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Prepared for

SAGA PETROLEUM A.S.

GEOCHEMICAL EVALUATION OF THE 6507/11-4 WELL

November 1987

GEOCHEMICAL EVALUATION OF THE SAGA PETROLEUM A.S. 6507/11-4 WELL

EXECUTIVE SUMMARY

The section between 2500 metres and 3041.6 metres (TD) has been evaluated.

Rich greyish black shales are present in the Nesna (2529.5-2535 metres) but similar shales from the Englevaer Formation (2535-2676.5 metres) samples are believed to be caved. The Engelvaer is characterised by poor mudstones and shales but there are good to rich interbeds of greyish black to dark grey shale within the interval.

Scattered good to rich shales, carbonaceous shales and coals are present in the Tomma-Aldra formations. Poor shales also occur in these samples but some of them are believed to be caved from the Engelvaer.

Weak shows of wet gas were detected in the Engelvaer and Tomma formations but the heavier hydrocarbons are dominantly source indigenous.

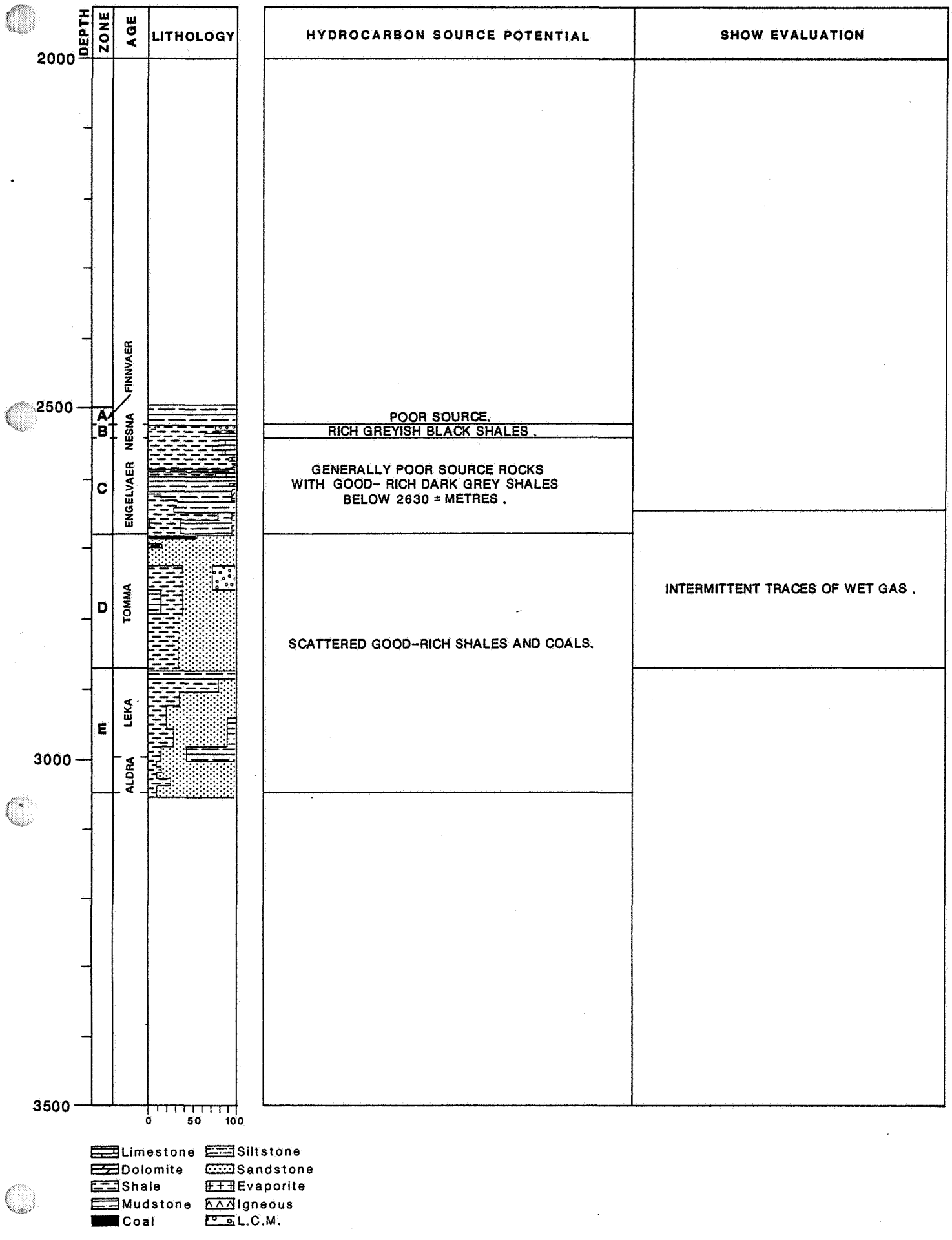
Mass fragmentograms of the steranes and triterpanes confirm that the organic matter in the sediments is immature and largely consists of land plant derived kerogen.

M.J. SAUER
GEOCHEM LABORATORIES LIMITED

FIGURE 1

WELL 6507/11-4

SUMMARY CHART



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INTRODUCTION

This report presents a geochemical evaluation of the 6507/11-4 well drilled by Saga Petroleum A.S. in Offshore Norwegian waters.

The study, based upon an analytical format supplied by the client, was designed to evaluate the Jurassic sediments in terms of source richness and hydrocarbon type. Hydrocarbon correlation analyses were also included in this specification.

The project was authorised by H.O. Augedal, Saga Petroleum A.S., Høvik.

ANALYTICAL

A total of seventy four (74) canned ditch cuttings samples and twelve (12) core/side-wall core samples were received from the 2500-3045 metre interval.

The samples were screened in accordance with an approved contract (No. K0-EUG-87-0016) and subsequent telexes 08.07.87 and 14.09.87 from Ellen Sofie Mo. Follow up analyses were performed in accordance with written instructions (05.10.86). Low gas abundances precluded the gas isotopes analyses on the canned samples. C_{15+} hydrocarbons were too lean to perform the aromatic hydrocarbons analyses on all of the specified samples. Substitutes from the GC-MS programme were run and extra analyses are included free of charge.

Analyses performed in this study are as follows:

ANALYSIS	NUMBER OF ANALYSES		
	CUTTINGS	SWC	CORE
Headspace gas	22		
Sample preparation	36	5	7
Total organic carbon	36	5	7
Pyrolysis	31		
C_{15+} extraction and chromatography	2	5	1
C_{15+} extractions	1		5

ANALYSIS	NUMBER OF ANALYSES		
	CUTTINGS	SWC	CORE
Capillary GC - paraffin-naphthenes	2	5	2
Capillary GC - aromatics	2	5	2
Carbon isotopes - extract fractions		12	4
GC-MS biomarker analysis	3	5	4

The results of these analyses are listed in tables 1 to 10 and presented graphically in figures 1 to 14.

A brief description of the analytical methods employed in this study is included at the back of this report.

Geochem were advised by letter (18.12.87) of the following Formation Tops.

	DEPTH	
FORMATION TOPS	mRKB	mMSL
Sula Group(Seabed)	314	288
Sklinna Group	1380	1354
Alstadhaug Formation	2015	1989
Bodø Formation	2066	2040
Flatøy Group	2134.5	2108.5
Nesna Formation	2529.5	2503.5
Engelvaer Formation	2535	2509
Tomma Unit I	2676.5	2650.5
Tomma Unit II	2732	2706
Tomma Unit III	2747	2721
Leka	2866	2848
Aldra	2992	2966
TD	3041.6	3015.6

and of casing points at

436 MRKB	30"
802 MRKB	20"
1489 MRKB	13 3/8"
2503 MRKB	9 5/8"

a log was also provided for this study

GENERAL INFORMATION

Ten (10) copies of this report have been forwarded to Ellen Sofie Mo, Saga Petroleum A.S., Høvik and a further copy retained by Geochem for future consultation with authorised Saga personnel.

The unused cuttings material has been forwarded to Saga Petroleum and the surplus core samples will follow without delay.

The results of this study are proprietary to Saga Petroleum A.S.

CONCLUSIONS

For the purposes of this study the 2500-3041.6 metre interval in 6507/11-4 has been divided into five (5) zones.

Visual kerogen, vitrinite reflectance and pyrolysis-GC analyses were not specified for this study. There is therefore no discussion of thermal maturity or of potential hydrocarbon products.

Zone A (2500-2529.5 metres) is composed of medium grey shaly mudstones within which are yellowish grey interbeds. Pyrolysate yields of 0.59-0.70 mg/g indicate that these are poor source rocks.

Zone B (2529.5-2535 metres) is equivalent to the Nesna Formation. This interval is represented by two sidewall cores consisting of greyish black shales. The latter, if one includes suspected cavings from Zone C are rich having organic carbon contents of 7.84-10.4% and pyrolysate yields of 42.6-63.9 mg/g. Hydrogen indices of 542-613 suggest that these greyish black shales may be oil prone but are unlikely to be mature on structure.

Zone C (2535-2676.5 metres) corresponds to the Engelvaer Formation. Medium grey shales grade into olive grey mudstones although greyish black (caved?) shales, minor limestones, and dark grey to medium dark grey shales plus traces of sandstone are also present in the samples. The lighter coloured shales produced less than 1.69mg/g pyrolysate and are poor source rocks. Below 2630± metres, however, the dark grey to medium dark grey shales are rated as good source rocks with rich interbeds. Hydrogen indices of 357-396 suggest that the richer shales will have a potential for gas and oil.

Zone D (2676.5-2866± metres) is equivalent to the Tomma Formation and is composed of sands with interbedded carbonaceous mudstones and greyish black to dark grey shales. Shales similar to those in the Engelvaer are also present and are poor source rocks (eg. 0.73 mg/g pyrolysate at 2852 metres). The scattered carbonaceous mudstones and greyish black to dark grey shales generated 15.9-52.9 mg/g pyrolysate and per unit volume are rich source rocks (for gas and oil from the hydrogen indices).

Zone E (2866-3041.6 metres) covers the Leka (down to 2992 metres) and Aldra formations. Sands are interbedded with greyish black to dark grey and medium greenish grey shales within this interval. The latter are poor source rocks (0.94-1.66 mg/g pyrolysate) but the greyish black to dark grey shales are variously good to very good in the Leka and fair with good interbeds in the Aldra.

The C_1-C_5 hydrocarbon gases are marginally wet to wet in Zone C and generally wet in Zone D but they are of poor abundance and negligible volumes of the C_5-C_7 hydrocarbons are present. The migrated hydrocarbons are therefore restricted to very weak shows of wet gas - principally in the Engelvaer and Tomma.

Apart from the coals at 2687± metres which yielded 11244ppm C_{15+} hydrocarbons and the shales at 2533 metres from which 817 ppm were extracted - but are believed to be slightly contaminated - the analysed sediments yielded less than 421 ppm C_{15+} hydrocarbons. Low (less than 31.5%) hydrocarbon to total extract ratios and saturates chromatograms that display a marked odd carbon paraffin preference indicate that the C_{15+} hydrocarbons are dominantly source indigenous species.

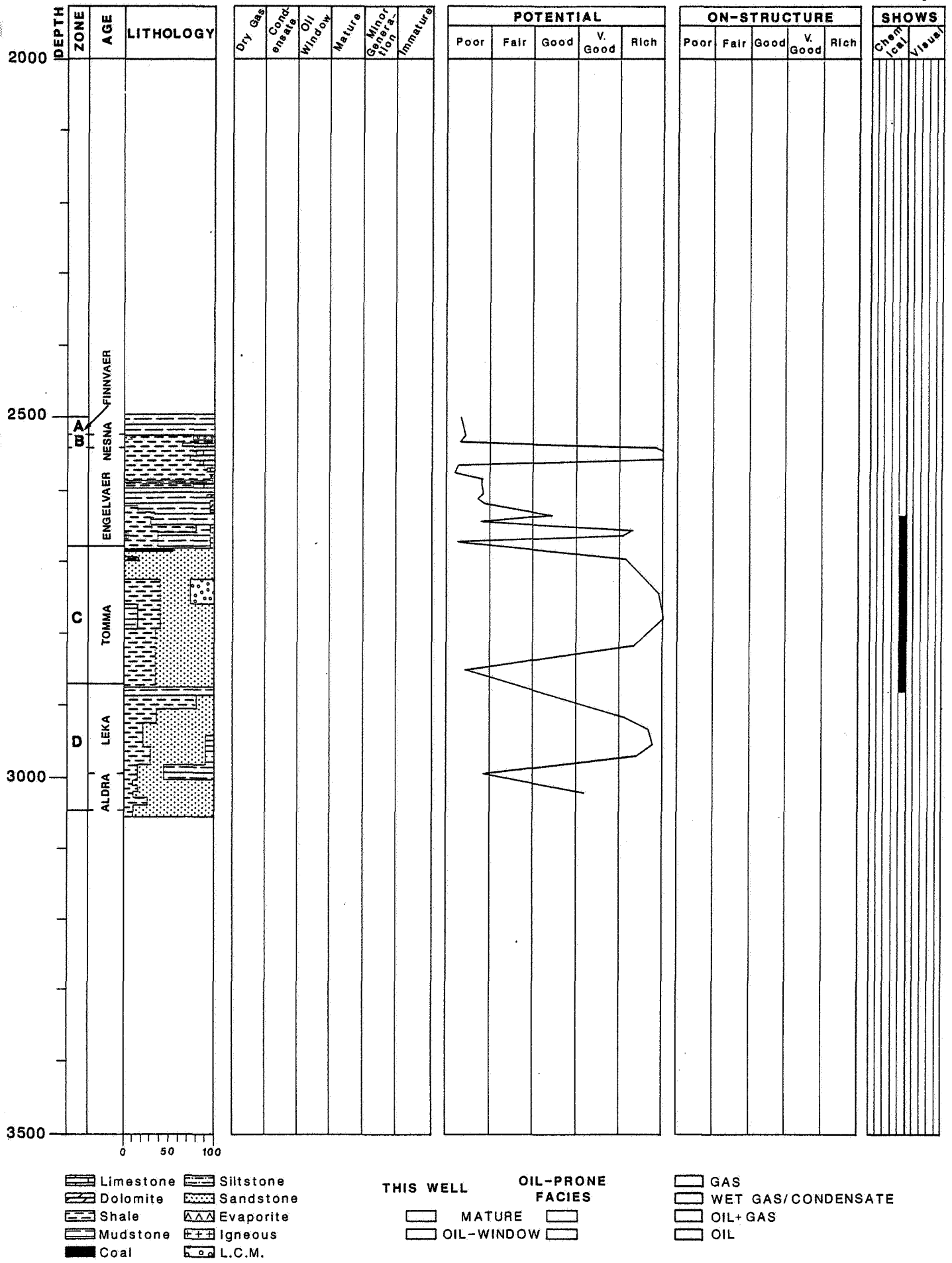
Small sample size (particularly the sidewall cores) and low relative hydrocarbon concentrations has resulted in extremely small fraction weights. Thus the C_{15+} saturates chromatograms apart from the immature features described above have little diagnostic information. The problem is even more acute with the C_{15+} aromatic hydrocarbons and the resulting methyl phenanthrene indices are therefore of minimal value above 2680± metres.

Strong R (biogenic) peaks are a feature of both the steranes and triterpanes fragmentograms and are indicative of immature source rocks. A bias to C_{29} steranes associated with land plant derived organic matter is common in the steranes fragmentograms down to 2589 metres and for the coal at 2681 metres. More nearly equal amounts of C_{27} and C_{29} steranes suggest that the remaining shales and mudstones contain a mixed marine and terrigenous kerogen type. Relatively light carbon isotope ratios for the mudstones at 2533 metres and at 2881.5 metres are also believed to be due to this type of organic matter. Somewhat heavier values for the shales at 2536 and 2612 metres are associated with a more terrigenous organic matter type. Carbon isotope data at 2612 metres are suspect due to small sample size (which also applies to most of the other samples) and in the aromatics, to the presence of traces of saturated hydrocarbons.

FIGURE 2

WELL 6507/11-4

RATING DIAGRAM



The GC-MS data whilst they cannot be used directly, due to wide differences in maturity, for correlation purposes, do represent at distinct organic facies. They also typify the lowest maturation level and are thus useful for comparative purposes in a regional study.

ZONATION

This zonation is based upon a consideration of the formation tops supplied by the client and variations in dominant lithology. A total of five (5) zones are recognised.

Zone A (2500-2529.5 metres) is largely composed of medium grey shaly mudstones although minor yellowish grey mudstones are also present.

Zone B at 2529.5-2535 metres is equivalent to the Nesna Formation. Side-wall core samples indicate that this interval is composed of greyish black to dark grey shales.

Zone C (2535-2676.5 metres) corresponds to the Engelvaer Formation and is lithologically varied. Medium grey shales grade into olive grey mudstones and are interbedded with greyish black (caved?) shales, minor limestones, and (below 2630 metres) dark grey to medium dark grey shales and traces of sandstone.

Zone D (2676.5-2866 metres) consists of sands with interbeds of carbonaceous mudstone and greyish black to dark grey shale, from the Tomma Formation,

Zone E (2866-3041.6 metres) includes the Leka and, below 2992 metres, Aldra formations. Sandstones are interbedded with greyish black to dark grey shales and medium greenish grey shales within this interval.

SOURCE RICHNESS

The specification for this well excluded the visual kerogen and pyrolysis-GC analyses, and this assessment of source richness if therefore based upon organic carbon contents and Rockeval pyrolysis data.

The Finnvaer Fm. mudstones above 2529.5 metres have organic carbon contents of 0.95-1.01%, yielded 0.59-0.70 mg/g pyrolysate and are, therefore poor source rocks. Similar values were obtained for the medium grey shales at 2528± metres but the greyish black Nesna shales and those, believed to be caved from the Nesna, in the Engelvaer Formation are rich. They have organic carbon contents of 7.84-10.4% generated 42.56-63.85 mg/g pyrolysate and clearly have an excellent hydrocarbon potential. The nature of these hydrocarbon products cannot be predicted from the available data but the hydrogen indices (542-613) suggest that these rich greyish black shales are oil prone.

The medium grey and olive grey shales from the Engelvaer Formation have organic carbon contents of 0.86-1.48% produced less than 1.69 mg/g pyrolysate and are poor source rocks. Interbeds of dark grey to medium dark grey shale occurring below 2630 metres are somewhat richer - 2.93-5.43% TOC and pyrolysate yields of 3.82-21.53 mg/g - and are rated as good source rocks with rich intervals.

Shales resembling those from the Engelvaer are present in Zone D but the beds of greyish black to dark grey shale and carbonaceous shale within the Tomma sands are generally rich, producing 15.9-52.9 mg/g pyrolysate. Further greyish black to dark grey shales are present in the samples from the Leka. They too have good to very good (up to 7.66%) carbon contents and S2 yields of 12.4-39.95 mg/g. The interbeds of greenish grey to dark greenish grey shale within Zone E however are leaner at 0.94-1.66% organic carbon and generated 1.69 to 5.78 mg/g pyrolysate; they are fair with good interbeds.

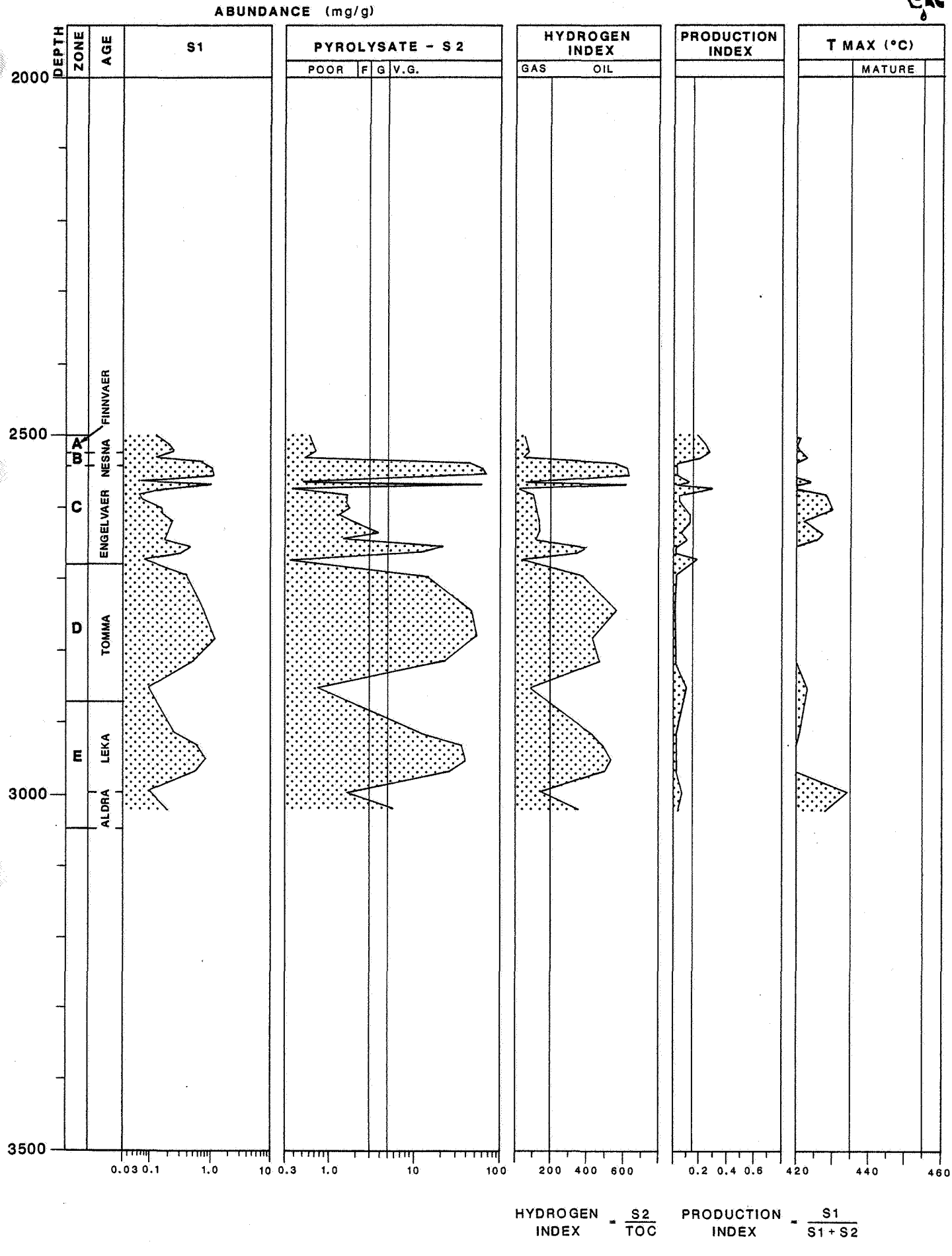
To summarise:

- Finnvaer (above 2529.5 metres) - poor mudstones.
- Nesna (2529.5-2535 metres) rich greyish black shales.
- Engelvaer (2535-2676.5 metres) medium grey and olive grey shales poor, dark grey to medium dark grey shales (below 2630 metres) good with rich interbeds.

FIGURE 3

PYROLYSIS

WELL 6507/11-4

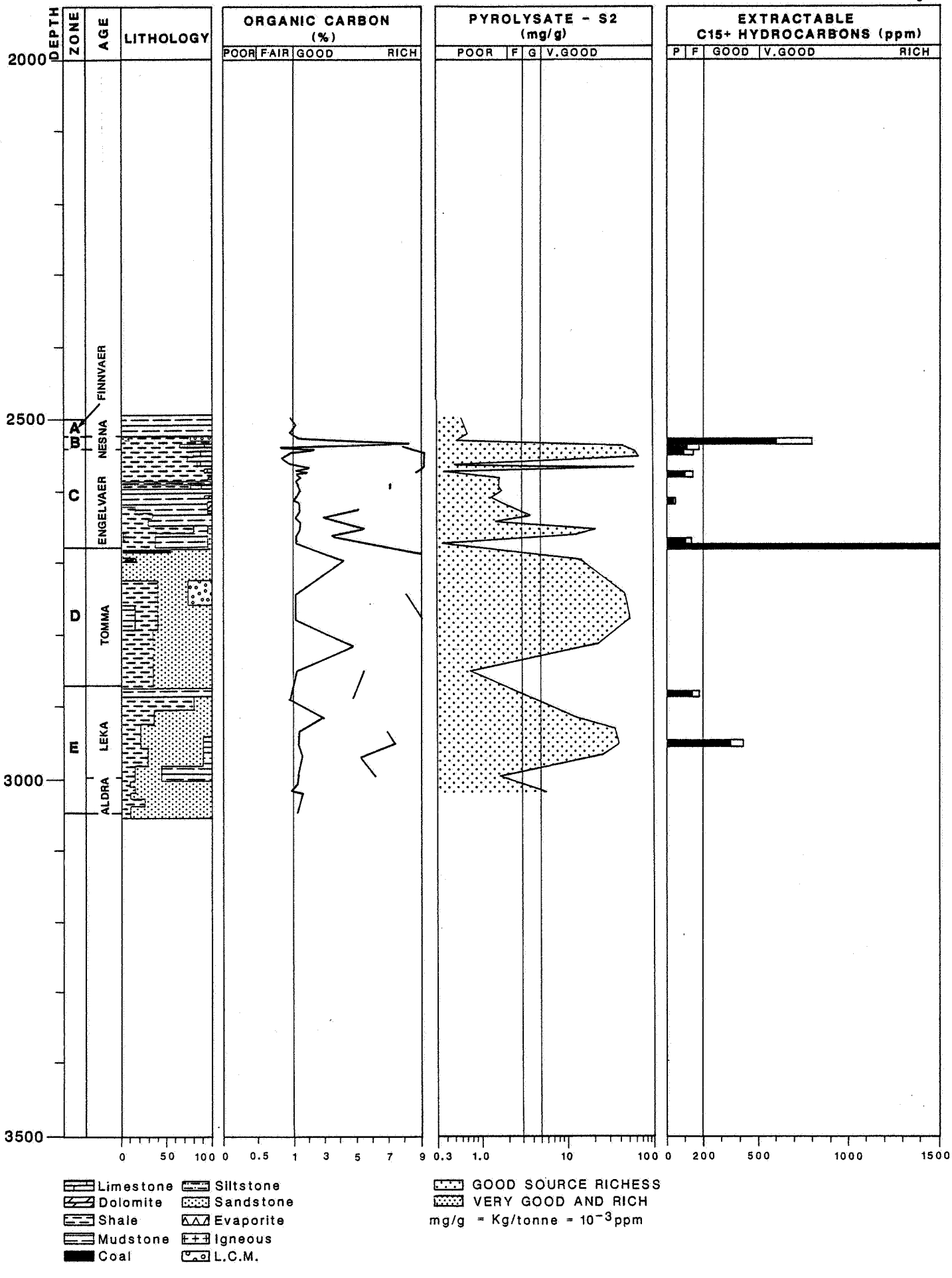


HYDROGEN INDEX = $\frac{S2}{TOC}$ PRODUCTION INDEX = $\frac{S1}{S1 + S2}$

FIGURE 4

WELL 6507/11-4

SOURCE RICHNESS



- Tomma 2676.5-2866 metres scattered rich greyish black to dark grey shales and carbonaceous mudstones.
- Leka and Aldra, interbeds of rich greyish black to dark grey shale and of fair to good dark greenish grey shale.

THERMAL MATURATION

Spore colour and vitrinite reflectance assessments of thermal maturity were not specified for this project. Tmax values from the Rockeval data reach a maximum of 430°C at 2600± metres and then diminish until values of 434 and 428°C are achieved at 2996-3023 metres. This reversal in the Tmax trend may be due to caved material in some samples but does emphasise the limited application of this parameter for maturity evaluations.

SHOW DETECTION AND CHARACTERISATION

Shows of migrated wet gas, condensate and crude oil are most effectively detected with the light C_1-C_7 hydrocarbons. Mature liquid hydrocarbons are characterised by high gas wetnesses and by low isobutane to normal butane ratios. Preliminary assessments of the character of the hydrocarbons in the shows can also be obtained from the light hydrocarbons but must be confirmed with the heavy C_{15+} hydrocarbon analyses, whilst the abundances of both fractions are used to determine the strength of the shows. The pyrolysis S1 parameter also detects shows but is severely affected by drilling-introduced contamination.

Airspace gas analyses were specified for this well but down to 2540± metres only traces (1768-2014 ppm) of dry to marginally wet (18.0-30.9% C_2+ species) hydrocarbons were detected. Negligible volumes (less than 69ppm) of C_5-C_7 hydrocarbons were detected and shows of migrated hydrocarbons are not indicated. Within Zone C gas wetness values increase from 23.5-26.5% up to 42.7-48.8% below 2610± metres although their abundance diminishes from 5920ppm with depth. Isobutane to normal butane ratios are greater than unity (1.24-1.41) and migrated liquid hydrocarbons are not suspected. Gas abundances in the Tomma sands/shales improve somewhat (to 734-5450 ppm) and these hydrocarbons are wet (37.2-64.7%) but the gasolines are very few (16-129 ppm) - only traces of wet gas are suspected. The Leka and Aldra formations are characterised by poor (1120-1926 ppm) abundance of marginally wet (30.7-40.4%) gas.

At 2533 metres 817 ppm C_{15+} hydrocarbons were detected but from the C_{15+} saturates chromatograms are indigenous to the rich greyish black shales within this interval. C_{15+} saturates chromatogram quality is poorer than normal, particularly for the sidewall cores. This is due to small sample size and is

aggrevated by low relative hydrocarbon abundances. The coals at 2687 metres yielded 11244ppm C_{15+} hydrocarbons which amount to only 28.5% of the total extract and are, from the saturates choromatograms, associated with the coals, and not out of place. With one further exception the C_{15+} hydrocarbon yields are generally less than 176 ppm, have low (14.25-31.50%) hydrocarbon to total extract ratios and saturates chromatograms which identify them as immature indigenous species.

Chromatograms of the aromatic hydrocarbons are noisy due to the low abundance of these compounds. In some instances the specified samples failed to produce a usable GC trace and in general the phenanthrenes are so sparse that the methyl phenanthrene indices are unreliable. The traces are frequently dominated by strong unidentified peaks - for example the peak adjacent to the methyl phenanthrenes (peaks 2-5).

The methyl naphthalenes (peaks A-C) are relatively abundant in the Nesna shales but the phenanthrenes are sparse whereas in the Engelvaer shales (down to at least 2570± metres) the aromatics are generally few. At 2576± metres and 2589± metres there is a slight enrichment in the methyl naphthalenes whilst at 2654± metres and at 2672± metres the traces display a strong tri-methyl naphthalene peak (C). Slight changes in organic facies are believed to be responsible for the differences in the aromatic hydrocarbons fingerprint. The coal at 2687 metres is rich in the methyl naphthalenes. Residual traces of saturated hydrocarbons are just visible in the traces at 2881.5 metres and 2951 metres but the diagnostic aromatic hydrocarbons are readily identified. These latter samples are somewhat richer in aromatics than most of the shales and resemble those at 2589± metres and 2672± metres.

In the absence of tested fluids or oil shows the aromatic hydrocarbon chromatograms cannot be used for correlation purposes; they do, nonetheless, reveal minor facies related changes in composition.

The sandstone cores fragments at 2687-2702± metres yielded 33-216 ppm total extract and are unlikely to contain significant hydrocarbon concentrations - no further analyses were attempted on them.

Mass fragmentograms of the steranes are characterised by two features - an appreciable bias to C_{29} hydrocarbons, and a predominance of R isomers. At 2533-2589 metres the biogenic peaks (e.g. J, T and, to a lesser extent, Q and R) are very prominent - indicating the immature nature of these mudstones and shales. Although the predominance of C_{29} species is more marked in the

Engelvaer shales those in the Nesna also have this characteristic too and a mainly, but not exclusively, land plant type is indicated. Strong C_{29} sterane peaks are visible on the m/z 218 fragmentogram for the coal at 2687 metres whilst at m/z 217 the trace is dominated by the biogenic C_{27}R. steranes. The remaining mudstones and shales have approximately equal proportions of C_{27} and C_{29} steranes - suggesting a mixed marine/terrigenous source type.

Mass fragmentograms of the triterpanes confirm the immature state of the mainly land plant derived organic matter in most of them. This conclusion is supported by the height of the 22R C_{31} hopane peak (H) and in the sample at 2533 metres by the total dominance of the bisnorhopane peak Z. Further support is provided by the significant moretane contents (peaks D and F) which normally diminish with increasing maturity.

Mass fragmentograms of the steranes and triterpanes from the analysed well section will have little value for correlation purposes since they represent very immature source indigenous hydrocarbons. They will nonetheless be invaluable for regional studies because they represent a distinct organic assemblage and an 'end member' in the range of inferred source maturities based upon extracted hydrocarbons. Mass fragmentograms of the aromatic hydrocarbons display several unidentified peaks which are believed to be associated with the immaturity of these sediments. The lack of triaromatic steranes and the configuration of the phenanthrenes also suggests low maturation levels.

Carbon isotope ratios range from $-29.6^{o}/oo$ and $-28.9^{o}/oo$ for the saturated and aromatic hydrocarbons at the top of the Nesna to $-26.4^{o}/oo$ to $-28.0^{o}/oo$ and $-25.4^{o}/oo$ to $-26.6^{o}/oo$ for the underlying mudstones and shales at 2586.7 metres, 2576 metres and 2612 metres (the aromatic value for the latter $-28.3^{o}/oo$ is suspect due to contamination). The heavier more positive values associated with these deeper sediments suggest that they have a greater proportion of land plant kerogen and that the sample at 2533 metres was laid down in a relatively more restricted environment. A more mixed kerogen type is suggested by the somewhat lighter values of $-28.6^{o}/oo$ and $-27.4^{o}/oo$ at 2851.5 metres. The carbon isotopic data quality is adversely affected by very small fraction weights and should be interpreted with caution.

FIGURE 5

WELL 6507/11-4

C_1-C_7 HYDROCARBONS

GEOCHEM

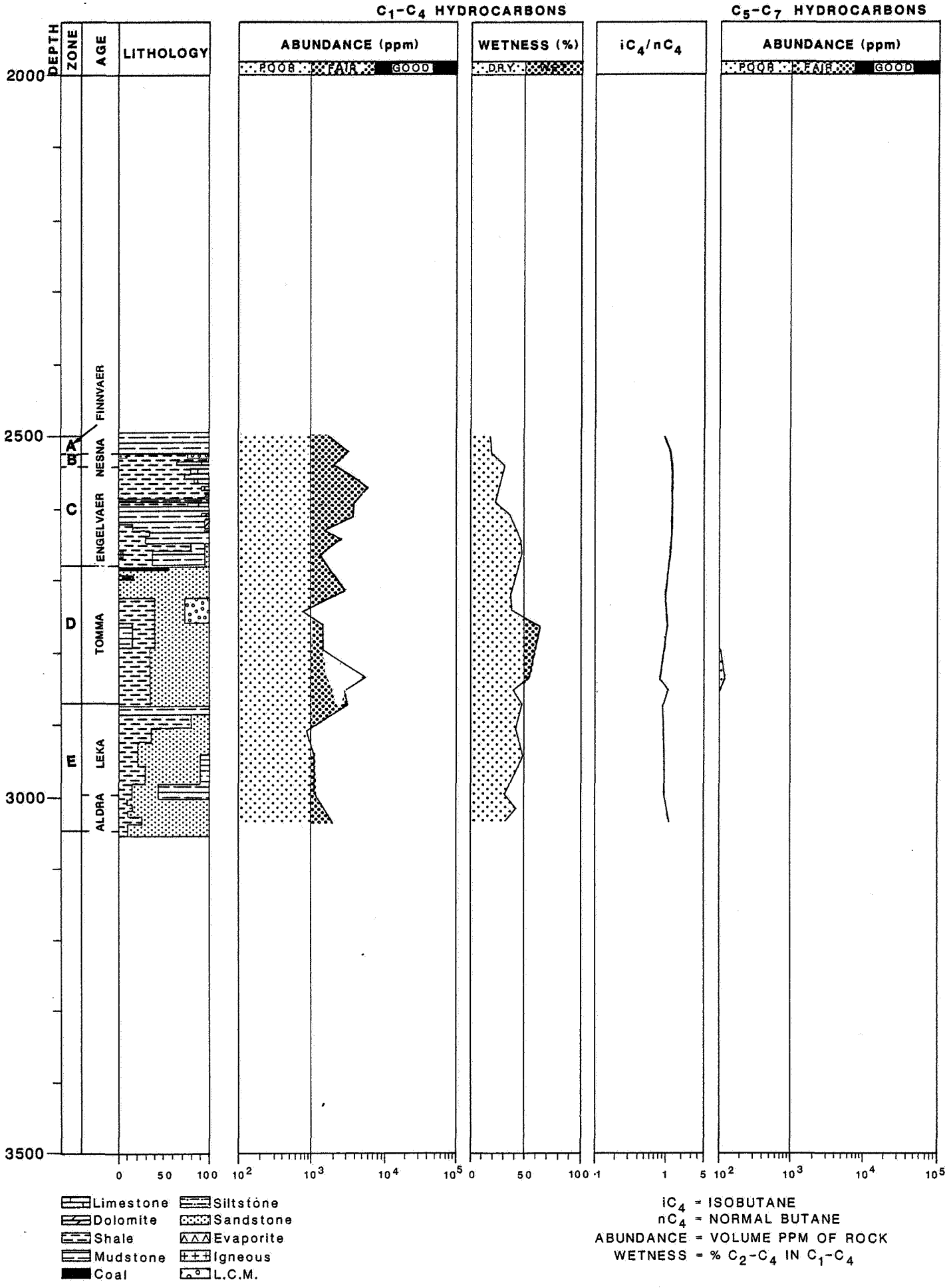


FIGURE 6

SHOW DETECTION

WELL 6507/11-4

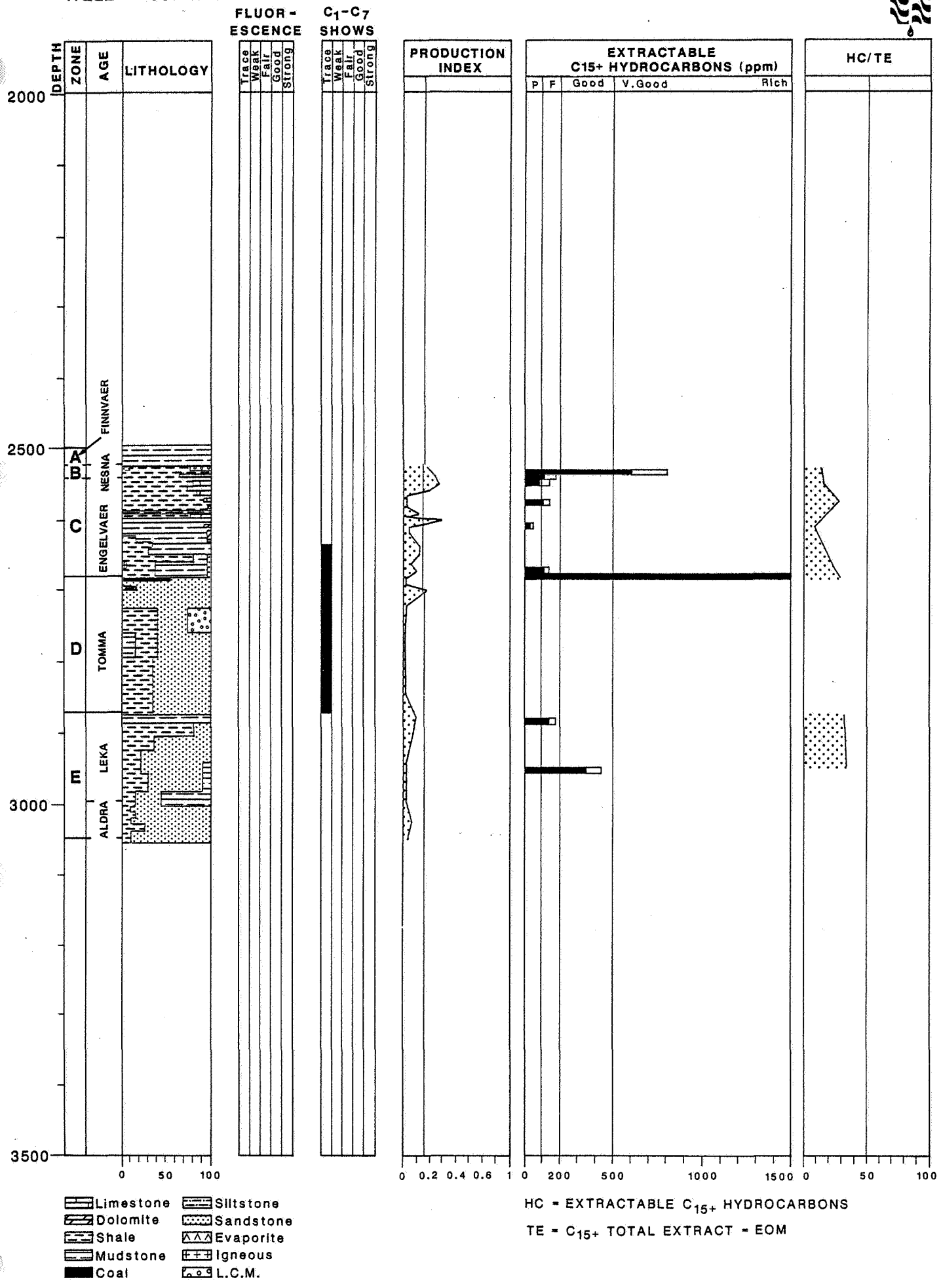


FIGURE 7

WELL 6507/11-4

GALIMOV CARBON ISOTOPE PLOT

(‰, PDB)

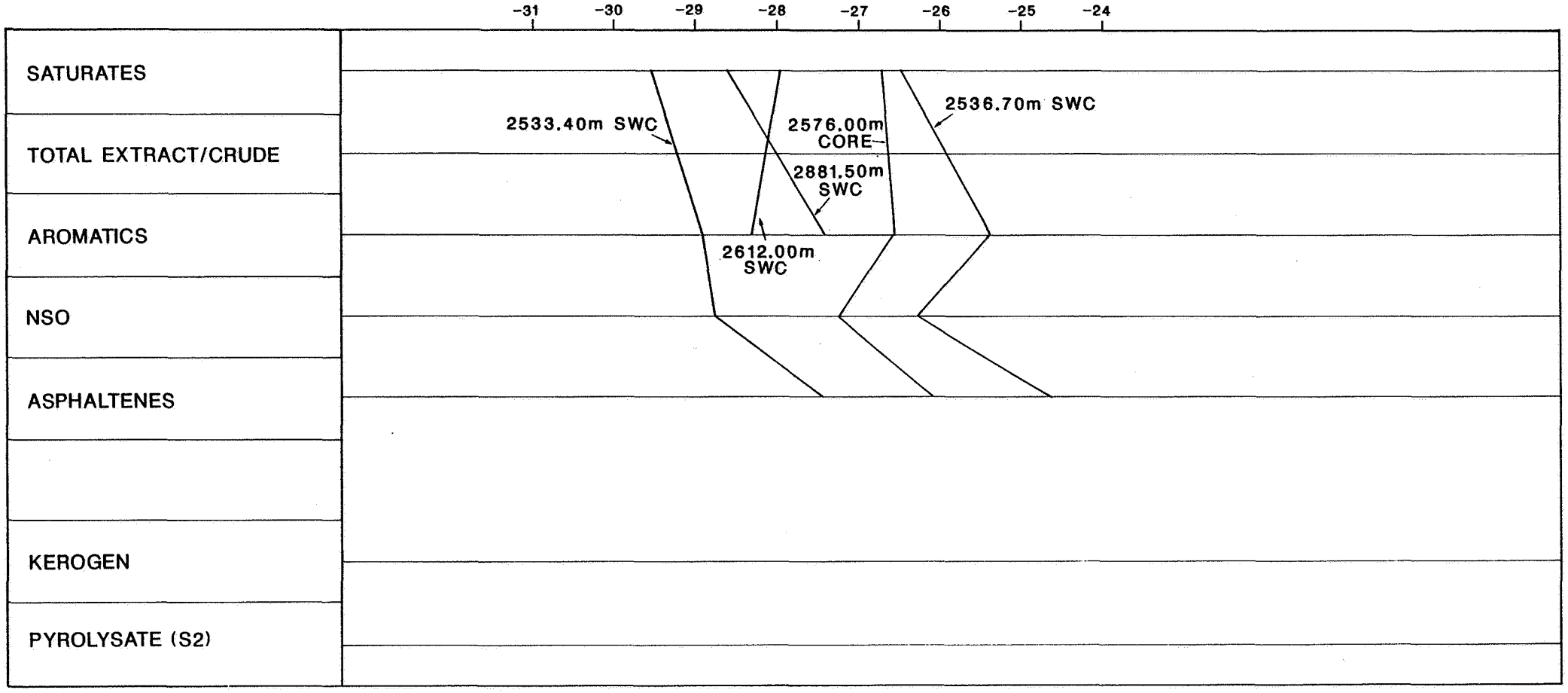


TABLE 1
ORGANIC CARBON RESULTS AND GROSS LITHOLOGIC DESCRIPTIONS

GEOCHEM SAMPLE NUMBER	DEPTH	GROSS LITHOLOGIC DESCRIPTION	G S A Colour Code	TOTAL ORGANIC CARBON (Wt. % of Rock)
1607-014	2500m	A 98% Shaly mudstone, platy to fissile, mod. soft, non-calc., medium grey Minor yellow mudstone	N5	0.99
1607-015	2510m	A 90% Shaly mudstone, as 1607-014A	N5	1.01
		B 10% Mudstone, blocky, soft, sl. calc., (evaporitic?), yellowish grey	5Y7/2	0.44
		Trace red mudstone, anhydrite		
1607-016	2520m	A 98% Shaly mudstone, as 1607-014A Minor mudstone	N5	0.96,0.95
1607-017	2528m	A 65% Shale, platy to fissile, mod. soft, non-calc. to sl. calc., medium grey	N5	1.02
		B 25% LCM - cement		
		C 10% Sand, fine to med. grained, subang. to subround, mod. to poorly sorted, white	N9	
		Minor limestone		
1607-075 SWC	2533m	A 98% Shale, carb. in part, subfissile to fissile, mod. soft, non-calc., greyish black	N2	8.31
1607-076 SWC	2536m	A 98% Shale, with carb. flecks, subfissile to fissile, mod. soft, non-calc., dark grey	N3	5.13
1607-018	2537m	A 35% Shale, as 1607-017A Significant cavings	N5	1.02
		B 35% Limestone, microcryst., sl. argill., sub-platy, mod. hard, pale yellowish brown to light grey	10YR6/2-N7	0.59
		C 30% Shale, subfissile to fissile, med. soft to mod. hard, non-calc., greyish black	N2	7.84
1607-077 SWC	2541m	A 98% Shale, occ. carb. flecks, subfissile to fissile, mod. soft, non-calc., sl. micaceous, dark grey	N3	2.32
1607-019	2546m	A 45% Shale, as 1607-017A Minor cavings	N5	0.97
		B 35% Shale, as 1607-018C	N2	9.59,9.62
		C 10% Limestone, chalky, blocky, soft, white	N9	
		D 10% Limestone, as 1607-018B	10YR6/2-N7	0.69
		Trace sandstone		

Abbreviations = arenaceous, argillaceous, calcareous, Cut, dolomitic, Fluorescence, foraminifera, fossiliferous
Lost Circulation Material, moderately, occasionally, slightly, very

TABLE 1
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GEOCHEM SAMPLE NUMBER	DEPTH	GROSS LITHOLOGIC DESCRIPTION	G S A Colour Code	TOTAL ORGANIC CARBON (Wt. % of Rock)
1607-020	2555m	A 55% Shale, platy to fissile, mod. hard to mod. soft, non. to sl. calc., medium grey	N5	0.86
		B 25% Limestone, as 1607-019C	N9	
		C 20% Shale, fissile, mod. hard, non-calc., greyish black	N2	10.40
		Minor limestone, Trace red mudstone		
1607-021	2564m	A 60% Shale, as 1607-020A	N5	0.91
		B 25% Shale, as 1607-020C	N2	9.72,9.64
		C 15% Limestone, microcryst, sl. argill. in part, sub-platy, mod. hard, pale yellowish brown	10YR6/2	0.86
		Minor LCM - cement		
1607-078 CORE	2567m	A 98% Shale, rare carb. flecks, fissile, mod. hard, non-calc., sl. micaceous, olive grey	5Y4/1	2.00,1.96
1607-022	2573m	A 65% Shale, fissile to subfissile, mod. hard, non-calc., medium grey to medium olive grey	N5-5Y5/1	1.11
		B 25% Shale, fissile to subfissile, mod. hard, non-calc., greyish black	N2	8.67
		C 10% Limestone, microcryst, sl. argill., sub-platy, mod. hard, pale yellowish brown to pale orange	10YR6/2-10YR7/2	0.53
		Trace LCM - cement, pyrite		
1607-079 CORE	2576m	A 98% Shale, as 1607-078A	5Y4/1	1.86
1607-023	2583m	A 90% Shale, fissile, mod. hard, non-calc., olive grey	5Y4/1	1.48
		B 5% Shale, as 1607-022B	N2	
		Abundant cavings		
		C 5% LCM - metal		
		Minor limestone		
1607-080 CORE	2589m	A 98% Shaly mudstone, silty in part, subfissile, mod. hard, non-calc., olive grey	5Y4/1	1.12
1607-024	2591m	A 65% Shale, as 1607-023A	5Y4/1	1.33,1.33
		B 25% Limestone, microcryst., sl. argill., sub-platy, mod. hard, dark yellowish brown to medium yellowish brown	10YR4/2-10YR5/2	0.58
		C 10% Shale, fissile, mod. hard, non-calc., greyish black	N2	7.16
		Significant cavings		
1607-025	2600m	A 98% Shaly mudstone, fissile to platy, mod. soft, non-calc., olive grey	5Y4/1	1.45
		Minor black shale, Trace limestone, LCM - cement		

Abbreviations = arenaceous, argillaceous, calcareous, Cut, dolomitic, Fluorescence, foraminifera, fossiliferous
Lost Circulation Material, moderately, occasionally, slightly, very

TABLE 1
ORGANIC CARBON RESULTS AND GROSS LITHOLOGIC DESCRIPTIONS

GEOCHEM SAMPLE NUMBER	DEPTH	GROSS LITHOLOGIC DESCRIPTION	G S A Colour Code	TOTAL ORGANIC CARBON (Wt. % of Rock)
1607-026	2609m	A 90% Shaly mudstone, as 1607-025A	5Y4/1	1.09
		B 10% Dolomite, argill. to microcryst., platy to sub-platy, mod. hard, yellowish grey	5Y7/2	0.45
		Minor dark shale		
1607-081 SWC	2612.5m	A 98% Shaly mudstone, platy, mod. hard, non-calc., medium dark grey	N4	1.00
1607-027	2618m	A 95% Shaly mudstone, as 1607-025A	5Y4/1	1.32,1.32
		B 5% Dolomite, as 1607-026B	5Y7/2	
		Minor dark shale		
1607-028	2627m	A 80% Shaly mudstone, fissile to platy, mod. soft, non-calc., olive grey	5Y4/1	1.39
		Minor cavings		
		B 15% Shale, fissile, mod. soft, non-calc., greyish black	N2	5.17
		C 5% Dolomitic limestone, microcryst. to argill., sub-platy, mod. hard, very pale orange	10YR8/2	0.60
1607-029	2636m	A 65% Shaly mudstone, as 1607-028A	5Y4/1	1.08
		B 35% Shale, fissile to subfissile, mod. hard, non-calc., dark grey to medium dark grey	N3-4	2.93,2.91
		Minor dolomite limestone		
1607-030	2645m	A 70% Shaly mudstone, as 1607-028A	5Y4/1	1.39
		B 30% Shale, as 1607-029B	N3-4	3.74
		Significant cavings		
		Minor limestone		
1607-031	2654m	A 80% Shale, as 1607-029B	N3-4	5.43
		Significant cavings		
		B 15% Shaly mudstone, as 1607-028A	5Y4/1	1.36
		C 5% Sandstone, v. fine grained, subang. to subround, mod. sorted, calc. cement, very light grey to white	N8-9	
		Minor limestone		
1607-032	2663m	A 60% Shaly mudstone, platy to subfissile, mod. hard, non-calc., olive grey	5Y4/1	1.12,1.13
		B 30% Shale, fissile to subfissile, mod. hard, non-calc., greyish black to dark grey	N2-3	3.45
		C 5% Sandstone, as 1607-031C	N8-9	
		D 5% Pyrite, crystalline, hard, dusky yellow	5Y6/4	
1607-033	2672m	A 60% Shaly mudstone, as 1607-032A	5Y4/1	1.13
		B 35% Shale, as 1607-032B	N2-3	4.25
		C 5% Sandstone, as 1607-031C	N8-9	
		Minor pyrite, limestone		

Abbreviations = arenaceous, argillaceous, calcareous, Cut, dolomitic, Fluorescence, foraminifera, fossiliferous
Lost Circulation Material, moderately, occasionally, slightly, very

TABLE 1
ORGANIC CARBON RESULTS AND GROSS LITHOLOGIC DESCRIPTIONS

GEOCHEM SAMPLE NUMBER	DEPTH	GROSS LITHOLOGIC DESCRIPTION	G S A Colour Code	TOTAL ORGANIC CARBON (Wt. % of Rock)
1607-082 CORE	2687m	A 55% Coal, shining lustre, brittle, black to greyish black	N1-2	56.92
		B 45% Silty sandstone, v. fine grained, subang. to subround, mod. sorted, medium grey	N5	
1607-083 CORE	2687m	A 98% Sandstone, v. fine grained, argill., subang. to subround, mod. sorted with argill/carb laminae, light grey to medium dark grey	N7-N4	
1607-089 CORE	2689m	A 98% Sandstone, poorly consolidated, fine to coarse grained, subang. to subround, mod. sorted, very light grey	N8	
1607-036	2699m	A 85% Sand, fine to coarse grained, subang. to subround, poorly sorted, white	N9	
		B 15% Shale, fissile, mod. hard, non-calc., greyish black to dark grey	N2-3	4.25
1607-085 CORE	2702.1m	A 98% Sandstone, med. to v. coarse grained, subang. to subround, mod. sorted, white	N9	
1607-041	2744m	A 30% Sandstone, gen. unconsolidated, fine to coarse grained, subang. to subround, poorly sorted, calc. matrix, very light grey to white	N8-9	
		B 30% LCM - lignite		
		C 25% Shale, subfissile to fissile, mod. hard, non-calc.,		1.04
		D 15% Shale, carbonaceous, platy to subfissile, mod. hard, non-calc., greyish black	N2	8.03,8.05
		Minor limestone, anhydrite		
1607-045	2780m	A 60% Sand, fine to coarse grained, subang. to subround, poorly sorted, white	N9	
		B 25% Shale, subfissile to fissile, mod. hard, non-calc., medium grey	N5	1.13
		C 15% Carbonaceous mudstone, platy to subfissile, mod. soft, non-calc., black to greyish black	N1-2	12.4
		Minor LCM - lignite		
1607-049	2816m	A 65% Sand, fine to coarse grained, subang. to subround, mod. sorted, white	N9	
		B 35% Shale, fissile, mod. hard, non-calc., greyish black to dark grey	N2-3	4.79
		Minor grey shale		

Abbreviations = arenaceous, argillaceous, calcareous, Cut, dolomitic, Fluorescence, foraminifera, fossiliferous Lost Circulation Material, moderately, occasionally, slightly, very

TABLE 1
ORGANIC CARBON RESULTS AND GROSS LITHOLOGIC DESCRIPTIONS

GEOCHEM SAMPLE NUMBER	DEPTH	GROSS LITHOLOGIC DESCRIPTION	G S A Colour Code	TOTAL ORGANIC CARBON (Wt. % of Rock)
1607-053	2852m	A 65% Sandstone, dom. unconsol., fine to coarse grained, subang. to subround., mod. to poorly sorted, white	N9	
		B 25% Shale, platy to fissile, mod. hard, non-calc., medium grey	N5	1.01
		C 10% Shale, fissile to subfissile, mod. hard, non-calc., greyish black to dark grey	N2-3	5.74,5.59
1607-086 SWC	2881.5m	A 98% Shaly mudstone, sl. silty in part, subfissile to platy, mod. hard, non-calc., sl. micaceous, olive grey	5Y4/1	0.71
1607-057	2888m	A 50% Shale, platy to fissile, mod. hard, non-calc., medium grey to medium greenish grey	N5-5GY5/1	0.94
		B 30% Shale, fissile, mod. hard, non-calc., greyish black to dark grey	N2-3	4.76
		C 20% Sandstone, often unconsol., fine to coarse grained, subang. to subround, mod. sorted, very light grey to white	N8-9	
1607-060	2915m	A 65% Sandstone, unconsol. in part, fine to med. grained, subang. to subround, med. sorted, calc. matrix in part, very light grey to white	N8-9	
		B 35% Shale, fissile, mod. hard, non-calc., greyish black to dark grey	N2-3	2.94
1607-062	2933m	A 60% Shale, platy to fissile, mod. hard, non-calc., medium grey to medium greenish grey	N5-5GY5/1	1.35
		B 20% Shale, fissile to subfissile, mod. hard, non-calc., greyish black to dark grey	N2-3	7.00
		C 20% Sandstone, unconsol. in part, fine to med. grained, subang., mod. sorted, calc. matrix, very light grey to white	N8-9	
1607-064	2951m	A 70% Sandstone, v. fine to fine grained, subang. to subround, mod. to poorly sorted, argill matrix, grading to siltstone in part, light grey to very light grey	N7-8	
		B 20% Shale, fissile, mod. hard, non-calc., greyish black to dark grey	N2-3	7.42,7.66
		C 10% Shaly mudstone, occ. sl. silty, subfissile to platy, mod. hard, non-calc., medium grey to medium greenish grey	N5-5GY5/1	1.24

Abbreviations = arenaceous, argillaceous, calcareous, Cut, dolomitic, Fluorescence, foraminifera, fossiliferous
Lost Circulation Material, moderately, occasionally, slightly, very

TABLE 1
ORGANIC CARBON RESULTS AND GROSS LITHOLOGIC DESCRIPTIONS

GEOCHEM SAMPLE NUMBER	DEPTH	GROSS LITHOLOGIC DESCRIPTION	G S A Colour Code	TOTAL ORGANIC CARBON (Wt. % of Rock)
1607-066	2969m	A 60% Sandstone, v. fine to fine grained, subang. to subround, mod. sorted, argill. matrix, grading to siltstone, medium light grey to light grey	N6-7	
		B 30% Shale, fissile to subfissile, mod. hard, non-calc., greyish black to dark grey	N2-3	5.07
		C 10% Mudstone, silty in part, platy, mod. hard, non-calc., medium greenish grey to medium grey	5GY5/1-N5	1.66
1607-069	2996m	A 55% Shaly mudstone, platy to subfissile, mod. hard, non-calc., medium greenish grey	5GY5/1	1.25
		B 30% Sandstone, v. fine to fine grained, subang. to subround, mod. sorted, very light grey to white	N8-9	
		C 15% Shale, fissile to platy, mod. hard, non-calc., greyish black to dark grey	N2-3	6.14,5.87
1607-070	3005m	A 90% Sand, fine to coarse grained, subang. to subround, mod. sorted, white	N9	
		B 10% Shale, subfissile to fissile, mod. hard, non-calc., medium greenish grey Minor dark shale	5GY5/1	1.13
1607-071	3014m	A 85% Sand, as 1607-070A	N9	
		B 15% Shale, subfissile to fissile, mod. had, non-calc., sl. silty in part, medium greenish grey Minor dark shale	5GY5/1	0.99
1607-072	3023m	A 90% Sand, as 1607-070A	N9	
		B 10% Shale, as 1607-071B Significant cavings	5GY5/1	1.67
1607-073	3032m	A 75% Sand, fine to coarse grained, subang. to subround., mod. sorted, white	N9	
		B 25% Shale, subfissile to fissile, mod. hard, non-calc., olive grey to dark grey Minor dark mudstone	5Y4/1-N3	1.45
1607-074	3045m	A 90% Sand, as 1607-073A	N9	
		B 10% Shale, as 1607-073B Significant cavings	5Y4/1-N3	1.14

Abbreviations = arenaceous, argillaceous, calcareous, Cut, dolomitic, Fluorescence, foraminifera, fossiliferous
Lost Circulation Material, moderately, occasionally, slightly, very

TABLE 2A

CONCENTRATION (VOL. PPM OF ROCK) OF C_1 - C_7 HYDROCARBONS IN AIR SPACE GAS

GEOCHEM SAMPLE NUMBER	DEPTH	C_1 Methane	C_2 Ethane	C_3 Propane	iC_4 Isobutane	nC_4 Butane	TOTAL C_1 - C_4	TOTAL C_2 - C_4	% GAS WETNESS	TOTAL C_5 - C_7	$\frac{iC_4}{nC_4}$
1607-014	2500	1455	174	87	29	30	1775	320	18.0	40	0.97
1607-016	2520	2573	395	155	55	45	3223	650	20.2	69	1.22
1607-018	2537	1397	455	102	38	27	2019	622	30.8	28	1.41
1607-020	2555	2670	836	169	61	43	3779	1109	29.3	45	1.42
1607-022	2573	4407	1160	235	78	60	5940	1533	25.8	71	1.30
1607-024	2591	3088	655	180	63	46	4032	944	23.4	61	1.37
1607-026	2609	2043	623	393	87	66	3212	1169	36.4	66	1.32
1607-028	2627	942	375	245	48	34	1644	702	42.7	26	1.41
1607-030	2645	1289	658	428	77	61	2513	1224	48.7	42	1.26
1607-032	2663	752	390	228	41	34	1445	693	48.0	23	1.21
1607-038	2717	1924	719	235	58	61	2997	1073	35.8	48	0.95
1607-041	2744	463	156	83	18	17	737	274	37.2	16	1.06
1607-043	2762	572	421	330	158	139	1620	1048	64.7	36	1.14
1607-047	2798	650	393	344	79	82	1548	898	58.0	42	0.96
1607-051	2834	2536	1535	1044	150	185	5450	2914	53.5	129	0.81
1607-053	2852	1828	661	336	67	64	2956	1128	38.2	69	1.05
1607-055	2870	1636	894	461	80	90	3161	1525	48.2	85	0.89
1607-059	2906	495	173	109	24	26	827	332	40.1	37	0.92
1607-063	2942	566	285	169	43	46	1109	543	49.0	69	0.93
1607-069	2996	779	166	117	30	32	1124	345	30.7	53	0.94
1607-071	3014	961	315	230	54	51	1611	650	40.3	73	1.06
1607-073	3032	1320	348	179	44	40	1931	611	31.6	56	1.10

TABLE 3

ROCKEVAL PYROLYSIS DATA

GEOCHEM SAMPLE NUMBER	DEPTH	TOC (%)	S1 (mg/g)	S2 (mg/g)	S3 (mg/g)	Production INDEX	Hydrogen INDEX	Oxygen INDEX	Tmax (%C)
1607-014A	2500	0.99	0.13	0.59	0.69	0.18	59.6	69.7	421
1607-015A	2510	1.01	0.20	0.62	0.53	0.24	61.4	52.5	418
1607-016A	2520	0.95	0.24	0.70	0.64	0.26	73.7	67.4	421
1607-017A	2528	1.02	0.13	0.51	0.80	0.20	50.0	78.4	423
1607-018C	2537	7.84	0.70	42.56	1.13	0.02	542.9	14.4	412
1607-019B	2546	9.60	1.02	58.67	1.92	0.02	611.1	20.0	409
1607-020C	2555	10.40	1.12	63.85	1.82	0.02	613.9	17.5	409
1607-021A	2564	0.91	0.07	0.50	0.98	0.12	54.9	107.7	424
1607-021B	2564	9.68	1.05	57.96	2.00	0.02	598.8	20.7	410
1607-022B	2573	8.67	0.17	0.39	1.71	0.30	4.5	19.7	414
1607-023A	2583	1.48	0.06	1.62	0.77	0.04	109.5	52.0	428
1607-024A	2591	1.33	0.07	1.59	0.61	0.04	119.5	45.9	429
1607-025A	2600	1.45	0.16	1.69	0.43	0.09	116.6	29.7	430
1607-026A	2609	1.09	0.16	1.35	0.48	0.11	123.9	44.0	426
1607-027A	2618	1.32	0.21	1.78	0.53	0.11	134.8	40.2	422
1607-029B	2636	2.92	0.19	3.82	0.61	0.05	130.8	20.9	427
1607-030A	2645	1.39	0.17	1.52	0.43	0.10	109.4	30.9	426
1607-031A	2654	5.43	0.44	21.53	0.87	0.02	396.5	16.0	413
1607-032B	2663	3.45	0.30	12.32	0.89	0.02	357.1	25.8	415
1607-033A	2672	1.13	0.08	0.34	1.21	0.19	30.1	107.1	410
1607-036B	2699	4.25	0.39	15.89	0.79	0.02	373.9	18.6	415
1607-041D	2744	8.04	0.67	45.22	1.38	0.01	562.4	17.2	409
1607-045C	2780	12.40	1.14	52.88	1.79	0.02	426.5	14.4	417
1607-049B	2816	4.79	0.44	22.16	1.20	0.02	462.6	25.1	413
1607-053B	2852	1.01	0.09	0.73	0.72	0.11	72.3	71.3	423
1607-060B	2915	2.94	0.24	12.39	0.69	0.02	421.4	23.5	421
1607-062B	2933	7.00	0.58	34.29	1.07	0.02	489.9	15.3	412
1607-064B	2951	7.54	0.77	39.95	1.45	0.02	529.8	19.2	415
1607-066B	2969	5.07	0.53	25.31	1.77	0.02	499.2	34.9	415
1607-069A	2996	1.25	0.10	1.69	0.96	0.06	135.2	76.8	434
1607-072B	3023	1.67	0.19	5.78	0.66	0.03	346.1	39.5	428

Table 4

METHYL PHENANTHRENE INDEX (1) AND (2)

SAMPLE NUMBER	DEPTH	% AREA	% HEIGHT	% AREA	% HEIGHT
1607-075	2533.4	0.21	0.29	0.14	0.19
1607-077	2541.0	1.74	0.46	2.27	0.32
1607-078	2567.0	0.65	0.65	0.19	0.25
1607-079	2576.0	0.45	0.66	0.33	0.51
1607-080	2589.0	0.70	0.88	1.11	1.32
1607-031	2654.0	0.29	0.21	0.38	0.28
1607-033B	2672.0	0.86	0.68	0.23	0.22
1607-082	2687.0	0.42	0.42	0.42	0.41
1607-086	2881.5	0.95	1.08	1.11	1.25
1607-064B	2951.0	0.90	1.15	1.03	1.31

TABLE 5a
CONCENTRATION (PPM) OF EXTRACTED C_{15+} MATERIAL IN ROCK

JOB GEOCHEM SAMPLE NUMBER	LITHO	DEPTH	TOTAL EXTRACT	HYDROCARBONS			NON HYDROCARBONS			
				Saturates	Aromatics	TOTAL	Preciptd. Asphaltenes	Eluted NSO's	Non-eluted NSO's	TOTAL
1607-075		2533.40	5811	618	198	817	3944	1047	3	4994
1607-076		2536.70	1233	115	61	176	818	236	3	1058
1607-077		2541.00	891	94	42	136	612	141	2	756
1607-079		2576.00	499	102	40	142	153	201	2	357
1607-081		2612.50	449	24	12	36	335	72	6	413
1607-033B		2672.00	580	107	30	137	188	254	1	443
1607-082		2687.00	39504	6573	4671	11244	21878	6346	37	28260
1607-086		2881.50	554	136	39	174	320	57	2	379
1607-064B		2951.00	1345	345	76	421	389	533	2	924
1607-078		2567.00	229							
1607-080		2589.00	68							
1607-031		2654.00	522							
1607-083		2687.00	216							
1607-084		2689	124							
1607-085		2702.00	33							

S — shale, SS — sandstone, L — limestone, D — dolomite, M — mixed, see Table 1.

TABLE 5b
COMPOSITION (NORMALISED %) OF C_{15+} MATERIAL

JOB	LITHO	DEPTH	HYDROCARBONS		NON HYDROCARBONS		
GEOCHEM SAMPLE NUMBER			Saturates	Aromatics	Preciptd. Asphaltenes	Eluted NSO's	Non eluted NSO's
1607-075		2533.40	10.64	3.41	67.87	18.02	0.05
1607-076		2536.70	9.33	4.92	66.32	19.17	0.26
1607-077		2541.00	10.53	4.71	68.70	15.79	0.28
1607-079		2576.00	20.50	8.00	30.75	40.25	0.50
1607-081		2612.50	5.33	2.67	74.67	16.00	1.33
1607-033B		2672.00	18.41	5.16	32.50	43.79	0.14
1607-082		2687.00	16.64	11.82	55.38	16.06	0.09
1607-086		2881.50	24.54	6.96	57.88	10.26	0.37
1607-064B		2951.00	25.63	5.65	28.90	39.67	0.15

S — shale, SS — sandstone, L — limestone, D — dolomite, M — mixed, see Table 1.

TABLE 6

SIGNIFICANT RATIOS (%) OF C_{15+} FRACTIONS AND ORGANIC CARBON

JOB / GEOCHEM SAMPLE NUMBER	LITHO	DEPTH	ORGANIC CARBON (wt. %)	HYDROCARBONS / TOTAL EXTRACT	HYDROCARBONS / ORG. CARBON	TOTAL EXTRACT / ORG. CARBON	SATURATES / AROMATICS
1607-075		2533.40	7.94	14.05	1.03	7.32	3.12
1607-076		2536.70	4.23	14.25	0.42	2.92	1.89
1607-077		2541.00	2.34	15.24	0.58	3.81	2.24
1607-079		2576.00	1.75	28.50	0.81	2.85	2.56
1607-081		2612.50	1.03	8.00	0.35	4.36	2.00
1607-033B		2672.00	1.77	23.57	0.77	3.27	3.57
1607-082		2687.00	57.40	28.46	1.96	6.88	1.41
1607-086		2881.50	0.66	31.50	2.64	8.39	3.53
1607-064B		2951.00	2.53	31.28	1.66	5.31	4.54

S – shale, SS – sandstone, L – limestone, D – dolomite, M – mixed, see Table 1.

TABLE 7

COMPOSITION (NORMALISED %) OF C_{15+} SATURATE (PARAFFIN – NAPHTHENE) HYDROCARBONS

GEOCHEM SAMPLE NUMBER	075	076	077	079	081
DEPTH	2533.40	2536.70	2541.00	2576.00	2612.50
SAMPLE TYPE					
nC15	13.36	16.07	6.93	9.35	7.03
nC16	9.27	12.40	5.80	10.88	7.14
nC17	8.18	9.87	5.92	11.78	9.58
nC18	8.45	12.63	8.07	14.98	14.27
nC19	6.54	6.66	7.25	12.93	8.26
nC20	5.04	5.05	6.05	7.30	5.30
nC21	4.50	3.90	5.80	6.27	6.12
nC22	4.36	3.90	5.48	4.48	6.83
nC23	4.77	4.13	5.92	3.71	6.32
nC24	4.09	3.21	4.98	2.56	4.28
nC25	5.45	4.36	5.61	3.59	5.10
nC26	3.68	2.99	4.60	1.79	2.55
nC27	3.41	3.67	6.62	1.66	3.57
nC28	2.32	2.30	4.35	1.54	2.65
nC29	10.63	2.76	5.17	1.41	3.87
nC30	1.64	1.84	3.53	1.02	1.63
nC31	1.64	2.07	3.15	0.90	2.85
nC32	1.09	0.46	1.83	1.28	0.71
nC33	0.95	1.15	1.58	1.02	1.33
nC34	0.41	0.46	0.76	0.90	0.41
nC35	0.20	0.11	0.63	0.64	0.20
Paraffin	40.14	41.69	54.65	25.41	57.33
Isoprenoid	12.53	6.13	4.20	3.32	3.21
Naphthene	47.33	52.18	41.15	71.27	39.45
CPI 1 Index	1.16	1.18	1.18	1.21	1.20
CPI 2 Index	2.11	1.47	1.31	1.22	1.71
CPI 3 Index	1.14	1.39	1.48	1.00	1.37
Prist/Phytane	1.57	3.27	2.94	3.08	1.62
Prist/nC17	2.33	1.14	0.97	0.84	0.36
Phytane/nC18	1.44	0.27	0.24	0.21	0.15

$$\text{C.P.I. } 1 = \frac{1}{2}\left(\frac{C21+C23+C25+C27}{C20+C22+C24+C26} + \frac{C21+C23+C25+C27}{C22+C24+C26+C28}\right)$$

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$$\text{C.P.I. } 2 = \frac{1}{2}\left(\frac{C25+C27+C29+C31}{C24+C26+C28+C30} + \frac{C25+C27+C29+C31}{C26+C28+C30+C32}\right)$$

$$\text{C.P.I. } 3 = \frac{2x\ (C27)}{C26+C28}$$

CT – ditch cuttings **CO**– core **SWC** – sidewall core

TABLE 7

COMPOSITION (NORMALISED %) OF C_{15+} SATURATE (PARAFFIN – NAPHTHENE) HYDROCARBONS

GEOCHEM SAMPLE NUMBER	033B	082	086	064B
DEPTH	2672.00	2687.00	2881.50	2951.00
SAMPLE TYPE				
nC15	16.94	5.65	7.55	4.78
nC16	14.75	20.90	10.90	6.76
nC17	11.98	6.78	12.12	9.25
nC18	7.95	8.47	12.30	8.61
nC19	6.34	5.65	10.90	7.91
nC20	4.38	5.08	8.48	8.80
nC21	4.03	3.95	7.74	6.82
nC22	4.03	3.95	6.06	7.65
nC23	3.57	5.08	5.31	6.25
nC24	3.34	3.95	3.91	4.97
nC25	3.69	4.52	3.82	5.29
nC26	2.53	3.95	2.05	3.64
nC27	3.92	4.52	2.24	4.72
nC28	2.53	2.26	1.30	3.06
nC29	2.88	3.95	1.58	3.25
nC30	1.61	2.26	0.93	2.23
nC31	2.07	3.95	0.84	2.10
nC32	1.15	1.69	0.65	1.59
nC33	1.27	1.69	0.47	1.08
nC34	0.58	0.56	0.56	0.77
nC35	0.46	1.13	0.28	0.45
Paraffin	61.43	26.14	44.12	60.15
Isoprenoid	5.94	9.90	5.10	4.95
Naphthene	32.63	63.96	50.78	34.91
CPI 1 Index	1.14	1.17	1.18	1.06
CPI 2 Index	1.43	1.52	1.38	1.28
CPI 3 Index	1.55	1.45	1.33	1.41
Prist/Phytane	2.00	5.09	1.82	1.48
Prist/nC17	0.54	4.67	0.62	0.53
Phytane/nC18	0.41	0.73	0.33	0.39

$$C.P.I.\ 1 = \frac{1}{2}\left(\frac{C21+C23+C25+C27}{C20+C22+C24+C26} + \frac{C21+C23+C25+C27}{C22+C24+C26+C28}\right)$$

$$C.P.I.\ 2 = \frac{1}{2}\left(\frac{C25+C27+C29+C31}{C24+C26+C28+C30} + \frac{C25+C27+C29+C31}{C26+C28+C30+C32}\right)$$

$$C.P.I.\ 3 = \frac{2x\ (C27)}{C26+C28}$$

Job Number : 1607

CT – ditch cuttings CO– core SWC – sidewall core

NBS 22 STANDARD	

TABLE 8
CARBON ISOTOPE COMPOSITIONS ($^{o}/_{oo}$, PDB)

GEOCHEM SAMPLE NUMBER	DEPTH	TOTAL EXTRACT WHOLE OIL	SATURATES	AROMATICS	NSO	ASPHALTENES	KEROGEN	PYROLYSATE S2
1607-075	2533.40m		-29.59	-28.94	-28.77	-27.45		
1607-076	2536.70m		-26.44	-25.39	-26.25	-24.62		
1607-079	2576.00m		-26.73	-26.59	-27.26	-26.15		
1607-081	2612.50m		-27.96	-28.34*				
1607-086	2881.50m		-28.63	-27.40				

* Contamination suspected

TABLE 9
BIOMARKER MOLECULAR RATIOS

GEOCHEM SAMPLE NUMBER	SAMPLE DEPTH/ IDENTITY	STERANES (m/z 217, 218)				TERPANES (m/z 191, 177)						
		$C_{29}\ \frac{\alpha\alpha\alpha\ 20S\ [Q]}{\alpha\alpha\alpha\ 20R\ [T]}$	$C_{29}\ \frac{\alpha\beta\beta\ 20R\ [R]}{\alpha\alpha\alpha\ 20R\ [T]}$	$C_{27}\ \frac{20SDIAST[A]}{20RDIAST\ [B]}$	$\frac{C_{27}\ \beta\beta}{C_{29}\ \beta\beta}\ (218)$	$\frac{Tm[B]}{Ts\ [A]}$	$\frac{C_{29}\ 17\alpha\text{-NH}\ [C]}{[C] + C_{30}\ 17\alpha\text{-H}\ [E]}$	$C_{29}\ \frac{NM\ [D]}{[D] + NH\ [C]}$	$\frac{28,30\text{-BNH}\ [Z]}{[Z] + C_{29}\ 17\text{-NH}\ [C]}$	$\frac{28,30\text{-BNH}\ [Z]}{[Z] + 25,28,30\text{-TNH}\ (177)}$	$C_{31}\ \frac{20S\ [G]}{[G] + 20R\ [H]}\ \%$	GAMMACERANE INDEX $\left[\frac{\theta_1}{\theta}\right]$
1607-075	2533.4m		0.21	0.95	0.40	12.42	0.26	0.51			21%	0.19
1607-076	2536.7m		0.23	1.22	0.53	2.42	0.29	0.40	0.17		24%	0.25
1607-077	2541m		0.33	0.77	0.29	10.77	0.09	0.78	0.34		19%	0.53
1607-078	2567m		0.56	0.51	0.22	25.18	0.25	0.51			19%	0.50
1607-079	2576m		0.46	0.69	0.35	11.5	0.37	0.47			16%	0.43
1607-080	2589m		0.47	0.87	0.40	7.47	0.34	0.40			18%	0.32
1607-081	2612.5m	0.26	0.62	1.38	0.63	5.79	0.08	0.76			19%	0.37
1607-031	2654m	0.1	0.63	0.91	0.66	3.5	0.16	0.58	0.58		19%	0.15
1607-033	2672m		0.38	1.02	0.57	7.36	0.21	0.52	0.46		20%	0.25
1607-082	2687m		0.50	0.74	0.44	4.6	0.18	0.54			22%	0.29
1607-086	2881.5m	0.18	0.57	1.13	0.60	2.80	0.37	0.27	0.16		37%	0.10
1607-064	2951m	0.15	0.32	1.18	0.78	1.65	0.37	0.29	0.39		38%	0.08

[A] etc. REFERS TO IDENTIFICATION ON APPROPRIATE MASS FRAGMENTOGRAM **DIAST** – DIASTERANES **H** – HOPANE **NH** – NORHOPANE **BNH** – BISNORHOPANE

CT – ditch cuttings **CO** – core **SWC** – sidewall core **TNH** – TRISNORHOPANE **NM** – NORMORETANE

TABLE 10a

PEAK AREA DATA
(M/Z 191)

SAMPLE NUMBER	DEPTH (METRES)	A	B	Z	C	C_1	X	D	E	F	G	H	G_1	I
1607-075	2533.4	104	1202		1695	1730	224	1809	4769	2264	1161	4370	898	1586
1607-076	2536.7	109	264	98	461	125	76	316	1118	324	271	838	281	305
1607-077	2541	104	1120	183	351	1309	155	1261	3269	1369	727	2973	1727	1262
1607-078	2567	138	3475		2678	3336	240	2864	7850	3634	1649	7022	3974	3539
1607-079	2576	337	3876		6748	4562	471	6171	11524	4596	1993	10291	4939	4174
1607-080	2589	113	844		1550	1301	104	1057	2913	884	696	3177	936	1175
1607-081	2612.5	108	626		169	951	40	555	1878	656	589	2416	707	437
1607-031	2654	96	337	313	221	615	69	307	1174	313	229	946	180	269
1607-033	2672	100	736	344	396	755	65	438	1484	441	325	1281	379	436
1607-082	2687	426	1974		1341	2361	599	1568	5976	2441	1345	4700	1784	2281
1607-086	2881.5	281	789	332	1768	395	207	653	3004	742	1319	2204	310	701
1607-064	2951	3242	5366	6687	10360	4102	1435	4305	17063	4720	6479	10439	1335	3171

TABLE 10b

PEAK AREA DATA
(M/Z 217)

SAMPLE NUMBER	DEPTH (METRES)	L	M	N	O	P	Q	R	S	T	U	V
1607-075	2533.4		823	196		1434		420	632	2001	88	26
1607-076	2536.7		47	10		47		29	35	126	19	9
1607-077	2541		82	23		37		90	99	270	30	12
1607-078	2567		172	110		101		212	171	378	160	41
1607-079	2576							664	483	1446	741	214
1607-080	2589							96	66	203	71	25
1607-081	2612.5					16	11	26	22	42	47	19
1607-031	2654		53	15		73	9	57	25	90	29	13
1607-033	2672		75	20		103		72	47	186	9	7
1607-082	2687							1029	872	2026	240	45
1607-086	2881.5					191	72	230	121	398	20	10
1607-064	2951		5099	2099		6911	1152	2391	2367	7425	1061	918

TABLE 10b

PEAK AREA DATA
(M/Z 217)

SAMPLE NUMBER	DEPTH (METRES)	A	B	C	D	E	F	G	H	I	J	K
1607-075	2533.4	247	258	132	118	73	179				1418	305
1607-076	2536.7	44	36	13	19	17	14				65	45
1607-077	2541	62	80	20	34	21					112	162
1607-078	2567	96	188	21	51	48					142	196
1607-079	2576	324	469	168	174	118					958	
1607-080	2589	56	64	15							149	68
1607-081	2612.5	47	34	9	14	17					41	36
1607-031	2654	33	36	12	14	19	15				81	26
1607-033	2672	52	51	17	19	12	26				163	46
1607-082	2687	167	223	159	595	360					6843	2589
1607-086	2881.5	201	177	85	85	73					296	317
1607-064	2951	3357	2834	1840	1574	1292					7410	3399

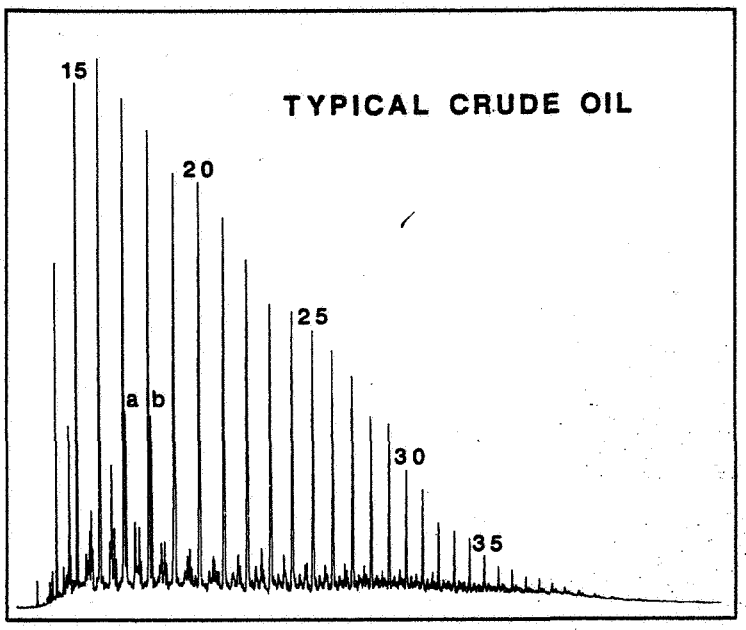
TABLE 10c

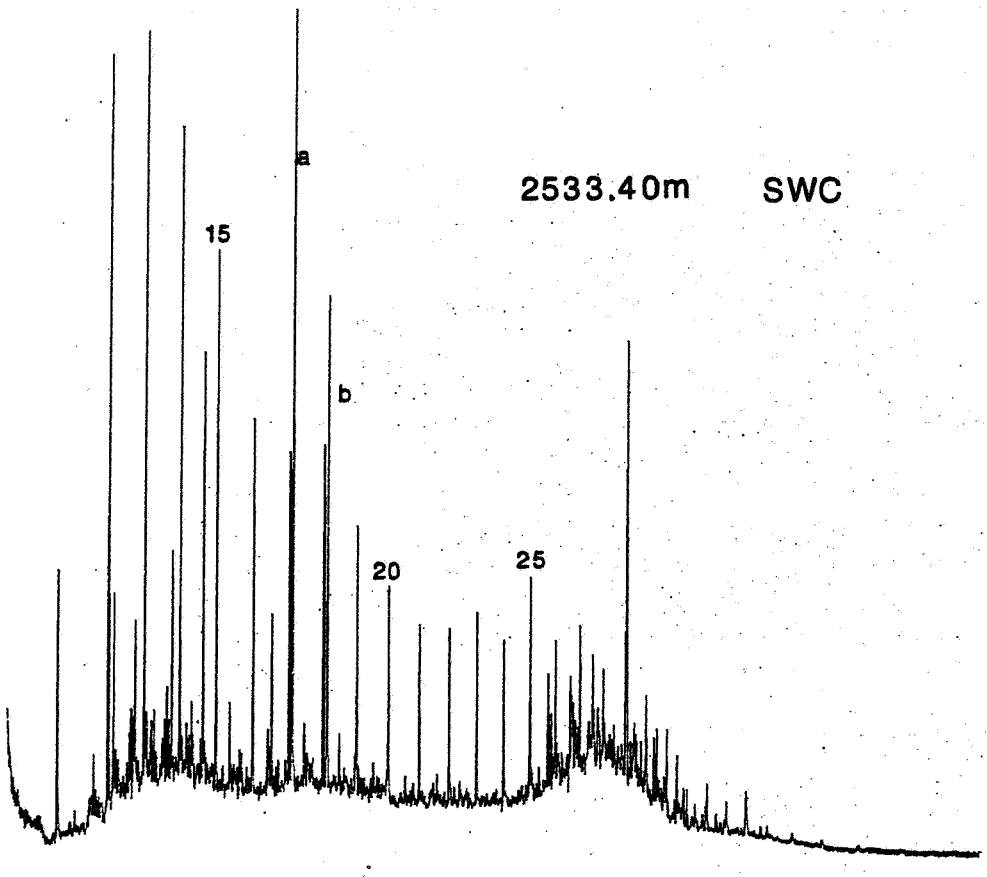
PEAK AREA DATA
(M/Z 218)

SAMPLE NUMBER	DEPTH (METRES)	A+B	C+D	E+F
1607-075	2533.4	497	714	1224
1607-076	2536.7	46	39	87
1607-077	2541	78	73	265
1607-078	2567	149	112	670
1607-079	2576	592	411	1679
1607-080	2589	92	73	231
1607-081	2612.5	54	44	85
1607-031	2654	62	69	94
1607-033	2672	90	97	156
1607-082	2687	1608	1841	3595
1607-086	2881.5	274	249	451
1607-064	2951	6662	7021	8536

FIGURE 8a C_{15+} SATURATES CHROMATOGRAMS

WELL 6507/11-4





a = PRISTANE

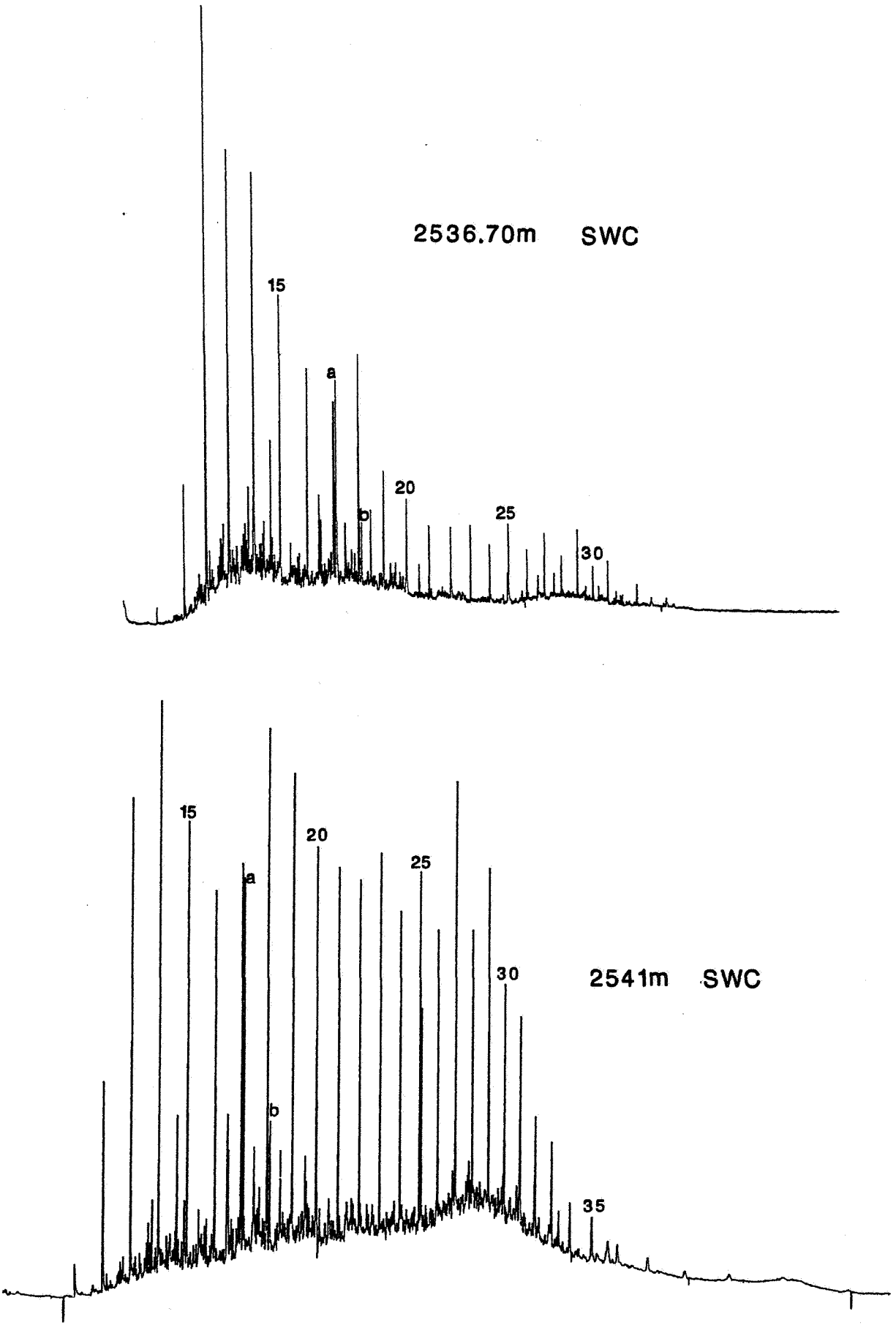
b = PHYTANE

CARBON NUMBERS OF NORMAL PARAFFINS INDICATED ($20-nC_{20}$)

FIGURE 8b C_{15+} SATURATES CHROMATOGRAMS

GEOCHEM

WELL 6507/11-4



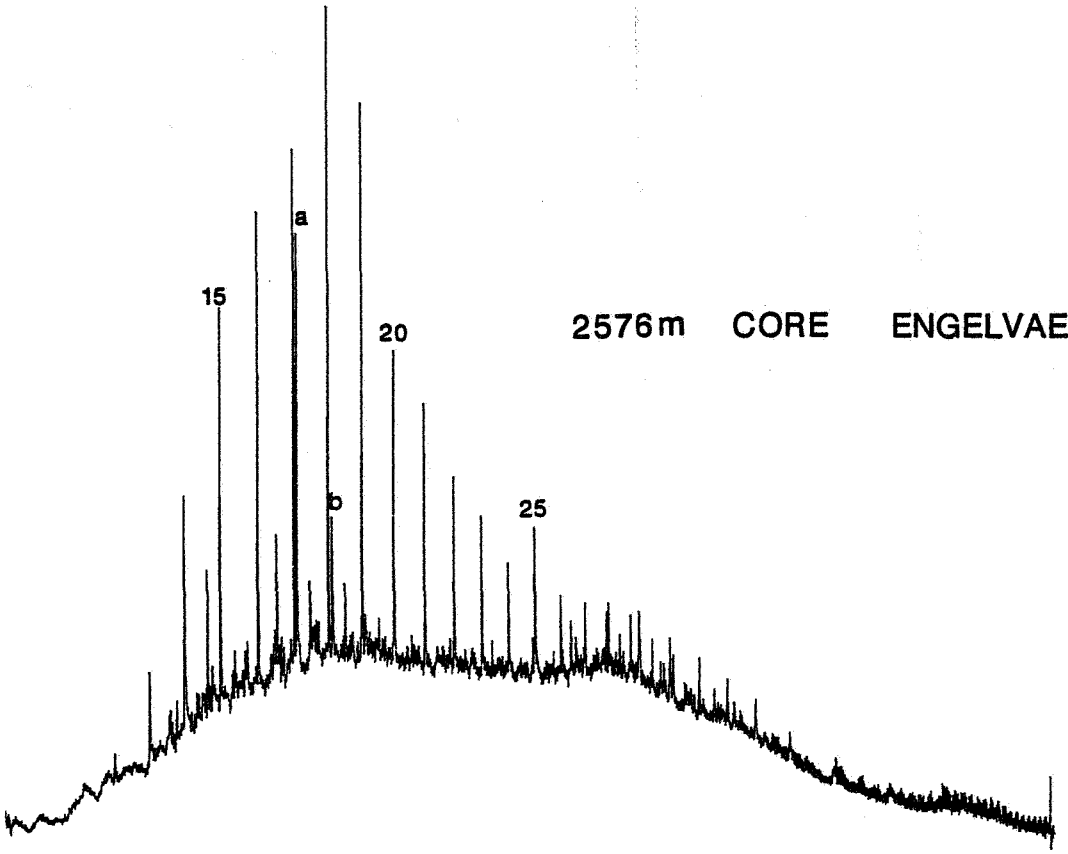
a = PRISTANE

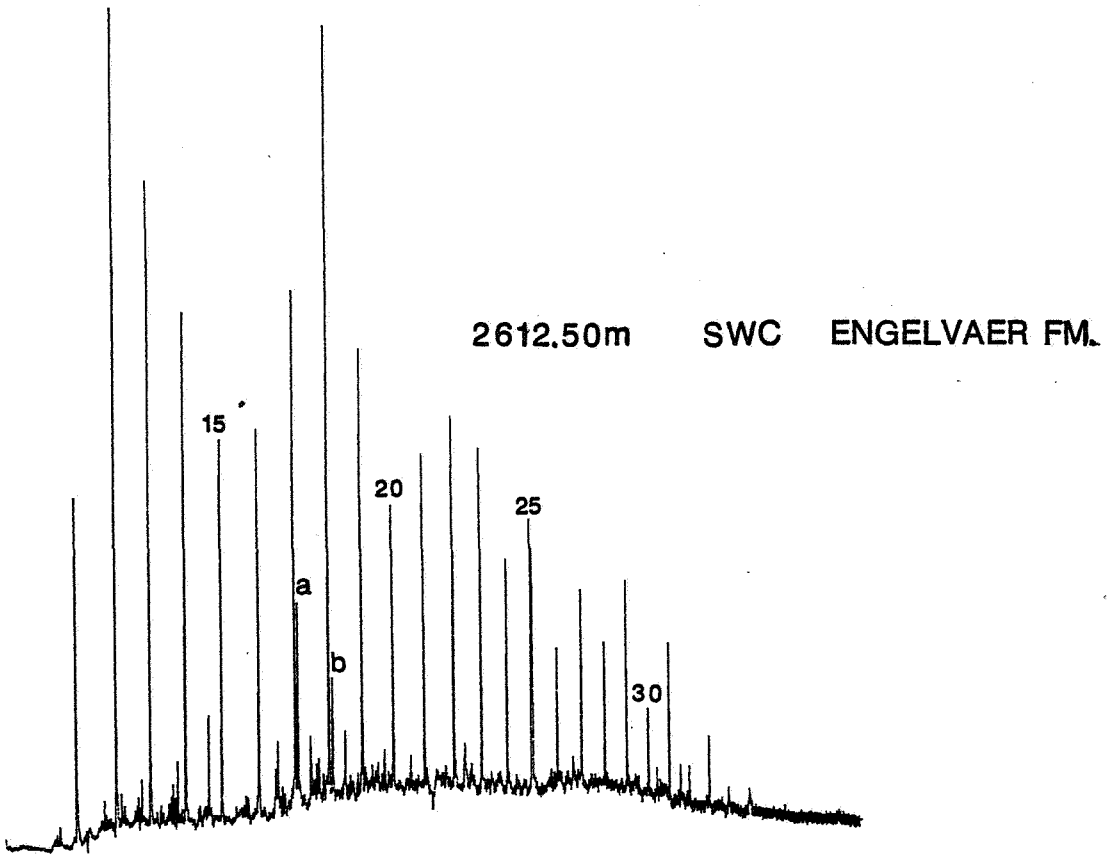
b = PHYTANE

CARBON NUMBERS OF NORMAL PARAFFINS INDICATED (20 - nC_{20})

FIGURE 8c C_{15+} SATURATES CHROMATOGRAMS

WELL 6507/11-4





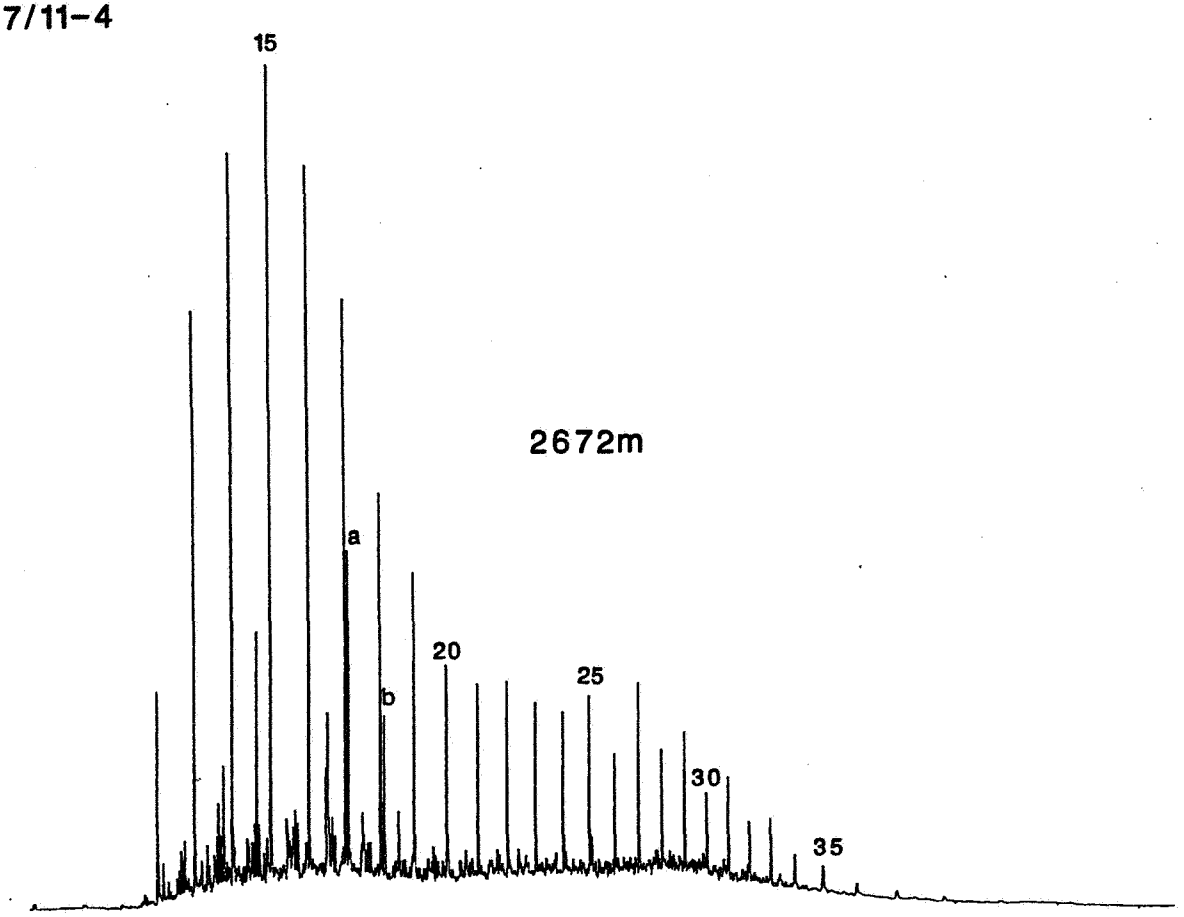
a = PRISTANE

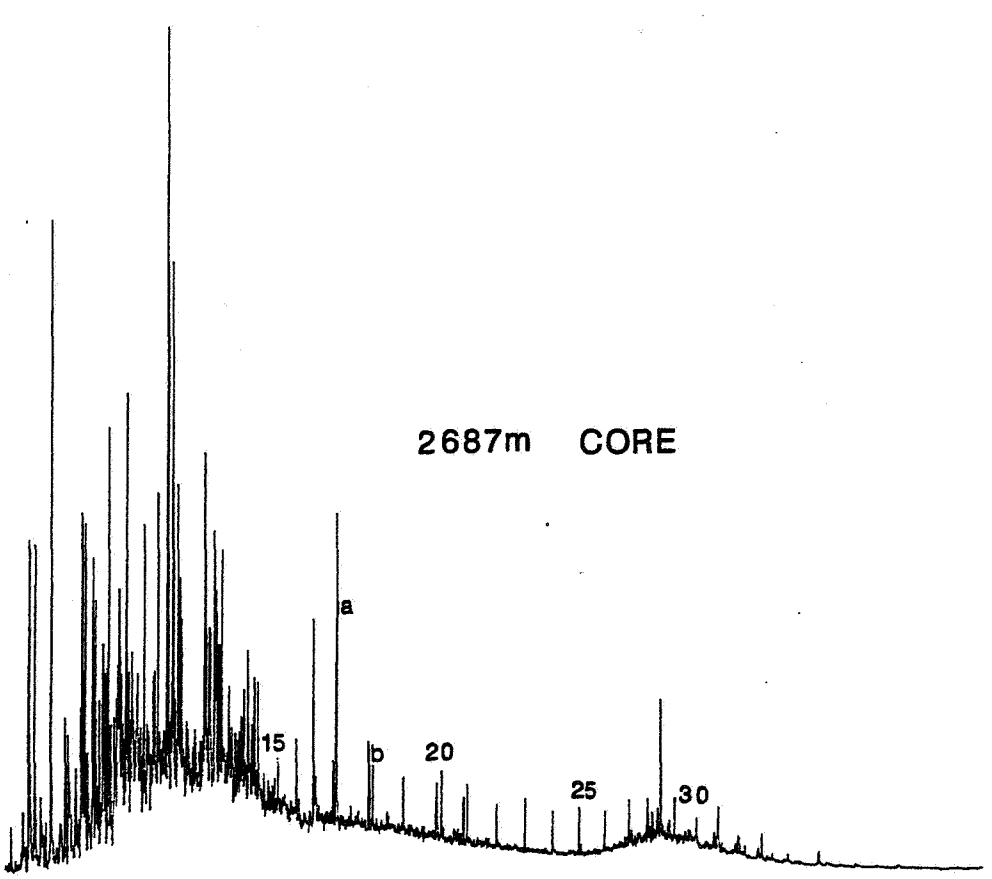
b = PHYTANE

CARBON NUMBERS OF NORMAL PARAFFINS INDICATED (20 - nC_{20})

FIGURE 8d C_{15+} SATURATES CHROMATOGRAMS

WELL 6507/11-4





a = PRISTANE

b = PHYTANE

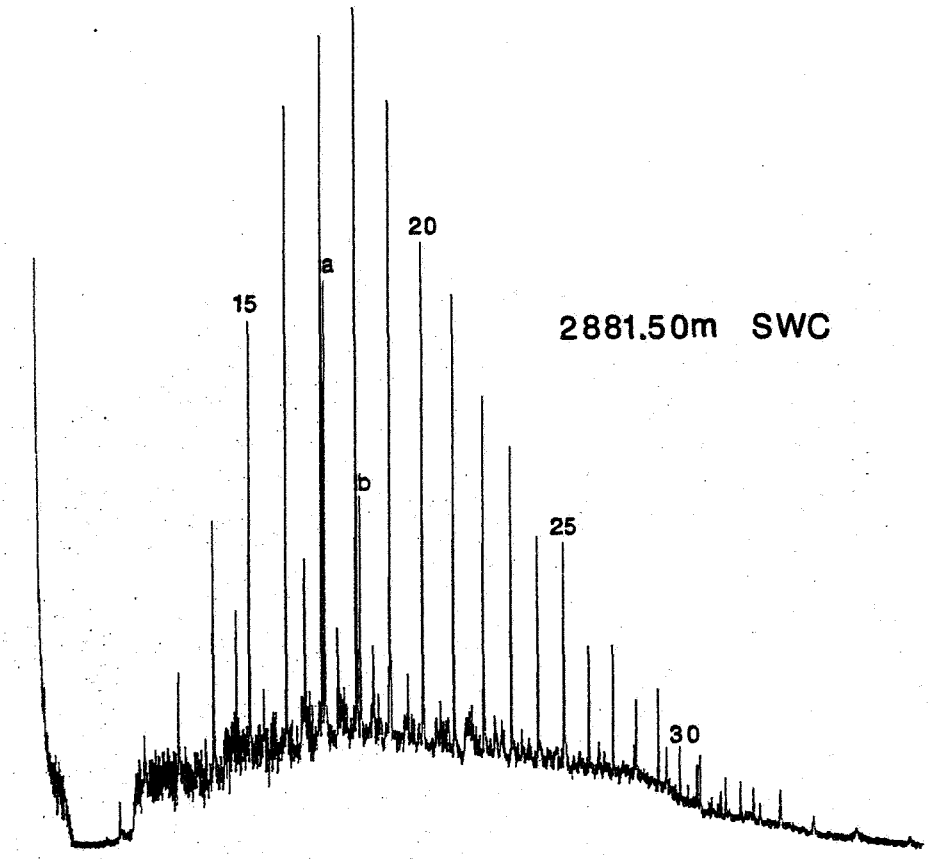
CARBON NUMBERS OF NORMAL PARAFFINS INDICATED (20 - nC_{20})

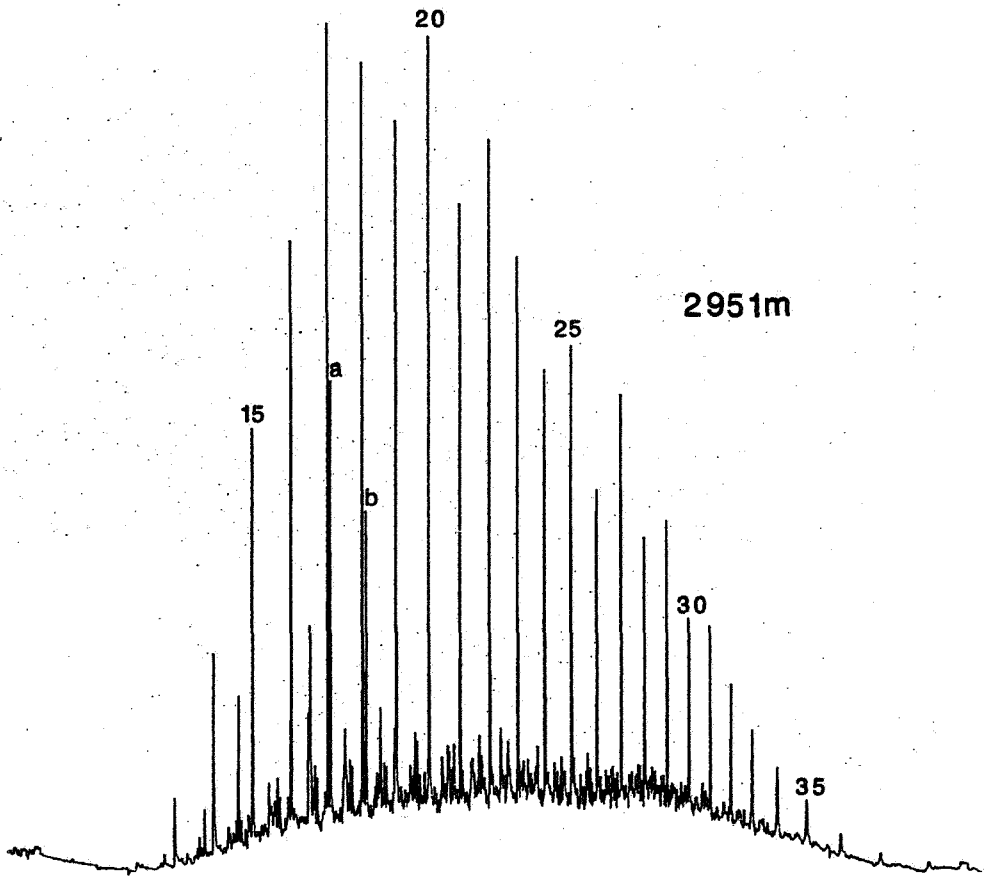
FIGURE 8e

C_{15+} SATURATES CHROMATOGRAMS

WELL 6507/11-4

GEOCHEM





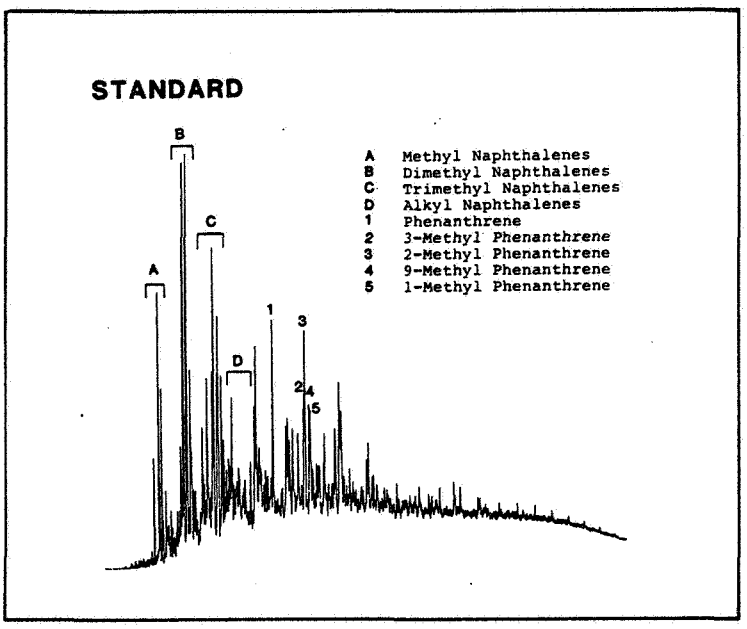
a = PRISTANE

b = PHYTANE

CARBON NUMBERS OF NORMAL PARAFFINS INDICATED (20 - nC_{20})

FIGURE 9a C_{15+} AROMATIC CHROMATOGRAMS

WELL 6507/11-4



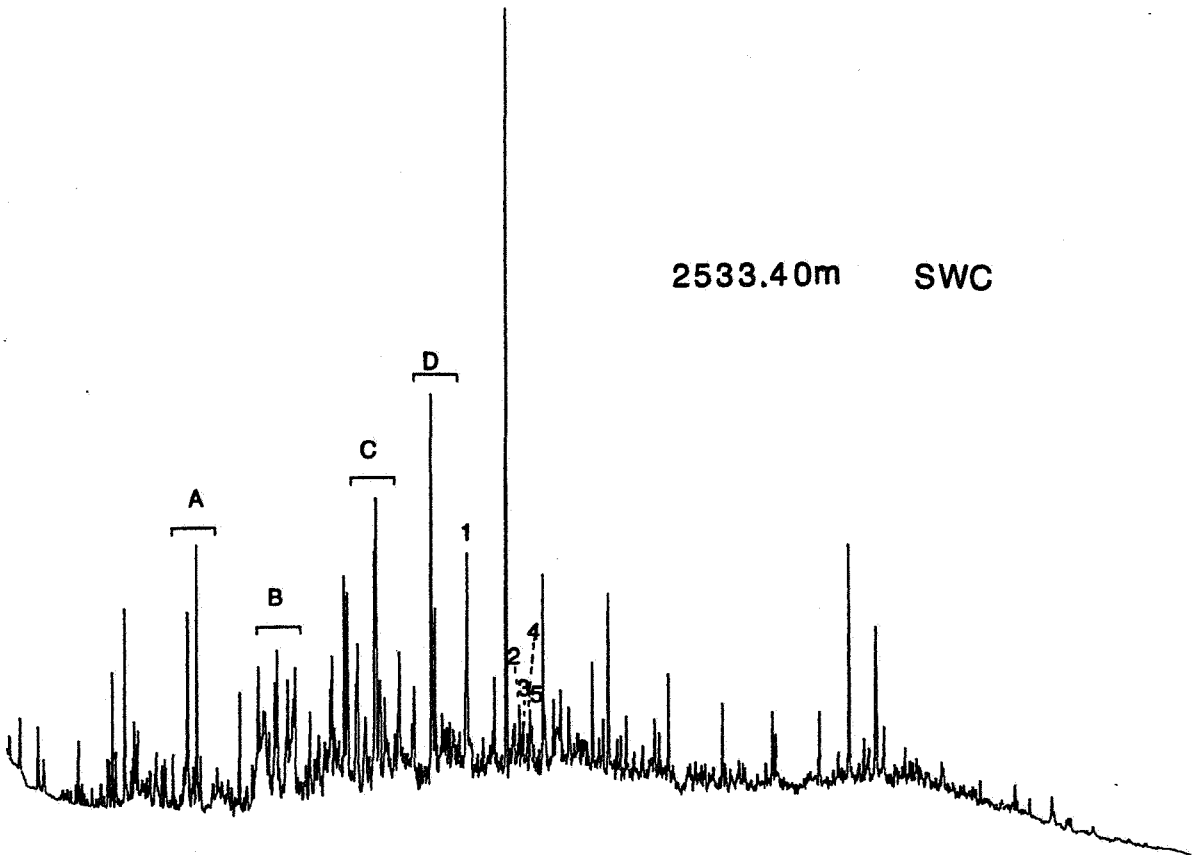
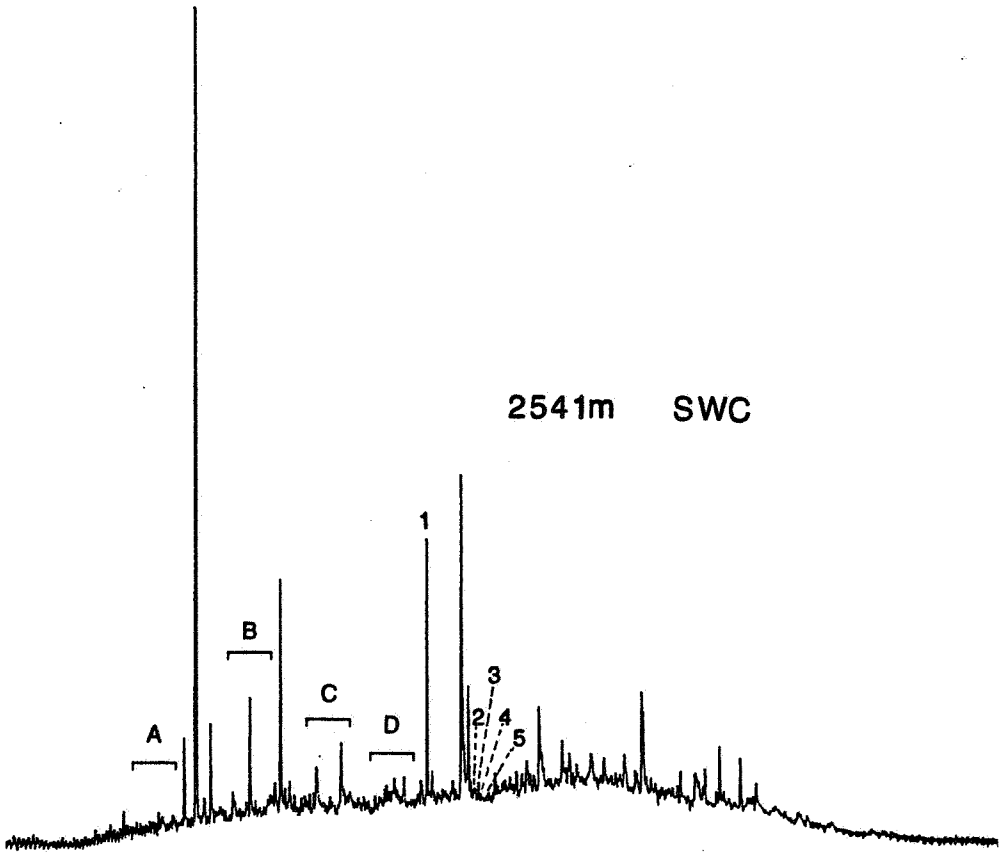
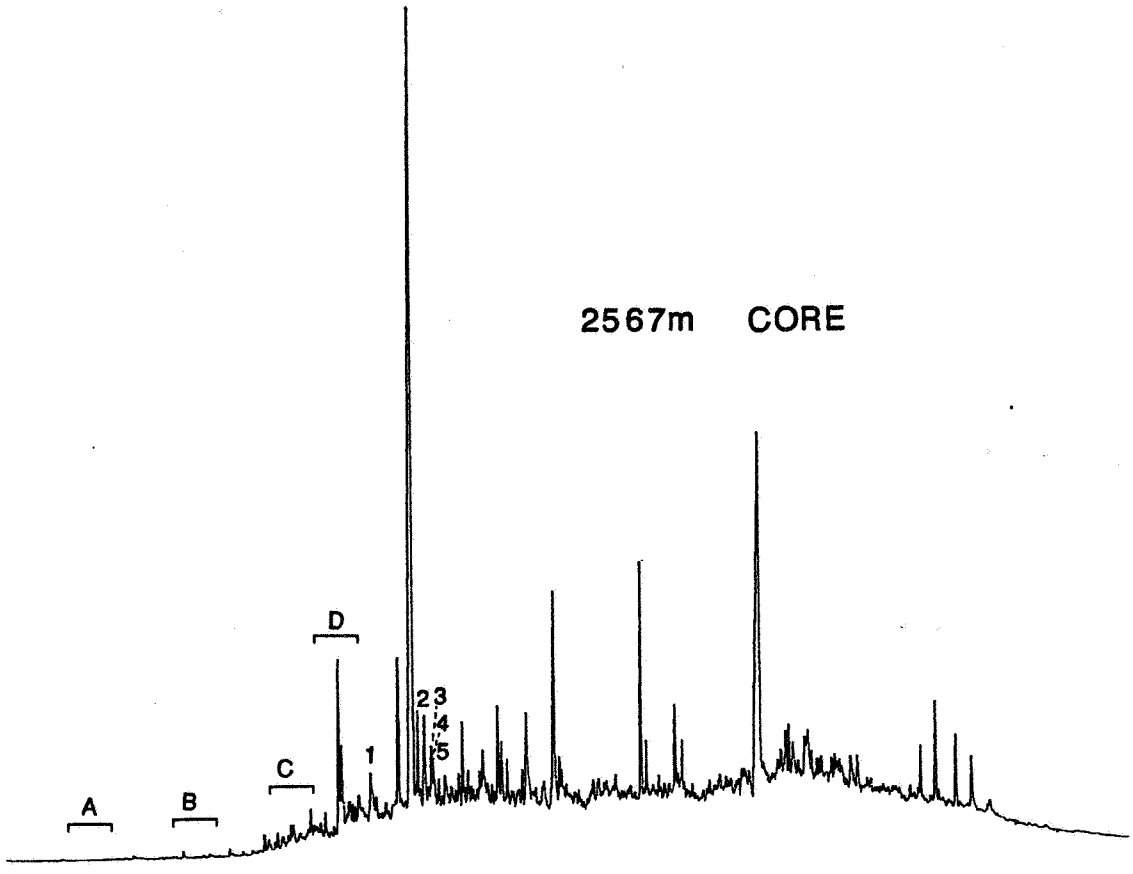


FIGURE 9b C_{15+} AROMATIC CHROMATOGRAMS

WELL 6507/11-4

GEOCHEM



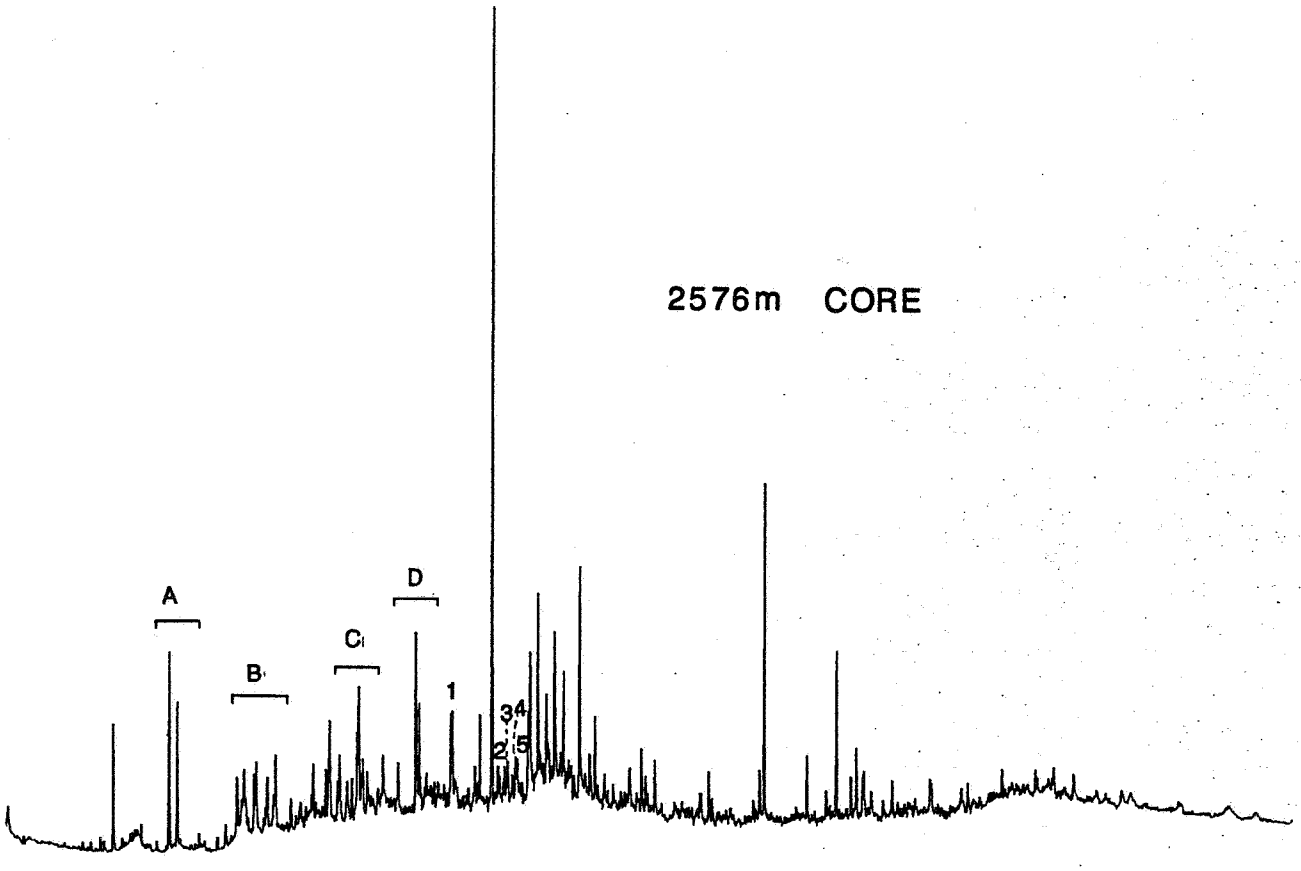


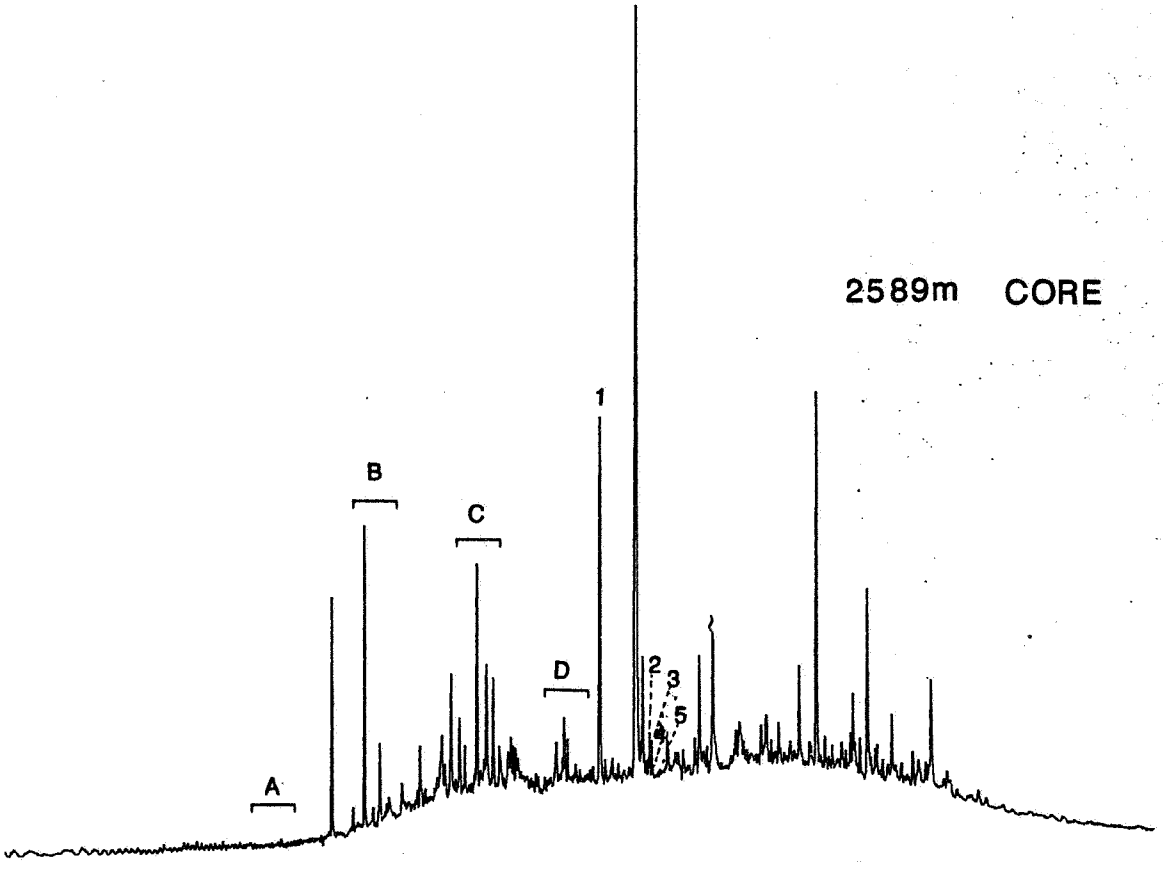
PEAK IDENTIFICATION ON FIRST SHEET

FIGURE 9c C_{15+} AROMATIC CHROMATOGRAMS

WELL 6507/11-4

GEOCHEM





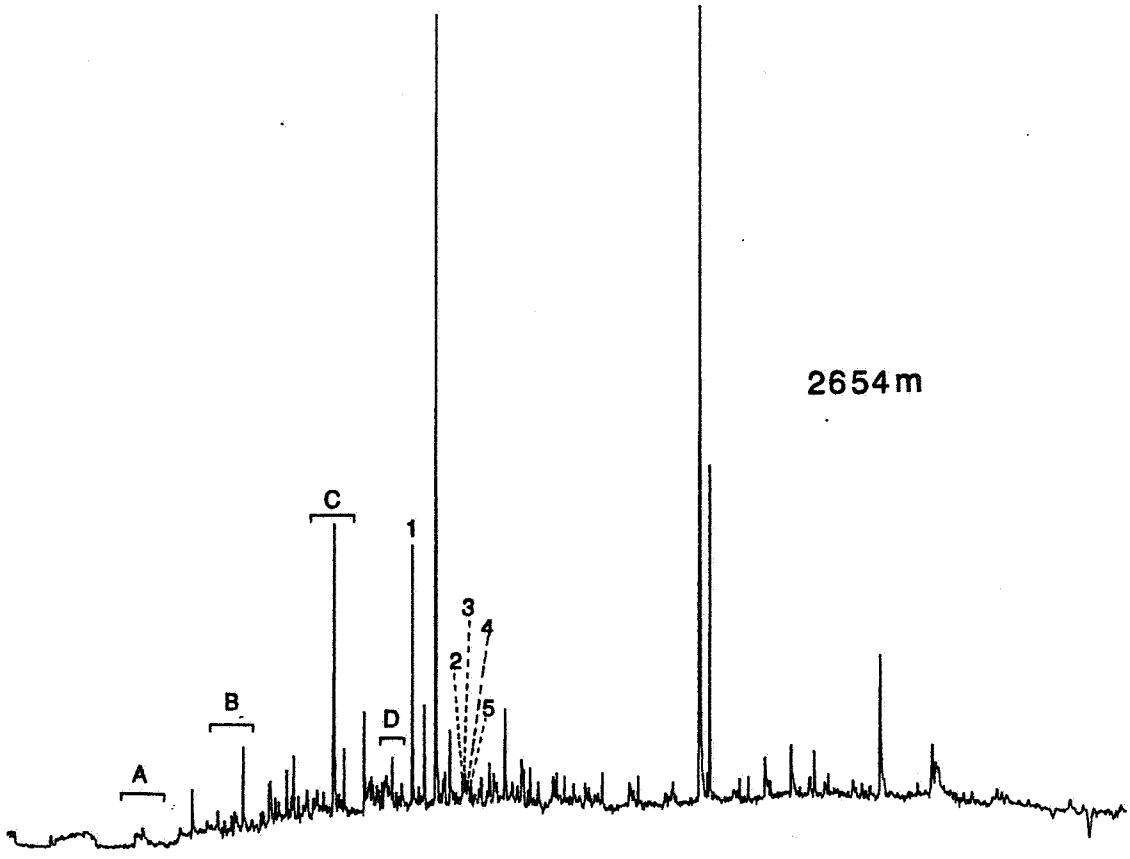
PEAK IDENTIFICATION ON FIRST SHEET

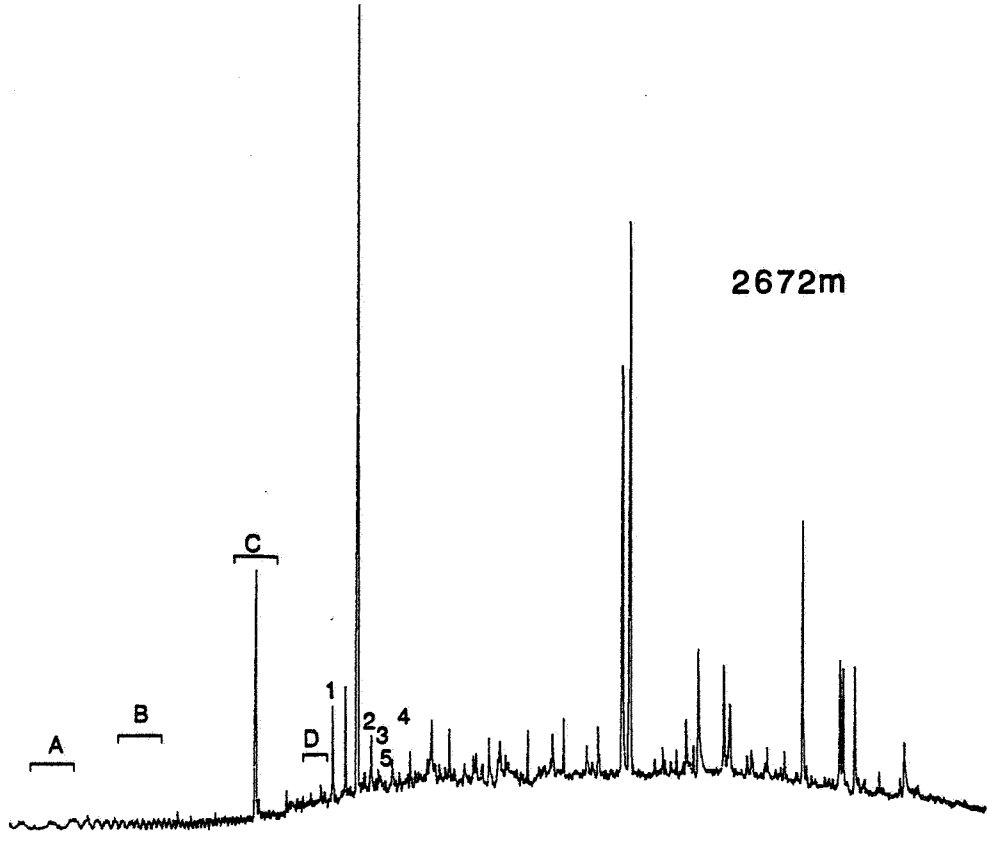
FIGURE 9d

C_{15+} AROMATIC CHROMATOGRAMS

WELL 6507/11-4

GEOCHEM



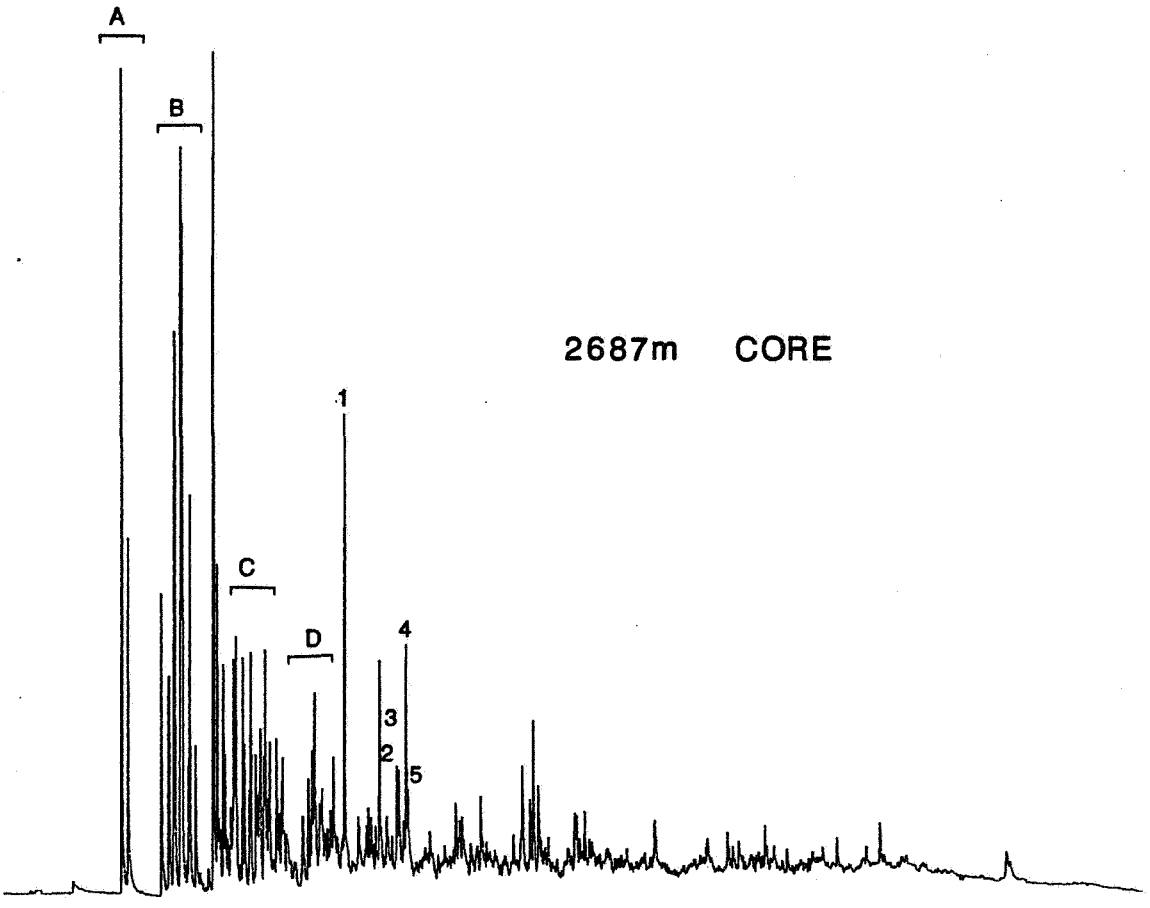


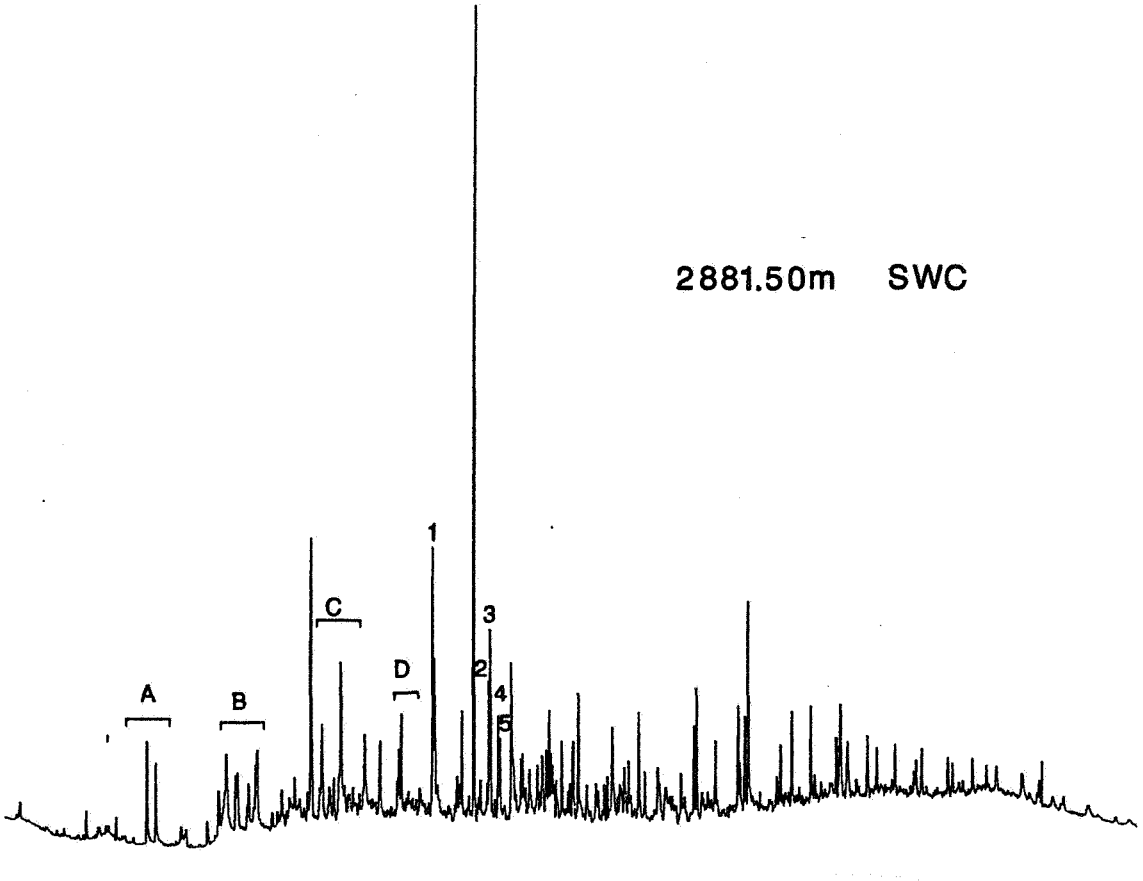
PEAK IDENTIFICATION ON FIRST SHEET

FIGURE 9e C_{15+} AROMATIC CHROMATOGRAMS

WELL 6507/11-4

GEOCHEM

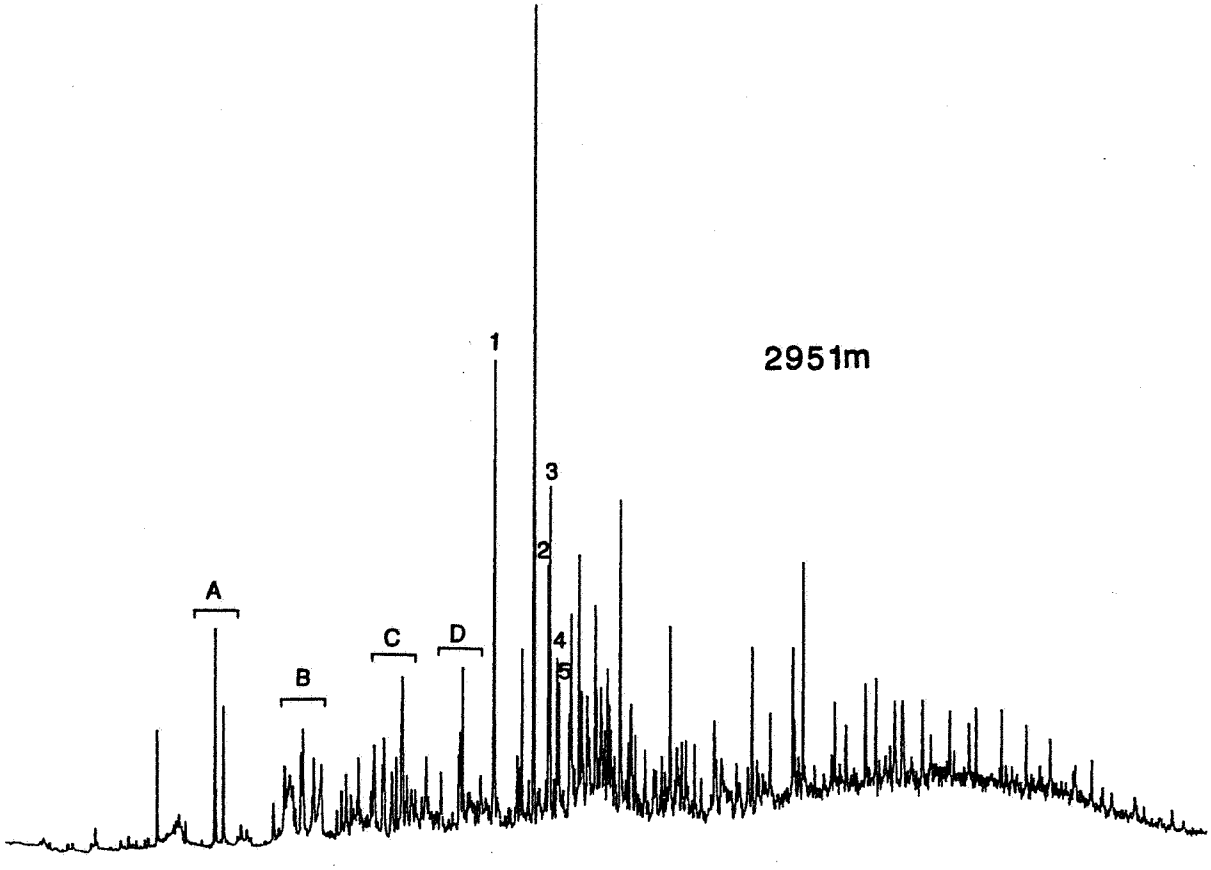




PEAK IDENTIFICATION ON FIRST SHEET

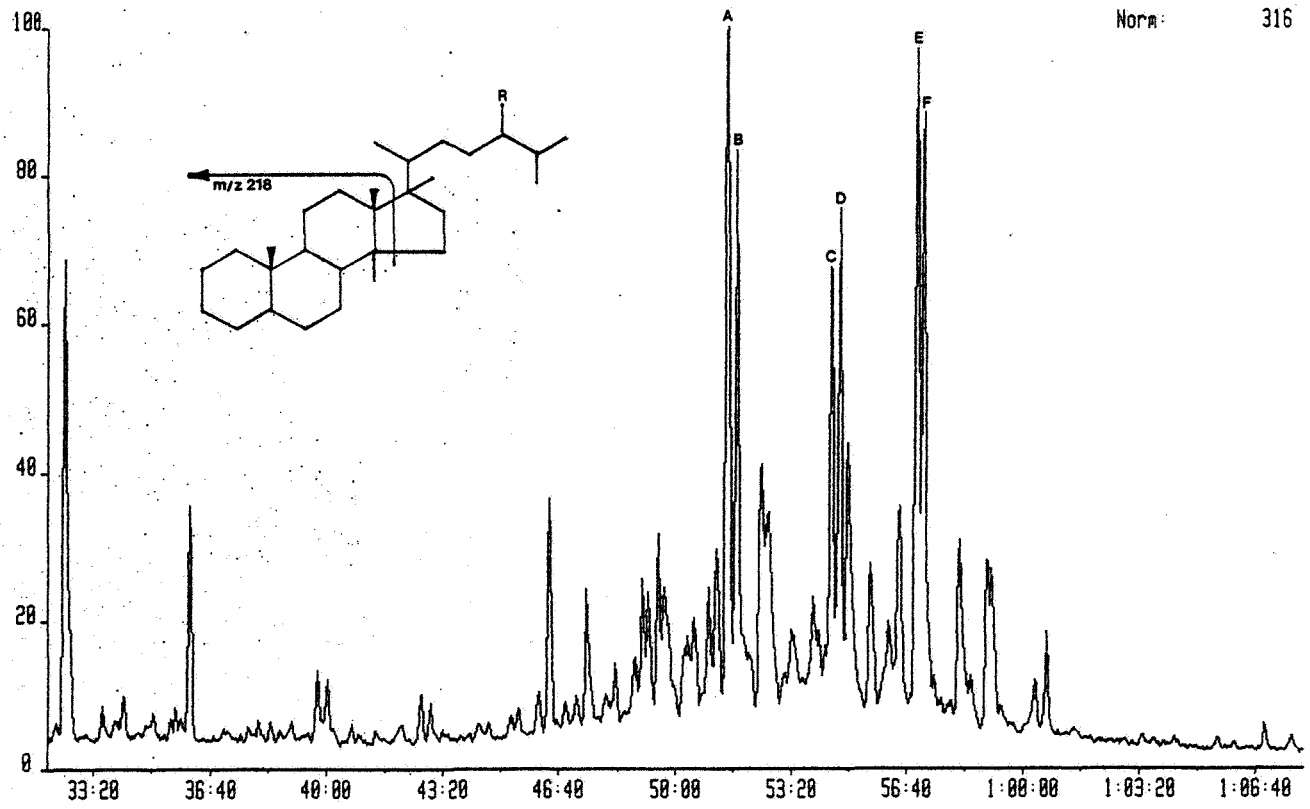
FIGURE 9f C_{15+} AROMATIC CHROMATOGRAMS

WELL 6507/11-4



PEAK IDENTIFICATION ON FIRST SHEET

GEH1 16-JUN-87 Sir:Magnetic TS250 Acnt:GEOCHEM Sys:BIOMARKER
Sample 1 Injection 1 Group 1 Mass 218.2034
Text:BIOMARKER TEST RUN

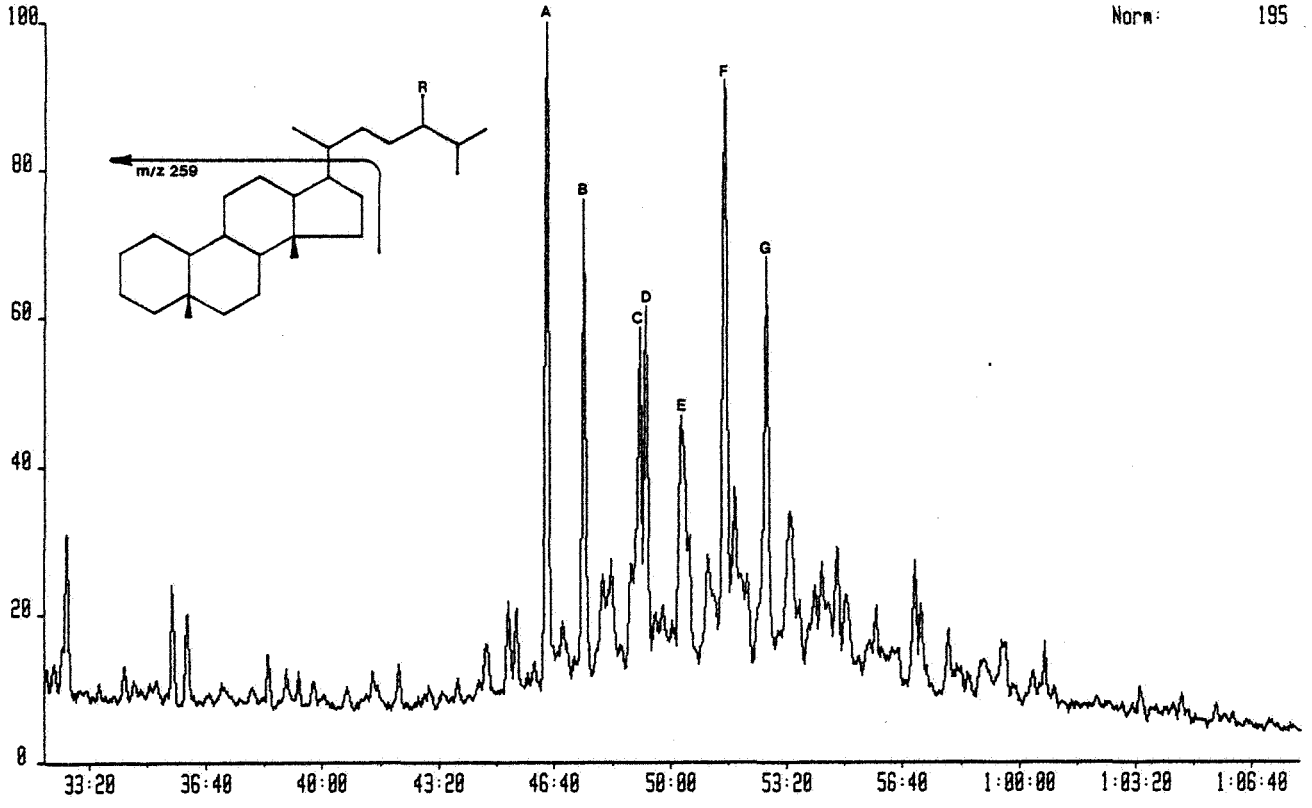


STERANE IDENTIFICATION

(M/Z 218 FRAGMENTOGRAM)

	COMPOUND	ELEMENTAL COMPOSITION
A	14β,17β-cholestane (20R)	$C_{27}H_{48}$
B	14β,17β-cholestane (20S)	$C_{27}H_{48}$
C	24-methyl-14β,17β-cholestane (20R)	$C_{28}H_{50}$
D	24-methyl-14β,17β-cholestane (20S)	$C_{28}H_{50}$
E	24-ethyl-14β,17β-cholestane (20R)	$C_{29}H_{52}$
F	24-ethyl-14β,17β-cholestane (20S)	$C_{29}H_{52}$

GEH1 16-JUN-87 Sir:Magnetic TS250 Acnt:GEOCHEM Sys:BIOMARKER
Sample 1 Injection 1 Group 1 Mass 259.2427
Text:BIOMARKER TEST RUN



STERANE IDENTIFICATION

(M/Z 259 FRAGMENTOGRAM)

	COMPOUND	ELEMENTAL COMPOSITION
A	13β,17α-diacholestane (20S)	$C_{27}H_{48}$
B	13β,17α-diacholestane (20R)	$C_{27}H_{48}$
C	13α,17β-diacholestane (20R)	$C_{27}H_{48}$
D	24,-methyl-13β,17α-diacholestane (20S)	$C_{28}H_{50}$
E	24,-methyl-13β,17α-diacholestane (20R)	$C_{28}H_{50}$
F	24,-ethyl-13β,17α-diacholestane (20S)	$C_{29}H_{52}$
G	24,-ethyl-13β,17α-diacholestane (20R)	$C_{29}H_{52}$

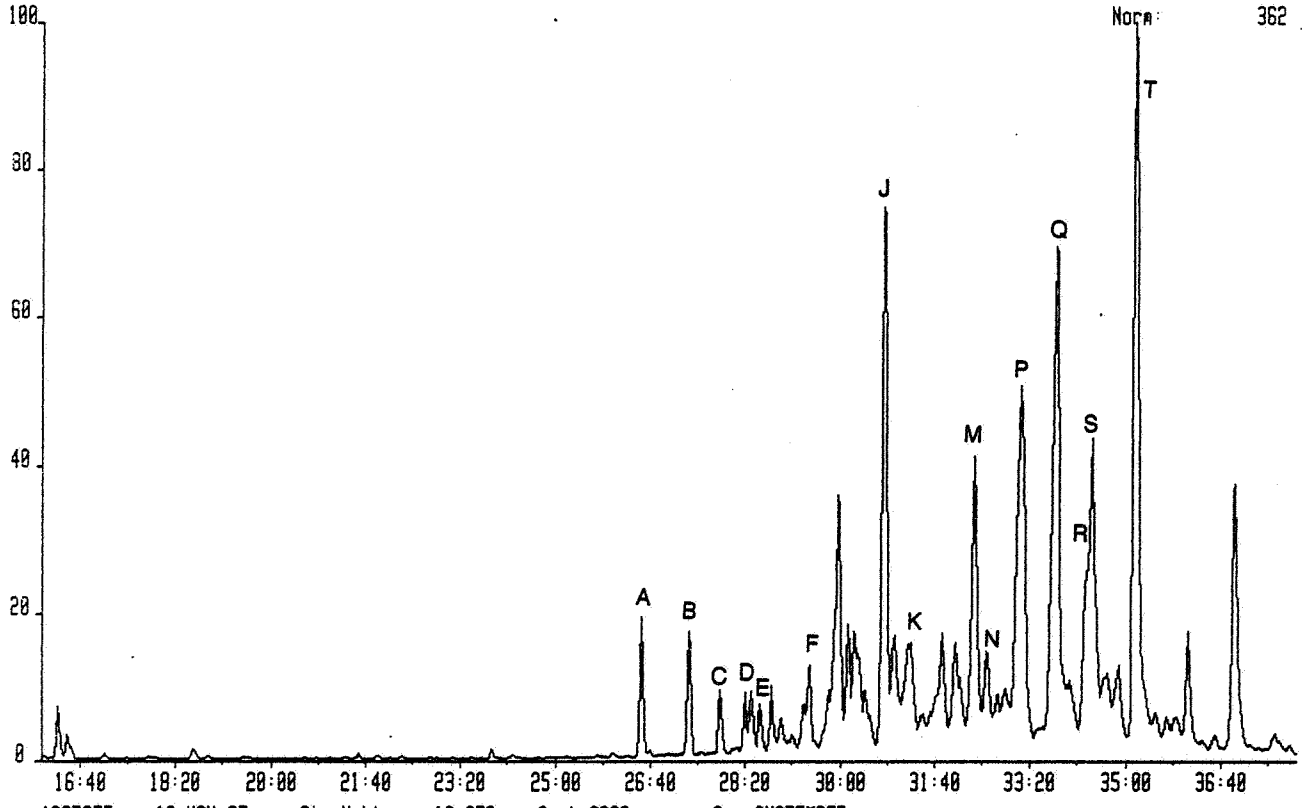
FIGURE 10a

MASS FRAGMENTOGRAMS

WELL 6507/11-4

STERANES

1607075 10-NOV-87 Sir:Voltage 12-250 Acnt:SAGA Sys:SYSTEMDEF
Sample 1 Injection 1 Group 1 Mass 217.1956
Text:WELL 6507/11-4 2533.4M SWC



1607075 10-NOV-87 Sir:Voltage 12-250 Acnt:SAGA Sys:SYSTEMDEF
Sample 1 Injection 1 Group 1 Mass 218.2034
Text:WELL 6507/11-4 2533.4M SWC

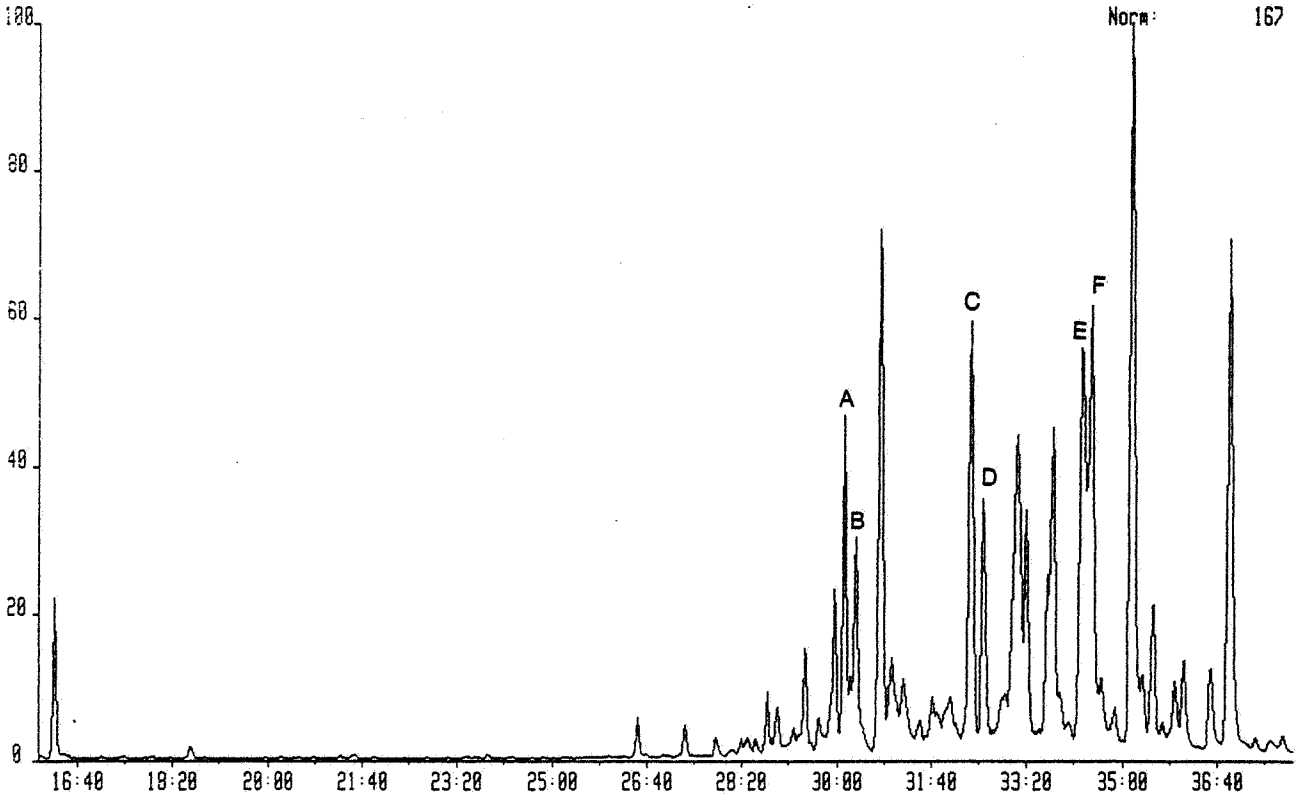


FIGURE 10a

MASS FRAGMENTOGRAMS

WELL 6507/11-4

STERANES

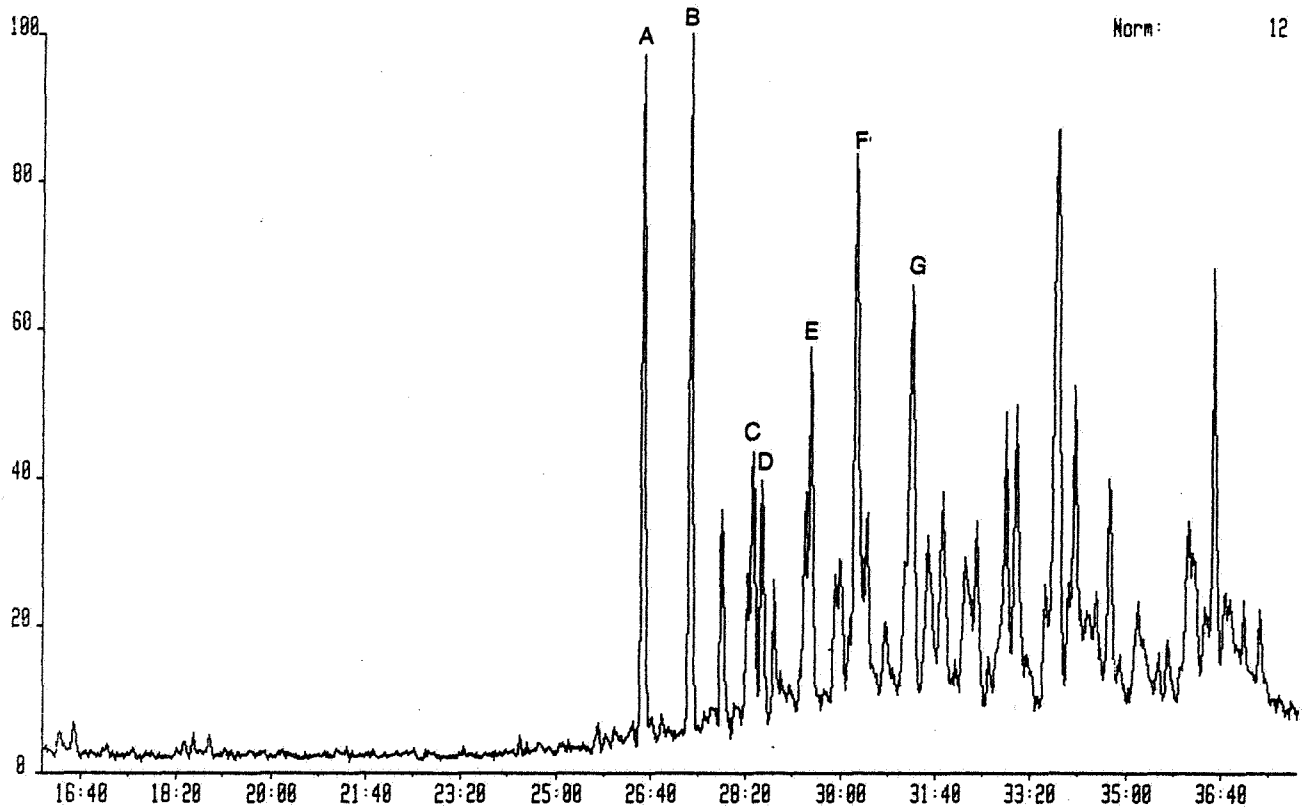


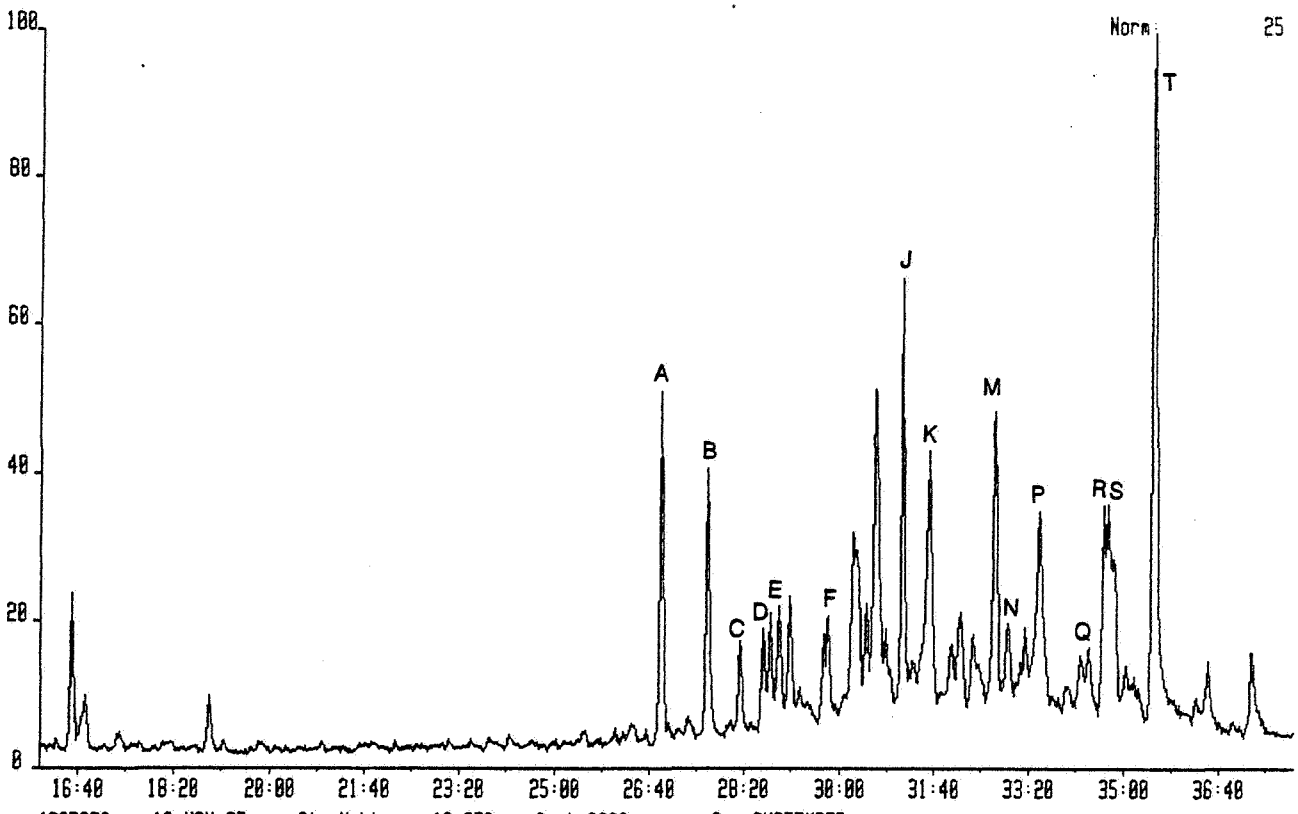
FIGURE 10b

MASS FRAGMENTOGRAMS

WELL 6507/11-4

STERANES

1607076 10-NOV-87 Sir:Voltage 12-250 Acnt:SAGA Sys:SYSTEMDEF
Sample 1 Injection 1 Group 1 Mass 217.1956
Text:WELL 6507/11-4 2536.7M SWC



1607076 10-NOV-87 Sir:Voltage 12-250 Acnt:SAGA Sys:SYSTEMDEF
Sample 1 Injection 1 Group 1 Mass 218.2034
Text:WELL 6507/11-4 2536.7M SWC

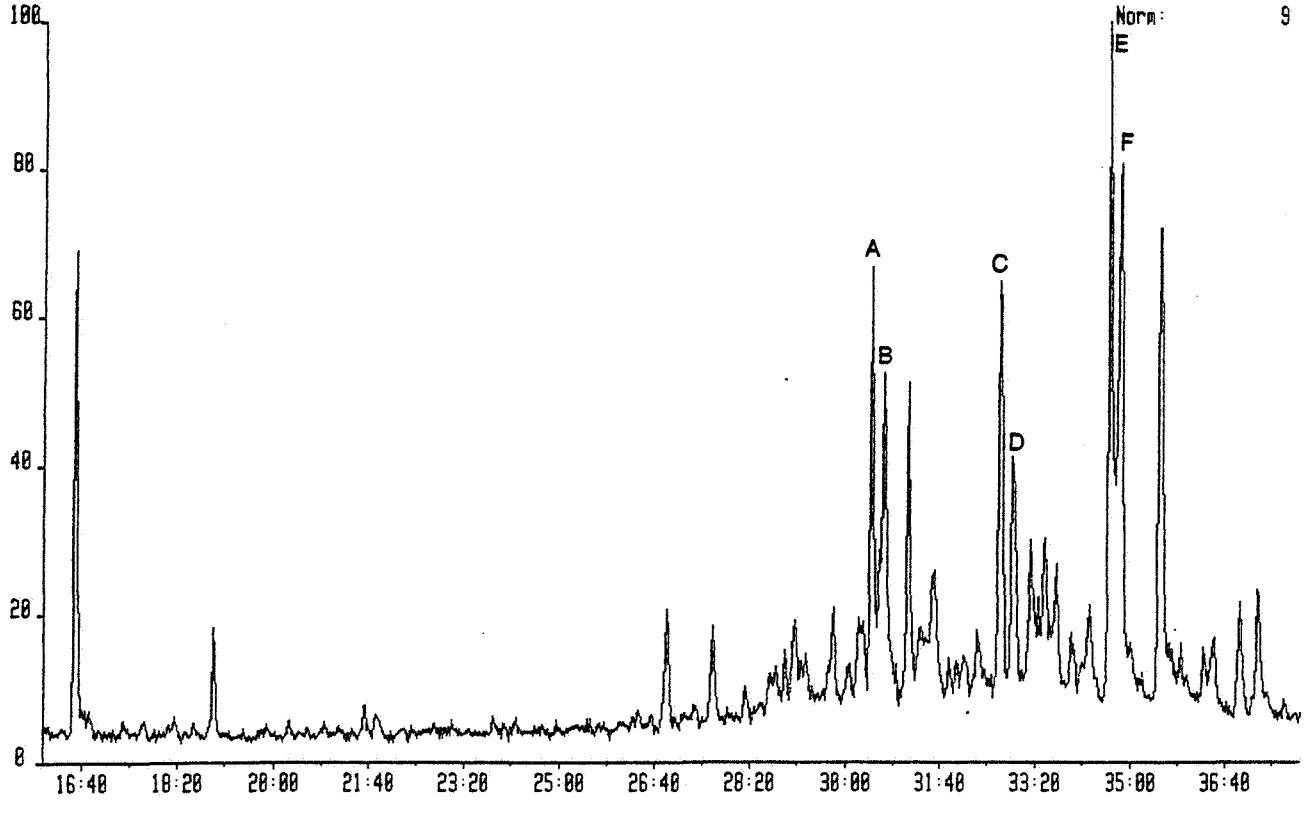


FIGURE 10b

MASS FRAGMENTOGRAMS

WELL 6507/11-4

STERANES

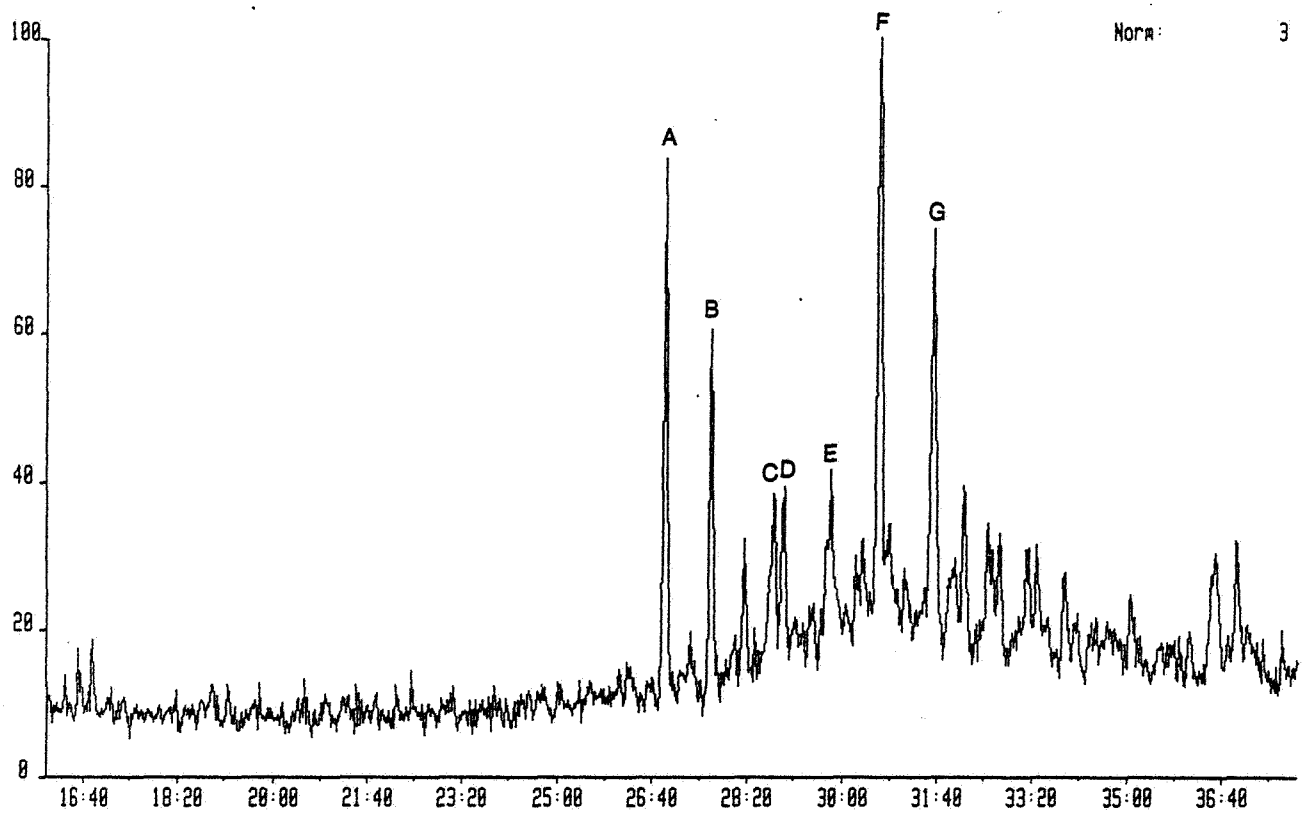


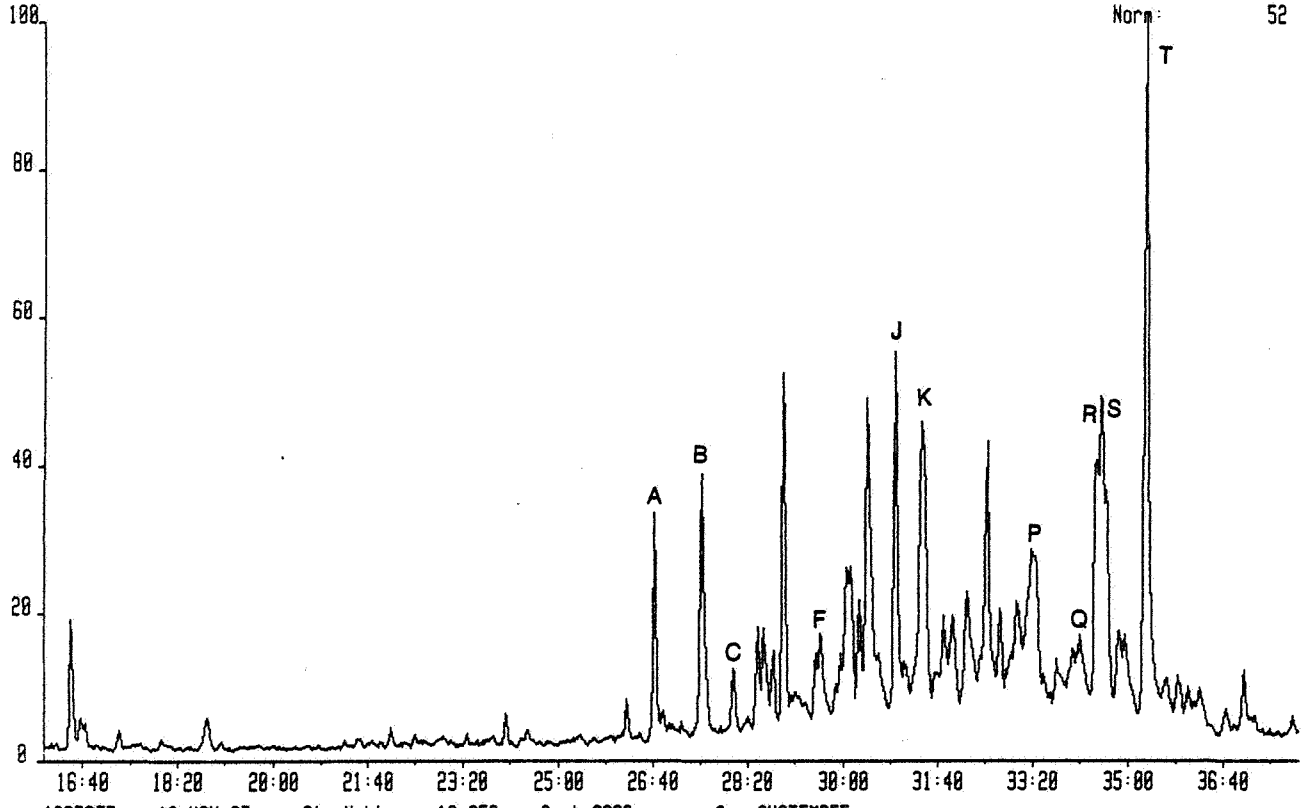
FIGURE 10c

MASS FRAGMENTOGRAMS

WELL 6507/11-4

STERANES

1607077 10-NOV-87 Sir:Voltage 12-250 Acnt:SAGA Sys:SYSTEMDEF
Sample 1 Injection 1 Group 1 Mass 217.1956
Text:WELL 6507/11-4 2541M SWC



1607077 10-NOV-87 Sir:Voltage 12-250 Acnt:SAGA Sys:SYSTEMDEF
Sample 1 Injection 1 Group 1 Mass 218.2034
Text:WELL 6507/11-4 2541M SWC

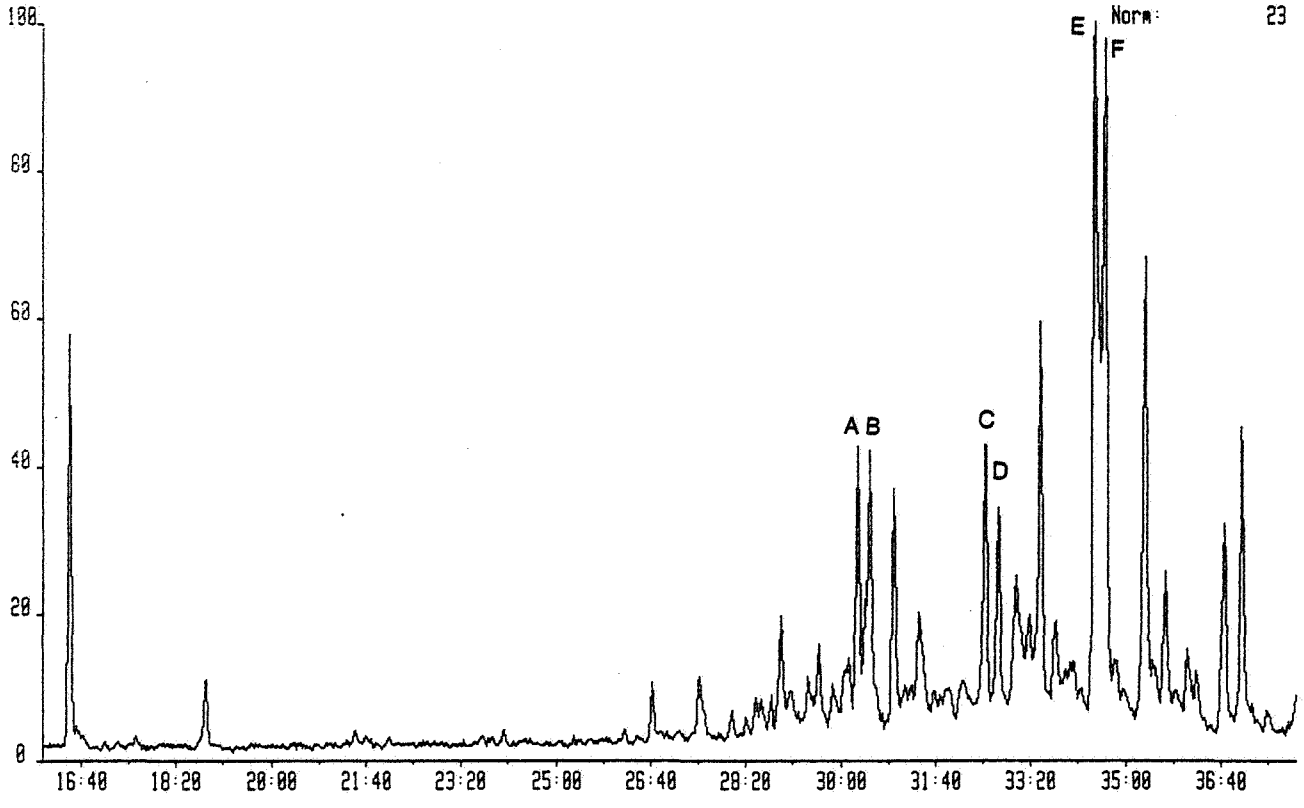


FIGURE 10c

MASS FRAGMENTOGRAMS

WELL 6507/11-4

STERANES

1607077 10-NOV-87 Sir:Voltage 12-250 Acnt:SAGA Sys:SYSTEMDEF
Sample 1 Injection 1 Group 1 Mass 259.2427
Text:WELL 6507/11-4 2541M SWC

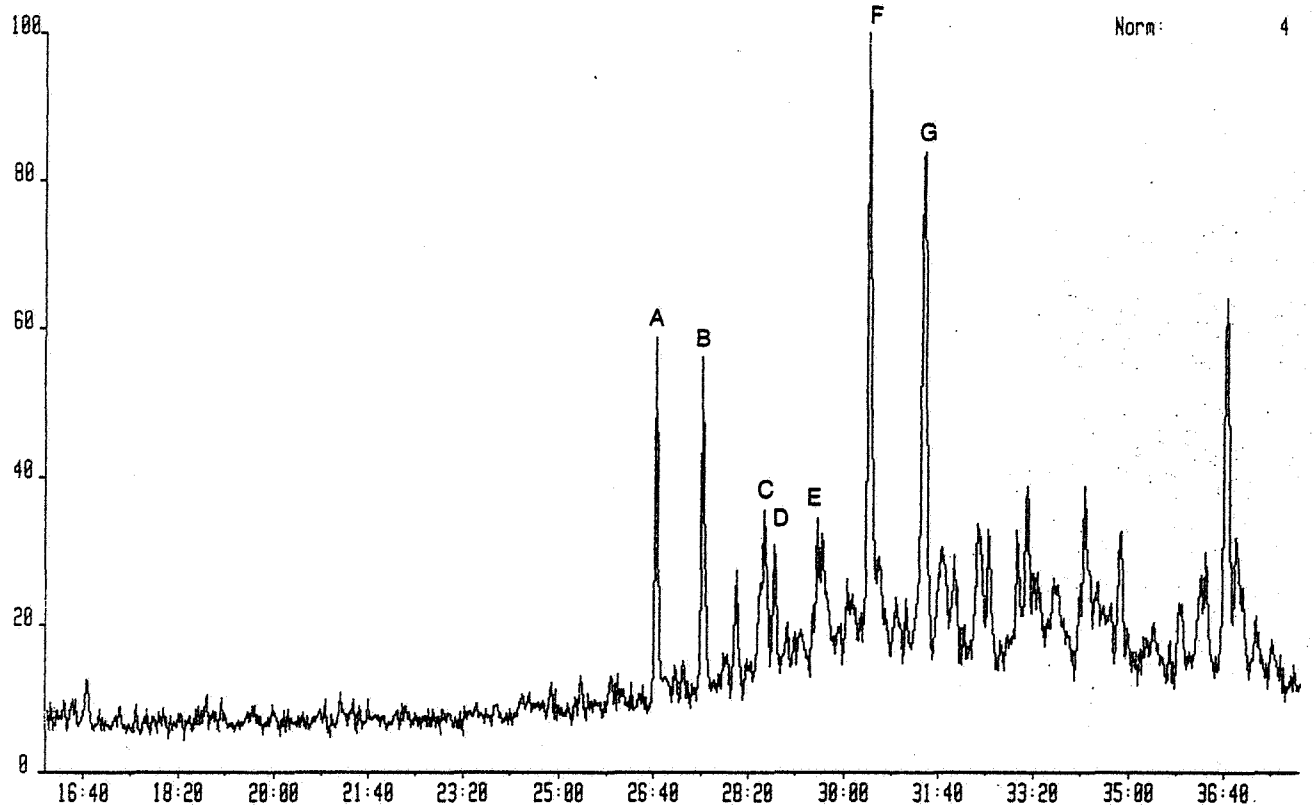
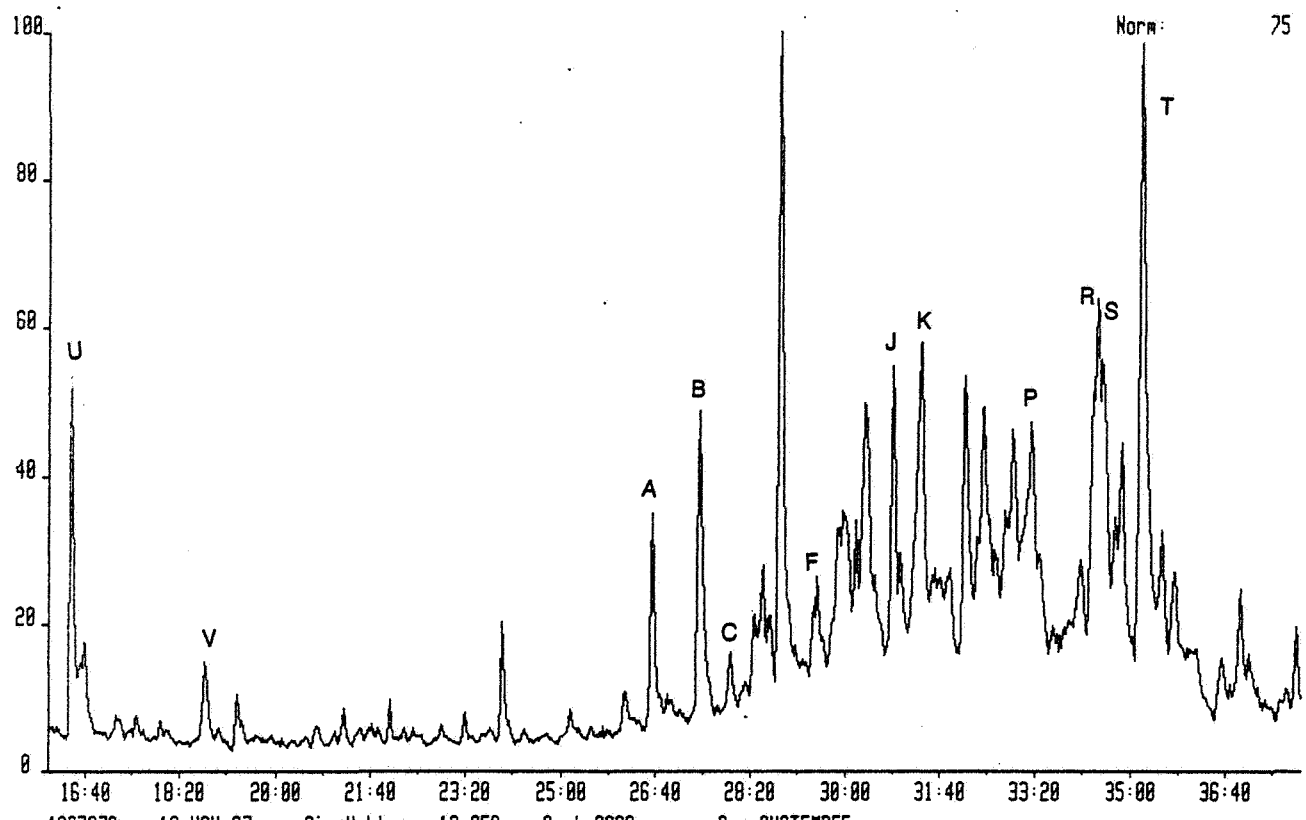


FIGURE 10d

MASS FRAGMENTOGRAMS

WELL 6507/11-4

STERANES



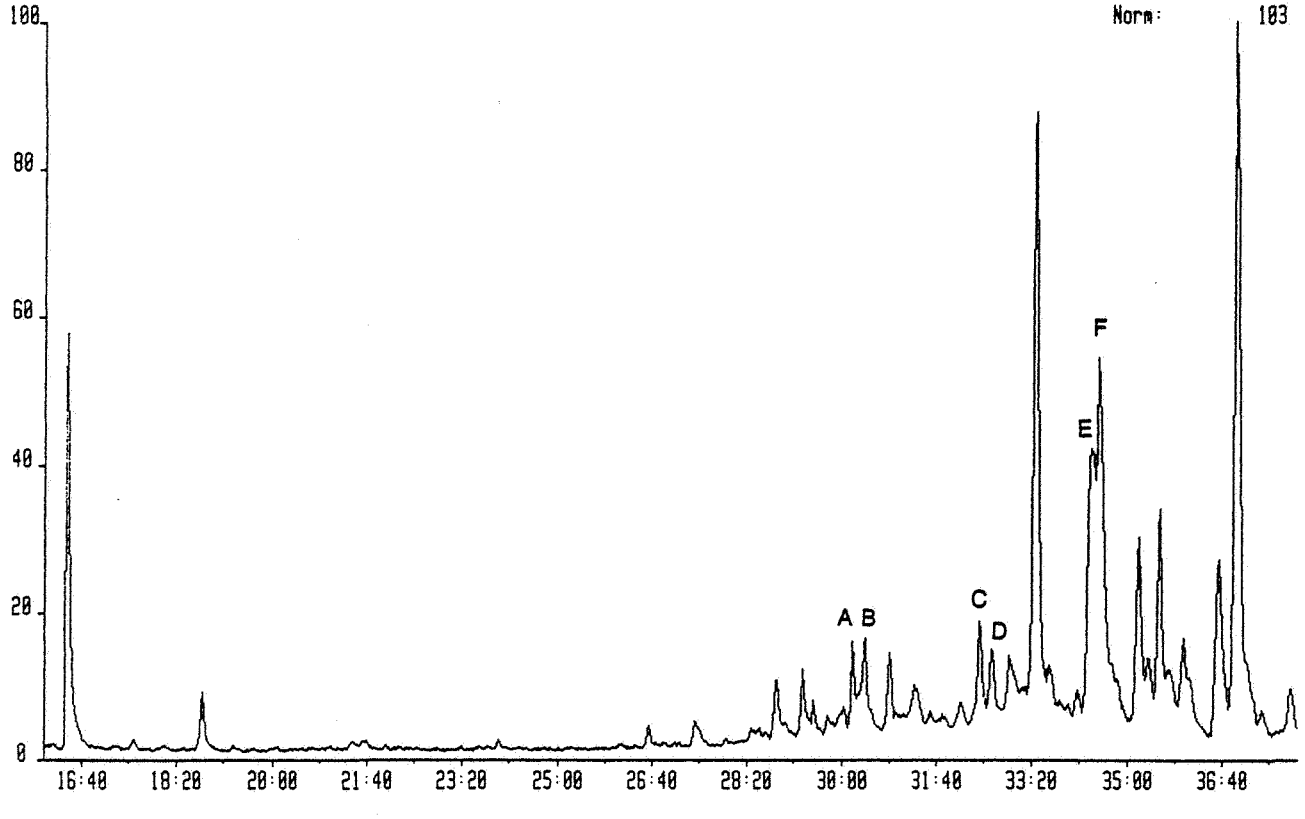


FIGURE 10d

MASS FRAGMENTOGRAMS

WELL 6507/11-4

STERANES

1607078 10-NOV-87 Sir:Voltage 12-250 Acnt:SAGA Sys:SYSTEMDEF
Sample 1 Injection 1 Group 1 Mass 259.2427
Text:WELL 6507/11-4 2567M CORE

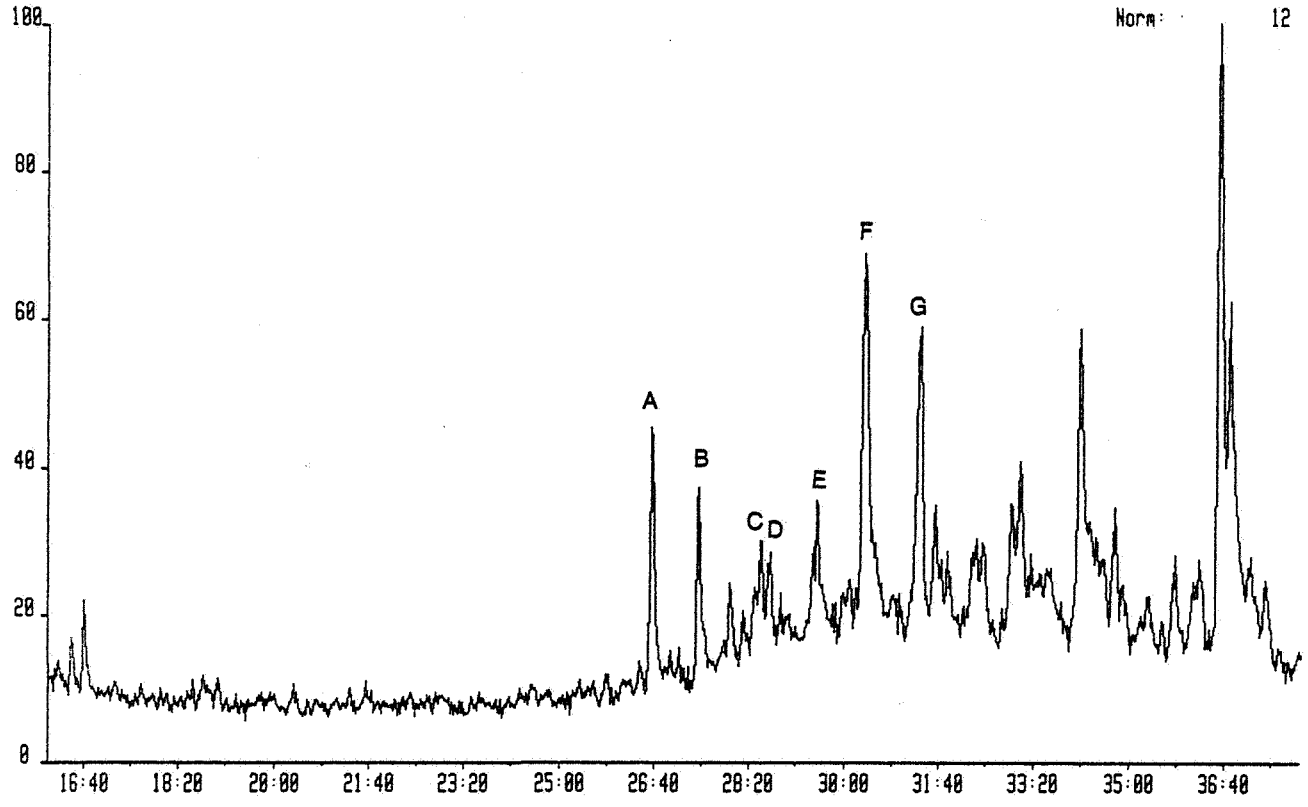
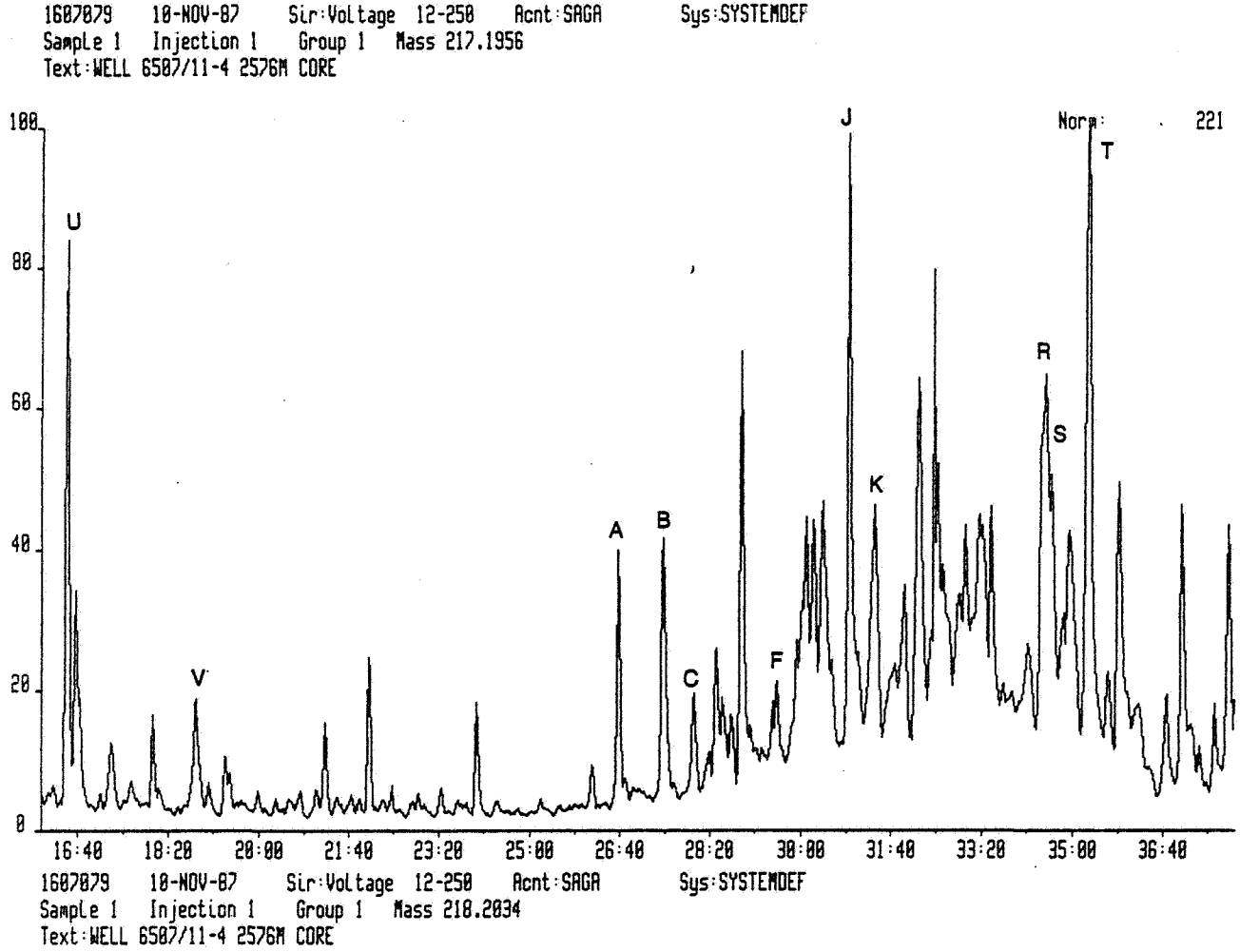


FIGURE 10e

MASS FRAGMENTOGRAMS

WELL 6507/11-4

STERANES



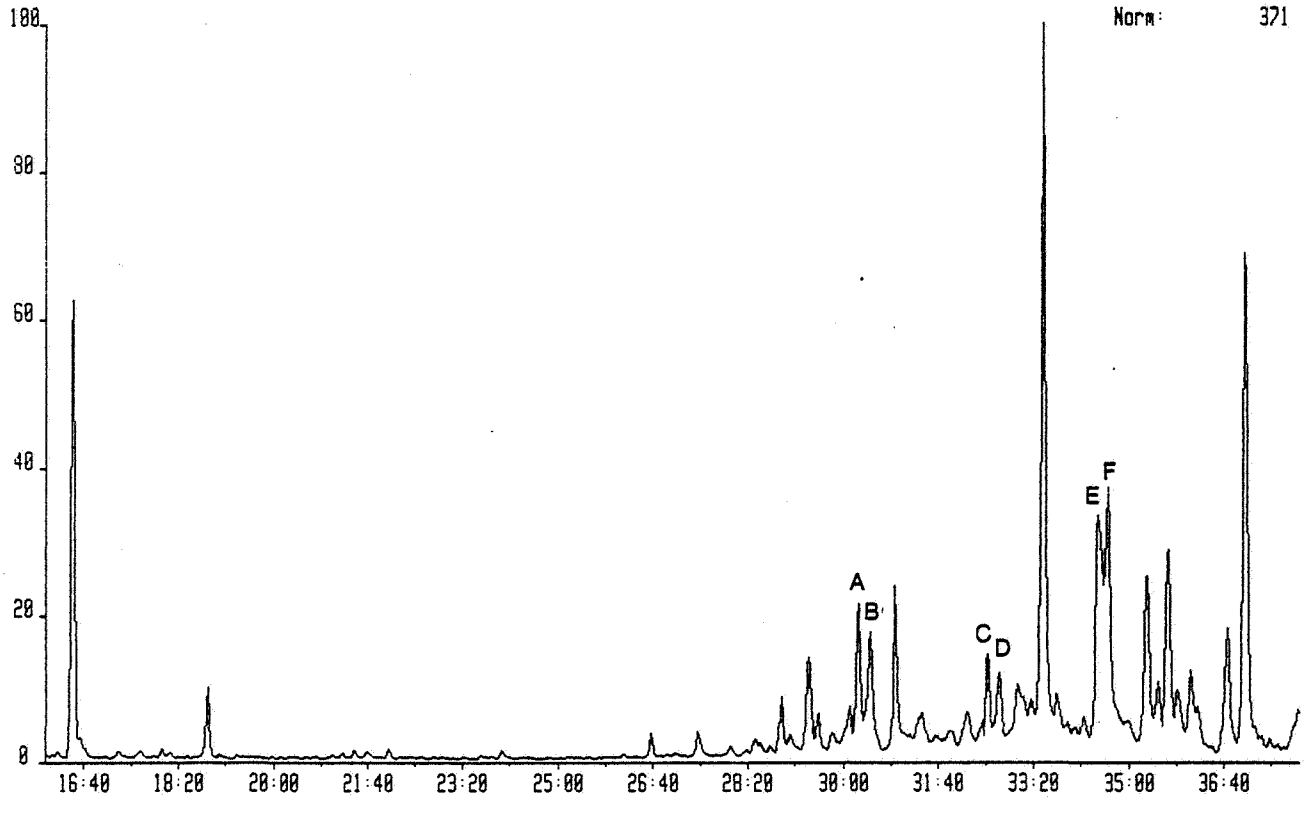


FIGURE 10e

MASS FRAGMENTOGRAMS

WELL 6507/11-4

STERANES

1607079 10-NOV-87 Sir:Voltage 12-250 Acnt:SAGA Sys:SYSTEMDEF
Sample 1 Injection 1 Group 1 Mass 259.2427
Text:WELL 6507/11-4 2576M CORE

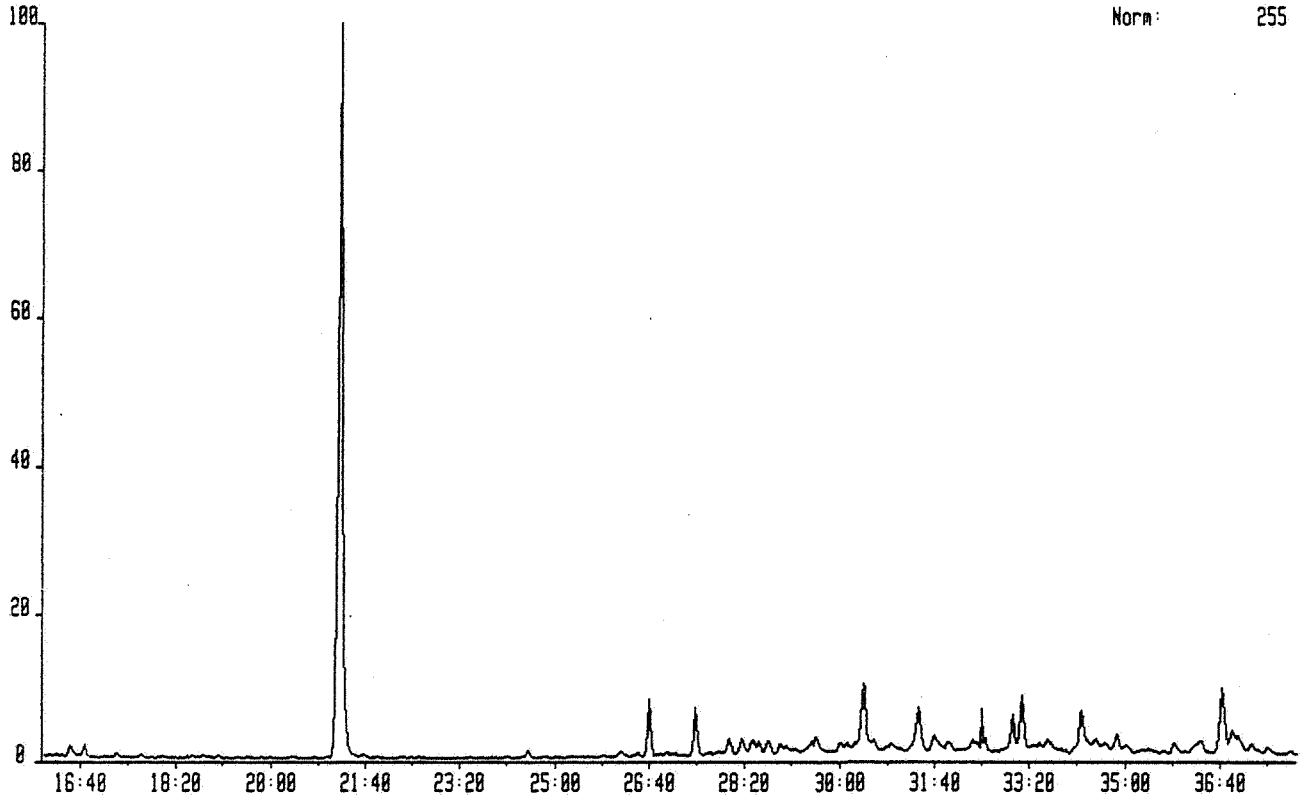
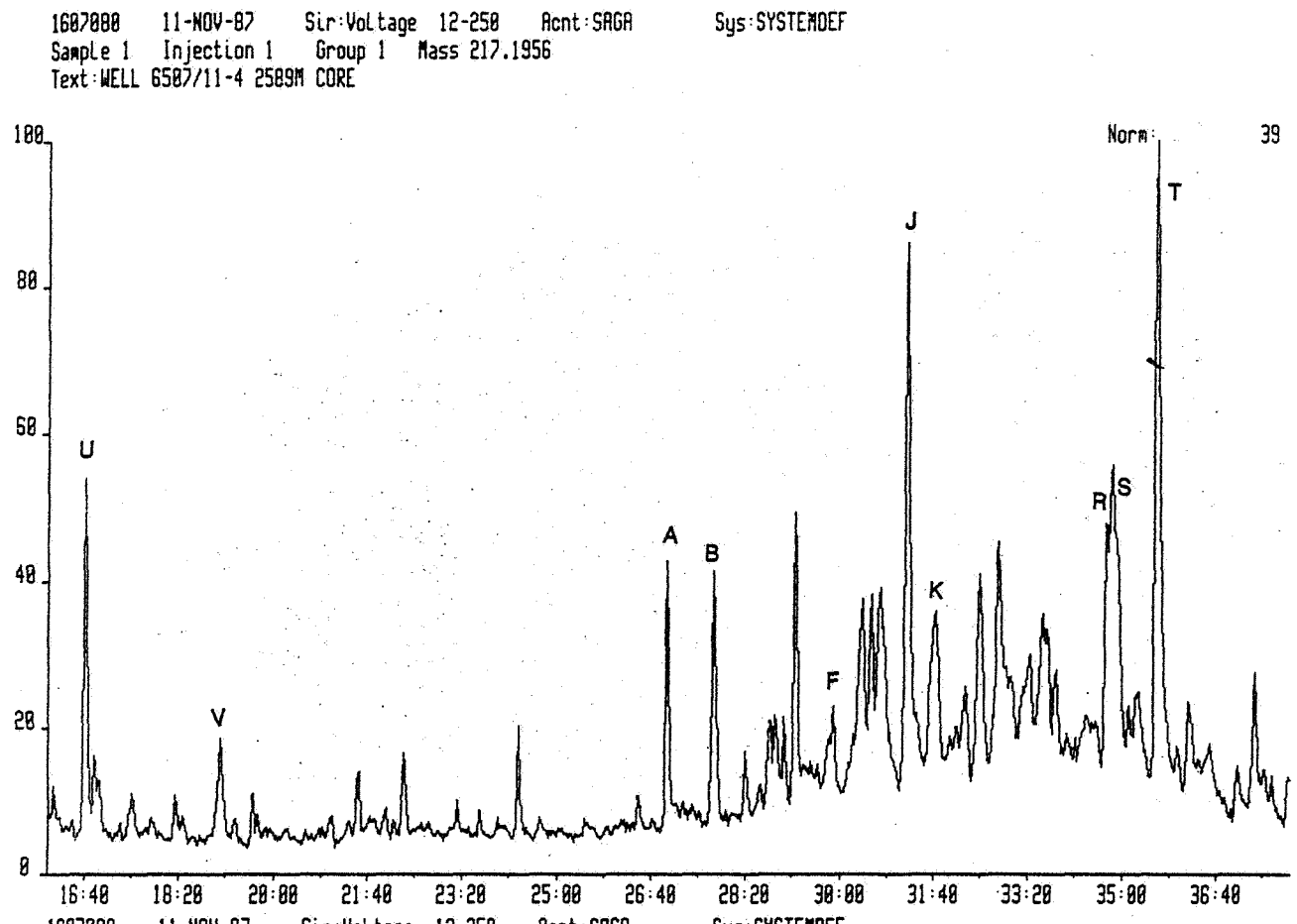


FIGURE 10f

MASS FRAGMENTOGRAMS

WELL 6507/11-4

STERANES



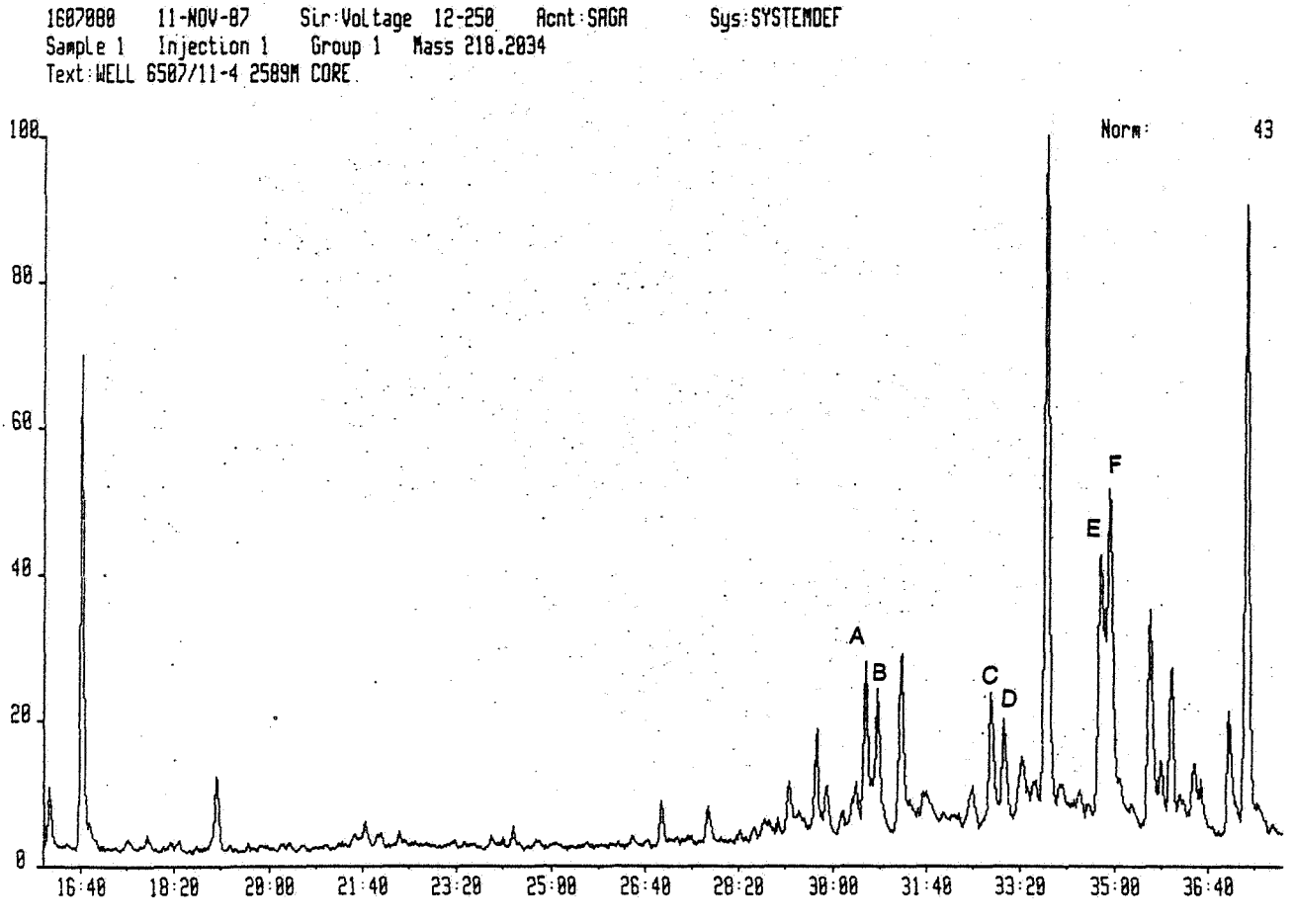


FIGURE 10f

MASS FRAGMENTOGRAMS

WELL 6507/11-4

STERANES

1607000 11-NOV-87 Sir:Voltage 12-250 Acnt:SAGA Sys:SYSTEMDEF
Sample 1 Injection 1 Group 1 Mass 259.2427
Text:WELL 6507/11-4 2589M CORE

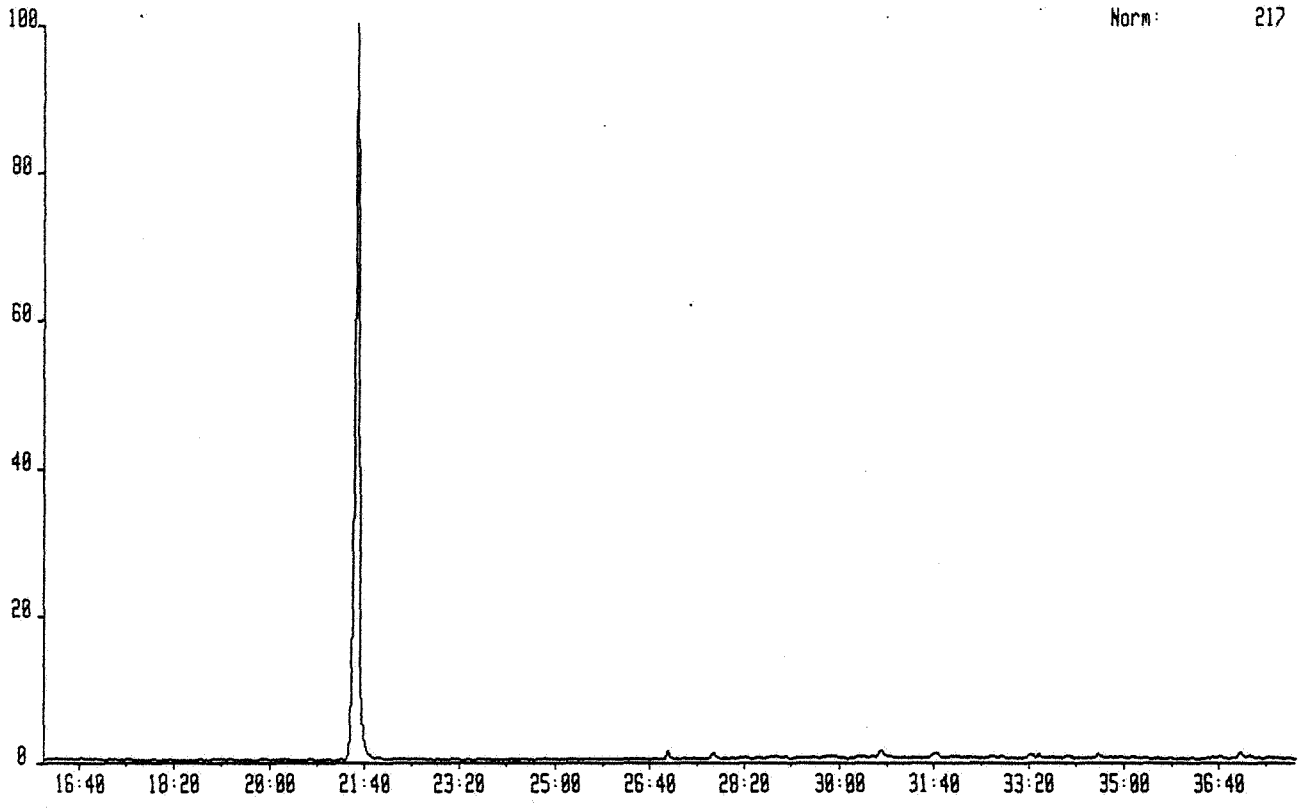
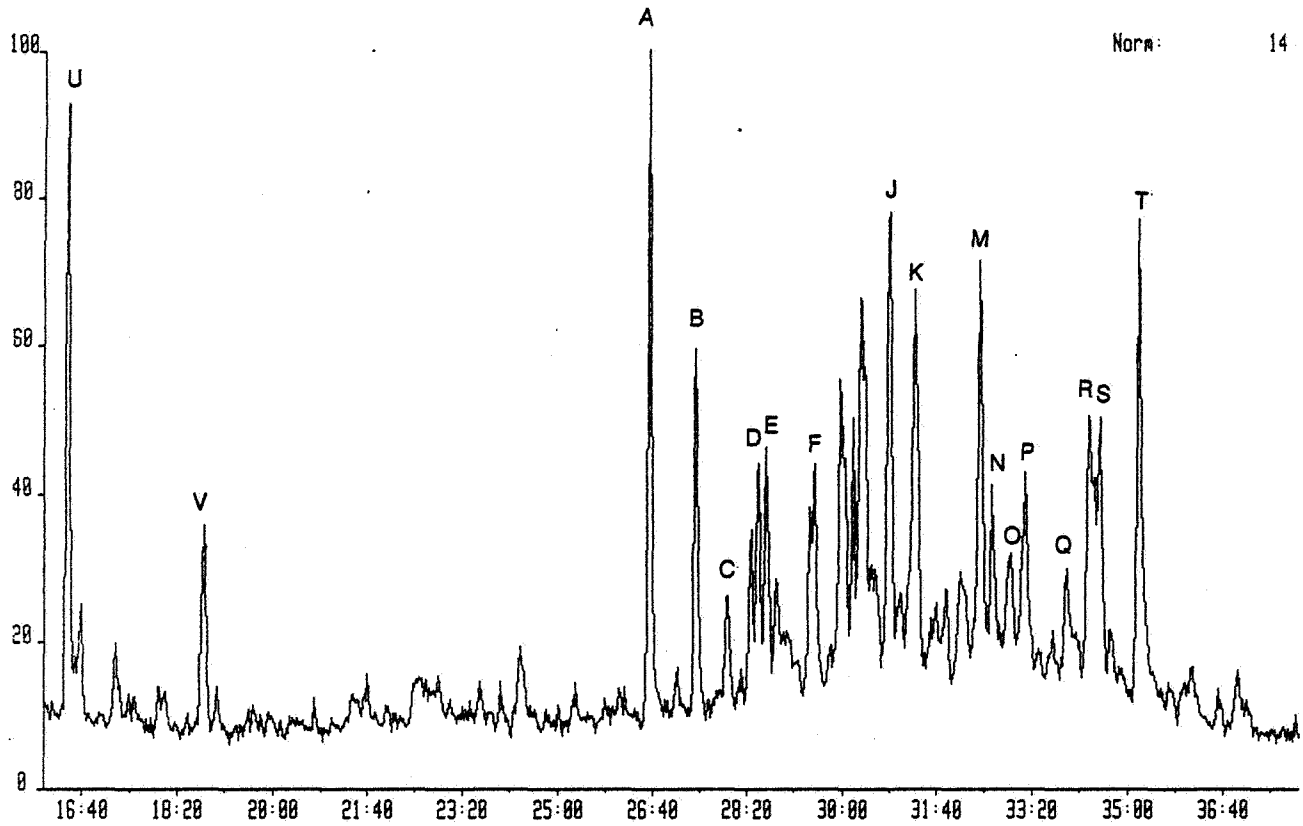


FIGURE 10g

MASS FRAGMENTOGRAMS

WELL 6507/11-4

STERANES



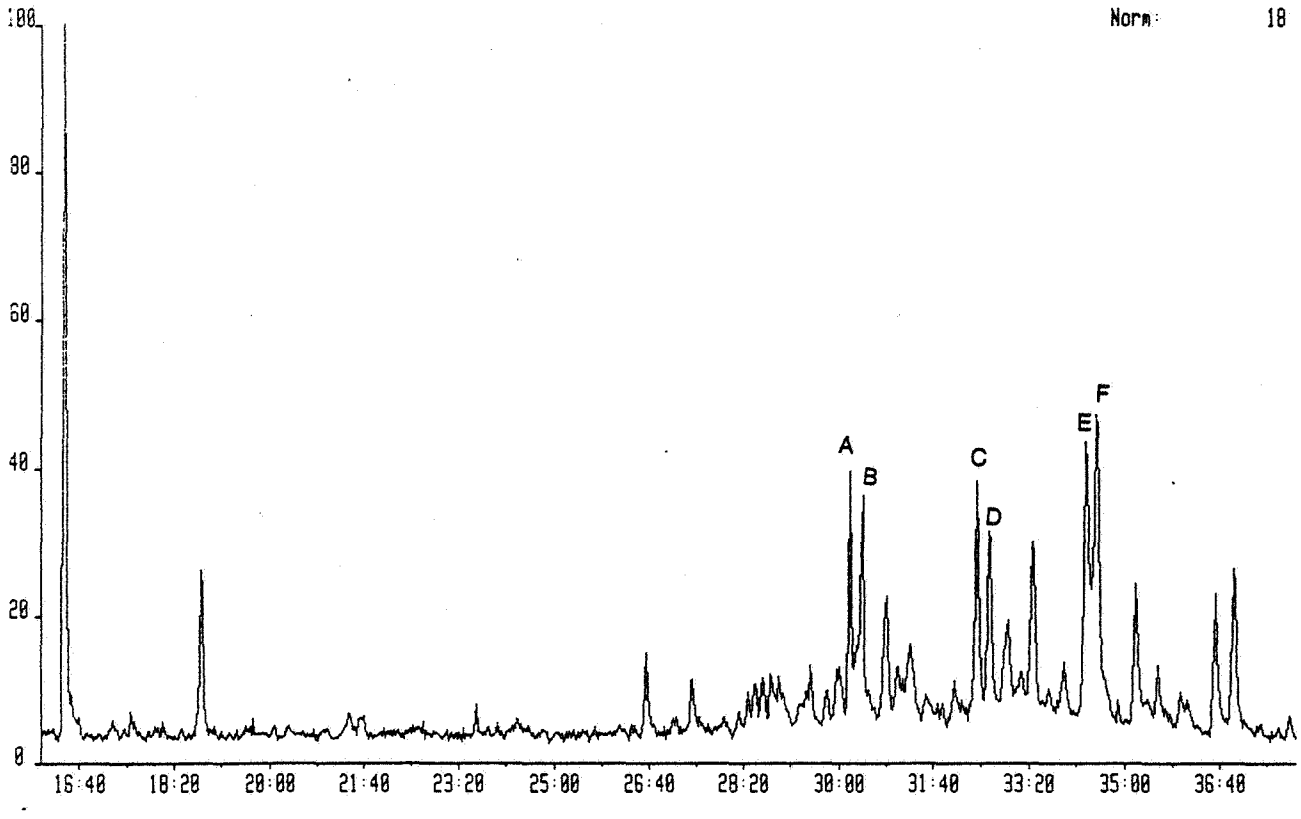


FIGURE 10g

MASS FRAGMENTOGRAMS

WELL 6507/11-4

STERANES

1607081 10-NOV-87 Sir:Voltage 12-250 Acnt:SAGA Sys:SYSTEMDEF
Sample 1 Injection 1 Group 1 Mass 259.2427
Text:WELL 6507/11-4 2612.5 SWC

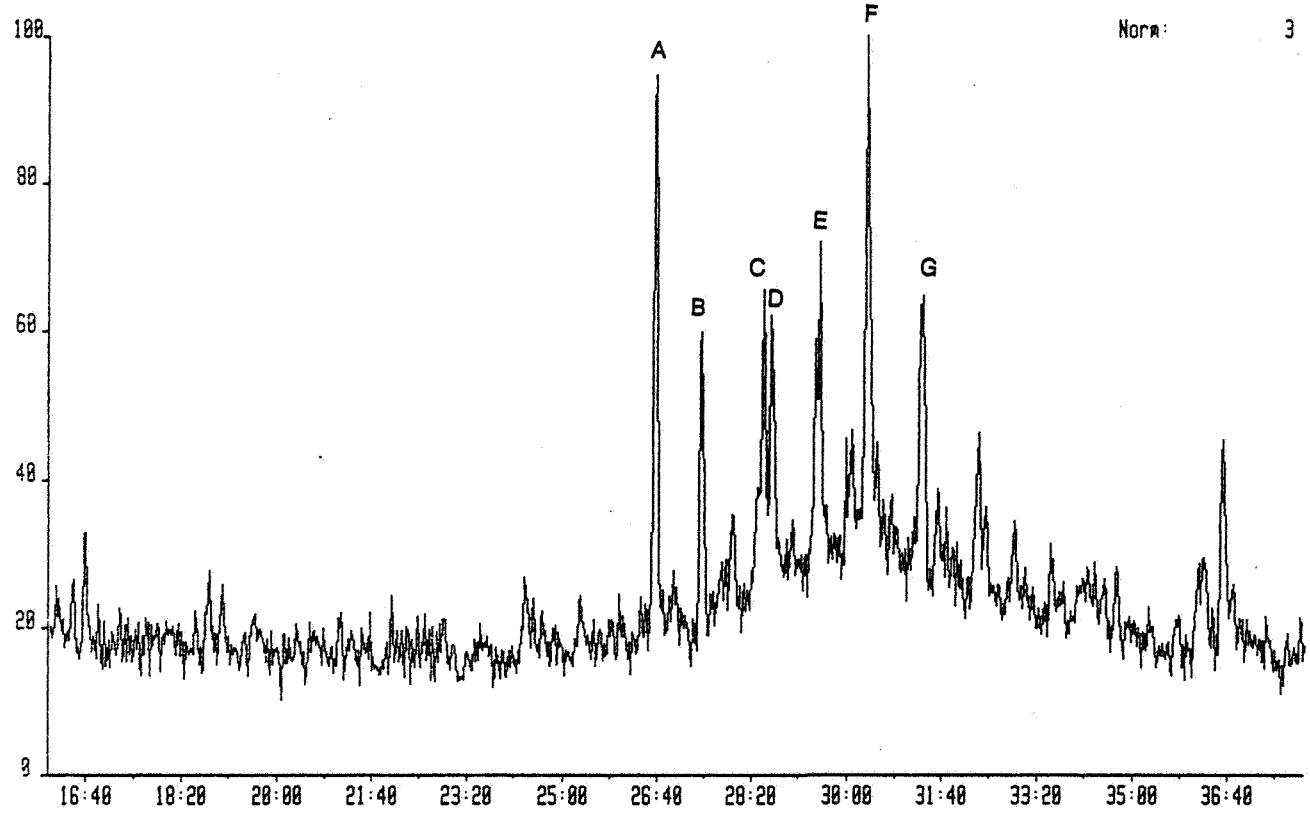
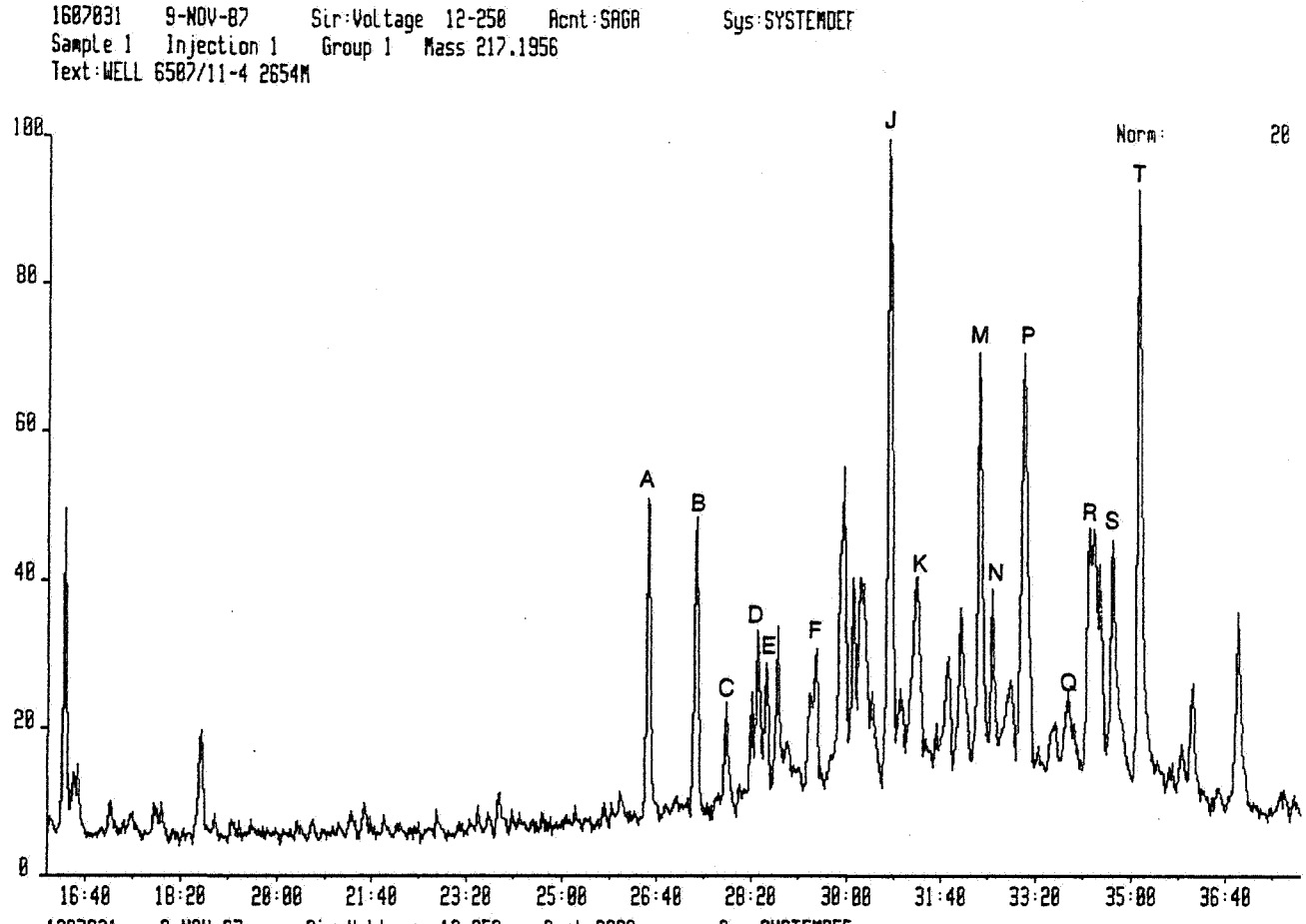


FIGURE 10h

MASS FRAGMENTOGRAMS

WELL 6507/11-4

STERANES



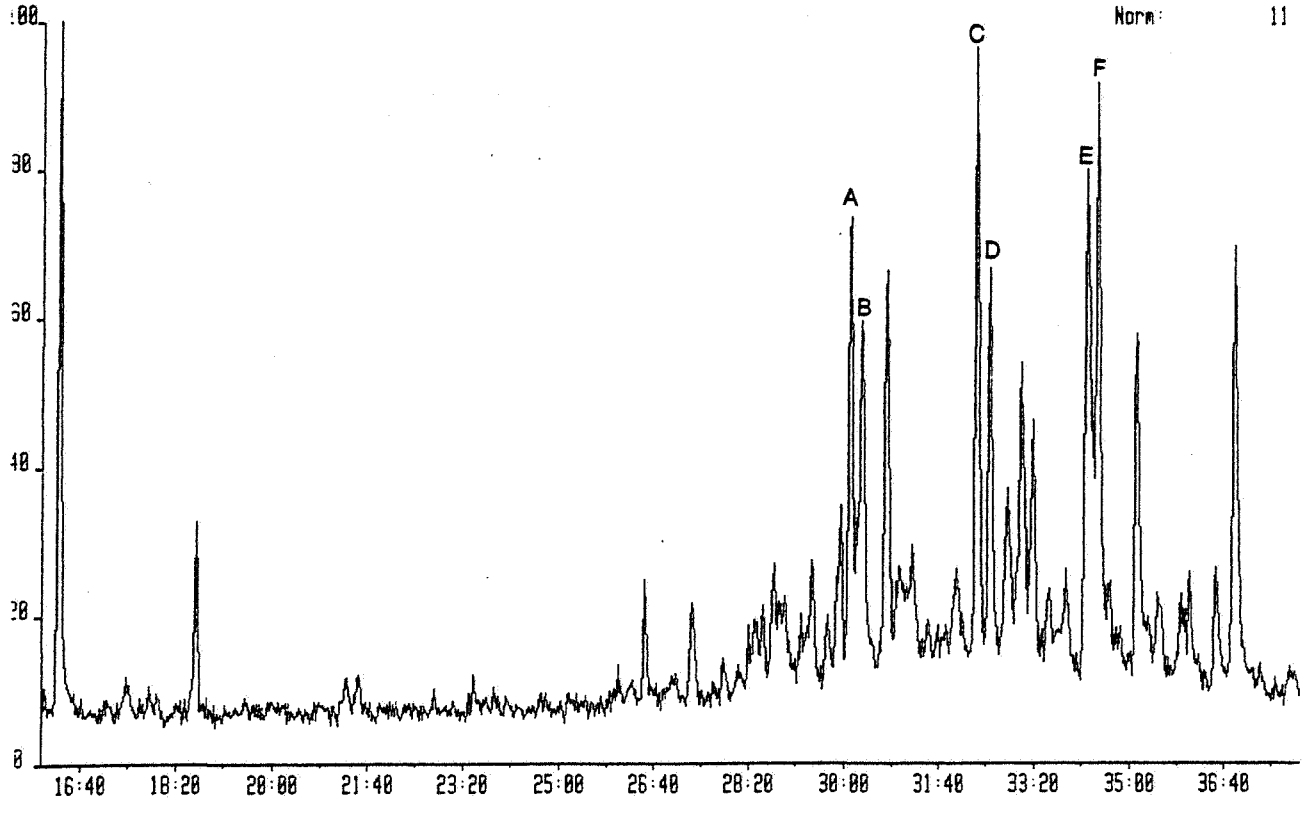


FIGURE 10h

MASS FRAGMENTOGRAMS

WELL 6507/11-4

STERANES

1607031 9-NOV-87 Sir:Voltage 12-250 Acnt:SAGA Sys:SYSTEMDEF
Sample 1 Injection 1 Group 1 Mass 259.2427
Text:WELL 6507/11-4 2654M

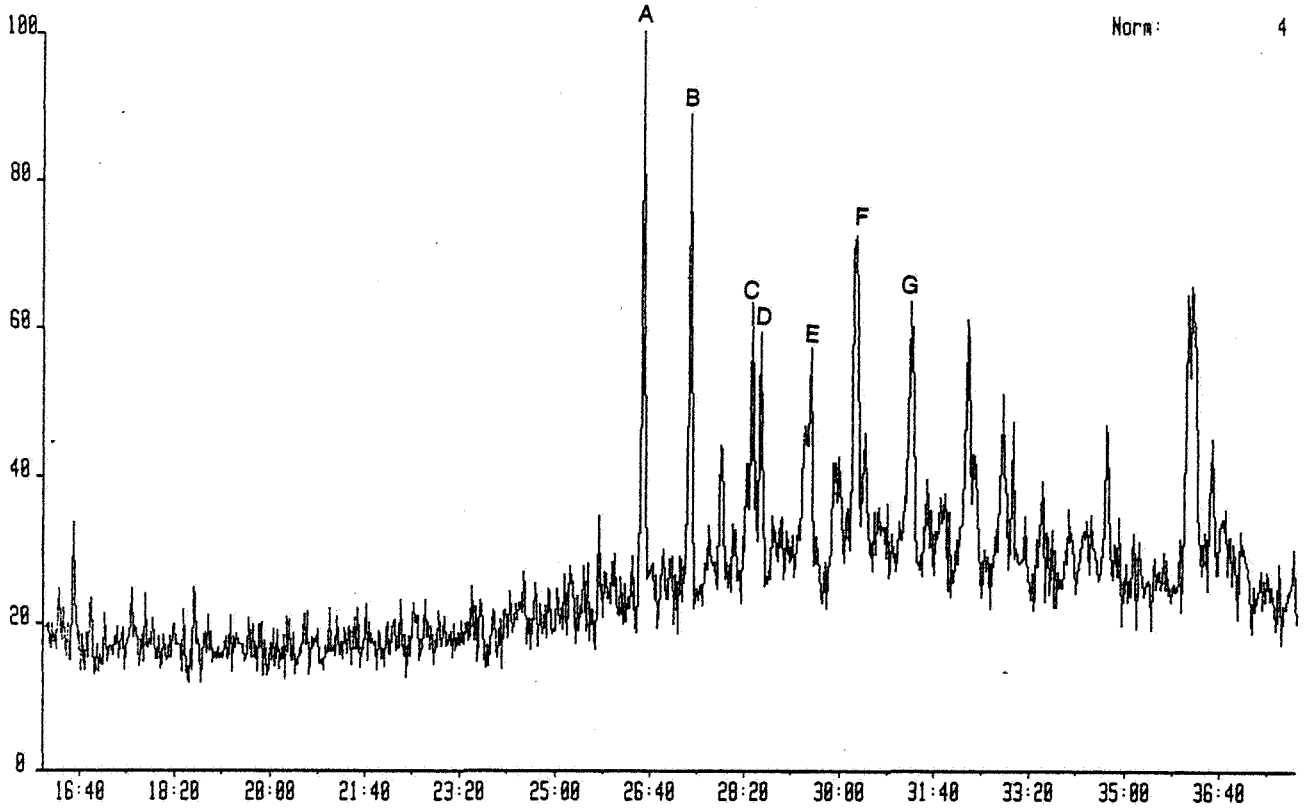
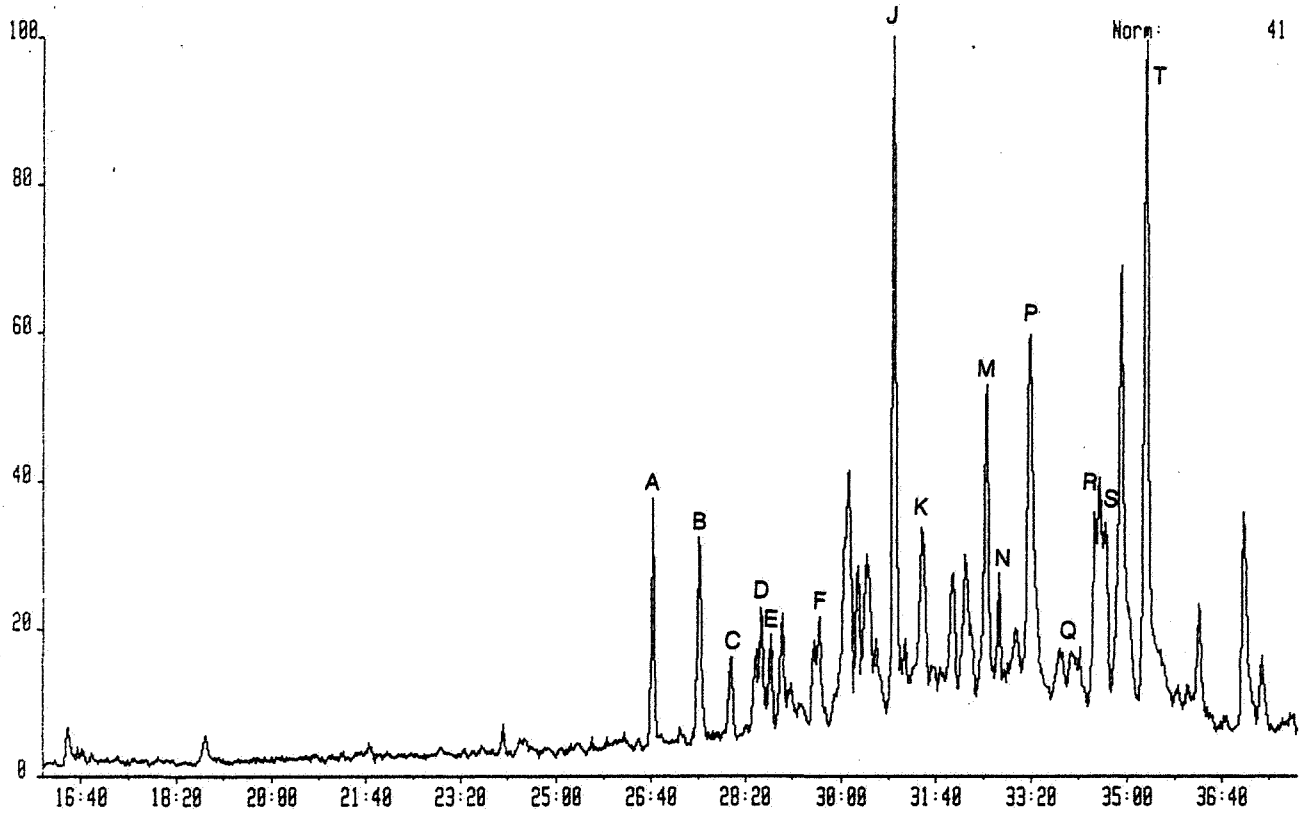


FIGURE 10i

MASS FRAGMENTOGRAMS

WELL 6507/11-4

STERANES



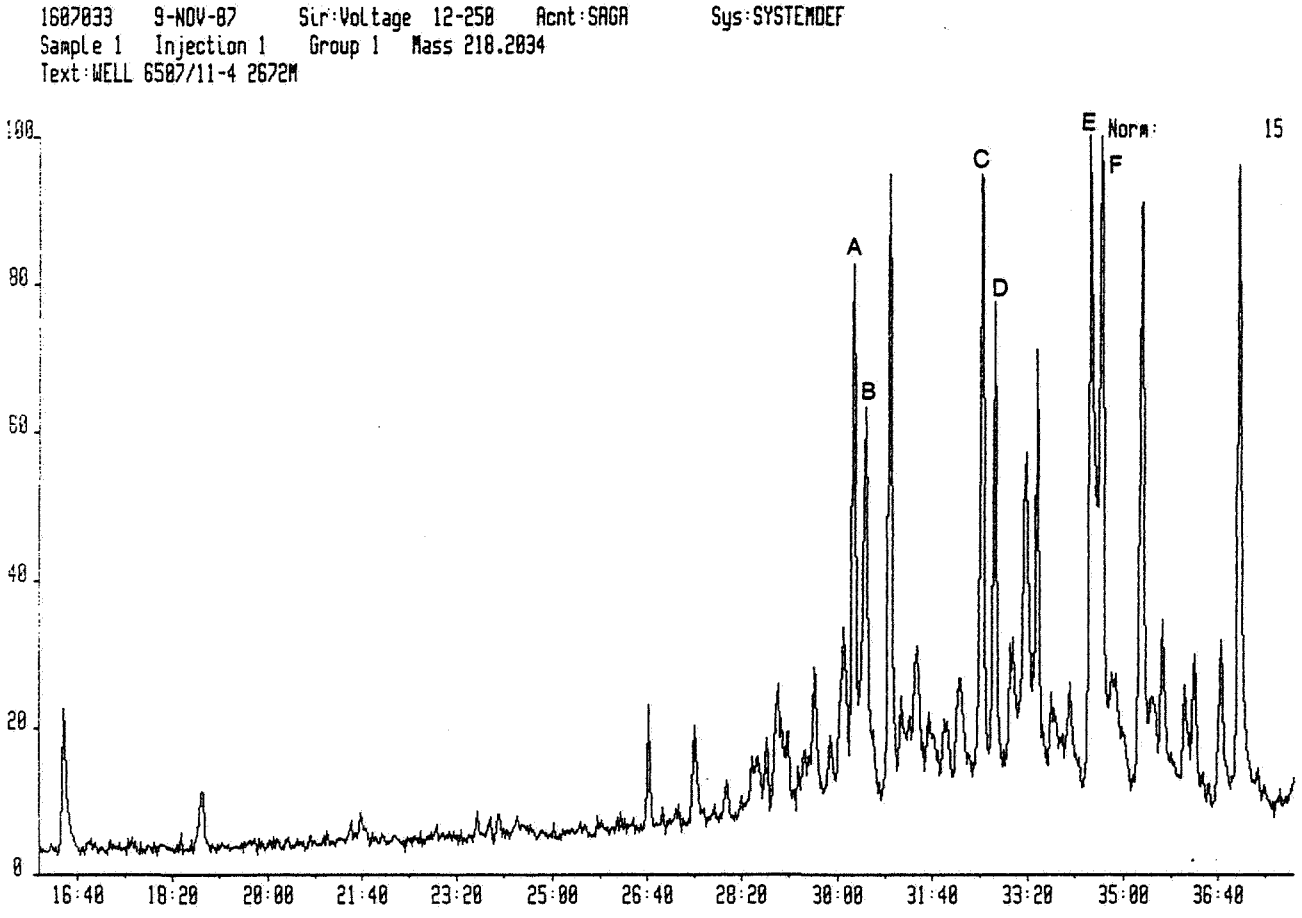


FIGURE 10i

MASS FRAGMENTOGRAMS

WELL 6507/11-4

STERANES

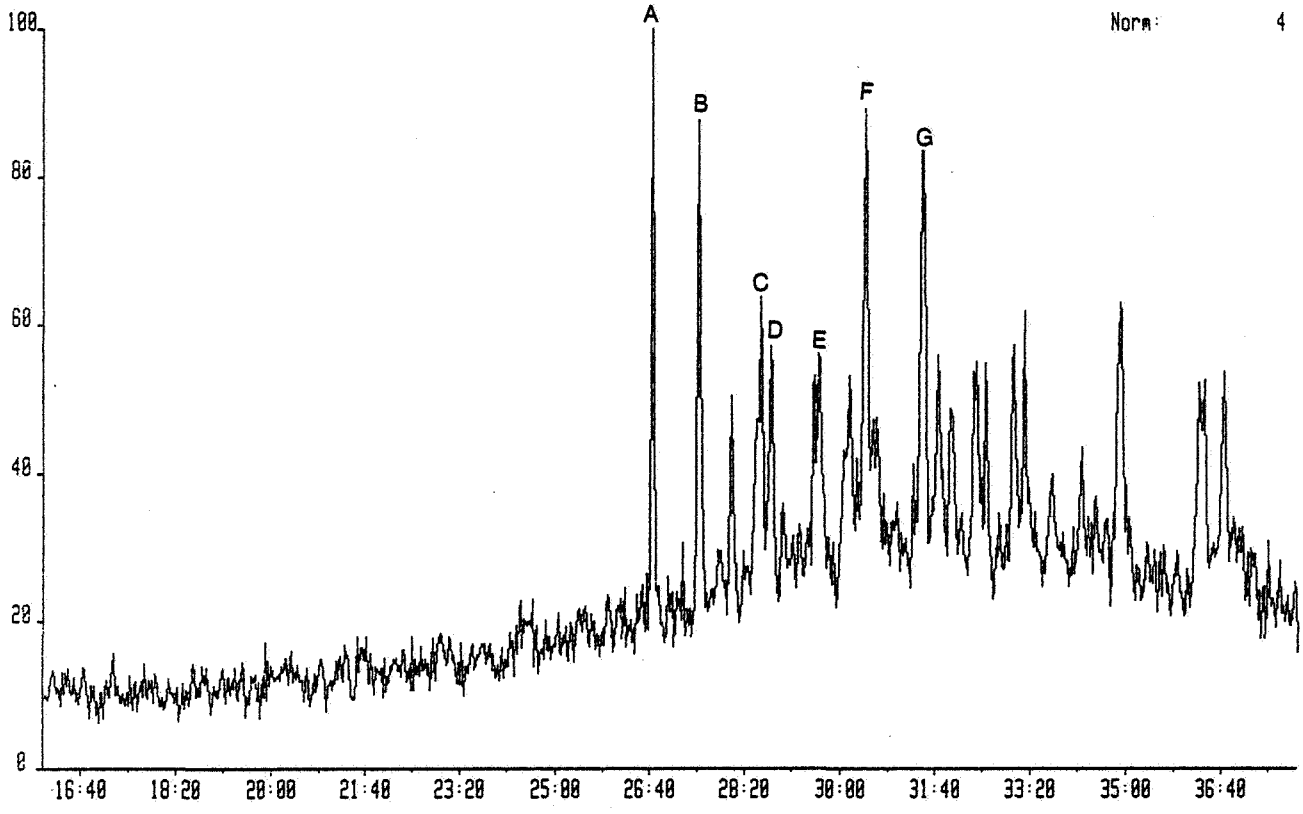
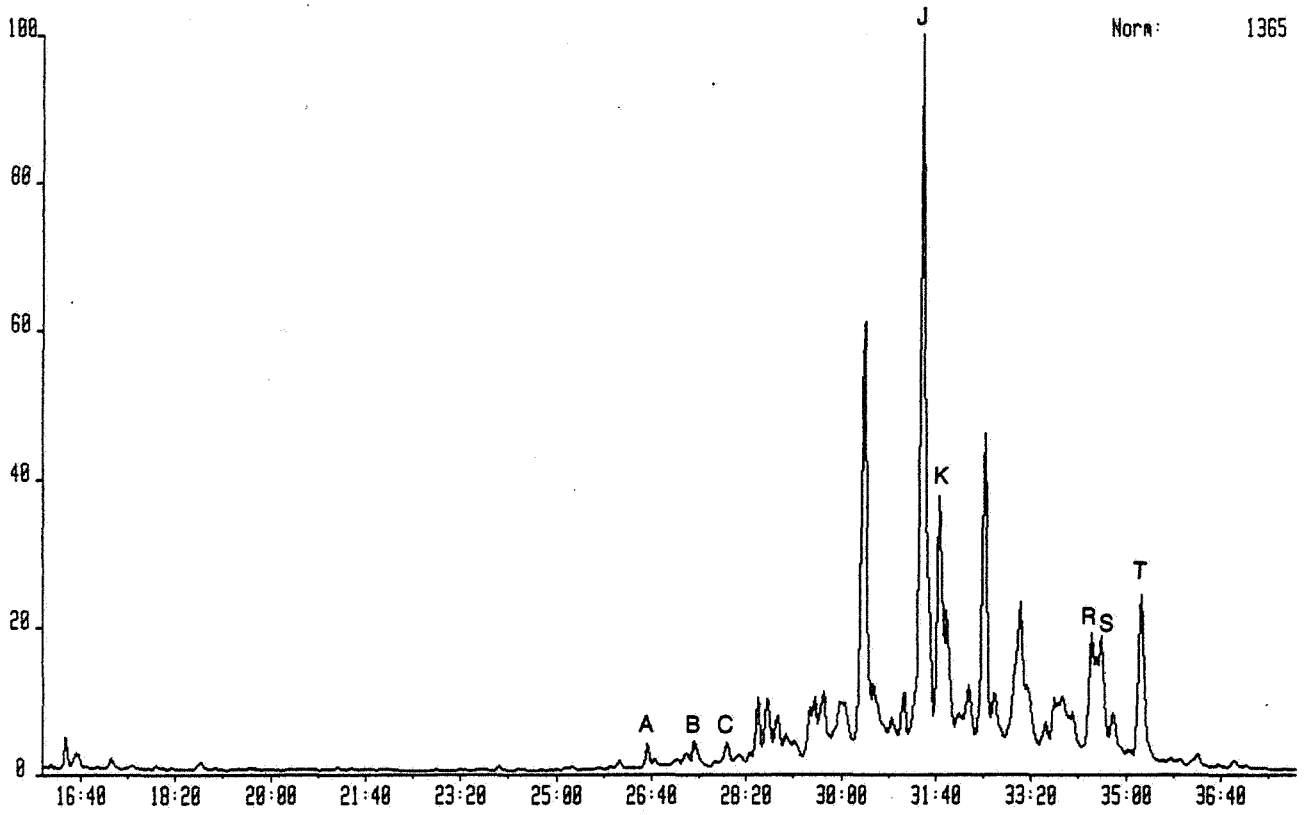


FIGURE 10j

MASS FRAGMENTOGRAMS

WELL 6507/11-4

STERANES



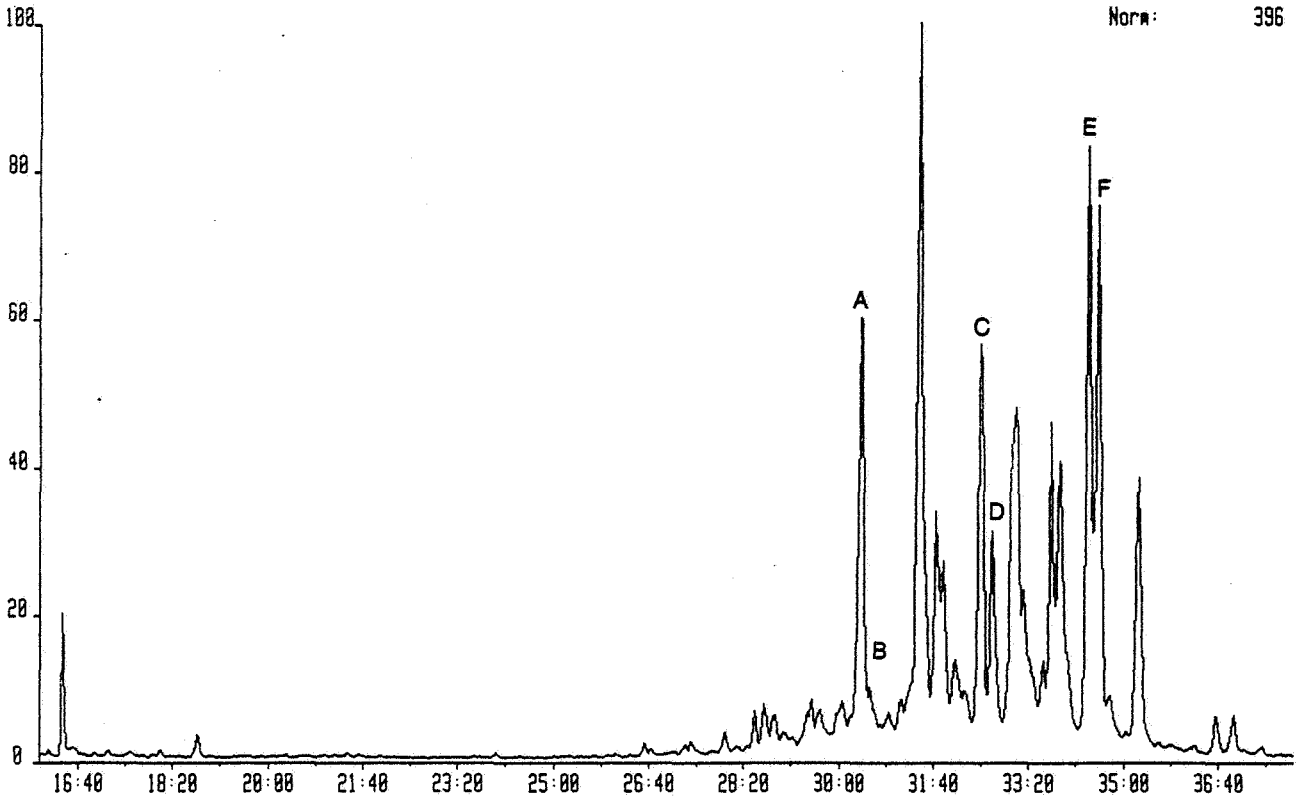


FIGURE 10j

MASS FRAGMENTOGRAMS

WELL 6507/11-4

STERANES

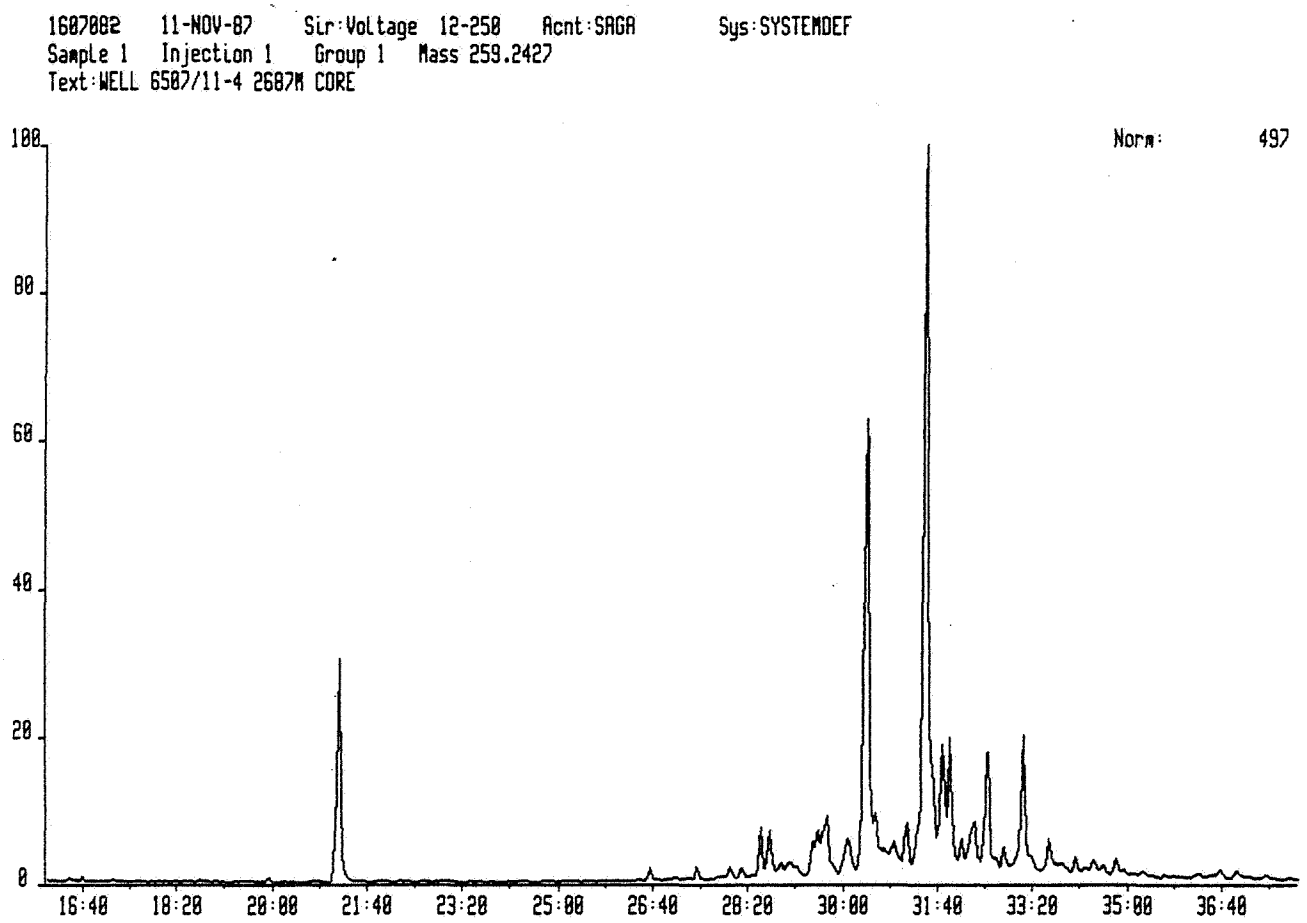


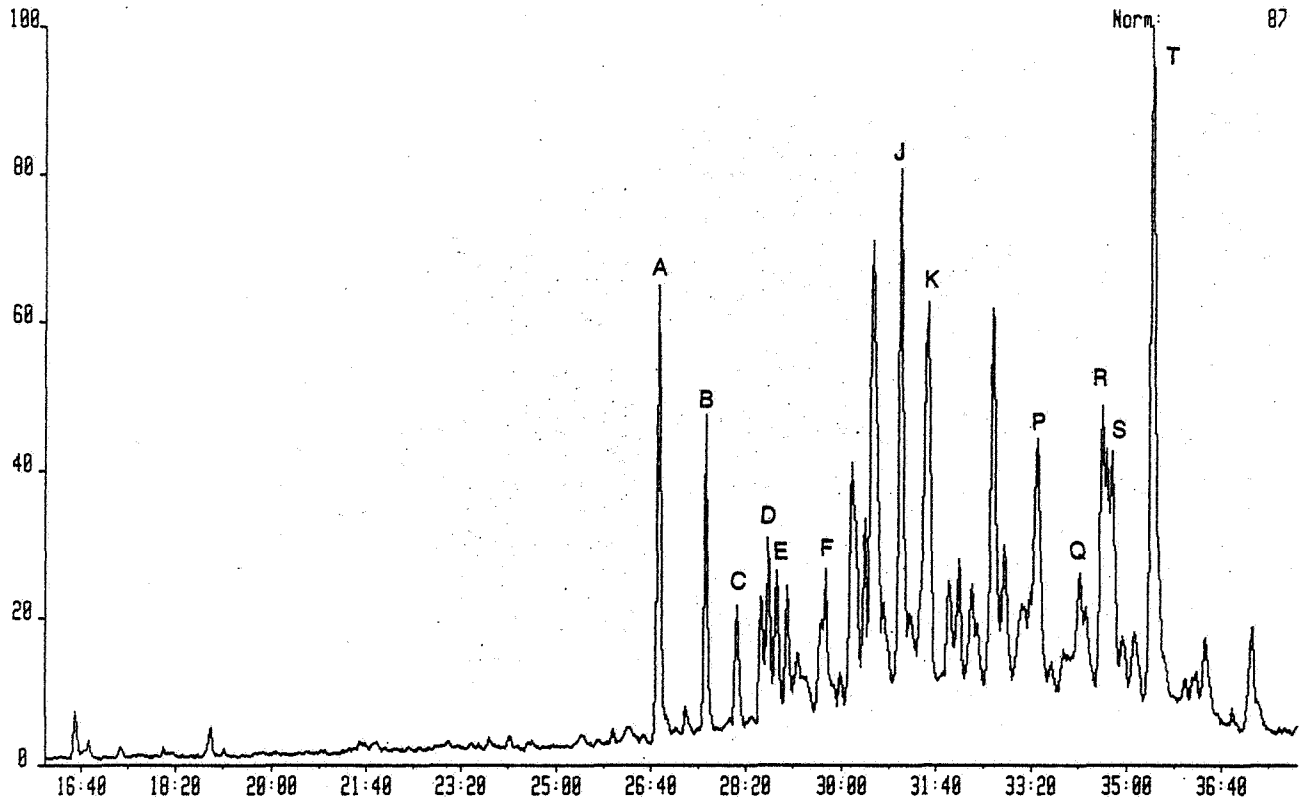
FIGURE 10k

MASS FRAGMENTOGRAMS

WELL 6507/11-4

STERANES

1607086 11-NOV-87 Sir:Voltage 12-250 Acnt:SAGA Sys:SYSTEMDEF
Sample 1 Injection 1 Group 1 Mass 217.1956
Text:WELL 6507/11-4 2881.5M SWC



1607086 11-NOV-87 Sir:Voltage 12-250 Acnt:SAGA Sys:SYSTEMDEF
Sample 1 Injection 1 Group 1 Mass 218.2034
Text:WELL 6507/11-4 2881.5M SWC

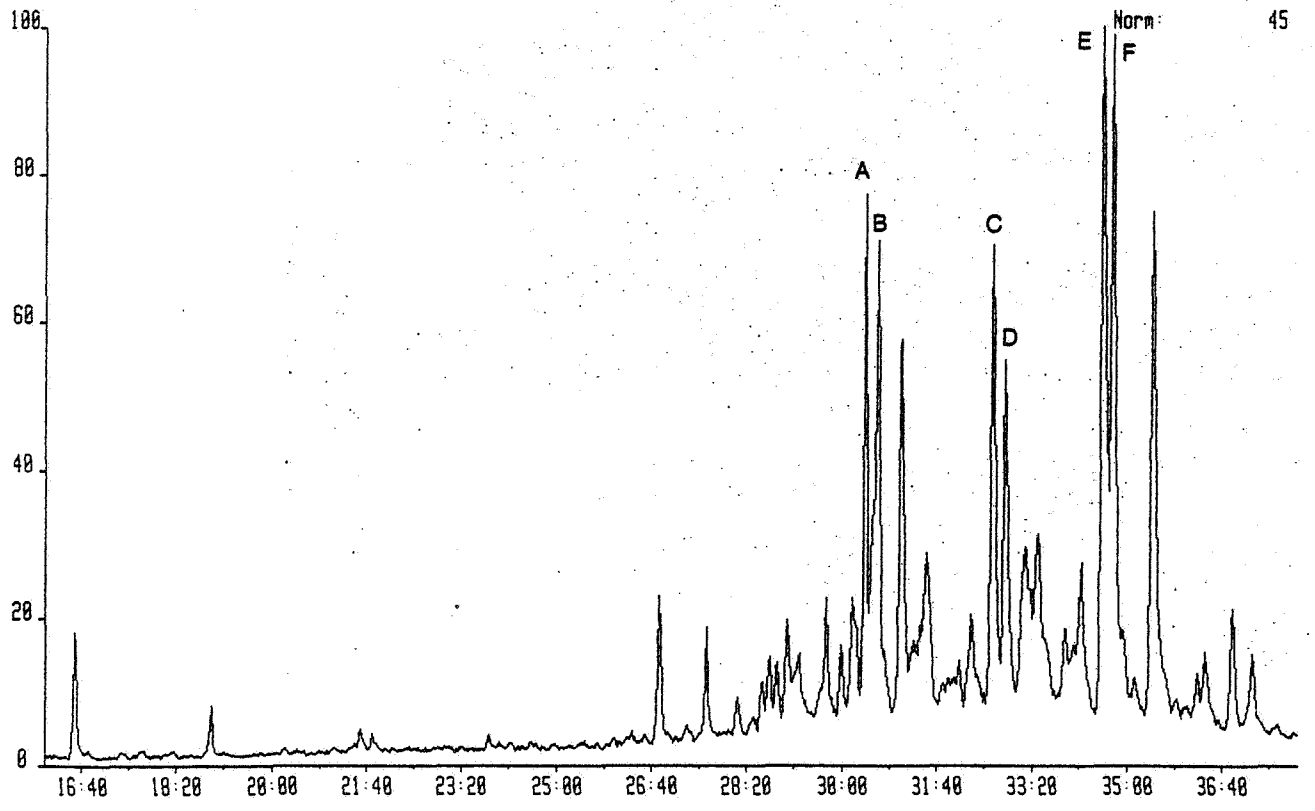


FIGURE 10k

MASS FRAGMENTOGRAMS

WELL 6507/11-4

STERANES

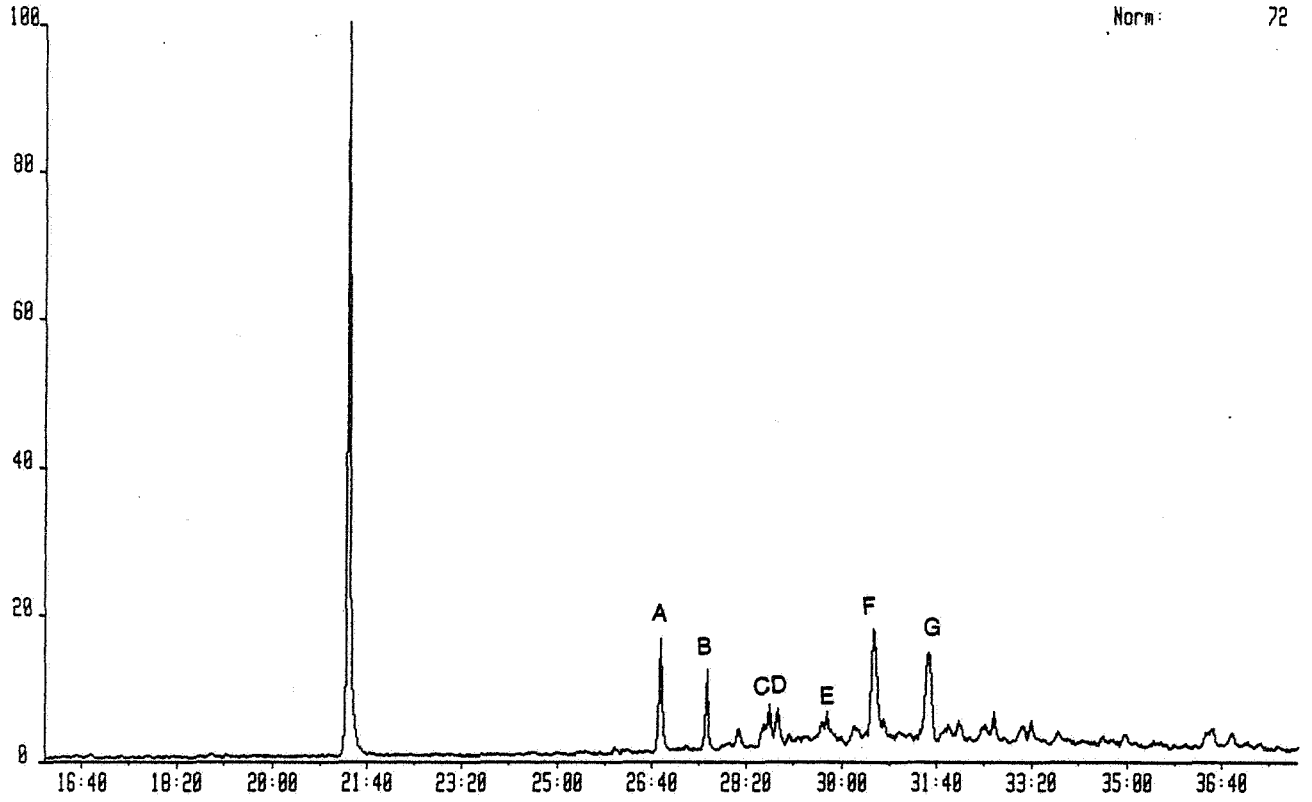


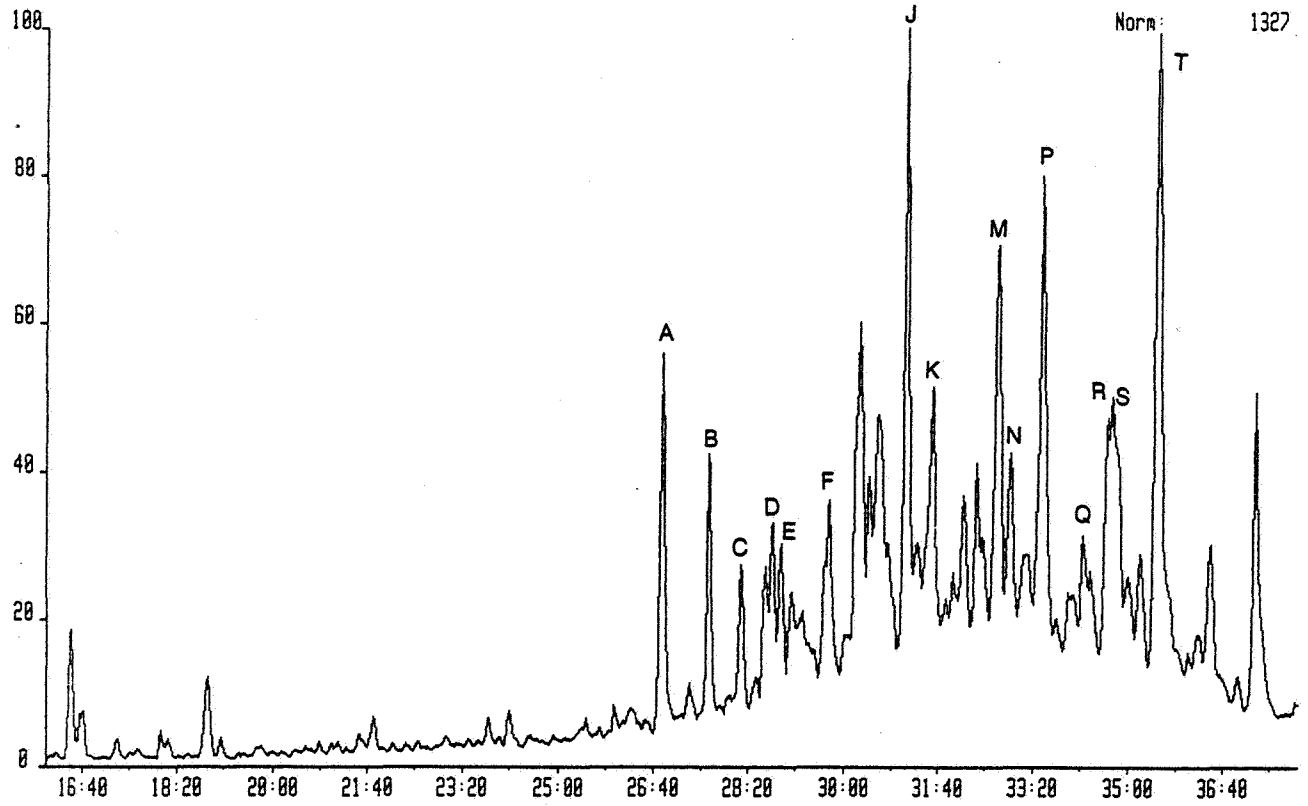
FIGURE 101

MASS FRAGMENTOGRAMS

WELL 6507/11-4

STERANES

1607064 10-NOV-87 Sir:Voltage 12-250 Acnt:SAGA Sys:SYSTEMDEF
Sample 1 Injection 1 Group 1 Mass 217.1956
Text:WELL 6507/11/4 2951M



1607064 10-NOV-87 Sir:Voltage 12-250 Acnt:SAGA Sys:SYSTEMDEF
Sample 1 Injection 1 Group 1 Mass 218.2034
Text:WELL 6507/11/4 2951M

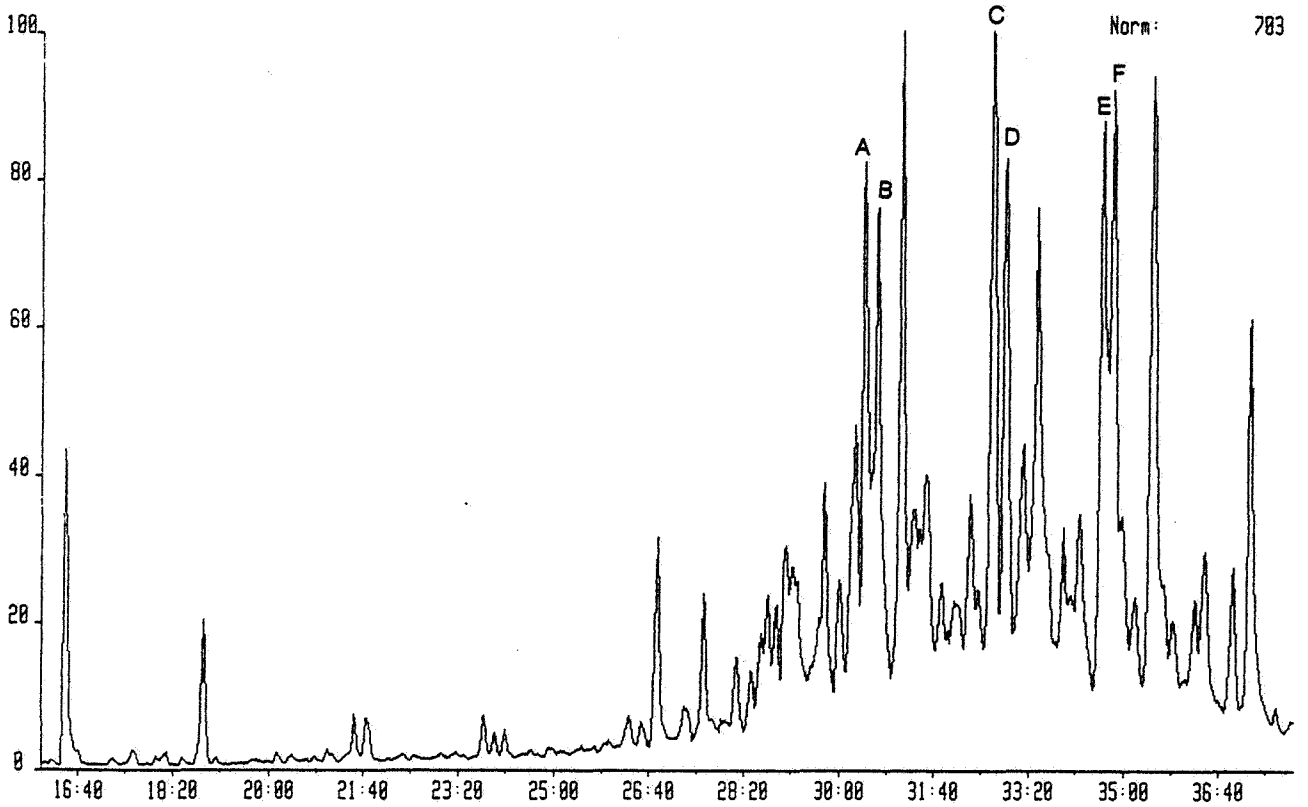
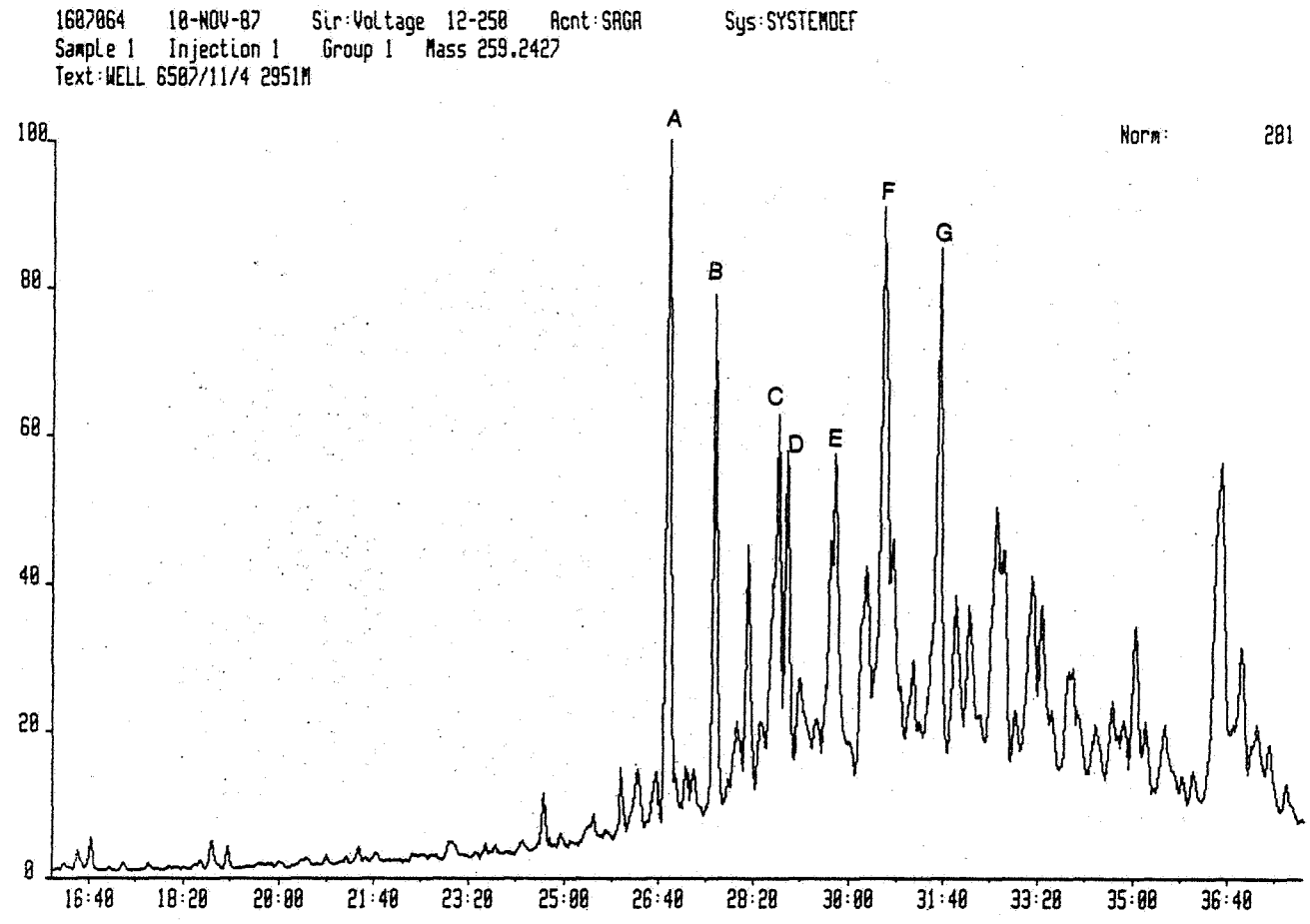


FIGURE 101

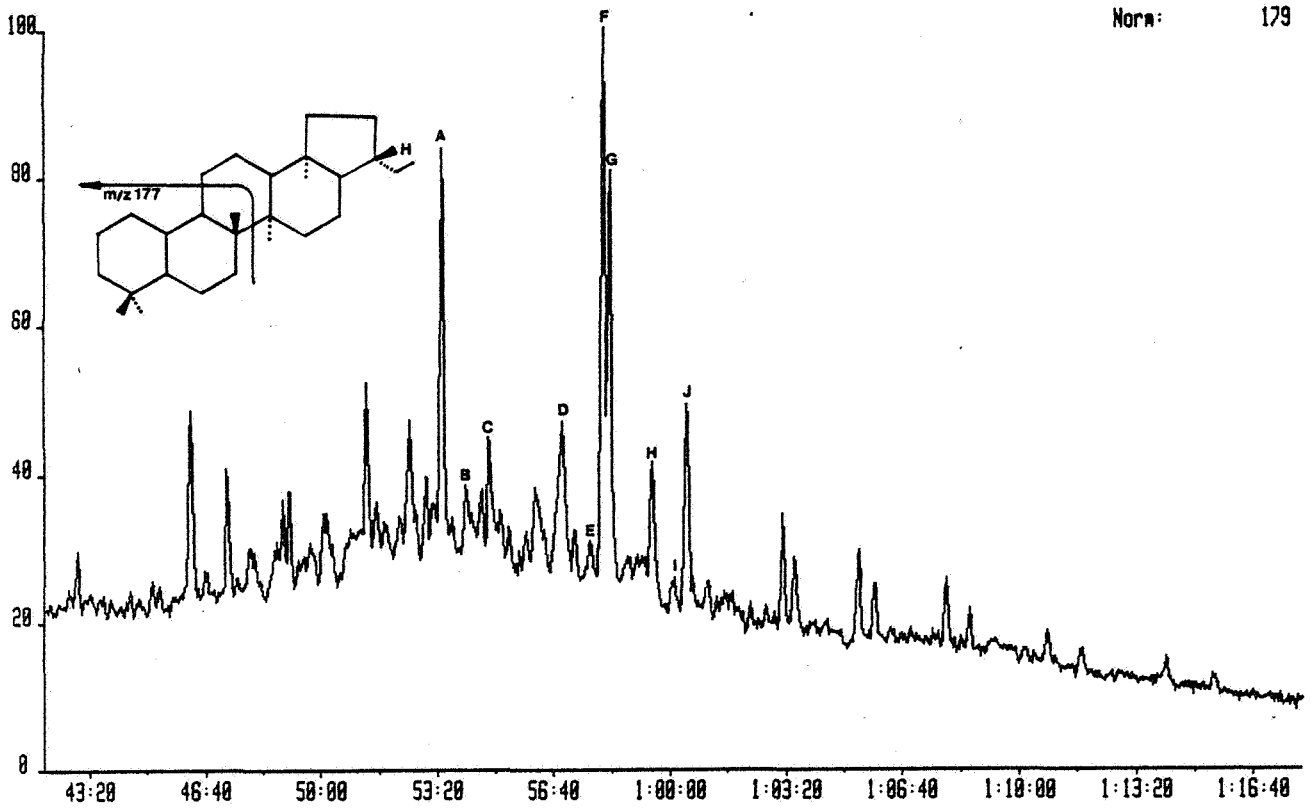
MASS FRAGMENTOGRAMS

WELL 6507/11-4

STERANES



GEH1A 30-JUN-87 Sir:Magnetic TS250 · Acnt:GEOCHEM Sys:BIOMARKER
Sample 1 Injection 1 Group 1 Mass 177.1642
Text:STANDARD BIOMARKER

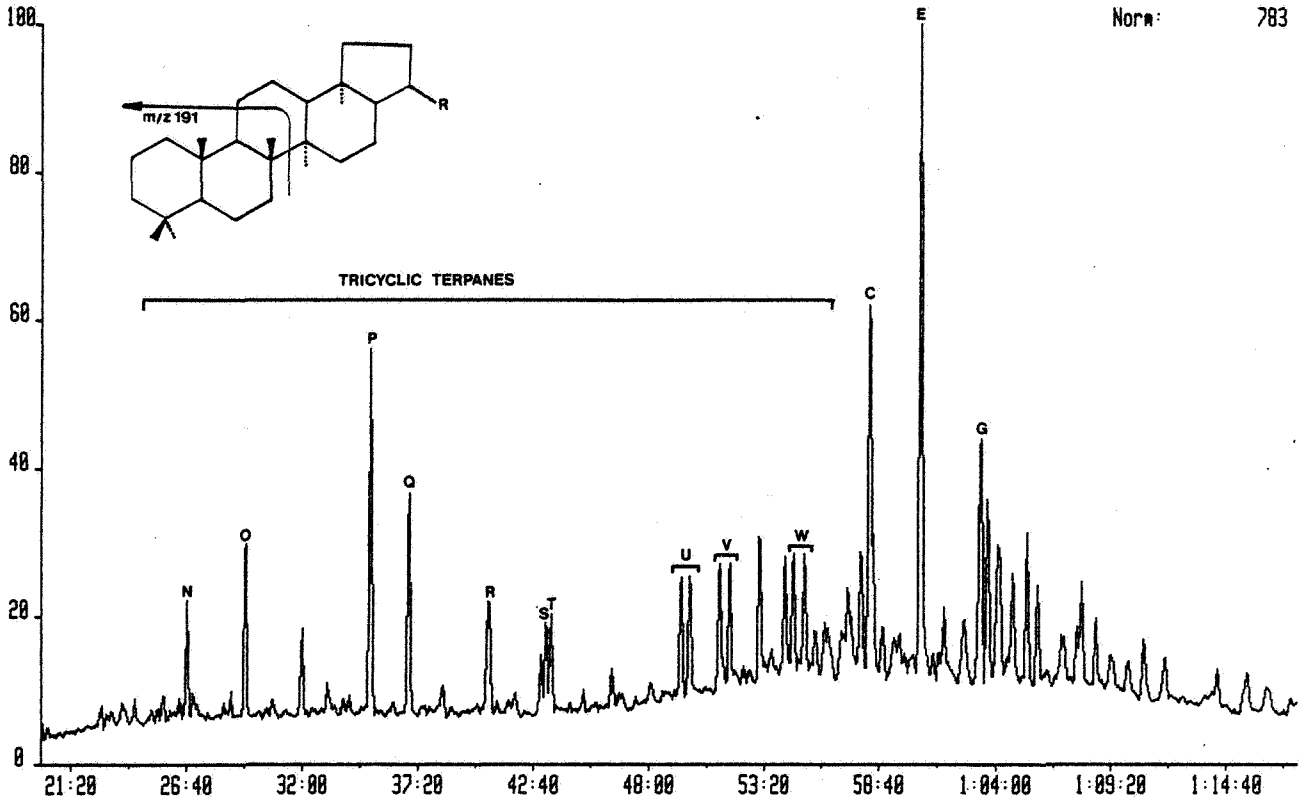


DEMETHYLATED HOPANES

(m/z 177 FRAGMENTOGRAM)

	COMPOUND
A	17α(H), 18α(H), 21β(H) 25, 28, 30 - trisnorhopane
B	17β(H), 18α(H), 21α(H) 25, 28, 30 - trisnormoretane
C	17α(H) -25, 30 - bisnorhopane
D	17α(H), 18α(H), 21β(H) -28, 30 bisnorhopane
E	17α(H),-25 - norhopane
F	17α(H) -30 - norhopane
G	X
H	17α(H) -30 - normoretane
I	(22S) -17α(H) -25 - norhomohopane
J	(22R) -17α(H) -25 - norhomohopane

1560007 1-JUL-87 Sir:Magnetic TS250 Acnt:GEOCHEM Sys:BIOMARKER
Sample 1 Injection 1 Group 1 Mass 191.1798
Text:0

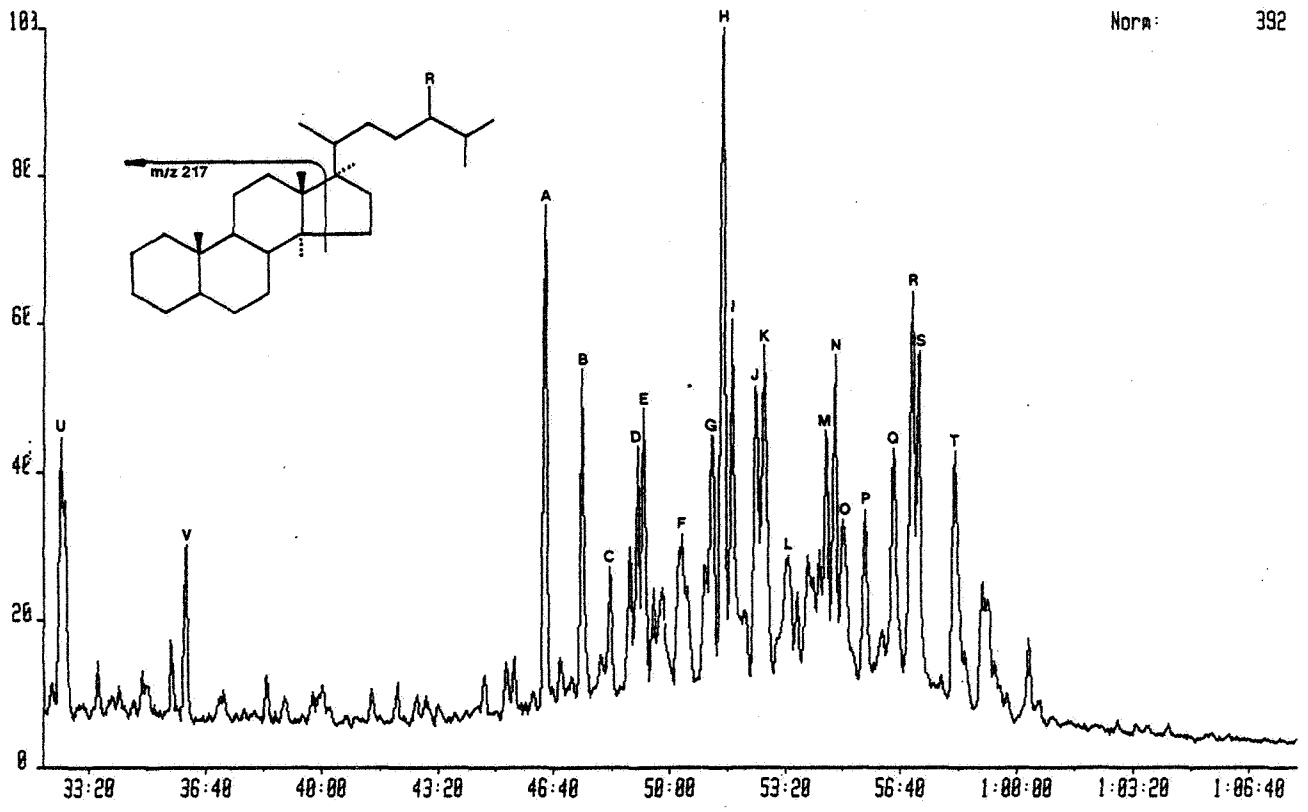


PEAK IDENTIFICATION FOR TRITERPANES (m/z 191)

A	18 α (H), 21 β (H) -22,29,30- trisnorhopane (Ts)
B	17 α (H), 21 β (H) -22,29,30- trisnorhopane Tm)
Z	17 α (H), 18 α (H) 21 (H) -28,30 bisnorhopane
C	17 α (H), 21 β (H) - norhopane
C_1	C_{29} pentacyclic triterpenoid (unidentified)
X	C_{30} pentacyclic triterpenoid (unidentified)
D	17 β (H), 21 α (H) -30 - normoretane
E	17 α (H), 21 β (H) - hopane
F	17 β (H), 21 α (H) - moretane
G	17 α (H), 21 β (H) - homohopane (22S)
H	17 α (H), 21 β (H) - homohopane (22R)
G_1	Gammacerane
I	17 β (H), 21 α (H) - homomoretane
J	17 α (H), 21 β (H) - bisnorhopane (22S and 22R)
K	17 α (H), 21 β (H) - trisnorhopane (22S and 22R)
L	17 α (H), 21 β (H) - tetrakishomohopane (22S and 22R)
M	17 α (H), 21 β (H) - pentakishomohopane (22S and 22R)

N	C_{20} Tricyclic Terpane
O	C_{21} Tricyclic Terpane
P	C_{23} Tricyclic Terpane
Q	C_{24} Tricyclic Terpane
R	C_{25} Tricyclic Terpane
S	C_{26} Tricyclic Terpane
T	C_{24} Tetracyclic Terpane
U	C_{28} Tricyclic Terpane
V	C_{29} Tricyclic Terpane
W	C_{30} Tricyclic Terpane

GEH1 16-JUN-87 Sir:Magnetic TS250 Acnt:GEOCHEM Sys:BIOMARKER
Sample 1 Injection 1 Group 1 Mass 217.1956
Text:BIOMARKER TEST RUN



STERANE IDENTIFICATION
(m/z 217 FRAGMENTOGRAM)

	COMPOUND	ELEMENTAL COMPOSITION
A	13β, 17α -diacholestane (20S)	$C_{27}H_{48}$
B	13β, 17α -diacholestane (20R)	$C_{27}H_{48}$
C	13α, 17β -diacholestane (20S)	$C_{27}H_{48}$
D	13α, 17β -diacholestane (20R)	$C_{27}H_{48}$
E	24-methyl - 13β, 17α -diacholestane (20S)	$C_{28}H_{50}$
F	24-methyl - 13β, 17α -diacholestane (20R)	$C_{28}H_{50}$
G	24-methyl - 13β, 17α -diacholestane (20S)	$C_{28}H_{50}$
+	14α, 17α -cholestane (20S)	$C_{27}H_{48}$
H	24-ethyl - 13β, 17α -diacholestane (20S)	$C_{29}H_{52}$
+	14β, 17β -cholestane (20R)	$C_{27}H_{48}$
I	14β, 17β -cholestane (20S)	$C_{27}H_{48}$
+	24-methyl - 13α, 17β -diacholestane (20R)	$C_{28}H_{50}$
J	14α, 17α -cholestane (20R)	$C_{27}H_{48}$
K	24-ethyl -13β, 17α-diacholestane (20R)	$C_{29}H_{52}$
L	24-ethyl -14α, 17α-diacholestane (20S)	$C_{29}H_{52}$
M	24-methyl -13β, 17β-cholestane (20S)	$C_{28}H_{50}$
N	24-ethyl -13β, 17β-diacholestane (20R)	$C_{29}H_{52}$
+	24-methyl -14α, 17β-cholestane (20R)	$C_{28}H_{50}$
O	24-methyl -14α, 17α-cholestane (20S)	$C_{28}H_{50}$
P	24-methyl -14α, 17α-cholestane (20R)	$C_{28}H_{50}$
Q	24-ethyl -14α, 17α-cholestane (20S)	$C_{29}H_{52}$
R	24-ethyl -14β, 17β-cholestane (20R)	$C_{29}H_{52}$
+	UNKNOWN STERANE	
S	24-ethyl -14β, 17β-cholestane (20S)	$C_{29}H_{52}$
T	24-ethyl -14α, 17α-cholestane (20R)	$C_{29}H_{52}$
U	5α(H)-pregnane	$C_{21}H_{36}$
V	5α(H)-bisnorcholane	$C_{22}H_{38}$

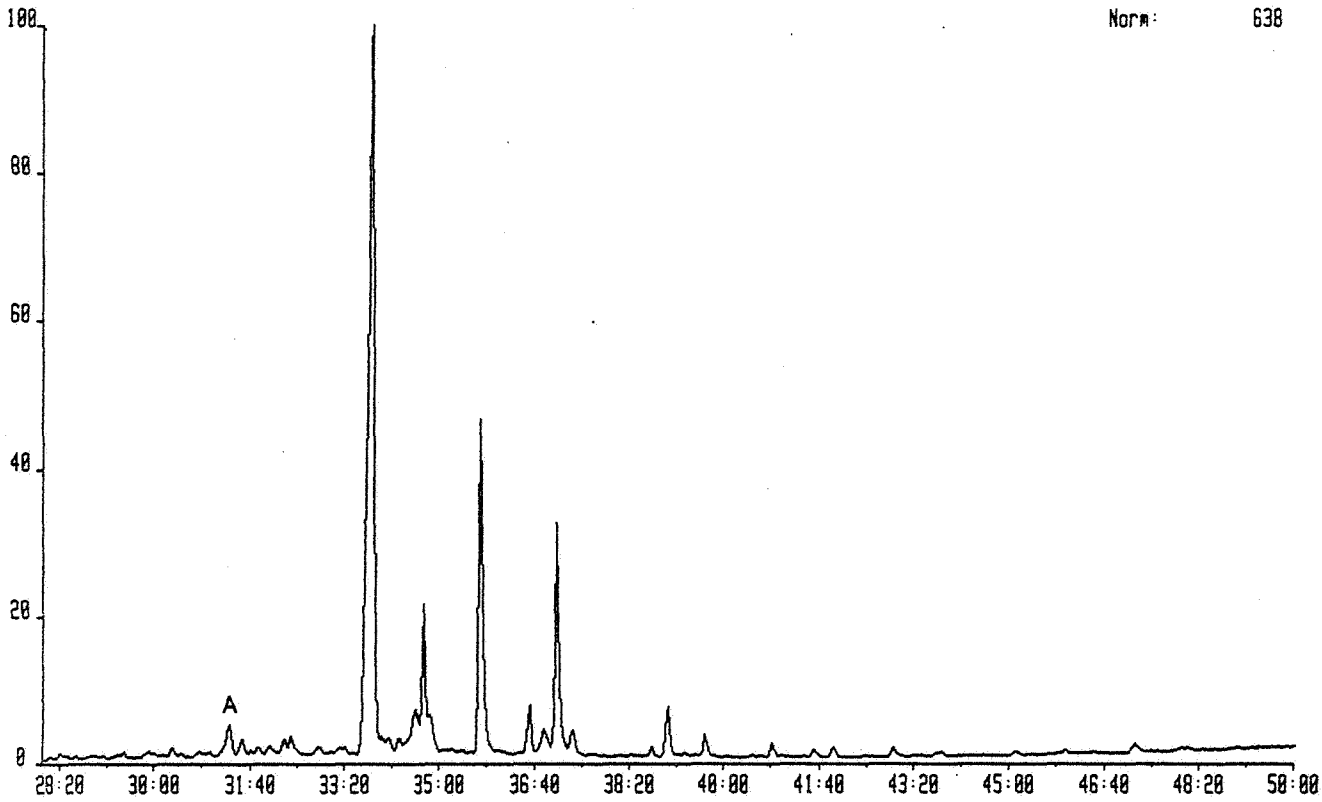
FIGURE 11a

MASS FRAGMENTOGRAMS

WELL 6507/11-4

TERPANES

1607075 10-NOV-87 Sir:Voltage 12-250 Acnt:SAGA Sys:SYSTEMDEF
Sample 1 Injection 1 Group 1 Mass 177.1642
Text:WELL 6507/11-4 2533.4M SWC



1607075 10-NOV-87 Sir:Voltage 12-250 Acnt:SAGA Sys:SYSTEMDEF
Sample 1 Injection 1 Group 1 Mass 191.1798
Text:WELL 6507/11-4 2533.4M SWC

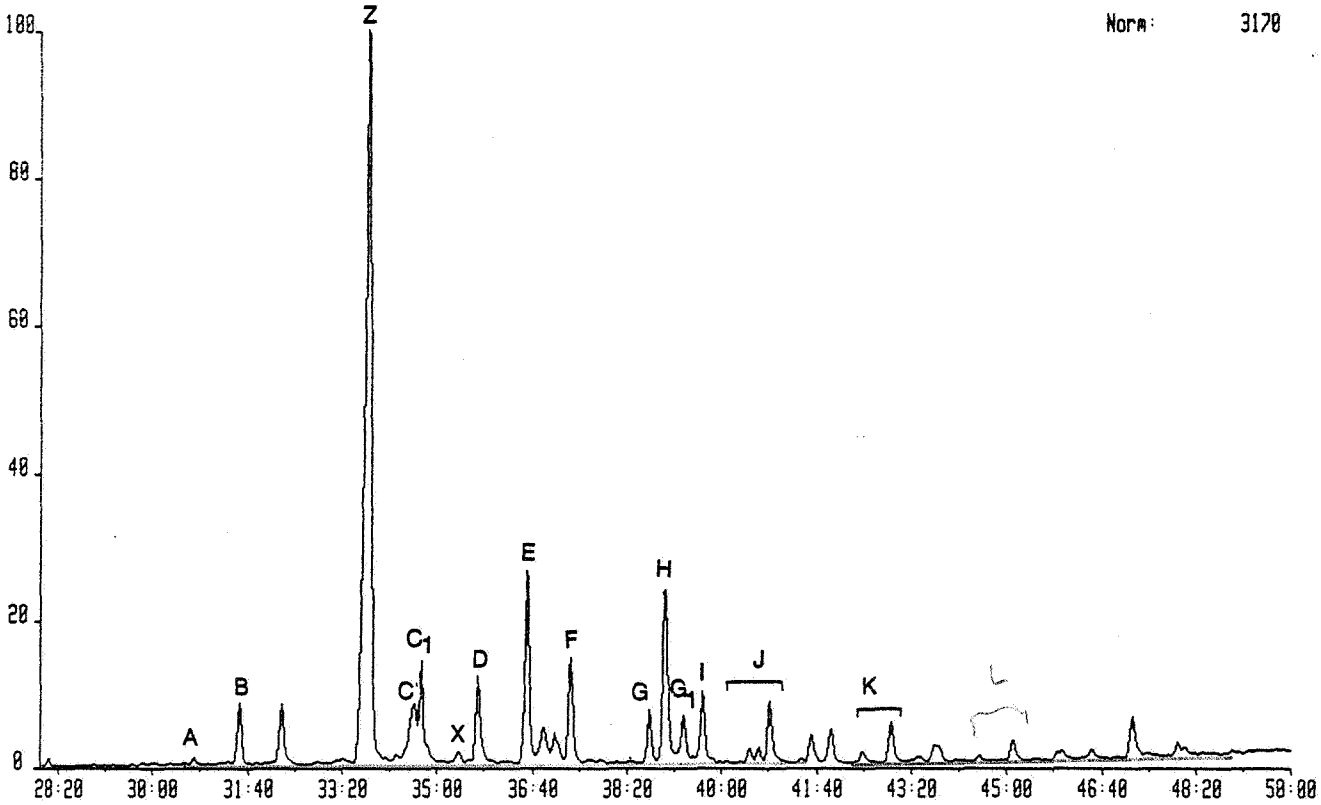


FIGURE 11a

MASS FRAGMENTOGRAMS

WELL 6507/11-4

TERPANES

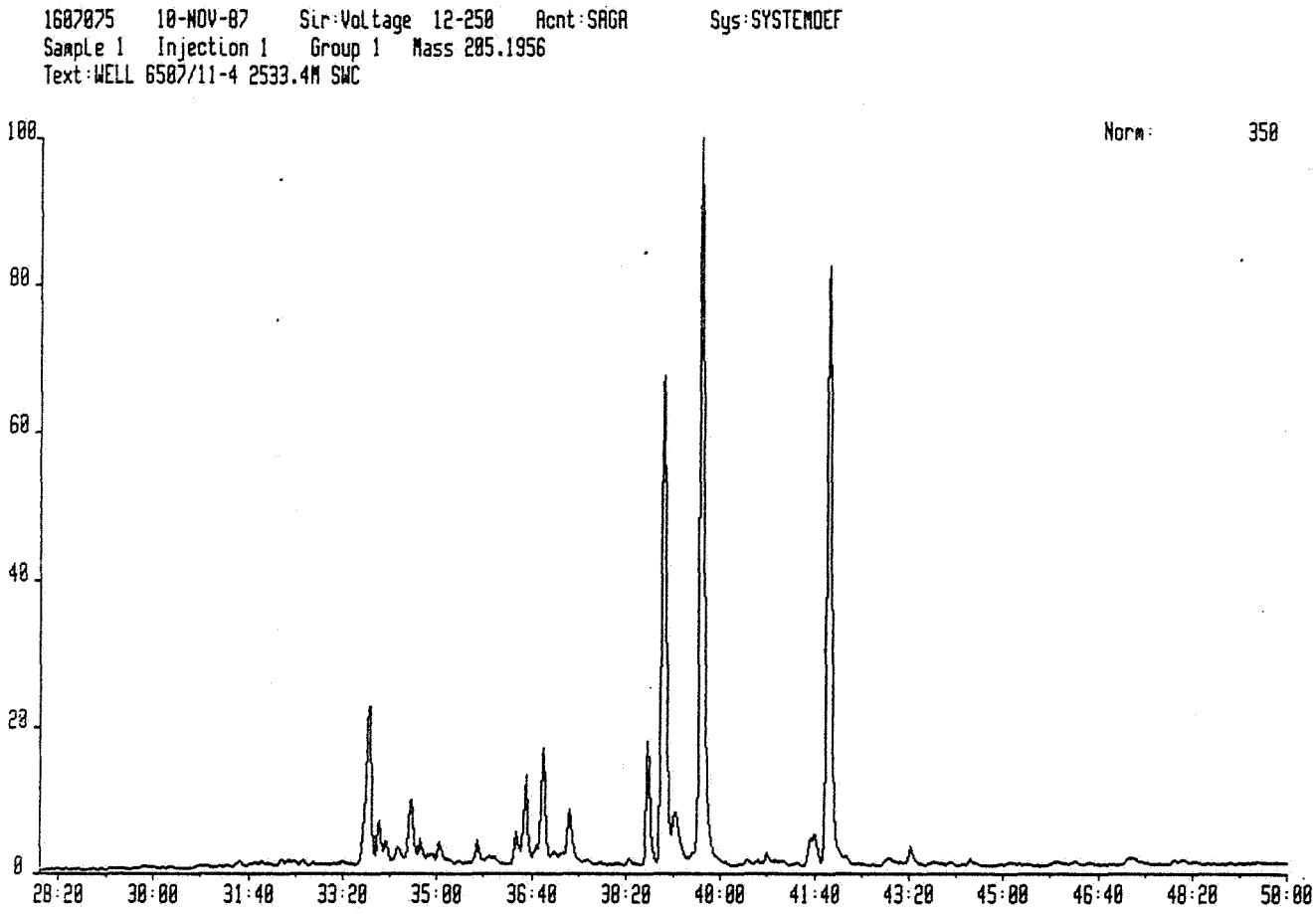


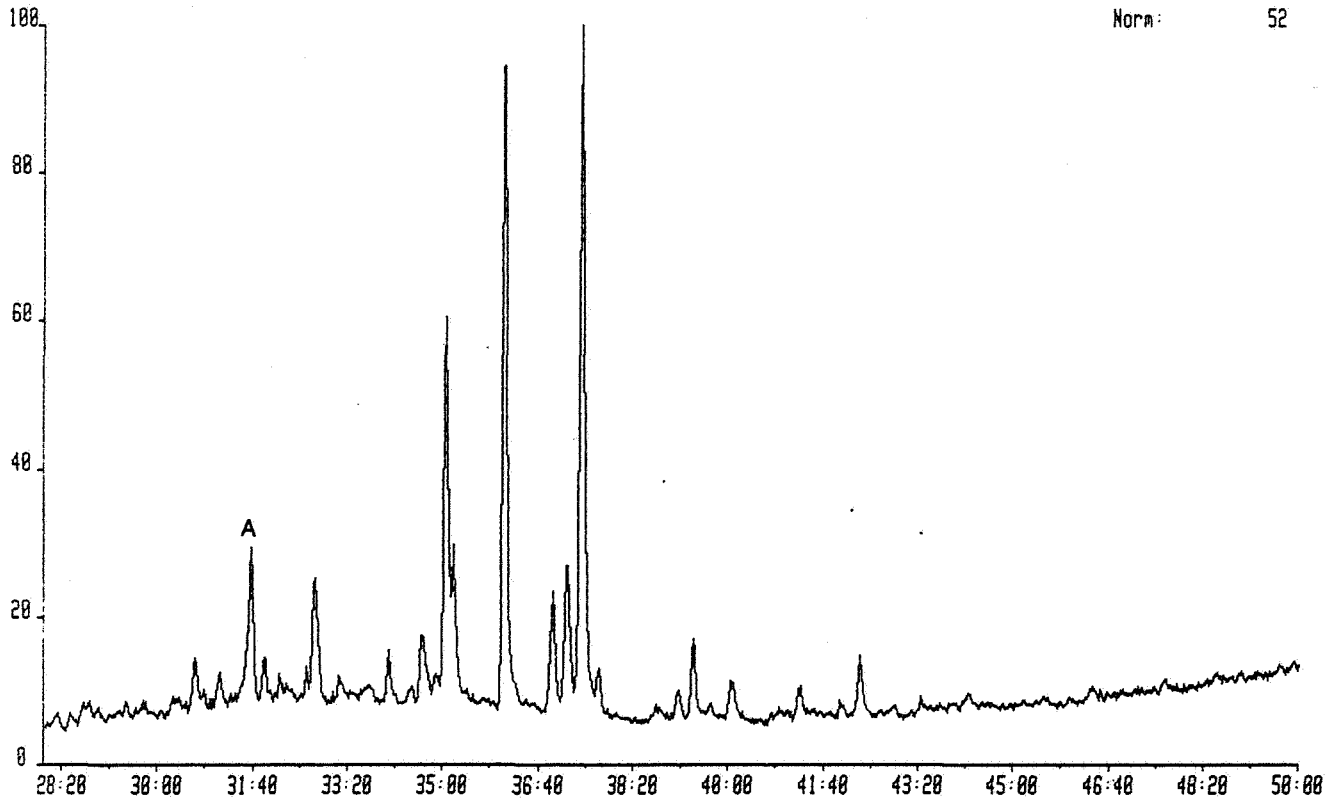
FIGURE 11b

MASS FRAGMENTOGRAMS

WELL 6507/11-4

TERPANES

1607076 10-NOV-87 Sir:Voltage 12-250 Acnt:SAGA Sys:SYSTEMDEF
Sample 1 Injection 1 Group 1 Mass 177.1642
Text:WELL 6507/11-4 2536.7M SWC



1607076 10-NOV-87 Sir:Voltage 12-250 Acnt:SAGA Sys:SYSTEMDEF
Sample 1 Injection 1 Group 1 Mass 191.1798
Text:WELL 6507/11-4 2536.7M SWC

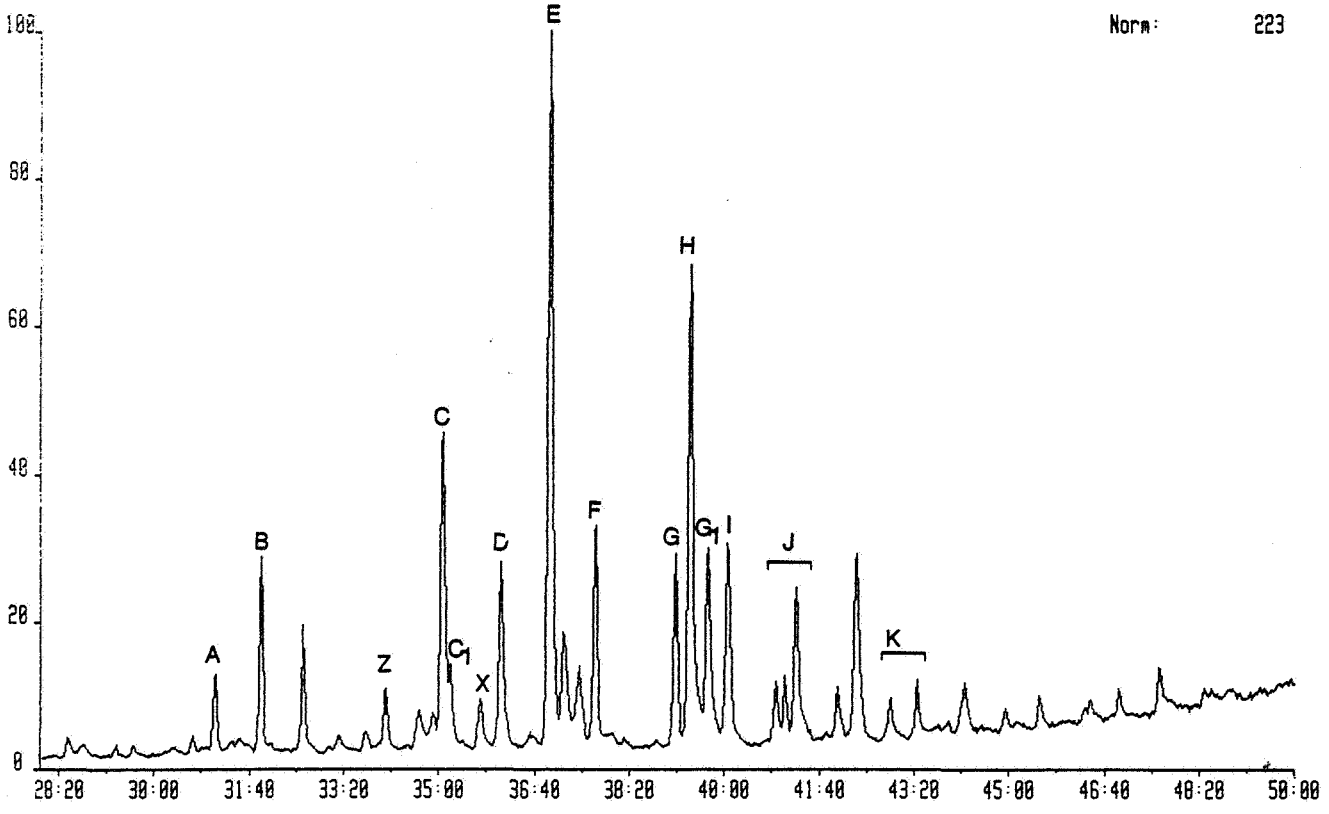


FIGURE 11b

MASS FRAGMENTOGRAMS

WELL 6507/11-4

TERPANES

1607076 10-NOV-87 Sir:Voltage 12-250 Acnt:SAGA Sys:SYSTEMDEF
Sample 1 Injection 1 Group 1 Mass 205.1956
Text:WELL 6507/11-4 2536.7M SWC

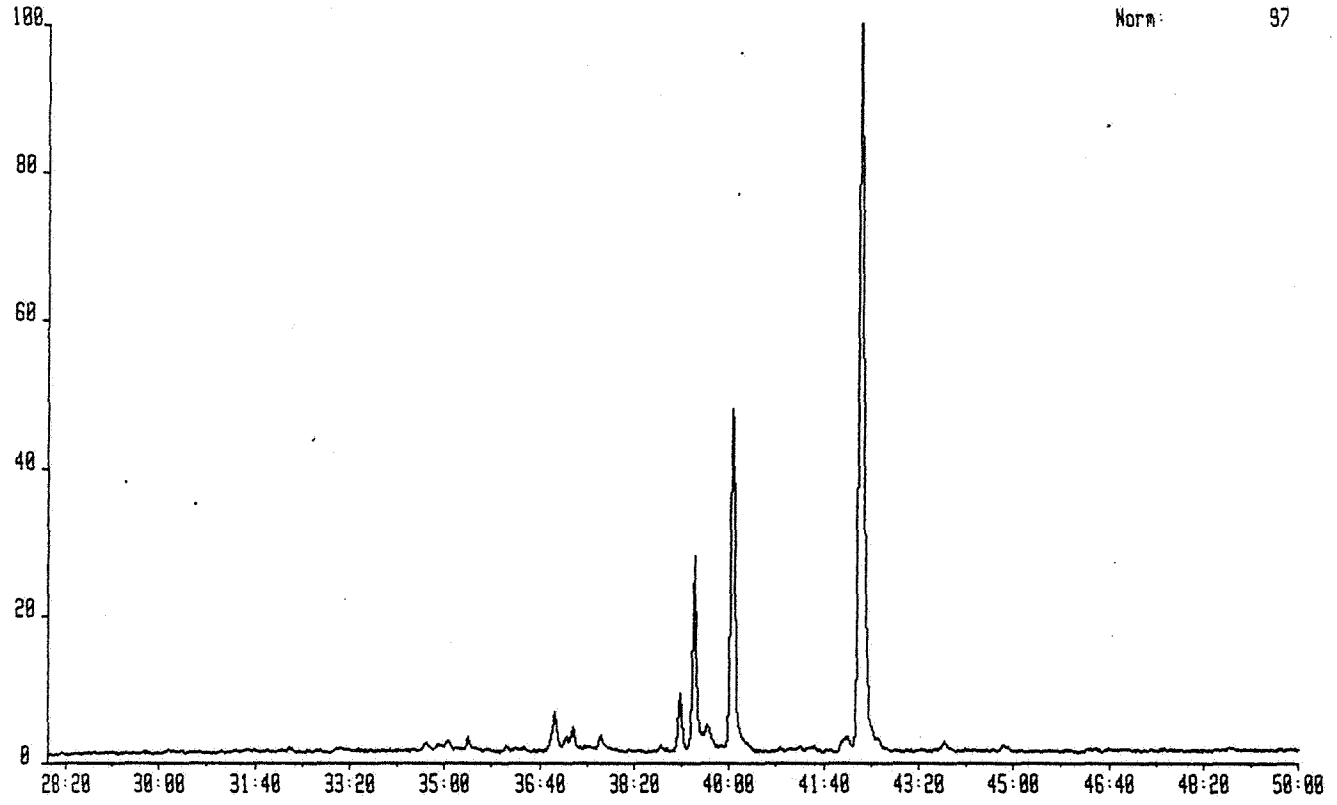


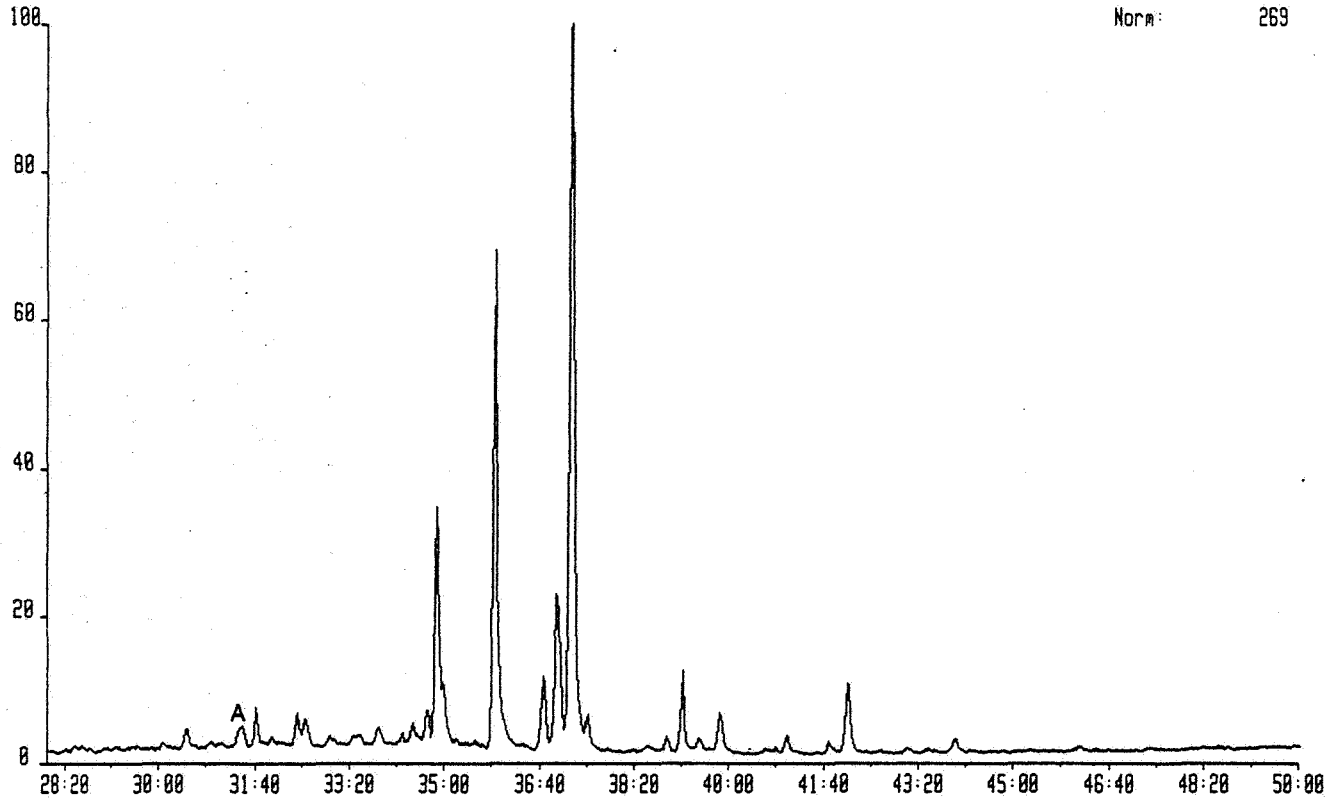
FIGURE 11c

MASS FRAGMENTOGRAMS

WELL 6507/11-4

TERPANES

1607077 10-NOV-87 Sir:Voltage 12-250 Acnt:SAGA Sys:SYSTEMDEF
Sample 1 Injection 1 Group 1 Mass 177.1642
Text:WELL 6507/11-4 2541M SWC



1607077 10-NOV-87 Sir:Voltage 12-250 Acnt:SAGA Sys:SYSTEMDEF
Sample 1 Injection 1 Group 1 Mass 191.1798
Text:WELL 6507/11-4 2541M SWC

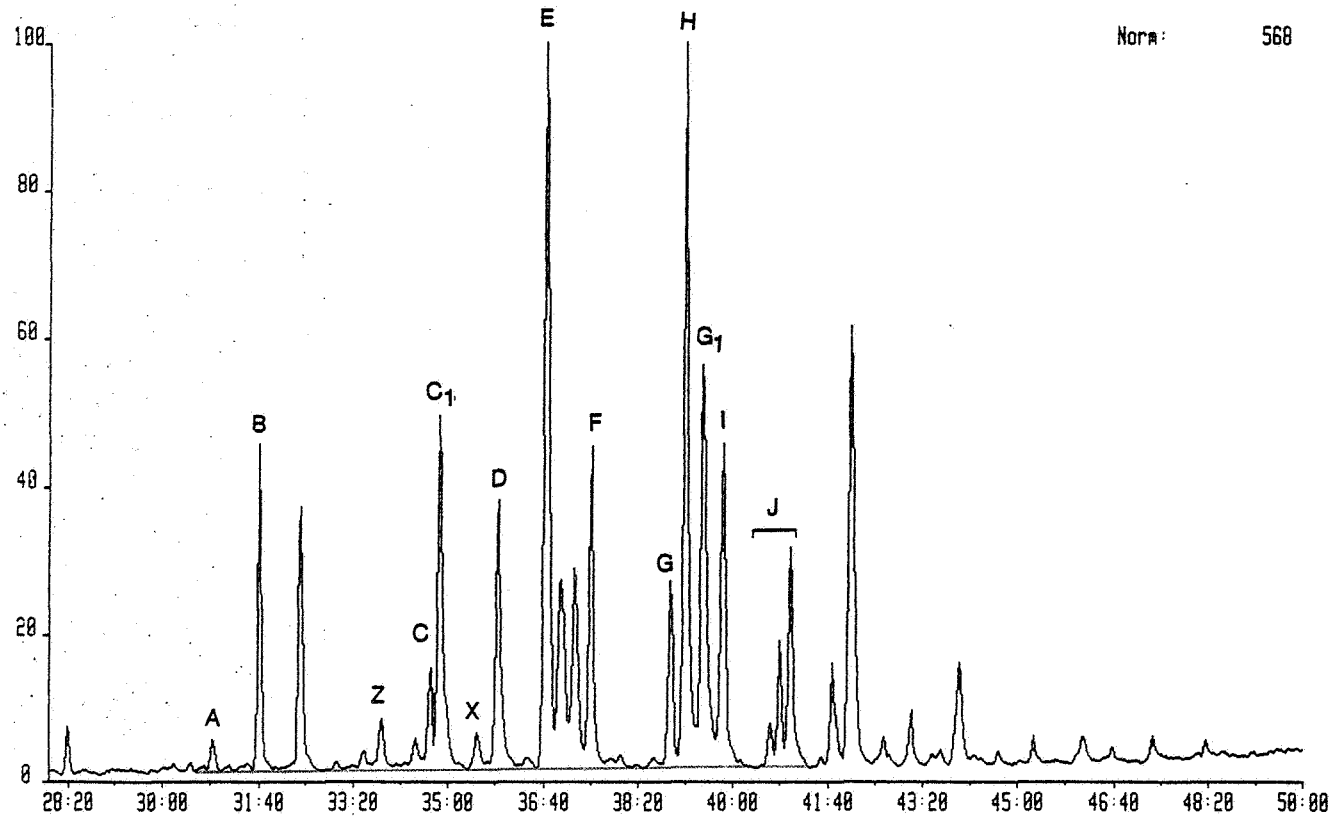


FIGURE 11c

MASS FRAGMENTOGRAMS

WELL 6507/11-4

TERPANES

1607077 10-NOV-87 Sir:Voltage 12-250 Acnt:SAGA Sys:SYSTEMDEF
Sample 1 Injection 1 Group 1 Mass 205.1956
Text:WELL 6507/11-4 2541M SWC

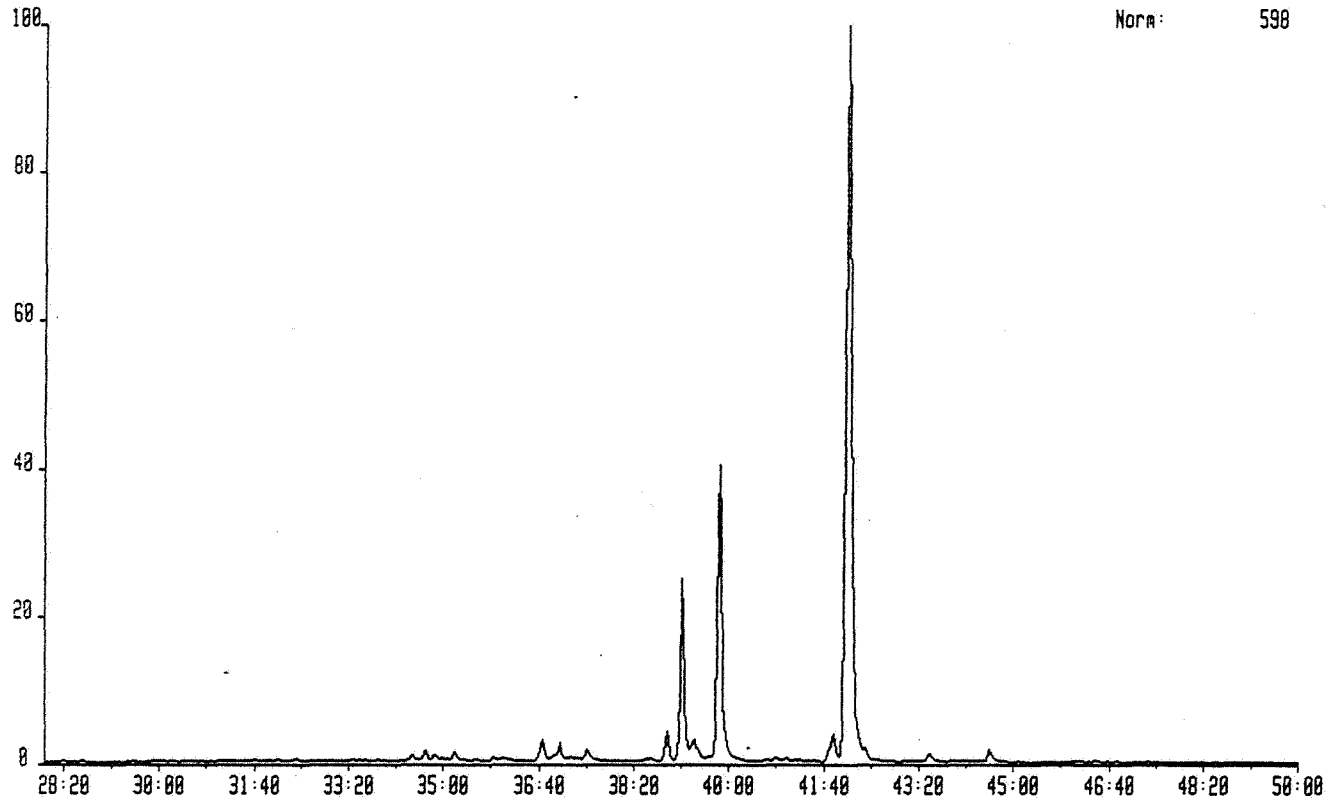


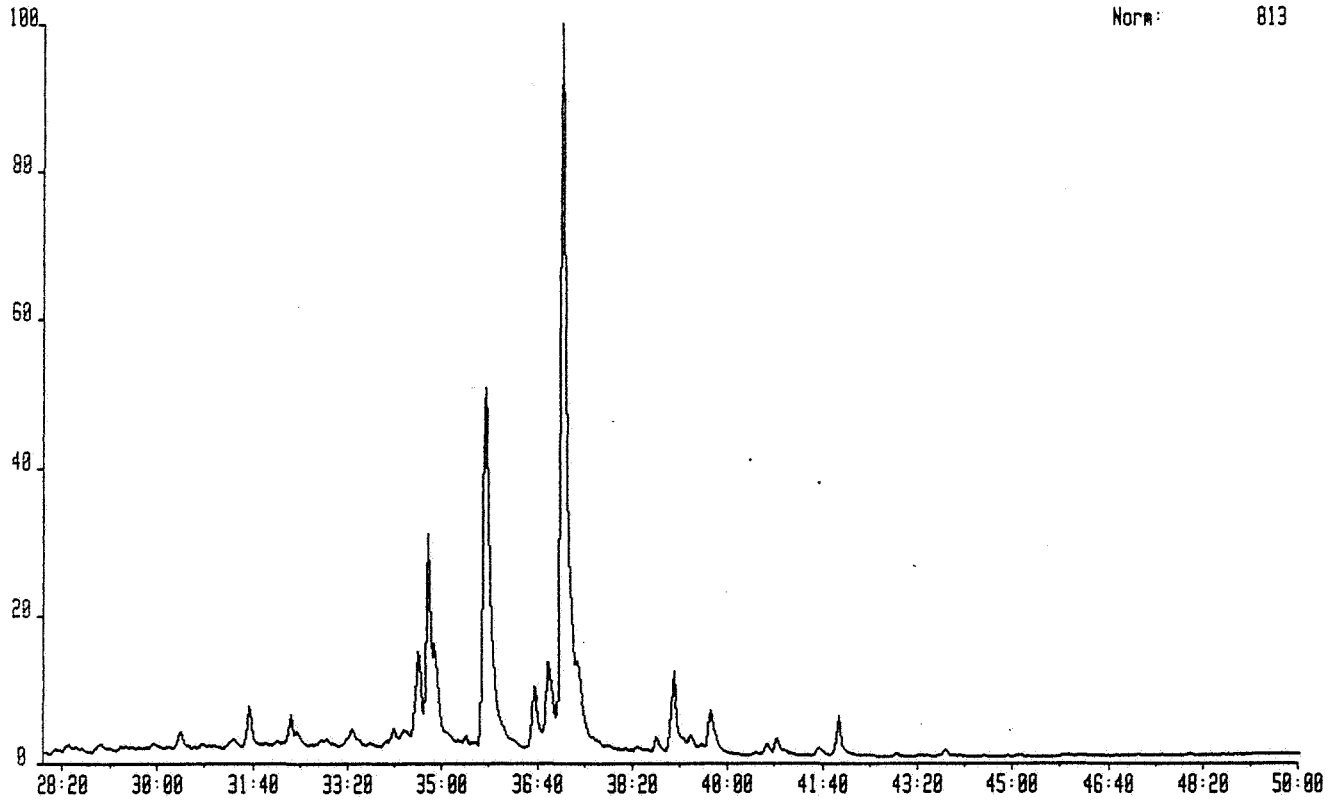
FIGURE 11d

MASS FRAGMENTOGRAMS

WELL 6507/11-4

TERPANES

1607078 10-NOV-87 Sir:Voltage 12-250 Acnt:SAGA Sys:SYSTEMDEF
Sample 1 Injection 1 Group 1 Mass 177.1642
Text:WELL 6507/11-4 2567M CORE



1607078 10-NOV-87 Sir:Voltage 12-250 Acnt:SAGA Sys:SYSTEMDEF
Sample 1 Injection 1 Group 1 Mass 191.1798
Text:WELL 6507/11-4 2567M CORE

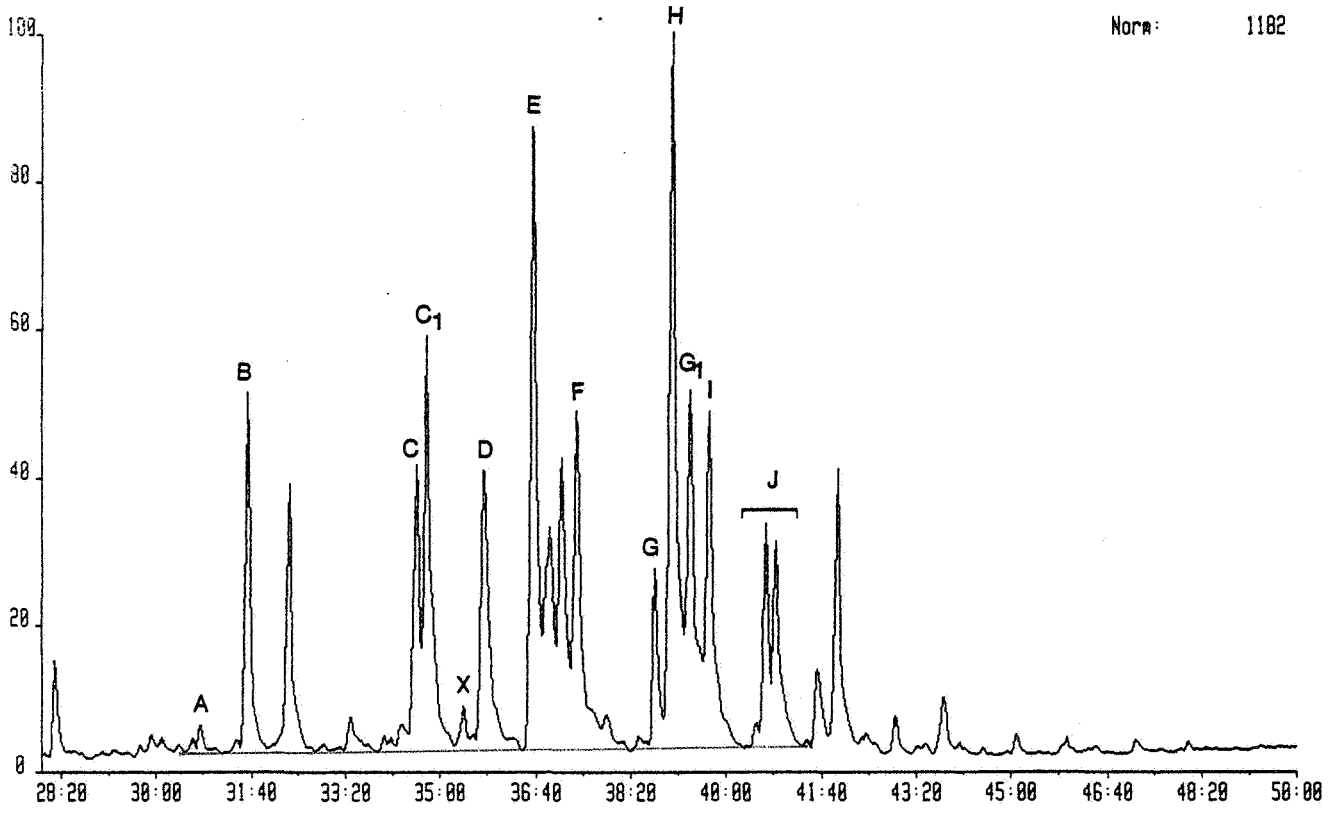


FIGURE 11d

MASS FRAGMENTOGRAMS

WELL 6507/11-4

TERPANES

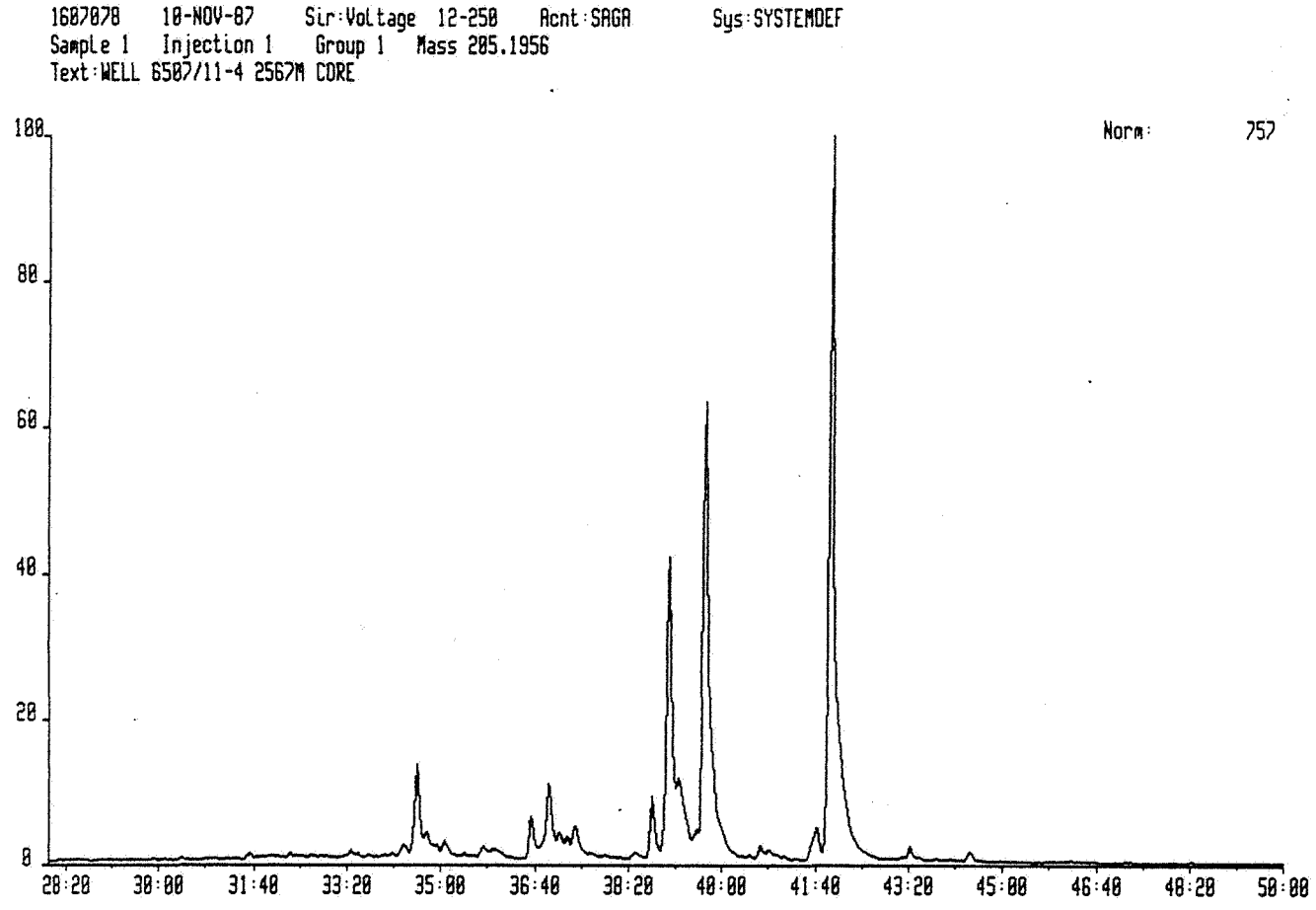
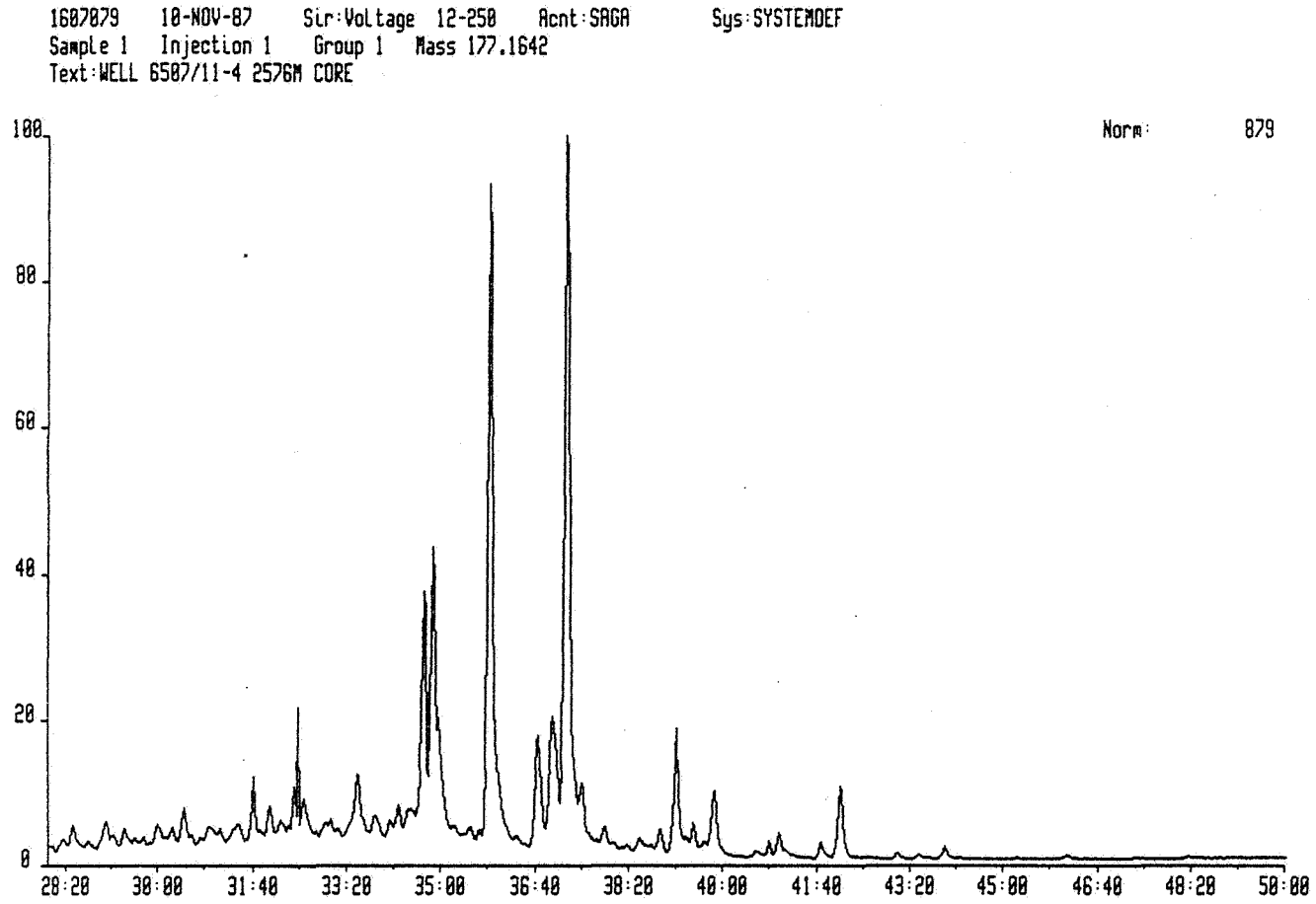


FIGURE 11e

MASS FRAGMENTOGRAMS

WELL 6507/11-4

TERPANES



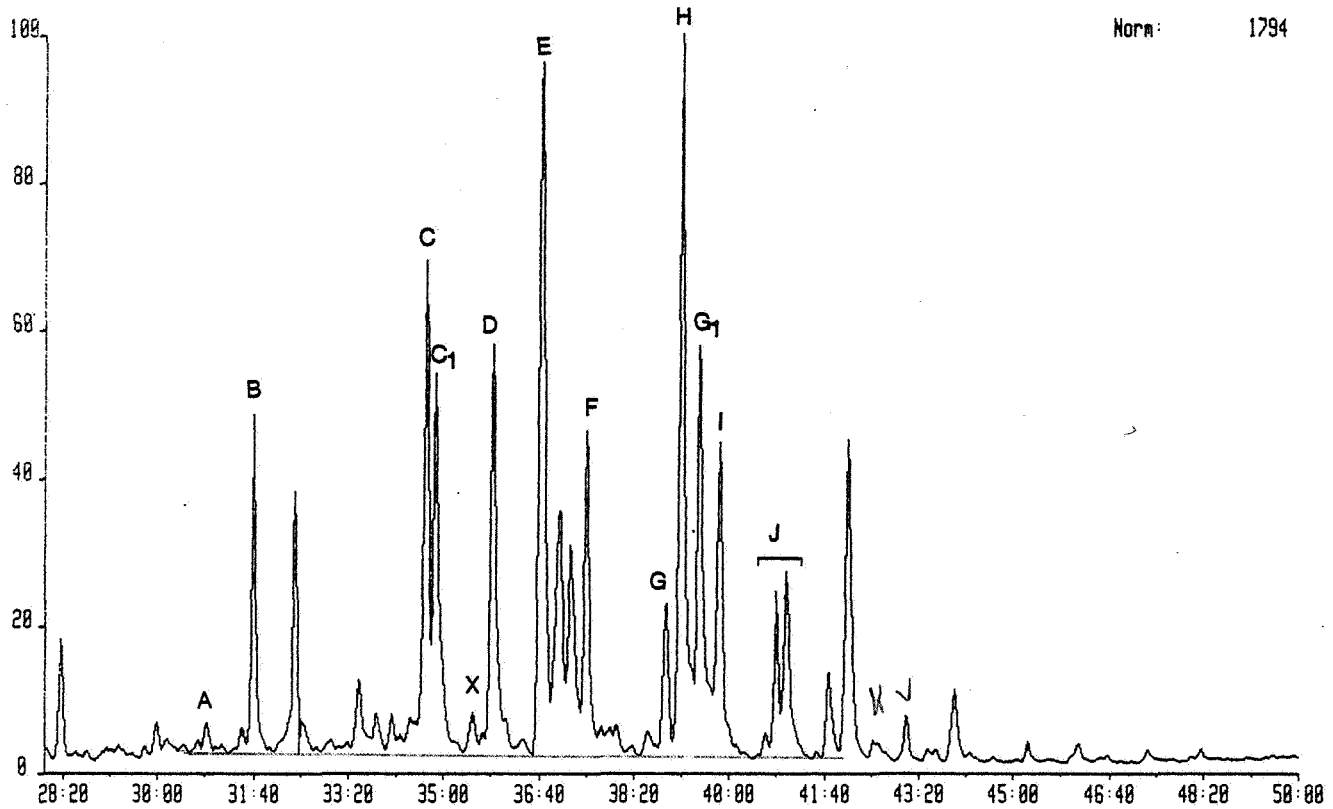


FIGURE 11e

MASS FRAGMENTOGRAMS

WELL 6507/11-4

TERPANES

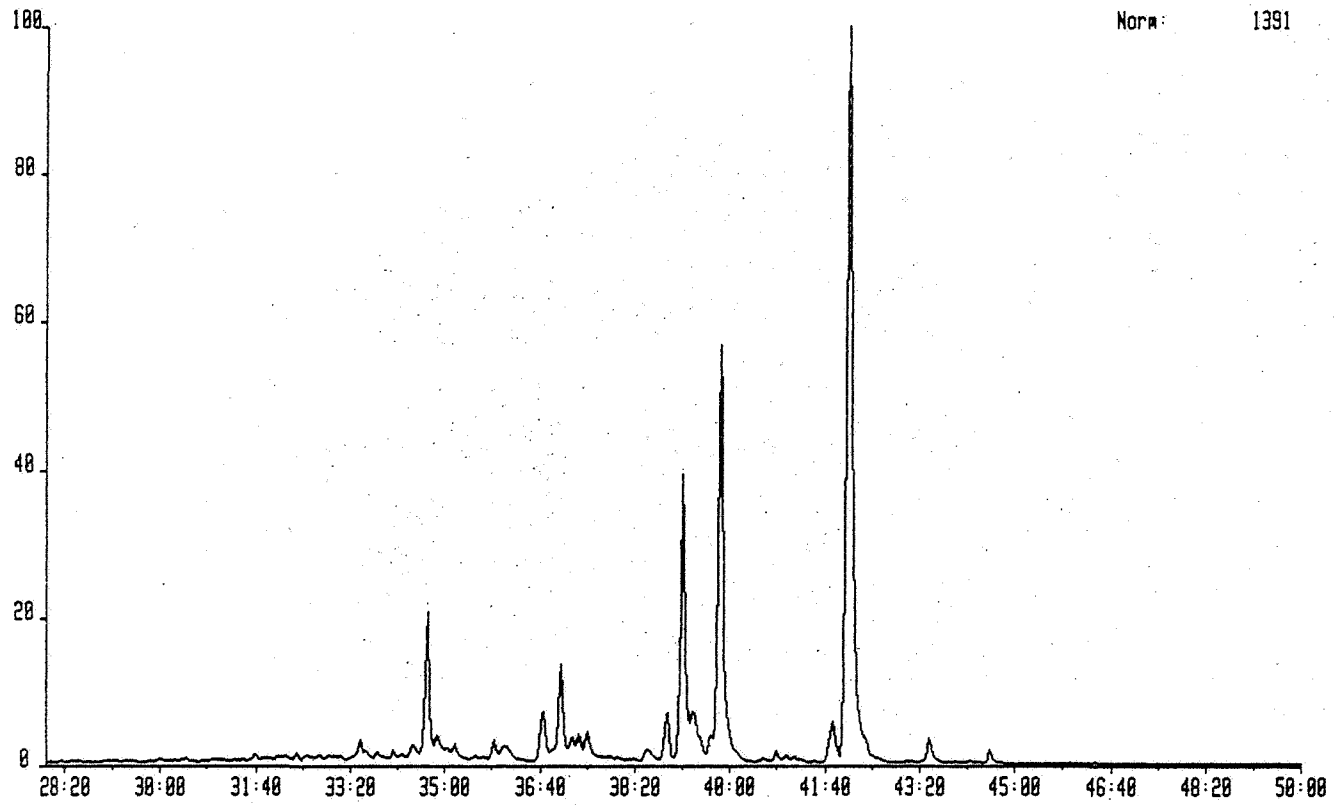


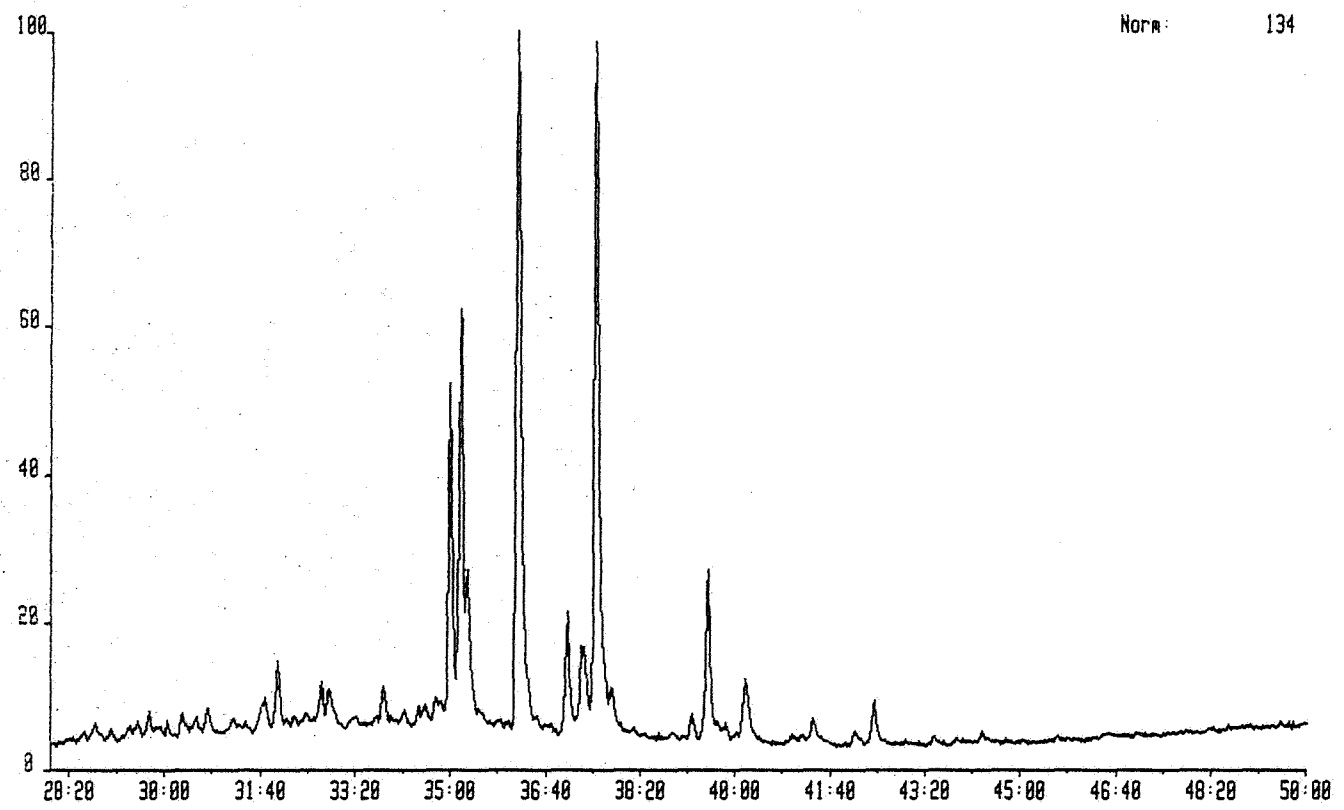
FIGURE 11f

MASS FRAGMENTOGRAMS

WELL 6507/11-4

TERPANES

1607080 11-NOV-87 Sir:Voltage 12-250 Acnt:SAGA Sys:SYSTEMDEF
Sample 1 Injection 1 Group 1 Mass 177.1642
Text:WELL 6507/11-4 2589M CORE



1607080 11-NOV-87 Sir:Voltage 12-250 Acnt:SAGA Sys:SYSTEMDEF
Sample 1 Injection 1 Group 1 Mass 191.1798
Text:WELL 6507/11-4 2589M CORE

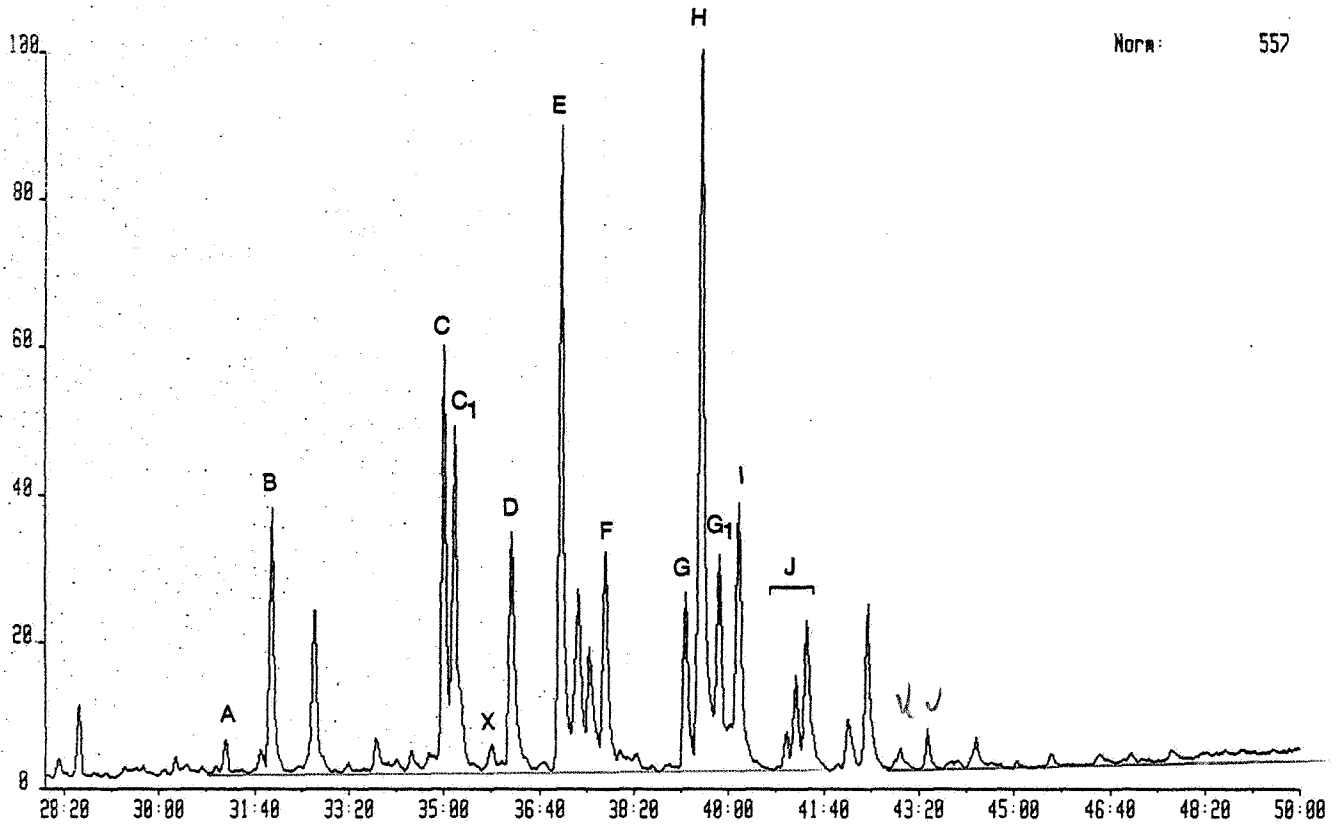


FIGURE 11f

MASS FRAGMENTOGRAMS

WELL 6507/11-4

TERPANES

1607080 11-NOV-87 Sir:Voltage 12-250 Acnt:SAGA Sys:SYSTEMDEF
Sample 1 Injection 1 Group 1 Mass 205.1956
Text:WELL 6507/11-4 2589M CORE

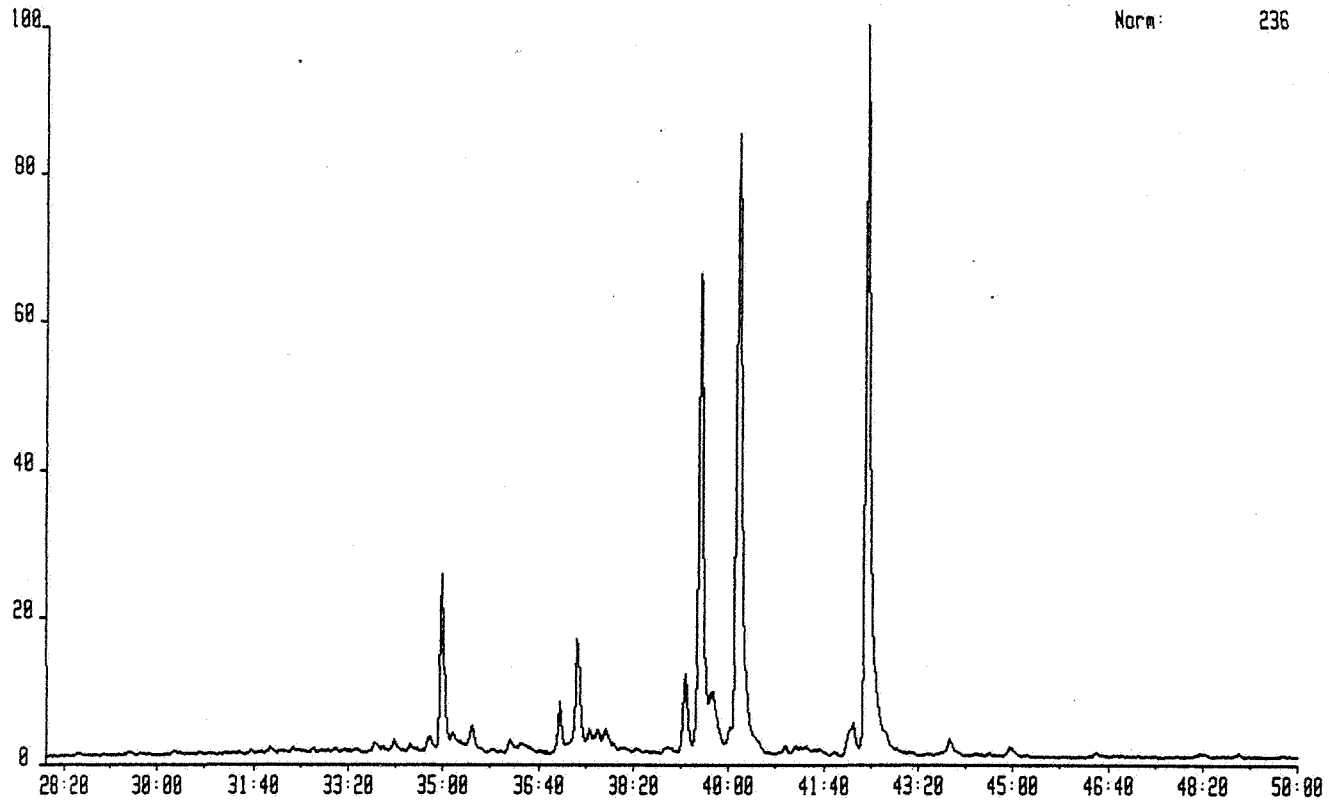
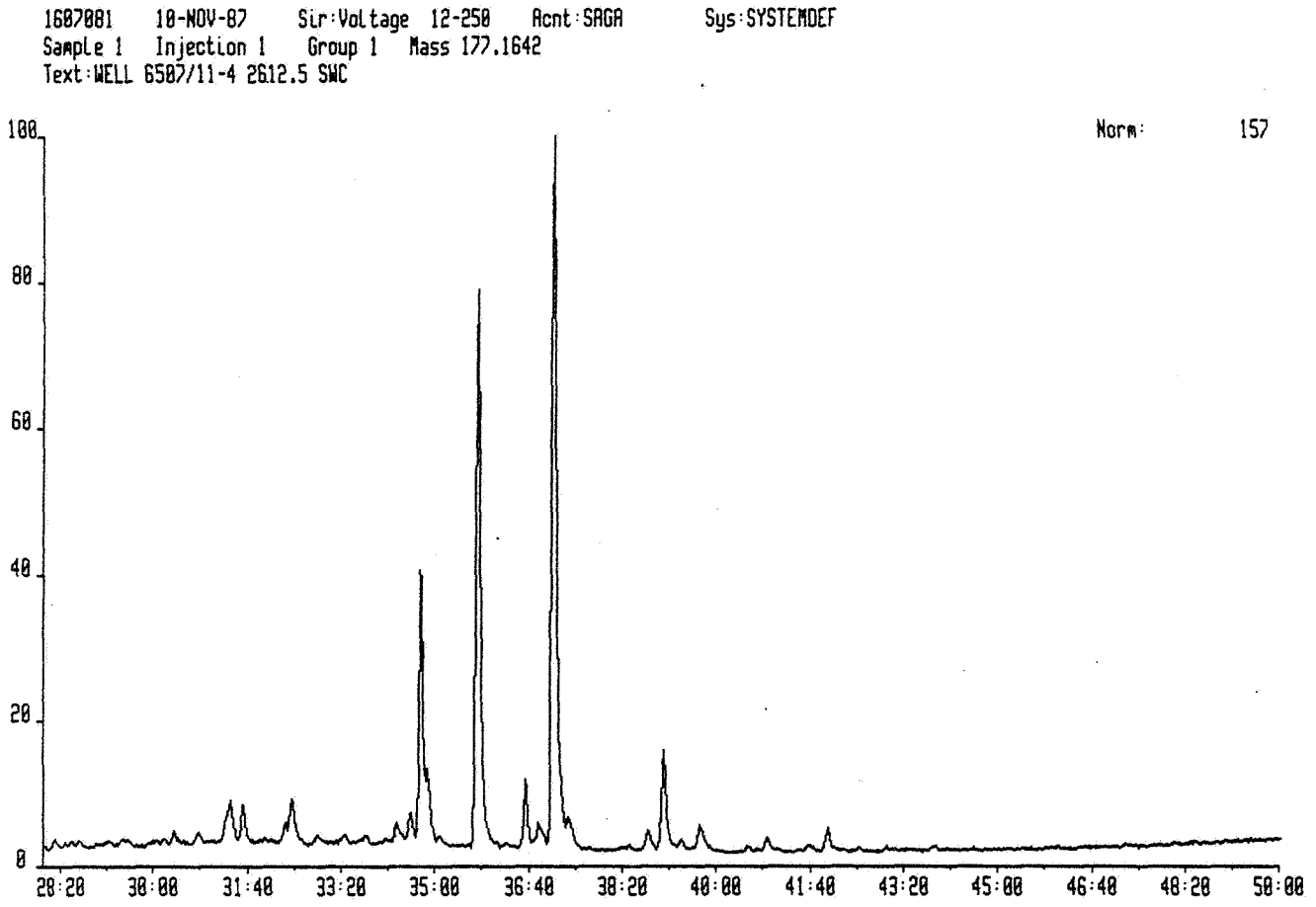


FIGURE 11g

MASS FRAGMENTOGRAMS

WELL 6507/11-4

TERPANES



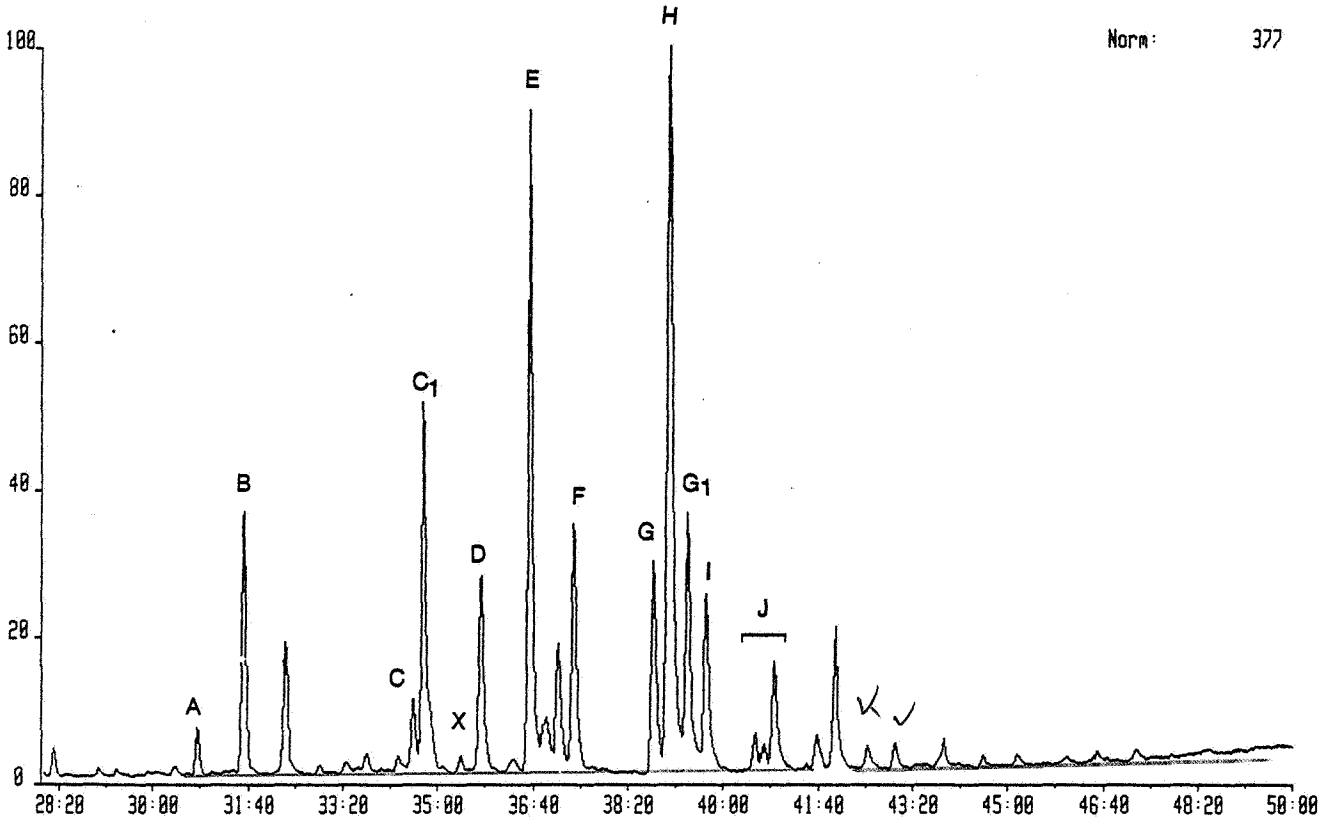


FIGURE 11g

MASS FRAGMENTOGRAMS

WELL 6507/11-4

TERPANES

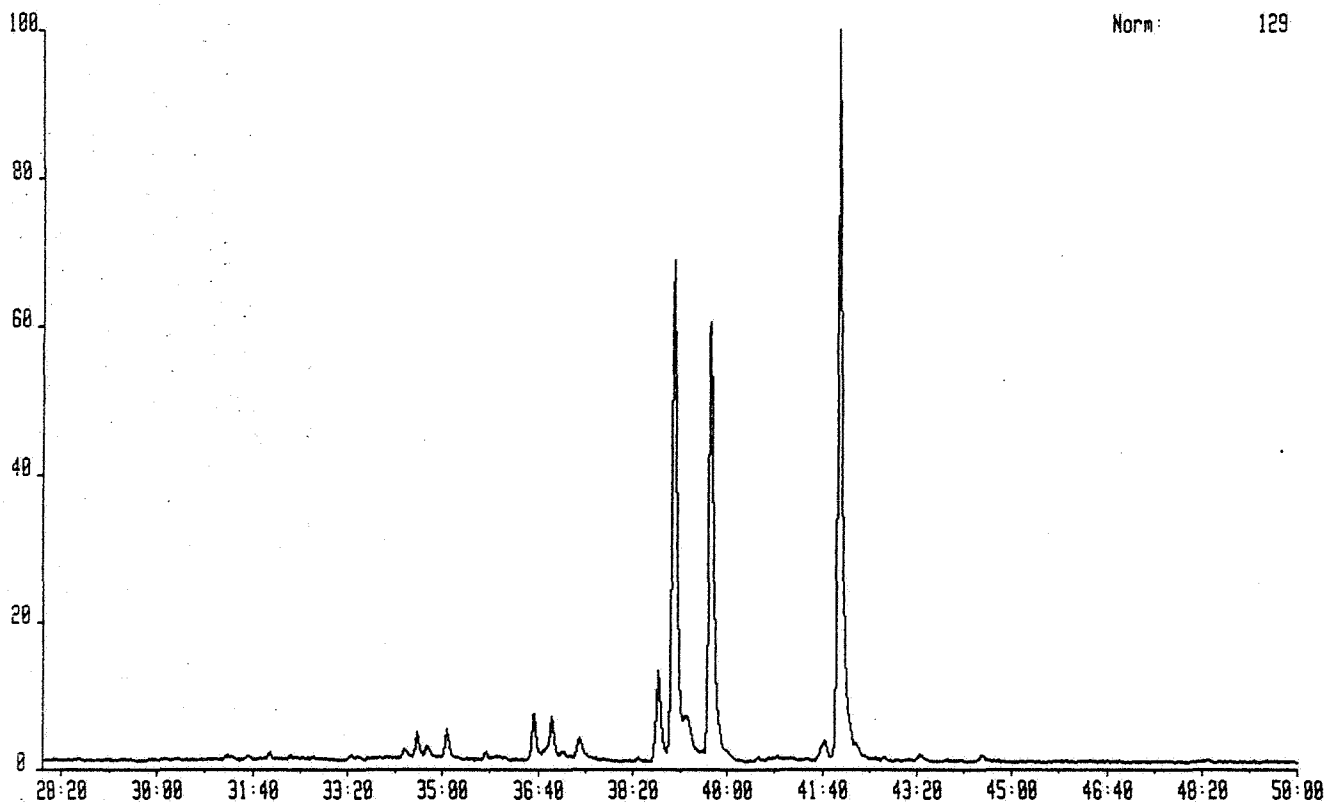
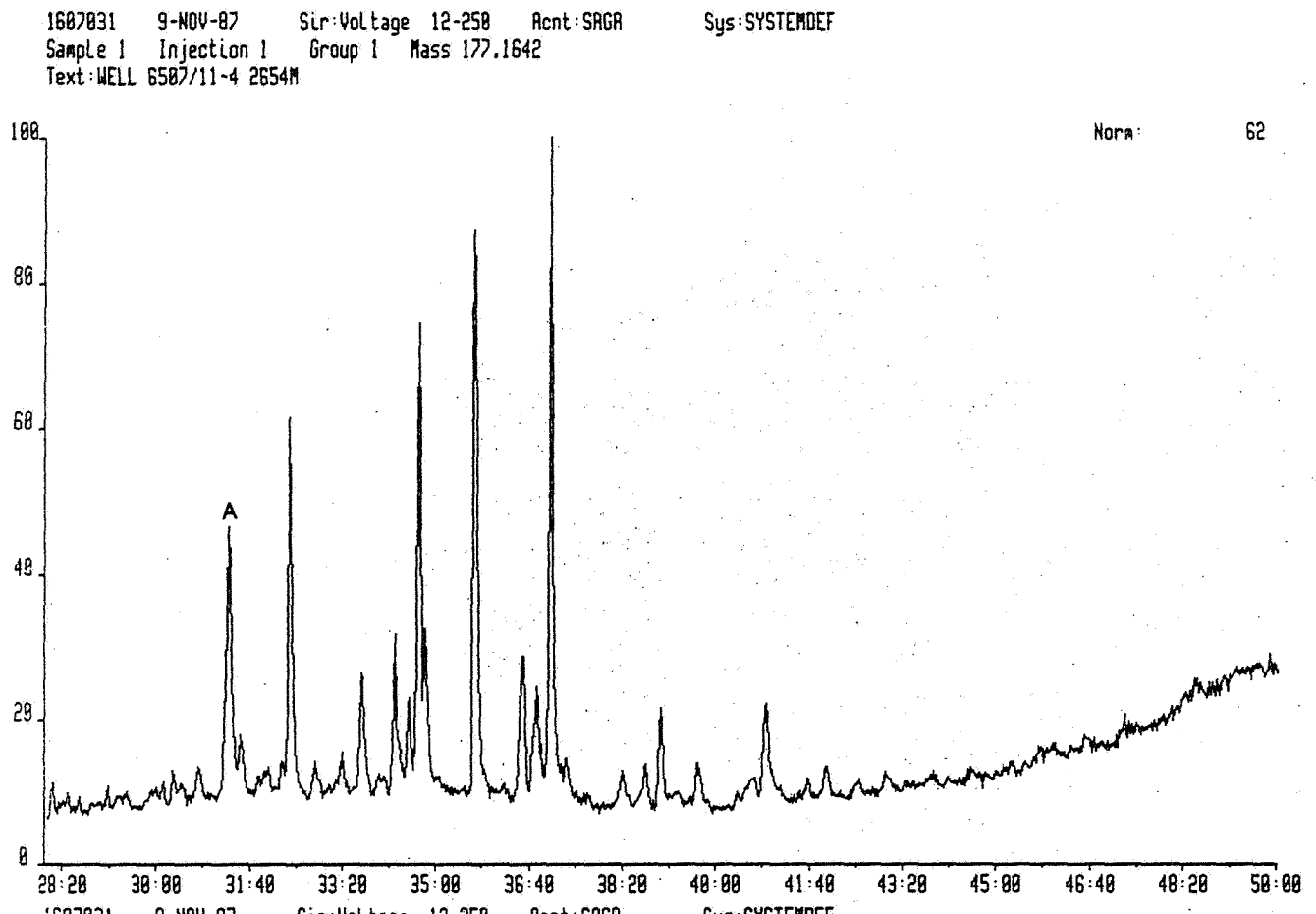


FIGURE 11h

MASS FRAGMENTOGRAMS

WELL 6507/11-4

TERPANES



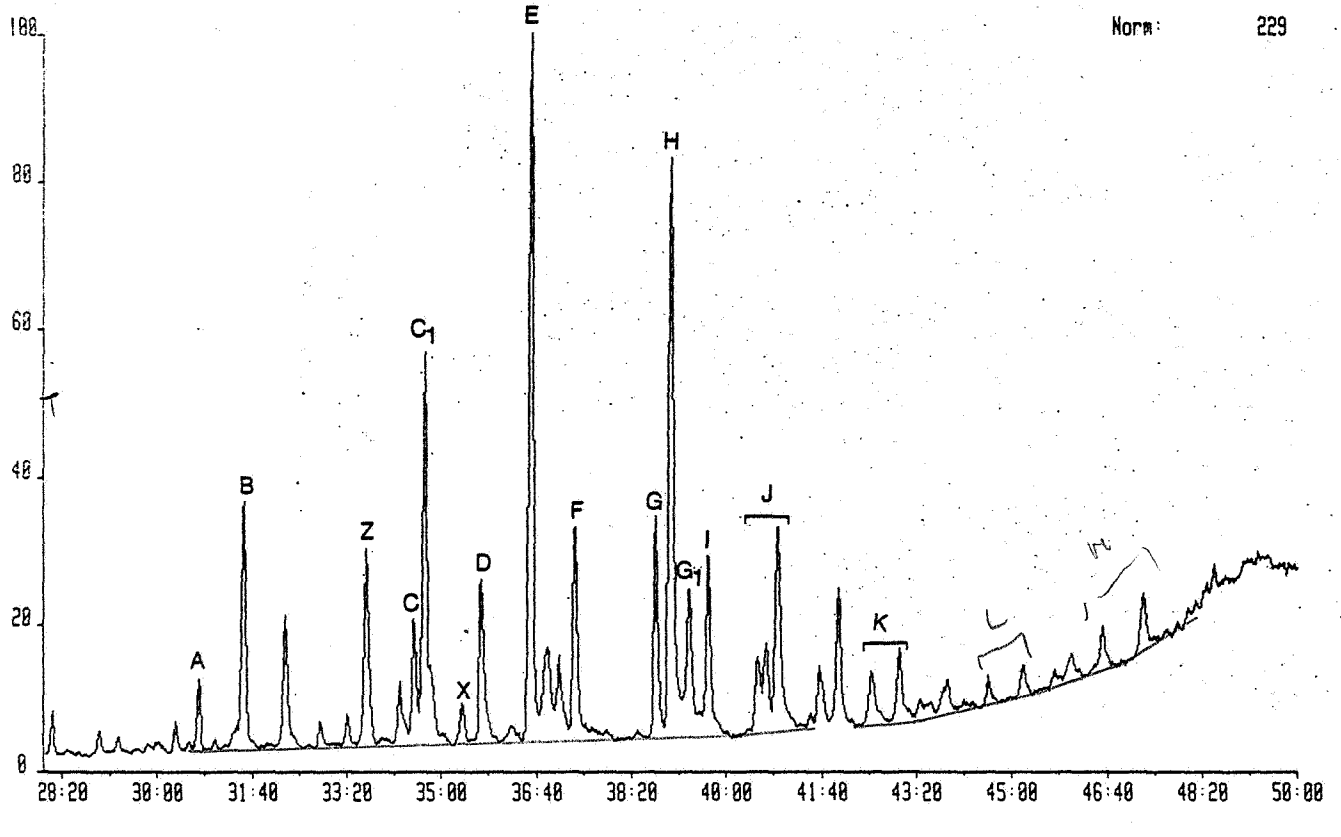


FIGURE 11h

MASS FRAGMENTOGRAMS

WELL 6507/11-4

TERPANES

1607031 9-NOV-87 Sir:Voltage 12-250 Acnt:SAGA Sys:SYSTEMDEF
Sample 1 Injection 1 Group 1 Mass 205.1956
Text:WELL 6507/11-4 2654M

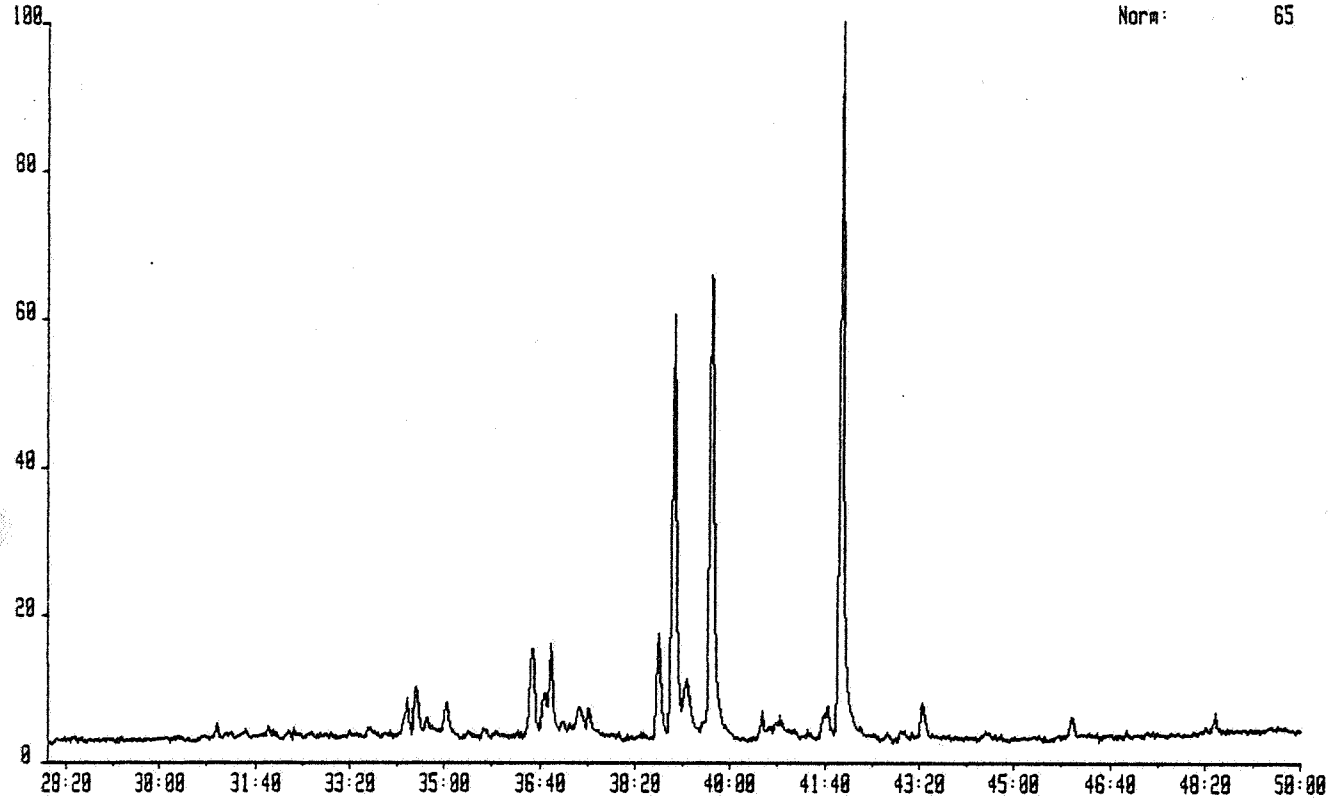


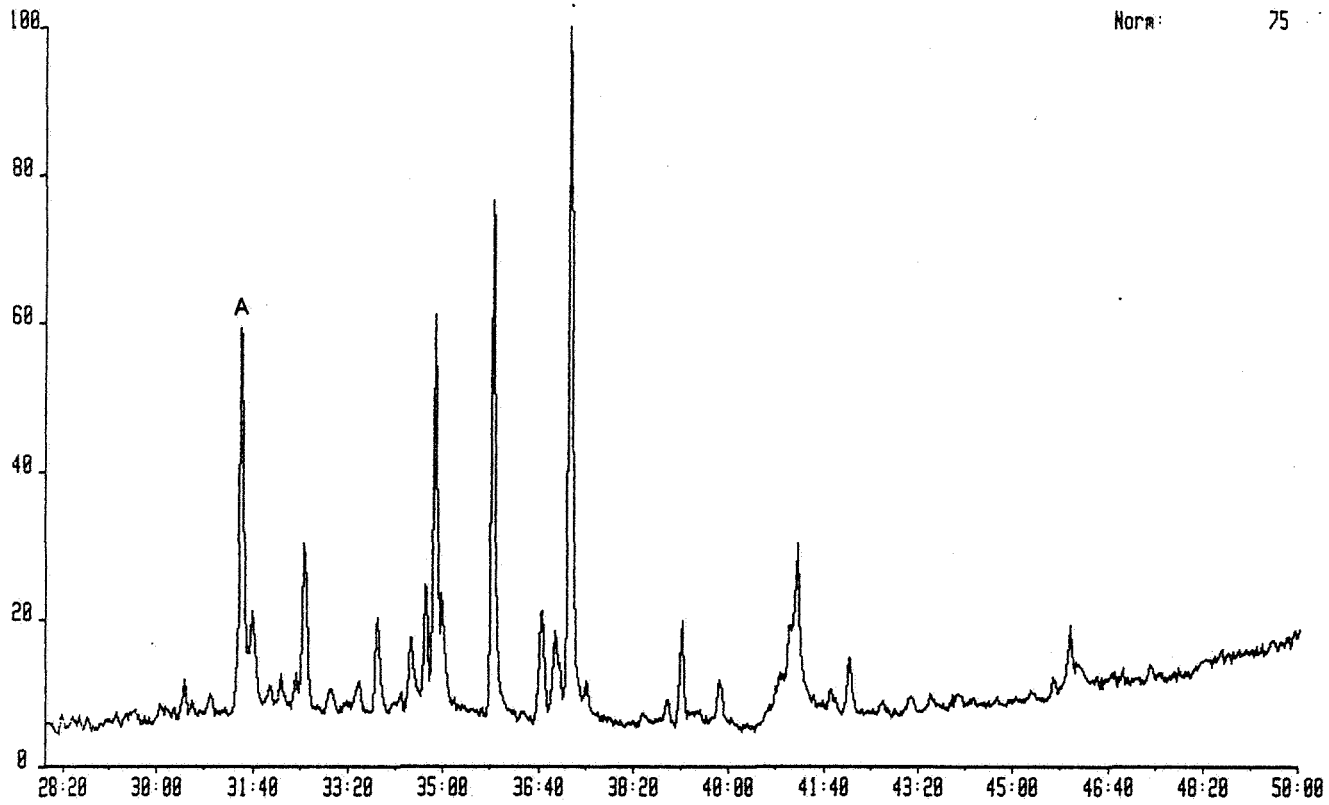
FIGURE 11i

MASS FRAGMENTOGRAMS

WELL 6507/11-4

TERPANES

1607033 9-NOV-87 Sir:Voltage 12-250 Acnt:SAGA Sys:SYSTEMDEF
Sample 1 Injection 1 Group 1 Mass 177.1642
Text:WELL 6507/11-4 2672M



1607033 9-NOV-87 Sir:Voltage 12-250 Acnt:SAGA Sys:SYSTEMDEF
Sample 1 Injection 1 Group 1 Mass 191.1798
Text:WELL 6507/11-4 2672M

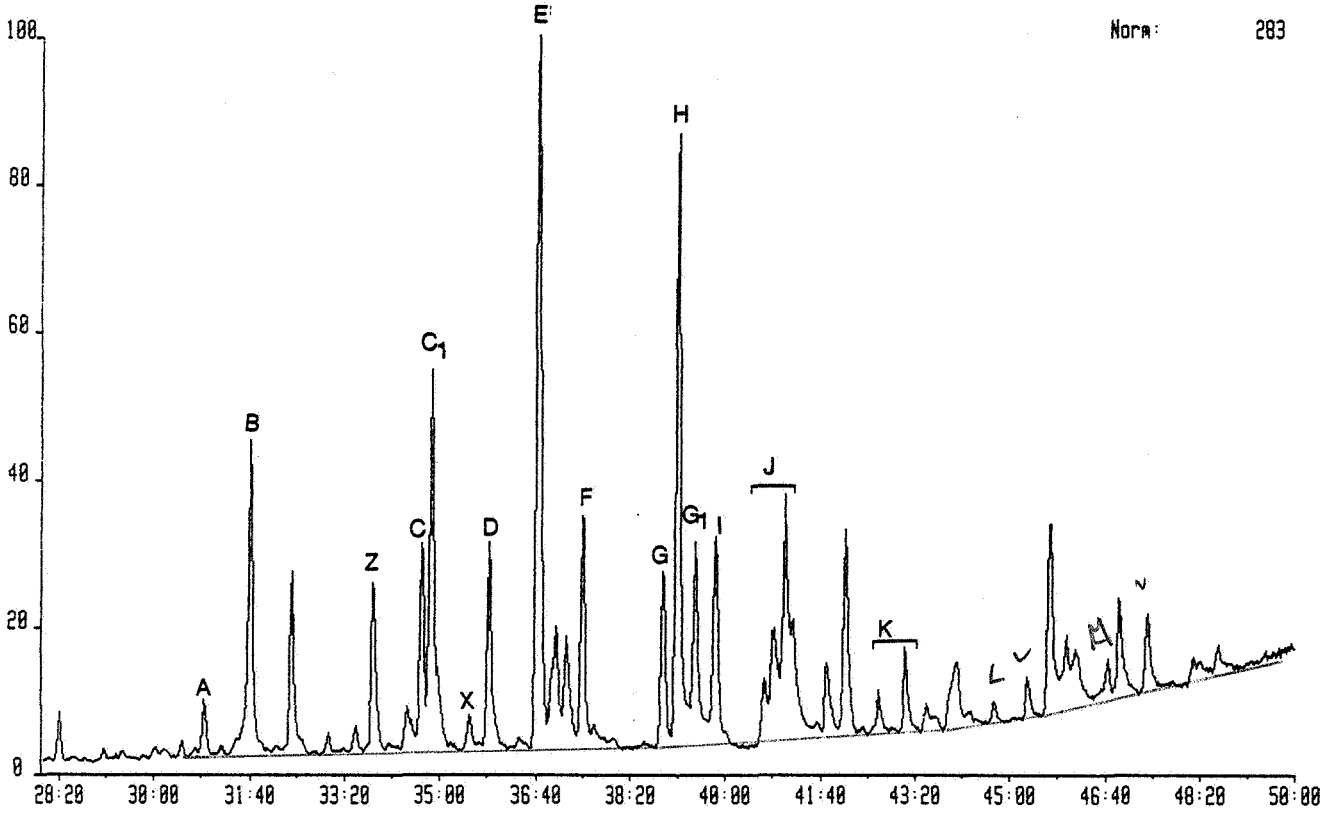


FIGURE 11i

MASS FRAGMENTOGRAMS

WELL 6507/11-4

TERPANES

1607033 9-NOV-87 Sir:Voltage 12-250 Acnt:SAGA Sys:SYSTEMDEF
Sample 1 Injection 1 Group 1 Mass 205.1956
Text:WELL 6507/11-4 2672M

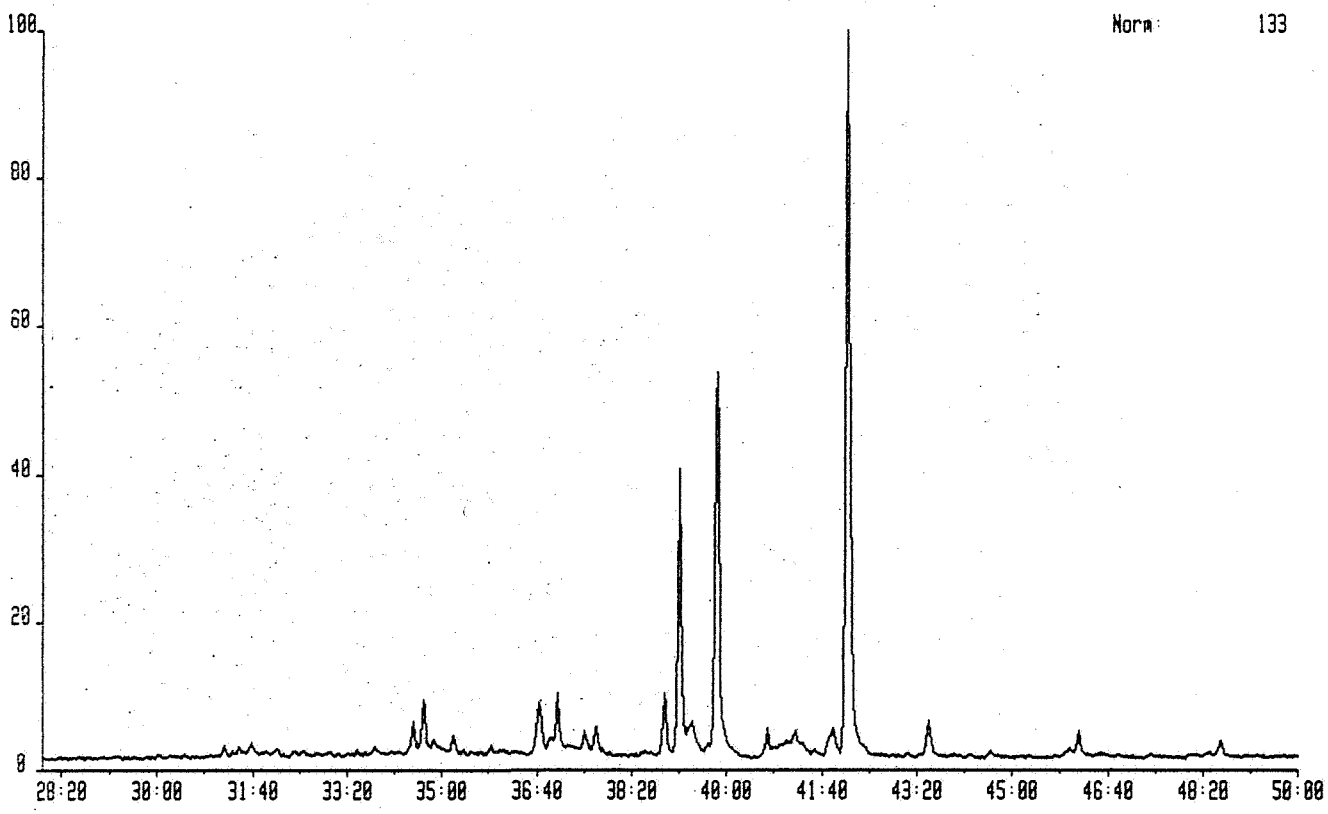


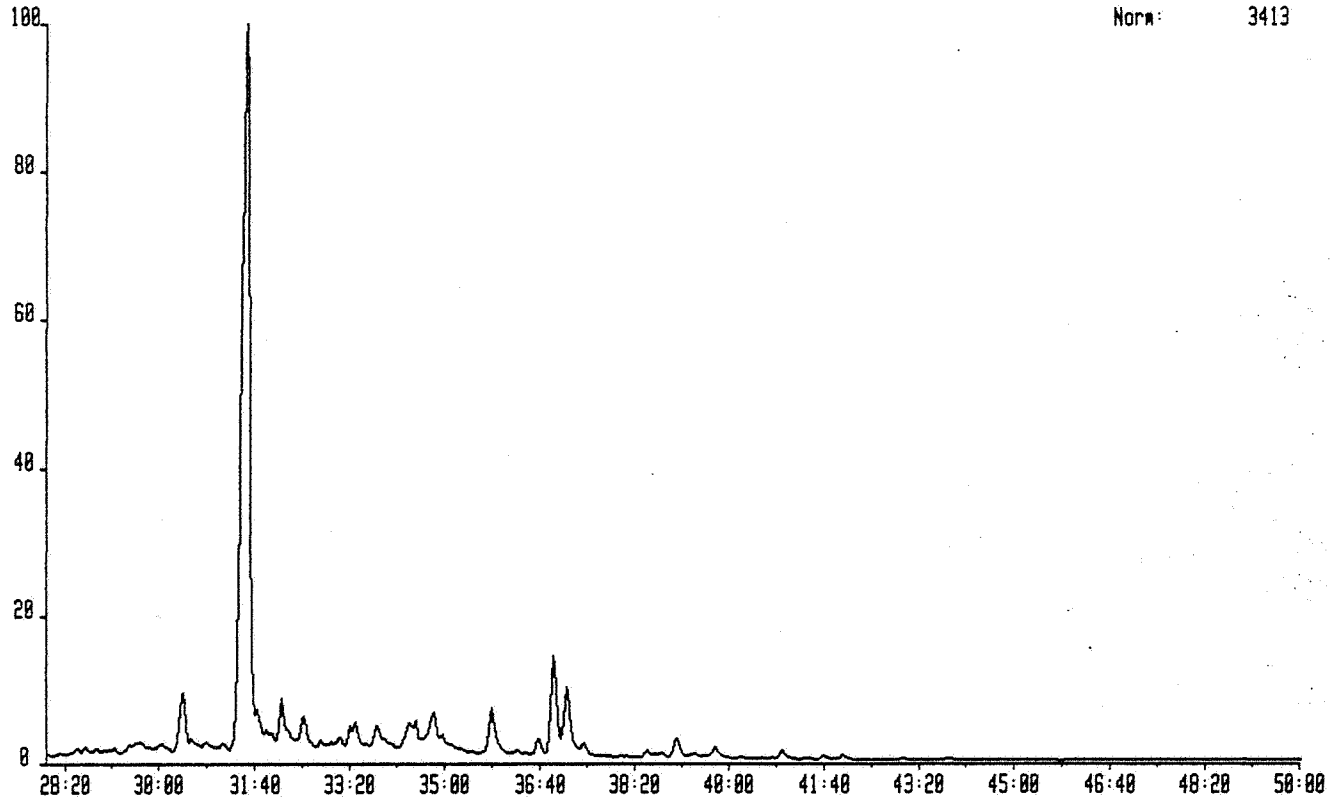
FIGURE 11j

MASS FRAGMENTOGRAMS

WELL 6507/11-4

TERPANES

1607082 11-NOV-87 Sir:Voltage 12-250 Acnt:SAGA Sys:SYSTEMDEF
Sample 1 Injection 1 Group 1 Mass 177.1642
Text:WELL 6507/11-4 2687M CORE



1607082 11-NOV-87 Sir:Voltage 12-250 Acnt:SAGA Sys:SYSTEMDEF
Sample 1 Injection 1 Group 1 Mass 191.1798
Text:WELL 6507/11-4 2687M CORE

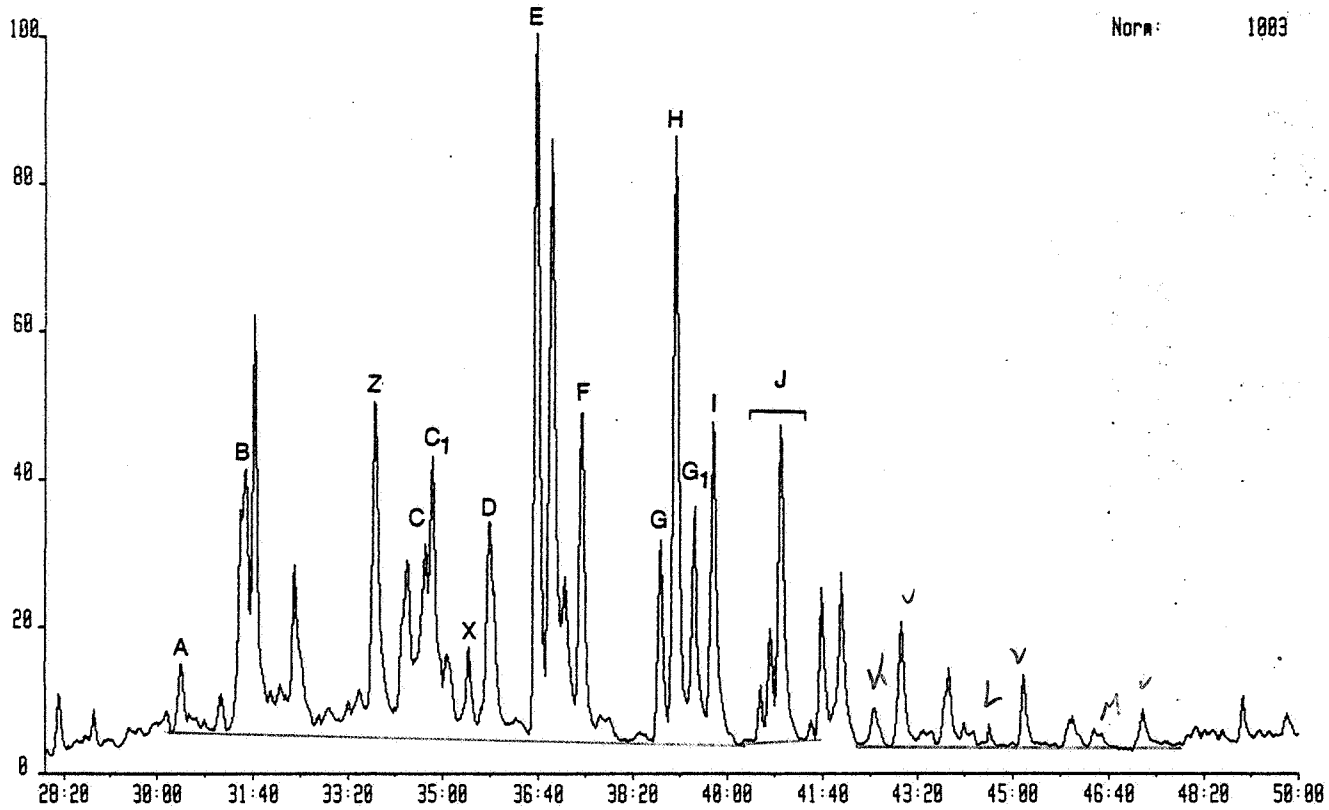


FIGURE 11j

MASS FRAGMENTOGRAMS

WELL 6507/11-4

TERPANES

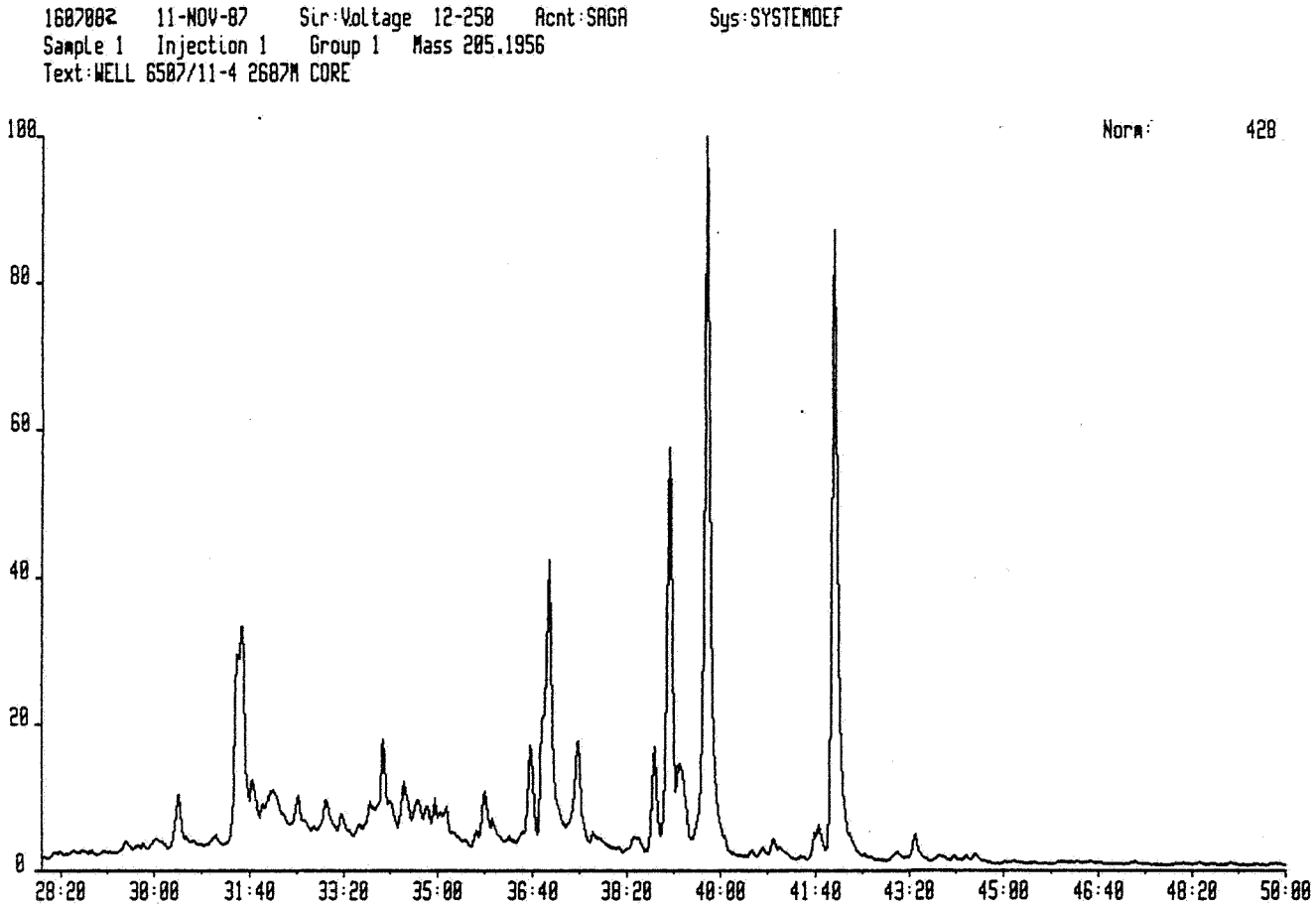


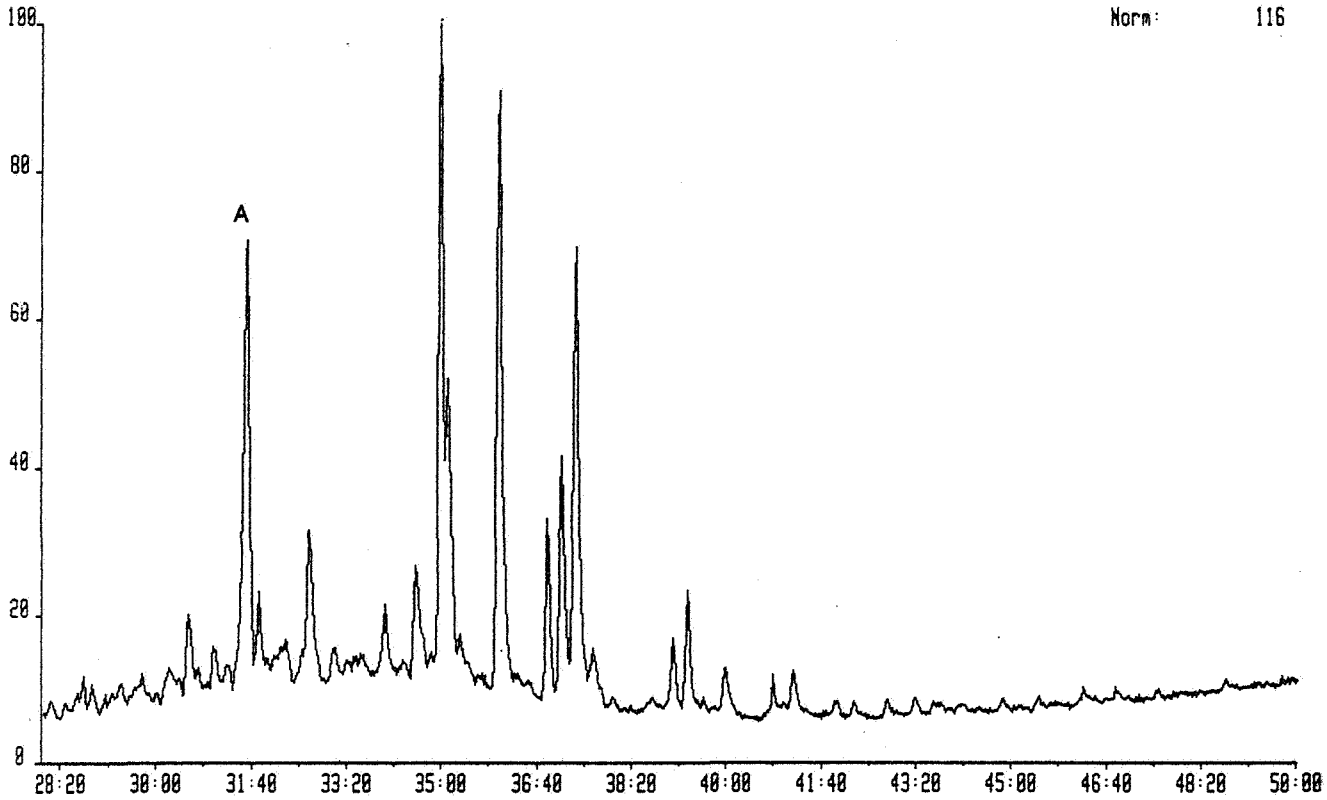
FIGURE 11k

MASS FRAGMENTOGRAMS

WELL 6507/11-4

TERPANES

1607086 11-NOV-87 Sir:Voltage 12-250 Acnt:SAGA Sys:SYSTEMDEF
Sample 1 Injection 1 Group 1 Mass 177.1642
Text:WELL 6507/11-4 2081.5M SWC



1607086 11-NOV-87 Sir:Voltage 12-250 Acnt:SAGA Sys:SYSTEMDEF
Sample 1 Injection 1 Group 1 Mass 191.1798
Text:WELL 6507/11-4 2081.5M SWC

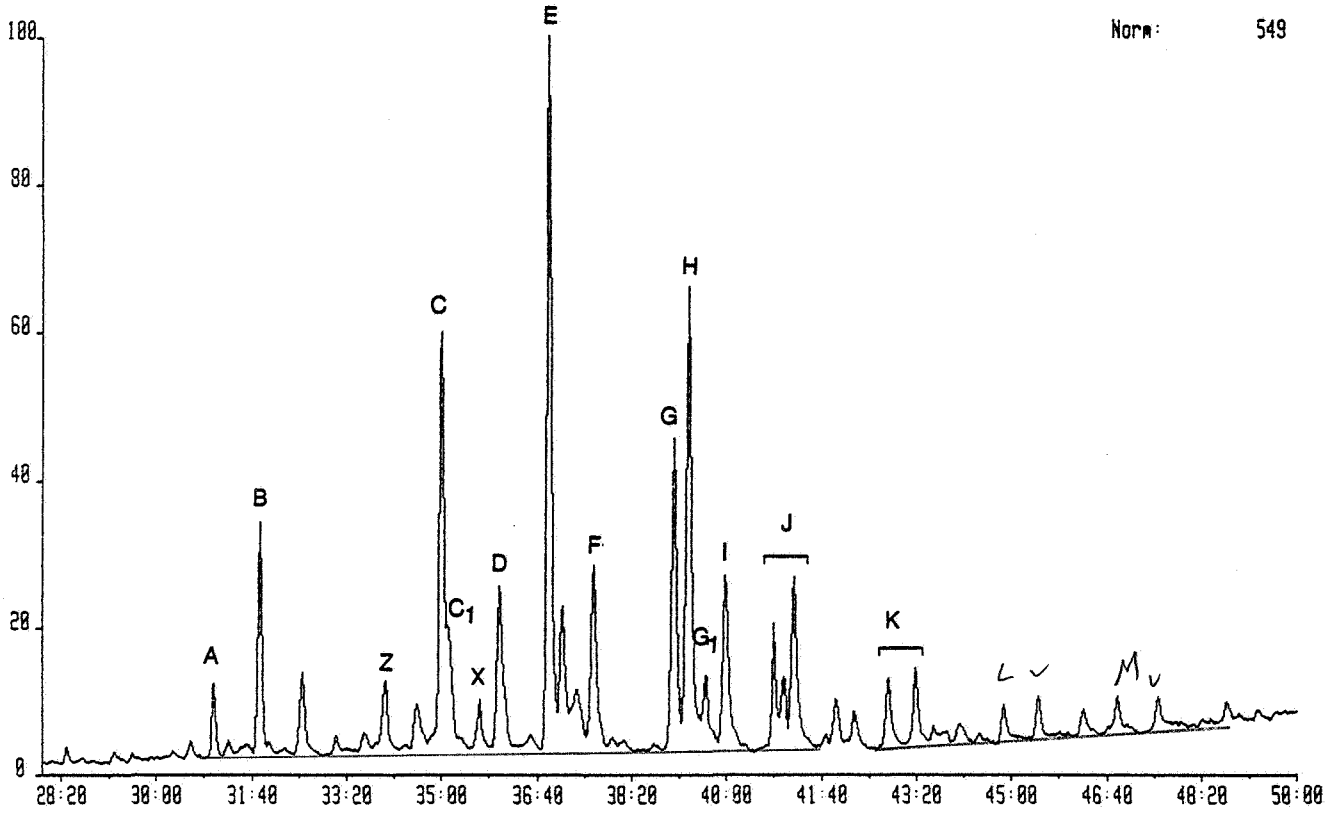


FIGURE 11k

MASS FRAGMENTOGRAMS

WELL 6507/11-4

TERPANES

1607086 11-NOV-87 Sir:Voltage 12-250 Acnt:SAGA Sys:SYSTEMDEF
Sample 1 Injection 1 Group 1 Mass 205.1956
Text:WELL 6507/11-4 2881.5M SWC

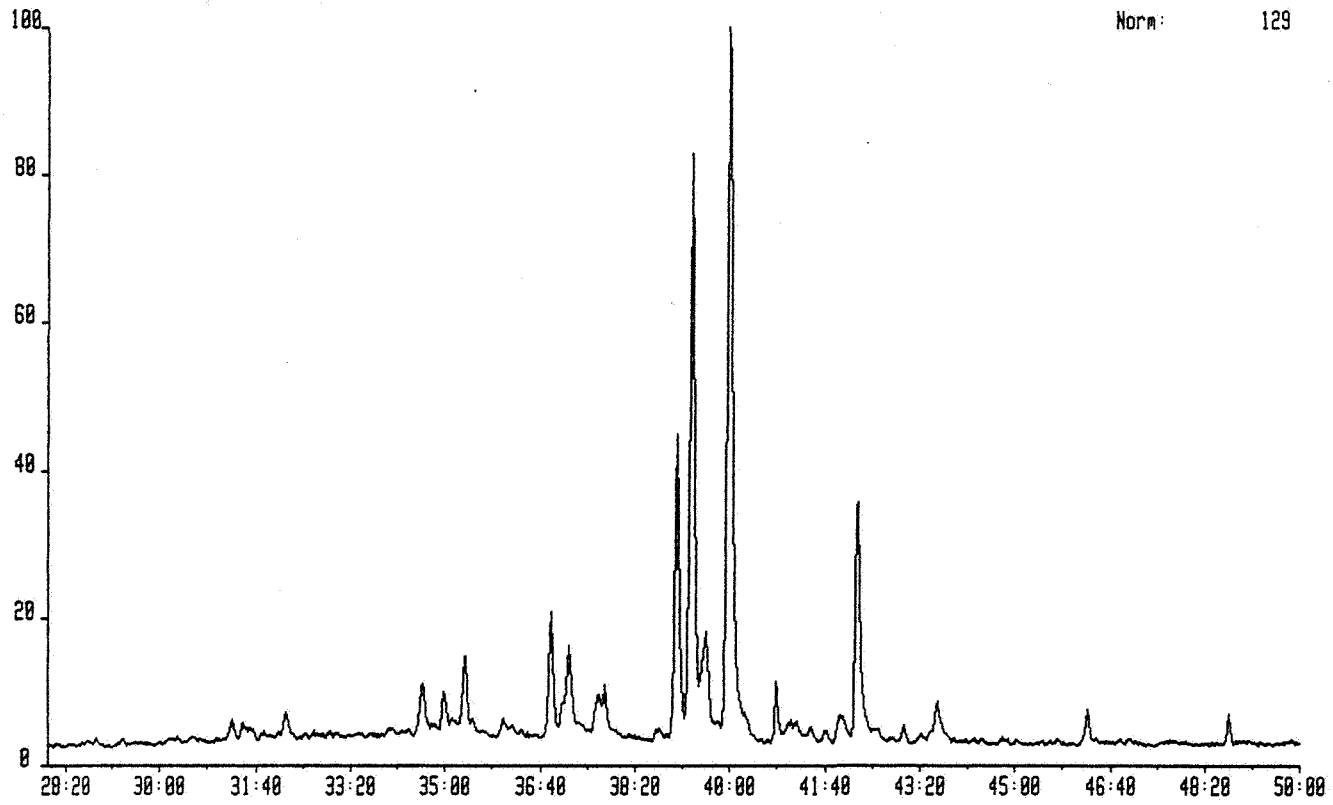
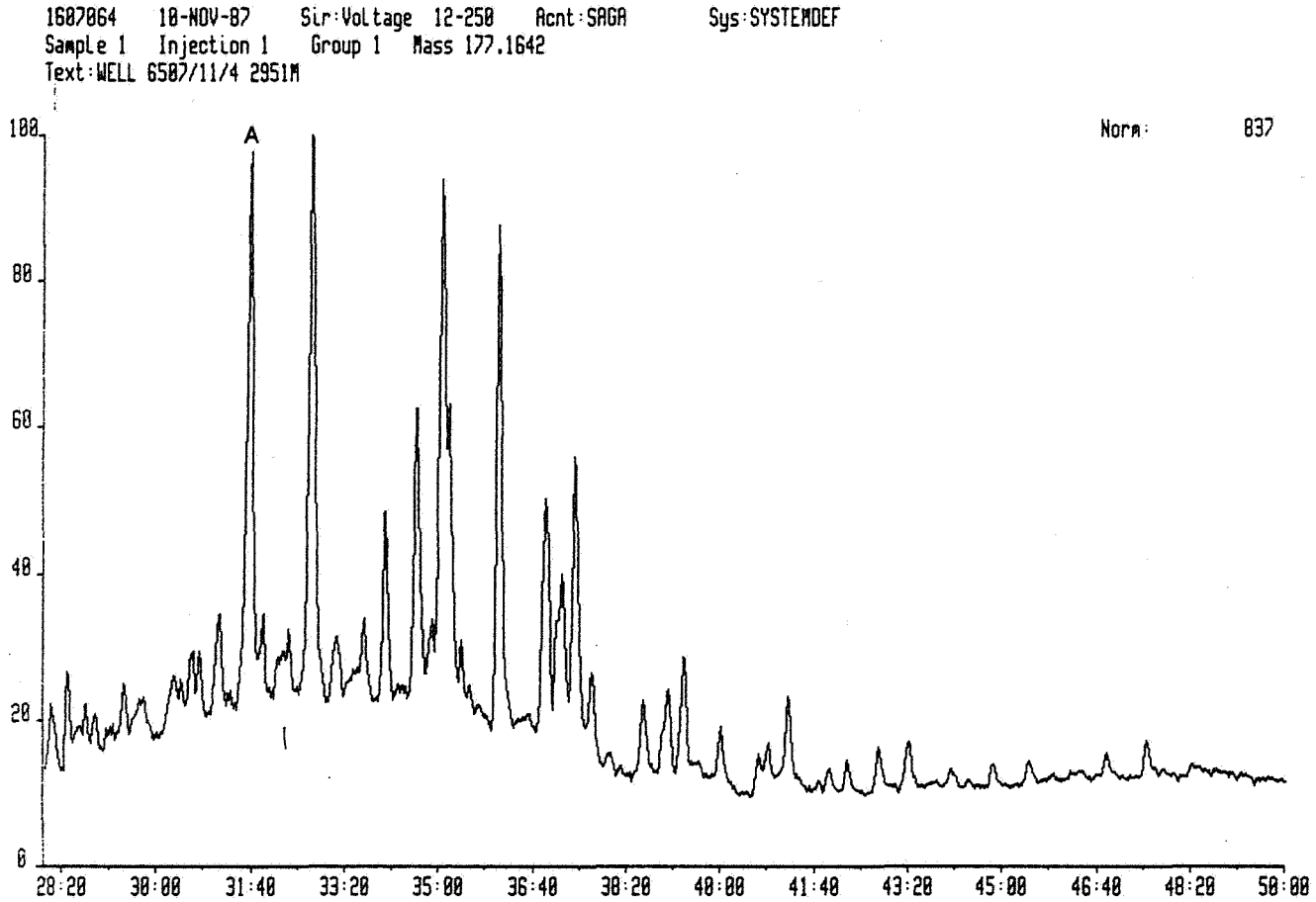


FIGURE 11l

MASS FRAGMENTOGRAMS

WELL 6507/11-4

TERPANES



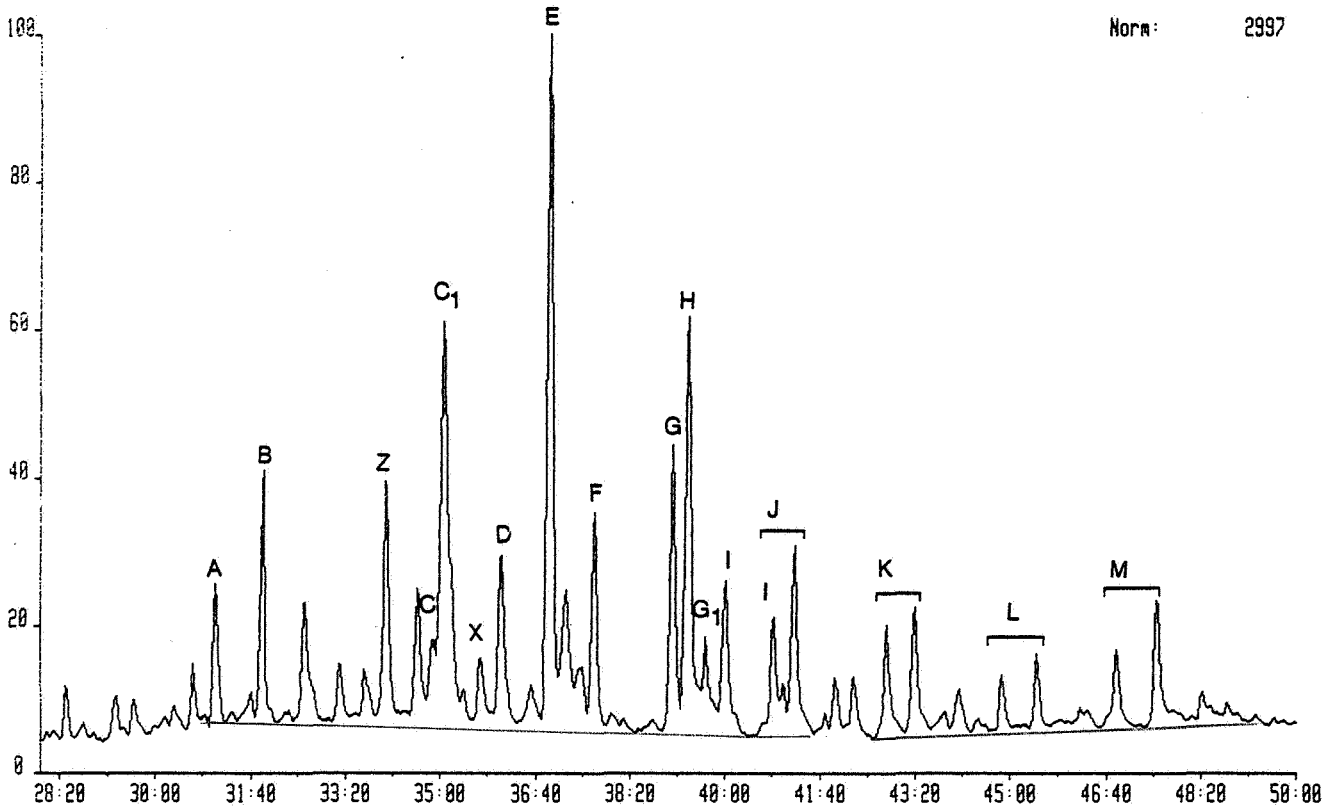


FIGURE 11 I

MASS FRAGMENTOGRAMS

WELL 6507/11-4

TERPANES

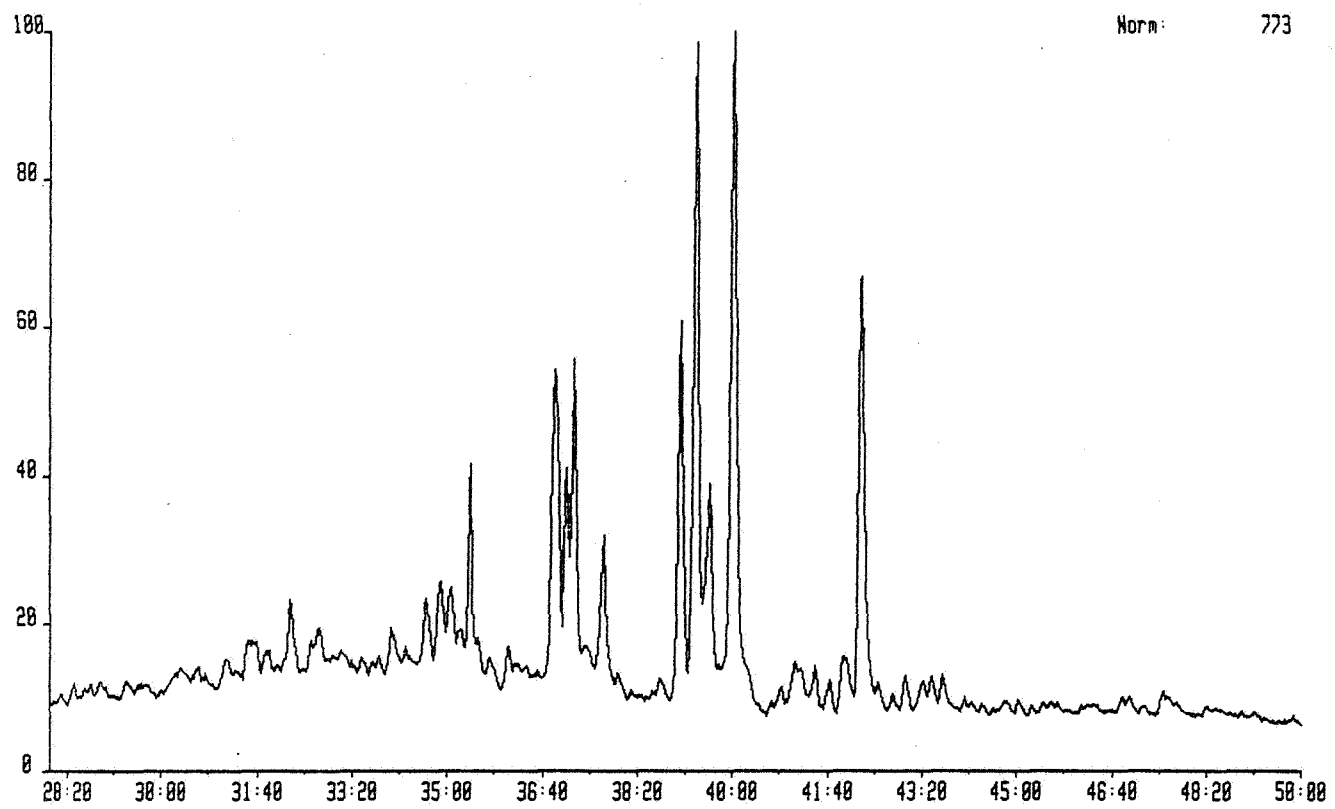


FIGURE 12a

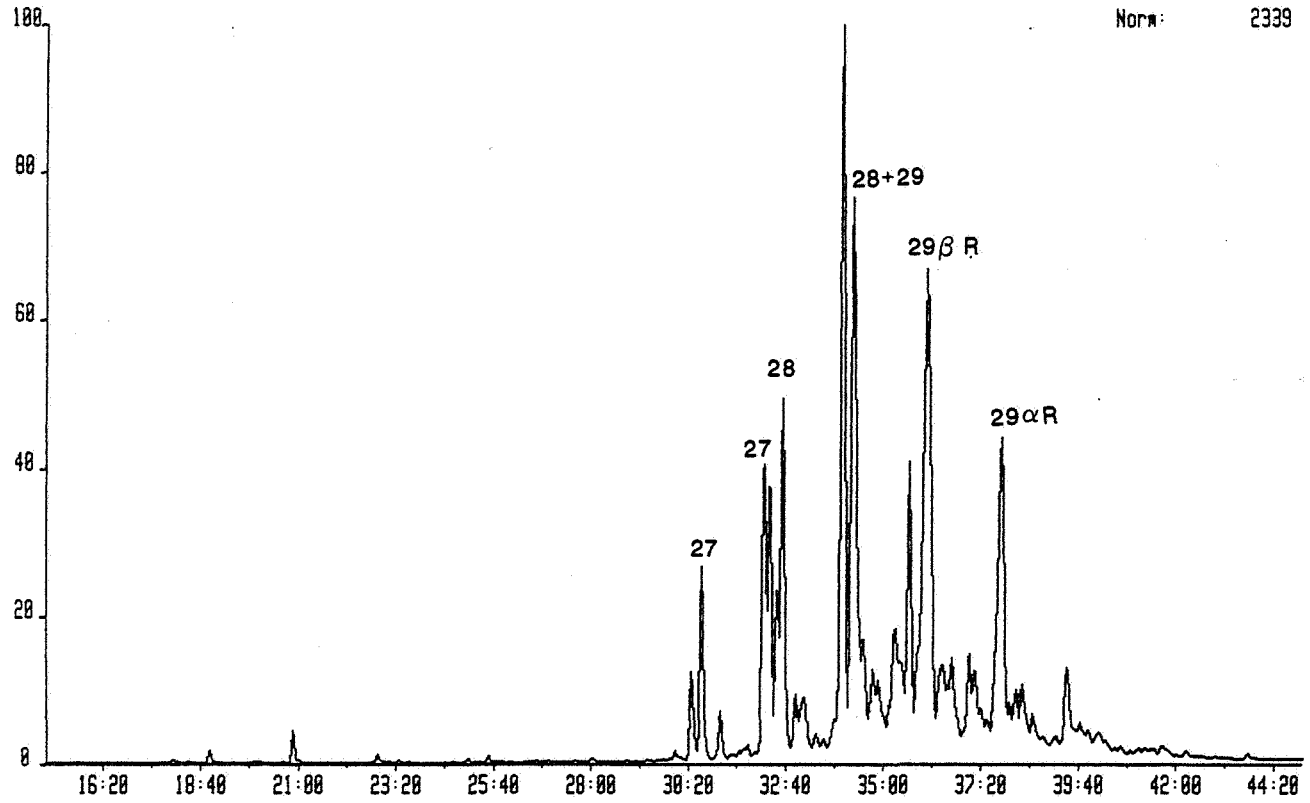
MASS FRAGMENTOGRAMS

GEOCHEM

WELL 6507/11-4 AROMATIC STERANES m/z 253 = MONOAROMATIC

m/z 231 = TRIAROMATIC

1607075A 12-NOV-08 Sir:Voltage 12-250 Acnt:SAGA Sys:AROMQUAD
Sample 1 Injection 1 Group 1 Mass 253.1956
Text:WELL 6507/11-4 2533.4M



1607075A 12-NOV-08 Sir:Voltage 12-250 Acnt:SAGA Sys:AROMQUAD
Sample 1 Injection 1 Group 1 Mass 231.2100
Text:WELL 6507/11-4 2533.4M

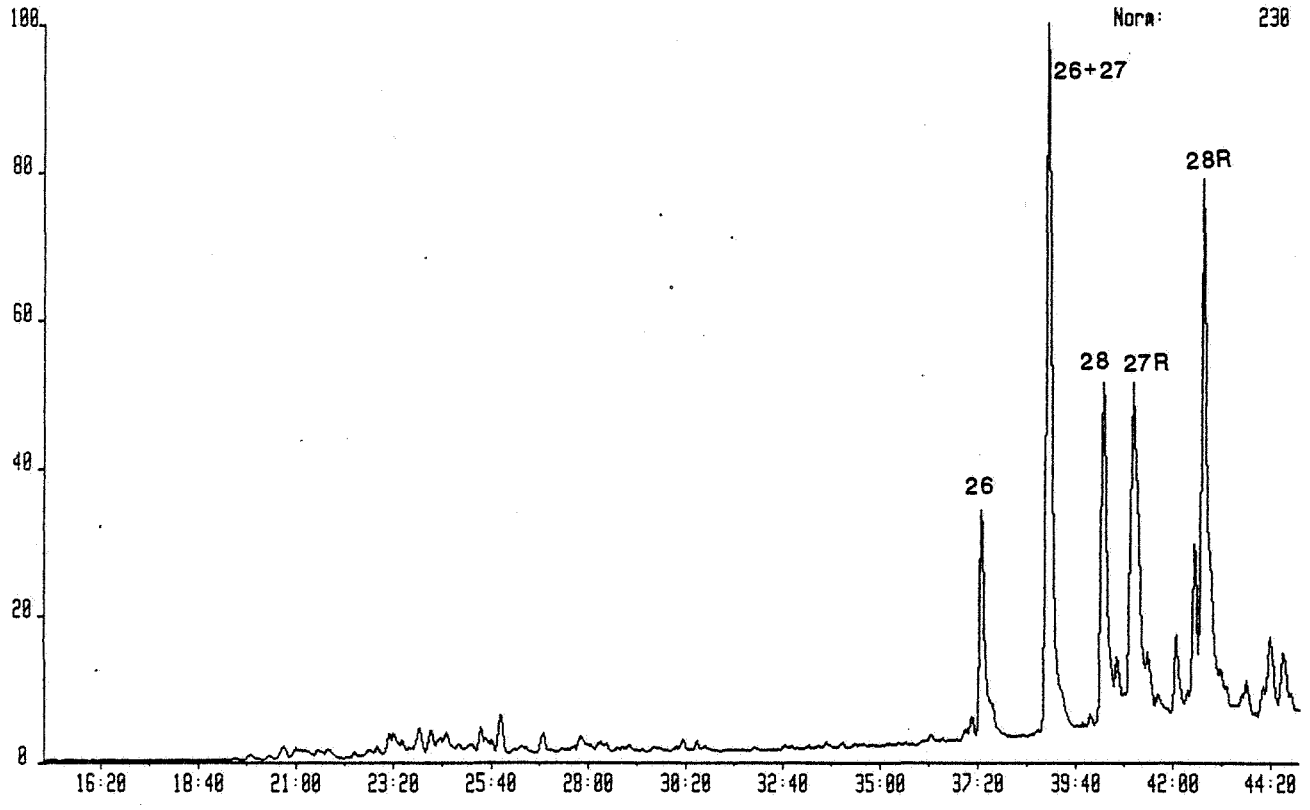
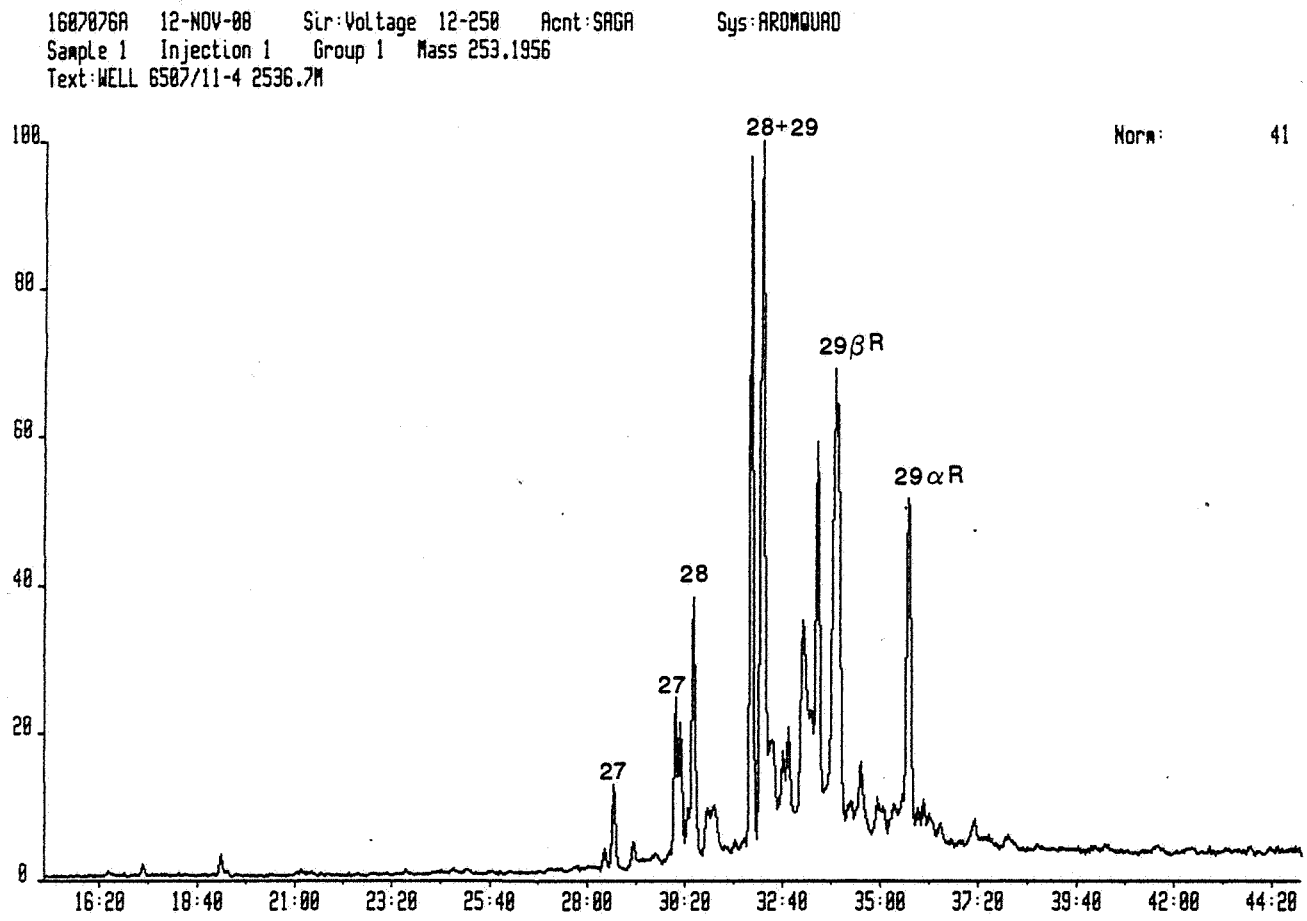


FIGURE 12b

MASS FRAGMENTOGRAMS

WELL 6507/11-4 AROMATIC STERANES m/z 253 = MONOAROMATIC

m/z 231 = TRIAROMATIC



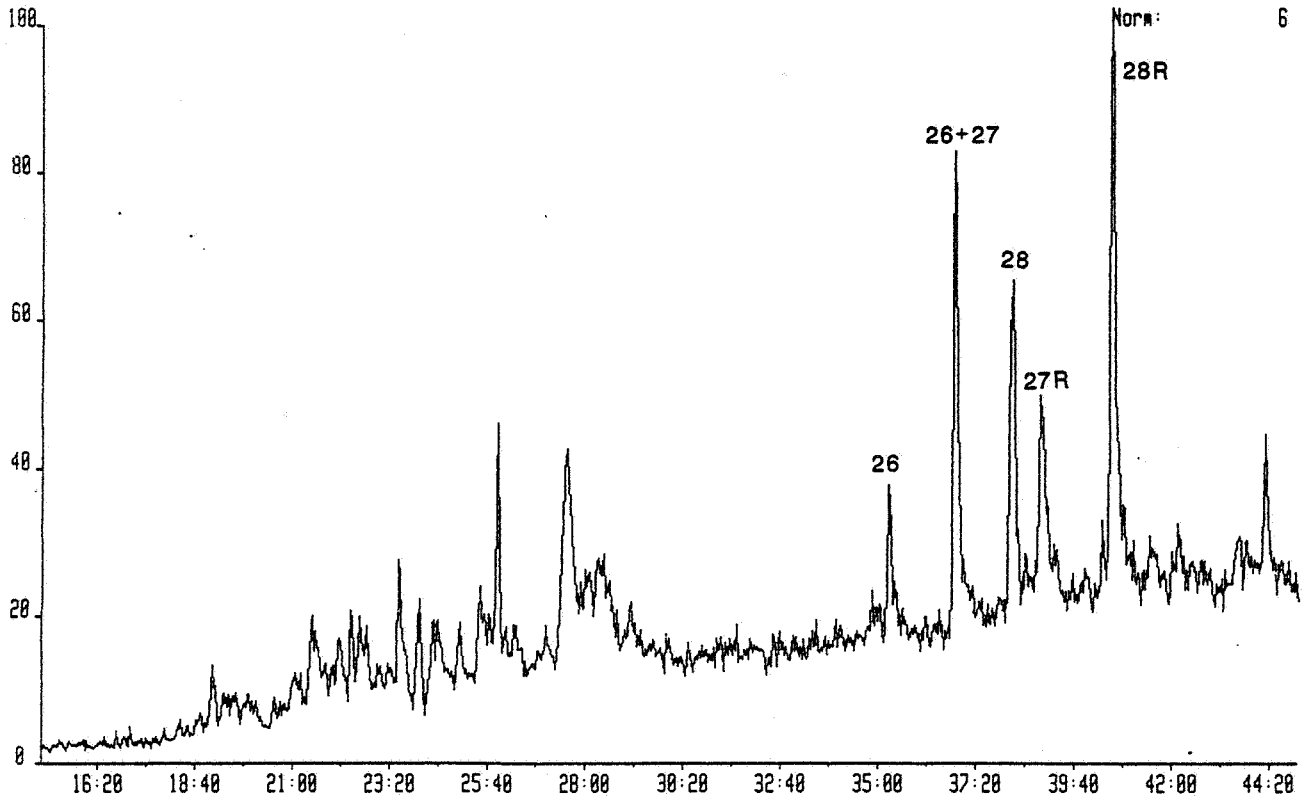
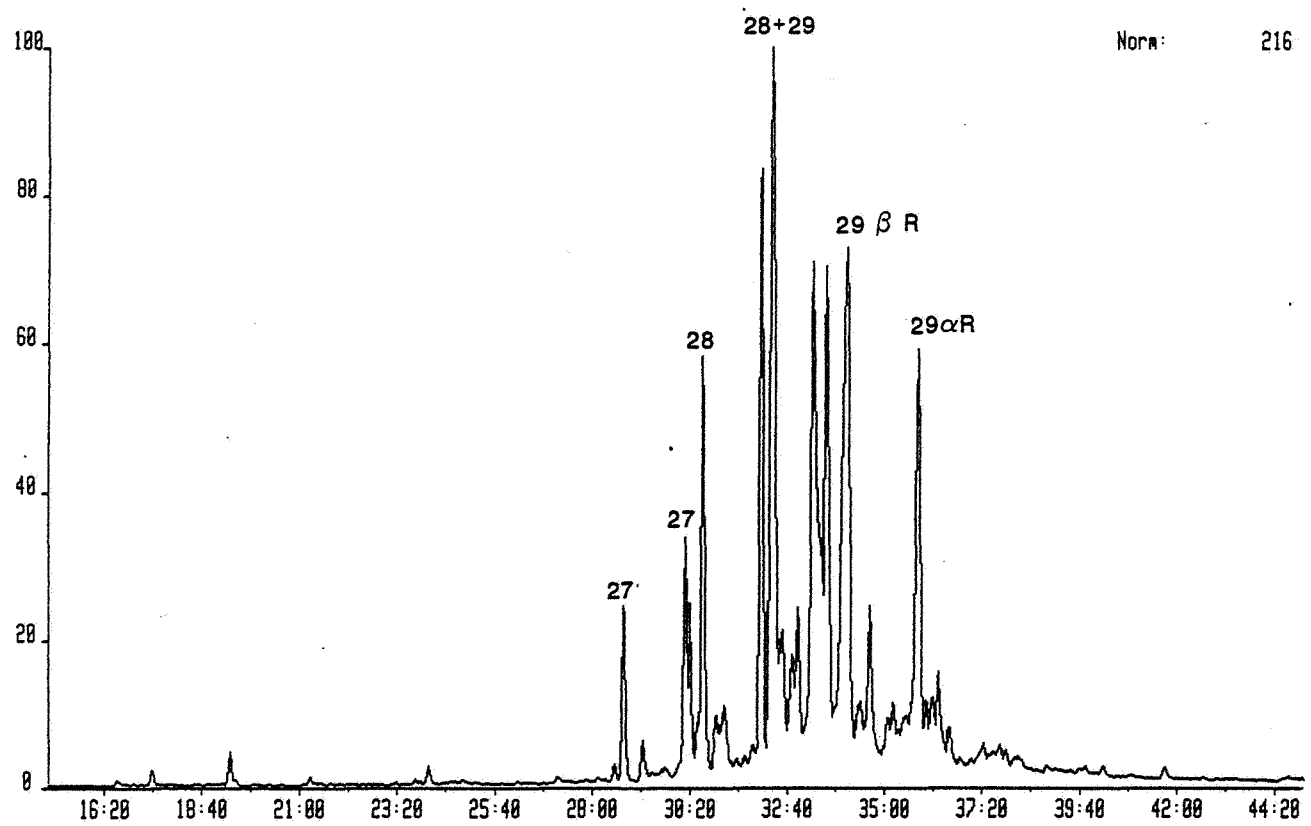


FIGURE 12c

MASS FRAGMENTOGRAMS

WELL 6507/11-4 AROMATIC STERANES m/z 253 = MONOAROMATIC

m/z 231 = TRIAROMATIC



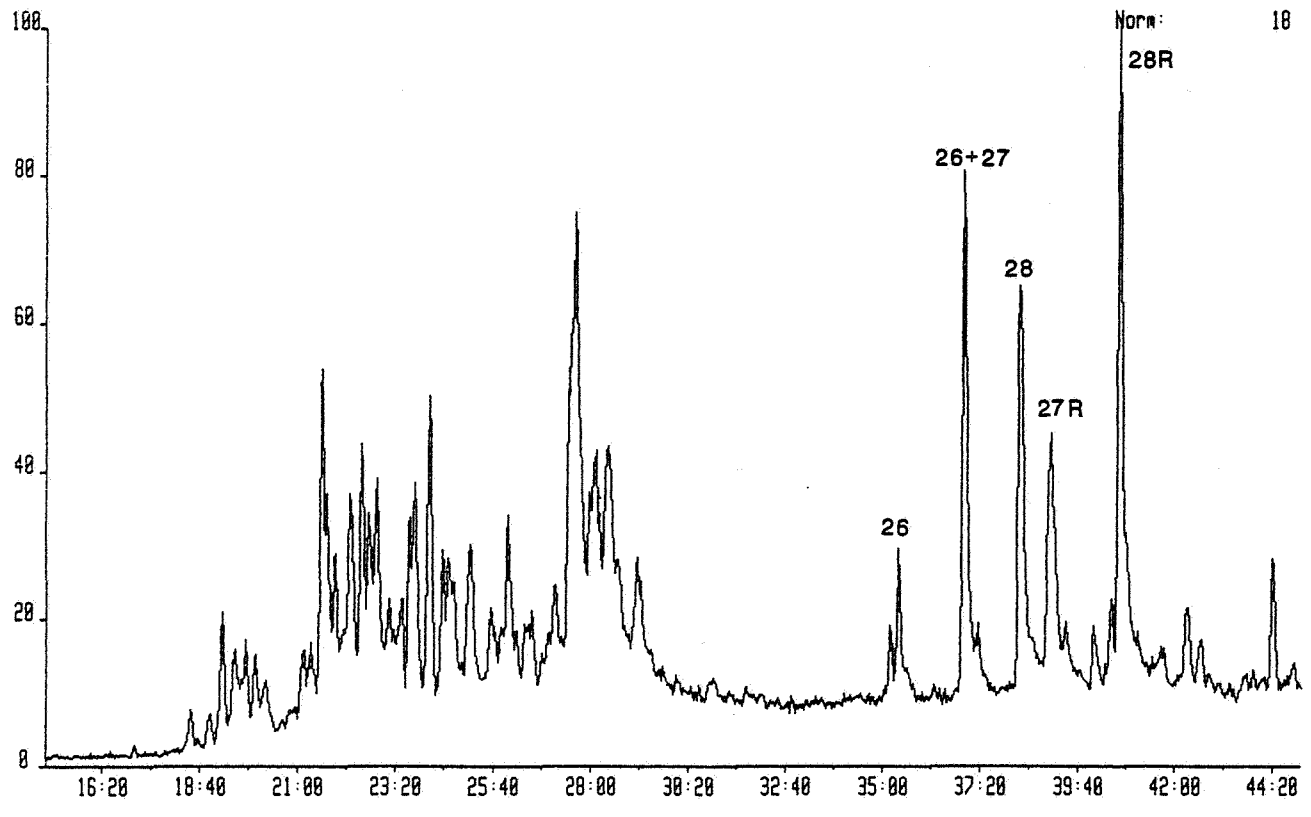
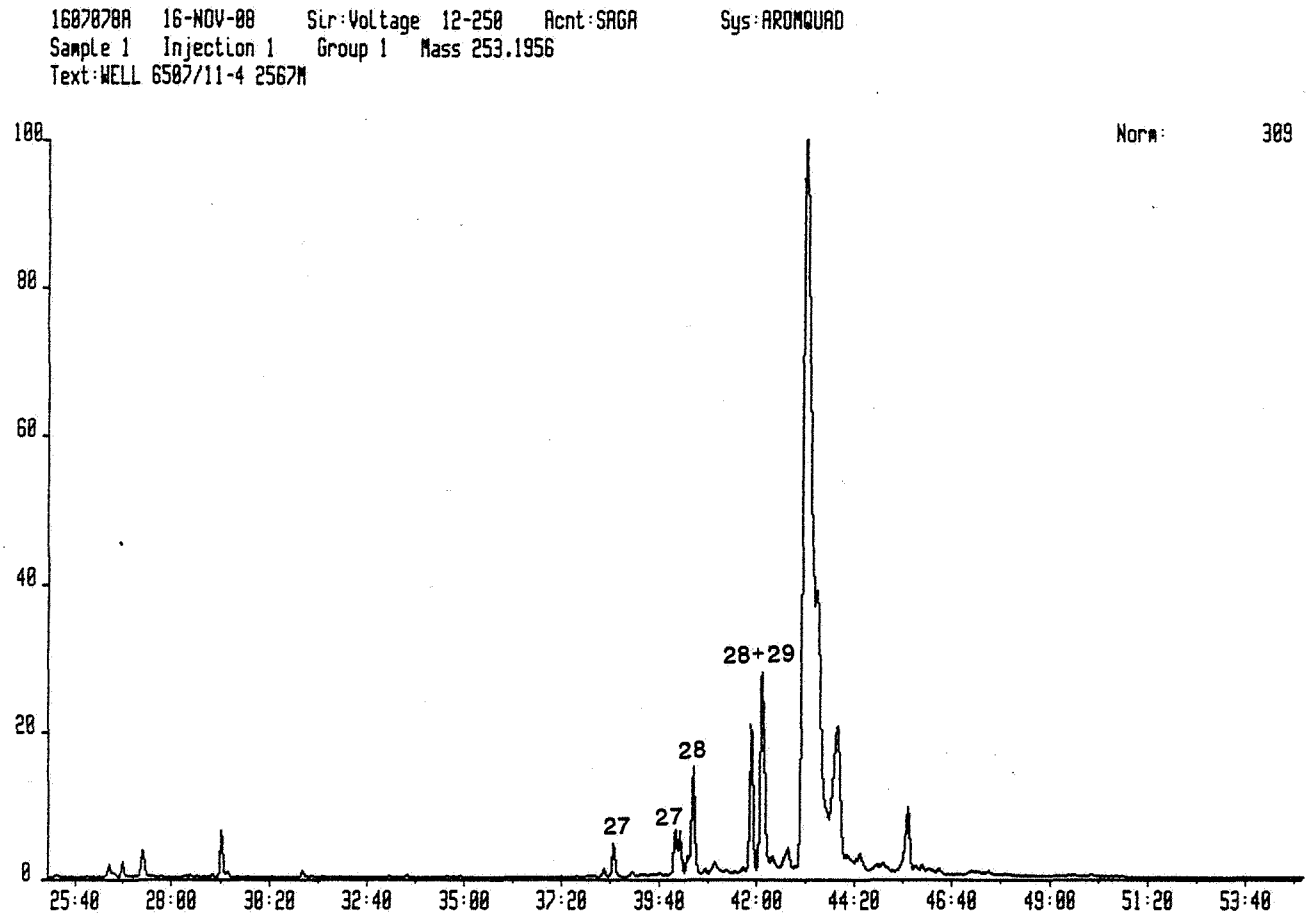


FIGURE 12d

MASS FRAGMENTOGRAMS

WELL 6507/11-4 AROMATIC STERANES m/z 253 = MONOAROMATIC

m/z 231 = TRIAROMATIC



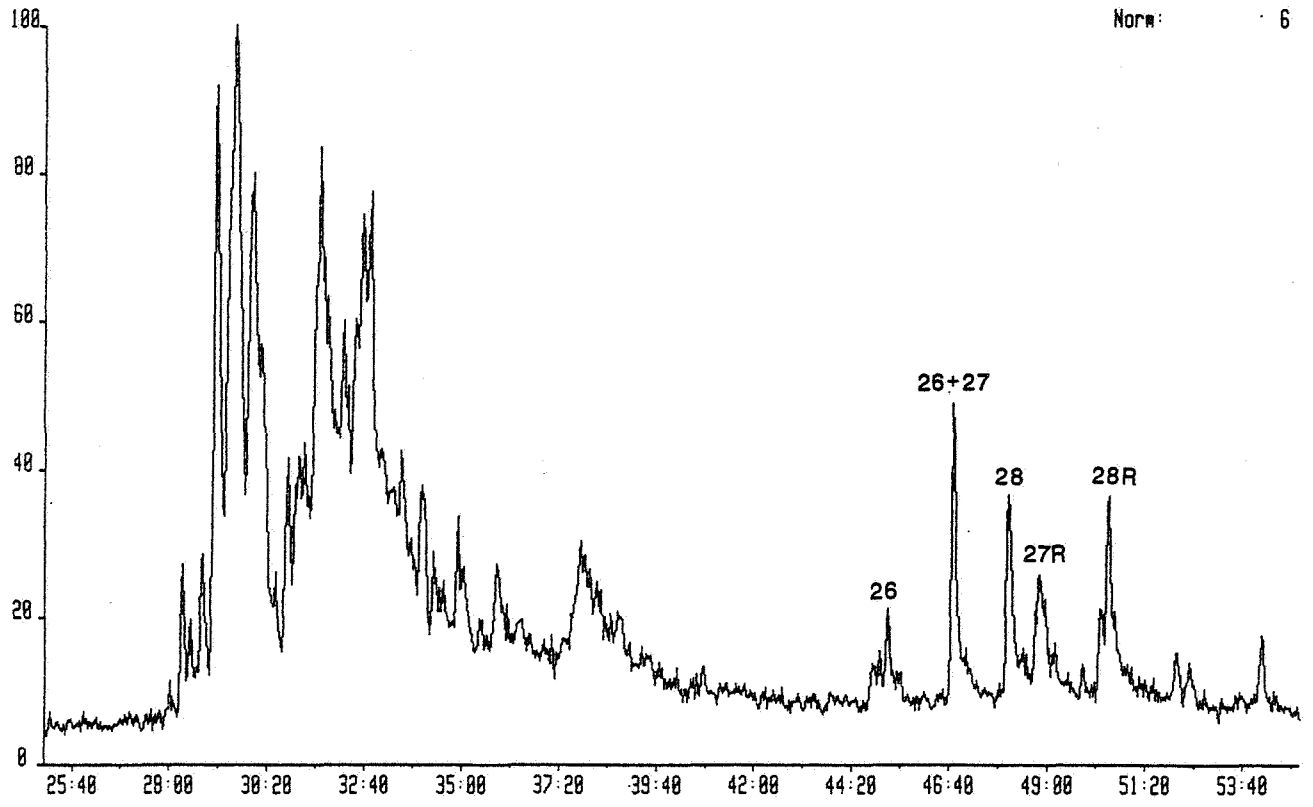
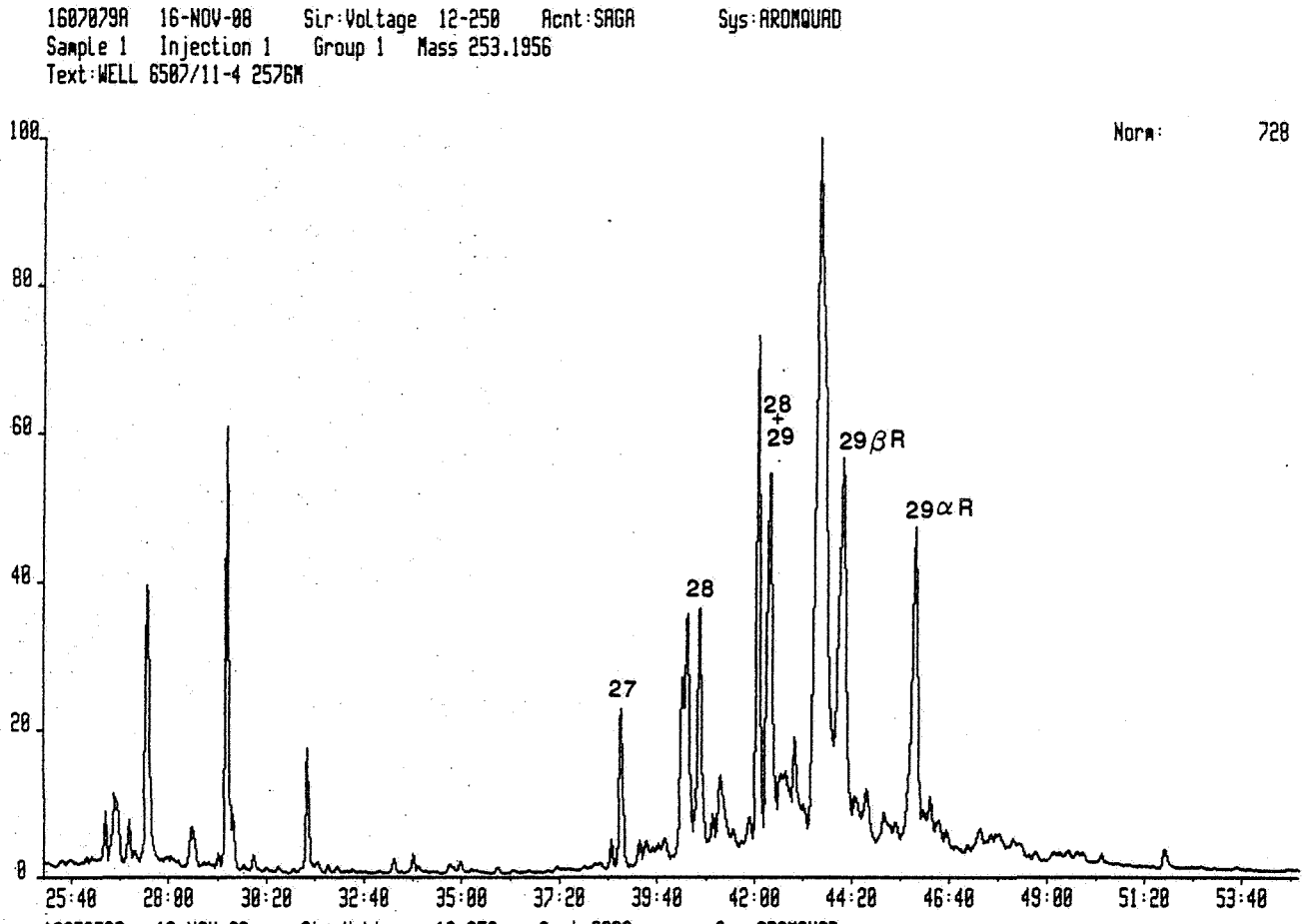


FIGURE 12e

MASS FRAGMENTOGRAMS

WELL 6507/11-4 AROMATIC STERANES m/z 253 = MONOAROMATIC

m/z 231 = TRIAROMATIC



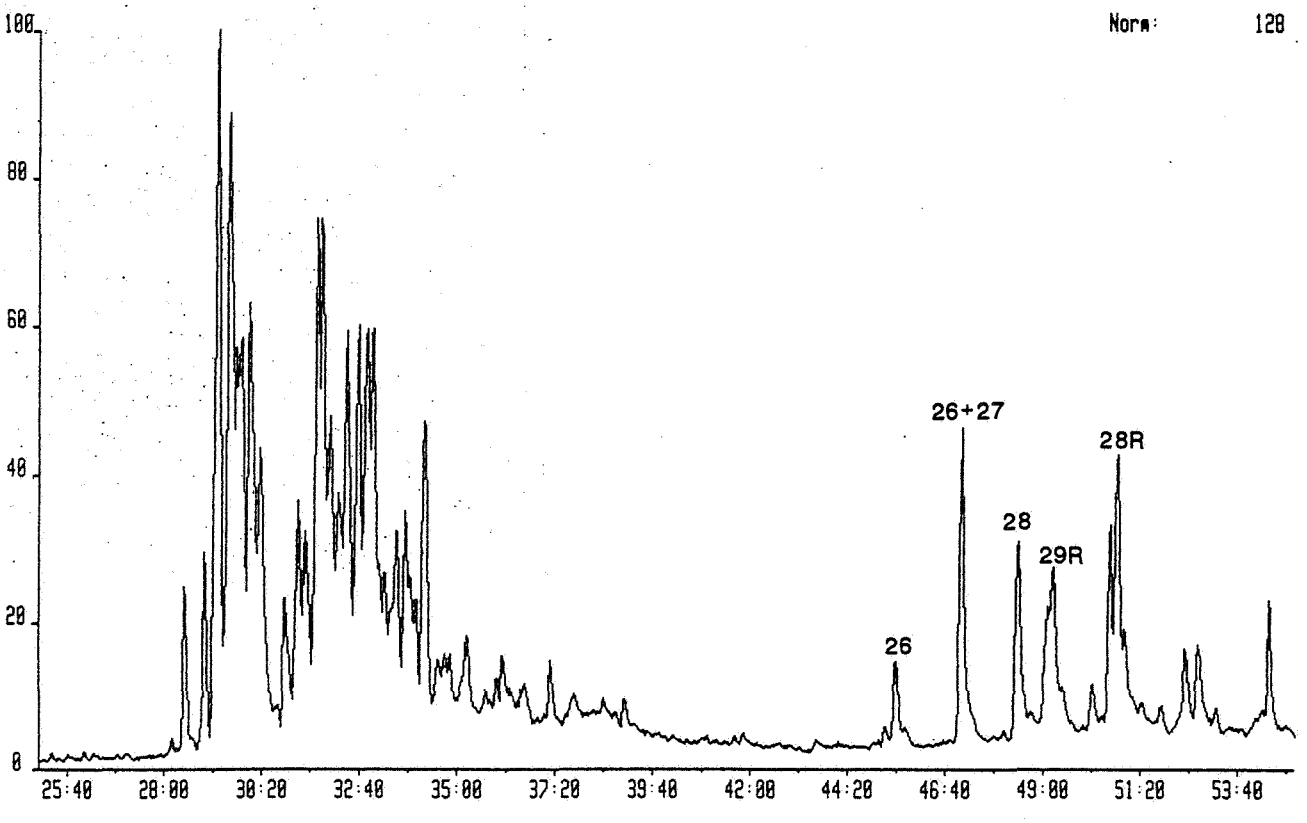


FIGURE 12f

MASS FRAGMENTOGRAMS

WELL 6507/11-4 AROMATIC STERANES m/z 253 = MONOAROMATIC

m/z 231 = TRIAROMATIC

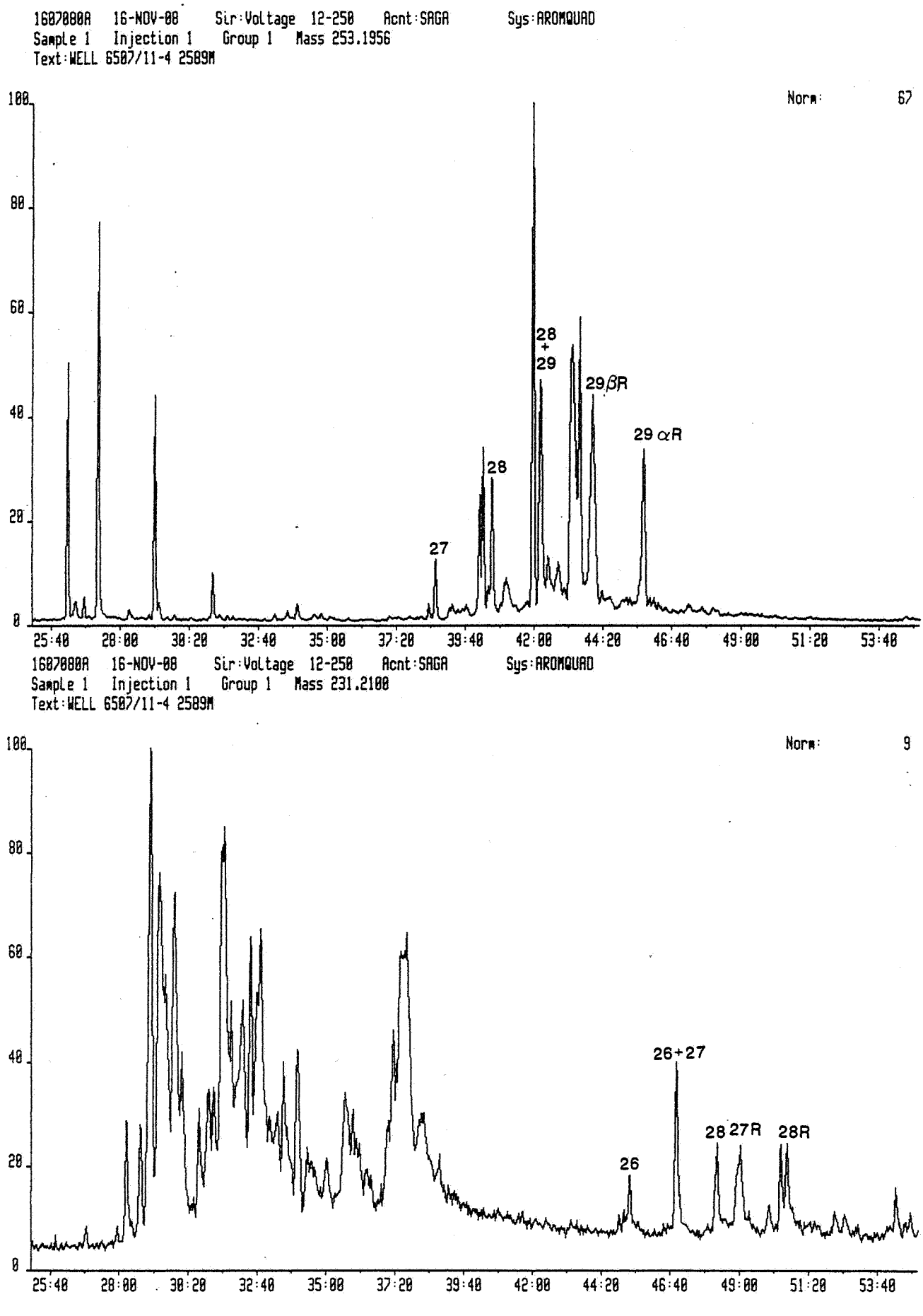


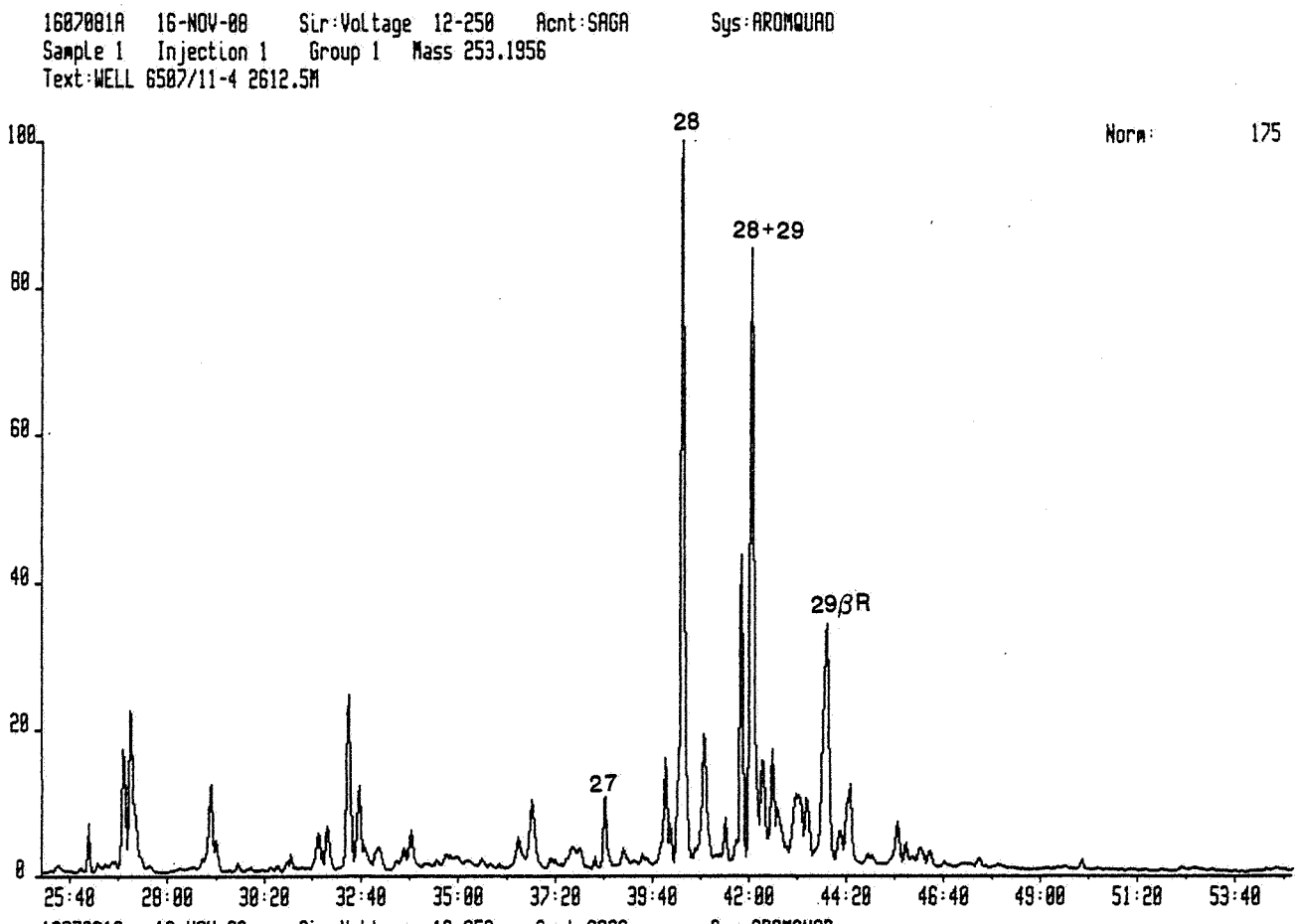
FIGURE 12g

MASS FRAGMENTOGRAMS

GEOCHEM

WELL 6507/11-4 AROMATIC STERANES m/z 253 = MONOAROMATIC

m/z 231 = TRIAROMATIC



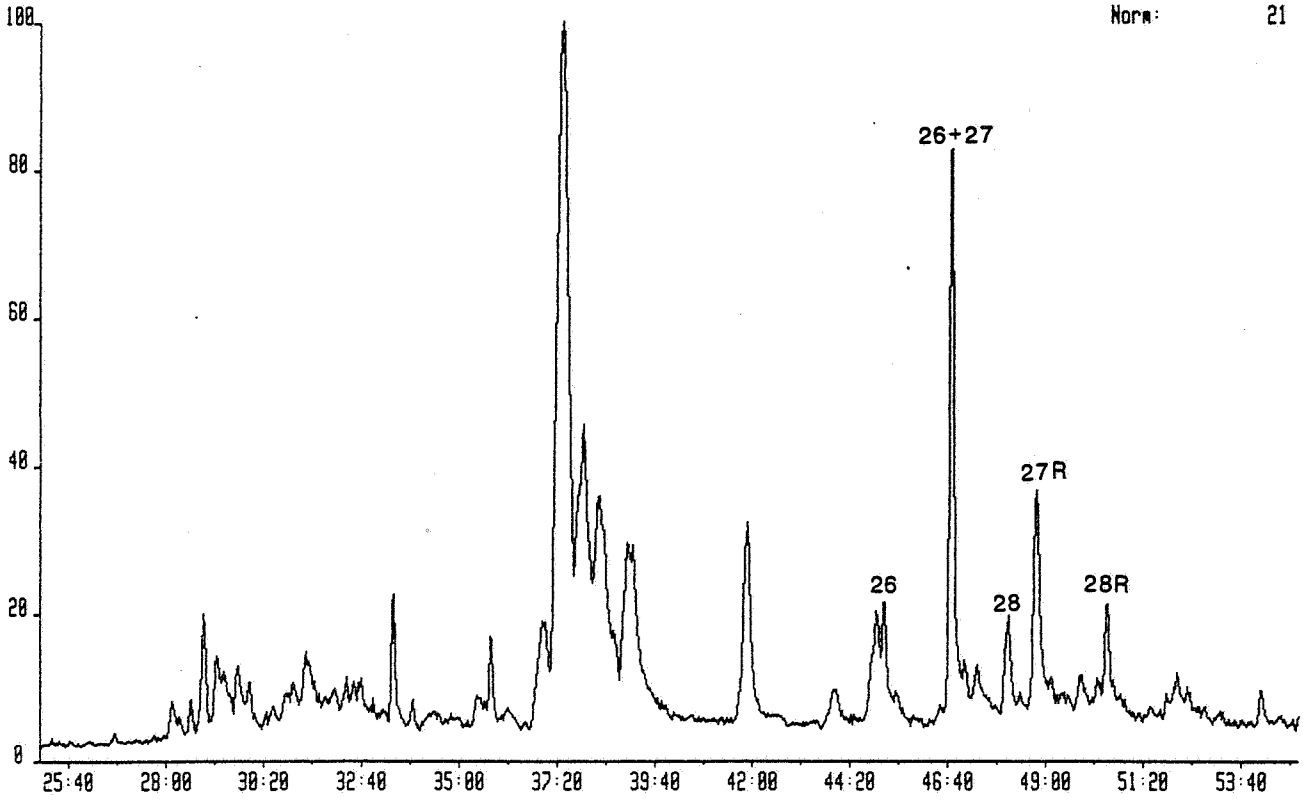
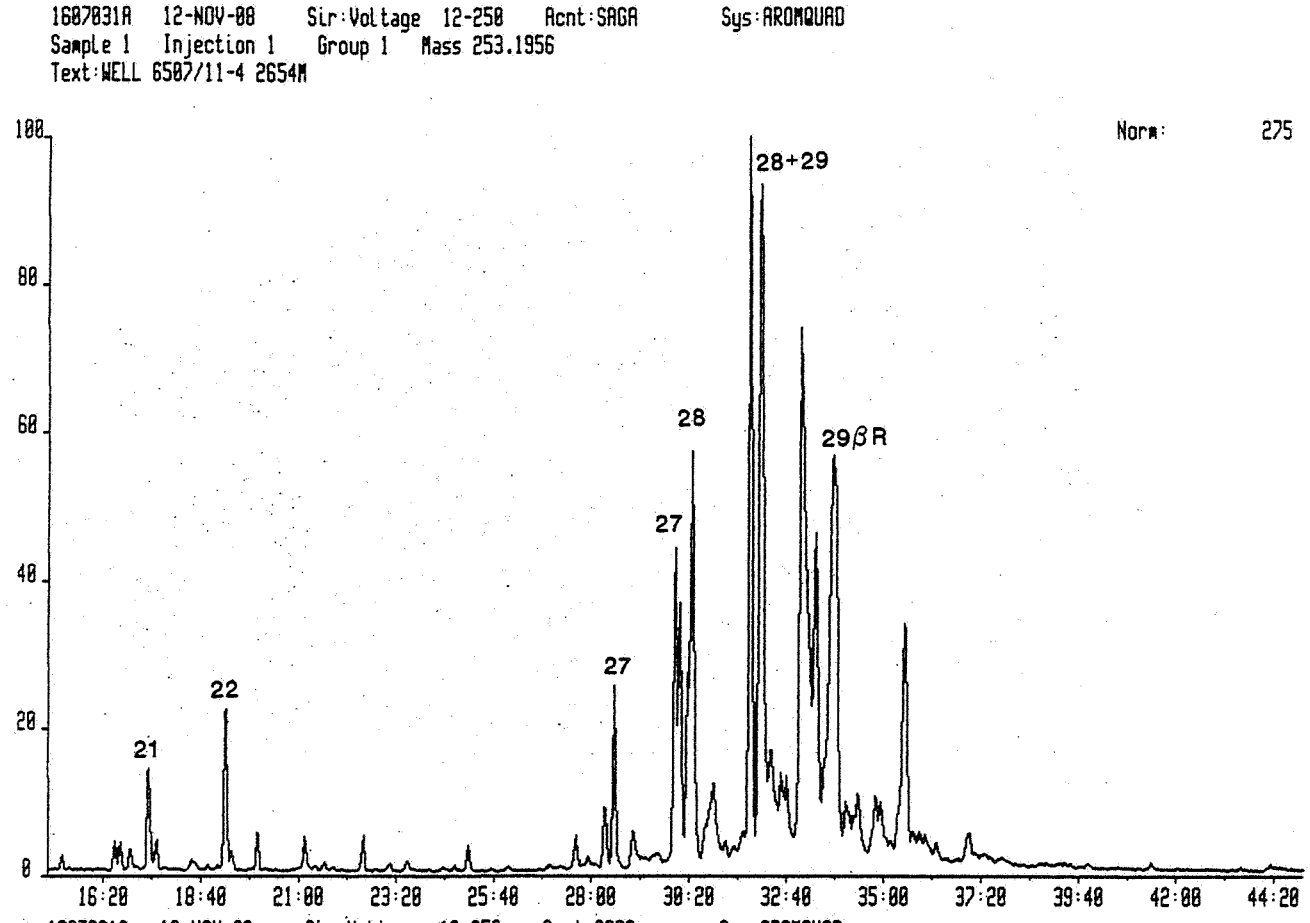


FIGURE 12h

MASS FRAGMENTOGRAMS

WELL 6507/11-4 AROMATIC STERANES m/z 253 = MONOAROMATIC

m/z 231 = TRIAROMATIC



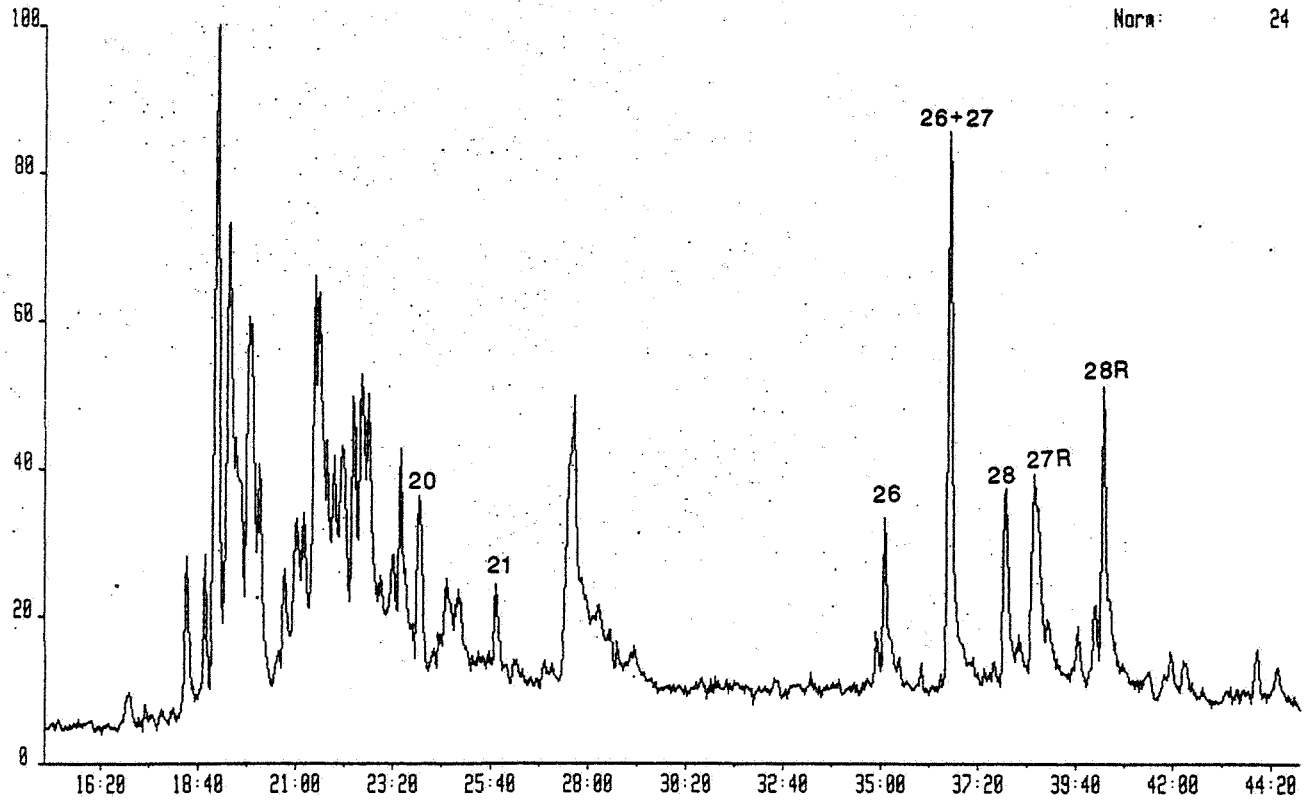
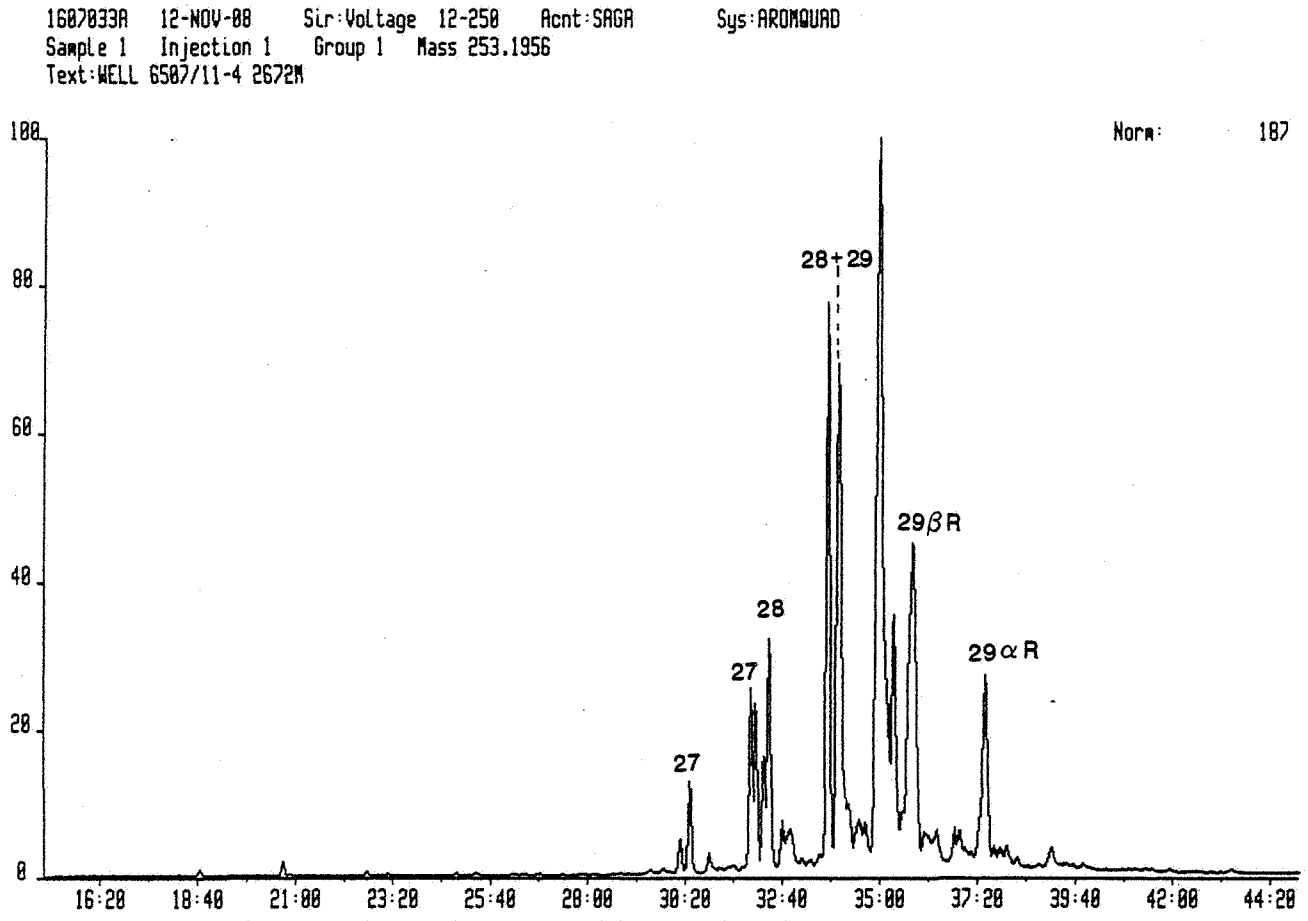


FIGURE 12i

MASS FRAGMENTOGRAMS

WELL 6507/11-4 AROMATIC STERANES m/z 253 = MONOAROMATIC

m/z 231 = TRIAROMATIC



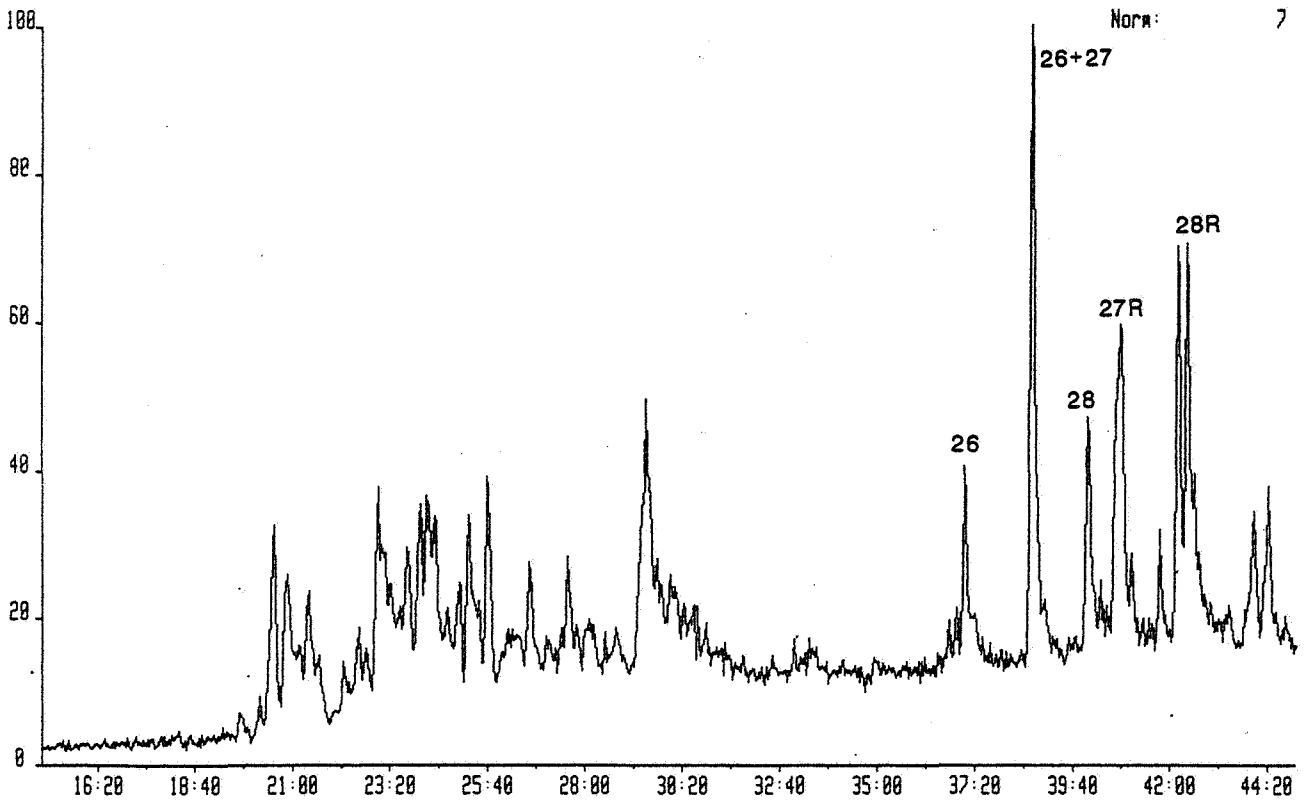


FIGURE 12j

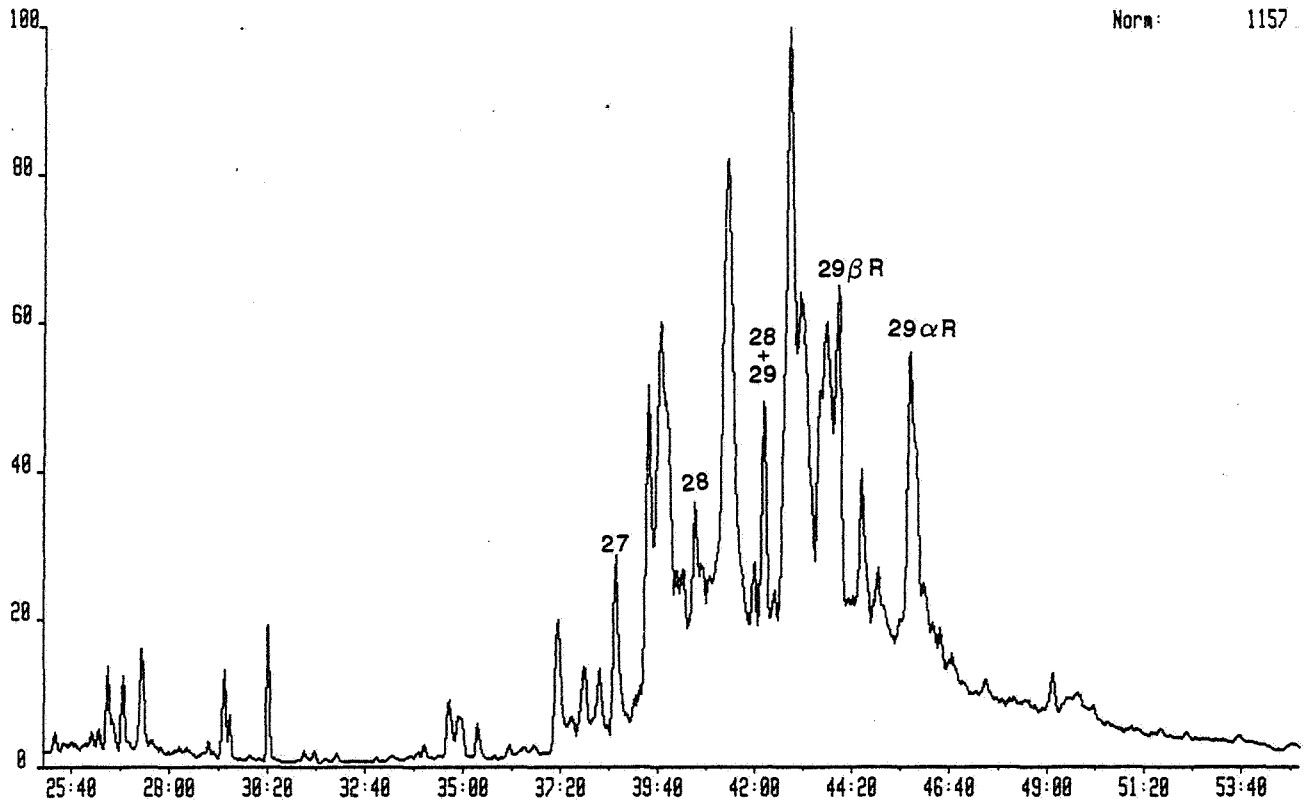
MASS FRAGMENTOGRAMS

GEOCHEM

WELL 6507/11-4 AROMATIC STERANES m/z 253 = MONOAROMATIC

m/z 231 = TRIAROMATIC

1607082A 13-NOV-08 Sir:Voltage 12-250 Acnt:SAGA Sys:AROMQUAD
Sample 1 Injection 1 Group 1 Mass 253.1956
Text:WELL 6507/11-4 2687M



1607082A 13-NOV-08 Sir:Voltage 12-250 Acnt:SAGA Sys:AROMQUAD
Sample 1 Injection 1 Group 1 Mass 231.2100
Text:WELL 6507/11-4 2687M

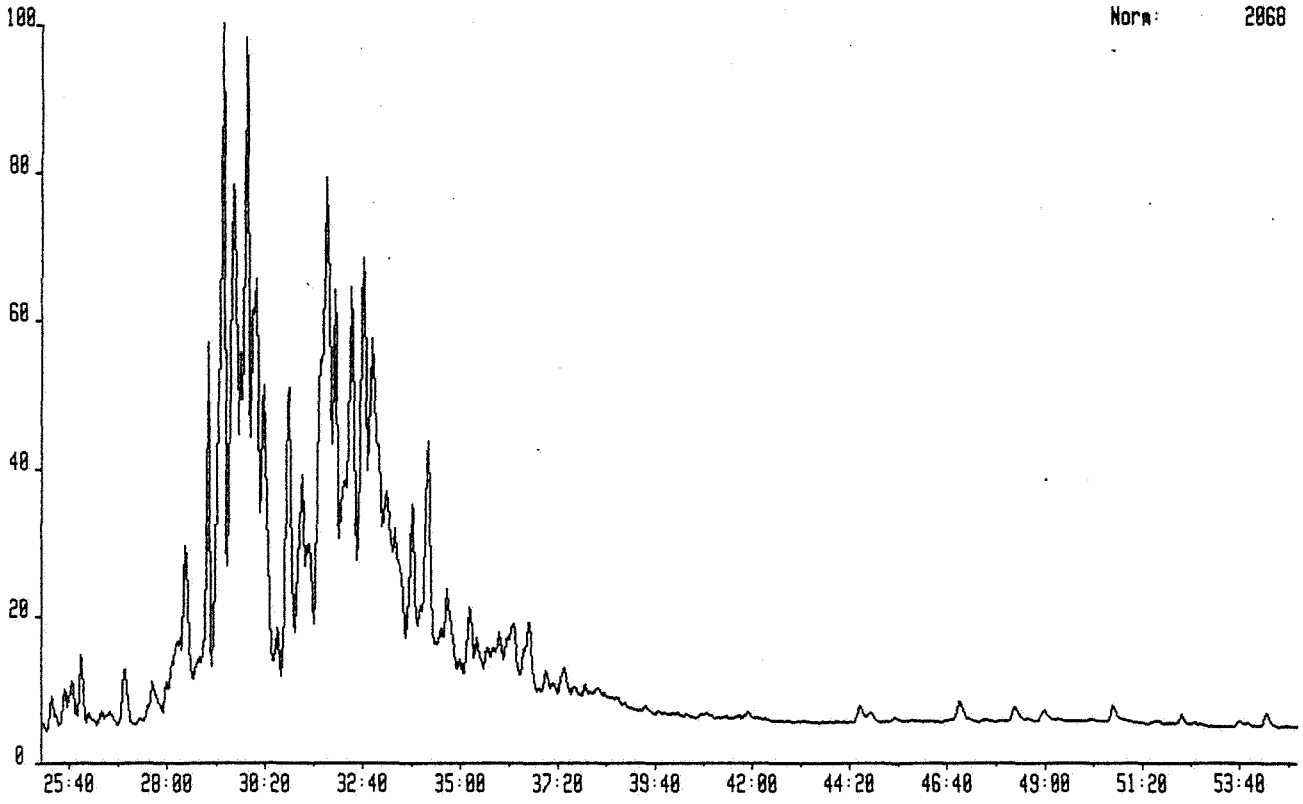
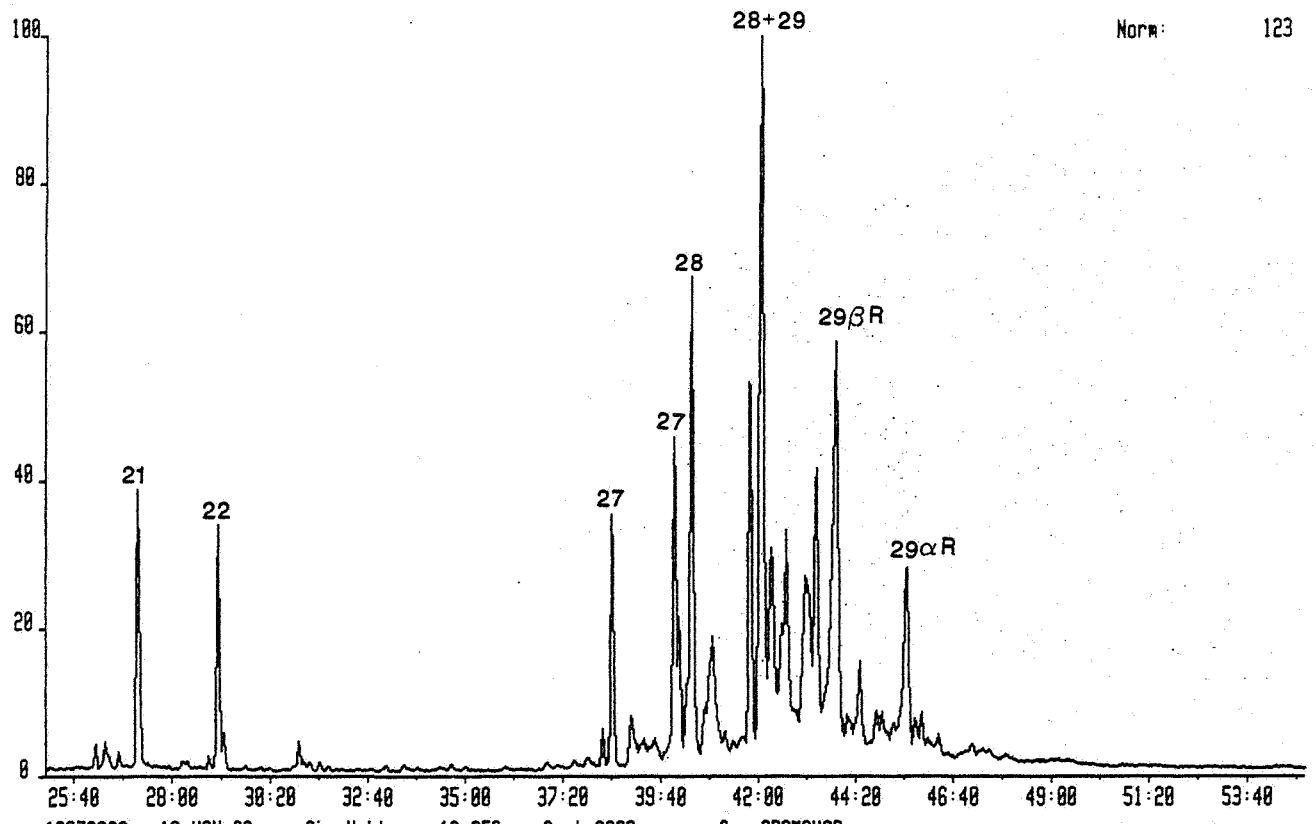


FIGURE 12k

MASS FRAGMENTOGRAMS

WELL 6507/11-4 AROMATIC STERANES m/z 253 = MONOAROMATIC

m/z 231 = TRIAROMATIC



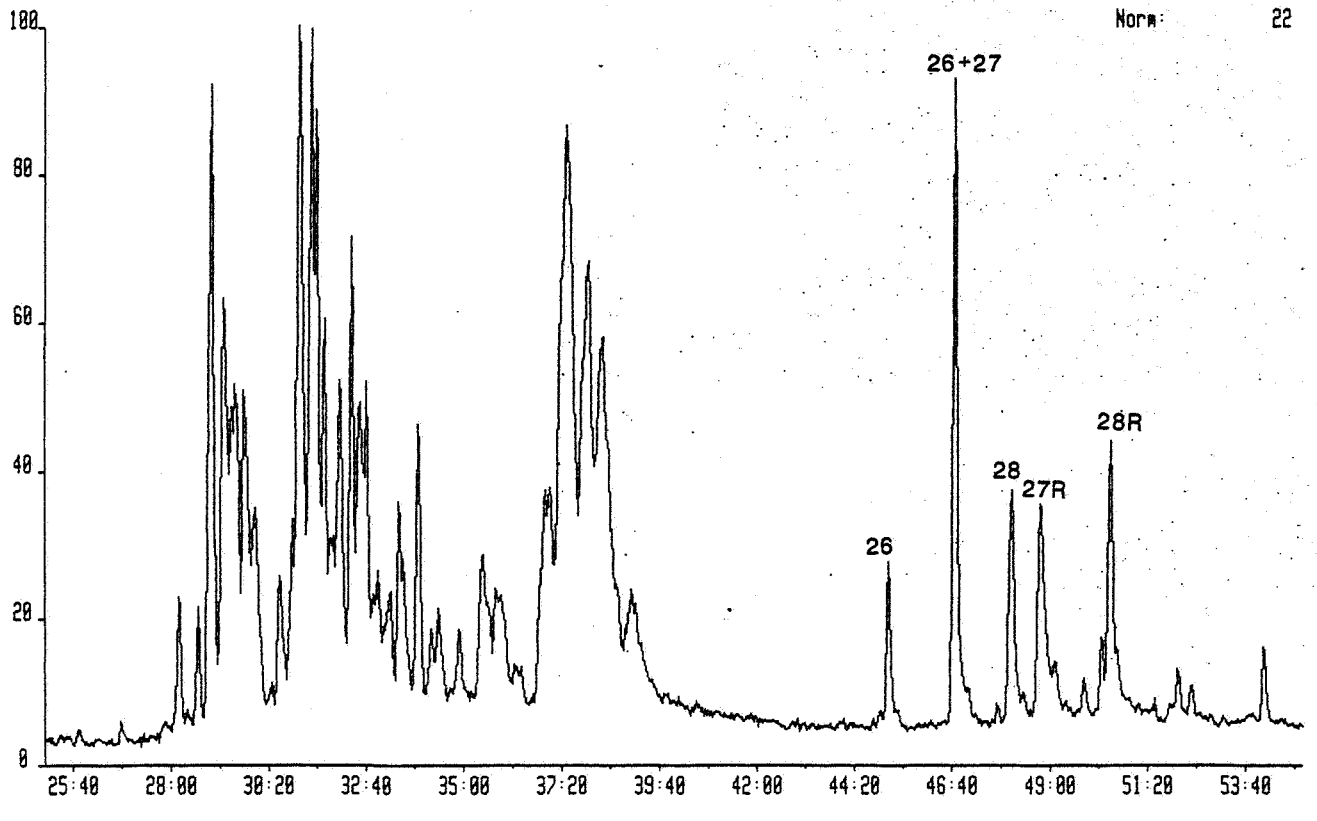


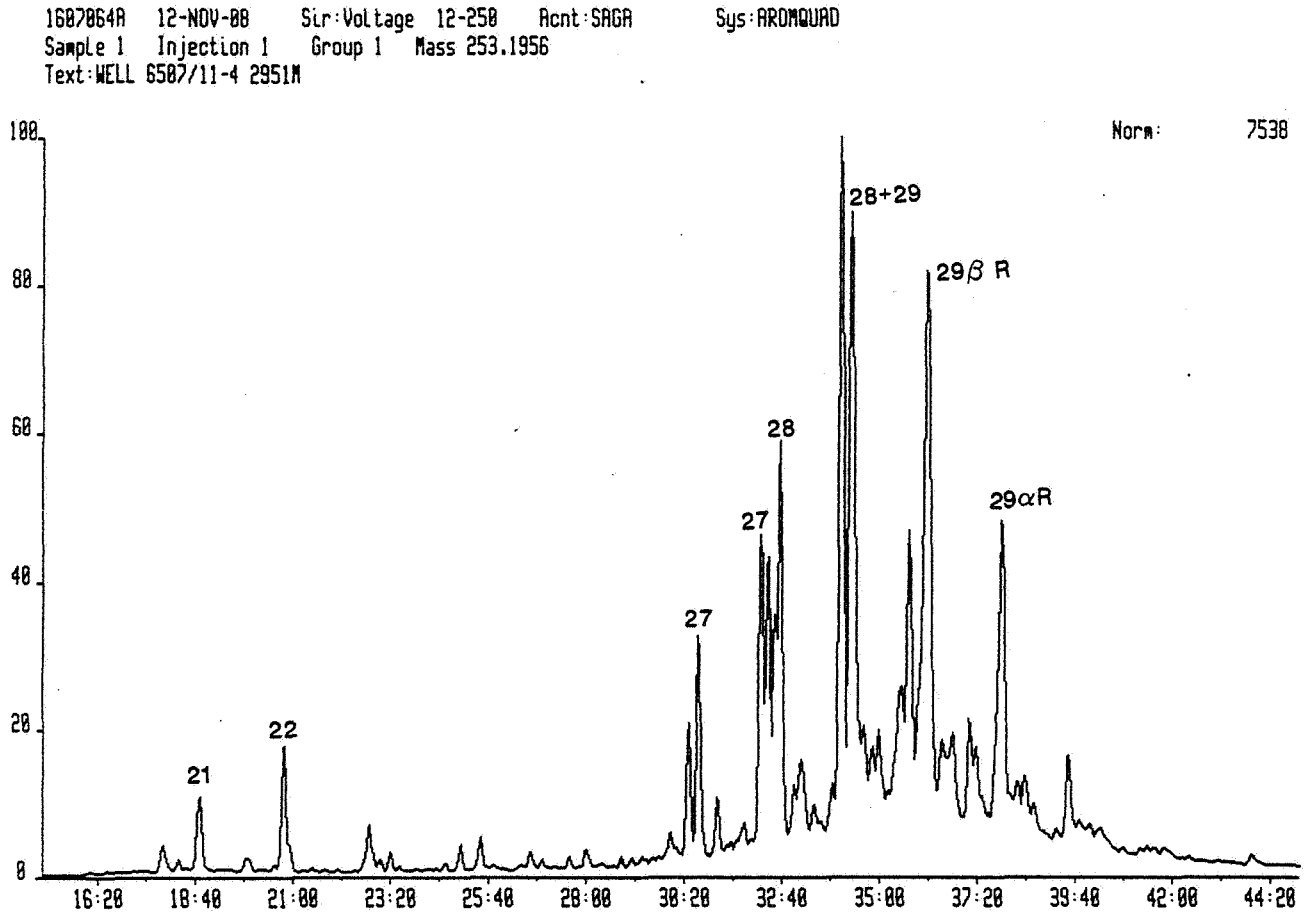
FIGURE 121

MASS FRAGMENTOGRAMS

GEOCHEM

WELL 6507/11-4 AROMATIC STERANES m/z 253 = MONOAROMATIC

m/z 231 = TRIAROMATIC



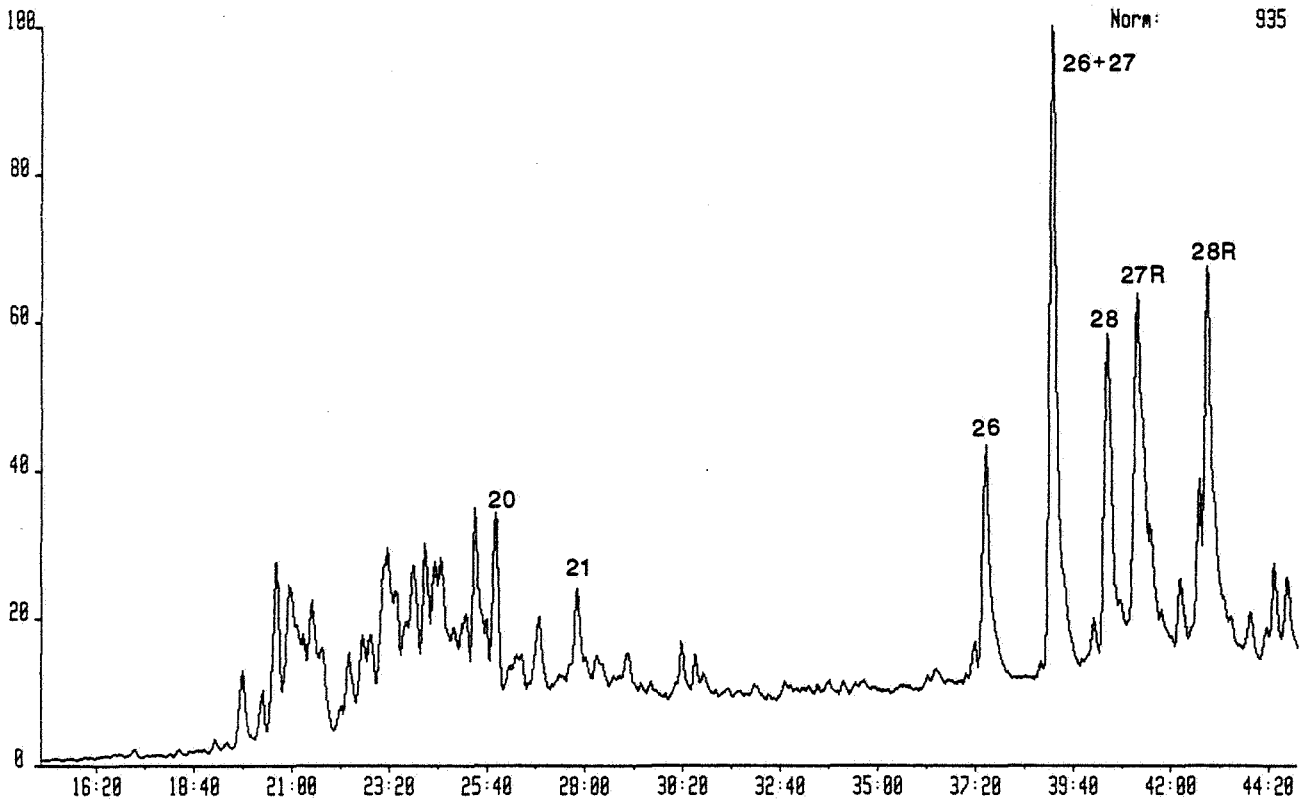


FIGURE 13a

MASS FRAGMENTOGRAMS

WELL 6507/11-4

C_{15+} AROMATIC HYDROCARBONS

PHENANTHRENE AND ALKYL PHENANTHRENE SERIES

m/z 178,192,206

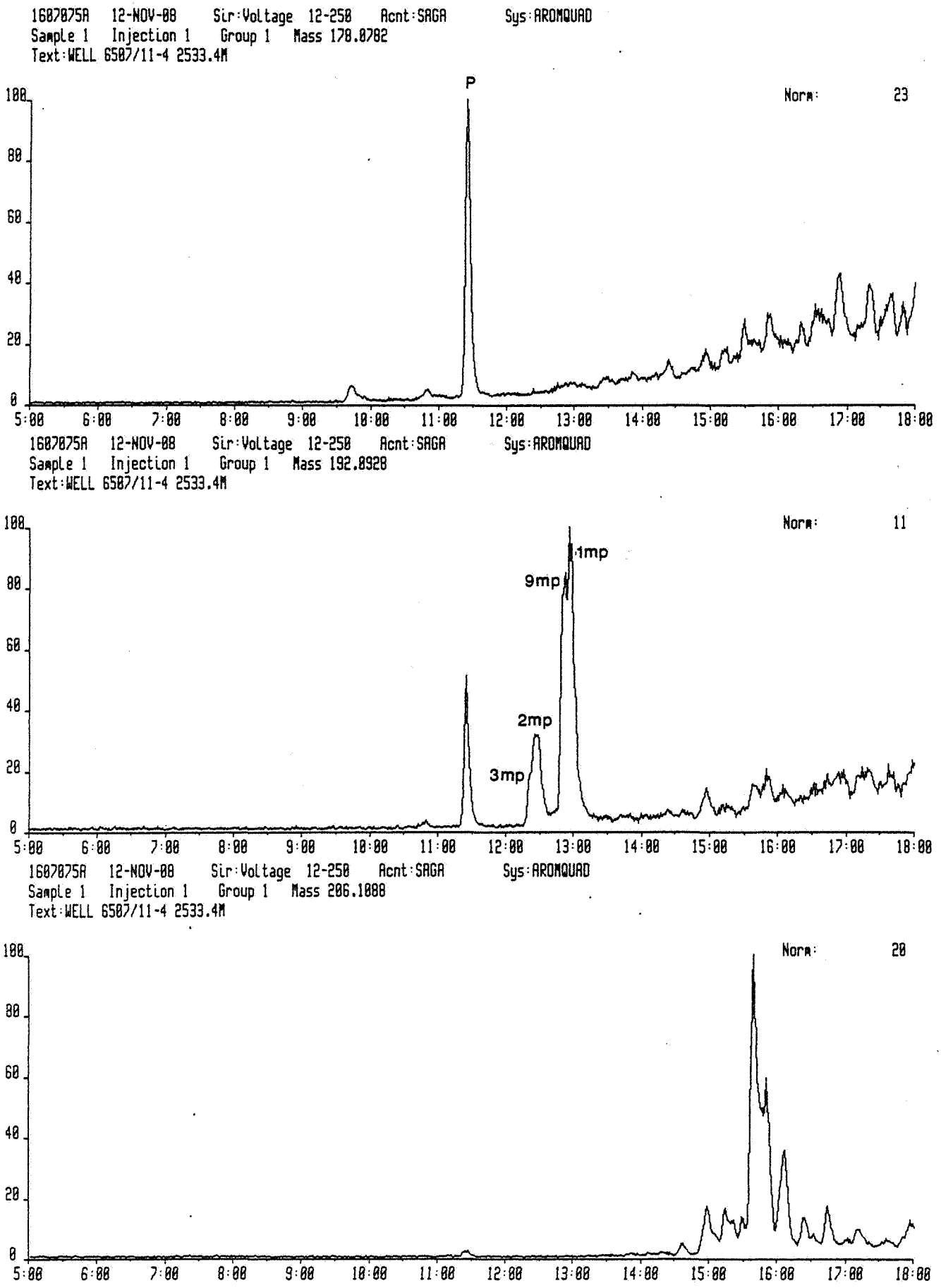


FIGURE 13b

MASS FRAGMENTOGRAMS

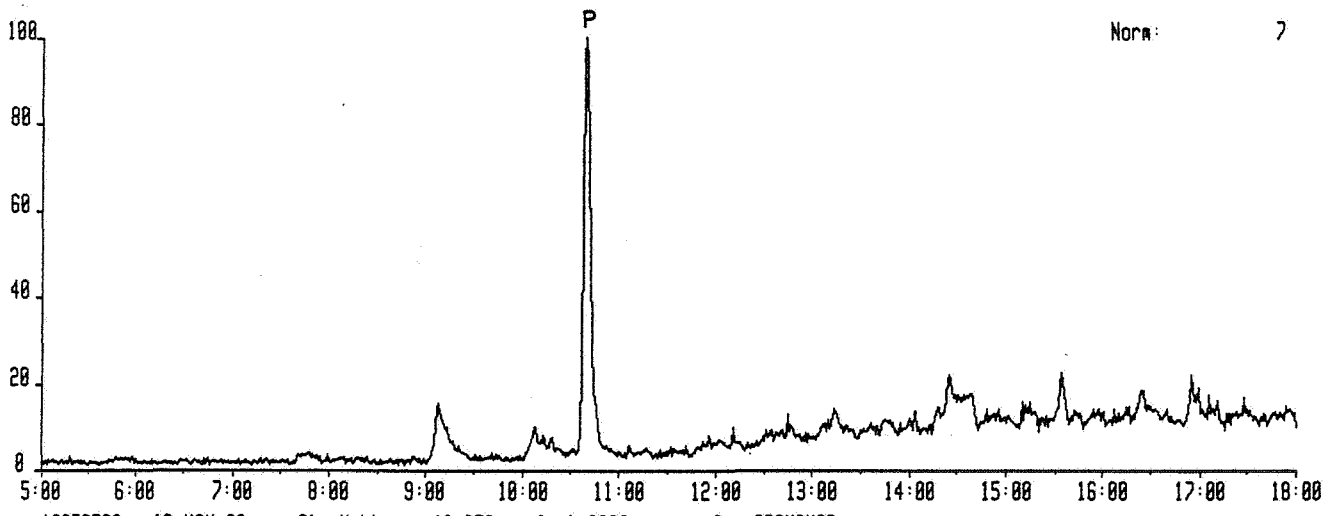
WELL 6507/11-4

C_{15+} AROMATIC HYDROCARBONS

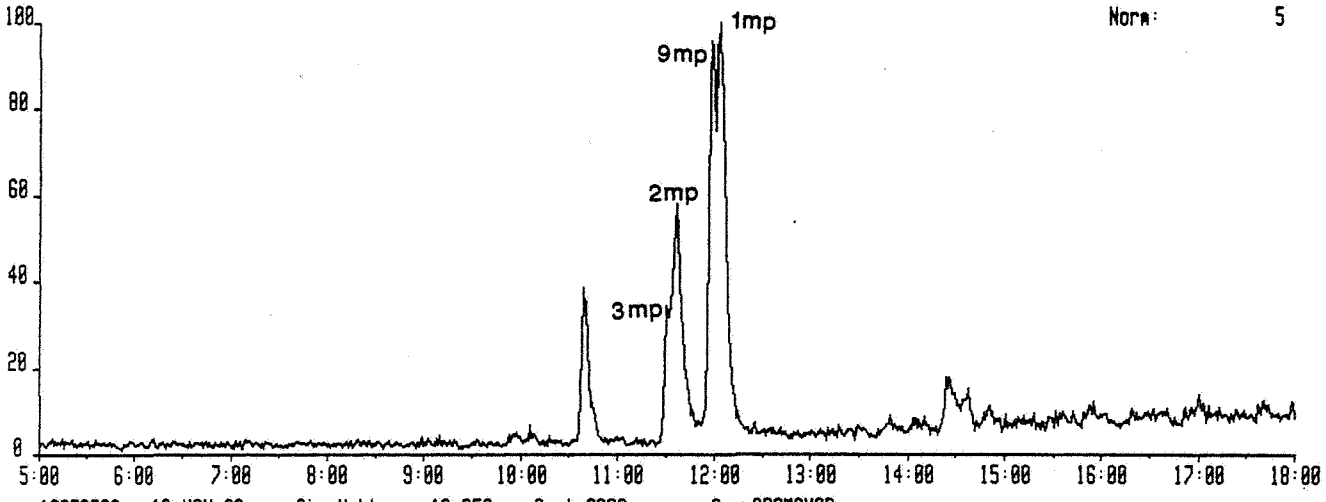
PHENANTHRENE AND ALKYL PHENANTHRENE SERIES

m/z 178,192,206

1607076A 12-NOV-08 Sir:Voltage 12-250 Acnt:SAGA Sys:AROMQUAD
Sample 1 Injection 1 Group 1 Mass 178.0782
Text:WELL 6507/11-4 2536.7M



1607076A 12-NOV-08 Sir:Voltage 12-250 Acnt:SAGA Sys:AROMQUAD
Sample 1 Injection 1 Group 1 Mass 192.0928
Text:WELL 6507/11-4 2536.7M



1607076A 12-NOV-08 Sir:Voltage 12-250 Acnt:SAGA Sys:AROMQUAD
Sample 1 Injection 1 Group 1 Mass 206.1008
Text:WELL 6507/11-4 2536.7M

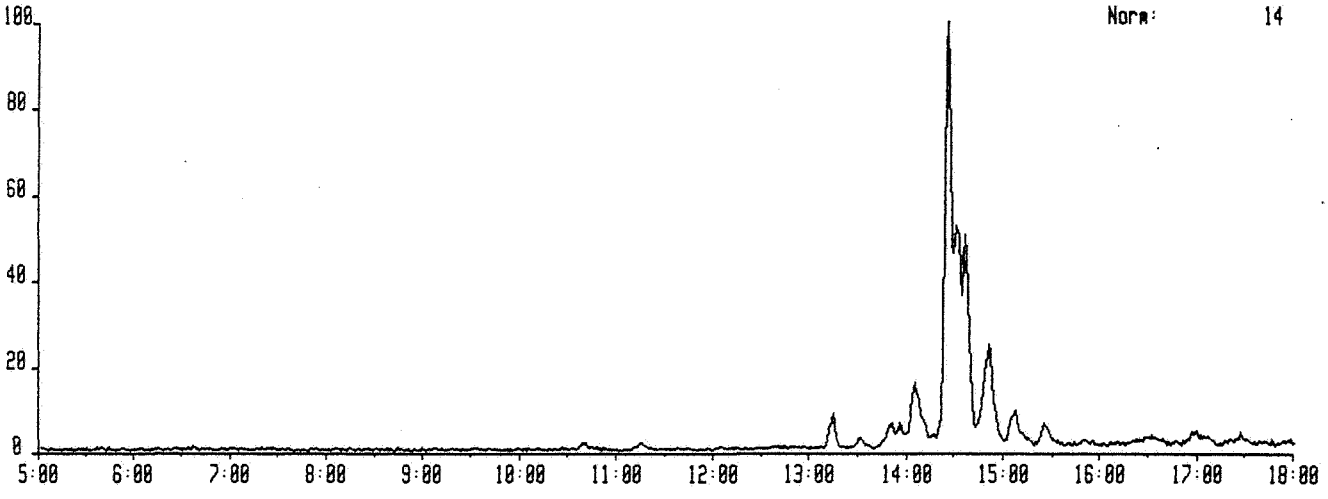


FIGURE 13c

MASS FRAGMENTOGRAMS

WELL 6507/11-4

C_{15+} AROMATIC HYDROCARBONS

PHENANTHRENE AND ALKYL PHENANTHRENE SERIES

m/z 178,192,206

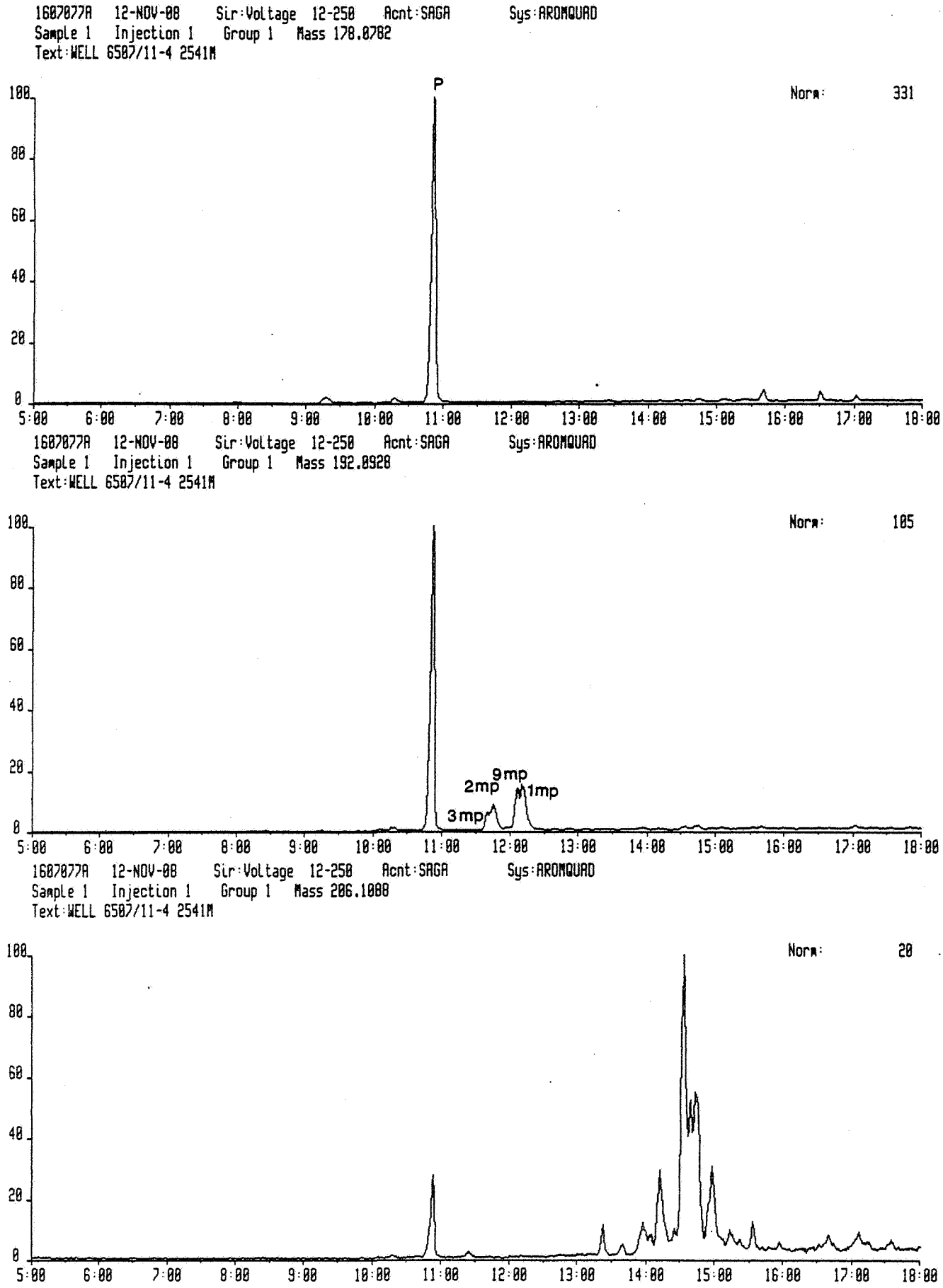


FIGURE 13d

MASS FRAGMENTOGRAMS

WELL 6507/11-4

C_{15+} AROMATIC HYDROCARBONS

PHENANTHRENE AND ALKYL PHENANTHRENE SERIES

m/z 178,192,206

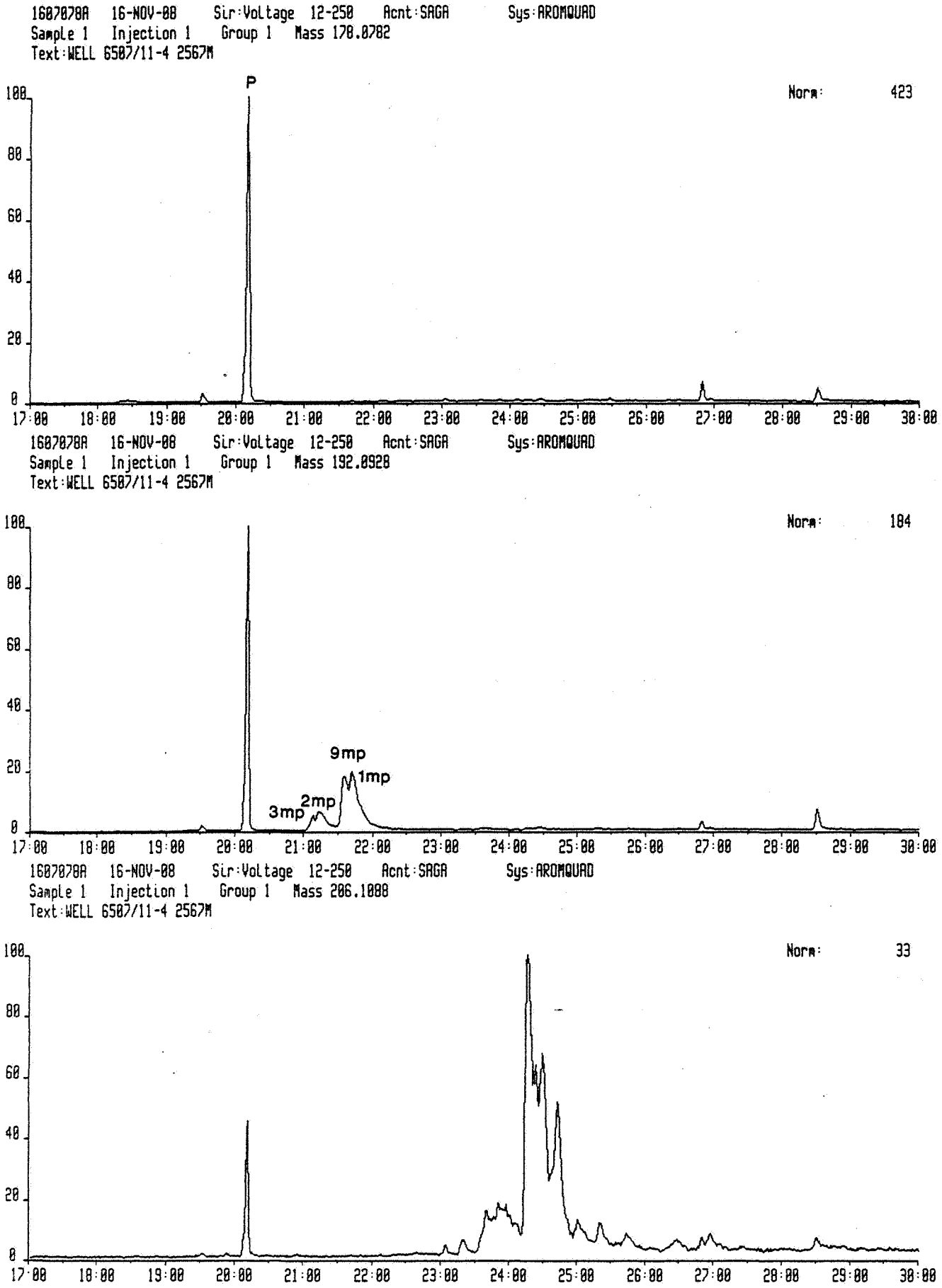


FIGURE 13e

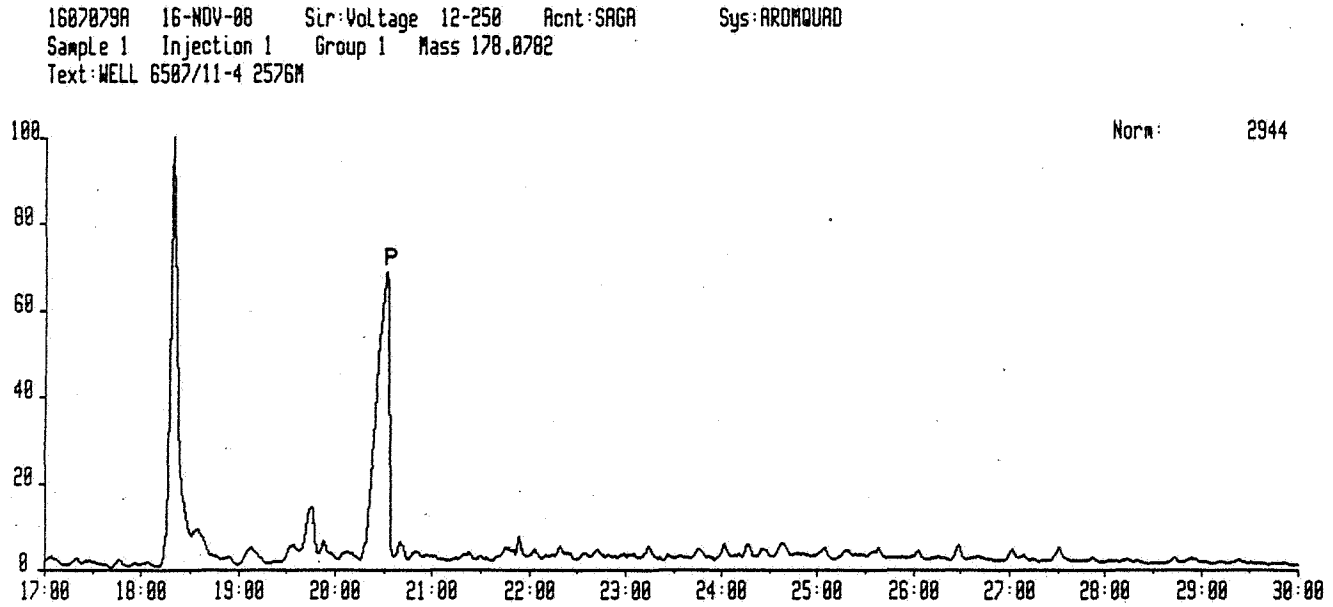
MASS FRAGMENTOGRAMS

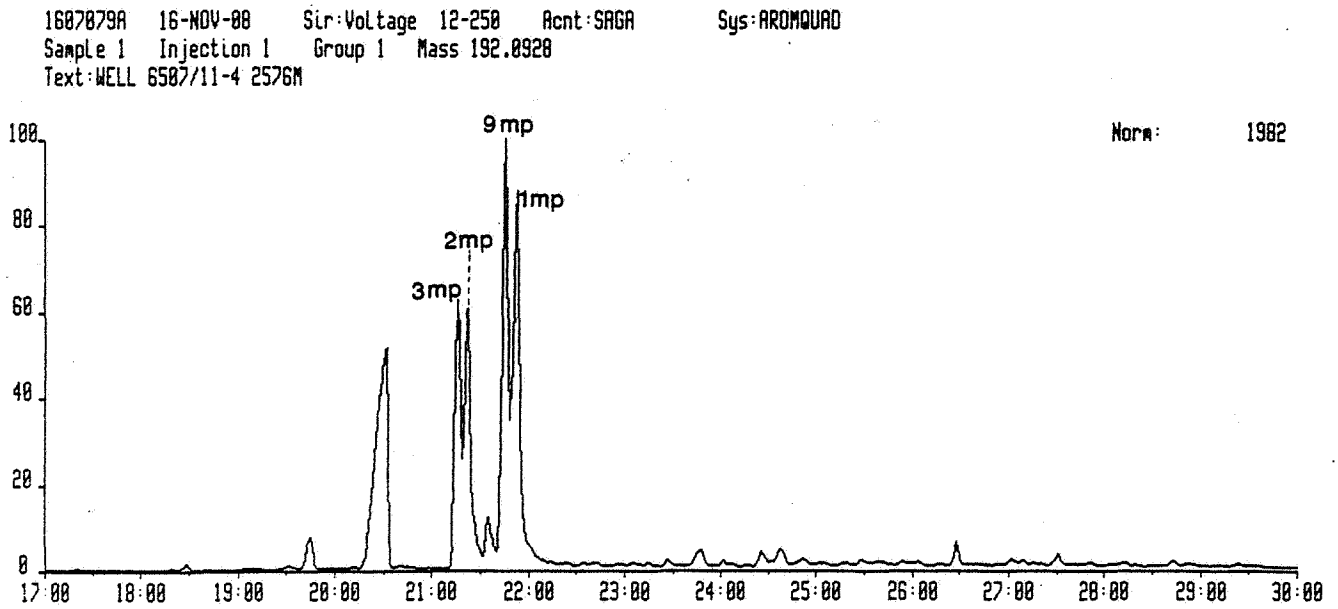
WELL 6507/11-4

C_{15+} AROMATIC HYDROCARBONS

PHENANTHRENE AND ALKYL PHENANTHRENE SERIES

m/z 178,192,206





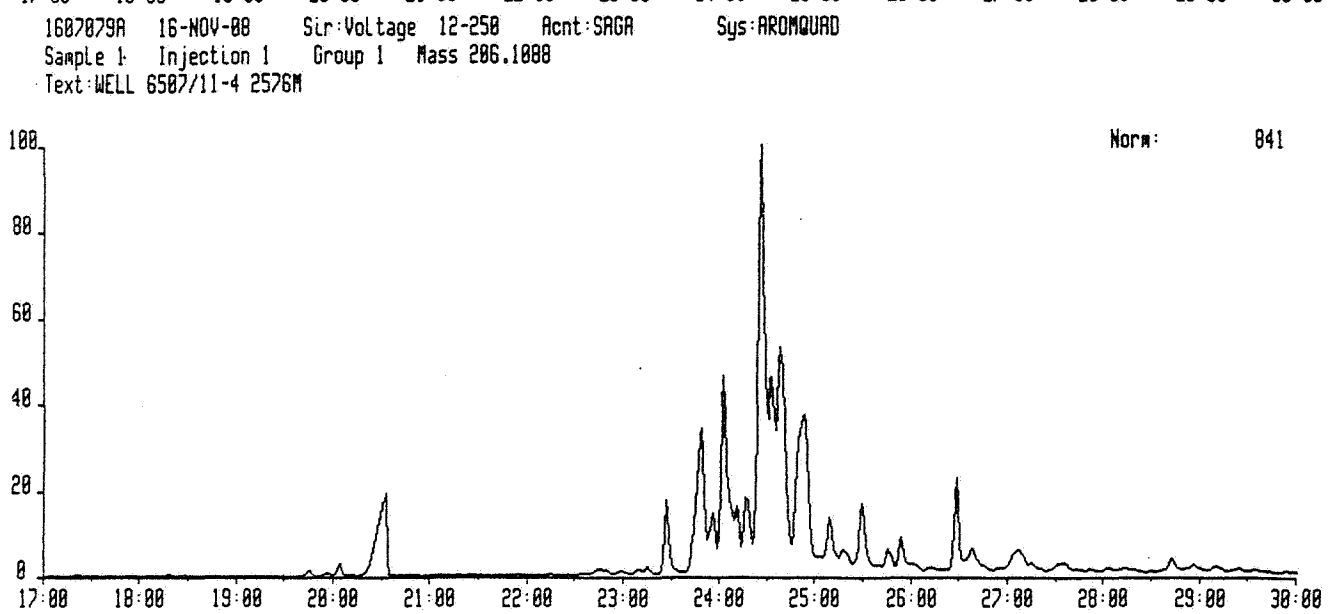


FIGURE 13f

MASS FRAGMENTOGRAMS

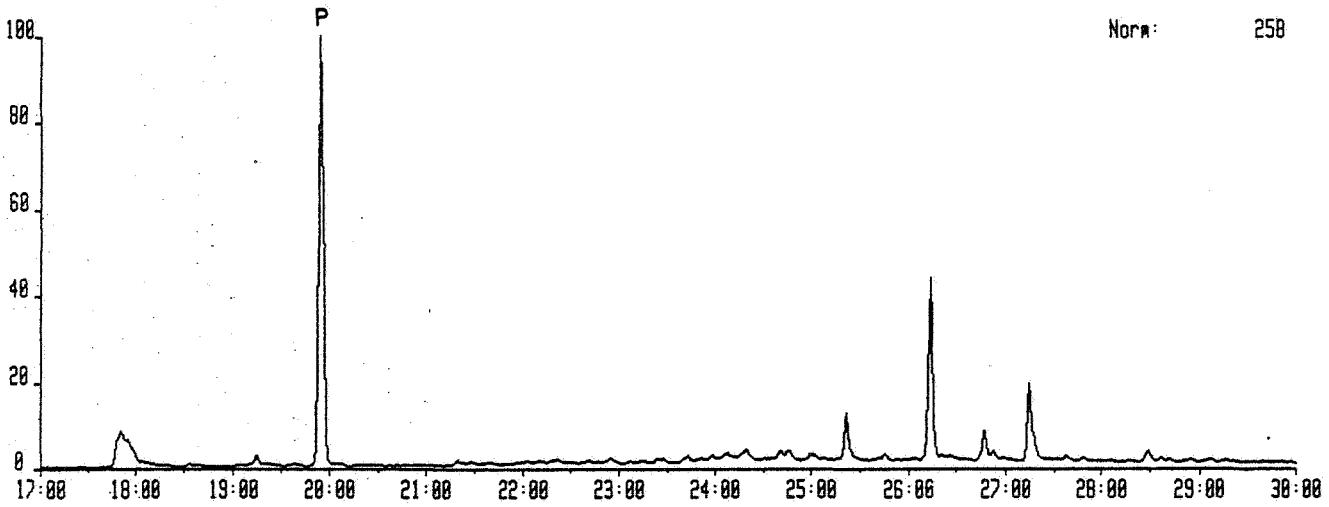
WELL 6507/11-4

C_{15+} AROMATIC HYDROCARBONS

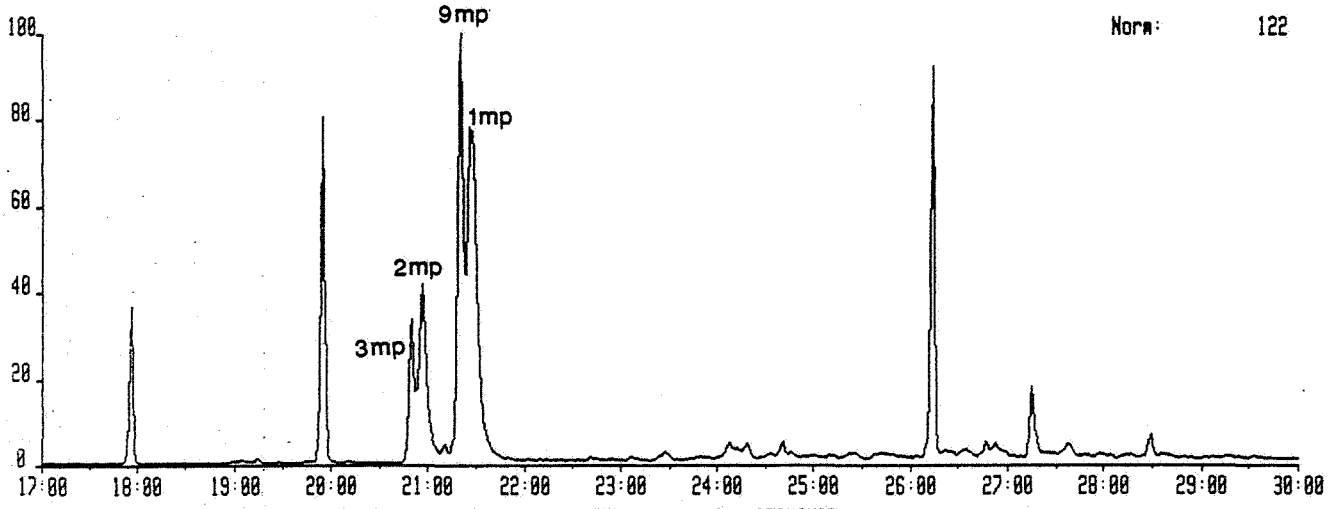
PHENANTHRENE AND ALKYL PHENANTHRENE SERIES

m/z 178,192,206

1607000A 16-NOV-00 Sir:Voltage 12-250 Acnt:SAGA Sys:AROMQUAD
Sample 1 Injection 1 Group 1 Mass 178.0782
Text:WELL 6507/11-4 2589M



1607000A 16-NOV-00 Sir:Voltage 12-250 Acnt:SAGA Sys:AROMQUAD
Sample 1 Injection 1 Group 1 Mass 192.0928
Text:WELL 6507/11-4 2589M



1607000A 16-NOV-00 Sir:Voltage 12-250 Acnt:SAGA Sys:AROMQUAD
Sample 1 Injection 1 Group 1 Mass 206.1088
Text:WELL 6507/11-4 2589M

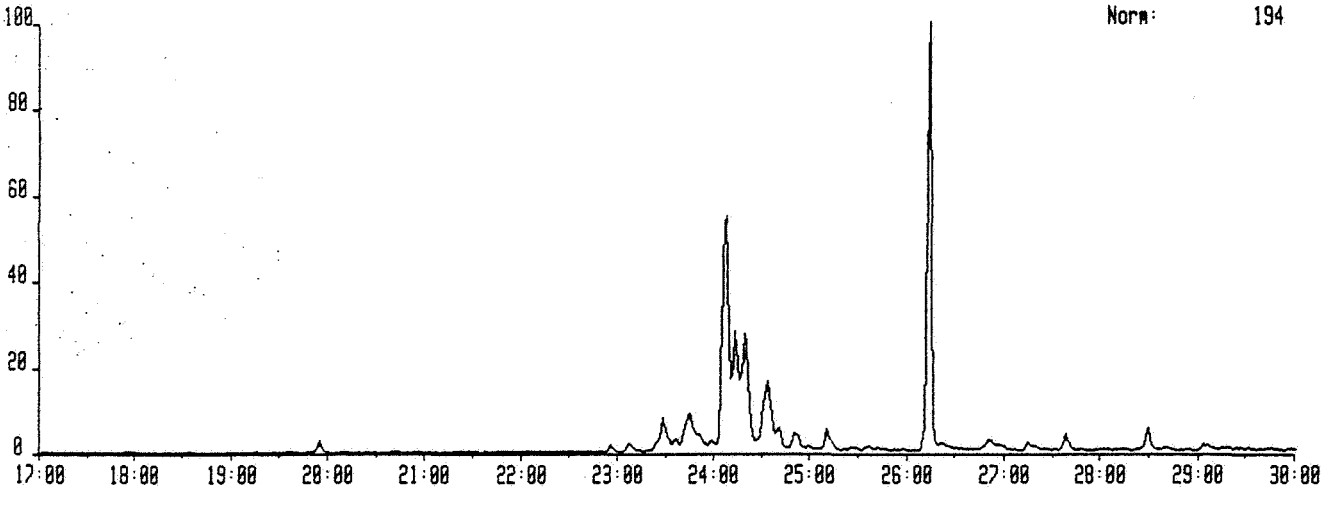


FIGURE 13g

MASS FRAGMENTOGRAMS

WELL 6507/11-4

C_{15+} AROMATIC HYDROCARBONS

PHENANTHRENE AND ALKYL PHENANTHRENE SERIES

m/z 178,192,206

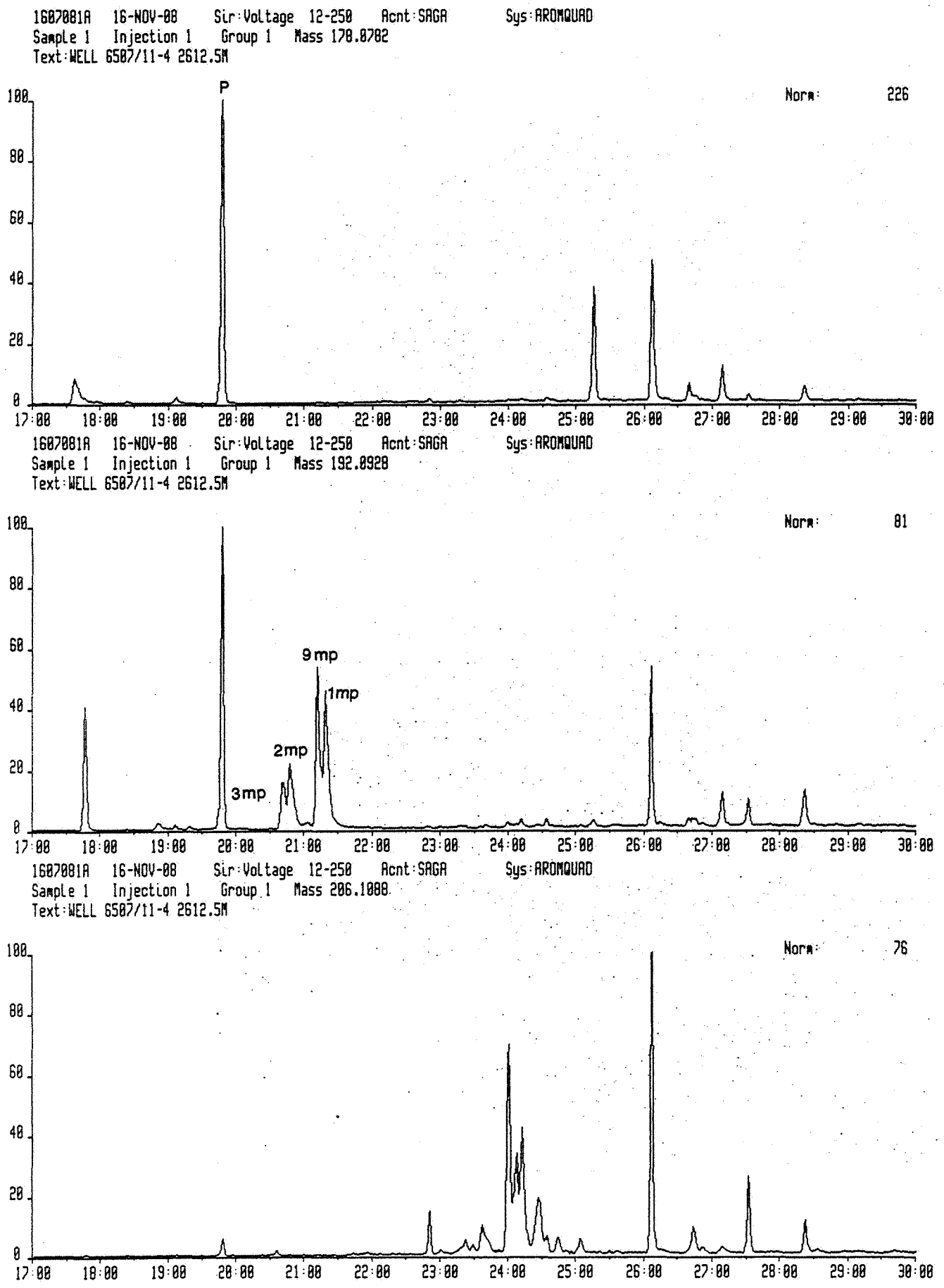


FIGURE 13h

MASS FRAGMENTOGRAMS

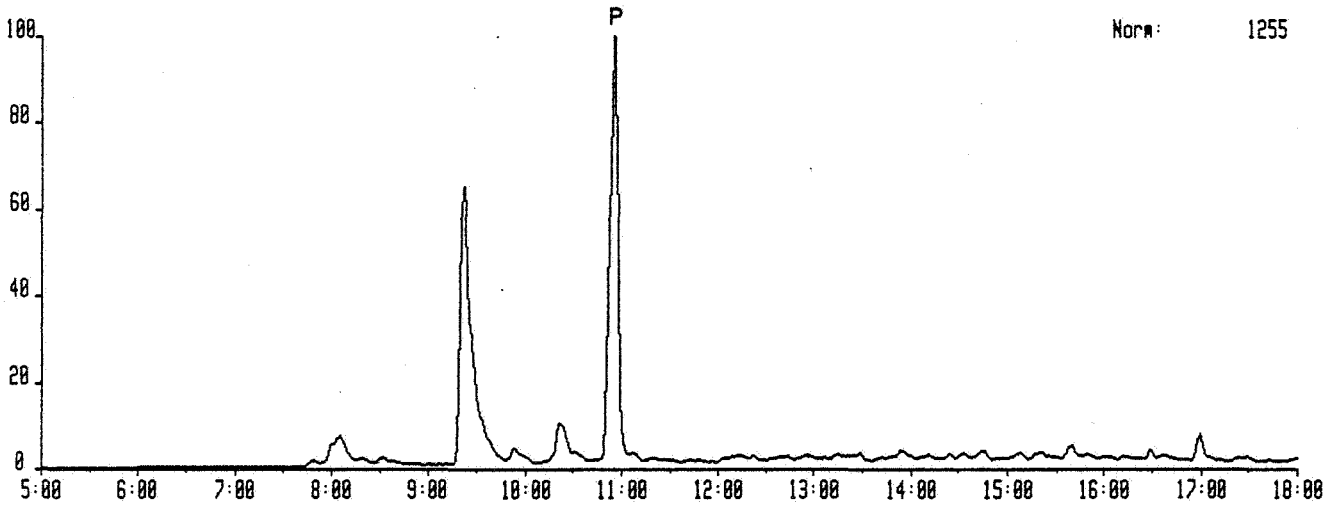
WELL 6507/11-4

C_{15+} AROMATIC HYDROCARBONS

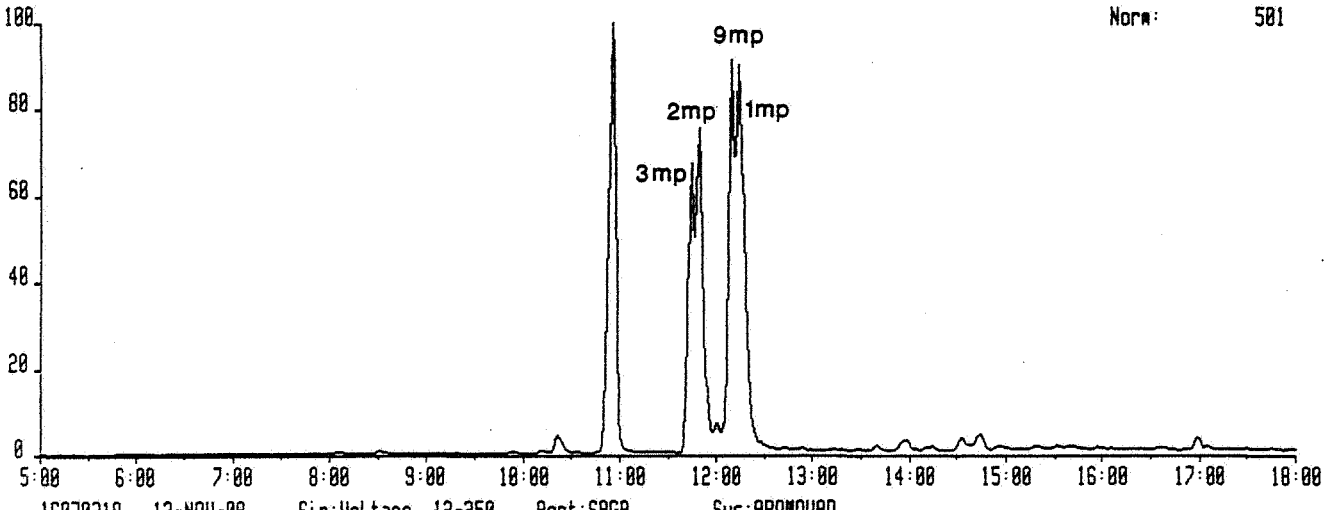
PHENANTHRENE AND ALKYL PHENANTHRENE SERIES

m/z 178,192,206

1607031A 12-NOV-08 Sir:Voltage 12-250 Acnt:SAGA Sys:AROMQUAD
Sample 1 Injection 1 Group 1 Mass 178.0782
Text:WELL 6507/11-4 2654M



1607031A 12-NOV-08 Sir:Voltage 12-250 Acnt:SAGA Sys:AROMQUAD
Sample 1 Injection 1 Group 1 Mass 192.0928
Text:WELL 6507/11-4 2654M



1607031A 12-NOV-08 Sir:Voltage 12-250 Acnt:SAGA Sys:AROMQUAD
Sample 1 Injection 1 Group 1 Mass 206.1088
Text:WELL 6507/11-4 2654M

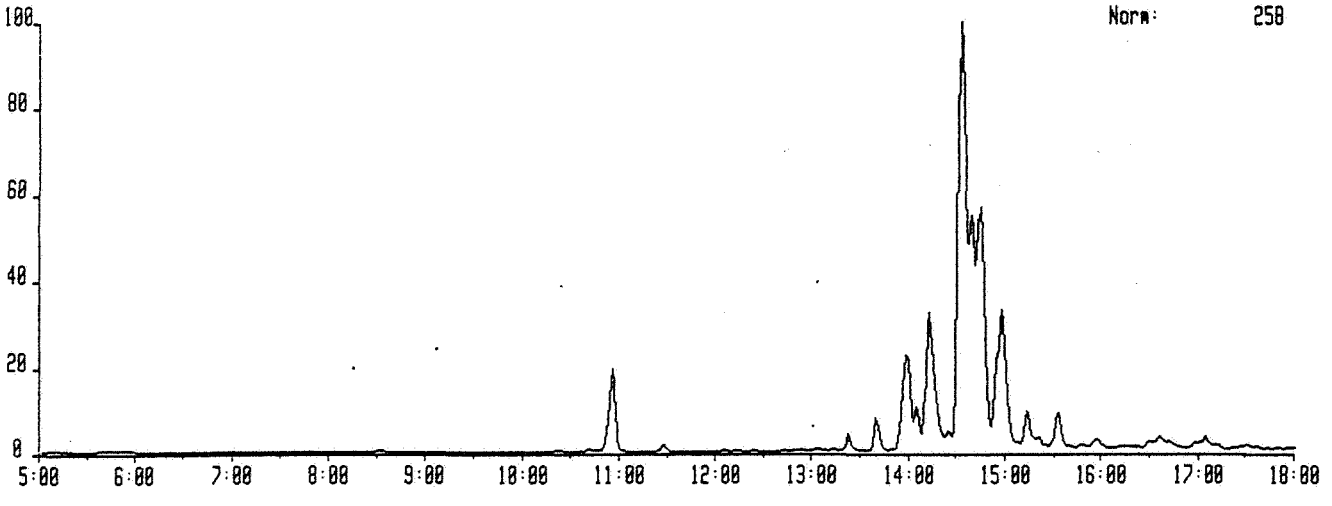


FIGURE 13i

MASS FRAGMENTOGRAMS

WELL 6507/11-4

C_{15+} AROMATIC HYDROCARBONS

PHENANTHRENE AND ALKYL PHENANTHRENE SERIES

m/z 178,192,206

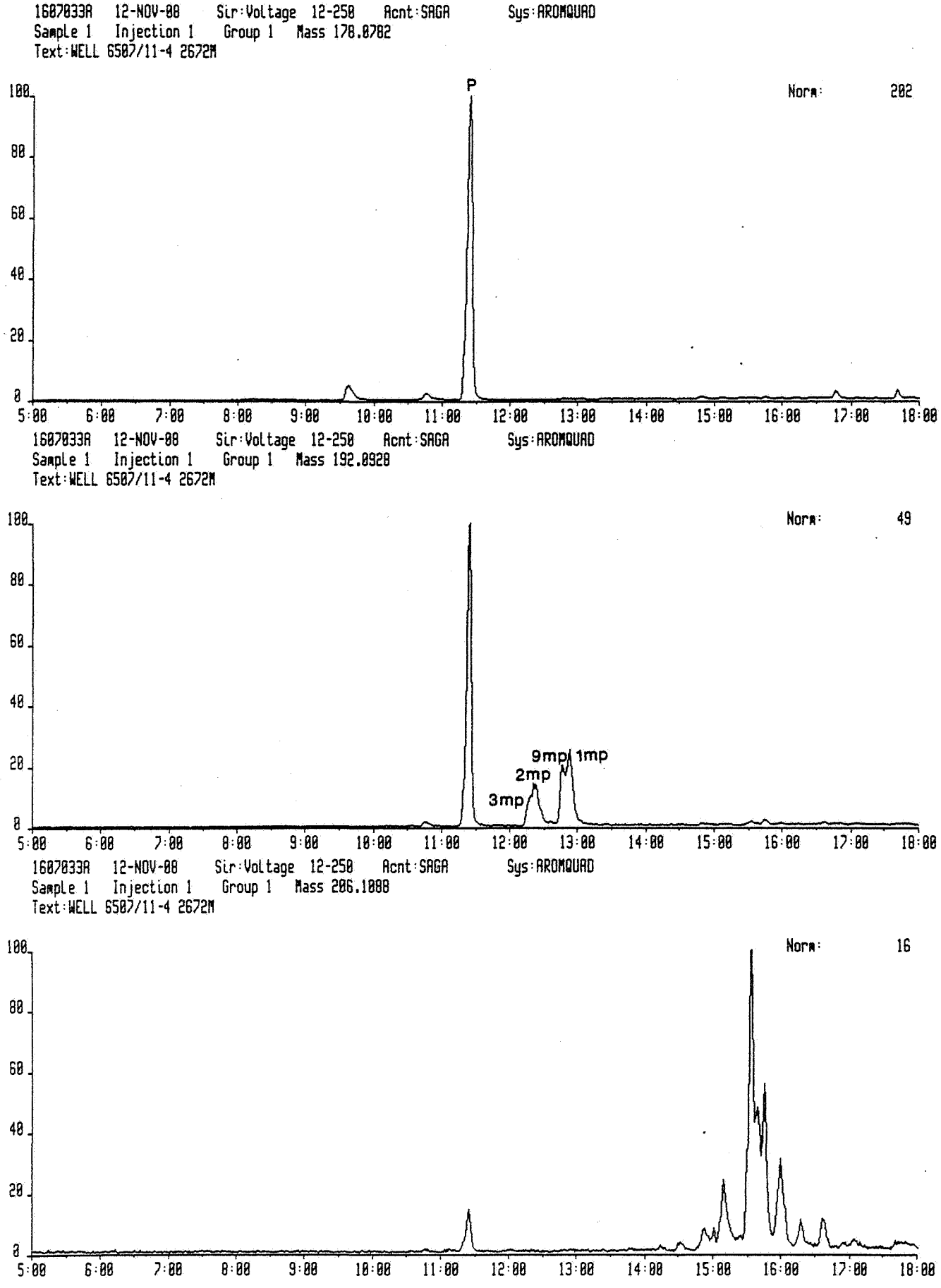


FIGURE 13j

MASS FRAGMENTOGRAMS

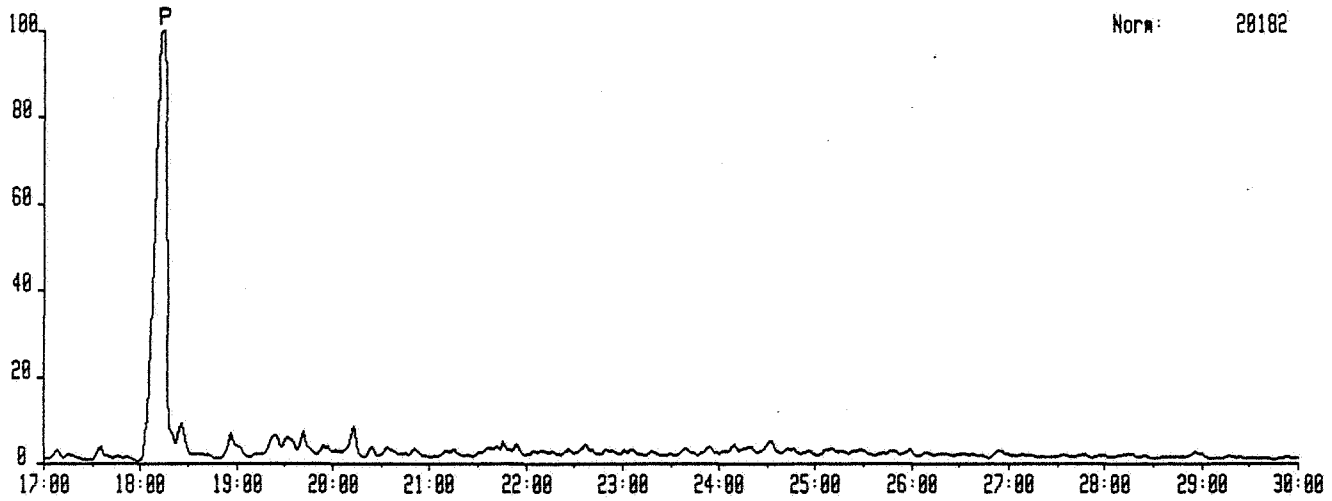
WELL 6507/11-4

C_{15+} AROMATIC HYDROCARBONS

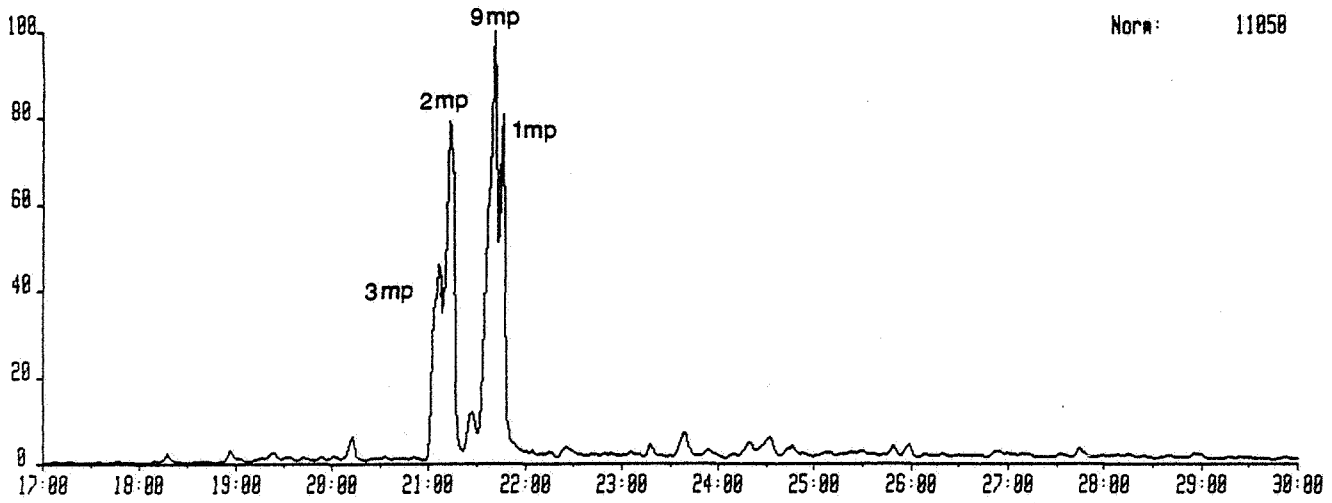
PHENANTHRENE AND ALKYL PHENANTHRENE SERIES

m/z 178,192,206

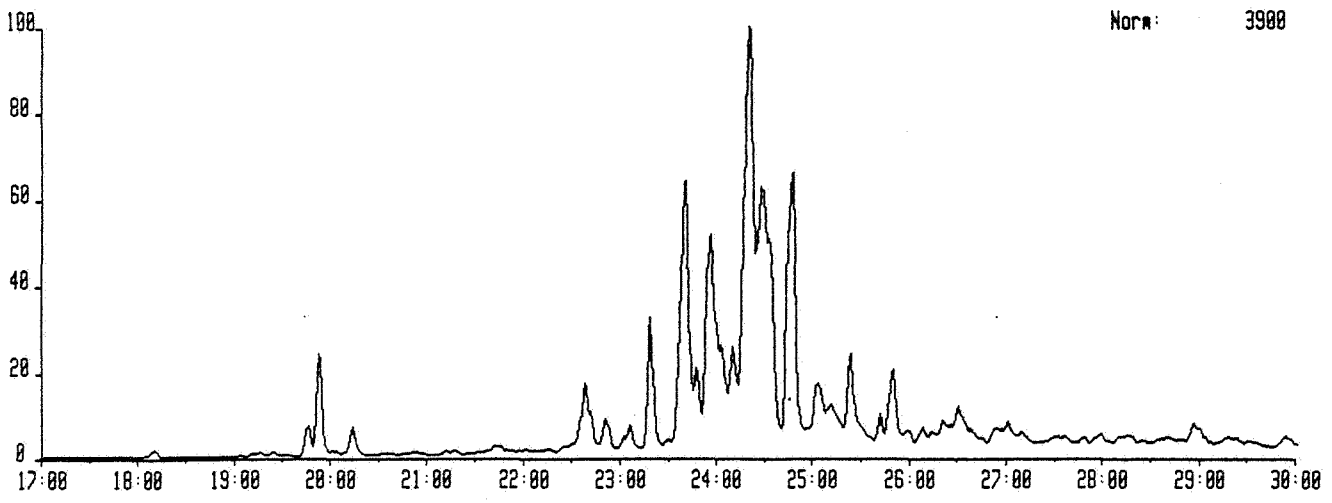
1607082A 13-NOV-08 Sir:Voltage 12-250 Acnt:SAGA Sys:AROMQUAD
Sample 1 Injection 1 Group 1 Mass 178.0782
Text:WELL 6507/11-4 2687M



1607082A 13-NOV-08 Sir:Voltage 12-250 Acnt:SAGA Sys:AROMQUAD
Sample 1 Injection 1 Group 1 Mass 192.0928
Text:WELL 6507/11-4 2687M



1607082A 13-NOV-08 Sir:Voltage 12-250 Acnt:SAGA Sys:AROMQUAD
Sample 1 Injection 1 Group 1 Mass 206.1088
Text:WELL 6507/11-4 2687M



MASS FRAGMENTOGRAMS

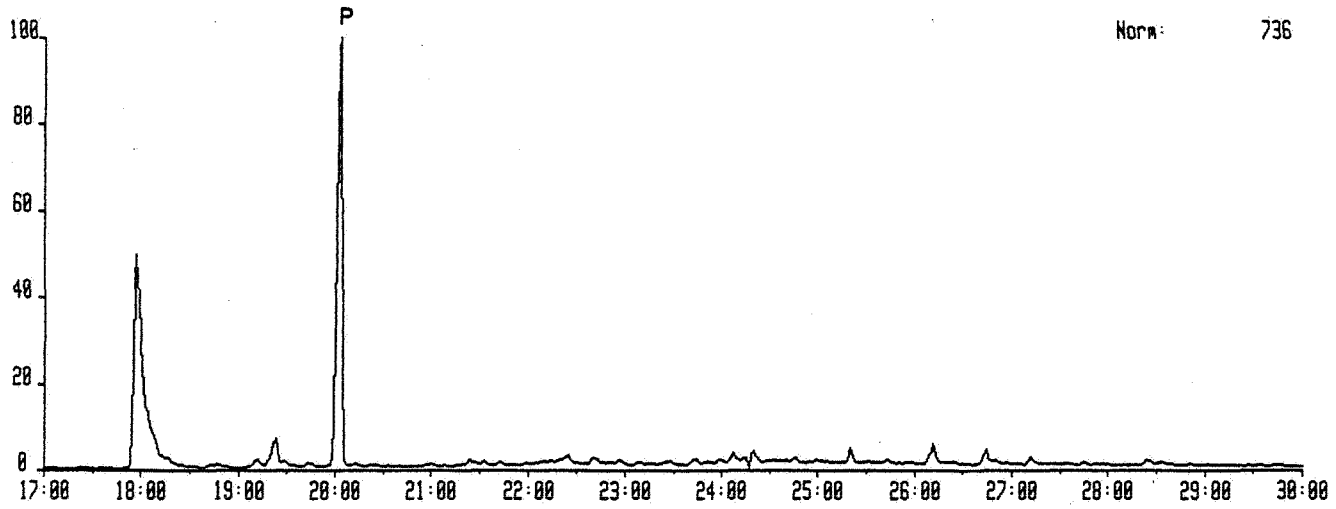
WELL 6507/11-4

C_{15+} AROMATIC HYDROCARBONS

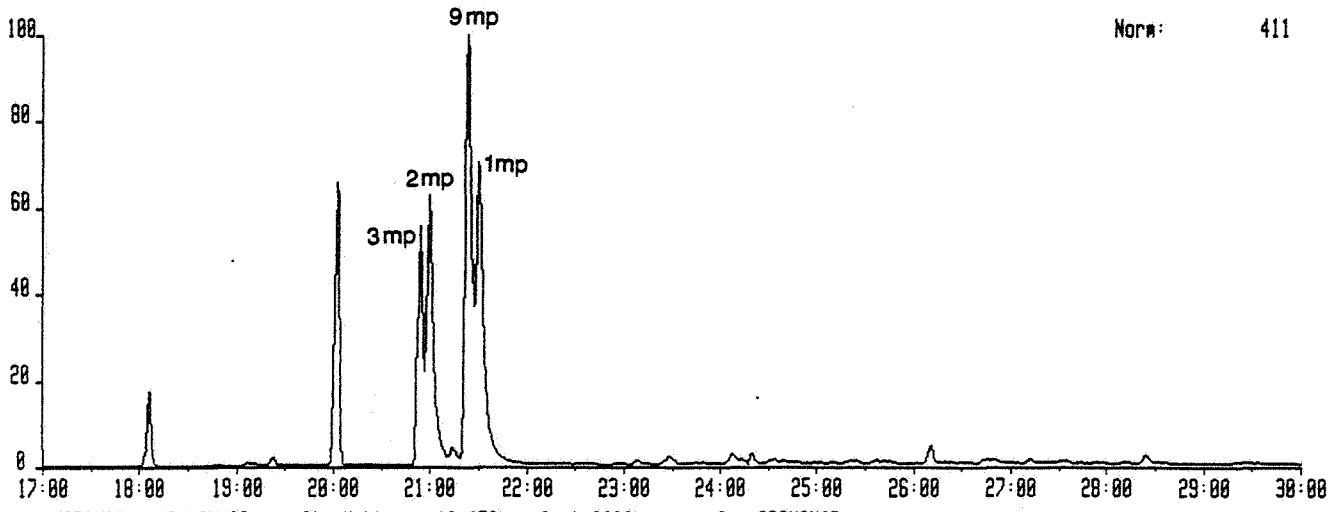
PHENANTHRENE AND ALKYL PHENANTHRENE SERIES

m/z 178,192,206

1687086A 16-NOV-88 Sir:Voltage 12-250 Acnt:SAGA Sys:AROMQUAD
Sample 1 Injection 1 Group 1 Mass 178.0782
Text:WELL 6507/11-4 2881.5M



1687086A 16-NOV-88 Sir:Voltage 12-250 Acnt:SAGA Sys:AROMQUAD
Sample 1 Injection 1 Group 1 Mass 192.0928
Text:WELL 6507/11-4 2881.5M



1687086A 16-NOV-88 Sir:Voltage 12-250 Acnt:SAGA Sys:AROMQUAD
Sample 1 Injection 1 Group 1 Mass 206.1088
Text:WELL 6507/11-4 2881.5M

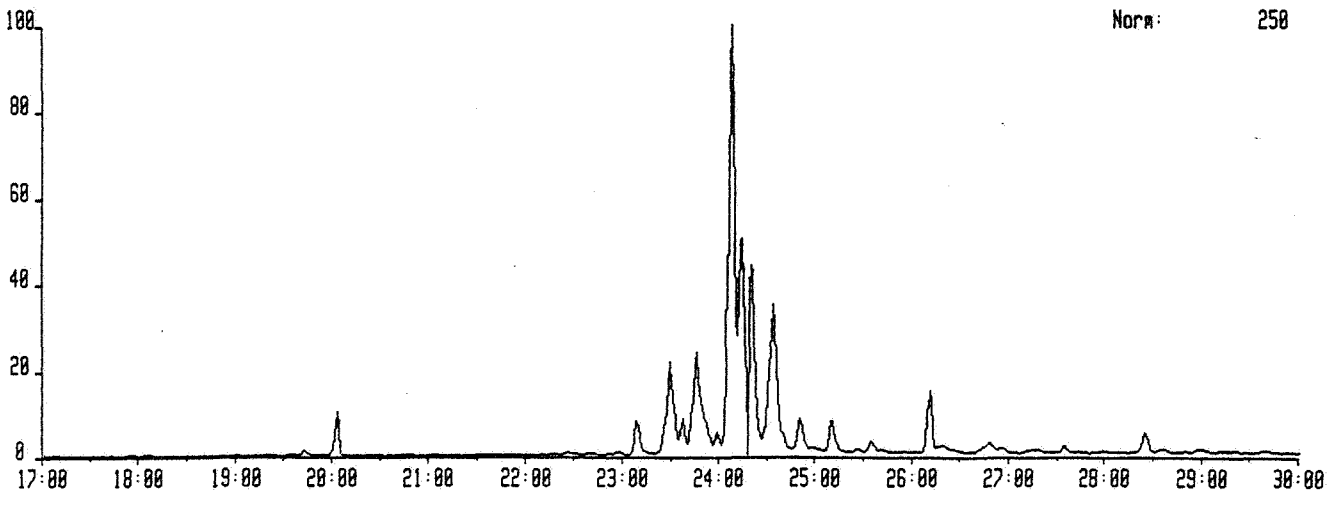


FIGURE 131

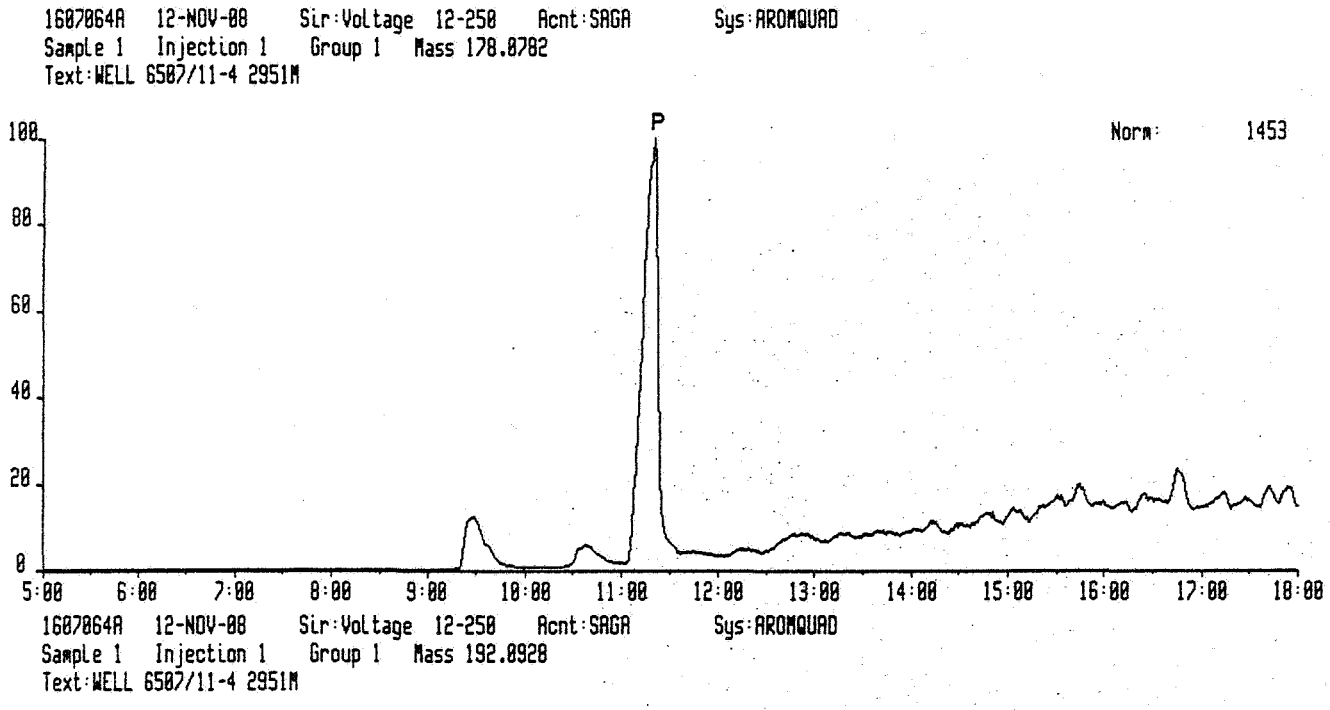
MASS FRAGMENTOGRAMS

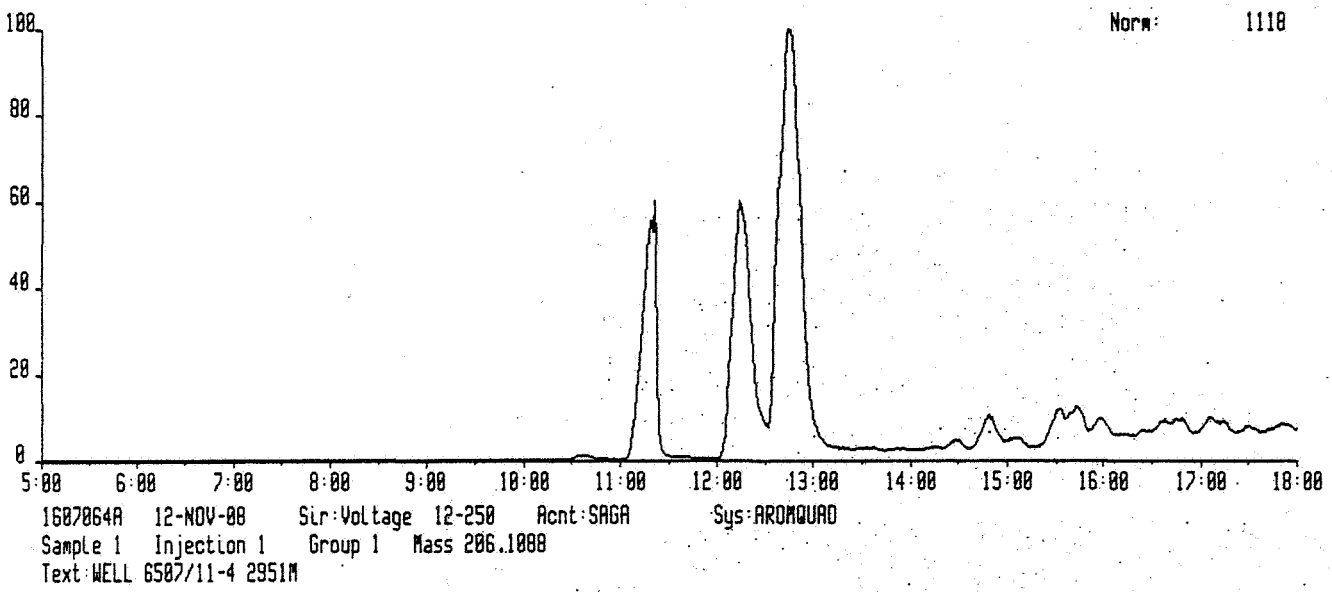
WELL 6507/11-4

C_{15+} AROMATIC HYDROCARBONS

PHENANTHRENE AND ALKYL PHENANTHRENE SERIES

m/z 178,192,206





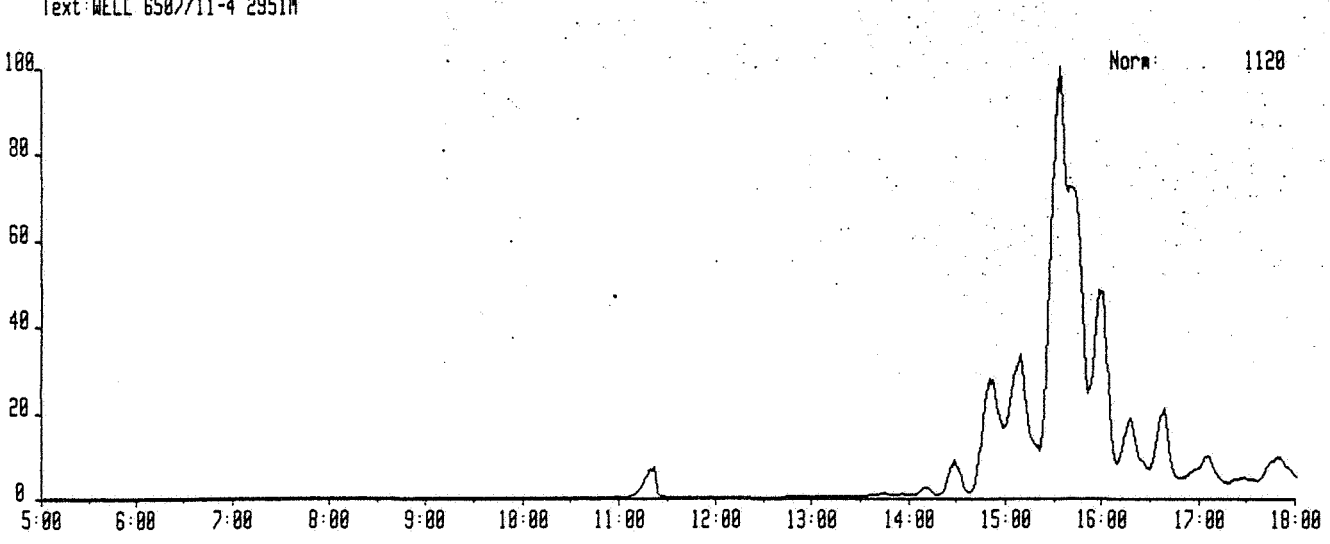


FIGURE 14a

MASS FRAGMENTOGRAMS

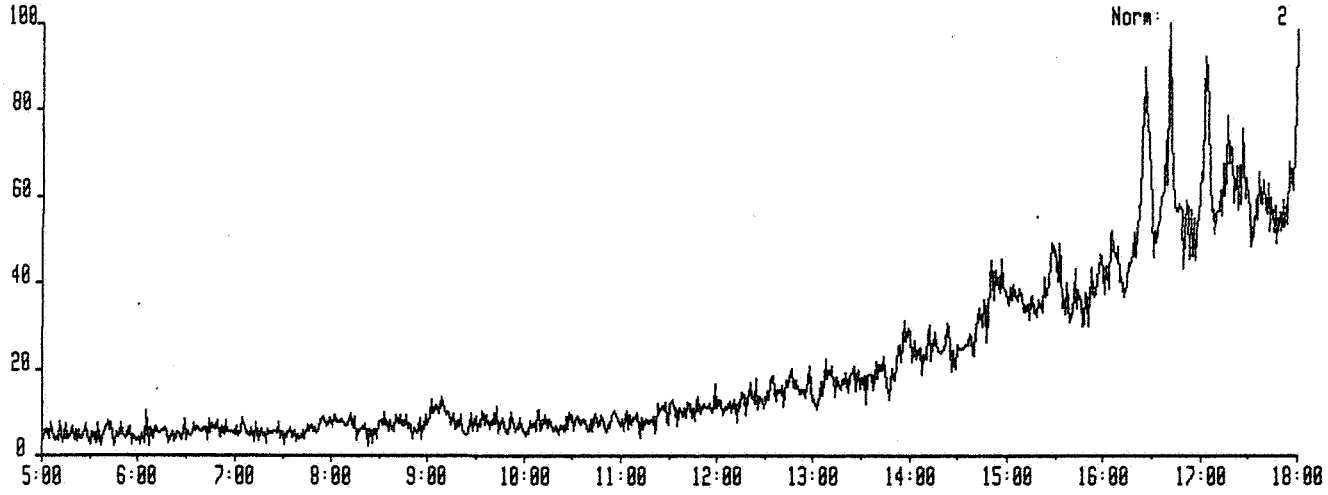
WELL 6507/11-4

C_{15+} AROMATIC HYDROCARBONS

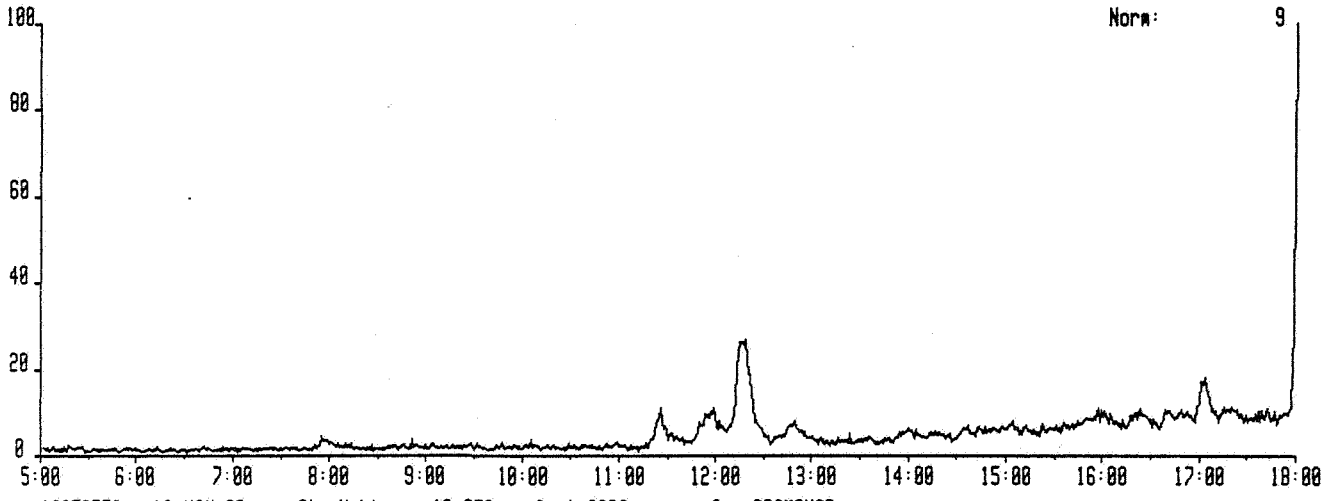
DIBENZOTHIOPHENE AND ALKYL DIBENZOTHIOPHENE SERIES

m/z 184,198,212

1607075A 12-NOV-08 Sir:Voltage 12-250 Acnt:SAGA Sys:AROMQUAD
Sample 1 Injection 1 Group 1 Mass 184.0344
Text:WELL 6507/11-4 2533.4M



1607075A 12-NOV-08 Sir:Voltage 12-250 Acnt:SAGA Sys:AROMQUAD
Sample 1 Injection 1 Group 1 Mass 198.0501
Text:WELL 6507/11-4 2533.4M



1607075A 12-NOV-08 Sir:Voltage 12-250 Acnt:SAGA Sys:AROMQUAD
Sample 1 Injection 1 Group 1 Mass 212.1560
Text:WELL 6507/11-4 2533.4M

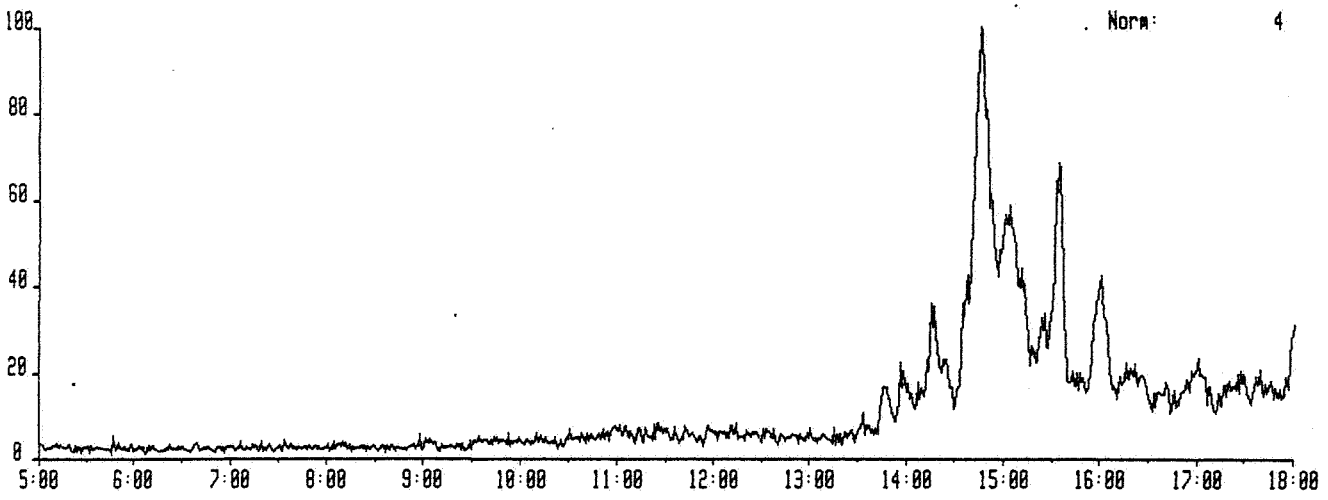


FIGURE 14b

MASS FRAGMENTOGRAMS

WELL 6507/11-4

C_{15+} AROMATIC HYDROCARBONS

DIBENZOTHIOPHENE AND ALKYL DIBENZOTHIOPHENE SERIES

m/z 184,198,212

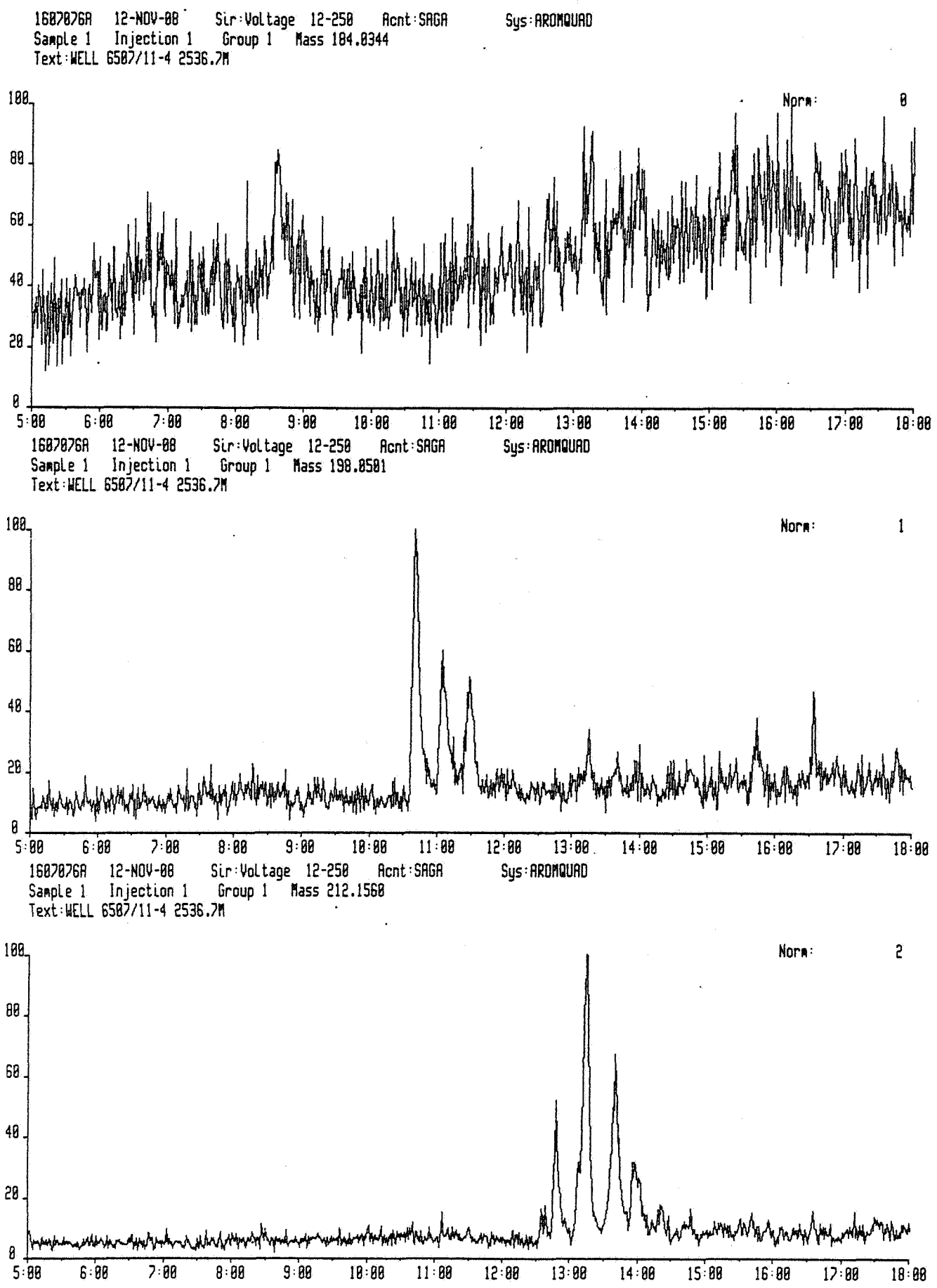


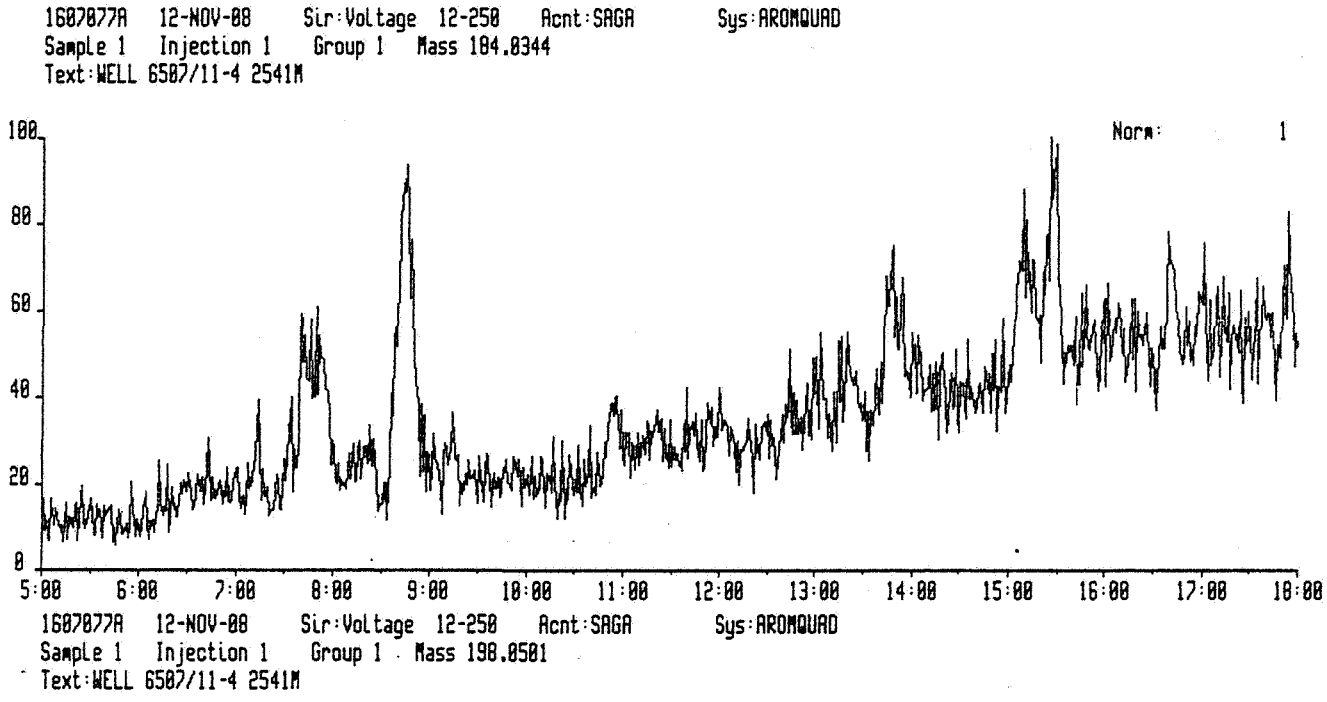
FIGURE 14c

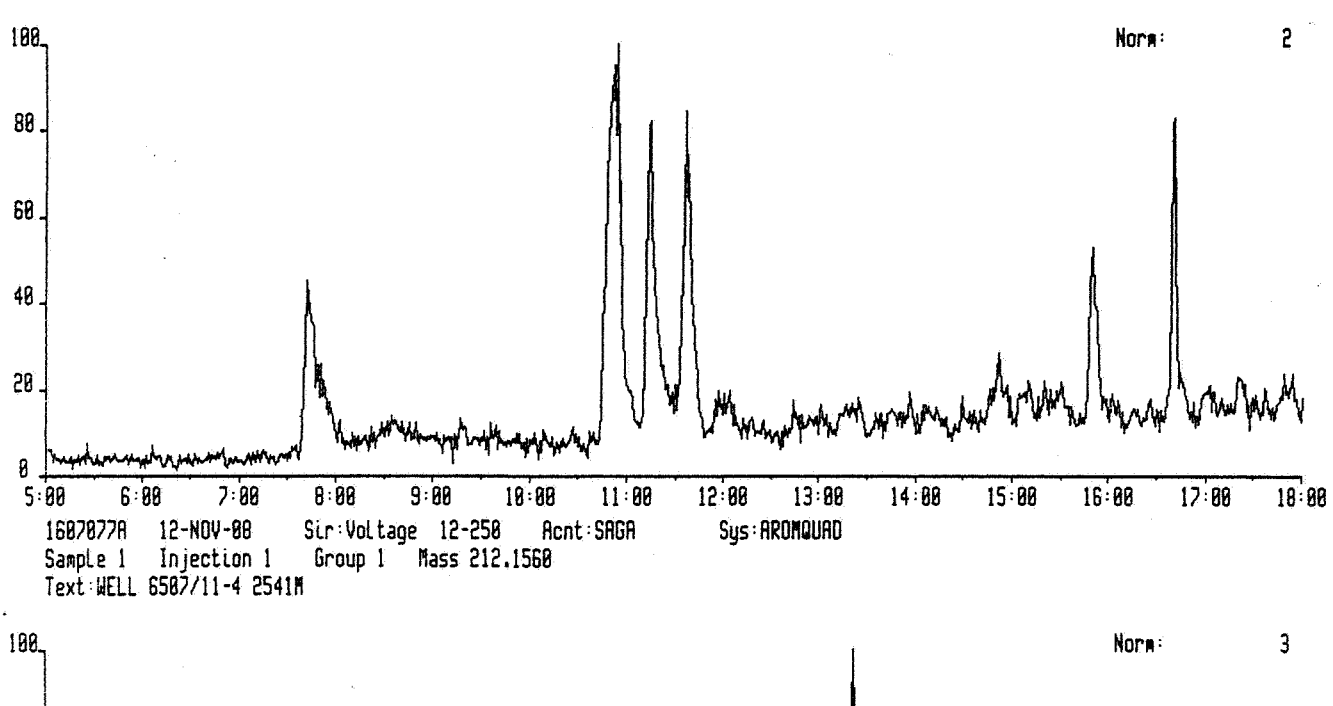
MASS FRAGMENTOGRAMS

WELL 6507/11-4 C_{15+} AROMATIC HYDROCARBONS

DIBENZOTHIOPHENE AND ALKYL DIBENZOTHIOPHENE SERIES

m/z 184,198,212





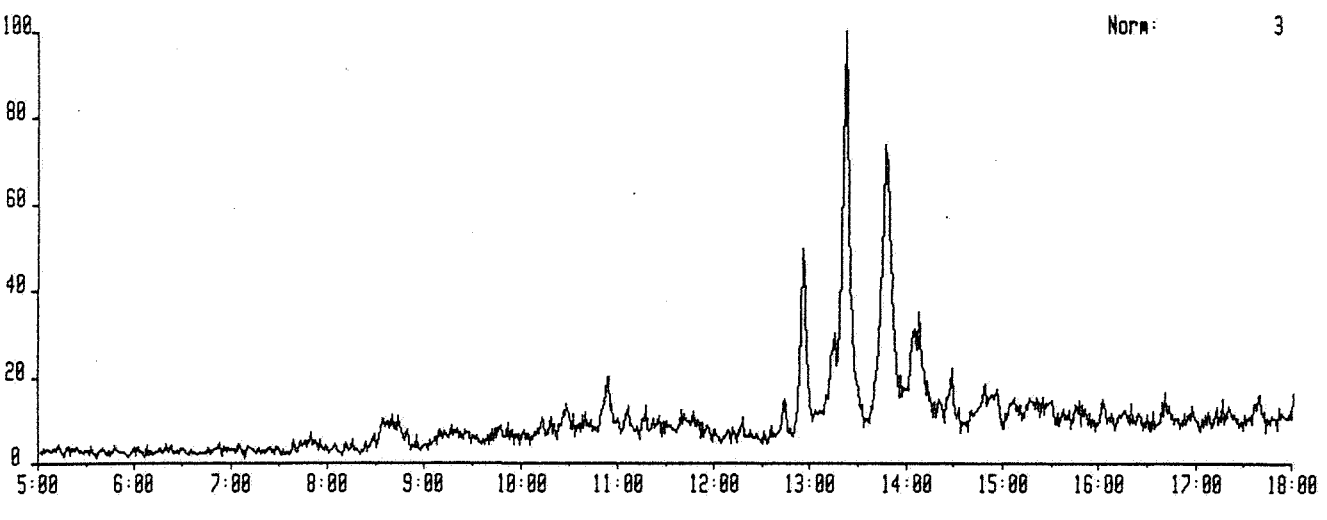


FIGURE 14d

MASS FRAGMENTOGRAMS

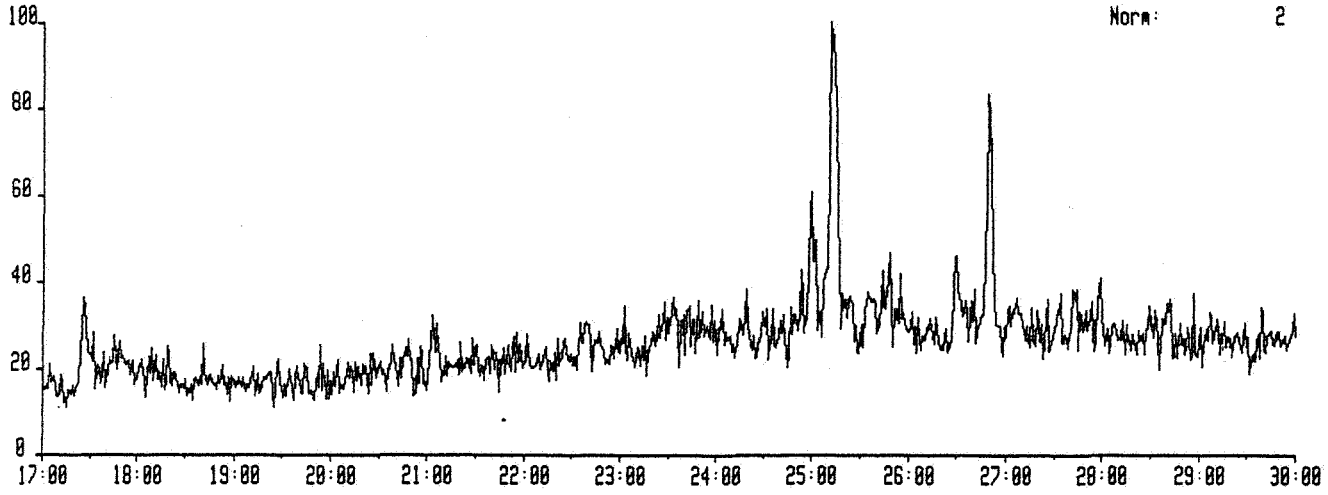
WELL 6507/11-4

C_{15+} AROMATIC HYDROCARBONS

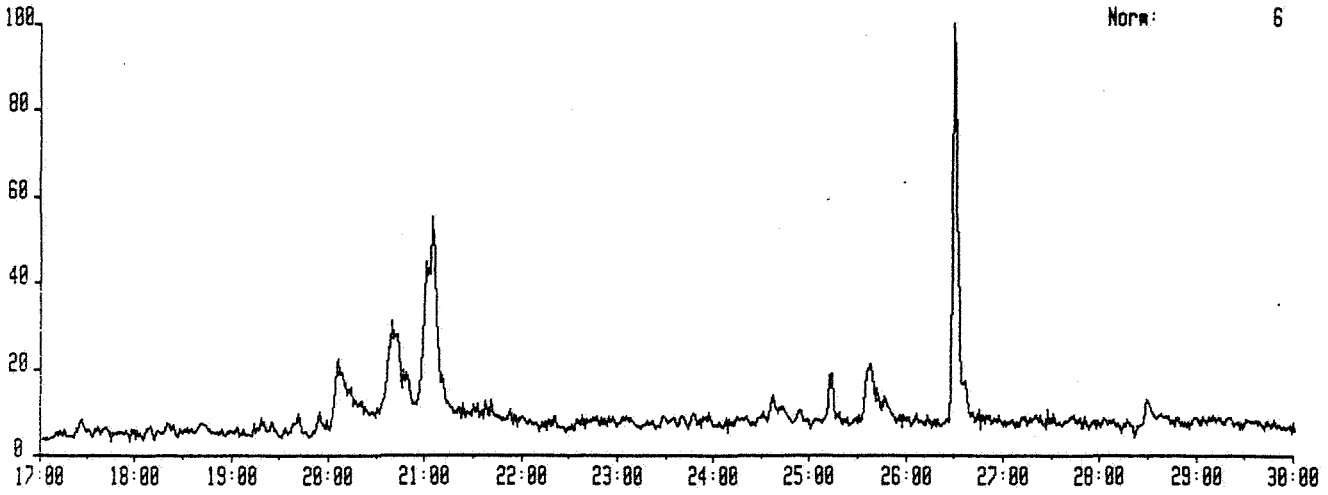
DIBENZOTHIOPHENE AND ALKYL DIBENZOTHIOPHENE SERIES

m/z 184,198,212

1607078A 16-NOV-08 Sir:Voltage 12-250 Acnt:SAGA Sys:AROMQUAD
Sample 1 Injection 1 Group 1 Mass 184.0344
Text:WELL 6507/11-4 2567M



1607078A 16-NOV-08 Sir:Voltage 12-250 Acnt:SAGA Sys:AROMQUAD
Sample 1 Injection 1 Group 1 Mass 198.0501
Text:WELL 6507/11-4 2567M



1607078A 16-NOV-08 Sir:Voltage 12-250 Acnt:SAGA Sys:AROMQUAD
Sample 1 Injection 1 Group 1 Mass 212.1568
Text:WELL 6507/11-4 2567M

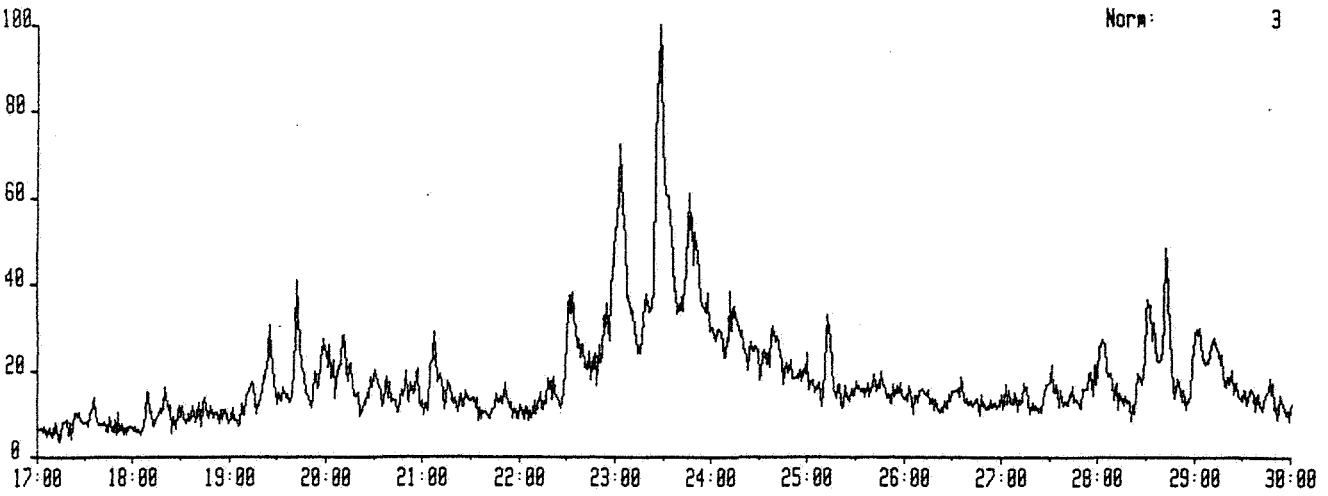


FIGURE 14e

MASS FRAGMENTOGRAMS

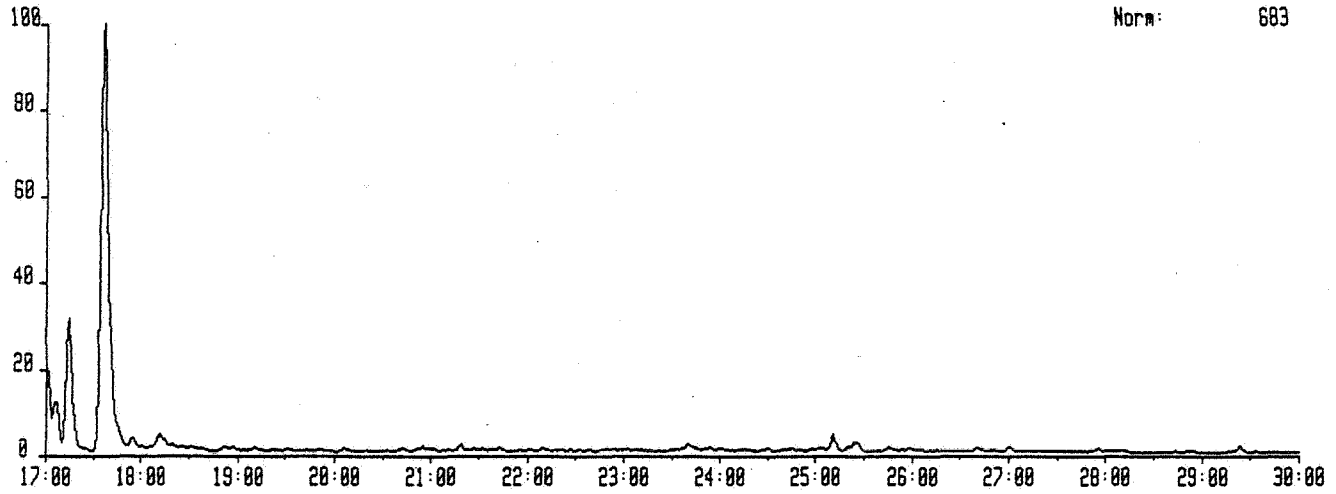
WELL 6507/11-4

C_{15+} AROMATIC HYDROCARBONS

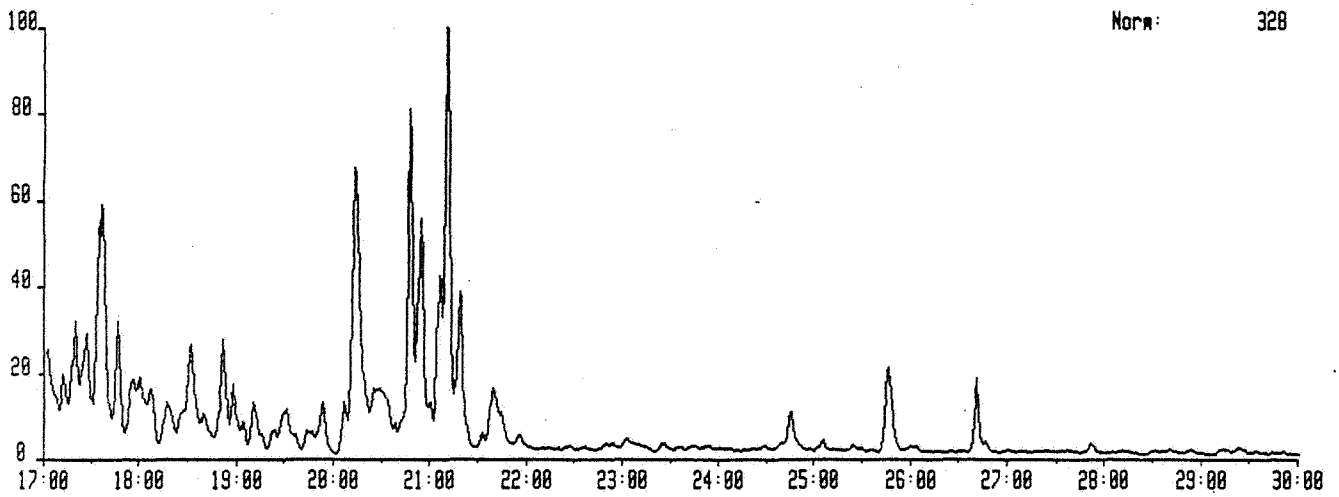
DIBENZOTHIOPHENE AND ALKYL DIBENZOTHIOPHENE SERIES

m/z 184,198,212

1607079A 16-NOV-00 Sir:Voltage 12-250 Acnt:SAGA Sys:AROMQUAD
Sample 1 Injection 1 Group 1 Mass 184.0344
Text:WELL 6507/11-4 2576M



1607079A 16-NOV-00 Sir:Voltage 12-250 Acnt:SAGA Sys:AROMQUAD
Sample 1 Injection 1 Group 1 Mass 198.0501
Text:WELL 6507/11-4 2576M



1607079A 16-NOV-00 Sir:Voltage 12-250 Acnt:SAGA Sys:AROMQUAD
Sample 1 Injection 1 Group 1 Mass 212.1560
Text:WELL 6507/11-4 2576M

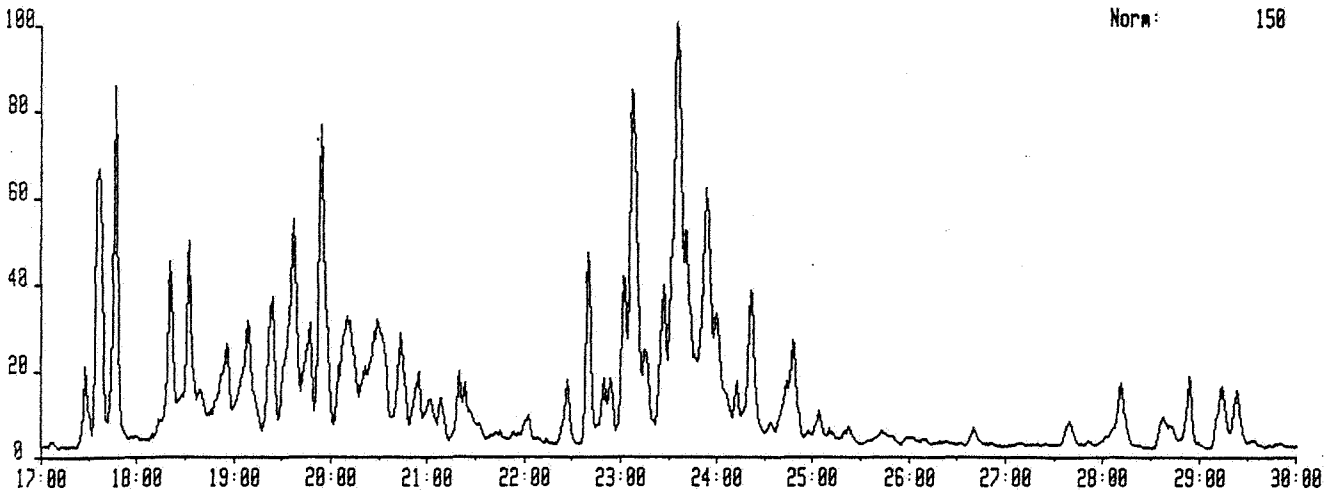


FIGURE 14f

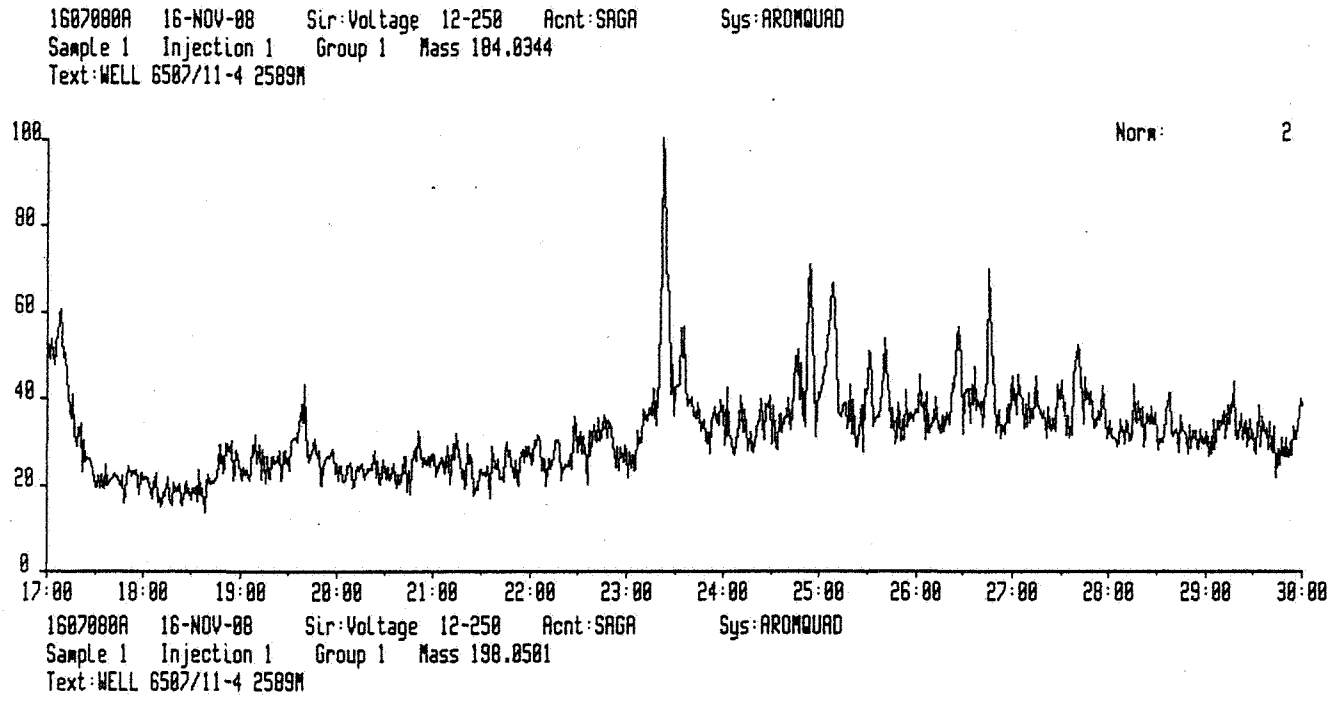
MASS FRAGMENTOGRAMS

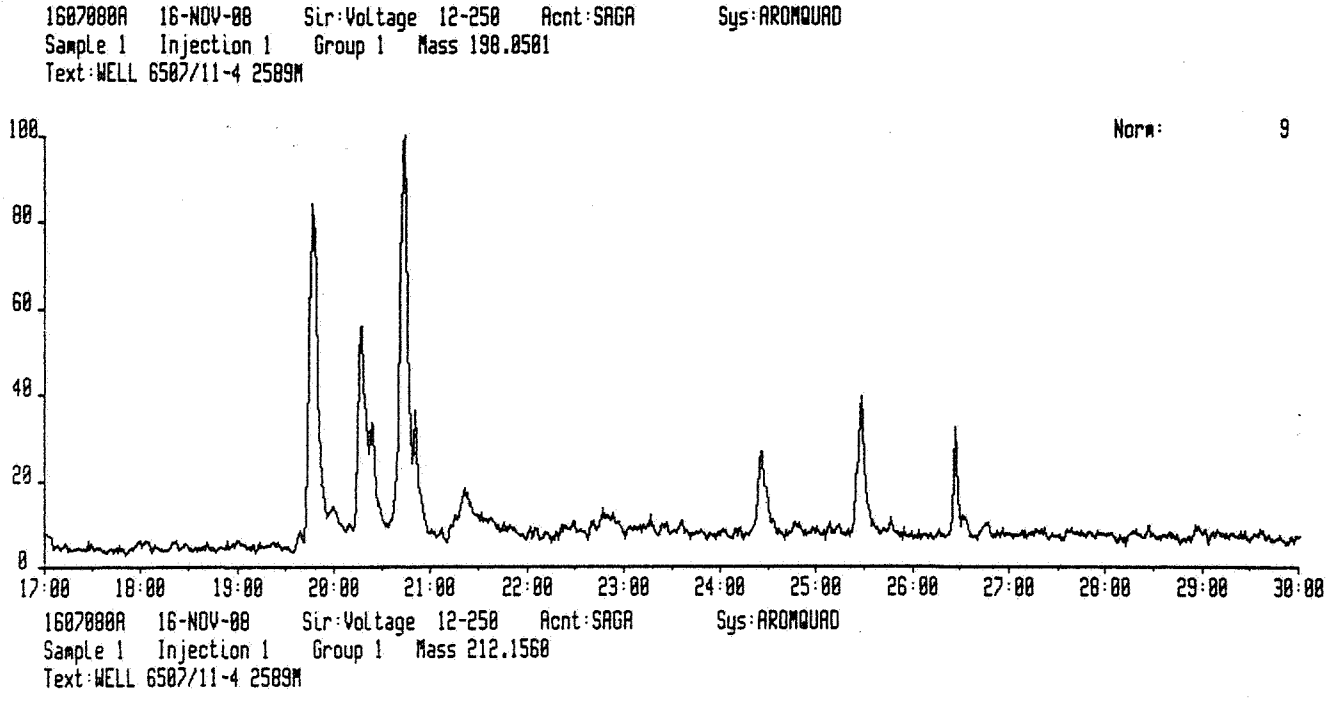
WELL 6507/11-4

C_{15+} AROMATIC HYDROCARBONS

DIBENZOTHIOPHENE AND ALKYL DIBENZOTHIOPHENE SERIES

m/z 184,198,212





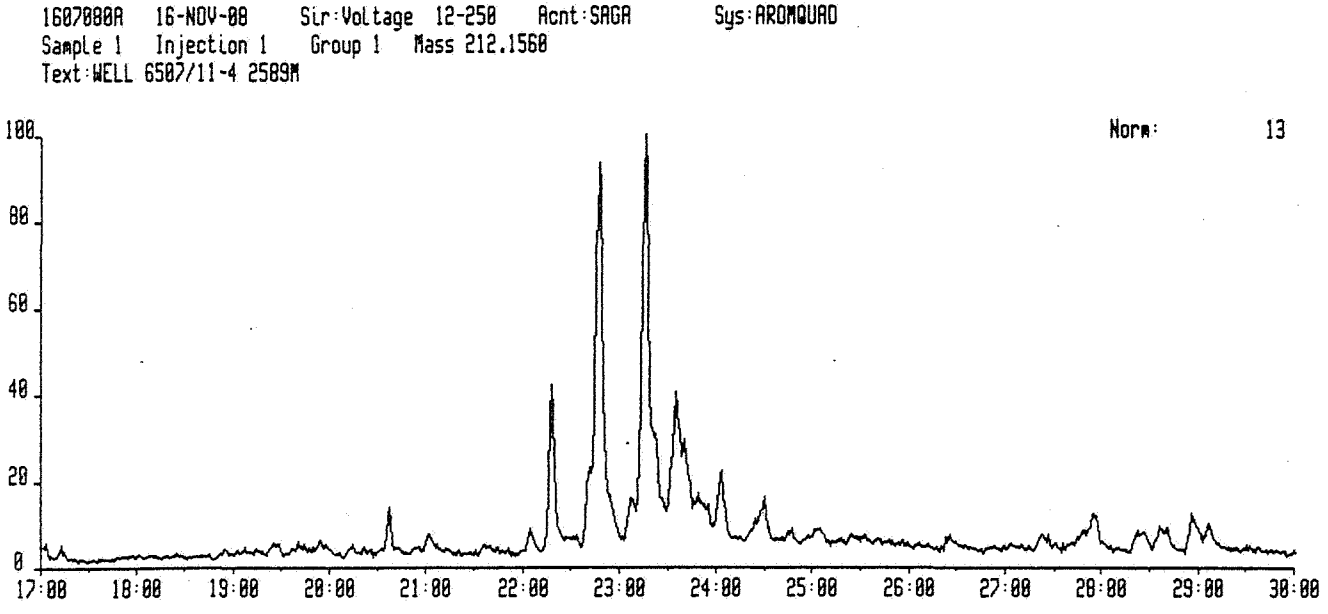


FIGURE 14g

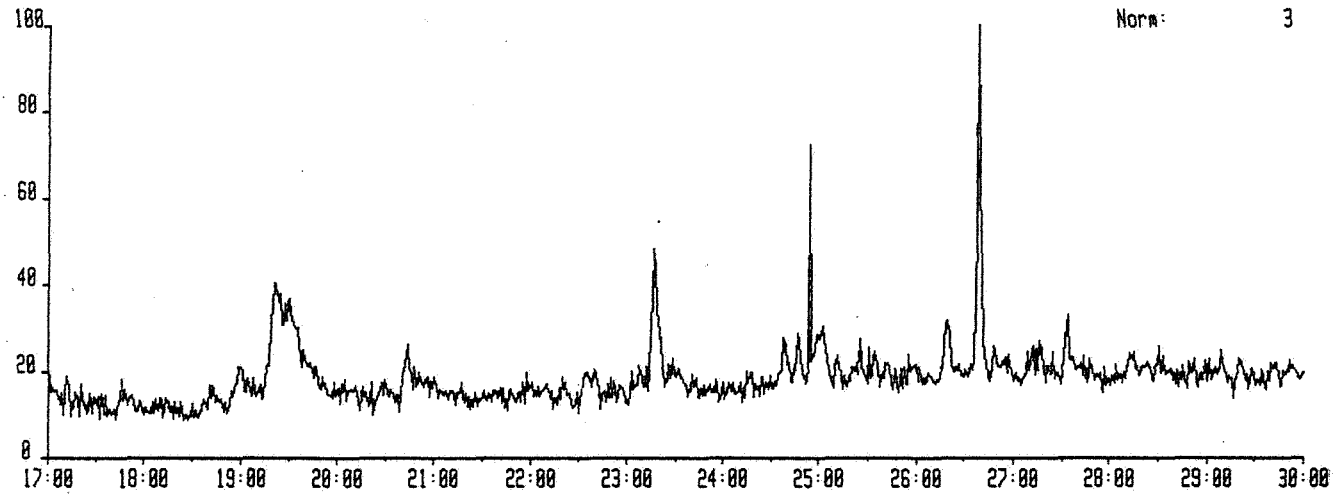
MASS FRAGMENTOGRAMS

WELL 6507/11-4 . C_{15+} AROMATIC HYDROCARBONS

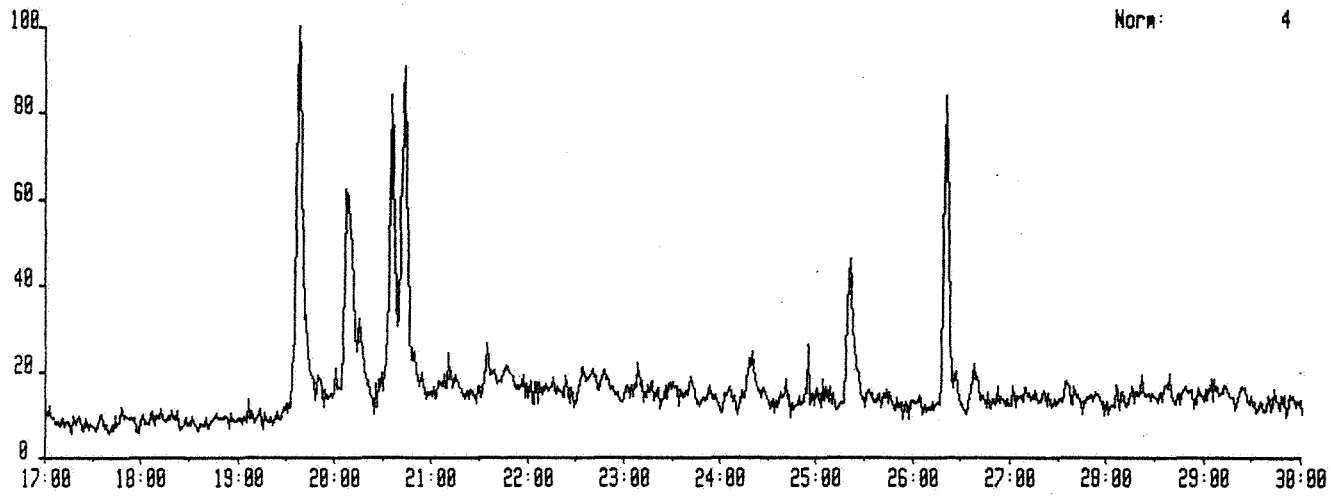
DIBENZOTHIOPHENE AND ALKYL DIBENZOTHIOPHENE SERIES

m/z 184,198,212

1607081A 16-NOV-08 Sir:Voltage 12-250 Acnt:SAGA Sys:AROMQUAD
Sample 1 Injection 1 Group 1 Mass 184.0344
Text:WELL 6507/11-4 2612.5M



1607081A 16-NOV-08 Sir:Voltage 12-250 Acnt:SAGA Sys:AROMQUAD
Sample 1 Injection 1 Group 1 Mass 198.0581
Text:WELL 6507/11-4 2612.5M



1607081A 16-NOV-08 Sir:Voltage 12-250 Acnt:SAGA Sys:AROMQUAD
Sample 1 Injection 1 Group 1 Mass 212.1560
Text:WELL 6507/11-4 2612.5M

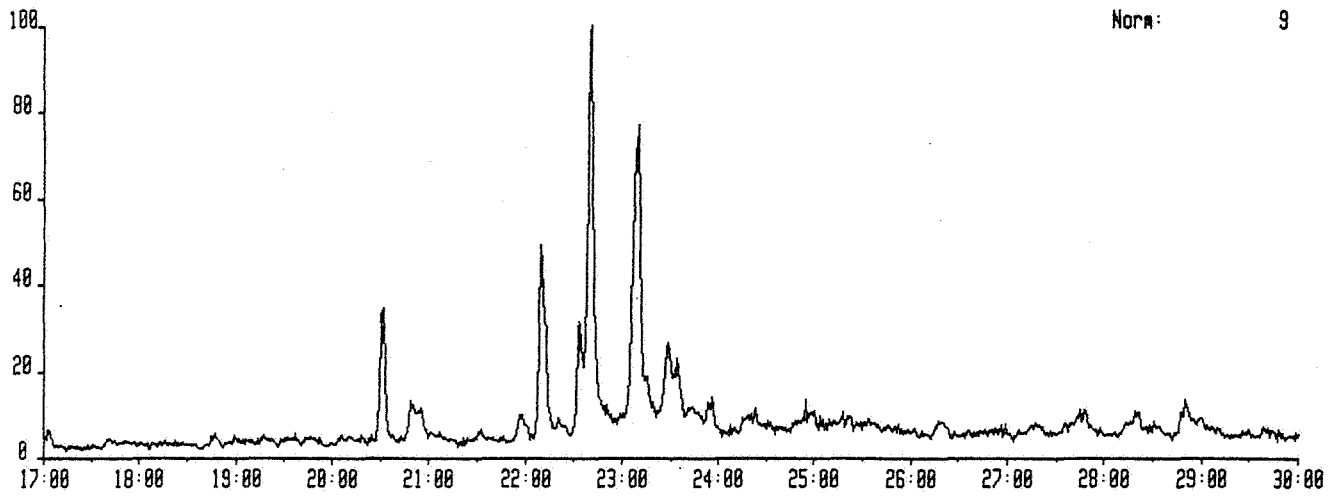


FIGURE 14h

MASS FRAGMENTOGRAMS

GEOCHEM

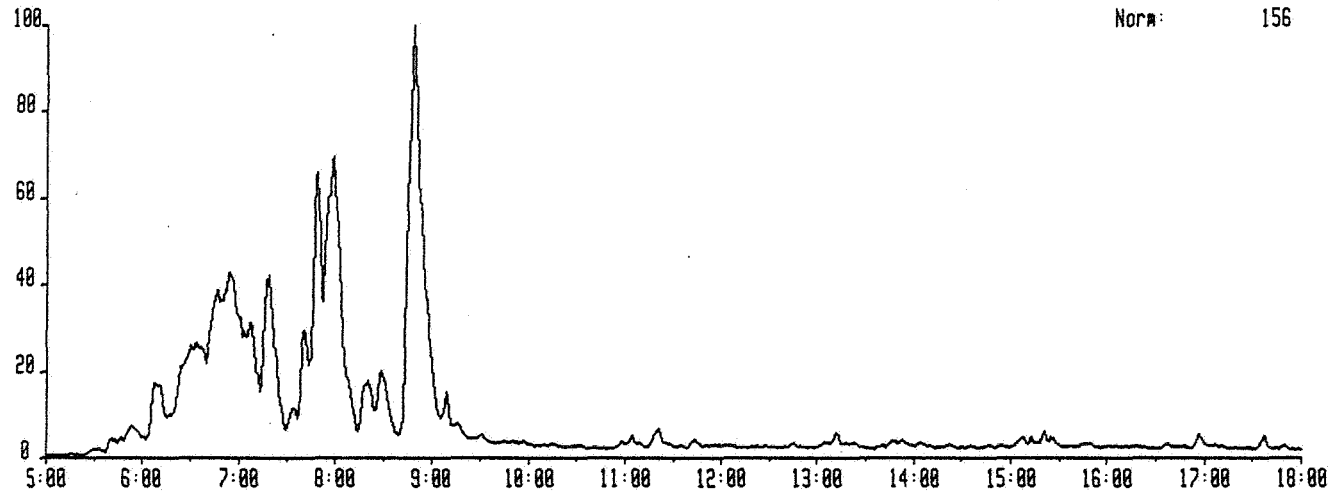
WELL 6507/11-4

C_{15+} AROMATIC HYDROCARBONS

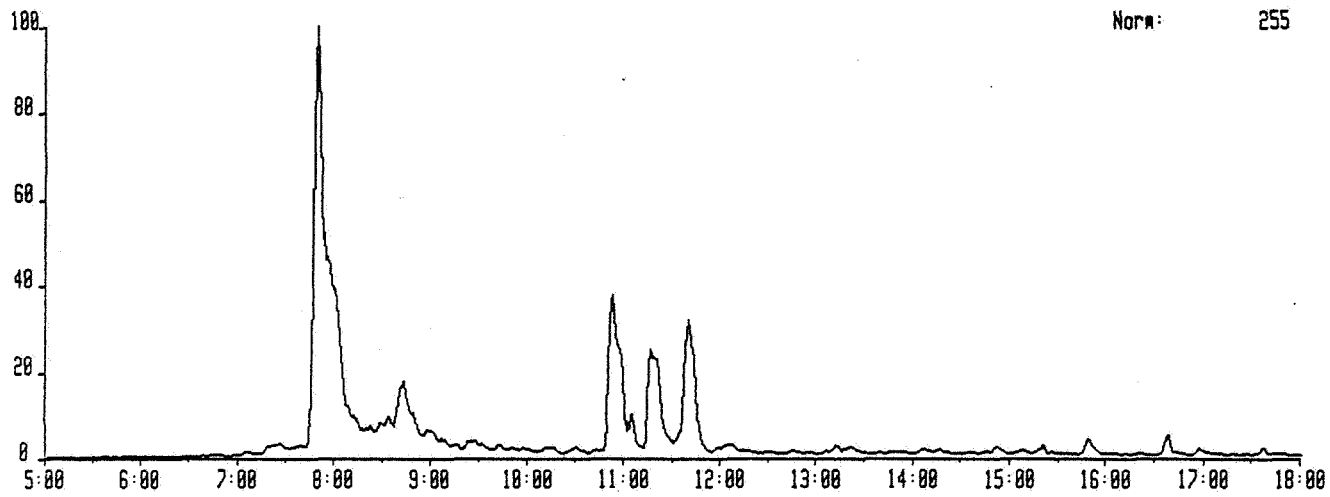
DIBENZOTHIOPHENE AND ALKYL DIBENZOTHIOPHENE SERIES

m/z 184,198,212

1607031A 12-NOV-08 Sir:Voltage 12-250 Acnt:SAGA Sys:AROMQUAD
Sample 1 Injection 1 Group 1 Mass 184.0344
Text:WELL 6507/11-4 2654M



1607031A 12-NOV-08 Sir:Voltage 12-250 Acnt:SAGA Sys:AROMQUAD
Sample 1 Injection 1 Group 1 Mass 198.0501
Text:WELL 6507/11-4 2654M



1607031A 12-NOV-08 Sir:Voltage 12-250 Acnt:SAGA Sys:AROMQUAD
Sample 1 Injection 1 Group 1 Mass 212.1560
Text:WELL 6507/11-4 2654M

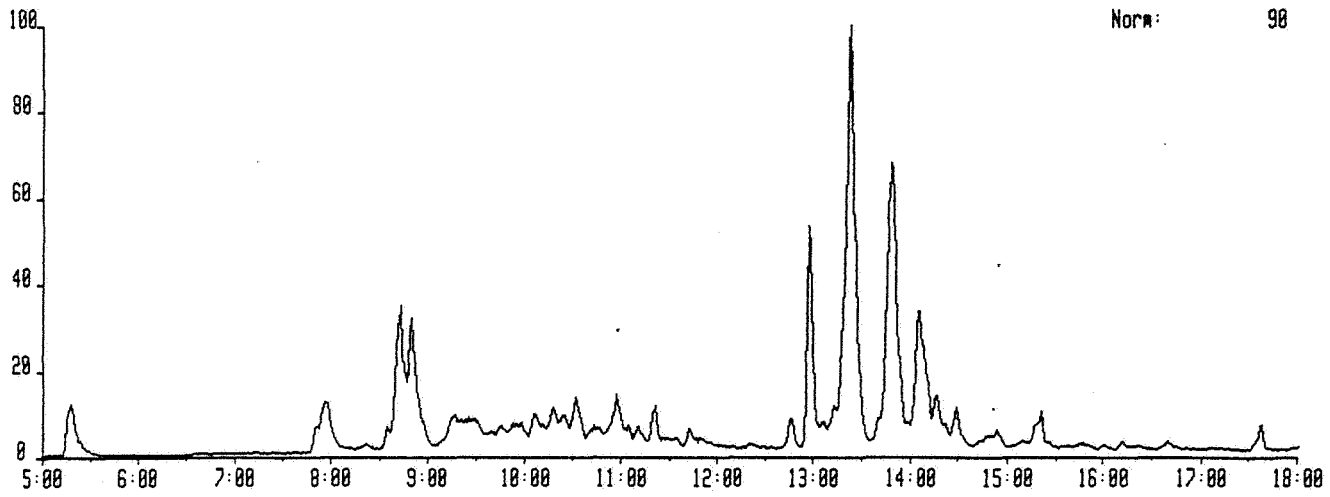


FIGURE 14i

MASS FRAGMENTOGRAMS

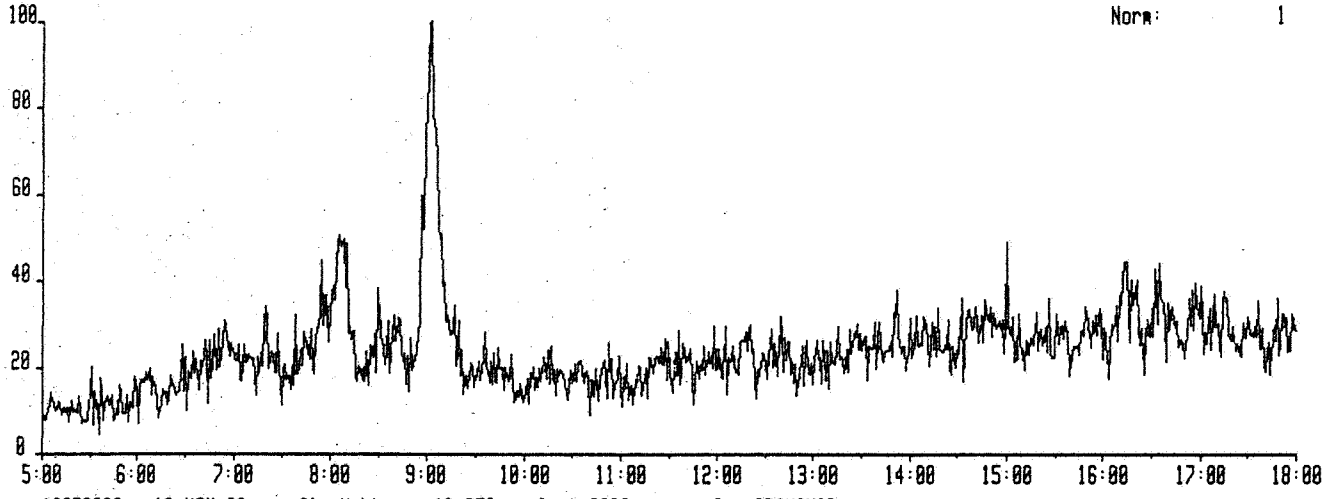
WELL 6507/11-4

C_{15+} AROMATIC HYDROCARBONS

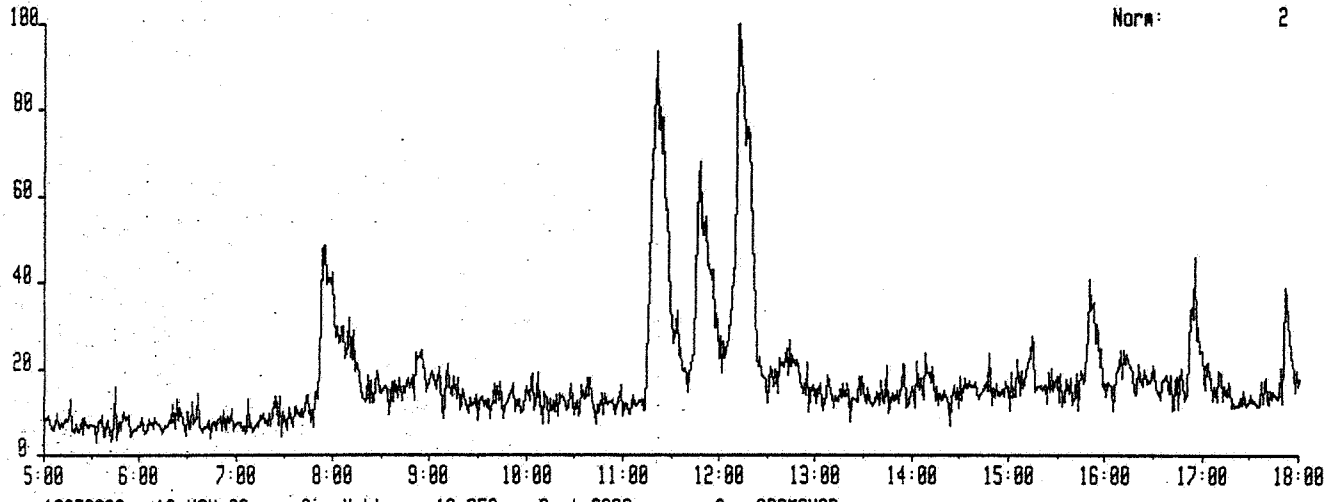
DIBENZOTHIOPHENE AND ALKYL DIBENZOTHIOPHENE SERIES

m/z 184,198,212

1607033A 12-NOV-08 Sir:Voltage 12-250 Acnt:SAGA Sys:AROMQUAD
Sample 1 Injection 1 Group 1 Mass 184.0344
Text:WELL 6507/11-4 2672M



1607033A 12-NOV-08 Sir:Voltage 12-250 Acnt:SAGA Sys:AROMQUAD
Sample 1 Injection 1 Group 1 Mass 198.0501
Text:WELL 6507/11-4 2672M



1607033A 12-NOV-08 Sir:Voltage 12-250 Acnt:SAGA Sys:AROMQUAD
Sample 1 Injection 1 Group 1 Mass 212.1560
Text:WELL 6507/11-4 2672M

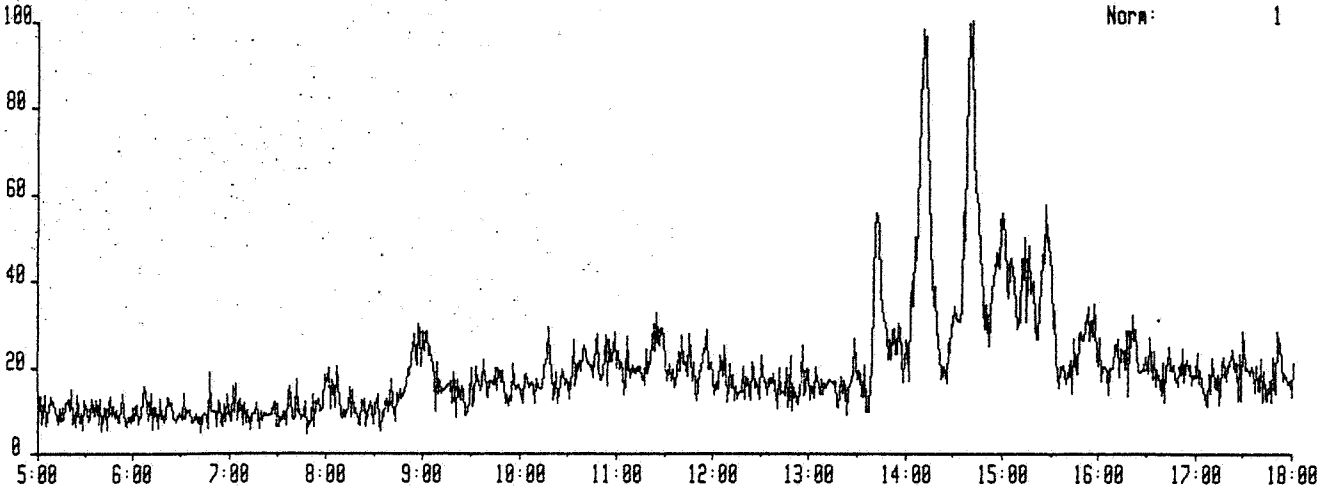


FIGURE 14j

MASS FRAGMENTOGRAMS

WELL 6507/11-4

C_{15+} AROMATIC HYDROCARBONS

DIBENZOTHIOPHENE AND ALKYL DIBENZOTHIOPHENE SERIES

m/z 184,198,212

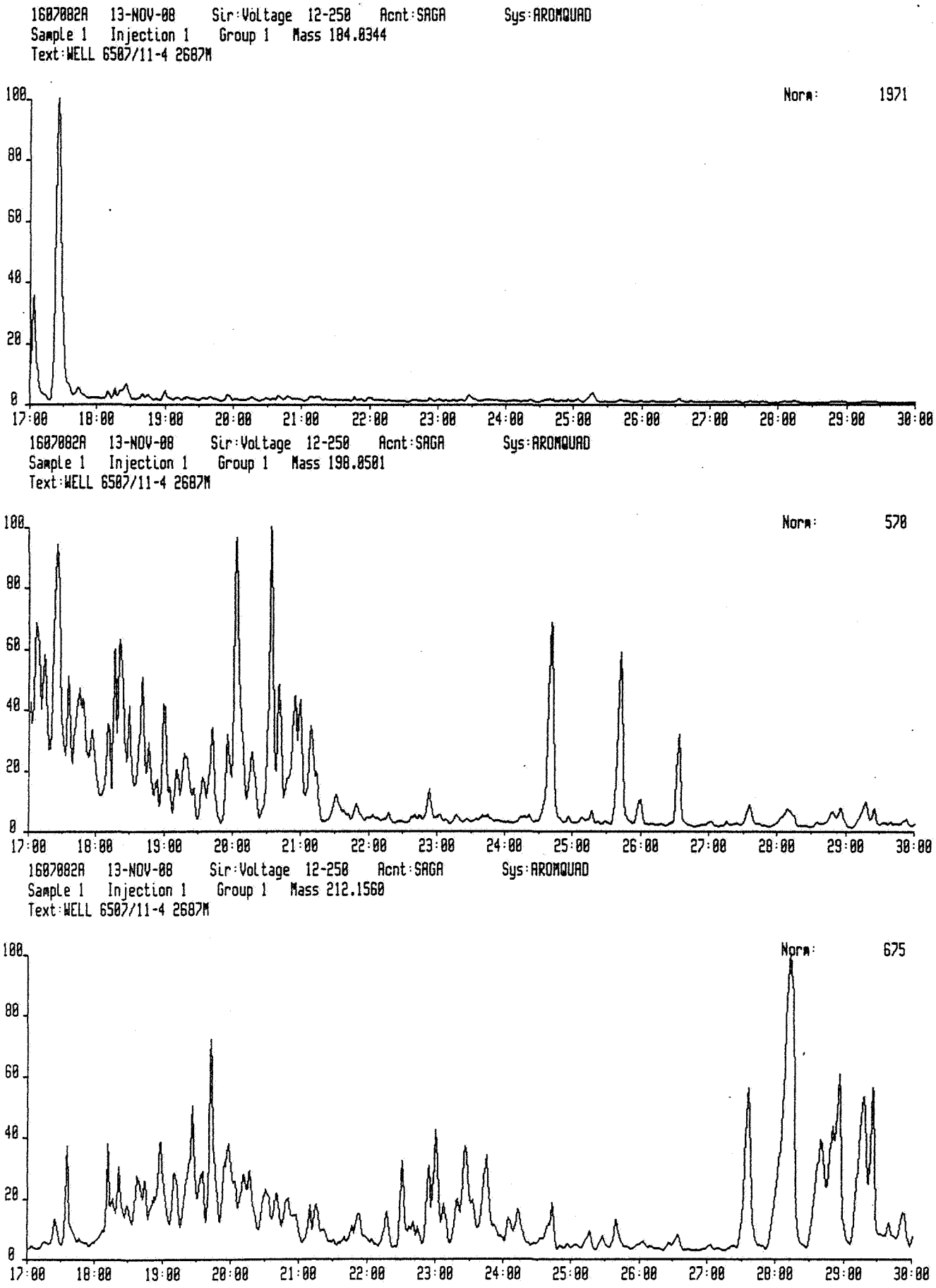


FIGURE 14k

MASS FRAGMENTOGRAMS

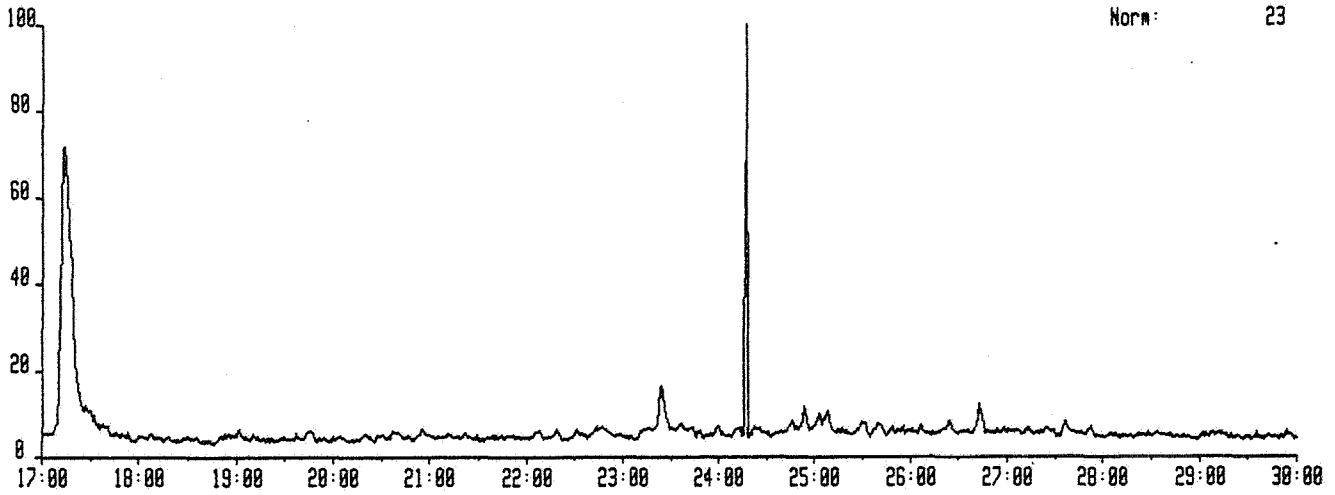
WELL 6507/11-4

C_{15+} AROMATIC HYDROCARBONS

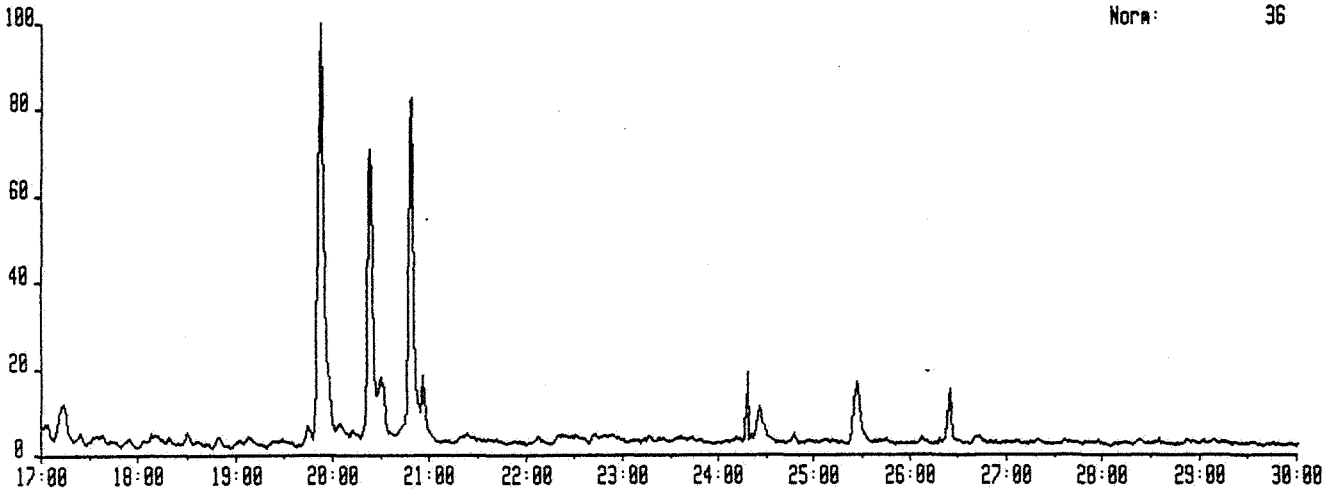
DIBENZOTHIOPHENE AND ALKYL DIBENZOTHIOPHENE SERIES

m/z 184,198,212

1607086A 16-NOV-08 Sir:Voltage 12-250 Acnt:SAGA Sys:AROMQUAD
Sample 1 Injection 1 Group 1 Mass 184.0344
Text:WELL 6507/11-4 2881.5M



1607086A 16-NOV-08 Sir:Voltage 12-250 Acnt:SAGA Sys:AROMQUAD
Sample 1 Injection 1 Group 1 Mass 198.0501
Text:WELL 6507/11-4 2881.5M



1607086A 16-NOV-08 Sir:Voltage 12-250 Acnt:SAGA Sys:AROMQUAD
Sample 1 Injection 1 Group 1 Mass 212.1560
Text:WELL 6507/11-4 2881.5M

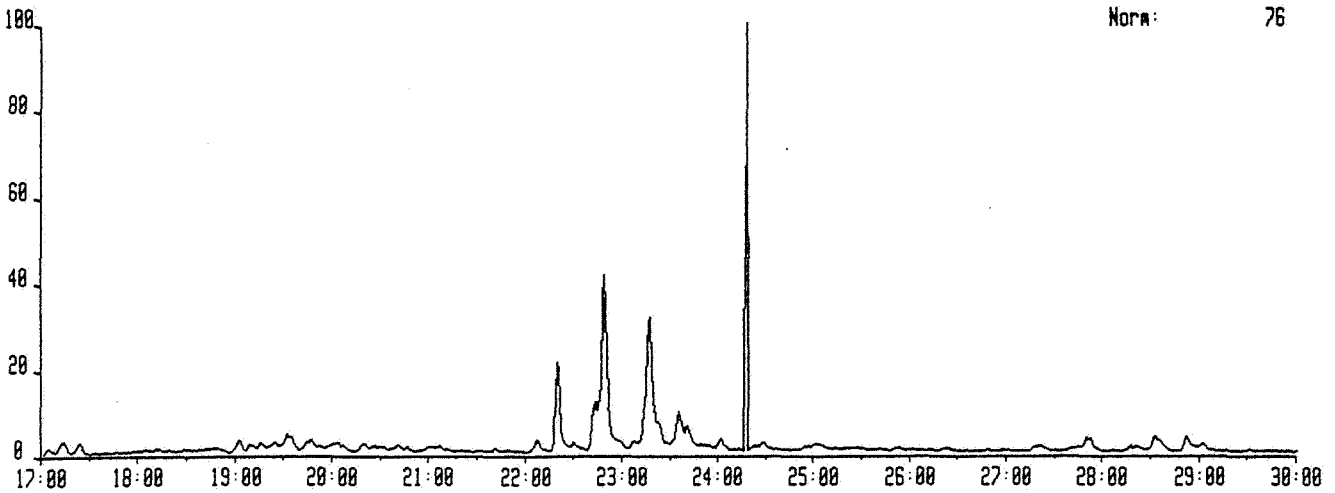


FIGURE 141

MASS FRAGMENTOGRAMS

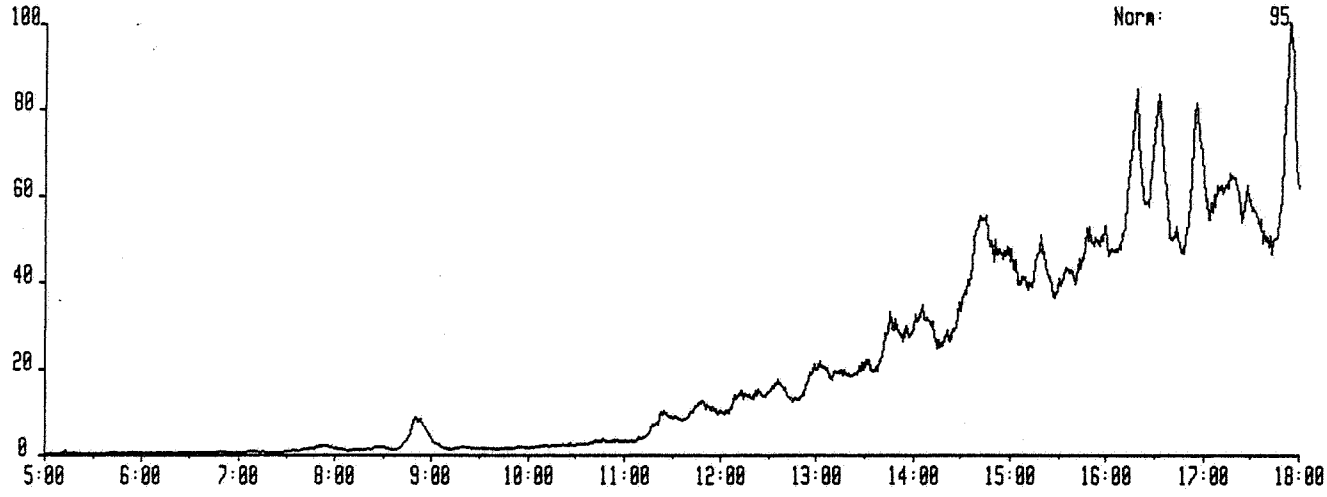
WELL 6507/11-4

C_{15+} AROMATIC HYDROCARBONS

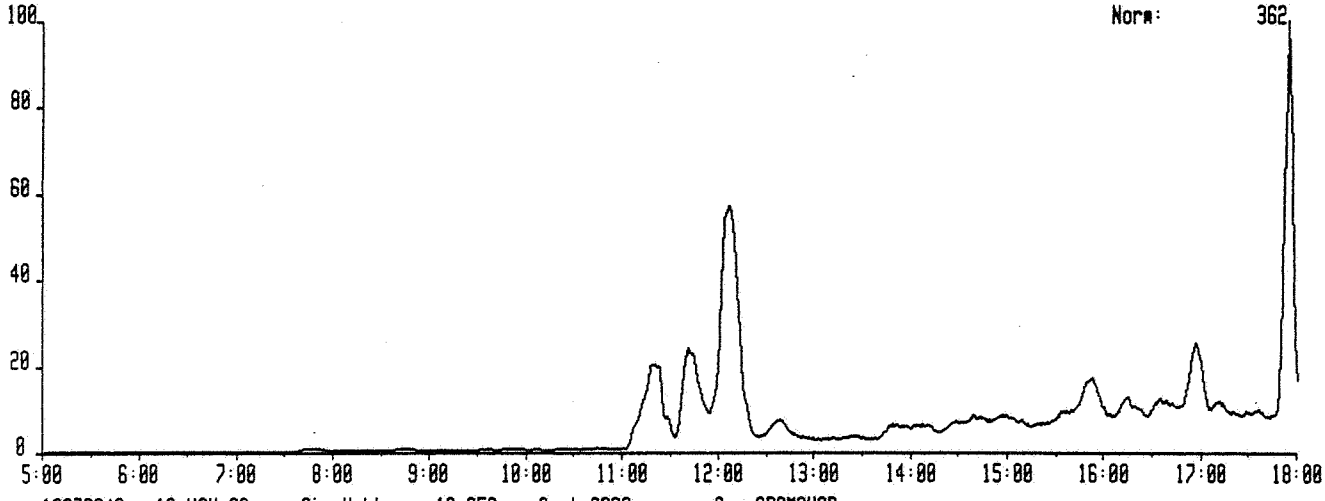
DIBENZOTHIOPHENE AND ALKYL DIBENZOTHIOPHENE SERIES

m/z 184,198,212

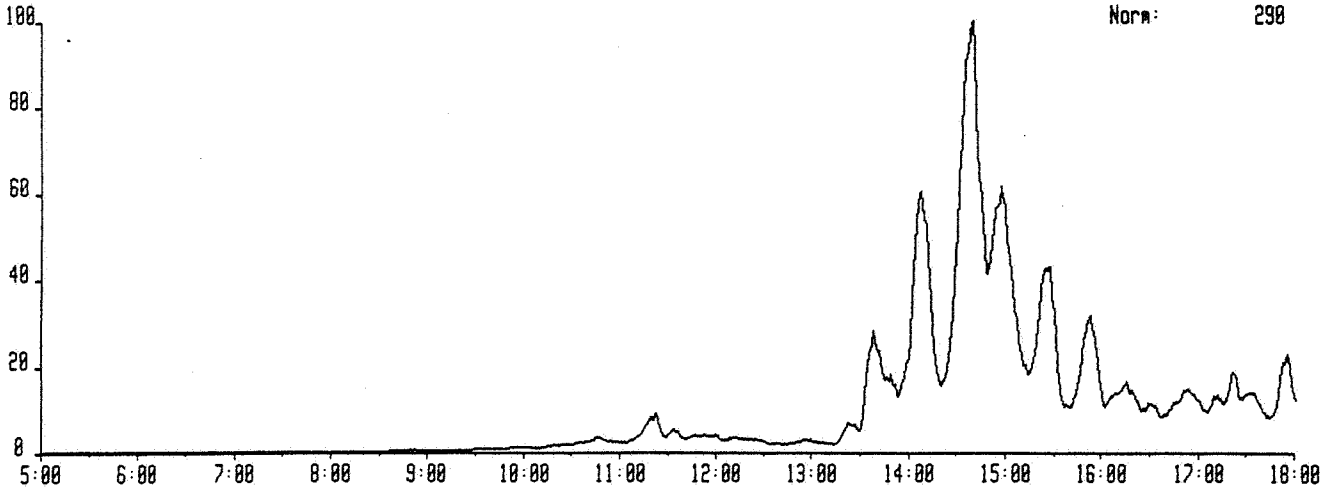
1607064A 12-NOV-08 Sir:Voltage 12-250 Acnt:SAGA Sys:AROMQUAD
Sample 1 Injection 1 Group 1 Mass 184.0344
Text:WELL 6507/11-4 2951M



1607064A 12-NOV-08 Sir:Voltage 12-250 Acnt:SAGA Sys:AROMQUAD
Sample 1 Injection 1 Group 1 Mass 198.0501
Text:WELL 6507/11-4 2951M



1607064A 12-NOV-08 Sir:Voltage 12-250 Acnt:SAGA Sys:AROMQUAD
Sample 1 Injection 1 Group 1 Mass 212.1560
Text:WELL 6507/11-4 2951M



BRIEF DESCRIPTION OF THE ANALYSES PERFORMED BY GEOCHEM

"Screen Analyses" are described in sections A, C and D, "Sample Preparation" in section B, "Follow-up Analyses" in sections E through K and "Correlation Studies" in section L. The analyses can be run on either core or cuttings material with the proviso that samples must be canned for the C_1-C_7 analysis and should be canned (or at least wet) for the C_4-C_7 analysis. The other analyses can be run on both canned and bagged samples.

A) C_1-C_7 LIGHT HYDROCARBON ANALYSIS

The abundance and composition of the C_1-C_7 hydrocarbons in sediments reflects their source richness, maturity and the character of the hydrocarbons they can yield. Most importantly, it is extremely sensitive to the presence of migrated hydrocarbons and is an excellent method for their detection. As it provides the information on most of the critical parameters and is also economical, this analysis is excellent for screening samples to decide which of them merit further analysis.

During the time which elapses between the collection of the sample at the wellsite and its analysis in the laboratory, a fraction of the total gas passes from the rock to the air space at the top of the can. For this reason, both the air space and the cuttings are analysed.

The analysis involves the gas chromatographic separation of the individual C_1-C_4 gaseous hydrocarbons (methane, ethane, propane, isobutane and normal butane) and a partial resolution of the C_5-C_7 gasoline-range hydrocarbons (for their complete resolution see Section E). The ppm abundance of the five gases and of the total C_5-C_7 hydrocarbons are calculated from their electronically integrated peak areas (not from peak height) by comparison with a standard.

In the report, the following data are tabulated: the abundance and composition of the air space gas, of the cuttings gas and of the combined air space and cuttings gases. The combined results are also presented graphically.

B) SAMPLE WASHING AND HAND PICKING

All of the analyses described in subsequent sections are run on washed and hand picked samples.

Cuttings are washed to remove the drilling mud, care being taken not to remove soft clays and fine sand during the washing procedure. Using the C_1-C_7 hydrocarbon data profile of the well, or the organic carbon profile (if this analysis is used for screening), electric logs (if supplied) and the appearance of the cuttings under the binocular microscope, samples are selected to represent the lithological and geochemical zones penetrated by the well. These samples are then carefully hand picked and the lithology of the uncaved material is described. It is these samples which are submitted for further analysis.

Sample material remaining after analysis is retained for six months. Unless instructions are received to the contrary, Geochem Laboratories may then destroy the samples.

Our reports incorporate a gross lithological description of all the samples which have been analysed and litho percentage logs. As screen analyses are recommended at narrow intervals, a complete lithological profile is obtained.

C) ORGANIC CARBON ANALYSIS

The organic carbon content of a rock is a measure of its total organic richness. Combined with the visual kerogen, C_1-C_7, C_4-C_7, pyrolysis and C_{15+} analyses, the organic carbon content is used to evaluate the potential (not necessarily actual) hydrocarbon source richness of the sediment. This analysis is an integral part of a total evaluation and it can also be used as an economical screen analysis for dry samples (when the C_1-C_7 analysis cannot be used).

Hand picked samples are dried, crushed and then acidised to remove the inorganic calcium and magnesium carbonates. The actual analysis involves combustion in a Leco carbon analyser. Blanks, standards and duplicates are run routinely for purposes of quality control at no extra cost to the client.

The data are tabulated and presented diagramatically in our reports in a manner which facilitates comparison with the gross lithology (see Section B) of the samples.

D) MINI-PYROLYSIS

An ideal screen analysis which provides a definitive measure of potential source richness upon those samples whose organic carbon contents suggest fair or good source potential. This is described in detail in section K.

E) DETAILED C_4-C_7 HYDROCARBON ANALYSIS

The abundance and composition of the C_4-C_7 gasoline-range hydrocarbons in sediments reflects their source quality, level of thermal maturation and organic facies. In addition, the data also reveal the present of migrated hydrocarbons and can be used for crude oil-parent source rock correlation studies.

This powerful analysis, performed upon hand picked lithologies, is employed as a follow-up to confirm the potential of samples which have been selected using the initial screen analysis. It is used in conjunction with the organic carbon, visual kerogen and C_{15+} analyses.

The individual normal paraffins, isoparaffins, naphthenes and aromatics with between four and seven carbon atoms in the molecule (but also including toluene) are resolved by capillary gas chromatography and their peak areas electronically integrated.

Normalised compositions, selected ratios and the ppm abundance of the total gasoline-range fraction are tabulated in the report and also presented graphically.

F) KEROGEN TYPE AND MATURATION

Kerogen is the insoluble organic matter in rocks. Visual examination of the kerogen gives a direct measure of thermal maturity and of the composition of the organic matter (organic facies) and indicates the source quality of the sediment - which is confirmed using the organic carbon, light hydrocarbon, pyrolysis and C_{15+} analyses.

The type of hydrocarbon (oil or gas) generated by a source rock is a function of the types and level of thermal maturation of the organic matter which are present. Both of these parameters are measured directly by this method.

Kerogen is separated from the inorganic rock matrix by acid digestion and flotation methods which avoid oxidation of the organic matter. It is then mounted on a glass slide and examined at high and low magnifications with a Leitz microscope. Chemical methods measure the total kerogen population but, with this technique, individual particles can be selected for examination and spurious material identified. This is particularly valuable in reworked, contaminated and turbodrilled sediments.

The following data are generated: the types of the organic matter present and their relative abundances, an estimate of the proportion of reworked material, preservation state, the thermal maturity of the non-reworked organic matter using the spore colouration technique.

Our maturation scale has been developed to digitise small but recognisable changes in organic matter colouration resulting from increasing maturity and to place particular emphasis upon the immature to mature transition. In the absence of a universal colouration scale, the most significant points on our scale have been calibrated against equivalent vitrinite reflectance values. The following maturation stages are recognised at the low end of the scale:-

a) immature; thermal index less than 2- (0.45% Ro)
b) marginally mature; indices between 2- and 2.
Minor hydrocarbon generation from amorphous and herbaceous (± algal) organic matter
c) mature; indices between 2 (0.53% Ro) and 2 to 2+ (0.72% Ro), significant generation from amorphous, algal and herbaceous organic matter but wood only marginally mature
d) oil window; indices of 2 to 2+ (0.72% Ro) through to 3 (1.2% Ro). Peak hydrocarbon generation.

The condensate zone starts at a thermal index of 3 whilst indices of 3+ (2.0% Ro) and higher indicate the eometamorphic dry gas stage.

A total of fourteen types of organic matter are sought based upon the major categories of algal, amorphous, herbaceous (spore, pollen, cuticle), wood, inertinite and resin. This detail is essential for a proper understanding of hydrocarbon source potential as the different sub-groups within each category have different properties.

Upon completion of the study, the kerogen slides are sent to the client.

G) VITRINITE REFLECTANCE

Vitrinite reflectance is an alternative/confirmatory method for evaluating thermal maturation which is used in conjection with the visual kerogen analysis. The reflectivity of vitrinite macerals increases in response to thermal alteration and is used to define maturation levels and, by projection, to predict maturity at depth or the thicknesses of section removed by erosion.

Measurements are made upon kerogen separations in conjunction with polished whole rock samples. In general, this analysis is performed upon the same samples as the visual kerogen analysis, thus facilitating a direct comparison of the two sets of results.

If possible, forty to fifty measurements are taken per sample - unless the sediments are organically lean, vitrinite is sparse or only a single uniform population is present. The data are plotted in a histogram which

distinguishes the indigenous vitrinite from possible reworked or caved material. Averages are calculated for each population. Comments upon exinite fluorescence and upon the character of the phytoclasts are noted on the histograms. The reports contain the tabulated data, histograms and the reflectivities plotted against depth.

The vitrinite and visual kerogen techniques provide mutually complementary information upon maturity, organic matter type and diagenesis.

H) C_{15+} EXTRACTION, DEASPHALTENING AND CHROMATOGRAPHIC SEPARATION

Sections "A" and "E" dealt with analyses covering the light end of the hydrocarbon spectrum. This section is concerned with the solvent extractable oranic material in the rock with more than fourteen carbon atoms in the molecule (i.e. the heavy end). The amount and composition of this extract indicates source richness and type, the level of thermal maturation and the possible presence of migrated hydrocarbons.

These results are integrated with those derived from the pyrolysis, visual kerogen, organic carbon and light hydrocarbon analyses.

The techniques involved in this analysis employ pure solvents and have been designed to give reproducible results. Hand picked samples are ground and then solvent extracted in a soxhlet apparatus, or by blending, with dichloromethane (the solvent system can be adapted to client's specifications). After asphaltene precipitation, the total extract is separated by column chromatography or high pressure liquid chromatography into the following fractions: paraffin-naphthene hydrocarbons, aromatic hydrocarbons, eluted NSO's (nitrogen-, sulphur-, and oxygen- containing non-hydrocarbons) and non-eluted NSO's. Note that the non-hydrocarbons are split into three fractions and not reported as a gross value. These fractions can be submitted for further analyses (carbon isotopes, gas chromatography, mass spectroscopy) including correlation studies.

For convenience and thoroughness, the data are reported in three formats: the weights of the fractions, ppm abundances and normalised percentage compositions. The data are also presented diagramatically.

J) GC ANALYSIS OF C_{15+} PARAFFIN-NAPHTHENE HYDROCARBONS

The gas chromatographic configurations of the heavy C_{15+} paraffin-naphthene hydrocarbons reflect source type, the degree of thermal maturation and the presence and character of migrated hydrocarbons or contamination.

Not only is this analysis an integral part of any source rocks study but it also provides a fingerprint for correlation purposes and helps to define the geochemical/palynological environmental character of the source rocks from which crude oils were derived.

The paraffin-naphthene hydrocarbons obtained by column chromatography are separated by high resolution capillary chromatography. Excellent resolution of the individual normal paraffins, isoprenoids and significant individual isoparaffins and naphthenes is achieved. Runs are normally terminated at nC_{35}. A powerful in-house microprocessor system is being introduced to correct for the change in response factor with chain length.

The normal paraffin carbon preference indices (C.P.I.) indicate if odd (values in excess of 1) or even (values less than 1) normal paraffins are dominant.

Strong odd preferences (± strong pristane peaks) are characteristic of immature land plant organic matter whilst even preferences (± strong phytane peaks) suggest a reducing environment of deposition. With increasing maturity, values approach 1.0 and oils are typically close to 1.0. The indices are calculated using the following formulae:

$$C.P.I_A = \frac{\left(\frac{C_{21} + C_{23} + C_{25} + C_{27}}{C_{20} + C_{22} + C_{24} + C_{26}} + \frac{C_{21} + C_{23} + C_{25} + C_{27}}{C_{22} + C_{24} + C_{26} + C_{28}}\right)}{2}$$

$$C.P.I_B = \frac{\left(\frac{C_{25} + C_{27} + C_{29} + C_{31}}{C_{24} + C_{26} + C_{28} + C_{30}} + \frac{C_{25} + C_{27} + C_{29} + C_{31}}{C_{26} + C_{28} + C_{30} + C_{32}}\right)}{2}$$

Chromatograms are reproduced in the report for use as visual fingerprints and in addition, the following data are tabulated: normalised normal paraffin distributions; proportions of paraffins, isoprenoids and naphthenes in the total paraffin-naphthene fraction; $C.P.I_A$ and $C.P.I_B$; pristane to phytane ratio; pristane to nC_{17} ratio.

K) PYROLYSIS

The process of thermal maturation can be simulated in the laboratory by pyrolysis, which involves heating the sample under specified conditions and measuring the oil-like material which is freed/generated from the rock. With this analysis, the potential richness of immature sediments can be determined and, by coupling the pyrolysis unit to a gas chromatograph, the liberated material can be characterised. These results are correlated with those obtained from the organic carbon, kerogen and C_{15+} analyses.

Small amounts of powdered sample are heated in helium to release the thermal bitumen (up to 340°C) and pyrolysate (340-550°C). The thermal bitumen correlates with the solvent extractable material (see above) whilst the pyrolysate fraction does not exist in a "free" state but is generated from the kerogen, thus simulating maturation in the subsurface. Abundances (weight ppm of rock) are measured with a flame ionisation detector against a standard. Thermal bitumen includes source indigenous, contaminant and migrated hydrocarbons but the pyrolysate abundance is a measure of ultimate source richness. The capillary gas chromatogram of the pyrolysate is used to evaluate the character of the parent organic matter and whether it is oil or gas prone. Peak temperature(s) of pyrolysate evolution is recorded. Carbon dioxide can be measured if requested but is normally ignored as the separation of the organic and inorganic species has been found to be artificial and unreliable.

Pyrolysate yields provide a definitive measure of potential source richness which avoids the ambiguities of the organic carbon data and the problem of contamination. This analysis is also used to evaluate the quality and character of the organic matter and the degree to which it has realised its ultimate hydrocarbon potential. Geochem does not employ the pyrolysis technique to evaluate maturation, preferring the kerogen and vitrinite reflectance analyses which avoid the problem of reworking and hence, are more reliable.

Capillary chromatograms produced for the pyrolysate hydrocarbons range from C_1 (methane) out towards C_{35} but exhibit considerable variations. They are used to define whether a source rock will yield oil, condensate or gas. With this new technique, it is now possible to complete the evaluation of a source rock.

The data are tabulated and presented graphically. MINI-PYROLYSIS includes ppm thermal bitumen and ppm pyrolysate. PYROLYSIS also provides the above together with the temperature of peak pyrolysate evolution. The capillary chromatograms of the pyrolysate obtained by PYROLYSIS-GC are reproduced in the report. The Mini-Pyrolysis analysis is recommended as a screening technique.

L) CORRELATION STUDY ANALYSES

Oil to oil and oil to parent source rock correlation studies require high resolution analytical techniques. This requirement is satisfied by some of the analyses discussed above but others have been selected specifically for correlation work. Many of these analyses also provide information upon the character of the environment of deposition of the parent source rocks.

- detailed C_4-C_7 hydrocarbon (gasoline range) analysis. See Section E. Although these hydrocarbons can be affected by migrational/alteration processes, they commonly provide a very useful correlation parameter.

- capillary gas chromatography of the C_{15+} paraffin-naphthenes. See section J. The branched±normal paraffin distributions are used to "fingerprint" the samples.

- capillary chromatograms of whole oils and of the C_{4+} fraction of source rocks.

- capillary gas chromatography of C_{15+} aromatic hydrocarbons. Separate chromatograms of the hydrocarbons and of the sulphur-bearing species are reproduced.

- high pressure liquid chromatograms.

- mass spectrometric carbon isotope analyses of crude oil and rock extract fractions and of kerogen separations. A powerful tool for comparing hydrocarbons and correlating hydrocarbons to organic matter. With this technique the problem of source rock contamination can be avoided. The data are recorded on x-y or Galimov plots.

- mass fragmentograms (mass chromatograms) of fragment ions characteristic of selected hydrocarbon groups such as the steranes and terpanes. The fragmentograms provide a convenient and simple means of presenting detailed mass spectrometric data and are used as a sophisticated fingerprinting technique. This provides the ultimate resolution for correlating hydrocarbons and facilitates the examination of hydrocarbon classes.

- vanadium and nickel contents.

Suites of (rather than single) analyses are employed in correlation studies, the actual selection depending upon the complexity of the problem. See also section N.

M) ANALYSES FOR SPECIAL CASES

M-1) ELEMENTAL KEROGEN ANALYSIS

This analysis evaluates source quality, whether the sediments are oil or gas prone, the character of the organic matter and its level of thermal maturation. It is the chemical equivalent of the visual kerogen analysis. The pyrolysis analysis is generally preferred to this technique, both methods providing similar information.

M-2) SULPHUR ANALYSIS

The abundance of sulphur in source rocks and crude oils.

M-3) CARBONATE CONTENT

The mineral carbonate content of sediments is determined by acid treatment. These data are particularly useful when used in conjunction with organic carbon contents as a screening technique.

M-4) NORMAL PARAFFIN ANALYSIS

Following the removal of the branched paraffins and naphthenes from the total paraffin-naphthene fraction, a chromatogram of the normal paraffins is obtained. The resulting less complicated chromatogram facilitates the examination of normal paraffin distributions.

M-5 SOLID BITUMEN EVALUATION

Residual solid bitumen after crude oil is generated by three prime processes; the action of waters, gas deasphalting, thermal alteration. Thus it provides a means of determining the reservoir history of a crude and of evaluating whether adjacent traps will or will not be prospective for oil. In carbonate sections, where organic matter is sometimes sparse, this technique is also used to evaluate thermal maturation levels.

The analysis involves the determination of the solubility (in CS_2) of the solid bitumen and of the atomic hydrogen to carbon ratio of the insoluble fraction.

N) CRUDE OIL ANALYSIS

N-1) API GRAVITY

This can be performed upon large (hydrometer) and small (SG bottle, pycnometer) samples and even upon stains extracted from sediments (refractive index).

N-2) SULPHUR CONTENTS (ASTM E30-47)

N-3) POUR POINT (ASTM D97-66, IP15/67)

N-4) VISCOSITY (ASTM D445-72, IP71/75)

N-5) FRACTIONAL DISTILLATION

Graph of cumulative distillation yield against temperature. Five percent cuts taken for further analysis. Mass spectrometric studies of these fractions provide a detailed picture of the distribution of paraffins and of the various naphthene and aromatic groups within a crude, which is useful both for correlation and for refinery evaluation purposes.

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