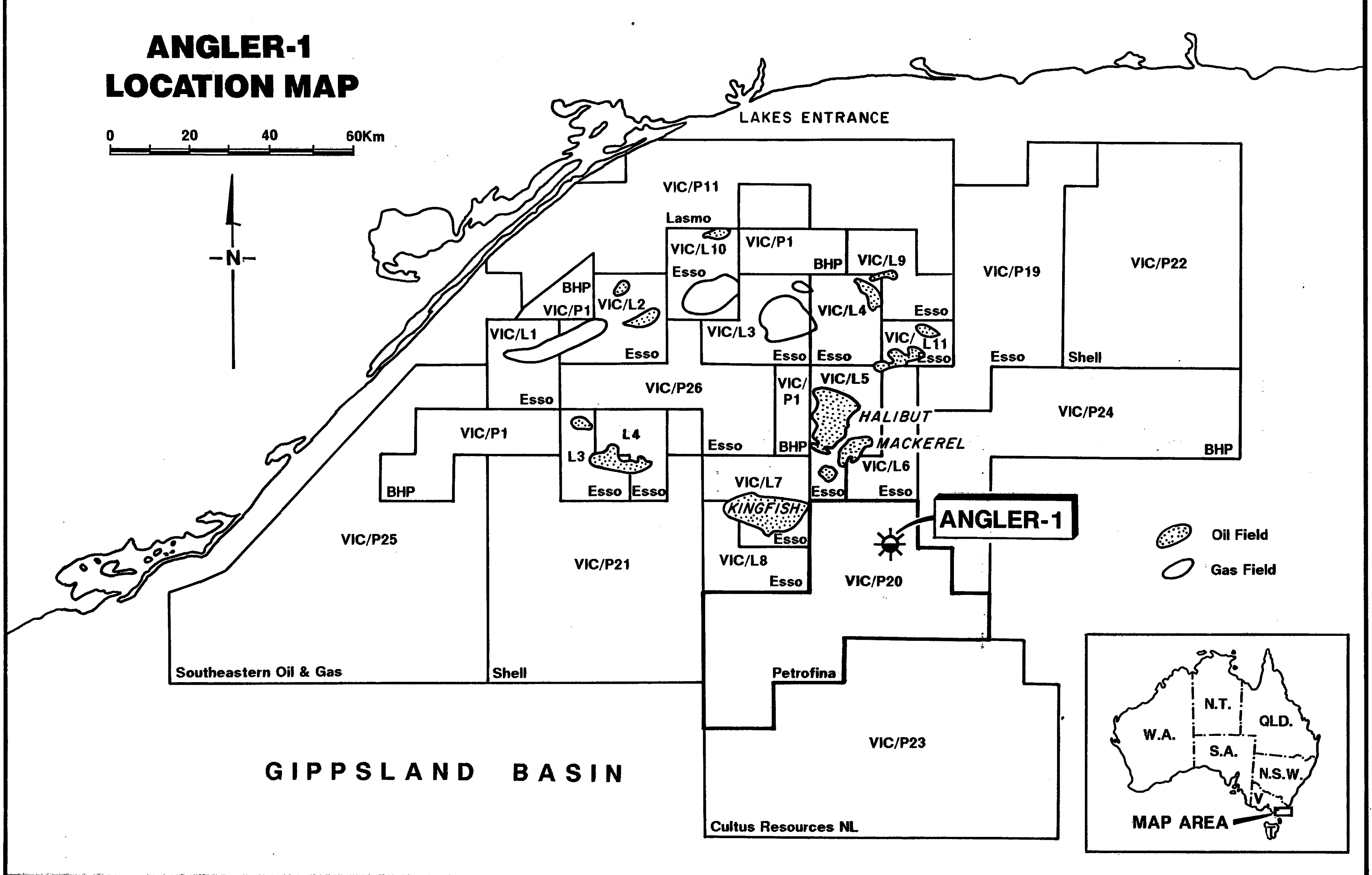
This report and location map completes the missing sections for the Angler-1 Volume 1, Basic Data Report.

Figure 1.


ANGLER-1
LOCATION MAP
0 20 40 60Km
N
LAKES ENTRANCE
VIC/P11
Lasmo
VIC/L10
Esso
VIC/P1
BHP
VIC/L9
Esso
VIC/P19
VIC/P22
BHP
VIC/P1
VIC/L2
VIC/L1
Esso
VIC/L3
VIC/L4
VIC/L11
Esso
Esso
Esso
Esso
Shell
VIC/P26
VIC/P1
VIC/L5
HALIBUT
MACKEREL
VIC/L6
VIC/P24
BHP
Esso
L3
L4
Esso
Esso
Esso
BHP
Esso
Esso
BHP
VIC/L7
KINGFISH
Esso
VIC/L8
Esso
ANGLER-1
VIC/P20
Oil Field
Gas Field
VIC/P25
VIC/P21
Southeastern Oil & Gas
Shell
Petrofina
VIC/P23
Cultus Resources NL
GIPPSLAND BASIN
N.T.
QLD.
W.A.
S.A.
N.S.W.
V
MAP AREA

amdel

GEOCHEMICAL EVALUATION OF ROCK AND FLUID SAMPLES

FROM ANGLER -1, VIC/P20 GIPPSLAND BASIN

amdel

CONTENTS

1. INTRODUCTION

2. ANALYTICAL PROCEDURES

3. RESULTS

4. INTERPRETATION

<u>Source Rock Geochemistry</u>

4.1 Maturity

4.2 Source Richness

4.3 Kerogen Type and Source Quality

<u>Petroleum Geochemistry</u>

4.4 Maturity and Bulk Composition

4.5 Source Affinity

5. CONCLUSIONS

6. REFERENCES

amdel

LIST OF TABLES

Table	1	Rock-Eval Pyrolysis Cuttings
Table	2	Rock-Eval Pyrolysis Sidewall Cores
Table	3	Summary of Vitrinite Reflectance Measurements
Table	4	Percentage of Inertinite, Vitrinite and Exinite in Dispersed Organic Matter
Table	5	Organic Matter Type and Abundance
Table	6	Exinite Maceral Abundance and Fluorescence Characteristics
Table	7	Stable Isotopic Analysis of Gas
Table	8	Density, API and Sulphur Content Angler -1 Condensate
Table	9	Quantified Whole Oil Composition Angler -1 Condensate
Table	10	Quantified Gasoline Range Analysis Angler -1 Condensate
Table	11	Quantified Gasoline Range Parameters Angler -1 Condensate
Table	12	C_{12+} Bulk Composition and Alkane Ratios Angler -1 Condensate
Table	13	Oil Maturity Based on Aromatic Hydrocarbon Distributions
Table	14	Biomarker Ratios in Angler -1 and other Intra-Latrobe Oils Gippsland Basin
Table	15	Stable Isotopic Carbon Composition of Condensate and Isolated Fractions

amdel

LIST OF FIGURES

Figure 1	Maastrichtian 2820-3230 m
Figure 2	Selene Sandstone 3250-3510 m
Figure 3	Campanian 3520-3880 m
Figure 4	Campanian Siltstone 3890-4200 m
Figure 5	Campanian "B" Siltstone 4220-4320 m
Figure 6	2760-4320 m
Figure 7	Sidewall Cores 3178-4324 m
Figure 8	Vitrinite Reflectance Versus Depth Profile
Figure 9	Whole Condensate Gas Chromatogram
Figure 10	Gasoline Range Chromatogram
Figure 11	Source Affinity Based on C_5 - C_7 Alkanes
Figure 12	Oil Maturity and Alteration Based on C_5 - C_7 Alkanes
Figure 13	Bulk Composotion
Figure 14	GC of Saturated Hydrocarbons
Figure 15	Genetic Affinity and Maturity
Figures 16-19	GC-MS of Aromatics
Figures 20-25	GC-MS of Naphthenes

amdel
technology and enterprise

Amdel Limited
(Incorporated in S.A.)
31 Flemington Street,
Frewville, S.A. 5063
Telephone: (08) 372 2700

P.O. Box 114,
Eastwood, S.A. 5063
Telex: AA82520
Facsimile: (08) 79 6623

30th August 1989

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

Attention: Mark Tringham/Brian Thurley

REPORT F 7574

TITLE:	Geochemical Evaluation of Rock and Fluid Samples from Angler -1, VIC/P20, Gippsland Basin
SAMPLE IDENTIFICATION:	As listed in Tables 1 - 14
MATERIAL:	Cuttings, Sidewall Core, Gas and Condensate
LOCALITY:	Angler -1
DATE RECEIVED:	22 May 1989
WORK REQUIRED:	TOC, Rock-Eval Pyrolysis, Organic Petrology, Stable Isotopic Determinations of Gas, Condensate and Condensate Fractions, API 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.

Investigation and Report by: Brian Watson

Dr Brian G Steveson
Manager, Petroleum Services Section

apk

1. INTRODUCTION

Rock-Eval pyrolysis, TOC and Organic Petrology analysis were requested on cuttings and sidewall core samples from Angler -1, Vic-P-20, Gippsland Basin. Petroleum geochemical analyses were also requested on gas and condensate from RFT and RFT pre 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 Angler -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.

This report is a formal presentation of results reported by telephone and facsimile as work was requested and completed over the period of 25th May 1989 to 27th July 1989.

2. ANALYTICAL PROCEDURES

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

3. RESULTS

Analytical data is presented in this reports as follows:

	Table	Figure	Appendix
Source Rock Analysis			
TOC and Rock-Eval data (cuttings)	1	1-6	
TOC and Rock-Eval data (SWC)	2	7	
Vitrinite Reflectance Determinations	3	8	2
Descriptions of Dispersed Organic Matter	4-6	-	3
Petroleum Geochemistry			
Stable Isotopic Composition of Gas	7	-	
Gravity and Sulphur of Condensate	8	-	
Quantified Whole Oil Composition	9	9	
Quantified Gasoline Range Analysis	10,11	10-12	
Bulk Composition of Condensate	12	13	
GC of Saturated Hydrocarbons and Isoprenoid/Alkane Ratios	12	14,15	
GC-MS of Aromatics	13	16-19	
GC-MS of Naphthenes	14	20-25	
Stable Isotopic Composition of Whole Condensate and Isolated Fractions	15		

4. INTERPRETATION

Source Rock Geochemistry

4.1 Maturity

Vitrinite reflectance data of cuttings and sidewall core samples (Table 3; Figure 8) indicate that the sediments intersected in the Angler -1 location are sufficiently mature for:

- the generation of light oil and condensate from sediments rich in resinite, suberinite and bituminite below 3300 metres depth (Upper Selene Sandstone; 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 4150 metres depth (Lower Campanian Siltstone; VR> 0.6%, Monnier *et al.*, 1983).
- oil generation from organic matter rich in exinites other than resinite, suberinite and bituminite below approximately 4700 metres depth in the Angler -1 location (VR > 0.7%; Connan and Cassou, 1980).

Rock-Eval Tmax values lie within the range 274 - 434°C in the samples examined. However, some Tmax values are anomalously low due to irregularly shaped S_2 peaks. Reliable Tmax values lie within the range 420 - 434°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
2930 - 2950	Latrobe Group	0.23 - 0.40
3178	Latrobe Group	0.43
3415	Selene Sandstone	0.33
3590 - 3600	Campanian	0.23 - 0.24

4.2 Source Richness

Organic richness ranges from poor to excellent in the sediments studied (TOC = 0.20-25.50%; Table 1) but is generally fair to good. Source richness for hydrocarbons (genetic potential) is also variable ($S_1 + S_2$ = 0.09 - 81.54 kg hydrocarbon/tonne) and is highest in the Maastrichtian and Selene Sandstone Latrobe Group coals. 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
2930-2940	Latrobe Group	2.35- 2.55	11.99-12.74	Excellent
3010-3230	Latrobe Group	2.05-25.50	4.65-81.54	Good to excellent
3250-3290	Selene S/Stone	0.95-14.90	2.06-41.25	Fair to excellent
3520-3570	Campanian	1.17- 3.00	2.38- 8.13	Fair to excellent
3590	Campanian	2.25	7.66	Excellent
3650	Campanian	1.25	3.16	Fair
3690	Campanian	1.12- 9.05	2.48-30.52	Fair to excellent
3890-4190	Campanian Sandstone	1.43- 6.65	3.09-21.74	Fair to excellent
4230	Campanian "B" Siltstone	1.11	3.17	Fair

4.3 Kerogen Type and Source Quality

Rock-Eval Hydrogen Index and Tmax data (Tables 1 and 2) indicates that sediments intersected in the Angler -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 III and Type II-III kerogen occur in each of the geological units examined from the Latrobe Group to Campanian "B" Siltstone.

Sediments in the upper Latrobe Group (2830-3230 metres depth; Maastrichtian) in this location contain organic matter with the bulk composition of Type II-III kerogen (Table 1, 2, Figure 1). Organic petrology of selected samples in this interval show that this organic matter consists largely of predominantly gas prone vitrinite (60-80%). Exinite contents are moderate to high (10-40) indicating that the potential for liquid hydrocarbon generation from this unit, on maturity, is significant. The remaining organic matter in this unit consists of inertinite (oxidised woody kerogen). The abundance of the thermally labile exinites, resinite, suberinite, and bituminite in coals in this unit, indicates that these coals have the potential to generate oil/condensate at low maturities (VR threshold for significant generation = 0.45%; Snowdon & Powell, 198?). Exsudatinite in these coals is primary oil (i.e. generated "in situ") and is direct evidence of early generation of oil from the thermally labile exinites in this unit. High Rock-Eval productions indices in the lower portion of this unit confirm the presence of oil. Whilst resinite in this location has reached the threshold for initial generation in this unit, more significant generation is likely to occur "down dip" where maturities are likely to be marginally greater.

The Selene Sandstone sediments contain organic matter with bulk compositions ranging from that of Type III kerogen to that of Type II-III kerogen (Table 1, 2, Figure 2) with the majority of samples containing organic matter with the bulk composition of Type III kerogen. Samples containing better quality Type II-III kerogen occur at 3250 and 3510 metres depth. These samples have both excellent organic richness and source richness. Their maceral composition has not been determined in this study.

The bulk composition of organic matter in the Campanian sediments varies from that of Type III to Type II kerogen and is most variable in the Upper Campanian Unit. Bulk compositions of organic matter in the Campanian Siltstone and Campanian "B" Siltstone range from that of Type III to Type II-III kerogen. Intervals with the best source quality in the Upper Campanian Unit (bulk composition of Type II kerogen) occur at 3760-3780 metres depth and 3880 metres depth. Samples containing organic matter with the bulk composition of Type II-III kerogen are widespread throughout this unit.

Organic petrology of samples from this unit identify variable organic richness and variable proportions of maceral groups (V, I, E). However, the dominant exinite macerals present are quite uniform. The most common exinite macerals present are liptodetrinite, cutinite, lamalginite, sporinite and resinite. Exudatinite in the sample from 3750 metres depth is further evidence of the onset of generation from the more thermally labile exinites at this location.

Campanian Siltstone sediments contain organic matter which generally have the bulk composition of Type II-III kerogen. Optical examination of the organic matter in these sediments reveals that they contain largely inertinite (75-85%) with low to moderate proportions of vitrinite (5-20%) and exinite (5-15%). The proportion of inertinite seems to increase with depth. The dominant exinite macerals in these samples vary with depth. With increasing depth phytoplankton becomes more abundant and cutinite becomes less abundant. Fluorescence colours of some carbonaceous shales in the sample from 4070 metres depth are incongruent with the maturity of this interval and are interpreted to be cavings. Thucholite occurs in the silty portions of this sample and forms by ionisation of hydrocarbons as they migrate past the radioactive mineral which forms the core of this maceral. Oil in the sample from 4110 metres depth occurs in the shale cuttings and does not appear to be intimately associated with the organic matter.

Companian "B" Siltstone sediments generally contain organic matter with the bulk composition of Type III kerogen. However, samples from the upper portions of this unit generally contain better quality Type II-III kerogen. Optical examination of the organic matter in the sidewall core sample from 4324 metres depth suggests that the trends evident within the overlying Campanian Siltstone continue into the Campanian "B" Siltstone. Inertinite and phytoplankton increase in abundance with increasing depth, whilst the terrestrial exinites (cutinite, sporinite and resinite) become less abundant.

Petroleum Geochemistry

4.4 Maturity and Bulk Composition

Maturation-sensitive ratios based on C_{12+} acyclic alkanes (Table 12, Fig 15) and triaromatic hydrocarbons (methylphenanthrene index, MPI: Table 13) concur in demonstrating that the Angler -1 (RFT; 4226 m) oil belongs to the peak mature group of Gippsland Basin crudes (Burns *et al.*, 1987), thus:

Well	Depth (m)	API Gravity	MPI	VR_{calc}* %	VR_{calc}+ %
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

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

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

These oils are of paraffinic bulk composition, (Table 12, Fig. 15), have specific gravities within the range 41-46° API, and possess characteristic trimodal n-alkane profiles. Moreover, all are located above (or adjacent to) the central deep of the Gippsland Basin (i.e. The inferred source kitchen or generative depression, Demaison, 1984). This maturity indicates that this oil was clearly generated from a source of much greater maturity than intersected in this location. Extrapolation of the vitrinite reflectance versus depth trend indicates that this maturity may be reached at approximately 6500 metres depth in this location (based on a linear extrapolation). However, in consideration of the marked similarities in composition and maturity of the Angler -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 isotopic separation between its hydrocarbon components, was developed by James (1983). This technique is independent of source Type, and illustrates that isotopic fractionation during migration is not a major factor effecting isotopic separation. The isotopic separation of the Angler -1 gas does not fit the LOM versus $\delta C13$ PDB curves of James (1983) suggesting it is a mixture of gases generated at different maturities. The separation of the C_2 - C_4 isotopes suggests that these components were generated at a level of organic maturity (LOM) of approximately 12 (VR $\approx$ 1.5%). However, the isotopic composition of methane and pentane are more consistent with generation at a level of organic maturity (LOM) of approximately 10 (VR $\approx$ 0.9%).

This lower maturity is in quite good agreement with the maturity sensitive ratios of the triaromatic hydrocarbons and C_{12+} acyclic alkanes (Table 12; Fig 15) confirming that the hydrocarbons recovered from the Angler -1 location represent a mixture of hydrocarbons generated at two distinct maturation stages (VR $\approx$ 1.5%, predominantly C_2 - C_4 and; VR $\approx$ 0.9-1%, C_1 - C_{35}). These maturation stages are very similar to those at which the Kingfish -7 gas and oil were generated (calculated using the same parameters)(Burns *et al*. 1984 and Burns *et al*. 1987).

4.5 Source Affinity

The terrestrial source affinity of the Angler -1 condensate is clearly evident from aspects of its C_{12+} molecular composition and gasoline range hydrocarbons. A high pristane/phytane ratio (pr/ph = 6.2), in combination with an intermediate pristane/n-heptadecane ratio and a low phytane/n-octadecane ratio (Table 12, Fig 15), indicates that the oil originated from land plant detritus which accumulated in an oxic aquatic environment.

GC-MS analysis of the naphthenes fraction of the oil identified a range of biomarker hydrocarbons (Table 14, Figs 20-25) which further characterise the land plant (and bacterial) precursors from which it was derived.

The saturated biomarkers (in approximate order of increasing abundance) are: C_{29} and C_{30} hopanes (m/z 191); C_{29} steranes and diasteranes (m/z 217, 259); C_{20} labdane, C_{19} and C_{20} isopimaranes (m/z 109, 123); C_{19} 17-nortetracyclane, C_{20} phyllocladanes, beyerane and kaurane (m/z 123, 259); C_{15} and C_{16} drimanes and rearranged drimanes (m/z 123); C_{16} - C_{20} acyclic isoprenoids (m/z 183); and C_{14} - C_{24} n-alkylcyclohexanes (m/z 83) (Figs 20-25).

The hopanes, steranes and monoaromatic steranes are present in only trace amounts (cf. low signal/noise ratio in m/z 191 and 217 mass fragmentograms: Figures 20 and 21), precluding use of the standard isomeric ratios as maturation indicators. The 191 and 217 mass fragmentograms included in this report were re-run after concentration of the urea adducted fraction using silicalite.

Nevertheless, it is clear that the C_{27} - C_{29} sterane and diasterane distributions of the Angler -1 condensate are dominated by the C_{29} homologues of higher plant origin. This is a characteristic feature of most Australian non-marine crude oils (see e.g. Vincent *et al.*, 1985; Philp and Gilbert, 1986). The carbon isotopic composition of the aromatic and saturated hydrocarbons of the Angler -1 condensate are consistent with the sterane and diasterane distributions in indicating that this oil was generated from a source containing predominantly land-plant derived kerogen.

The very low abundance of hopanes (pentacyclic triterpanes) relative to other biomarkers (parameters 1-4, Table 14) is probably the result of intense degradation of primary bacterial hopanoids to drimanes (bicyclic sesquiterpanes) by other bacteria prior to burial of the terrestrial source material beyond the zone of near-surface microbiological activity.

The n-alkylcyclohexanes are probably derived from bacteria which are capable of tolerating low pH (acidic) conditions such as those which exist in coal swamps and certain freshwater lakes.

The bicyclic and tricyclic diterpenoid alkanes identified in Figures 24 and 25 are derived from resins of the type synthesised by Araucariacean conifers (kauri pines: Alexander *et al.*, 1988). The diterpane distribution of the Angler -1 condensate, like those of other Gippsland Basin crudes (Alexander *et al.*, 1987), is characterised by a predominance of tetracyclics over tricyclic (and bicyclic) compounds. Precursors of the tetracyclic diterpanes (notably 17-nortetracyclane, phyllocladane, beyerane and kaurane) occur widely in conifers of the Podocarpaceal family (Alexander *et al.*, 1987). However, on the basis of significant differences in the relative abundances of certain individual diterpanes (parameters 5-7, Table 3), the Angler -1 oil can be distinguished from the intra-Latrobe crudes at Volador -1 and Basker -1.

Gasoline range hydrocarbons (C_3 - C_7; Table 10, 11 Fig 10-12) are also consistent with generation from terrestrial, "land plant" kerogen. The maturity indicated by the isoheptane value versus heptane value plot is broadly consistent with that of the parameters previously discussed. These ratios are also sensitive to biodegradation and the fact that the Angler -1 values plot slightly below the mature range indicates that this condensate may have been slightly biodegraded.

However, the n-alkane/iso-alkane ratios of Burns *et al.*, (1987) suggest that the degree of biodegradation of this condensate is very minor (Table 12).

5. CONCLUSIONS

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

   - the generation of light oil and condensate from sediments rich in resinite, suberinite and bituminite below 3300 metres depth (Upper Selene Sandstone; 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 4150 metres depth (Lower Campanian Siltstone; VR> 0.6%, Monnier *et al.*, 1983).
   - oil generation from organic matter rich in exinites other than resinite, suberinite and bituminite below approximately 4700 metres depth in the Angler -1 location (VR > 0.7%; Connan and Cassou, 1980).

   Exsudatinite in samples from 3150, 3220 and 3750 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
2930 - 2950	Latrobe Group	0.23 - 0.40
3178	Latrobe Group	0.43
3415	Selene Sandstone	0.33
3590 - 3600	Campanian	0.23 - 0.24

3. The origin of oil noted in the cuttings sample from 4110 metres depth is unclear. However, the occurrence of thucholite in the sample from 4070 metres depth suggests that this oil may represent a migrated phase and is possibly related to hydrocarbons recovered from the 4226 metres depth RFT.

4. Exsudatinite in the Lower Maastrichtian and upper Selene Sandstone units is likely to be generated from the thermally labile exinites (resinite, suberinite and bituminite) in these sediments. Whilst these macerals have reached the maturity threshold for initial generation in this location, more significant generation is likely to occur "down-dip" where maturities are likely to be marginally higher.

5. Organic richness ranges from poor to excellent in the sediments studied but is generally fair to good (TOC = 1-6%). Source richness for hydrocarbons (genetic potential) is highest in the Latrobe Group coals. Intervals with the best organic and source richness are listed below.

Depth (m)	Formation	TOC (%)	$S_1 + S_2$ (kg of hydrocarbons/tonne)	Source Richness Rating
2930-2940	Latrobe Group	2.35- 2.55	11.99-12.74	Excellent
3010-3230	Latrobe Group	2.05-25.50	4.65-81.54	Good to excellent
3250-3290	Selene S/Stone	0.95-14.90	2.06-41.25	Fair to excellent
3520-3570	Campanian	1.17- 3.00	2.38- 8.13	Fair to excellent
3590	Campanian	2.25	7.66	Excellent
3650	Campanian	1.25	3.16	Fair
3690	Campanian	1.12- 9.05	2.48-30.52	Fair to excellent
3890-4190	Campanian Sandstone	1.43- 6.65	3.09-21.74	Fair to excellent
4230	Campanian "B" Siltstone	1.11	3.17	Fair

6. Thermally labile exinites (resinite, suberinite and bituminite) are present in significant amounts in the "Latrobe Group" and upper "Campanian" unit.

7. The Angler -1 condensate belongs to the peak mature group of Gippsland Basin crudes. The MPI-derived maturity (VR_{calc} = 0.98%; *Boreham et al* calibration) refers to the maturity of the source rock at the time of expulsion.

8. Isotopic separation of the gas components suggests that the hydrocarbons recovered from 4226 metres depth are a mixture of hydrocarbons phases generated at two distinct maturation stages (Gas, C_2 - C_4, VR = 1.5% and; condensate, C_1 - C_{35}, VR = 0.9 - 1.0%).

9. The maturity of the hydrocarbons recovered from 4226 metres depth is clearly out of place in terms of maturity. In consideration of the marked similarity and maturity of the Angler -1 hydrocarbons with those from Kingfish -7, it seems likely that these hydrocarbons were generated in the central deep of the basin and migrated to their present position.

10. The terrestrial source affinity of the Angler -1 condensate is clearly evident from aspects of its C_{12+} molecular composition and gasoline range hydrocarbons. Carbon isotopic compositions of aromatic and saturated hydrocarbons indicate that this condensate was generated from a source containing predominantly land-plant derived kerogen. GC-MS analysis of the naphthenes fraction of the oil identified a range of hydrocarbons which further characterise the land plant (and bacterial) precursors from which it was derived.

11. Gasoline range ratios, isoheptane value and heptane value indicate that this condensate may be slightly biodegraded.

REFERENCES

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

ALEXANDER, R., LARCHER, A.V., KAGI, R.I. & PRICE, P.L., 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, C.J., CRICK, I.H. & POWELL, T.G., 1988. Alternative calibration of the Methylphenanthrene Index against vitrinite reflectance:application to maturation measurement of oils and sediments. *Org. Geochem.*, 12, 289-294.

BURNS, B.J., BOSTWICK, T.R. & EMMETT, J.K., 1987. Gippsland terrestrial oils - recognition of compositional variations due to maturity and biodegradation effects. *APEA J.*, 27(1), 74-84.

BURNS, B.J., JAMES, A.T., EMMETT, J.K., 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, R.J.), AAPG Memoir 35, pp 1-14.

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

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

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

SNOWDON, L.R. and POWELL, T.G., 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, P.W., MORTIMORE, I.R. & MCKIRDY, D.M., 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

Rock-Eval Pyrolysis 23/06/89

Client: PETROFINA EXPLORATION AUSTRALIA S.A.

Well: ANGLER-1

Depth (m)	T Max	S1	S2	S3	S1+S2	PI	S2/S3	PC	TOC	HI	OI
2750									0.37		
2760	424	0.03	0.09	0.74	0.12	0.25	0.12	0.01	0.40	23	189
GURNARD											
2790	326	0.03	0.06	0.70	0.09	0.37	0.08	0.00	0.40	15	179
2800	274	0.05	0.11	0.73	0.16	0.31	0.15	0.01	0.42	26	173
2810									0.36		
LATROBE GROUP											
2820									0.32		
2830									0.37		
2840									0.32		
2850									0.23		
2860									0.31		
2870									0.21		
2880									0.31		
2890									0.20		
2900									0.32		
2910									0.35		
2930	408	4.63	8.11	2.35	12.74	0.36	3.45	1.06	2.55	318	92
2940	408	4.75	7.24	1.82	11.99	0.40	3.97	0.99	2.35	308	77
2950	406	0.31	1.05	1.43	1.36	0.23	0.73	0.11	0.93	112	153
3000	404	0.02	0.18	0.59	0.20	0.10	0.30	0.01	0.52	34	113
3010	397	0.66	14.21	0.80	14.87	0.04	17.76	1.23	5.40	263	14
3020	400	0.18	4.47	0.68	4.65	0.04	6.57	0.38	2.25	198	30
3040	415	2.15	45.29	1.97	47.44	0.05	22.98	3.95	15.50	292	12
3050	417	0.33	8.74	0.43	9.07	0.04	20.32	0.75	3.56	245	12
3060	418	0.51	13.07	0.67	13.58	0.04	19.50	1.13	4.60	284	14
3070	416	0.38	10.46	0.56	10.84	0.04	18.67	0.90	4.30	243	13
3080	419	0.44	10.75	0.36	11.19	0.04	29.86	0.93	4.30	250	8
3090	418	1.29	25.19	1.17	26.48	0.04	21.53	2.31	9.50	265	12
3120	417	1.34	29.21	1.32	30.55	0.04	22.12	2.54	10.60	275	12
3130	421	0.75	15.70	0.78	16.45	0.05	20.12	1.37	5.65	277	13
3140	421	0.26	6.05	0.27	6.31	0.04	22.40	0.52	2.05	295	13
3150	418	3.31	57.21	1.89	60.52	0.05	30.26	5.04	19.30	296	9
3160	419	3.96	77.58	2.17	81.54	0.05	35.75	6.79	25.50	304	8
3170	420	1.29	30.48	1.45	31.77	0.04	21.02	2.64	10.90	279	13
3180	419	0.77	18.20	0.98	18.97	0.04	18.57	1.58	6.70	271	14
3190	419	0.48	9.18	0.41	9.66	0.05	22.39	0.80	3.65	251	11
3200	420	0.34	5.67	0.39	6.01	0.06	14.53	0.50	2.30	246	16
3210	420	1.42	15.16	0.89	16.58	0.09	17.03	1.38	6.00	252	14
3220	420	1.67	39.87	1.70	41.54	0.04	23.45	3.46	15.80	252	10
3230	421	0.91	15.03	0.78	15.94	0.06	19.26	1.32	6.65	226	11
SELENE SANDSTONE											
3250	421	1.45	39.80	1.50	41.25	0.04	26.53	3.43	14.90	267	10
3260	421	0.48	13.62	0.75	14.10	0.03	18.16	1.17	6.60	206	11
3270	420	0.33	6.87	0.30	7.20	0.05	22.90	0.60	3.20	214	9
3280	420	0.18	2.33	0.17	2.51	0.07	13.70	0.20	2.05	113	8

AMDEL

Rock-Eval Pyrolysis 23/06/89

Client: PETROFINA EXPLORATION AUSTRALIA S.A.

Well: ANGLER-1

Depth (m)	T Max	S1	S2	S3	S1+S2	PI	S2/S3	PC	TOC	HI	OI
3290	418	0.14	1.92	0.19	2.06	0.07	10.10	0.17	0.95	202	20
3415	427	0.40	0.82	0.18	1.22	0.33	4.52	1.02	0.74	111	25
3440	422	0.07	0.99	0.29	1.06	0.07	3.41	0.08	0.76	130	38
3480	422	0.09	1.13	0.13	1.22	0.07	8.69	0.10	0.72	156	18
3490	422	0.20	2.31	0.28	2.51	0.08	8.25	0.20	1.43	161	19
3500	423	0.35	3.69	0.63	4.04	0.09	5.85	0.33	2.15	171	29
3510	390	1.41	28.62	1.89	30.03	0.05	15.14	2.50	9.30	307	20
CAMPANIAN											
3520	419	0.68	7.45	0.85	8.13	0.08	8.76	0.67	3.00	248	28
3560	424	0.41	5.18	0.30	5.59	0.07	17.26	0.46	2.20	235	13
3570	426	0.19	2.19	0.28	2.38	0.08	7.82	0.19	1.17	187	23
3580	425	0.09	1.17	0.13	1.26	0.07	9.00	0.10	0.69	169	18
3590	423	1.85	5.81	0.34	7.66	0.24	17.08	0.63	2.25	258	15
3600	424	0.28	0.92	0.13	1.20	0.23	7.07	0.10	0.43	213	30
3650	423	0.21	2.95	0.19	3.16	0.07	15.52	0.26	1.25	236	15
3660	426	0.09	0.64	0.09	0.73	0.12	7.11	0.06	0.51	125	17
3690	425	0.13	2.35	0.19	2.48	0.05	12.36	0.20	1.27	185	14
3700	420	0.40	6.30	0.35	6.70	0.06	18.00	0.55	2.40	262	14
3710	420	0.45	7.30	0.28	7.75	0.06	26.07	0.64	3.80	192	7
3730	419	0.90	16.01	0.36	16.91	0.05	44.47	1.40	6.15	260	5
3740	422	0.86	15.52	0.26	16.38	0.05	59.69	1.36	5.85	265	4
3750	425	0.63	12.24	0.28	12.87	0.05	43.71	1.07	8.55	143	3
3760	422	1.34	18.48	0.31	19.82	0.07	59.61	1.65	3.35	552	9
3770	420	1.78	28.74	0.54	30.52	0.06	53.22	2.54	4.90	587	11
3790	428	0.45	9.87	0.28	10.32	0.04	35.25	0.86	6.75	146	4
3810	424	0.66	12.65	0.21	13.31	0.05	60.23	1.10	9.05	140	2
3820	428	0.41	7.04	0.35	7.45	0.06	20.11	0.62	2.70	261	13
3830	427	0.72	12.61	0.53	13.33	0.05	23.79	1.11	4.00	315	13
3840	425	0.37	7.62	0.61	7.99	0.05	12.49	0.66	3.15	242	19
3850	426	0.46	10.26	0.51	10.72	0.04	20.11	0.89	3.60	285	14
3860	427	0.19	3.20	0.34	3.39	0.06	9.41	0.28	1.12	286	30
3880	428	0.62	10.00	0.89	10.62	0.06	11.23	0.88	2.20	455	40
CAMPANIAN SILTSTONE											
3890	429	0.25	3.32	0.38	3.57	0.07	8.73	0.29	1.74	191	22
3900	433	0.32	4.49	0.55	4.81	0.07	8.16	0.40	1.96	229	28
3910	433	0.28	4.99	0.43	5.27	0.05	11.60	0.43	2.10	238	20
3920	430	0.21	3.30	0.39	3.51	0.06	8.46	0.29	1.45	228	27
3940	432	0.30	5.12	0.63	5.42	0.06	8.12	0.45	2.10	244	30
3950	432	0.30	5.06	0.58	5.36	0.06	8.72	0.44	2.45	207	24
3960	432	0.32	5.56	0.82	5.88	0.05	6.78	0.49	2.55	218	32
3970	429	0.36	5.84	0.69	6.20	0.06	8.46	0.51	2.40	243	29
3980	431	0.31	4.11	1.33	4.42	0.07	3.09	0.36	2.10	196	63
3990	426	0.45	6.49	0.66	6.94	0.06	9.83	0.57	2.60	250	25
4000	428	0.39	5.76	0.65	6.15	0.06	8.86	0.51	2.50	230	26
4010	425	0.24	3.01	0.51	3.25	0.07	5.90	0.27	1.43	210	36
4020	429	0.35	5.76	0.65	6.11	0.06	8.86	0.51	2.55	225	25

AMDEL

Rock-Eval Pyrolysis 29/08/89

Client: PETROFINA EXPLORATION AUSTRALIA S.A.

Well: ANGLER-1

Depth (m)	T Max	S1	S2	S3	S1+S2	PI	S2/S3	PC	TOC	HI	OI
4030	431	0.37	5.12	0.40	5.49	0.07	12.80	0.45	2.15	238	18
4040	429	0.88	7.32	0.80	8.20	0.11	9.15	0.68	1.90	385	42
4050	433	0.22	3.57	0.39	3.79	0.06	9.15	0.31	1.88	189	20
4060	431	0.22	3.66	0.33	3.88	0.06	11.09	0.32	1.80	203	18
4070	424	0.85	20.89	0.49	21.74	0.04	42.63	1.81	6.65	314	7
4080	432	0.15	3.82	0.67	3.97	0.04	5.70	0.33	2.10	181	31
4090	427	0.29	5.06	0.39	5.35	0.05	12.97	0.44	2.35	215	16
4100	428	0.47	5.76	0.33	6.23	0.08	17.45	0.51	2.75	209	12
4110	429	0.27	3.76	0.32	4.03	0.07	11.75	0.33	1.85	203	17
4120	432	0.42	4.35	3.18	4.77	0.09	1.36	0.39	2.10	207	151
4130	432	0.32	3.73	0.32	4.05	0.08	11.65	0.33	1.78	209	17
4140	428	0.39	6.73	0.35	7.12	0.05	19.22	0.59	2.65	253	13
4150	431	0.23	2.95	0.54	3.18	0.07	5.46	0.26	1.69	174	31
4160	431	0.25	3.34	0.69	3.59	0.07	4.84	0.29	1.66	201	41
4170	422	0.37	8.91	0.50	9.28	0.04	17.82	0.77	3.30	270	15
4180	432	0.22	2.87	0.61	3.09	0.07	4.70	0.25	1.68	170	36
4190	431	0.28	3.51	0.53	3.79	0.07	6.62	0.31	1.94	180	27
4200	432	0.12	1.11	0.17	1.23	0.10	6.52	0.10	0.70	158	24
CAMPANIAN 'B' SILTSTONE											
4220	431	0.16	1.34	0.36	1.50	0.11	3.72	0.12	0.73	183	49
4230	424	0.26	2.91	0.20	3.17	0.08	14.55	0.26	1.11	262	18
4260	428	0.19	1.58	0.17	1.77	0.10	9.29	0.12	0.43	367	39
4270	428	0.14	1.63	0.17	1.77	0.08	9.58	0.14	0.67	243	25
4280	431	0.07	0.60	0.12	0.67	0.11	5.00	0.05	0.42	142	28
4290	430	0.07	0.65	0.13	0.72	0.10	5.00	0.06	0.43	151	30
4300	431	0.09	0.60	0.30	0.69	0.13	2.00	0.05	0.43	139	69
4310	433	0.12	1.20	0.39	1.32	0.09	3.07	0.11	0.79	151	49
4320	434	0.16	1.48	0.45	1.64	0.10	3.28	0.13	0.90	164	50

TABLE 2

SIDEWALL CORES

AMDEL

Rock-Eval Pyrolysis 29/08/89

Client: PETROFINA EXPLORATION AUST. S.A.

Well: ANGLER-1

Depth (m)	T Max	S1	S2	S3	S1+S2	PI	S2/S3	PC	TOC	HI	OI
LATROBE GROUP											
3178	421	3.49	4.65	4.78	8.14	0.43	0.97	0.67	1.74	267	274
SELENE SANDSTONE											
3496	432	0.26	2.38	0.62	2.64	0.10	3.83	0.22	1.71	139	36
CAMPANIAN											
3689	428	0.96	28.98	0.63	29.94	0.03	46.00	2.49	9.15	316	6
3827	431	0.50	5.18	2.73	5.68	0.09	1.89	0.47	2.50	207	109
CAMPANIAN SILTSTONE											
4032	419	0.36	5.33	0.60	5.69	0.06	8.88	0.47	3.95	134	15
4181	430	0.57	3.21	2.84	3.78	0.15	1.13	0.31	1.69	189	168
CAMPANIAN 'B' SILTSTONE											
4324	432	0.33	1.84	3.75	2.17	0.15	0.49	0.18	1.12	164	334

KEY TO ROCK-EVAL PYROLYSIS DATA SHEET

	PARAMETER	SPECIFICITY
T max	position of S_2 peak in temperature program (^oC)	Maturity/Kerogen type
S_1	kg hydrocarbons (extractable)/tonne rock	Kerogen type/Maturity/Migrated oil
S_2	kg hydrocarbons (kerogen pyrolysate)/tonne rock	Kerogen type/Maturity
S_3	kg CO_2 (organic)/tonne rock	Kerogen type/Maturity *
$S_1 + S_2$	Potential Yield	Organic richness/Kerogen type
PI	Production Index ($S_1/S_1 + S_2$)	Maturity/Migrated Oil
PC	Pyrolysable Carbon (wt. percent)	Organic richness/Kerogen type/Maturity
TOC	Total Organic Carbon (wt. percent)	Organic richness
HI	Hydrogen Index (mg h'c (S_2)/g TOC)	Kerogen type/Maturity
OI	Oxygen Index (mg CO_2(S_3)/g TOC)	Kerogen type/Maturity *

*Also subject to interference by CO_2 from decomposition of carbonate minerals.

amdel

TABLE 3

SUMMARY OF VITRINITE REFLECTANCE MEASUREMENTS, ANGLER -1

Depth (m)	Mean Maximum Reflectance (%)	Standard Deviation	Range	Number of Determinations
2750	-	-	-	-
Gurnard				
2790	0.39	0.07	0.28 - 0.49	11
Latrobe Group				
2830	0.46*	0.04	0.39 - 0.52	7
2880	0.36	0.02	0.31 - 0.40	13
3010	0.38	0.06	0.20 - 0.50	29
3040	0.40	0.04	0.32 - 0.50	35
3120	0.43	0.04	0.33 - 0.52	36
3150	0.41	0.03	0.34 - 0.47	34
3178•	0.43	0.05	0.32 - 0.52	35
3220	0.43	0.05	0.32 - 0.56	33
Selene Sandstone				
3250	0.42	0.03	0.32 - 0.49	32
3440	0.50*	0.06	0.34 - 0.55	10
3496•	0.50	0.07	0.35 - 0.62	36
3510	0.45**	0.05	0.34 - 0.56	35
Campanian				
3560	0.50	0.04	0.44 - 0.60	34
3590	0.51	0.03	0.44 - 0.57	29
3689•	0.52	0.07	0.37 - 0.67	36
3750	0.53*(0.50)	0.06	0.39 - 0.65	34
3810	0.55*(0.52)	0.05	0.42 - 0.69	38
3827•	0.57	0.06	0.42 - 0.71	58
Campanian Siltstone				
3900	0.55*(0.53)	0.06	0.44 - 0.65	23
3950	0.52**	0.06	0.41 - 0.63	34
3990	0.51**	0.04	0.40 - 0.63	26
4032•	0.59	0.05	0.48 - 0.68	29
4070	0.54**	0.05	0.45 - 0.66	22
4110	0.55**	0.04	0.47 - 0.65	29
4150	0.53**(0.58)	0.05	0.45 - 0.63	20
4181•	0.57	0.08	0.44 - 0.71	28
4200	0.53**	0.06	0.42 - 0.67	26
Campanian "B" Siltstone				
4270	0.54**	0.02	0.50 - 0.58	14
4320	0.55**(0.61)	0.08	0.41 - 0.78	42
4324	0.64	0.05	0.51 - 0.74	36

* Influenced by reworked vitrinite.
** Influenced by caved cuttings.
() Preferred value.
• SWC's

amdel

TABLE 4

PERCENTAGE OF VITRINITE, INERTINITE AND EXINITE IN

DISPERSED ORGANIC MATTER, ANGLER -1

Depth (m)	Percentage of		
	Vitrinite	Inertinite	Exinite
Latrobe Group			
3150	60 - 65	20	15 - 20
3220	75 - 80	10 - 15	10
Selene Sandstone			
3496	20 - 25	70	5 - 10
Campanian			
3689	20	70	10
3750	60	30	10
3827	65	20	15
Campanian Siltstone			
3900	10	80	10
3990	10	80	10
4032	15 - 20	80 - 85	10
4070	10 - 15	75	10 - 15
4110	5 - 10	85	5 - 10
4181	10	80 - 85	5 - 10
Campanian "B" Siltstone			
4324	10	85	5

amdel

TABLE 5

ORGANIC MATTER TYPE AND ABUNDANCE, ANGLER -1

Depth (m)	Estimated Volume of DOM	Estimated Volume of Exinites	Exinite Macerals
Latrobe Group			
3150	>20	Ab	lipto, spo, res, cut, bmite sub exs
3220	>15	Ab	lipto, cut, res, spo, lama, bmite, sub, tela, exs
Selene Sandstone			
3496	~1	Sp	lipto, cut
Campanian			
3689	5-10	Ra	lipto, lama, res
3750	~10	Sp	cut, lipto, lama, spo, res, sub, bmite, exs
3827	2-5	Ra-Sp	cut, lipto, res, lama, sub, tela
Campanian Siltstone			
3900	~2	Ra	cut, lipto, spo, res
3990	~2	Sp	cut, lama, bmite, lipto, phyto, res
4032	~2	Ra	lama, lipto, spo, phyto, ?tela
4070	3-5	Ra	phyto, lipto, cut, spo, thuc
4110	~1	Ra	lipto, spo, cut, phyto, oil
4181	~1	Ra	phyto, lipto, cut, res
Campanian "B" Siltstone			
4324	~1	Ra	phyto, lipto, res, lama, cut

KEY TO DISPERSED ORGANIC MATTER DESCRIPTIONS

MACERAL GROUPS

V	Vitrinite
I	Inertinite
E	Exinite

EXINITE MACERALS

spo	Sporinite
cut	Cutinite
res	Resinite
sub	Suberinite
lipto	Liptodetrinite
fluor	Fluorinite
terp	Terpenite
exs	Exsudatinite
phyto	Phytoplankton
tela	Telalginite
lama	Lamalginite
bmite	Bituminite
bmen	Bitumen
thuc	Thucholite

ABUNDANCE (by vol.)

Ma	Major	>15%
Ab	Abundant	2-15%
Co	Common	1-2%
Sp	Sparse	0.5-1%
Ra	Rare	0.1-0.5%
Vr	Very Rare	=0.1%
Tr	Trace	<0.1

FLUORESCENCE COLOUR AND INTENSITY

G	Green	i	Intense
Y	Yellow	m	Moderate
O	Orange	d	Dull
B	Brown	nofl	No Visible Fluorescence

TABLE 6

EXINITE MACERAL ABUNDANCE AND FLUORESCENCE CHARACTERISTICS, ANGLER -1

Depth (m)	Exinite Macerals	Lithology/Comments
Latrobe Group		
3150	lipto(Ab;mY-mO), spo(Ab;mY-mO), res(Ab;iY), cut(Co-Ab;iY-mO), bmite(Co-Ab;dO), sub(Ra;dO), exs (Ra;dO)	Chiefly carbonaceous shale, ~15% coal (duroclarite); exinite content is variable. Some coals contain up to 40% exinite. Exsudatinite is primary oil.
3220	lipto(Ab;mY-mO), cut(Co-Ab; mY-mO), res(Co-Ab;iY-dO), spo(Co;mO), lama(Co;mY-mO), bmite(Co;dO), sub (Sp;dO-nofl), tela(Tr;iO), exs(Tr;dO)	Chiefly carbonaceous shale, ~10% coal (clarite, duroclarite); some coals contain up to 30% exinite. Telalginite is *Botryococcus*-related. Exsudatinite is primary oil.
Selene Sandstone		
3496	lipto(Ra-Sp;mY-mO), cut(Ra;mO)	Shale with minor silty bands; most exinites are fragmented.
Campanian		
3689	lipto(Ra;mY-mO), lama(Ra;-mY-mO) res (Tr;iO-mO)	Silty shale; DOM content is variable. Exinite is more abundant in DOM rich bands.
3750	cut(Sp;mO), lipto(Sp;mO), lama (Ra-Sp;mO), spo(Ra;mO), res(Ra; iY-dO), sub(Ra;dO), bmite(Ra;dO), exs(Tr;dO)	Chiefly carbonaceous shale, 10-20% sandstone; exsudatinite is primary oil.
3827	cut(Ra-Sp;mY-mO), lipto(Ra-Sp;mY -mO), res(Ra;iY-mO), ?lama(Ra;mO), sub (Vr;nofl), tela (Tr;iY)	Shale; telalginite is ?Tasmanites algae.
Campanian Siltstone		
3900	cut(Ra;mO-dO), lipto(Ra;mO), spo(Vr;dO), res(Vr;iO-dO), lama (Vr;mO).	Chiefly shale, ~10% sandstone.

Depth (m)	Exinite Macerals	Lithology/Comments
3990	cut(Ra-Sp;mO-dO), lama(Ra;mY-mO) bmite(Ra;dO), lipto(Ra;mY-mO)	Sandy shale; some exinite is oxidised.
4032	lama(Ra;mO), lipto(Ra;mY-mO), spo(Ra-Vr;mO), phyto(Ra-Vr;mY), ?tela(Vr;iY)	Silty shale; ?telalginite is Tasmanites algae.
4070	phyto(Ra;mY-mO),lipto(Ra;mY-mO) cut(Ra-Vr;mO-nofl),spo(Vr;nofl), thuc (Tr;dO)	Silty shale; common cavings. Most sporinite and cutinite are slightly to moderately oxidised. Thucholite is evidence of oil migration.
4110	lipto(Ra;mY-mO),spo(Vr;mO-nofl), cut(Vr;nofl),phyto(Vr;mY-mO), oil (Vr-Tr;iY)	Shale; oil occurs as small accumulations in the shale and does not appear to be intimately associated with the organic matter.
4181	phyto(Ra;mY-mO),lipto(Ra;mY-mO), cut(Vr;mO-dO), res(Tr;mY)	Shale
Campanian "B" Siltstone		
4324	phyto(Ra;mY-mO),lipto(Ra;mO), res(Vr;mY),lama(Vr;mO),cut (Tr;dO)	Shale

amdel

TABLE 7

STABLE ISOTOPIC ANALYSIS OF GAS FROM ANGLER -1 (4226 m)

Component	Vol %	$\delta^{13}C$(°/∞)	$\delta^{18}O$(°/∞)	δD(°/∞)
Carbon Dioxide	3.08	-9.2	-8.6	
Methane	86.26	-36.7		-232.0
Ethane	7.25	-26.0		
Propane	2.34	-25.2		
iso-Butane	0.32			
n-Butane	0.51	-23.5		
iso-Pentane	0.12			
n-Pentane	0.11	-20.3		
Oxygen	tr			
Nitrogen	tr			

Carbon and oxygen isotope ratios are expressed relative to the P.D.B. Standard, while the δD value for methane is measured relative to S.M.O.W. standard.

TABLE 9

amdel technology and enterprise

NATA CERTIFICATE

Amdel Limited
(Incorporated in S.A.)
31 Flemington Street,
Frewville, S.A. 5063

Telephone: (08) 372 2700

P.O. Box 114,
Eastwood, S.A. 5063

Telex: AA82520
Facsimile: (08) 79 6623

AMDEL LIQUID ANALYSIS SERVICE Method R2.1

Client: PETROFINA EXPLORATION AUSTRALIA Report # F7574/89

Sample: ANGLER 1
RFT pre-test sample

Boiling Point Range (Deg.C)	Component	Weight%	Mol%
-88.6	ETHANE	0.13	0.54
-42.1	PROPANE	1.14	3.25
-11.7	I-BUTANE	0.80	1.73
-0.5	N-BUTANE	2.11	4.55
27.9	I-PENTANE	1.60	2.78
36.1	N-PENTANE	2.08	3.62
36.1-68.9	C-6	4.39	6.39
80.0	BENZENE	1.73	2.78
68.9-98.3	C-7	8.72	10.92
100.9	METHYLCYCHX	5.43	6.94
110.6	TOLUENE	5.79	7.88
98.3-125.6	C-8	6.21	6.82
136.1-144.4	ETHYLBZ+XYL	6.71	7.93
125.6-150.6	C-9	4.91	4.79
150.6-173.9	C-10	7.25	6.39
173.9-196.1	C-11	4.74	3.80
196.1-215.0	C-12	3.51	2.59
215.0-235.0	C-13	4.28	2.91
235.0-252.2	C-14	3.50	2.21
252.2-270.6	C-15	3.17	1.87
270.6-287.8	C-16	2.45	1.36
287.8-302.8	C-17	1.99	1.04
302.8-317.2	C-18	2.19	1.08
317.2-330.0	C-19	1.84	0.86
330.0-344.4	C-20	1.66	0.74
344.4-357.2	C-21	1.41	0.60
357.2-369.4	C-22	1.46	0.59
369.4-380.0	C-23	1.46	0.56
380.0-391.1	C-24	1.27	0.47
391.1-401.7	C-25	1.13	0.40
401.7-412.2	C-26	1.30	0.44
412.2-422.2	C-27	1.07	0.35
>422.2	C-28+	2.57	0.82
	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 [signature]

Date 20-Jun-89

TABLE 10

AMDEL
GASOLINE-RANGE ANALYSIS

ANGLER-1
RFT PRE-TEST SAMPLE

COMPOUND	NORMAL %	BRANCHED %	CYCLIC %	AROMATIC %
2-METHYLBUTANE		4.43		
N-PENTANE	5.71			
2,2-DIMETHYLBUTANE		0.34		
CYCLOPENTANE			0.20	
2,3-DIMETHYLBUTANE		1.15		
2-METHYLPENTANE		2.97		
3-METHYLPENTANE		1.91		
N-HEXANE	6.05			
2,2-DIMETHYLPENTANE		0.03		
METHYLCYCLOPENTANE			4.30	
2,4-DIMETHYLPENTANE		0.28		
2,2,3-TRIMETHYLBUTANE		0.07		
BENZENE				5.89
3,3-DIMETHYLPENTANE		0.11		
CYCLOHEXANE			7.06	
2-METHYLHEXANE		1.96		
2,3-DIMETHYLPENTANE		0.07		
1,1-DIMETHYLCYCLOPENTANE			0.57	
3-METHYLHEXANE		2.13		
TRANS-1,3-DIMETHYLCYCLOPENTANE			1.06	
CIS-1,3-DIMETHYLCYCLOPENTANE			0.96	
3-ETHYLPENTANE		0.00		
TRANS-1,2-DIMETHYLCYCLOPENTANE			1.67	
N-HEPTANE	7.25			
METHYLCYCLOHEXANE			19.38	
ETHYLCYCLOPENTANE			0.61	
TOLUENE				23.83
TOTAL PERCENTAGES	19.02	15.44	35.82	29.72

AMDEL
GASOLINE-RANGE PARAMETERS

ANGLER-1
RFT PRE-TEST SAMPLE

PARAMETER	
1	1.41
2	0.37
3	0.32
4	1.20
5	0.81
6	0.78
7	0.32
8	1.11
9	17.22

KEY TO PARAMETERS

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

(* from Thompson, 1983)

TABLE 12

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

Sample Test	C_{12+} Composition: N+ iso para %	Naph %	Arom %	Res+Asph %	Alkane Ratios: $n\text{-}C_{10}$ / a	$n\text{-}C_{15}$ / b	Np/Pr	Pr/Ph	Pr/$n\text{-}C_{17}$	Ph/$n\text{-}C_{18}$
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

* 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
$n\text{-}C_{17}$ = n-heptadecane
$n\text{-}C_{18}$ = n-octadecane

amdel

TABLE 13

OIL MATURITY BASED ON AROMATIC HYDROCARBON DISTRIBUTIONS*, ANGLER -1

Depth (m)	Test	MPI	MPR	MPDF	VR_{calc} (a)	(b)	(c)	(d)	(e) •	(f)
4226	RFT	1.08	1.49	0.56	1.05	1.65	1.11	nd	0.98	1.08

* = See key next page

nd = not determined

• = preferred value

TABLE 14

SOURCE-DEPENDENT BIOMARKER RATIOS IN ANGLER -1 AND OTHER INTRA-LATROBE OILS, GIPPSLAND BASIN

Well	C_{30} Hopane / C_{29} Steranes	C_{15}, C_{16} Drimanes / C_{30} Hopane	C_{30} ACH / C_{30} Hopane	Diterpanes / C_{30} Hopane	Tricyclics / Tetracyclics	C_{20} Labdane / C_{19} Isopim	Rimurane / 17-Nortetra
Angler -1	0.38	40	470	106	0.34	0.44	0.13
Volador -1 *	nd	nd	nd	5.9	0.62	1.1	1.3
Basker -1 *	nd	nd	nd	5.3	0.60	0.65	0.97
Parameter	1	2	3	4	5	6	7

* Data from Alexander *et al* (1987)
nd not determined

Ratios measured from mass fragmentograms as follows:

parameter 1	m/z 191, 217
parameter 2 & 4	m/z 123, 191
parameter 3	m/z 83, 191
parameters 5-7	m/z 123

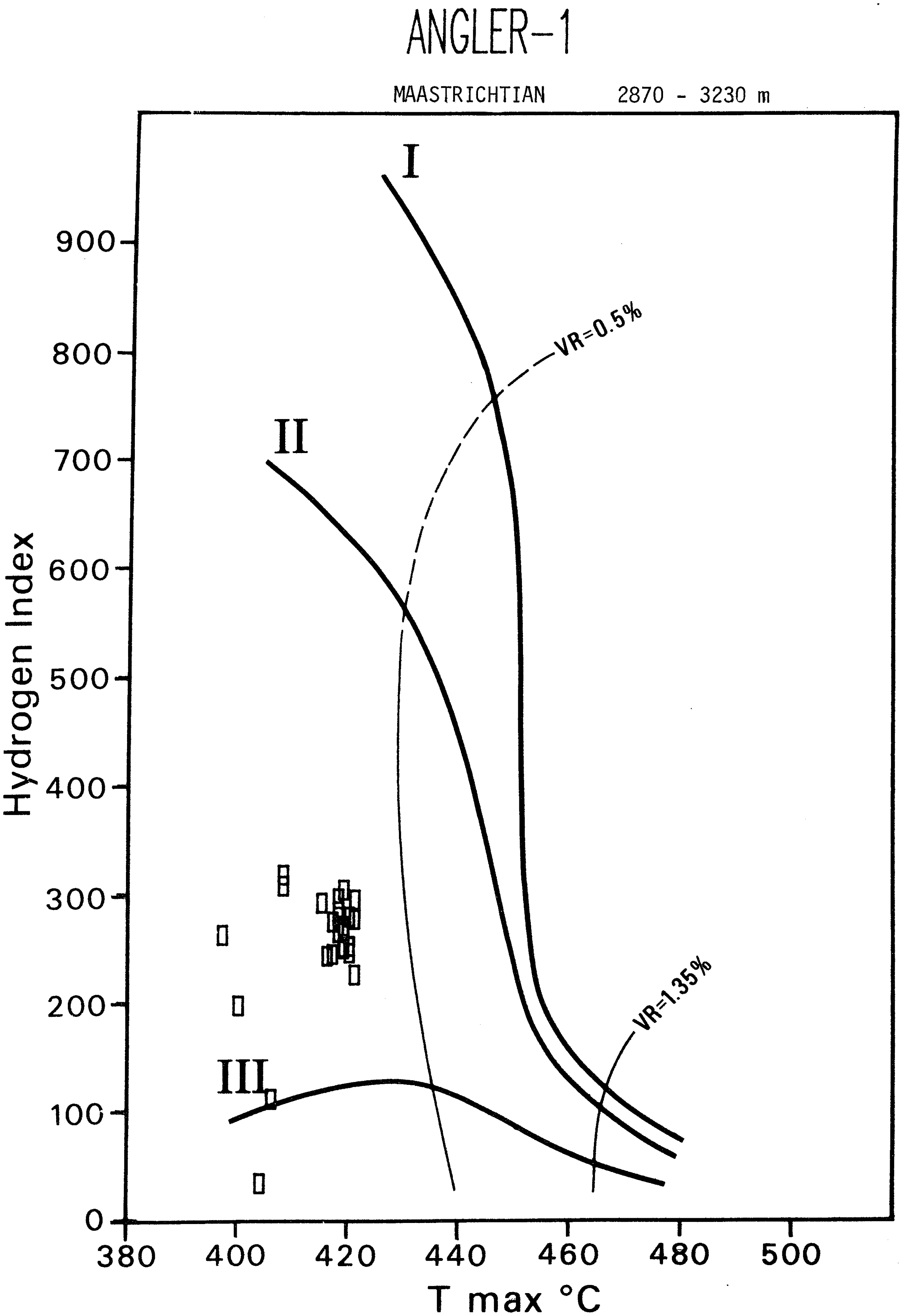
TABLE 15

STABLE CARBON ISOTOPIC COMPOSITION OF CONDENSATE AND ISOLATED FRACTIONS, ANGLER -1

Fraction	δC_{PDB} (°/∞)
Saturated Hydrocarbons	-26.4
Aromatics	-24.7
NSO Compounds	-26.1
Whole Oil	-25.5
Topped Oil	-26.0
Canonical Variable*	0.7

* after Sofer. (1984)

FIGURE 1



ANGLER-1
MAASTRICHTIAN 2870 - 3230 m
I
II
III
VR=0.5%
VR=1.35%
900
800
700
600
500
400
300
200
100
0
Hydrogen Index
380
400
420
440
460
480
500
T max °C

KEY TO AROMATIC MATURITY INDICATORS

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

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

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

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

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

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

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

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

Where

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

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

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

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

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

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

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

TABLE 8

DENSITY, API AND SULPHUR CONTENT, ANGLER -1 CONDENSATE

Depth (m)	Test	Density g/cc	API	Sulphur (%)
4226	RFT	0.8111	42.87	<0.1

FIGURE 2

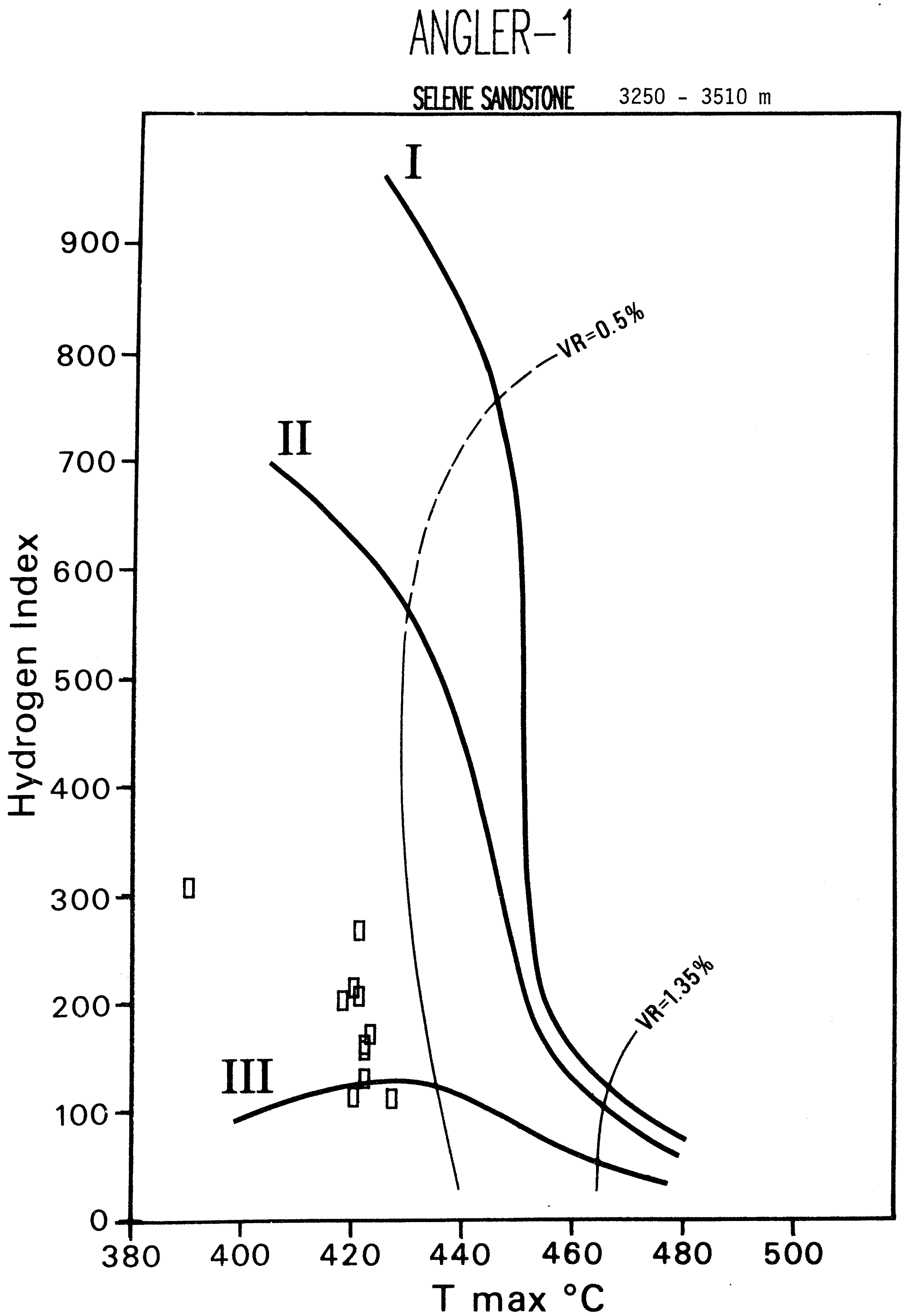

ANGLER-1
SELENE SANDSTONE 3250 - 3510 m
I
II
III
VR=0.5%
VR=1.35%
Hydrogen Index
0
100
200
300
400
500
600
700
800
900
380
400
420
440
460
480
500
T max °C

FIGURE 3

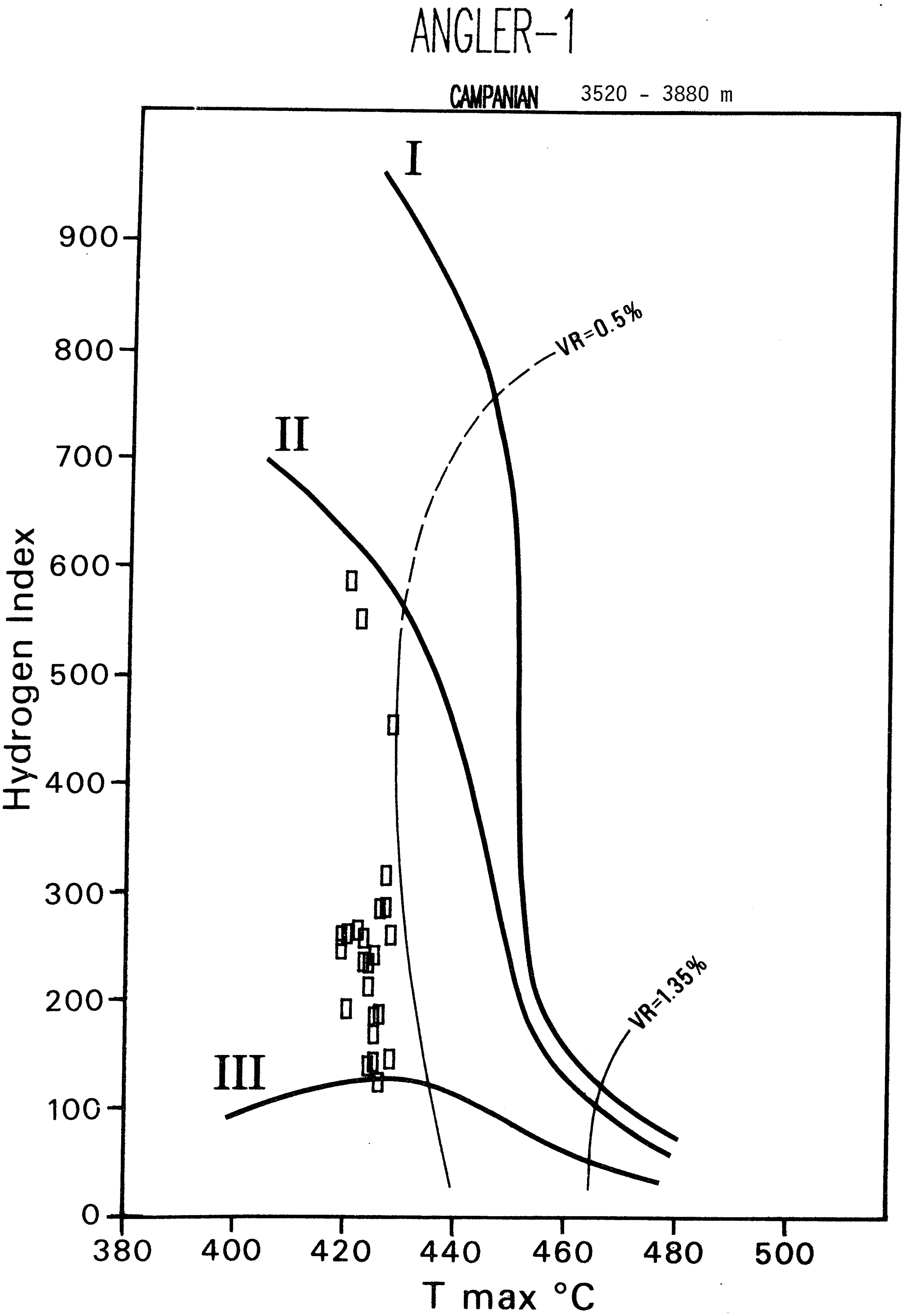

ANGLER-1
CAMPANIAN 3520 - 3880 m
Hydrogen Index
0
100
200
300
400
500
600
700
800
900
380
400
420
440
460
480
500
T max °C
I
II
III
VR=0.5%
VR=1.35%

FIGURE 4

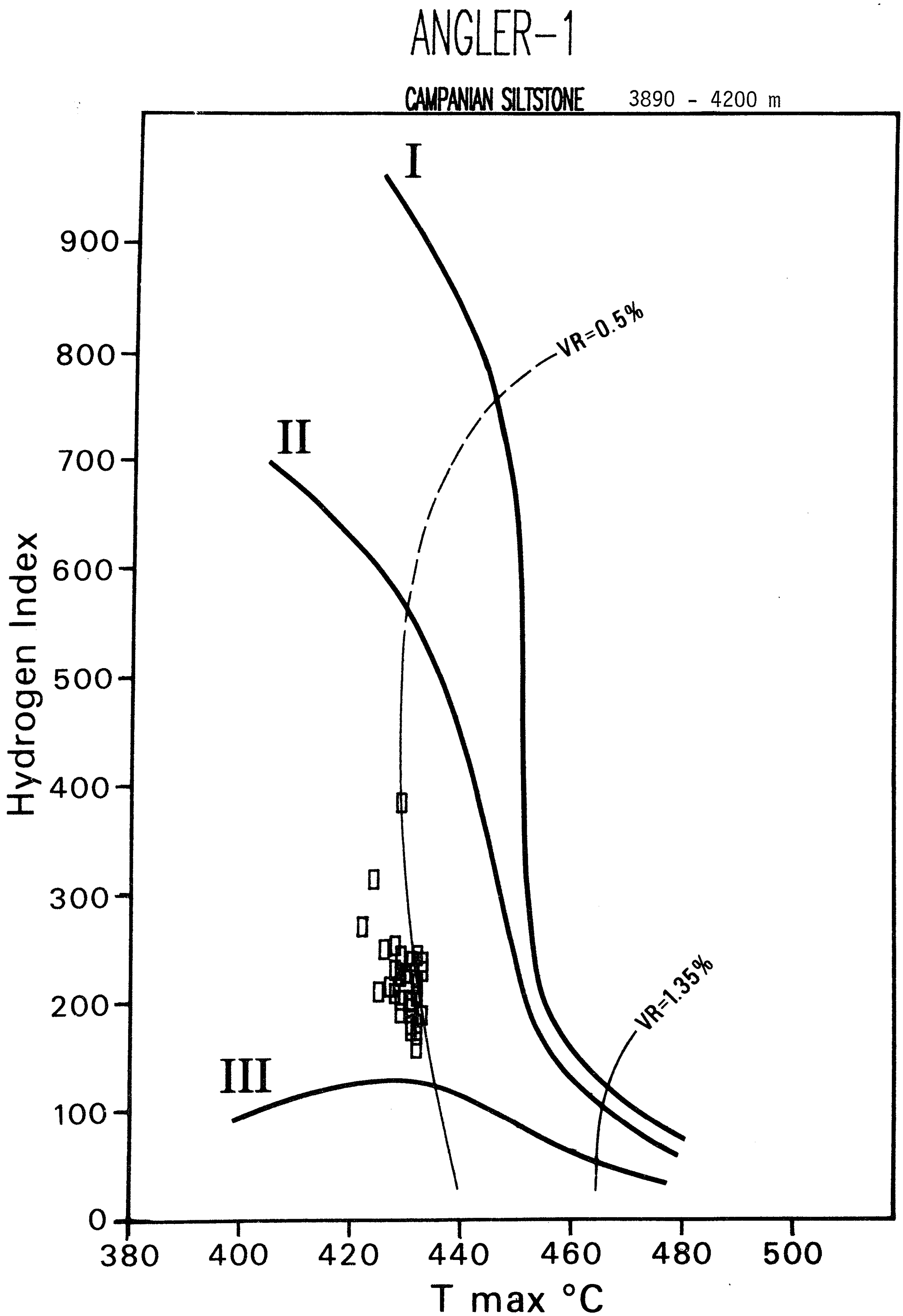

ANGLER-1
CAMPANIAN SILTSTONE 3890 - 4200 m
I
II
III
VR=0.5%
VR=1.35%
Hydrogen Index
0
100
200
300
400
500
600
700
800
900
T max °C
380
400
420
440
460
480
500

FIGURE 5

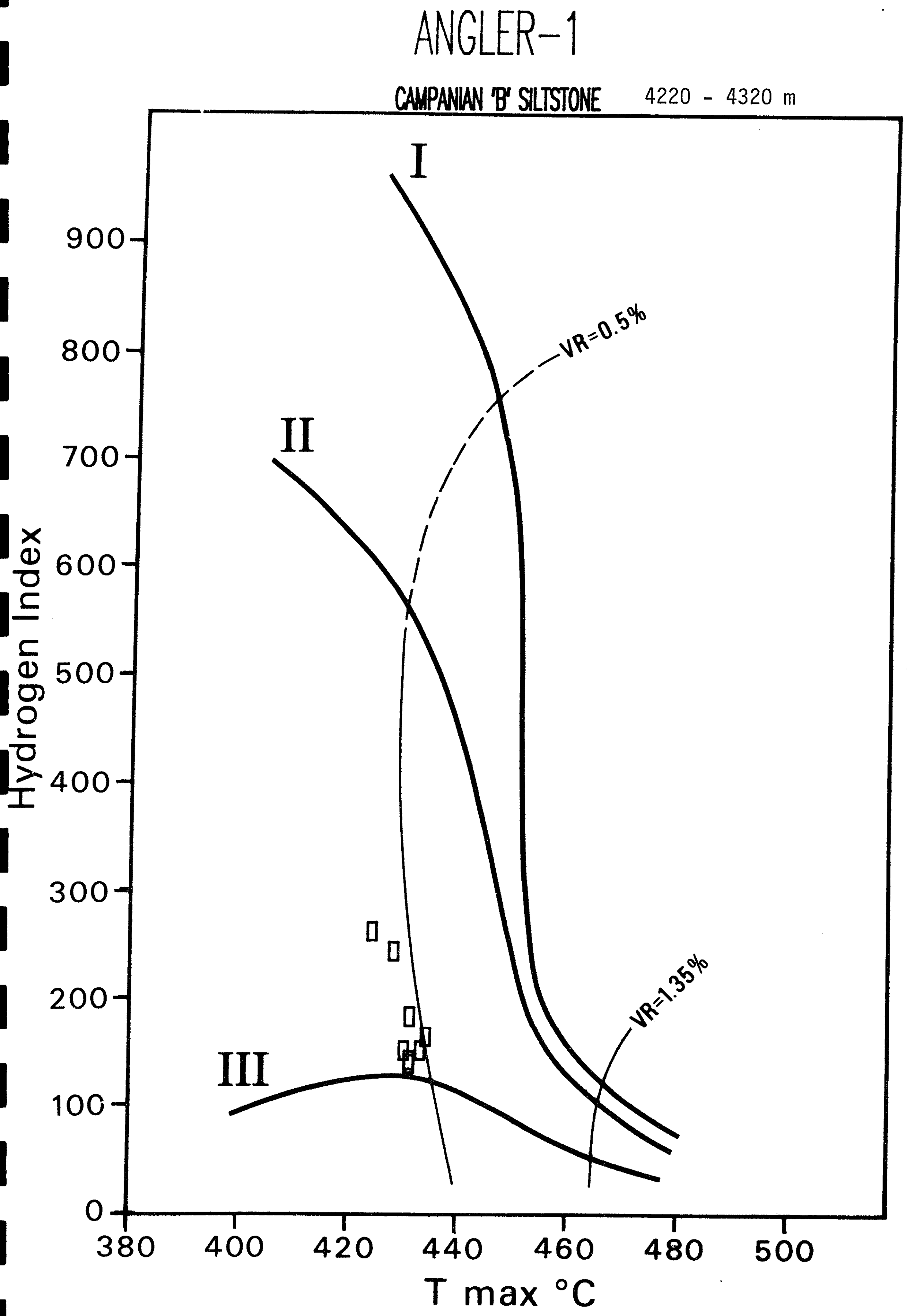
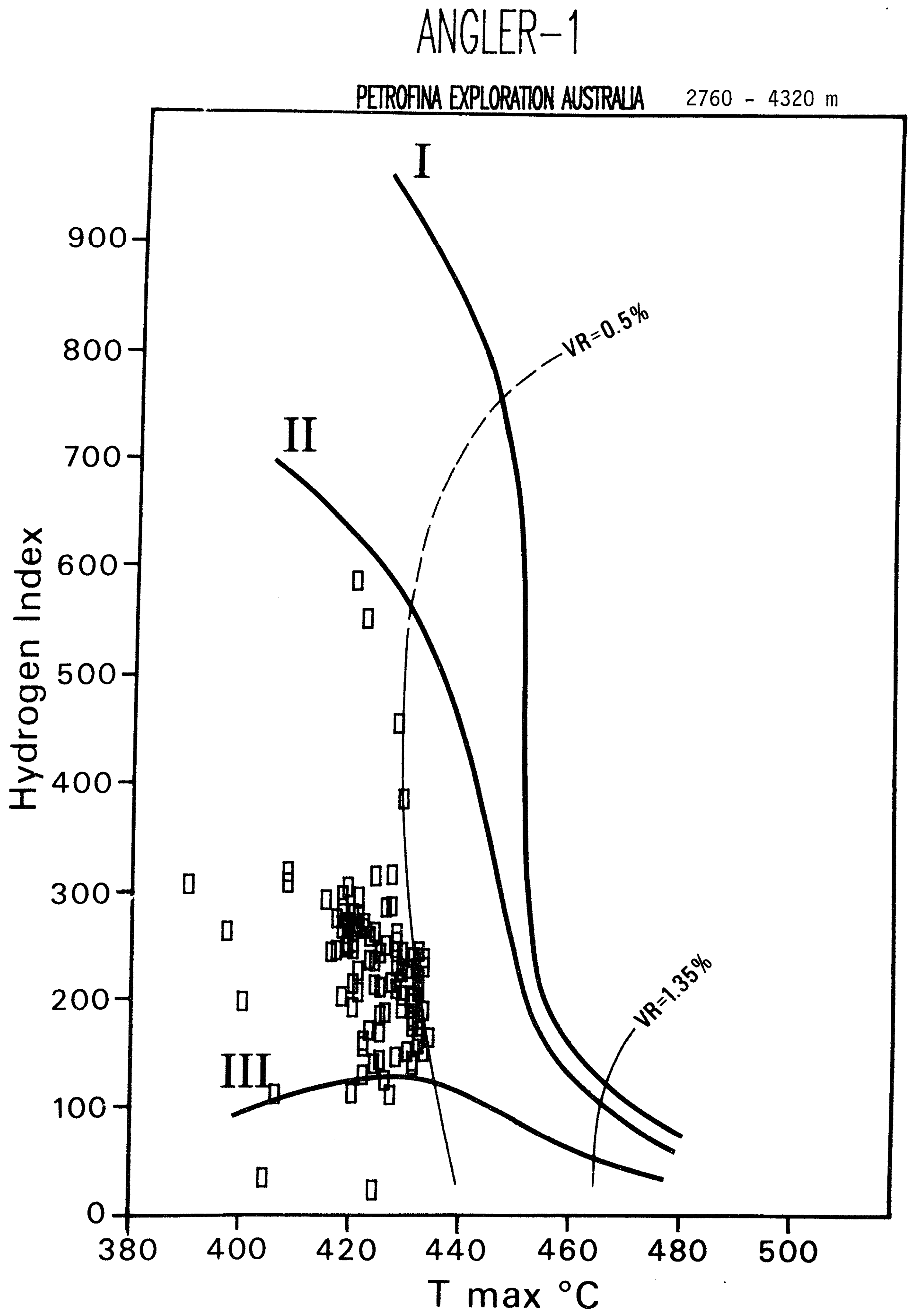

ANGLER-1
CAMPANIAN 'B' SILTSTONE 4220 - 4320 m
I
II
III
VR=0.5%
VR=1.35%
Hydrogen Index
900
800
700
600
500
400
300
200
100
0
380
400
420
440
460
480
500
T max °C

FIGURE 6



ANGLER-1
PETROFINA EXPLORATION AUSTRALIA
2760 - 4320 m
I
II
III
VR=0.5%
VR=1.35%
Hydrogen Index
900
800
700
600
500
400
300
200
100
0
380
400
420
440
460
480
500
T max °C

FIGURE 7

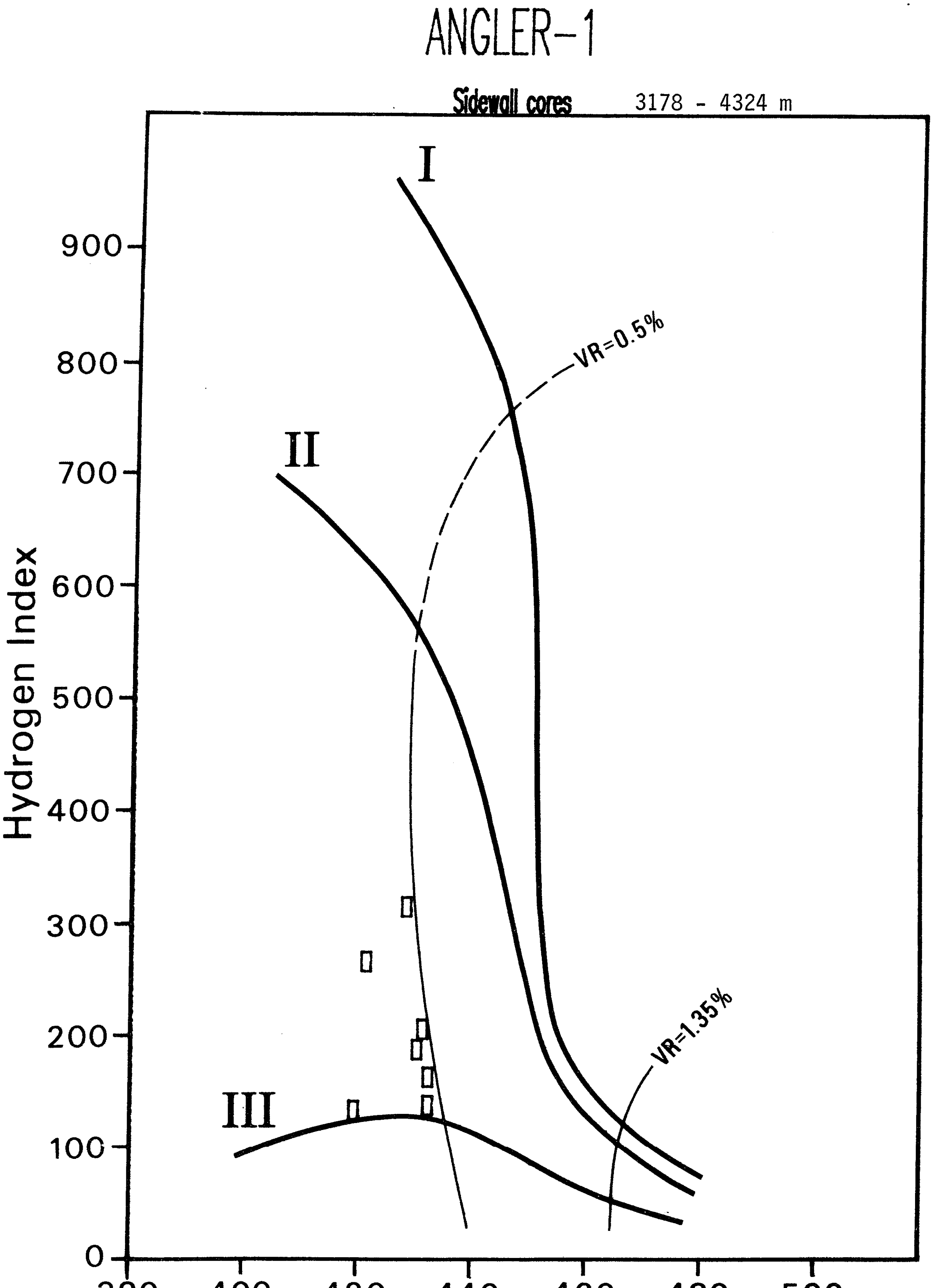

ANGLER-1
Sidewall cores 3178 - 4324 m
I
II
III
VR=0.5%
VR=1.35%
Hydrogen Index
900
800
700
600
500
400
300
200
100
0
380
400
420
440
460
480
500
T max °C

FIGURE 8

VITRINITE REFLECTANCE VERSUS DEPTH
ANGLER-1

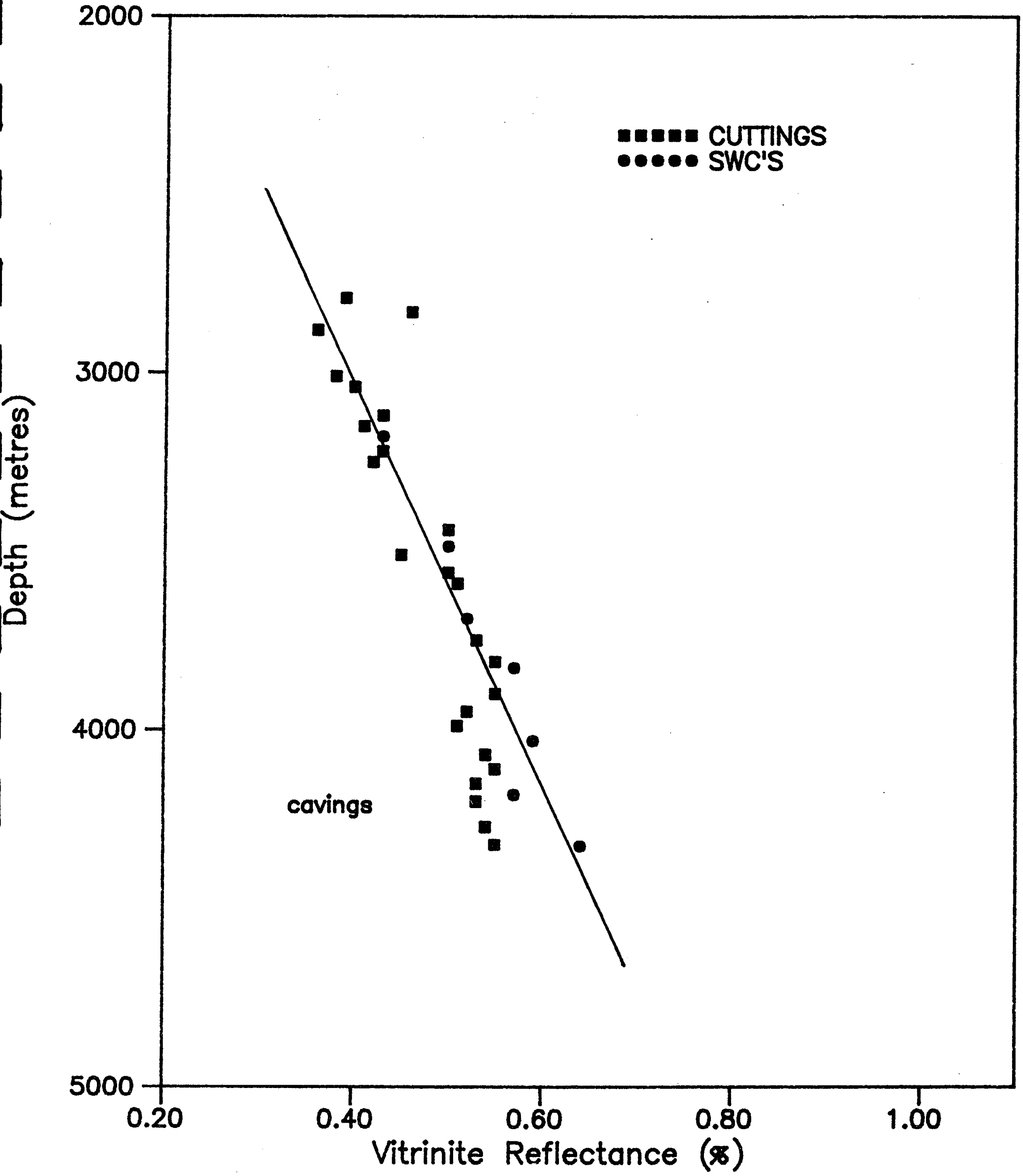
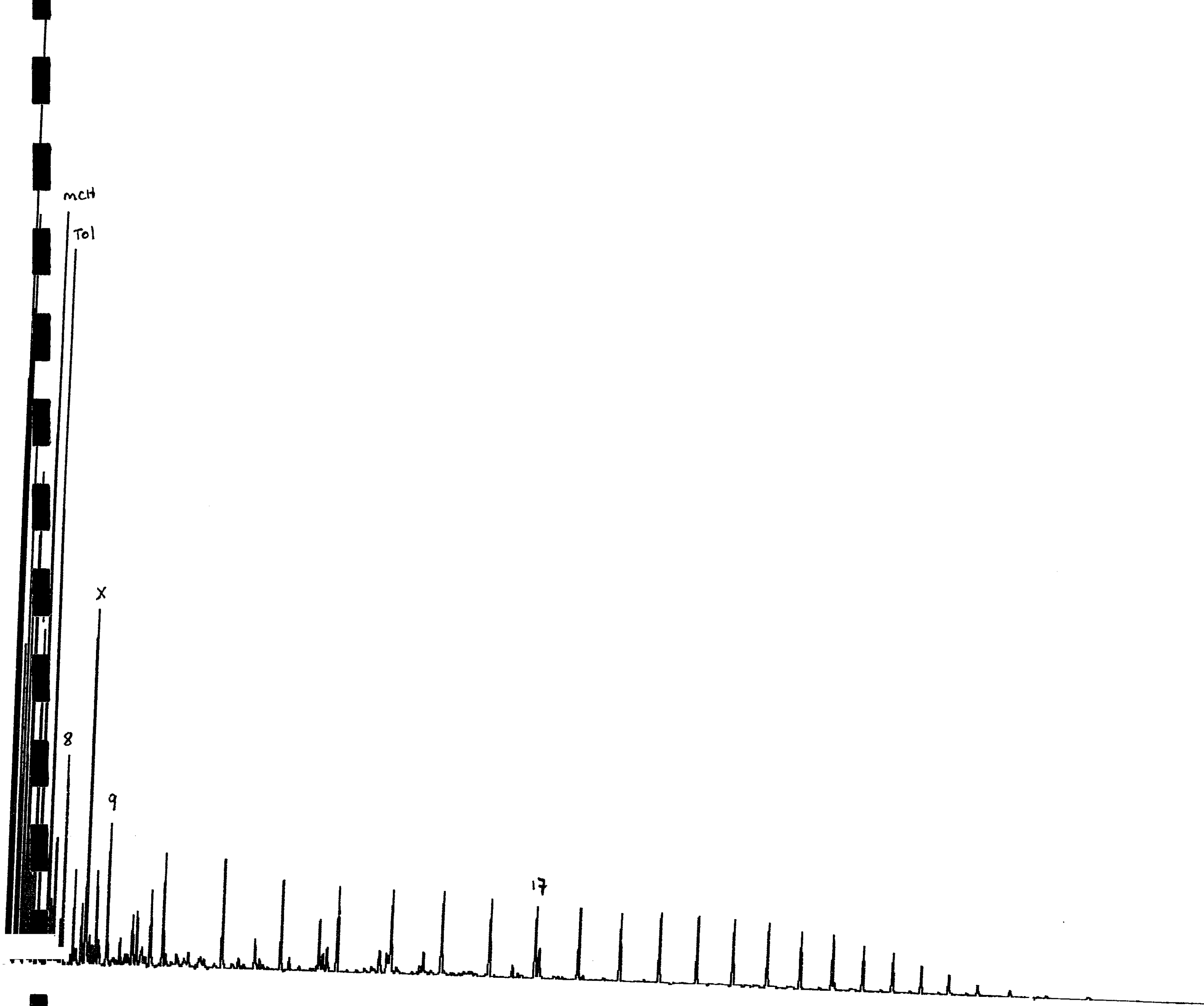


FIGURE 9

GC of Whole Condensate
RFT Pre-test
4226 m



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 10

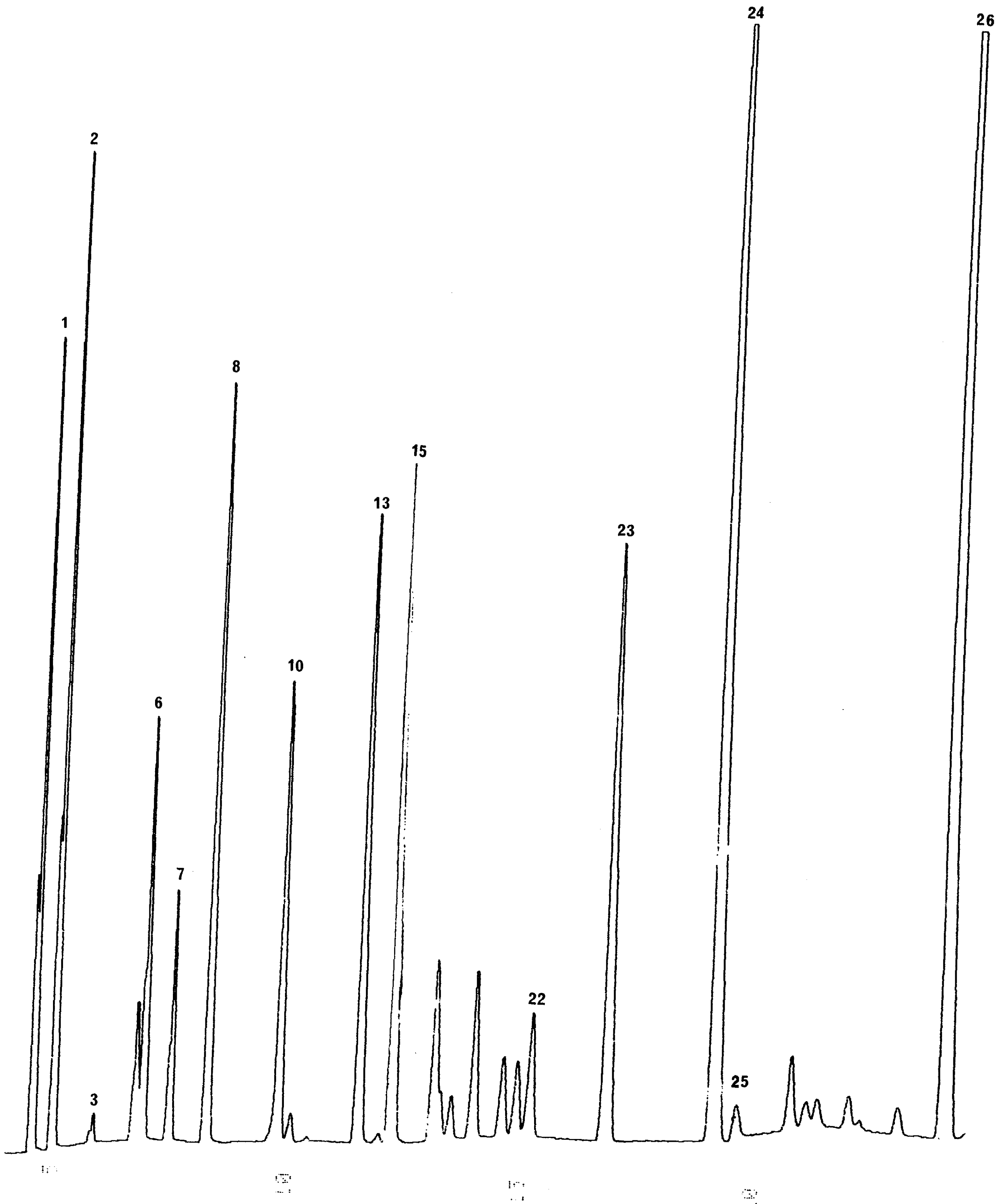


FIGURE 11

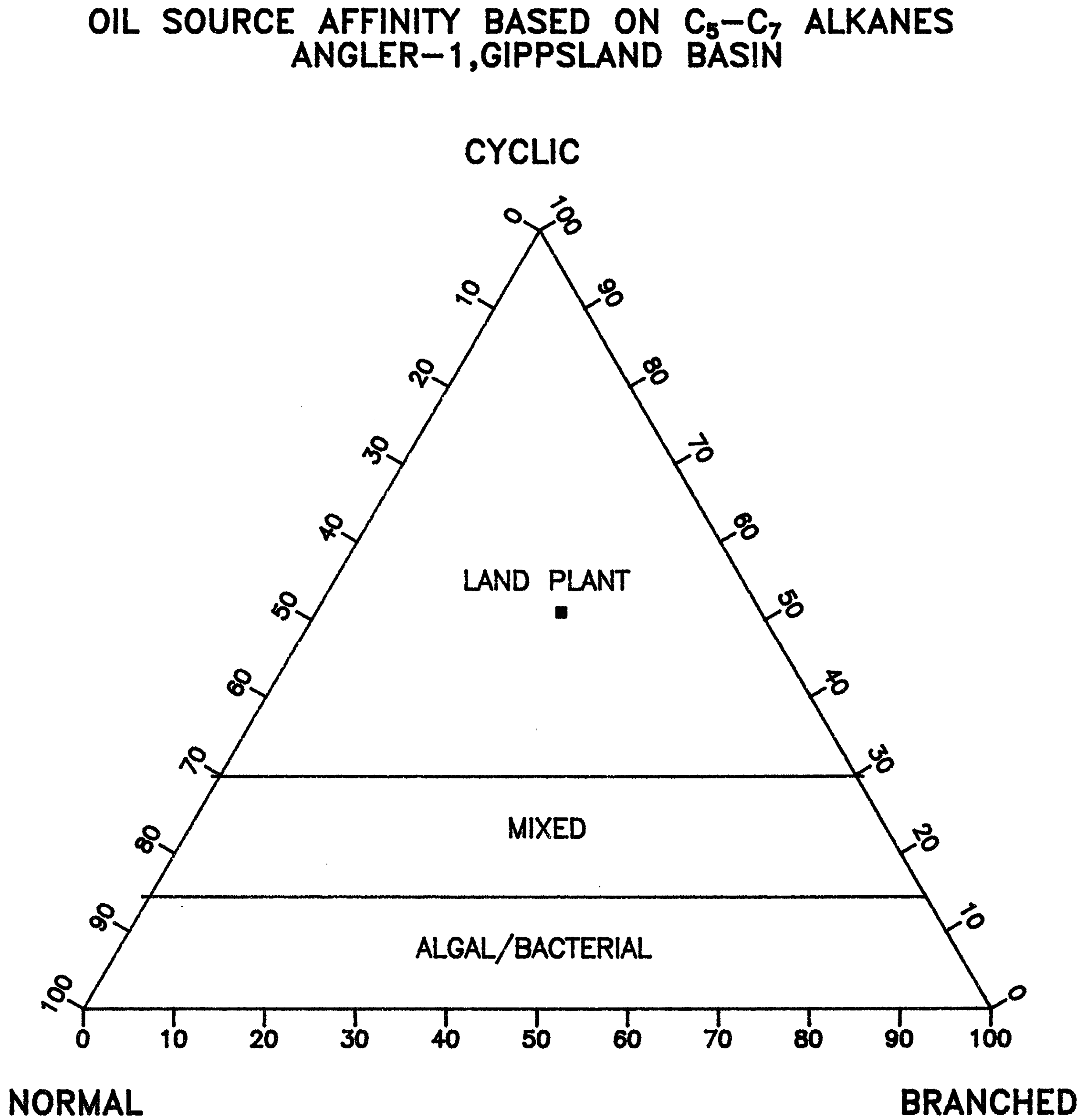

OIL SOURCE AFFINITY BASED ON C5–C7 ALKANES
ANGLER–1, GIPPSLAND BASIN
CYCLIC
LAND PLANT
MIXED
ALGAL/BACTERIAL
NORMAL
BRANCHED
0
10
20
30
40
50
60
70
80
90
100

FIGURE 12

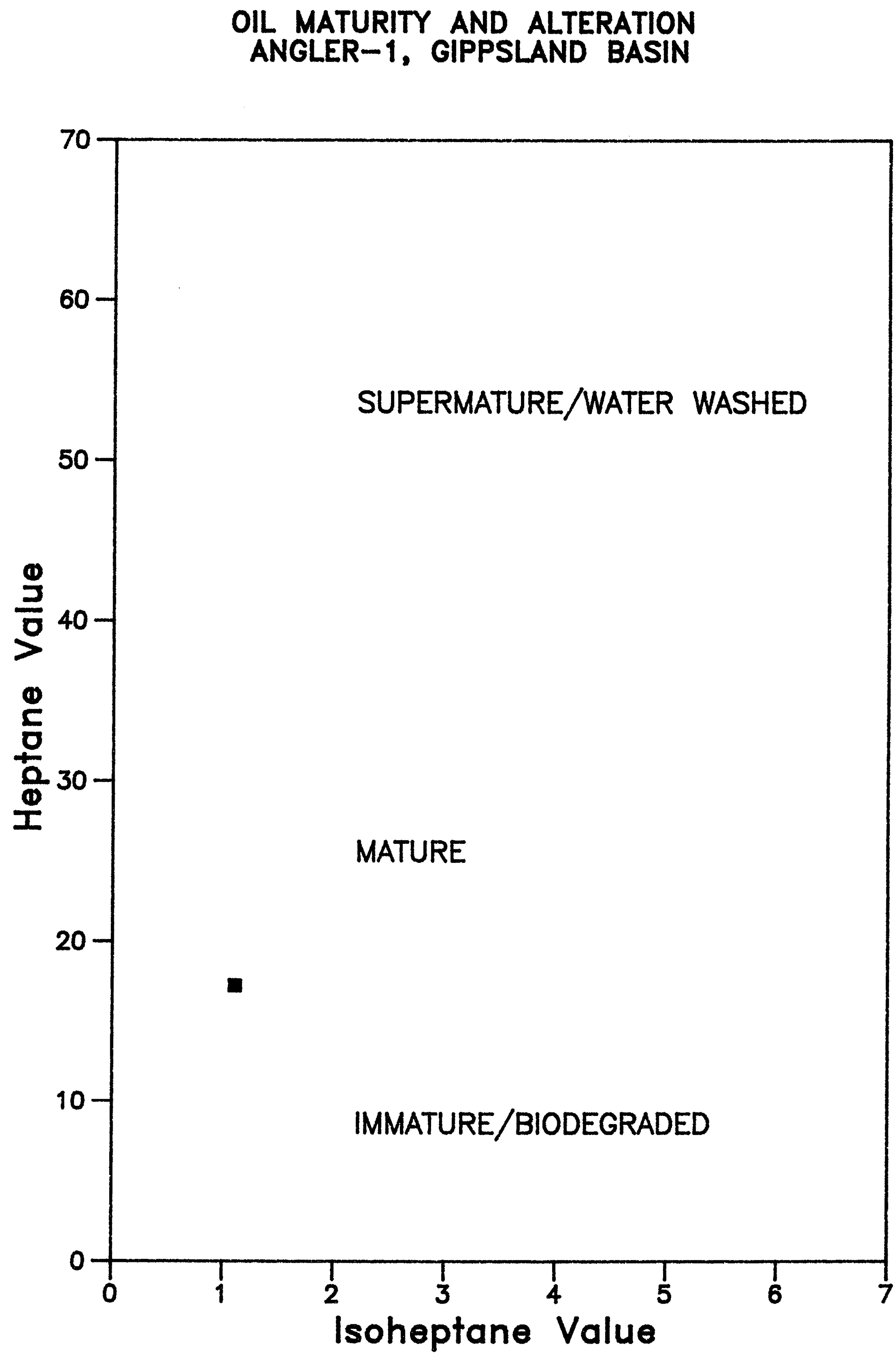

OIL MATURITY AND ALTERATION
ANGLER-1, GIPPSLAND BASIN
70
60
50
40
30
20
10
0
Heptane Value
SUPERMATURE/WATER WASHED
MATURE
IMMATURE/BIODEGRADED
0
1
2
3
4
5
6
7
Isoheptane Value

FIGURE 13

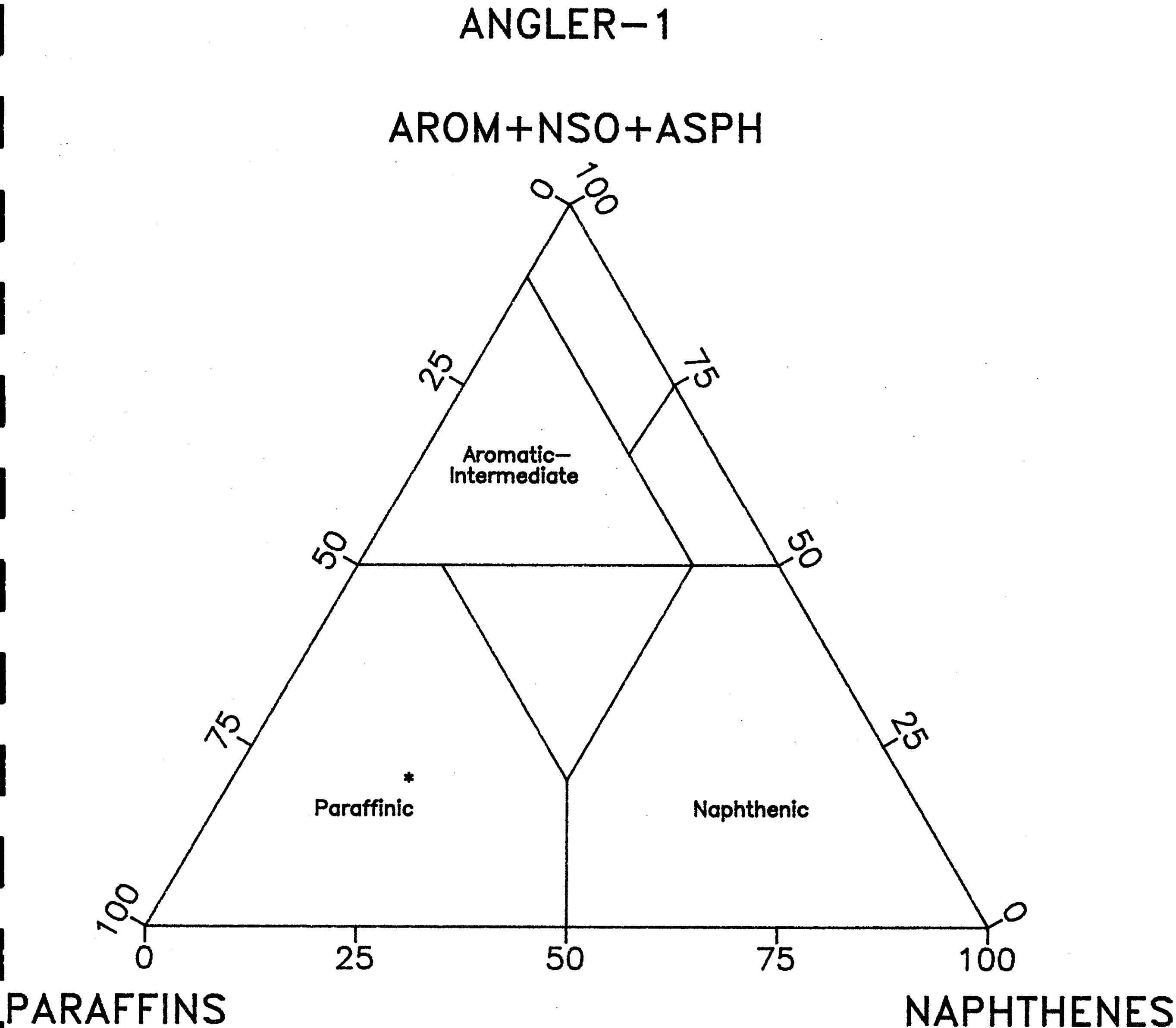

ANGLER-1
AROM+NSO+ASPH
Aromatic-
Intermediate
Paraffinic
Naphthenic
0
25
50
75
100
PARAFFINS
NAPHTHENES

FIGURE 14

ANGLER -1
RFT Pre-test
GC of Saturated Hydrocarbons

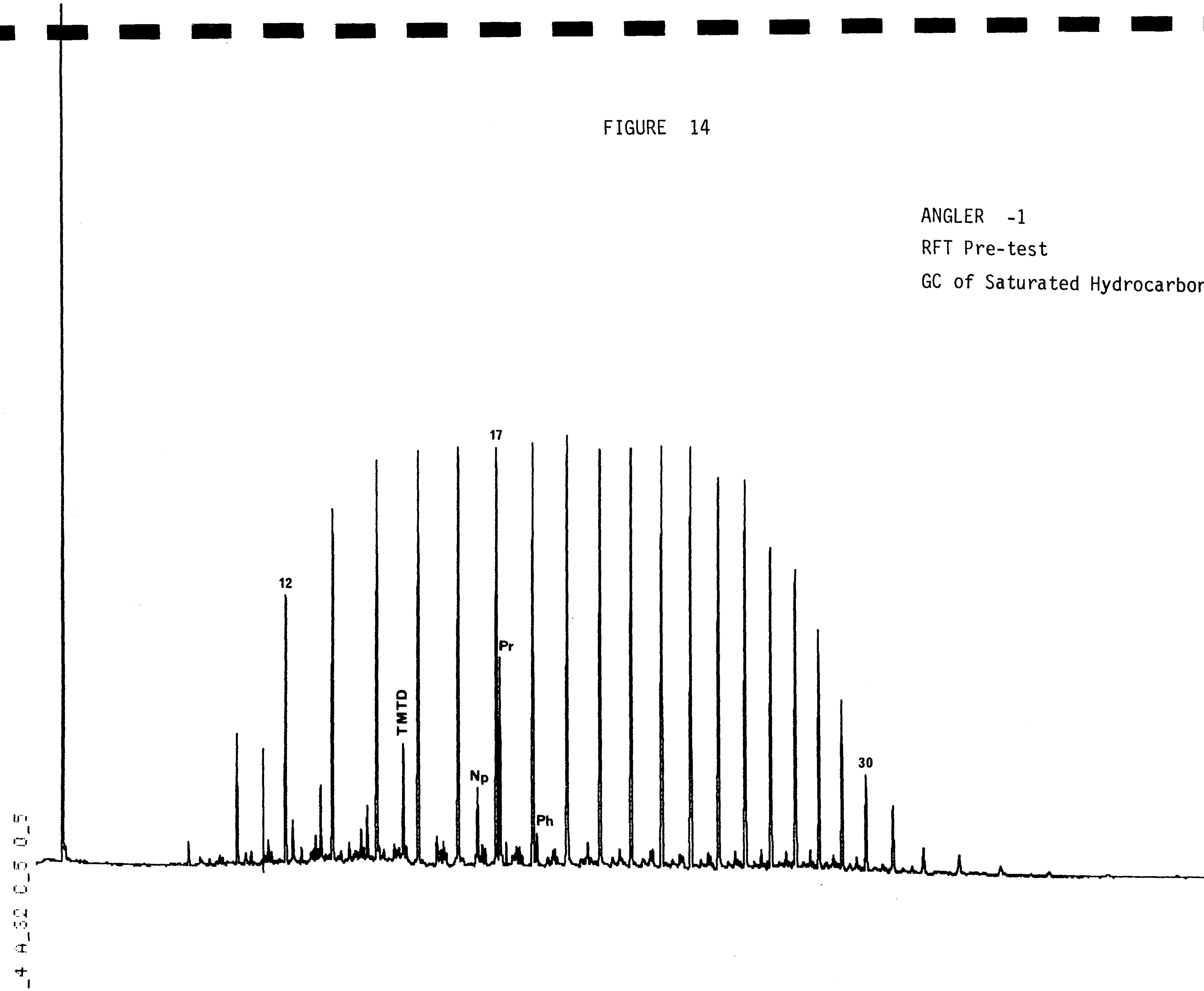


FIGURE 15

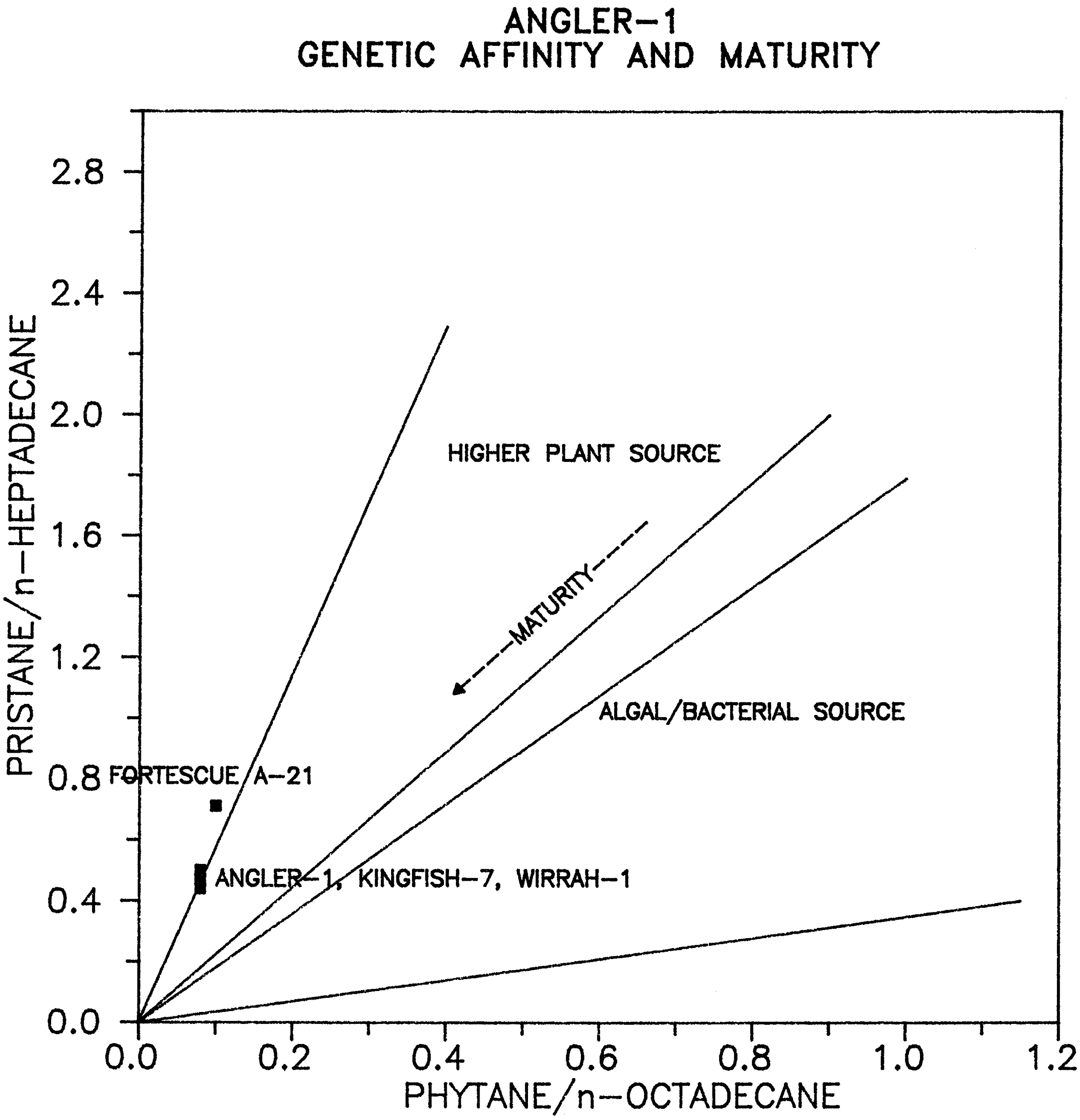
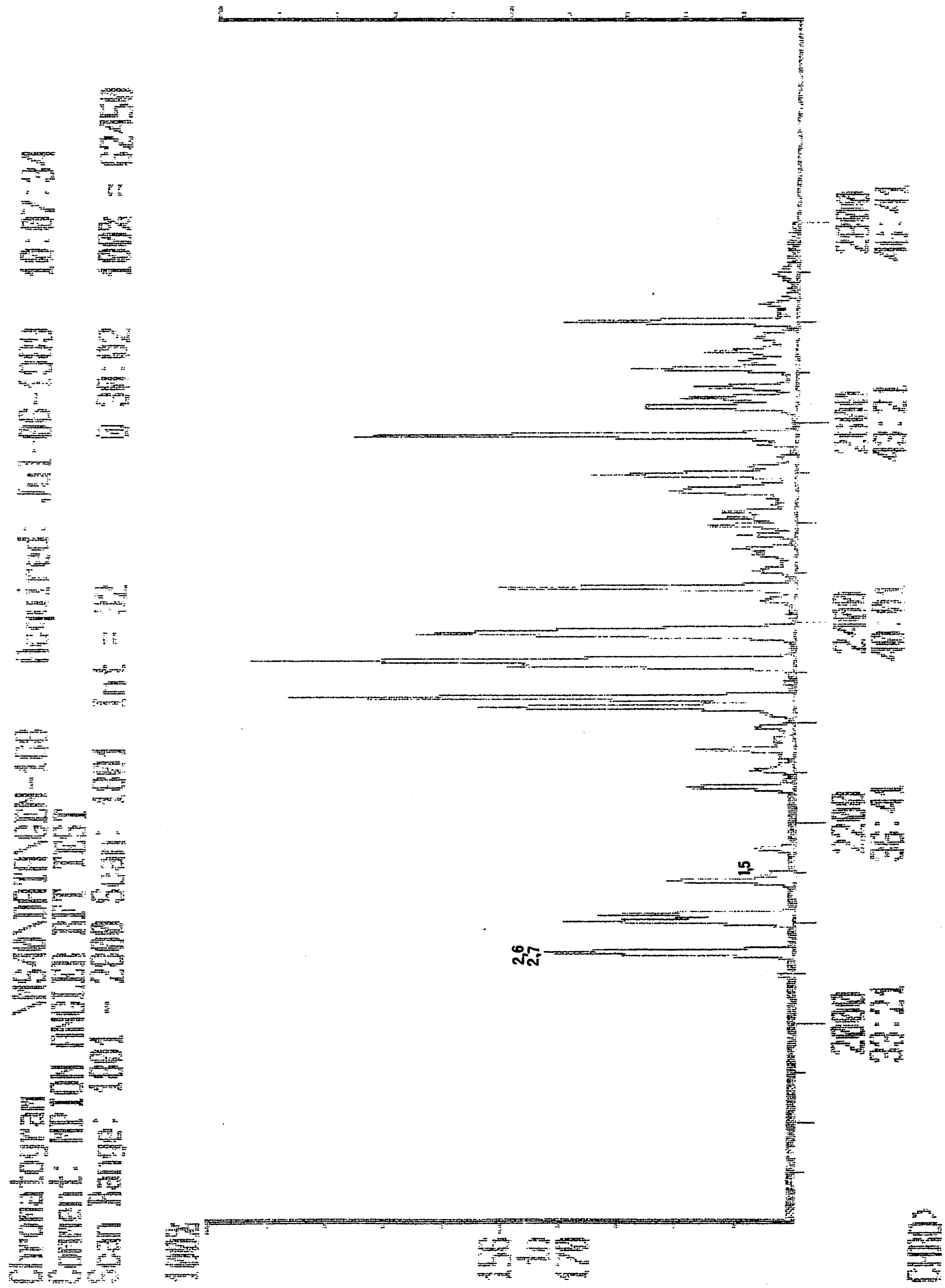

ANGLER–1
GENETIC AFFINITY AND MATURITY
HIGHER PLANT SOURCE
MATURITY
ALGAL/BACTERIAL SOURCE
FORTESCUE A–21
ANGLER–1, KINGFISH–7, WIRRAH–1
PRISTANE/n–HEPTADECANE
PHYTANE/n–OCTADECANE
0.0
0.4
0.8
1.2
1.6
2.0
2.4
2.8
0.0
0.2
0.4
0.6
0.8
1.0
1.2

FIGURE 16



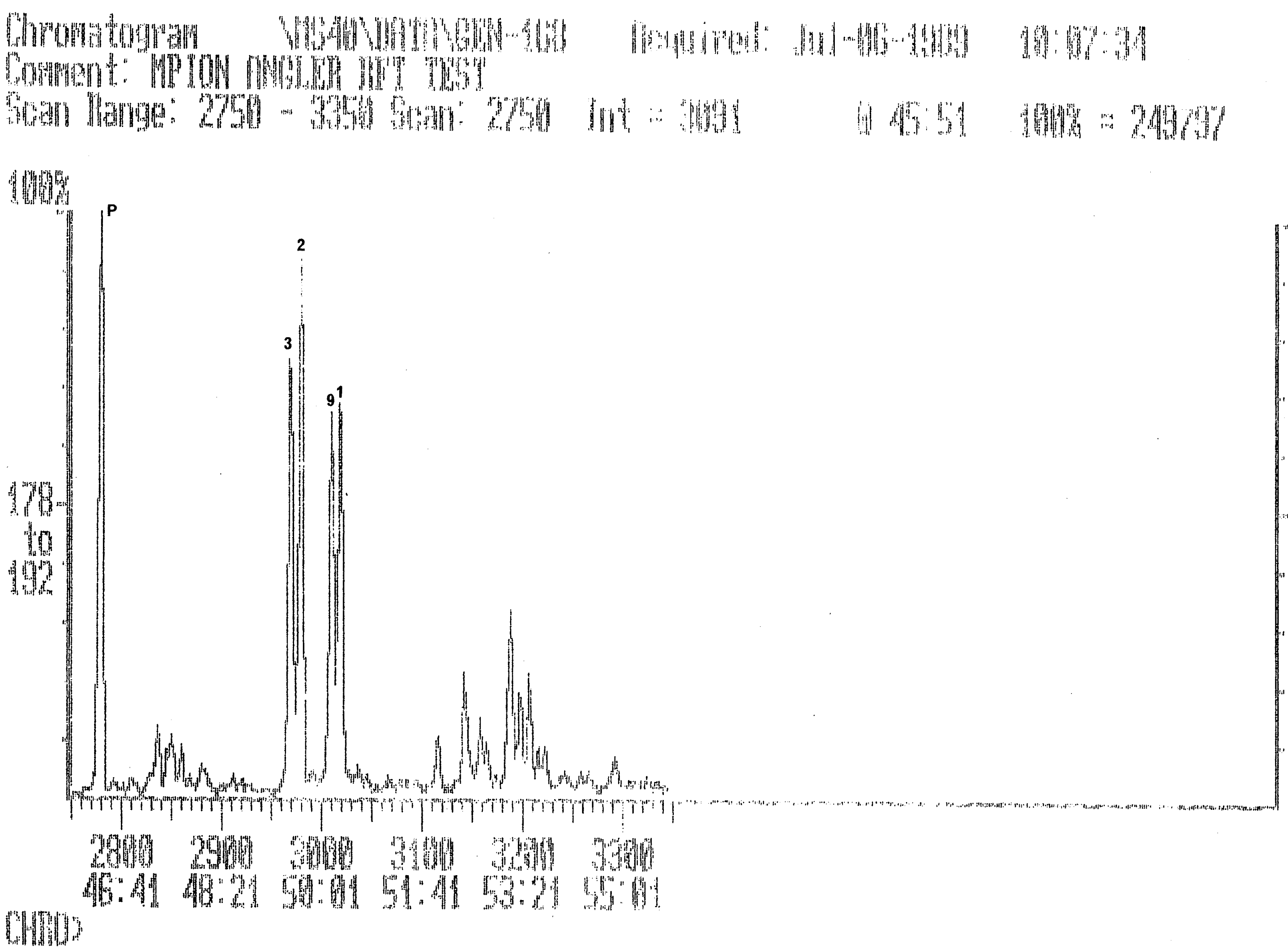
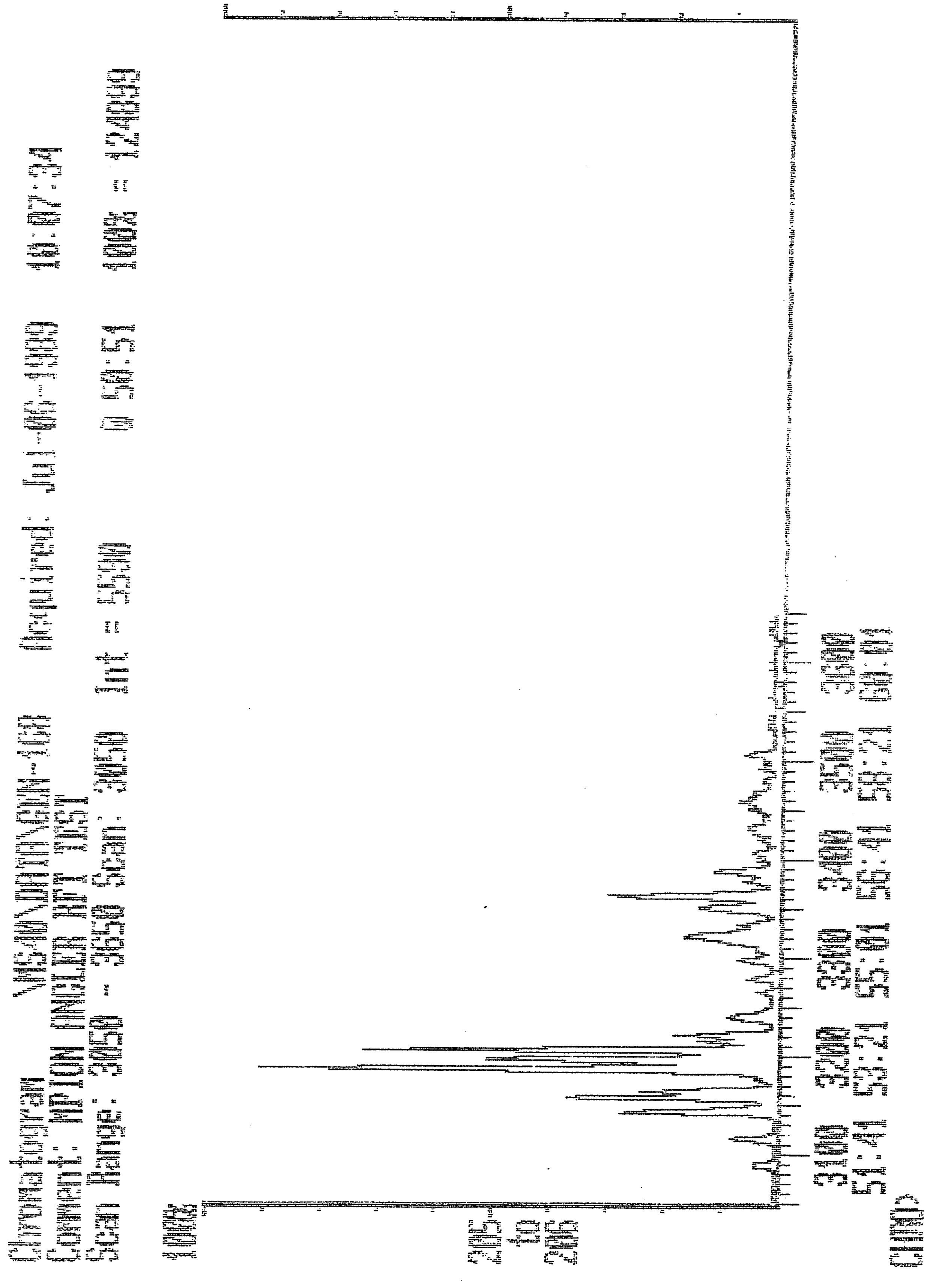

Chromatogram
Comment:
Scan Range: 2750 - 3350 Scan: 2750
10:07:34
100%
P
2
3
9
1
178 to 192
2800 2900 3000 3100 3200 3300
46:41 48:21 50:01 51:41 53:21 55:01
CHRO>

FIGURE 17

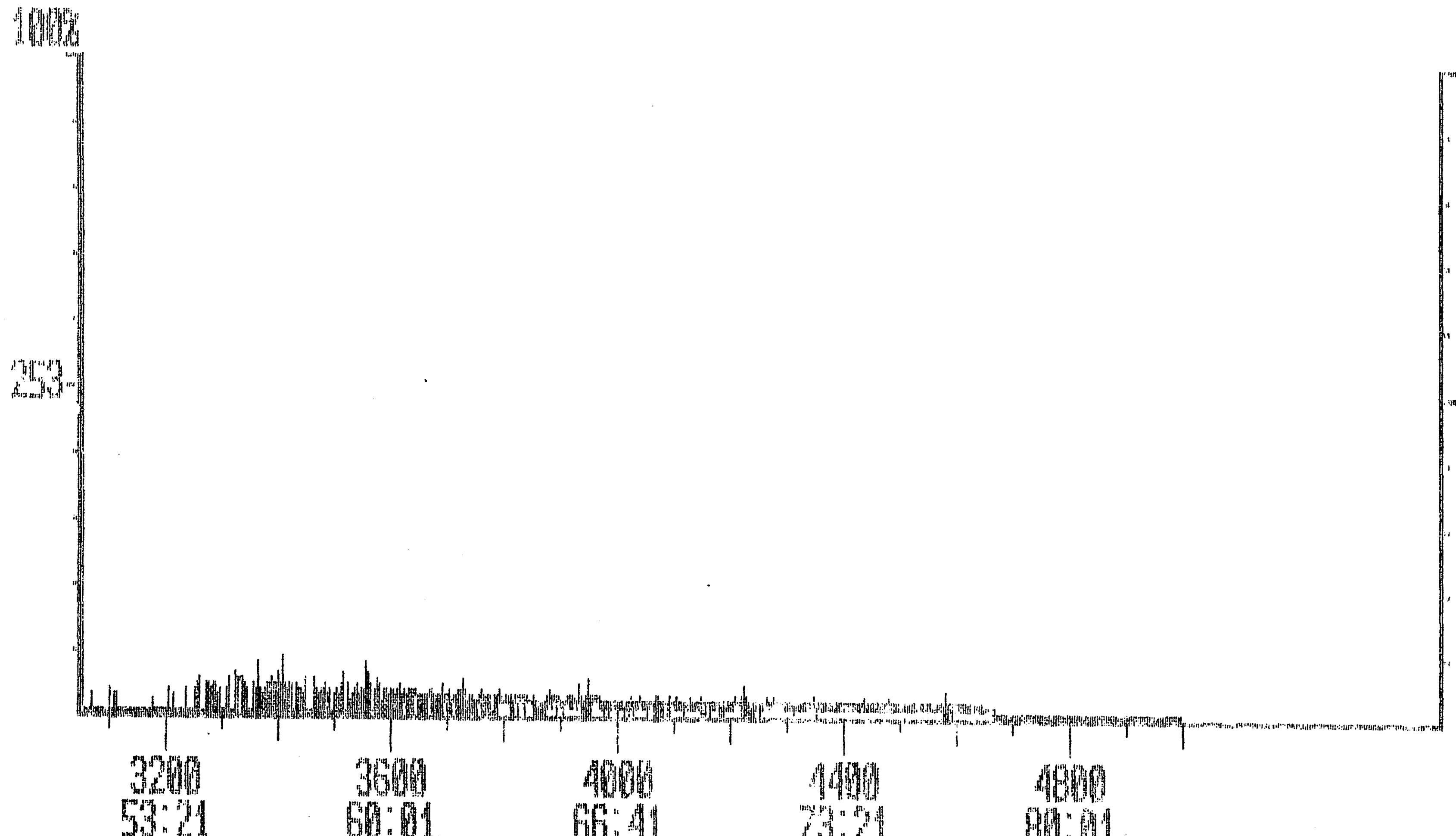
FIGURE 18



Chromatogram \MS40\DATA\GEN-160 Acquired: Jul-06-1989 10:07:34
Comment: MPION ANGLER RFT TEST
Scan Range: 3050 - 3650 Scan: 3050 Int = 5590 @ 50:51 100% = 124899
100%
205-
to
206
3100 3200 3300 3400 3500 3600
51:41 53:21 55:01 56:41 58:21 60:01
CHRO>

FIGURE 19

Chromatogram \HS40\DATA\GEN-160 Acquired: Jul-06-1989 10:07:34
Comment: MPION ANGLER RFT TEST
Scan Range: 3050 - 5000 Scan: 3050 Int = 5590 @ 50:51 100% = 3904



CHRO>

FIGURE 20

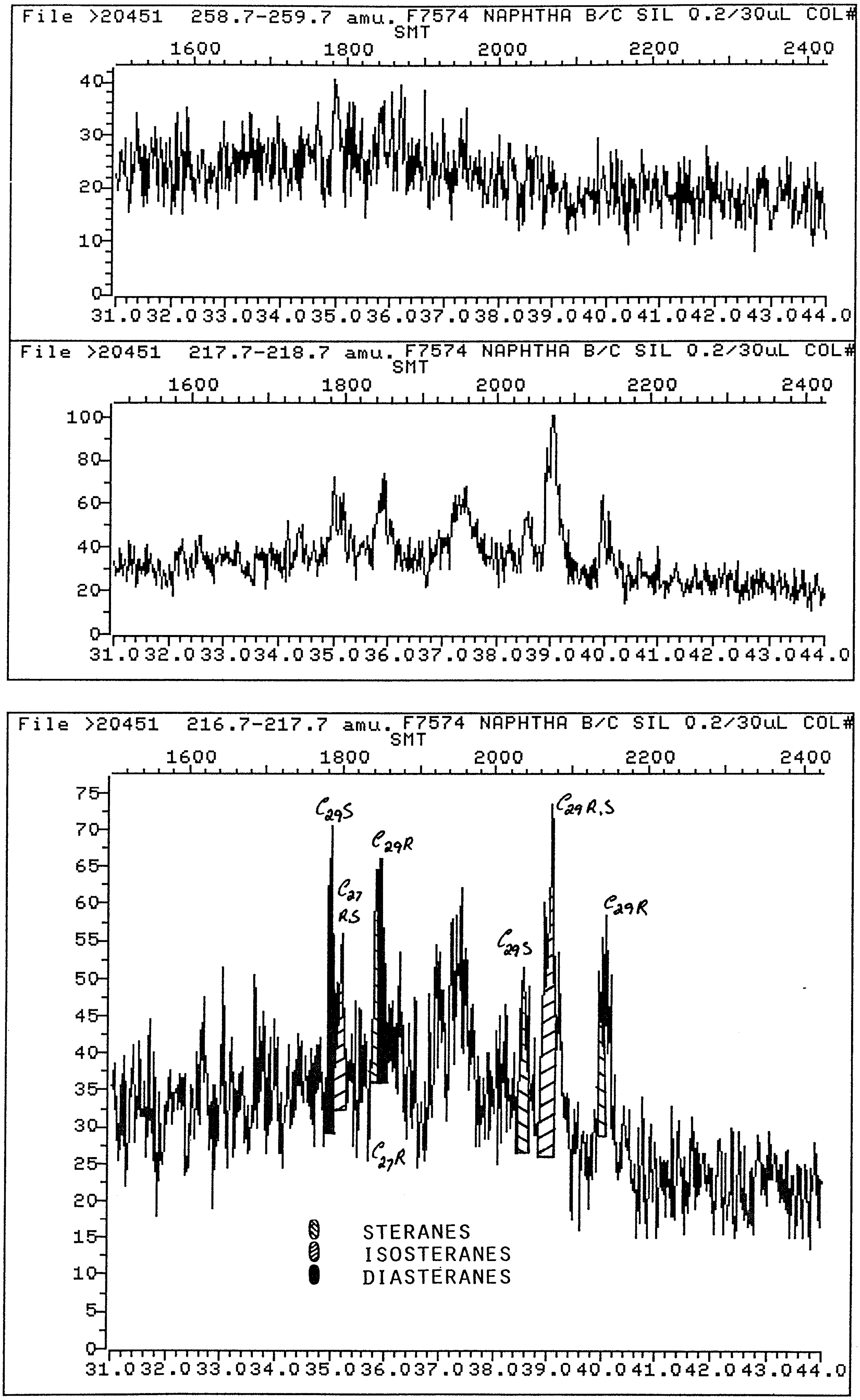

File >20451 258.7-259.7 amu. F7574 NAPHTHA B/C SIL 0.2/30uL COL#
SMT
1600
1800
2000
2200
2400
0
10
20
30
40
31.0 32.0 33.0 34.0 35.0 36.0 37.0 38.0 39.0 40.0 41.0 42.0 43.0 44.0
File >20451 217.7-218.7 amu. F7574 NAPHTHA B/C SIL 0.2/30uL COL#
SMT
1600
1800
2000
2200
2400
0
20
40
60
80
100
31.0 32.0 33.0 34.0 35.0 36.0 37.0 38.0 39.0 40.0 41.0 42.0 43.0 44.0
File >20451 216.7-217.7 amu. F7574 NAPHTHA B/C SIL 0.2/30uL COL#
SMT
1600
1800
2000
2200
2400
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
C29S
C29R
C27 RS
C27R
C29S
C29R,S
C29R
STERANES
ISOSTERANES
DIASTERANES
31.0 32.0 33.0 34.0 35.0 36.0 37.0 38.0 39.0 40.0 41.0 42.0 43.0 44.0

FIGURE 21

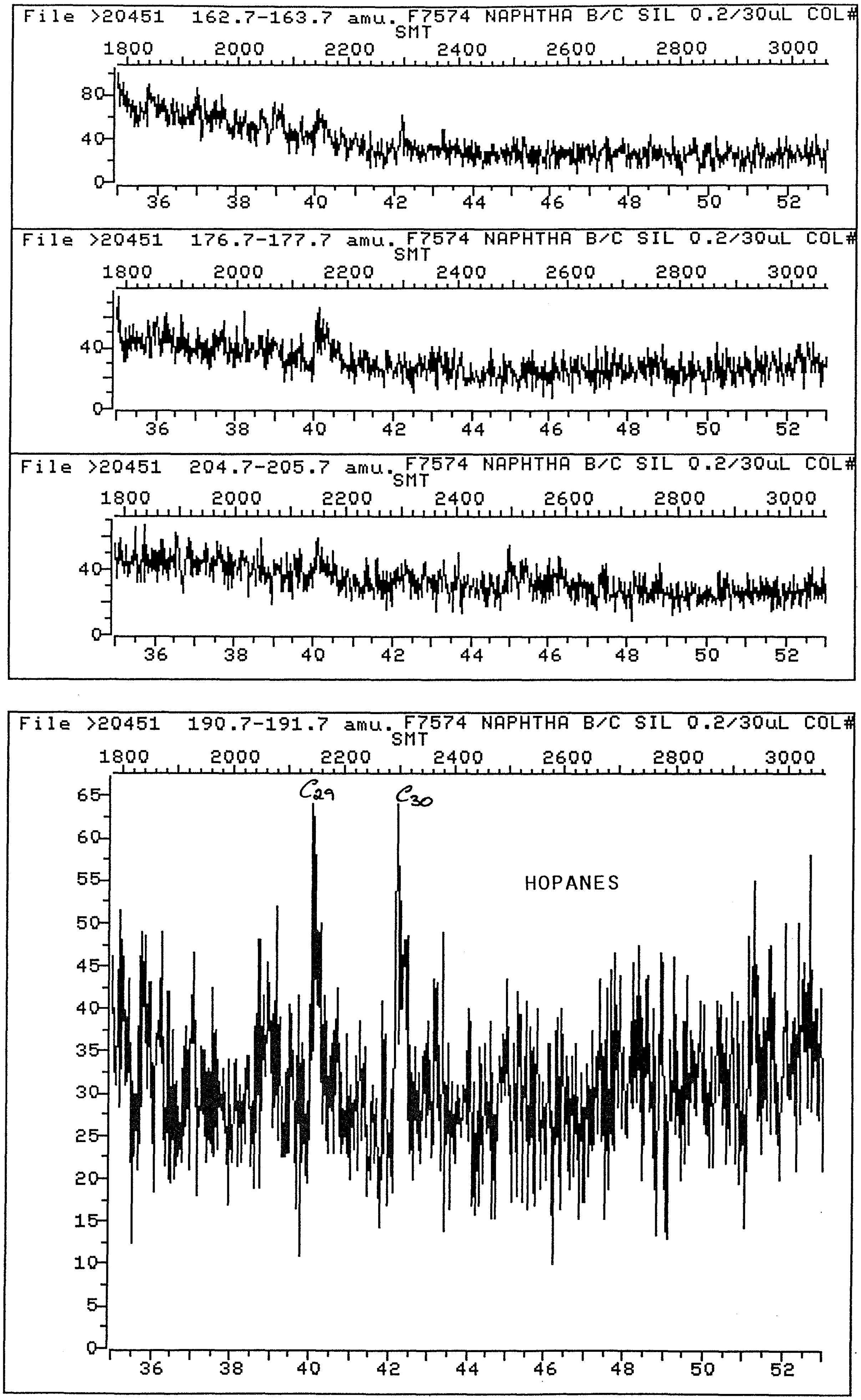
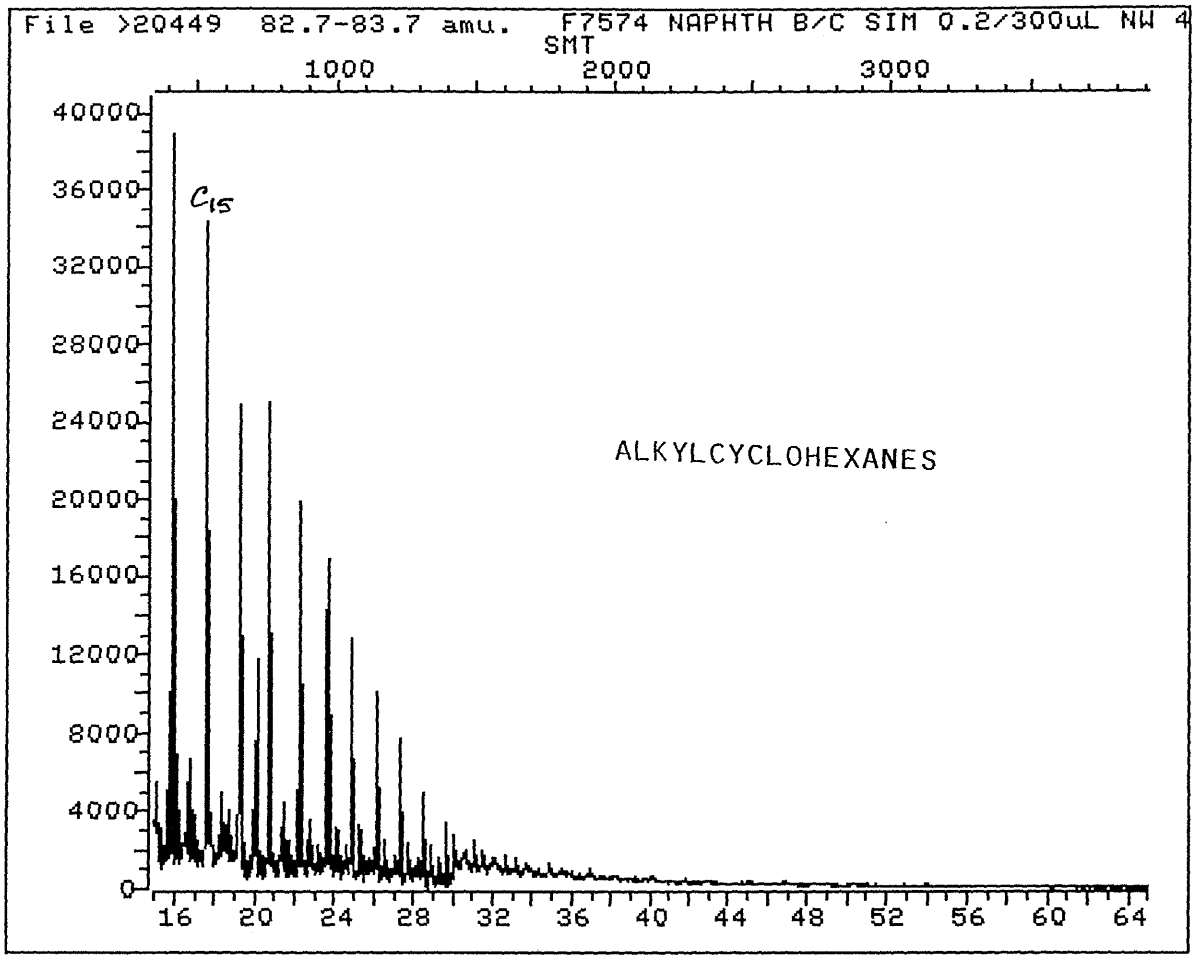

File >20451 162.7-163.7 amu. F7574 NAPHTHA B/C SIL 0.2/30uL COL#
SMT
1800 2000 2200 2400 2600 2800 3000
80 40 0
36 38 40 42 44 46 48 50 52
File >20451 176.7-177.7 amu. F7574 NAPHTHA B/C SIL 0.2/30uL COL#
SMT
1800 2000 2200 2400 2600 2800 3000
40 0
36 38 40 42 44 46 48 50 52
File >20451 204.7-205.7 amu. F7574 NAPHTHA B/C SIL 0.2/30uL COL#
SMT
1800 2000 2200 2400 2600 2800 3000
40 0
36 38 40 42 44 46 48 50 52
File >20451 190.7-191.7 amu. F7574 NAPHTHA B/C SIL 0.2/30uL COL#
SMT
1800 2000 2200 2400 2600 2800 3000
65 60 55 50 45 40 35 30 25 20 15 10 5 0
C29
C30
HOPANES
36 38 40 42 44 46 48 50 52

FIGURE 22


File >20449 82.7-83.7 amu. F7574 NAPHTH B/C SIM 0.2/300uL NW 4
SMT
1000
2000
3000
40000
36000
32000
28000
24000
20000
16000
12000
8000
4000
0
C_{15}
ALKYLCYCLOHEXANES
16
20
24
28
32
36
40
44
48
52
56
60
64

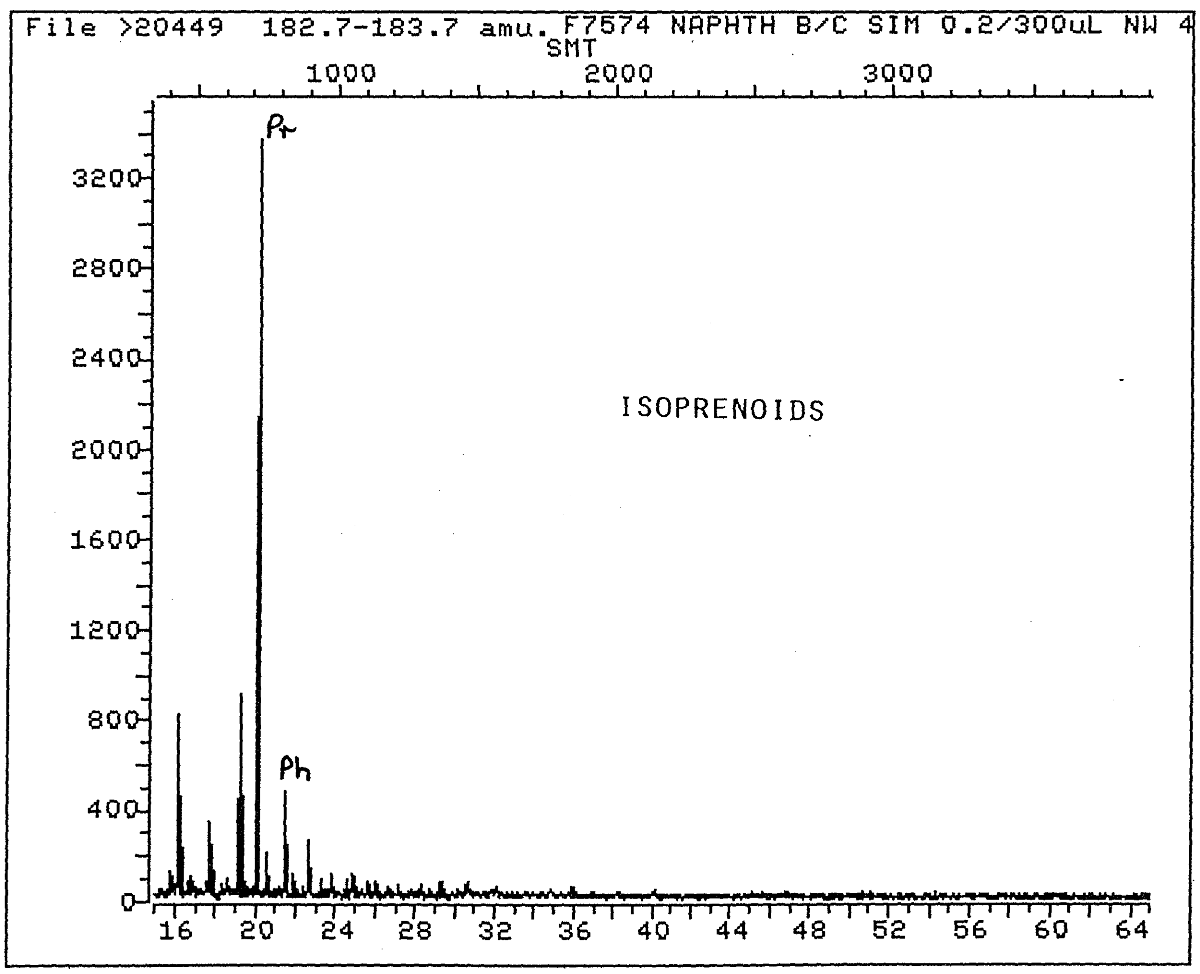

File >20449 182.7-183.7 amu. F7574 NAPHTH B/C SIM 0.2/300uL NW 4
SMT
1000
2000
3000
3200
2800
2400
2000
1600
1200
800
400
0
Pr
Ph
ISOPRENOIDS
16
20
24
28
32
36
40
44
48
52
56
60
64

FIGURE 23

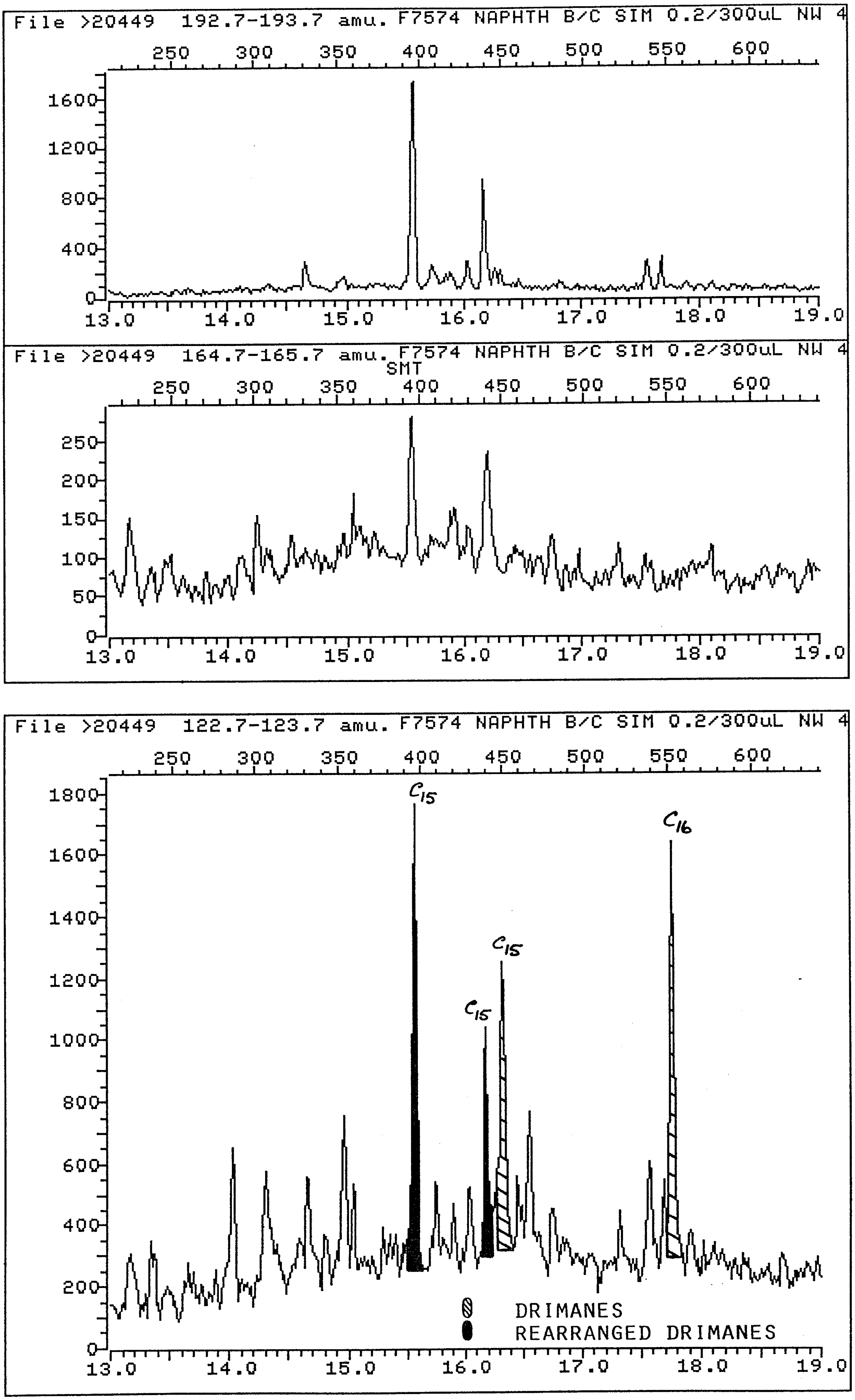
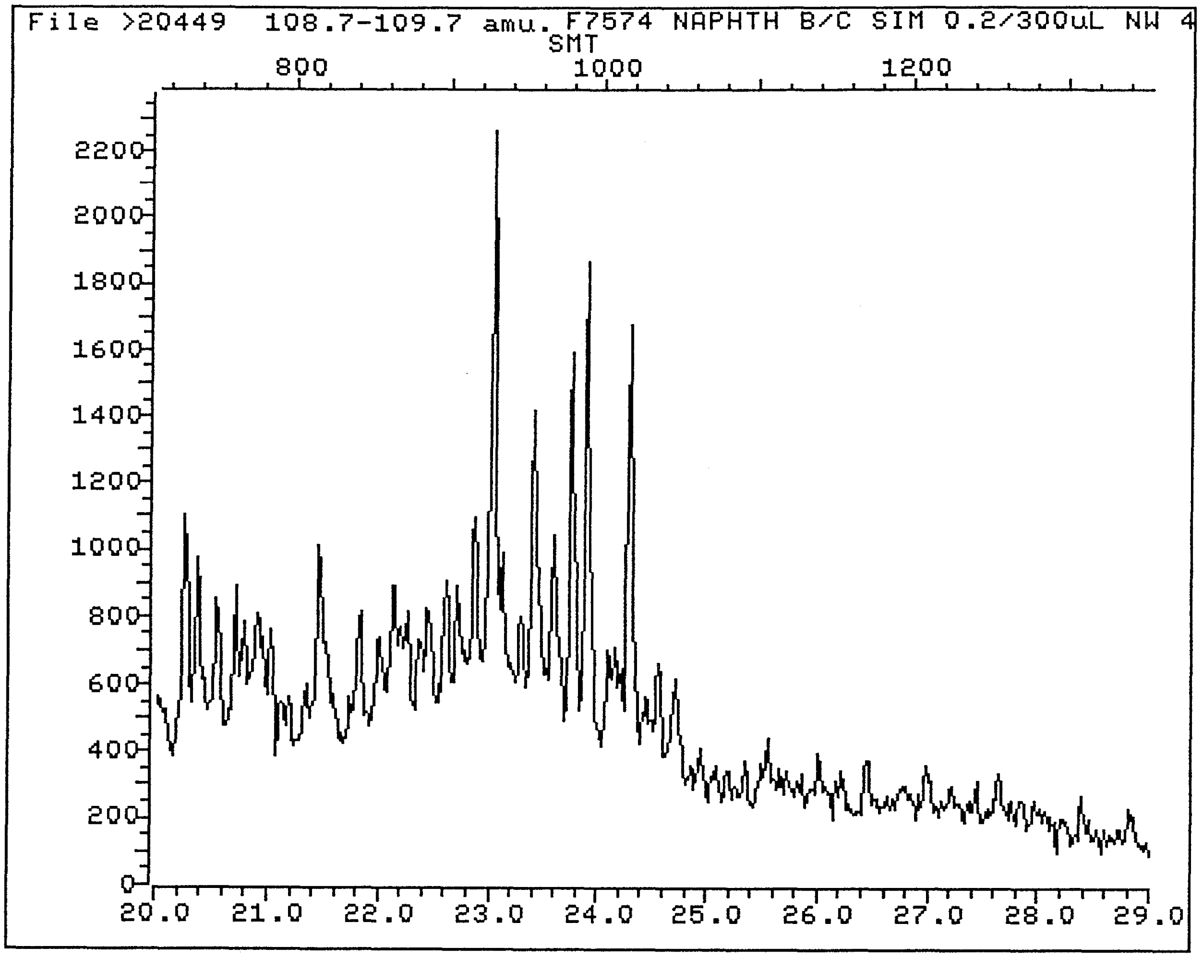
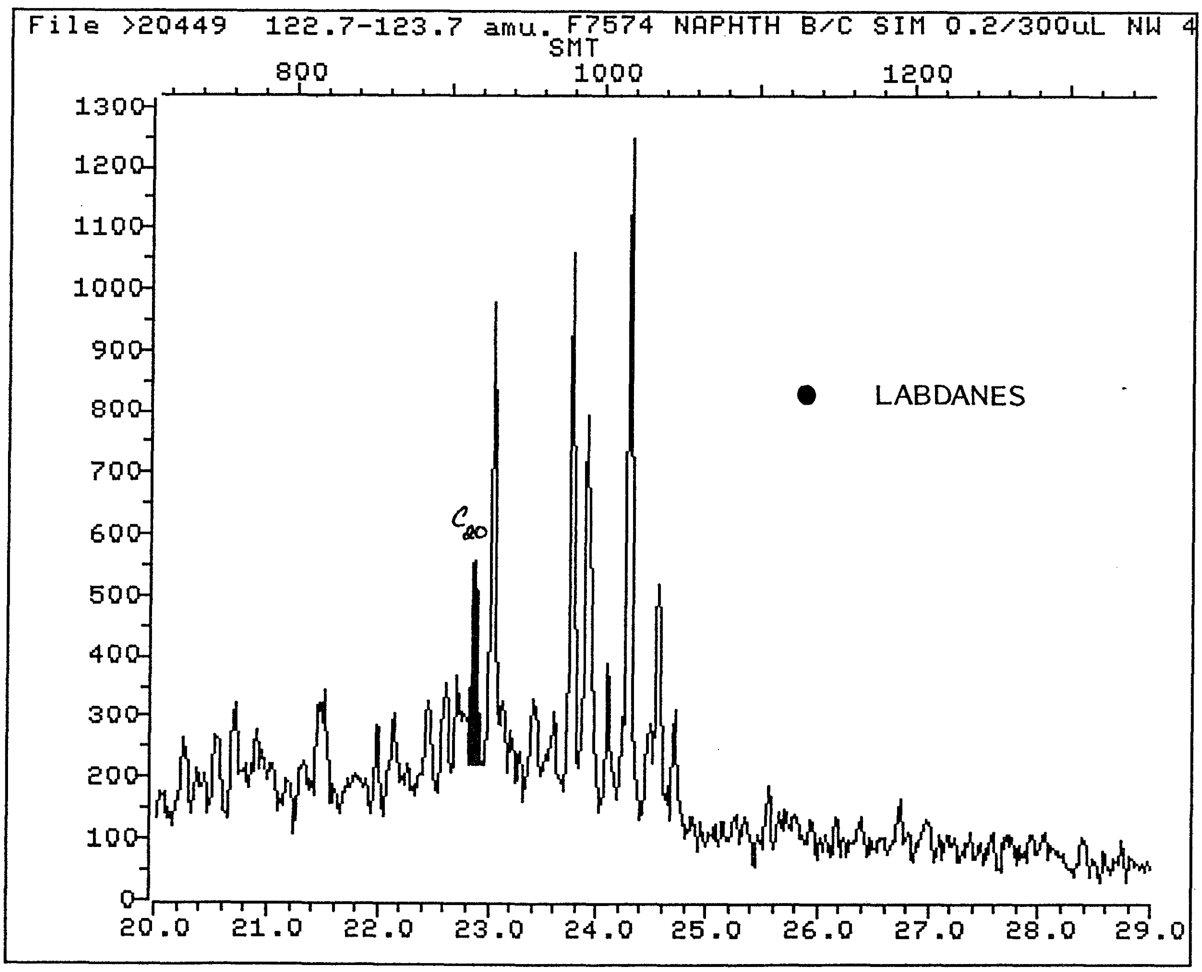

File >20449 192.7-193.7 amu. F7574 NAPHTH B/C SIM 0.2/300uL NW 4
250 300 350 400 450 500 550 600
1600 1200 800 400 0
13.0 14.0 15.0 16.0 17.0 18.0 19.0
File >20449 164.7-165.7 amu. F7574 NAPHTH B/C SIM 0.2/300uL NW 4
SMT
250 300 350 400 450 500 550 600
250 200 150 100 50 0
13.0 14.0 15.0 16.0 17.0 18.0 19.0
File >20449 122.7-123.7 amu. F7574 NAPHTH B/C SIM 0.2/300uL NW 4
250 300 350 400 450 500 550 600
1800 1600 1400 1200 1000 800 600 400 200 0
C15
C15
C15
C16
DRIMANES
REARRANGED DRIMANES
13.0 14.0 15.0 16.0 17.0 18.0 19.0

FIGURE 24

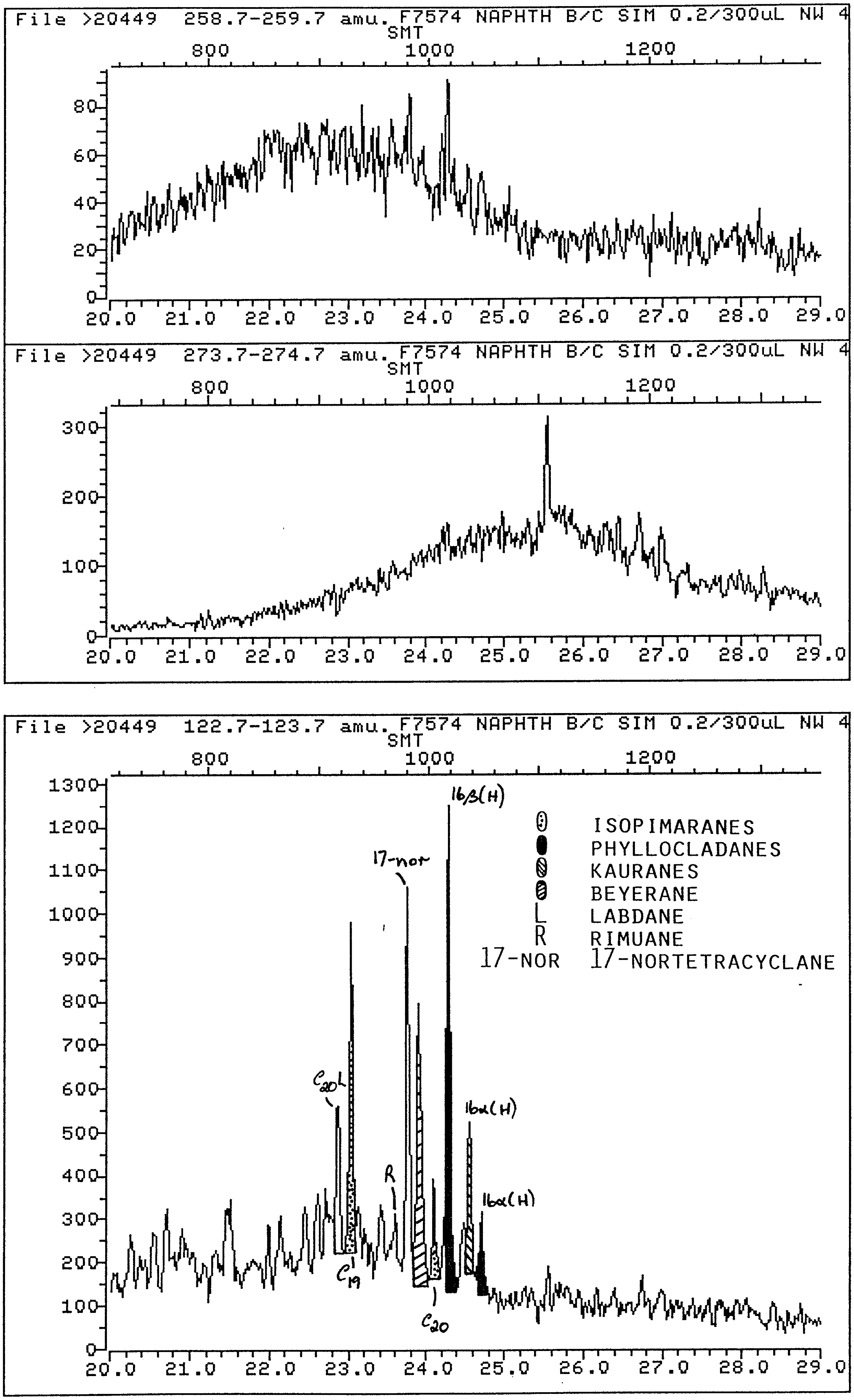


File >20449 108.7-109.7 amu. F7574 NAPHTH B/C SIM 0.2/300uL NW 4
SMT
800
1000
1200
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
20.0
21.0
22.0
23.0
24.0
25.0
26.0
27.0
28.0
29.0



File >20449 122.7-123.7 amu. F7574 NAPHTH B/C SIM 0.2/300uL NW 4
SMT
800
1000
1200
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
20.0
21.0
22.0
23.0
24.0
25.0
26.0
27.0
28.0
29.0
LABDANES

FIGURE 25


File >20449 258.7-259.7 amu. F7574 NAPHTH B/C SIM 0.2/300uL NW 4
SMT
800
1000
1200
80
60
40
20
0
20.0 21.0 22.0 23.0 24.0 25.0 26.0 27.0 28.0 29.0
File >20449 273.7-274.7 amu. F7574 NAPHTH B/C SIM 0.2/300uL NW 4
SMT
800
1000
1200
300
200
100
0
20.0 21.0 22.0 23.0 24.0 25.0 26.0 27.0 28.0 29.0
File >20449 122.7-123.7 amu. F7574 NAPHTH B/C SIM 0.2/300uL NW 4
SMT
800
1000
1200
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
20.0 21.0 22.0 23.0 24.0 25.0 26.0 27.0 28.0 29.0
16β(H)
17-nor
C20L
C19
R
C20
16α(H)
16α(H)
ISOPIMARANES
PHYLLOCLADANES
KAURANES
BEYERANE
L LABDANE
R RIMUANE
17-NOR 17-NORTETRACYCLANE

APPENDIX 1

ANALYTICAL METHODS

amdel

1. Total Organic Carbon (TOC)

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

2. Rock-Eval Pyrolysis

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

3. Organic Petrology

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

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

4. Gasoline-Range Hydrocarbons

The RFT pre-test sample was analysed on a Perkin-Elmer 8500 Gas Chromatograph equipped with a 50 m, 0.2 mm i.d. HP PONA column.

5. Liquid Chromatography

Asphaltenes were not precipitated from the condensate prior to liquid chromatography. The condensate was separated into hydrocarbons (saturates and aromatics) and polar compounds (resins) by liquid chromatography on activated alumina (sample: adsorbent ratio = 1:100). Hydrocarbons were eluted with petroleum ether/dichloromethane (50:50) and resins with methanol/dichloromethane (65:35). The saturated and aromatic hydrocarbons were then separated by liquid chromatography on activated silica gel (sample: adsorbent ratio = 1:100) eluting in turn with petroleum ether and petroleum ether/dichloromethane (91:9).

6. Gas Chromatography

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

Gas Chromatograph:	Perkin Elmer Sigma 2 operated in the split injection mode
Column:	25 m x 0.3 mm fused silica, SGE QC3/BP1
Detector Temperature:	300°C

Column Temperature:	40°C for 1 minute, then 8° per min. to 300°C and held isothermal at 300°C until all peaks eluted
Quantification:	Relative concentrations of individual hydrocarbons were obtained by measurement of peak areas with a Perkin Elmer LCI 100 integrator. The areas of peaks corresponding to aromatic hydrocarbons were multiplied by appropriate response factors

7. Thin Layer Chromatography (TLC)

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

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

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

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

System:	Hewlett Packard (HP) 5790 GC coupled with a HP5970A mass selective detector and HP9816S data system
Column:	50 mm x 0.2 mm i.d. HP PONA cross-linked methylsilicone phase fused silica, interfaced directly to source of mass spectrometer
Injector:	Split injection (40:1)
Carrier Gas:	He at 1.2 kg/cm^2 head pressure
Column Temperature:	50-260°C @ 4°/min
Mass Spectrometer Conditions:	70 eV EI; 9-ion selected ion monitoring, 70 millisec dwell time for each ion

The following mass fragmentograms were recorded:

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

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

Naphthenes (branched/cyclic alkanes) were isolated from the oils by urea adduction of their saturates fractions.

GC-MS analysis of the naphthenes (urea non-adduct) was undertaken in the multiple ion detection (MID) mode. Instrumental conditions are given in the table above.

The following mass fragmentograms were recorded:

m/z	Compound Type
177	demethylated triterpanes
183	acyclic alkanes (incl. isoprenoids, botryococcanes)
191	triterpanes (incl. hopanes, moretanes)
205	methyltriterpanes
217	steranes
218	steranes
231	4-methylsteranes
259	diasteranes

9. Stable Isotopic Ratios

All stable isotope determinations were performed at the CSIRO Isotope centre in Sydney.

APPENDIX 2

HISTOGRAM PLOTS OF VITRINITE REFLECTANCE DETERMINATIONS

VITRINITE REFLECTANCE VALUES

Well Name: ANGLER-1
Depth: 2790 m

Sorted List

0.28	0.49
0.30	
0.31	
0.31	
0.41	
0.42	
0.42	
0.43	
0.44	
0.45	

Number of values= 11

Mean of values 0.39
Standard Deviation 0.07

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

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

VITRINITE REFLECTANCE VALUES

Well Name: ANGLER-1
Depth: 2830 m

Sorted List

0.39
0.43
0.44
0.48
0.49
0.50
0.52

Number of values= 7

Mean of values 0.46
Standard Deviation 0.04

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

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

VITRINITE REFLECTANCE VALUES

Well Name: ANGLER-1
Depth: 2880 m

Sorted List

0.31	0.38
0.32	0.38
0.34	0.40
0.36	
0.36	
0.36	
0.37	
0.37	
0.37	
0.37	

Number of values= 13

Mean of values 0.36
Standard Deviation 0.02

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

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

VITRINITE REFLECTANCE VALUES

Well Name: ANGLER-1
Depth: 3010 m

Sorted List

0.20	0.36	0.39
0.33	0.36	0.41
0.34	0.36	0.43
0.34	0.36	0.43
0.35	0.37	0.44
0.35	0.37	0.45
0.35	0.37	0.47
0.35	0.37	0.48
0.35	0.38	0.50
0.36	0.38	

Number of values= 29

Mean of values 0.38
Standard Deviation 0.06

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

```
20-22    *
23-25
26-28
29-31
32-34    ***
35-37    **************
38-40    ***
41-43    ***
44-46    **
47-49    **
50-52    *
```

VITRINITE REFLECTANCE VALUES

Well Name: ANGLER-1
Depth: 3040 m

Sorted List

0.32	0.37	0.41	0.45
0.32	0.38	0.42	0.45
0.33	0.38	0.42	0.46
0.34	0.38	0.42	0.46
0.34	0.38	0.43	0.50
0.35	0.39	0.43	
0.36	0.40	0.43	
0.37	0.40	0.43	
0.37	0.40	0.44	
0.37	0.40	0.44	

Number of values= 35

Mean of values 0.40
Standard Deviation 0.04

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

```
32-34    *****
35-37    ******
38-40    *********
41-43    ********
44-46    ******
47-49
50-52    *
```

VITRINITE REFLECTANCE VALUES

Well Name: ANGLER-1
Depth: 3120 m

Sorted List

0.33	0.41	0.43	0.46
0.36	0.41	0.43	0.46
0.38	0.42	0.43	0.46
0.38	0.42	0.44	0.48
0.39	0.42	0.44	0.51
0.40	0.42	0.44	0.52
0.40	0.43	0.45	
0.40	0.43	0.45	
0.41	0.43	0.45	
0.41	0.43	0.46	

Number of values= 36

Mean of values 0.43
Standard Deviation 0.04

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

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

VITRINITE REFLECTANCE VALUES

Well Name: ANGLER-1
Depth: 3150 m

Sorted List

0.34	0.40	0.42	0.44
0.35	0.40	0.42	0.45
0.37	0.41	0.42	0.46
0.37	0.41	0.42	0.47
0.39	0.41	0.43	
0.39	0.41	0.43	
0.39	0.41	0.43	
0.40	0.41	0.43	
0.40	0.41	0.43	
0.40	0.42	0.43	

Number of values= 34

Mean of values 0.41
Standard Deviation 0.03

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

```
34-36    **
37-39    *****
40-42    *****************
43-45    ********
46-48    **
```

VITRINITE REFLECTANCE VALUES

Well Name: ANGLER-1
Depth: 3178 m

Sorted List

0.32	0.39	0.44	0.48
0.35	0.41	0.44	0.49
0.36	0.42	0.44	0.49
0.36	0.42	0.44	0.51
0.36	0.43	0.45	0.52
0.37	0.43	0.45	
0.38	0.43	0.46	
0.38	0.43	0.47	
0.38	0.44	0.47	
0.39	0.44	0.48	

Number of values= 35

Mean of values 0.43
Standard Deviation 0.05

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

32-34	*
35-37	*****
38-40	*****
41-43	*******
44-46	*********
47-49	******
50-52	**

VITRINITE REFLECTANCE VALUES

Well Name: ANGLER-1
Depth: 3220 m

Sorted List

0.32	0.41	0.44	0.50
0.36	0.42	0.45	0.51
0.36	0.43	0.46	0.56
0.36	0.43	0.46	
0.37	0.43	0.47	
0.39	0.43	0.47	
0.40	0.43	0.47	
0.40	0.43	0.47	
0.40	0.44	0.49	
0.40	0.44	0.49	

Number of values= 33

Mean of values 0.43
Standard Deviation 0.05

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

```
32-34    *
35-37    ****
38-40    *****
41-43    ********
44-46    ******
47-49    ******
50-52    **
53-55
56-58    *
```

VITRINITE REFLECTANCE VALUES

Well Name: ANGLER-1
Depth: 3250 m

Sorted List

0.32	0.41	0.43	0.47
0.34	0.41	0.43	0.49
0.37	0.42	0.43	
0.38	0.42	0.43	
0.39	0.42	0.43	
0.39	0.42	0.43	
0.40	0.42	0.44	
0.40	0.42	0.45	
0.40	0.43	0.45	
0.41	0.43	0.47	

Number of values= 32

Mean of values 0.42
Standard Deviation 0.03

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

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

VITRINITE REFLECTANCE VALUES

Well Name: ANGLER-1
Depth: 3440 m

Sorted List

0.34
0.44
0.51
0.51
0.51
0.52
0.52
0.53
0.53
0.55

Number of values= 10

Mean of values 0.50
Standard Deviation 0.06

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: ANGLER-1
Depth: 3496 m

Sorted List

0.35	0.45	0.52	0.57
0.37	0.47	0.52	0.58
0.37	0.48	0.52	0.58
0.38	0.48	0.53	0.58
0.40	0.49	0.54	0.60
0.40	0.50	0.55	0.62
0.41	0.50	0.56	
0.41	0.51	0.57	
0.43	0.51	0.57	
0.44	0.52	0.57	

Number of values= 36

Mean of values 0.50
Standard Deviation 0.07

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

```
35-37    ***
38-40    ***
41-43    ***
44-46    **
47-49    ****
50-52    ********
53-55    **
56-58    *********
59-61    *
62-64    *
```

VITRINITE REFLECTANCE VALUES

Well Name: ANGLER-1
Depth: 3510 m

Sorted List

0.34	0.42	0.46	0.51
0.38	0.42	0.46	0.52
0.38	0.43	0.46	0.54
0.39	0.43	0.46	0.54
0.39	0.44	0.47	0.56
0.40	0.44	0.47	
0.40	0.44	0.48	
0.41	0.45	0.49	
0.41	0.45	0.49	
0.42	0.46	0.50	

Number of values= 35

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: ANGLER-1
Depth: 3560 m

Sorted List

0.44	0.48	0.50	0.56
0.44	0.49	0.50	0.56
0.45	0.49	0.51	0.59
0.46	0.49	0.51	0.60
0.46	0.49	0.51	
0.47	0.49	0.51	
0.47	0.50	0.53	
0.47	0.50	0.54	
0.48	0.50	0.54	
0.48	0.50	0.54	

Number of values= 34

Mean of values 0.50
Standard Deviation 0.04

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

```
44-46    *****
47-49    ***********
50-52    **********
53-55    ****
56-58    **
59-61    **
```

VITRINITE REFLECTANCE VALUES

Well Name: ANGLER-1
Depth: 3590 m

Sorted List

0.44	0.51	0.53
0.45	0.51	0.53
0.47	0.51	0.53
0.47	0.51	0.54
0.49	0.51	0.55
0.49	0.52	0.55
0.50	0.52	0.55
0.50	0.52	0.56
0.50	0.53	0.57
0.50	0.53	

Number of values= 29

Mean of values 0.51
Standard Deviation 0.03

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

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

VITRINITE REFLECTANCE VALUES

Well Name: ANGLER-1
Depth: 3689 m

Sorted List

0.37	0.49	0.53	0.60
0.37	0.49	0.54	0.60
0.40	0.49	0.54	0.61
0.41	0.50	0.55	0.62
0.44	0.50	0.55	0.63
0.45	0.50	0.55	0.67
0.46	0.51	0.56	
0.46	0.52	0.58	
0.49	0.52	0.59	
0.49	0.53	0.60	

Number of values= 36

Mean of values 0.52
Standard Deviation 0.07

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

```
37-39    **
40-42    **
43-45    **
46-48    **
49-51    *********
52-54    ****
55-57    ******
58-60    *****
61-63    ***
64-66
67-69    *
```

VITRINITE REFLECTANCE VALUES

Well Name: ANGLER-1
Depth: 3750 m

Sorted List

0.39	0.50	0.55	0.61
0.39	0.50	0.55	0.62
0.43	0.51	0.56	0.63
0.43	0.51	0.56	0.65
0.47	0.52	0.57	
0.47	0.52	0.57	
0.47	0.52	0.57	
0.47	0.53	0.57	
0.47	0.54	0.58	
0.50	0.54	0.61	

Number of values= 34

Mean of values 0.53
Standard Deviation 0.06

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

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

VITRINITE REFLECTANCE VALUES

Well Name: ANGLER-1
Depth: 3810 m

Sorted List

0.42	0.51	0.55	0.61
0.48	0.52	0.55	0.62
0.49	0.52	0.55	0.62
0.49	0.52	0.56	0.62
0.50	0.52	0.57	0.62
0.50	0.52	0.57	0.62
0.50	0.53	0.58	0.63
0.51	0.53	0.59	0.69
0.51	0.54	0.59	
0.51	0.54	0.59	

Number of values= 38

Mean of values 0.55
Standard Deviation 0.05

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

```
42-44    *
45-47
48-50    ******
51-53    ***********
54-56    *****
57-59    *******
60-62    ******
63-65    *
66-68
69-71    *
```

VITRINITE REFLECTANCE VALUES

Well Name: ANGLER-1
Depth: 3827 m

Sorted List

0.42	0.52	0.55	0.58	0.61	0.64
0.46	0.52	0.55	0.58	0.61	0.65
0.48	0.52	0.56	0.59	0.61	0.65
0.49	0.53	0.56	0.59	0.62	0.65
0.49	0.53	0.56	0.59	0.63	0.66
0.51	0.53	0.56	0.59	0.63	0.67
0.51	0.53	0.56	0.59	0.63	0.67
0.52	0.53	0.56	0.59	0.63	0.71
0.52	0.54	0.57	0.60	0.64	
0.52	0.54	0.57	0.61	0.64	

Number of values= 58

Mean of values 0.57
Standard Deviation 0.06

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

42-44	*
45-47	*
48-50	***
51-53	*************
54-56	****
57-59	****************
60-62	******
63-65	**********
66-68	***
69-71	*

VITRINITE REFLECTANCE VALUES

Well Name: ANGLER-1
Depth: 3900 m

Sorted List

0.44	0.54	0.64
0.45	0.56	0.65
0.47	0.57	0.65
0.47	0.57	
0.48	0.57	
0.51	0.58	
0.52	0.58	
0.52	0.59	
0.53	0.59	
0.53	0.61	

Number of values= 23

Mean of values 0.55
Standard Deviation 0.06

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

44-46	**
47-49	***
50-52	***
53-55	***
56-58	******
59-61	***
62-64	*
65-67	**

VITRINITE REFLECTANCE VALUES

Well Name: ANGLER-1
Depth: 3950-3960 m

Sorted List

0.41	0.48	0.53	0.61
0.41	0.48	0.54	0.61
0.42	0.49	0.54	0.62
0.42	0.50	0.55	0.63
0.44	0.51	0.57	
0.45	0.51	0.58	
0.46	0.51	0.58	
0.46	0.52	0.59	
0.47	0.52	0.59	
0.47	0.53	0.59	

Number of values= 34

Mean of values 0.52
Standard Deviation 0.06

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

```
41-43    ****
44-46    ****
47-49    *****
50-52    ******
53-55    ****
56-58    ****
59-61    *****
62-64    **
```

VITRINITE REFLECTANCE VALUES

Well Name: ANGLER-1
Depth: 3990 m

Sorted List

0.40	0.50	0.54
0.46	0.50	0.55
0.46	0.50	0.56
0.47	0.51	0.56
0.47	0.51	0.59
0.48	0.51	0.63
0.49	0.52	
0.49	0.52	
0.49	0.53	
0.50	0.54	

Number of values= 26

Mean of values 0.51
Standard Deviation 0.04

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

40-42	*
43-45	
46-48	*****
49-51	**********
52-54	***
55-57	*****
58-60	*
61-63	*

VITRINITE REFLECTANCE VALUES

Well Name: ANGLER-1
Depth: 4032 m

Sorted List

0.48	0.57	0.62
0.48	0.57	0.62
0.49	0.58	0.64
0.52	0.60	0.64
0.54	0.60	0.65
0.54	0.60	0.66
0.55	0.60	0.66
0.55	0.61	0.67
0.57	0.61	0.68
0.57	0.61	

Number of values= 29

Mean of values 0.59
Standard Deviation 0.05

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

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

VITRINITE REFLECTANCE VALUES

Well Name: ANGLER-1
Depth: 4070 m

Sorted List

0.45	0.54	0.62
0.47	0.54	0.66
0.47	0.55	
0.49	0.55	
0.50	0.55	
0.52	0.56	
0.53	0.56	
0.53	0.56	
0.53	0.61	
0.54	0.61	

Number of values= 22

Mean of values 0.54
Standard Deviation 0.05

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

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

VITRINITE REFLECTANCE VALUES

Well Name: ANGLER-1
Depth: 4110 m

Sorted List

0.47	0.53	0.57
0.48	0.53	0.57
0.49	0.53	0.58
0.50	0.53	0.58
0.51	0.53	0.60
0.51	0.54	0.60
0.51	0.54	0.62
0.51	0.55	0.63
0.51	0.56	0.65
0.52	0.56	

Number of values= 29

Mean of values 0.55
Standard Deviation 0.04

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

47-49	***
50-52	*******
53-55	*******
56-58	*******
59-61	**
62-64	**
65-67	*

VITRINITE REFLECTANCE VALUES

Well Name: ANGLER-1
Depth: 4150 m

Sorted List

0.45	0.53
0.46	0.53
0.47	0.53
0.47	0.55
0.49	0.55
0.49	0.56
0.49	0.56
0.50	0.58
0.52	0.62
0.52	0.63

Number of values= 20

Mean of values 0.53
Standard Deviation 0.05

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

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

VITRINITE REFLECTANCE VALUES

Well Name: ANGLER-1
Depth: 4181 m

Sorted List

0.44	0.54	0.63
0.45	0.56	0.63
0.45	0.56	0.66
0.48	0.57	0.66
0.48	0.58	0.68
0.49	0.58	0.68
0.50	0.58	0.70
0.50	0.59	0.71
0.51	0.60	
0.52	0.62	

Number of values= 28

Mean of values 0.57
Standard Deviation 0.08

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

```
44-46    ***
47-49    ***
50-52    ****
53-55    *
56-58    ******
59-61    **
62-64    ***
65-67    **
68-70    ***
71-73    *
```

VITRINITE REFLECTANCE VALUES

Well Name: ANGLER-1
Depth: 4200-4210 m

Sorted List

0.42	0.50	0.57
0.44	0.51	0.58
0.45	0.51	0.58
0.46	0.53	0.62
0.46	0.53	0.67
0.49	0.53	0.67
0.49	0.53	
0.49	0.53	
0.50	0.54	
0.50	0.55	

Number of values= 26

Mean of values 0.53
Standard Deviation 0.06

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

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

VITRINITE REFLECTANCE VALUES

Well Name: ANGLER-1
Depth: 4270 m

Sorted List

0.50	0.55
0.50	0.56
0.51	0.56
0.52	0.58
0.52	
0.53	
0.54	
0.54	
0.55	
0.55	

Number of values= 14

Mean of values 0.54
Standard Deviation 0.02

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

50-52 *****
53-55 ***
56-58 ******

VITRINITE REFLECTANCE VALUES

Well Name: ANGLER-1
Depth: 4320-4330 m

Sorted List

0.41	0.48	0.55	0.59	0.66
0.41	0.48	0.56	0.61	0.78
0.43	0.49	0.57	0.61	
0.43	0.49	0.57	0.61	
0.44	0.50	0.57	0.61	
0.45	0.51	0.58	0.62	
0.45	0.51	0.58	0.62	
0.46	0.52	0.59	0.64	
0.47	0.53	0.59	0.65	
0.48	0.55	0.59	0.65	

Number of values= 42

Mean of values 0.55
Standard Deviation 0.08

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

```
41-43    ****
44-46    ****
47-49    ******
50-52    ****
53-55    *
56-58    ********
59-61    ********
62-64    ***
65-67    ***
68-70
71-73
74-76
77-79    *
```

VITRINITE REFLECTANCE VALUES

Well Name: ANGLER-1
Depth: 4324 m

Sorted List

0.51	0.61	0.66	0.68
0.56	0.61	0.66	0.70
0.56	0.62	0.66	0.71
0.57	0.62	0.67	0.71
0.57	0.63	0.67	0.73
0.58	0.63	0.67	0.74
0.58	0.64	0.68	
0.59	0.64	0.68	
0.59	0.65	0.68	
0.60	0.65	0.68	

Number of values= 36

Mean of values 0.64
Standard Deviation 0.05

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

```
51-53    *
54-56
57-59    ********
60-62    *****
63-65    ******
66-68    ***********
69-71    ***
72-74    **
```

APPENDIX 3

PLATES

PE905466

This is an enclosure indicator page.
The enclosure PE905466 is enclosed within the container PE903255 at this location in this document.

The enclosure PE905466 has the following characteristics:

ITEM_BARCODE =	PE905466
CONTAINER_BARCODE =	PE903255
NAME =	Angler 1 photomicrographic plates (reflected & fluor)
BASIN =	GIPPSLAND
PERMIT =	VIC/P20
TYPE =	WELL
SUBTYPE =	PHOTOMICROGRAPH
DESCRIPTION =	Angler 1 photomicrographic plates (from geochem. report). Reflected & fluorescence mode.
REMARKS =	
DATE_CREATED =	30/08/89
DATE_RECEIVED =	20/10/89
W_NO =	W993
WELL_NAME =	Angler-1
CONTRACTOR =	Amdel Ltd.
CLIENT_OP_CO =	Petrofina Exploration Australia S.A

(Inserted by DNRE - Vic Govt Mines Dept)

Plate 1: 3150 m (Latrobe Group) **Reflected Light**
Vitrinite (grey) is the dominant maceral in this field. Inertinite (white) is much less abundant.
Field Dimensions: 0.26 x 0.18 mm

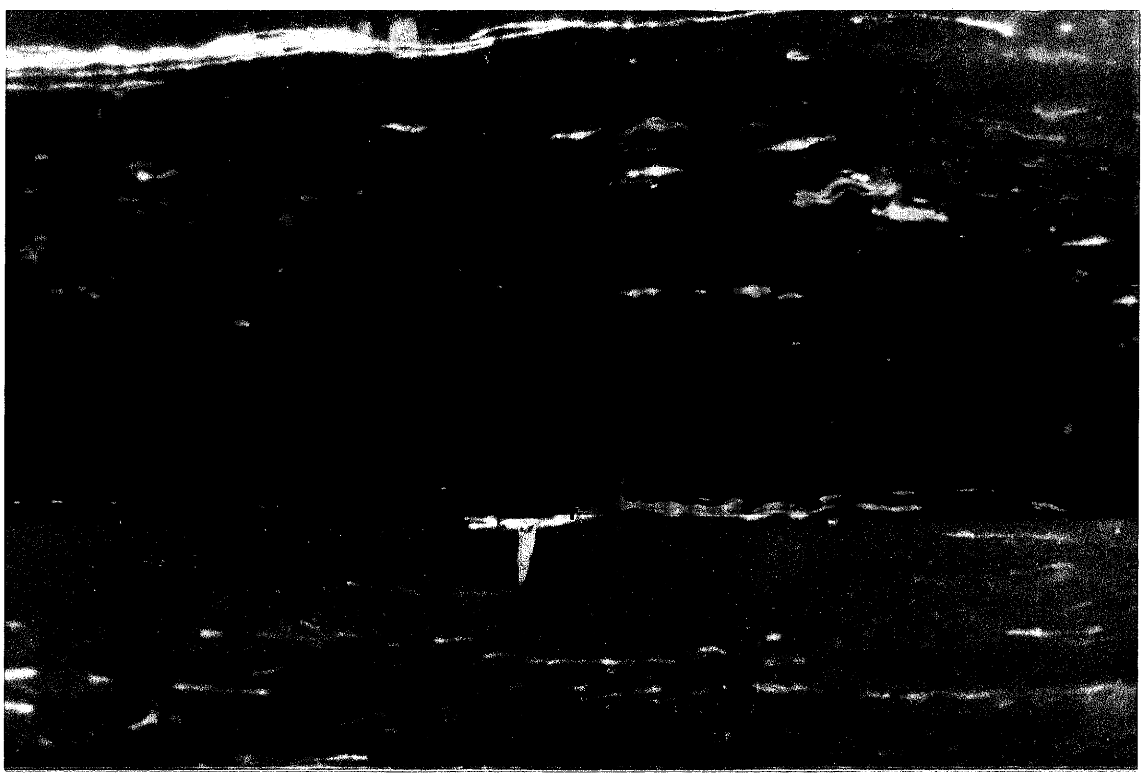


Plate 2: Same Field as above **Fluorescence Mode**
Exinite (moderate yellow) is abundant in this sample. Exsudatinite (e) is clearly associated with resinite (r). Other exinites consist largely of cutinite and liptodetrinite.

PE905467

This is an enclosure indicator page.
The enclosure PE905467 is enclosed within the container PE903255 at this location in this document.

The enclosure PE905467 has the following characteristics:

ITEM_BARCODE = PE905467
CONTAINER_BARCODE = PE903255
NAME = Angler 1 photomicrographic plates (reflected & fluor)
BASIN = GIPPSLAND
PERMIT = VIC/P20
TYPE = WELL
SUBTYPE = PHOTOMICROGRAPH
DESCRIPTION = Angler 1 photomicrographic plates (from geochem. report). Reflected & fluorescence mode.
REMARKS =
DATE_CREATED = 30/08/89
DATE_RECEIVED = 20/10/89
W_NO = W993
WELL_NAME = Angler-1
CONTRACTOR = Amdel Ltd.
CLIENT_OP_CO = Petrofina Exploration Australia S.A

(Inserted by DNRE - Vic Govt Mines Dept)

Plate 3: 3220 m (Latrobe Group) **Reflected Light**
Exinite (brown) is much more abundant than vitrinite (grey) in this coal fragment.
Field Dimensions: 0.26 x 0.18 mm.

Plate 4: Same Field as above. **Reflected Light**
Exinite in this field consists almost entirely of resinite. Exsudatinite (bottom; veins in vitrinite) is common.

PE905468

This is an enclosure indicator page.
The enclosure PE905468 is enclosed within the container PE903255 at this location in this document.

The enclosure PE905468 has the following characteristics:

ITEM_BARCODE =	PE905468
CONTAINER_BARCODE =	PE903255
NAME =	Angler 1 photomicrographic plates (reflected & fluor)
BASIN =	GIPPSLAND
PERMIT =	VIC/P20
TYPE =	WELL
SUBTYPE =	PHOTOMICROGRAPH
DESCRIPTION =	Angler 1 photomicrographic plates (from geochem. report). Reflected & fluorescence mode.
REMARKS =	
DATE_CREATED =	30/08/89
DATE_RECEIVED =	20/10/89
W_NO =	W993
WELL_NAME =	Angler-1
CONTRACTOR =	Amdel Ltd.
CLIENT_OP_CO =	Petrofina Exploration Australia S.A

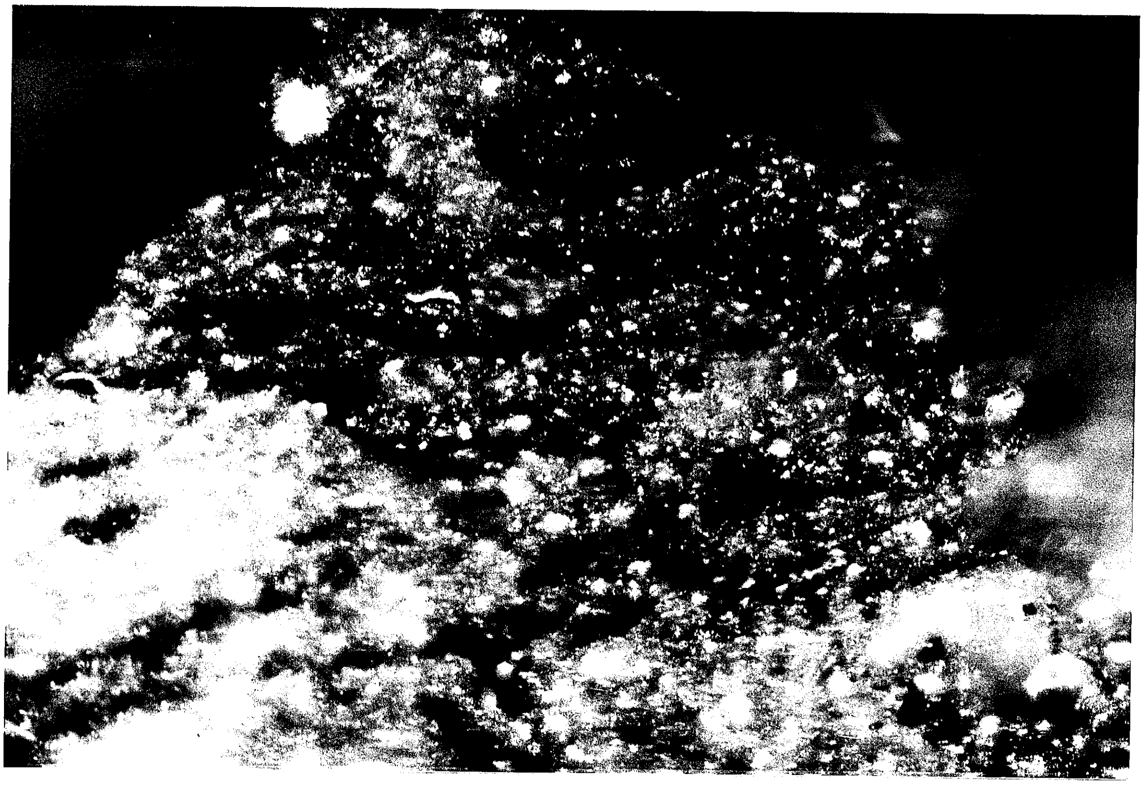


Plate 5: 3827 m (Campanian)
Dispersed organic matter in this shale consists largely of inertinite and liptodetrinite. ?Telalginite (?Tasmanites algae) occurs in the top centre of this plate.
Field Dimensions: 0.26 x 0.18 mm.

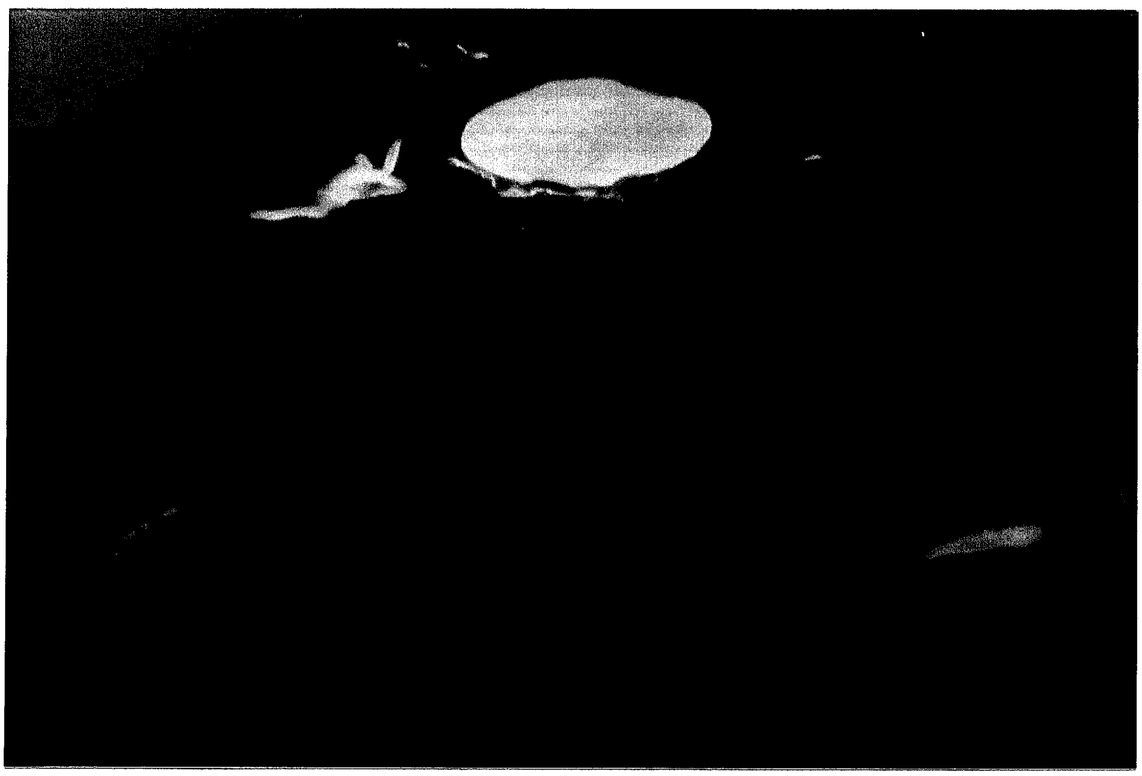


Plate 6: Same Field as above. **Fluorescence Mode**
?Telalginite has a markedly more intense fluorescence than the liptodetrinite in this sample.

PE905469

This is an enclosure indicator page.
The enclosure PE905469 is enclosed within the container PE903255 at this location in this document.

The enclosure PE905469 has the following characteristics:

ITEM_BARCODE =	PE905469
CONTAINER_BARCODE =	PE903255
NAME =	Angler 1 photomicrographic plates (reflected & fluor)
BASIN =	GIPPSLAND
PERMIT =	VIC/P20
TYPE =	WELL
SUBTYPE =	PHOTOMICROGRAPH
DESCRIPTION =	Angler 1 photomicrographic plates (from geochem. report). Reflected & fluorescence mode.
REMARKS =	
DATE_CREATED =	30/08/89
DATE_RECEIVED =	20/10/89
W_NO =	W993
WELL_NAME =	Angler-1
CONTRACTOR =	Amdel Ltd.
CLIENT_OP_CO =	Petrofina Exploration Australia S.A

(Inserted by DNRE - Vic Govt Mines Dept)

Plate 7: 4070 m (Campanian Siltstone) **Reflected Light**
Thucholite (top centre) occurs adjacent to vitrinite (grey) in this siltstone.
Field Dimensions: 0.26 x 0.18 mm.

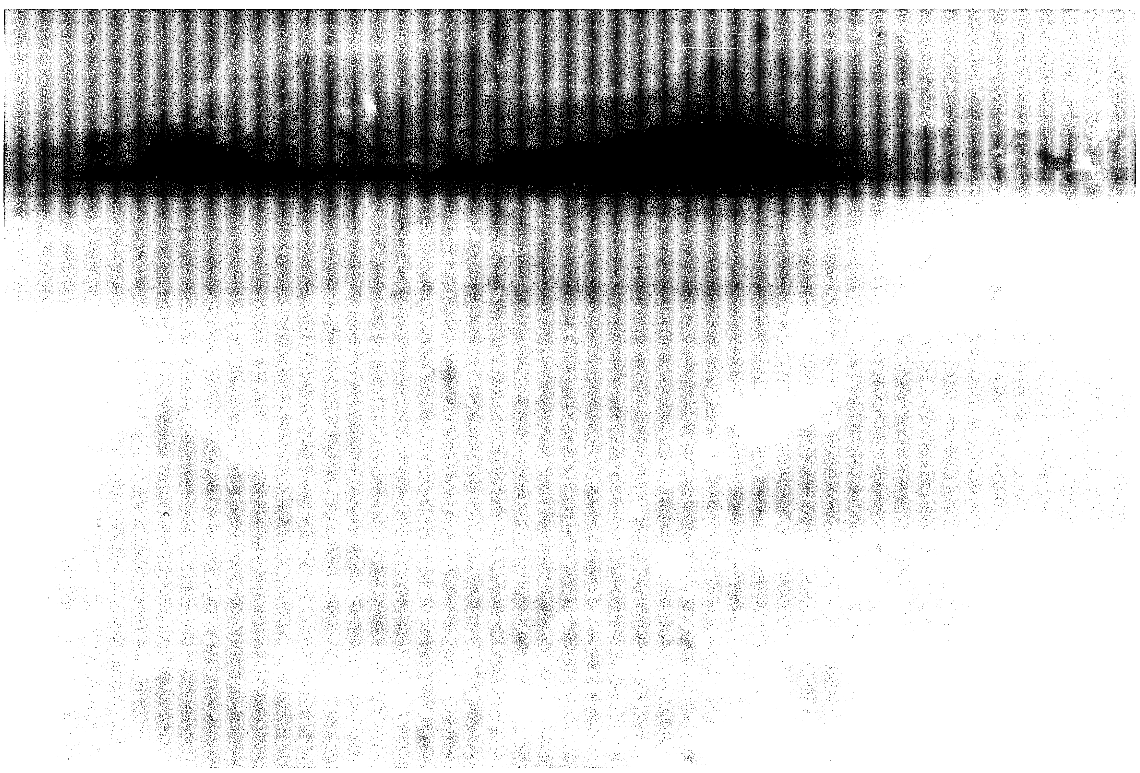


Plate 8: Same Field as above. **Fluorescence Mode**
The thucholite has a dull brown fluorescence.

PE905470

This is an enclosure indicator page.
The enclosure PE905470 is enclosed within the container PE903255 at this location in this document.

The enclosure PE905470 has the following characteristics:

ITEM_BARCODE =	PE905470
CONTAINER_BARCODE =	PE903255
NAME =	Angler 1 photomicrographic plates (reflected & fluor)
BASIN =	GIPPSLAND
PERMIT =	VIC/P20
TYPE =	WELL
SUBTYPE =	PHOTOMICROGRAPH
DESCRIPTION =	Angler 1 photomicrographic plates (from geochem. report). Reflected & fluorescence mode.
REMARKS =	
DATE_CREATED =	30/08/89
DATE_RECEIVED =	20/10/89
W_NO =	W993
WELL_NAME =	Angler-1
CONTRACTOR =	Amdel Ltd.
CLIENT_OP_CO =	Petrofina Exploration Australia S.A

(Inserted by DNRE - Vic Govt Mines Dept)

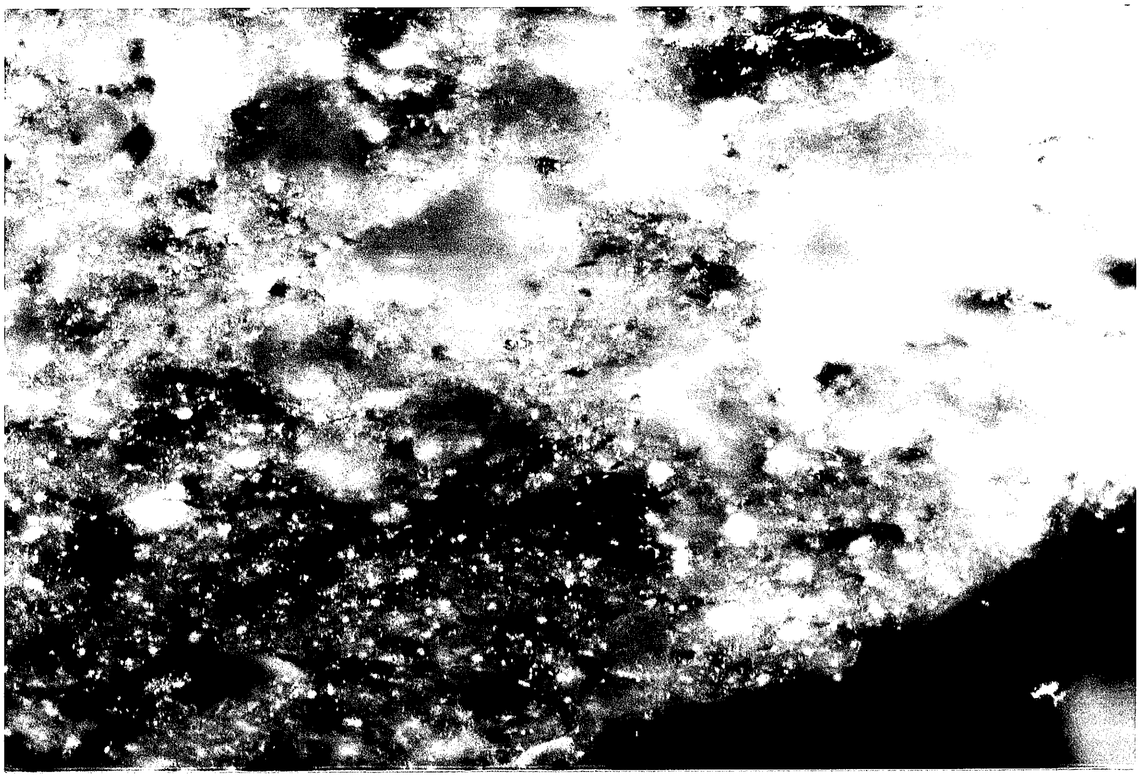


Plate 9: 4110 m (Campanian Siltstone). **Reflected Light**
Dispersed organic matter in this siltstone fragment consists largely of inertinite (white). Exinite (brown) is rare.
Field Dimensions: 0.26 x 0.18 mm.

Plate 10: Same Field as above. **Fluorescence Mode**
Oil (intense yellow; bottom centre) is clearly distinguished in fluorescence mode. Exinite (orange) is liptodetrinite.