FINA EXPLORATION AUSTRALIA S. A.

FINA

ARCHER-1

WELL COMPLETION REPORT

VOLUME 3

(INTERPRETATIVE DATA)

PETROFINA EXPLORATION AUSTRALIA S.A.

WELL COMPLETION REPORT ARCHER-1

VOLUME III

INTERPRETATIVE DATA

GL/90/048
JMQ/PhL/NG/kl
2 August 1990

WELL COMPLETION REPORT ARCHER-1

VOLUME III

INTERPRETATIVE DATA

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APPENDIX 5

WELL COMPLETION REPORT

ARCHER-1

INTERPRETATIVE DATA

A P P E N D I X 5

GEOCHEMICAL EVALUATION OF ROCK AND FLUID SAMPLES

GEOCHEMICAL EVALUATION OF ROCK AND FLUID SAMPLES

FROM ARCHER -1, VIC/P20 GIPPSLAND BASIN

009/260

Amdel Core Services Pty Limited
Incorporated in South Australia

AMDEL CORE SERVICES

26 July 1990

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

Attention: Jean-Marie Questiaux

REPORT: 009/260

CLIENT REFERENCE:	Facsimile req 8/5/90
MATERIAL:	Cuttings, Sidewall Cores, Gas and Condensate
LOCALITY:	Archer -1
WORK REQUIRED:	TOC, Rock-Eval Pyrolysis, Organic Petrology, Stable Isotopic Determinations of Gas, API Gravity and Sulphur Content of Condensate, Quantified Whole Oil Composition, Quantified Gasoline Range Analysis, Liquid Chromatography, GC of Saturated Hydrocarbons, GC-MS of Aromatics, GC-MS of Naphthenes

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

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

Please reply to: PO Box 109 Eastwood SA 5063 Ph: (08)372 2834

Amdel Core Services Pty Limited
Incorporated in South Australia

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1. INTRODUCTION

Rock-Eval pyrolysis, TOC and Organic Petrology analysis were requested on cuttings and sidewall core samples from Archer -1, Vic-P-20, Gippsland Basin. Petroleum geochemical analyses were also requested on gas and condensate from RFT tests. The aims of these analyses are outlined below:

- To determine the maturity, source richness and source quality of the sedimentary section intersected in the Archer -1 location.
- To determine the maturity and source affinity of the condensate as well as the maturity of the gas recovered from Repeat Formation Testing.
- To compare the condensate maturity and source affinity with the maturity and source quality data of the intersected sediments, to indicate whether the condensate was generated either "in situ" or alternatively from a distant source.
- To compare the source affinity and maturity of the Archer -1 gas and condensate samples to that of other oils analysed for Petrofina in this permit area.

This report is a formal presentation of results reported by telephone and facsimile as work was requested and completed.

2. ANALYTICAL PROCEDURES

The analytical procedures used in this study are provided in Appendix 1.

3. RESULTS

Analytical data is presented in this report as follows:

	Table	Figure	Appendix
Source Rock Analysis			
TOC and Rock-Eval data (cuttings)	1	1-5	-
Vitrinite Reflectance Determinations	2	6	-
Descriptions of Dispersed Organic Matter	3-5	-	-
Petroleum Geochemistry			
Stable Isotopic Composition of Gas	6	-	-
Gravity and Pour Point of Condensates	7-10	-	-
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	Table	Figure	Appendix
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4. INTERPRETATION

Source Rock Geochemistry

4.1 Maturity

Vitrinite reflectance data of cuttings and sidewall core samples (Table 2; Figure 1) indicate that the sediments intersected in the Archer -1 location are sufficiently mature for:

- The generation of light oil and condensate from sediments rich in resinite, suberinite and bituminite below 3000 metres depth threshold VR for significant generation = 0.45%; Snowdon and Powell, 1982).

- Significant gas generation from woody-herbaceous organic matter (vitrinite and to a lesser extent inertinite) below 4000 metres depth (Lower Latrobe Group (Campanian); VR> 0.6%, Monier *et al*., 1983).

- Oil generation from organic matter rich in exinites other than resinite, suberinite and bituminite below approximately 4400 metres depth in the Archer -1 location (VR > 0.7%; Connan and Cassou, 1980).

Rock-Eval Tmax values lie within the range 272 - 433°C in the samples examined. However, some Tmax values are anomalously low due to small and irregularly shaped S_2 peaks. Reliable Tmax values lie within the range 420 - 433°C and indicate equivalent vitrinite reflectance values of 0.3 - 0.5%.

A comparison of equivalent vitrinite reflectance values (from Tmax versus Hydrogen Index plots) with measured vitrinite reflectance values, indicates that the equivalent values are consistently lower than the measured values by approximately 0.1%.

This disparity is most likely due to matrix effects in these samples. In this case the pyrolysate produced from the organic components is released more easily than normal due to the absence of active clays or saturation of active sites on the surface of the clay minerals in these samples. This effect is common in samples which contain migrated hydrocarbons. However, although production indices are elevated in a number of samples, the occurrence of migrated hydrocarbons does not appear to be sufficiently widespread to account for the consistently low Tmax values.

Production indices greater than 0.2 indicate the presence of migrated hydrocarbons in the following intervals:

Depth (m)	Formation/Unit	Production Index
3400	Latrobe Group (Campanian)	0.31
3440 - 3760	Latrobe Group (Campanian)	0.28 - 0.43
3830 - 3900	Latrobe Group (Campanian)	0.20 - 0.41
3911	Latrobe Group (Campanian)	0.21
3930 - 4000	Latrobe Group (Campanian)	0.20 - 0.28
4002	Latrobe Group (Campanian)	0.22
4035	Latrobe Group (Campanian)	0.30

4.2 Source Richness

Organic richness ranges from poor to excellent in the sediments studied (TOC = 0.05-21.80%; Table 1) but is generally fair to good. Intervals which consisted of predominantly sandy sediments were not analysed. Source richness for hydrocarbons (genetic potential) is also variable ($S_1 + S_2$ = 0.06 - 61.10 kg hydrocarbons/tonne) and is highest in the Latrobe Group (Maastrichtian) and Latrobe Group (Upper Campanian). Intervals with the best organic and source richness are listed in the table below.

Depth (m)	Formation	TOC	$S_1 + S_2$ (kg of hydro-carbons/tonne)	Source Richness Rating
2790-3140	Latrobe Gp (Maast-Camp)	0.79 - 21.80	1.45 - 61.10	Fair to excellent
3160-3260	Latrobe (Camp)	0.86 - 10.73	2.17 - 30.98	Fair to excellent
3310-3330	Latrobe (Camp)	1.32 - 1.43	2.02 - 2.51	Fair
3732		1.78	2.39	Fair
3780-3810		8.96 - 1.64	2.26 - 4.29	Fair to Good
3841-4030		0.45 - 2.17	0.46 - 3.84	Generally Fair

4.3 Kerogen Type and Source Quality

Rock-Eval Hydrogen Index and Tmax data (Table 1) indicates that sediments intersected in the Archer -1 location contain organic matter with bulk compositions ranging from Type II to Type IV kerogen. However, sediments containing organic matter with the bulk composition of more oil prone Type II and Type II-III kerogen occur only in the Latrobe Group (Maastrichtian and Campanian).

Organic petrology of selected samples from the Latrobe Group show that this organic matter consists of moderate amounts of oil prone exinites (5-15%) together with larger quantities of gas/condensate prone vitrinite (10-40%).

The remaining organic matter in these sediments consists of inertinite (oxidised woody-herbaceous kerogen).

Thermally labile exinites (resinite, suberinite and bituminite) are present in moderately low abundances in the Latrobe Group indicating that these sediments have a fairly limited potential for the generation of light oil/condensate at low maturities (VR threshold for significant generation = 0.45%; Snowdon and Powell, 1982). Exsudatinite in these sediments (3000m) is primary oil and is direct evidence of early generation of oil from thermally labile exinites.

Petroleum Geochemistry

4.4 Maturity and Bulk Composition

Maturation-sensitive ratios based on C_{12+} acyclic alkanes and triaromatic hydrocarbons (methylphenanthrene index, MPI: Table 40) concur in demonstrating that the Archer -1 condensates belong to the peak mature group of Gippsland Basin crudes (Burns *et al*., 1987).

Well	Depth (m)	API Gravity	MPI	VR_{calc}* %	VR_{calc}+ %
Anemone -1	4230.5	51.9	1.62	1.35	1.33
Angler -1	4226	42.9	1.08	0.98	1.05
Kingfish -7	2314	46.0	1.26	1.10	1.16
Fortescue -A21	2735	41.2	1.14	1.02	1.08
Kipper -1	1823	45.0	1.07	0.97	1.04
Archer -1	3390-3947.5	33.02-47.93	1.00-1.26	0.92-1.10	1.00-1.15

* Derived using calibration of Boreham *et al* (1988)

\+ Derived using calibration of Radke and Welte (1983)

These oils are of paraffinic to paraffin-naphthenic bulk composition, (Table 12, Fig 15), have specific gravities within the range 41-46° API, and possess characteristic trimodal n-alkane profiles. The oils described by Burns are located above (or adjacent to) the central deep of the Gippsland Basin (ie The inferred source kitchen or generative depression, Demaison, 1984).

The maturity of these condensates indicates that they were clearly generated from a source of much greater maturity than that of the sediments intersected in this location. Extrapolation of the vitrinite reflectance versus depth trend indicates that this maturity may be reached at approximately 4800 metres depth in this location (based on non-linear extrapolation). However, in consideration of the marked similarities in composition and maturity of the Archer -1, Angler -1 and Anemone -1, hydrocarbons with those from Kingfish -7, it seems more likely that these hydrocarbons were generated in the central deep of the basin and migrated to their present position.

The technique of determining the level of maturity (LOM) of a gas by using the isotope separation between its hydrocarbon components, was developed by James (1983). This technique is independent of source Type, and illustrates that separation. The isotopic separation of the Archer -1 gas does not fit the LOM versus δC13 PDB curves of James (1983) suggesting it is a mixture of gases generated at different maturities.

The separation of the C_1 - C_2 isotopes suggests that these components were generated at a level of organic maturity (LOM of approximately 7 - 7.5 (VR = 0.5%). However, the isotopic composition of the C_2 - C_5 components are more consistent with generation at a level of organic maturity (LOM) of approximately 11 (VR = 1.1%). These higher values show good agreement with the maturity at which the liquid hydrocarbons recovered from RFT testing were generated (VR = 1-1.1%). It is therefore most likely that the C_2 - C_5 gases were generated from the same source as these liquid samples. The isotopic separation of methane and ethane in these gases suggest that the heavier gases and condensates which have accumulated in this location were supplemented by lighter hydrocarbons generated "in-situ" from the marginally mature sediments intersected in this location.

These maturation stages are very similar to those of the Angler -1, Anemone - 1 and Kingfish -7 hydrocarbons with the exception that the Archer -1 hydrocarbons contain significantly lower concentrations of gases generated at higher maturities (VR = 1.5%).

4.5 Source Affinity

The terrestrial source affinity of the Archer -1 condensates is clearly evident from aspects of their C_{12+} molecular composition and gasoline range (C_3 - C_7) hydrocarbons. (Tables 19-32, Figures 14-22). Pristane/phytane ratios lie within the range 2.05 - 3.51 and in combination with intermediate pristane/n-heptadecane ratios (0.73 - 1.01) and low phytane/n-octadecane ratios (0.22 - 0.41) indicate that these oils originated from land plant detritus which accumulated in an oxic aquatic environment. The variation of these ratios suggest that these oils may have been generated from a range of source rocks with a range of maturities. However, as discussed in previous sections, these oils were generated and expulsed from a source with a narrow maturation range (vitrinite reflectance value of 1-1.1%). Therefore, the range of these alkane ratios is most likely indicative of variable biodegradation of these oils.

Variable biodegradation is also evident from both the whole oil chromatograms (Figures 12-18) and gasoline range analyses (Tables 19-32, Figures 14-22). Bacteria preferentially degrade n-lkanes prior to iso-alkanes, cycloalkanes and aromatics and also prefer light hydrocarbons to heavier more complex hydrocarbons. Therefore, the degree of biodegradation of these condensates may be gauged by the loss of light n-alkanes compared to iso-alkanes and cyclo-alkanes. The loss of light alkanes is most pronounced in condensate from 3947 metres depth. C_2 - C_8 compounds comprise 10.73% of this sample compared to ~35-60% in the other condensates. However, the biodegradation sensitive ratios from the gasoline range analyses show little variation for the sample from 3947.5 metres depth. This may be explained by vertical fractionation within the reservoir in this location or more likely, light and loss. However, more work is necessary to determine if this is the case.

GC-MS analysis of the naphthenes fraction of these oils yielded little information to further characterise the land plant precursors from which they were derived.

5. CONCLUSIONS

1. Sediments intersected in the Archer -1 location are sufficiently mature for:

   - the generation of light oil and condensate from sediments rich in resinite, suberinite and bituminite below 3000 metres depth; threshold VR for significant generation = 0.45%; Snowdon and Powell, 1982).

   - significant gas generation from woody-herbaceous organic matter (vitrinite and to a lesser extent inertinite) below 4000 metres depth (Lower Latrobe Group (Campanian) VR> 0.6%, Monnier *et al.*, 1983).

   - oil generation from organic matter rich in exinites other than resinite, suberinite and bituminite below approximately 4400 metres depth in the Archer -1 location (VR > 0.7%; Connan and Cassou, 1980).

   Exsudatinite in samples from 3000 metres depth is direct evidence that hydrocarbon generation from the more thermally labile exinites has commenced.

2. Production indices greater than 0.2 indicate the presence of migrated hydrocarbons in the following intervals:

Depth (m)	Formation/Unit	Production Index
3400	Latrobe Group (Campanian)	0.31
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3. Source Richness

   Organic richness ranges from poor to excellent in the sediments studied (TOC = 0.05-21.80%; Table 1) but is generally fair to good. Invervals which consisted of predominantly sandy sediments were not analysed. Source richness for hydrocarbons (genetic potential) is also variable ($S_1 + S_2$ = 0.06 - 61.10 kg hydrocarbons/tonne) and is highest in the Larobe Group (Maastrichtian) and Latrobe Group (Upper Campanian). Intervals with the best organic and source richness are listed in the table below:

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3780-3810		8.96 - 1.64	2.26 - 4.29	Fair to Good
3841-4030		0.45 - 2.17	0.46 - 3.84	Generally Fair

4. Maturation-sensitive ratios based on C_{12+} acyclic alkanes and triaromatic hydrocarbons (methylphenanthrene index, MPI: Table 40) concur in demonstrating that the Archer -1 condensates belong to the <u>peak mature</u> group of Gippsland Basin crudes (Burns *et al.*, 1987).

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Archer -1	3390-3947.5	33.02-47.93	1.00-1.26	0.92-1.10	1.00-1.15

* Derived using calibration of Boreham *et al* (1988)
\+ Derived using calibration of Radke and Welte (1983)

5. In consideration of the maturity of the Archer -1 condensates and the marked similarities with those from other wells studied previously it seems most likely that the condensates recovered from this location were generated in the central deep of the basin and migrated to their present position.

6. Isotopic separation of the gas components suggest that these hydrocarbons were generated primarily from sediments of a maturity corresponding to a vitrinite reflectance (VR) of ~1.1%. These components appear to have been supplemented by early mature light hydrocarbons generated at a maturity of VR = 0.5%.

7. The Terrestrial source affinity of the Archer -1 condensate is clearly evident of aspects of its C_{12+} molecular composition and gasoline range hydrocarbons.

REFERENCES

ALEXANDER, R., NOBLE, RA & KAGI, RI, 1987. Fossil resin biomarkers and their application in oil to source-rock correlation, Gippsland Basin, Australia. AA J., 27(1), 63-72.

ALEXANDER, R., LARCHER, AV, KAGI, RI & PRICE, PL, 1988. The use of plant-derived biomarkers for correlation of oils with source rocks in the Cooper/Eromanga Basin system, Australia. APEA J., 28(1), 310-324.

BOREHAM, CJ., CRICK, IH & POWELL, TG, 1988. Alternative calibration of the Methylphenanthrene Index against vitrinite reflectance:application to maturation measurement of oils and sediments. Org. Geochem., 12, 289-294.

BURNS, BJ, BOSTWICK, TR & EMMETT, JK, 1987. Gippsland terrestrial oils - recognition of compositional variations due to maturity and biodegradation effects. APEA J., 27(1), 74-84.

BURNS, BJ, JAMES, AT, EMMETT, JK, 1984. The use of gas isotopes in determining the source of some Gippsland Basin oils. APEA J., 24(1), 217-221.

DEMAISON, G, 1984. The generative basin concept. In: Petroleum Geochemistry and Basin Evaluation (eds. DEMAISON, G. & MORRIS, RJ), AAPG Memoir 35, pp 1-14.

JAMES, AT, 1983. Correlation of natural gas using the carbon isotopic distribution between hydrocarbon component. AAPG Bulletin, 67, 1176-1191.

PHILP, RP & GILBERT, RD, 1985. Biomarker distribution in Australian oils predominantly derived from terrigenous source material. In: Advances in Organic Geochemistry, 1985 (eds LEYTHAEUSER, D & RULLKOTTER, J), Pergamon, Exford, pp 73-84.

POWELL, TG and SNOWDON, LR, 1983. A composite hydrocarbon generation model - implications for evaluation of basins for oil and gas. Erdol und Kohle, 36(4), 163-170.

SNOWDON, LR and POWELL, TG, 1982. Immature oil and condensate - modification of hydrocarbon generation model for terrestrial organic matter. Bull. Am. Assoc. Petrol. Geol., 66, 775-788.

SOFER, Z, 1984. Stable carbon isotope compositions of crude oils: application to source depositional environments and petroleum alteration. Bull. Am. Assoc. Petrol. Geol., 68, 31-49.

VINCENT, PW, MORTIMORE, IR & MCKIRDY DM, 1985. Hydrocarbon generation, migration and entrapment in the Jackson-Naccowlah area, ATP-259-P, Southwestern Queensland. APEA J, 25(1), 62-84.

TABLE #1

AMDEL CORE SERVICES

Rock-Eval Pyrolysis 07/21/90

Client: PETROFINA EXPLORATION S.A.

Well: ARCHER-1

Depth (m)	T Max	S1	S2	S3	S1+S2	PI	S2/S3	PC	TOC	HI	OI
2450 - 2460	420	0.03	0.31	0.28	0.34	0.09	1.10	0.02	0.40	77	70
2460 - 2470									0.31		
2470 - 2480									0.32		
2480 - 2490									0.37		
2490 - 2500	339	0.01	0.20	0.33	0.21	0.05	0.60	0.01	0.51	39	64
2500 - 2510	276	0.02	0.11	0.35	0.13	0.17	0.31	0.01	0.46	23	76
2510 - 2520									0.28		
2520 - 2530									0.31		
2530 - 2540									0.25		
2540 - 2550	336	0.05	0.50	0.60	0.55	0.09	0.83	0.04	0.46	108	130
2550 - 2560									0.29		
GURNARD FORMATION											
2560 - 2570									0.26		
2570 - 2580	430	0.05	0.06	0.78	0.11	0.50	0.07	0.00	0.43	13	18
2580 - 2590									0.37		
2590 - 2600	414	0.11	0.52	0.52	0.63	0.18	1.00	0.05	0.41	126	128
2600 - 2610									0.35		
2610 - 2620									0.37		
2620 - 2630	268	0.03	0.06	0.60	0.09	0.33	0.10	0.02	0.45	133	133
2630 - 2640	287	0.03	0.09	0.54	0.12	0.25	0.16	0.01	0.40	22	135
LATROBE GROUP (PALEOCENE)											
2640 - 2650									0.26		
2650 - 2660									0.28		
2660 - 2670									0.13		
2670 - 2680									0.14		
2680 - 2690									0.29		
2690 - 2700	282	0.02	0.08	0.40	0.10	0.20	0.20	0.00	0.40	20	100
2700 - 2710									0.15		
LATROBE GROUP (MAASTRICHTIAN)											
2710 - 2720	272	0.01	0.09	0.22	0.10	0.10	0.40	0.00	0.61	14	36
2720 - 2730	278	0.00	0.06	0.24	0.06	0.00	0.25	0.00	0.54	11	44
2730 - 2740	254	0.07	0.04	0.27	0.11	0.70	0.14	0.00	0.60	6	45
2740 - 2750									0.35		
2770 - 2780									0.05		
2780 - 2790	424	0.03	0.62	0.10	0.65	0.05	6.20	0.05	0.42	147	23
2790 - 2800	423	0.09	2.74	0.17	2.83	0.03	16.11	0.23	1.32	207	12
2800 - 2810	425	0.19	4.89	0.30	5.08	0.04	16.30	0.42	1.96	249	15
2810 - 2820	425	0.03	1.42	0.14	1.45	0.02	10.14	0.12	0.79	179	17
2820 - 2830	423	0.07	2.89	0.16	2.96	0.02	18.06	0.24	1.14	253	14
2830 - 2840	425	0.34	5.90	0.32	6.24	0.05	18.43	0.52	2.15	274	14
2840 - 2850	425	0.24	2.29	0.10	2.53	0.10	22.90	0.21	0.99	231	10
2850 - 2860	422	0.55	7.45	0.34	8.00	0.07	21.91	0.66	2.87	259	11
2860 - 2870	425	0.13	3.31	0.23	3.44	0.04	14.39	0.28	1.32	250	17
2880 - 2890	423	0.29	7.97	0.36	8.26	0.04	22.13	0.68	2.73	291	13

AMDEL CORE SERVICES

Rock-Eval Pyrolysis 07/21/90

Client: PETROFINA EXPLORATION S.A.

Well: ARCHER-1

Depth (m)	T Max	S1	S2	S3	S1+S2	PI	S2/S3	PC	TOC	HI	OI
2890 - 2900	421	0.40	12.68	0.58	13.08	0.03	21.86	1.09	4.65	272	12
2910 - 2920	425	0.24	6.96	0.20	7.20	0.03	34.80	0.60	3.54	196	5
2920 - 2930	426	0.34	10.55	0.42	10.89	0.03	25.11	0.90	4.22	250	9
2930 - 2940	428	0.14	6.13	0.10	6.27	0.02	61.30	0.52	2.66	230	3
2940 - 2950	425	0.69	14.29	0.69	14.98	0.05	20.71	1.24	6.70	213	10
2950 - 2960	421	0.61	14.25	0.50	14.86	0.04	28.50	1.23	9.05	157	5
2960 - 2970	420	1.09	28.49	1.06	29.58	0.04	26.87	2.46	5.73	497	18
2970 - 2980	424	0.27	11.11	0.61	11.38	0.02	18.21	0.94	5.97	186	10
2980 - 2990	422	0.69	18.22	0.66	18.91	0.04	27.60	1.57	10.46	174	6
2990 - 3000	426	1.79	59.31	0.85	61.10	0.03	69.77	5.09	21.80	272	3
3000 - 3010	423	0.34	10.39	0.36	10.73	0.03	28.86	0.89	5.13	202	7
3010 - 3020	425	0.23	6.47	0.15	6.70	0.04	43.13	0.56	2.51	257	5
3020 - 3030	427	0.16	3.57	0.08	3.73	0.04	44.62	0.31	1.52	230	5
3030 - 3040	424	0.18	3.02	0.28	3.20	0.06	10.78	0.26	2.38	126	11
3040 - 3050	421	0.26	5.24	0.29	5.50	0.05	18.06	0.45	1.63	321	17
3050 - 3060	419	0.16	3.29	0.23	3.45	0.05	14.30	0.28	1.58	208	14
3060 - 3070	424	0.11	3.63	0.23	3.74	0.03	15.78	0.31	1.68	216	13
LATROBE GROUP (CAMPANIAN)											
3080 - 3090	423	0.12	3.65	0.24	3.77	0.03	15.20	0.31	0.91	401	26
3090 - 3100	428	0.10	5.17	0.20	5.27	0.02	25.85	0.43	2.18	237	9
3100 - 3110	425	0.11	3.61	0.20	3.72	0.03	18.05	0.31	1.49	242	13
3110 - 3120	425	0.13	4.49	0.28	4.62	0.03	16.03	0.38	1.90	236	14
3120 - 3130	428	0.33	8.48	0.27	8.81	0.04	31.40	0.73	3.22	263	8
3130 - 3140	427	0.18	7.03	0.40	7.21	0.02	17.57	0.60	2.61	269	15
3140 - 3150	427	0.09	1.68	0.13	1.77	0.05	12.92	0.14	0.74	227	17
3150 - 3160	424	0.04	0.97	0.08	1.01	0.04	12.12	0.08	0.40	242	20
3160 - 3170	427	0.13	4.17	0.20	4.30	0.03	20.85	0.35	1.60	260	12
3170 - 3180	425	0.85	18.87	0.63	19.72	0.04	29.95	1.64	4.59	411	140
3180 - 3190	424	0.39	7.76	0.31	8.15	0.05	25.03	0.67	2.97	261	10
3190 - 3200	422	1.17	13.07	0.26	14.24	0.08	54.26	1.18	4.99	261	5
3200 - 3210	420	1.63	24.22	0.50	25.85	0.06	48.44	2.15	8.45	286	5
3210 - 3220	425	1.91	29.07	0.61	30.98	0.06	47.65	2.58	10.23	284	5
3220 - 3230	425	0.56	8.58	0.34	9.14	0.06	25.23	0.76	3.98	215	8
3230 - 3240	424	0.47	6.53	0.28	7.00	0.07	23.32	0.58	2.88	226	9
3240 - 3250	422	0.17	2.00	0.14	2.17	0.08	14.28	0.18	0.86	232	16
3250 - 3260	423	0.17	2.52	0.14	2.69	0.06	18.00	0.22	0.91	276	15
3260 - 3270									0.31		
3270 - 3280	422	0.08	1.14	0.21	1.22	0.07	5.42	0.10	0.74	154	28
3280 - 3290									0.23		
3290 - 3300	426	0.17	3.43	0.76	3.60	0.05	4.51	0.30	1.58	217	48
3300 - 3310	429	0.04	1.77	0.66	1.81	0.02	2.68	0.15	1.14	155	57
3310 - 3320	427	0.06	2.45	0.50	2.51	0.02	4.90	0.20	1.32	185	37
3320 - 3330	429	0.08	1.94	0.34	2.02	0.04	5.70	0.16	1.43	135	23
3330 - 3340	415	0.03	0.86	0.24	0.89	0.03	3.58	0.07	0.49	175	48

AMDEL CORE SERVICES

Rock-Eval Pyrolysis 07/21/90

Client: PETROFINA EXPLORATION S.A.

Well: ARCHER-1

Depth (m)	T Max	S1	S2	S3	S1+S2	PI	S2/S3	PC	TOC	HI	OI
3340 - 3350									0.32		
3350 - 3360	427	0.03	1.85	0.46	1.88	0.02	4.02	0.15	1.20	154	38
3360 - 3370	428	0.05	2.08	0.46	2.13	0.02	4.52	0.17	1.38	150	33
3370 - 3380	427	0.25	4.63	0.53	4.88	0.05	8.73	0.40	2.02	229	26
3380 *	429	0.52	5.73	0.26	6.25	0.08	22.03	0.52	1.79	320	14
3380 - 3390	424	0.05	0.54	0.24	0.59	0.09	2.25	0.04	0.55	98	43
3390 - 3400									0.32		
3400 *	422	0.52	1.17	0.21	1.69	0.31	5.57	0.14	1.22	95	17
3400 - 3410									0.16		
3410 - 3420	423	0.11	0.65	0.14	0.76	0.14	4.64	0.06	0.52	125	26
3440 - 3450	410	0.45	1.16	3.59	1.61	0.28	0.32	0.13	0.41	282	875
3460 - 3470									0.23		
3470 - 3480									0.29		
3480 - 3490									0.16		
3490 - 3500									0.24		
3500 - 3510									0.21		
3510 - 3520									0.15		
3520 - 3530									0.18		
3519 *	417	0.17	0.72	0.14	0.89	0.19	5.14	0.07	0.84	85	16
3530 - 3540									0.11		
3570 - 3580									0.09		
3576 *	420	0.34	0.63	0.10	0.97	0.35	6.30	0.08	0.89	70	21
3600 - 3610									0.07		
3652 *	353	0.39	0.49	0.26	0.88	0.44	1.88	0.07	0.58	84	44
3660 - 3670									0.06		
3680 - 3690									0.06		
3710 - 3720									0.11		
3720 - 3730	365	0.08	0.31	0.21	0.39	0.21	1.47	0.03	0.42	73	50
3730 - 3740	428	0.14	0.97	0.25	1.11	0.13	3.88	0.09	0.94	103	26
3732 *	431	0.53	1.86	0.35	2.39	0.22	5.31	0.19	1.78	104	19
3740 - 3750	429	0.21	0.56	0.30	0.77	0.28	1.86	0.06	0.71	78	42
3750 - 3760	386	0.12	0.16	0.21	0.28	0.43	0.76	0.02	0.42	38	50
3760 - 3770	430	0.27	1.65	0.13	1.92	0.14	12.69	0.16	0.91	181	14
3770 - 3780	429	0.26	1.39	0.08	1.65	0.16	17.37	0.13	0.88	157	9
3780 - 3790	426	0.39	3.90	0.26	4.29	0.09	15.00	0.35	1.64	237	15
3790 - 3800									0.37		
3800 - 3810	430	0.38	1.88	0.39	2.26	0.17	4.82	0.18	0.96	195	40
3810 - 3820	430	0.30	1.46	0.24	1.76	0.17	6.08	0.14	0.88	165	27
3820 - 3830									0.27		
3830 - 3840	430	0.19	0.28	0.18	0.47	0.41	1.55	0.03	0.53	52	33
3840 - 3850	430	0.20	0.44	0.20	0.64	0.31	2.20	0.05	0.66	66	30
3841 *	433	0.58	2.33	0.43	2.91	0.20	5.41	0.24	1.91	121	22
3850 - 3860									0.27		
3869 *	435	0.67	2.33	0.24	3.00	0.22	9.70	0.25	2.17	107	11

AMDEL CORE SERVICES

Rock-Eval Pyrolysis 07/21/90

Client: PETROFINA EXPLORATION S.A.

Well: ARCHER-1

Depth (m)	T Max	S1	S2	S3	S1+S2	PI	S2/S3	PC	TOC	HI	OI
3870 - 3880	428	0.17	0.40	0.45	0.57	0.30	0.88	0.04	0.60	66	75
3890 - 3900	430	0.30	1.08	1.79	1.38	0.22	0.60	0.11	0.99	109	180
3897 *	431	0.43	2.15	0.72	2.58	0.17	2.98	0.21	1.97	109	36
3900 - 3910	432	0.36	1.70	1.67	2.06	0.17	1.01	0.17	1.41	120	118
3910 - 3920	433	0.42	2.37	1.19	2.79	0.15	1.99	0.23	1.85	128	64
3911 *	431	0.39	1.45	0.74	1.84	0.21	1.95	0.15	1.85	78	40
3920 *	430	0.73	3.11	0.72	3.84	0.19	4.31	0.32	1.67	186	43
3920 - 3930	431	0.36	2.73	0.79	3.09	0.12	3.45	0.25	1.93	141	40
3930 - 3940	427	0.52	2.14	0.33	2.66	0.20	6.48	0.22	1.58	135	20
3930 *	426	0.72	2.92	0.42	3.64	0.20	6.95	0.30	1.58	184	26
3940 - 3950	426	0.19	0.54	0.13	0.73	0.26	4.15	0.06	0.57	94	22
3940 *	424	0.63	2.46	0.31	3.09	0.20	7.93	0.25	1.54	159	20
3947 *	431	0.83	2.79	0.37	3.62	0.23	7.54	0.30	2.07	134	17
3960 - 3970	421	0.15	0.31	0.73	0.46	0.33	0.42	0.03	0.45	68	162
3969 *	430	0.67	2.67	0.58	3.34	0.20	4.60	0.27	2.07	128	28
3970 - 3980	431	0.26	1.06	0.99	1.32	0.20	1.07	0.11	0.74	143	133
3977 *	433	0.42	2.14	0.96	2.56	0.16	2.22	0.21	1.61	132	59
3980 - 3990	430	0.22	0.57	0.45	0.79	0.28	1.26	0.06	0.66	86	68
3990 - 4000	428	0.20	0.65	0.30	0.85	0.24	2.16	0.07	0.72	90	41
4000 - 4010	431	0.27	1.83	0.35	2.10	0.13	5.22	0.17	1.46	125	23
4002 *	431	0.57	1.97	0.68	2.54	0.22	2.89	0.21	2.10	93	32
4010 - 4020	432	0.35	2.11	0.58	2.46	0.14	3.63	0.20	2.04	103	28
4020 - 4030	431	0.38	1.91	0.53	2.29	0.17	3.60	0.19	1.70	112	31
4030 - 4040	431	0.26	1.44	0.81	1.70	0.15	1.77	0.14	1.47	97	55
4035 *	431	0.44	1.03	0.89	1.47	0.30	1.15	0.12	1.87	55	47
4040 - 4050	432	0.19	1.55	0.53	1.74	0.11	2.92	0.14	1.48	104	35

TABLE 2

SUMMARY OF VITRINITE REFLECTANCE MEASUREMENTS

Depth (m)	Mean Maximum Reflectance (%)	Standard Deviation	Range	Number of Determinations
2450				
2500	.37	.03	.33 - .41	4
2560	.44	.01	.43 - .44	2
2600	.44	.01	.42 - .46	4
2650				
2700				
2740	.47	.03	.44 - .50	2
2790	.44	.04	.36 - .54	16
2850	.45	.05	.34 - .55	22
2900	.47	.05	.47 - .55	26
2950	.48	.05	.37 - .55	26
3000	.45	.03	.38 - .50	24
3040	.47	.04	.39 - .54	22
3100	.48	.04	.41 - .56	18
3140	.48	.04	.43 - .54	4
3190-3200	.45	.04	.36 - .51	28
3240-3250	.47	.04	.42 - .53	10
3290-3300*	.45	.03	.41 - .50	14
3340-3350	.48	.03	.44 - .55	2
3390-3400				
3440*	.44	.02	.41 - .48	8
3490-3500				
3519	.47	.01	.46 - .48	2
3530				
3600				
3652	.49	.01	.48 - .50	2
3710				
3750				
3810	.50	.04	.46 - .58	8
3869	.59		.59	2
3911				
3940*	.50	.01	.49 - .51	2
4002	.63	.03	.58 - .65	4
4035	.67		.67	2

* Influenced by caved cuttings

TABLE 3

PERCENTAGE OF VITRINITE, INERTINITE AND EXINITE IN DISPERSED ORGANIC MATTER, ARCHER -1

Depth (m)	Percentage of Vitrinite	Percentage of Inertinite	Percentage of Exinite
2450	5-10	85	5-10
2500	5	90	5
2560	5	90	5
2600	<5	90	5
2650	5	90	5
2700	5	90	5
2740	5	90	5
2790	<5	90	5-10
2850	5-10	90	5
2900	20	70-75	5-10
2950	40	45-50	10-15
3000	20	70-75	5-10
3040	10	80-85	5-10
3100	25	65	10
3140	20	70	10
3190	10-15	80	5-10
3240	10	80-85	5-10
3290	5-10	85	5-10
3340	<5	90	<5
3390	<5	90	<5
3440	<5	90	5
3490	<5	90	5
3519	5-10	85-90	5
3530	-	100	<5
3600	-	95	<5
3652	10	85	<5
3710	<5	90	<5
3750	10	85	5
3810	5-10	85	5-10
3869	10	80	10
3911	5	90	5
3940	10	80-85	5-10
4002	5	90	5
4035	5	90	5

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TABLE 4

ORGANIC MATTER TYPE AND ABUNDANCE, ARCHER -1

Depth (m)	Estimated Volume of DOM	Exinites	Exinite Macerals
2450	<0.5	Ra-Vr	phyto, lipto
2500	<0.5	Ra-Vr	lipto, phyto
2560	<0.5	Tr	spo, phyto, lipto
2600	<0.5	Ra-Vr	bmite, phyto, lipto
2650	<0.5	Ra-Vr	bmite, phyto, lipto
2700	<0.5	Vr	lipto
2740	<0.5	Vr	bmite
2790	1 - 2	Ra	spo, lama, cut, res, lipto, tela
2850	1 - 2	Ra	lipto, spo, cut, lama, bmite
2900	3 - 5	Ra	spo, cut, lipto, res, sub
2950	1 - 2	Ra	cut, spo, res, lama, lipto
3000	1 - 2	Ra	lipto, spo, res, sub, cut, exs
3040	0.5-1	Ra	cut, lipto, spo, res
3100	0.5-1	Ra	cut, lipto, lama
3140	0.5-1	Ra	cut, lipto, lama
3190	2 - 3	Ra	cut, lipto, spo, bmite, res
3240	~0.5	Ra-Vr	cut, lipto
3290	0.5-1	Ra	cut, res, lipto, spo
3340	<0.5	Ra-Vr	lipto, cut
3390	<0.5	Vr	bmite, lipto
3440	~0.5	Vr	phyto, lipto, cut
3490	<0.5	Vr	cut, lipto, spo, res
3519	~1	Ra	lipto, cut, spo
3530	<0.5	Tr	lipto
3600	<0.5	Tr	lipto
3652	0.5-1	Vr	lipto, cut
3710	<0.5	Vr	lipto
3750	~0.5	Vr	lipto, cut
3810	0.5-1	Ra	cut, lipto, spo, res
3869	~1	Ra	lipto, cut, res, oil
3911	1 - 2	Ra	lipto, cut, ?lama, res, ?tela, oil
3940	~1	Ra	spo, lipto, cut
4002	1 - 2	Ra	lipto, cut, res, lama
4035	1 - 2	Ra	lipto, cut, lama, res

TABLE 5

EXINITE MACERAL ABUNDANCE AND FLUORESCENCE CHARACTERISTICS,

ARCHER -1

Depth (m)	Exinite Macerals	Lithology/Comments
2450	phyto (Ra-Vr; mY-dO), lipto	Shale
2500	lipto (Ra;mY-mO), (Ra-Vr;mO), phyto, (Vr;mO)	Shale
2560	spo (Tr;mO), phyto (Tr;mO), lipto (Tr;mO)	Chiefly shale, 20-30% sandstone
2600	bmite(Ra-Vr;dO), lipto(Vr;mO-dB)	Sandy shale; some exinite is oxidised
2650	bmite(Ra-Vr;dO), phyto(Vr;mO) lipto(Vr;mO-dO)	Sandy siltstone; some exinite as above
2700	lipto (Vr;mY-mO)	Chiefly silty sandstone ~10% shale
2740	bmite(Vr;dO-dB)	Sandstone with minor shale
2790	spo(Ra;mY-mO), lama(Ra;mO) cut (Ra-Vr;mO-dO), res(Ra-Vr; mO-dO), lipto(Vr;mY-mO), tela (Tr;iO)	Chiefly sandstone, 5-10% carbonaceous shale
2850	lipto(Ra;mY-mO), spo(Ra-Vr;mO) cut(Vr;mO), lama(Vr;mO), bmite (Vr;mO-dO)	Chiefly shale, ~10% carbonaceous shale
2900	spo(Ra;mY-mO), cut(Ra;mY-mO), lipto(Ra-Vr;mY-mO), res (Vr;mY-mO), sub(Vr;dO-dB)	Chiefly silty shale, 5-10% coal
2950	cut(Ra;mO), spo(Vr;mY-mO), res (Vr;mY-mO), lama(Vr;mO), lipto (Vr;mO)	Silty shale with minor coal
3000	lipto(Ra;mY-dB),spo(Vr;mO) res(Vr;iY-mO),sub(Vr;dO) cut(Tr;dO-dB),exs(Tr;dO)	Sandy siltstone with minor coal and shale. Exsudatinite is primary oil exsuding from some coal fragments
3040	cut(Ra;iY-dO),lipto(Ra;mY-mO) spo(Vr;mO), res(Vr;mY)	Silty sandstone

Depth (m)	Exinite Macerals	Lithology/Comments
3100	cut(Ra;mY-mO),lipto(Ra;mY-mO) lama(Tr;mO)	Chiefly sandstone, ~10% shale
3140	cut(Ra;mY-mO),lipto(Ra;mO), lama(Vr;mO)	Chiefly sandstone, ~10% silty shale
3190	cut(Ra;mO),lipto(Ra;mO), spo (Ra-Vr;mY-mO), bmite(Ra-Vr;dO), res(Vr;mY-mO), sub(Tr;dO)	Silty shale
3240	cut(Ra-Vr;mO), lipto(Ra-Vr; mY-mO)	Chiefly sandstone, ~5% shale (?cavings)
3340	lipto(Ra-Vr;mY-mO), cut(Vr;mO)	Chiefly sandstone, ~5% shale
3390	bmite(Vr;dO), lipto(Vr;mY-mO) (Vr;iY-mO)	Chiefly sandstone, <5% siltstone (?cavings)
3440	phyto (Vr;iY-mY),lipto(Vr;mO-dO), cut (Tr; mO-dO)	Silty shale
3490	cut(Vr;mY-mO), lipto(Vr;mY-mO), spo(Tr;mO), res(Tr;iY)	Chiefly sandstone, ~5% siltstone
3519	lipto(Ra;mY-mO), cut(Vr;mY-mO) spo(Tr;mO)	Siltstone
3530	lipto (Tr;mO-dO)	Chiefly sandstone, <5% siltstone (cavings). Organic matter occurs mainly in the caved cuttings
3600	lipto (Tr;mO)	Chiefly sandstone, <5% shale (?cavings)
3652	lipto(Vr;mO), cut(Tr;mO)	Siltstone
3710	lipto(Vr;mY-mO)	Chiefly sandstone, 5-10% siltstone
3750	lipto(Vr;mO), cut(Tr;mO)	Chiefly sandstone, <5% sandstone
3810	cut(Ra;mY-mO), lipto(mY-mO), spo(Vr;mO), res(Vr;mY-mO)	Siltstone
3869	lipto(Ra;mO), cut(Ra;mO), res (Vr;mO-dO), oil(Tr;mO)	Siltstone; oil occurs in the interstices of the quartz grains

Depth (m)	Exinite Macerals	Lithology/Comments
3911	lipto(Ra;mO), cut(Vr;mO), ?lama (Vr;mO), res(Tr;mO), ?tela (Tr;iY), oil(Tr;iYG)	Shale, oil as above
3940	spo(Ra;iY-mY), lipto(Ra; mY-mO), cut(Vr;mY-mO)	Siltstone
4002	lipto(Ra;mO-dO), cut(Tr;mO), res(Tr;mY-mO), lama(Tr;mO)	Silty shale; some exinite is oxidised
4035	lipto(Ra;mO), cut(Ra-Vr;mO-dO) res(mY-mO), lama(Vr;mO)	Siltstone; some exinite as above

TABLE 6

STABLE GAS ISOTOPES

δ^{13} C $^0/_{00}$ PDB ARCHER -1

RFS	1131	1118	1114	1120	1123	1129	1286
Methane	-40.6	-40.6	-41.3	-40.8	-41.4	-41.2	-41.0
Ethane	-28.2	-28.1	-27.7	-27.8	-27.7	-27.8	-27.8
Propane	-26.3	-26.2	-25.6	-25.7	-25.6	-25.8	-25.7
n-Butane	-25.9	-25.9	-25.6	-25.6	-25.6	-25.7	-25.8
n-Pentane	-25.5	-25.6	-22.7	-24.1	-23.1	-22.5	-23.0

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TABLE #7

National Association of Testing Authorities, Australia

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AMDEL CORE SERVICES

Physical Properties　　　　Report # 009/260

Client: PETROFINA EXPLORATION AUSTRALIA

Sample: ARCHER-1
Depth: 3390.2m, REF: AD-1117
Depth: 3403.5m, REF: AD-1118

Method		Description	Units	3390.2m	3403.5m
IP2	ASTM D611	Aniline Point	°C		
	ASTM D4176	Appearance, Free water and Particulate Matter			
IP364	ASTM D976	Calculated Cetane Index			
IP219	ASTM D2500	Cloud Point	°C		
IP17		Colour by Lovibond Tintometer			
IP274	ASTM D2624	Conductivity of Fuels	pS		
IP13	ASTM D189	Conradson Carbon Residue	%wt		
IP154	ASTM D130	Copper Corrosion			
IP160	ASTM D1298	Density @ 15°C	gm/ml	0.7906	0.7883
IP21		Diesel Index			
IP123	ASTM D86	Distillation			
		IBP	°C		
		10%	°C		
		20%	°C		
		50%	°C		
		90%	°C		
		FBP	°C		
		Residue	%vol		
		Loss	%vol		
		Evaporated @ 75°C, 105°C, 135°C	%vol		
IP131	ASTM D381	Existent Gum by Evaporation	mg/100ml		
IP170		Flash Point Abel Closed Cup	°C		
IP34	ASTM D93	Flash Point Pensky Martens Closed Cup	°C		
IP156	ASTM D1319	Fluorescent Indicator Absorption Aromatics	%		
IP16	ASTM D2386	Freezing Point of Aviation Fuels	°C		
IP71	ASTM D445	Kinematic Viscosity @ 40°C	cSt		
IP71	ASTM D445	Kinematic Viscosity @100°C	cSt		
IP15	ASTM D97	Pour Point	°C	[illegible]	14
	ASTM D323	Reid Vapour Pressure	kPa		
IP277		Silver Corrosion			
IP57		Smoke Point	mm		
IP160	ASTM D1298	Specific Gravity @ 60/60 F		0.7909	0.7886
IP354	ASTM D3242	Total Acidity in Aviation Fuel	mgKOH/gm		
IP270		Total Lead in Gasoline by Iodine Monochloride	gm/l		
	ASTM D2270	Viscosity Index			
IP289	ASTM D1094	Water Reaction　Interface Rating			
		Separation			
	ASTM D96	Water and Sediment	%vol		
IP74	ASTM D95	Water in Petroleum Products by Distillation	%vol		
IP160		API Gravity		47.41	47.93

Approved Signatory: [signature]

Date 07-JUL-81

Please reply to:

Amdel Core Services Pty Limited
Incorporated in South Australia

TABLE #8

AMDEL
CORE
SERVICES

Physical Properties — Report # 009/260

Client: PETROFINA EXPLORATION AUSTRALIA

Sample: ARCHER-1
Depth: 3499.0m, RFT: 1286
Depth: 3514.2m, RFT: 1129

Method		Description		Units	3489.0m	3514.2m
IP2	ASTM D611	Aniline Point		°C		
	ASTM D4176	Appearance, Free water and Particulate Matter				
IP364	ASTM D976	Calculated Cetane Index				
IP219	ASTM D2500	Cloud Point		C		
IP17		Colour by Lovibond Tintometer				
IP274	ASTM D2624	Conductivity of Fuels		pS		
IP13	ASTM D189	Conradson Carbon Residue		%wt		
IP154	ASTM D130	Copper Corrosion				
IP160	ASTM D1298	Density @ 15 C		gm/ml	0.7927	0.8017
IP21		Diesel Index				
IP123	ASTM D86	Distillation				
			IBP	°C		
			10%	°C		
			30%	°C		
			50%	°C		
			90%	°C		
			FBP	°C		
			Residue	%vol		
			Loss	%vol		
		Evaporated @ 75°C, 105 C, 135 C		%vol		
IP131	ASTM D381	Existent Gum by Evaporation		mg/100ml		
IP170		Flash Point Abel Closed Cup		C		
IP34	ASTM D93	Flash Point Pensky Martens Closed Cup		C		
IP156	ASTM D1319	Fluorescent Indicator Absorption Aromatics		%		
IP16	ASTM D2386	Freezing Point of Aviation Fuels		C		
IP71	ASTM D445	Kinematic Viscosity	@ 40°C	cSt		
IP71	ASTM D445	Kinematic Viscosity	@100 C	cSt		
IP15	ASTM D97	Pour Point		C	14	14
	ASTM D323	Reid Vapour Pressure		kPa		
IP227		Silver Corrosion				
IP57		Smoke Point		mm		
IP160	ASTM D1298	Specific Gravity @ 60/60 F			0.7930	0.8021
IP354	ASTM D3242	Total Acidity in Aviation Fuel		mgKOH gm		
IP270		Total Lead in Gasoline by Iodine Monochloride		gm/l		
	ASTM D2270	Viscosity Index				
IP289	ASTM D1094	Water Reaction	Interface Rating			
			Separation			
	ASTM D96	Water and Sediment		%vol		
IP74	ASTM D95	Water in Petroleum Products by Distillation		%vol		
IP160		API Gravity			46.94	44.91

Approved Signator [signature]

Date 23-Jul-[illegible]

TABLE #9

National Association of Testing Authorities, Australia

This laboratory is registered by the National Association of Testing Authorities, Australia. The tests reported herein have been performed in accordance with its terms of registration. This report may not be reproduced except in full.

AMDEL CORE SERVICES

Physical Properties Report # 009/260

Client: PETROFINA EXPLORATION AUSTRALIA

Sample: ARCHER-1
Depth: 3591.5m, RFT: 1120
Depth: 3681.0m, RFT: 1123

Method		Description		Units	3591.5m	3681.0m
IP2	ASTM D611	Aniline Point		°C		
	ASTM D4176	Appearance, Free Water and Particulate Matter				
IP364	ASTM D976	Calculated Cetane Index				
IP219	ASTM D2500	Cloud Point		°C		
IP17		Colour by Lovibond Tintometer				
IP274	ASTM D2624	Conductivity of Fuels		pS		
IP13	ASTM D189	Conradson Carbon Residue		%wt		
IP154	ASTM D130	Copper Corrosion				
IP160	ASTM D1298	Density @ 15°C		gm/ml	0.8059	0.8196
IP21		Diesel Index				
IP123	ASTM D86	Distillation				
			IBP	°C		
			10%	°C		
			20%	°C		
			50%	°C		
			90%	°C		
			FBP	°C		
			Residue	%vol		
			Loss	%vol		
		Evaporated @ 75°C, 105°C, 135°C		%vol		
IP131	ASTM D381	Existent Gum by Evaporation		mg/100ml		
IP170		Flash Point Abel Closed Cup		°C		
IP34	ASTM D93	Flash Point Pensky Martens Closed Cup		°C		
IP156	ASTM D1319	Fluorescent Indicator Absorption Aromatics		%		
IP16	ASTM D2386	Freezing Point of Aviation Fuels		°C		
IP71	ASTM D445	Kinematic Viscosity	@ 40°C	cSt		
IP71	ASTM D445	Kinematic Viscosity	@100°C	cSt		
IP15	ASTM D97	Pour Point		°C	14	14
	ASTM D323	Reid Vapour Pressure		kPa		
IP227		Silver Corrosion				
IP57		Smoke Point		mm		
IP160	ASTM D1298	Specific Gravity @ 60/60 F			0.8063	0.8200
IP354	ASTM D3242	Total Acidity in Aviation Fuel		mgKOH/gm		
IP270		Total Lead in Gasoline by Iodine Monochloride		gm/l		
	ASTM D2270	Viscosity Index				
IP289	ASTM D1094	Water Reaction	Interface Rating			
			Separation			
	ASTM D96	Water and Sediment		%vol		
IP74	ASTM D95	Water in Petroleum Products by Distillation		%vol		
IP160		API Gravity			43.99	41.06

Approved Signatory [illegible signature]

Date [illegible]

National Association of Testing Authorities, Australia

This laboratory is registered by the National Association of Testing Authorities, Australia. The tests reported herein have been performed in accordance with its terms of registration. This report may not be reproduced except in full.

TABLE #10

AMDEL CORE SERVICES

Physical Properties | Report # 009/260

Client: PETROFINA EXPLORATION AUSTRALIA

Sample: ARCHER-1
Depth: 3947.5m, RFT: 1114

Method		Description		Units	3947.5m
IP2	ASTM D611	Aniline Point		°C	
	ASTM D4176	Appearance, Free Water and Particulate Matter			
IP364	ASTM D976	Calculated Cetane Index			
IP219	ASTM D2500	Cloud Point		°C	
IP17		Colour by Lovibond Tintometer			
IP274	ASTM D2624	Conductivity of Fuels		pS	
IP13	ASTM D189	Conradson Carbon Residue		%wt	
IP154	ASTM D130	Copper Corrosion			
IP160	ASTM D1298	Density @ 15 C		gm/ml	0.8597
IP21		Diesel Index			
IP123	ASTM D86	Distillation			
			IBP	°C	
			10%	°C	
			20%	°C	
			50%	°C	
			90%	°C	
			FBP	°C	
			Residue	%vol	
			Loss	%vol	
		Evaporated @ 75 C, 105 C, 135°C		%vol	
IP131	ASTM D381	Existent Gum by Evaporation		mg/100ml	
IP170		Flash Point Abel Closed Cup		°C	
IP34	ASTM D93	Flash Point Pensky Martens Closed Cup		°C	
IP156	ASTM D1319	Fluorescent Indicator Adsorption Aromatics		%	
IP16	ASTM D2386	Freezing Point of Aviation Fuels		°C	
IP71	ASTM D445	Kinematic Viscosity	@ 40°C	cSt	
IP71	ASTM D445	Kinematic Viscosity	@100 C	cSt	
IP15	ASTM D97	Pour Point		°C	27
	ASTM D323	Reid Vapour Pressure		kPa	
IP227		Silver Corrosion			
IP57		Smoke Point		mm	
IP160	ASTM D1298	Specific Gravity @ 60/60°F			0.8601
IP354	ASTM D3242	Total Acidity in Aviation Fuel		mgKOH/gm	
IP270		Total Lead in Gasoline by Iodine Monochloride		gm/l	
	ASTM D2270	Viscosity Index			
IP289	ASTM D1094	Water Reaction	Interface Rating		
			Separation		
	ASTM D96	Water and Sediment		%vol	
IP74	ASTM D95	Water in Petroleum Products by Distillation		%vol	
IP160		API Gravity			33.02

Approved Signatory: Brian Watson

Date 23-Jul-91

Please reply to:

Amdel Core Services Pty Limited
Incorporated in South Australia

TABLE 11

SULPHUR CONTENT OF CONDENSATES

Depth (m)	Sulphur (%)
3390.2	0.03
3403.5	0.04
3489.0	0.04
3514.2	0.04
3591.5	0.04
3681.0	0.05
3947.5	0.05

TABLE #12

AMDEL CORE SERVICES

AMDEL CORE SERVICES LIQUID ANALYSIS Method GL-02-01

Client: PETROFINA EXPLORATION AUSTRALIA Report # 009/260

Sample: ARCHER-1
Depth: 3390.2M
RFT: AD-1131

Boiling Point Range (Deg.C)	Component	Weight%	Mol%
-88.6	ETHANE	0.03	0.13
-42.1	PROPANE	0.54	1.57
-11.7	I-BUTANE	0.52	1.15
-0.5	N-BUTANE	1.72	3.79
27.9	I-PENTANE	2.02	3.59
36.1	N-PENTANE	2.59	4.60
36.1-68.9	C-6	6.51	9.68
80.0	BENZENE	0.02	0.03
68.9-98.3	C-7	11.77	15.05
100.9	METHYLCYCHX	5.19	6.77
110.6	TOLUENE	0.16	0.22
98.3-125.6	C-8	10.23	11.47
136.1-144.4	ETHYLBZ+XYL	2.86	3.45
125.6-150.6	C-9	7.39	7.35
150.6-173.9	C-10	8.07	7.27
173.9-196.1	C-11	5.55	4.55
196.1-215.0	C-12	4.33	3.26
215.0-235.0	C-13	4.31	3.00
235.0-252.2	C-14	3.68	2.38
252.2-270.6	C-15	3.65	2.20
270.6-287.8	C-16	2.85	1.61
287.8-302.8	C-17	2.02	1.08
302.8-317.2	C-18	2.22	1.12
317.2-330.0	C-19	1.52	0.73
330.0-344.4	C-20	1.36	0.62
344.4-357.2	C-21	1.28	0.55
357.2-369.4	C-22	1.24	0.51
369.4-380.0	C-23	1.06	0.42
380.0-391.1	C-24	0.98	0.37
391.1-401.7	C-25	0.96	0.35
401.7-412.2	C-26	0.80	0.28
412.2-422.2	C-27	0.76	0.26
>422.2	C-28+	1.81	0.59
	Total	100.00	100.00

(0.00 = LESS THAN 0.01%)

The above boiling point ranges refer to the normal paraffin hydrocarbon boiling in that range. Aromatics, branched hydrocarbons, naphthenes and olefins may have higher or lower carbon numbers but are grouped and reported according to their boiling points.

Average molecular weight of C-8 plus 165 g/mol

This report relates specifically to the sample tested; it also relates to the batch insofar as the sample is representative of the Batch.

Approved Signatory R. Hamle

Date 23-Jul-90

TABLE #13

AMDEL CORE SERVICES

AMDEL CORE SERVICES LIQUID ANALYSIS Method GL-02-01

Client: PETROFINA EXPLORATION AUSTRALIA Report # 009/260

Sample: ARCHER-1
Depth: 3403.5m
RFT: AD-1118

Boiling Point Range (Deg.C)	Component	Weight%	Mol%
-88.6	ETHANE	0.03	0.13
-42.1	PROPANE	0.52	1.50
-11.7	I-BUTANE	0.54	1.18
-0.5	N-BUTANE	1.85	4.04
27.9	I-PENTANE	2.28	4.01
36.1	N-PENTANE	2.37	4.17
36.1-68.9	C-6	6.82	10.05
80.0	BENZENE	0.01	0.02
68.9-98.3	C-7	12.13	15.38
100.9	METHYLCYCHX	5.78	7.48
110.6	TOLUENE	0.17	0.23
98.3-125.6	C-8	10.38	11.54
136.1-144.4	ETHYLBZ+XYL	3.27	3.91
125.6-150.6	C-9	6.90	6.83
150.6-173.9	C-10	7.87	7.03
173.9-196.1	C-11	5.15	4.19
196.1-215.0	C-12	3.95	2.95
215.0-235.0	C-13	3.94	2.71
235.0-252.2	C-14	3.43	2.20
252.2-270.6	C-15	3.32	1.99
270.6-287.8	C-16	2.78	1.56
287.8-302.8	C-17	1.78	0.94
302.8-317.2	C-18	2.03	1.01
317.2-330.0	C-19	1.72	0.81
330.0-344.4	C-20	1.32	0.59
344.4-357.2	C-21	1.21	0.52
357.2-369.4	C-22	1.18	0.48
369.4-380.0	C-23	1.05	0.41
380.0-391.1	C-24	1.06	0.40
391.1-401.7	C-25	1.10	0.40
401.7-412.2	C-26	0.95	0.33
412.2-422.2	C-27	0.91	0.30
>422.2	C-28+	2.20	0.71
	Total	100.00	100.00

(0.00 = LESS THAN 0.01%)

The above boiling point ranges refer to the normal paraffin hydrocarbon boiling in that range. Aromatics, branched hydrocarbons, naphthenes and olefins may have higher or lower carbon numbers but are grouped and reported according to their boiling points.

Average molecular weight of C-8 plus 165 g/mol

This report relates specifically to the sample tested; it also relates to the batch insofar as the sample is representative of the Batch.

Approved Signatory [signature]

Date 23-Jul-90

TABLE #14

AMDEL CORE SERVICES

AMDEL CORE SERVICES LIQUID ANALYSIS Method GL-02-01

Client: PETROFINA EXPLORATION AUSTRALIA Report # 009/260

Sample: ARCHER-1
Depth: 3489.0m
RFT: 1286

Boiling Point Range (Deg.C)	Component	Weight%	Mol%
-88.6	ETHANE	0.21	0.88
-42.1	PROPANE	0.38	1.09
-11.7	I-BUTANE	1.22	2.65
-0.5	N-BUTANE	1.90	4.12
27.9	I-PENTANE	2.31	4.04
36.1	N-PENTANE	3.16	5.52
36.1-68.9	C-6	3.52	5.15
80.0	BENZENE	0.06	0.10
68.9-98.3	C-7	12.97	16.33
100.9	METHYLCYCHX	6.33	8.13
110.6	TOLUENE	0.15	0.21
98.3-125.6	C-8	9.66	10.67
136.1-144.4	ETHYLBZ+XYL	4.16	4.94
125.6-150.6	C-9	6.02	5.91
150.6-173.9	C-10	7.82	6.93
173.9-196.1	C-11	5.08	4.10
196.1-215.0	C-12	4.21	3.12
215.0-235.0	C-13	4.19	2.87
235.0-252.2	C-14	3.35	2.13
252.2-270.6	C-15	3.98	2.36
270.6-287.8	C-16	2.96	1.65
287.8-302.8	C-17	2.24	1.18
302.8-317.2	C-18	2.43	1.20
317.2-330.0	C-19	2.30	1.08
330.0-344.4	C-20	1.49	0.67
344.4-357.2	C-21	1.61	0.68
357.2-369.4	C-22	1.44	0.58
369.4-380.0	C-23	1.11	0.43
380.0-391.1	C-24	0.88	0.33
391.1-401.7	C-25	0.74	0.26
401.7-412.2	C-26	0.01	0.00
412.2-422.2	C-27	0.56	0.19
>422.2	C-28+	1.55	0.50
	Total	100.00	100.00

(0.00 = LESS THAN 0.01%)

The above boiling point ranges refer to the normal paraffin hydrocarbon boiling in that range. Aromatics, branched hydrocarbons, naphthenes and olefins may have higher or lower carbon numbers but are grouped and reported according to their boiling points.

Average molecular weight of C-8 plus 165 g/mol

This report relates specifically to the sample tested; it also relates to the batch insofar as the sample is representative of the Batch.

Approved Signatory [signature]

Date 23-Jul-90

TABLE #15

AMDEL CORE SERVICES

AMDEL CORE SERVICES LIQUID ANALYSIS   Method GL-02-01

Client: PETROFINA EXPLORATION AUSTRALIA   Report # 009/260

Sample: ARCHER-1
Depth: 3514.2m
RFT: 1129

Boiling Point Range (Deg.C)	Component	Weight%	Mol%
-88.6	ETHANE	0.15	0.64
-42.1	PROPANE	0.22	0.64
-11.7	I-BUTANE	0.88	1.95
-0.5	N-BUTANE	1.38	3.06
27.9	I-PENTANE	1.63	2.91
36.1	N-PENTANE	2.15	3.83
36.1-68.9	C-6	5.34	7.97
80.0	BENZENE	0.01	0.02
68.9-98.3	C-7	9.97	12.80
100.9	METHYLCYCHX	6.69	8.77
110.6	TOLUENE	0.18	0.25
98.3-125.6	C-8	12.88	14.51
136.1-144.4	ETHYLBZ+XYL	5.42	6.57
125.6-150.6	C-9	4.14	4.16
150.6-173.9	C-10	8.66	7.83
173.9-196.1	C-11	5.44	4.48
196.1-215.0	C-12	4.51	3.41
215.0-235.0	C-13	4.38	3.06
235.0-252.2	C-14	3.43	2.22
252.2-270.6	C-15	3.93	2.38
270.6-287.8	C-16	3.14	1.78
287.8-302.8	C-17	2.15	1.15
302.8-317.2	C-18	2.20	1.11
317.2-330.0	C-19	2.02	0.97
330.0-344.4	C-20	1.25	0.57
344.4-357.2	C-21	1.39	0.60
357.2-369.4	C-22	0.95	0.39
369.4-380.0	C-23	1.08	0.43
380.0-391.1	C-24	0.71	0.27
391.1-401.7	C-25	0.70	0.26
401.7-412.2	C-26	0.64	0.22
412.2-422.2	C-27	0.58	0.20
>422.2	C-28+	1.80	0.59
	Total	100.00	100.00

(0.00 = LESS THAN 0.01%)

The above boiling point ranges refer to the normal paraffin hydrocarbon boiling in that range. Aromatics, branched hydrocarbons, naphthenes and olefins may have higher or lower carbon numbers but are grouped and reported according to their boiling points.

Average molecular weight of C-8 plus   160 g/mol

This report relates specifically to the sample tested; it also relates to the batch insofar as the sample is representative of the Batch.

Approved Signatory   RTamke.

Date   23-Jul-90

TABLE #16

AMDEL CORE SERVICES

AMDEL CORE SERVICES LIQUID ANALYSIS   Method GL-02-01

Client: PETROFINA EXPLORATION AUSTRALIA   Report # 009/260

Sample: ARCHER-1
Depth: 3591.5m
RFT: 1120

Boiling Point Range (Deg.C)	Component	Weight%	Mol%
-88.6	ETHANE	0.00	0.00
-42.1	PROPANE	0.06	0.18
-11.7	I-BUTANE	0.38	0.87
-0.5	N-BUTANE	1.12	2.57
27.9	I-PENTANE	1.40	2.59
36.1	N-PENTANE	2.01	3.72
36.1-68.9	C-6	4.74	7.34
80.0	BENZENE	0.07	0.12
68.9-98.3	C-7	9.38	12.50
100.9	METHYLCYCHX	6.34	8.62
110.6	TOLUENE	0.16	0.23
98.3-125.6	C-8	10.84	12.67
136.1-144.4	ETHYLBZ+XYL	5.51	6.93
125.6-150.6	C-9	6.28	6.53
150.6-173.9	C-10	8.89	8.34
173.9-196.1	C-11	5.93	5.06
196.1-215.0	C-12	5.02	3.93
215.0-235.0	C-13	4.87	3.53
235.0-252.2	C-14	3.70	2.49
252.2-270.6	C-15	4.22	2.65
270.6-287.8	C-16	3.26	1.92
287.8-302.8	C-17	2.26	1.25
302.8-317.2	C-18	2.32	1.22
317.2-330.0	C-19	2.11	1.05
330.0-344.4	C-20	1.33	0.63
344.4-357.2	C-21	1.35	0.61
357.2-369.4	C-22	1.13	0.49
369.4-380.0	C-23	0.88	0.36
380.0-391.1	C-24	0.73	0.29
391.1-401.7	C-25	0.77	0.29
401.7-412.2	C-26	0.63	0.23
412.2-422.2	C-27	0.59	0.21
>422.2	C-28+	1.72	0.58
	Total	100.00	100.00

(0.00 = LESS THAN 0.01%)

The above boiling point ranges refer to the normal paraffin hydrocarbon boiling in that range. Aromatics, branched hydrocarbons, naphthenes and olefins may have higher or lower carbon numbers but are grouped and reported according to their boiling points.

Average molecular weight of C-8 plus 162 g/mol

This report relates specifically to the sample tested; it also relates to the batch insofar as the sample is representative of the Batch.

Approved Signatory [signature]

Date 23-Jul-90

TABLE #17

AMDEL CORE SERVICES

AMDEL CORE SERVICES LIQUID ANALYSIS   Method GL-02-01

Client: PETROFINA EXPLORATION AUSTRALIA   Report # 009/260

Sample: ARCHER-1
Depth: 3681.0m
RFT: 1123

Boiling Point Range (Deg.C)	Component	Weight%	Mol%
-88.6	ETHANE	0.00	0.00
-42.1	PROPANE	0.03	0.10
-11.7	I-BUTANE	0.05	0.12
-0.5	N-BUTANE	0.20	0.48
27.9	I-PENTANE	0.38	0.74
36.1	N-PENTANE	0.59	1.15
36.1-68.9	C-6	2.66	4.35
80.0	BENZENE	0.01	0.02
68.9-98.3	C-7	8.68	12.21
100.9	METHYLCYCHX	5.70	8.18
110.6	TOLUENE	0.15	0.23
98.3-125.6	C-8	11.77	14.52
136.1-144.4	ETHYLBZ+XYL	7.14	9.48
125.6-150.6	C-9	6.80	7.47
150.6-173.9	C-10	10.39	10.29
173.9-196.1	C-11	6.61	5.96
196.1-215.0	C-12	5.64	4.67
215.0-235.0	C-13	5.47	4.18
235.0-252.2	C-14	4.13	2.93
252.2-270.6	C-15	4.74	3.14
270.6-287.8	C-16	3.51	2.18
287.8-302.8	C-17	2.55	1.49
302.8-317.2	C-18	2.54	1.41
317.2-330.0	C-19	2.06	1.08
330.0-344.4	C-20	1.79	0.89
344.4-357.2	C-21	1.63	0.77
357.2-369.4	C-22	1.03	0.47
369.4-380.0	C-23	1.15	0.50
380.0-391.1	C-24	0.70	0.29
391.1-401.7	C-25	0.50	0.20
401.7-412.2	C-26	0.35	0.13
412.2-422.2	C-27	0.31	0.11
>422.2	C-28+	0.74	0.26
	Total	100.00	100.00

(0.00 = LESS THAN 0.01%)

The above boiling point ranges refer to the normal paraffin hydrocarbon boiling in that range. Aromatics, branched hydrocarbons, naphthenes and olefins may have higher or lower carbon numbers but are grouped and reported according to their boiling points.

Average molecular weight of C-8 plus   158 g/mol

This report relates specifically to the sample tested; it also relates to the batch insofar as the sample is representative of the Batch.

Approved Signatory   R Tamke.

Date   23-Jul-90

AMDEL CORE SERVICES

AMDEL CORE SERVICES LIQUID ANALYSIS Method GL-02-01

Client: PETROFINA EXPLORATION AUSTRALIA Report # 009/260

Sample: ARCHER-1
Depth: 3947.5m
RFT: 1114

Boiling Point Range (Deg.C)	Component	Weight%	Mol%
-88.6	ETHANE	0.00	0.00
-42.1	PROPANE	0.01	0.05
-11.7	I-BUTANE	0.01	0.04
-0.5	N-BUTANE	0.04	0.14
27.9	I-PENTANE	0.07	0.20
36.1	N-PENTANE	0.11	0.32
36.1-68.9	C-6	0.46	1.11
80.0	BENZENE	0.01	0.03
68.9-98.3	C-7	1.46	3.03
100.9	METHYLCYCHX	0.94	1.99
110.6	TOLUENE	0.04	0.09
98.3-125.6	C-8	2.05	3.73
136.1-144.4	ETHYLBZ+XYL	1.03	2.01
125.6-150.6	C-9	1.50	2.41
150.6-173.9	C-10	2.10	3.06
173.9-196.1	C-11	4.39	5.83
196.1-215.0	C-12	9.13	11.13
215.0-235.0	C-13	10.54	11.87
235.0-252.2	C-14	8.52	8.92
252.2-270.6	C-15	9.44	9.23
270.6-287.8	C-16	7.22	6.62
287.8-302.8	C-17	5.10	4.40
302.8-317.2	C-18	5.21	4.25
317.2-330.0	C-19	4.19	3.24
330.0-344.4	C-20	3.57	2.62
344.4-357.2	C-21	3.29	2.30
357.2-369.4	C-22	2.33	1.56
369.4-380.0	C-23	2.59	1.66
380.0-391.1	C-24	2.24	1.37
391.1-401.7	C-25	2.22	1.31
401.7-412.2	C-26	2.11	1.19
412.2-422.2	C-27	2.05	1.12
>422.2	C-28+	6.03	3.17
	Total	100.00	100.00

(0.00 = LESS THAN 0.01%)

The above boiling point ranges refer to the normal paraffin hydrocarbon boiling in that range. Aromatics, branched hydrocarbons, naphthenes and olefins may have higher or lower carbon numbers but are grouped and reported according to their boiling points.

Average molecular weight of C-8 plus 216 g/mol

This report relates specifically to the sample tested; it also relates to the batch insofar as the sample is representative of the Batch.

Approved Signatory [signature]

Date 23-Jul-90

TABLE #19

AMDEL CORE SERVICES
GASOLINE-RANGE ANALYSIS

ARCHER-1
3390.2m

COMPOUND	NORMAL %	BRANCHED %	CYCLIC %	AROMATIC %
2-METHYLBUTANE		9.39		
N-PENTANE	1.04			
2,2-DIMETHYLBUTANE		0.37		
CYCLOPENTANE			0.76	
2,3-DIMETHYLBUTANE		0.93		
2-METHYLPENTANE		6.34		
3-METHYLPENTANE		3.58		
N-HEXANE	10.31			
2,2-DIMETHYLPENTANE		0.28		
METHYLCYCLOPENTANE			5.92	
2,4-DIMETHYLPENTANE		0.46		
2,2,3-TRIMETHYLBUTANE		0.15		
BENZENE				0.41
3,3-DIMETHYLPENTANE		0.14		
CYCLOHEXANE			8.91	
2-METHYLHEXANE		3.26		
2,3-DIMETHYLPENTANE		0.77		
1,1-DIMETHYLCYCLOPENTANE			0.59	
3-METHYLHEXANE		3.17		
TRANS-1,3-DIMETHYLCYCLOPENTANE			1.20	
CIS-1,3-DIMETHYLCYCLOPENTANE			1.11	
3-ETHYLPENTANE		0.00		
TRANS-1,2-DIMETHYLCYCLOPENTANE			2.08	
N-HEPTANE	9.34			
METHYLCYCLOHEXANE			23.31	
ETHYLCYCLOPENTANE			1.27	
TOLUENE				4.90
TOTAL PERCENTAGES	20.69	28.84	45.16	5.31

TABLE #20

AMDEL CORE SERVICES
GASOLINE-RANGE ANALYSIS

ARCHER-1
3403.5m

COMPOUND	NORMAL %	BRANCHED %	CYCLIC %	AROMATIC %
2-METHYLBUTANE		8.29		
N-PENTANE	9.36			
2,2-DIMETHYLBUTANE		0.34		
CYCLOPENTANE			0.81	
2,3-DIMETHYLBUTANE		0.79		
2-METHYLPENTANE		5.66		
3-METHYLPENTANE		3.24		
N-HEXANE	9.01			
2,2-DIMETHYLPENTANE		0.24		
METHYLCYCLOPENTANE			5.71	
2,4-DIMETHYLPENTANE		0.39		
2,2,3-TRIMETHYLBUTANE		0.07		
BENZENE				0.48
3,3-DIMETHYLPENTANE		0.12		
CYCLOHEXANE			8.73	
2-METHYLHEXANE		2.77		
2,3-DIMETHYLPENTANE		0.66		
1,1-DIMETHYLCYCLOPENTANE			0.55	
3-METHYLHEXANE		2.72		
TRANS-1,3-DIMETHYLCYCLOPENTANE			1.09	
CIS-1,3-DIMETHYLCYCLOPENTANE			1.01	
3-ETHYLPENTANE		0.00		
TRANS-1,2-DIMETHYLCYCLOPENTANE			1.88	
N-HEPTANE	7.68			
METHYLCYCLOHEXANE			21.41	
ETHYLCYCLOPENTANE			1.30	
TOLUENE				5.70
TOTAL PERCENTAGES	26.05	25.30	42.47	6.18

TABLE #21

AMDEL CORE SERVICES
GASOLINE-RANGE ANALYSIS

ARCHER-1
3489.0m

COMPOUND	NORMAL %	BRANCHED %	CYCLIC %	AROMATIC %
2-METHYLBUTANE		8.45		
N-PENTANE	10.10			
2,2-DIMETHYLBUTANE		0.33		
CYCLOPENTANE			0.84	
2,3-DIMETHYLBUTANE		0.82		
2-METHYLPENTANE		5.78		
3-METHYLPENTANE		0.33		
N-HEXANE	9.48			
2,2-DIMETHYLPENTANE		0.24		
METHYLCYCLOPENTANE			5.99	
2,4-DIMETHYLPENTANE		0.38		
2,2,3-TRIMETHYLBUTANE		0.06		
BENZENE				0.67
3,3-DIMETHYLPENTANE		0.12		
CYCLOHEXANE			9.18	
2-METHYLHEXANE		2.76		
2,3-DIMETHYLPENTANE		0.68		
1,1-DIMETHYLCYCLOPENTANE			0.55	
3-METHYLHEXANE		2.74		
TRANS-1,3-DIMETHYLCYCLOPENTANE			1.10	
CIS-1,3-DIMETHYLCYCLOPENTANE			1.02	
3-ETHYLPENTANE		0.00		
TRANS-1,2-DIMETHYLCYCLOPENTANE			1.89	
N-HEPTANE	7.71			
METHYLCYCLOHEXANE			21.51	
ETHYLCYCLOPENTANE			0.52	
TOLUENE				6.73
TOTAL PERCENTAGES	27.30	22.69	42.61	7.41

TABLE #22

AMDEL CORE SERVICES
GASOLINE-RANGE ANALYSIS

ARCHER-1
3514.2m

COMPOUND	NORMAL %	BRANCHED %	CYCLIC %	AROMATIC %
2-METHYLBUTANE		6.53		
N-PENTANE	8.33			
2,2-DIMETHYLBUTANE		0.31		
CYCLOPENTANE			0.79	
2,3-DIMETHYLBUTANE		0.81		
2-METHYLPENTANE		5.66		
3-METHYLPENTANE		3.36		
N-HEXANE	1.00			
2,2-DIMETHYLPENTANE		0.27		
METHYLCYCLOPENTANE			6.82	
2,4-DIMETHYLPENTANE		0.43		
2,2,3-TRIMETHYLBUTANE		0.08		
BENZENE				1.38
3,3-DIMETHYLPENTANE		0.14		
CYCLOHEXANE			1.09	
2-METHYLHEXANE		3.24		
2,3-DIMETHYLPENTANE		0.78		
1,1-DIMETHYLCYCLOPENTANE			0.66	
3-METHYLHEXANE		3.23		
TRANS-1,3-DIMETHYLCYCLOPENTANE			1.30	
CIS-1,3-DIMETHYLCYCLOPENTANE			1.22	
3-ETHYLPENTANE		0.00		
TRANS-1,2-DIMETHYLCYCLOPENTANE			2.27	
N-HEPTANE	9.25			
METHYLCYCLOHEXANE			27.29	
ETHYLCYCLOPENTANE			1.68	
TOLUENE				12.11
TOTAL PERCENTAGES	18.57	24.82	43.12	13.48

TABLE #23

AMDEL CORE SERVICES
GASOLINE-RANGE ANALYSIS

ARCHER-1
3591.5m

COMPOUND	NORMAL %	BRANCHED %	CYCLIC %	AROMATIC %
2-METHYLBUTANE		5.33		
N-PENTANE	6.99			
2,2-DIMETHYLBUTANE		0.27		
CYCLOPENTANE			0.71	
2,3-DIMETHYLBUTANE		0.66		
2-METHYLPENTANE		4.75		
3-METHYLPENTANE		2.83		
N-HEXANE	8.15			
2,2-DIMETHYLPENTANE		0.25		
METHYLCYCLOPENTANE			5.74	
2,4-DIMETHYLPENTANE		0.37		
2,2,3-TRIMETHYLBUTANE		0.20		
BENZENE				1.30
3,3-DIMETHYLPENTANE		0.12		
CYCLOHEXANE			9.27	
2-METHYLHEXANE		2.70		
2,3-DIMETHYLPENTANE		0.66		
1,1-DIMETHYLCYCLOPENTANE			0.57	
3-METHYLHEXANE		2.69		
TRANS-1,3-DIMETHYLCYCLOPENTANE			1.11	
CIS-1,3-DIMETHYLCYCLOPENTANE			1.04	
3-ETHYLPENTANE		0.00		
TRANS-1,2-DIMETHYLCYCLOPENTANE			1.93	
N-HEPTANE	7.68			
METHYLCYCLOHEXANE			22.90	
ETHYLCYCLOPENTANE			0.55	
TOLUENE				11.25
TOTAL PERCENTAGES	22.82	20.82	43.81	12.55

TABLE #24

AMDEL CORE SERVICES
GASOLINE-RANGE ANALYSIS

ARCHER-1
3681.0m

COMPOUND	NORMAL %	BRANCHED %	CYCLIC %	AROMATIC %
2-METHYLBUTANE		2.02		
N-PENTANE	2.78			
2,2-DIMETHYLBUTANE		0.13		
CYCLOPENTANE			0.47	
2,3-DIMETHYLBUTANE		0.40		
2-METHYLPENTANE		2.82		
3-METHYLPENTANE		1.84		
N-HEXANE	5.94			
2,2-DIMETHYLPENTANE		0.20		
METHYLCYCLOPENTANE			4.67	
2,4-DIMETHYLPENTANE		0.31		
2,2,3-TRIMETHYLBUTANE		0.06		
BENZENE				2.09
3,3-DIMETHYLPENTANE		0.12		
CYCLOHEXANE			8.88	
2-METHYLHEXANE		2.76		
2,3-DIMETHYLPENTANE		0.67		
1,1-DIMETHYLCYCLOPENTANE			0.58	
3-METHYLHEXANE		2.84		
TRANS-1,3-DIMETHYLCYCLOPENTANE			1.17	
CIS-1,3-DIMETHYLCYCLOPENTANE			1.10	
3-ETHYLPENTANE		0.00		
TRANS-1,2-DIMETHYLCYCLOPENTANE			2.04	
N-HEPTANE	8.89			
METHYLCYCLOHEXANE			27.08	
ETHYLCYCLOPENTANE			0.65	
TOLUENE				19.48
TOTAL PERCENTAGES	17.61	14.19	46.63	21.57

TABLE #25

AMDEL CORE SERVICES
GASOLINE-RANGE ANALYSIS

ARCHER-1
3947.5

COMPOUND	NORMAL %	BRANCHED %	CYCLIC %	AROMATIC %
2-METHYLBUTANE		1.96		
N-PENTANE	2.70			
2,2-DIMETHYLBUTANE		0.14		
CYCLOPENTANE			0.36	
2,3-DIMETHYLBUTANE		0.40		
2-METHYLPENTANE		2.78		
3-METHYLPENTANE		1.80		
N-HEXANE	5.85			
2,2-DIMETHYLPENTANE		0.19		
METHYLCYCLOPENTANE			4.56	
2,4-DIMETHYLPENTANE		0.32		
2,2,3-TRIMETHYLBUTANE		0.06		
BENZENE				2.13
3,3-DIMETHYLPENTANE		0.12		
CYCLOHEXANE			8.57	
2-METHYLHEXANE		2.74		
2,3-DIMETHYLPENTANE		0.66		
1,1-DIMETHYLCYCLOPENTANE			0.56	
3-METHYLHEXANE		2.85		
TRANS-1,3-DIMETHYLCYCLOPENTANE			1.15	
CIS-1,3-DIMETHYLCYCLOPENTANE			1.09	
3-ETHYLPENTANE		0.00		
TRANS-1,2-DIMETHYLCYCLOPENTANE			2.04	
N-HEPTANE	8.92			
METHYLCYCLOHEXANE			27.32	
ETHYLCYCLOPENTANE			0.65	
TOLUENE				20.09
TOTAL PERCENTAGES	17.47	14.02	46.29	22.22

AMDEL CORE SERVICES
GASOLINE-RANGE PARAMETERS

ARCHER-1
3390.2m

PARAMETER	
1	1.74
2	0.40
3	8.68
4	21.59
5	4.76
6	9.07
7	0.35
8	1.46
9	17.38

KEY TO PARAMETERS

Parameter	Derivation
1	n-hexane/methylcyclopentane
2	n-heptane/methylcyclohexane
3	3-methylpentane/benzene
4	cyclohexane/benzene
5	methylcyclohexane/toluene
6	isopentane/normal pentane
7	3-methylpentane/n-hexane
8	isoheptane value *
9	heptane value *

(* from Thompson, 1983)

TABLE #27

AMDEL CORE SERVICES
GASOLINE-RANGE PARAMETERS

ARCHER-1
3403.5m

PARAMETER	
1	1.58
2	0.36
3	6.83
4	18.38
5	3.76
6	0.89
7	0.36
8	1.38
9	15.84

KEY TO PARAMETERS

Parameter	Derivation
1	n-hexane/methylcyclopentane
2	n-heptane/methylcyclohexane
3	3-methylpentane/benzene
4	cyclohexane/benzene
5	methylcyclohexane/toluene
6	isopentane/normal pentane
7	3-methylpentane/n-hexane
8	isoheptane value *
9	heptane value *

(* from Thompson, 1983)

TABLE #28

AMDEL CORE SERVICES
GASOLINE-RANGE PARAMETERS

ARCHER-1
3489.0m

PARAMETER	
1	1.58
2	0.36
3	0.49
4	13.69
5	3.19
6	0.84
7	0.03
8	1.37
9	15.69

KEY TO PARAMETERS

Parameter	Derivation
1	n-hexane/methylcyclopentane
2	n-heptane/methylcyclohexane
3	3-methylpentane/benzene
4	cyclohexane/benzene
5	methylcyclohexane/toluene
6	isopentane/normal pentane
7	3-methylpentane/n-hexane
8	isoheptane value *
9	heptane value *

(* from Thompson, 1983)

TABLE #29

AMDEL CORE SERVICES
GASOLINE-RANGE PARAMETERS

ARCHER-1
3514.2m

PARAMETER	
1	0.15
2	0.34
3	2.44
4	0.80
5	2.25
6	0.78
7	3.37
8	1.35
9	18.37

KEY TO PARAMETERS

Parameter	Derivation
1	n-hexane/methylcyclopentane
2	n-heptane/methylcyclohexane
3	3-methylpentane/benzene
4	cyclohexane/benzene
5	methylcyclohexane/toluene
6	isopentane/normal pentane
7	3-methylpentane/n-hexane
8	isoheptane value *
9	heptane value *

(* from Thompson, 1983)

TABLE #30

AMDEL CORE SERVICES
GASOLINE-RANGE PARAMETERS

ARCHER-1
3591.5m

PARAMETER	
1	1.42
2	0.34
3	2.18
4	7.13
5	2.04
6	0.76
7	0.35
8	1.32
9	15.20

KEY TO PARAMETERS

Parameter	Derivation
1	n-hexane/methylcyclopentane
2	n-heptane/methylcyclohexane
3	3-methylpentane/benzene
4	cyclohexane/benzene
5	methylcyclohexane/toluene
6	isopentane/normal pentane
7	3-methylpentane/n-hexane
8	isoheptane value *
9	heptane value *

(* from Thompson, 1983)

TABLE #31

AMDEL CORE SERVICES
GASOLINE-RANGE PARAMETERS

ARCHER-1
3681.0m

PARAMETER	
1	1.27
2	0.33
3	0.88
4	4.26
5	1.39
6	0.73
7	0.31
8	1.30
9	15.87

KEY TO PARAMETERS

Parameter	Derivation
1	n-hexane/methylcyclopentane
2	n-heptane/methylcyclohexane
3	3-methylpentane/benzene
4	cyclohexane/benzene
5	methylcyclohexane/toluene
6	isopentane/normal pentane
7	3-methylpentane/n-hexane
8	isoheptane value *
9	heptane value *

(* from Thompson, 1983)

TABLE #32

AMDEL CORE SERVICES
GASOLINE-RANGE PARAMETERS

ARCHER-1
3947.5

PARAMETER	
1	1.28
2	0.33
3	0.84
4	4.02
5	1.36
6	0.73
7	0.31
8	1.31
9	15.96

KEY TO PARAMETERS

Parameter	Derivation
1	n-hexane/methylcyclopentane
2	n-heptane/methylcyclohexane
3	3-methylpentane/benzene
4	cyclohexane/benzene
5	methylcyclohexane/toluene
6	isopentane/normal pentane
7	3-methylpentane/n-hexane
8	isoheptane value *
9	heptane value *

(* from Thompson, 1983)

AMDEL CORE SERVICES

AMDEL CORE SERVICES GAS ANALYSIS Method GL-01-01
ASTM D 1945-81 (modified)

Client: PETROFINA EXPLORATION AUSTRALIA Report # 009/280

Sample: ARCHER 1
Pressure: 50 psi, Temp:25 deg C
RFS-AD-1118, Bottle #L-115
Date: 27/3/90, Cylinder: Amdel #151

GAS	MOL %
Nitrogen	0.46
Carbon Dioxide	0.07
Methane	56.86
Ethane	15.18
Propane	15.31
I-Butane	2.71
N-Butane	5.23
I-Pentane	1.35
N-Pentane	1.09
Hexanes	1.07
Heptanes	0.43
Octanes and higher h'c	0.24
Total	100.00

(0.00 = less than 0.01%)

Calculated Gas Density
(Air = 1) : 0.992

Calorific Value (15.0 deg C, 101.325 kPa)

Gross:	1678 BTU/CU Ft	62.49 MJ/CU.M
Nett:	1532 BTU/CU Ft	57.08 MJ/CU.M
Gross calorific value of water-saturated gas		61.41 MJ/CU.M

Average Molecular Weight = 28.600

All results are calculated on the basis that only the measured constituents are present. This report relates specifically to the sample tested; it also relates to the entire batch insofar as the sample is truly representative of the batch.

Approved Signatory [signature]

Date 30-Mar-90

NATA CERTIFICATE: This laboratory is registered by NATA. The tests have been performed in accordance with its terms of registration.

Please reply to:

Amdel Core Services Pty Limited
Incorporated in South Australia

AMDEL CORE SERVICES

AMDEL CORE SERVICES GAS ANALYSIS — Method GL-01-01

ASTM D 1945-81 (modified)

Client: PETROFINA EXPLORATION AUSTRALIA Report # 009/260

Sample: ARCHER 1
Pressure: 50 psi, Temp:25 deg C
RFS-AD-1131, Bottle #L-110
Date: 27/3/90, Cylinder: Amdel #114

GAS	MOL %
Nitrogen	0.36
Carbon Dioxide	0.08
Methane	51.76
Ethane	16.68
Propane	17.23
I-Butane	3.17
N-Butane	5.78
I-Pentane	1.58
N-Pentane	1.29
Hexanes	1.26
Heptanes	0.57
Octanes and higher h'c	0.24
Total	100.00

(0.00 = less than 0.01%)

Calculated Gas Density
(Air = 1) : 1.050

Calorific Value (15.0 deg C, 101.325 kPa)

Gross:	1768 BTU/CU Ft	65.87 MJ/CU.M
Nett:	1617 BTU/CU Ft	60.23 MJ/CU.M
Gross calorific value of water-saturated gas		64.73 MJ/CU.M

Average Molecular Weight = 30.259

All results are calculated on the basis that only the measured constituents are present. This report relates specifically to the sample tested; it also relates to the entire batch insofar as the sample is truly representative of the batch.

Approved Signatory RTanke.

Date 30-Mar-90

NATA CERTIFICATE: This laboratory is registered by NATA. The tests have been performed in accordance with its terms of registration.

TABLE #34

AMDEL CORE SERVICES

AMDEL CORE SERVICES GAS ANALYSIS

Method GL-01-01
ASTM D 1945-81 (modified)
Report # 009/260

Client: PETROFINA AUSTRALIA

Sample: ARCHER 1
RFS-AD-1114
Sample 1.

GAS	MOL %
Nitrogen	1.45
Carbon Dioxide	2.25
Methane	75.45
Ethane	10.65
Propane	5.45
I-Butane	0.93
N-Butane	1.80
I-Pentane	0.58
N-Pentane	0.52
Hexanes	0.63
Heptanes	0.22
Octanes and higher h'c	0.07
Total	100.00

(0.00 = less than 0.01%)

Calculated Gas Density
(Air = 1) : 0.773

Calorific Value (15.0 deg C, 101.325 kPa)

Gross:	1270 BTU/CU Ft	47.30 MJ/CU.M
Nett:	1153 BTU/CU Ft	42.94 MJ/CU.M
Gross calorific value of water-saturated gas		46.47 MJ/CU.M
Average Molecular Weight =	22.330	

All results are calculated on the basis that only the measured constituents are present. This report relates specifically to the sample tested; it also relates to the entire batch insofar as the sample is truly representative of the batch.

Approved Signatory [signature]

Date 14-May-90

National Association of Testing Authorities, Australia

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TABLE #35

AMDEL CORE SERVICES

AMDEL CORE SERVICES GAS ANALYSIS Method GL-01-01
ASTM D 1945-81 (modified)

Client: PETROFINA AUSTRALIA Report # 009/260

Sample: ARCHER 1
RFS-AD-1120
Sample 1, Bottle L-108

GAS	MOL %
Nitrogen	1.13
Carbon Dioxide	0.71
Methane	63.25
Ethane	18.56
Propane	8.11
I-Butane	1.76
N-Butane	3.29
I-Pentane	0.95
N-Pentane	0.81
Hexanes	0.91
Heptanes	0.36
Octanes and higher h'c	0.16
Total	100.00

(0.00 = less than 0.01%)

Calculated Gas Density
(Air = 1) : 0.882

Calorific Value (15.0 deg C, 101.325 kPa)

Gross:	1482 BTU/CU Ft	55.21 MJ/CU.M
Nett:	1351 BTU/CU Ft	50.31 MJ/CU.M
Gross calorific value of water-saturated gas		54.26 MJ/CU.M
Average Molecular Weight =	25.462	

All results are calculated on the basis that only the measured constituents are present. This report relates specifically to the sample tested; it also relates to the entire batch insofar as the sample is truly representative of the batch.

Approved Signatory [signature]

Date 14-May-90

National Association of Testing Authorities, Australia

TABLE #36

AMDEL CORE SERVICES

AMDEL CORE SERVICES GAS ANALYSIS — Method GL-01-01

ASTM D 1945-81 (modified)

Client: PETROFINA AUSTRALIA — Report # 009/260

Sample: ARCHER 1
RFS-AD-1123
Sample 1, Bottle L-092

GAS	MOL %
Nitrogen	0.59
Carbon Dioxide	1.19
Methane	74.91
Ethane	11.59
Propane	6.24
I-Butane	1.01
N-Butane	1.90
I-Pentane	0.60
N-Pentane	0.53
Hexanes	0.80
Heptanes	0.42
Octanes and higher h'c	0.22
Total	100.00

(0.00 = less than 0.01%)

Calculated Gas Density
(Air = 1) : 0.789

Calorific Value (15.0 deg C, 101.325 kPa)

Gross:	1336 BTU/CU Ft	49.78 MJ/CU.M
Nett:	1214 BTU/CU Ft	45.24 MJ/CU.M
Gross calorific value of water-saturated gas		48.91 MJ/CU.M
Average Molecular Weight =	22.810	

All results are calculated on the basis that only the measured constituents are present. This report relates specifically to the sample tested; it also relates to the entire batch insofar as the sample is truly representative of the batch.

Approved Signatory [signature]

Date 14-May-90

National Association of Testing Authorities, Australia

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TABLE #37

AMDEL CORE SERVICES

AMDEL CORE SERVICES GAS ANALYSIS — Method GL-01-01

ASTM D 1945-81 (modified)

Client: PETROFINA AUSTRALIA — Report # 009/260

Sample: ARCHER 1
RFS-AD-1129
Sample 1, Bottle L-112

GAS	MOL %
Nitrogen	0.73
Carbon Dioxide	0.52
Methane	58.58
Ethane	16.36
Propane	12.07
I-Butane	2.33
N-Butane	4.55
I-Pentane	1.52
N-Pentane	1.34
Hexanes	1.44
Heptanes	0.45
Octanes and higher h'c	0.11
Total	100.00

(0.00 = less than 0.01%)

Calculated Gas Density
(Air = 1) : 0.969

Calorific Value (15.0 deg C, 101.325 kPa)

Gross:	1627 BTU/CU Ft	60.61 MJ/CU.M
Nett:	1485 BTU/CU Ft	55.33 MJ/CU.M
Gross calorific value of water-saturated gas		59.56 MJ/CU.M

Average Molecular Weight = 27.953

All results are calculated on the basis that only the measured constituents are present. This report relates specifically to the sample tested; it also relates to the entire batch insofar as the sample is truly representative of the batch.

Approved Signatory

Date 14-May-90

TABLE #38

AMDEL CORE SERVICES

AMDEL CORE SERVICES GAS ANALYSIS Method GL-01-01
ASTM D 1945-81 (modified)

Client: PETROFINA AUSTRALIA Report # 009/260

Sample: ARCHER 1
RFS-AD-1286
Sample 1, Bottle L-118

GAS	MOL %
Nitrogen	1.07
Carbon Dioxide	0.79
Methane	47.50
Ethane	18.99
Propane	17.46
I-Butane	3.44
N-Butane	6.00
I-Pentane	1.61
N-Pentane	1.32
Hexanes	1.29
Heptanes	0.41
Octanes and higher h´c	0.12
Total	100.00

(0.00 = less than 0.01%)

Calculated Gas Density
(Air = 1) : 1.073

Calorific Value (15.0 deg C, 101.325 kPa)

Gross:	1775 BTU/CU Ft	66.12 MJ/CU.M
Nett:	1624 BTU/CU Ft	60.49 MJ/CU.M
Gross calorific value of water-saturated gas		64.98 MJ/CU.M
Average Molecular Weight =	30.937	

All results are calculated on the basis that only the measured constituents are present. This report relates specifically to the sample tested; it also relates to the entire batch insofar as the sample is truly representative of the batch.

Approved Signatory

Date 14-May-90

National Association of Testing Authorities, Australia

TABLE 39

C_{12+} BULK COMPOSITION AND ALKANE RATIOS OF OILS, ANGLER -1

Sample/Test	C_{12+} Composition					Alkane Ratios					
	N+ iso para %		Naph %	Arom %	Res+Asph %	$\frac{n\text{-}C_{10}}{a}$	$\frac{n\text{-}C_{15}}{b}$	Np/Pr	Pr/Ph	Pr/n-C_{17}	Ph/n-C_{18}
Archer -1											
3390.2	42.57		21.44	10.87	25.12	5.0	0.46	0.43	3.51	0.77	0.22
3403.5	41.27		22.64	14.96	20.95	5.3	0.47	0.43	3.23	0.74	0.23
3489.0	-	65.45	-	12.96	21.59	3.3	0.46	0.49	2.63	0.93	0.32
3514.2	-	67.57	-	17.43	15.00	2.8	0.48	0.51	2.49	0.96	0.36
3591.5	-	69.30	-	19.30	11.40	2.6	0.48	0.47	2.77	0.83	0.28
3681.0	-	69.72	-	20.24	10.04	3.1	0.48	0.48	2.05	1.01	0.41
3947.5	-	67.67	-	21.75	10.58	3.6	0.46	0.47	2.71	0.88	0.31
Angler -1											
RFT Pre-Test 4226 m	58.5		20.9	12.6	8.0	8.05	3.66	0.37	6.22	0.50	0.08
Wirrah -1* 2195.3 m						6.8	3.8	nd	9.5	nd	0.05
Anemone -1A											
RFT	24.0		16.5	8.78	50.7	3.0	3.3	0.50	4.03	0.54	0.15
DST	17.2		12.3	24.1	46.3	3.2	2.7	0.64	2.72	0.64	0.24

* From Burns (1987)

N+ iso para = normal + isoparaffins
Naph = naphthenes
Arom = aromatic hydrocarbons

Res = resins + polar compounds
Asph = asphaltenes

a,b = isoalkanes (after Burns et al 1987)
Np = norpristane
Pr = pristane

Ph = phytane
n-C_{17} = n-heptadecane
n-C_{18} = n-octadecane

TABLE #40

TABLE 1: AROMATIC MATURITY DATA

SAMPLE	MPI	MPR	MPDF	VR CALC A	B	C	E	F
ARCHER-1								
3390.2	1.229	1.394	0.516	1.14	1.56	1.08	1.08	0.99
3403.5	1.256	1.245	0.520	1.15	1.55	1.03	1.10	1.00
3489.0	1.153	1.054	0.523	1.09	1.61	0.96	1.03	1.01
3514.2	1.110	0.948	0.525	1.07	1.63	0.92	1.00	1.01
3591.5	1.041	0.853	0.508	1.02	1.68	0.87	0.95	0.97
3681.0	1.149	0.938	0.525	1.09	1.61	0.91	1.02	1.01
3947.5	1.003	0.888	0.493	1.00	1.70	0.89	0.92	0.94

FIGURE #1

HYDROGEN INDEX vs T max

Company : PETROFINA EXPLORATION AUSTRALIA S.A.
Location: ARCHER-1
Unit : LAKES ENTRANCE FORMATION

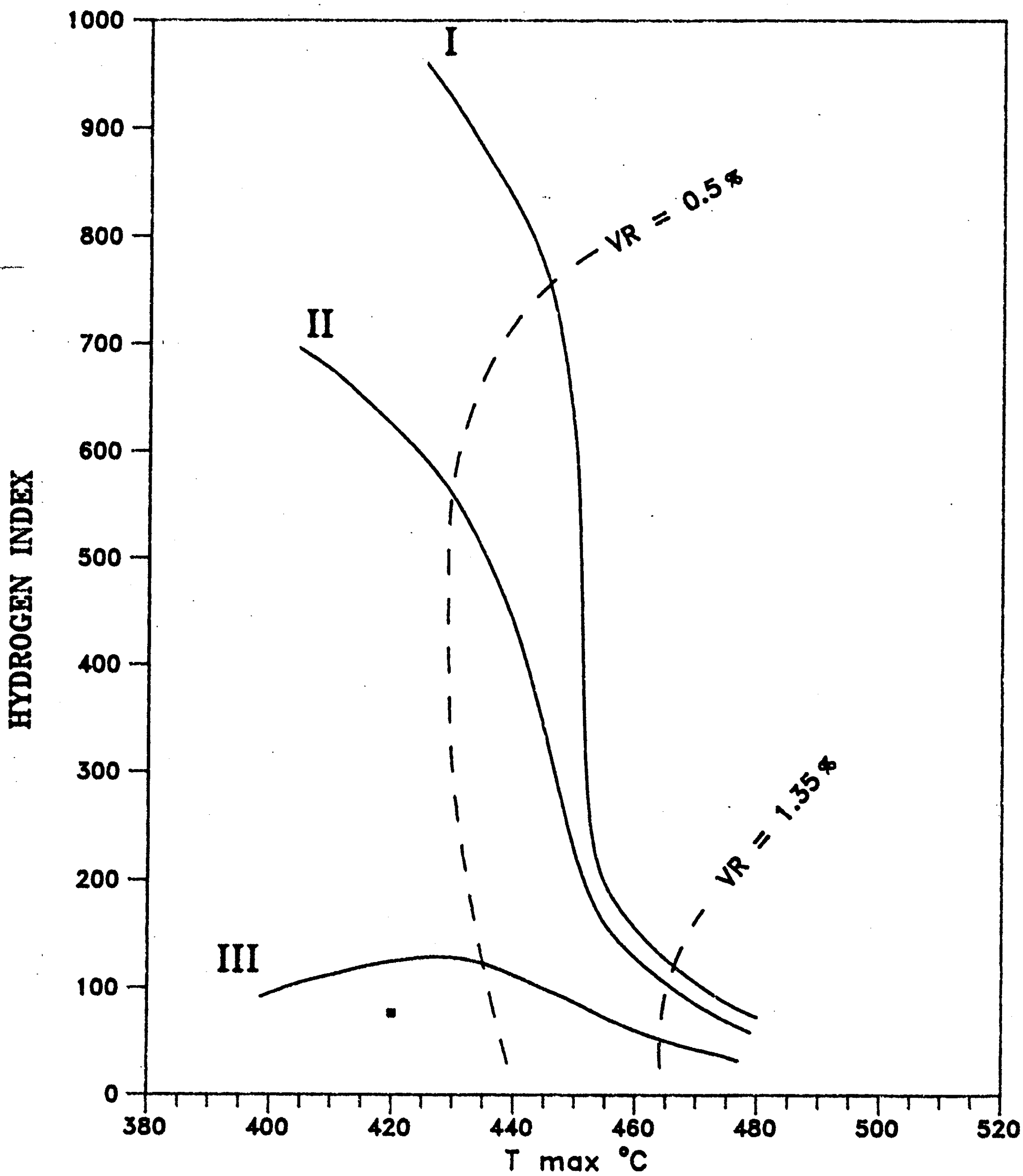
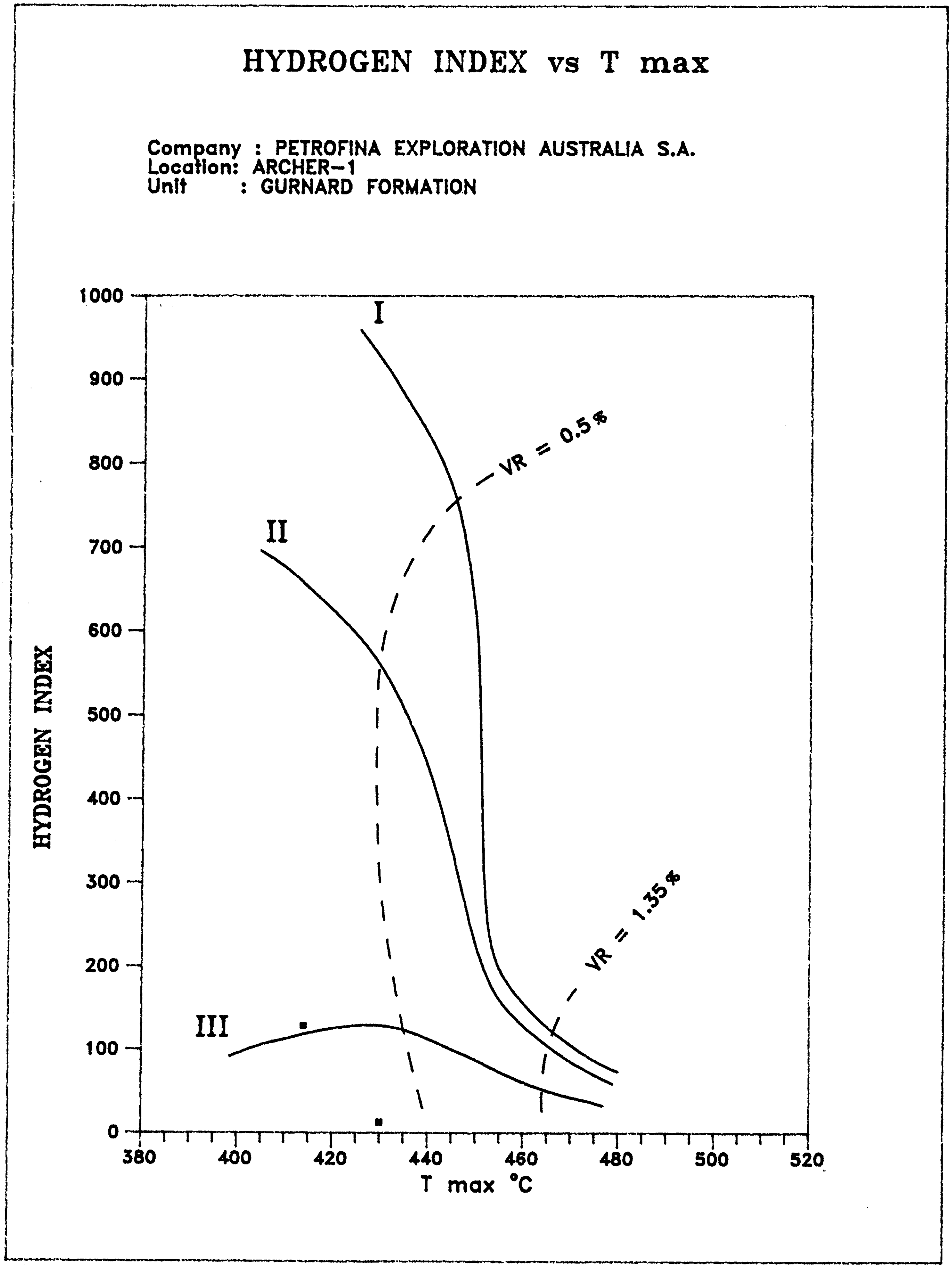
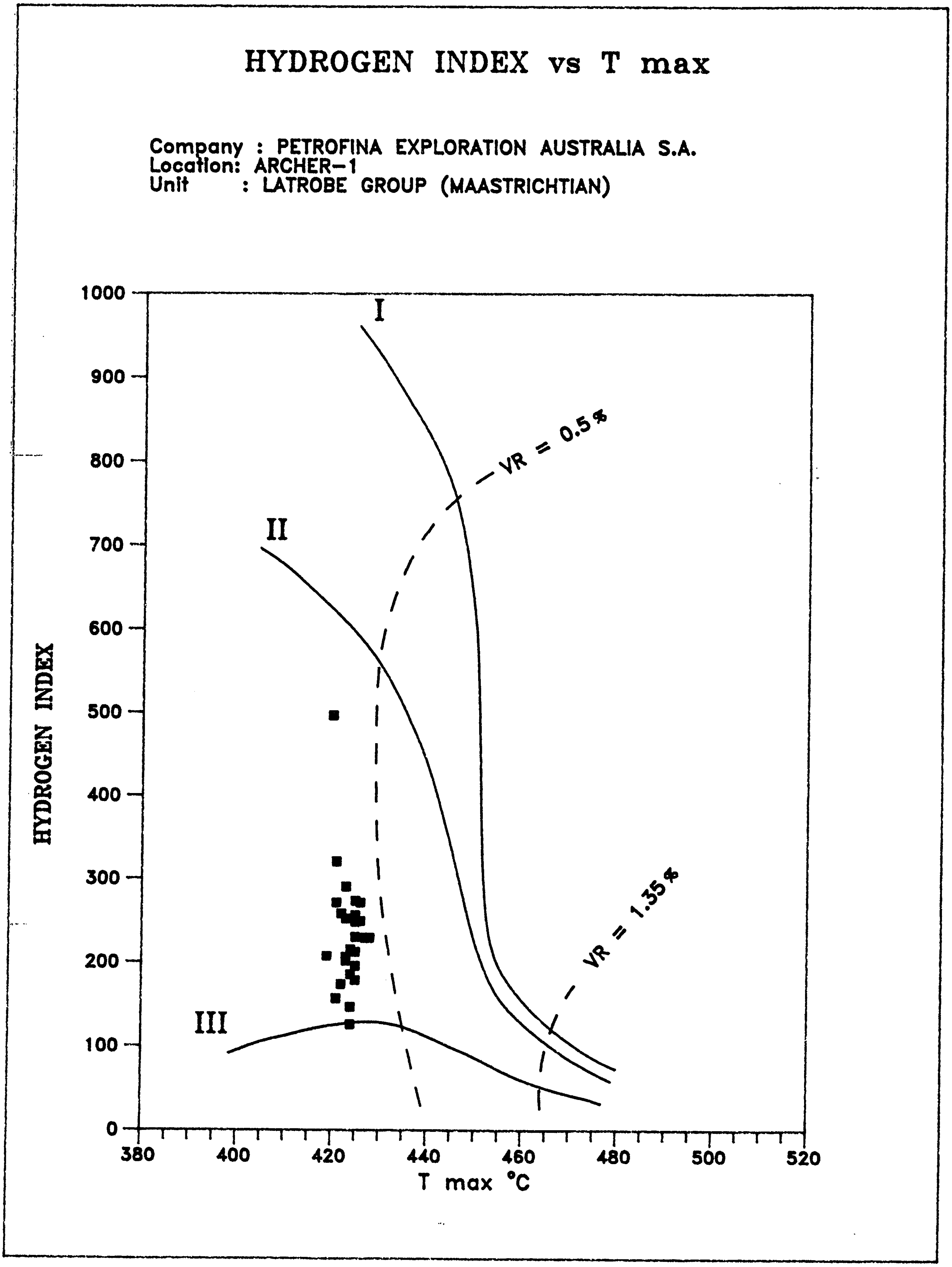


FIGURE #2



HYDROGEN INDEX vs T max
Company : PETROFINA EXPLORATION AUSTRALIA S.A.
Location: ARCHER-1
Unit : GURNARD FORMATION
1000
900
800
700
600
500
400
300
200
100
0
HYDROGEN INDEX
I
II
III
VR = 0.5%
VR = 1.35%
380
400
420
440
460
480
500
520
T max °C

FIGURE #3



HYDROGEN INDEX vs T max
Company : PETROFINA EXPLORATION AUSTRALIA S.A.
Location: ARCHER-1
Unit : LATROBE GROUP (MAASTRICHTIAN)
HYDROGEN INDEX
1000
900
800
700
600
500
400
300
200
100
0
I
II
III
VR = 0.5%
VR = 1.35%
380
400
420
440
460
480
500
520
T max °C

FIGURE #4

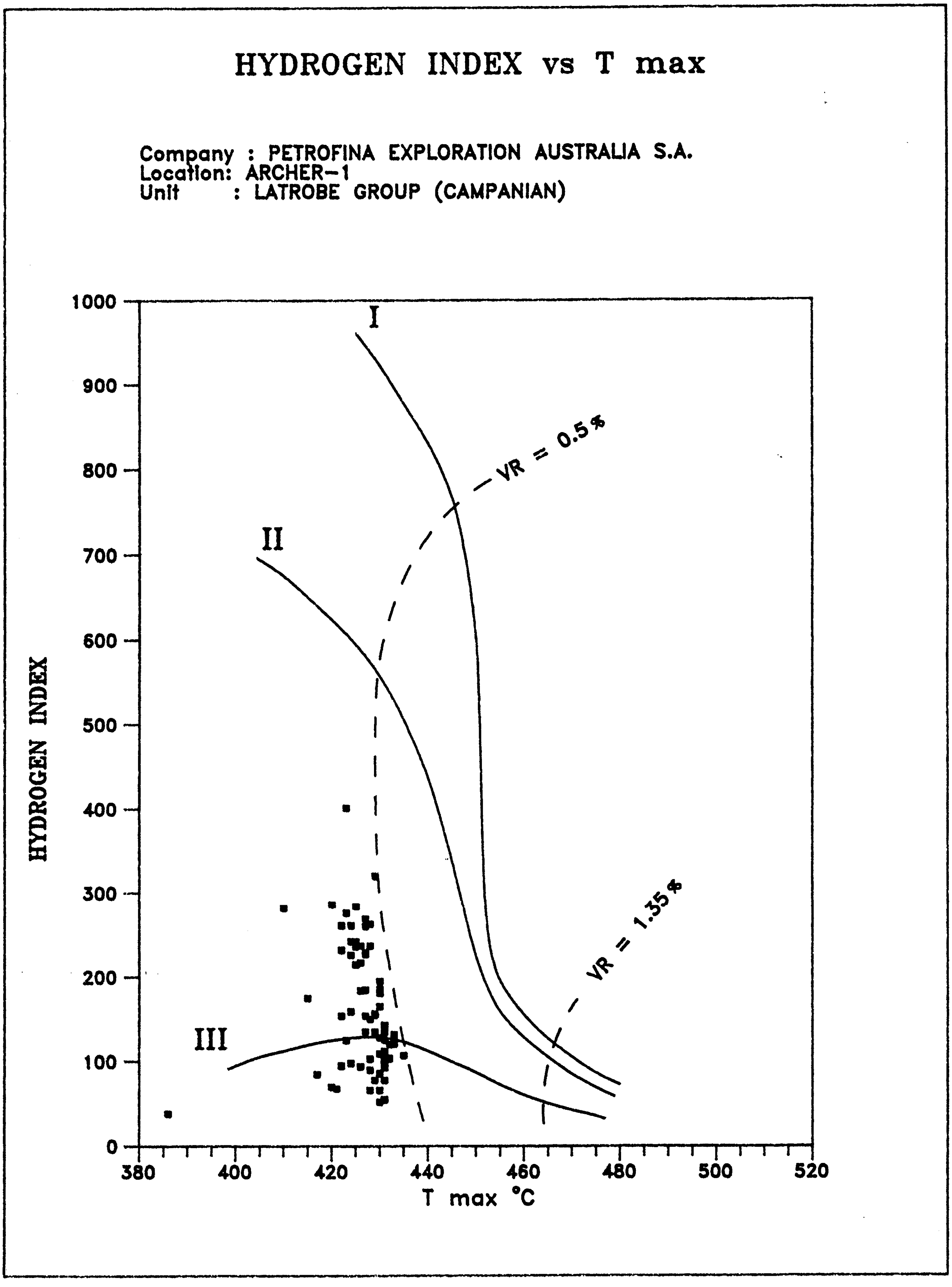

HYDROGEN INDEX vs T max
Company : PETROFINA EXPLORATION AUSTRALIA S.A.
Location: ARCHER-1
Unit : LATROBE GROUP (CAMPANIAN)
HYDROGEN INDEX
T max °C
I
II
III
VR = 0.5%
VR = 1.35%
0
100
200
300
400
500
600
700
800
900
1000
380
400
420
440
460
480
500
520

FIGURE #5

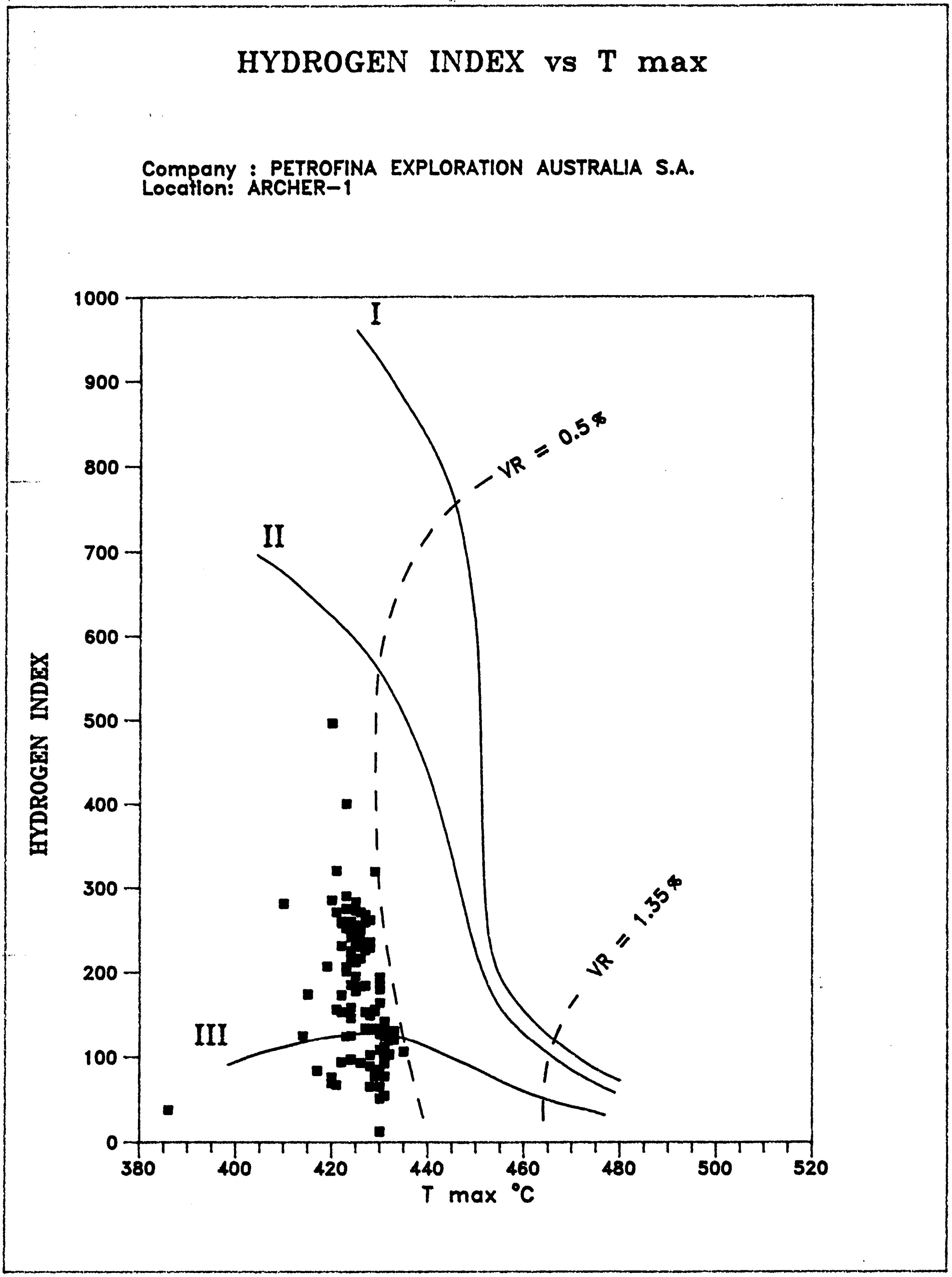

HYDROGEN INDEX vs T max
Company : PETROFINA EXPLORATION AUSTRALIA S.A.
Location: ARCHER-1
HYDROGEN INDEX
1000
900
800
700
600
500
400
300
200
100
0
380
400
420
440
460
480
500
520
T max °C
I
II
III
VR = 0.5%
VR = 1.35%

FIGURE #6

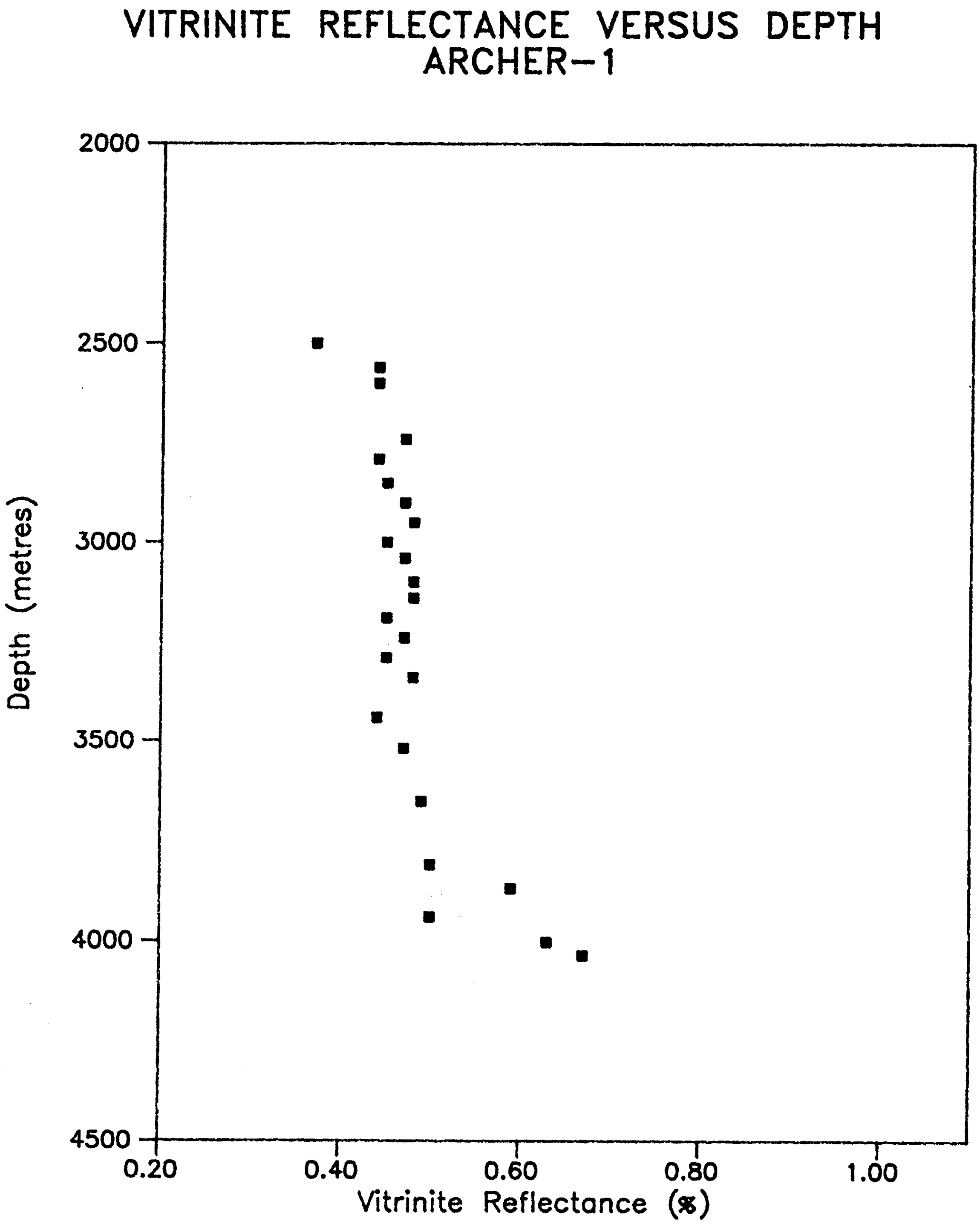

VITRINITE REFLECTANCE VERSUS DEPTH
ARCHER-1
2000
2500
3000
3500
4000
4500
Depth (metres)
0.20
0.40
0.60
0.80
1.00
Vitrinite Reflectance (%)

FIGURE #7
3390.2m, RFT-AD-1131

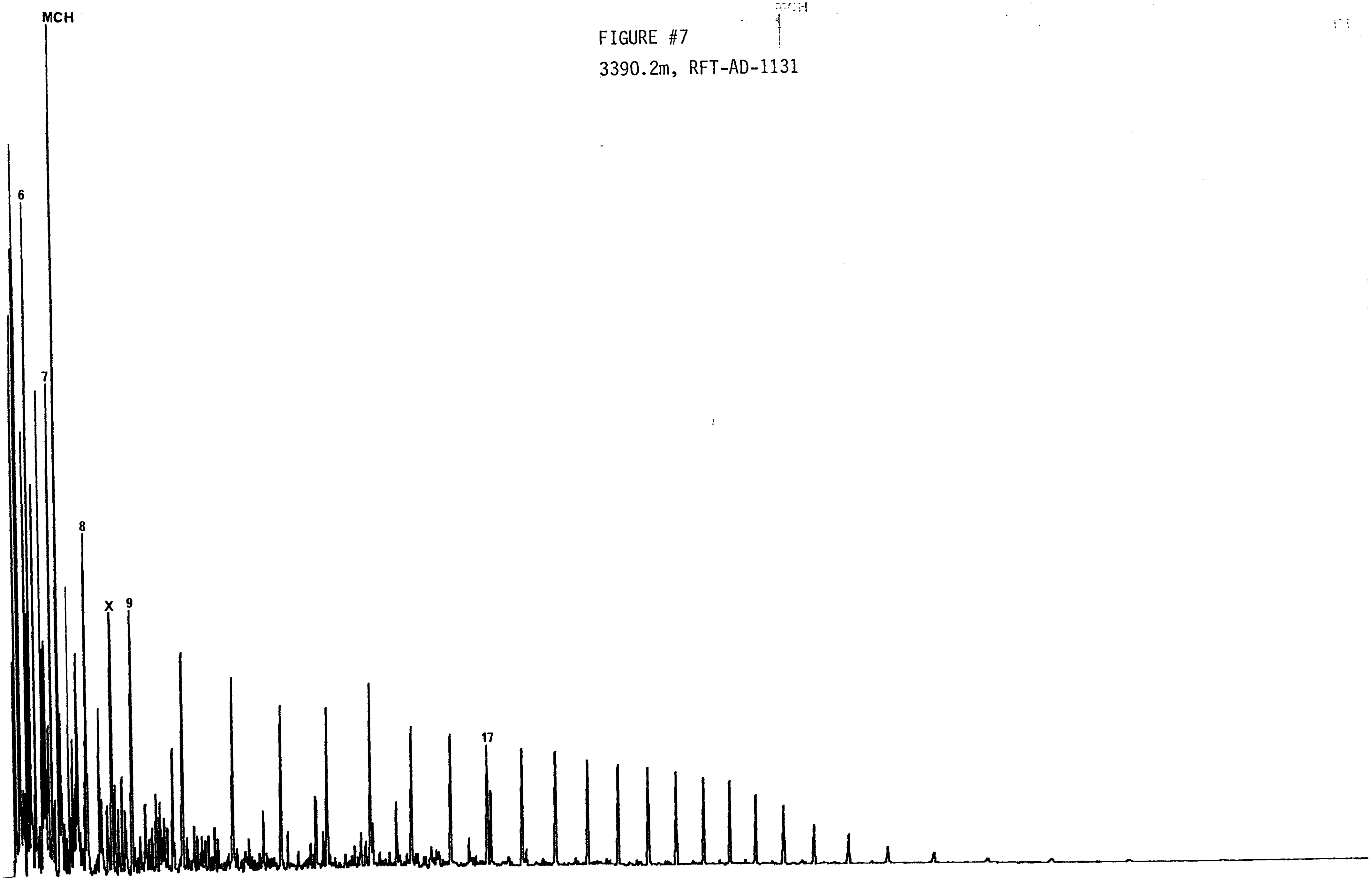


FIGURE #8

3403.5m, RFT-AD-1118

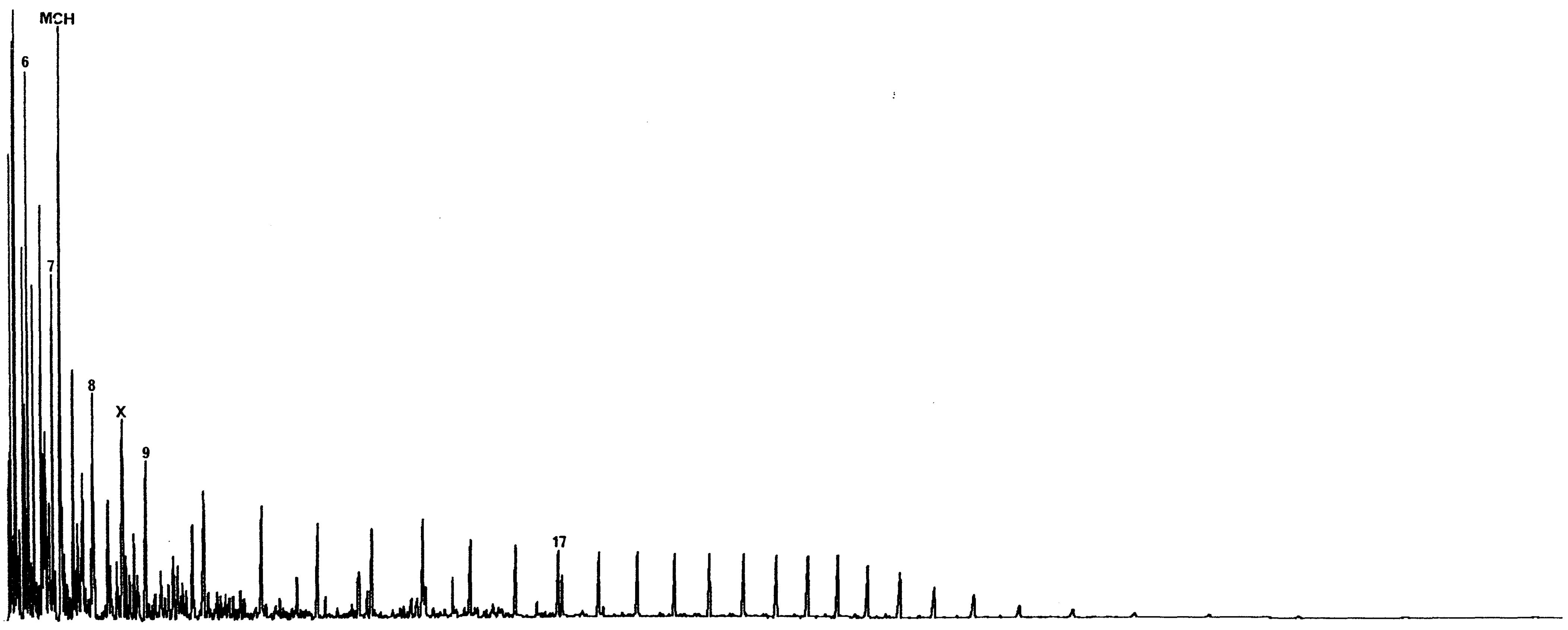


FIGURE #9

3489.0m, RFT-1286

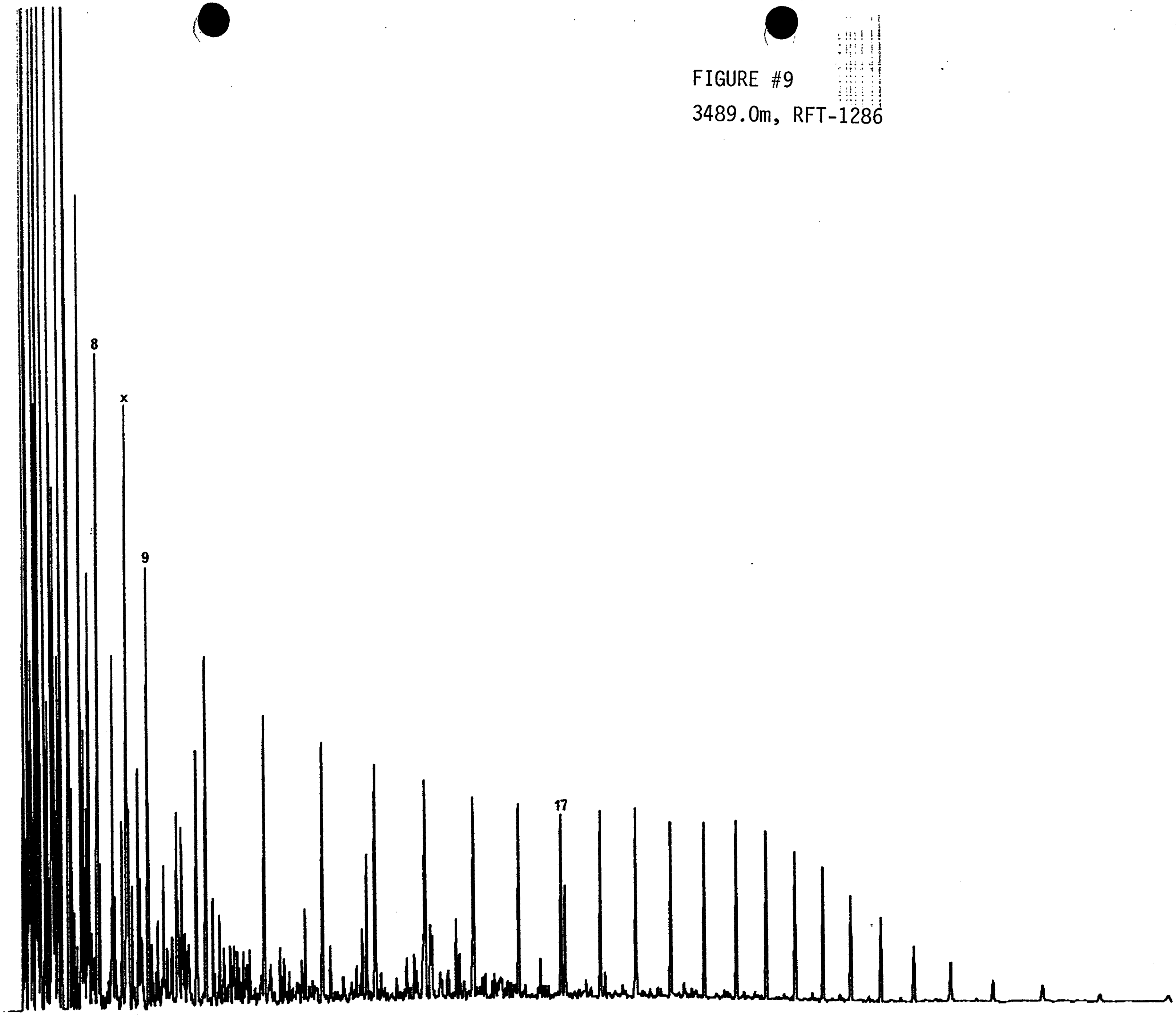


FIGURE #10
3514.2m, RFT-1129

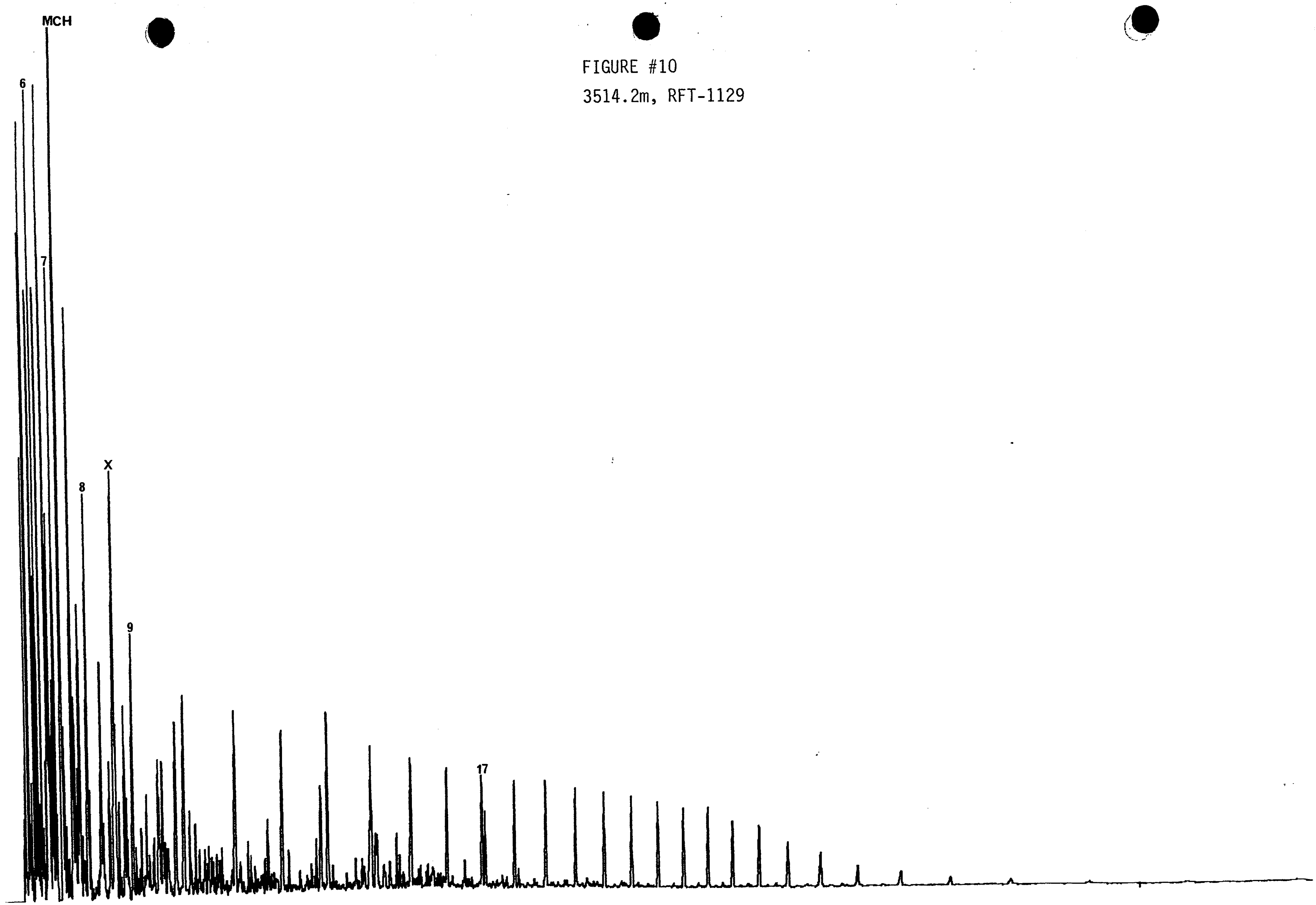


FIGURE #11
3591.5m, RFT-1120

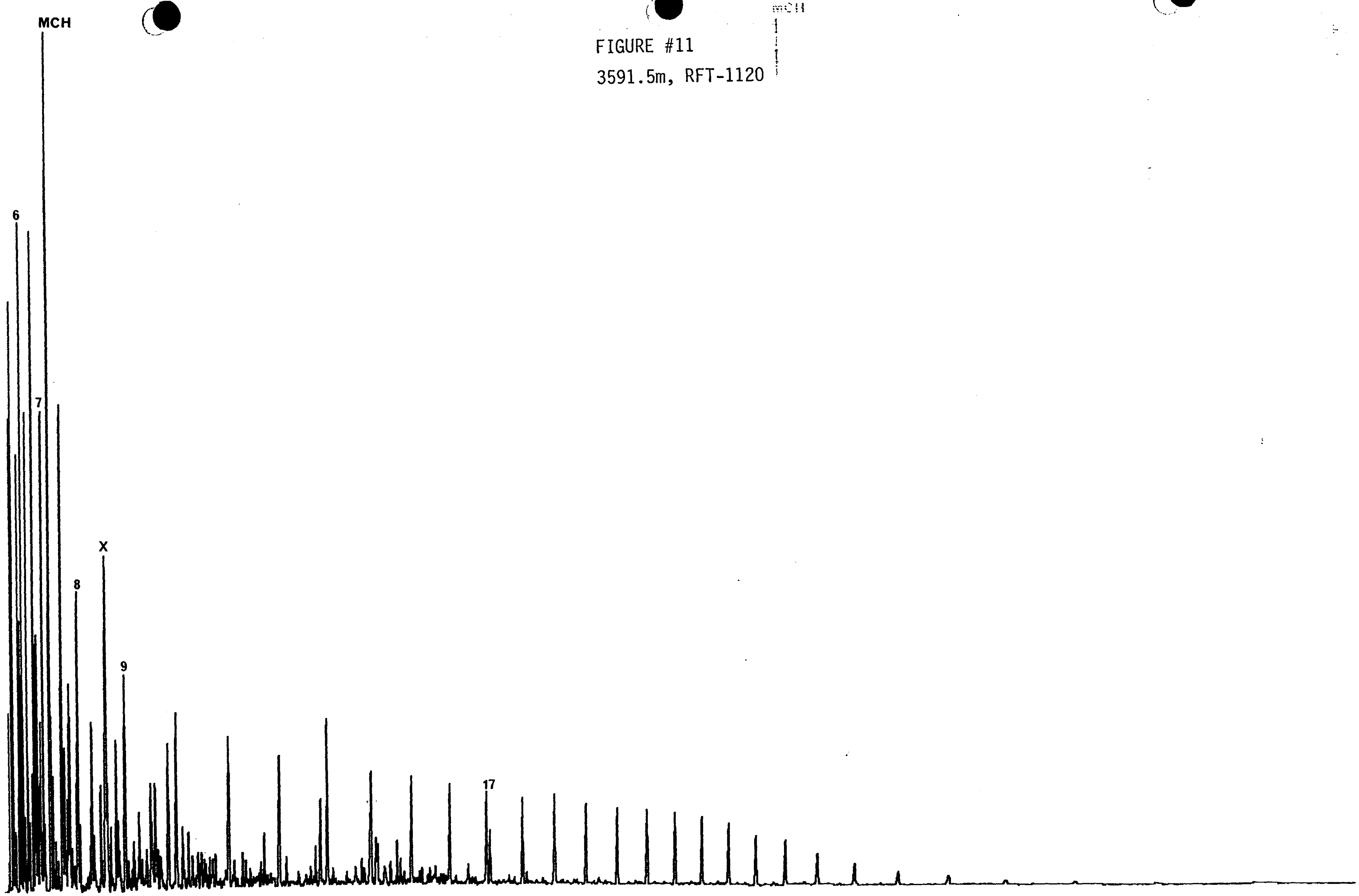


FIGURE #12

3681.0m, RFT-1123

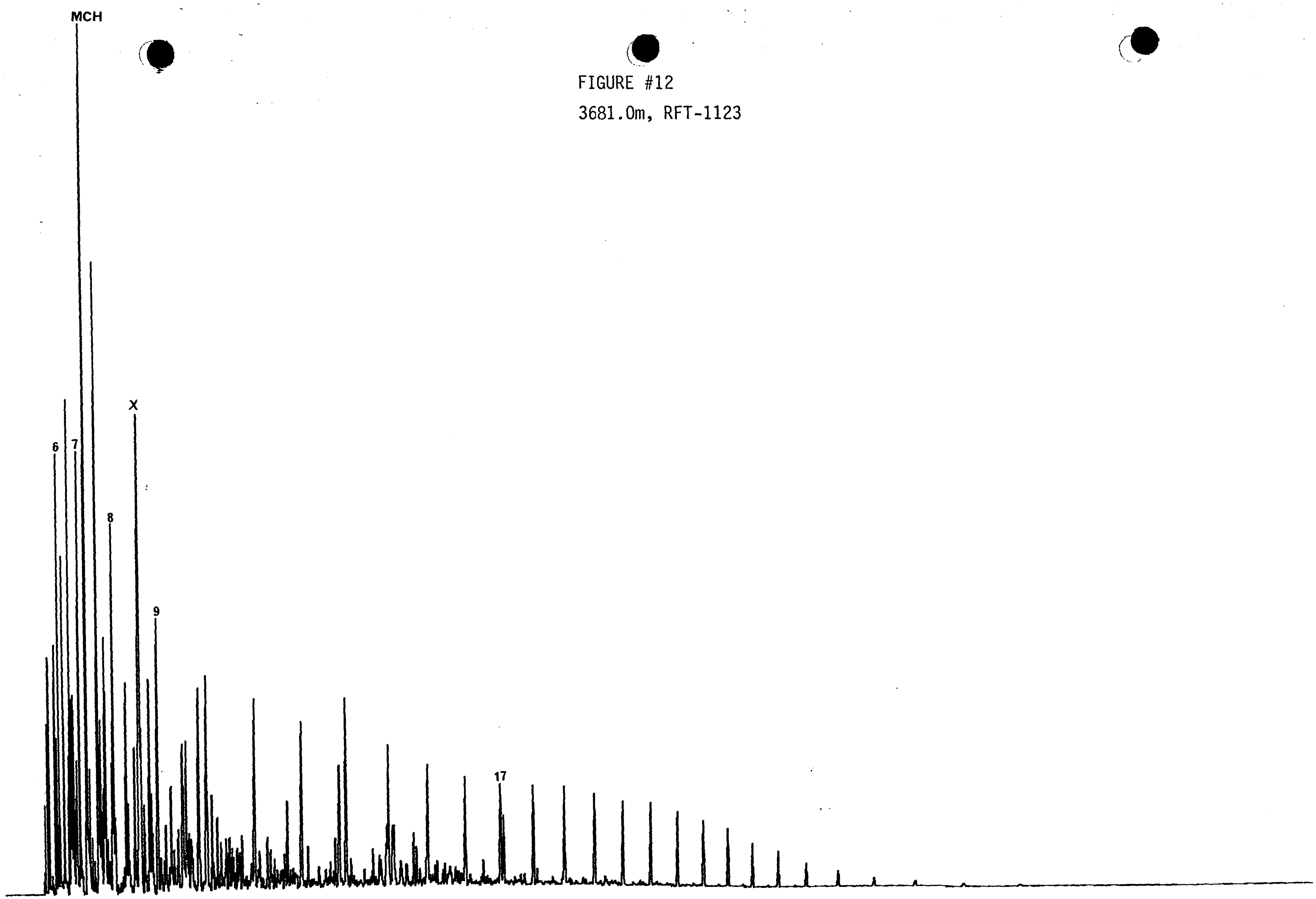
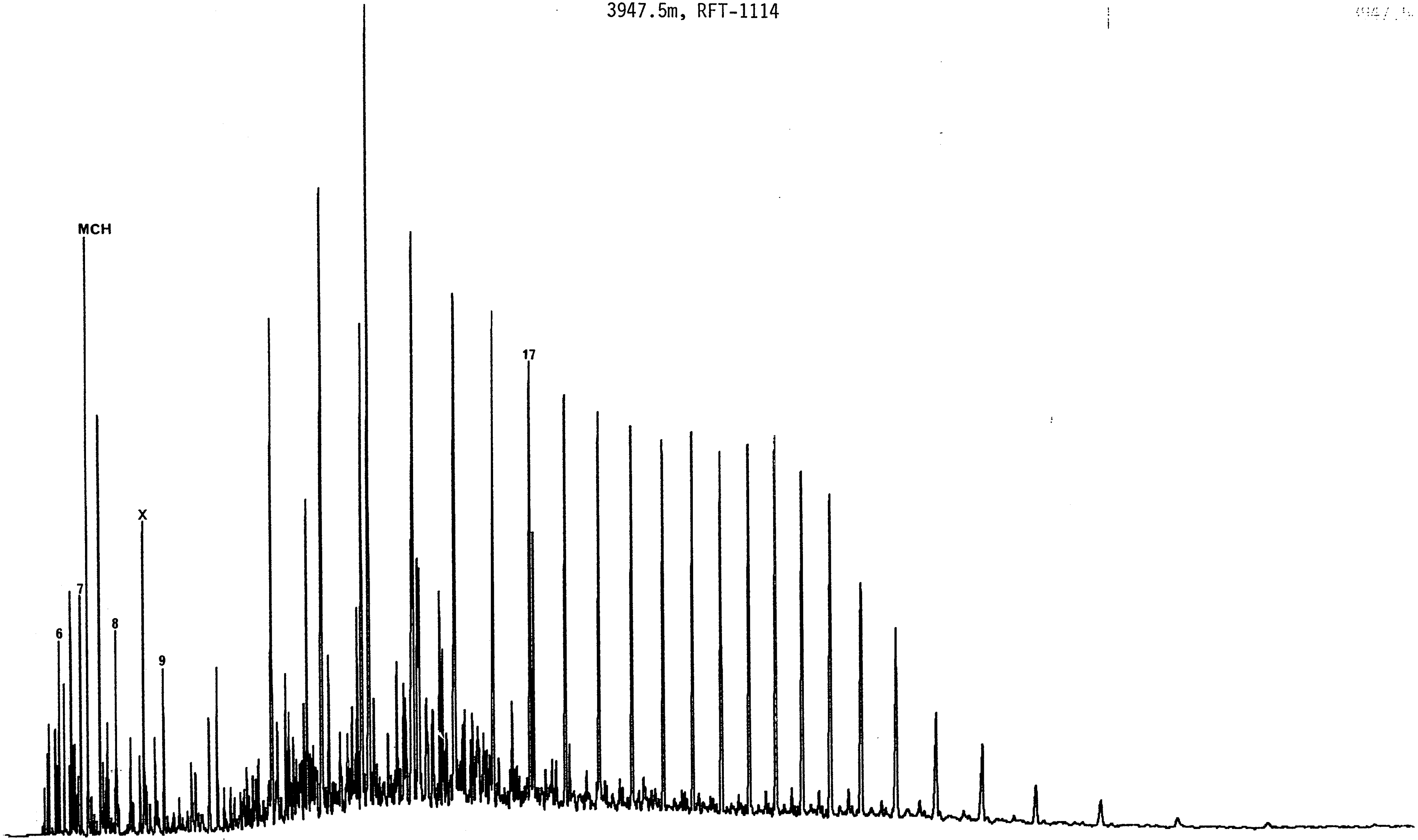


FIGURE #13

3947.5m, RFT-1114



KEY TO GASOLINE-RANGE CHROMATOGRAM

1. 2-Methylbutane (Isopentane)
2. *n*-Pentane
3. 2,2-Dimethylbutane
4. Cyclopentane
5. 2,3-Dimethylbutane
6. 2-Methylpentane
7. 3-Methylpentane
8. *n*-Hexane
9. 2,2-Dimethylpentane
10. Methylcyclopentane
11. 2,4-Dimethylpentane
12. 2,2,3-Trimethylbutane
13. Benzene
14. 3,3-Dimethylpentane
15. Cyclohexane
16. 2-Methylhexane
17. 2,3-Dimethylpentane
18. 1,1-Dimethylcyclopentane
19. 3-Methylhexane
20. *cis*-1,3-Dimethylcyclopentane
21. *trans*-1,3-Dimethylcyclopentane
22. 3-Ethylpentane and *trans*-1,2-Dimethylcyclopentane
23. *n*-Heptane
24. Methylcyclohexane
25. Ethylcyclopentane
26. Toluene

FIGURE #14 3390.2m

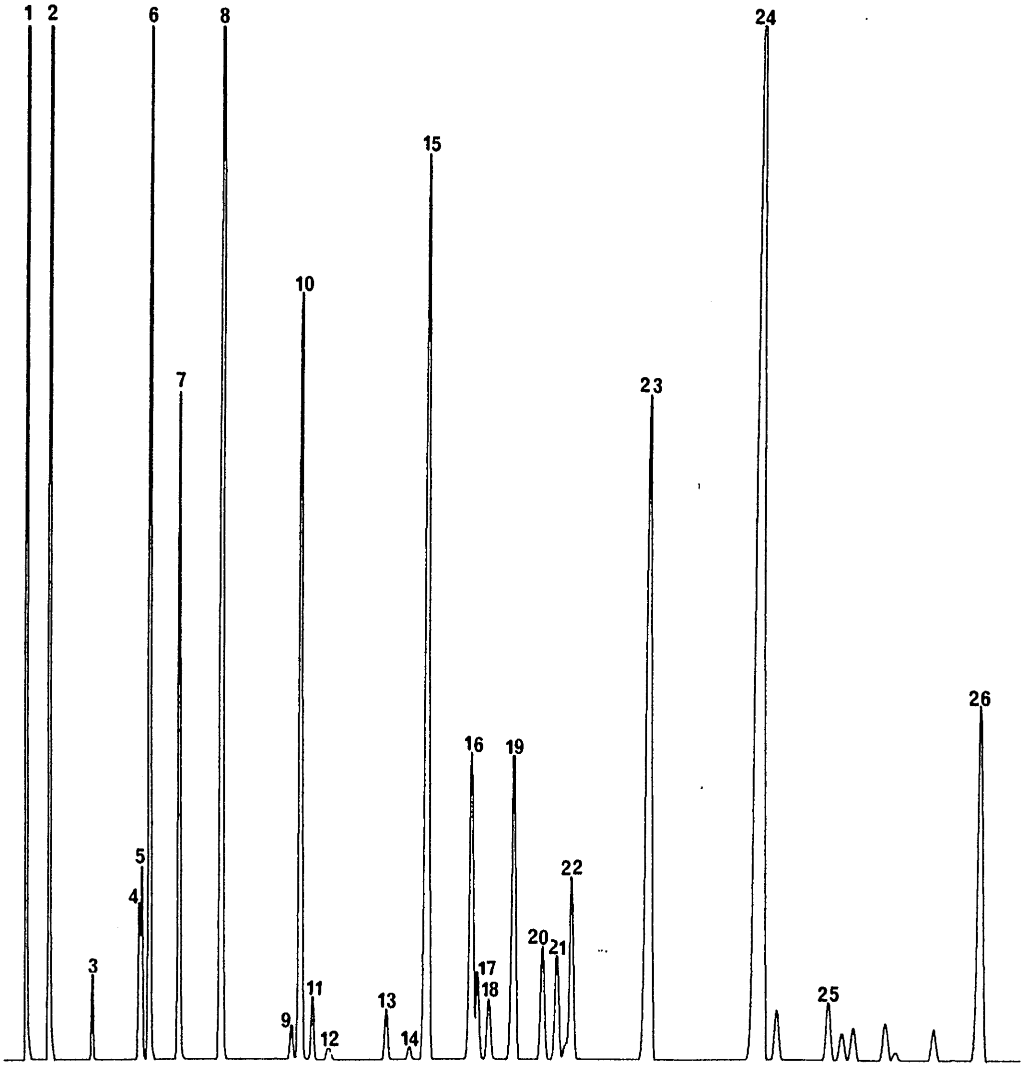


FIGURE #15 - 3403.5m

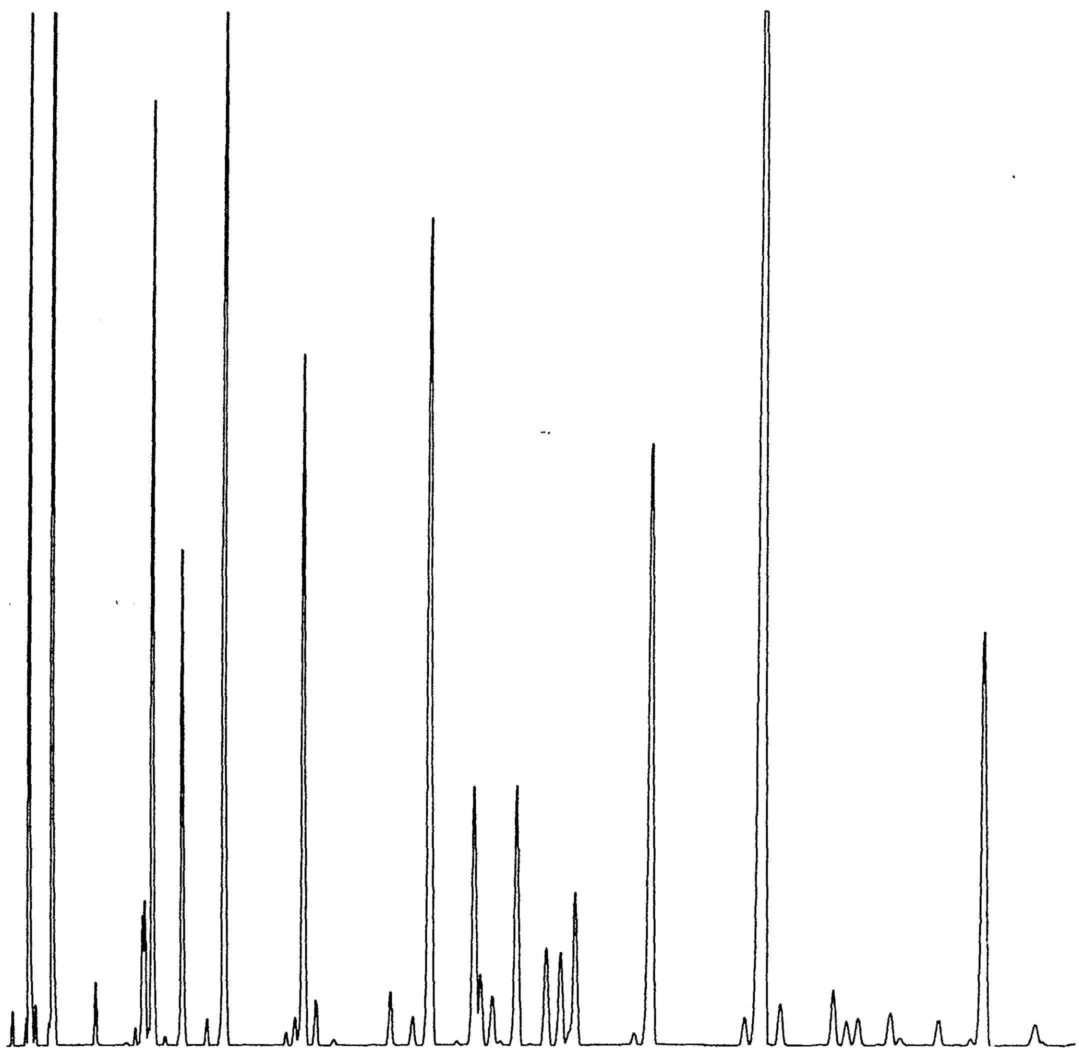


FIGURE #16 3489.0m

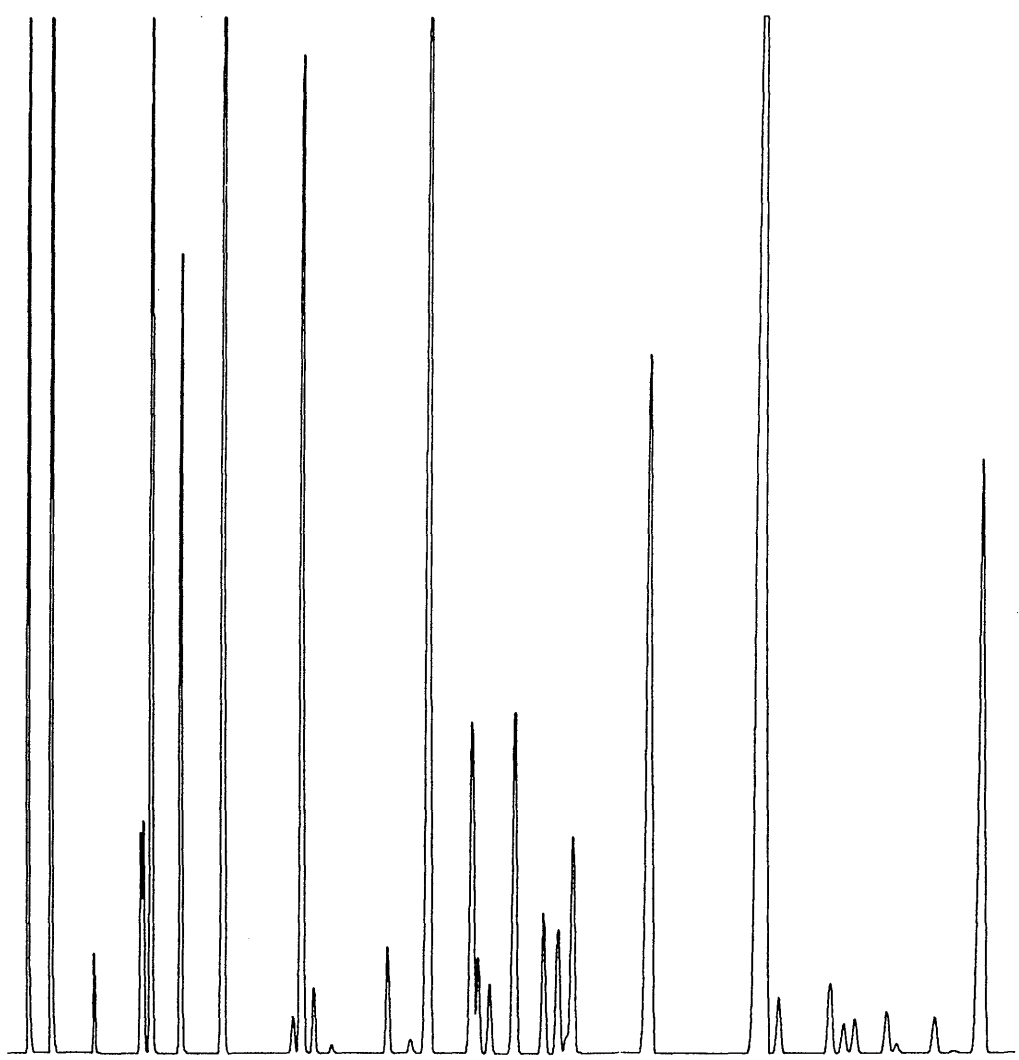


FIGURE #17 3514.2m

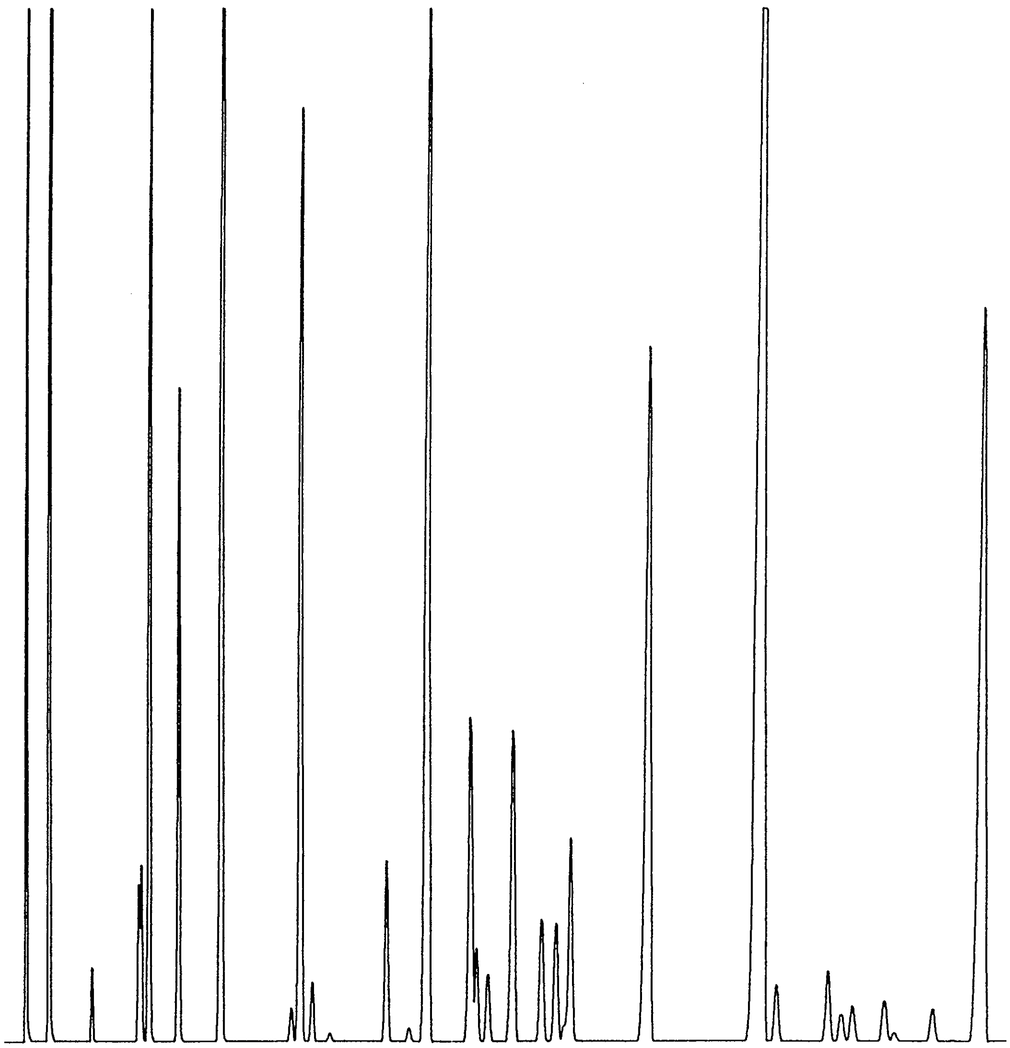


FIGURE #18 3591.5m

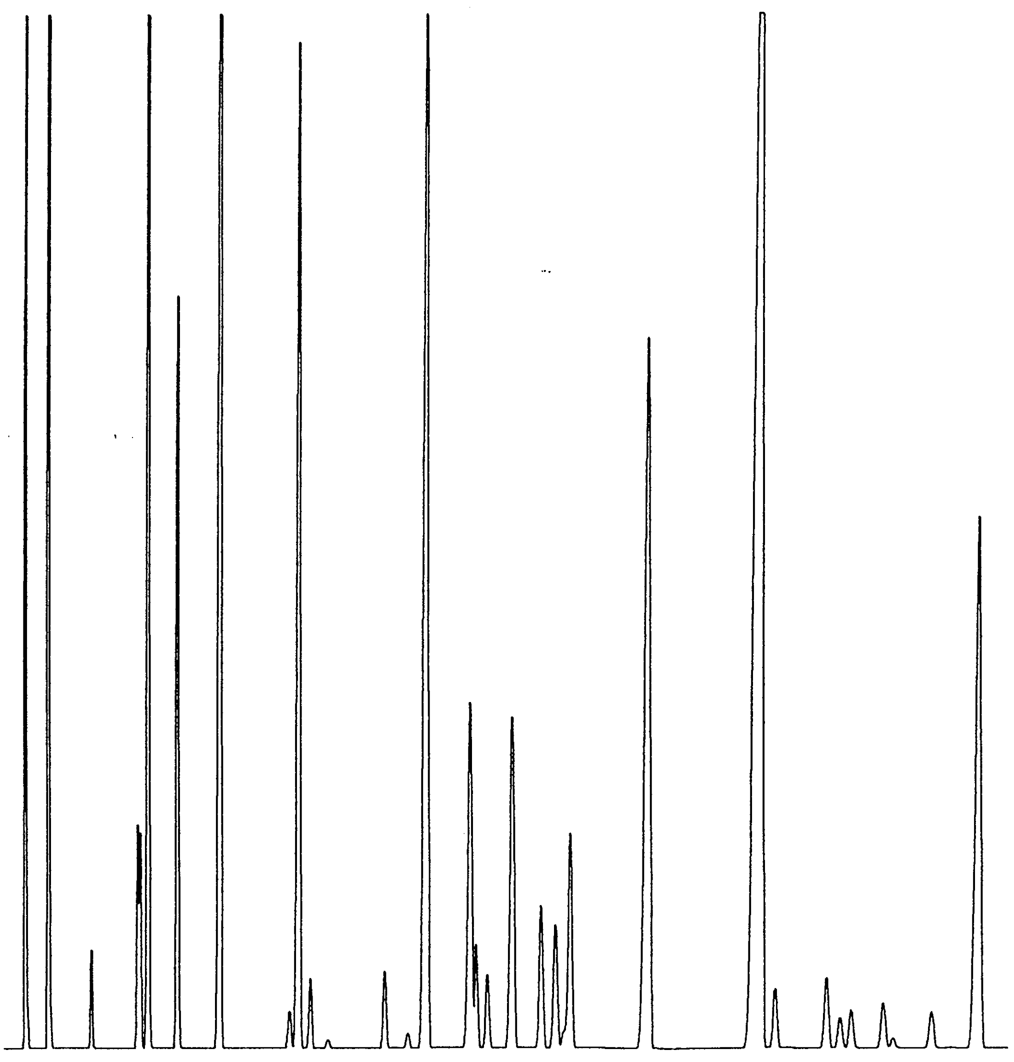


FIGURE #19 3681.0m

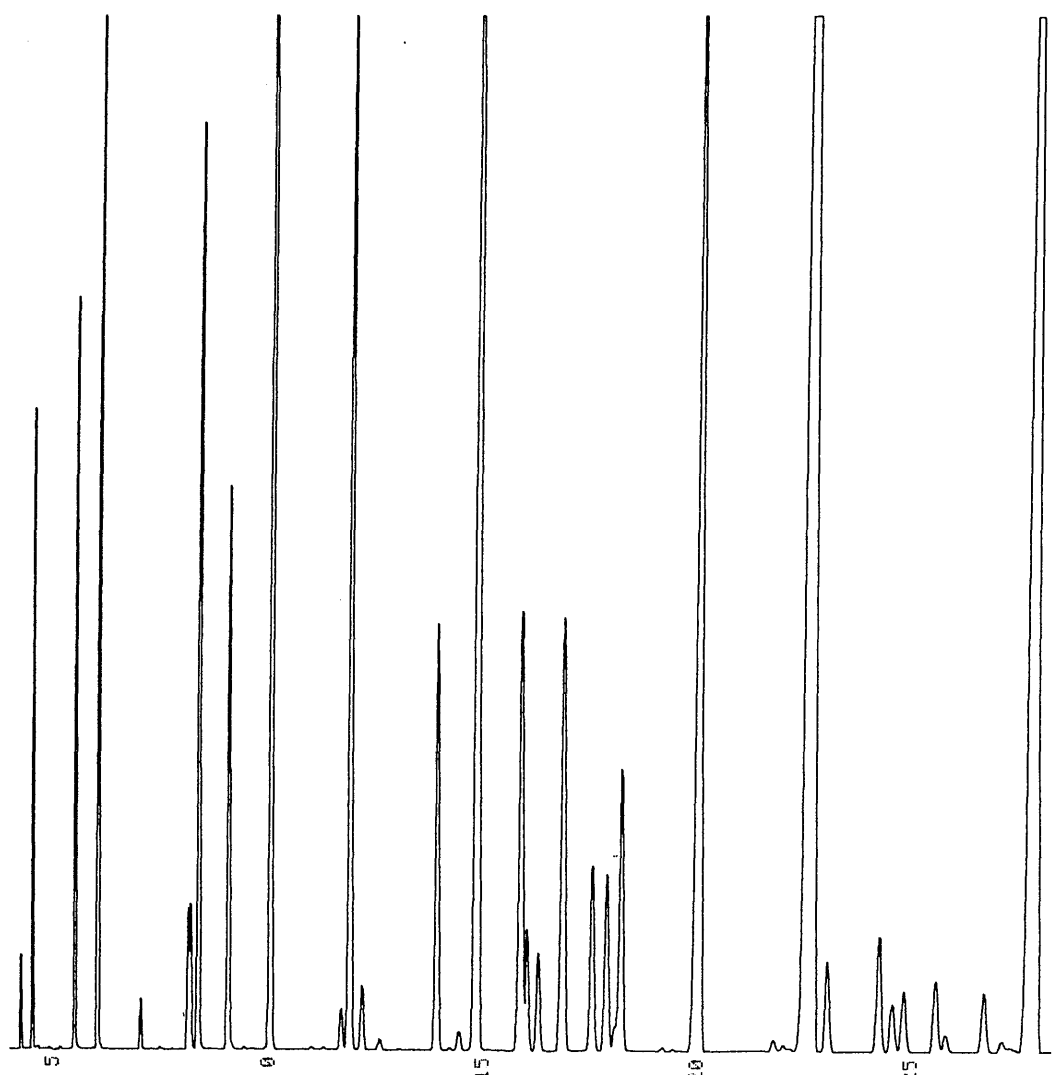


FIGURE #20 3947.5m

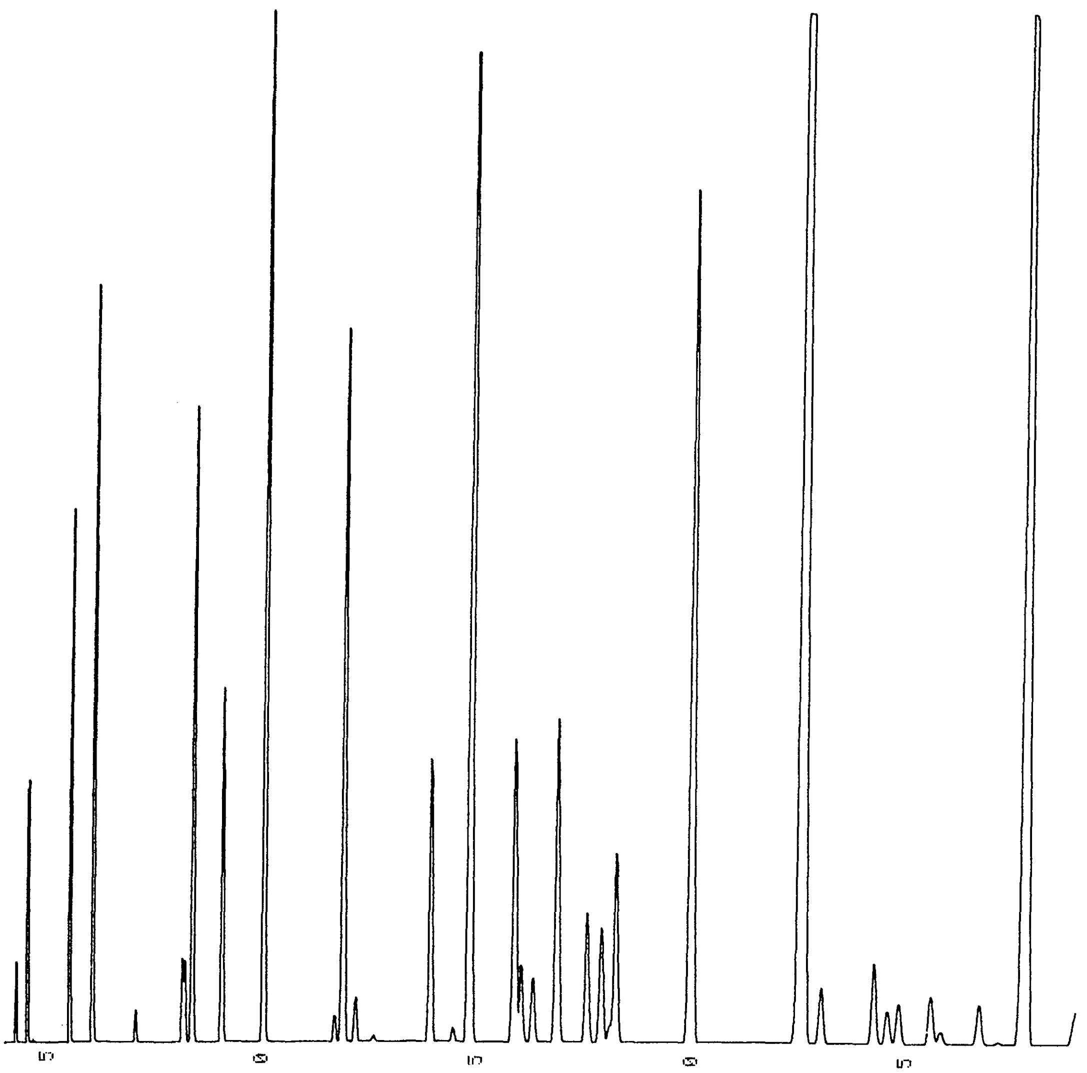


FIGURE #21

OIL SOURCE AFFINITY BASED ON C_5–C_7 ALKANES
ARCHER-1

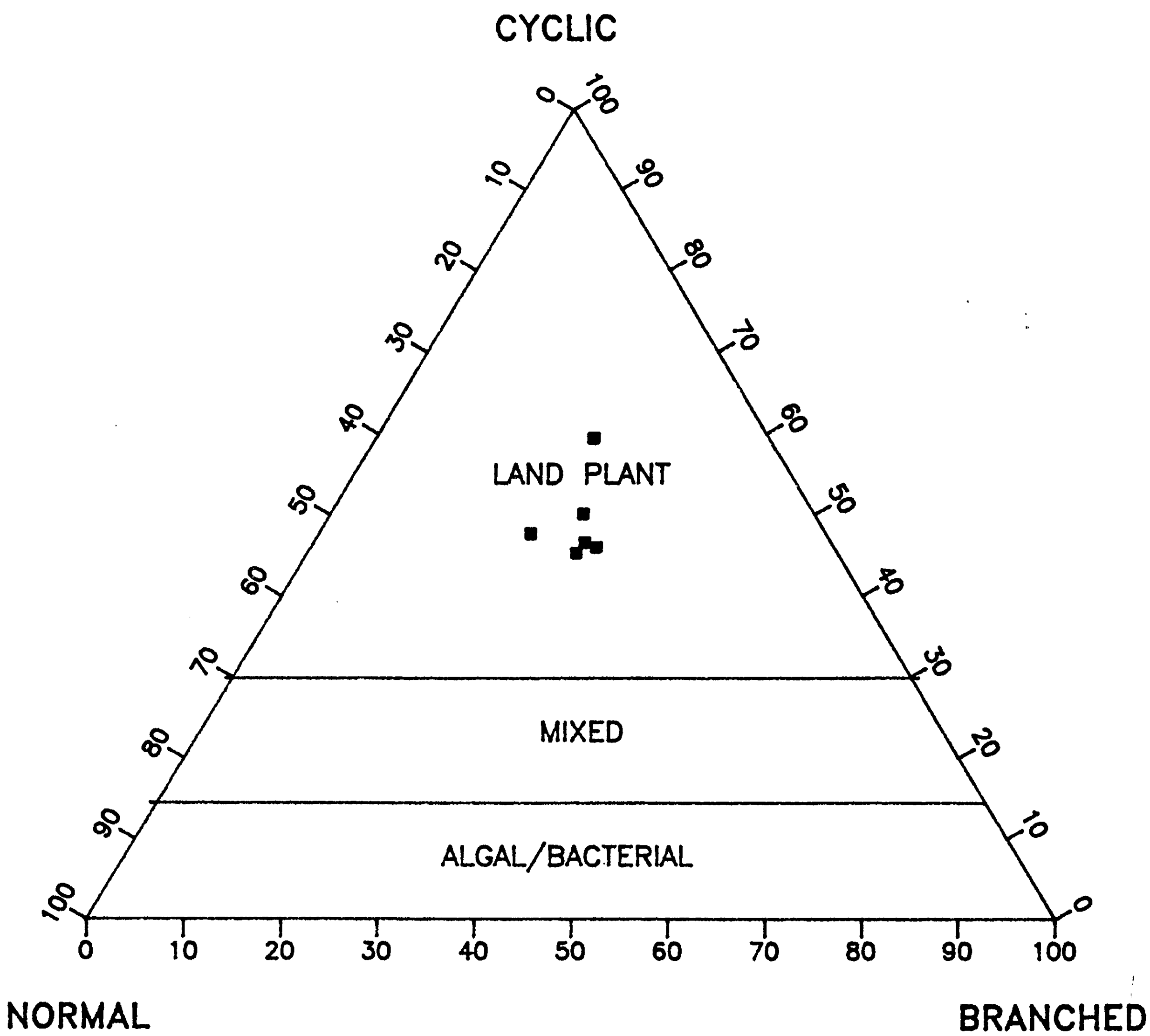


FIGURE #22

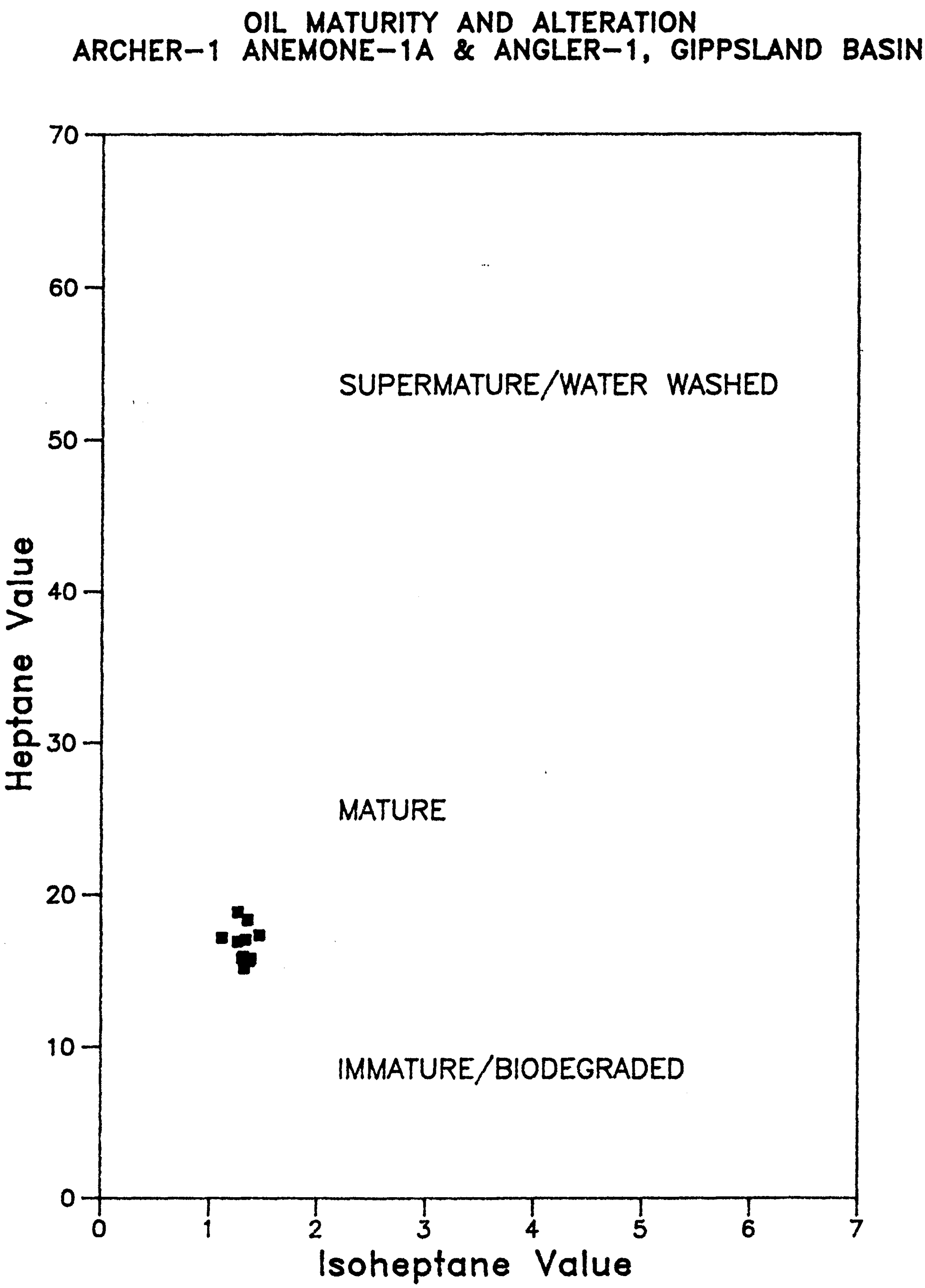

OIL MATURITY AND ALTERATION
ARCHER-1 ANEMONE-1A & ANGLER-1, GIPPSLAND BASIN
SUPERMATURE/WATER WASHED
MATURE
IMMATURE/BIODEGRADED
Heptane Value
Isoheptane Value
70
60
50
40
30
20
10
0
0
1
2
3
4
5
6
7

FIGURE #23

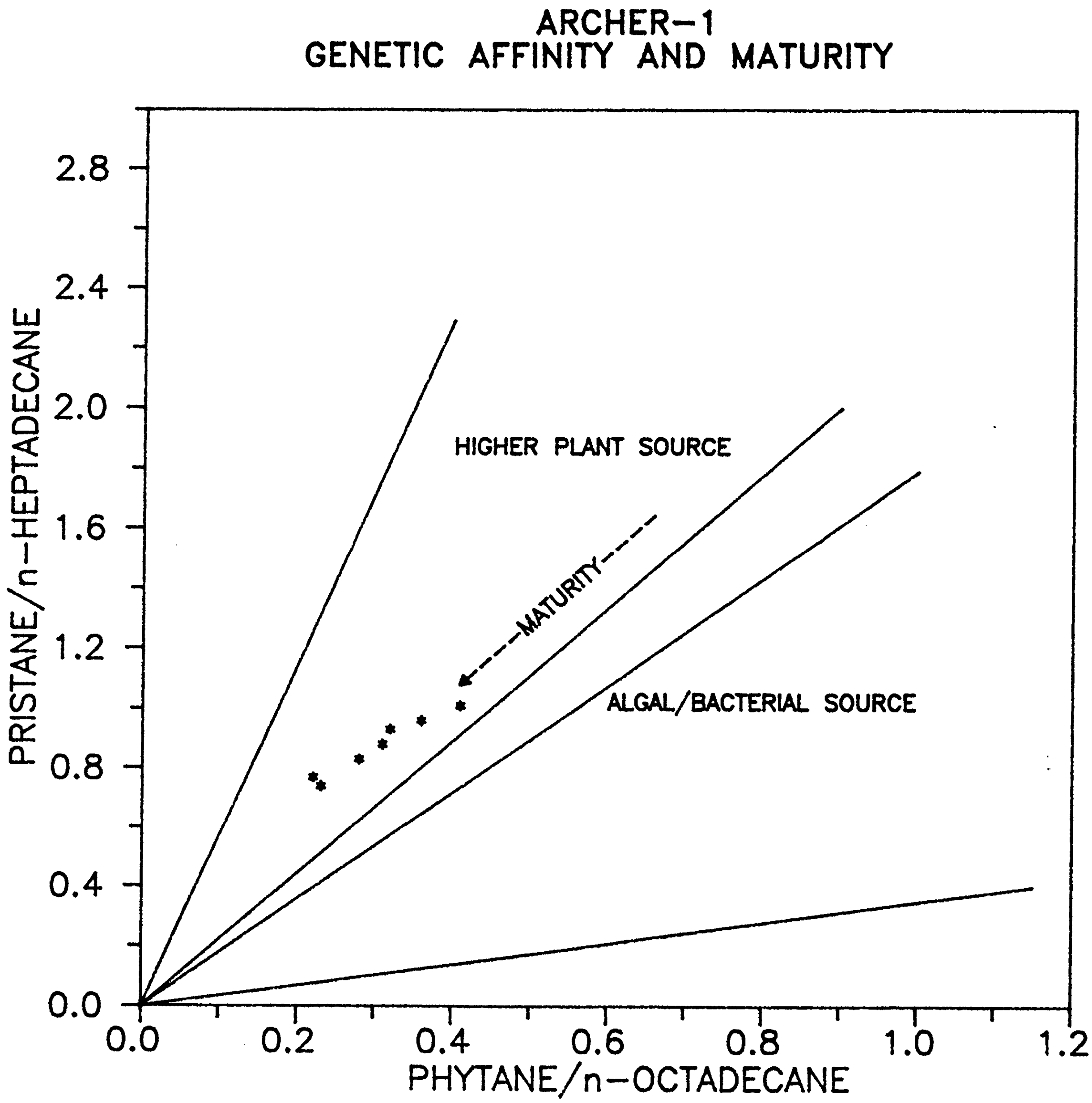

ARCHER-1
GENETIC AFFINITY AND MATURITY
PRISTANE/n-HEPTADECANE
2.8
2.4
2.0
1.6
1.2
0.8
0.4
0.0
0.0
0.2
0.4
0.6
0.8
1.0
1.2
PHYTANE/n-OCTADECANE
HIGHER PLANT SOURCE
MATURITY
ALGAL/BACTERIAL SOURCE

FIGURE #24

3390.2m, RFT-AD-1131

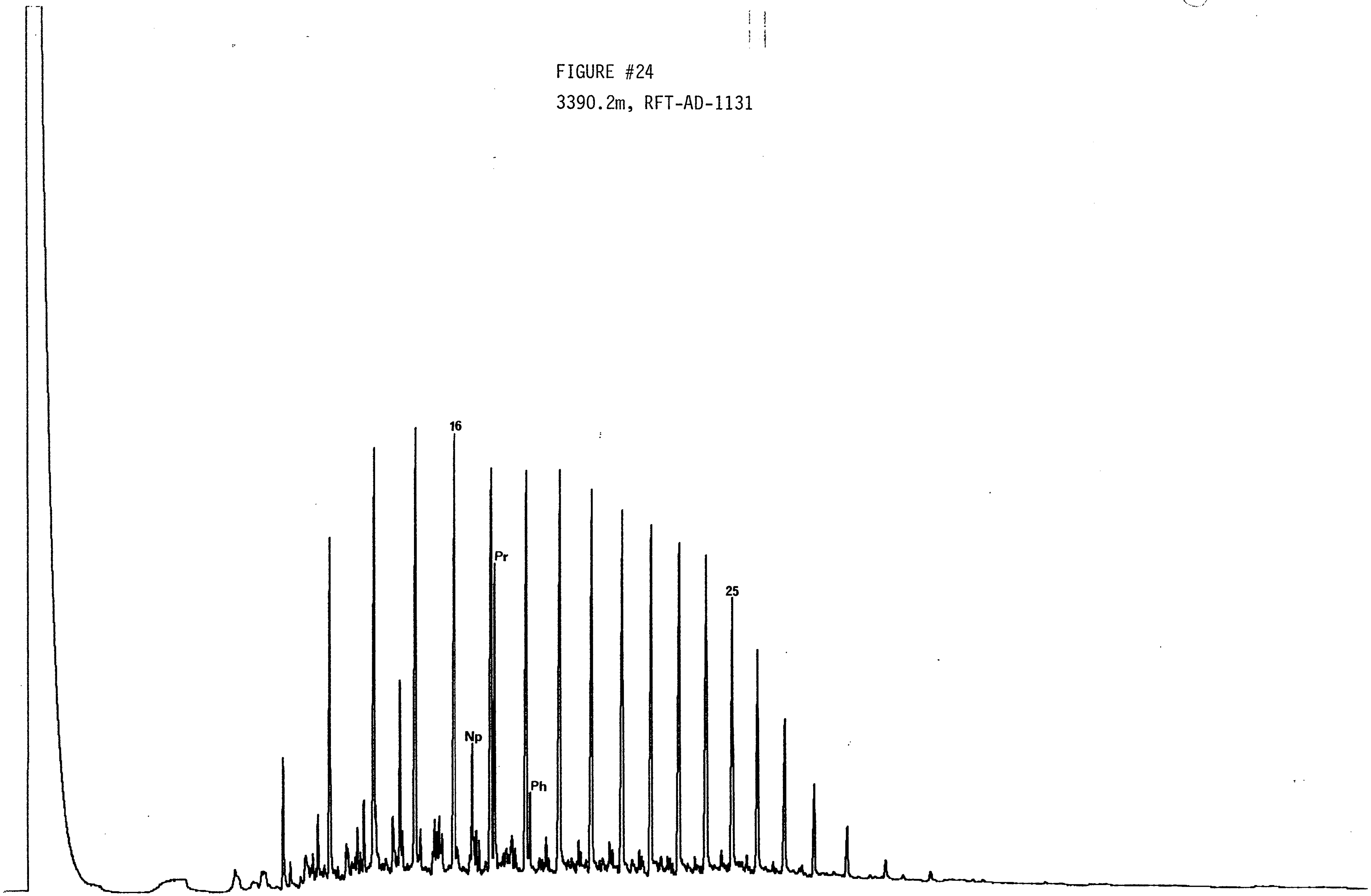


FIGURE #25

3403.5m, RFT-AD-1118

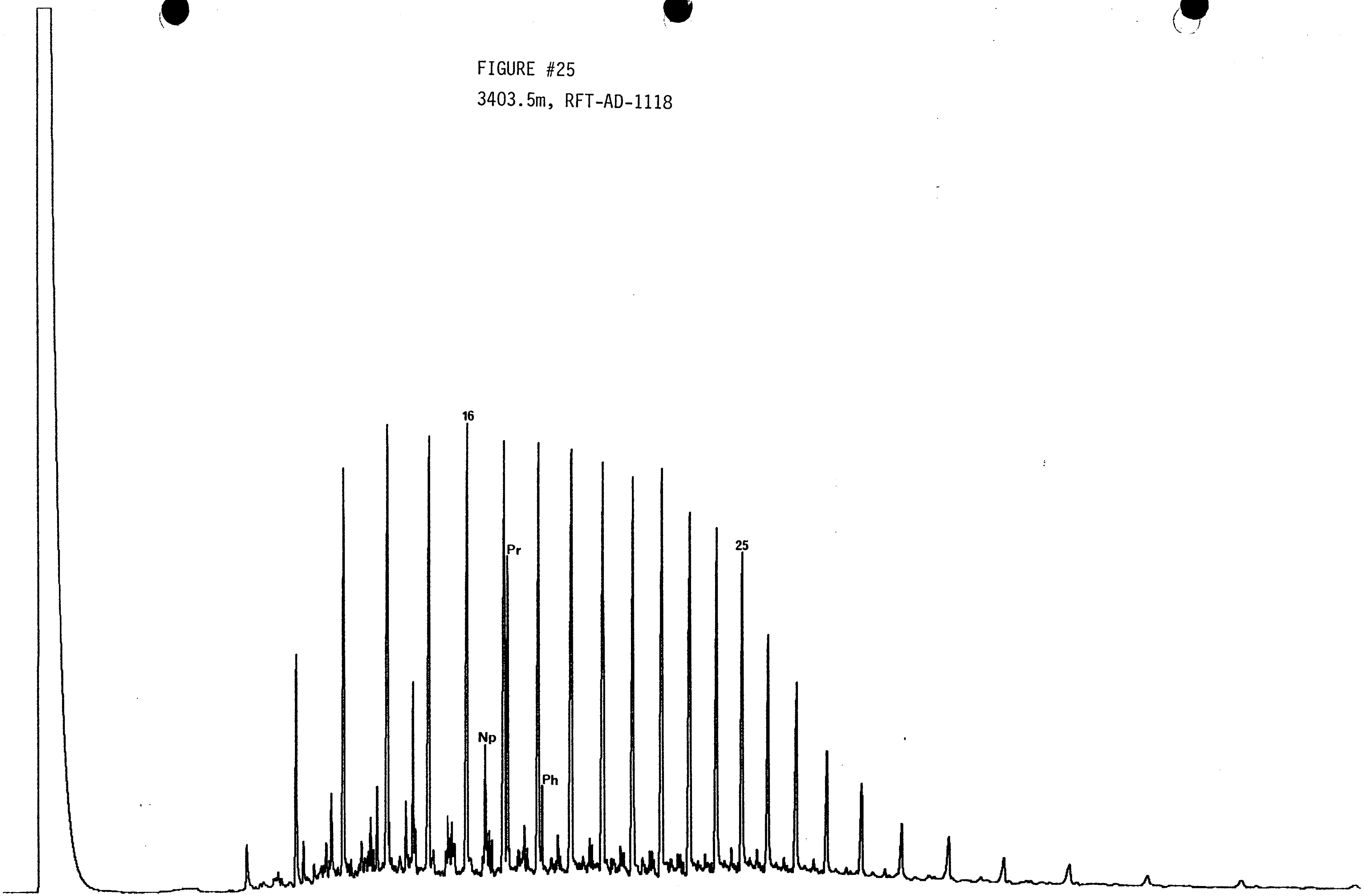


FIGURE #26

3489.0m, RFT-1286

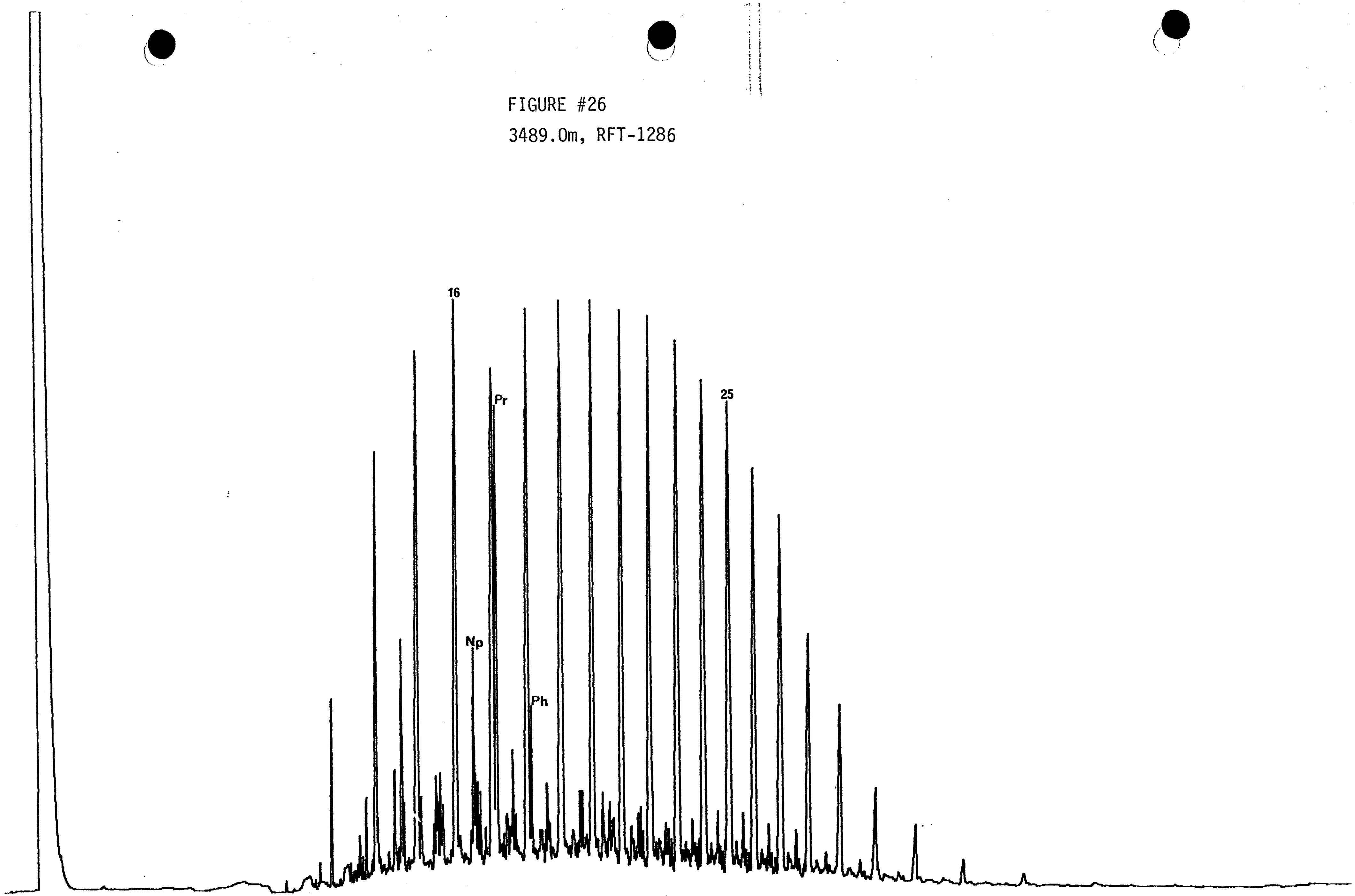


FIGURE #27

3514.2m, RFT-1129

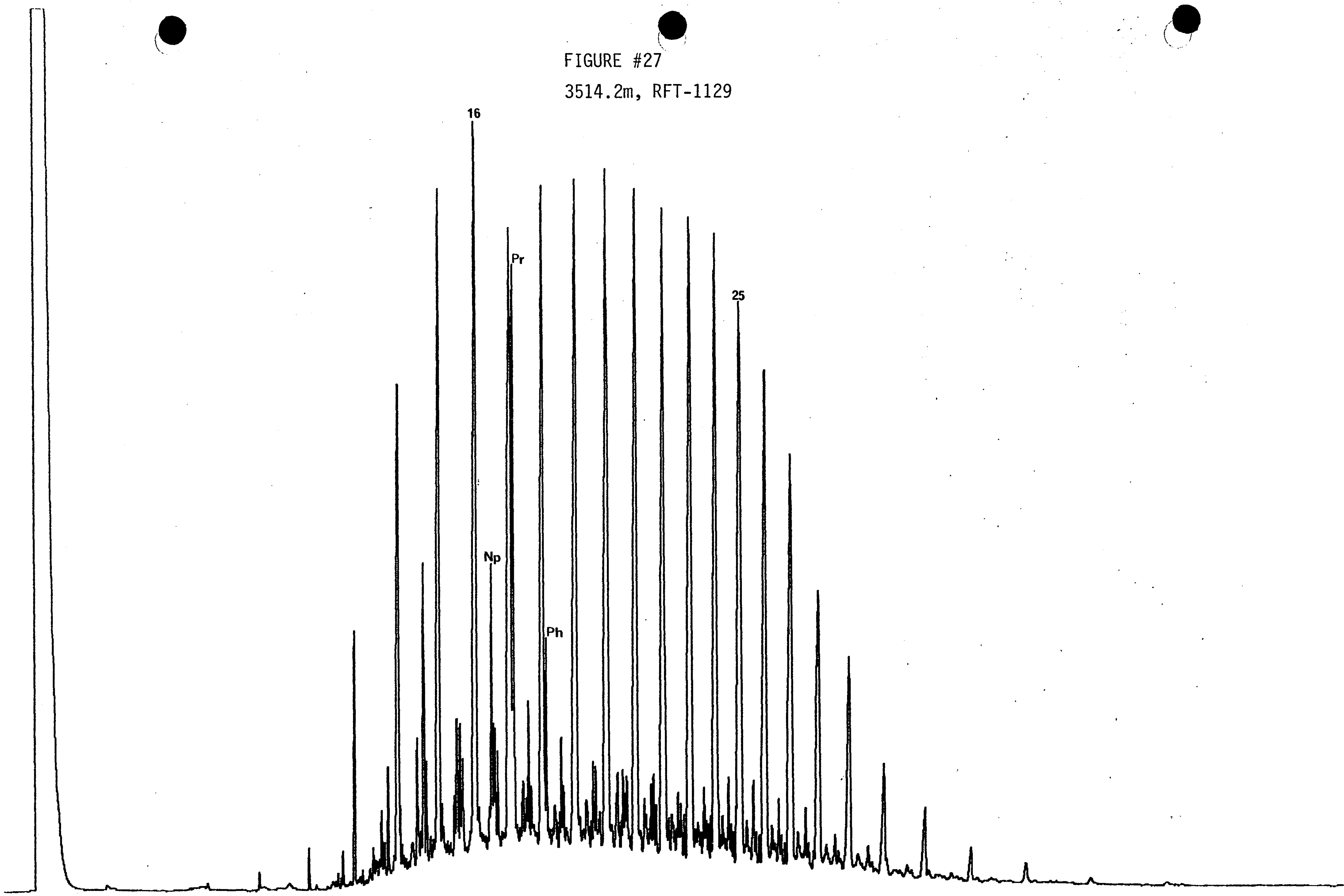


FIGURE #28

3591.5m, RFT-1120

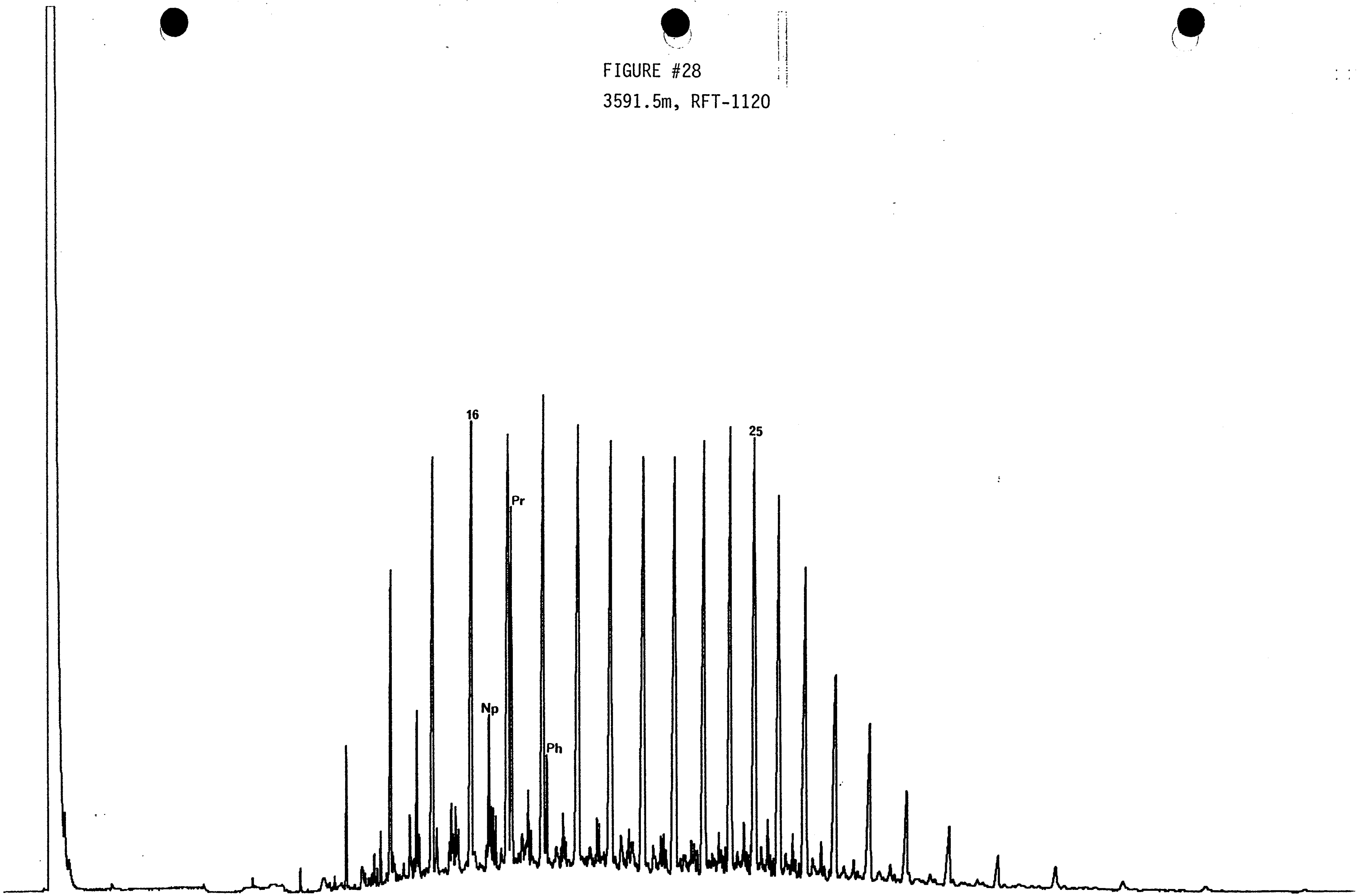


FIGURE #29

3681.0m, RFT-1123

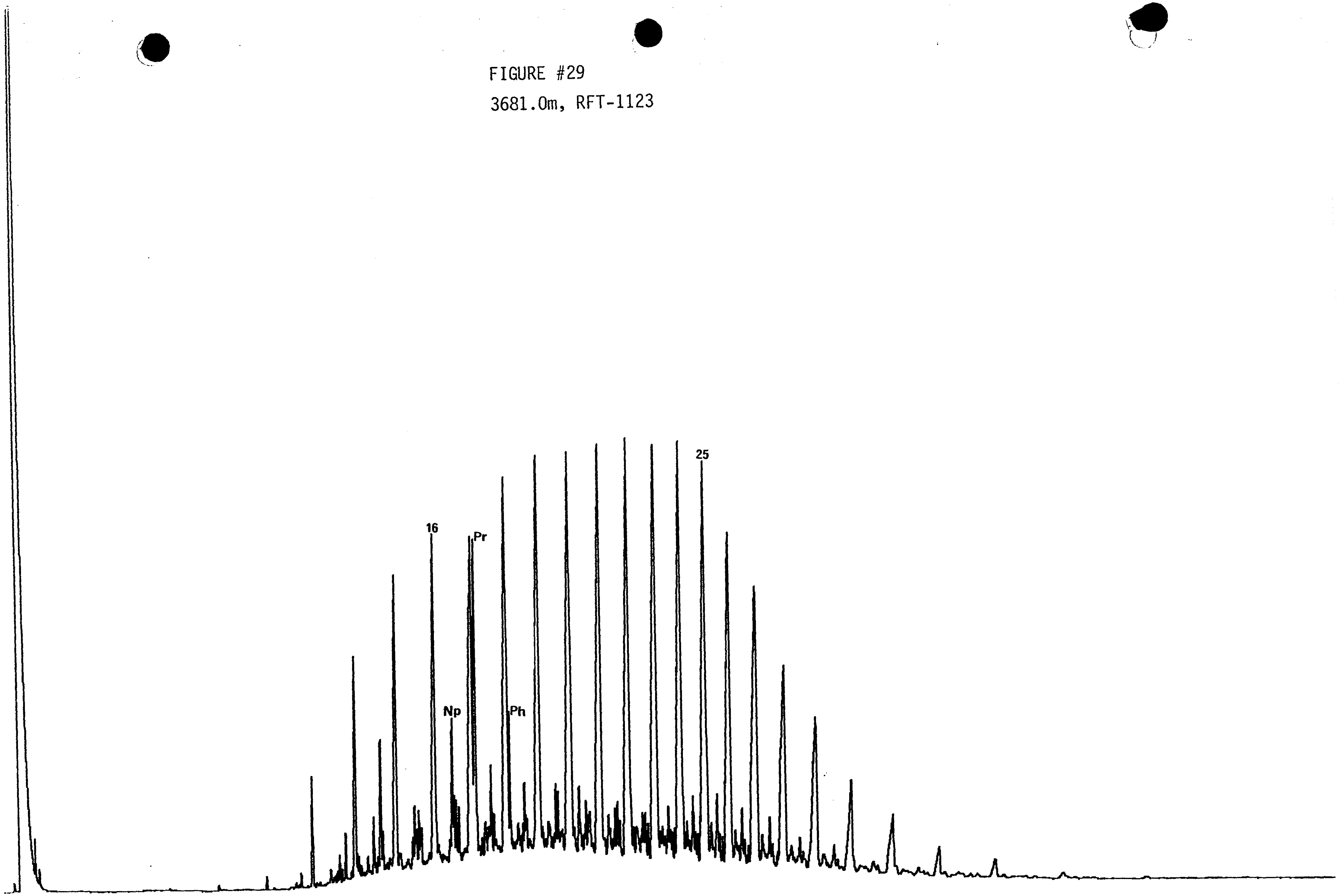
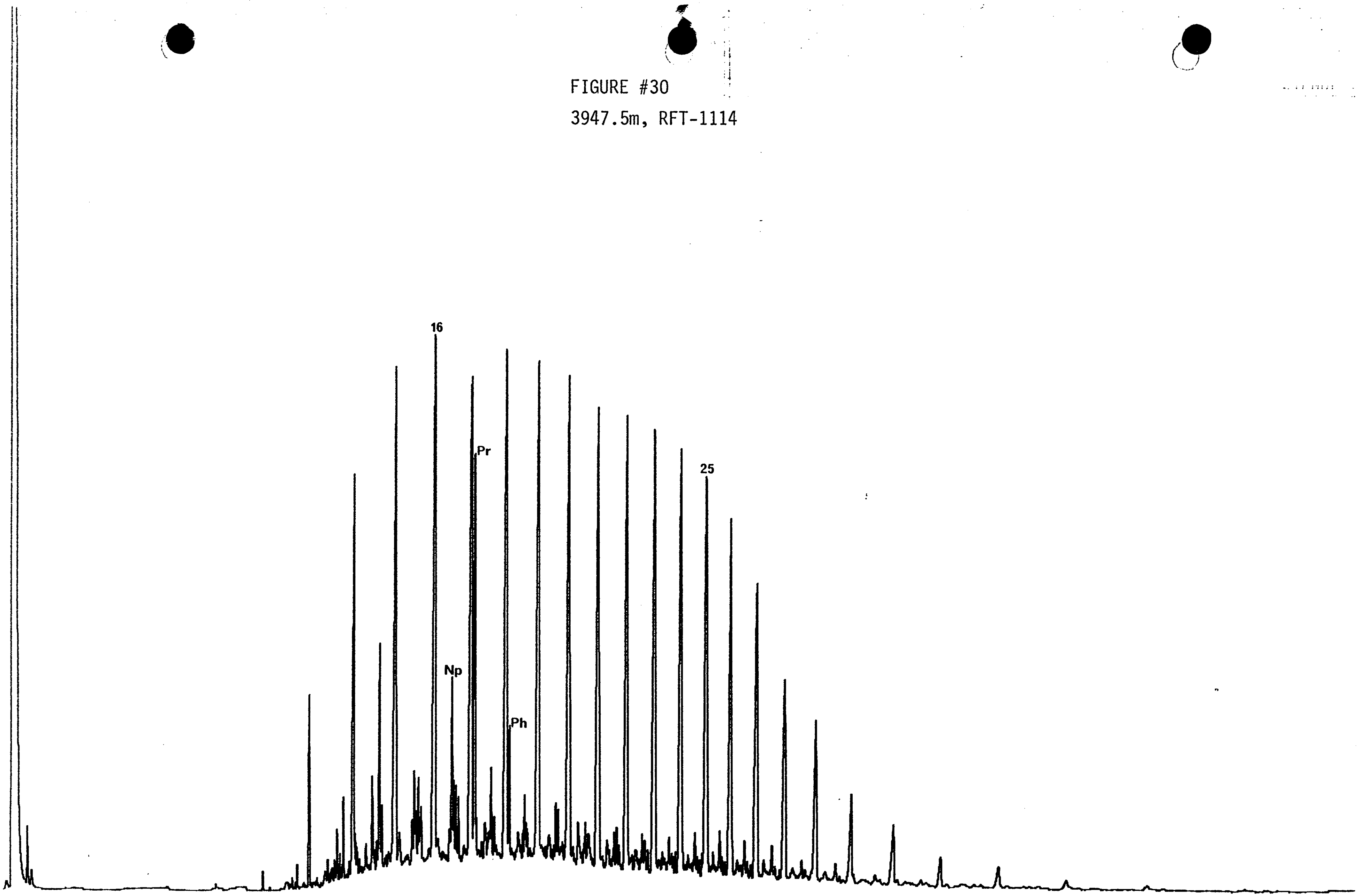


FIGURE #30

3947.5m, RFT-1114



APPENDIX 1

HISTOGRAM PLOTS OF VITRINITE REFLECTANCE VALUES,

ARCHER -1

VITRINITE REFLECTANCE VALUES

Well Name: ARCHER-1
Depth: 2500m

Sorted List

0.33
0.35
0.39
0.41

Number of values= 4

Mean of values 0.37
Standard Deviation 0.03

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

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

VITRINITE REFLECTANCE VALUES

Well Name: ARCHER-1
Depth: 2560m

Sorted List

0.43
0.44

Number of values= 2

Mean of values 0.44
Standard Deviation 0.01

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

43-45 **

VITRINITE REFLECTANCE VALUES

Well Name: ARCHER-1
Depth: 2600m

Sorted List

0.42
0.43
0.44
0.46

Number of values= 4

Mean of values 0.44
Standard Deviation 0.01

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

42-44	***
45-47	*

VITRINITE REFLECTANCE VALUES

Well Name: ARCHER-1
Depth: 2740m

Sorted List

0.44
0.50

Number of values= 2

Mean of values 0.47
Standard Deviation 0.03

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

44-46	*
47-49	
50-52	*

VITRINITE REFLECTANCE VALUES

Well Name: ARCHER-1
Depth: 2790m

Sorted List

0.36	0.45
0.39	0.46
0.39	0.46
0.40	0.48
0.40	0.49
0.41	0.54
0.43	
0.43	
0.43	
0.45	

Number of values= 16

Mean of values 0.44
Standard Deviation 0.04

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

36-38	*
39-41	*****
42-44	***
45-47	****
48-50	**
51-53	
54-56	*

VITRINITE REFLECTANCE VALUES

Well Name: ARCHER-1
Depth: 2850m

Sorted List

0.34	0.45	0.54
0.38	0.47	0.55
0.38	0.48	
0.38	0.48	
0.39	0.49	
0.42	0.49	
0.42	0.49	
0.43	0.49	
0.43	0.50	
0.43	0.51	

Number of values= 22

Mean of values 0.45
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	
55-57	**

VITRINITE REFLECTANCE VALUES

Well Name: ARCHER-1
Depth: 2900m

Sorted List

0.33	0.46	0.51
0.40	0.46	0.51
0.40	0.47	0.51
0.41	0.47	0.52
0.41	0.47	0.53
0.43	0.48	0.55
0.44	0.48	0.55
0.44	0.50	0.55
0.45	0.50	
0.46	0.50	

Number of values= 28

Mean of values 0.47
Standard Deviation 0.05

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

33-35	*
36-38	
39-41	****
42-44	***
45-47	*******
48-50	*****
51-53	*****
54-56	***

VITRINITE REFLECTANCE VALUES

Well Name: ARCHER-1
Depth: 2950m

Sorted List

0.37	0.48	0.51
0.40	0.49	0.53
0.41	0.49	0.54
0.42	0.50	0.54
0.42	0.51	0.55
0.42	0.51	0.55
0.45	0.51	
0.45	0.51	
0.46	0.51	
0.46	0.51	

Number of values= 26

Mean of values 0.48
Standard Deviation 0.05

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

37-39	*
40-42	*****
43-45	**
46-48	***
49-51	**********
52-54	*
55-57	****

VITRINITE REFLECTANCE VALUES

Well Name: ARCHER-1
Depth: 3000m

Sorted List

0.38	0.44	0.49
0.40	0.44	0.50
0.41	0.45	0.50
0.42	0.46	0.50
0.43	0.46	
0.43	0.46	
0.43	0.46	
0.43	0.46	
0.43	0.48	
0.44	0.48	

Number of values= 24

Mean of values 0.45
Standard Deviation 0.03

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

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

VITRINITE REFLECTANCE VALUES

Well Name: ARCHER-1
Depth: 3040m

Sorted List

0.39	0.46	0.52
0.41	0.46	0.54
0.42	0.47	
0.43	0.48	
0.44	0.48	
0.44	0.50	
0.44	0.51	
0.44	0.51	
0.45	0.51	
0.45	0.52	

Number of values= 22

Mean of values 0.47
Standard Deviation 0.04

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

39-41	**
42-44	******
45-47	*****
48-50	***
51-53	*****
54-56	*

VITRINITE REFLECTANCE VALUES

Well Name: ARCHER-1
Depth: 3100m

Sorted List

0.41	0.48
0.41	0.49
0.42	0.50
0.43	0.51
0.43	0.53
0.45	0.53
0.46	0.54
0.47	0.56
0.47	
0.48	

Number of values= 18

Mean of values 0.48
Standard Deviation 0.04

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

41-43	*****
44-46	**
47-49	*****
50-52	**
53-55	***
56-58	*

VITRINITE REFLECTANCE VALUES

Well Name: ARCHER-1
Depth: 3140m

Sorted List

0.43
0.45
0.49
0.54

Number of values= 4

Mean of values 0.48
Standard Deviation 0.04

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

43-45	**
46-48	
49-51	*
52-54	

VITRINITE REFLECTANCE VALUES

Well Name: ARCHER-1
Depth: 3190-3200m

Sorted List

0.36	0.44	0.47
0.37	0.44	0.48
0.37	0.44	0.48
0.38	0.45	0.49
0.39	0.45	0.50
0.43	0.45	0.50
0.43	0.45	0.51
0.43	0.46	0.51
0.44	0.46	
0.44	0.47	

Number of values= 28

Mean of values 0.45
Standard Deviation 0.04

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

36-38	****
39-41	*
42-44	********
45-47	********
48-50	*****
51-53	**

VITRINITE REFLECTANCE VALUES

Well Name:	ARCHER-1
Depth:	3240-3250m

Sorted List

0.42
0.44
0.44
0.45
0.46
0.46
0.48
0.51
0.52
0.53

Number of values=	10
Mean of values	0.47
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:	ARCHER-1
Depth:	3240-3250m

Sorted List

0.42
0.44
0.44
0.45
0.46
0.46
0.48
0.51
0.52
0.53

Number of values=	10
Mean of values	0.47
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: ARCHER-1
Depth: 3290-3300m

Sorted List

0.41	0.47
0.41	0.48
0.42	0.49
0.43	0.50
0.44	
0.45	
0.45	
0.45	
0.46	
0.46	

Number of values= 14

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:	ARCHER-1
Depth:	3340-3350m

Sorted List

0.44
0.51

Number of values=	2
Mean of values	0.48
Standard Deviation	0.03

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

44-46	*
47-49	
50-52	*

VITRINITE REFLECTANCE VALUES

Well Name:	ARCHER-1
Depth:	3440m

Sorted List

0.41
0.42
0.43
0.43
0.44
0.45
0.46
0.48

Number of values=	8
Mean of values	0.44
Standard Deviation	0.02

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

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

VITRINITE REFLECTANCE VALUES

Well Name: ARCHER-1
Depth: 3519m

Sorted List

0.46
0.48

Number of values= 2

Mean of values 0.47
Standard Deviation 0.01

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

46-48 **

VITRINITE REFLECTANCE VALUES

Well Name: ARCHER-1
Depth: 3625m

Sorted List

0.48
0.50

Number of values= 2

Mean of values 0.49
Standard Deviation 0.01

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

48-50 **

VITRINITE REFLECTANCE VALUES

Well Name:	ARCHER-1
Depth:	3810m

Sorted List

0.46
0.47
0.47
0.48
0.48
0.52
0.54
0.58

Number of values=	8
Mean of values	0.50
Standard Deviation	0.04

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

46-48	*****
49-51	
52-54	*
55-57	*
58-60	*

VITRINITE REFLECTANCE VALUES

Well Name: ARCHER-1
Depth: 3869m

Sorted List

0.59
0.59

Number of values= 2

Mean of values 0.59
Standard Deviation 0.00

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

59-61 **

VITRINITE REFLECTANCE VALUES

Well Name: ARCHER-1
Depth: 3940m

Sorted List

0.49
0.51

Number of values= 2

Mean of values 0.50
Standard Deviation 0.01

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

49-51 **

VITRINITE REFLECTANCE VALUES

Well Name:	ARCHER-1
Depth:	4002m

Sorted List

0.58
0.63
0.64
0.65

Number of values= 4

Mean of values	0.63
Standard Deviation	0.03

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

58-60	*
61-63	*
64-66	**

VITRINITE REFLECTANCE VALUES

Well Name: ARCHER-1
Depth: 4035m

Sorted List

0.67
0.67

Number of values= 2

Mean of values 0.67
Standard Deviation 0.00

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

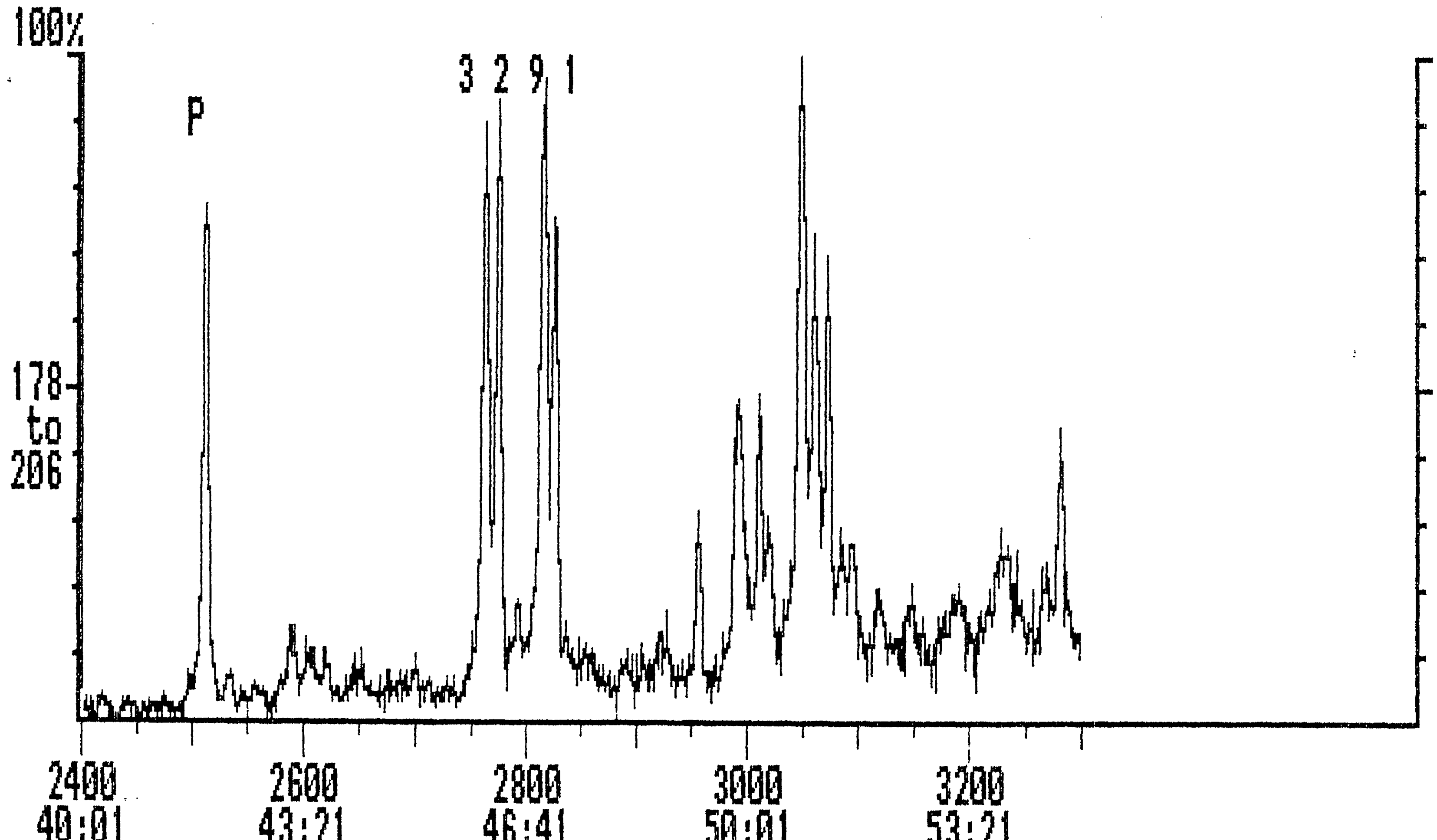
67-69 **

APPENDIX 2

GC-MS OF AROMATIC HYDROCARBONS, ARCHER -1

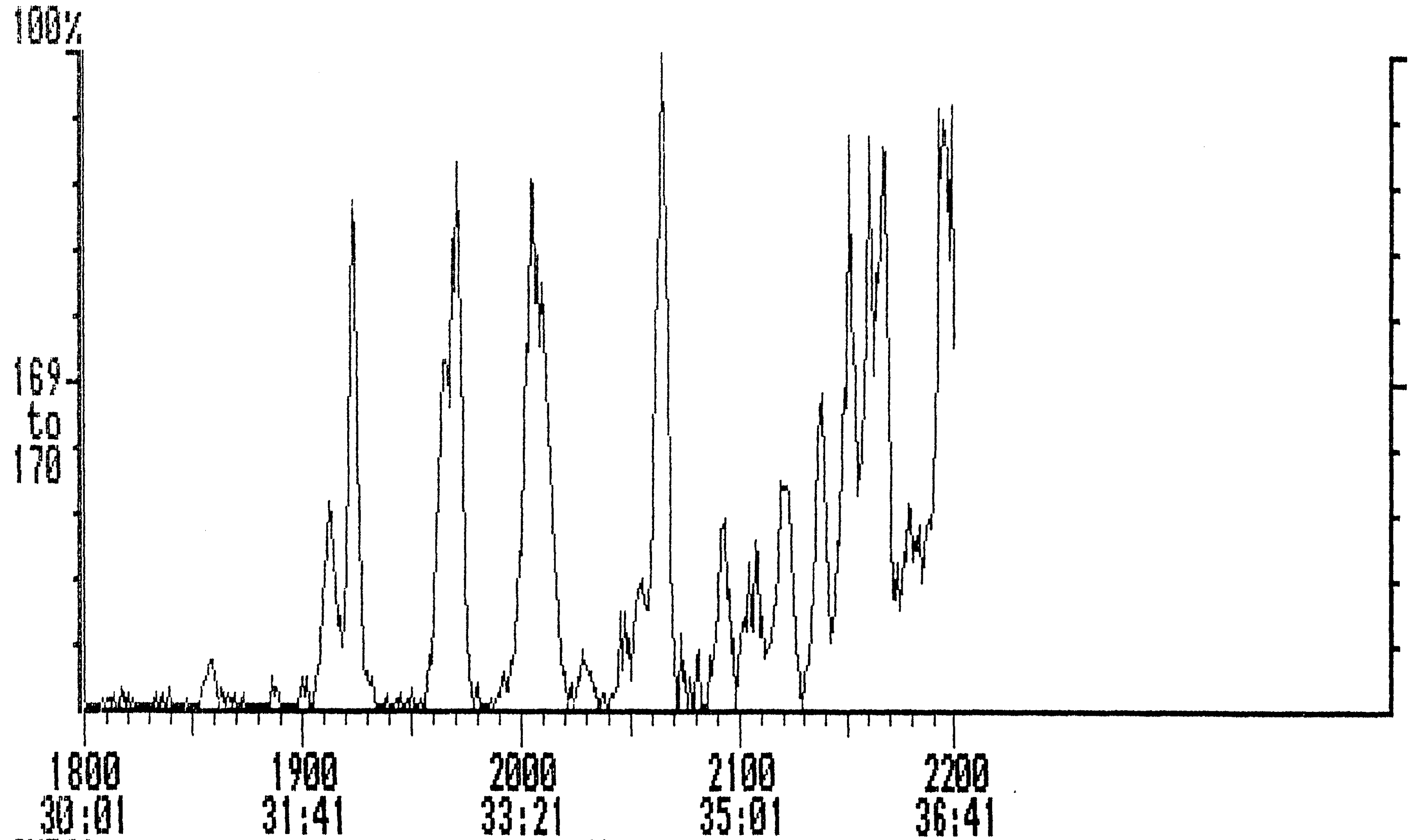
Amdel Core Services Pty Limited
Incorporated in South Australia

Chromatogram A:MPI123 Acquired: Jun-12-1990 03:55:58
Comment: ARCHER-1 3390.2 m AMDEL CORE SERVICES
Scan Range: 2400 - 3300 Scan: 2400 Int = 1458 @ 40:01 100% = 8650



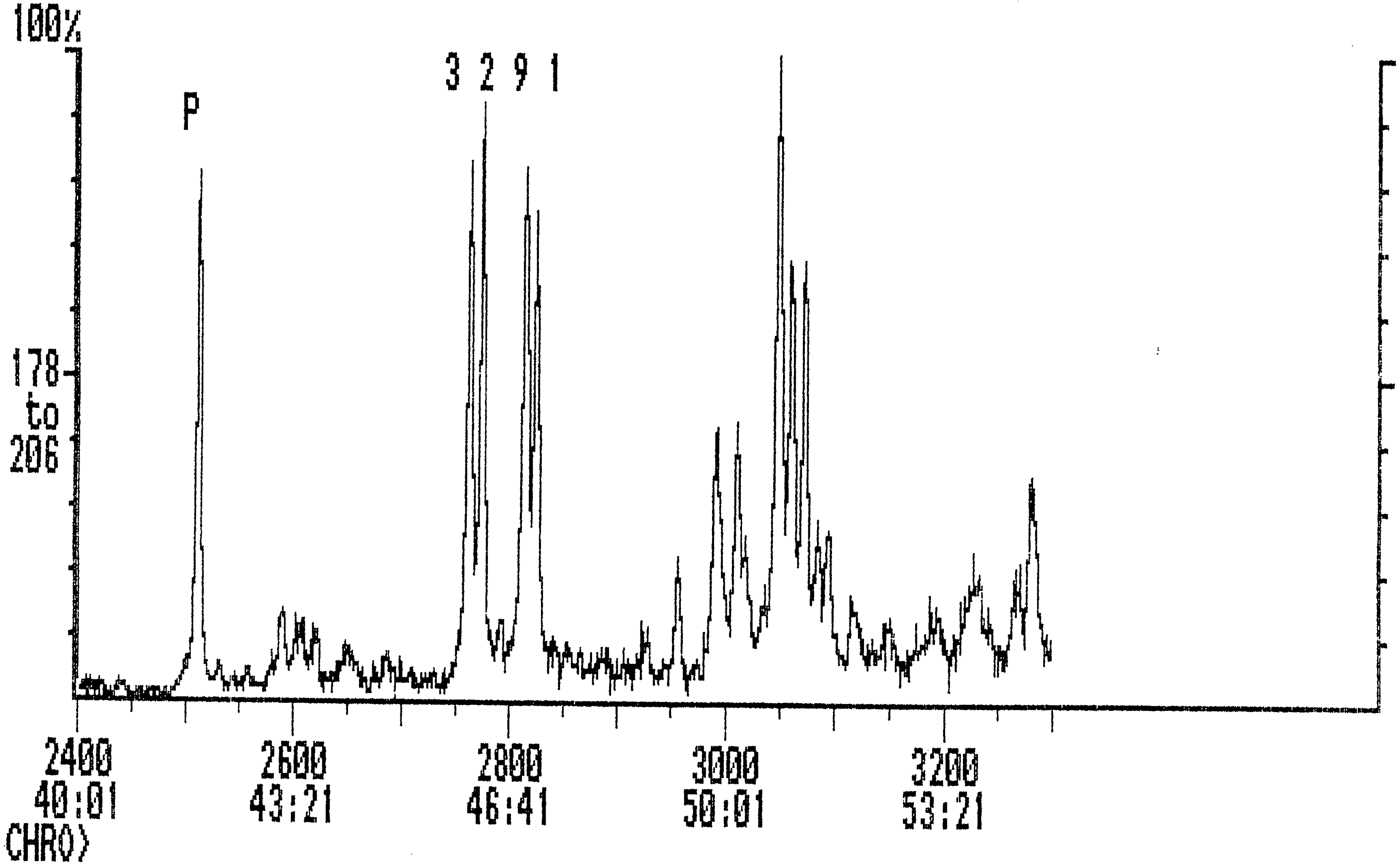
CHRO>

Chromatogram A:MPI123 Acquired: Jun-12-1990 03:55:58
Comment: ARCHER-1 3390.2 m AMDEL CORE SERVICES
Scan Range: 1800 - 2200 Scan: 1800 Int = 0 @ 30:01 100% = 1167

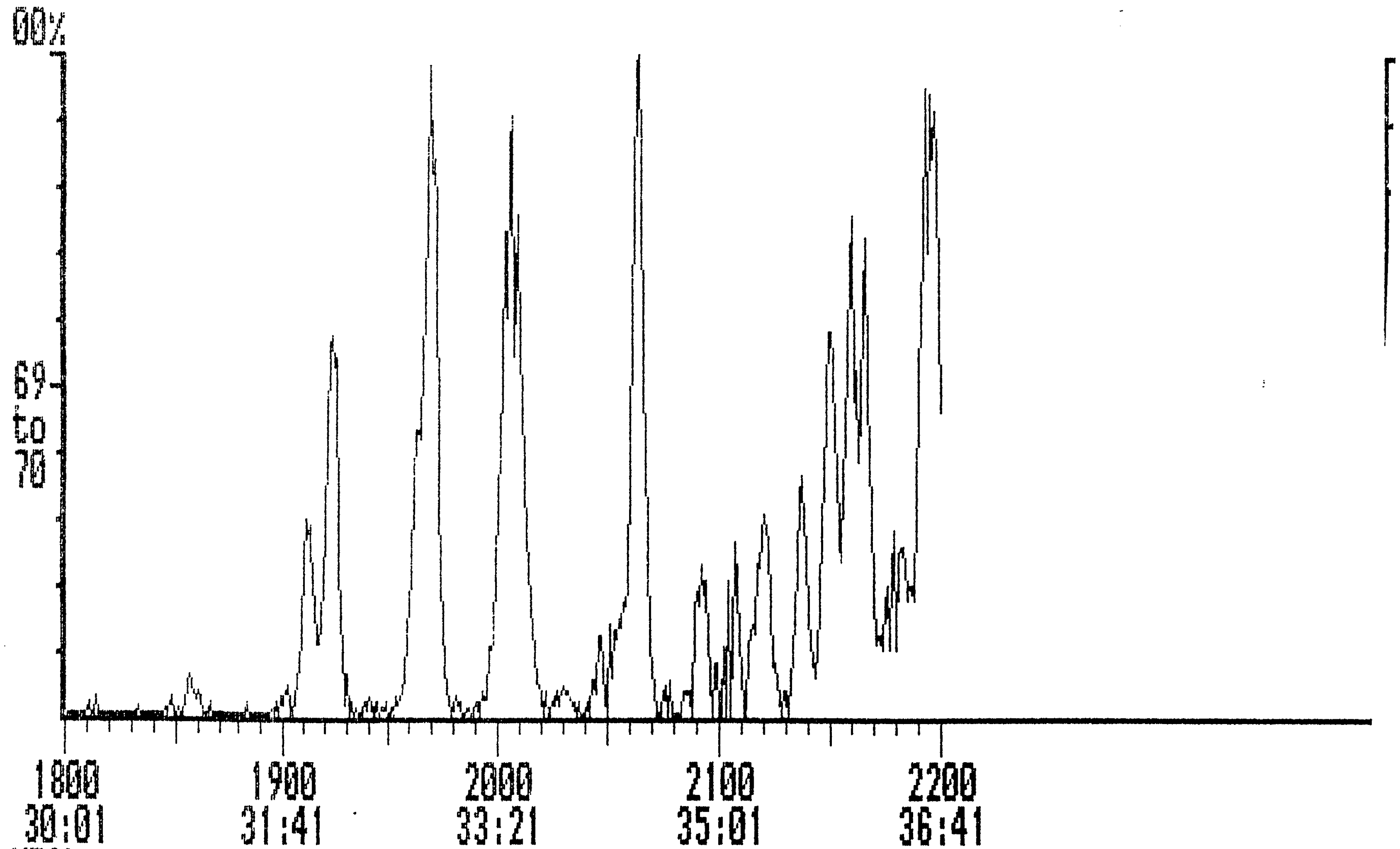


CHRO>

Chromatogram A:MPI124 Acquired: Jun-12-1990 05:09:48
Comment: ARCHER-1 3403.5 m AMDEL CORE SERVICES
Scan Range: 2400 - 3300 Scan: 2400 Int = 905 @ 40:01 100% = 11571

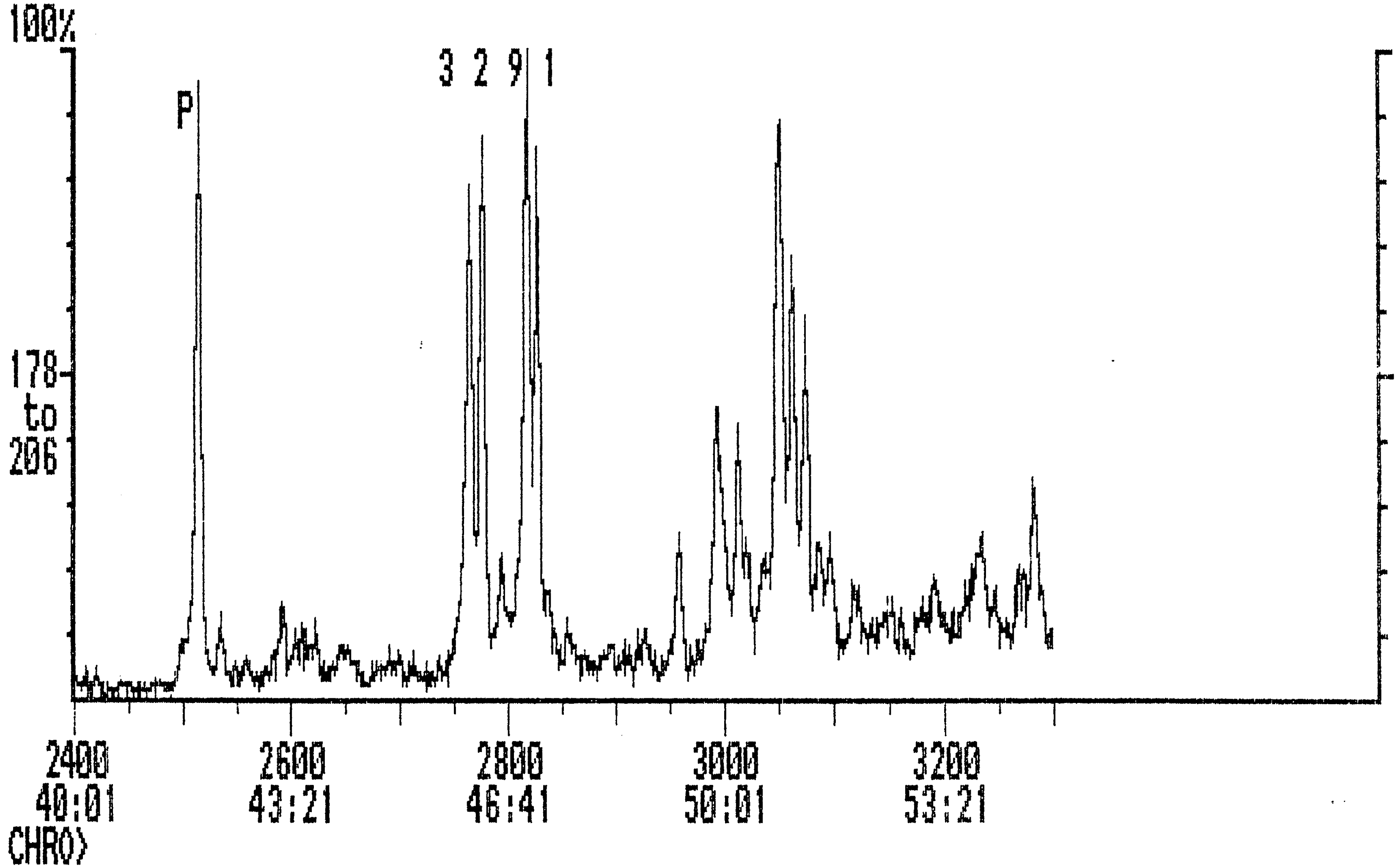


hromatogram A:MPI124 Acquired: Jun-12-1990 05:09:48
omment: ARCHER-1 3403.5 m AMDEL CORE SERVICES
can Range: 1800 - 2200 Scan: 1800 Int = 14 @ 30:01 100% = 1130

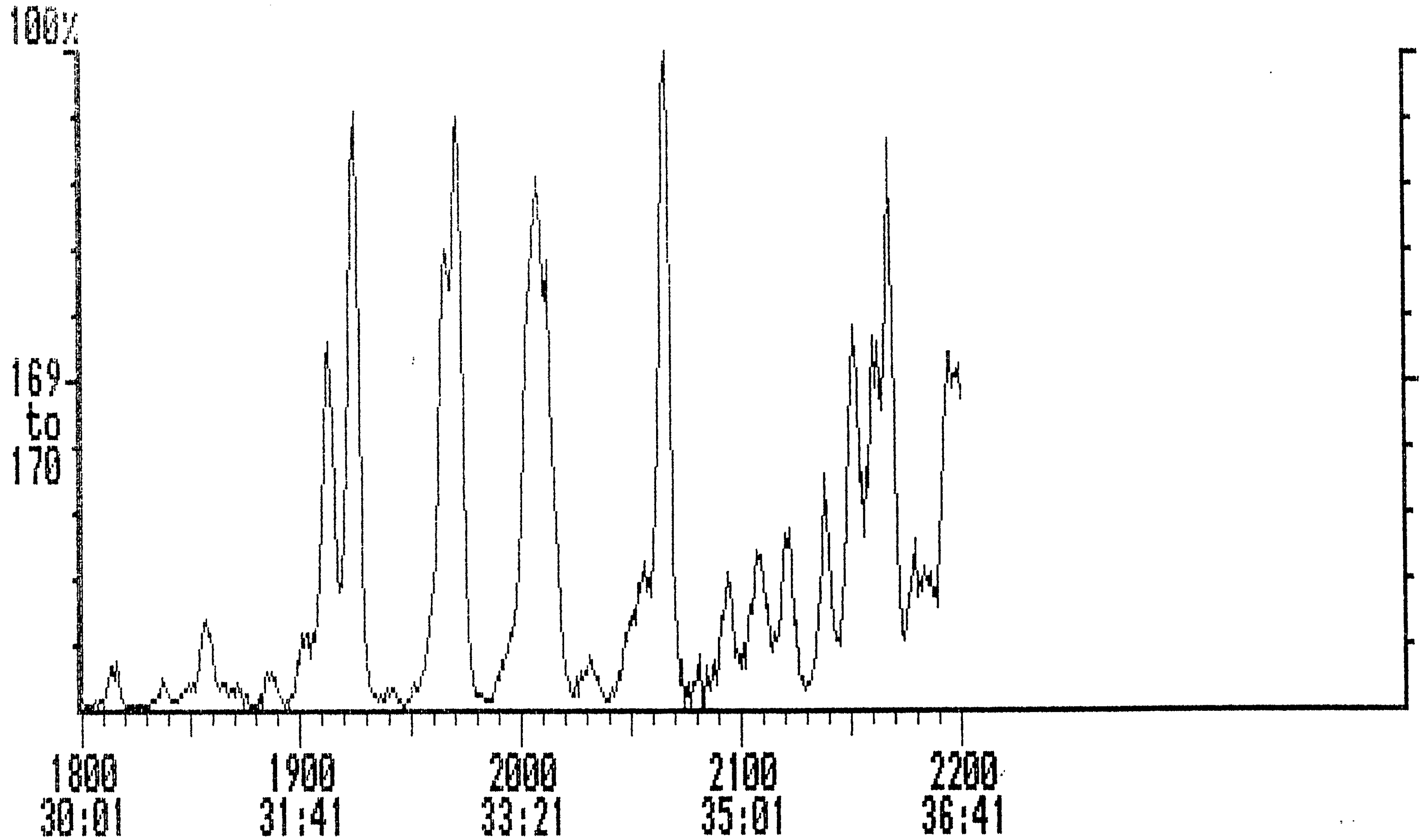


HRO)

Chromatogram A:MPI125 Acquired: Jun-12-1990 06:23:44
Comment: ARCHER-1 3489.0 m AMDEL CORE SERVICES
Scan Range: 2400 - 3300 Scan: 2400 Int = 3031 @ 40:01 100% = 17314

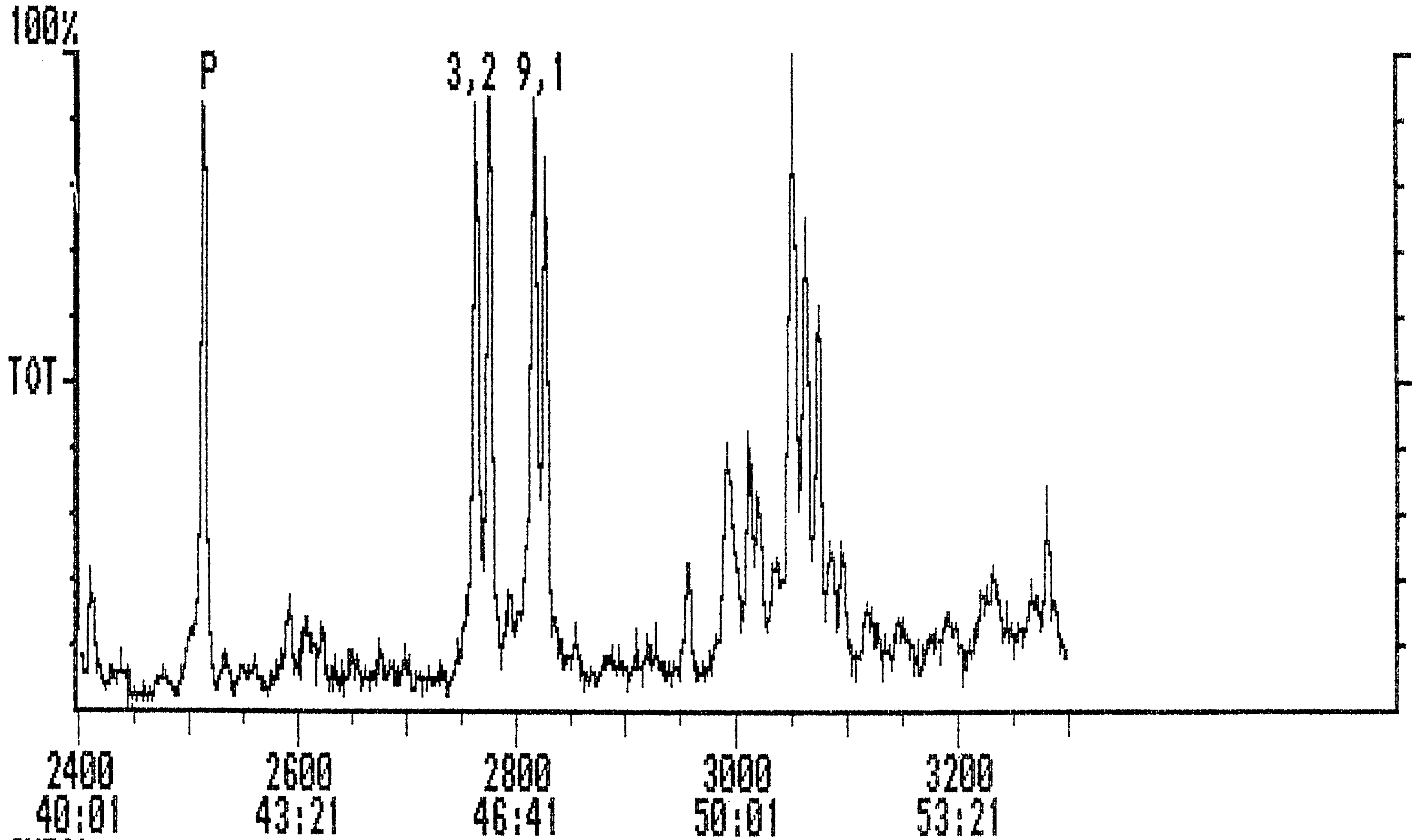


Chromatogram A:MPI125 Acquired: Jun-12-1990 06:23:44
Comment: ARCHER-1 3489.0 m AMDEL CORE SERVICES
Scan Range: 1800 - 2200 Scan: 1800 Int = 33 @ 30:01 100% = 4743



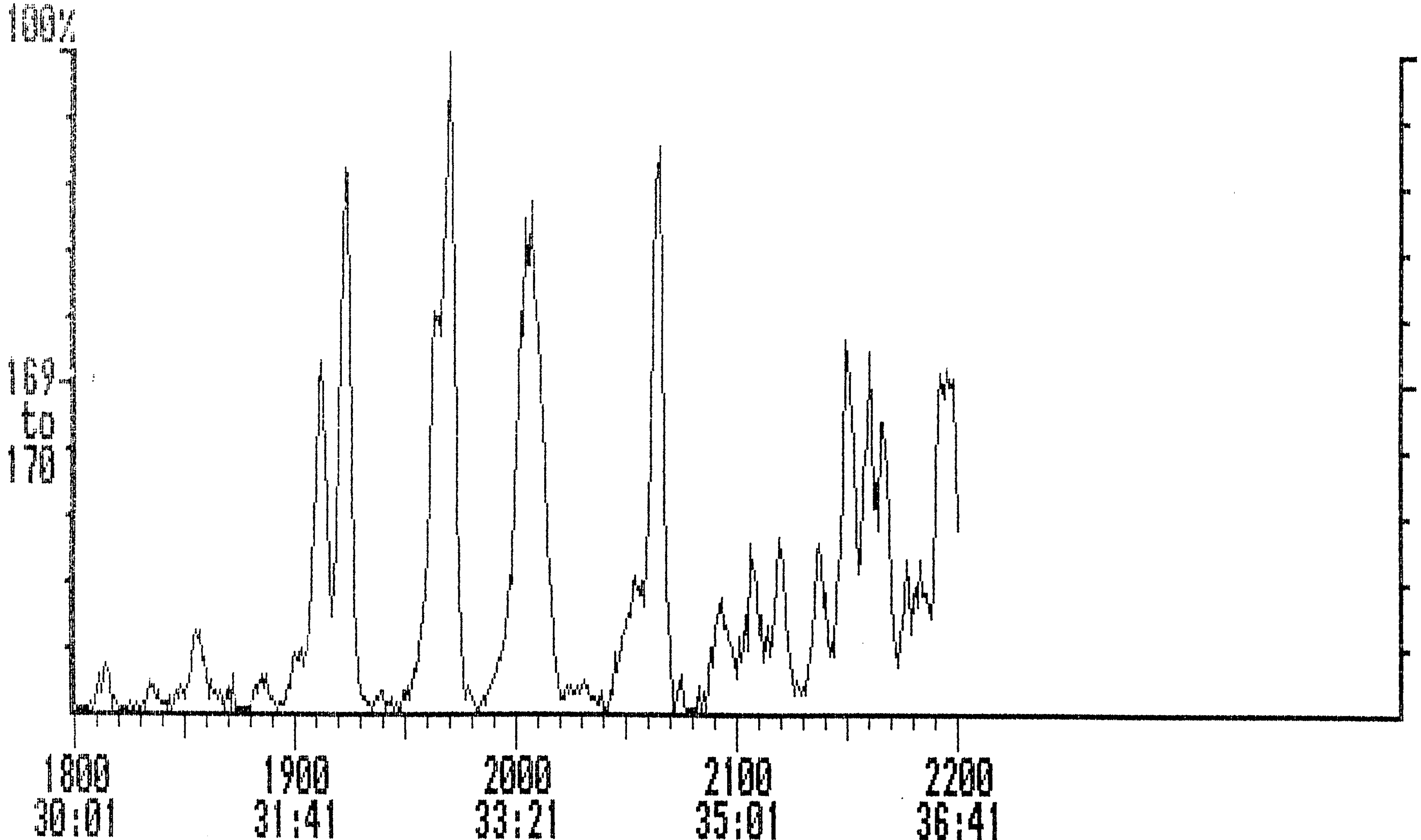
CHRO)

Chromatogram A:MPI122 Acquired: Jun-12-1990 02:42:06
Comment: ARCHER-1 3514.2 m AMDEL CORE SERVICES
Scan Range: 2400 - 3300 Scan: 2400 Int = 2576 @ 40:01 100% = 22325



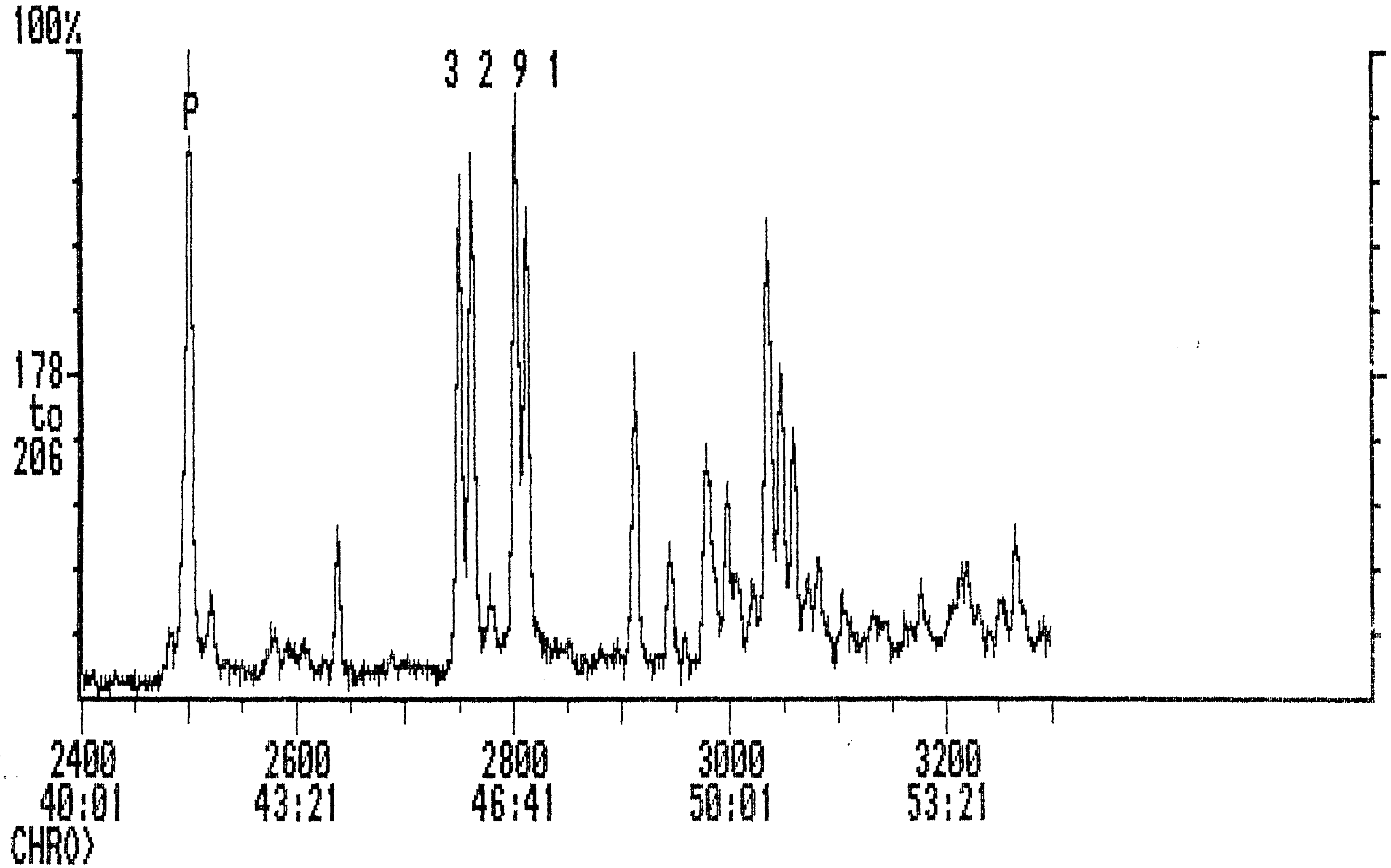
CHRO>

Chromatogram A:MPI122 Acquired: Jun-12-1990 02:42:06
Comment: ARCHER-1 3514.2 m AMDEL CORE SERVICES
Scan Range: 1800 - 2200 Scan: 1800 Int = 19 @ 30:01 100% = 3928

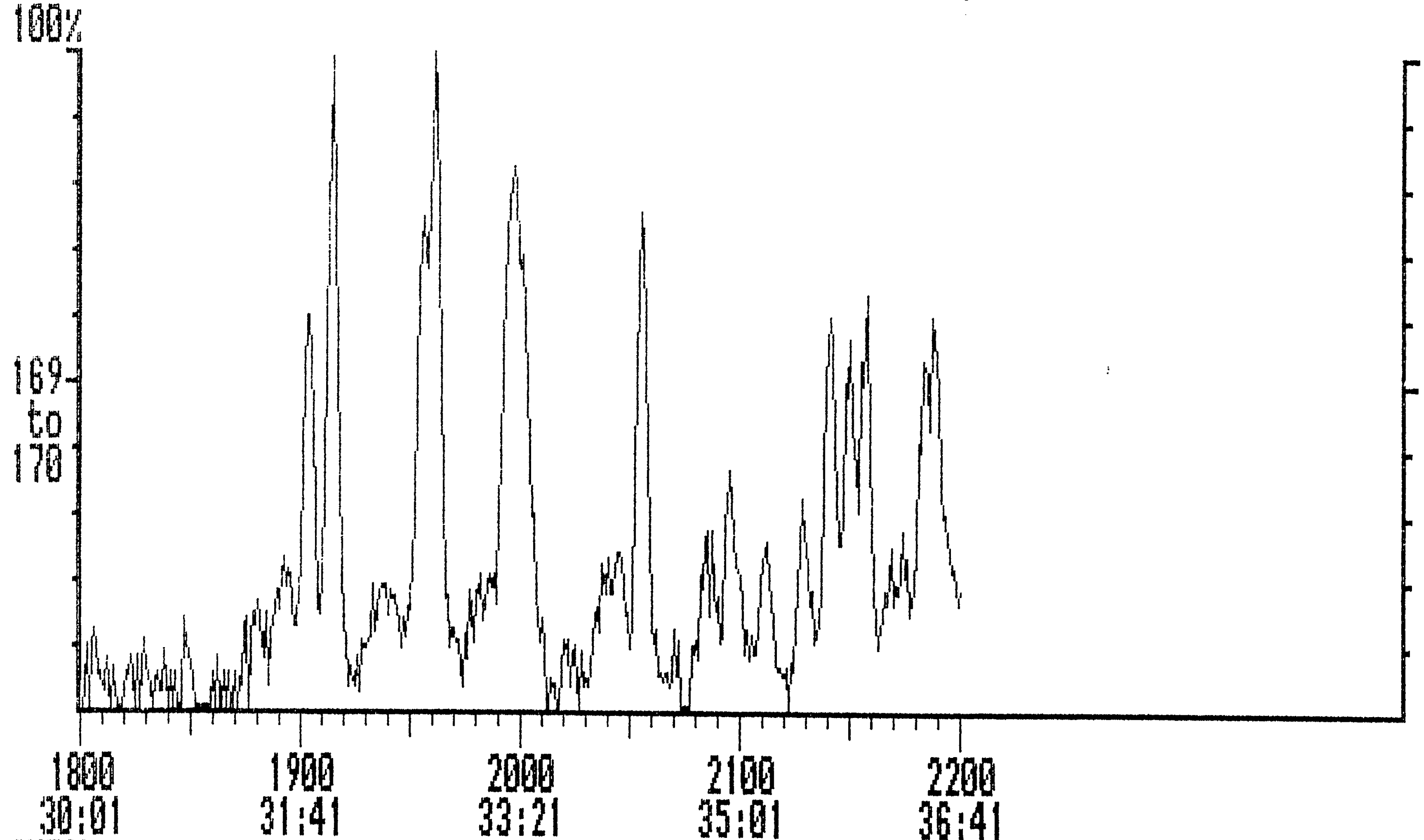


CHRO>

Chromatogram A:MPI126 Acquired: Jun-13-1990 18:59:59
Comment: ARCHER-1 3591.5 m AMDEL CORE SERVICES
Scan Range: 2400 - 3300 Scan: 2400 Int = 792 @ 40:01 100% = 2635

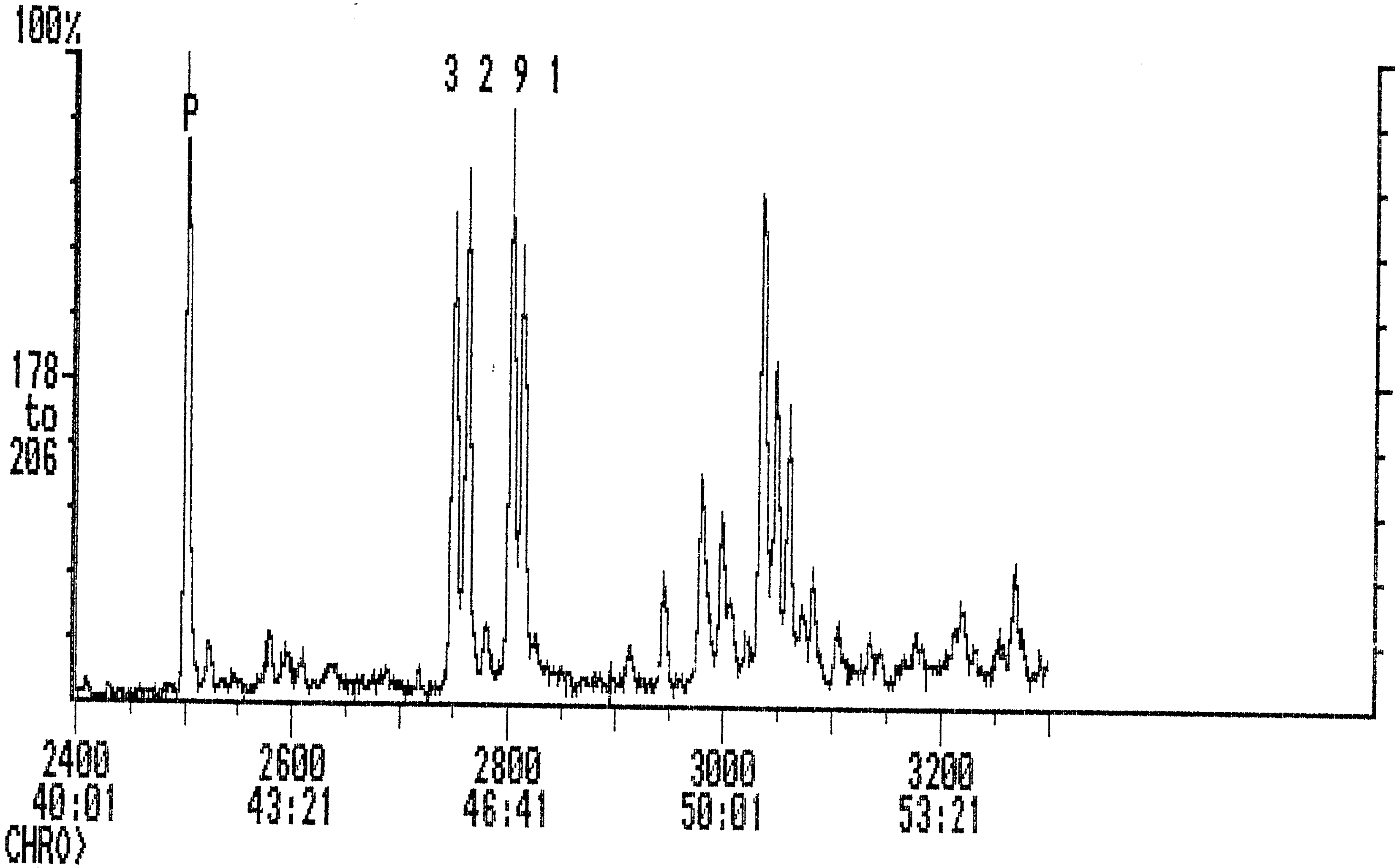


Chromatogram A:MPI126 Acquired: Jun-13-1990 18:59:59
Comment: ARCHER-1 3591.5 m AMDEL CORE SERVICES
Scan Range: 1800 - 2200 Scan: 1800 Int = 40 @ 30:01 100% = 485

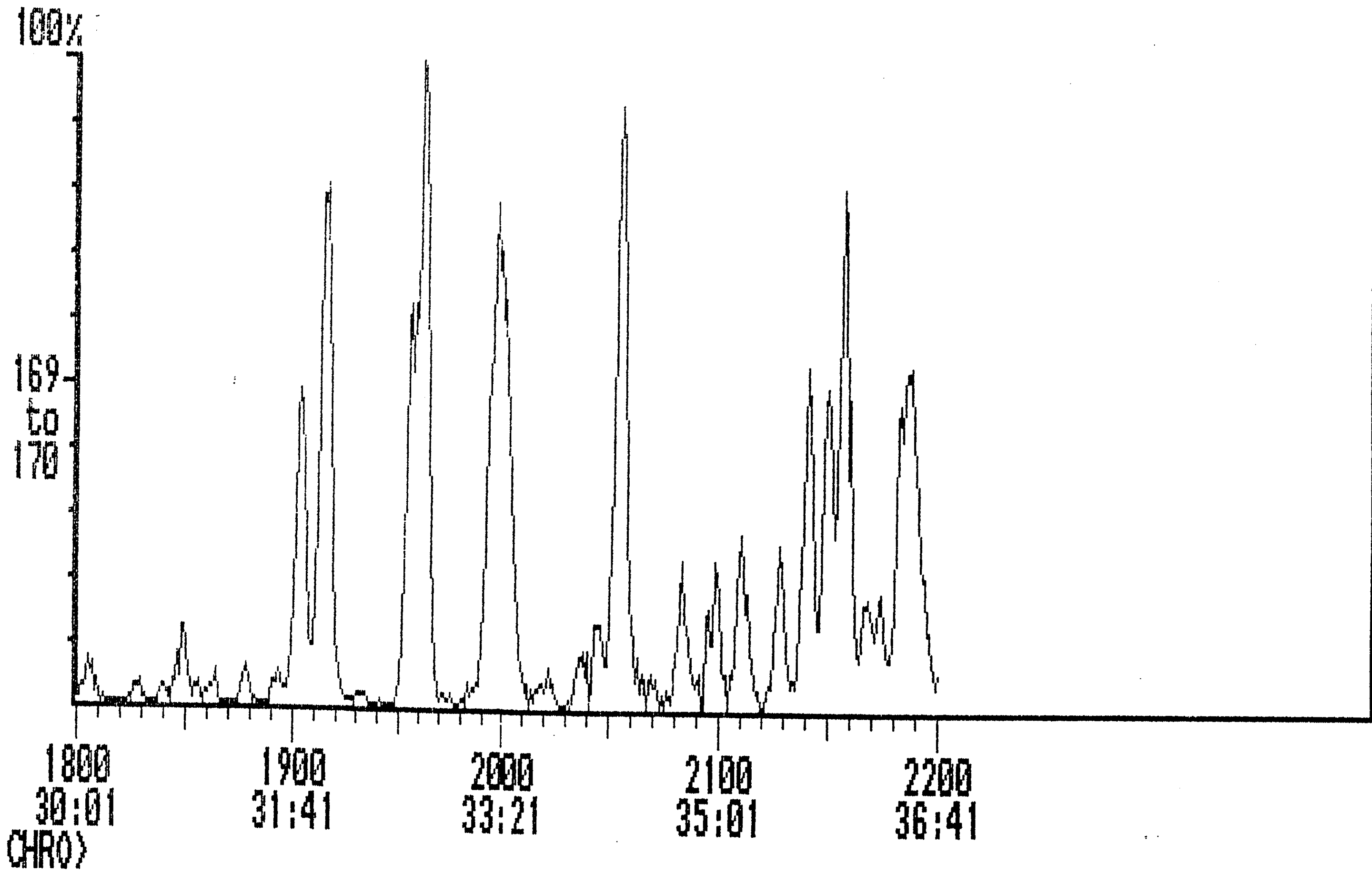


CHRO>

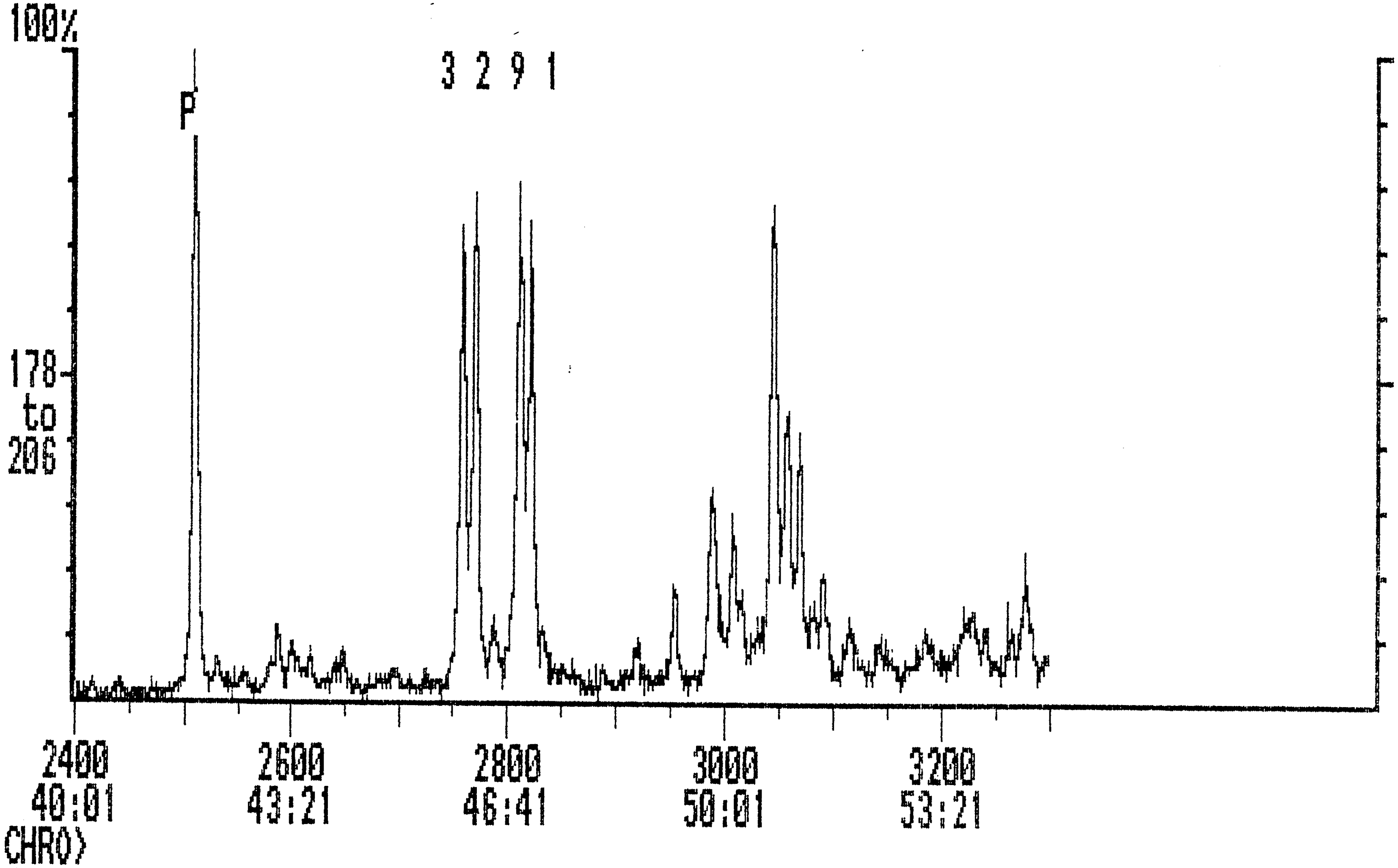
Chromatogram A:MPI127 Acquired: Jun-14-1990 10:44:45
Comment: ARCHER-1 3681.0 m AMDEL CORE SERVICES
Scan Range: 2400 - 3300 Scan: 2400 Int = 1416 @ 40:01 100% = 7184



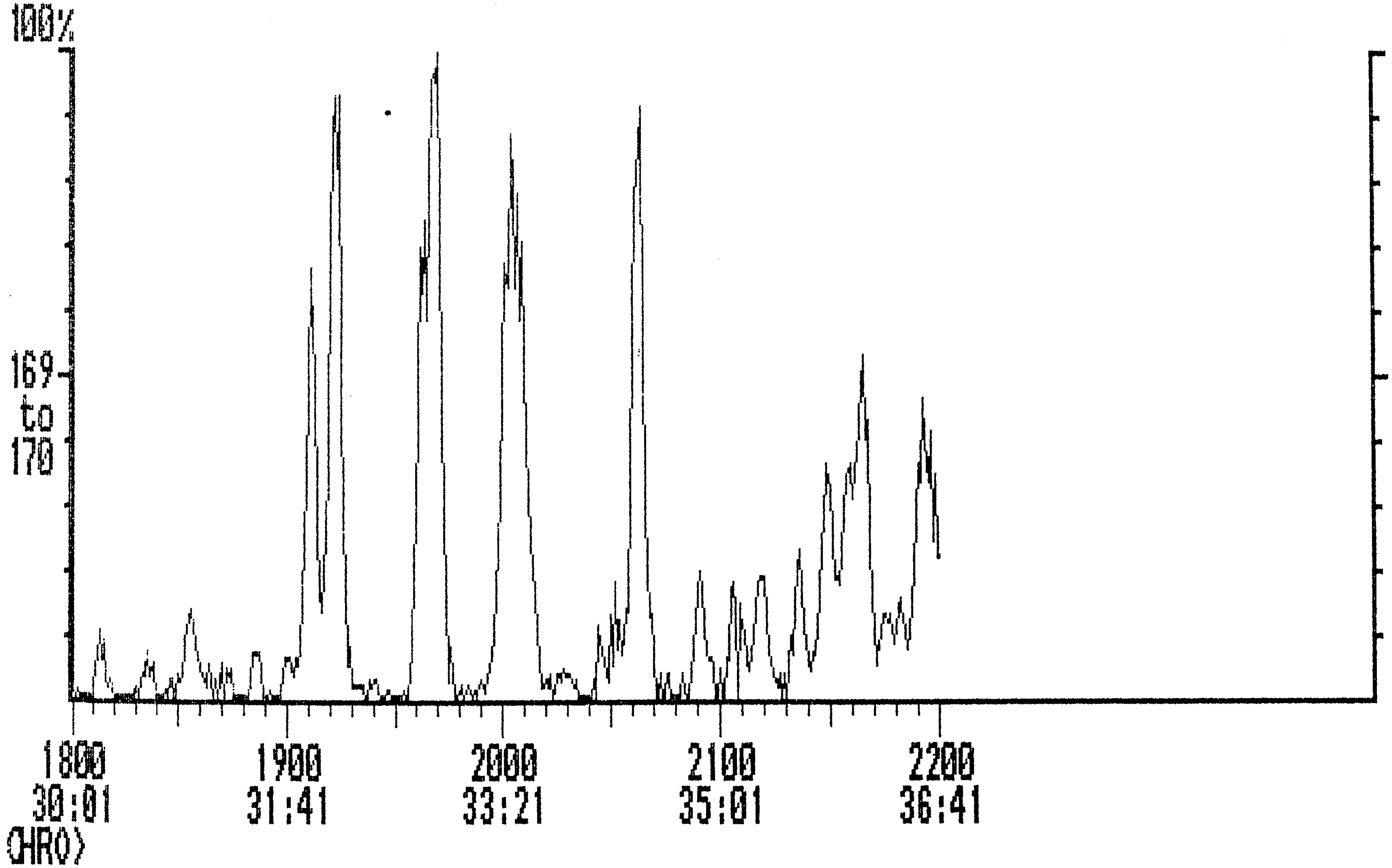
Chromatogram A:MPI127 Acquired: Jun-14-1990 10:44:45
Comment: ARCHER-1 3681.0 m AMDEL CORE SERVICES
Scan Range: 1800 - 2200 Scan: 1800 Int = 13 @ 30:01 100% = 1033



Chromatogram A:MPI128 Acquired: Jun-12-1990 10:03:05
Comment: ARCHER-1 3947.5 m AMDEL CORE SERVICES
Scan Range: 2400 - 3300 Scan: 2400 Int = 341 @ 40:01 100% = 5246



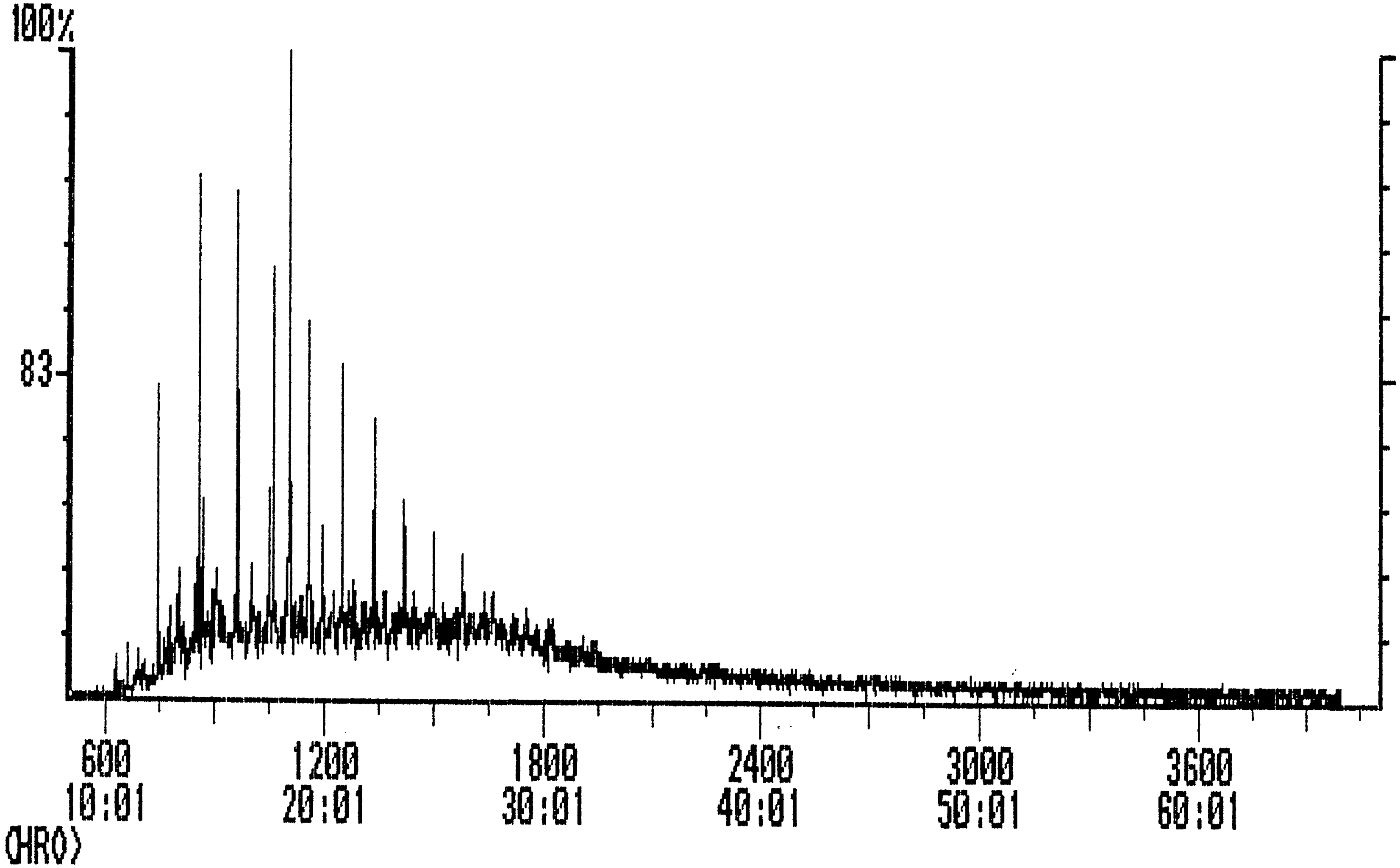
Chromatogram A:MPI128 Acquired: Jun-12-1990 10:03:05
Comment: ARCHER-1 3947.5 m AMDEL CORE SERVICES
Scan Range: 1800 - 2200 Scan: 1800 Int = 11 @ 30:01 100% = 1299



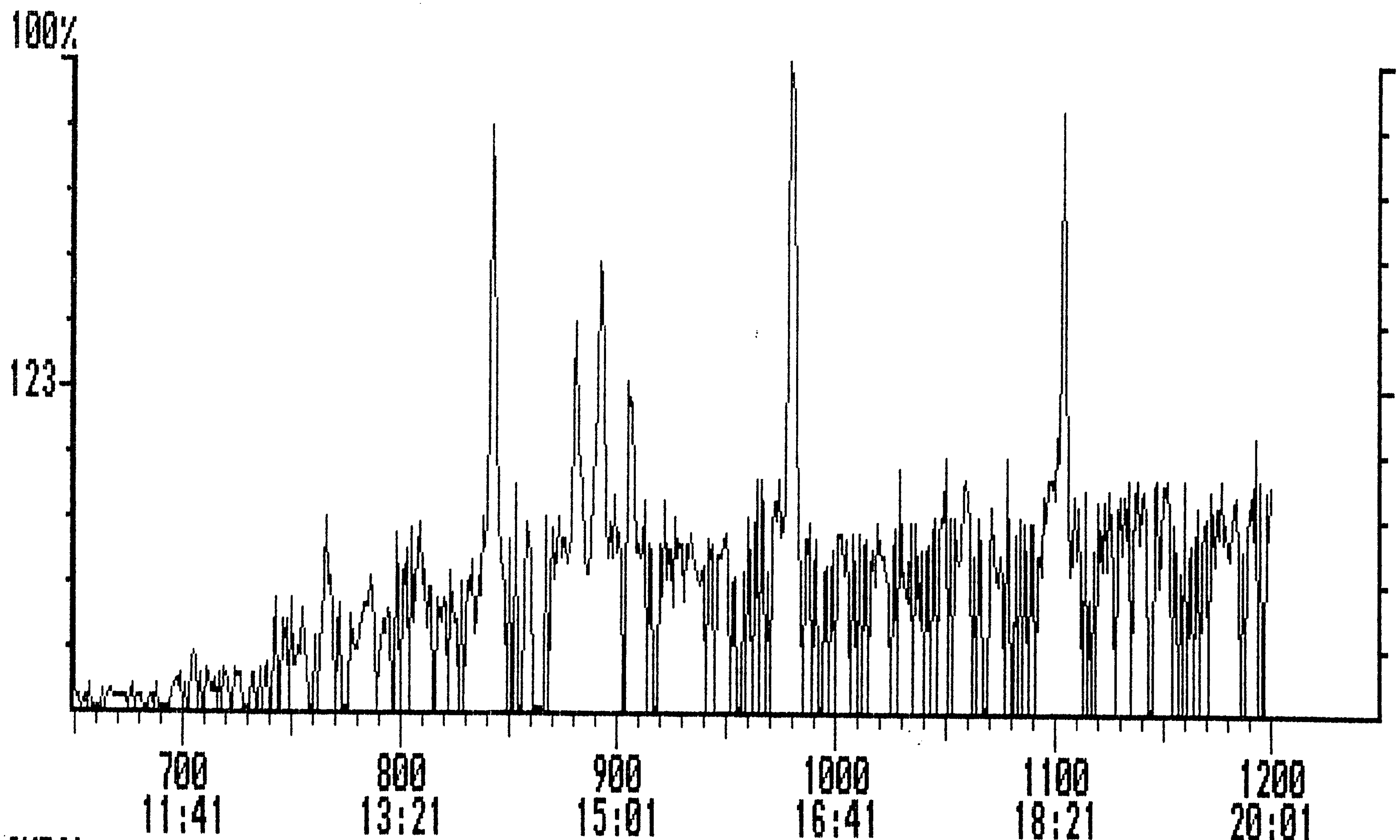
APPENDIX 3

GC-MS OF NAPHTHENES, ARCHER -1

Chromatogram DATA\MISC331 Acquired: Jul-23-1990 14:03:11
Comment: ARCHER-1 3390.2 m AMDEL CORE SERVICES
Scan Range: 500 - 4000 Scan: 500 Int = 926 @ 8:21 100% = 80400

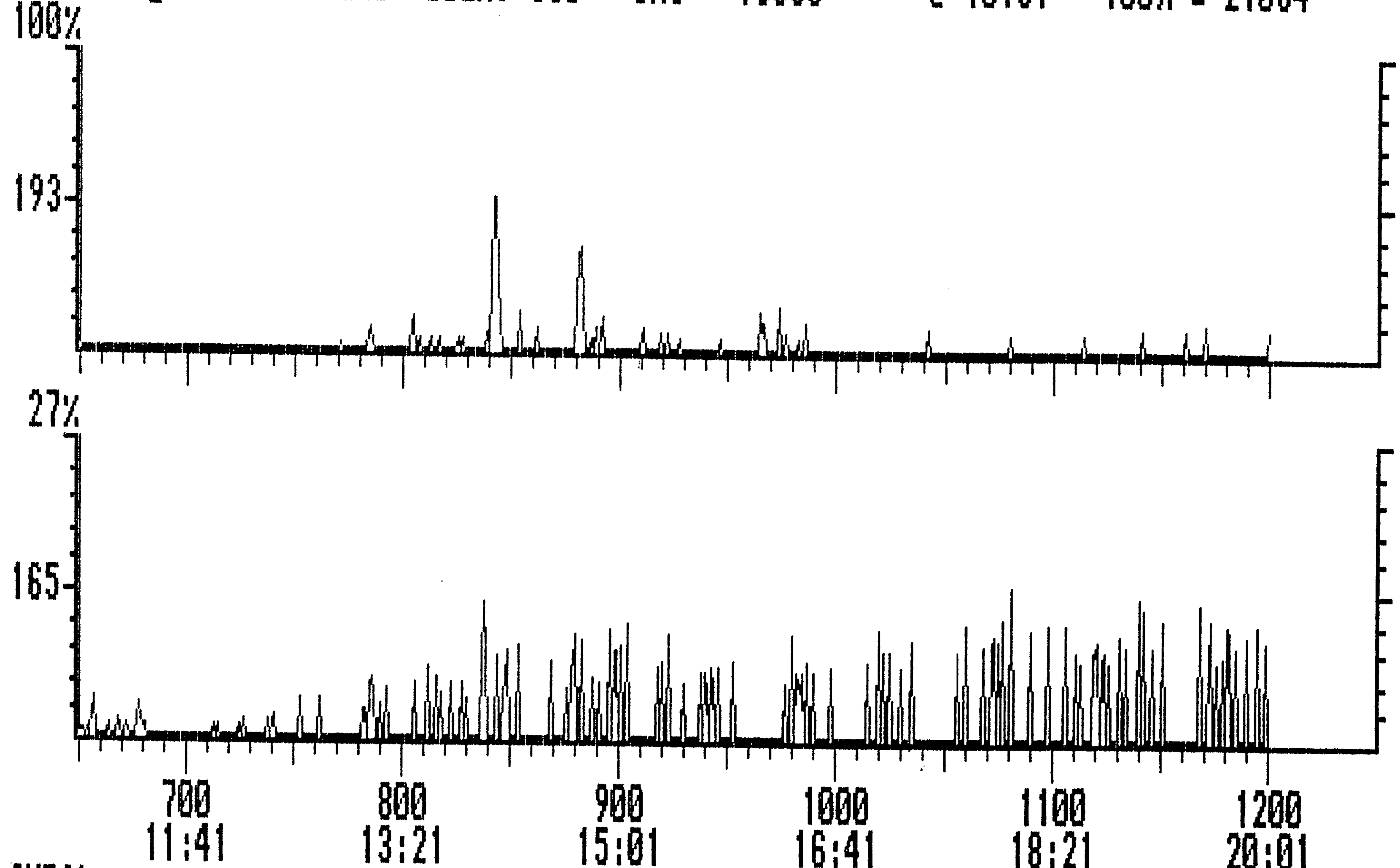


Chromatogram DATA\MISC331 Acquired: Jul-23-1990 14:03:11
Comment: ARCHER-1 3390.2 m AMDEL CORE SERVICES
Scan Range: 650 - 1200 Scan: 650 Int = 13856 @ 10:51 100% = 11786



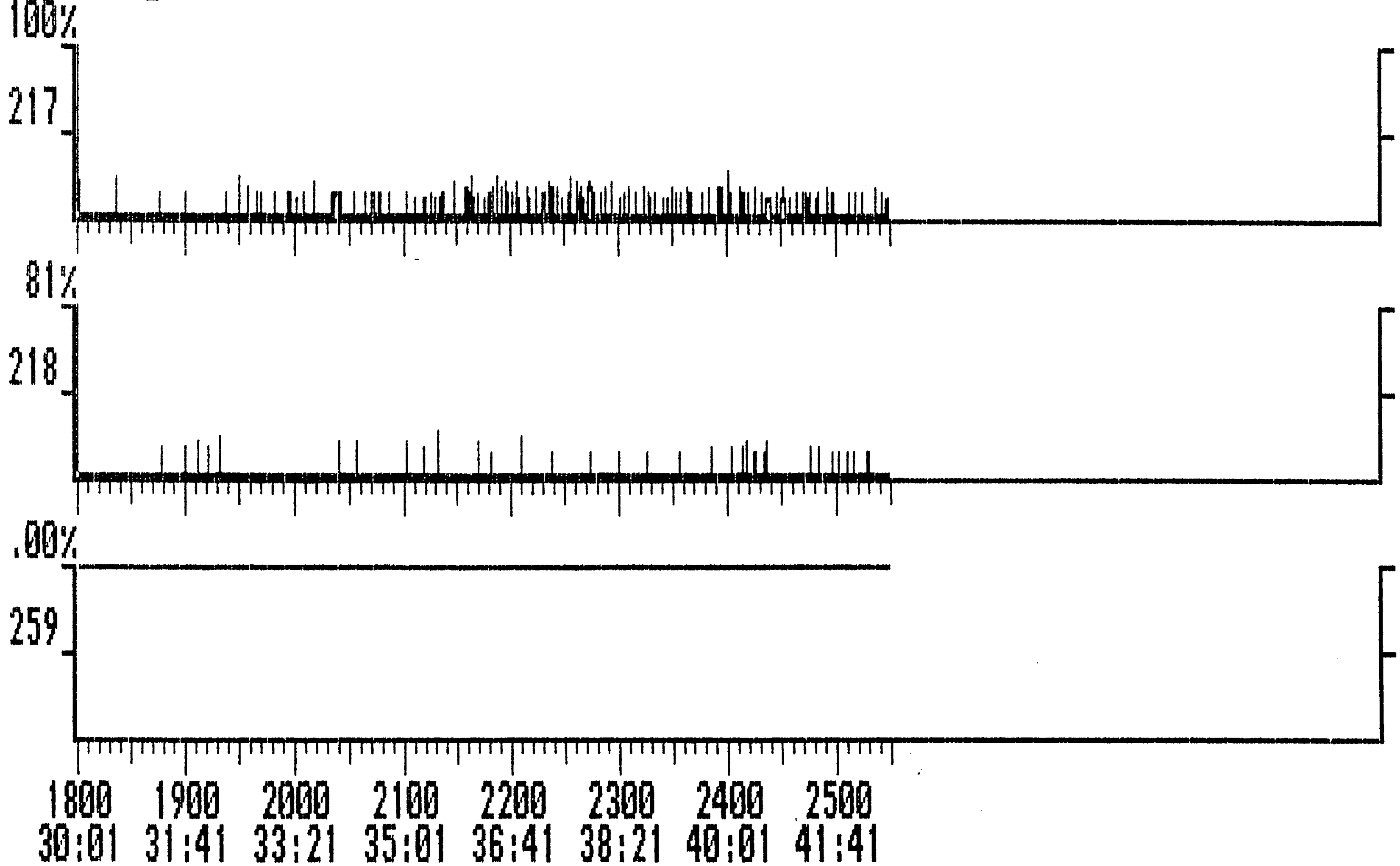
CHRO>

Chromatogram DATA\MISC331 Acquired: Jul-23-1990 14:03:11
Comment: ARCHER-1 3390.2 m AMDEL CORE SERVICES
Scan Range: 650 - 1200 Scan: 650 Int = 13856 @ 10:51 100% = 21064



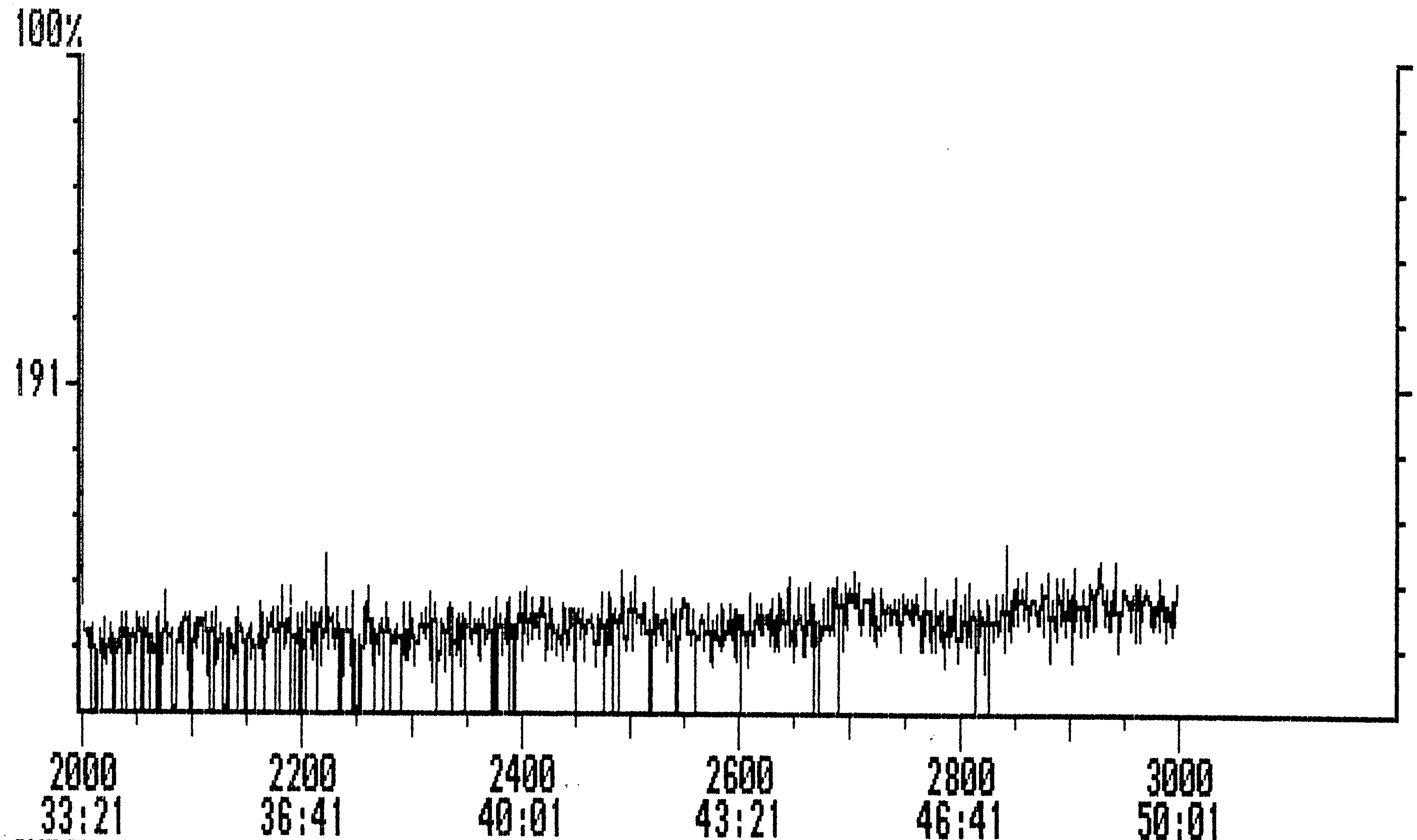
CHRO>

Chromatogram DATA\MISC331 Acquired: Jul-23-1990 14:03:11
Comment: ARCHER-1 3390.2 m AMDEL CORE SERVICES
Scan Range: 1800 - 2550 Scan: 1800 Int = 92312 @ 30:01 100% = 5504



CHRO>

Chromatogram DATA\MISC331 Acquired: Jul-23-1990 14:03:11
Comment: ARCHER-1 3390.2 m AMDEL CORE SERVICES
Scan Range: 2000 - 3000 Scan: 2000 Int = 67037 @ 33:21 100% = 13840



CHRO>

APPENDIX 6

APPENDIX 6

WELL COMPLETION REPORT

ARCHER-1

INTERPRETATIVE DATA

A P P E N D I X 6

PETROGRAPHY REPORT

AMDEL CORE SERVICES

PETROLOGY REPORT

ARCHER #1

GIPPSLAND BASIN

Report prepared for Petrofina Exploration Australia S.A.

by

DR N M LEMON

NATIONAL CENTRE FOR PETROLEUM GEOLOGY & GEOPHYSICS

for

Amdel Core Services Pty Limited
PO Box 109
Eastwood SA 5063

July 1990

INDEX

 Amdel Core Services Pty Limited Incorporated in South Australia

1. SUMMARY

Nineteen cuttings samples and eight sidewall cores from Archer #1 were submitted for petrological description. The aims of the study were to identify the grain, matrix and cement mineralogy and proportions, detail the diagenetic history of the sediments and establish whether the mineralogy may have influenced the interpretation of wireline logs.

All samples showed a remarkably similar original mineralogy, due largely to the fact that the source area for the sediments contained little else apart from granite. All samples were texturally and mineralogically immature feldsarenites. All samples showed a very high potassium feldspar content (20-30% of the framework grains) made up of microcline, microcline perthite and orthoclase. Minor variation between samples is shown by matrix content and traces of metamorphic quartz, volcanic grains and reworked sediments.

The main variation within this suite of samples is diagenetic. The small but ubiquitous plagioclase component is invariably altered to sericite/illite. This creates some microporosity and introduces potassium to the sample. With increasing depth, microcline begins to alter then dissolve. A little secondary porosity was noted at the top of the suite but this increases substantially with depth.

The main cement observed was carbonate, probably dolomite, which occurs as micrite in the matrix and as spar in the cleaner sands. There is a rare early stage of carbonate cement which prevents later alteration and another stage that postdates the alteration. Other cements include, pyrite which fills micropores and occurs in the matrix, adularia overgrowths on microcline, and authigenic quartz, which occurs in places as druse. The proportion of adularia overgrowths increase with depth towards the middle of the suite then gradually disappear deeper in the section where they were removed by dissolution. Experience from Anemone #1A suggests that the adularia is high in potassium with respect to other feldspars and its formation introduces potassium to the sample.

Diagenesis of this suite of samples involves the movement of a considerable amount of potassium. The source of the element is likely to be the dissolution of feldspars deeper in the section. It is introduced into higher levels as illite (sericite), particularly where it forms as the alteration of plagioclase, and as adularia overgrowths. The gamma log response to these sediments will be enhanced due to the high proportion of K feldspars, but will be further increased by cementation and alteration.

The diagenetic sequence includes the following events:-

- Minor compaction (bent micas)
- Early carbonate cement (micrite and spar)
- Alteration of biotite to chlorite
- Alteration of plagioclase to sericite
- Pyrite cement
- Authigenic quartz and adularia overgrowths
- Later carbonate spar
- Kaolin cement
- Kaolin alteration of microcline and muscovite
- Illite growth on kaolin
- Late compaction (suturing and stylolites)

Not all stages are observed in each sample as the sequence is largely depth controlled. Some stages may well be concurrent.

Very few indications of hydrocarbons were observed in any of the samples. Sample collection and thin section preparation mitigate against the preservation of light oil and condensate. Some bitumen or heavy oil was observed trapped along stylolites and sutured contacts between grains but as these are interpreted to be late stage events, it gives little assistance to timing the movement of hydrocarbons through the rock with respect to its cementation.

2. INTRODUCTION

Petrofina Exploration Australia sent 8 sidewall cores and 19 cuttings samples from Archer #1, in the Gippsland Basin, to Amdel Core Services for petrological studies. For the sidewall cores, the client requested that attention be paid to grain and cement mineralogy and diagenesis, the identification of matrix and any signs of oil. These samples also required point count analysis, grain size analysis and photomicroscopy. Petrology of cuttings samples was undertaken to ascertain the influence of the mineral suite on the wireline logs.

Samples from the following depths were studied:

Sidewall cores No.	Sidewall cores Depth (m)	Cuttings Depth (m)
56	3471.5	3390
53	3488.5	3400
48	3515.0	3405
42	3591.0	3410
40	3598.0	3425
34	3681.0	3475
19	3845.5	3515
8	3946.0	3550
		3560
		3565
		3575
		3590
		3640
		3660
		3685
		3695
		3745
		3755
		3800

3. METHODS

All samples were impregnated with araldite prior to thin section preparation. Blue dye was used to facilitate the description of porosity. Thin sections were systematically scanned to determine lithology, composition, porosity and textural relationships. Percentages given in the cuttings descriptions are based on visual estimates, not point counts.

Point counting on the sidewall samples assessed 300 points on a 1mm grid across the area of the slide. Primary porosity was ignored in this count as it varied from slide to slide, depending on the amount of crushing and compaction induced by sidewall collection. Individual components of composite grains were measured separately. Both these procedures allow for ease of comparison between samples.

Grain size analysis was done by accumulating 80 measurements of the long axis of the nearest grain to the cross hair on a "random walk" across the slide. This allowed fractured and disaggregated grains to be measured but slightly biases the sample against the finer fractions (sub silt).

4. CUTTINGS PETROLOGY

4.1 ARCHER #1, CUTTINGS, DEPTH 3390M

This sample appears moderately contaminated. 20% of the chips are of siltstone and micrite while the bulk of the sample is a moderately sorted firm to very coarse grained feldsarenite.

Feldsarenite

The majority of the grains are angular to subangular with cleavage fragments of feldspar prominent. The sand sized grains consist of 65% quartz, 30% feldspar and 5% mica, biotite and muscovite. The quartz grains are all of igneous origin; low strain, with abundant vacuole trails. The feldspars are predominantly potassic, orthoclase, microcline and perthite/plagioclase blebs in microcline. Many of the feldspars show various degrees of alteration, ranging from a slight dustiness due to incipient sericite alteration to complete sericite/illite alteration with associated pyrite invasion. Experience from other wells in this programme suggests that the highly altered grains were plagioclase. About 10% of the feldspar grains show a ragged overgrowth edge of adularia. There is no secondary porosity due to plagioclase dissolution in perthite grains. Some perthites do contain glauconite, probably replacing sericite after plagioclase, as the glauconite now occupies the position of the original plagioclase blebs.

Some groups of grains are well cemented by carbonate spar (dolomite?) which has corroded the framework grains. The feldspars in the cemented clusters are largely unaltered. Minor pyrite and glauconite adhering to the grains suggests these also act as cement.

Siltstone

10% of the chips are comprised of organic rich brown silty mudstone with some scattered sand grains.

Micrite

Fossiliferous micrite, rich in largely intact foraminifera, accounts for about 10% of the sample. This rock is also organic rich. The micrite has partially recrystallized to microspar and pyrite infills half the fossil tests thus acting as cement.

4.2 ARCHER #1, CUTTINGS, DEPTH 3400M

This sample is moderately contaminated with 25% of the chips comprised of micrite and silty mudstone. The bulk of the sample is a moderately sorted medium to very coarse grained feldsarenite with some granite grains.

Feldsarenite

The sand sized grains are mainly angular to subangular. Some larger grains show fractured edges but overall there appears to be little cement. Quartz, accounts for 65% of the sand grains and is mainly a low strain variety with lines of vacuoles probably derived from a granitic terrain. There are about 5% grains of chert, possibly altered volcanics. The majority of the feldspars are relatively fresh with only incipient alteration. Feldspars represent 30% of the sample. Potassic feldspars dominate, with orthoclase, microcline and perthite well represented. A few grains are highly altered and may have originally been plagioclase. Some perthites show rare dissolution of the plagioclase blebs to give secondary porosity.

There is very little cement in this sample. Most of the grains are disaggregated. No adularia was observed. Some grains have minor veins of drusy quartz and a little kaolin and illite.

Micrite

Brown, organic rich, fossiliferous (foraminifera) rich micrite makes up 5% of the sample. This is incipiently recrystallized and partially cemented with pyrite.

Mudstone

A range of silty and very poorly sorted sandy mudstones make up 20% of the samples. These are generally massive (no bedding) and variously cemented with glauconite pyrite and minor carbonate.

4.3 ARCHER #1, CUTTINGS, DEPTH 3405M

This sample contains 40% sandy mudstone chips and 60% liberated fine to very coarse, angular to subangular, sand grains. The interval could be an interbedded sandy mudstone and poorly sorted feldsarenite sequence.

Feldsarenite

The feldsarenite is composed of 25% feldspar grains and 70% quartz grains. The feldspars are dominated by potassic varieties, orthoclase, microcline and microcline perthite. Most grains show some degree of alteration, from incipient sericitization giving a dusty look to the grain, to complete sericite/illite alteration with associated pyrite invasion. The quartz grains have a granitic origin as indicated by their low strain and lines of inclusions. Biotite and minor muscovite make up the rest of the framework suite.

Liberation of individual grains suggests there is minimal cement in the formation. Many of the dusty altered microcline grains have a clear, jagged rim of adularia overgrowth. Matrix of clay and silt surrounds some of the grains and this is held in part by pyrite. Rare pyrite rich chips show pyrite cement deeply etching framework grains. There is minor secondary porosity induced by dissolution of plagioclase blebs from within perthite grains.

Mudstone

The bulk of the mudstone is relatively massive and quite sandy. It is organic rich with common disseminated pyrite cement. Fossil rich micrite and glauconite siltstone account for 5% of the total sample. One sandy mudstone shows rounded glauconite grains and glauconite coated grains.

4.4 ARCHER #1, CUTTINGS, DEPTH 3410M

Larger chips in this sample show the interval to be interbedded sandy mudstone and poorly sorted fine to very coarse subangular feldsarenite. There are about 35% mudstone chips and 65% sand grains in the sample.

Feldsarenite

Quartz (65%) and feldspar (25%) dominate the sand grains with minor biotite, chert, siliceous siltstone, and possibly altered volcanic grains. The quartz has a granite origin indicated by low strain and lines of inclusions. Some vein quartz is evident, shown by abundant vacuoles. The feldspar suite is mainly potassic and includes orthoclase, microcline, microcline perthite, granophyre and minor plagioclase. The plagioclase is highly altered (sericitized) and the potassic feldspars show various degrees of alteration from virtually unaltered to very dusty sericitized grains. There is almost no plagioclase dissolution.

Although many grains are liberated, cements include adularia overgrowths, mainly on microcline; carbonate spar, which deeply etches the framework grains; and pyrite, mainly cementing areas where muddy matrix surrounds the framework grains.

Mudstone

This sample shows a graduation from the feldsarenite to a sandy mudstone. The mudstone also contains glauconite grains and rarely has abundant foraminifera. This suggests the interval was deposited under marine conditions. Pyrite is common in the finer sediments, particularly around organic concentrations and infilling fossil tests. Some mudstone is quite micritic with incipient recrystallisation.

4.5 ARCHER #1, CUTTINGS, DEPTH 3425M

This interval is dominantly a moderately sorted, angular to subangular, fine to very coarse feldsarenite. There is about 5% contamination of the sample by chips of sandy mudstone.

Feldsarenite

Quartz (65%) and feldspar (30%) makes up the majority of the sand grains with the remaining 5% composed of biotite and minor muscovite.

The feldspars are mainly potassic varieties, orthoclase, microcline and microcline perthite with some plagioclase. All grains except quartz show some degree of alteration. Plagioclase is most heavily altered, being extensively sericitized/illitized. The plagioclase blebs in the perthite also alter and dissolve to create secondary porosity. Intense alteration is associated with microporosity but this is likely to be ineffective due to the growth of fibrous illite. Microcline grains show incipient alteration and orthoclase grains show a slight dustiness. Biotite is weakly altered to chlorite, and muscovite shows some kaolinization.

The quartz grains are mainly of granitic origin, showing low strain and lines of inclusions and vacuoles.

The liberation of individual grains suggests a lack of cement in the formation. There are very minor adularia overgrowths on the feldspars and a little illite clinging to some of the grains. The majority of clay in the sample is contamination via the drilling mud. A few clusters of grains are cemented by corrosive pyrite.

Mudstone

The contaminants of this interval are pyrite cemented, organic rich, clayey micrite with abundant foraminifera, and brown, organic rich (coaly?) sandy mudstone.

4.6 ARCHER #1, CUTTINGS, DEPTH 3475M

This interval is uncontaminated by mudstone chips and the sample depicts a moderate to well sorted, fine to coarse grained feldsarenite. The majority of the grains are angular to subangular, with some grains being barely rounded cleavage chips of feldspar.

Quartz makes up 70% of the sample. It is mainly granitic in origin, as indicated by low strain and lines of inclusions.

Feldspar accounts for 25% of the framework grains. These are mainly potassic varieties, microcline, orthoclase and microcline perthite, all showing varying degrees of incipient to light sericite (illite) alteration. The few plagioclase grains show extensive alteration to sericite/illite and minor kaolin. There is microporosity associated with this alteration but this is often filled with pyrite cement.

Biotite, partially altered to chlorite, and muscovite make up the remaining 5% of the framework grains.

There is minor dissolution of plagioclase in perthite to produce secondary porosity.

Cementation is minimal. Rare thin adularia overgrowths rim some of the microcline and perthite grains. Rims of carbonate spar adhere to 5% of the grains. Of these, there are one or two clusters of carbonate spar grains. No clay or quartz cement was identified.

4.7 ARCHER #1, CUTTINGS, DEPTH 3515M

This sample represents an interval of moderately sorted, fine to very coarse, angular to subangular feldsarenite. There is minor contamination (≤5%) by brown organic rich sandy mudstone.

Quartz accounts for 70% of the framework grains. The quartz is mainly of granitic origin, showing low strain and lines of inclusions and vacuoles. There is minor vein quartz and rare metamorphic grains.

The feldspars, 25% of the sample, are mainly potassic varieties, microcline, orthoclase and microcline perthite. About 5% of the total grains are plagioclase. These invariably show a greater degree of sericite alteration than the potassic grains. Biotite, altering to chlorite, and muscovite make up the remainder of the framework grains.

Carbonate cement is seen adhering to 20% of the grains. This is usually in the form of spar, but some micrite and microspar also occurs. The sparry forms are corrosive, deeply etching the adjacent framework grains. Pyrite also acts as cement, holding clusters of deeply etched grains together. There are minor rims of adularia on some of the microcline grains.

There are traces of secondary porosity associated with dissolution of plagioclase in perthite and micro-porosity associated with plagioclase alteration.

4.8 ARCHER #1, CUTTINGS, DEPTH 3550M

The nature of the muddy material in this sample suggests that the interval is on interbedded, poorly sorted silty, very fine to very coarse, angular to subangular feldsarenite and sandy mudstone.

The main framework grains are composed of 65% quartz, 30% feldspar, 4% biotite and 1% muscovite. The quartz is mainly of granitic origin (low strain with lines of vacuoles and inclusions). There is minor chert, metamorphic quartz and siliceous siltstone.

The feldspars are mainly potassic, orthoclase, microcline and microcline perthite, with 4% plagioclase. Most of the plagioclase, including the blebs in the perthite grains, are highly sericitized (illitized). The potassic feldspars show some dustiness due to incipient sericitization. All biotite grains have been altered to chlorite.

40% of the whole sample consists of sandy, silty mudstone. This occurs as both whole chips and as matrix attached to framework grains. Because of this, porosity in this interval is likely to be low. Areas with little matrix have been cemented by blocky carbonate spar which has deeply corroded the framework grains. Some chips show complete corrosion to leave spar only. Unlike the samples above, carbonate cement in this zone postdates feldspar alterations. Some plagioclase has dissolved to create secondary porosity but these are adularia overgrowths on microcline grains.

4.9 ARCHER #1, CUTTINGS, DEPTH 3560M

Although there is considerable mud in this sample, it appears to be matrix rather than contamination via drilling mud. The sample is therefore a very poorly sorted, muddy, very fine to very coarse grained feldsarenite.

The sample consists of quartz (55%), feldspar (20%), biotite (3%), muscovite (trace), and matrix (22%). The quartz grains are dominantly of granitic origin showing low strain and lines of inclusions and vacuoles. The feldspars are dominantly potassic, orthoclase microcline and microcline perthite, but there is about 8% plagioclase in this sample. The plagioclase is strongly altered, sometimes completely, to sericite/illite. Potassic feldspars have only incipient alterations, showing as a dusty haze. There is minor dissolution of plagioclase, but many microclines show a thin adularia overgrowth.

Finely disseminated pyrite and slightly larger pyrite crystals in the brown, organic rich matrix, appears to be the main cement.

The matrix is a silty sandy mud and is seen rimming most grains and holding some small clusters of grains together. Porosity in this interval is expected to be low.

4.10 ARCHER #1, CUTTINGS, DEPTH 3565M

This sample depicts an interval of moderately sorted fine to very coarse, angular to subangular feldsarenite. A few chips have a rim of sandy mud matrix adhering, but this probably represents an overlap with the interval above. Essentially, this interval is clean.

Quartz accounts for 70% of the sample with feldspar (25%), biotite 3% and muscovite making up the rest of the framework grains. The quartz is mainly of low strain, vacuole and inclusion lined granitic origin. Biotite shows alteration to chlorite.

The feldspars are mainly potassic varieties, orthoclase, microcline and microcline perthite. Plagioclase is about 4% of the sample and is usually heavily altered to sericite/illite. This produces some microporosity but this is frequently filled with pyrite.

There is minor dissolution of plagioclase blebs in perthite to produce obvious secondary porosity. The main cement in this interval is adularia overgrowths on microcline and orthoclase. At least two phases are present and some of the rims are quite thick. Based on experiences from previous holes, Angler and Anemone, this could significantly alter the gamma log response as these overgrowths appear to be anomalous in potassium.

There may also be some thin drusy quartz overgrowths in this interval but identification of such thin rinds is difficult.

4.11 ARCHER #1, CUTTINGS, DEPTH 3575M

This sample indicates an interval of clean, moderately well sorted, fine to coarse grained, angular to subangular feldsarenite. There is minor contamination by drilling mud.

Quartz accounts for 70% of the framework grains. Although dominantly of granitic origin (low strain with lines of vacuoles), 7% of the sample shows metamorphic characteristics; high strain with sutured contact between the sub-grains.

There is 25% feldspar in the sample, mainly the potassic varieties microcline, microcline perthite and orthoclase. The 3% plagioclase is generally highly altered to sericite/illite. Microcline and perthite show sericite alteration giving a dusty appearance in transmitted light, but the orthoclase grains show minimal alteration.

Biotite, a little muscovite and a trace of silty matrix make up the remaining 5% of the sample.

There is no obvious dissolution of feldspars to create secondary porosity. Intense sericite alteration of plagioclase does, however, generate some microporosity.

Quartz cement is obvious in this sample with many grains showing a thin rim of authigenic overgrowth. There is minor adularia, generally developed on the microcline grains.

4.12 ARCHER #1, CUTTINGS, DEPTH 3590M

This sample is dominantly a moderately well sorted, very fine to coarse grained, angular to subangular feldsarenite. There is 2% contamination of the chips from micritic siltstone.

Quartz makes up 65% of the sample. The quartz is dominantly low strain, varieties with vacuole inclusions of probably granitic source but there is 2% of metamorphic origin. Feldspars, mainly the potassic varieties, microcline, microcline perthite and orthoclase, make up 25% of the sample. Of this, 4% is highly altered (sericitized) plagioclase. This alteration is often accompanied by disseminated pyrite. Biotite, altered to chlorite and pyrite, and minor muscovite total 4%, and make up the remainder of the framework grains.

Cement accounts for 6% of the sample. This is dominantly carbonate (dolomite) spar which is highly corrosive and deeply etches the framework grains. Drusy overgrowths form small veins on some of the quartz grains and rinds of adularia on the microcline grains are evident. Pyrite also acts as a minor cement.

Dissolution of feldspars, particularly plagioclase has generated a small amount of secondary porosity. Some highly altered grains show a little microporosity.

4.13 ARCHER #1, CUTTINGS, DEPTH 3640M

The sample depicts a poorly sorted, very fine to very coarse grained, angular feldsarenite. Many of the smaller grains, however, appear to be crushed fragments. The original sample may well be better sorted and coarser grained. This may be due to a dull drilling bit as there is no more cement evident in other less crushed samples.

Quartz accounts for 65% of this sample. It generally exhibits low strain with lines of vacuoles, suggestive of a granitic origin.

Some of the larger grains are composites, quartz-quartz or quartz-feldspar but there is no metamorphic input evident.

Feldspars make up 25% of the sample and are mainly the potassic varieties, microcline, microcline perthite and orthoclase. Most feldspars show slight alteration to sericite/illite but the majority of the plagioclase (3%) are highly altered to sericite with accompanying pyrite.

Biotite, muscovite and traces of monazite make up the rest of the framework suite, totalling 4% of the sample.

Spar and microspar carbonate (dolomite?) are the main cements. These are highly corrosive and deeply etch the framework grains. There is minor feldspar (adularia) overgrowth on some microcline grains. Total cement is 6% of the sample.

This sample shows considerable feldspar dissolution to create secondary porosity. Many grains show ragged ends where dissolution has etched along the cleavage traces. Plagioclase has completely dissolved in places. This is most evident in perthite grains where dissolution of blebs gives a "Swiss cheese" appearance.

4.14 ARCHER #1, CUTTINGS, DEPTH 3660M

This sample shows a moderately well sorted, fine to very coarse grained, angular to subangular feldsarenite.

The bulk of the sample consists of quartz (70%). These grains are dominantly of granitic origin and display low strain and numerous lines of vacuoles. There are a few composite quartz grains, but these are knots of small igneous grains rather than metamorphic grains.

Feldspars make up 20% of the sample. These are dominantly potassic varieties, microcline, microcline perthite and orthoclase with varying but incipient sericite alteration. The few plagioclase grains are highly altered to sericite/illite. Commonly pyrite infills microporosity associated with this alteration.

Clusters of quartz-feldspar-muscovite-biotite grains and individual biotite altering to chlorite accounts for a further 4% of the sample. There is 2% muddy siltstone matrix. The remaining 4% of the sample is cement. This is mainly carbonate spar and microspar which deeply etches the framework grains. Some areas of spar have completely dissolved the framework grains. There is minor adularia overgrowth.

Feldspar dissolution to create secondary porosity is evident in many of these grain boundaries. There is some removal of plagioclase blebs within perthite grains.

4.15 ARCHER #1, CUTTINGS, DEPTH 3685M

The sample supplied depicts a moderately sorted, slightly muddy, very fine to medium grained feldsarenite. Many finer grains are crushed fragments so that the original sample may well have been coarser grained.

Quartz makes up 60% of this sample. The grains are dominantly of granitic origin, showing lines of vacuoles and low strain. There are a few grains of metamorphic origin.

Feldspar, 20% of the sample, is dominantly potassic; microcline, microcline perthite and orthoclase. These grains show incipient sericite alteration. The few plagioclase grains are usually highly altered to sericite.

The micas, biotite and minor muscovite, contribute a further 4% to the sample.

Clay and silt matrix (6%) adheres to a quarter of the framework grains. This material is usually organic rich (dark brown) and is cemented by pyrite (1%).

The main cement in the sample is carbonate (8%). Micrite and microspar help cement the matrix but spar cements the larger framework grains, often deeply corroding them so that little remains. Thin adularia rims on microcline grains make up 1% of the sample.

Secondary porosity by feldspar dissolution is evident as minor ragged edges on some grains and a few holes where plagioclase blebs have been removed from perthite grains.

4.16 ARCHER #1, CUTTINGS, DEPTH 3695M

The sample depicts a very poorly sorted, slightly silty, very fine to very coarse, angular to subangular feldsarenite.

Quartz is the dominant component of the sample, 60%. The grains are mainly of granitic origin, with low strain and lines of inclusions, mainly vacuoles. These are rare grains of chert.

Feldspar makes up 25% of the sample and is dominantly potassic types, orthoclase, microcline and microcline perthite. There are subsidiary amounts of plagioclase and, although some grains in this sample are unaltered, most have been sericitized and partially dissolved. Mica, mainly biotite altered to chlorite, makes up 3% of the sample.

A slightly organic rich, silty clay matrix (5%) adheres to 15% of the grains and glues small clusters of grains together with the aid of disseminated pyrite (1%).

Carbonate spar is the main cement. This mineral deeply etches the framework grains and in this case is probably a late stage cement, as it surrounds microcline grains that have been partially sericitized and already have an adularia rim. Adularia accounts for 1% of the sample.

Feldspar dissolution is quite apparent in this sample. Plagioclase has been almost completely removed in some cases, some perthite has developed a "Swiss cheese" texture and some of the potassic grains show etching along cleavage.

A few clusters of grains show a glauconite matrix/cement but this may be contamination.

4.17 ARCHER #1, CUTTINGS, DEPTH 3745M

A very poorly sorted, silty, muddy, very fine to very coarse grained, angular to subangular feldsarenite.

Quartz dominates the framework suite but only comprises 28% of the entire sample. The grains are nearly all of granitic origin as indicated by their low strain and lines of inclusions (vacuoles).

The feldspars make up 12% of the sample and are dominated by potassic varieties, microcline, microcline perthite and orthoclase. The microcline grains are incipiently sericitized but the few plagioclase grains are highly altered to sericite/illite and some kaolin.

Mica, particularly biotite, is relatively common in the finer fractions and totals 4% of the sample.

Matrix dominates the sample, being 45% of the total sample. The matrix is brown and usually organic rich. It contains micrite and pyrite, both which glue the matrix together and make it adhere to the framework grains. The micrite has recrystallized to spar which cements framework grains together while deeply corroding them. Patches of grains are cemented by corrosive pyrite.

The total cements are carbonate 6%, pyrite 4% and adularia, as thin veins on microcline, 1%. Despite the degree of cementation of the sample, there is evidence of feldspar dissolution. Some plagioclase has been completely removed, the rest altered to create microporosity. K feldspar grains show etching along cleavage. Some perthites have developed a "Swiss cheese" texture.

Reservoir quality of this interval is much lower than most other samples in this suite.

4.18 ARCHER #1, CUTTINGS, DEPTH 3755M

A very poorly sorted, silty, muddy, very fine to coarse grained, angular feldsarenite.

Quartz of granitic origin makes up 32% of the sample. Its characteristics are low strain and lines of inclusions, mainly vacuoles. There are traces of chert and vein quartz.

The 15% feldspar in this sample is mainly potassic varieties, microcline, microcline perthite and orthoclase. There are a few grains of plagioclase but these are generally highly altered to sericite/illite. This is accompanied by pyrite infill of the microporosity generated. Unlike all the samples above, alteration of microcline is quite advanced in this sample.

Mica, mainly biotite altered to chlorite, accounts for 3% of the sample and is generally associated with the fine fractions.

Organic rich, brown silty mud appears to be matrix to this interval and accounts for 40% of the sample. The matrix adheres to the larger grains and surrounds clusters of smaller grains. Micrite and pyrite cement the matrix and glue it to the framework grains. Recrystallized micrite (to spar) and pyrite cements, corrode cleaner zones of framework grains.

Cementation appears to be late as extensive alteration of the grains has already taken place. Dissolution of plagioclase and some microcline is evident as etching along cleavage and removal of blebs in perthite. The cement proportions are carbonate 6%, pyrite 3% and adularia, as rims on microcline, 1%.

4.19 ARCHER #1, CUTTINGS, DEPTH 3800M

A poorly sorted, silty, very fine to coarse grained, angular to subangular feldsarenite.

Quartz, mainly of granitic origin with low strain and lines of vacuole inclusions, constitutes 52% of the sample. There is minor chert evident. Feldspars, mainly potassic varieties, microcline, microcline perthite and orthoclase, make up 22% of the sample. The few plagioclase grains are highly altered to sericite/illite with accompanying partial infill of the resultant microporosity by pyrite. The microcline grains are also substantially sericitized as well. Many of the perthite grains have sericite in place of the plagioclase blebs, but not much dissolution to create large holes has taken place. Many feldspars have jagged edges indicating dissolution. There are no adularia veins, these may have dissolved.

Carbonate is common; 10% of the sample. This is mainly as corrosive spar amongst the clean zones of framework grains. There is some micrite in the 10% matrix. Disseminated pyrite also cements the slightly organic rich matrix, allowing it to adhere to the framework grains. Recrystallized pyrite cements and corrodes some areas of framework grains. Total pyrite is 3%.

There is a fair amount of microporosity associated with the more highly altered feldspar grains and some more effective secondary porosity associated with dissolution of feldspars along cleavage. However, the reservoir quality of this interval is probably low due to the combination of carbonate and pyrite cement and matrix.

TABLE 1

SUMMARY OF MINERALOGY AND DIAGENETIC ALTERATION - ARCHER #1 CUTTINGS

DEPTH (M)	QUARTZ	FELDSPAR	MICA	QUARTZ CEMENT	ADULARIA	CARBONATE	CLAY CEMENT	PYRITE	MATRIX	FELDSPAR DISSOLUTION	"SWISS CHEESE"	MICRO POROSITY	METAMORPHIC QUARTZ	CHERT/ VOLCANICS
3390	65	30	5		**	**		*				*		
3400	65	30		*			*							5
3405	70	25			**			**			*	*		
3410	65	25			*	*		*				*		*
3425	65	30	5		*		*	*			*	*		
3475	70	25	5		*	*		*			*	*		
3515	70	25	5		*	***		*			*	*		
3550	39	18	3		*	**			40	*		*	*	
3560	55	20	3		**			*	22	*		**		
3565	70	25	3	*	***			*			*	**		
3575	70	25	5	**	*							**	7	*
3590	65	25	4	*	*	6		*		*	*	*	2	*
3640	65	25	4		1	5		*		***	**	*		
3660	70	20	4		*	4		*	2	**	*	*		
3685	60	20	4		1	8		1	6	*	*	*		
3695	60	25	3		1	5		1	5	***	*	**		
3745	28	12	4		1	6		4	45	**	*	**		
3755	32	15	3		1	6		3	40	***	**	*		
3800	52	22	3			10		3	10	**	*	**		

*	**	***	****
TRACE	SAME	COMMON	ABUNDANT

5. SIDEWALL CORE PETROLOGY

The nomenclature used in the thin section descriptions below takes into account the grain size analyses shown in Table 2 and the point count compositions shown in Table 3.

5.1 ARCHER #1, SIDEWALL CORE 56, 3471.5 METRES

Hand specimen description
A poorly sorted, pale grey, fine to very coarse grained feldsarenite and granule conglomerate. The opaque white colouration of the majority of the grains is due to crushing during sample collection. The sample smelt strongly of hydrocarbons and showed a very slow reaction to 10% HCl.
The core received was 1cm long.

Thin section description
A clean, carbonate cemented, poorly sorted, very coarse feldsarenite composed of angular to subrounded fine sand to small pebbles (Figs 1 & 2).

The quartz is mainly of igneous origin, showing low strain (except when crushed) and lines of vacuoles. The feldspars are mainly potassic varieties, microcline, microcline perthite and orthoclase. Microcline and perthite show incipient sericite alteration while the orthoclase grains are virtually unaltered. The plagioclase grains are highly altered to sericite with some pyrite infill of the micropores (Fig. 3). Biotite alters to chlorite with the release of finely divided pyrite.

There is some silt in the clay matrix which is only a minor component of this sample.

Carbonate cement is common with an early micrite rim on some of the grains and a later blocky spar infilling primary pores (Figs 1&2). The carbonate (probably dolomite) is slightly corrosive to the framework grains but particularly so to plagioclase. There are minor quartz and feldspar (adularia) overgrowths, and some pyrite in the primary pores acting as cement.

Compaction is indicated by distorted mica grains and minor sutured (stylolitic) contacts between some of the larger grains.

5.2 ARCHER #1, SIDEWALL CORE 53, 3488.5 METRES

Hand specimen description
A light grey, poorly sorted, very fine to very coarse grained feldsarenite and granule conglomerate composed of angular clasts. The core has suffered considerable crushing during sidewall collection with the 1.5 cm core received largely collapsed to dust. There was a moderate hydrocarbon odour and no reaction to 10% HCl.

Thin section description
A slightly muddy, poorly sorted, weakly cemented, coarse feldsarenite composed of angular to subrounded coarse silt to granules.

The quartz grains are mainly of igneous origin, indicated by low strain and lines of vacuoles. The feldspar grains are dominated by potassic varieties, microcline, microcline perthite and orthoclase. Most of the plagioclase present is highly altered to sericite. Many of the microcline grains are dusty with incipient sericite alteration (Figs 4&5). There is minor mica in the sample, mainly biotite , partially altered to chlorite.

The sample is weakly cemented with clays, illite and kaolin, and adularia overgrowths, which are restricted to the microcline grains.

The sample shows some crushing and disaggregation from sidewall collection with associated mud infiltration.

5.3 ARCHER #1, SIDEWALL CORE 48, 3515 METRES

Macro description
A white to off white, poorly sorted, fine to very coarse subfeldsarenite and granule conglomerate. There was a weak hydrocarbon odour and the sample showed no reaction to 10% HCl. The 1.8 cm of core was weakly cemented and showed considerable crushing during sample collection.

Thin section description
A slightly silty, poorly sorted, medium feldsarenite composed of angular to subrounded grains ranging from coarse silt to granule size.

The quartz grains are dominantly of igneous origin, as indicated by their low strain and lines of vacuoles. The feldspar grains are nearly all potassic varieties, microcline, microcline perthite and orthoclase. The small proportion of plagioclase is usually heavily altered to sericite (Figs 6&7). The mica is mainly biotite, which shows alteration to chlorite. There are a few heavy minerals, including monazite and zircon.

The sample is friable with weak cementation afforded by minor quartz and feldspar overgrowths (Fig. 6), traces of carbonate and some mixed kaolin and illite.

Very little secondary porosity was observed although some microporosity is to be expected in association with sericite alteration.

The sample is slightly silty but much of this could be a result of sample collection. The sample was extensively crushed with considerable infiltration of drilling mud.

5.4 ARCHER #1, SIDEWALL CORE 42, 3591 METRES

Hand specimen description
A white to pale grey, poorly sorted, fine to very coarse, angular feldsarenite and granule conglomerate. The 1.2 cm of core had been crushed during sample collection and had all but disintegrated on delivery. There was a weak hydrocarbon odour and no reaction to 10% HCl.

Thin section description
A poorly sorted, silty, coarse feldsarenite composed of angular to subrounded coarse silt to granule sized grains.

The quartz is dominantly of igneous origin with low strain and lines of vacuoles. The feldspar are mainly potassic varieties, microcline, microcline perthite and orthoclase. The plagioclase grains are invariably completely altered to sericite. Many of the microcline grains show incipient sericite alteration. The biotite is partially altered to chlorite (Fig. 8) and the muscovite to illite.

Silt and illite make up the matrix but the crushed and shattered nature of this sidewall sample adds to the apparent amount of these components (Figs 8&9).

Authigenic kaolin booklets fill some of the primary porosity and are intermixed with authigenic illite. Disorientation and crushing during collection has affected the relationships between these minerals. Authigenic feldspar grows on some of the microcline grains and there is minor quartz cement, usually as drusy overgrowths.

Dissolution of plagioclase from perthite has created some secondary porosity.

5.5 ARCHER #1, SIDEWALL CORE 40, 3598 METRES

Hand specimen description
An off white to pale grey, moderately to poorly sorted, angular, very fine to coarse grained feldsarenite with rare larger grains. Although crushed, the 2 cm of core was largely intact and cemented by dolomite as suggested by the slow reaction with 10% HCl. There was a weak hydrocarbon odour.

Thin section description
A clean, poorly sorted, medium feldsarenite composed of angular to subrounded coarse silt to very coarse sand.

The quartz grains are all of igneous origin, as indicated by their low strain, included rutile needles and lines of vacuoles. The feldspar grains are mainly potassic varieties, microcline, microcline perthite and orthoclase. The minor plagioclase component is invariably completely altered to sericite. Some microcline grains have a very dirty, dusty brown appearance due to incipient sericite alteration. Biotite alters to chlorite with the release of iron, now pyrite.

There are scattered knots of carbonate, spar and micrite, cementing small clusters of framework grains (Figs 10&11). Large vermiform booklets of authigenic kaolin with traces of associated illite fill some of the primary pores.

The silt content registered in the point count may be largely due to the considerable crushing and shattering associated with sidewall collection as there is no matrix clay in the sample.

There is obvious development of secondary dissolution porosity in this sample. This is mainly seen as etching of feldspar grains with some plagioclase removal from perthite (Fig. 12). Etching has been enhanced by the emplacement of carbonate cement.

5.6 ARCHER #1, SIDEWALL CORE 34, 3681 METRES

Hand specimen description
A pale grey, poorly sorted, medium to very coarse grained feldsarenite and granule conglomerate. The 1.5 cm of core received had virtually disintegrated during transport, due to both crushing during collection and a lack of cement. Some carbonate cement is evident from a weak reaction with 10% HCl. The sample had a slight hydrocarbon odour.

Thin section description
A slightly muddy, poorly sorted very coarse feldsarenite composed of angular to subrounded very fine sand to small pebbles.

All the quartz grains show low strain and lines of vacuoles, characteristics of an igneous origin. The feldspar grains are mainly potassic varieties, microcline, microcline perthite and orthoclase. There is incipient sericite alteration to some of the microcline grains (Figs 13 & 14). The few plagioclase grains in the slide are highly sericitized and are barely recognizable. Biotite grains show alteration to green chlorite but some alter to another chlorite form, pennine, which has a characteristic blue interference colour and associated disseminated magnetite. Large composite framework grains are clearly derived from granite.

The sample contains some muddy matrix, illitic clay and silt.

Kaolin is the main cement. Large vermiform stacked booklets, probably of the dickite form, completely fill some areas of the primary porosity (Figs 15 & 16). Minor amounts of a finer grained form of kaolin are the result of microcline alteration.

Etching of feldspar grains along the cleavage traces creates secondary porosity that enhances primary porosity (Fig. 13). There is considerable microporosity associated with the coarse grained kaolin (Fig. 15) and some where traces of plagioclase have been removed from perthite.

5.7 ARCHER #1, SIDEWALL CORE 19, 3845.5 METRES

Hand specimen description
A pale grey, poorly sorted, fine to very coarse grained angular, slightly micaceous feldsarenite and granule conglomerate. The sample had a weak hydrocarbon odour but no reaction with 10% HCl. Although crushed during sidewall collection, the 3 cm of core received was relatively intact.

Thin section description
A slightly muddy, poorly sorted, very coarse feldsarenite composed of angular to subangular coarse silt to small pebbles.

Low strain and vacuole trails indicate that nearly all the quartz grains are of igneous origin. The feldspars are dominantly of the potassic varieties, microcline, microcline perthite and orthoclase. There has been minor sericite alteration of the microcline. The few plagioclase grains are invariably highly sericitized, even the blebs within perthite. Biotite grains are partially altered to chlorite and muscovite to illite.

The sample has been crushed, shattered and disturbed by sidewall collection. This has added to the silt component but there is still a certain amount of matrix in the sample indicated by the detrital illite content.

There is very little cement in the rock. There are thin authigenic overgrowths on a few quartz and feldspar grains and some kaolin in the primary porosity.

Secondary porosity is evident where plagioclase blebs have been removed from perthite and as dissolution along cleavage planes in K feldspars (Figs 17 & 18). Micro porosity is associated with areas of intense sericite/illite alteration and with areas of kaolin cement.

5.8 ARCHER #1, SIDEWALL CORE 8, 3946 METRES

Hand specimen description
A light greenish grey, poorly sorted, fine to very coarse, angular, slightly micaceous feldsarenite with a few granules. This sample, although partly crushed, was received as an intact 2.5 cm length of core. A slow reaction with 10% HCl suggested some dolomitic cement. The sample had a very slight odour of hydrocarbons.

Thin section description
A poorly sorted, muddy, very coarse feldsarenite composed of angular to subangular coarse silt to granules (Figs 19 & 20).

Low strain (in uncrushed grains) and lines of vacuoles suggest that the quartz grains are dominantly of igneous origin. The feldspar grains are dominated by potassic varieties, microcline, microcline perthite and orthoclase. There is minor plagioclase but this has been heavily altered to sericite.

The sample has a high matrix component, especially when compared to the rest of the suite of samples. However, some of the silt and illite reporting in this classification could be an artifact of sidewall collection. Crushing could add to the silt fraction and squeezing of altered plagioclase grains could see sericite added to the matrix illite class.

The sample also shows more cement than others, particularly crystalline pyrite (Figs 21 & 22) and large booklets of kaolin, possibly dickite (Fig. 23).

Secondary porosity is evident in the form of plagioclase removal from perthite and dissolution of microcline and orthoclase along cleavage traces (Figs 19 & 20). There could be considerable micro porosity associated with the dickite cement and with sericite/illite alteration.

Table 2

Composition by Point Count - Archer #1 Sidewall Core

Sample Number	swc56	swc53	swc48	swc42	swc40	swc34	swc19	swc8
Depth (m)	3471.5	3488.5	3515	3591	3598	3681	3845.5	3946
Component %								
Framework Grains								
Quartz								
- igneous	46.0	49.0	52.5	51.2	47.3	53.0	54.0	55.0
- metamorphic	1.7	1.0	0.7	0.6	0.0	0.3	0.7	0.7
Feldspar								
- orthoclase	6.8	4.5	3.9	5.9	2.8	3.5	3.3	3.7
- microcline	20.2	23.0	24.3	22.5	24.7	17.4	16.7	17.0
- plagioclase	2.4	0.6	0.3	0.0	0.0	1.4	0.0	0.0
- sericite	3.8	4.3	2.5	2.0	2.1	4.9	3.0	0.7
Biotite	1.7	2.2	2.1	1.3	1.8	1.0	1.3	0.3
Muscovite	0.7	0.3	0.7	0.7	1.0	0.3	1.3	0.3
Sediment grains	0.0	0.3	0.3	0.0	0.0	0.0	0.0	0.0
Heavy minerals	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0
Cements and authigenic minerals								
Carbonate	8.5	0.0	0.3	0.0	7.4	0.0	0.0	0.0
Quartz	0.7	0.3	1.4	1.0	0.7	0.0	0.7	0.7
Feldspar	1.0	1.6	1.0	2.0	0.0	0.0	1.0	0.3
Pyrite	1.7	0.6	0.0	0.7	0.3	1.0	0.0	3.3
Kaolin	0.3	1.0	2.8	2.0	3.9	5.9	2.3	6.0
Illite	0.0	1.0	2.1	1.3	1.8	0.3	0.3	0.7
Matrix								
Kaolin	0.3	0.3	0.0	0.0	0.0	0.3	0.7	3.3
Illite	0.3	3.6	0.0	1.3	0.0	1.7	3.3	2.7
Silt	3.4	5.2	4.2	5.9	2.5	2.8	3.7	3.0
Porosity								
Dissolution	0.0	1.0	0.0	1.0	4.2	2.0	3.7	2.3

Table 3

Grainsize Analysis - Archer #1 Sidewall Core

Sample	Average grain size	Range	Std Dev.	Sorting
swc 56 3471.5m	1.67mm v. coarse sand	1.0-6.0mm v. fine sand to small pebble	1.4	poor
swc 53 3488.5m	0.75mm coarse sand	0.05-2.75mm coarse silt to granule	1.64	poor
swc 48 3515m	0.45mm medium sand	0.05-3.8mm coarse silt to granules	1.35	poor
swc 42 3591m	0.76mm coarse sand	0.05-3.0mm coarse silt to granules	1.63	poor
swc 40 3598m	0.44mm medium sand	0.05-1.75mm coarse silt to v. coarse sand	1.24	poor
swc 34 3681m	1.57mm v. coarse sand	0.1-6.0mm v. fine sand to small pebble	1.88	poor
swc 19 3845.5m	1.32mm v. coarse sand	0.05-4.6mm coarse silt to small pebble	1.89	poor
swc 8 3946m	1.17mm v. coarse sand	0.05-3.5mm coarse silt to granule	1.79	poor

6. CONCLUSIONS

The entire suite of 19 cuttings samples and 8 sidewall samples between 3390 metres and 3946 metres in Archer #1 show a remarkably similar depositional mineralogy throughout. This appears to be largely due to a single granitic source for all the clastic sediments.

Nearly all the quartz grains have low strain under crossed polars and lines of vacuoles, both indicators of high level igneous intrusives such as granites. The suite of feldspars support a granitic source. The suite is dominated by potassic varieties, microcline, microcline perthite and orthoclase. There are a few plagioclase grains in each sample but these are invariably highly altered. The consistent 1-5% mica in each sample is mainly biotite with some muscovite. The only grains which cannot be assigned to a granitic source are some chert fragments around 3400-3410 metres, a few metamorphic quartz grains throughout and rare reworked silts and possible altered and devitrified volcanics around 3570-3600 metres.

All the sandstones are both texturally and mineralogically immature. Grain size analysis showed that the standard deviation of the phi sizes lay between 1 and 2 for all samples, classifying them as poorly sorted. The measuring technique used did not account for much of the mud fraction so that the muddier samples probably would in truth have a standard deviation greater than 2 and be called very poorly sorted. The samples are all feldsarenites which would normally suggest moderate maturity but the single granitic source would preclude the availability of more labile components. The high feldspar content indicates the basin of deposition is proximal to the source with rapid weathering under cold conditions. The finer grained rocks and matrix associated with the sandstones show a moderate organic component, probably coaly, but with some marine indicators such as micritic carbonate and rare glauconite. (The glauconite may be a contaminant as it was only observed in the cuttings)

Most of the samples are only weakly cemented but certain levels show more complete cementation. In these cases, carbonate is the main cement, with kaolin playing an increasingly important role below 3600 metres. The carbonate was usually spar, probably dolomite, although this was underlain by earlier micrite in a few cases. Some of the carbonate cement is early in that it prevents alteration of the more labile grains, but much of it postdates alteration.

Pyrite cement was seen in many of the samples. Very finely disseminated pyrite infills some of the microporosity created by plagioclase alteration to sericite. Larger euhedral crystals grow in the matrix of the more poorly sorted samples.

Overgrowths on microcline were seen in most samples, but became less common with depth where they appear to have been removed by dissolution. The overgrowth mineral has been called "adularia", a low temperature, pure potassium end member microcline. SEM studies on samples from Anemone #1A show this mineral to have an unusually high potassium content when compared to microcline or orthoclase. The fact that overgrowths in all the Petrofina samples examined from Angler, Anemone and Archer are not in exact optical continuity with the underlying feldspar suggests that the mineralogy is not the same as the substrate. Where "adularia" is common, a high gamma response is expected on the logs due to the greater potassium content of the sample.

Authigenic quartz overgrowths form a minor component of the cement in the samples. This cement is often drusy, ie a number of small crystals rimming the framework grain. Quartz cement was more common in the cuttings samples where associated with chert, metamorphic grains and possible altered volcanics.

Very little clay cement was seen in the cuttings samples. This is probably due to clay removal during drilling and cuttings collection procedures. Most of the clay was associated with the matrix, often cemented by pyrite, micrite or spar. Both illite and kaolin occur as matrix. Illite and some kaolin result from the alteration of feldspars, particularly the more labile types, and from muscovite. Kaolin becomes an increasingly important cement with depth. Several sidewall cores show very coarse grained, vermiform stacks of kaolin platelets partially filling some of the primary porosity. This coarse authigenic form is probably dickite with the finer grained alteration form being kaolinite. Later authigenic illite grows on the kaolin.

Alteration is common in all samples. Plagioclase is the main mineral affected. Most grains show intensive sericitization. Although sericite is essentially illite, this term has been retained to distinguish between alteration of feldspars and muscovite, and authigenic pore-filling illite. Alteration increases with depth. Table 1 shows a steady increase with plagioclase being removed from perthite grains from 3400 metres down, then dissolution of microcline increasing from 3600 metres down. From 3700 metres onwards, microcline becomes increasingly sericitized and dissolved. The decline in adularia from 3600 metres may well be due to dissolution.

Sericite alteration introduces potassium to the rock, particularly in the case of plagioclase alteration. A Na-Ca feldspar alters to a K rich clay.

The other common form of alteration in this suite is biotite to chlorite. Usually a green clinochlore is the end product accompanied by the release of iron as pyrite. Rarely the distinctive pennite type of chlorite forms, with the consequent release of iron which precipitates as finely divided magnetite.

Alteration of feldspars and micas occurs within the sediment. Subgrains of these minerals trapped within quartzose composite grains remain unaltered as do grains protected by early, complete carbonate cementation.

Primary porosity is very difficult to assess in both cuttings and sidewall samples due to the disaggregation or crushing of the rock. Original high primary porosity is, however, indicated by the lack of clusters of grains and the abundance of individual grains in the cuttings, the lack of cement adhering to the framework grains and the lack of interactional boundaries to the grains. Low primary porosity is expected where there is a high matrix component or obvious carbonate or clay cement.

Secondary porosity is more easily seen in this suite of samples as it influences individual grains. Alteration to sericite introduces microporosity to a sample, but the effectiveness of this is limited by the nature of the sericite/illite and its interconnectedness via the primary pores. Feldspar dissolution was seen in most samples. This generally involved plagioclase, with parts of highly altered grains removed and the dissolution of blebs from perthite grains to give an obvious and characteristic "swiss cheese" texture. The samples from deeper in the hole also show dissolution of microcline, both as ragged edges to grains where dissolution has penetrated along cleavage traces and a vuggy texture in perthite grains where initial plagioclase dissolution has spread to the host mineral. This form of secondary porosity is likely to be effective as it enlarges pores, both primary and secondary. Ultimate effectiveness still depends on primary porosity.

Although this suite of samples has very similar original mineralogy, ultimate mineralogy varies with depth and is controlled by diagenesis. Because the diagenesis mainly involves potassium-rich minerals, it will influence the gamma ray signature of the sediments. This signature will already be high throughout due to the preponderance of potassium feldspars, 20-30% of most samples. The signature will increase with the abundance of sericitization and "adularia" overgrowth. The source of potassium is from deeper in the sediment pile and deeper in the basin where active dissolution of microcline and its overgrowths is observed.

The diagenetic sequence includes the following events:-

Minor compaction (bent micas)
Early carbonate cement (micrite and spar)
Alteration of biotite to chlorite
Alteration of plagioclase to sericite
Pyrite cement
Authigenic quartz and adularia overgrowths
Later carbonate spar
Kaolin cement
Kaolin alteration of microcline and muscovite
Illite growth on kaolin
Late compaction (suturing and stylolites)

Not all stages are observed in each sample as the sequence is largely depth controlled. Some stages may well be concurrent.

Very few indications of hydrocarbons were observed in any of the samples. Sample collection and thin section preparation mitigate against the preservation of light oil and condensate. Some bitumen or heavy oil was observed trapped along stylolites and sutured contacts between grains but as these are interpreted to be late stage events, it gives little assistance to timing the movement of hydrocarbons through the rock with respect to its cementation.

7. FIGURES AND CAPTIONS

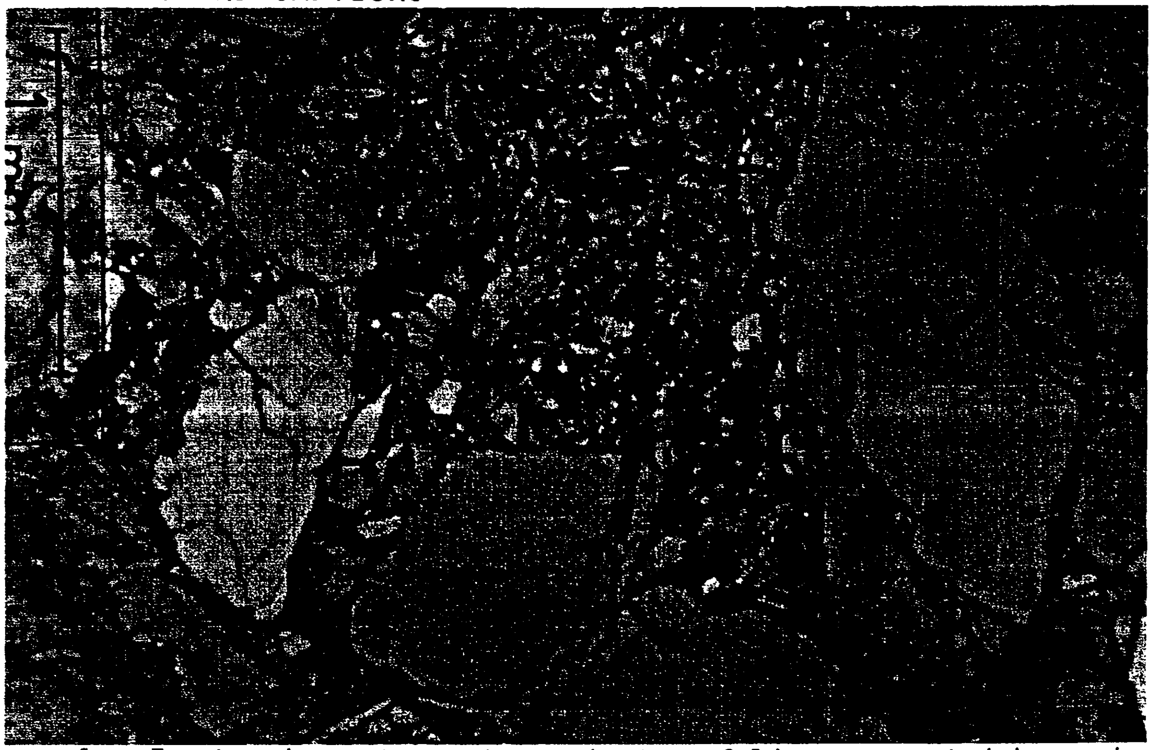


Figure 1. Fractured quartz grains and minor feldspar cemented by carbonate micrite and spar (the higher relief area in the centre of the scene). Crushing has reduced the evidence of primary porosity. Archer #1, sidewall core 56, 3471.5 m. Plane polarized light. Scale bar 1mm.

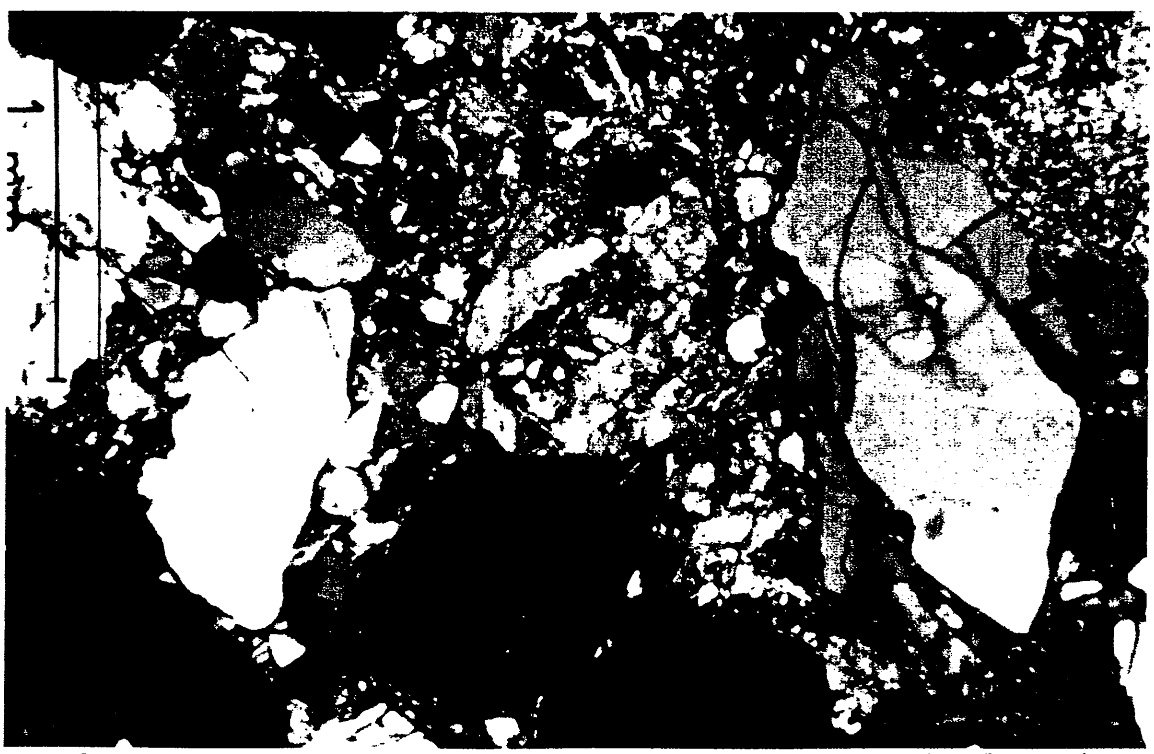


Figure 2. The same field of view as Figure 1 under crossed polars shows the carbonate cement as yellow and brown areas. A highly altered plagioclase grain (P) is now a mass of sericite with some finely dispersed pyrite.

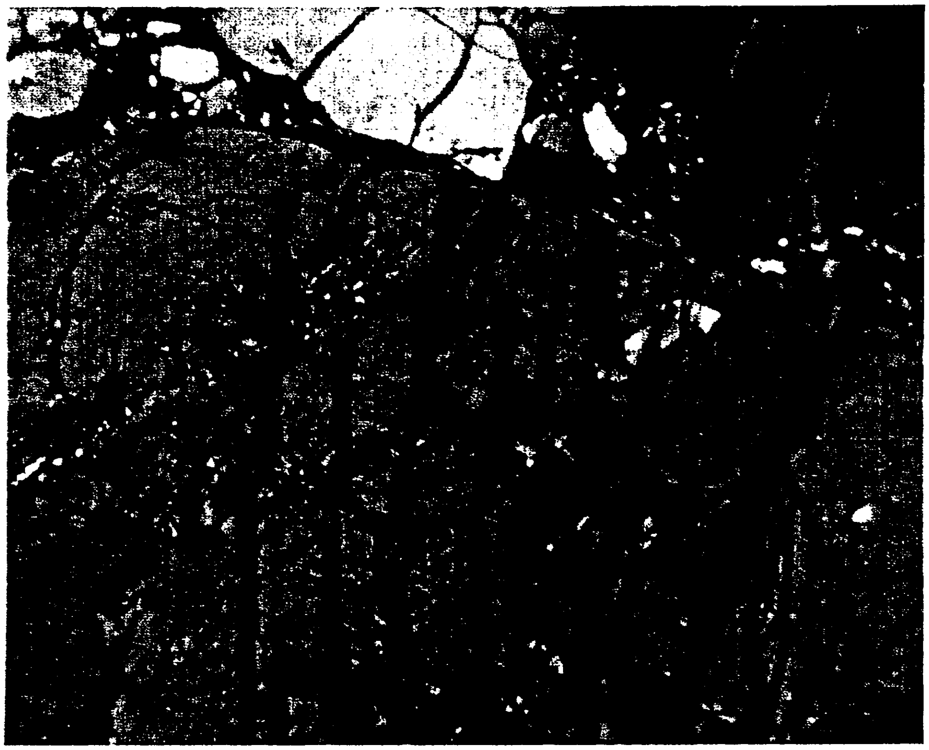


Figure 3. Detail of a grain of microcline perthite under crossed polars shows white blebs of plagioclase altered to sericite with associated secondary porosity (arrowed). Archer #1, sidewall core 56, 3471.5 m. Scale bar 250 microns.

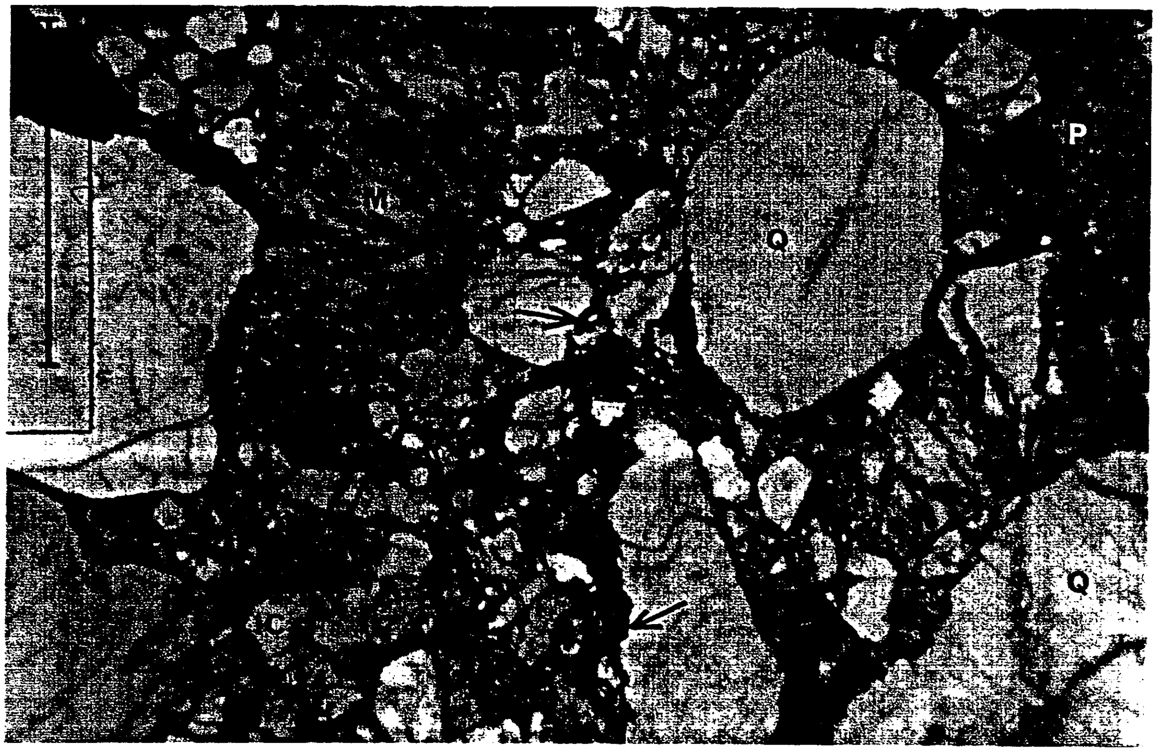


Figure 4. Quartz (Q), microcline (M), plagioclase (P) and composite grains (C) in a silty illitic matrix. The microcline has darkened patches of sericite alteration while the plagioclase has completely altered. The composite grain consists of quartz, perthite (with altered plagioclase) and biotite. A late stage compactional stylolite contains some bitumen. Archer #1, sidewall core 53, 3488.5 m. Plane polarized light. Scale bar 1mm.

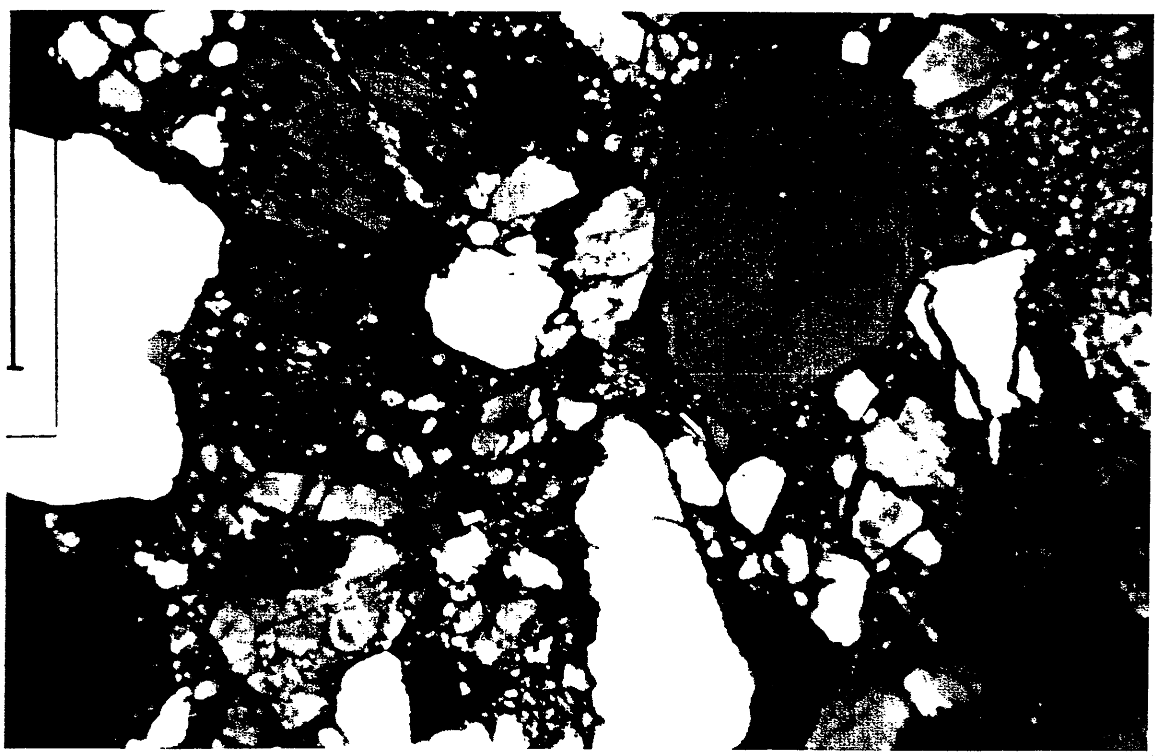


Figure 5. The same field of view as Figure 4 under crossed polars allows clearer definition of the crushed and altered grains and the illitic nature of the matrix (speckled yellow).

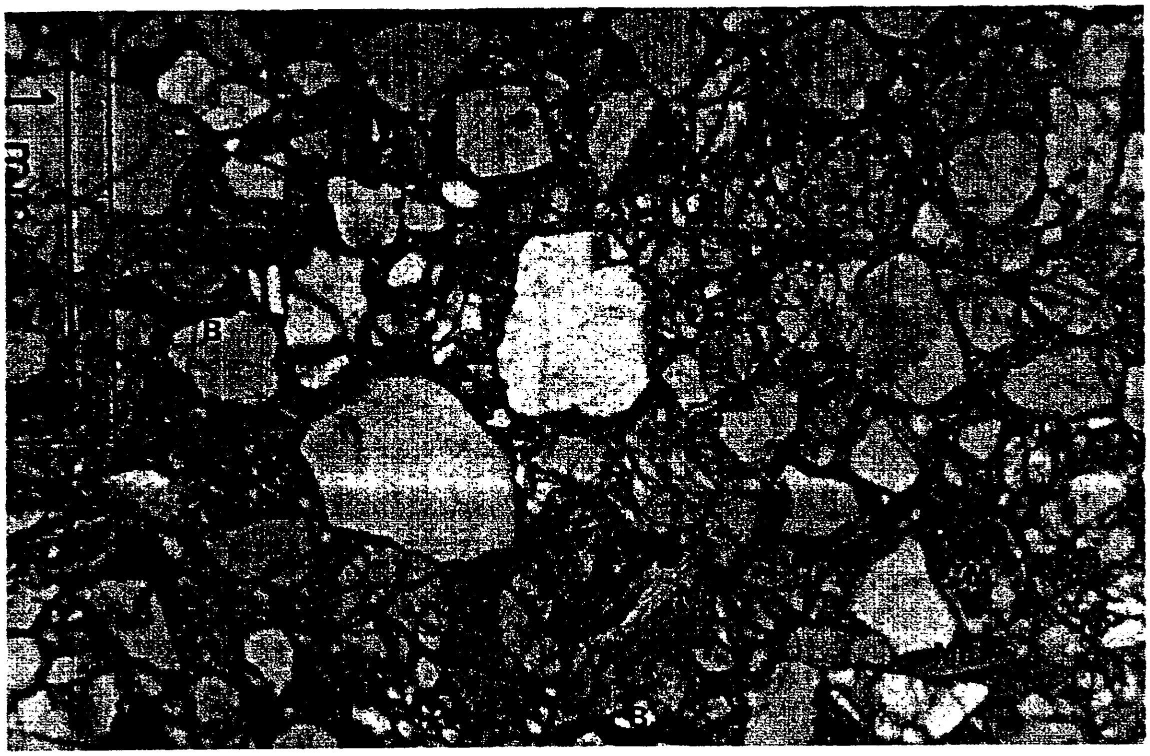


Figure 6. Virtually uncemented, angular to subrounded grains of quartz, microcline, plagioclase (P), biotite (B) and muscovite (Mu). The plagioclase shows complete alteration to sericite while one microcline (M) shows an overgrowth of adularia. Although the grains are largely shattered by sidewall collection, there has been little crushing of the sample, leaving primary porosity reasonably intact. Archer #1, sidewall core 48, 3515 m. Plane polarized light. Scale bar 1mm.

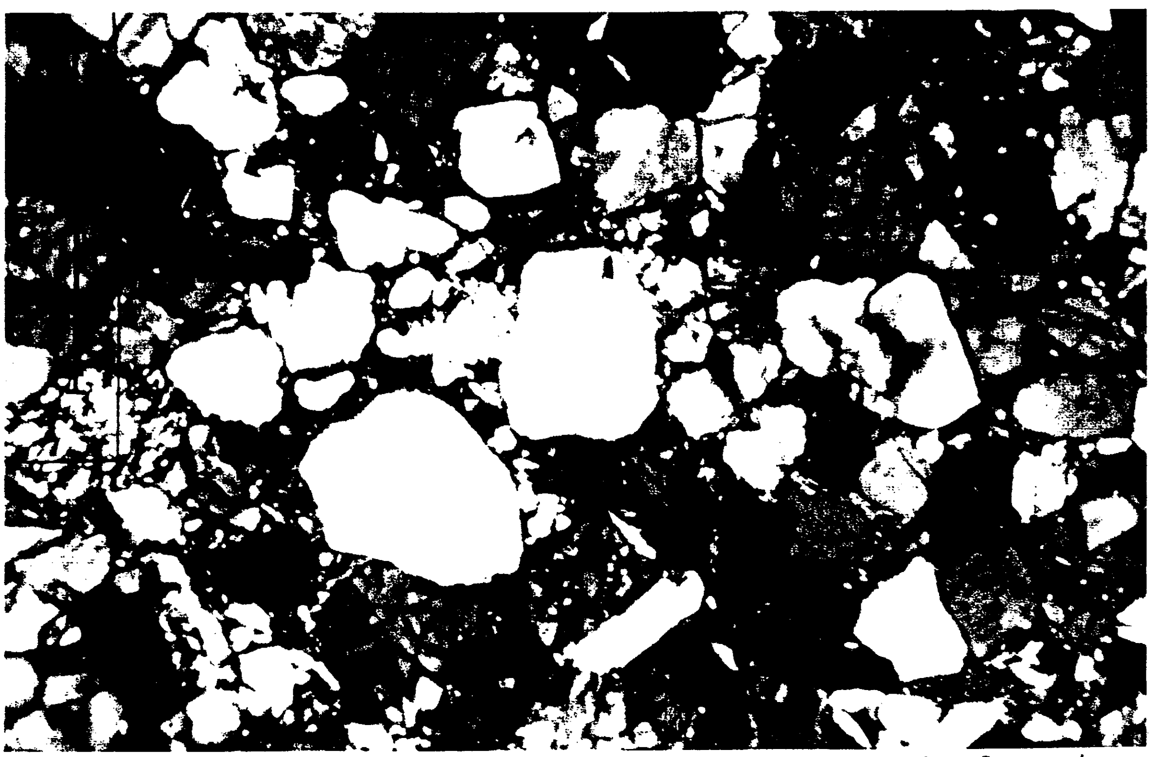


Figure 7. The same field of view as Figure 6 under crossed polars shows the mica grains and sericitic plagioclase as birefringent yellow areas.

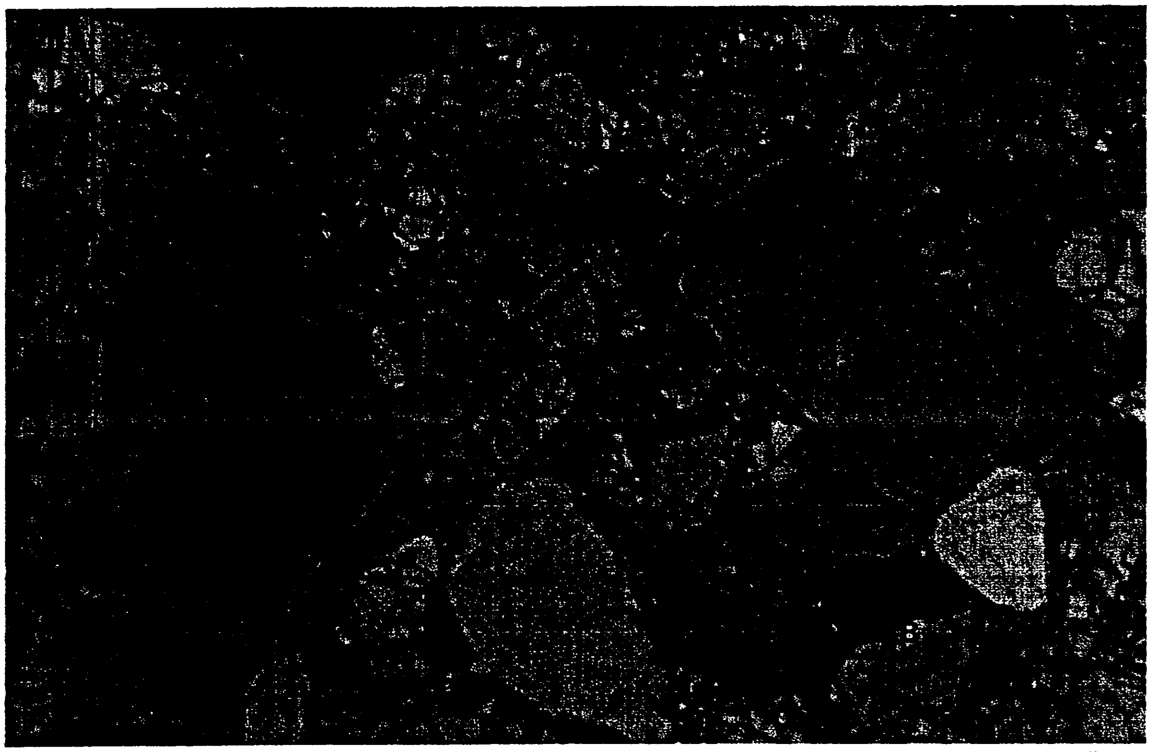


Figure 8. A shattered and crushed feldsarenite. Much of the brown "matrix" areas are silt-sized crushed grains. The quartz (Q) has a thin overgrowth. The biotite grains (B) have completely altered to green chlorite. Archer #1, sidewall core 42, 3591 m. Plane polarized light. Scale bar 1mm.

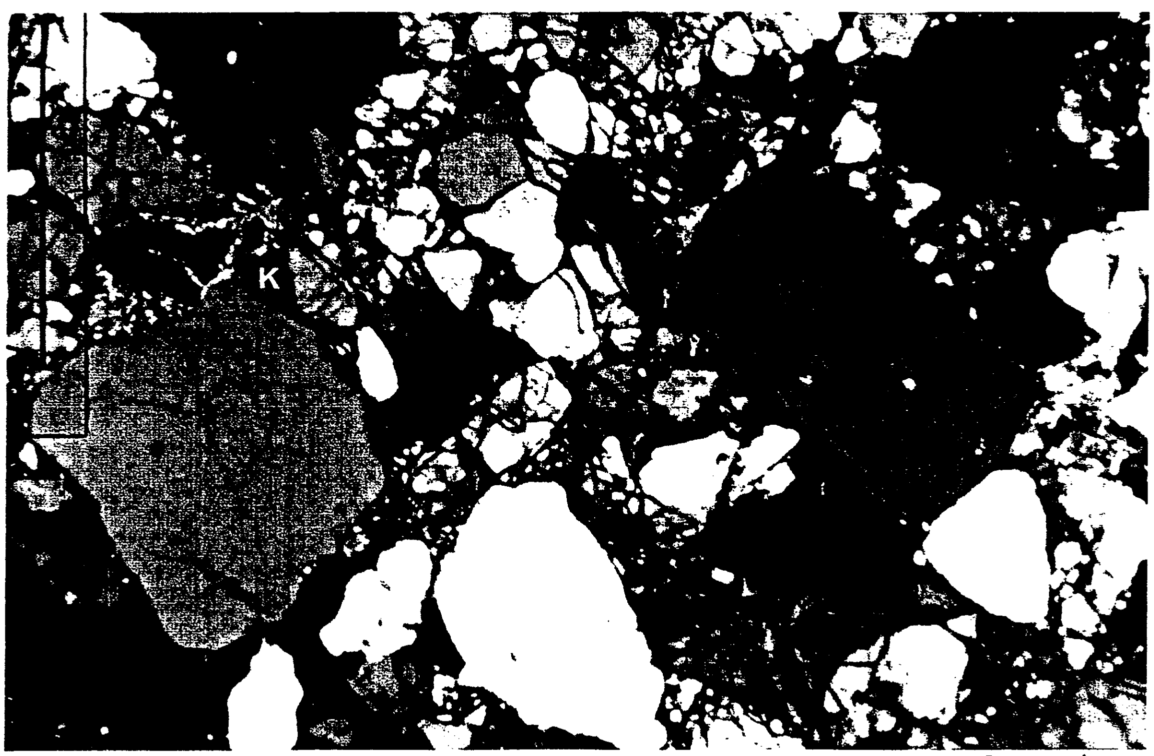


Figure 9. The same field of view as Figure 8 under crossed polars shows the complete alteration of biotite to low birefringent chlorite. Some kaolin (K) fills parts of the primary porosity. Crossed polars also groups areas of crushed silt into recognizable larger grains.

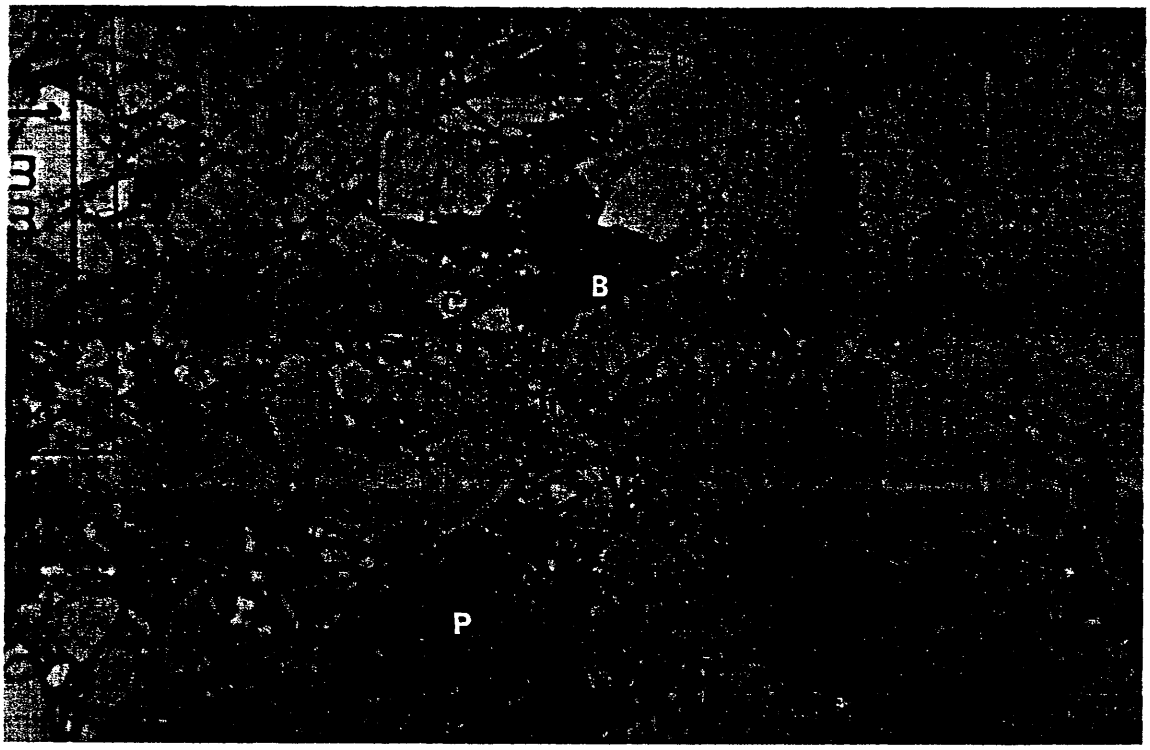


Figure 10. Shattered and partly crushed grains in a feldsarenite. Brown biotite (B) alters to green chlorite (Ch). A large plagioclase grain (P) is sericitized and partly dissolved. A microcline (M) shows partial dissolution to create microporosity. There are some knots of carbonate cement (C). Archer #1, sidewall core 40, 3598 m. Plane polarized light. Scale bar 1mm.

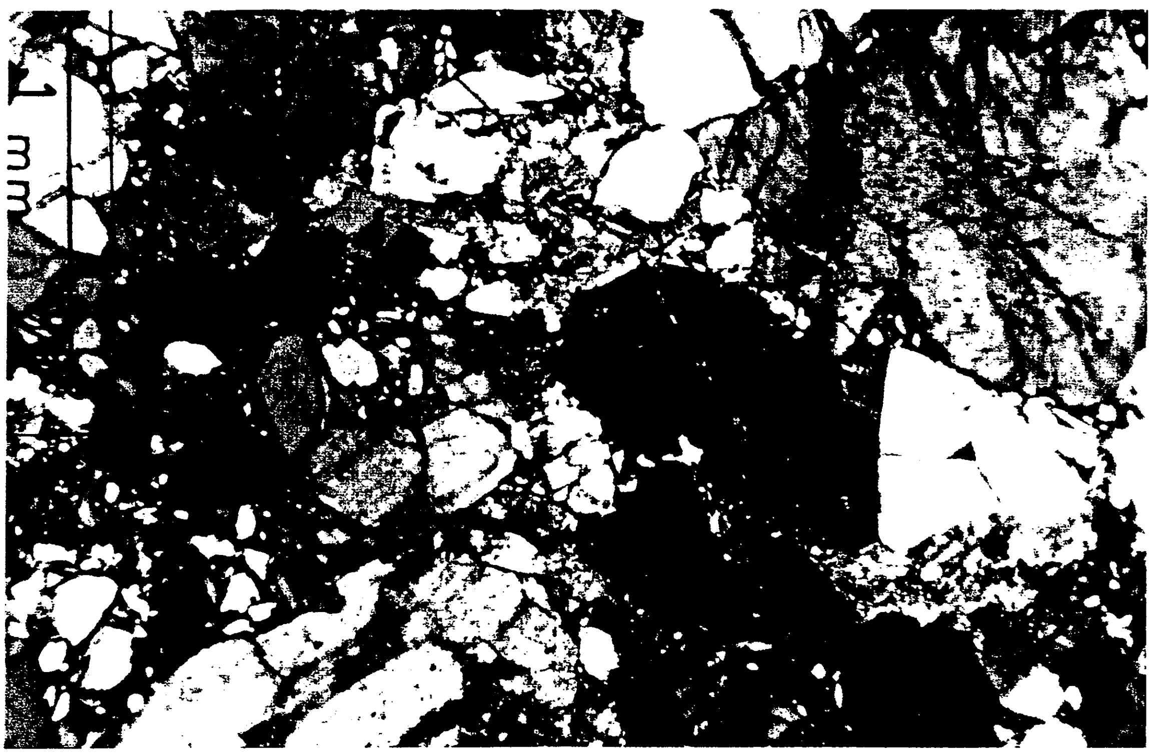


Figure 11. The same field of view as Figure 10 under crossed polars clearly shows the original extent of some of the crushed grains. Orange biotite and yellow carbonate areas are easily distinguishable. Archer 31, sidewall core 40, 3598 m.

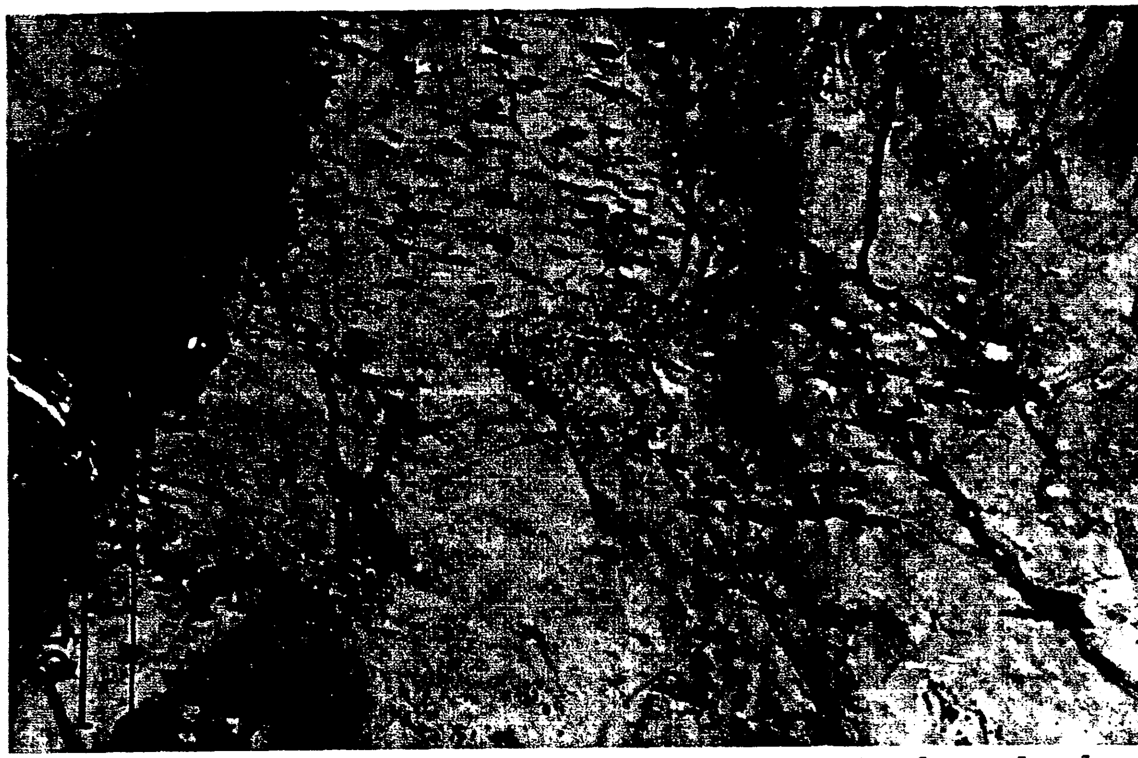


Figure 12. Detail of a microcline grain under crossed polars clearly shows white plagioclase blebs in one half of the grain that have been dissolved to create black microporosity in the other half. Archer #1, sidewall core 40, 3598 m. Scale bar 250 microns.

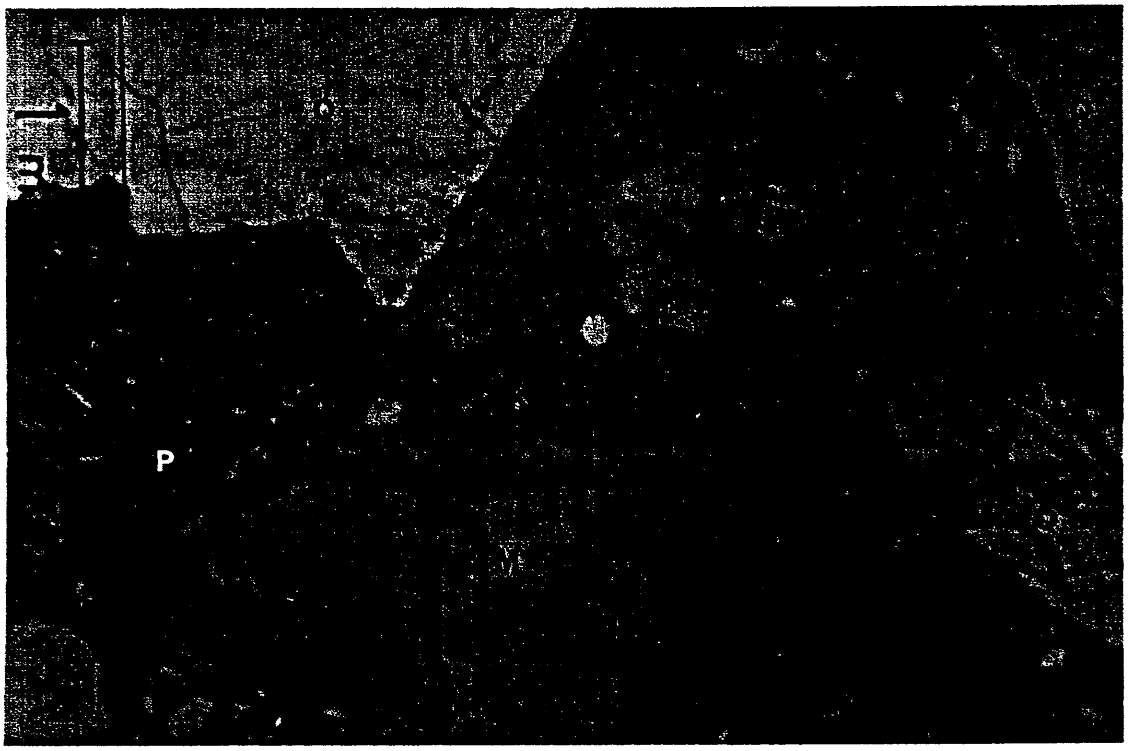


Figure 13. Large grains of quartz (Q) and microcline (M) and biotite (B) loosely held by kaolin (K) which partly fills the primary porosity. The plagioclase grain (P) has completely altered to sericite and created considerable secondary porosity. Archer #1, sidewall core 34, 3681 m. Plane polarized light. Scale bar 1mm.

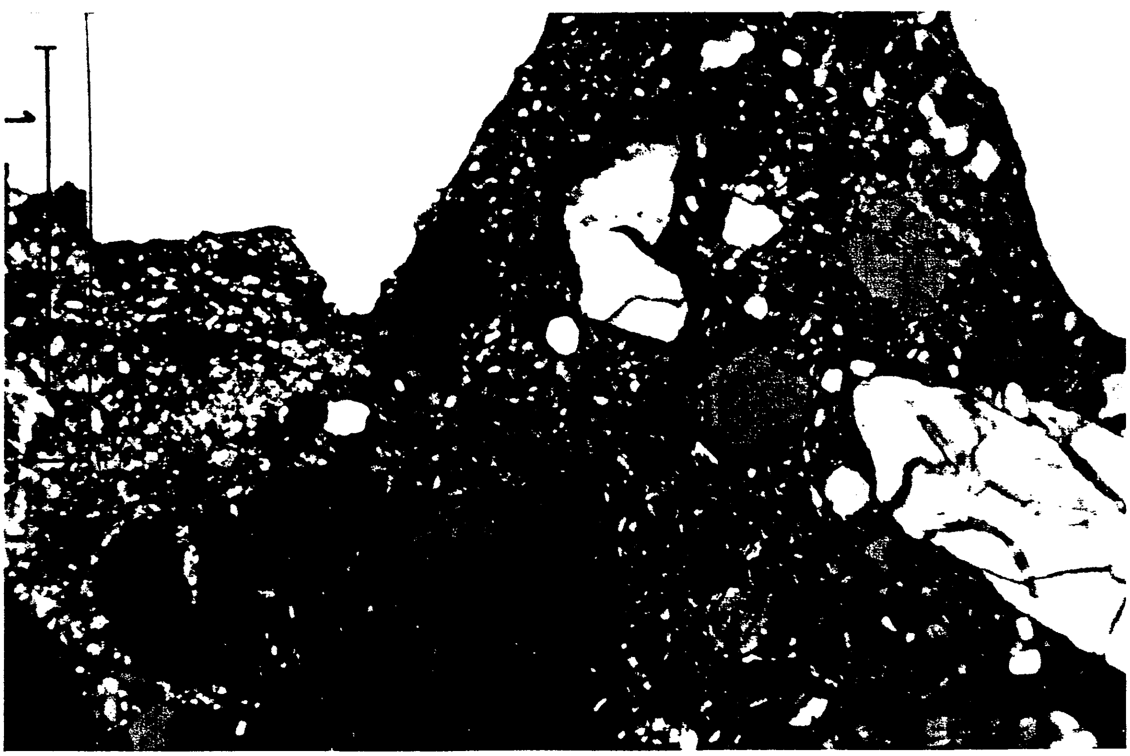


Figure 14. The same field of view as Figure 13 under crossed polars allows the distinction between yellow birefringent sericite and grey birefringent kaolin.

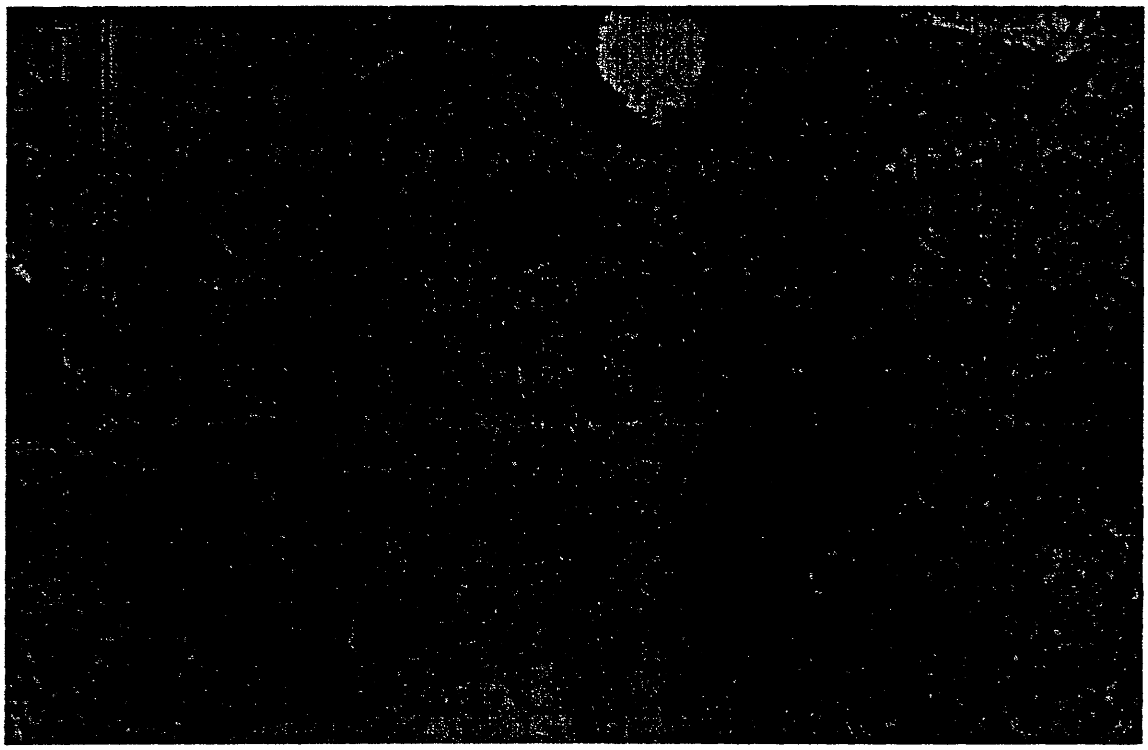


Figure 15. Detail of the pore filling kaolin in the centre of the field of view of Figures 13 and 14 shows the considerable amount of microporosity (blue) associated with this cement. Archer #1, sidewall core 34, 3681 m. Scale bar 250 microns.

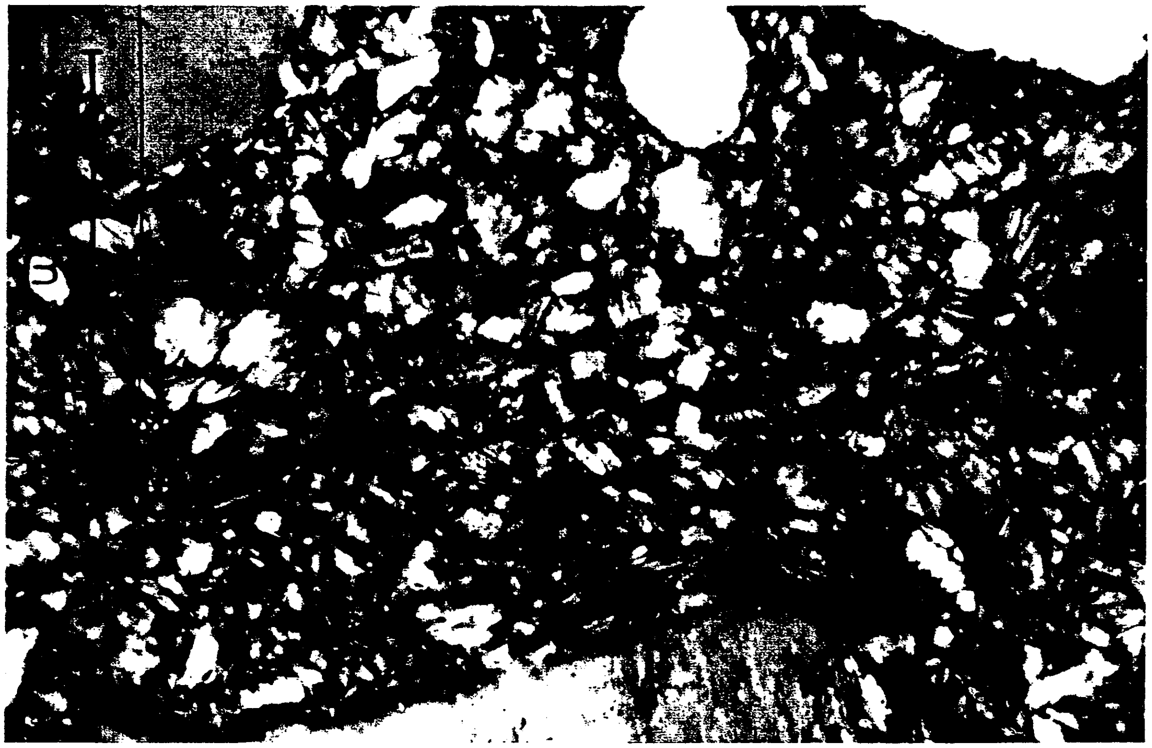


Figure 16. The same field of view as Figure 15 under crossed polars shows vermiform stacks of large pseudo-hexagonal platelets of kaolin. The size of the plates suggests that the mineral may be dickite, a specific form of kaolin.

Figure 17. A poorly sorted feldsarenite with large grains of quartz (Q), microcline (M) and perthite (Pe). The perthite shows development of secondary porosity within the grain where plagioclase has dissolved and around the margins where dissolution has enlarged the primary porosity (arrowed). The microcline grains also show dissolution along cleavage traces. Archer #1, sidewall core 19, 3845.5 m. Plane polarized light. Scale bar 1mm.

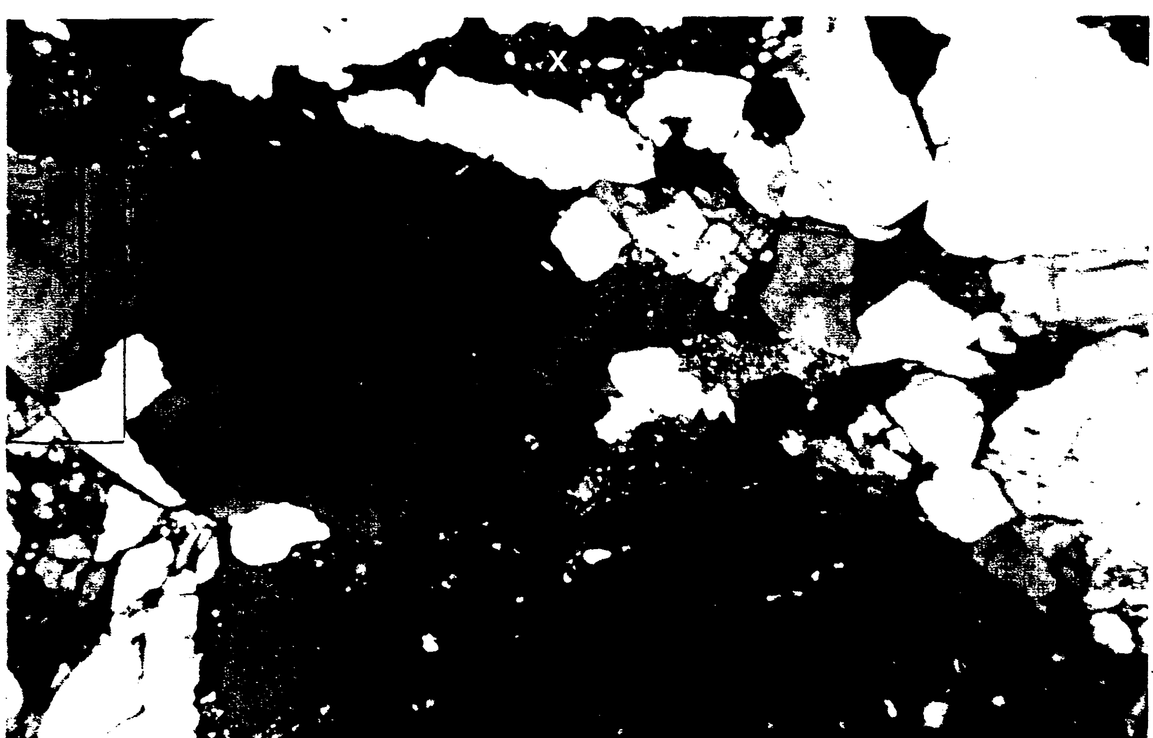


Figure 18. The same field of view as Figure 17 under crossed polars shows altered biotite as yellow and an area of matrix in the top centre of the scene (X).

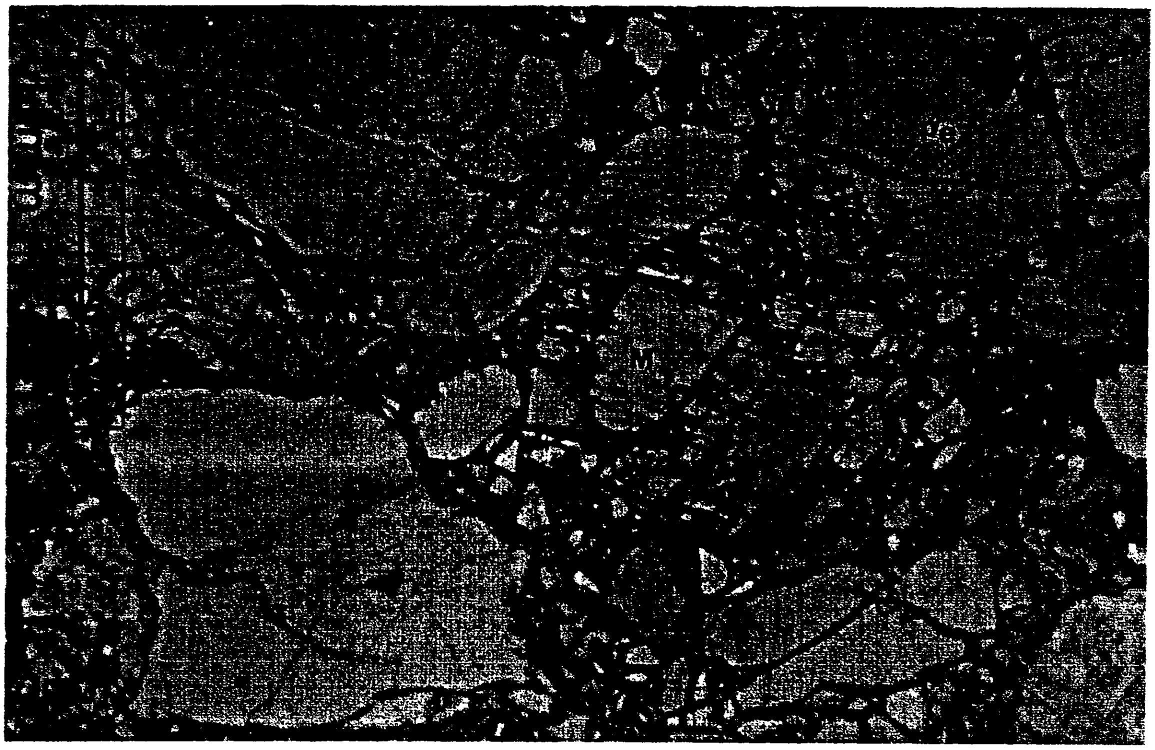


Figure 19. Relatively intact quartz grains and fractured microcline (M) and perthite (Pe) grains in a brown, silty, illitic matrix with lighter brown kaolin cement. The microcline shows dissolution along cleavage traces while the perthite shows complete plagioclase removal and further dissolution to open up large effective secondary porosity. Archer #1, sidewall core 8, 3946 m. Plane polarized light. Scale bar 1mm.

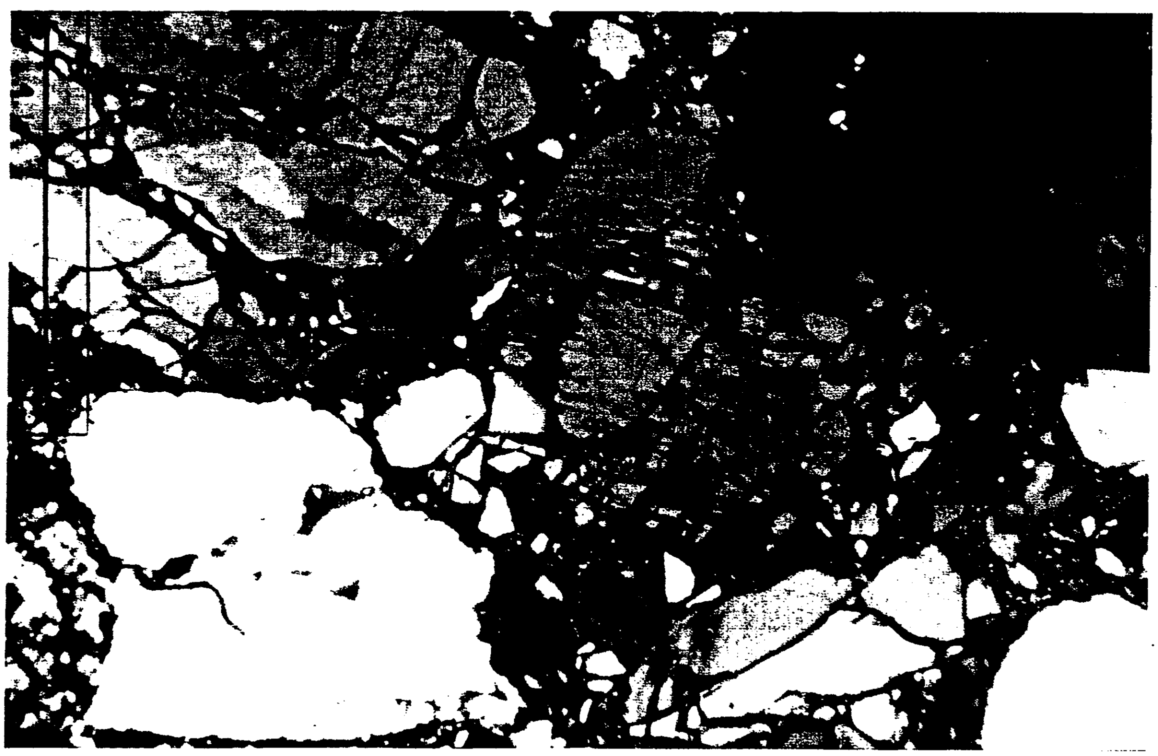


Figure 20. The same area as Figure 19 under crossed polars shows the extent of the yellow speckled illitic matrix.

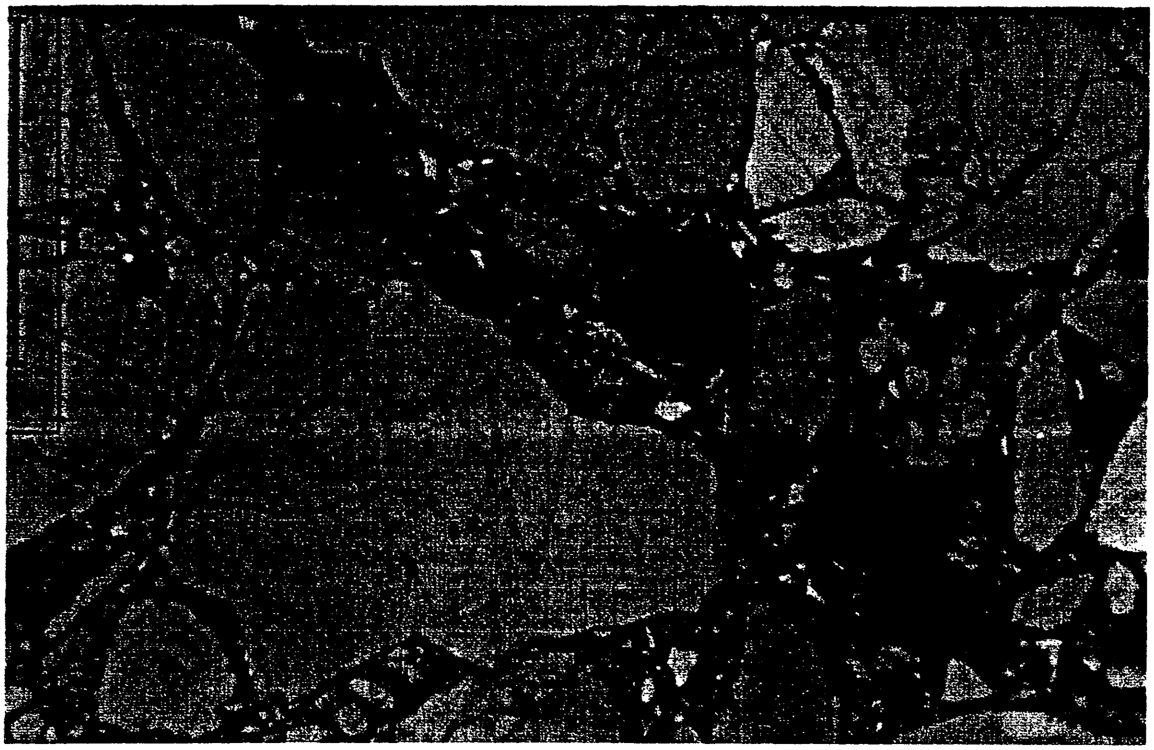


Figure 21. Large euhedral pyrite crystals grow in the matrix. Archer #1, sidewall core 8, 3946 m. Plane polarized light. Scale bar 1mm.

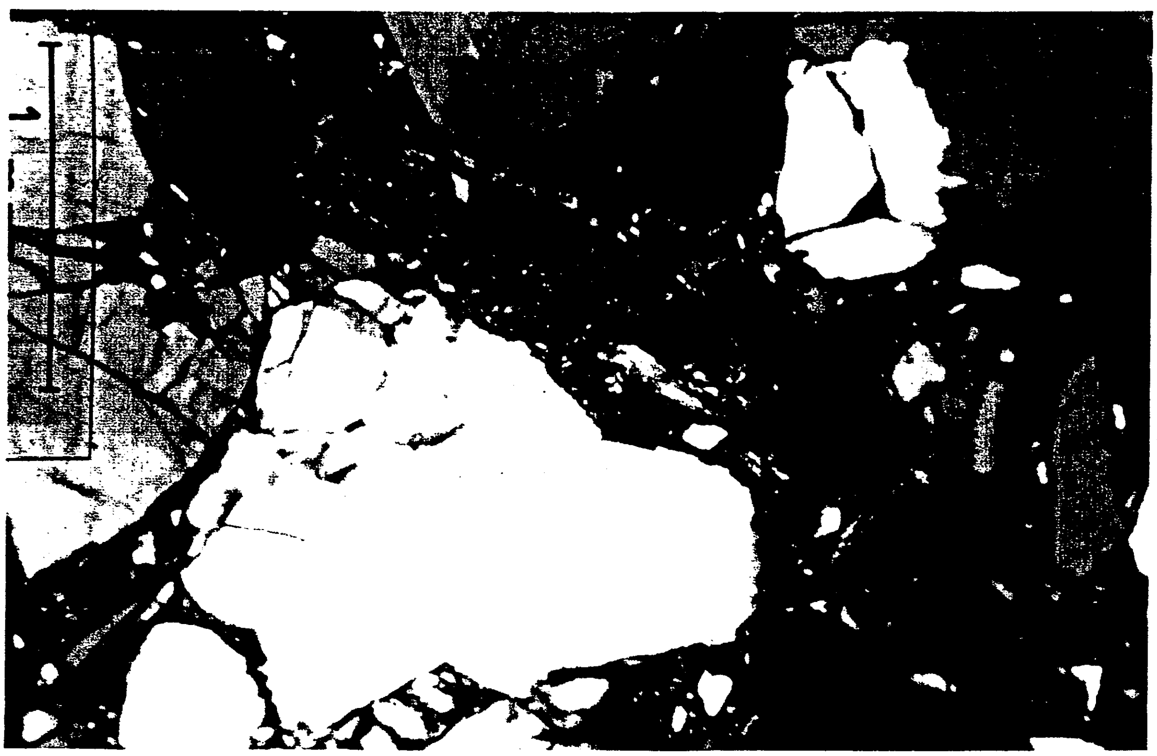


Figure 22. The same field of view as Figure 21 under crossed polars shows the matrix to contain both illite (yellow) and kaolin (grey).

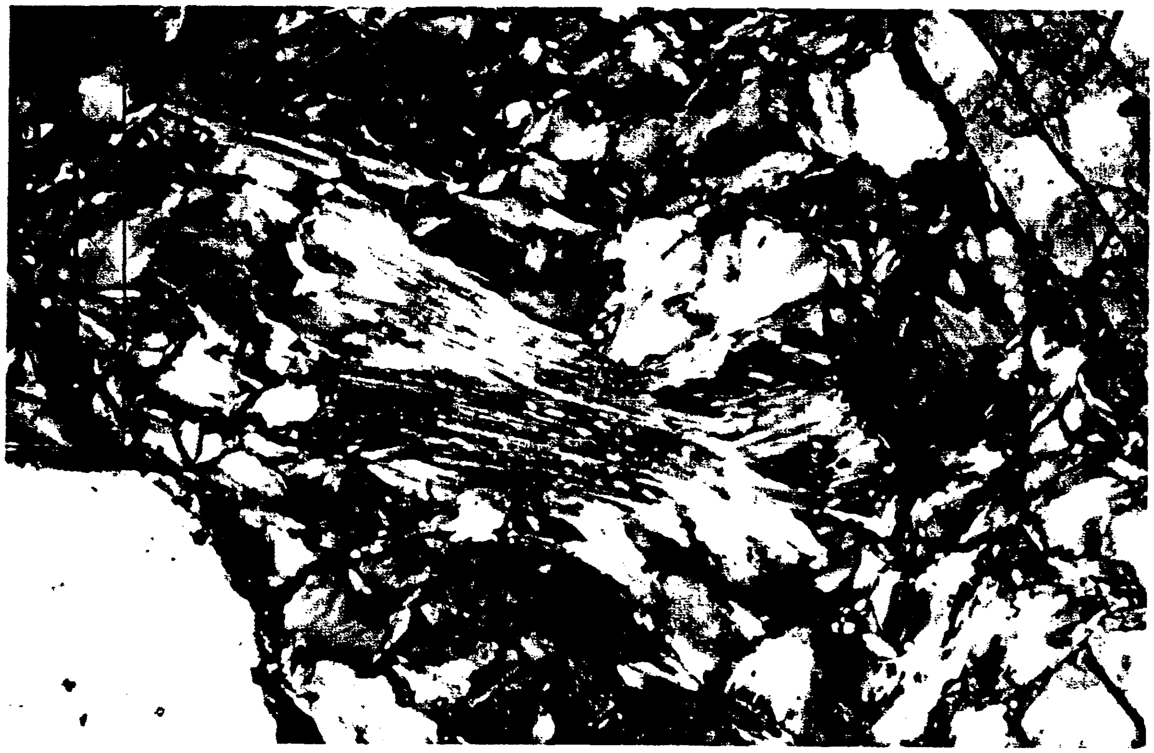


Figure 23. Detail from this slide under crossed polars shows the alteration of muscovite to kaolin, possibly dickite. A yellow and blue grain of muscovite splays the cleavage plates as alteration to stacked plates of kaolin progresses. The kaolin completely fills some of the primary porosity. Archer #1, sidewall core 8, 3946 m. Scale bar 250 microns.

APPENDIX 7

WELL COMPLETION REPORT

ARCHER-1

INTERPRETATIVE DATA

A P P E N D I X 7

PALYNOLOGY

PALYNOLOGY OF PETROFINA ARCHER-1, GIPPSLAND BASIN, AUSTRALIA

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for PETROFINA EXPLORATION AUSTRALIA SA JULY 1990

PALYNOLOGY OF PETROFINA ARCHER-1

BY

ROGER MORGAN

CONTENTS

I SUMMARY

2400m (cutts)-2550m (cutts) : lean P. tuberculatus Zone : Oligocene : offshore marine : immature

2560m (cutts) : extremely lean probably upper N. asperus Zone : late Eocene : marine : immature

2580m (cutts)-2630m (cutts) : lower N. asperus Zone (2580-2600m D. heterophlycta Dinoflagellate Zone, 2630m W. echinosuturata Dinoflagellate Zone) : Middle Eocene : offshore marine : immature

2640m (cutts)-2700m (cutts) : lean but apparently all L. balmei Zone (2700m apparently E. crassitabulata Dinoflagellate Zone but contains a single M. druggii specimen presumed reworked) : Paleocene : marine : immature

2715m (cutts)-2730m (cutts) : upper T. longus Zone (M. druggii Dinoflagellate Zone) : Maastrichtian : nearshore marine : immature

2785m (cutts)-3085m (cutts) ; lower T. longus Zone : Maastrichtian : non-marine : immature

3120m (cutts)-3260m (cutts) : upper T. lilliei Zone (non-marine part) : early Maastrichtian - late Campanian : non-marine : immature

3280m (cutts)-3519m (swc) : lower T. lilliei Zone (I. korojonense Dinoflagellate Zone) : Campanian : nearshore to marginal marine : immature

3595m (swc)-3869m (swc) : upper N. senectus Zone (less marine part) : Campanian : marginally marine to

non-marine : marginally mature for oil, immature for gas/condensate

3897m (swc)-4035m (swc) : lower N. senectus Zone (3897-3962 N. aceras Zone) : Campanian : marginally marine to offshore marine : marginally mature for oil, immature for gas/condensate

II INTRODUCTION

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

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

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

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

FIGURE 1 ZONATION FRAMEWORK

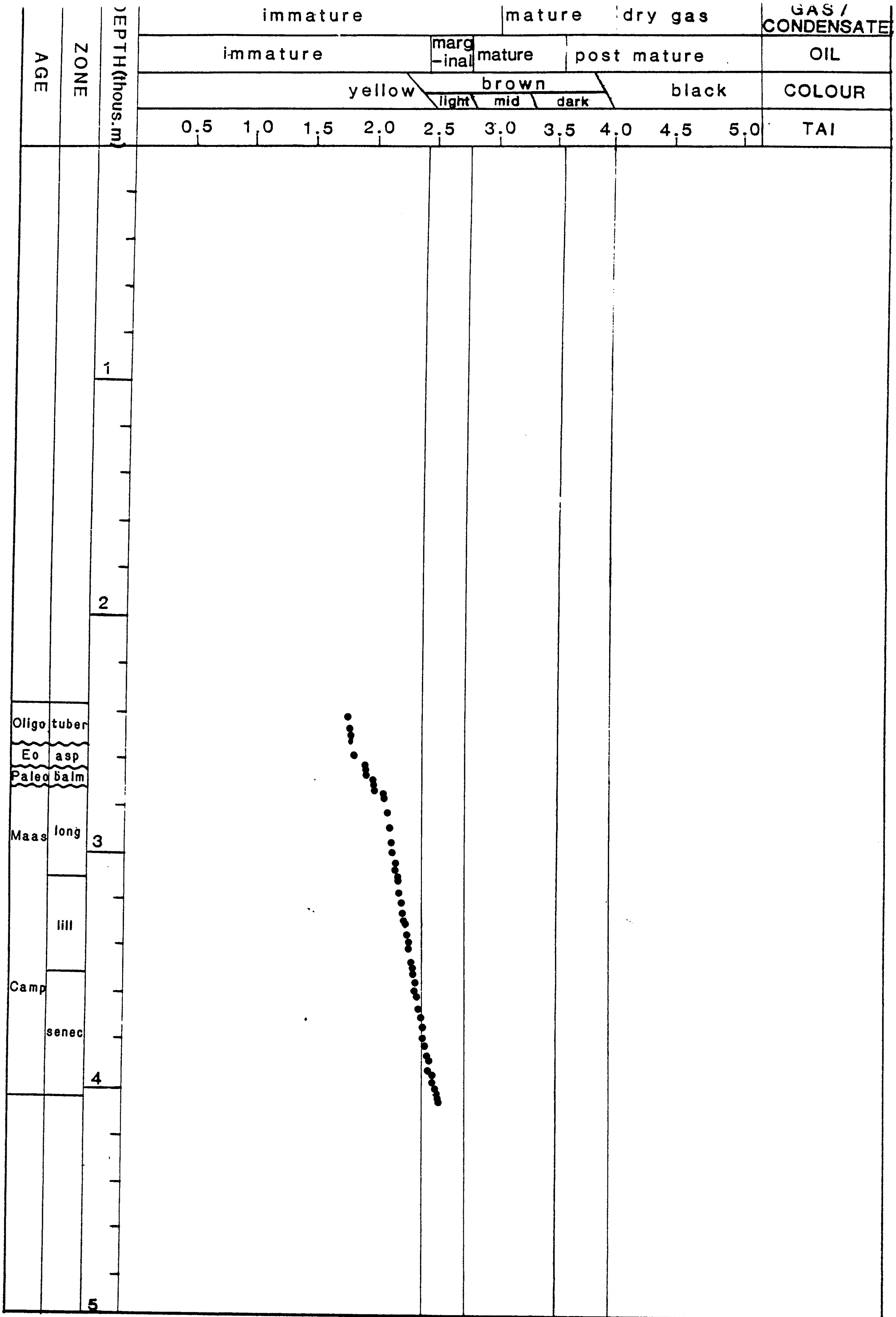

FIGURE 2 MATURITY PROFILE ARCHER 1

III PALYNOSTRATIGRAPHY

A 2400m (cutts)-2550m (cutts) : P. tuberculatus Zone

Assignment to the Proteacidites tuberculatus Zone is indicated by the consistent presence of Cyatheacidites annulatus without younger indicators. Yields are generally poor but C. annulatus, Falcisporites, Nothofagidites and Proteacidites are frequent amongst the subordinate spores and pollen.

Dinoflagellates dominate (60 to 95% of palynomorphs) and are moderately diverse given the poor yields. Common components are Spiniferites spp and Operculodinium spp., indicating the dinoflagellate correlatives of the P. tuberculatus Zone.

Offshore marine environments are indicated by the dominant and diverse dinoflagellates.

Colourless palynomorphs indicate immaturity for hydrocarbons.

B. 2560m (cutts) : lean -? upper N. asperus Zone

This sample was extremely lean and is strictly speaking indeterminate. However, Nothofagidites spp. are common and the Oligocene indicators are absent. Dinoflagellates were too rare to be diagnostic. Assignment to the middle or upper N. asperus Zone is indicated by exclusion from the zonal assignments above and below, and the middle N. asperus Zone is usually quite distinctive. The upper N. asperus Zone is therefore most likely.

The presence of subordinate dinoflagellates indicates nearshore marine environments.

Colourless palynomorphs indicate immaturity for hydrocarbons.

C. 2580m (cutts)-2630m (cutts) : lower N. asperus Zone

Assignment to the lower Nothofagidites asperus Zone is indicated by the dinoflagellates, as the spore pollen are subordinate (5-10% of palynomorphs), of low diversity , and not zone diagnostic. Common forms include Proteacidites, Cyathidites and Haloragacidites. Rare forms include Proteacidites pachypolus, Kuylisporites waterbolkii, Banksieacidites elongatus and Malvacipollis diversus, confirming the zonal assignments.

The dinoflagellates are common, diverse and distinctive. At 2580m (cutts) Deflandra heterophlycta, Kisselovia coleothrypta and Tritonites tricornis indicate the D. heterophlycta dinoflagellate Zone in an Operculodinium dominated assemblage. At 2600m (cutts), D. heterophlycta, Rhombodinium glabrum, Achilleodinium biformoides and abundant Homotriblium tasmaniense indicate the D. heterophlycta zone in a H. tasmaniense and Areoligera senonensis dominated assemblage. At 2630m (cutts) common Areosphaeridium multicornutum and H. tasmaniense indicate the W. echinosuturata dinoflagellate zone.

Offshore marine environments are indicated by the common and diverse dinoflagellates, rare spores and pollen, and common amorphous sapropel (particularly at the base of the interval).

Colourless palynomrphs indicate immaturity for hydrocarbon generation.

D. 2640m (cutts)-2700m (cutts) : L. balmei Zone

These samples are all extremely lean of in situ palynomorphs, with significant Oligocene and Eocene caving. Amongst the in situ palynomorphs, the presence of Lygistepollenites balmei and Gambierina rudata without younger or older markers indicates the L. balmei zone. Oldest Proteacidites incurvatus at 2650m (cutts) may indicate the base of the upper L. balmei Zone, but could also be caved. At 2700m, youngest Tricolpites longus occurs, (suggesting penetration of the Cretaceous) but it is considered reworked.

Dinoflagellates include significant caving, but Deflandrea speciosus and D. medcalfii indicate generally Paleocene ages. At 2700m, Eisenackia crassitabulata and frequent Glaphyrocysta retiintexta indicate the mid Paleocene E. crassitabulata dinoflagellate zone, but could be caved a short distance, and actually exist in the interval 2680-2700m. A single specimen of Manumiella druggii was also recorde3d at 2700m (suggesting penetration of the Cretaceous) but is considered reworked. Clearly it is possible that the Cretaceous occurs in this interval but cuttings confuse the issue.

Environments are marine because of the in situ dinoflagellates, but the lean Paleocene and extent of caving precludes accurate extimates of content and diversity.

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

E. 2715m (cutts)-2730m (cutts) : upper T. longus Zone

These samples are extremely lean and contain 80% caved Paleocene and Eocene. The rare spore pollen include G. rudata and Tricolpites longus indicating the T. longus zone.

Dinoflagellates include frequent M. druggii at 2715m (rare at 2730m) and indicate the M. druggii dinoflagellate zone, correlative with the upper T. longus spore pollen zone. It is possible that the middle T. longus zone also exists in this interval, masked by lean yields and caving in these cuttings.

Nearshore marine environments are indicated by the low diversity in situ dinoflagellates.

Light yellow spore colours indicate immaturity for hydrocarbon generation.

F. 2785m (cutts)-3085m (cutts) : lower T. longus Zone

Assignment is indicated at the top by youngest Tricolpites confessus, T. waiparaensis, Tricolporites lillei, Triporopollenites sectilis and the dominance of Nothofagidites endurus over Gambierina rudata. At the base, oldest consistent Tetracolporites verrucosus (below this point it is inconsistent and considered caved), indicates the assignment. Plant debris dominate all residues with cuticle fragments and amorphous sapropel diluting the scarce spores and pollen. N. endurus and Proteacidites are common, with frequent T. confessus at 2865-2910 and 3005m. T. longus is rare in this well, and T. verrucosus is more consistent.

Non-marine environments are indicated by the abundant plant debris, common and diverse spores and pollen, and absence of dinoflagellates (other than trace caved Tertiary taxa).

Yellow spore colours indicate immaturity for hydrocarbon generation.

G. 3120m (cutts)-3260m (cutts) : upper T. lillei Zone

Assignment is indicated at the top by the absence of consistent T. verrucosus above, and at the base by diverse dinoflagellates. Residues are swamped by plant debris, with consistent and diverse spores and pollen. Nothofagidites and Proteacidites are consistently common, with consistent T. confessus, T. sectilis and T. lillei.

Non-marine environments are indicated by the abundant plant debris, diverse spores and pollen, and probably lack of in situ dinoflagellates. The few dinoflagellate seen are probably all caved.

H. 3280m (cutts)-3519m (swc) : lower T. lillei Zone

Assignment is indicated at the top on youngest diverse dinoflagellates particularly Isabelidinium cretaceum, and at the base on oldest T. lillei and T. waiparaensis and supported by oldest T. sectilis at 2497m. In the interval, Proteacidites and Nothofagidites are consistently common, with P. mawsonii and T. gillii intermittently frequent.

Dinoflagellates include youngest I. cretaceum and I. pellucidum (greenense) at the top, and oldest I. pellucidum and I. pellucidum (greenense) at the base, and indicate the Isabelidinium korojonense dinoflagellate zone. Within the interval, very rare dinoflagellates occur (3285-3315m) and include I. cretaceum. Dinoflagellates comprise 3% of palynomorphs 3350 (cutts)-3380m (swc), dominated by I. pellucidum (greenense). Dinoflagellates are absent 3400m (swc)-3470m (swc), but again comprise 2% of palynomorphs with common I. pellucidum (greenense) at 3497m (swc). At 3519m, Cyclopsiella is abundant with frequent I. pellucidum (greenense) in a diverse microplankton assemblage comprising 20% of palynomorphs.

Nearshore to marginal marine environments are indicated by the frequent and diverse dinoflagellates at the base becoming less frequent and less diverse upwards.

Yellow to light brown spore colours indicate immaturity for hydrocarbons.

I. 3595m (swc)-3869m (swc) : upper N. senectus Zone

Assignment is indicated at the top on the absence of the T. lillei zone markers listed above, and at the base on youngest Nelsoniella spp. Within the interval, Cyathidites, Nothofagidites and Proteacidites dominate, in relative low diversity assemblages. Many samples are lean, and the interval 3610-3732m is especially so.

Dinoflagellates lack formal zone indicators. At the top (3576-95m) they are frequent with Cyclopsiella, Trithyrodinium suspectum, T. "marshallii" and Exochosphaeridium phragmites frequent. Dinoflagellates are rare or absent in the almost barren samples 3610-3732m. Dinoflagellates are absent from the average yielding samples 3762-3810m which are considered non-marine. Dinoflagellates comprise 5% of palynomorphs at the base with Cyclopsiella and Isabelidinium variable frequent at 3841.5m, and T. suspectum frequent at 3869m.

Marginally marine to non-marine environments are indicated by the low content and diversity of the dinoflagellates and their absence respectively.

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

J. 3897m (swc)-4035m (swc) : lower N. senectus Zone

Assignment is indicated at the top by youngest Nelsoniella spp. and at the base by oldest Nothofagidites senectus. Within the interval, Proteacidites, Falcisporites and Cyathidites are the most common. T. confessus occurs down to 4002m, and N. endurus and T. sabulosus to 4035m.

Dinoflagellates include Nelsoniella spp in the interval 3897-3962m, indicating the N. aceras dinoflagellate zone. In this interval, dinoflagellates are common and diverse, with Chatangiella victoriensis, Isabelidinium variabile and T. suspectum common. Nelsoniella semireticulata occurs in the interval 3911-3962m while N. aceras occurs in the interval 3940-3962m. Below this, C. victoriensis and I. variabile dominate at 3969m while I. variabile is the most common dinoflagellate in a meagre assemblage at 3977-4002m. At 4035m, only a single dinoflagellate was seen.

Environments show a progressive deepening from marginally marine at 4002-4035m to nearshore marine 3969-77m and offshore marine 3897-3962m.

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

IV REFERENCES

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

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

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

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

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

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

APPENDIX 8

APPENDIX

WELL COMPLETION REPORT

ARCHER-1

INTERPRETATIVE DATA

A P P E N D I X   8

MICROPALAEONTOLOGICAL ANALYSIS

MICROPALAEONTOLOGICAL ANALYSIS, ARCHER-1, GIPPSLAND BASIN

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July, 1990.

C O N T E N T S

I. SUMMARY

Archer-1 was drilled in offshore petroleum permit Vic P/20, Gippsland Basin to a depth of 4050mKB. Ditch cuttings from 1000m to 2690m have been examined for foraminifera. A summary of the biostratigraphic and environmental subdivision is given below:-

Planktonic Foraminiferal Subdivision

1000m	:	Zones A3 & A4	Late-Middle Pliocene
1200m	:	Zones B1 & B2	Early Pliocene-Late Miocene
1310m	:	Zones B2 & C	Late-upper Middle Miocene
1330m-1700m	:	Zone D1	mid Middle Miocene
1900m	:	Zone D2	lower Middle Miocene
2000m	:	Zone E1	basal Middle Miocene
2140m	:	?Zone F	?upper Early Miocene
2160m	:	Zones F & G	upper-mid Early Miocene
2300m	:	Zone G	mid Early Miocene
2550m	:	Zone J2	lower Early Oligocene
2565m	:	Zones J2 & K	lower Early Oligocene-upper Late Eocene
2580m	:	Zone K	upper Late Eocene
2600m	:	Zone N	upper Middle Eocene
2640m-2690m	:	Indeterminate	

Environment of Deposition

Samples 1000-1400m inclusive	:	outer neritic-upper bathyal
Samples 1560-2300m inclusive	:	upper bathyal
2550m	:	undifferentiated marine
Samples 2565-2600m inclusive	:	undifferentiated neritic
Samples 2640-2690m inclusive	:	indeterminate

II. INTRODUCTION

A total of 20 ditch cuttings samples have been scrutinized for foraminifera from the interval 1000m to 2690m in Archer-1. Fossil assemblages identified in the well section, interpreted zonation and depositional environment subdivision have been plotted on the distribution chart (Enclosure No. 1).

III. BIOSTRATIGRAPHIC ANALYSIS

The planktonic foraminiferal letter zonal scheme of Taylor (in prep.) is used for biostratigraphic subdivision.

1. 1000m : Zones A3 & A4 (Late-Middle Pliocene)

   The abundance of the Globorotalia inflata group and the lack of post-Zone A3 index species indicates that the cuttings sample at 1000m is assignable to Zones A3 and A4.

2. 1200m : Zones B1 & B2 (Early Pliocene-Late Miocene)

   Assignment to Zones B1 and B2 is based on the occurrence of Globorotalia acostaensis and the lack of Turborotalia mayeri (top Zone C index species) and the Globorotalia inflata group (base Zone A4 defining event). Minor Globorotalia inflata recorded in the sample is interpreted to have caved downhole.

3. 1310m : Zones B2 & C (Late-upper Middle Miocene)

   The cuttings sample at 1310m includes very rare Turborotalia aff. mayeri together with minor Globorotalia miotumida, and lacks Globorotalia acostaensis. The assemblage is probably near the boundary between Zones B2 and C.

4. 1330m-1700m : Zone D1 (mid Middle Miocene)

   The association of Globorotalia praescitula and Globorotalia miozea miozea in the interval, and the lack of several taxa with known last appearances in Zone D2 (Globigerinoides sicanus, Orbulina suturalis and Praeorbulina glomerosa), indicates that the interval is assignable to Zone D1.

5. 1900m : Zone D2 (lower Middle Miocene)

   The sample at 1900m is assigned to Zone D2 on the basis of the association of Globigerinoides sicanus, Orbulina suturalis and Orbulina universa.

6. 2000m : Zone E1 (basal Middle Miocene)

   The rich planktonic foraminiferal fauna at 2000m includes frequent Orbulina suturalis together with minor Praeorbulina glomerosa. On this basis the sample is assigned a Zone E1 age although it is possible it may be older (Zone E2 or even Zone F) if Orbulina suturalis has caved downhole. The lack of Orbulina universa (base Zone D2 index species) however indicates that Orbulina suturalis is likely to be in-situ.

7. 2140m : ? Zone F (? upper Early Miocene)

   The occurrence of minor Globigerinoides sicanus and very low numbers of younger index species (e.g. Orbulina group) indicates a probable Zone F assignment for the sample at 2140m.

8. 2160m : Zones F & G (upper-mid Early Miocene)

The occurrence of common Globigerinoides trilobus and frequent Globorotalia miozea miozea indicates an age no older than Zone G. The presence of several specimens of Globigerinoides sicanus, and the lack of younger index species, suggests a Zone F assignment. It is possible however that the specimens of Globigerinoides sicanus have caved downhole. For that reason the cuttings sample at 2160m is assigned to Zones F and G.

9. 2300m : Zone G (mid Early Miocene)

The sample at 2300m includes common Globigerinoides trilobus, and lacks Globigerinoides sicanus, and on this basis is assigned to Zone G.

10. 2550m : Zone J2 (lower Early Oligocene)

The cuttings sample at 2550m is assigned to Zone J2 on the basis of the association of Subbotina angiporoides and Turborotalia gemma, and the lack of Subbotina linaperta.

11. 2565m : Zones J2 & K (lower Early Oligocene-upper Late Eocene)

The cuttings sample at 2565m contains frequent Subbotina angiporoides. Although the Zone K index species Subbotina linaperta was not recorded, it is interpreted that the sample may be as old as Zone K. The lack of Subbotina angiporoides minima indicates an age no older than Zone K.

12. 2580m : Zone K (upper Late Eocene)

The occurrence of minor Subbotina linaperta, and the lack Subbotina angiporoides minima, indicates that the cuttings sample at 2580m is assignable to Zone K.

13. 2600m : Zone N (upper Middle Miocene)

The occurrence of rare Subbotina angiporoides minima, and lack of pre-Zone N index species, is consistent with a Zone N assignment.

14. 2640m-2690m : Indeterminate

The cuttings in the interval contain moderate to low yielding planktonic foraminiferal faunas. Unfortunately the majority of these taxa represent cavings from higher in the well section. The interval lacks in-situ index species.

IV. ENVIRONMENT OF DEPOSITION

1. **Samples 1000m-1400m inclusive : Outer neritic-upper bathyal**

   The calcilutites in the interval contain rich foraminiferal faunas with the percentage of planktonics generally exceeding 80%. The diverse benthonic faunas include: Euuvigerina peregrina group (frequent-abundant), Pleurostomella (rare), Siphouvigerina proboscidea (rare-few) and Pullenia bulloides (rare-few). Sporadic and rare occurrences of Planulina aff. wuellerstorfi (rare at 1200m), Globobulimina pacifica (rare at 1000m) and Melonis aff. pompilioides (rare at 1310m) indicates a bathyal setting. The assemblage as a whole however is consistent with deposition in an outer neritic to upper bathyal environment.

2. **Samples 1560m-2300m inclusive : Upper bathyal**

   The samples of calcareous claystone and calcilutite in the interval are interpreted to have been deposited in an upper bathyal environment. The rich foraminiferal faunas are dominated by planktonics with the percentage generally ranging from 85% to 97%. The benthonic assemblages include Hoeglundina cf. elegans (few at 1560m), Pullenia bulloides (rare-few), Siphouvigerina proboscidea (rare-few), Pleurostomella (rare-few), Osangularia (rare at 2140m and 2160m) and Hyperammina (rare-few at 2160m and 2300m).

3. **2550m : Undifferentiated marine**

   The high proportion of caved taxa restricts environmental interpretation. The occurrence of in-situ Zone J2 planktonic foraminifera indicates deposition in an undifferentiated marine environment.

4. **Samples 2565m-2600m : Undifferentiated neritic**

   The cuttings in the interval contain minor to common pelletal glauconite (fresh and oxidised grains). In-situ benthonic foraminifera are lacking although a single specimen of Bathysiphon angleseaensis was recorded in the sample at 2600m. Deposition in an undifferentiated neritic environment seems likely given the occurrence of pelletal glauconite and in-situ planktonic foraminifera in the interval.

5. **Samples 2640m-2690m inclusive : Indeterminate**

   The interval comprises essentially caved foraminifera from higher in the well section. No environmental assessment is possible although the relatively common occurrence of pelletal glauconite in all cuttings samples suggests probable deposition in a neritic setting.

V. REFERENCES

TAYLOR, D.J., (in prep.). Observed Gippsland biostratigraphic sequences of planktonic foraminiferal assemblages.

APPENDIX NO. 1: SUMMARY OF MICROPALAEONTOLOGICAL DATA, ARCHER-1

CUTTINGS SAMPLE	FORAM YIELD	FORAM PRESERV.	FORAM DIVERSITY
1000m	high	mod/poor	moderate
1200m	high	moderate	mod/high
1310m	high	mod/poor	moderate
1330m	high	moderate	moderate
1400m	high	moderate	mod/high
1560m	high	moderate	mod/high
1700m	high	moderate	mod/low
1900m	mod/high	poor	moderate
2000m	mod/high	moderate	mod/low
2140m	mod/high	moderate	mod/low
2160m	high	poor	mod/high
2300m	high	mod/poor	high
*2550m	mod/low	mod/poor	moderate
*2565m	low	poor	low
*2580m	low/very low	poor	low
*2600m	low/very low	poor	low
*2640m	low/very low	poor	low
*2650m	low/very low	poor	low
*2670m	very low	poor	very low
*2690m	moderate	poor	mod/low

* moderate to very high proportion of caved taxa.

PE900806

This is an enclosure indicator page.
The enclosure PE900806 is enclosed within the container PE902094 at this location in this document.

The enclosure PE900806 has the following characteristics:

ITEM_BARCODE =	PE900806
CONTAINER_BARCODE =	PE902094
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BASIN =	GIPPSLAND
PERMIT =	VIC/P20
TYPE =	WELL
SUBTYPE =	DIAGRAM
DESCRIPTION =	Archer 1 Micropaleontological Distribution Chart. Enclosure from appendix 8 of WCR volume 3.
REMARKS =	
DATE_CREATED =	31/07/90
DATE_RECEIVED =	4/09/90
W_NO =	W1021
WELL_NAME =	Archer-1
CONTRACTOR =	International Stratigraphic Consultants Pty Ltd.
CLIENT_OP_CO =	Petrofina Exploration Australia S.A.

(Inserted by DNRE - Vic Govt Mines Dept)

APPENDIX 9

APPENDI

WELL COMPLETION REPORT

ARCHER-1

INTERPRETATIVE DATA

A P P E N D I X   9

SEDIMENTARY INTERPRETATION REPORT AND LOG

PETROFINA EXPLORATION AUSTRALIA S.A.

Sedimentological Interpretation of the Latrobe Group in Archer-1 and Revision of Anemone-1,1A

GL/90/062
PhL/kl
17 August 1990

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1. SUMMARY

The interpreted sedimentary facies at Archer-1 were essentially similar to their counterparts at Anemone-1,1A, and were not, contrary to expectation, significantly more proximal. Interpretations at Anemone-1,1A have been revised, mainly in the UK1, Top UK2 and Upper UK4 Sequences, to fit in with the Archer-1 interpretation. These intervals are now interpreted as lower coastal plain deposits with minor marine incursions rather than entirely marine as previously thought.

Below the Top Latrobe Group Unconformity, shallow marine shoreface units of Palaeocene and Late Maastrichtian age grade downwards to an alternating sequence of non-marine coastal plain and coastal sediments. These persist down to the top of the Mid Campanian Upper UK3 Sequence. In comparison to Angler-1 and the other wells in the permit, coal beds are not well developed in either Anemone-1,1A or Archer-1.

The lower part of Unit UK3.1, at the base of the Latrobe Group, was deposited under transgressive marine conditions and contains thick coastal sandstones with excellent reservoir characteristics. The upper part of the Unit was deposited under regressive, deltaic conditions.

The Campanian Golden Beach Group (Upper UK2 Sequence) is composed of three sub-units, with the two lower sub-units representing regressive marine sedimentary cycles and the upper unit being a non-marine sequence. The basal parts of each of the two lower sub-units comprise lower shoreface and offshore shales, coarsening upwards to upper shoreface sandstones. The uppermost sub-unit is a lower coastal plain sequence of sandstones; siltstones and minor coals. The interval includes good reservoirs (Campanian '2' Sandstones or Zone 7) sealed by marine shales.

The Santonian UK2.1 Sequence, intersected only at Anemone-1,1A, comprises upper delta front and stream mouth bar sandstones overlying the near-shore to back-shore sandstones and siltstones of the UK1 Sequence. The reservoir potential of these Santonian Sandstones (UK2.1 and UK1 Sequences) has been adversely affected by diagenesis and especially by recrystallisation of the feldspars.

2. INTRODUCTION

A detailed sedimentological study of the Latrobe and Golden Beach Groups has been carried out at Archer-1. The section studied is from 2640m (Top Latrobe Group) to 4050m (TD), a thickness of 1410m.

The study of Archer-1 induced some revisions of the interpretation of Anemone-1,1A, which is situated 1.8 km to the northeast and which shows a similar range of facies. This report includes the new and revised interpretations of the two wells and will discuss variations within each of the intervals between the two wells.

All available wireline logs were used in this study, including the MSD processed dipmeter log. Results from sidewall cores, cuttings descriptions and palynological results were also integrated in this work. The interpretation has been compiled as a sedimentological log (Encls. 1 and 2), incorporating the composite log, the MSD dipmeter log (tadpoles and SHDT resistivity traces), and the sedimentary interpretations. The section below the Top Latrobe Group Unconformity has been divided into ten distinct sequences, each of which is described in Section 3. The sequence definition is based on seismostratigraphic analysis.

3. LATROBE GROUP SEDIMENTARY INTERPRETATION

Three main depositional environments have been identified in the Latrobe Group at Archer-1 and Anemone-1,1A. These are shallow marine, deltaic and lower coastal plain environments, similar to those previously described in the other wells situated in the Central Deep in VIC/P20 (Questiaux and Tringham 1988). Figure 1 schematically illustrates a typical log for the four depositional environments and their sub-environments, while Table 1 summarizes their main diagnostic features.

4. WELL INTERPRETATION RESULTS

4.1 The UK1 Sequence (Lower Santonian Sandstone)

The UK1 Sequence was penetrated by Anemone-1,1A only, between 4629.5m and 4775m bkb (TD), a total of 145.5m. The poor log quality (caving effects) and absence of dipmeter data in this interval made the sedimentary interpretation difficult. However, on the basis of the basin evolution study, this sequence is now interpreted as having been deposited under near-shore to back-shore conditions in the Anemone area.

The general upward increase in sandstone content in this interval may be related to the increase of marine influence near the top, leading to the marine transgression clearly evident in the overlying sequence.

4.2 The UK2.1 Sequence (Upper Santonian Sandstone)

This sequence was also penetrated only by Anemone-1,1A, in the interval 4525m to 4629.5m bkb. A marine transgression at 4629.5m bkb marks the base of this sequence, with pro-delta siltstones lying directly above the unconformity passing rapidly upwards into massive stacked stream mouth bar sandstones. The interval as a whole shows an upward-coarsening trend indicating a regressive depositional cycle dominated by compositionally and texturally immature sandstones with high feldspathic contents.

Reservoir properties of this interval have been greatly affected by diagenesis, especially by recrystallisation of the feldspars, with almost no primary porosity preserved in the sandstones.

4.3 The Upper UK2 Sequence (Late Santonian-Early Campanian)

The Upper UK2 Sequence has been fully intersected by Anemone-1,1A where it is 613m thick (from 3912m to 4525m bkb) and has been partially penetrated at Archer-1 in the interval 3651.4m bkb to 4050m (TD), a thickness of 398.6m.

The Upper UK2 Sequence shows an overall regressive trend, with three sub-units recognizable. These are:

4.3.1 Lower Unit (4525m to 4199m bkb in Anemone-1,1A, 4050m (TD) to 3933m in Archer-1)

A major marine transgressive unit of late Santonian age marks the base of this unit, and comprises offshore siltstones deposited directly above and effectively sealing the stream mouth bar sandstones below. It is possible that a thin sandstone unit from 4533.5m to 4525m in Anemone-1,1A presently included as part of the Santonian Sandstones is in fact a basal transgressive sandstone which should be included in this sequence.

Near the top of this interval, the siltstones grade into a sequence of interbedded siltstones and sandstones deposited in a lower to upper shoreface environment, and generally referred to as the Campanian "2" Sandstones.

The dipmeter indicates steep eastward structural dips of 10° to 14° in Anemone-1,1A and of 4° to the west in Archer-1, and displays no clear depositional trends.

4.3.2 Middle Unit (3933m to 3815.5m in Archer-1, 4199m to 4042m in Anemone-1,1A)

This interval is a continuation of the underlying regressive cycle, except for a minor transgressive sand at the base. Environments are similar to those of the underlying interval, passing upwards from massive offshore siltstones to upper shoreface or beach sandstones, referred to as the Campanian "1" Sandstones and which have good reservoir potential. Palynological data suggests that the upper part of this interval could be non-marine.

The siltstones and claystones at the base of this unit seal the underlying Campanian "2" sandstones.

The dipmeter displays blue and red depositional patterns in the upper part with a general trend to the east in Anemone-1,1A and to the southwest in Archer-1.

Sedimentary interpretation suggests that Archer-1 was in the same depositional environment as Anemone-1,1A, during UK2 time, although the general thinning and better sandstone development towards Archer-1 could indicate a slightly higher structural elevation and/or proximal position at Archer-1.

4.3.3 Upper Unit (4042m to 3912m in Anemone-1,1A and 3815.5m to 3651.4m in Archer-1)

This unit was interpreted at Anemone-1,1A to have been deposited in a shallow marine environment. This interpretation has been revised in view of the Archer-1 results to a Lower Coastal Plain depositional environment, characterized by point bar sandstones interbedded with flood plain siltstones, and minor coal stringers.

In Archer-1, the top of the unit shows some marine influence with the development of an alternating sequence of estuarine and non-marine sediments.

The Top UK2 or Base UK3 marks a major regional unconformity within the basin, which separates the Golden Beach Group (UK1 and UK2 Sequences) from the overlying Latrobe Group sensu stricto (UK3 to UK5 and PL1, PL2, EO1 Sequences). It appears that the erosion associated with the Top Golden Beach Unconformity (Top UK2) was more severe in the Anemone Area than at Archer, since the Upper UK2 Sequence is the only interval in the Latrobe and Golden Beach Groups which is thinner in Anemone-1,1A than at Archer-1 (130m versus 164.1m).

Depositional dips show a mixture of blue and red patterns trending northeast in Anemone-1,1A, and trending southwest to southeast in Archer-1.

4.4 <u>UK3.1 Sequence (3912m to 3734m in Anemone-1,1A, 3651.4m to 3480.5m in Archer-1)</u>

This Intra Campanian interval is characterised at the base by massive sandstone units fining up into pro-delta siltstones. These have been interpreted as transgressive sands deposited after a major tectonic event in the Gippsland Basin. Depositional dips are not clear in the sands, but indicate possible northward sediment transport. The two intra-UK3.1 'A' and 'B' Sandstones, separated by 20.5m of good shales at Anemone-1,1A, merge into a single sandstone body at Archer-1 (Zone 4) with no significant shale beds present. The upper part of this interval consists of stacked regressive, upward-coarsening units of lower to upper delta front siltstones and stream mouth bar sandstones.

The gross sandstone thickness to total thickness ratio in the UK3.1 Sequence improves from Anemone-1,1A to Archer-1 (54% at Anemone-1,1A versus 73.9% at Archer-1) with a concurrent decrease in shale content. This reflects the more proximal sedimentary conditions prevailing at the Archer location at that time.

The almost uniform thickness of the various sedimentary units between the two wells over the entire UK3.1 interval suggests that the marine transgression at the base and the regressive sedimentary cycle which followed it appear to have taken place over a wide platform with little or no relief. Structural relief became more prominent during Upper UK3 time with significantly thinner sequences being deposited at Archer during that time.

Thin, well cemented sandstone beds are present throughout the interval. These are interpreted as shelf deposits and may indicate breaks in sedimentation allowing time for cementation near the seabed.

Depositional dips in the upper part of the interval trend toward the northeast in Anemone-1,1A but show no clear trend in Archer-1.

The entire interval is characterised by a large terrestial palynomorph input.

4.5 Upper UK3 Sequence (3734m to 3422m in Anemone-1,1A, 3480.5m to 3270m in Archer-1)

This upper Campanian interval, equivalent to the T.lilliei zone, shows a typical upward-coarsening trend associated with a regressive depositional cycle.

The interval consists of a thick sequence of offshore shales and lower shoreface siltstones interbedded with minor lower and upper shoreface sandstones. The base of the sequence is richer in sandstones in Archer-1 than in Anemone-1,1A. Good reservoirs are present at this level at Archer-1 (Zones 1 and 2).

The offshore shales within this sequence have excellent sealing potential and rapidly thicken to the north of the Permit, reaching 274m at Angler-1.

Blue and red patterns are more frequent in Archer-1 than in Anemone-1,1A and trend between southwest and southeast. The southeastern trend is only prominent at the top of the sequence at Archer-1.

4.6 UK4.1 Sequence (3422m to 3217m in Anemone-1,1A, 3270m to 3094m in Archer-1)

This sequence appears as a continuation of the regressive depositional cycle in the underlying sequence.

A massive upper shoreface sandstone developed from 3422m up to 3387m in Anemone-1,1A and from 3270m to 3243m in Archer-1 shows herring-bone cross bedding trending east-southeast and west-northwest in Anemone-1,1A; and southwest to south-southeast in Archer-1. This sandstone is capped by lower coastal plain siltstone and coal and point bar and back-shore sandstones, and marks the transition from the essentially marine conditions prevailing in UK2 and UK3.1 time to the non-marine conditions in the younger UK4 and UK5.1 Sequences.

The dipmeter in the overlying lower coastal plain sequence displays blue and red patterns, with a general trend to the south-southwest in Archer-1, and no clear trend in Anemone-1,1A.

4.7 Early Maastrichtian Upper UK4 Sequence (3217m to 3111m in Anemone-1,1A, 3094m to 3016m in Archer-1)

The Upper UK4 Sequence equivalent to the Selene Sandstone interval defined in the northeastern part of the Permit is characterized at the base by the appearance of T.longus spores (Maastrichtian age).

The previous interpretation at Anemone-1,1A of a shallow marine environment for this interval has been revised, and it is now considered as a lower coastal plain sequence. Its higher sandstone content compared to the underlying and overlying lower coastal plain sequences may be the result of greater marine influence at that time, especially at Anemone-1,1A.

The base of the interval may correspond to an angular unconformity in the two wells. No clear dipmeter pattern could be established at Anemone-1,1A, but numerous minor blue and red patterns trending northwest to southwest are present in Archer-1.

4.8 Intra Maastrichtian UK5.1 Sequence (3111m to 2831m in Anemone-1,1A, 3016m to 2768m in Archer-1)

This essentially non-marine intra-Maastrichtian sequence is a continuation of the underlying regressive cycle, with only minor marine incursions noted. Sedimentary units alternate between coastal plain siltstones and coals and deltaic stream mouth bar sandstones.

Sedimentary dips in Anemone-1,1A trend northwest, swinging to the west-southwest near the top of the interval. In Archer-1 the dips trend west-southwest with a southeast component near the top.

4.9 <u>Late Maastrichtian Upper UK5 Sequence (2831m to 2760m in Anemone-1,1A, 2768m to 2707m in Archer-1)</u>

A transgressive marine sandstone marks the top of the underlying sequence. This passes rapidly upwards in the Upper UK5 Sequence to pro-delta and lower delta front siltstones at Anemone-1,1A, while at Archer-1 this sequence corresponds to stacked stream mouth bar sandstones. Overall the Upper UK5 interval shows a marked upward-coarsening, indicating a regressive depositional phase.

Sedimentary dips show a mixture of blue and red patterns trending to the northwest in Anemone-1,1A and to the west-southwest in Archer-1.

4.10 <u>Palaeocene Sequence (2760m to 2676.5m in Anemone-1,1A, 2707m to 2640m in Archer-1)</u>

This interval comprises a thin transgressive marine sandstone at the base, overlain by a massive siltstone sequence deposited in an offshore to lower shoreface environment. The sequence shows a general upward-coarsening in the lower and middle parts, and upward-fining in the upper part.

Sedimentary dips show no clear trend in Anemone-1,1A but a dominant north-northwesterly trend in Archer-1.

The top of this interval which equates with the Top Latrobe Group is capped by offshore marine shales of the overlying Gurnard and Lakes Entrance Formations.

5. REFERENCES

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

Lays, Ph., 1989, Sedimentological Interpretation of the Latrobe Group in Anemone-1,1A. Petrofina Exploration Australia S.A., Unpublished Report.

TABLE 1

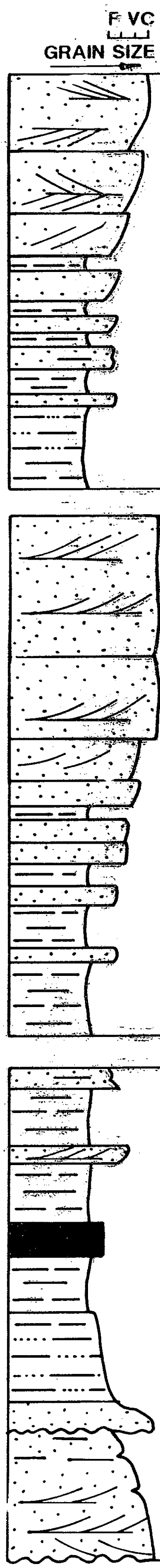
SUMMARY OF SEDIMENTARY ENVIRONMENTS

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

FIGURE 1

LATROBE DEPOSITIONAL ENVIRONMENTS

LITHOLOGY



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

G 729

PE600956

This is an enclosure indicator page.
The enclosure PE600956 is enclosed within the container PE902094 at this location in this document.

The enclosure PE600956 has the following characteristics:

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BASIN = GIPPSLAND
PERMIT = VIC/P20
TYPE = WELL
SUBTYPE = WELL_LOG
DESCRIPTION = Semintary Interpretation Log (enclosure from WCR vol.3) for Archer-1
REMARKS =
DATE_CREATED =
DATE_RECEIVED = 4/09/90
W_NO = W1021
WELL_NAME = Archer-1
CONTRACTOR = Petrofina Exploration
CLIENT_OP_CO = Petrofina Exploration

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PE600957

This is an enclosure indicator page.
The enclosure PE600957 is enclosed within the container PE902094 at this location in this document.

The enclosure PE600957 has the following characteristics:

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BASIN =	GIPPSLAND
PERMIT =	VIC/P20
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SUBTYPE =	WELL_LOG
DESCRIPTION =	Anemone 1, 1a sedimentary interpretation log (enclosure from WCR vol.3) for Archer-1
REMARKS =	This Log is for Anemone1-1A yet resides in Archer-1 WCR (it may be in the wrong place)
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DATE_RECEIVED =	4/09/90
W_NO =	W1021
WELL_NAME =	Archer-1
CONTRACTOR =	Petrofina Exploration
CLIENT_OP_CO =	Petrofina Exploration

(Inserted by DNRE - Vic Govt Mines Dept)

APPENDIX 10

APPENDIX 10

WELL COMPLETION REPORT

ARCHER-1

INTERPRETATIVE DATA

A P P E N D I X 1 0

COMPOSITE LOG

PE600958

This is an enclosure indicator page.
The enclosure PE600958 is enclosed within the container PE902094 at this location in this document.

The enclosure PE600958 has the following characteristics:

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BASIN =	GIPPSLAND
PERMIT =	VIC/P20
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DESCRIPTION =	Composite well log (enclosure from WCR vol.3) for Archer-1
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DATE_CREATED =	9/04/90
DATE_RECEIVED =	4/09/90
W_NO =	W1021
WELL_NAME =	Archer-1
CONTRACTOR =	Petrofina Exploration
CLIENT_OP_CO =	Petrofina Exploration

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