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Keywords

Source rocks, maturity, migrated hydrocarbons.

Abstract

This study has been performed in accordance with the Statoil standard guide for organic geochemistry.

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REPORT

TITLE

ORGANIC GEOCHEMICAL CHARACTERIZATION OF WELL 15/12-9 S

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SUMMARY

Altogether 24 sediment samples, 2 oil samples and 1 gas sample from the Viking Group were subjected to different organic geochemical analyses.

The claystones from the upper part of the Viking Group contain Type II/III kerogen. They have a rich potential for oil and gas. In this well the claystones have just started oil generation (VR ~ 0.5 %Ro).

The "Oxfordian sandstones" gave high extraction yields. The extracts showed mature composition with high hydrocarbon contents. All of them have probably the same source and no significant vertical variations are seen. A mixed marine and terrestrial source, possibly a more mature version of the upper Viking Group claystones in this well is suggested.

A palaeo oil-water contact is suggested between 2907 m RKB and 2921 m RKB.

The oil samples from DST 2 (2810.0 m RKB) and from FMT (2863.5 m RKB) are moderately light with API gravities of 34.0° and 30.7°, respectively. They have low asphaltene contents and have a moderately mature composition. The two oil samples are probably generated from the same source as the sandstone extracts.

The natural gas sample from DST 2 (2810 m RKB) was a relatively dry (88.1 % methane) thermogenic gas.

The maturity of the indigenous organic material in this well is 0.55 %Ro in the Sleipner Formation (~ 3000 m RKB) which lies below the reservoir.

KEYWORDS ENGLISH	KEYWORDS NORWEGIAN
Organic Geochemistry 15/12-9 S	Organisk geokjemi 15/12-9 S

Trykkenhuset Skipnes

CONTENTS

1. INTRODUCTION

Well 15/12-9 S was drilled on the Beta-structure 32 km south of the Sleipner field. A location map is shown in Figure 1.1.

IKU has performed organic geochemical analyses for Statoil under Contract T.121.450, Order no. 182875. The vitrinite reflectance and isotope measurements were performed at Institutt for energiteknikk (IFE).

A total of 24 sediment samples, 2 oil samples and 1 gas sample were subjected to the different analyses listed in Table 1.1.

Formation tops and drilling information were supplied by Statoil and are shown in Table 1.2 and Table 1.3, respectively. All depths referred to in the report text, the tables and figures are given as m RKB TVD, unless otherwise stated.

1.1 Comments on some of the analyses

The sandstone core from 2921.00 m smelled like "almond essence". The weight of the EOM of this sample was more difficult to stabilise than those of the other samples.

1.2 Personnel participating in the project

The analysis were performed by Torun Vinge, Cecilie Sneeggen and Kristin Lind. The lithological description was done by Deborah Ann Leith. Inger Lisbeth Skjervold drafted most of the figures and Jorunn B. Lundhaug typed the final version of the manuscript. Leslie Leith was responsible for the scientific control. May Britt Myhr was in charge of the project.

Table 1.1 *Samples and analyses*

IKUNO.	Depth (m)	Type	Rock-Eval	TOC	Visual Kerogen	Therm. extr.	EOM/MPLC	GC SAT/ARO	GC/MS SAT	Isotope ker.	Isotope extr.
G5666	2673	cutt	x	x	x						
G5667	2682	cutt	x	x							
G5650	2692.5	swc	x	x			x	x	x		
G5668	2706	cutt	x	x							
G5669	2715	cutt	x	x			x	x	x		x
G5670	2724	cutt	x	x	x	x				x	
G5651	2767.50	core	x								
G5652	2787.00	core	x			x	x	x	x		x
G5653	2802.00	core	x								
G5654	2807.00	core	x				x	x	x		x
G5683	2810.00	oil DST 2					x	x	x		x
G5685	2810.00	gas DST 2									
G5655	2824.00	core	x								
G5656	2862.00	core	x				x	x	x		x
G5684	2863.50	oil FMT					x	x	x		x
G5657	2865.00	core	x			x					
G5658	2868.00	core	x				x	x	x		
G5659	2871.50	core	x				x	x	x		
G5660	2878.50	core	x			x					
G5661	2886.50	core	x				x	x	x		
G5662	2897.50	core	x								
G5663	2907.00	core	x				x	x	x		x
G5664	2921.00	core	x				x	x	x		
G5671	2934	cutt	x			x					
G5672	2943.5	cutt	x								
G5673	2952.5	cutt	x								
G5674	2967.5	cutt	x								

Table 1.2 Formation tops

GROUP	FORMATION	MD RKB	m RKB TVD
Nordland		107	107
	Utsira	1357	1212
Hordaland		1400	1239
Rogaland	Balder	2930	2295
	Sele	2945	2310
	Lista	3005	2370
	Våle	3082	2447
Shetland	Tor	3091	2456
	Hod	3187	2552
	Blodøks	3260	2625
Cromer Knoll	Rødby	3295	2660
Viking		3304	2669
Vestland	"Oxfordian sst"	3385	2750
	Sleipner	3620	2985
?	Salt/Skagerak	3688	3053
TD		3848	3213

Table 1.3 Drilling information

KB:	23 m
Water depth:	84 m
Casing MD RKB:	
30"	167 m
20"	599 m
13 3/8"	2207 m
9 5/8"	2677 m

Oil water contact: 3503 MD RKB = 2868.5 m RKB TVD

2. RESULTS AND DISCUSSION

From well 15/12-9S only samples from the Viking Group (2669 - 2750 m, TD) and the Vestland Group were analysed by organic geochemical methods. The upper part of the Viking Group (2669 - 2724 m) consisted mainly of dark grey micaceous claystones which are considered as potential source rocks. Brown micaceous sandstones within the "Oxfordian sandstone" zone (2750 - 2985 m) constituted the remaining part of the analysed section. All the analysed sandstone samples were oil- stained.

2.1 Characterization of potential source rocks

Six dark grey claystone samples from the interval 2673 - 2724 m in the upper part of the Viking Group were analysed (Table 2.1). The total organic carbon (TOC) content of the samples varied between 1.2 % and 3.1 % (Table 2.2, Figure 2.1). The Rock-Eval Tmax showed values between 430°C and 434°C, and the hydrogen index (HI) was between 195 mg HC/g TOC and 384 mg HC/g TOC (Table 2.2, Figure 2.1). This classifies the kerogen as Type II/III. Low Rock-Eval production indices suggest that the claystones have experienced little or no impregnation from the underlying reservoir.

The vitrinite reflectance profile (Figure 2.3) indicates a maturity around 0.5 % Ro for this claystone interval. This agrees well with thermal alteration indices (TAI) of 3-4 (Table 2.3) and the Tmax values (430 - 434°C). Sterane and hopane isomerization have reached completion or are close to it (Tables 2.18 and 2.19), which suggests a vitrinite reflectance equivalent maturity of 0.4 - 0.5 % Ro. All maturity data thus indicate that these claystones have reached a thermal maturity which is close to or just in the beginning of the oil generating stage.

The claystone samples from 2692.5 m and 2715 m were selected for solvent extraction and follow-up analyses. The yields of extractable organic matter (EOM) were 1453 ppm and 918 ppm of rock weight, respectively. This is regarded as rich, especially at the low maturity of these rocks. The Rock-Eval petroleum potential (S1 + S2 = 2.4 - 12.7 mg/g rock, Table 2.2) also indicates that the claystones are good to rich potential source rocks, The two uppermost samples (2673 m and 2682 m) show the best petroleum potential from Rock-Eval (12.6 mg/g rock and 11.2 mg/g rock, respectively).

The extractable organic material from the claystones consists of more than 50 % non-hydrocarbons, and the saturated to aromatic hydrocarbon ratio

(SAT/ARO) is lower than one (Table 3.9, Figure 2.4). Such a composition is often observed in EOM generated at low maturity.

Carbon isotope analysis was performed on the 2715 m sample. The EOM and extract fractions gave $\delta^{13}C$ values from -29.3 $^{o}/_{oo}$ PDB (saturates) to -28.3 $^{o}/_{oo}$ PDB (polar compounds and asphaltenes, Table 2.14, Figure 2.8). The kerogen gave somewhat heavier isotope values than the extract, as expected. The carbon isotope data point at a mixed marine-terrestrial source for the organic matter in the claystone (Figure 2.7).

The claystone sample from 2724.00 m was analysed by thermal extraction-gas chromatography and subsequent pyrolysis gas chromatography. The extract (S1, Figure 2.11) was dominated by compounds below n-C_{12}. The pyrolysate (S2, Figure 2.11) gave approximately as high peak intensity as the peak intensity of the thermal extract and was dominated by n-alkene and n-alkane homologues up to n-C_{30}. Aromatic hydrocarbons were moderately abundant. This pyrolysate composition is frequently observed in Type II/III kerogen (and asphaltenes).

The gas chromatograms of the saturated hydrocarbons (2692.5 m and 2715 m) show some typical immature features such as an unresolved hump in the biomarker region and high pristane/n-C_{17} ratio (Figure 2.12). The 2715 m sample also shows a high phytane/n-C_{18} ratio and a slight odd over even n-alkane predominance in the high molecular weight region. The most pronounced difference between the two chromatograms lies, however, in the different shape of the n-alkane envelope. The 2692.5 m sample is front end biased with a maximum at n-C_{18}, while the 2715 m sample is back end biased with maximum at n-C_{27}. The reason for these differences is not known. They could have been caused by a more terrestrial input to the latter sample but this would be in contrast to the higher HI of this sample. Maturity differences must also be ruled out due to the close spacing of the samples.

The aromatic hydrocarbon gas chromatograms (ARO GCs) of the two samples are fairly similar (Figure 2.13), their most pronounced feature being the large unresolved hump over the whole chromatographic range. This hump is probably due to low maturity and is consistent with the MPI-1 values of 0.54 and 0.52, respectively.

The terpane mass chromatograms (m/z 191, Figure 2.14) of the two claystones are almost identical, and they show the typical patterns of Upper Jurassic North Sea mudstones with the 17α(H),21β(H)-hopanes as the most dominating peaks with the C_{30}-17α(H),21β(H)-hopane as the most prominent one. The only significant difference in the terpane composition of the two samples seems to be the somewhat higher relative content of 27Tm in the 2692.5 m sample. The distribution of regular steranes is similar for the two samples (Table 2.20, Figure 2.15) and points to a mixed marine-terrestrial source.

Summary of characterization of potential source rocks

The analysed claystones from the upper part of the Viking Group contain Type II/III kerogen with input from both terrestrial and marine organic matter. They have a rich potential for oil and gas. In this well the claystones have just started oil generation (VR ~ 0.5 % Ro).

2.2 Characterization of reservoir hydrocarbons

Sandstone extracts

All eight extracted sandstone samples yielded very high EOM contents (Table 2.10, Figure 2.4). Six of the samples had EOM contents of 12500 - 33600 ppm of rock, while the samples at 2886.50 m and 2921.00 m showed lower EOM values of 4900 ppm and 1600 ppm, respectively.

With the exception of one sample (2921 m), all the extracted sandstones gave high hydrocarbon/non-hydrocarbon (HC/nonHC) ratios of between 2.6 and 9.3, which is consistent with mature EOM (Table 2.12, Figure 2.4). Also the high SAT/ARO ratios (1.5 - 2.0) point at mature hydrocarbons in all eight samples. The lowermost sandstone sample (2921.00 m) has a HC/non HC ratio of 0.28. This low HC/nonHC ratio is unlikely to be due to source or maturity differences (further discussion of this below), therefore it may be the result of a deeper oil-water contact (OWC) in the past. The present OWC was determined by Statoil to be at 2868.5 m (Table 1.3). Since the sample at 2907.00 m is not depleted in hydrocarbons, the palaeo oil water contact (POWC) could have been between 2907.00 and 2921.00 m. It should be noted that a deeper (than 2868.5 m) present OWC also could have given these effects, but it is assumed that the present OWC is correctly established by Statoil.

Four samples from the "Oxfordian sandstones" were analysed by thermal extraction-gas chromatography and following pyrolysis-gas chromatography. The three uppermost samples (2787.00 m, 2865.00 m and 2878.50 m) yielded thermal extracts of similar composition (S1, Figure 2.11). The resolved peaks were mainly n-alkanes in the n-C_{12} to n-C_{23} range. The pyrolysate (S2, Figure 2.11) gave a low response compared to the thermal extract (S2:S1 < 1:10) and probably consisted mainly of pyrolysed asphaltenes since little kerogen is expected in these reservoir sandstones. The lowermost sample (2934.00 m) yielded a thermal extract dominated by compounds below n-C_{12}. In contrast to the three uppermost samples, the pyrolysate gave an equally high GC response as the thermal extract, which may indicate a higher non-HC/HC ratio. This suggests that this sample (2934.00 m) is located below the palaeo oil-water contact, in accordance with the indications from the extraction data above.

Carbon isotope data were obtained from four of the sandstone extracts (2787.00 m, 2807.00 m, 2862.00 m and 2863.00 m). The saturated hydrocarbon fraction is similar with values of -29.1 to -29.5 $^{\circ}/_{\circ\circ}$ PDB. Also the aromatic hydrocarbon fraction shows similar values for all four samples (-28.4 to - 28.6 $^{\circ}/_{\circ\circ}$ PDB, Table 2.14). These values are consistent with a mixed marine and terrestrial source for the hydrocarbons (Figure 2.7). The isotope type curves ("Galimov plots", Figure 2.8) of the four samples are nearly identical. The type curves also resemble that of the claystone sample which could indicate a similar source of the organic matter.

The saturated hydrocarbon gas chromatograms of the sandstones samples all show well developed n-alkane patterns with a maximum around n-C_{17} and extending up to n-C_{35} (Figure 2.12). The low isoprenoid to n-alkane ratios (pr/n-C_{17} = 0.6-0.7, Table 2.15) and CPI values of 1.0 are typical of mature hydrocarbons, even though the pr/n-C_{17} ratio suggests that the hydrocarbons have lower maturities than the most mature North Sea oils, which may have pr/n-C_{17} ratios as low as 0.3. The broad n-alkane distributions indicate contribution from both marine and terrestrial sources. Although the saturated hydrocarbon GC patterns are broadly similar through the whole "Oxfordian sandstone" sequence, some variations are encountered. The sandstones between 2871.50 m and 2907.00 m show lower relative contents of high molecular weight n-alkanes compared to the sandstones at shallower depths. The pattern becomes more pronounced front-end-biased in the lower sample from this interval (2907.00 m).

The aromatic hydrocarbon gas chromatograms (Figure 2.13) show well developed alkylated naphthalenes and phenanthrenes. The largest variation between the aromatic hydrocarbon GCs is seen in the relative proportion of unresolved and resolved compounds. The relative size of the "hump" is low at 2807 m, 2871.50 m and 2907.00 m while it is largest in the gas chromatogram of the deepest sample (2721.00 m). This gas chromatogram also differs from those of the other sandstone extracts in containing several prominent (unidentified) peaks in the high molecular weight area.

The sterane and terpane mass chromatograms of the eight sandstone extracts are almost identical. They show more mature patterns than the claystone extracts, e.g. higher relative contents of tricyclic terpanes and higher relative 27Ts contents. The C_{28} regular steranes content (Table 2.20, Figure 2.15) is somewhat higher relative to the C_{27} and C_{29} regular steranes content in the sandstone extracts compared to the claystone extracts. This relatively small difference should, however, not exclude more mature claystones of the upper Viking Group as source of the hydrocarbons in the sandstones.

Summary of sandstone extracts

The "Oxfordian sandstones" gave high extraction yields and the extracts were mature with high hydrocarbon contents. The EOM and hydrocarbon composition at different levels show a high degree of similarity which suggests that these extracts have the same source. The hydrocarbon fractions contain a significant proportion of high molecular weight alkanes of probably terrestrial origin, and therefore a mixed marine and terrestrial source is suggested. The source might be a more mature version of the upper Viking Group claystones in this well.

The most important difference in the extract composition through the "Oxfordian sandstones", is the significantly higher content of non-hydrocarbons in the lowermost sandstone sample. Assuming that the present oil-water contact is correctly determined, it is suggested that this reflects a palaeo oil-water contact between 2907.00 and 2921.00 m.

Oil samples

Two oil samples were received for analysis, one from drill stem test 2 (DST 2) at 2810.0 m and one from the formation test (FMT) at 2863.5 m. The density of the DST 2 sample was 0.855 g/ml and the API gravity was 34.0° (Table 2.7). The FMT sample had a somewhat higher density of 0.873 g/ml and an API gravity of 30.7°. The fraction of the oil boiling below 210°C constituted 18.6 % of the DST 2 sample and 23.8 % of the FMT sample (Table 2.6).

The asphaltene contents of the DST 2 and FMT samples were low (2.8 % and 2.1 %, respectively, Table 2.12) and so were the contents in polar compounds (8.5 % and 6.2 %, respectively). The saturated to aromatic hydrocarbon ratio (SAT/ARO) was somewhat lower for the DST 2 sample (1.2) than for the FMT sample (1.8), the last value being comparable to those of the sandstone extracts (1.5 - 2.0). The carbon isotope data of the two oils are identical (within ± 0.1 $^{\circ}/_{\circ\circ}$ PDB) for EOM and the SAT, ARO and asphaltene fractions while the NSO fraction of the FMT sample is isotopically slightly heavier (Table 2.14). The isotope type curves of the oils resemble those of the sandstone extracts (Figure 2.8).

The gas chromatograms of the total oils (Figure 2.9) are similar and show a low molecular weight biased n-alkane distribution which has a maximum at n-C_7 and extends up to n-C_{35}. Also the detailed composition of the C_2-C_8 fraction is similar for the two samples (Table 2.8, Figure 2.10). The DST sample and the FMT sample may be characterized as "aliphatic" oils.

The gas chromatograms of the saturated hydrocarbon fractions of the two oils (Figure 2.12) are overall similar, although the FMT sample shows a slightly lower relative content of C_{16}-C_{21} n-alkanes, which is reflected in the respective molecular ratios listed in Table 2.16 (n-C_{17}/n-C_{27} and n-C_{31}/n-C_{19}). There is a strong similarity between the saturated fractions of the oils and those of the sandstone extracts, especially those above the oil water contact.

The aromatic hydrocarbon gas chromatograms are essentially similar for the two oils (Figure 2.13). Methylated naphthalenes and phenanthrenes are the dominating compounds as they were in the sandstone extracts. The methylphenanthrene index (MPI-1, Table 2.16) of both samples is 0.64 which is similar to the sandstone extracts and indicate oils of low to moderate maturity.

The two oil samples have the same distribution of regular steranes as the sandstone extracts (Table 2.20, Figure 2.15).

Summary of oil samples

The oils from DST 2 (2810.0 m) and from FMT (2863.5 m) are moderately light with API gravities of 34.0° and 30.7°, respectively. They have a low asphaltene content (2.8 % and 2.1 %), contain a relatively high proportion of high molecular weight alkanes and have a moderately mature composition.

The two oil samples are similar in most respects and are probably from the same source, which is also similar to the source of the sandstone extracts. Claystones of the upper Viking Group are suggested to be the most likely source rock for these oils. The thermal maturity of these source rocks must, however, be higher than that of the Upper Jurassic claystones found in this well.

Gas sample

One natural gas sample from DST 2 at 2810.0 m was analysed. The gas contained 88.1% methane (wetness = 0.11, Table 2.4) which is fairly dry. The $\delta^{13}C$ value of methane (-37.5 $^{o}/_{oo}$ PDB, Table 2.5) clearly indicates a termogenic origin of the gas. The plot of $\delta^{13}C_1$ versus $\delta^{13}C_2$ suggests that methane and ethane are cogenetic, and the plot of $\delta^{13}C_1$ versus δDC_1 suggests wet gas maturity ("Schoell plots", Figure 2.5). According to James (1983) the maturity of the source of a thermogenic natural gas may be determined from the differences between the carbon isotope values of the individual gas components. For this gas sample the differences between $\delta^{13}C$ values for ethane - propane and for propane - n-butane are small (both 0.7 $^{o}/_{oo}$ PDB, Table 2.5, Figure 2.6) which is typical of a gas generated at high maturity. On the other hand the difference between the carbon isotope values of methane and ethane is relatively large (9.3 $^{o}/_{oo}$ PDB) and should indicate low maturity. It is, however, known that methane from the North Sea has lighter carbon isotope values than suggested by James' diagram, and therefore the larger methane - ethane difference should not be given too much attention. The gas from DST 2 is thus most probably of high maturity. The reason for the seemingly higher maturity of the gas compared to its associated oil, is not known.

Summary of gas sample

The natural gas sample from DST 2 (2810 m) was a relatively dry thermogenic gas with a methane content of 88.1 %. The maturity of the source of the gas is probably high.

2.3 Maturity level through the well

The thermal maturity level of the indigenous organic material in the well is described by the vitrinite reflectance profile in Figure 2.3 and the reflectance increases from around 0.25 % Ro at 800 m to 0.6 % Ro at 3200 m. At about 3000 m the vitrinite reflectance is 0.55 % Ro. The most reliable measurement was from this depth. The rest of the measurements were from samples of moderate quality (according to IFE). The claystones in the upper part of the Viking Group show a slightly lower vitrinite reflectance of around 0.50 % Ro, which is consistent with the other analytical data from these claystones (see chapter 2.1).

The maturity of the non-indigenous extractable material is discussed under chapter 2.2.

3. CONCLUSIONS

Altogether 24 sediment samples, 2 oil samples and 1 gas sample from the Viking Group and the Vestland Group, were subjected to different organic geochemical analyses.

The analysed claystones of the upper part of the Viking Group contain a Type II/III kerogen with input from both terrestrial and marine organic matter. They have a rich potential for oil and gas. The maturity of the kerogen in these claystones is consistant with early phase of oil generation (VR ~ 0.5 % Ro).

The "Oxfordian sandstones" gave high extraction yields. The extracts showed a moderately mature composition with high hydrocarbon contents. EOM and hydrocarbon composition at different levels show a high degree of similarity, which suggests that these bitumens have the same source. The hydrocarbon fractions contain a significant proportion of high molecular weight alkanes of probably terrestrial origin, and therefore a mixed marine and terrestrial source is suggested. The source could be a more mature version of the upper Viking Group claystones in this well.

The most important difference in the extract composition through the "Oxfordian sandstones", is the significantly higher content of non-hydrocarbons in the lowermost sandstone sample. It is suggested that this reflects a palaeo oil-water contact between 2907.00 m RKB and 2921.00 m RKB.

The oils from DST 2 (2810.0 m RKB) and from FMT (2863.5 m RKB) are moderately light with API gravities of 34.0° and 30.7°, respectively. They have a low asphaltene content (2.8 % and 2.1 %), contain a relatively high proportion of high molecular weight alkanes and have a moderately mature composition. The two oil samples are similar in most respects and are probably from the same source, which is most likely similar to the source of the sandstone extracts.

The natural gas sample from DST 2 (2810 m RKB) was a relatively dry thermogenic gas with a methane content of 88.1 %. The maturity of the source of the gas is probably high.

The maturity of the indigenous material in the well is 0.55 % Ro in the Sleipner Formation (~ 3000 m RKB) which lies below the reservoir.

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Table 2.1 Lithology and total organic carbon content

Sample		Depth (m)	TOC (% of rock wt)	Lithology	
G5666	cuttings	2673	3.10	50%	Claystone, micaceous, dark grey 1)
				30%	Sandstone, light grey, micaceous, fine grained
				20%	Sandstone, red brown, fine grained
				Sm.am.	Drilling fluids, Cement, Caving
G5667	cuttings	2682	2.99	90%	Claystone, micaceous, dark grey 1)
				5%	Sandstone, red brown, fine grained
				5%	Portland Cement (Drilling Contaminant)
				Sm.am.	Drilling fluids
G5650	swc	2692.5	1.15	100%	Claystone, dark grey, micaceous
G5668	cuttings	2706	2.32	100%	Claystone, micaceous, dark grey
				Sm.am.	Paint, Metal, Pyrite, Portland Cement, Sandstone, red brown, fine grained
G5669	cuttings	2715	2.34	100%	Claystone, micaceous, dark grey
				Sm.am.	Paint, Metal, Pyrite, Baryte, Portland Cement
G5670	cuttings	2724	1.84	100%	Claystone, micaceous, dark grey
				Sm.am.	Paint, Metal, Baryte, Portland Cement
G5651	core	2767.50		100%	Sandstone, medium brown, micaceous, fine-grained (oil stained)
G5652	core	2787.00		100%	Sandstone, brown, micaceous, carbonaceous laminae, fine grained (oil stained)
G5653	core	2802.00		100%	Sandstone, medium brown micaceous, medium grained (oil stained)
G5654	core	2807.00		100%	Sandstone, medium brown micaceous, medium grained (oil stained)
G5655	core	2824.00		100%	Sandstone, medium brown, micaceous, calcareous, fine grained (oil stained)
G5656	core	2862.00		100%	Sandstone, light brown, micaceous, fine grained (oil stained)
G5657	core	2865.00		100%	Sandstone, medium brown, micaceous, medium grained (oil stained)

1) The underlined lithology was picked for analysis.

Table 2.1 *Lithology and total organic carbon content*
Well no. 15/12-9S.

Sample		**Depth (m)**	**TOC (% of rock wt)**	**Lithology**	
G5658	core	2868.00		100%	Sandstone, medium - dark brown, micaceous, fine - medium grained
				Sm.am.	(oil stained) Drilling deposits (metal)
G5659	core	2871.50		100%	Sandstone, medium - dark brown, micaceous, fine - medium grained (oil stained)
G5660	core	2878.50		100%	Sandstone, light brown, micaceous, fine - medium grained (oil stained)
G5661	core	2886.50		100%	Sandstone, light brown, micaceous, calcareous, fine grained (oil stained)
G5662	core	2897.50		100%	Sandstone, light grey, brown, micaceous, calcareous, carbonaceous laminae, very fine-grained (oil stained)
G5663	core	2907.00		100%	Sandstone, medium - dark brown, micaceous, carbonaceous, fine - medium grained (oil stained)
G5664	core	2921.00		100%	Sandstone, light - medium grey, micaceous, fine - medium grained
				Sm.am.	Drilling mud
G5671	cuttings	2934		95%	Sandstone, light grey - grey, coarse grained, micaceous
				5%	Sandstone, medium grey, very fine grained
				Sm.am.	Paint, Metal, Plastic, Claystone, micaceous, dark grey
G5672	cuttings	2943.5		95%	Sandstone, light grey - grey, coarse grained, micaceous
				5%	Claystone, micaceous, dark grey
				Sm.am.	Sandstone, medium grey, very fine grained, Metal plastic, Baryte
G5673	cuttings	2952.5		90%	Sandstone, light grey - grey, coarse grained, micaceous
				10%	Sandstone, medium grey, very fine grained
				Sm.am.	Barytes, Metal, Plastic, Claystone, micaceous, dark grey
G5674	cuttings	2967.5		95%	Sandstone, light grey - grey, coarse grained, micaceous
				5%	Claystone, micaceous, dark grey
				Sm.am.	Metal, Plastic, Baryte

Table 2.2 Data from Rock-Eval pyrolysis

IKUNO	LITH-OLOGY	DEPTH	SAMPLE TYPE	S1	S2	TOC	HYDRO. INDEX	PETR. POTEN. S1+S2	PROD. INDEX S1 ----- S1+S2	Tmax
		(m)		(mg/g rock)		(wt%)	(mg/g TOC)	(mg/g rock)		(°C)
15/12-09										
G5666	clst	2673	CUTT	0.76	11.89	3.10	384	12.65	0.06	430
G5667	clst	2682	CUTT	0.74	10.48	2.99	351	11.22	0.07	431
G5650	clst	2692.5	SWC	0.16	2.24	1.15	195	2.40	0.07	434
G5668	clst	2706	CUTT	0.50	7.63	2.32	329	8.13	0.06	432
G5669	clst	2715	CUTT	0.48	7.52	2.34	321	8.00	0.06	431
G5670	clst	2724	CUTT	0.35	5.79	1.84	315	6.14	0.06	434
G5651	sst	2767.50	CORE	16.14	4.25			20.39	0.79	420
G5652	sst	2787.00	CORE	23.31	7.57			30.88	0.75	420
G5653	sst	2802.00	CORE	10.75	2.19			12.94	0.83	416
G5654	sst	2807.00	CORE	21.80	7.59			29.39	0.74	350*
G5655	sst	2824.00	CORE	4.93	0.94			5.87	0.84	419
G5656	sst	2862.00	CORE	8.28	1.84			10.12	0.82	423
G5657	sst	2865.00	CORE	13.86	6.34			20.20	0.69	341*
G5658	sst	2868.00	CORE	14.17	2.91			17.08	0.83	420
G5659	sst	2871.50	CORE	13.28	4.10			17.38	0.76	342*
G5660	sst	2878.50	CORE	3.74	0.88			4.62	0.81	420
G5661	sst	2886.50	CORE	2.04	0.55			2.59	0.79	420
G5662	sst	2897.50	CORE	2.53	1.15			3.68	0.69	428
G5663	sst	2907.00	CORE	12.36	3.00			15.36	0.80	424
G5664	sst	2921.00	CORE	2.89	6.07			8.96	0.32	323*
G5671	sst	2934	CUTT	0.14	0.77			0.91	0.15	441
G5672	sst	2943.5	CUTT	0.08	0.38			0.46	0.17	442
G5673	sst	2952.5	CUTT	0.04	0.2			0.29	0.14	441
G5674	sst	2967.5	CUTT	0.01	0.3			0.04	0.25	436

Legend

-1 - No data available.

* - Unreliable Tmax

Table 2.3 Data from visual kerogen analysis

IKUNO	Depth (m)	Composition of residue Am	Al	He	Wo	Co	Particle size	Preservation of palynomorphs	Thermal Alteration Index (TAI)[1]	Remarks
		(% of total residue)								
G 5666	2673	50	20	10	15	5	f-m-c	p	3 - 4	Artificially formed crystals in slide. Black minerals disturb. Equidimensional W/C fragments. Biodegraded Wo. Good yellow fluorescence from Al, poor from Am.
G 5670	2724	50	25	15	<10	<5	f-m-c	p - f	3 - 4	Degraded He, very thin walled or irregularly thick. Black minerals (?pyrite) disturb. Foraminifer linings. Some bladeshaped Co. He includes large cuticular fragments. Good fluoresence from Al and pollen. Contaminants Extracted residue.

Legend:

Composition
Am = Amorphous organic material
Al = Algal material
He = Herbaceous (lipoid) material and dinocysts
Wo = Woody material
Co = Coaly fragments

Particle size
f = fine
m = medium
c = coarse

Preservation of palynomorphs
p = poor
f = fair
g = good

n.d.p. = no determination possible
n.d. = not determined

[1] TAI 1-10 scale

Table 2.4 Gas compostion (C_1 - C_5)

Sample		C_1	C_2	C_3	iC_4	nC_4	iC_5	nC_5	CO_2	ΣC_1-C_5	Wet-ness	iC_4/nC_4
		volume %										
G 5685	DST2	88.1	6.5	2.9	0.35	0.60	0.04	0.04	1.4	98.6	0.11	0.58

Table 2.5 Isotope composition of gas compounds

Sample		C_1 $\delta^{13}C$ $^o/_{oo}$PDB	C_1 δD $^o/_{oo}$SMOW	C_2 $\delta^{13}C$ $^o/_{oo}$PDB	C_3 $\delta^{13}C$ $^o/_{oo}$PDB	iC_4 $\delta^{13}C$ $^o/_{oo}$PDB	nC_4 $\delta^{13}C$ $^o/_{oo}$PDB	CO_2 $\delta^{13}C$ $^o/_{oo}$PDB	CO_2 $\delta^{18}O$ $^o/_{oo}$PDB
G 5685	DST 2	-37.5	-203	-28.2	-27.5	-26.9	-28.2	-12.2	-14.2

Table 2.6 Percentage of oil boiling below 210°C

IKUNO	EXTERNAL ID	SAMPLE TYPE	Crude oil (mg)	oil > 210°C (mg)	Low molecular weight compounds (mg)	(%)
15/12-09						
G5683	2810.0m, DST 2	OIL	781.7	636.5	145.2	18.6
G5684	3498.0m, FMT	OIL	335.2	255.5	79.7	23.8

Table 2.7 Density and API gravity of oils

IKUNO	EXTERNAL ID	SAMPLE TYPE	TOTAL OIL DENSITY (g/ml)	TOTAL OIL DENSITY (°API)
G5683	2810.0m DST 2	OIL	0.855	34.0
G5684	3498.0m FMT	OIL	0.873	30.7

Table 2.8 *Composition of the C_2-C_8 fraction of oils*

```
                         Injection Report

Acquired on 16-DEC-1992 at 09:03

Sample Name   : G-5683, oil, DST 2
Sample Id     :
Sample Type   : Sample     Amount=1.00000
Bottle No     : 1


                 PEAK INFORMATION

Peak RT mins Hght uV   Area uVs      ul/ml  Peak name
------------------------------------------------------
   2   0.899   25286     11459      0.415  n-C2
   3   1.160  165508    118812      4.306  n-C3
   4   1.917   51107     77357      2.804  i-C4
   5   2.827  182799    308408     11.178  n-C4
   7   5.963  121972    281748     10.212  i-C5
   8   7.443  230191    488007     17.687  n-C5
  13  11.336  121453    286849     10.396  2MC5
  14  12.080   77528    175367      6.356  3MC5
  15  13.179  260046    606936     21.997  n-C6
  16  14.403  170082    405650     14.702  MCyC5
  19  16.107  207958    495394     17.955  Benzene
  22  16.877   97918    236642      8.577  2MC6
  23  17.307   93714    219844      7.968  3MC6
C1            142306    352388     12.772  DMCyC5
  24  17.483   36610     86646      3.140    - C1
  25  17.624   35018     81174      2.942    - C1
  26  17.779   70677    184568      6.689    - C1
  27  18.683  294329    694377     25.167  n-C7
  28  19.421  413579   1017108     36.864  MCyC6
  37  21.013  169170    413868             int.std.
  40  21.771  341516    882660     31.991  Toluene
  41  22.080  113563    274392      9.945  2+4MC7
C2            155681    482588     17.491  DMCyC6
  44  22.323   81580    209353      7.588    - C2
  45  22.432   74101    273234      9.903    - C2
  54  23.813  279530    687017     24.900  n-C8
  63  25.051  106160    319475     11.579  EtCyC6
  77  26.811  202805    747172     27.080  m+p-xylene
  81  27.213   53152    159345      5.775  2MC8
  84  27.680   47016    160548      5.819  4MC8
  86  27.859  105493    267604      9.699  o-xylene
  91  28.552  279997    765303     27.737  n-C9

Totals
-------------------------------------------
Unknowns     7860779  27156008       N/A
Quantified   4509856  10936315    381.370
Grand Total 12370635  38092324    381.370
```

Injection Report

Acquired on 16-DEC-1992 at 11:15

Sample Name : G-5684, oil
Sample Id :
Sample Type : Sample Amount=1.00000
Bottle No : 2

PEAK INFORMATION

Peak	RT mins	Hght uV	Area uVs	ul/ml	Peak name
2	0.952	31019	15344	0.322	n-C2
3	1.253	172616	136796	2.869	n-C3
4	2.173	48502	85068	1.784	i-C4
5	3.232	189050	334016	7.005	n-C4
7	6.323	147118	306630	6.431	i-C5
8	7.699	254934	530736	11.131	n-C5
12	11.443	139254	317201	6.652	2MC5
13	12.165	91178	192860	4.045	3MC5
14	13.245	302860	667379	13.996	n-C6
15	14.453	197118	448402	9.404	MCyC5
18	16.141	220040	514760	10.795	Benzene
21	16.901	104211	254564	5.339	2MC6
22	17.336	100186	238236	4.996	3MC6
C1		158447	393645	8.255	DMCyC5
23	17.509	41887	96209	2.018	– C1
24	17.651	39085	90408	1.896	– C1
25	17.808	77474	207028	4.342	– C1
26	18.709	314850	745763	15.640	n-C7
27	19.443	424912	1078318	22.614	MCyC6
36	21.035	283089	715244		int.std.
40	21.781	316753	795217	16.677	Toluene
41	22.093	119279	290932	6.101	2+4MC7
C2		169289	505971	10.611	DMCyC6
44	22.333	88357	222766	4.672	– C2
45	22.435	80932	283205	5.939	– C2
53	23.824	291466	717331	15.044	n-C8
62	25.061	109469	334374	7.012	EtCyC6
76	26.819	203773	739254	15.504	m+p-xylene
80	27.219	53478	139946	2.935	2MC8
84	27.685	50159	166974	3.502	4MC8
86	27.864	100983	258837	5.428	o-xylene
91	28.555	291795	781393	16.387	n-C9

Totals			
Unknowns	7984535	27839206	N/A
Quantified	4885827	11705192	230.480
Grand Total	12870362	39544400	230.480

Table 2.9 Weight of chromatographic fractions (from MPLC)

IKUNO	**LITHO-LOGY**	**DEPTH (m)**	**SAMPLE TYPE**	**ROCK EXTR. (g)**	**EOM (mg)**	**ASPH (mg)**	**SAT HC (mg)**	**ARO HC (mg)**	**POLAR COMP. (mg)**	**HC (mg)**	**NONHC # (mg)**	**TOC (%)**
15/12-09												
G5650	clst	2692.5	SWC	3.4	5.0	1.5	0.8	1.0	1.6	1.8	3.2	1.15
G5669	clst	2715	CUTT	21.6	19.8	6.7	3.2	4.5	4.8	7.7	12.1	2.34
G5652	sst	2787.00	CORE	23.5	789.5	29.6	498.0	283.9	89.4	781.9	7.6	
G5654	sst	2807.00	CORE	24.9	795.8	28.8	452.3	266.6	85.1	718.9	76.9	
G5683		2810.00	OIL DST		111.5	3.1	55.1	46.5	9.5	101.6	9.9	
G5656	sst	2862.00	CORE	25.7	320.0	13.2	187.6	95.4	33.3	283.0	37.0	
G5684		2863.50	OIL FMT		167.7	3.5	98.4	55.9	10.4	154.3	13.4	
G5658	sst	2868.00	CORE	25.8	523.7	24.6	288.9	152.8	57.6	441.7	82.0	
G5659	sst	2871.50	CORE	28.8	579.9	64.4	287.0	187.2	55.7	474.2	105.7	
G5661	sst	2886.50	CORE	16.1	64.1	4.0	29.3	17.1	4.9	46.4	17.7	
G5663	sst	2907.00	CORE	18.1	368.7	46.4	185.2	105.4	25.8	290.6	78.1	
G5664	sst	2921.00	CORE	18.3	29.7	3.6	4.0	2.6	12.1	6.6	23.1	

Legend:

- NONHC is calculated as the difference : NONHC = EOM - HC

Table 2.10 *Concentration of EOM and chromatographic fractions (Weight ppm of rock, from MPLC)*

IKUNO	LITHO-LOGY	DEPTH (m)	SAMPLE TYPE	EOM	ASPH	SAT HC	ARO HC	POLAR COMP.	HC	NONHC #
15/12-09										
G5650	clst	2692.5	SWC	1453	436	241	286	454	527	926
G5669	clst	2715	CUTT	918	311	151	209	225	360	558
G5652	sst	2787.00	CORE	33643	1261	21222	12097	3808	33319	324
G5654	sst	2807.00	CORE	31944	1156	18155	10702	3417	28857	3087
G5683		2810.00	OIL DST							
G5656	sst	2862.00	CORE	12460	514	7303	3713	1297	11016	1444
G5684		2863.50	OIL FMT							
G5658	sst	2868.00	CORE	20322	955	11210	5929	2236	17139	3183
G5659	sst	2871.50	CORE	20129	2235	9962	6497	1933	16459	3670
G5661	sst	2886.50	CORE	3986	249	1825	1063	305	2888	1098
G5663	sst	2907.00	CORE	20315	2557	10202	5810	1422	16012	4303
G5664	sst	2921.00	CORE	1627	199	222	140	663	362	1265

Legend:

- NONHC is calculated as the difference : NONHC = EOM - HC

Table 2.11 *Concentration of EOM and chromatographic fractions, (mg/g TOC, from MPLC)*

IKUNO	LITHO-LOGY	DEPTH (m)	SAMPLE TYPE	EOM	ASPH	SAT HC	ARO HC	POLAR COMP.	HC	NONHC #
15/12-09										
G5650	clst	2692.5	SWC	126.3	37.9	21.0	24.9	39.5	45.9	80.4
G5669	clst	2715	CUTT	39.3	13.3	6.4	8.9	9.6	15.3	24.0
G5652	sst	2787.00	CORE	-1	-1	-1	-1	-1	-1	-1
G5654	sst	2807.00	CORE	-1	-1	-1	-1	-1	-1	-1
G5683		2810.00	OIL DST	-1	-1	-1	-1	-1	-1	-1
G5656	sst	2862.00	CORE	-1	-1	-1	-1	-1	-1	-1
G5684		2863.50	OIL FMT	-1	-1	-1	-1	-1	-1	-1
G5658	sst	2868.00	CORE	-1	-1	-1	-1	-1	-1	-1
G5659	sst	2871.50	CORE	-1	-1	-1	-1	-1	-1	-1
G5661	sst	2886.50	CORE	-1	-1	-1	-1	-1	-1	-1
G5663	sst	2907.00	CORE	-1	-1	-1	-1	-1	-1	-1
G5664	sst	2921.00	CORE	-1	-1	-1	-1	-1	-1	-1

Legend:
- NONHC is calculated as the difference : NONHC = EOM - HC
-1 - No data available.

Table 2.12 *Bulk composition of EOM and oils (from MPLC)*

IKUNO	FRAC NAME	DEPTH (m)	SAMPLE TYPE	ASPH / EOM (%)	SAT / EOM (%)	ARO / EOM (%)	HC / EOM (%)	POLAR / EOM (%)	SAT / ARO x 100	HC / NONHC x 100
15/12-09										
G5650	clst	2692.5	SWC	30.0	16.6	19.7	36.3	31.3	84.1	57.0
G5669	clst	2715	CUTT	33.8	16.4	22.8	39.2	24.5	72.0	64.3
G5652	sst	2787.00	CORE	3.7	63.1	36.0	99.1	11.3	175.4	1023.4
G5654	sst	2807.00	CORE	3.6	56.8	33.5	90.3	10.7	169.6	934.7
G5683		2810.00	OIL DST	2.8	49.4	41.7	91.1	8.5	118.5	1026.0
G5656	sst	2862.00	CORE	4.1	58.6	29.8	88.4	10.4	196.7	763.1
G5684		2863.50	OIL FMT	2.1	58.7	33.3	92.0	6.2	176.2	1151.5
G5658	sst	2868.00	CORE	4.7	55.2	29.2	84.4	11.0	189.1	538.4
G5659	sst	2871.50	CORE	11.1	49.5	32.3	81.8	9.6	153.3	448.4
G5661	sst	2886.50	CORE	6.2	45.8	26.7	72.5	7.7	171.6	262.9
G5663	sst	2907.00	CORE	12.6	50.2	28.6	78.8	7.0	175.6	372.1
G5664	sst	2921.00	CORE	12.3	13.6	8.6	22.2	40.7	158.4	28.6

Legend:

\# - NONHC is calculated as the difference : NONHC = EOM - HC

Table 2.13 *Bulk composition of EOM and oils (from Iatroscan)*

IKUNO	FRAC NAME	DEPTH (m)	SAMPLE TYPE	SAT --- EOM %	ARO --- EOM %	RESIN1 ------ EOM %	RESIN2 ------ EOM %	SAT --- ARO %	RESIN1 ------ RESIN2 %
15/12-09									
G5650		2692.5	SWC	19.18	28.29	43.97	8.57	67.80	513.07
G5669		2715	CUTT	23.39	31.58	39.11	5.94	74.07	658.42
G5652		2787.00	CORE	67.83	30.44	1.04	0.70	222.83	148.57
G5654		2807.00	CORE	63.77	34.89	0.91	0.45	182.77	202.22
G5683		2810.00	OIL DST	42.66	56.38	0.60	0.38	75.67	157.89
G5656		2862.00	CORE	63.00	35.10	1.47	0.44	179.49	334.09
G5684		2863.50	OIL FMT	55.45	43.55	0.64	0.36	127.32	177.78
G5658		2868.00	CORE	63.05	34.48	2.06	0.42	182.86	490.48
G5659		2871.50	CORE	56.10	40.40	1.99	1.52	138.86	130.92
G5661		2886.50	CORE	63.56	32.49	3.01	0.95	195.63	316.84
G5663		2907.00	CORE	65.96	30.22	1.80	2.03	218.27	88.67
G5664		2921.00	CORE	16.46	7.33	20.58	55.64	224.56	36.99

Legend
-1 - No data available.

Table 2.14 Isotope composition of EOM, oils, chromatographic fractions and kerogen.

Sample	Depth m RKB	Sample type	EOM $\delta^{13}C$ ($^0/_{00}$PDB)	SAT $\delta^{13}C$ ($^0/_{00}$PDB)	ARO $\delta^{13}C$ ($^0/_{00}$PDB)	NSO $\delta^{13}C$ ($^0/_{00}$PDB)	ASPH $\delta^{13}C$ ($^0/_{00}$PDB)	KEROGEN $\delta^{13}C$ ($^0/_{00}$PDB)
G 5669	2715	cut	-28.3	-29.3	-28.5	-28.3	-28.3	
G 5652	2787.00	core	-28.9	-29.1	-28.4	-28.0	-28.8	
G 5654	2807.00	core	-28.9	-29.4	-28.5	-28.2	-29.0	
G 5683	2810.00	oil	-28.9	-29.3	-28.6	-29.0	-28.9	
G 5656	2862.00	core	-28.9	-29.2	-28.4	-28.5	-28.8	
G 5684	2863.50	oil	-28.9	-29.2	-28.5	-28.4	-29.0	
G 5670	2724	cut						-27.7

Table 2.15 *Ratios derived from gas chromatograms of saturated hydrocarbons*

IKUNO	LITHOLOGY	DEPTH	Pri / Phy	A= Pri / n-C17	B= Phy / n-C18	A / B	n-C17 / n-C27	n-C31 / n-C19	CPI 1	CPI 2
15/12-09										
G5650	clst	2692.5	2.5	1.9	0.7	2.9	2.0	0.4	1.0	1.0
G5669	clst	2715	2.0	1.8	1.1	1.7	0.9	0.9	1.1	1.2
G5652	sst	2787.00	1.2	0.6	0.5	1.1	1.6	0.4	1.0	1.0
G5654	sst	2807.00	1.3	0.6	0.5	1.2	1.9	0.4	1.0	1.0
G5683	oil	2810.00	1.3	0.6	0.5	1.2	1.6	0.4	1.0	1.0
G5656	sst	2862.00	1.3	0.6	0.5	1.2	1.5	0.5	1.0	1.0
G5684	oil	2863.50	1.3	0.6	0.5	1.2	1.3	0.6	1.0	1.0
G5658	sst	2868.00	1.2	0.6	0.6	1.2	1.5	0.5	1.0	1.0
G5659	sst	2871.50	1.2	0.6	0.6	1.2	1.9	0.3	1.0	1.0
G5661	sst	2886.50	1.4	0.7	0.5	1.2	2.0	0.3	1.0	1.0
G5663	sst	2907.00	1.5	0.7	0.5	1.3	3.1	0.3	1.0	1.0
G5664	sst	2921.00	1.2	0.6	0.5	1.3	1.5	0.5	1.0	1.0

$$CPI1 = \frac{1}{2} * \left(\frac{C25+C27+C29+C31}{C24+C26+C28+C30} + \frac{C25+C27+C29+C31}{C26+C28+C30+C32} \right)$$

$$CPI2 = 2 * C27 / (C26+C28)$$

Ratios involving pristane and phytane are calculated from peak areas.
All other ratios are calculated from peak heights.

Table 2.16 *Ratios derived from gas chromatograms of aromatic hydrocarbons*

IKUNO	LITHOLOGY	DEPTH	MPI-1	MPI-2
15/12-09				
G5650	clst	2692.5	0.54	0.50
G5669	clst	2715	0.52	0.49
G5652	sst	2787.00	0.65	0.66
G5654	sst	2807.00	0.62	0.61
G5683		2810.00	0.64	0.60
G5656	sst	2862.00	0.63	0.65
G5684		2863.50	0.64	0.61
G5658	sst	2868.00	0.62	0.58
G5659	sst	2871.50	0.68	0.68
G5661	sst	2886.50		
G5663	sst	2907.00	0.65	0.62
G5664	sst	2921.00	0.51	0.55

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

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

All ratios are calculated from peak heights.

Table 2.17 *Ratios derived from thermal extractions (S,1) gas chromatograms*

IKUNO	LITHO-LOGY	DEPTH	Pri / Phy	A= Pri / n-C17	B= Phy / n-C18	A / B
15/12-09						
G5670	clst	2724	-1	-1	-1	-1
G5652	sst	2787.00	1.2	0.8	0.7	1.1
G5657	sst	2865.00	1.1	0.8	0.7	1.1
G5660	sst	2878.50	1.0	1.0	0.8	1.2
G5671	sst	2934	-1	-1	-1	-1

Ratios are calculated from peak areas.

Table 2.18 *Molecular ratios from sterane and terpane mass chromatograms (maturity characteristic ratios)*

IKUNO	**DEPTH m**	**αβ/αβ+βα hopanes** 1)	**22S hopanes** 2)	**22S hopanes** 3)	**22S hopanes** 4)	20S steranes 5)	ββ steranes 6)	ββ steranes 7)
15/12-09								
G5650	2692.5	0.83	61	60	60	40	58	41
G5669	2715	0.84	60	60	61	40	56	39
G5652	2787.00	0.92	58	60	62	41	73	58
G5654	2807.00	0.92	59	61	62	41	73	58
G5683	2810.00	0.92	59	62	62	39	75	60
G5656	2862.00	0.92	58	61	62	41	74	58
G5684	2863.50	0.92	59	62	61	39	76	61
G5658	2868.00	0.92	59	61	62	43	74	59
G5659	2871.50	0.92	59	60	61	41	74	59
G5661	2886.50	0.92	60	60	62	40	74	59
G5663	2907.00	0.92	58	59	61	41	75	60
G5664	2921.00	0.92	58	62	63	43	76	62

Legend:

1) 30αβ/(30αβ+30βα) in m/z 191.
2) 100 * 31αβS/(31αβS+31αβR) in m/z 191.
3) 100 * 32αβS/(32αβS+32αβR) in m/z 191.
4) 100 * average of 31αβS/(31αβS+31αβR),.....,35αβS/(35αβS+35αβR) in m/z 191.
5) 100 * 29ααS/(29ααS+29ααR) in m/z 217.
6) 100 * 2 * (29ββR+29ββS)/(29ααS+29ααR+2(29ββR+29ββS)) in m/z 217.
7) 100 * (29ββR+29ββS)/(29ααS+29ααR+29ββR+29ββS) in m/z 217.

Table 2.19 Molecular ratios from sterane and terpane mass chromatograms (maturity and source characteristic ratios)

IKUNO	**DEPTH m**	**(24/3)/30αβ terpanes 1)**	**27Tm/27Ts terpanes 2)**	**30d/30αβ terpanes 3)**	**28αβ/30αβ terpanes 4)**	**27dβS/ 27dβS+27ααR 5)**
15/12-09						
G5650	2692.5	0.03	5.26	0.08	-1	-1
G5669	2715	0.04	3.25	0.07	-1	0.55
G5652	2787.00	0.10	0.77	0.08	-1	0.63
G5654	2807.00	0.09	0.74	0.07	-1	0.63
G5683	2810.00	0.09	0.75	0.08	-1	0.65
G5656	2862.00	0.09	0.73	0.07	-1	-1
G5684	2863.50	0.10	0.75	0.06	-1	-1
G5658	2868.00	0.08	0.80	0.07	-1	0.63
G5659	2871.50	0.09	0.77	0.08	-1	0.62
G5661	2886.50	0.09	0.77	0.07	-1	0.62
G5663	2907.00	0.10	0.75	0.07	-1	0.63
G5664	2921.00	0.11	0.98	0.06	-1	-1

1) (24/3)/30αβ in m/z 191.
2) 27Tm/27Ts in m/z 191.
3) 30d/30αβ in m/z 191.
4) 28αβ/30αβ in m/z 191.
5) 27dβS/(27dβS+27ααR) in m/z 217.

Table 2.20 *Internal distribution of C_{27}, C_{28} and C_{29} regular steranes*

IKUNO	DEPTH m	from m/z 217 1) C27 (%)	 C28 (%)	 C29 (%)	from m/z 218 2) C27 (%)	 C28 (%)	 C29 (%)
15/12-09							
G5650	2692.5	-1	-1	-1	39.2	17.7	43.1
G5669	2715	45.1	18.5	36.4	36.0	20.8	43.2
G5652	2787.00	52.8	18.8	28.4	37.9	28.0	34.1
G5654	2807.00	53.6	18.9	27.4	36.9	28.6	34.5
G5683	2810.00	52.5	19.5	28.1	39.2	27.4	33.3
G5656	2862.00	-1	-1	-1	36.7	28.7	34.5
G5684	2863.50	-1	-1	-1	38.8	26.5	34.8
G5658	2868.00	53.3	19.7	27.0	36.9	28.6	34.5
G5659	2871.50	52.6	19.9	27.5	37.6	27.9	34.6
G5661	2886.50	53.5	19.3	27.2	37.6	28.6	33.8
G5663	2907.00	54.2	18.8	27.0	38.0	27.3	34.7
G5664	2921.00	-1	-1	-1	38.6	26.5	34.9

Legend:

1) distribution of peaks 27ααR, 28ααR, 29ααR in m/z 217.

2) distribution of peaks
h+i: (28dβS+27ββR)+(27ββS+28dαR)
n+o: (29dαR+28ββR)+28ββS
r+s: 29ββR+29ββS.

-1 = Data are not available or cannot be calculated.

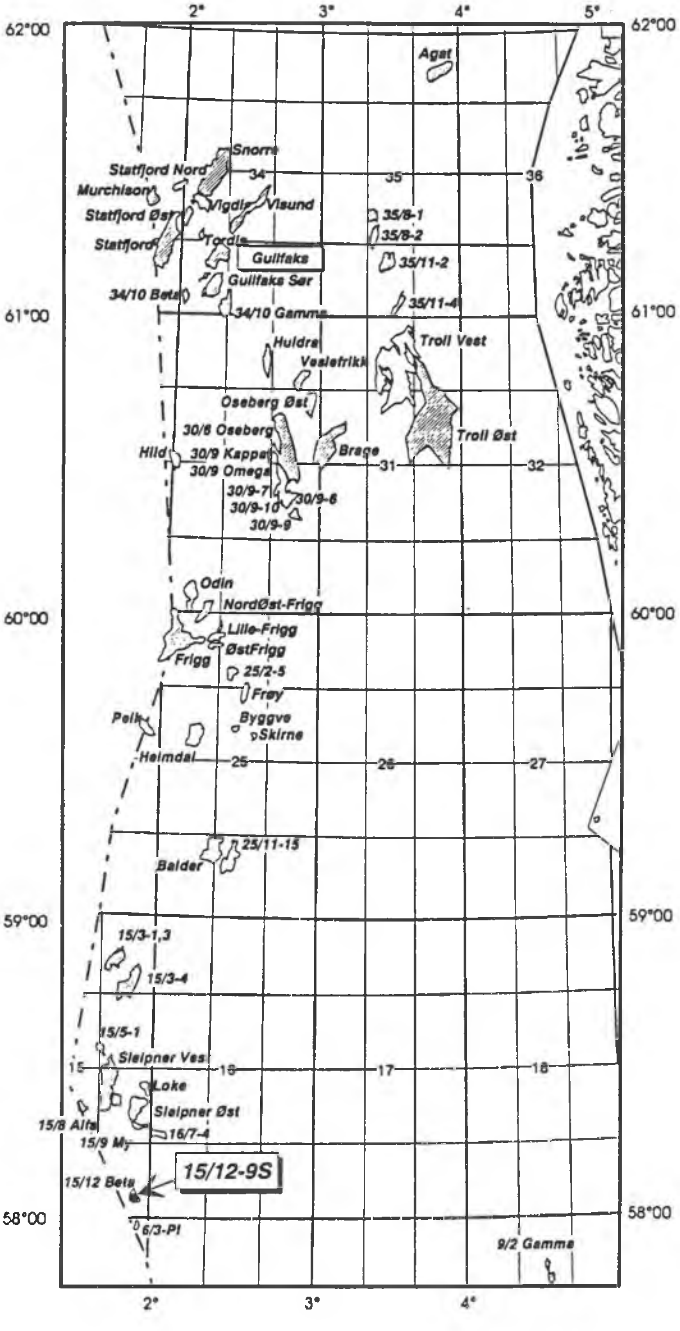
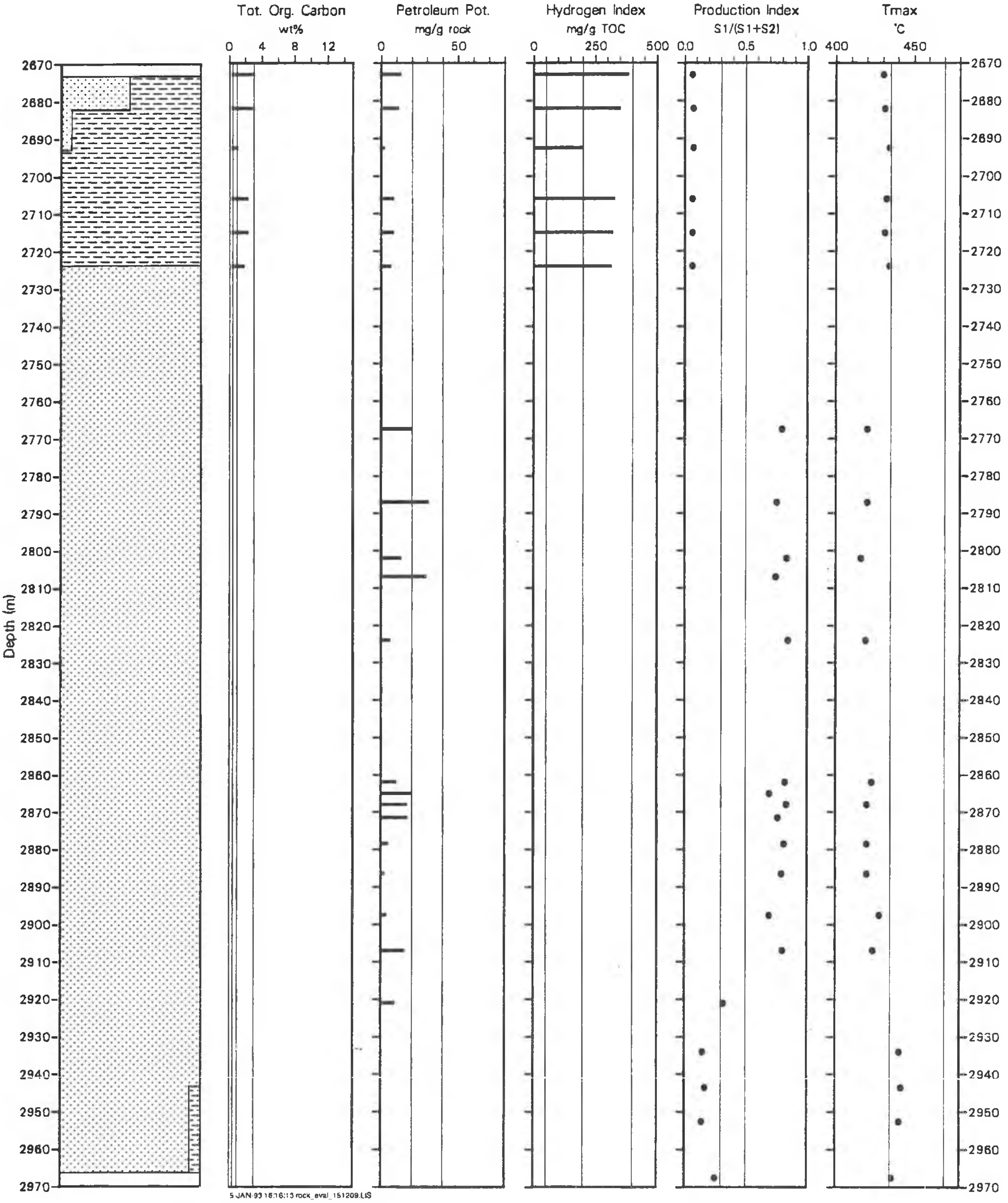


Figure 1.1 *Location map*

15/12-9S
ROCK-EVAL PYROLYSIS DATA



▤ Claystone
▒ Sandstone

Figure 2.1 *Rock-Eval pyrolysis data versus depth*

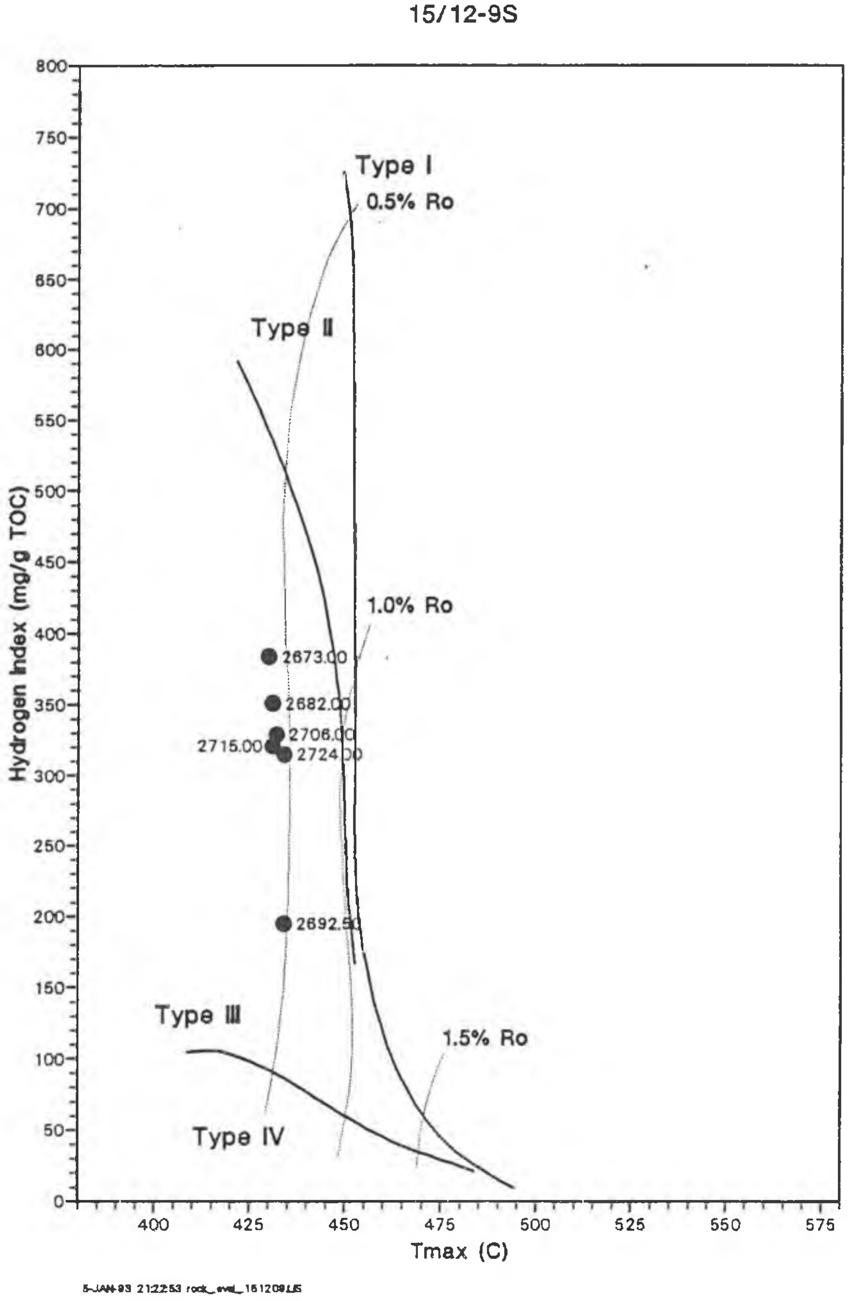


Figure 2.2 *Rock-Eval hydrogen index versus Tmax*

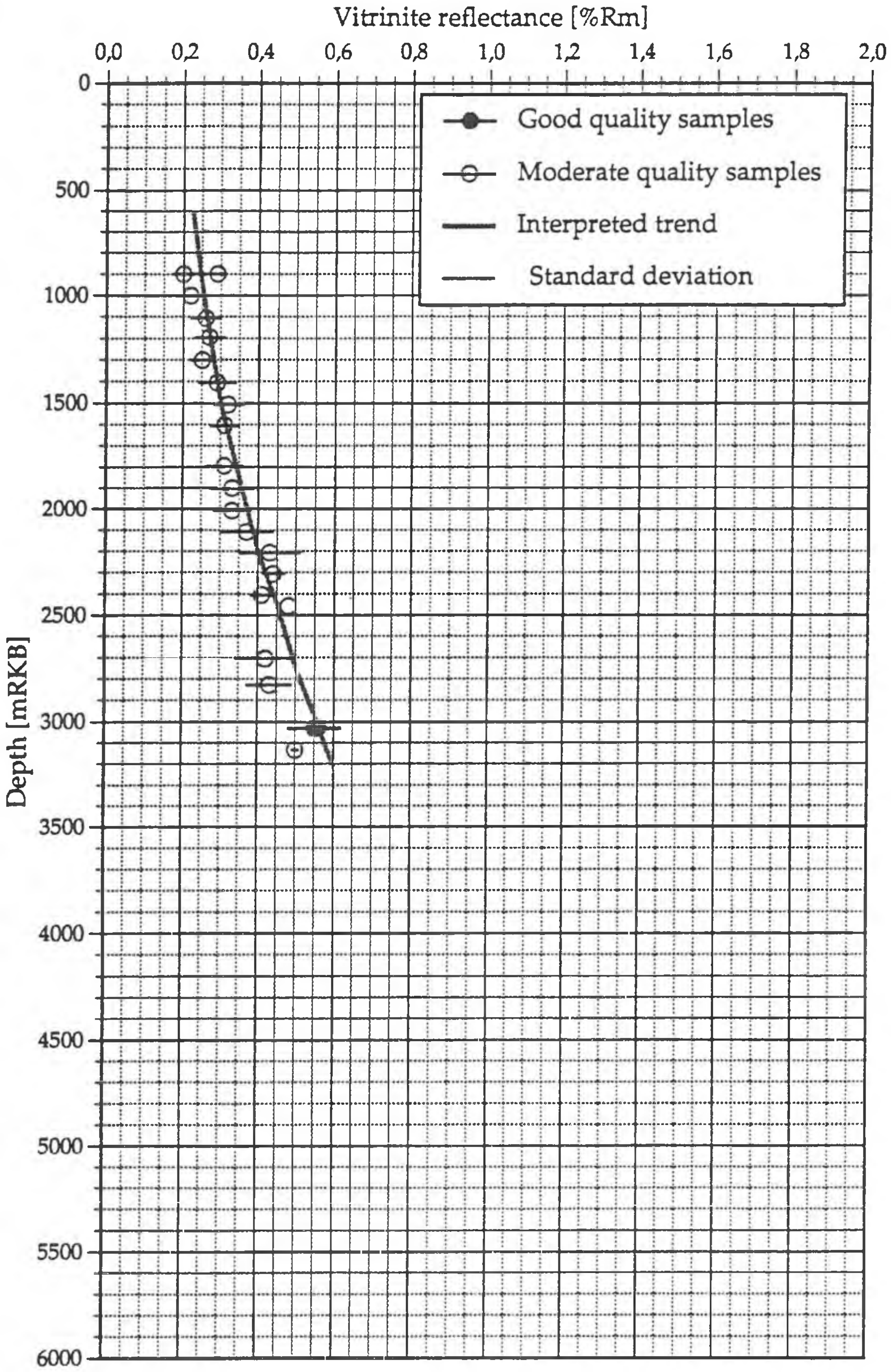


Figure 2.3 *Vitrinite reflectance versus depth*

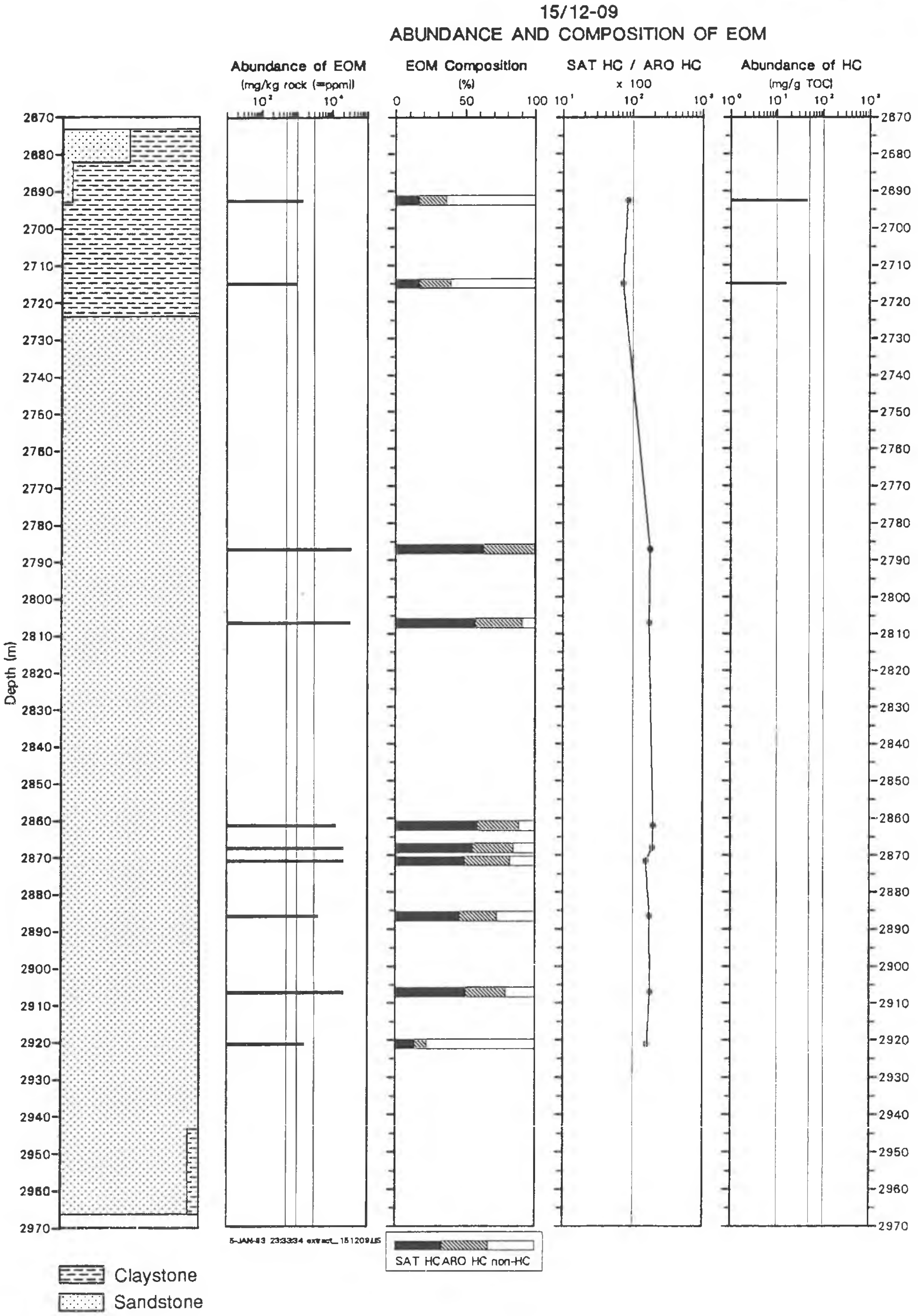
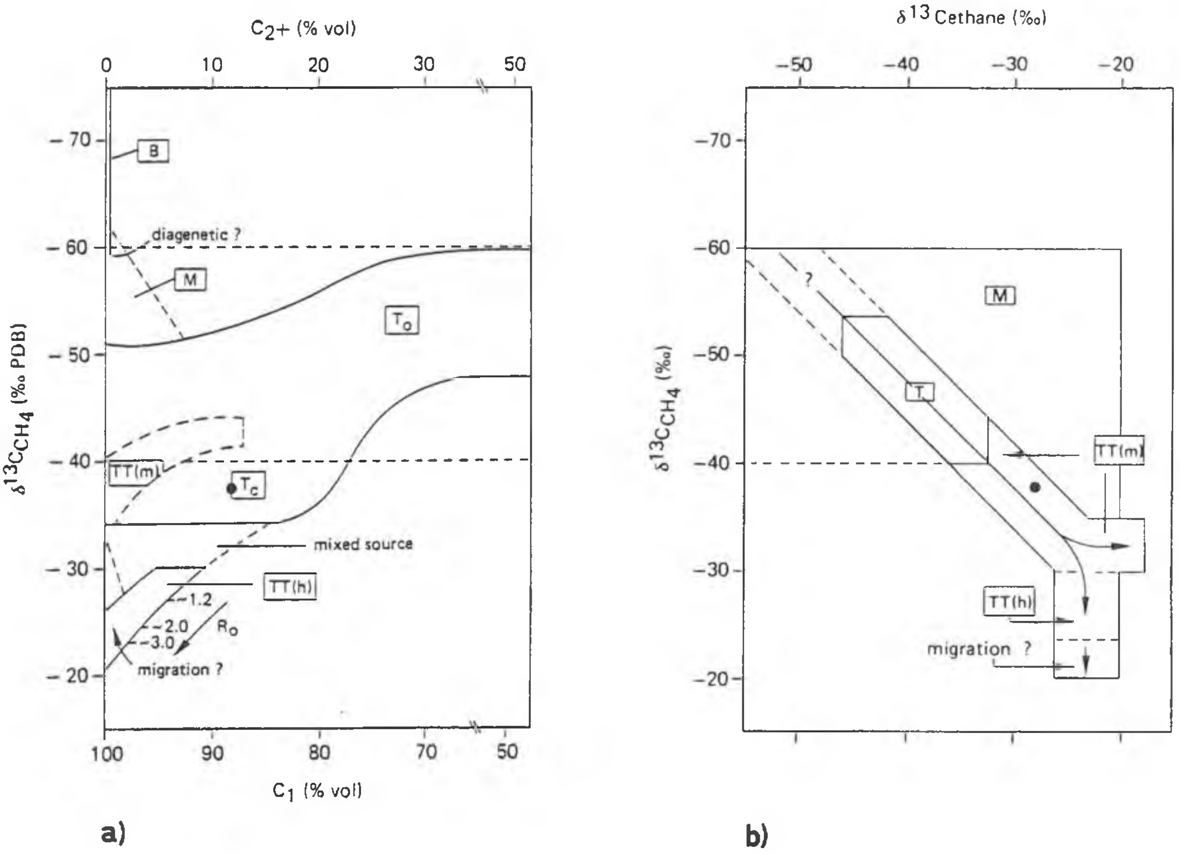
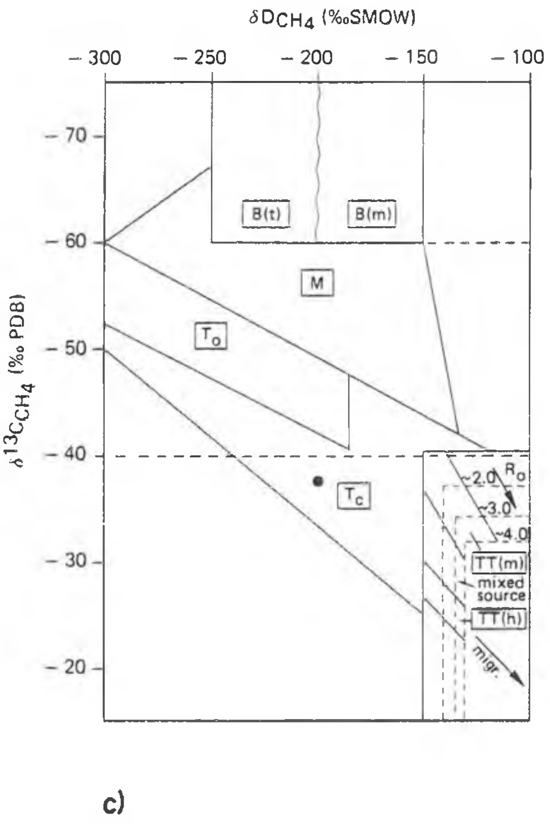


Figure 2.4 *Abundance and composition of EOM versus depth*



a)

b)



c)

Figure 2.5

Isotope plots for characterization of natural gas (after Schoell 1983). DST 2 gas sample (2810.00 m).

a) *Carbon isotope value of methane vs.* C_{2+}*-content.*

b) *Carbon isotope value of methane vs. carbon isotope value of ethane.*

c) *Carbon isotope value vs. hydrogen isotope value of methane.*

B = *bacterial gases*
T = *thermogenic (catagenetic) gases:*
T_o *associated with oil*
T_c *associated with condensate*
TT = *metagenetic gases*
(m) = *marine source material*
(h) = *humic source material*

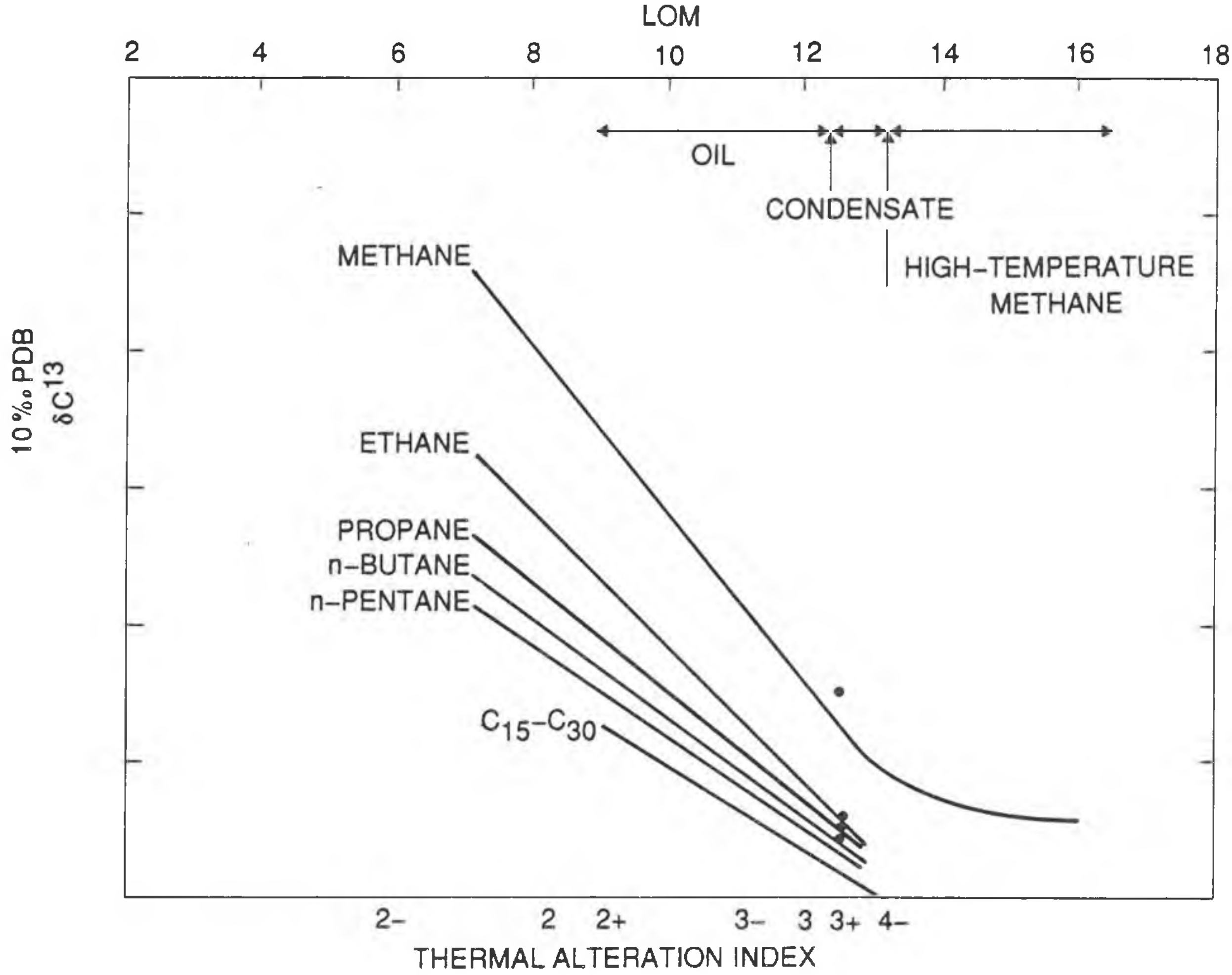


Figure 2.6 *Isotope plot for maturity characterization of natural gas (after James, 1983). Differences in carbon isotope values for individual gas components of the DST 2 gas sample (2810.00 m) are plotted. Note that other plotting positions are possible since the data do not match the curves perfectly.*
"Old" TAI (scale 1-5) is used.

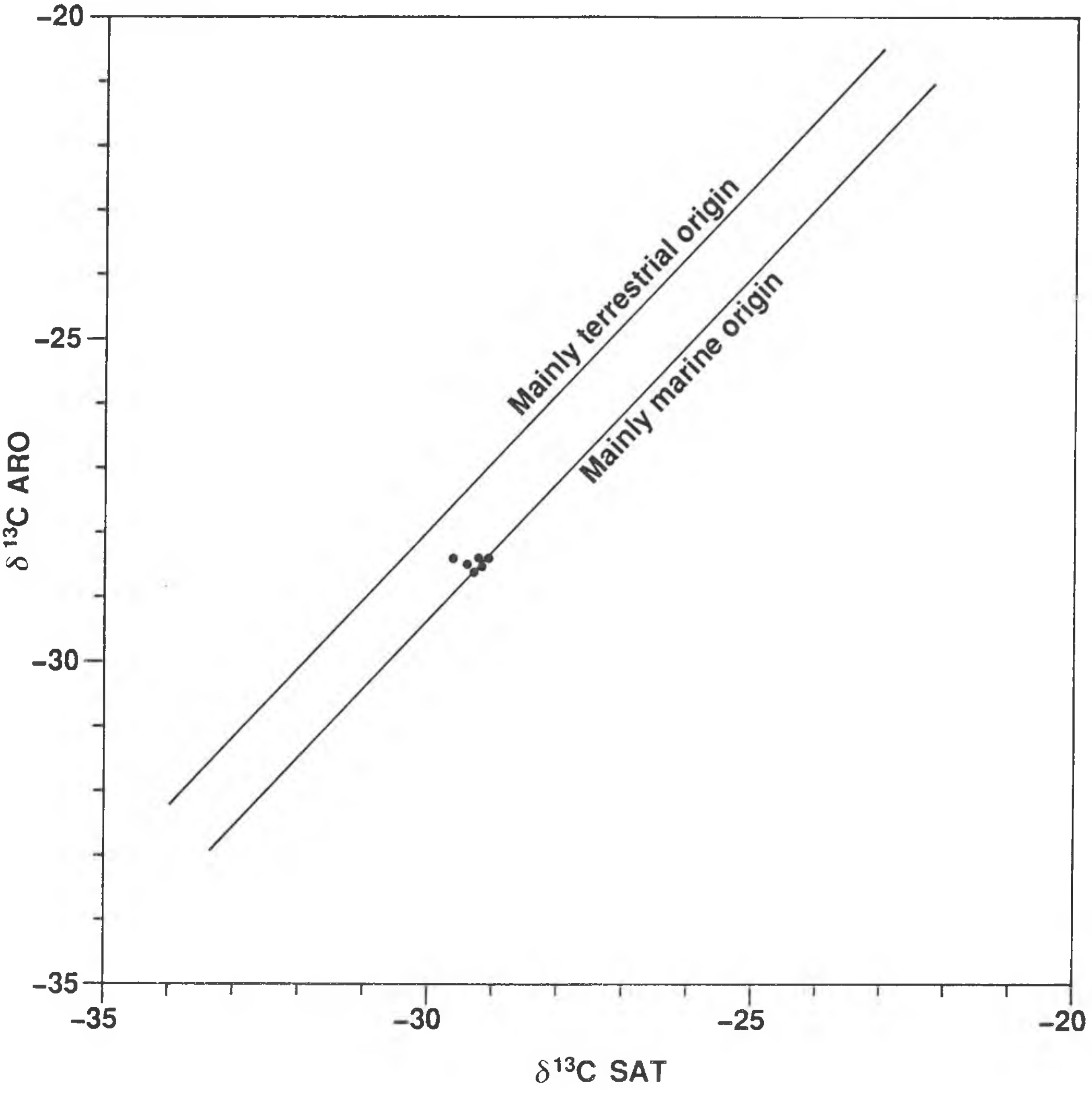
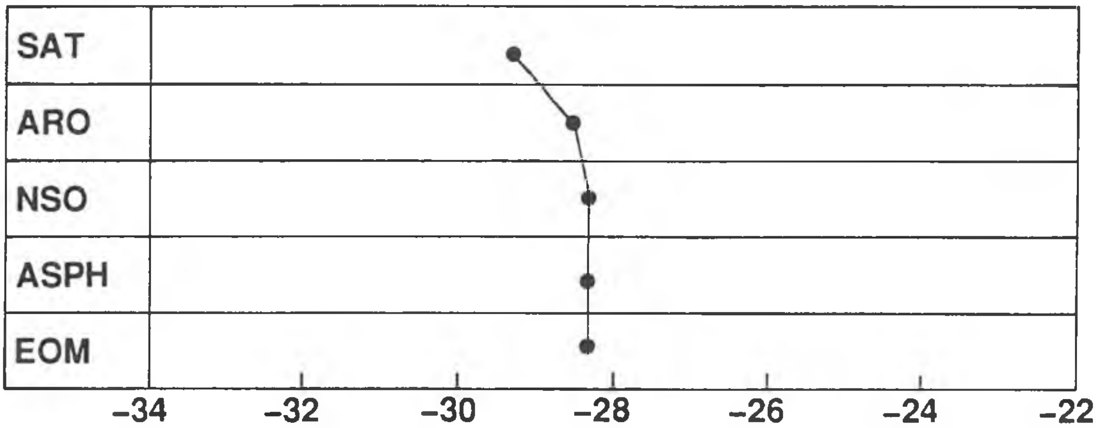


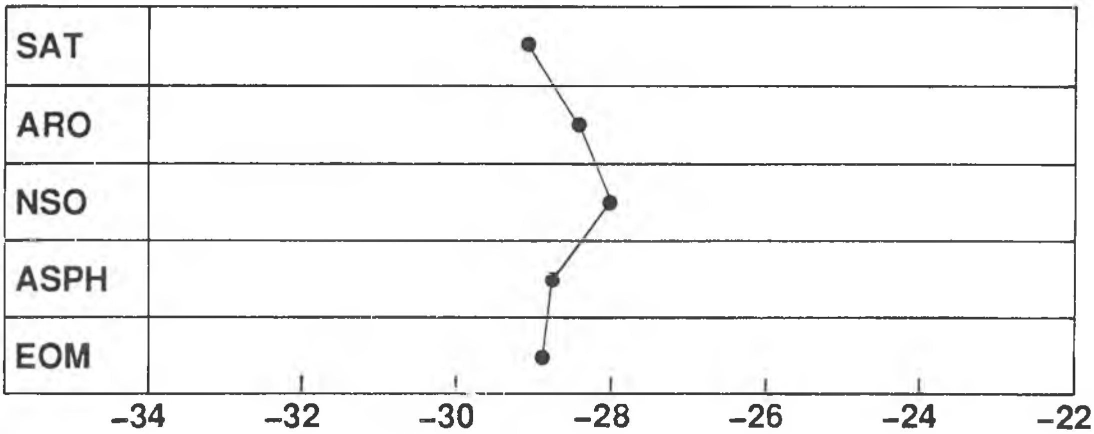
Figure 2.7 $\delta^{13}C$ *isotope values of saturated versus aromatic hydrocarbons (°/₀₀ PDB). After Sofer, 1984.*

Figure 2.8

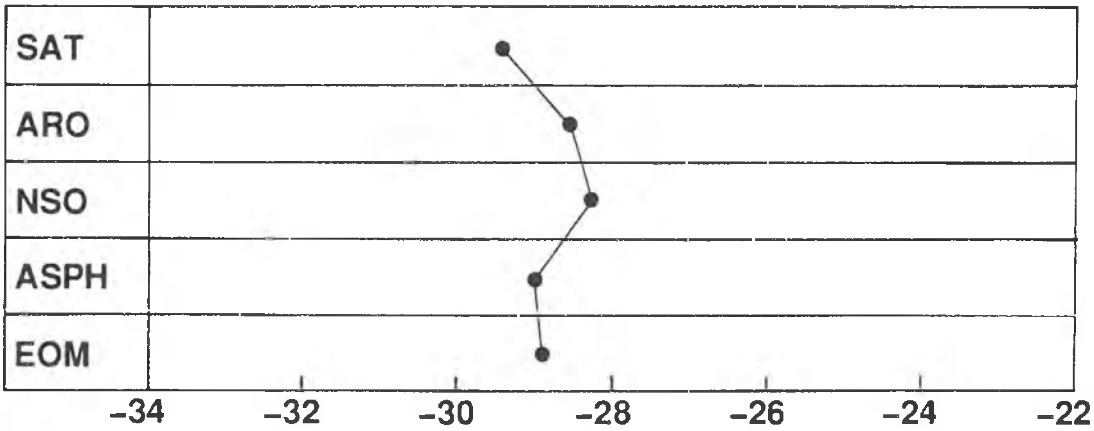
Isotope type curves (Galimov plot)



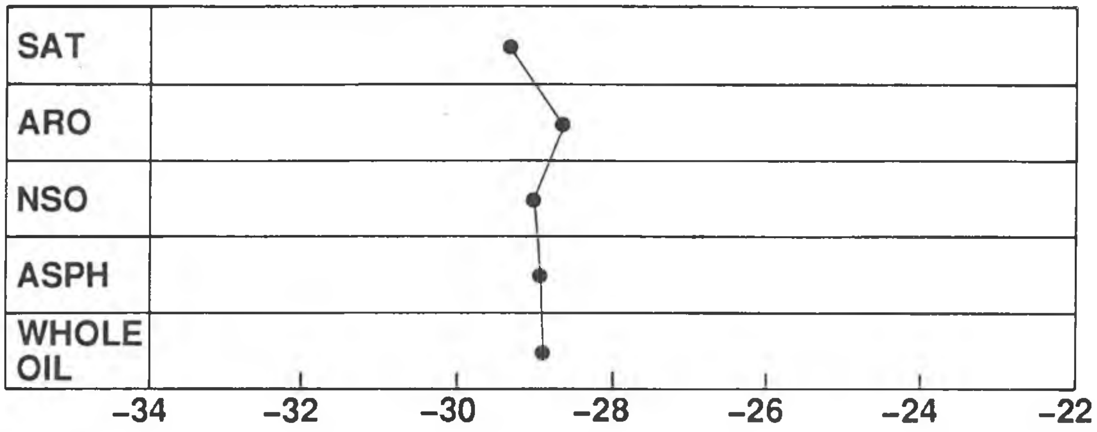
G 5669
2715m
Claystone



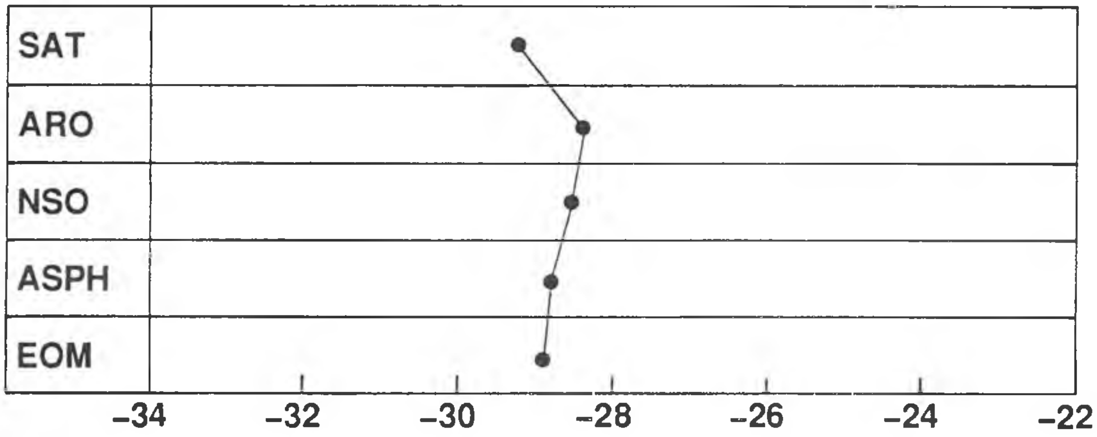
G 5652
2787.00m
Sandstone



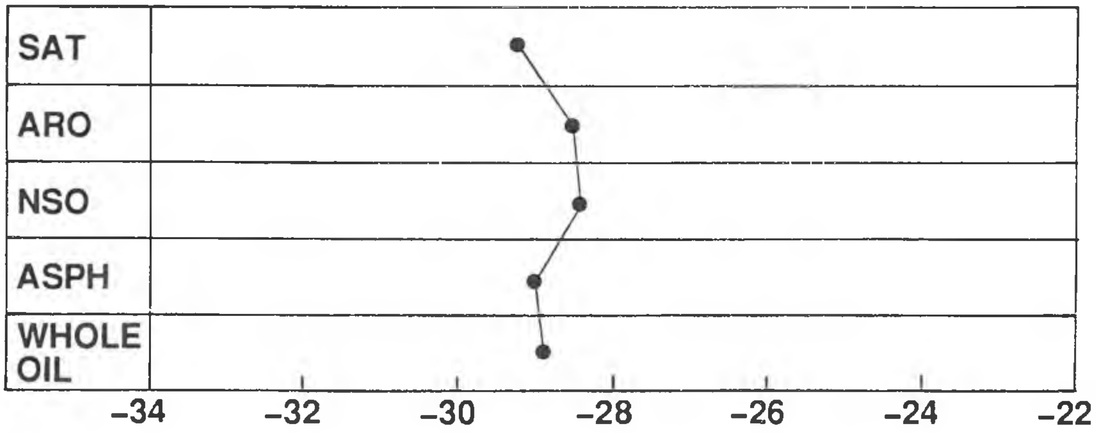
G 5654
2807.00m
Sandstone



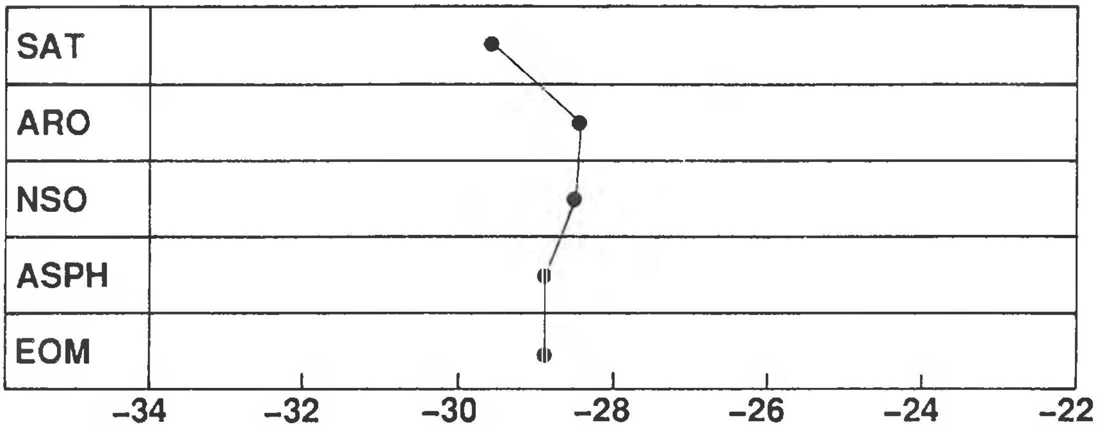
G 5683
2810.00m
Oil



G 5656
2862.00m
Sandstone



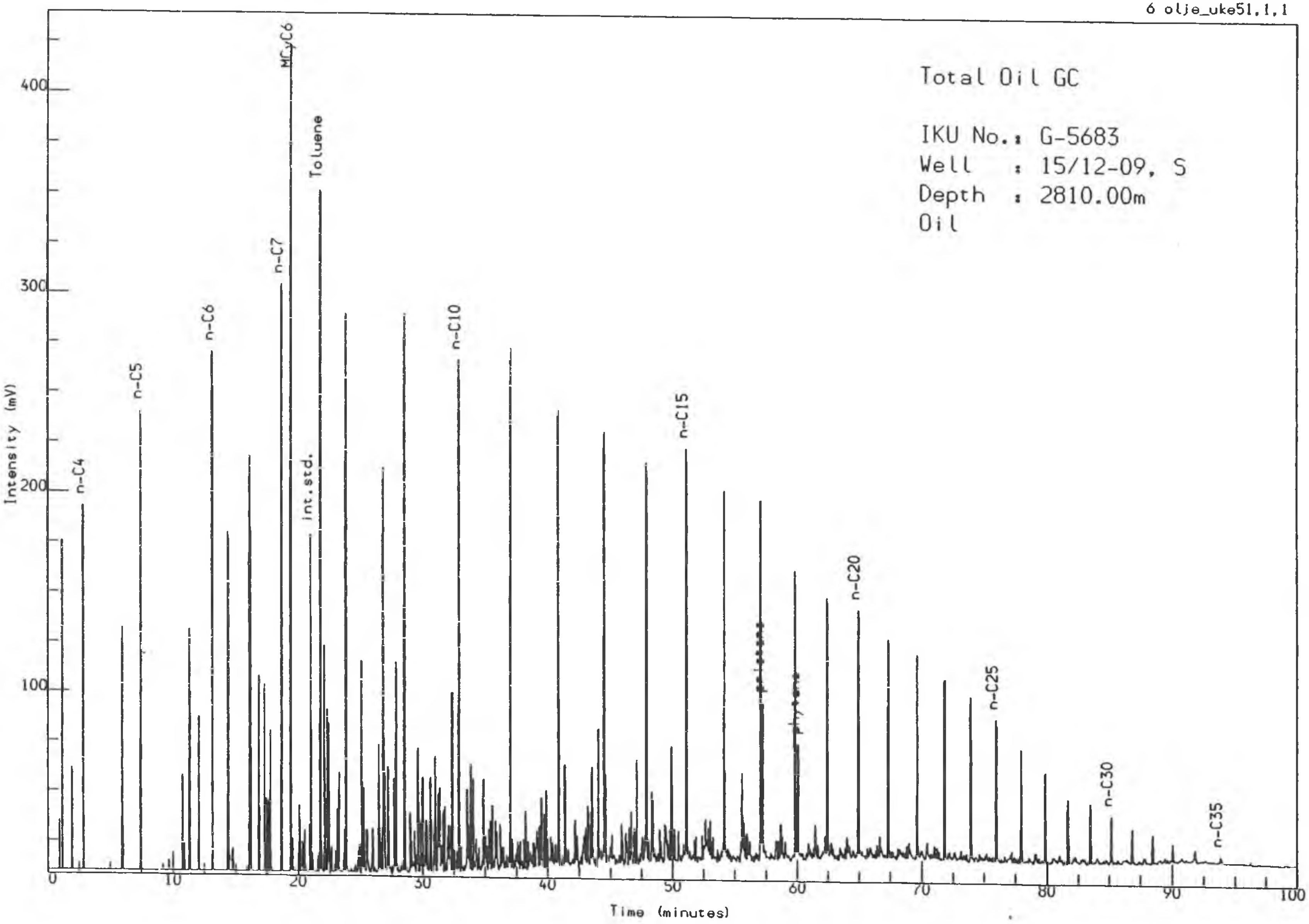
G 5684
2863.50m
Oil



G 5663
2907.00m
Sandstone

Figure 2.9

Gas chromatograms of total oil


6 olje_uke51.1.1
Total Oil GC
IKU No.: G-5683
Well : 15/12-09, S
Depth : 2810.00m
Oil
Intensity (mV)
400
300
200
100
n-C4
n-C5
n-C6
n-C7
MCyC6
Toluene
int.std.
n-C10
n-C15
pristane
phytane
n-C20
n-C25
n-C30
n-C35
0
10
20
30
40
50
60
70
80
90
100
Time (minutes)

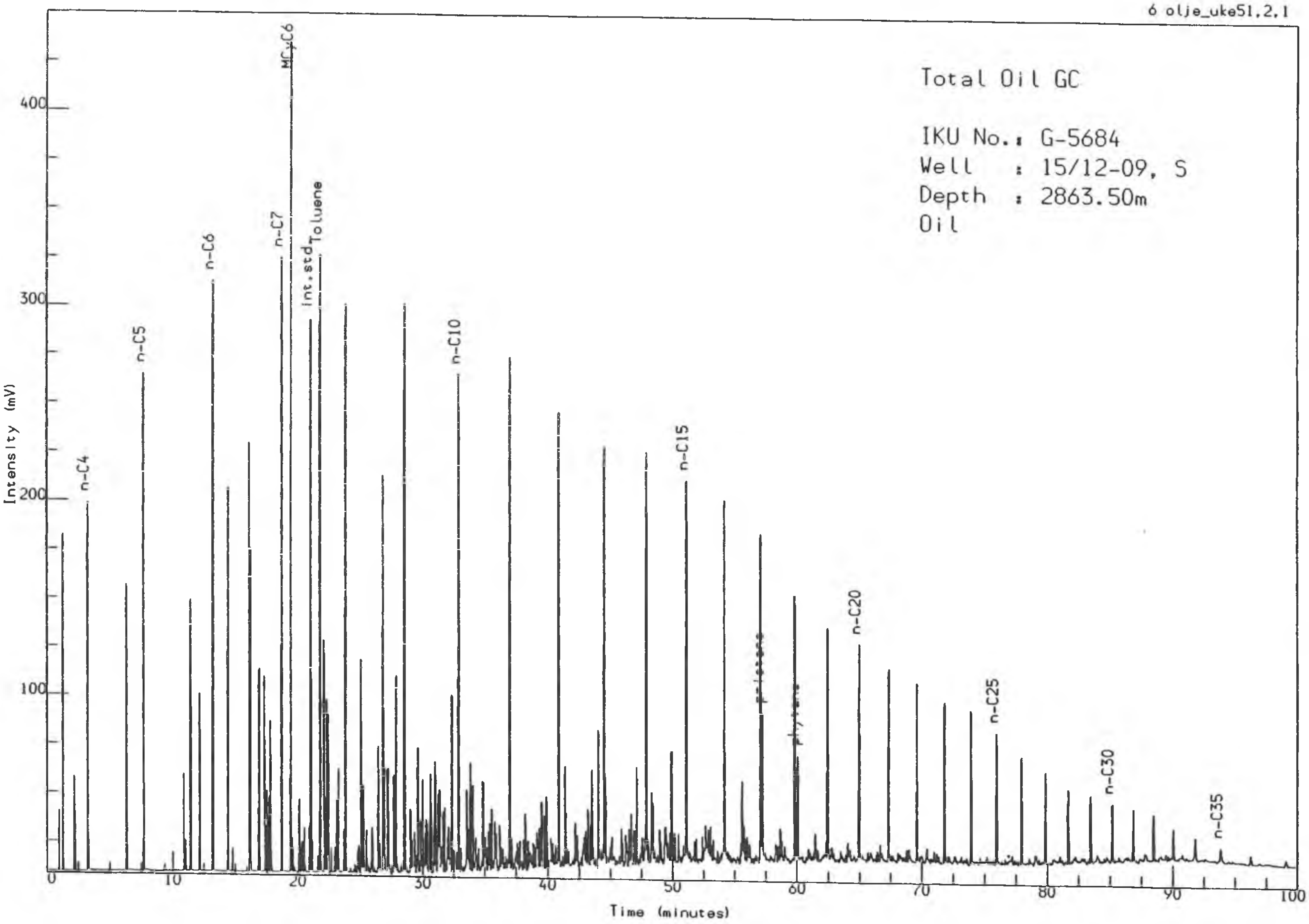
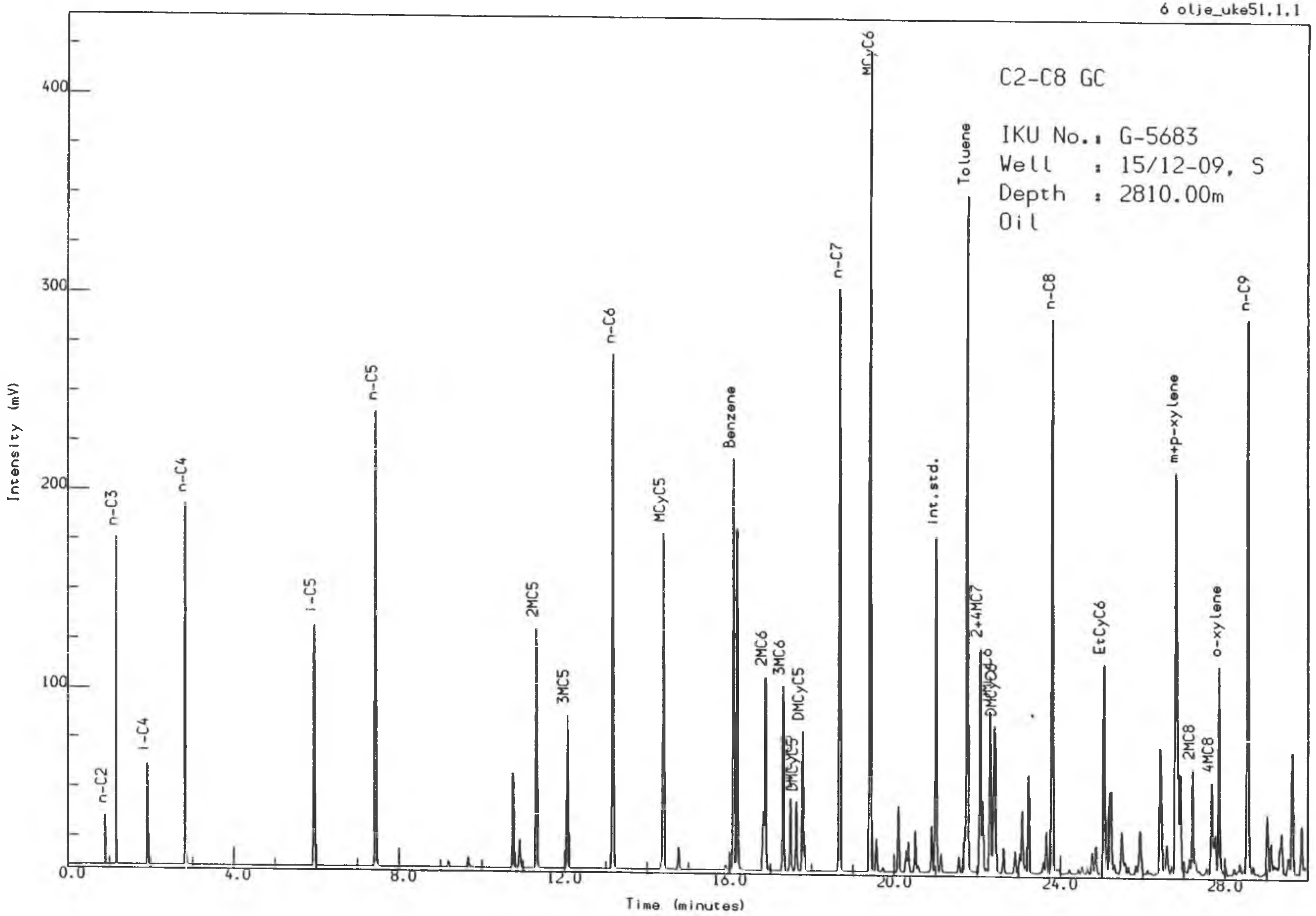
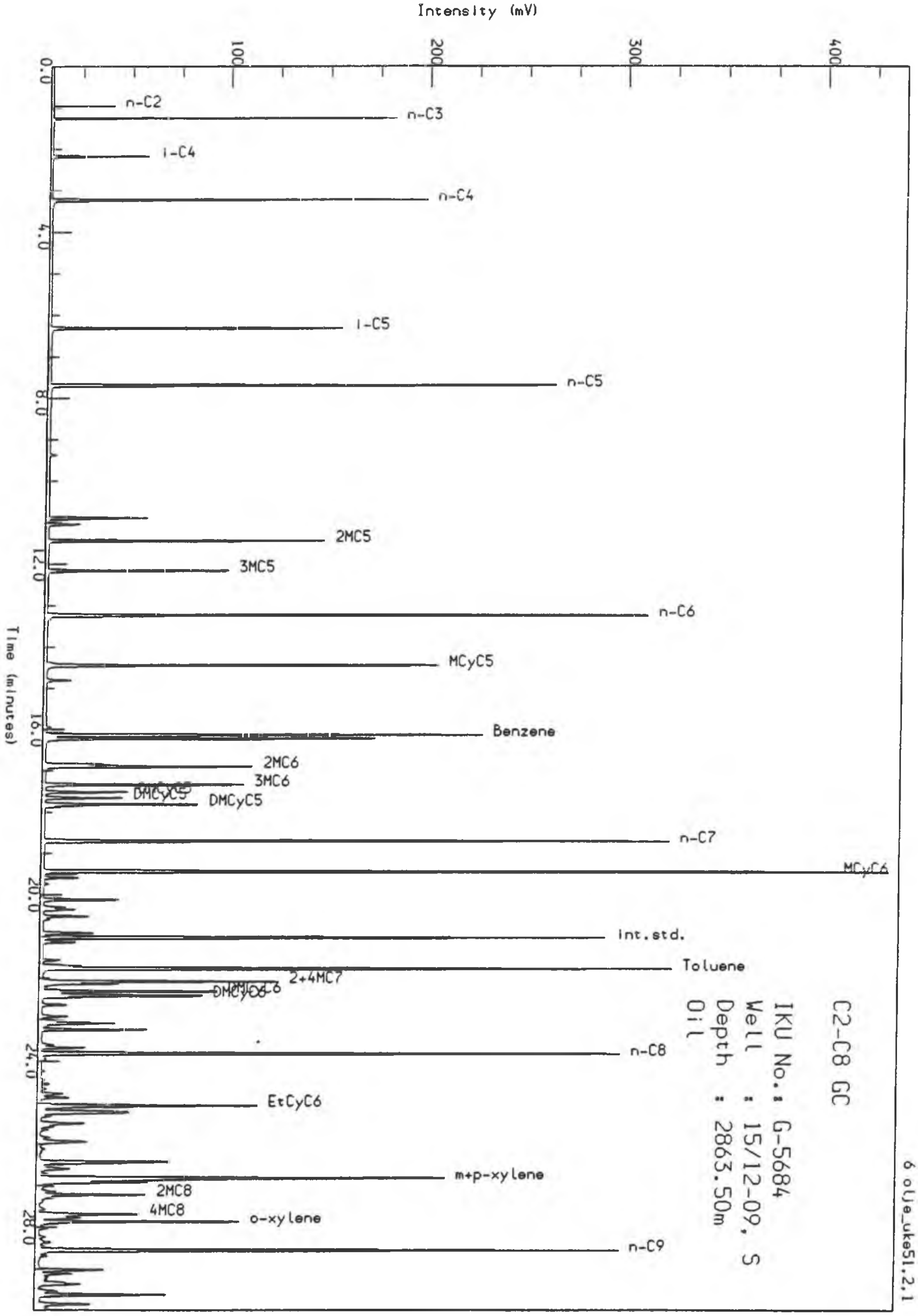

6 olje_uke51.2.1
Total Oil GC
IKU No.: G-5684
Well : 15/12-09, S
Depth : 2863.50m
Oil
n-C4
n-C5
n-C6
n-C7
MCyC6
int.std
Toluene
n-C10
n-C15
pristane
phytane
n-C20
n-C25
n-C30
n-C35
Intensity (mV)
100
200
300
400
Time (minutes)
0
10
20
30
40
50
60
70
80
90
100

Figure 2.10

Gas chromatograms of the C_2-C_8 fraction of oils


6 olje_uke51.1.1
C2-C8 GC
IKU No.: G-5683
Well : 15/12-09, S
Depth : 2810.00m
Oil
Intensity (mV)
0.0
100
200
300
400
Time (minutes)
4.0
8.0
12.0
16.0
20.0
24.0
28.0
n-C2
n-C3
i-C4
n-C4
i-C5
n-C5
2MC5
3MC5
n-C6
MCyC5
Benzene
2MC6
3MC6
DMCyC5
DMCyC5
n-C7
MCyC6
int.std.
Toluene
2+4MC7
DMCyC6
n-C8
EtCyC6
m+p-xylene
2MC8
4MC8
o-xylene
n-C9

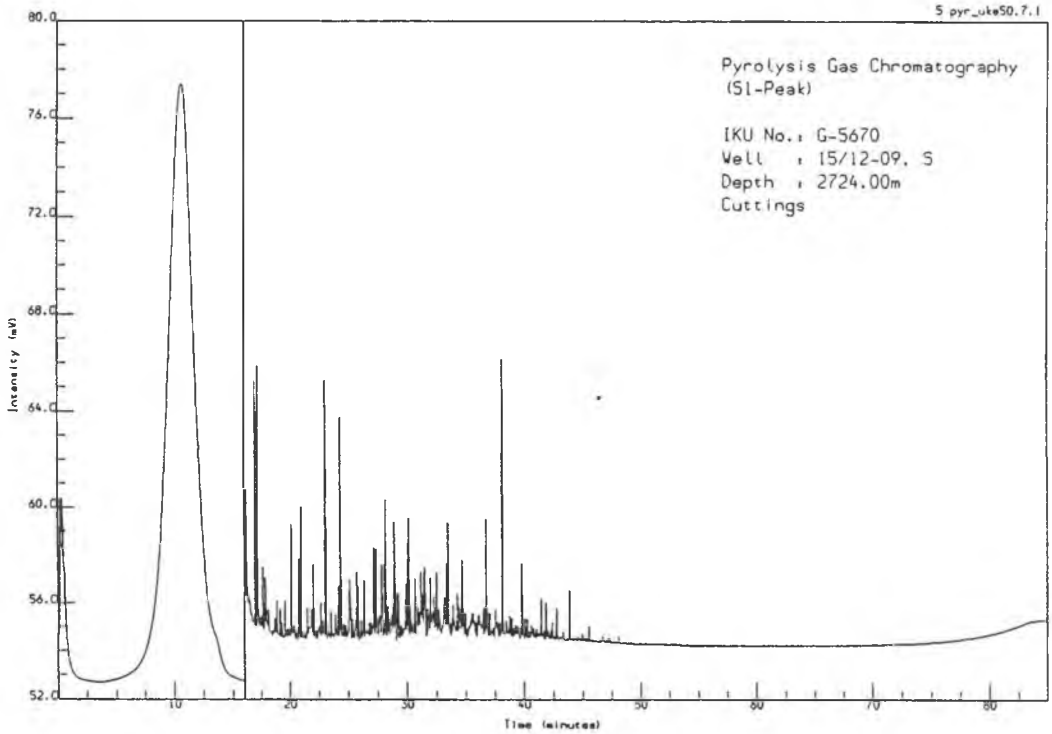


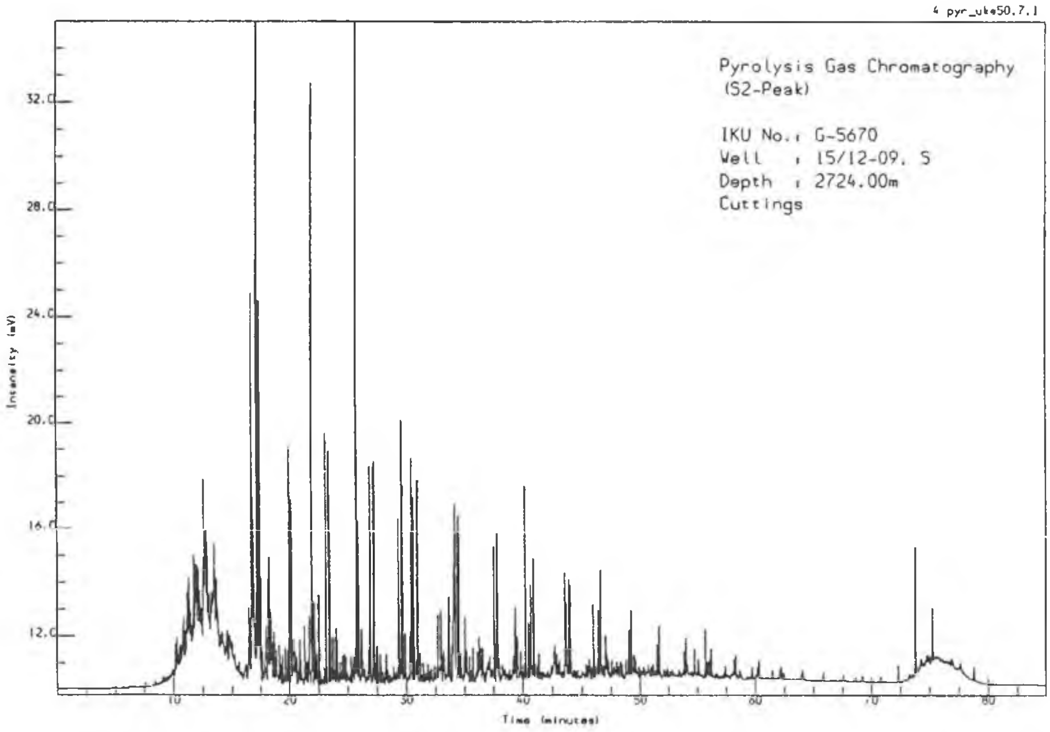
C2-C8 GC

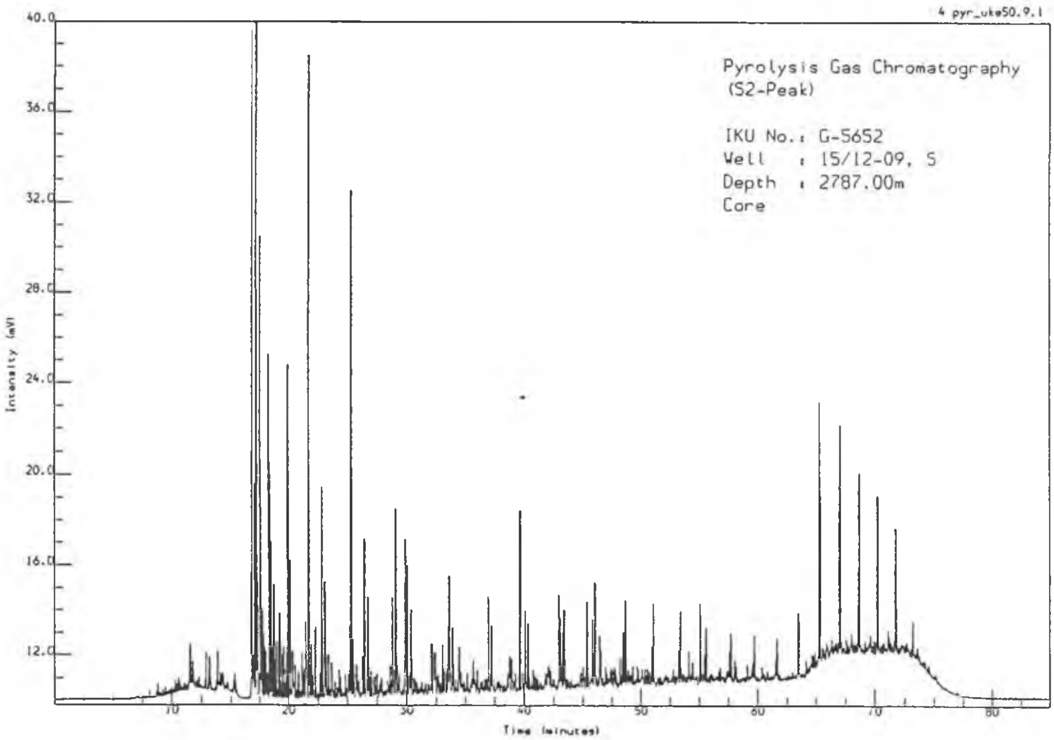
IKU No.: G-5684
Well : 15/12-09, S
Depth : 2863.50m
Oil

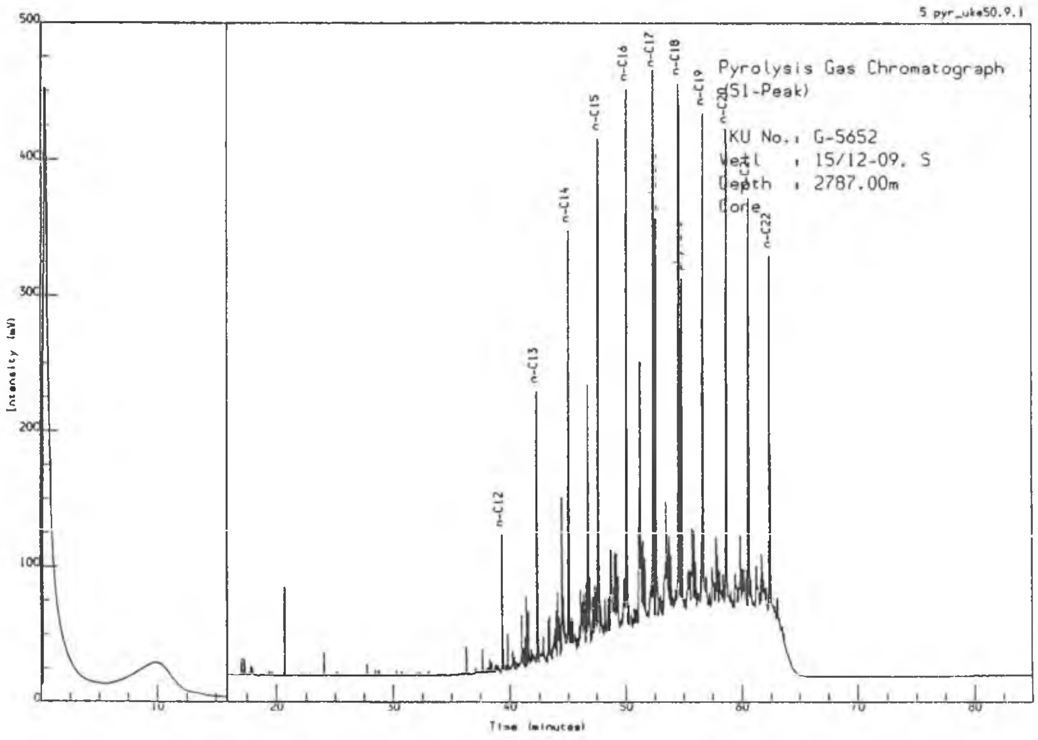
Figure 2.11

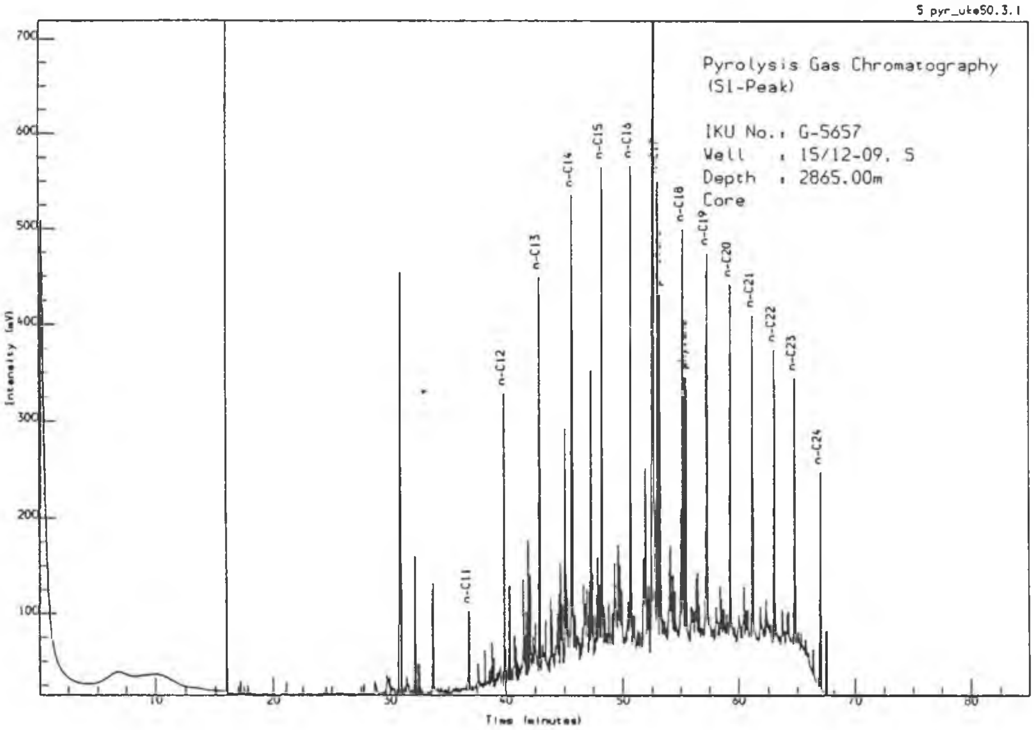
Gas chromatograms of thermal extract and pyrolysate

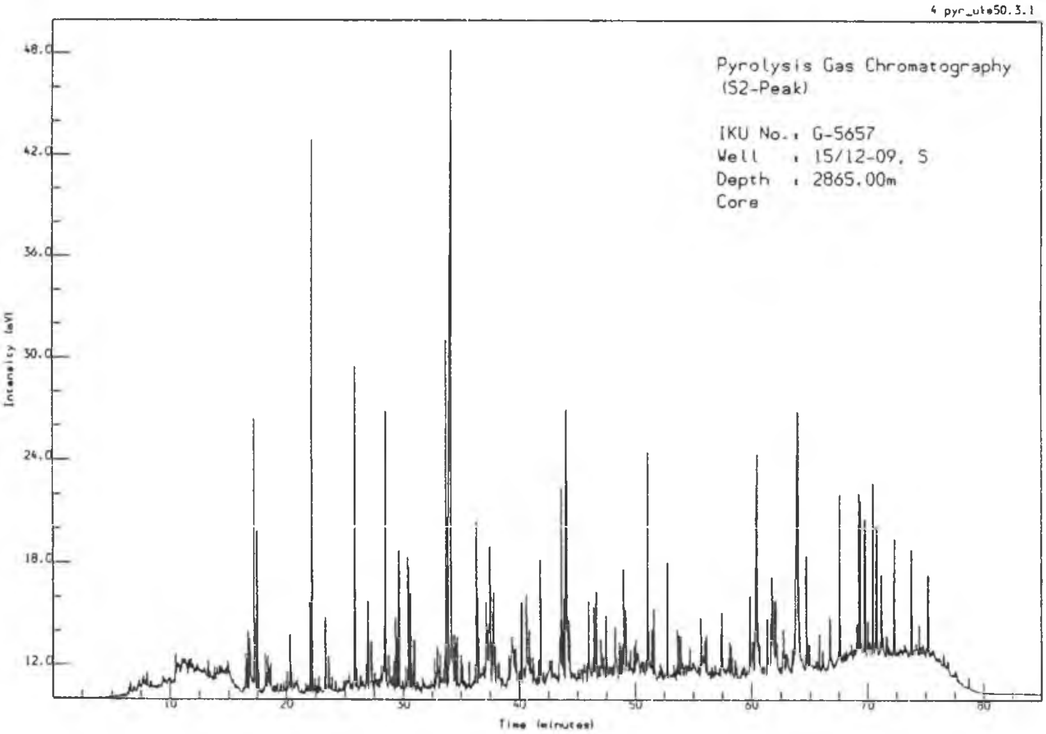

5 pyr_uke50.7.1
Pyrolysis Gas Chromatography
(S1-Peak)
IKU No.: G-5670
Well : 15/12-09, S
Depth : 2724.00m
Cuttings
80.0
76.0
72.0
68.0
64.0
60.0
56.0
52.0
Intensity (mV)
10
20
30
40
50
60
70
80
Time (minutes)

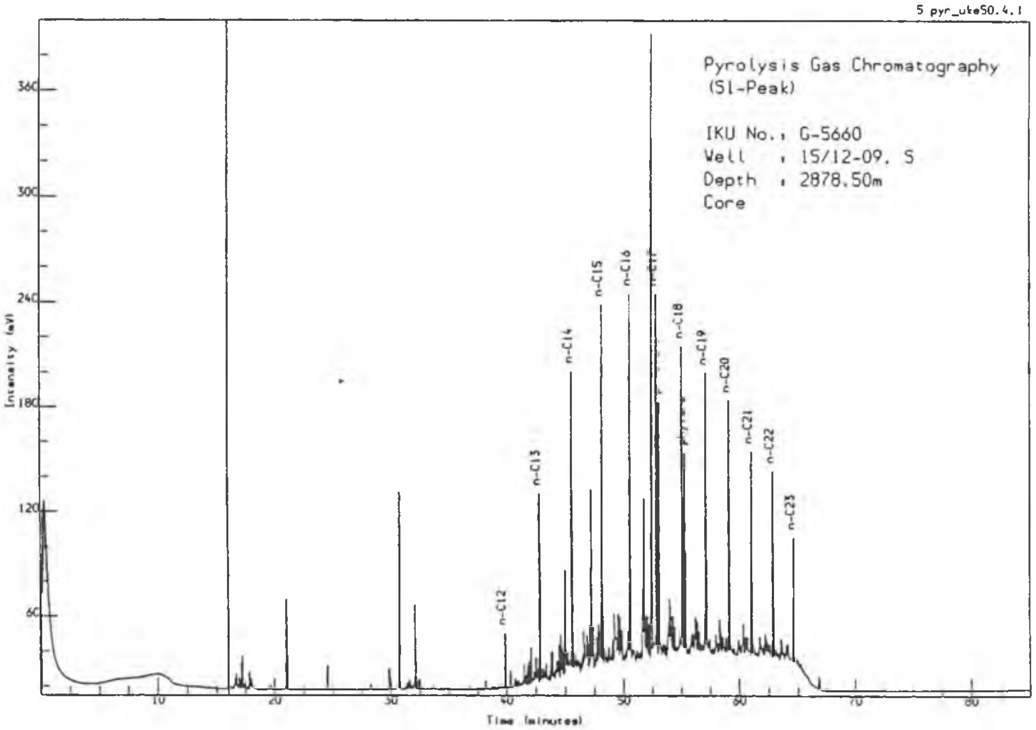

4 pyr_uke50.7.1
Pyrolysis Gas Chromatography
(S2-Peak)
IKU No.: G-5670
Well : 15/12-09, S
Depth : 2724.00m
Cuttings
32.0
28.0
24.0
20.0
16.0
12.0
Intensity (mV)
10
20
30
40
50
60
70
80
Time (minutes)

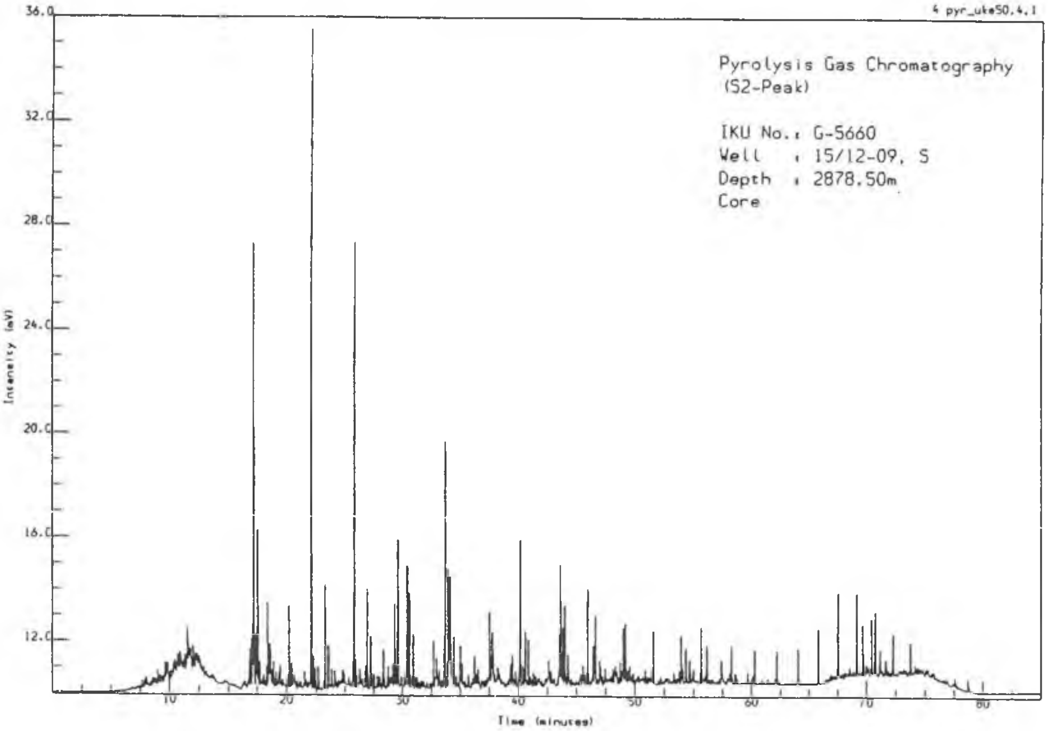

4 pyr_uke50.9.1
Pyrolysis Gas Chromatography
(S2-Peak)
IKU No.: G-5652
Well : 15/12-09, S
Depth : 2787.00m
Core
Intensity (mV)
40.0
36.0
32.0
28.0
24.0
20.0
16.0
12.0
10
20
30
40
50
60
70
80
Time (minutes)

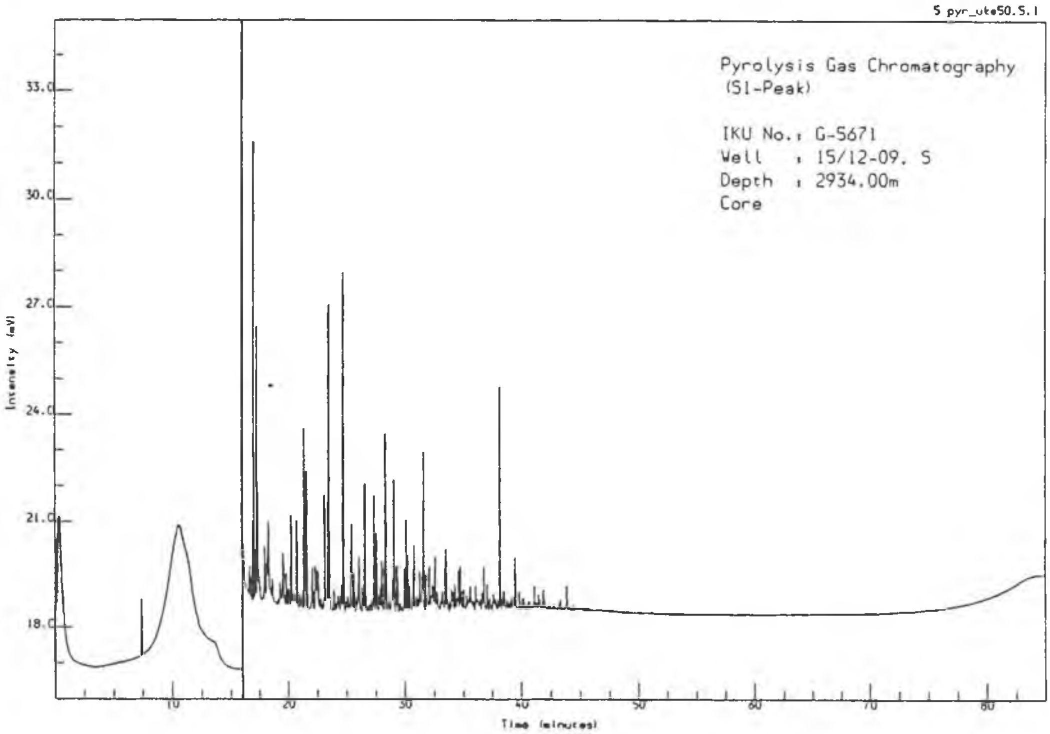

5 pyr_uke50.9.1
Pyrolysis Gas Chromatograph
(S1-Peak)
IKU No.: G-5652
Well : 15/12-09, S
Depth : 2787.00m
Core
n-C12
n-C13
n-C14
n-C15
n-C16
n-C17
n-C18
n-C19
n-C20
n-C22
Intensity (mV)
500
400
300
200
100
0
10
20
30
40
50
60
70
80
Time (minutes)


5 pyr_uke50.3.1
Pyrolysis Gas Chromatography
(S1-Peak)
IKU No.: G-5657
Well : 15/12-09, S
Depth : 2865.00m
Core
Intensity (mV)
700
600
500
400
300
200
100
n-C11
n-C12
n-C13
n-C14
n-C15
n-C16
n-C17
pristane
n-C18
phytane
n-C19
n-C20
n-C21
n-C22
n-C23
n-C24
10
20
30
40
50
60
70
80
Time (minutes)


4 pyr_uke50.3.1
Pyrolysis Gas Chromatography
(S2-Peak)
IKU No.: G-5657
Well : 15/12-09, S
Depth : 2865.00m
Core
Intensity (mV)
48.0
42.0
36.0
30.0
24.0
18.0
12.0
10
20
30
40
50
60
70
80
Time (minutes)


5 pyr_uke50.4.1
Pyrolysis Gas Chromatography
(S1-Peak)
IKU No.: G-5660
Well : 15/12-09, S
Depth : 2878.50m
Core
Intensity (mV)
360
300
240
180
120
60
n-C12
n-C13
n-C14
n-C15
n-C16
n-C17
n-C18
n-C19
n-C20
n-C21
n-C22
n-C23
10
20
30
40
50
60
70
80
Time (minutes)


4 pyr_uke50.4.1
Pyrolysis Gas Chromatography
(S2-Peak)
IKU No.: G-5660
Well : 15/12-09, S
Depth : 2878.50m
Core
Intensity (mV)
36.0
32.0
28.0
24.0
20.0
16.0
12.0
10
20
30
40
50
60
70
80
Time (minutes)


5 pyr_uke50.S.1
Pyrolysis Gas Chromatography
(S1-Peak)
IKU No. : G-5671
Well : 15/12-09. S
Depth : 2934.00m
Core
Intensity (mV)
33.0
30.0
27.0
24.0
21.0
18.0
10
20
30
40
50
60
70
80
Time (minutes)

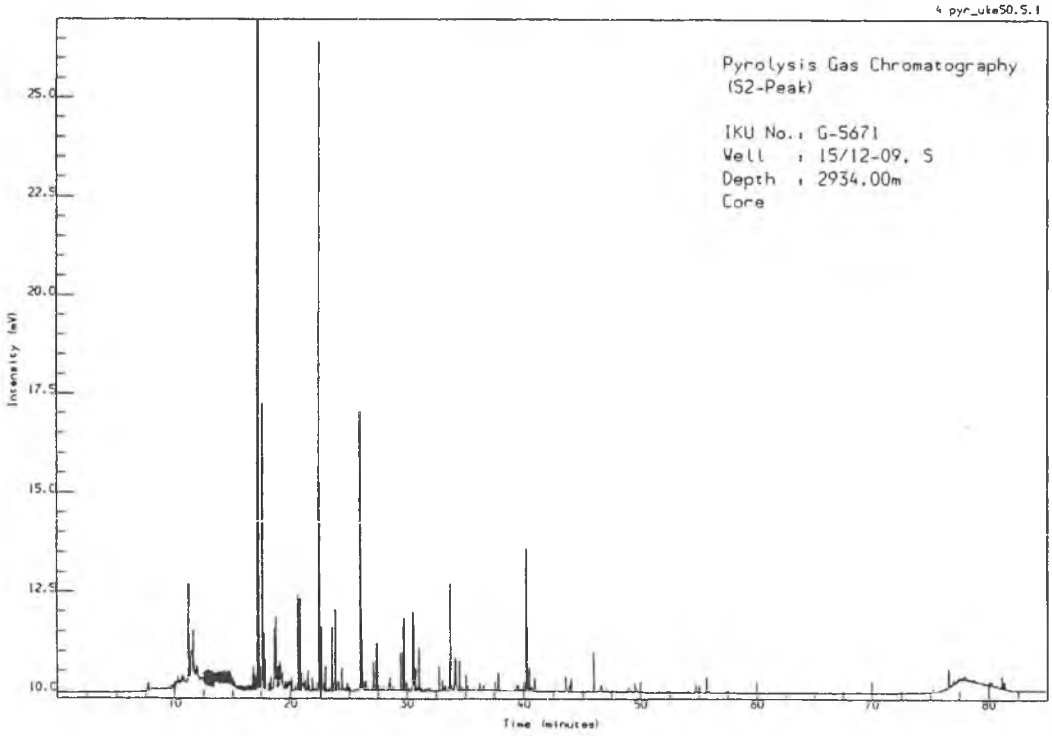
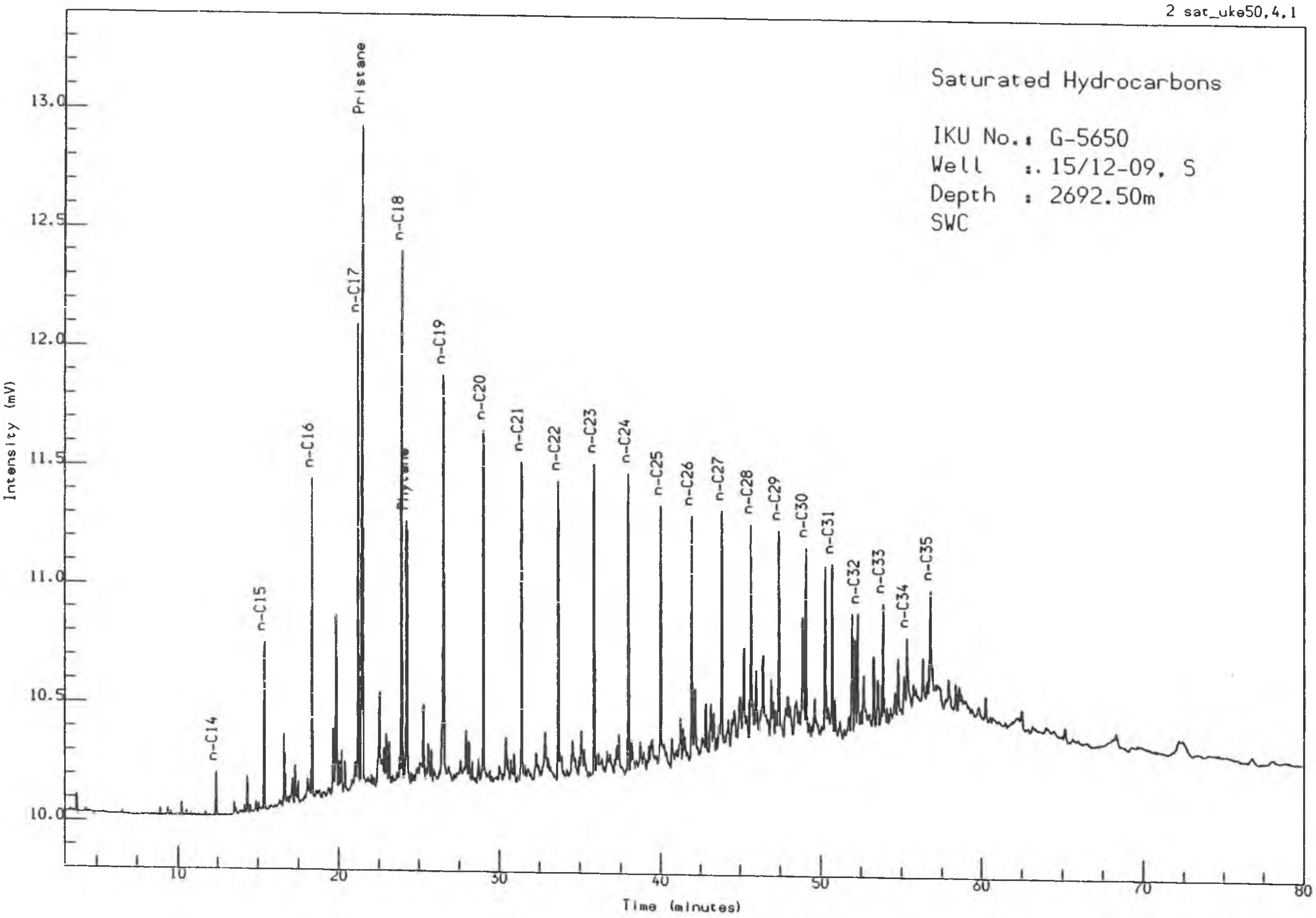
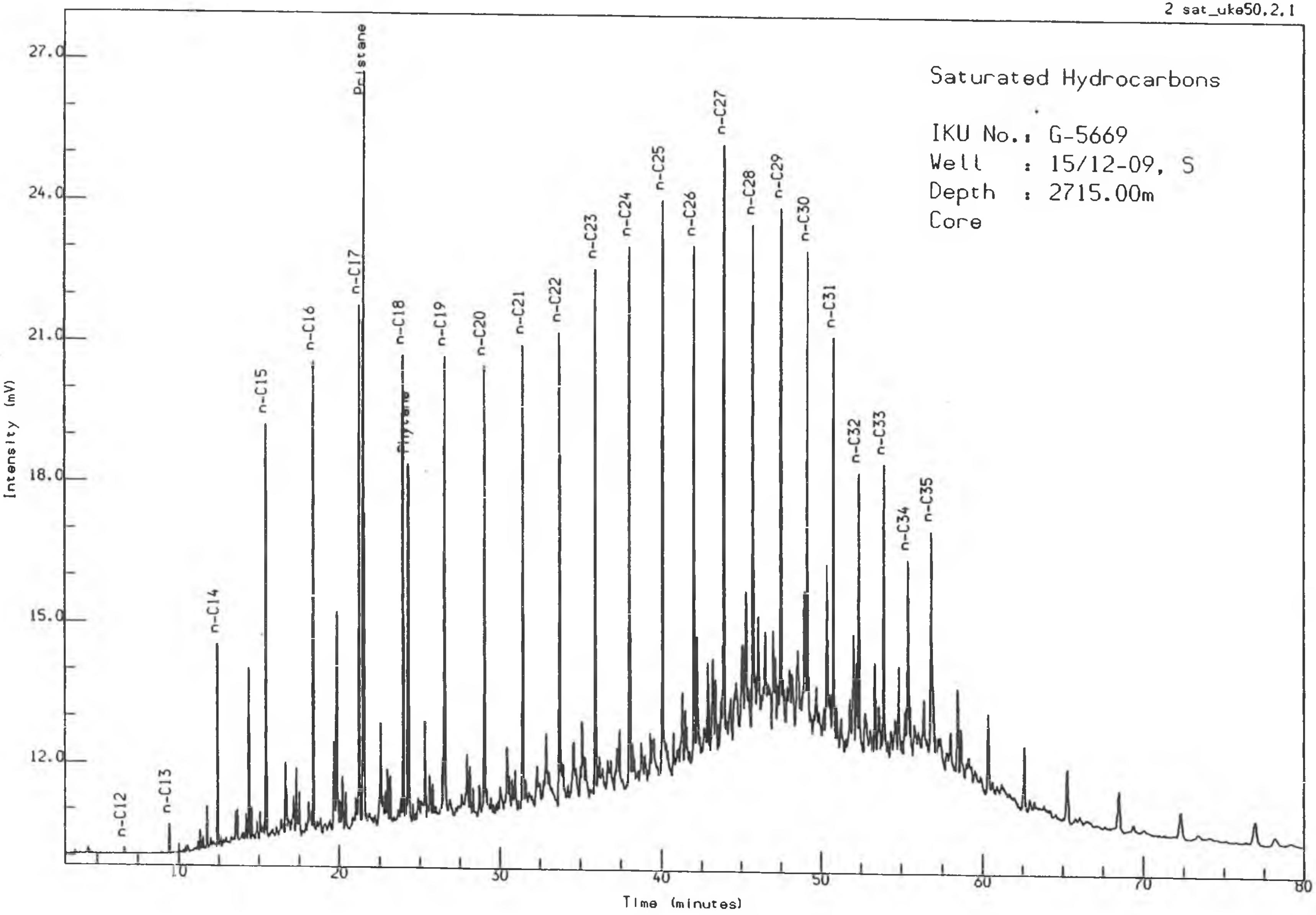
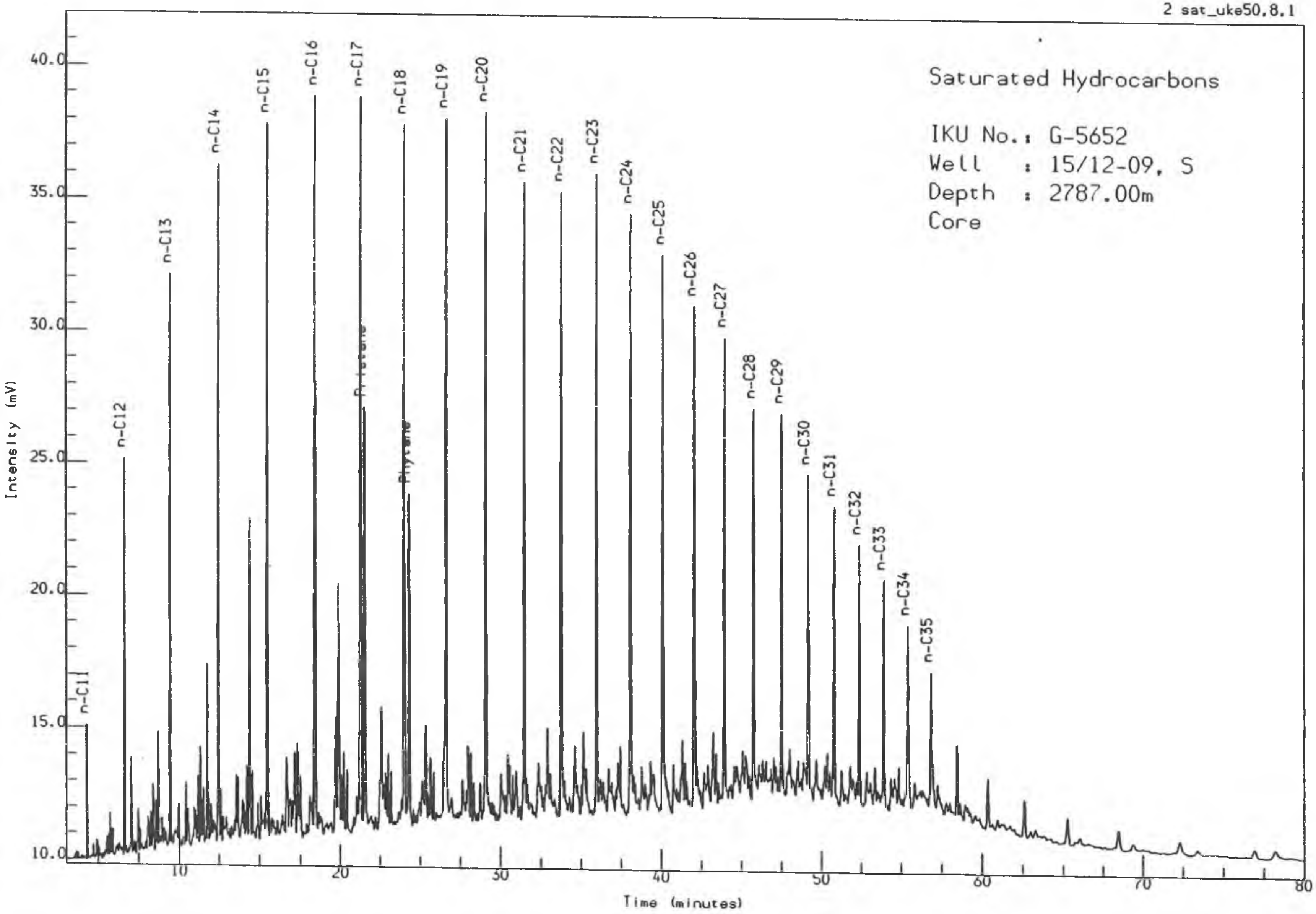

4 pyr_uke50.S.1
Pyrolysis Gas Chromatography
(S2-Peak)
IKU No. : G-5671
Well : 15/12-09. S
Depth : 2934.00m
Core
Intensity (mV)
25.0
22.5
20.0
17.5
15.0
12.5
10.0
10
20
30
40
50
60
70
80
Time (minutes)

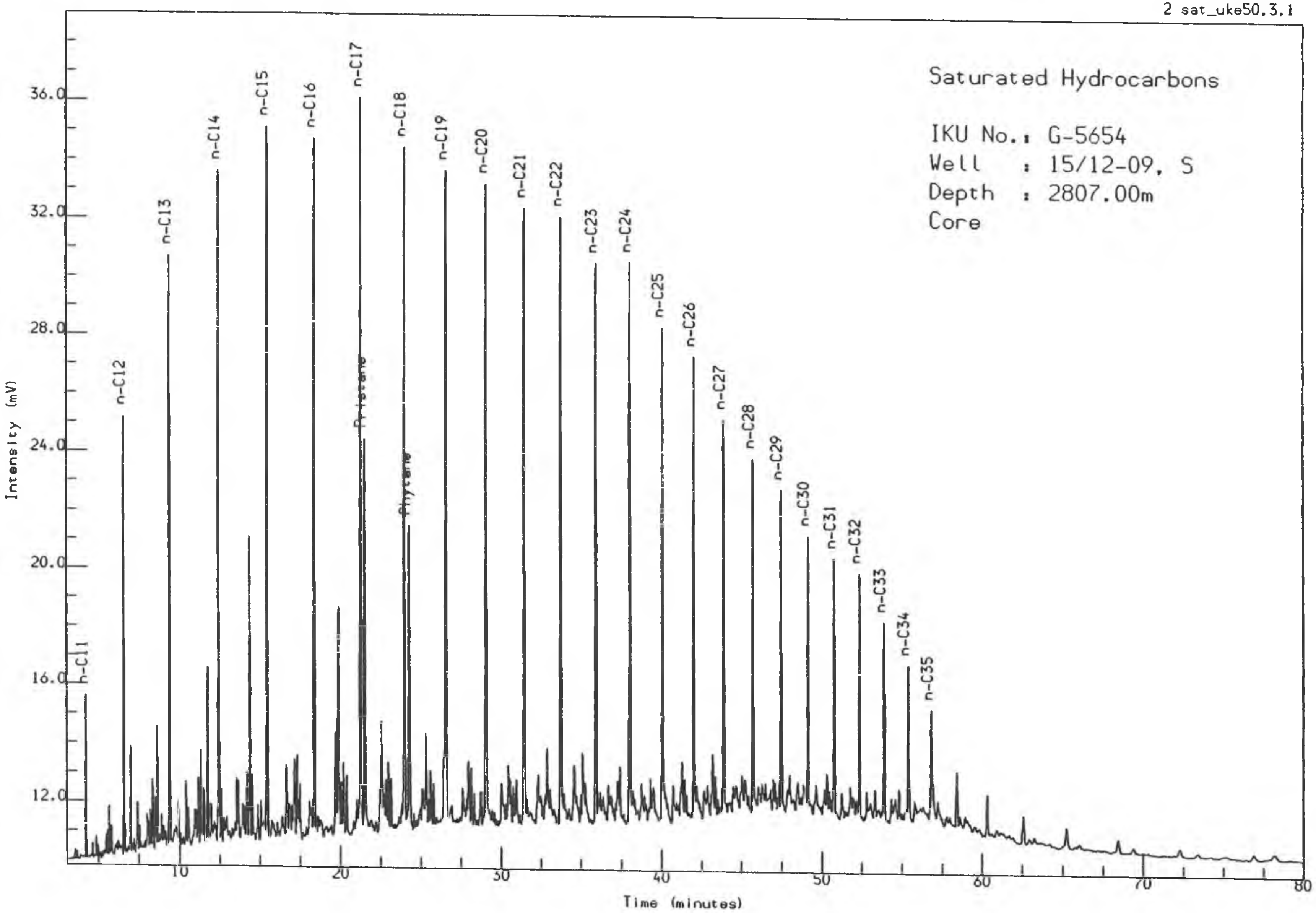
Figure 2.12

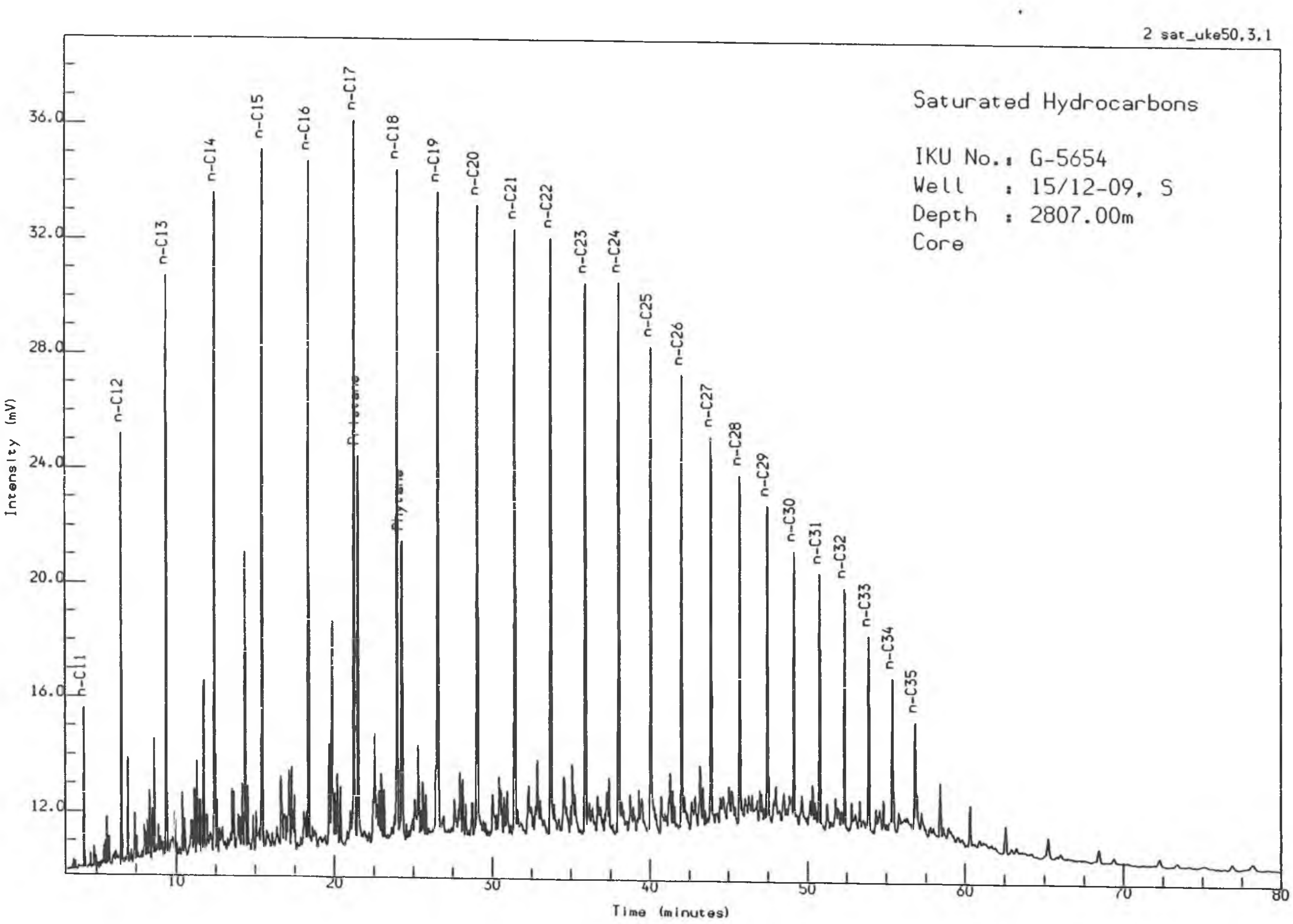
Gas chromatograms of saturated hydrocarbons


2 sat_uke50,4,1
Saturated Hydrocarbons
IKU No.: G-5650
Well :. 15/12-09, S
Depth : 2692.50m
SWC
Intensity (mV)
13.0
12.5
12.0
11.5
11.0
10.5
10.0
Time (minutes)
10
20
30
40
50
60
70
80
n-C14
n-C15
n-C16
n-C17
Pristane
n-C18
Phytane
n-C19
n-C20
n-C21
n-C22
n-C23
n-C24
n-C25
n-C26
n-C27
n-C28
n-C29
n-C30
n-C31
n-C32
n-C33
n-C34
n-C35


2 sat_uke50.2.1
Saturated Hydrocarbons
IKU No.: G-5669
Well : 15/12-09, S
Depth : 2715.00m
Core
Intensity (mV)
27.0
24.0
21.0
18.0
15.0
12.0
Time (minutes)
10
20
30
40
50
60
70
80
n-C12
n-C13
n-C14
n-C15
n-C16
n-C17
Pristane
n-C18
Phytane
n-C19
n-C20
n-C21
n-C22
n-C23
n-C24
n-C25
n-C26
n-C27
n-C28
n-C29
n-C30
n-C31
n-C32
n-C33
n-C34
n-C35

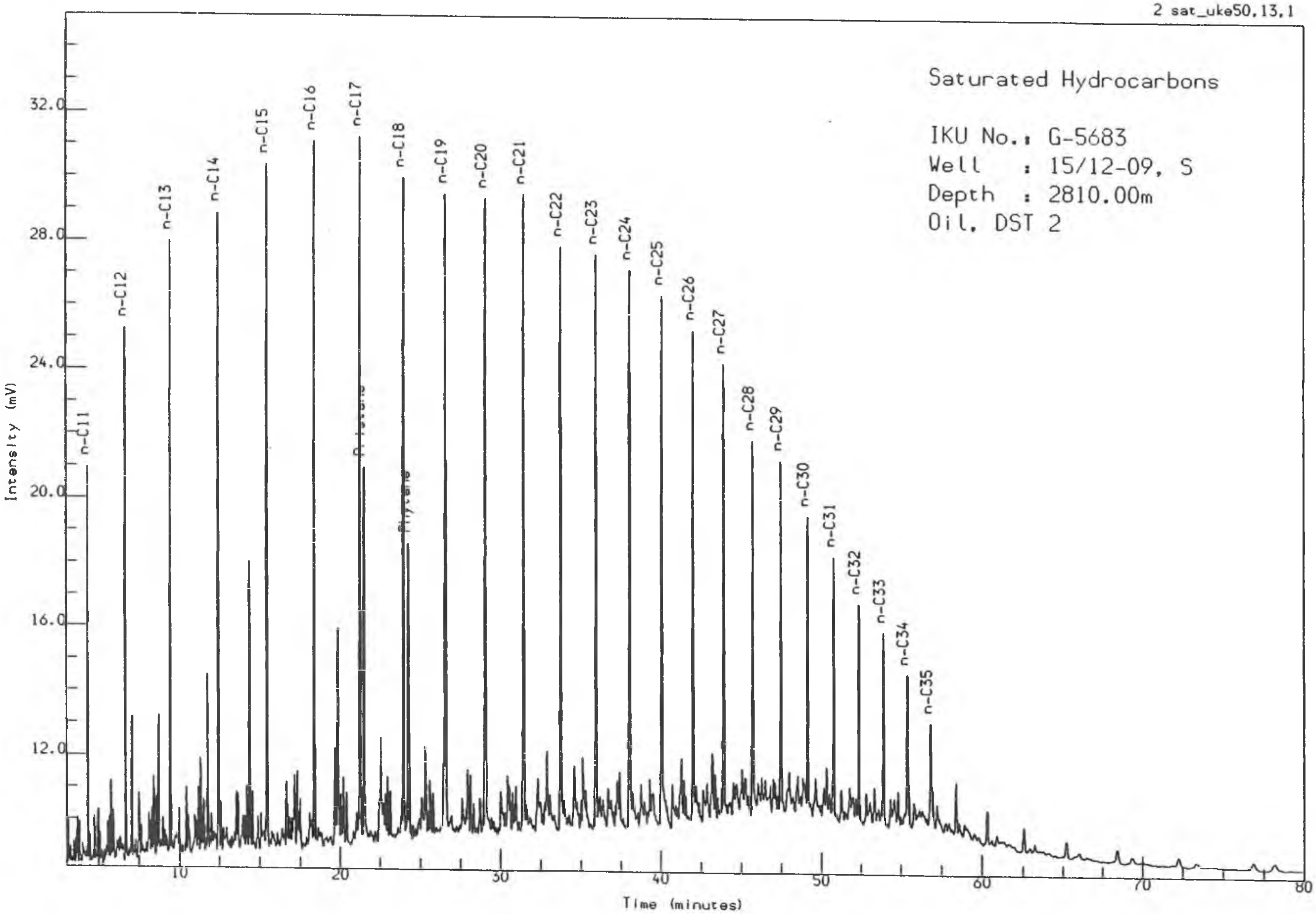

2 sat_uke50.8.1
Saturated Hydrocarbons
IKU No.: G-5652
Well : 15/12-09, S
Depth : 2787.00m
Core
Intensity (mV)
10.0
15.0
20.0
25.0
30.0
35.0
40.0
Time (minutes)
10
20
30
40
50
60
70
80
n-C11
n-C12
n-C13
n-C14
n-C15
n-C16
n-C17
Pristane
n-C18
Phytane
n-C19
n-C20
n-C21
n-C22
n-C23
n-C24
n-C25
n-C26
n-C27
n-C28
n-C29
n-C30
n-C31
n-C32
n-C33
n-C34
n-C35


2 sat_uke50.3.1
Saturated Hydrocarbons
IKU No. : G-5654
Well : 15/12-09, S
Depth : 2807.00m
Core
Intensity (mV)
36.0
32.0
28.0
24.0
20.0
16.0
12.0
Time (minutes)
10
20
30
40
50
60
70
80
n-C11
n-C12
n-C13
n-C14
n-C15
n-C16
n-C17
Pristane
n-C18
Phytane
n-C19
n-C20
n-C21
n-C22
n-C23
n-C24
n-C25
n-C26
n-C27
n-C28
n-C29
n-C30
n-C31
n-C32
n-C33
n-C34
n-C35



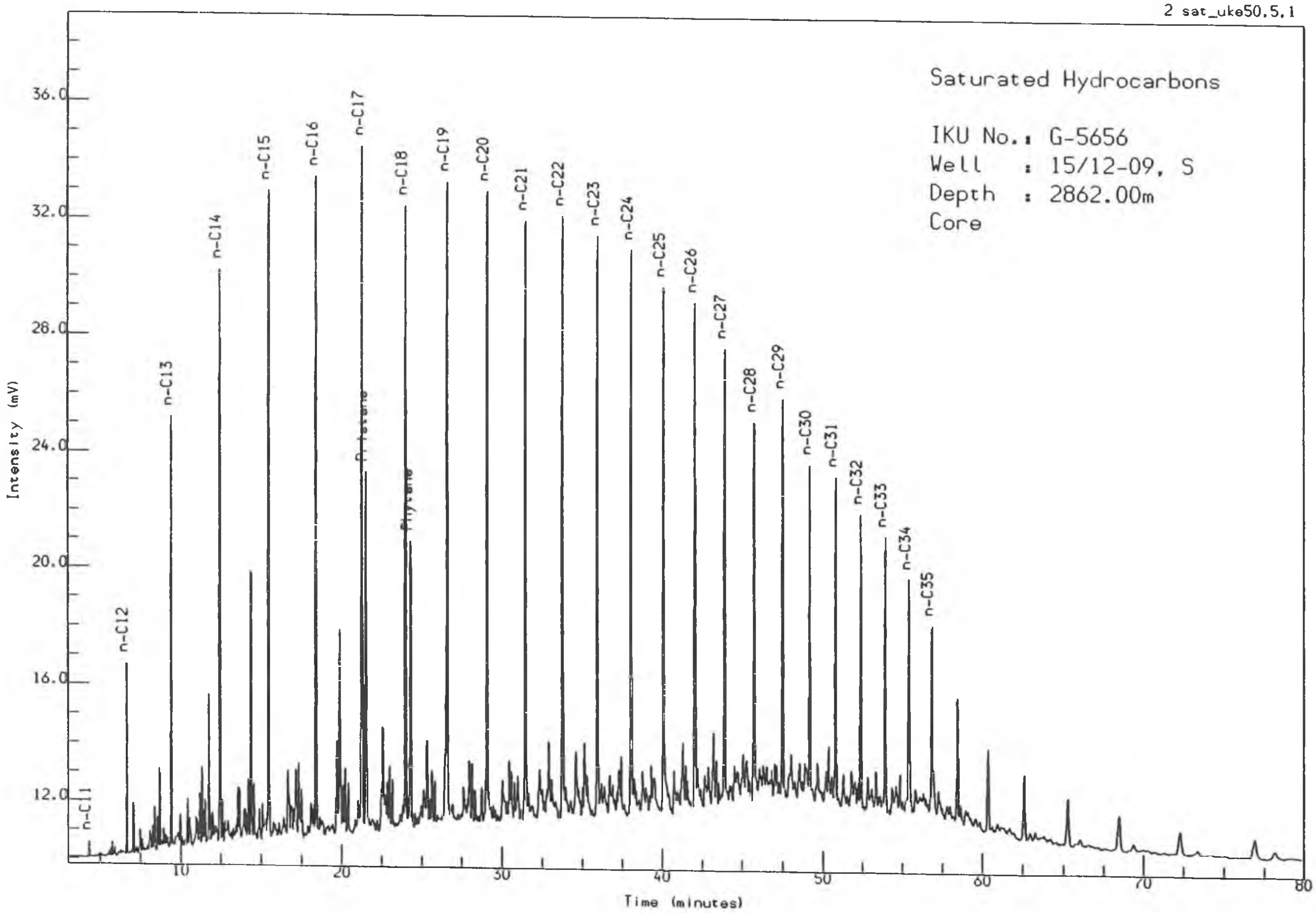
Saturated Hydrocarbons

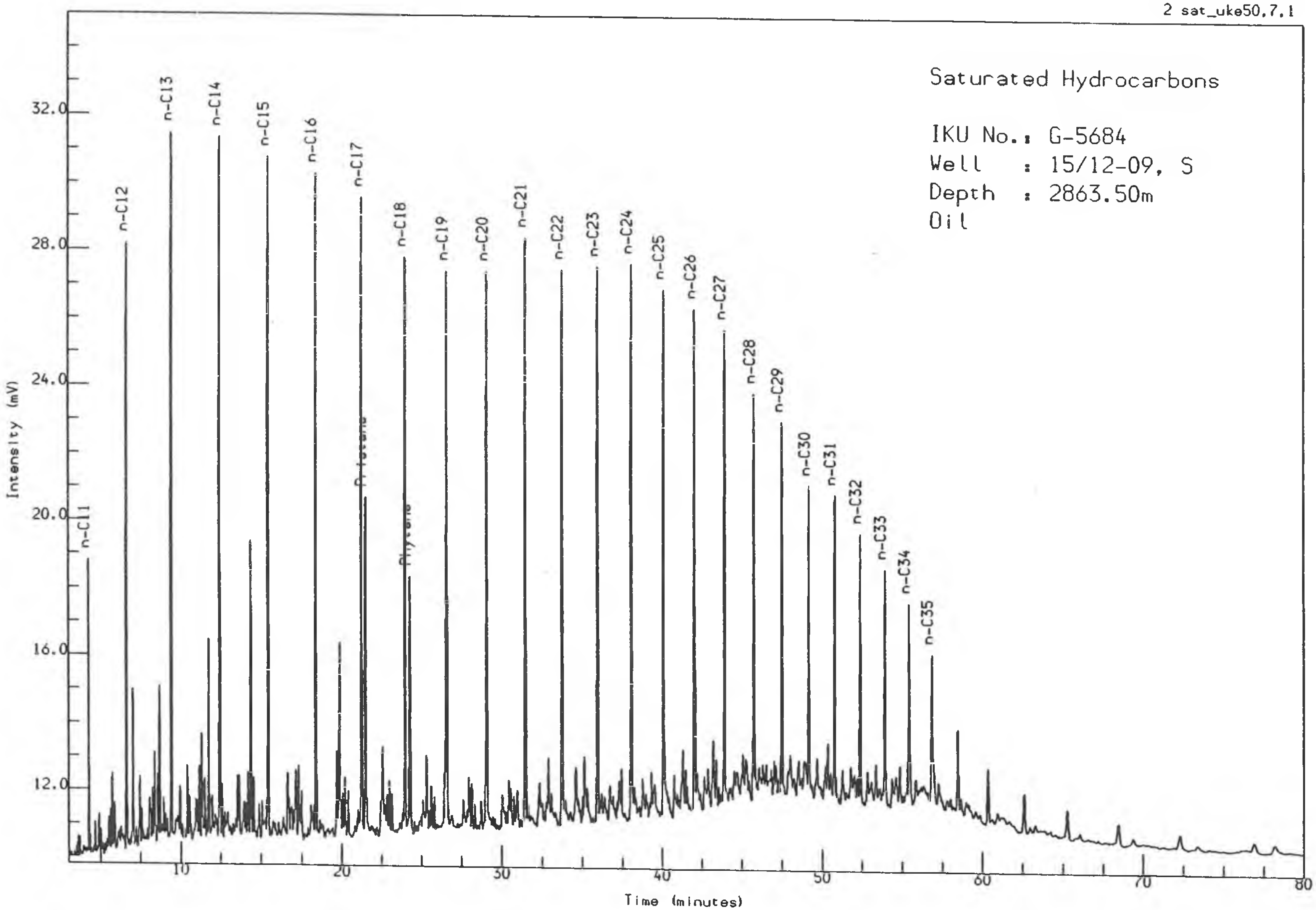
IKU No.: G-5654
Well : 15/12-09, S
Depth : 2807.00m
Core



Saturated Hydrocarbons

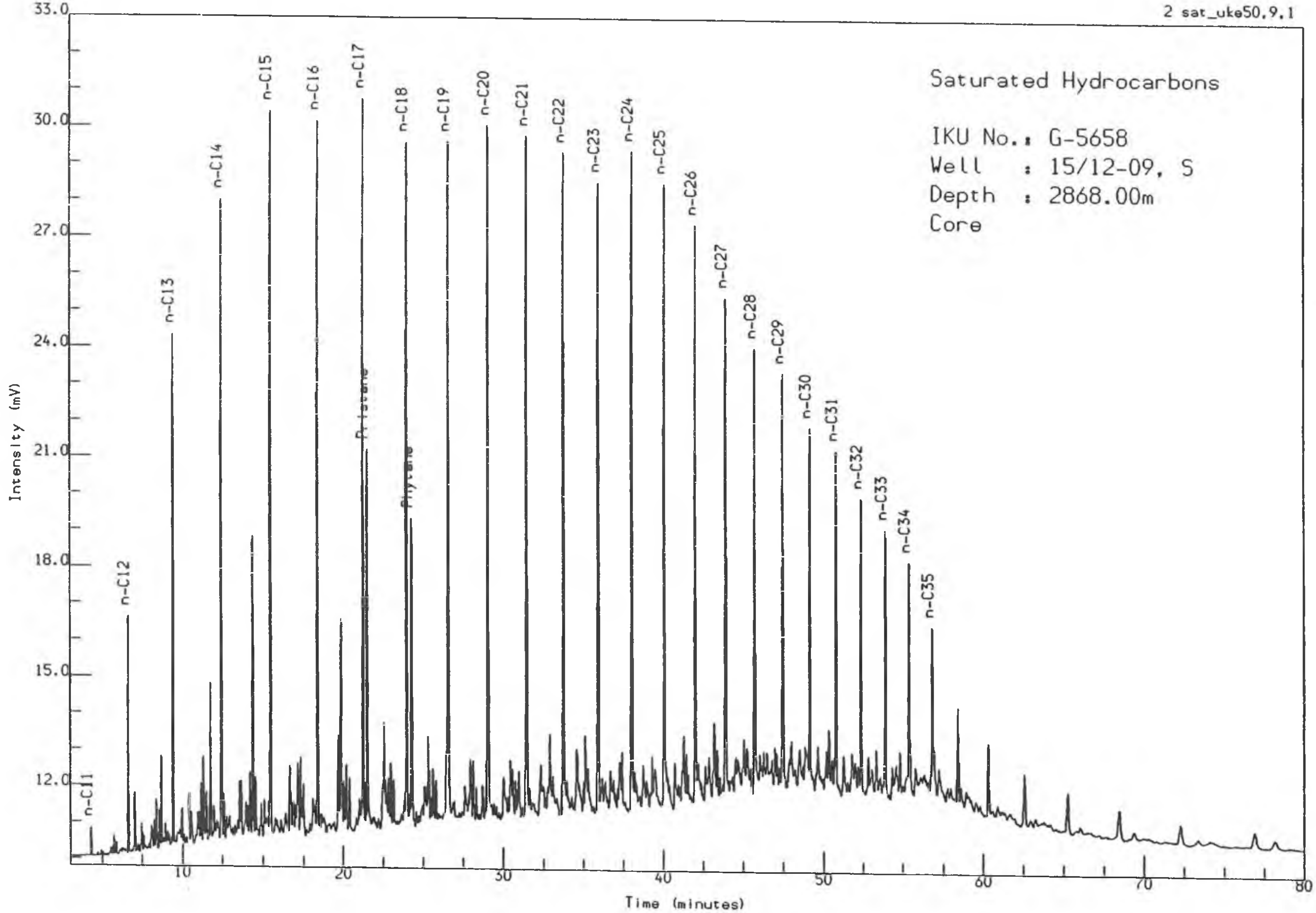
IKU No.: G-5683
Well : 15/12-09, S
Depth : 2810.00m
Oil, DST 2

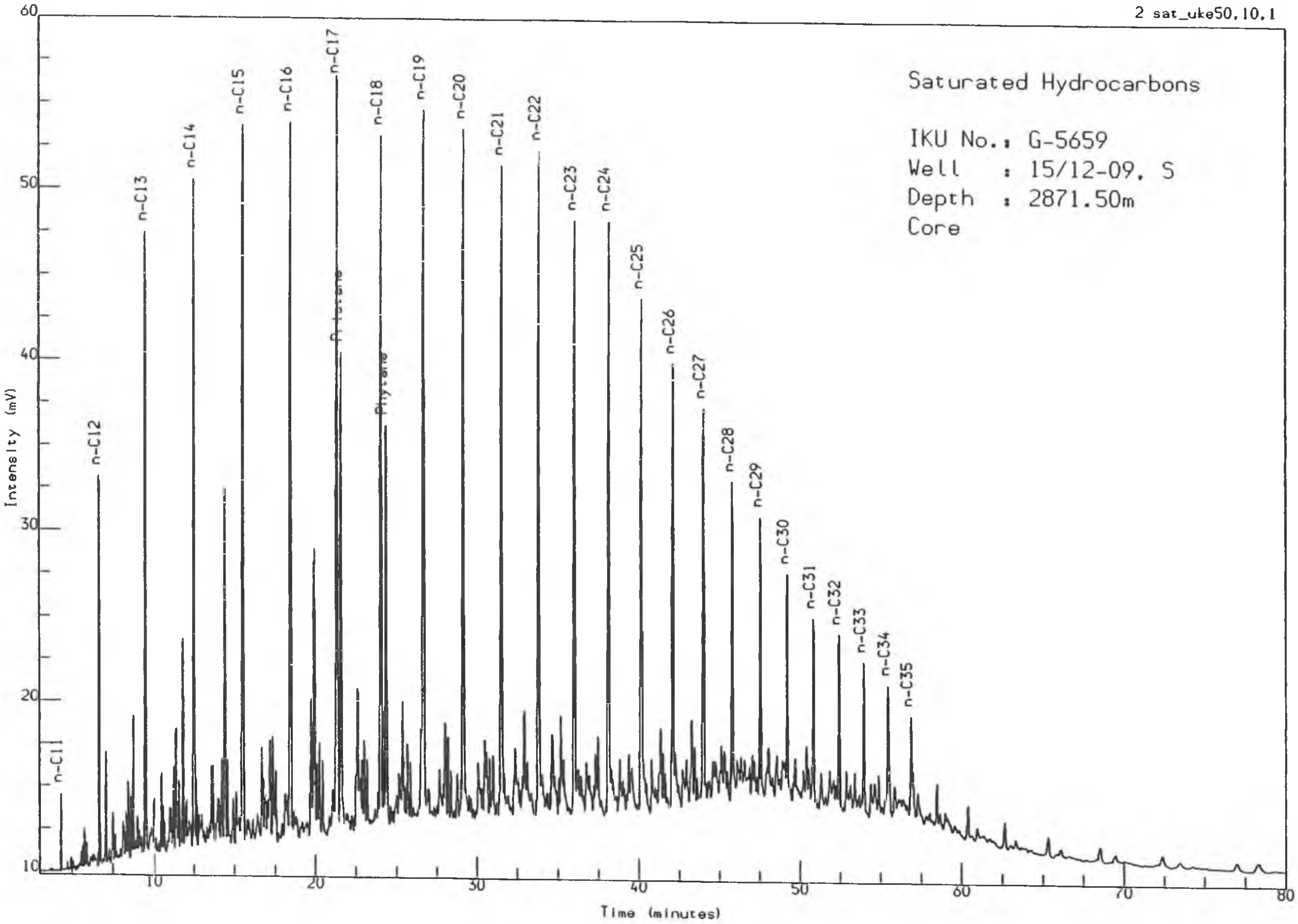

2 sat_uke50.5.1
Saturated Hydrocarbons
IKU No. : G-5656
Well : 15/12-09, S
Depth : 2862.00m
Core
Intensity (mV)
36.0
32.0
28.0
24.0
20.0
16.0
12.0
Time (minutes)
10
20
30
40
50
60
70
80
n-C11
n-C12
n-C13
n-C14
n-C15
n-C16
n-C17
Pristane
n-C18
Phytane
n-C19
n-C20
n-C21
n-C22
n-C23
n-C24
n-C25
n-C26
n-C27
n-C28
n-C29
n-C30
n-C31
n-C32
n-C33
n-C34
n-C35

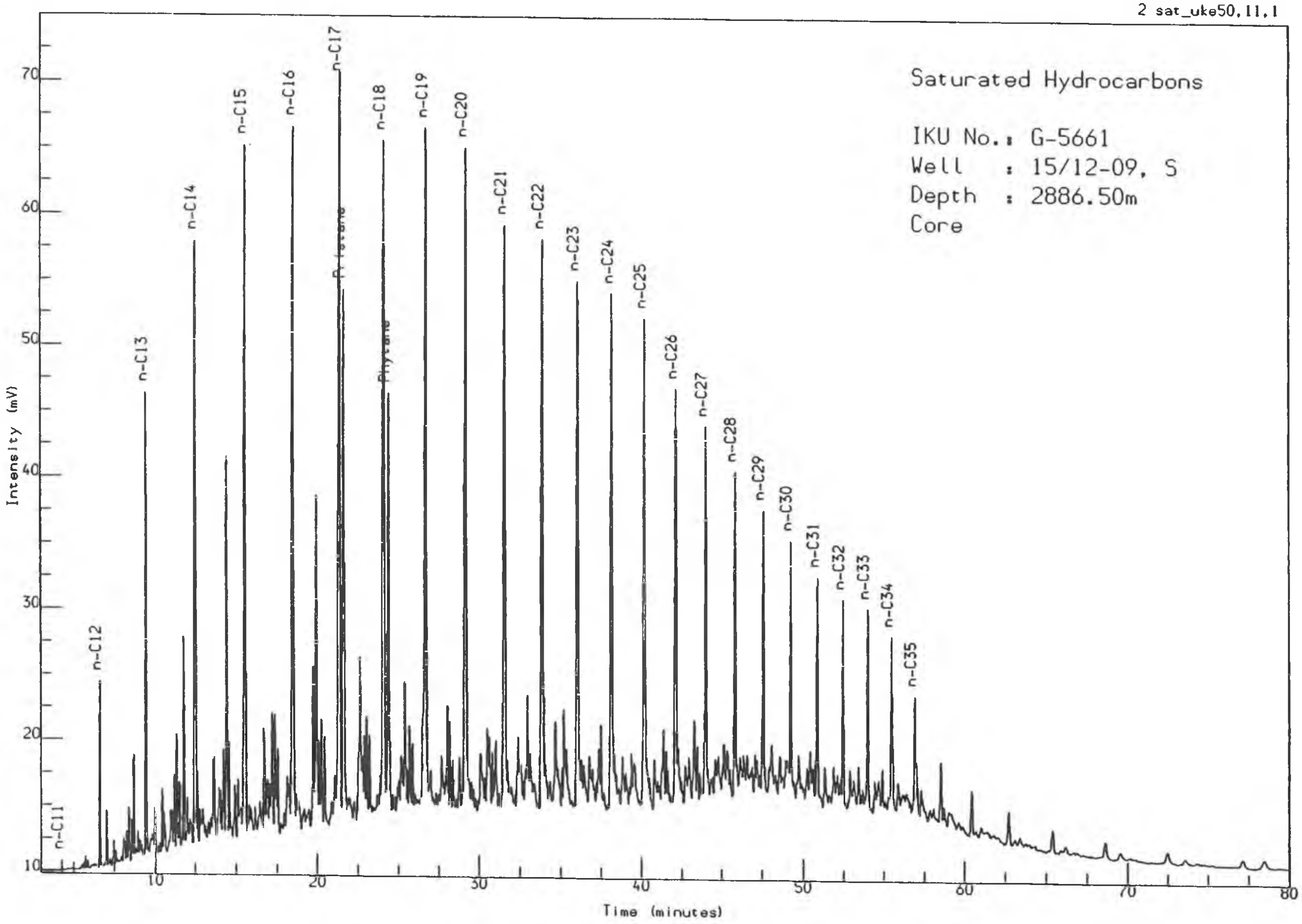


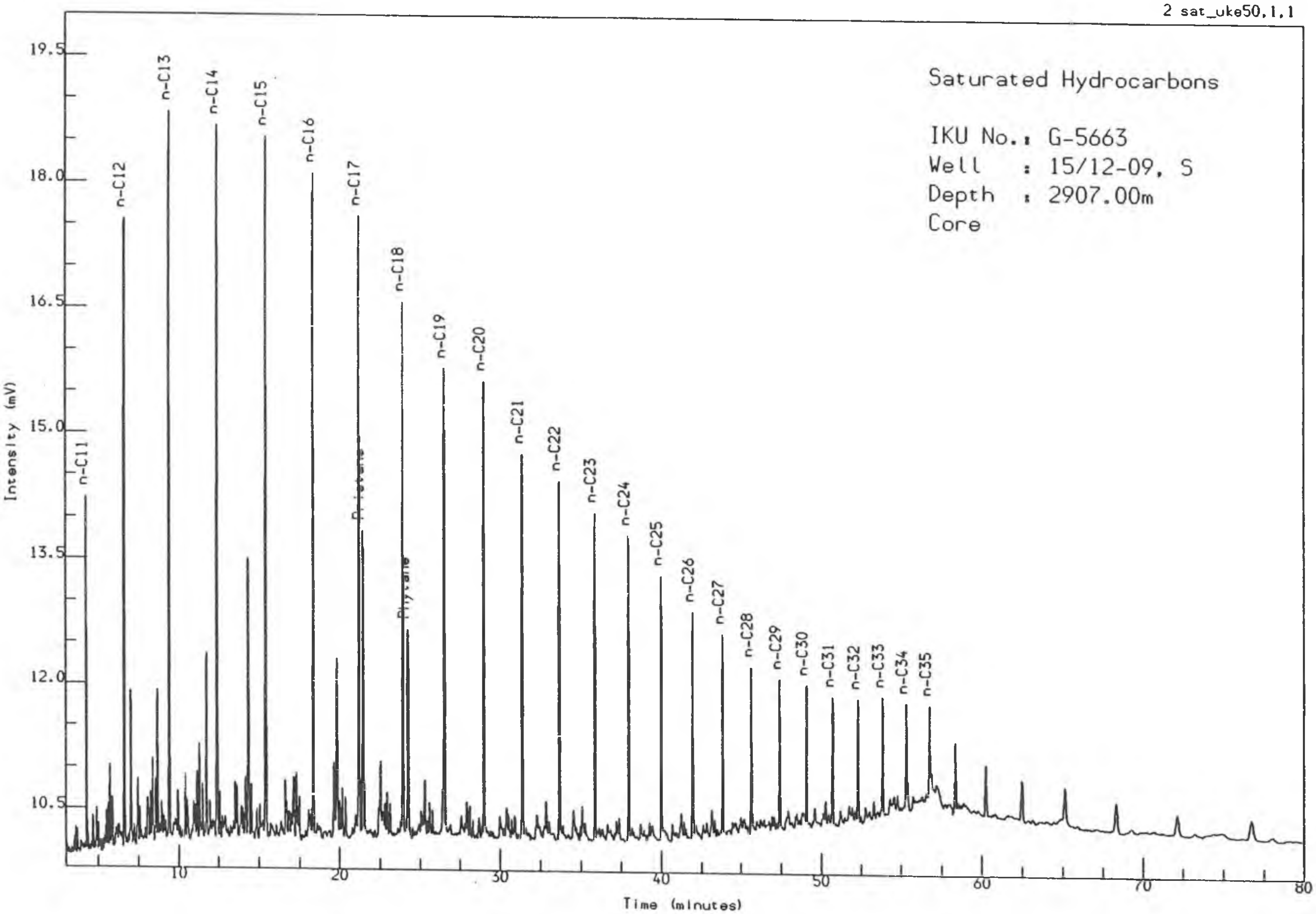
Saturated Hydrocarbons

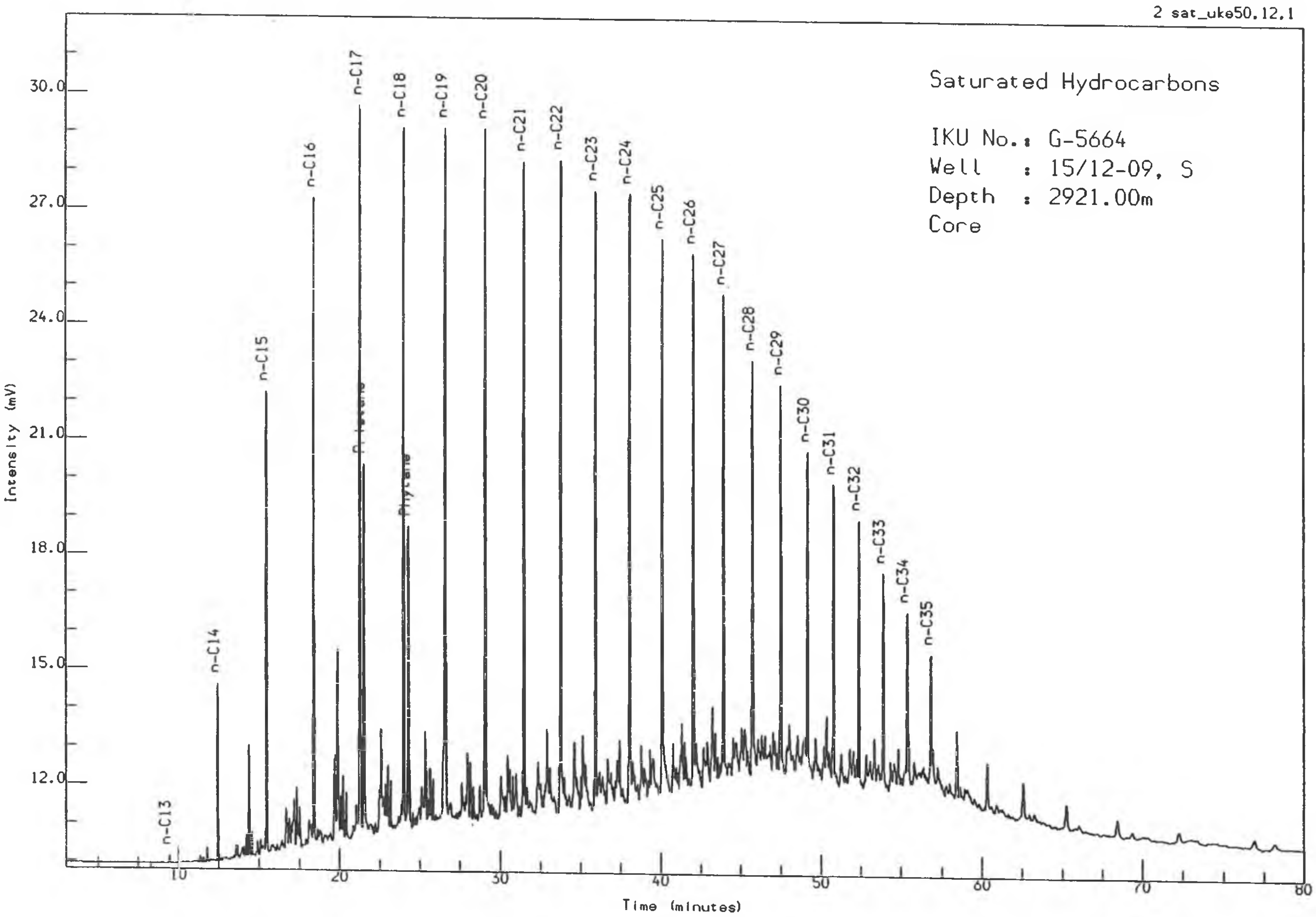
IKU No.: G-5684
Well : 15/12-09, S
Depth : 2863.50m
Oil


2 sat_uke50.9.1
Saturated Hydrocarbons
IKU No.: G-5658
Well : 15/12-09, S
Depth : 2868.00m
Core
Intensity (mV)
33.0
30.0
27.0
24.0
21.0
18.0
15.0
12.0
Time (minutes)
10
20
30
40
50
60
70
80
n-C11
n-C12
n-C13
n-C14
n-C15
n-C16
n-C17
Pristane
n-C18
Phytane
n-C19
n-C20
n-C21
n-C22
n-C23
n-C24
n-C25
n-C26
n-C27
n-C28
n-C29
n-C30
n-C31
n-C32
n-C33
n-C34
n-C35


2 sat_uke50.10.1
Saturated Hydrocarbons
IKU No.: G-5659
Well : 15/12-09. S
Depth : 2871.50m
Core
Intensity (mV)
60
50
40
30
20
10
Time (minutes)
10
20
30
40
50
60
70
80
n-C11
n-C12
n-C13
n-C14
n-C15
n-C16
n-C17
Pristane
n-C18
Phytane
n-C19
n-C20
n-C21
n-C22
n-C23
n-C24
n-C25
n-C26
n-C27
n-C28
n-C29
n-C30
n-C31
n-C32
n-C33
n-C34
n-C35


2 sat_uke50,11,1
Saturated Hydrocarbons
IKU No.: G-5661
Well : 15/12-09, S
Depth : 2886.50m
Core
n-C11
n-C12
n-C13
n-C14
n-C15
n-C16
n-C17
Pristane
n-C18
Phytane
n-C19
n-C20
n-C21
n-C22
n-C23
n-C24
n-C25
n-C26
n-C27
n-C28
n-C29
n-C30
n-C31
n-C32
n-C33
n-C34
n-C35
Intensity (mV)
10
20
30
40
50
60
70
Time (minutes)
10
20
30
40
50
60
70
80


2 sat_uke50.1.1
Saturated Hydrocarbons
IKU No.: G-5663
Well : 15/12-09, S
Depth : 2907.00m
Core
Intensity (mV)
19.5
18.0
16.5
15.0
13.5
12.0
10.5
n-C11
n-C12
n-C13
n-C14
n-C15
n-C16
n-C17
Pristane
n-C18
Phytane
n-C19
n-C20
n-C21
n-C22
n-C23
n-C24
n-C25
n-C26
n-C27
n-C28
n-C29
n-C30
n-C31
n-C32
n-C33
n-C34
n-C35
10
20
30
40
50
60
70
80
Time (minutes)

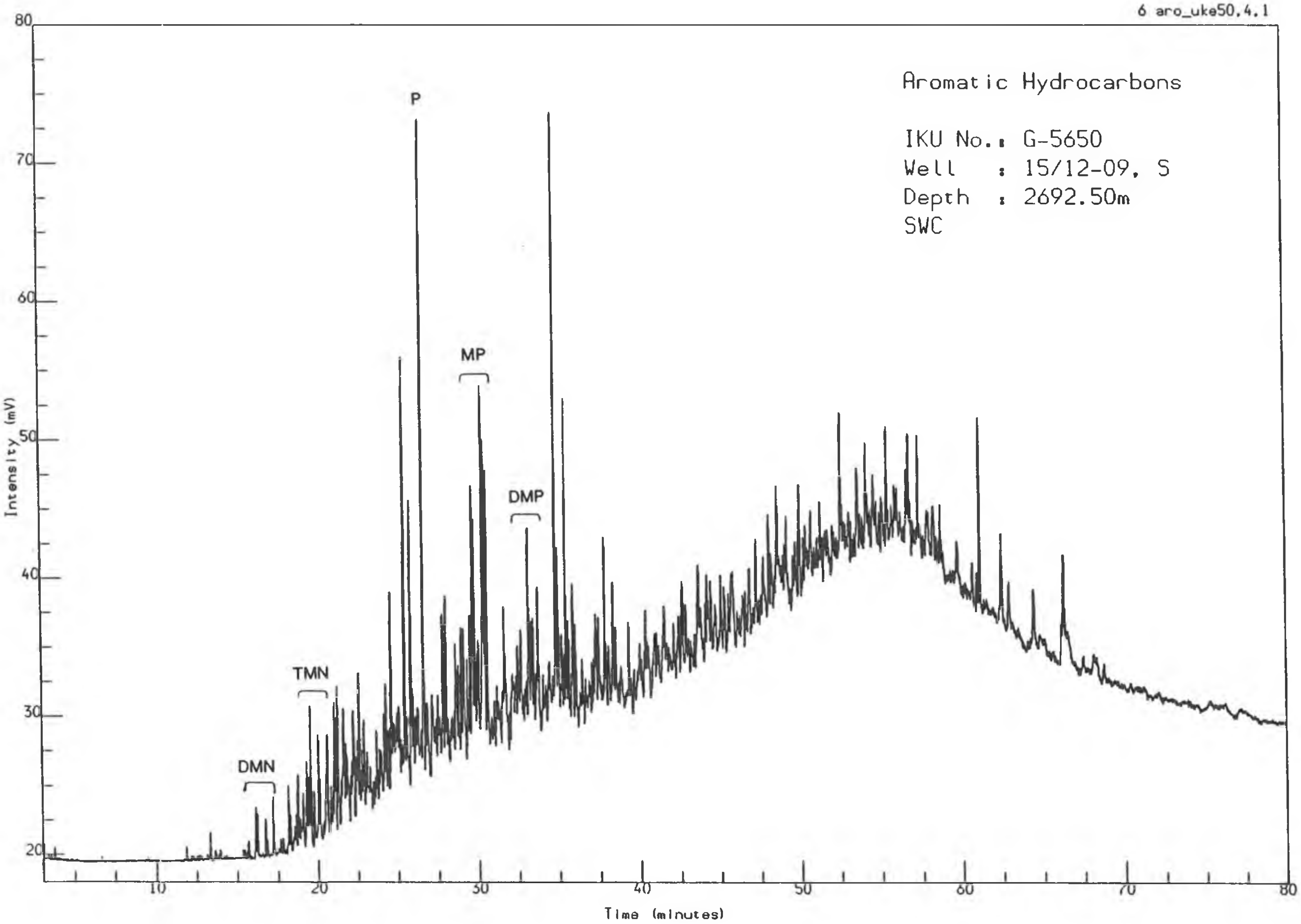


Saturated Hydrocarbons

IKU No.: G-5664
Well : 15/12-09, S
Depth : 2921.00m
Core

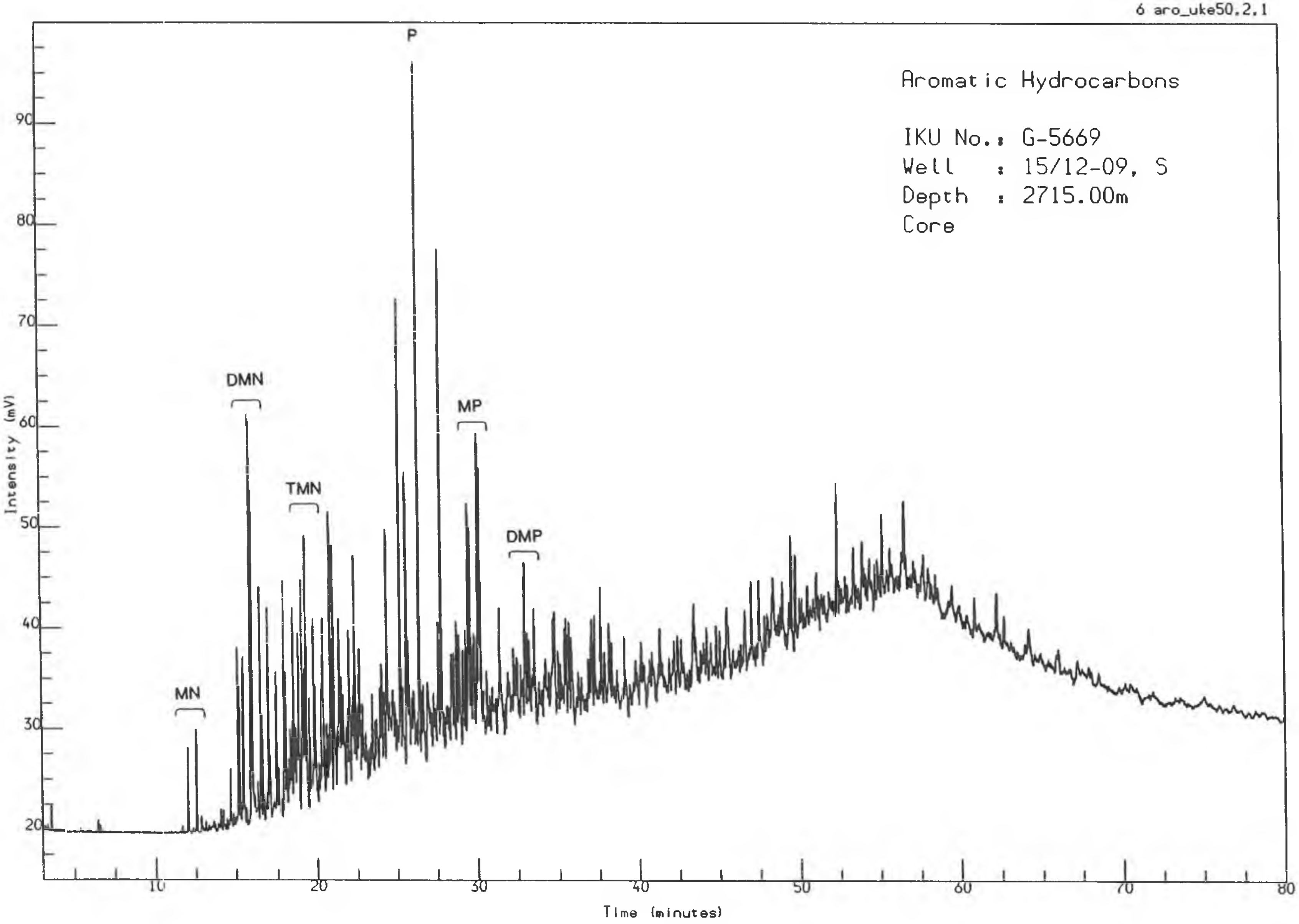
Figure 2.13

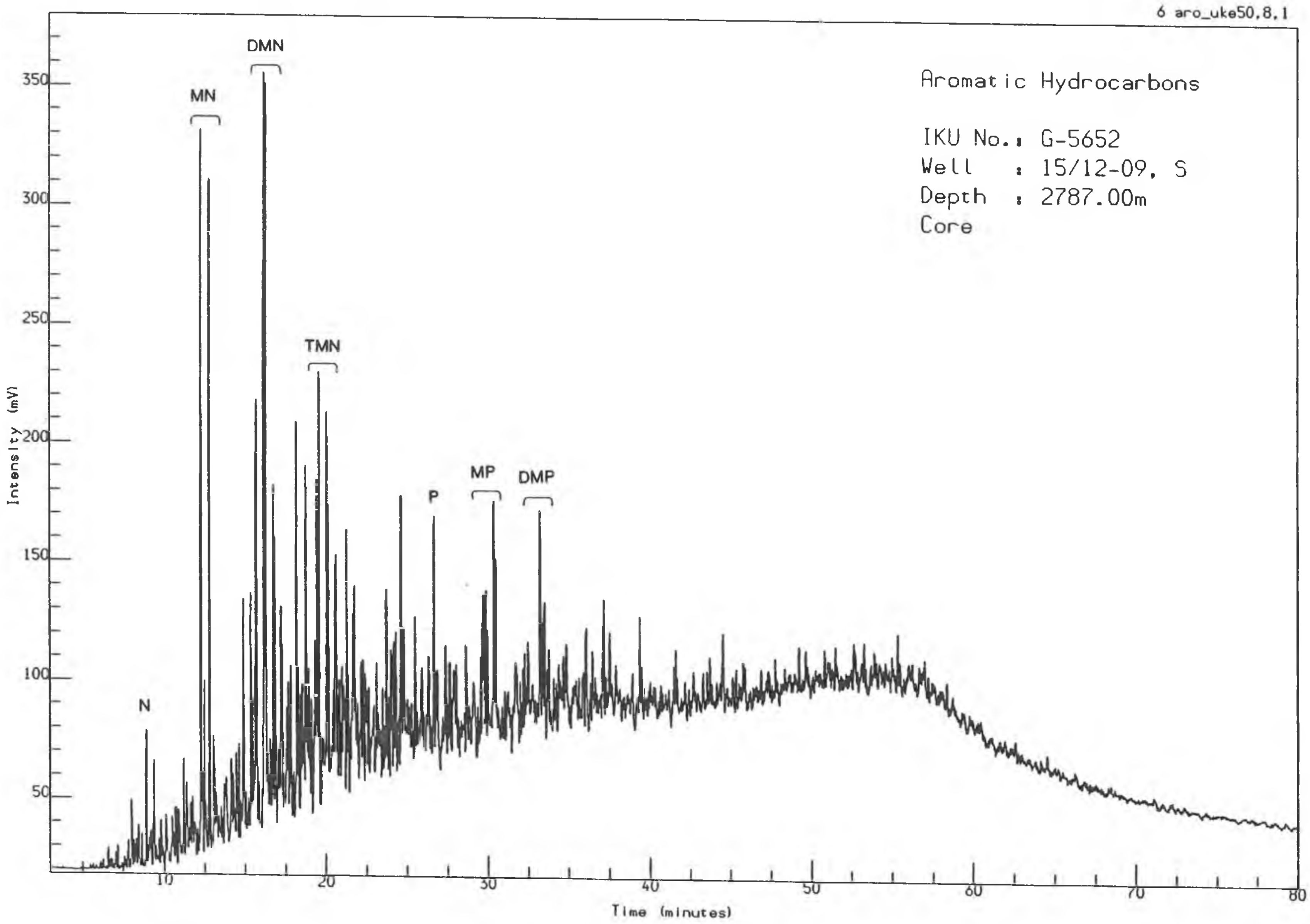
Gas chromatograms of aromatic hydrocarbons (FID)

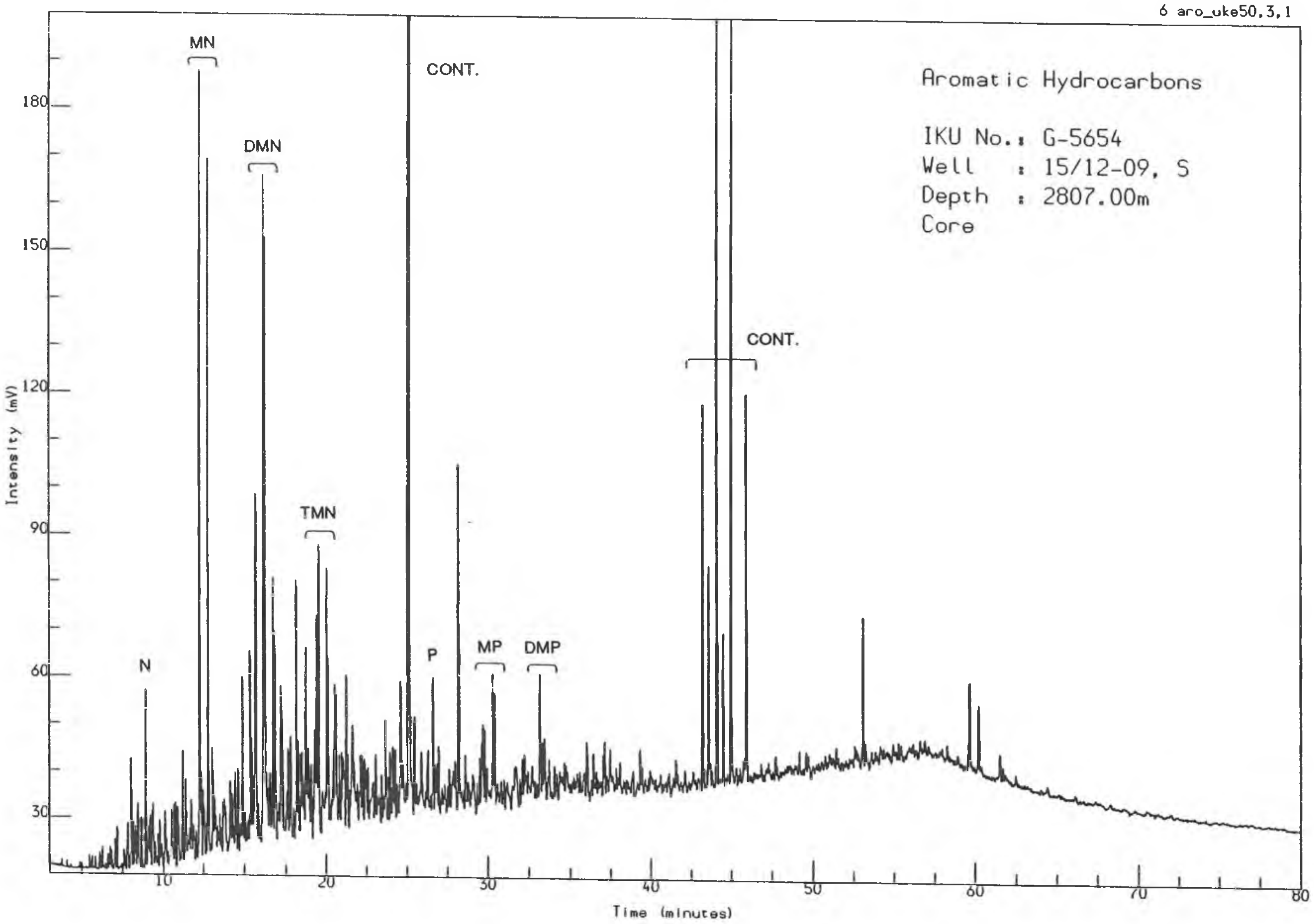


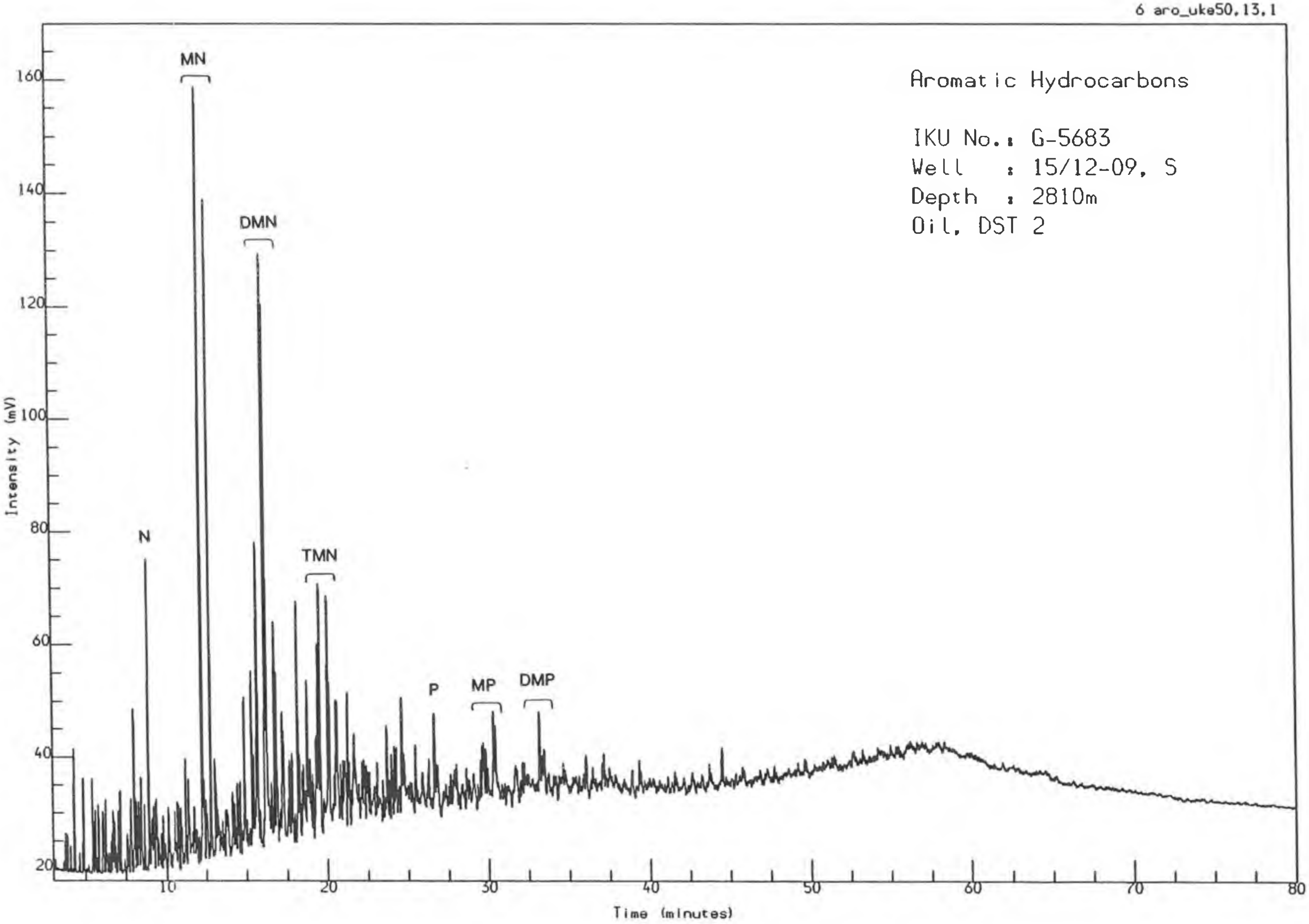
Aromatic Hydrocarbons

IKU No.: G-5650
Well : 15/12-09, S
Depth : 2692.50m
SWC


6 aro_uke50.2.1
Aromatic Hydrocarbons
IKU No.: G-5669
Well : 15/12-09, S
Depth : 2715.00m
Core
P
DMN
MP
TMN
DMP
MN
Intensity (mV)
20
30
40
50
60
70
80
90
10
20
30
40
50
60
70
80
Time (minutes)

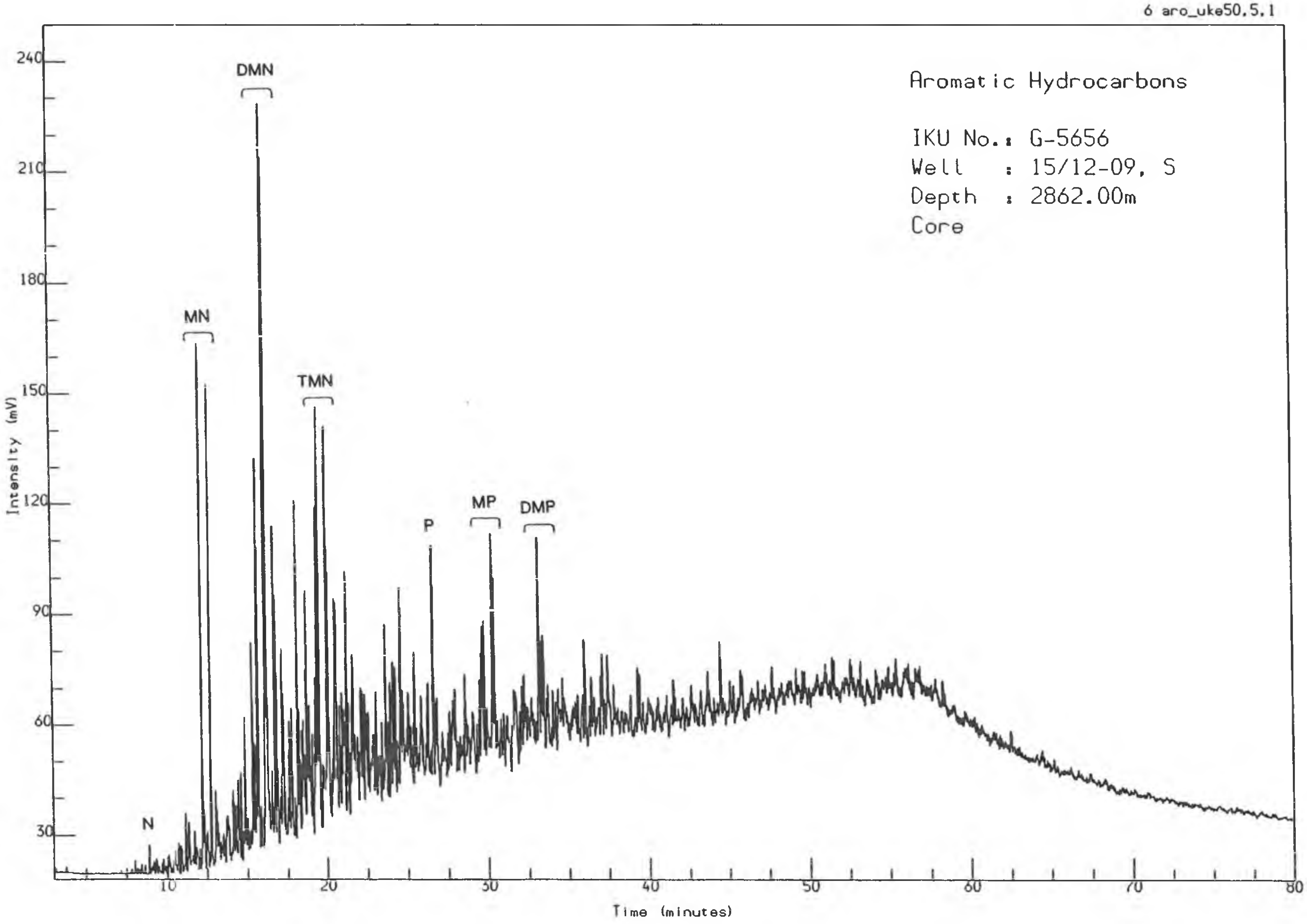

6 aro_uke50,8,1
Aromatic Hydrocarbons
IKU No.: G-5652
Well : 15/12-09, S
Depth : 2787.00m
Core
N
MN
DMN
TMN
P
MP
DMP
Intensity (mV)
350
300
250
200
150
100
50
10
20
30
40
50
60
70
80
Time (minutes)

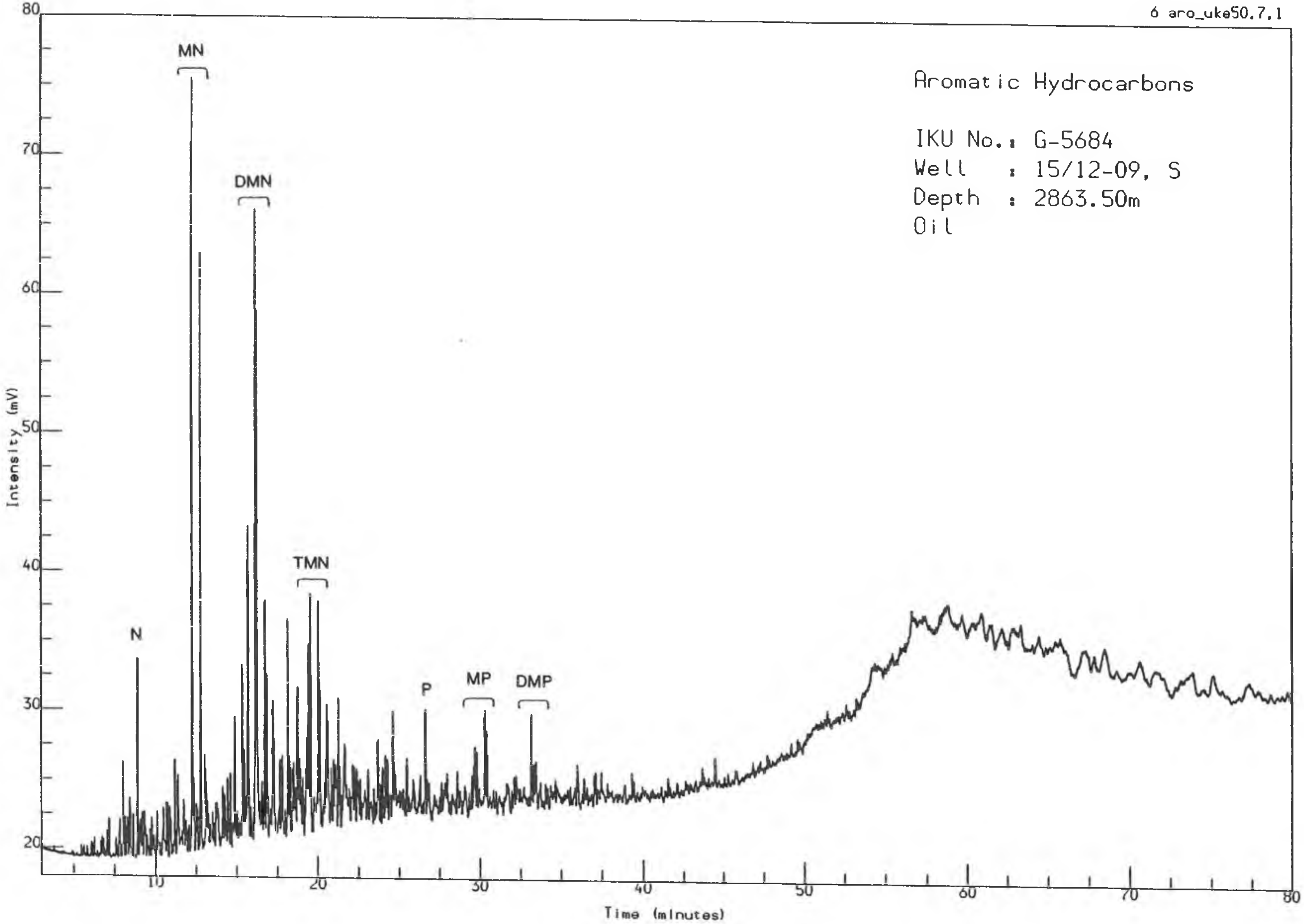

6 aro_uke50.3,1
Aromatic Hydrocarbons
IKU No.: G-5654
Well : 15/12-09, S
Depth : 2807.00m
Core
MN
DMN
TMN
CONT.
CONT.
N
P
MP
DMP
Intensity (mV)
180
150
120
90
60
30
10
20
30
40
50
60
70
80
Time (minutes)

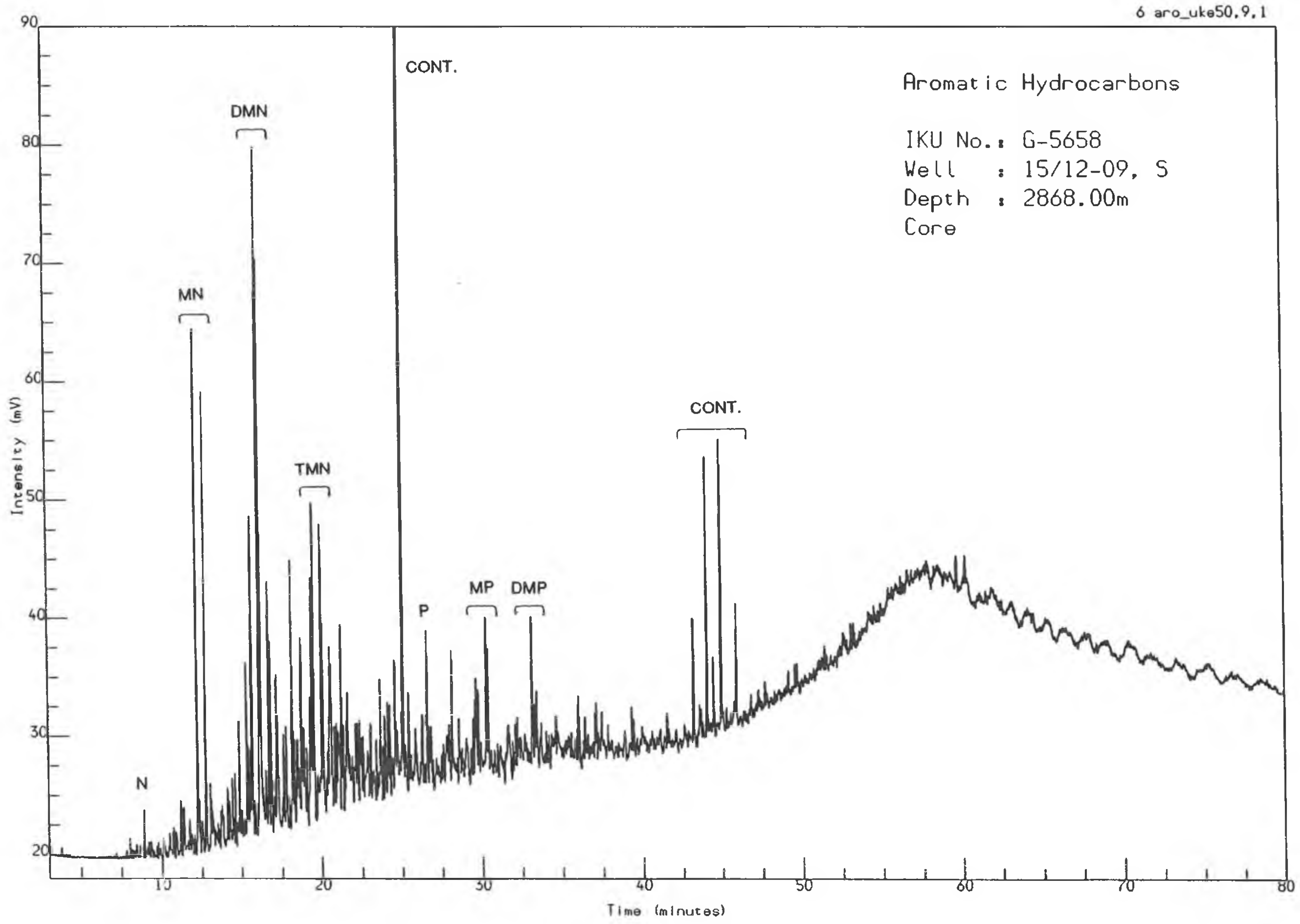


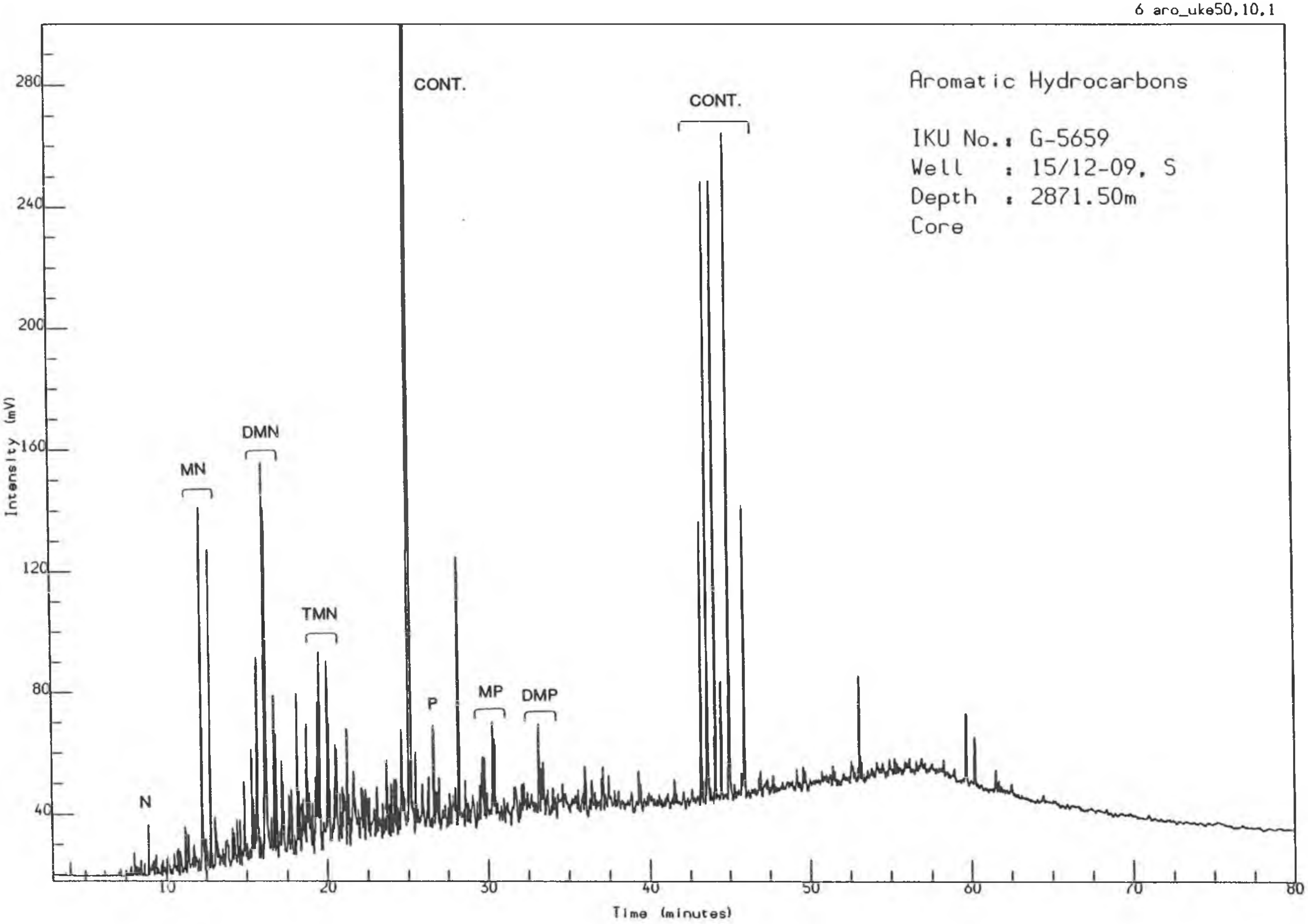
Aromat ic Hydrocarbons

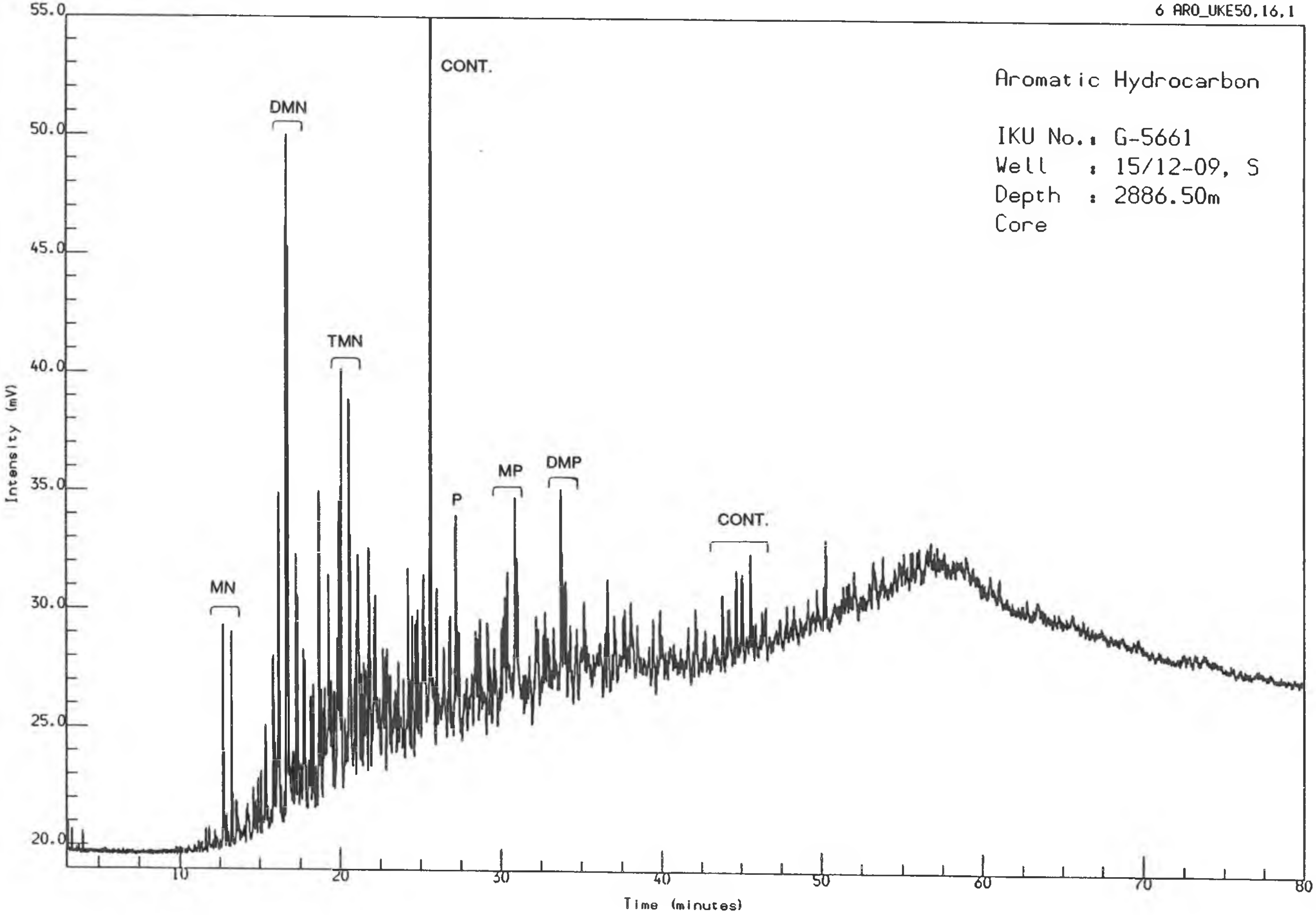
IKU No.: G-5683
Well : 15/12-09, S
Depth : 2810m
Oil, DST 2

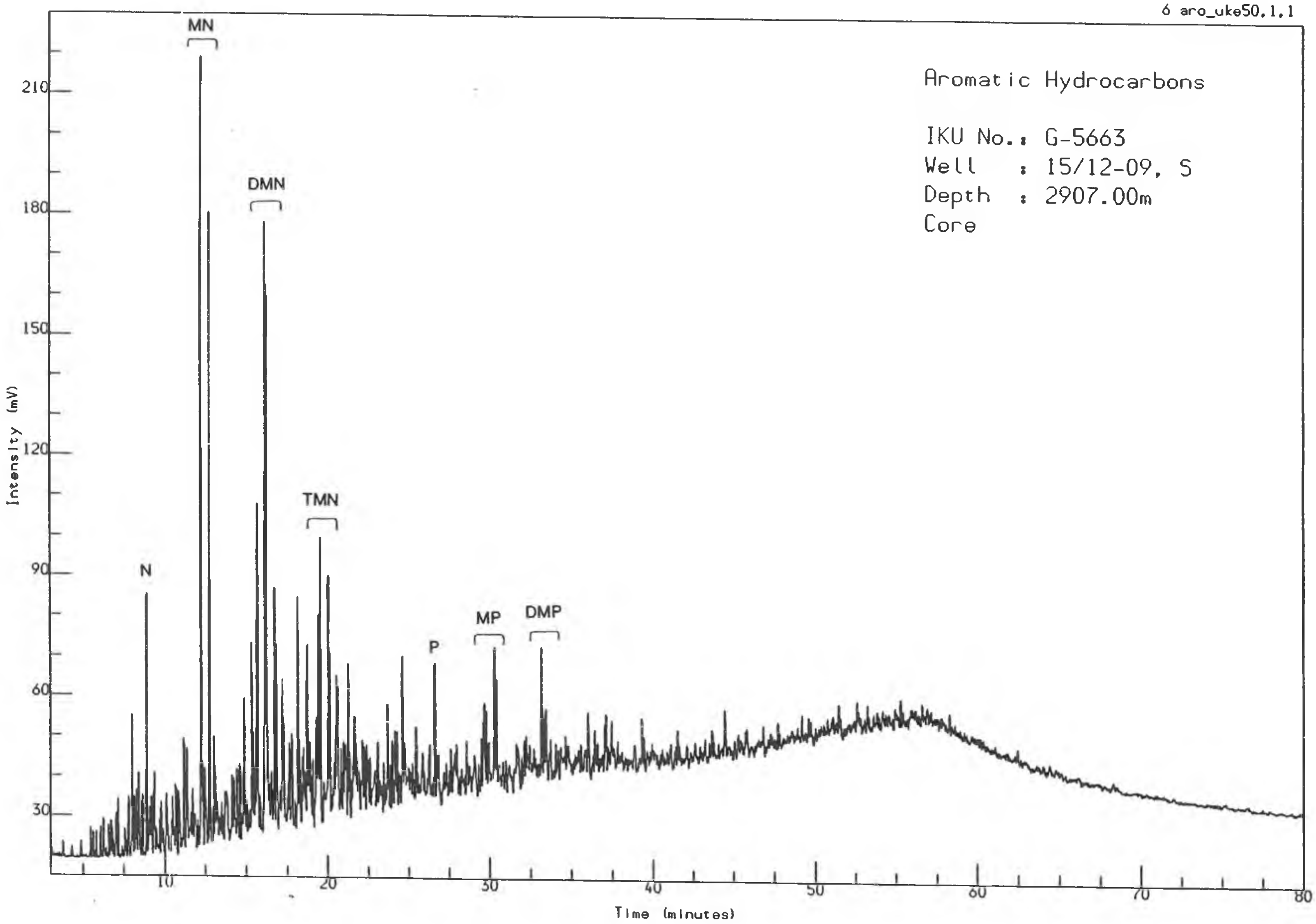

6 aro_uke50.5.1
Aromatic Hydrocarbons
IKU No.: G-5656
Well : 15/12-09, S
Depth : 2862.00m
Core
Intensity (mV)
240
210
180
150
120
90
60
30
Time (minutes)
10
20
30
40
50
60
70
80
N
MN
DMN
TMN
P
MP
DMP


6 aro_uke50.7.1
Aromatic Hydrocarbons
IKU No.: G-5684
Well : 15/12-09, S
Depth : 2863.50m
Oil
MN
DMN
TMN
N
P
MP
DMP
Intensity (mV)
80
70
60
50
40
30
20
10
20
30
40
50
60
70
80
Time (minutes)


6 aro_uke50,9,1
Aromatic Hydrocarbons
IKU No.: G-5658
Well : 15/12-09, S
Depth : 2868.00m
Core
CONT.
DMN
MN
TMN
N
P
MP
DMP
CONT.
Intensity (mV)
90
80
70
60
50
40
30
20
10
20
30
40
50
60
70
80
Time (minutes)


6 aro_uke50.10.1
Aromatic Hydrocarbons
IKU No.: G-5659
Well : 15/12-09, S
Depth : 2871.50m
Core
Intensity (mV)
280
240
200
160
120
80
40
Time (minutes)
10
20
30
40
50
60
70
80
CONT.
CONT.
N
MN
DMN
TMN
P
MP
DMP


6 ARO_UKE50.16.1
Aromatic Hydrocarbon
IKU No.: G-5661
Well : 15/12-09, S
Depth : 2886.50m
Core
CONT.
DMN
TMN
MN
P
MP
DMP
CONT.
Intensity (mV)
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
10
20
30
40
50
60
70
80
Time (minutes)


6 aro_uke50.1.1
Aromatic Hydrocarbons
IKU No.: G-5663
Well : 15/12-09, S
Depth : 2907.00m
Core
MN
DMN
TMN
N
P
MP
DMP
Intensity (mV)
210
180
150
120
90
60
30
10
20
30
40
50
60
70
80
Time (minutes)

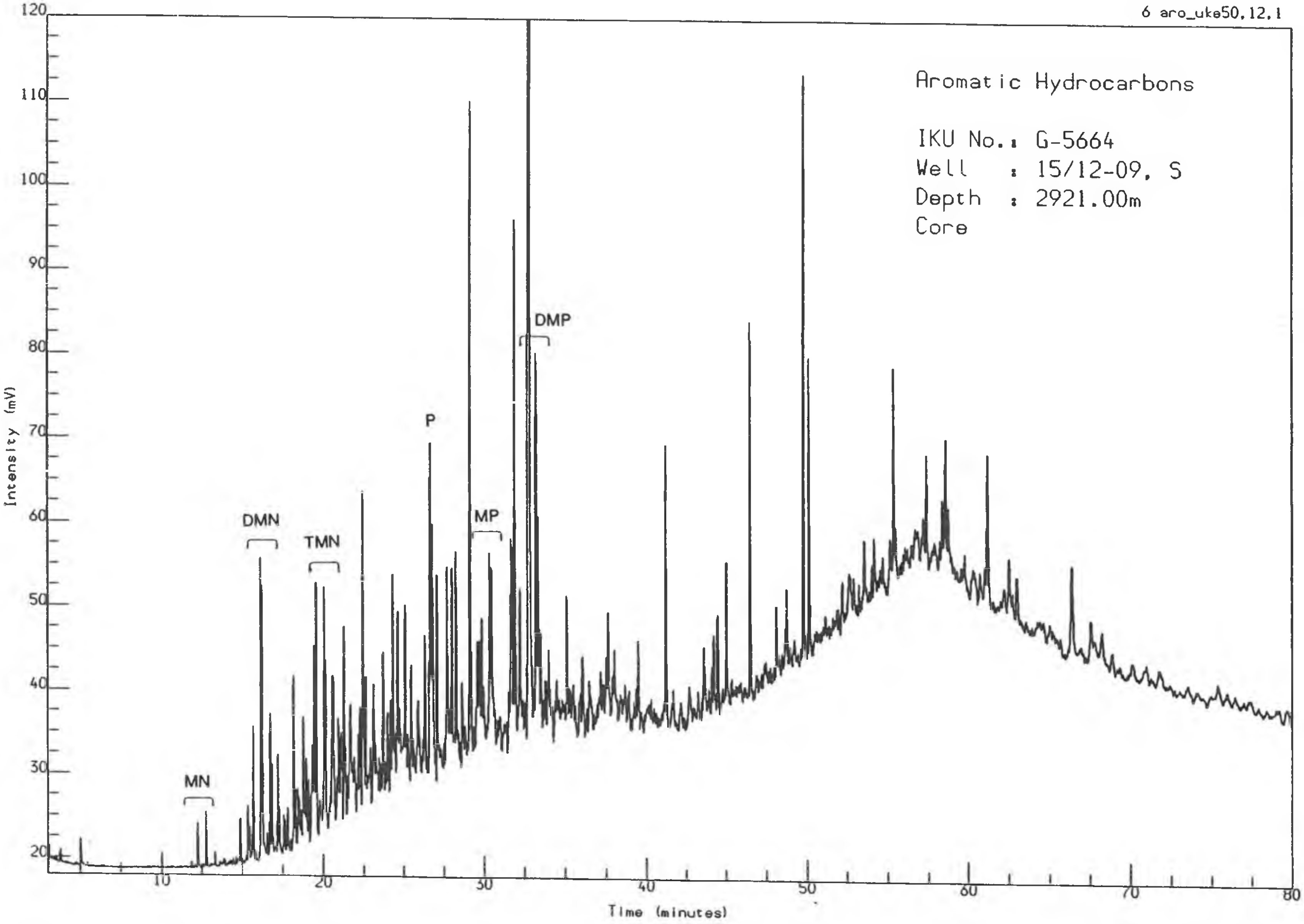

6 aro_uke50.12.1
Aromatic Hydrocarbons
IKU No.: G-5664
Well : 15/12-09, S
Depth : 2921.00m
Core
Intensity (mV)
120
110
100
90
80
70
60
50
40
30
20
Time (minutes)
10
20
30
40
50
60
70
80
MN
DMN
TMN
P
MP
DMP

Figure 2.14

GC-MS chromatograms of saturated hydrocarbons

M/Z: 177, 191, 205, 217, 218, 231, 259

STERANES (m/z 217, 218)

Name	Previous Code	New Code
13β(H), 17α(H), 20(S)-cholestane (diasterane)	27a	27dβS
13β(H), 17α(H), 20(R)-cholestane (diasterane)	27b	27dβR
13α(H), 17β(H), 20(S)-cholestane (diasterane)	27c	27dαS
13α(H), 17β(H), 20(R)-cholestane (diasterane)	27d	27dαR
5α(H), 14α(H), 17α(H), 20(S)-cholestane	27e	27ααS
5α(H), 14β(H), 17β(H), 20(R)-cholestane	27f	27ββR
5α(H), 14β(H), 17β(H), 20(S)-cholestane	27g	27ββS
5α(H), 14α(H), 17α(H), 20(R)-cholestane	27h	27ααR
24-methyl-13β(H), 17α(H), 20(S)-cholestane (diasterane)	28a	28dβS
24-methyl-13β(H), 17α(H), 20(R)-cholestane (diasterane)	28b	28dβR
24-methyl-13α(H), 17β(H), 20(S)-cholestane (diasterane)	28c	28dαS
24-methyl-13α(H), 17β(H), 20(R)-cholestane (diasterane)	28d	28dαR
24-methyl-5α(H), 14α(H), 17α(H), 20(S)-cholestane	28e	28ααS
24-methyl-5α(H), 14β(H), 17β(H), 20(R)-cholestane	28f	28ββR
24-methyl-5α(H), 14β(H), 17β(H), 20(S)-cholestane	28g	28ββS
24-ethyl-13β(H), 17α(H), 20(S)-cholestane (diasterane)	29a	29dβS
24-ethyl-13β(H), 17α(H), 20(R)-cholestane (diasterane)	29b	29dβR
24-ethyl-13α(H), 17β(H), 20(S)-cholestane (diasterane)	29c	29dαS
24-ethyl-13α(H), 17β(H), 20(R)-cholestane (diasterane)	29d	29dαR
24-ethyl-5α(H), 14α(H), 17α(H), 20(S)-cholestane	29e	29ααS
24-ethyl-5α(H), 14β(H), 17β(H), 20(R)-cholestane	29f	29ββR
24-ethyl-5α(H), 14β(H), 17β(H), 20(S)-cholestane	29g	29ββS
24-ethyl-5α(H), 14α(H), 17α(H), 20(R)-cholestane	29h	29ααR
24-propyl-5α(H), 14α(H), 17α(H), 20(S)-cholestane	30e	30ααS
24-propyl-5α(H), 14β(H), 17β(H), 20(R)-cholestane	30f	30ββR
24-propyl-5α(H), 14β(H), 17β(H), 20(S)-cholestane	30g	30ββS
24-propyl-5α(H), 14α(H), 17α(H), 20(R)-cholestane	30h	30ααR
4-methyl-14α(H), 17α(H)-cholestanes[x]		M28αα
4,24-dimethyl-14α(H), 17α(H)-cholestanes[*]		M29αα
4-methyl-24-ethyl-14α(H), 17α(H)-cholestanes[*]		M30αα
4,23,24-trimethyl-14α(H), 17α(H)-cholestanes[#] (dinosteranes)		M30D

x various possible isomers at 4,5,20 positions

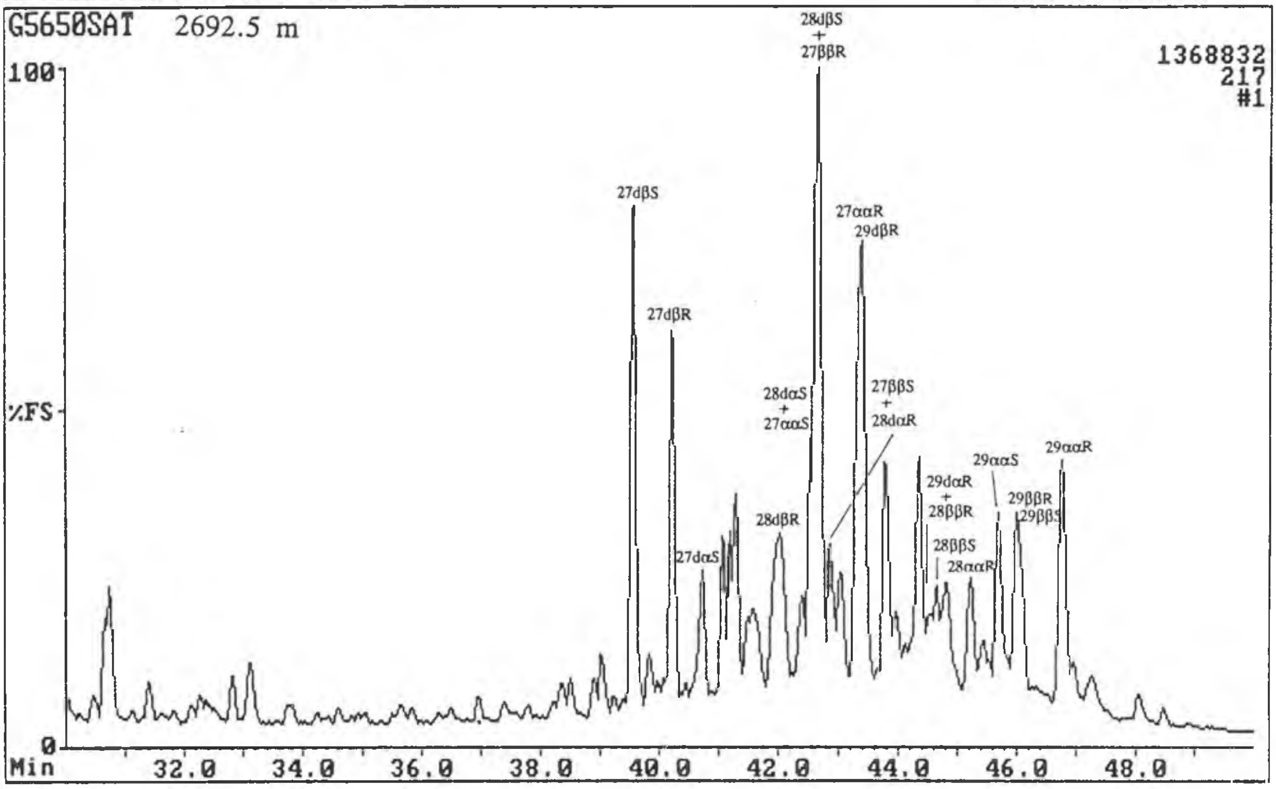
* various possible isomers at 4,5,20,24 positions

various possible isomers at 4,5,20,23,24 positions

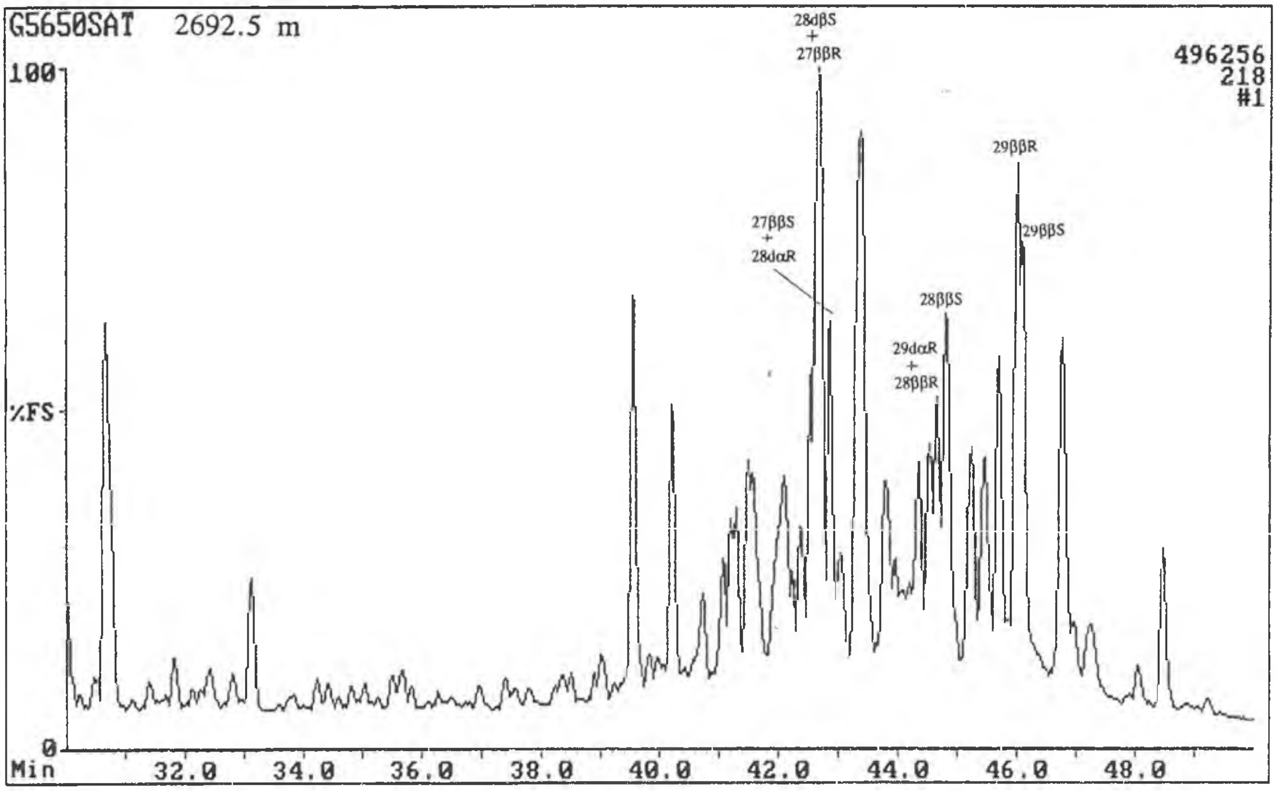
TRITERPANES (m/z 177, 191)

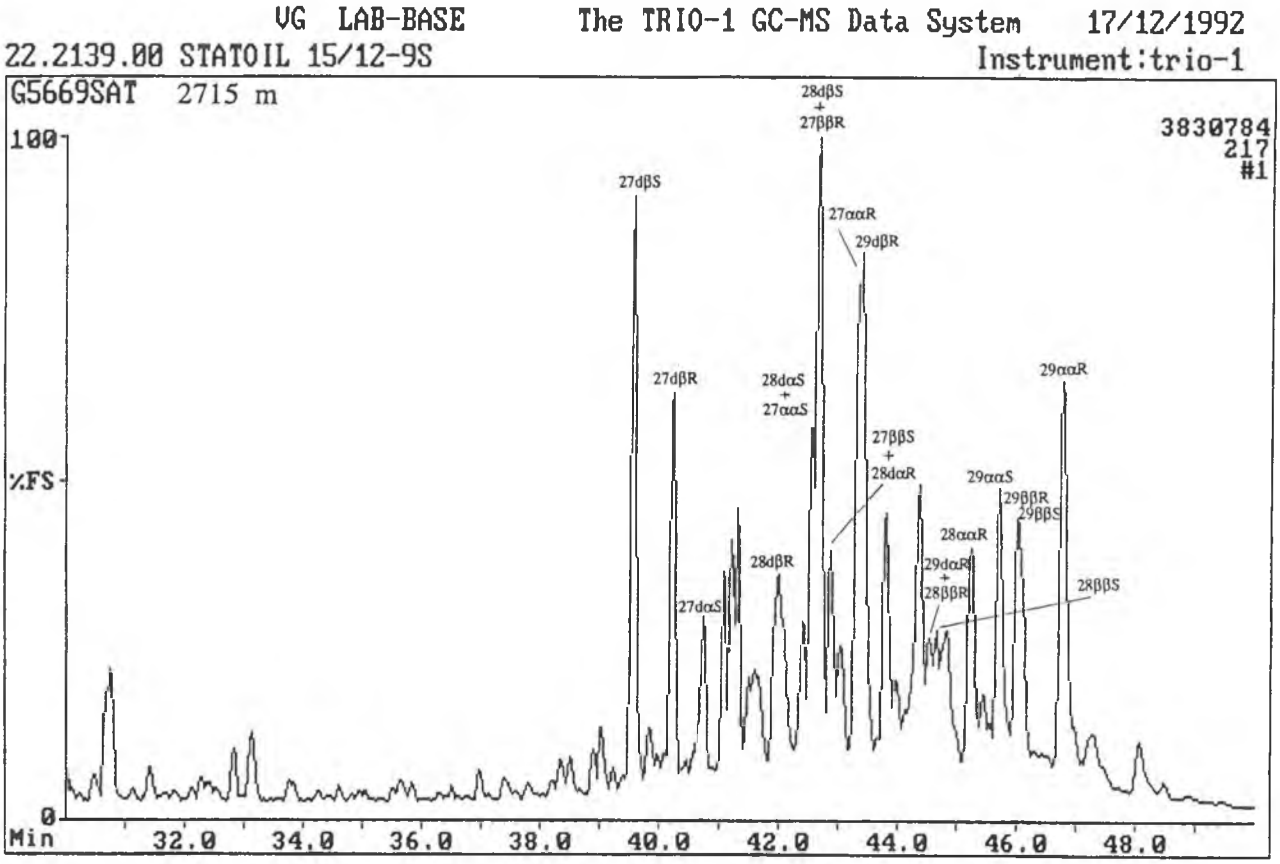
Name	Previous Code	New Code
$C_{23}H_{42}$ tricyclic terpane	P	23/3
$C_{24}H_{44}$ tricyclic terpane	Q	24/3
$C_{25}H_{46}$ tricyclic terpane	R	25/3
$C_{24}H_{42}$ tetracyclic terpane	S	24/4
$C_{26}H_{48}$ tricyclic terpane	T	26/3
18α(H)-22,29,30-trisnorneohopane	27A	27Ts
17α(H)-22,29,30-trisnorhopane	27B	27Tm
17α(H), 21β(H)-28,30-bisnorhopane	28A	28αβ
18α(H)-30-norneohopane		29Ts
17α(H), 21β(H)-30-norhopane	C29A	29αβ
17β(H), 21α(H)-30-norhopane	C29B	29βα
15α-methyl-17α(H)-27-norhopane (TtX)	X	30d
18α(H)-oleanane		30O
17α(H), 21β(H)-hopane	C30A	30αβ
17β(H), 21α(H)-hopane (moretane)	C30B	30βα
Gammacerane		30G
17α(H), 21β(H), 22(S)-homohopane	C31S	31αβS
17α(H), 21β(H), 22(R)-homohopane	C31R	31αβR
17α(H), 21β(H), 22(S)-bishomohopane	C32S	32αβS
17α(H), 21β(H), 22(R)-bishomohopane	C32R	32αβR
17α(H), 21β(H), 22(S)-trishomohopane	C33S	33αβS
17α(H), 21β(H), 22(R)-trishomohopane	C33R	33αβR
17α(H), 21β(H), 22(S)-tetrakishomohopane	C34S	34αβS
17α(H), 21β(H), 22(R)-tetrakishomohopane	C34R	34αβR
17α(H), 21β(H), 22(S)-pentakishomohopane	C35S	35αβS
17α(H), 21β(H), 22(R)-pentakishomohopane	C35R	35αβR
17α(H), 21β(H)-25,28,30-trisnorhopane		25nor28αβ
17α(H), 21β(H)-25-norhopane		25nor30αβ

VG LAB-BASE The TRIO-1 GC-MS Data System 17/12/1992
22.2139.00 STATOIL 15/12-9S Instrument:trio-1



VG LAB-BASE The TRIO-1 GC-MS Data System 17/12/1992
22.2139.00 STATOIL 15/12-9S Instrument:trio-1

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The TRIO-1 GC-MS Data System
17/12/1992
22.2139.00 STATOIL 15/12-9S
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3830784
217
#1
100
%FS
0
Min
32.0
34.0
36.0
38.0
40.0
42.0
44.0
46.0
48.0
28dβS + 27ββR
27dβS
27ααR
29dβR
27dβR
28dαS + 27ααS
29ααR
27ββS + 28dαR
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29ββR
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28ααR
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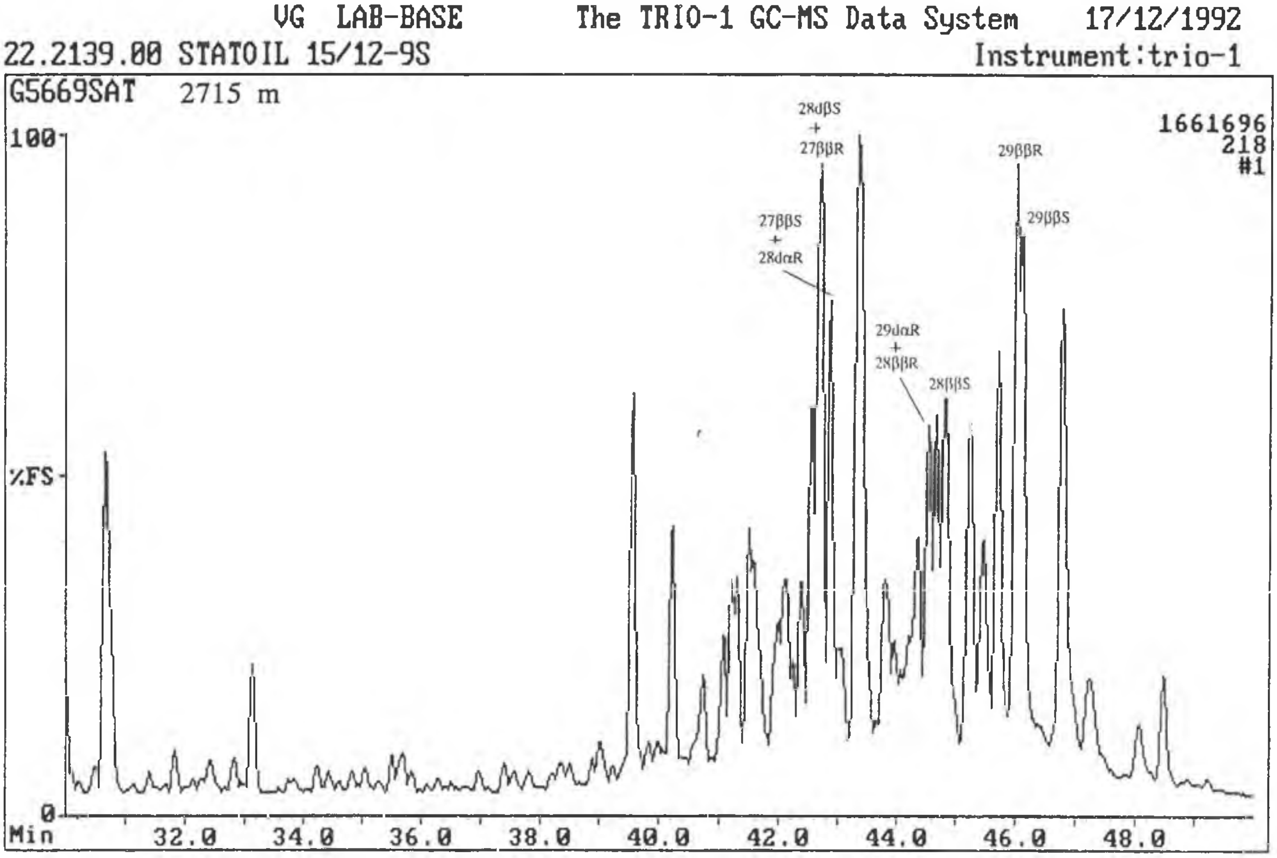
29dαR + 28ββR
28ββS
27dαS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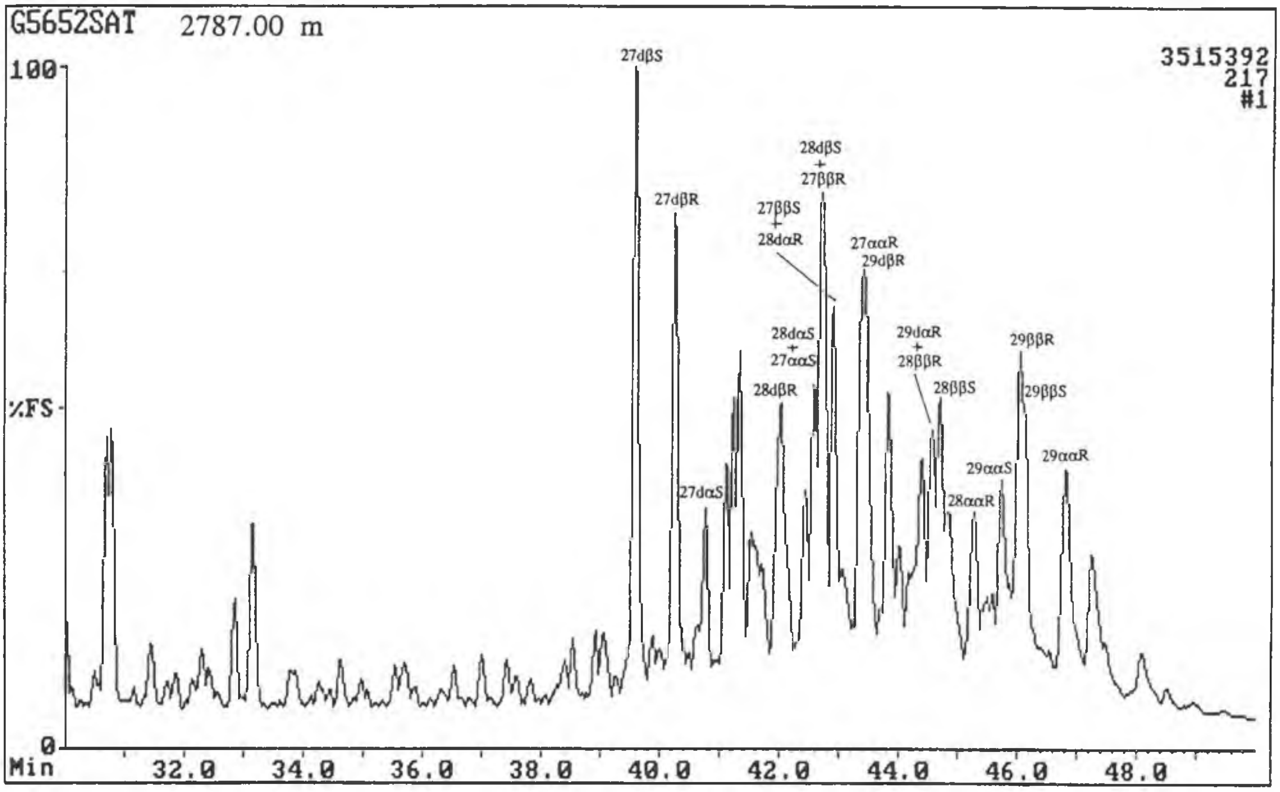
The TRIO-1 GC-MS Data System
17/12/1992
22.2139.00 STATOIL 15/12-9S
Instrument:trio-1
G5669SAT 2715 m
1661696
218
#1
100
%FS
0
Min
32.0
34.0
36.0
38.0
40.0
42.0
44.0
46.0
48.0
28dβS + 27ββR
29ββR
27ββS + 28dαR
29ββS
29dαR + 28ββR
28ββS

VG LAB-BASE The TRIO-1 GC-MS Data System 17/12/1992
22.2139.00 STATOIL 15/12-9S Instrument:trio-1



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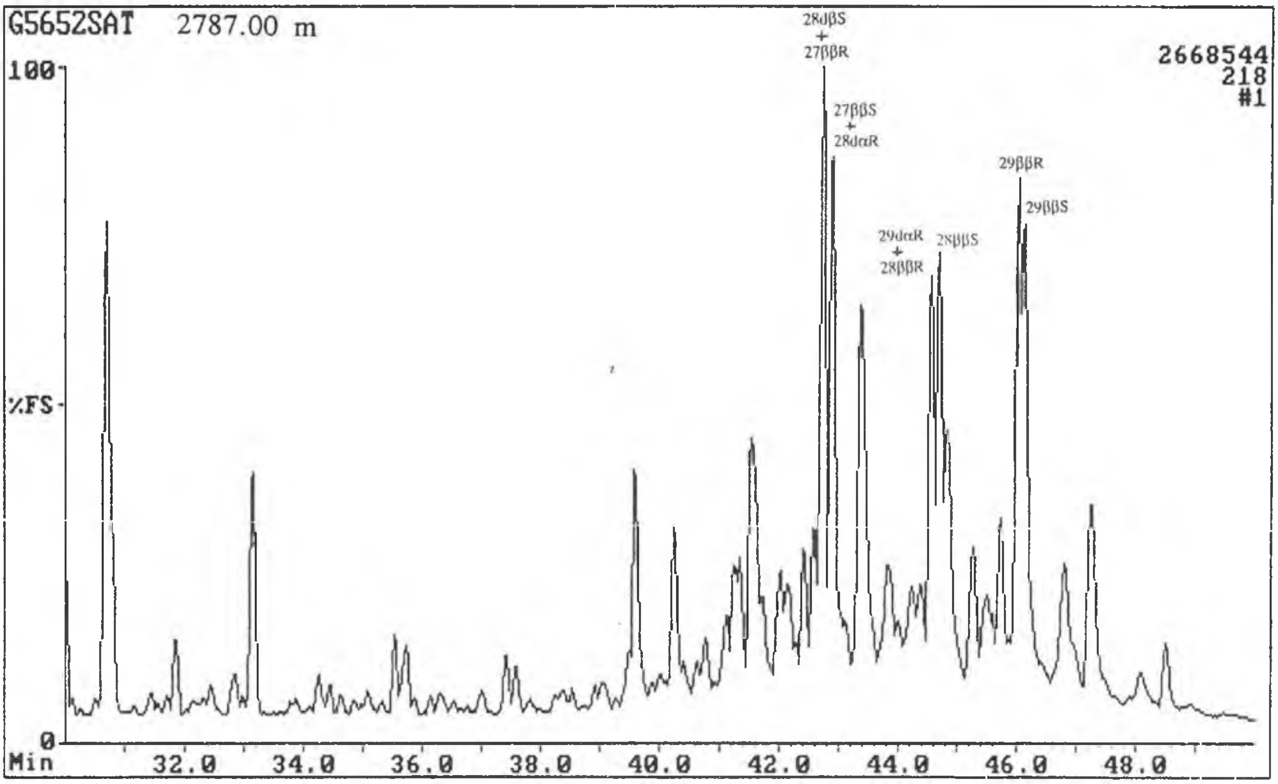

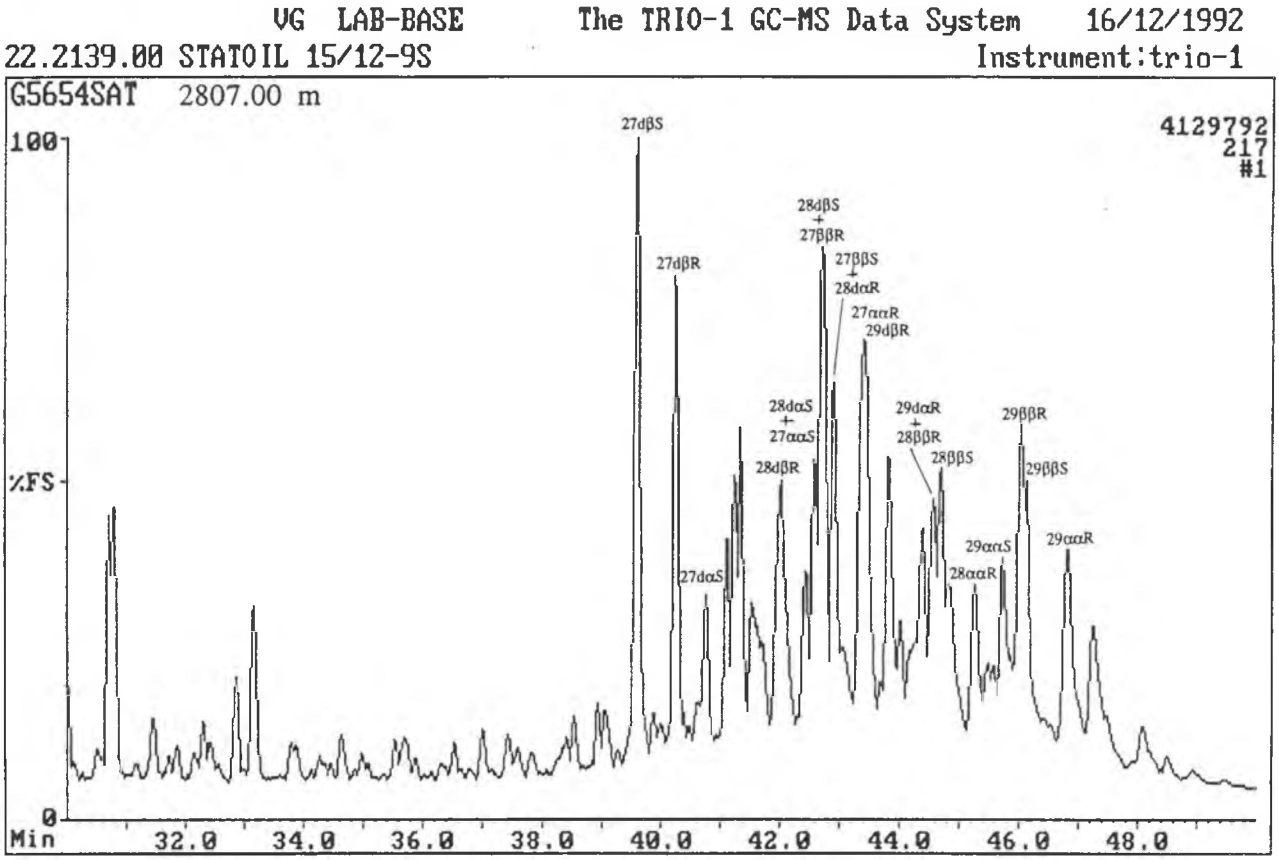
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The TRIO-1 GC-MS Data System
16/12/1992
22.2139.00 STATOIL 15/12-9S
Instrument:trio-1
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100
%FS
0
Min
32.0
34.0
36.0
38.0
40.0
42.0
44.0
46.0
48.0
4129792
217
#1
27dβS
27dβR
27dαS
28dβR
28dαS + 27ααS
28dβS + 27ββR
27ββS + 28dαR
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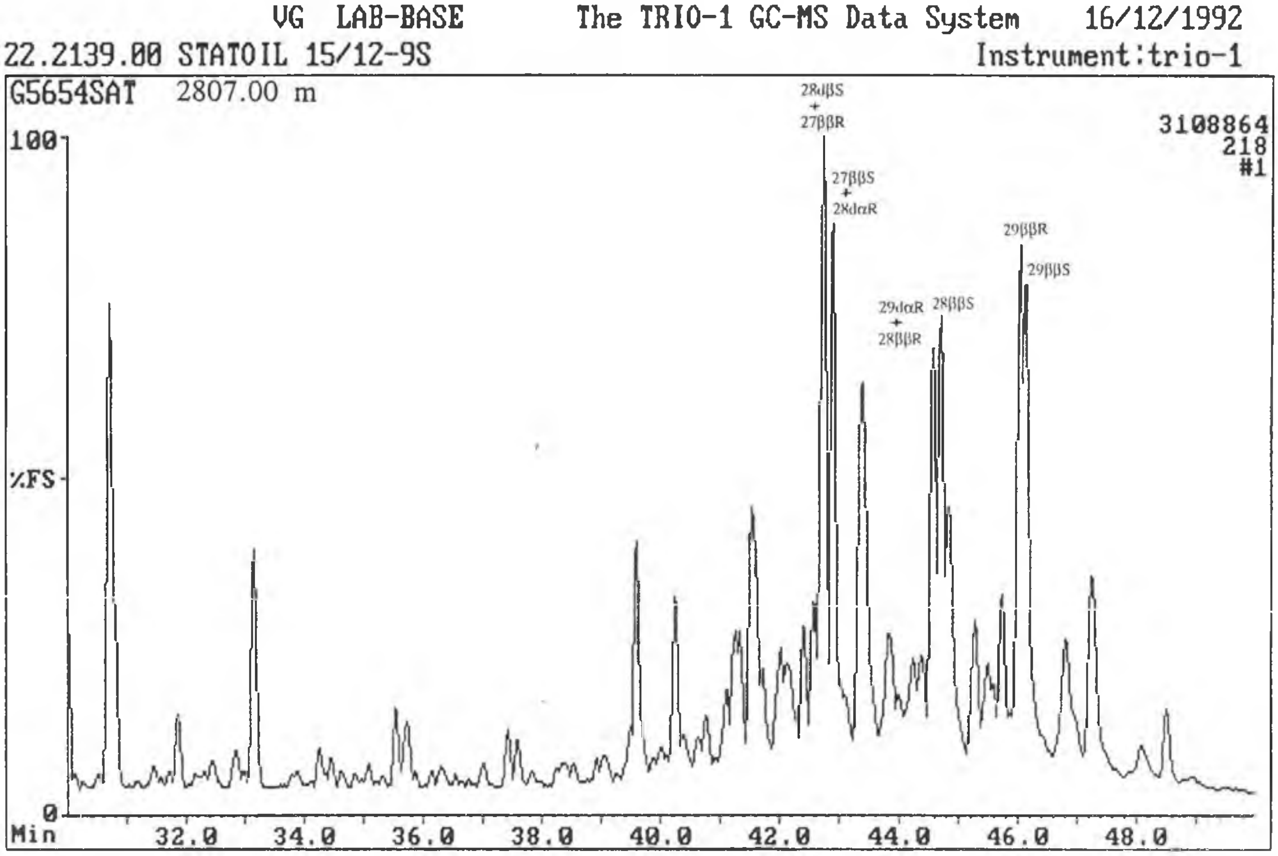
29ββR
29ββS
29ααR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The TRIO-1 GC-MS Data System
16/12/1992
22.2139.00 STATOIL 15/12-9S
Instrument:trio-1
G5654SAT 2807.00 m
100
%FS
0
Min
32.0
34.0
36.0
38.0
40.0
42.0
44.0
46.0
48.0
3108864
218
#1
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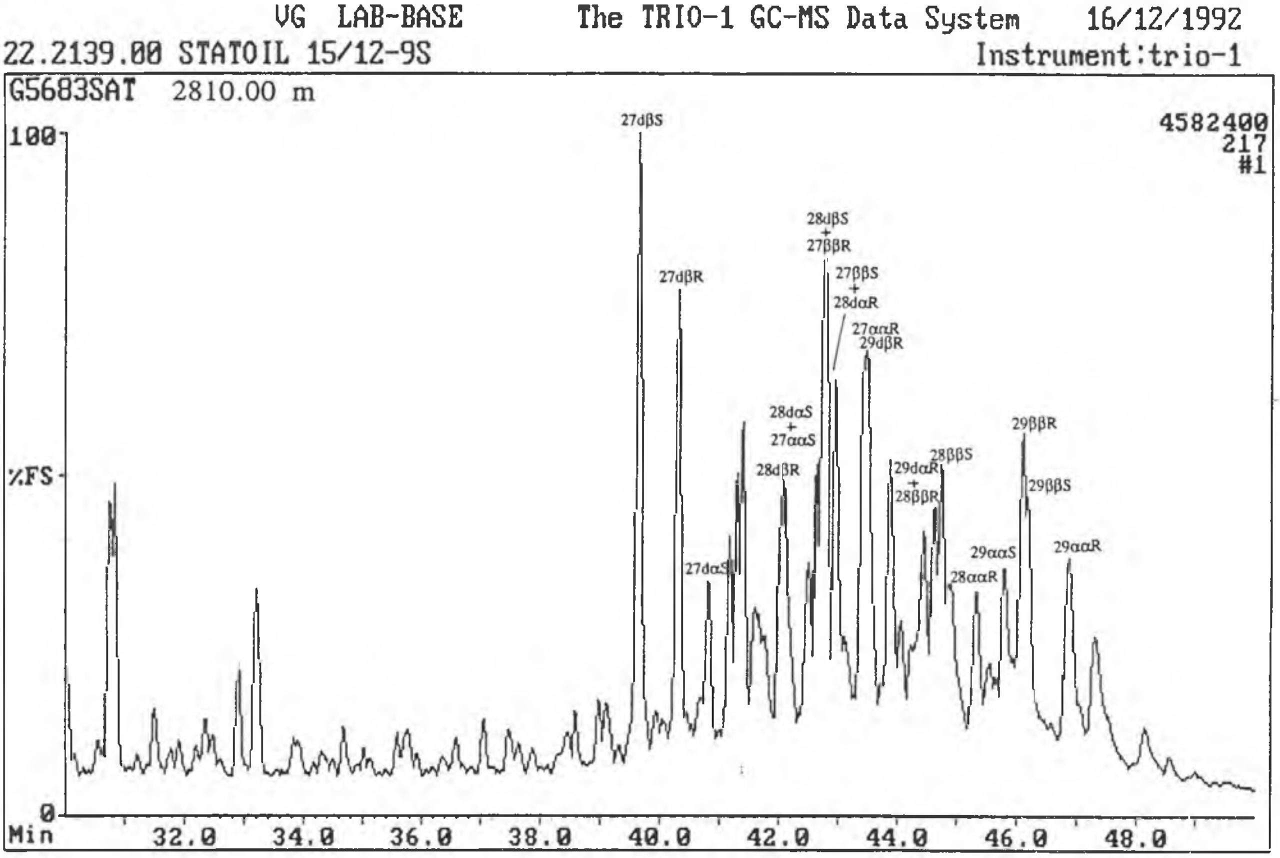
27ββS + 28dαR
29ββR
29ββS
29dαR + 28ββR
28ββS


VG LAB-BASE
The TRIO-1 GC-MS Data System
16/12/1992
22.2139.00 STATOIL 15/12-9S
Instrument:trio-1
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4582400
217
#1
100
%FS
0
Min
32.0
34.0
36.0
38.0
40.0
42.0
44.0
46.0
48.0
27dβS
27dβR
27dαS
28dβS + 27ββR
27ββS + 28dαR
27ααR
29dβR
28dαS + 27ααS
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29dαR + 28ββR
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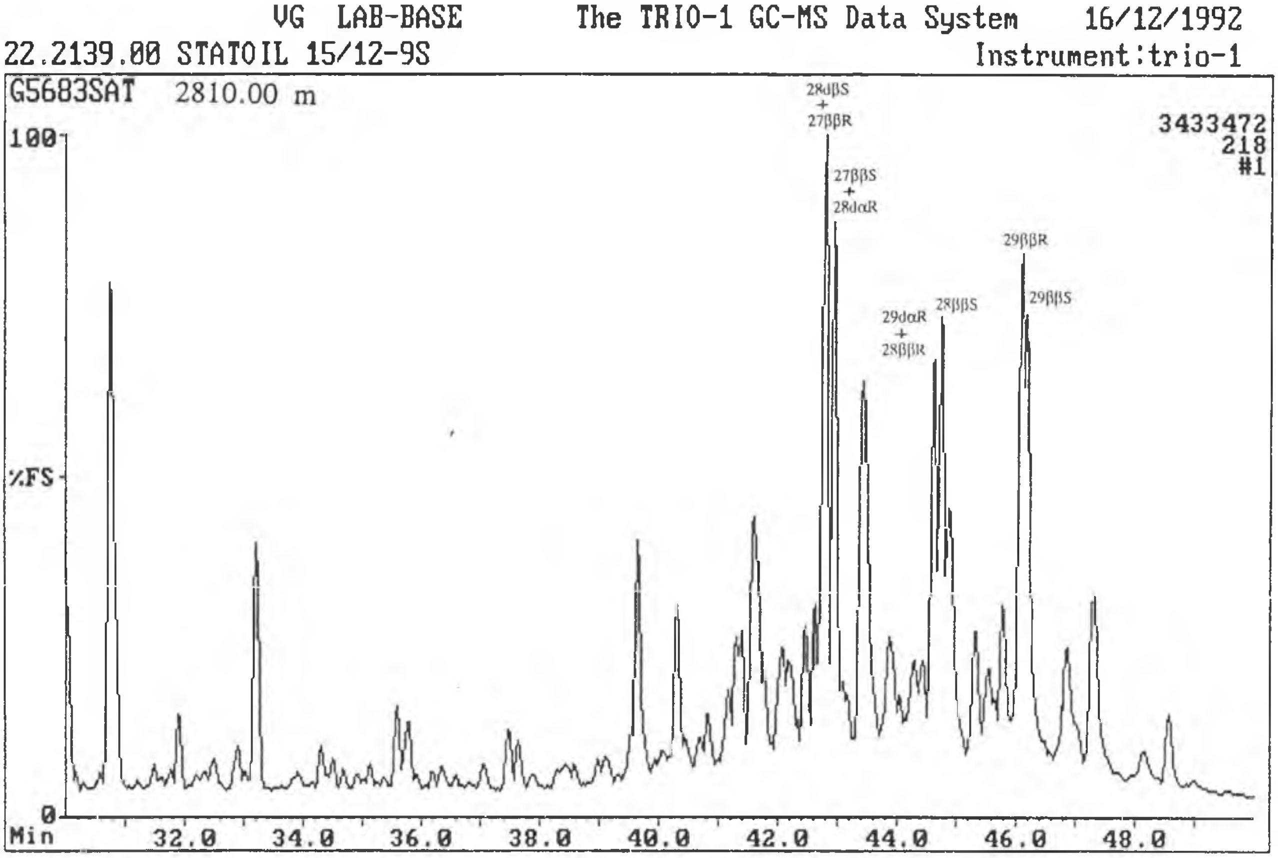
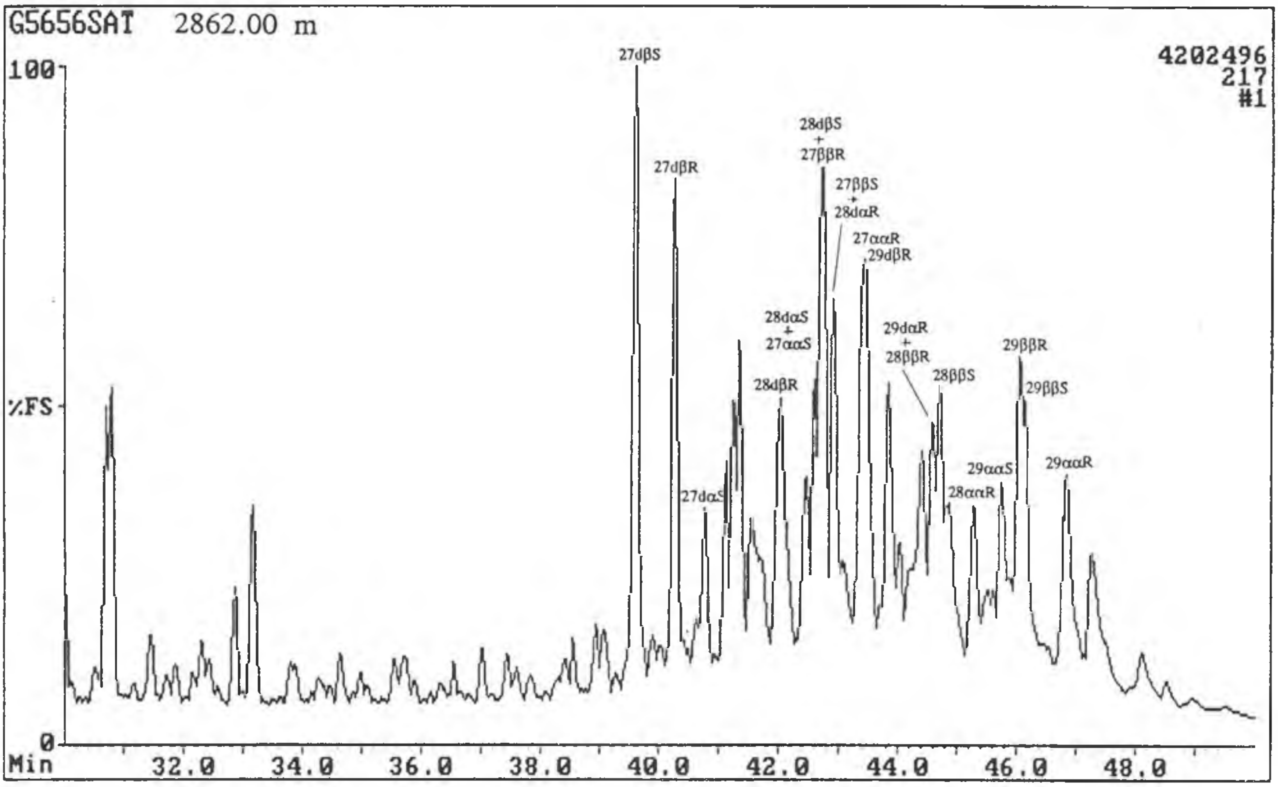
28ααR
29ββR
29ββS
29ααR


VG LAB-BASE
The TRIO-1 GC-MS Data System
16/12/1992
22.2139.00 STATOIL 15/12-9S
Instrument:trio-1
G5683SAT 2810.00 m
3433472
218
#1
100
%FS
0
Min
32.0
34.0
36.0
38.0
40.0
42.0
44.0
46.0
48.0
28dβS + 27ββR
27ββS + 28dαR
29dαR + 28ββR
28ββS
29ββR
29ββS

VG LAB-BASE The TRIO-1 GC-MS Data System 16/12/1992
22.2139.00 STATOIL 15/12-9S Instrument:trio-1



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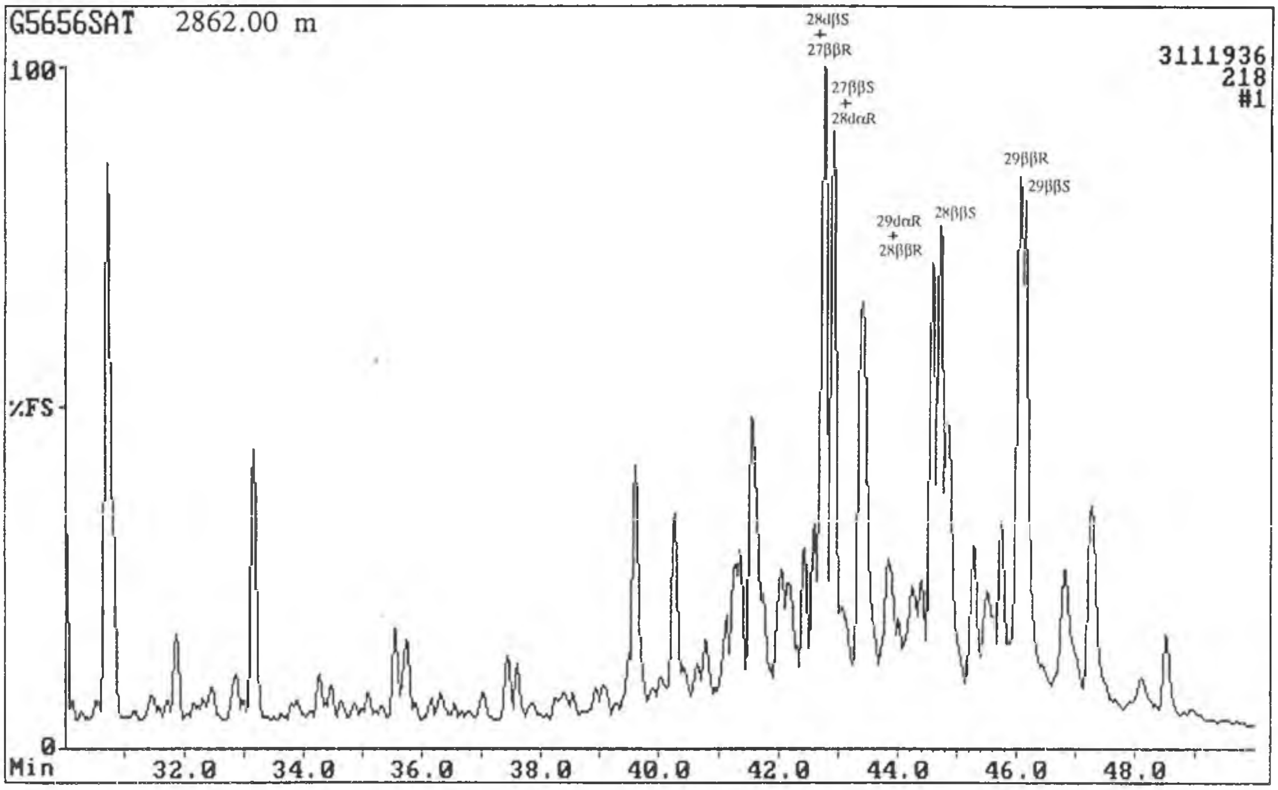

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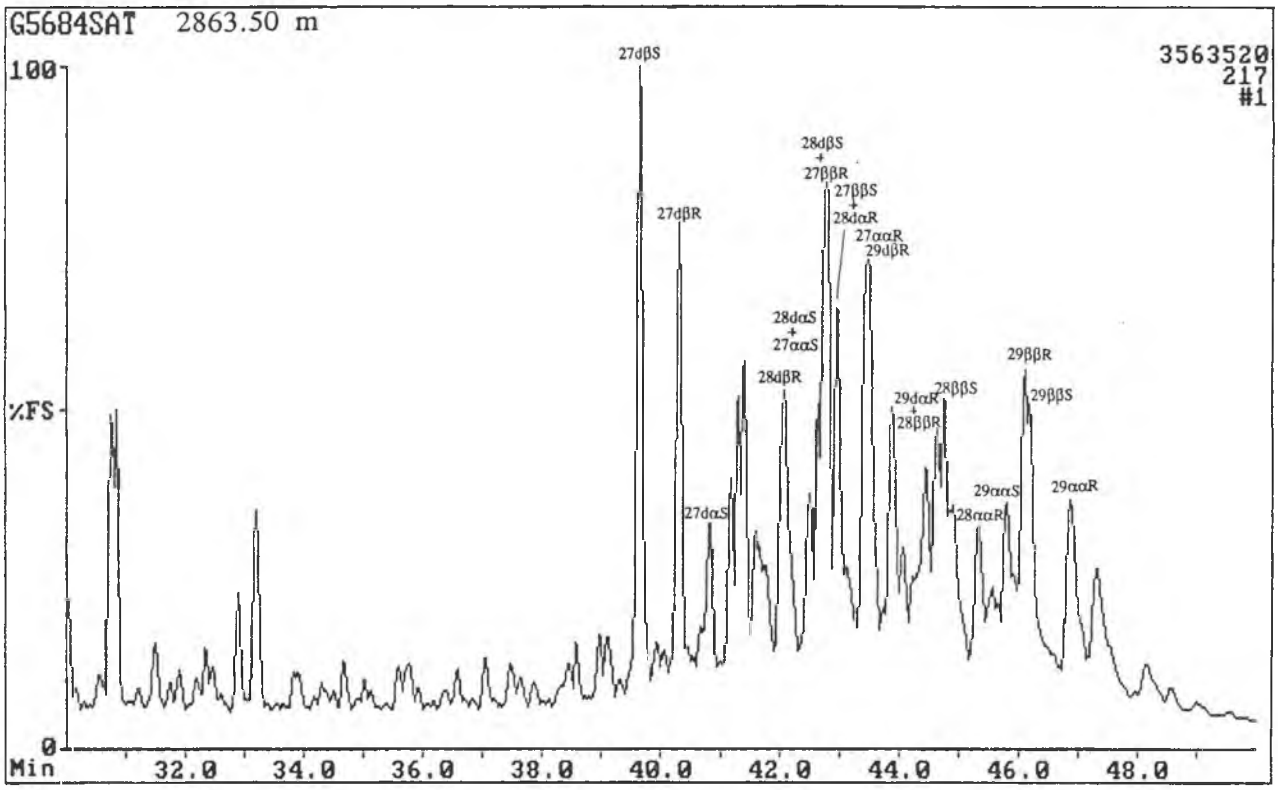

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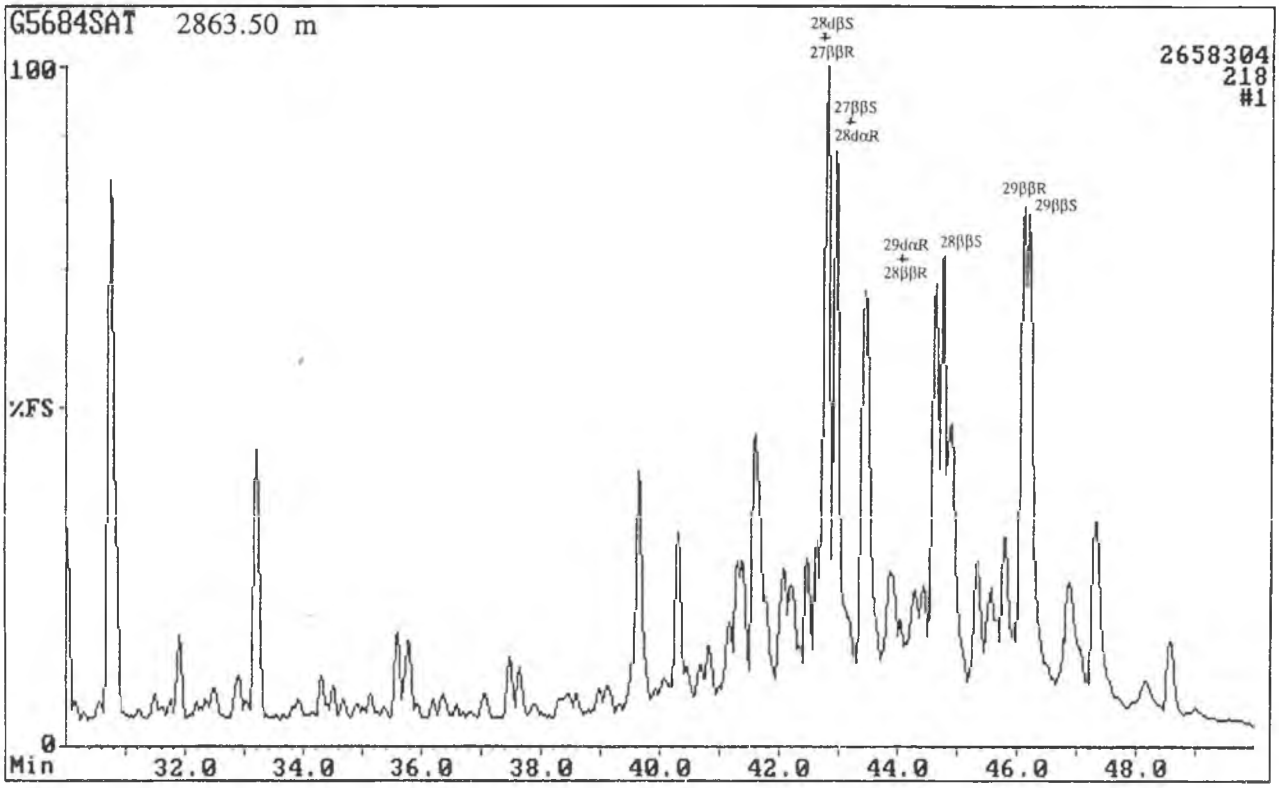
22.2139.00 STATOIL 15/12-9S Instrument:trio-1



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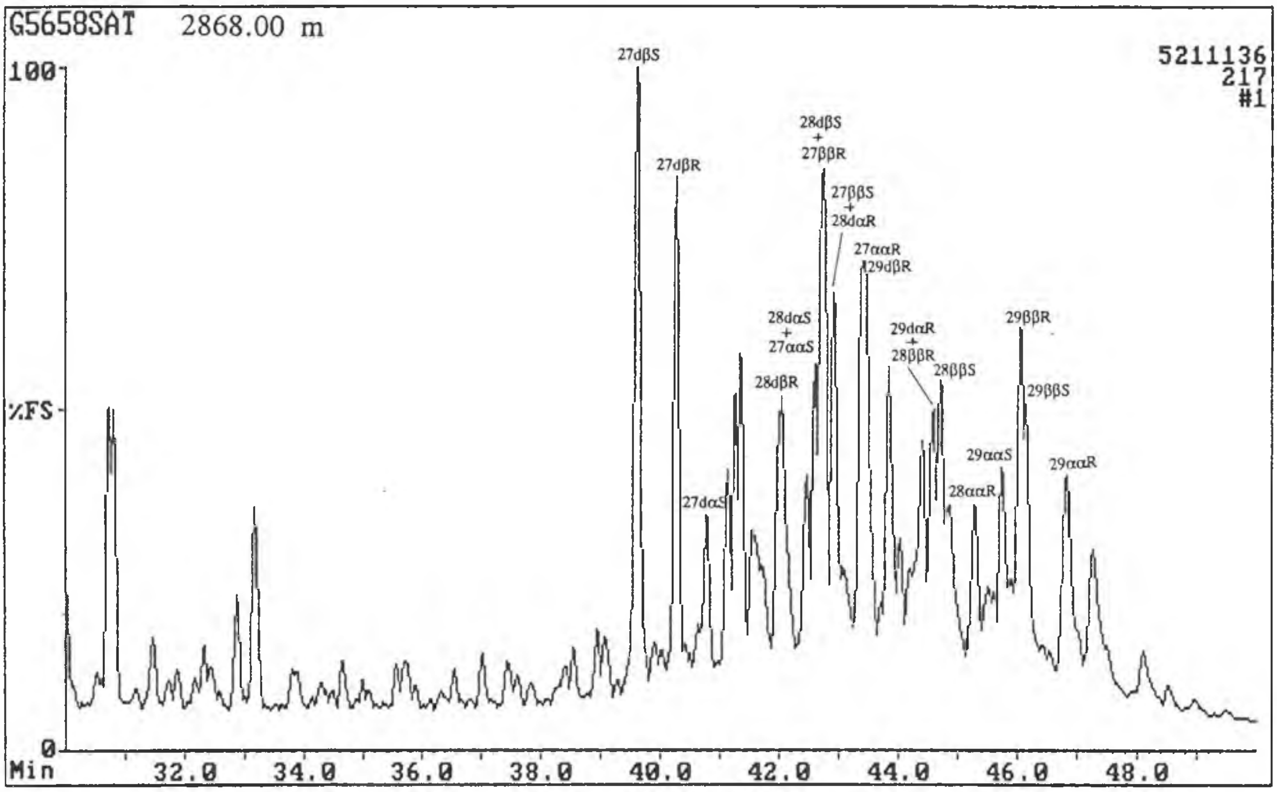

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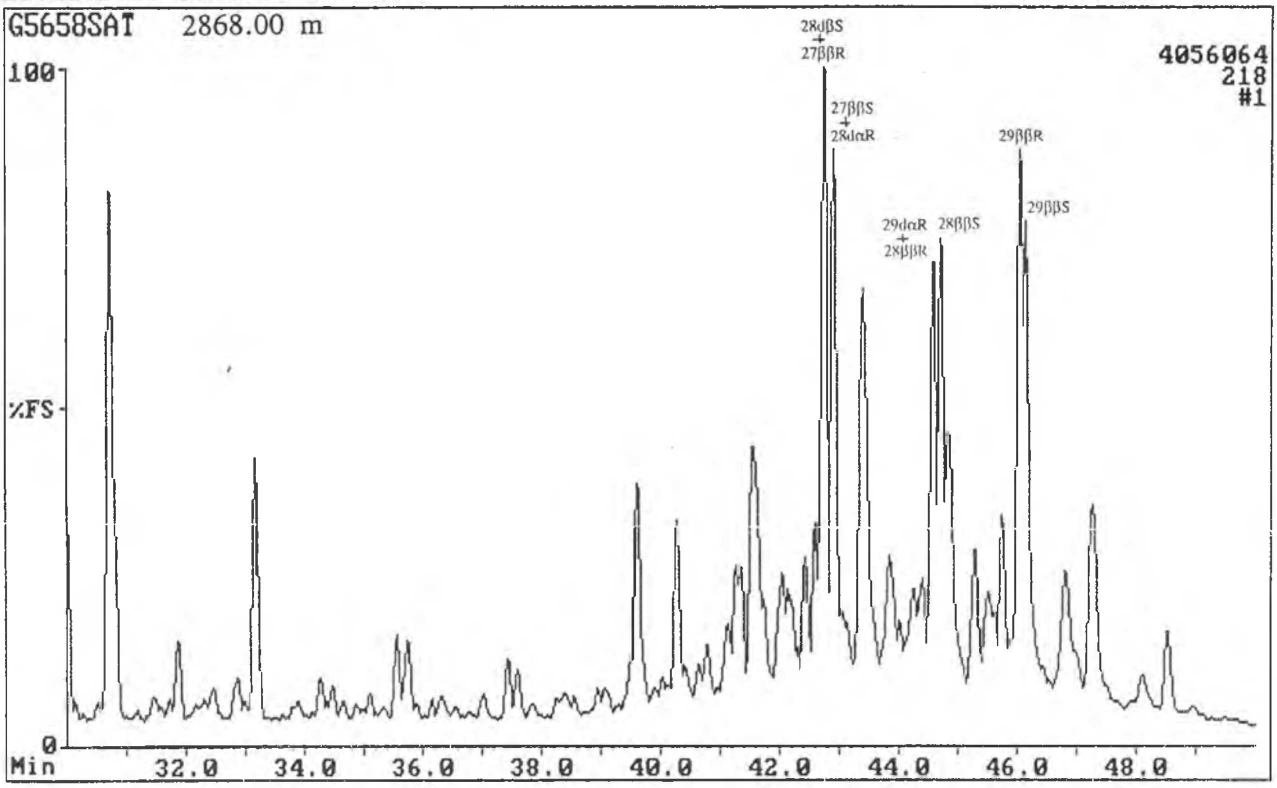

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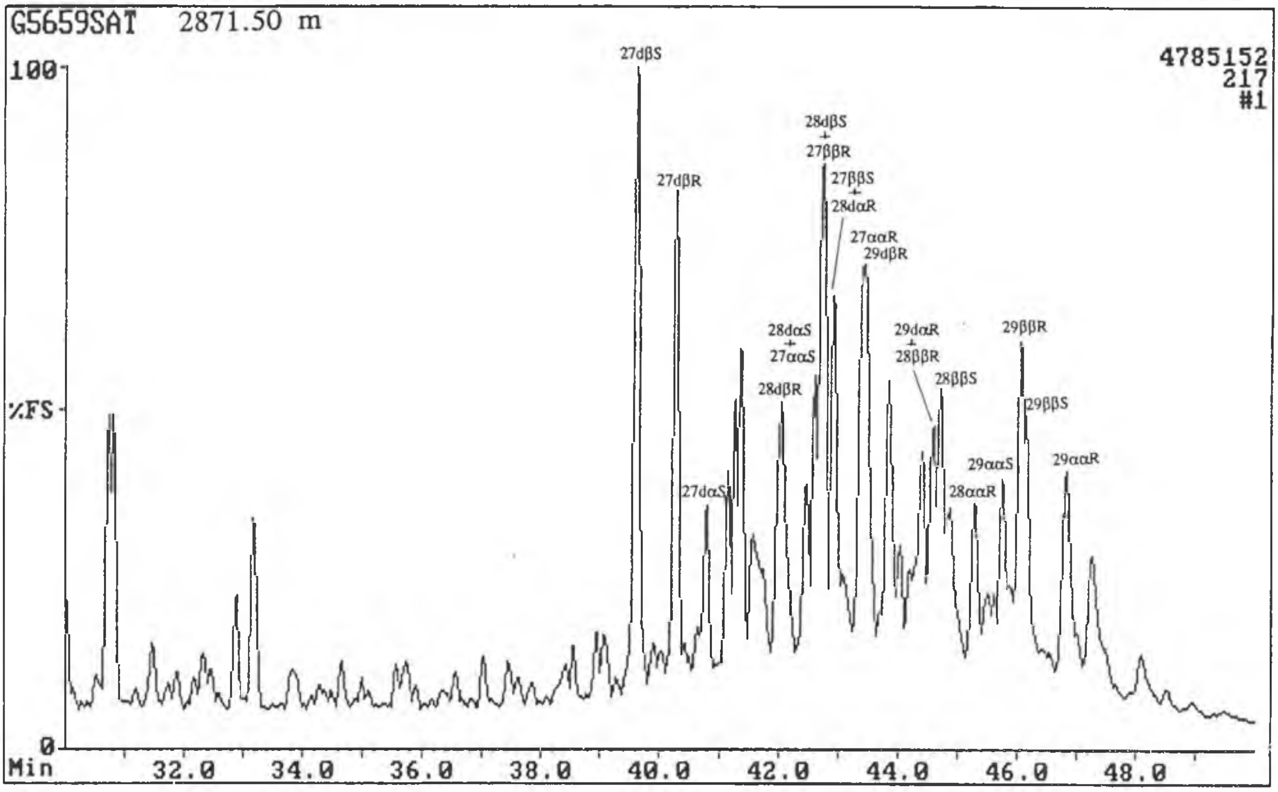

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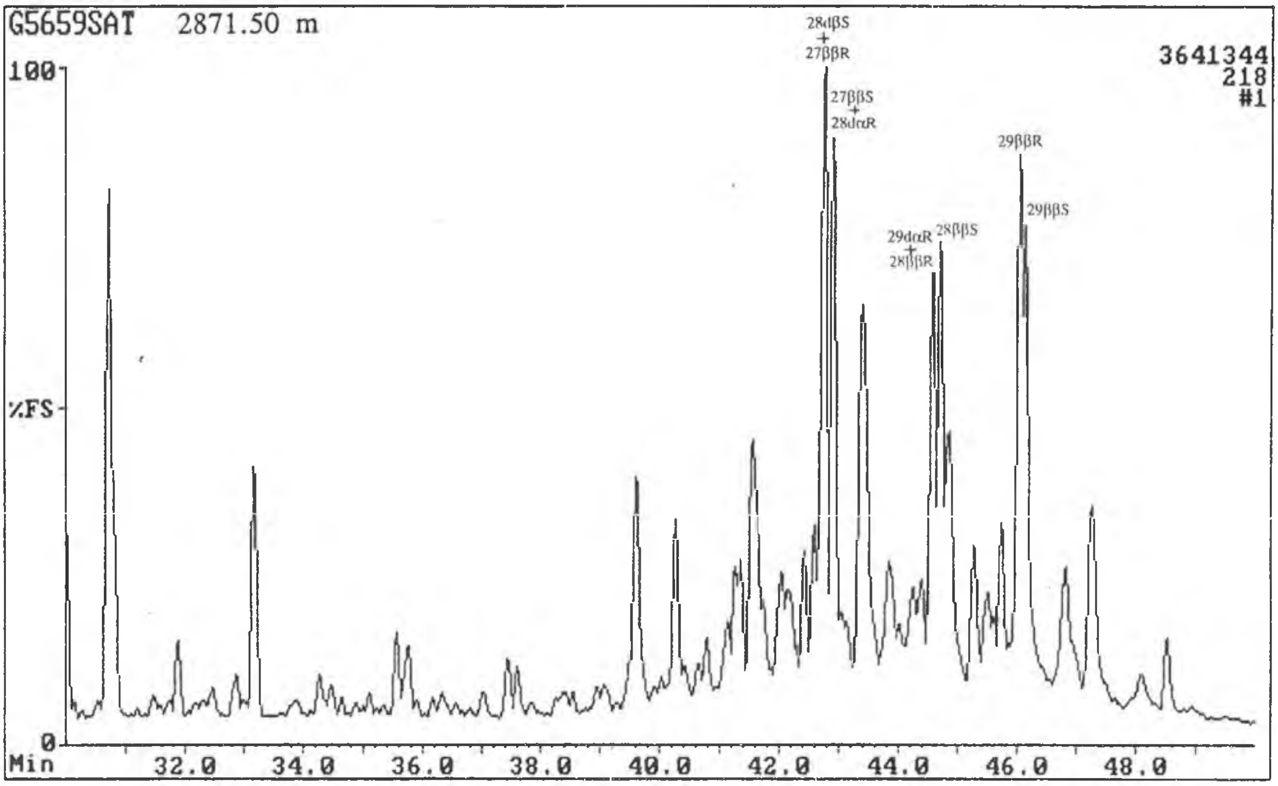

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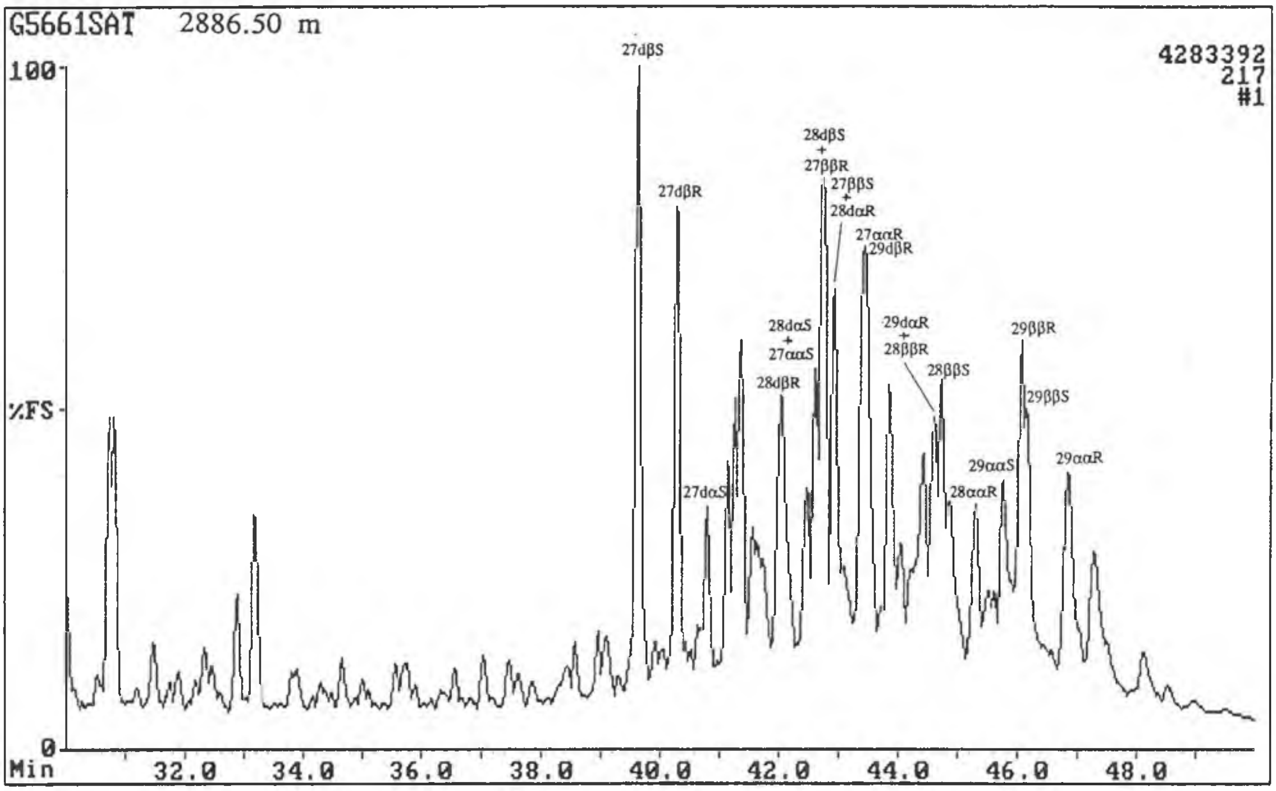

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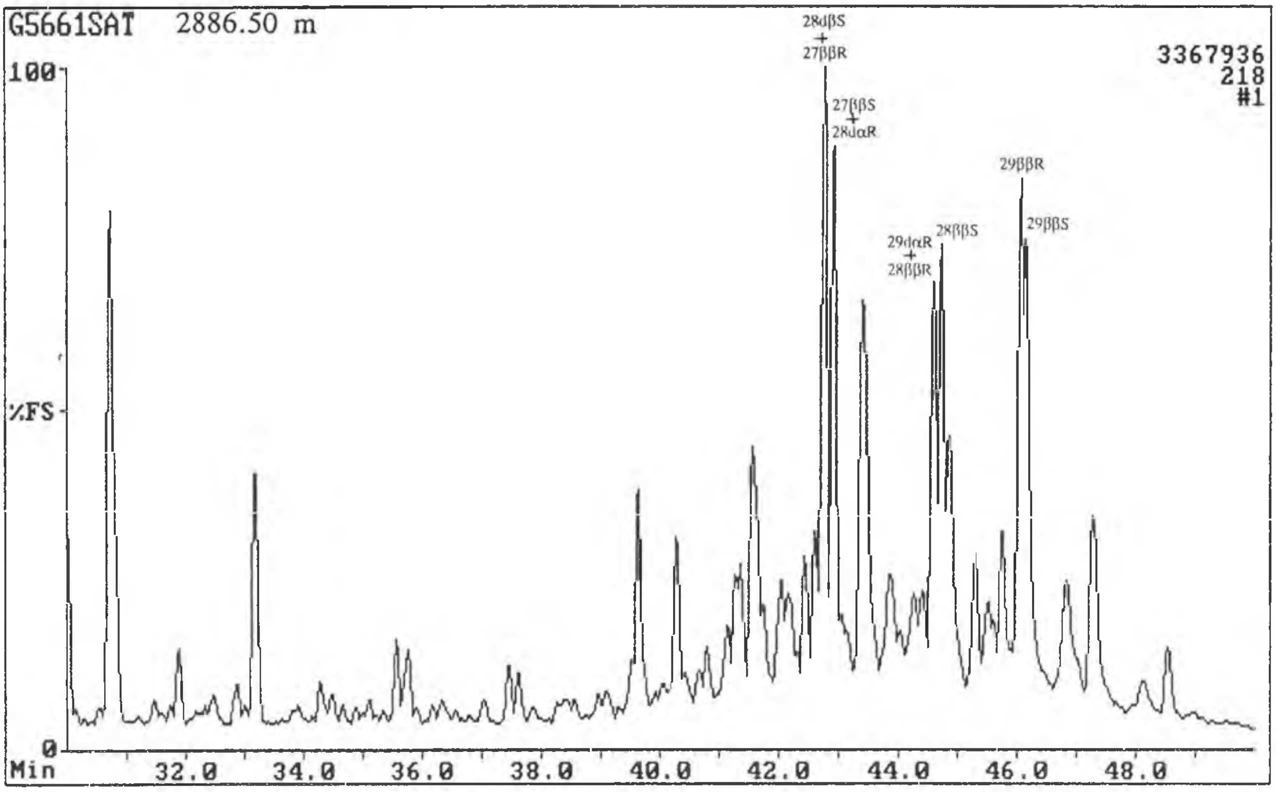
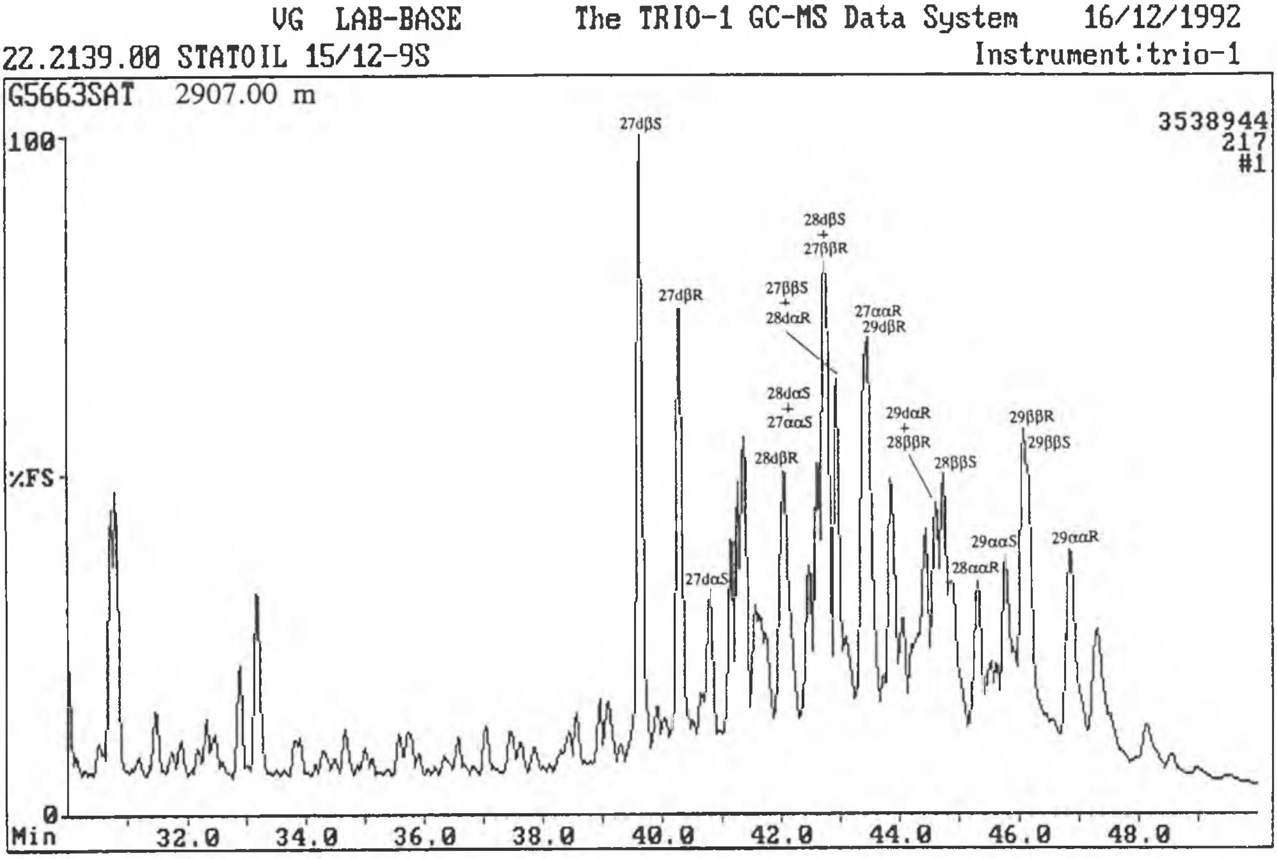
22.2139.00 STATOIL 15/12-9S Instrument:trio-1





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22.2139.00 STATOIL 15/12-9S Instrument:trio-1
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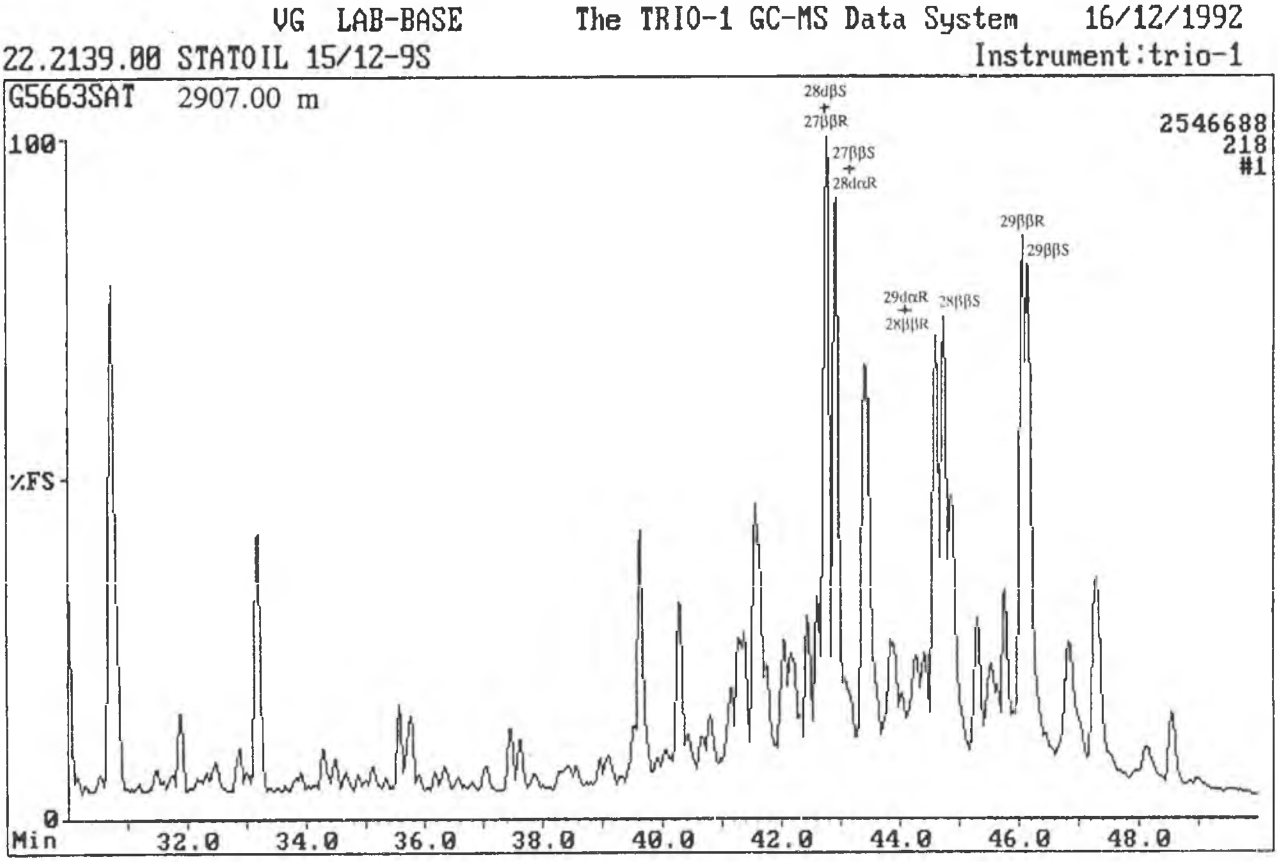

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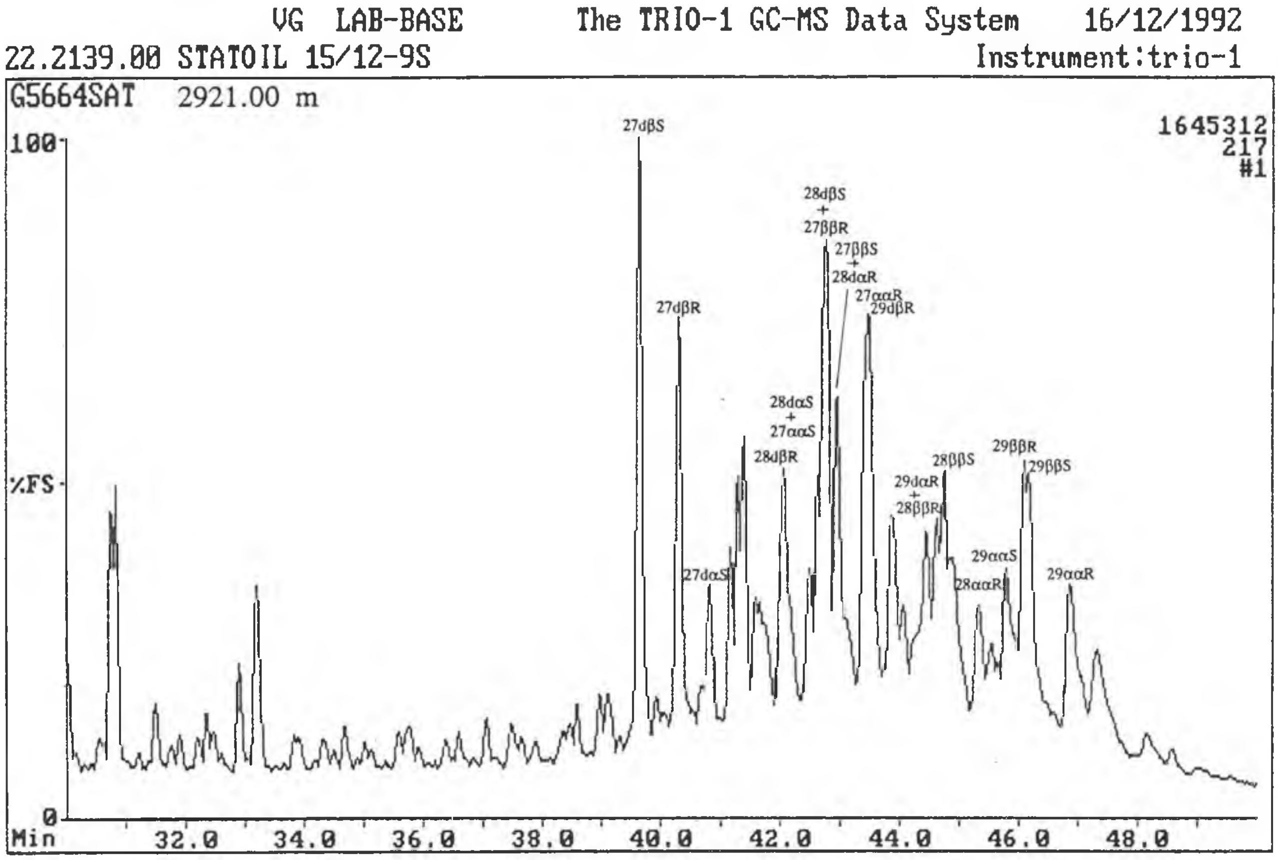
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1645312
217
#1
100
%FS
0
Min
32.0
34.0
36.0
38.0
40.0
42.0
44.0
46.0
48.0
27dβS
27dβR
28dβS + 27ββR
27ββS + 28dαR
27ααR
29dβR
28dαS + 27ααS
28dβR
27dαS
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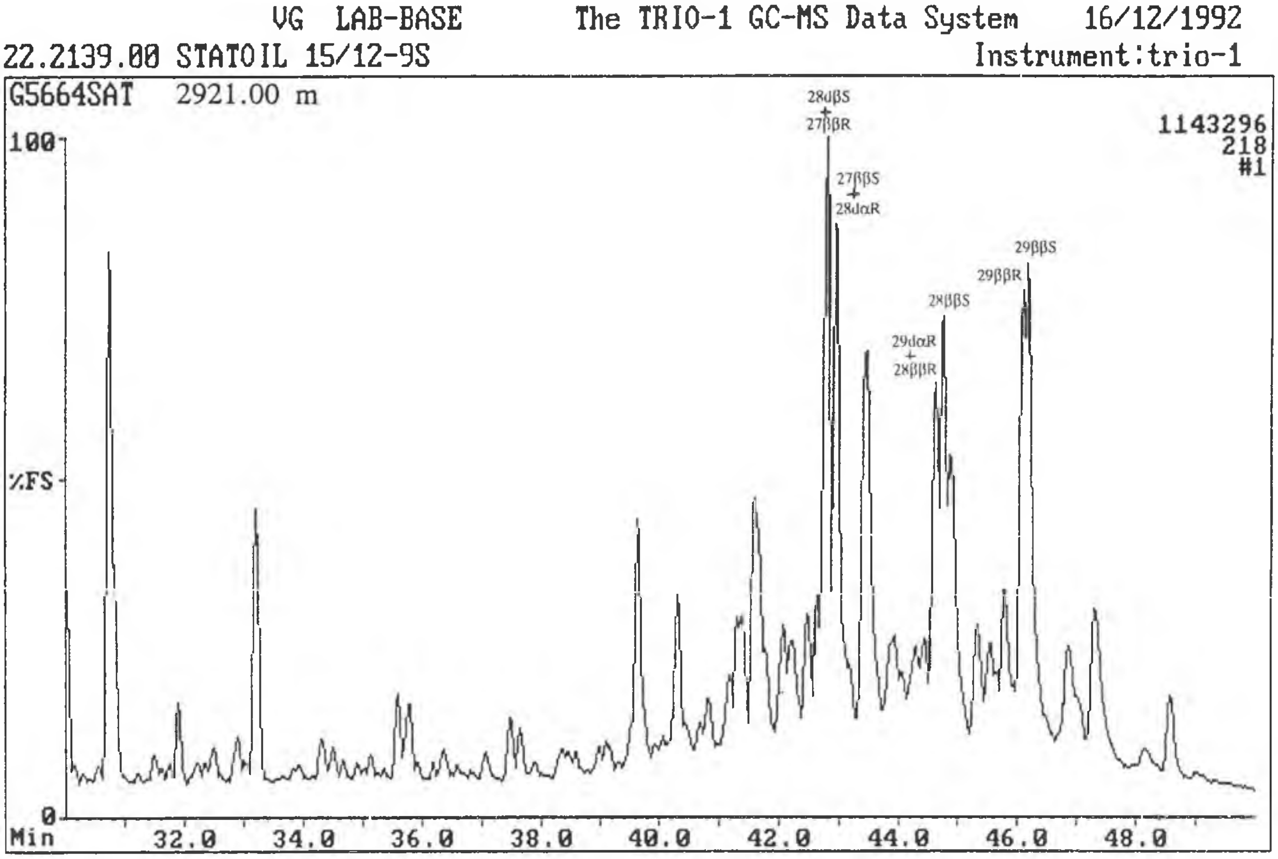
28ααR
29ααR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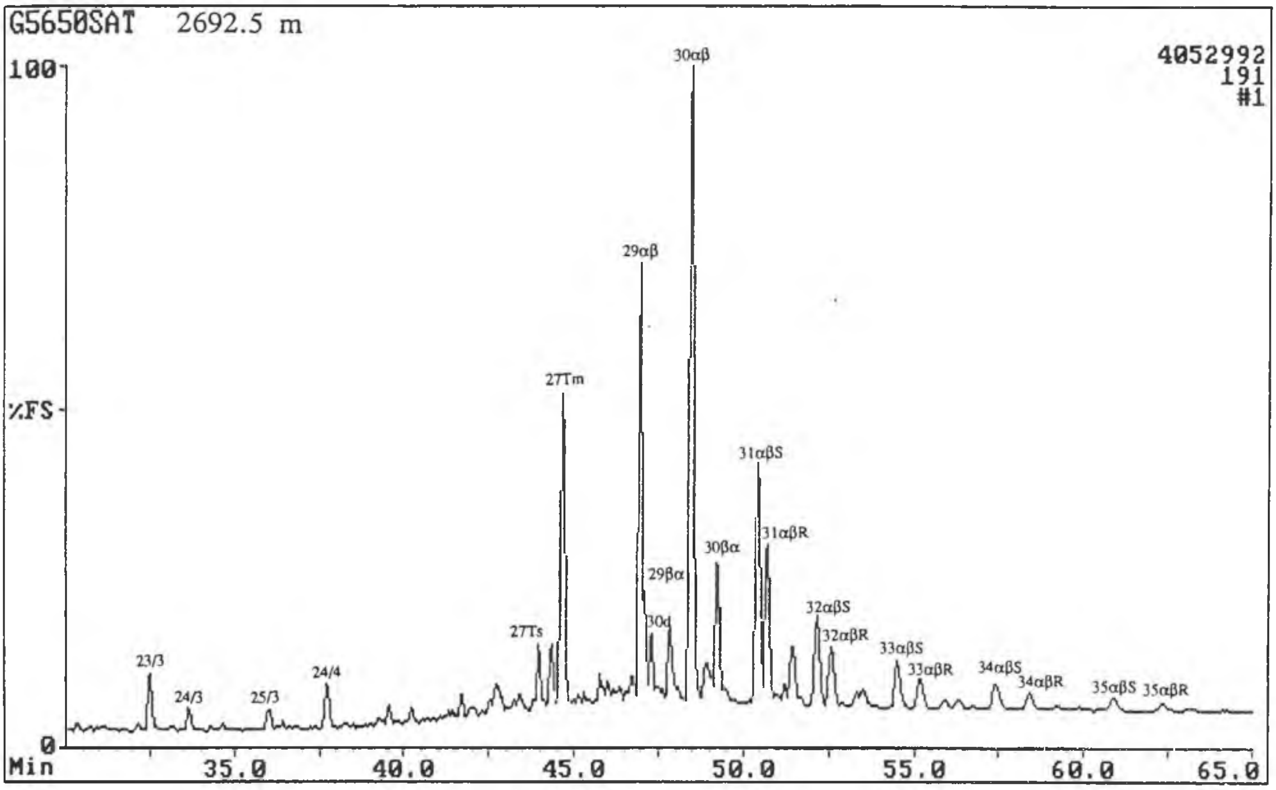
218
#1
100
%FS
0
Min
32.0
34.0
36.0
38.0
40.0
42.0
44.0
46.0
48.0
28dβS + 27ββR
27ββS + 28dαR
29ββS
29ββR
28ββS
29dαR + 28ββR

VG LAB-BASE The TRIO-1 GC-MS Data System 17/12/1992
22.2139.00 STATOIL 15/12-9S Instrument:trio-1



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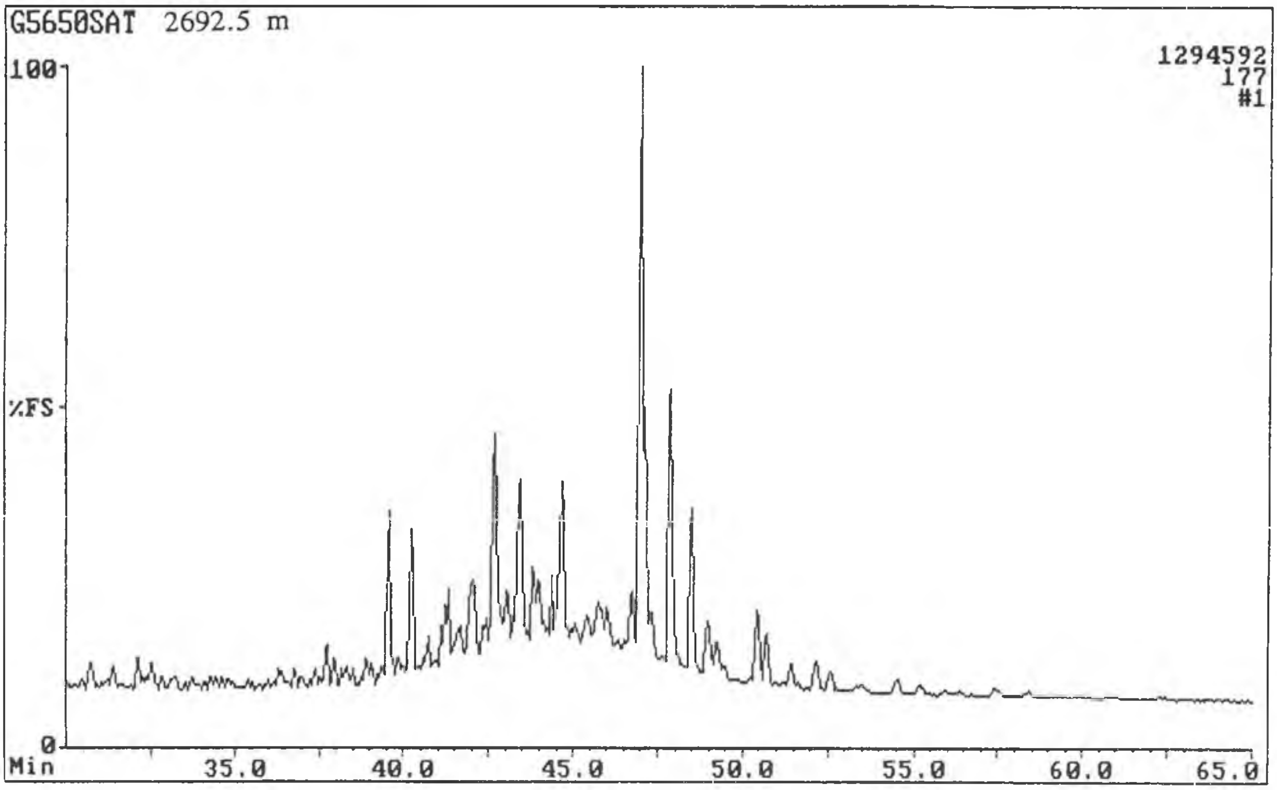

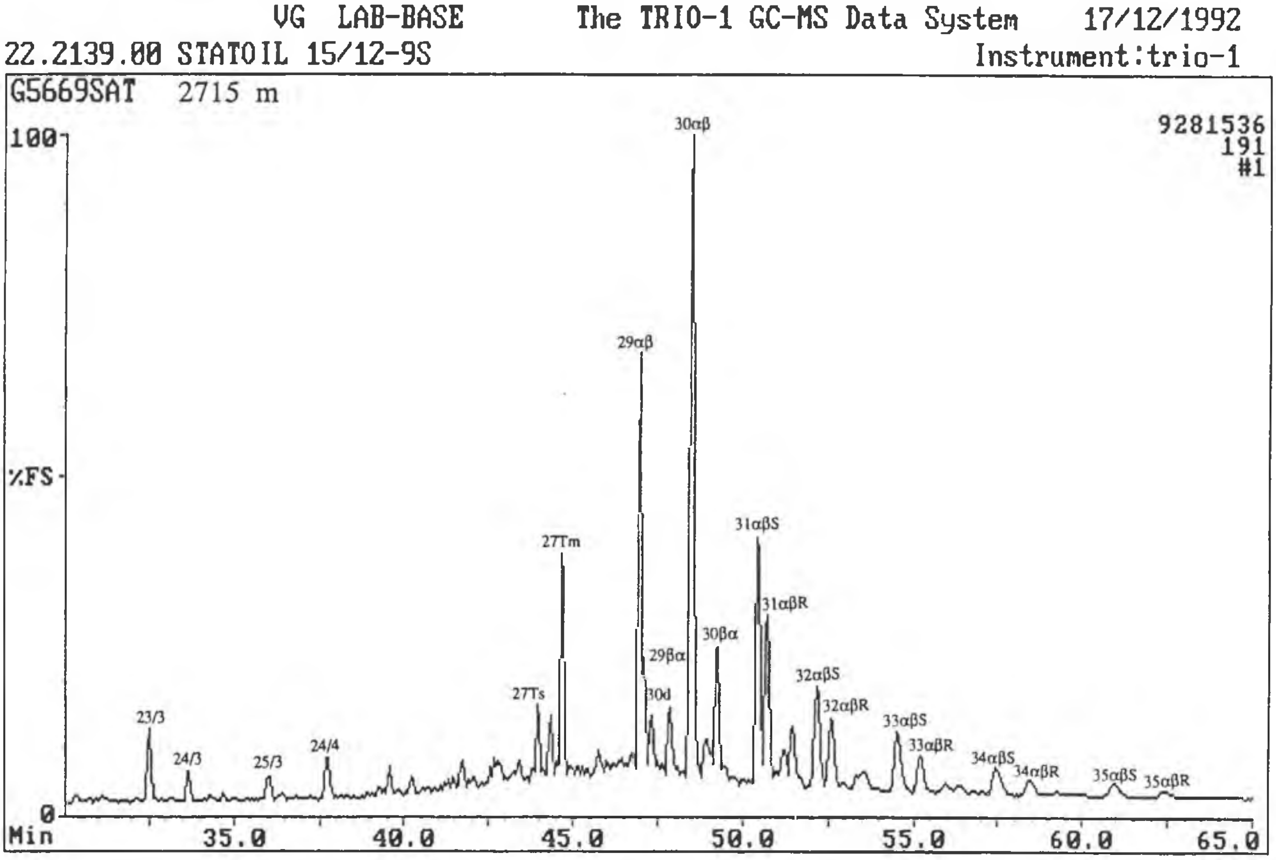
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The TRIO-1 GC-MS Data System
17/12/1992
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100
%FS
0
Min
9281536
191
#1
35.0
40.0
45.0
50.0
55.0
60.0
65.0
23/3
24/3
25/3
24/4
27Ts
27Tm
29αβ
29βα
30d
30αβ
30βα
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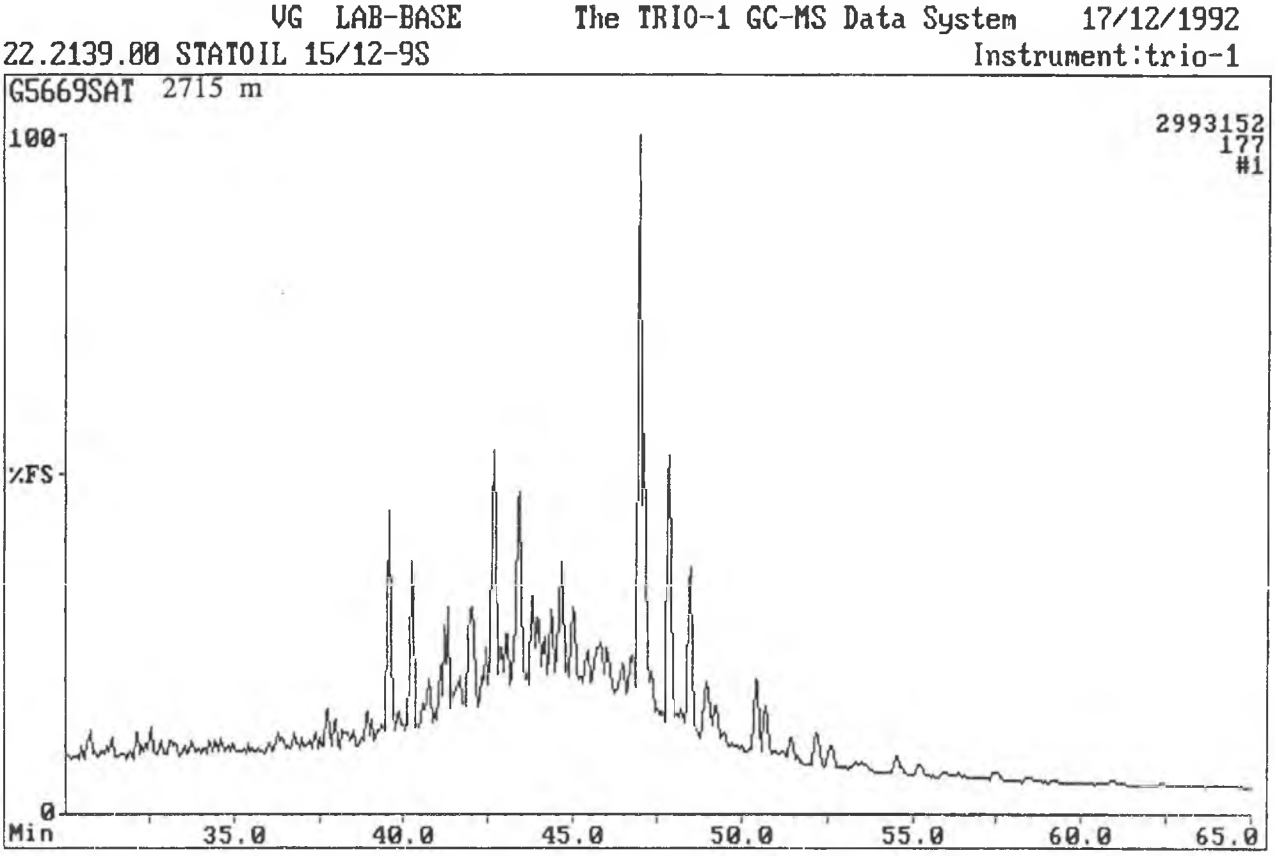
34αβR
35αβS
35αβR


VG LAB-BASE
The TRIO-1 GC-MS Data System
17/12/1992
22.2139.00 STATOIL 15/12-9S
Instrument:trio-1
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Min
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177
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55.0
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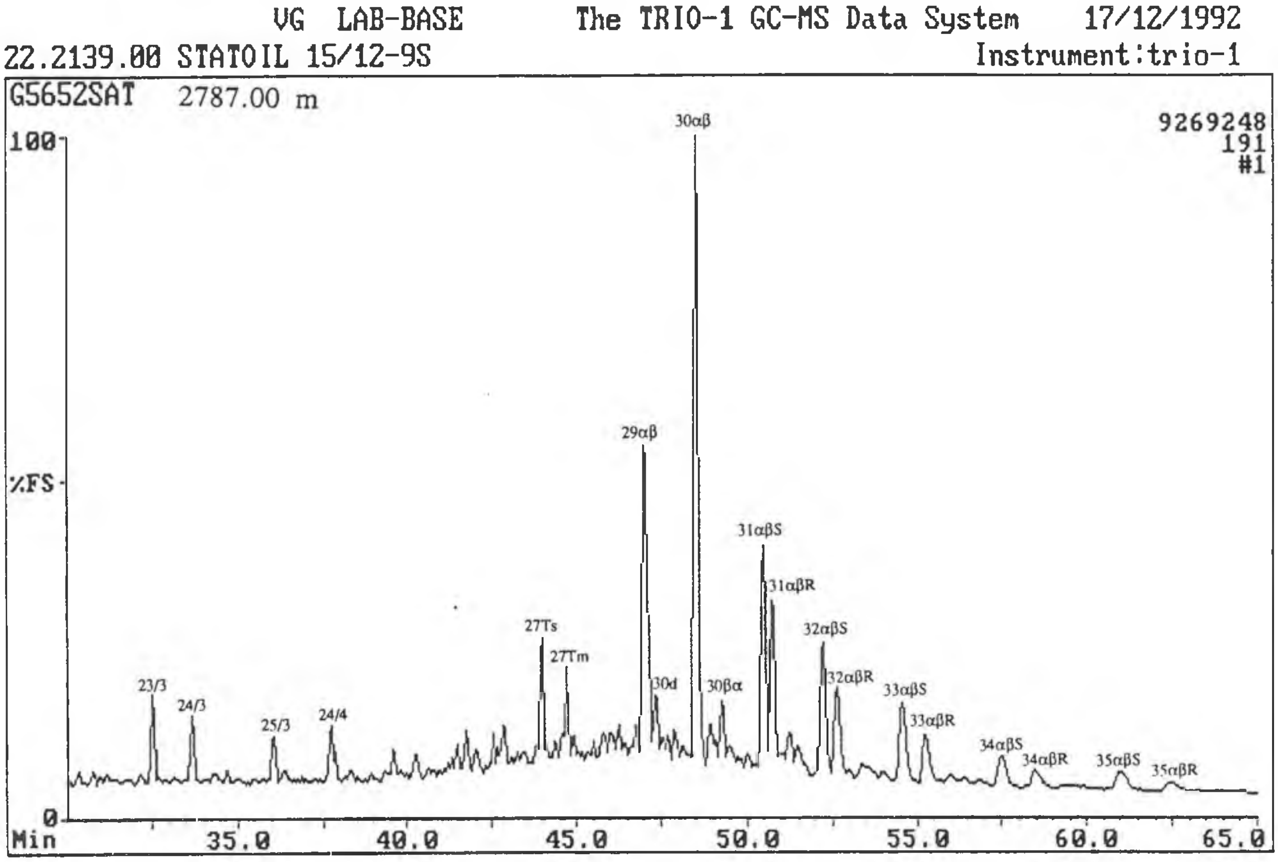
65.0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The TRIO-1 GC-MS Data System
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2787.00 m
9269248
191
#1
100
%FS
0
Min
35.0
40.0
45.0
50.0
55.0
60.0
65.0
23/3
24/3
25/3
24/4
27Ts
27Tm
29αβ
30d
30αβ
30βα
31αβS
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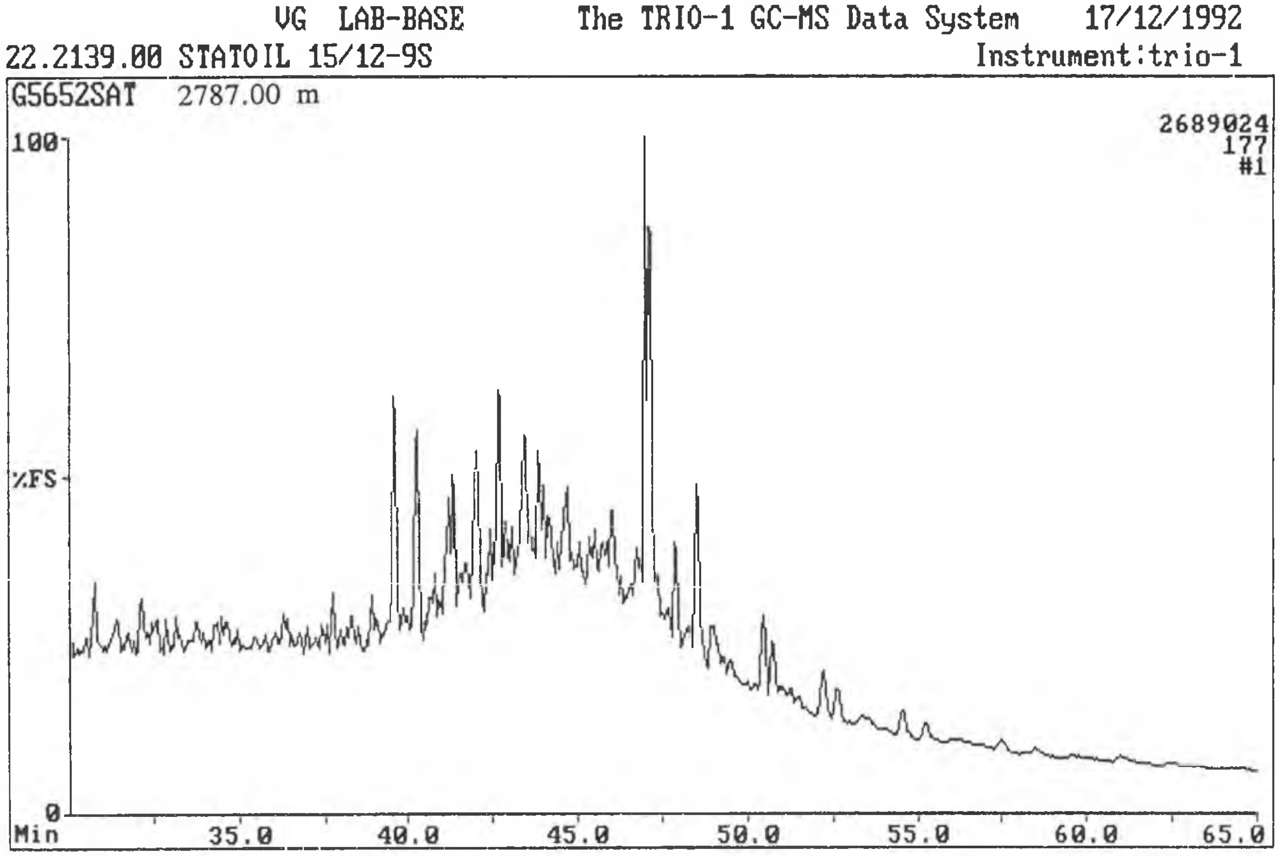
33αβR
34αβS
34αβR
35αβS
35αβR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The TRIO-1 GC-MS Data System
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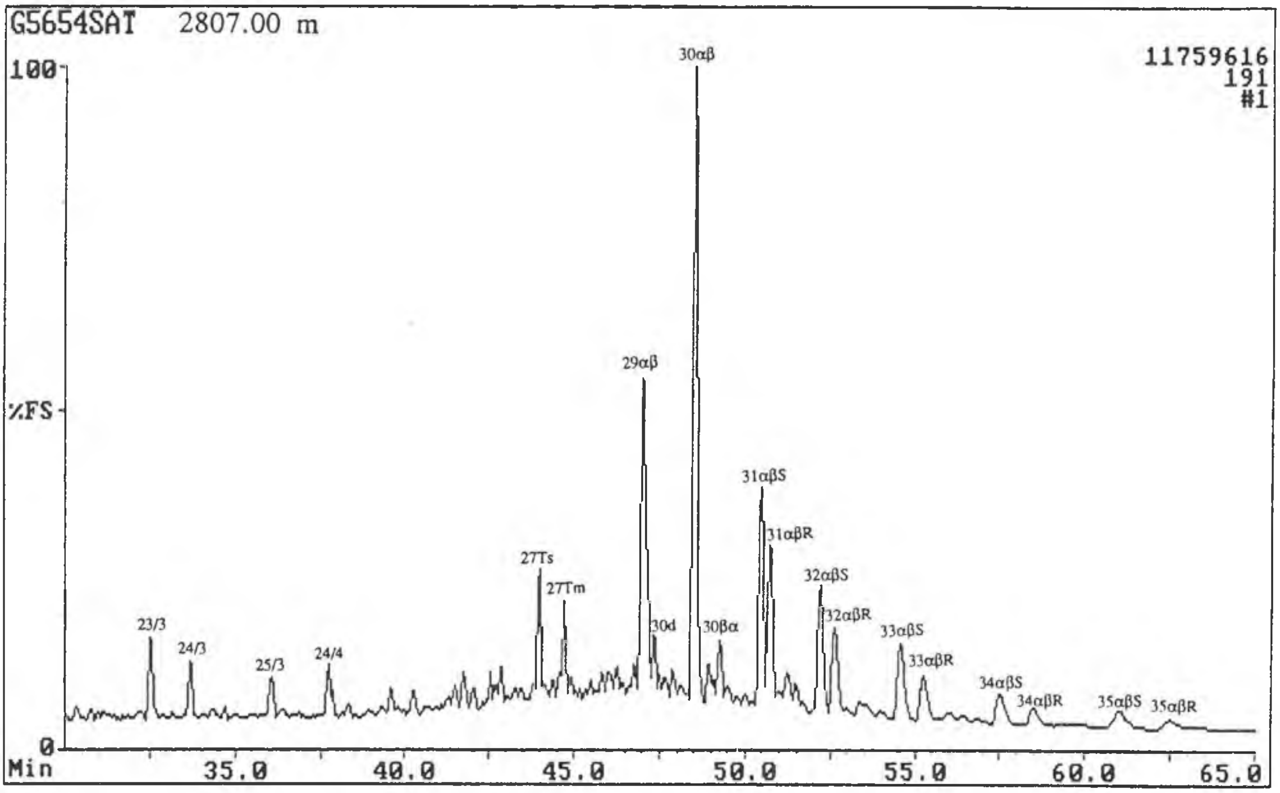
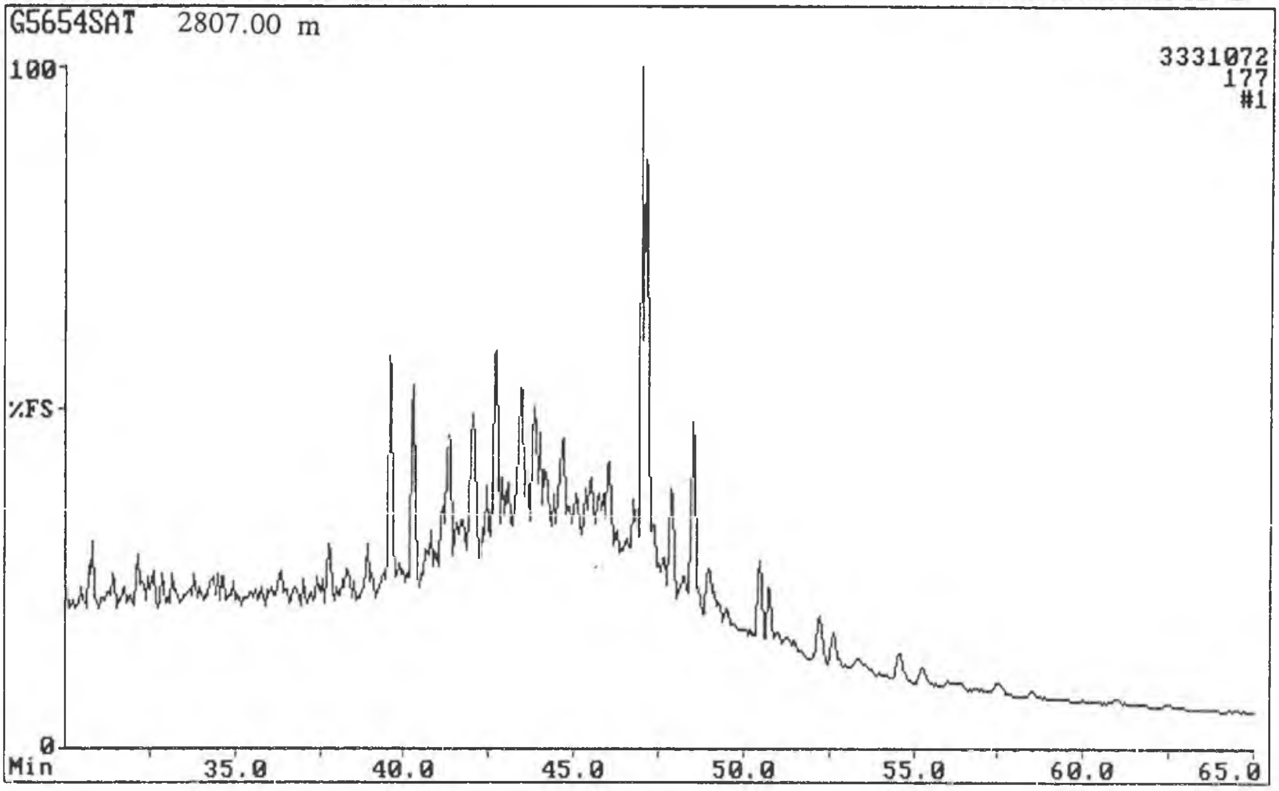
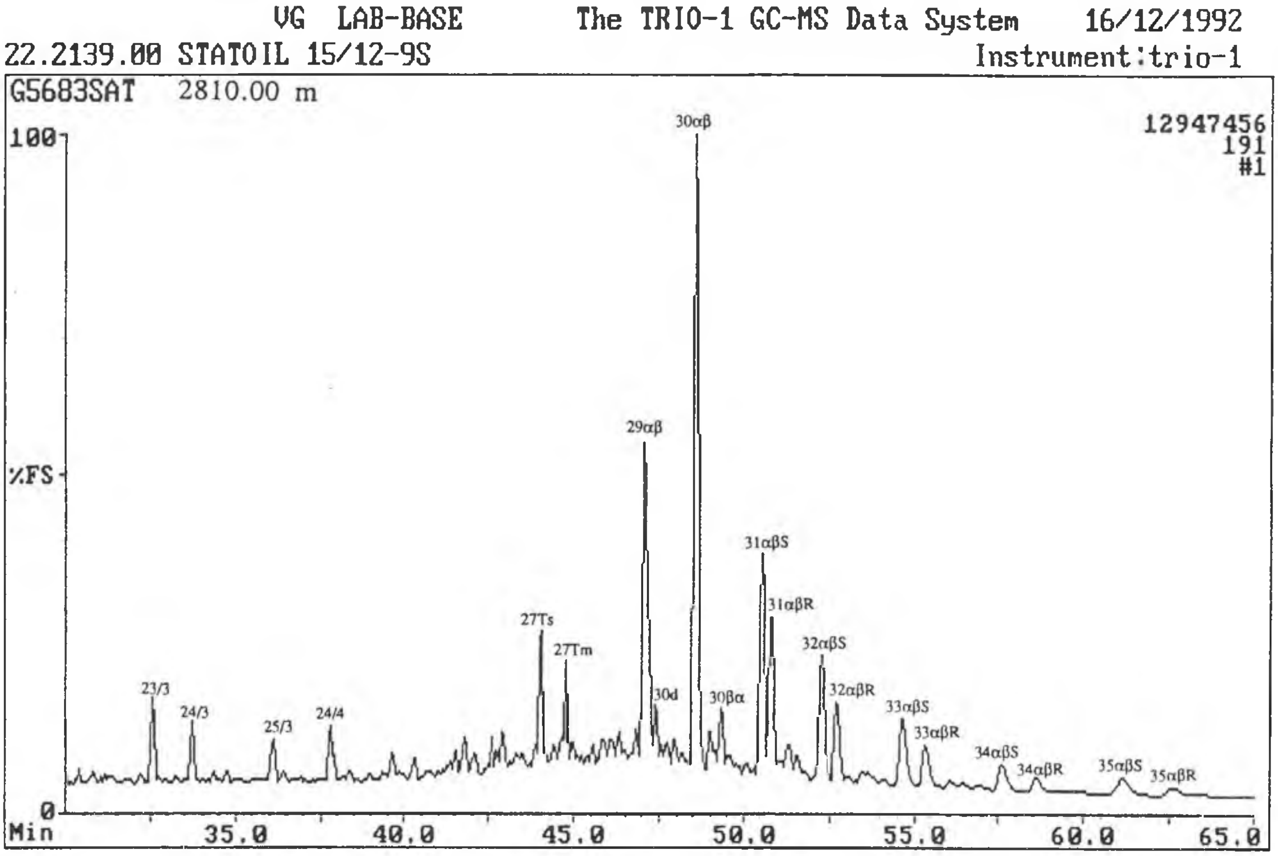
2689024
177
#1
100
%FS
0
Min
35.0
40.0
45.0
50.0
55.0
60.0
65.0

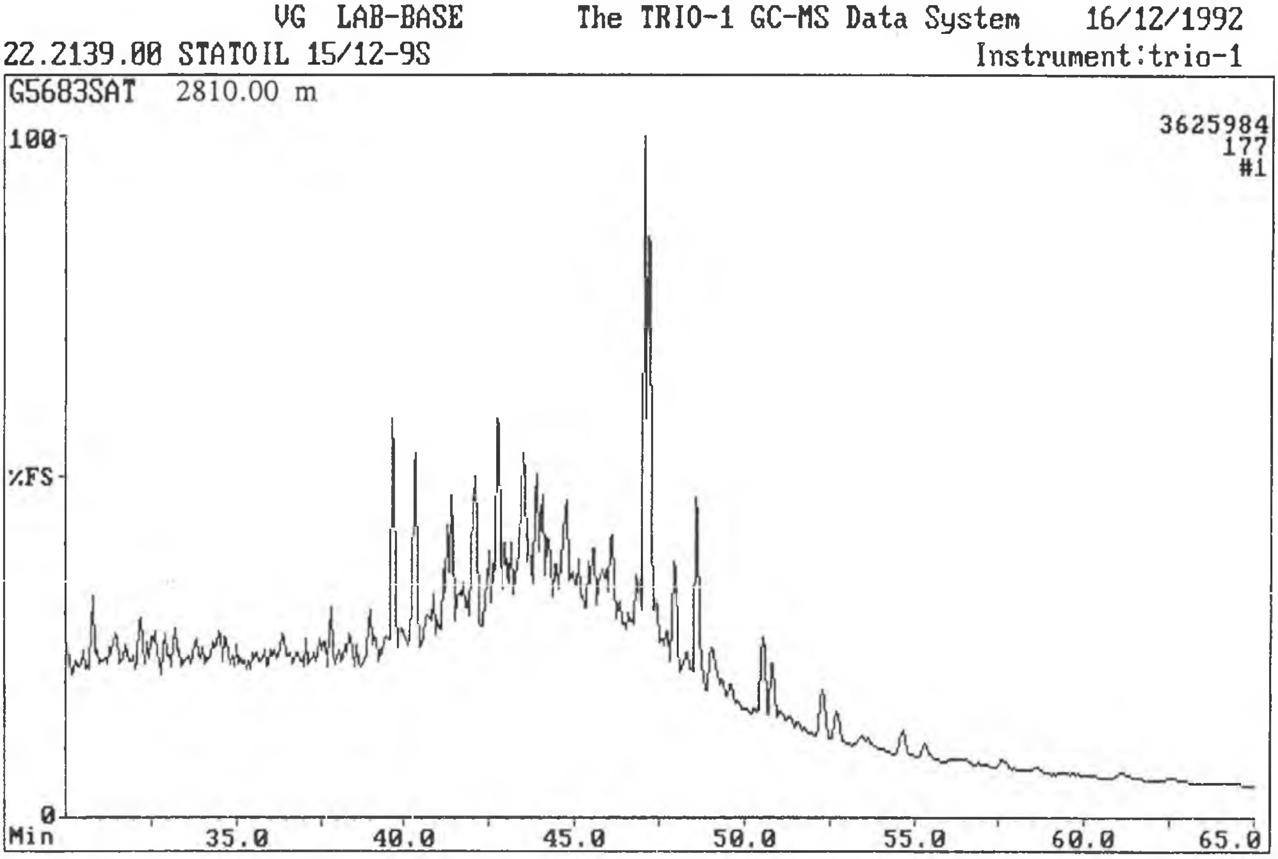
VG LAB-BASE The TRIO-1 GC-MS Data System 16/12/1992
22.2139.00 STATOIL 15/12-9S Instrument:trio-1



VG LAB-BASE The TRIO-1 GC-MS Data System 16/12/1992
22.2139.00 STATOIL 15/12-9S Instrument:trio-1




VG LAB-BASE
The TRIO-1 GC-MS Data System
16/12/1992
22.2139.00 STATOIL 15/12-9S
Instrument:trio-1
G5683SAT
2810.00 m
12947456
191
#1
100
%FS
0
Min
35.0
40.0
45.0
50.0
55.0
60.0
65.0
30αβ
29αβ
31αβS
31αβR
27Ts
27Tm
32αβS
32αβR
23/3
24/3
25/3
24/4
30d
30βα
33αβS
33αβR
34αβS
34αβR
35αβS
35αβR


VG LAB-BASE
The TRIO-1 GC-MS Data System
16/12/1992
22.2139.00 STATOIL 15/12-9S
Instrument:trio-1
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2810.00 m
3625984
177
#1
100
%FS
0
Min
35.0
40.0
45.0
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VG LAB-BASE The TRIO-1 GC-MS Data System 16/12/1992
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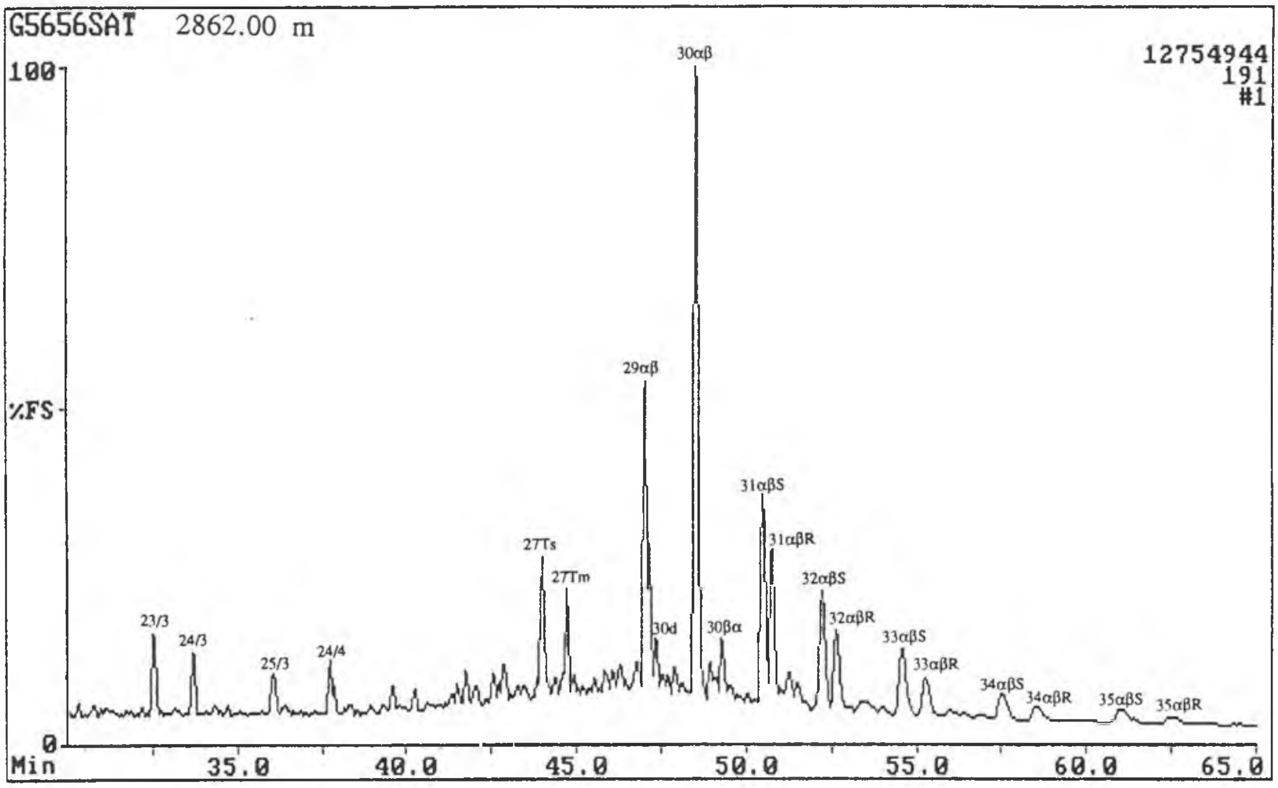

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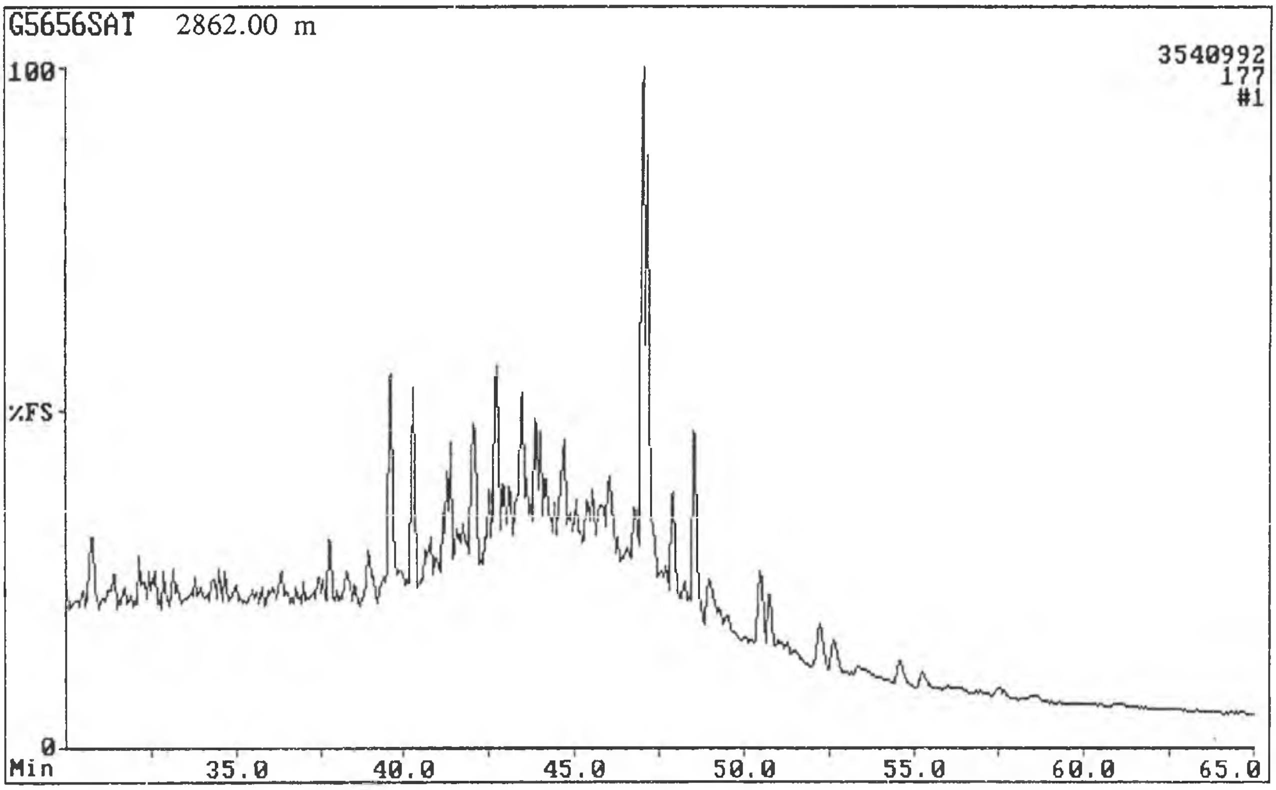

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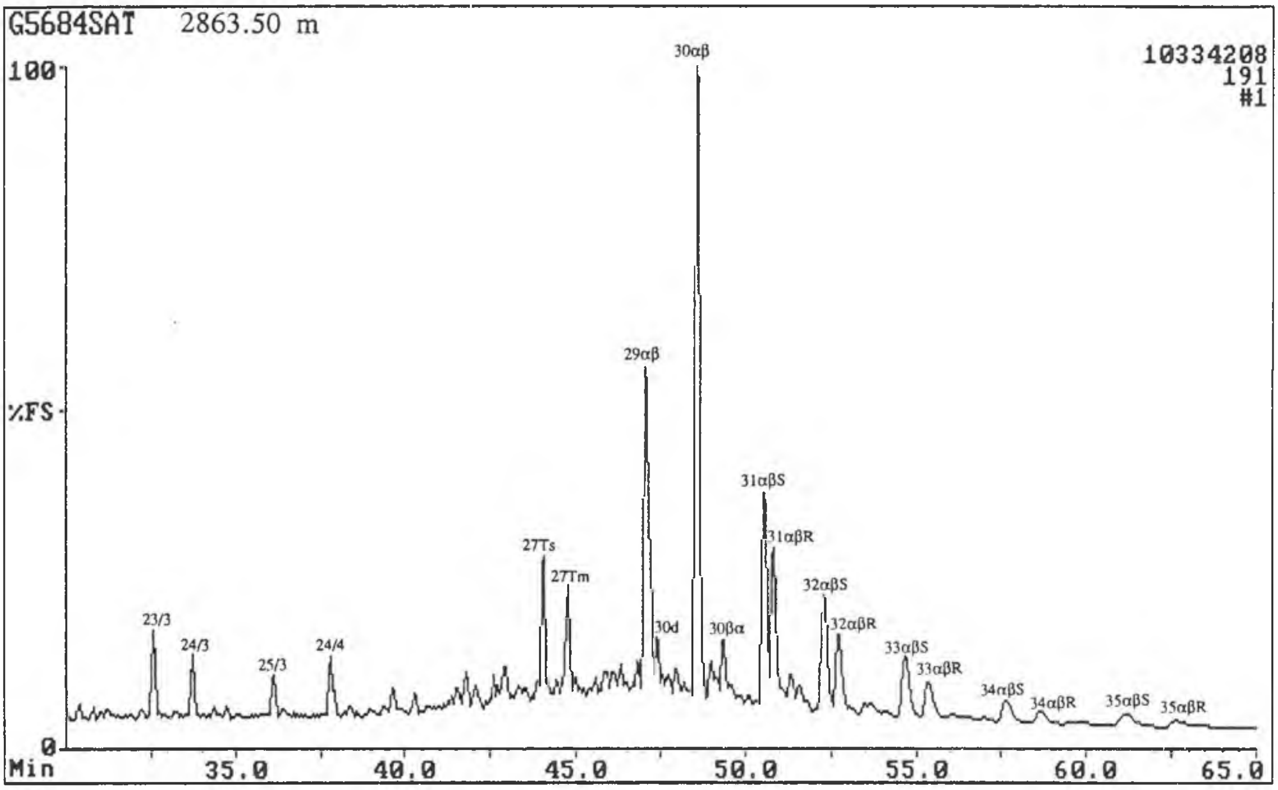

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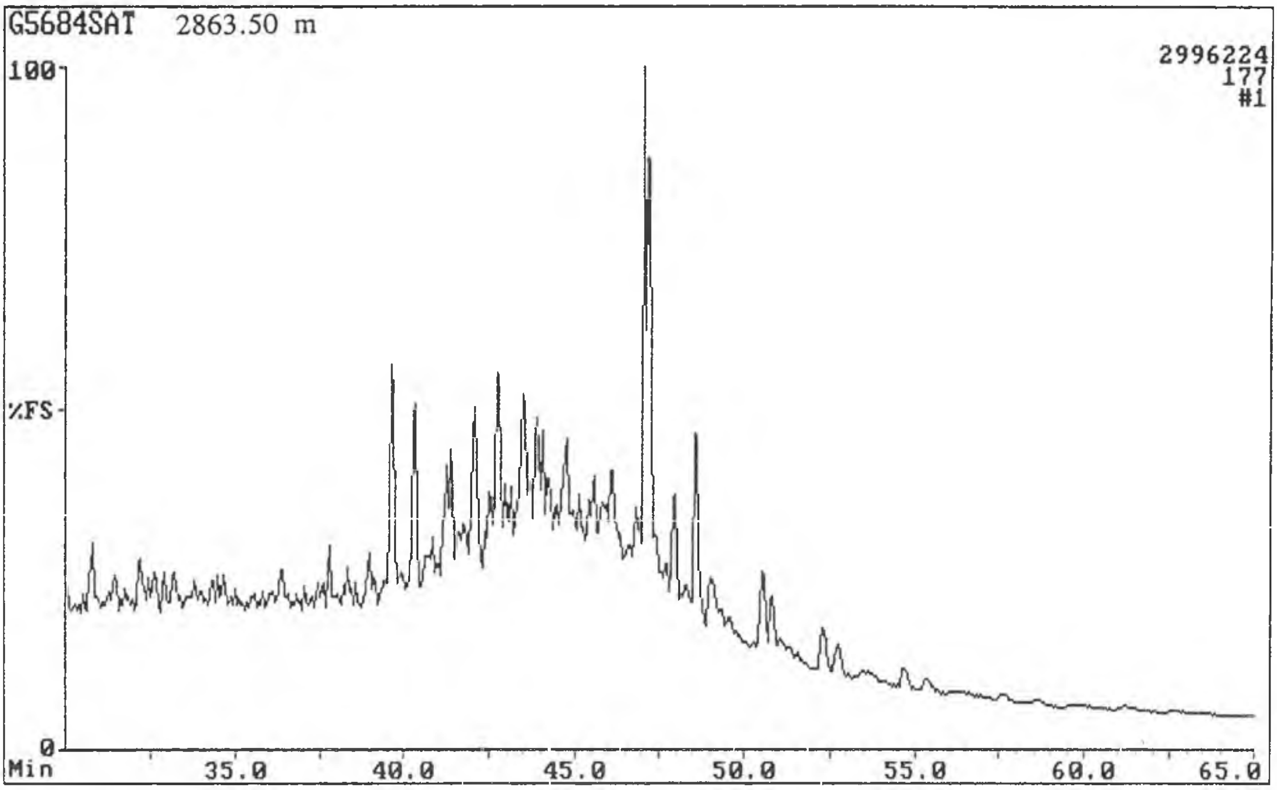

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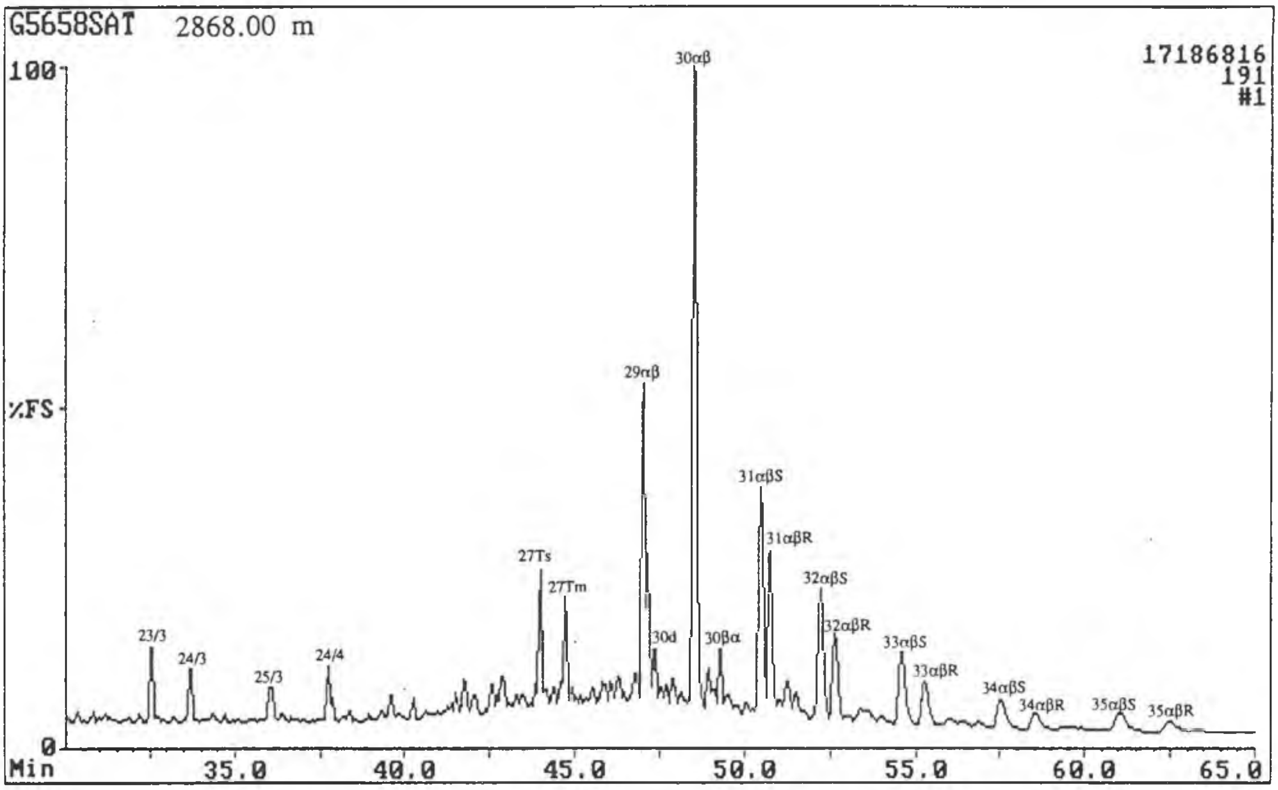

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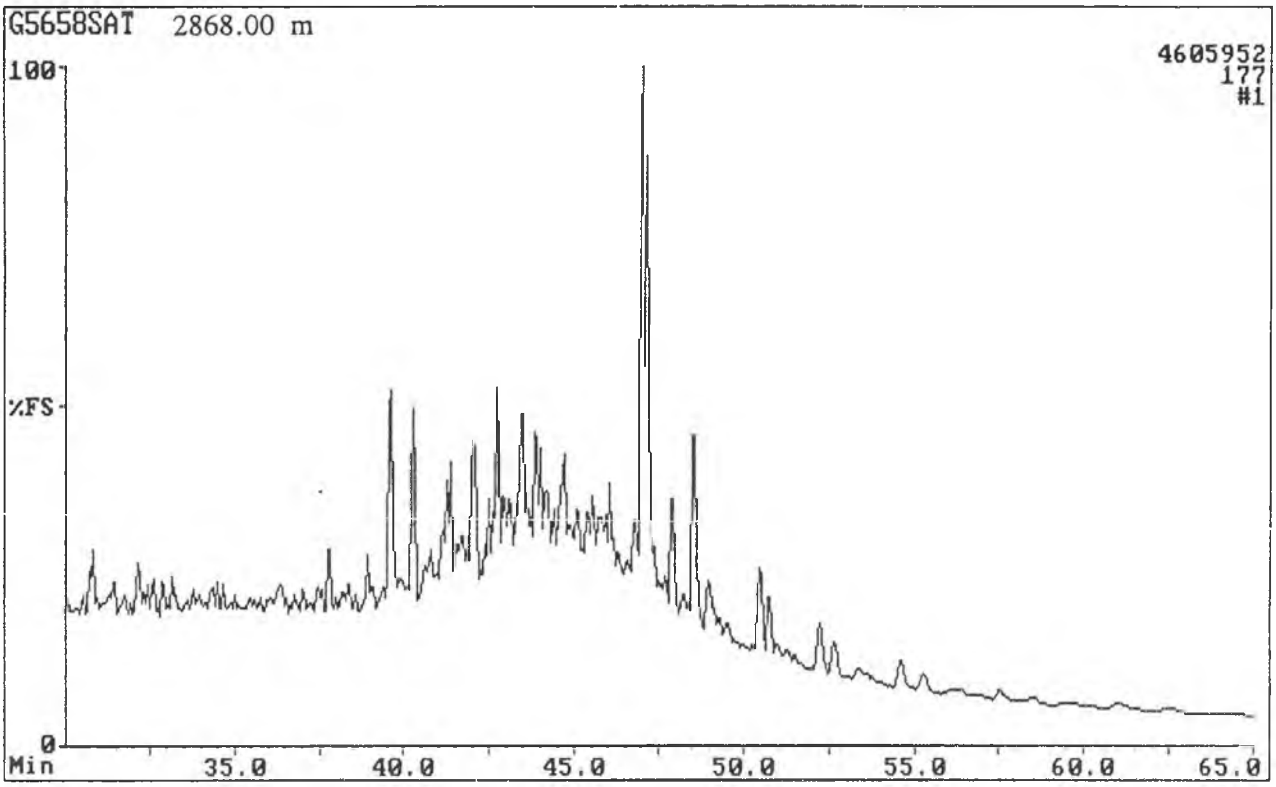

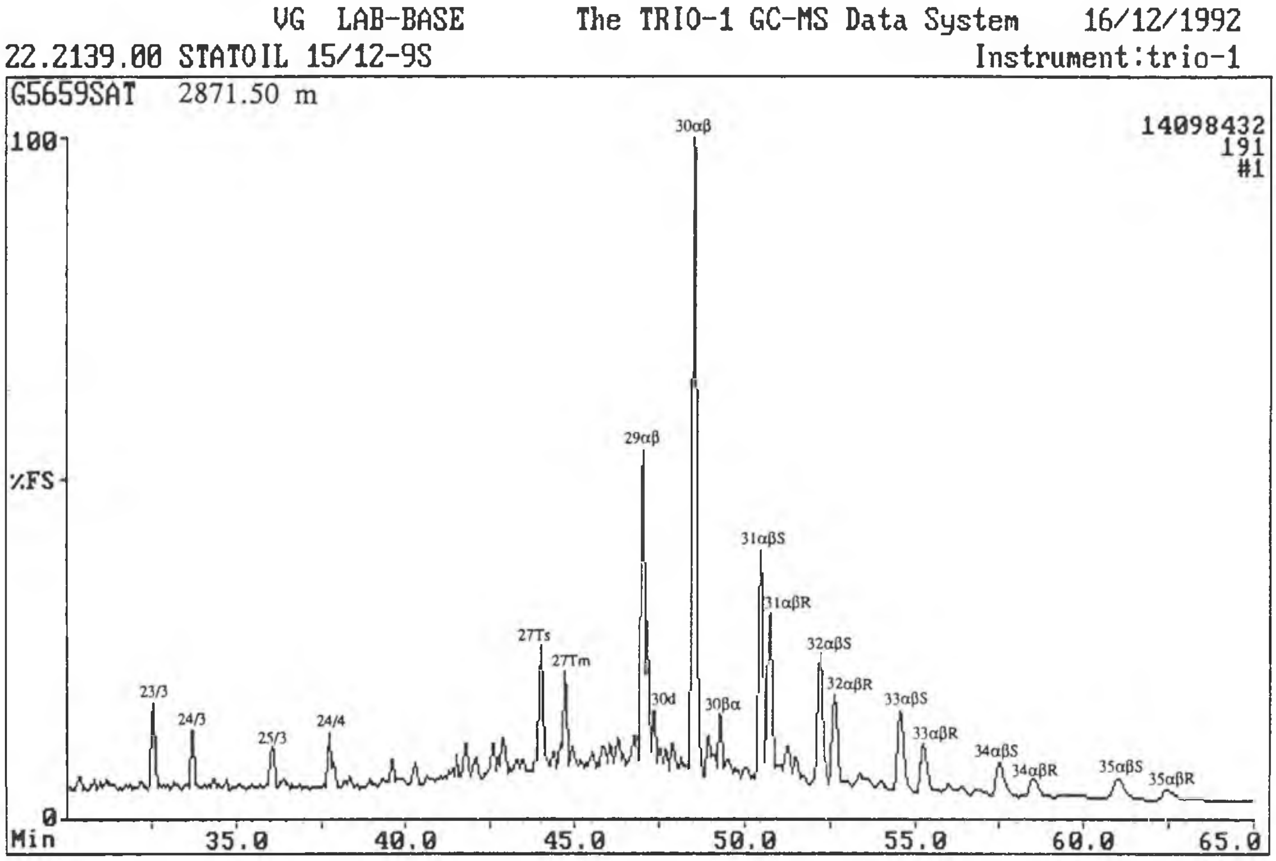
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The TRIO-1 GC-MS Data System
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Min
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24/3
25/3
24/4
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27Tm
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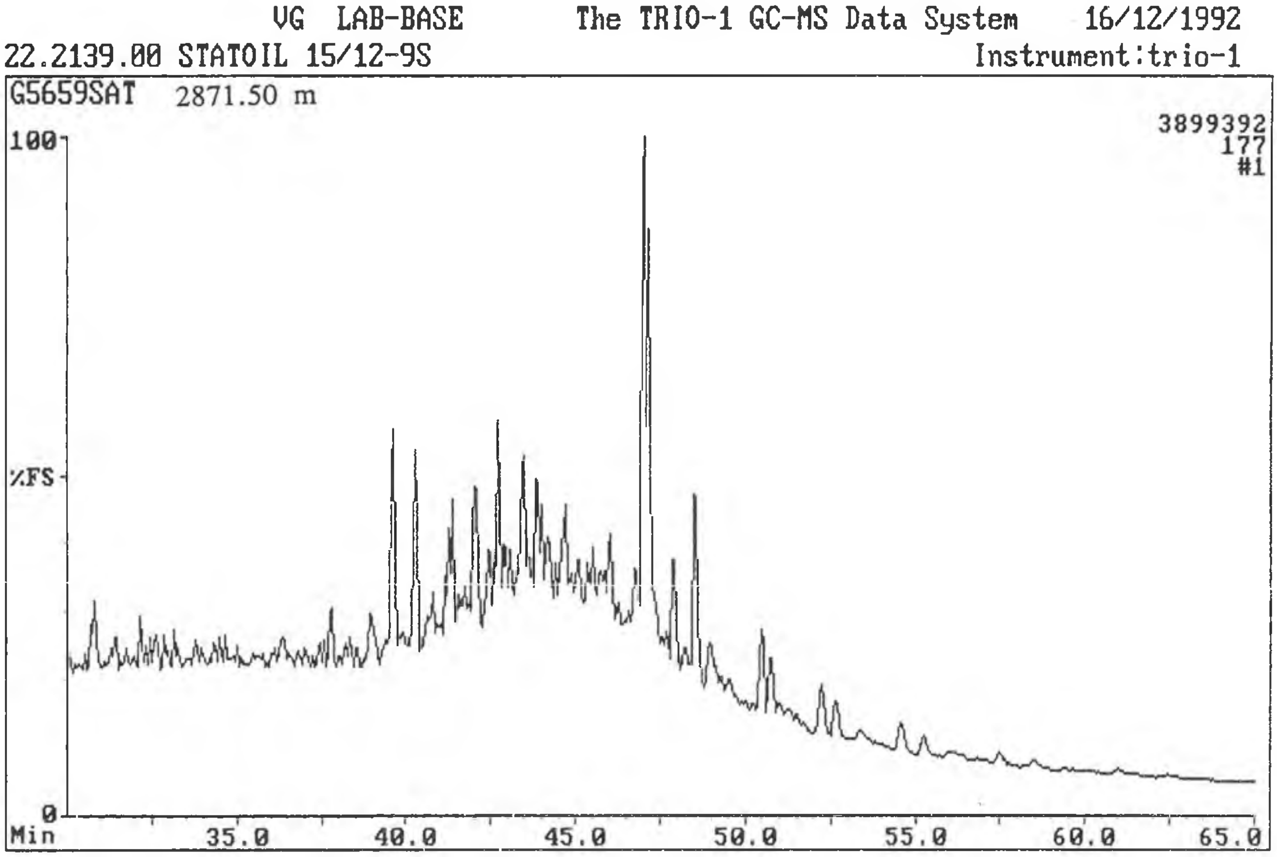
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Instrument:trio-1
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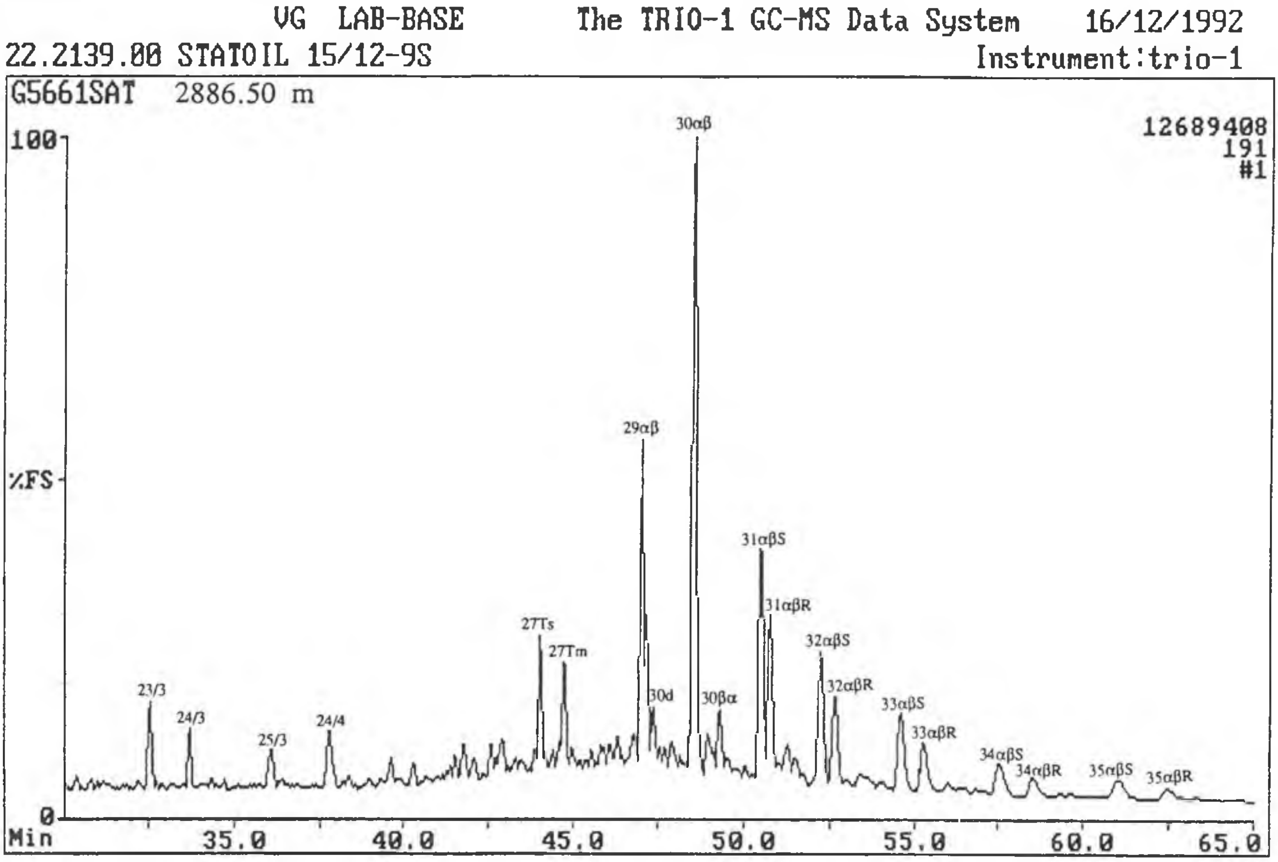
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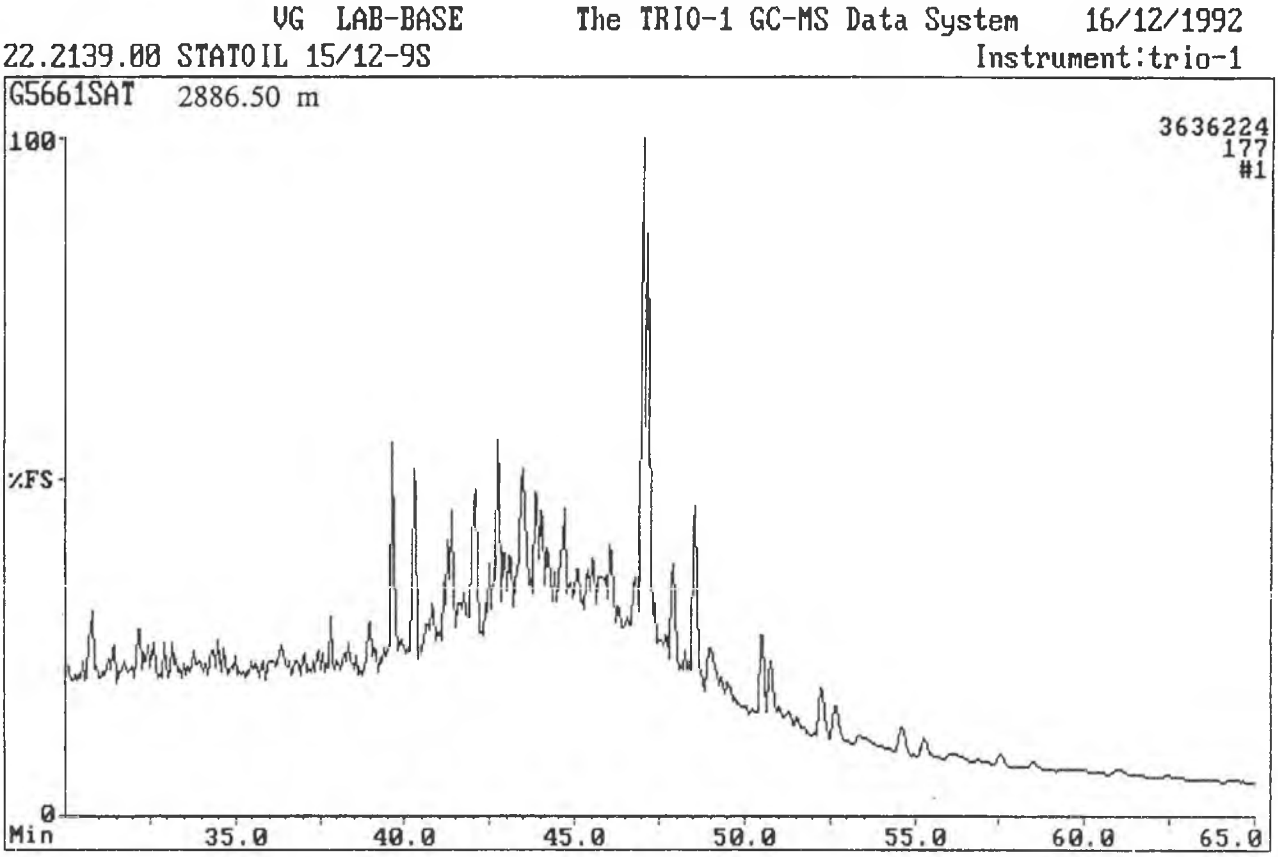
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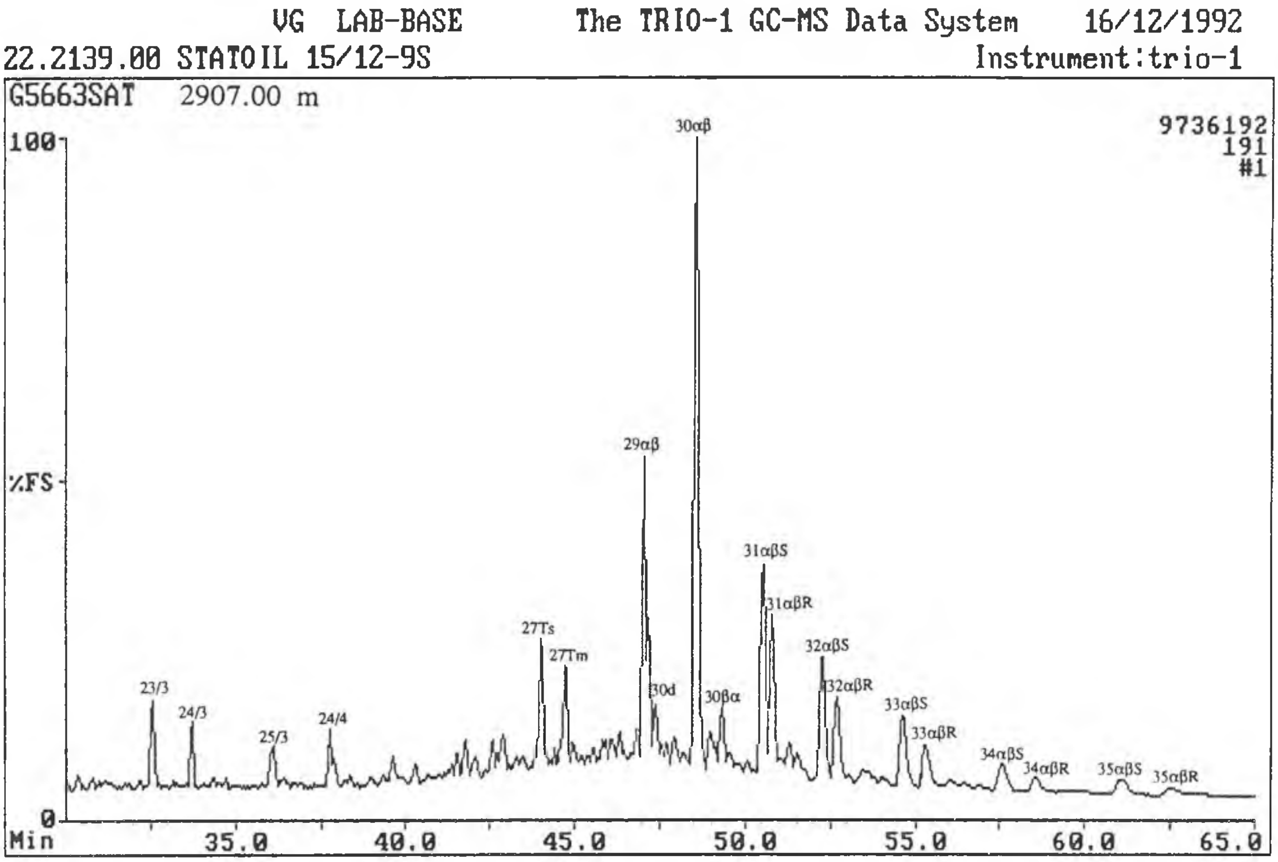
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27Tm
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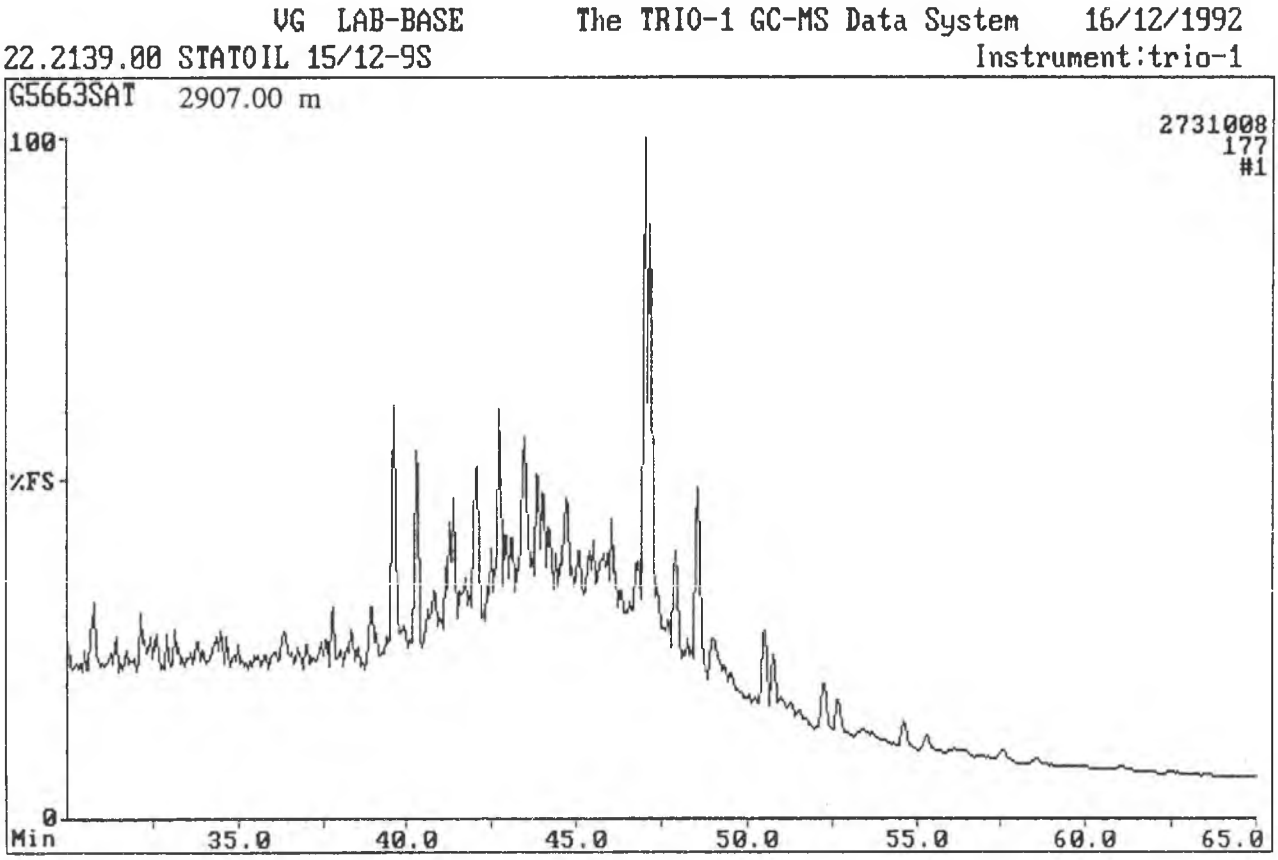
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VG LAB-BASE The TRIO-1 GC-MS Data System 16/12/1992
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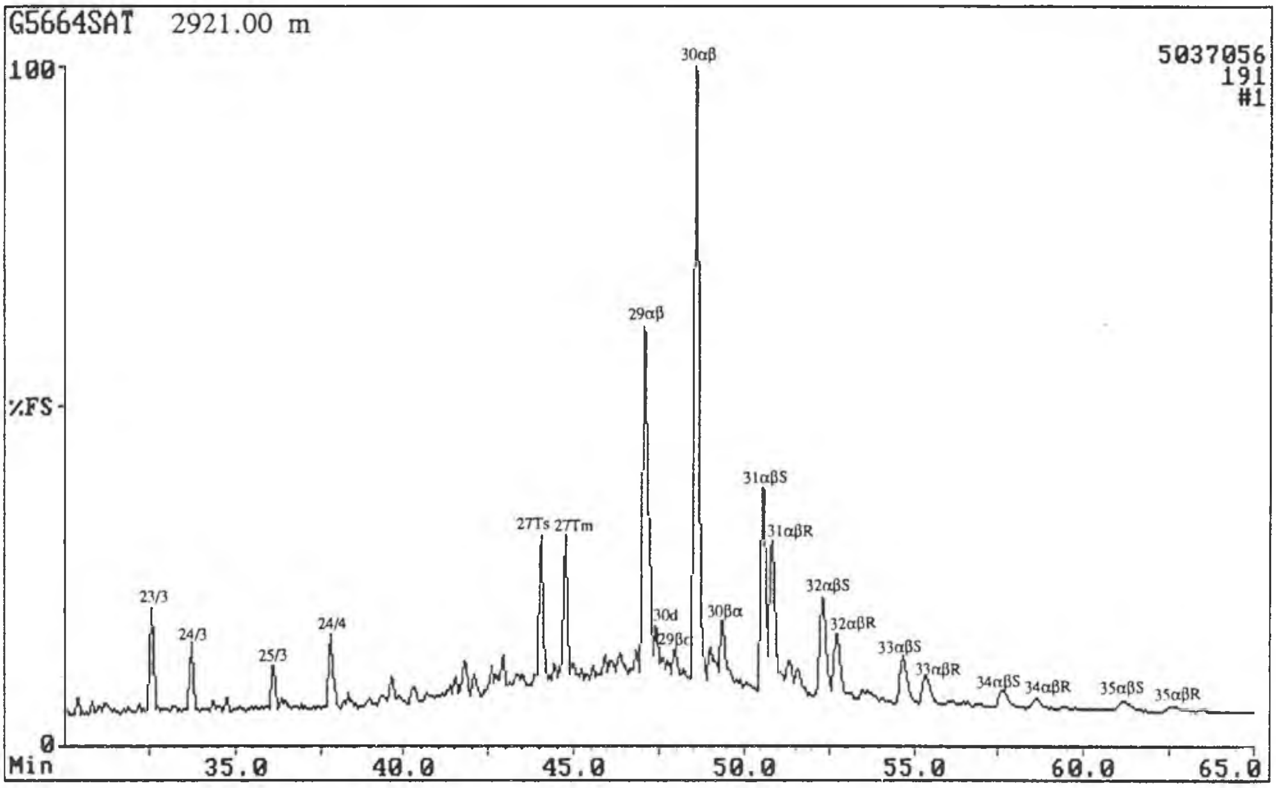

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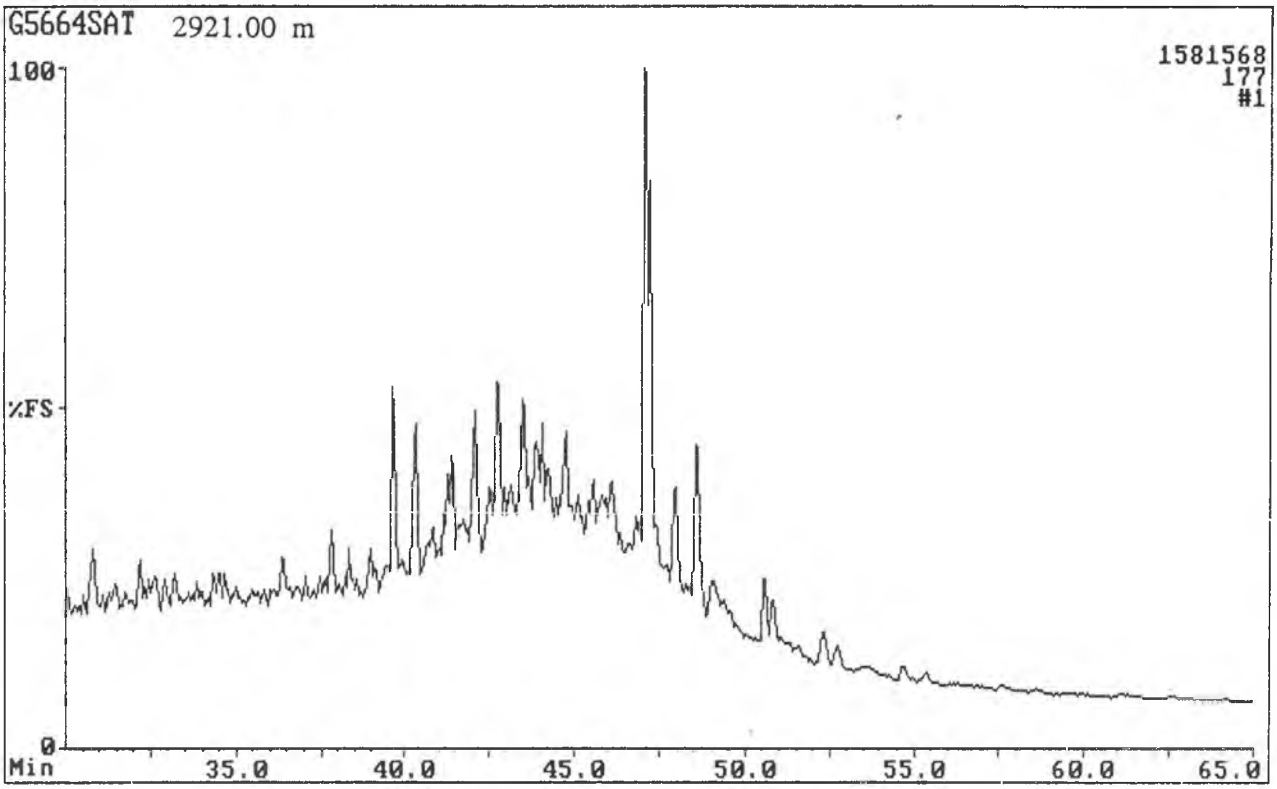

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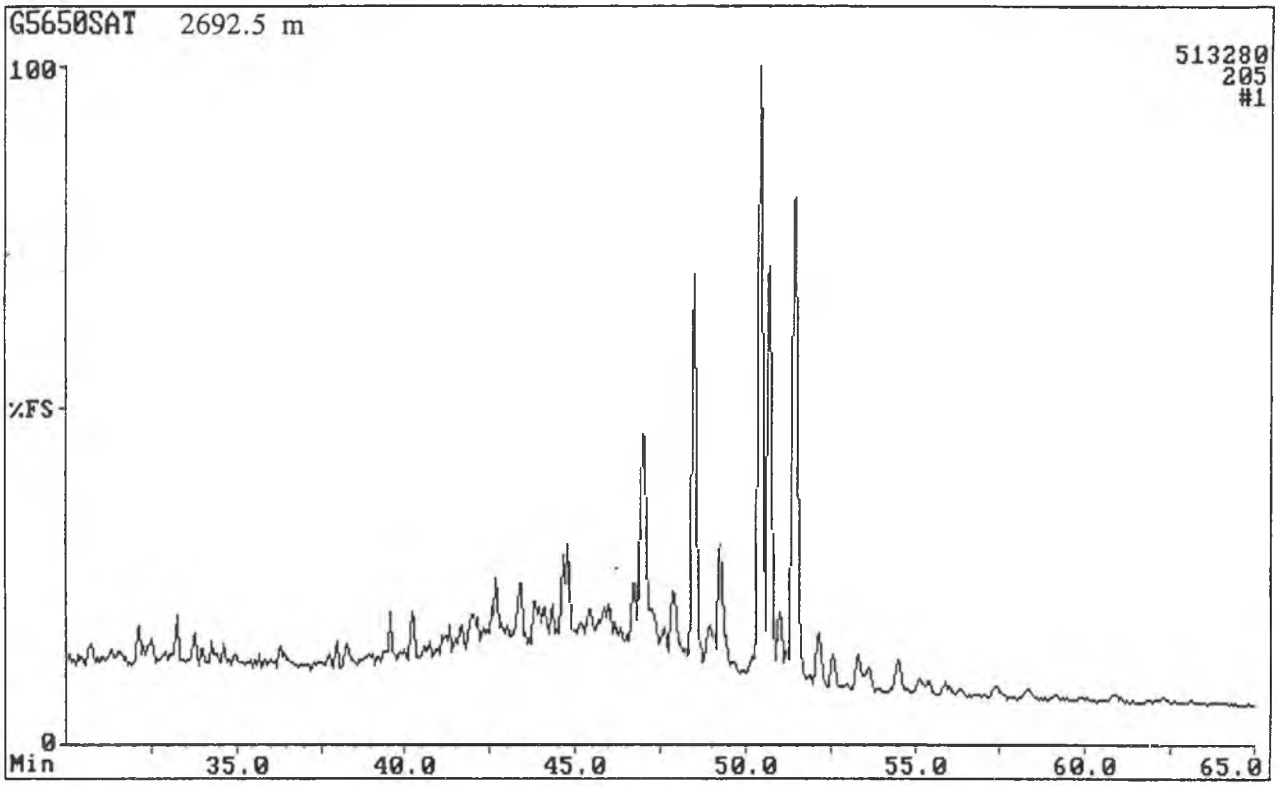

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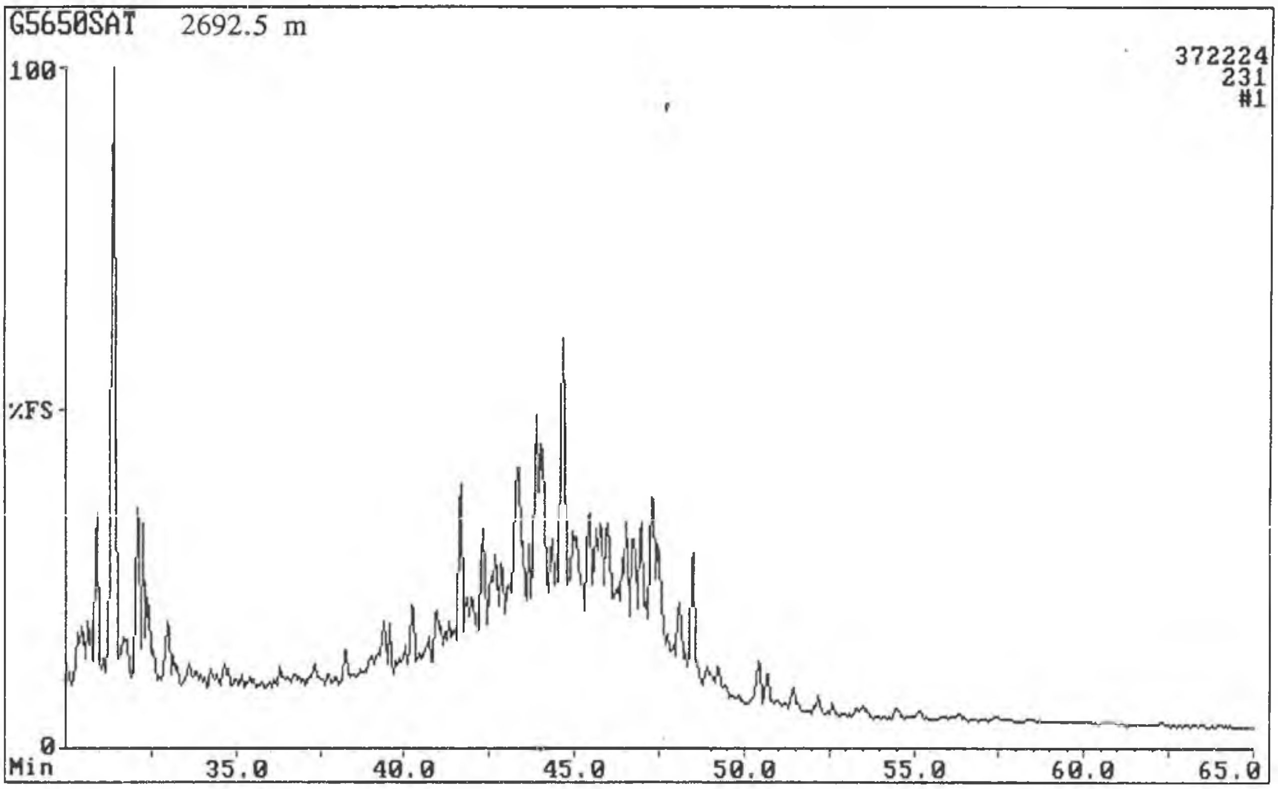

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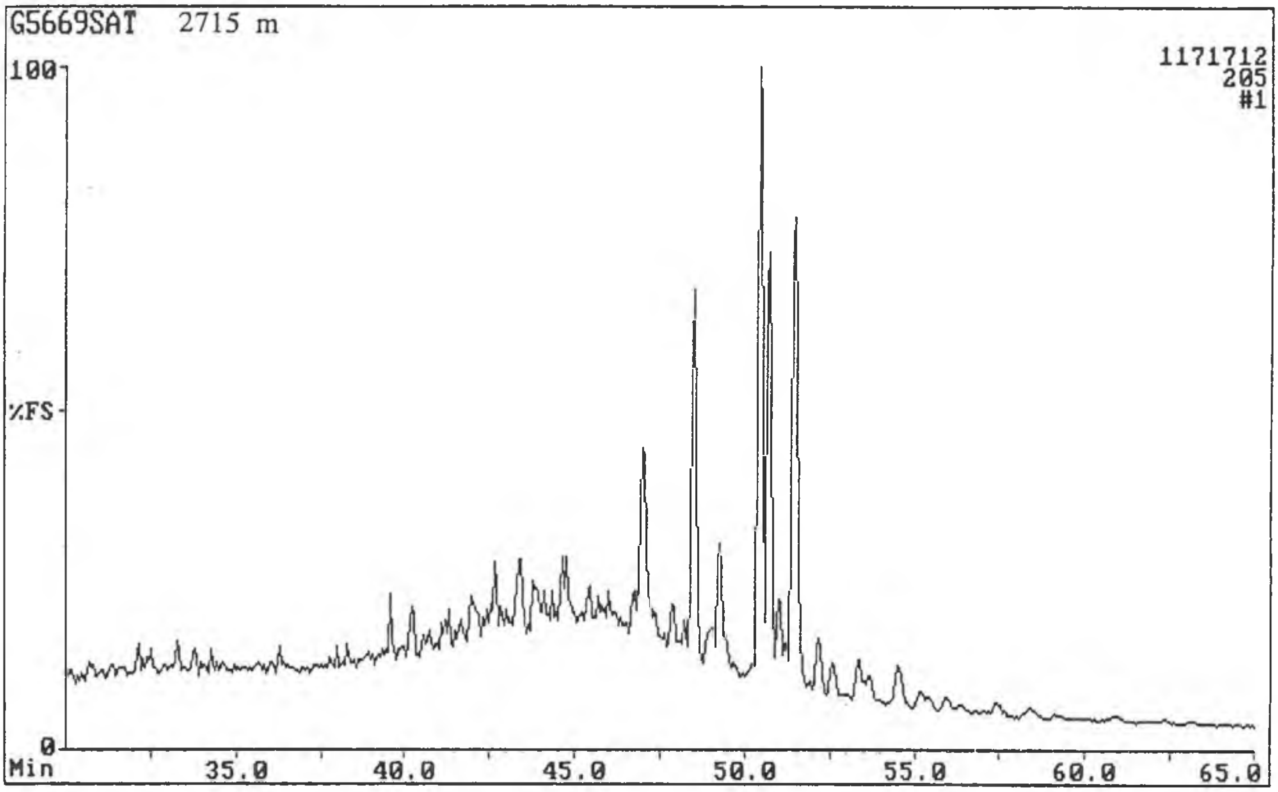

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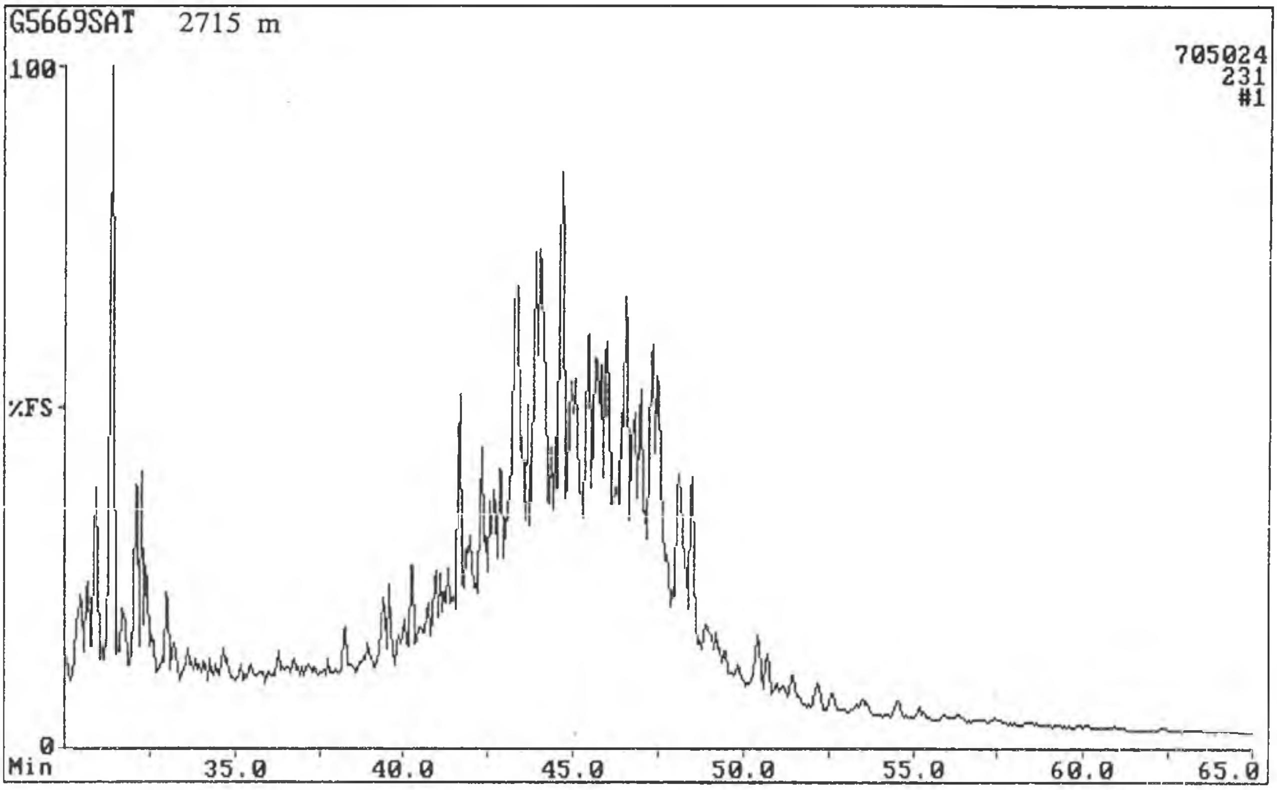

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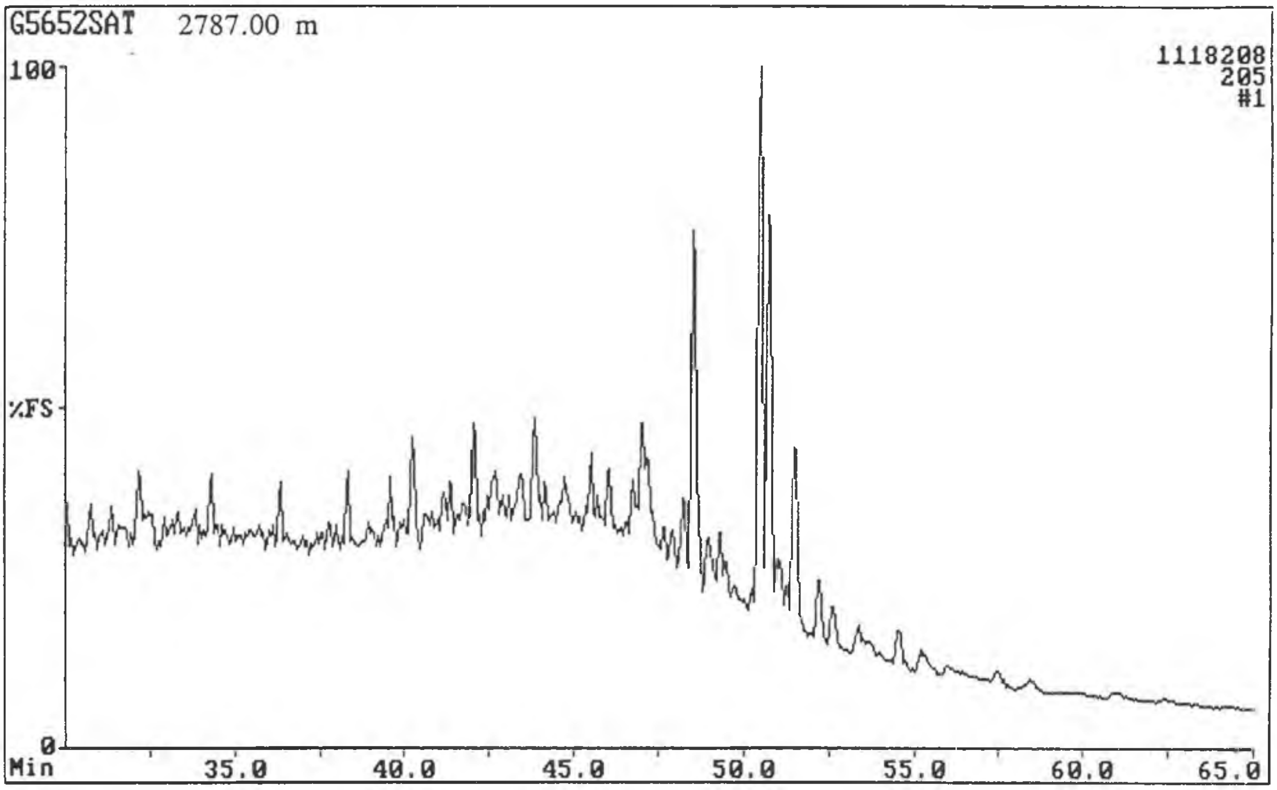

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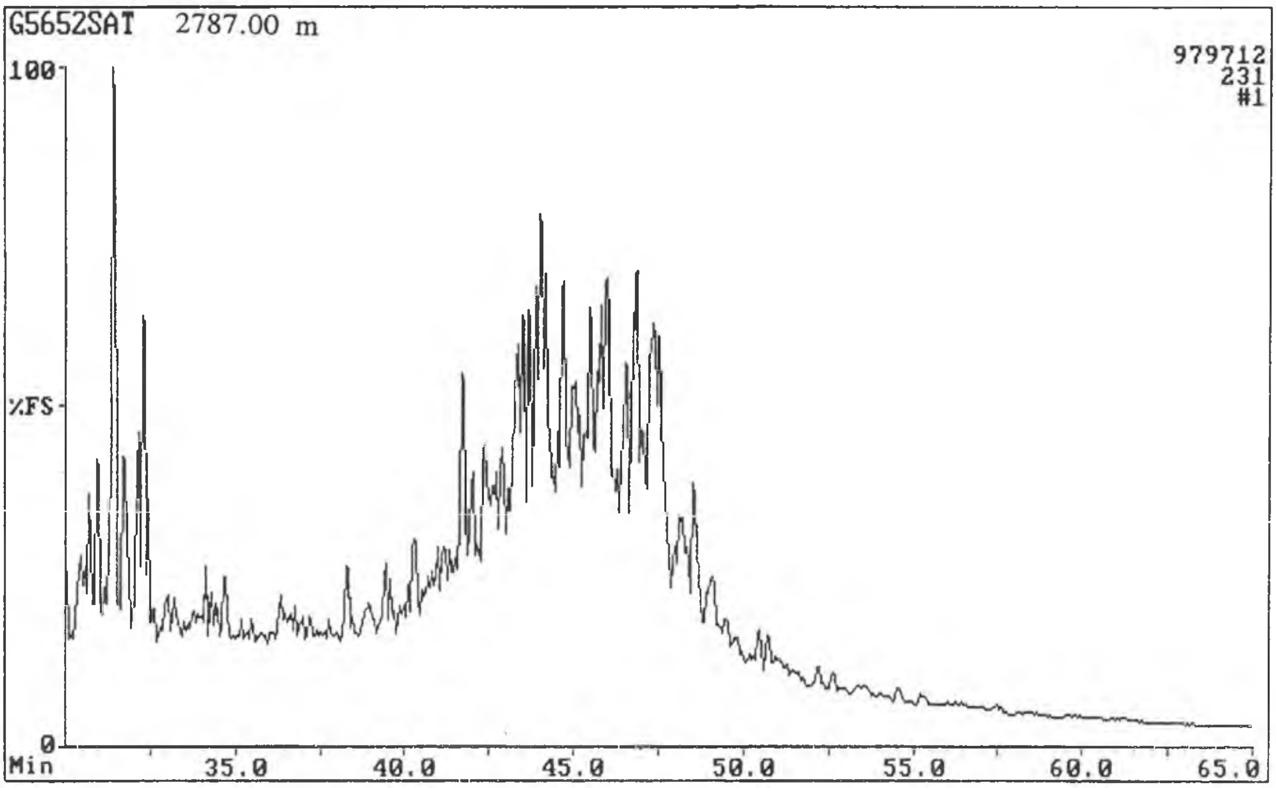

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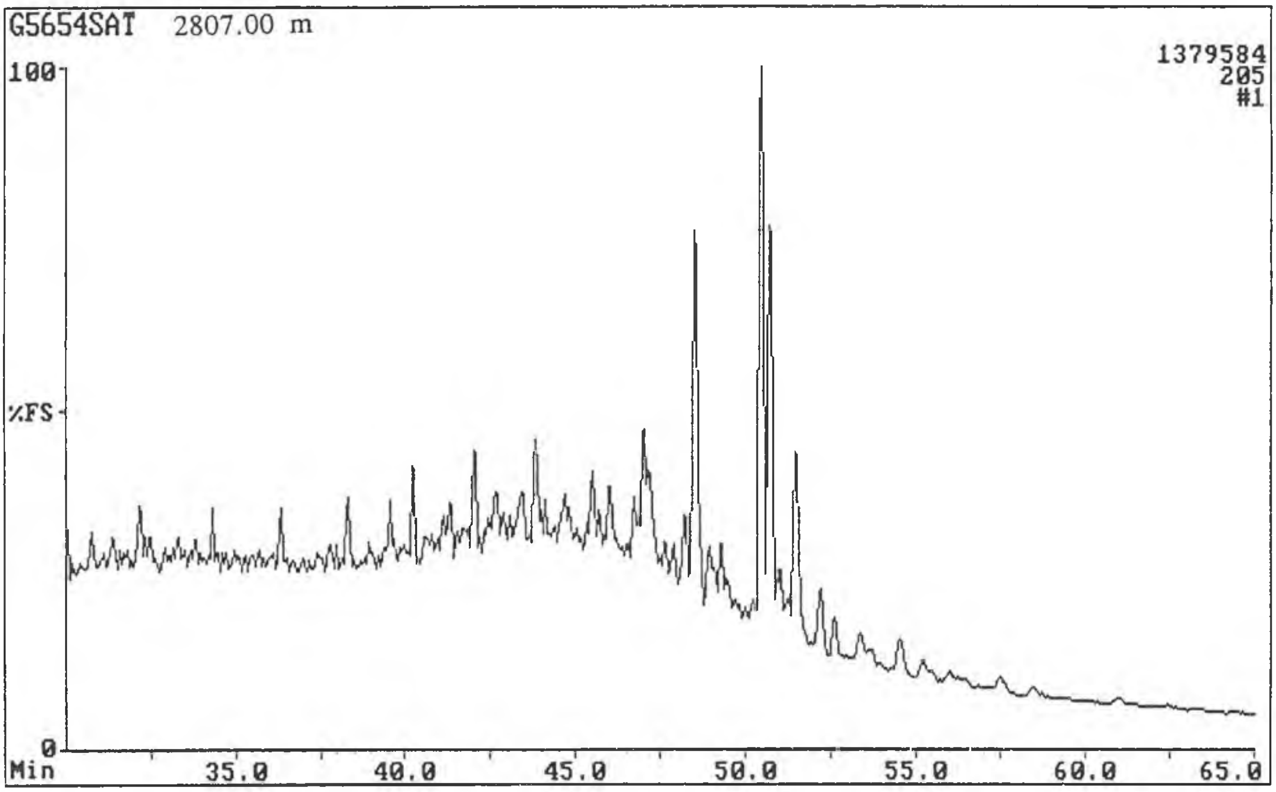

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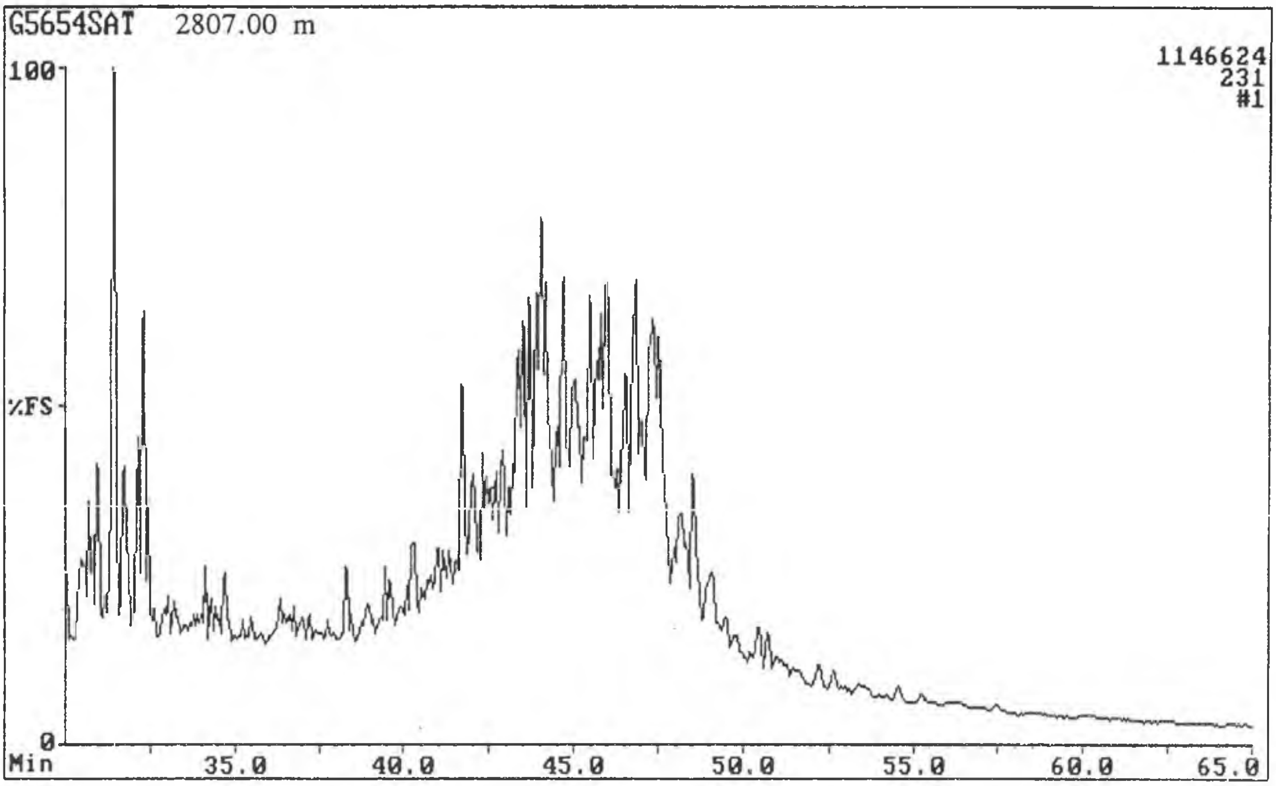

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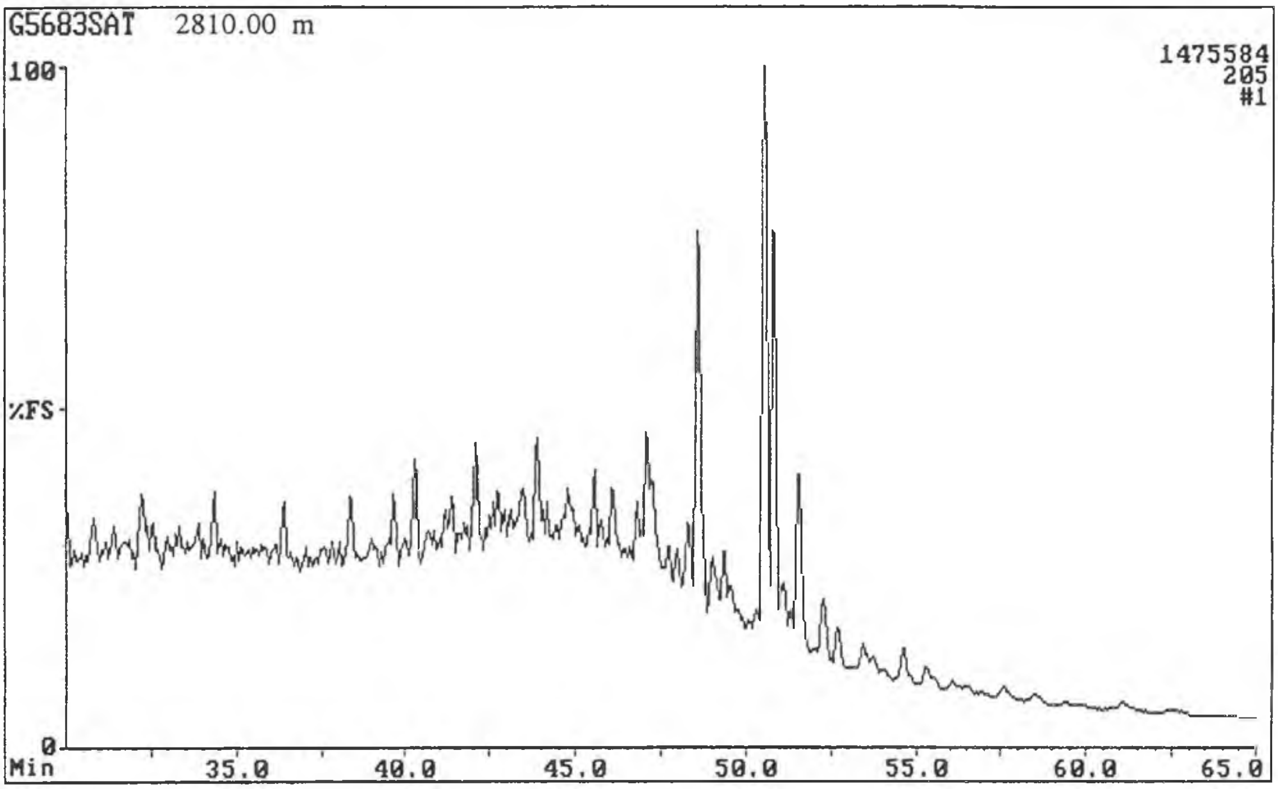

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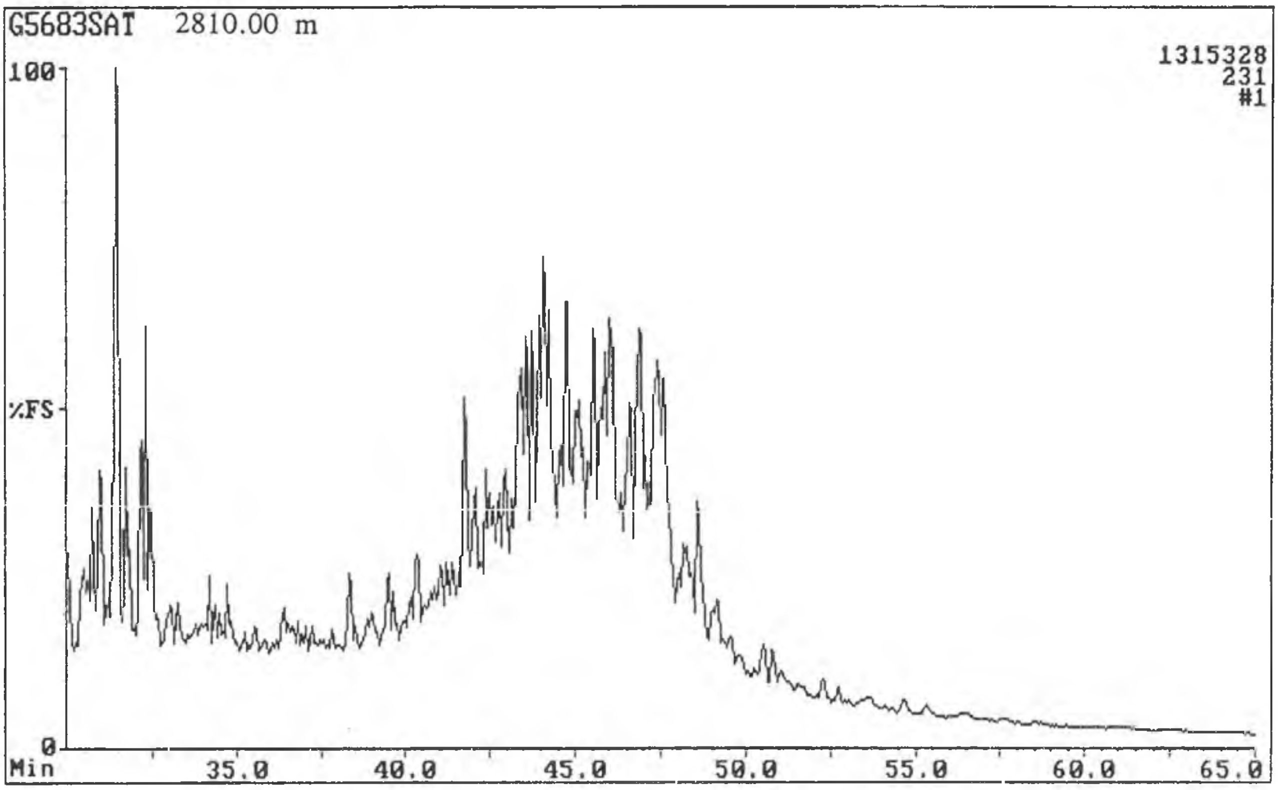

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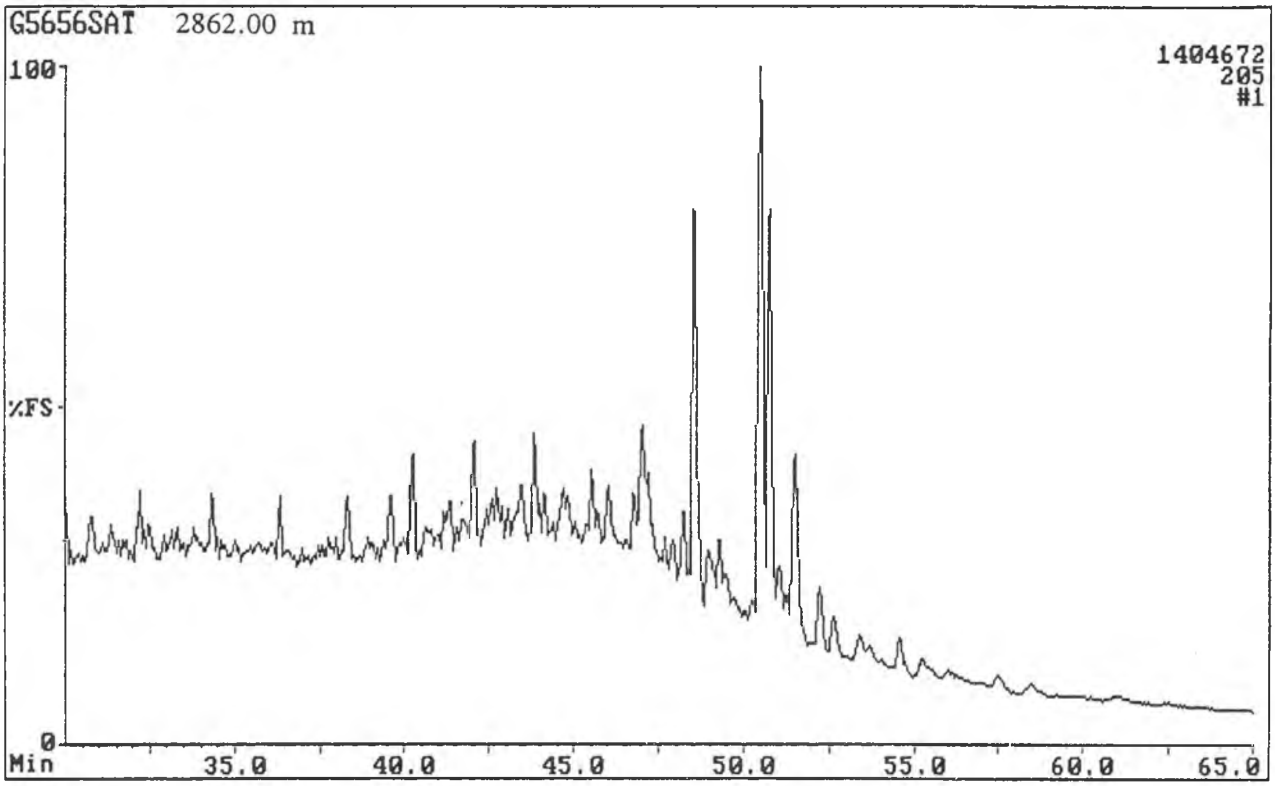

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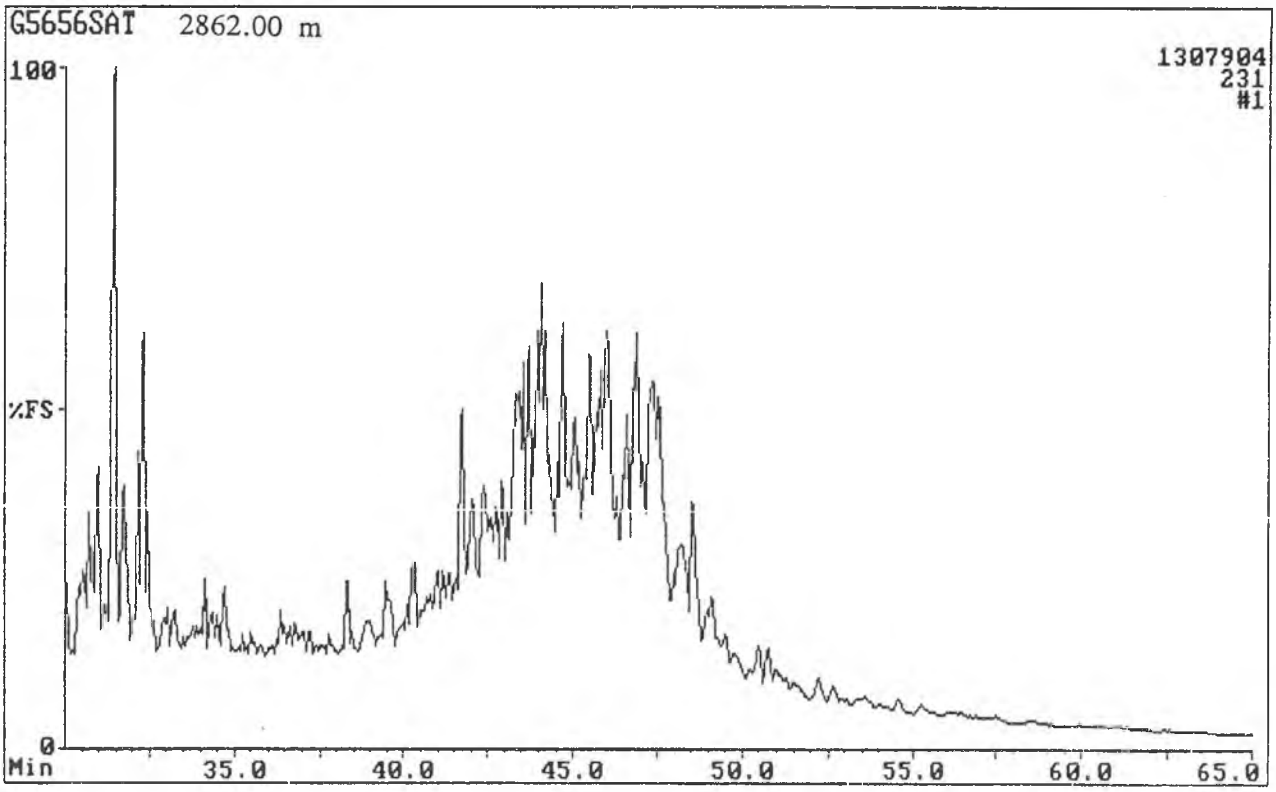

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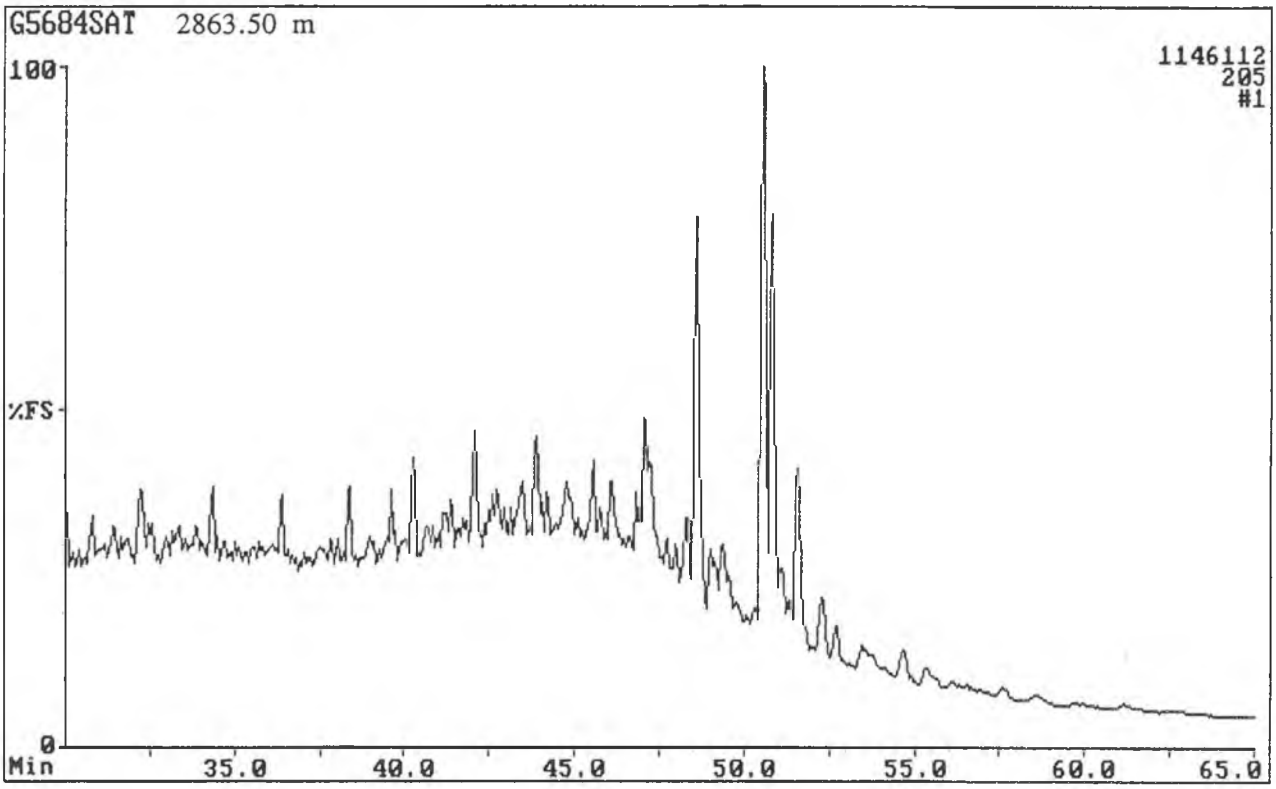

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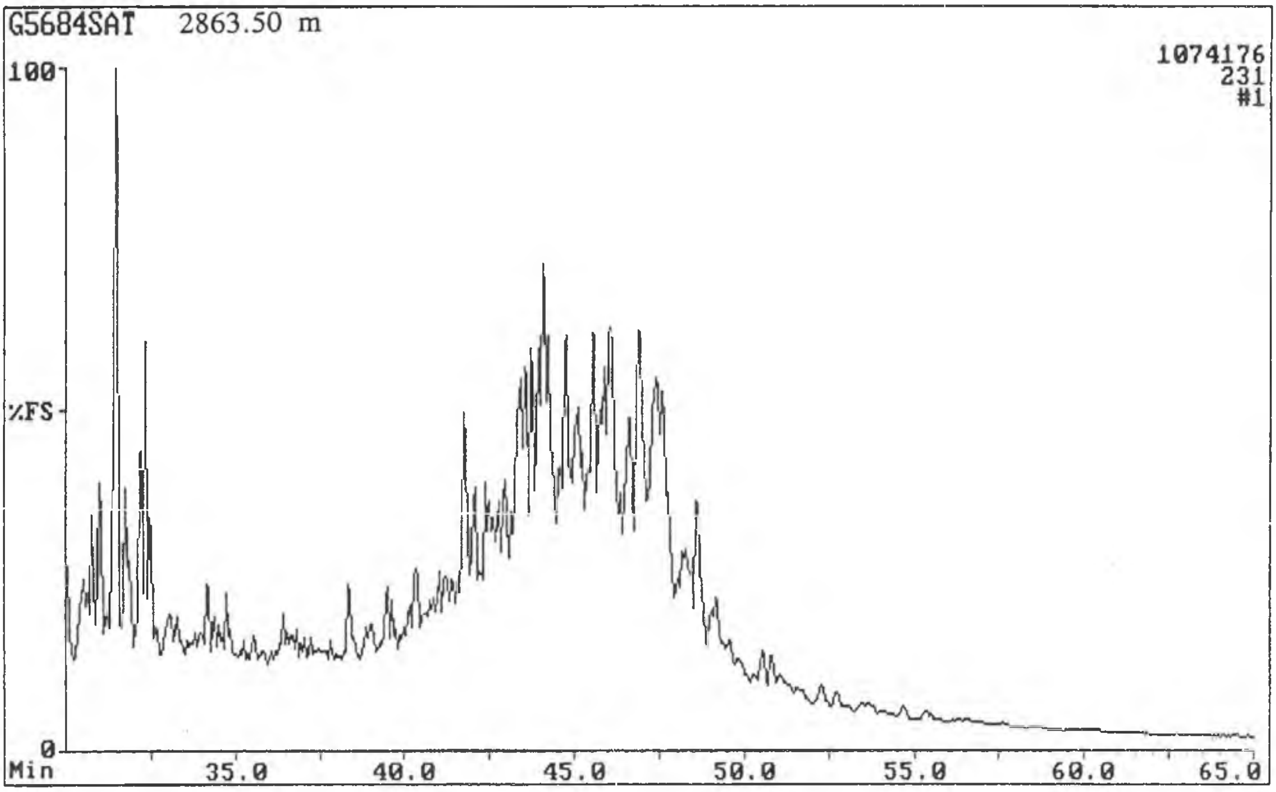

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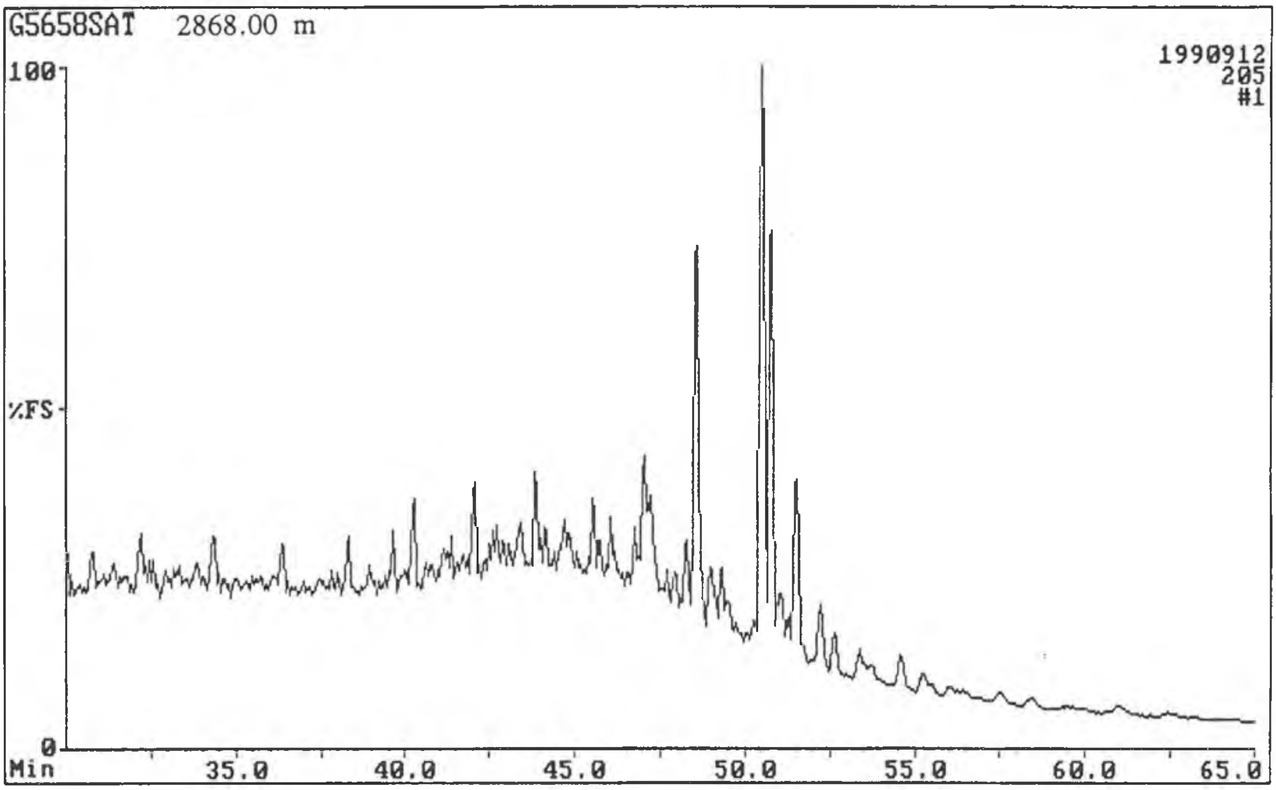

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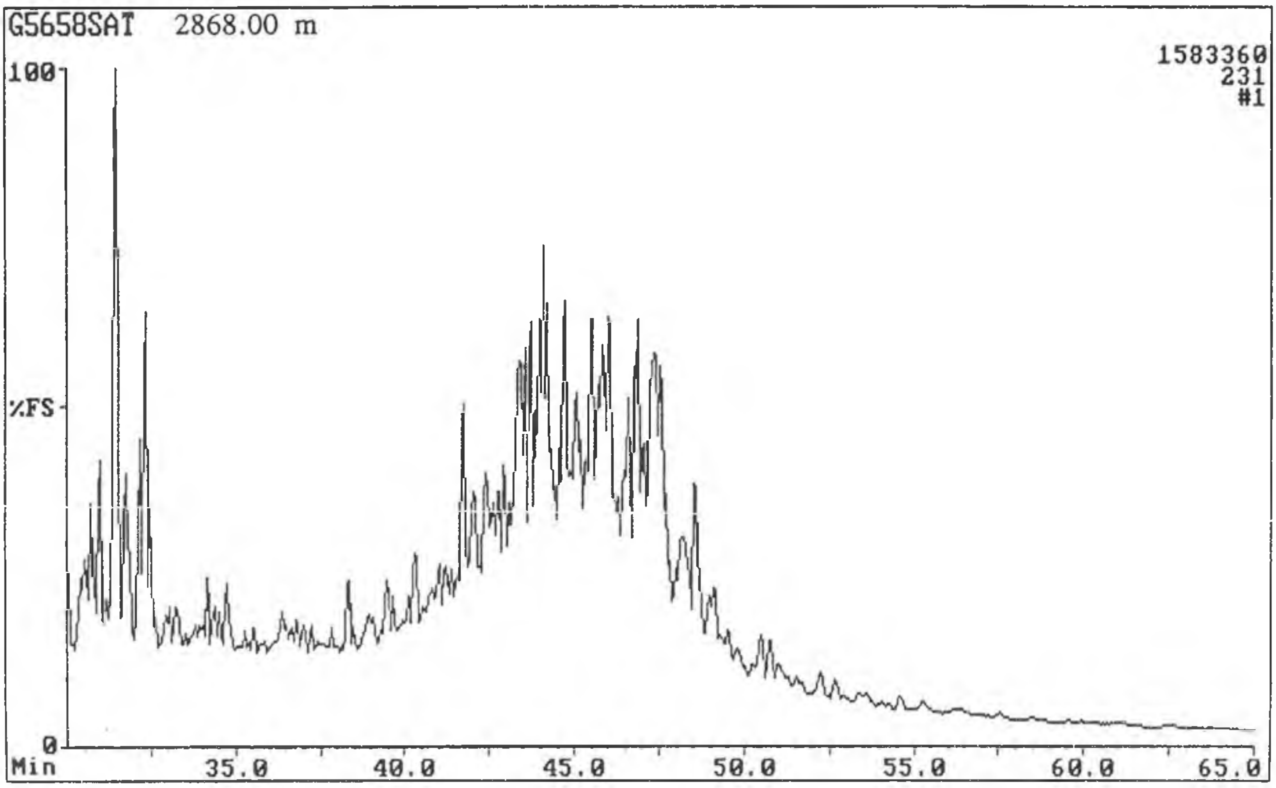

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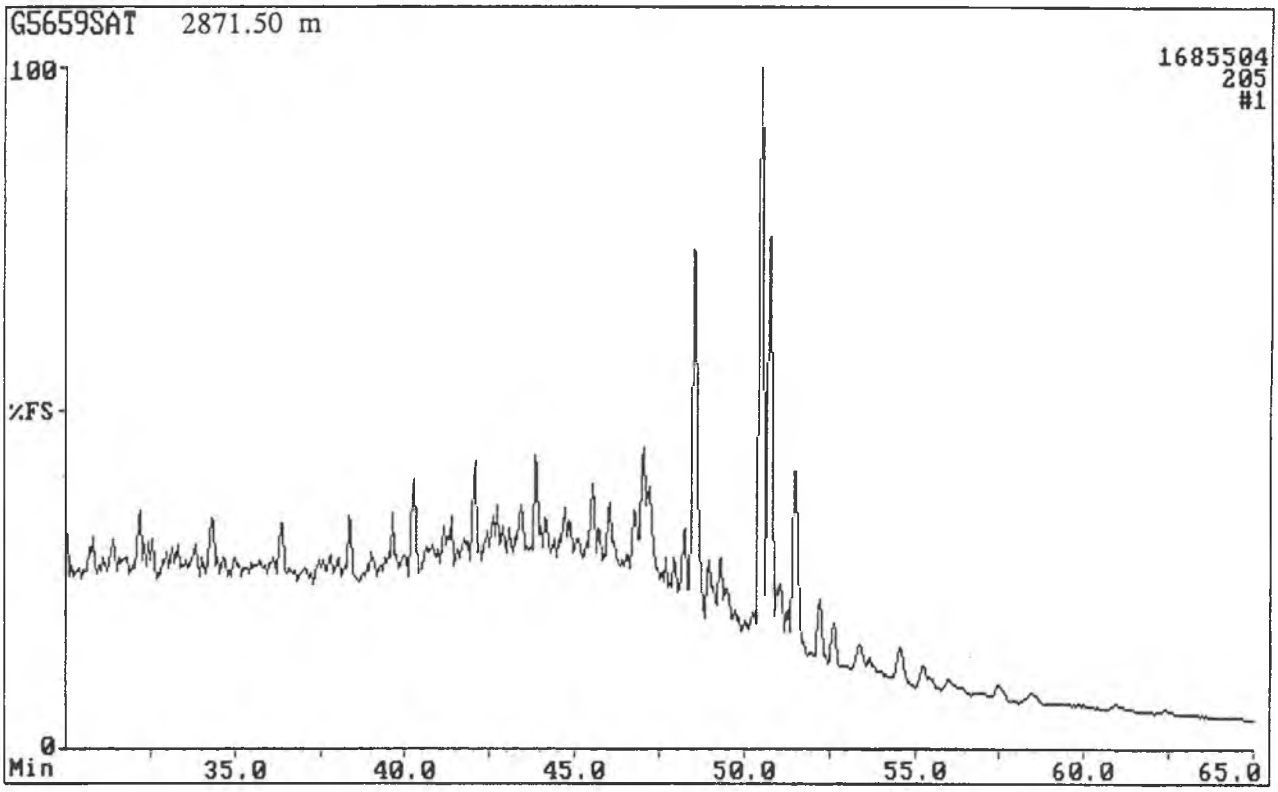

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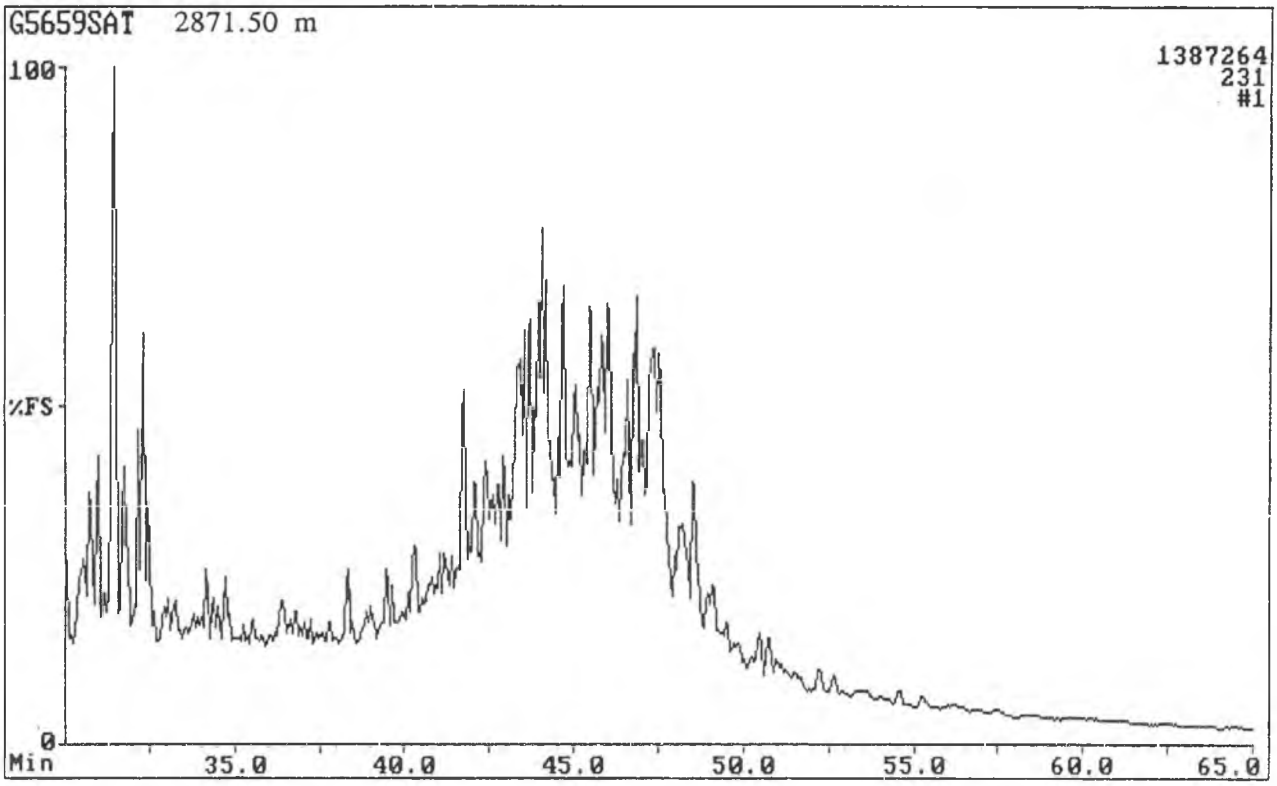

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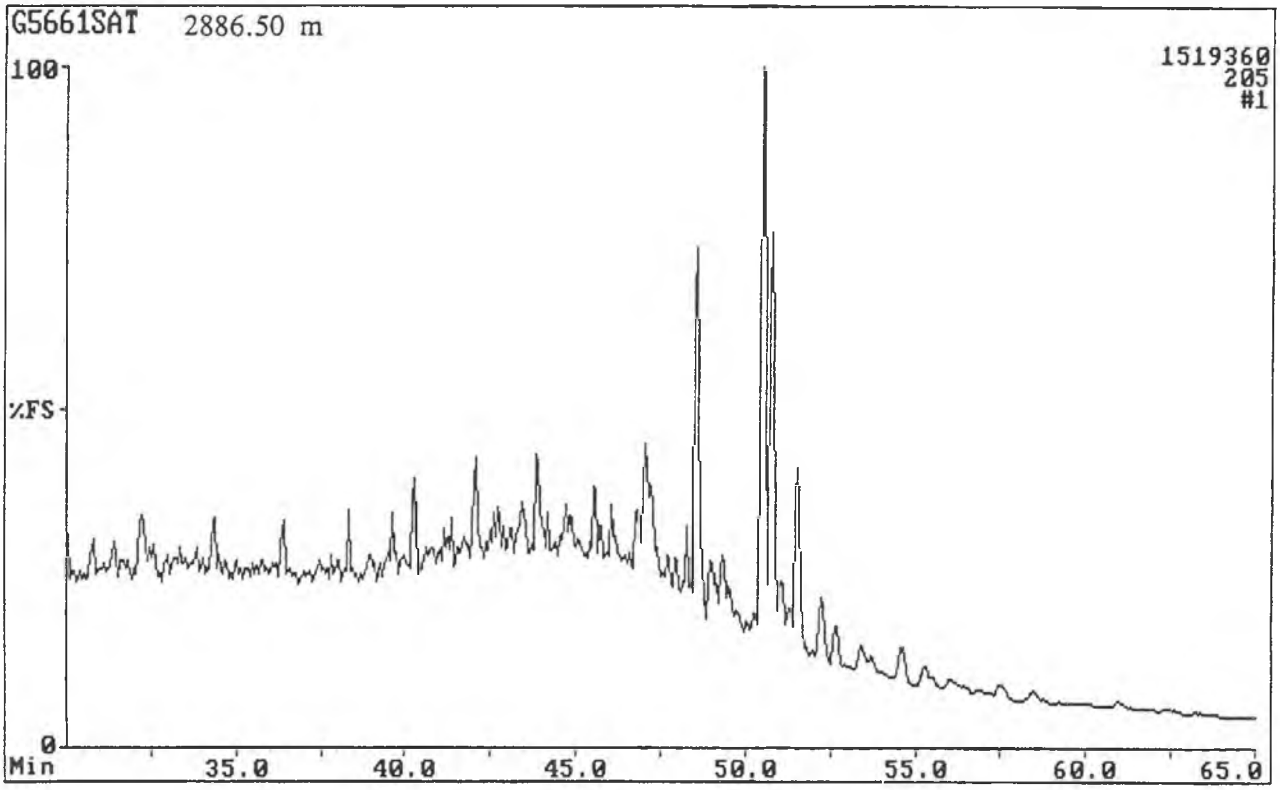

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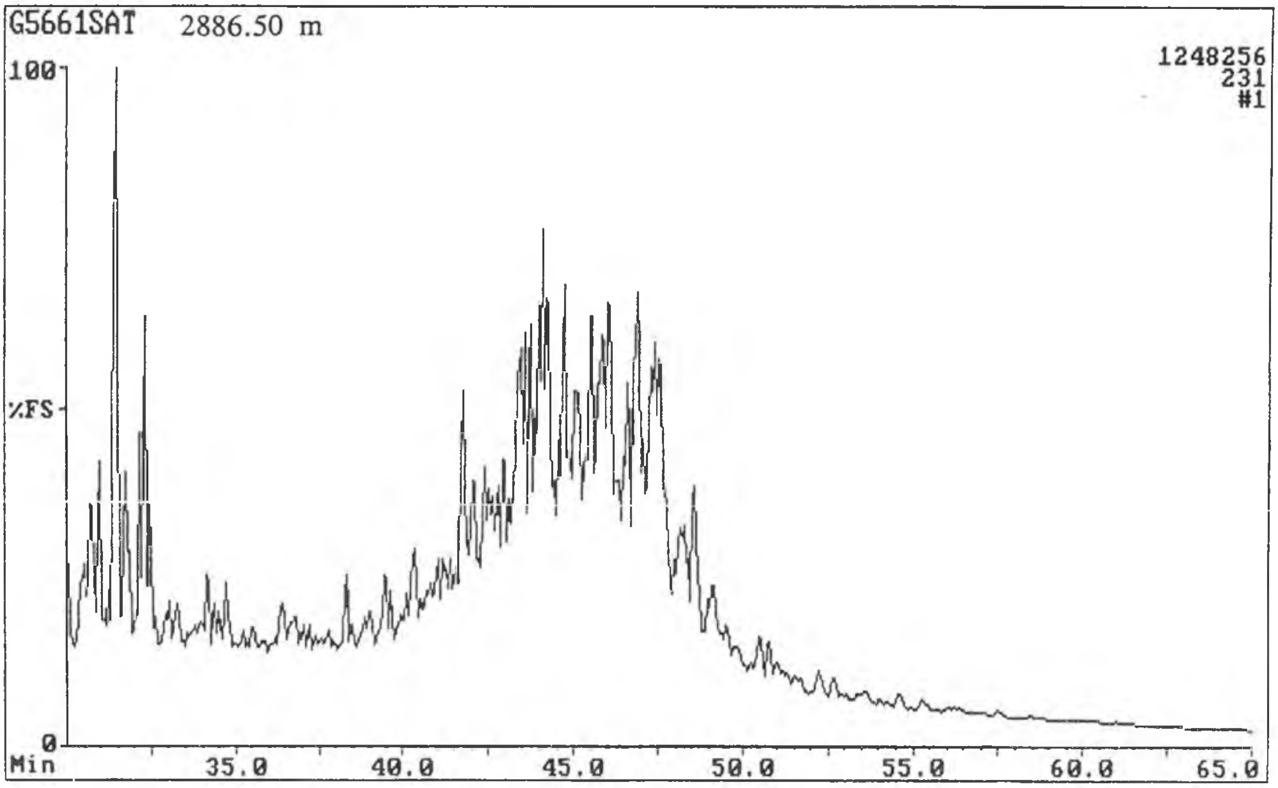

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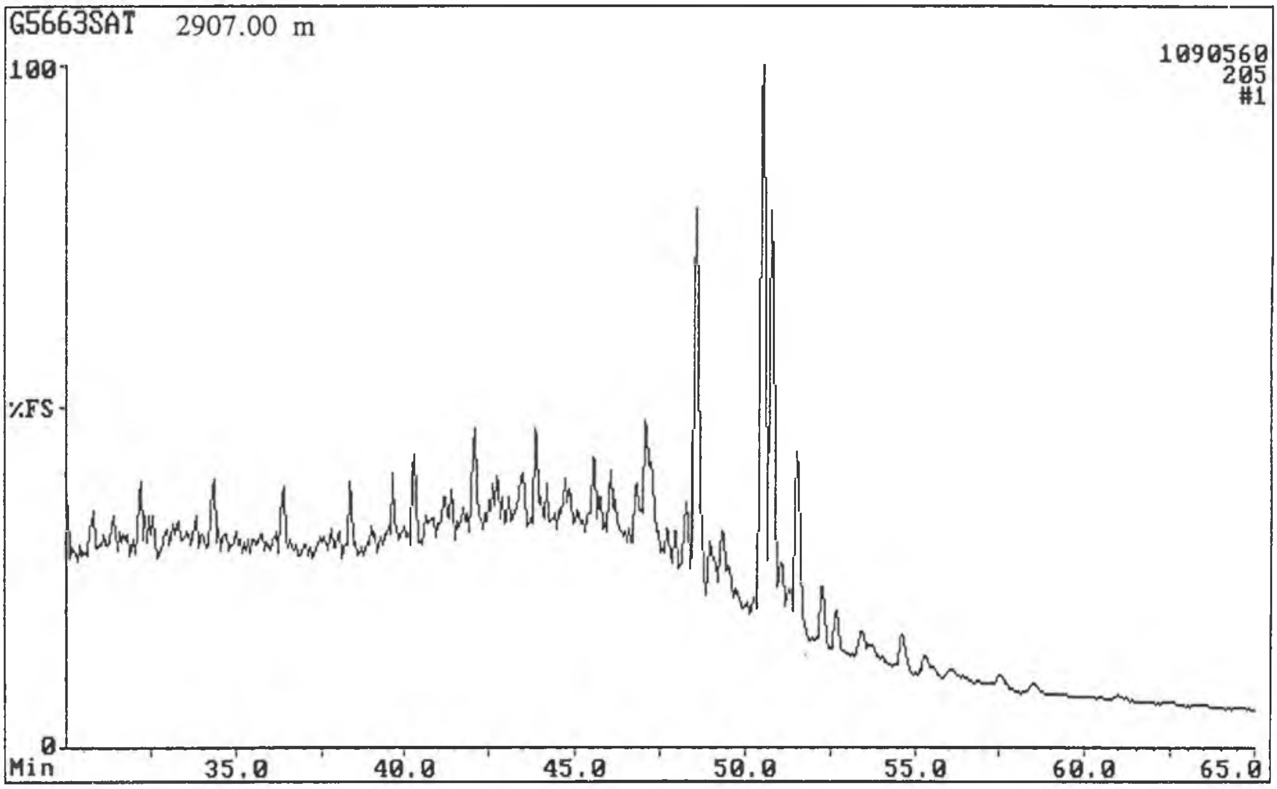

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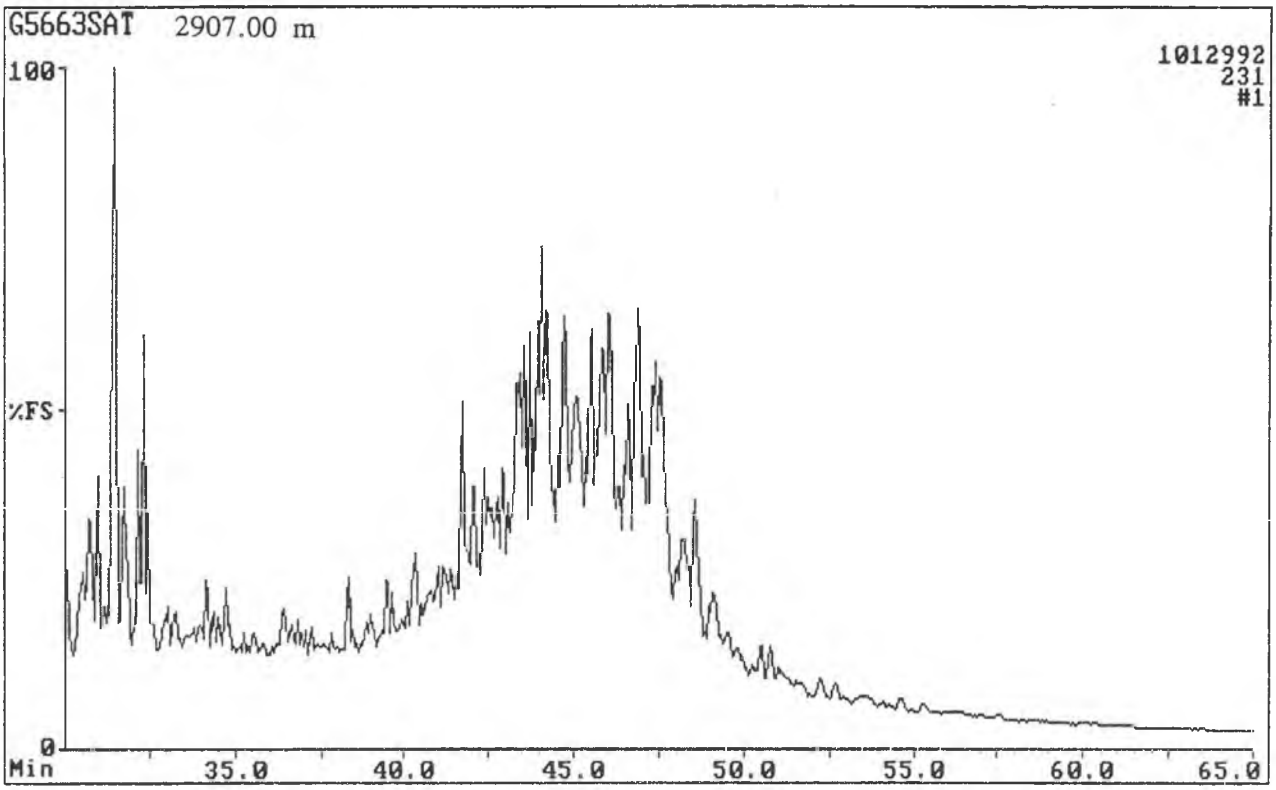

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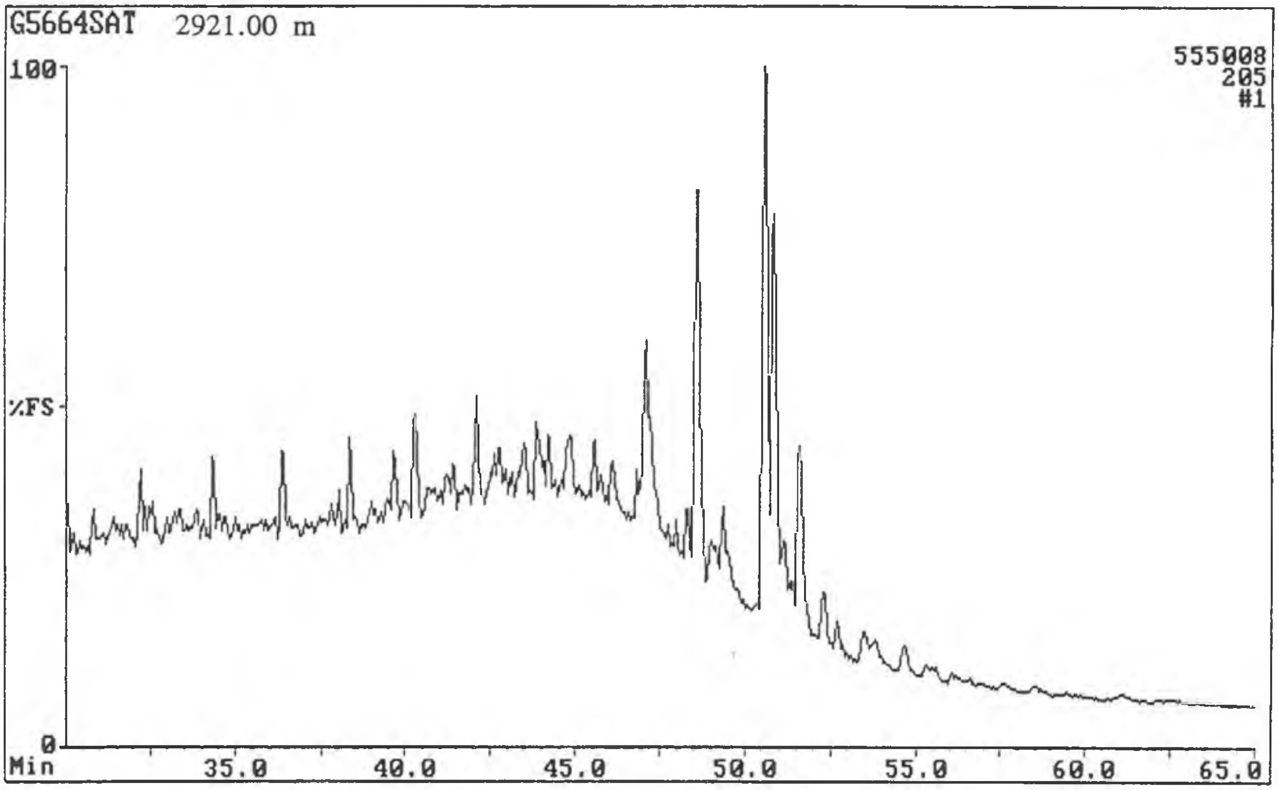

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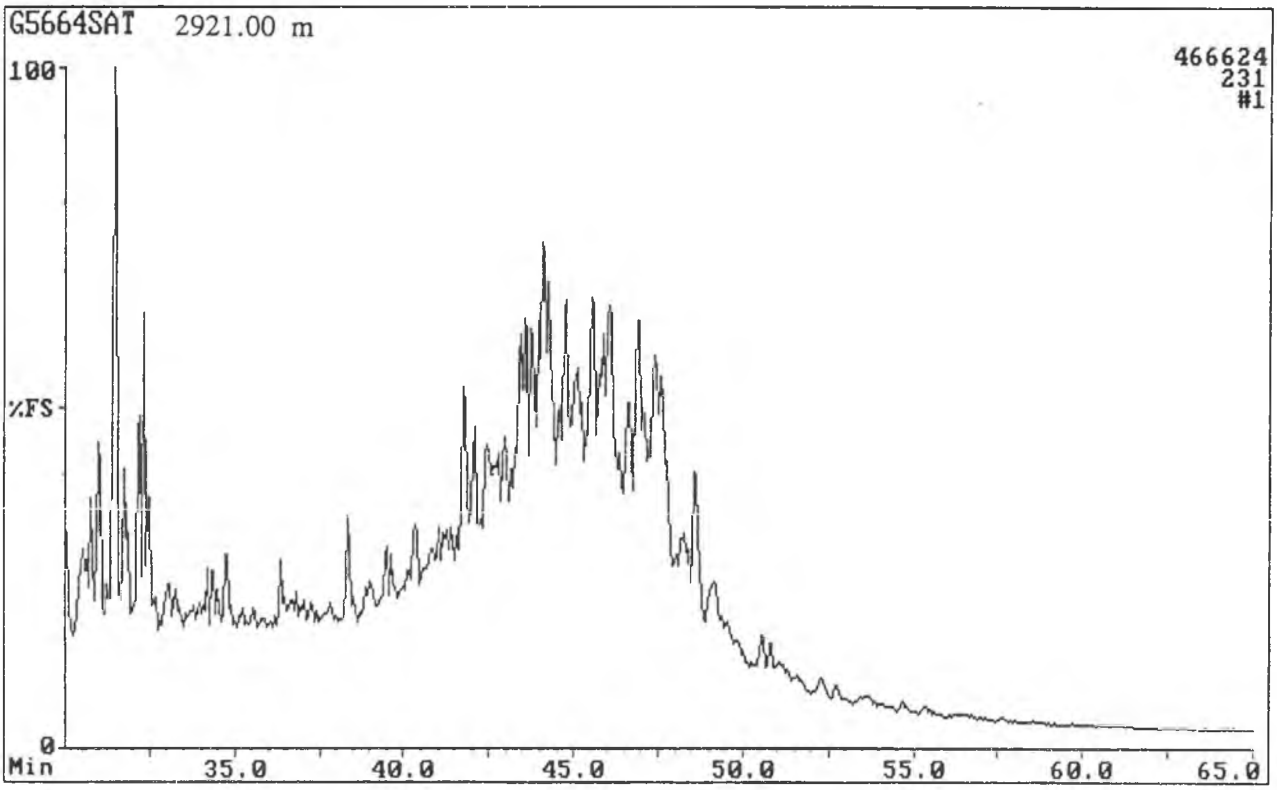

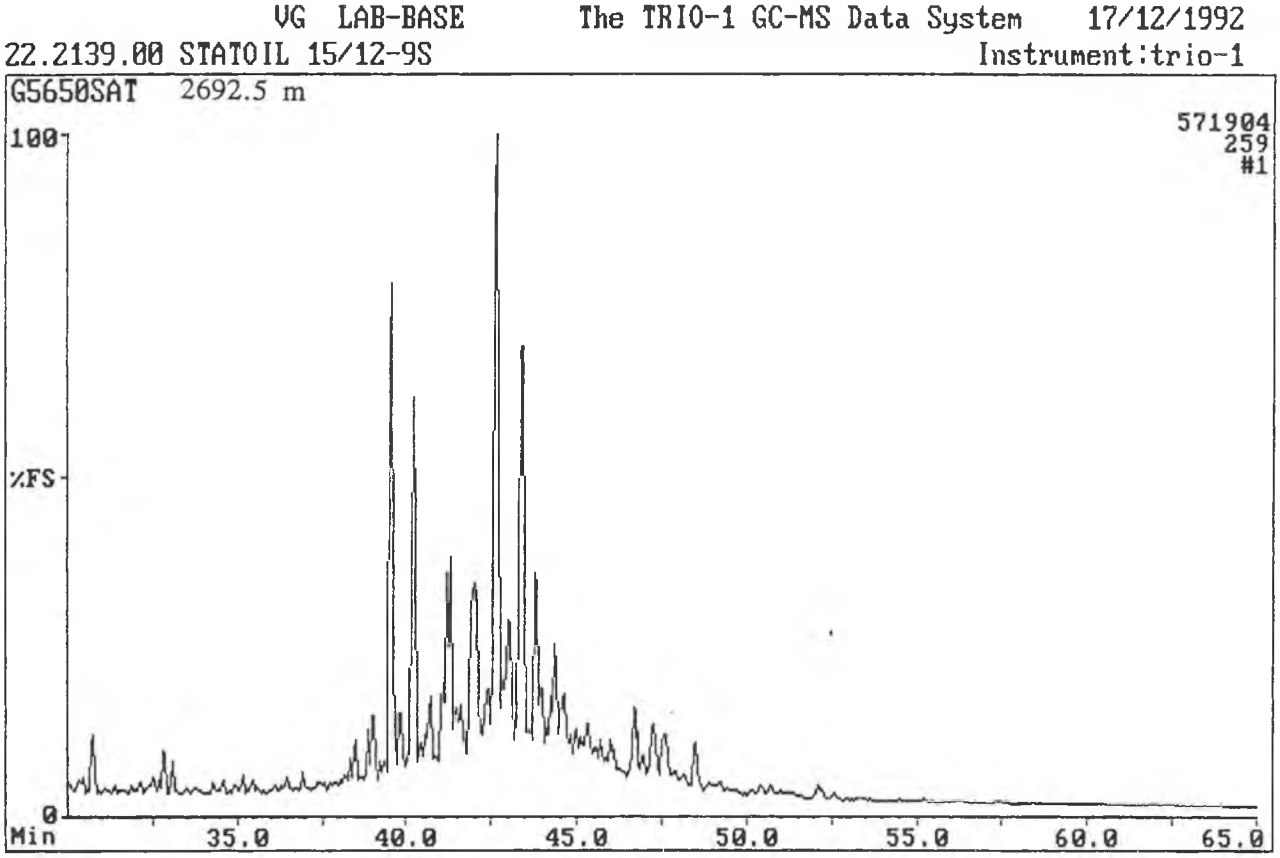
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The TRIO-1 GC-MS Data System
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VG LAB-BASE The TRIO-1 GC-MS Data System 17/12/1992
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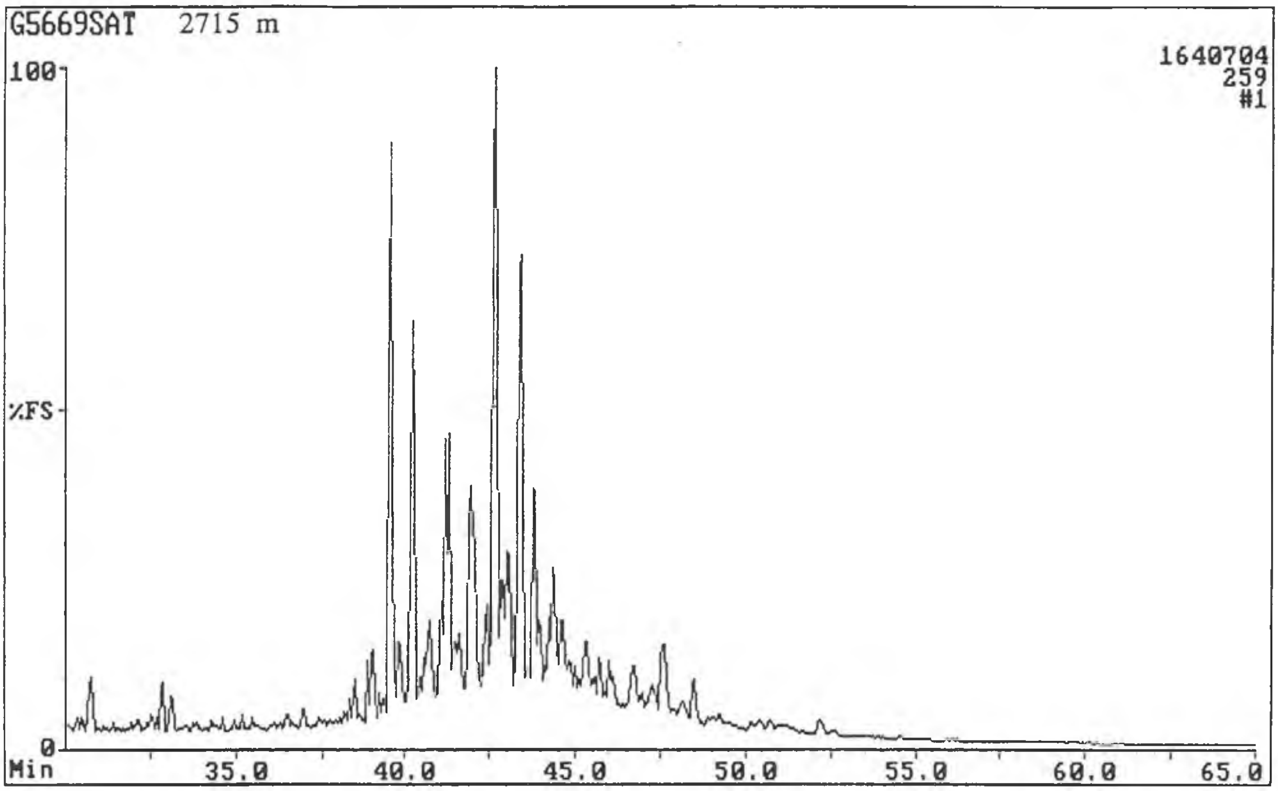

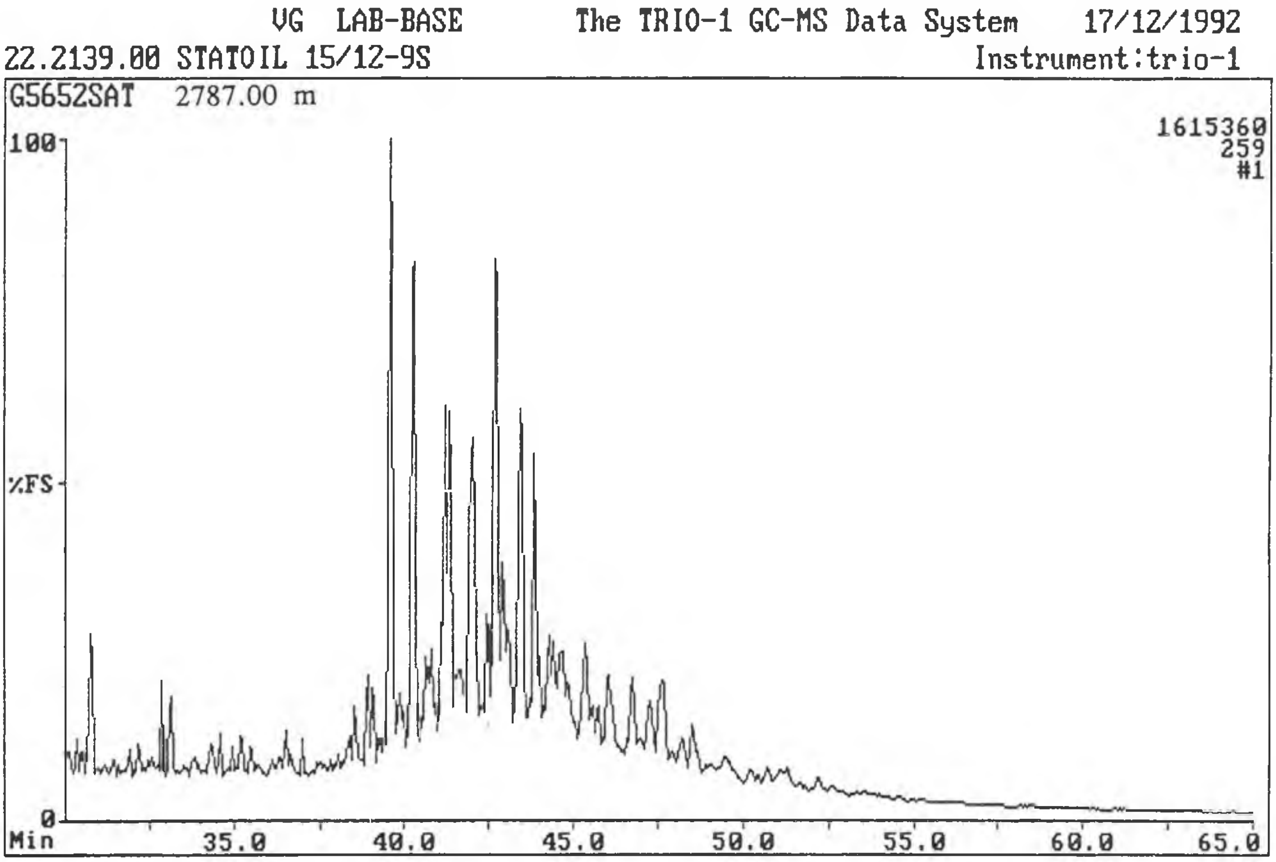

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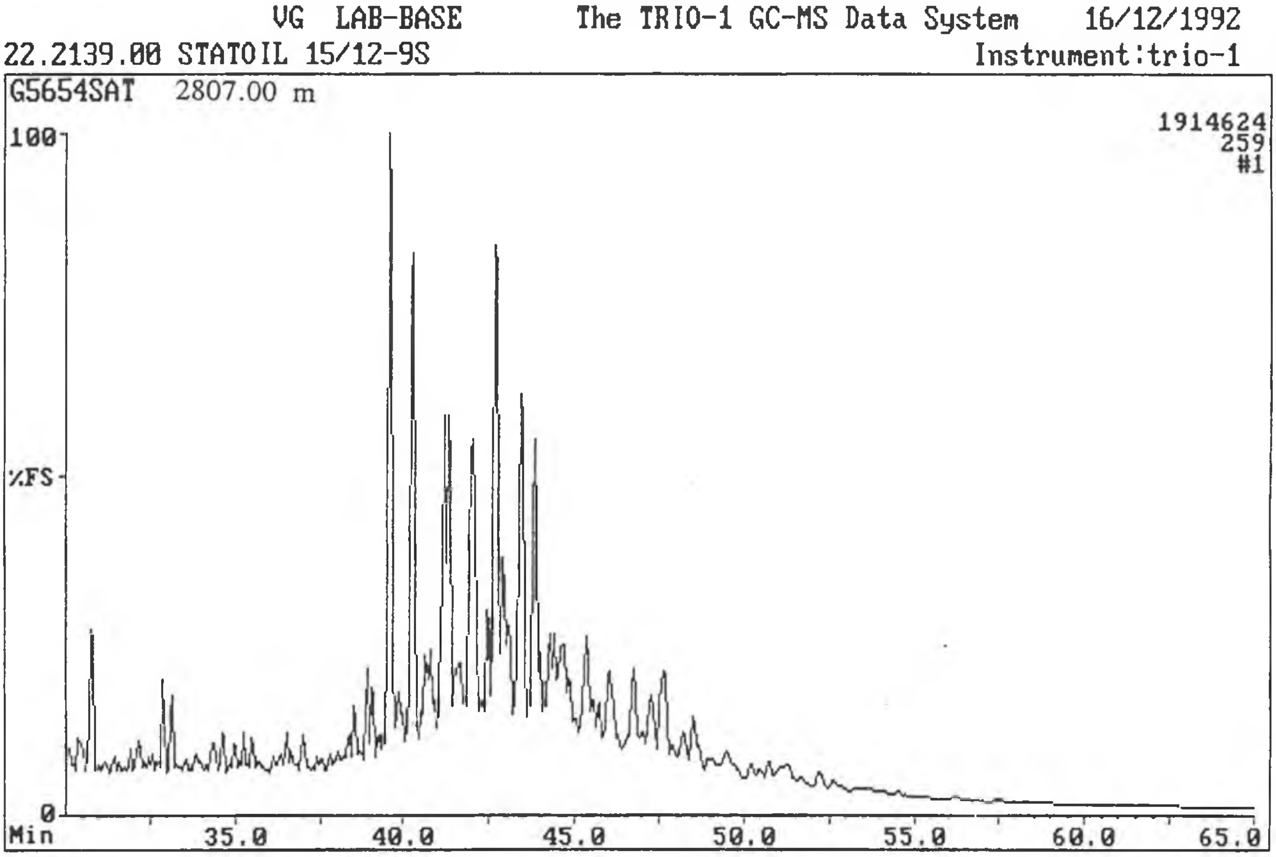
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The TRIO-1 GC-MS Data System
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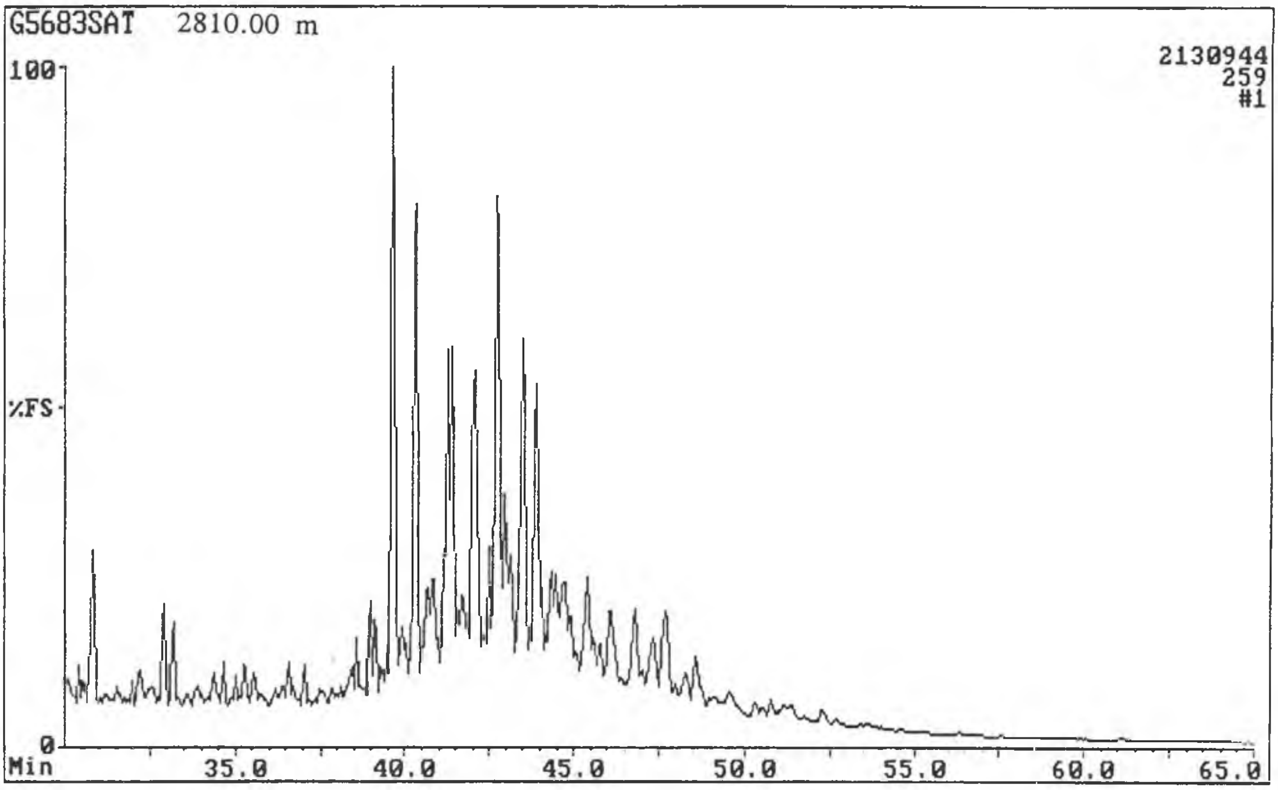

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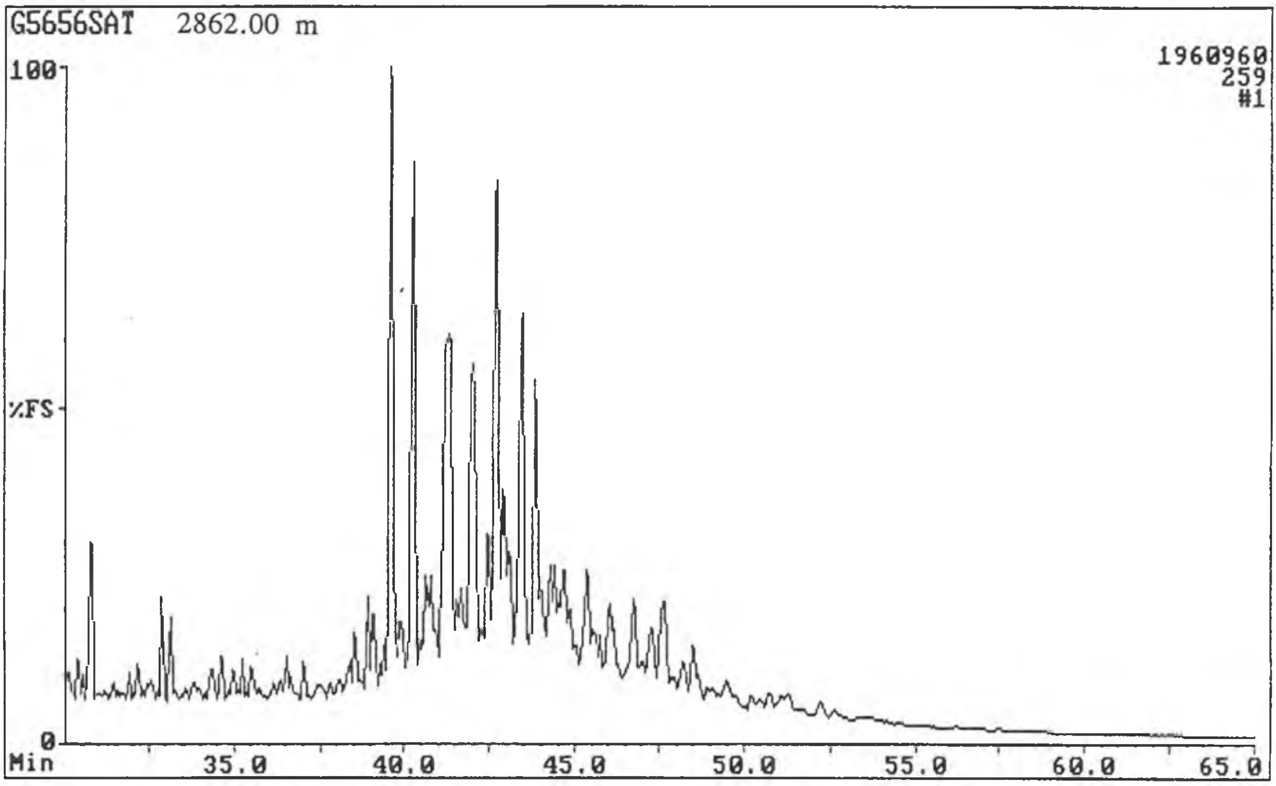

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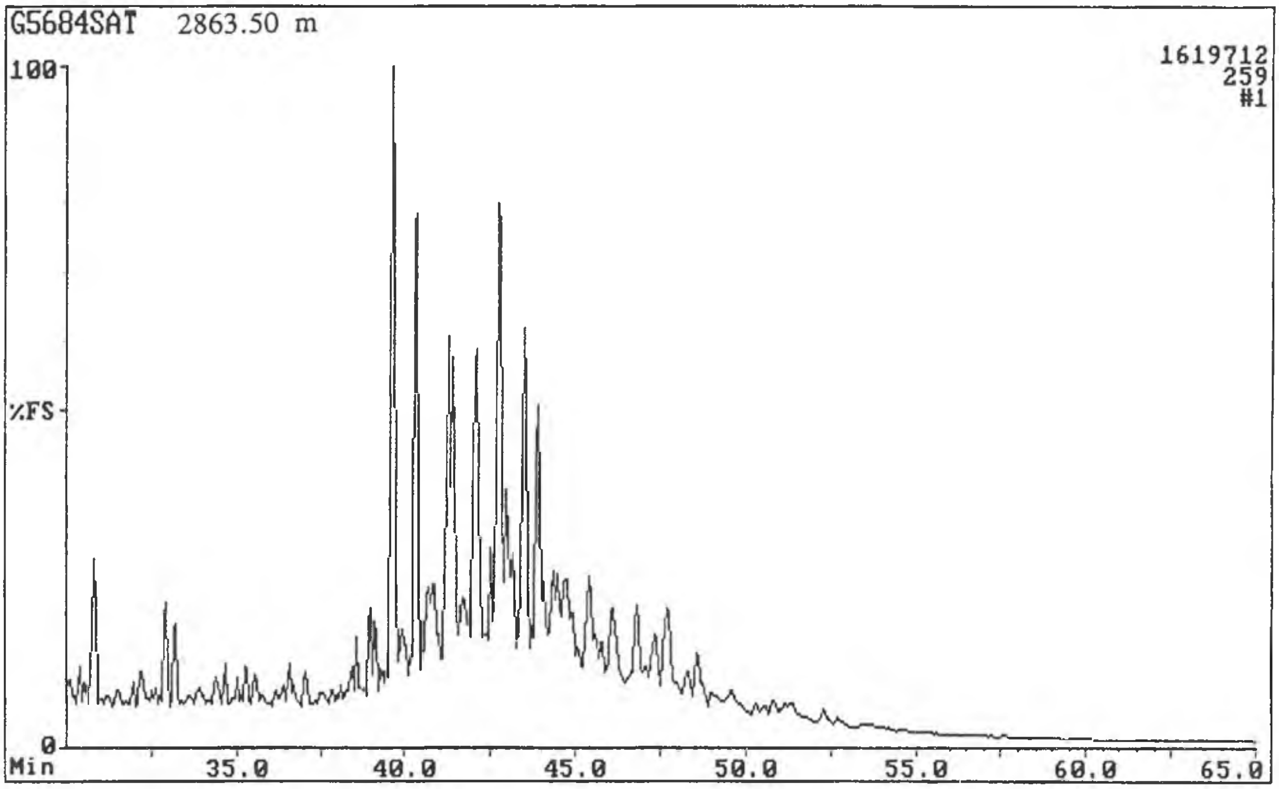

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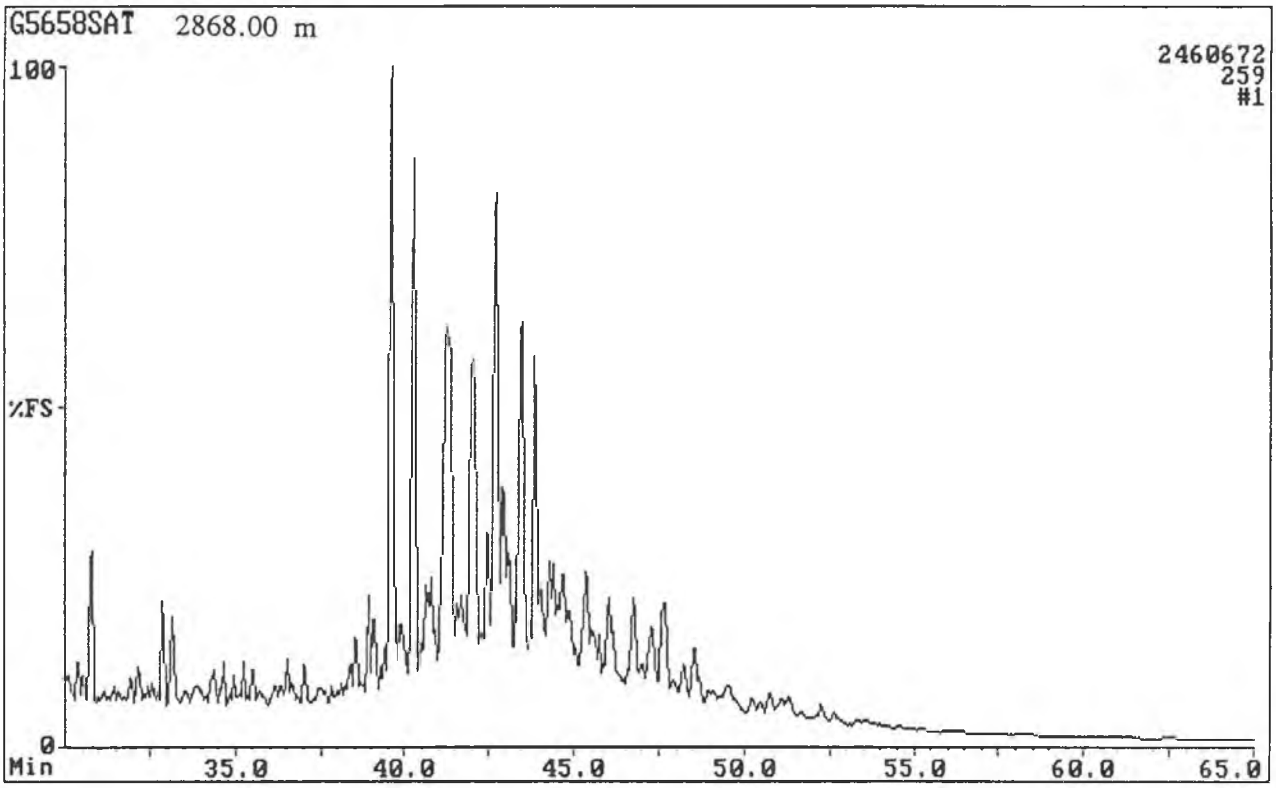

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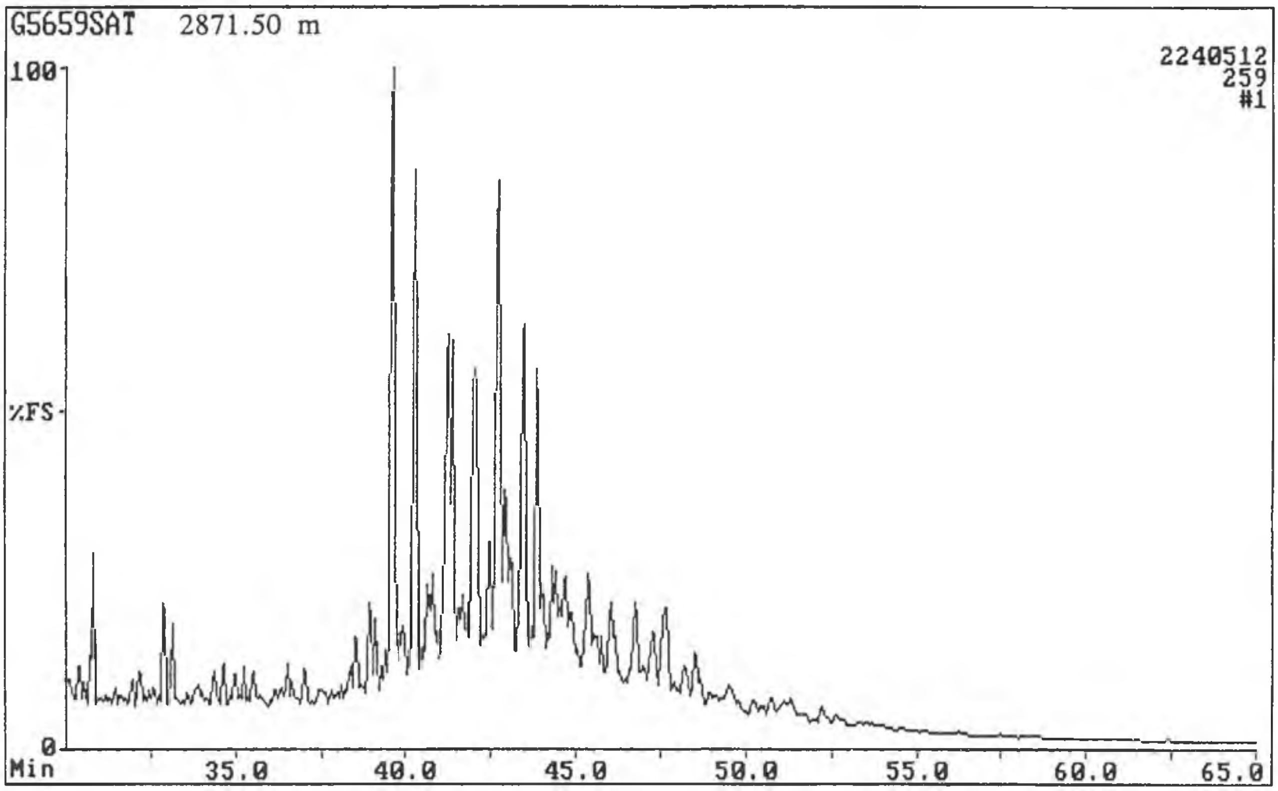

VG LAB-BASE The TRIO-1 GC-MS Data System 16/12/1992
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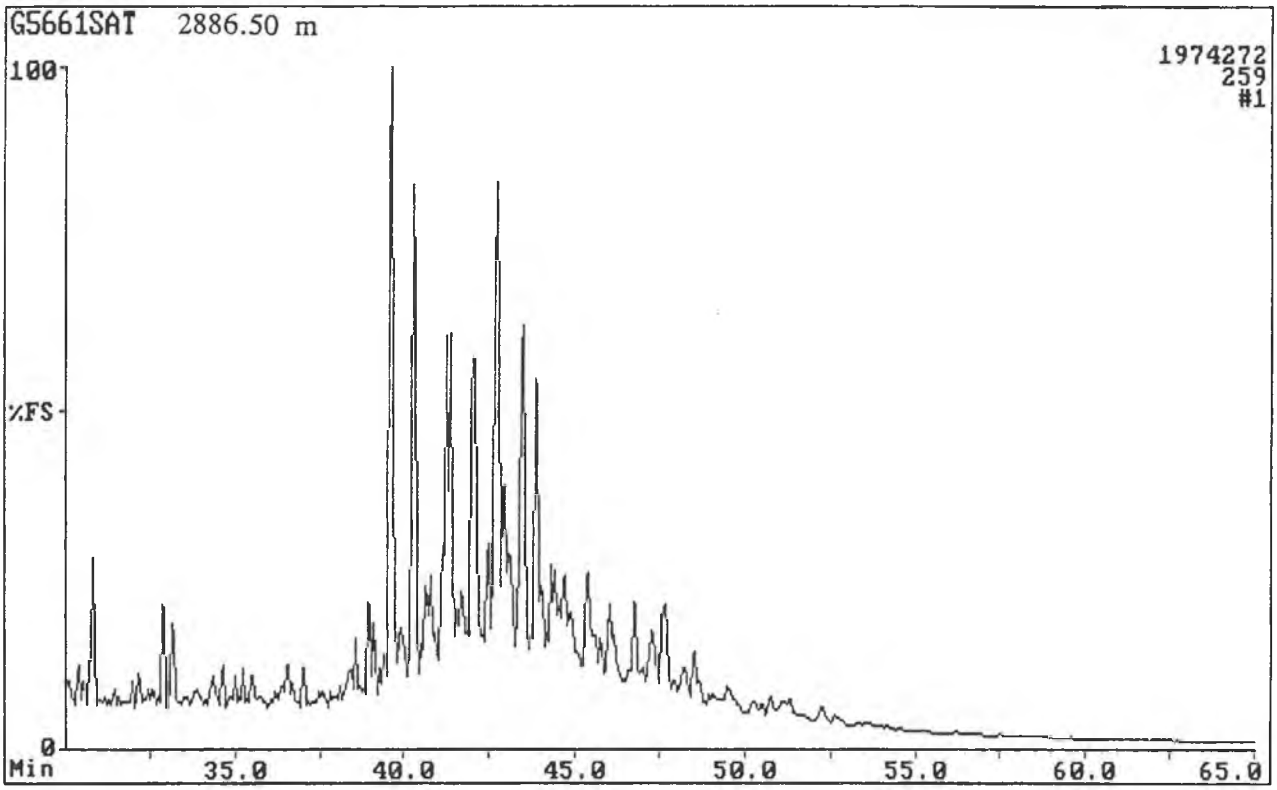

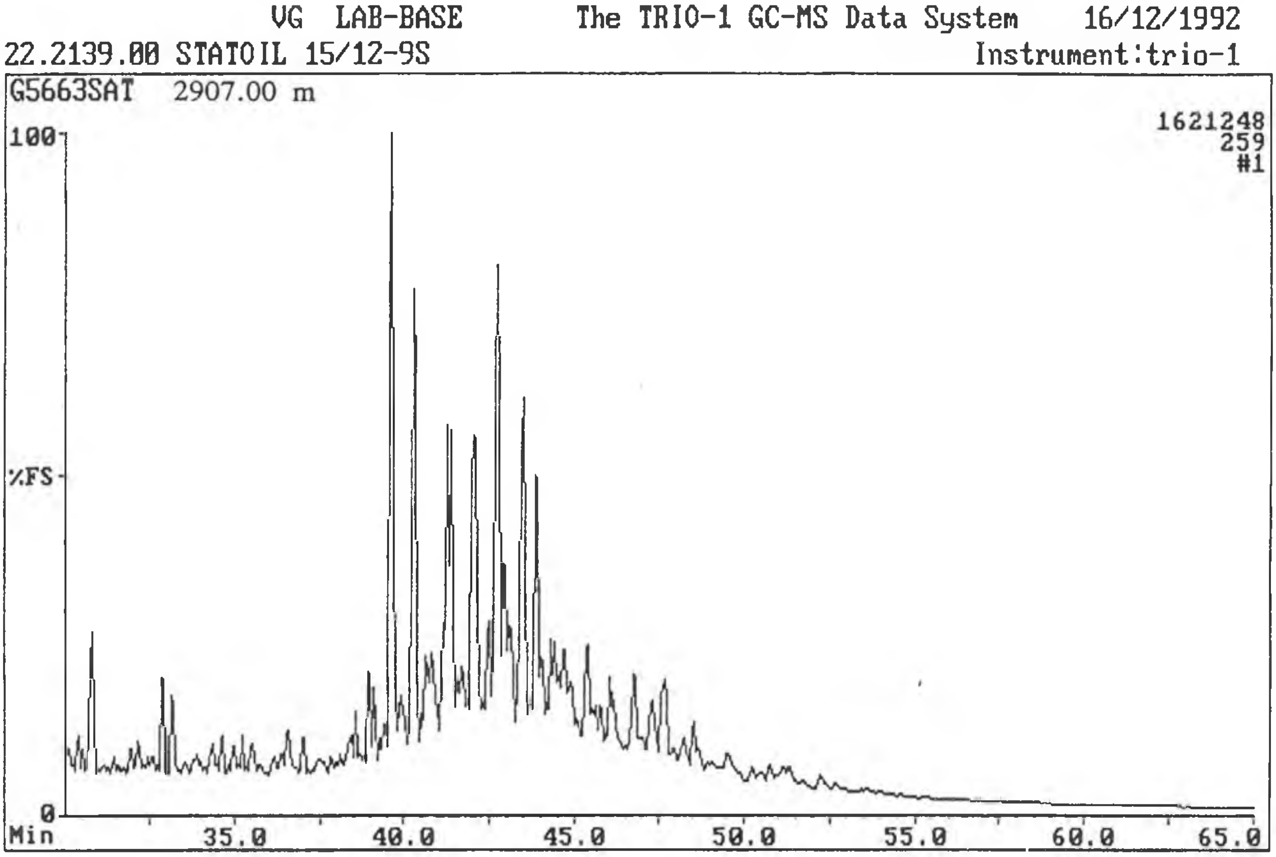

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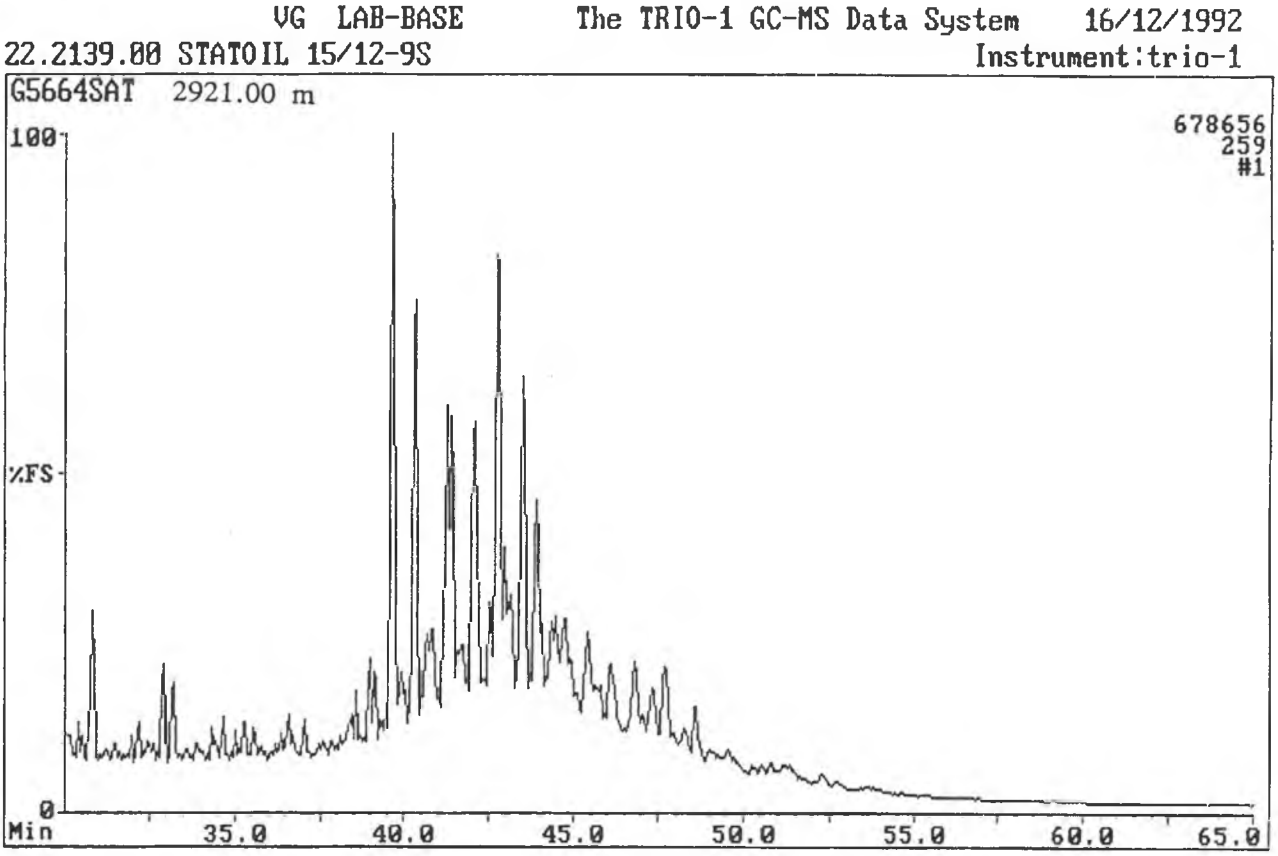
22.2139.00 STATOIL 15/12-9S Instrument:trio-1
G5663SAT 2907.00 m



VG LAB-BASE The TRIO-1 GC-MS Data System 16/12/1992

22.2139.00 STATOIL 15/12-9S Instrument:trio-1

G5664SAT 2921.00 m

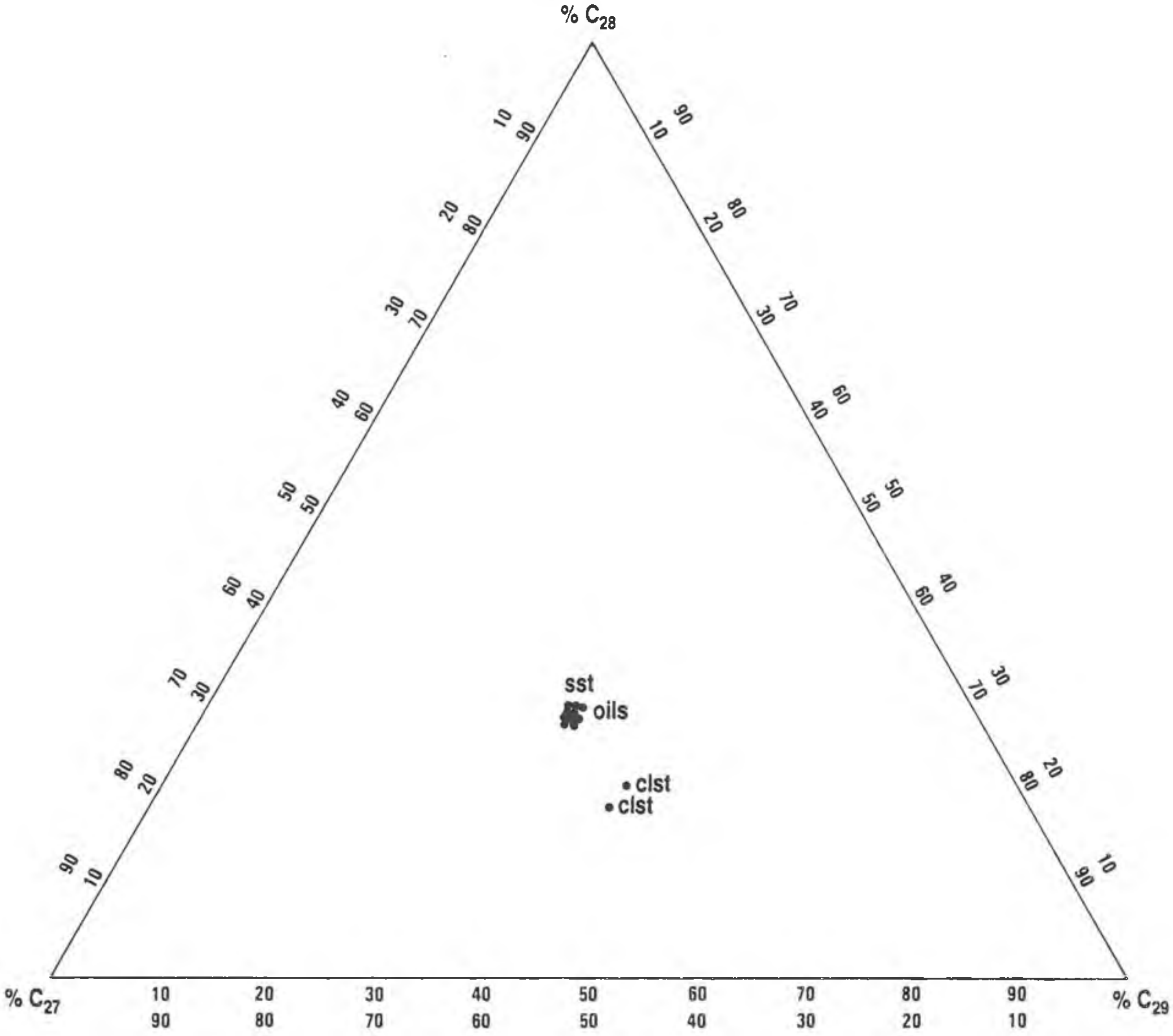


Figure 2.15 *Internal distribution of C_{27}, C_{28} and C_{29} regular steranes (from m/z 218)*

APPENDIX I

ANALYTICAL MEHODS
AND INTERPRETATION LEVELS

Lithological descriptions

Lithological examinations were carried out using a binocular microscope (maximum 50x magnification). Colour were described on dry samples according to the "Rock Colour Chart" published in 1979 by the Geological Society of America, Boulder, Colorado. Handpicking of the cuttings for organic geochemical analyses was based on the lithological descriptions.

Total Organic Carbon

Picked and bulk samples were crushed in a mortar. Aliquots of the samples were then weighed into Leco crucibles, then treated three times with hot 10% HCl in order to remove carbonate, and finally washed four times with distilled water in order to remove any traces of HCl. The crucibles were then placed on a hot plate (60°C) and dried for 24 hours. The total organic carbon (TOC) content of the dried samples was determined using a CS 244 carbon/sulphur analyser.

The instrument was calibrated using a sediment standard with 2.72% carbon. Calibration and blank runs were carried out every 15th measurement.

Rock-Eval pyrolysis

Powdered sample (100 mg shale, 5-10 mg coal) was weighed into a platinum crucible (the base and cover of which are made of sintered steel), and analysed on a modified Rock-Eval II pyrolyser (Girdel/IFP) under standard conditions (Carrier gas: helium; flow rate: 50 ml/min.; temperature programme: 300°C (3 min.) - 25°C/min. - 550°C).

Preparation of kerogen concentrates

The powdered and pre-extracted rock sample was treated overnight with concentrated HCl (200 ml), followed by treatment with hot 40% HF (100 ml, 70°C, overnight). The acid was removed by decanting and repeated washing with hot water (on a 10µ sieve), 10% ammonium carbonate solution was added after HF treatment (>2 hours), and the kerogen concentrate was washed with cold water (2x).

The kerogen concentrates for isotop analyses was dried in a vacuum oven.

Pyrolysis Gas Chromatography (Py-GC Programmed)

Thermal extraction (S1)

The whole rock sample (20-30 mg) was placed in a boat-shaped sample probe and thermo-extracted in a stream of helium at 340°C for 4 minutes.

Pyrolysis-Gas Chromatography (S2)

The thermo-extracted sample was pyrolysed in a helium atmosphere using a transformed injector system from Varian mounted on a Varian 3400 GC after the principles described by Solli et al. (1984). The pyrolysis temperature program was 340°C - 50°C/min. - 550°C. The outlet of the furnace was directly connected to a splitter (30:1) which enabled the pyrolysis products to be simultaneously recorded as a bulk "S2" peak by an FID and passed into a gas chromatograph. The pyrolysis products were trapped on the chromatographic column by cooling the front part of the column with liquid nitrogen. On completion of the pyrolysis programme, the collected pyrolysis products were injected on to the column by removing the nitrogen bath. The GC conditions are outlined below.

GC conditions

Column: S1: 30 m DB-1, i.d. 0.32 mm, fused silica capillary column.
S2: 30 m DB-5, i.d. 0.32 mm, fused silica capillary column.
Carrier gas: Helium, inlet pressure 7.5. psi; flow rate 1.5 ml/min.

Temp. programme: -10°C (16 min.) - 5°C/min. - 320°C (10 min.)

Extractable Organic Matter

Powdered rock was extracted by Soxhlet technique with boiling dichloromethane (DCM) containing 7%(v/v) methanol as solvent in a Soxhlet apparatus for 24 hours.

DCM of organic geochemical grade was used and blank analyses indicated that the occurrence of contaminating hydrocarbons was negligible. Activated copper fillings were used in order to remove any free sulfur from the samples.

After extraction, the solvent was evaporated off using a Büchi Rotavapor and the amount of extracted organic matter (EOM) was determined.

Evaporation of the light components in fluid samples

Prior to chromatographic separation, the oil/condensate samples were evaporated in a rotary evaporator for 10 min. The waterbath was about 90°C and the waterpump was at a maximum. This is equivalent to topping up to 210°C.

The fraction of light components was determined as the weight difference between the original sample and the residuum left after heating.

Medium-pressure liquid chromatography (MPLC)

The EOM or oil (>210°C) sample was diluted in DCM (1:3 mg/µl) and the asphaltenes were precipitated using excess n-pentane (40:1 pentane: (DCM+EOM)). The asphaltene fraction was weighed after drying at room temperature until constant weight was obtained.

The remaining maltenes were separated into saturated, aromatic and non-hydrocarbon fractions using an MPLC system with n-hexane as eluant (Radke et al. 1980). The various fractions were concentrated using a Büchi Rotavapor. Then they were transferred to glass vials. The remaining solvent was removed.

Iatroscan

The extractable organic material was diluted with DCM and ca. 20 µg of the solution were applied to a precleaned and activated Chromarod (type SIII). Two replicates of each sample were analysed. The rods were fully developed with n-hexane (10-11 cm), then dried and redeveloped to half-rod height

(5.5 cm) in toluene, and finally developed in DCM+MeOH (93:7 v/v, 2.5 cm).

The rods were passed through the flame-ionisation detector (FID) of a Iatroscan TH-10 (H_2 = 160 ml/min; air = 2 l/min; scan speed = 0.38 cm/sec (gear no. 30)). The FID response was recorded and integrated using a VG Multichrom lab data system. Relative response factors were determined by using an external standard.

Gas chromatographic analysis

The saturated hydrocarbon fractions were diluted with n-hexane and analysed on a Hewlett Packard 5730A gas chromatograph equipped with a 15 m DB-1 or fused silica column (0.25 mm id). Hydrogen was used as a carrier gas with a flow rate of about 1.5 ml/min. Injections were performed in split mode (split ratio 1:20). The temperature program used was 80°C (2 min.) - 4°C/min. - 300°C.

The whole oil sample from hydrous pyrolysis was analysed using a Varian 3400 gas chromatograph fitted with a 30 m DB-5 fused silica column (0.32 mm id). 0.02µl of sample solution were injected in split mode (split ratio 1:20). Hydrogen with a flow rate of 2.5 ml/min. was used as a carrier gas, and the temperature programme used was -50°C (2 min.) - 4°C/min. - 300°C.

The total aromatic fractions were diluted with n-hexane and analysed on a Varian 3400 gas chromatograph, fitted with a DB-5 fused silica column (30 m x 0.32 mm i.d.), using a hydrogen carrier gas with a flow rate of 2.5 ml/min. The injection split ratio was 1:20. The temperature programme used was 80°C (2 min.) - 4°C/min. - 300°C.

All the data from the GC analyses were processed on a VG Multichrom lab data system.

Gas chromatography - mass spectrometry (GC-MS)

GC-MS analyses of the saturated hydrocarbons were performed on a VG TRIO 1 quadrupol.

A HP 5890 Series II GC was fitted with a fused silica DB-5 capillary column (30 m x 0.25 mm i.d.). Helium was used as carrier gas with 7 psi as inlet pressure. The injections were performed in splitless mode.

The GC oven was programmed from 120°C (2 min.) to 300°C at 4°C/min.

The saturated hydrocarbons were analysed in multiple ion mode (MID) at a scan cycle time of approximately 2 secs. The mass spectrometers operated at 70eV electron energy with an ion source temperature of 200°C. Data acquisition was performed using VG data systems.

Peaks were identified by comparison with elution patterns in certain mass chromatograms. Peak ratios were calculated from peak heights in the appropriate mass chromatograms.

Evaluation of kerogen type and thermal maturity in transmitted light

The rock samples were crushed and treated with hydrochloric acid and hydrofluoric acid in order to remove the mineral matter and isolate the kerogen. The isolated kerogen was mounted in glycerine jelly on microscope slides as a strew-mount.

The treatment of the isolated kerogen varied according to the requirements and preservation of the samples. This included:

T-slide:	total acid residue.
O-slide:	kerogen debris remaining after flotation in $ZnBr_2$ to remove heavy minerals.
Si-slide:	sieved residue.
X-slide:	oxidised residue.

T- and/or O-slides were necessary in order to evaluate the kerogen composition/palynofacies of the samples.

Si- and/or X-slides were required if it was necessary to concentrate larger kerogen fragments or spores/pollen for spore colouration and/or age determination, respectively, (N.B.: oxidised residue is not used for spore colour determination as oxidation will alter the colour).

The samples were examined using a Leitz Dialux microscope with a white halogen light source. Objective lenses of 10x and 63x magnification were used. The higher magnification allowed a more detailed description of the kerogen, with resolution down to 2µm diameter.

Thermal alteration indices (TAI) were measured from the colour of spores and pollen. The techniques used for this are adapted from Staplin (1969) and Burgess (1974). IKU has used a 1-10 scale for thermal alteration index (TAI)/Spore colouration index (SCI) since December, 1986.

Kerogen terminology

The following kerogen terminology is used:

1. Amorphous material - degraded, unstructured material of unidentified origin.
2. Algal material - particles of recogniseably algal origin.
3. Liptinitic material - recogniseable spores, pollen, cuticle and cysts.
4. Woody material - structured and unstructured woody tissue.
5. Coaly material - black, reworked or oxidised material.

Comparison of microscopic thermal maturation systems at IKU

SPORE COLOUR		VITRINITE REFLECTANCE	SPORINITE FLUORESCENCE
TAI	NEW TAI	%	
1 - 2-	1.0- 3.5	0.25-0.40	1-4
2- - 2	3.5- 4.0	0.40-0.60	4-6
2 - 2+	4.0- 4.5	0.60-0.80	6-7
2+ - 3-	4.5- 5.5	0.80-1.00	7-8
3- - 3	5.5- 6.0	1.00-1.20	8-9
3 - 5	6.0-10.0	<1.20	Absent

At IKU, TAI determination is generally undertaken on bisaccates.

Relation between fluorescence colour and sporinite fluorescence zones:

EXC. 400 nm
BAR. 530 nm

colour	G	G/Y	Y	Y/O	L.O	M.O.	D.O.	O/R	R
zone	1	2	3	4	5	6	7	8	9

Isotope IFE

The $\delta^{13}C$ isotope analysis was performed by mass spectrometry at the Institute for Energy Technology (IFE) in Oslo according to their method. Their reference value for the standard NBS-22 is -29.8.

APENDIX II

ROCK-EVAL ANALYSES OF ROCK STANDARD

ROCK-EVAL ANALYSIS OF ROCK STANDARD

Project : 22213900
Date : 93.01.05

Rock standard analysis number	Date	Weight mg	S1 mg/g rock	S2 mg/g rock	Tmax °C
Black Ven Marl (nominal values):			0.47	19.00	420
46	92.11.20	102.8	0.19	19.92	417
47	92.11.20	108.3	0.26	20.54	418*
48	92.11.20	100.3	0.25	19.32	419
49	92.11.20	97.0	0.21	18.90	419
50	92.11.20	101.4	0.21	19.30	419
51	92.11.20	102.3	0.24	19.29	420
minimum			0.19	18.90	417
maximum			0.26	20.54	420
average			0.23	19.55	419
standard deviation			0.0	0.0	0
number of measurements			6	6	6

Legend :
-1 : Missing value

* : not used