size fragments. Carbonate cement appears to be confined to fragments of coarser grain size, trace mica, coal fragments strongly oriented, coarser fraction is moderately well sorted, sub angular to sub rounded, no visual porosity.
759.31-763.26m	Core #15. Recovery 10%.
762-765m Siltstone:	Dark grey to medium grey, with minor fine to very fine, very light grey sandstone. Sandstone fragments are carbonate cemented, siltstone is non carbonate. Sandstone is sub rounded, well sorted, no visual porosity, minor mica. Few large coal fragments (> 2mm) sandstone is arkosic. Rare grains of brownish-black siltstone, fine sandstone, non-carbonate cemented, no fluorescence.
765-768m Siltstone:	Dark to medium grey, minor light grey very fine sandstone, rare brownish grey and greenish grey siltstone, carbonate cement confined to coarser grained fragments which consist predominantly of quartz, arkosic, sub-rounded, moderately well sorted, minor mica, rare blabs of pyrite in coarser fragments, rare coaly fragments, no fluorescence.
768-771m Siltstone:	Medium dark grey, occasionally dark greenish grey, with some light to very light grey fine to medium grained sandstone, micaceous, rare coaly fragments. Coarser phase; carbonate cemented. Sand is predominantly quartz moderately well sorted but rounded, no visual porosity, no fluorescence.

771-774m Siltstone:	Medium grey to medium light grey, minor very light grey to light grey, carbonate cemented, micaceous, quartz sandstone, fine to very fine, occasional large (>3mm) coal fragments, no visual porosity, no fluorescence.
774-777m Sandstone:	Very light grey, very fine grained, carbonate cemented, arkosic quartz sandstone, very rare mica, green, rounded grains, greenolite?, sub rounded, well sorted, with medium light grey siltstone, non carbonate cemented, no visual porosity, no fluorescence.
777.8-783.65m	Core #16. Recovery 92%.
783.65-784.95m	Core #17. Recovery 10%.
783-786m Siltstone:	Medium dark grey to medium light grey predominantly quartz siltstone, fine grained sandstone, quartz is sub rounded, well sorted, with coaly fragments & rare mica and rare pyrite blebs. Slight fluorescence on filter paper.
786-789m Siltstone:	Medium light grey to very light grey siltstone, with some very light grey to white, very fine sandstone, some carbonate cement, but less than in preceeding samples, abundant coaly fragments (up to 5mm). The finer grained siltstone is hard and well cemented, the sandstone is generally more friable, probably cemented by white clay, no visible porosity, weak yellow fluorescent, crush cut.
789-792m Sandstone:	Light grey to very light grey, very fine grained to fine grained, friable, carbonate cemented, rounded, well sorted, quartz siltstone, with medium light grey, well cemented siltstone, abundant, large coal fragments, no visible porosity.
792-795m Sandstone:	Light grey to very light grey, rarely light brownish grey, very fine grained to fine grained, carbonate/clay cement (friable when cement is non-carbonate), rounded, well sorted, predominantly quartz sandstone, with some medium light grey siltstone and large coaly fragments, as well as coaly fragments within the light brownish grey sandstone, no visible porosity.
795-798m Siltstone:	Light grey to white siltstone, with some very fine grained sandstone, minor carbonate cement, friable, occasional coal fragments, no visible porosity.
798-801m Sandstone:	Medium grey to medium light grey, with some light brownish grey very fine to fine grained sized arkosic quartz sandstone with minor siltstone; mica and coal fragments, no visible porosity, rare carbonate cement, fluorescence; crush cut, weak yellow.

801-804m Siltstone:	Medium grey to medium light grey siltstone with some carbonate cement, fine sandstone containing coal fragments, no visible porosity; sandstone is rounded, well sorted.
804-807m Siltstone:	Medium dark grey, clayey, some sandstone fragments, rare carbonate cement, few coal fragments, no visible porosity.
807-810m Siltstone:	Medium dark grey, abundant very fine grained sandstone fragments, quartz, rounded well sorted, with rare grains of quartz.
810-813m Claystone:	Medium light grey claystone with fragments of carbonate cemented very fine grained sandstone and fragments of siltstone, soft, fluorescence; crush cut (relatively strong).
814.32-816.82m	Core #18. Recovery 100%.
816-819m Siltstone:	Medium dark grey to medium grey siltstone, with fragments of very light grey carbonate cemented very fine grained sandstone, large (5mm) coal fragments, faint yellow-green fluorescence on crush cut (delayed).
819-822m Siltstone:	Medium dark grey to medium grey siltstone, as above no fluorescence.
822-825m siltstone:	Medium grey siltstone, as above.
825-828m Siltstone:	Medium grey siltstone, as above.
828-831m Siltstone:	Medium grey siltstone, as above, with some fragments with a brown-grey colour, and slightly more micaceous.
832.58-835.43m	Core #19. Recovery 100%.
834-837m Sandstone:	Medium grey., fine to very fine sand, with some unconsolidated medium to very coarse sand consisting of clear quartz, rarely pink, sub angular to rounded, as well as common large coal fragments up to 5mm, the fine sandstone, which is consolidated, has no visual porosity, rare large grains of pyrite (2mm), no fluorescence.
837-840m Sandstone:	Medium grey, fine to medium grained, carbonate cemented sand, common clear quartz sand grains up to 2mm, common large coal fragments, rare large pyrite (up to 2mm), no visual porosity in carbonate cemented sandstone fragments, no fluorescence.
840-843m Sandstone:	Medium grey to medium light grey, fine to medium carbonate cemented sand, sub angular to sub rounded quartz, some grains up to 1mm, common mica flakes, coal fragments, no visual porosity in cemented fragments, but common unconsolidated sand, no fluorescence.

843-846 Sandstone:	Dark grey, very fine to fine grained quartz sandstone, occasionally carbonate cemented, well consolidated, no visual porosity, common mica, coal fragments, no fluorescence.
846-849m Sandstone:	Medium dark grey, very fine grained quartz sandstone, some carbonate cement, occasional large (to 3mm) fragments of calcite, common mica flakes, rare coal fragments, no fluorescence.
850.97-853.47m	Core #20. Recovery 97%

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852-855m Claystone:	Medium light grey to medium dark grey, trace of pyrite, carbonaceous in parts, trace of mica, common fragments of very fine to fine grained arkosic sandstone and siltstone, blocky, moderately hard, trace of calcite cement in sandstone.
855-858m Siltstone:	Medium grey to medium dark grey, common carbonaceous flecks, trace of pyrite, trace of mica, common fragments of very fine to fine grained arkosic sandstone, sub blocky, moderately firm to moderately hard, trace of calcite cement in sandstone.
858-861m Sandstone:	Very light grey to light grey, very fine to fine grained, arkosic, well sorted, angular to sub angular, abundant silty and argillaceous matrix, abundant calcite cement, trace of pyrite, trace of mica, common fragments of siltstone and claystone, traces of coal and coaly laminae, moderately firm, no visual porosity.
861-864m Sandstone:	As for 858-861m Crush cut fluorescence, yellowish white with weak to moderate yellowish white residue ring.
864-867m Sandstone:	As for 858-861m.
869.42-871.47m	Core #21. Recovery 95%
Fluorescence 873-891m	Weak yellowish crush cut fluorescence with weak to moderate yellowish white residue ring.
873-876m Claystone:	Greenish grey to medium dark grey, common very fine to fine sand and siltstone, trace of pyrite, trace of coaly flecks and fragments, trace of calcite cement in sandstone, sub blocky, moderately firm to firm.
876-879m Sandstone:	Light grey to medium light grey, occasionally greenish grey, arkosic, very fine to occasionally fine grained, well sorted, angular to sub angular, common argillaceous matrix, common calcite cement, micaceous, common siltstone fragments, trace of claystone, friable, no visual porosity.

879-882m Siltstone:	Light grey to medium light grey, grading to very fine sand in parts, common claystone fragments, trace of coaly laminae, calcite cement in some sandstone fragments, trace of coaly laminae, calcite cement in some sandstone fragments, moderately firm to occasional soft, sub blocky.
882-885m Siltstone:	Medium light grey to medium grey, occasionally brownish grey, trace of pyrite, common medium grey claystone, occasional sandstone A/A, rare coaly flecks, trace of calcite cement in sandstone, moderately firm, sub blocky.
885-888m Siltstone:	As for 882-885m.
888-891m Siltstone:	As for 882-885m.
891-894m Siltstone:	Light grey to medium light grey, common sandstone and claystone fragments, trace of mica, trace of pyrite, occasional coaly flecks and fragments, trace of calcareous cement in sandstones, but blocky to blocky, moderately firm.
Fluorescence 894-933m	Weak yellowish to yellow white crush cut fluorescence with weak to moderate yellowish white residue ring.
894-897m Siltstone:	Medium grey to medium light grey, common fragments of very fine grained silty sandstone and claystone, trace of pyrite, occasional coaly flecks and fragments, rare calcite cement in sandstone, sub blocky, moderately firm.
897-900m Siltstone:	As for 894-897m.
900-903m Siltstone:	As for 894-897m.
905.87-907.62m	Core #22. Recovery 70%.
906.909m Siltstone:	Medium light grey to medium dark grey, occasional dark grey claystone, common fragments of very fine grained arkosic sandstone which are calcite cemented in part, occasional coaly flecks and fragments, occasional greenish grey claystone fragments, blocky to sub blocky, soft to moderately firm.
909-912m Sandstone:	Very light grey to light grey, very fine grained, arkosic, well sorted, very angular to angular, silty to argillaceous matrix in parts, trace of calcite cement, common coaly flecks and fragments of greenish grey and brownish black claystone, no visual porosity, friable.
912-915m Siltstone:	Medium grey to medium dark grey, occasionally greenish grey, occasional brownish grey and medium dark grey claystone, common light grey sandstone A/A, trace of coal, sub blocky, moderately firm, silt and clay are non calcareous.

915-918m Sandstone:	Very light grey to light grey, very fine grained, arkosic, well sorted, very angular to angular, silty to argillaceous matrix in parts, abundant calcite cement, trace of mica, trace of coal, becoming medium grey siltstone in parts, no visual porosity.
918-921m Sandstone:	Very light grey to light grey and occasionally light greenish grey, arkosic, very fine grained, rare medium quartz grain, well sorted, very angular to angular, trace of silty matrix, abundant calcite cement, trace of mica, trace of pyrite, occasional coaly fragments, no visual porosity.
921-924m Sandstone:	Medium light grey to greenish grey, common sandstone A/A, occasional medium grey claystone, occasional coaly fragments, sub blocky, soft to moderately firm.
924-927m Siltstone:	As for 921-924m.
927-930m Siltstone:	As for 921-924m.
930-933m Sandstone:	Very light grey to light grey, occasionally medium light grey, arkosic, predominantly very fine grained and grading to siltstone in parts, moderately well sorted, angular to sub angular, occasionally sub rounded, common silty matrix, abundant calcite cement, common mica, common coaly fragments, predominantly friable, occasionally moderately firm, no visual porosity.
933-936m Siltstone:	Medium light grey to medium grey, becoming very fine grained silty sandstone in parts, light grey to medium light grey claystone fragments, common coaly flecks and occasional coaly laminae, blocky to sub blocky, moderately firm to occasionally soft, calcite cement common in sandstone.
936-939m Siltstone:	As for 933-936m, crush cut fluorescence: pale yellow/white mottling @ 5 min.
939-942m Claystone:	Medium grey to medium dark grey, occasionally brownish grey, coaly flecks and fragments, common siltstone and sandstone fragments, sub fissile in parts, sub blocky to blocky, predominantly moderately firm to occasionally soft, calcite cement in sandstone fragments, no fluorescence.
942.57-944.02m	Core # 23. Recovery 70%.

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942-945m Siltstone:	Medium dark grey and dark greenish grey, occasionally light grey and greenish grey, generally well sorted siltstone, fine quartz grains poorly to medium-well rounded, other dominant mineralogy is diagenetic muscovite and chlorite and 10-15% arkosic material, occasional medium to coarse quartz grains, always angular and low sphericity, flecked with black coaly

fragments, disseminated with carbonate cement (5% of cuttings fizz in 10% HCL) and framboidal, pyrite, crush cut fluorescence, yellow white glow @ 10 min.

945-948m Siltstone: Medium light grey to light grey; occasionally greenish or brownish grey, generally well sorted siltstone as above, abundant fine quartz and arkose grains, often angular, mica locally abundant, flecked with black coaly fragments, mostly quite firm, but pale mica rich fragments are much softer, disseminated with calcite cement. Yellowish white cut fluorescence with yellowish white residue.

948-951m Siltstone: As for 945-948m. Crush cut fluorescence: white/yellow mottles @ 15 min.

951-954m Siltstone: Medium grey to medium dark grey, very fine grained quartz arkose grains, quartz angular to sub rounded, generally low sphericity, arkose fragments 5%, white irregular shaped, quartz predominant, micas are dominant diagenetic component of rock; mostly muscovite $\pm$ chlorite?, very fine grained, some calcite vein material (reacted to HCL), pervasive cementing of rocks probably diagenetic, overgrowths on quartz grains, very fine grained-coarse black coaly fragments all through the rock, and occasional coaly laminae, very occasional greenish lithic fragments, very fine to fine. Fluorescence as for 948-951.

954-957m Siltstone: Medium dark grey to medium light grey, occasionally brownish or greenish grey, arkose quartz sands, very fine quartz grains predominate; angular and low sphericity, very low porosity, coaly flecks and fragments, especially in darker quartz rich siltstone, which is quite firm, paler fragments contain abundant muscovite, and are quite soft, locally cemented with calcite, probably fracture infilling with calcite. Weak yellow cut fluorescence with pale yellowish white residue ring.

957-960m Siltstone: As for 954-957m. Except calcite cement/fracture infilling quite prevalent, occasional fine to medium quartz grains present: angular of low sphericity, occasional rounded detrital garnet grains, medium size. Fluorescence as for 954-957m.

960-963m Siltstone: Medium dark grey to medium grey, very fine grained quartz, arkose siltstone, quartz is always angular and low sphericity, and constitutes up to 50% of rock, pale feldspathic fragments, black coaly flecks, cherty lithic fragments (often coarser than the rest of groundmass) and detrital and diagenetic mica constitute the rest of the groundmass, occasional grey-brown siltstones have higher organic content. Darker rocks predominantly firm, but pale grey calcite-rich layers are soft, calcite cementation generally restricted to pale horizon, or as fracture fill. Pyrite occurs both as a paint on chip fracture plains, and as massive deposits in fractures (up to 2mm diameter) or as a matrix cement enclosing detrital quartz and coal fragments. Fluorescence as for 954-957.

963-966m Siltstone: As for 960-963m. Occasional coarser detrital quartz, always angular, low-medium sphericity, rare pyrite, Small red detrital grain; garnet sub-rounded, medium sphericity, calcite cement generally restricted to thin sandy laminae, where increased porosity has provided space for precipitation. Fluorescence as for 954-957.

966-969m Sandy Siltstones: Dark grey to medium light grey and brown siltstone, generally well sorted, very fine grained claystones and siltstones, very fine quartz and micas dominant, as well as small coaly flecks, generally non-calcareous, and no porosity, interbedded with fine grained quartz and lithic sandstones, often cemented with calcite, firm siltstones and claystones, cemented sandstones usually soft, occasional red detrital grains. Patchy greenish yellow cut fluorescence with place whire residue ring.

969-972 Sandstone: Clean pale grey to white medium to coarse grained interbedded or beneath dark grey to pale green or brown grey siltstones (as described for 966-969m). Massive pyrite common (up to 1mm blocks), sands composed of medium to coarse quartz grains (90%), grains are very angular with very low to medium sphericity, generally very immature clasts, 2-3% of grains are 'milky quartz', these grains are very well rounded, and have high sphericity, this indicates both fresh sediments source, and a substantially reworked one. Other grains in the sand: 1% angular pink-red garnet grains, 2-3% feldspathic & detrital lithic fragments, (includes well rounded igneous granite grains). No visual porosity. Fluorescence as for 966-969m.

972-975m Sandstone: Fine to very coarse sandstones, poorly sorted, predominantly quartz; smaller grains mostly angular in low sphericity, but some sub to rounded, larger quartz grains are milker, quite rounded with generally high sphericity, ie. much more mature, diagenetic muscovite ($\leq$ 0.5mm) interleaved through the sandstones.

Other clasts are lithic fragments and rounded anthracite fragments, 60% of other clasts are dark grey - pale grey brown quartz arkose siltstones with abundant mica, these rocks are firm and cohesive, while sandstones are generally incompetent, except where cemented with calcite, coaly flecks are abundant in the siltstone units and also occur within the sandstones, siltstones are non-calcareous; sandstone extensively cemented. Mottled pale greenish yellow cut fluorescence.

975-978m Sandstone: White, well sorted quartz sandstones, medium to coarse grain size, generally quite well rounded, a wide range of quartz grain maturity is present as above, 90% quartz sand, 10% dark to medium grey brown siltstones and claystones, these are fine grained, arkose, immature, and flecked with fine coal fragments, non calcareous. In contrast, the sandstones are highly cemented with calcite in places, other sandstone clasts: green cherty material, fine grained igneous (dark) clasts, pale pink-red angular garnet grains. Weak whitish cut fluorescence.

979.05-985.00m Core #24. Recovery 90%.

Fluorescence 984-996m Pale yellowish white cut fluorescence.

984-987m Sandstone: Clean pale grey to white, medium to coarse quartz sandstones, (Arkose), also medium dark grey to dark greenish and brownish grey siltstones to claystones, sandstones predominantly angular to rounded quartz (90%) trace of pyrite, broad range of quartz grain maturity, but moderately well sorted, common clasts include garnet as medium sized, sub rounded grains, and muscovite as .5mm 'books' and single plates, also fragments of anthracite prevalent, siltstones and claystones closely resemble earlier lithologies, and generally non-calcareous, very fine grained, quartz arkose silts and muds, with abundant blocky coal flecks and diagenetic micas, siltstones and claystones are firm and blocky, sandstones generally incompetent but calcite cementing is widespread.

987-990m Sandstone: Clean pale grey to white, medium to very coarse quartz sandstones also siltstones and claystone as above, essentially the same as 984-987m with following exceptions:

1 Large moderate to well-rounded quartz grains are more prevalent (5%), lithology is less well sorted.

2 There are relatively less siltstone & claystone lithologies.

3 Small, sub-rounded garnets are much more prevalent in the groundmass (1-2%).

990-993m Sandstone: As for 987-990m.

993-996m Sandstone: Pale grey, quartz rich sandstone, medium grained, angular to rounded, low to high sphericity, quartz grains predominate, well sorted, slightly calcareous, high porosity, minor siltstone fragments.

Up to 3% garnets: fine to coarse, angular to very well rounded large garnets (up to 1mm).

997.26-1000.36m Core #25. Recovery 95%.

999-1002m Sandstone:	Very well sorted pale grey quartz sandstone, interbedded with dark green grey to grey brown siltstone and claystone, quartz grains generally very angular and sub-spherical, 2-5% of quartz grains are larger (medium to coarse), and are generally more rounded, accessories in the sandstone include fine muscovite and biotite flakes, and occasional very fine garnets, in parts cemented with calcite, but in general a soft, incompetent rock, flakes of anthracite common, interbedded with sandstones are very fine grey brown siltstones, very well sorted, non-calcareous, organic rich, and siltstones; dark to pale grey, arkosic, and with abundant micas. These finer grained units are generally blocky and firm.
1002-1005m Sandstone:	Pale grey quartz sandstone and siltstones as for 999-1002m. except : fine-medium sands, not as well sorted. : calcite cement quite abundant. : 1% lithic fragments include detrital feldspar fragments. Weak mottled green cut fluorescence with weak whitish residue.
1005-1008m Sandstone:	As for 1002-1005m.
1008-1011m Sandstone:	Medium to light grey quartz rich sandstones, fine to medium grained as for 1002-1005m; quartz grains generally angular, moderate sphericity, abundant $\leq$ 3mm anthracite fragments around 8-10%, interbedded dark to medium brown grey mudstones and pale grey siltstones, well sorted, arkose, with abundant fine diagenetic mica and coal fragments, and non-calcareous, sandstones locally cemented with carbonate, pyrite present as small frambroidal clasts. Strong, immediate greenish white crush cut fluorescence with strong blue green residue ring.
1011-1014m Sandstone:	Medium to light grey, medium to coarse grained quartz sand, 5% pale-dark grey siltstones and mudstones as above, trace black coal, quartz grains fairly poorly sorted, smaller ones generally angular, larger ones often more rounded, sub-spherical, common muscovite and biotite platelets, occasional small rounded garnets and small granitic lithic fragments, local calcareous cement.
1015.65-1021.4m	Core #26. Recovery 90%.
1020-1023m Siltstone:	Medium dark grey to medium greenish grey siltstones, and brownish grey claystones, interbedded pale grey quartz sandstones comprise 20% of sample, siltstones and claystones well sorted arkose with abundant fine mica and black coaly flecks, very fine groundmass is probably largely quartz and lithic material. Subfissile in parts predominantly blocky and firm, non calcareous, sandstones fine to coarse grained,

	angular to rounded, cemented with calcite in places, occasional detrital garnet and lithic fragments, sandstones generally incompetent.
1023-1026m Sandstones and Siltstones:	Interbedded sandstones and siltstones as above. 50% of each lithology.
1026-1029m Siltstones and Sandstones:	Interbedded dark grey to green grey siltstones and grey brown mudstones; arkose, mica and coal fragment rich, very well sorted, non-calcareous, firm, interbedded with quartz arkose sands, medium grey, fine to medium grained, angular to rounded, sub-spherical quartz grains, occasional coarse grains, accessories to quartz include lithic and feldspathic clasts and occasional micas and garnet, but extensively cemented with calcite, trace of pyrite. Weak yellow cut fluorescence.
1029-1032m Sandstone:	Pale grey quartz sandstones, medium grained, arkose, locally cemented with calcite, quartz grains generally angular, trace of pyrite, accessory minerals include detrital garnet and diagenetic micas, also anthracite fragments, interbedded dark grey to greenish grey siltstones and grey brown mud and claystones as for 1020-1023m. Weak mottled green cut fluorescence with weak yellowish green residue ring.
1033.92-1037.92m	Core #27. Recovery 19%.

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1035-1038m Sandstone:	Clear to translucent, occasionally white, very fine to coarse grained, occasional very coarse grain, poorly sorted, sub angular to sub rounded, occasionally angular, common to abundant calcite cement, trace of quartz cement, occasional garnet, common fragments of greenish grey, medium dark grey and brownish grey claystone and siltstone, trace of mica, occasional coaly fragments and laminae, trace of pyrite, unconsolidated to firm, moderate visual porosity, nil fluorescence. Strong yellowish green cut and yellowish which crush cut fluorescence.
1038-1041m Sandstone:	As for 1035-1038m.
1041-1044m Siltstone and Sandstone:	Clear to translucent, occasionally white, very fine grained predominant with a few coarse grains and occasional very coarse grains, moderately sorted, sub angular to sub rounded with occasional angular, common to abundant calcite cement, mica, common lithic fragments, angular to sub angular, coarse to medium in size made up of siltsized particles some containing carbonaceous laminae light brownish to brownish grey in colour, common fragments of greenish grey, medium dark grey and brownish grey claystone and siltstone, firm with some unconsolidation, poor visual porosity, nil fluorescence. Patchy yellow green cut and strong yellow green crush cut fluorescence.

1044-1047m Siltstone:	Light grey to medium dark grey, grading to very fine sandstone in parts, occasional coaly fragments, abundant fragments of very fine grained lithic sandstone, trace of greenish grey claystone, occasional medium to coarse quartz grains, common calcite cement in sandstone fragments, blocky to sub blocky, sub fissile in parts, moderately firm to occasionally soft. Weak yellow green cut and moderate yellow green crush cut fluorescence.
1047-1050m Sandstone:	Very light grey to light grey, very fine grained quartz, very well sorted, sub rounded to rounded, common calcite cement, trace of quartz cement, occasional red and pink garnets, trace to occasional mica, trace of coaly fragments, occasional lithic fragments, occasional to common fragments of light to medium grey and brownish grey siltstone A/A, trace of pyrite cement, moderately firm to friable, poor visual porosity. Trace of yellow green cut and weak yellow green crush cut fluorescence.
1050-1053m Sandstone:	Quartz clear to translucent, very fine to medium grained, moderately sorted, subangular to subrounded, lithic sandstone clasts, abundant calcite, lithic fragments angular to sub rounded, coarse to medium in size, light brownish to brownish grey in colour, occasional pinkish garnet also mica, common fragments of greenish grey, medium dark grey claystone and siltstone, firm with some unconsolidation, poor visual porosity, nil fluorescence. Trace of weak yellow crush cut fluorescence.
1053-1056m Sandstone:	Very light grey to medium light grey, very fine to fine grained quartz, occasional medium and coarse grains, well sorted, angular to sub angular, coarser grains generally sub rounded to rounded, abundant calcite cement, occasional pink and red garnets, trace of mica, occasional lithic grains, trace of pyrite, occasional fragments of medium grey to medium dark grey claystone and siltstone, occasional coaly fragments, moderately firm, fissile in parts, poor visual porosity.
1056-1059m Sandstone:	Very light grey to medium light grey, predominantly very fine to occasionaly fine grained quartz, occasional medium grain, very well sorted, angular to sub angular, abundant calcite cement, common lithic fragments, occasional pink garnet, trace of mica, rare pyrite, occasional feldspars, occasional coaly fragments, occasional medium grey siltstone fragments, predominantly unconsolidated, occasionally friable to moderately hard, poor visual porosity. Weak yellowish green cut and crush cut fluorescence.
1061.12-1066.67m	Core #28. Recovery 77%.
1065-1068m Sandstone:	Very light grey, predominantly clear to translucent grains, fine to predominantly medium grained, occasional coarse and very coarse grains, moderately

sorted, sub rounded to rounded, occasionally sub angular, common calcite cement, common to abundant pale pink to reddish garnets, occasional feldspathic and lithic grains, trace of mica, slightly argillaceous matrix in parts, occasional claystone clasts, predominantly unconsolidated, moderate visual porosity, nil fluorescence. Strong yellowish green crush cut fluorescence with yellowish green residue ring.

1068-1071m Sandstone: Very light grey, predominantly clear to translucent grains, coarse to very coarse grains, abundant fine to medium grains, poorly sorted, sub angular to sub rounded, occasionally angular, common calcite cement, occasional to common pale pink to reddish garnets, occasional feldspathic and lithic grains, abundant medium dark grey to dark grey claystone fragments and common medium light grey siltstone fragments, trace of mica, predominantly unconsolidated, moderate visual porosity nil fluorescence. Moderate yellowish green fluorescent crush cut residue ring.

1071-1074m Sandstone: Very light grey, predominantly clear to translucent grains, medium grained, occasional coarse and fine grains, well sorted angular to sub angular, trace of calcite cement, occasional light pink to reddish garnets, occasional lithic and feldspathic grains, trace of mica, common coaly fragments, unconsolidated poor visual porosity, nil fluorescence. Weak yellowish fluorescent crush cut residue ring.

1074-1077m Sandstone: As for 1071-1074m.

1077-1080m Sandstone: Very light grey, predominantly clear to translucent grains, medium to coarse grained, occasional very coarse and fine to very fine grains, poorly sorted, sub angular to sub rounded, occasionally angular, abundant calcite cement, slightly argillaceous matrix, common pale pink to reddish garnets, occasional lithic and feldspathic grains, occasional medium grey and dark grey claystone fragments, trace of siltstone, green translucent grain probably tourmaline, trace of mica, unconsolidated, poor visual porosity, nil fluorescence. Weak patchy yellowish crush cut fluorescence.

1080-1083m Sandstone: Very light grey, made up of clear to translucent grains, occasional pink stained grains, majority of grains medium to fine with rare to occasional coarse grains, moderately sorted, sub angular to sub rounded, abundant calcite cement, common pale to dark pink garnets, rare feldspar grains, occasional lithic grains which are light brown to brownish gray in colour, trace fragment of coal containing wood grain, medium grey, dark grey and greenish grey claystone fragments, trace siltstone, unconsolidated, nil fluorescence, poor visual porosity. Weak patchy yellowish crush cut fluorescence.

1083-1086m Sandstone:	Very light grey, clear to translucent grains, occasionally stained pink, medium to fine grained, moderately sorted, sub angular to sub rounded, abundant calcite cement, pale pink to red garnets common, rare feldspar, occasional lithic grains, light brown to brownish grey in colour, claystone greenish gray through to medium dark grey, rare siltstone, unconsolidated, poor visual porosity, nil fluorescence.
1086-1089m Sandstone:	Very light grey, predominantly clear to translucent grains, fine to occasionally medium grained quartz, well sorted, very angular to angular, occasionally sub angular, trace of calcite cement, occasional light pink garnets, occasional fragments of greenish grey and dark grey claystone, trace of feldspathic and lithic grains, unconsolidated.
1088.58-1090.68m	Core #29. Recovery 100%.
1089-1092m Sandstone:	Clear to translucent grains, fine to medium and occasionally coarse grained, moderately sorted, sub angular to sub rounded, occasionally angular, trace of silica cement, rare calcite cement, trace of argillaceous matrix, common pale pink to dark red garnets, occasional feldspathic and lithic grains, trace of dark grey claystone, unconsolidated.
1092-1095m Sandstone:	Clear to translucent, occasionally milky, predominantly fine to medium grained, abundant very fine grains, occasional coarse and rare very coarse grains, poorly sorted, angular to sub angular and occasionally sub rounded, trace of quartz overgrowth cementation, usually in medium to coarse grains, rare calcite cement, trace of argillaceous matrix, occasional light pink garnets (predominantly fine grained or smaller), occasional feldspathic and lithic grains, trace of dark grey claystone, predominantly unconsolidated, good visual porosity where competent, nil fluorescence.
1095-1098m Sandstone:	As for 1092-1095m. Weak yellowish cut and crush cut fluorescence with weak yellowish residue ring.
1098-1011m Sandstone:	As for 1092-1095m.
1101-1104m Sandstone:	Clear to translucent, predominantly medium grained, common fine grains and coarse to rare very coarse grains, moderately to well sorted, sub angular to sub rounded, occasionally angular, trace of quartz overgrowth cement, rare calcite cement, common lithic and occasional feldspathic grains, common light pink to red garnets, trace of claystone, unconsolidated, nil fluorescence.
1104-1107m Sandstone:	Clear to translucent and occasionally milky grains, very fine to fine and occasionally medium grained, abundant coarse to very coarse grains, bimodal, poorly sorted, angular to sub angular, occasional

	calcite cement, slightly argillaceous in parts, quartz overgrowths, common pink garnets, common feldspathic grains, coal cavings, trace dark grey claystone, unconsolidated, nil fluorescence.
1107-1110m Sandstone:	Clear to translucent, occasionally milky quartz grains, predominantly medium grains, occasional fine and coarse-grains, well sorted, sub angular to sub rounded, occasionally rounded, trace of quartz overgrowths, occasional light pink garnets, rare red, occasional feldspathic grains, unconsolidated, nil fluorescence.
1110-1113m Sandstone:	As for 1107-1110m. Faint yellowish crush cut fluorescence.
1113-1116m Sandstone:	As for 1107-1110m. Weak yellowish cut and crush cut fluorescence with weak yellowish residue ring.
1116-1119m Sandstone:	Clear to translucent, occasionally milky, medium to coarse grained, occasional fine grains, well sorted, subrounded to rounded, occasionally angular, trace of quartz overgrowth, trace of silica cement, trace of argillaceous matrix in parts, rare calcite, occasional light pink to dark red garnets, occasional feldspar grains, unconsolidated, nil fluorescence. Moderate yellowish white crush cut fluorescence with moderate yellowish white residue ring.
1119-1122m Sandstone:	As for 1116-1119m. Weak yellowish cut and crush cut fluorescence with moderate yellowish residue ring.
1122-1125m Sandstone:	As for 1116-1119m.
1125.21-1129.86m	Core #30. Recovery 29%
1128-1131m Sandstone:	Clear to translucent, occasionally milky grains, predominantly quartz, medium to coarse grained, occasionally very coarse and fine grains, moderately sorted, angular to sub angular, occasionally sub rounded, trace of quartz overgrowth, trace of white argillaceous matrix, abundant light pink to brownish red garnets, trace of pyrite, trace of feldspathic grains, unconsolidated, nil fluorescence.
1131-1134m Sandstone:	As for 1128-1131m.
1134-1137m Sandstone:	Clear to translucent, occasionally milky grains, predominantly quartz, fine to medium grained, common very fine grains, occasional coarse and very coarse grains, moderately sorted, sub angular to sub rounded, occasionally angular, trace of quartz overgrowth, trace of light grey to light brownish grey matrix, abundant light pink to red garnets, occasional feldspathic grains, unconsolidated, nil fluorescence.
1137-1140m Sandstone:	As for 1134-1137m.

1140-1143m Sandstone:	Clear to translucent and occasionally milky grains, quartz, medium to coarse grained, occasional fine and very coarse grains, moderately to poorly sorted, sub angular to sub rounded and occasionally angular, trace of quartz overgrowth cementation, traces of kaolinisation of feldspar grains, trace of light grey argillaceous matrix, common light pink to red garnets, trace of lithic and feldspasthic grains, unconsolidated, nil fluorescence.
1143-1146m Sandstone:	Clear to translucent and occasionally milky and light reddish brown grains, predominantly quartz, medium to coarse grained, abundant fine and very coarse grains, poorly sorted, angular to sub angular trace of quartz overgrowth cement, trace of light brownish grey argillaceous matrix, abundant light pink to red garnets, trace of coal, common feldspar grains, unconsolidated, nil fluorescence.
1146-1149m Sandstone:	As for 1143-1146m.
1149-1152m Sandstone:	Clear to translucent and occasionally milky quartz grains, medium to coarse grained, occasional fine and very coarse grains, well sorted, trace of silica cement and quartz overgrowths, trace of light brownish grey argillaceous matrix, abundant light pink to red garnets, occasional fragments of light brown siltstone and dark grey claystone, trace of kaolinitic matrix, trace of coal, occasional lithic and feldspathic grains, unconsolidated, nil fluorescence.
1152-1155m Sandstone:	Clear to translucent and milky quartz grains, medium to coarse grained common very coarse grains, occasional fine grains moderately to poorly sorted, sub rounded to rounded, occasionally angular, trace of quartz overgrowth cement, trace of pyrite cement trace of light brown argillaceous and white kaolinitic matrix, abundant light pink to red garnets, occasional coal and medium grey siltstone, common feldspathic grains, occasional lithic grains, unconsolidated, nil fluorescence.
1155-1158m Sandstone:	Clear to translucent quartz grains, medium to coarse grained, occasional very coarse grains, well sorted, sub angular to sub rounded, occasionally angular, trace of quartz overgrowth cement, abundant light pink to red garnets, common feldspar grains, trace of coal and siltstone, unconsolidated, nil fluorescence.
1158-1161m Sandstone:	As for 1155-1158m.
1161.75-1166.1m	Core #31. Recovery 29%.
1164-1167m Sandstone:	Clear to translucent quartz grains, fine to medium and occasionally coarse grains, occasional very fine grains, moderately sorted, angular to sub angular, occasionally sub rounded, silica cement, quartz

	overgrowths on larger grains, trace of kaolinitic matrix, abundant light pink to red garnets, occasional feldspathic and lithic grains, trace of pyrite, trace of coal, siltstone cavings, unconsolidated, nil fluorescence.
1167-1170m Sandstone:	As for 1164-1167m.
1170-1173m Sandstone:	As for 1164-1167m.
1173-1176m Sandstone:	Clear to translucent quartz, medium to coarse grained, occasionally fine grained, well sorted, angular to sub angular and occasionally sub rounded, quartz overgrowth cement, trace of pyrite cement, common light pink to red garnets, rare feldspar grains, trace of coal, unconsolidated, nil fluorescence.
1176-1179m Sandstone:	Clear to translucent quartz grains, medium to coarse grained, common very coarse grains, well sorted, angular to sub angular abundant silica cement, quartz overgrowths, abundant light pink to red garnets, trace of kaolinitic matrix, trace of pyrite cement, trace of coal, trace of mica, rare feldspathic grains, moderately hard, poor visual porosity, nil fluorescence.
1179-1182m Sandstone:	Clear to translucent and occasionally milky quartz grains, fine to medium grained with abundant coarse and occasional very coarse grains, moderately sorted, sub angular to sub rounded and occasionally angular, abundant silica cement and quartz overgrowths, abundant pyrite cement, abundant light pink to red garnets, trace to occasional coal fragments, rare feldspathic grains, moderately hard, poor visual porosity, nil fluorescence.
1182-1185m Sandstone:	As for 1179-1182m.
1185-1188m Sandstone:	Clear to translucent and occasionally milky quartz grains, predominantly medium grained, common to abundant fine to very fine grains, occasional coarse and very coarse grains, moderately to poorly sorted, angular to very angular, occasionally sub angular, abundant silica cement and quartz overgrowths, trace pyrite cement, common garnets, common coal fragments, rare feldspathic grains, trace of kaolinitic matrix and mica, moderately hard, poor visual porosity, nil fluorescence.
1188-1191m Sandstone:	Clear to translucent and occasionally milky grains, fine to medium grained, abundant coarse and very coarse grains, occasional very fine grains, poorly sorted, angular to sub angular and occasionally sub rounded to rounded, common silica cement, occasional quartz overgrowths, common light pink to red garnets, occasional feldspathic grains, trace of pyrite and coal, firm to moderately hard, poor visual porosity, nil fluorescence.

1191-1194m Sandstone:	Clear to translucent quartz, medium to coarse grained, occasional fine grains, well sorted, sub angular to angular, common silica cement, common to abundant light pink to red garnets, trace of pyrite cement, occasional feldspathic grains, trace of coal, firm to moderately hard, poor visual porosity, nil fluorescence.
1194-1197m Sandstone:	As for 1191-1194m.
1197.94-1199.94m	Core #32. Recovery 55%.

Logged by R Cayley

1197-1200m Sandstone:	Very light grey quartz sandstones, translucent to milky grains, medium to coarse grained, mostly angular but occasionally sub rounded to rounded, 1-2% detrital garnet grains, often rounded, occasional feldspathic grains, trace of pyrite, trace of carbonate, up to 10% dark grey to green grey siltstones, very fine grained, well sorted, non calcareous, present as either interbeds, or more likely as 'rip up' clasts as in core #32. No crush cut fluorescence.
1200-1203m Sandstone:	Medium grained, pale white quartz sandstone, very well sorted, quartz grains gneerally angular, but moderately high sphericity, 2-3% each of detrital garnet (pink-red) and feldspar (white, kaolinised) grains, trace of dark grey siltstone fragments, trace of coal, trace of pyrite, unconsolidated, white crush cut fluorescence, with weak white residue ring.
1203-1206m Sandstone:	As for 1200-1203m. Faint white fluorescence and residue ring.
1206-1209m Sandstone:	As for 1200-1203m. Faint white mottled fluorescence. (crush cut).
1209-1212m Sandstone:	As for 1200-1203m. No fluorescence.
1212-1215m Sandstone:	As for 1200-1203m, except more poorly sorted, tending to be slightly coarser grained, and more arkose, also firmer ie: some quartz remains cemented into small clasts by its arkose matrix. No fluorescence.
1215-1218m Sandstone:	As for 1200-1203m, except locally cemented by massive pyrite (around 0.51%) into millimetre sized clumps, occasionally 1.2mm, apparently unaltered feldspars (orthoclase), which are rounded, but slow distinct cleavage planes, pale white crush cut fluorescence and residence ring.
1218-1221m Sandstone:	As for 1212-1215m occasional dark to light grey, very fine grained siltstone fragments. No crush cut fluorescence.
1221-1224m Sandstone:	As for 1218-1221m. No fluorescence.

1224-1227m Sandstone:	As for 1218-1221m, local pods (around 1mm) of pyrite growth. No fluorescence.
1227-1230m Sandstone:	As for 1218-1221m. No fluorescence.
1230-1233m Sandstone:	Medium to coarse grained quartz sandstone, quartz grains mostly sub rounded, especially the larger ones, poorly sorted, high feldspathic content, visible as a pale white infilling between angular and rounded quartz grains, occasional large diagenetic mica flakes, garnets (pink-pale red) are notably predominant (up to 5%), some dark grey to green grey siltstones are also present, most likely as 'rip up' clasts, trace of pyrite, occasional anthracite fragments.
1233.46-1235.74m	Core #33. Recovery 50%
1236-1239m Sandstone:	As for 1230-1233m, but fewer garnets, and quartz grains are generally angular.
1239-1242m Sandstone:	As for 1230-1233m, but fewer garnets, and quartz grains are generally angular.
1242-1245m Sandstone:	Pale grey, medium to very coarse grained quartz sandstones and dark grey siltstones, sandstones are predominantly angular to sub-rounded quartz grains, poorly sorted, and a broad range of grain maturity present, detrital garnets abundant (3.5%), and those are generally rounded, and medium sphericity, occasional angular grains of feldspar, apparently unaltered, abundant black coaly fragments, and pyrite, siltstones are very fine grained, well sorted, coal rich, arkose and non calcareous. These rocks are firm and competent.
1245-1248m Sandstone:	As for 1200-1203m.
1248-1251m Sandstone:	As for 1200-1203m, except for 1-2% grey siltstone fragments and 1-2% coal fragments and occasional 1-2% lithic fragments of a finely foliated, pale grey micaceous slate, which are moderately to well rounded, well sorted, internally recrystallised, and may represent fragments of the underlaying basement (palaeozoic), abundant pyrite.
1252.69-1258.84m	Core #34. Recovery % .

Logged by A Olshina

1257-1260m Sandstone:	Light grey to very light grey, medium to coarse grained quartz sand, moderately sorted, sub angular to sub rounded, some pink garnet, coal fragments, rare mica.
1260-1263m Sandstone:	As for 1257-1260m, but coarse to very coarse with quartz grains up to 3-4mm, rare fragments of schist.
1263-1266m Sandstone:	As for 1257-1260 but medium grained.

1266-1269m Sandstone:	As for 1263-1266m.
1271.08-1276.03m	Core #35. Recovery 60%.
1275-1278m Sandstone:	Light grey, medium to very coarse grained quartz sand with fragments of coal, and medium grey claystone, minor feldspar, pink garnet, pyrite, grey brown siltstone, quartz is subangular to sub rounded, and moderately sorted.
1278-1281m Sandstone:	Light grey medium to coarse sand, predominantly quartz, with minor fresh feldspar, garnets, siltstone and claystone fragments, grey to brownish grey, some coal fragments, rare pyrite.
1281-1284m Sandstone:	Light grey sandstone as above, but no pyrite noted, one large fragment of green biotite, about 5mm diameter, 0.5mm thick, granite source (?).
1284-1287m Sandstone:	As for 1278-1281m.
1289.54-1294.69m	Core #36 Recovery 63%.
1293-1296m Sandstone:	Light grey to very light grey, medium to very coarse grained, subrounded quartz common coal fragments, claystone fragments, rare schist fragments (greyish-black), occasional pyrite, pink garnets, fresh feldspar.
1296-1299m Sandstone:	Very light grey, well sorted to very well sorted, sub rounded quartz, common coal fragments, small clasts of claystone, all medium to coarse grained, and rare pink garnets, fresh feldspar.
1299-1302m Sandstone:	As for 1296-1299m, with rare pyrite, rare lithic fragments.
1302-1305m Sandstone:	As for 1296-1299m, with rare pyrite and lithic fragments, grain size of quartz fine to medium.
1305-1308m Sandstone:	Medium grey, medium grained, sub rounded, moderately sorted quartz sand, with common coal fragments, rare lithic fragments (claystone), pink garnet, rare pyrite and feldspar.
1308-1311m Sandstone:	Light grey, fine to medium grained, moderately well sorted, sub rounded quartz, with common coal fragments, pink garnet, rate pyrite and feldspar, occasional lithic fragments, rare mica.
1311-1313m Sandstone:	As for 1308-1311m.
1316.97-1322.97m	Core #37. Recovery 97%.

Logged by C Menhennit

1323-1326m Sandstone:	Clear to translucent quartz, medium grains, occasional fine and coarse grains, well sorted, very angular to angular, occasionally rounded, common silica cement, abundant calcite cement, trace of

kaolinitic matrix in parts, common medium grey to medium dark grey claystone fragments, occasional medium light grey micaceous siltstone fragments, occasionally feldspathic and lithic grains, occasional fragments of brownish grey carbonaceous claystone, common coaly fragments, trace of pyrite, occasional light pink to red garnets, trace of mica, moderately hard, poor usual porosity, nil fluorescence.

1326-1329m Sandstone: As for 1321-1326m.

1329-1332m Sandstone: Clear to translucent quartz, medium to coarse grained, occasionally very coarse grained, well sorted, very angular to angular, occasionally sub angular to rounded, abundant calcite cement, common quartz overgrowth cementation, trace of kaolinitic and brownish grey argillaceous matrix, common light pink to dark red garnets, trace of pyrite, occasional feldspathic and lithic grains, trace of mica, trace of coal, moderately hard, poor visual porosity, nil fluorescence.

1332-1335m Sandstone: Clear to translucent quartz, medium to coarse grained, well sorted, sub angular to sub rounded, occasionally angular, trace of silica cement, trace of calcareous cement, common light pink to dark red garnets, common feldspars, occasional pyrite, predominantly unconsolidated, nil fluorescence.

1335-1338m Sandstone: As for 1329-1332m.

1338-1341m Sandstone: Clear to translucent quartz, medium to coarse grained, abundant very fine to fine grains, poorly sorted, sub angular to sub rounded, occasional angular and well rounded grains, common calcite cement, trace of silica cement, occasional pyrite cement, abundant light pink to dark red garnets, occasional feldspars, occasional medium light grey claystone, moderately hard, poor visual porosity, nil fluorescence.

1341-1344m Sandstone: As for 1338-1341m.

1344-1347m Sandstone: Clear to translucent and common milky quartz, coarse to very coarse grained, occasionally fine to medium grained, moderately sorted, sub rounded to rounded with common angular surfaces, common calcareous cement, quartz overgrowths, trace of pyrite cement, abundant black coal, trace of medium grey claystone, common to occasional feldspars, occasional light pink to red garnets, trace of mica, unconsolidated, nil fluorescence.

1347-1350m Sandstone: As for 1344-1347m minus the coal.

1350-1353m Sandstone: Clear to translucent quartz, fine to medium grained with common coarse and very fine grains, poorly sorted, very angular to angular, coarser grains tending to be subrounded to rounded, trace of calcite cement, occasional quartz overgrowths, common light pink garnets, occasional feldspars, trace of mica and pyrite, moderately, hard poor visual porosity, nil fluorescence.

1353-1356m Sandstone: As for 1350-1353m.

1356-1359m Sandstone: As for 1350-1353m.

1359-1362m Sandstone: As for 1350-1353m.

1362-1365m Sandstone: As for 1350-1353m.

1365-1368m Sandstone: Clear to translucent and occasionally milky grains, medium to coarse grained, common very coarse grains, abundant very fine to fine grains, poorly sorted, sub angular to sub rounded and occasionally rounded, occasionally angular, abundant calcite cement, occasional quartz overgrowths, abundant light pink to red garnets, common feldspars, trace of pyrite nodules and pyrite cement, rate schistose lithic fragment, trace of coal and medium grey claystone moderately hard, poor visual porosity, nil fluorescence.

1368-1371m Sandstone: As for 1365-1368m.

1371-1374m Sandstone: Clear to translucent and occasionally milky quartz, predominantly coarse grained with abundant fine to very fine grains, poorly sorted, angular to very angular, occasionally sub rounded to rounded, abundant calcite cement, quartz overgrowths, abundant light pink garnets, common feldspars, trace of pyrite, trace of mica, common medium dark grey claystone fragments which are micro micaceous in parts, rare schistose lithic fragment, moderately hard, poor visual porosity, nil fluorescence.

1374-1377m Sandstone: Light greenish grey, common translucent to milky quartz grains, fine to very coarse, poorly sorted, angular to sub angular, common carbonate cement, occasional quartz overgrowths, occasional light pink to red garnets, common feldspar grains, abundant lithic fragments including mica schist, weathered quartzose schist, greyish green phyllite, possible graphite, trace of coal. trace of pyrite, trace of mica, moderately hard, nil visual porosity, nil fluorescence.

1377-1380m Sandstone: As for 1374-1377m.

1380-1383m Claystone: Light greyish green and greenish white, common brownish grey, micromicaceous and fissile in parts, phyllitic, common fragments of fine to medium grained sandstone which has abundant carbonate cement and occasional pyrite cement, occasional very coarse quartz grains, rare feldspathic grains, brownish grey

	fragments commonly carbonaceous, common fragments of greenish grey, schistose, fine grained sandstone, moderately firm, non calcareous.
1383-1386m Sandstone:	Light greyish green, fine to medium grained, well cemented, slightly schistose, common coarse to very coarse grains, moderately sorted, sub rounded, abundant silica cement, common calcite cement, abundant lithic fragments including mica schist, phyllite, brownish grey carbonaceous siltstone, rare pyrite, moderately hard, nil visual porosity, nil fluorescence.
1386-1389m Sandstone:	As above.
1390.2-1393.45m	Core #38. Recovery 44%.
1392-1395m Claystone (phyllite):	Light greenish grey, micro micaceous, sub fissile to fissile, slaty cleavage, moderately firm to firm, non calcareous.
1427.19-1431.94m	Core #39. Recovery 4%.
1431.94-1435.04m	Core #40. Recovery 10%.

APPENDIX 5

APPENDIX
5

CORE & SIDE WALL
CORE DESCRIPTIONS

CORE DESCRIPTIONS

Core No. 1 9.78 - 12.78m Recovery 100%

Eumeralla Formation

Predominantly claystone which is commonly silty to sandy with minor beds of fine sandstone. The claystone is medium light grey to light grey, weathered to a light to moderate reddish brown in parts, particularly in the upper section of the core. It has rare to common, clear and translucent, medium to coarse, sub rounded quartz grains, limonite fracture infills, and occasional darker bands with common coaly fragments and flecks. There are traces of pyrite and the rock is moderately firm to firm and generally non calcareous. Depositional features noted in the claystone are horizontal to sub horizontal laminar bedding while in the more arenaceous sections of the core some small scale cross bedding is apparent. The core is obviously within the zone of surface weathering.

Core No. 2 25.86 - 28.75m Recovery 100%

Eumeralla Formation

Predominantly siltstone which is commonly sandy, grading to silty sandstone and claystone. Fine black organic fragments contribute 1 to 5% of the rock and there are traces of very fine diagenetic pyrite in the groundmass. The core is uniform and generally very cohesive with bedding defined by slight grading within the beds which may be up to 150mm thick. The beds grade from fine muscovite quartz sandy siltstone to very fine micaceous siltstone. Contacts between the beds are often erosional, and display loading structures such as flame structures. Rip up clasts are noted at 26.66m where commonly bedding consists of very fine lamellae (1-2mm) thick.

At the base of the core dark organic layers coincide with increased grain size of diagenetic micas. The core is below the surface weathering horizon and is not calcareous.

Core No. 3 60.78 - 61.78m Recovery 100%

Eumeralla Formation

A medium to light olive grey silty sandstone comprised of very fine to fine grained, well sorted and sub rounded quartz grains with common (12-20%) lithic and feldspathic grains. The rock is pervasively cemented by calcite which also infills fractures. Localised zones have up to 20% dark organic fragments. Some structure is apparent, the most common being cross bedding on a small scale which is made more noticeable by the presence of organic material.

Core No. 4 **61.78 - 67.78m** **Recovery 75%**

Eumeralla Formation

<u>61.78 - 63.5m</u>

Predominantly medium grey to medium dark grey sandstone which is quartzose with up to 30% of the volume comprised of lithic and feldspathic grains and diagenetic micas. The sand is very fine to fine grained, well sorted and angular to sub-rounded. There are local horizons of coalified wood up to 5mm thick. The lithology alternates between uniform units of sandstone up to 100mm thick, with cross bedding, which are defined by organic rich zones and finely interbedded siltstone and sandstone lamellae, 0.5-2mm thick in packages up to 200mm thick. These units have low organic contents.

The contacts between these two units are typically of the sharp erosional type. Locally both lithologies show varying degrees of calcite cementation, with the more sandy units being the most affected.

<u>63.5 - 67.5m</u>

Medium grey to medium dark grey sandstone as above with no calcite cementation and therefore more friable. There is a high organic content, with common scattered coalified wood fragments.

The sandstone units are separated by 50mm thick zones of disrupted bedding including 10mm diameter rip up clasts of siltstone and claystone. These clasts of siltstone and claystone become more predominant with depth prior to a contact with a claystone at approximately 64.4 metres.

The claystone is medium dark grey to dark grey with common to abundant coaly fragments and common pyrite. The rock is silty in parts and non calcareous. Bedding where evident is laminar. There are occasional very organic rich beds up to 300mm thick. The unit coarsens downward over the basal metre becoming a uniformly interlaminated sequence of siltstone sandstone and claystone.

Core No. 5 96.79 - 102.79m Recovery 94%

Eumeralla Formation

Medium light grey to light grey claystone with minor interbeds of siltstone and sandstone. There are common coaly fragments throughout and occasional coalified root remnants. Traces of pyrite are noted and structure, where apparent, consists of horizontal to sub-horizontal laminae. The claystone is non calcareous and grades into a 2.5m thick section of sandstone. There is also a 45° orientated fracture with silica vein infill.

The sandstone is medium grey to medium dark grey with an olive hue. It is very fine to fine grained, well sorted, with an argillaceous matrix which becomes progressively more silty with increasing depth. There are common coaly fragments and carbonaceous laminae with indications of both laminar and cross bedding. The sandstone has minor claystone interbeds and is arkosic. It abruptly overlies an approximately two metre thick section of claystone of a similar appearance to the top 0.5 metre of the core.

This in turn grades into a monotonous 2.5 metres of medium grey to medium dark grey, very fine to fine grained arkosic sandstone as previously described. Calcite cementation is absent in this core. Overall the core is moderately firm to firm and quite competent.

Core No. 6 115.14 - 117.14m Recovery 100%

Eumeralla Formation

Predominantly sandstone which is medium light grey to light grey and fine to very fine grained. It has abundant silty to argillaceous matrix and in parts grades into a sandy siltstone. There is minor coaly material throughout and no apparent structure through the bulk of the core. The top 50cm of the core is a medium dark grey silty claystone which coarsens downwards to the sandstone. The core is firm to moderately hard and non calcareous.

Core No. 7 213.44 - 214.33m Recovery 100%

Eumeralla Formation

Predominantly medium grey to dark grey claystone with several coal bands up to 2 cm thick and sandstone in the top 20cm of the core. The claystone becomes very silty in parts, particularly in proximity to the coal. The coal is dark grey to brownish black, soft, and of low grade. Lithology changes in the core are generally gradational although some laminar bedding is apparent in proximity to the coal. The claystone is firm slightly micaceous and non calcareous.

The sandstone is medium grey to light olive grey with very fine to fine quartz grains which are well sorted and sub-rounded. There are common lithic and feldspathic grains and common silt. The rock is pervasively cemented by calcite and has some indications of small scale cross bedding. It is hard and has no porosity.

Core No. 8 **307.52 - 313.44m** **Recovery 92%**

Eumeralla Formation

313.44 - 312.0m

Siltstone which is medium grey to medium dark grey with abundant very fine sand. The rock grades into an argillaceous and silty sandstone in parts which is also micaceous. It is predominantly quartzose with the sand grading to fine in parts, very well sorted, angular to sub-angular and non-calcareous.

The interval has minor bands (up to 1cm) of medium dark grey, slightly micaceous claystone which have abrupt and laminar contacts with the coarser units.

312 - 311.76m

Homogeneous medium dark grey claystone which is slightly silty and micaceous. There are occasional coaly fragments and no apparent structure. The section is moderately firm and non calcareous, and in laminar contact with adjacent units.

311.76 - 309m

An alternating sequence of siltstones and claystones as described above.

309 - 307.52m

A sandstone which is medium light grey and dominantly fine grained with occasional medium grains. The grains are well sorted, angular to sub-angular and dominantly quartz with common lithic sand feldspars. The rock has a very silty to argillaceous matrix and poor visual porosity. There are some indications of horizontal to sub-horizontal bedding and the rock is non calcareous and moderately firm.

Core No. 9 324.52 - 328.52m Recovery 97%

Eumeralla Formation

<u>328.52 - 328.22m</u>

Medium light grey sandstone which is fine to occasionally medium grained, well sorted and angular to sub-angular. It is dominantly quartzose with common lithic and feldspathic grains throughout with a very argillaceous to silty matrix. The rock is slightly micaceous in parts, moderately firm and in laminar contact with the overlying bed.

<u>328.22 - 325.30m</u>

A medium dark grey claystone which is slightly micaceous and silty and sandy in parts. There are abundant thin (< 1mm) interbeds of fine sand and silt throughout.

The bedding is generally horizontal to sub-horizontal with some indications of cross bedding in the more sandy sections. The rock is moderately firm, non-calcareous and has some load deformation structuring.

<u>325.30 - 324.95m</u>

Medium light grey, fine to occasionally medium grained sandstone which is well sorted and angular to sub-angular. It has a very argillaceous matrix and abundant lithic and feldspathic grains. The rock is moderately firm and non-calcareous but becomes firmer and slightly calcareous with decreasing depth.

324.95 - 324.52m

A light grey fine grained quartzose sandstone which is pervasively cemented by calcite. The sand is well sorted and of apparently similar makeup to the underlying bed. The calcite invasion appears to have removed most of the non quartz material, particularly the feldspathic grains. This section of the core is very hard and has no porosity.

Core No. 10 577.23 - 578.48m Recovery 10%

Eumeralla Formation

Very poor recovery of medium light grey to medium grey claystone. It is commonly carbonaceous with traces of mica, firm to hard and non calcareous. There is no apparent bedding in this sample.

Core No. 11 613.67 - 618.14m Recovery 95%

Eumeralla Formation

Predominantly very fine to fine grained quartzose sandstone with common lithic and feldspathic grains. It is well sorted, very angular to sub-angular, with argillaceous to silty matrix in parts. There is common calcite throughout and the section is regularly interbedded with medium grey siltstones and claystones which have occasional coaly laminae and fragments. Observable structures include abundant cross bedding, occasional scour and fill, gradational and abrupt laminar lithology changes. There are also some indications of slumping and fossilised plant remnants. Overall the core is moderately hard to hard.

Core No. 12 650.61 - 653.01m Recovery 100%

Eumeralla Formation

Predominantly medium light grey to light grey claystone which is commonly silty and interbedded throughout with very fine to fine grained arkosic sandstones. The claystone has common to abundant coaly flecks and fragments, particularly towards the top of the core where the incidence of sandy interbeds is less. The claystone is also micaceous and is moderately firm to firm. There are some organic rich laminae, particularly towards the base of the core, which are usually in close proximity to sandier intervals.

The sandstone interbeds are rarely more than 3cm thick and generally on a millimetre scale. The sand is predominantly quartz with abundant lithic and feldspathic grains. It is dominantly very fine to fine grained, well sorted and angular to sub-angular. It has weak calcite cement and abundant argillaceous matrix throughout. There is a broad trend throughout the core of upward fining from sandstone, occasionally through siltstone to claystone, although the reverse is also observable.

Laminar bedding is observable throughout the core and there is also small scale cross bedding observable within the thicker sand intervals. Load deformation and flame structures are also common and there are some indications of erosional contacts and slumping.

Core No. 13   705.11 - 706.26m   Recovery 90%

Eumeralla Formation

Light grey to medium light grey claystone, with occasional coaly flecks and fragments, which is slightly silty in parts. There are occasional fine to very fine sand grains throughout and an apparent slickenside surface. There is no other observable structure. The lower 25-30cm of the core is a grey black to black organic rich claystone with common coaly fragments. Testing with trichloroethane yields a slow yellowish blue to yellowish white crush cut fluorescence which leaves a strong yellowish white fluorescent residue ring around the spot tray.

Core No. 14 741.27 - 745.02m Recovery 76%

Eumeralla Formation

Medium light grey to light grey claystone which grades to siltstone in parts and is very finely interbedded by very fine grained arkosic sandstone. The claystone is commonly silty to very silty and slightly micaceous. There are common coaly flecks and fragments throughout and a common occurrence on fracture surfaces are aggregations of coaly fragments which appear to be plant and leaf remnants. The claystone is moderately firm to firm and generally non calcareous.

The interbedded sandstones are light grey to very light grey and very fine to occasionally fine grained quartz with abundant lithic and feldspathic grains. They are well sorted and angular to sub-angular with weak to common calcite cementation and abundant argillaceous matrix throughout. In this core the sandstones are very wispily interbedded with the claystones and rarely approach 1cm in thickness. Some intervals of up to 50cm show no sand content.

Laminar bedding is the dominant structural feature of this core. This bedding is generally sub-horizontal, often up to 10°. The wispy nature of the sand interbedding gives the impression of cross bedding. Some post burial load deformation is also apparent.

Core No. 15 759.31 - 763.26m Recovery 10%

Eumeralla Formation

A very poor recovery of mostly smallish fractured pieces which are claystone and sandstone.

The claystone is medium light grey to medium grey with occasional coaly flecks and clasts. There are also minor wispy interbeds of arkosic sandstone. It is slightly silty in parts and occasionally sandy. It is moderately firm to firm and non-calcareous.

The sandstone is light grey to medium light grey, very fine to fine grained quartz with abundant lithic and feldspathic grains. It is slightly calcite cemented and has a very argillaceous matrix throughout. The sandstone also has occasional to common coaly flecks and fragments and is moderately hard to hard.

Interpretation of structural information in this core is difficult due to its broken up state. Some cross bedding is observable in the sandstones as well as some fine grading to siltstone and claystone. Some polished fracture surfaces may be slickensides but could be an event within the core barrel. Little structure other than sub-horizontal laminar bedding is observable in the claystones.

Core No. 16 777.80 - 783.65m Recovery 92%

Eumeralla Formation

An alternating sequence of predominantly claystone and siltstone with lesser interbeds of fine to very fine sandstone, particularly towards the base of the core.

The claystones are medium light grey to dark grey, being organic rich in parts. The darker areas tend to be slightly micaceous with only traces of silt. Increasing silt content correlates with a lightening in the colour. These intervals in particular show very few features and changes to other lithologies are subtle and gradational.

The siltstones are light grey to medium light grey and are commonly very argillaceous. The silt size varies and commonly grades into very fine grained sandstone. Bedding indications within the siltstone are commonly noted in proximity to the sandstones. These bedding structures are generally laminar but cross bedding is increasingly prevalent in proximity to the sands. There is some calcite cementation in this unit.

The sandstones are very light grey to light grey and very fine to fine grained, grading to siltstone in parts, however contact with the siltstones and claystones are generally abrupt. The sandstones are strongly cross bedded with silty and clayey beds within cross bedding sets. There are erosional surfaces on the claystones and siltstones over which the sands have been deposited. These are characterised by rip up clasts and scour and fill features. The sands are commonly calcite cemented. Fine organic material is common throughout the core.

Core No. 17 783.65 - 784.95 Recovery 10%

Eumeralla Formation

Poor recovery of interbedded siltstone and very fine grained sandstone typical of this formation. The core is medium grey to brownish grey and has very strong bedding throughout. In the finer section of the core, bedding is commonly horizontal to sub-horizontal and laminar with occasional cross bedding. With increasing grain size cross bedding becomes very prominent and is often highlighted by the presence of organic material in some beds. The sandstone and siltstone are often very wispily interbedded within cross bed sets. There is some calcite cementation and the core is firm to moderately hard.

Core No. 18 814.32 - 846.52m Recovery 100%

Eumeralla Formation

Predominantly light grey to medium brownish grey claystone which becomes silty and grades into siltstone in parts. There are common sandstone interbeds, which are always less than 5cm in thickness, in the bottom third of the core.

Where bedding is apparent amongst the siltstone and claystone it is generally laminar. There are some minor occurrences of cross bedding in the siltstone. Both the siltstone and the claystone have common organic material. On fracture surfaces it is common to observe coalified plant remnants, up to 5mm in size.

The sandstones are very light grey to light grey, very fine to fine grained quartz with abundant lithic and feldspathic grains. They are well sorted with angular to sub-angular and occasionally sub-rounded grains. There is some laminar bedding but the dominant bedding form is small scale cross bedding with clayey and silty laminae within cross bedding sets. There is no evidence of carbonate cementation but an abundant argillaceous matrix fills pore spaces.

Core No. 19   832.58 - 835.43m   Recovery 100%

Eumeralla Formation

Very finely interbedded sequence of sandstones and siltstones with minor claystones. Overall the siltstone is the dominant lithology. It is medium light grey to medium dark grey with occasional mica and organic material. It is strongly interbedded by the sandstone with which it is in gradational and more defined contact. Low amplitude cross bedding is apparent as well as some horizontal to sub-horizontal bedding. The siltstone also grades to claystone in parts.

The sandstone is very light grey to light grey and fine to very fine grained. It has common lithic and feldspathic grains but is predominantly quartz. It is well sorted and the grains are angular to sub-angular and occasionally sub-rounded. There is common calcite cementation throughout of varying intensity and abundant argillaceous matrix. There is abundant cross bedding with common siltstone laminae within the bedding sets. Minor laminar bedding is also apparent. Abrupt contacts with the siltstones. There is evidence of slumping, microfaulting and load deformation structures. Bed thickness is always less than 10mm. Some erosional surfaces present as abrupt laminar or sub-laminar contacts with adjacent lithologies.

The claystone is medium dark grey to dark grey with common organic fragments and occasional micas. Structural features in the lithology are usually laminar or gradational contacts with adjacent siltstones. Some minor laminar bedding can be observed. Overall the core is moderately hard and breakages occur along horizontal to sub-horizontal planes.

Core No. 20 850.97 - 853.47m Recovery 97%

Eumeralla Formation

850.97 - 852.22m

Light grey to medium light grey arkosic sandstone which is predominantly very fine grained, well sorted with angular to sub-angular grains. There is common calcite cement and argillaceous matrix.

Interbeds of medium grey to medium dark grey siltstone and greenish grey to medium dark grey claystone are common throughout with individual beds rarely more than 5mm thick and generally less than 2mm.

Laminar bedding is common in the finer sediments while small scale cross bedding is noted throughout the coarser fraction.

852.22 - 853.47m

Medium dark grey to dark grey claystone with minor interbedded very fine sandstone and siltstone. Flecks and fragments of coaly material are common throughout and minor calcite cementation is present in the sandier sections. There is a trace of pyrite and some laminar bedding with minor cross bedding in coarser zones.

Core No. 21 869.42 - 871.47m Recovery 95%

Eumeralla Formation

869.42 - 869.53m

Medium grey to medium dark grey siltstone with common carbonaceous flecks, traces of mica and pyrite and common very fine grained arkosic sand throughout. There is horizontal to sub-horizontal laminar bedding which is often defined by organic content. Evidence of some slumping is also apparent.

869.53 - 870.07m

Very light grey to light grey interbedded sandstone and siltstone. the sand is very fine grained, arkosic, well sorted and angular to sub-angular. There are traces of pyrite and mica, coal and coaly laminae and the sand is grading to siltstone throughout. Small scale trough cross bedding is apparent with sets generally less than 1cm. Alternation of siltstone and sandstone is noted within cross-bedding sets and some flaser bedding is also rated.

870.07 - 870.23m

Medium light grey siltstone with very minor coaly flecks and very fine sand throughout. Traces of pyrite and mica and weak indications of laminar bedding.

870.23 - 871.47m

Light grey to medium light grey sandstone which is very fine grained, arkosic, and commonly silty but becoming less silty with depth. The sand is well sorted, angular to sub-angular with weak calcite cementation. There is abundant trough cross bedding throughout, with some flaser bedding and slumping.

Core No. 22 905.87 - 907.62m Recovery 70%

Eumeralla Formation

Interbedded medium light grey to medium dark grey sandstone and siltstone with occasional claystone laminae. The sandstone is very fine grained, commonly grading to siltstone, well sorted and angular to sub-angular. It has minor calcite cementation and occasional coaly flecks and fragments. Throughout the section there is cross bedding with some horizontal to sub-horizontal laminar bedding which is generally in the siltier and clayier zones.

Some flaser bedding is apparent and there is also evidence of slumping and bioturbation. There are also indications of reworking such as scour and fill.

Core No. 23 **942.57 - 944.02m** **Recovery 70%**

Eumeralla Formation

942.57 - 943.0m

Medium light grey to dark grey finely interbedded claystone and siltstone which occasionally grade to very fine to fine grained arkosic sandstones. The siltstones are commonly micaceous with up to 10% black coaly fragments. The lamellae range from 0.1cm to 10cm in thickness with substantial sub-vertical fracturing offsetting beds by up to 5mm Fracture fill is predominantly siliceous and occasionally micaceous.

943.0 - 944.02m

Medium light grey to medium dark grey siltstone with minor greyish black claystone lamellae and common black coaly fragments. Centimetre scale cross bedding dominates the bottom 20cm of the core.

Scour and fill features indicate a degree of reworking and there is calcite infill in fractures.

Core No. 24 979.05 - 985.0m Recovery 90%

Pretty Hill Formation

Medium grey, medium grained sandstone comprised of up to 80% moderately well sorted, angular to sub-angular quartz grains of low to medium sphericity. The rock is generally only sparsely cemented with calcite although zones of strong cementation up to 10cm wide are present. An example of this is at 980m where the calcite cement crystallographic fabric is aligned throughout the rock suggesting that cementation may have taken place as a discrete event. Other grains present are muscovite, biotite, garnets and some lithics. A green crystalline mineral, possibly Tourmaline is also noted. Bedding is apparent as either fine black coal laminae, or 0.5 to 5 centimetre alternation of finer and coarser sandstones, for example at 980.5 - 981m. From 983.2m to 984+m the sandstones coarsen and become more poorly sorted with quartz grains up to 3mm, and contain claystone up clasts. Underlying the coarse base is a finer laminated sandstone and coal rich unit, possibly reworked, which coarsens downward into very coarse, poorly sorted sandstones.

Core No. 25 997.26 - 1000.36m Recovery 95%

Pretty Hill Formation

A sequence of thick fine to coarse sandstone units interbedded with very uniform dark grey claystone on a two metre scale.

997.26 - 998m

Medium grey to light grey quartzose sandstone, medium grained, moderately well sorted with predominantly angular to occasionally rounded grains. The sandstone is extensively cemented with calcite, has abundant coaly fragments. Repetitive finer and coarser sandstone layers define bedding on a one to five centimetre scale. Centimetre scale cross bedding may indicate local reworking. At 988.1m, claystone and siltstone rip up clasts lie in and above very coarse, poorly sorted sandstones with lithic fragments and black coal indicating a zone of reworking between depositional cycles.

Below, to 998.4m are graded coarse sandstone to fine siltstone and claystone beds. The grading is quite abrupt and contacts between Bouma units are very sharp.

998.4 - 998.7m

Here there are rip up clasts at the base of graded beds. Beneath, sandstones fine downwards to medium grained. This broad sandy unit, described above, abruptly overlies a thick monotonous sequence of siltstones and claystones. These are dark grey, well sorted and non calcareous with black coaly flecks and abundant diagenetic muscovite and biotite. The unit possibly coarsens slightly towards the bottom of the core where there are occasional sandy interbeds and evidence of slumping or load structures.

Core No. 26   1015.65 - 1021.40m   Recovery 90%

Pretty Hill Formation

Medium to dark grey sandstones, occasionally arkosic, fine to medium grained, poorly sorted, angular to sub-rounded with weak silica cementation and occasional calcite cementation. Some beds exhibit slight fine to medium grading. There are occasional 1mm coal laminae and laminated siltstone layers up to two centimetres thick which show internal cross bedding. The top and bottom contacts are substantially reworked. At 1016.7 metres a patch of 80% calcite cementation is enclosed by only weakly cemented sandstones. Occasional pale non calcareous cement is distributed in leisgang like bands around its sedimentary host. Coarse micas are concentrated in coal rich layers.

At 1020.3m an abrupt erosional contact exists with underlying very coarse matted arkose sands. These are very immature, containing granitic, feldspar rich, rounded clasts up to 5mm in a poorly sorted arkosic angular quartz groundmass. The top 10cm is strongly calcite cemented. The base is a very coarse sandstone, abruptly overlying dark grey laminated siltstones, these are well sorted, coal fragment and mica rich, arkosic and non calcareous.

Core No. 27 1033.92 - 1037.92m Recovery 19%

Pretty Hill Formation

A low recovery of two distinctly different sandstones. There is no discernible contact between the two types and the upper unit in particular is somewhat fragmented.

The lower 30cm of the recovered core is a light grey to medium light grey fine to very fine grained quartzose sandstone with common lithic and feldspathic grains. The grains are well sorted and angular to sub-angular. There is very strong silica cementation throughout and a common argillaceous matrix. Both laminar and cross bedding are a feature of this core. The bedding is highlighted by abundant thick organic and argillaceous laminae throughout the core. There is also more evidence of microfaulting. The core is non calcareous.

The remainder of the core is a light olive grey to olive grey medium to coarse grained sandstone. It has abundant fine grains and argillaceous matrix. Constituent grains are predominantly quartz but there are abundant lithics and feldspars. There is some evidence of weathered pyrite and occasional coaly fragments. There is little evidence o\ structure in the core except occasional occurrences of coarse to very coarse grain aggregates which are in approximately horizontal laminae. The core is non calcareous and has good visual porosity.

Core No. 28 **1061.12 - 1066.67m** **Recovery 77%**

Pretty Hill Formation

The bottom 80cm of the core is a sandstone which is very fine to coarse grained with occasional granule sized grains. It is very poorly sorted and the grains are sub-angular to sub-rounded and occasionally angular. There is common calcite cement and argillaceous matrix. Claystone clasts up to 8cm are abundant and there are occasional granitic fragments up to 2cm. Light pink to red garnets are common amongst the sand and there are occasional micas, lithic and feldspathic grains.

Over the next 75cm sorting varies to poor to moderate with grain size being predominantly fine to medium and becoming slightly less angular. The level of cementation appears to be steadily increasing while the proportion of argillaceous matrix material is diminishing.

Claystone clasts are also common across this interval and some are horizontally to sub-horizontally oriented.

The occurrence and orientation of the claystones within the core are strongly indicative of horizontal to more commonly sub-horizontal bedding. The core is also slightly friable and has moderate to good visual porosity.

Core No. 29 1088.58 - 1090.68m Recovery 100%

Pretty Hill Formation

The bottom 40cm of the core is comprised of a medium grey, fine to very fine grained sandstone that is predominantly quartz with occasional lithic and feldspathic grains. The grains are moderately sorted, sub-angular to sub-rounded and occasionally angular. Silica cementation is dominant with patchy weak calcite cement throughout. This section has very argillaceous matrix and is slightly arkosic with lithic and feldspathic grains and occasional to common pale pink to dark red garnets.

The remainder of the core is a medium grey to medium dark grey sandstone which is very fine to fine grained. The grains are well sorted and sub-rounded to rounded with minor calcite cement and argillaceous matrix. There are common feldspathic and occasional lithic grains and pale pink garnets. At 1089.5m there is a 3cm diameter pyrite nodule. There is little notable structure with occasional sub-horizontal coaly laminae and some indications of cross bedding.

Core No. 30 1125.21 - 1129.86m Recovery 29%

Pretty Hill Formation

Medium light grey to medium grey sandstone which is predominantly medium to coarse grained quartz with common very coarse and fine grains which are poorly to moderately sorted and sub-rounded to rounded. There is silica and quartz overgrowth cementation and abundant light grey argillaceous matrix and white kaolinitic pore fill. Light pink to red garnets are common throughout the core and there are traces of coal in the upper half of the recovered core. The rock is generally friable, becoming firmer with increasing matrix material. Towards the base of the core there is a piece of solid pyrite which is covered with greyish brown clay.

The core has generally good visual porosity and is non calcareous.

Core No. 31 **1161.75 - 1166.10m** **Recovery 76%**

Pretty Hill Formation

Medium light grey to medium grey sandstone which is predominantly medium grained quartz with a variable content of lithics, feldspars and garnets.

There are several identifiable fining upward sequences in the core where grain size ranges from coarse through to fine. In some instances the alternation of grain size is more abrupt. Silica cementation is common throughout the core.

Towards the top of the core there are common very coarse to granule sized grains and a pyrite layer some 10mm thick. With decreasing depth the content of feldspars, lithic grains, and garnets increase and grain size trends towards fine to medium. There is also an increase in kaolinitic matrix material which is filling the pores. Bedding features are generally poorly preserved and where variations are not gradational a sub-horizontal laminar trend is apparent. This is further highlighted by the presence of very thin (< 1mm) coaly laminae in several areas. The core is slightly friable in parts and generally non-calcareous.

Core No. 32 1197.94 - 1199.94m Recovery 55%

Pretty Hill Formation

Light grey to brownish grey, medium to coarse grained sandstone which is predominantly quartzose with abundant lithic and feldspathic grains which are commonly weathered. These are very coarse to granule sized grains in parts and laminar aggregations of these are the main indicator of slightly sub-horizontal bedding. Occasional organic rich laminae are also sub-horizontally oriented.

At the top of the core is a horizon of 1 to 5cm sized reworked claystone clasts. These clasts are commonly rounded, imbricate and locally pyritised. They are greyish brown to olive grey, slightly micaceous and non-calcareous. Overall the core is non calcareous and has moderate visual porosity.

Core No. 33 1233.46 - 1235.74m Recovery 50%

Pretty Hill Formation

Medium grey to medium dark grey, medium to occasionally coarse grained sandstone which is predominantly quartzose with a high feldspar content which gives a white speckled appearance to the core. The grains are moderately well rounded to sub-rounded and angular to sub-rounded. Cementation is siliceous with common argillaceous matrix throughout.

Visible bedding is apparent where there is a 1-5cm scale alternation in grain size with occasional narrow finer grained layers having some organic content which heightens definition. Faint cross bedding features can also be observed.

Pale pink to light red garnets are especially prevalent as an accessory mineral in this core. Other minerals include mica pyrite and black coaly flecks. The section is a massive competent sandstone which is very evenly grained over the length of the core which is non calcareous and slightly friable.

Core No. 34 1252.69 - 1258.84m Recovery 73%

Pretty Hill Formation

Brownish grey to medium light grey sandstones which are widely varied in grain size and matrix content. Near the base of the core a 30cm section of medium to coarse and commonly very coarse sand is abruptly overlain by a medium to fine sequence. Throughout the rest of the core grain size variation tends to be more gradational.

Constituent grains are predominantly quartz with common garnets, lithics and feldspars. In some sections there is an increase in the content of feldspars and weathered feldspars which gives a whitish, speckled appearance to the core. Throughout the core there are common coal fragments and laminae. There are also occasional claystone clasts up to 5 cm. Organic rich argillaceous laminae within finer grained areas indicate a bedding dip of up to 30°. Indications of laminar bedding are also common throughout the core however the beds have often undergone some deformation. There are occasional nodules and blebs of pyrite throughout the core which is slightly friable and non calcareous.

Core No. 35 1271. 08 - 1276.03m Recovery 60%

Pretty Hill Formation

Massive medium light grey to medium dark grey quartzose sandstone which is predominantly medium to coarse grained with occasional granule to pebble sized grains. The grains are generally angular to sub-rounded with the pebbles and granules usually rounded. They are poor to moderately sorted with weak to moderate silica cementation and common argillaceous matrix material.

There are occasional reworked clasts of light brownish grey micaceous claystone which are up to 3cm in diameter. Garnets are common throughout.

There is little observable structure in the core. Occasional organic and silt rich laminae oriented at up to 20° are present. Rare coaly clasts also have a sub-horizontal orientation. The core is slightly friable and generally non-calcareous.

Core No. 36 1289.54 - 1294.69m Recovery 63%

Pretty Hill Formation

Generally massive light grey to medium light grey quartzose sandstone of which the major feature is grain size variation from medium to coarse to fine to medium. The grains are angular to sub-rounded and occasionally rounded, moderately sorted and silica cemented with common argillaceous matrix. There are common lithic and feldspathic grains throughout, in some areas the concentration and weathering of the feldspar grains giving the core a speckled appearance. There are occasional coaly flecks and fragments and some zones of localised pyrite invasion.

At the base of the core there is a 15cm interval which is a conglomeritic assemblage of lithic clasts up to 5cm in size. These clasts include granite, very indurated red sandstone as well as siltstone and claystone. The granitic and sandstone clasts in particular are very rounded indicating extensive reworking. The siltstone and claystone clasts are quite the opposite and blade like in some cases. Similar clasts also appear singly towards the top of the core.

Bedding indications are rare, however there are several instances of fine organic rich laminae which indicate sub-horizontal bedding. The core is moderately hard to hard very slightly friable and exhibits poor to very poor visual porosity.

Core No. 37 1316.97 - 1323.12m Recovery 79%

Pretty Hill Formation

Sandstone; near the top of the core it is a medium light grey to light grey sandstone which is medium to coarse grained and moderately to poorly sorted. The grains are predominantly quartz which are sub-angular to angular and occasionally rounded. In parts there is carbonate cementation.

Accessories include pink garnets, coal fragments and small dark lithic fragments which are possibly schistose. There is a narrow band of large clasts consisting of siltstone and claystone (up to 5cm in length) and quartz grains up to pebble size. There are also coarse to very coarse grain sized pink garnets, books of bright green mica and common pyrite.

This interval is followed by approximately 1.6m of light grey, medium grained, non carbonate cemented quartzose sandstone which has occasional coal fragments, pink garnets, pyrite and rare books of mica. Some of the pyrite forms fine laminae along bedding planes. Some very light grey to white blebs in the sandstone contain some carbonate. Below this is a thin (2cm) pyritic band containing clasts of siltstone, quartz and metamorphics.

This is followed by 1.6 metres of medium dark grey to medium light grey, very finely laminated, fine to medium grained sandstone and siltstone which contains pink garnets and abundant mica which is aligned along bedding planes. The dip of bedding is approximately twenty degrees. Structure apparent includes small scale slumping, intraformational faulting and cross bedding. This unit coarsens downwards with the laminae becoming more erratically oriented.

This section is followed by medium to coarse grained light grey sandstone, which is silica cemented with some pyrite cementation along bedding planes. There are also rare clasts of finer grained sandstone and siltstone.

Towards the base of the core there was a band of coaly brown stained sandstone, a 10cm section of which was sealed in wax for hydrocarbon extraction. A detailed description of this section is presented below.

Sealed section

Medium grained, light grey, well sorted sandstone, well cemented, rare pink garnets, with fine sandstone/siltstone, brownish grey, with brownish black streaks, with darker streaks around the coarser grained sandstone. Colour both follows and cuts across laminations. Occasional blebs of pyrite within the finer grained, brown coloured sections. The brownish black matter appears to be staining.

The brownish grey material shows bright blue immediate fluorescence on trichloroethane cut. This tends to fade to a greenish yellow fluorescence after about 1 hour.

Core No. 38 1390.20 - 1393.45m Recovery 44%

Palaeozoic Basement

Greenish grey to dark greenish grey phyllite with occasional very dark greenish grey mottling. The rock is quite homogeneous and has strong vertical to sub-vertical slaty cleavage. There are fracture sets oriented at approximately 60° which may represent original bedding. Several of these fractures contain siliceous veining while others have argillaceous fill. There are some indications of pyrite but overall the rock has a very smooth soapy feel. It is moderately hard to hard and non calcareous.

Thin Section Description By K. Inan

Greenish grey very finely laminated and metamorphosed mudrock. In hand specimen the rock exhibits a well developed slaty cleavage.

The rock is very fine grained and composed entirely of clay sized particles now crystalised to muscovite and chlorite with some dispersed euhedral pyrite crystals (up to 0.2mm in diameter) and black organic matter.

It is a very finely laminated rock which appears to show diffused cross bedding and contains siliceous veins of polycrystalline quartz. This may be due to diagenetic concretion of quartz and/or the introduction of silica from an external source.

Rock Name: The rock was probably claystone but has undergone a degree of metamorphism which has resulted in the development of slaty cleavage. The rock is a phyllite.

Core No. 39 1428.19 - 1431.94m Recovery 4%

Palaeozoic Basement

Very poor recovery of a greenish grey to dark greenish grey metamorphosed siltstone. The rock is strongly silicified and has few notable features apart from some indications of sub-vertical cleavage or fracturing. It is very hard and non calcareous.

Thin Section Description By K. Inan.

Greenish grey, fine grained, well sorted, immature to submature sandstone.

The rock is massive and shows a grain supported packing. Detrital grains are composed largely of fine sand sized, subrounded quartz, K Feldspar, plagioclase crystals, a few muscovite flakes and rare tourmaline. The quartz is mainly monocrystalline but some polycrystalline lithic grains of probable metamorphic origin are also present. K Feldspar is mainly untwinned but a few grains show carlsbad twinning. Plagioclase is less common and shows albite twinning.

Interstitial materials are mainly made up of finer quartz grains, colourless muscovite and greenish chlorite crystal aggregates, some of which surround the feldspar and quartz grains, and minor black organic matter.

Rock Name: Immature lithic subarkose/sublitharenite.

Core No. 40 1431.64 - 1435.04m Recovery 10%

Palaeozoic Basement

Poor recovery of dark greenish grey metamorphosed sandstone and brownish grey to brownish black claystone.

The sandstone is fine to very fine grained quartz in a greenish grey siliceous ground mass. There are rare indications of pyrite and the core is non calcareous. Only small pieces of core were recovered making determinations of bedding or structure impossible. The rock is very hard and has no porosity. The claystone is slightly silty and under high magnification appears to be organic rich with some indications of laminar bedding. Again the small pieces make other determinations difficult. The rock is hard and non calcareous.

Thin section Description By K. Inan.

Greenish grey finely laminated mudrock with an originally clayey matrix now converted to chlorite and muscovite. In the hand specimen it shows a poorly developed cleavage.

The rock is bimodal and very fine grained with grain sizes mainly in the silt range. Under the microscope it shows partially matrix supported packing with dispersed euhedral to subhedral pyrite crystals. Black organic matter forms thin laminae which give the rock a layered appearance. The grains, with the exception of the pyrite crystals show a preferred orientation with their long axis parallel to the lamination. the detrital grains are mainly composed of monocrystalline quartz, with a few feldspar crystals and muscovite flakes. The matrix is now completely recrystallised to colourless muscovite and greenish chlorite.

Rock Name: The rock is mudstone which has undergone compaction and probably very slight metamorphism which caused the recrystallisation of the original clayey matrix to produce mica and chlorite.

SIDE-WALL CORE DESCRIPTIONS

SIDEWALL CORE DESCRIPTIONS

MOCAMBORO 11

DEPTH (m) REC. (mm)	PREDOMINANT LITHOLOGY	DESCRIPTION
1380m 25mm	Claystone	greyish green, common fine to medium quartz sand, siliceous matrix, slightly micromicaceous, soft, non calcareous.
1346m 30mm	Claystone	medium light grey to medium grey with two dark grey horizontal laminae which are 1 mm thick, common very fine sand to silt throughout, soft non calcareous.
1304.5m 38mm	Argillaceous sandstone	medium light grey to medium grey, occasionally very light grey, medium to coarse grained, common very coarse grains, occasional fine grains, moderately sorted, angular to very angular, occasionally sub angular, trace of siliceous cement, abundant argillaceous matrix, occasional light pink and red garnets, traces of coal on core exterior are probably cavings, soft to moderately soft, no visual porosity, immediate strong bluish white cut and crush cut from coal with moderate to strong yellowish residue ring.
1241m 40mm	Argillaceous sandstone	medium light grey to light brownish grey fine to predominantly medium grained, moderately well sorted, sub rounded to rounded, abundant argillaceous matrix, trace of mica, rare garnet, soft, friable, no visual porosity, weak yellowish to yellowish white cut and crush cut fluorescence with a moderate yellowish white residue ring.
1164m 34mm	Argillaceous sandstone	light grey to medium light grey, fine to medium grained, well sorted, angular to sub angular, occasionally rounded, abundant argillaceous matrix, trace of mica, rare garnet, single horizontal coaly lamination (< 1mm) in centre of core, moderately soft, no visual porosity.
1119.5m 30mm	Argillaceous sandstone	light grey to very light grey, fine to medium grained, well sorted, angular to sub angular occasionally rounded, abundant very light grey argillaceous matrix, occasional garnet, rare feldspathic grain, moderately soft, no visual porosity.

1081.5m 26mm	Argillaceous sandstone	light grey to medium light grey, fine to very fine grained, well sorted, sub rounded abundant argillaceous matrix, rare garnets, soft, no visual porosity.
1060m 30mm	Argillaceous sandstone	light grey to medium light grey, fine to very fine grained, well sorted, sub rounded to rounded, abundant argillaceous matrix, rare garnet, rare feldspathic and lithic grains, soft, no visual porosity.
1041m 25mm	Claystone	medium grey to medium dark grey, slightly silty, trace of mica, moderately firm, non calcareous, weak yellowish crush cut fluorescence.
1030m 30mm	Claystone	medium grey to medium dark grey, commonly very light grey where calcite replacement has occurred, slightly sandy, soft to friable, slow weak yellowish cut and crush cut fluorescence.
1022m 30mm	Claystone	medium dark grey to dark grey, slightly silty, trace of medium to coarse sand, moderately firm to firm, non calcareous, slow cut and crush cut with weak to moderate yellowish fluorescence.
1006m 23mm	Claystone	medium light grey to medium grey, slightly silty moderately firm, non calcareous.
965m 20mm	Claystone	medium light grey, trace of fine sand, trace of pyrite, trace of mica, soft to moderately firm, slightly calcareous.
933m 20mm	Claystone	medium light grey, trace of fine sand, trace of silt, trace of pyrite, trace of mica, soft to moderately firm, non calcareous, weak patchy yellowish cut and crush cut fluorescence.
904m 31mm	Claystone	medium light grey to medium grey, trace of fine sand, trace of mica, moderately firm, very weak yellowish cut and crush cut fluorescence.
890m 30mm	Claystone	medium light grey to greenish grey, slightly silty, moderately firm to firm, non calcareous weak yellowish cut and crush cut fluorescence.
877m 15mm	Claystone	medium light grey to greenish grey, slightly silty, soft, non calcareous, weak yellowish cut and crush cut fluorescence.

861m 20mm	Claystone	medium light grey to greenish grey, slightly silty, micaceous, moderately firm, non calcareous, weak yellowish cut and crush cut fluorescence.
842m 20mm	Claystone	medium light grey to greenish grey, slightly silty, slightly micaceous, moderately firm, non calcareous.
823m 20mm	Claystone	medium light grey to medium grey, slightly silty, trace of very fine sand, slightly micaceous, moderately soft, non calcareous.
808m 23mm	Claystone	medium dark grey to dark grey, trace of silt, trace of mica, moderately firm to firm, non calcareous.
792m 35mm	Claystone	medium grey to medium dark grey, trace of silt, trace to occasional mica, moderately firm to firm, non calcareous.
769.5m 40mm	Claystone	medium dark grey to dark grey, moderately firm to firm, non calcareous.
750.5m 38mm	Claystone	medium light grey to medium grey, trace of mica, moderately firm to firm, non calcareous.
734.5m 31mm	Claystone	medium light grey to medium grey, trace of silt, rare fine sand, firm, non calcareous, weak yellowish cut and crush cut fluorescence.
727m 28mm	Claystone	greyish black to black, slightly micromicaceous, firm, non calcareous, moderate yellowish white and crush cut fluorescence.
695m 30mm	Claystone	medium grey to medium dark grey, firm, non calcareous, weak yellowish cut and crush cut fluorescence.
680.5m 32mm	Claystone	medium light grey to greenish grey, trace of silt, rare very fine sand, firm, non calcareous, weak yellowish crush cut fluorescence.
667.5m 30mm	Coal	black, vitreous lustre, moderately hard, sub conchoidal fracture, strong to moderate yellowish white cut and crush cut fluorescence with strong to moderate yellowish white residue ring.
644m 40mm	Claystone	dark grey to greyish black, trace of silt, firm, non calcareous.

626m 40mm	Coal	black, sub vitreous to occasionally vitreous, dull in parts, moderately firm, brittle, moderate yellowish white cut and crush cut fluorescence and residue ring.
609m 41mm	Claystone	medium light grey to medium grey, trace to common silt, trace of mica, moderately firm to firm, non calcareous.
605m 39mm	Claystone	medium grey to medium dark grey, trace of silt, trace of pyrite, trace of mica, moderately firm, non calcareous.
590m 40mm	Claystone	medium light grey to medium grey, common very fine sand, trace of pyrite, trace of mica, moderately firm, slightly crumbly, non calcareous weak to moderate yellowish to yellowish white cut and crush cut fluorescence.
582.5m 41mm	Claystone	medium light grey to medium grey, trace of silt, trace of mica, moderately firm, non calcareous, weak to moderate yellowish to yellowish white cut and crush cut fluorescence.
580m 38mm	Claystone	medium grey to medium dark grey, common silt, trace of mica, firm, slightly calcareous, weak to moderate yellowish to yellowish white cut and crush cut fluorescence.
569m 33mm	Claystone	light grey to medium light grey, trace of silt, trace of mica, firm, non calcareous, weak to moderate yellowish white cut and crush cut fluorescence.
550m 41mm	Claystone	medium grey to medium dark grey, trace of silt, trace of pyrite, firm, non calcareous, weak to moderate yellowish to yellowish white cut and crush cut fluorescence.
517m 30mm	Sandstone	medium light grey to greenish grey, fine to very fine grained, well sorted, sub rounded to rounded, abundant argillaceous matrix, common lithic and feldspathic grains, trace of pyrite, soft to moderately firm, no visual porosity.
455m 15mm	Siltstone	light grey to medium light grey, commonly argillaceous, trace of very fine sand, soft to moderately firm, non calcareous.

414m 27mm	Claystone	medium dark grey, trace of mica, moderately firm to firm, non calcareous.
360m 28mm	Siltstone	light grey to medium light grey, argillaceous interbeds, common very fine sand, moderately firm, non calcareous.
159m 38mm	Claystone	medium light grey to medium grey, commonly silty, trace of mica, moderately firm, non calcareous.

APPENDIX 6

APPENDIX
6

VELOCITY SURVEY REPORT

Velocity Data

WELL VELOCITY SURVEY

MOCAMBORO #1

PEP 118

OTWAY BASIN

for

GEOLOGICAL SURVEY OF VICTORIA

recorded by

VELOCITY DATA PTY. LTD.

processed by

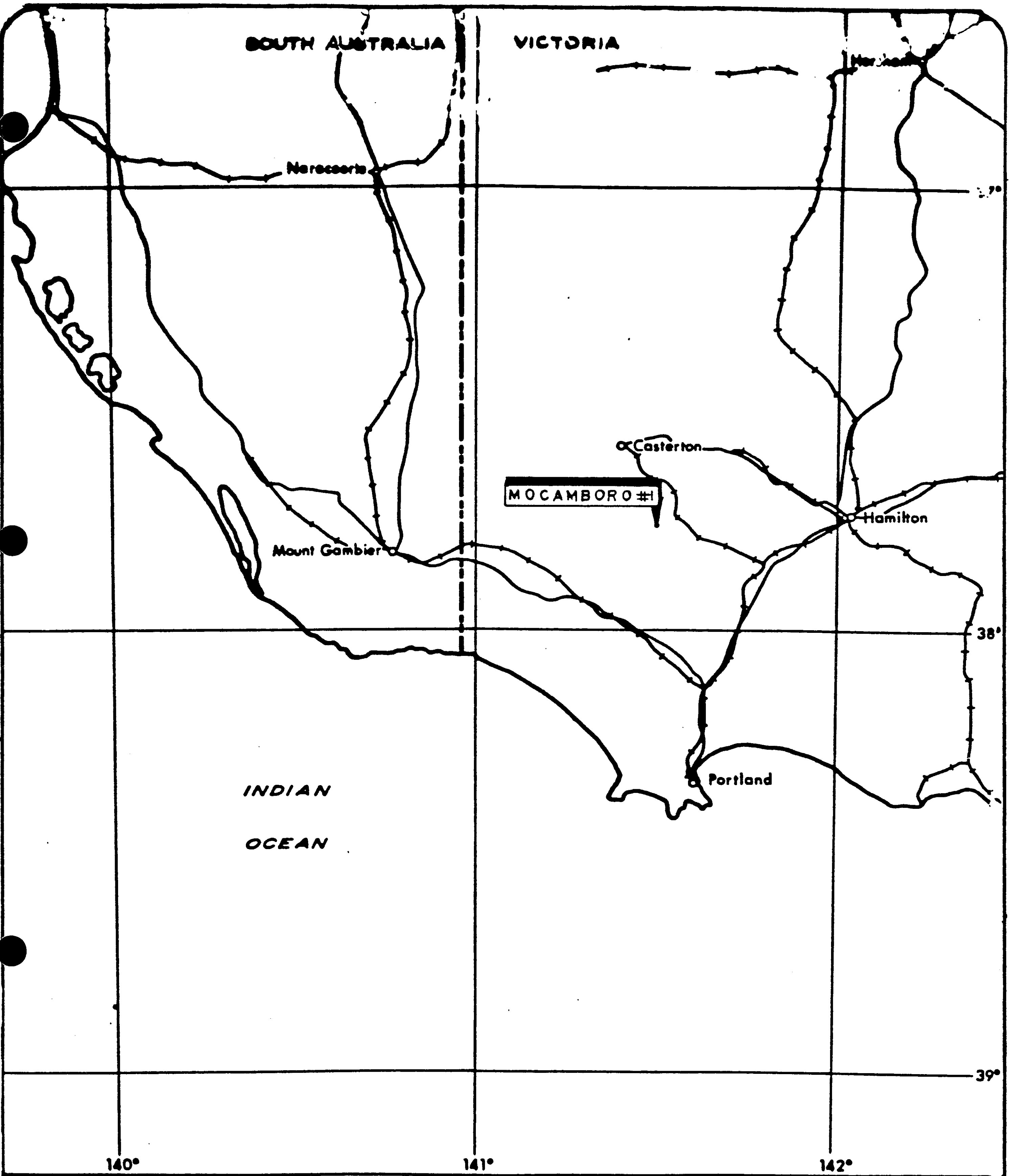
VELSEIS PTY LTD

Integrated Seismic Technologies

Brisbane, Australia

March 28, 1991

CONTENTS



MOCAMBORO #1

GEOLOGICAL SURVEY OF VICT.

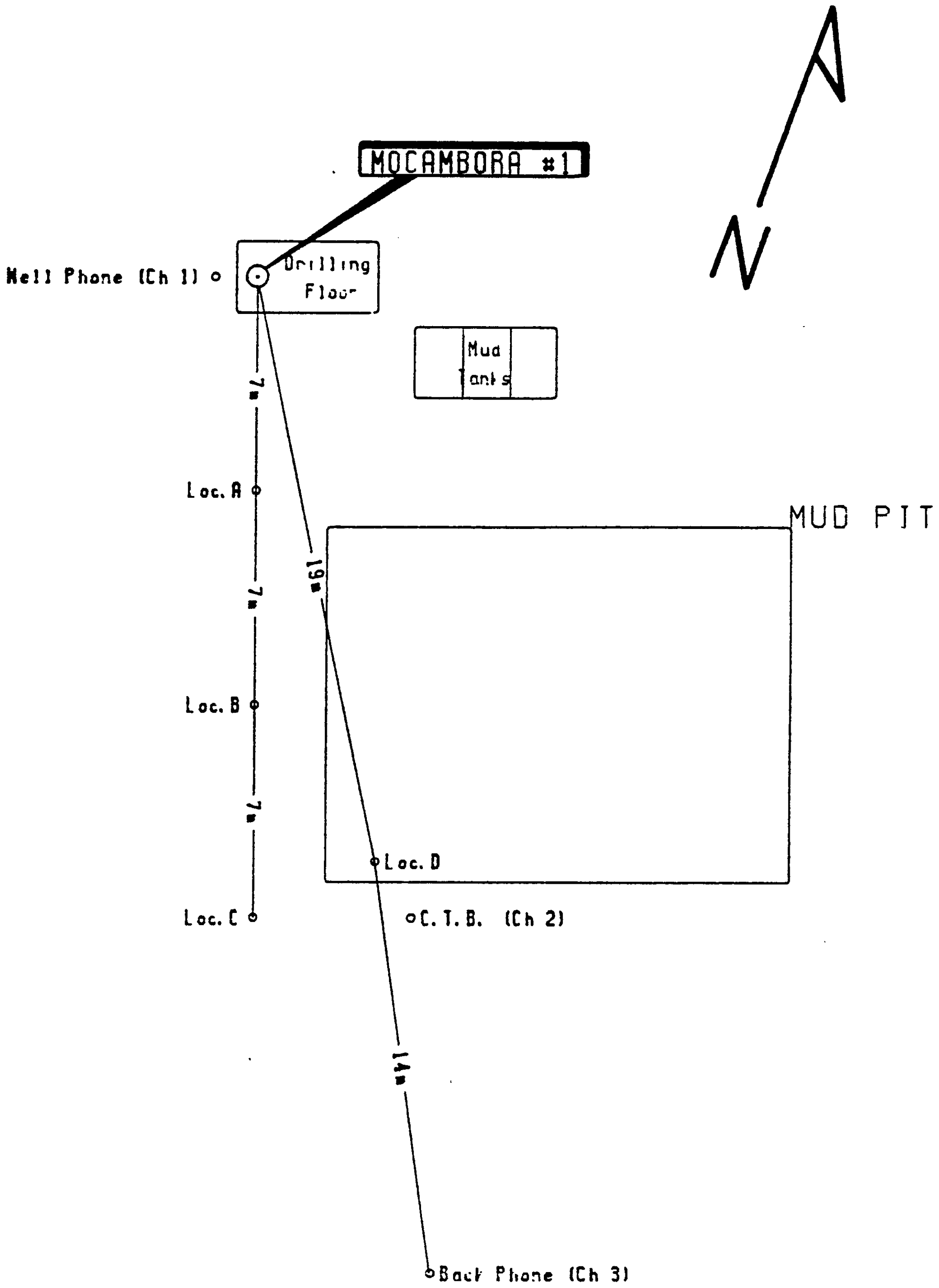
WELL LOCATION MAP

Scale 1:1250000 approx. (1 in. = 20 mi.)

0 5 10 20 30 40 50 MILES

0 5 10 20 30 40 50 60 KILOMETRES

Figure 1



MOCAMBORA #1

GEOLOGICAL SURVEY OF VICTORIA

SHOT POINT LOCATION SKETCH

Figure 2

PE906579

This is an enclosure indicator page.
The enclosure PE906579 is enclosed within the container PE906578 at this location in this document.

The enclosure PE906579 has the following characteristics:

ITEM_BARCODE = PE906579
CONTAINER_BARCODE = PE906578
NAME = Time-Depth and Velocity Curves
BASIN = OTWAY
PERMIT = PEP118
TYPE = WELL
SUBTYPE = VELOCITY_CHART
DESCRIPTION = Time-Depth and Velocity Curves for Mocamboro-11
REMARKS =
DATE_CREATED = 28/03/1991
DATE_RECEIVED =
W_NO = W1032A
WELL_NAME = MOCAMBORO-11
CONTRACTOR = VELSEIS PTY LTD
CLIENT_OP_CO = GSV

(Inserted by DNRE - Vic Govt Mines Dept)

SUMMARY

Velocity Data Pty Ltd conducted a velocity survey for Geological Survey of Victoria in the Mocamboro No1 well , PEP 118, Otway Basin, Victoria.

The date of the survey was the 13th September 1990.

The results of the survey, which are considered to be reliable, have been used to calibrate the sonic log.

Explosives were used as an energy source with shots being fired in the mud pit in the majority of instances.

GENERAL INFORMATION

Name of Well	:	Mocamboro #1
Location (Figure 1)	:	PEP 118, Otway Basin
Coordinates	:	Latitude 037 45 11
	:	Longitude 141 30 02
Date of Survey	:	September 13th, 1990.
Wireline Logging	:	BPB Unit V1030
Weather	:	Fine
Operational Base	:	Brisbane
Operator	:	N. Delfos
Shooter	:	J. Brown
Client Representative	:	Dr. A. Tabassi

EQUIPMENT

Downhole Tool

Veldata Camlock 100 (90 mm)

Sensors:

6 HSI 4.5 Hz 215 ohm, high temperature (300 degrees F) detectors connected in series parallel. Frequency response 8-300 Hz within 3 dB.

Preamplifier:

48 dB fixed gain.
Frequency response 5-200 Hz within 3 dB.

Reference Geophone

Mark Products L1 4.5 Hz

Recording Instrument

VDLS 11/10 software controlled digital recording system utilising SIE OPA-10 floating point amplifiers for digital recording and SIE OPA-4 amplifiers for analog presentation. The system includes a DEC LSI-11 CPU,twin cassette tape unit and printer.

RECORDING

Energy Source	:	Explosive, AN-60
Shot Location	:	Mud pit
Charge Size	:	0.5 / 1.0 (125grm) sticks
Average Shot Depth	:	1.0 metre
Average Shot Offset	:	19.0 metres
Recording Geometry	:	Figure 2

Shots were recorded on digital cassette tape. Printouts of the shots used are included with this report.(Enclosure 2)

The sample rate was 1 ms with 0.5 ms sampling over a 200ms window encompassing the first arrivals. The scale of the graphic display varies with signal strength and is noted on each playout.

The times were picked from the printouts using the numerical value of the signal strength. (Enclosure 2)

PROCESSING

Elevation Data

Elevation of KB	:	143.4m above sea level
Elevation of Ground	:	140.0m above sea level
Elevation of Seismic Datum	:	0.0m above sea level
Depth Surveyed	:	1415.5m below KB
Total Depth	:	1432.0m below KB
Depth of Casing	:	1231.0m below KB
Sonic Log Interval	:	11.0 to 1432.0m below KB

PROCESSING

Recorded Data

Number of Shots Used	:	24
Number of Levels Recorded	:	18
Data Quality	:	Fair
Noise Level	:	Low
Rejected Shots	:	9

Correction for Instrument Delay and Shot Offset

The 'corrected' times shown on the calculation sheet have been obtained by:

(i) Subtraction of the instrument delay (4msec) from the recorded arrival times
(ii) geometric correction for non-verticality of ray paths resulting from shot offset.
(iii) shot static correction to correct for the depth of shot below ground level at the well head using a correction velocity of 884 metres/sec
(iv) readdition of the instrument delay (4msec).

Correction to Datum

The datum chosen was 0.0 metres ASL that is 140.0 metres below ground. This level was shot four times during the survey. Using these shots an average time has been computed of 79.5msecs for the effective datum correction, please note that this time includes an instrumentation delay of 4msecs. Shot levels have been referenced to ground level and not true KB as is normal. Consequently on the calculation sheet the KB has been entered as ground level in order to bring the calculations into line.

PROCESSING

Calibration of Sonic Log - Method

Sonic times were adjusted to checkshot times using a polynomial derived least squares fit correction of the sonic transient times.

These differences arise as the sonic tool measures the local velocity characteristics of the formation with a high frequency signal, whereas the downhole geophone records the bulk velocity character using a signal of significantly lower frequency.

Calibration of Sonic Log - Results (Enclosure 1)

The discrepancies between shot and sonic interval velocities were in general quite small. The largest adjustment was 59.31 μsecs/m on the interval 527.5m and 600m below KB.

In aggregate, the shot and sonic interval times differed by 23.5 msec over the logged portion of the well.

PROCESSING

Trace Playouts (Figure 4)

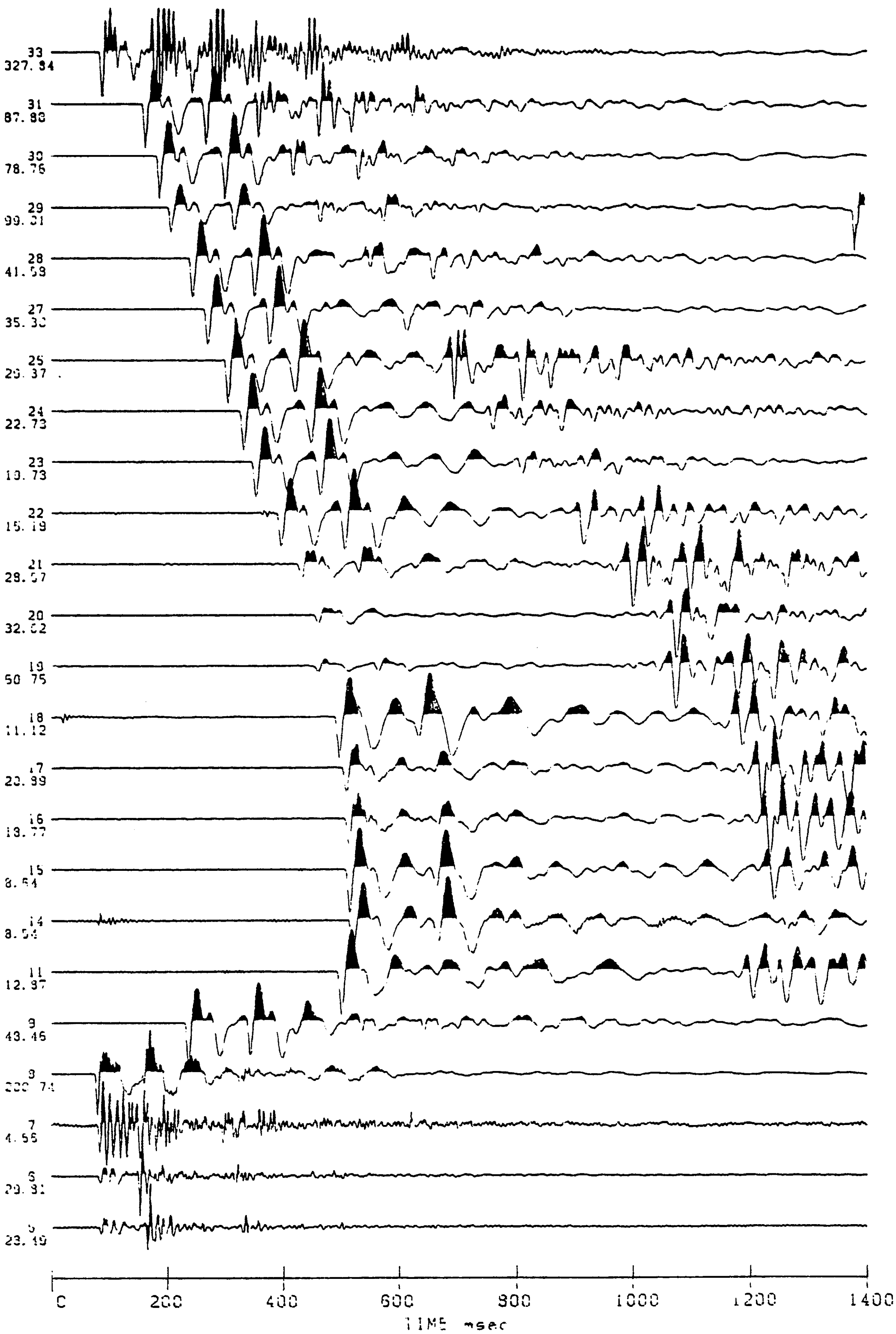
Figure 4A is a plot of all traces used. No filter or gain recovery has been applied.

Figure 4B is a plot to scale in depth and time of selected traces. No filter or gain recovery has been applied.

Figure 4C is a plot to scale in depth and time of selected traces with a 5 Hz - 40 Hz filter and a gain recovery function of t^2 applied.

Figure 4D is a plot of selected surface traces. No filter or gain recovery has been applied.

Troy Peters
Geophysical Analyst.



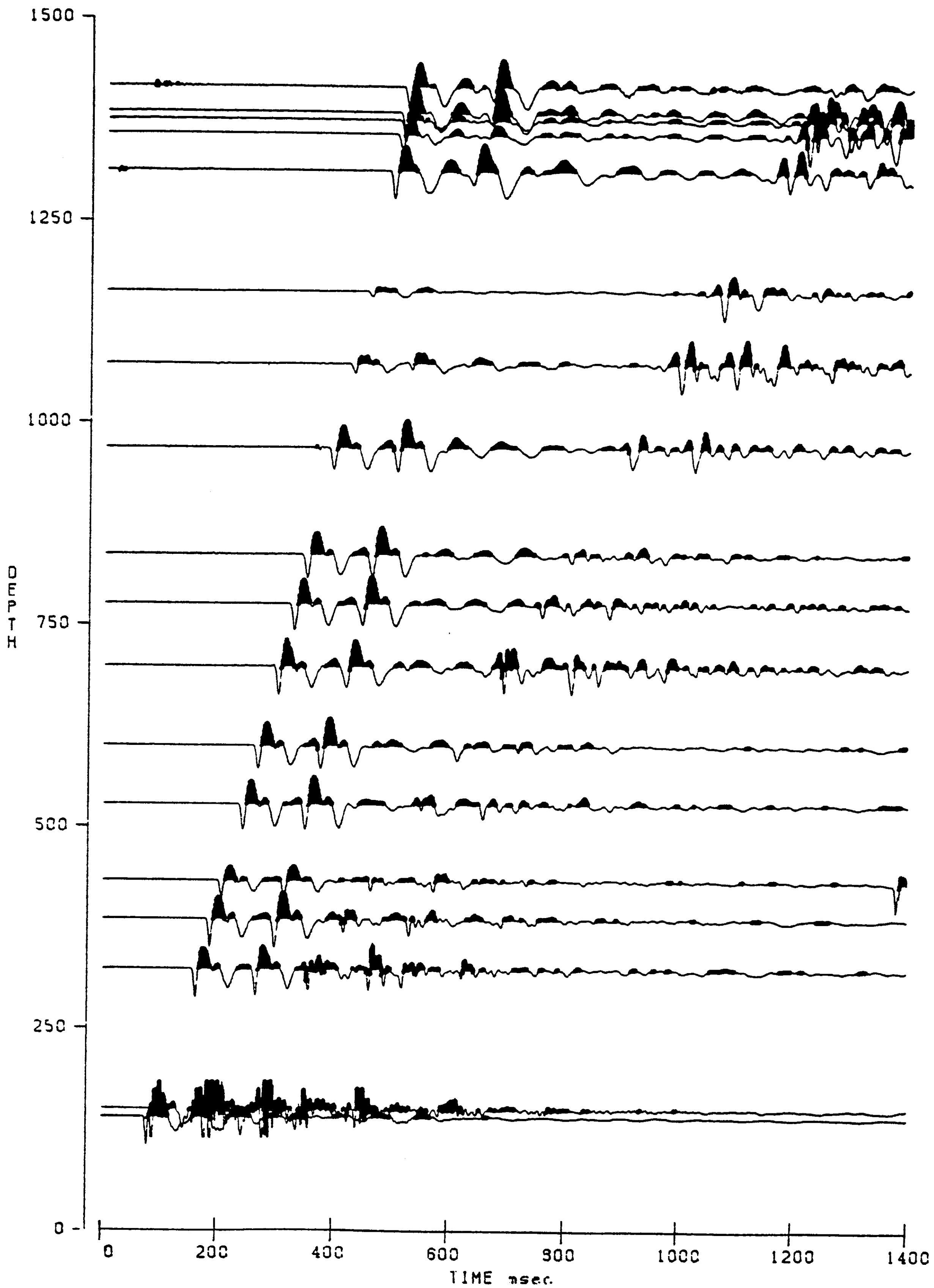
MOCAMBORA #1

VELOCITY SURVEY TRACE DISPLAY

Filter OUT - OUT

No gain recovery

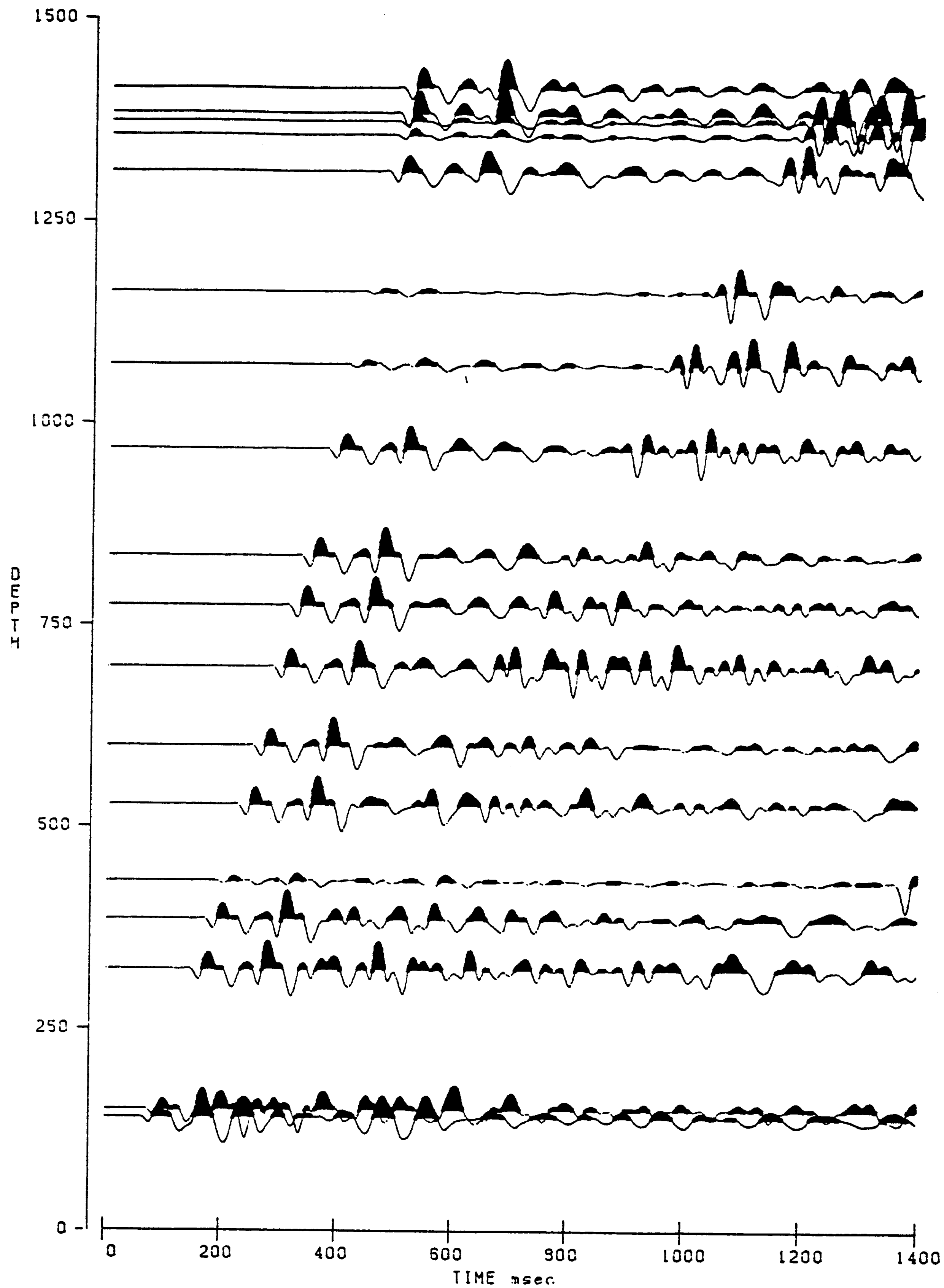
Figure 4A



MOCAMBORA #1

VELOCITY SURVEY TRACE DISPLAY
Filter OUT-OUT
No gain recovery

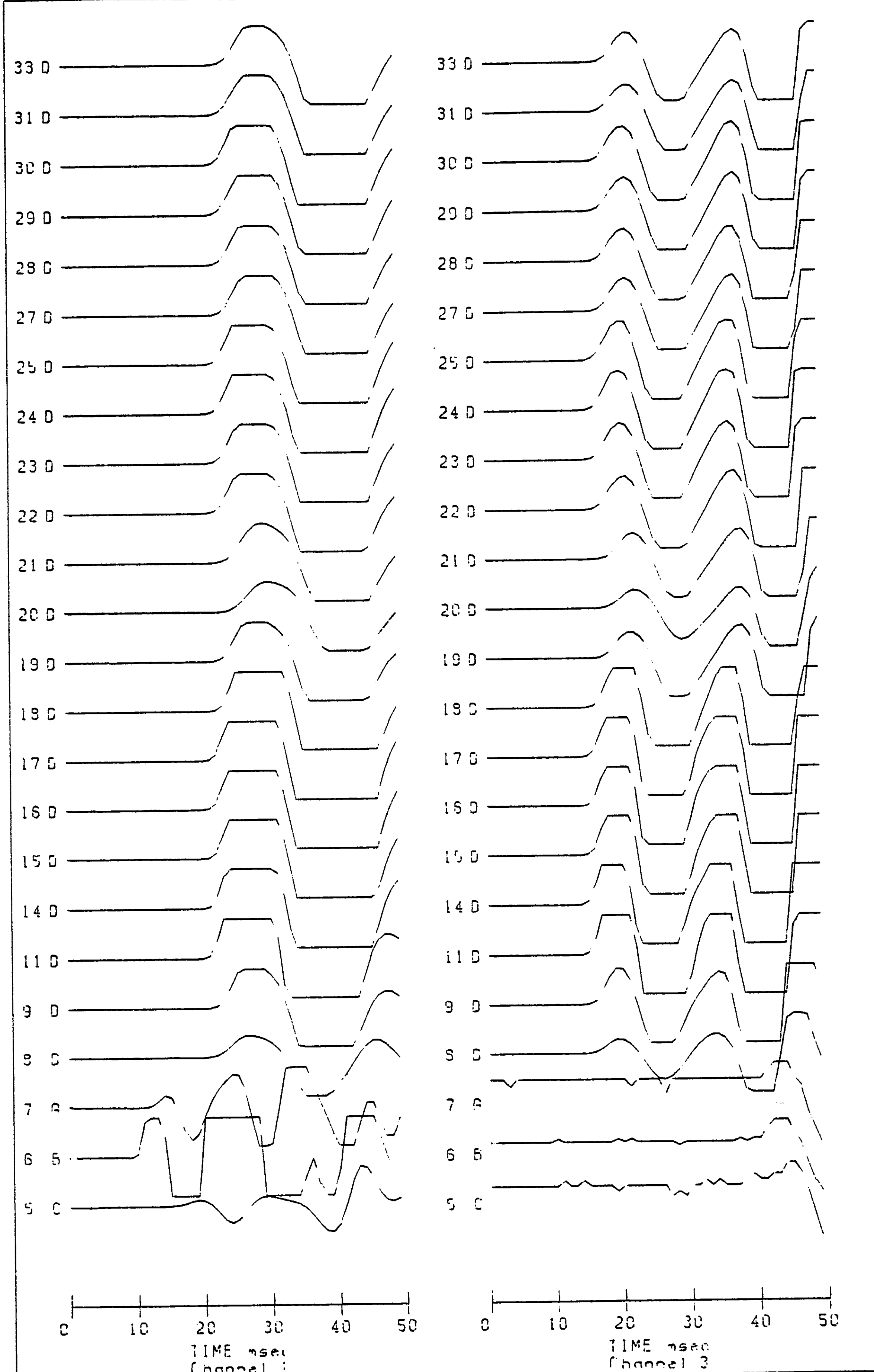
Figure 4B



MOCAMBORA #1

VELOCITY SURVEY TRACE DISPLAY
Filter 5-40
Gain $T^{2.0}$

Figure 4C



MOCAMBORA #1

VELOCITY SURVEY TRACE DISPLAY
Auxiliary channels
Filter OUT-OUT

Figure 4D

TABLE 1. Time-Depth curve values Page 1.

Well : MOCAMBORA #1 Client : GEOLOGICAL SURVEY OF VICTORIA
Survey units : METRES Datum : 0.0
Calibrated sonic interval velocities used from 140.0 to 1274.0

Datum Depth	One-way time(ms)	VELOCITIES Average	RMS	Interval	Datum Depth	One-way time(ms)	VELOCITIES Average	RMS	Interval
142.0	61.6	2305	282	2454	222.0	94.6	2347	1456	2615
144.0	62.4	2307	397	2464	224.0	95.3	2350	1471	2773
146.0	63.2	2309	483	2460	226.0	96.1	2352	1483	2531
148.0	64.1	2311	554	2438	228.0	96.9	2353	1494	2525
150.0	64.8	2314	618	2546	230.0	97.6	2356	1507	2674
152.0	65.6	2316	673	2485	232.0	98.3	2360	1521	2940
154.0	66.5	2317	721	2443	234.0	99.1	2362	1533	2667
56.0	67.3	2317	763	2324	236.0	99.9	2363	1543	2483
158.0	68.2	2316	800	2237	238.0	100.7	2364	1553	2532
160.0	69.1	2316	836	2275	240.0	101.5	2365	1563	2508
162.0	69.9	2317	872	2458	242.0	102.3	2366	1572	2449
164.0	70.7	2320	909	2604	244.0	103.1	2367	1582	2522
166.0	71.4	2324	944	2661	246.0	103.6	2374	1599	3545
168.0	72.2	2326	975	2487	248.0	104.4	2374	1607	2481
170.0	73.0	2327	1003	2444	250.0	105.3	2375	1616	2454
172.0	74.1	2322	1023	1965	252.0	106.1	2375	1624	2430
174.0	75.1	2316	1040	1860	254.0	106.9	2376	1631	2449
176.0	76.1	2311	1058	1996	256.0	107.6	2380	1644	3016
178.0	77.0	2313	1082	2423	258.0	108.4	2381	1651	2451
180.0	77.9	2311	1101	2166	260.0	109.2	2380	1657	2311
182.0	78.7	2311	1122	2369	262.0	110.1	2379	1664	2308
184.0	79.4	2318	1153	3184	264.0	111.0	2379	1670	2346
186.0	80.2	2320	1173	2433	266.0	111.8	2380	1677	2466
88.0	81.0	2321	1193	2432	268.0	112.6	2381	1684	2503
190.0	81.8	2321	1211	2393	270.0	113.3	2382	1692	2602
192.0	82.7	2321	1227	2306	272.0	114.1	2385	1701	2749
194.0	83.5	2323	1245	2450	274.0	114.9	2385	1708	2482
196.0	84.2	2327	1267	2872	276.0	115.7	2386	1714	2504
198.0	85.1	2328	1283	2387	278.0	116.5	2387	1721	2461
200.0	85.9	2329	1299	2466	280.0	117.3	2387	1727	2434
202.0	86.7	2330	1315	2461	282.0	118.1	2388	1733	2523
204.0	87.5	2332	1330	2486	284.0	118.9	2389	1740	2497
206.0	88.3	2333	1345	2426	286.0	119.7	2389	1746	2499
208.0	89.1	2334	1359	2483	288.0	120.5	2390	1752	2557
210.0	90.0	2335	1373	2412	290.0	121.3	2391	1758	2477
212.0	90.8	2336	1386	2455	292.0	122.1	2391	1764	2443
214.0	91.6	2337	1399	2442	294.0	122.6	2398	1778	3975
216.0	92.3	2339	1414	2671	296.0	123.4	2398	1784	2479
218.0	93.1	2341	1427	2549	298.0	124.2	2399	1789	2506
20.0	93.8	2345	1443	2825	300.0	125.0	2400	1795	2567

TABLE 1. Time-Depth curve values Page 2.

Well : MOCAMBORA #1 Client : GEOLOGICAL SURVEY OF VICTORIA
Survey units : METRES Datum : 0.0
Calibrated sonic interval velocities used from 140.0 to 1274.0

Datum	One-way	-----VELOCITIES-----			Datum	One-way	-----VELOCITIES-----		
Depth	time(ms)	Average	RMS	Interval	Depth	time(ms)	Average	RMS	Interval
302.0	125.8	2401	1801	2489	382.0	156.6	2439	1983	2614
304.0	126.6	2402	1806	2566	384.0	157.4	2440	1987	2601
306.0	127.4	2403	1812	2594	386.0	158.2	2441	1990	2605
308.0	128.1	2404	1817	2522	388.0	158.7	2444	1997	3349
310.0	128.9	2404	1822	2498	390.0	159.5	2445	2001	2655
312.0	129.7	2405	1827	2511	392.0	160.3	2446	2004	2663
314.0	130.5	2405	1832	2498	394.0	161.0	2447	2008	2625
316.0	131.3	2406	1837	2571	396.0	161.8	2447	2011	2558
318.0	132.1	2408	1843	2635	398.0	162.6	2448	2014	2569
320.0	132.8	2409	1849	2722	400.0	163.3	2449	2017	2660
322.0	133.6	2410	1854	2503	402.0	164.0	2451	2021	2833
324.0	134.4	2411	1858	2549	404.0	164.8	2452	2025	2631
326.0	135.2	2412	1863	2568	406.0	165.5	2453	2028	2694
328.0	135.9	2414	1870	2900	408.0	166.3	2454	2031	2659
330.0	136.6	2415	1875	2577	410.0	167.0	2455	2035	2666
332.0	137.4	2416	1879	2548	412.0	167.7	2456	2039	2839
334.0	138.2	2417	1884	2539	414.0	168.5	2457	2042	2666
336.0	139.0	2417	1888	2563	416.0	169.3	2458	2045	2619
338.0	139.8	2418	1893	2556	418.0	170.0	2459	2048	2635
340.0	140.6	2418	1896	2463	420.0	170.8	2459	2051	2569
342.0	141.4	2419	1901	2596	422.0	171.6	2459	2053	2442
344.0	142.0	2423	1908	3175	424.0	172.4	2460	2056	2620
346.0	142.8	2423	1913	2564	426.0	173.1	2461	2059	2668
348.0	143.6	2424	1917	2549	428.0	173.9	2461	2061	2631
350.0	144.3	2425	1921	2587	430.0	174.6	2462	2064	2640
352.0	145.1	2426	1925	2525	432.0	175.4	2463	2067	2659
354.0	145.9	2426	1928	2478	434.0	176.2	2463	2070	2556
356.0	146.7	2427	1933	2715	436.0	176.9	2464	2072	2629
358.0	147.4	2428	1937	2566	438.0	177.7	2465	2075	2646
360.0	148.2	2430	1942	2743	440.0	178.5	2466	2078	2632
362.0	148.9	2431	1946	2637	442.0	179.2	2466	2081	2651
364.0	149.7	2431	1949	2464	444.0	180.0	2467	2083	2623
366.0	150.5	2431	1952	2519	446.0	180.7	2468	2086	2618
368.0	151.3	2432	1957	2657	448.0	181.4	2470	2090	2975
370.0	152.1	2433	1960	2601	450.0	182.2	2470	2092	2682
372.0	152.8	2434	1964	2609	452.0	182.8	2473	2097	3189
374.0	153.6	2435	1968	2590	454.0	183.4	2475	2102	3223
376.0	154.4	2435	1971	2471	456.0	184.1	2477	2105	2822
378.0	155.2	2436	1974	2616	458.0	184.7	2480	2111	3460
380.0	155.9	2438	1980	2944	460.0	185.4	2481	2114	2756

TABLE 1.   Time-Depth curve values   Page 3.

Well : MOCAMBORA #1   Client : GEOLOGICAL SURVEY OF VICTORIA
Survey units : METRES   Datum : 0.0
Calibrated sonic interval velocities used from 140.0 to 1274.0

Datum Depth	One-way time(ms)	-----VELOCITIES----- Average	RMS	Interval	Datum Depth	One-way time(ms)	-----VELOCITIES----- Average	RMS	Interval
462.0	186.2	2482	2116	2655	542.0	215.3	2517	2213	2812
464.0	186.9	2482	2119	2671	544.0	216.0	2519	2215	2961
466.0	187.7	2483	2121	2638	546.0	216.7	2519	2217	2702
468.0	188.4	2483	2123	2590	548.0	217.4	2521	2221	3177
470.0	189.2	2484	2126	2623	550.0	218.1	2522	2223	2813
472.0	190.0	2485	2128	2654	552.0	218.8	2523	2225	2879
474.0	190.7	2485	2130	2673	554.0	219.5	2524	2227	2688
476.0	191.4	2487	2133	2774	556.0	220.2	2525	2229	2845
478.0	192.2	2487	2136	2706	558.0	220.9	2526	2232	2986
480.0	192.9	2488	2138	2619	560.0	221.5	2528	2236	3319
482.0	193.7	2489	2140	2681	562.0	222.2	2529	2238	2776
484.0	194.4	2490	2143	2782	564.0	222.9	2530	2240	2847
486.0	195.2	2490	2145	2625	566.0	223.7	2530	2241	2608
488.0	195.9	2491	2147	2682	568.0	224.4	2531	2243	2674
490.0	196.6	2492	2150	2798	570.0	225.2	2531	2244	2673
492.0	197.3	2493	2152	2771	572.0	226.0	2531	2245	2447
494.0	197.9	2496	2158	3711	574.0	226.7	2532	2247	2766
496.0	198.6	2498	2161	2829	576.0	227.4	2534	2250	3119
498.0	199.3	2498	2163	2731	578.0	228.1	2534	2251	2560
500.0	200.0	2499	2166	2762	580.0	228.9	2534	2252	2670
502.0	200.8	2500	2168	2733	582.0	229.6	2535	2254	2779
504.0	201.5	2501	2170	2683	584.0	230.3	2536	2256	2782
506.0	202.3	2502	2173	2757	586.0	231.1	2536	2258	2716
508.0	203.0	2502	2174	2586	588.0	231.8	2537	2259	2766
510.0	203.7	2504	2178	2958	590.0	232.6	2537	2260	2492
512.0	204.4	2505	2180	2778	592.0	233.3	2537	2262	2787
514.0	205.1	2506	2183	2836	594.0	234.0	2538	2264	2865
516.0	205.8	2508	2186	3081	596.0	234.7	2539	2266	2832
518.0	206.5	2508	2188	2658	598.0	235.4	2541	2269	3019
520.0	207.3	2509	2190	2656	600.0	236.1	2541	2270	2682
522.0	208.0	2509	2192	2725	602.0	236.8	2542	2272	2815
524.0	208.8	2510	2194	2661	604.0	237.5	2543	2274	2879
526.0	209.5	2511	2196	2853	606.0	238.2	2544	2276	2828
528.0	210.3	2511	2197	2507	608.0	238.9	2545	2278	3020
530.0	211.0	2511	2199	2601	610.0	239.6	2546	2280	2852
532.0	211.8	2512	2201	2746	612.0	240.3	2547	2282	2808
534.0	212.5	2513	2203	2738	614.0	241.0	2548	2283	2790
536.0	213.2	2514	2206	2849	616.0	241.7	2548	2285	2831
538.0	213.9	2515	2208	2797	618.0	242.4	2549	2287	2889
540.0	214.6	2516	2210	2875	620.0	243.1	2550	2289	2919

Well : MOCAMBORA #1 Client : GEOLOGICAL SURVEY OF VICTORIA
Survey units : METRES Datum : 0.0
Calibrated sonic interval velocities used from 140.0 to 1274.0

Datum Depth	One-way time(ms)	VELOCITIES Average	RMS	Interval	Datum Depth	One-way time(ms)	VELOCITIES Average	RMS	Interval
622.0	243.8	2551	2291	2943	702.0	271.7	2584	2357	2899
624.0	244.5	2552	2293	2816	704.0	272.4	2585	2359	2922
626.0	245.3	2552	2294	2642	706.0	273.0	2586	2361	2931
628.0	246.0	2553	2295	2624	708.0	273.7	2587	2362	2964
630.0	246.8	2553	2296	2665	710.0	274.4	2587	2364	2939
632.0	247.5	2553	2298	2697	712.0	275.1	2588	2365	2851
634.0	248.2	2554	2299	2732	714.0	275.8	2589	2367	2921
636.0	248.8	2556	2303	3544	716.0	276.5	2590	2368	2920
638.0	249.5	2558	2305	3038	718.0	277.1	2591	2370	2970
640.0	250.2	2558	2307	2816	720.0	277.8	2592	2372	3032
642.0	250.9	2559	2308	2878	722.0	278.5	2593	2373	2962
644.0	251.6	2560	2310	2829	724.0	279.2	2593	2375	2933
646.0	252.3	2560	2311	2733	726.0	279.8	2594	2376	2931
648.0	253.0	2561	2313	2748	728.0	280.5	2595	2378	2856
650.0	253.7	2562	2315	3009	730.0	281.2	2596	2379	2961
652.0	254.4	2563	2316	2853	732.0	281.9	2597	2381	2927
654.0	255.1	2564	2318	2917	734.0	282.6	2597	2382	2941
656.0	255.7	2565	2321	3126	736.0	283.3	2598	2384	3009
658.0	256.4	2566	2322	2876	738.0	284.0	2599	2385	2849
660.0	257.1	2567	2324	2762	740.0	284.6	2600	2387	2983
662.0	257.8	2567	2325	2851	742.0	285.3	2601	2388	2985
664.0	258.5	2568	2327	2834	744.0	286.0	2602	2390	2934
666.0	259.2	2569	2328	2861	746.0	286.7	2602	2391	2951
668.0	259.9	2570	2330	2867	748.0	287.3	2603	2393	2985
670.0	260.7	2570	2332	2839	750.0	288.0	2604	2395	3041
672.0	261.3	2571	2333	2958	752.0	288.7	2605	2396	2970
674.0	262.0	2572	2335	2823	754.0	289.3	2606	2398	2995
676.0	262.8	2573	2336	2745	756.0	290.0	2607	2399	2967
678.0	263.5	2573	2338	2893	758.0	290.7	2608	2401	2993
680.0	264.1	2574	2339	2890	760.0	291.3	2609	2402	3050
682.0	264.8	2576	2342	3157	762.0	292.0	2610	2404	2964
684.0	265.5	2576	2343	2844	764.0	292.7	2610	2404	2664
686.0	266.2	2577	2345	2844	766.0	293.4	2611	2406	2973
688.0	266.9	2578	2346	2879	768.0	294.1	2612	2407	3021
690.0	267.6	2578	2347	2781	770.0	294.7	2612	2409	3019
692.0	268.3	2579	2349	2887	772.0	295.4	2613	2411	2993
694.0	269.0	2580	2350	2873	774.0	296.1	2614	2412	2913
696.0	269.6	2581	2353	3216	776.0	296.8	2615	2413	3017
698.0	270.3	2582	2355	2964	778.0	297.4	2616	2415	3300
700.0	271.0	2583	2356	2836	780.0	298.0	2617	2417	3050

Well : MOCAMBORA #1 Client : GEOLOGICAL SURVEY OF VICTORI
Survey units : METRES Datum : 0.0
Calibrated sonic interval velocities used from 140.0 to 1274.0

Datum Depth	One-way time(ms)	-----VELOCITIES----- Average	RMS	Interval	Datum Depth	One-way time(ms)	-----VELOCITIES----- Average	RMS	Interva
782.0	298.7	2618	2419	3011	862.0	324.7	2655	2478	3291
784.0	299.4	2619	2420	2894	864.0	325.3	2656	2479	3276
786.0	300.0	2620	2421	3068	866.0	326.0	2657	2481	3170
788.0	300.7	2621	2423	3085	868.0	326.6	2658	2482	3037
790.0	301.3	2622	2425	3214	870.0	327.2	2659	2484	3137
792.0	302.0	2623	2426	2964	872.0	327.9	2660	2485	3177
794.0	302.7	2623	2427	2957	874.0	328.5	2661	2487	3253
796.0	303.3	2624	2429	3011	876.0	329.1	2662	2488	3225
98.0	304.0	2625	2431	3084	878.0	329.7	2663	2490	3190
800.0	304.6	2626	2432	2929	880.0	330.4	2663	2491	3065
802.0	305.3	2627	2433	3050	882.0	331.1	2664	2492	2808
804.0	306.0	2628	2435	2969	884.0	331.8	2665	2493	3030
806.0	306.6	2629	2436	3027	886.0	332.4	2666	2495	3361
808.0	307.3	2629	2437	3054	888.0	332.9	2667	2497	3463
810.0	308.0	2630	2439	3017	890.0	333.6	2668	2498	3099
812.0	308.6	2631	2440	3010	892.0	334.2	2669	2500	3297
814.0	309.3	2632	2442	3045	894.0	334.8	2670	2501	3109
816.0	309.9	2633	2443	3006	896.0	335.5	2671	2503	3181
818.0	310.6	2634	2444	3009	898.0	336.1	2672	2504	3253
820.0	311.3	2634	2446	3033	900.0	336.7	2673	2506	3186
822.0	311.9	2635	2447	3074	902.0	337.3	2674	2507	3167
824.0	312.6	2636	2449	3041	904.0	338.0	2675	2508	3091
826.0	313.2	2637	2450	3099	906.0	338.6	2676	2510	3170
28.0	313.9	2638	2451	2812	908.0	339.3	2676	2511	3083
830.0	314.6	2639	2453	3165	910.0	339.9	2678	2513	3323
832.0	315.2	2640	2455	3313	912.0	340.4	2679	2515	3542
834.0	315.7	2641	2457	3489	914.0	341.0	2680	2516	3253
836.0	316.3	2643	2459	3342	916.0	341.6	2681	2518	3397
838.0	317.0	2643	2460	2998	918.0	342.2	2682	2520	3328
840.0	317.7	2644	2461	3053	920.0	342.9	2683	2521	3195
842.0	318.3	2645	2463	3018	922.0	343.5	2685	2523	3383
844.0	319.0	2646	2464	3156	924.0	344.1	2685	2524	3198
846.0	319.6	2647	2466	3257	926.0	344.7	2686	2526	3198
848.0	320.2	2648	2467	3011	928.0	345.3	2687	2527	3154
850.0	320.9	2649	2469	3152	930.0	346.0	2688	2528	3059
852.0	321.5	2650	2470	3059	932.0	346.6	2689	2530	3368
854.0	322.2	2651	2472	3182	934.0	347.3	2690	2531	2925
856.0	322.8	2652	2473	3093	936.0	347.9	2691	2532	3235
858.0	323.4	2653	2475	3147	938.0	348.5	2692	2533	3281
60.0	324.1	2653	2476	2987	940.0	349.1	2693	2535	3336

Well : MOCAMBORA #1 Client : GEOLOGICAL SURVEY OF VICTORIA
Survey units : METRES Datum : 0.0
Calibrated sonic interval velocities used from 140.0 to 1274.0

Datum Depth	One-way time(ms)	-----VELOCITIES----- Average	RMS	Interval	Datum Depth	One-way time(ms)	-----VELOCITIES----- Average	RMS	Interval
942.0	349.7	2694	2536	3248	1022.0	374.8	2727	2585	3146
944.0	350.3	2695	2538	3346	1024.0	375.4	2728	2587	3525
946.0	350.9	2696	2540	3261	1026.0	375.9	2729	2589	3692
948.0	351.5	2697	2541	3255	1028.0	376.5	2731	2591	3794
950.0	352.2	2698	2542	3155	1030.0	376.9	2733	2594	4272
952.0	352.8	2698	2543	3196	1032.0	377.4	2735	2596	4216
954.0	353.5	2699	2544	2918	1034.0	377.9	2736	2599	4150
956.0	354.1	2700	2546	3304	1036.0	378.4	2738	2601	3914
[illegible]58.0	354.7	2701	2547	3129	1038.0	378.9	2740	2603	3953
960.0	355.4	2702	2548	3203	1040.0	379.5	2741	2605	3520
962.0	356.0	2702	2549	3016	1042.0	380.0	2742	2607	3440
964.0	356.7	2703	2550	3062	1044.0	380.6	2743	2608	3507
966.0	357.3	2704	2551	3163	1046.0	381.1	2744	2610	3849
968.0	357.9	2705	2553	3320	1048.0	381.6	2746	2613	3977
970.0	358.5	2706	2554	3292	1050.0	382.2	2747	2614	3762
972.0	359.2	2706	2555	3030	1052.0	382.7	2749	2616	3660
974.0	359.8	2707	2557	3372	1054.0	383.3	2750	2618	3742
976.0	360.4	2708	2558	3218	1056.0	383.8	2751	2620	3672
978.0	361.0	2709	2559	3071	1058.0	384.3	2753	2622	3861
980.0	361.6	2710	2561	3313	1060.0	384.9	2754	2624	3615
982.0	362.3	2711	2562	3139	1062.0	385.4	2755	2625	3618
984.0	362.9	2712	2563	3249	1064.0	386.0	2757	2627	3583
986.0	363.5	2712	2564	3062	1066.0	386.5	2758	2629	3730
988.0	364.2	2713	2565	2965	1068.0	387.0	2759	2631	3828
[illegible]90.0	364.9	2713	2566	2999	1070.0	387.6	2761	2633	3851
992.0	365.5	2714	2567	3341	1072.0	388.1	2762	2635	3766
994.0	366.1	2715	2568	3253	1074.0	388.6	2764	2637	3907
996.0	366.7	2716	2570	3272	1076.0	389.1	2765	2639	3848
998.0	367.3	2717	2571	3169	1078.0	389.6	2767	2641	3770
1000.0	368.0	2718	2572	3134	1080.0	390.2	2768	2642	3636
1002.0	368.6	2718	2573	3153	1082.0	390.7	2769	2644	3837
1004.0	369.2	2719	2574	3277	1084.0	391.2	2771	2646	3876
1006.0	369.8	2720	2576	3319	1086.0	391.7	2772	2648	3951
1008.0	370.4	2721	2577	3229	1088.0	392.3	2774	2650	3825
1010.0	371.1	2722	2578	3203	1090.0	392.8	2775	2652	3902
1012.0	371.7	2722	2579	3089	1092.0	393.3	2777	2654	3942
1014.0	372.3	2723	2580	3207	1094.0	393.8	2778	2656	3811
1016.0	373.0	2724	2582	3265	1096.0	394.3	2779	2658	3946
1018.0	373.6	2725	2583	3237	1098.0	394.8	2781	2661	3999
[illegible]20.0	374.2	2726	2584	3277	1100.0	395.3	2782	2662	3882

Well : MOCAMBORA #1
Client : GEOLOGICAL SURVEY OF VICTORIA
Survey units : METRES
Datum : 0.0
Calibrated sonic interval velocities used from 140.0 to 1274.0

Datum Depth	One-way time(ms)	VELOCITIES Average	RMS	Interval	Datum Depth	One-way time(ms)	VELOCITIES Average	RMS	Interval
1102.0	395.9	2784	2664	3730	1182.0	416.6	2838	2737	4034
1104.0	396.4	2785	2666	3948	1184.0	417.0	2839	2739	4371
1106.0	396.9	2787	2668	4055	1186.0	417.5	2841	2741	4166
1108.0	397.4	2788	2670	3906	1188.0	418.0	2842	2743	3993
1110.0	397.9	2790	2672	3795	1190.0	418.5	2843	2745	3917
1112.0	398.4	2791	2674	3774	1192.0	419.0	2845	2746	3900
1114.0	399.0	2792	2676	3752	1194.0	419.6	2846	2748	3634
1116.0	399.5	2793	2677	3726	1196.0	420.1	2847	2750	3941
1118.0	400.0	2795	2679	3758	1198.0	420.6	2848	2751	3839
1120.0	400.6	2796	2681	3671	1200.0	421.1	2850	2754	4423
1122.0	401.1	2797	2682	3714	1202.0	421.5	2851	2755	4080
1124.0	401.7	2798	2684	3735	1204.0	422.0	2853	2757	4072
1126.0	402.2	2799	2685	3521	1206.0	422.5	2854	2759	4096
1128.0	402.8	2801	2687	3670	1208.0	423.1	2855	2761	3706
1130.0	403.3	2802	2689	3751	1210.0	423.6	2856	2762	3666
1132.0	403.9	2803	2690	3659	1212.0	424.1	2858	2763	3730
1134.0	404.4	2804	2692	3736	1214.0	424.6	2859	2765	4099
1136.0	404.9	2805	2693	3730	1216.0	425.1	2861	2768	4408
1138.0	405.5	2807	2695	3700	1218.0	425.5	2862	2770	4409
1140.0	406.0	2808	2697	3673	1220.0	426.0	2864	2772	4347
1142.0	406.5	2809	2698	3794	1222.0	426.4	2866	2774	4479
1144.0	407.1	2810	2700	3701	1224.0	426.9	2867	2777	4509
1146.0	407.6	2812	2702	3733	1226.0	427.4	2869	2779	4283
1148.0	408.1	2813	2703	3919	1228.0	427.8	2870	2781	4462
1150.0	408.6	2814	2705	3800	1230.0	428.3	2872	2783	4385
1152.0	409.2	2816	2707	3891	1232.0	428.7	2874	2786	4315
1154.0	409.7	2817	2709	3966	1234.0	429.2	2875	2788	4547
1156.0	410.2	2818	2711	3972	1236.0	429.6	2877	2791	5202
1158.0	410.7	2820	2712	3739	1238.0	429.9	2880	2794	5510
1160.0	411.2	2821	2714	4076	1240.0	430.3	2882	2797	5036
1162.0	411.7	2822	2716	3798	1242.0	430.7	2884	2800	4968
1164.0	412.2	2824	2718	4030	1244.0	431.1	2886	2803	5112
1166.0	412.7	2825	2720	4272	1246.0	431.5	2888	2806	5371
1168.0	413.2	2827	2722	3995	1248.0	431.9	2890	2809	5308
1170.0	413.6	2829	2725	4507	1250.0	432.2	2892	2813	6164
1172.0	414.1	2831	2727	4634	1252.0	432.5	2895	2817	5758
1174.0	414.5	2832	2730	4310	1254.0	432.9	2897	2821	5641
1176.0	415.0	2833	2731	3862	1256.0	433.2	2899	2824	6108
1178.0	415.6	2835	2733	3873	1258.0	433.5	2902	2828	6105
1180.0	416.1	2836	2735	3939	1260.0	433.9	2904	2832	6203

Well : MOCAMBORA #1
Survey units : METRES
Calibrated sonic interval velocities used from 140.0 to 1274.0

Client : GEOLOGICAL SURVEY OF VICTORIA
Datum : 0.0

Datum Depth	One-way time(ms)	VELOCITIES Average	RMS	Interval	Datum Depth	One-way time(ms)	VELOCITIES Average	RMS	Interval
1262.0	434.2	2907	2837	6804	1268.0	435.1	2915	2850	6370
1264.0	434.5	2909	2841	6480	1270.0	435.4	2917	2854	6129
1266.0	434.7	2912	2846	7254	1272.0	435.7	2919	2857	5437

ELSEIS PTY LTD — WELL SURVEY CALCULATIONS — Page 1

Company : GEOLOGICAL SURVEY OF VICTORIA
Well : MOCAMBORA #1
Elevations : Datum : 0.0 Ground : 140.0 Kelly : 140.0

Shot data :

Location	Elevation	Offset
A	139.7	7.0
B	139.7	14.0
C	139.7	21.0
D	138.5	19.0

Latitude : 7 45 11
Longitude : 141 30 02
Rig identification :
Energy source : AN60
Logger : BPB V1030
Near surface velocity
for shot statics: 884
Instrument delay: 4.0 ms

Survey date : SEP-90
Survey units : METRES
Times in milliseconds.

SHOT CALCULATIONS

Shot No	Geophone depth Kelly	-- Datum	Shot Locn	Shot Depth	TIMES Record	- Corr.	---- Avg.	- Below datum	Check shot interval Distance	-- Time	Velocities Average	-- RMS	-- Interval
DATUM													
5	140.0	0.0	C	0.7	80.0	80.3							
6	140.0	0.0	B	0.7	80.0	80.7							
7	140.0	0.0	A	0.7	79.0	80.0							
8	140.0	0.0	D	1.0	75.0	77.2	79.6	0.0					
									10.0	4.6			2173.9
33	150.0	10.0	D	1.0	82.0	84.2	84.2	4.6			2173.9	2173.9	
									174.0	72.9			2386.8
31	324.0	184.0	D	1.0	154.5	157.1	157.1	77.5			2374.2	2374.7	
									62.0	26.5			2339.6
30	386.0	246.0	D	1.0	181.0	183.6	183.6	104.0			2365.4	2365.8	
									47.0	19.0			2473.7
29	433.0	293.0	D	1.0	200.0	202.6	202.6	123.0			2382.1	2382.8	
									94.5	35.6			2654.5
9	527.5	387.5	D	1.0	230.0	232.7 N/U							
28	527.5	387.5	D	1.0	235.5	238.2	238.2	158.6			2443.3	2446.4	
									72.5	28.5			2543.9
CRAYFISH FMN BLUE													
27	600.0	460.0	D	1.0	264.0	266.7	266.7	187.1			2458.6	2461.5	
									98.5	35.0			2814.3
25	698.5	558.5	D	1.0	299.0	301.7	301.7	222.1			2514.6	2520.4	
									77.0	25.5			3019.6
24	775.5	635.5	D	1.0	324.5	327.2	327.2	247.6			2566.6	2576.3	
									60.5	20.5			2951.2
23	836.0	696.0	D	1.0	345.0	347.7	347.7	268.1			2596.0	2606.8	
									132.0	45.1			2926.8
CRAYFISH FMN YELLOW													
22	968.0	828.0	D	1.0	390.0	392.8	392.8	313.2			2643.7	2655.3	
									104.0	34.0			3058.8
21	1072.0	932.0	D	1.0	424.0	426.8	426.8	347.2			2684.3	2697.5	
									90.0	28.7			3135.9
19	1162.0	1022.0	D	1.0	453.0	455.8							
20	1162.0	1022.0	D	1.0	452.5	455.3	455.5	375.9			2718.8	2733.4	
									149.0	37.8			3941.8
18	1311.0	1171.0	D	1.0	490.5	493.3	493.3	413.7			2830.6	2865.1	
									45.0	11.5			3913.0
17	1356.0	1216.0	D	1.0	502.0	504.8	504.8	425.2			2859.8	2898.4	

VELSEIS PTY LTD

WELL SURVEY CALCULATIONS Page 2

Company : GEOLOGICAL SURVEY OF VICTORIA
Well : MOCAMBORA #1
Elevations : Datum : 0.0 Ground : 140.0 Kelly : 140.0
Shot data : Location Elevation Offset

Location	Elevation	Offset
A	139.7	7.0
B	139.7	14.0
C	139.7	21.0
D	138.5	19.0

Latitude : 037 45 11
Longitude : 141 30 02
Rig identification :
Energy source : AN60
Logger : BPB V1030
Near surface velocity for shot statics: 884
Instrument delay: 4.0 ms

Survey date : 12-SEP-90
Survey units : METRES
Times in milliseconds.

SHOT CALCULATIONS

Shot No	Geophone depth Kelly	Geophone depth Datum	Shot Locn	Shot Depth	TIMES Record	TIMES Corr.	TIMES Avg.	TIMES Below datum	Check shot interval Distance	Check shot interval Time	Velocities Average	Velocities RMS	Velocities Interval
17	1356.0	1216.0	D	1.0	502.0	504.8	504.8	425.2			2859.8	2898.4	
PRE CRETACEOUS BMENT									18.0	3.5			5142.9
11	1374.0	1234.0	D	1.0	493.0	495.8 N/U							
16	1374.0	1234.0	D	1.0	505.5	508.3	508.3	428.7			2878.5	2923.7	
									9.5	2.0			4750.0
15	1383.5	1243.5	D	1.0	507.5	510.3	510.3	430.7			2887.2	2934.8	
									32.0	6.0			5333.4
14	1415.5	1275.5	D	1.0	513.5	516.3	516.3	436.7			2920.8	2980.9	

VELSEIS PTY LTD

WELL SURVEY CALCULATIONS

Page

ıpany : GEOLOGICAL SURVEY OF VICTORIA
Well : MOCAMBORA #1
Elevations : Datum : 0.0 Ground : 140.0 Kelly : 140.0

Latitude : 37 45 11
Longitude : 141 30 02

Survey date : 12-SEP-90
Survey units : METRES
Times in milliseconds.

SONIC DRIFT

Geophone depth Kelly	---- Datum	Check shot times Average	- Below datum	Check shot interval Distance	-- Time	Sonic Int. time	Interval usec/m	sonic drift --- msec	Cumulative drift msec
DATUM									
140.0	0.0	79.6	0.0						
				10.0	4.6	4.9	-30.00	-0.3	-0.3
150.0	10.0	84.2	4.6						
				174.0	72.9	74.4	-8.62	-1.5	-1.8
324.0	184.0	157.1	77.5						
				62.0	26.5	23.1	54.84	3.4	1.6
386.0	246.0	183.6	104.0						
				47.0	19.0	17.6	29.79	1.4	3.0
433.0	293.0	202.6	123.0						
				94.5	35.6	33.5	22.22	2.1	5.1
527.5	387.5	238.2	158.6						
				72.5	28.5	24.2	59.31	4.3	9.4
CRAYFISH FMN BLUE									
600.0	460.0	266.7	187.1						
				98.5	35.0	31.9	31.47	3.1	12.5
698.5	558.5	301.7	222.1						
				77.0	25.5	24.7	10.39	0.8	13.3
775.5	635.5	327.2	247.6						
				60.5	20.5	18.6	31.41	1.9	15.2
836.0	696.0	347.7	268.1						
				132.0	45.1	39.9	39.39	5.2	20.4
CRAYFISH FMN YELLOW									
968.0	828.0	392.8	313.2						
				104.0	34.0	29.9	39.42	4.1	24.5
1072.0	932.0	426.8	347.2						
				90.0	28.7	26.8	21.11	1.9	26.4
1162.0	1022.0	455.5	375.9						
				149.0	37.8	39.1	-8.72	-1.3	25.1
1311.0	1171.0	493.3	413.7						
				45.0	11.5	12.0	-11.11	-0.5	24.6
1356.0	1216.0	504.8	425.2						
				18.0	3.5	4.5	-55.56	-1.0	23.6
PRE CRETACEOUS BMENT									
1374.0	1234.0	508.3	428.7						
				9.5	2.0	2.1	-10.53	-0.1	23.5
1383.5	1243.5	510.3	430.7						
				32.0	6.0	6.2	-6.25	-0.2	23.3
1415.5	1275.5	516.3	436.7						

mpany : GEOLOGICAL SURVEY OF VICTORI
Well : MOCAMBORA #1
Elevations : Datum : 0.0 Ground : 140.0 Kelly : 140.0

Latitude : 037 4 1
Longitude : 141 30 02

Survey date : 12-SE
Survey units : METRES
Times in milliseconds.

SONIC CALIBRATION

	Geophone depth Kelly	Datum	Interval Distance	Original sonic times Interval	Cumulative	Adjusted sonic times Interval	Calibrated	Velocities Average	RMS	Interval
DATUM										
	140.0	0.0								
			10.0	4.9		4.6				2173.9
	150.0	10.0			4.9		4.6	2173.9	2173.9	
			174.0	74.4		72.9				2386.8
	324.0	184.0			79.3		77.5	2374.2	2374.7	
			42.0	16.0		18.3				2294.7
HEATHFIELD SAND MBR	366.0	226.0			95.3		95.8	2359.0	2359.6	
			6.0	2.1		2.4				2470.1
EUMERALLA	372.0	232.0			97.4		98.2	2361.7	2362.4	
			14.0	5.0		5.8				2427.3
	386.0	246.0			102.4		104.0	2365.4	2366.1	
			47.0	17.6		19.0				2473.7
	433.0	293.0			120.0		123.0	2382.1	2383.0	
			94.5	33.5		35.6				2654.5
	527.5	387.5			153.5		158.6	2443.3	2446.6	
			72.5	24.2		28.5				2543.9
CRAYFISH FMN BLUE	600.0	460.0			177.7		187.1	2458.6	2461.6	
			98.5	31.9		35.0				2814.3
	698.5	558.5			209.6		222.1	2514.6	2520.5	
			77.0	24.7		25.5				3019.6
	775.5	635.5			234.3		247.6	2566.6	2576.4	
			60.5	18.6		20.5				2951.2
	836.0	696.0			252.9		268.1	2596.0	2606.9	
			132.0	39.9		45.1				2926.8
CRAYFISH FMN YELLOW	968.0	828.0			292.8		313.2	2643.7	2655.4	
			104.0	29.9		34.0				3058.8
	1072.0	932.0			322.7		347.2	2684.3	2697.5	
			90.0	26.8		28.7				3135.9
	1162.0	1022.0			349.5		375.9	2718.8	2733.5	
			149.0	39.1		37.8				3941.8
	1311.0	1171.0			388.6		413.7	2830.6	2865.1	
			45.0	12.0		11.5				3913.0
	1356.0	1216.0			400.6		425.2	2859.8	2898.5	
			18.0	4.5		3.5				5142.9
PRE CRETACEOUS BMENT	1374.0	1234.0			405.1		428.7	2878.5	2923.8	
			9.5	2.1		2.0				4750.0
	1383.5	1243.5			407.2		430.7	2887.2	2934.9	
			32.0	6.2		6.0				5333.4
	1415.5	1275.5			413.4		436.7	2920.8	2980.9	

APPENDIX 7

APPENDIX
7

GEOCHEMISTRY REPORT

AMDEL
CORE
SERVICES

12 July 1991

Department of Mines Industry
and Development
PO Box 173
EAST MELBOURNE VIC 3002

Attention: John Leonard (Basin Studies Manager)

REPORT: 009/825

CLIENT REFERENCE:	Fax from Tabassi and Associates 11/2/91
MATERIAL:	SWC, Core and Cuttings
LOCALITY:	Mocamboro-11
WORK REQUIRED:	Geochemistry

Please direct technical enquiries regarding this work to the signatory below under whose supervision the work was carried out.

for

BRIAN L WATSON
Laboratory Supervisor
on behalf of Amdel Core Services Pty Ltd

1. INTRODUCTION

Core, sidewall core and cuttings samples from Mocamboro-11 were received for geochemical analyses with the following aims:

- to determine the maturity, source richness and source quality of the shales and siltstones intersected in this location
- to isolate migrated hydrocarbons from sandstone units intersected in this well and determine the source affinity and maturity of these oils
- to determine whether the oils isolated from the sandstones in this location were generated "in situ" or alternatively migrated from a distant source.

This report is a formal presentation of results reported by facsimile as analyses were completed and includes an interpretation of the complete data set.

2. ANALYTICAL PROCEDURES

Analytical procedures used in this study are presented in Appendix 1 of this report.

3. RESULTS

TOC and Rock-Eval pyrolysis data are presented in Table 1. Figure 1 is a plot of Hydrogen Index versus T_{max} illustrating kerogen Type and maturity. Table 2 is a summary of the Vitrinite Reflectance determinations. This data is presented graphically in Figure 2. Histogram plots of this data are presented in Appendix 2.

Extract Yield, Bulk Composition and Alkane Ratios calculated from chromatograms of the C_{12}+ saturated (aliphatic) hydrocarbons are presented in Table 3. Figures 3-8 are gas chromatograms of the saturated hydrocarbons isolated from the extracted residual oils.

Aromatic maturity ratios and calculated equivalent Vitrinite Reflectance determinations are presented in Table 4. Mass Fragmentograms of the aromatic hydrocarbons are included as Figures 10-14.

4. INTERPRETATION

4.1 SOURCE ROCK GEOCHEMISTRY

4.1.1 Maturity

Vitrinite Reflectance determinations (Table 2, Figure 2) indicate that the sediments intersected in this location have maturities ranging from immature to marginally mature. This data indicates that the sedimentary sequence is sufficiently mature for the generation of:

- light oil/condensate from sediments rich in resinite and bituminite below approximately 800 metres depth (VR threshold = 0.45%)

- significant gas generation below approximately 1600 metres depth (VR ≥0.6%)

- oil from sediments rich in exinites other than resinite and bituminte below approximately 2100 metres depth (VR ≥0.7%)

Rock-Eval Hydrogen Index and T_{max} data indicate maturities which are quite consistent with the maturities indicated by the measured Vitrinite Reflectance data. However, the Rock-Eval maturity data is somewhat more erratic.

Rock-Eval Production Indices are also maturation dependent. However, production indices >0.2 indicate that the following samples contain migrated hydrocarbons:

Depth (m)	Production Index
350	0.25
861	0.35
933	0.21

It should be noted here that the Production Index of the sample from 350 metres depth may not be reliable due to the small size of the S_1 and S_2 peaks from which it is calculated.

Residual oil was identified optically in sidewall cores from 626.0, 667.5 and 792.0 metres depth (Appendix 2).

4.1.2 Source Richness

Source richness for the generation of hydrocarbons is generally poor ($S_1 + S_2$ = 0.13-0.90 kg of hydrocarbons/tonne) in the samples analysed. However, two samples (426-429 and 626 metres depth) have $S_1 + S_2$ values which are indicative of excellent source richness ($S_1 + S_2$ = 79.99 and 36.88 kg of hydrocarbons/tonne respectively). These two samples also have excellent organic richness (TOC = 35.00 and 16.50%). Organic richness is uniformly poor in remaining samples examined (TOC = 0.18-1.03%).

4.1.3 Kerogen Type and Source Quality

Rock-Eval Hydrogen Index and T_{max} data (Table 1, Figure 1) indicates that the majority of the samples examined contain organic matter which has bulk compositions ranging from Type III to Type IV kerogen. However, the two organic rich samples (426-429 and 626 metres depth) contain organic matter which has the bulk composition of Type II-III kerogen. Organic Petrology of these two samples (Appendix 2) illustrates that they contain organic matter which consists largely of vitrinite, with moderate amounts of exinite (sporinite, cutinite, resinite and bituminite) and lesser amounts of inertinite.

4.2 OIL CHEMISTRY

4.2.1 Genetic Affinity

The terrestrial source affinity of the oils extracted from the sandstone core and sidewall core from Mocamboro-11 is evident from the pristane/n-heptadecane, phytane/n-octadecane ratios (Table 3, Figure 9) and alkane distribution. However, these pristane/n-heptadecane and phytane/n-octadecane ratios are also influenced by biodegradation. Biodegradation removes normal alkanes in preference to branched alkanes and cycloalkanes which causes both of these ratios to increase (Figure 9). This biodegradation has had a more pronounced effect on the pristane/n-heptadecane ratios than on the phytane/n-octadecane ratios. The high abundance of C_{25}+ alkanes is also typical of oil generated from terrestrial organic matter.

Pristane/phytane ratios range from 2.01-4.03 in these oils but generally lie within the range of 2.01-2.85. These values indicate that the source of these oils was deposited in slightly oxic conditions. Oxic conditions typically occur in terrestrial environments of deposition.

GC-MS of cycloalkanes (naphthenes) were not performed on these oils due to their degree of biodegradation.

4.2.2 Oil Maturity

Aromatic maturity ratios (Table 4) indicate the residual oils present in the three cores examined from the 1289.6-1317 metres depth interval are generated and expulsed at essentially the same maturity (VR_{calc} = 0.98-1.05%; Boreham et al calculation).

This maturity is significantly higher than that of the sedimentary sequence intersected in this location and indicates this oil has not been generated in situ. The available information suggests that this oil was generated either at depth in this location (between approximately 3100-3700 metres depth using an extrapolation of the measured Vitrinite Reflectance versus depth curve) or alternatively from a more mature part of the basin.

The isomerisation reactions influencing the abundance of the methyl phenanthrene isomers and phenanthrene abundance has been found to be influenced by clay catalysis and is not purely a thermally dependent reaction.

These recent findings indicate that the MPI derived maturity is not as precise a measure of maturity of the oil source at the time of primary migration as was previously believed. However, the lack of any noticeable odd-over-even carbon number preference is consistent with the maturity calculated from the aromatic maturity ratios (VR_{calc} = 0.98-1.05%).

Pristane/n-heptadecane and phytane/n-octadecane ratios are also maturation dependent but have been altered by the biodegradation of these oils. These ratios cannot be used as indicators of maturation levels for the oils reservoired in this location.

TABLE 1

AMDEL CORE SERVICES

Rock-Eval Pyrolysis 15/03/91

Client: Tabassi & Associates Pty.Ltd

Well: Mocamboro-11

Depth	T Max	S1	S2	S3	S1+S2	PI	S2/S3	PC	TOC	HI	OI
159									0.35		
260	398	0.07	0.46	0.40	0.53	0.13	1.15	0.04	0.83	55	48
307.5-313	277	0.01	0.12	0.34	0.13	0.08	0.35	0.01	0.54	22	62
350	275	0.05	0.16	0.39	0.21	0.25	0.41	0.01	0.50	32	78
400	377	0.09	0.46	0.36	0.55	0.17	1.27	0.04	0.69	66	52
426-429	428	1.25	78.74	7.08	79.99	0.02	11.12	6.66	35.00	224	20
465	438	0.04	0.26	0.32	0.30	0.13	0.81	0.02	0.60	43	53
500	438	0.07	0.67	0.29	0.74	0.09	2.31	0.06	0.93	72	31
550	441	0.05	0.46	0.35	0.51	0.10	1.31	0.04	0.86	53	40
582.5	439	0.06	0.64	0.30	0.70	0.09	2.13	0.05	1.03	62	29
605	439	0.06	0.44	0.35	0.50	0.12	1.25	0.04	0.75	58	46
626	438	0.55	36.33	2.61	36.88	0.01	13.91	3.07	16.50	220	15
759.3-763.3									0.30		
792	443	0.10	0.80	0.40	0.90	0.11	2.00	0.07	0.98	81	40
808									0.23		
861	438	0.14	0.27	0.48	0.41	0.35	0.56	0.03	0.44	61	109
890									0.18		
933	436	0.12	0.47	3.33	0.59	0.21	0.14	0.04	0.62	75	537

TABLE 2

SUMMARY OF VITRINITE REFLECTANCE MEASUREMENTS

MOCAMBORO-11

Depth (m)	Mean Maximum Reflectance (%)	Standard Deviation	Range	Number of Determinations
96.8 - 103.0	0.32	0.03	0.27 - 0.38	24
159.0	0.33	0.03	0.30 - 0.40	11
213.4 - 214.4	0.34	0.04	0.25 - 0.45	31
260+	0.33	0.02	0.27 - 0.36	9
307.5 - 313.4	0.38	0.01	0.36 - 0.40	6
350+	0.39	0.04	0.33 - 0.42	4
400+	0.38	0.06	0.28 - 0.51	12
426 - 429+	0.39	0.03	0.31 - 0.43	27
465+	0.41	0.03	0.36 - 0.48	9
500+	0.41	0.04	0.38 - 0.48	6
556.0	0.44	0.05	0.38 - 0.52	14
582.0	0.45	0.03	0.41 - 0.49	4
605.0	0.45	0.02	0.40 - 0.48	12
626.0	0.41	0.03	0.36 - 0.47	24
667.5	0.44	0.04	0.38 - 0.49	27
705.1 - 706.3	0.45	0.03	0.39 - 0.48	5
759.3 - 763.3	0.48	0.04	0.42 - 0.52	4
792.0	0.44	0.04	0.38 - 0.54	21
808.0	0.42	0.02	0.39 - 0.44	4
861.0	0.55	0.04	0.48 - 0.61	13
933.0	0.45	0.03	0.41 - 0.52	10
997.3 - 1000.0	0.53	0.05	0.40 - 0.60	31
1061.1 - 1066.7	0.50	0.05	0.40 - 0.58	20
1161.8 - 1166.1	0.50	0.03	0.47 - 0.54	4
1346.0	0.56	0.07	0.45 - 0.66	17

+ Cuttings samples
* Influenced by re-worked vitrinite

TABLE 3

EXTRACT YIELD C_{12+} BULK COMPOSITION AND ALKANE RATIOS OF RESIDUAL OILS

MOCAMBORO-11

Depth (m)	Extract Yield (ppm)	C_{12}+ Bulk Composition			Alkane Ratios				
		Sats	Arom	NSO + Asph (%)	Np/Pr	Pr/Ph	Pr/ $n\text{-}C_{17}$	Ph/ $n\text{-}C_{18}$	TMTD/ Pr
580.0	151.8	26.32	10.53	63.15	0.33	2.06	0.64	0.11	0.56
1198.0	36.0	16.07	16.07	67.86	0.18	2.85	0.85	0.11	0.24
1241.0	182.5	15.56	8.88	75.56	0.47	2.01	0.81	0.08	-
1289.6	97.7	38.93	15.44	45.64	0.13	2.48	1.27	0.35	0.08
1304.5	800.6	14.62	13.68	71.70	0.28	2.40	1.56	0.21	0.36
1317.0	6048.8	5.46	17.73	76.81	0.38	4.03	3.26	0.56	0.72

Sats = saturated hydrocarbons
Arom = aromatic hydrocarbons
NSO = compounds containing nitrogen sulphur and oxygen
Asph = asphaltenes

TMTD = trimethyltridecane
Np = norpristane
Pr = pristane
Ph = phytane
$n\text{-}C_{17}$ = n-heptadecane
$n\text{-}C_{18}$ = n-octadecane

TABLE 4

TABLE 1: AROMATIC MATURITY DATA

SAMPLE	MPI	MPR	DNR	MPDF	VR CALC					
					A	B	C	D	E	F
MOCAMBORO-11										
1289.6 m	1.183	1.421	1.389	0.513	1.11	1.59	1.09	1.53	1.05	0.98
1304 m	1.154	1.250	1.640	0.502	1.09	1.61	1.04	1.64	1.03	0.96
1317 m	1.085	1.213	1.569	0.497	1.05	1.65	1.02	1.61	0.98	0.95

KEY TO AROMATIC MATURITY INDICATORS

Methylphenanthrene index (MPI), methylphenanthrene ratio (MPR), dimethylnaphthalene ratio (DNR) and calculated vitrinite reflectance (VR_{calc}) are derived from the following equations (after Radke and Welte, 1983; Radke *et al.*, 1984):

$$MPI = \frac{1.5\ (2\text{-}MP + 3\text{-}MP)}{P + 1\text{-}MP + 9\text{-}MP}$$

VR_{calc} (a) = 0.6 MPI + 0.4 (for VR < 1.35%)

VR_{calc} (b) = -0.6 MPI + 2.3 (for VR > 1.35%)

$$MPR = \frac{2\text{-}MP}{1\text{-}MP}$$

VR_{calc} (c) = 0.99 $\log_{10}$ MPR + 0.94 (VR = 0.5-1.7%)

$$DNR = \frac{2{,}6\text{-}DMN + 2{,}7\text{-}DMN}{1{,}5\text{-}DMN}$$

VR_{calc} (d) = 0.046 DNR + 0.89 (for VR = 0.9-1.5%)

Where

P	=	phenanthrene
1-MP	=	1-methylphenanthrene
2-MP	=	2-methylphenanthrene
3-MP	=	3-methylphenanthrene
9-MP	=	9-methylphenanthrene
1,5-DMN	=	1,5-dimethylnaphthalene
2,6-DMN	=	2,6-dimethylnaphthalene
2,7-DMN	=	2,7-dimethylnaphthalene

Peak areas measured from m/z 156 (dimethylnaphthalene), m/z 178 (phenanthrene) and m/z 192 (methylphenanthrene) mass fragmentograms of diaromatic and triaromatic hydrocarbon fraction isolated by thin layer chromatography.

Recalibration of the methylphanthrene index using data from a suite of Australian coals has given rise to another equation for calculated vitrinite reflectance (after Boreham *et al.*, 1988):

VR_{calc} (e) = 0.7 MPI + 0.22 (for VR < 1.7%)

The methylphenanthrene distribution ratio (MPDF) and calculated vitrinite reflectance VR_{calc} (f) is derived from the following equation (after Kvalheim *et al.*, 1987):

$$MPDF = \frac{(2\text{-}MP + 3\text{-}MP)}{(2\text{-}MP + 3\text{-}MP + 1\text{-}MP + 9\text{-}MP)}$$

VR_{calc} (f) = -0.166 + 2.242 MPDF

FIGURE 1

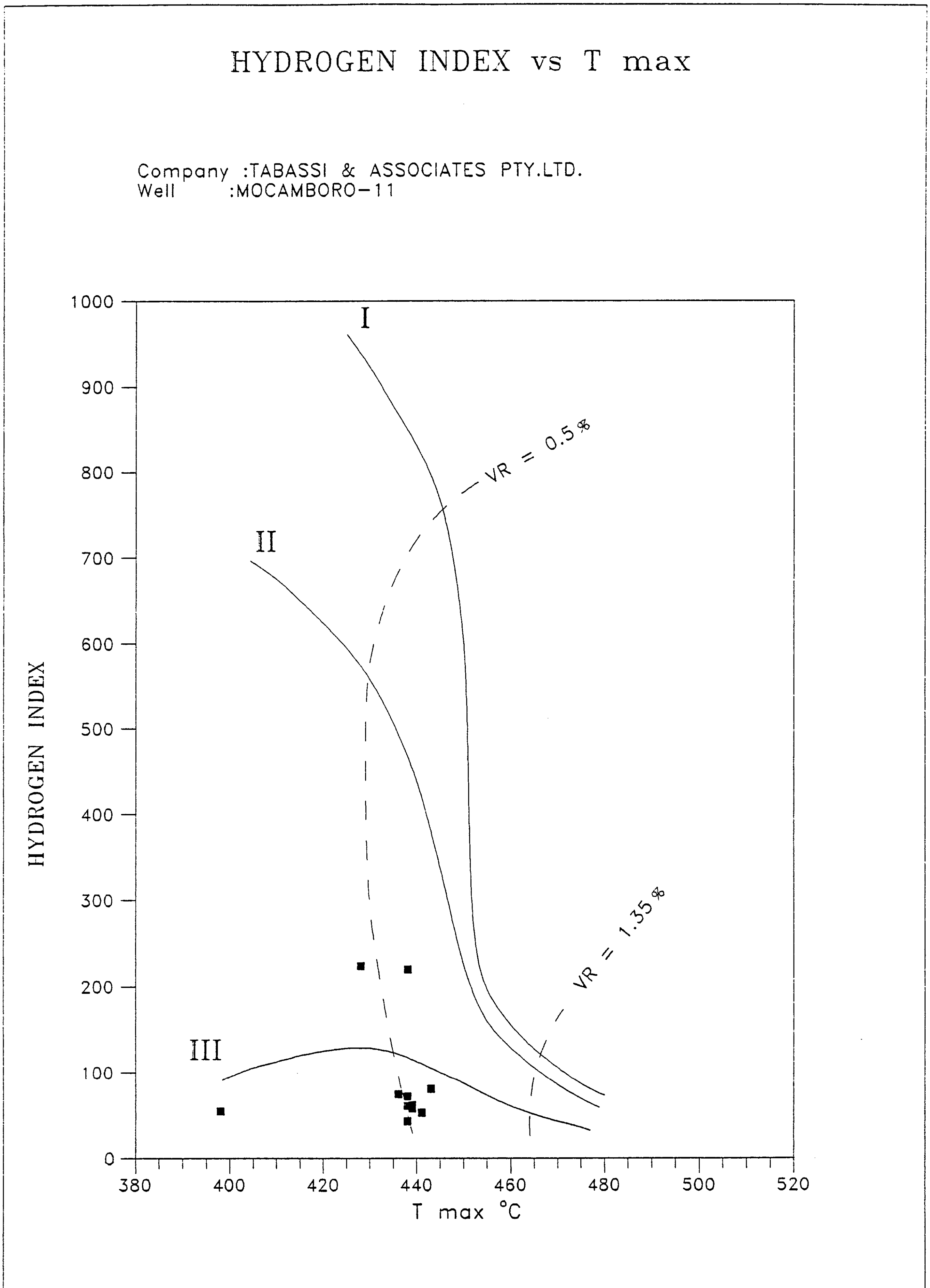
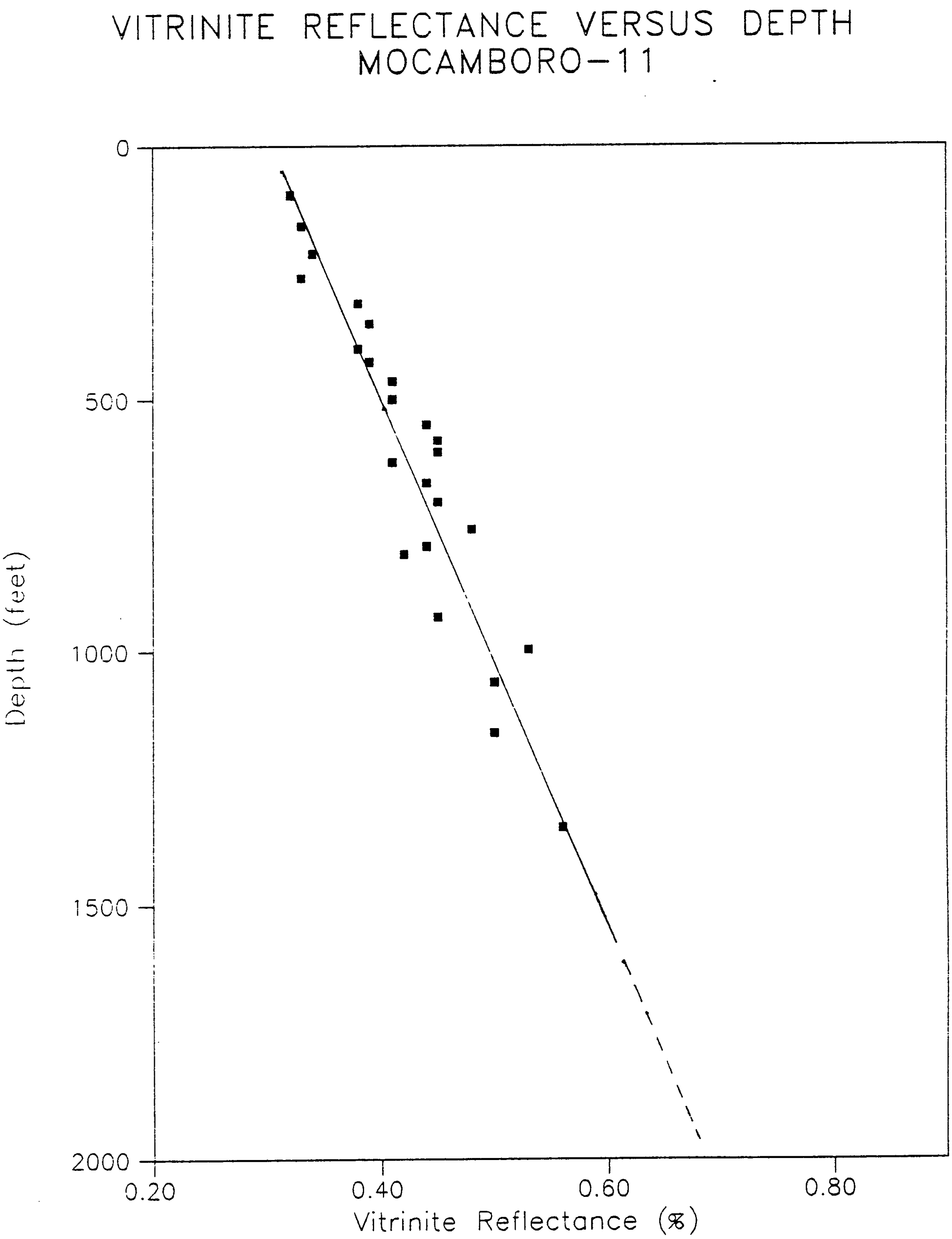

HYDROGEN INDEX vs T max
Company :TABASSI & ASSOCIATES PTY.LTD.
Well :MOCAMBORO-11
HYDROGEN INDEX
T max °C
I
II
III
VR = 0.5%
VR = 1.35%
1000
900
800
700
600
500
400
300
200
100
0
380
400
420
440
460
480
500
520

FIGURE 2



VR ≈ 1.0 at 3500 m depth

FIGURE 3

SATURATES GC

MOCAMBORO-11

SWC #39

580.0 m

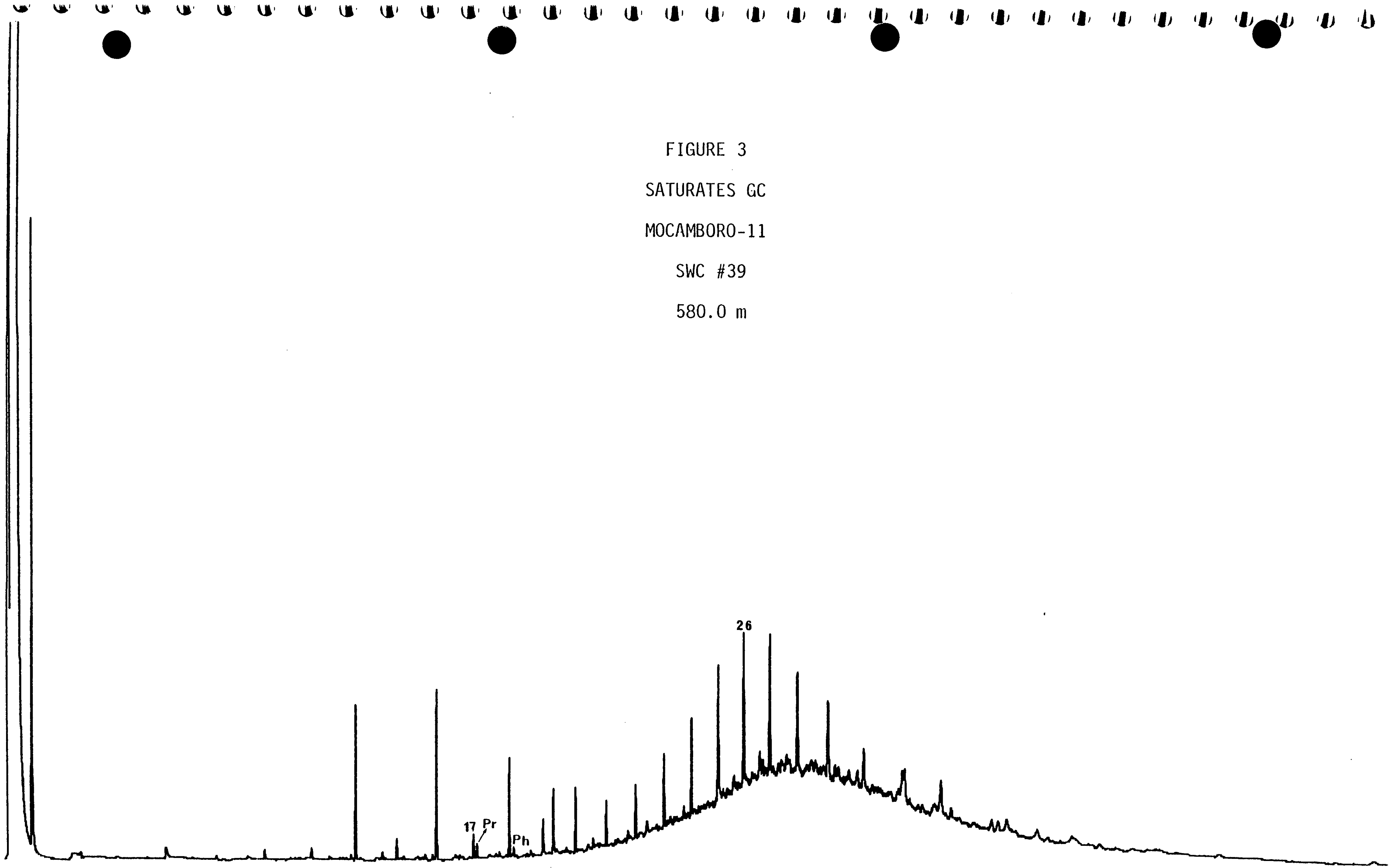


FIGURE 4

SATURATES GC

MOCAMBORO-11

CORE #32

1198.0 - 1166.1 m

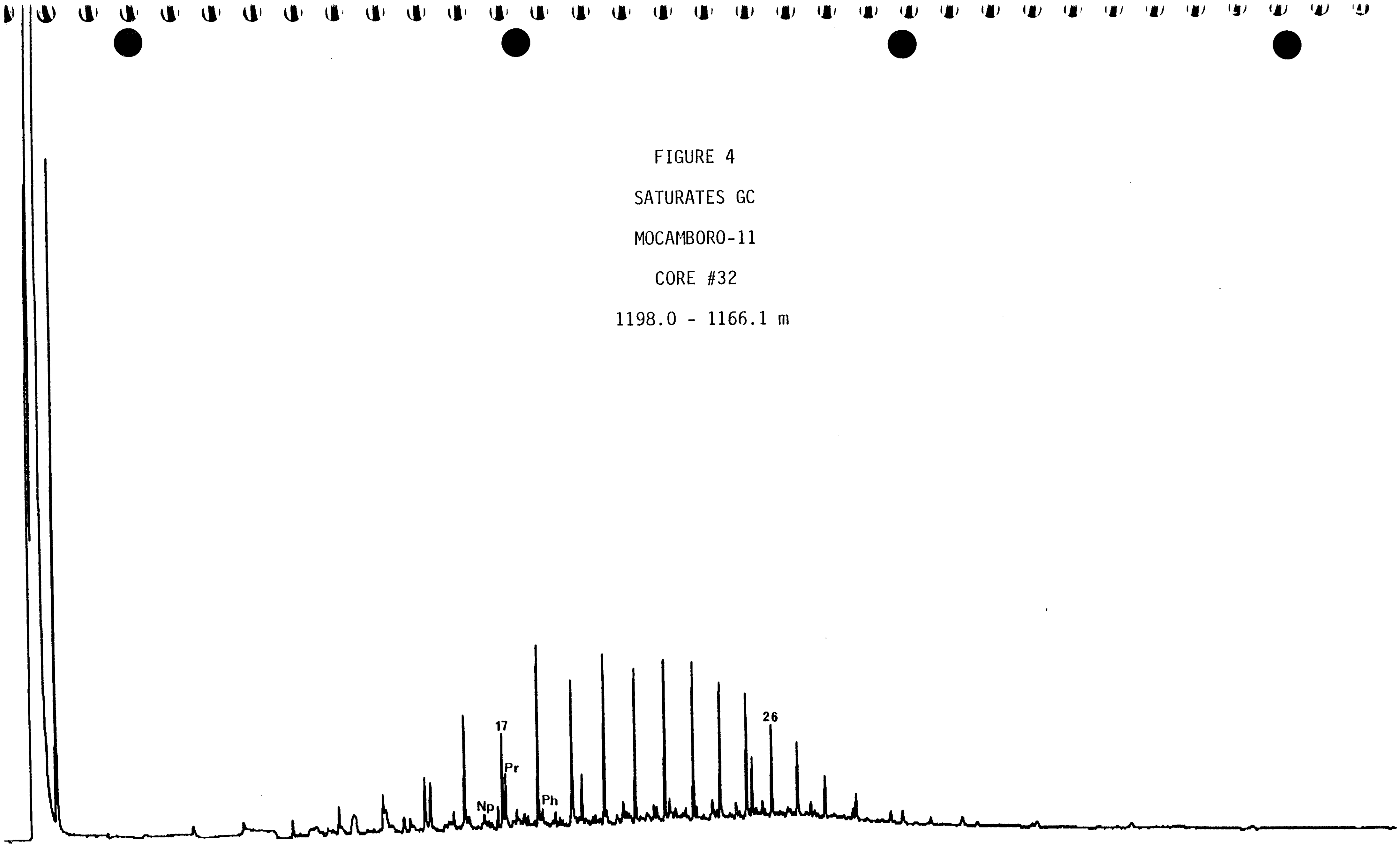


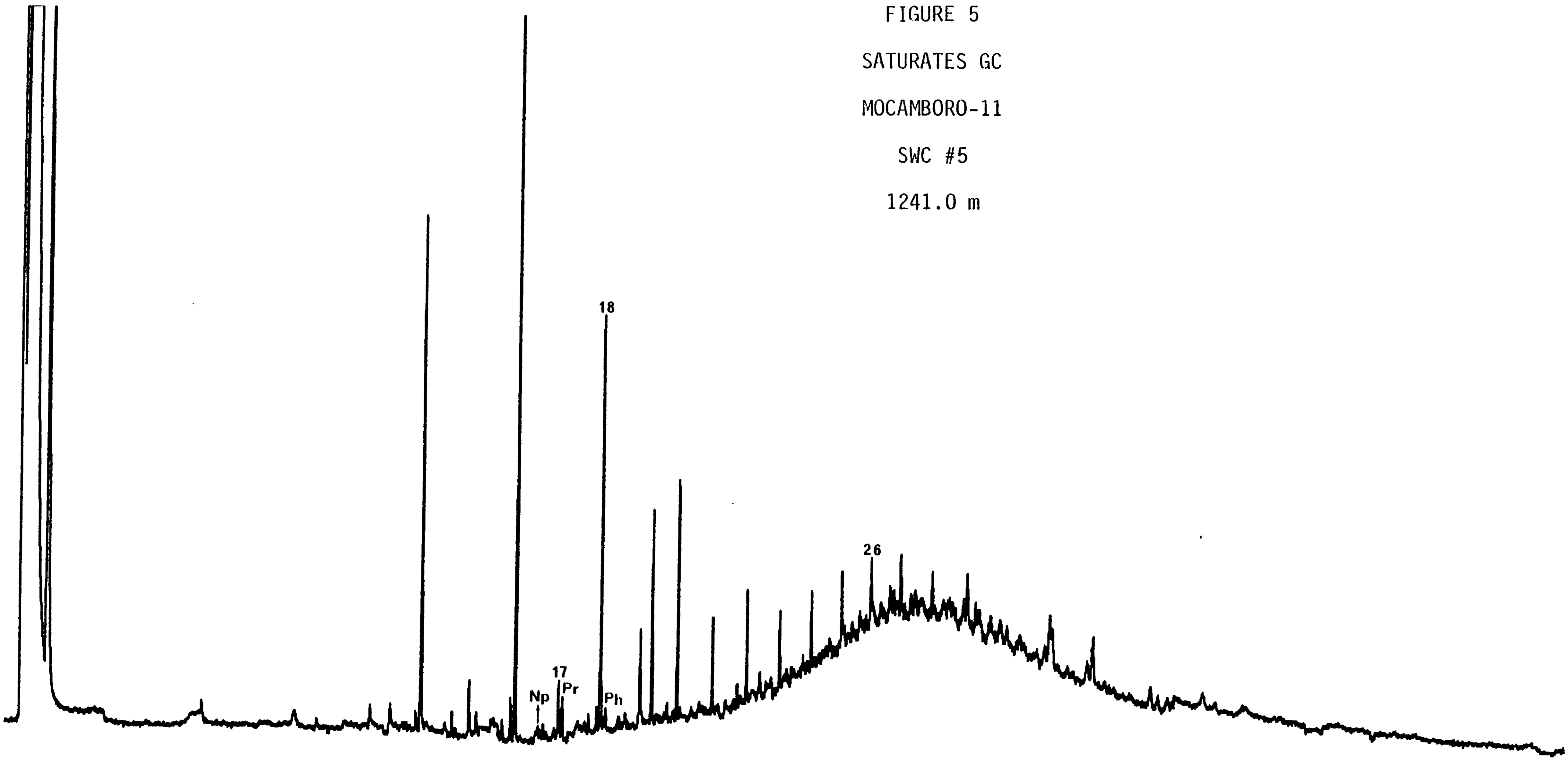
FIGURE 5

SATURATES GC

MOCAMBORO-11

SWC #5

1241.0 m



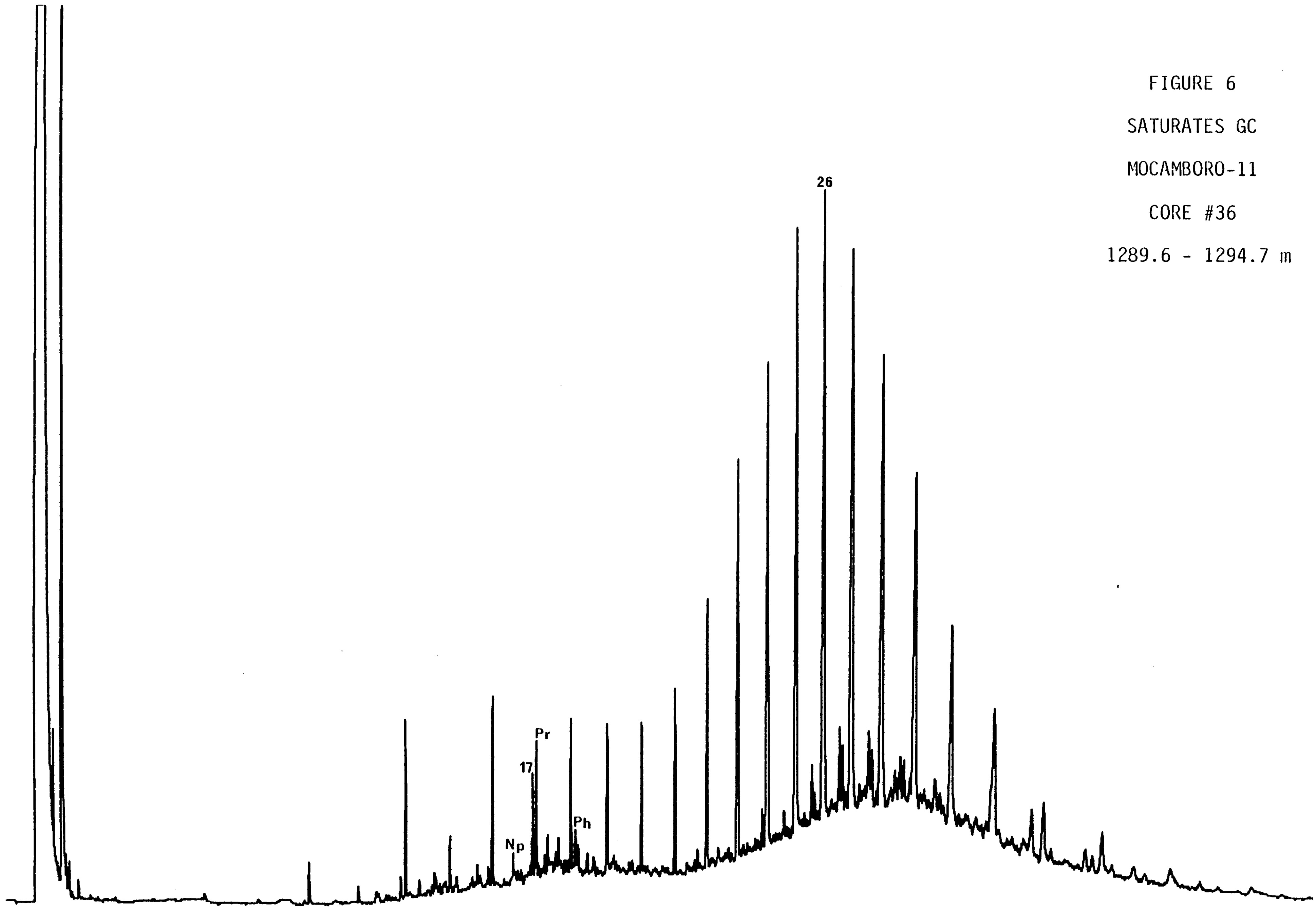


FIGURE 6

SATURATES GC

MOCAMBORO-11

CORE #36

1289.6 - 1294.7 m

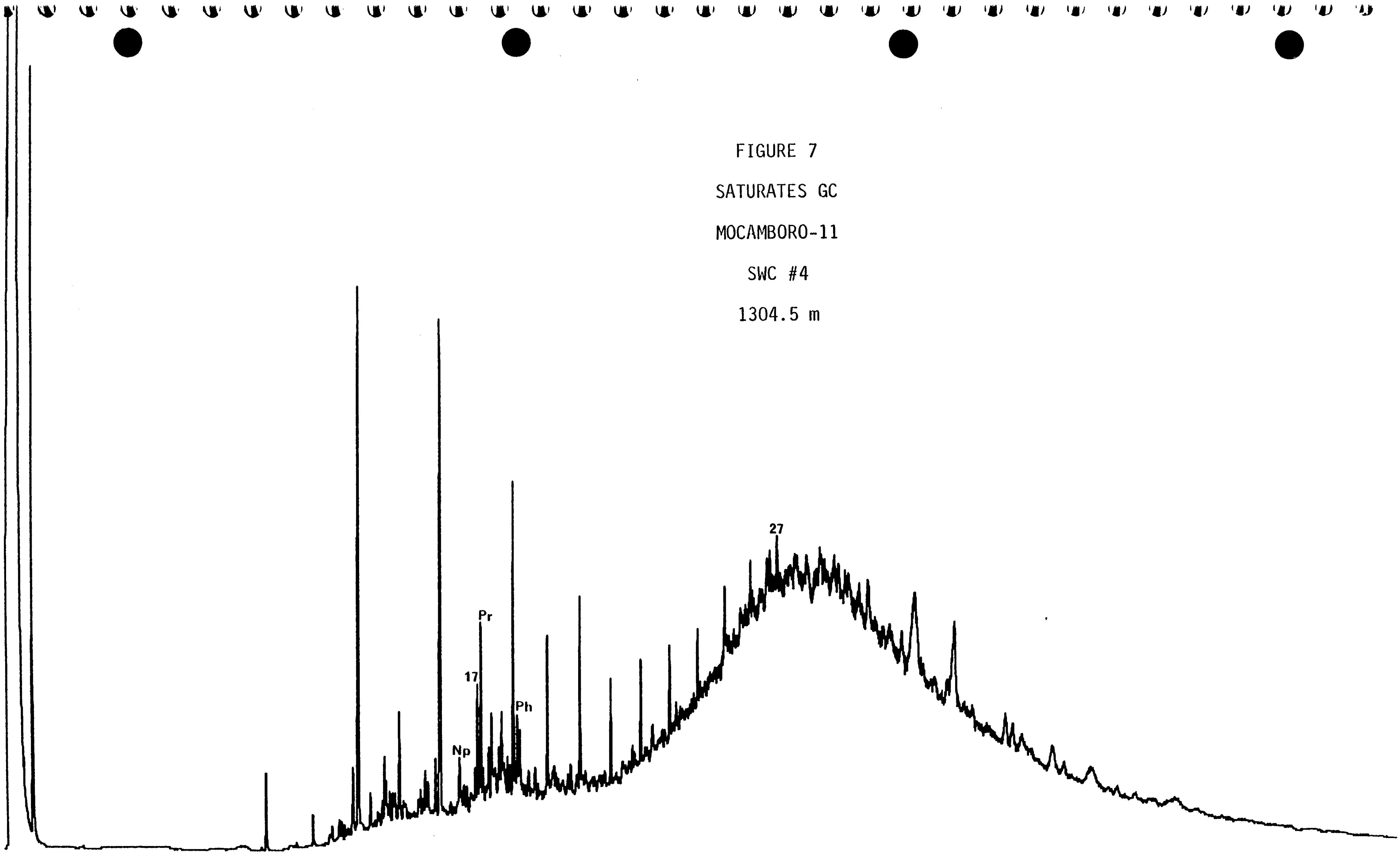
FIGURE 7

SATURATES GC

MOCAMBORO-11

SWC #4

1304.5 m



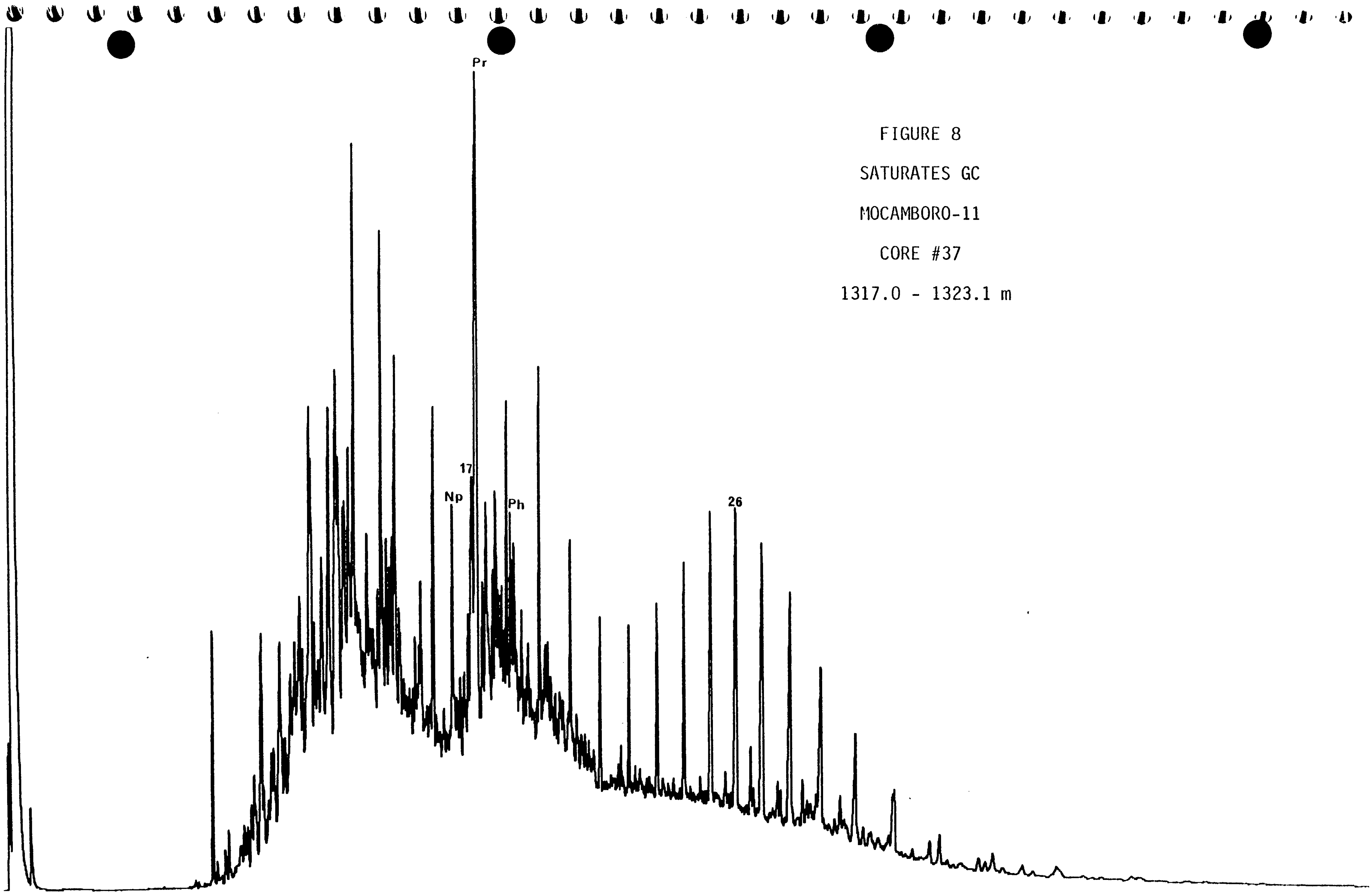


FIGURE 8

SATURATES GC

MOCAMBORO-11

CORE #37

1317.0 - 1323.1 m

FIGURE 9

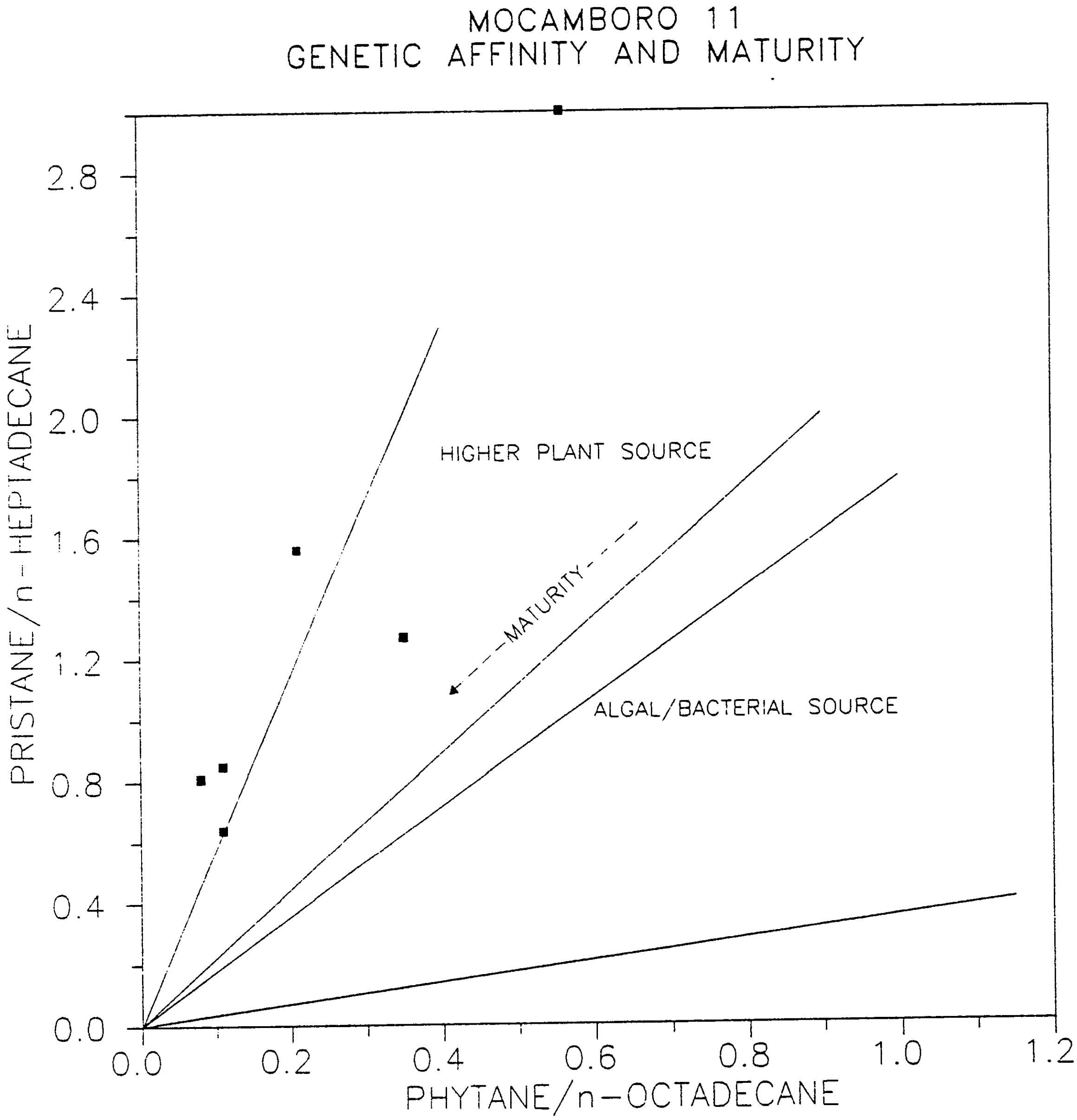

MOCAMBORO 11
GENETIC AFFINITY AND MATURITY
HIGHER PLANT SOURCE
MATURITY
ALGAL/BACTERIAL SOURCE
PRISTANE/n-HEPTADECANE
PHYTANE/n-OCTADECANE
0.0
0.4
0.8
1.2
1.6
2.0
2.4
2.8
0.0
0.2
0.4
0.6
0.8
1.0
1.2

FIGURE 10
PHENANTHRENE AND METHYLPHENANTHRENES
1289.6 m

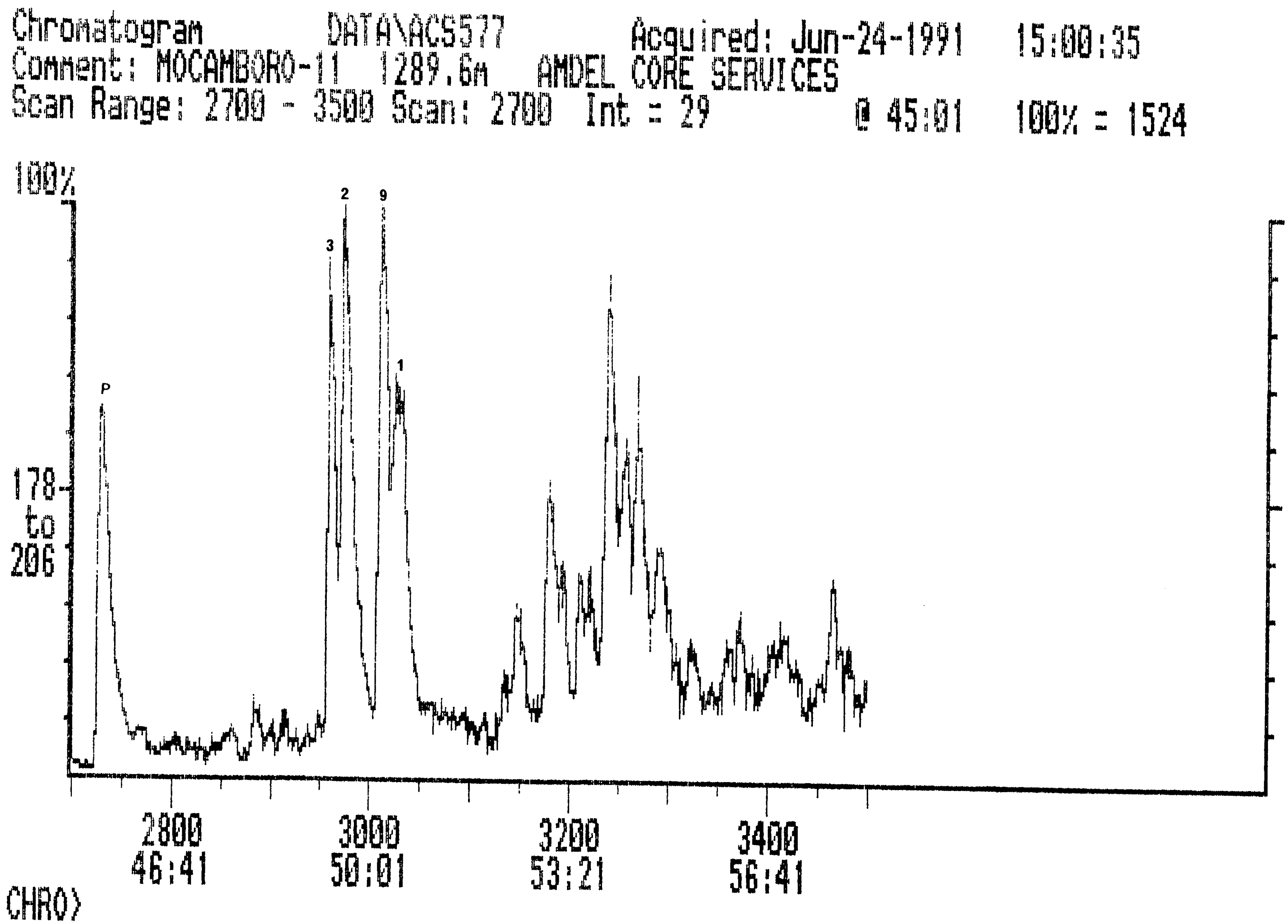


FIGURE 11
DI- AND TRIMETHYLNAPHTHALENES
1289.6 m

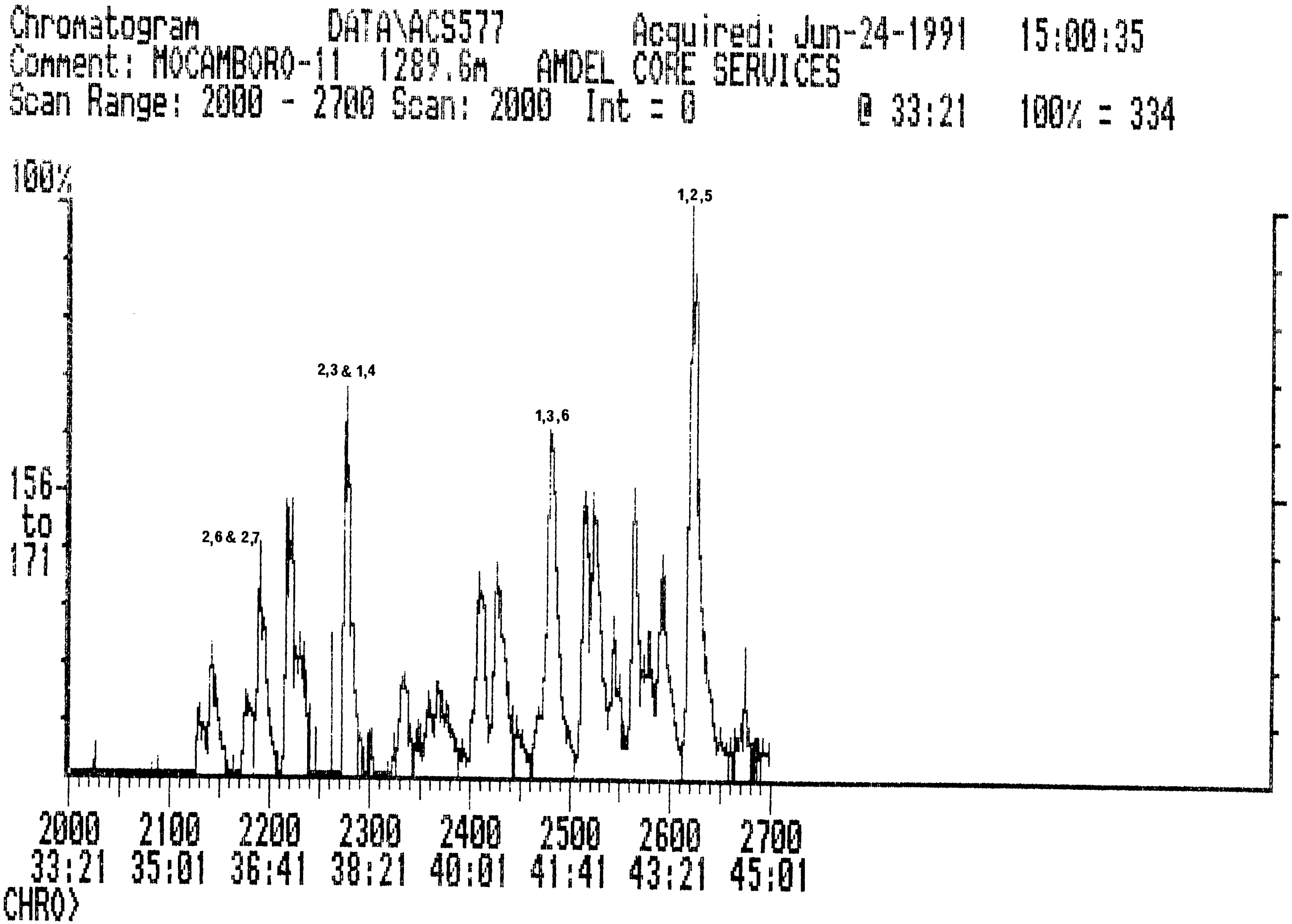


FIGURE 12
PHENANTHRENE AND METHYLPHENANTHRENES
1304 m

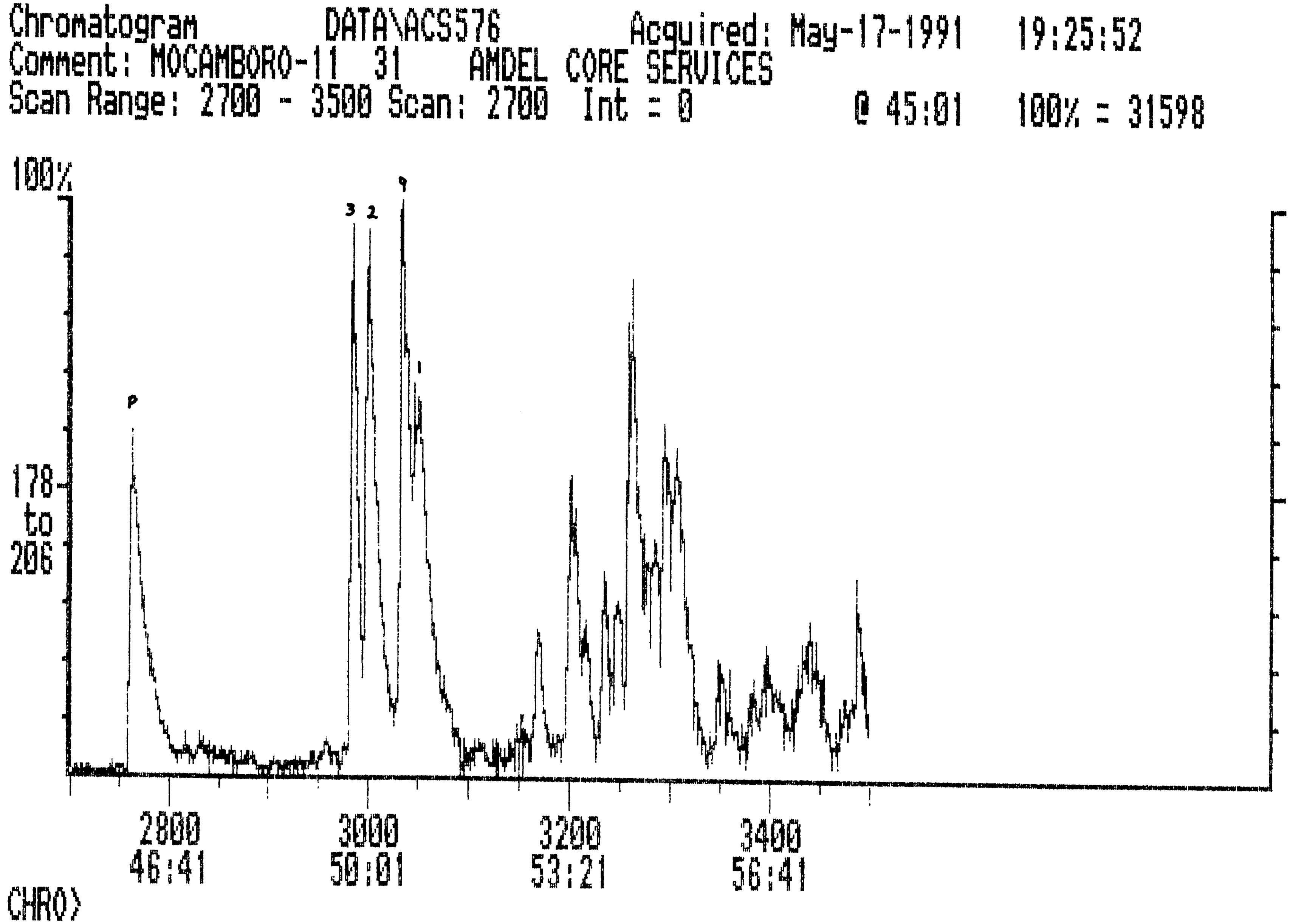


FIGURE 13
P[illegible]NANTHRENE AND METHYLPHENANTHRENE
1317 m

Chromatogram DATA\ACS575 Acquired: May-17-1991 18:02:31
Comment: MOCAMBORO-11 1317 m AMDEL CORE SERVICES
Scan Range: 2700 - 3500 Scan: 2700 Int = 1462 @ 45:01 100% = 135171

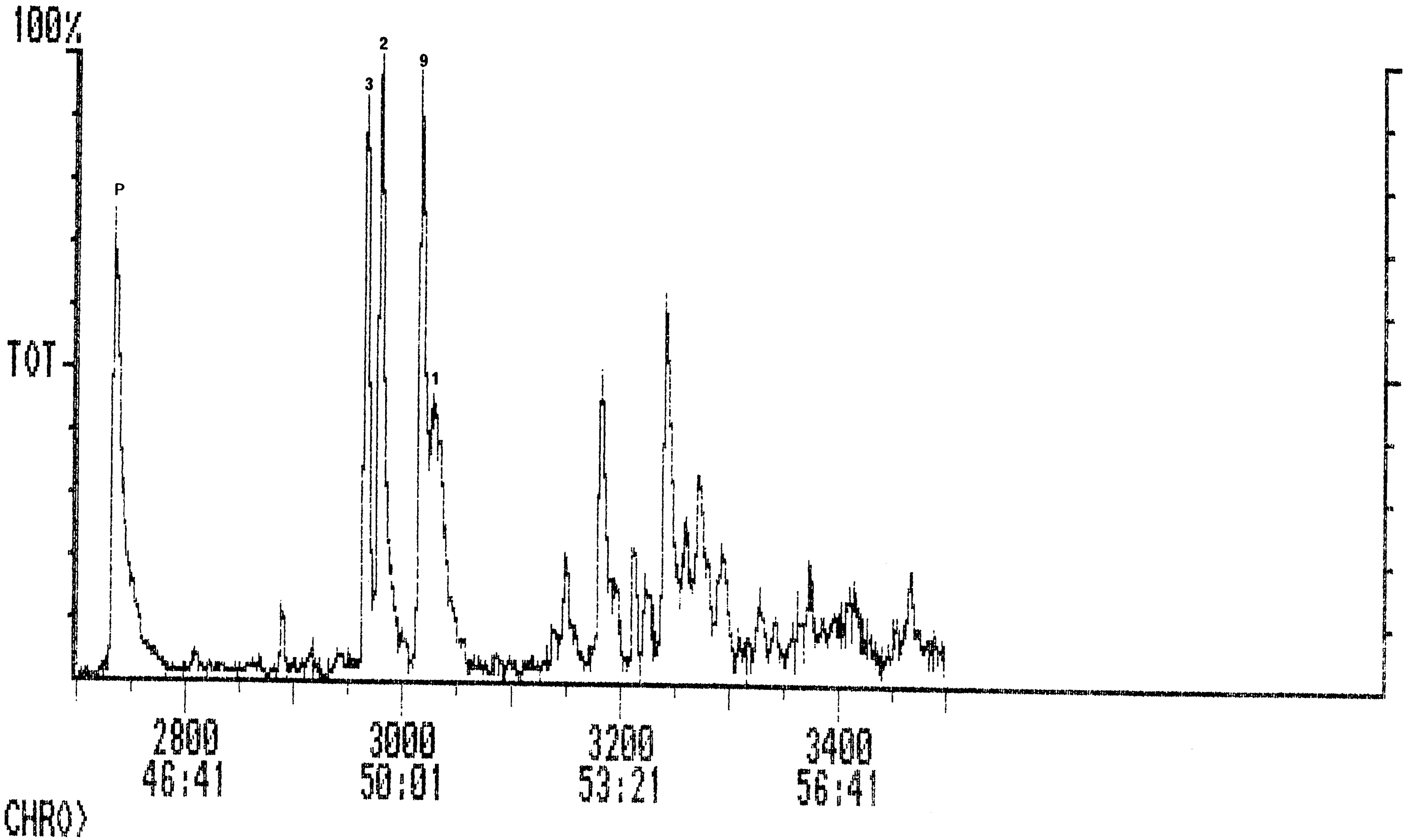
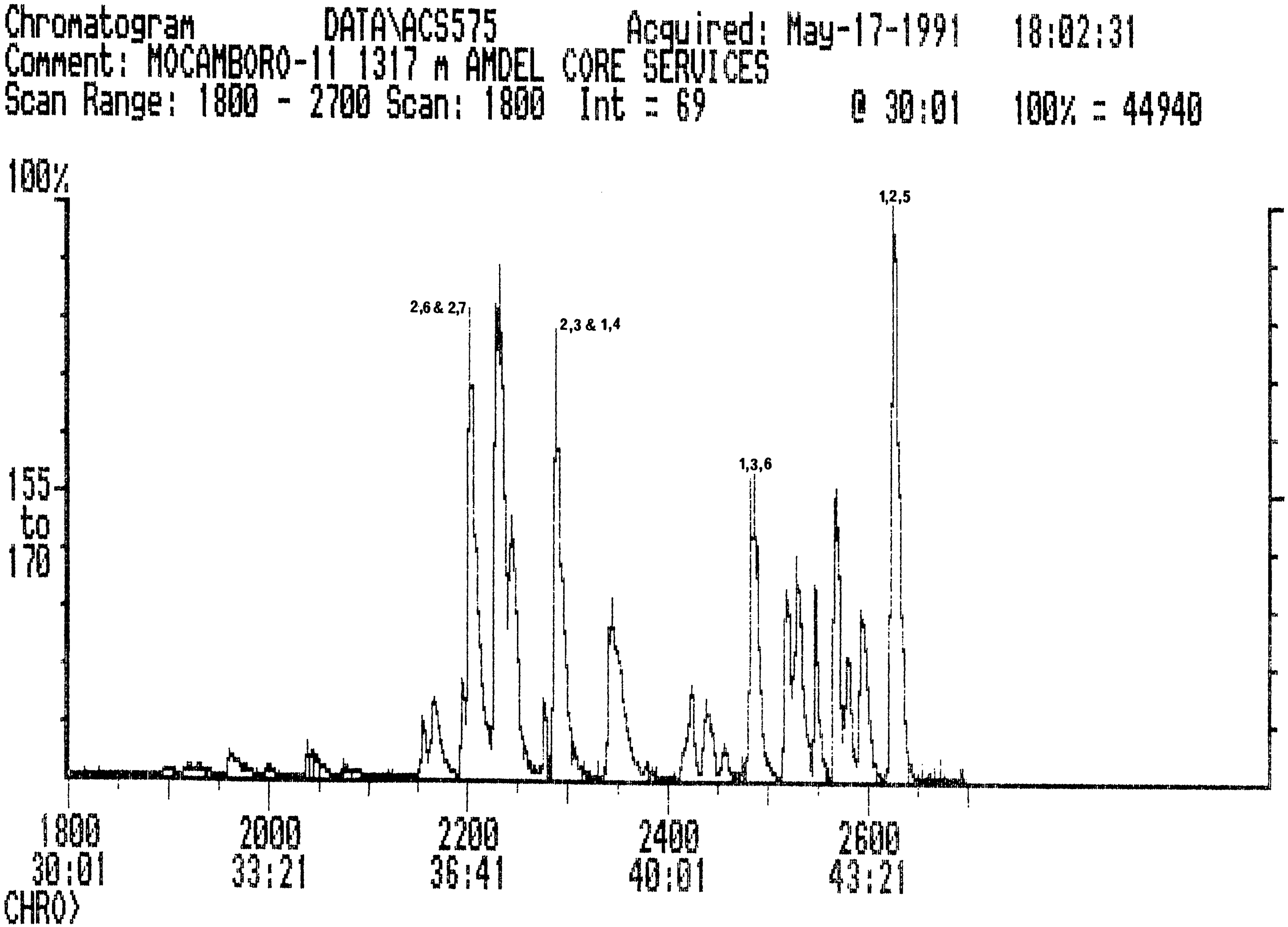


FIGURE 14
DI- AND TRIMETHYLNAPHTHALENES
1317 m



APPENDIX 1

ANALYTICAL METHODS

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±1°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.

4. Liquid Chromatography

Asphaltenes were not precipitated from the condensate prior to liquid chromatography. The condensate was separated into hydrocarbons (saturates and aromatics) and polar compounds (resins) by liquid chromatography on activated alumina (sample: adsorbent ratio = 1.100). Hydrocarbons were eluted with petroleum ether/dichloromethane (50:50) and resins with methanol/dichloromethane (65:35). The saturated and aromatic hydrocarbons were then separated by liquid chromatography on activated silica gel (sample: adsorbent ratio = 1.100) eluting in turn with petroleum ether and petroleum ether/dichloromethane (91:9).

5. Gas Chromatography

Whole oils and saturated hydrocarbons (alkanes) were examined by gas chromatography using the following instrumental parameters:

Gas Chromatograph:	Carlo Erba 5140 operated in the split injection mode
Column:	25 m x 0.3 mm fused silica, SGE QC3/BP1
Detector Temperature:	300°C
Column Temperature:	40°C for 1 minute, then 8° per minute to 300°C and held isothermal at 300°C until all peaks eluted

Quantification:	Relative concentrations of individual hydrocarbons were obtained by measurement of peak areas with a Perkin-Elmer LCI 100 integrator. The areas of peaks responding to aromatic hydrocarbons were multiplied by appropriate response factors

6. Thin Layer Chromatography (TLC)

Aromatic hydrocarbons were isolated from the extracted oil by preparative TLC using Merck GF_{254} silica plates and distilled AR grade n-pentane as eluent. Naphthalene and anthracene were employed as reference standards for the diaromatic and triaromatic hydrocarbons, respectively. These two bands, visualised under UV light, were scraped from the plate and the aromatic hydrocarbons redissolved in dichloromethane.

7. Gas Chromatography-Mass Spectrometry (GC-MS)

The di- and triaromatic hydrocarbons isolated from the extracted oil by thin layer chromatography were analysed by GC-MS.

GC-MS analysis of the aromatic hydrocarbons was undertaken in the selected ion detection (SID) mode. The instrument and its operating parameters were as follows:

System:	Perkin-Elmer 8420 GC coupled with a Finiga Ion Trap mass selective detector and data system
Column:	25 mm x 0.2 mm i.d. HP BP5 cross-linked methylsilicone phase fused silica, interfaced to source of mass spectrometer
Injector:	Split injection (8:1)
Carrier Gas:	He at 60 kpa head pressure
Column Temperature:	50-260°C @ 4°/minute
Mass Spectrometer Conditions:	Selected ion monitoring

The following mass fragmentograms were recorded:

m/z	Compound Type
155 + 156	dimethylnaphthalenes
169 + 170	trimethylnaphthalenes
178	phenanthrene
191 + 192	methylphenanthrene

The area of the phenanthrene peak was multiplied by a response factor of 0.667 when calculating the methylphenanthrene index (MPI).

APPENDIX 2

HISTOGRAM PLOTS OF VITRINITE REFLECTANCE DATA

MOCAMBORO-11

VITRINITE REFLECTANCE VALUES

Well Name: MOCAMBORO-11
Depth: 96.8-103.0m

Sorted List

0.27	0.32	0.35
0.28	0.32	0.35
0.28	0.32	0.36
0.29	0.32	0.38
0.30	0.33	
0.31	0.33	
0.31	0.33	
0.31	0.33	
0.31	0.34	
0.31	0.34	

Number of values= 24

Mean of values 0.32
Standard Deviation 0.03

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

27-29	****
30-32	**********
33-35	********
36-38	**

VITRINITE REFLECTANCE VALUES

Well Name: MOCAMBORO-11
Depth: 159.0m

Sorted List

0.30	0.40
0.30	
0.31	
0.32	
0.32	
0.33	
0.33	
0.33	
0.34	
0.36	

Number of values= 11

Mean of values 0.33
Standard Deviation 0.03

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

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

VITRINITE REFLECTANCE VALUES

Well Name: MOCAMBORO-11
Depth: 213.4-214.4m

Sorted List

0.25	0.32	0.36	0.45
0.26	0.33	0.36	
0.27	0.33	0.36	
0.28	0.34	0.37	
0.28	0.34	0.37	
0.28	0.34	0.37	
0.30	0.34	0.37	
0.30	0.35	0.38	
0.32	0.35	0.38	
0.32	0.35	0.42	

Number of values= 31

Mean of values 0.34
Standard Deviation 0.04

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

25-27	**
28-30	******
31-33	*****
34-36	**********
37-39	******
40-42	*
43-45	*

VITRINITE REFLECTANCE VALUES

Well Name: MOCAMBORO-11
Depth: 260m

Sorted List

0.27
0.32
0.32
0.32
0.33
0.34
0.34
0.34
0.36

Number of values= 9

Mean of values 0.33
Standard Deviation 0.02

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

27-29	*
30-32	***
33-35	****
36-38	*

VITRINITE REFLECTANCE VALUES

Well Name: MOCAMBORO-11
Depth: 307.5-313.4m

Sorted List

0.36
0.37
0.38
0.39
0.40
0.40

Number of values= 6

Mean of values 0.38
Standard Deviation 0.01

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

```
36-38    ***
39-41    ***
```

VITRINITE REFLECTANCE VALUES

Well Name: MOCAMBORO-11
Depth: 350m

Sorted List

0.33
0.41
0.41
0.42

Number of values= 4

Mean of values 0.39
Standard Deviation 0.04

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

33-35	*
36-38	
39-41	**
42-44	*

VITRINITE REFLECTANCE VALUES

Well Name: MOCAMBORO-11
Depth: 400m

Sorted List

0.28	0.47
0.32	0.51
0.35	
0.35	
0.35	
0.36	
0.37	
0.37	
0.38	
0.40	

Number of values= 12

Mean of values 0.38
Standard Deviation 0.06

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

28-30	*
31-33	*
34-36	****
37-39	***
40-42	*
43-45	
46-48	*
49-51	*

VITRINITE REFLECTANCE VALUES

Well Name: MOCAMBORO-11
Depth: 426-429m

Sorted List

0.31	0.38	0.41
0.34	0.39	0.41
0.36	0.39	0.41
0.36	0.39	0.42
0.37	0.39	0.42
0.38	0.39	0.43
0.38	0.40	0.43
0.38	0.40	
0.38	0.40	
0.38	0.41	

Number of values= 27

Mean of values 0.39
Standard Deviation 0.03

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

```
31-33    *
34-36    ***
37-39    ************
40-42    *********
43-45    **
```

VITRINITE REFLECTANCE VALUES

Well Name: MOCAMBORO-11
Depth: 465m

Sorted List

0.36
0.37
0.38
0.40
0.40
0.40
0.43
0.43
0.48

Number of values= 9

Mean of values 0.41
Standard Deviation 0.03

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

36-38	***
39-41	***
42-44	**
45-47	
48-50	*

VITRINITE REFLECTANCE VALUES

Well Name:	MOCAMBORO-11
Depth:	500m

Sorted List

0.38
0.39
0.39
0.39
0.44
0.48

Number of values=	6
Mean of values	0.41
Standard Deviation	0.04

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

38-40	****
41-43	
44-46	*
47-49	*

VITRINITE REFLECTANCE VALUES

Well Name: MOCAMBORO-11
Depth: 550.0m

Sorted List

0.34	0.48
0.37	0.49
0.38	0.51
0.40	0.52
0.40	
0.41	
0.44	
0.44	
0.45	
0.47	

Number of values= 14

Mean of values 0.44
Standard Deviation 0.05

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

34-36	*
37-39	**
40-42	***
43-45	***
46-48	**
49-51	**
52-54	*

VITRINITE REFLECTANCE VALUES

Well Name: MOCAMBORO-11
Depth: 582.5m

Sorted List

0.41
0.43
0.46
0.49

Number of values= 4

Mean of values 0.45
Standard Deviation 0.03

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

41-43	**
44-46	*
47-49	*

VITRINITE REFLECTANCE VALUES

Well Name: MOCAMBORO-11
Depth: 605.0m

Sorted List

0.40	0.48
0.41	0.48
0.42	
0.44	
0.44	
0.45	
0.45	
0.45	
0.46	
0.47	

Number of values= 12

Mean of values 0.45
Standard Deviation 0.02

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

40-42	***
43-45	*****
46-48	****

VITRINITE REFLECTANCE VALUES

Well Name: MOCAMBORO-11
Depth: 626.0m

Sorted List

0.36	0.41	0.46
0.36	0.41	0.46
0.37	0.41	0.46
0.37	0.42	0.47
0.38	0.42	
0.38	0.43	
0.39	0.43	
0.39	0.45	
0.39	0.45	
0.40	0.46	

Number of values= 24

Mean of values 0.41
Standard Deviation 0.03

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

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

VITRINITE REFLECTANCE VALUES

Well Name: MOCAMBORO-11
Depth: 667.5m

Sorted List

0.38	0.43	0.48
0.39	0.43	0.48
0.40	0.45	0.48
0.40	0.46	0.48
0.40	0.46	0.49
0.40	0.46	0.49
0.41	0.47	0.49
0.41	0.47	
0.41	0.48	
0.43	0.48	

Number of values= 27

Mean of values 0.44
Standard Deviation 0.04

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

38-40	******
41-43	******
44-46	****
47-49	***********

VITRINITE REFLECTANCE VALUES

Well Name: MOCAMBORO-11
Depth: 705.1-706.3m

Sorted List

0.39
0.44
0.47
0.47
0.48

Number of values= 5

Mean of values 0.45
Standard Deviation 0.03

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

39-41	*
42-44	*
45-47	**
48-50	*

VITRINITE REFLECTANCE VALUES

Well Name: MOCAMBORO-11
Depth: 759.3-763.3m

Sorted List

0.42
0.46
0.50
0.52

Number of values= 4

Mean of values 0.48
Standard Deviation 0.04

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

42-44	*
45-47	*
48-50	*
51-53	*

VITRINITE REFLECTANCE VALUES

Well Name: MOCAMBORO-11
Depth: 792.0m

Sorted List

0.38	0.44	0.54
0.41	0.44	
0.41	0.44	
0.41	0.45	
0.41	0.45	
0.42	0.46	
0.42	0.46	
0.43	0.46	
0.43	0.50	
0.44	0.53	

Number of values= 21

Mean of values 0.44
Standard Deviation 0.04

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

```
38-40    *
41-43    ********
44-46    *********
47-49
50-52    *
53-55    **
```

VITRINITE REFLECTANCE VALUES

Well Name: MOCAMBORO-11
Depth: 808.0m

Sorted List

0.39
0.40
0.43
0.44

Number of values= 4

Mean of values 0.42
Standard Deviation 0.02

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

39-41	**
42-44	**

VITRINITE REFLECTANCE VALUES

Well Name: MOCAMBORO-11
Depth: 861.0m

Sorted List

0.48	0.59
0.49	0.59
0.49	0.61
0.51	
0.54	
0.54	
0.55	
0.56	
0.57	
0.58	

Number of values= 13

Mean of values 0.55
Standard Deviation 0.04

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

48-50	***
51-53	*
54-56	***
57-59	*****
60-62	*

VITRINITE REFLECTANCE VALUES

Well Name: MOCAMBORO-11
Depth: 933.0m

Sorted List

0.41
0.41
0.43
0.44
0.44
0.45
0.46
0.46
0.50
0.52

Number of values= 10

Mean of values 0.45
Standard Deviation 0.03

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

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

VITRINITE REFLECTANCE VALUES

Well Name: MOCAMBORO-11
Depth: 997.5-1000.0M

Sorted List

0.40	0.50	0.57	0.60
0.41	0.51	0.57	
0.47	0.51	0.57	
0.47	0.51	0.58	
0.49	0.51	0.58	
0.49	0.52	0.59	
0.49	0.54	0.59	
0.49	0.56	0.59	
0.50	0.56	0.60	
0.50	0.56	0.60	

Number of values= 31

Mean of values 0.53
Standard Deviation 0.05

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

```
40-42    **
43-45
46-48    **
49-51    ***********
52-54    *
55-57    *******
58-60    ********
```

VITRINITE REFLECTANCE VALUES

Well Name: MOCAMBORO-11
Depth: 1061.1-1066.7m

Sorted List

0.40	0.51
0.43	0.51
0.43	0.51
0.43	0.53
0.47	0.54
0.47	0.55
0.47	0.56
0.49	0.56
0.50	0.57
0.50	0.58

Number of values= 20

Mean of values 0.50
Standard Deviation 0.05

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

```
40-42    *
43-45    ***
46-48    ***
49-51    ******
52-54    *
55-57    *****
58-60    *
```

VITRINITE REFLECTANCE VALUES

Well Name: MOCAMBORO-11
Depth: 1161.8-1166.1m

Sorted List

0.47
0.49
0.51
0.54

Number of values= 4

Mean of values 0.50
Standard Deviation 0.03

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

47-49	**
50-52	*
53-55	*

VITRINITE REFLECTANCE VALUES

Well Name: MOCAMBORO-11
Depth: 1346.0m

Sorted List

0.45	0.61
0.47	0.62
0.47	0.62
0.47	0.62
0.50	0.62
0.51	0.64
0.54	0.66
0.55	
0.56	
0.57	

Number of values= 17

Mean of values 0.56
Standard Deviation 0.07

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

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

PE906580

This is an enclosure indicator page.
The enclosure PE906580 is enclosed within the container PE906578 at this location in this document.

The enclosure PE906580 has the following characteristics:

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CONTAINER_BARCODE = PE906578
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BASIN = OTWAY
PERMIT = PEP118
TYPE = WELL
SUBTYPE = PHOTOMICROGRAPH
DESCRIPTION = Photomicrographs - Organic Matter, 1 of 3, Appenix 7, Mocamboro-11
REMARKS =
DATE_CREATED = 12/07/1991
DATE_RECEIVED =
W_NO = W1032A
WELL_NAME = MOCAMBORO-11
CONTRACTOR = AMDEL
CLIENT_OP_CO = GSV

(Inserted by DNRE - Vic Govt Mines Dept)

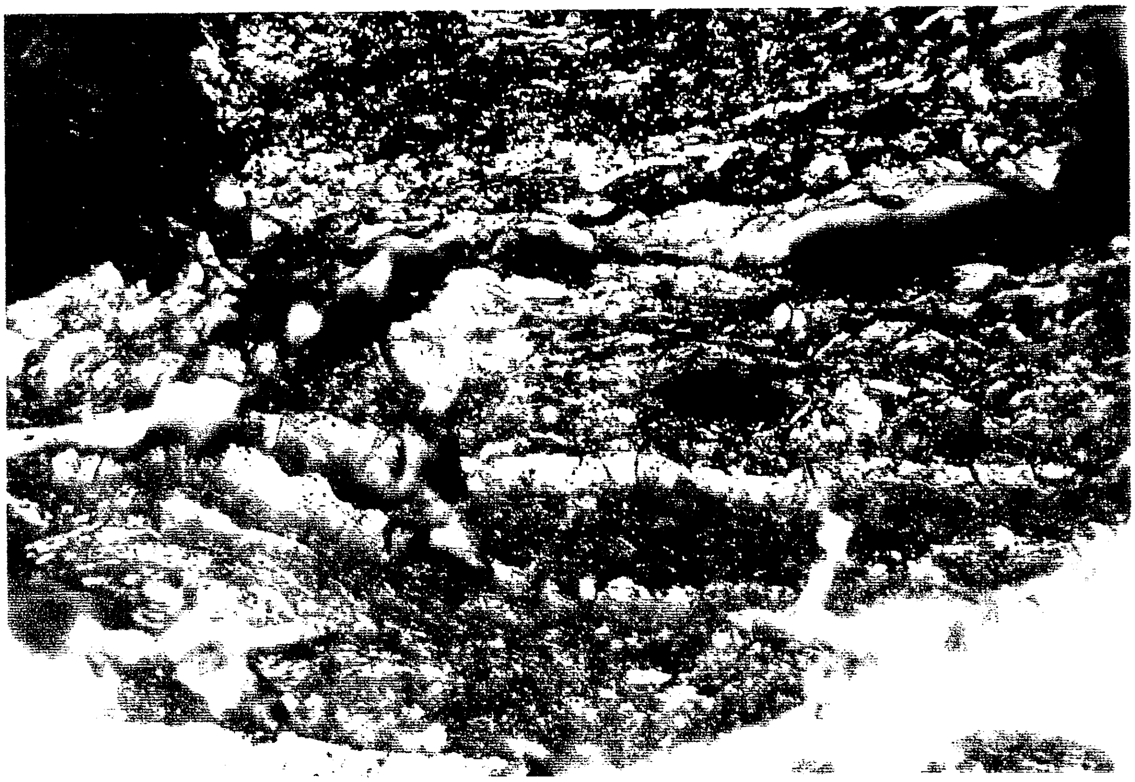

Plate 1: **626.0 metres** **Reflected Light**
This coal consists largely of vitrinite (grey) with moderate quantities of exinite (brown) and inertinite (white).
Field dimensions 0.26 x 0.18 mm

Plate 2: **Same field as above** **Fluorescence Mode**
Primary oil (intense yellow - intense green) fluorescence is associated with resinite in this coal.

PE906581

This is an enclosure indicator page.
The enclosure PE906581 is enclosed within the container PE906578 at this location in this document.

The enclosure PE906581 has the following characteristics:

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CONTAINER_BARCODE = PE906578
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BASIN = OTWAY
PERMIT = PEP118
TYPE = WELL
SUBTYPE = PHOTOMICROGRAPH
DESCRIPTION = Photomicrographs - Organic Matter, 2 of 3, Appenix 7, Mocamboro-11
REMARKS =
DATE_CREATED = 12/07/1991
DATE_RECEIVED =
W_NO = W1032A
WELL_NAME = MOCAMBORO-11
CONTRACTOR = AMDEL
CLIENT_OP_CO = GSV

(Inserted by DNRE - Vic Govt Mines Dept)

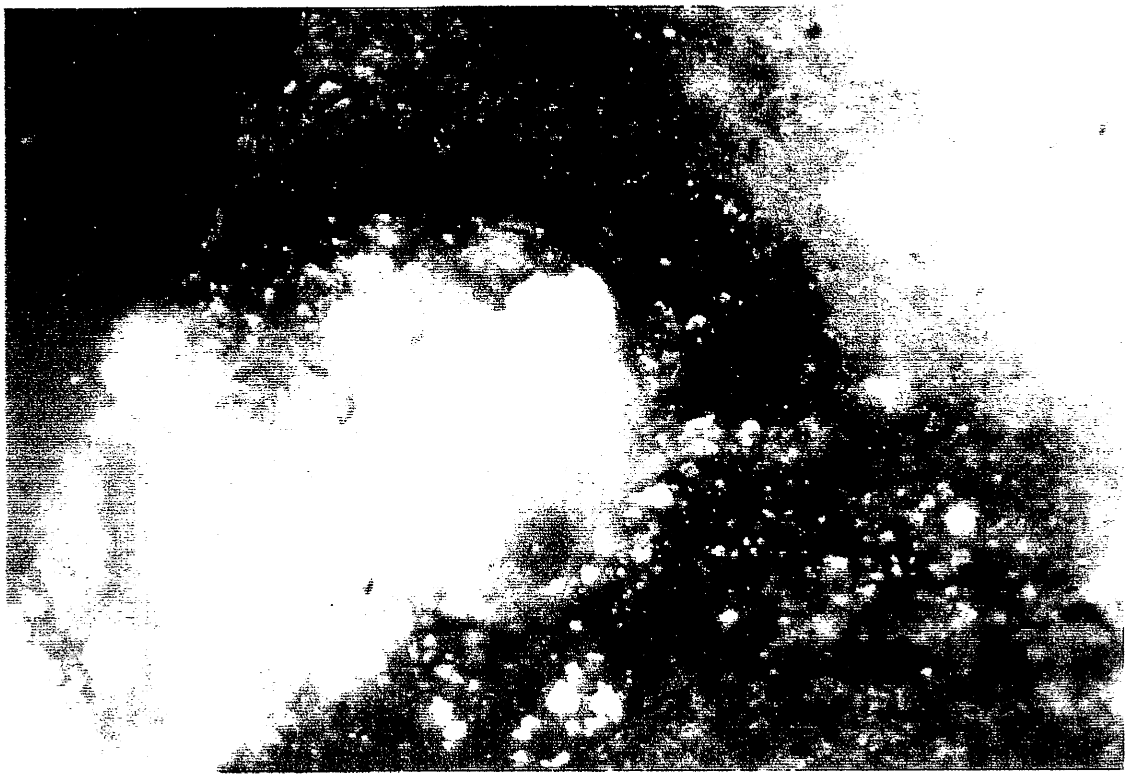

Plate 3: 792.0 metres Reflected Light
Bituminite (brown) is intimately associated with vitrinite (grey) in this siltstone.
Field dimensions 0.26 x 0.18 mm

Plate 4: Same field as above Fluorescence Mode
Oil (intense yellow green) is closely associated with the bituminite and vitrinite in this siltstone suggesting that this oil may have been generated "in situ" from this bituminite.

PE906582

This is an enclosure indicator page.
The enclosure PE906582 is enclosed within the container PE906578 at this location in this document.

The enclosure PE906582 has the following characteristics:

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CONTAINER_BARCODE =	PE906578
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BASIN =	OTWAY
PERMIT =	PEP118
TYPE =	WELL
SUBTYPE =	PHOTOMICROGRAPH
DESCRIPTION =	Photomicrographs - Organic Matter, 3 of 3, Appenix 7, Mocamboro-11
REMARKS =	
DATE_CREATED =	12/07/1991
DATE_RECEIVED =	
W_NO =	W1032A
WELL_NAME =	MOCAMBORO-11
CONTRACTOR =	AMDEL
CLIENT_OP_CO =	GSV

(Inserted by DNRE - Vic Govt Mines Dept)

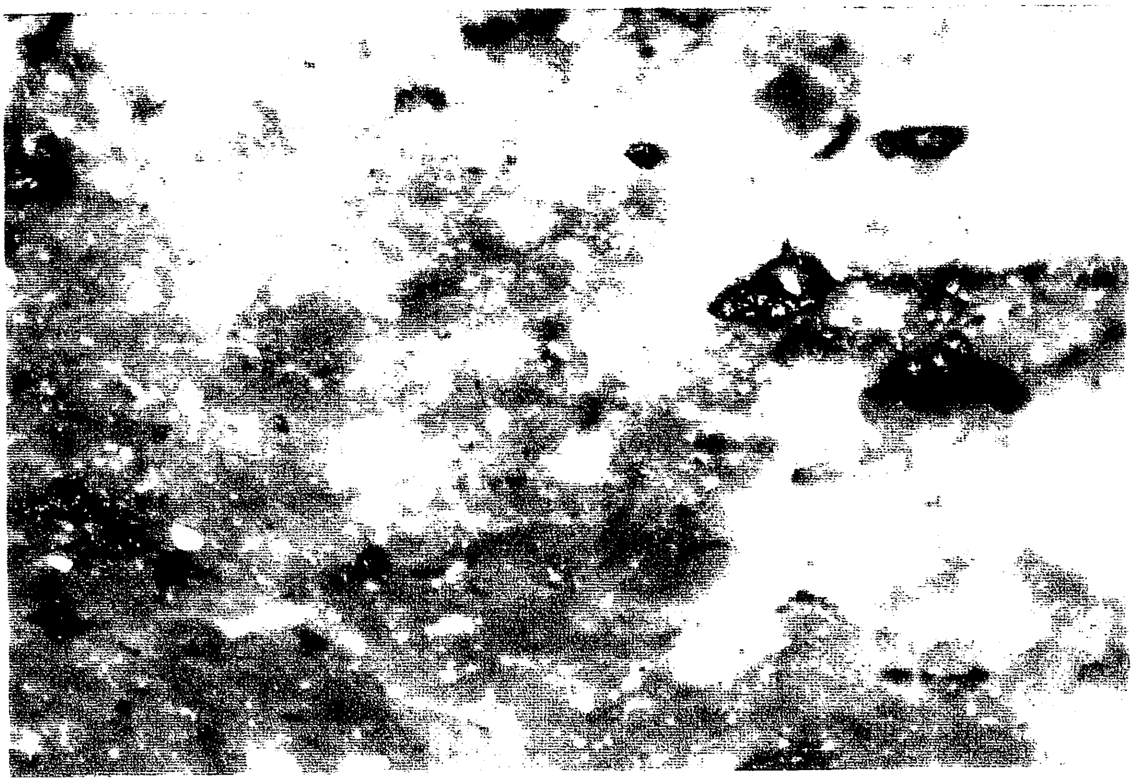

Plate 5: **792.0 metres** **Reflected Light**

Organic matter in this silty shale consists largely of vitrinite (grey), inertinite (white) and exinite (brown). Field dimensions 0.26 x 0.18

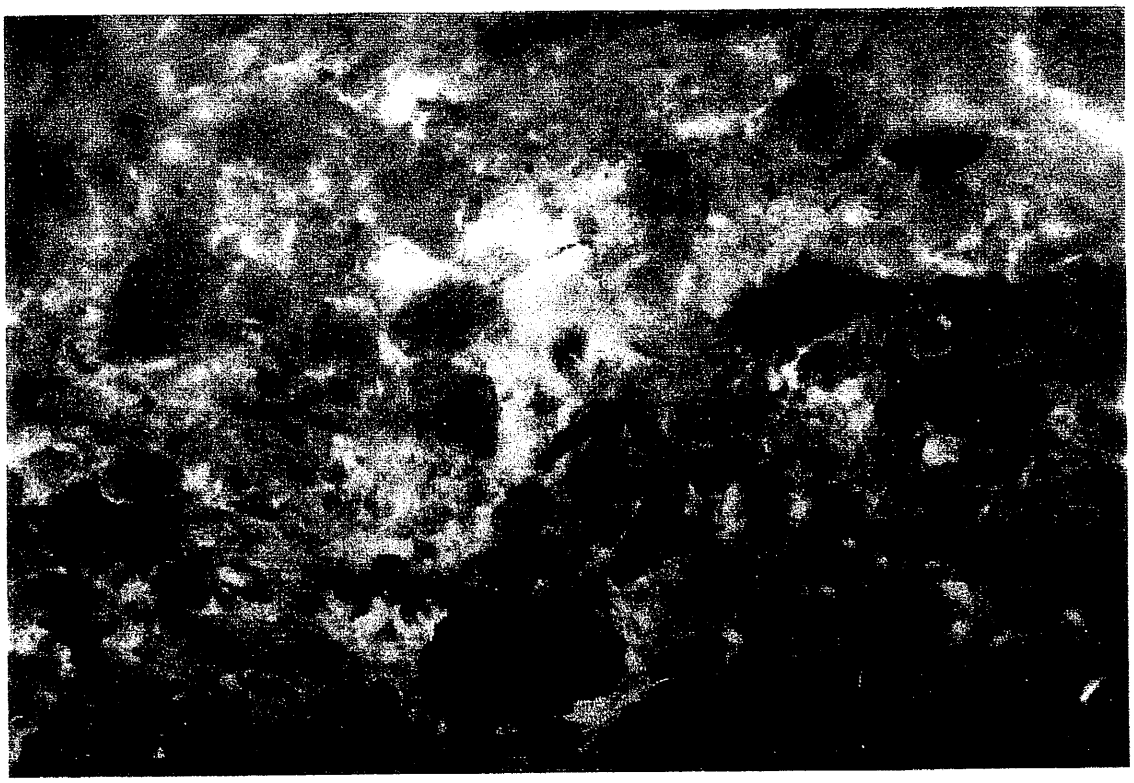

Plate 6: **Same field as above** **Fluorescence Mode**

Oil (intense green) is dispersed throughout this siltstone. Variable fluorescence of the exinites (moderate orange to dull brown) is due to variations in the degree of oxidation.

APPENDIX 8

APPENDIX
8

MACERAL ANALYSIS
&
VITRINITE REFLECTANCE
DATA

Maceral Analyses and Vitrinite Reflectance Data for Mocamboro-1, Otway Basin, Victoria

for

Geological Survey of Victoria

by

DIANNE PADLEY © 1991

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University of Adelaide

February 1991

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1. Introduction

A detailed petrographic examination was undertaken of five organic-rich sediments from the Eumeralla Formation in Mocamboro-1, Otway Basin, for Geological Survey of Victoria. The aim of the study was to determine their dispersed organic matter content.

2. Petrographic Procedures

2.1 Samples

A total of 1 cuttings and 4 core samples, consisting of coals and dark-grey argillaceous sediments, were selected from Mocamboro-1 for organic petrographic analysis (Table 1). All samples were cleaned to remove any contaminants (*e.g.* drilling mud and ink). Vitrinite reflectance and petrographic analyses of the above samples were then carried out (Table 1).

2.2 Preparation

A representative portion of each sample was crushed and mounted in cold-setting epoxy resin using a 2.5 cm diameter mould. On hardening, the samples were ground flat using a diamond impregnated lap, followed by corundum paper (400 and 600 grades) with kerosene as the lubricant. The surface was polished on "Lamplan 450" microcloth using three grades of diamond paste (3μm, 1μm and 0.5μm, respectively) and kerosene as the lubricant.

2.3 Petrographic Analysis

Organic petrographic observations and assessment of sediment type were made with a Leitz Ortholux II reflectance microscope using Leitz oil immersion objectives (x50/0.85, x32/0.65) in incident white light and UV light. The maceral classification scheme is shown in Table 2, and the coal microlithotype classification in Table 3.

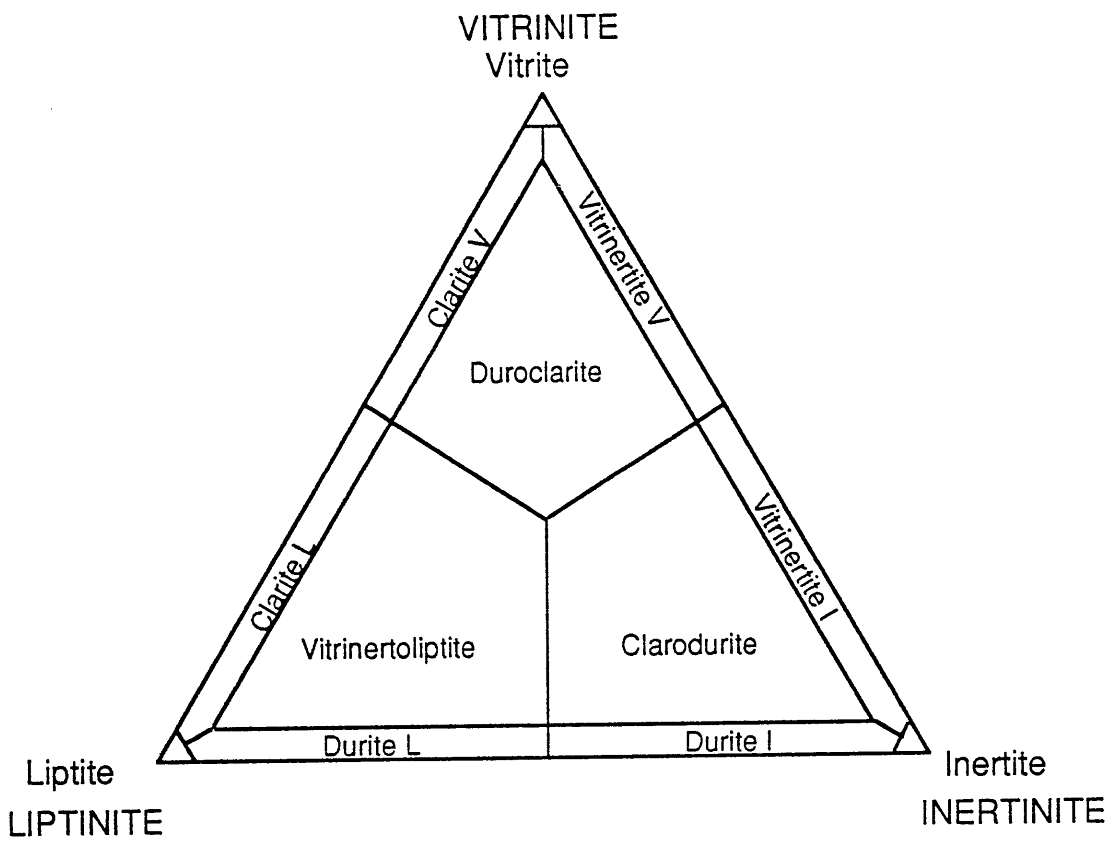
TABLE 1: Samples Selected for Petrographic Descriptions and Vitrinite Reflectance Measurements, Mocamboro-1.

SAMPLE N°	Depth Range (m)	Sample Type	Lithology
A-923.184	64.2	Core 4C	Shale; Coal
A-923.185	96.8	Core 5A	Shale
A-923.186	213.6	Core 7B	Coal; Shale
A-923.187	667 - 669	Cuttings	Coal
A-923.188	706.0	Core 13B	Shale

TABLE 2: Coal Maceral Classification (modified from AS 2856-1986)

MACERAL GROUP	MACERAL SUBGROUP	MACERAL
Vitrinite	Telovitrinite	Textinite Texto-ulminite Eu-ulminite Telocollinite
	Detrovitrinite	Attrinite Densinite Desmocollinite
	Gelovitrinite	Corpogelinite Porigelinite Eugelinite
Liptinite		Sporinite Cutinite Resinite Liptodetrinite Alginite Suberinite Fluorinite Exsudatinite Bituminite
Inertinite	Telo-inertinite	Fusinite Semifusinite Sclerotinite
	Detro-inertinite	Inertodetrinite Micrinite
	Gelo-inertinite	Macrinite

TABLE 3: Coal Microlithotype Classification



2.4 Reflected Light Microscopy

Vitrinite reflectances were measured in accordance with the guidelines published by the Australian Standard AS 2486 (Standards Association of Australia, 1989).

The analyses were made using a Leitz Ortholux II petrographic microscope connected to a Leitz MPV compact microphotometer with a digital display unit. Linearity of the microphotometer was established by calibrating against the synthetic standards, spinel, yttrium aluminium garnet and gadolinium gallium garnet with reflectance values of 0.421%, 0.924% and 1.726%, respectively. The microscope was fitted with a Leitz oil immersion (x50/0.85) objective. The immersion oil has a refractive index of 1.5180 at 23°C in sodium light (589.3nm). Reflectance was measured in normal incident white light. A Berek prism was used as the vertical illuminator. The aperture diaphram to the microphotometer had an area of $2\mu m^2$ and the monochromatic interference filter had a fixed central wavelength of 546nm. Measurements were made, wherever possible, on telovitrinite (vitrinite A). Maximum vitrinite reflectance ($R_V max$) was measured by rotating the microscope stage through 360° and recording the two maxima. If the two $R_V max$ values differed by no more than 2%, the readings were summed and the arithmetic mean recorded as $R_V max$. A minimum of 30 reflectance measurements were made on each sample unless otherwise stated. Due to the small size of the vitrinite phytoclasts in sample A-923.185, only average vitrinite reflectance ($R_V av$) was measurable, (*i.e.* there was no rotation of the stage).

3. Results and Discussion

Photomicrographs of the samples examined in this study are given in Appendix A. The organic petrographic descriptions of the samples, which include both coals and clastic sediments with dispersed organic matter (d.o.m.), are summarised in Appendix B. The vitrinite reflectance data for each sample is presented both in a table and as a histogram in Appendix C.

This report assesses the maturity and organic matter content of the Eumeralla Formation from the interval 64.2 - 706.0 metres depth in Mocamboro-1.

3.1 Organic Petrology of Coal and Shale

Sample A-923.184, depth 64.2m

This sample consists of two different lithologies, shale and coal.

The shale contains a moderate amount (5% - 10% by volume) of dispersed organic matter (d.o.m.), comprising inertinite as the most abundant maceral and minor amounts of vitrinite and liptinite. Vitrinite occurs as wisps and stringers which are commonly associated with dark-brown matrix bituminite; as small reworked phytoclasts; and more rarely as large coaly fragments with cellular structures (*viz.* texto-ulminite and eu-ulminite). Inertinite is present as detro-inertinite and to a lesser extent as telo-inertinite, with semifusinite predominating over fusinite. The liptinite macerals include sporinite, resinite and liptodetrinite with minor amounts of cutinite. The resinite usually occurs within vitrinite, as opposed to discrete isolated globules (Plate 1). In addition, there is the rare maceral telalginite which appears as small bodies (30µm) with an intense yellow fluorescence under ultraviolet light (Plate 2a).

The coal consists entirely of vitrinite, represented by the macerals texto-ulminite, eu-ulminite and telocollinite and hence can be classified as the microlithotype vitrite.

Sample A-923.185, depth 96.8m

The shale contains a very low amount (<1% by volume) of dispersed organic matter (d.o.m.). Inertinite makes up the largest portion of the d.o.m. with inertodetrinite as the dominant maceral and subordinate semifusinite. There are only minor amounts of vitrinite and liptinite (Plate 2b).

Sample A-923.186, depth 213.6m

The lithologies represented in this sample grade from shale through to coal.

The shale is rich in d o.m. (10% - 50% by volume). Inertinite (semifusinite and fusinite) is the dominant maceral group with lesser amounts of vitrinite and liptinite. Vitrinite is present as wisps and stringers of poorly gelified telovitrinite. Sporinite and liptodetrinite dominate the liptinites with only minor amounts of resinite and cutinite (Plate 3).

In the coal, inertinite is the dominant maceral group with subordinate vitrinite and liptinite. Hence it is classified as the microlithotype clarodurite (Plate 4). The inertinite occurs mainly as telo-inertinite, although a considerable quantity of detro-inertinite is also present. Semifusinite is the most abundant maceral, although fusinite and sclerotinite were also observed. Vitrinite occurs in pure bands as telovitrinite, and as the granular matrix detrovitrinite. Sporinite and resinite are the dominant liptinites although lesser amounts of liptodetrinite, and more rarely cutinite and suberinite, are also present. In addition, there is a minor amount of the microlithotype vitrite. The vitrinite occurs as texto-ulminite, eu-ulminite and telocollinite (Plate 5a).

Sample A-923.187, depth 667 - 669m

This coal is composed largely of vitrinite and is classified as the microlithotype vitrite. Due to increasing maturity and gelification the most common maceral is now telocollinite (Plate 5b). In addition, the microlithotype duroclarite is also present (Plate 6). Detrovitrinite (desmocollinite) is more abundant than telovitrinite (texto-ulminite, eu-ulminite and telocollinite). The gelovitrinite maceral corpogelinite is also present in this sample. The liptinites are dominated by sporinite, resinite and liptodetrinite with minor amounts of cutinite. The inertinites are represented by inertodetrinite and lesser amounts of semifusinite and fusinite.

Sample A-923.188, depth 706m

The shale is rich in d.o.m. (5% - 10% by volume). Inertinite, as inertodetrinite, makes up the largest proportion of the d.o.m. although significant amounts of very well preserved liptinite, notably sporinite were seen (Plate 7). Vitrinite is rare, occurring as reworked phytoclasts and wisps.

3.2 Vitrinite Reflectance Measurements

The results of the vitrinite reflectance measurements are shown in Table 4. The samples from the depths 64.2m, 213.6m and 667m (A-923-184, A-923-186 and A-923.187) are rich in the maceral subgroup telovitrinite, and hence reliable vitrinite reflectance measurements were obtained. Due to the paucity and small size of the vitrinite phytoclasts in the shales from 96.8m and 706m (A-923.185 and A-923.188) the reflectance data for these two samples are less accurate.

Table 4: Summary of Vitrinite Reflectance Measurements, Mocamboro-1

Sample N°	Depth (m)	Mean Average Reflectance	Mean Max Reflectance	Range $R_V max$	SD	Number of readings
A-923.184	64.2	-	0.27	0.23 - 0.35	0.03	30
A-923.185	96.8	0.48	-	-	0.08	7
A-923.186	213.6	-	0.28	0.22 - 0.47	0.05	30
A-923.187	667.0	-	0.44	0.36 - 0.49	0.03	30
A-923.188	706.0	-	0.55	0.46 - 0.64	0.05	17

4. Summary

The d.o.m. content of the shales examined is typically inertinite-rich with variable, but lesser quantities, of vitrinite and liptinite. The preferential presence of the resistant oxidised woody fragments and their small size in sample A-923.185 would imply that they were deposited distally from their source in an oxic-suboxic aqueous environment. In contrast, the assemblage of inertinite with well preserved liptinite macerals in sample A-923.188 would suggest an input of water and wind-borne inertinite and sporinite into a lacustrine environment with more anoxic bottom waters.

All the coal samples examined are humic - composed of land plants which were predominantly deposited as peats. They are either monomaceralic (*i.e.* vitrite or inertite), or a mixture of all three maceral groups, with duroclarite (vitrinite > inertinite and liptinite) or clarodurite (inertinite > vitrinite and liptinite) as the characteristic microlithotypes. Their liptinite content is restricted to higher plant derived macerals where sporinite and resinite are the dominant constituents, although subordinate amounts of cutinite and suberinite are also present.

The vitrinite reflectance data obtained indicate that the Lower Cretaceous Eumeralla Formation from 64.2 - 706.0 metres depth in Mocamboro-1 are thermally immature ($R_V max < 0.5\%$).

5. References

Standards Association of Australia, 1982. Glossary of terms relating to solid mineral fuels. Part 5 - Terms relating to the petrographic analysis of bituminous coal and anthracite (hard coal). Australian Standard AS 2418.

Standards Association of Australia, 1986. Coal maceral analysis. Australian Standard AS 2856.

Standards Association of Australia, 1989. Methods for microscopical determination of the reflectance of coal macerals. Australian Standard AS 2486.

7. Acknowledgements

I would like to thank Mr. B. Watson (Amdel Core Services) for access to their microscope for the vitrinite reflectance work.

6. Glossary

The coal maceral terms used in this report are briefly defined below. These definitions are an abbreviated version of those published in AS 2418, Part 5 - 1982 and AS 2856 - 1986.

MACERAL	:	The microscopically recognisable organic components of coal.
MACERAL GROUP	:	Three maceral groups are distinguished on the basis of their optical properties, *viz* vitrinite, liptinite (exinite) and inertinite. The macerals in each group have broadly similar properties in a single coal of specific rank.
<u>VITRINITE</u>	:	Generally this is the major component of most coal seams. Vitrinite macerals are derived from plant tissues (*e.g.* stem, root, bark, leaf) which have undergone only vitrinite diagenesis. It appears grey in reflected light. The vitrinite macerals are organised into subgroups according to their origin *viz* telovitrinite, detrovitrinite, gelovitrinite.
1) TELOVITRINITE	:	Intact plant tissue phytoclasts, which include both cell wall and cell contents, that are larger than 0.02 mm in greatest dimension.
1a) Texto-ulminite	:	Telovitrinite with well preserved and distinct cell walls which show no significant effects of compaction, but have undergone minor vitrinite diagenesis so that internal wall structures are not evident.
1b) Eu-ulminite	:	Telovitrinite with distinct cell walls and no open or partly filled cell lumens due to compaction of the cell walls or complete infilling of the cell lumens.
1c) Telocollinite	:	Telovitrinite which is internally structureless.
2) DETROVITRINITE	:	Fine-grained (less than 0.02 mm greatest dimension) fragmented clasts of tissue which commonly forms a groundmass for all the other coal macerals.
2a) Desmocollinite	:	Detrovitrinite groundmass which is compacted and cemented, internally structureless or massive, and without significant intergranular porosity.
3) GELOVITRINITE	:	Consists of massive or submicroscopic granular vitrinite gel larger than 0.02 mm and not clearly part of telo- of detrovitrinite.
3a) Corpogelinite	:	Massive gelovitrinite occurring as rounded or oval grains or fragments.

<u>LIPTINITE</u>	:	Formed from substances rich in volatiles and hydrogen and resistant to decay and decomposition.
Sporinite	:	Originates from pollen grains, spores and sporangia.
Cutinite	:	Originates from the cuticle and associated tissue of needles, shoots, stalks, leaves, roots and thin stems.
Resinite	:	Lensoid masses, cell fillings or isolated bodies which originate from plant resins, fats, waxes and oils.
Liptodetrinite	:	Small fragments, typically less than 0.01 mm, that are formed from mechanically or biodegraded liptinite.
ALGINITE	:	Derived from some (lipidic or aliphatic walled) algae, including dinoflagellates and acritarchs. In UV light it is intense to bright, green/yellow, yellow, orange or brown.
Telalginite	:	Consists of discrete structured algal bodies (both colonial and unicellular) which are spherical to disc-shaped and > 0.005 mm thickness in sections perpendicular to bedding. In reflected light it is commonly translucent, black or dark-grey.
Bituminite	:	Specific botanical origins are unknown, it may result from the anaerobic degradation of higher plants or algae. It exhibits no specific form but can be present as a fine-grained groundmass, irregular laminae or as pod-like masses. It commonly appears dark-grey in reflected light and fluoresces weakly.
<u>INERTINITE</u>	:	Formed from woody tissues which have undergone mouldering or incomplete combustion; alternatively it maybe produced from the coalification of humic or liptinitic macerals.
1) TELO-INERTINITE	:	Shows distinctive cell structure and exceeds 0.03 mm in its minimum dimension.
1a) Fusinite	:	Most common colour is yellowish-white in reflected light.
1b) Semifusinite	:	In reflected light it is pale-grey to white in colour, with reflectance values ranging between those of co-existing vitrinite and fusinite.
1c) Sclerotinite	:	Consists of fungal remains.
2) DETRO-INERTINITE	:	Includes all inertinite less than 0.03 mm in longest dimension.
2a) Inertodetrinite	:	Inertinite which is < 0.03 mm but is > 0.002 mm.

MICROLITHOTYPE	:	Naturally occurring macerals or associations of macerals with minimum band widths of 0.05 mm. Microlithotypes are classified into one of three categories, *viz* monomaceral, bimaceral or trimaceral, according to whether they contain components of one, two or three maceral groups.
ORGANOCLAST	:	A discrete particle of organic matter in a sedimentary rock.
PHYTOCLAST	:	Any piece of organic material that is derived from plants occurring within a clastic matrix.

APPENDIX A
PLATES

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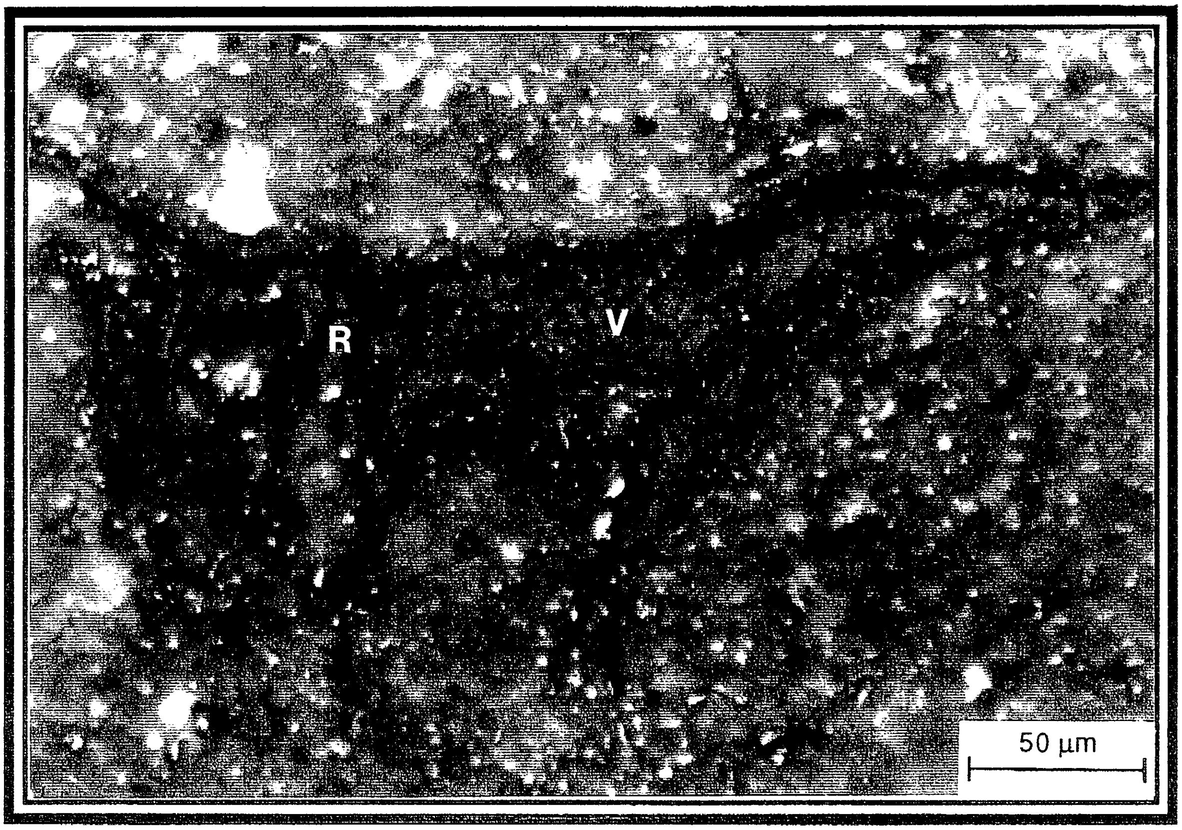

PLATE 1a: Photomicrograph of a phytoclast in shale. The plant tissue is composed of telovitrinite {V: mid-grey) and resinite (R: brown) [Sample A-923.184, 64.2m, oil immersion, reflected light, X32].

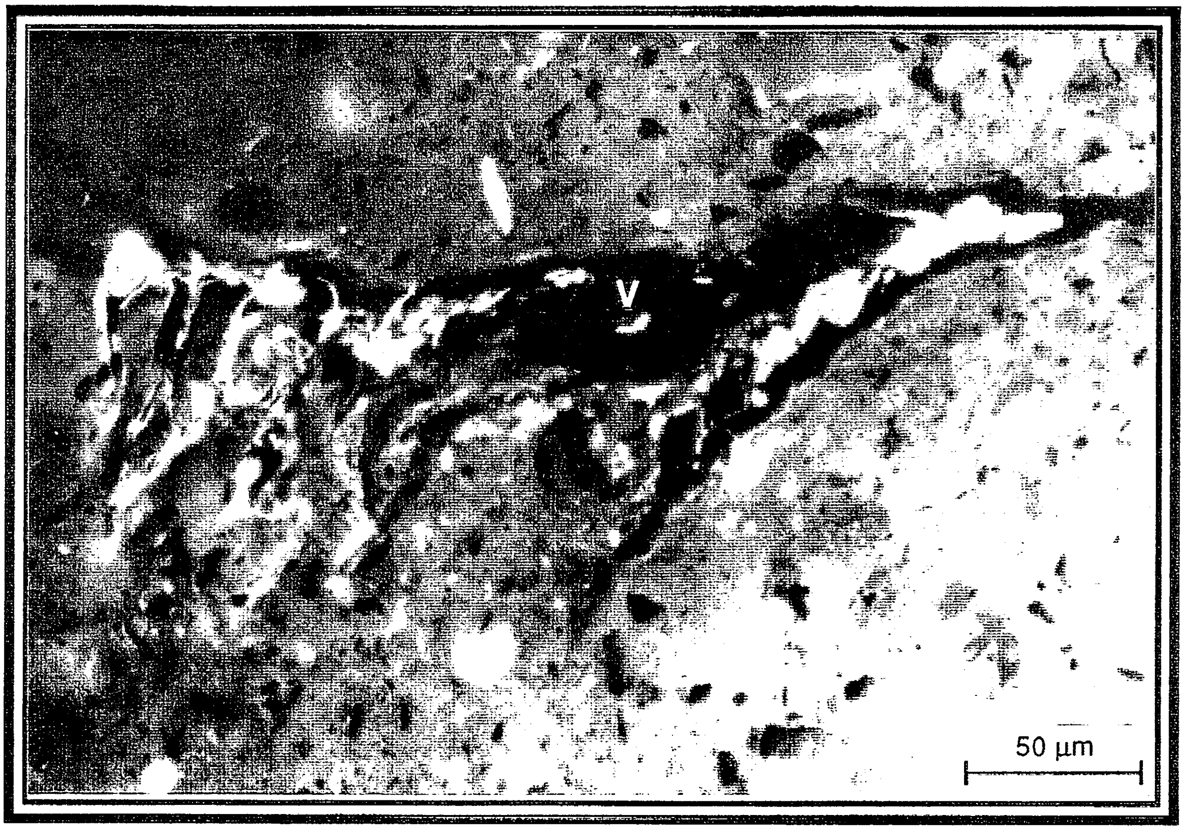

PLATE 1b: Photomicrograph of a phytoclast in shale. The plant tissue is composed of telovitrinite {V: black) and resinite (R: yellow) [Sample A-923.184, 64.2m, oil immersion, UV light, X32].

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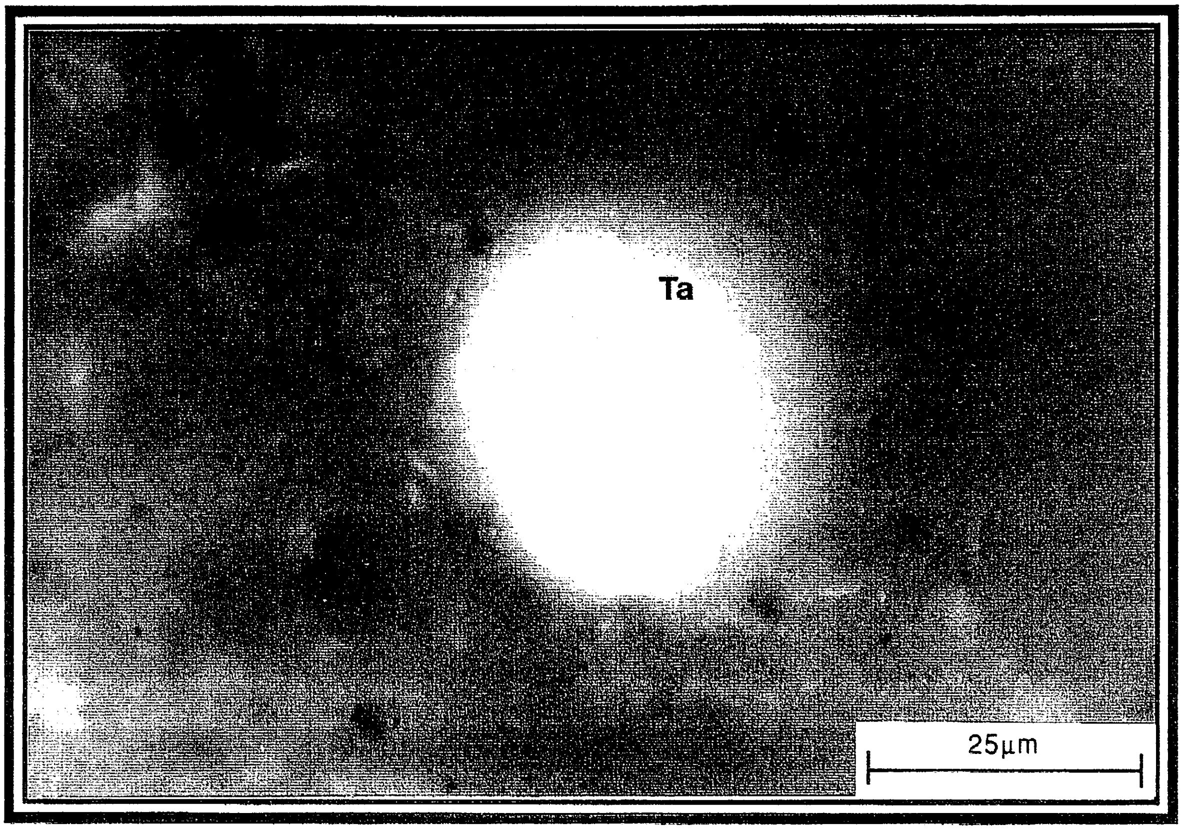

PLATE 2a: Photomicrograph showing telalginite (Ta: yellow) in shale. [Sample A-923.184, 64.2m, oil immersion, UV light, X125].

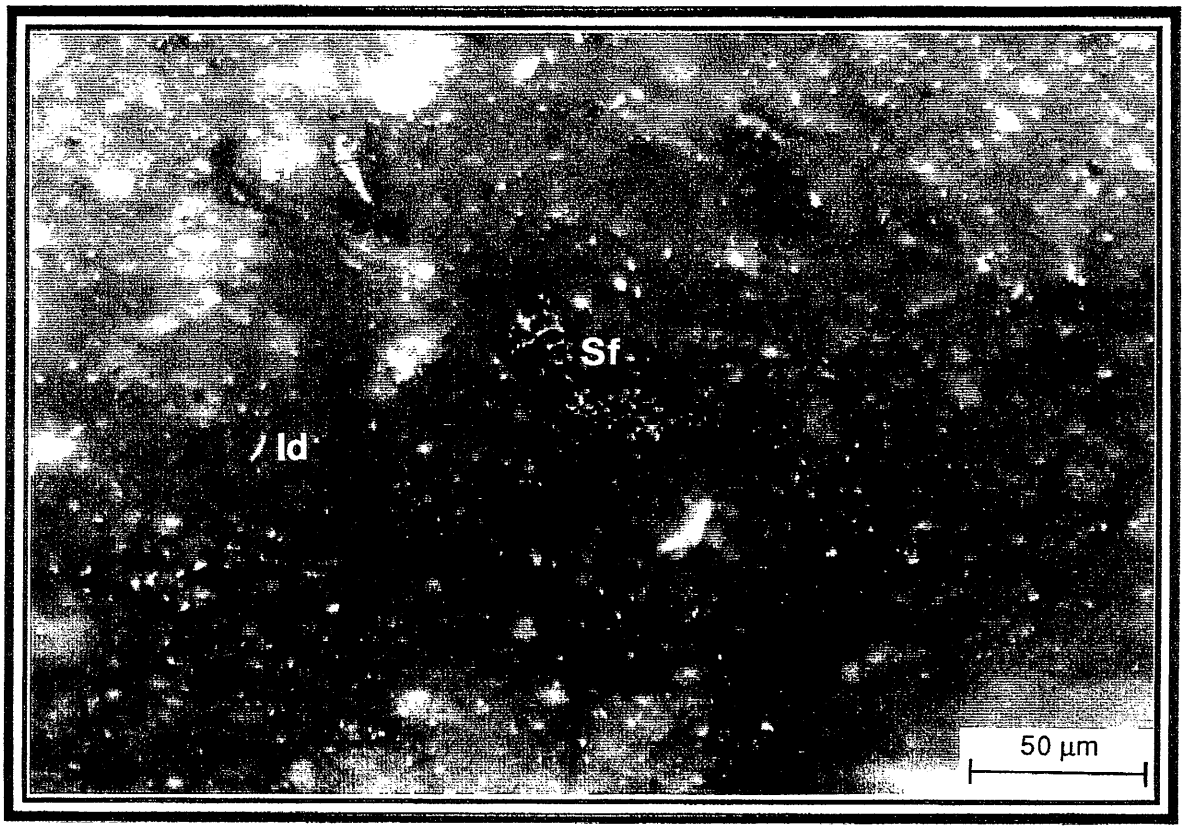

PLATE 2b: Photomicrograph showing a typical view of d.o.m. in shale. Macerals comprise semifusinite (Sf: pale-grey), inertodetrinite (Id: pale-grey) and liptodetrinite (Li: brown). [Sample A-923.185, 96.8m, oil immersion, reflected light, X32].

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PLATE 3a: Photomicrograph showing d.o.m. in shale. Macerals comprise vitrinite (V: mid-grey), fusinite (F: white), inertodetrinite (Id: pale-grey) and the liptinites sporinite (Sp: black) and liptodetrinite (Li: black). [Sample A-923.186, 213.6m, oil immersion, reflected light, X32].

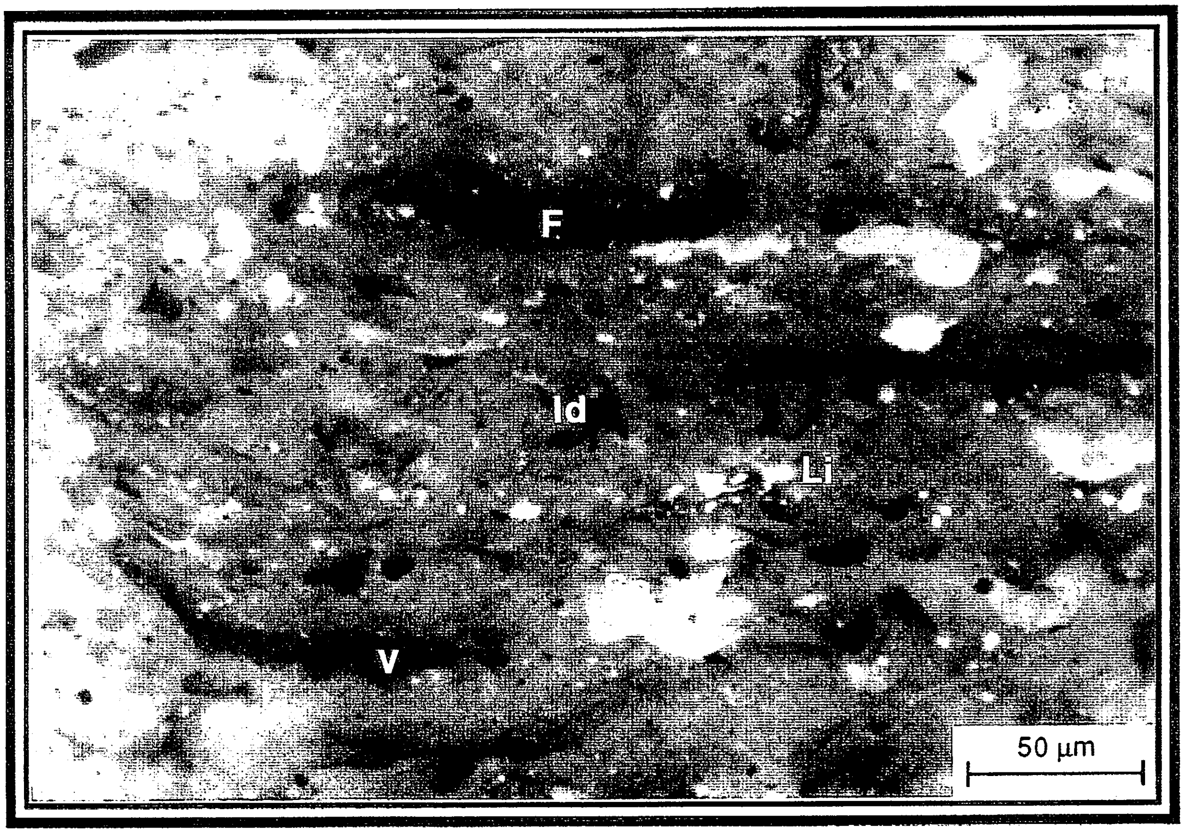

PLATE 3b: Photomicrograph showing d.o.m. in shale. Macerals comprise vitrinite (V: black), fusinite (F: black), inertodetrinite (Id: black) and the liptinites sporinite (Sp: yellow) and liptodetrinite (Li: yellow). [Sample A-923.186, 213.6m, oil immersion, UV light, X32].

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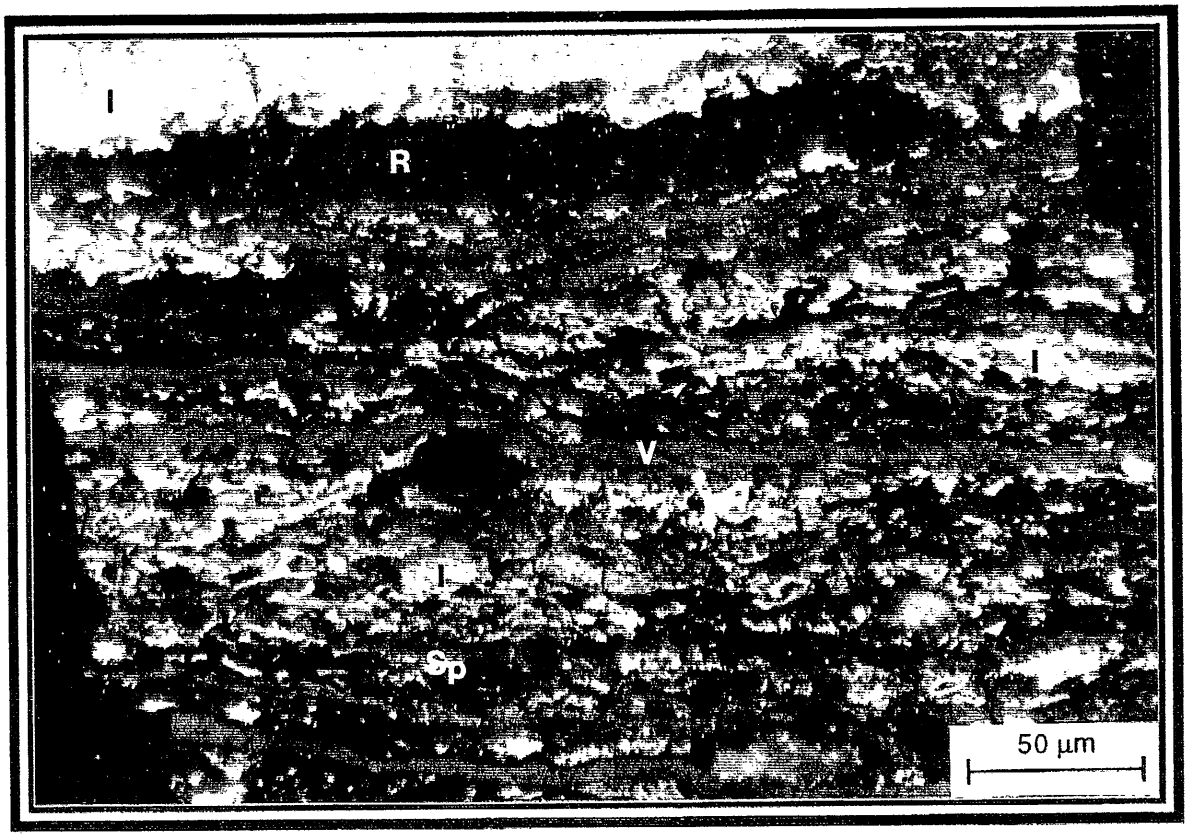

PLATE 4a: Photomicrograph showing coal, microlithotype clarodurite. Vitrinite (V: mid-grey), inertinite (I: pale-grey to white) and liptinites, resinite (R: black] and sporinite (Sp: black). [Sample A-923.186, 213.6m, oil immersion, reflected light, X32].

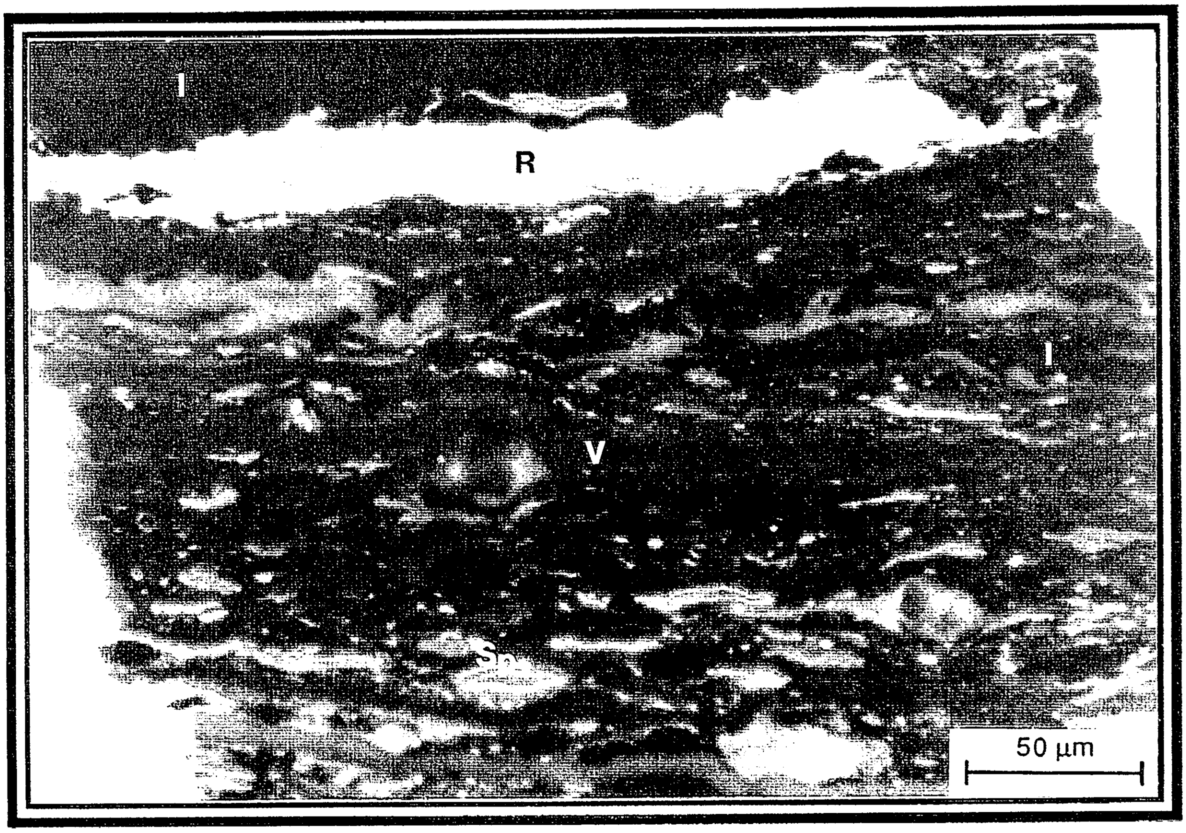

PLATE 4b: Photomicrograph showing coal, microlithotype clarodurite. Vitrinite (V: black), inertinite (I: black) and liptinites, resinite (R: yellow) and sporinite (Sp: yellow/orange). [Sample A-923.186, 213.6m, oil immersion, UV light, X32].

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PLATE 5a: Photomicrograph showing coal, microlithotype vitrite. Texto-ulminite (T1), eu-ulminite (T2) and telocollinite (T3). [Sample A-923.186, 213.6m, oil immersion, reflected light, X50].

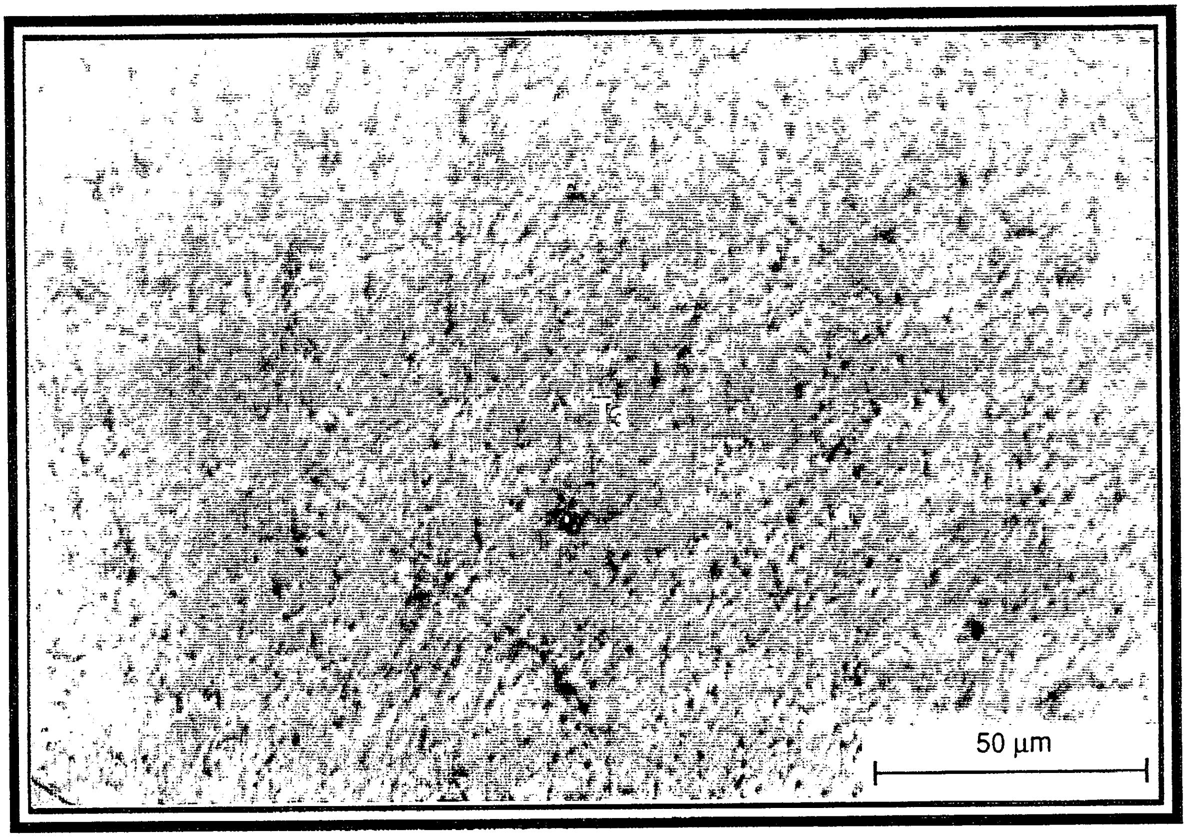

PLATE 5b: Photomicrograph showing coal, microlithotype vitrite. Poorly gelified telocollinite (T3). [Sample A-923.187, 667m, oil immersion, reflected light, X50].

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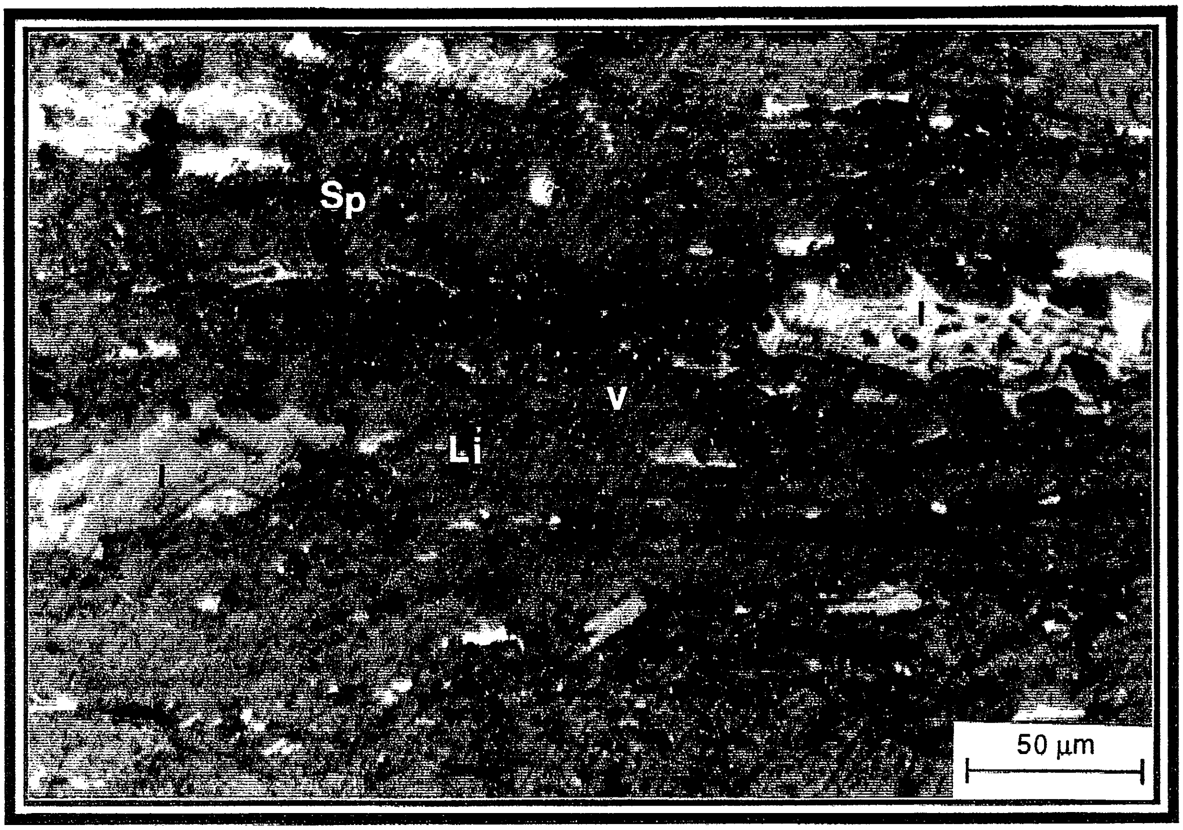

PLATE 6a: Photomicrograph showing coal, microlithotype duroclarite. Vitrinite (V: mid-grey), inertinite (I: pale-grey), liptinites sporinite (Sp: black) and liptodetrinite (Li: black). [Sample A-915.187, 667m, oil immersion, reflected light, X32].

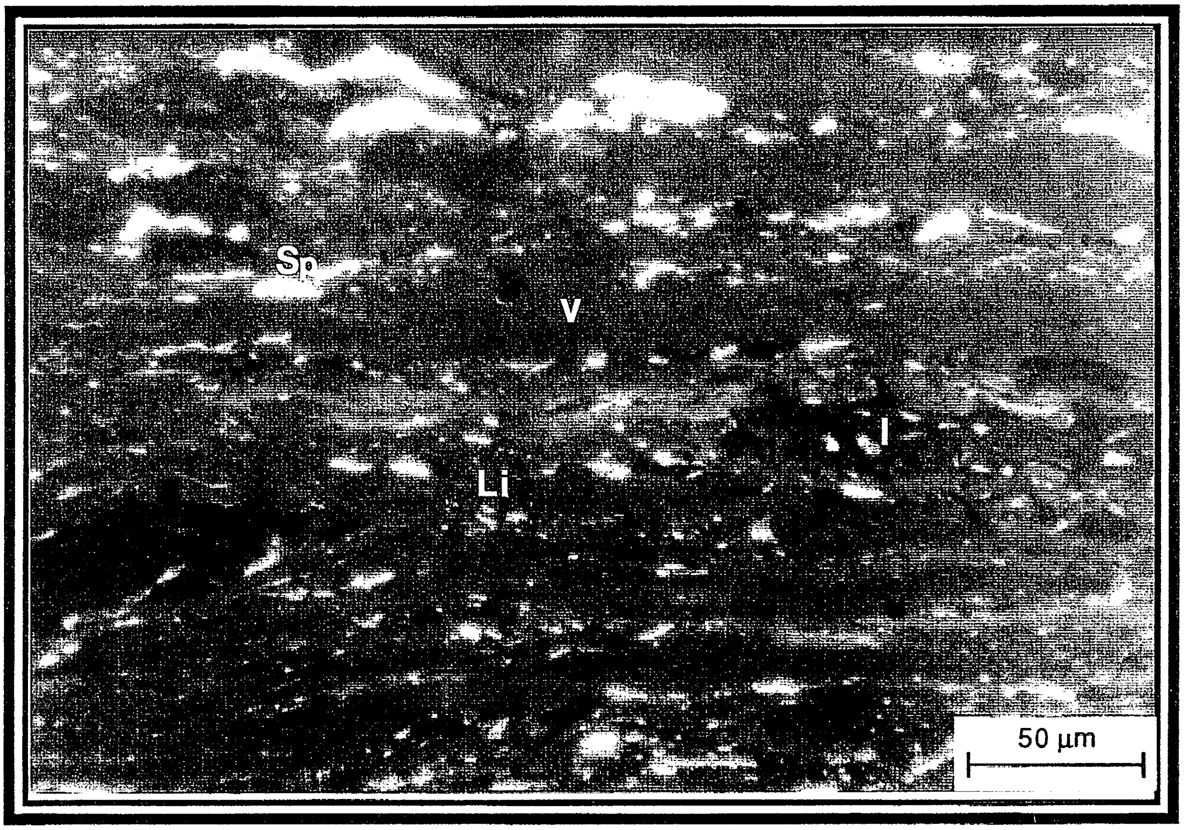

PLATE 6b: Photomicrograph showing coal, microlithotype duroclarite. Vitrinite (V: black), inertinite (I: black), liptinites sporinite (Sp: yellow] and liptodetrinite (Li: yellow/orange). [Sample A-915.187, 667m, oil immersion, UV light, X32].

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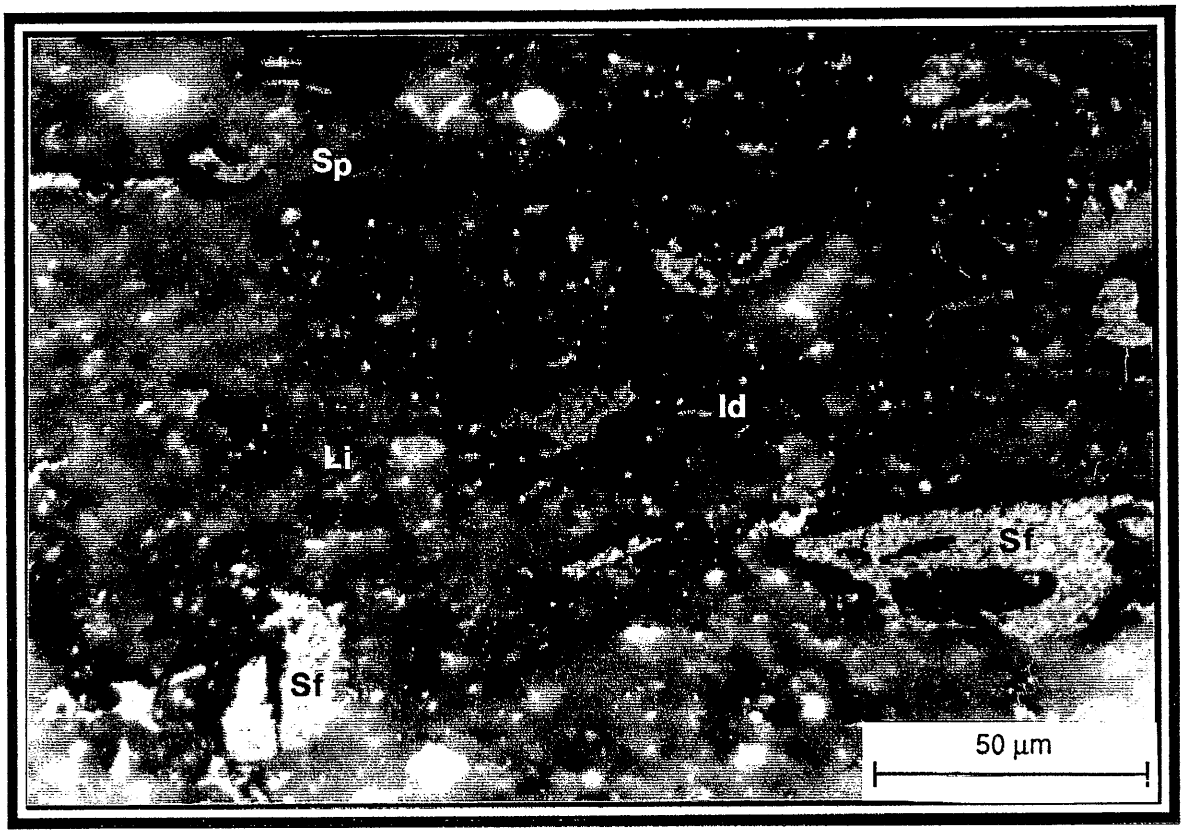


PLATE 7a: Photomicrograph showing a typical view of d.o.m. in shale. Macerals comprise sporinite (Sp: brown), liptodetrinite (Li: brown), semifusinite (Sf: pale-grey) and inertodetrinite (Id: pale-grey). [Sample A-915.188, 706.0m, oil immersion, reflected light, X50].

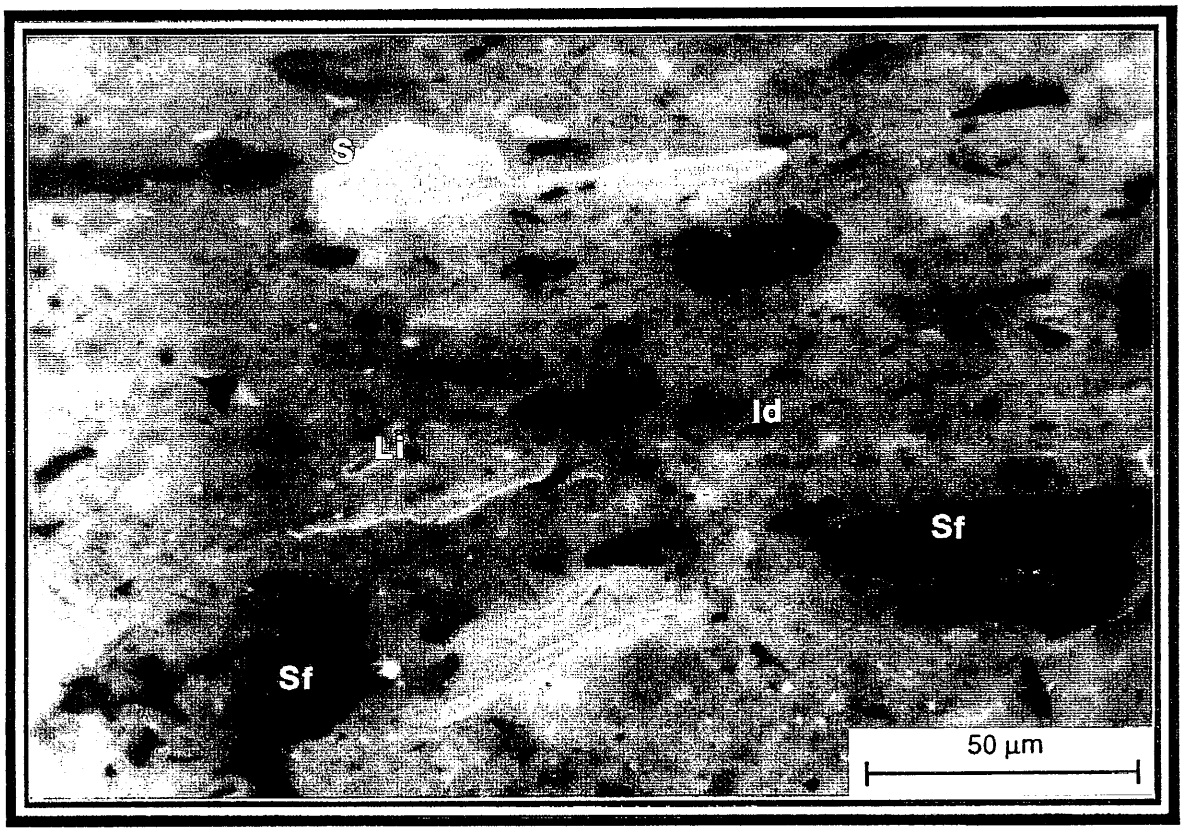


PLATE 7b: Photomicrograph showing a typical view of d.o.m. in shale. Macerals comprise sporinite (Sp: yellow/orange), liptodetrinite (Li: yellow/orange), semifusinite (Sf: black) and inertodetrinite (Id: black). [Sample A-915.188, 706.0m, oil immersion, UV light, X50].

APPENDIX B
PETROGRAPHIC DESCRIPTIONS

KEY TO PETROLOGICAL DESCRIPTIONS

Maceral Group

V	Vitrinite
I	Inertinite
L	Liptinite

Colour in UV Light (F)

G	Green
G/Y	Green/yellow
LY	Lemon-yellow
Y	Yellow
Y/O	Yellow/orange
LO	Light-orange
MO	Mid-orange
DO	Dark-orange
Br	Brown

Colour in Reflected Light (R)

PBr	Pale-brown
DBr	Dark-brown
R/Br	Red/brown
B	Black

Liptinite Abundance Category

ABUNDANCE	RANGE (vol %)
Major	> 10.0
Abundant	2.0 -10.0
Common	0.5 - 2.0
Sparse	0.1 - 0.5
Rare	< 0.1

APPENDIX B

Organic Petrographic Descriptions: Mocamboro-1

Sample N°	: A-923.184	**Group**	: Otway
Depth (m)	: 64.2	**Formation**	: Eumeralla
Sample	: Core 4C	**D.O.M.**	: Moderate/Rich 5 - 10%

Lithology : Shale >> Coal (90:10) The folowing is the maceral description for the shale

Ratio V:I:L : I > V ≥ L (80:10:5)

Vitrinite : The texto-ulminite, eu-ulminite and telocollinite phytoclasts are surrounded by black matrix bituminite. Some coal fragments occur in the shale, vitrinite is present as eu-ulminite and telocollinite both are associated with resinite.

Inertinite : Detro-inertinite (inertodetrinite) > telo-inertinite (semifusinite > fusinite).

Liptinite :

Maceral	**Colour**	**Intensity**	**Abundance**
Sporinite	Y	Bright-Dull	Abundant
Resinite	Y	Bright	Common
Liptodetrinite	G/Y-Y	Intense	Sparse
Cutinite	Y	Intense	Rare

Bituminite :

Staining	**Colour (F)**	**Colour (R)**	**Abundance**
Matrix	None	R/Br - B	Moderate
Wisps/Patches	None	DBr	Common

Mineralogy : Pyrite; common, unoxidised framboids and specks.

Comments : Occasionally there are small (30µm) intensely yellow fluorescing forms, possibly planktonic algae.

Sample N°	: A-923.184	**Group**	: Otway
Depth (m)	: 64.2	**Formation**	: Eumeralla
Sample	: Core 4C	**Microlithotype**	: Vitrite

Lithology : Coal.

Ratio V:I:L : V >> I (95:<5)

Vitrinite : Telovitrinite is present as texto-ulminite grading through to telocollinite. Eu-ulminite is the dominant maceral.

Inertinite : Telo-inertinte is present as rare phytoclasts of cellular semifusinite.

Liptinite : None.

Mineralogy : No pyrite.

Comments : The coal is poorly gelified.

Sample N°	:	A-923.185	**Group**	:	Otway
Depth (m)	:	96.8	**Formation**	:	Eumeralla
Sample	:	Core 5A	**D.O.M.**	:	Poor <1%

Lithology : Shale
Ratio V:I:L : I >> V > L [99:1: <1]
Vitrinite : Texto-ulminite phytoclasts are surrounded by black matrix bituminite.
Inertinite : Detro-inertinite (inertodetrinite) > telo-inertinite (semifusinite) are also commonly surrounded by matrix bituminite.

Liptinite :

Maceral	**Colour (F)**	**Intensity**	**Abundance**
Sporinite	Y/O	Dull	Rare

Bituminite :

Staining	**Colour (F)**	**Colour (R)**	**Abundance**
Matrix	None	O	Light
Wisps	None	B	Sparse

Mineralogy : Pyrite: rare, unoxidised crystals.
Comments :

Sample N°	:	A-923.186	**Group**	:	Otway
Depth (m)	:	213.6	**Formation**	:	Eumeralla
Sample	:	Core 7B	**Microlithotype**	:	Clarodurite & vitrite

Lithology : Coal > shale The folowing is the maceral description for the coal.
Ratio V:I:L : I > V > L 70:20:10
Vitrinite : Telovitrinite (texto-ulminite to telocollinite with texto-ulminite and eu-ulminite most abundant) = detrovitirnite (densinite to desmocollinite), poorly gelified.
Inertinite : Telo-inertinite (semifusinite > fusinite>> sclerotinite) > detro-inertinite (inertodetrinite).

Liptinite :

Maceral	**Colour (F)**	**Intensity**	**Abundance**
Sporinite	Y/O	Bright-Dull	Abundant
Resinite	Y	Intense/Bright	Abundant
Liptodetrinite	LO	Dull	Common
Cutinite	LO	Dull	Common
Suberinite	LO	Dull	Sparse

Mineralogy : Pyrite; none.
Comments : The coal is banded, the microlithotypes clarodurite alternate with vitrite and inertite. Occasionally sclerotinite and also thick walled megaspores (400µm diameter) with a resinite filling are present.

Sample N°	:	A-923.186	**Group**	:	Otway
Depth (m)	:	213.6	**Formation**	:	Eumeralla
Sample	:	Core 7B	**D.O.M.**	:	Rich 10% - 50%

Lithology : Coaly shale

Ratio V:I:L : I > V $\geq$ L [60:30:10]

Vitrinite : Wisps and stringers of poorly gelified texto-ulminite, eu-ulminite and telocollinite are surrounded by black matrix bituminite.

Inertinite : Telo-inertinite (semifusinite > fusinite) > detro-inertinite (inertodetrinite).

Liptinite :

Maceral	**Colour (F)**	**Intensity**	**Abundance**
Sporinite	Y/O	Moderate-Dull	Common
Liptodetrinite	Y?o	Moderate-Dull	Common
Resinite	Y	Bright	Common
Cutinite	DO	Dull	Sparse

Bituminite :

Staining	**Colour (F)**	**Colour (R)**	**Abundance**
Background	DB	O-B	Light-dark

Mineralogy : Pyrite; as sparse unoxidised crystals and also replacing woody tissues.

Comments :

Sample N°	:	A-923.187	**Group**	:	Otway
Depth (m)	:	667 - 669	**Formation**	:	Eumeralla
Sample	:	Cuttings	**Microlithotype**	:	Vitrite & duroclarite

Lithology : Coal

Ratio V:I:L : V >> I > L [80: 15 :5]

Vitrinite : Detrovitrinite (desmocollinite) >> telovitrinite (eu-ulminite and telocollinite).

Inertinite : Detro-inertinite (inertodetrinite) > telo-inertinte (semifusinite)

Liptinite :

Maceral	**Colour (F)**	**Intensity**	**Abundance**
Sporinite	Y/O	Moderate - Dull	Abundant
Resinite	Y-B	Bright-Dull	Common
Liptodetrinite	Y/O	Moderate	Common
Cutinite	Y/O-LO	Bright-Dull	Rare

Mineralogy : Pyrite: none.

Sample N°	:	A-923.188	**Group**	:	Otway
Depth (m)	:	706.0	**Formation**	:	Eumeralla
Sample	:	Core 13B	**D.O.M.**	:	Rich 5% - 10%

Lithology	:	Shale			
Ratio V:I:L	:	I >> L > V	[90:10:<1]		
Vitrinite	:	Reworked phytoclasts < 20 µm, some wisps with dark matrix bituminite staining around the edges and as minor woody fragments (texto-ulminite).			
Inertinite	:	Detro-inertinite (inertodetrinite) = telo-inertinite (semifusinite).			
Liptinite	:	**Maceral**	**Colour (F)**	**Intensity**	**Abundance**
		Sporinite	MO	Moderate - None	Common
		Liptodetrinite	LO	Moderate	Sparse
		Cutinite	MO	Bright-Dull	Rare
Bituminite	:	**Staining**	**Colour (F)**	**Colour (R)**	**Abundance**
	:	Matrix	None	Br	Light
	:	Wisps	None	O-Br	Rich
Mineralogy	:	Pyrite; rare, unoxidised crystals.			
Comments	:	Very occasionally there are small (mm) planktonic cysts, possibly dinoflagellates.			

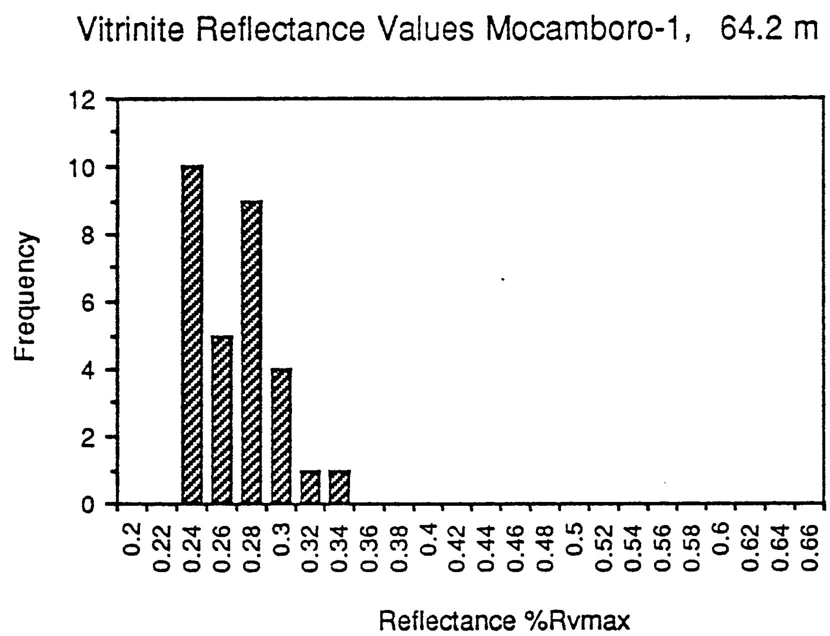
APPENDIX C
Vitrinite Reflectance Measurements

Sample Number: A-923-184
Depth: 64.2 m
Reflectance Measured: Maximum
Client: SADME

Vitrinite Reflectance Values

0.24	0.26	0.29
0.24	0.27	0.29
0.24	0.27	0.29
0.24	0.27	0.29
0.24	0.27	0.30
0.25	0.28	0.30
0.25	0.28	0.30
0.25	0.28	0.31
0.25	0.28	0.33
0.25	0.29	0.35

Number of Measurements = 30
Mean Maximum Reflectance = 0.27
Standard Deviation = 0.03
Range = 0.23 - 0.35



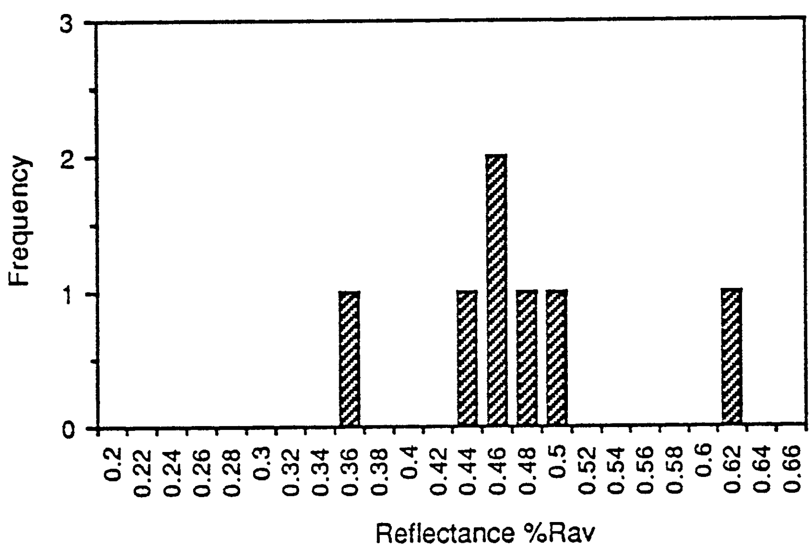
Sample Number: A-923-185
Depth: 96.8 m
Reflectance Measured: Average
Client: SADME

Vitrinite Reflectance Values

0.36	0.49
0.44	0.51
0.45	0.62
0.46	

Number of Measurements	= 7
Mean Average Reflectance	= 0.48
Standard Deviation	= 0.08
Range	= 0.36 - 0.62

Vitrinite Reflectance Values Mocamboro-1, 96.8m

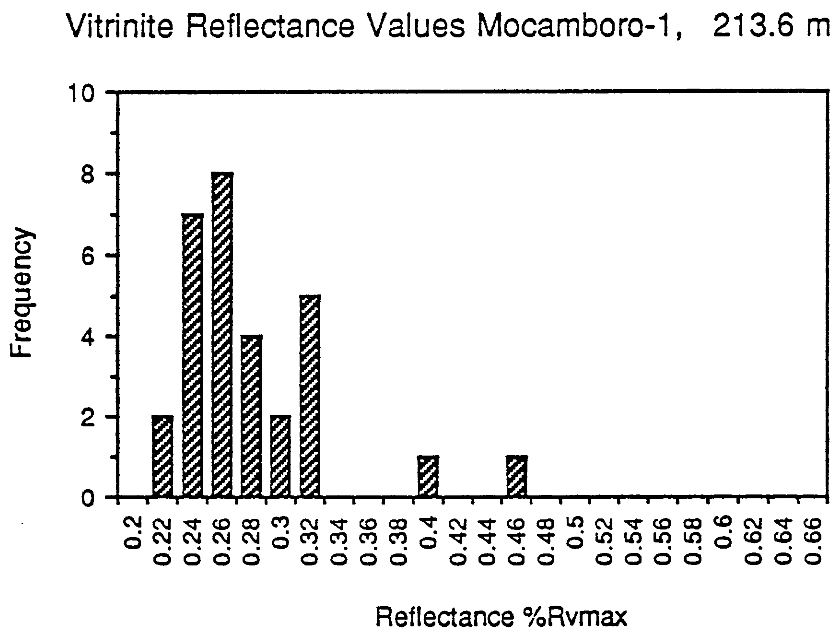


Sample Number: A-923-186
Depth: 213.6 m
Reflectance Measured: Maximum
Client: SADME

Vitrinite Reflectance Values

0.22	0.26	0.29
0.22	0.26	0.30
0.24	0.26	0.31
0.24	0.26	0.32
0.25	0.26	0.32
0.25	0.27	0.32
0.25	0.27	0.32
0.25	0.28	0.33
0.25	0.28	0.40
0.26	0.29	0.47

Number of Measurements	= 30
Mean Maximum Reflectance	= 0.28
Standard Deviation	= 0.05
Range	= 0.22 - 0.47



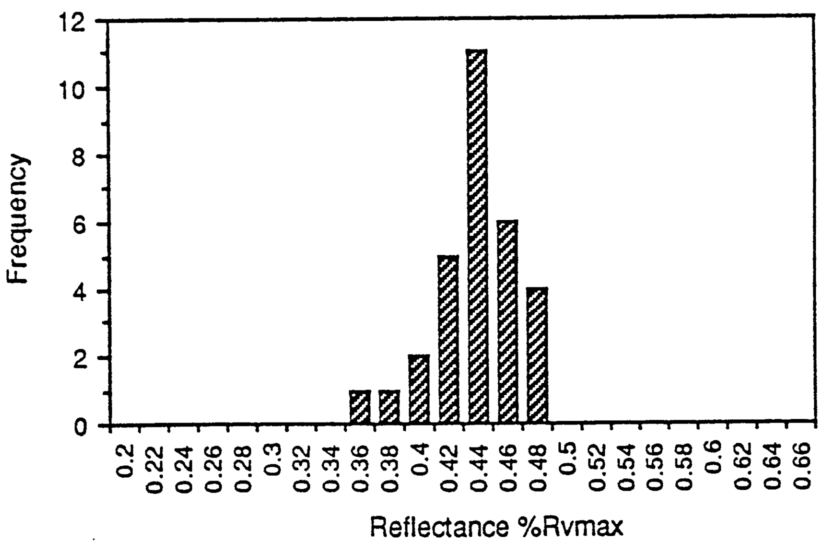
Sample Number: A-923-187
Depth: 667- 669 m
Reflectance Measured: Maximum
Client: SADME

Vitrinite Reflectance Values

0.36	0.44	0.46
0.38	0.44	0.46
0.40	0.44	0.47
0.41	0.44	0.47
0.42	0.44	0.47
0.43	0.44	0.47
0.43	0.44	0.48
0.43	0.45	0.48
0.43	0.45	0.49
0.44	0.45	0.49

Number of Measurements = 30
Mean Maximum Reflectance = 0.44
Standard Deviation = 0.03
Range = 0.36 - 0.49

Vitrinite Reflectance Values Mocamboro-1, 667 m



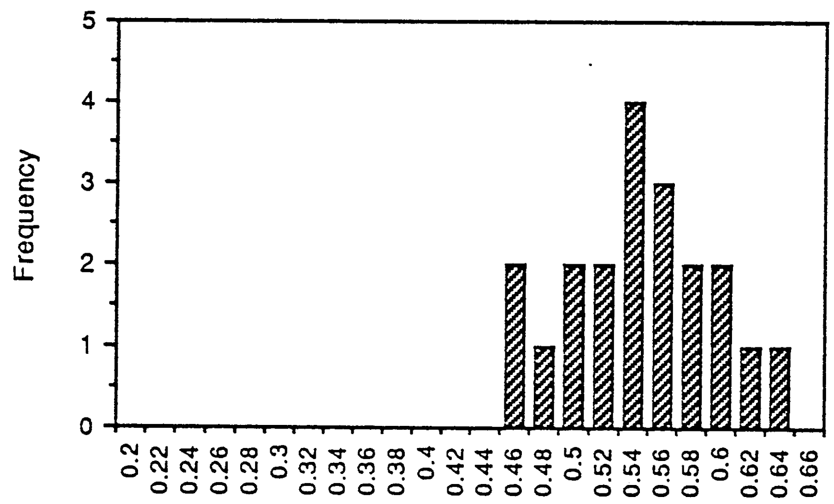
Sample Number: A-923-188
Depth: 706.0 m
Reflectance Measured: Maximum
Client: SADME

Vitrinite Reflectance Values

0.46	0.54	0.58
0.47	0.55	0.59
0.49	0.55	0.60
0.50	0.55	0.61
0.51	0.56	0.62
0.52	0.56	0.64
0.52	0.57	

Number of Measurements = 20
Mean Maximum Reflectance = 0.55
Standard Deviation = 0.05
Range = 0.46 - 0.64

Vitrinite Reflectance Values Mocamboro-1, 706.0 m



APPENDIX 9

APPENDIX
9

PALYNOLOGICAL REPORT

PALYNOLOGY OF VICTORIAN GEOLOGICAL SURVEY

MOCAMBORO-11, OTWAY BASIN, VICTORIA

BY

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FOR VICTORIAN GEOLOGICAL SURVEY JUNE, 1991.

PALYNOLOGY OF VICTORIAN GEOLOGICAL SURVEY

MOCAMBORO-11, OTWAY BASIN, VICTORIA

BY

ROGER MORGAN

CONTENTS

I SUMMARY:

9.8m (core)-28.8m (core) : upper paradoxa zone : mid Albian : non-marine : immature

102.99m (core) : lower paradoxa zone : mid Albian : non-marine : immature

213.44m (core)-360m (swc) : striatus zone : early Albian : non-marine : immature

414m (swc)-965m (swc) : hughesi zone : Aptian : non-marine : marginally mature

1006m (swc)-1066.7m (core) : upper wonthaggiensis zone : late Neocomian : marginally mature

1161.8m (core)-1258.8m (core) : lean and indeterminate : non-marine : marginally mature

1317m (core)-1346m (swc) : upper australiensis zone : early Neocomian : non-marine : marginally mature

II INTRODUCTION:

Twenty-six sidewall core and conventional core samples were processed, to provide information on age, environment and maturity .

Palynomorph occurence data are shown as Appendix I and form the basis for the assignment of the samples to six spore-pollen units of mid Albian to early Neocomian age. The Cretaceous spore-pollen zonation is essentially that of Dettmann and Playford (1969), but has been significantly modified and improved by various authors since, and most recently discussed in Helby et al (1987), as shown on figure 1 and modified by Morgan (1985) for application in the Otway Basin. The Tertiary zonation is that of Stover and Partridge (1973) and Stover and Evans (1973) as modified by Partridge (1976).

Maturity data was generated in the form of Spore Colour Index, and is plotted on figure 2 Maturity profile of Mocamboro-11. The oil and gas windows in figure 2 follow the general consensus of geochemical literature. The oil window corresponds to spore colours of light-mid brown (Staplin Spore Colour Index of 2.7) to dark brown (3.6). These correspond to vitrinite reflectance values of 0.6% to 1.3%.

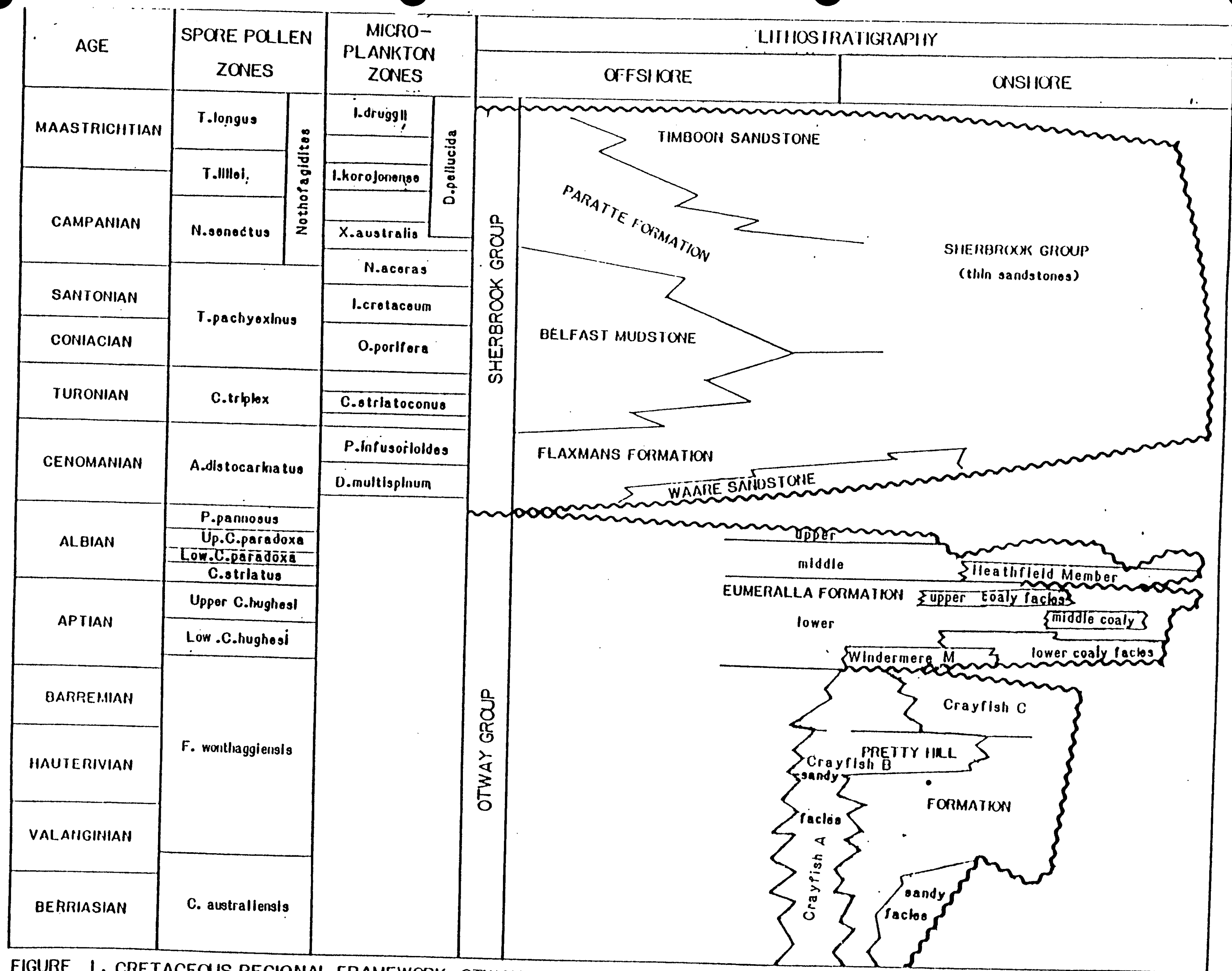

FIGURE 1. CRETACEOUS REGIONAL FRAMEWORK, OTWAY BASIN

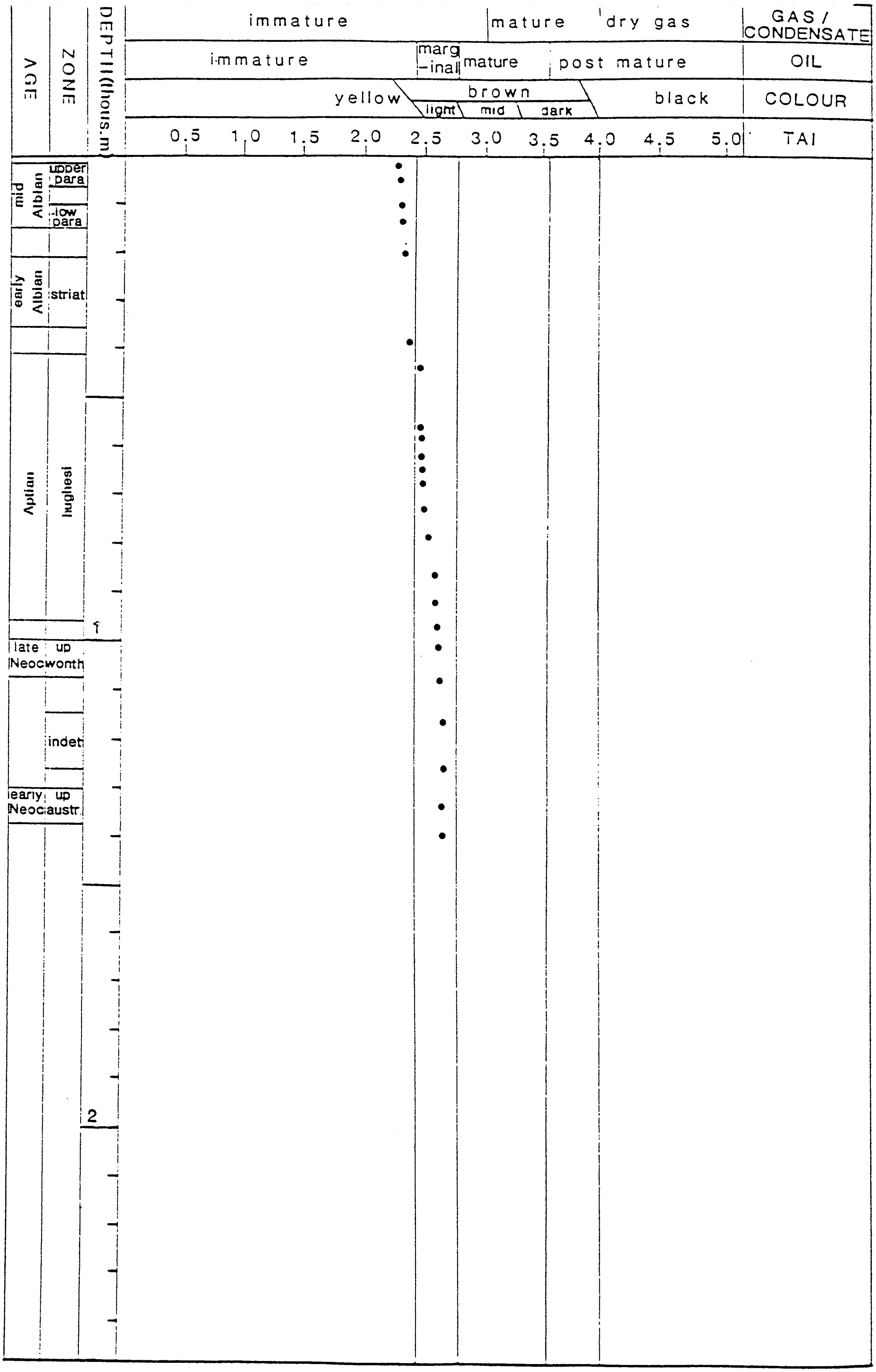

FIGURE 2 MATURITY PROFILE, MOCAMBORO-11

IIII PALYNOSTRATIGRAPHY:

A. 9.8m (core)-28.8m (core) : upper paradoxa zone

Assignment to the upper Coptospora paradoxa zone of mid Albian age is indicated at the top by the absence of younger indicators and at the base by oldest Pilosisporites grandis. Trilobosporites tribotrys was not seen below this interval and confirms the assignment. Frequent species include Cyathidites, Falcisporites similis and Microcachryidites antarcticus.

Non-marine fluvial environments are indicated by the common and diverse spore-pollen, common cuticle, and absence of freshwater or saline acritarchs.

Yellow to light brown spore colours indicate immaturity for hydrocarbon generation.

These features normally occur in the upper part of the middle Eumeralla Formation in the sense of the Kopsen and Scholefield (1990). this implies that the upper Eumeralla Formation has been lost by erosion.

B. 102.99m (swc) : lower paradoxa zone

Assignment to the lower C. paradoxa zone of mid Albian age is indicated by oldest C. paradoxa without younger indicators. Common forms are Cyathidites spp and Cicatricosisporites australiensis. Trilobosporites trioreticulosus occurs to the interval base.

Non-marine fluvial environments are indicated by the common and diverse spore-pollen and the absence of acritarchs.

Yellow to light brown spore colours indicate immaturity for hydrocarbon generation.

These features normally occur in the lower part of the middle Eumeralla Formation of Kopsen and Scholefield (1990) including the Heathfield Sandstone Member.

C. 213.44m (core)-360m (swc) : striatus zone

Assignment to the Crybelosporites striatus spore-pollen zone is indicated at the top by the absence of younger markers and confirmed by youngest Pilosisporites parvispinosus and at the base by oldest C. striatus, confirmed by youngest Cyclosporites hughesi in the sample beneath. Within the interval, common species include Cyathidites spp., Cicatricosisporites australiensis, F. similis, M. antarcticus, and Osmundacidites wellmannii. The top sample is distinctively different from the others by containing frequent C. australiensis and Aequitriradites verrucosus. Within the interval, Dictyotosporites speciosus, Pilosisporites spp. and Triassic reworking are consistent.

Non-marine environments are indicated by common and diverse spores and pollen, common cuticle fragments, and the absence of saline acritarchs. Rare algal acritarchs (Schizosporis spp) indicate some lacustrine influence.

Yellow to light brown spore colours indicate immaturity for hydrocarbon generation.

These features are normally seen in the upper part of the lower Eumeralla Formaiton, often in coaly facies.

D. 414m (swc)-965m (swc) : hughesi zone - notensis now

Assignment to the Cyclosporites hughesi zone is indicated at the top by youngest C. hughesi and at the base by oldest Pilosisporites notensis. Within the interval Cyathidites, F. similis and O. wellmanii are frequent in most samples. C. australiensis, P. notensis and Aequitriradites verrucosus are intermittently frequent (618.14m, 788m and 835m) and may represent particular fern rich environments at lake or swamp margin. C. australiensis does not occur below this interval while D. speciosus, C. hughesi and P. notensis are consistent elements. In contrast to the zone above, Triassic reworking was not seen.

Non-marine environments with alternating lacustrine and fluvial influence is indicated by the common and diverse spore-pollen, common cuticle, absence of saline acritarchs and intermittent presence of algal forms (Schizosporis spp). Algal forms are absent at 550m, 590m 669m, 907m and 965m, and present at 414m, 578m, 609m, 618m, 706m, 778m and 835m.

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

These features are normally seen in all except the top of the lower Eumeralla Formation of Kopson and Scholefield (1990).

E. 979.1 (swc)-1000m (core) : indeterminate

These samples were virtually barren with only a few spores and pollen. The upper core includes C. paradoxa and T. trioreticulosus which are clearly caved into the porous sandstone. The lower core contains a very nondescript assemblage of long ranging forms and could be in place. Clearly neither are zone diagnostic.

F. 1006m (swc)-1066.7m (core) : upper wonthaggiensis

Assignment to the upper Foraminisporis wonthaggiensis zone is indicated at the top by the absence of younger indicators (supported by youngest Microfasta evansii and a downhole influx of Contignisporites cooksoniae) and at the base by oldest Foraminisporis wonthaggiensis (at 1006m swc) and Triporoletes reticulatus (at 1066.7m core) Retitriletes watherooensis has its youngest occurrence at 1066.7m. Within the interval, Cyathidites, Falcisporites and Osmundacidites are common. C. hughesi, D. speciosus, C. cooksoniae and T. reticulatus are consistent components.

Non-marine dominantly fluvial environments are indicated by the common and diverse spore-pollen and absence of spiny acritarchs. Non-spiny acritarchs are represented only by a single specimen of M. evansii at 1006m suggest slight lacustrine influence.

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

These features are normally seen in the upper part of the Pretty Hill or Crayfish Formations (in the Crayfish C to D units of Kopsen and Scholefield (1990)).

G. 1161.8m (core)-1258.8m (core) : lean and indeteminate

these samples are very lean but do contain small assemblages of longranging spores and pollen. zone diagnostic taxa are absent, but the dates above and below suggest that this interval probably belongs to the lower wonthaggiensis zone.

Non-marine fluvial environments are indicated by the dominant spore-pollen, common cuticle and absence of acritarchs.

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

These features are common in the very sandy parts of the Pretty Hill Formation and correlatives.

H. 1317m (core)-1346m (swc) : upper australiensis zone

Assignment to the upper part of the Cicatricosisporites australiensis zone is indicated at the top by the absence of the younger indicator D. speciosus and at the base by oldest Cyclosporites hughesi. Crybelosporites stylosus occurs at 1317-23m and R. watherooensis occurs at 1346m. Cyathidites, Falcisporites and Osmundacidites are frequent.

Non-marine fluvial environments are indicated by the common and diverse spore-pollen and the absence of acritarchs or algal forms.

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

These features are normally seen at the base of the Pretty Hill Formation and its correlatives.

IV CONCLUSIONS:

The well appears to have drilled a conformable Pretty Hill to middle Eumeralla sequence. The most likely Pretty Hill top is the log pick at 968m with the shaley interval 968-1164m corresponding to the shaley upper Pretty Hill (= Crayfish B-D) and the massive sand 1164-1374m to the sandy lower Pretty Hill (= Crayfish A). The minor sand at 588-602m is therefore an intra Eumeralla sand significantly older than the Heathfield Member and younger than the Eumeralla Marker.

V REFERENCES:

Dettmann, M.E. and Playford, G. (1969) Palynology of the Australian Cretaceous : a review In Stratigraphy and Palaeontology. Essays in honour of Dorothy Hill, KSW Campbell Ed. ANU Press, Canberra 174-210

Helby, R.J., Morgan, R.P. and Partridge, A.D. (1987) A palynological zonation of the Australian Mesozoic In Studies in Australian Mesozoic Palynology Assoc. Australas. Palaeontols. Mem 4 1-94

Kopsen, E. and Scholefield, T. (1990) Prospectivity of the Otway Supergroup in the Central and Western Otway Basin Apea J. 30 (1) : 263-279

Morgan, R.P. (1985) Palynology review of selected oil drilling, Otway basin, South Australia unpubl. rept. for Ultramar Australia

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

Stover, L.E. and Evans, P.R. (1973) Upper Cretaceous-Eocene spore-pollen zonation, offshore Gippsland Basin, Australia Spec. Publ. geol. Soc. Austr. 4 : 55-72

Stover, L.E. and Partridge, A.D. (1973) Tertiary and Late Cretaceous spores and pollen from the Gippsland Basin, south-eastern Australia Proc. R. Soc. Vict., 85 : 236-286

MOCAMBORA - 11 Palynological data

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C L I E N T: GEOLOGICAL SOCIETY of VICTORIA
W E L L: MOCAMBORO-11
F I E L D / A R E A: ONSHORE OTWAY BASIN, VICTORIA

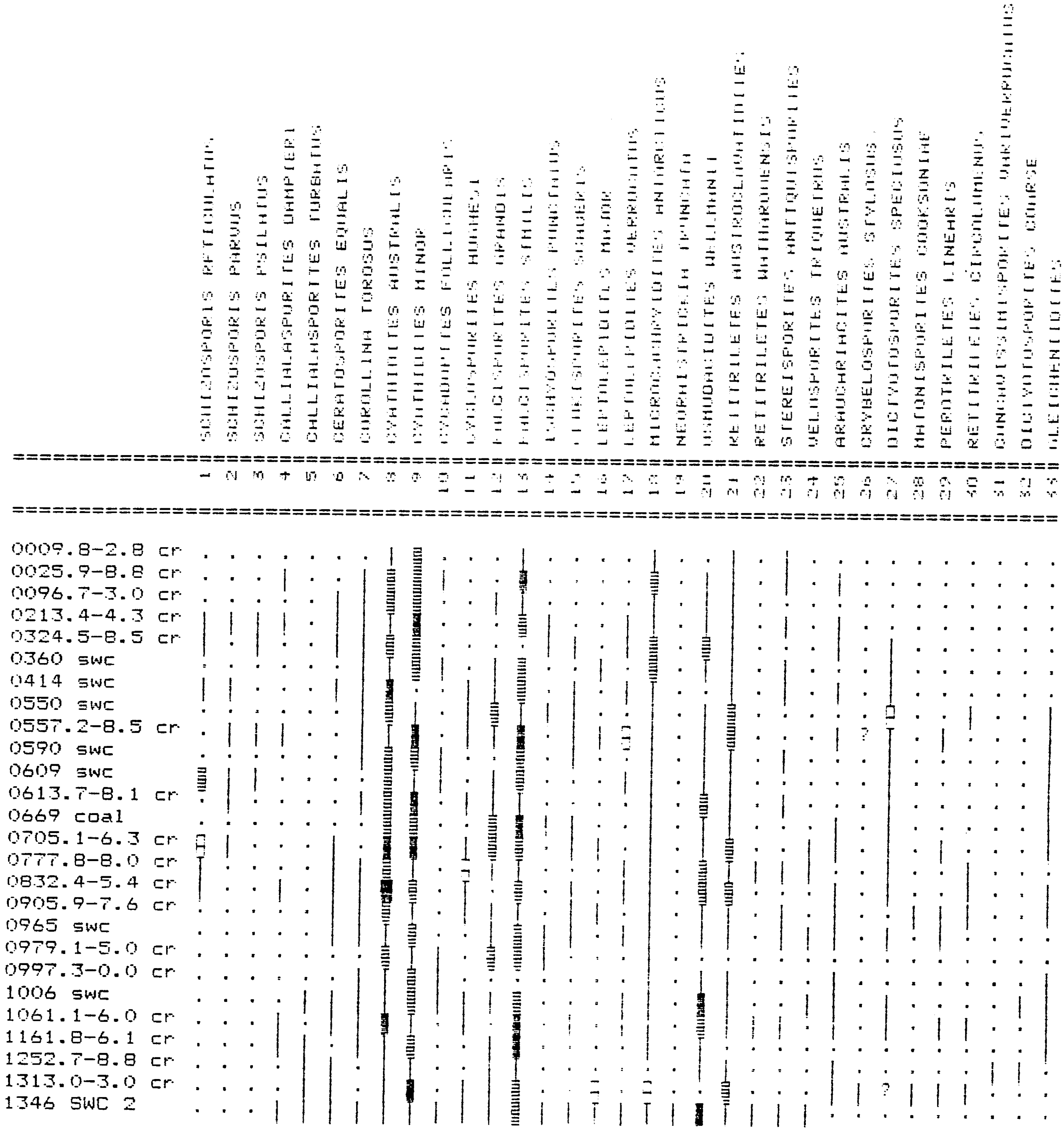
A N A L Y S T: ROGER MORGAN   D A T E : MAY 1991
N O T E S: ALL DEPTHS IN METRES

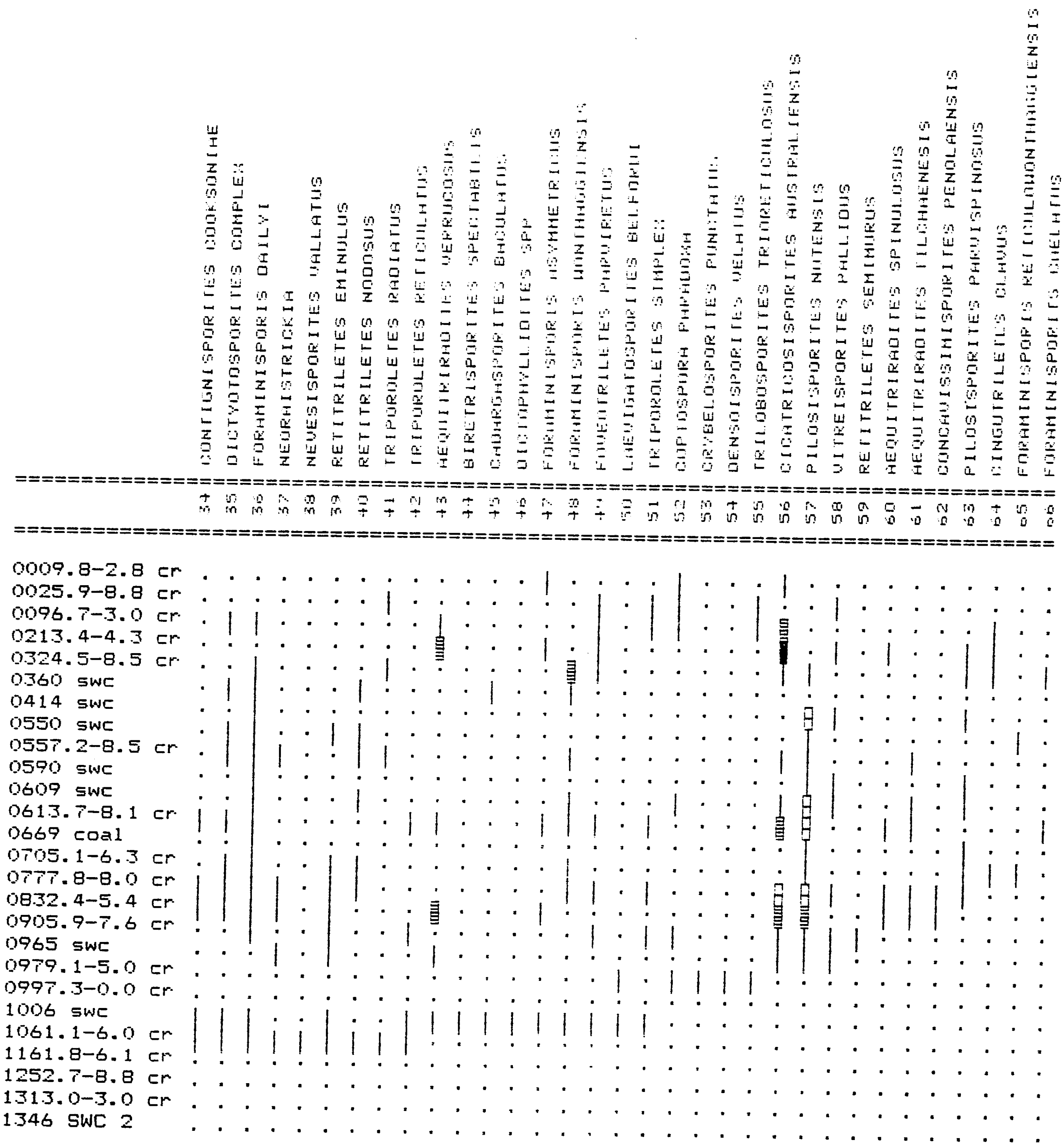
RANGE CHART OF GRAPHIC ABUNDANCES BY LOWEST APPEARANCE Dinos & S/P

Key to Symbols

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

| = Few
= Common
= Abundant
? = Questionably Present
. = Not Present





34 CONTIGNISPORITES COOKSONIAE
35 DICTYOTOSPORITES COMPLEX
36 FORAMINISPORIS DAILYI
37 NEORAISTRICKIA
38 NEVESISPORITES VALLATUS
39 RETITRILETES EMINULUS
40 RETITRILETES NODOSUS
41 TRIPOROLETES RADIATUS
42 TRIPOROLETES RETICULATUS
43 AEQUITRIRADITES VERRUCOSUS
44 BIRETRISPORITES SPECTABILIS
45 CAVARGASPORITES BACULATUS
46 DICTOPHYLLIDITES SPP
47 FORAMINISPORIS ASYMMETRICUS
48 FORAMINISPORIS WONTHAGGIENSIS
49 FOVEOTRILETES PARVIRETUS
50 LAEVIGATOSPORITES BELFORDII
51 TRIPOROLETES SIMPLEX
52 COPTOSPORA PARADOXA
53 CRYBELOSPORITES PUNCTATUS
54 DENSOISPORITES VELATUS
55 TRILOBOSPORITES TRIORETICULOSUS
56 CICATRICOSISPORITES AUSTRALIENSIS
57 PILOSISPORITES NOTENSIS
58 VITREISPORITES PALLIDUS
59 RETITRILETES SEMIMURUS
60 AEQUITRIRADITES SPINULOSUS
61 AEQUITRIRADITES TILCHAENESIS
62 CONCAVISSIMISPORITES PENOLAENSIS
63 PILOSISPORITES PARVISPINOSUS
64 CINGUTRILETES CLAVUS
65 FORAMINISPORIS RETICULOWONTHAGGIENSIS
66 FORAMINISPORITES ASALATUS
0009.8-2.8 cr
0025.9-8.8 cr
0096.7-3.0 cr
0213.4-4.3 cr
0324.5-8.5 cr
0360 swc
0414 swc
0550 swc
0557.2-8.5 cr
0590 swc
0609 swc
0613.7-8.1 cr
0669 coal
0705.1-6.3 cr
0777.8-8.0 cr
0832.4-5.4 cr
0905.9-7.6 cr
0965 swc
0979.1-5.0 cr
0997.3-0.0 cr
1006 swc
1061.1-6.0 cr
1161.8-6.1 cr
1252.7-8.8 cr
1313.0-3.0 cr
1346 SWC 2

	67 LYCOPODIACIDITES ASPERATUS	68 STOVERISPORITES LUNARIS	69 RETITRILETES FACETUS	70 CRYBELOSPORITES STRIATUS	71 CRYBELOSPORITES BERBEROIDES	72 NOTHOFAGIDITES EMARCIDUS	73 NOTHOFAGIDITES FALCATA	74 PROTEACIDITES SP	75 CICATRICOSISPORITES CUNEIFORMIS	76 CICATRICOSISPORITES HUGHESI	77 COPTOSPORA SP	78 DICTYOPHYLLIDITES HARRISII	79 DICTYOPHYLLIDITES MORTONI	80 LAEVIGATOSPORITES OVATUS	81 PILOSISPORITES GRANDIS	82 TRILOBOSPORITES TRIBOTRYS	83 FOVEOSPORITES MORETONENSIS	
0009.8-2.8 cr	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	x	0009.8-2.8 cr
0025.9-8.8 cr	.	.	.	x	.	.	.	.	.	.	.	.	.	.	x	x	.	0025.9-8.8 cr
0096.7-3.0 cr	.	.	x	x	.	.	.	.	x	x	x	x	x	x	.	.	.	0096.7-3.0 cr
0213.4-4.3 cr	.	.	.	□	.	.	.	.	.	.	.	.	.	.	.	.	.	0213.4-4.3 cr
0324.5-8.5 cr	.	.	.	x	x	x	x	x	.	.	.	.	.	.	.	.	.	0324.5-8.5 cr
0360 swc	x	.	.	x	.	.	.	.	.	.	.	.	.	.	.	.	.	0360 swc
0414 swc	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0414 swc
0550 swc	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0550 swc
0557.2-8.5 cr	x	.	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0557.2-8.5 cr
0590 swc	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0590 swc
0609 swc	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0609 swc
0613.7-8.1 cr	x	x	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0613.7-8.1 cr
0669 coal	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0669 coal
0705.1-6.3 cr	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0705.1-6.3 cr
0777.8-8.0 cr	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0777.8-8.0 cr
0832.4-5.4 cr	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0832.4-5.4 cr
0905.9-7.6 cr	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0905.9-7.6 cr
0965 swc	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0965 swc
0979.1-5.0 cr	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0979.1-5.0 cr
0997.3-0.0 cr	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0997.3-0.0 cr
1006 swc	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1006 swc
1061.1-6.0 cr	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1061.1-6.0 cr
1161.8-6.1 cr	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1161.8-6.1 cr
1252.7-8.8 cr	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1252.7-8.8 cr
1313.0-3.0 cr	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1313.0-3.0 cr
1346 SWC 2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1346 SWC 2

SPECIES LOCATION INDEX

Index numbers are the columns in which species appear.

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43	AEQUITRIRADITES VERRUCOSUS
25	ARAUCARIACITES AUSTRALIS
44	BIRETRISPORITES SPECTABILIS
45	CADARGASPORITES BACULATUS
4	CALLIALASPORITES DAMPIERI
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APPENDIX 10

APPENDIX
10

CORE ANALYSIS
&
PETROLOGICAL REPORT

28 August 1990

SA Department of Mines & Energy
Oil, Gas and Coal Division
PO Box 151
EASTWOOD SA 5063

Attention: The Director-General

REPORT: 008/055

CLIENT REFERENCE:	NERDDC Project 1424
MATERIAL:	Core Plugs
LOCALITY:	Victoria
WORK REQUIRED:	Core Analysis

Please direct technical enquiries regarding this work to the signatory below under whose supervision the work was carried out.

RUSSELL R MARTIN
Laboratory Supervisor
Core Analysis/Special Core Analysis
on behalf of Amdel Core Services Pty Ltd

28 August 1990

SA Department of Mines & Energy
Oil, Gas and Coal Division
PO Box 151
EASTWOOD SA 5063

Attention: The Director-General

FINAL DATA REPORT - CONVENTIONAL CORE ANALYSIS

REPORT: 008/055 - MOCAMBORO NO 11

Sections of core from Mocamboro No 11 were delivered to Amdel Core Services, Adelaide on the 10th of August.

The following report includes tabular data of permeability to air, helium injection porosity, and density determinations. Data presented graphically includes a porosity versus permeability to air plot.

The data contained in this report has been derived by the following methods:

1. PLUG CUTTING & DRYING

One inch diameter plugs were taken from the sections of core where indicated by the SA Department of Mines. Tap water is used as the bit lubricant. Samples are trimmed square and the offcuts retained. Residual hydrocarbons are extracted from the plugs using a 3:1 chloroform/methanol mix in a Soxhlet extractor.

After cleaning, the plugs were air dried before measurements of helium injection porosity and air permeability were taken.

2. PERMEABILITY TO AIR

A plug sample is used for this measurement and is placed in a Hassler cell to which a confining pressure of 250 psig (1725 kPa) is applied; this pressure is used to prevent bypassing of air around the sides of the sample when the measurement is made. A known pressure is then applied to the upstream sample face and the differential pressure (between the upstream and downstream faces) is monitored at the downstream face. Permeability is then calculated using Darcy's Law.

3. HELIUM INJECTION POROSITY

The porosity of a clean dry core plug is determined as follows: it is first placed in a matrix cup where the grain volume is measured by helium injection: a known volume of helium at a known pressure is expanded into the matrix cup which contains the core plug; the resulting pressure is recorded and the unknown volume (that is, the volume of the grains) is determined using Boyle's Law. The bulk volume is determined by mercury immersion. The difference between the grain volume and the bulk volume is the pore volume and from this the porosity is calculated as the volume percentage of pores with respect to the bulk volume.

4. APPARENT GRAIN DENSITY

The apparent grain density is derived from the measurements described in Section 3, above, and is the ratio of the weight of the core plug divided by the grain volume determined as in paragraph 4.

5. POROSITY AND PERMEABILITY AT OVERBURDEN PRESSURE

To determine the porosity and permeability of the core plug at overburden pressure, the sample is first placed in a cylindrical neoprene sheath and this assembly is loaded into a triaxial hydrostatic cell. The pore volume is then determined at "ambient" pressure. The overburden pressure (the value as supplied by the client) is then applied to the sample in the cell and the pore volume reduction caused by this increase in pressure, is measured. By this means the actual overburden pore volume and the bulk volume can be determined and are used to derive a value for the porosity at the applied overburden pressure. The permeability at overburden pressure is then measured in the hydrostatic cell exactly as described in paragraph 3.

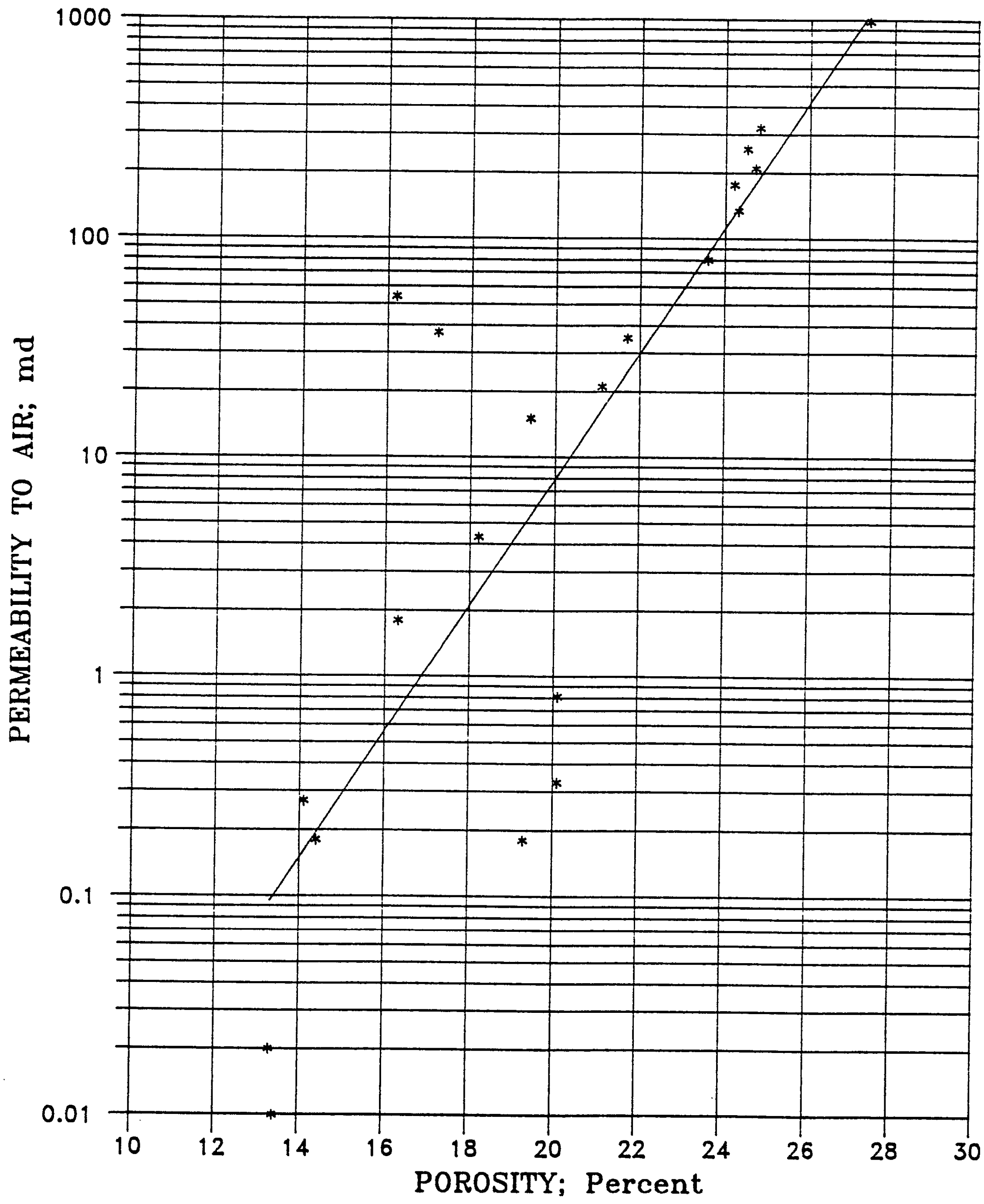
6. ABSOLUTE GRAIN DENSITY

An irregular fragment of sample which has been dried is used for this determination; the sample is coarsely crushed to approximately grain size or a little coarser and the granular material is then weighed. The volume of the grains is determined by conventional pycnometry and by this means the actual density of the grains is determined.

POROSITY vs PERMEABILITY

Company: S.A. Department Mines & Energy
Well : Mocamboro No. 11

Ambient Y = EXP(0.6616X) * 1.421E-005



CONVENTIONAL CORE ANALYSIS

Company: S.A. DEPARTMENT OF MINES
Well: MOCAMBORO No. 11
Field: MOCAMBORO
Location: OTWAY BASIN
Country: AUSTRALIA

File: 008-055
Date: 23/08/90
Core Intervals:

Sample Number	Depth (m)	Porosity (%)		Density		Permeability (md)		Summation of Fluids			Remarks
		He Inj	Roll Av	ABS	Grain	Ka	Roll Av Ka	Por %	Oil %	Water %	
1	984.96	17.2		2.66	2.67	37					
2	983.40	23.6		2.66	2.66	80					
3	982.78	24.3		2.65	2.66	134					SP
4	982.40	24.2		2.65	2.66	176					
5	981.98	21.7		2.65	2.65	35					
6	981.70	24.8		2.65	2.66	321					
7	981.50	24.5		2.65	2.65	256					
8	980.96	21.1		2.64	2.66	21					
9	980.50	24.7		2.65	2.66	209					
10	1021.10	27.4		2.64	2.65	980					
11	1020.28	19.3		2.65	2.66	0.18					
12	1019.27	13.3		2.65	2.64	0.02					
13	1018.25	14.4		2.66	2.66	0.18					
14	1017.45	20.1		2.64	2.64	0.33					
15	1017.10	13.4		2.60	2.61	0.01					
16	1016.38	19.4		2.66	2.67	15					
17	1066.64	16.3		2.65	2.66	1.8					
18	1065.90	16.2		2.60	2.60	54					SP/VF
19	1065.05	18.2		2.65	2.65	4.3					SP/VF
20	1064.15	20.1		2.66	2.68	0.81					SP
21	1063.50	14.1		2.65	2.68	0.27					

VF = Vertical Fracture; HF = Horizontal Fracture; MP = Mounted plug; SP = Short plug
C# = Top of Core; B# = Bottom of Core; OWC = Probable Oil/Water Content;
Tr = Probable Transition Zone; GC = Probable Gas Cap

OVERBURDEN CORE ANALYSIS

Company: S.A. DEPARTMENT OF MINES

Well: MOCAMBORO NO 11 Date: 23/08/90

Field: MOCAMBORO Core Interval:

Location: OTWAY BASIN

Country: AUSTRALIA

Sample Number	Depth	Porosity (%) at Overburden Pressure				Roll Av	Permeability (md) at Overburden Pressure				Roll Av
		Ambient	1500				Ambient	1500			
1	984.96	17.2	16.1				37	30			
2	983.40	23.6	22.7				80	69			
3	982.78	24.3	23.4				134	118			
4	982.40	24.2	22.8				176	151			
5	981.98	21.7	20.8				35	29			
6	981.70	24.8	23.8				321	283			
7	981.50	24.5	23.4				256	221			
8	980.96	21.1	20.1				21	17			
9	980.50	24.7	23.8				209	184			
10	1021.10	27.4	26.3				980	854			
11	1020.28	19.3	18.4				0.18	0.11			
12	1019.27	13.3	13.0				0.02	0.02			
13	1018.25	14.4	13.9				0.18	0.09			
14	1017.45	20.1	19.4				0.33	0.22			
15	1017.10	13.4	13.2				0.01	0.01			
16	1016.38	19.4	18.6				15	12			
17	1066.64	16.3	13.6				1.8	0.58			
18	1065.90	16.2	11.2				54	1.2			
19	1065.05	18.2	16.1				4.3	1.5			
20	1064.15	20.1	19.1				0.81	0.40			
21	1063.50	14.1	13.3				0.27	0.10			

CORE PLUG DESCRIPTION

Well: S.A. DEPARTMENT OF MINES

Field: MOCAMBORO   Date: 23/08/90

Location: OTWAY BASIN   Core Interval:

Country: AUSTRALIA

Sample Number	Depth	Description
1	984.96	Sst: lt gry, med-crs gr, p-mod srt, sbang-sbrnd, mod wl cmt, tr mic - Biot, tr carb spk, abd Cl-Chlor? cotd gn and mtrx, rr qtz o'gth, wh bnd thru which is calc rest of plug non calc
2	983.40	Sst: lt gry/gnsh, med gr, w/ srt, sbang-rr sbrnd, mod wl cmt, tr mic-Biot, tr carb spk, abd Cl-Chlor, mnr cotd gr, rr qtz o'gth, mnr calc cmt i/p
3	982.78	Sst: a/a but w/ rr tr Garnett and rr calc incl
4	982.40	Sst: a/a
5	981.98	Sst: lt gry/gnsh, med gr, wl srt, sbang-rr sbrnd, mod wl cmt, tr mic-Biot, rr carb incl, abd Cl-Chlor, mnr cotd gn, rr qtz o'gth, rr calc incl, abd Cl poss Kaolin? rr slty clas. rr tr Garnett
6	981.70	Sst: a/a
7	981.50	Sst: a/a
8	980.96	Sst: a/a but w/ cmt
9	980.50	Sst: a/a
10	1021.10	Sst: lt gry, med gr, wl srt, ang i/p - rr sbrnd, mod-p cmt, tr mic-Biot, rr carb spk, mnr Cl mtrx, mainly Cl cotd gn, abd Garnett thru, non calc, mnr filled frac
11	1020.28	Sst: lt gry/gnsh, fn gr, wl srt, sbang, wl cmt, tr mic-Biot, rr carb incl, abd Cl-Chlor, tr Garnett, non calc
12	1019.27	Sst: a/a
13	1018.25	Sst: a/a

Sample Number	Depth	Description
14	1017.45	Sst: a/a but w/ rr med gr thru
15	1017.10	Sst: a/a but w/ carb and mica lam thru
16	1016.38	Sst: a/a but w/ occ med gr thru
17	1066.64	Sst: lt gry, med-occ v crs gr thru, sbang, mod-p cmt, tr mic - Biot, carb spk, abd Cl both Chlor and Kaolin? which ap as Agg thru, abd calc incl thru poss part of cmt? tr Garnett (irregular plug)
18	1065.90	Sst: a/a but also abd slty clas thru, poss infill, mnr frac, (irregular plug)
19	1065.05	Sst: a/a for 17
20	1064.15	Sst: lt gry/gnsh, fn-med gr, mod wl srt, sbang, mod wl cmt, tr Biot mic thru, rr carb incl, abd Cl - Chlor, tr Garnett, mnr calc incl through part of cmt or poss shell frags?
21	1063.50	Sst: a/a

PETROLOGY REPORT

MOCAMBORO #11

OTWAY BASIN

Report prepared for South Australia Department of Mines and Energy

by

S E PHILLIPS & A P THOMAS

Amdel Core Services
PO Box 109
Eastwood
SA 5063

January 1991

Please Reply To:

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Telephone: 61-8-372 2834 Facsimile: 61-8-372 2861

Amdel Core Services Pty Limited
(Incorporated in South Australia)

INDEX

1. INTRODUCTION

The South Australian Department of Mines and Energy requested X-ray diffraction (XRD) analysis of 21 core plug samples from the Pretty Hill Sandstone in Mocamboro #11, Otway Basin. To determine bulk mineralogy by X-ray diffraction, samples were hand ground in acetone and smeared onto glass slides. Continuous scans were run of these smears from 3^o to 75^o 2 theta, at 1^o/minute, using Co K alpha radiation, 50kV and 35mA, on a Philips PW1050 diffractometer. For detailed clay mineralogy a less than 2 micron size fraction was separated. This was done by hand crushing, addition of dispersion solution, mechanical shaking for 10 minutes and settling of dispersed material in a water column according to Stokes' Law. The less than 2 micron fraction was pipetted off and prepared as an oriented sample on ceramic plates held under vacuum. Samples were saturated with Mg solution and treated with glycerol. Continuous scans of oriented clay samples were run from 3^o to 35^o 2 theta at 1^o/minute. Peaks were identified by comparison with JCPDS files stored in a computer program called XPLOT.

2. X-RAY DIFFRACTION RESULTS

All XRD analyses are summarised in Tables 3.1 and 3.2.

2.1 <u>Mocamboro #11, core plug 1, depth 984.96m</u>

Bulk XRD (Fig. 1a) indicates that quartz is dominant, feldspar (probably both potassic and sodic varieties), clinochlore and/or kaolinite, calcite and siderite are in minor amounts. Kaolinite is suggested by a poorly defined peak at 1.49 Angstroms. In addition, ankerite/ferroan dolomite possibly occurs in trace amounts. The clay trace (Fig. 1b) reveals the presence of clinochlore IIB, together with quartz, illite 2M1 and traces of feldspar. The peak doublet at 3.55 Angstroms may be due to compositional variations in the clinochlore or the presence of both clinochlore and kaolinite. Interstratified clays are suggested by the broad nature of the strongest illite peak.

2.2 <u>Mocamboro #11, core plug 2, depth 983.40m</u>

Quartz dominates the bulk XRD trace, feldspar and kaolinite/clinochlore are in minor proportions and there are possible traces of ankerite/ferroan dolomite (Fig. 2a). Both potassic and sodic feldspars may be present in this core plug. Interstratified clays are suggested by a broad shoulder at low 2 theta angles. The clay trace (Fig. 2b) displays the presence of kaolinite and/or clinochlore IIB, together with illite 2M1, quartz and traces of feldspar. Two very close peaks at 3.55 Angstroms suggest either the presence of both clinochlore and kaolinite or compositional variation in the clinochlore. The broad nature of the strongest illite peak could be attributed to a minor amount of interstratified clay or poor crystallinity.

2.3 <u>Mocamboro #11, core plug 3, depth 982.78m</u>

Bulk XRD (Fig. 3a) indicates that quartz is dominant and feldspar (sodic and potassic varieties), kaolinite and/or clinochlore are present in minor proportions. Kaolinite is suggested by a poorly defined peak at 1.49 Angstroms. The clay trace (Fig. 3b) reveals the presence of clinochlore IIB, together with illite 2M1, quartz and feldspar. The two peaks at 3.59 and 3.53 Angstroms suggest that both kaolinite and clinochlore may occur in the sample.

2.4 <u>Mocamboro #11, core plug 4, depth 982.40m</u>

Quartz is dominant in the bulk XRD trace of this sample (Fig. 4a). Kaolinite (and possibly clinochlore), feldspar (potassic and sodic varieties) occur in minor amounts. The clay trace (Fig. 4b) reveals the presence of clinochlore IIB, together with illite 2M1, quartz and a trace of feldspar. Two adjacent peaks at 3.59 and 3.53 Angstroms suggest that both kaolinite and clinochlore occur in the sample. Illite is very poorly crystalline.

2.5 <u>Mocamboro #11, core plug 5, depth 981.98m</u>

Bulk XRD (Fig. 5a) indicates quartz is dominant and that feldspar (potassic and sodic varieties) and kaolinite/clinochlore occur in minor proportions. The clay trace (Fig. 5b) reveals the presence of clinochlore IIB, ?kaolinite, illite 2M1, quartz and traces of feldspar. Adjacent peaks at 3.57 and 3.53 Angstroms suggest that there is kaolinite as well as clinochlore.

2.6 Mocamboro #11, core plug 6, depth 981.70m

Quartz is dominant in the bulk XRD trace of this sample (Fig. 6a). Potassic and sodic feldspar, kaolinite/clinochlore and siderite are in minor proportions. The clay trace (Fig. 6b) reveals the presence of clinochlore IIB, together with illite 2M1, quartz and traces of feldspar. Kaolinite is also likely to occur in the clay fraction because minor peaks unique to the mineral are detected in the bulk trace. However, indicators such as the peak doublet at approximately 3.53 Angstroms, seen in previous samples, are not evident.

2.7 Mocamboro #11, core plug 7, depth 981.50m

Bulk XRD (Fig. 7a) illustrates that quartz is dominant and feldspar (both potassic and sodic varieties), kaolinite and/or clinochlore and siderite are in minor proportions. The clay trace (Fig. 7b) reveals clinochlore IIB, together with illite 2M1, quartz and feldspar. Two adjacent peaks at 3.58 and 3.53 Angstroms suggest that both kaolinite and clinochlore are present, and marked asymmetry of the strongest illite peak implies interstratification with other clays.

2.8 Mocamboro #11, core plug 8, depth 980.96m

Bulk XRD (Fig. 8a) indicates quartz is dominant and that feldspar (potassic and sodic varieties) and kaolinite and/or clinochlore are in minor proportions. The clay trace (Fig. 8b) exhibits peaks for clinochlore IIB, together with illite 2M1, quartz and feldspar. Major clinochlore peaks are doublets, which suggests that kaolinite may also be present or that there is compositional variation in the clinochlore. Conspicuous asymmetry of the strongest illite peak may be due to interstratification with other clays.

2.9 Mocamboro #11, core plug 9, depth 980.50m

Bulk XRD (Fig. 9a) identifies quartz to be dominant, and feldspar (potassic and sodic varieties) and clinochlore to occur in minor proportions. The definitive peak for kaolinite, 1.49 Angstroms, is not present in this trace. The clay trace (Fig. 9b) depicts clinochlore IIB, illite 2M1, quartz and trace amounts of feldspar. Doubled clinochlore peaks suggest compositional variation, and asymmetry of the strongest illite peak implies interstratification with other clays, possibly the clinochlore.

2.10 Mocamboro #11, core plug 10, depth 1021.10m

Bulk XRD (Fig. 10a) indicates that quartz is dominant, feldspar (potassic and sodic varieties), clinochlore and/or kaolinite are in minor proportions and illite/muscovite, possibly occurs in trace amounts. The clay trace (Fig. 10b) discloses the presence of clinochlore IIB, kaolinite, illite 2M1, quartz and feldspar.

2.11 Mocamboro #11, core plug 11, depth 1020.28m

Quartz is dominant in the bulk XRD trace of this sample (Fig. 11a). Feldspar (potassic and sodic varieties) and clinochlore and/or kaolinite are in minor proportions. The clay trace (Fig. 11b) reveals the presence of clinochlore IIB, smectite (?montmorillonite), kaolinite, illite 2M1, quartz and feldspar. A peak at a very low 2 theta angle may be the result of interstratification between clinochlore and smectite.

2.12 Mocamboro #11, core plug 12, depth 1019.27m

Bulk XRD (Fig. 12a) discloses that quartz is dominant and sodic feldspar, clinochlore and/or kaolinite are in minor proportions. The clay trace (Fig. 12b) illustrates the presence of smectite (18 Angstrom montmorillonite), clinochlore IIB, illite 2M1, quartz, kaolinite and feldspar. A low 2 theta angle peak is probably due to interstratified smectite-clinochlore. The broad nature of the strongest illite peak suggests either that it is interstratified or poorly crystalline. Note that the scale of this trace has been expanded to accommodate the ?smectite-clinochlore peak.

2.13 Mocamboro #11, core plug 13, depth 1018.25m

Bulk XRD (Fig. 13a) identifies quartz to be dominant and feldspar (sodic and potassic varieties), clinochlore and calcite in minor proportions. Kaolinite is not established from the bulk trace. The clay trace (Fig. 13b) depicts clinochlore IIB, together with illite 2M1, quartz and feldspar. A peak at 3.79 Angstroms suggests that dickite rather than kaolinite may be present.

2.14 Mocamboro #11, core plug 14, depth 1017.45m

Bulk XRD (Fig. 14a) indicates that quartz is dominant and feldspar (sodic and potassic varieties) and kaolinite/clinochlore are in minor proportions. The presence of interstratified clays is suggested by a high background at low 2 theta angles. The clay trace (Fig. 14b) reveals the presence of clinochlore IIB, kaolinite, illite 2M1, quartz and feldspar.

2.15 Mocamboro #11, core plug 15, depth 1017.10m

Bulk XRD (Fig. 15a) illustrates that quartz is dominant, feldspar (sodic and potassic varieties) is sub-dominant, and clinochlore and/or kaolinite are in minor proportions. Interstratified clays are possibly indicated by a high background at low 2 theta angles. The clay trace (Fig. 15b) indicates smectite (18 Angstrom montmorillonite), clinochlore IIB, illite 2M1, kaolinite, quartz and feldspar. The small peak at 9.97 Angstroms has been labelled as a ?mica. Although this is a clay size fraction it is possible that a micaceous mineral has been fractured to a crystal size equivalent to clay. This suggestion is supported by the sharp nature of the peak. A low 2 theta angle peak is possibly due to interstratified smectite-clinochlore and the broad nature of the strongest illite peak suggests that it is also interstratified.

2.16 Mocamboro #11, core plug 16, depth 1016.38m

Bulk XRD (Fig. 16a) indicates that quartz is dominant, feldspar (sodic and potassic varieties), clinochlore and/or kaolinite and calcite are in minor proportions and illite/muscovite occurs in trace amounts. The clay trace (Fig. 16b) discloses the presence of clinochlore IIB, kaolinite, illite 2M1, quartz and feldspar.

2.17 Mocamboro #11, core plug 17, depth 1066.64m

Bulk XRD (Fig. 17a) illustrates that quartz is dominant, feldspar (sodic and potassic varieties), calcite and clinochlore and/or kaolinite are in minor proportions, and that there are trace amounts of illite/muscovite. The clay trace (Fig. 17b) indicates the presence of clinochlore IIB, kaolinite, illite, quartz and feldspar.

2.18 Mocamboro #11, core plug 18, depth 1065.90m

Bulk XRD (Fig. 18a) demonstrates that quartz is dominant, feldspar (potassic and sodic varieties) and clinochlore and/or kaolinite are in minor proportions, and illite/muscovite, calcite and siderite occur in trace amounts. The clay trace (Fig. 18b) exhibits clinochlore IIB, kaolinite, illite 2M1, quartz and feldspar.

2.19 Mocamboro #11, core plug 19, depth 1065.05m

The bulk XRD trace (Fig. 19a) depicts quartz as dominant, feldspar (sodic and potassic varieties) and clinochlore and/or kaolinite are in minor proportions and illite/muscovite, calcite and siderite occur in trace amounts. The clay trace (Fig. 19b) reveals clinochlore IIB, kaolinite, illite, quartz and feldspar. The relatively small clinochlore peak at 13 Angstroms suggests that kaolinite is in greater abundance than clinochlore in this sample.

2.20 Mocamboro #11, core plug 20, depth 1064.15m

Bulk XRD (Fig. 20a) illustrates that quartz is dominant and feldspar (sodic and potassic varieties) and clinochlore and/or kaolinite are in minor proportions. There are traces of illite/muscovite and possibly calcite. The clay trace (Fig. 20b) depicts the presence of clinochlore IIB, kaolinite, illite, quartz and trace amounts of feldspar.

2.21 Mocamboro #11, core plug 21, depth 1063.50m

Bulk XRD (Fig. 21a) indicates that quartz is dominant, feldspar (sodic and potassic varieties), clinochlore and/or kaolinite and calcite are in minor proportions and there is a trace amount of illite/muscovite. The clay trace (Fig. 21b) reveals the presence of clinochlore IIB, together with illite 2M1, quartz and trace amounts of feldspar.

3. TABLES

3.1 BULK XRD MINERALOGY MOCAMBORO #11

Plug No	Depth	Qtz	K+Cl	Feld	I/M	Cal	Sid	Others
		Strongest peak height in counts						
1	984.96m	5379	242	304	-	tr	103	An
2	983.40m	4771	1124	559	-	-	-	An, In
3	982.78m	4378	535	462	-	-	-	-
4	982.40m	3766	291	361	-	-	-	-
5	981.98m	6266	385	431	-	-	-	-
6	981.70m	4596	283	432	-	-	87	-
7	981.50m	5241	438	391	-	-	94	-
8	980.96m	4299	497	520	-	-	-	-
9	980.50m	5067	329	354	-	-	-	-
10	1021.10m	5045	267	744	tr	-	-	-
11	1020.28m	3439	312	965	-	-	-	-
12	1019.27m	4558	242	814	-	-	-	-
13	1018.25m	3625	205	1147	-	443	-	-
14	1017.45m	2298	329	789	-	-	-	In
15	1017.10m	5376	282	1124	-	-	-	In
16	1016.38m	3190	207	717	tr	251	-	-
17	1066.64m	2973	274	532	207	554	-	-
18	1065.90m	6045	458	313	238	115	100	-
19	1065.05m	4369	400	362	tr	tr	85	-
20	1064.15m	5655	312	491	tr	129	-	-
21	1063.50m	4460	313	911	tr	468	-	-

Qtz = quartz, K+Cl = kaolinite and/or clinochlore, I/M = illite/muscovite, Cal = calcite, Sid = siderite, Feld = feldspar, In = interstratified clays, An = ankerite/ferroan dolomite.

3.2 CLAY XRD MINERALOGY MOCAMBORO #11

Plug No	Depth	Cl+K	Ill	Qtz	Feld	Sm	Sm-Cl	Others
		Strongest peak height in counts						
1	984.96m	2634	399	1153	158	-	-	-
2	983.40m	3268	456	586	206	-	-	-
3	982.78m	3356	438	529	tr	-	-	-
4	982.40m	3879	438	446	tr	-	-	-
5	981.98m	3889	450	784	198	-	-	-
6	981.70m	2258	319	905	tr	-	-	-
7	981.50m	2550	398	522	198	-	-	-
8	980.96m	3266	401	1490	214	-	-	-
9	980.50m	3703	413	777	tr	-	-	-
10	1021.10m	1704	405	615	221	-	-	-
11	1020.28m	2534	430	658	237	463	3499	-
12	1019.27m	1306	515	700	tr	1261	4553	-
13	1018.25m	1849*	387	787	174	-	-	-
14	1017.45m	2213	463	890	266	-	-	-
15	1017.10m	1256	621	723	232	2239	3994	M
16	1016.38m	2815	383	598	245	-	-	-
17	1066.64m	2477	348	594	197	-	-	-
18	1065.90m	1471	442	1109	186	-	-	-
19	1065.05m	4323	384	637	243	-	-	-
20	1064.15m	2573	335	724	212	-	-	-
21	1063.50m	2739	295	591	169	-	-	-

Qtz = quartz, Cl+K = Clinochlore and kaolinite, Ill = illite, Feld = feldspar, Sm = smectite (montmorillonite), M = micaceous mineral, Sm-Cl = smectite-clinochlore. The value for Cl+K marked "*" refers to clinochlore and dickite rather than clinochlore and kaolinite.

All the XRD results are summarised in the tables above. To facilitate between-sample comparisons of relative abundance for the same mineral, the results in Tables 3.1 and 3.2 are given in counts of peak height. These figures are based on the strongest line for each mineral detected. Caution should be used in assessing relative abundance from these figures since peak height is also significantly affected by factors such as crystal size and crystallinity. For these reasons the figures are even more unreliable when comparing different minerals in the same sample. For example, based on peak height alone carbonate minerals will always appear less abundant than similar proportions of quartz because of differences in crystallinity. Clay minerals will also appear to be less abundant than quartz in a bulk XRD trace because of differences in crystal size. Furthermore, comparison should not be made between peak heights given for bulk samples and those for the clay fractions. Results have been influenced by the sampling and preparation methods. Note that XRD will not detect minerals which represent less than approximately 5% of the total rock composition.

5. FIGURES AND CAPTIONS

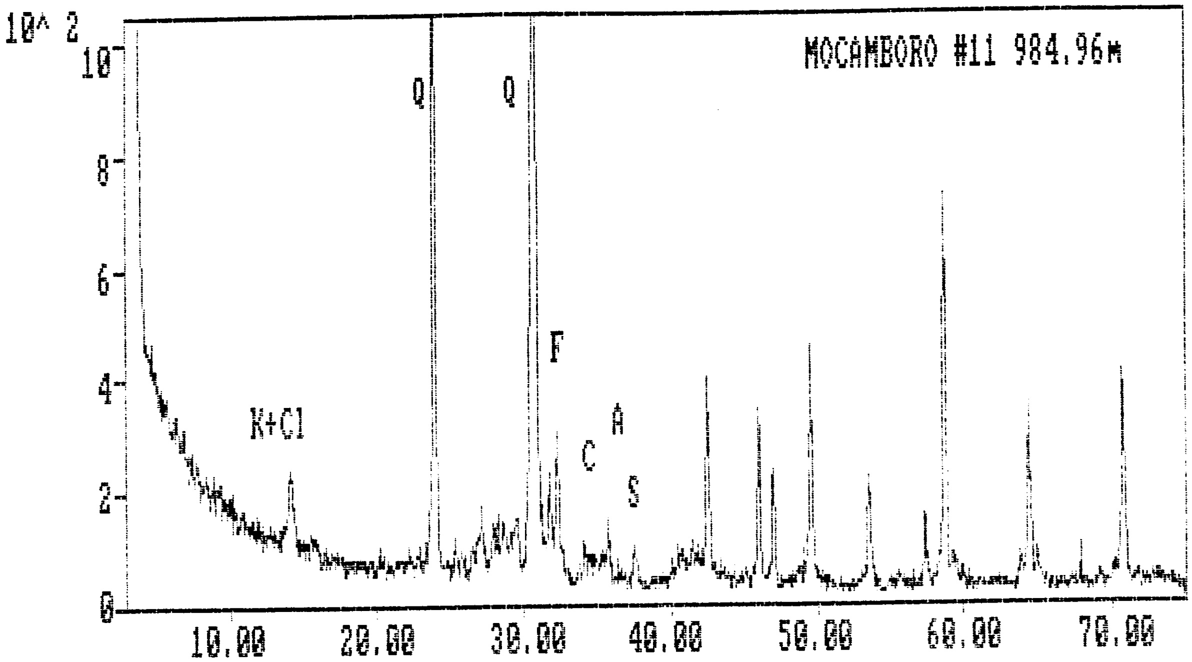

Figure 1a. Bulk XRD trace of core plug 1, Mocamboro #11, depth 984.96m. Only the strongest peaks for each mineral identified have been labelled. Q=quartz, A=ankerite/ferroan dolomite, F=feldspar, C=calcite, S=siderite, Cl=clinochlore and K=kaolinite.

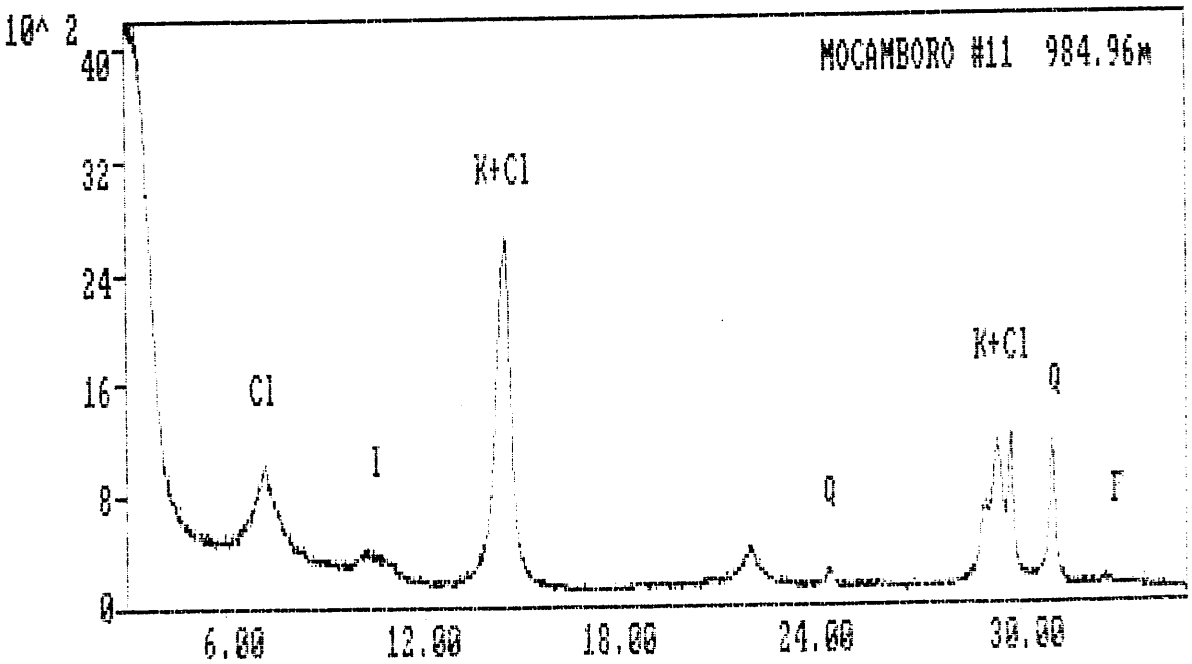

Figure 1b. Clay XRD trace of core plug 1, Mocamboro #11, depth 984.96m. Only the strongest peaks for each mineral identified have been labelled. Cl=clinochlore IIB, I=illite 2M1, K=kaolinite, Q=quartz and F=feldspar.

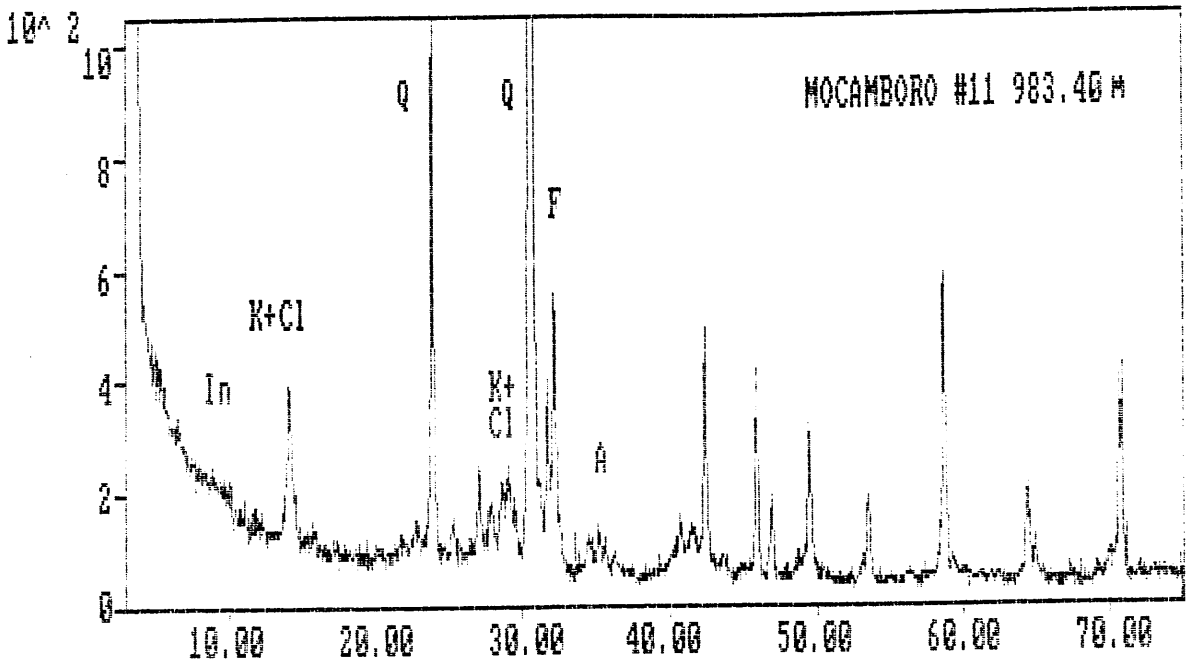

Figure 2a. Bulk XRD trace of core plug 2, Mocamboro #11, depth 983.40m. Only the strongest peaks for each mineral identified have been labelled. Q=quartz, In=interstratified clays, F=feldspar, A=Ankerite/ferroan dolomite, Cl=clinochlore and K=kaolinite.

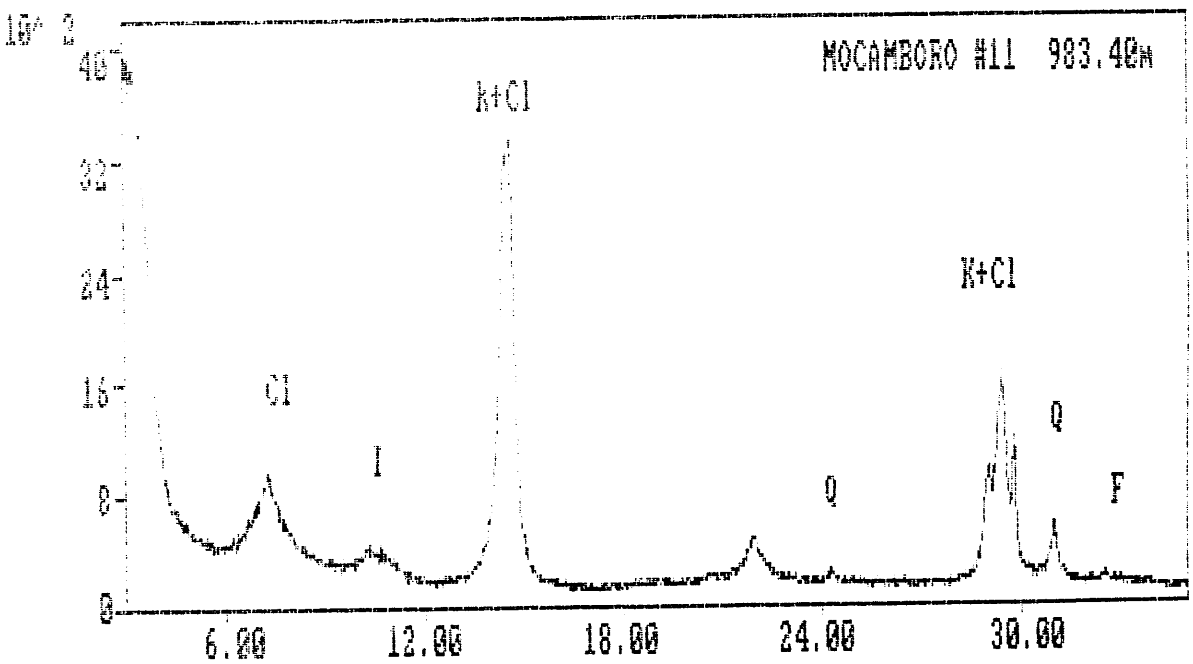

Figure 2b. Clay XRD trace of core plug 2, Mocamboro #11, depth **Figure 2b.** the strongest peaks for each mineral identified have been labelled. Cl=clinochlore IIB, I=illite 2M1, K=kaolinite, Q=quartz and F=feldspar.

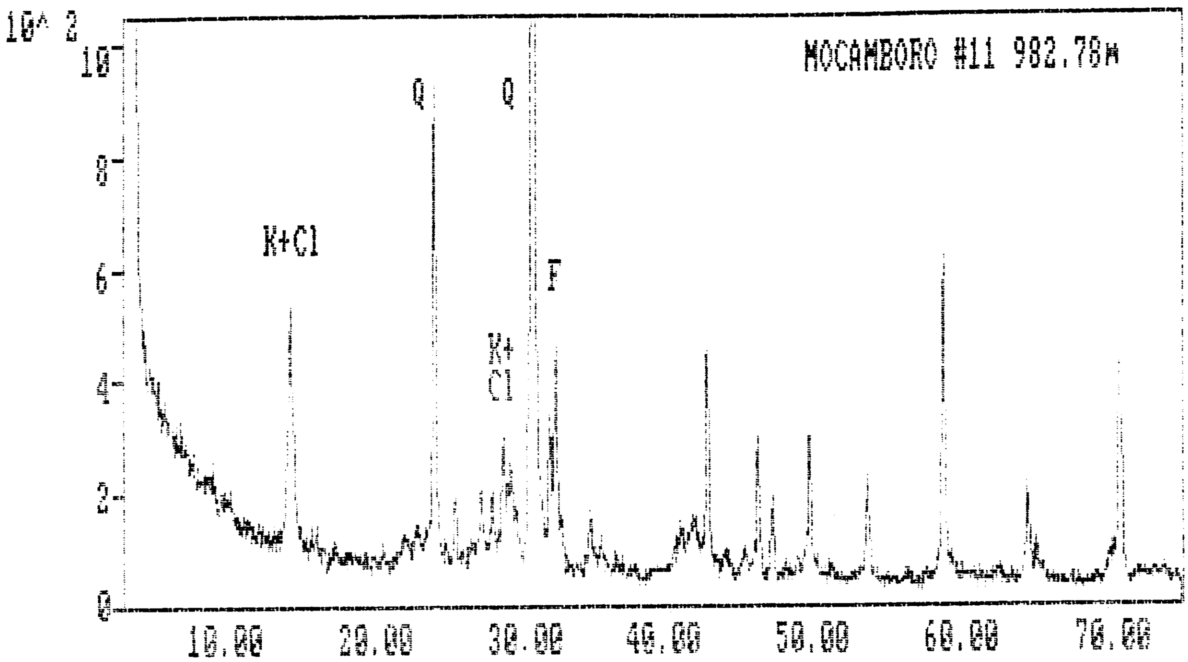

Figure 3a. Bulk XRD trace of core plug 3, Mocamboro #11, depth 982.78m. Only the strongest peaks for each mineral identified have been labelled. Q=quartz, F=feldspar, Cl=clinochlore and K=kaolinite.

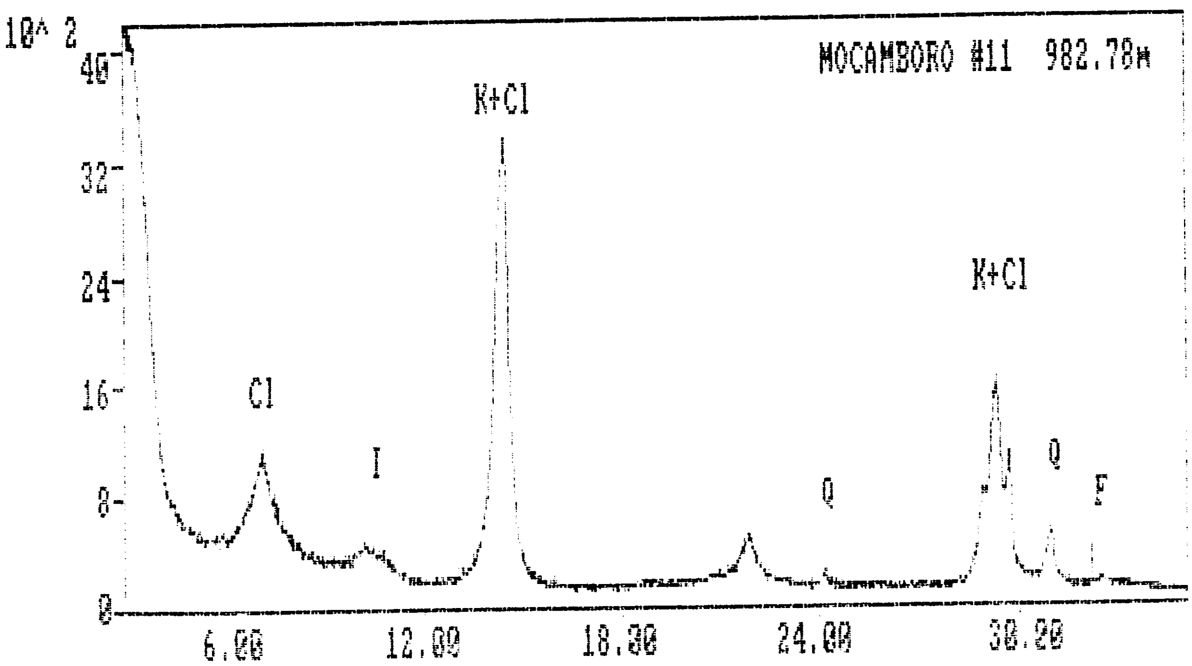

Figure 3b. Clay XRD trace of core plug 3, Mocamboro #11, depth 982.78m. Only the strongest peaks for each mineral identified have been labelled. Cl=clinochlore IIB, I=illite 2M1, K=kaolinite, Q=quartz and F=feldspar.

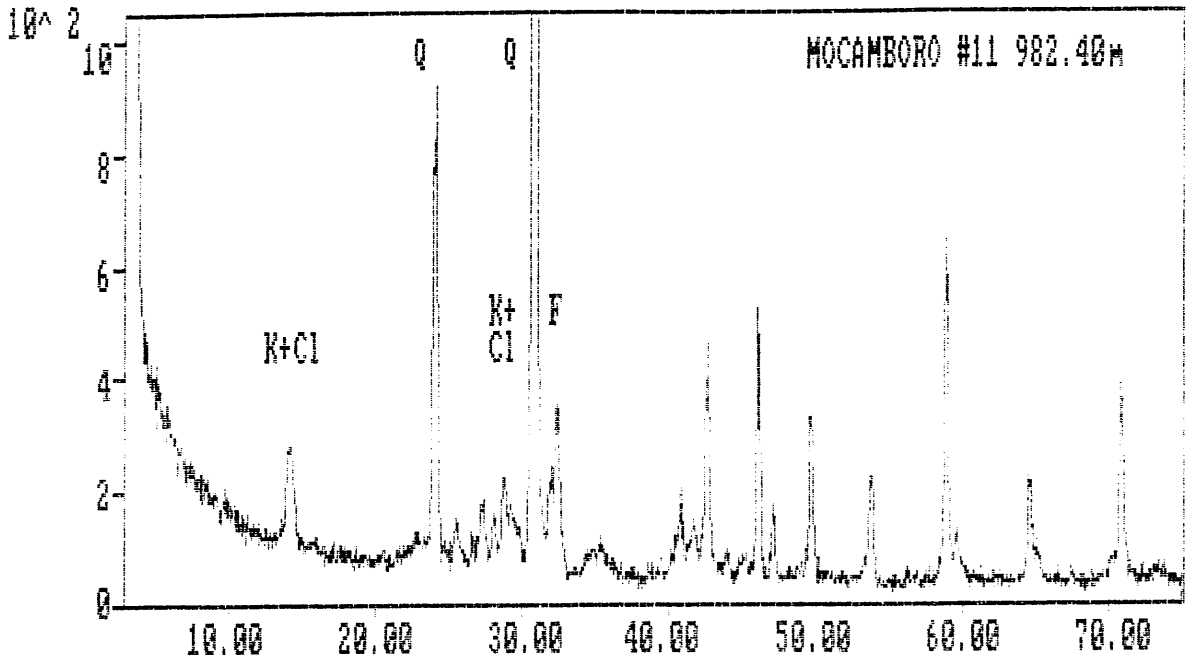

Figure 4a. Bulk XRD trace of core plug 4, Mocamboro #11, depth 982.40m. Only the strongest peaks for each mineral identified have been labelled. Q=quartz, F=feldspar, K=kaolinite and Cl=clinochlore.

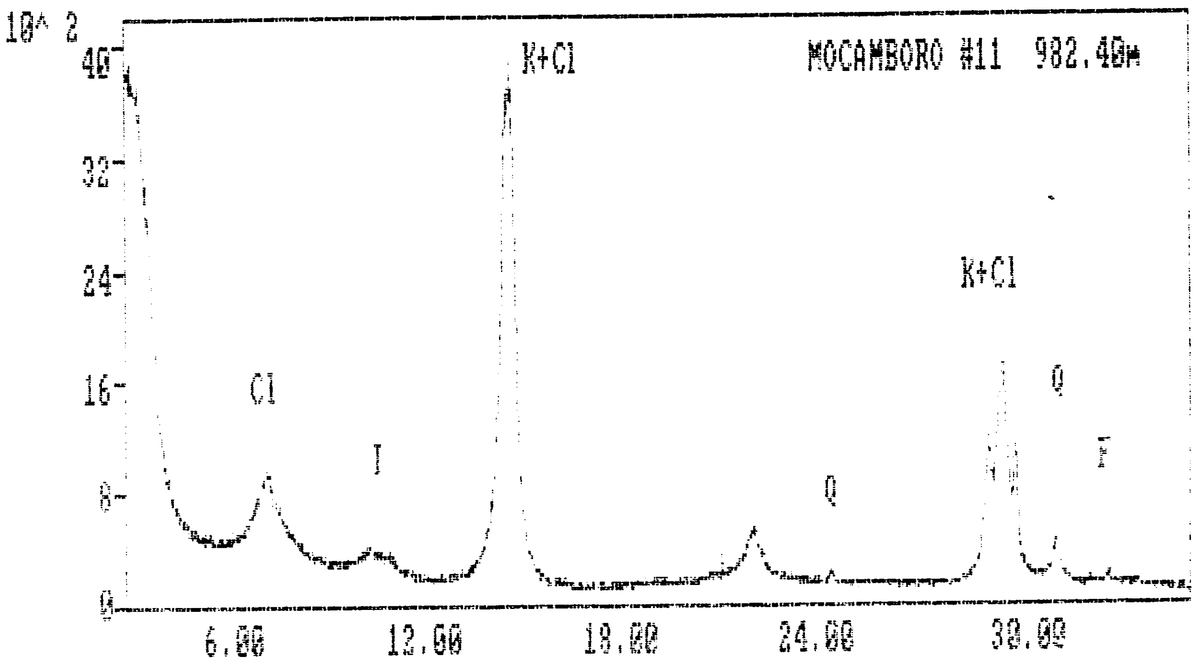

Figure 4b. Clay XRD trace of core plug 4, Mocamboro #11, depth 982.40m. Only the strongest peaks for each mineral identified have been labelled. Cl=clinochlore IIB, I=illite 2M1, K=kaolinite, Q=quartz and F=feldspar.

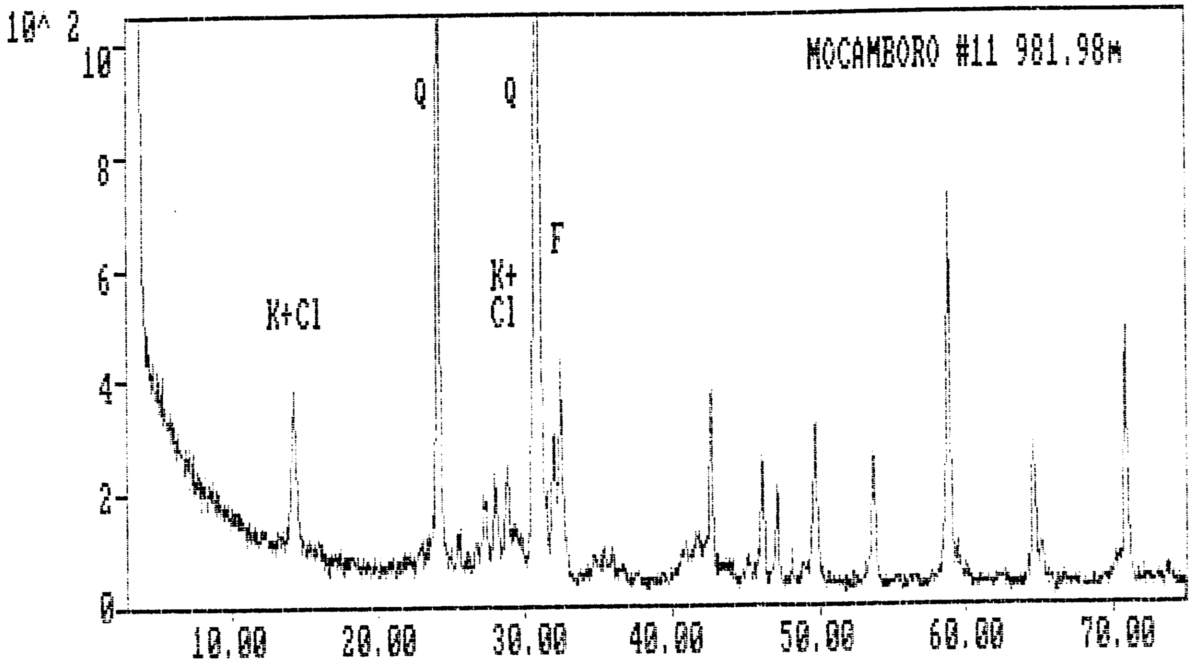

Figure 5a. Bulk XRD trace of core plug 5, Mocamboro #11, depth 981.98m. Only the strongest peaks for each mineral identified have been labelled. Q=quartz, F=feldspar, K=kaolinite and Cl=clinochlore.

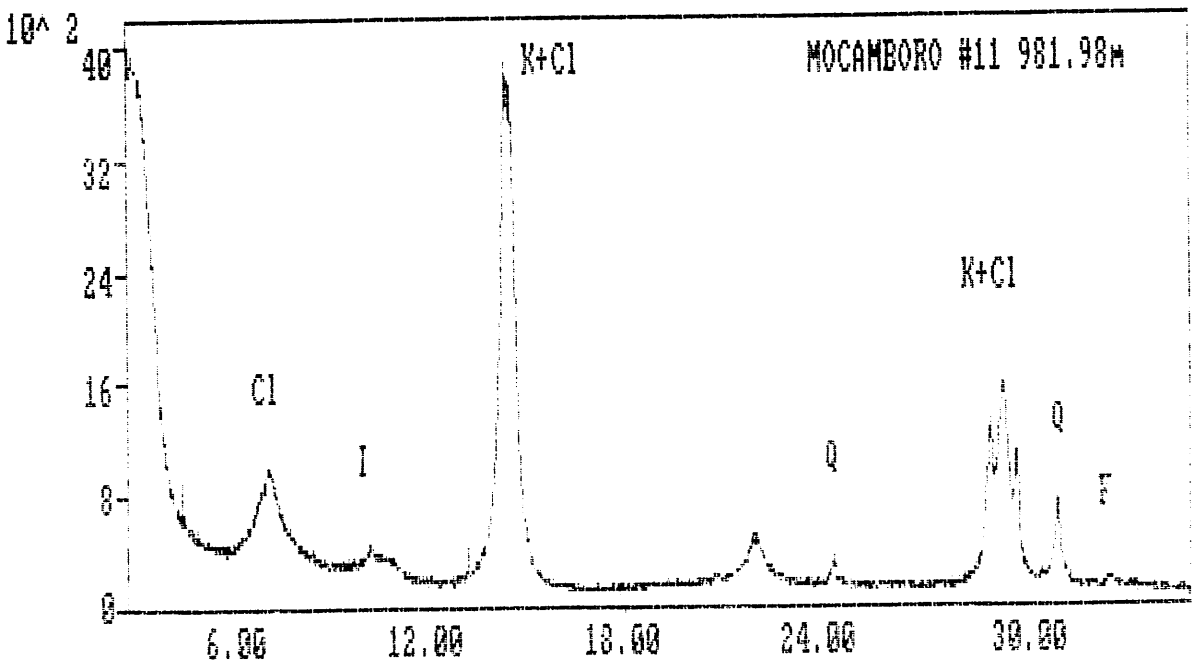

Figure 5b. Clay XRD trace of core plug 5, Mocamboro #11, depth 981.98m. Only the strongest peaks for each mineral identified have been labelled. Cl=clinochlore IIB, I=illite 2M1, K=kaolinite, Q=quartz and F=feldspar.

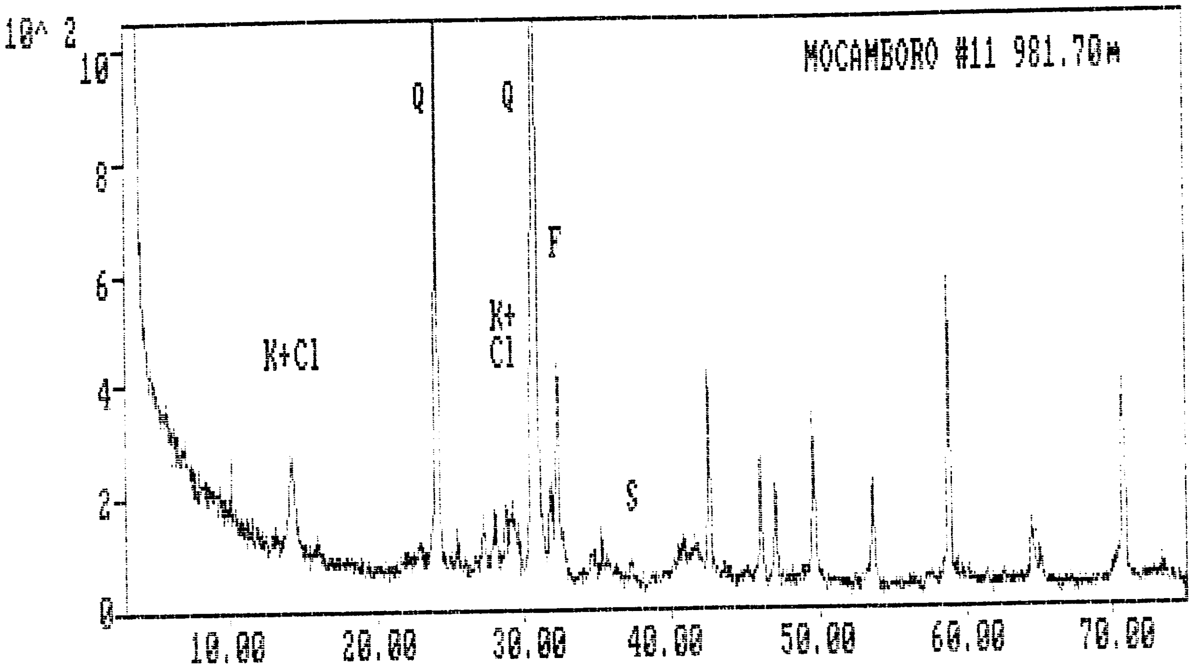

Figure 6a. Bulk XRD trace of core plug 6, Mocamboro #11, depth 981.70m. Only the strongest peaks for each mineral identified have been labelled. Q=quartz, F=feldspar, K=kaolinite, Cl=clinochlore and S=siderite.

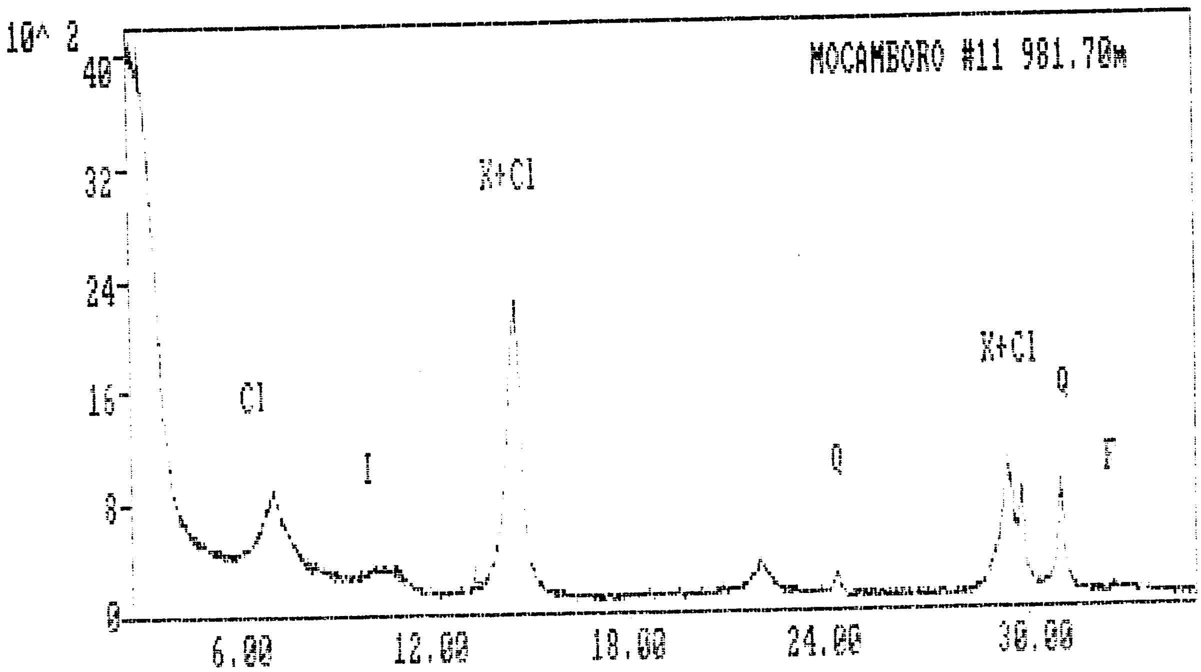

Figure 6b. Clay XRD trace of core plug 6, Mocamboro #11, depth 981.70m. Only the strongest peaks for each mineral identified have been labelled. Cl=clinochlore IIB, I=illite 2M1, K=kaolinite, Q=quartz and F=feldspar.

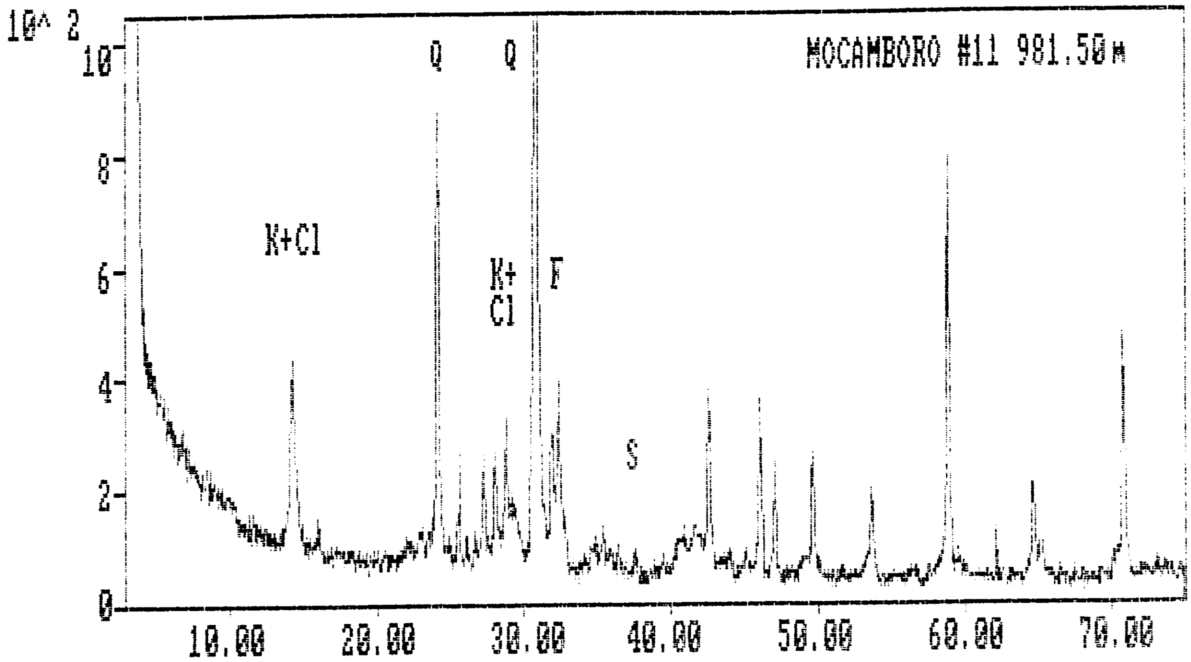

Figure 7a. Bulk XRD trace of core plug 7, Mocamboro #11, depth 981.50m. Only the strongest peaks for each mineral identified have been labelled. Q=quartz, F=feldspar, K=kaolinite, Cl=clinochlore and S=siderite.

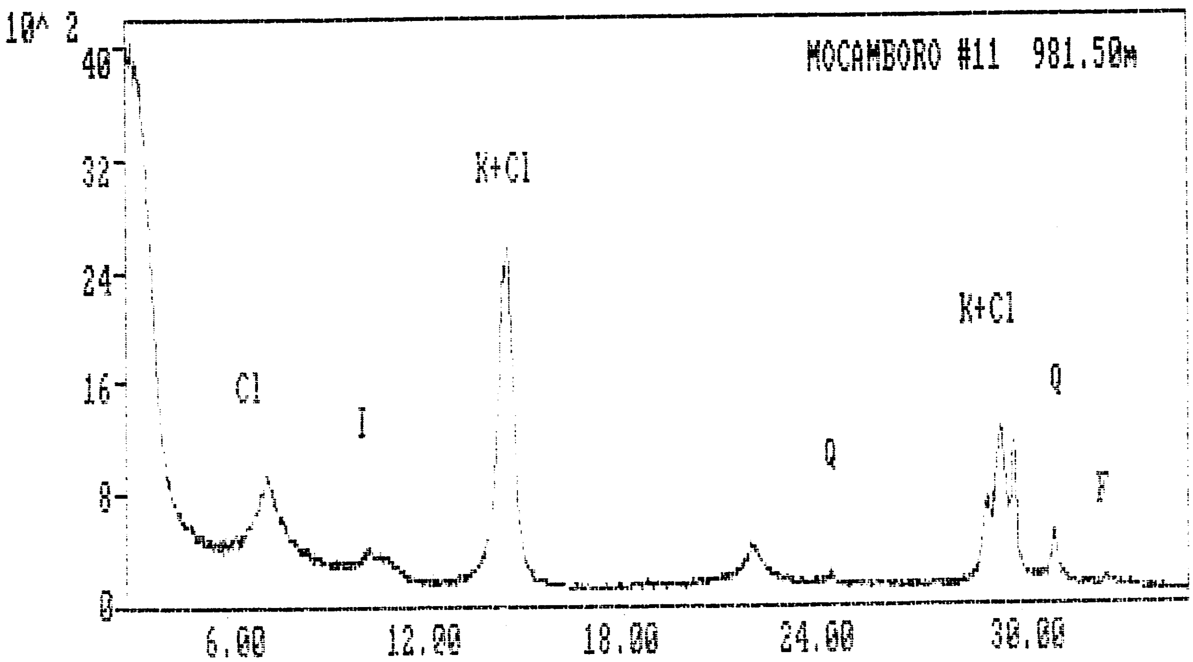

Figure 7b. Clay XRD trace of core plug 7, Mocamboro #11, depth 981.50m. Only the strongest peaks for each mineral identified have been labelled. Cl=clinochlore IIB, I=illite 2M1, K=kaolinite, Q=quartz and F=feldspar.

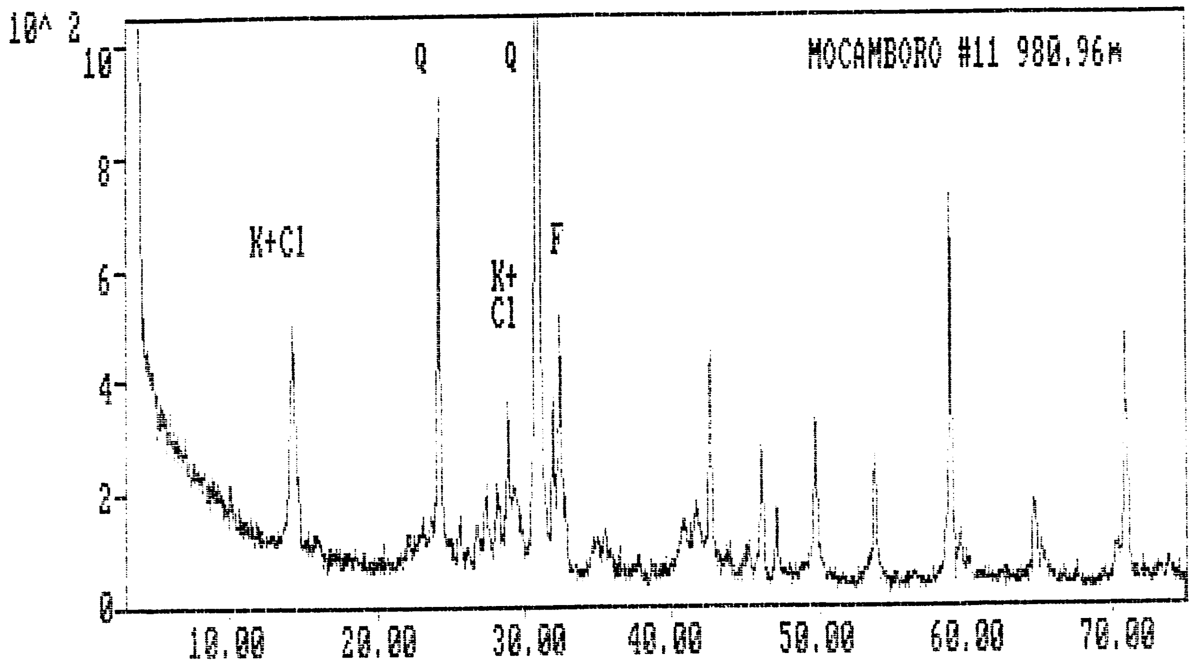

Figure 8a. Bulk XRD trace of core plug 8, Mocamboro #11, depth 980.96m. Only the strongest peaks for each mineral identified have been labelled. Q=quartz, F=feldspar, K=kaolinite and Cl=clinochlore.

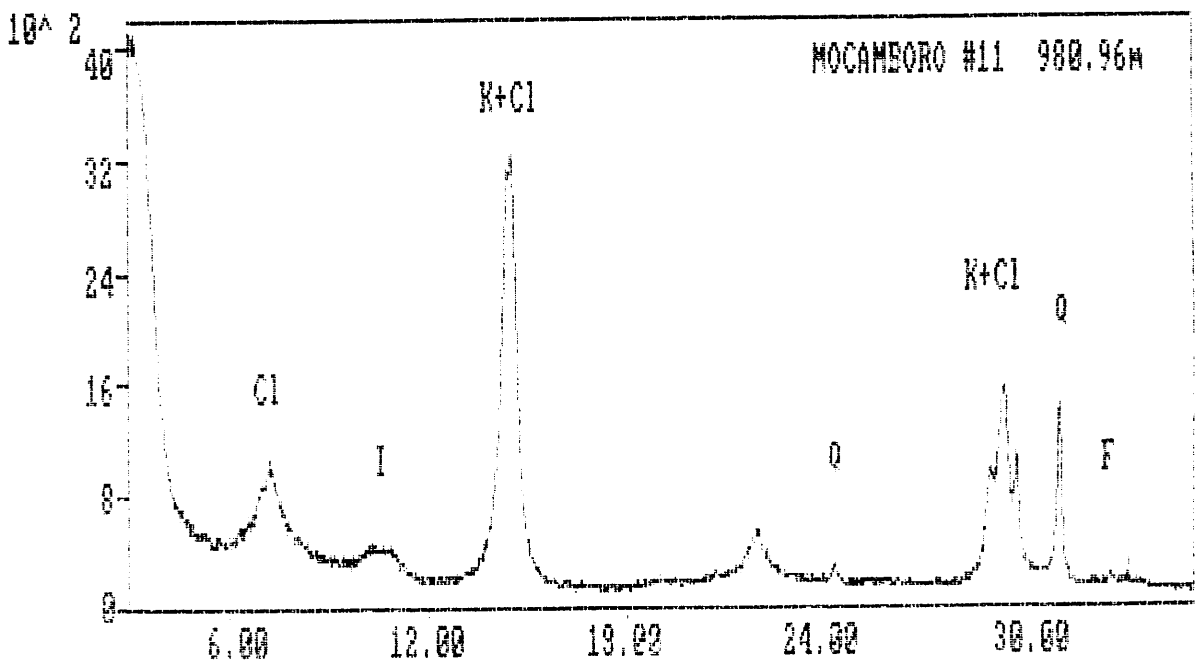

Figure 8b. Clay XRD trace of core plug 8, Mocamboro #11, depth 980.96m. Only the strongest peaks for each mineral identified have been labelled. Cl=clinochlore IIB, I=illite 2M1, K=kaolinite, Q=quartz and F=feldspar.

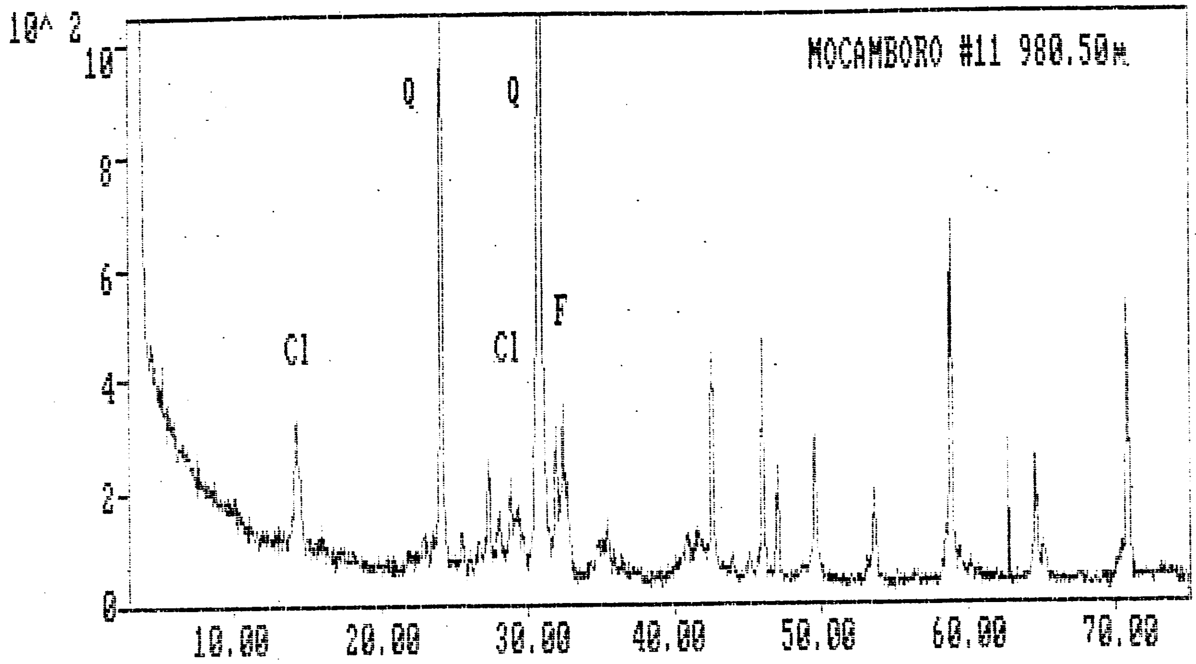

Figure 9a. Bulk XRD trace of core plug 9, Mocamboro #11, depth 980.50m. Only the strongest peaks for each mineral identified have been labelled. Q=quartz, F=feldspar and Cl=clinochlore.

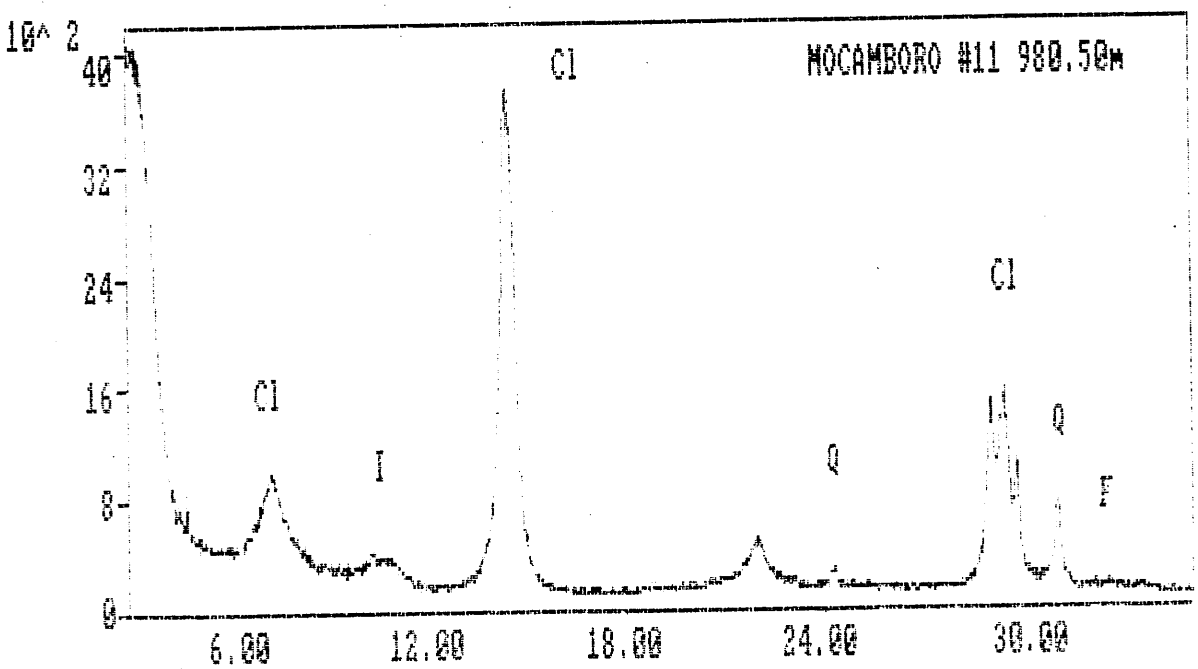

Figure 9b. Clay XRD trace of core plug 9, Mocamboro #11, depth 980.50m. Only the strongest peaks for each mineral identified have been labelled. Cl=clinochlore IIB, I=illite 2M1, Q=quartz and F=feldspar.

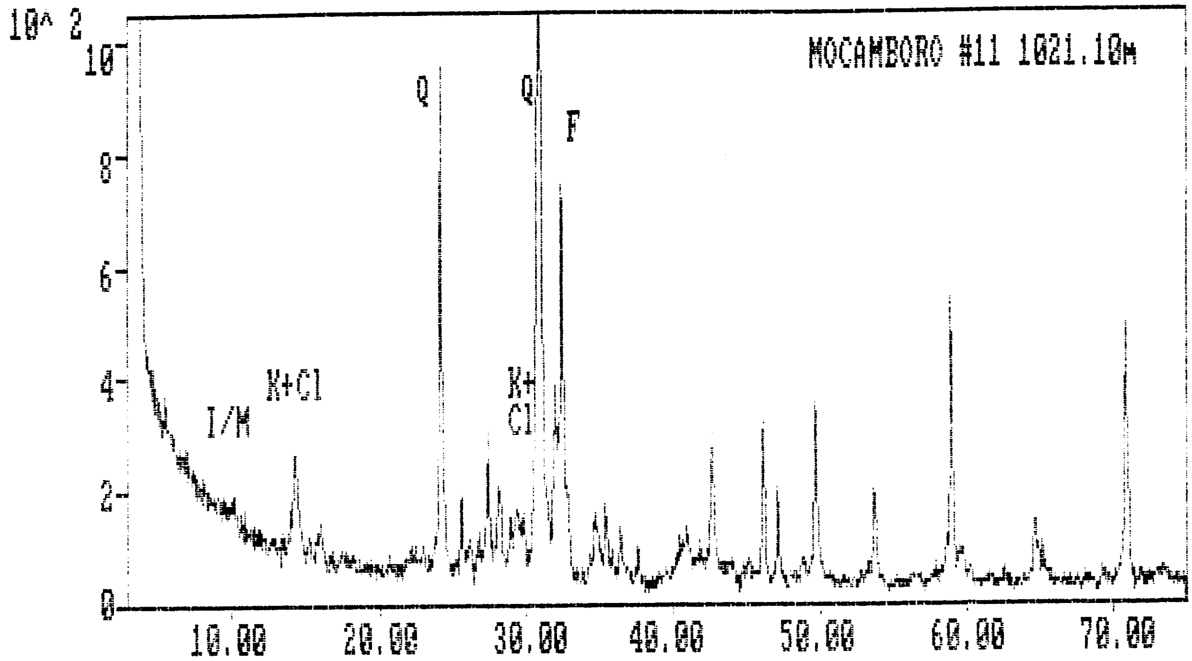

Figure 10a. Bulk XRD trace of core plug 10, Mocamboro #11, depth 1021.10m. Only the strongest peaks for each mineral identified have been labelled. Q=quartz, K=kaolinite, I/M=illite/muscovite, F=feldspar and Cl=clinochlore.

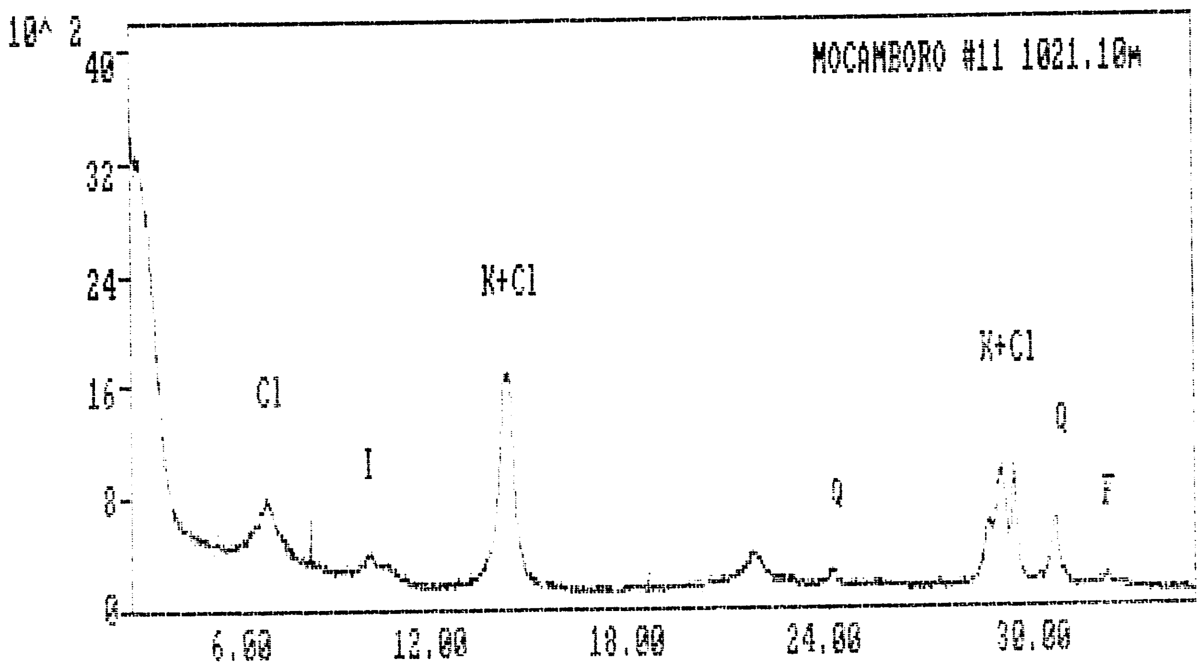

Figure 10b. Clay XRD trace of core plug 10, Mocamboro #11, depth 1021.10m. Only the strongest peaks for each mineral identified have been labelled. Cl=clinochlore IIB, I=illite 2M1, K=kaolinite, Q=quartz and F=feldspar.

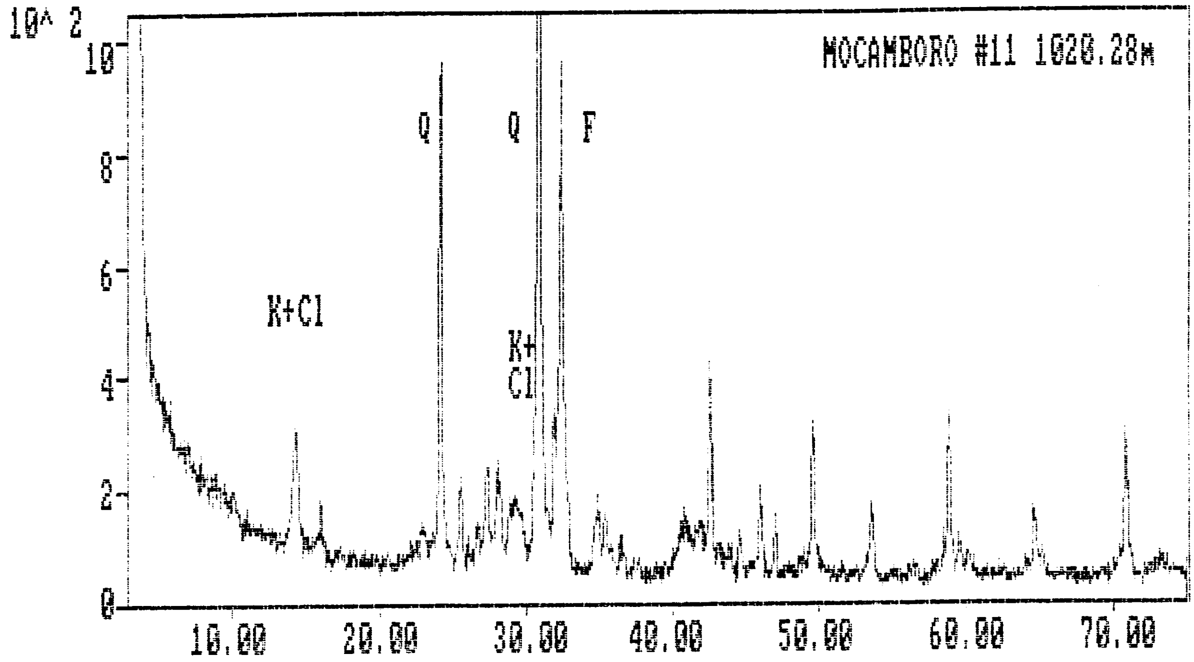

Figure 11a. Bulk XRD trace of core plug 11, Mocamboro #11, depth 1020.28m. Only the strongest peaks for each mineral identified have been labelled. Q=quartz, F=feldspar, K=kaolinite and Cl=clinochlore.

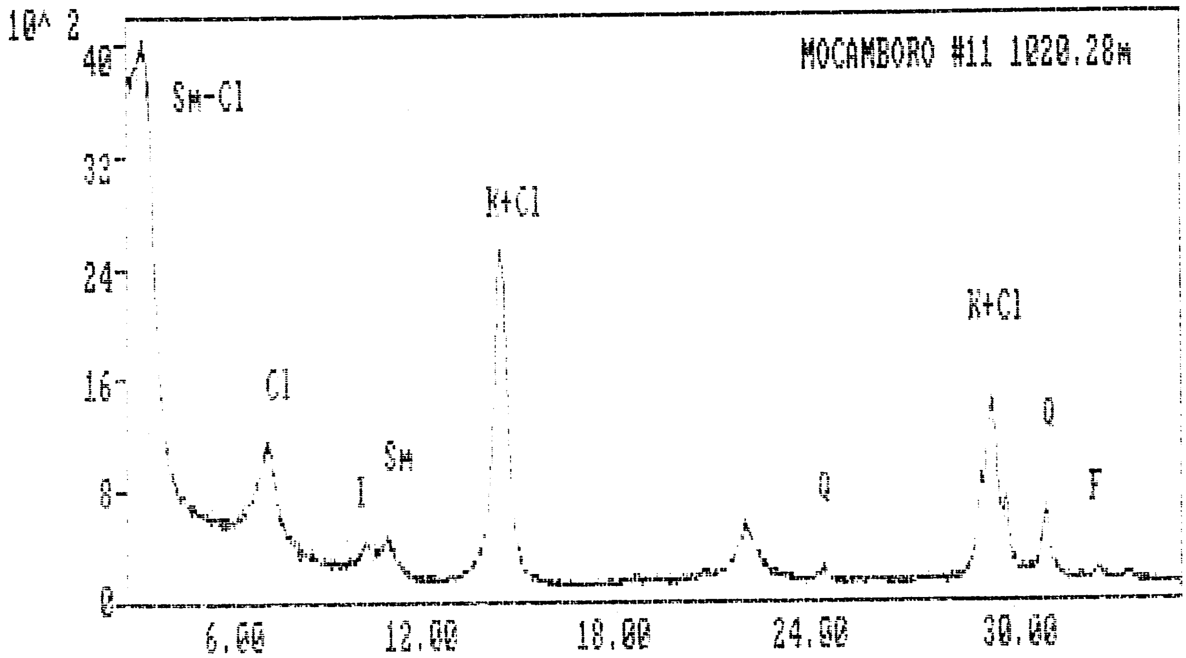

Figure 11b. Clay XRD trace of core plug 11, Mocamboro #11, depth 1020.28m. Only the strongest peaks for each mineral identified have been labelled. Cl=clinochlore IIB, I=illite 2M1, Sm=smectite, K=kaolinite, Q=quartz and F=feldspar.

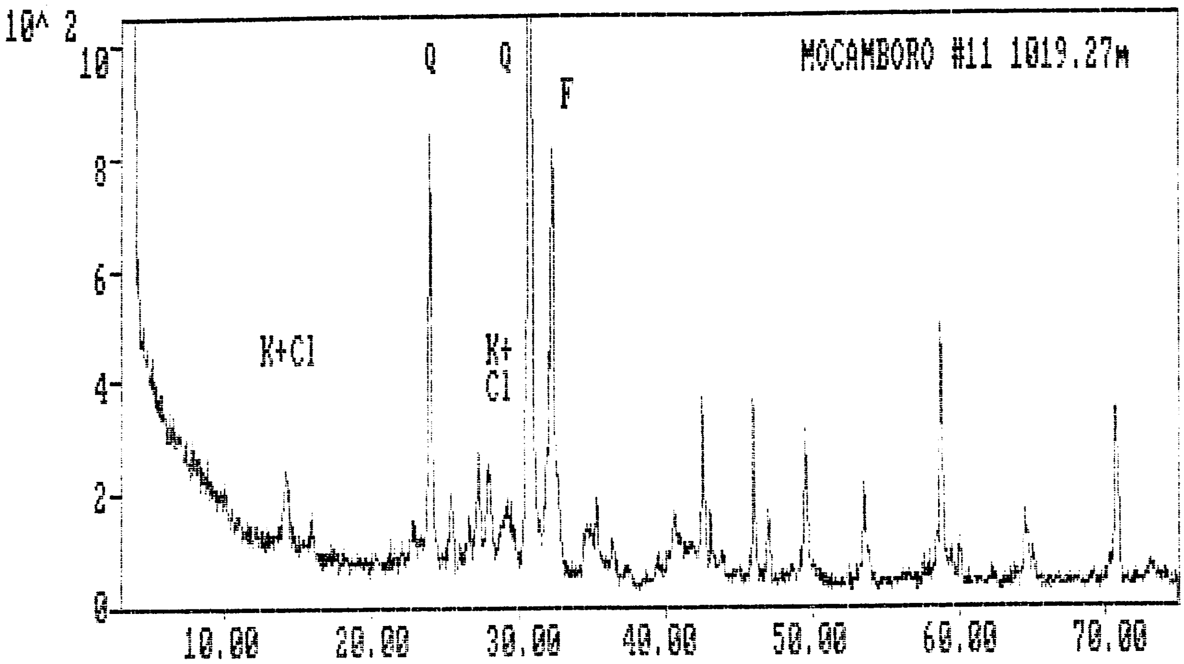

Figure 12a. Bulk XRD trace of core plug 12, Mocamboro #11, depth 1019.27m. Only the strongest peaks for each mineral identified have been labelled. Q=quartz, F=feldspar, K=kaolinite and Cl=clinochlore.

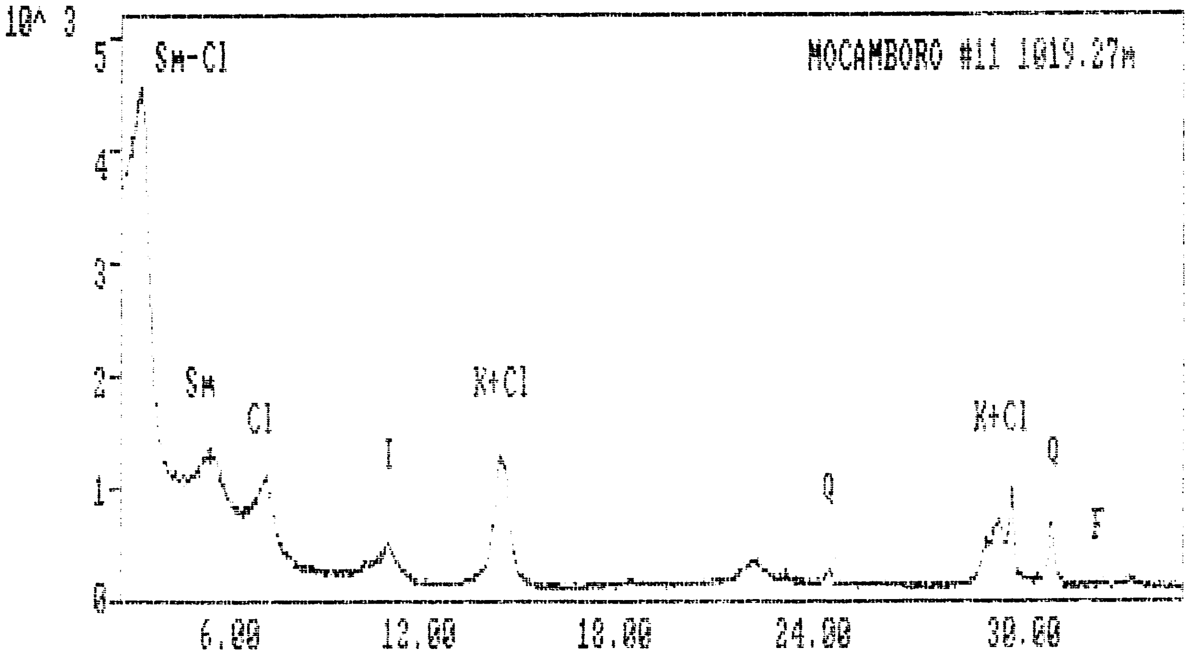

Figure 12b. Clay XRD trace of core plug 12, Mocamboro #11, depth 1019.27m. Only the strongest peaks for each mineral identified have been labelled. Sm=smectite (18 Angstrom montmorillonite), Cl=clinochlore IIB, I=illite 2M1, K=kaolinite, Q=quartz and F=feldspar.

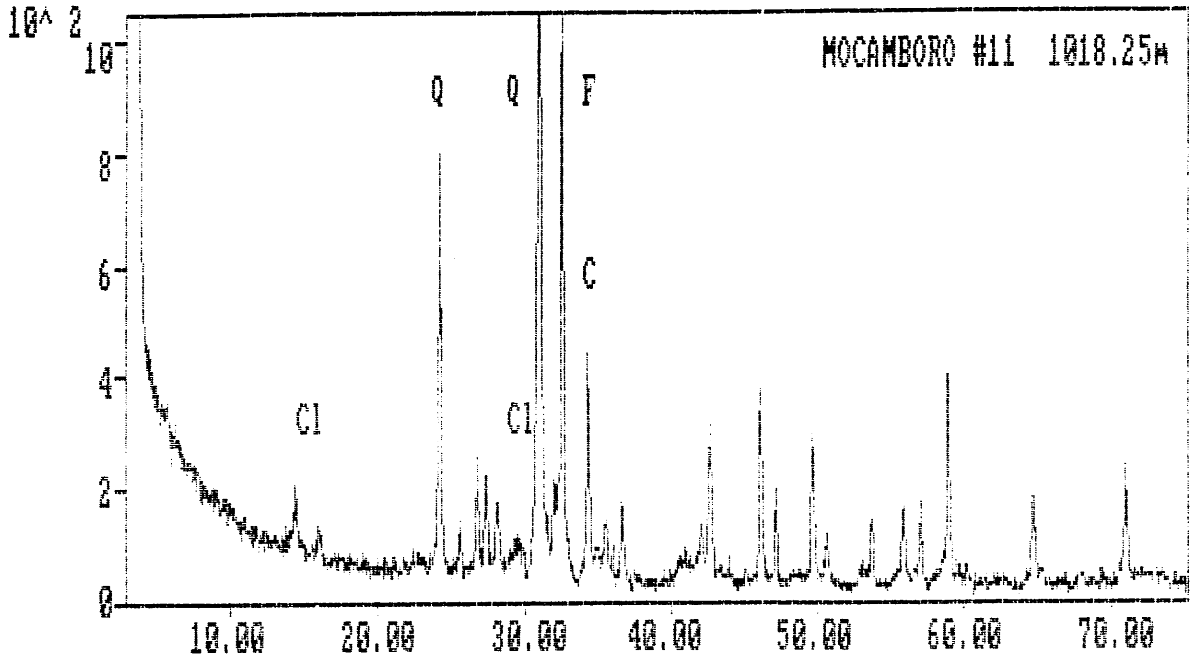

Figure 13a. Bulk XRD trace of core plug 13, Mocamboro #11, depth 1018.25m. Only the strongest peaks for each mineral identified have been labelled. Q=quartz, C=calcite, F=feldspar and Cl=clinochlore.

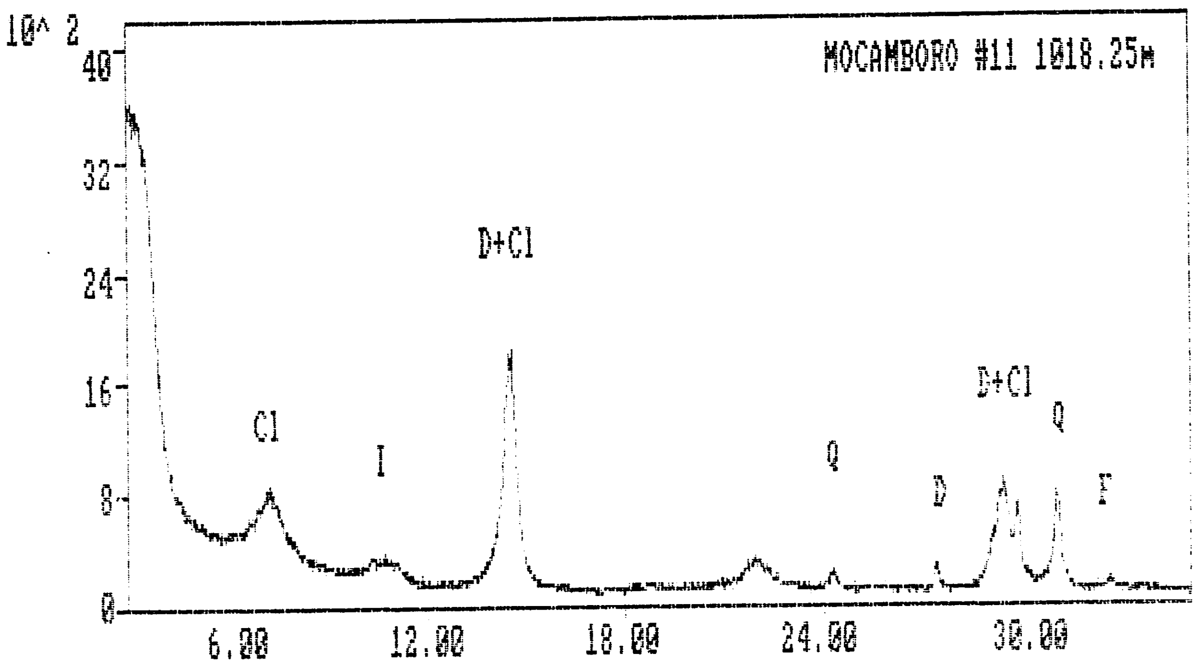

Figure 13b. Clay XRD trace of core plug 13, Mocamboro #11, depth 1018.25m. Only the strongest peaks for each mineral identified have been labelled. Cl=clinochlore IIB, I=illite 2M1, D=dickite, Q=quartz and F=feldspar.

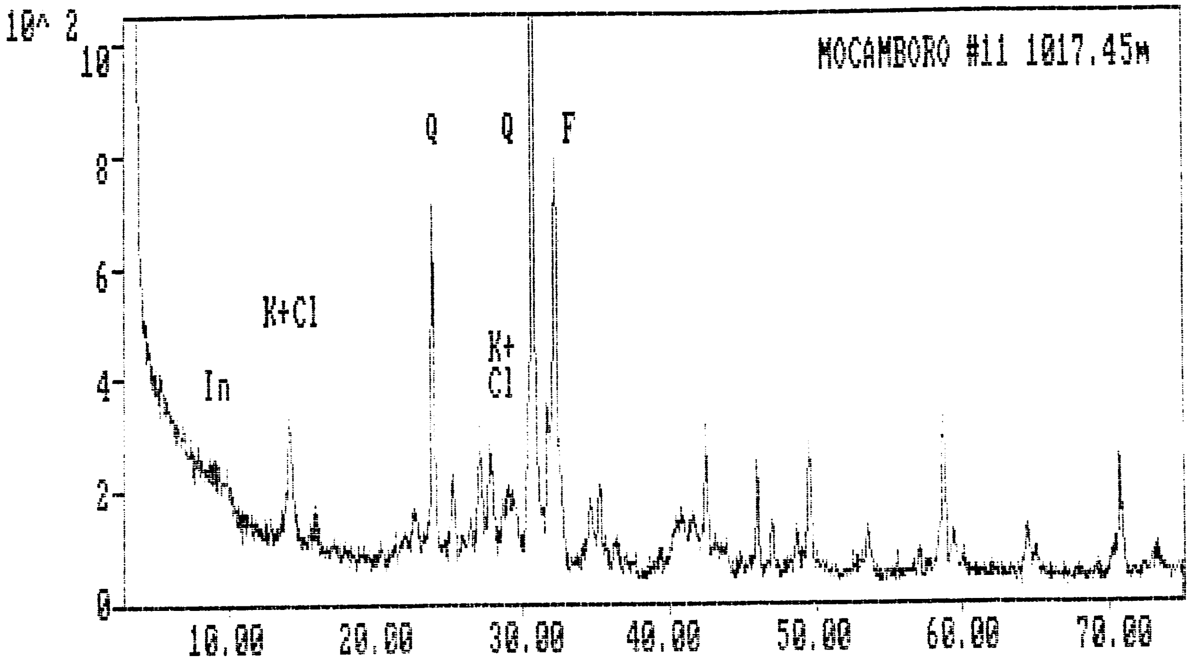

Figure 14a. Bulk XRD trace of core plug 14, Mocamboro #11, depth 1017.45m. Only the strongest peaks for each mineral identified have been labelled. Q=quartz, K=kaolinite, In=interstratified clays, F=feldspar and Cl=clinochlore.

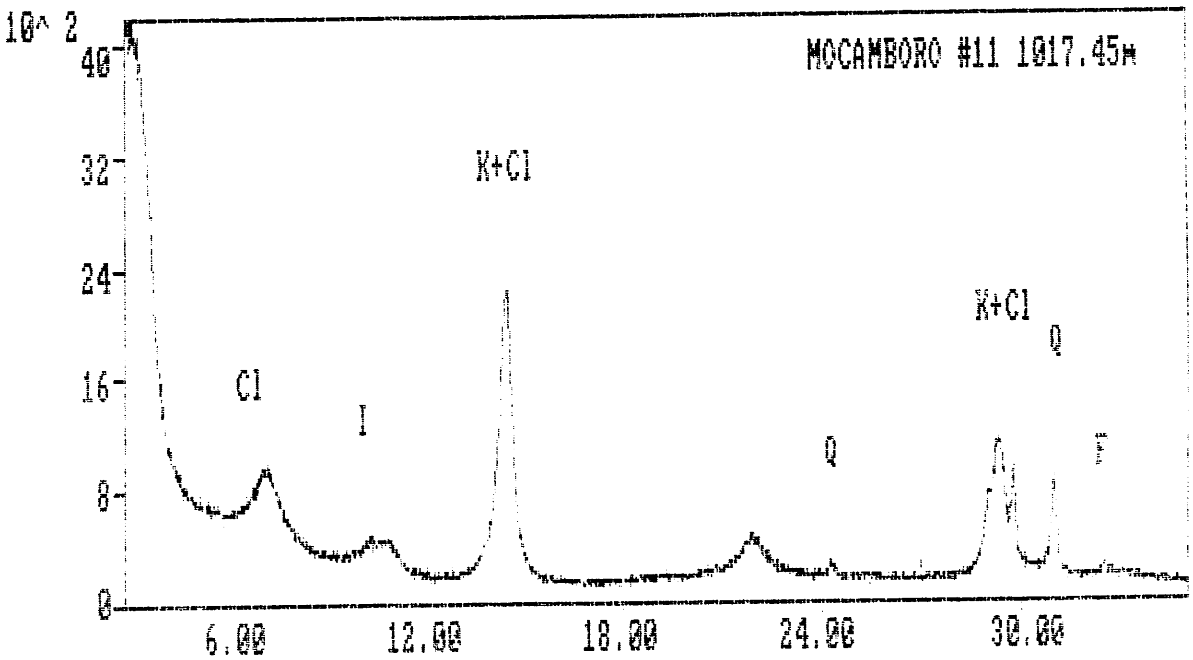

Figure 14b. Clay XRD trace of core plug 14, Mocamboro #11, depth 1017.45m. Only the strongest peaks for each mineral identified have been labelled. Cl=clinochlore IIB, I=illite 2M1, K=kaolinite, Q=quartz and F=feldspar.

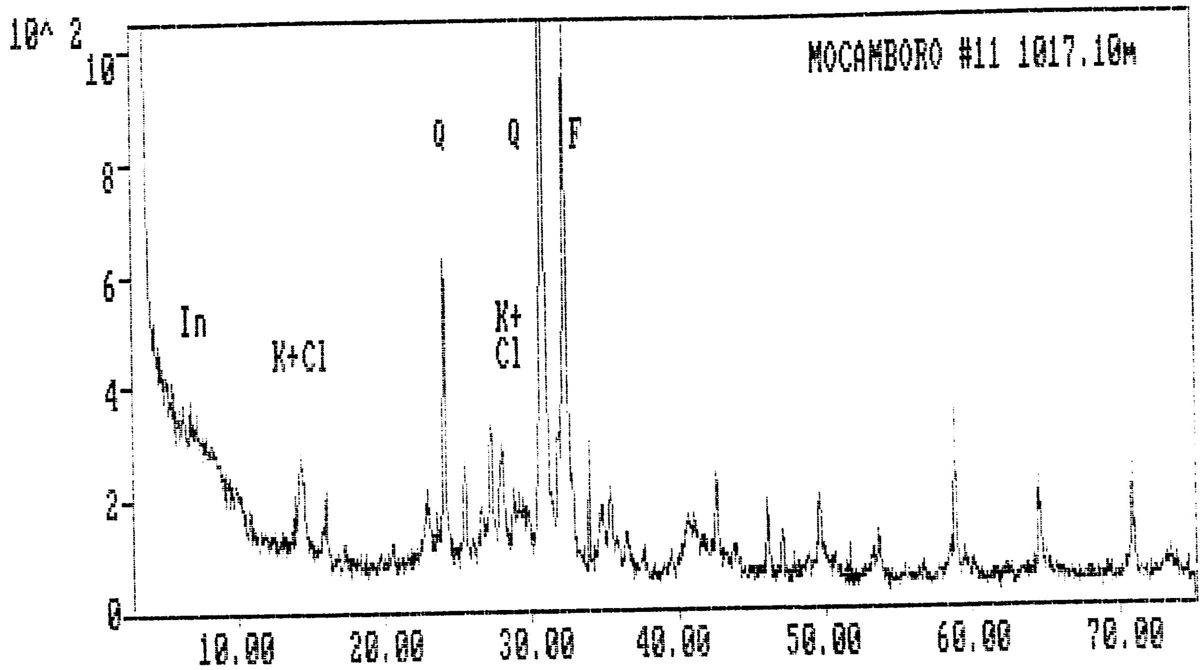

Figure 15a. Bulk XRD trace of core plug 15, Mocamboro #11, depth 1017.10m. Only the strongest peaks for each mineral identified have been labelled. Q=quartz, F=feldspar, K=kaolinite, Cl=clinochlore and In=interstratified clays.

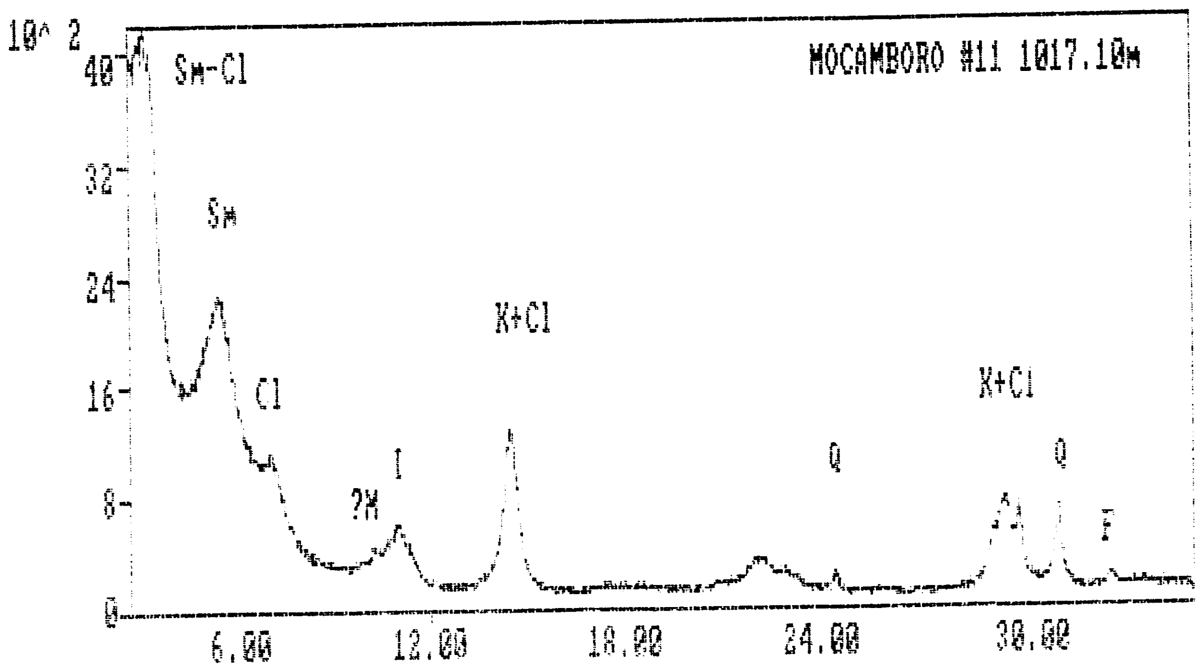

Figure 15b. Clay XRD trace of core plug 15, Mocamboro #11, depth 1017.10m. Only the strongest peaks for each mineral identified have been labelled. Sm=smectite (18 Angstrom montmorillonite), Cl=clinochlore IIB, M=micaceous mineral, I=illite 2M1, K=kaolinite, Q=quartz and F=feldspar.

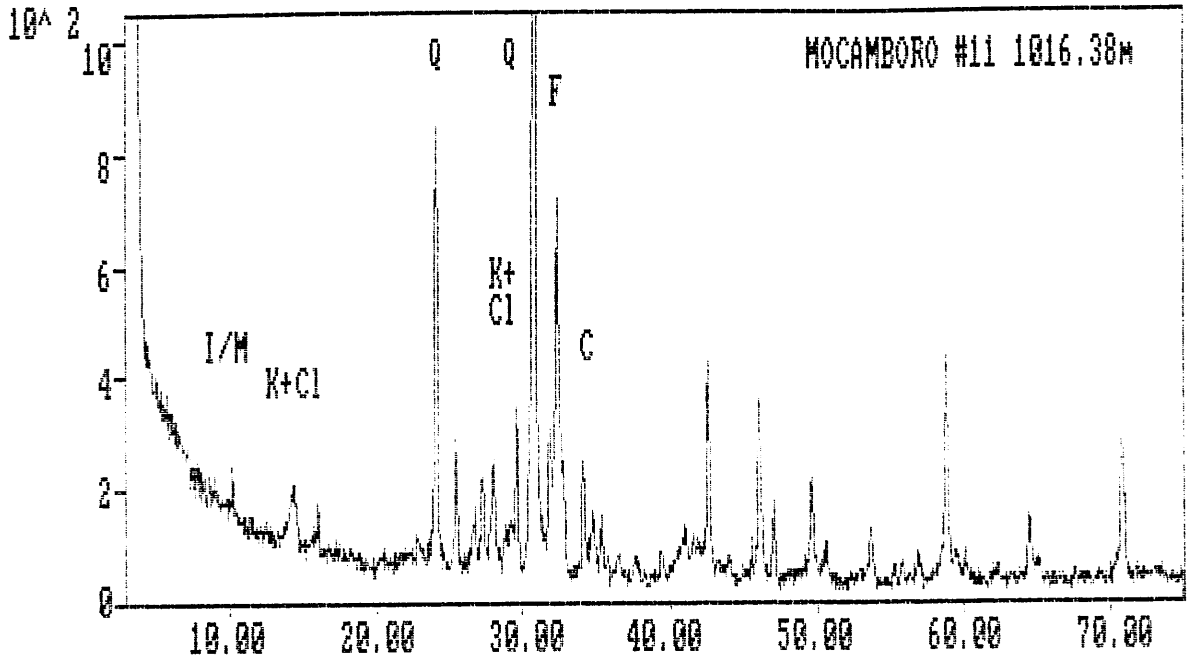

Figure 16a. Bulk XRD trace of core plug 16, Mocamboro #11, depth 1016.38m. Only the strongest peaks for each mineral identified have been labelled. Q=quartz, K=kaolinite, C=calcite, I/M=illite/muscovite, F=feldspar and Cl=clinochlore.

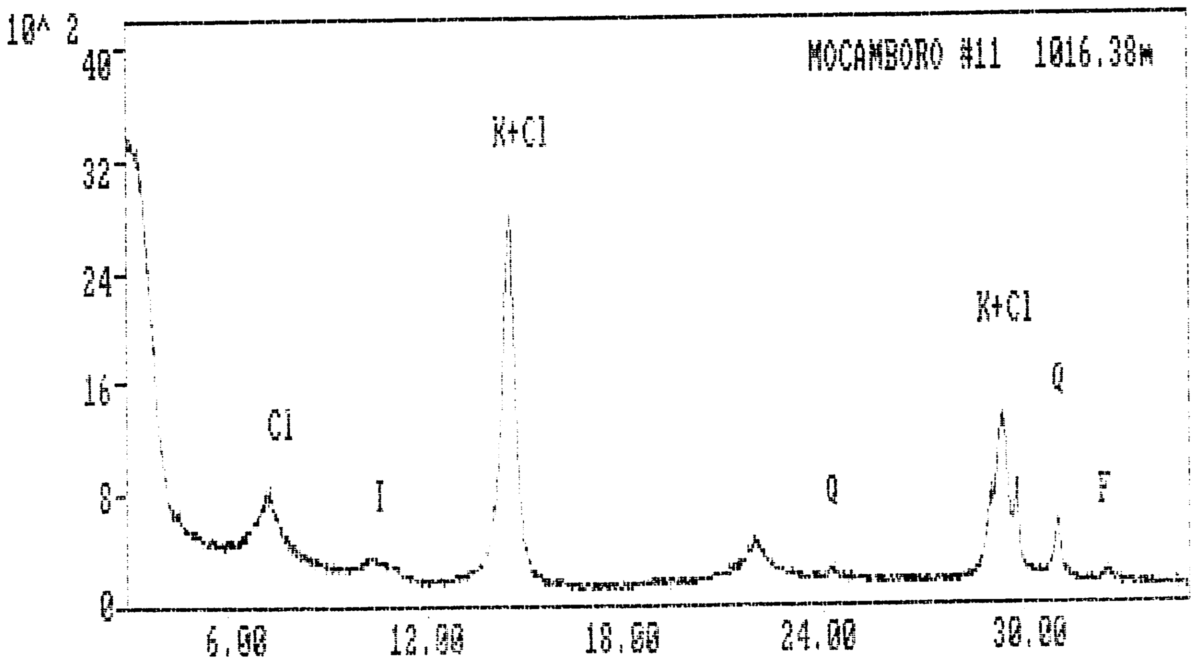

Figure 16b. Clay XRD trace of core plug 16, Mocamboro #11, depth 1016.38m. Only the strongest peaks for each mineral identified have been labelled. Cl=clinochlore IIB, I=illite 2M1, K=kaolinite, Q=quartz and F=feldspar.

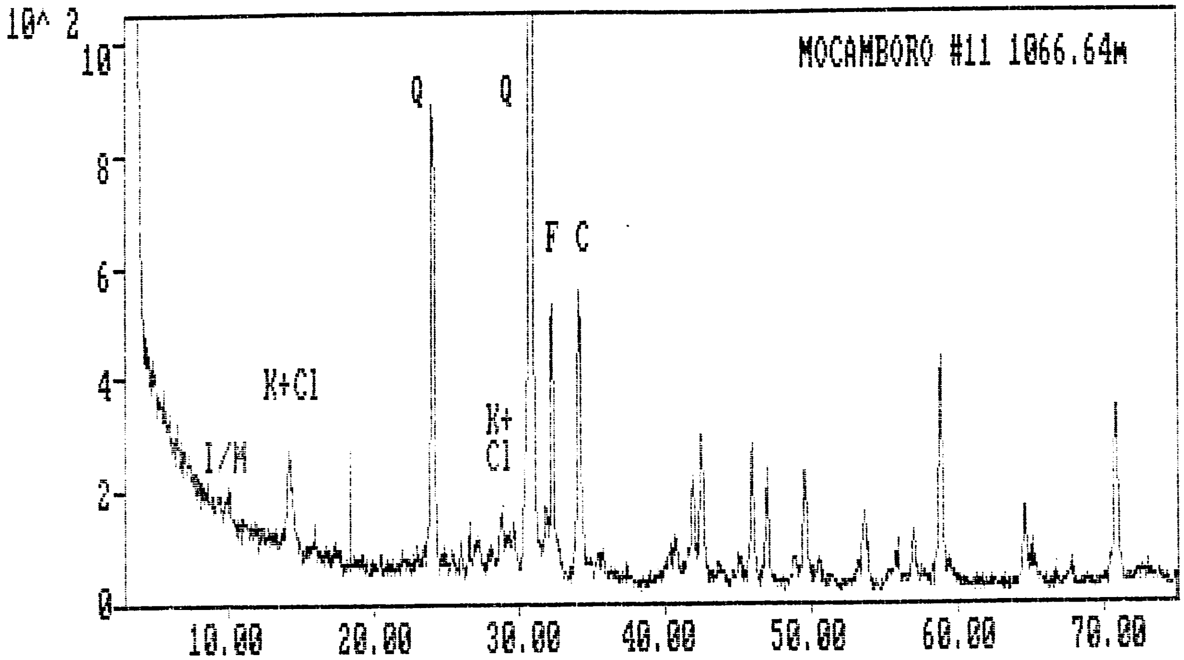

Figure 17a. Bulk XRD trace of core plug 17, Mocamboro #11, depth 1066.64m. Only the strongest peaks for each mineral identified have been labelled. Q=quartz, K=kaolinite, C=calcite, I/M=illite/muscovite, F=feldspar and Cl=clinochlore.

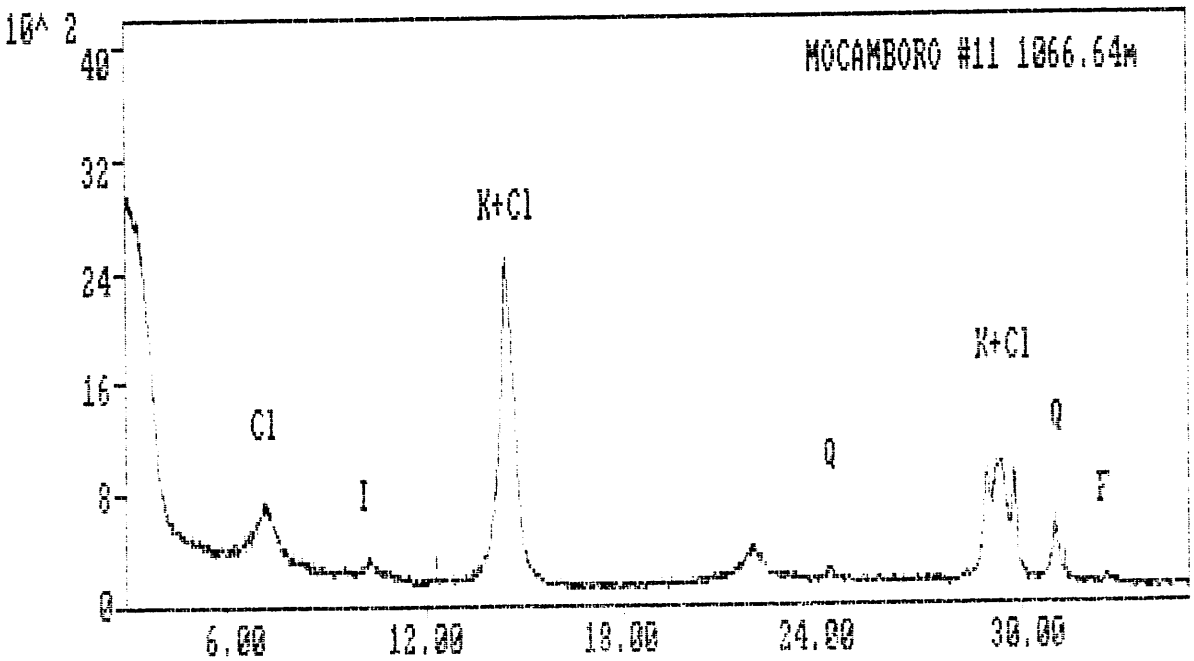

Figure 17b. Clay XRD trace of core plug 17, Mocamboro #11, depth 1066.64m. Only the strongest peaks for each mineral identified have been labelled. Cl=clinochlore IIB, I=illite 2M1, K=kaolinite, Q=quartz and F=feldspar.

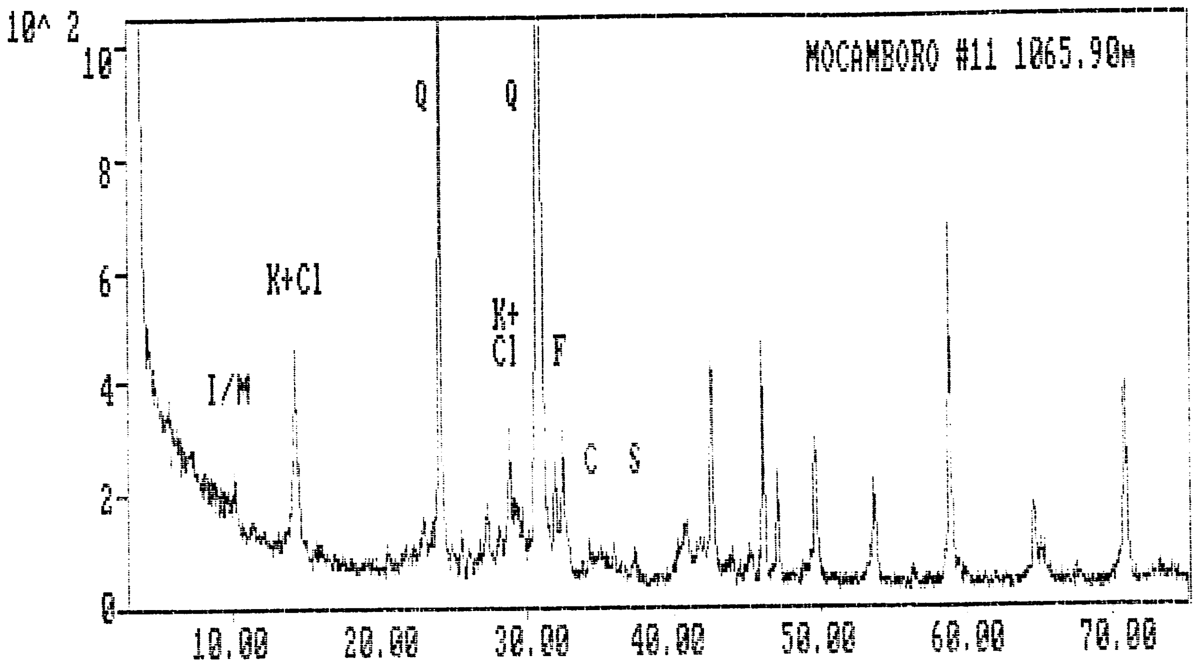

Figure 18a. Bulk XRD trace of core plug 18, Mocamboro #11, depth 1065.90m. Only the strongest peaks for each mineral identified have been labelled. Q=quartz, K=kaolinite, Cl=clinochlore, I/M=illite/muscovite, C=calcite, F=feldspar and S=siderite.

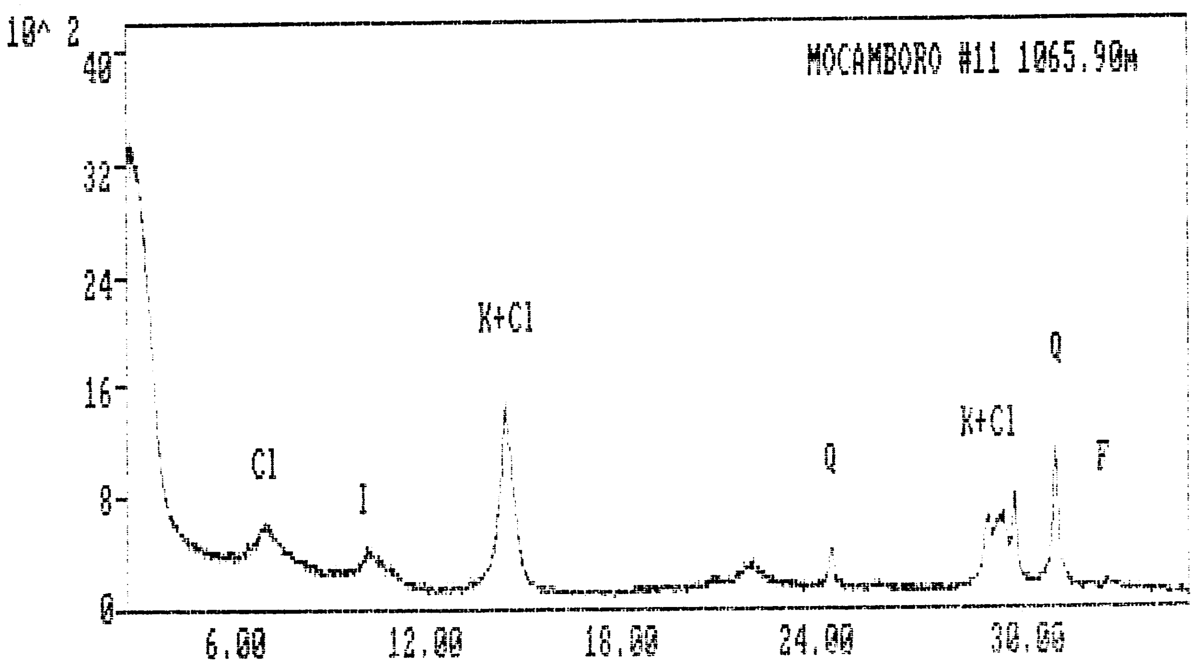

Figure 18b. Clay XRD trace of core plug 18, Mocamboro #11, depth 1065.90m. Only the strongest peaks for each mineral identified have been labelled. Cl=clinochlore IIB, I=illite 2M1, K=kaolinite, Q=quartz and F=feldspar.

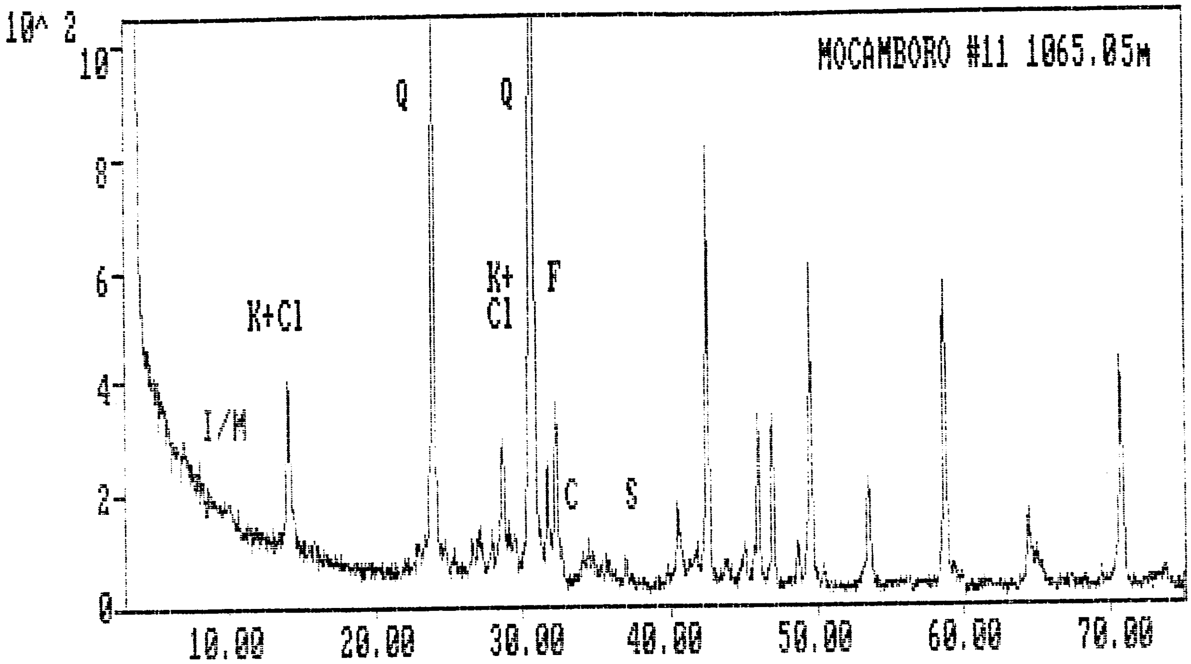

Figure 19a. Bulk XRD trace of core plug 19, Mocamboro #11, depth 1065.05m. Only the strongest peaks for each mineral identified have been labelled. Q=quartz, K=kaolinite, Cl=clinochlore, I/M=illite/muscovite, C=calcite, F=feldspar and S=siderite.

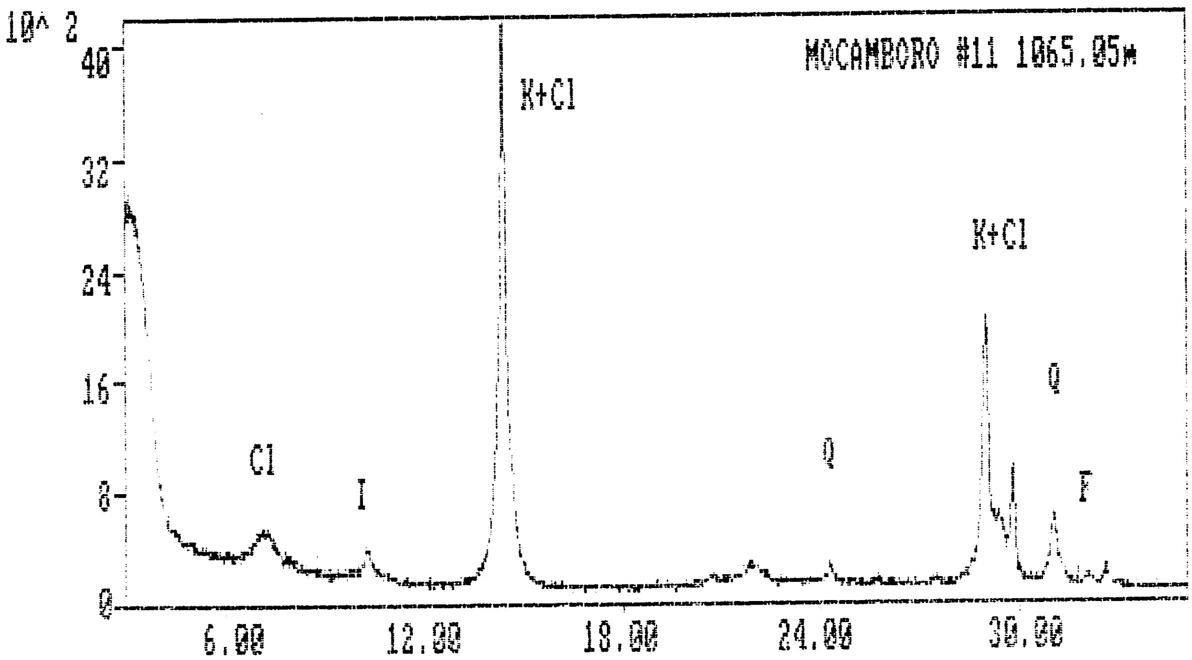

Figure 19b. Clay XRD trace of core plug 19, Mocamboro #11, depth 1065.05m. Only the strongest peaks for each mineral identified have been labelled. Cl=clinochlore IIB, I=illite 2M1, K=kaolinite, Q=quartz and F=feldspar.

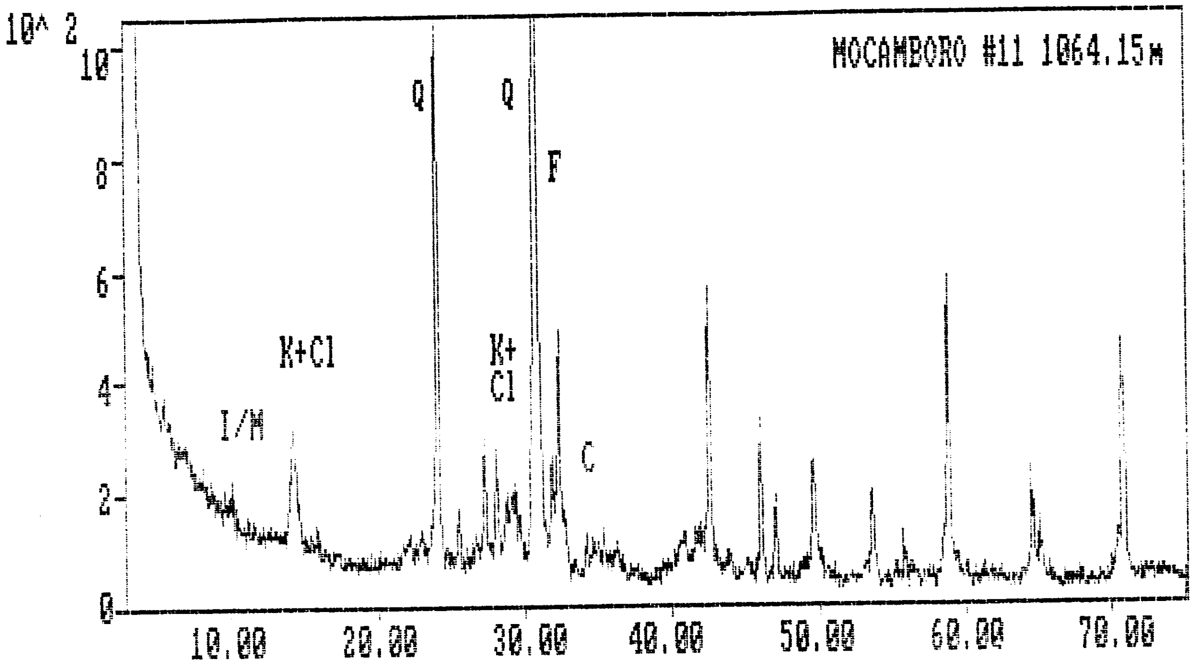

Figure 20a. Bulk XRD trace of core plug 20, Mocamboro #11, depth 1064.15m. Only the strongest peaks for each mineral identified have been labelled. Q=quartz, F=feldspar, K=kaolinite, I/M=illite/muscovite, Cl=clinochlore and C=calcite.

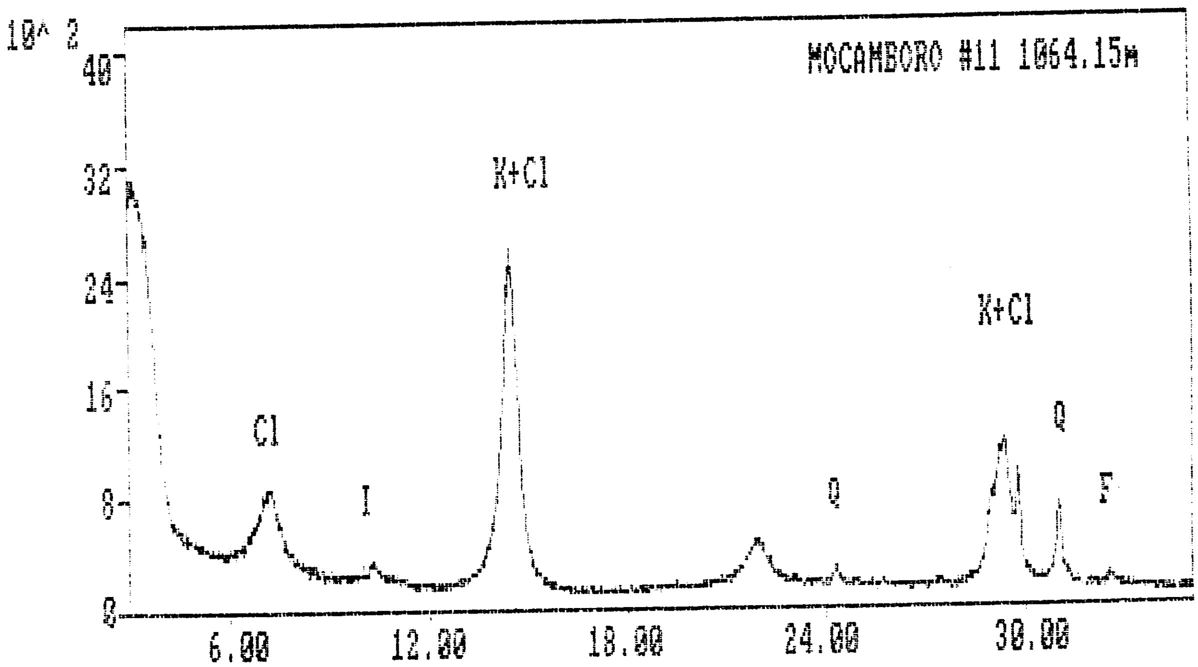

Figure 20b. Clay XRD trace of core plug 20, Mocamboro #11, depth 1064.15m. Only the strongest peaks for each mineral identified have been labelled. Cl=clinochlore IIB, I=illite 2M1, K=kaolinite, Q=quartz and F=feldspar.

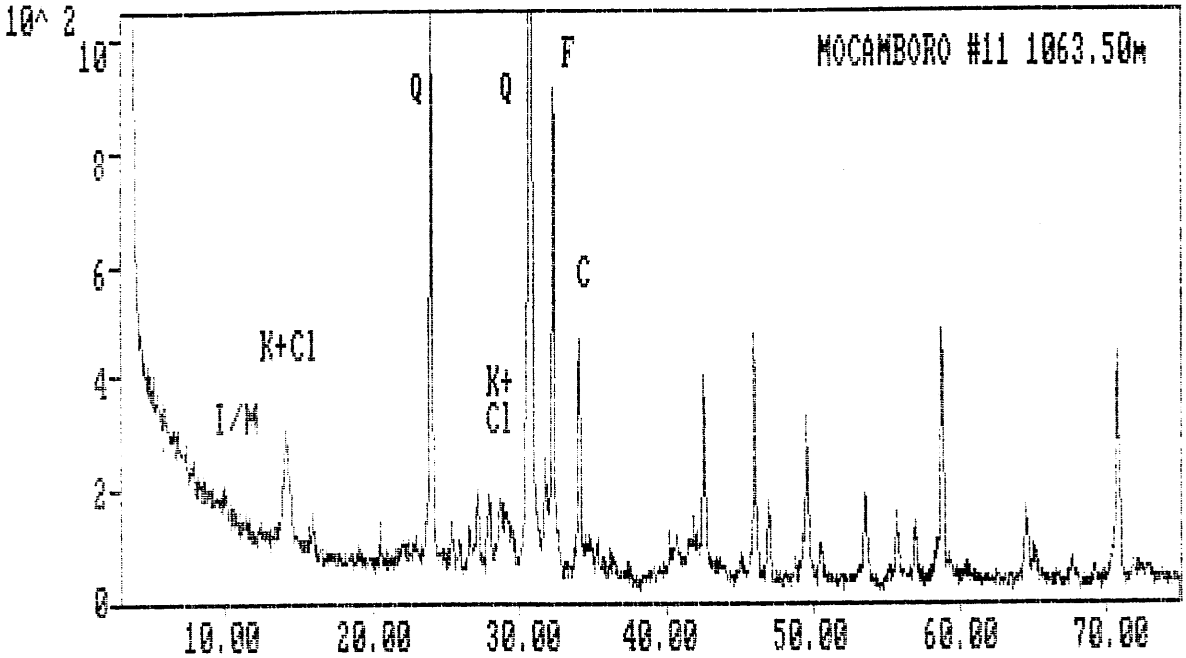

Figure 21a. Bulk XRD trace of core plug 21, Mocamboro #11, depth 1063.50m. Only the strongest peaks for each mineral identified have been labelled. Q=quartz, F=feldspar, K=kaolinite, Cl=clinochlore, C=calcite and I/M=illite/muscovite.

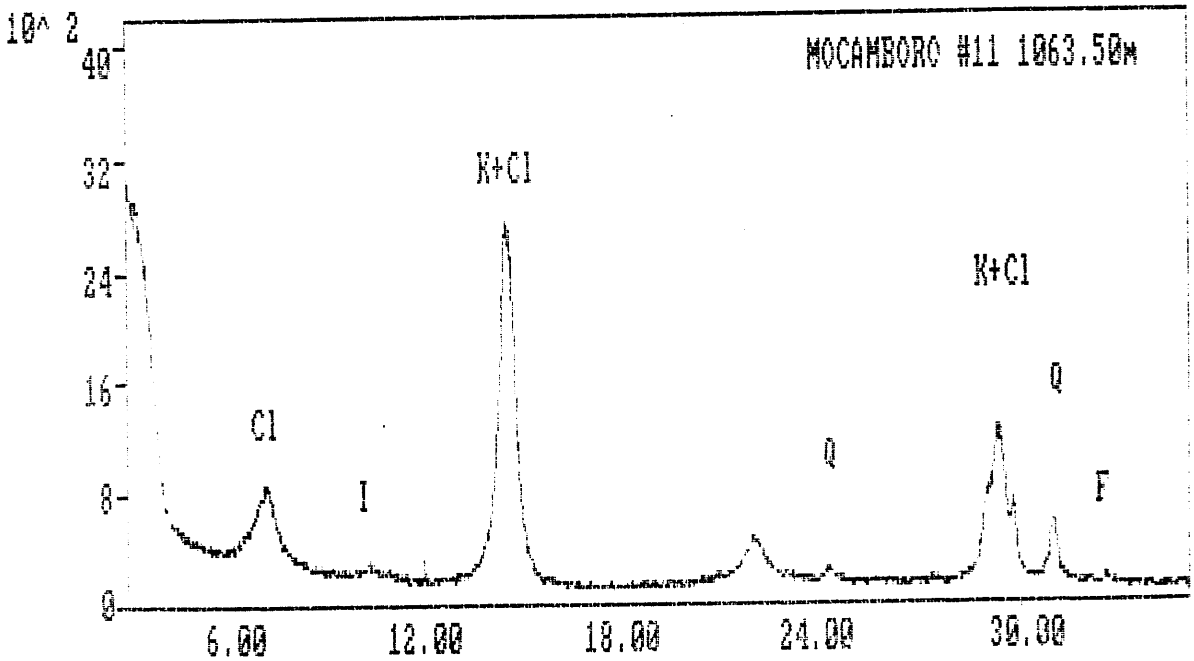

Figure 21b. Clay XRD trace of core plug 21, Mocamboro #11, depth 1063.50m. Only the strongest peaks for each mineral identified have been labelled. Cl=clinochlore IIB, I=illite 2M1, K=kaolinite, Q=quartz and F=feldspar.