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Petra-Chem Limited, Old Court House, Trinity Road, Marlow,
Buckinghamshire SL7 3AN England
Telephone (06284) 75175/6 Telex 847837 PETRA G

Geochemical Consultants to the Oil Industry

PROJECT NO: 57184

SOURCE ROCK EVALUATION OF SEDIMENTS

FROM WELL: 7/8-3 AND

CORRELATION TO A RESERVOIRED OIL

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A Petroleum Geochemistry Report

prepared by Petra-Chem Ltd.

on behalf of CONOCO NORWAY INC.

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Directors; T. Doran (Managing), S.P. Lowe (Technical)
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SUMMARY

Sixty-nine cuttings samples and one crude oil sample from well: 7/8-3 were used for a geochemical source rock evaluation study and an oil-to-source correlation between Jurasic sediments and a crude oil reservoired in the Jurassic sands interval of this well.

Sediments from the Tertiary and Lower Cretaceous intervals were found to be too immature for any hydrocarbon generation. The Tertiary interval contained two sections with good hydrocarbon potential, between 1400-2200m and 2550-2650m. The sediments from both sections were classified as being predominantly prone to source light oils, should they achieve maturity. The Lower Cretaceous sediments were found to have only poor hydrocarbon potential. The Jurassic sediments were considered to have just reached threshold for liquid hydrocarbon generation. Two organic rich intervals were identified within the argillaceous section of the Jurassic, between 3638-3676m and 3721-3730m. Both of these intervals were found to have good hydrocarbon potential and were predominantly oil prone. The Trias sediments were considered to be mature for hydrocarbon generation, but lacked sufficient hydrocarbon potential to source any significant quantities of hydrocarbons.

An oil-to-source correlation between sediments from the organic rich intervals of the Jurassic and an oil reservoired in the Jurassic sands was completed. It was concluded that the sediment from 3655m could well have sourced the oil.

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Contents

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1. INTRODUCTION

A total of eighty-six cuttings samples and one crude oil sample were supplied for a source rock evaluation of sediments from well: 7/8-3 from the Norwegian sector of the North Sea. The stratigraphy used in this report is based upon log picks supplied by CONOCO NORWAY, which have been taken below MSL. Allowance of 25m for rig elevation was therefore made, in order that the stratigraphic depths coincided with those of the samples. Samples were supplied throughout the well, which terminated in Zechstein salt. After preliminary examination and consultation with the available logs, seventeen samples were not considered likely to be of value. These samples were those from 300m and 400m, which were comprised primarily of drilling mud, those from the Cretaceous chalk section (2950m-3400m) and also those from Triassic red beds section (4000m-4250m). Study was therefore confined to the argillaceous sections of the Tertiary, Lower Cretaceous, Jurassic and Trias. Samples were made available at a greater frequency in the Jurassic interval, so that this section could be studied in greater detail.

The aims of the study were; to establish the maturity of the various stratigraphic intervals by the use of vitrinite reflectance measurements, supported by spore colouration and sediment extract studies. Hydrocarbon generation threshold values were calculated using statistical correlation of vitrinite reflectance values with depth. Potential source horizons were identified using total organic carbon and pyrolysis measurements. The source type of the various sediments was characterised using chromatographic and microscopic techniques. Finally, an oil to source correlation between Jurassic sediments and the crude oil from this well was completed. Full details of the methods utilised in this study can be found in the appendix of techniques.

2. MATERIAL AVAILABLE FOR STUDY

Both canned cuttings and bagged cuttings were made available from this well, which was drilled with a water based mud. The samples were washed in water to remove all traces of drilling mud and then air dried under controlled conditions at 40°C for not longer than twelve hours. The samples were carefully hand picked to eliminate cavings as far as possible and to obtain a uniform and potentially organic rich lithology for examination. Some samples were found to contain two lithologies in abundance. Thus, in order not to miss a potential source rock, both were picked. Detailed lithological descriptions of the cuttings samples are given in Table 7. It was noted during sample picking, that samples which were older than Lower Cretaceous in age, appeared to be extensively caved.

Cavings in samples older than Lower Cretaceous

The oil sample arrived in five 50ml sealed glass bottles. One portion of the oil was topped to remove compounds with boiling points below 210°C using the method published by Feux (1). This was completed before carbon isotope studies were carried out, in order that if further oil samples became available, isotope studies could be completed on comparable samples.

3. RESULTS AND DISCUSSION

The results of vitrinite reflectance measurements are detailed in Table 1. It was noted that the pre-Jurassic sediments contained greater amounts of vitrinite, presumably a consequence of differing depositional environments. A statistical correlation of reflectivity values versus depth and calculation of generation thresholds was carried out using those autochthonous reflectivity values which were considered to be unaffected by bitumen staining. The phenomenon of bitumen staining has been found to artificially lower vitrinite reflectance values (2). The correlation gave rise to a good correlation coefficient of 0.97 and a least squares fit of 0.93. The calculated hydrocarbon generation thresholds with their respective error windows are as follows;

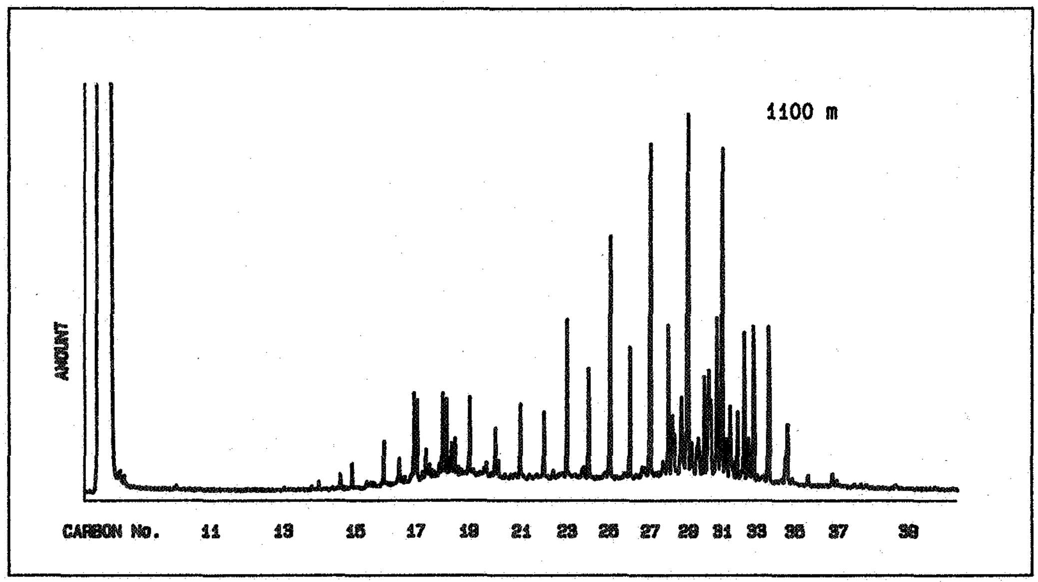
Onset of Liquid Hydrocarbon Generation (R_o=0.55%)	3731 +/- 253m
Onset of Gaseous Hydrocarbon Generation (R_o=0.70%)	4756 +/- 384m
Peak Liquid Hydrocarbon Generation (R_o=0.80%)	5323 +/- 426m
Peak Gaseous Hydrocarbon Generation (R_o=1.20%)	7047 +/- 705m
Liquid Hydrocarbon Destruction (R_o=1.30%)	7387 +/- 753m
Gaseous Hydrocarbon Destruction (R_o=3.20%)	11256 +/- 1307m

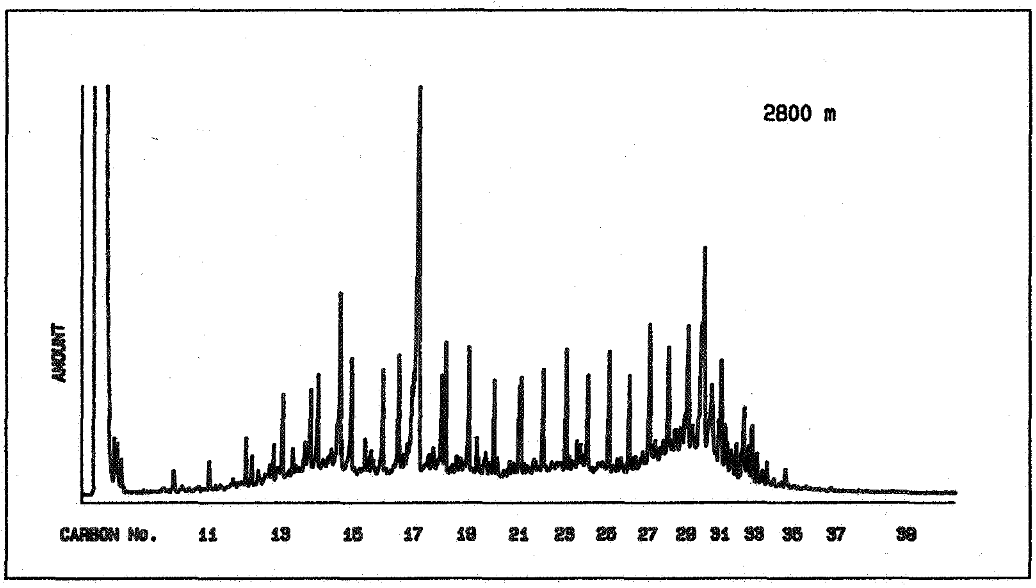
These thresholds imply that the Tertiary and Lower

Cretaceous sediments from this well are immature for any hydrocarbon generation and the Jurassic sediments may be just mature for liquid hydrocarbon generation.

i) Tertiary (700-3023.5m)

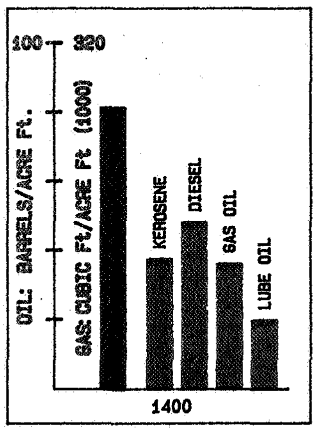
The conclusion from statistical correlation of vitrinite reflectance measurements, that sediments from the Tertiary are immature, was supported by the spore colours in transmitted light (spore colour ratings ranging from 2/3 to 3/4) and spore fluorescence colours observed in reflected light (ranging from yellow for the younger sediments to light orange for the deeper sediments). Further evidence for this conclusion was provided by the saturate alkane distributions of the solvent extracts of sediments from this interval. The two examples shown overleaf, from 1100m and 2800m, both exhibit prominent sterane and pentacyclane peaks in the range n-C_{27} to n-C_{34} and a pronounced odd-over-even predominance of n-alkanes in the range n-C_{22} to n-C_{30}. These features have both been associated with sediment immaturity (3)(4). It was also noted that the odd-over-even predominance decreased gradually with increase in depth, particularly in the n-C_{27} to n-C_{31} range. This point can be seen in figures 1 to 3, illustrated at the back of this report.

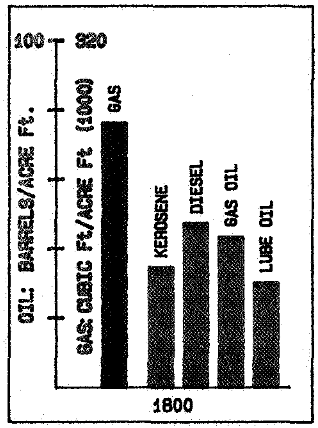


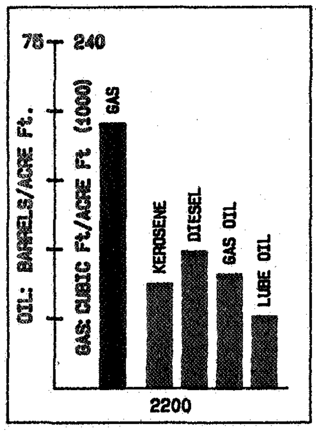


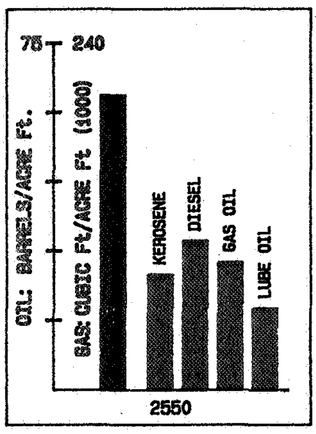
Total organic carbon (TOC) contents for sediments from this interval ranged from 0.19% wt. to 8.11% wt. (Table 2). Only two sediments, both blue-grey mudstones from the interval 2700m to 2800m, were rated as having poor organic contents. Nine sediments were rated as having moderate organic contents and the remaining nineteen sediments were rated as having good organic contents. It was noted that sediments between 1400m and 2200m and between 2550m and 2650m were particularly organic rich, probably representing changes in depositional environment, or preservation of the organic matter and possibly deliniating stratigraphic intervals. All sediments with TOC contents greater than 0.50% wt. were further examined using hydrocarbon potential by pyrolysis measurements. P2 values established for these sediments ranged from 1036 ppm to 11555 ppm (Table 3). Five sediments were rated as having poor hydrocarbon potential (700, 800, 1300, 2400 and 2750m), eleven were rated as having moderate hydrocarbon potential and the remaining eleven as having good hydrocarbon potential. The organic rich intervals identified by TOC gave the highest P2 yields, as would be expected.

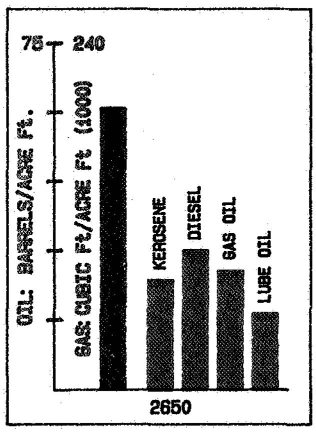
Visual kerogen descriptions of the eleven sediments examined from the Tertiary interval are detailed in Table 5. Sediments from this section contained either common or abundant amounts of amorphous kerogen, which were considered to be of predominantly land plant origin. Several sediments contained traces of other land plant material such as cuticle, black wood and brown wood. In view of the amorphous Kerogen being derived from plant material of mainly terrestrial origin they were assessed as having the potential to source significant quantities of light oils, provided they become mature. Kerogen characterisation by pyrolysis results (Table 6) supported the conclusion from the visual kerogen descriptions, that these sediments have the potential to source light oils. In a few cases (notably 2700m and 2900m) appreciable quantities of gaseous hydrocarbons would also be sourced. The following histograms show the range of Kerogen breakdown products that could be expected from these sediments.

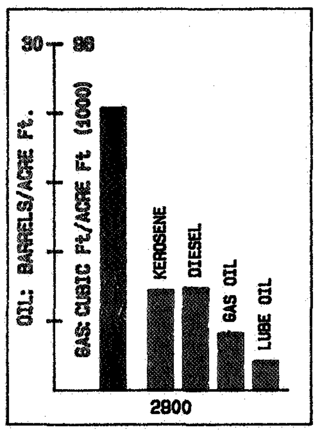












The saturate alkane distributions, illustrated previously and in figures 1 to 3, show that the bulk of the n-alkanes eluted in the range n-C_{26} to n-C_{34}, a clear indication of significant land plant input. Also consistent with high land plant input are the very high pristane/phytane ratios and the low n-C_{17}/pristane ratios (Table 4) (5).

ii) Lower Cretaceous (3393-3638m)

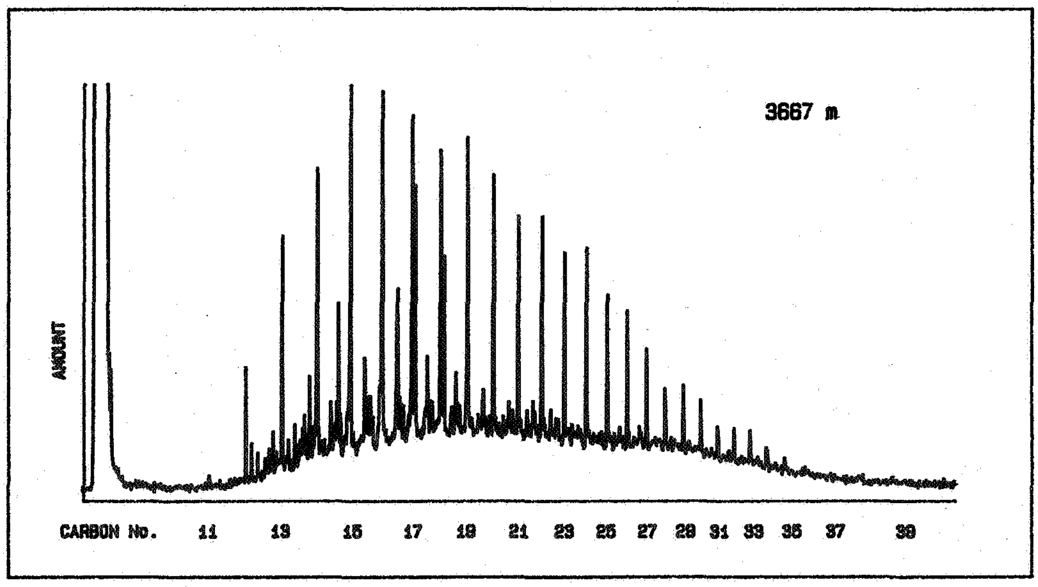
The one reflectivity value obtained in this section of $R_o$ave = 0.54% ties in well with the maturity level predicted from the vitrinite profile correlation. The maturity level predicted suggests that the Lower Cretaceous sediment are immature, but are approaching the liquid hydrocarbon generation threshold of R_o = 0.55%. A spore colour rating of 4 was recorded in transmitted light and a spore fluorescence colour of yellow/orange was recorded in reflected light. These colours suggest slightly higher and lower maturity levels respectively, than is suggested by the vitrinite correlation. Since the statistical correlation gave rise to a good least squares fit value and spore colour assessments are inherently more subjective than vitrinite measurements, the maturity level predicted from the vitrinite correlation is considered to be the best indication of the true maturity level.

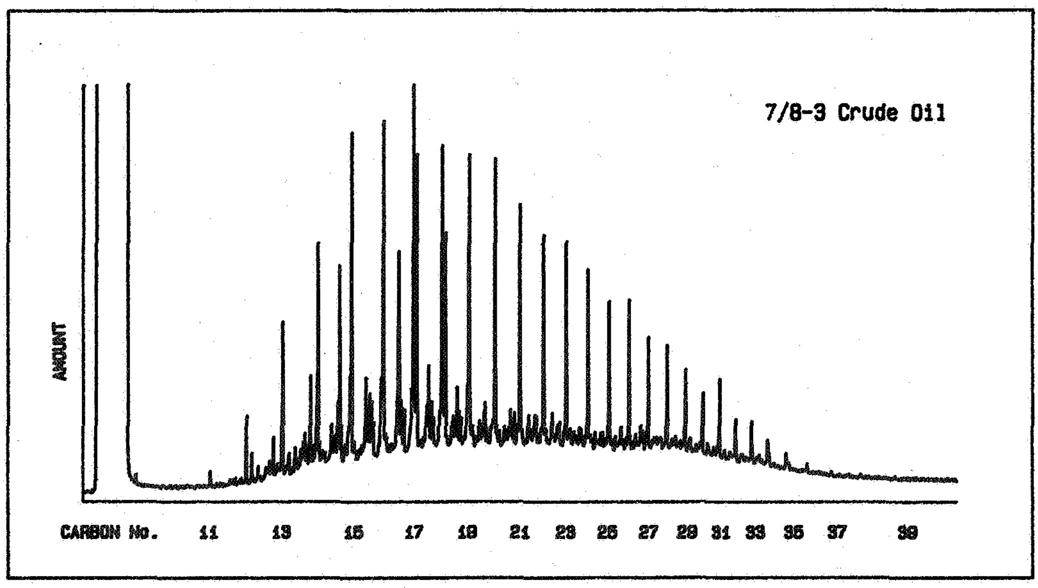
Total organic carbon contents for Lower Cretaceous sediments ranged from 0.25% wt. to 1.40% wt. with three sediments rated as having poor organic contents and one (3450m) rated as having a moderate organic content. Hydrocarbon potential by pyrolysis measurements carried out on the sediment from 3450m gave a P2 yield of 1817 ppm, classifying this sediment as having poor hydrocarbon potential, despite its moderate organic content.

Visual kerogen description of the sediment from 3450m revealed that it contained small amounts of amorphous kerogen of marine origin and traces of cuticle. The kerogen was therefore rated as having limited potential to source liquid hydrocarbon products, but it should be stressed that pyrolysis measurements demonstrate it to have no significant potential for sourcing hydrocarbons. Kerogen characterisation by pyrolysis was not carried out on this sediment, due to its poor potential rating from pyrolysis.

iii) **Jurassic (3638-3767m)**

Statistical correlation of vitrinite reflectance measurements place the Jurassic sediments from this well as being just mature for liquid hydrocarbon generation, or in other words, at the top of the oil generation 'window'. Consistent with this observation are the spore fluorescence colours recorded in reflected light (light to mid-orange) and the spore colour ratings of 4 seen in transmitted white light (Table 5). The sediment extracts from this section all had carbon preference indices (CPI) close to 1.0 (Table 4). This once again, suggests that these sediments are mature for liquid hydrocarbon generation (5). It must be stressed however that the extracts could represent migrated, rather than indigenous hydrocarbons. Evidence for this suggestion is given by the strong similarity between the saturate alkane distributions of the sediment extracts and that of the crude oil reservoired in the lower Jurassic sands, as can be seen in the following chromatograms.



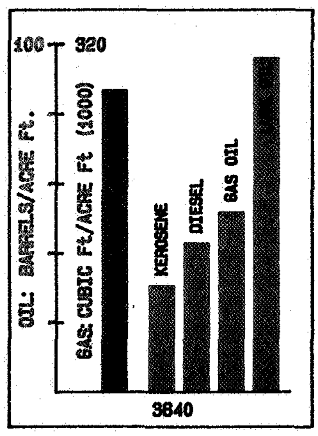


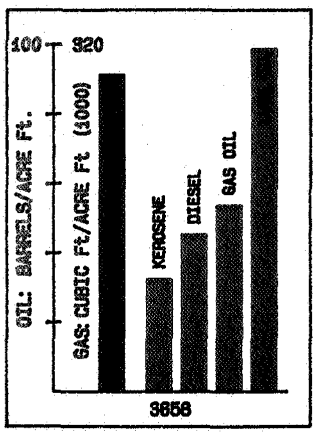
This similarity between the extract and the oil could alternatively imply that the oil has been sourced in situ, from Jurassic sediments. Since the Jurassic sediments from this well have only just reached maturity for liquid hydrocarbon generation, the quantities of hydrocarbons likely to have been generated would be relatively insignificant compared with sediments presently buried to a depth of 5323 +/- 426m (the level at which peak oil production would take place). The results from carbon isotope measurements, which are discussed in greater detail in section v), do not rule out the possibility of in-situ generation.

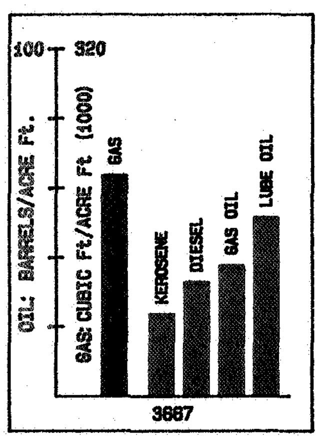
Total organic carbon contents for the Jurassic sediments ranged from poor (0.12% wt.) to good (9.11% wt.) and appeared to define three quite distinguishable sections. Brown-black mudstones were taken to represent the section from 3637m to 3676m. All these sediments had good organic contents, with TOC values ranging from 5.05% wt. to 9.11% wt.. Predominantly grey calcareous mudstones, taken to represent the section from 3679m to 3718m, had only poor to moderate organic contents. One exception picked from this interval was a dark grey mudstone selected from the canned cuttings sample from 3700m. It was noted that this had characteristics of the shallower Jurassic sediments (eg. high TOC and pyrolysis yield values), suggesting that it might be caved. The sediments from 3721m to 3730m contained a mixture of lithologies, both light and dark coloured. These varied lithologies gave rise to poor and good organic contents respectively (Table 2).

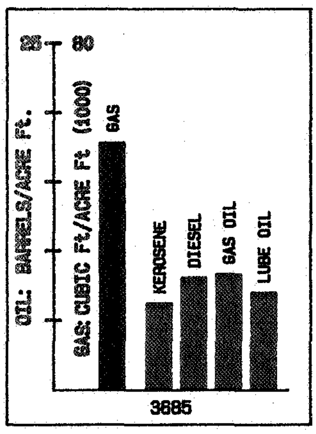
Hydrocarbon potential by pyrolysis measurements emphasised the divisions discussed in the paragraph above (Table 3). Sediments from the shallowest section were all classified as having good hydrocarbon potentials (P2 yields ranging from 9171 ppm to 18249 ppm). Those from the middle section were classified as having poor to moderate hydrocarbon potentials (P2 yields ranging from 1161-2763 ppm), whilst the most organic rich lithologies from the deepest section were all classified as having good hydrocarbon potentials (P2 yields ranging from 6121-11694 ppm). The light coloured lithologies from the deepest section contained less that 0.50% wt. organic carbon and were not therefore examined using pyrolysis.

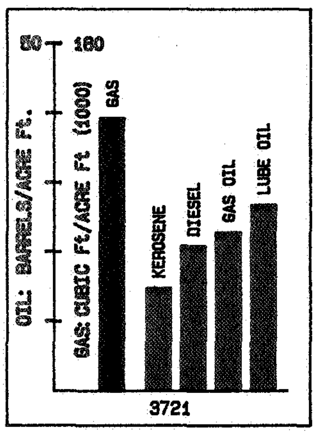
Visual kerogen description of the five sediments examined from the Jurassic interval revealed that kerogens from the shallowest organic rich sediments (3637, 3650, 3655 and 3667m) comprised almost exclusively abundant amorphous kerogen, suggesting that they are predominantly oil prone. In contrast, the sediment examined from the deepest organic rich section (3721m) contained common amounts of amorphous kerogen, in addition to traces of brown wood, black wood and finely disseminated vascular plant debris. The relative proportions of amorphous kerogen to structured kerogen led to the conclusion that the kerogen from 3721m would still be predominantly oil prone. The results of kerogen characterisation by pyrolysis supported the conclusions drawn from visual kerogen description, that the organic-rich Jurassic sediments are predominantly oil prone. The bulk of the pyrolysis products eluted in the liquid hydrocarbon fractions, as is illustrated in the following histograms.

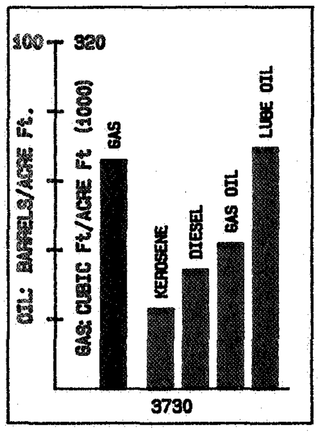












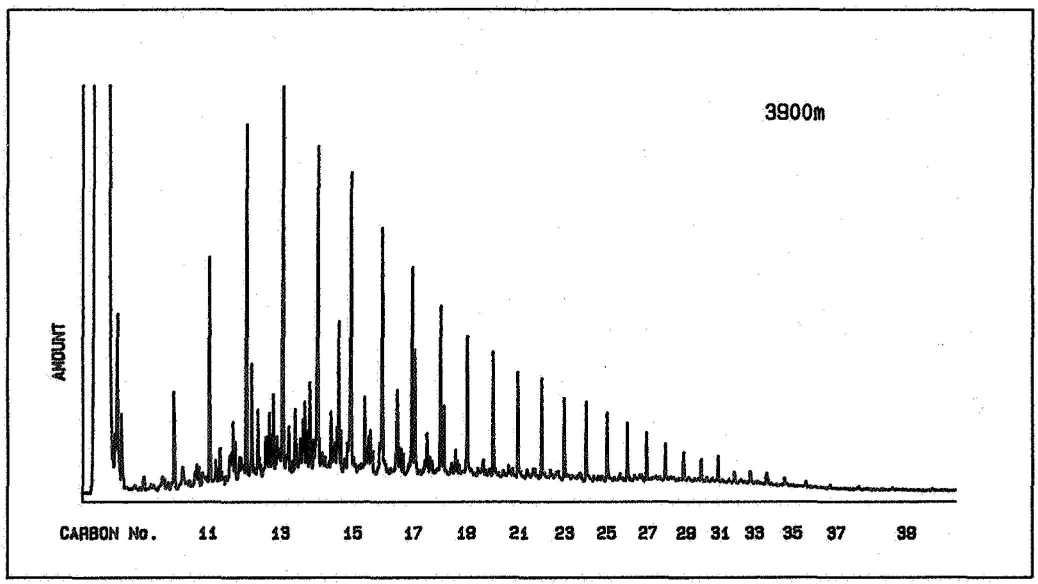
It was noted that the sediment from 3685m would source significantly more gaseous hydrocarbons, in addition to the liquid hydrocarbons. Unfortunately, there was insufficient material to complete a visual kerogen description at this depth, for corroboration.

The saturate alkane distributions from the sediment extracts of the Jurassic sediments were found to be similar to one another. This point is illustrated by the chromatograms shown previously and at the back of this report. The n-alkanes peak around n-C_{15} to n-C_{17} suggesting a mainly marine input and supporting the observations from the visual kerogen descriptions. The possibility discussed earlier, that the sediment extracts may represent migrated hydrocarbons should be borne in mind.

iv) Trias (below 3767m)

Vitrinite reflectance measurements carried out on Triassic sediments gave rise to only one sediment which was considered to contain autochthonous vitrinite and not to be influenced by the cavings observed in this section. Only one vitrinite particle was observed in this sediment from

3900m and gave a reflectivity value of R_o = 0.61%. This reflectivity value suggests the Trias sediments are mature for liquid hydrocarbon generation, but not for gaseous hydrocarbon generation. The value corresponded very well to the level of maturity predicted by the vitrinite/depth correlation and the spore colour rating of 4, observed in transmitted white light microscopy. The saturate alkane distribution obtained from the sediment extract of the same sediment is also consistent with this level of maturity. No significant odd over even preference was observed, as illustrated below.



Total organic carbon contents recorded from sediments from the Trias interval ranged from 0.33% wt. to 3.89% wt.. It was noted that the cuttings appeared to be extensively caved, as demonstrated in Table 7 and after elimination of those lithologies which were thought to be possibly caved, the range of TOC values varied from 0.33% wt. to 0.68% wt. (Table 2). The hydrocarbon potential of the one sediment found to have a moderate organic content gave rise to a pyrolysis P2 yield of 795 ppm, and therefore falls into the "poor" potential category.

Visual kerogen description of the sediment from 3900m revealed that it contained both structured and amorphous kerogen, in varying proportions (Table 5). As the quantities observed were relatively small, the sediment was rated as having no significant potential to source hydrocarbons. The n-alkane distributions of the sediment extracts obtained from the Trias interval were similar to those from the Jurassic sediments, suggesting they may represent migrated hydrocarbons rather than indigenous material.

v) Oil-to-Source correlation

An oil-to-source correlation was completed between an oil reservoired in the Jurassic sands and the two organic rich sections identified in the argillaceous part of the Jurassic. The two main parameters used for this correlation were stable carbon isotope $^{12}C/^{13}C$ data and Gas Chromatography - Mass Spectrometry (GCMS).

The data derived from the source rock evaluation of the argillaceous Jurassic sediments pointed towards the existence of mature (although only just into the top of the 'oil window'), organic rich and predominantly oil prone sediments. Therefore two sediments were selected for carbon isotope determinations from 3655 and 3730m. The results of these determinations are shown in Table 8 and clearly demonstrate that the sediment examined from 3655m is a more likely source of the oil, than the sediment examined from 3730m. Theoretically, the carbon isotope value of an oil should be isotopically lighter than the kerogen from which it is sourced by 1 to 2 parts per mil (1). On this basis, the sediment from 3730m is unlikely to have sourced the oil reservoired in the Jurassic sands. It was noted that the isotope value of the kerogen from 3655m was relatively light, suggesting the presence of significant quantities of plant material of terrestrial origin and contrasting with the evidence from visual kerogen descriptions and n-alkane distributions. The carbon isotope value of the sediment from 3730m implied that this sediment had a more marine character than expected of the sediment that sourced the oil reservoired in the Jurasic sands.

GCMS data was less definitive than the carbon isotope data, showing a broad similarity between the sterane and pentacyclane fingerprints of the oil and both sediment extracts. The fingerprints are illustrated in figures 7 to 9 at the back of this report and the ratios of those peaks considered most useful in identifying possible oil/sediment extract correlations are tabulated in Table 9.

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4. CONCLUSIONS

i) Tertiary (700-3023.5m)

These sediments are immature for any hydrocarbon generation. The majority of sediments have moderate to good organic carbon contents and have the potential to source light oils, should they reach maturity.

ii) Lower Cretaceous (3393-3638m)

These sediments are immature for any hydrocarbon generation. The sediments have poor to moderate organic contents, but only poor hydrocarbon potential from pyrolysis (after solvent extraction).

iii) Jurassic (3638-3767m)

These sediments are considered to be just mature for liquid hydrocarbon generation. Two organic rich sections were identified, which also have good hydrocarbon potentials from pyrolysis and were found to be predominantly oil prone.

iv) Trias (below 3767m)

These sediments are mature for liquid hydrocarbon generation, but not for gaseous hydrocarbon generation. They have generally poor organic contents and hydrocarbon potentials.

v) Oil-to-Source Correlation

Carbon isotope data indicated that the sediment examined in detail from 3655m is more likely to be the source of the hydrocarbons reservoired in the Jurassic sands than the sediment examined in detail from 3730m.

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VITRINITE REFLECTANCE DATA

WELL NO: 7/8-3

DEPTH (M)		VITRINITE REFLECTANCE (R_o ave%) AUTOCHTHONOUS	ALLOCHTHONOUS
800		0.29 (9)	
900		0.28 (3)	0.41 (3)
1100		0.30 (6)	
1300		0.28 (5)	0.52 (1)
1500		0.37 (22)	
1700		0.34 (20)	0.50 (1)
1900		0.33 (21)	
2100		0.36 (22)	
2300		0.38 (14)	0.52 (1)
2500			0.50 (20)
2600		0.40 (21)	
2650	[b]0.33 (4)	0.47 (15)	0.59 (3)
2750		0.41 (1)	0.61 (1)

TABLE 1

Continued ...

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DEPTH (M)	VITRINITE REFLECTANCE (R_o ave%) AUTOCHTHONOUS		ALLOCHTHONOUS
2850		0.48 (22)	
3450	[b]0.39 (1)	0.54 (12)	0.71 (1)
3550			0.71 (1)
3600	[c]0.39 (11)		
3650	[b]0.39 (4)	0.52 (2)	
3700		N.D.P.	
3800	[c]0.46 (4)		
3850	[c]0.45 (3)		
3900		0.61 (1)	

KEY

Figures in parenthesis refer to the number of measurements completed

NDP = No determination possible

b = bitumen staining present

c = caved material

TABLE 1

LITHOLOGICAL AND ORGANIC RICHNESS DATA

Well No: 7/8-3

DEPTH (M)	STRATIGRAPHY	LITHOLOGY	TOTAL ORGANIC CARBON %wt.
700	Tertiary	Dk.gy.calc.mudstone(5%)	0.60
800	Tertiary	Grey/brown calc. mudstone(25%)	1.56
900	Tertiary	Grey/brown calc. mudstone(49%)	1.42
1000	Tertiary	Grey/brown calc. mudstone(49%)	1.86
1100	Tertiary	Grey/brown calc. mudstone(60%)	1.44
1200	Tertiary	Grey/brown calc. mudstone(90%)	1.53
1300	Tertiary	Grey/brown calc. mudstone(95%)	1.56
1400	Tertiary	Black/brown calc. mudstone(40%)	8.11
1500	Tertiary	Dark brown calc. mudstone(35%)	4.03

TABLE 2

Continued ...

DEPTH (M)	STRATIGRAPHY	LITHOLOGY	TOTAL ORGANIC CARBON %wt.
1600	Tertiary	Dark brown calc. mudstone(35%)	6.65
1700	Tertiary	Dk.bn.dolomitic mudstone(50%)	4.44
1800	Tertiary	Dk.bn.dolomitic mudstone(80%)	5.92
1900	Tertiary	Dk.bn.dolomitic mudstone(99%)	5.58(5.73R)
2000	Tertiary	Dk.bn.dolomitic mudstone(93%)	2.65
2100	Tertiary	Dk.bn.dolomitic mudstone(90%)	4.05
2200	Tertiary	Dk.bn.dolomitic mudstone(50%)	3.96
2300	Tertiary	Dk.bn.dolomitic mudstone(30%)	1.57
2400	Tertiary	Dark brown calc. mudstone(95%)	1.43
2500	Tertiary	Dk.bn.dolomitic mudstone(95%)	1.34(1.28R)
2550	Tertiary	Dk.bn.dolomitic mudstone(55%)	4.39

TABLE 2

Continued ...

DEPTH (M)	STRATIGRAPHY	LITHOLOGY	TOTAL ORGANIC CARBON %wt.
2600	Tertiary	Dk.bn.dolomitic mudstone(60%)	4.23
2650	Tertiary	Dark brown calc. mudstone(40%)	4.58
2700BN	Tertiary	Dark brown calc. mudstone(40%)	1.85
2700BL	Tertiary	Blue/grey calc. mudstone(50%)	0.19
2750	Tertiary	Light grey/brown calc.mudstone(50%)	1.15
2800BN	Tertiary	Grey/brown calc.mudstone(40%)	1.39
2800BL	Tertiary	Blue/grey mudstone(30%)	0.33
2850	Tertiary	Brown/grey mudstone(25%)	1.27(1.29R)
2900	Tertiary	Grey/brown mudstone(45%)	1.48
3450	Lower Cretaceous	Brown/grey dolomitic mudstone(40%)	1.40
3500	Lower Cretaceous	Black/grey mudstone(40%)	0.48

TABLE 2

Continued ...

DEPTH (M)	STRATIGRAPHY	LITHOLOGY	TOTAL ORGANIC CARBON %wt.
3550	Lower Cretaceous	Black/grey mudstone(85%)	0.33
3600	Lower Cretaceous	Black/grey dolomitic mudstone(99%)	0.25
3637	Jurassic	Brown/black mudstone(80%)	7.62(7.56R)
3640	Jurassic	Brown/black mudstone(90%)	7.04
3643	Jurassic	Brown/black dolomitic mudstone(90%)	6.34
3646	Jurassic	Brown/black mudstone(95%)	6.61
3649	Jurassic	Brown/black mudstone(95%)	7.71
3650	Jurassic	Dk.gy/bn.dolomitic mudstone(95%)	8.95
3652	Jurassic	Brown/black mudstone(95%)	8.69
3655	Jurassic	Brown/black mudstone(95%)	9.11(9.16R)
3658	Jurassic	Brown/black mudstone(98%)	8.49

TABLE 2

Continued ...

DEPTH (M)	STRATIGRAPHY	LITHOLOGY	TOTAL ORGANIC CARBON %wt.
3661	Jurassic	Brown/black mudstone(98%)	7.83
3664	Jurassic	Brown/black mudstone(95%)	7.26
3667	Jurassic	Brown/black mudstone(95%)	5.41
3670	Jurassic	Brown/black mudstone(85%)	5.72
3672	Jurassic	Brown/black mudstone(50%)	5.05
3676	Jurassic	Brown/black mudstone(50%)	6.13
3679	Jurassic	Dark grey mudstone(28%)	0.12
3682	Jurassic	Dark grey mudstone(33%)	0.24
3685sl	Jurassic	Grey calcareous silty mudstone(28%)	1.57
3685md	Jurassic	Grey mudstone(20%)	0.26
3688	Jurassic	Grey calcareous silty mudstone(55%)	1.31

TABLE 2

Continued ...

DEPTH (M)	STRATIGRAPHY	LITHOLOGY	TOTAL ORGANIC CARBON %wt.
3691	Jurassic	Brown/grey calcareous silty mudstone(50%)	1.48
3694sl	Jurassic	Grey silty calc.mudstone(45%)	1.28
3694md	Jurassic	Grey mudstone(33%)	0.21
3697	Jurassic	Grey silty calc.mudstone(55%)	0.97
3700	Jurassic	Grey calcareous silty mudstone(50%)	1.21
3700BN	Jurassic	Dk.gy.bn.dolomitic mudstone(40%)	6.22
3700GY	Jurassic	Grey dolomitic mudstone(60%)	0.32
3703	Jurassic	Grey calcareous silty mudstone(55%)	0.85
3706	Jurassic	Grey calcareous mudstone(70%)	0.30
3709	Jurassic	Grey calcareous silty mudstone(55%)	0.99
3712	Jurassic	Grey mudstone(70%)	0.23(0.23R)
3715	Jurassic	Grey mudstone(70%)	0.34

TABLE 2

Continued ...

DEPTH (M)	STRATIGRAPHY	LITHOLOGY	TOTAL ORGANIC CARBON %wt.
3718	Jurassic	Grey calc.mudstone(40%)	0.27
3721LT	Jurassic	Grey mudstone(65%)	0.33(0.31R)
3721DK	Jurassic	Dark grey mudstone(30%)	4.50
3724LT	Jurassic	Grey mudstone(55%)	0.32
3724DK	Jurassic	Dark grey calcareous silty mudstone(30%)	3.98
3730LT	Jurassic	Grey mudstone(50%)	0.32
3730DK	Jurassic	Dark grey silty mudstone(10%)	5.71
c3800DK	Trias	Grey siltstone(28%)	2.77
3800LT	Trias	Lt.gy.mudstone(70%)	0.48
3850	Trias	Grey dolomitic mudstone(95%)	0.33
3900	Trias	Grey mudstone(95%)	0.68
c3950	Trias	Gy/bk.mudstone(30%)	3.89

TABLE 2

Continued ...

KEY

BN = Brown lithology
BL = Blue/grey lithology
sl = Silty mudstone
md = Mudstone
GY = Grey lithology
DK = Darker lithology
LT = Lighter lithology
c = thought to be caved
R = Repeat value

TABLE 2

PETRA-CHEM

PYROLYSIS DATA

WELL NO: 7/8-3

DEPTH (M)	P1 YIELD (ppm)	P2 YIELD (ppm)	EXTRACTED P2 YIELD	% USEABLE CARBON	T_{max}
700	59	1036		17.2	440
800	48	1930		12.3	440
900	25	2329		16.4	442
1000	41 (44R)	2854 (2869R)		15.3	439
1100	271	2285	2375	16.4	443
1200	44	2347		15.3	435
1300	43	1856		11.8	447
1400	241	13256	11126	13.7	453
1500	139	8271		20.5	445
1600	383 (86R)	11586 (11377R)	10770	15.1	440
1700	60	9924		22.3	445
1800	131	11849	11555	19.5	445
1900	359	11488	10264	18.3	440

Litt forskjell i prøver fra samme dyp må forventes

TABLE 3

Continued ...

DEPTH (M)	P1 YIELD (ppm)	P2 YIELD (ppm)	EXTRACTED P2 YIELD	% USEABLE CARBON	T_{max}
2000	58	5109	4971	18.7	449
2100	125	7720		19.0	455
2200	165	6965	7437	18.7	434
2300	38	3197	3065	19.5	440
2400	14	1933		13.5	446
2500	24 (24R)	2131 (2122R)		15.9	437
2550	108	8253	8276	18.8	445
2600	124	8399	7487	17.6	445
2650	101	8125	7844	17.1	444
2700BN	51	4791	4242	22.9	445
2750	42	1750		15.2	442
2800BN	32	2515	2010	14.4	436
2850	35	2296		18.0	449
2900	50	2692	2468	16.6	441
3450	33	2302	1817	16.4	454
3637	4955	21463	16829	22.0	456

TABLE 3

Continued ...

DEPTH (M)	P1 YIELD (ppm)	P2 YIELD (ppm)	EXTRACTED P2 YIELD	% USEABLE CARBON	T_{max}
3640	4864	19261	15380	21.8	453
3643	5045	17348	14641	23.0	457
3646	7019	18525	13346	20.1	454
3649	7506	19627	14693	19.0	447
3650	9671 (11835R)	24823 (24839R)	18085	20.2	454
3652	9469	21842	15885	18.2	448
3655	10614	22330	18249	20.0	448
3658	9492	22680	16077	18.9	449
3661	9975	19119	15453	19.7	444
3664	8791	19677	11109	15.3	443
3667	6947	14600	10463	19.3	452
3670	6175	14448	10946	19.1	450
3672	5269	12155	9171	18.1	450
3676	5959	15538	12271	20.0	448
3685SL	1173	3407	2362	15.0	454
3688	830	3000	2151	16.4	455

TABLE 3

Continued ...

DEPTH (M)	P1 YIELD (ppm)	P2 YIELD (ppm)	EXTRACTED P2 YIELD	% USEABLE CARBON	T_{max}
3691	794 (724R)	2763 (2542R)	1684	11.3	476
3694SL	570	2587	1541	12.0	463
3697	352	1319		13.5	452
3700BN	4216	13434	13914	22.3	463
3700	458	1914		15.8	449
3703	195	1161		13.6	476
3709	441	1498		15.1	463
3721	2680	8326	6200	13.7	455
3724	3735	9740	6121	15.3	455
3730	3966 (3576R)	14061 (14472R)	11694	20.4	463
c3800DK	2260	6774	5743	20.7	464
3900	25	796		11.7	454
c3950	3256	10070	5033	12.9	455

KEY

R = Repeat value
c = Thought to be caved material
BN = Brown lithology
SL = Silty Mudstone
DK = Dark lithology

TABLE 3

SOLVENT EXTRACT EXAMINATIONS

WELL NO. 7/8-3

DEPTH (M)	TSE (% wt)	SAC (% TSE)	CPI	PR/PH	C_{17}/PR	C_{18}/PH
1100	0.008	9.0	*	1.01	1.14	1.10
1400	0.037	11.8	*	1.66	0.44	0.62
1900	0.032	24.8	*	3.72	0.28	0.48
2200	0.028	8.7	*	4.85	0.25	0.68
2550	0.041	11.7	*	6.18	0.29	0.81
2650	0.021	25.3	*	5.85	0.27	0.83
2800BN	0.024	20.2	*	7.47	0.13	0.74
3640	0.472	30.3	0.97	1.80	1.74	2.11
3650	1.359	47.3	0.94	1.81	1.56	1.90
3667	0.730	28.2	1.01	1.77	1.47	2.03
3688	0.159	38.2	0.99	1.72	1.74	2.69
3697	0.022	37.1	1.03	2.54	1.88	3.61
3700BN	0.759	50.8	0.97	1.84	1.74	2.18

TABLE 4

Continued ...

DEPTH (M)	TSE (% wt)	SAC (% TSE)	CPI	PR/PH	C_{17}/PR	C_{18}/PH
3724DK	0.381	24.0	0.99	1.96	1.67	2.33
^{c}3800	0.449	42.5	0.98	1.90	1.86	2.49
3900	0.006	29.3	1.00	2.20	1.79	2.71
^{c}3950	0.308	51.4	0.99	1.96	1.66	2.39

KEY

* = No calculation of CPl due to masking of n-alkanes by steranes and pentacyclanes.

c = Thought to be caved

BN = Brown Lithology

DK = Dark Lithology

TABLE 4

PETRA-CHEM

VISUAL KEROGEN DESCRIPTIONS

WELL NO: 7/8-3

DEPTH (M)	STRUCTURED KEROGEN CUTICLE	BROWN WOOD	BLACK WOOD	AMORPHOUS KEROGEN	SPORE COLOUR	POTENTIAL RATING (1-7)
900	Trace	Trace	Trace	Common	2/3	Oil (light)
1100	Trace	-	Trace	Common	2/3	Oil (light)
1300	-	-	-	Common	2/3	Oil (light)
1400	-	-	-	Abundant	R	Oil (light)
1600	-	-	-	Abundant	-	Oil (light)
1900	-	-	Trace	Abundant	R	Oil (light)
2100	-	-	-	Abundant	3	Oil (light)
2400	-	-	-	Abundant	3	Oil (light)
2600	-	-	-	Abundant	3/4	Oil (light)

TABLE 5

Continued ...

DEPTH (M)	STRUCTURED KEROGEN CUTICLE	BROWN WOOD	BLACK WOOD	AMORPHOUS KEROGEN	SPORE COLOUR	POTENTIAL RATING (1-7)
2750	Trace	-	-	Common	3/4	Oil (light)
2850	-	Trace	-	Common	-	Oil (light)
3450	Trace	-	-	Trace/ Common	4	Oil/ None
3637	-	-	-	Abundant	4(t)	Oil
3650	-	-	Trace	Abundant	4	Oil
3655	-	-	-	Abundant	4	Oil
3667	-	-	-	Abundant	4/5 (t)	Oil
3721	-	Trace	Trace	Common	4	Oil
c3800	-	-	Trace/ Common	Abundant	4	Oil
3900	Trace	Trace	Common	Trace/ Common	4	None

TABLE 5

Continued ..

KEY

c = Thought to be caved

t = Thermal Alteration Index (no spores)

R = Reworked material

TABLE 5

KEROGEN CHARACTERISATION BY PYROLYSIS

WELL NO:7/8-3

DEPTH (M)	% GASES & GASOLINE	% KEROSENE	% DIESEL	% HEAVY GAS OIL	% LUBE OIL	SOURCE FACTOR
1400	36.5	16.8	21.6	16.2	8.9	19.3
1600	36.8	16.6	21.1	16.0	9.5	20.3
1800	33.0	14.9	20.4	18.7	13.0	19.1
1900	34.1	15.5	20.5	18.3	11.6	19.8
2000	41.0	16.3	19.9	15.0	7.8	23.9
2200	38.4	15.1	19.8	16.4	10.3	22.8
2300	44.5	17.3	19.7	12.6	5.9	26.0
2550	38.5	15.0	19.4	16.6	10.6	24.0
2600	37.9	15.2	19.7	16.5	10.7	22.9
2650	38.8	15.1	19.2	16.4	10.5	24.3
2700	47.1	17.0	18.4	12.1	5.4	28.7
2900	49.5	17.5	17.9	10.0	5.1	28.9
3640	28.2	9.9	13.9	16.8	31.2	16.1

TABLE 6

Continued ....

DEPTH (M)	% GASES & GASOLINE	% KEROSENE	% DIESEL	% HEAVY GAS OIL	% LUBE OIL	SOURCE FACTOR
3650	28.7	10.1	14.1	16.8	30.3	16.2
3658	28.4	10.1	14.1	16.7	30.7	16.1
3667	30.4	11.3	15.7	18.0	24.6	17.4
3685	37.7	13.1	17.0	17.5	14.7	21.7
3700BN	30.2	10.4	14.5	16.8	28.1	17.7
3721	31.7	11.8	16.7	18.3	21.5	17.5
3730	28.2	9.8	14.6	17.8	29.6	16.4
c 3800 DK	32.8	12.2	17.3	18.9	18.8	18.4
c 3950	34.4	12.8	17.6	18.3	17.0	19.3

KEY

c = Thought to be caved material
DK = Dark Lithology
BN = Brown Lithology

TABLE 6

LITHOLOGY SHEET

WELL NO: 7/8-3

DEPTH (M)	GROSS SAMPLE DESCRIP. (% OF WHOLE SAMPLE)	LITHOLOGICAL DESCRIPTION OF CUTTINGS (% OF TOTAL IN PLACE)
700	Cavings(60%) Cuttings(40%)	Light gy.calc.mudstone(70%) Light gy/bn.mudstone(20%) Dk.gy.highly dol.mudstone(5%) Remainder(5%)
800	Cuttings(60%) Cavings(39%) Paint(1%) Iron oxide(trace)	Light gy/gn.mudstone(65%) Gy/bn.dol.mudstone(25%) Remainder(10%)
900	Cuttings(90%) Cavings(10%)	gy/bn.dol.mudstone(49%) Lt.gy/gn.mudstone(49%) Remainder(2%)
1000	Cuttings(95%) Cavings(5%) Paint(trace) Rusty metal(trace)	Gy/bn.dol.mudstone(49%) Lt.gy/gn.mudstone(49%) Remainder(2%)
1100	Cuttings(90%) Cavings(10%) Paint(trace)	gy/bn.dol.mudstone(60%) Lt.gy/gn.mudstone(35%) Remainder(5%)
1200	Cuttings(75%) Cavings(25%) Rusty metal(trace) Paint(trace)	Bn/gy.dol.mudstone(90%) Lt.gn/gy.mudstone(8%) Remainder(2%)

TABLE 7

Continued ...

DEPTH (M)	GROSS SAMPLE DESCRIP. (% OF WHOLE SAMPLE)	LITHOLOGICAL DESCRIPTION OF CUTTINGS (% OF TOTAL IN PLACE)
1300	Cavings(70%) Cuttings(30%) Organic matter(trace)	**Bn/gy.dol.mudstone(95%)** Remainder(5%)
1400	Cuttings(65%) Cavings(35%) Paint(trace)	Bn/gy.mudstone(55%) **Dk.bn.dol.micaceous mudstone(40%)** Lt.gy/gn.mudstone(4%) Remainder(1%)
1500	Cuttings(65%) Cavings(35%)	**Dk.bn.dol.micaceous mudstone(35%)** Bn.micaceous mudstone(35%) Gn/gy.mudstone(30%)
1600	Cuttings(65%) Cavings(35%)	Bn.micaceous mudstone(50%) **Dk/bn.dol.micaceous mudstone(35%)** Lt.gy/gn.mudstone(13%) Remainder(2%)
1700	Cuttings(65%) Cavings(35%)	**Dk.bn.dol.mudstone(50%)** Brown mudstone(30%) Dolomite(10%) Lt.gn/gy.mudstone(7%) Gypsum(3%)
1800	Cuttings(90%) Cavings(10%) Organic matter(trace)	**Dk.bn.dol.mudstone(80%)** Gy/bn.mudstone(15%) Remainder(5%)

TABLE 7

Continued ...

DEPTH (M)	GROSS SAMPLE DESCRIP. (% OF WHOLE SAMPLE)	LITHOLOGICAL DESCRIPTION OF CUTTINGS (% OF TOTAL IN PLACE)
1900	Cuttings(85%) Cavings(15%)	Dk.bn.dol.micaceous mudstone(99%) Remainder(1%)
2000	Cuttings(70%) Cavings(29%) Rusty metal(1%) Organic matter(trace) Paint(trace)	Dk.gy/bn.dol.micaceous mudstone(93%)) Lt.gy.calc.mudstone(5%) Remainder(2%)
2100	Cuttings(70%) Cavings(29%) Walnut shells(1%)	Dk.gy/bn.dol.mudstone(90%) Lt.gy.calc.mudstone(10%)
2200	Cuttings(75%) Cavings(25%) Walnut shells(trace) Rusty metal(trace)	Dk.gy/bn.dol.micaceous mudstone(50%) Gy/bn.mudstone(45%) Lt.bn/gy.mudstone(4%) Remainder(1%)
2300	Cuttings(70%) Cavings(29%) Walnut shells(1%)	Gy/bn.mudstone(60%) Dk.gy/bn.dol.micaceous mudstone(30%) V.lt.gy.calc.mudstone(5%) Remainder(5%)
2400	Cuttings(60%) Cavings(40%)	Bn/gy.dol.mudstone(95%) Remainder(5%)
2500	Cuttings(60%) Cavings(40%)	Bn/gy.dol.mudstone(95%) Remainder(5%)

TABLE 7

Continued ...

DEPTH (M)	GROSS SAMPLE DESCRIP. (% OF WHOLE SAMPLE)	LITHOLOGICAL DESCRIPTION OF CUTTINGS (% OF TOTAL IN PLACE)
2550	Cuttings(80%) Cavings(20%)	Dk.bn.dol.mudstone(55%) Gn/gy.mudstone(30%) Lt.gy/gn.mudstone(8%) Lt.yellow/bn.limestone(5%) Remainder(2%)
2600	Cuttings(70%) Cavings(30%)	Dk.bn.dol.mudstone(60%) Gn/gy.mudstone(20%) Lt.yellow/bn.limestone(15%) Lt.gy/gn.mudstone(5%)
2650	Cuttings(50%) Cavings(48%) Walnut shells(2%)	Dk.bn.dol.micaceous mudstone(40%) Lt.gn/blue mudstone(35%) Gy/bn.mudstone(15%) Remainder(10%)
2700	Cavings(60%) Cuttings(39%) Walnut shells(1%) Iron oxide(trace)	Bl/gy.dol.mudstone(50%) Gy/bn.dol.mudstone(40%) Red/bn.mudstone(5%) Remainder(5%)
2750	Cuttings(50%) Cavings(49%) Walnut shells(1%) Iron oxide(trace)	Lt.gy/bn.dol.mudstone(50%) Lt.bl/gy.mudstone(30%) Red/bn mudstone(15%) Remainder(5%) Minor pyrite

TABLE 7

Continued....

DEPTH (M)	GROSS SAMPLE DESCRIP. (% OF WHOLE SAMPLE)	LITHOLOGICAL DESCRIPTION OF CUTTINGS (% OF TOTAL IN PLACE)
2800	Cavings(60%) Cuttings(40%) Walnut shells(trace)	Gy/bn.dol.mudstone(40%) Bl/gy.mudstone(30%) Blue/gn.mudstone(10%) Red/bn.mudstone(10%) Lt.gn/bl.mudstone(5%) Remainder(5%) Minor pyrite
2850	Cavings(55%) Cuttings(44%) Walnut shells(1%) Iron oxide(trace)	Bl/gy.mudstone(30%) Gy/bn.dol.mudstone(25%) Bn/gy.mudstone(20%) White chalk(15%) Red/bn.mudstone(5%) Dk.gy.mudstone(4%) Remainder(1%)
2900	Cavings(55%) Cuttings(45%) Walnut shells(trace)	Bn/gy.dol.mudstone(45%) Bl/gy.mudstone(30%) Dk.gy.dol.mudstone(10%) White chalk(10%) Red/bn.mudstone(5%) Minor pyrite
3450	Cavings(60%) Cuttings(40%) Walnut shells(trace) Iron oxide(trace)	Bn/gy.dol.mudstone(40%) Lt.bl/gy.mudstone(25%) Lt.gy.calc.sandstone(20%) Wh.chalk(10%) Remainder(5%)

TABLE 7

Continued ....

PETRA -CHEM

DEPTH (M)	GROSS SAMPLE DESCRIP. (% OF WHOLE SAMPLE)	LITHOLOGICAL DESCRIPTION OF CUTTINGS (% OF TOTAL IN PLACE)
3500	Cavings(90%) Cuttings(10%) Organic matter(trace) Walnut shells(trace) Iron oxide(trace)	**Dk/gy.dol.mudstone(40%)** Off wh.dol.limestone(30%) Lt.gy.calc.sandstone(5%) Gy/bn.mudstone(5%) Gy/red mudstone(5%) Remainder(5%)
3550	Cavings(90%) Cuttings(10%) Walnut shells(trace) Iron oxide(trace)	**Dk.gy.dol.mudstone(85%)** Off wh.dol.limestone(10%) Remainder(5%)
3600	Cavings(94%) Cuttings(5%) Iron oxide(1%) Paint(trace) Metal(trace)	**Dk/gy.dol.mudstone(99%)** Remainder(1%)
3637	Cavings(85%) Cuttings(15%) Iron oxide(trace)	**Bn/bk.mudstone(80%)** Dk.gy.mudstone(20%)
3640	Cavings(85%) Cuttings(15%) Iron oxide(trace)	**Bn/bk.mudstone(90%)** Dk.gy.mudstone(10%)
3643	Cavings(90%) Cuttings(10%) Iron oxide(trace) Organic matter(trace)	**Bn/bk.dol.mudstone(90%)** Dk.gy.dol.mudstone(10%)

TABLE 7

Continued ......

DEPTH (M)	GROSS SAMPLE DESCRIP. (% OF WHOLE SAMPLE)	LITHOLOGICAL DESCRIPTION OF CUTTINGS (% OF TOTAL IN PLACE)
3646	Cavings(90%) Cuttings(10%) Iron oxide(trace)	Bn/bk.mudstone(95%) Dk/gy.mudstone(5%)
3649	Cavings(55%) Cuttings(45%) Iron oxide(trace)	Bn/bk.mudstone(95%) Dk.gy.mudstone(5%)
3650	Cavings(60%) Cuttings(40%)	Dk.gy/bn.dol.mudstone(95%) Light grey mudstone(5%)
3652	Cavings(50%) Cuttings(50%) Iron oxide(trace)	Bn/bk.mudstone(95%) Dk/gy.mudstone(5%)
3655	Cavings(65%) Cuttings(35%) Iron oxide(trace)	Bn/bk.mudstone(95%) Remainder(5%) Minor pyrite
3658	Cavings(65%) Cuttings(35%) Iron oxide(trace) Organic matter(trace)	Bn/bk.mudstone(98%) Remainder(2%)
3661	Cavings(70%) Cuttings(29%) Organic matter(1%) Iron oxide(trace)	Bn/bk.mudstone(98%) Remainder(2%)

TABLE 7

Continued....

DEPTH (M)	GROSS SAMPLE DESCRIP. (% OF WHOLE SAMPLE)	LITHOLOGICAL DESCRIPTION OF CUTTINGS (% OF TOTAL IN PLACE)
3664	Cavings(80%) Cuttings(20%) Iron oxide(trace) Paint(trace)	Bn/bk.mudstone(95%) Remainder(5%)
3667	Cavings(80%) Cuttings(20%) Iron oxide(trace)	Bn/bk.mudstone(95%) Remainder(5%)
3670	Cavings(95%) cuttings(5%) Plastic(trace) Iron oxide(trace)	Bn/bk.mudstone(85%) Dk.gy.mudstone(13%) Remainder(2%) Minor pyrite
3672	Cavings(90%) Cuttings(10%) Iron oxide(trace)	Bn/bk.mudstone(50%) Dk.gy.mudstone(50%)
3676	Cavings(95%) Cuttings(5%) Iron oxide(trace)	Bn/bk.mudstone(50%) Dk.gy.mudstone(45%) Remainder(5%)
3679	Cavings(70%) Cuttings(29%) Organic matter(1%) Iron oxide(trace)	Bn/bk.mudstone(70%) Dk.gy.mudstone(28%) Remainder(2%) Minor pyrite
3682	Cavings(50%) Cuttings(50%) Iron oxide(trace) Organic matter(trace)	Bn/bk.mudstone(65%) Dk.gy.mudstone(33%) Remainder(2%)

TABLE 7

Continued ......

DEPTH (M)	GROSS SAMPLE DESCRIP. (% OF WHOLE SAMPLE)	LITHOLOGICAL DESCRIPTION OF CUTTINGS (% OF TOTAL IN PLACE)
3712	Cavings(98%) Cuttings(2%) Iron oxide(trace) Pipe dope(trace)	Gy.mudstone(70%) Bn/bk.mudstone(15%) Gy.calc.silty mudstone(13%) Remainder(2%)
3715	Cavings(95%) Cuttings(5%) Iron oxide(trace)	Gy.mudstone(70%) Gy.calc.silty mudstone(15%) Bn/bk.mudstone(15%)
3718	Cavings(98%) Cuttings(2%) Iron oxide(trace)	Gy.calc.mudstone(40%) Bn/bk.mudstone(35%) Gy.calc.silty mudstone(20%) Remainder(5%)
3721	Cavings(85%) Cuttings(14%) Pipe dope(1%) Iron oxide(trace)	Grey mudstone(65%) Dk.gy.mudstone(30%) Remainder(5%)
3724	Cavings(94%) Cuttings(5%) Plastic(1%) Iron oxide(trace) Organic matter(trace)	Grey mudstone(55%) Dk.gy.calc.silty mudstone(30%) Gy.fine sandstone(10%) Remainder(5%) Minor pyrite
3730	Cavings(85%) Cuttings(14%) Organic matter(1%) Iron oxide(trace)	Gy.mudstone(50%) Dk.gy.fine sandstone(35%) Dk.gy.silty mudstone(10%) Remainder(5%)

TABLE 7

Continued ......

DEPTH (M)	GROSS SAMPLE DESCRIP. (% OF WHOLE SAMPLE)	LITHOLOGICAL DESCRIPTION OF CUTTINGS (% OF TOTAL IN PLACE)
3685	Cavings(90%) Cuttings(10%) Iron oxide(trace)	Bn/bk.mudstone(50%) Gy.calc.silty mudstone(28%) Gy.mudstone(20%) Remainder(2%)
3688	Cavings(90%) Cuttings(9%) Pipe dope(1%) Iron oxide(trace) Organic matter(trace)	Bn/gy.calc.silty mudstone(55%) Dk.gy.mudstone(15%) Bn/bk.mudstone(25%) Remainder(5%)
3691	Cavings(95%) Cuttings(5%) Iron oxide(trace)	Bn/gy.calc.silty mudstone(50%) Bn/bk.mudstone(35%) Gy.mudstone(10%) Remainder(5%) Minor pyrite
3694	Cavings(95%) Cuttings(5%) Iron oxide(trace)	Gy.silty calc.mudstone(45%) Gy.mudstone(33%) Bn/bk.mudstone(20%) Remainder(2%)
3697	Cavings(95%) Cuttings(5%) Iron oxide(trace) Organic matter(trace)	Gy.calc.silty mudstone(55%) Bn/bk.mudstone(30%) Grey mudstone(13%) Remainder(2%) Minor pyrite

TABLE 7

Continued ......

DEPTH (M)	GROSS SAMPLE DESCRIP. (% OF WHOLE SAMPLE)	LITHOLOGICAL DESCRIPTION OF CUTTINGS (% OF TOTAL IN PLACE)
3700 (can)	Cavings(94%) Cuttings(5%) Iron oxide(1%)	Dk.gy.dol.mudstone(60%) Dk.gy/bn.dol.mudstone(40%)
3700 (bag)	Cavings(90%) Cuttings(5%) Paint(trace) Organic matter(trace) Pipe dope(trace) Iron oxide(trace)	Gy.calc.silty mudstone(50%) Gy.mudstone(35%) Bn/bk.mudstone(10%) Remainder(5%)
3703	Cavings(95%) Cuttings(5%) Iron oxide(trace) Organic matter(trace)	Gy.calc.silty mudstone(55%) Bn/bk.mudstone(30%) Gy.mudstone(13%) Remainder(2%)
3706	Cavings(90%) Cuttings(10%) Iron oxide(trace) Paint(trace)	Gy.calc.mudstone(70%) Gy.silty calc.mudstone(20%) Bn/bk.mudstone(10%)
3709	Cavings(98%) Cuttings(2%) Iron oxide(trace) Paint(trace) Organic matter(trace)	Gy.calc.silty mudstone(55%) Grey mudstone(30%) Bn/bk.mudstone(14%) Remainder(1%)

TABLE 7

Continued .....

DEPTH (M)	GROSS SAMPLE DESCRIP. (% OF WHOLE SAMPLE)	LITHOLOGICAL DESCRIPTION OF CUTTINGS (% OF TOTAL IN PLACE)
3800	Cavings(85%) Cuttings(15%)	Gy.dol.mudstone(70%) Grey dol.siltstone(70%) White sandstone(2%)
3850	Cavings(85%) Cuttings(40%)	Gy.dol.mudstone(95%) Lt.gy.micaceous siltstone(3%)
3900	Cavings(60%) Cuttings(40%)	Gy.dol.mudstone(95%) Red/bn.silty mudstone(3%) Gy.sandstone(2%)
3950	Cavings(60%) Cuttings(40%)	Gy/bk.dol.mudstone(30%) Bn.siltstone(10%) Beige sandstone(5%) Gy/gn.siltstone(5%)

TABLE 7

STABLE CARBON ISOTOPE DATA

SAMPLE	$^{12}C/^{13}C$ ISOTOPE RATIO$_{-PDB}$ (per mil.)
OIL	-30.08
3655 (Kerogen)	-29.73
3730 (Kerogen)	-26.87

TABLE 8

GCMS STERANE AND PENTACYCLANE RATIOS

SAMPLE	RATIO OF ASSIGNED PEAKS			
	Pentacyclanes	Steranes		
	D:G	1:2	8:11	10:9
OIL	0.69	1.39	2.12	0.74
3640 (Extract)	0.66	1.36	1.69	0.87
3724 (Extract)	0.64	1.24	1.49	0.78

TABLE 9

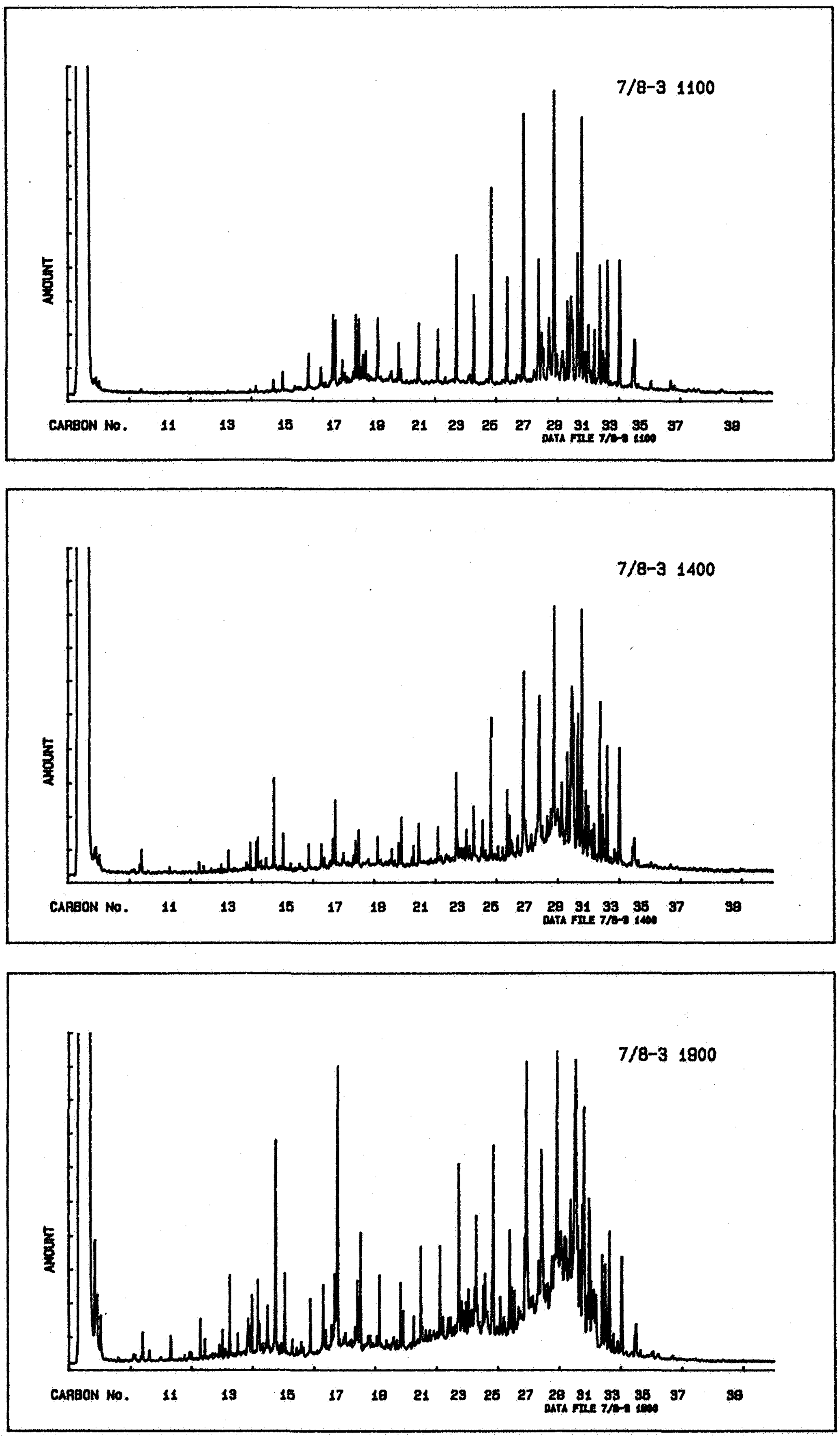
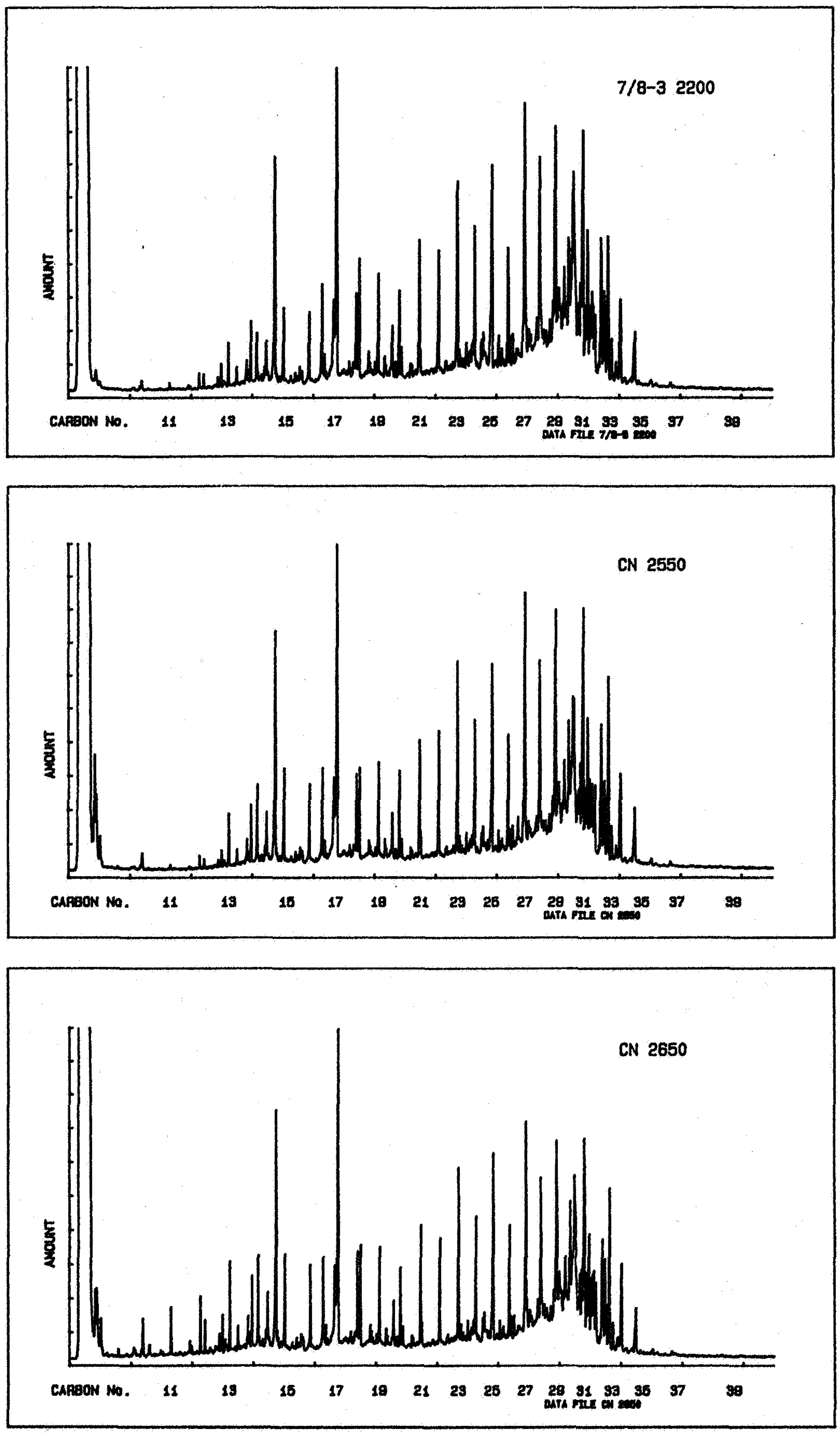

7/8-3 1100
AMOUNT
CARBON No.
11 13 15 17 19 21 23 25 27 29 31 33 35 37 39
7/8-3 1400
AMOUNT
CARBON No.
11 13 15 17 19 21 23 25 27 29 31 33 35 37 39
7/8-3 1900
AMOUNT
CARBON No.
11 13 15 17 19 21 23 25 27 29 31 33 35 37 39

Figure 1



7/8-3 2200
AMOUNT
CARBON No. 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39
DATA FILE 7/8-3 2200
CN 2550
AMOUNT
CARBON No. 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39
DATA FILE CN 2550
CN 2650
AMOUNT
CARBON No. 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39
DATA FILE CN 2650

Figure 2

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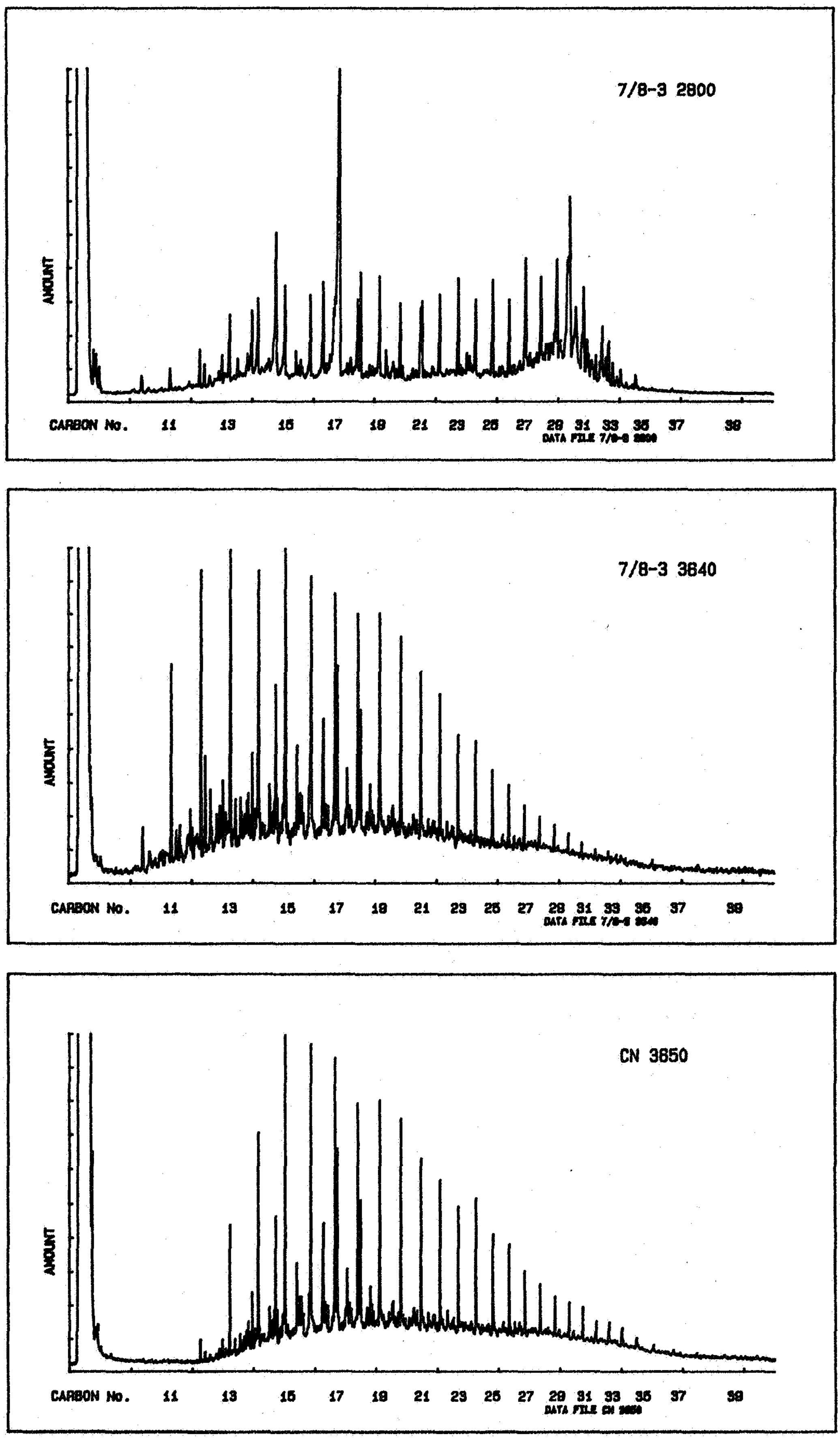
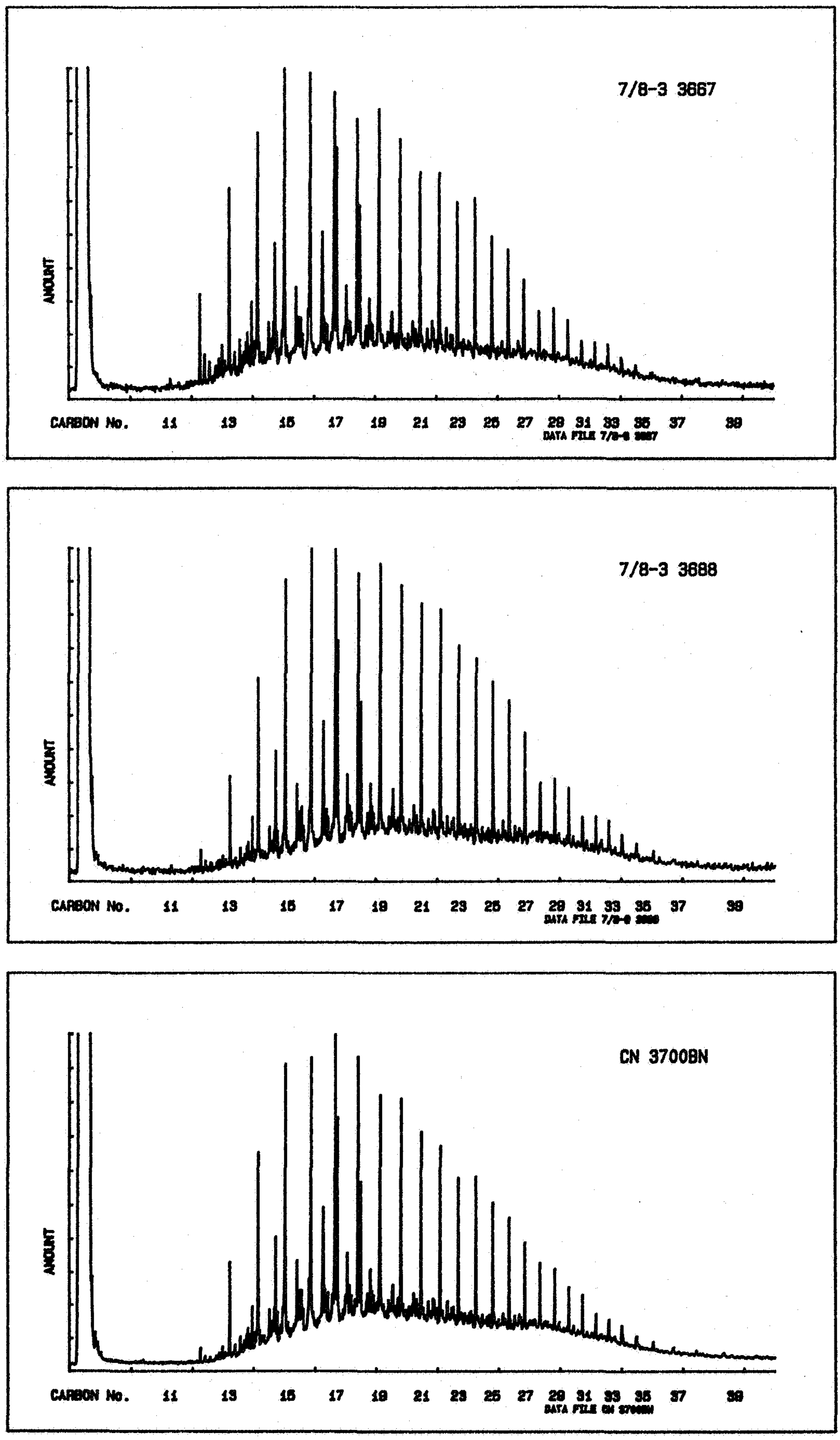
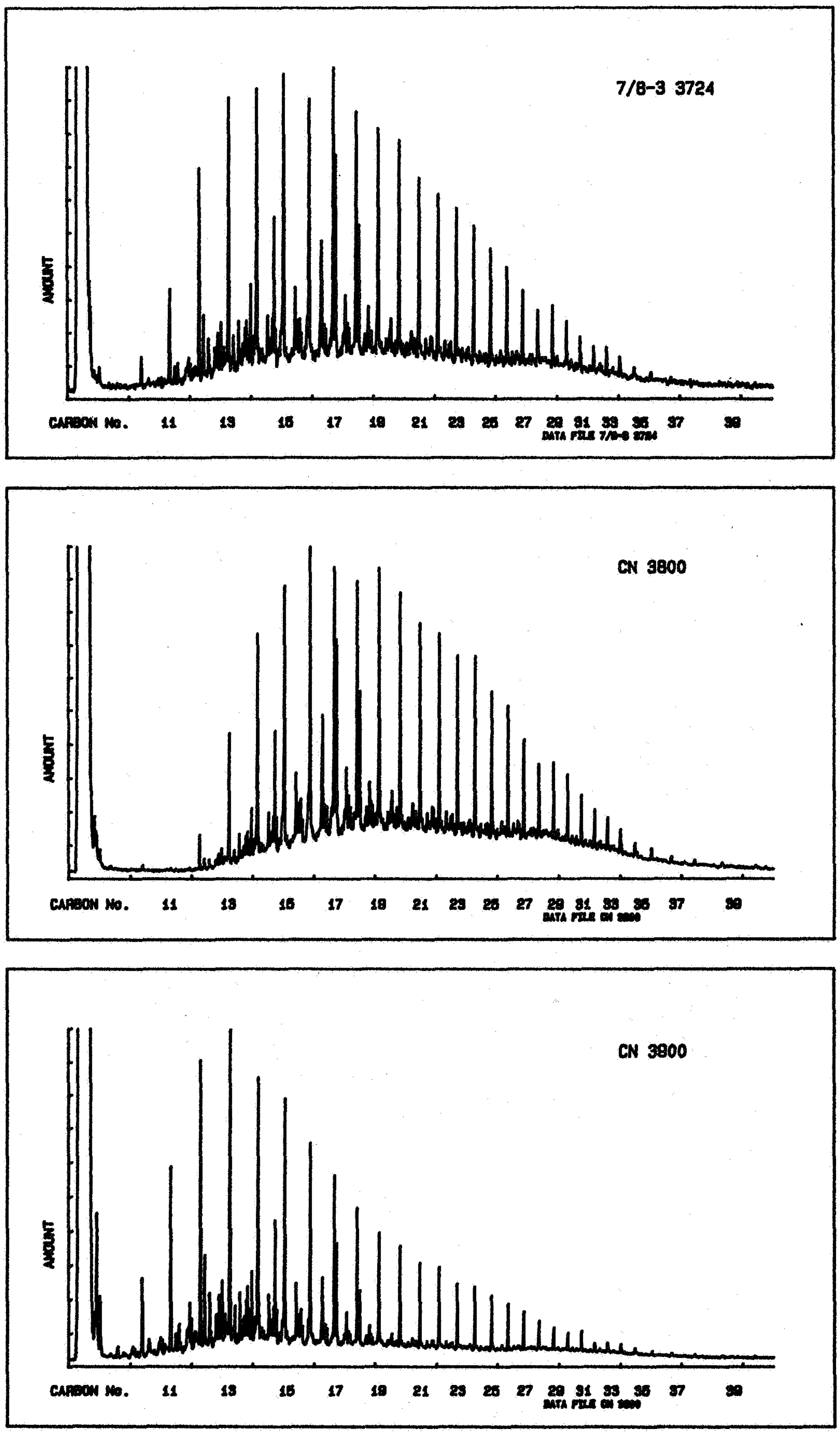


Figure 3



7/8-3 3667
AMOUNT
CARBON No. 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39
7/8-3 3688
AMOUNT
CARBON No. 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39
CN 3700BN
AMOUNT
CARBON No. 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39

Figure 4


7/8-3 3724
AMOUNT
CARBON No. 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39
CN 3800
AMOUNT
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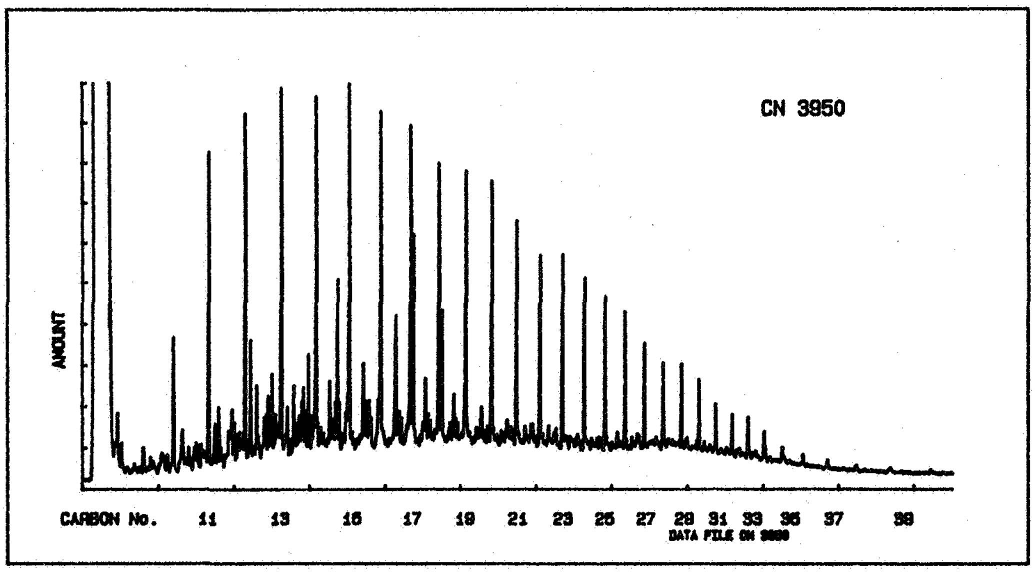
CN 3900
AMOUNT
CARBON No. 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39

Figure 5


CN 3950
AMOUNT
CARBON No.
11
13
15
17
19
21
23
25
27
29
31
33
35
37
39

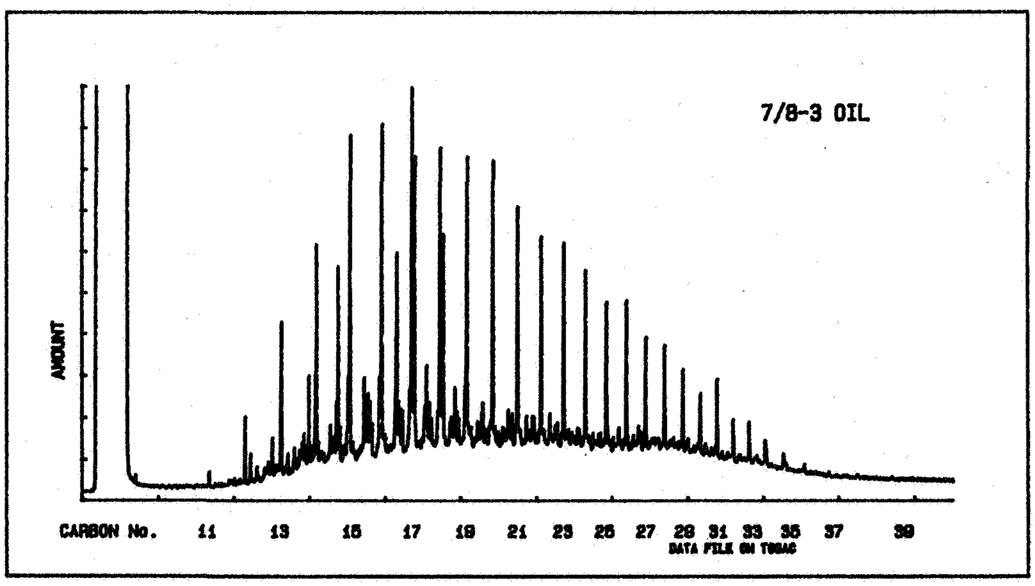
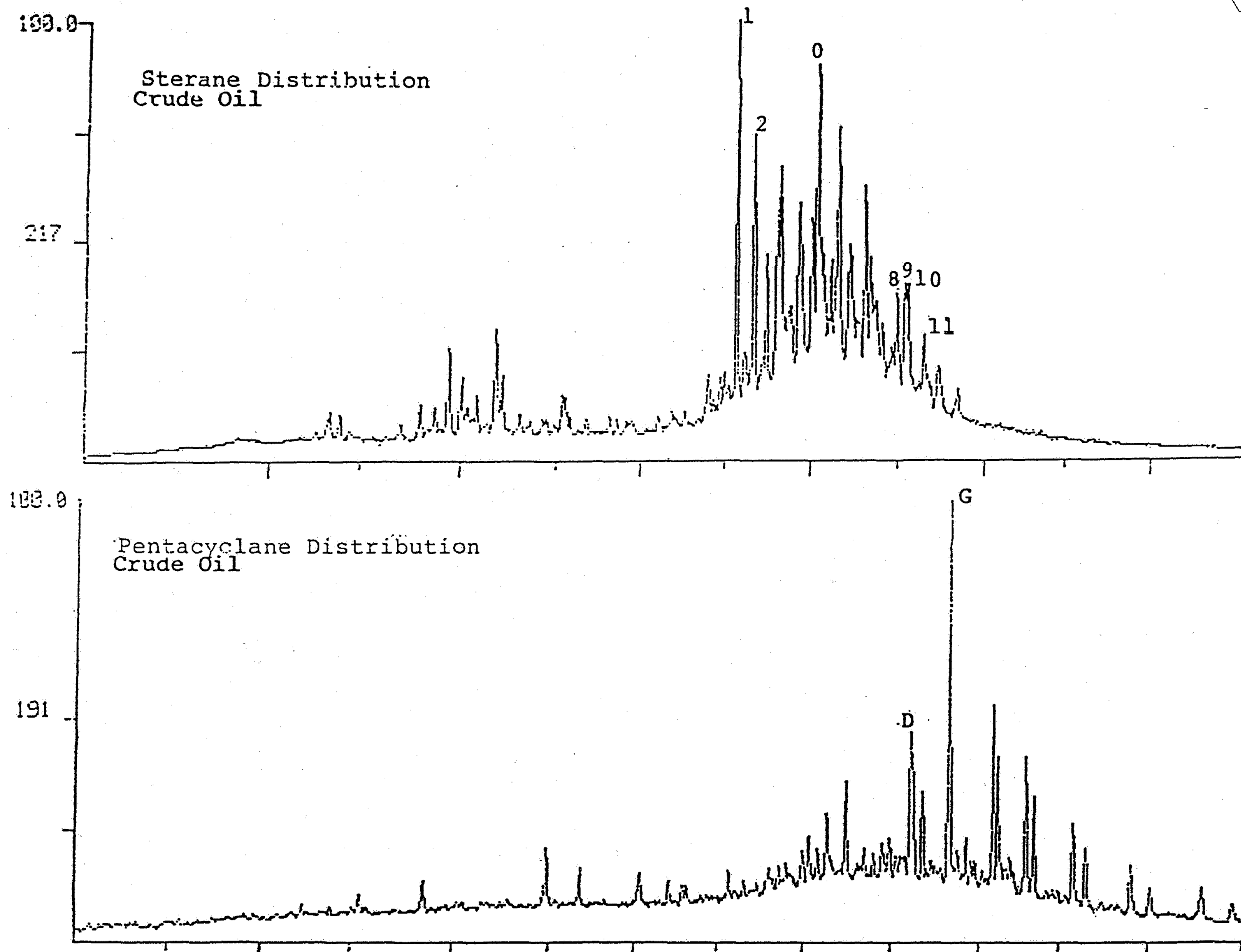
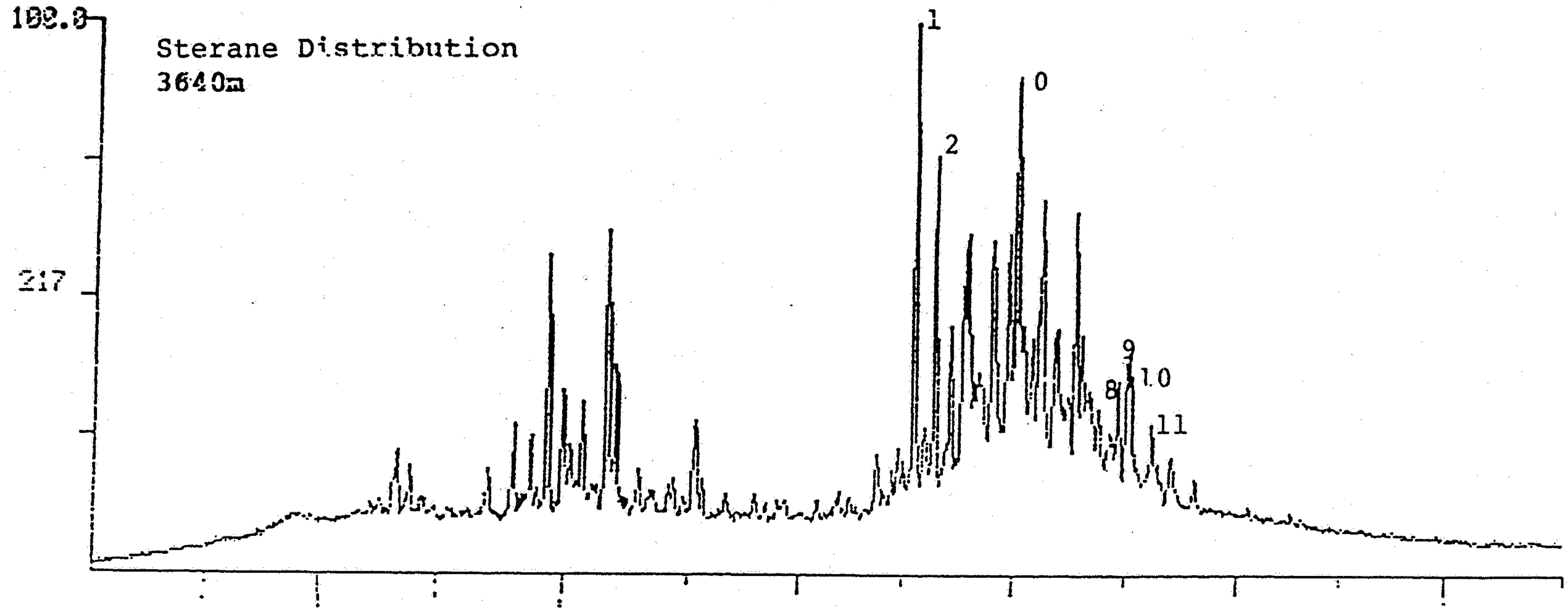

7/8-3 OIL
AMOUNT
CARBON No.
11
13
15
17
19
21
23
25
27
29
31
33
35
37
39

Figure 6



100.0
Sterane Distribution
Crude Oil
217
1
2
0
8
9
10
11
100.0
Pentacyclane Distribution
Crude Oil
191
D
G

Figure 7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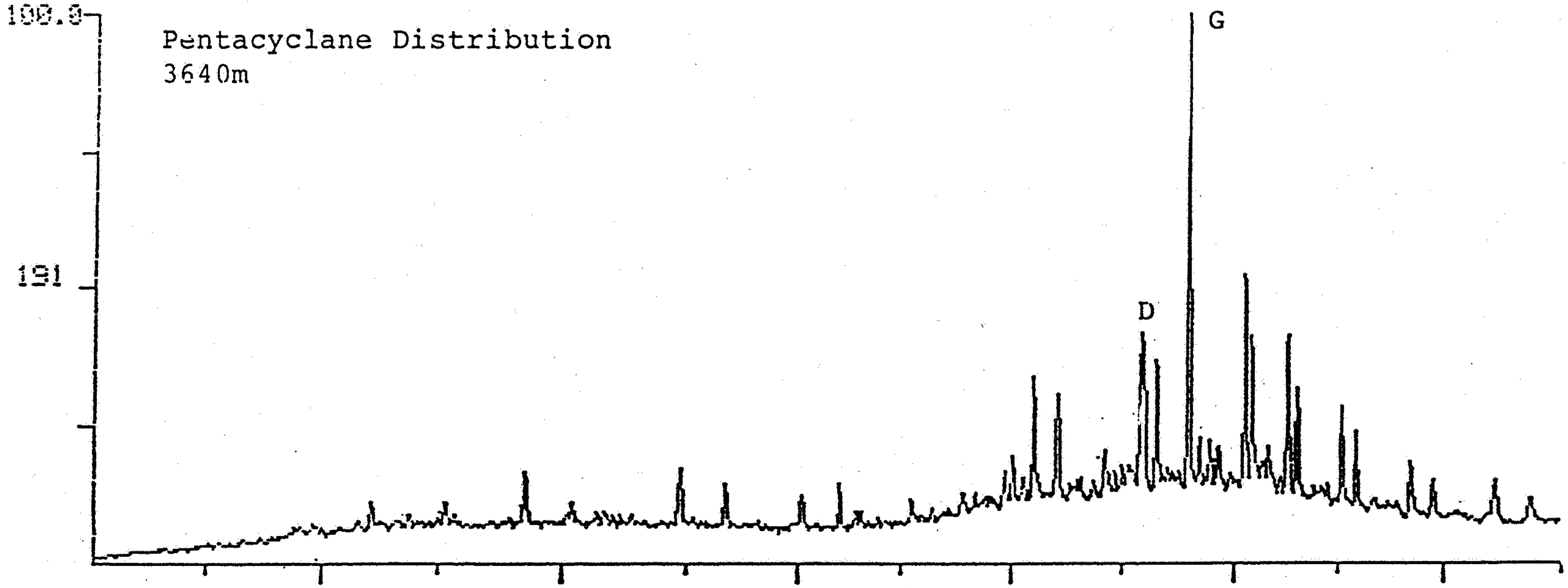
Sterane Distribution
3640m
217
1
0
2
9
8
10
11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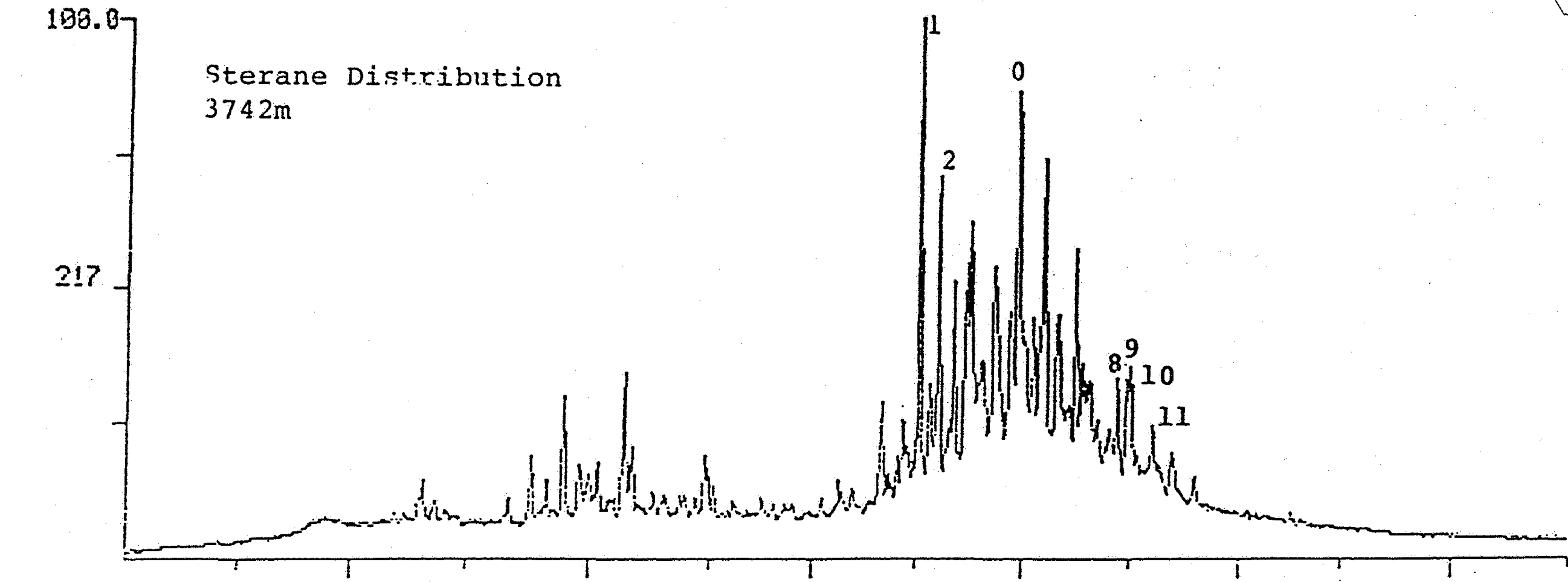
Pentacyclane Distribution
3640m
191
G
D

Figure 8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Sterane Distribution
3742m
217
1
2
0
8
9
10
11

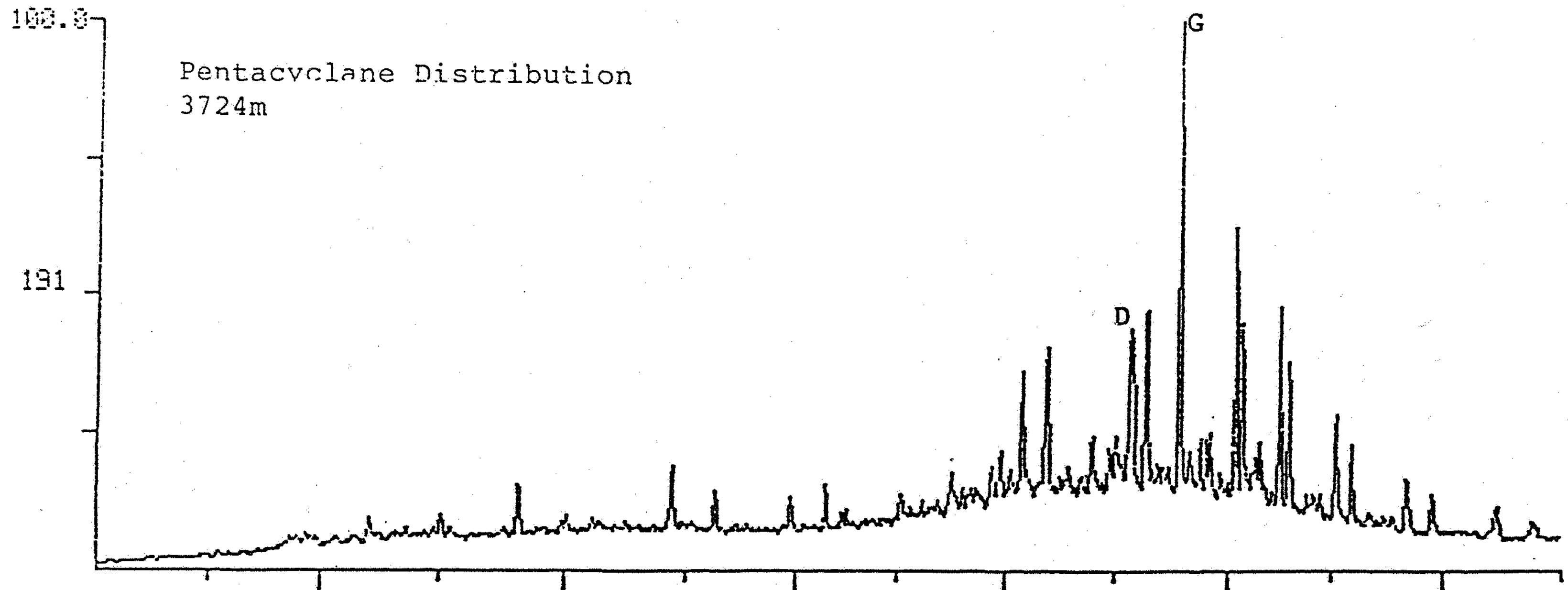
100.0
Pentacyclane Distribution
3724m
191
D
G

Figure 9

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APPENDIX OF TECHNIQUES

1. Vitrinite Reflectance Measurements

A sample of washed and dried material was crushed to a rock flour in a pestle and mortar and mounted in epoxy resin. The surface of the hardened epoxy resin block was highly polished using carborundum paper and aluminium oxide powder, before being examined by reflected light microscopy using an oil immersion objective. Up to twenty selected vitrinite particles were measured and the value of each individual measurement was recorded. The values quoted in Table 1 represent an average value, with the figures in parenthesis representing the number of measurements averaged together. The emboldened figures shown in Table 1 are those thought representative of the true maturity level of the sediments at their respective present day depths.

Vitrinite Reflectance is a reliable technique for defining the thermal maturity of sedimentary rocks. Vitrinite is the coal maceral most often used for thermal maturity measurements, because its optical properties alter more uniformly during catagenesis than do the other maturation indices. These measurements can be used to derive zones of petroleum generation and destruction. The threshold values of the type used by Petra-Chem are:-

Liquid Hydrocarbon Threshold	Ro	=	0.55%
Gaseous Hydrocarbon Threshold	Ro	=	0.70%
Maximum Oil Production	Ro	=	0.80%
Liquid Hydrocarbon Destruction	Ro	=	1.30%

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2. Total Organic Carbon Measurements

A sample of the washed and dried material was ground to a fine powder. The fine powder was sieved through a 150 micron sieve to homogenise the sample, before weighing into a crucible and treatment with concentrated hydrochloric acid. The decarbonated sample was then combusted in a stream of oxygen in a Carlo Erba Elemental Analyser. The evolved carbon dioxide was measured, compared with the amount evolved by reference standards and converted to a weight percent Total Organic Carbon (TOC) content value. The organic carbon values obtained from sediments examined for this study are listed in Table 2.

Total Organic Carbon Measurements provide a direct measure of the total amount of organic carbon present in rock samples. In general, shales with an organic content value below 0.50% wt. are not generally considered prospective sources for the generation of commercial quantities of oil and/or gas. Bearing this in mind, the definition of cut-off values used by Petra-Chem Ltd are as itemised overleaf:-

Poor	=	< 0.50% wt
Moderate	=	0.50 - 1.50% wt
Good	=	> 1.50% wt

3. Hydrocarbon Potential by Pyrolysis.

A further sample of washed, dried and finely ground material was weighed into a pyrolysis boat before being

Ikke HCl-behandlet prøver (=> høy CO_2 pga nedbryting av karbonater) heated to 80°C and held isothermally. It was then ramped to 325°C and again held isothermally, before final ramping to 550°C. The products from pyrolysis were swept in a carrier gas stream to a detector for measurement. The amounts evolved were compared with those evolved from calibrated standards. Pyrolysis yields obtained from the sediments examined in this study are listed in Table 3.

Pyrolysis is the process whereby a sample of rock is heated under controlled conditions for a certain time interval. Organic compounds are traditionally believed to be released in three stages: (a) at low temperatures (80°C), which are equivalent to the gaseous hydrocarbons present in the sediment up to a carbon number of about C_8, (b) at moderate temperatures (325°C), which are equivalent to volatile, indigenous and/or migrated hydrocarbons and (c) those released at high temperatures (550°C), which are equivalent to the volatile hydrocarbons produced from thermal cracking of the kerogen. The cut-off values used by Petra-Chem are as follows:-

Poor = < 2000ppm (2.0mg./g or kg./tonne)

Moderate = > 2000ppm and < 5000ppm

Good = > 5000ppm (5.0mg./g or kg./tonne)

4. Solvent Extract Examination.

A sample of washed, dried, finely ground and weighed material was extracted using dichloromethane. The extract was then separated on activated silica to provide a saturate alkane fraction for examination by high resolution capillary gas chromatography. The results of solvent extract examinations are listed in Table 4.

Solvent extractable bitumens can be readily removed from sedimentary rocks, with suitable polar solvents. The amount and chemical composition of the bitumens removed, provide an indication of the source of the bitumen and the degree of thermal maturity the rock has attained.

5. Visual Kerogen Descriptions/Spore Colourations

A sample of washed and dried material was digested in both hydrochloric and hydrofluoric acids to dissolve away mineral matter. The remaining debris was mounted on a glass slide, with cover slip and then examined in transmitted light. A description of the plant material present was completed in white light, including an assessment of the colour of spores if present. These spores were then examined in UV light, when another assessment of their colour was made.

Visual Kerogen Description provides diagnostic information about the type of organic matter present in sediments. By definition, kerogen is the insoluble organic matter found in sedimentary rocks. When this insoluble organic matter is examined under a high-magnification microscope, after the mineral content of the rock has been removed using acids, recognisable relics of fossil leaves, stems, woody tissues, spores, pollen and amorphous material etc. can be observed. This assortment of plant debris is categorised into two principle groups: Structured Kerogen and Amorphous Kerogen. The descriptions of the various kerogens studied for this project are listed in Table 5.

Divisions within the structured Kerogen group include cuticles, brown and black wood. The various plant types described above all change colour at different rates with increase in maturity. For this reason, Petra-Chem adopts the principle of observing colour changes from spores only and ideally, from spores of similar taxa throughout the stratigraphic interval being examined. The colour scale used in Petra-Chem is that devised by Dr. D.J. Batten of Aberdeen University and formally of BP, Sunbury Research Centre. It is a scale ranging from 1 to 7, with the following colours corresponding to the various points on the scale:

1. Colourless, Pale Yellow, Yellowish Green (Unaltered)

2. Yellow

3. Light Brownish Yellow, Yellowish Orange

4. Light - Medium Brown

5. Dark Brown

6. Brown - Black

7. Black

The colour rating taken to depict the onset of liquid hydrocarbon generation is 3/4.

The colour ratings for the kerogens described in this study are listed in Table 5.

6. **Kerogen Typing by Pyrolysis.** Py - GC

A sample of washed, dried and finely ground material was weighed into a pyrolysis boat after special treatment to avoid the problems of heavy bitumens leading to erroneous inferences regarding the kerogen. The sediment was heated to 500°C, when the produced hydrocarbons are stopped at the front of a GC column, before being evolved in order of their boiling points. Mathematical treatment of the data was then completed, to provide a breakdown of the kerogen pyrolysis products in terms of their refinery cuts and relative proportions of liquid hydrocarbons to gaseous hydrocarbons. The kerogen breakdown products are listed in their various refinery cut categories in Table 6.

This pyrolysis process is a means of characterising the type of hydrocarbon products released by a kerogen on reaching maturity. It is a more precise method of determining the type of hydrocarbons which will be produced by a kerogen, than the more traditional visual method. This pyrolysis method provides quantitative yields of hydrocarbons in terms of their boiling ranges, from gases through to lubricating oil products.

7. Lithological descriptions.

A detailed description of each sample is given in Table 7, depicting the various lithologies present, together with an estimate of the amount of cavings present.