U-533

PETROLEUM TECHNOLOGY

Report no.
GEOLAB 87.41
Copy no. 4
No. of copies 10

Grading 3

GEOLOGICAL LABORATORIES

Title
GEOCHEMICAL EVALUATION AND HYDROCARBON CHARACTERISATION OF STATOIL WELL 6407/6-3, HALTENBANKEN.

Requested by	**Project**	
T. G. Gloppen, Let-K	Routine geochemistry	
Date 18.11.87	**Number of pages** 29 Figures/Tables	**No. of encs.** 7 Appendices

Key words Source rock evaluation, maturity study, hydrocarbon characterisation, hydrocarbon contacts, cap rock sealing

Abstract

Immature, rich source rocks of kerogen type II/III with potential for light oil/condensate are found in the Upper Jurassic Nesna Formation. Immature, rich source rocks of kerogen type III with potential for gas/condensate are found in the Middle Jurassic Tomma II Formation.
Gas/condensate prone, immature coals are found in the Tomma III Formation. Early mature coals and siltstones (kerogen type III/II) within the Hitra Formation have potential for gas/condensate.
A tentative base for the gas/condensate column in Tomma I Formation is found at approx. 2524± m within the Tomma II Formation. A tentative GOC is indicated between 2564.25 and 2575.86 m and a tentative OWC is indicated between 2578.89 and 2601.34 m, respectively, within Tomma III Formation.
The DST-1 (oil, 42.5 ° API), 2 and 3 (gas/condensates, 57.4 and 58.9 ° API) are mainly generated from a mixed marine/terrigenous source facies with a more marine dominance for the oil.
Gas from the Tomma I Formation reservoir has indicatively penetrated into the Upper Jurassic Engelvær Formation but not into the Nesna Formation, which is a better cap rock.

lett olje

Prepared by Edle Berge
Trygve Meyer

Special analyses: IKU
IFE

Textoperator

Approved by
30/11.87 Snorre Olaussen
Snorre Olaussen
Dept. Manager, Statoil Geolab

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1. INTRODUCTION

This report presents the result of a routine geochemical study of the well 6407/6-3 on Haltenbanken offshore Norway. A well location map is given in figure 1.

The aim of this study was to define source rock organic facies and depositional environment, to estimate the sedimentary maturity profile, to characterise migrant hydrocarbons and test samples and correlate these hydrocarbons with potential source rocks and finally to establish hydrocarbon contacts.

The present project was carried out at Statoil's GEOLAB with subcontracts at IKU (optical maturity and biomarker analyses) and IFE (carbon isotope and gas analyses).

2. GENERAL WELL INFORMATION

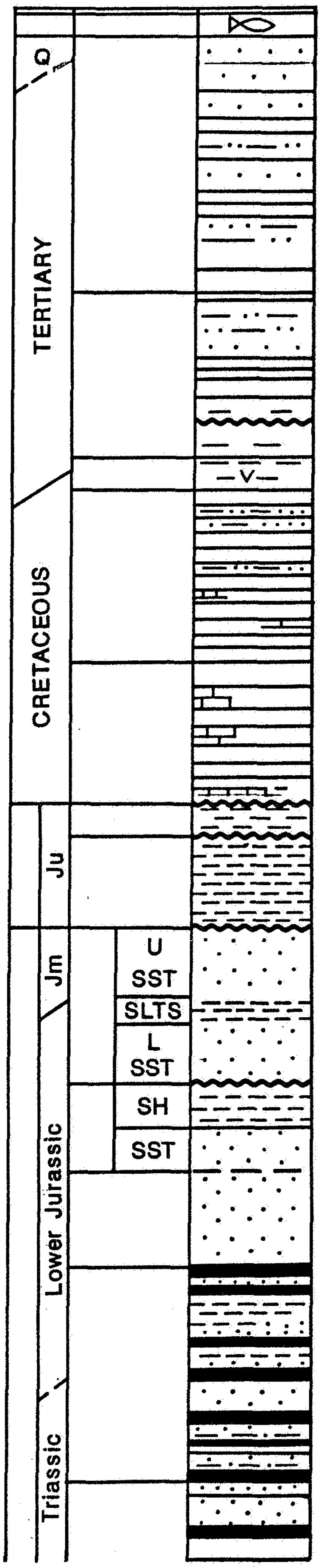
Figure 2 shows lithostratigraphic formation tops penetrated in this well.

Other general informations:

Casing:	30"	324m
	20"	430m
	13 3/8"	1391m
	9 5/8"	2460m
	7"	3083m

Mud additives: Gypsum polymer
Lignite from 9 5/8"

Lithostratigraphic formation tops, well 6407/6-3



MSL
Sea floor / Sula Group: 251mRKB

Skilnna Group / Korgen Formation: 1227mRKB
Narvik Formation: 1463mRKB

Skomvær Group / Alstadhaug Formation: 1915mRKB
Bodø Formation: 1977.5mRKB

Flatøy Group: 2069mRKB

Finnvær Group: 2415mRKB

Grip Group / Nesna Formation: 2445.5mRKB
Engelvær Formation: 2452mRKB

Halten Group / Tomma Formation I : 2462mRKB

Tomma Formation II :2493mRKB
Tomma Formation III :2549mRKB
Leka Formation I :2641mRKB
Leka Formation II: 2693mRKB
Leka Formation III :2700mRKB
Aldra Formation :2729mRKB

Hitra Formation :2906mRKB

(Triassic:3195mRKB?)

TD 3220mRKB

Fig. 2

Coring program:	Core no. 1:	2472 - 2491 m	
	" " 2:	2491 - 2509 m	
	" " 3:	2509.4 - 2522 m	
	" " 4:	2522 - 2545 m	
	" " 5:	2552 - 2566.2 m	
	" " 6:	2575 - 2584.5 m	
	" " 7:	2588 - 2615 m	

Test program: DST-1 (2570-77m): Oil and gas
DST-2 (2546-55m): Gas and condensate
DST-3 (2479-89m): Gas and condensate

Analytical program:
- Sample preparation
- Sample description
- TOC
- Rock-Eval
- Vitrinite reflectance
- Sporinite fluorescence
- Kerogen description and TAI
- Topping of oils at 210^{o}C
- Extraction
- Quantification and separation into SATS, ARO, NSO's and ASPH
- GC of SATS
- GC of ARO
- GC/MS biomarker analysis
- Carbon isotop analysis of SATS, ARO, NSO's, ASPH, extract, oil and kerogen
- Carbon isotope and composition analysis of gas
- Kerogen preparation

Lithological description of sediments used in this study is shown in Tables 1a, b and c.

3. INTERPRETATION LEVEL

3.1 Source rock richness and quality

	TOC (%)	S_2 mgHC/ g rock	C_{15+} HC (ppm)
Poor source rock	< 0.5	< 2	100
Fair source rock	0.5-1	2-3	100-250
Good source rock	1.0-3.0	3-5	250-500
Very good source rock	3.0-5.0	5-10	500-1000
Rich source rock	> 5.0	> 10	> 1000

3.2 Maturity related to kerogen type II

	% Ro	Tmax (°C)	SF*	TAI (Scale:1-10)
Immature	< 0.5	< 425	3,4	1.0-3.5
Early mature	0.5-0.7	425-435	5,6	3.5-4.5
Oil mature	0.7-1.0	435-460	7	4.5-7.0
Oil/condensate	1.0-1.3	>460	8,9	7.0-9.0
Wet gas	1.3-2.0		-	> 9.0
Dry gas	> 20		-	

* Sporite Fluorescence

3	yellow
4	yellow orange
5	light orange
6	mid orange
7	dark orange
8	orange red
9	orange red

4. SOURCE ROCK EVALUATION

4.1 TOC and Rock-eval (Table 2)

Sediments from the Cretaceous Flatøy and Finnvær Groups from 2413-2443 mRKB are characterised by low TOC-values (generally < 1 %). Hydrogen indices (HI) of 55 - 73 mg HC/gTOC mean a sedimentary organic matter classified as kerogen type IV. This in addition to low petroleum potential (PP: (S_1 + S_2) mg HC/g rock) rate these sediments as extremely poor source rocks.

Within the Upper Jurassic sediments of the Grip Group Nesna Formation a claystone sample at 2446 mRKB possess a TOC of 1.3%. A hydrogen index of 105 mg HC/g TOC combined with a low petroleum potential (1.5 mg HC/g rock) recognize this lithology as a poor source for minor gas.

A dark grey claystone at 2449 m RKB is typical of an immature Upper Jurassic Kimmeridge Clay equivalent source rock sample. The TOC content is 11.2%, and a hydrogen index of 380 mg HC/g TOC combined with a petroleum potential of 44.5 mg HC/g rock confirm the impression of a rich source rock with a kerogen type II/III. At appropriate levels of maturity this lithology has a generating potential for light oil/condensate.

A grey claystone sample at 2455m RKB within the Upper Jurassic Engelvær Formation is found to be very similar to the above Finnvær Group sediments with respect to source rock richness and quality, which are low.

Within the Middle Jurassic Tomma II a core ships at 2524.2 m contains a TOC of 7.8%. A petroleum potential of 16.4 mg HC/g rock combined with a hydrogen index of 171 mg HC/g TOC characterise this sample as a rich source rock for gas/condensate at appropriate levels of maturity.

Core chips from 2535.4-2543.78 m are recognized as very poor source rocks and comparable with the above Finnvær Group samples with respect to source richness and kerogen quality.

Possibly redeposited coal clasts within the core samples from the Tomma III at 2555.2 and 2555.68 m, respectively, are typical coals (kerogen type III) with TOC values of 52-57 %. Petroleum potentials of 142-160 mg HC/g rock and hydrogen indecies of 226-234 mg HC/g TOC recognize these coals as rich and prone for gas/condensate at appropriate levels og maturity.

Siltstone samples at 2578.22 and 2600.48 m are as poor source rocks as the above Finnvær Group sediments.

Hitra Formation coals from 2914-3154 m RKB are typical with TOC values in the range of 50-69% TOC. A petroleum potential from 113-172 mg HC/g rock combined with hydrogen index values ranging from 181-242 mg HC/g TOC classify the coals as rich and prone for gas/condensate at appropriate levels of maturity.

Grey siltstones at 2998 and 3055 m RKB, respectively, have TOC values of approx. 2 %. The petroleum potential of 5.2 mg HC/g rock and hydrogen index of 241 mg HC/g TOC characterize this lithology as good source rock for gas/condensate at appropriate levels og maturity.

A siltstone sample at 3121 m RKB possess no source rock potential.

4.2 Characterization of source rock extracts. (Table 3)

Core samples from 2535.4 and 2540.32 m within the Tomma II contain 446 and 403 ppm of EOM, of which 206 and 96 ppm are C_{15+} hydrocarbons. This rates the samples as fair and poor, respectively, with respect to source rock richness. Both samples contain large amounts of asphaltenes (47 and 53 %, respectively).

Hitra Formation coals contain from 19775 to 56326 ppm of EOM within the interval 2914 - 3193 m. The C_{15+} hydrocarbons within the same interval are 4711-11987 ppm. The coal samples also contain large portions of asphaltenes (43-61 % of EOM). Two grey siltstone samples at 2998 and 3055 m, respectively, contain 1428 and 1237 ppm of EOM which futhermore consist of 457 and 308 ppm of hydrocarbons. This rates these samples as good source rocks. The asphaltene content is 43 and 48% of the total EOM at the above respective depths.

4.3 Sataurate fraction gas chromatography (Table 4, figures 3a-l)

The saturate fraction chromatograms show immature extracts with characteristic high Pr/n-C_{17} ratios and high CPI values. The Pr/Ph ratios are also high for the present source rock samples with values from 7.1-10.8 for the Hitra Formation coals and from 3.3-4.5 for both the Tomma II and Hitra Formation grey siltstones/ claystones.

The data support a terrigenous relationship for the above samples, and also highly oxic conditions for the sedimentary conditions for the coals. Somewhat more reducing sedimentary conditions are shown for the siltstone/claystones.

4.4 Aromatic fraction gas chromatography (Figures 4a-l)

Dark grey siltstone and claystone samples at 2535.4 and 2540.32 m, respectively, within the Tomma II lack the presence of naphthalene. The lower alkyl substituted naphthalenes are present to various extent and generally in higher abundances in the former sample. The total amount of aromatics is about the same in both samples.

Coal extracts from the Hitra Formation are rich in aromatics even though the percentages of aromatic components related to the respective total EOM are very similar to both siltstone/claystone samples within this formation and to the above samples in the Tomma II. One striking feature is, however, seen in the aromatic chromatograms. The coals contain both naphthalene and methyl naphthalenes in addition to a rich varity of higher homologous compounds, phenanthrenes and dibenzothiophenes. All coal samples are similar with only minor differences in single component abundances. The siltstone/claystone samples are more similar to the above Tomma II samples where the lower members of the naphthalene family are more or less missing.

4.5 Biomarker distribution (Table 5a-c, Appendix A)

The 28,30 bisnorhopane is missing from the two Tomma II samples. Low Ts/Tm ratios may indicate typical terrigenous derived organic matter, but this ratio is also considered maturity related. A peak eluting between hopane and moretane is tentatively identified as a C_{30} hopene, and, furthermore, belived to be related to terrigenous organic matter. This is supported by a dominance of terpanes over steranes. The presence of rearranged steranes confirms the presence of acidic clay minerals in this section, in which also is shown a preponderance of C_{29} steranes over C_{27} and C_{28} steranes. This furtherly cupports a close terrigenous relationship for these samples.

The coal and siltstone/claystone samples from the Hitra Formation contain three major and dominant peaks in the hopane fragmentograms. Thus, Tm [17α(H)-22,29,30-trisnorhopane] is very often the most prominent peak. But as Ts [18α(H)- 22,29,30 - trisnorneohopane] in most cases is lacking, an indicative Ts/Tm ratio is not possible to calculate. However, the relationship with terrigenous material is obvious.

The other two major components in the samples are norhopane and hopane. The presence of 28,30-bisnorhopane in only some of the coals but **not in the** both siltstone/claystone samples may indicate facies variations within the sequence. All the samples contain the tentatively identified C_{30} hopene, a believed support for terrigenous organic matter. The hopanes strongly dominate over the steranes in the coal samples while the two biomarker groups are of similar abundance in the siltstone/claystone samples. This strongly supports a more marine type organic matter in the two latter samples. A further support for this is given by the relative distribution of C_{27}, C_{28} and C_{29} steranes. The coals show a very strong preponderance of C_{29} steranes over the other homologous component groups. The presence of rearranged steranes confirms a certain catalytic effect of the acidic siliciclastic sediment matrix for all the samples.

4.6 Carbon isotope composition (Table 6, figures 5a and b)

The isotopic composition of the total extracts and the respective fractions and kerogens the Tomma II and Hitra Formation samples are shown to be closely related to oxic deposited terrigenous organic matter. A large spread in $\delta^{13}C$ value between the different fractions reflect the low sediment maturity and also facies variations. Thus, a light saturate fraction signature is a low maturity indication. Through increased maturity an increasingly heavier saturate fraction will be generated from a kerogen sample. The kerogen signature will through increased maturity only become slightly heavier if at all possible to measure. Heavier kerogen and asphaltenes are recognized as reflecting oxic sedimentary conditions of terrigenous related organic matter.

5. MATURITY EVALUATION

5.1 Optical methods

5.1.1 Description of samples in reflected light

(Table 7, figure 6, Appendix B)

C-6735: S-2354 (2555.2 m)
Vitrinite Reflectance: 0.44%(29).
Sporinite Fluorescence: 4-6.

The samples consisted of sandstone chips with large coaly fragments. The fragments consisted largely of vitrinite, which could be sub-divided into a darker liptinite-rich varity comprising the groundmass, and a lighter, often patchy, band vitrinite. The latter type was selected for measurement. In ultra-violet light, most of the liptinitic material was very dully fluorescing, occasional brighter particles having a yellow/orange to medium orange fluorescence.

C-6736: S-2355 (2555.68 m)
Vitrinite Reflectance: 0.43%(27), 0.28%(2), 0.62%(1).
Sporinite Fluorescence: 4-6.

This sample was largely similar to that described above, although the coaly particles in this sample showed more evidence of weathering. The darker vitrinite type was more common in this sample.

C-6737: S-2367 (2914.0 m)
Vitrinite Reflectance: 0.48%(30).
Sporinite Fluorescence: 4-5.

The sample was a liptinite-rich, largely detrital coal. The abundant liptinite, consisting of sporinite, cutinite and resinite occurs in densely packed laminae. Intertinitic macerals tended to be restricted to individual rock chips where they often dominated the chip. Good band vitrinite particles (collinite) provided good reflectance values. Liptinite fluorescence colours varied from yellow-orange to light orange in ultra-violet light.

C-6738: S-2369 (2956 m)
Vitrinite Reflecetance: 0.56%(30).
Sporinite Fluorescence: 4-6.

This sample consisted of a mixed coal/carbonaceous claystone lithology in which inertinite and liptinite were quite common. The liptinite tended to be locallised in densly packed laminae, although a bitumenite groundmass was observed in some samples.

Telinitic structures could be observed in a number of vitrinite bands/particles. Some vitrinite showed evidence of weathering. It was noted that reflectance measurements taken on stringers next to inertinite tended to be higher than measurements taken on other vitrinite particles. The sample was similar to the previous samples when viewed in ultra-violet light.

C-6740: S-2371 (2983 m)
Vitrinite Reflectance: 0.53%(29).
Sporinite Fluorescence: 4-6.

The carbonaceous claystone lithology which comprised the major part of this sample contained abundant liptinite and common vitrinite stringers, the latter often displaying an undulose reflectance. Reflectance measurements on these stringers were avoided. Inertinitic macerals were locally abundant. The sample was similar to the previous sample when viewed in ultra-violet light.

C-6742: S-2373 (3028 m)
Vitrinite Reflectance: 0.53%(27), 0.82%(1).
Sporinite Fluorescence: 5-7.

This coal sample was similar in appearance to the coal described from sample C-6738 (S-2369) in both white and ultra-violet light.

C-6745: S-2375 (3100 m)
Vitrinite Reflectance: 0.57%(29), 0.81%(1).
Sporinite Fluorescence: 5-7.

This sample was characterised by a mixed claystone/-siltstone/coal lithology in which semi-fusinite and liptinite were the main macerals. Vitrinite occured in stringers and bands of rather variables quality. The sample is similar in appearance to the previous samples when viewed in ultra-violet light.

C-6746: S-2377 (3154 m)
Vitrinite Reflectance: 0.56%(28), 0.80%(1).
Sporinite Fluorescence: 5-7.

This samples was largely similar in appearance to the previous mixed lithology sample when viewed in both white and ultra-violet light. However, in this sample it was noted that reflectance measurements taken on vitrinite particles which showed evidence of weathering tended to be higher than those which did not. Measurements on these 'weathered' particles were avoided.

C-6748: S-2385 (506 m)
Vitrinite Reflectance: 0.56%(16), 0.91%(2).
Sporinite Fluorescence: 4?

This sample consisted of an organic-lean siltstone lithology containing only a few liptinite wisps and scattered vitrinite particles, a number of which were either reworked or stained. The vitrinite particles were mainly small and were often difficult to measure accurately. In ultra-violet light, only a few scattered particles of yellow cutinite and yellow/orange sporinite were observed.

C-6749: S-2389 (508 m)
Vitrinite Reflectance: 0.54%(15).
Sporinite Fluorescence: 4?

This sample was similar in appearance to the preceding sample when viewed in white and ultra-violet light.

The present analyses inidicate immature samples down to 2800+ m where the early mature stage for oil generation from a kerogen of type II starts. The mid maturity stage for oil generation (0.7-1.0 % Ro) is appearantly not reached before 3600 m and below the TD of this well.

5.1.2 Visual kerogen analysis and TAI

(Table 8)

The visual kerogen analyses mainly describe woody/coaly samples from Tomma II and Hitra Formations. The palynomorph preservation is recognised as fair to good and the level of maturity increases from 3.0-3.5 at 2555.2 m to 3.5-4.0 at 3154 m, using a scale from 1.0-10.0 for the TAI.

5.2 Rock-eval Tmax
(Table 2)

The Rock-eval Tmax is recorded at 420^{o}C for pyrolysis of a kerogen sample of type II at 2449 m, indicating immaturity at this depth. Coaly samples at 2555.2-.68 m are recorded at 423-425°C which also indicates immaturity for a kerogen of type II. Coaly samples from 2914 to 3193 m are recorded with pyrolysis Tmax values from 432-441°C. These values indicate the early mature stage for hydrocarbon generation from a kerogen of type III, while the oil maturity level for a kerogen of type II is just reached.

5.3 Biomarker analysis (Tables 5a-c, Appendix A)

Biomarker analyses of samples from the Tomma II and Hitra Formations show rather low maturity for the extracts. This interpretation is based both on the biomarker composition and on the generally used biomarker ratios for maturity. The presence of larger amounts of moretanes and tentatively of the relatively unstable hopenes support the low maturity impression. Due to interferences from hopanes in the sterane fragmentograms and possibly also interferance from $\beta\alpha\alpha$ steranes in the $\alpha\beta\beta$ steranes the normally used sterane ratios for maturity evaluations are not considered applicable in most of the presently analysed samples. The biomarker data indicate that a maturity level of just within the early mature zone for oil of a kerogen type II is reached at TD.

6. CONCLUSION ON SOURCE ROCK EVALUATION AND MATURITY

- Immature, poor source rocks characterise both the Cretaceons Flatøy and Finnvær Groups.

- Immature, rich dark grey claystones of the Upper Jurassic Nesna Formation contain kerogen of type II/III with potential for light oil/condensate.

- Immature, rich grey siltstones are encountered within the middle Jurassic Tomma II Formation. Terrigenous related organic matter classified as kerogen type III has source potential for gas/condensate.

- Coals within the Tomma III are immature but gas/condensate prone.

- Coals within the Hitra Formation are just within the early mature zone for oil, but has not generated any significant amounts of hydrocarbons yet. The coals have potential for gas/condensate. Grey siltstones within this formation are rich. A sligtly marine influenced kerogen of type III/II with potential for gas/condensate has not generated any significant amounts of hydrocarbon yet.

7. MIGRANT HYDROCARBON CHARACTERISATION AND CORRELATION

7.1 Reservoir sediments

7.1.1 Composition of extracts

(Table 9)

Tomma I sediments at 2473.39-2481.08 m are lean with only 320-570 ppm of total extracts (EOM) composed of 44-51 % hydrocarbons. The saturates make up 27-31 % and the nonhydrocarbon group consists of 21-37 % asphaltenes.

Tomma II sediments from 2499.75-2514.79 m are also lean, containing only 390-435 ppm of total EOM. The hydrocarbons make up 43-47 % of the total extracts of which 25-29 % are saturates. Of the nonhydrocarbon group, the asphaltenes make up 28-33 %.

In the Tomma III sediments at 2552.36 m contain approx. 355 ppm for EOM in average. The extract content increases through the sediment samples at 2560.10 and 2564.25 m to about 11534 and 11478 ppm at 2575.86 and 2578.89 m, respectively. Through the sediment sample at 2601.34 and an EOM of approx. 1043 ppm, the extract amounts decrease to about 344 ppm at 2604.80 and 134 ppm at 2614.68 m, respectively. There are also compositional variation within the Tomma III sediment extracts. The extracts from the interval 2552.36 to 2564.25 m contain 48-59 % hydrocarbons of which 28-32 % are saturates. The asphaltene content is 15-23 % of the EOM. From 2575.86 to 2601.34 m the extracts contain 80-81 %

hydrocarbons of which 41-56 % are saturates. The asphaltene content is found to have decreased to only 3-6 % of the EOM. At 2604.80 m the extract contains approx. 60 % hydrocarbons of which the saturates are found to make up for 40 %. The group of nonhydrocarbons consists of approx. 14 % asphaltenes of the total extract at this level.

With support in available test and Rock-eval data it is possible to speculate if there are lighter hydrocarbons (gas/condensate) within the Tomma I/II Formation down to 2524± m. This is thus consistant with having gas/condensate down to where the silt/shales in the Tomma II seal off this formation unit according to the well logs.

In the Tomma III unit a gas/condensate column is interpreted down to approx. 2564± m, and a heavier hydrocarbon column is indicated by the analytical results from the sample at 2575.86 m and down to somewhere between 2578.89 and 2601.34 m. This means that a GOC occurs between 2564.25 and 2575.86 m, and an OWC occurs some few meters shallower than 2601.34 m, with the hydrocarbon richest sediments found between the two contacts.

7.1.2 Saturate fraction gas chromatography

(Table 10, figures 7a-m)

Gas chroatographic analyses of the saturate extract fractions from the reservoir sands within the Tomma I, II and III reveal fair similarities between the samples. An unimodal distribution of n-paraffines smoothly distributed with a maximum at n-C_{16} characterises the Tomma I and II and also the shallowest Tomma III samples. Normal paraffins are seen up to n-C_{39}. From 2560.10 to 2578.89 m waxy components are clearly seen in the boiling range above n-C_{23} - n-C_{24} and up to n-C_{35}. Below 2601.34 m the chromatograms show a fairly narrow selection of n-paraffins from n-C_{13} to approx. n-C_{23} and also some residual waxy components.

All samples have Pr/Ph ratios below 1.5, Pr/n-C_{17} ratios within the range 0.6-0.8 and Ph/n-C_{18} ratios within the range 0.5-0.8. This indicates the presence of hydrocarbons generated in the transitional zone where organic matter from both marine and terrigenous sources mix under rather reducing sedimentary conditions. This is in contrast to shaly source rock sequences of early to middle Jurassic age and also to coals from the Hitra Formation, respectively, which all have much higher values for the Pr/Ph and Pr/n-C_{17}. The latter is interpreted as more terrigenous related organic matter deposited under oxic sedimentary conditions. The hydrocarbons from the source rock sequences are clearly of lower maturity than the reservoir sand hydrocarbons, which have CPI values close to 1.0.

7.1.3 Aromatic fraction gas chromatography

(Figures 8a-m)

The aromatic fraction from the reservoir sand extracts are chromatographic fairly similar showing an unresolved envelope under the alkylated naphthalenes and phenenthrenes. The samples are different to the above source rock aromatic fractions.

7.1.4 Biomarker distribution

(Table 11a-c, Appendix C)

The two Tomma I extracts contain normal distributions of terpanes but somewhat enhanced abundances of C_{23} - C_{26} tri- and tetracyclic terpanes and the presence of 28,30-bisnorhopane. The abundances of hopanes in the two sample are of the same order of magnitude as the sterane abundances. The assemblages of steranes and hopanes support the interpretation of a marine influenced siliciclastic source rock for the hydrocarbons despite the presence of 28,30 - bisnorhopane. The biomarker ratios for maturity show that the hydrocarbons were generated within the oil mature stage (> 0.7 % Ro) of the oil window.

The Tomma III extracts from 2499.75 to 2575.86 m are generally very similar with respect to abundances and distribution of steranes and hopanes. Thus, marine siliciclastic source rocks within the main oil generating phase of the oil window are invoked also for most of the Tomma III hydrocarbons. At 2578.89 m only trace of the 28,30 - bisnorhopane is present in the m/z 191 fragmentogram, and the C_{27} diasteranes are the most prominent components in the m/z 217 fragmentograms. Relative distribution of biomarkers still supports a source rock and a maturity level similar to the above Tomma II samples.

Two samples at 2601.34 and 2604.80 m, respectively, have more abundant C_{23}-C_{26} tri- and tetracyclic terpanes relatively to the hopanes. Among the hopanes the 28,30 -

bisnorhopane is present, and the hopane/moretane ratios support a higher level of maturity than implied from other hopane and sterane paramethers used for maturity evaluation. The steranes and hopanes are about equally abundant, and component distributions suggest a similar source facies as the above Tomme II samples. The maturity diversity and other compositional differences at this level may be related to lower extract amounts and a mixture of in situ and migrated residual biological markers in the water zone just below an interpreted OWC described above.

7.1.5 Carbon isotopic distribution

(Table 12, figures 5a, b)

The Tomma I reservoir rock extract saturate and aromatics show an isotopic signature relating the samples to mixed marine/terrigenous sources. The asphaltenes are, moreover, generally lighter (more negative) than the terrigenous asphaltenes from the present Hitra Formation coals and siltstone/claystones and also from the Tomma II silstone/claystones. This may imply a more reducing and marine sedimentary condition for the reservoir hydrocarbon source rocks.

The reservoir rock extracts from Tomma III are related to a marine nonwaxy source through the saturate and aromatic isotopic signatures. The asphaltenes of the respective Tomma III extracts relate these samples to more reducing and marine sedimentary conditions based on similarities with the above Tomma I samples.

7.2 DST samples

7.2.1 Whole oil characterization

(Table 9, figures 9a-c and 10a-c)

The whole oil chromatogram of the DST-1 (Tomma III: 2570-77 m) show a light oil, also confirmed by an API value of 42.5^{o}. The topped oil (C_{15+}) is 59.35 % of the whole oil. This fraction consists of 42 % saturates, 39.8 % aromatics, 17.4 % NSO's and only 0.8 % asphaltenes in average of duplicate analyses. The whole oil chromatograms of the DST-2 (Tomma III: 2546-55 m) and the DST-3 (Tomma I: 2479-89 m) show gas/ condensates, confirmed by API values of 57.4 and 58.9, respectively. The respective topped oils (C_{15+}) are 22.9 and 33.5 % of the whole oil samples and compositional anlyses show in average 58.3 and 47.0 % saturates, 23.8 and 22.3 % aromatics, 15.1 and 30.3 % NSO's and 0.9 and 0.5 % asphaltenes.

The whole oil chromatograms show close similarities within the C_2-C_8 hydrocarbon range of the three test samples.

7.2.2 Saturate fraction gas chromatography

(Table 10, figures 11a-c)

Gas chromatography show close relationships between the DST-2 and 3 C_{15+} saturate fractions and the C_{15+} fractions of Tomma I, II and the shallowest Tomma III reservoir samples above. The DST-1 sample is more waxy and similar to the deeper Tomma III extract samples within the predicted oil column.

7.2.3 Aromatic fraction gas chromatography

(Figures 12a-c)

The aromatic fraction chromatograms of all the three test samples are very similar and not to different to the reservoir rock extracts from the Tomma Formation above, particularly concerning the samples within the predicted oil column. Both alkylated naphthalenes and pheneanthrenes are distinctly seen above an UCM.

7.2.4 Biomarker composition

(Table 11a-c, Appendix D)

The DST-1 oil show a normal distribution of hopanes. Minor amounts of 28,30- bisnorhopane and moretanes are present in addition to a minor amount of the unidentified hopene, above. The hopanes are only 5 times as abundant as the sterens, which also show a normal distribution. The diasteranes (rearranged) link the DST-1 oil to siliciclastic source rocks and the C_{27}:C_{28}:C_{29} distribution of steranes indicates a marine source rock relationship, also supported by a tentative identification fo C_{30} steranes in minor amounts. The biomarker parameters for maturity evaluation indicate a source rock maturity within the main oil generating zone of the oil window.

Both DST-2 and 3 are gas/condensates and the biomarker analyses may therefore be somewhat uncertain due to possible extraction of sedimentary biomarkers during migration and from the reservoir rocks to originally biomarker lean samples. However, a tentative interpretation indicate a slightly more terrigenous input to possible source rocks for these condensates than for the oil, still with a dominance of the marine contribution. An impression of higher abundances of tri- and tetracyclic terpanes compared to the hopanes may be the result of effects as mentioned above. The biomarker data indicate, furthermore, a siliciclastic source rock for the gas/condensates and a maturity level somewhat higher than for the DST-1 oil, still within the main oil generating zone of the oil window.

7.2.5 Carbon isotop distribution

(Table 12, figures 5a and b)

The DST-1 oil saturate and aromatic C_{15+} fractions show an isotopic signature relating the hydrocarbons to a marine source. Similar considerations relate DST-2 and 3 gas/condensates to mixed marine/terrigenous organic source matter. The asphaltenes from the three test samples are generally isotopic lighter than asphaltenes from the present Hitra Formation coals and siltstone/claystones and also from the Tomma II siltstone/claystones. Thus, a more marine/reducing sedimentary condition is invoked for the source of the test samples as it is for the reservoir extracts above.

8. CONCLUSION OF MIGRANT HYDROCARBON EVALUATION AND CORRELATION

- A tentative base for the gas/condensate in Tomma I is found at approx. 2524± m within the upper part of Tomma II.

- A tentative GOC is found between 2564.25 and 2575.86 m within Tomma III.

- A tentative OWC is found between 2578.89 and 2601.34 m within Tomma III.

- The DST-1 (oil), 2 and 3 (gas/condensates) are mainly generated from mixed marine/terrigenous source facies with a more marine dominance for the oil. The hydrocarbons were generated at maturity levels within the main oil generating zone of the oil window "off structure". The condensates are somewhat more mature than the oil.

9. HEADSPACE GAS COMPOSITION AND ISOTOPICAL SIGNATURE (TABLE 13 AND 14)

The present results show that there is a fair similarity between the isotopic signature of the wet gas components of the headspace gases from the Engelvær and Tomma I Formations (2452-2498 m RKB) and the Tomma I DST-3 gas previously reported [see: Report on stable isotopes ($\delta^{13}C$, δD, $\delta^{18}O$) on natural gases from well 6407/6-3. IFE 1987]. There are, however, compositional differences and also inter sample differences with respect to $\delta^{13}C$ of methane.

The Nesna Formation headspace gas sample is both compositionally and isotopically different to the Engelvær and Tomma I Formation gases and the DST-3 test gas.

This is interpreted as an indication of gas from the Tomma I reservoir gas/condensate penetration the Engelvær but not the Nesna Formation, which is through a denser lithology a better cap rock.

T A B L E S

Table 1 a.

WELL no.: 6407/6-3 Cuttings, Wet samples.

LITHOLOGIC DESCRIPTION: Picked matr: ________

Sample no.	Depth mRKB	TOC	Lithology — Rock name, mod. lith, colour, grain size, sorting, roundness, matrix, cementation, hardness, accessories, fossils, porosity, contamination
S2358	2413		80% Claystone, light grey to grey occ. brownish, mod. hard.
			20% Sandstone, quartz, fine, well sorted.
			Tr. Dolomite, glauconite, mica, kaolinite.
S2359	2419		85% Claystone, as above. (grey).
			15% Sandstone, as above.
			Tr. Dolomite, glauconite, mica, pyrite.
S2360	2428		70% Claystone, light grey to grey, mod. hard.
		?	20% Limestone, calcareous, reddish brown.
			10% Sandstone, as above.
			Tr. Dolomite, glauconite, mica, pyrite, quartz.
S2361	2431		65% Claystone as above (grey).
		?	25% Limestone as above.
			10% Sandstone as above.
			Tr. Dolomite, mica pyrite, quartz, kaolinite.
S2362	2440		60% Claystone as above (grey)
		?	30% Limestone as above.
			10% Sandstone as above.
			Tr. Kaolinite.

Sample no.	Depth mRKB	TOC	Lithology — Rock name, mod. lith, colour, grain size, sorting, roundness, matrix, cementation, hardness, accessories, fossils, porosity, contamination
S2363	2443		55% Claystone, light grey to dark grey,
			mod. hard.
		?	35% Limestone as above.
			10% Sandstone as above.
			Tr. Kaolinite, mica, pyrite, glanconite.
S2364	2446		50% Claystone, light grey to dark grey,
			occ. greenish, moc. hard.
			40% Limestone, calcareous, reddish brown,
			occ. white to light grey.
			10% Sandstone as above.
			Tr. Pyrite, quartz.
S2365	2449		75% Claystone, as above (dark grey)
			15% Limestone as above.
			10% Sandstone as above.
			Tr. Pyrite, quartz, carbonaceous shale.
S2366	2455		70% Claystone as above (grey)
			25% Limestone as above.
			5% Sandstone as above.
			Tr. Pyrite, quartz.

Sample no.	Depth mRKB	TOC	Lithology — Rock name, mod. lith, colour, grain size, sorting, roundness, matrix, cementation, hardness, accessories, fossils, porosity, contamination
S2367	2914		60% Coal - carbonaceous shale.
			30% Sandstone, quartz, clear to milky white,
			fine to coase, mod. sorted.
			5% Cemented sandstone, calcareous, very
			fine.
			5% Siltstone, brownish grey, micro-
			micaceous.
			Tr. Mica.
S2368	2926		40% Coal - carbonaceous shale.
			35% Sandstone as above.
			15% Cemented sandstone as above.
			10% Siltstone as above.
			Tr. Mica.
S2369	2956		70% Coal - carbonaceous shale.
			30% Sandstone as above.
			Tr. Cemented sandstone, siltstone, mica.
S2370	2965		85% Coal - carbonaceous shale.
			15% Sandstone as above.
			Tr. Cemented sandstone, siltstone mica.

Sample no.	Depth mRKB	TOC	Lithology (Rock name, mod. lith, colour, grain size, sorting, roundness, matrix, cementation, hardness, accessories, fossils, porosity, contamination)
S2371	2983		70% Carbonaceous shale - coal.
			15% Sandstone as above.
			15% Siltstone, grey to brownish grey,
			micro-micaceous.
			Tr. Cemented sandstone, mica.
S2372	2998		25% Carbonaceous shale - coal.
			15% Sandstone as above.
			50% Siltstone, grey to dark grey, and
			brownish grey, occ. light greenish
			grey, micro-micaceous.
			10% Cemendted sandstone, carbonaceous.
			Tr. Mica, pyrite.
S2373	3028		55% Carbonaceous shale - coal.
			20% Sandstone as above.
			20% Siltstone as above.
			5% Cemented sandstone as above.
			Tr. Mica.
S2374	3055	A	40% Carbonaceous shale - coal.
			20% Sandstone as above.
		B	35% Siltstone as above (grey).
			5% Cemented sandstone.
			Tr. Mica.

Sample no.	Depth mRKB	TOC	Lithology — Rock name, mod. lith, colour, grain size, sorting, roundness, matrix, cementation, hardness, accessories, fossils, porosity, contamination
S2375	3100		65% Carbonaceous shale - coal.
			15% Sandstone as above.
			15% Siltstone as above.
			5% Cemented sandstone.
			Tr. Mica.
S2376	3121		20% Shale, dark grey, mod. hard (carbonaceous)
			10% Sandstone.
			65% Siltstone.
			5% Cemented sandstone.
			Tr. Mica.
S2377	3154		65% Carbonaceous shale - coal.
			15% Sandstone as above.
			10% Siltstone as above.
			10% Cemented sandstone.
			Tr. Mica.
S2378	3193		50% Carbonaceous shale (-coal)
			15% Sandstone as above.
			10% Siltstone as above.
			25% Cemented sandstone as above.
			Tr. Mica.

Table 1b.

WELL no.: 6407/6-3

Sample no.	Depth mRKB	TOC	Lithology — Rock name, mod. lith, colour, grain size, sorting, roundness, matrix, cementation, hardness, accessories, fossils, porosity, contamination
S2350	2540.20		Siltstone,sst, parallell-laminated, light grey, mica.
S2351	2535.40		Siltstone, laminated, mainly dark grey, mica.
S2352	2540.32		Claystone, silty, laminated, mainly dark grey, mica.
S2353	2543.78		Claystone, silty, shaly, dark grey mica.
S2354	2555.20		Sandstone, fine, coaly. (Difficult to separate the coal from the sand physically)
S2355	2555.68		As S2354.
S2356	2578.22		Siltstone, parallell laminated, light grey - grey, mica.
S2357	2600.48		Siltstone, grey, mica.

Table 1c.

WELL no.: 6407/6-3

Sample no.	Depth mRKB	TOC	Lithology — Rock name, mod. lith, colour, grain size, sorting, roundness, matrix, cementation, hardness, accessories, fossils, porosity, contamination
S2337	2473.39		Light to medium grey, med. to coase,
			friable to mod. hard. (HC smell).
S2338	2481.08		As above.
S2339	2499.75		Grey, mod.hard, fine sst.
S2340	2506.59		As above. (HC smell).
S2341	2552.36		As above.
S2342	2552.36		Brownish grey, mod. hard, coase. (HC smell)
S2343	2560.10		Grey, mod. hard, med. to coase laminated
			with siltstone (not included in crushed
			material).
S2344	2564.25		Laminated with siltstone.
			Sst: Grey, mod. hard fine.
			Siltst: Brownish grey, micaceous.
S2345	2575.86		(Brownish) grey, mod. hard, fine.
			(Siltstone laminated) (HC smell).
S2346	2578.89		Brownish grey, mod. hard, fine (HC smell).
S2347	2601.34		Brownish grey, mod. hard, med coase to
			coase (HC smell).
S2348	2604.80		Grey, mod. hard, coarse.
S2349	2614.68		Grey mod. hard, med. to coarse, micaceous.

6407/6-3

Table 2. TOC and Rock-Eval data

Snr. Statoil	Depth	Sample Type	S_1 mg HC / g rock	S_2 mg HC / g rock	Tmax (°C)	HI mg HC / g TOC	PP mg HC / g rock	GP mg HC / g TOC	PI	TOC %
2358	2413	Ctgs	0.08	0.60	430	65.93	0.68	74.73	0.12	0.91
2359	2419	-:-	0.08	0.54	433	58.70	0.62	67.39	0.13	0.92
2360	2428	-:-	0.11	0.57	429	64.77	0.68	77.27	0.16	0.88
2361	2431	-:-	0.06	0.48	428	54.55	0.54	61.36	0.11	0.88
2362	2440	-:-	0.09	0.51	432	57.30	0.60	67.42	0.15	0.89
2363	2443	-:-	0.12	1.58	437	72.48	1.70	77.98	0.07	2.18
2364	2446	-:-	0.12	1.39	433	104.51	1.51	113.53	0.08	1.33
2365	2449	-:-	1.89	42.60	420	380.36	44.49	397.23	0.04	11.20
2366	2455	-:-	0.09	0.47	433	47.47	0.56	56.57	0.16	0.99
2350	2524.2	Core	3 02	13.38	431	171.32	16.40	209.99	0.18	7.81
2351	2535.4	-:-	0.16	0.79	443	53.74	0.95	64.63	0.17	1.47
2352	2540.32	-:-	0.14	0.89	440	54.60	1.03	63.19	0.14	1.63
2353	2543.78	-:-	0.08	0.65	438	83.33	0.73	93.59	0.11	0.78
2354	2555.2	-:-	22.72	119.30	425	225.99	142.02	269.03	0.16	52.79
2355	2555.68	-:-	26.76	134.10	423	234.40	160.86	281.17	0.17	57.21
2356	2578.22	-:-	0.24	0.82	440	81.19	1.06	104.95	0.23	1.01
2357	2600.48	-:-	0.10	1.05	439	111.70	1.15	122.34	0.09	0.94
2367	2914	Ctgs	9.58	155.97	441	227.49	165.55	241.47	0.06	68.56
2368	2926	-:-	5.73	128.57	438	236.39	134.30	246.92	0.04	54.39
2369	2956	-:-	7.75	164.40	439	236.89	172.15	248.05	0.05	69.40
2370	2965	-:-	6.53	131.05	435	191.68	137.58	201.23	0.05	68.37
2371	2983	-:-	4.93	108.01	441	181.10	112.94	189.37	0.04	59.64
2372	2998	-:-	0.27	4.98	432	240.58	5.25	253.62	0.05	2.07
2373	3028	-:-	4.69	115.85	435	200.22	120.54	208.33	0.04	57.86

6407/6-3

TOC and Rock-Eval data

Snr. Statoil	Depth	Sample Type	S_1 mg HC / g rock	S_2 mg HC / g rock	Tmax (°C)	HI mg HC / g TOC	PP mg HC / g rock	GP mg HC / g TOC	PI	TOC %
2374	3055	ctgs a,	5.16	126.51	436	229.90	131.67	239.27	0.04	55.03
-:-	-:-	-:- b,	0.23	4.93	435	241.67	5.16	252.94	0.04	2.04
2375	3100	-:-	7.53	119.29	439	238.39	126.82	253.44	0.06	50.04
2376	3121	-:-	0.03	0.31	440	48.44	0.34	53.13	0.09	0.64
2377	3154	-:-	8.31	114.04	441	225.60	122.35	242.04	0.07	50.55
2378	3193	-:-	4.42	71.93	441	209.34	76.35	222.21	0.06	34.36

Table 3.

Extract data from source rock samples, well 6407/6-3

Sample No.	Depth (m)	Formation	EOM ppm	SAT ppm (%)	ARO ppm (%)	NSO ppm (%)	ASPH ppm (%)
S-2351	2535.40[1)]	Tomma II	446	120 (27.0)	86 (19.3)	30 (6.7)	209 (47.0)
S-2352	2540.32[1)]	-:-	403	29 (7.2)	66 (16.4)	95 (23.6)	212 (52.7)
S-2367	2914	Hitra	41182	857 (2.1)	9196 (22.3)	7133 (17.3)	24001 (58.3)
S-2369	2956	-:-	36200	1705 (4.7)	7081 (19.6)	7128 (19.7)	20286 (56.0)
S-2370	2965	-:-	30138	1486 (4.9)	6073 (20.2)	6223 (20.6)	16356 (54.3)
S-2371	2983	-:-	22650	827 (3.7)	3884 (17.1)	4578 (20.2)	13361 (59.0)
S-2372	2998	-:-	1428	146 (10.2)	311 (21.8)	356 (24.9)	615 (43.1)
S-2373	3028	-:-	31167	1106 (3.5)	5965 (19.1)	5785 (18.6)	18314 (58.8)
S-2374 A	3055	-:-	35216	1303 (3.7)	7054 (20.0)	6353 (18.0)	20506 (58.2)

X PC

X D

Extract data from source rock samples, well 6407/6-3

Sample No.	Depth (m)	Formation	EOM ppm	SAT ppm (%)	ARO ppm (%)	NSO ppm (%)	ASPH ppm (%)
S-2374 B	-:-	-:-	1237	106 (8.6)	202 (16.3)	336 (27.2)	593 (47.9)
S-2377	3154	-:-	56326	1769 (3.1)	10218 (18.1)	10263 (18.2)	34077 (60.5)
S-2378	3193	-:-	19775	722 (3.7)	4042 (20.4)	3546 (17.9)	11464 (58.0)

X DC

1) Core depth

Table 4

Chromatographic data from source rock samples, well 6407/6-3

Samples No.	Depth (m)	Formation	Pr/Ph	$Pr/n\text{-}C_{17}$ (A)	$Ph/n\text{-}C_{18}$ (B)	A/B	CPI 1	CPI 2	C_{17}/C_{27}
S-2351	2535.40[1]	Tomma II	3.93	1.70	0.49	3.79	1.47	1.29	1.81
S-2352	2540.32[1]	-:-	4.48	1.34	0.29	4.67	1.83	1.83	0.56
S-2367	2914	Hitra	7.21	2.58	0.37	7.05	1.52	1.44	0.45
S-2369	2956	-:-	10.23	3.98	0.38	10.60	1.44	1.55	0.60
S-2370	2965	-:-	10.81	3.87	0.34	11.36	1.31	1.41	0.60
S-2371	2983	-:-	9.43	2.80	0.29	9.60	1.41	1.43	0.80
S-2372	2998	-:-	3.31	1.42	0.51	2.81	1.47	1.56	1.04
S-2373	3028	-:-	8.61	3.62	0.43	8.39	1.35	1.49	0.70
S-2374 A	3055	-:-	8.59	4.38	0.52	8.50	1.35	1.51	0.61
S-2374 B	-:-	-:-	3.41	1.47	0.56	2.62	1.61	1.76	1.50
S-2377	3154	-:-	8.09	7.02	0.91	7.76	1.25	1.38	0.61

Chromatographic data from source rock samples, well 6407/6-3

Samples No.	Depth (m)	Formation	Pr/Ph	$Pr/n-C_{17}$ (A)	$Ph/n-C_{18}$ (B)	A/B	CPI 1	CPI 2	C_{17}/C_{27}
S-2378	3193	-:-	7.59	5.84	0.74	7.88	1.15	1.41	0.61

1) Core depth

Table 5a: Molecular ratios from sterane and terpane mass chromatograms. Maturity ratios.

IKU code	Statoil no.	$\alpha\beta/\alpha\beta+\beta\alpha$ 1)	%22S 2)	%$\beta\beta$ 3)	%20S 4)
Source rocks					
C 6721	S 2351 I	0.77	52.7	54.9	16.2
C 6722	S 2352 I	0.76	54.7	36.0	13.8
C 6723	S 2367 I	0.76	61.3	59.0	32.0
C 6724	S 2369 I	0.72	59.6	47.3	36.6
C 6725	S 2370 I	0.68	55.5	38.7	36.8
C 6726	S 2371 I	0.73	60.1	37.9	33.3
C 6727	S 2372 I	0.81	56.3	37.9	24.8
C 6728	S 2373 I	0.75	60.0	41.0	39.5
C 6729	S 2374 AI	0.75	60.6	42.9	40.7
C 6730	S 2374 BI	0.79	55.0	36.1	20.5
C 6731	S 2377 I	0.76	60.8	44.4	41.7
C 6732	S 2378 I	0.70	57.7	40.5	37.3

1) E/E+F in m/z 191
2) Average % distribution between first and second eluting isomers of extended hopanes (G-M in m/z 191)
3) 2(r+s)/q+t+2(r+s)) in m/z 217
4) q/q+t in m/z 217

Table 5b: Molecular ratios from terpane and sterane mass chromatograms. Maturity and source characteristic ratios.

IKU code	Statoil no.	Q/E[1]	Tm/Ts[2]	X/E[3]	Z/E[4]	a/a+j[5]
Source rocks						
C 6721	S 2351 I	-	22.3	0.03	-	0.43
C 6722	S 2352 I	-	-	0.03	-	0.32
C 6723	S 2367 I	-	-	0.08	0.15	0.34
C 6724	S 2369 I	-	-	0.06	-	0.50
C 6725	S 2370 I	-	-	0.04	-	0.56
C 6726	S 2371 I	-	-	0.02	-	0.43
C 6727	S 2372 I	0.08	7.8	0.08	0.08	0.51
C 6728	S 2373 I	-	-	0.06	-	0.73
C 6729	S 2374 AI	-	-	0.06	-	0.54
C 6730	S 2374 BI	0.09	8.1	0.08	0.24	0.52
C 6731	S 2377 I	-	14.1	0.05	0.09	0.60
C 6732	S 2378 I	0.04	-	0.07	0.05	0.67

1) Relative abundance of tricyclic terpanes (Q/E in m/z 191)
2) B/A in m/z 191
3) Relative abundance of unknown (X/E in m/z 191)
4) Relative abundance of bisnorhopane (Z/E in m/z 191)
5) Relative abundance of C27 rearranged steranes (a/a+j in m/z 217)

Table 5 c: Biomarker ratios for source and maturity. Source rocks.

Sample No.	Depth (m)	Formation	Tt/X 1)	C/E	m/z 191 G/J_1	Z 2)	Mor. 3)	m/z 217, 218, 259 C_{27}:C_{28}:C_{29} 4)	C_{30} 5)	Dia 6)
S-2351	2535.4	Tomma II	11.5	0.65	6.25	-	+	25:25:50	-	+
S-2352	2540.32	-:-	10.3	0.62	10.0	-	+	22:28:50	-	+
S-2367	2914	Hitra	20.6	0.97	3.64	+	+	5:34:61	-	+
S-2369	2956	-:-	13.6	1.11	3.65	-	+	5:36:59	-	+
S-2370	2965	-:-	8.6	1.03	2.19	-	+	9:36:55	-	+
S-2371	2983	-:-	5.0	1.04	5.1	-	+	5:27:68	-	+
S-2372	2998	-:-	25.0	0.79	5.9	+	+	42:27:31	-	+
S-2373	3028	-:-	13.2	1.12	3.5	-	+	13:33:54	-	+
S-2374 A	3055	-:-	13.0	1.29	4.0	-	+	10:34:56	-	+
S-2374 B	-:-	-:-	22.9	0.83	5.19	+	+	43:27:30	-	+
S-2377	3154	-:-	13.3	1.32	2.86	+	+	11:35:54	-	+
S-2378	3193	-:-	17.1	1.14	1.85	+	+	16:38:46	-	+

1) $\frac{X}{X+D}$ in m/z 191

2) Bisnorhopane ($C_{28}H_{48}$)

3) 17β(H), 21α(H)- Hopanes

4) C_{27}, C_{28}, C_{29} diasteranes in m/z 259
(C_{27}, C_{28}, C_{29} ββ-steranes in m/z 218)

5) C_{30} Steranes

6) Diasteranes in m/z 259

Table 6

Isotope data from source rock samples, extracts and fractions, well 6407/6-3

Sample No.	IFE No.	IKU	Depth (m)	Formation	$\delta^{13}C_{PDB}$ Total EOM	SAT	ARO	NSO	ASPH	Kerogen
S-2351	6973 6913	C-6633	2535.4 [1)]	Tomma II	-27.8	-30.9	-25.8	-26.8	-26.2	-24.3
S-2352	6914	-	2540.32 [1)]	-:-	-26.9	-28.9	-26.2	-27.9	-26.0	- -
S-2367	6974 6915	C-6737	2914	Hitra	-26.4	-29.0	-27.2	-26.6	-25.7	-26.0
S-2369	6975 6916	C-6738	2956	-:-	-26.2	-28.2	-26.3	-26.2	-25.7	-25.5
S-2370	6976 6917	C-6739	2965	-:-	-25.6	-28.1	-26.7	-26.1	-25.1	-24.9
S-2371	6977 6918	C-6740	2983	-:-	-26.2	-28.6	-26.4	-26.4	-26.1	-25.3
S-2372	6978 6919	C-6741	2998	-:-	-28.9	-30.3	-29.1	-28.8	-27.8	-27.8
S-2373	6979 6920	C-6742	3028	-:-	-26.6	-29.2	-26.9	-26.7	-25.7	-26.0
S-2374A	6980 6921	C-6743	3055	-:-	-26.8	-29.3	-27.0	-26.5	-26.3	-26.0
S-2374B	6981 6922	C-6744	-:-	-:-	-28.9	-31.5	-29.1	-29.1	-28.2	-27.2

Isotope data from source rock samples, extracts and fractions, well 6407/6-3

					$\delta^{13}C_{PDB}$					
Sample No.	IFE No.	IKU	Depth (m)	Formation	Total EOM	SAT	ARO	NSO	ASPH	Kerogen
S-2377	6982 6923	C-6746	3154	-:-	-28.7	-31.4	-28.7	-27.8	-28.0	-27.8
S-2378	6983 6924	C-6747	3193	-:-	-28.1	-32.7	-28.7	-28.1	-27.5	-27.8

1) Core depth

Well number:6407/6-3
Reference number:22.1875
(1/1)

Table 7:

VITRINITE REFLECTANCE DATA

IKU NO	LOCATION	DEPTH (M)	VITRINITE REFLECTANCE	REL RAT	STANDARD DEVIATION	FLUORE-SCENCE
C-6735	S-2354	2555.20	0.44 (29)	G	0.06	4-6
C-6736	S-2355	2555.68	0.43 (27)	G	0.05	4-6
			0.28 (2)	S	0.01	
			0.62 (1)	R	0.00	
C-6737	S-2367	2914	0.48 (30)	G	0.06	4-5
C-6738	S-2369	2956	0.56 (30)	G	0.06	4-6
C-6740	S-2371	2983	0.53 (29)	F	0.09	4-6
C-6742	S-2373	3028	0.53 (27)	F	0.09	5-7
			0.82 (1)	R	0.00	
C-6745	S-2375	3100	0.57 (29)	G	0.07	5-7
			0.81 (1)	R	0.00	
C-6746	S-2377	3154	0.56 (28)	G	0.06	5-7
			0.80 (1)	R	0.00	
C-6748	S-2385	506	0.56 (16)	F	0.10	4?*
			0.91 (2)	R	0.08	
C-6749	S-2389	508	0.54 (15)	F	0.09	4?*

REL RAT (Reliability Rating): G = Good; F = Fair; P = Poor
S = Stained; R = Reworked.

*: Fluorescence colour obtained on cutinite.
(Sample identifications are detailled in appendix 1).

IKU SINTEF-GRUPPEN

Visual Kerogen Analysis

Table no.: 8
Well no.: 6407/6-3

Sample	Depth (m)	Composition of residue	Particle size	Preservation palynomorphs	Thermal maturation index *)	Remarks
C6735	S 2354 2555.20m	Am: <5% Lm: <5% w+c: >95%	F-M-L	Good	? 3.0-3.5	Organic residue is totally dominated by dark brown to black (mostly elongated, "bladeshaped") woody phytoclasts; together with black coaly fragments and terrestrial palynomorphs.
C6736	S 2355 2555.68m	Am: <5% Lm: <5% w+c: >95%	F-M-L	Good	? 3.0-3.5	As sample C6735, but with both terrestrial and marine palynomorphs recorded.
C6737	S 2367 2914m	Am: + Lm: + w+c: >95%	(F)-M-L	No palynomorphs recorded	NDP	As sample C6735, but rounded black woody/coaly fragments are more common.
C6738	S 2369 2956m	Am: 5% Lm: 5% w+c: 90%	F-M-L	Fair	? 3.0-3.5	As sample C6737, but with a slightly increased proportion of amorphous (? degraded woody) and liptinitic (palynomorphs) material.

Abbreviations

Am Amorphous
Al Algal material
Lm Liptinitic material
W Woody material
C Coaly fragments
F Fine
M Medium
L Large

*) NEWTAI, Scale: 1.0 - 10.0

ORG/E/lso/1

IKU SINTEF-GRUPPEN

Visual Kerogen Analysis

Table no.: 8
Well no.: 6407/6-3

Sample	Depth (m)	Composition of residue	Particle size	Preservation palynomorphs	Thermal maturation index *)	Remarks
C6740	S 2371 2983m	Am: 5-10% Lm: 5% w+c: 85-90%	F-M-L	Fair	? 3.0-3.5	As sample C6738
C6742	S 2373 3028m	Am: 5% Lm: 5% w+c: 90%	F-M-L	Fair	? 3.0-3.5	As sample C6738
C6745	S 2375 3100m	Am: 5% Lm: 5% w+c: 90%	F-M-L	Fair	3.5-4.0 ?	As above
C6746	S 2377 3154m	Am: 5% Lm: 5% w+c: 90%	F-M-L	Fair	3.5-4.0 ?	Organic residue totally dominated by black (mostly rounded) woody/coaly fragments, together with degraded phytoclasts of woody origin.

Abbreviations

Am **Amorphous**
Al **Algal material**
Lm **Liptinitic material**
W **Woody material**
C **Coaly fragments**
F **Fine**
M **Medium**
L **Large**

*) NEWTAI, Scale: 1.0 - 10.0

ORG/E/lso/2

IKU SINTEF-GRUPPEN

Visual Kerogen Analysis

Table no.: 8
Well no.: 6407/6-3

Sample	Depth (m)	Composition of residue	Particle size	Preservation palynomorphs	Thermal maturation index *)	Remarks
C6748	S 2385 506m	Am: <90% Lm: >5% w: >5% c: >5%	F-M	Fair	3.0-3.5	Organic residue totally dominated by speckled ? amorphous matter, i.e. sapropel containing? small black woody/coaly fragments, and pyrite framboids. Both terrestrial and marine palynomorphs recorded.
C6749	S 2389 508m	Am: <90% Lm: <5% w: >5% c: 5%	F-M-L	Fair	3.0-3.5	As sample C6748.

Abbreviations

Am	**Amorphous**	**Al**	**Algal material**	**W**	**Woody material**	**F**	**Fine**
		Lm	**Liptinitic material**	**C**	**Coaly fragments**	**M**	**Medium**
						L	**Large**

*) NEWTAI, Scale: 1.0 - 10.0

ORG/E/lso/3

Table 9

Composition of reservoir sediment extracts and oils, well 6407/6-3

Sample No.	Depth[2] (m)	Formation	EOM[1] ppm	SAT[1] ppm (%)	ARO[1] ppm (%)	NSO[1] ppm (%)	ASPH[1] ppm (%)
S-2337	2473.39	Tomma I	573/305	112/106 (19.5/34.8)	72/65 (12.5/21.3)	86/71 (15.0/23.3)	304/63 (53.0/20.7)
S-2338	2481.08	-:-	315/328	98/104 (31.1/31.7)	54/71 (17.1/21.6)	96/86 (30.5/26.2)	67/67 (21.3/20.4)
S-2339	2499.75	Tomma II	411/435	111/99 (27.0/22.8)	75/79 (18.2/18.2)	118/83 (28.7/19.1)	107/174 (26.0/40.0)
S-2340	2506.59	-:-	412/-	-	-	-	-
S-2341	2514.79	-:-	393/392	103/120 (26.3/30.6)	63/81 (16.1/20.7)	112/90 (28.6/23.0)	114/101 (29.1/25.8)
S-2342	2552.36	Tomma III	385/325	113/87 (29.4/26.7)	84/62 (21.8/19.0)	116/90 (30.1/27.6)	72/87 (18.7/26.7)
S-2343	2560.10	-:-	553/618	162/211 (29.3/34.2)	155/160 (28.0/25.9)	155/151 (28.0/24.5)	81/95 (14.6/15.4)
S-2344	2564.25	-:-	1286/1215	341/371 (26.5/30.5)	402/331 (31.3/27.2)	302/289 (23.5/23.8)	240/224 (18.7/18.4)

Composition of reservoir sediment extracts and oils, well 6407/6-3

Sample No.	Depth[2] (m) [API value]	Formation	EOM[1] ppm C_{15+}[3] (%)	SAT[1] ppm (%)	ARO[1] ppm (%)	NSO[1] ppm (%)	ASPH[1] ppm (%)
S-2345	2575.86	Tomma III	11565/11504	4706/5033 (40.7/43.8)	4798/4015 (41.5/34.9)	1631/2007 (14.1/17.4)	430/449 (3.7/3.9)
S-2346	2578.89	-:-	11405/11551	4622/4811 (40.5/41.7)	4752/4292 (41.7/37.2)	1599/2146 (14.0/18.6)	431/300 (3.8/2.6)
S-2347	2601.34	-:-	1241/845	-/471 (-/55.8)	-/201 (-/23.8)	-/120 (-/14.2)	107/52 (-/6.2)
S-2348	2604.80	-:-	384/305	153/122 (39.7/40.0)	86/53 (22.3/17.4)	94/88 (24.4/28.9)	52/42 (13.5/13.8)
S-2349	2614.68	-:-	150/119	-	-	-	-
S-2077 (DST-1)	2570-77 [42.5°]	Tomma III	(59.35)	- (39.24/44.94) 42,09	- (40.36/39.16) 39,76	- (20.18/14.53) 17,36	- (0.23/1.37) 0,80
S-2078 (DST-2)	2546-55 [57.4°]	Tomma III	(22.92)	- (56.49/60.02) 58,26	- (24.05/23.47) 23,76	- (18.56/11.69) 15,13	- (0.90/0.82) 0,86
S-2079 (DST-3)	2479-89 [58,9°]	Tomma I	(33.50)	- (36.20/57.71) 46,96	- (19.30/25.31) 22,31	- (44.13/16.44) 30,29	- (0.38/0.54) 0,46

1) Two sets of analysis performed
2) Core depth
3) Only one result pr. sample

Table 10

Chromatographic data of reservoir sediment extracts and oils, well 6407/6-3

Sample No.	Depth[2] (m)	Formation	$Pr/_{Ph}$[2]	$Pr/n-C_{17}$[2] (A)	$Ph/n-C_{18}$[2] (B)	$A/_B$[2]	CPI 1[2]	CPI 2[2]	C_{17}/C_{27}[2]
S-2337	2471.39	Tomma I	1.28/1.22	0.79/0.81	0.74/0.75	1.07/1.08	1.0/1.05	0.95/0.92	7.30/7.13
S-2338	2381.08	-:-	1.33/1.27	0.79/0.79	0.73/0.73	1.08/1.08	1.0/1.01	0.94/0.92	7.64/7.27
S-2339	2499.75	Tomma II	1.28/1.22	0.78/0.78	0.72/0.72	1.08/1.08	1.0/1.03	0.92/1.00	7.11/5.25
S-2340	2506.59	-:-	1.31	0.79	0.74	1.07	0.96	0.91	8.19
S-2341	2514.79	-:-	1.35	0.79	0.73	1.09	1.01	0.97	8.20
S-2342	2552.36	Tomma III	1.40	0.83	0.72	1.14	1.04	0.98	7.30
S-2343	2560.10	-:-	1.35	0.82	0.72	1.14	1.01	0.98	4.09
S-2344	2564.25	-:-	1.42	0.80	0.70	1.13	0.99	1.00	3.58
S-2345	2575.86	-:-	1.32	0.76	0.69	1.11	1.0	0.99	2.93
S-2346	2578.89	-:-	1.21	0.79	0.71	1.12	1.02	1.00	2.71
S-2347	2601.34	-:-	1.44	0.56	0.48	1.17	ND	ND	ND

Chromatographic data of reservoir sediment extracts and oils, well 6407/6-3

Sample No.	Depth[2)] (m) [API value]	Formation	$Pr/_{Ph}$ [2)]	$Pr/n\text{-}C_{17}$ [2)] (A)	$Ph/n\text{-}C_{18}$ [2)] (B)	$A/_B$ [2)]	CPI 1[2)]	CPI 2[2)]	C_{17}/C_{27} [2)]
S-2348	2604.80	Tomma III	1.49	0.57	0.47	1.22	0.99	0.83	15.33
S-2349	2614.68	Tomma III	1.19	0.65	0.51	1.26	1.12	1.04	13.23
S-2077 (DST-1)	2570-77 [42.5°]	Tomma III	1.32	0.75	0.69	1.12	0.99	0.94	5.19
S-2078 (DST-2)	2546-55 [57.4°]	Tomma III	1.46	0.82	0.72	1.14	0.99	0.96	10.14
S-2079 (DST-3)	2479-89 [58.9°]	Tomma I	1.43	0.79	0.72	1.10	0.95	0.87	13.20

1) Core depth

2) Two sets of analyses for samples S-2337 to S-2339

ND Not calculated

Table 11a: Molecular ratios from terpane and sterane mass chromatograms. Maturity and source characteristic ratios.

IKU code	Statoil no	Q/E[1]	Tm/Ts[2]	X/E[3]	Z/E[4]	a/a+j[5]
Sandstones						
C 6710	S 2337	0.30	1.44	0.04	0.10	0.91
C 6711	S 2338	0.27	1.27	0.04	0.09	0.88
C 6712	S 2339	0.20	1.40	0.04	0.08	0.85
C 6713	S 2341	0.30	1.38	0.04	0.11	0.87
C 6714	S 2342	0.29	1.33	0.05	0.08	0.84
C 6715	S 2343	0.36	1.39	0.06	0.08	0.87
C 6716	S 2344	0.12	1.56	0.04	0.06	0.89
C 6717	S 2345	0.23	1.53	0.05	0.08	0.88
C 6718	S 2346	0.20	1.10	0.05	0.03	0.97
C 6719	S 2347	0.62	0.92	0.03	0.12	0.86
C 6720	S 2348	1.33	1.12	-	-	0.88
Oil samples						
C 6707	S 2077, DST 1	0.07	2.27	0.04	0.03	0.87
C 6708	S 2078, DST 2	0.64	1.06	-	0.09	0.92
C 6709	S 2079, DST 3	1.07	1.21	-	0.06	0.94

1) Relative abundance of tricyclic terpanes (Q/E in m/z 191)
2) B/A in m/z 191
3) Relative abundance of unknown (X/E in m/z 191)
4) Relative abundance of bisnorhopane (Z/E in m/z 191)
5) Relative abundance of C27 rearranged steranes (a/a+j in m/z 217)

Table 11b: Molecular ratios from sterane and terpane mass chromatograms.
Maturity ratios.

IKU code	Statoil no.	$\alpha\beta/\alpha\beta+\beta\alpha$[1]	%22S[2]	%$\beta\beta$[3]	%20S[4]
Sandstones					
C 6710	S 2337	0.97	63.5	80.3	52.0
C 6711	S 2338	0.96	61.8	80.2	51.1
C 6712	S 2339	0.97	64.2	78.7	53.5
C 6713	S 2341	0.97	63.3	79.2	52.4
C 6714	S 2342	0.96	57.4	77.7	44.4
C 6715	S 2343	0.97	64.3	78.4	50.0
C 6716	S 2344	0.98	63.7	76.8	50.0
C 6717	S 2345	0.98	62.2	78.6	54.8
C 6718	S 2346	0.98	64.0	-	-
C 6719	S 2347	0.96	40.3	80.0	46.3
C 6720	S 2348	0.95	38.9	73.2	45.5
Oil samples					
C 6707	S 2077, DST 1	0.94	61.5	76.8	43.0
C 6708	S 2078, DST 2	0.96	65.4	77.2	46.2
C 6709	S 2079, DST 3	-	56.8	78.1	55.6

1) E/E+F in m/z 191
2) Average % distribution between first and second eluting iosmers of extended hopanes (G-M in m/z 191)
3) 2(r+s)/(q+t+2(r+s)) in m/z 217
4) q/q+t in m/z 217

Table 11c:

Biomarker ratios for source and maturity. Reservoir rocks and test samples.

Sample No.	Depth (m)	Formation	Tt/X[1)]	C/E	m/z 191			m/z 217, 218, 259		
					G/J_1	Z[2)]	Mor.[3)]	$C_{27}:C_{28}:C_{29}$[4)]	C_{30}[5)]	Dia[6)]
S-2337	2473.39	Tomma I	53.3	9.90	3.77	+	+	41:34:25 (40:30:30)	+	+
S-2338	2481.08	-:-	57.1	0.65	3.33	+	+	43:33:24 (41:29:30)	+	+
S-2339	2499.75	Tomma III	57.1	0.60	3.83	+	+	41:34:25 (39:30:31)	+	+
S-2341	2514.79	-:-	50.0	0.67	3.33	+	+	41:35:24 (44:30:26)	+	+
S-2342	2552.36	-:-	58.8	0.66	3.06	+	+	39:34:27 (42:31:27)	+	+
S-2343	2560.10	-:-	60.0	0.69	3.19	+	+	40:34:26 (45:30:25)	+	+
S-2344	2564.25	-:-	57.1	0.80	4.40	+	+	35:40:25 (55:26:19)	+	+
S-2345	2575.86	-:-	62.5	0.65	3.33	+	+	39:36:25 (50:31:19)	+	+
S-2346	2578.89	-:-	60.0	0.62	2.12	+	+	72:20:8 (60:16:24)	+	+
S-2347	2601.34	-:-	28.6	0.65	3.14	+	+	44:32:24 (48:26:26)	+	+
S-2348	2604.80	-:-	33.3	0.82	3.75	+	+	46:35:19 (42:37:19)	+	+

Biomarker ratios for source and maturity. Reservoir rocks and test samples.

Sample No.	Depth (m)	Formation	Tt/X[1]	C/E	m/z 191 G/J_1	Z[2]	Mor.[3]	m/z 217, 218, 259 $C_{27}:C_{28}:C_{29}$[4]	C_{30}[5]	Dia[6]
S-2077 (DST-1)	2570-77	Tomma III	44.4	0.48	2.26	+	+	39:33:28 (35:31:34)	+	+
S-2078 (DST-2)	2546-55	-:-	57.1	0.54	2.78	+	+	44:31:25 (52:25:23)	+	+
S-2079 (DST-3)	2479-89	Tomma I	54.5	0.45	2.50	+	+	53:28:19 (48:30:22)	+	+

1) $\frac{X}{X+D}$ in m/z 191

2) Bisnorhopane ($C_{28}H_{48}$)

3) 17β(H), 21α(H) - Hopanes (traces)

4) C_{27}, C_{28}, C_{29} Diasteranes in m/z 259
(C-27, C_{28}, C_{29} ββ-steranes in m/z 218

5) C_{30} Steranes

6) Diasteranes in m/z 259

Table 12

Isotope data from reservoir sediment extracts and oils and their fractions, well 6407/6-3

Sample No.	IFE No.	Depth[1] (m)	Formation	$\delta^{13}C_{PDB}$ Total EOM	SAT	ARO	NSO	ASPH
S-2337	6899	2473.39	Tomma I	-29.3	-29.9		-28.5	-28.6
S-2338	6900	2481.08	-:-	-29.3	-29.9	-28.6	-28.8	-28.6
S-2339	6901	2499.75	Tomma III	-29.2	-29.8		-29.2	-28.5
S-2341	6902	2514.79	-:-	-29.2	-29.9		-28.9	-28.9
S-2342	6903	2552.36	-:-	-29.2	-29.6		-28.9	-28.4
S-2343	6904	2560.10	-:-	-29.6	-29.7		-29.2	-28.7
S-2344	6905	2564.25	-:-	-29.2	-29.8	-28.8	-28.9	-28.0
S-2345	6906	2575.86	-:-	-29.4	-29.7	-29.0	-29.3	-29.3
S-2346	6907	2578.89	-:-	-29.5	-29.8	-29.5	-29.3	-29.4
S-2647	6908	2601.34	-:-	-29.5	-29.9	-28.8		-28.1
S-2648	6909	2604.80	-:-	-29.3	-29.9		-29.2	-28.2
S-2077 (DST-1)	6910	2570-77	-:-	-29.4 2)	-29.7	-29.2	-29.1	-29.0
S-2078 (DST-2)	6911	2546-55	-:-	-29.3 2)	-29.4	-28.2	-28.5	-29.0
S-2079 (DST-3)	6912	2479-89	Tomma I	-29.2 2)	-29.3	-28.0	-27.8	-28.1

1) Core depth

2) Whole oil

Table 13: Isotopic composition of headspace gas, well 6407/6-3

Sample depth	IFE no.	C_1 $\delta^{13}C$	C_2 $\delta^{13}C$	C_3 $\delta^{13}C$	iC_4 $\delta^{13}C$	nC_4 $\delta^{13}C$
2443-52 m	6968	-29.5	-26.7	-28.4	-29.0	-29.8
2452-61 m	6969	-46.4	-31.3	-30.6	-29.9	-30.6
2461-70 m	6970	-39.2	-30.9	-29.3	-28.9	-30.4
2471-80 m	6971	-35.5				
2489-98 m	6972	-23.9	-30.2	-30.0	-29.3	-30.1

Table 14: Normalised composition of headspace gas relatively to air, well 6407/6-3

Sample depth	IFE no.	C_1 %	C_2 %	C_3 %	iC_4 %	nC_4 %	Wetness	$\frac{iC_4}{nC_4}$
2443-52 m	6968	43.10	18.97	24.57	4.31	9.05	0.57	0.48
2452-61 m	6969	50.34	17.79	20.81	3.69	7.38	0.50	0.50
2461-70 m	6970	51.72	14.78	19.21	4.68	9.61	0.48	0.49
2471-80 m	6971	62.50	3.13	12.50	6.25	15.63	0.38	0.40
2489-98 m	6972	58.35	11.27	18.71	3.82	7.85	0.42	0.49

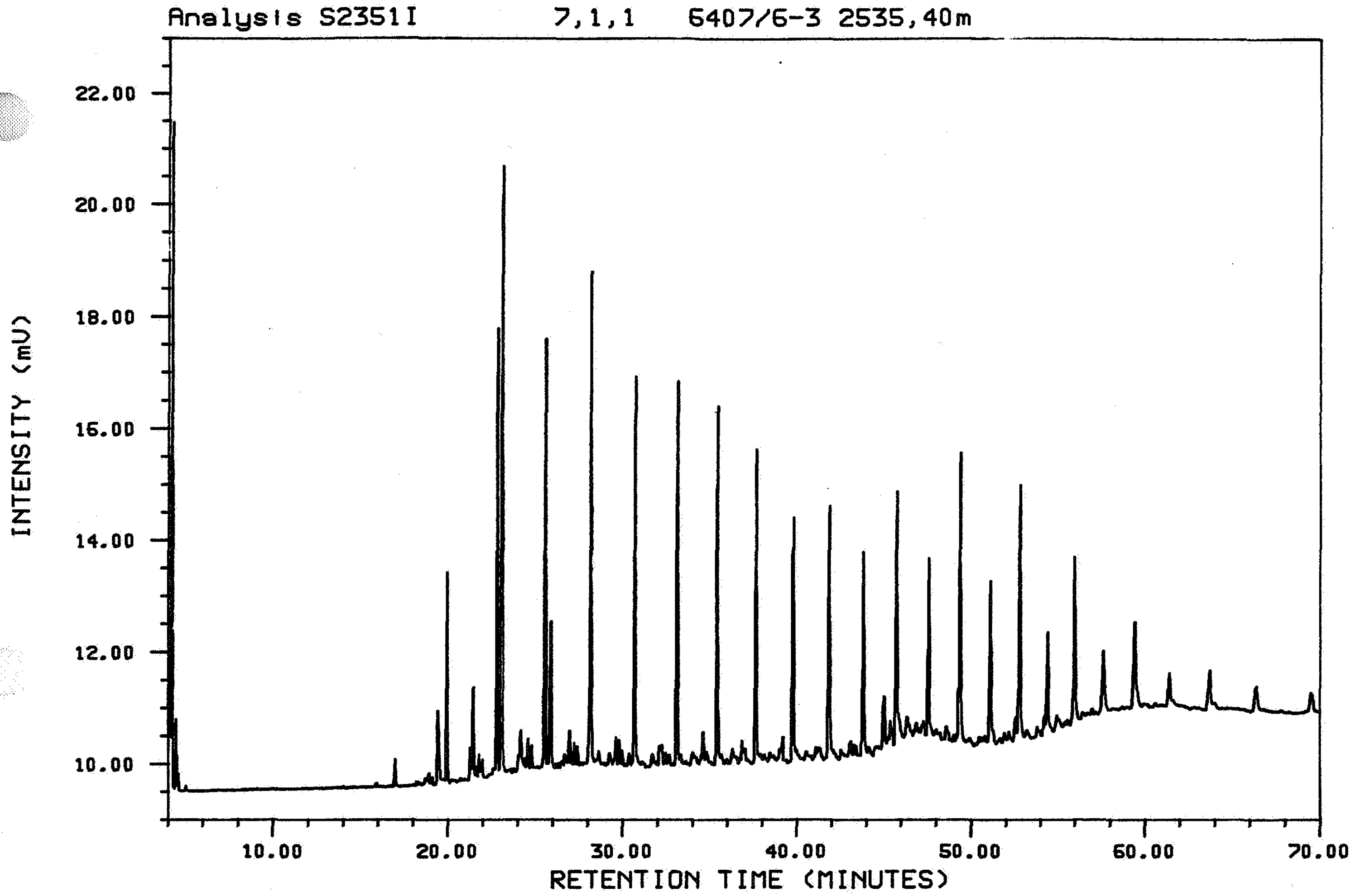
F I G U R E S

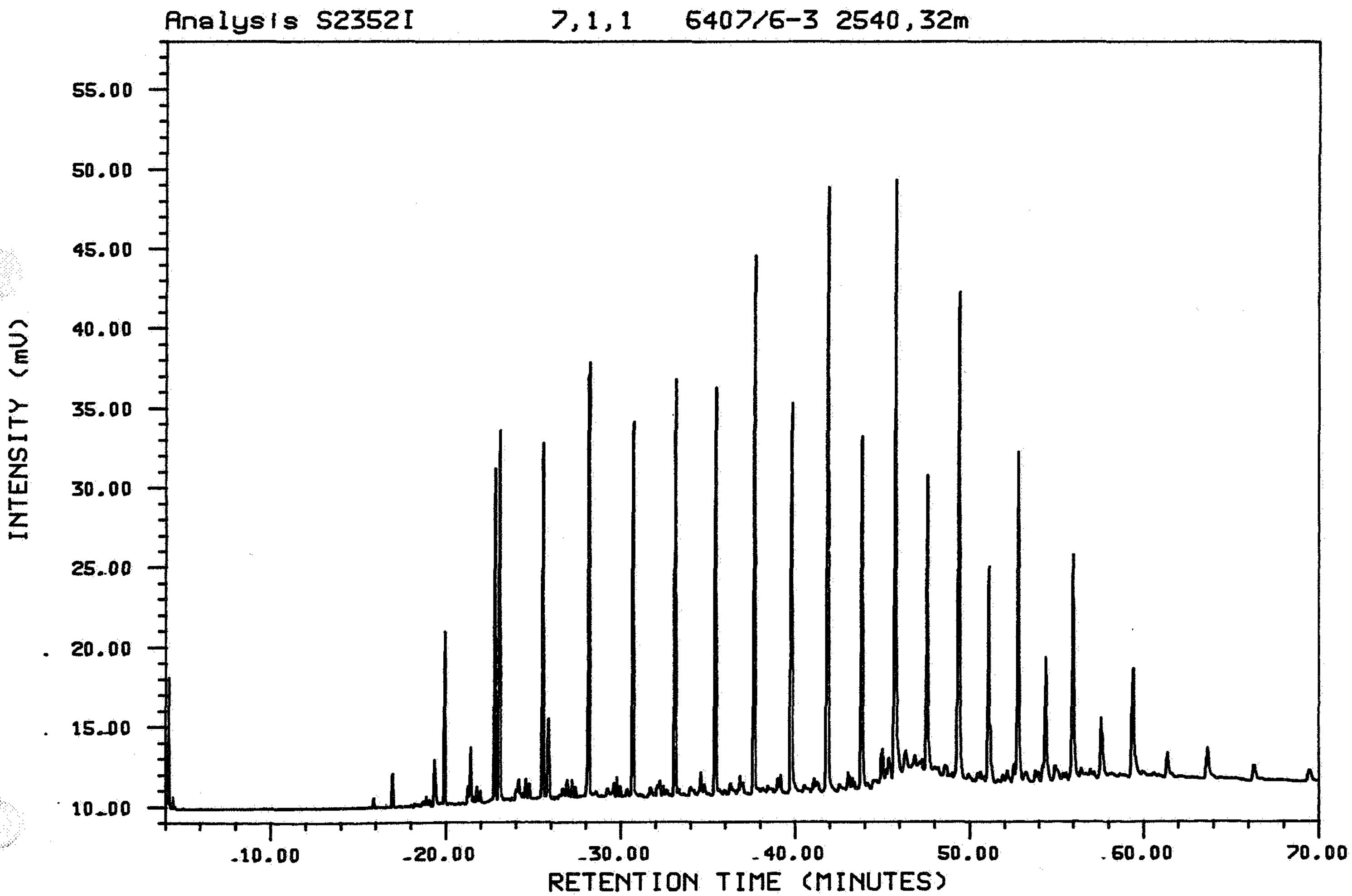
(Figures 3-12)

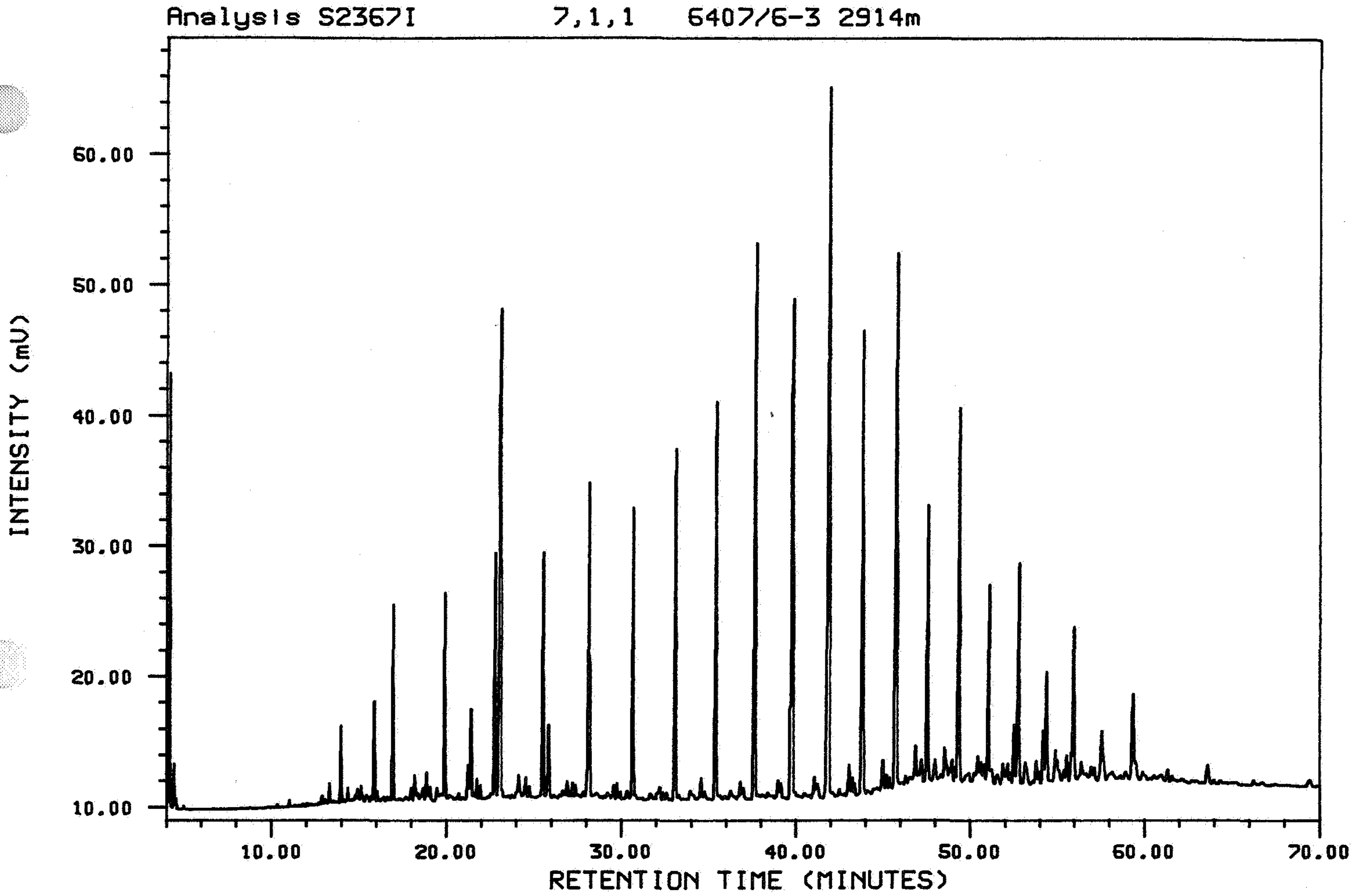
Figure 3a-1

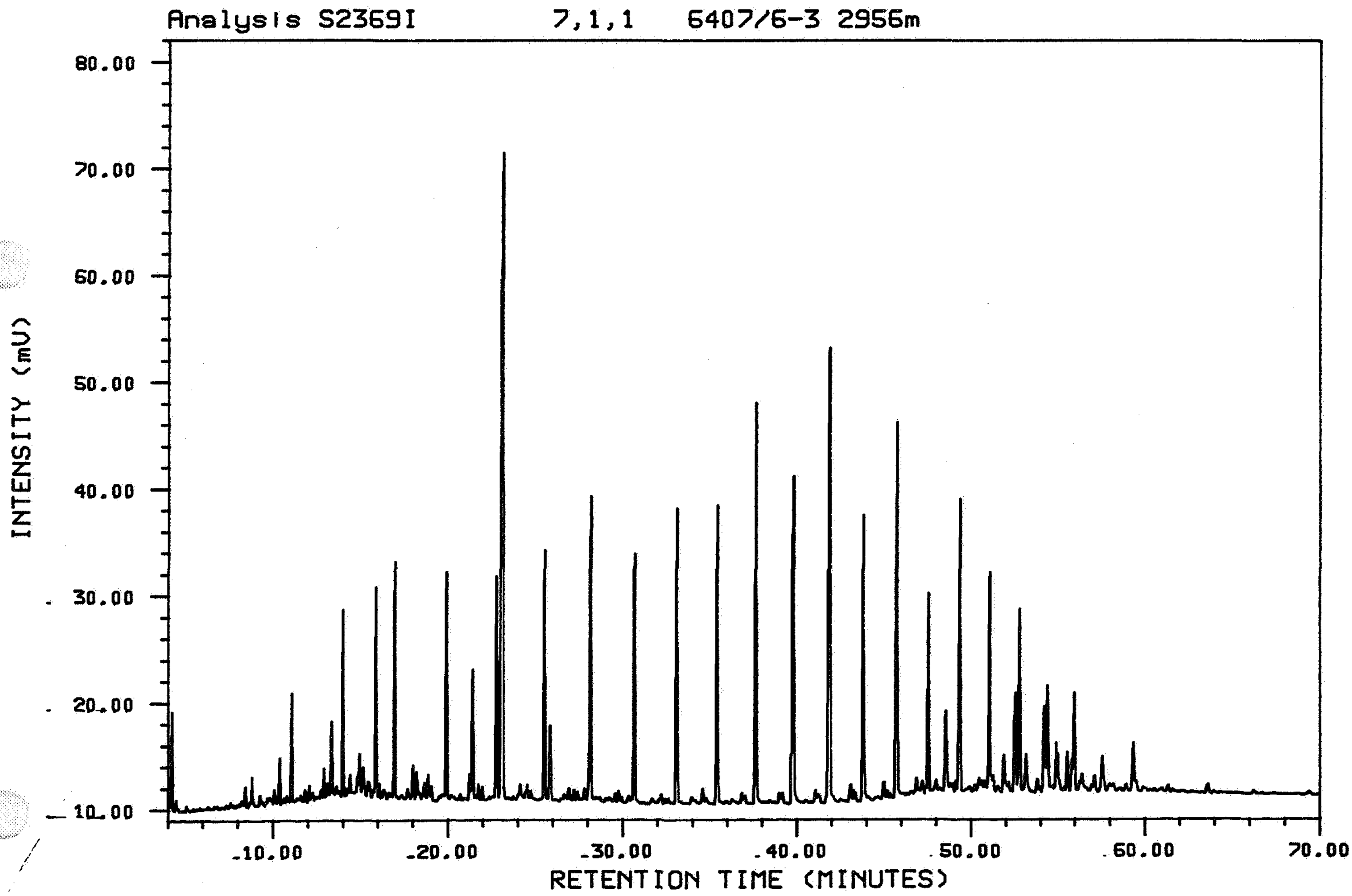
Gas chromotograms, C_{15+}

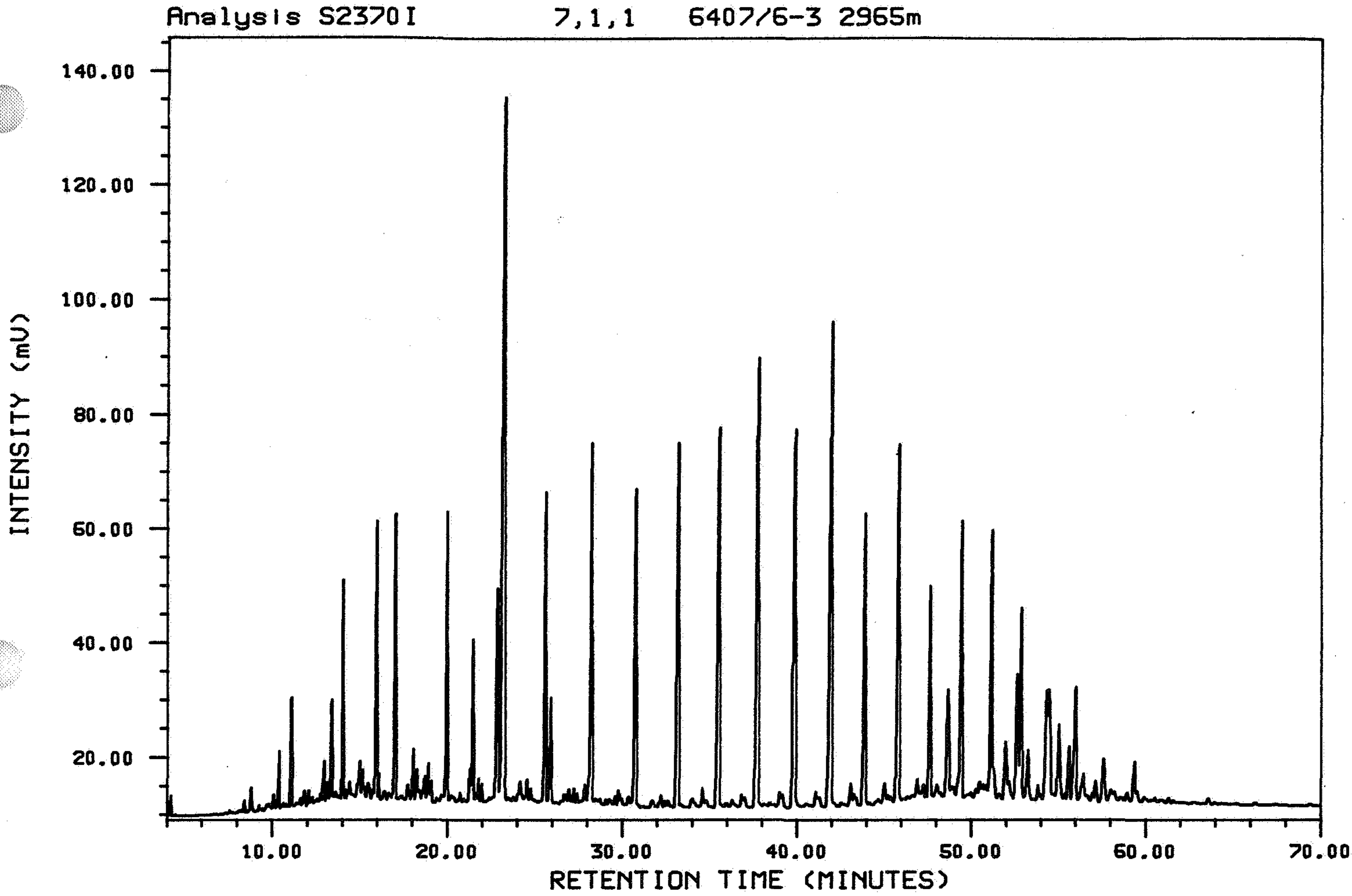
SAT fraction, source rock samples


Analysis S2351I 7,1,1 6407/6-3 2535,40m
INTENSITY (mV)
22.00
20.00
18.00
16.00
14.00
12.00
10.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
RETENTION TIME (MINUTES)

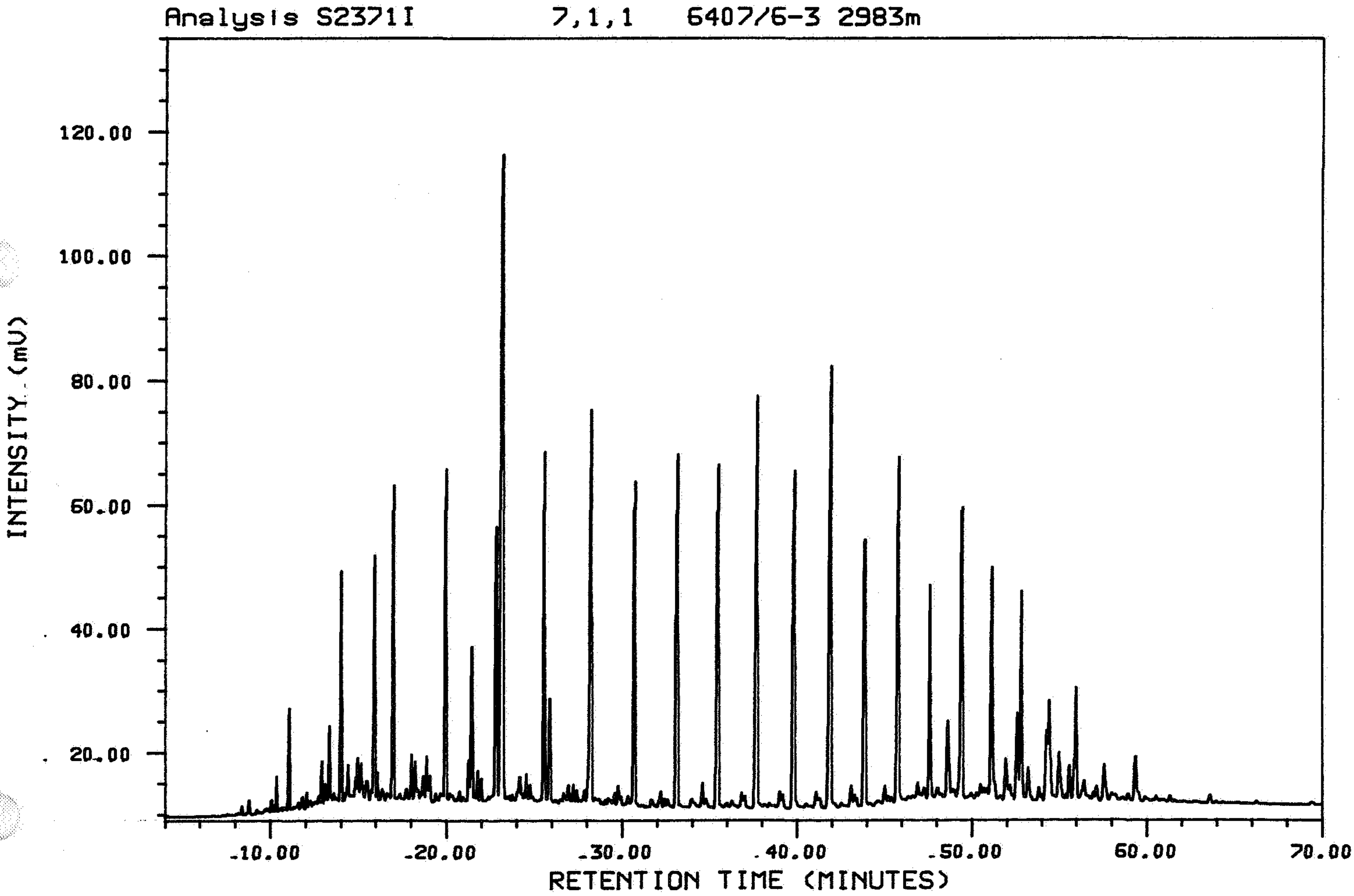

Analysis S2352I 7,1,1 6407/6-3 2540,32m
INTENSITY (mV)
55.00
50.00
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
RETENTION TIME (MINUTES)


Analysis S2367I 7,1,1 6407/6-3 2914m
INTENSITY (mV)
60.00
50.00
40.00
30.00
20.00
10.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
RETENTION TIME (MINUTES)

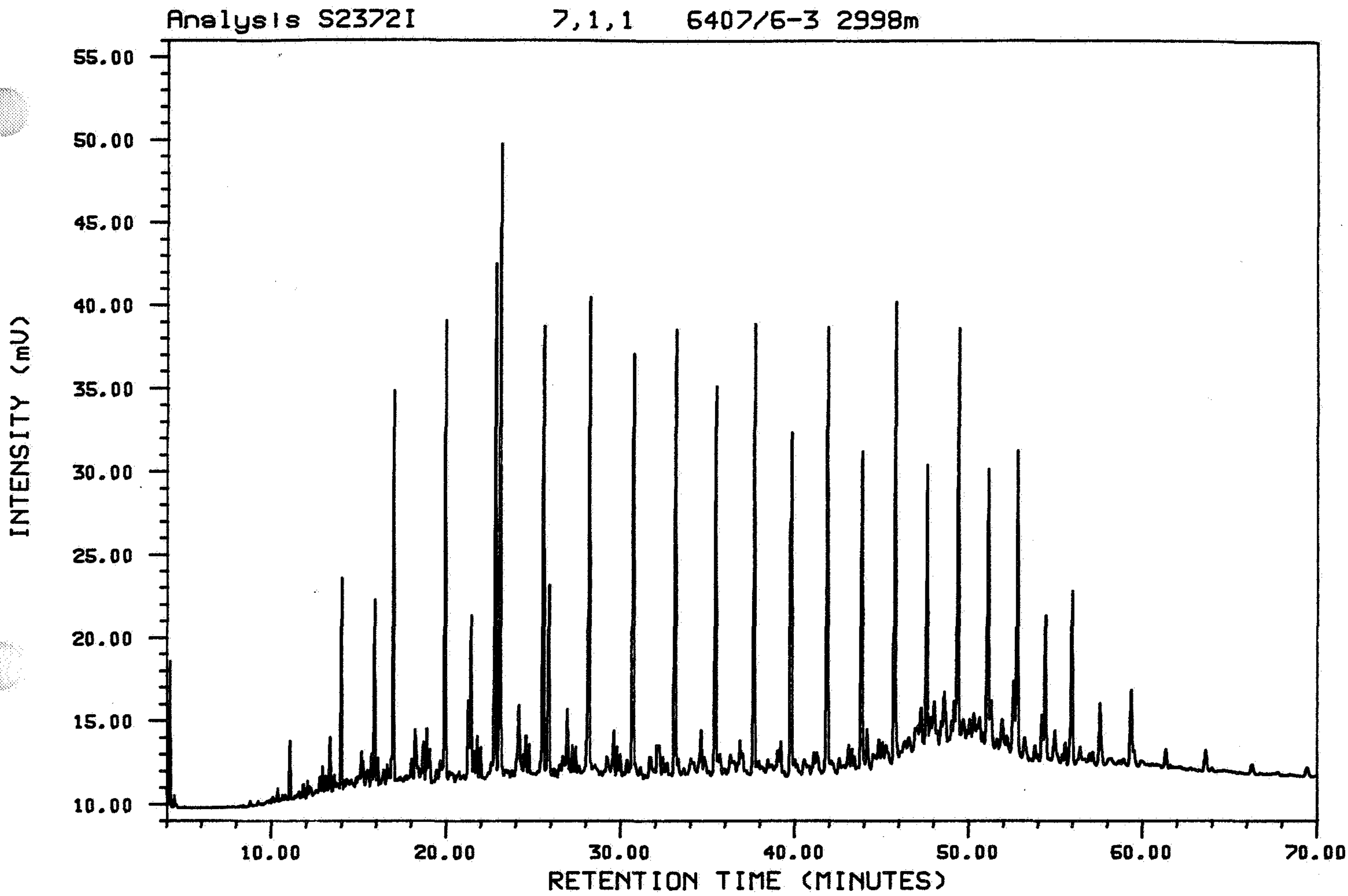

Analysis S2369I 7,1,1 6407/6-3 2956m
INTENSITY (mV)
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
RETENTION TIME (MINUTES)



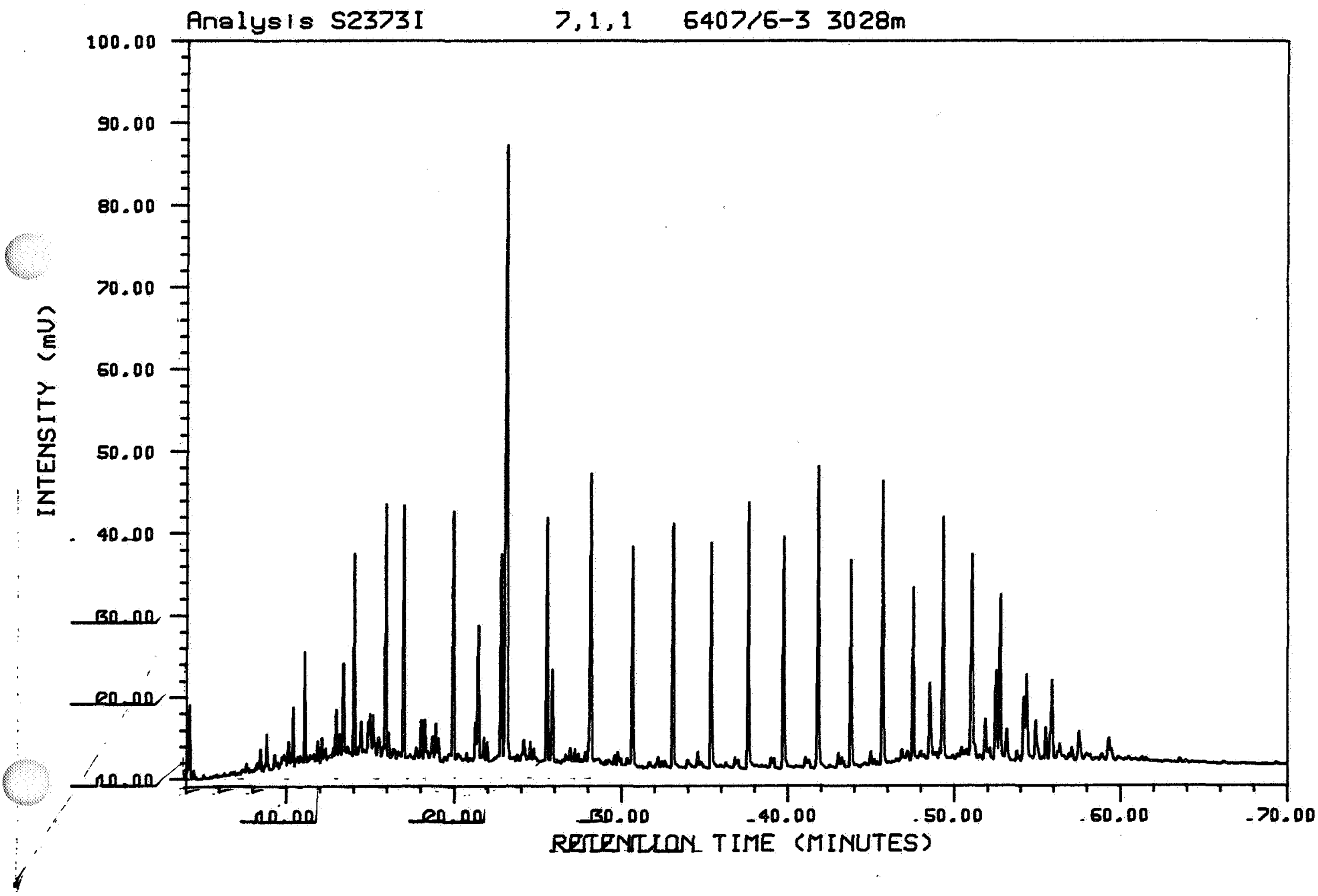
Analysis S2370I 7,1,1 6407/6-3 2965m
140.00
120.00
100.00
80.00
60.00
40.00
20.00
INTENSITY (mV)
10.00
20.00
30.00
40.00
50.00
60.00
70.00
RETENTION TIME (MINUTES)



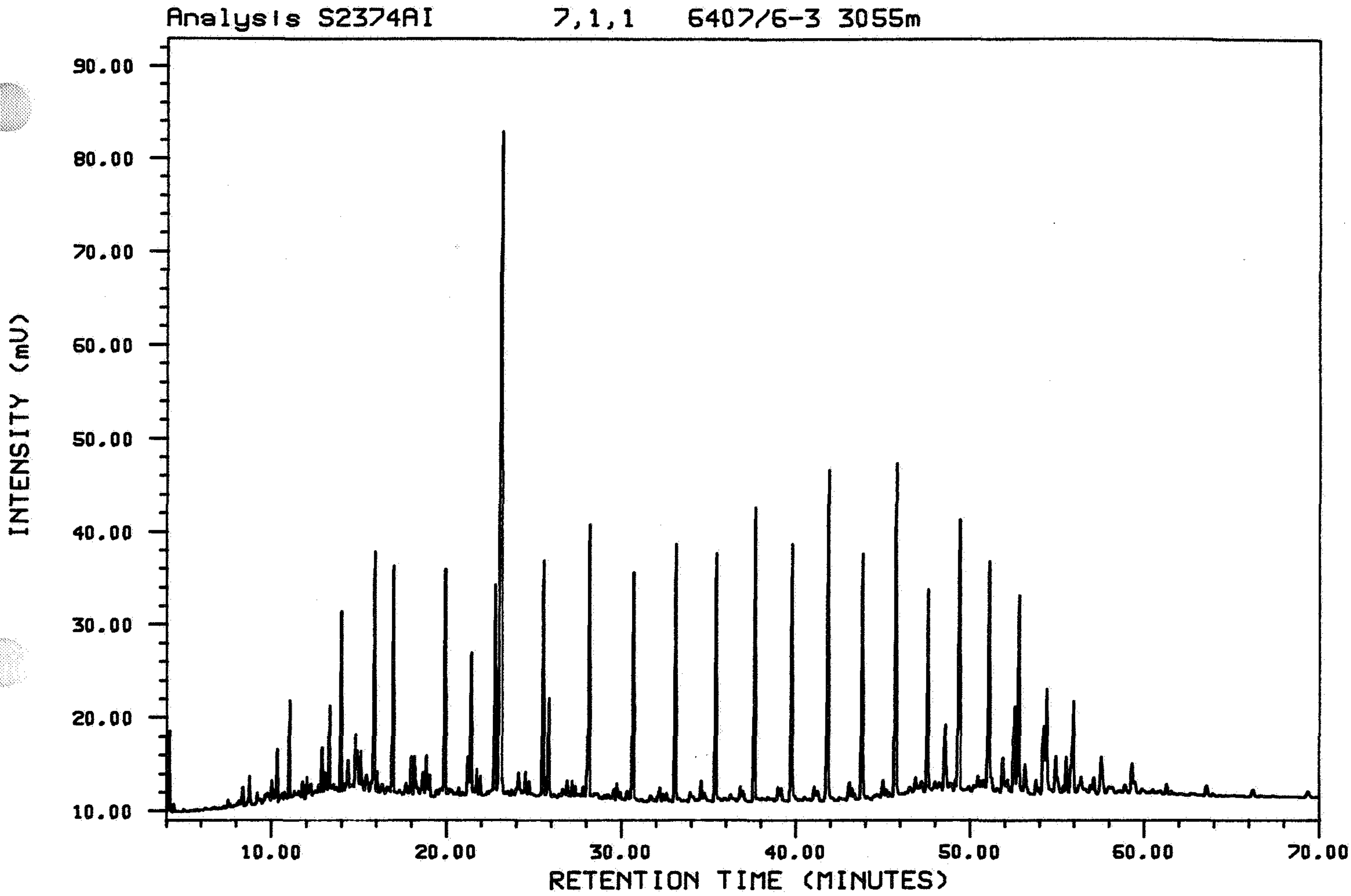
Analysis S2371I 7,1,1 6407/6-3 2983m
120.00
100.00
80.00
60.00
40.00
20.00
INTENSITY (mV)
10.00
20.00
30.00
40.00
50.00
60.00
70.00
RETENTION TIME (MINUTES)

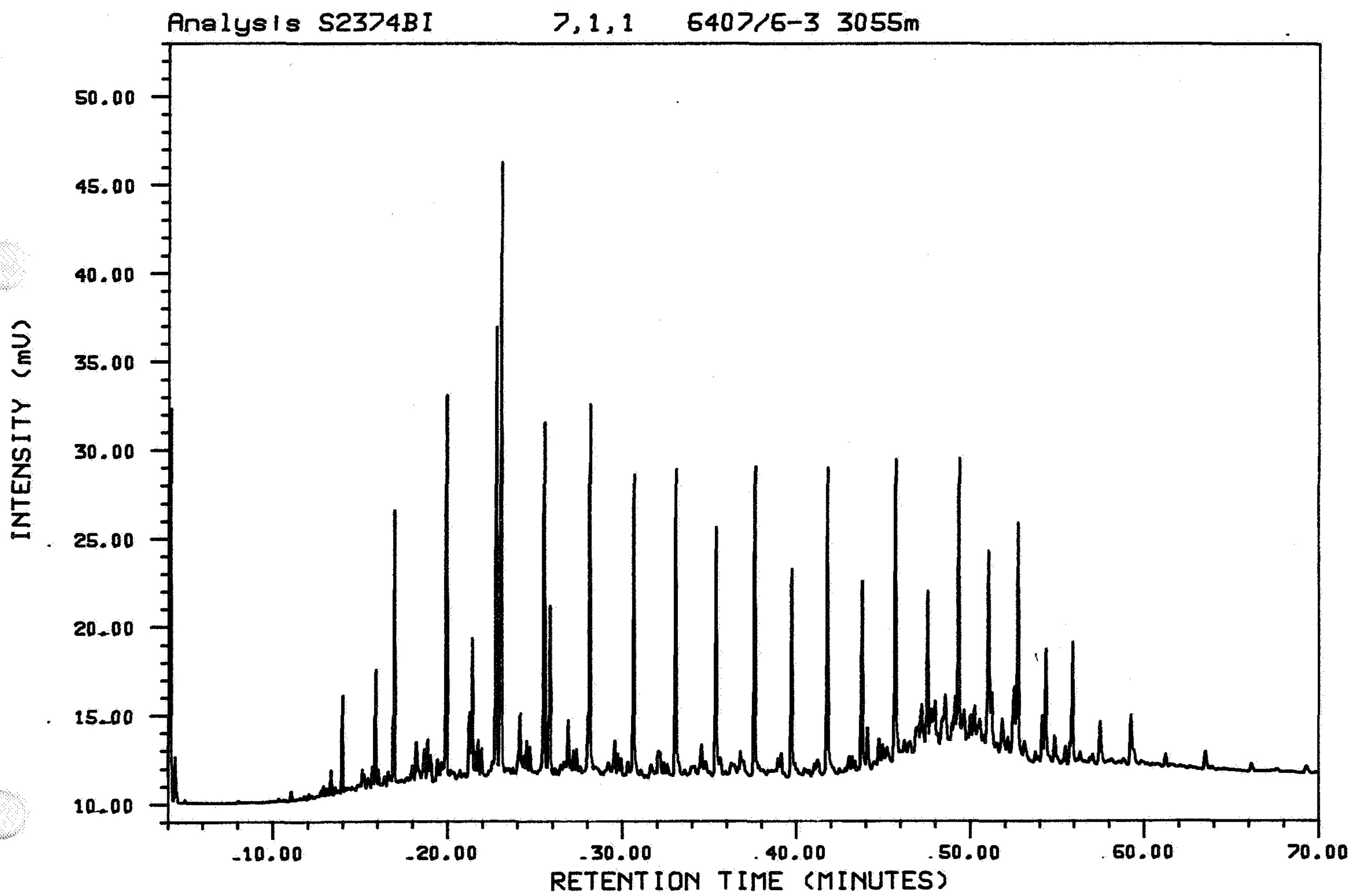


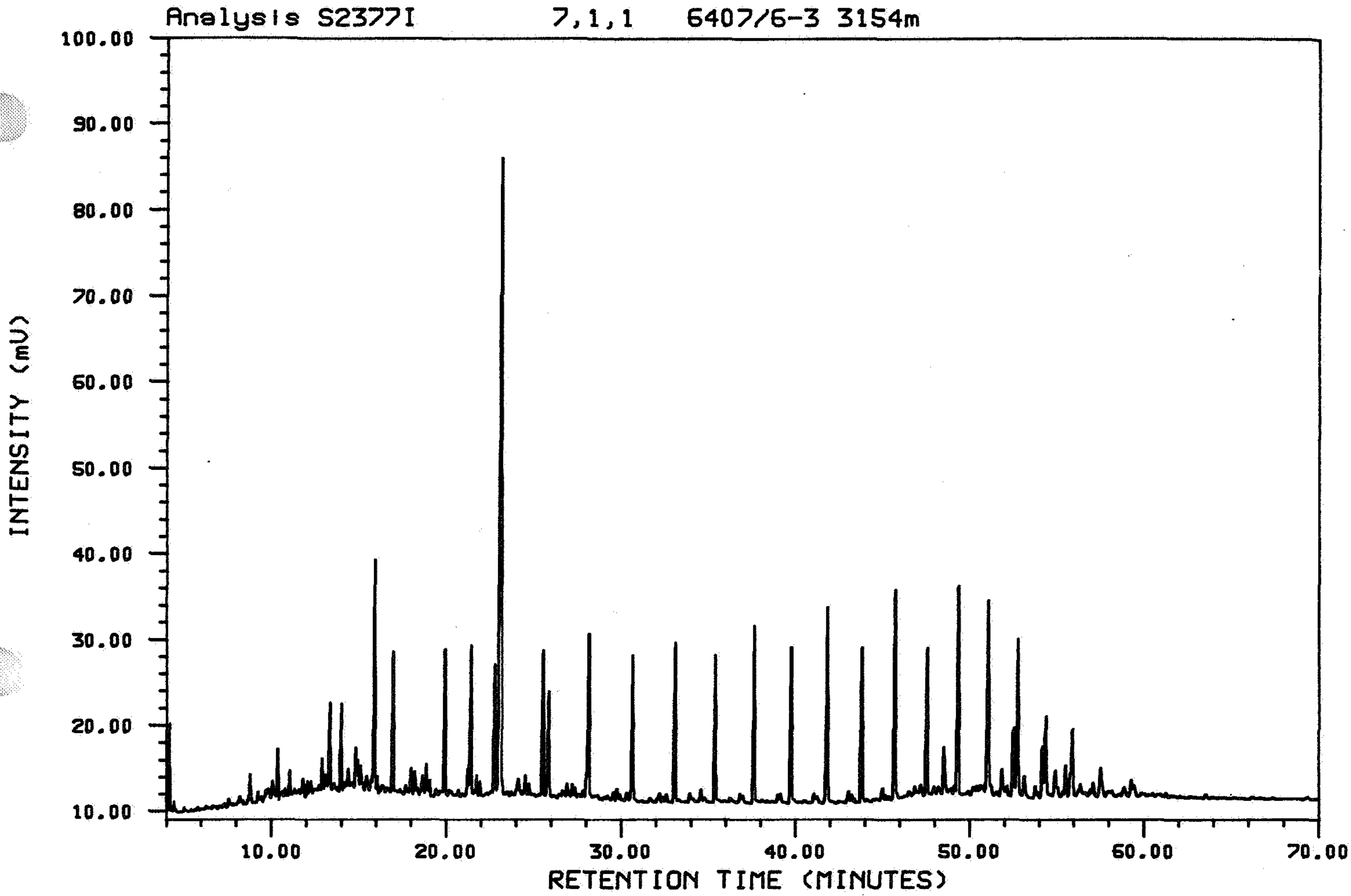
Analysis S2372I 7,1,1 6407/6-3 2998m
INTENSITY (mV)
55.00
50.00
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
RETENTION TIME (MINUTES)



Analysis S2373I 7,1,1 6407/6-3 3028m
INTENSITY (mV)
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
RETENTION TIME (MINUTES)


Analysis S2374AI 7,1,1 6407/6-3 3055m
INTENSITY (mU)
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
10.00 20.00 30.00 40.00 50.00 60.00 70.00
RETENTION TIME (MINUTES)


Analysis S2374BI 7,1,1 6407/6-3 3055m
INTENSITY (mU)
50.00
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
10.00 20.00 30.00 40.00 50.00 60.00 70.00
RETENTION TIME (MINUTES)


Analysis S2377I 7,1,1 6407/6-3 3154m
INTENSITY (mV)
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
RETENTION TIME (MINUTES)

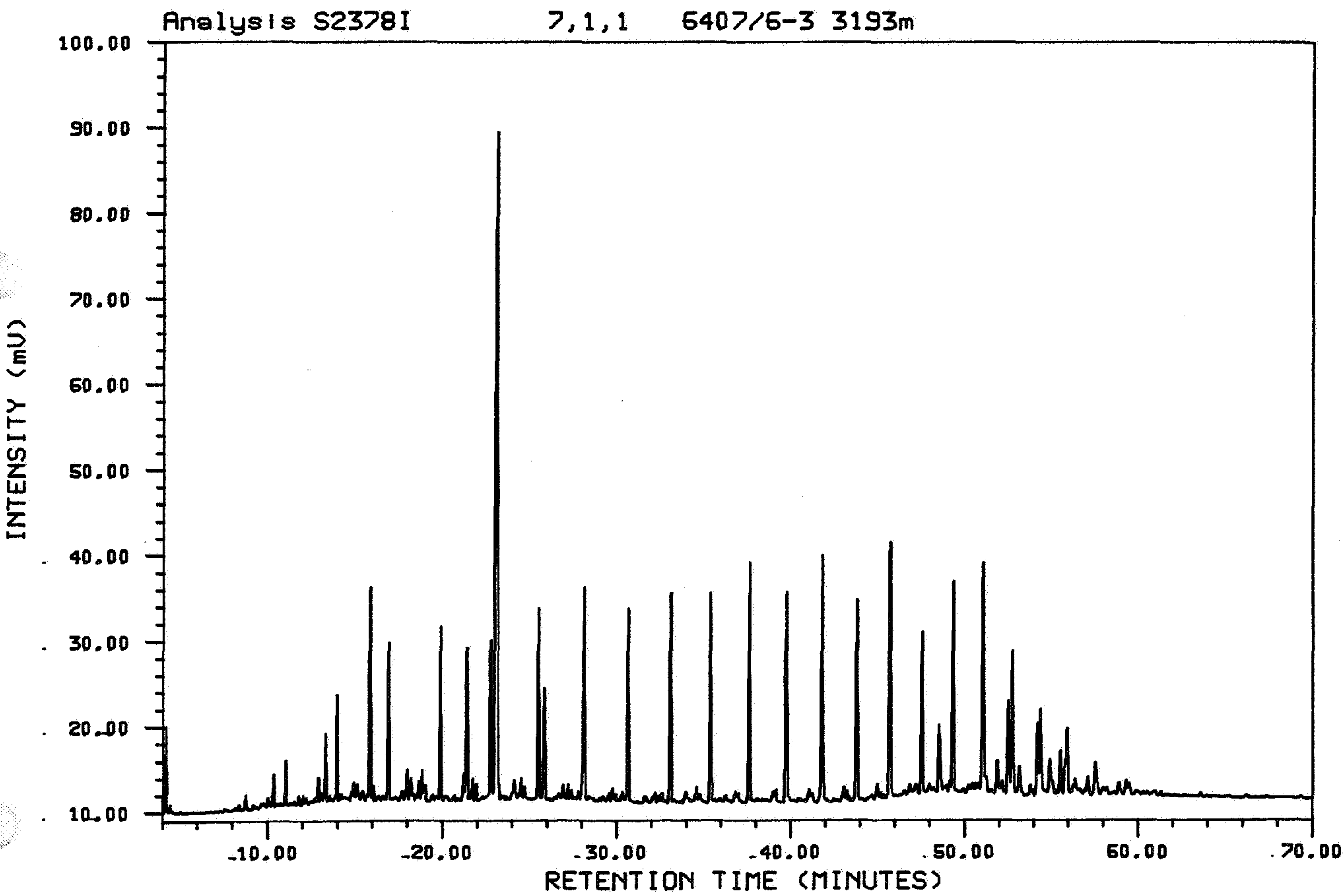
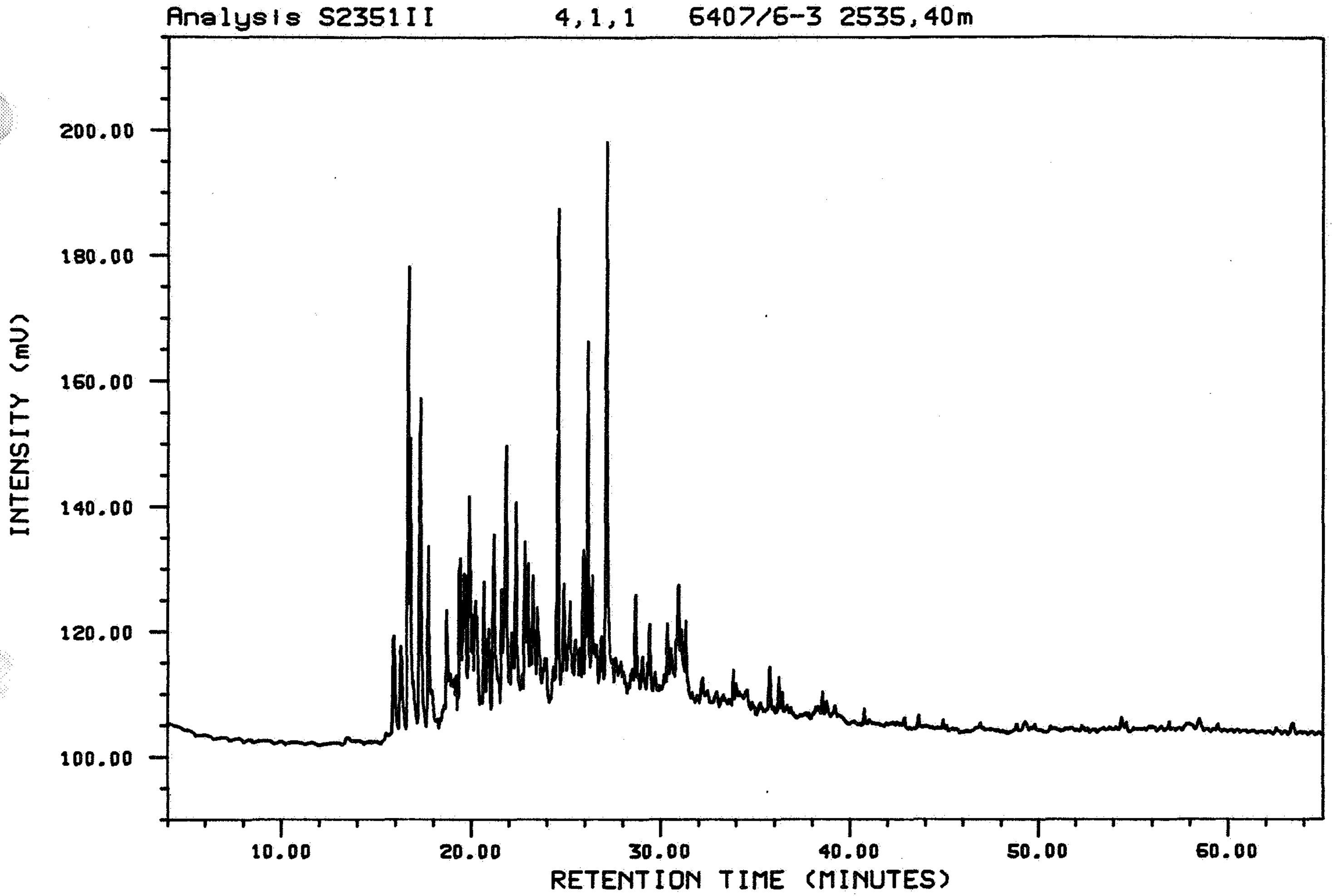
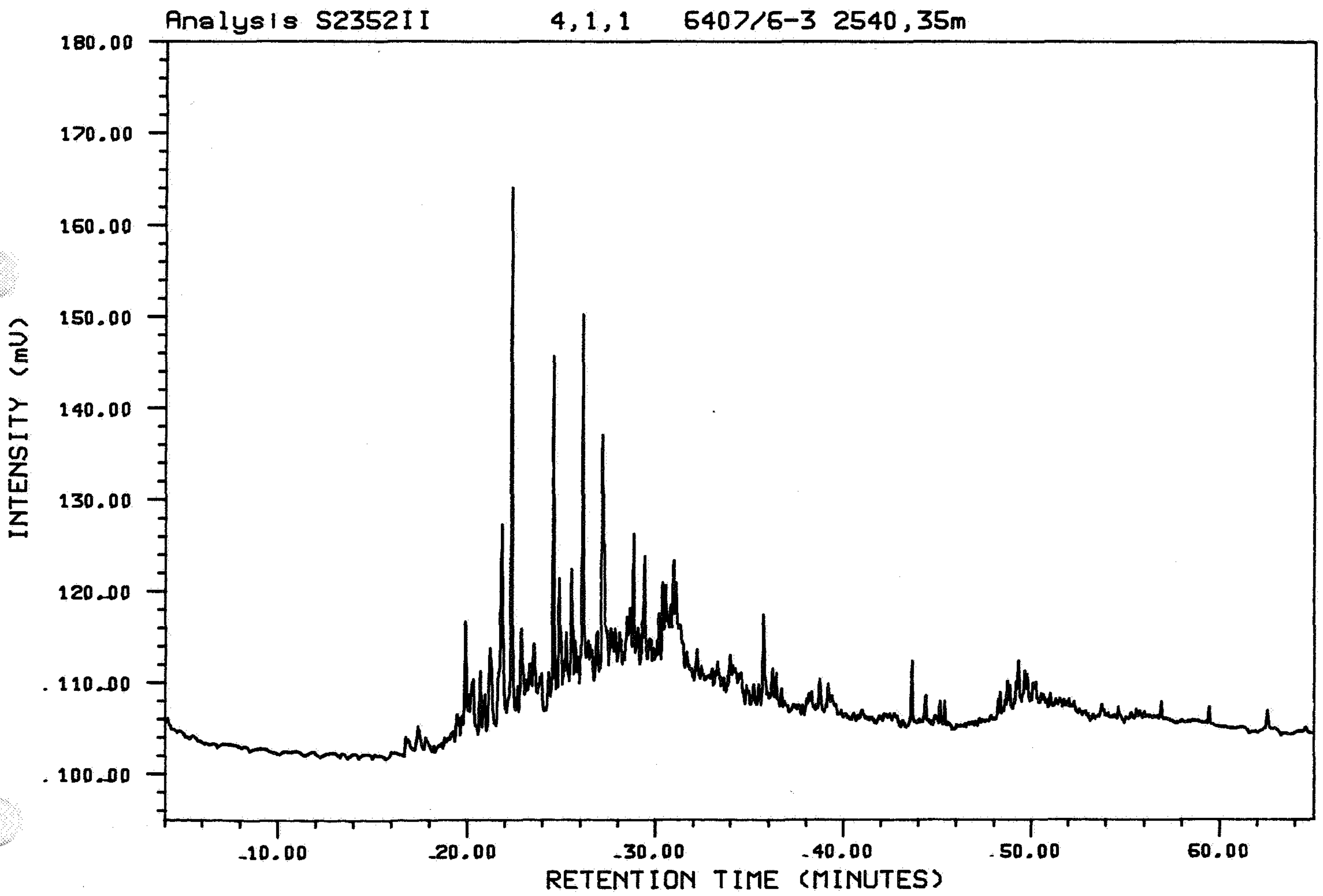

Analysis S2378I 7,1,1 6407/6-3 3193m
INTENSITY (mV)
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
RETENTION TIME (MINUTES)

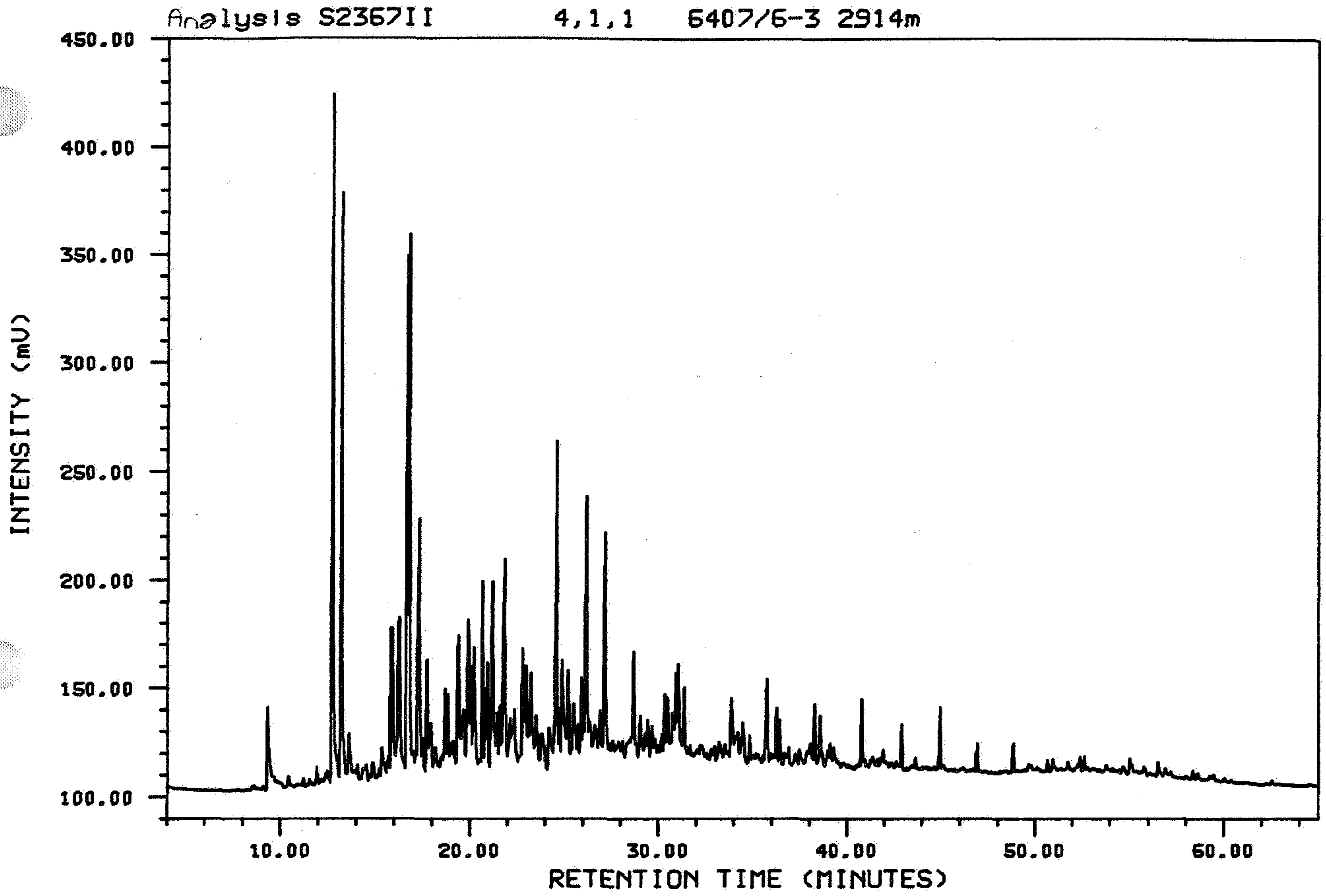
Figure 4a-1

Gas chromatograms, C_{15+}

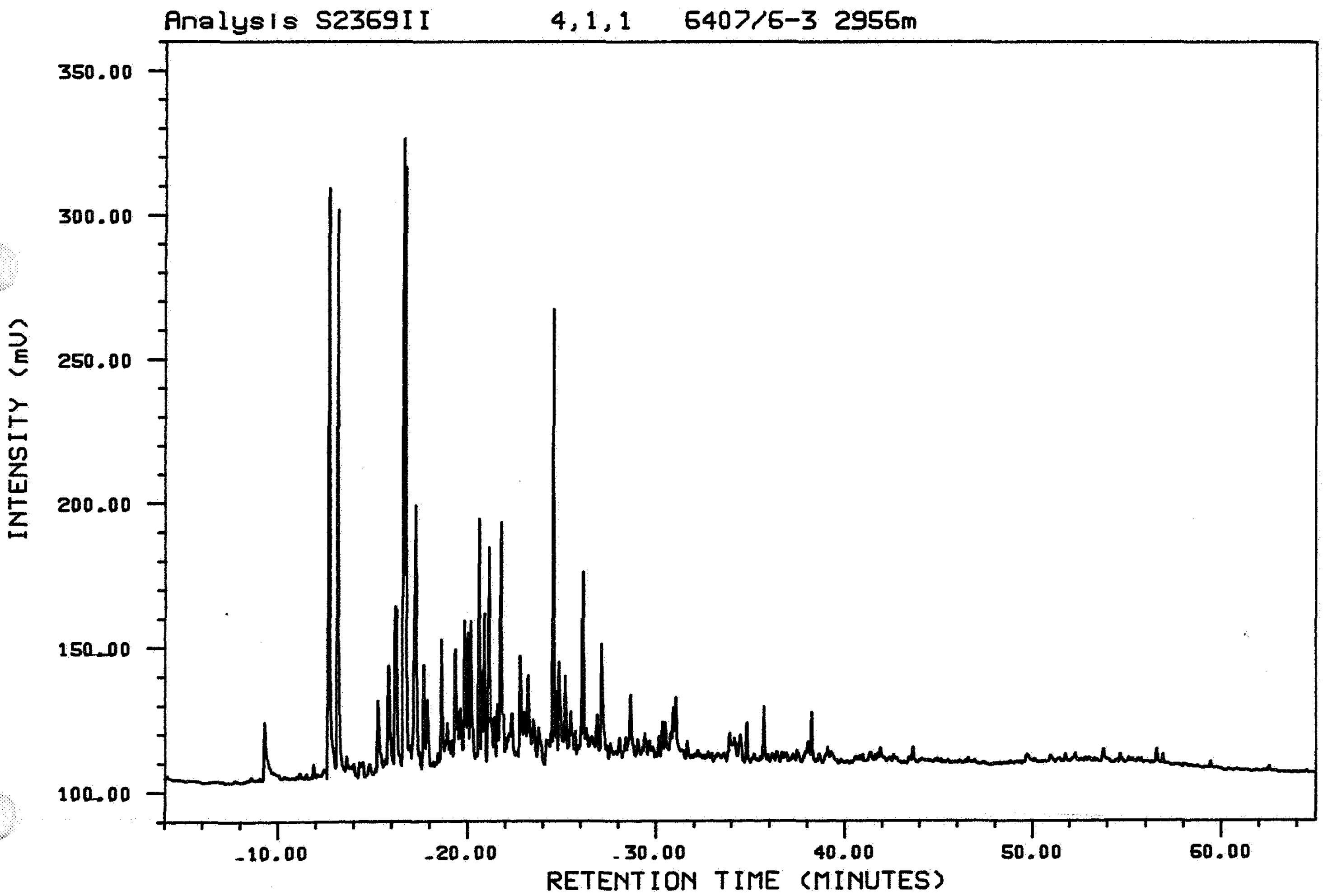
ARO fraction, source rock samples


Analysis S2351II 4,1,1 6407/6-3 2535,40m
200.00
180.00
160.00
140.00
120.00
100.00
INTENSITY (mV)
10.00
20.00
30.00
40.00
50.00
60.00
RETENTION TIME (MINUTES)

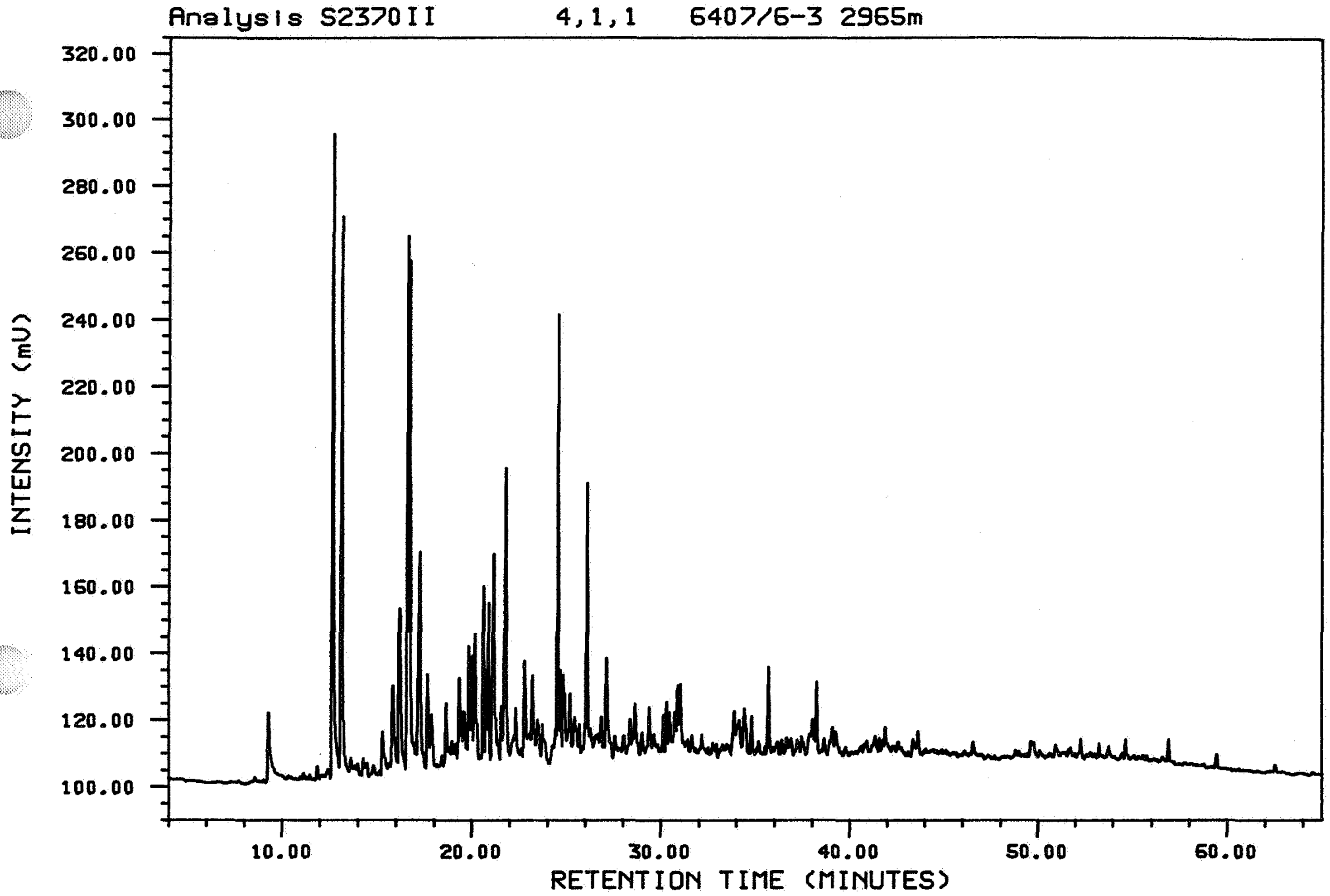

Analysis S2352II 4,1,1 6407/6-3 2540,35m
180.00
170.00
160.00
150.00
140.00
130.00
120.00
110.00
100.00
INTENSITY (mV)
10.00
20.00
30.00
40.00
50.00
60.00
RETENTION TIME (MINUTES)

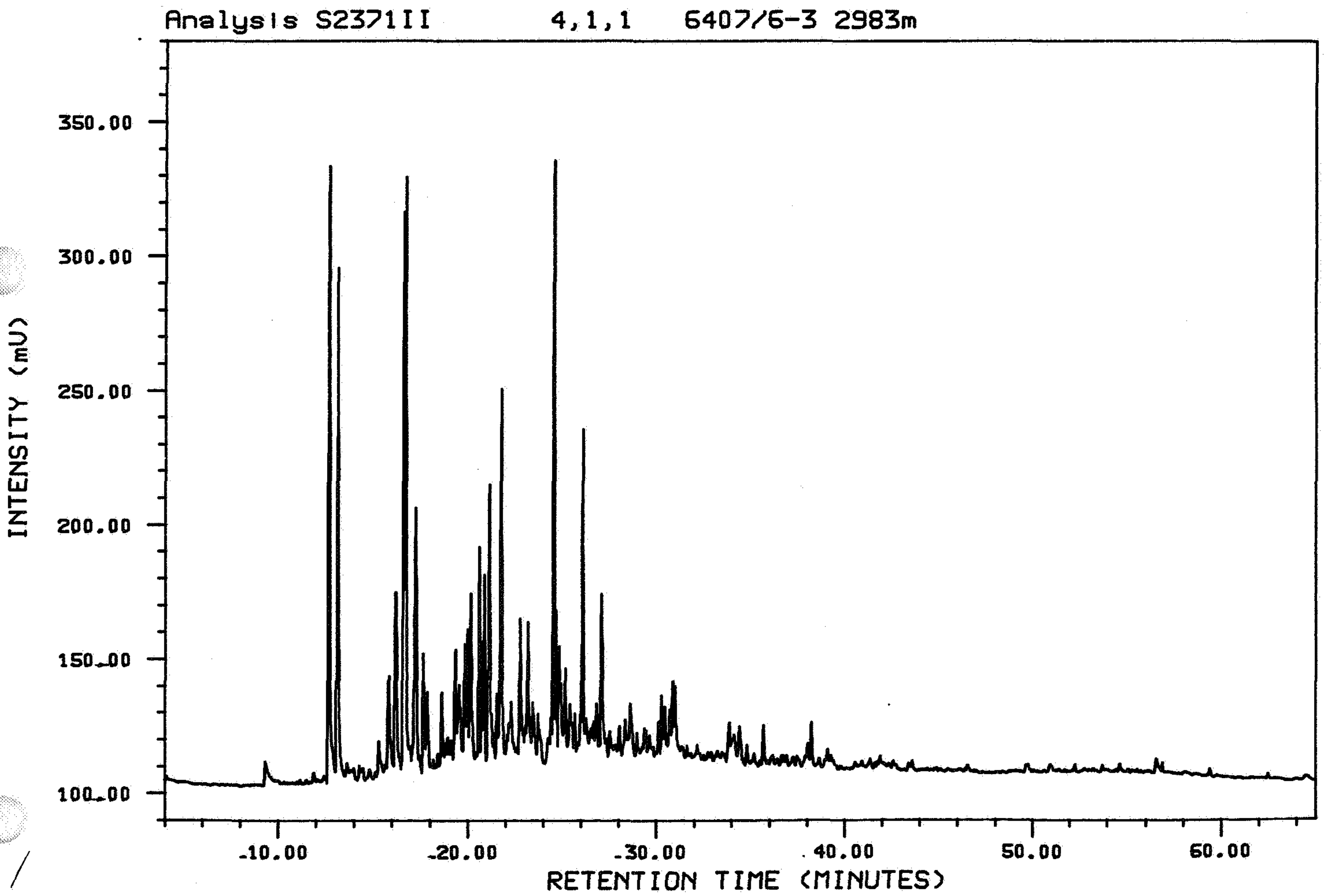


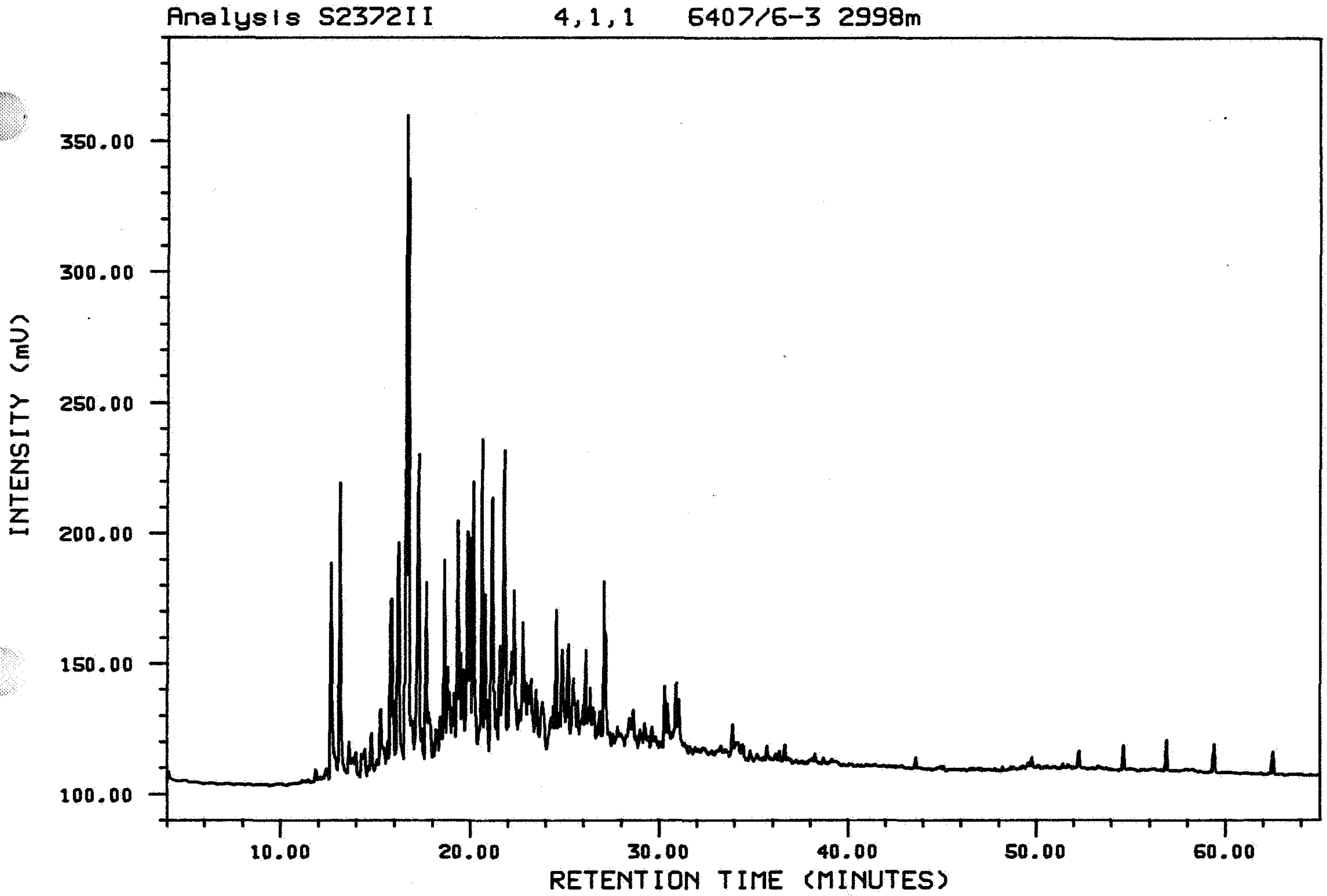
Analysis S2367II 4,1,1 6407/6-3 2914m
450.00
400.00
350.00
300.00
250.00
200.00
150.00
100.00
INTENSITY (mV)
10.00
20.00
30.00
40.00
50.00
60.00
RETENTION TIME (MINUTES)



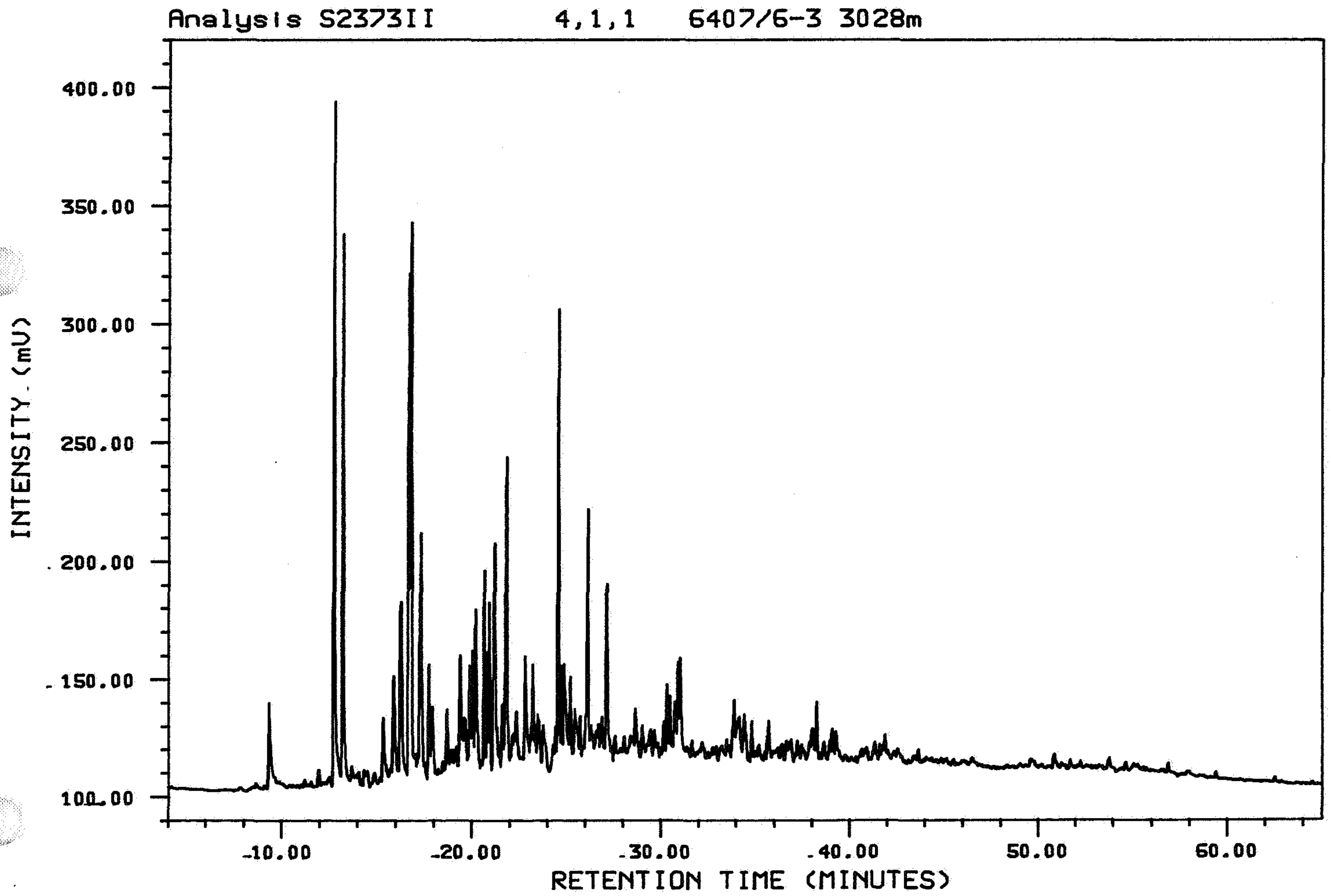
Analysis S2369II 4,1,1 6407/6-3 2956m
350.00
300.00
250.00
200.00
150.00
100.00
INTENSITY (mV)
10.00
20.00
30.00
40.00
50.00
60.00
RETENTION TIME (MINUTES)


Analysis S2370II 4,1,1 6407/6-3 2965m
INTENSITY (mV)
320.00
300.00
280.00
260.00
240.00
220.00
200.00
180.00
160.00
140.00
120.00
100.00
10.00
20.00
30.00
40.00
50.00
60.00
RETENTION TIME (MINUTES)

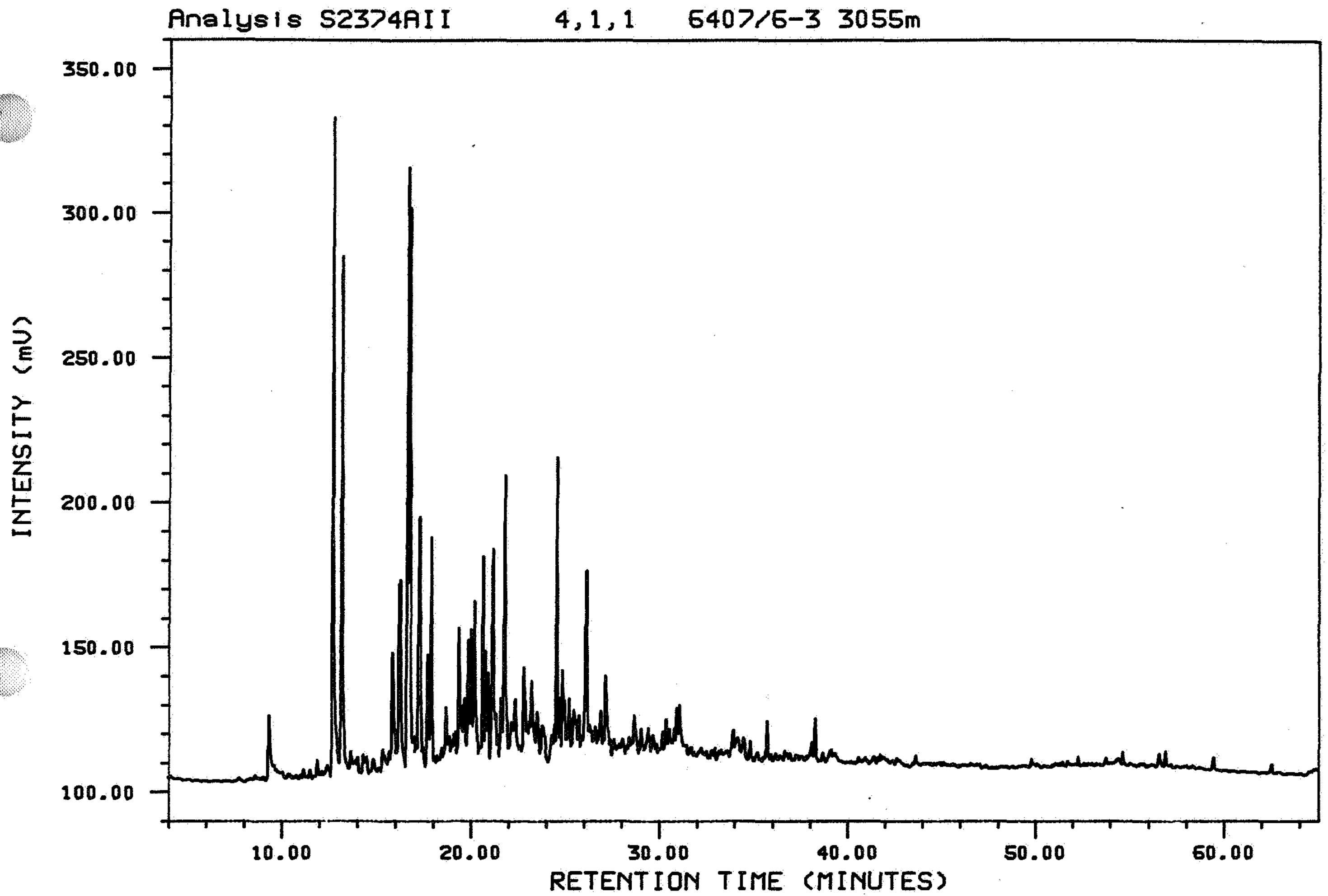

Analysis S2371II 4,1,1 6407/6-3 2983m
INTENSITY (mV)
350.00
300.00
250.00
200.00
150.00
100.00
10.00
20.00
30.00
40.00
50.00
60.00
RETENTION TIME (MINUTES)



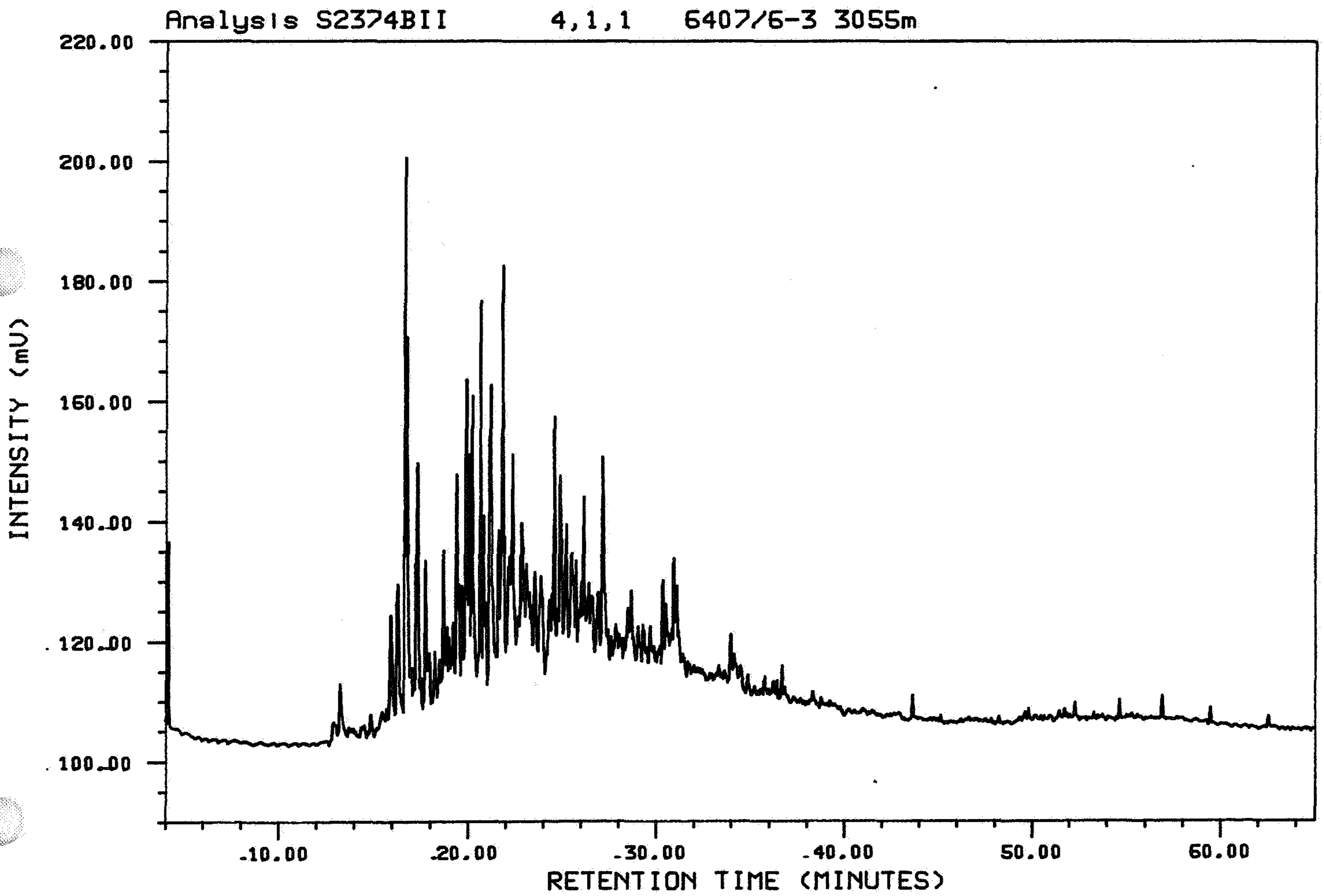
Analysis S2372II 4,1,1 6407/6-3 2998m
INTENSITY (mV)
350.00
300.00
250.00
200.00
150.00
100.00
10.00
20.00
30.00
40.00
50.00
60.00
RETENTION TIME (MINUTES)



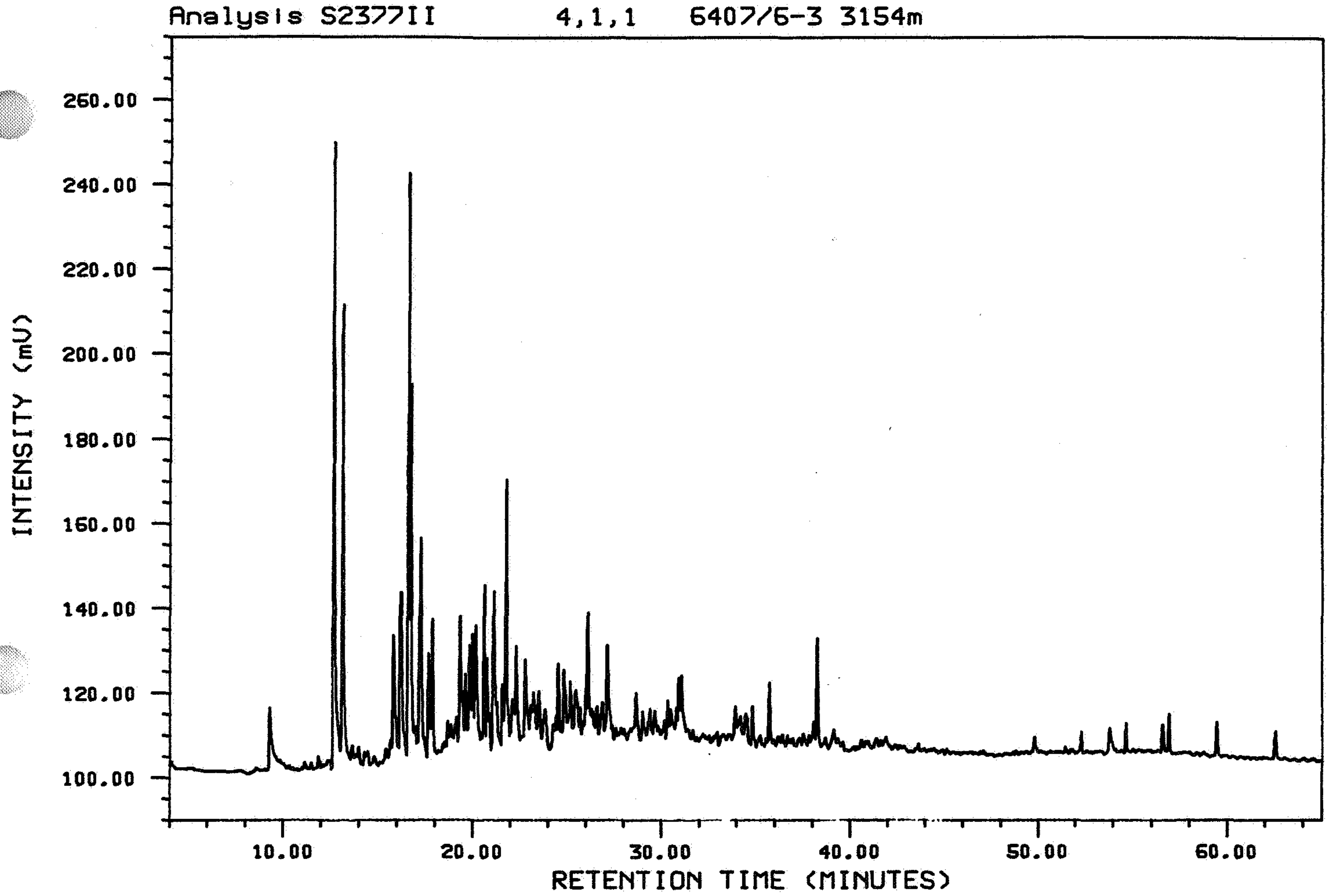
Analysis S2373II 4,1,1 6407/6-3 3028m
INTENSITY (mV)
400.00
350.00
300.00
250.00
200.00
150.00
100.00
10.00
20.00
30.00
40.00
50.00
60.00
RETENTION TIME (MINUTES)

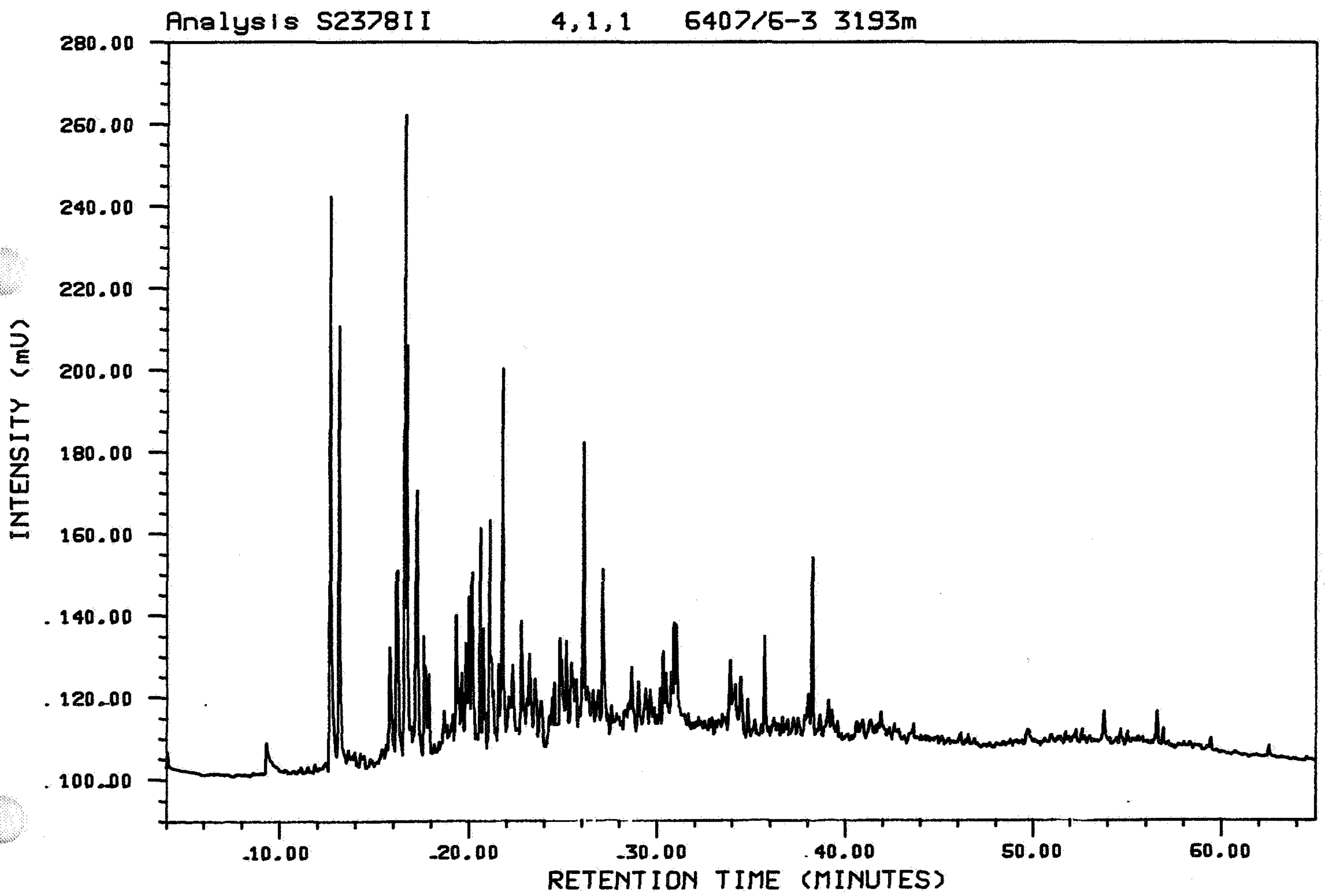


Analysis S2374AII 4,1,1 6407/6-3 3055m
INTENSITY (mV)
350.00
300.00
250.00
200.00
150.00
100.00
10.00
20.00
30.00
40.00
50.00
60.00
RETENTION TIME (MINUTES)

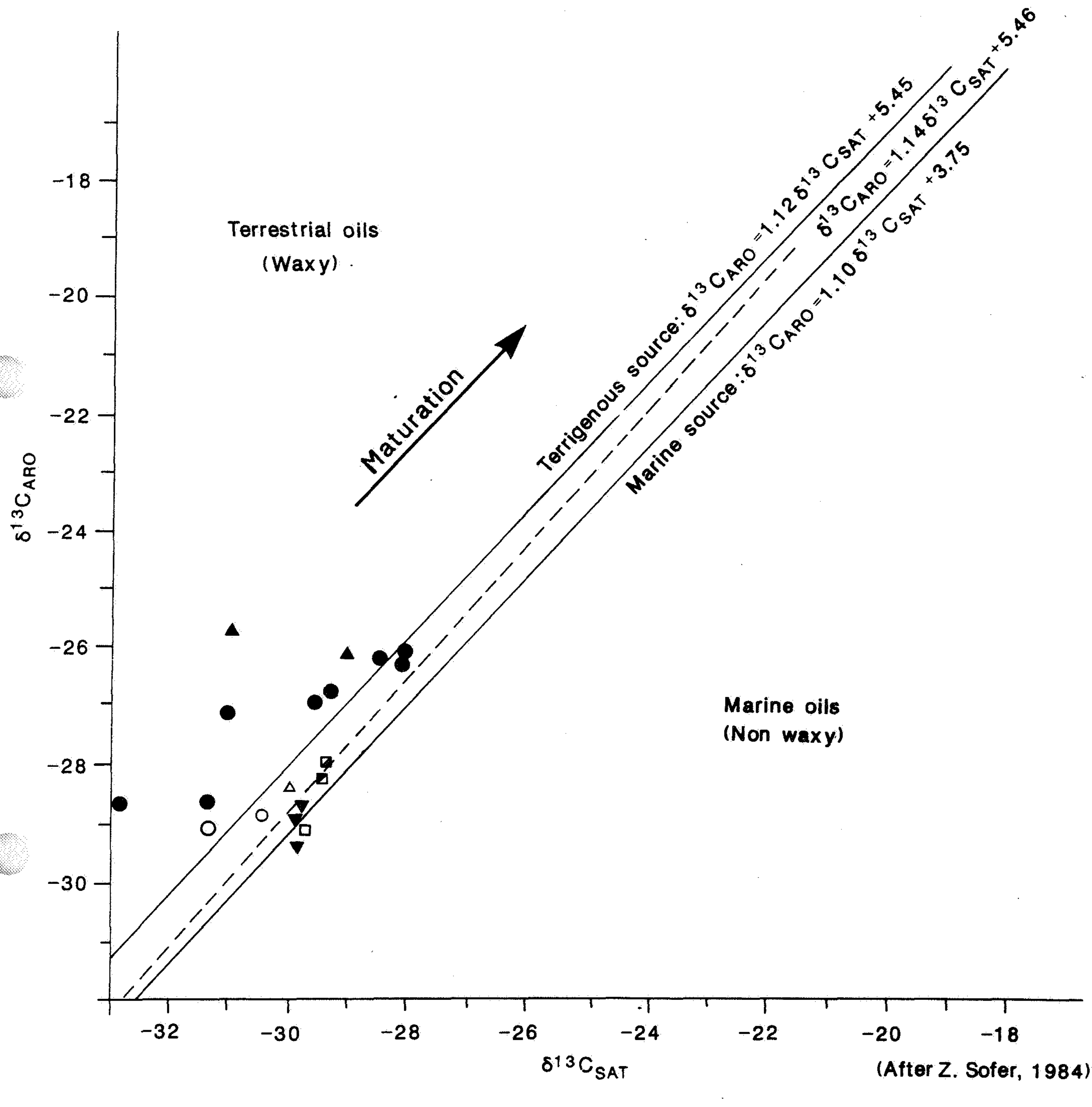


Analysis S2374BII 4,1,1 6407/6-3 3055m
INTENSITY (mV)
220.00
200.00
180.00
160.00
140.00
120.00
100.00
10.00
20.00
30.00
40.00
50.00
60.00
RETENTION TIME (MINUTES)


Analysis S2377II 4,1,1 6407/6-3 3154m
INTENSITY (mV)
260.00
240.00
220.00
200.00
180.00
160.00
140.00
120.00
100.00
10.00
20.00
30.00
40.00
50.00
60.00
RETENTION TIME (MINUTES)


Analysis S2378II 4,1,1 6407/6-3 3193m
INTENSITY (mV)
280.00
260.00
240.00
220.00
200.00
180.00
160.00
140.00
120.00
100.00
10.00
20.00
30.00
40.00
50.00
60.00
RETENTION TIME (MINUTES)

$\delta^{13}C$ ON SATURATED AND AROMATIC HYDROCARBONS FROM THE SOURCE ROCKS, RESERVOIR ROCKS AND CRUDE OILS.



(After Z. Sofer, 1984)

SOURCE ROCKS

- ● Hitra Fm coal
- ○ Hitra Fm shale
- ▲ Tomma II Fm

RESERVOIR HC'S

- △ Tomma I Fm
- ▼ Tomma III Fm
- □ DST-1
- DST-2
- DST-3

Dotted line is best separation between waxy and non waxy oils.

Fig. 5a

Stahl diagram for the isotopic ranges of test samples,

reservoir rock and source rock extracts from the well 6407/6-3

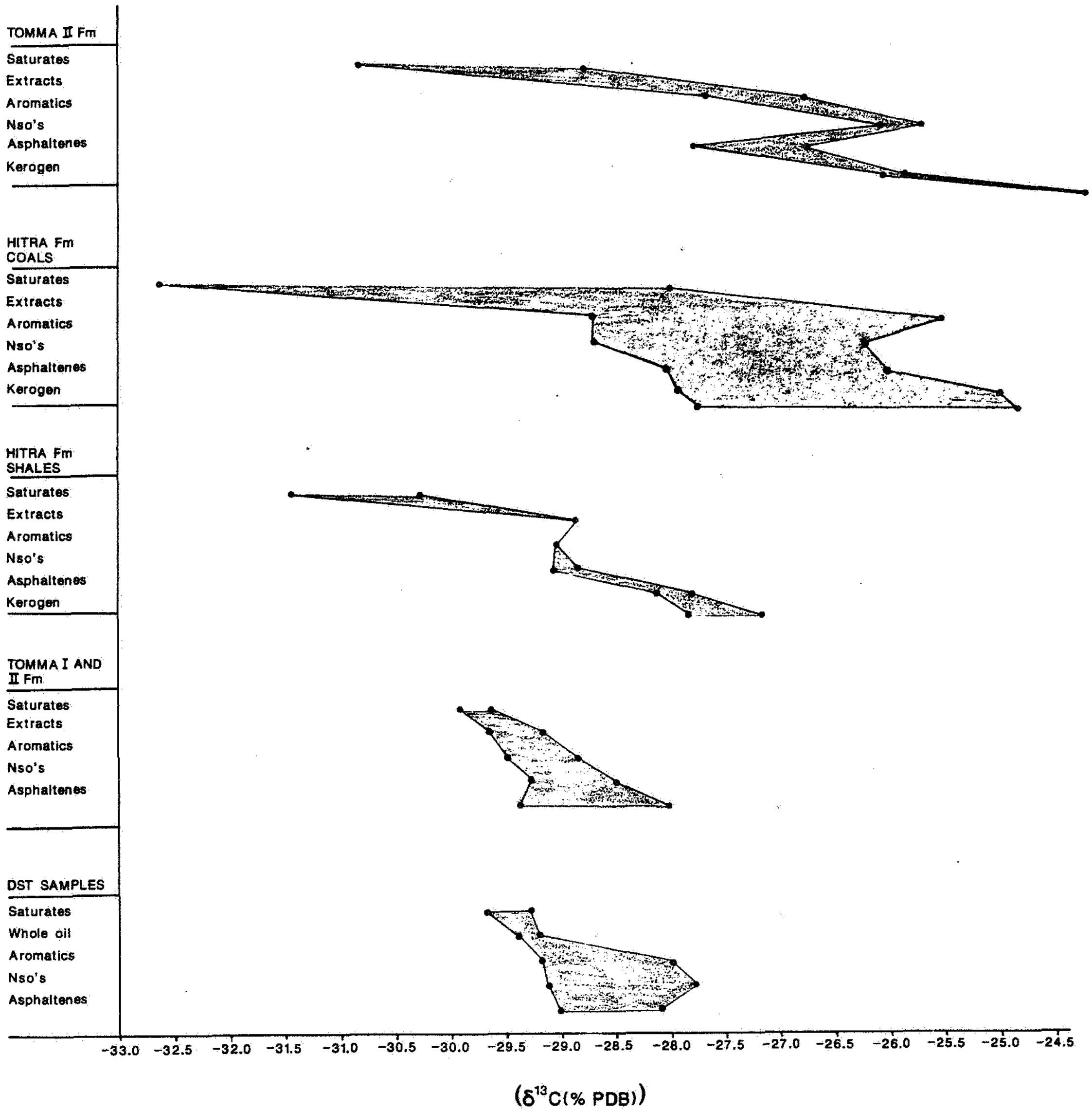


Fig. 5b

MATURATION

Well no.: 6407/6-3

Company: STATOIL

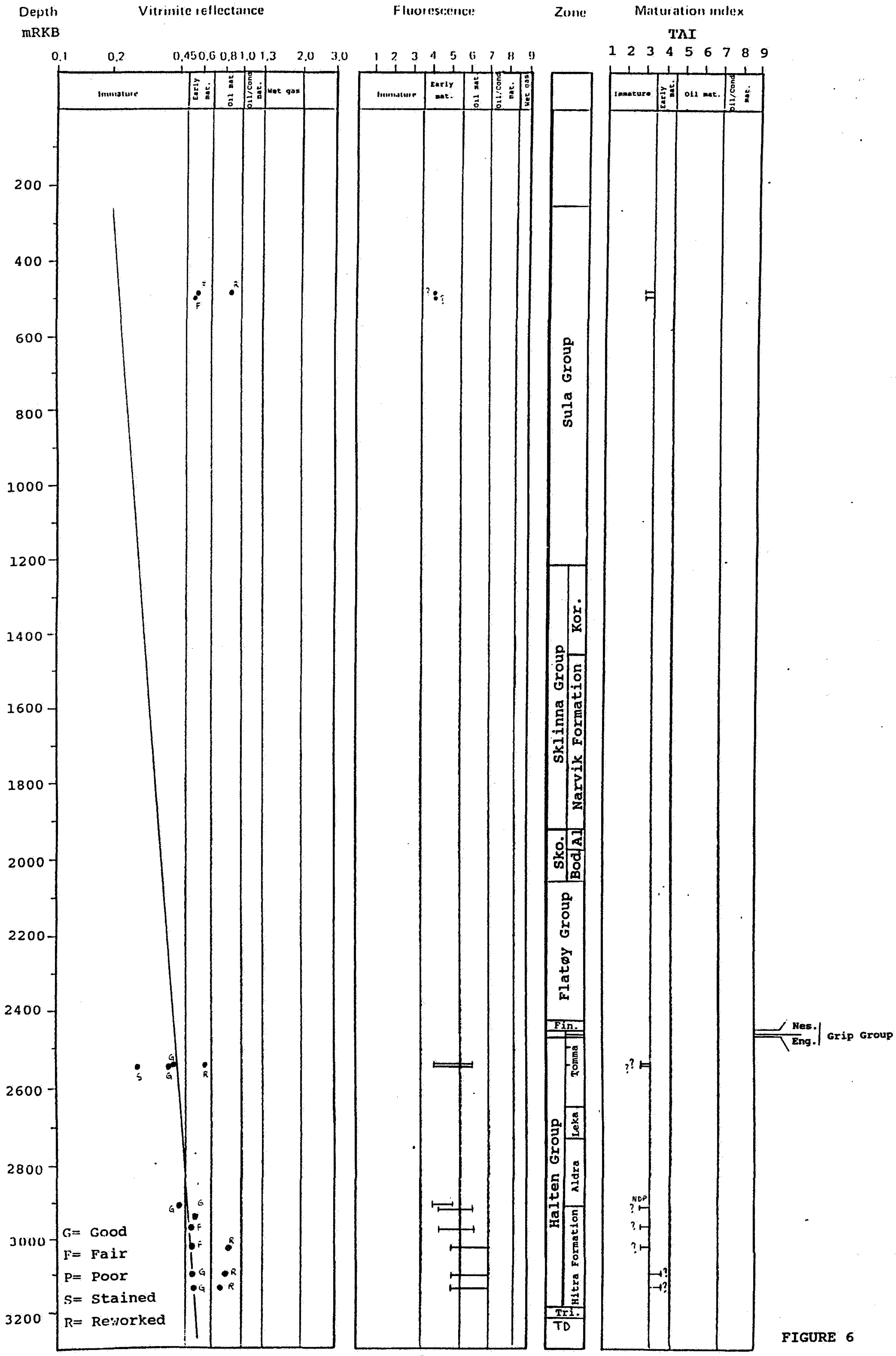
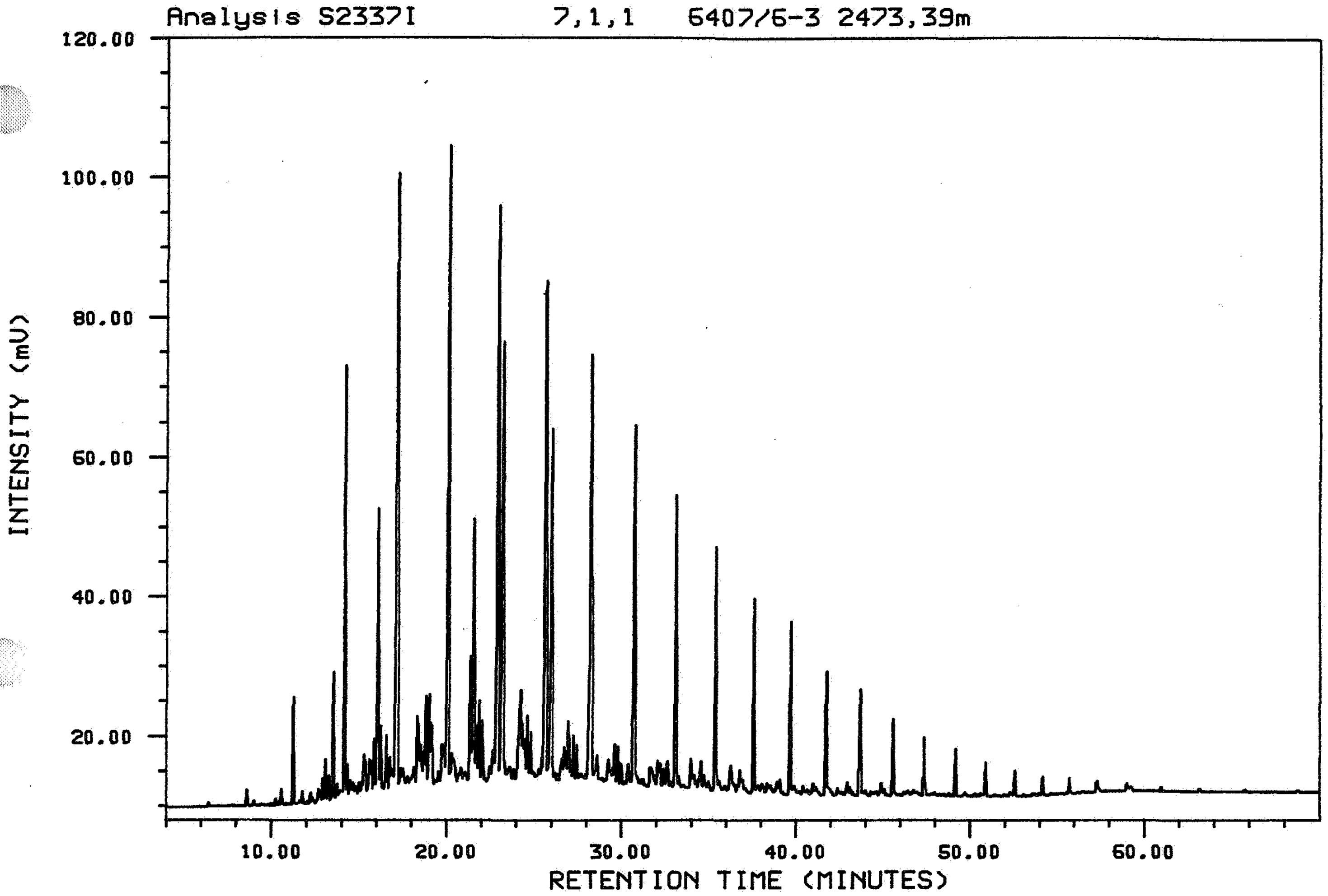


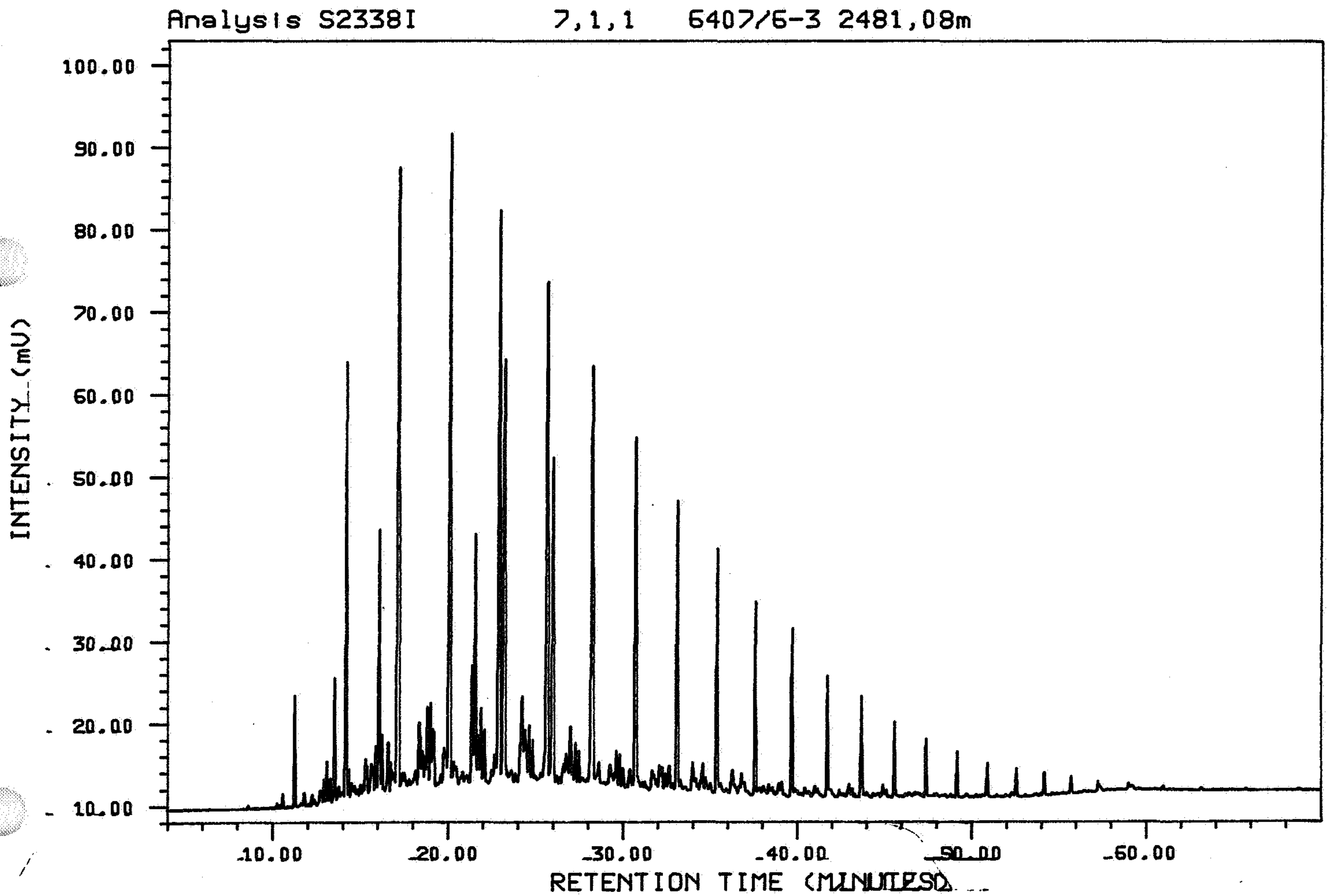
FIGURE 6

Figures 7a-m

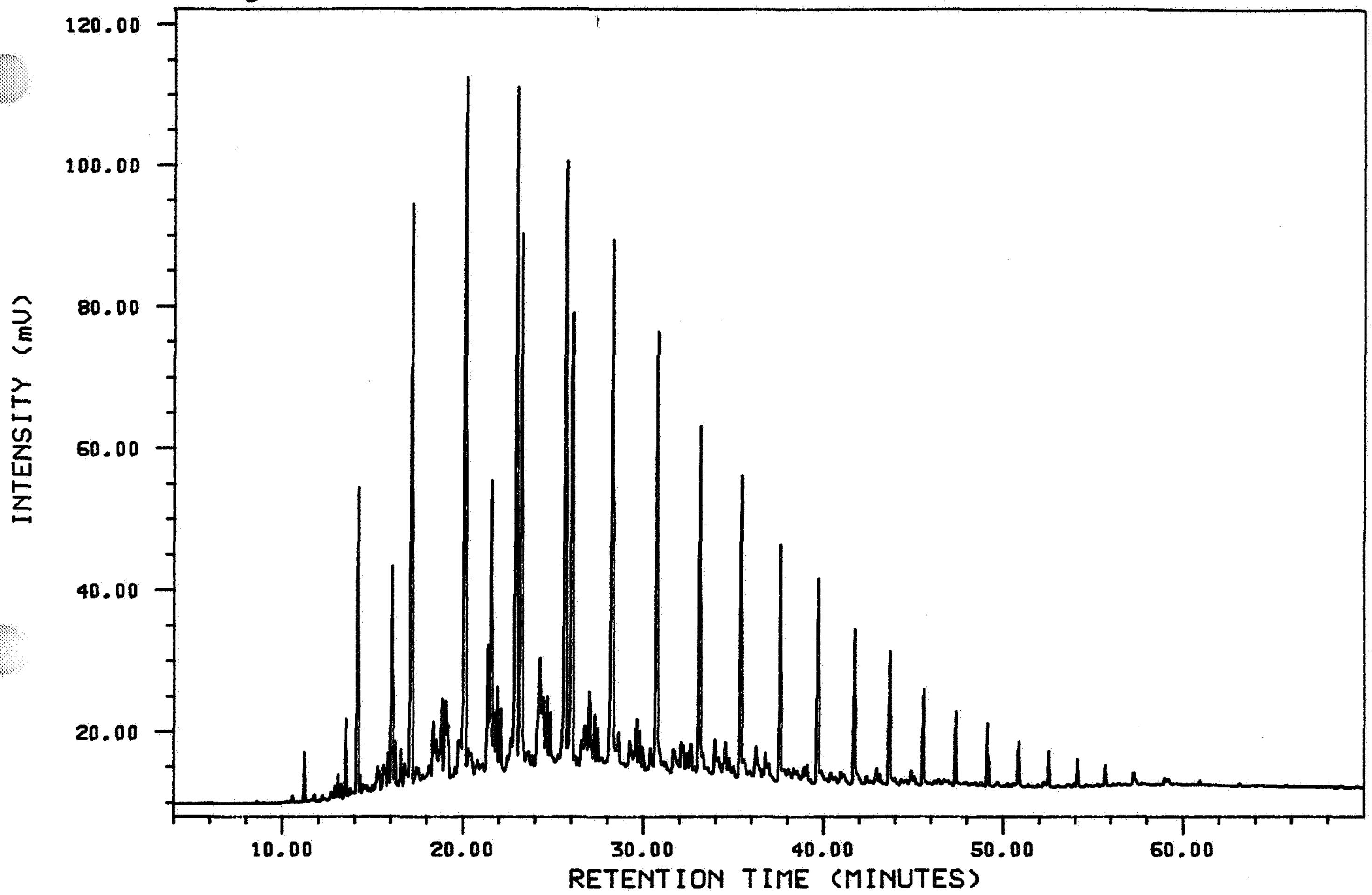
Gas chromatograms, C_{15+}

SAT fraction, reservoir sediment samples

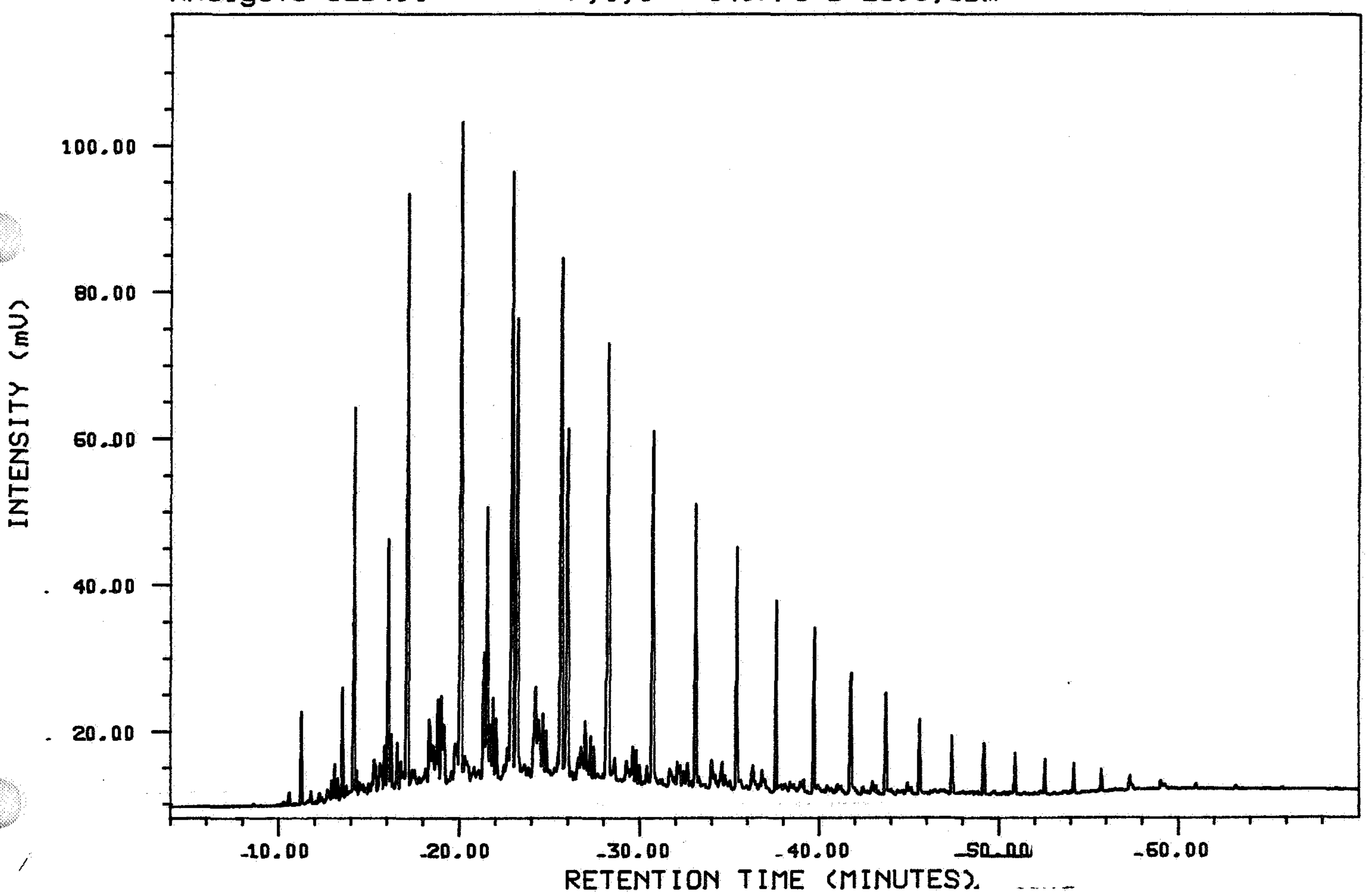

Analysis S2337I 7,1,1 6407/6-3 2473,39m
INTENSITY (mV)
120.00
100.00
80.00
60.00
40.00
20.00
10.00
20.00
30.00
40.00
50.00
60.00
RETENTION TIME (MINUTES)


Analysis S2338I 7,1,1 6407/6-3 2481,08m
INTENSITY (mV)
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
10.00
20.00
30.00
40.00
50.00
60.00
RETENTION TIME (MINUTES)

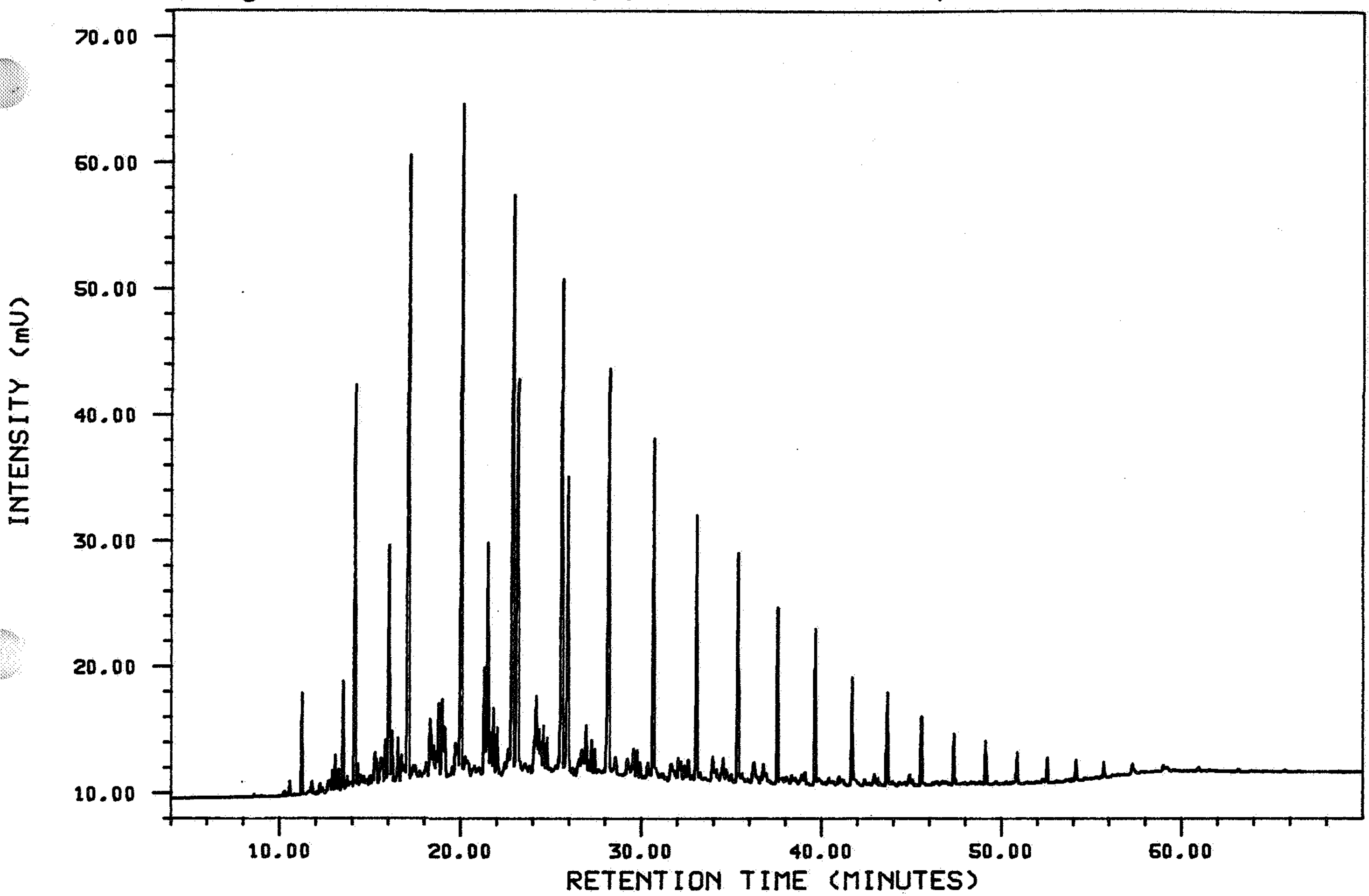
Analysis S2339I 7,1,1 6407/6-3 2499,75m



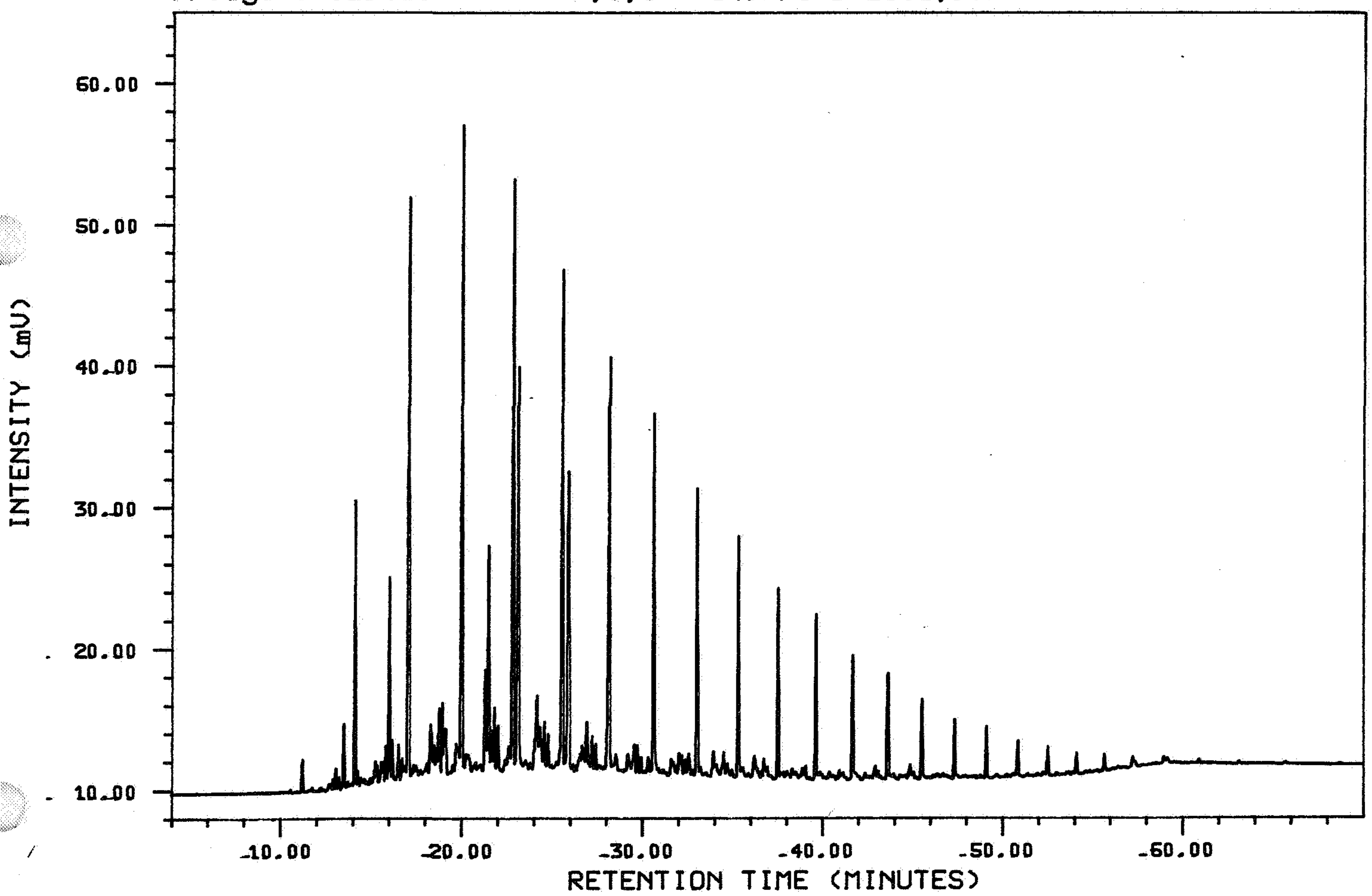
Analysis S2340I 7,1,1 6407/6-3 2506,59m

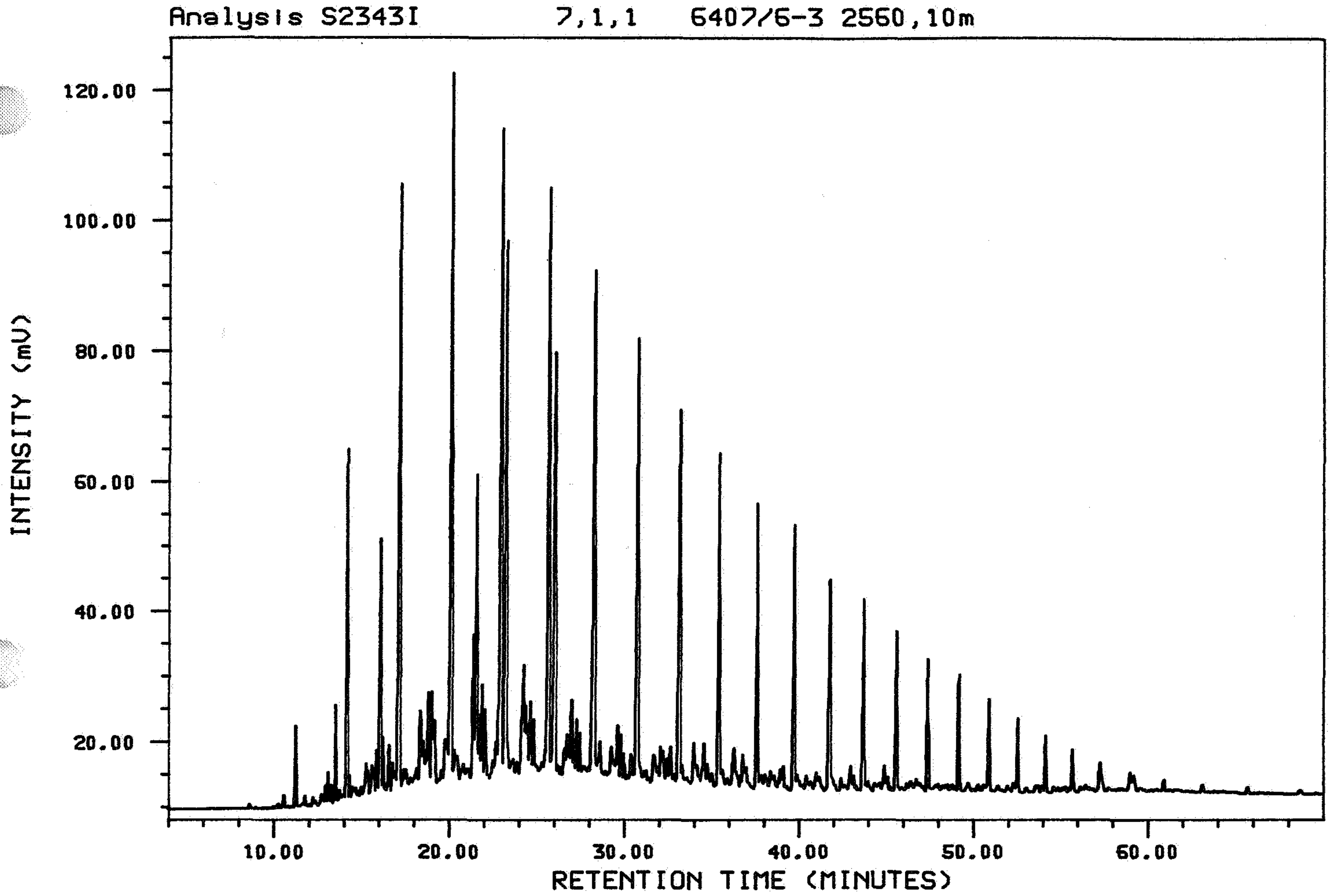


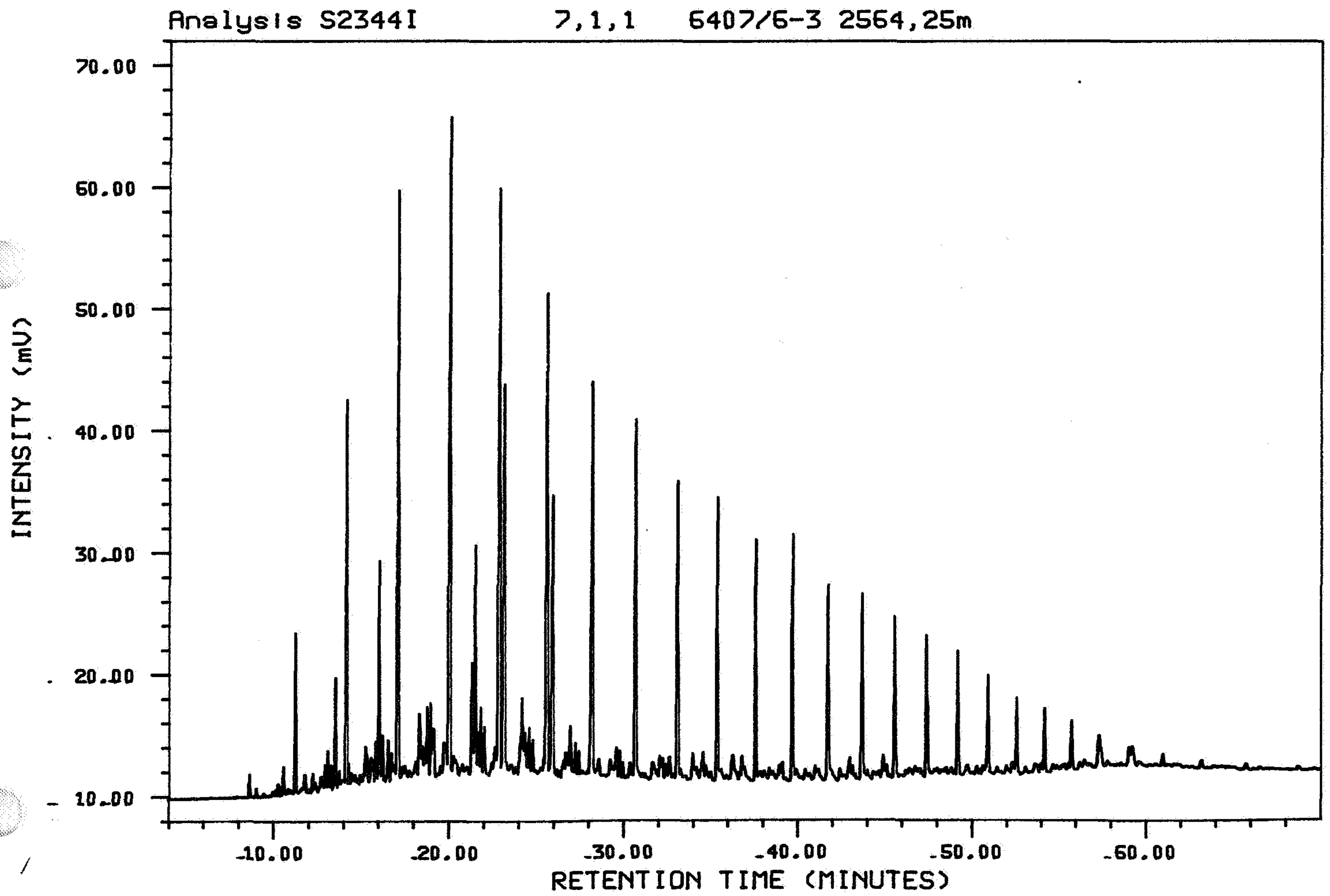
Analysis S2341I 7,1,1 6407/6-3 2514,79m

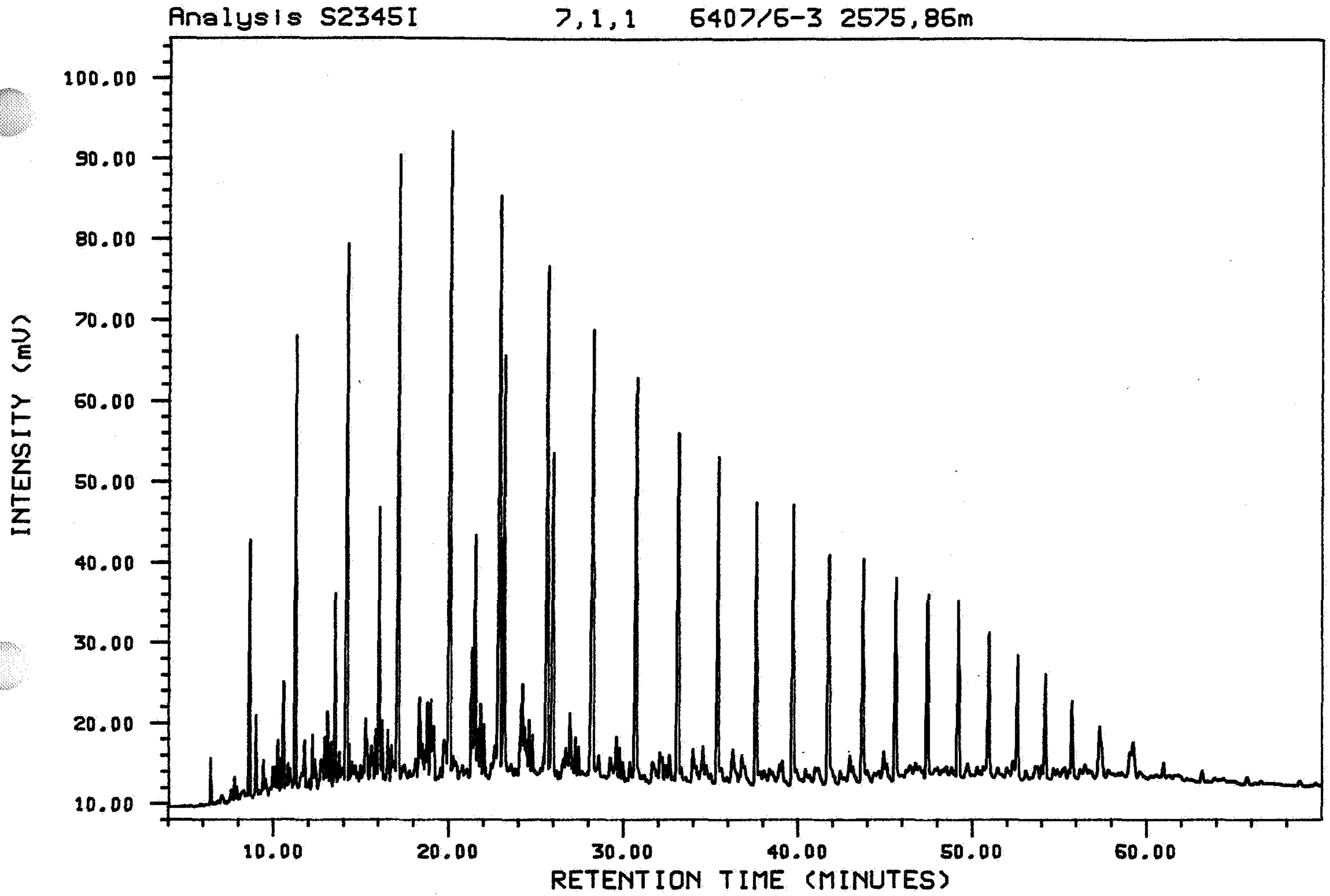


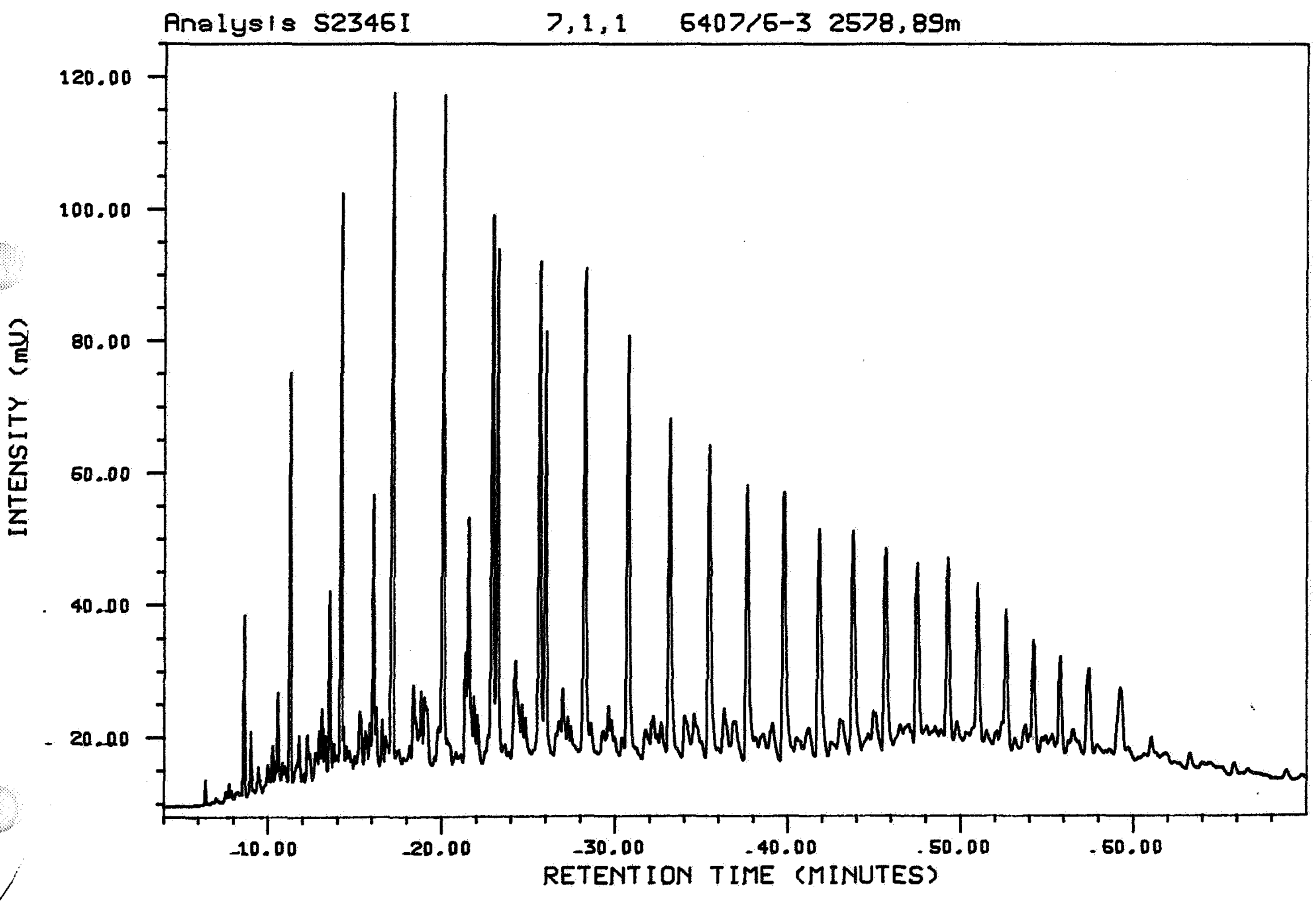
Analysis S2342I 7,1,1 6407/6-3 2552,36m



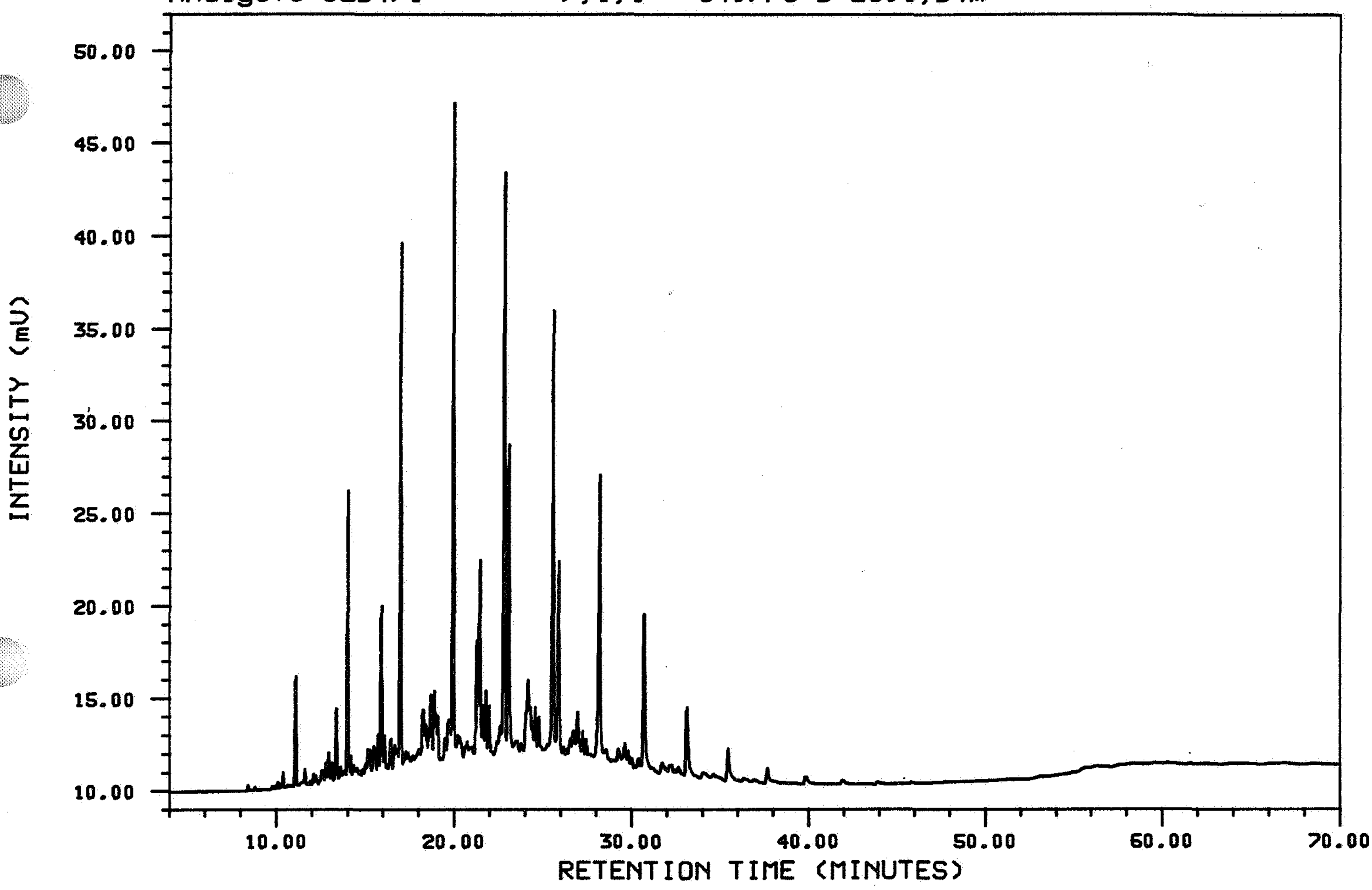

Analysis S2343I 7,1,1 6407/6-3 2560,10m
INTENSITY (mV)
120.00
100.00
80.00
60.00
40.00
20.00
10.00
20.00
30.00
40.00
50.00
60.00
RETENTION TIME (MINUTES)

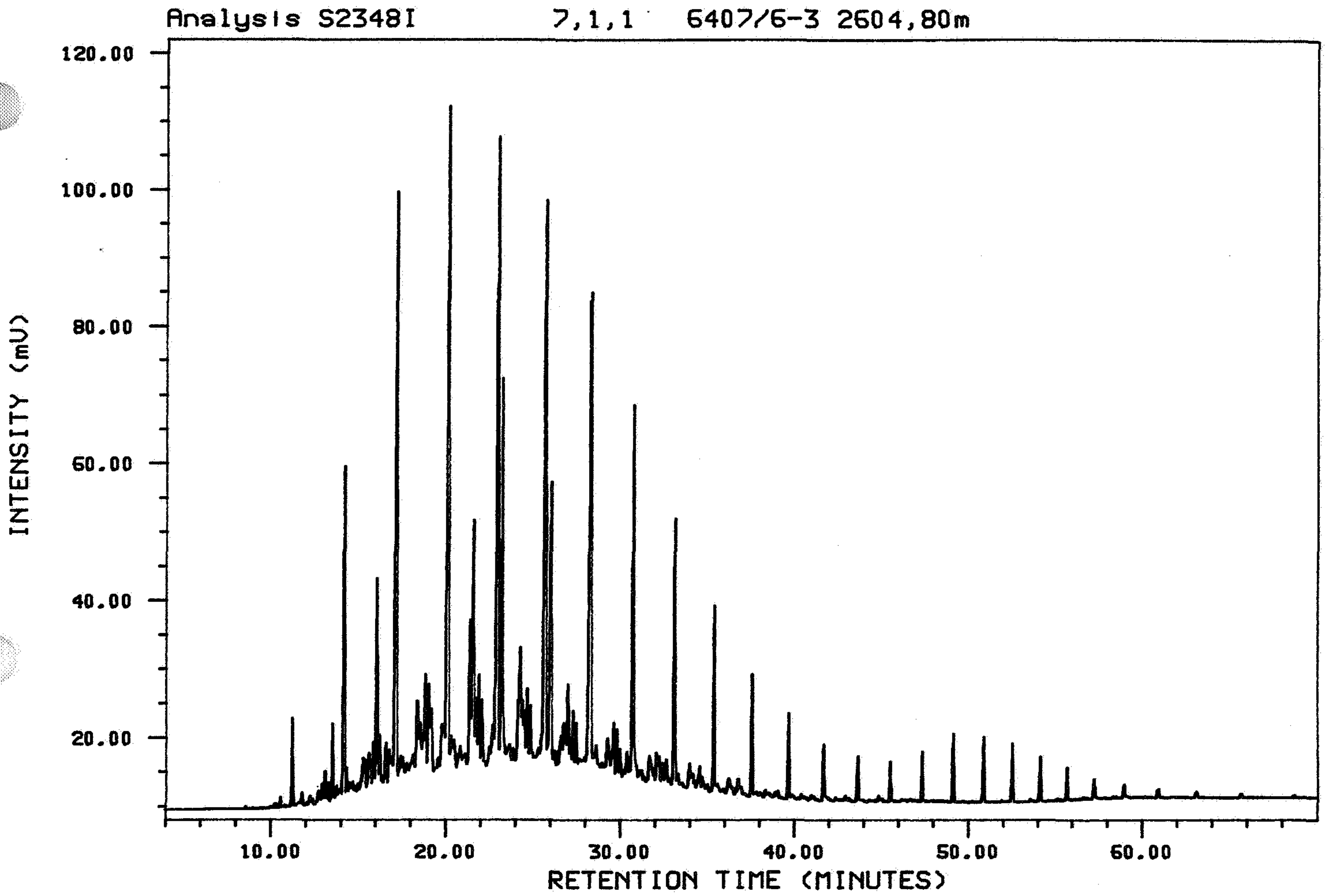

Analysis S2344I 7,1,1 6407/6-3 2564,25m
INTENSITY (mV)
70.00
60.00
50.00
40.00
30.00
20.00
10.00
10.00
20.00
30.00
40.00
50.00
60.00
RETENTION TIME (MINUTES)

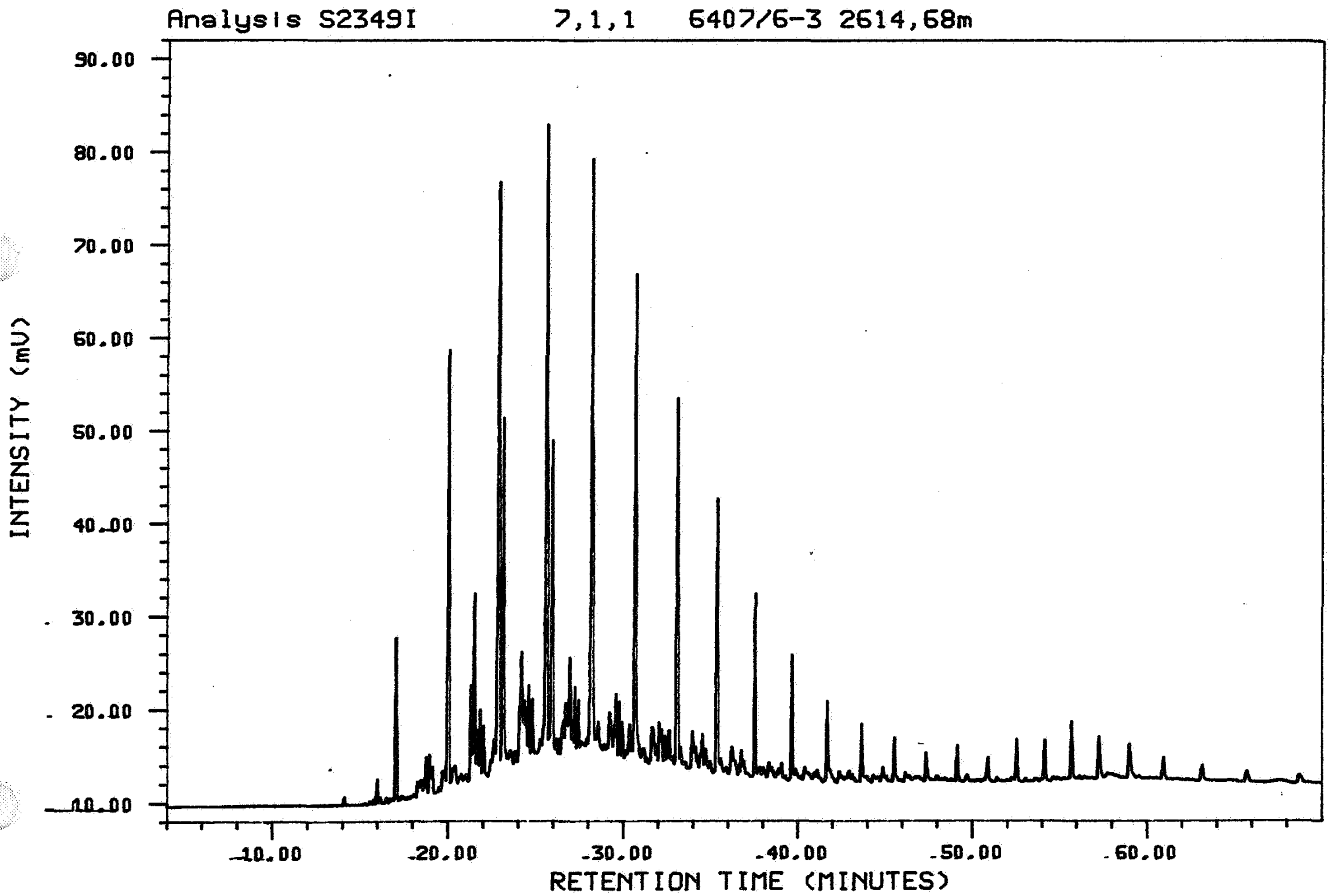

Analysis S2345I 7,1,1 6407/6-3 2575,86m
INTENSITY (mV)
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
10.00
20.00
30.00
40.00
50.00
60.00
RETENTION TIME (MINUTES)


Analysis S2346I 7,1,1 6407/6-3 2578,89m
INTENSITY (mV)
120.00
100.00
80.00
60.00
40.00
20.00
10.00
20.00
30.00
40.00
50.00
60.00
RETENTION TIME (MINUTES)

Analysis S2347I 7,1,1 6407/6-3 2601,34m



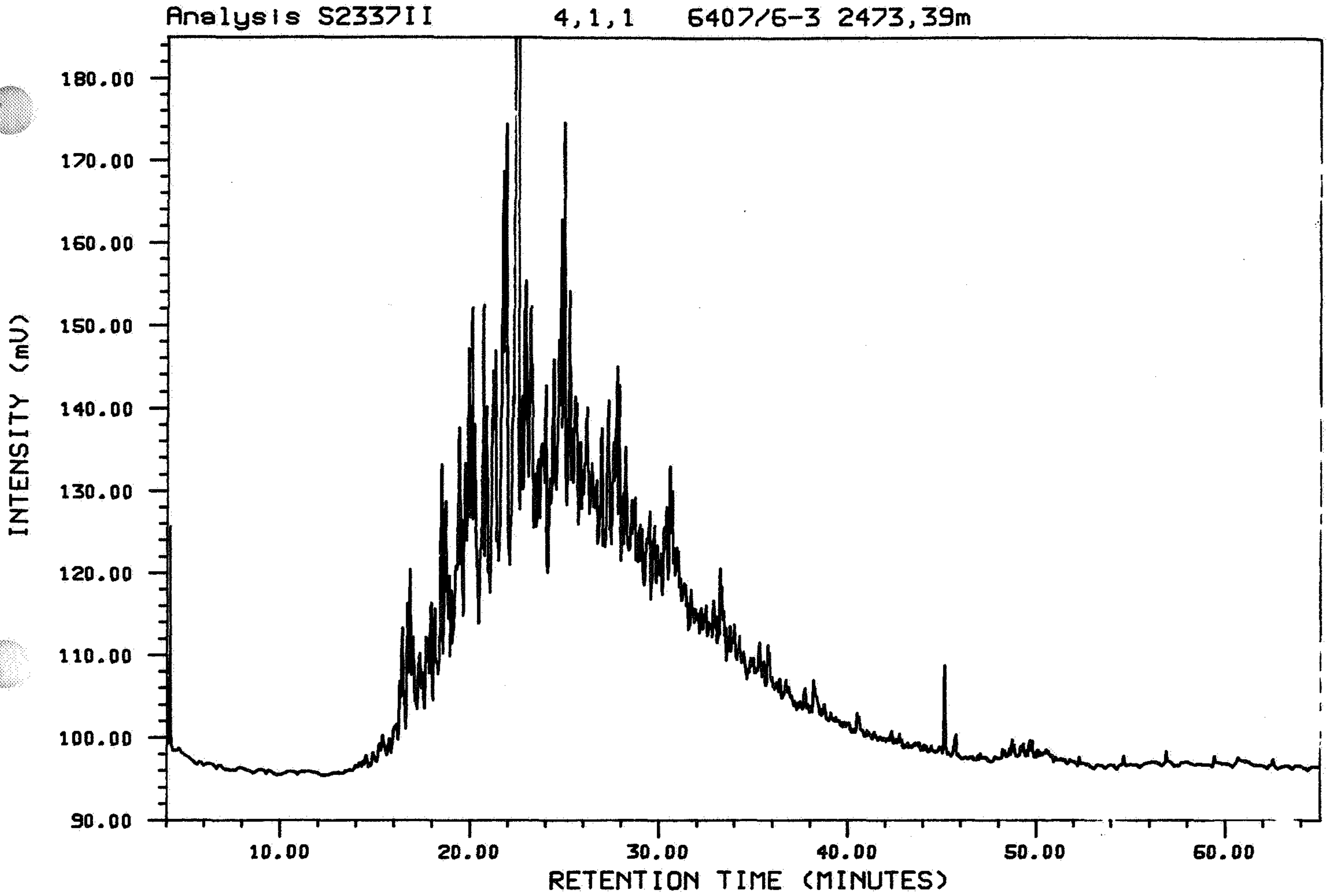

Analysis S2348I 7,1,1 6407/6-3 2604,80m
INTENSITY (mV)
120.00
100.00
80.00
60.00
40.00
20.00
10.00
20.00
30.00
40.00
50.00
60.00
RETENTION TIME (MINUTES)


Analysis S2349I 7,1,1 6407/6-3 2614,68m
INTENSITY (mV)
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
10.00
20.00
30.00
40.00
50.00
60.00
RETENTION TIME (MINUTES)

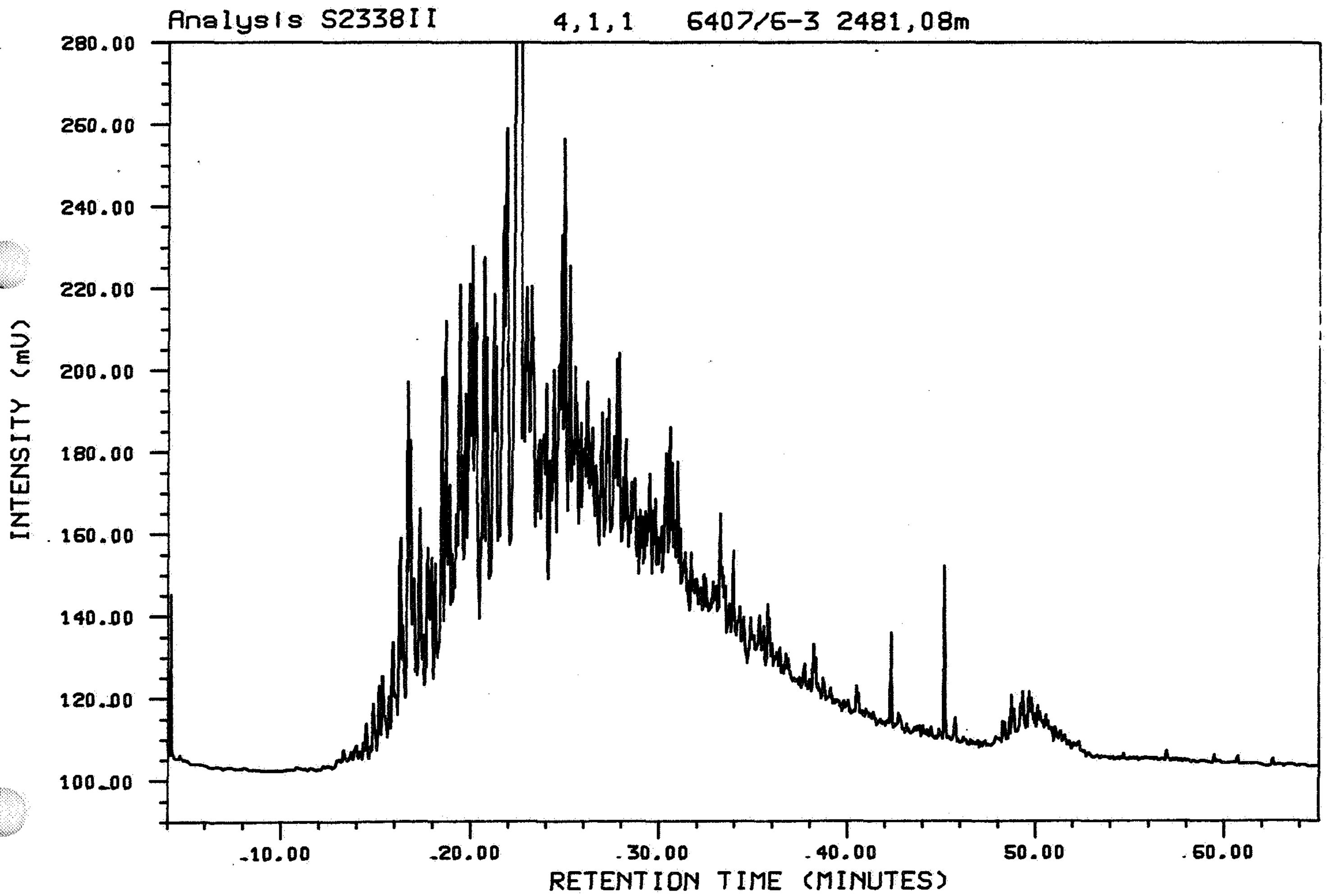
Figures 8a-m

Gas chromatograms, C_{15+}

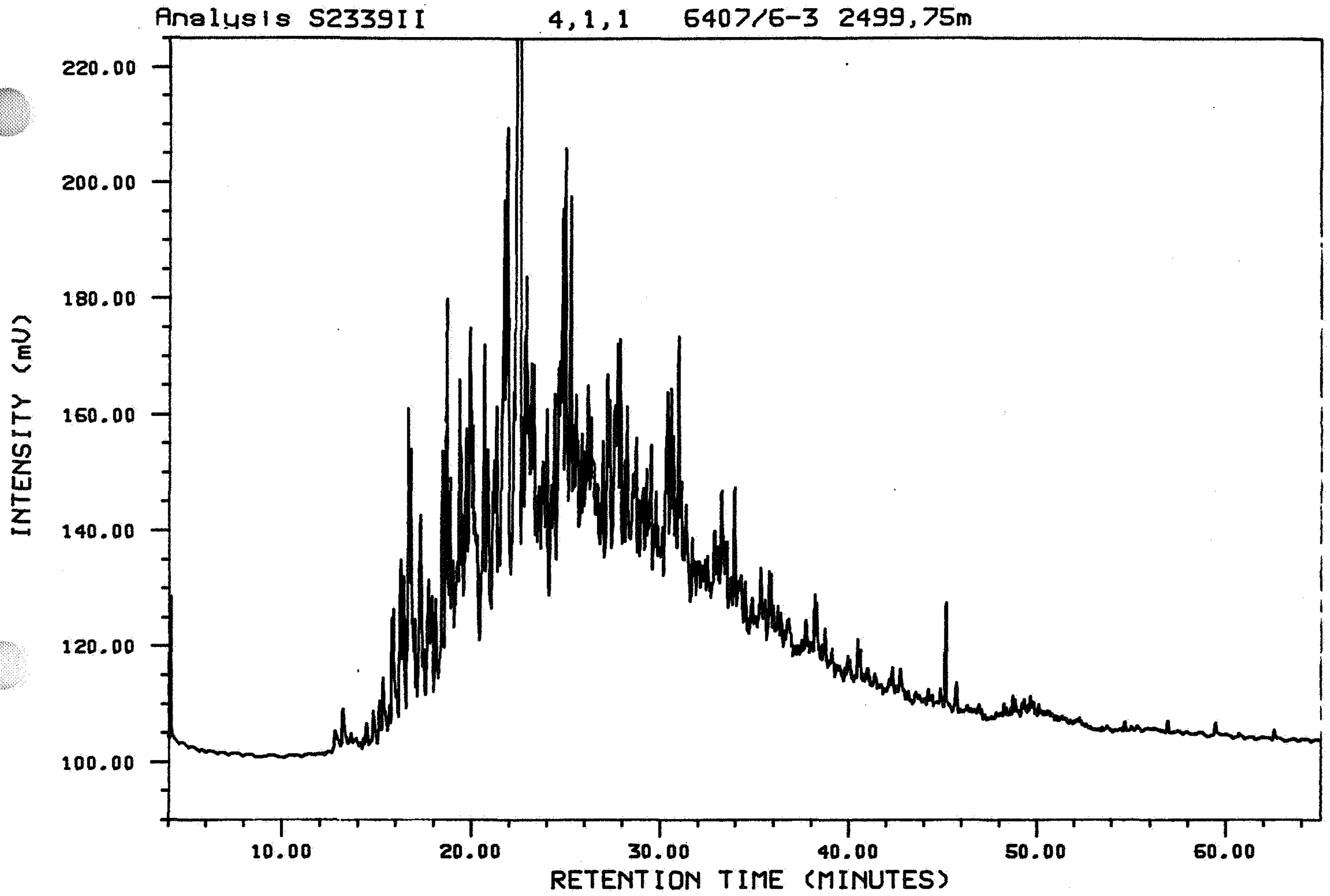
ARO fraction, reservoir sediment samples

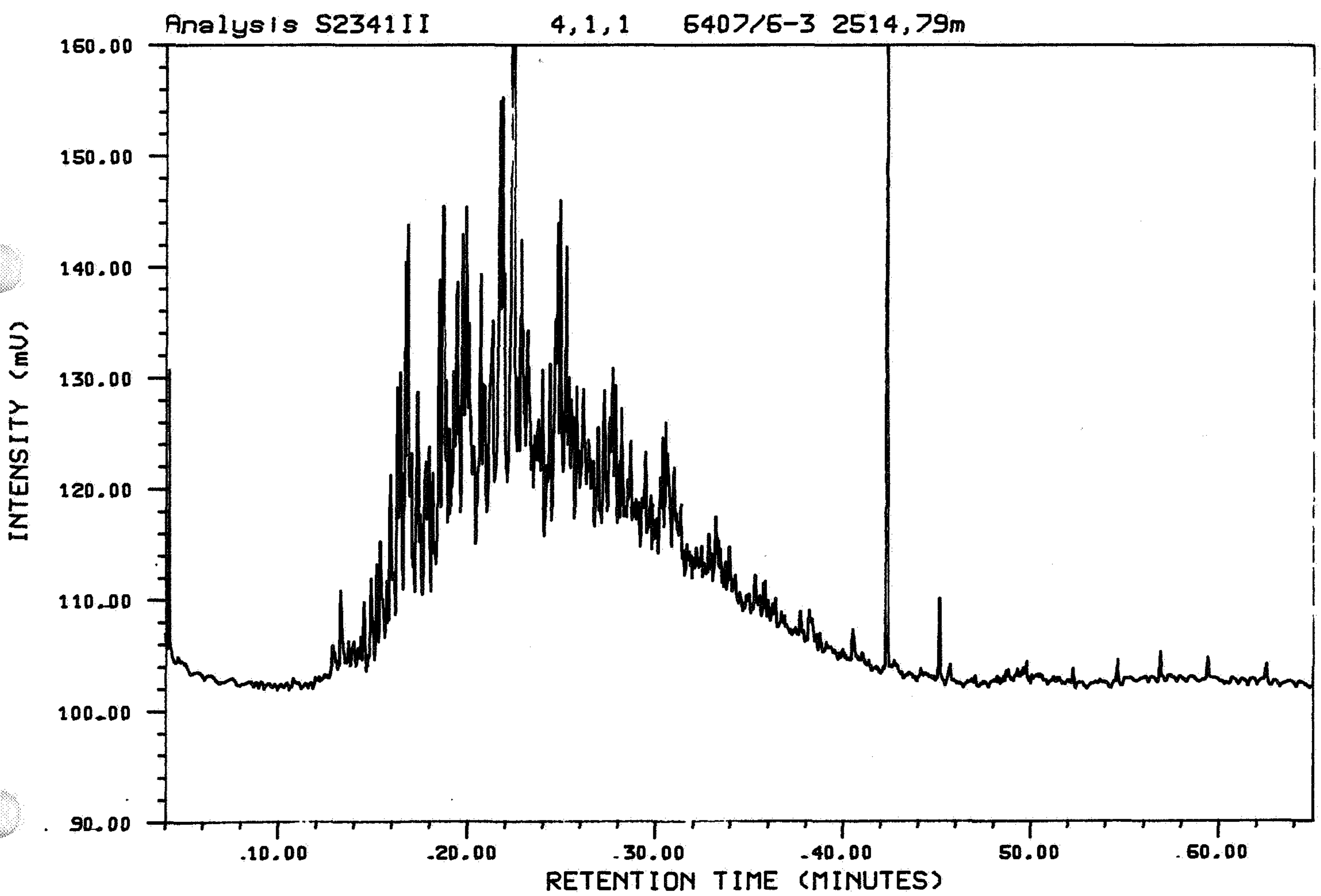


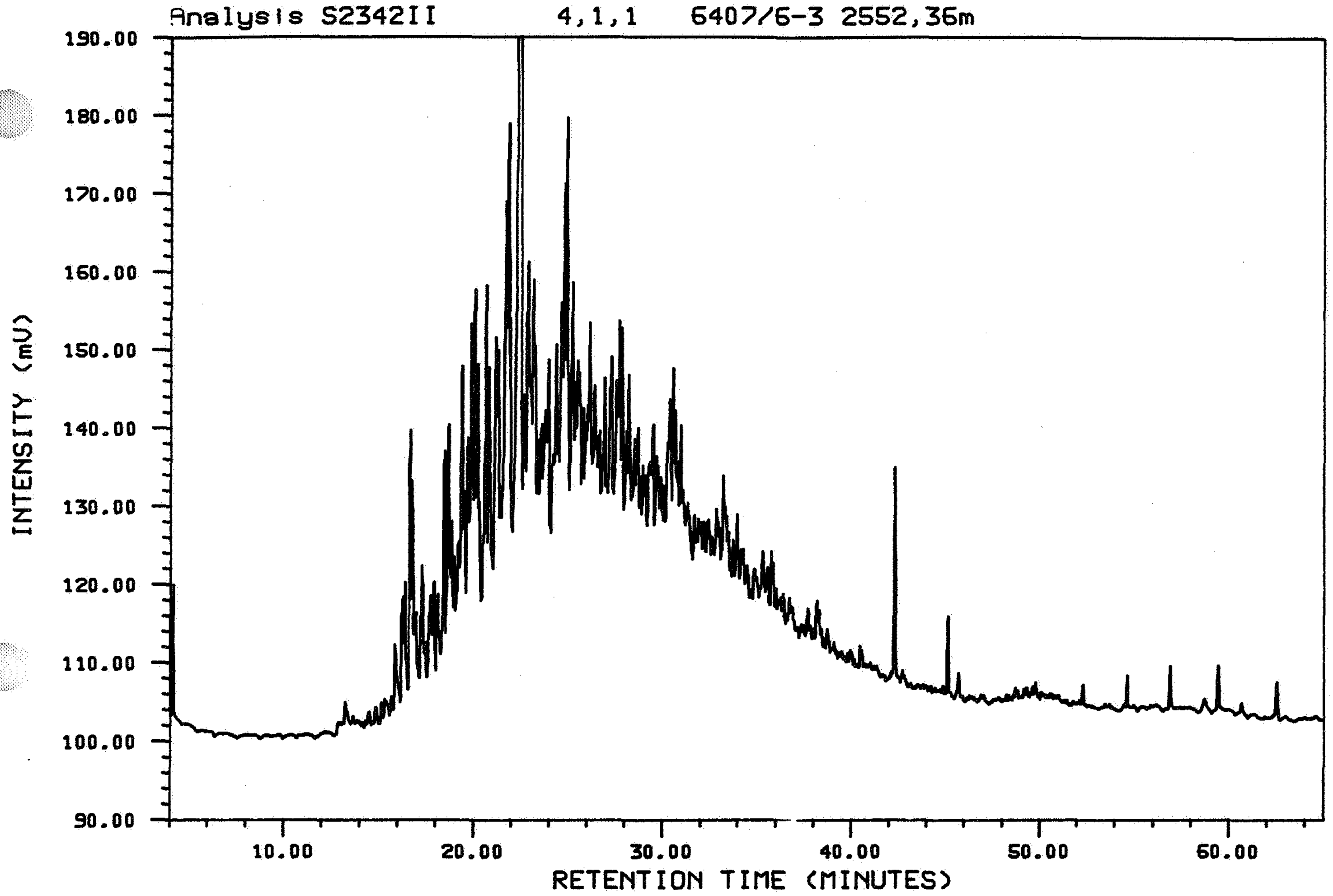
Analysis S2337II 4,1,1 6407/6-3 2473,39m
INTENSITY (mV)
180.00
170.00
160.00
150.00
140.00
130.00
120.00
110.00
100.00
90.00
10.00
20.00
30.00
40.00
50.00
60.00
RETENTION TIME (MINUTES)

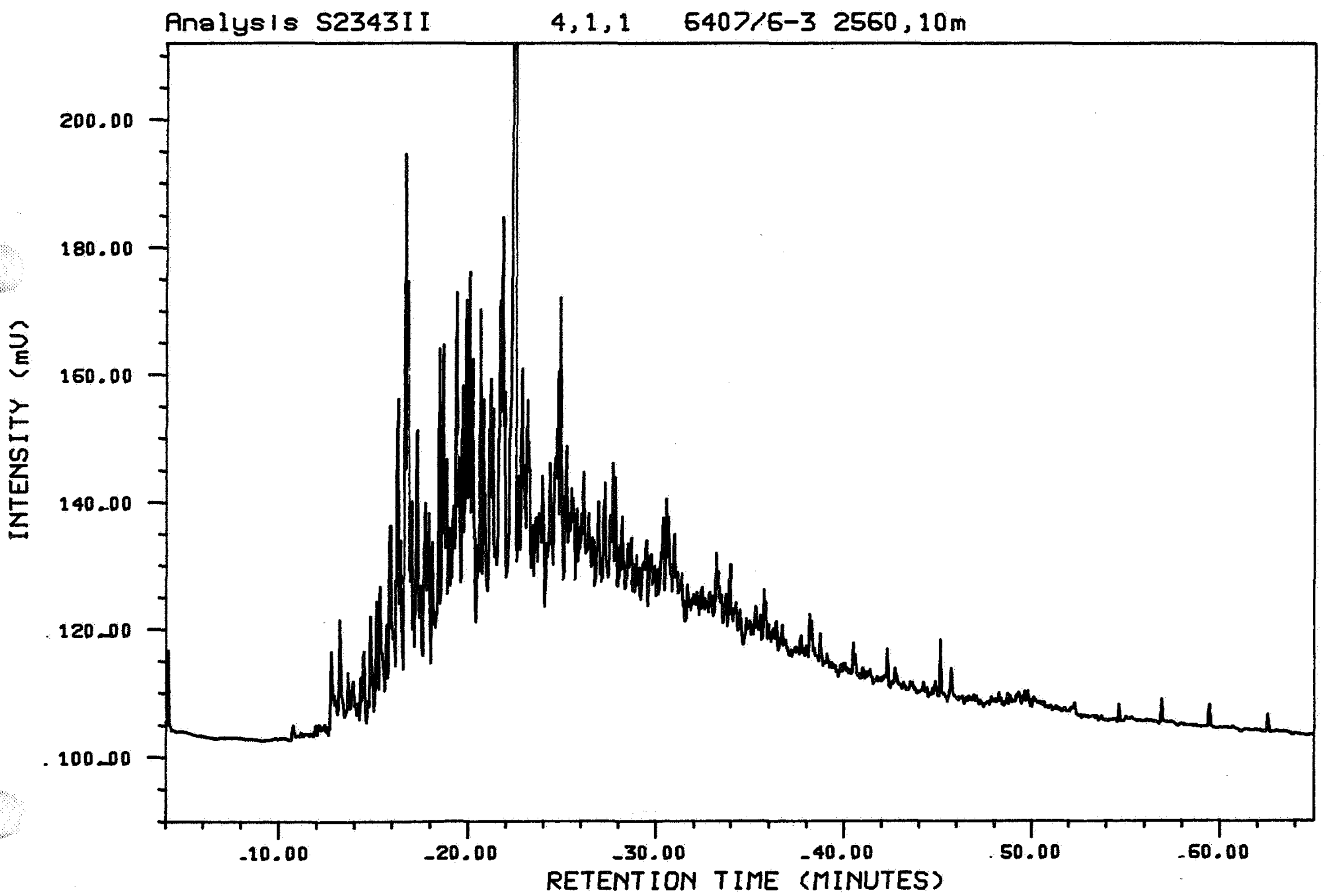


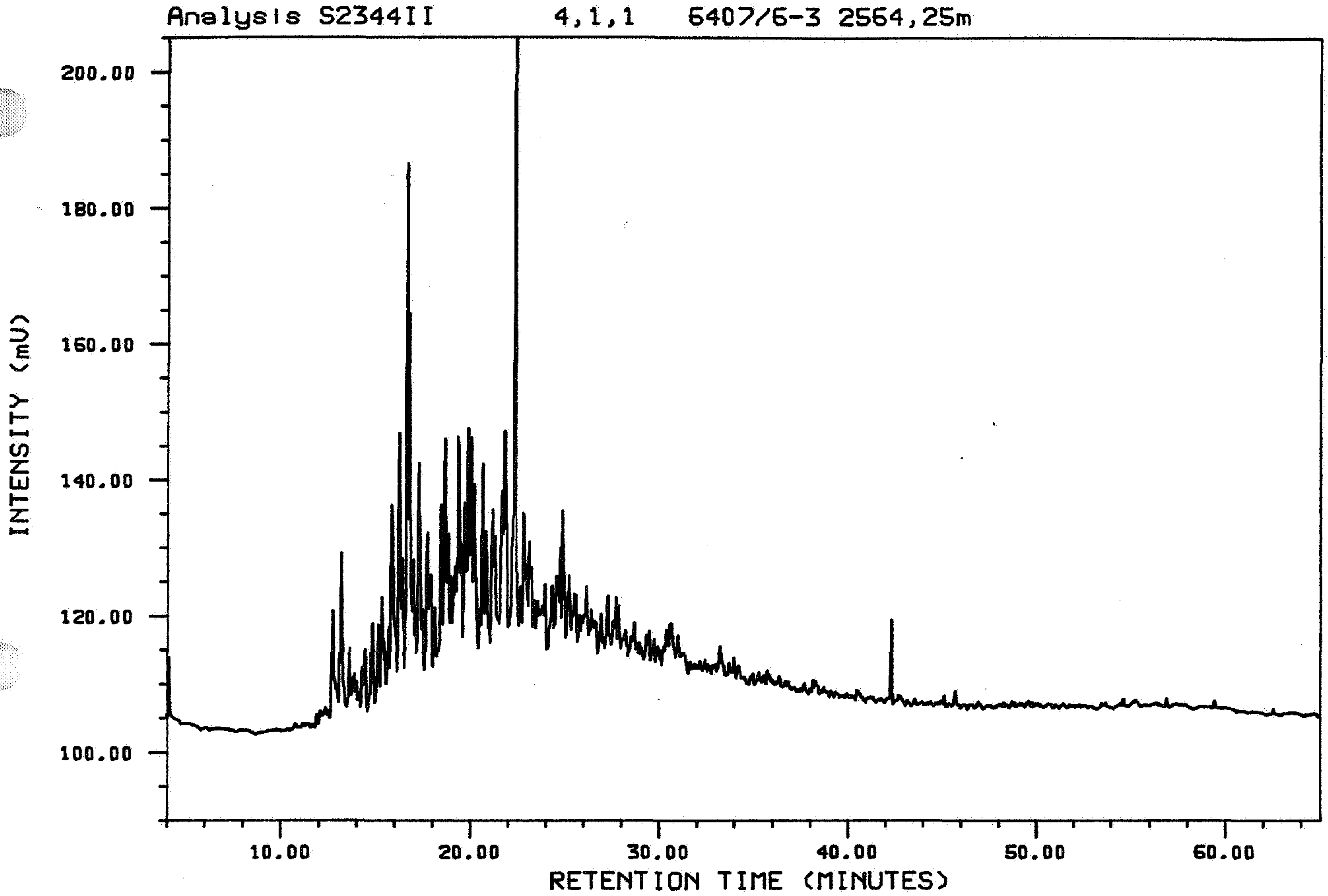
Analysis S2338II 4,1,1 6407/6-3 2481,08m
INTENSITY (mV)
280.00
260.00
240.00
220.00
200.00
180.00
160.00
140.00
120.00
100.00
10.00
20.00
30.00
40.00
50.00
60.00
RETENTION TIME (MINUTES)

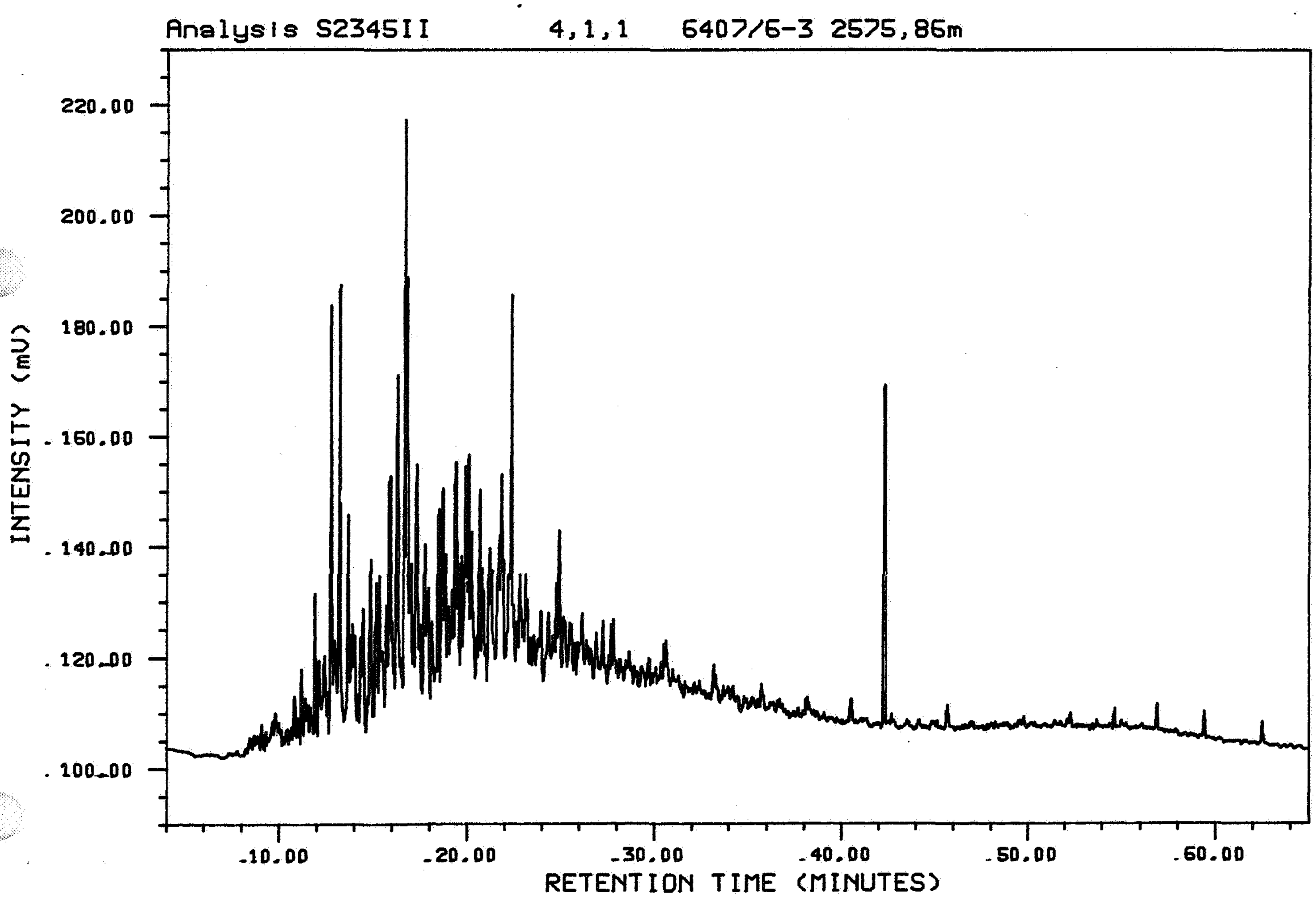

Analysis S2339II 4,1,1 6407/6-3 2499,75m
220.00
200.00
180.00
160.00
140.00
120.00
100.00
INTENSITY (mV)
10.00
20.00
30.00
40.00
50.00
60.00
RETENTION TIME (MINUTES)


Analysis S2341II 4,1,1 6407/6-3 2514,79m
160.00
150.00
140.00
130.00
120.00
110.00
100.00
90.00
INTENSITY (mV)
10.00
20.00
30.00
40.00
50.00
60.00
RETENTION TIME (MINUTES)

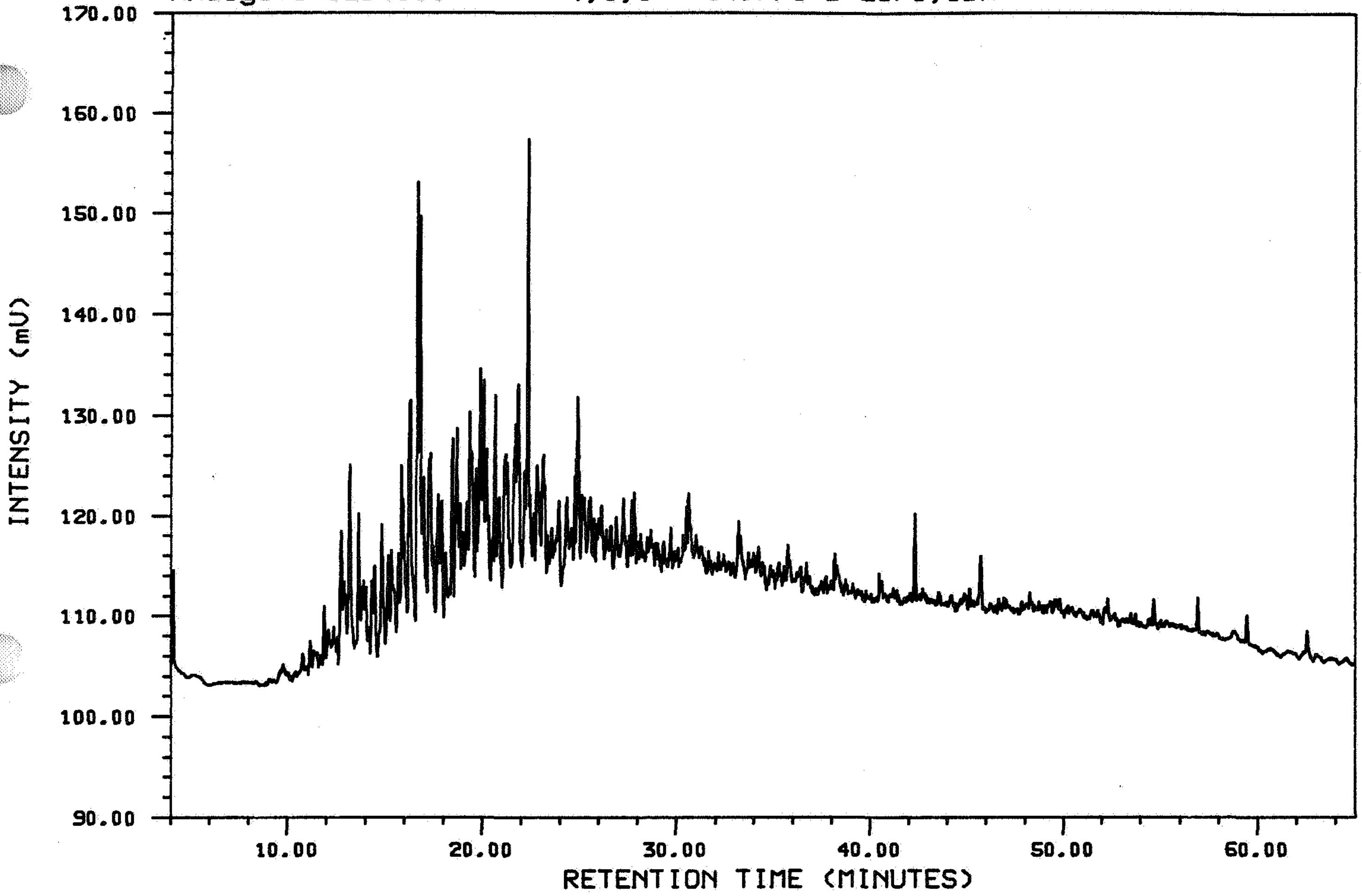

Analysis S2342II 4,1,1 6407/6-3 2552,36m
INTENSITY (mU)
190.00
180.00
170.00
160.00
150.00
140.00
130.00
120.00
110.00
100.00
90.00
10.00
20.00
30.00
40.00
50.00
60.00
RETENTION TIME (MINUTES)


Analysis S2343II 4,1,1 6407/6-3 2560,10m
INTENSITY (mU)
200.00
180.00
160.00
140.00
120.00
100.00
10.00
20.00
30.00
40.00
50.00
60.00
RETENTION TIME (MINUTES)

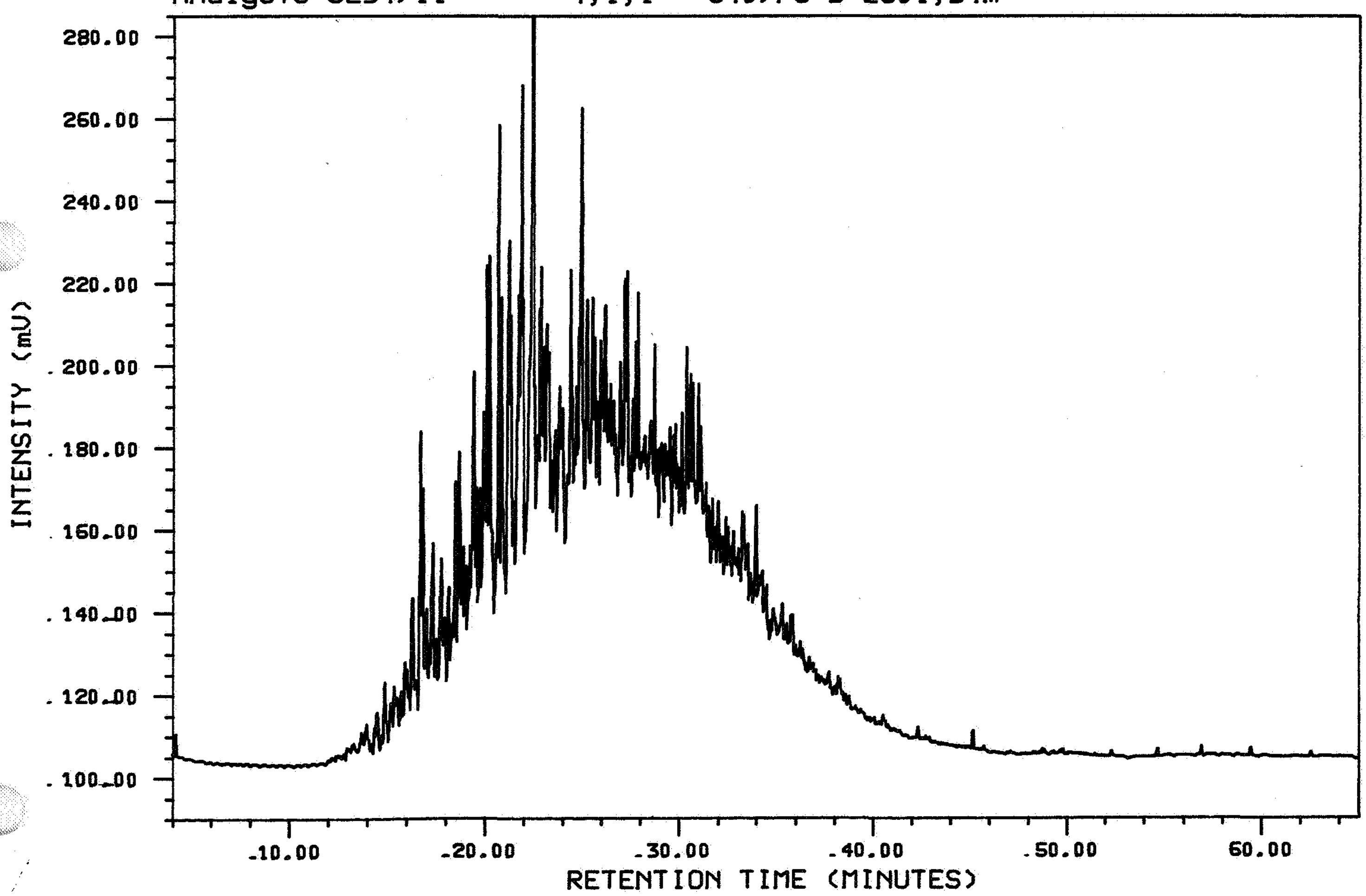

Analysis S2344II 4,1,1 6407/6-3 2564,25m
200.00
180.00
160.00
140.00
120.00
100.00
INTENSITY (mV)
10.00
20.00
30.00
40.00
50.00
60.00
RETENTION TIME (MINUTES)

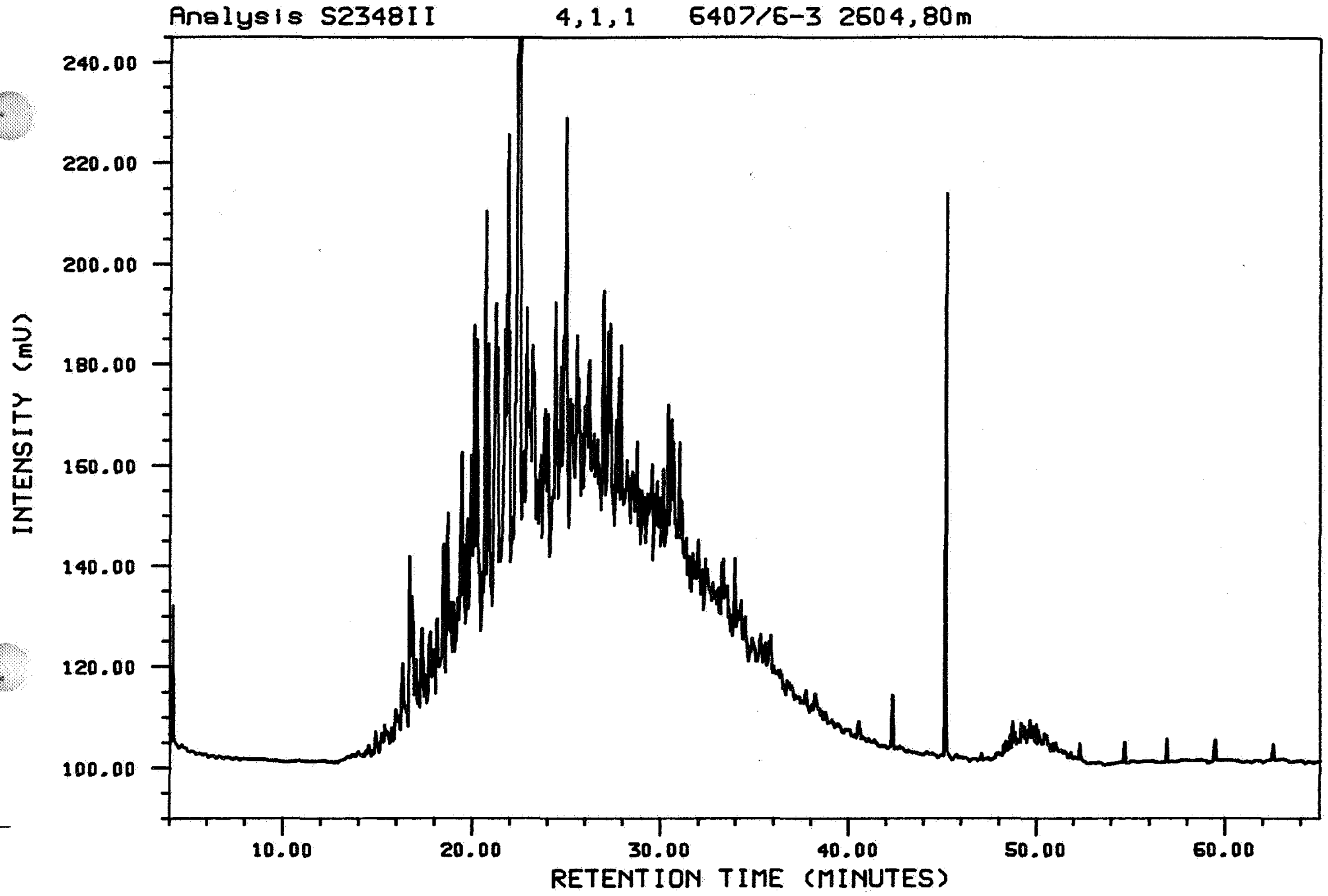

Analysis S2345II 4,1,1 6407/6-3 2575,86m
220.00
200.00
180.00
160.00
140.00
120.00
100.00
INTENSITY (mV)
10.00
20.00
30.00
40.00
50.00
60.00
RETENTION TIME (MINUTES)

Analysis S2346II 4,1,1 6407/6-3 2578,89m



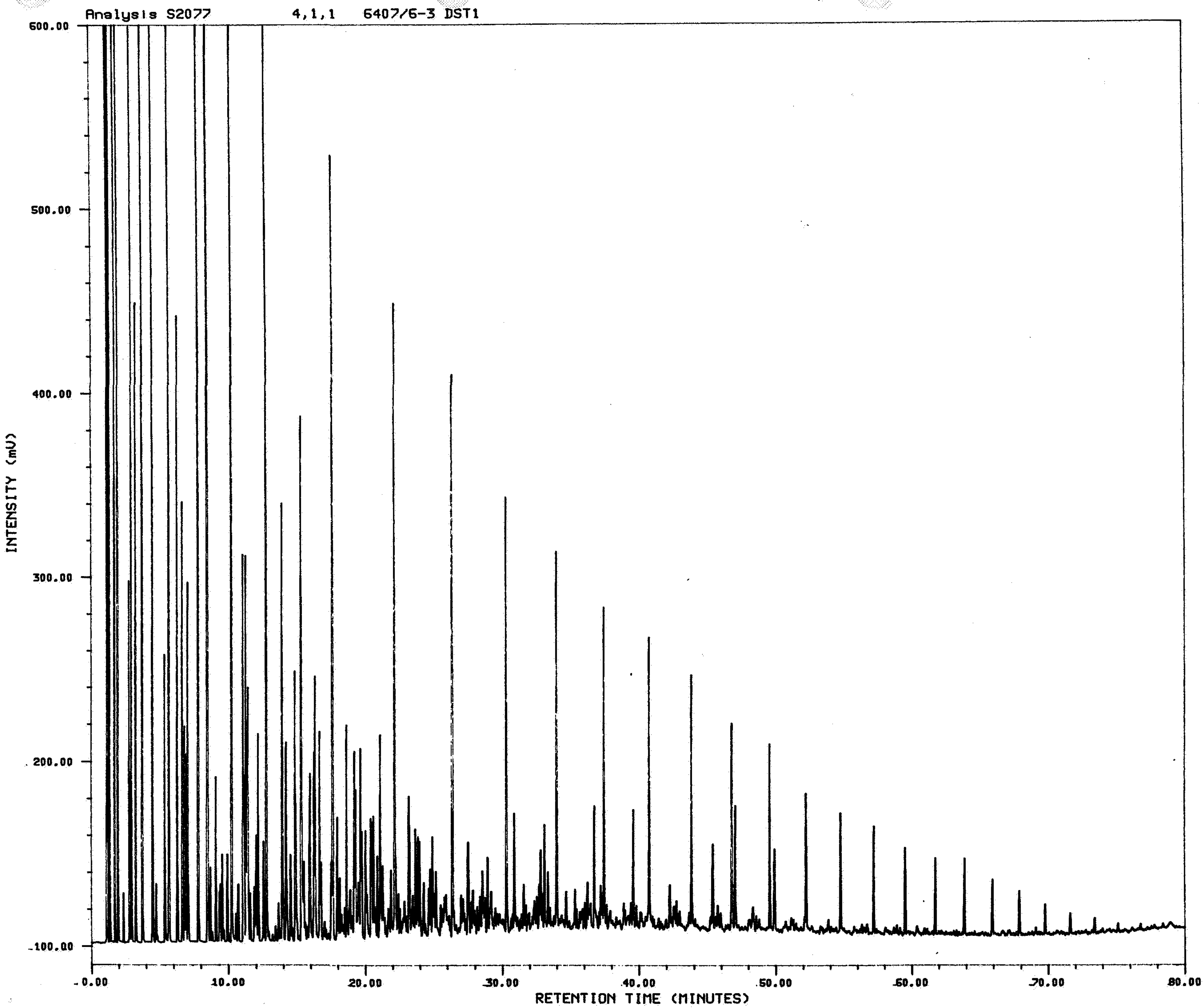
Analysis S2347II 4,1,1 6407/6-3 2601,34m



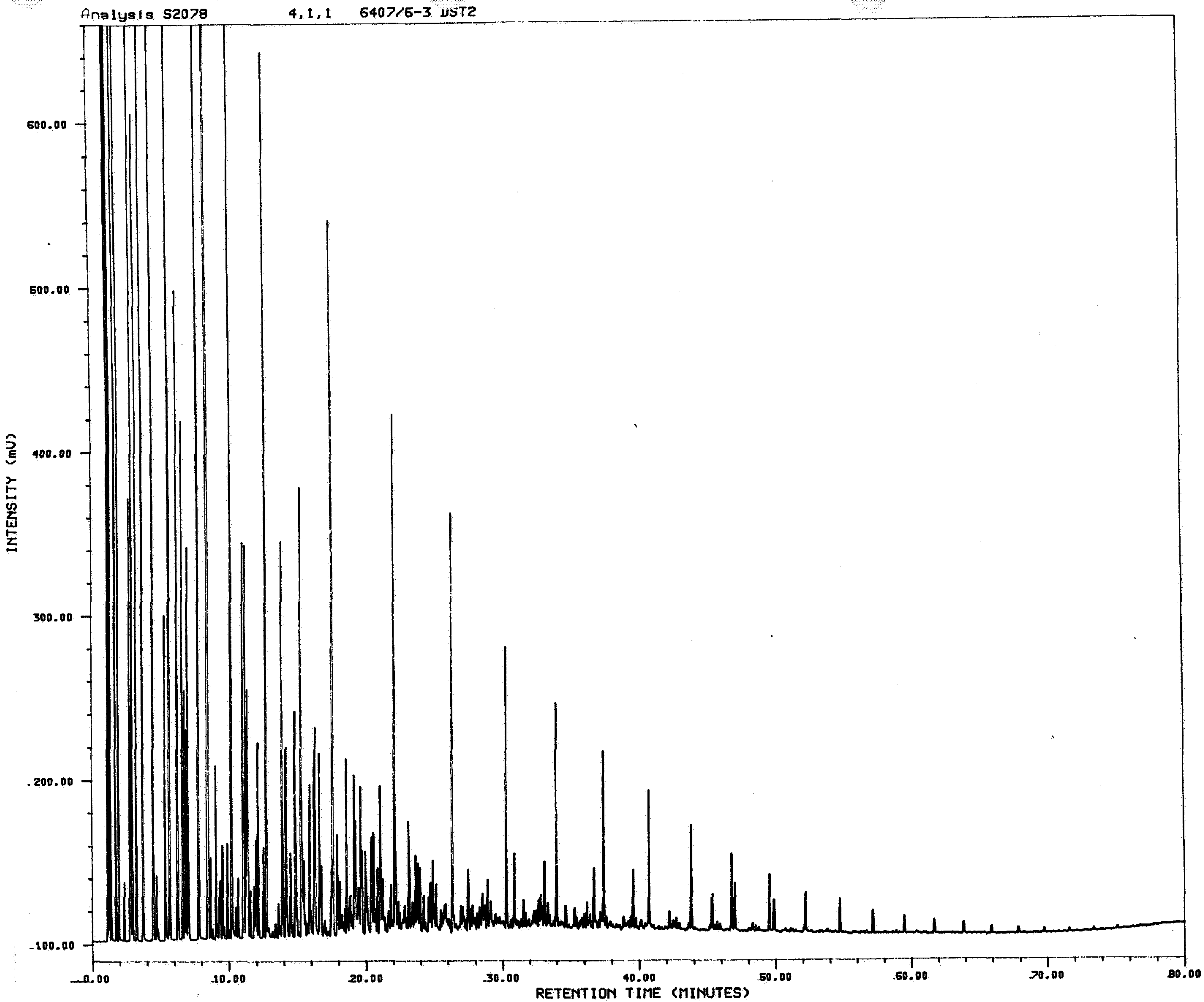


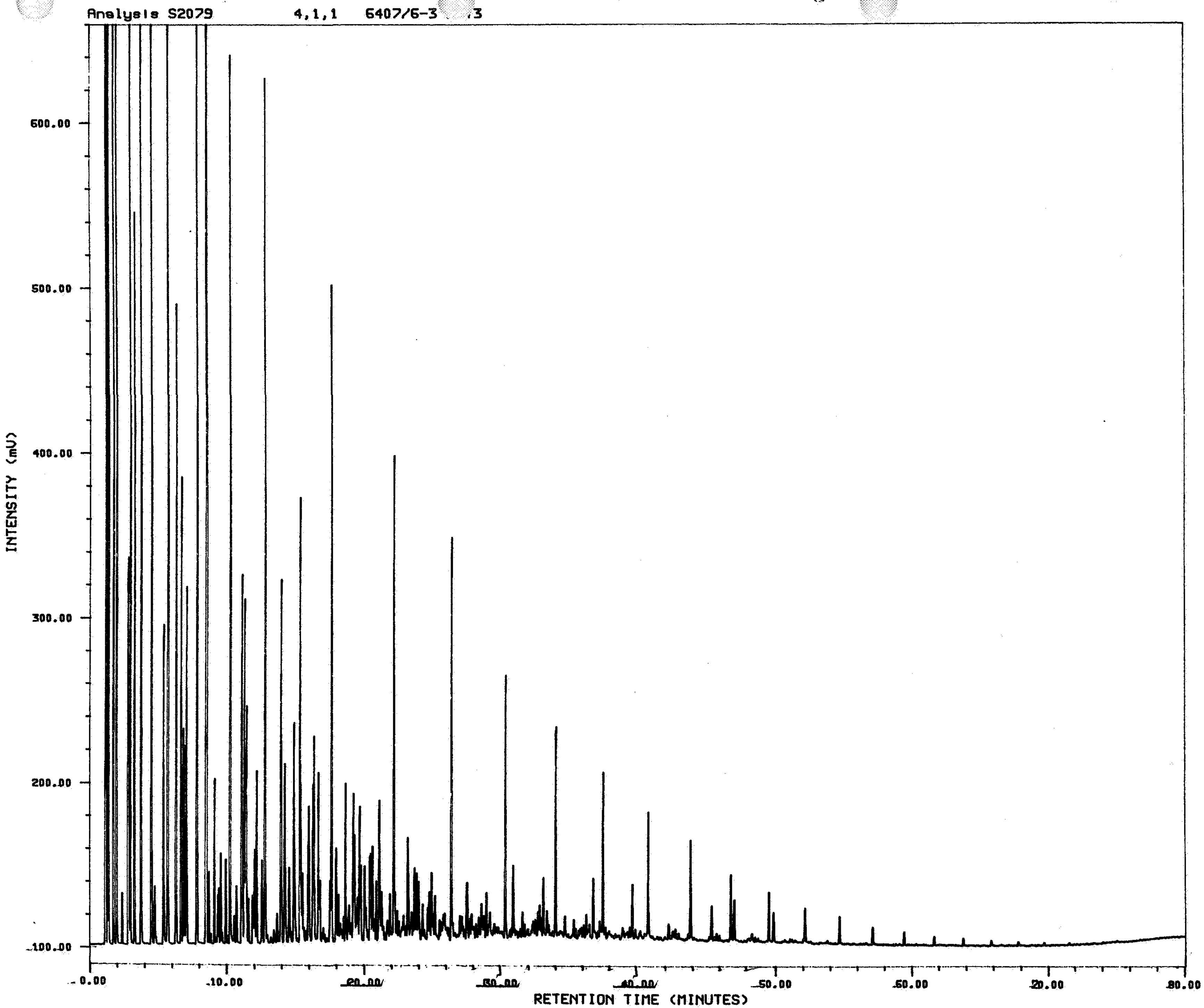
Analysis S2348II 4,1,1 6407/6-3 2604,80m
240.00
220.00
200.00
180.00
160.00
140.00
120.00
100.00
INTENSITY (mU)
10.00
20.00
30.00
40.00
50.00
60.00
RETENTION TIME (MINUTES)

Figures 9a-c
Gas chromatograms
Whole oils



Analysis S2077 4,1,1 6407/6-3 DST1
INTENSITY (mV)
600.00
500.00
400.00
300.00
200.00
100.00
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
RETENTION TIME (MINUTES)


Analysis S2078 4,1,1 6407/6-3 DST2
INTENSITY (mV)
600.00
500.00
400.00
300.00
200.00
100.00
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
RETENTION TIME (MINUTES)



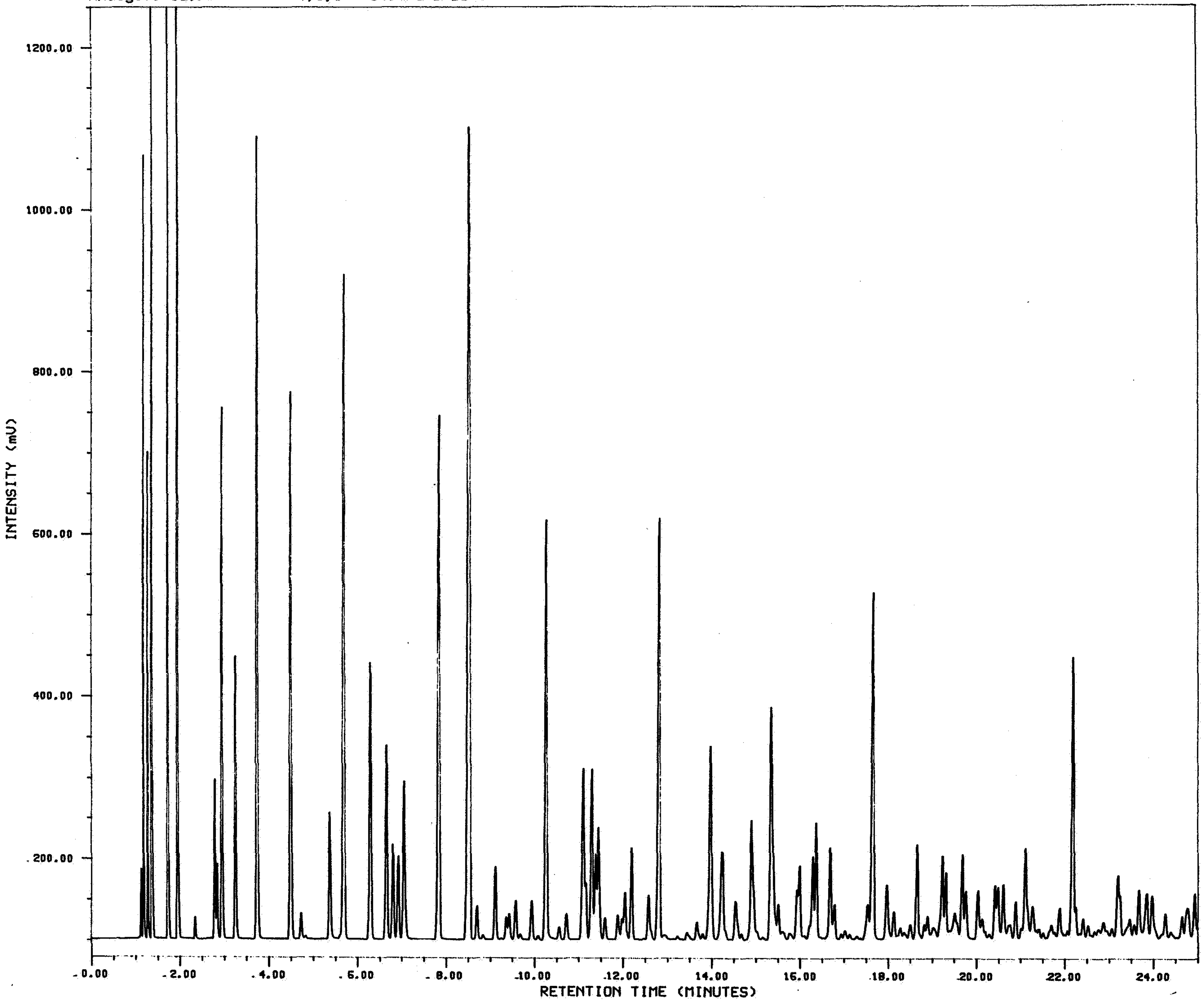
Analysis S2079 4,1,1 6407/6-3 .3
600.00
500.00
400.00
300.00
200.00
100.00
INTENSITY (mV)
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
RETENTION TIME (MINUTES)

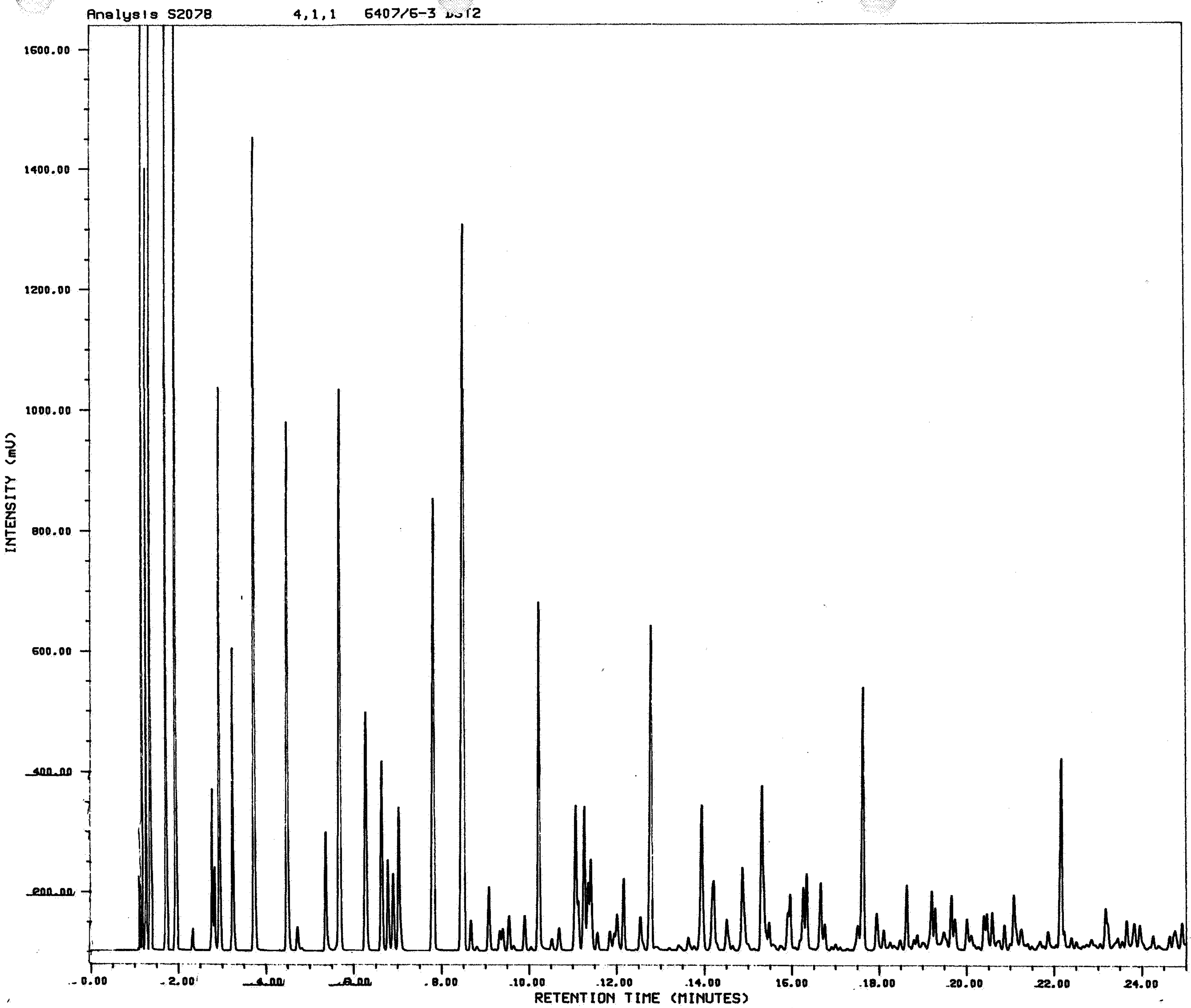
Figures 10a-c

Gas chromatograms

Whole oils, C_2-C_8 range

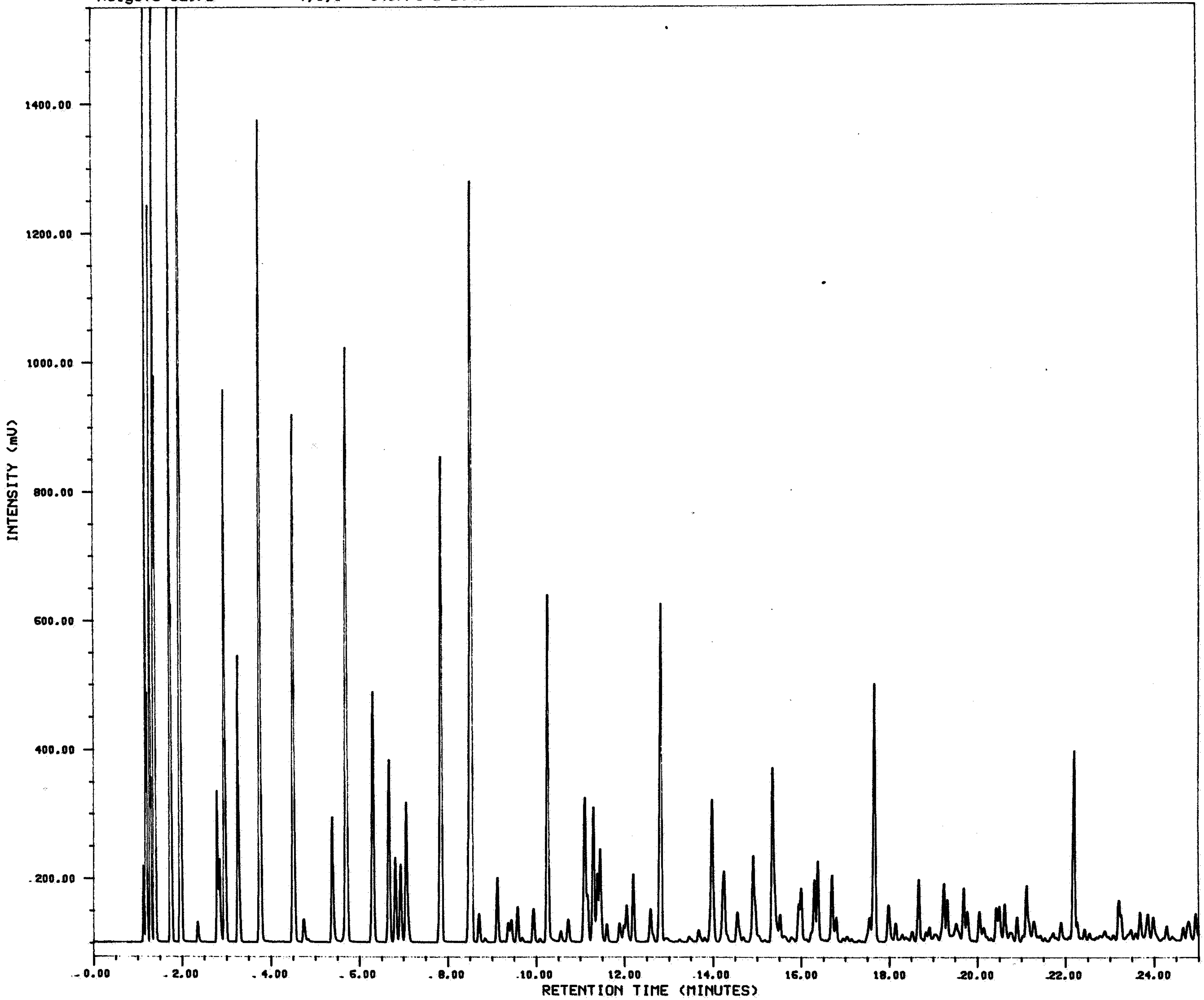
Analysis S2077 4,1,1 6407/6-3 DST1





Analysis S2078 4,1,1 6407/6-3 DST2
INTENSITY (mV)
1600.00
1400.00
1200.00
1000.00
800.00
600.00
400.00
200.00
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
22.00
24.00
RETENTION TIME (MINUTES)

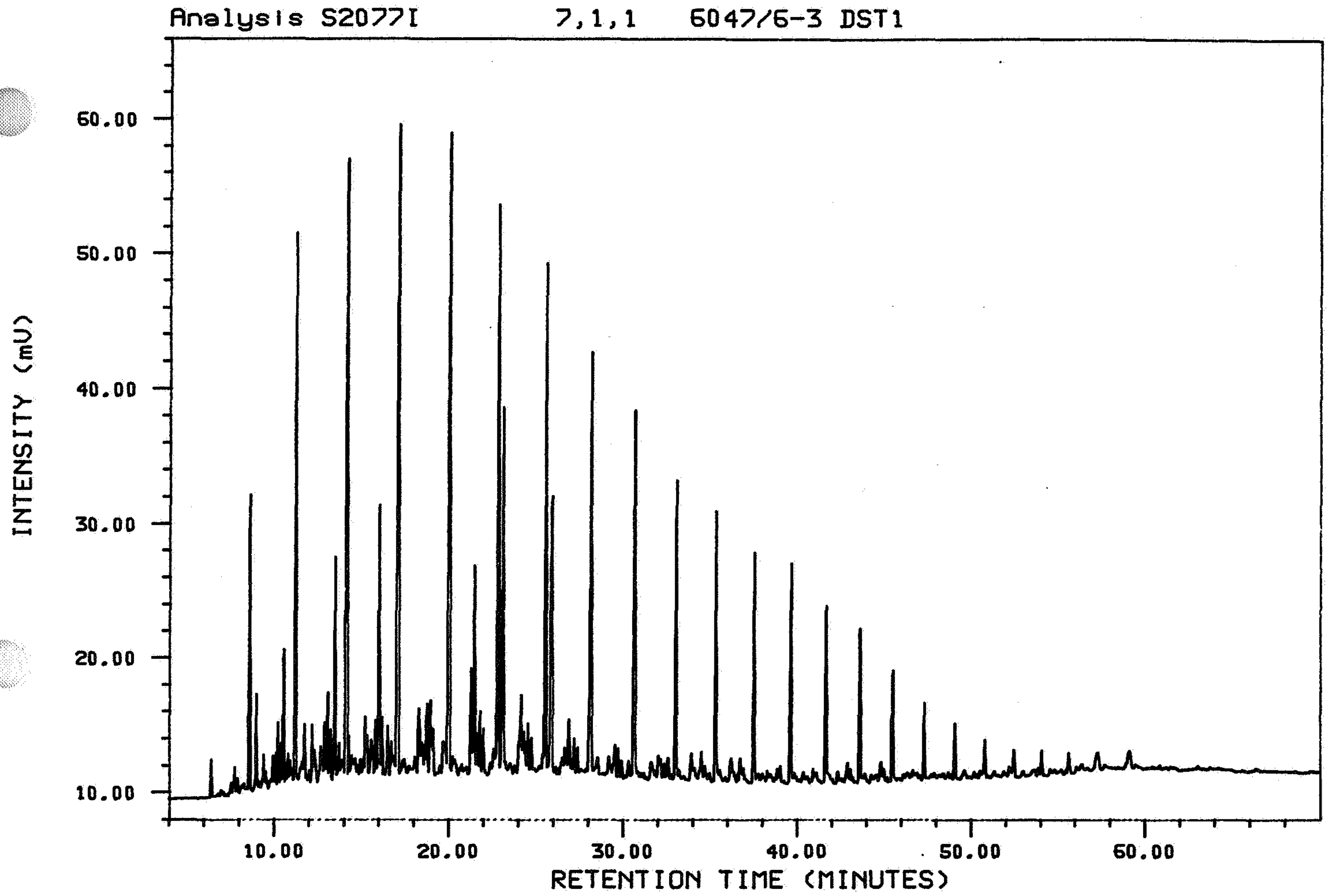
nalysis S2079 4,1,1 6407/6-3 DST3

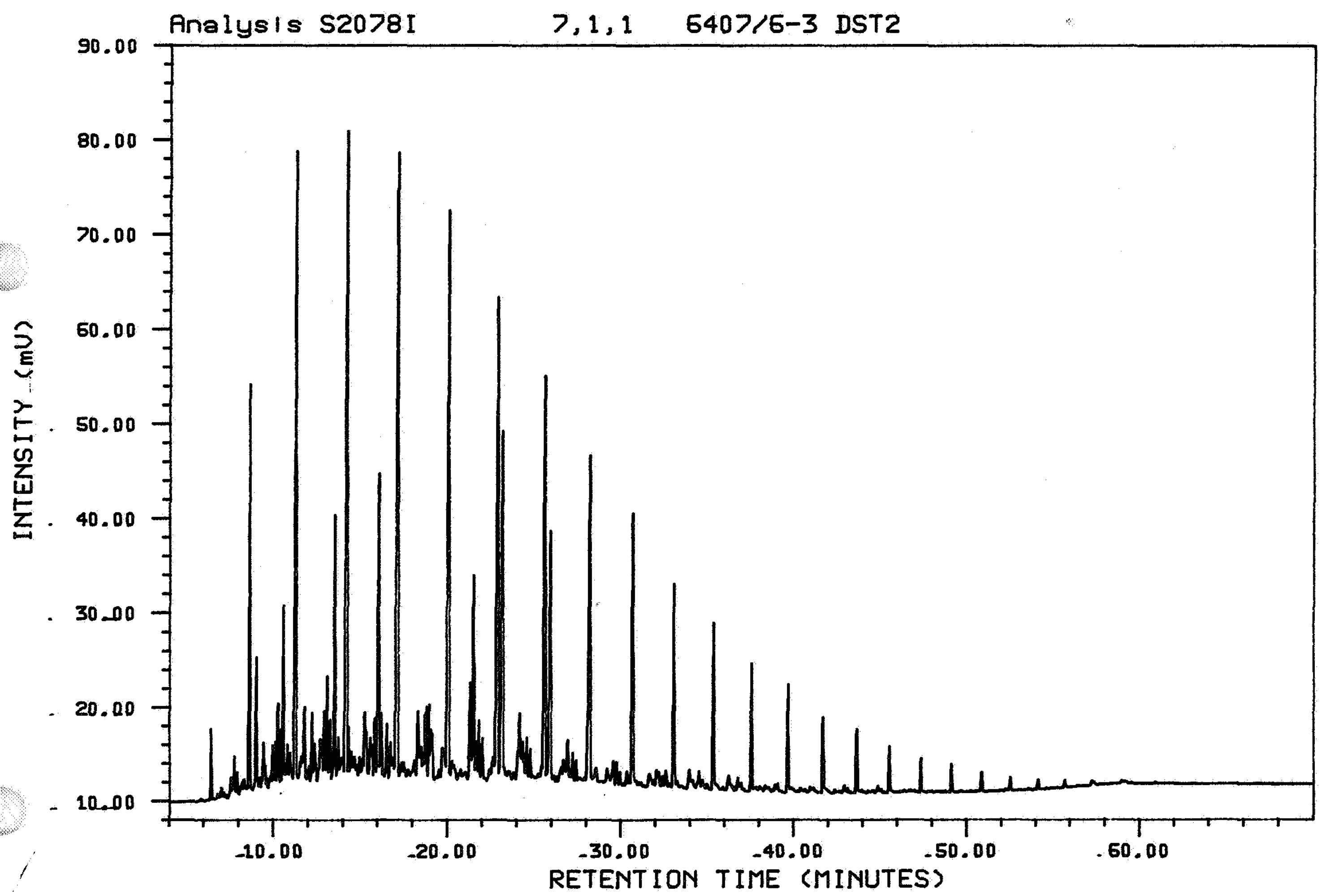


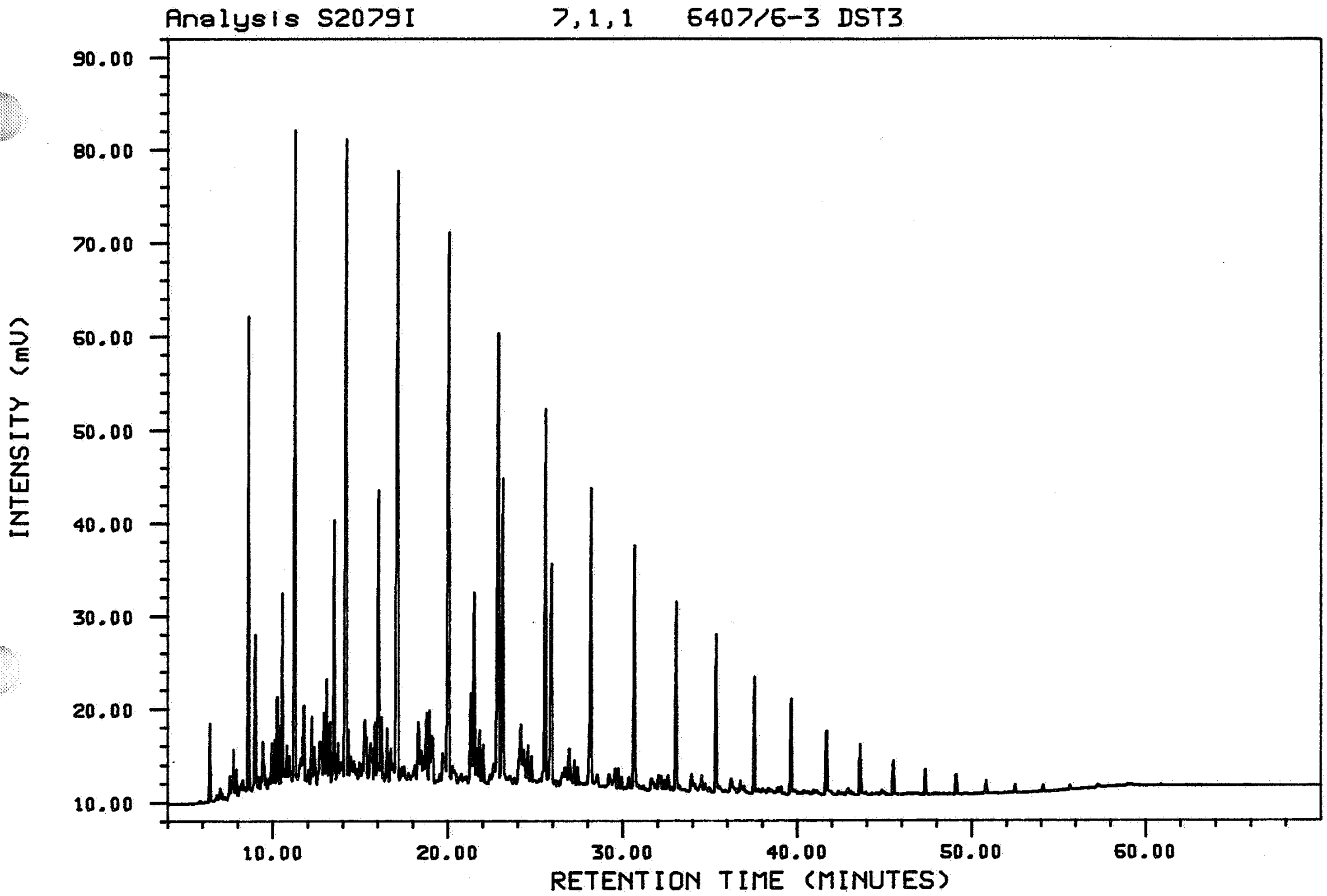
Figures 11a-e

Gas chromatograms, "C_{15+}"

SAT fraction, topped oils


Analysis S2077I 7,1,1 6047/6-3 DST1
INTENSITY (mV)
60.00
50.00
40.00
30.00
20.00
10.00
10.00
20.00
30.00
40.00
50.00
60.00
RETENTION TIME (MINUTES)


Analysis S2078I 7,1,1 6407/6-3 DST2
INTENSITY (mV)
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
10.00
20.00
30.00
40.00
50.00
60.00
RETENTION TIME (MINUTES)



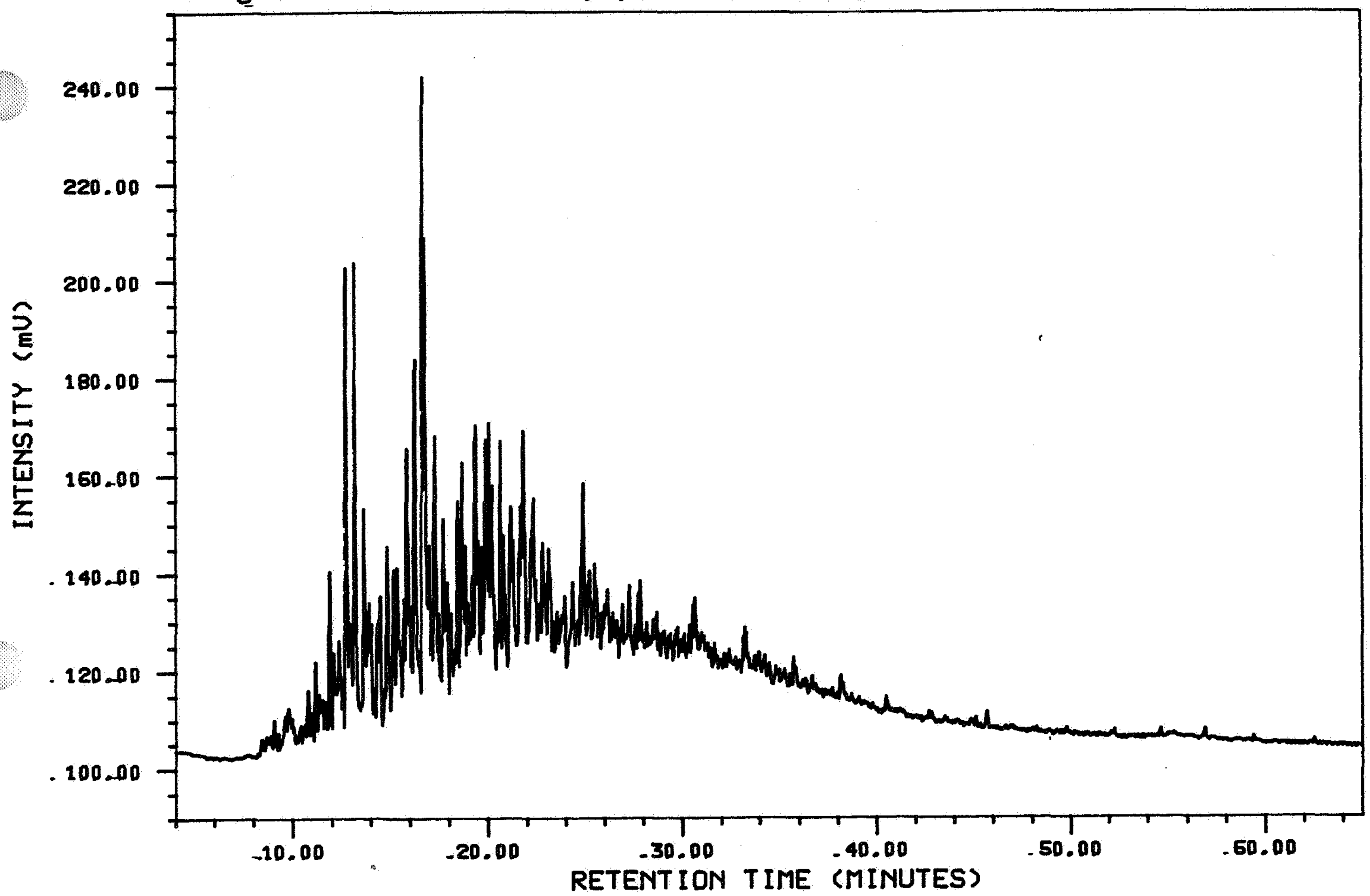
Analysis S2079I 7,1,1 6407/6-3 DST3
INTENSITY (mV)
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
10.00
20.00
30.00
40.00
50.00
60.00
RETENTION TIME (MINUTES)

Figures 12a-c

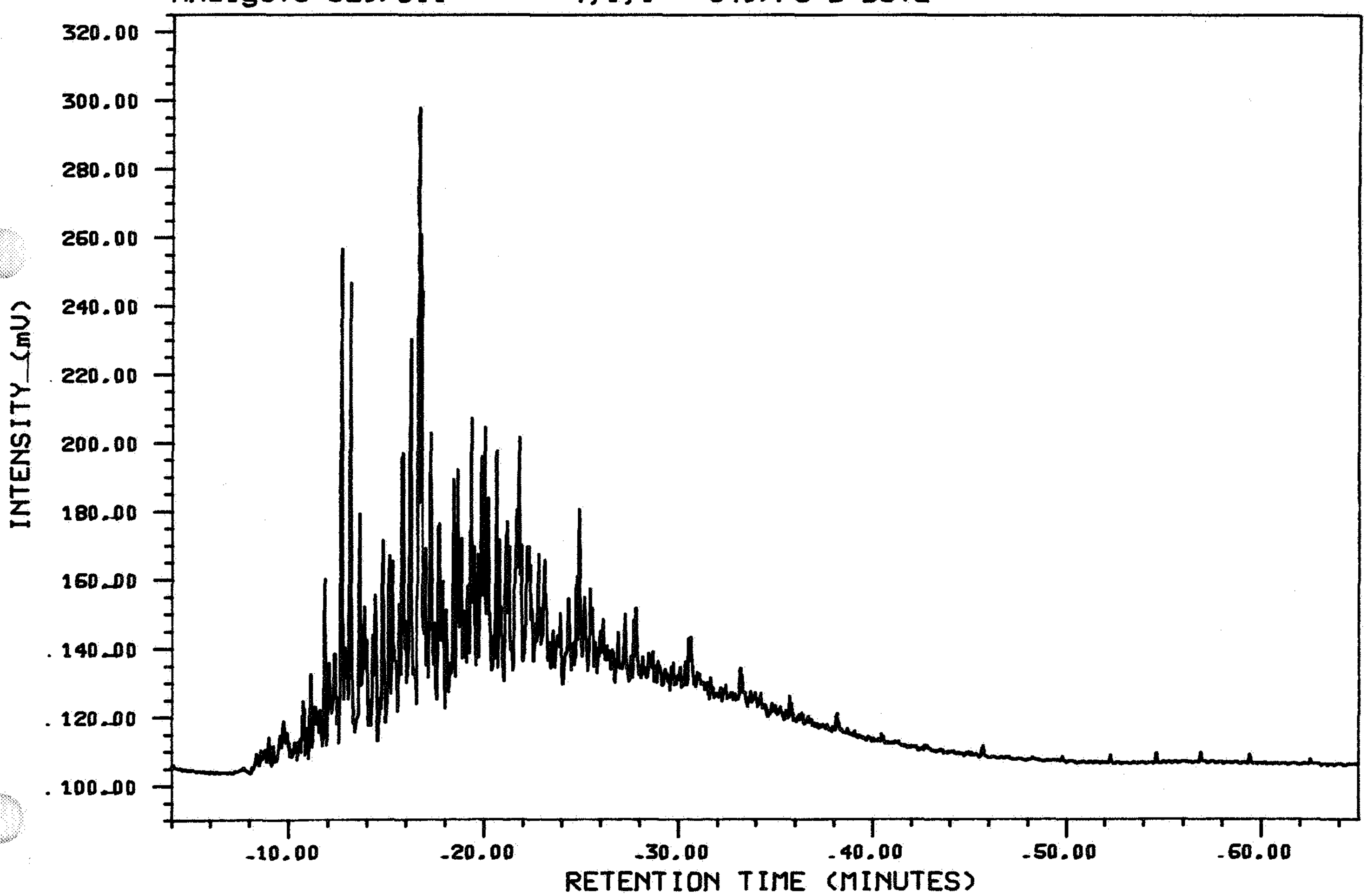
Gas chromatograms , "C_{15+}"

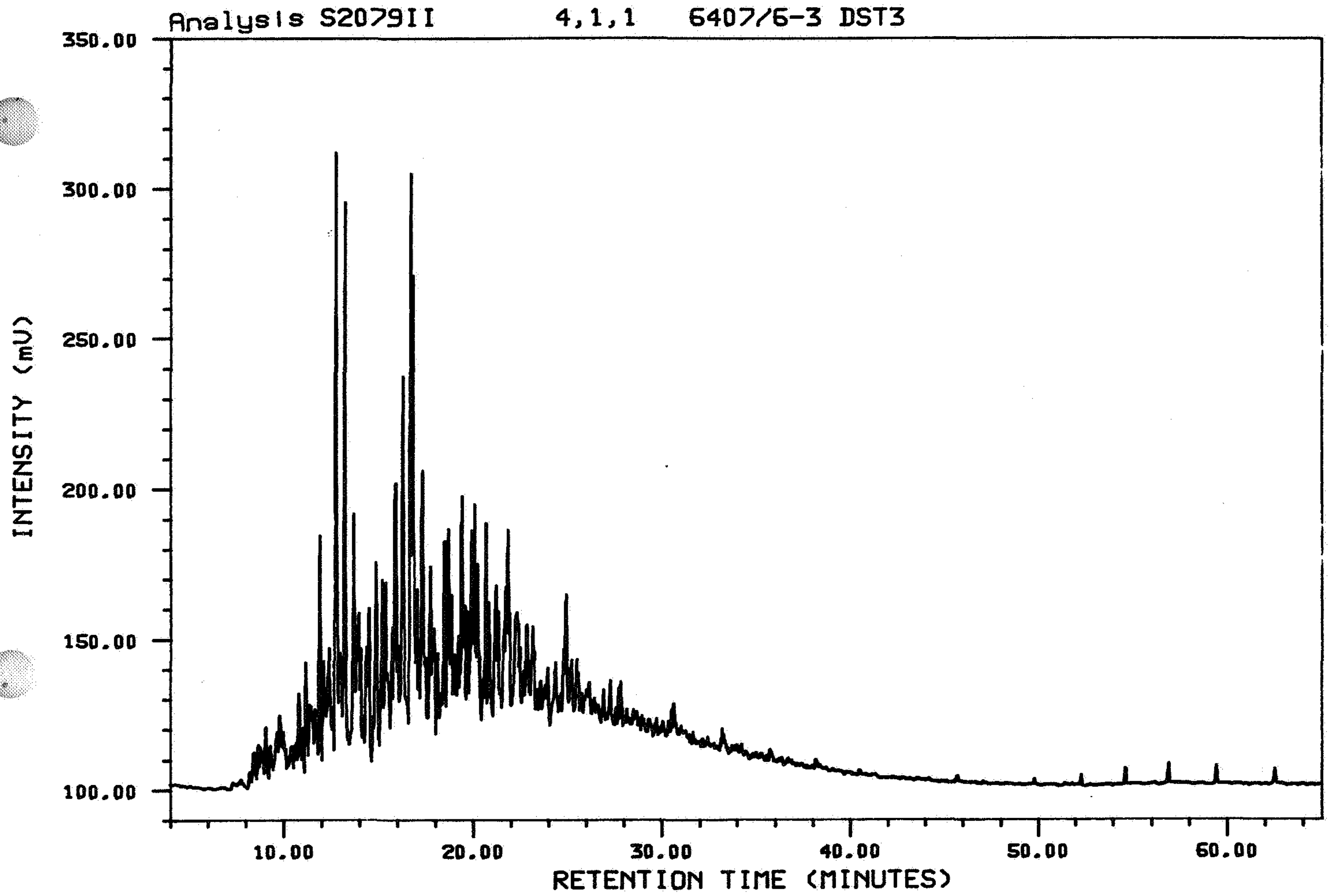
ARO fraction, topped oils

Analysis S2077II 4,1,1 6407/6-3 DST1



Analysis S2078II 4,1,1 6407/6-3 DST2



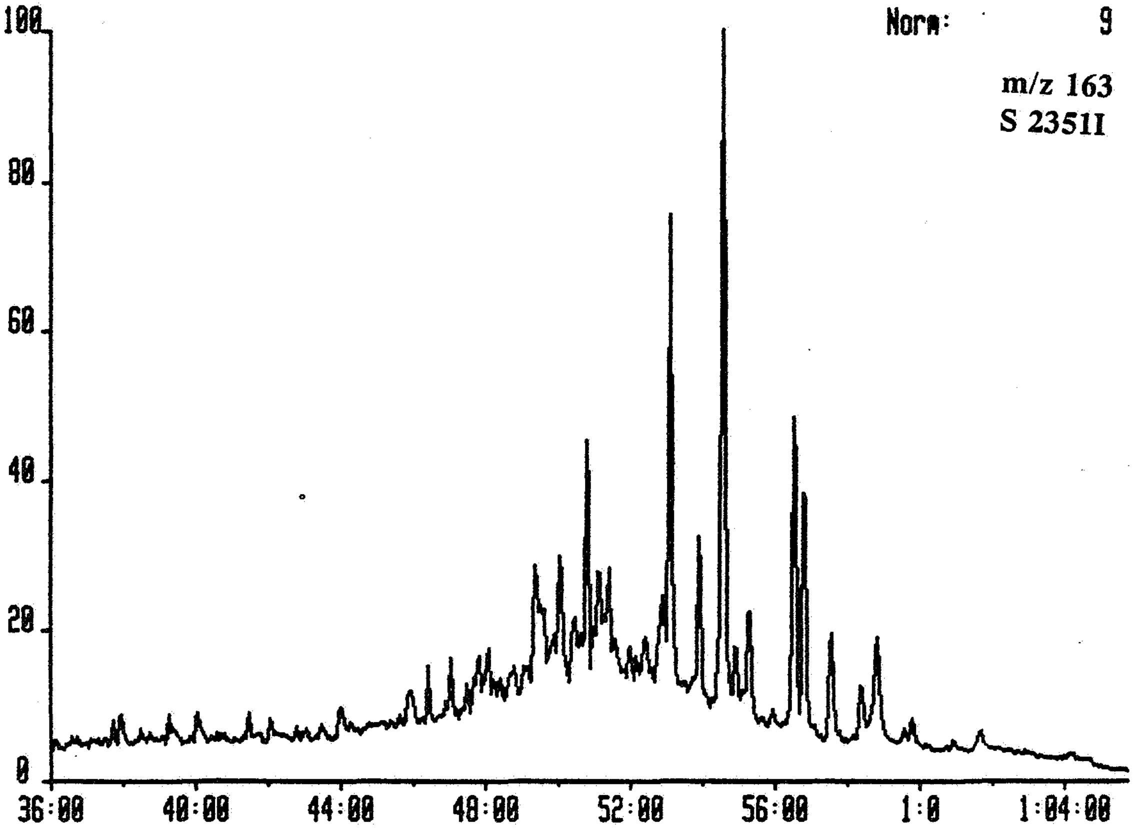


Analysis S2079II 4,1,1 6407/6-3 DST3
350.00
300.00
250.00
200.00
150.00
100.00
INTENSITY (mU)
10.00
20.00
30.00
40.00
50.00
60.00
RETENTION TIME (MINUTES)

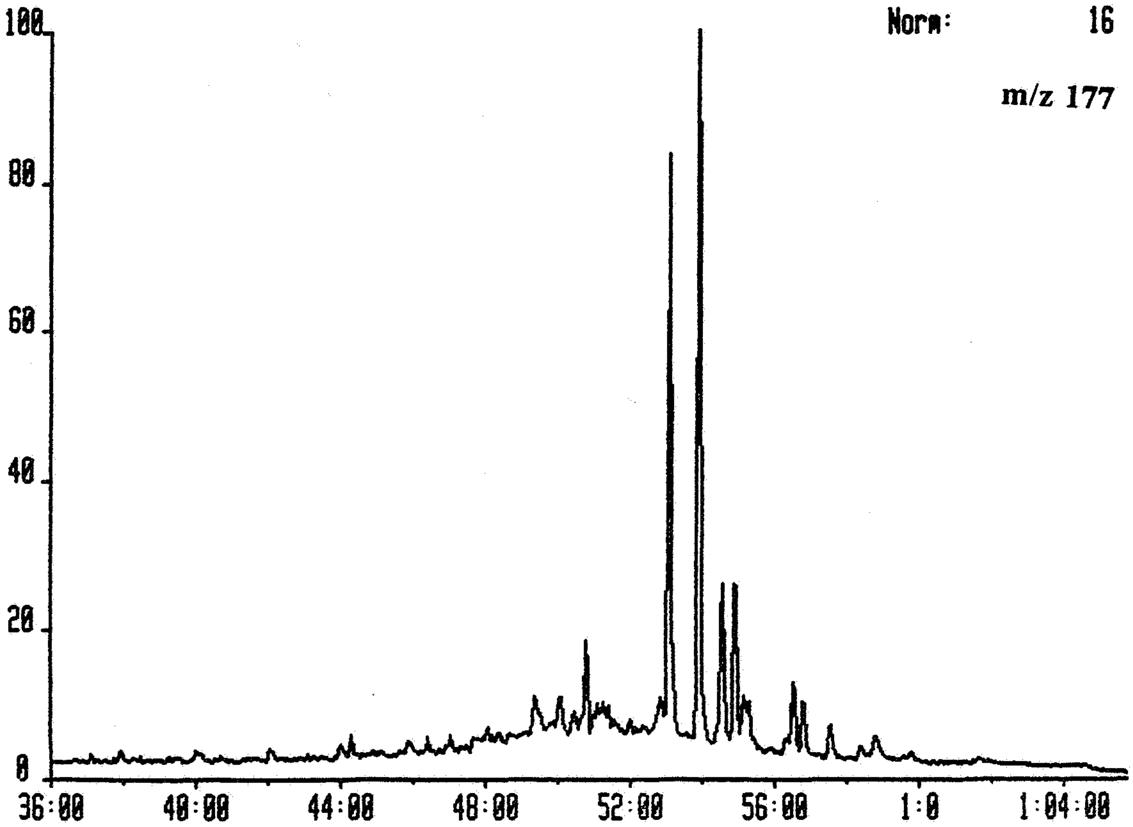
Appendix A
Source rock biomarkers

Source rock samples

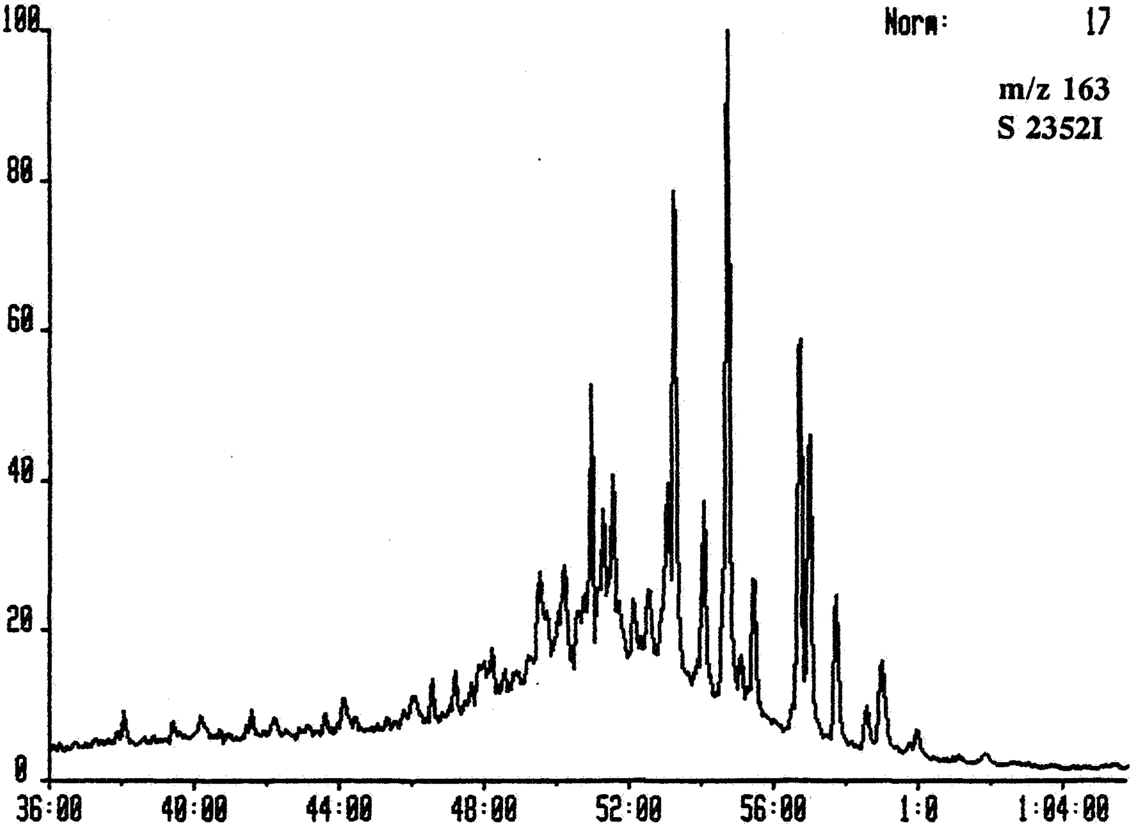
C6721SAT 1-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 163.1000
Text:



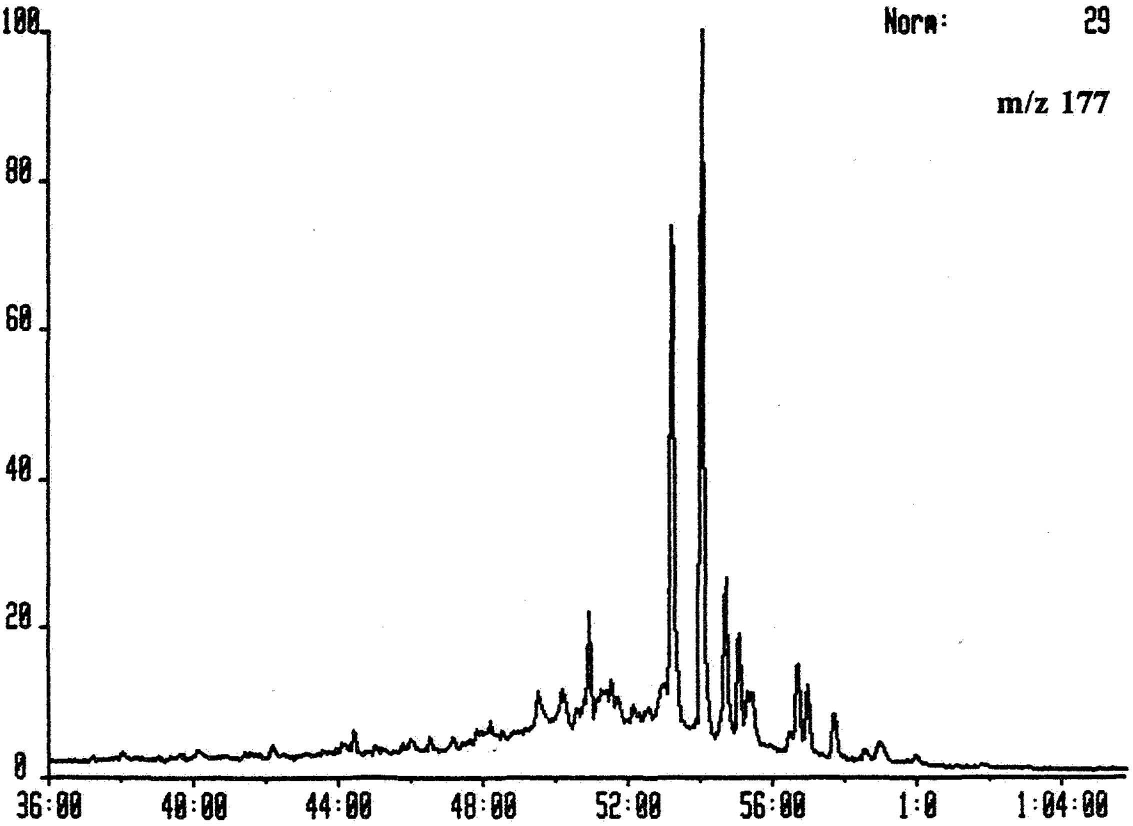
C6721SAT 1-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 177.1000
Text:



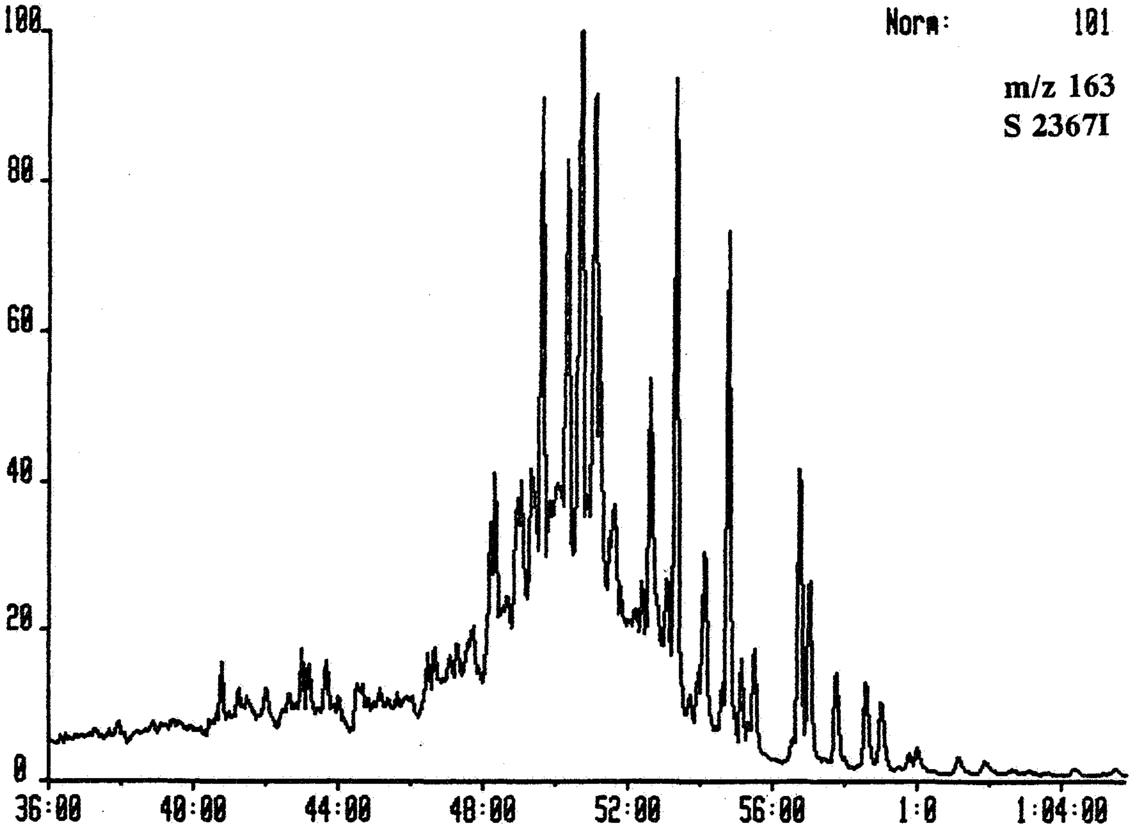
C6722SAT 29-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 163.1000
Text:



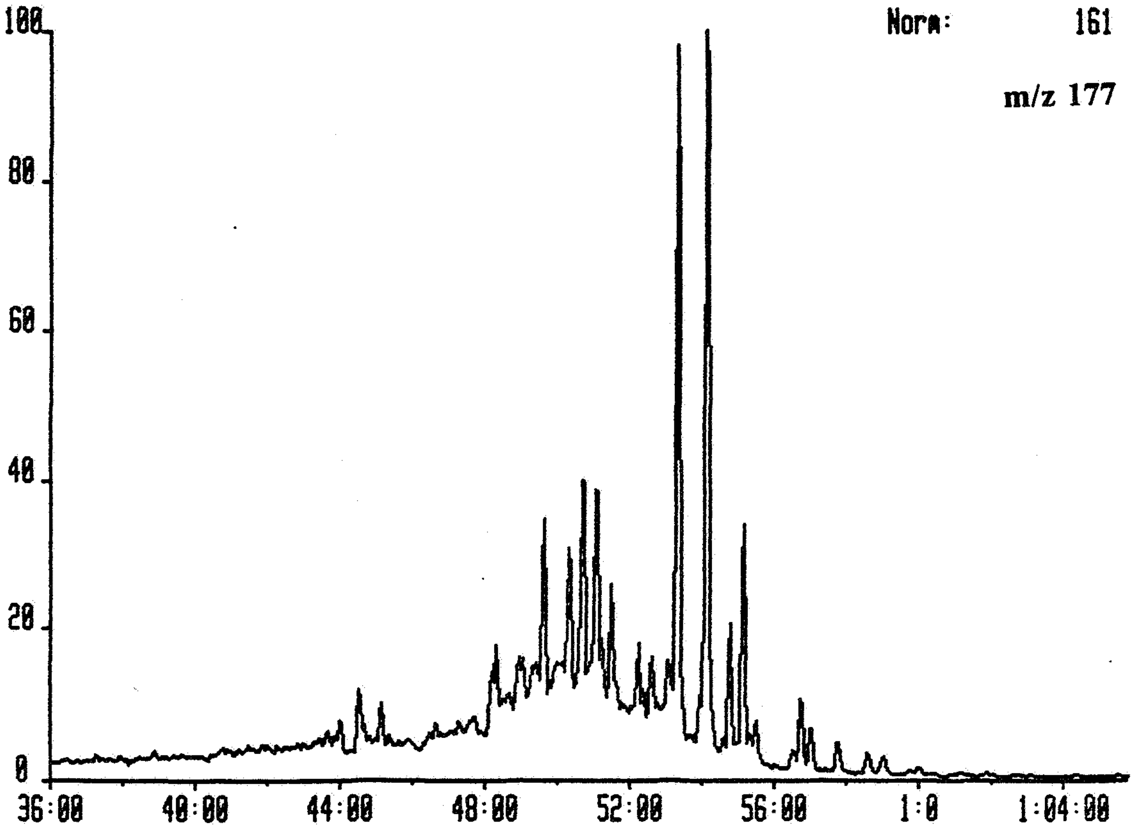
C6722SAT 29-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 177.1000
Text:



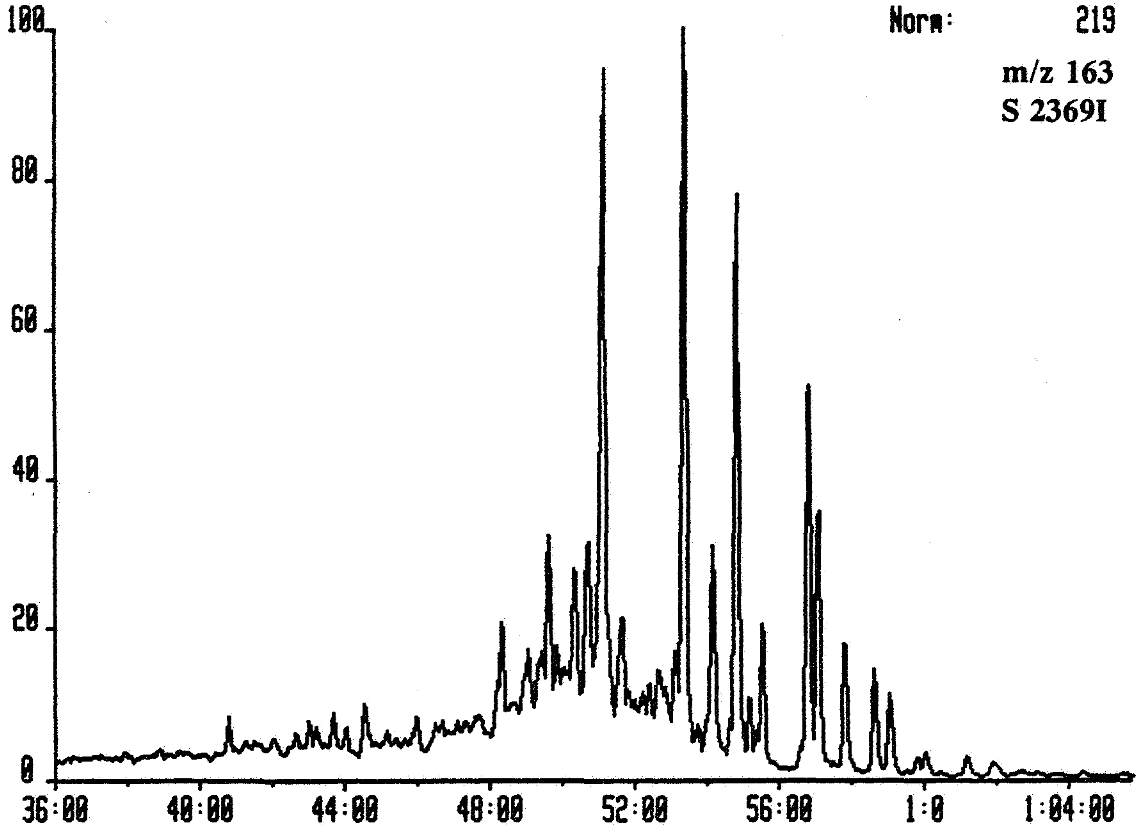
C6723SAT 29-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 163.1000
Text:



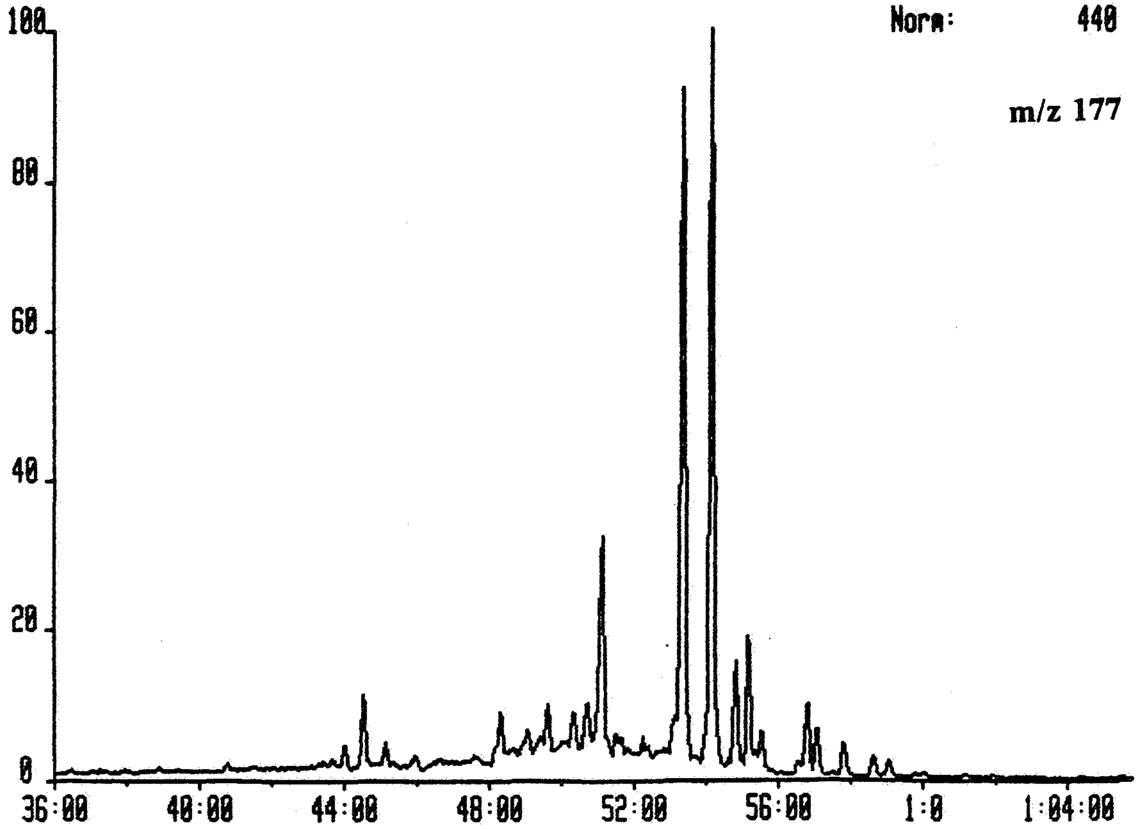
C6723SAT 29-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 177.1000
Text:



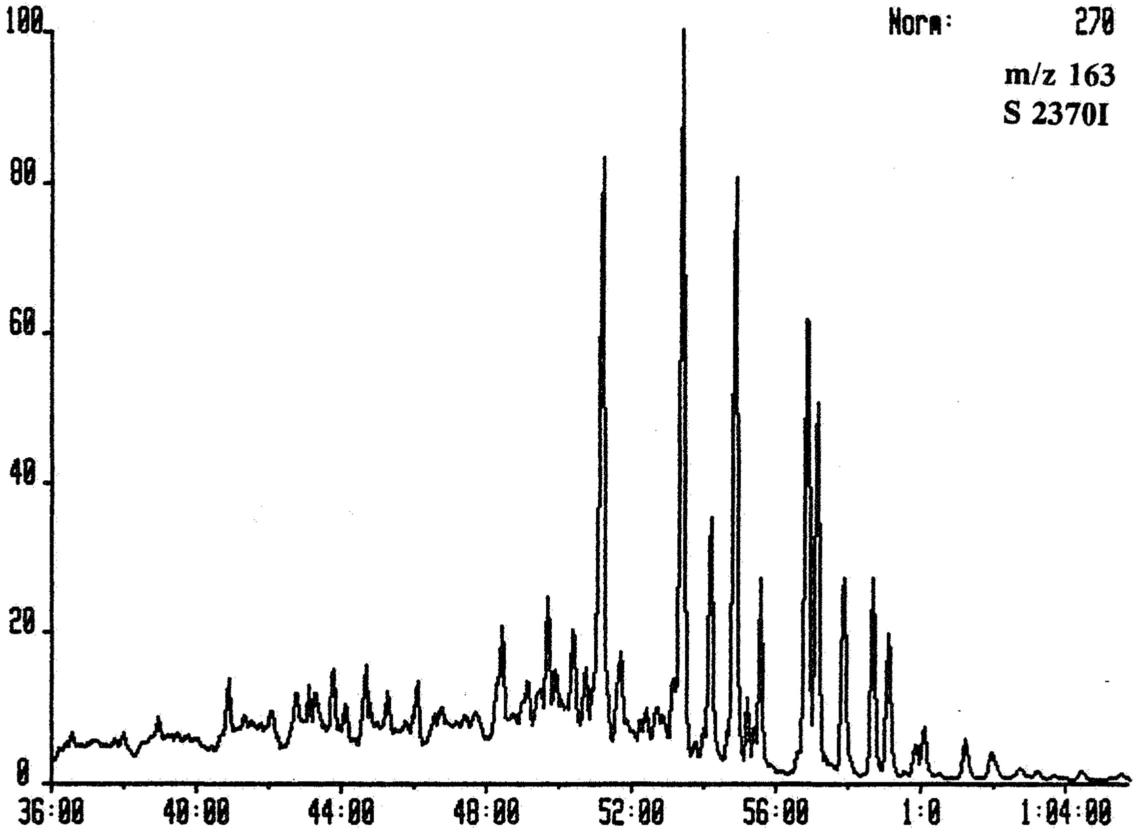
C6724SAT 29-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 163.1000
Text:



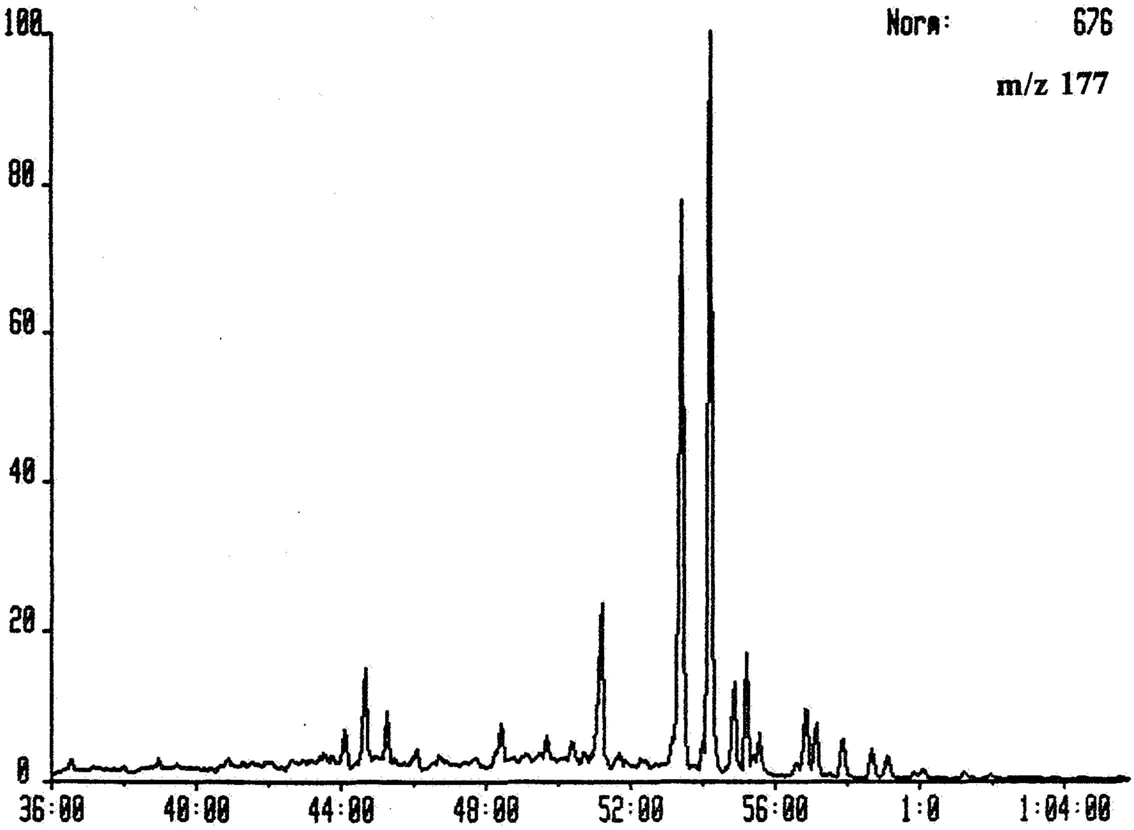
C6724SAT 29-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 177.1000
Text:



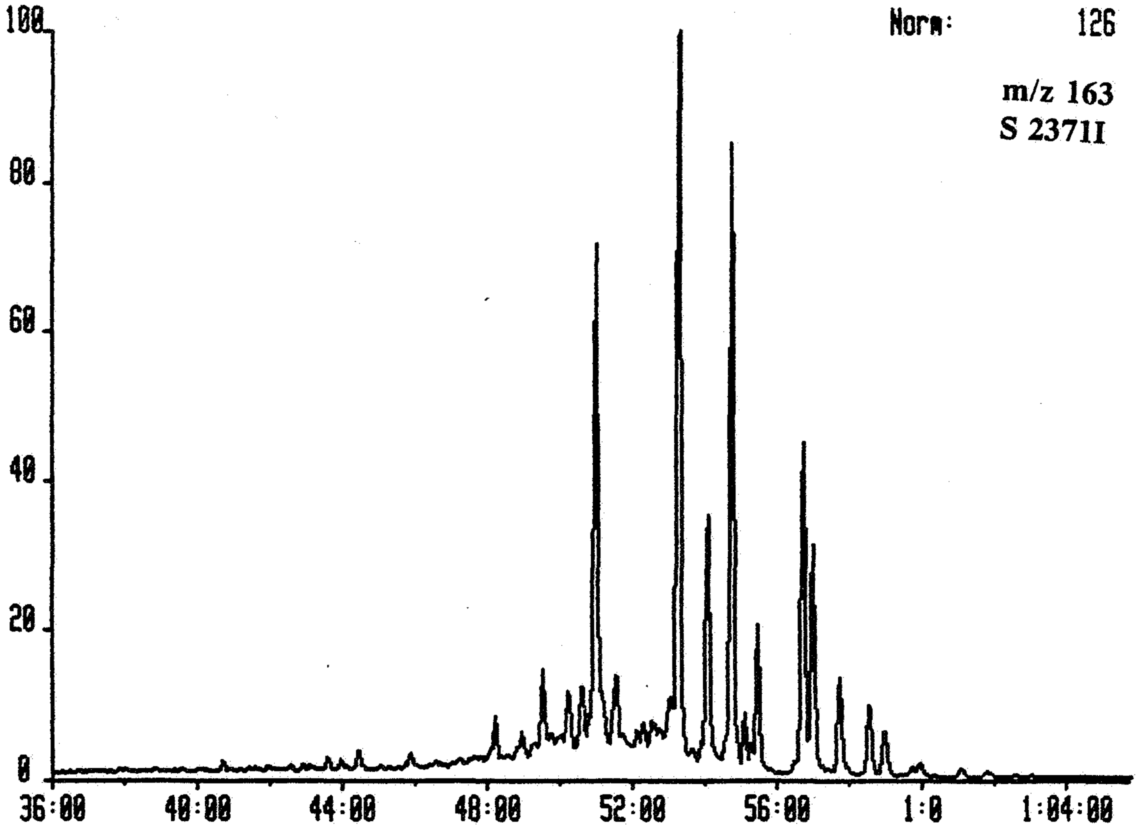
C6725SAT 29-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 163.1000
Text:



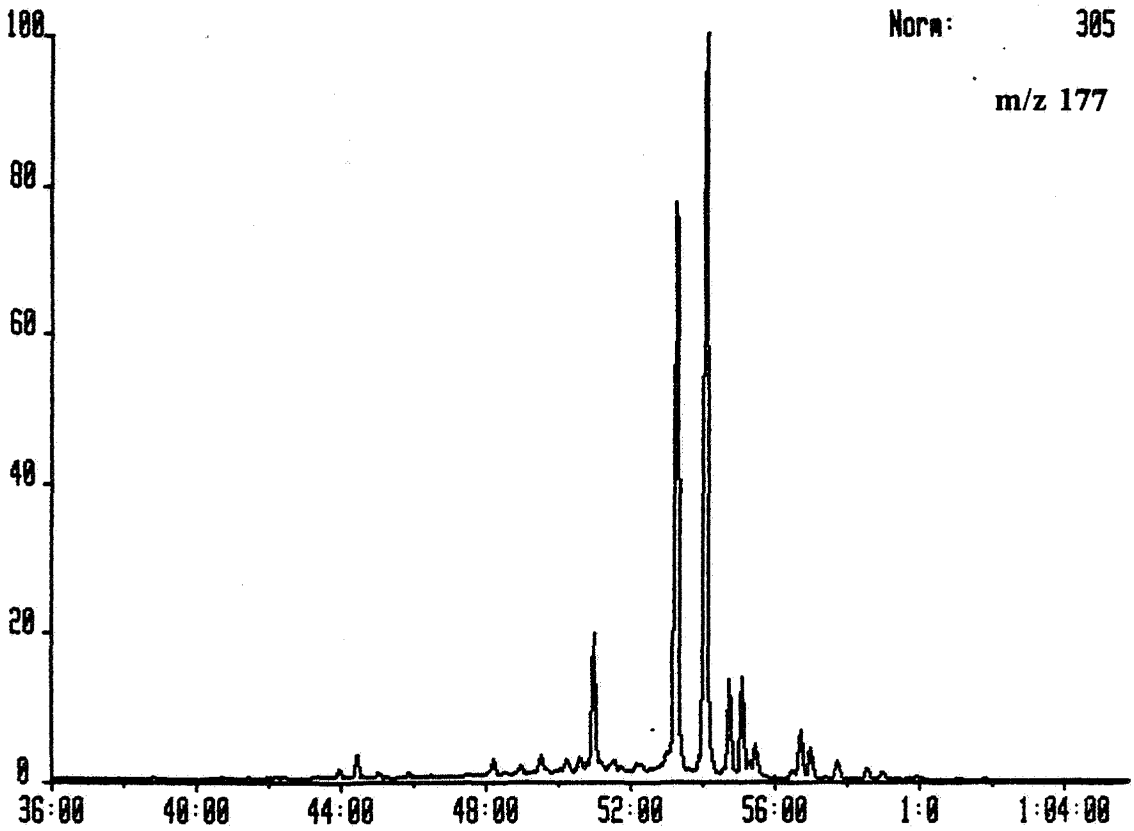
C6725SAT 29-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 177.1000
Text:



C6726SAT 30-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 163.1000
Text:

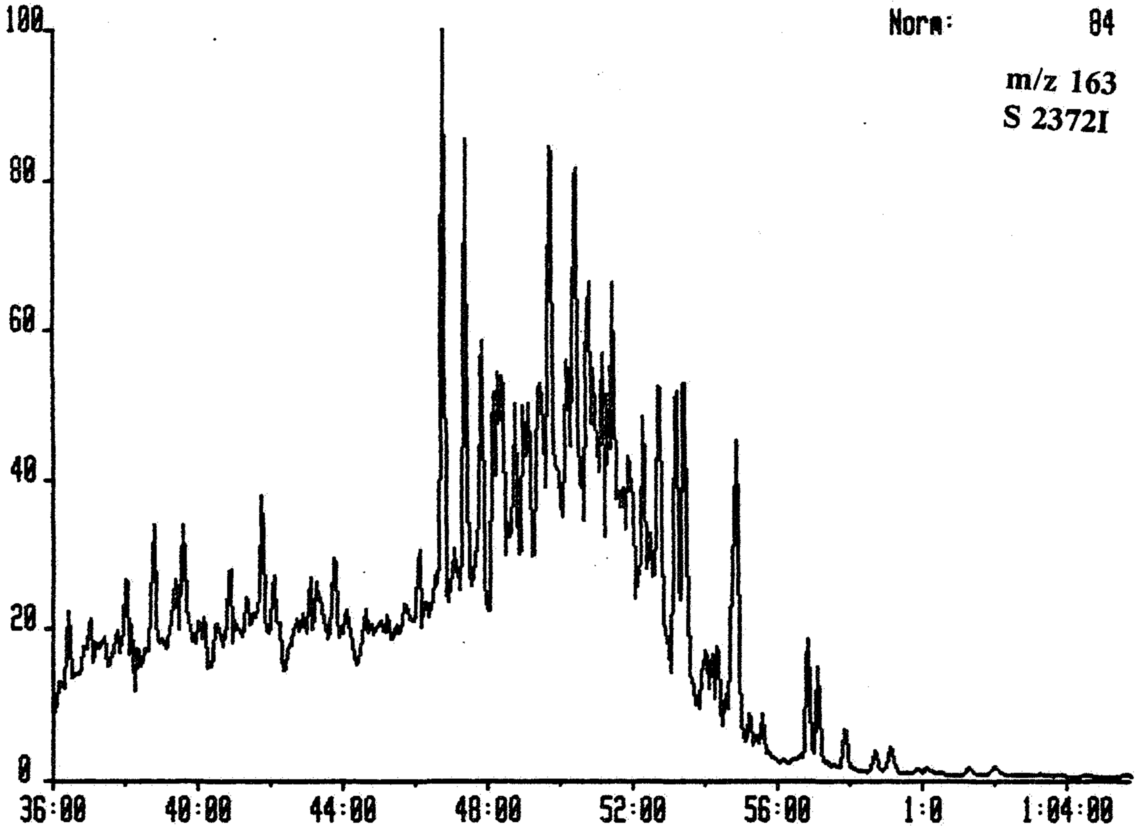


C6726SAT 30-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 177.1000
Text:

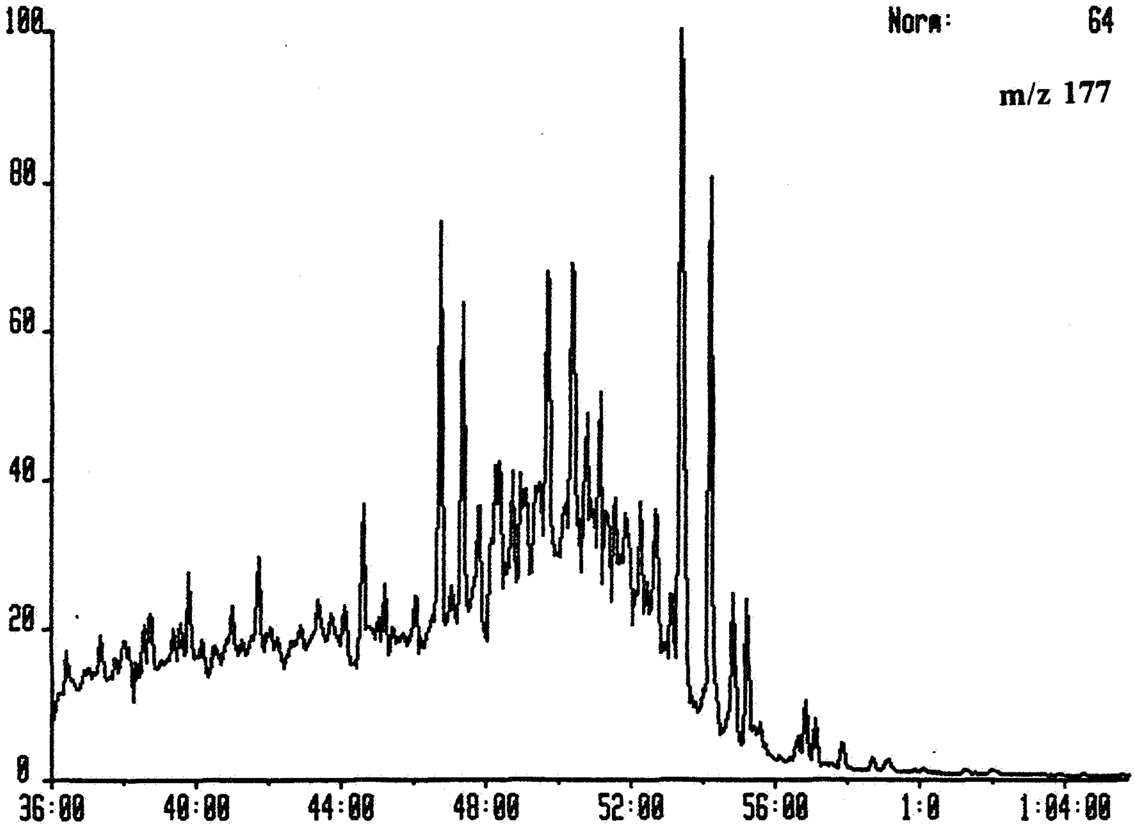


IKU
SINTEF-GRUPPEN

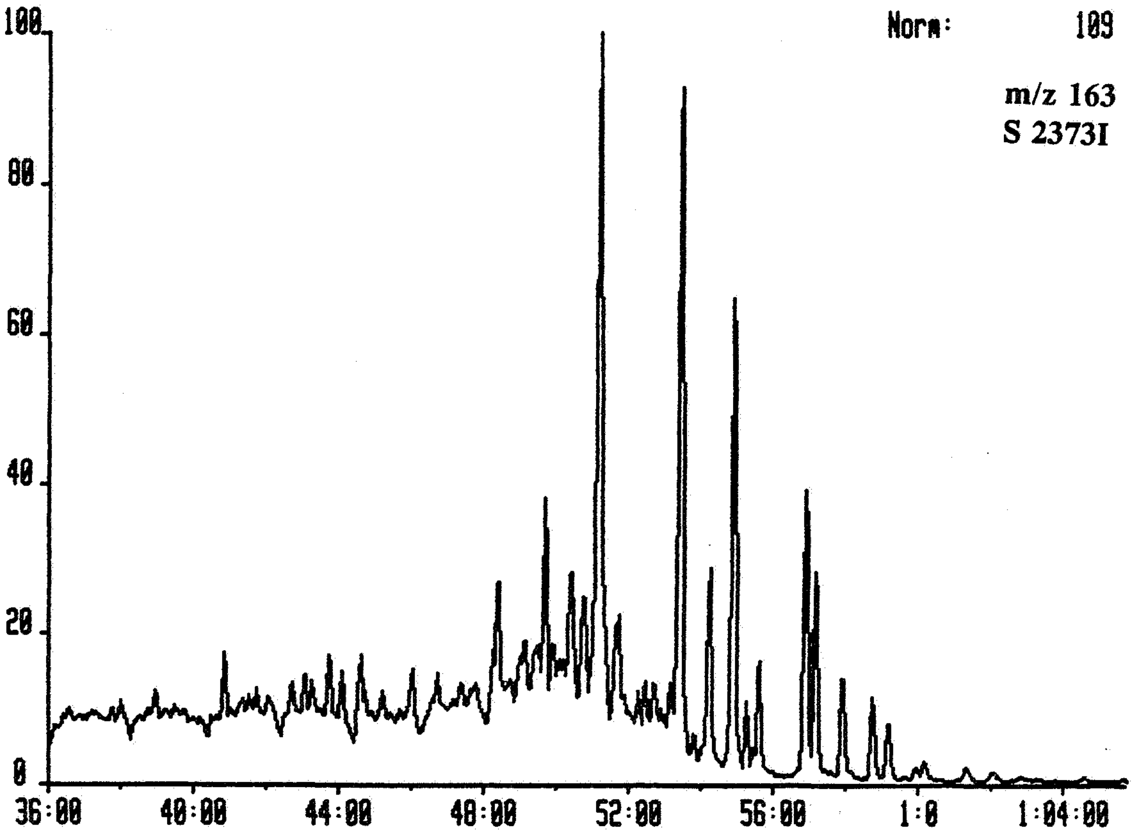
C6727SAT 30-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 163.1000
Text:



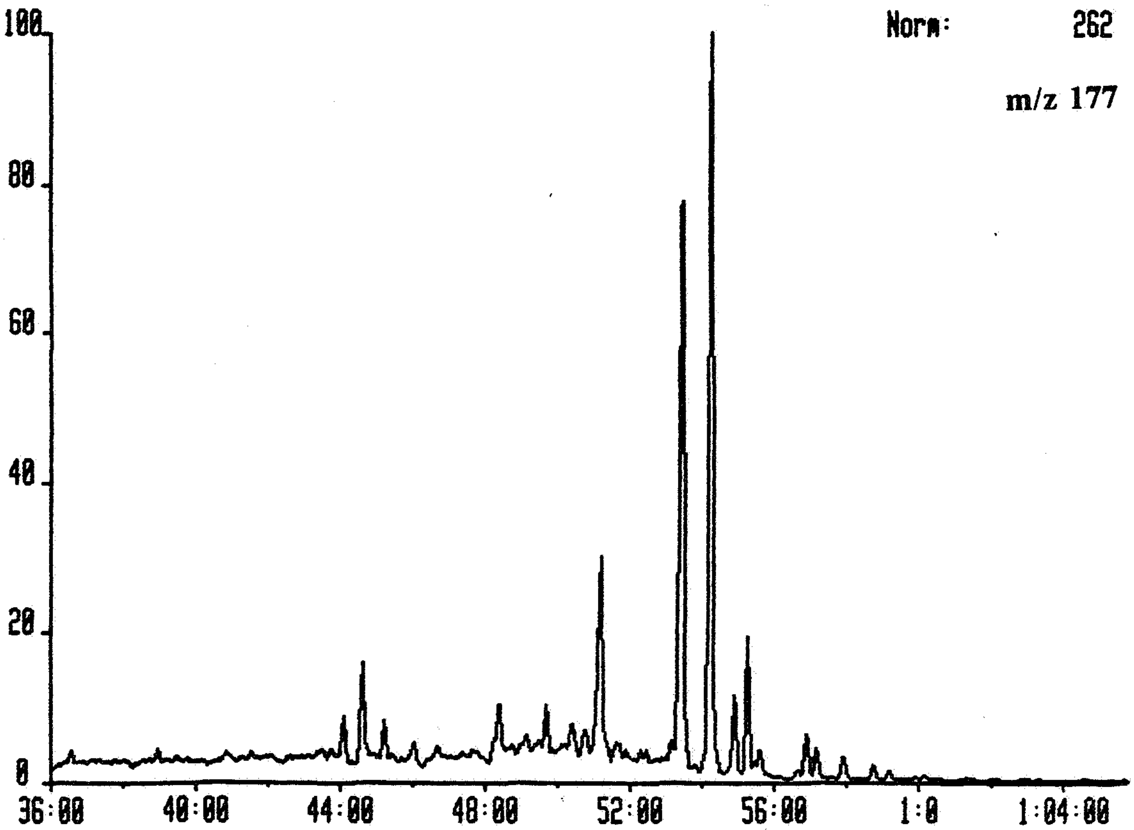
C6727SAT 30-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 177.1000
Text:



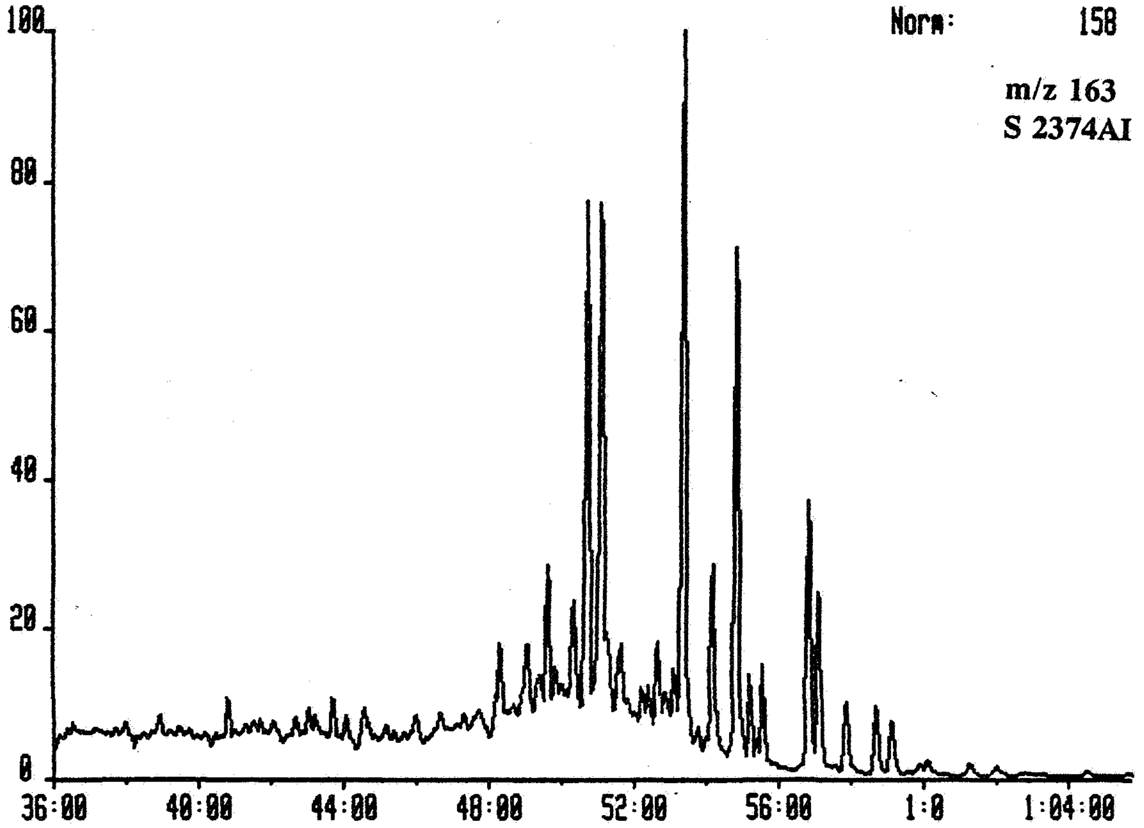
C6720SAT 30-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 163.1000
Text:



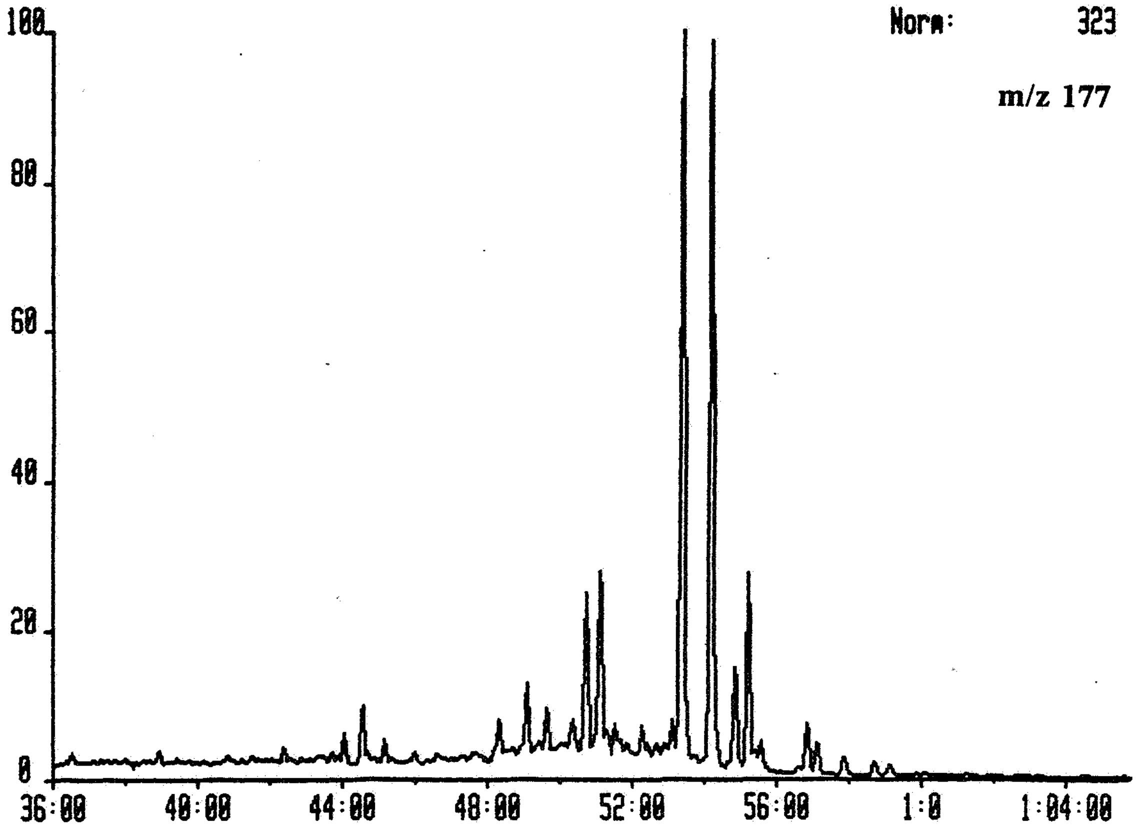
C6720SAT 30-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 177.1000
Text:



C6729SAT 30-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 163.1000
Text:

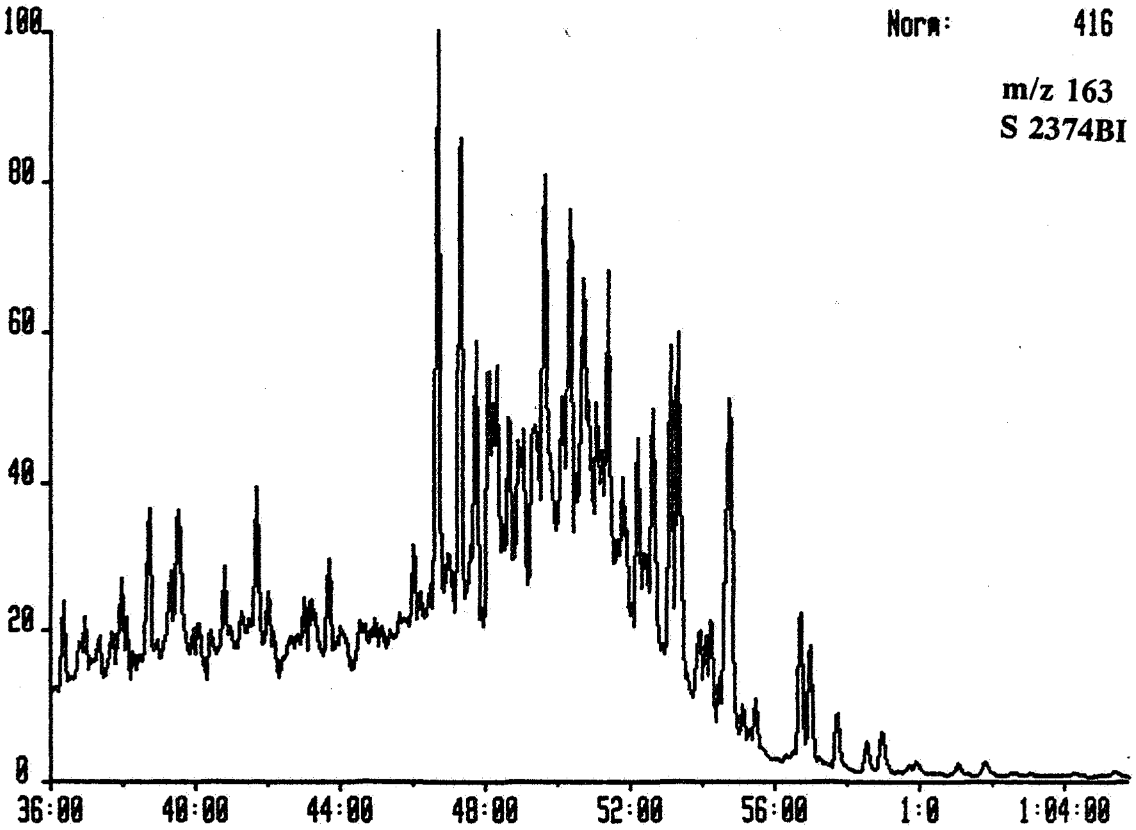


C6729SAT 30-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 177.1000
Text:

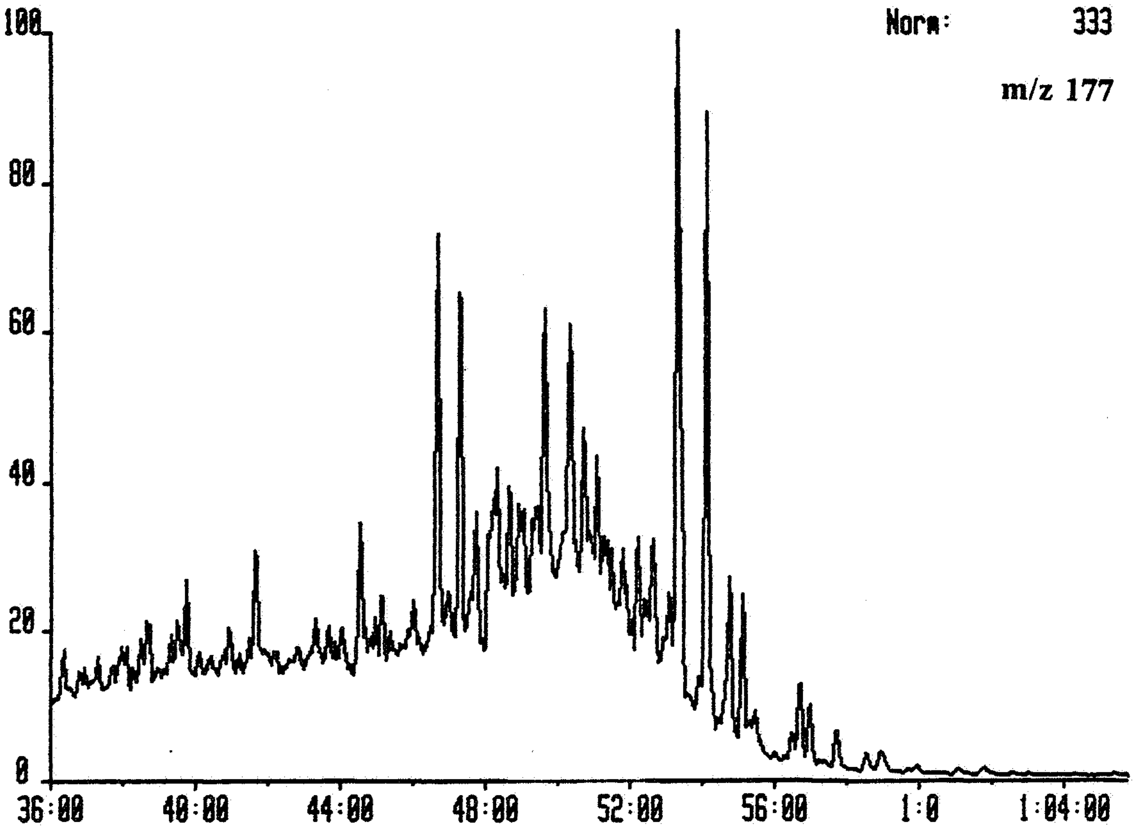


IKU
SINTEF-GRUPPEN

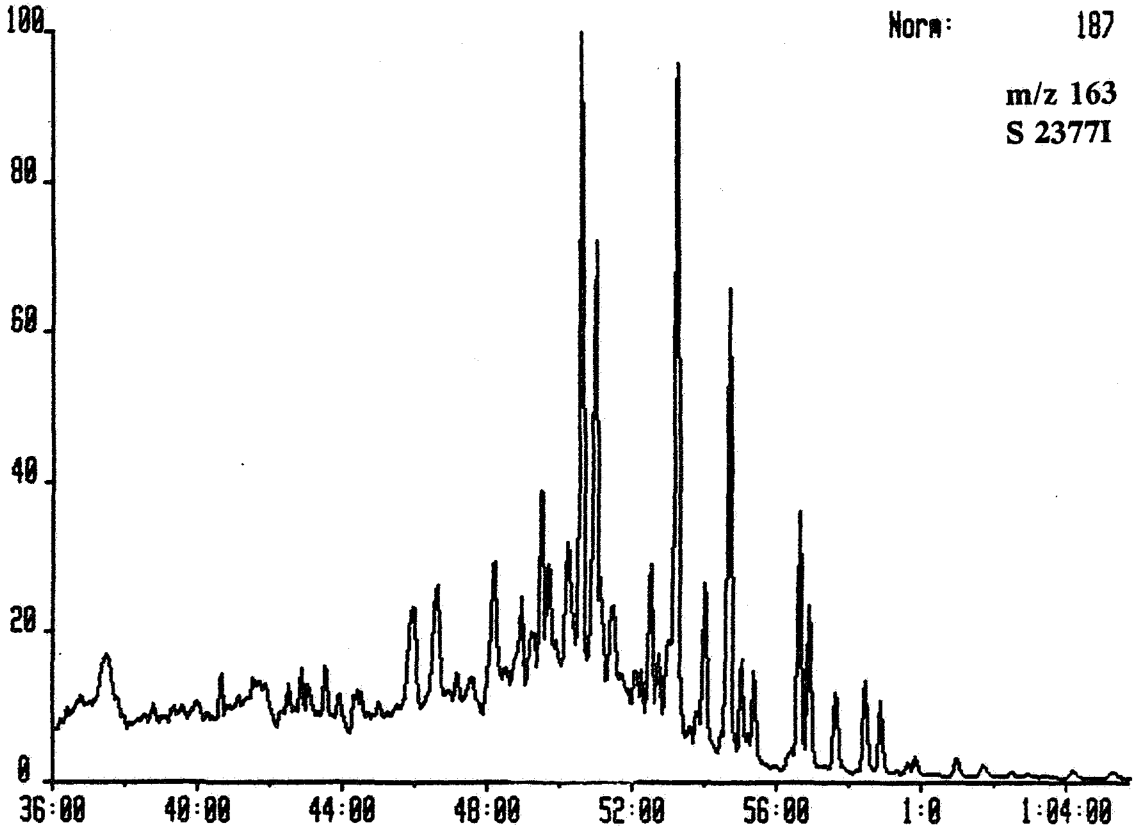
C6730SAT 1-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 163.1000
Text:



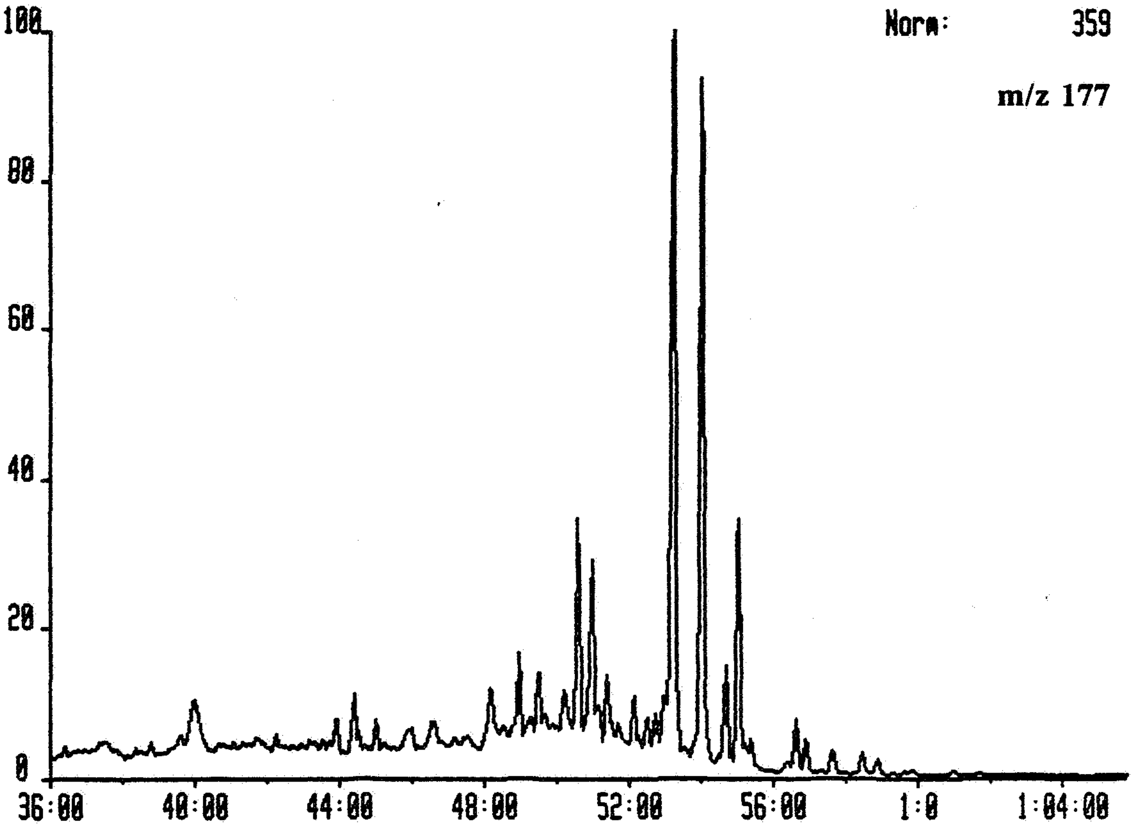
C6730SAT 1-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 177.1000
Text:



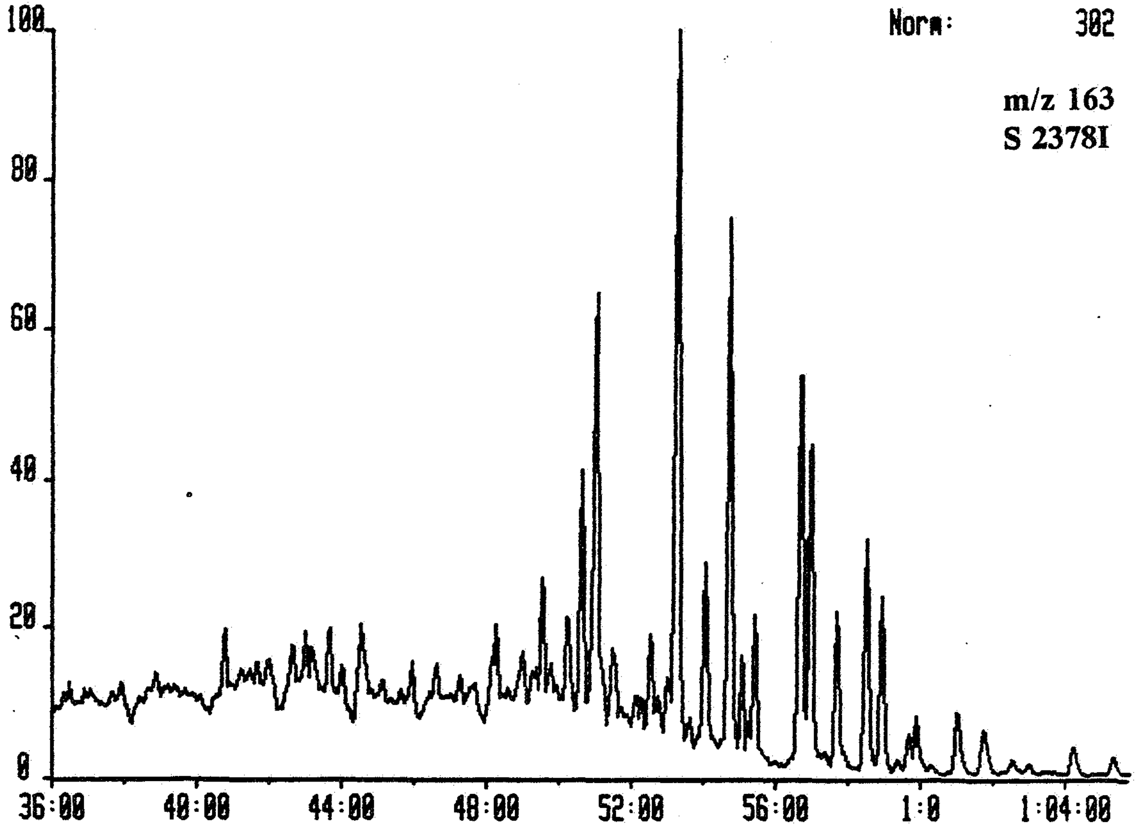
C6731SAT 1-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 163.1000
Text:



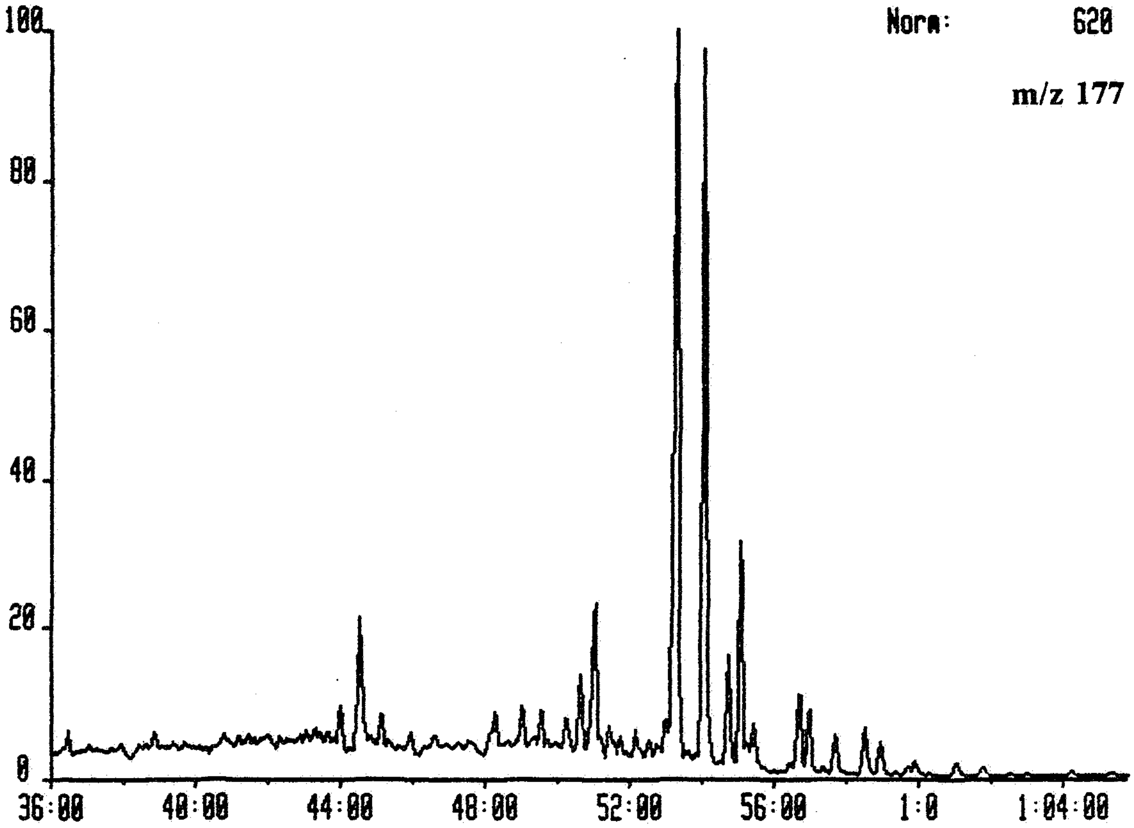
C6731SAT 1-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 177.1000
Text:



C6732SAT 1-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 163.1000
Text:



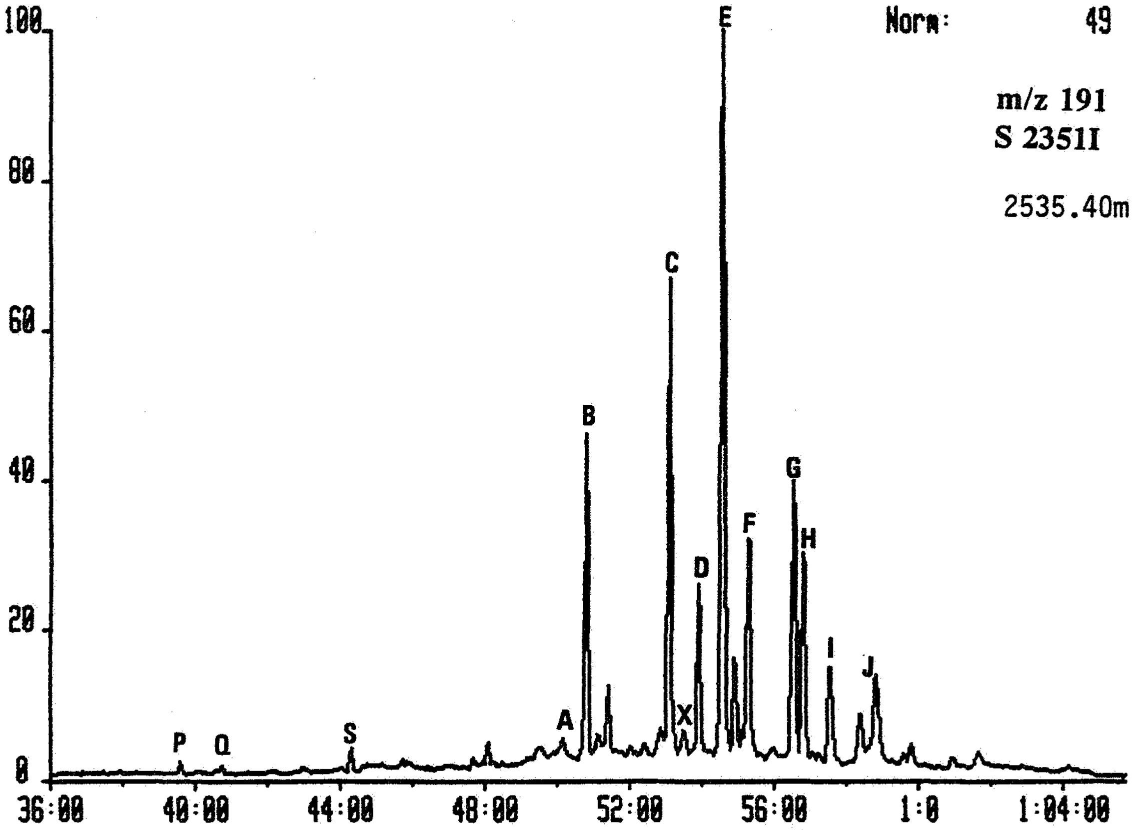
C6732SAT 1-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 177.1000
Text:



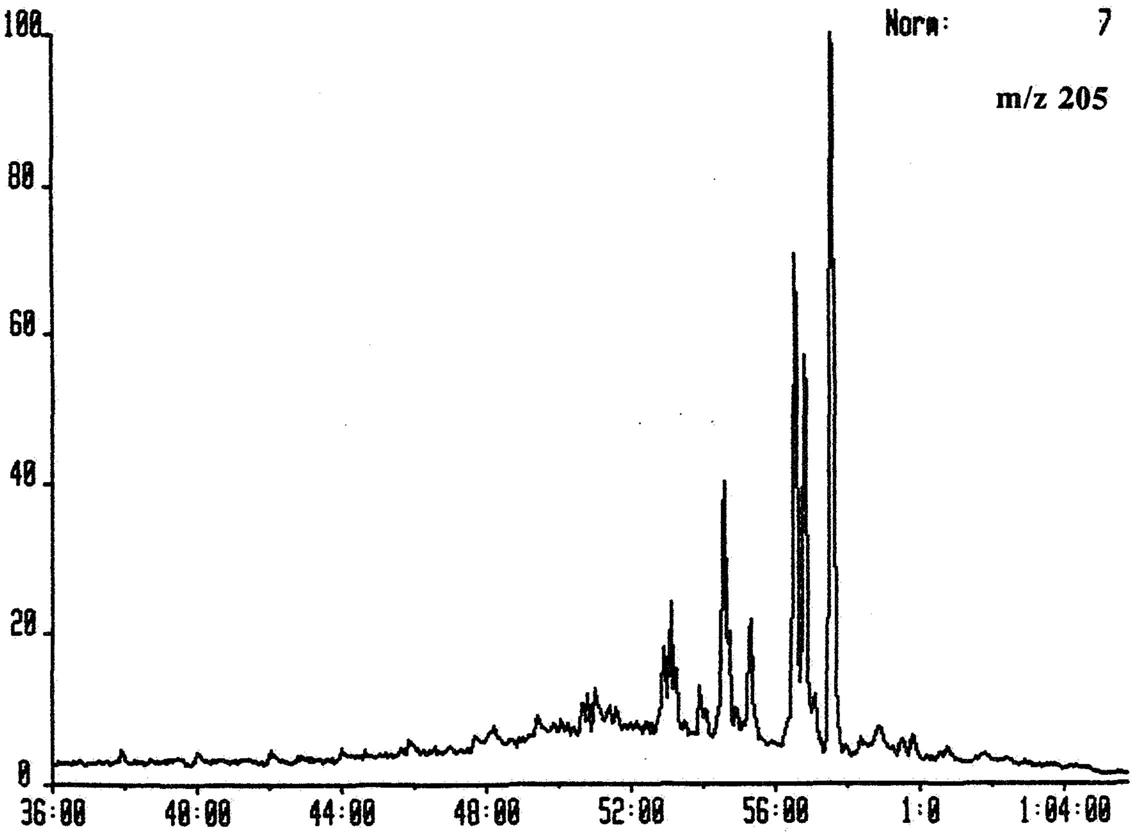
Source rock samples

IKU SINTEF-GRUPPEN

C6721SAT 1-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 191.1000
Text:

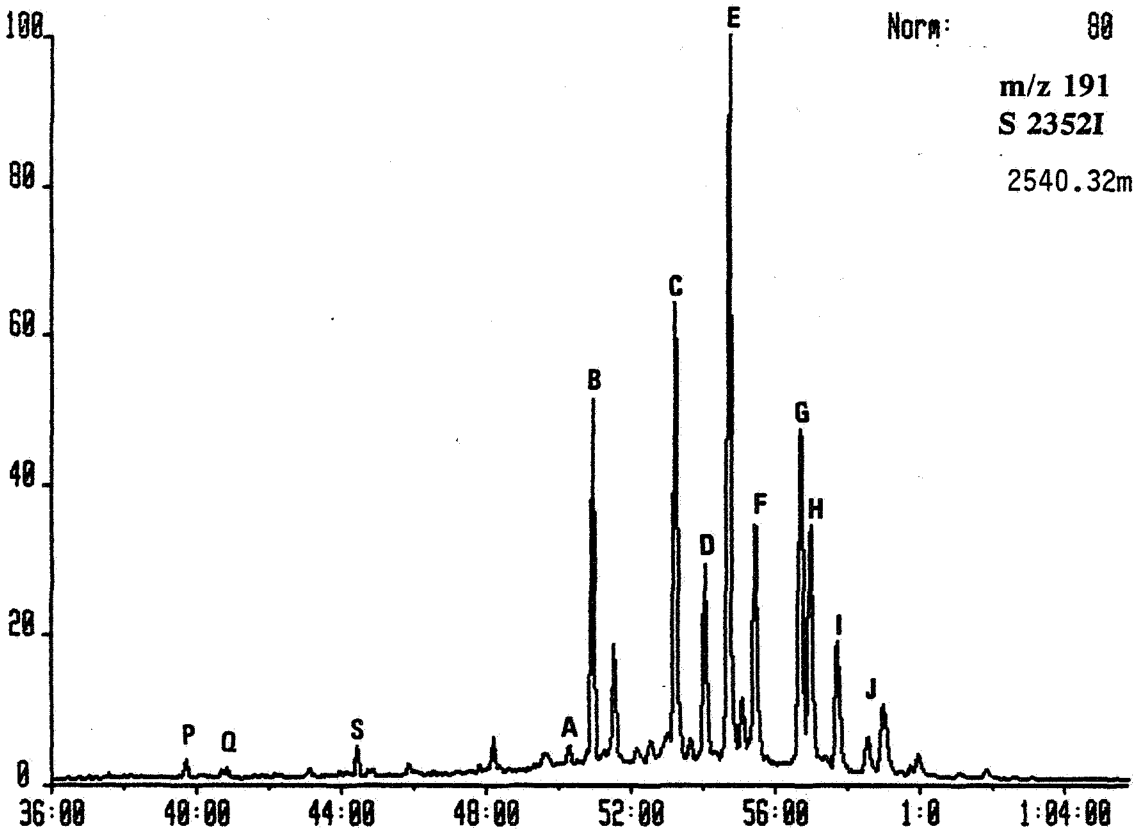


C6721SAT 1-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 205.1000
Text:

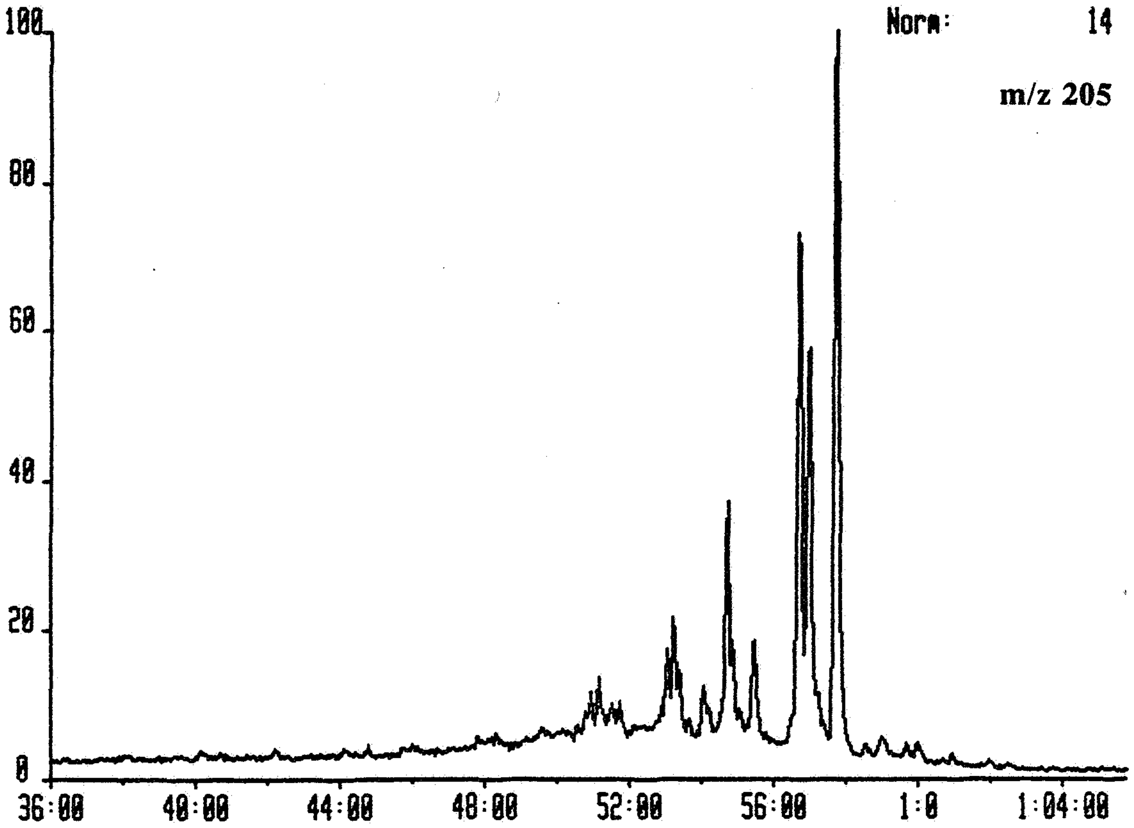


IKU SINTEF-GRUPPEN

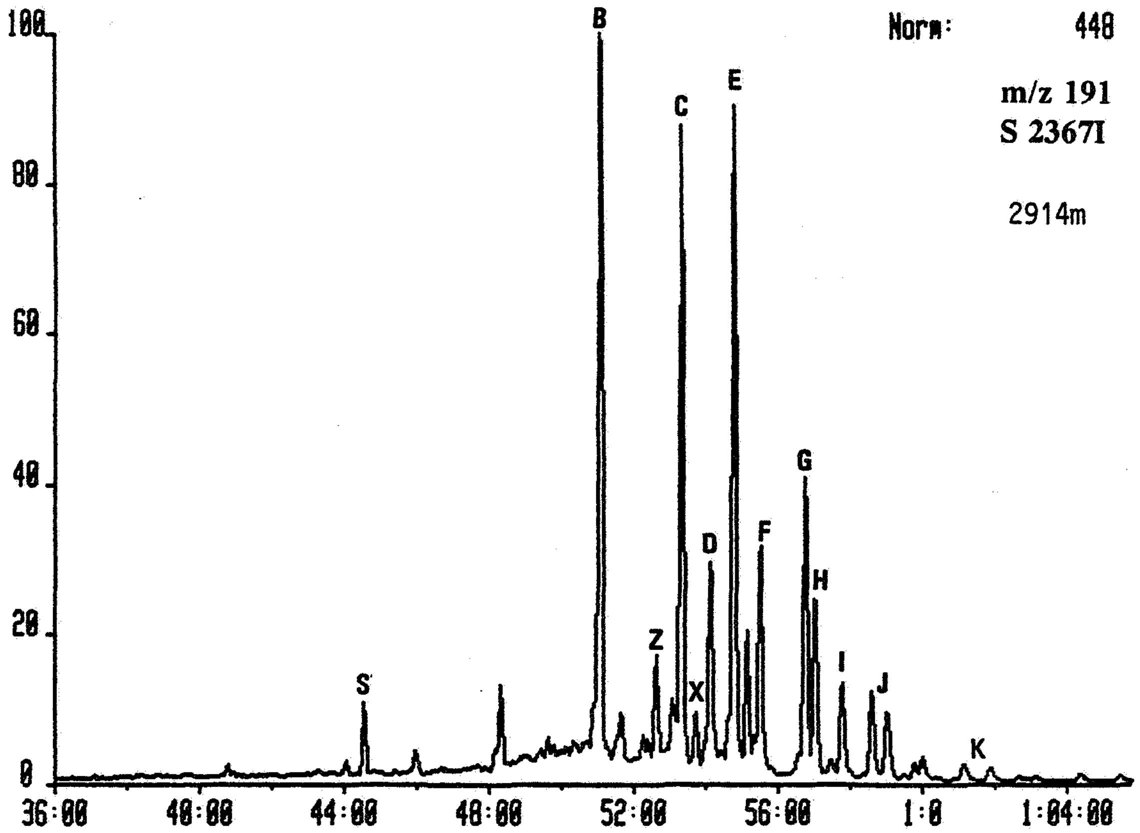
C6722SAT 29-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 191.1000
Text:



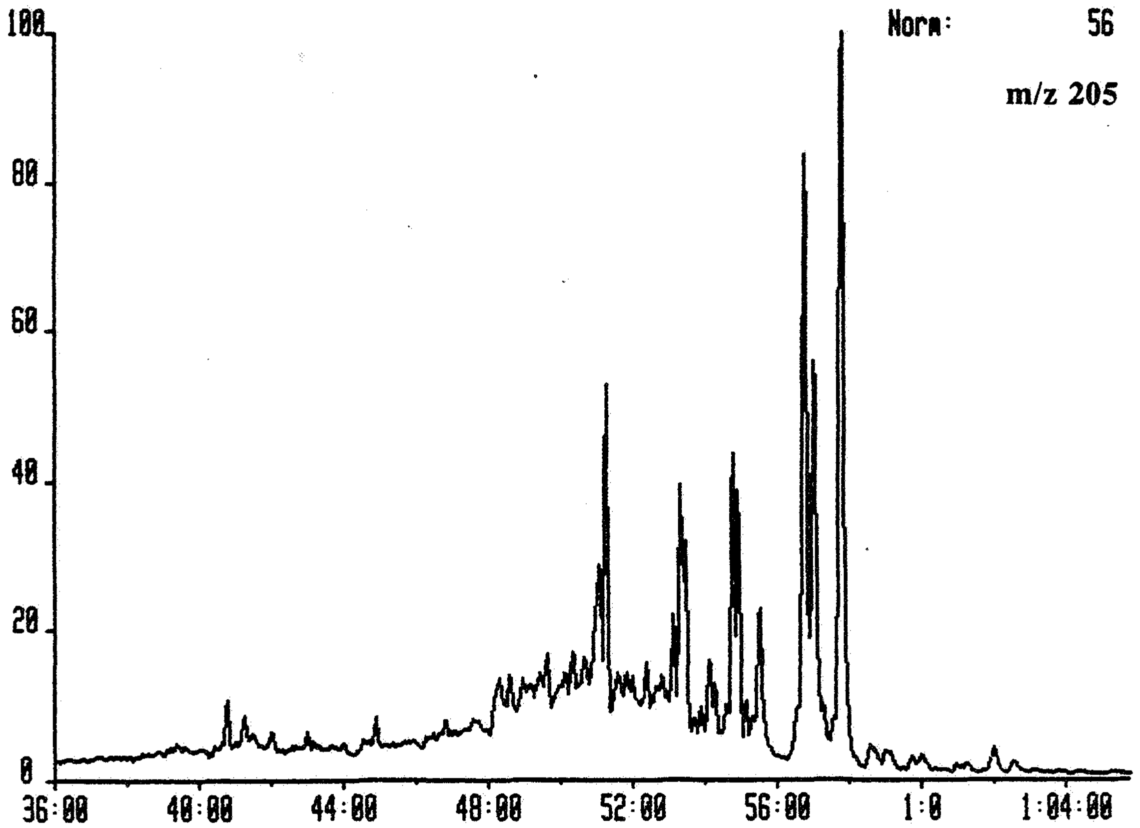
C6722SAT 29-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 205.1000
Text:



C6723SAT 29-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 191.1000
Text:

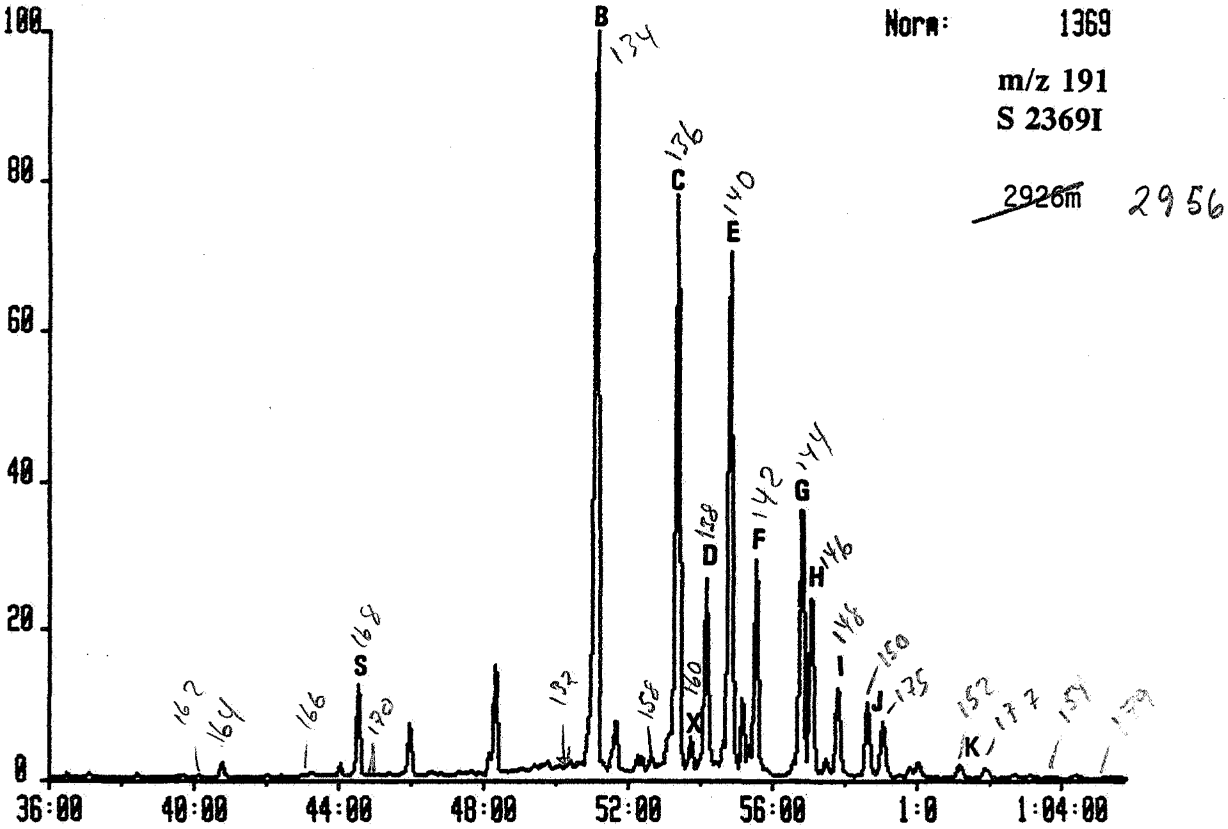


C6723SAT 29-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 205.1000
Text:

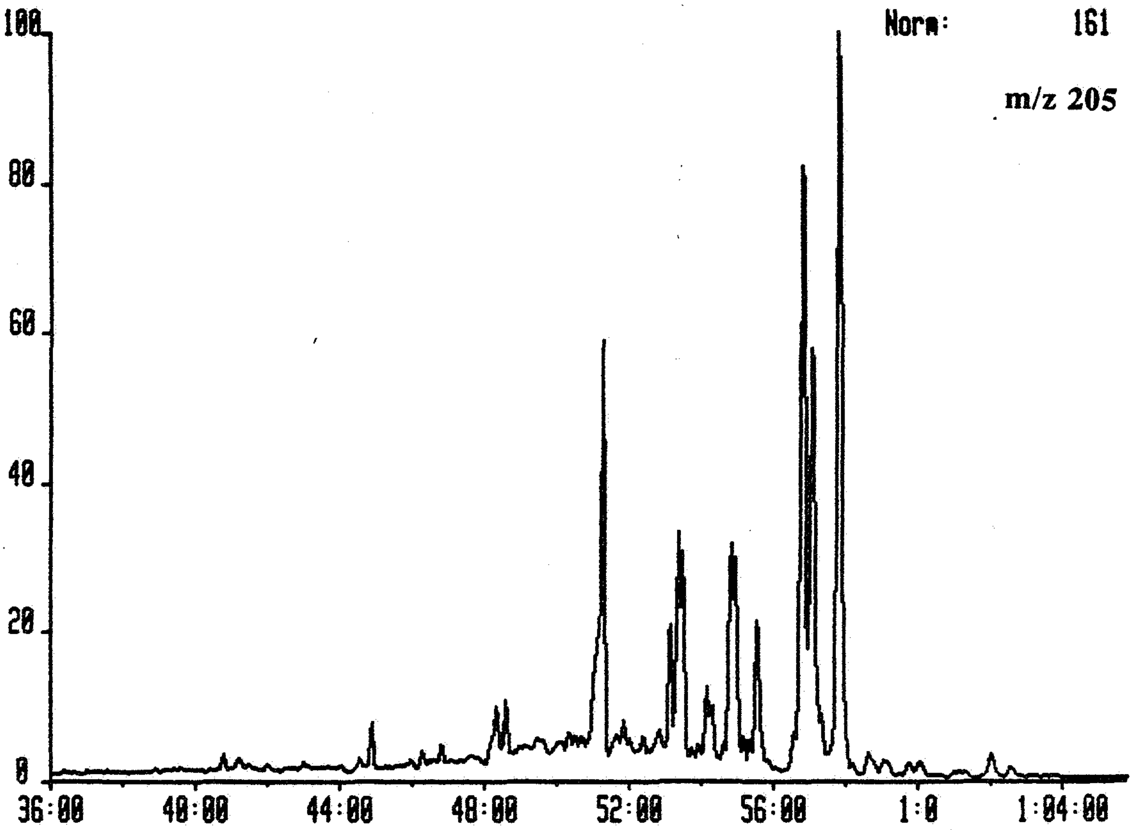


IKU SINTEF-GRUPPEN

C6724SAT 29-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 191.1000
Text:

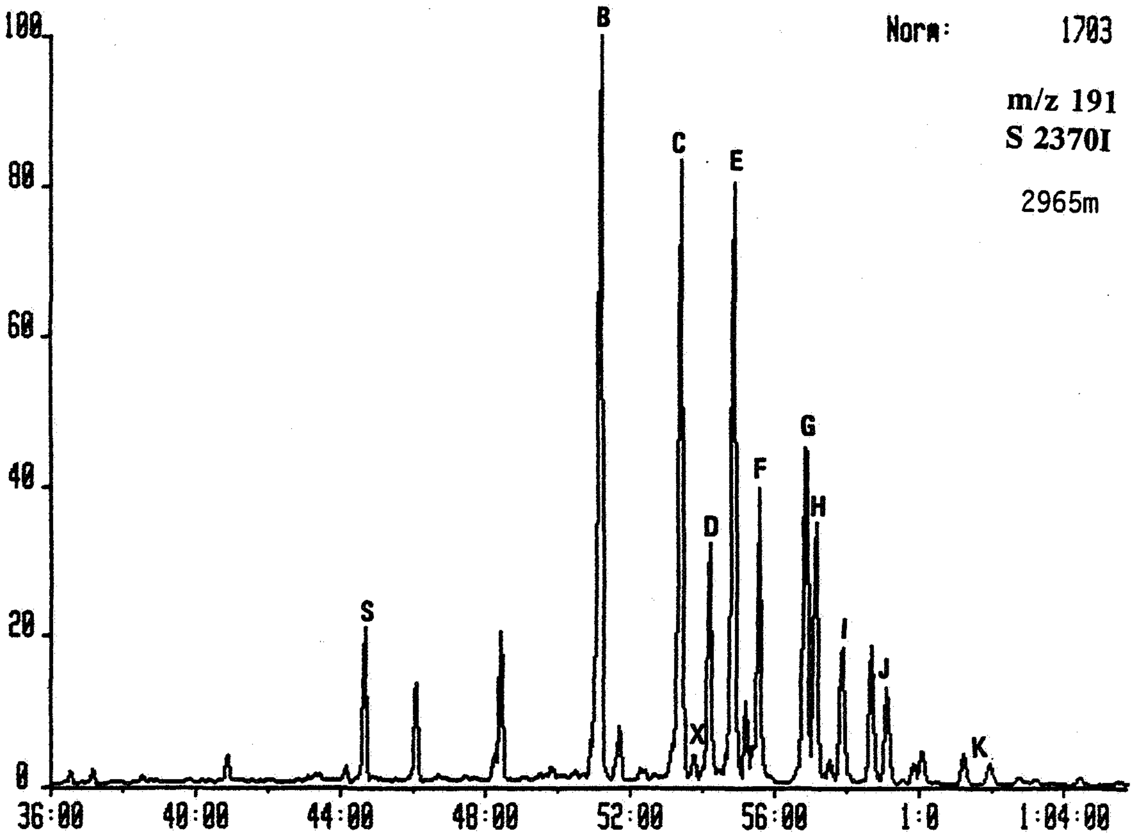


C6724SAT 29-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 205.1000
Text:

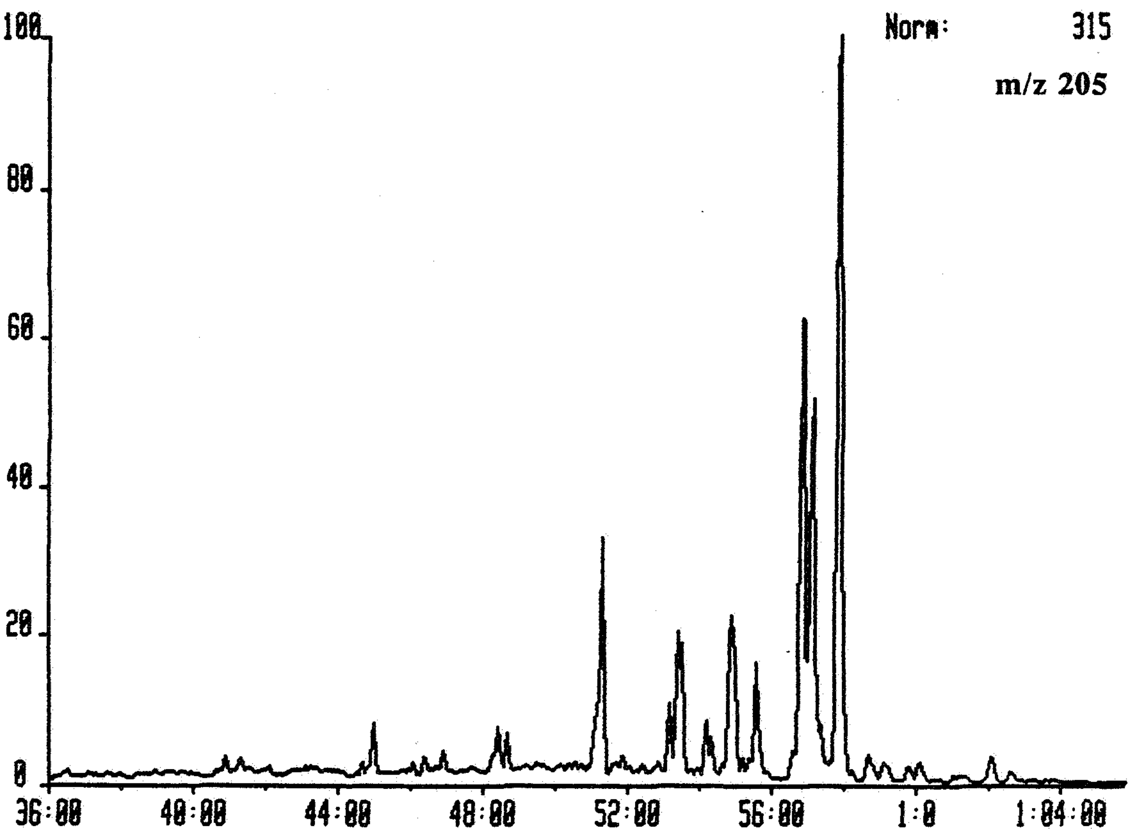


IKU SINTEF-GRUPPEN

C6725SAT 29-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 191.1000
Text:

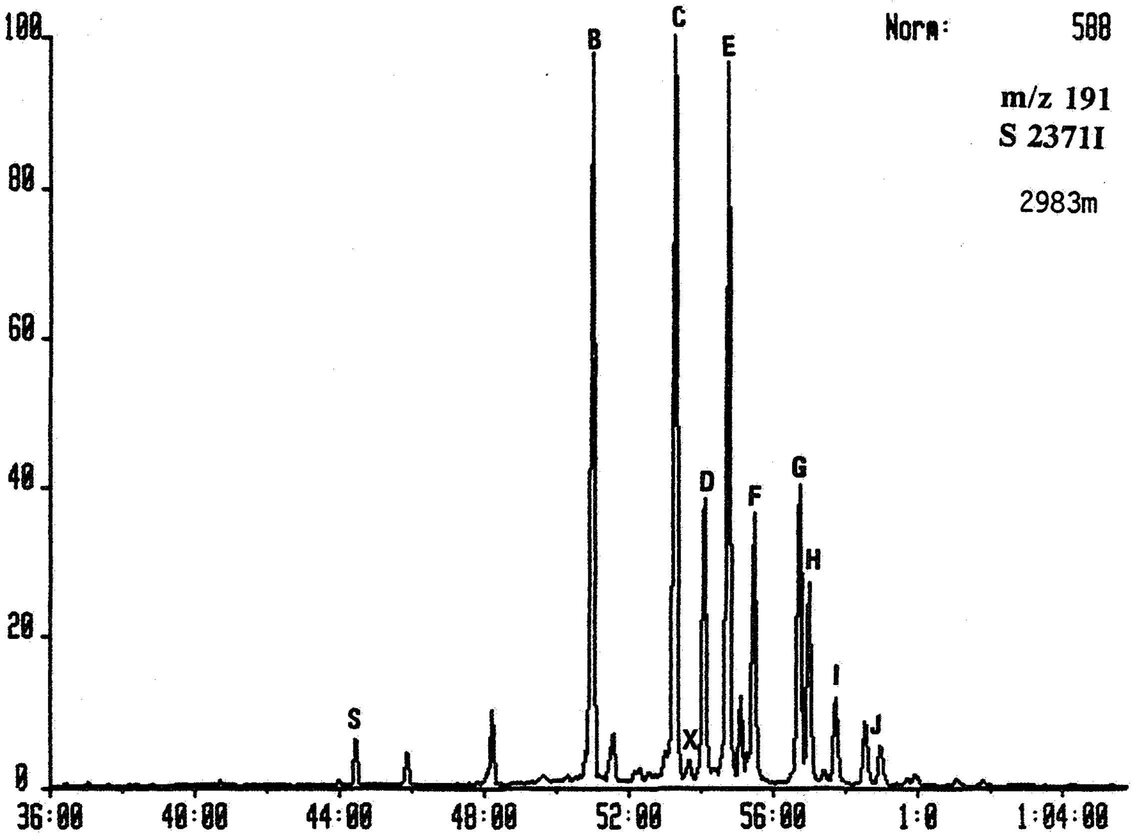


C6725SAT 29-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 205.1000
Text:

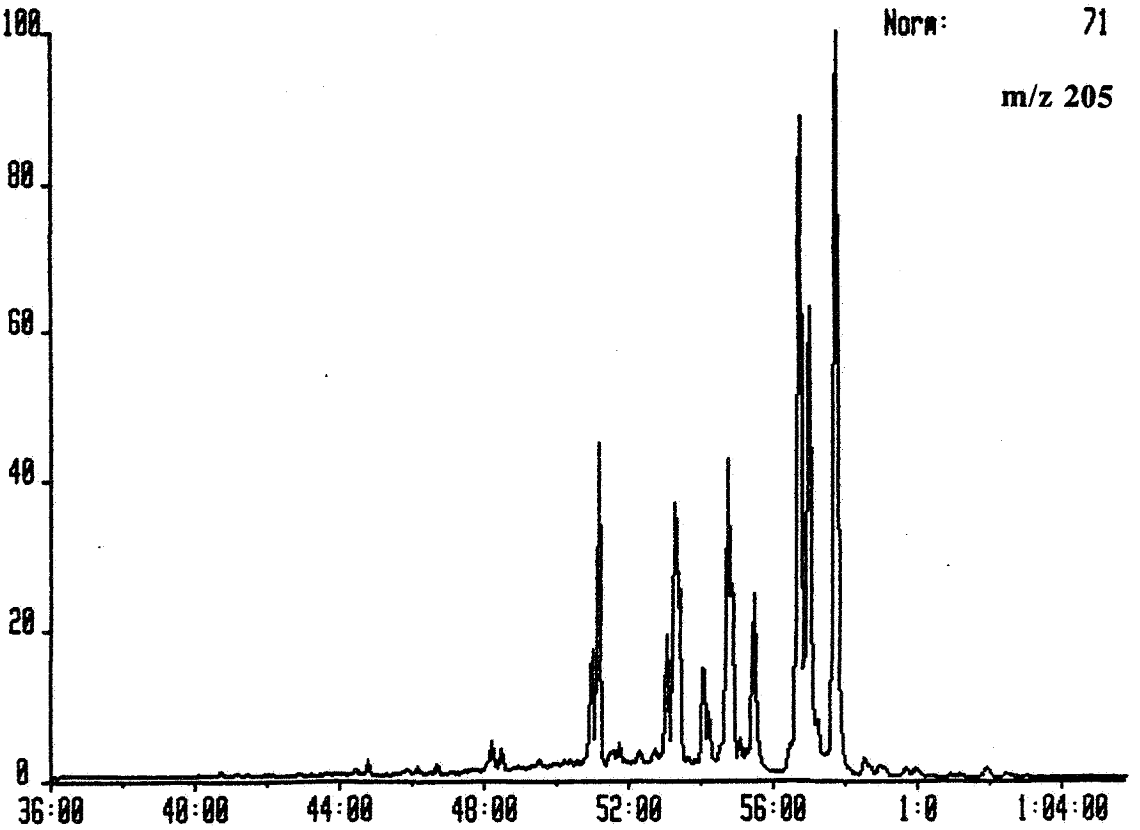


IKU
SINTEF-GRUPPEN

C6726SAT 30-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 191.1000
Text:

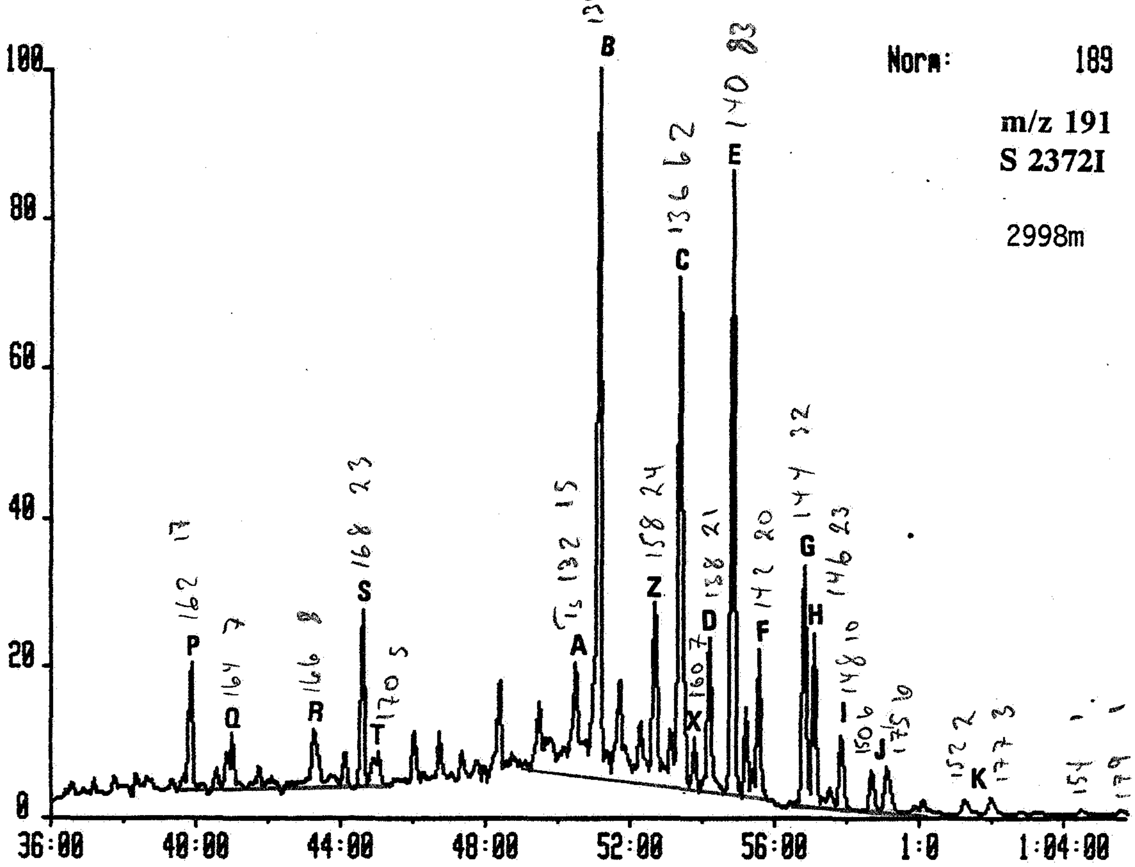


C6726SAT 30-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 205.1000
Text:

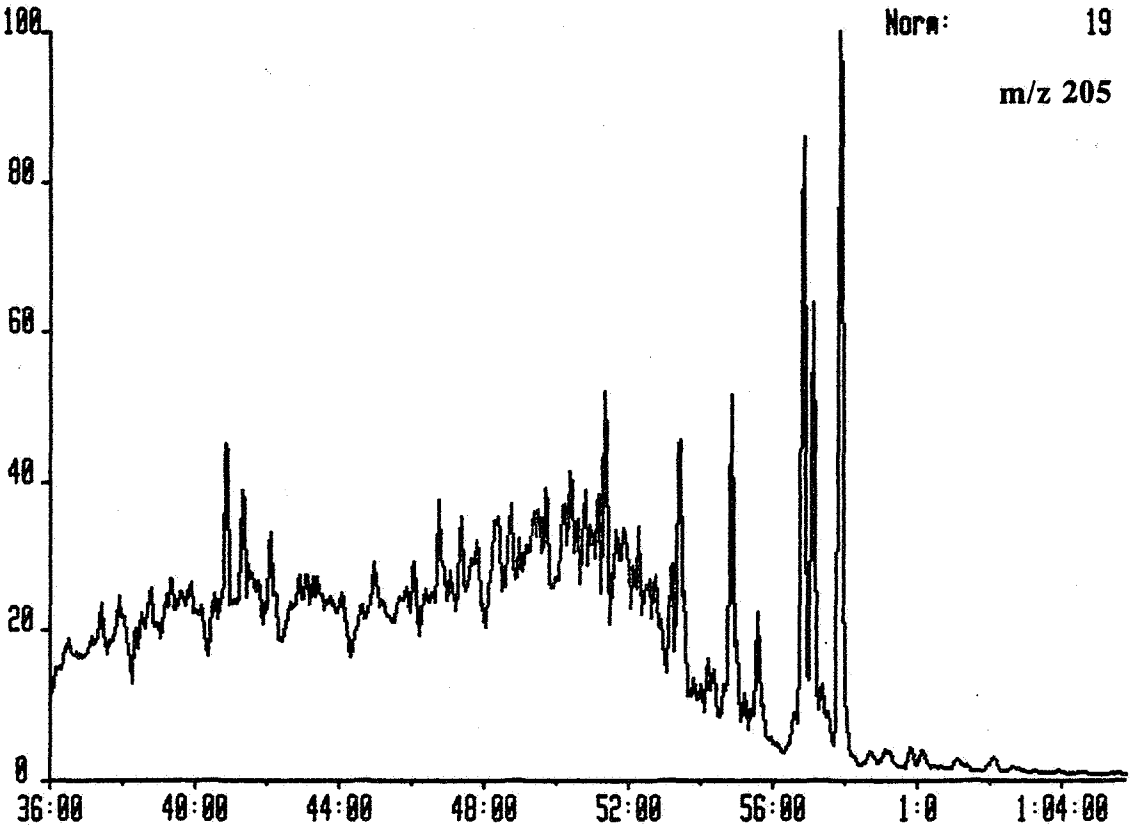


IKU SINTEF-GRUPPEN

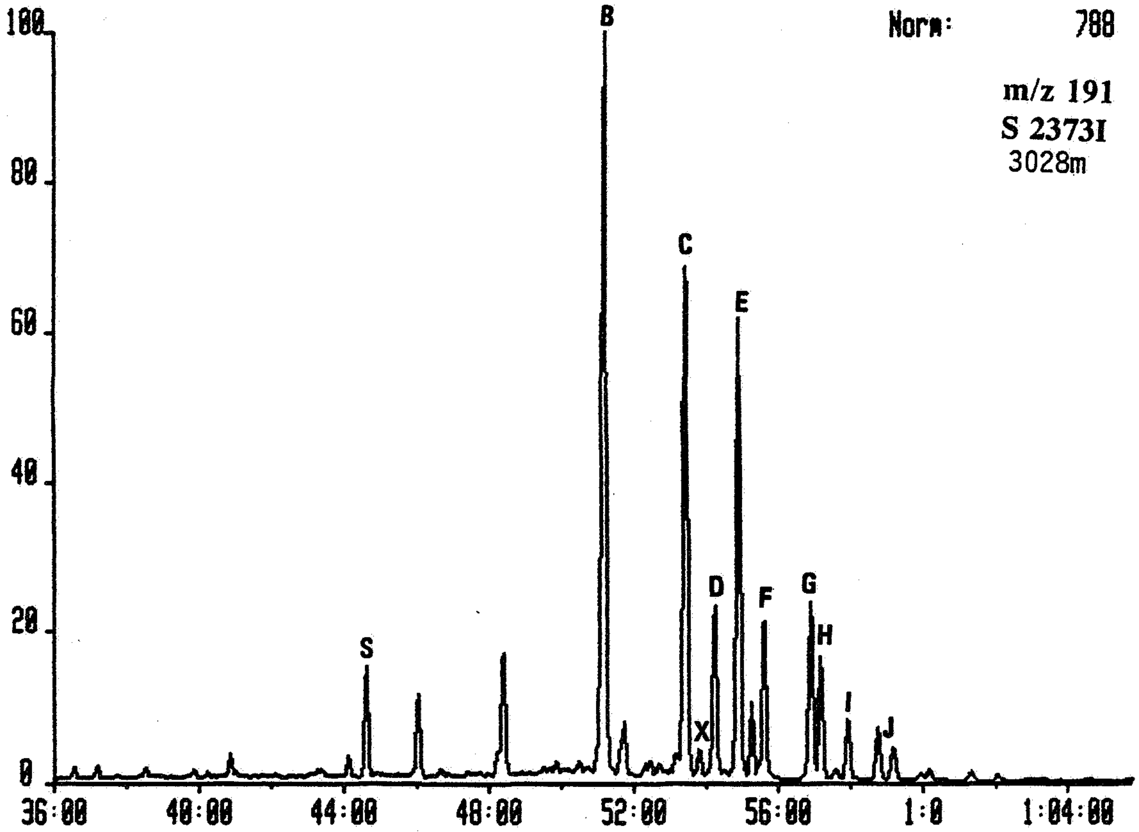
C6727SAT 30-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 191.1000
Text:



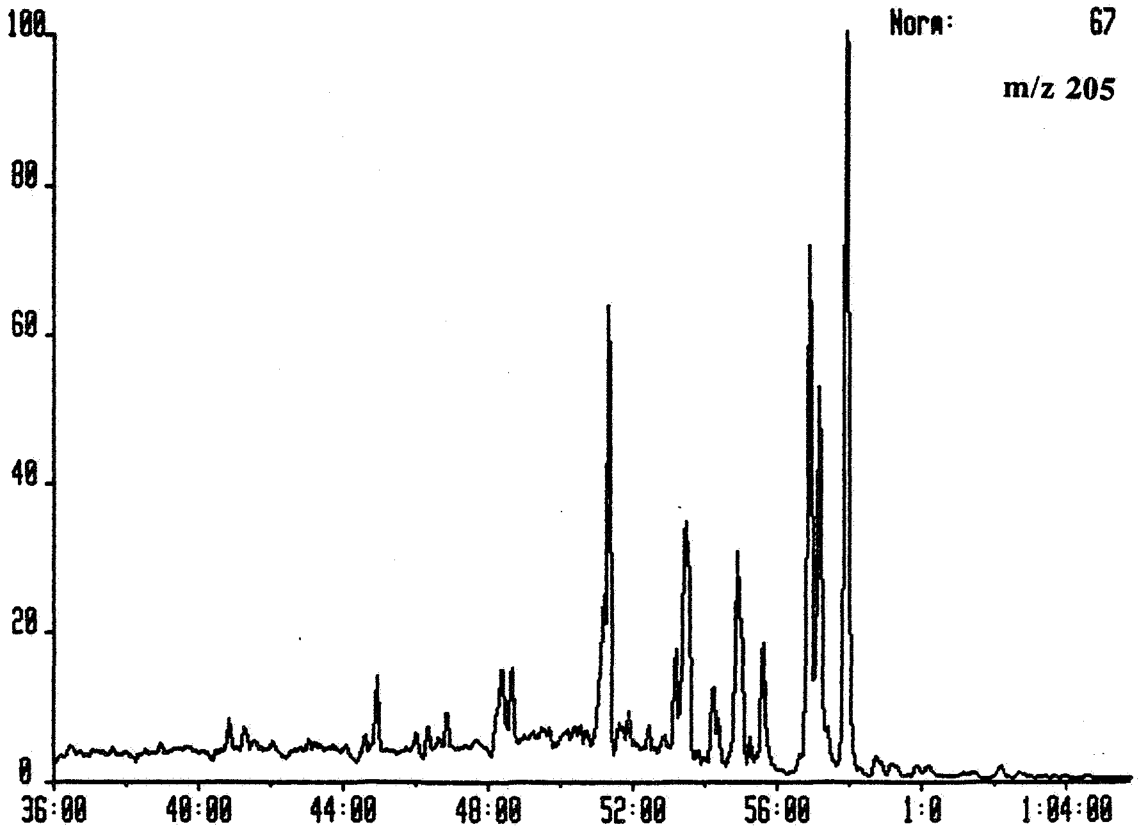
C6727SAT 30-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 205.1000
Text:



C6728SAT 30-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 191.1000
Text:

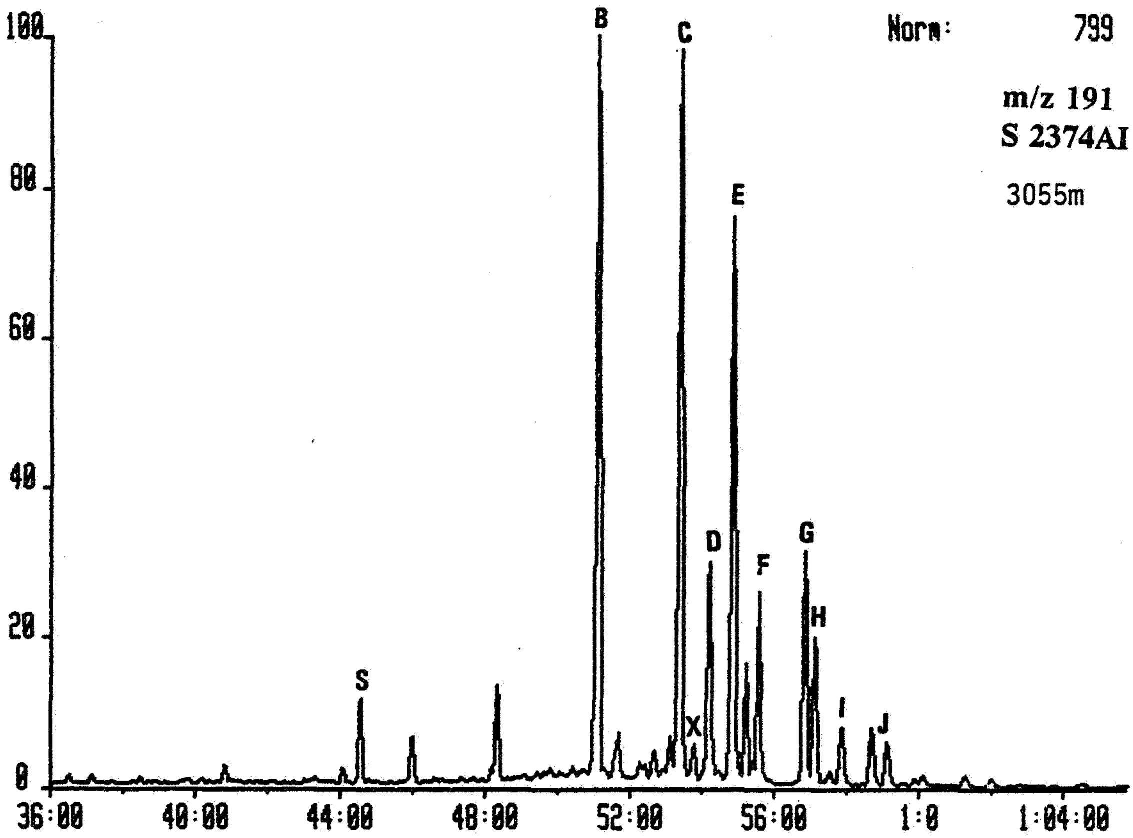


C6728SAT 30-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 205.1000
Text:

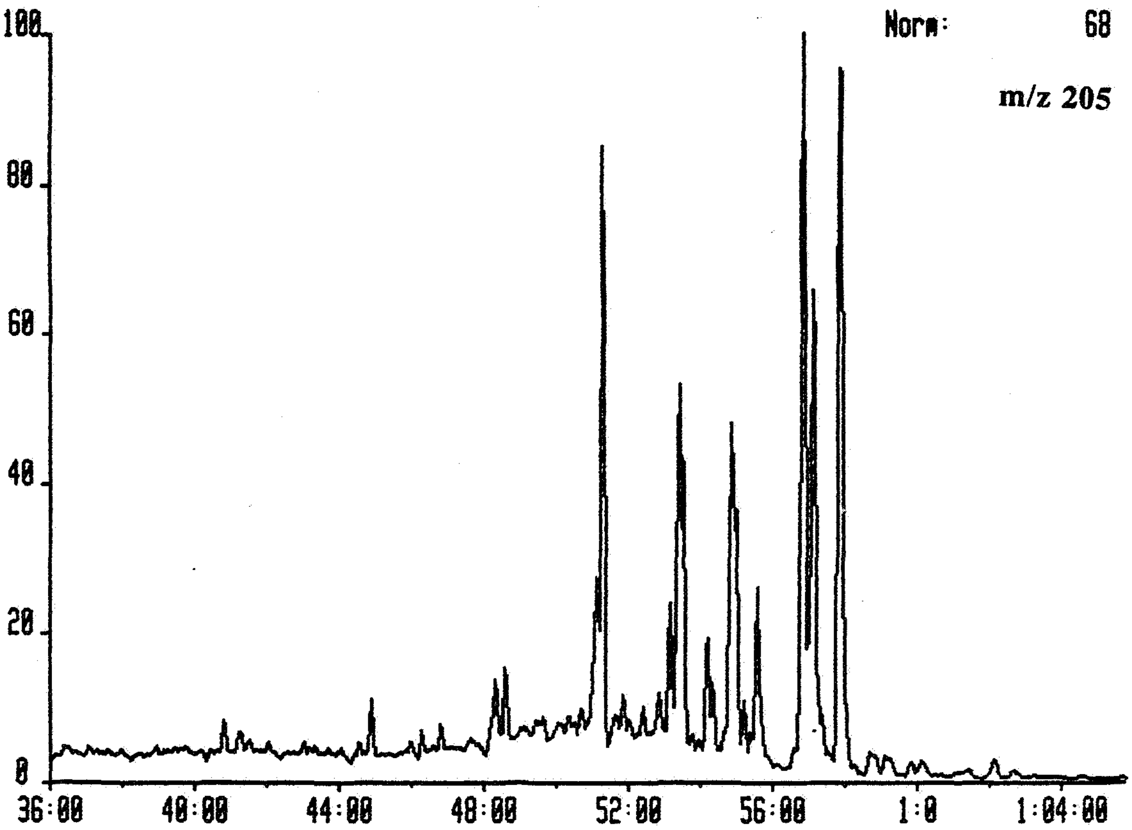


IKU
SINTEF-GRUPPEN

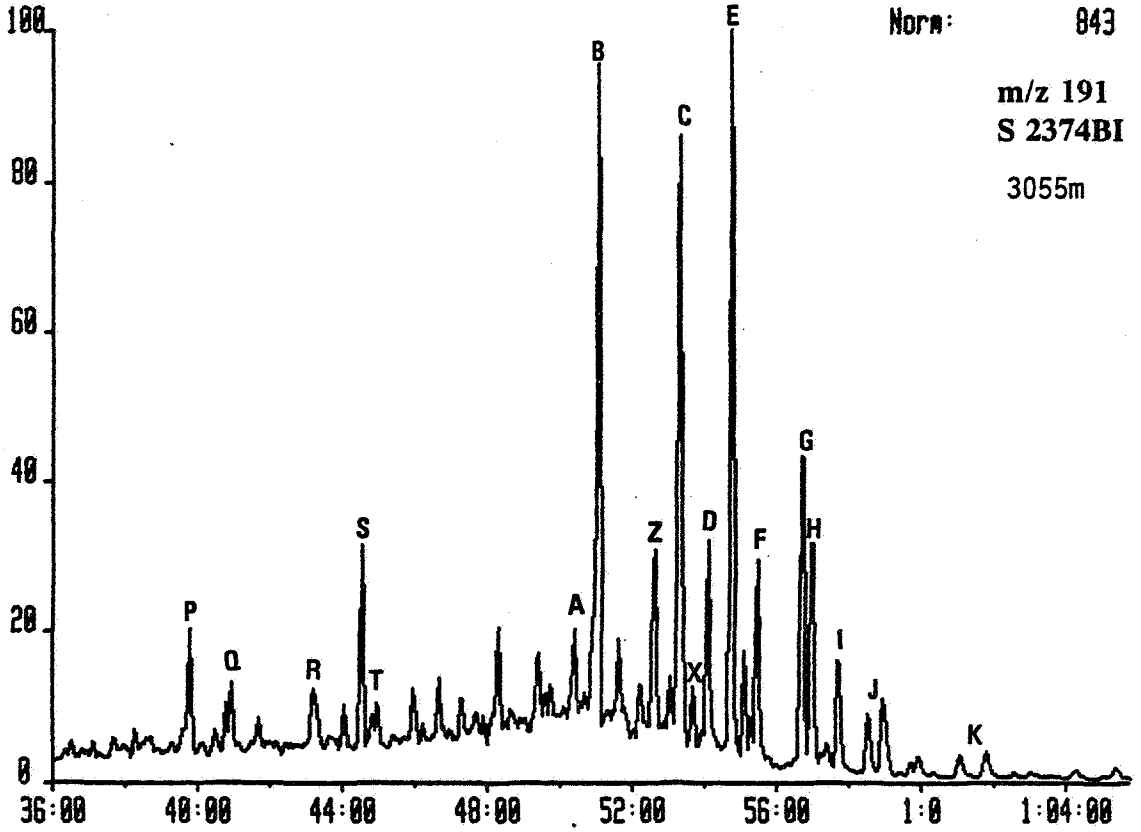
C6729SAT 30-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 191.1000
Text:



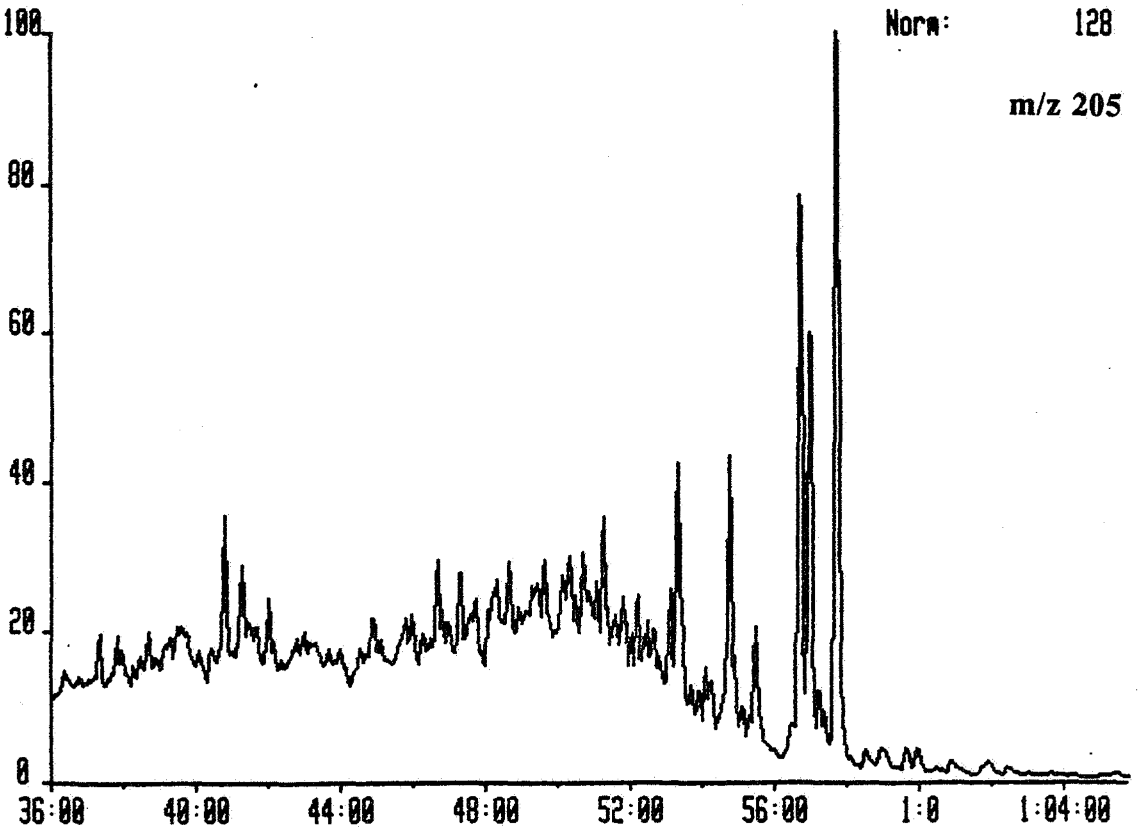
C6729SAT 30-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 205.1000
Text:



C6730SAT 1-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 191.1000
Text:

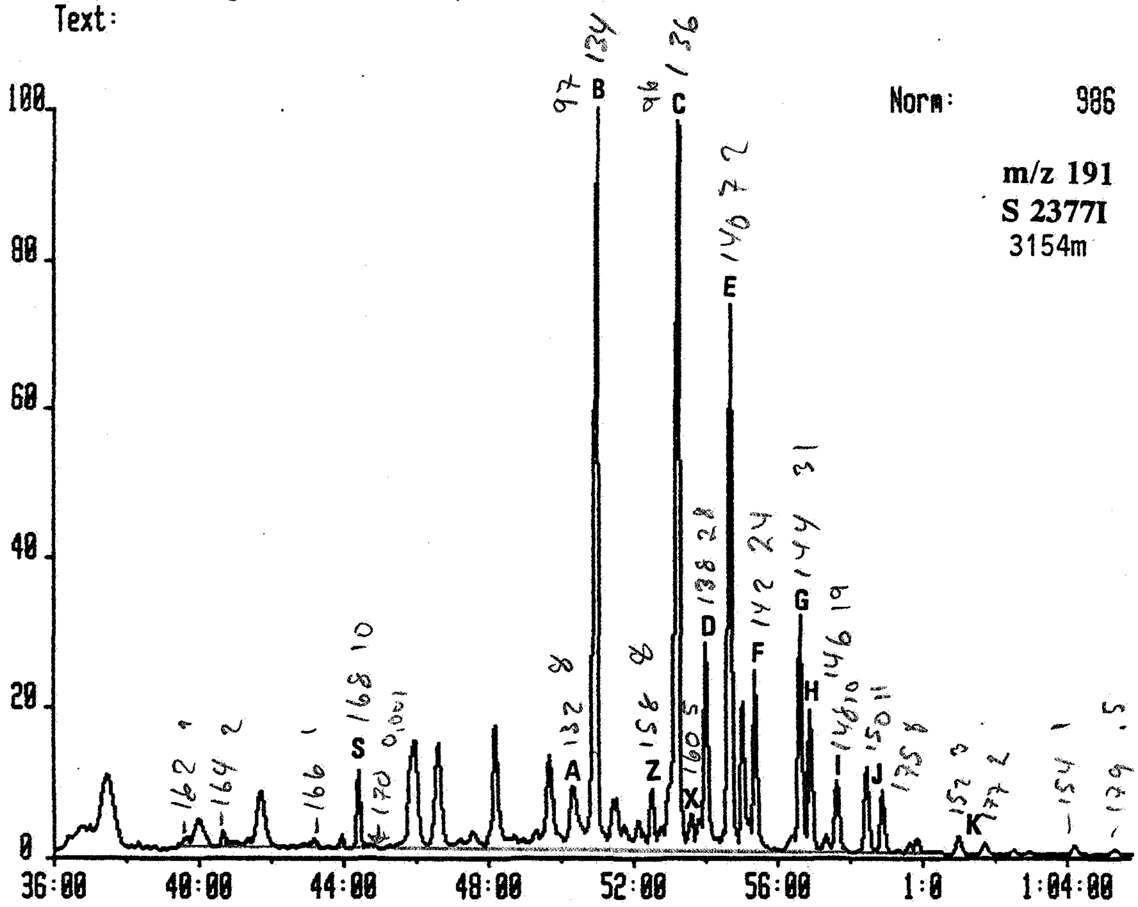


C6730SAT 1-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 205.1000
Text:

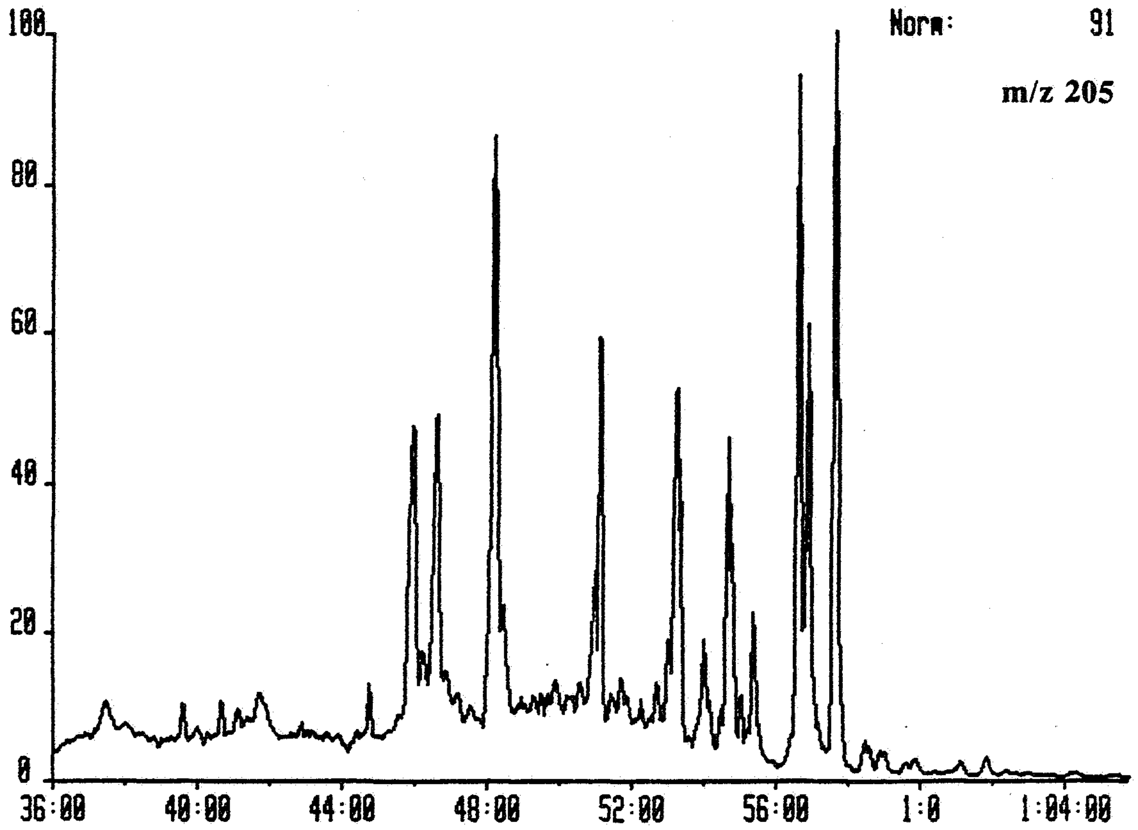


IKU
SINTEF-GRUPPEN

C6731SAT   1-OCT-87   Sir:Voltage 12-250   Acnt:IKU   System:QUAMID
Sample 1   Injection 1   Group 1   Mass 191.1000
Text:

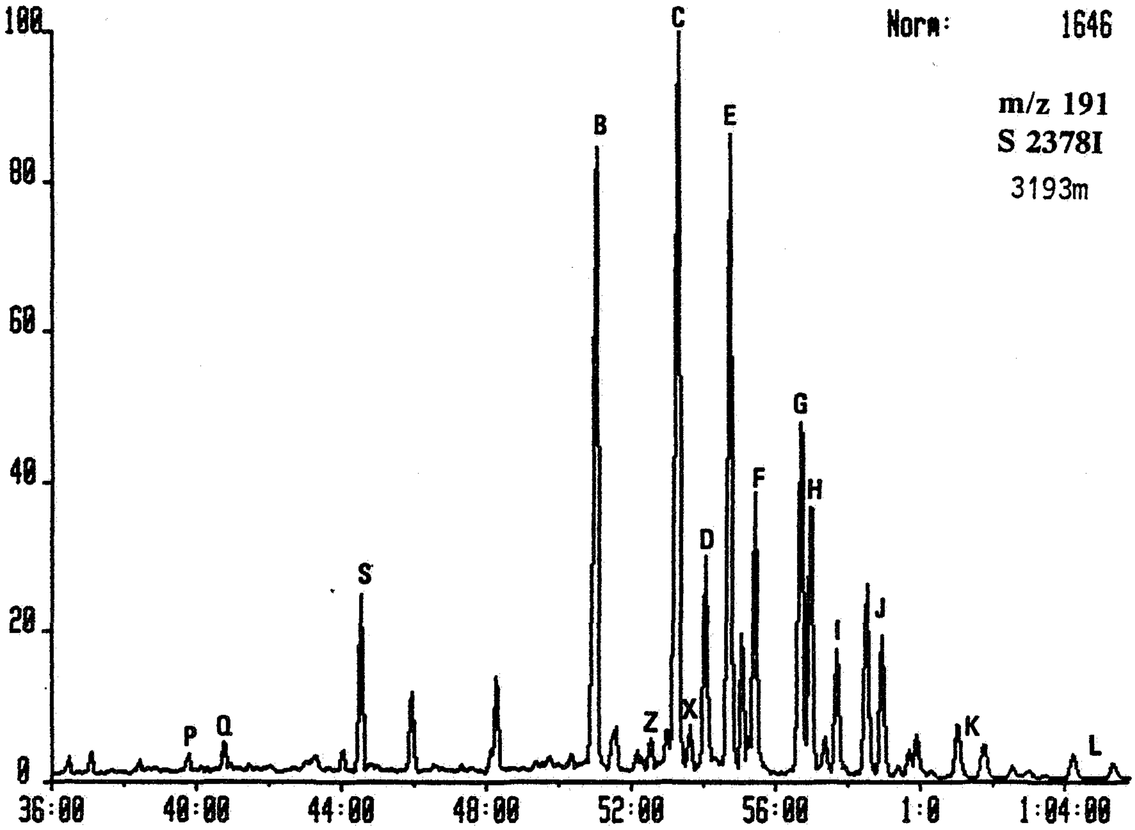


C6731SAT   1-OCT-87   Sir:Voltage 12-250   Acnt:IKU   System:QUAMID
Sample 1   Injection 1   Group 1   Mass 205.1000
Text:

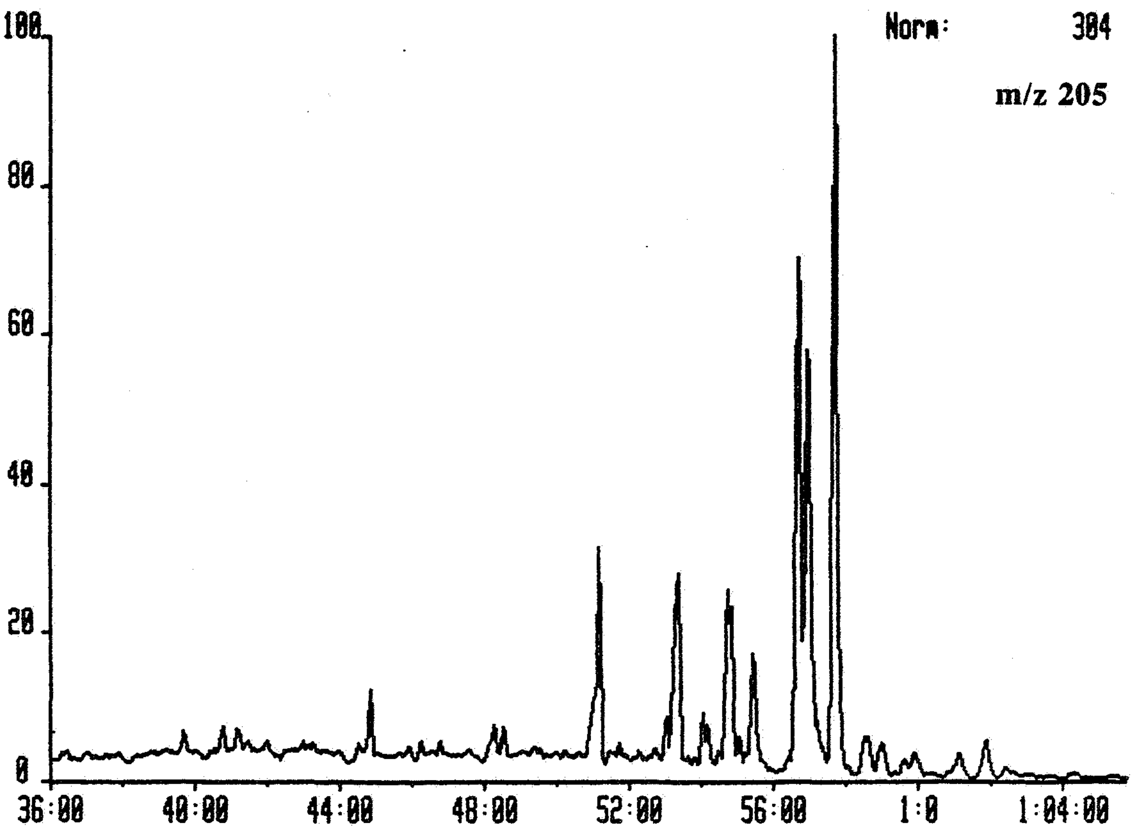


IKU SINTEF-GRUPPEN

C6732SAT 1-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 191.1000
Text:

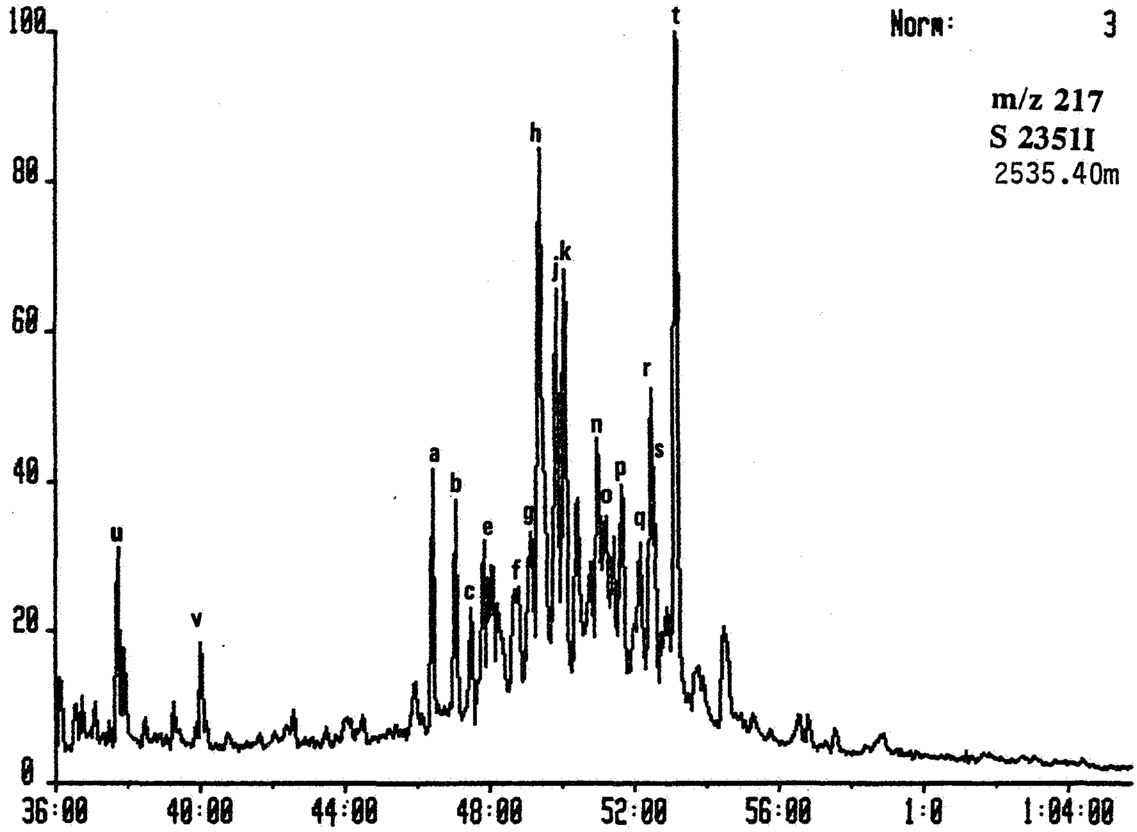


C6732SAT 1-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 205.1000
Text:

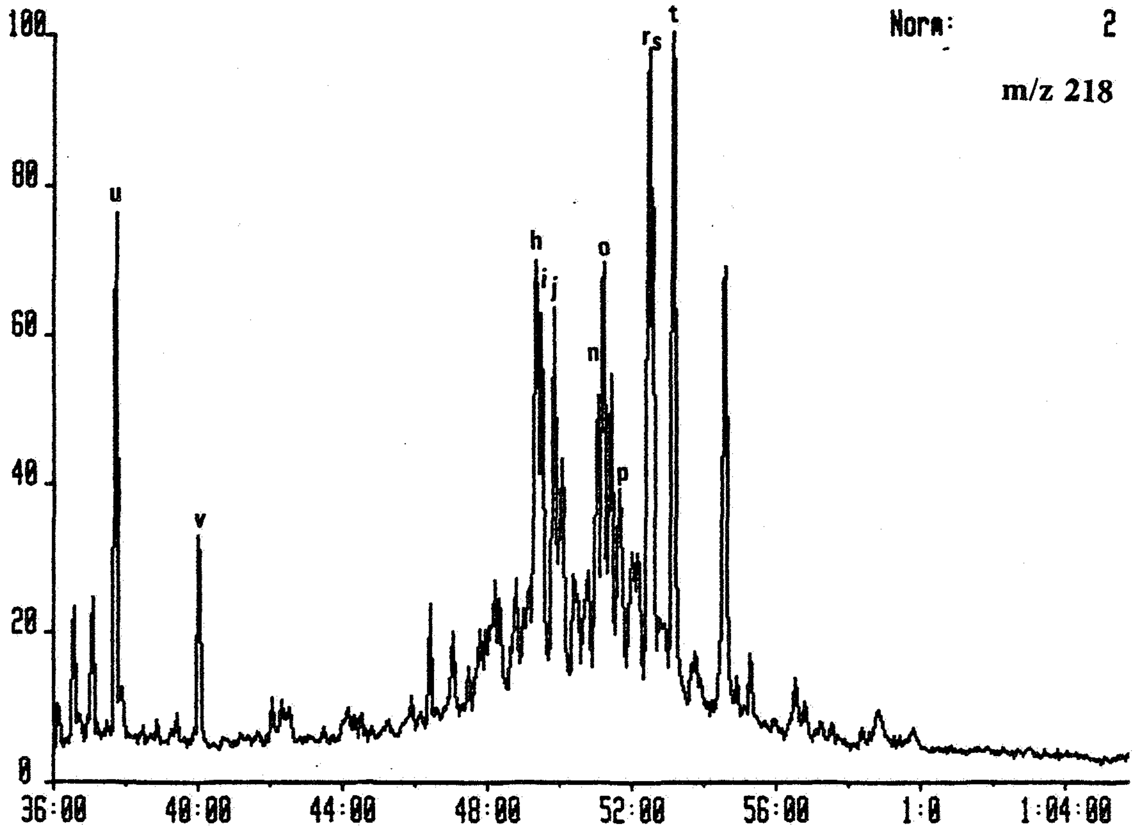


Source rock samples

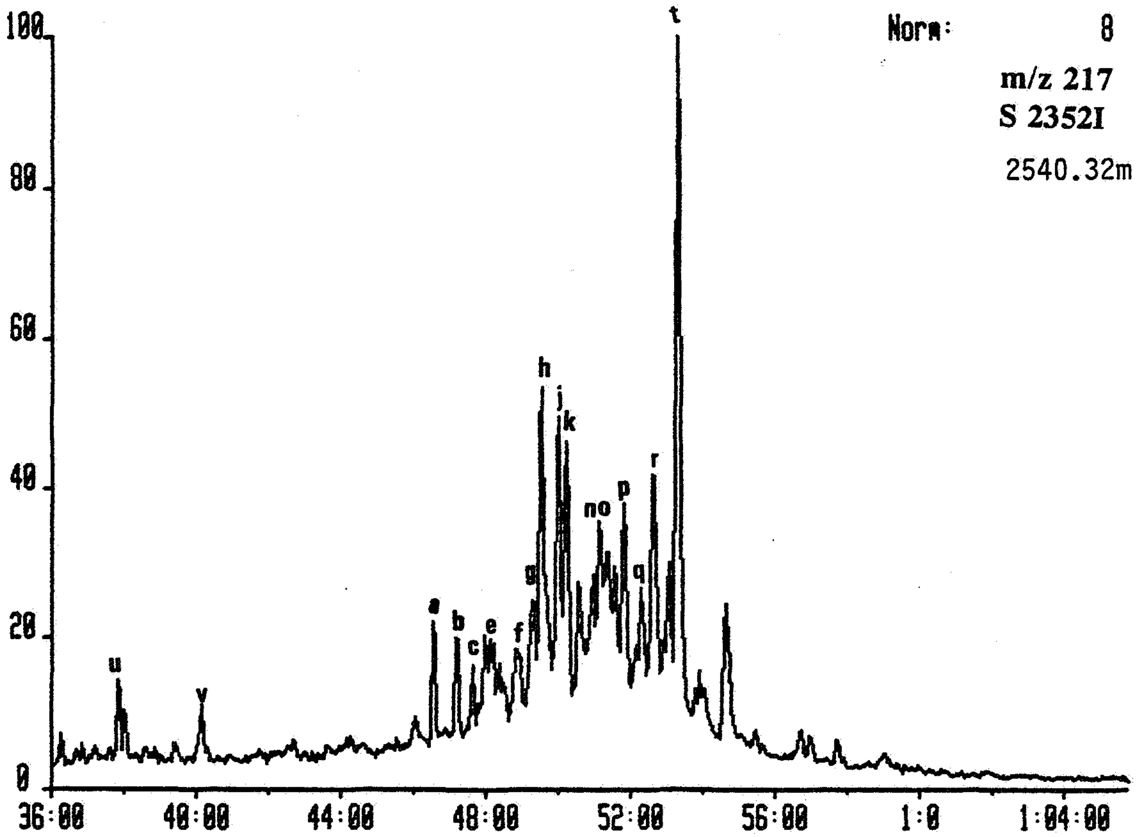
C6721SAT 1-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 217.1000
Text:



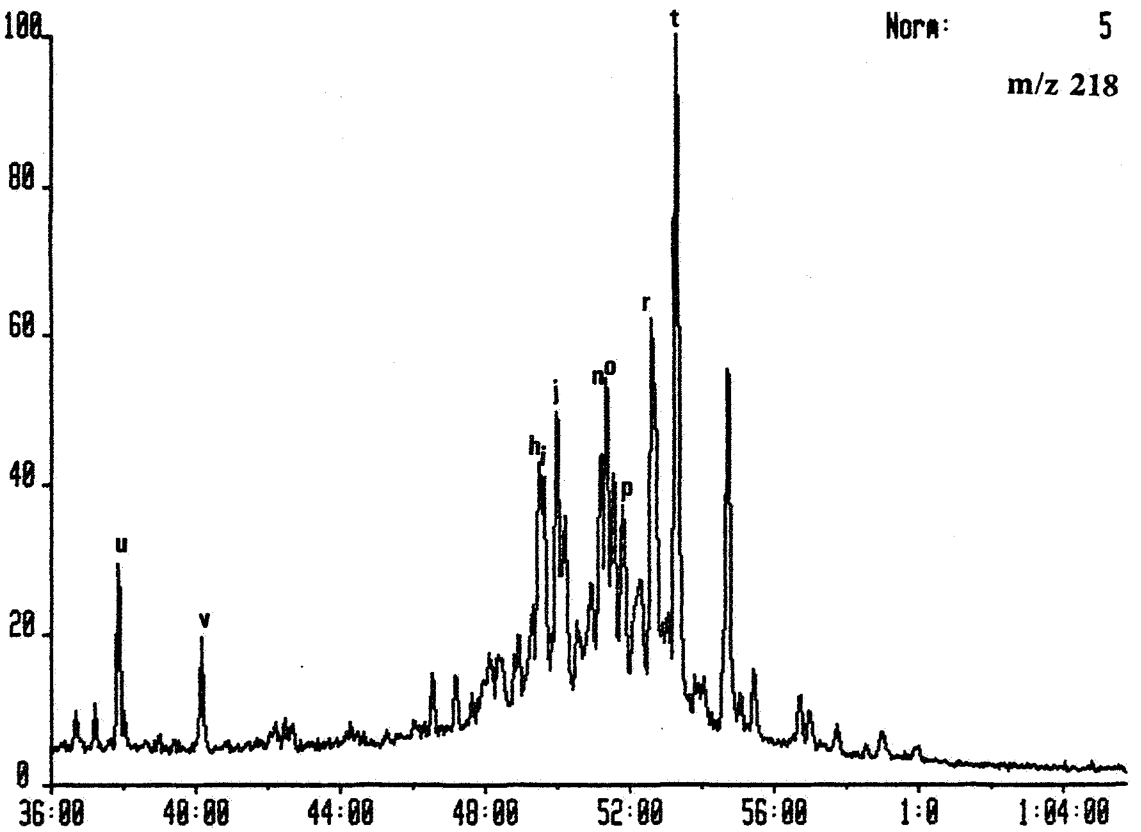
C6721SAT 1-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 218.1000
Text:



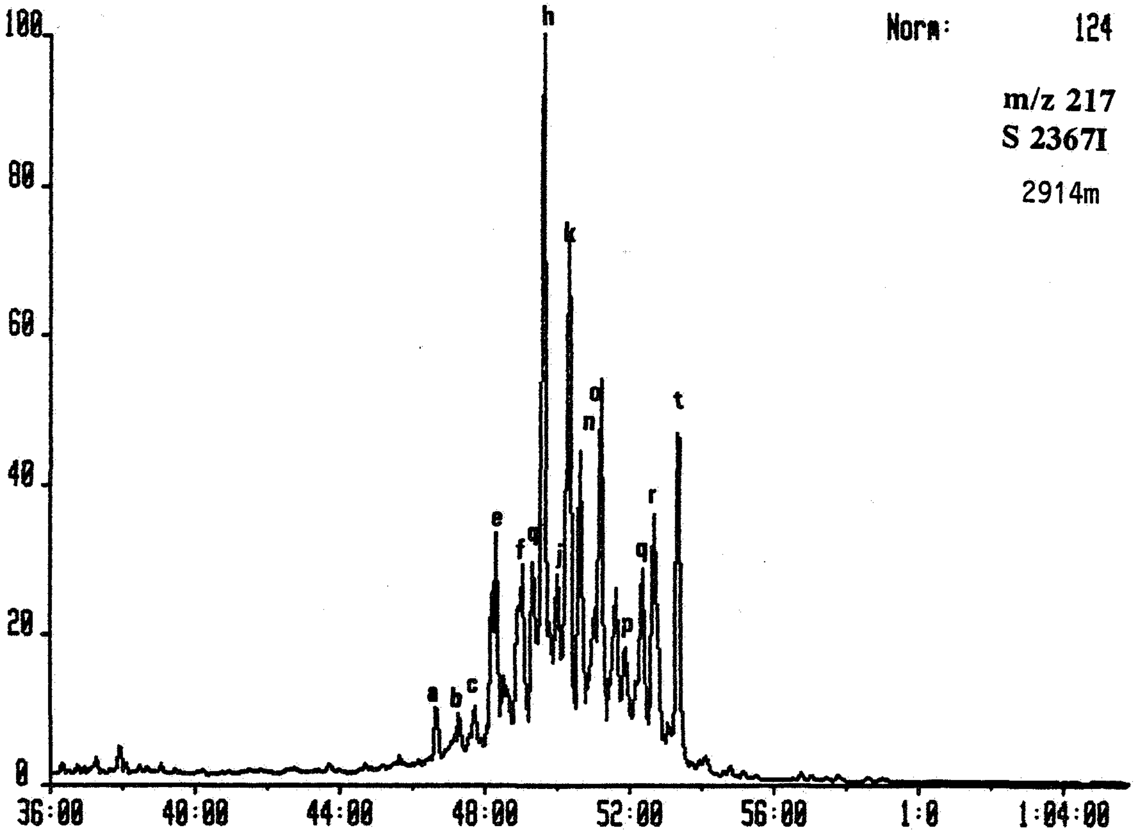
C6722SAT 29-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 217.1000
Text:



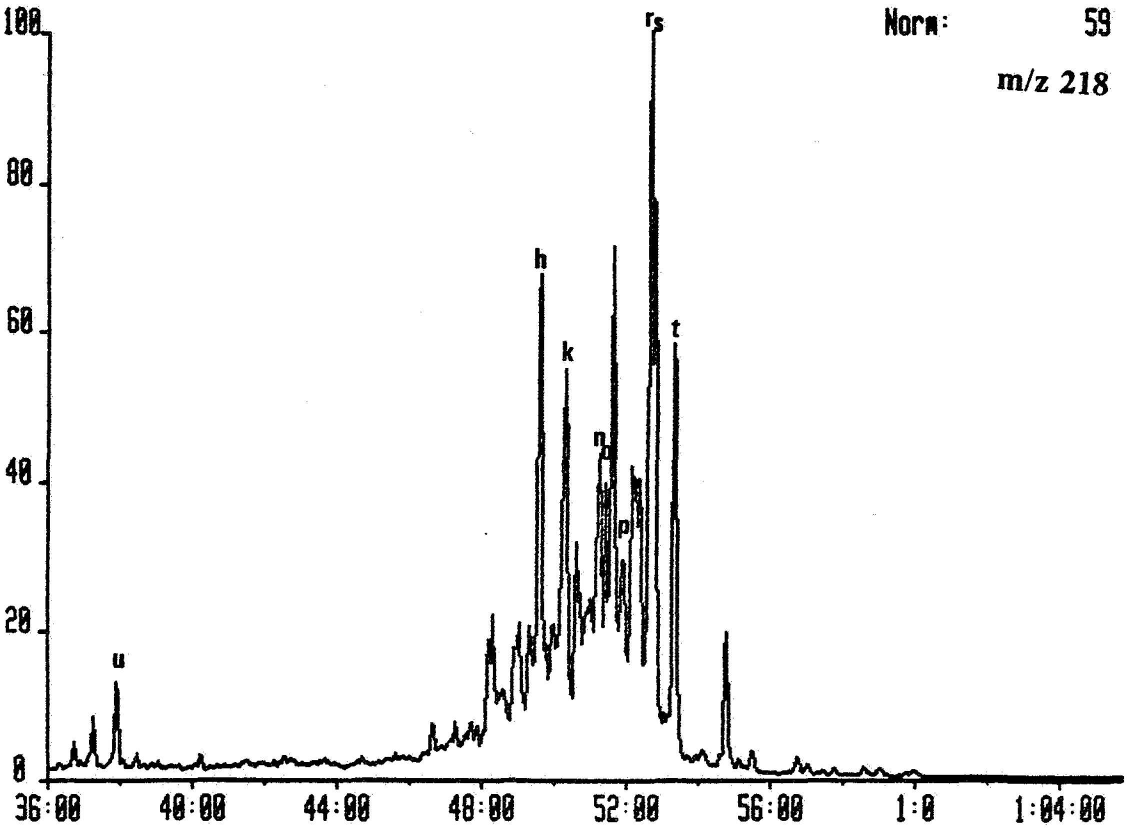
C6722SAT 29-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 218.1000
Text:



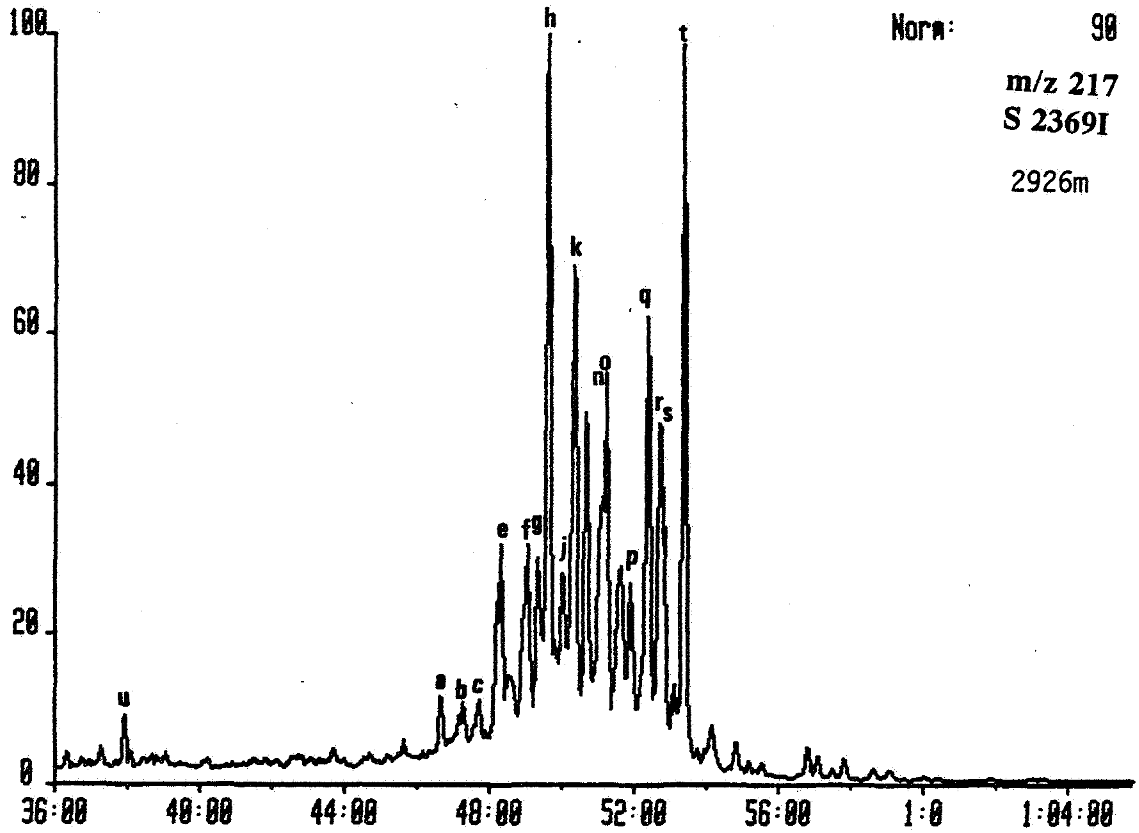
C6723SAT 29-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 217.1000
Text:



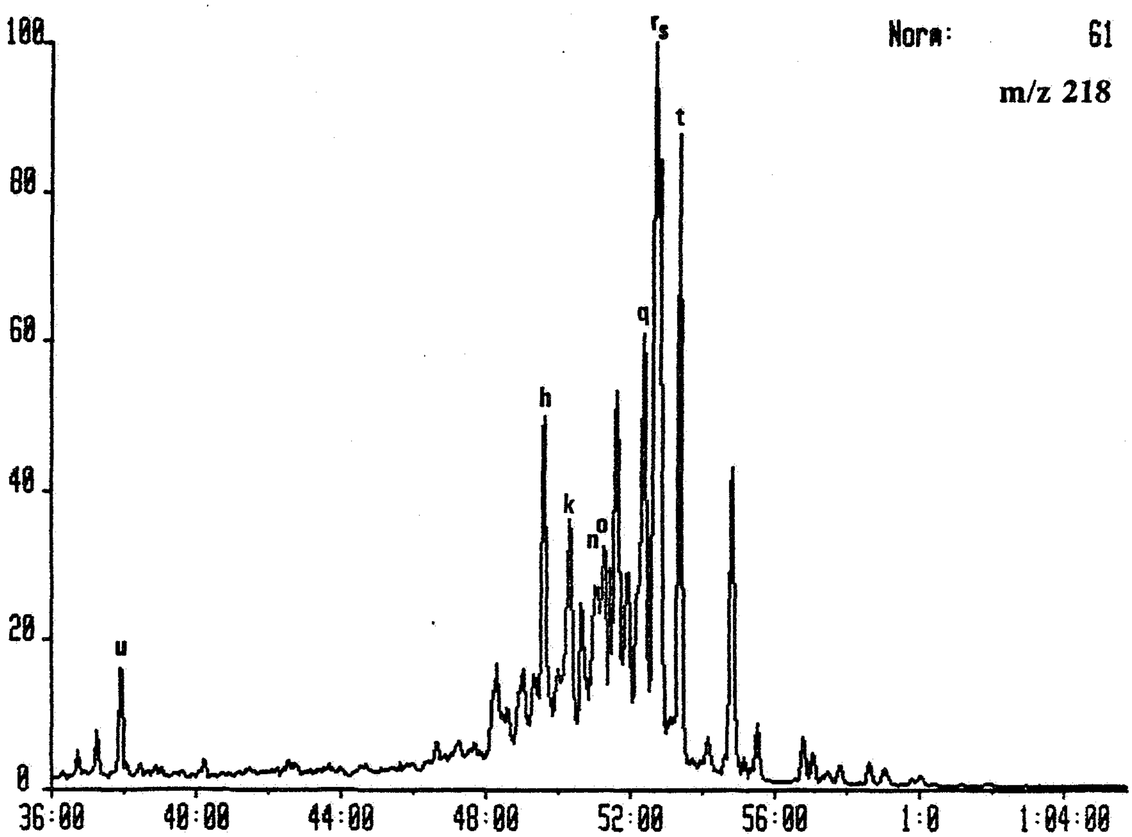
C6723SAT 29-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 218.1000
Text:



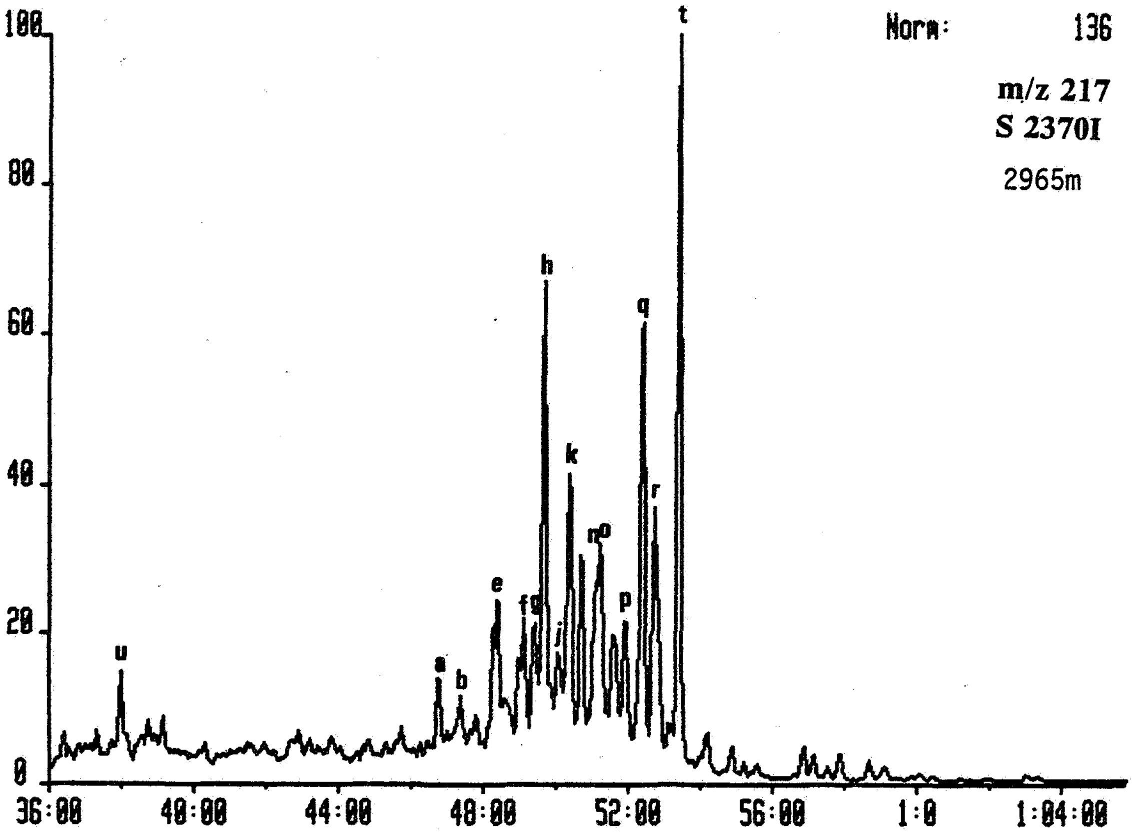
C6724SAT 29-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 217.1000
Text:



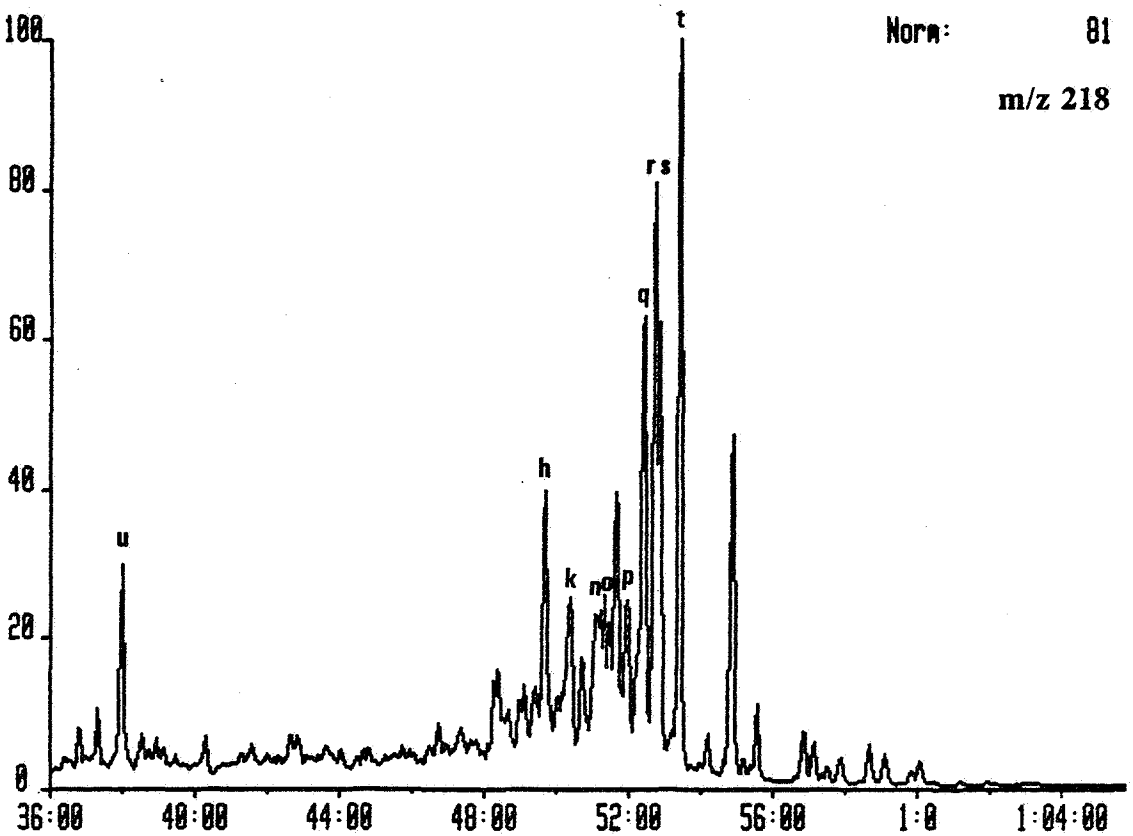
C6724SAT 29-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 218.1000
Text:



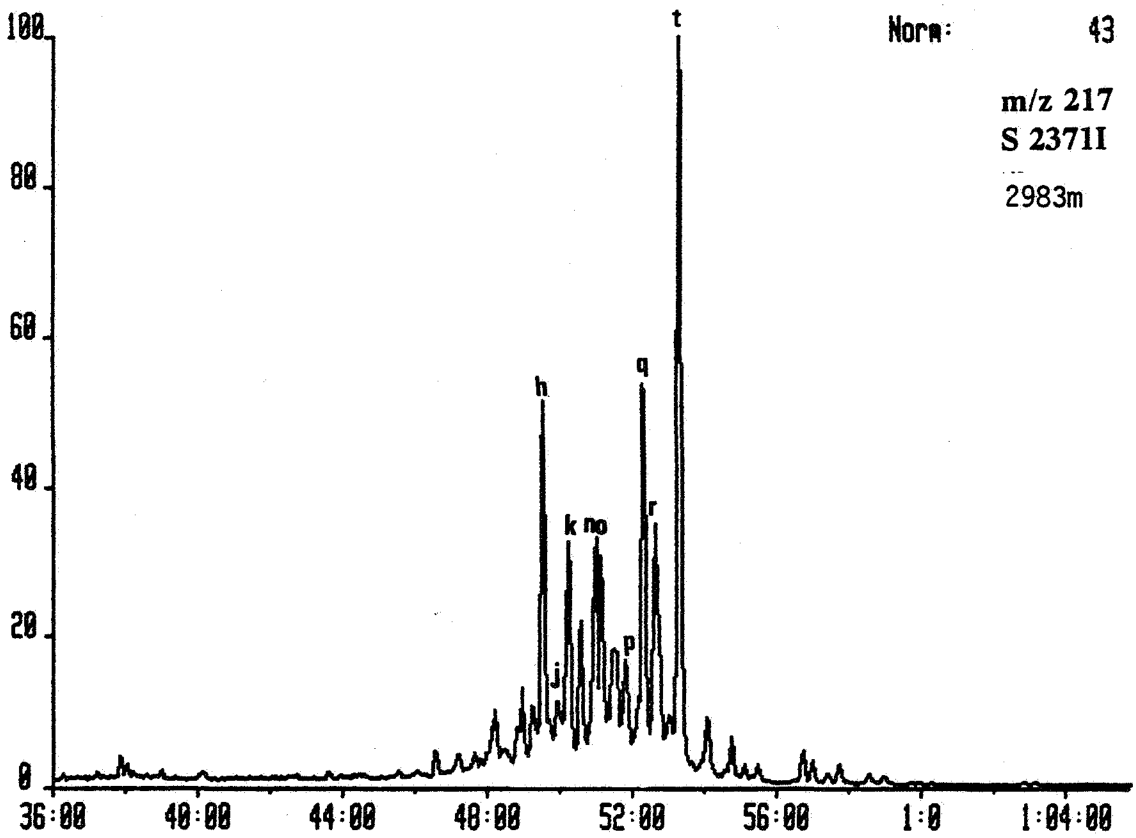
C6725SAT 29-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 217.1000
Text:



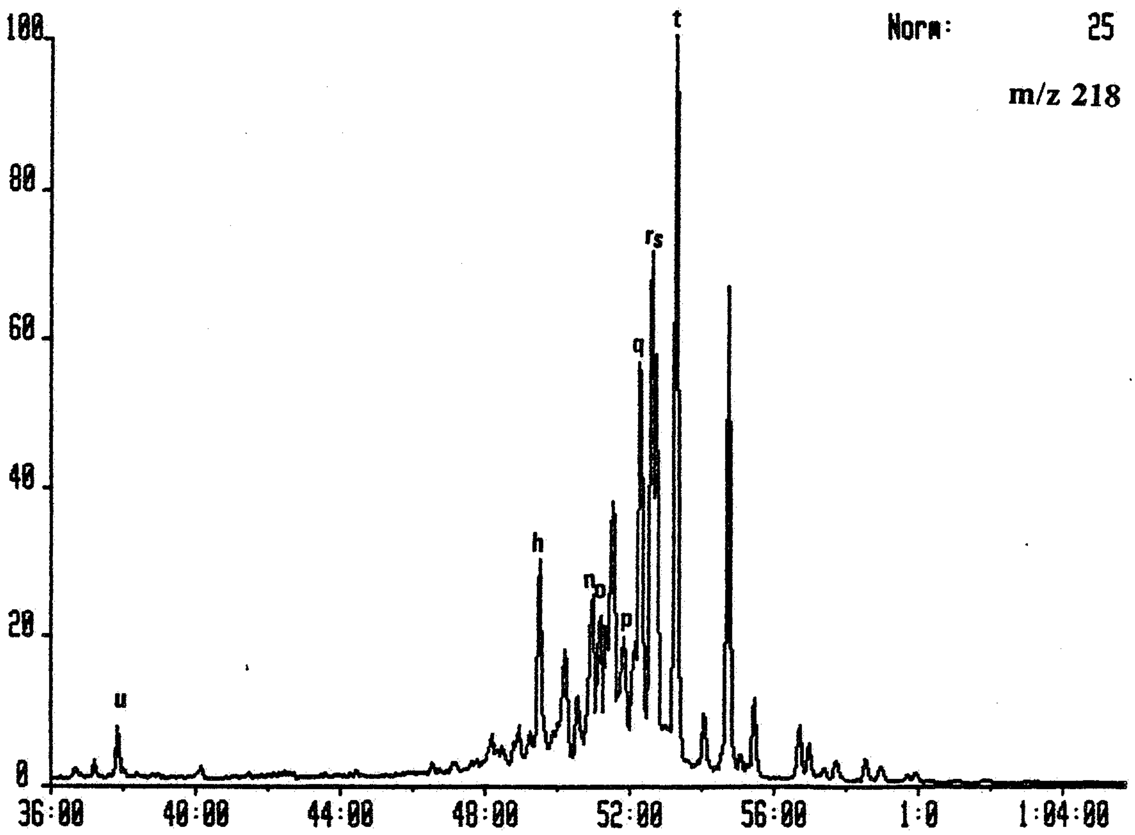
C6725SAT 29-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 218.1000
Text:



C6726SAT 30-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 217.1000
Text:

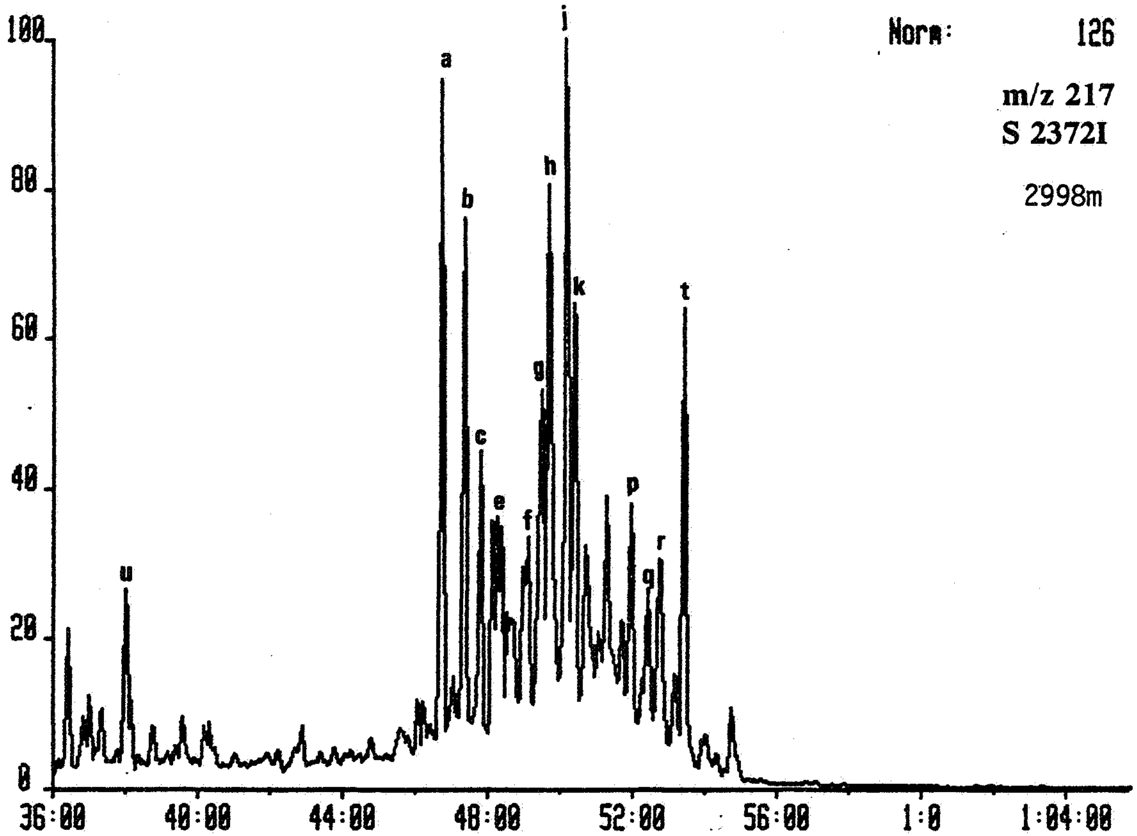


C6726SAT 30-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 218.1000
Text:

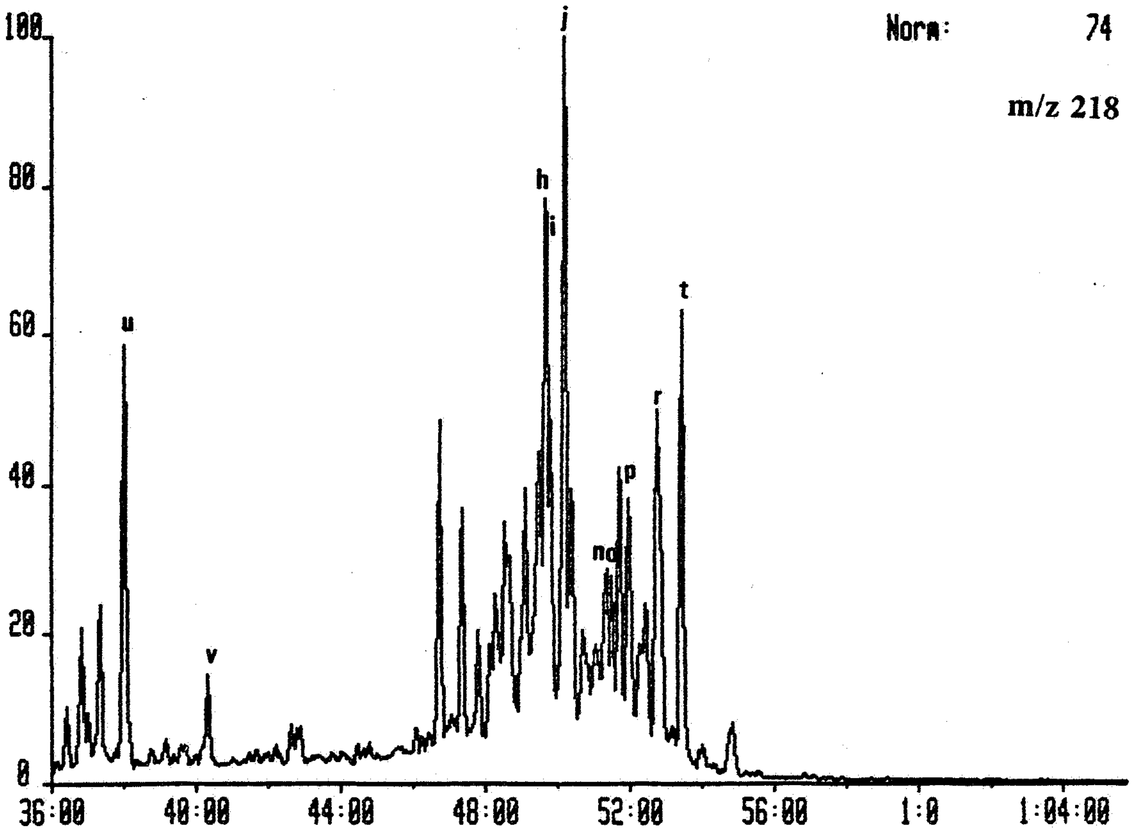


IKU SINTEF-GRUPPEN

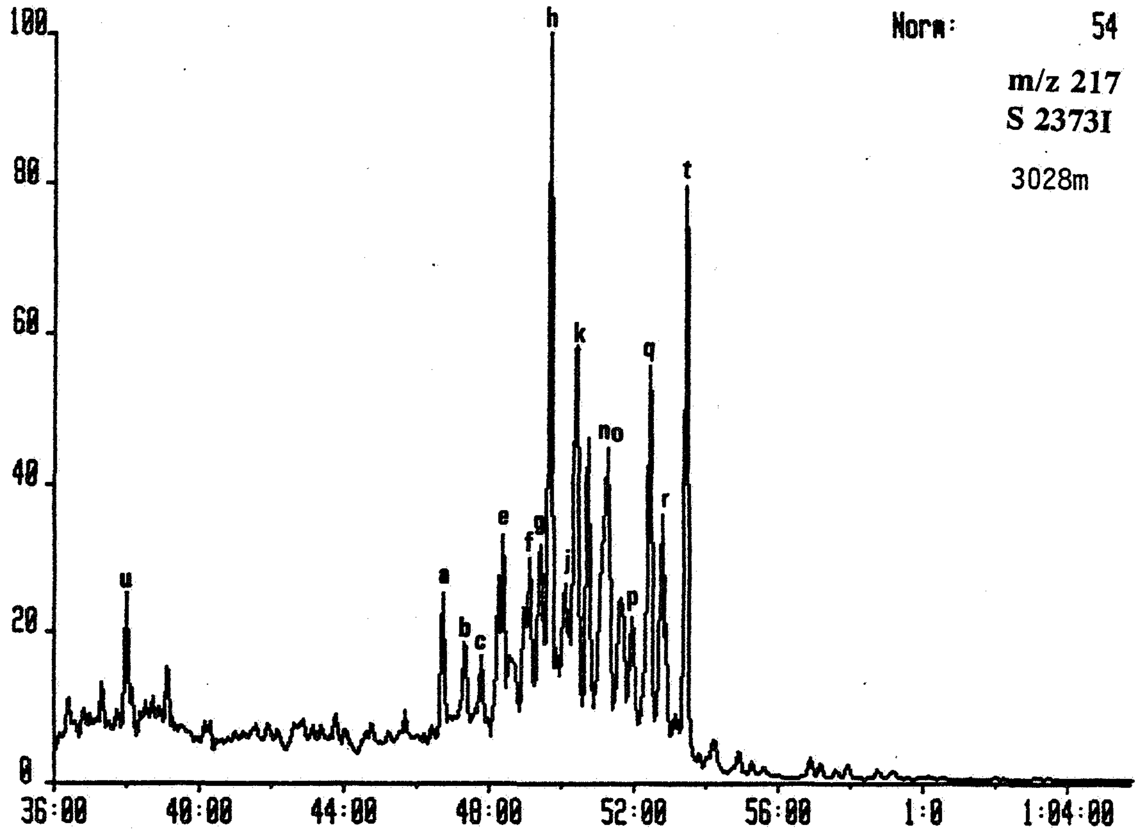
C6727SAT 30-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 217.1000
Text:



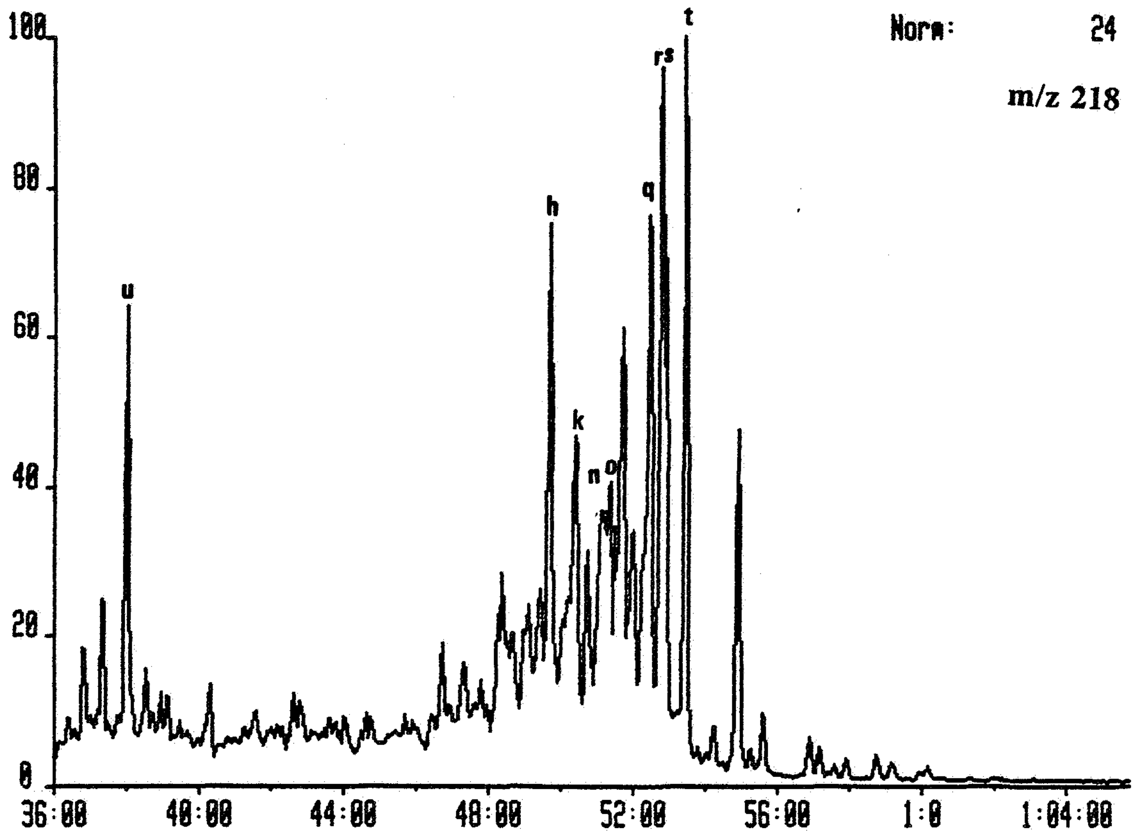
C6727SAT 30-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 218.1000
Text:



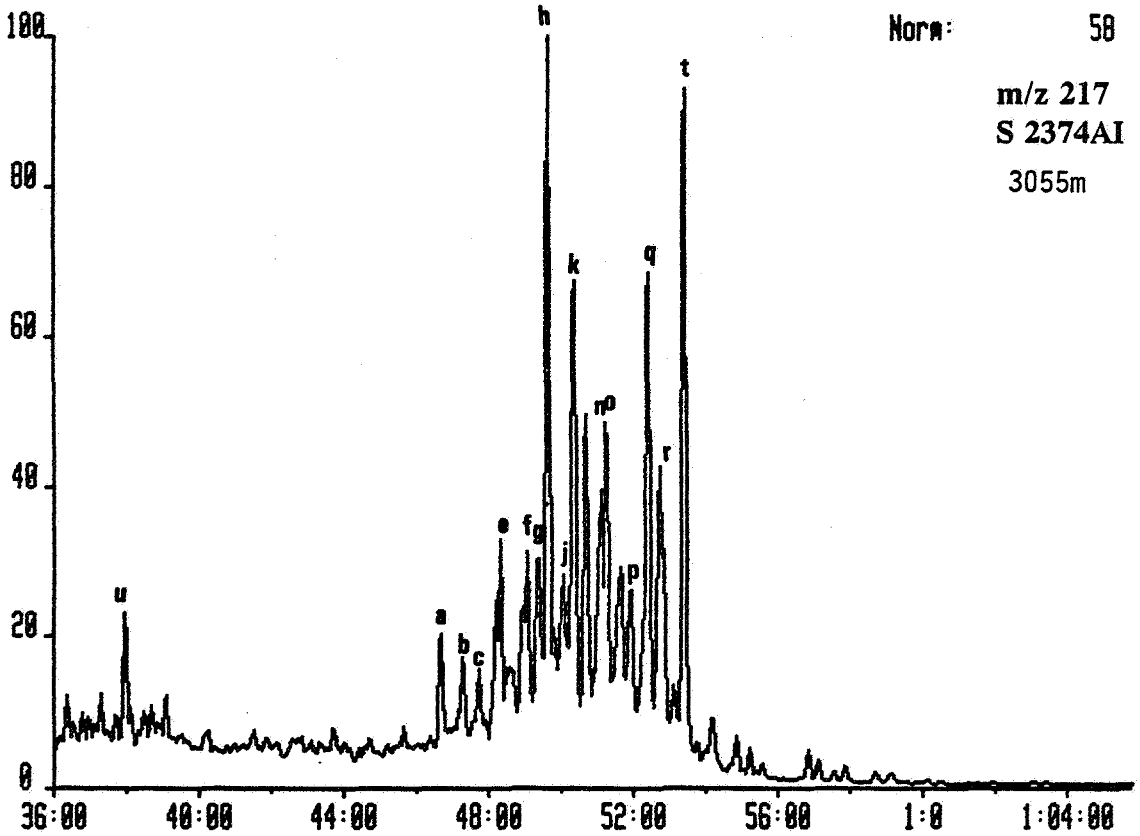
C6728SAT 30-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 217.1000
Text:



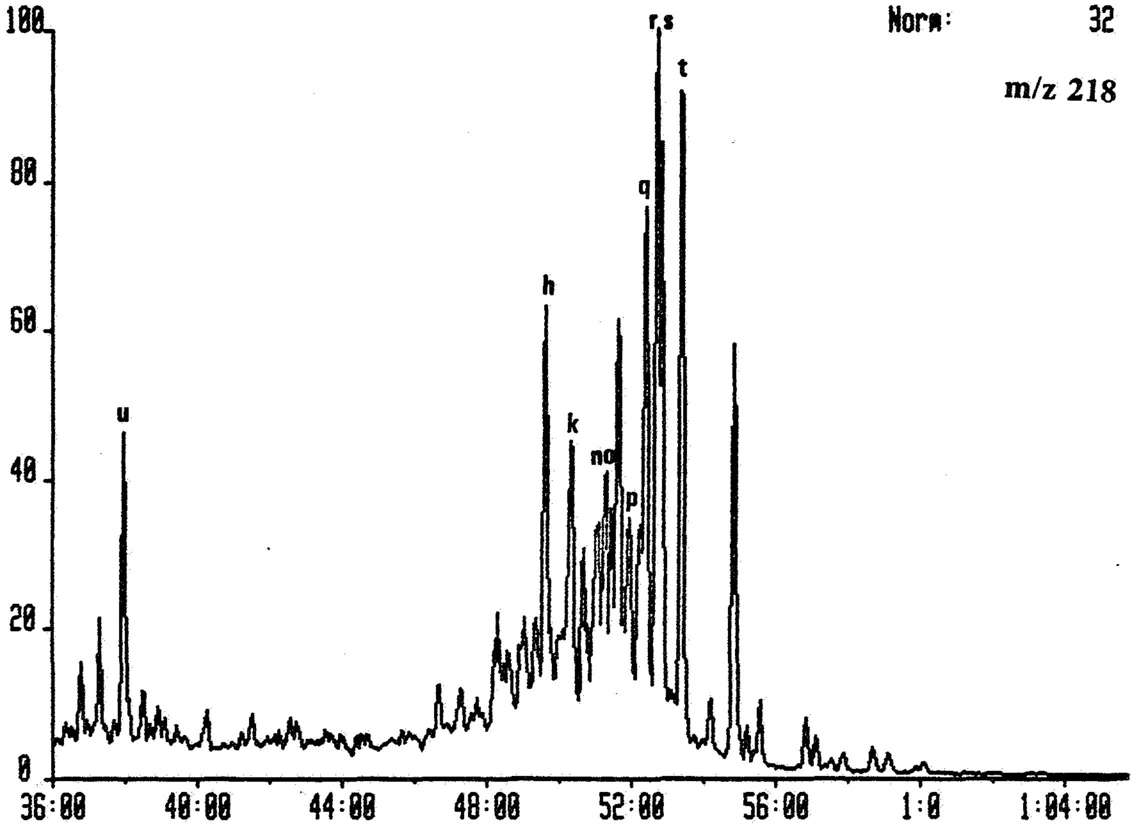
C6728SAT 30-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 218.1000
Text:



C6729SAT 30-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 217.1000
Text:

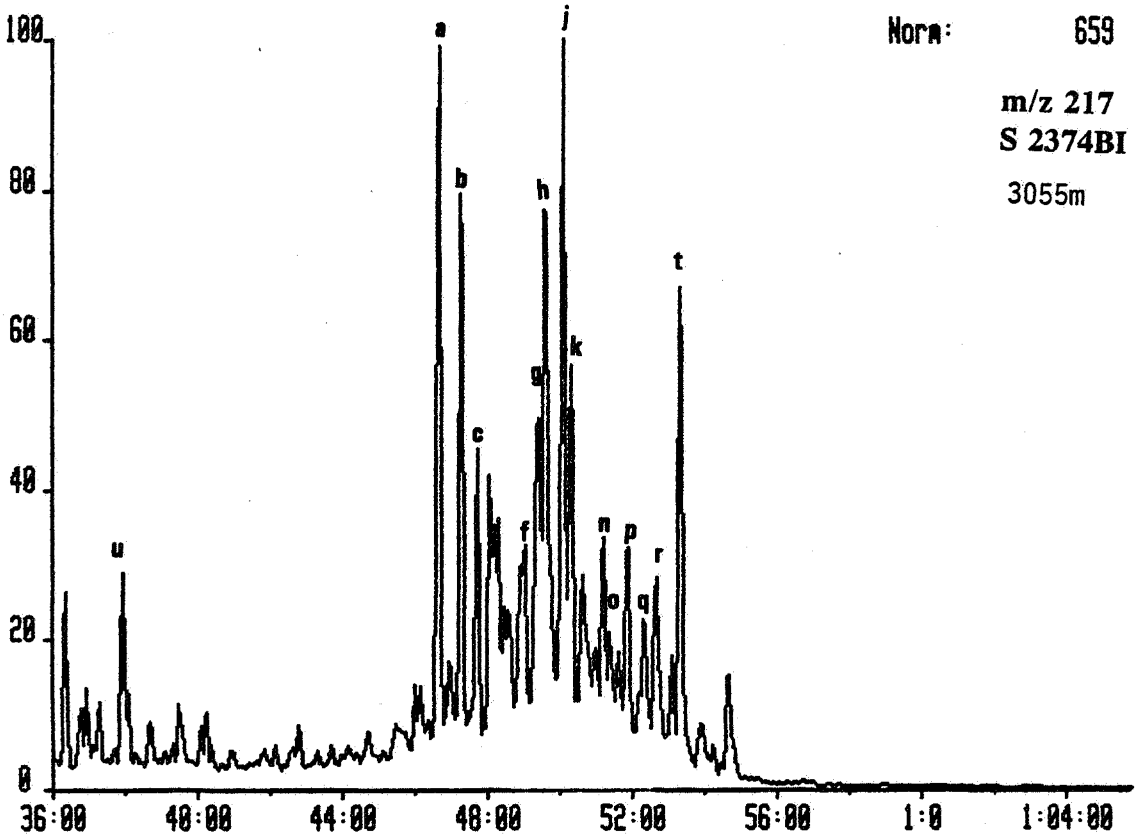


C6729SAT 30-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 218.1000
Text:

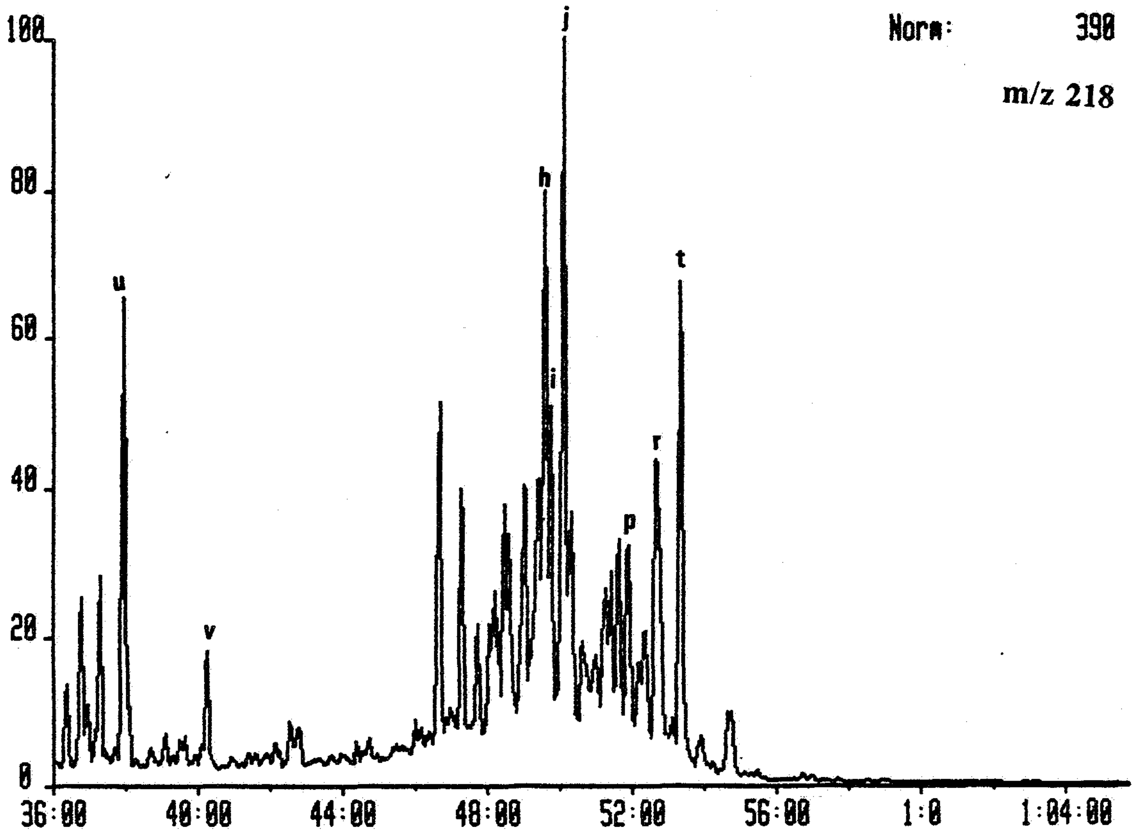


IKU SINTEF-GRUPPEN

C6730SAT 1-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 217.1000
Text:

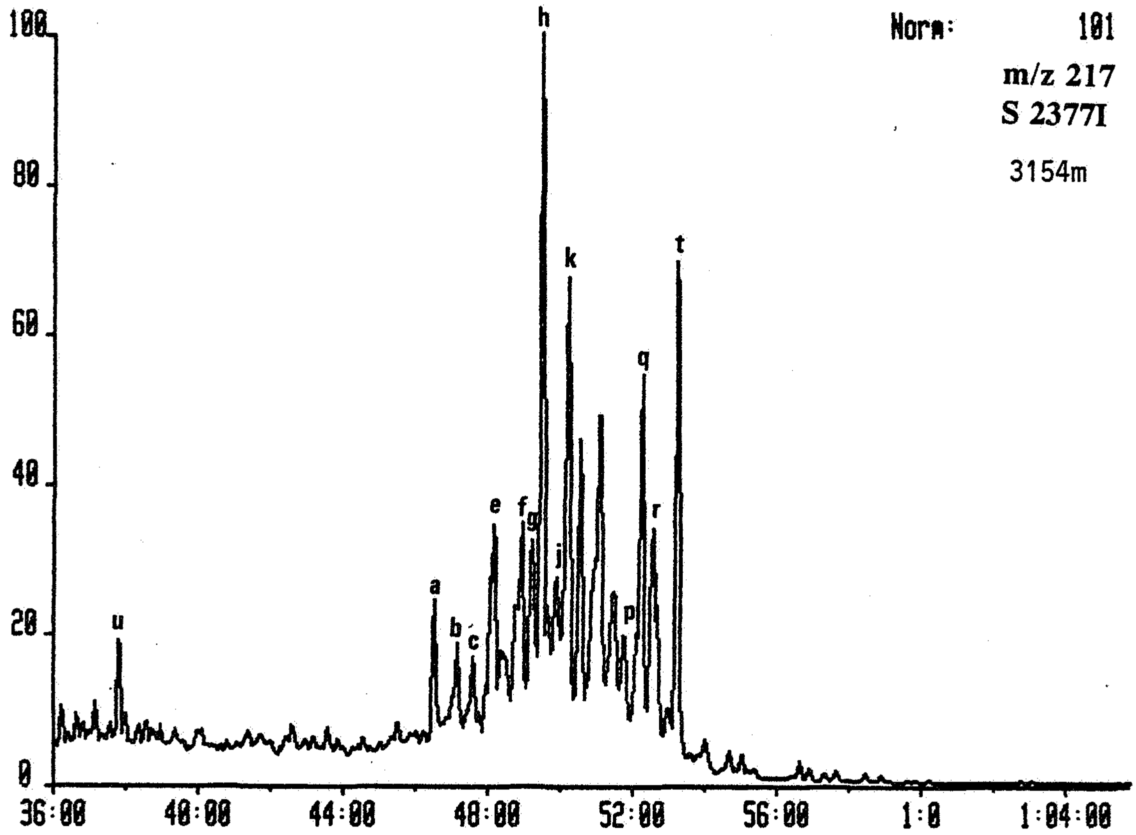


C6730SAT 1-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 218.1000
Text:

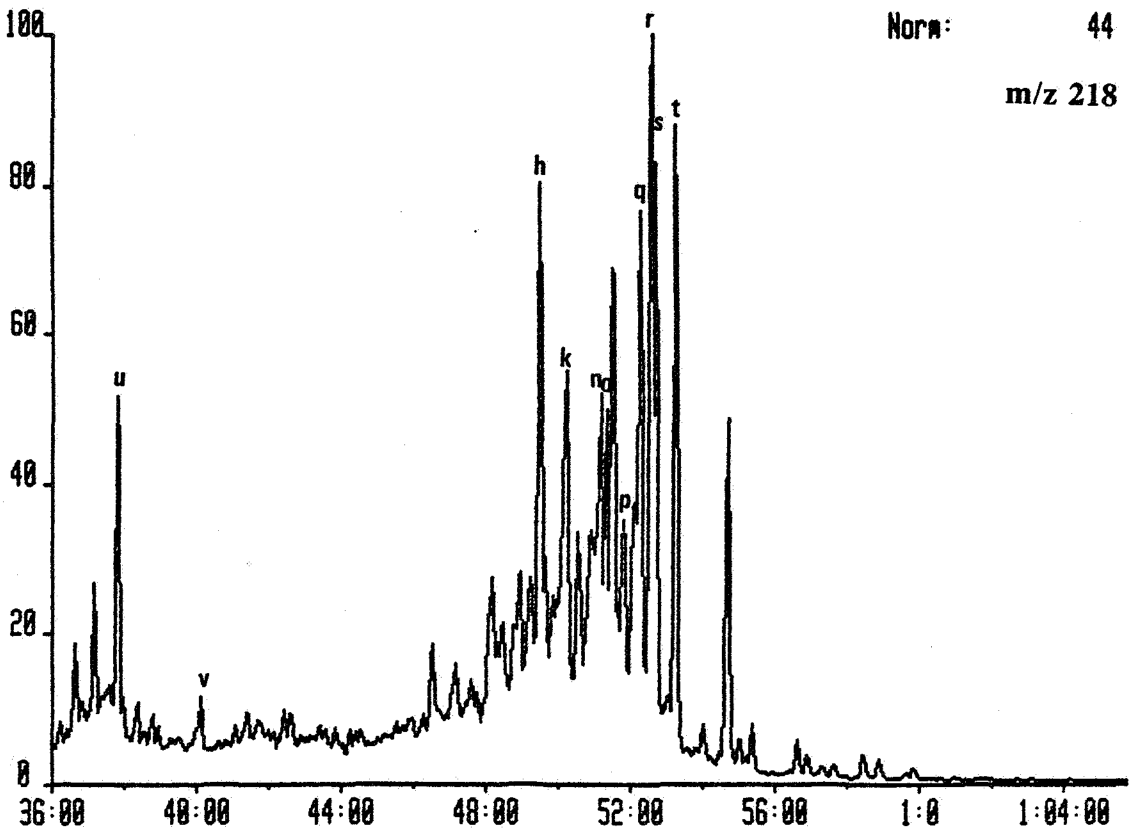


IKU
SINTEF-GRUPPEN

C6731SAT 1-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 217.1000
Text:

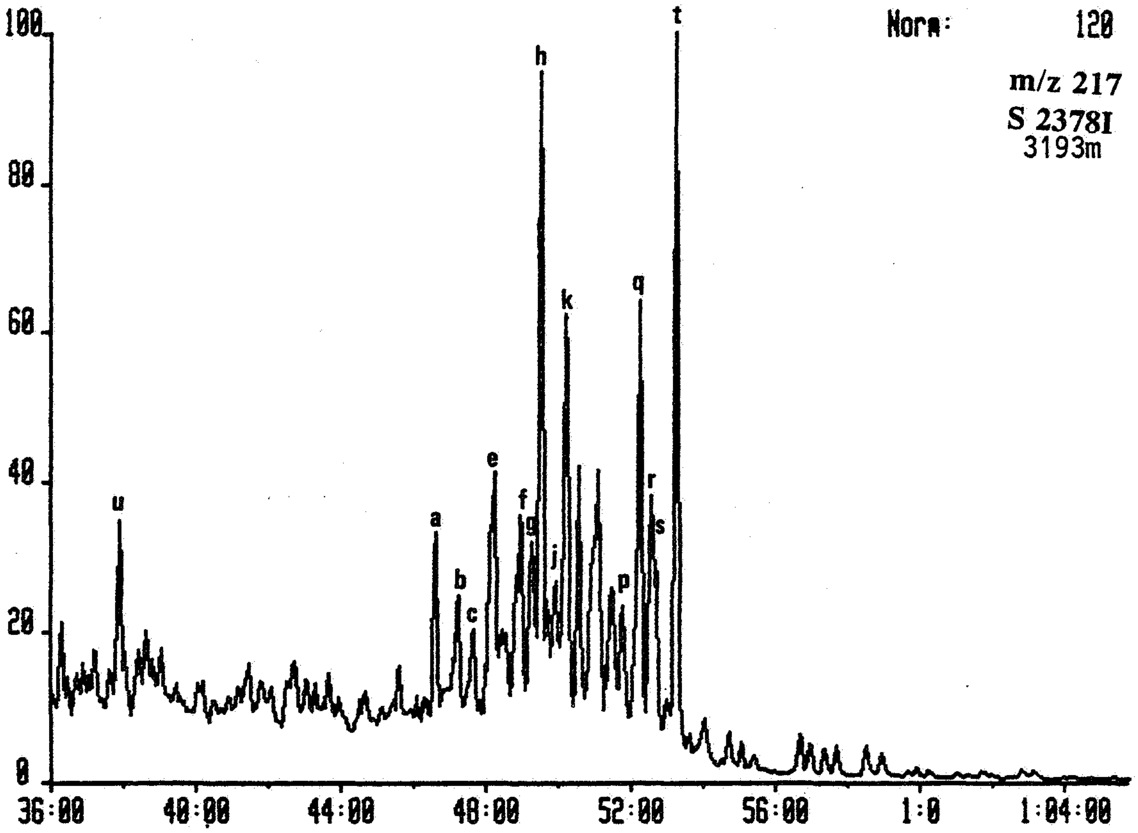


C6731SAT 1-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 218.1000
Text:

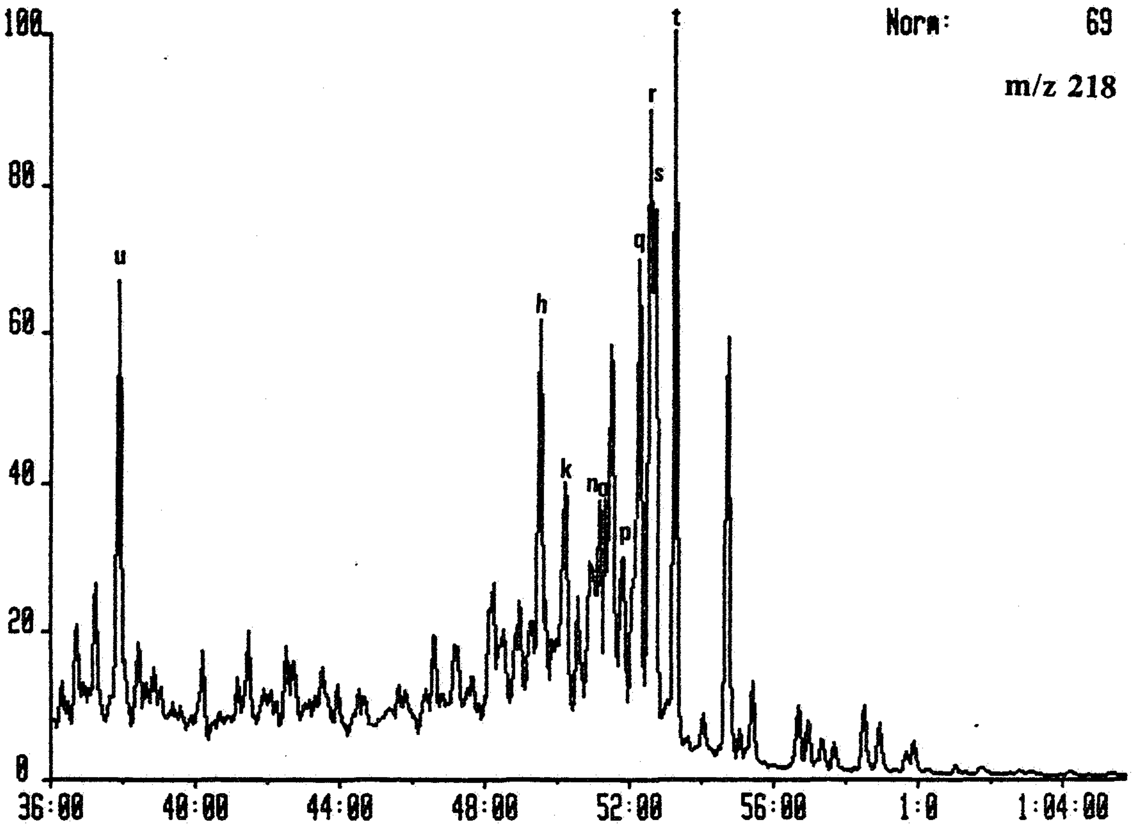


IKU
SINTEF-GRUPPEN

C6732SAT 1-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 217.1000
Text:

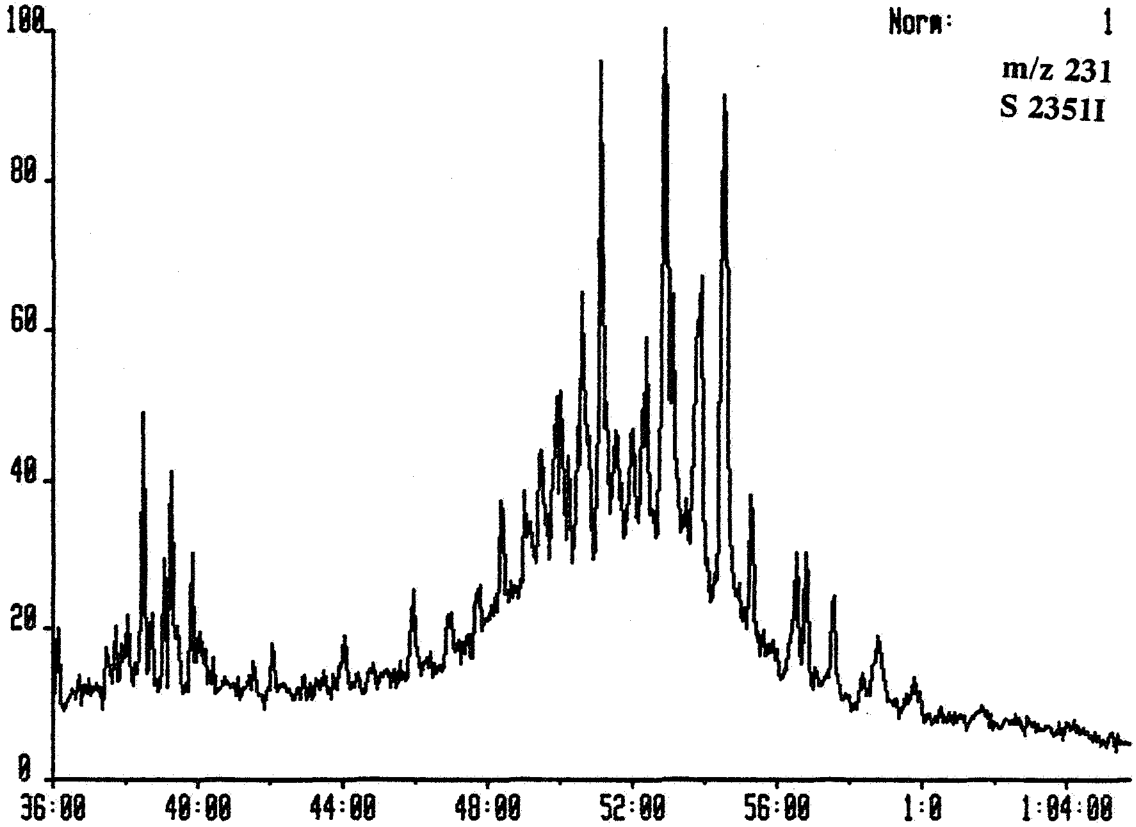


C6732SAT 1-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 218.1000
Text:

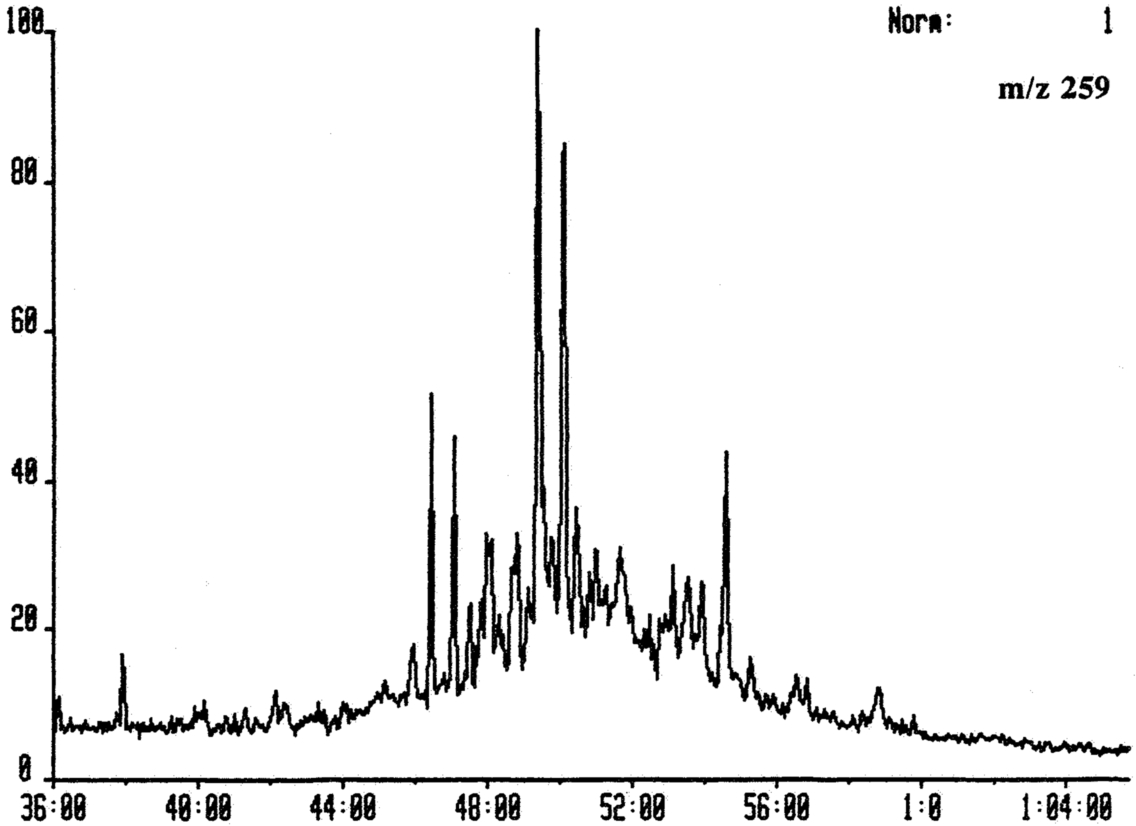


Source rock samples

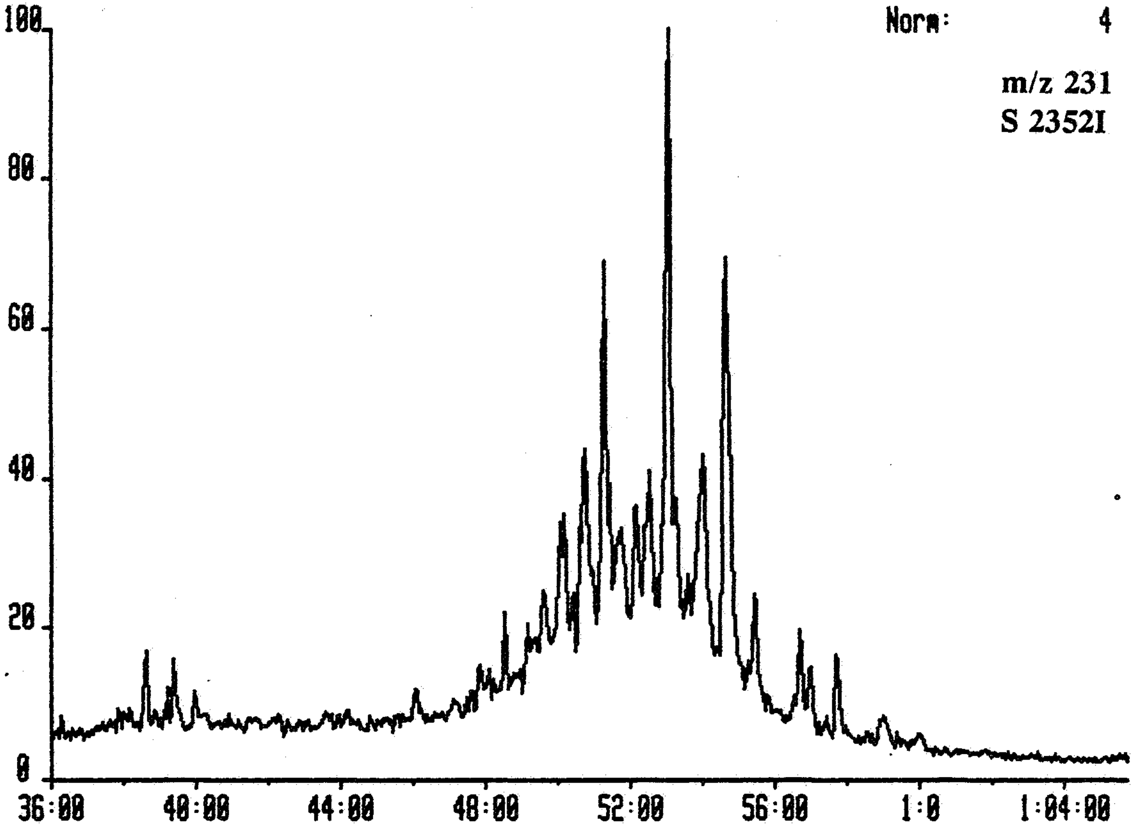
C6721SAT 1-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 231.1000
Text:



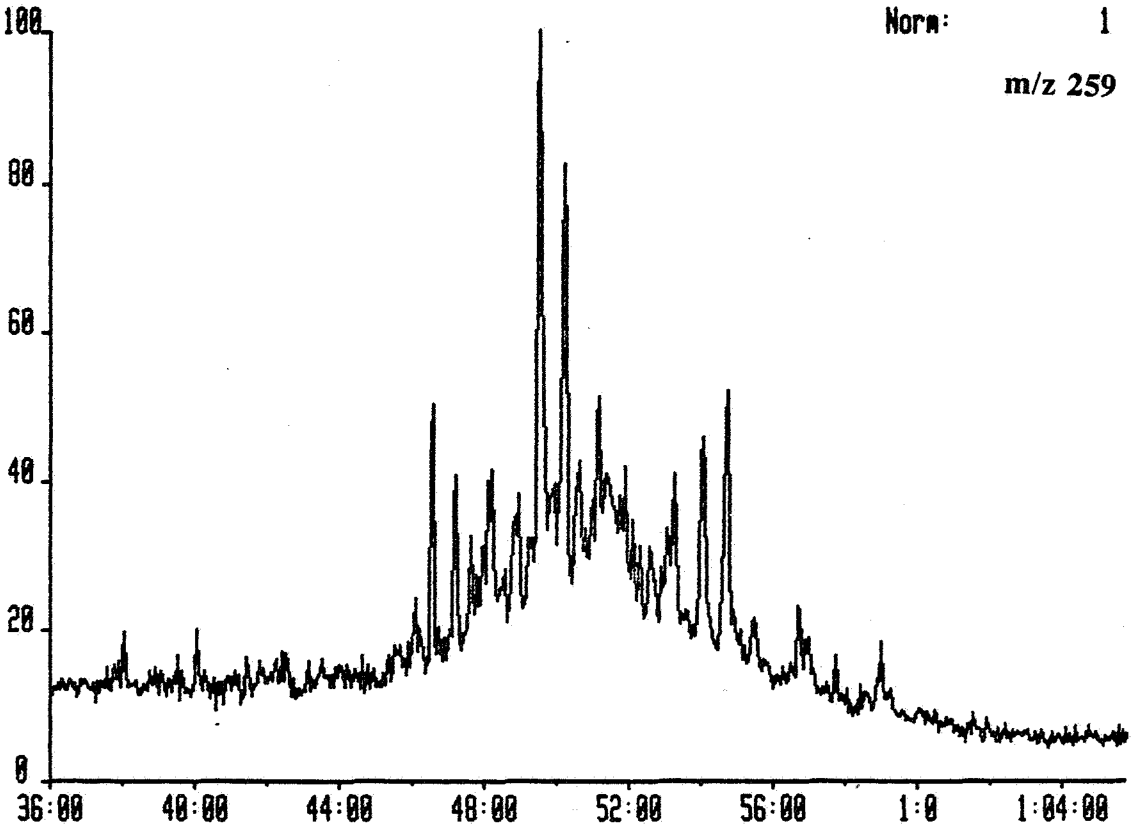
C6721SAT 1-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 259.1000
Text:



C6722SAT 29-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 231.1000
Text:

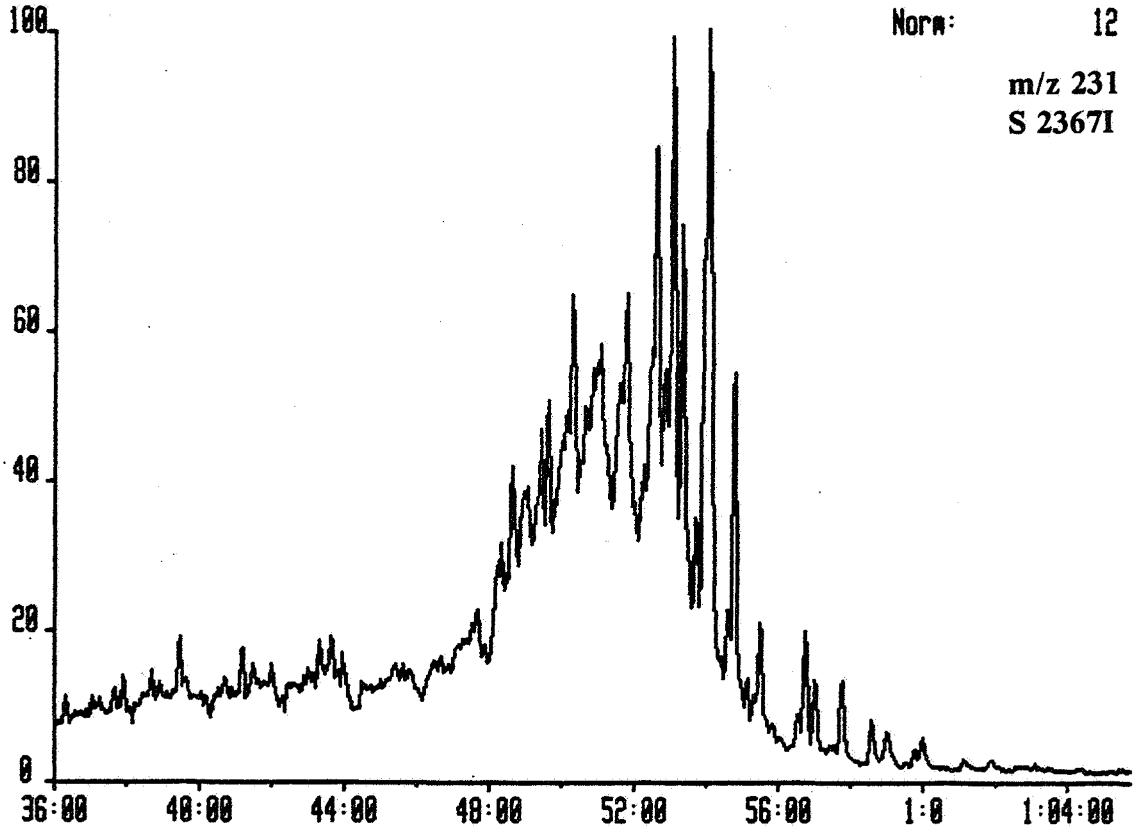


C6722SAT 29-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 259.1000
Text:

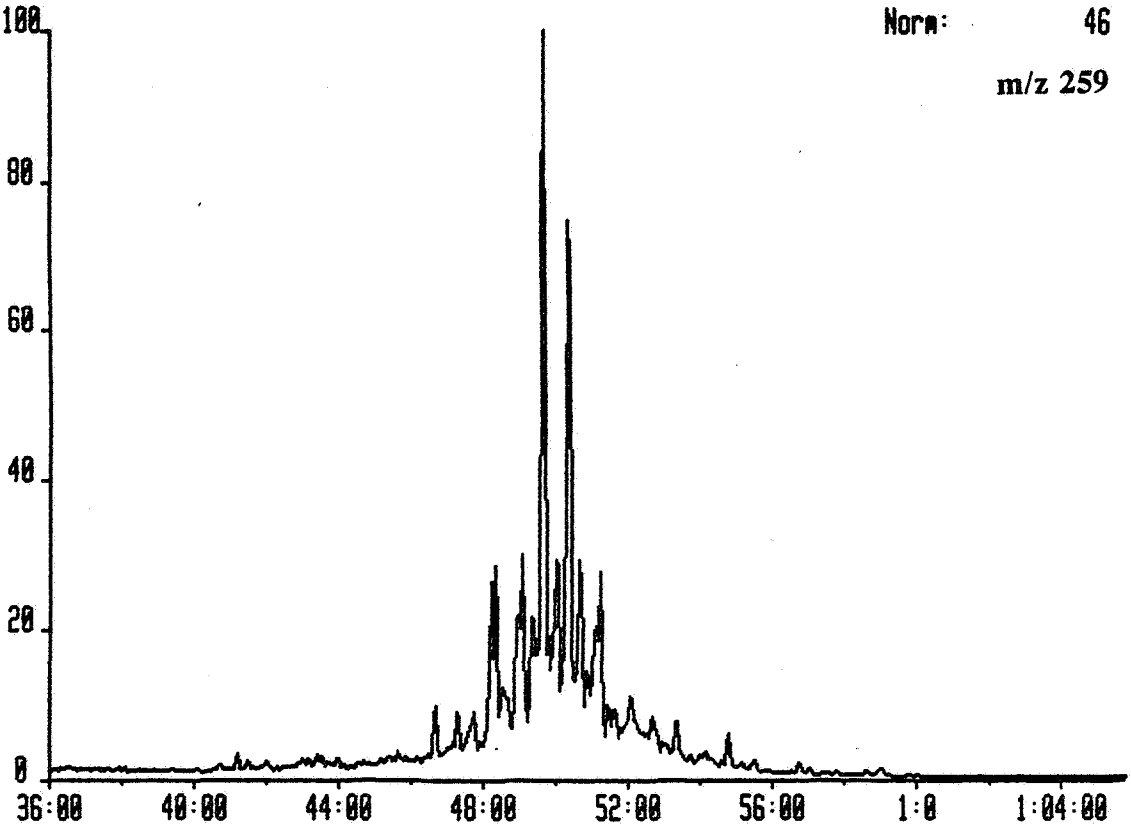


IKU
SINTEF-GRUPPEN

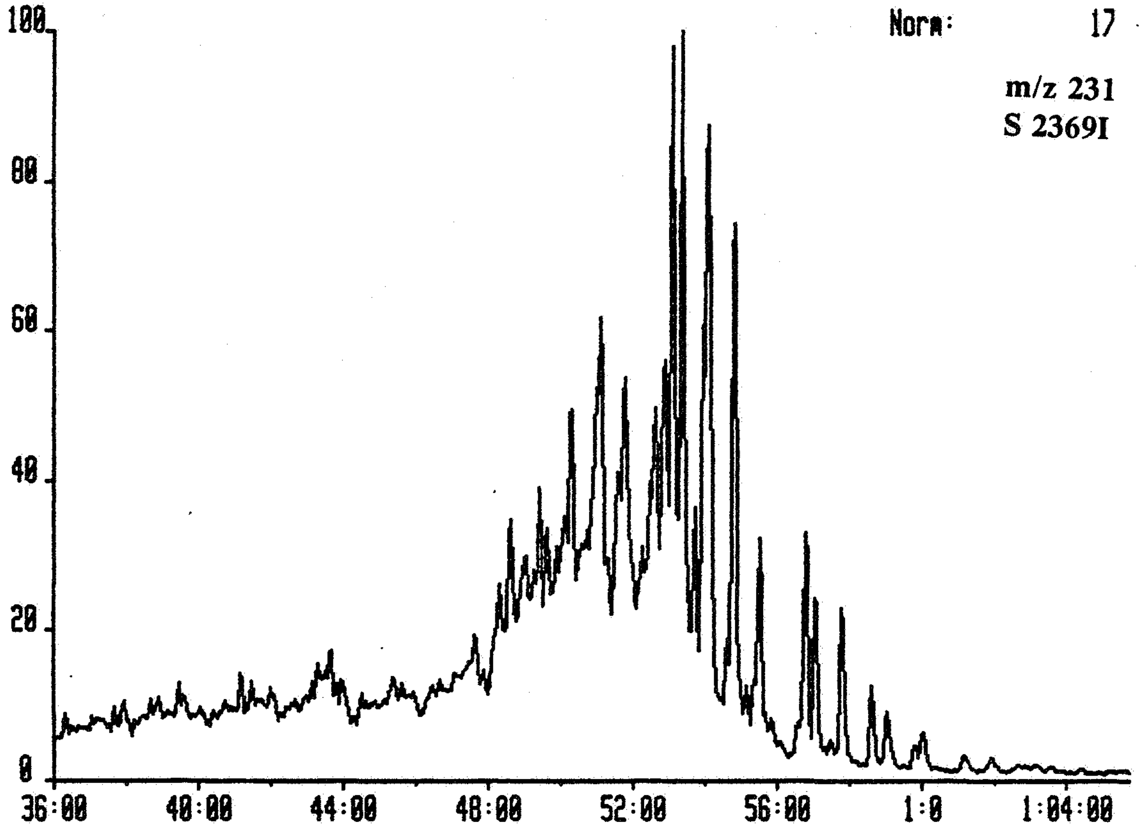
C6723SAT 29-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 231.1000
Text:



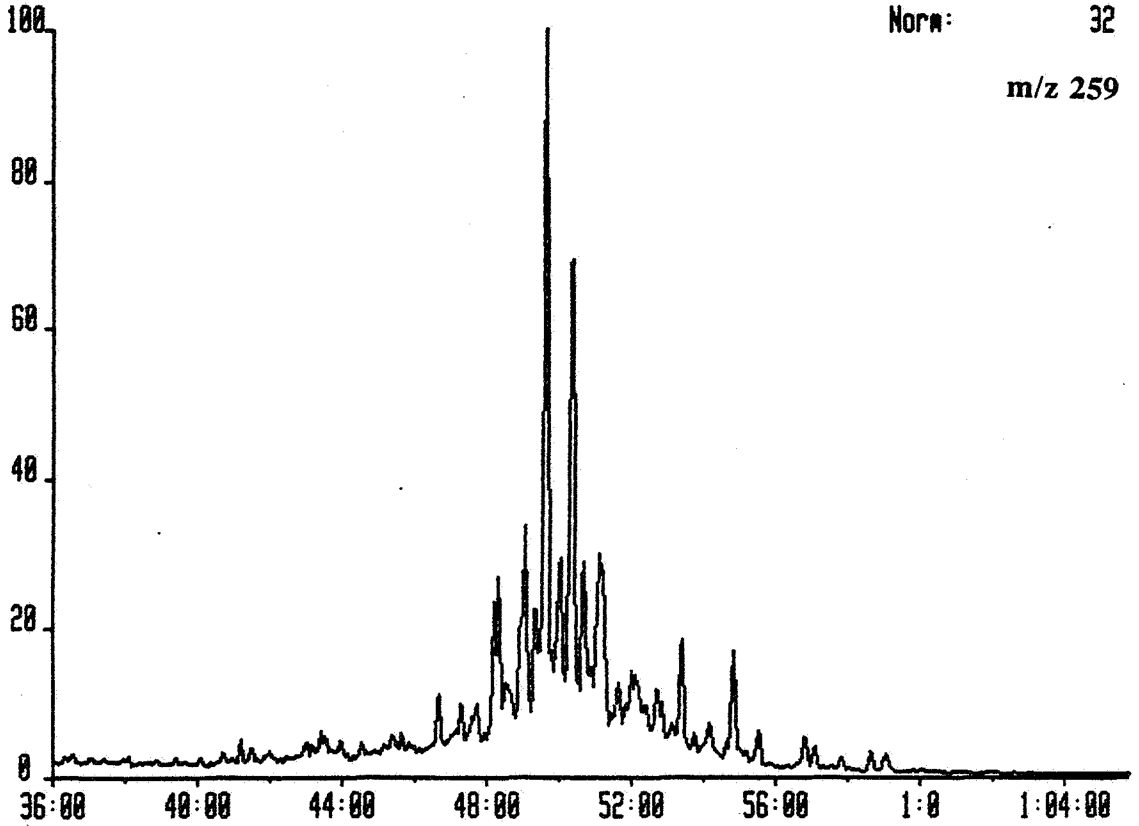
C6723SAT 29-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 259.1000
Text:



C6724SAT 29-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 231.1000
Text:

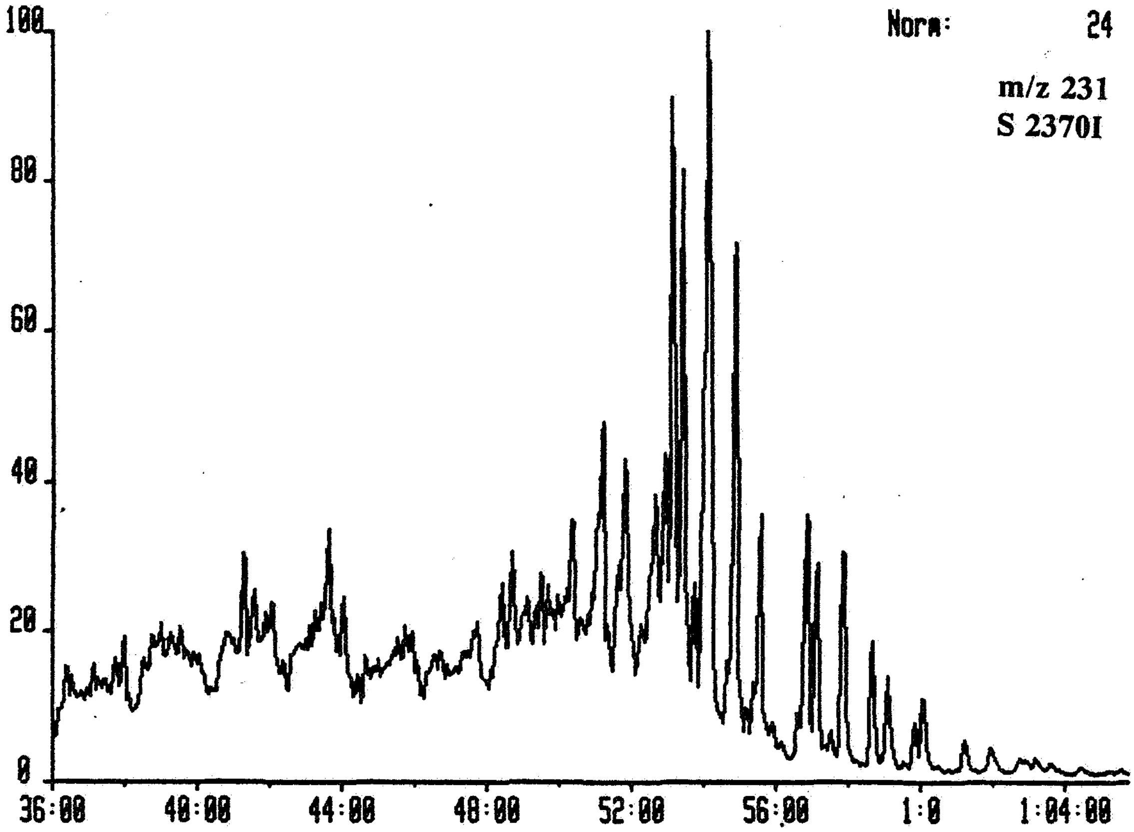


C6724SAT 29-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 259.1000
Text:

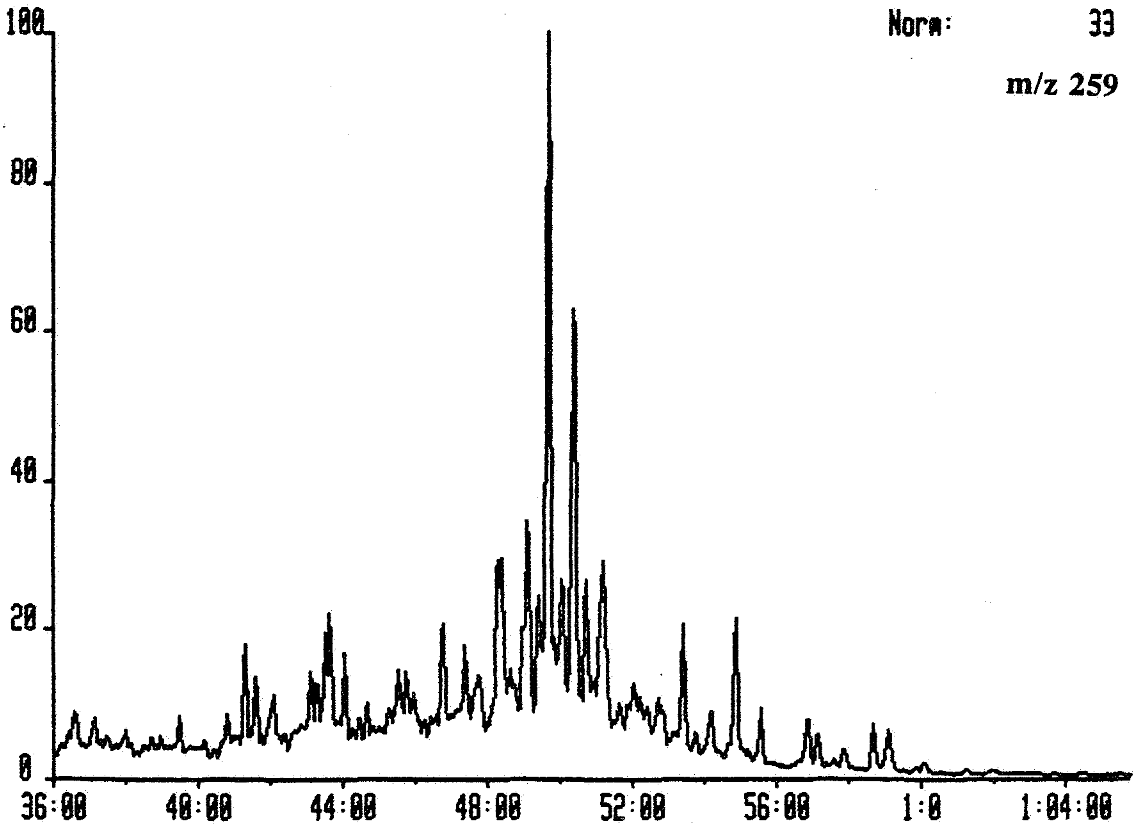


IKU
SINTEF-GRUPPEN

C6725SAT 29-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 231.1000
Text:

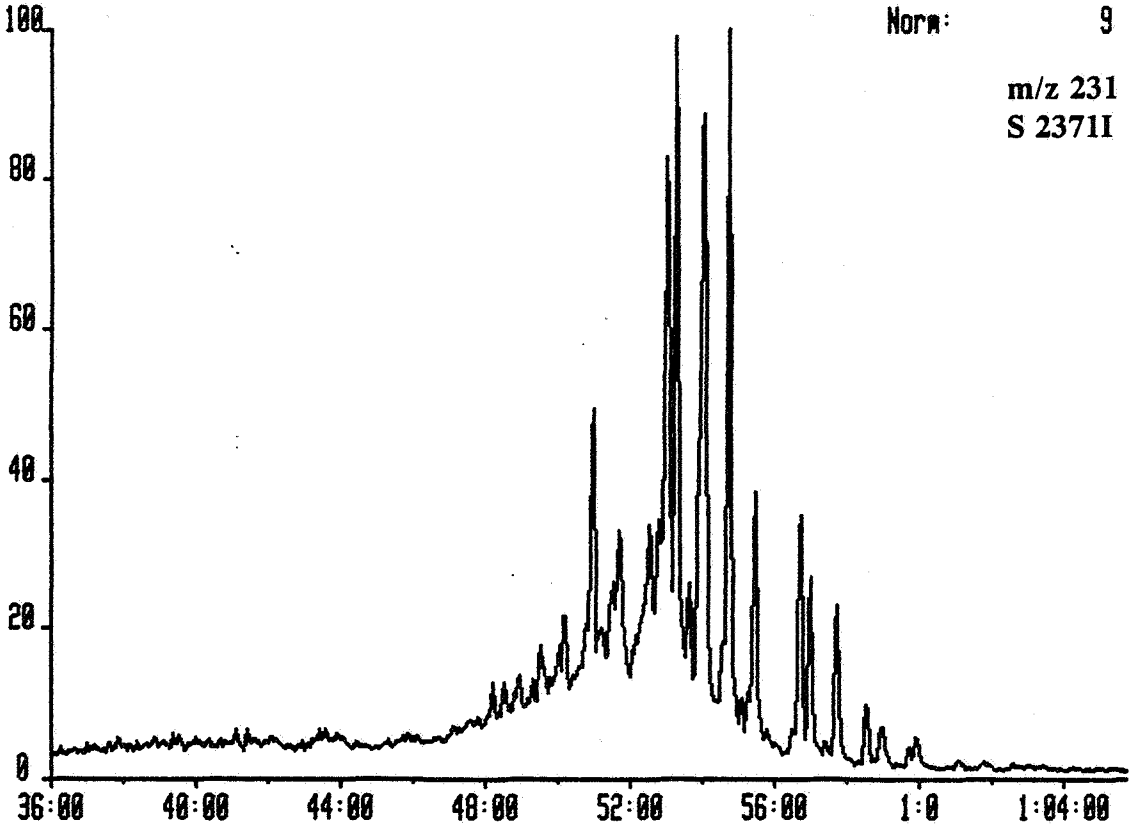


C6725SAT 29-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 259.1000
Text:

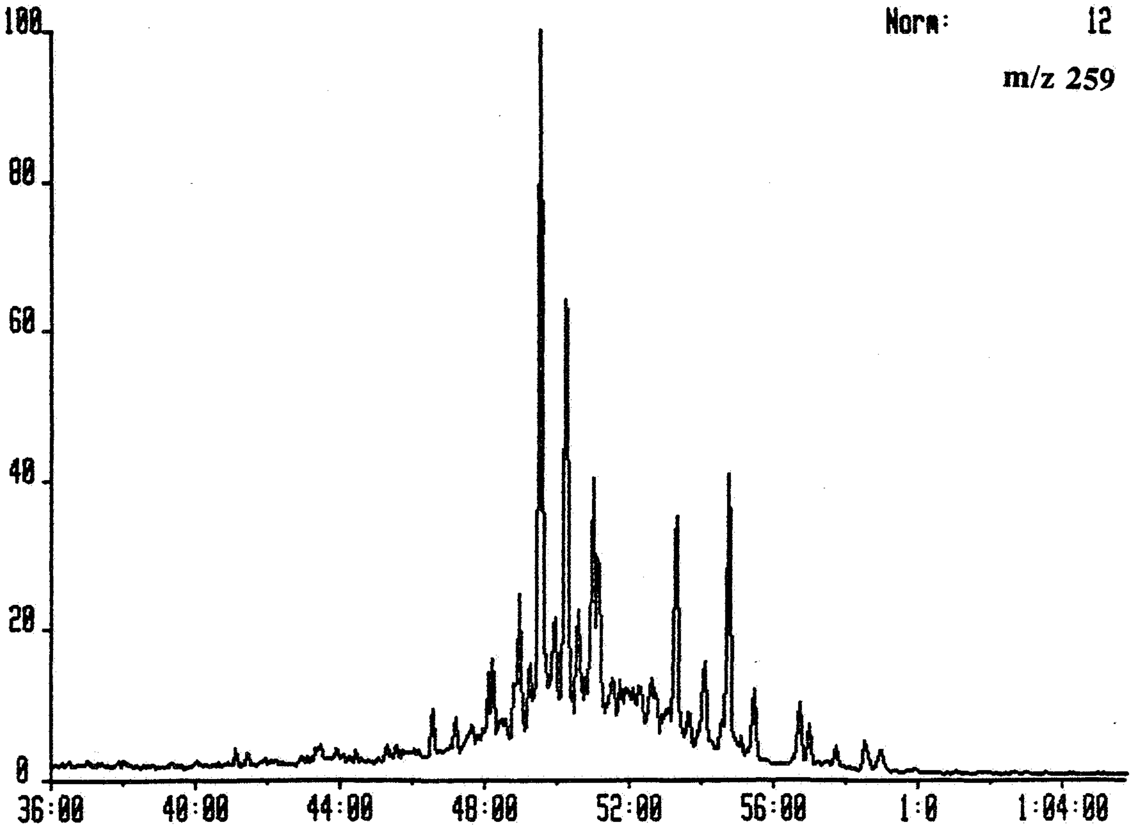


IKU SINTEF-GRUPPEN

C6726SAT 30-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 231.1000
Text:

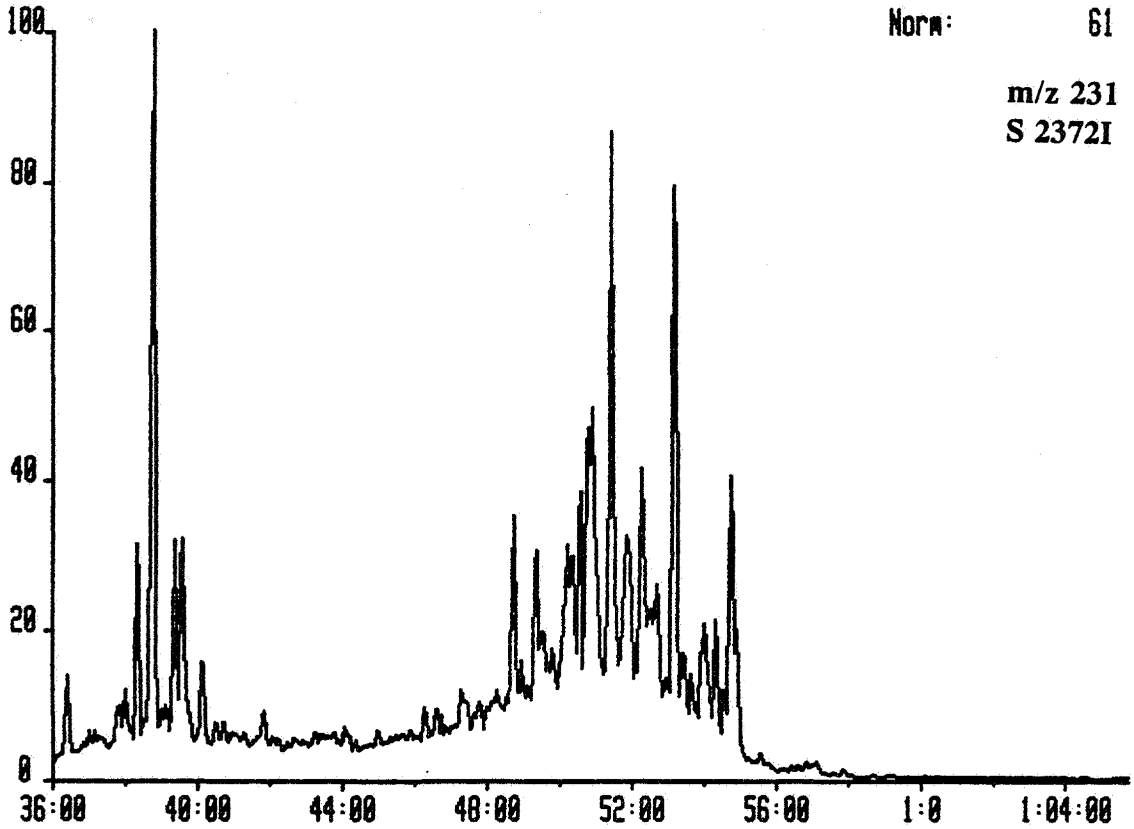


C6726SAT 30-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 259.1000
Text:

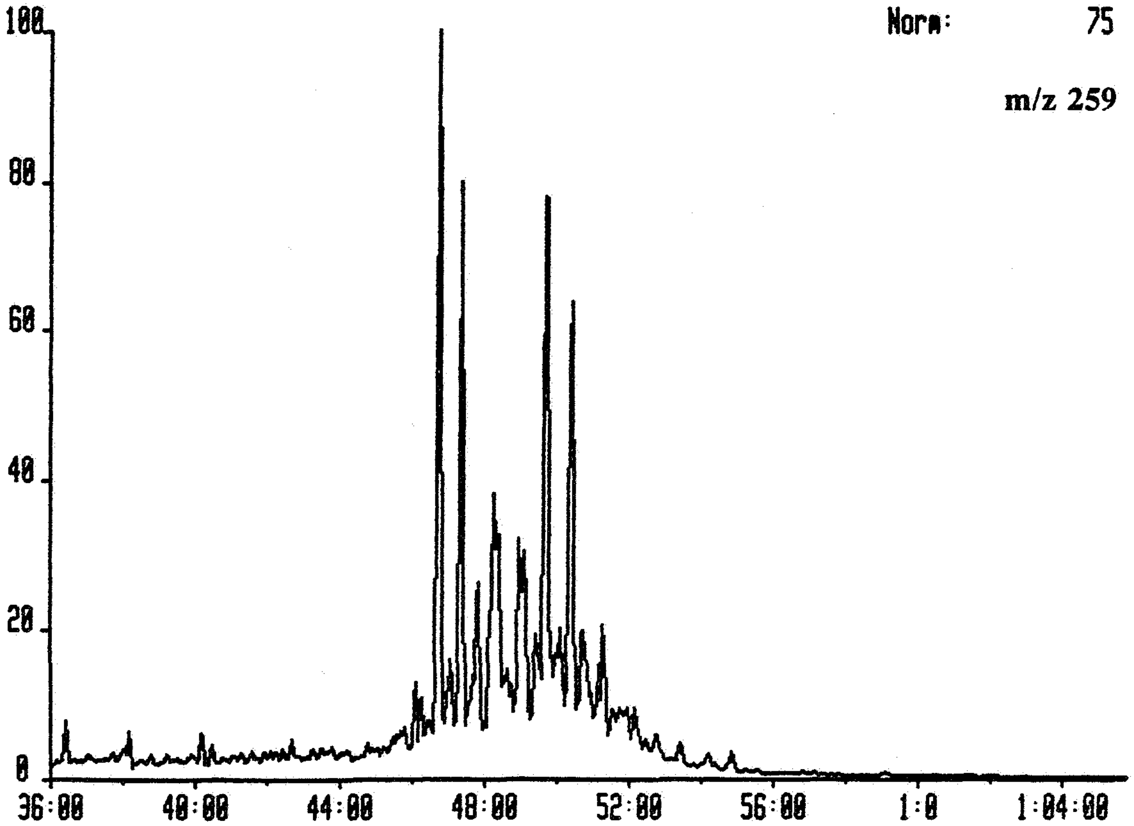


IKU SINTEF-GRUPPEN

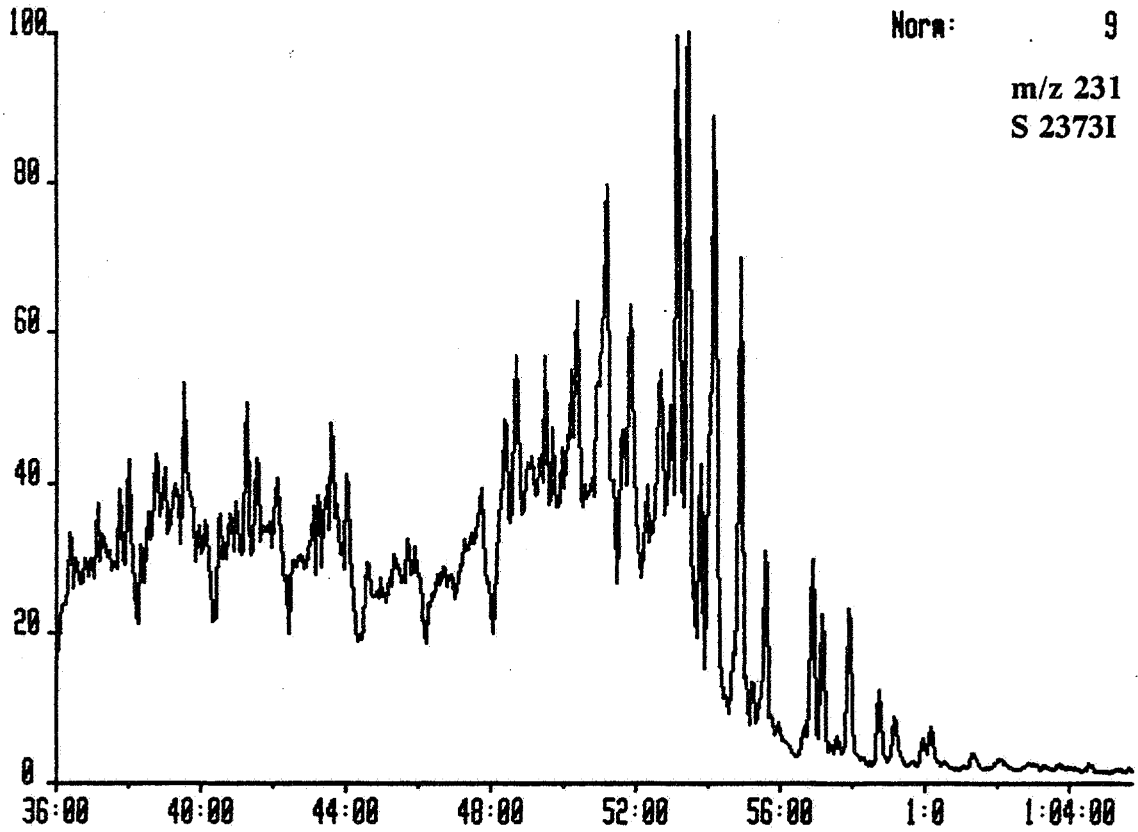
C6727SAT 30-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 231.1000
Text:



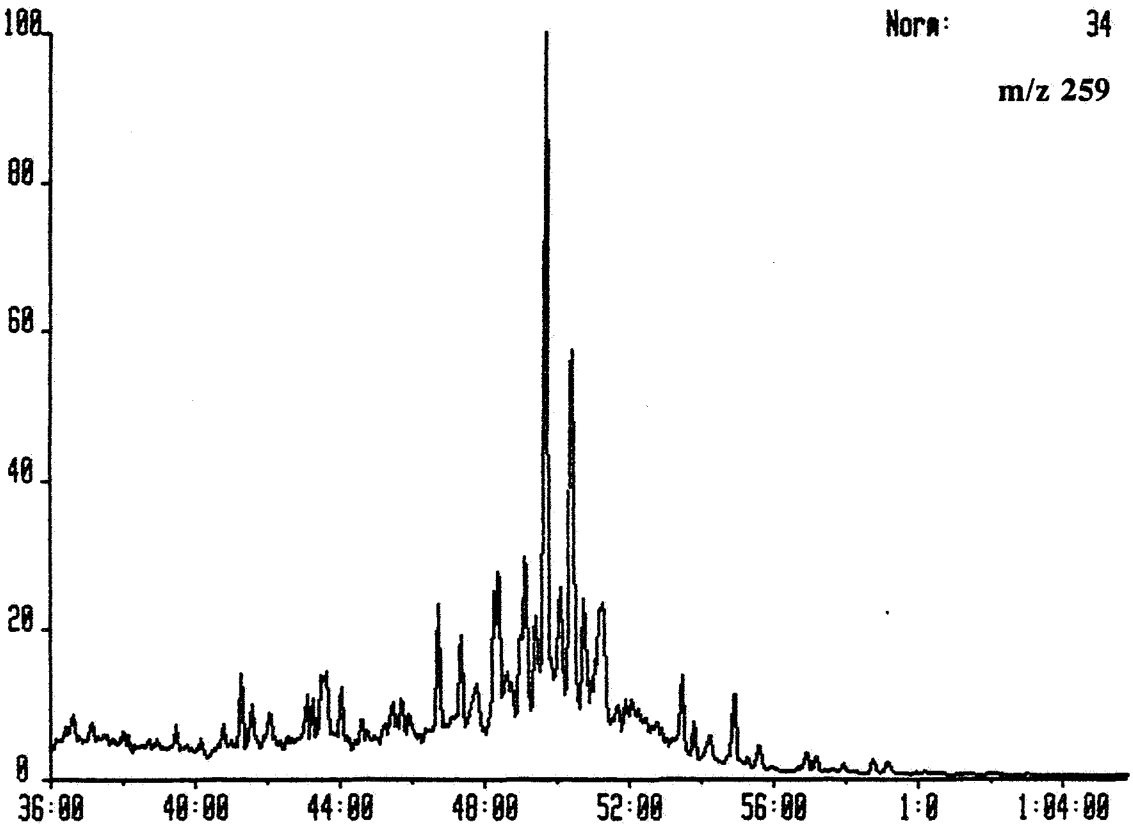
C6727SAT 30-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 259.1000
Text:



C6728SAT 30-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 231.1000
Text:

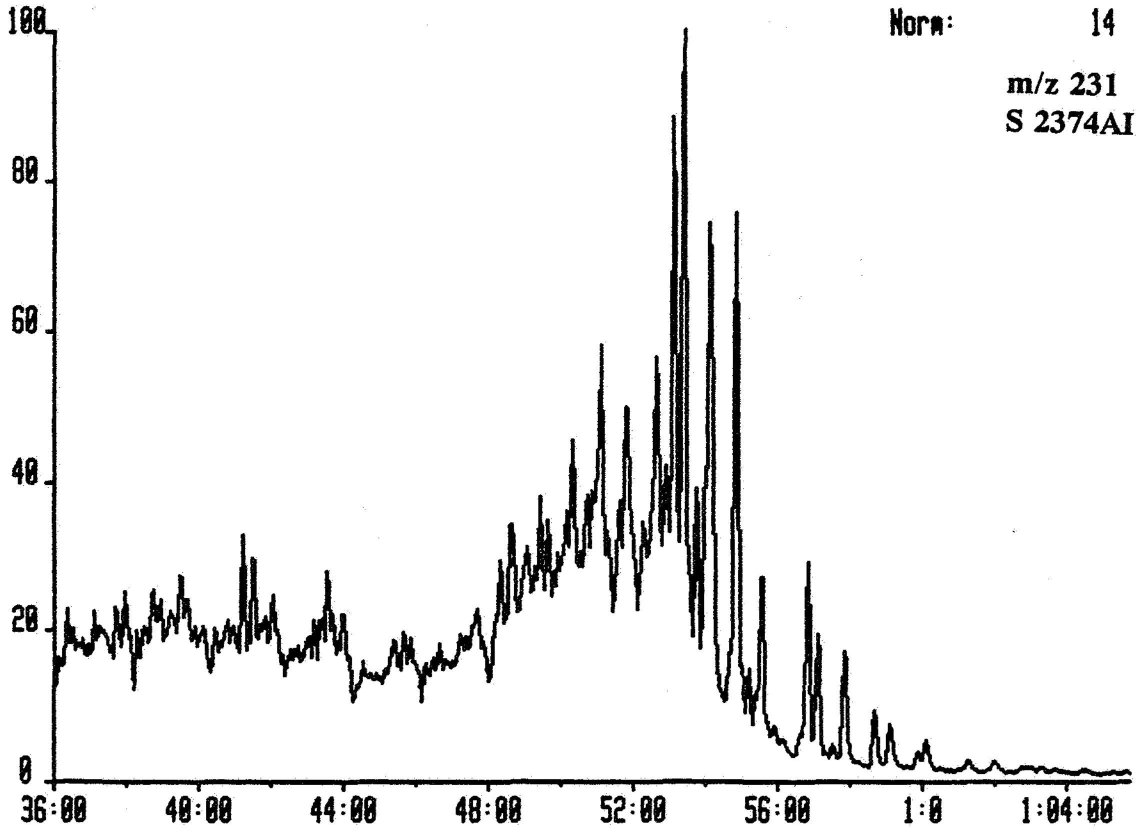


C6728SAT 30-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 259.1000
Text:

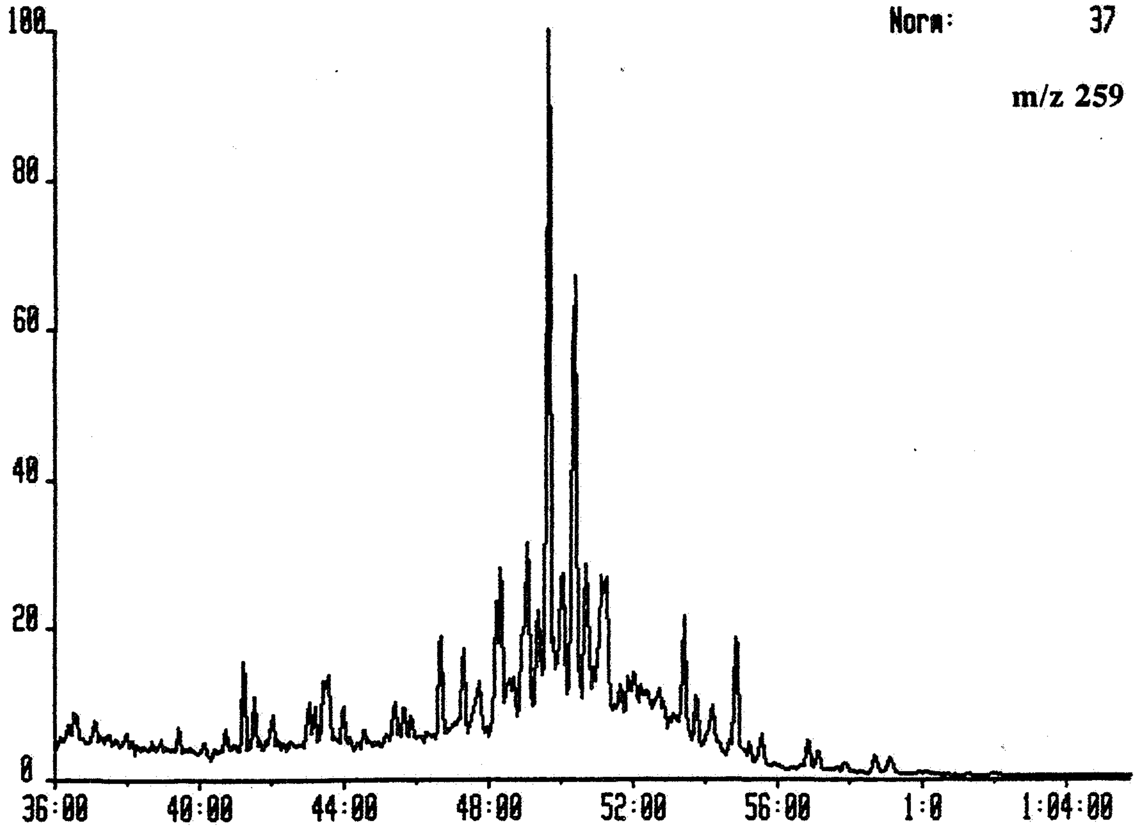


IKU
SINTEF-GRUPPEN

C6729SAT 30-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 231.1000
Text:

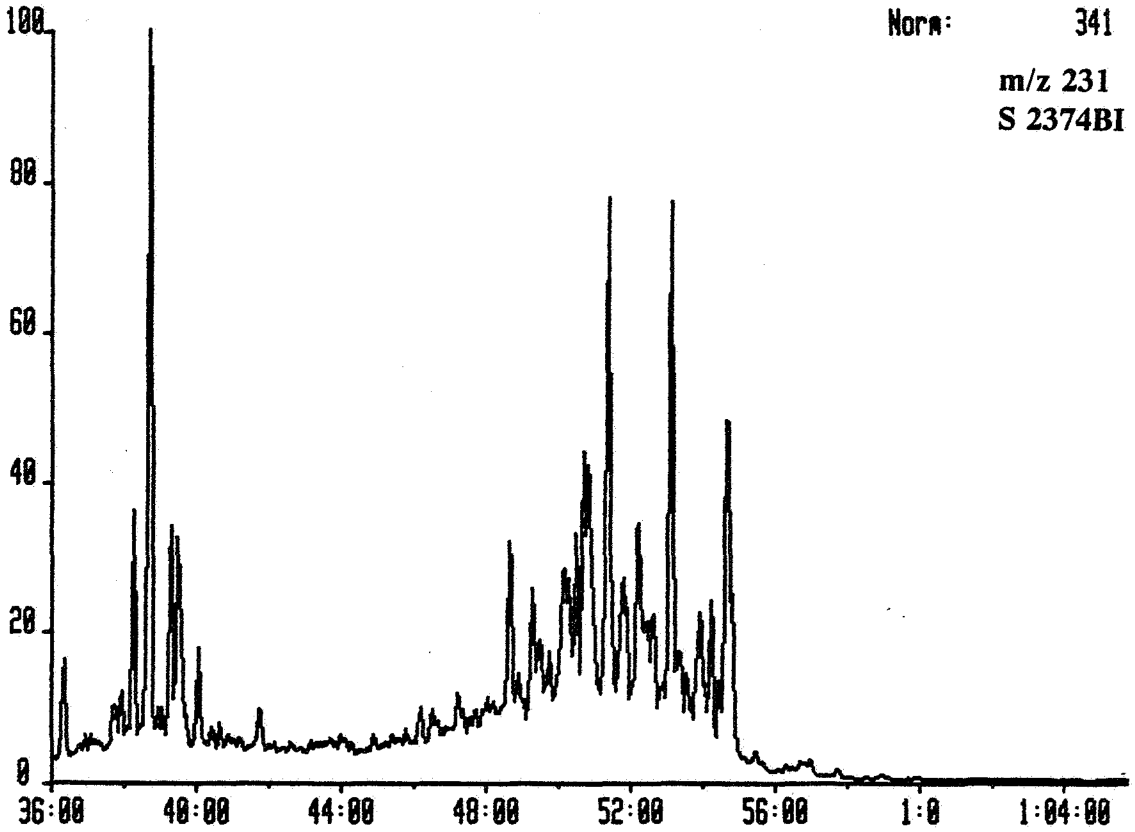


C6729SAT 30-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 259.1000
Text:

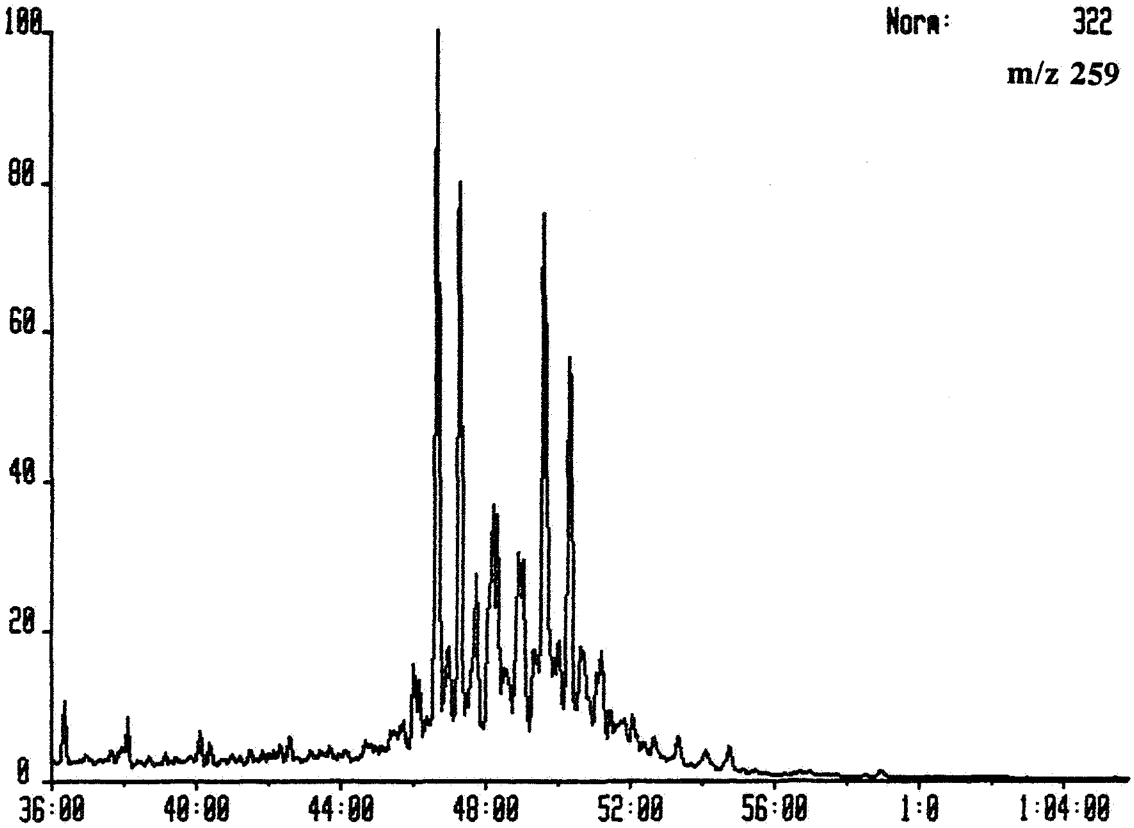


IKU
SINTEF-GRUPPEN

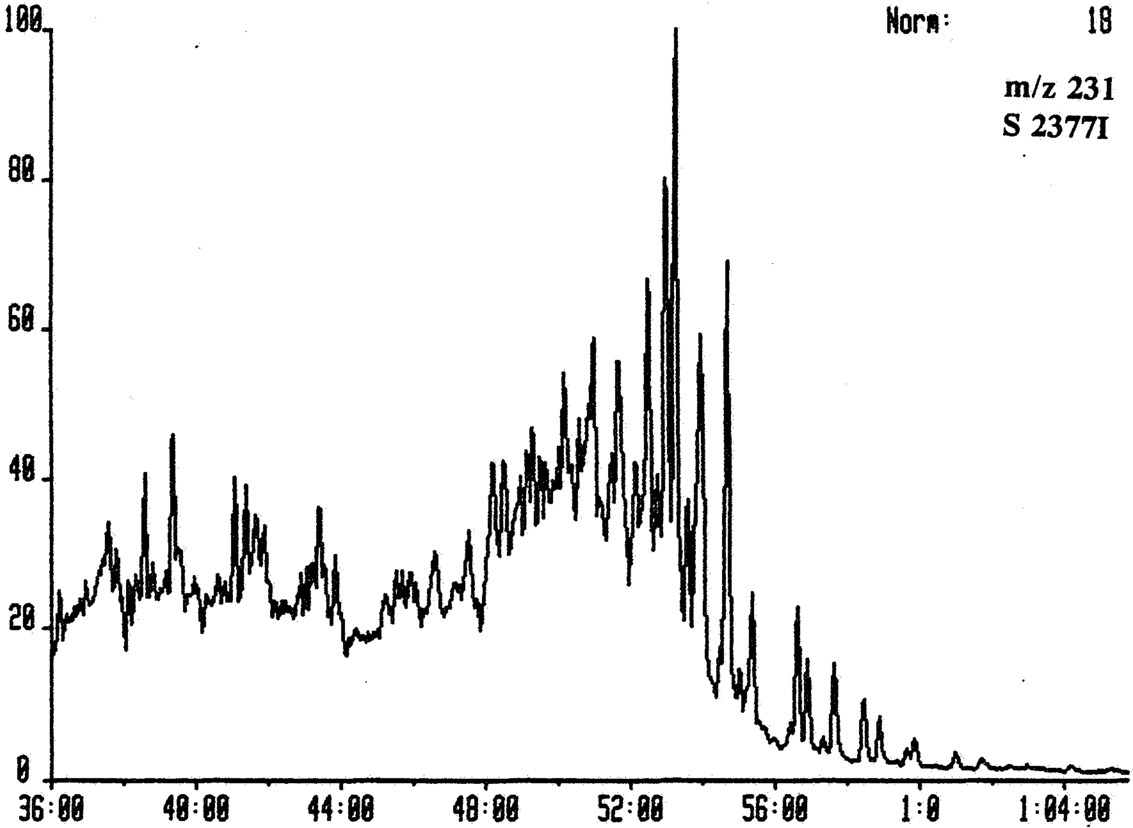
C6730SAT 1-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 231.1000
Text:



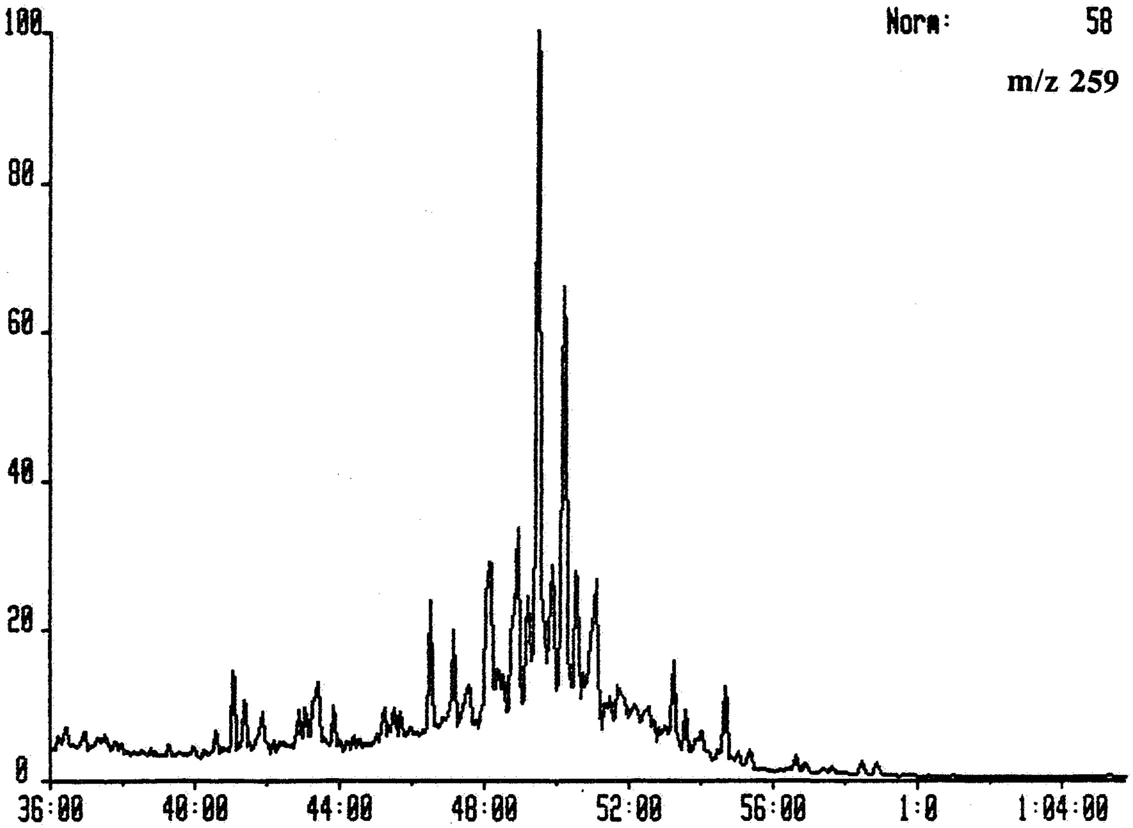
C6730SAT 1-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 259.1000
Text:



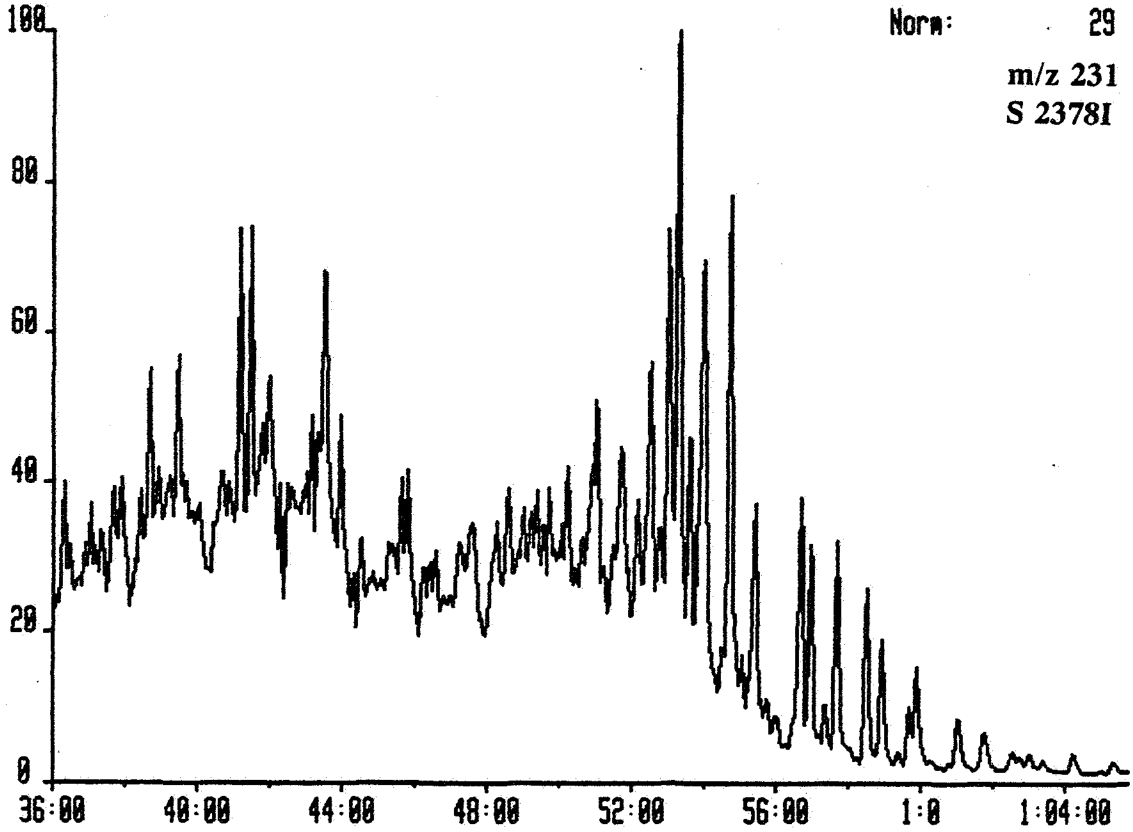
C6731SAT 1-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 231.1000
Text:



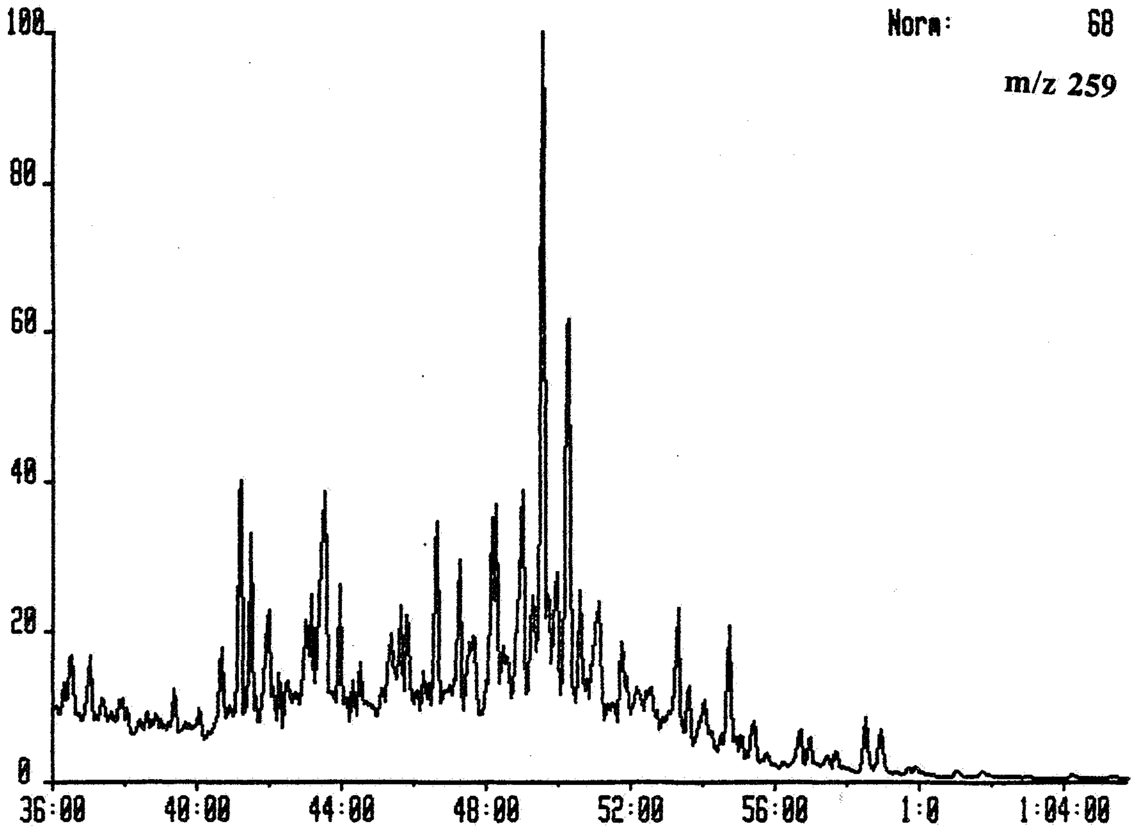
C6731SAT 1-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 259.1000
Text:



C6732SAT 1-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 231.1000
Text:



C6732SAT 1-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 259.1000
Text:



Appendix B
Vitrinite reflectance histograms

EXPERIMENTAL

Vitrinite reflectance

Vitrinite reflectance measurements were carried out on whole-rock samples using the following method. The rock samples were broken up, if necessary, and mounted in a fast-setting, synthetic resin. Temperatures in excess of about 50°C were avoided as these can result in alteration of the organic material. Once the resin was set, the samples were ground on coarse silicon carbine paper in order to expose an area of sample for polishing. The samples were then ground on 600 and 280 grade silicon carbide paper to remove any coarse scratches. Where clastic sediments were involved, grinding and polishing was carried out using propan-2-ol to avoid swelling of any clay minerals in the sample. If coals were to be measured, water was used. The samples were then polished on Selvyt cloth using 5/20, 3/50 and gamma grade alumina powder. Following polishing, the surface of the samples was carefully cleaned to remove any traces of the polishing powders.

Reflectance measurements were carried out using a Leitz M.P.V. microscope and photomultiplier combination. The measurements were made under oil immersion, using an oil with a refractive index of 1.518, at a wavelength of 546 nm. The surface of the sample was examined for suitable particles of vitrinite and reflectance measurements were taken on these. The reflectance of the vitrinite particle was determined relative to an optical glass standard with a known reflectance of a similar order to that of the sample. If possible, a minimum of twenty reflectance measurements were made on each rock sample.

Coals and carbonaceous claystones generally provide the most reliable data, while sandstones and carbonates generally provide the least reliable data.

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 organic matter/kerogen was mounted in glycerine jelly on microscope slides as a strew mount.

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

T-slide: represented the total acid residue
O-slide: represented the kerogen debris remaining after flotation in $3nBr_2$ to remove heavy minerals
N-slide: represented a sieved residue (15 µm mesh)
X-slide: represented oxidised residue.

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

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

The samples were studied 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 of particles down to 2 µm diameter. The thermal alteration index measurements were preferentially obtained from the colour of bisaccate and pollen. The techniques used in visual kerogen study are modified from Staplin (1969) and Burgess (1974).

DESCRIPTION OF SAMPLES IN REFLECTED LIGHT

C-6735: S-2354 2555.20m
Vitrinite Reflectance: 0.44%(29). Sporinite Fluorescence: 4-6.

The sample consisted of sandstone chips with large coaly fragments. The fragments consisted largely of vitrinite, which could be sub-divided into a darker liptinite-rich variety comprising the groundmass, and a lighter, often patchy, band vitrinite. The latter type was selected for measurement. In ultra-violet light, most of the liptinitic material was very dully fluorescing, occaisional brighter particles having a yellow/orange to medium orange fluorescence.

C-6736: S-2355 2555.68m
Vitrinite Reflectance: 0.43%(27), 0.28%(2), 0.62%(1).
Sporinite Fluorescence: 4-6.

This sample was largely similar to that described above, although the coaly particles in this sample showed more evidence of weathering. The darker vitrinite type was more common in this sample.

C-6737: S-2367 2914m
Vitrinite Reflectance: 0.48%(30). Sporinite Fluorescence: 4-5.

The sample was a liptinite-rich, largely detrital coal. The abundant liptinite, consisting of sporinite, cutinite and resinite occurs in densely packed laminae. Inertinitic macerals tended to be restricted to individual rock chips where they often dominated the chip. Good band vitrinite particles (collinite) provided good reflectance values. Liptinite fluorescence colours varied from yellow-orange to light orange in ultra-violet light.

C-6738: S-2369 2956m
Vitrinite Reflectance: 0.56%(30). Sporinite Fluorescence: 4-6.

This sample consisted of a mixed coal/carbonaceous claystone lithology in which inertinite and liptinite were quite common. The liptinite tended to be locallised in densely packed laminae, although a bitumenite groundmass was observed in some samples. Telinitic structures could be observed in a number of vitrinite bands/particles. Some vitrinite showed evidence of weathering. It was noted that reflectance measurements taken on stringers next to inertinite tended to be higher than measurements taken on other vitrinite particles. The sample was similar to the previous sample when viewed in ultra-violet light.

C-6740: S-2371 2983m
Vitrinite Reflectance: 0.53%(29). Sporinite Fluorescence: 4-6.

The carbonaceous claystone lithology which comprised the major part of this sample contained abundant liptinite and common vitrinite stringers, the latter often displaying an undulose reflectance. Reflectance measurements on these stringers were avoided. Inertinitic macerals were locally abundant. The sample was similar to the previous sample when viewed in ultra-violet light.

C-6742: S-2373 3028m
Vitrinite Reflectance: 0.53%(27), 0.82%(1). Sporinite Fluorescence: 5-7.

This coal sample was similar in appearance to the coal described from sample C-6738 (S-2369) in both white and ultra-violet light.

C-6745: S-2375 3100m
Vitrinite Reflectance: 0.57%(29), 0.81%(1). Sporinite Fluorescence: 5-7.

This sample was characterised by a mixed claystone/siltstone/coal lithology in which semi-fusinite and liptinite were the main macerals. Vitrinite occured in stringers and bands of rather variable quality. The sample is similar in appearance to the previous samples when viewed in ultra-violet light.

C-6746: S-2377 3154m
Vitrinite Reflectance: 0.56%(28), 0.80%(1). Sporinite Fluorescence: 5-7.

This sample was largely similar in appearance to the previous mixed litholgy sample when viewed in both white and ultra-violet light. However, in this sample it was noted that reflectance measurements taken on vitrinite particles which showed evidence of weathering tended to be higher than those which did not. Measurements on these 'weathered' particles were avoided.

C-6748: S-2385 506m
Vitrinite Reflectance: 0.56%(16), 0.91%(2). Sporinite Fluorescence: 4?

This sample consisted of an organic-lean siltstone lithology containing only a few liptinite wisps and scattered vitrinite particles, a number of which were either reworked or stained. The vitrinite particles were mainly small and were often difficult to measure accurately. In ultra-violet light, only a few scattered particles of yellow cutinite and yellow/orange sporinite were observed.

C-6749: S-2389 508m
Vitrinite Reflectance: 0.54%(15). Sporinite Fluorescence: 4?

This sample was similar in appearance to the preceding sample when viewed in white and ultra-violet light.

Figure 1

Vitrinite reflectance histograms

Key:			
	A	=	Grey-black-brown claystone. Upper case letters indicate values included in the main population. Lower case letters represent values in other populations.
	PP	=	Statistical data populations Y = Main population, not neccessarily representative of sample maturity. N = Other populations.
	LOW+ HIGH	=	Population limits.
	VAL.	=	Number of measurements in that population.

Lithology cross-reference table

A = Clst. gy
B = Clst. dk gy
C = Clst. gn
D = Clst. bn
E = Clst. rd
F = Clst. calc.
G = Clst. carb.
H = Shale
I = Sandstone
J = Limestone
K = Coal
L = Lignite
M = Carbargillite
N = Siltstone
O = Bit
P = X

```
IKU# C-6735          6407/6-3 , S 2354, 2555.20m
    !
14-!
    !
12-!
    !
10-!
    !
 8-!       K K
    !      K K
 6-!       KKKK
    !      KKKK
 4-!       KKKK
    !      KKKK
 2-!       KKKK
    !     KKKKK
 0--+----+----+----+----+----+----+----+----+----+----+---
   0.00 0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50

PP LOW HIGH LIT #VAL MEAN STDV
Y 0.33 0.54 ALL   29 0.44 0.06
          OVERALL 29 0.44 0.06

ORDERED VALUES FOLLOW:

 0.33K 0.36K 0.36K 0.38K 0.38K 0.39K 0.39K 0.39K 0.39K 0.41K 0.42K
 0.43K 0.43K 0.43K 0.43K 0.46K 0.46K 0.46K 0.47K 0.48K 0.48K 0.48K
 0.49K 0.50K 0.50K 0.51K 0.51K 0.53K 0.53K
```

```
IKU# C-6736          6407/6-3 , S 2355, 2555.68m
   |
14-|
   |
12-|
   |
10-|
   |        KK
 8-|        KK
   |        KK
 6-|       KKK
   |       KKK
 4-|       KKK
   |       KKK
 2-|     k KKKK
   |     kKKKKK k
 0--+----+----+----+----+----+----+----+----+----+----+---
   0.00 0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50
```

PP	LOW	HIGH	LIT	#VAL	MEAN	STDV
Y	0.33	0.52	ALL	27	0.43	0.05
N	0.28	0.30	ALL	2	0.28	0.01
N	0.62	0.63	ALL	1	0.62	0.00
			OVERALL	30	0.43	0.07

ORDERED VALUES FOLLOW:

0.28k 0.29k 0.33K 0.35K 0.37K 0.37K 0.37K 0.38K 0.39K 0.40K 0.40K
0.40K 0.40K 0.41K 0.42K 0.42K 0.44K 0.44K 0.45K 0.45K 0.46K 0.47K
0.48K 0.49K 0.49K 0.49K 0.49K 0.50K 0.51K 0.62k

```
IKU# C-6737          6407/6-3 , S 2367, 2914m
   |
14-|
   |
12-|
   |
10-|
   |
 8-|
   |         KK
 6-|        KKKK
   |        KKKK
 4-|       KKKKK
   |       KKKKK
 2-|       KKKKK
   |       KKKKK
 0--+----+----+----+----+----+----+----+----+----+----+---
   0.00 0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50

PP LOW HIGH LIT #VAL MEAN STDV
Y 0.36 0.59 ALL   30 0.48 0.06
          OVERALL 30 0.48 0.06

ORDERED VALUES FOLLOW:

 0.36K 0.38K 0.39K 0.39K 0.40K 0.42K 0.43K 0.43K 0.44K 0.44K 0.46K
 0.46K 0.46K 0.47K 0.48K 0.48K 0.49K 0.50K 0.51K 0.52K 0.52K 0.52K
 0.54K 0.54K 0.56K 0.56K 0.56K 0.57K 0.57K 0.58K
```

```
IKU# C-6738          6407/6-3 , S 2369, 2956m
   |
14-|           K
   |           K
12-|           K
   |           K
10-|           K
   |          KK
 8-|          KK
   |          KK
 6-|          KK
   |          KK
 4-|          KK
   |          KK
 2-|         KKK K
   |        KKKKKKK
 0--+----+----+----+----+----+----+----+----+----+----+---
   0.00 0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50

PP LOW HIGH LIT #VAL MEAN STDV
Y 0.43 0.74 ALL   30 0.56 0.06
          OVERALL 30 0.56 0.06

ORDERED VALUES FOLLOW:

 0.43K 0.47K 0.47K 0.50K 0.50K 0.51K 0.51K 0.52K 0.52K 0.53K 0.53K
 0.54K 0.55K 0.55K 0.55K 0.55K 0.57K 0.57K 0.58K 0.58K 0.58K 0.58K
 0.58K 0.58K 0.59K 0.59K 0.62K 0.65K 0.68K 0.73K
```

```
IKU# C-6740          6407/6-3 , S 2371, 2983m
    !
 14-!
    !
 12-!
    !
 10-!
    !
  8-!
    !          G
  6-!        G G
    !      G G G
  4-!      GGG G
    !      GGGGGG
  2-!      GGGGGG
    !     GGGGGGG
  0--+----+----+----+----+----+----+----+----+----+----+---
   0.00 0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50

PP LOW HIGH LIT #VAL MEAN STDV
Y 0.36 0.70 ALL   29 0.53 0.09
          OVERALL 29 0.53 0.09

ORDERED VALUES FOLLOW:

 0.36G 0.40G 0.41G 0.42G 0.42G 0.44G 0.47G 0.47G 0.48G 0.49G 0.50G
 0.50G 0.51G 0.51G 0.52G 0.54G 0.57G 0.59G 0.59G 0.60G 0.60G 0.60G
 0.61G 0.61G 0.62G 0.63G 0.65G 0.65G 0.69G
```

IKU# C-6742 6407/6-3 , S 2373, 3028m

```
    |
14-|
    |
12-|
    |
10-|
    |         K
 8-|         K
    |         K
 6-|         KG
    |         KK
 4-|         KKK
    |         KKKK
 2-|         KKKKK   k
    |       KKKKKKKK k
 0--+----+----+----+----+----+----+----+----+----+----+---
   0.00 0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50
```

PP	LOW	HIGH	LIT	#VAL	MEAN	STDV
Y	0.39	0.73	ALL	27	0.53	0.09
N	0.82	0.83	ALL	1	0.82	0.00
			OVERALL	29	0.55	0.11

ORDERED VALUES FOLLOW:

0.39K 0.43K 0.45K 0.46K 0.46K 0.46K 0.46K 0.46K 0.46K 0.47K 0.48K
0.50K 0.50K 0.52K 0.53K 0.54K 0.54G 0.55K 0.56K 0.57K 0.59K 0.61K
0.64K 0.64K 0.67K 0.68K 0.72K 0.82k 0.83k

```
IKU# C-6745          6407/6-3 , S 2375, 3100m
   |
14-|
   |
12-|
   |
10-|           G
   |           D
 8-|           D
   |           D
 6-|          GD G
   |          GD D
 4-|          DD D
   |         GDKDK
 2-|         GDKDK
   |        DDKKKK  g
 0--+----+----+----+----+----+----+----+----+----+----+---
   0.00 0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50

PP LOW HIGH LIT #VAL MEAN STDV
Y 0.43 0.70 ALL   29 0.57 0.07
N 0.81 0.82 ALL    1 0.81 0.00
          OVERALL 30 0.58 0.08

ORDERED VALUES FOLLOW:

 0.43D 0.46G 0.47G 0.49D 0.50D 0.51G 0.52D 0.52G 0.52K 0.53D 0.55K
 0.56D 0.56D 0.56D 0.56G 0.57D 0.57D 0.58D 0.58K 0.58K 0.61D 0.63D
 0.63K 0.65D 0.65K 0.66D 0.66K 0.68K 0.69G 0.81g
```

```
IKU# C-6746          6407/6-3 , S 2377, 3154m
   |
14-|
   |
12-|
   |          G
10-|          K
   |          K
 8-|          KG
   |          KG
 6-|          KD
   |          KK
 4-|          KK K
   |          KKDK
 2-|         GKKKK
   |         KKKKK   k
 0--+----+----+----+----+----+----+----+----+----+----+---
   0.00 0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50

PP LOW  HIGH LIT #VAL MEAN STDV
Y 0.45 0.69 ALL   28 0.56 0.06
N 0.80 0.81 ALL    1 0.80 0.00
          OVERALL 29 0.57 0.07

ORDERED VALUES FOLLOW:

 0.45G 0.45K 0.50K 0.51K 0.51K 0.51G 0.51K 0.52K 0.53K 0.54K 0.54K
 0.54K 0.54K 0.56G 0.57K 0.57K 0.57K 0.58K 0.58G 0.58D 0.59K 0.60K
 0.60D 0.61K 0.65K 0.65K 0.67K 0.68K 0.80k
```

```
IKU# C-6748          6407/6-3 , S 2385, 506m
     I
 14-I
     I
 12-I
     I
 10-I
     I
  8-I
     I
  6-I
     I
  4-I         N N
     I        N N
  2-I        NN NNNN
     I       NK KINI  n n
  0--+----+----+----+----+----+----+----+----+----+----+---
    0.00 0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50
```

PP	LOW	HIGH	LIT	#VAL	MEAN	STDV
Y	0.41	0.72	ALL	16	0.56	0.10
N	0.85	0.97	ALL	2	0.91	0.08
			OVERALL	18	0.60	0.15

ORDERED VALUES FOLLOW:

0.41N 0.43N 0.45K 0.47N 0.47N 0.48N 0.55K 0.55N 0.57N 0.59N 0.60N
0.62I 0.67N 0.67N 0.70I 0.71N 0.85n 0.96n

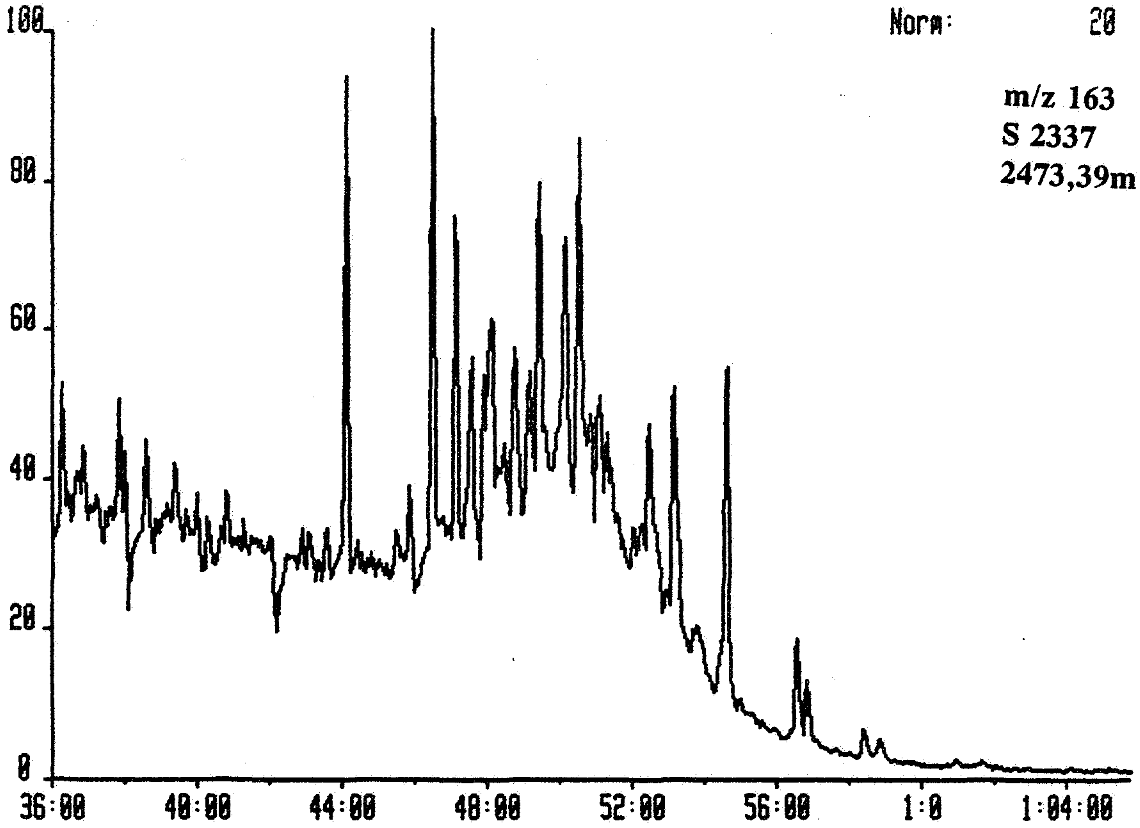
IKU SINTEF-GRUPPEN

```
IKU# C-6749          6407/6-3 , S 2389, 508m
   |
14-|
   |
12-|
   |
10-|
   |
 8-|
   |
 6-|
   |
 4-|
   |         KIK
 2-|         KKKK
   |       AKKKAAKI
 0--+----+----+----+----+----+----+----+----+----+----+---
   0.00 0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50

PP LOW HIGH LIT #VAL MEAN STDV
Y 0.38 0.71 ALL    15 0.54 0.09
          OVERALL 15 0.54 0.09

ORDERED VALUES FOLLOW:

 0.38A 0.41K 0.45K 0.48K 0.49K 0.50K 0.52K 0.53I 0.55K 0.55K 0.56A
 0.60K 0.64A 0.68K 0.70I
```

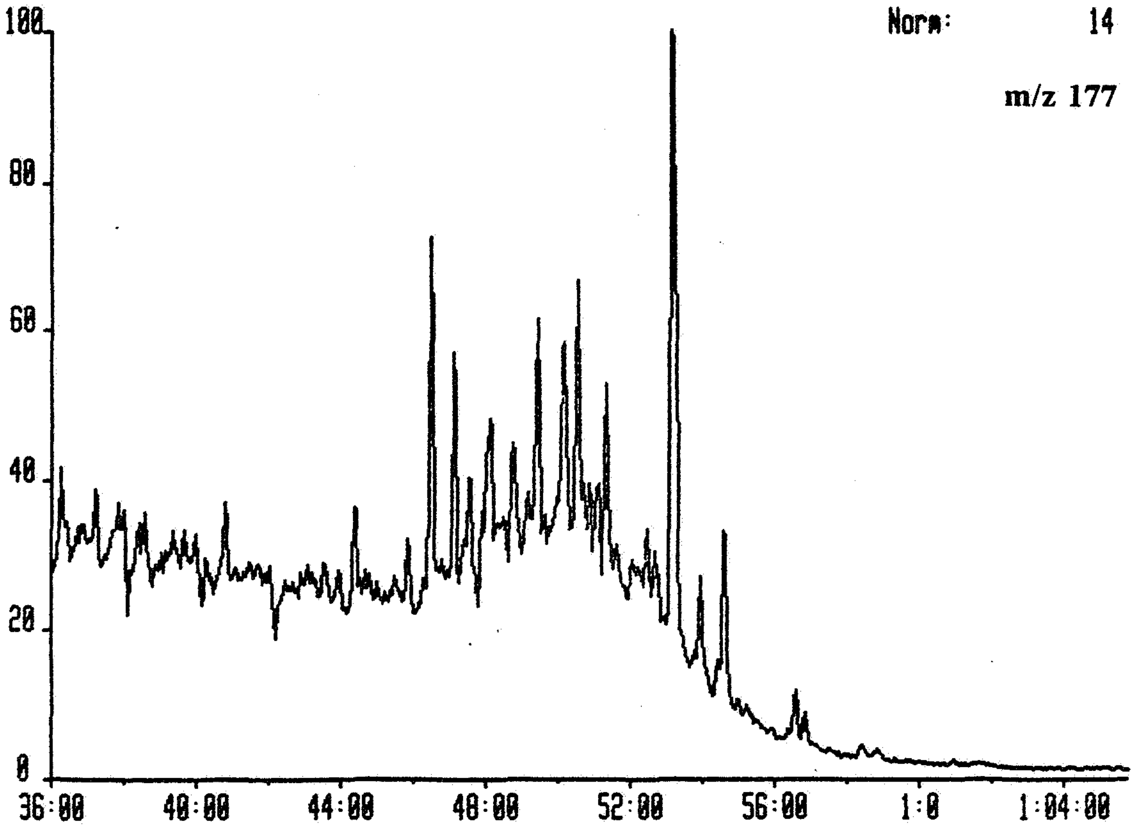
Appendix C
Reservoir rock biomarkers

Sandstones

C6710SAT 2-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 163.1000
Text:

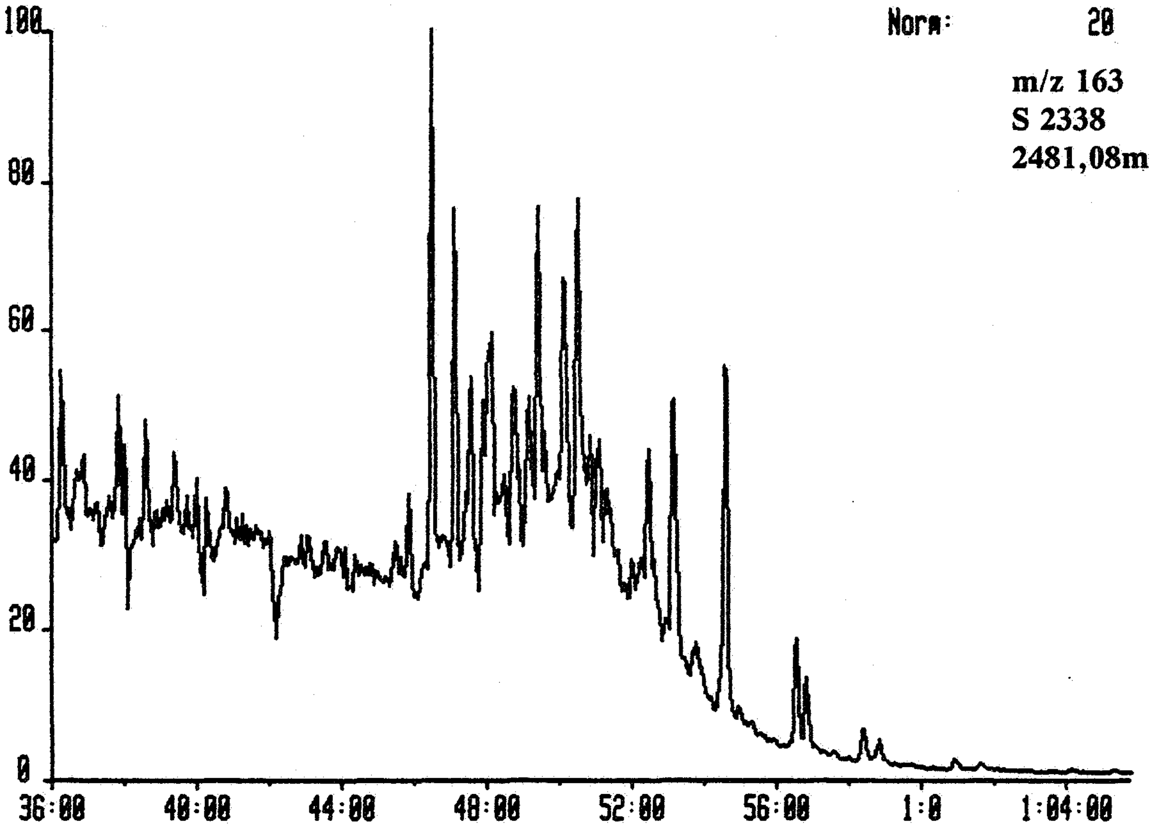


C6710SAT 2-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 177.1000
Text:

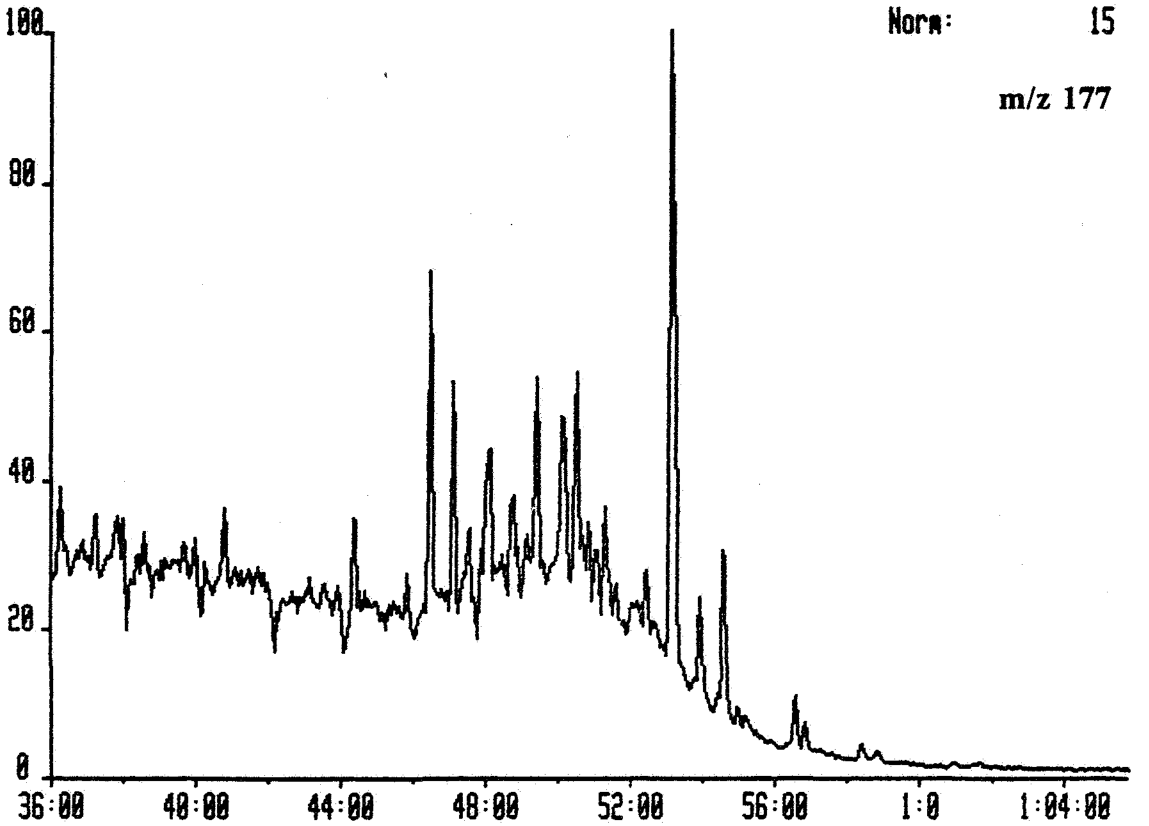


IKU SINTEF-GRUPPEN

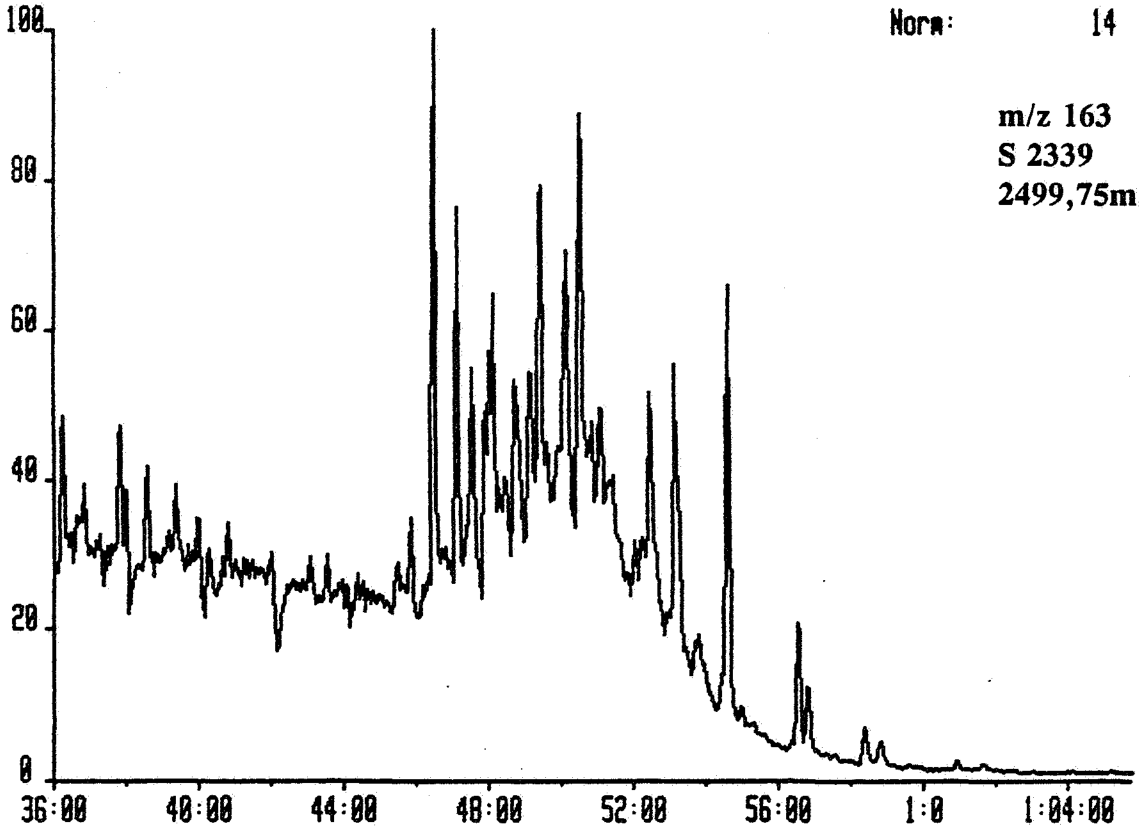
C6711SAT 2-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 163.1000
Text:



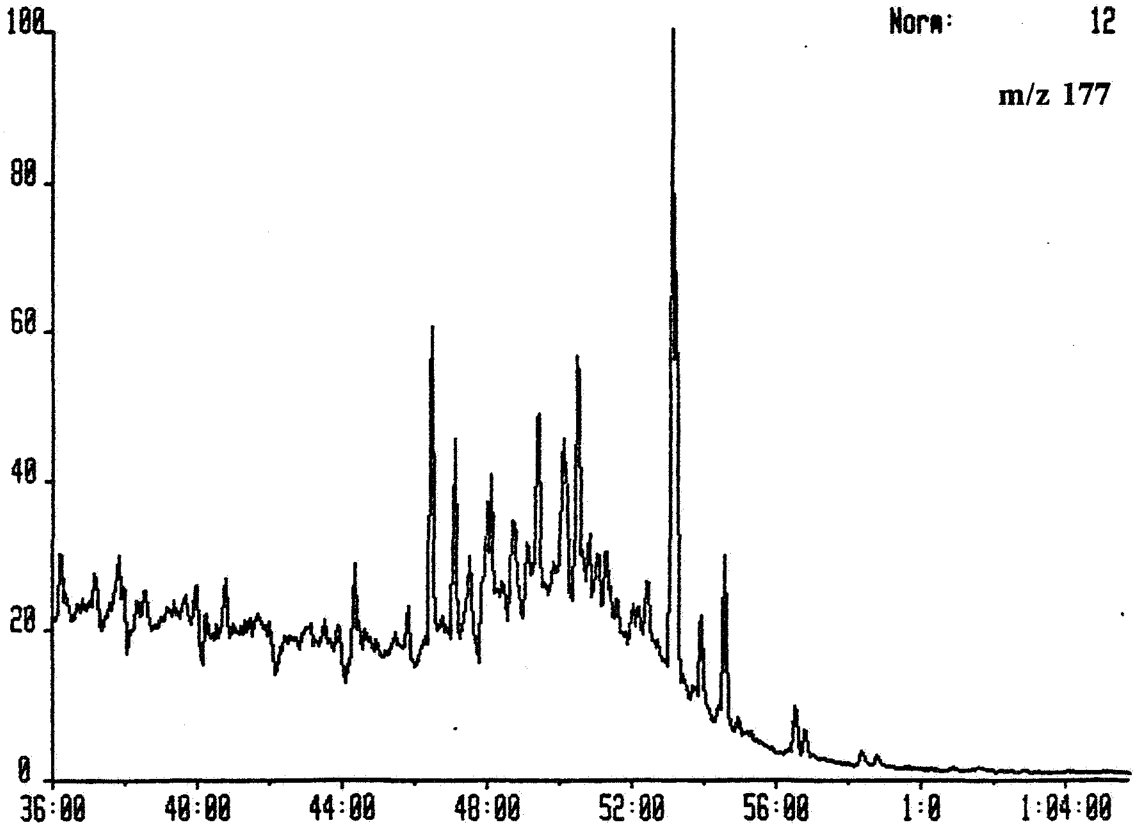
C6711SAT 2-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 177.1000
Text:



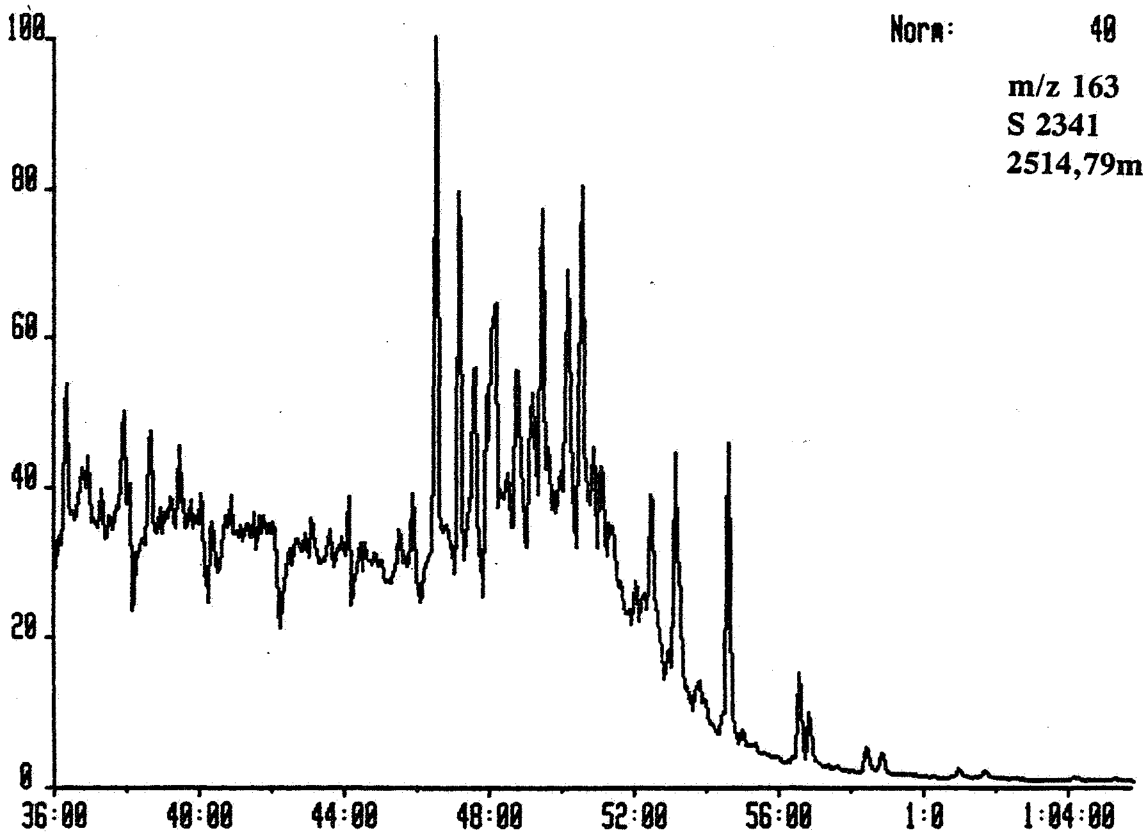
C6712SAT 2-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 163.1000
Text:



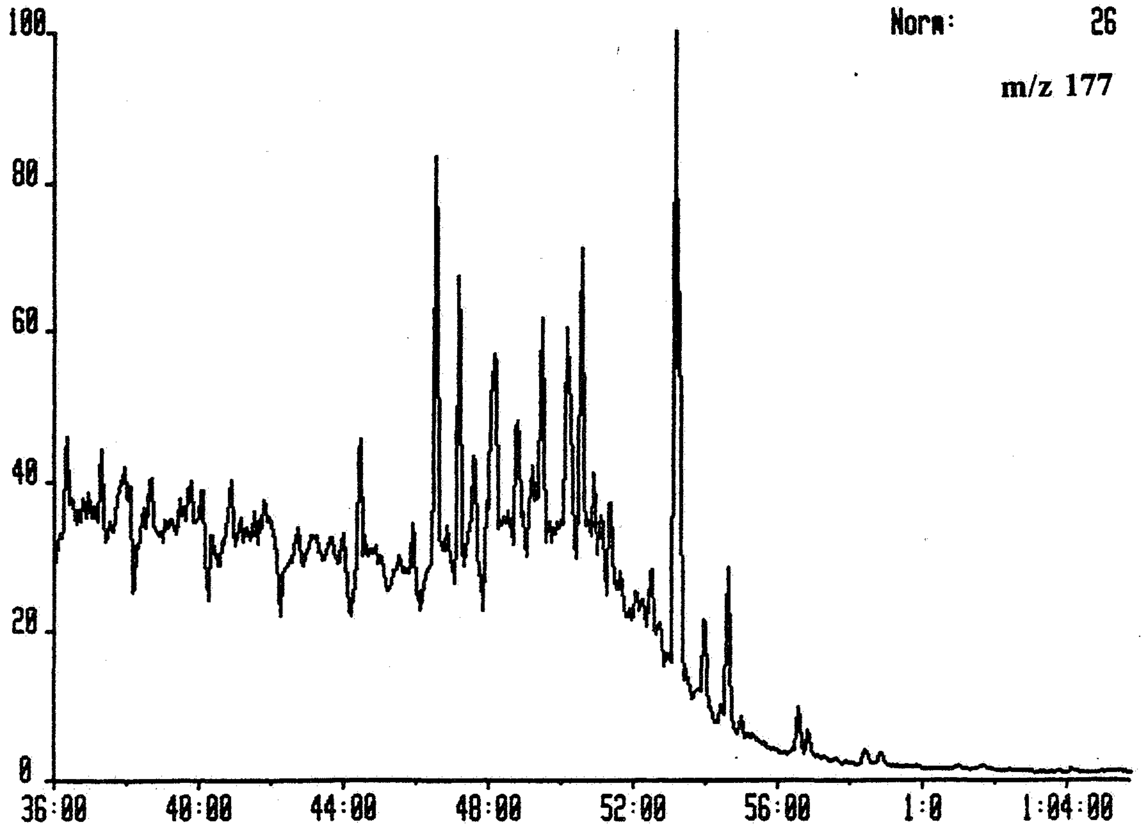
C6712SAT 2-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 177.1000
Text:



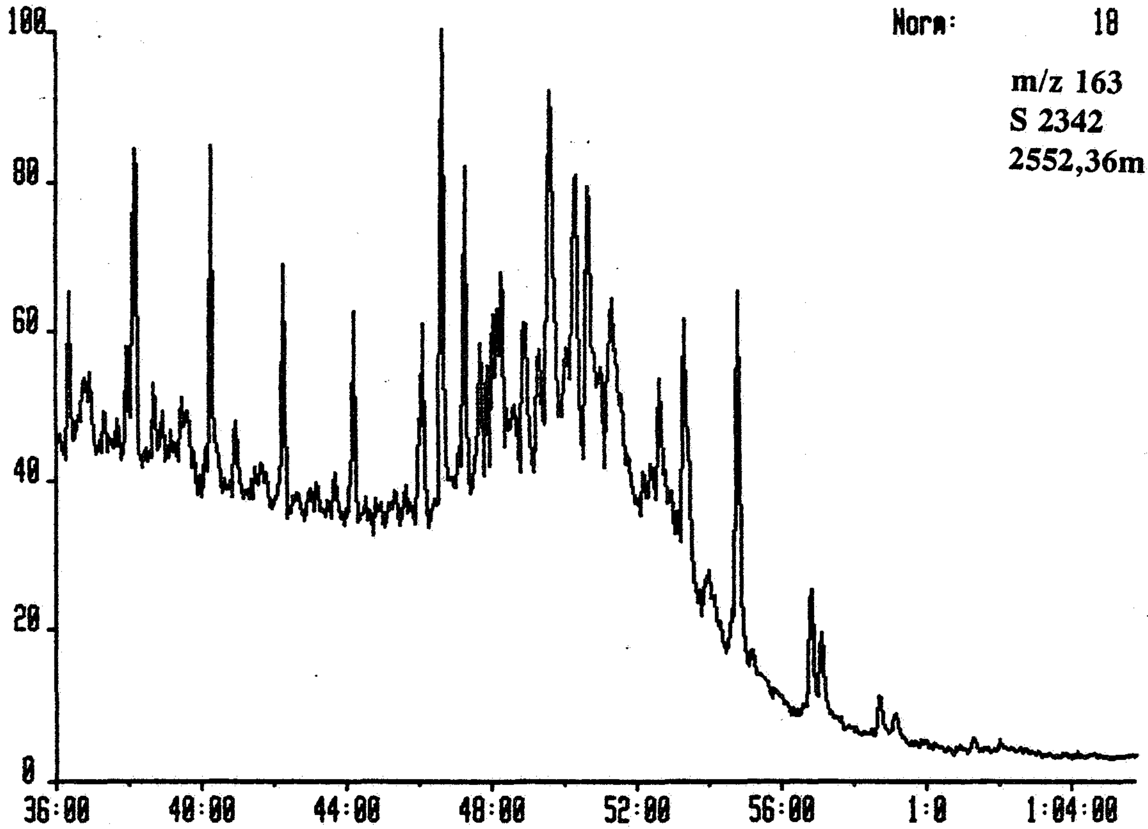
C6713SAT 2-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 163.1000
Text:



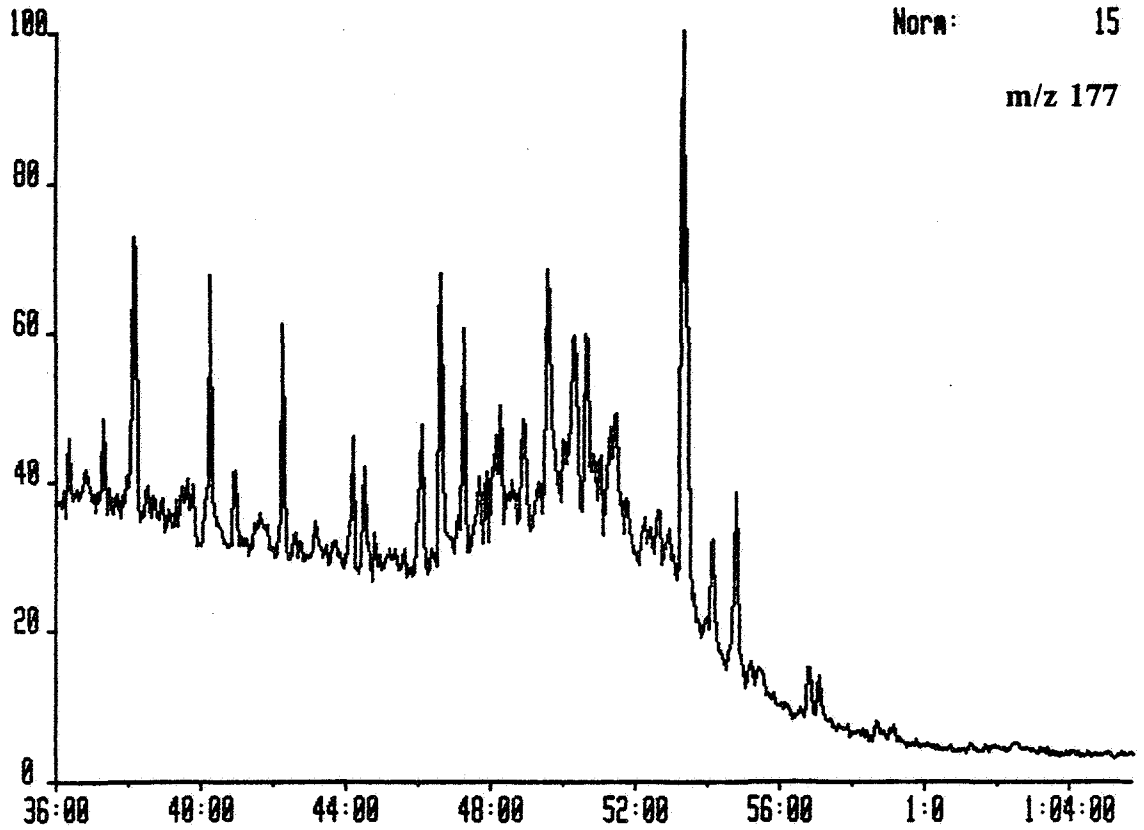
C6713SAT 2-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 177.1000
Text:



C6714SAT 5-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 163.1000
Text:

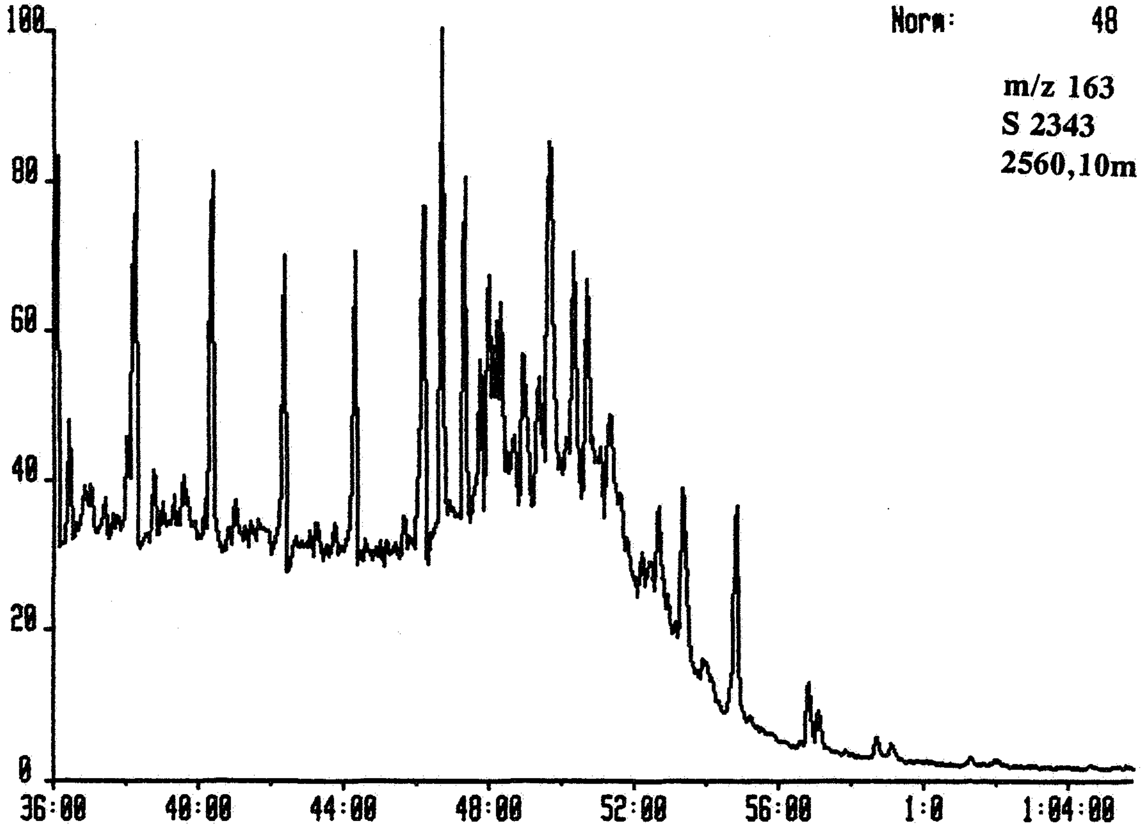


C6714SAT 5-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 177.1000
Text:

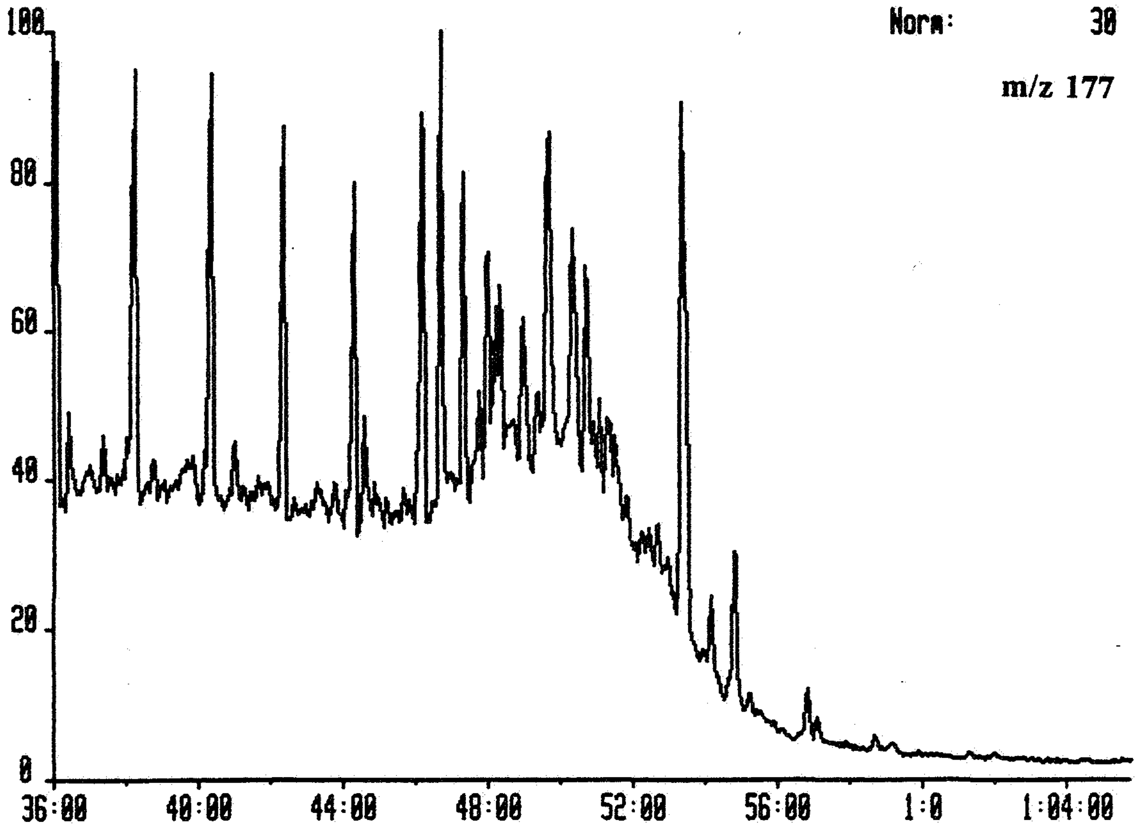


IKU
SINTEF-GRUPPEN

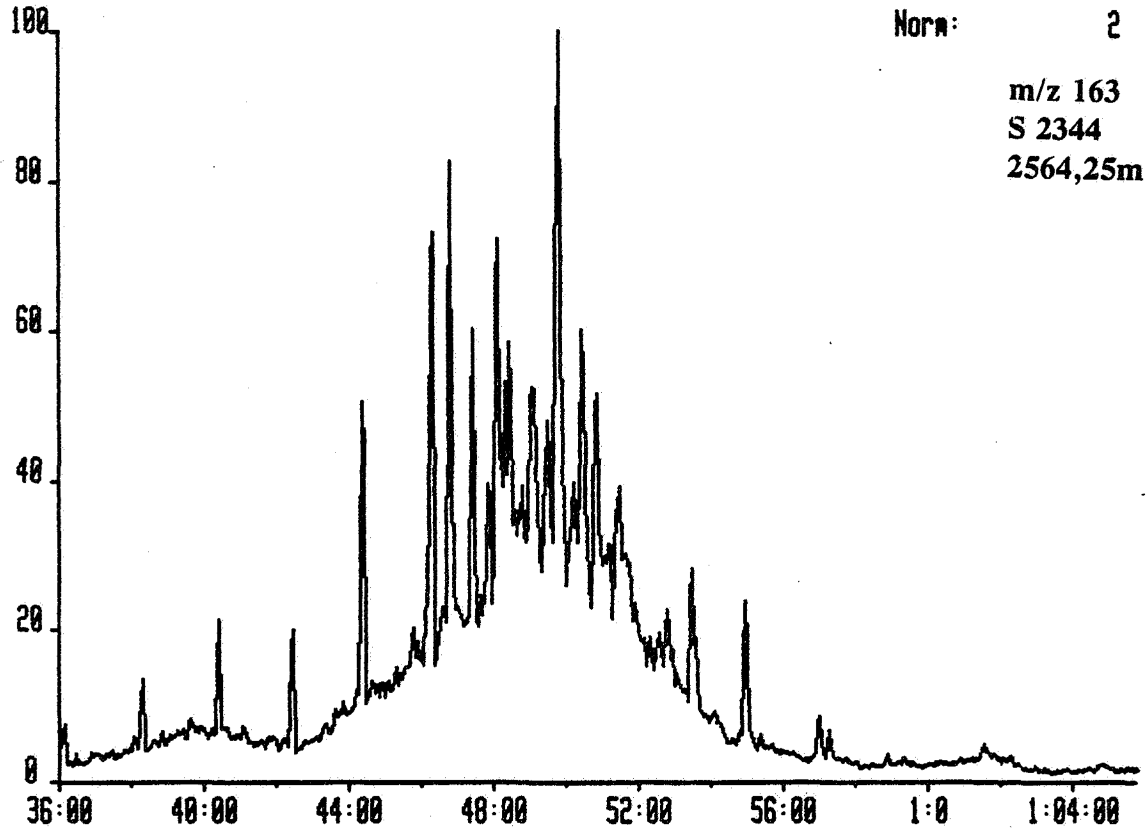
C6715SAT 5-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 163.1000
Text:



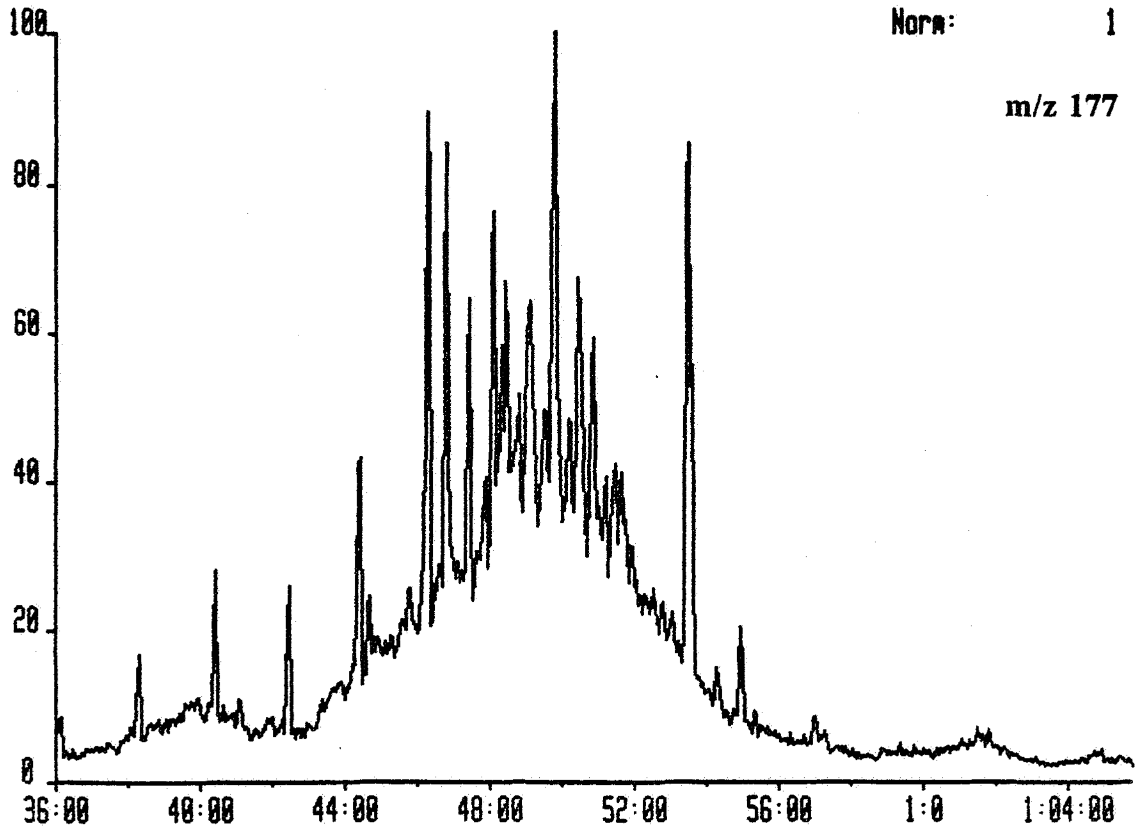
C6715SAT 5-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 177.1000
Text:



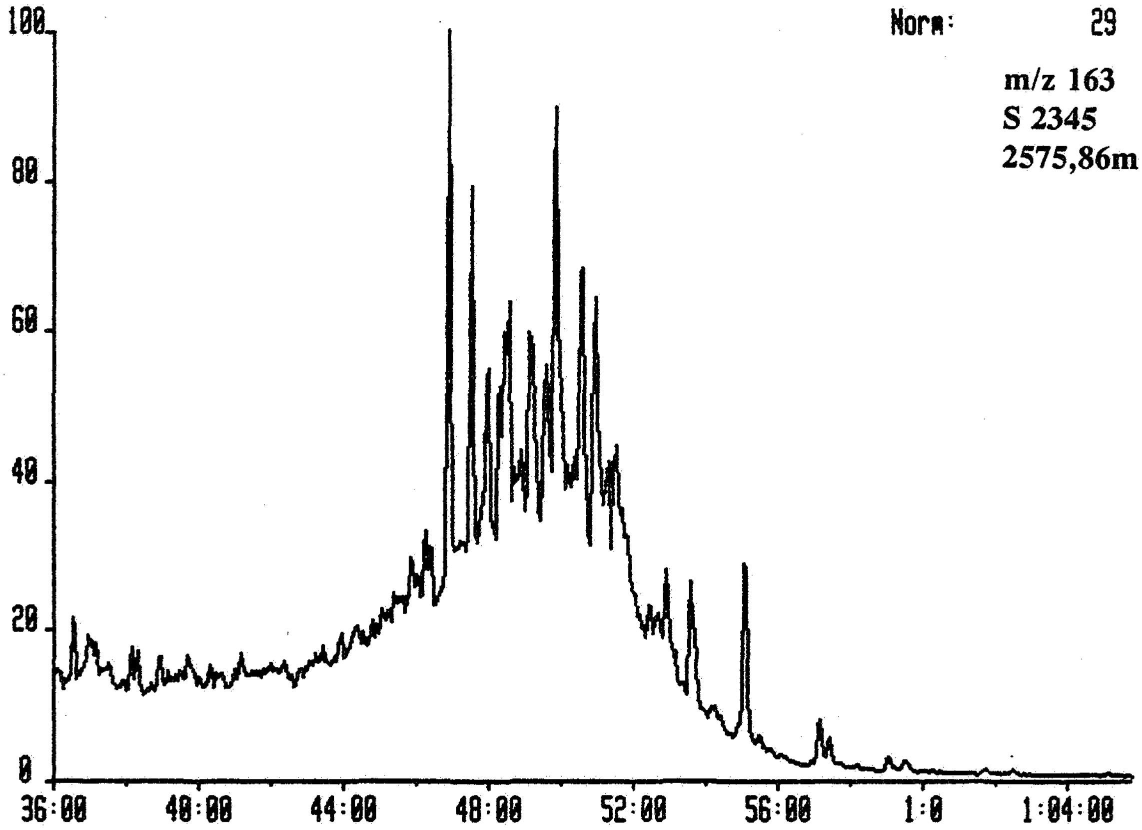
C6716SAT 6-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 163.1000
Text:



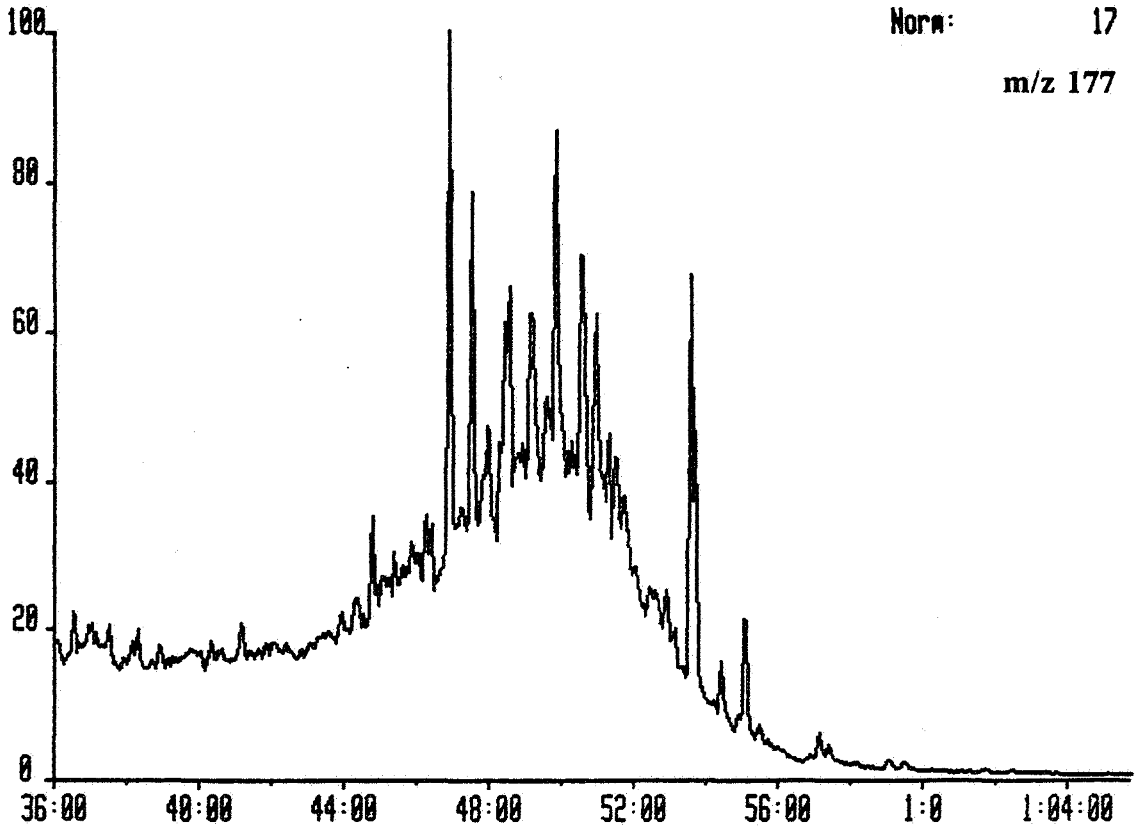
C6716SAT 6-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 177.1000
Text:



C6717SAT 7-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMIO
Sample 1 Injection 1 Group 1 Mass 163.1000
Text:

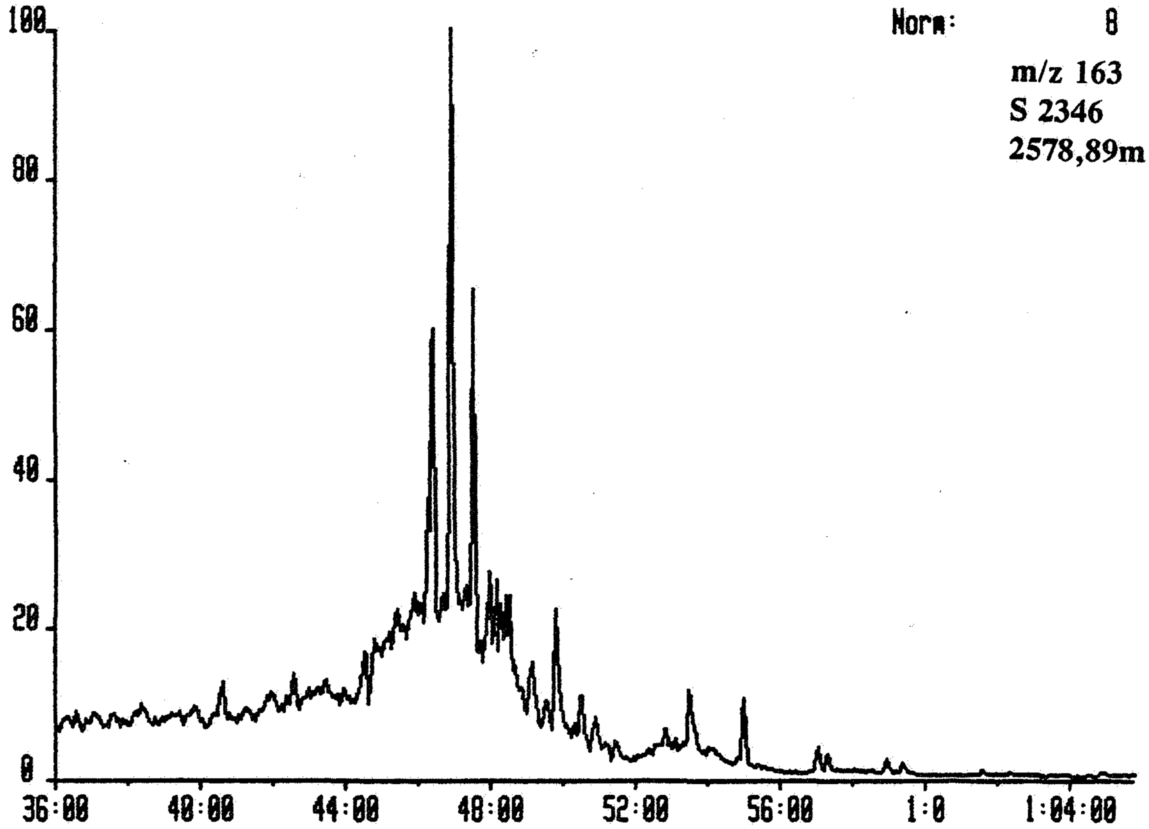


C6717SAT 7-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMIO
Sample 1 Injection 1 Group 1 Mass 177.1000
Text:

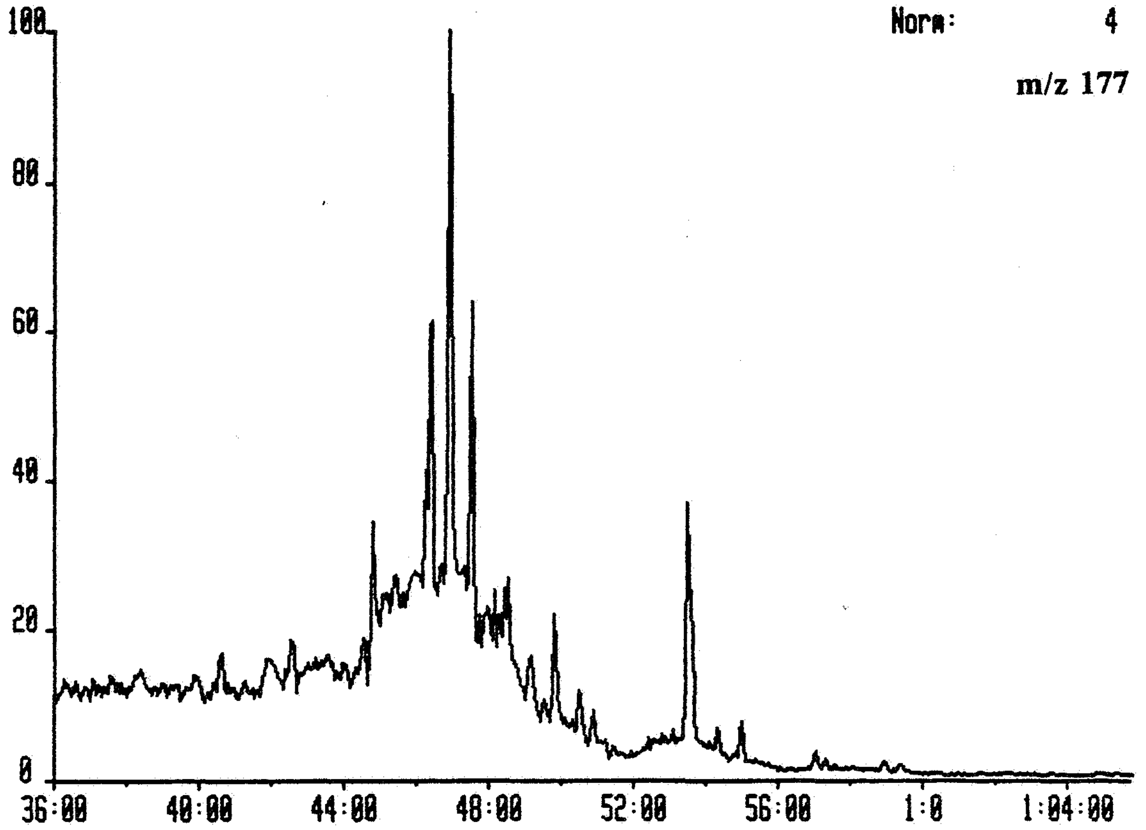


IKU SINTEF-GRUPPEN

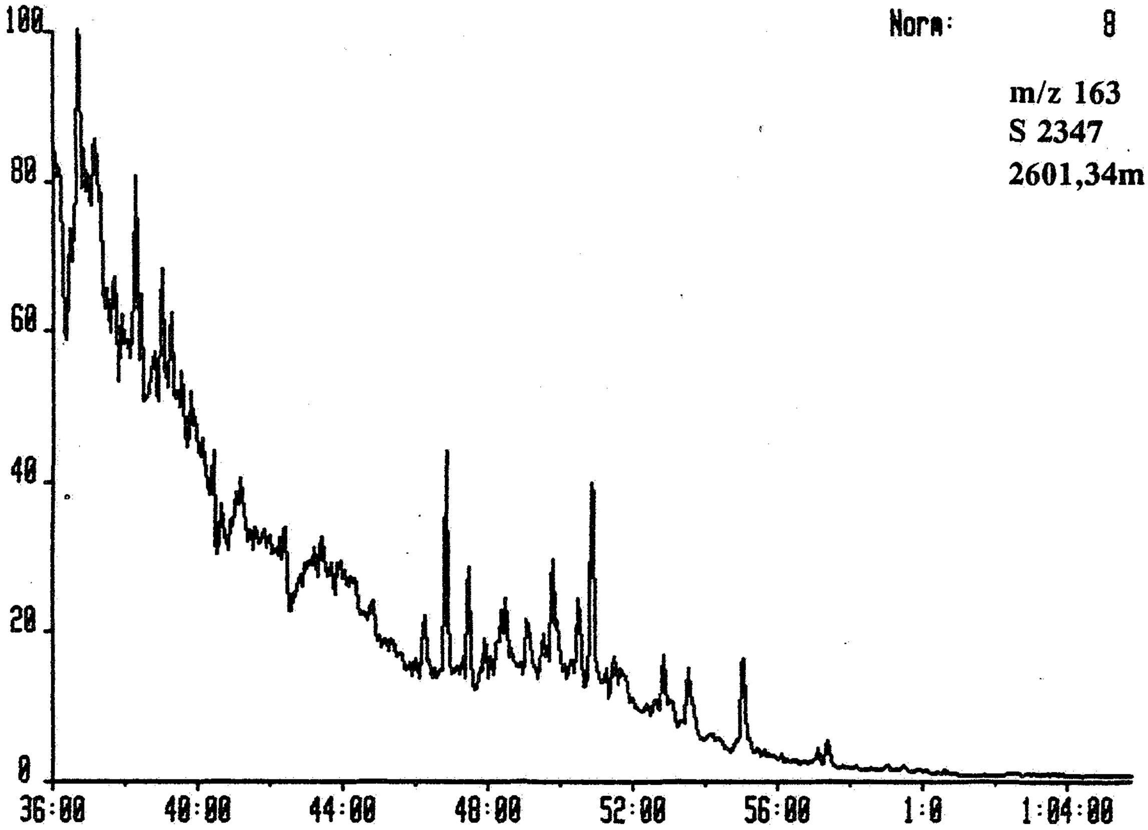
C6718SAT 6-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 163.1000
Text:



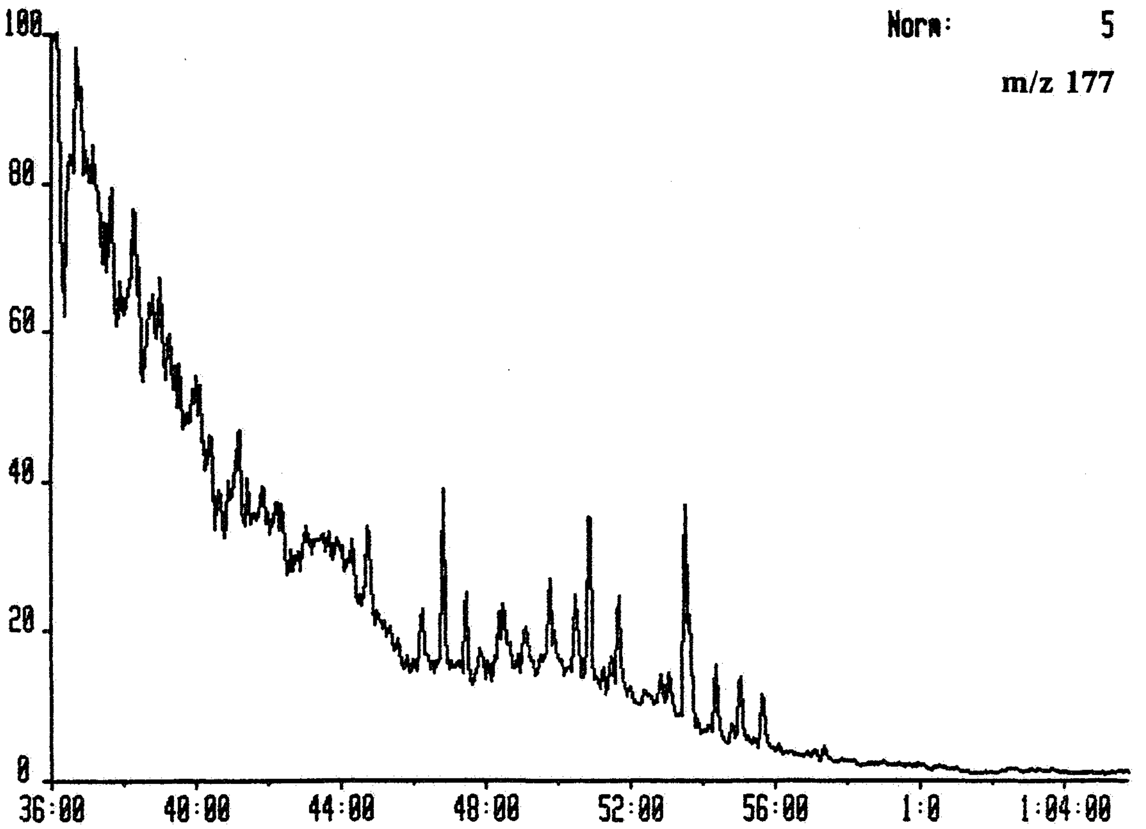
C6718SAT 6-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 177.1000
Text:



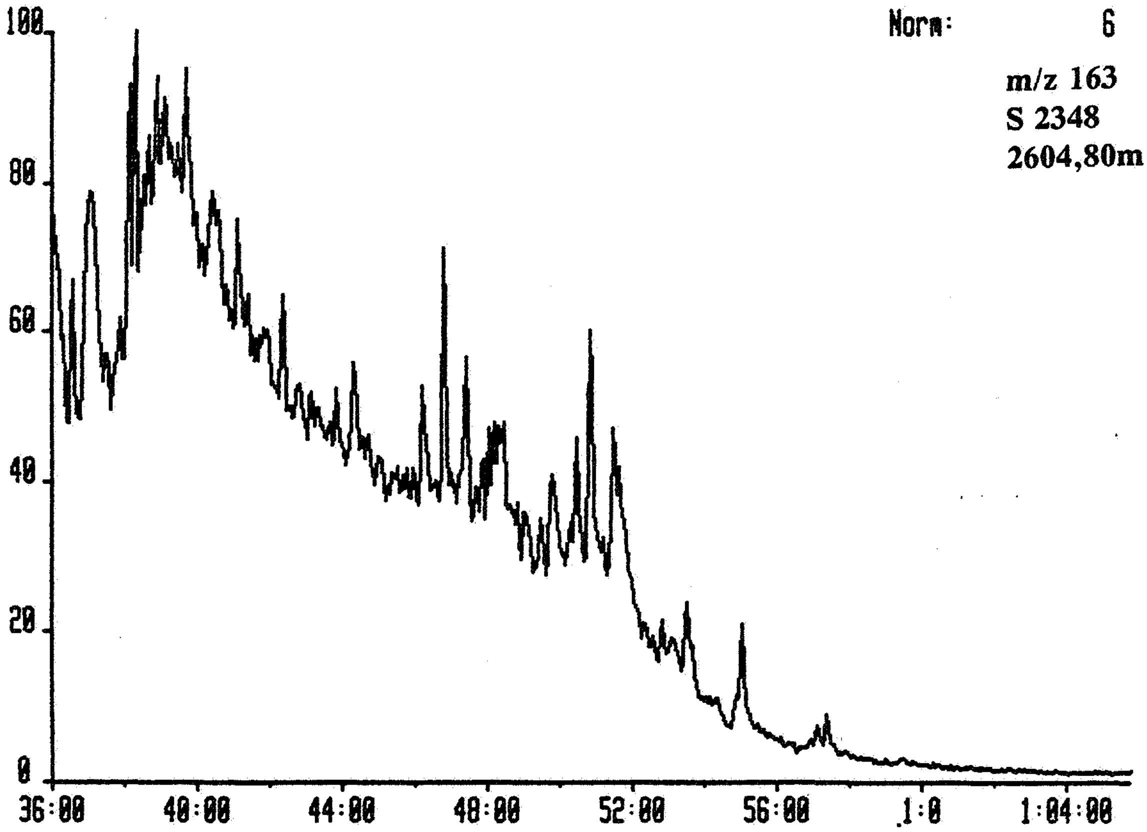
C6719SAT 7-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 163.1000
Text:



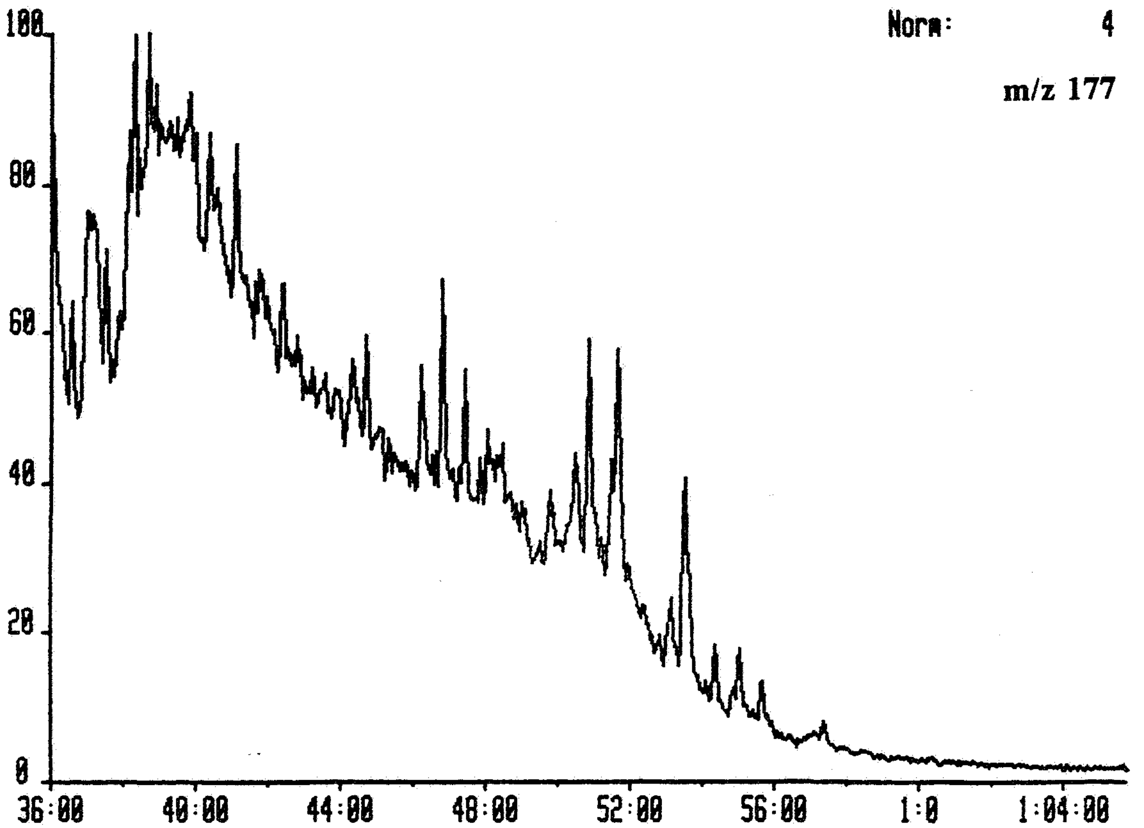
C6719SAT 7-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 177.1000
Text:



C6720SAT 7-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 163.1000
Text:



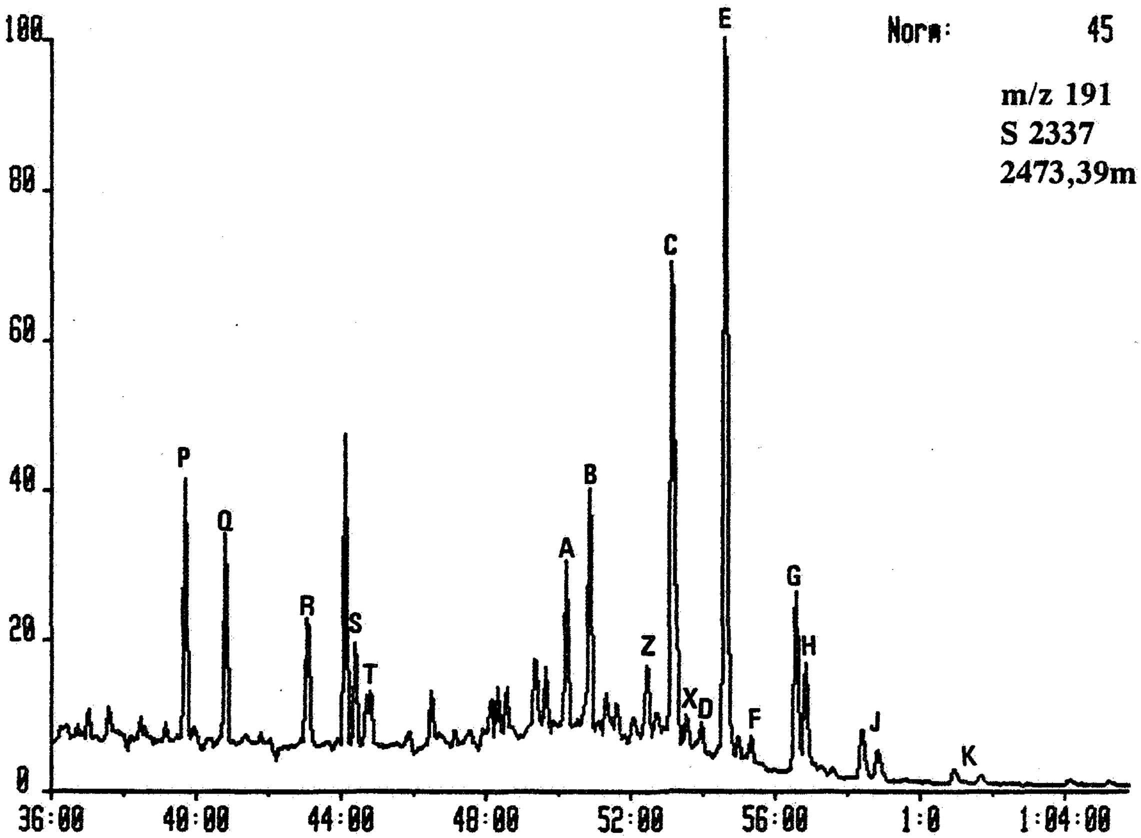
C6720SAT 7-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 177.1000
Text:



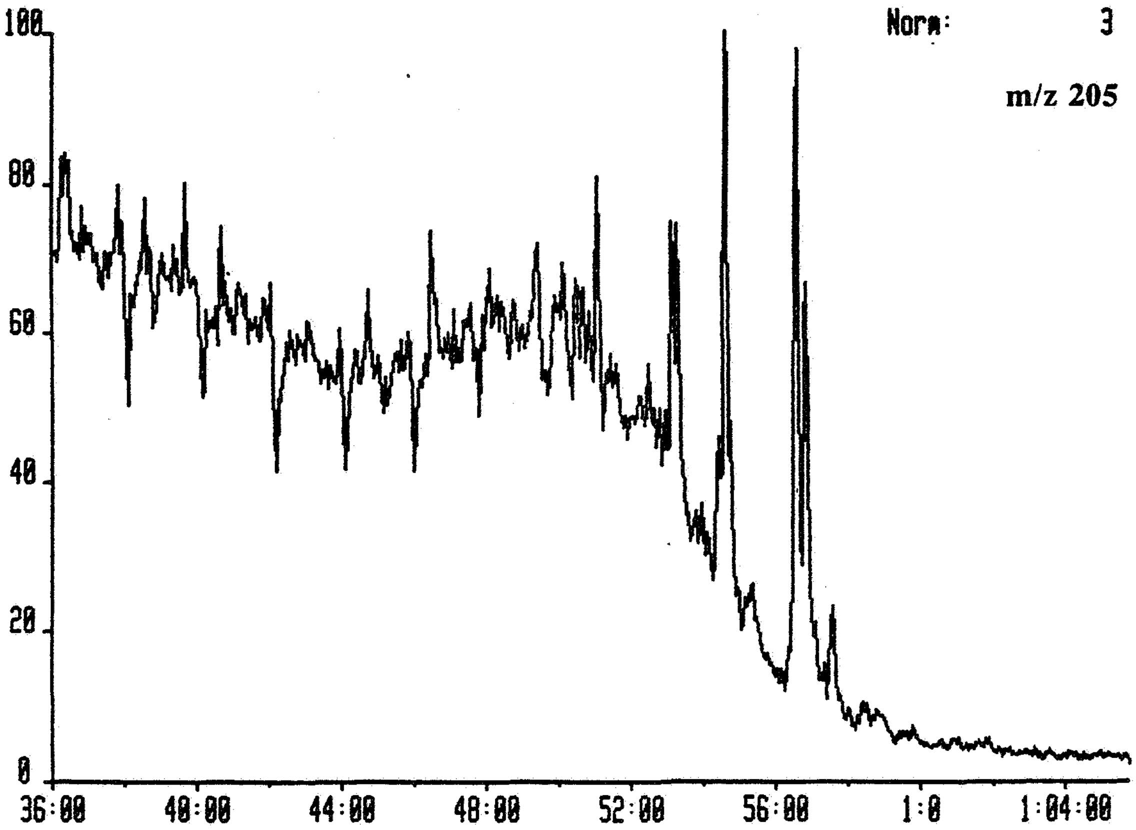
Sandstones

IKU SINTEF-GRUPPEN

C6710SAT 2-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 191.1000
Text:

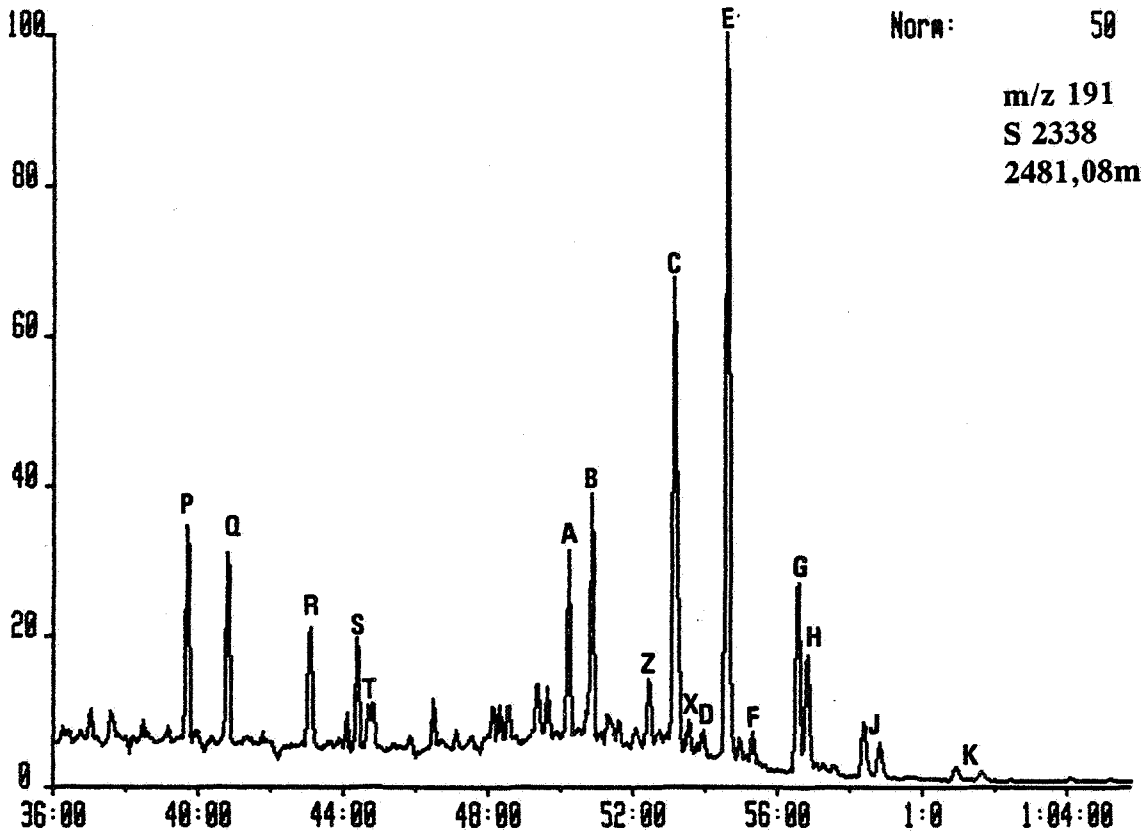


C6710SAT 2-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 205.1000
Text:

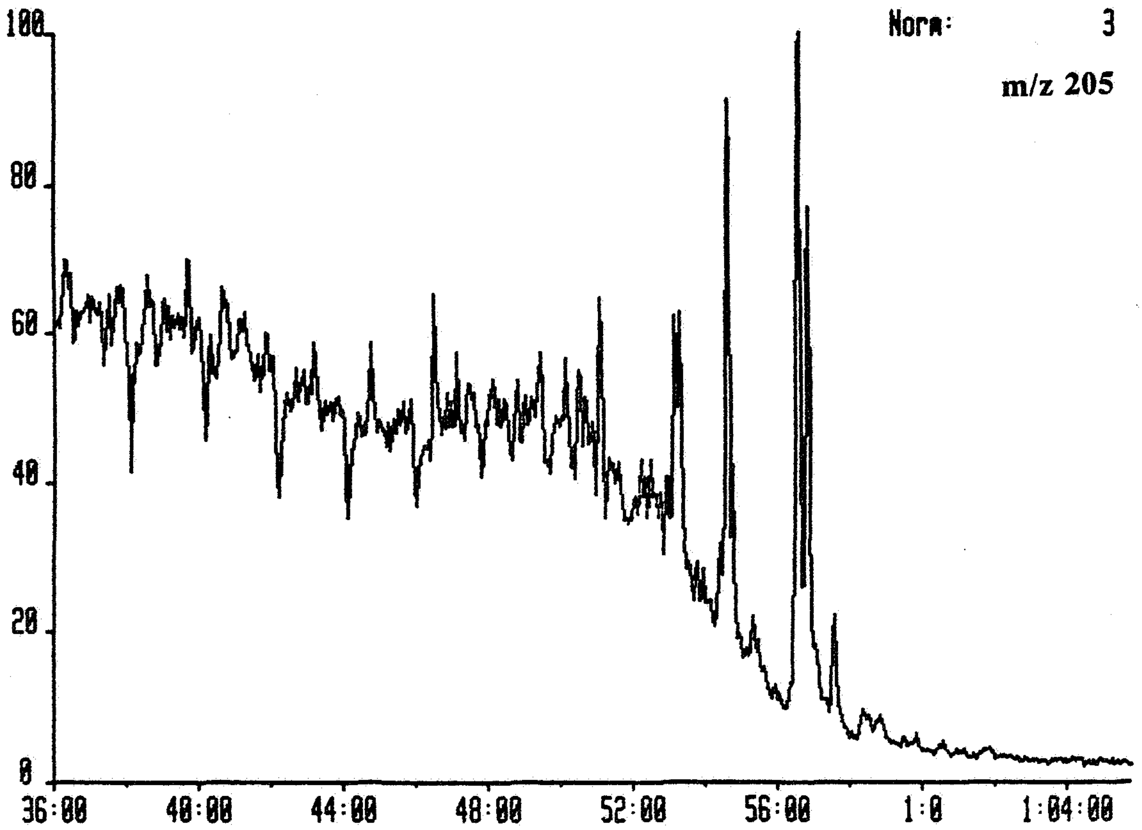


IKU
SINTEF-GRUPPEN

C6711SAT 2-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 191.1000
Text:

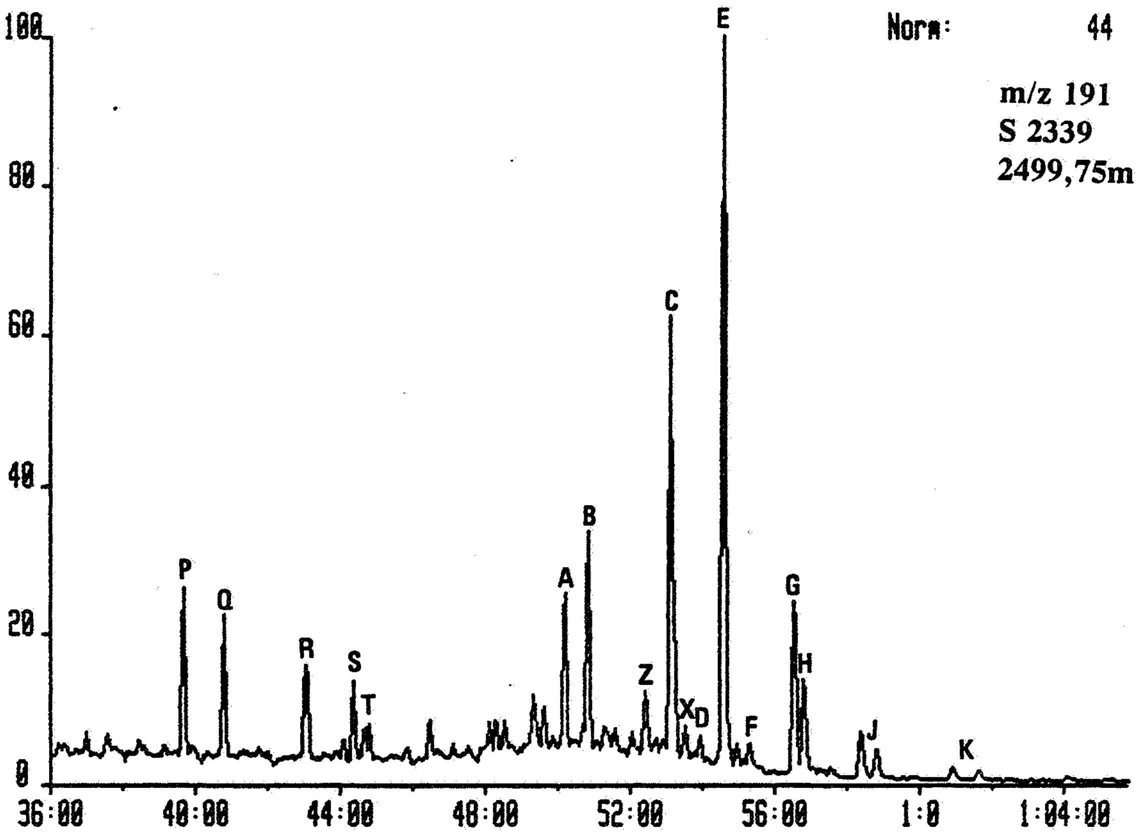


C6711SAT 2-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 205.1000
Text:

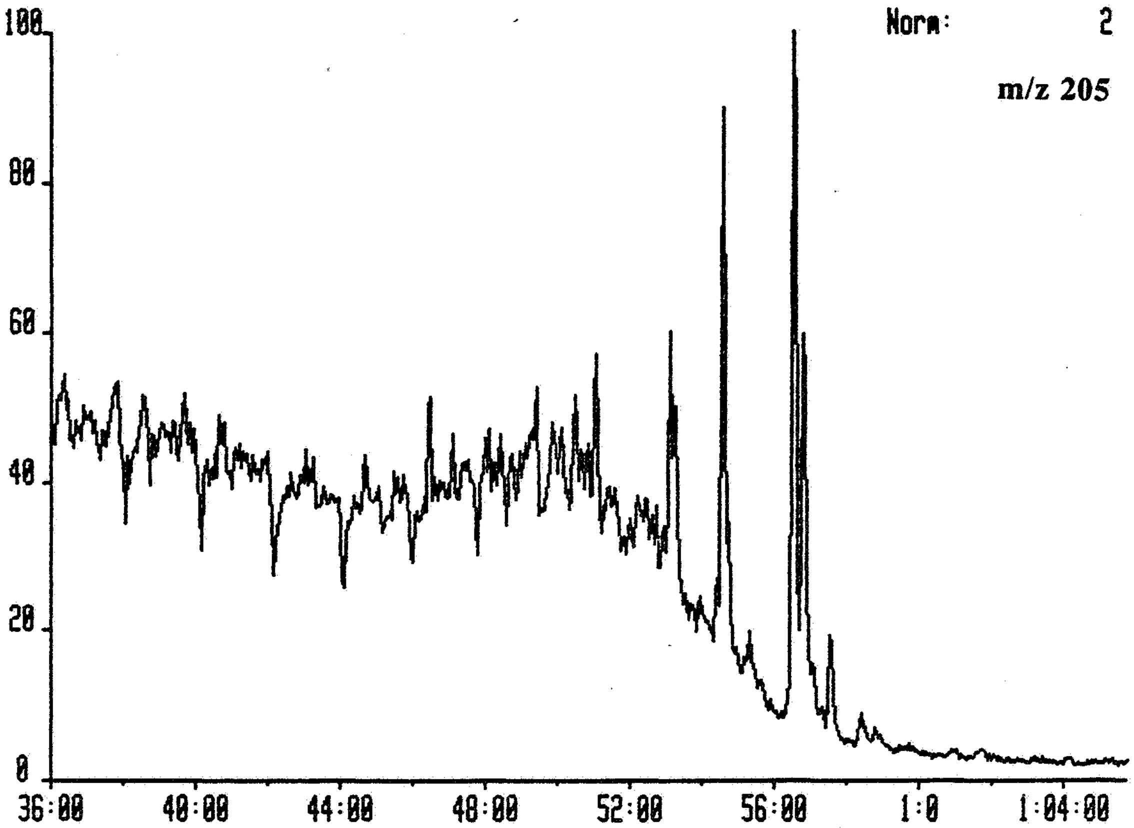


IKU
SINTEF-GRUPPEN

C6712SAT 2-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 191.1000
Text:

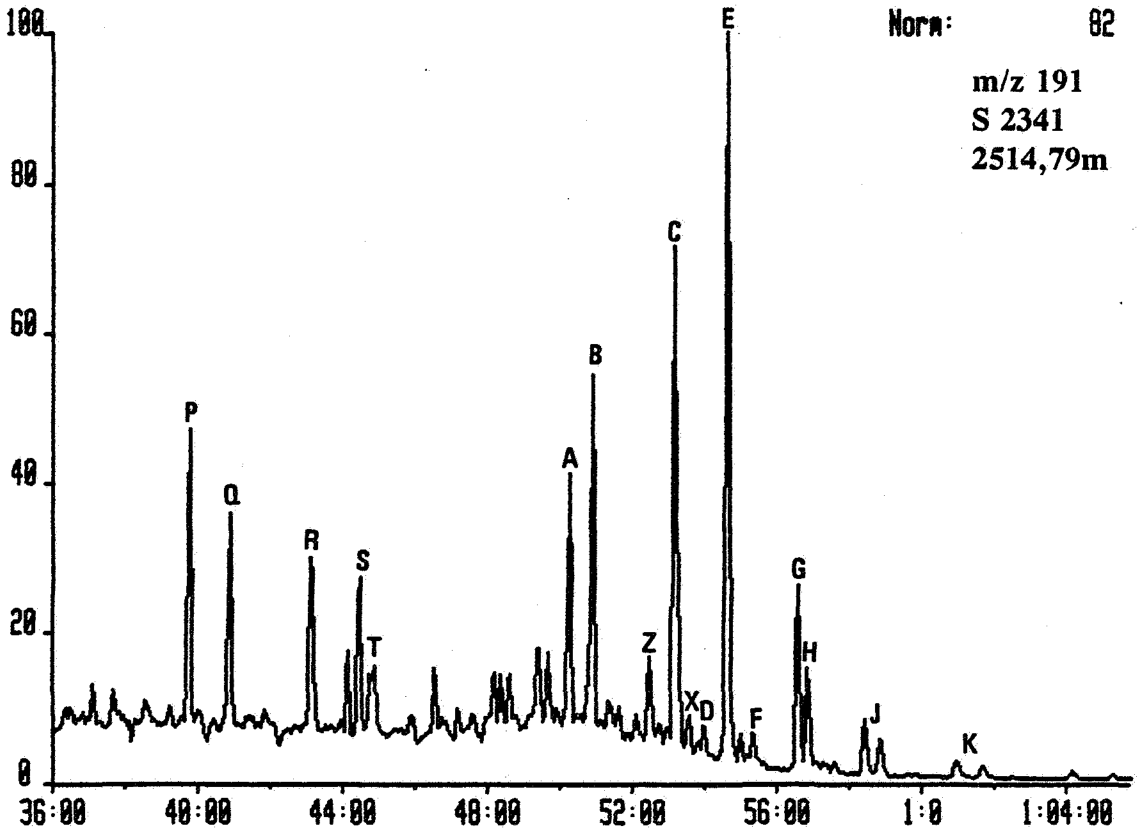


C6712SAT 2-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 205.1000
Text:

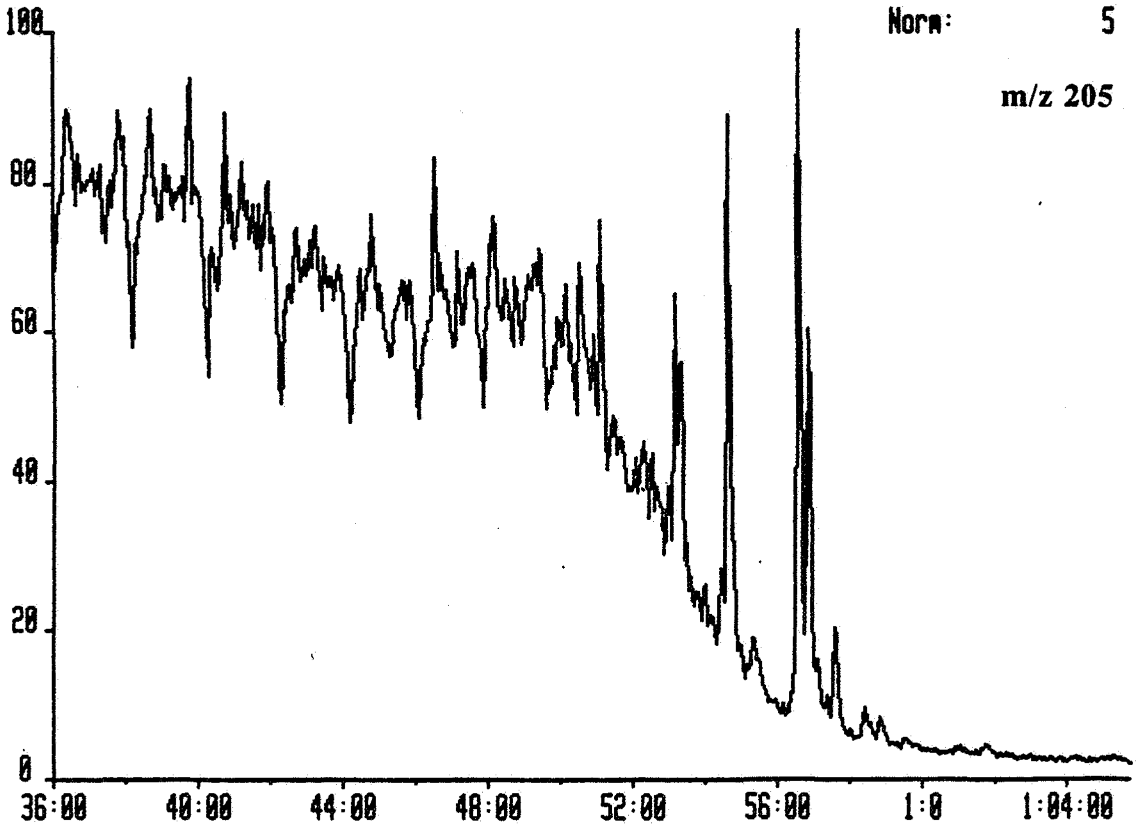


IKU SINTEF-GRUPPEN

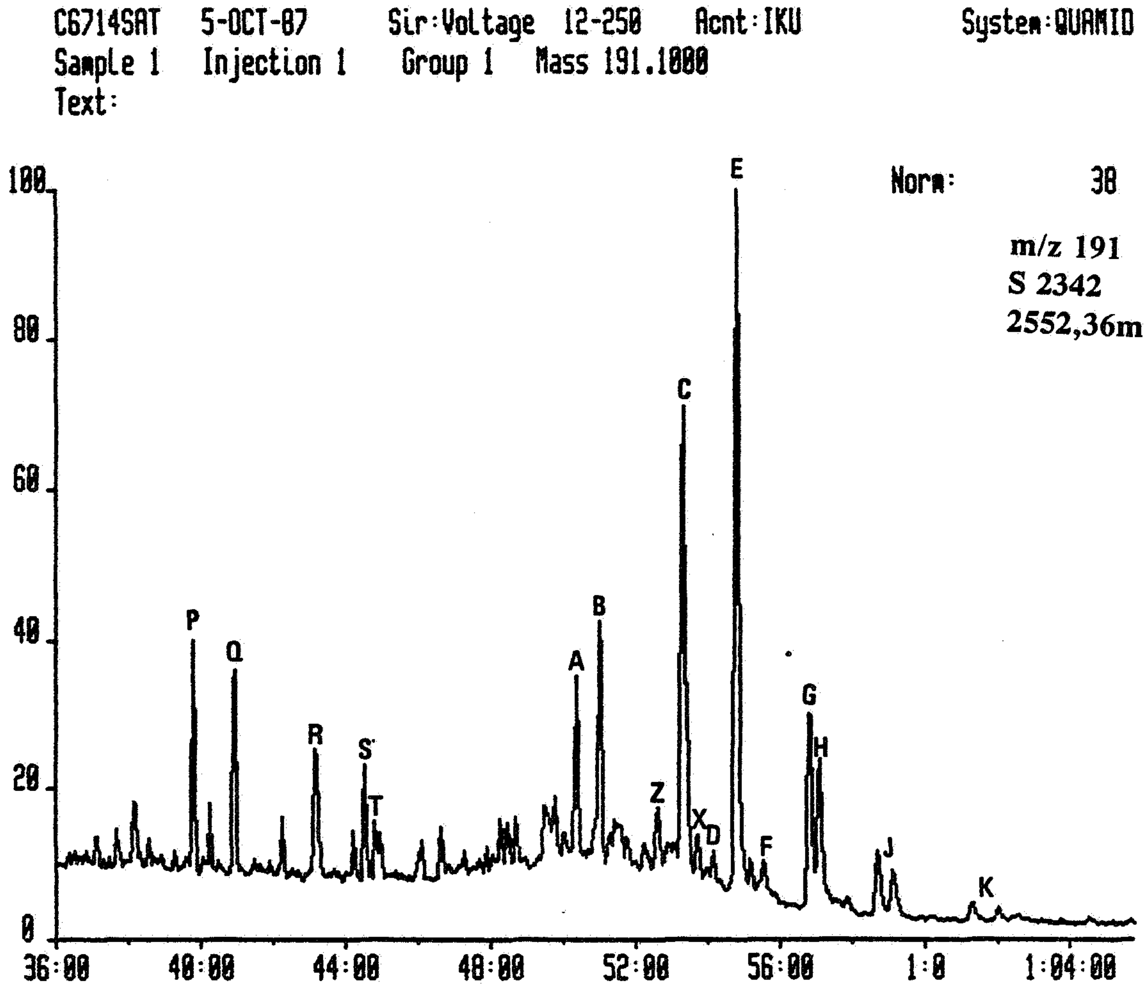
C6713SAT 2-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 191.1000
Text:

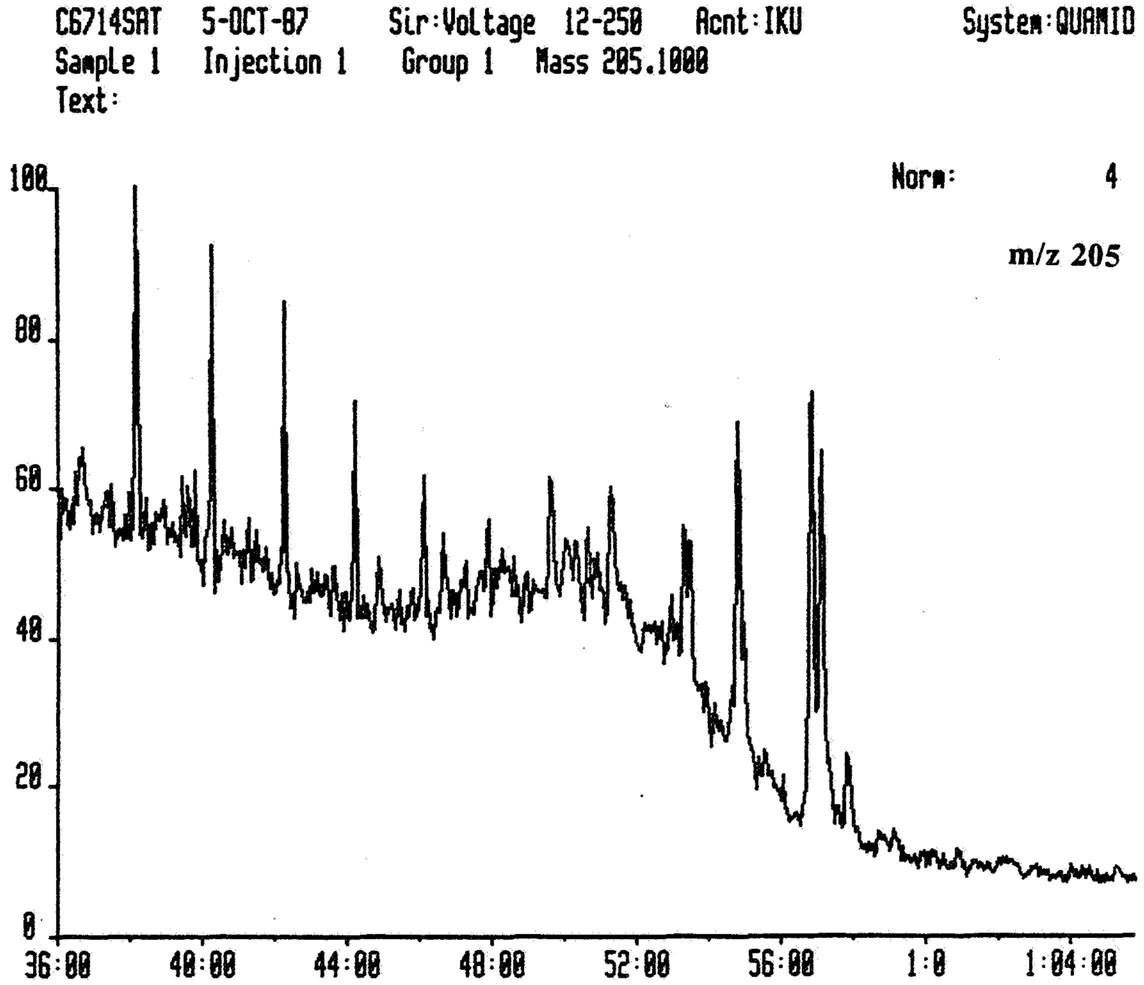


C6713SAT 2-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 205.1000
Text:



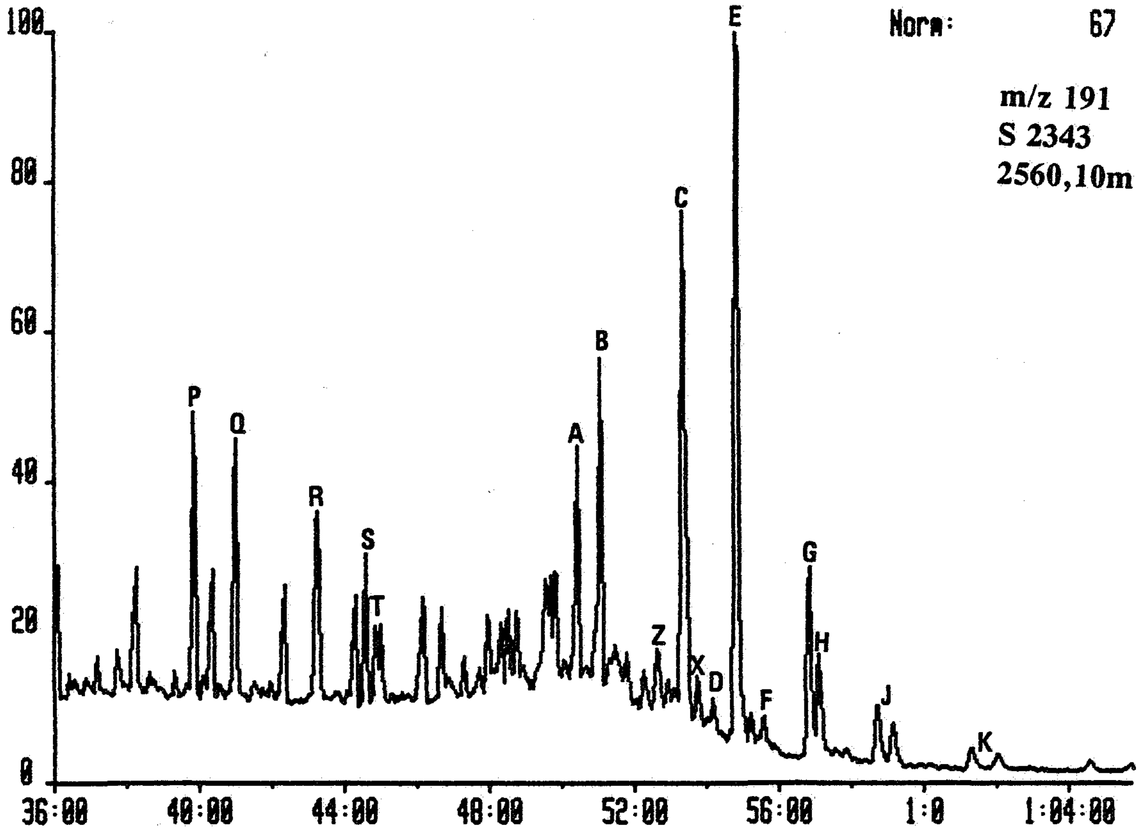
IKU SINTEF-GRUPPEN



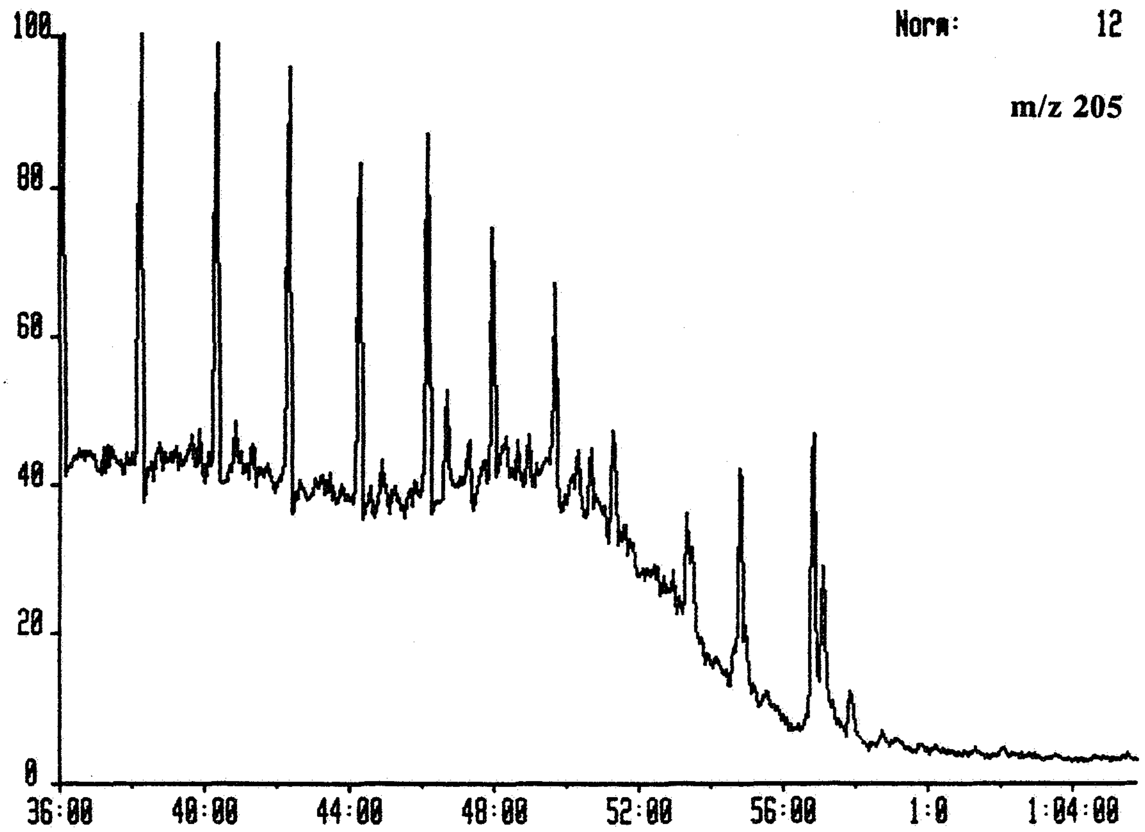


IKU
SINTEF-GRUPPEN

C6715SAT 5-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 191.1000
Text:

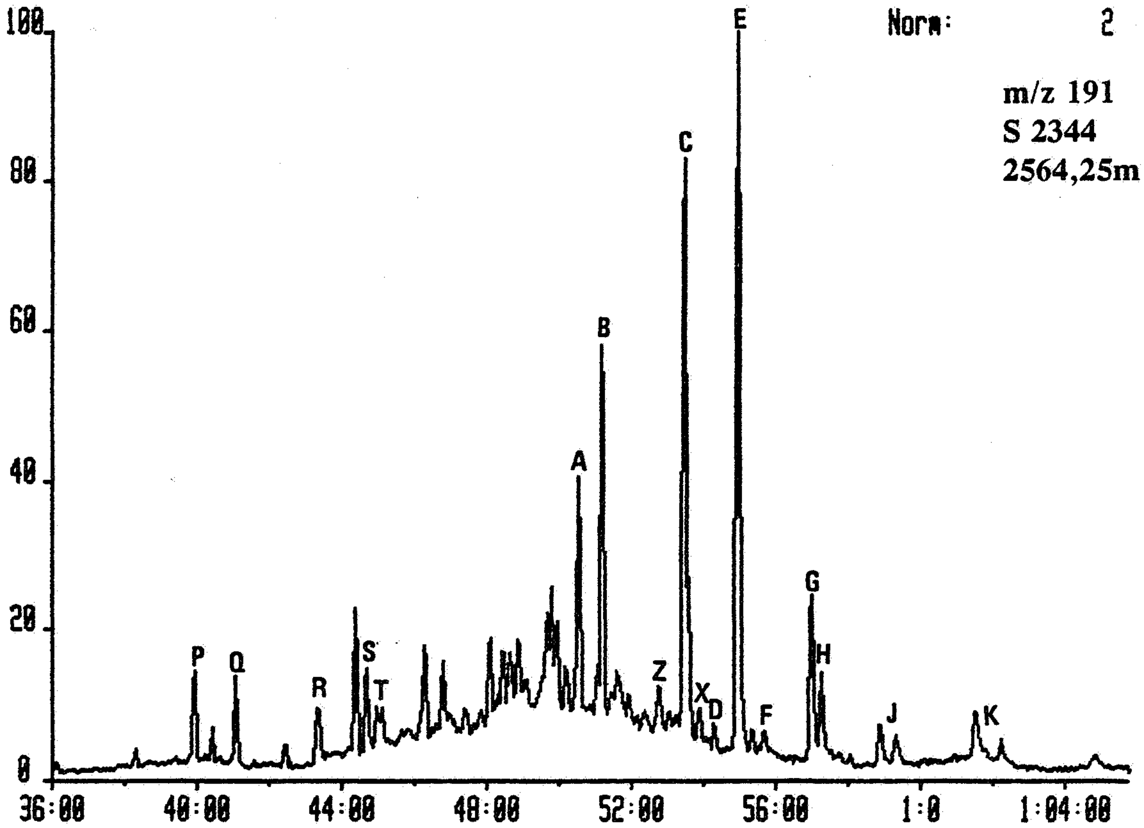


C6715SAT 5-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 205.1000
Text:

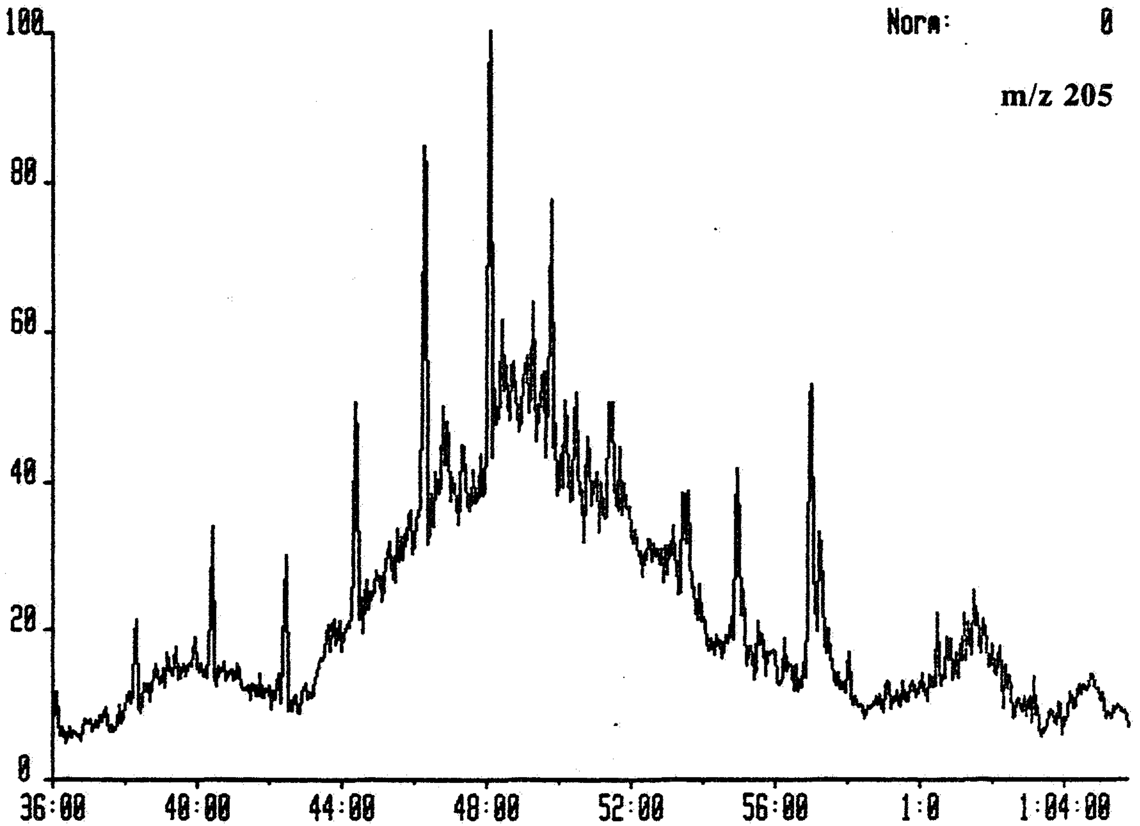


IKU SINTEF-GRUPPEN

C6716SAT 6-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 191.1000
Text:

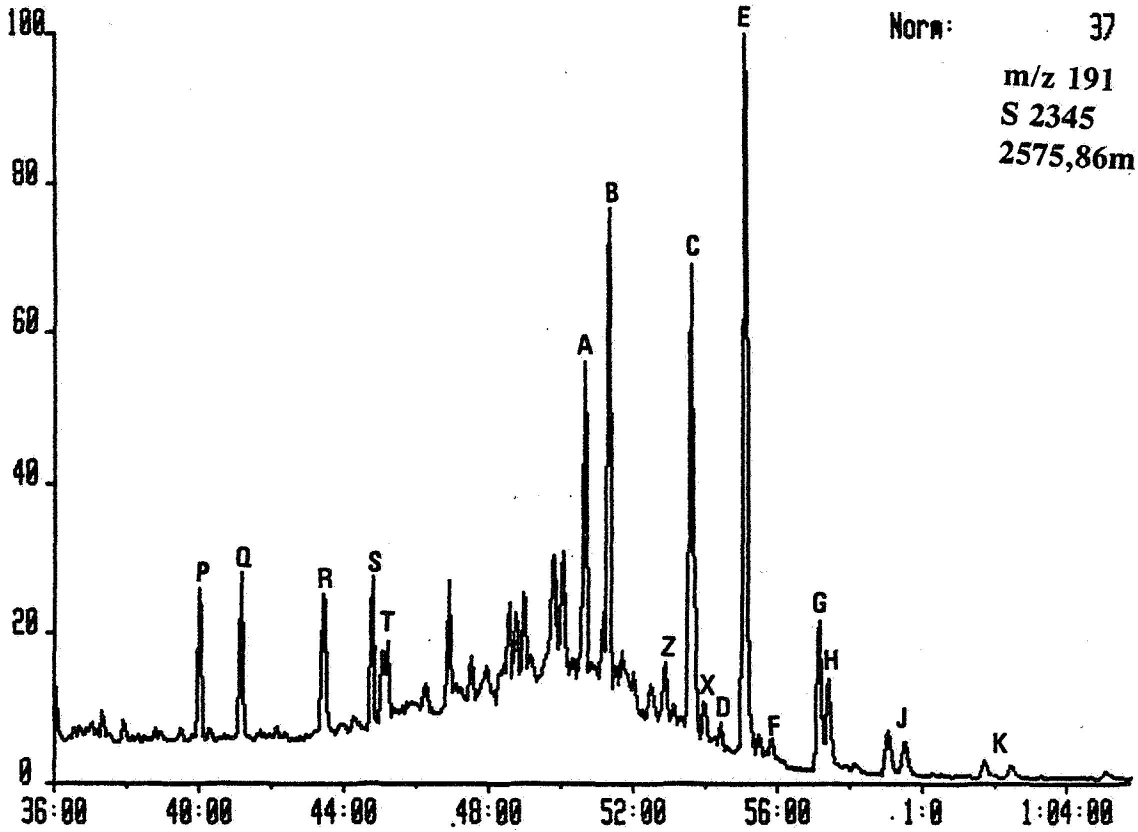


C6716SAT 6-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 205.1000
Text:

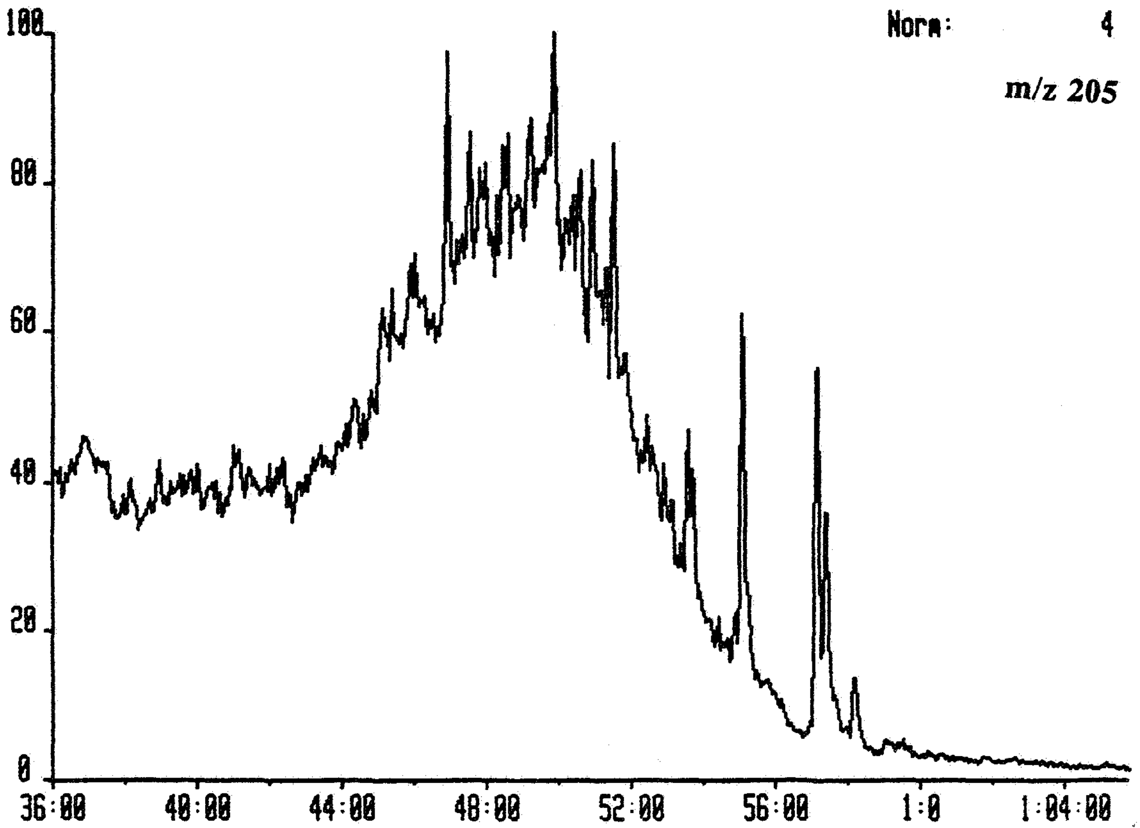


IKU
SINTEF-GRUPPEN

C6717SAT 7-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 191.1000
Text:

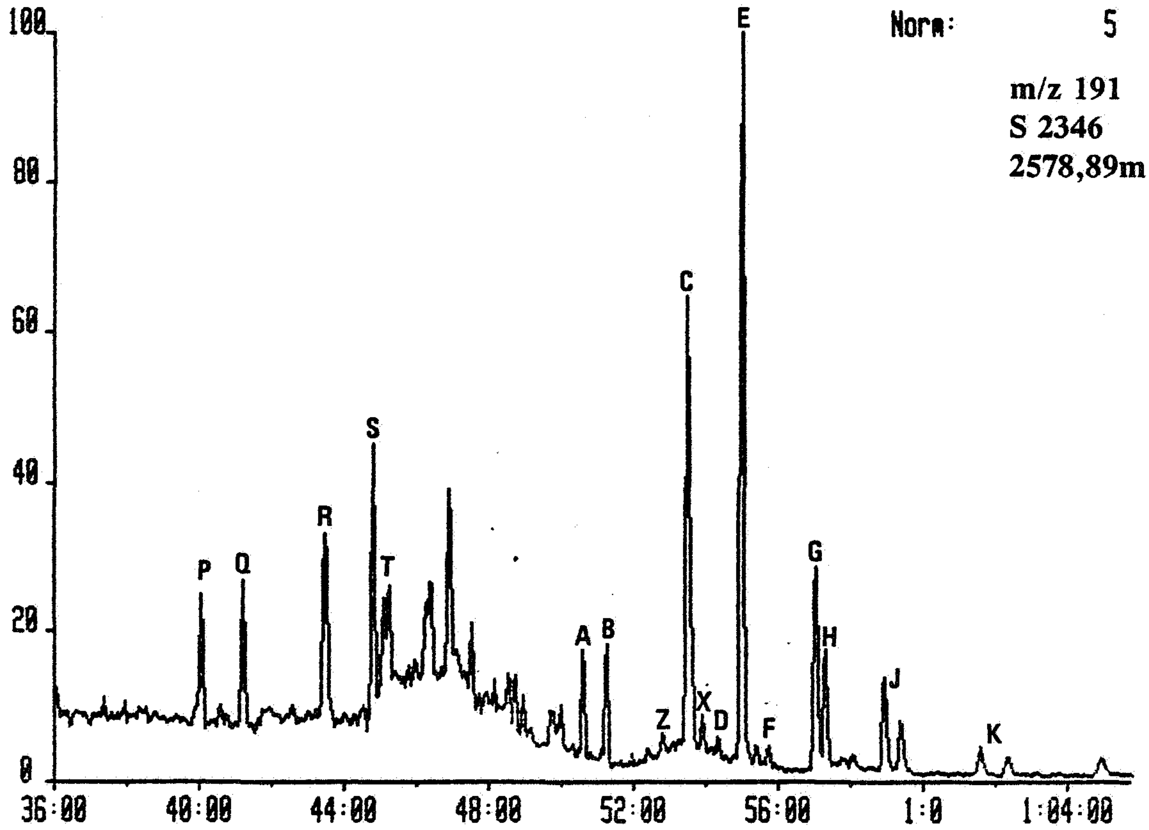


C6717SAT 7-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 205.1000
Text:

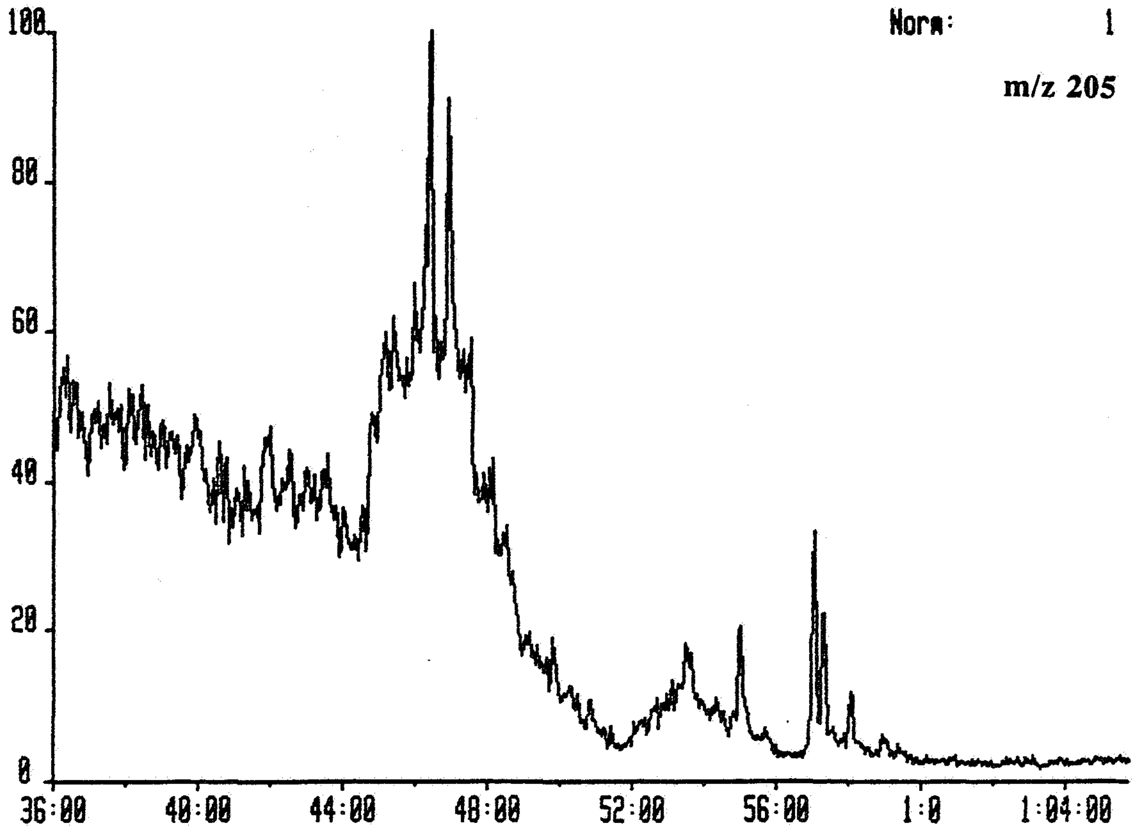


IKU SINTEF-GRUPPEN

C6718SAT 6-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 191.1000
Text:

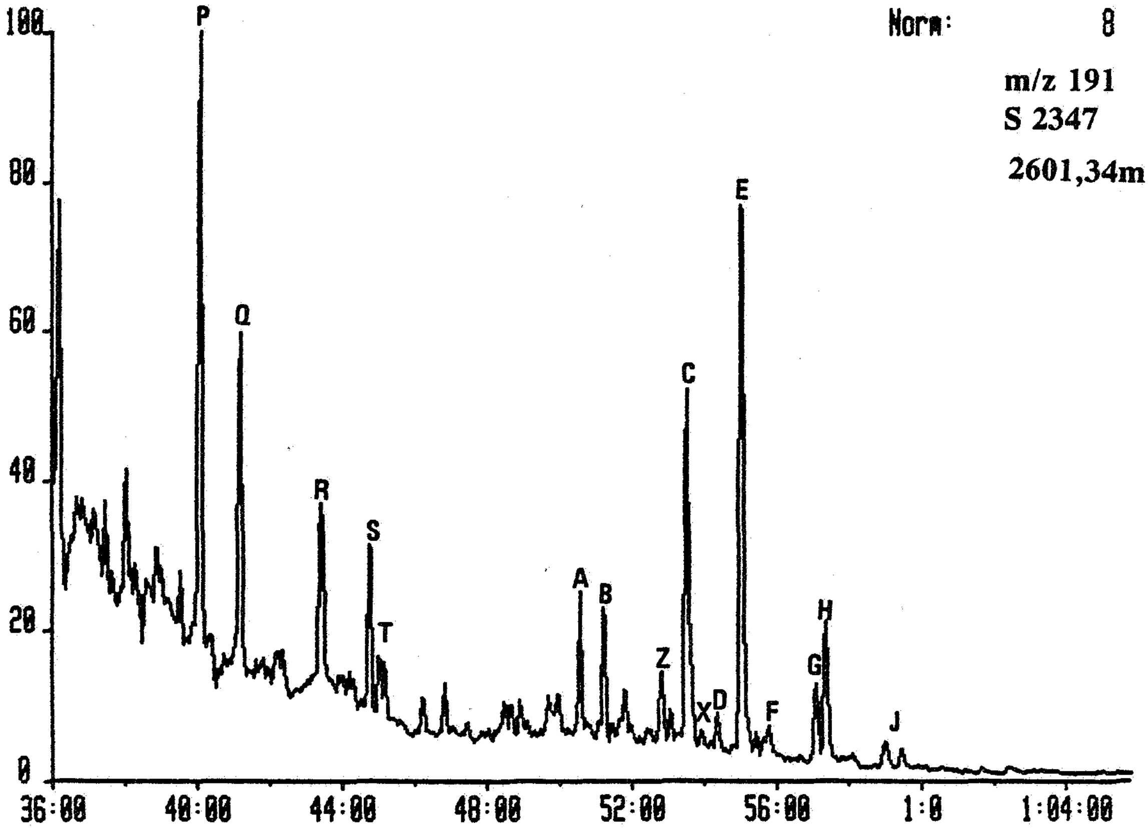


C6718SAT 6-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 205.1000
Text:

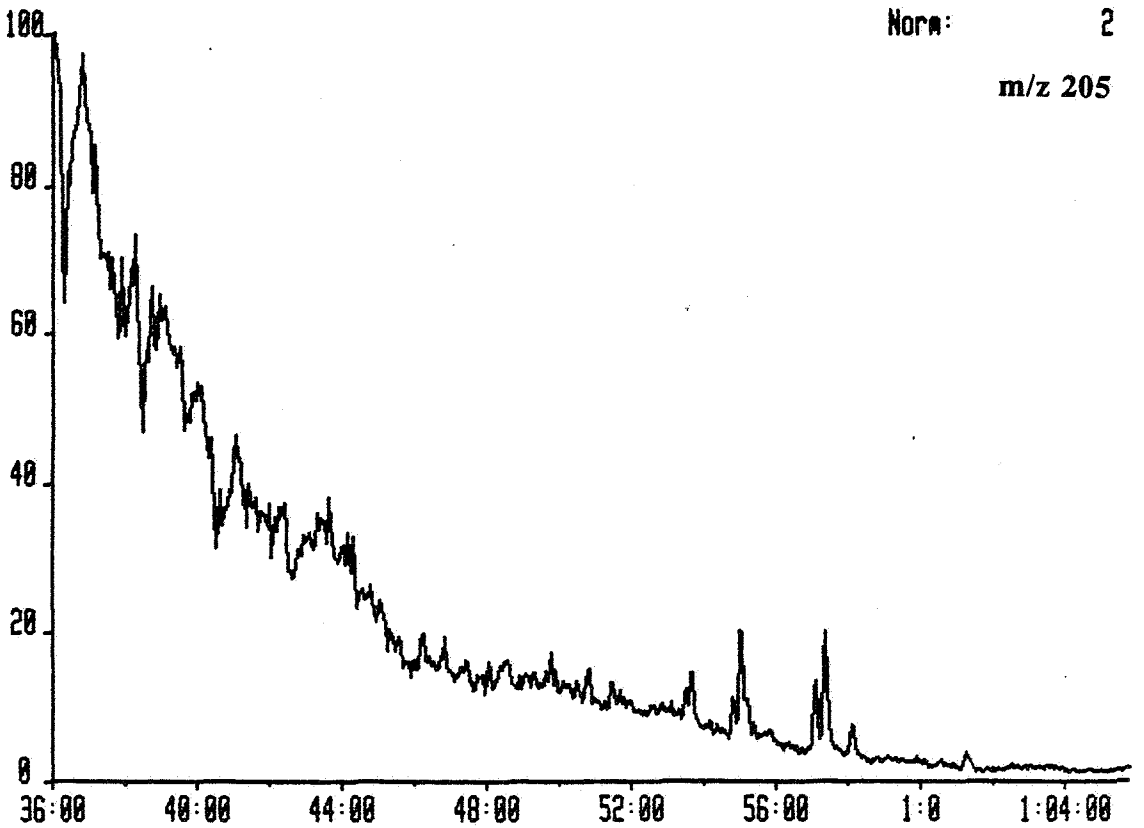


IKU
SINTEF-GRUPPEN

C6719SAT 7-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 191.1000
Text:

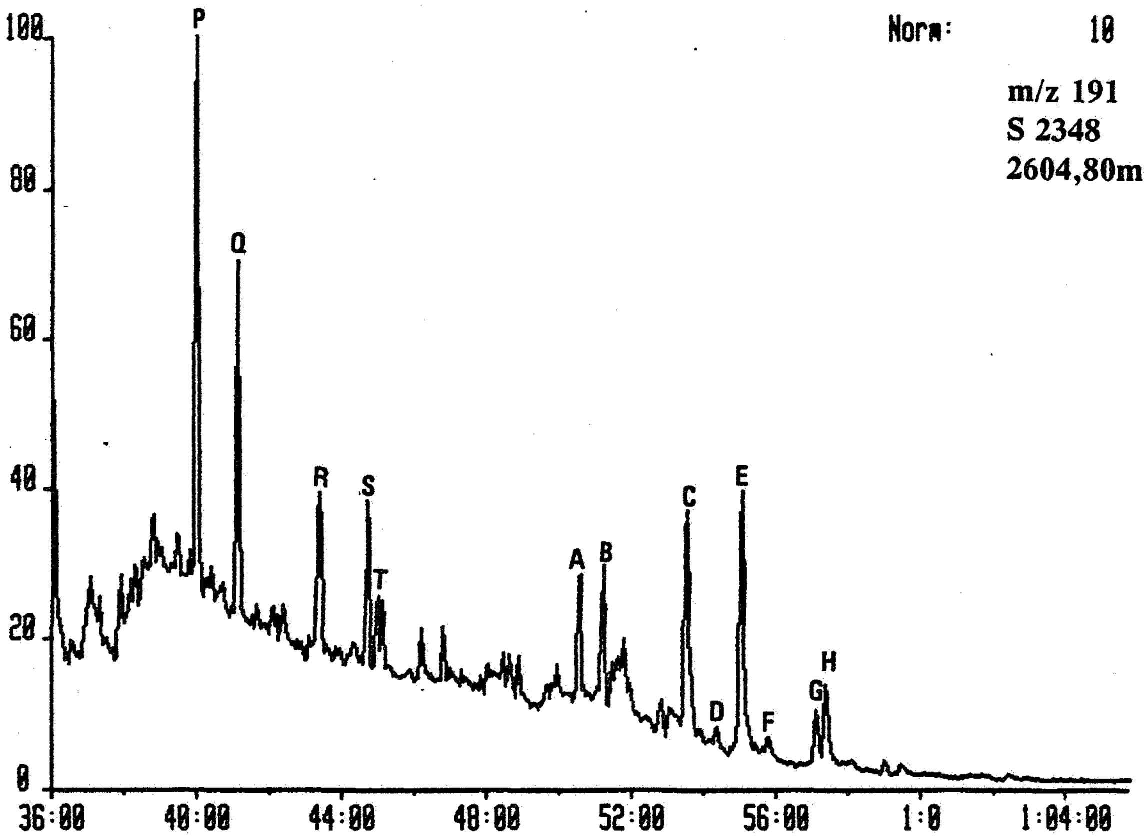


C6719SAT 7-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 205.1000
Text:

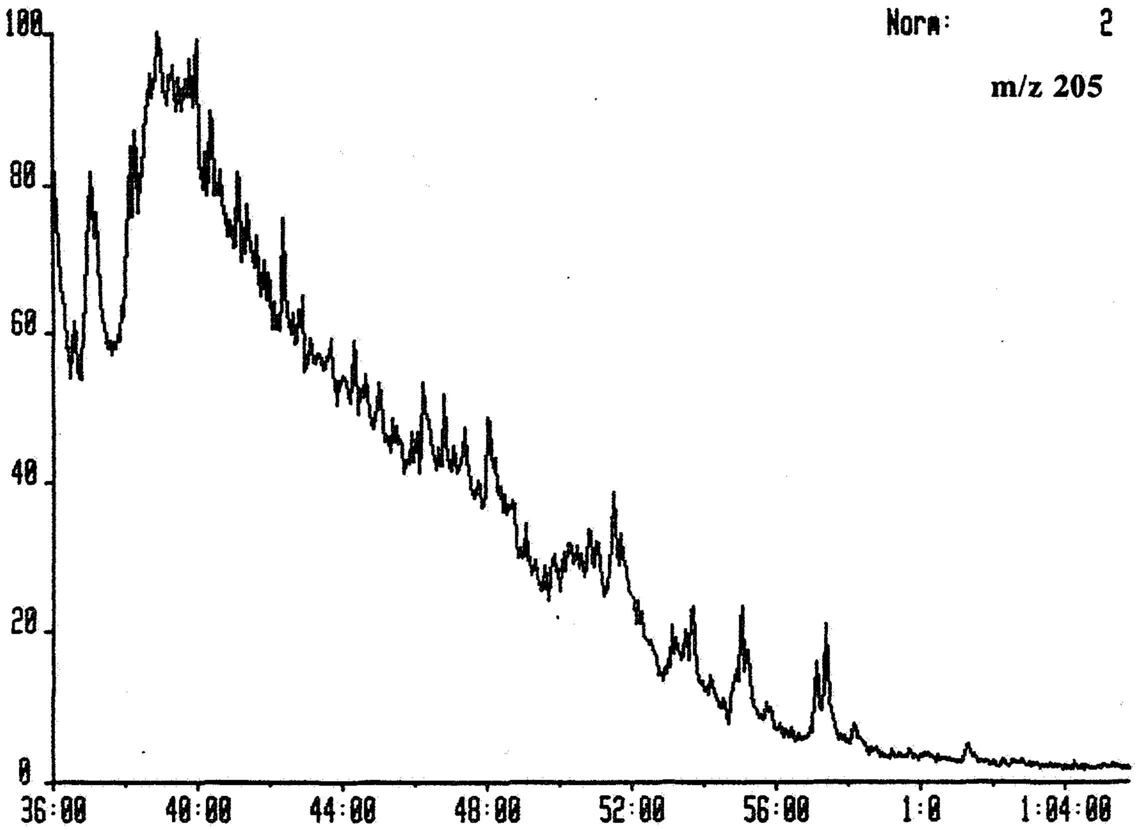


IKU
SINTEF-GRUPPEN

C6720SAT 7-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 191.1000
Text:

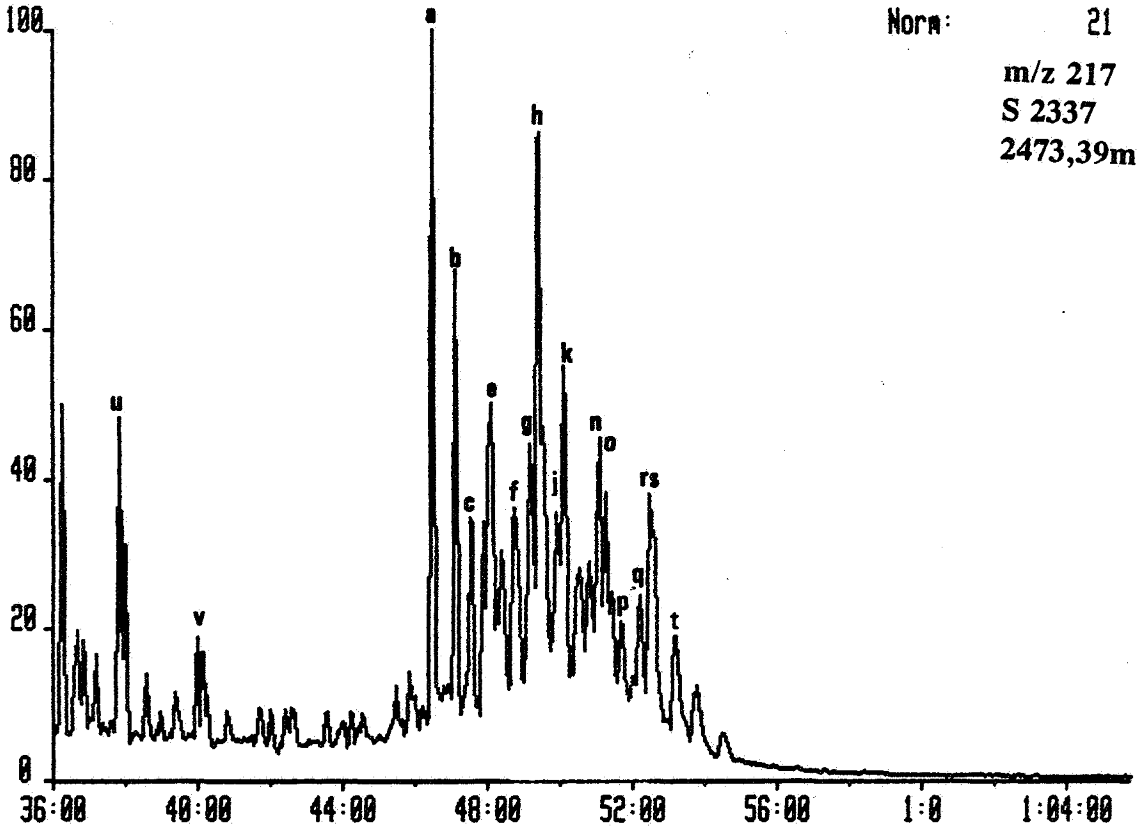


C6720SAT 7-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 205.1000
Text:

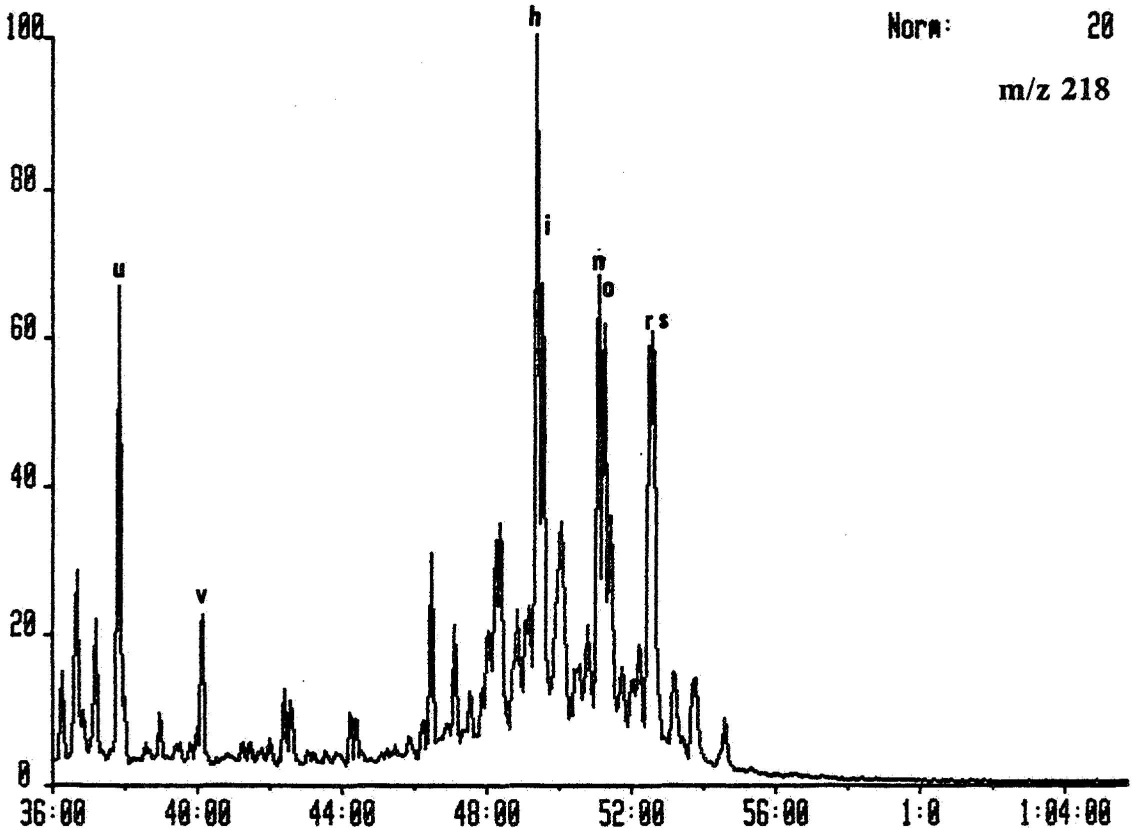


Sandstones

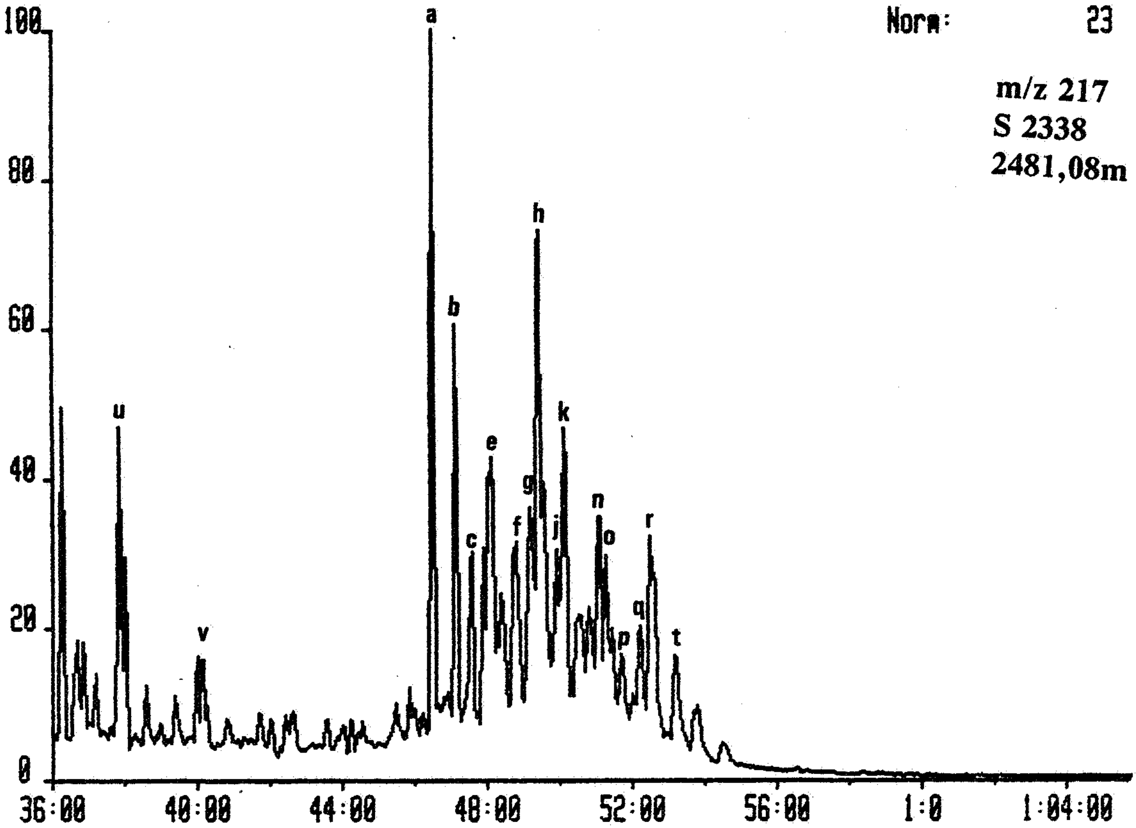
C6710SAT 2-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 217.1000
Text:



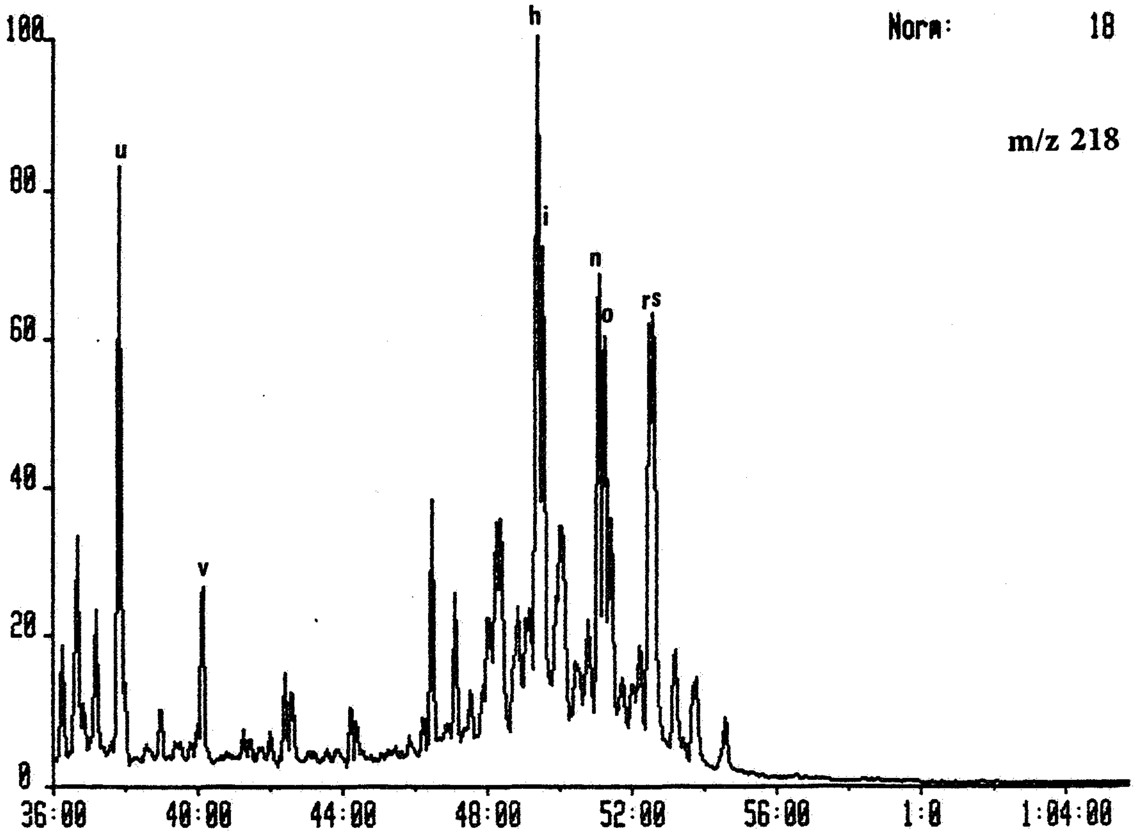
C6710SAT 2-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 218.1000
Text:



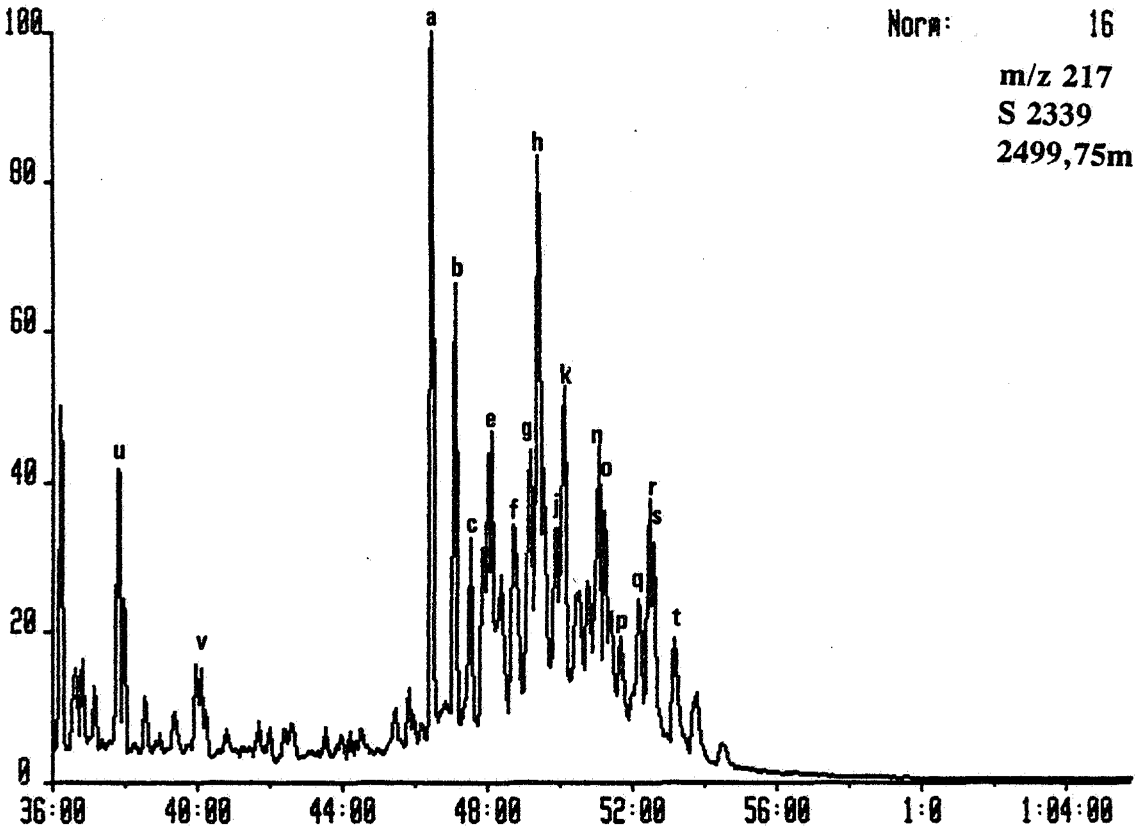
C6711SAT . 2-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 217.1000
Text:



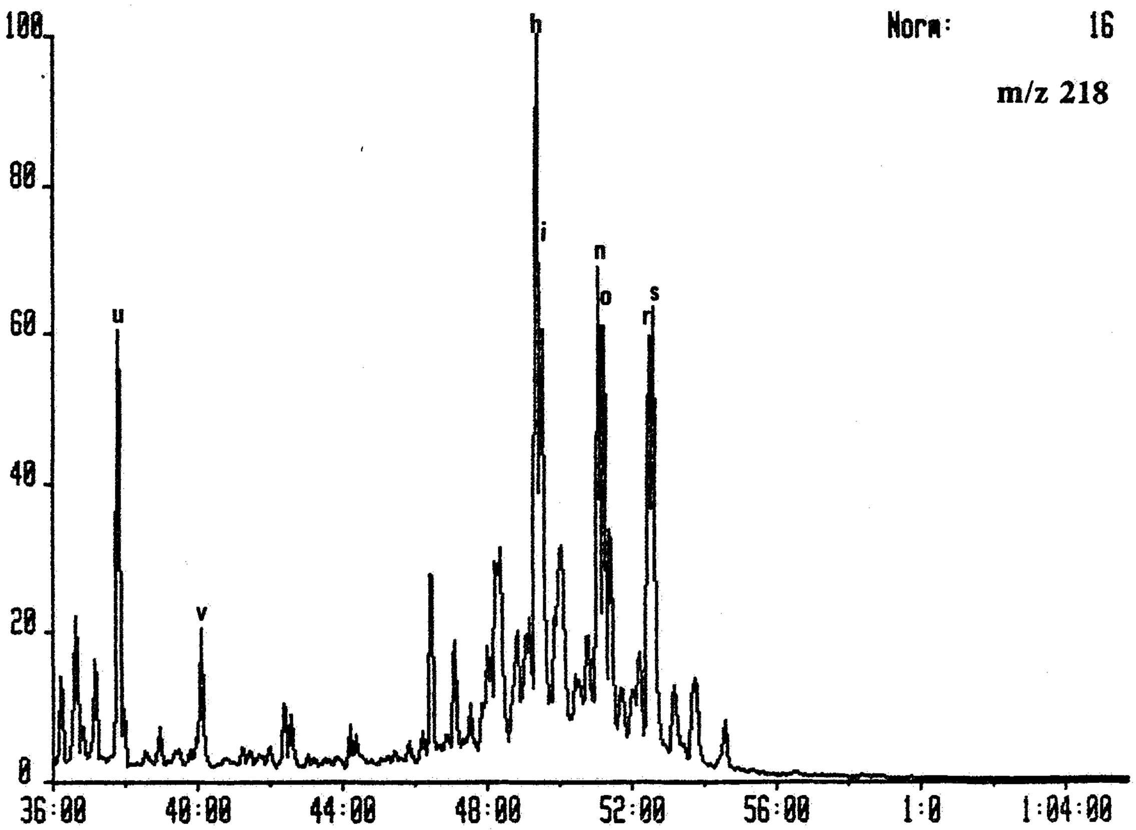
C6711SAT 2-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 218.1000
Text:



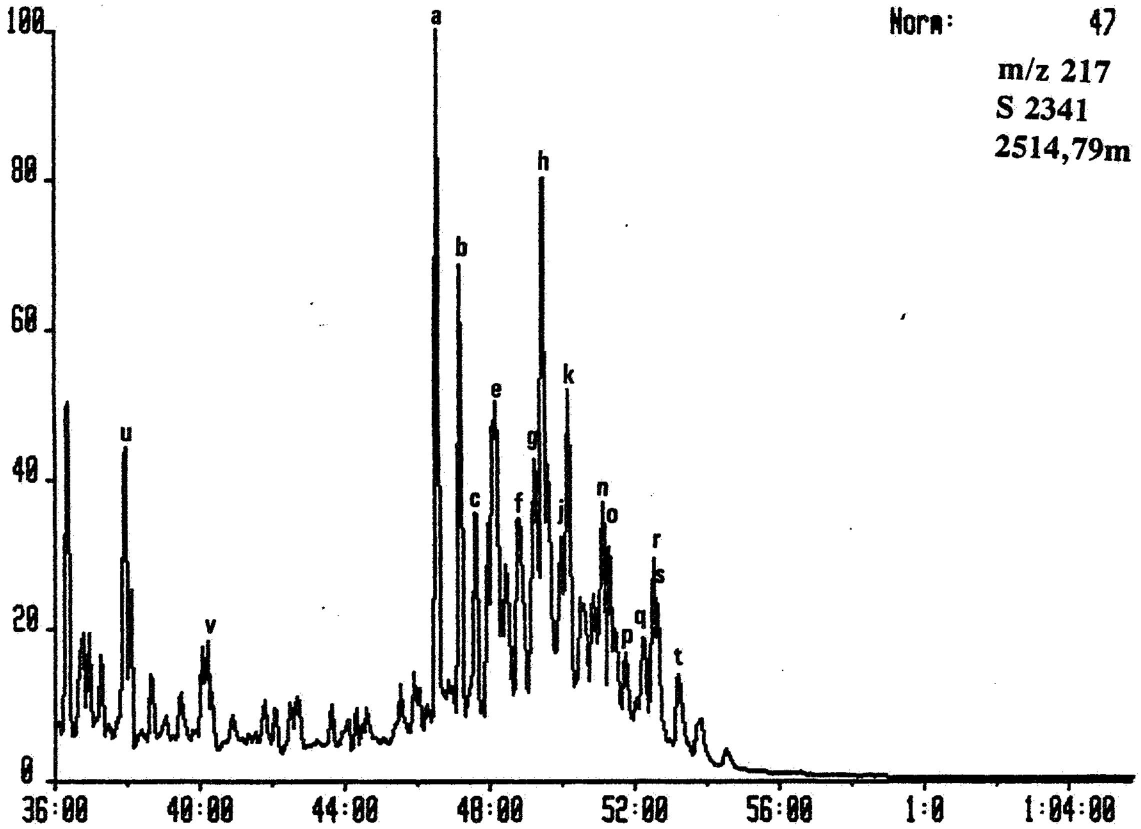
C6712SAT 2-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 217.1000
Text:



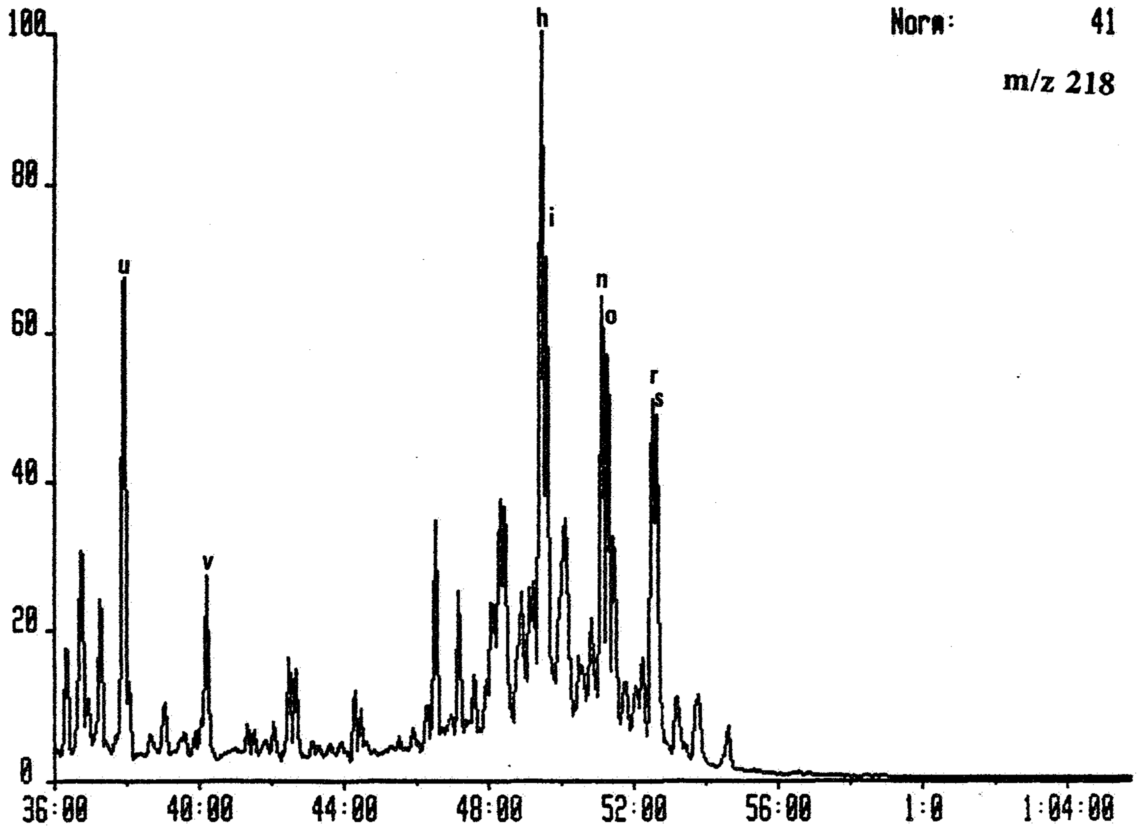
C6712SAT 2-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 218.1000
Text:



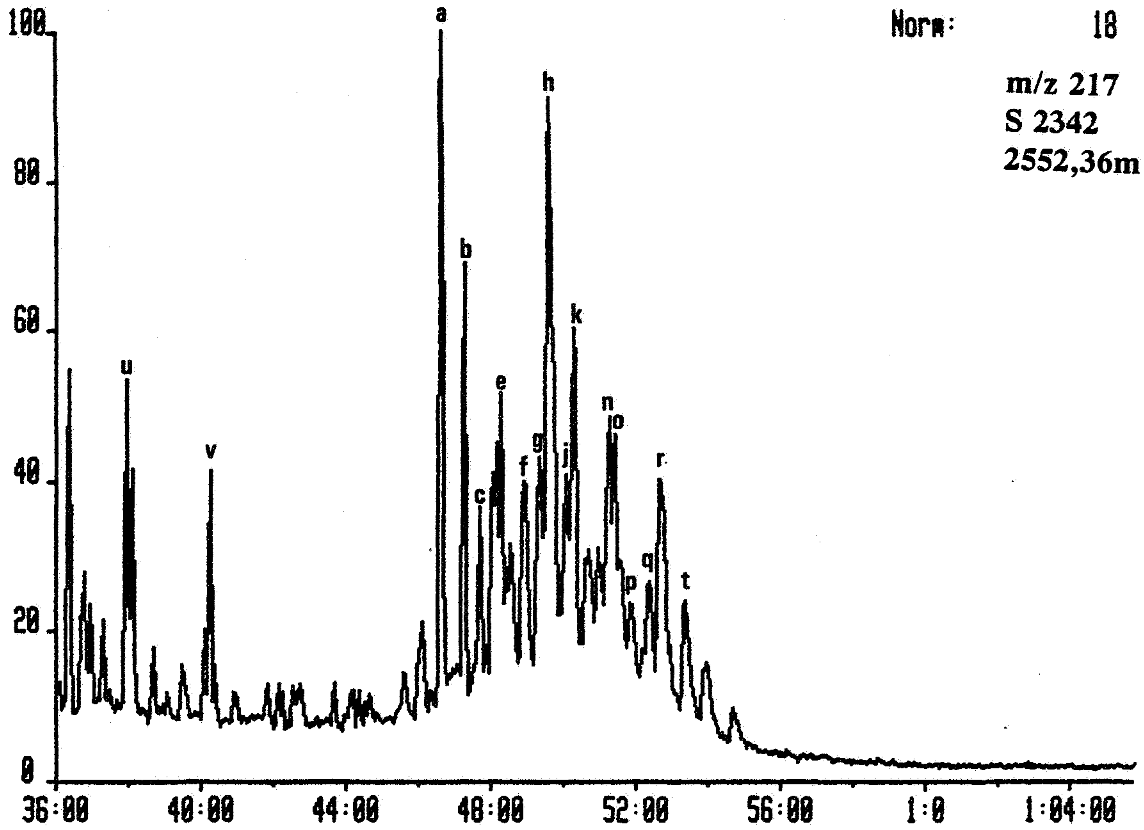
C6713SAT 2-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 217.1000
Text:



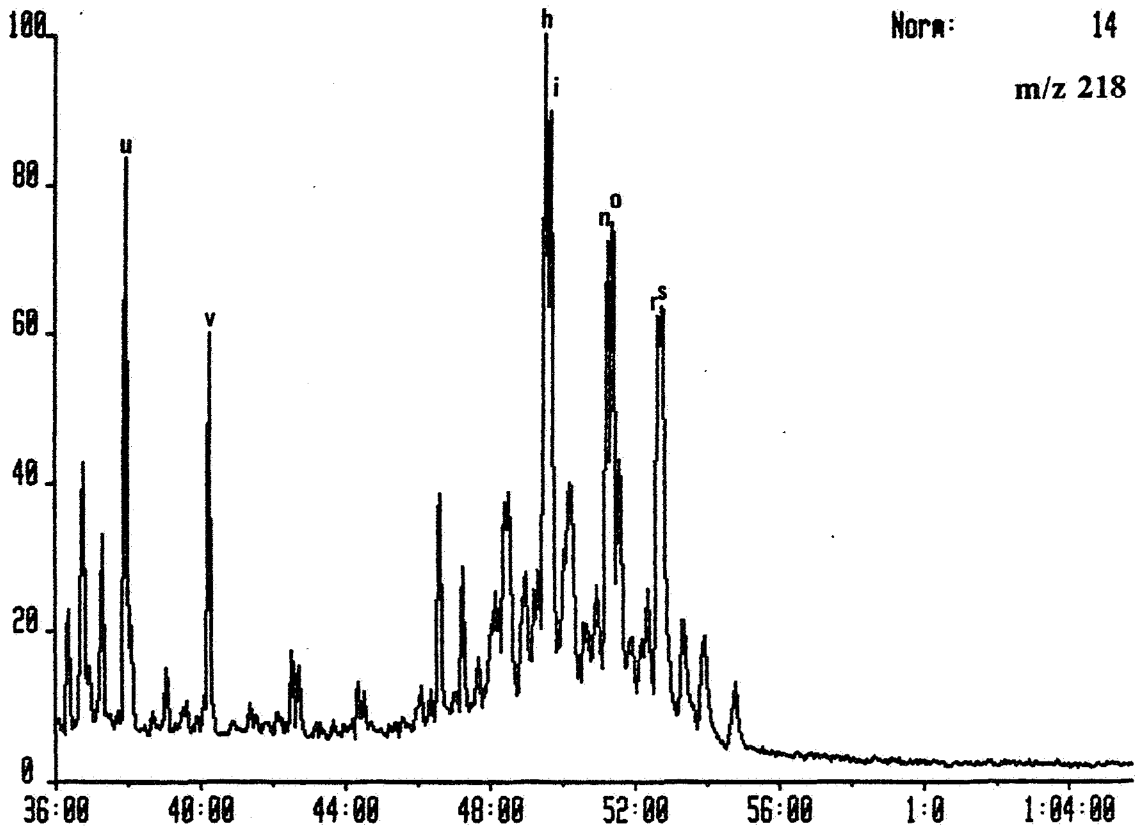
C6713SAT 2-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 218.1000
Text:



C6714SAT 5-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 217.1000
Text:

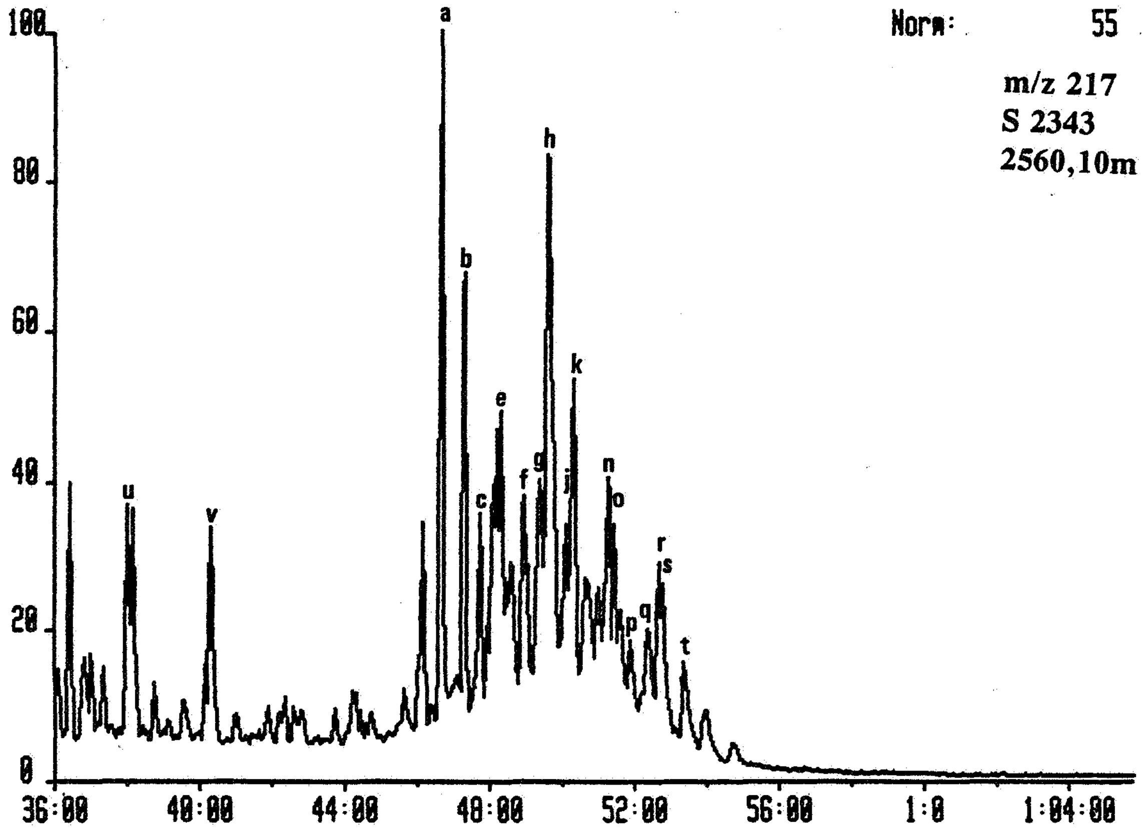


C6714SAT 5-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 218.1000
Text:

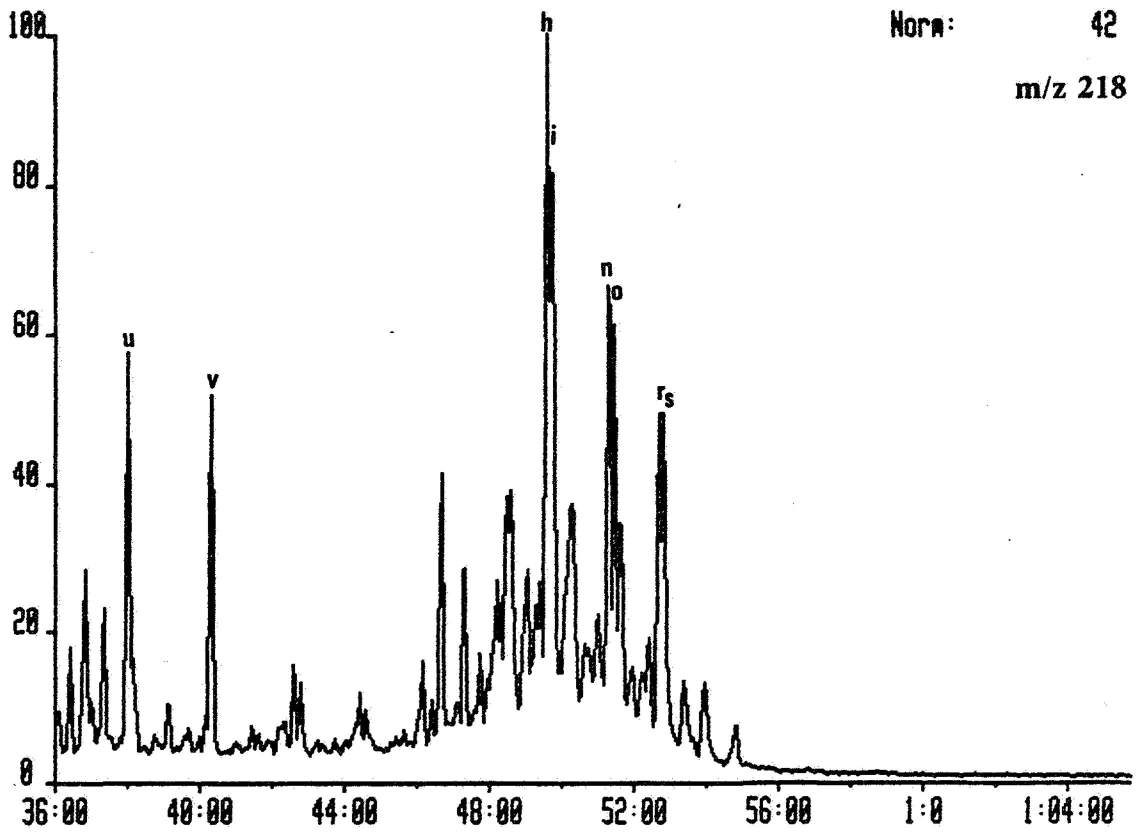


IKU SINTEF-GRUPPEN

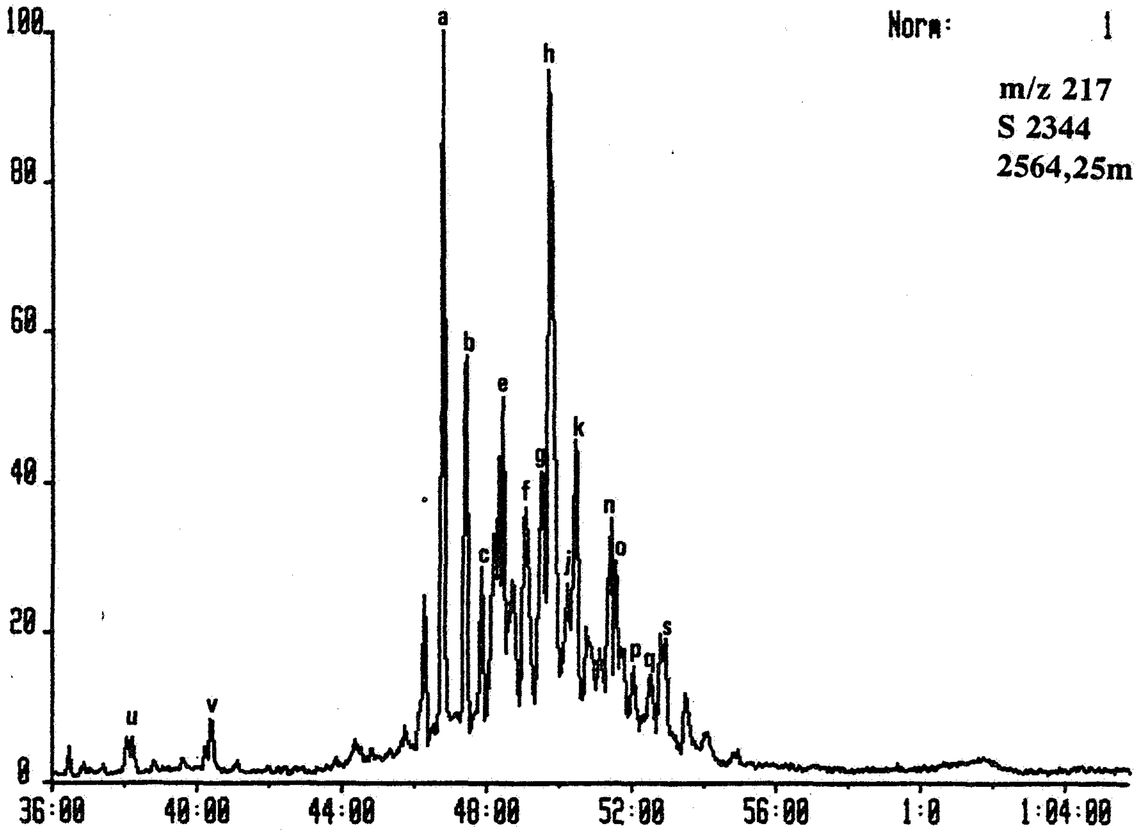
C6715SAT 5-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 217.1000
Text:



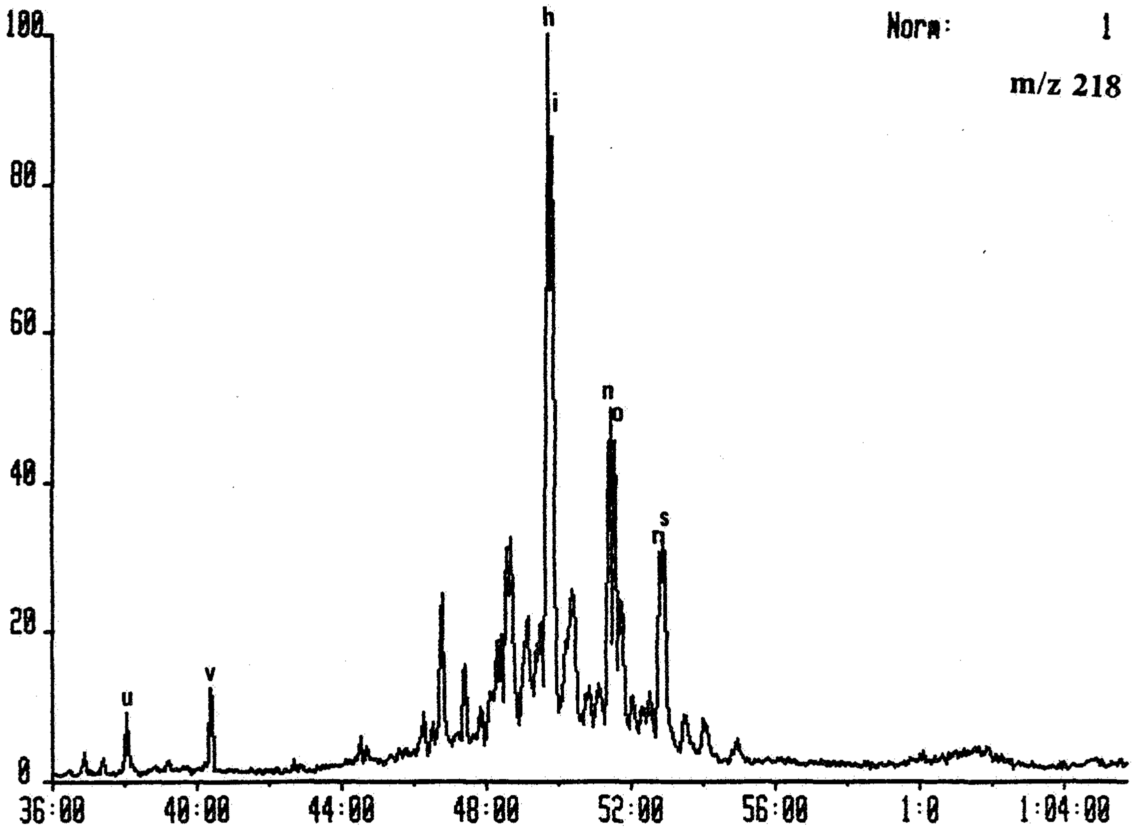
C6715SAT 5-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 218.1000
Text:



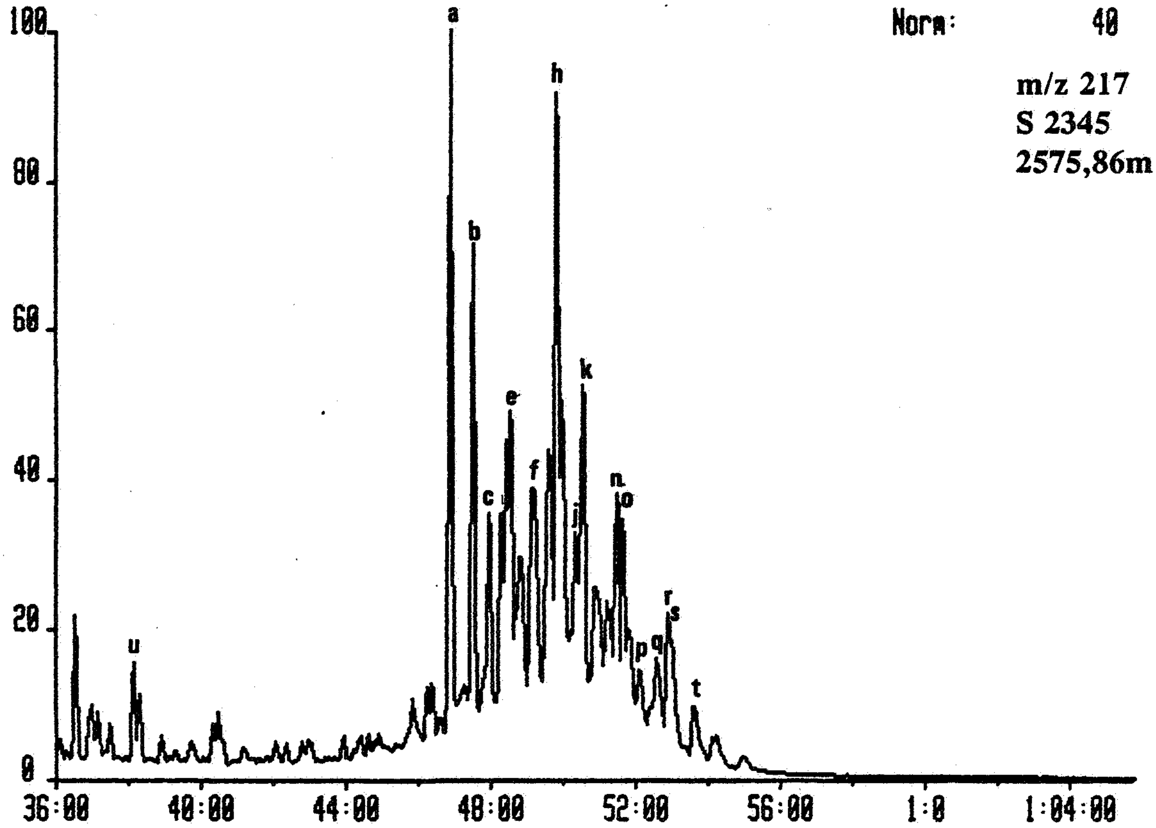
C6716SAT 6-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 217.1000
Text:



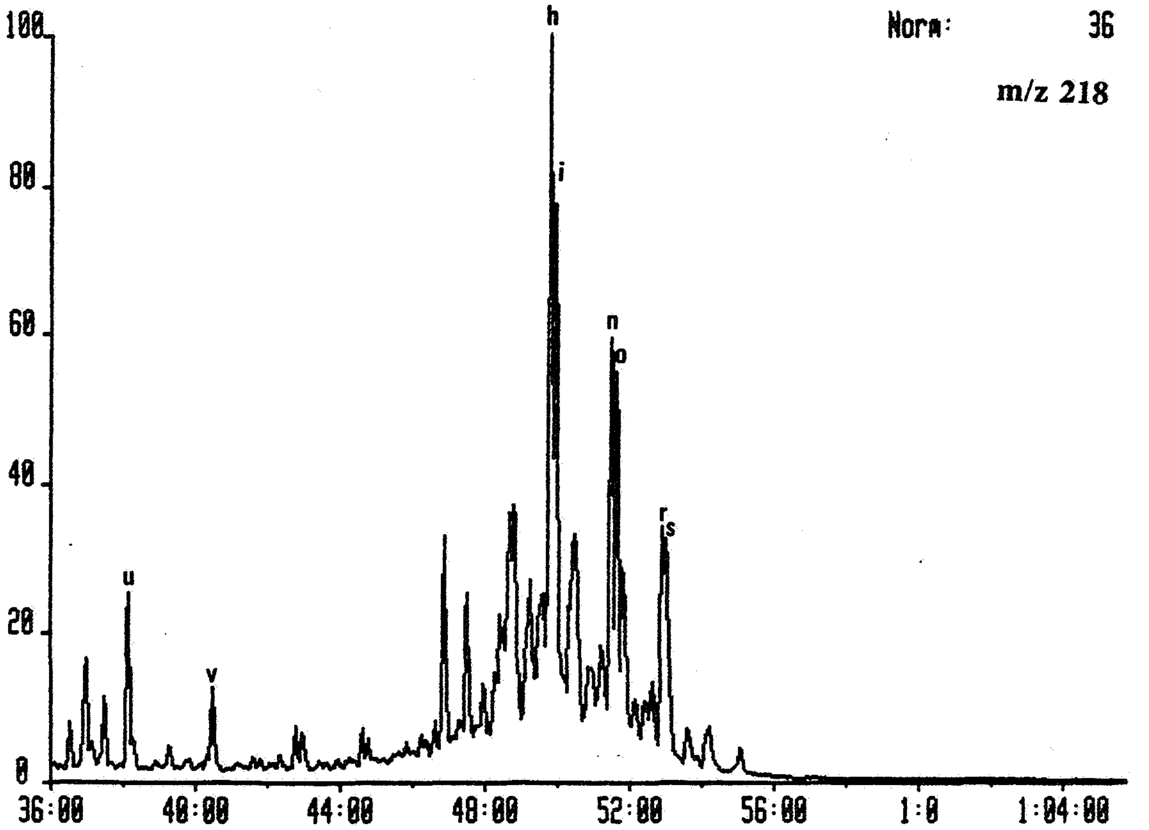
C6716SAT 6-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 218.1000
Text:



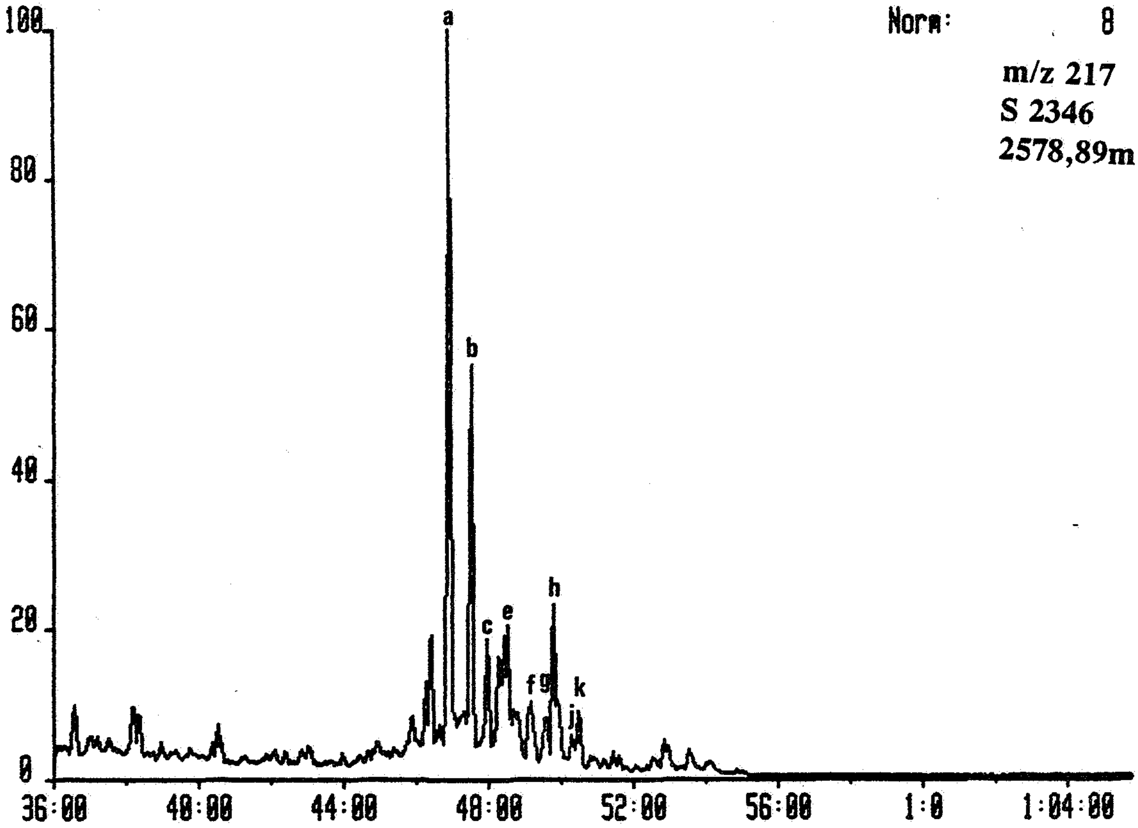
C6717SAT 7-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 217.1000
Text:



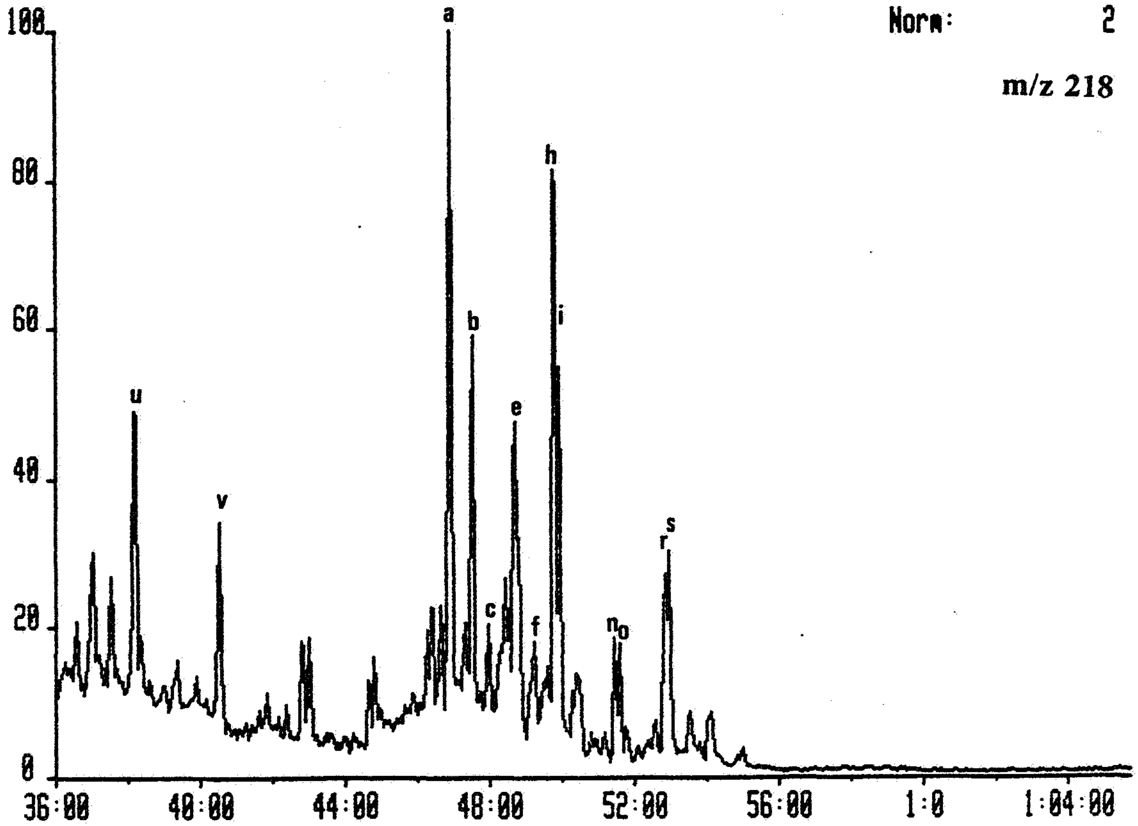
C6717SAT 7-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 218.1000
Text:



C6718SAT 6-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 217.1000
Text:

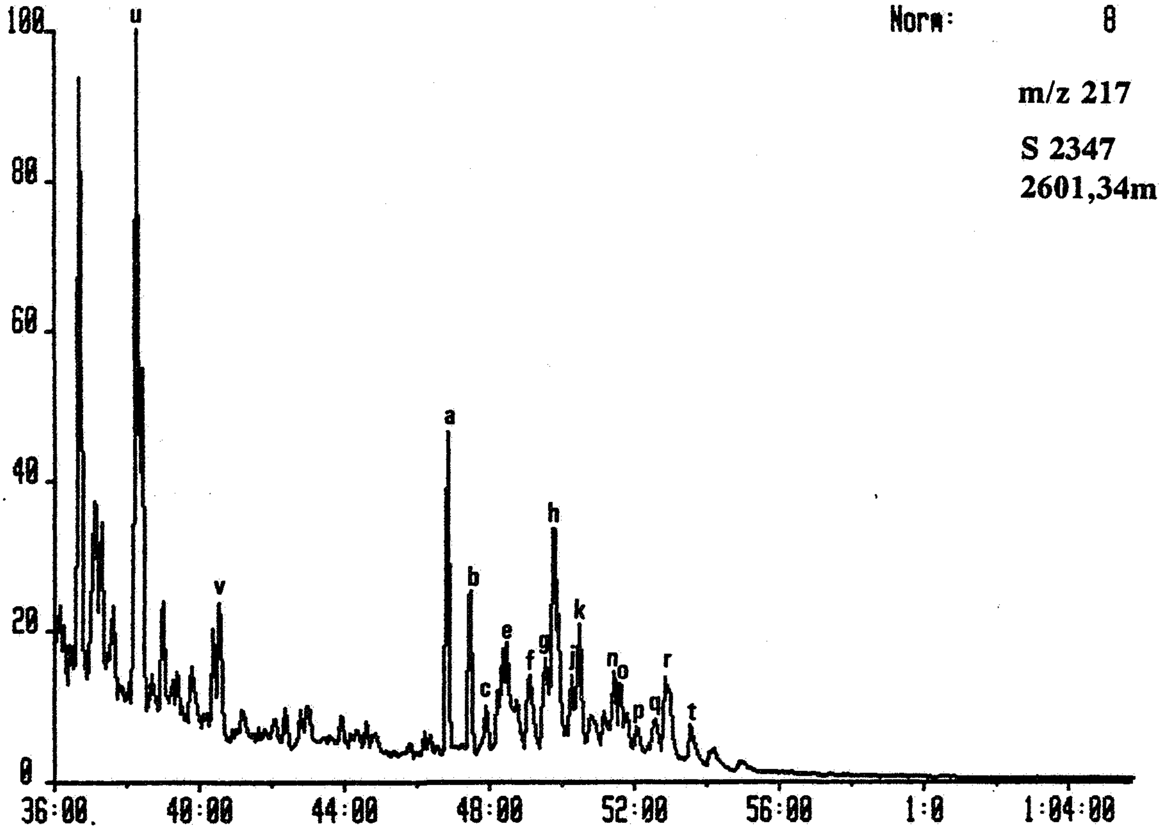


C6718SAT 6-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 218.1000
Text:

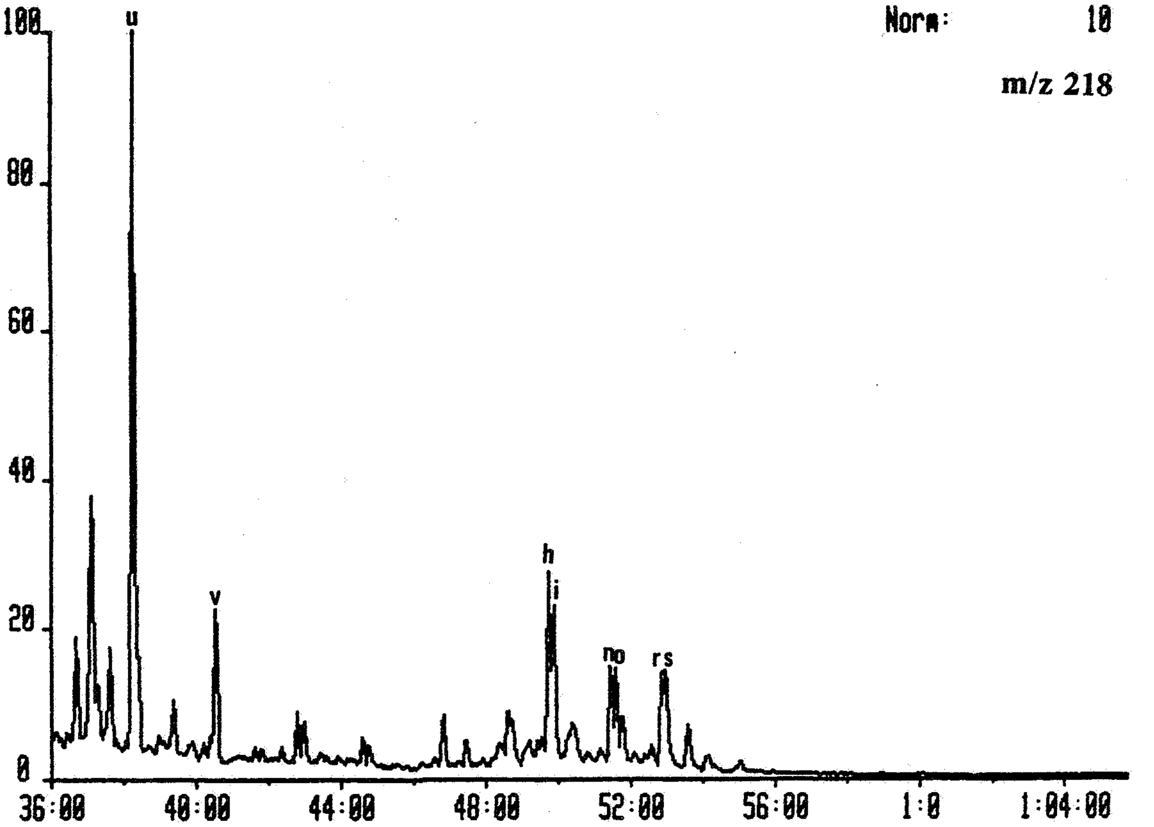


IKU SINTEF-GRUPPEN

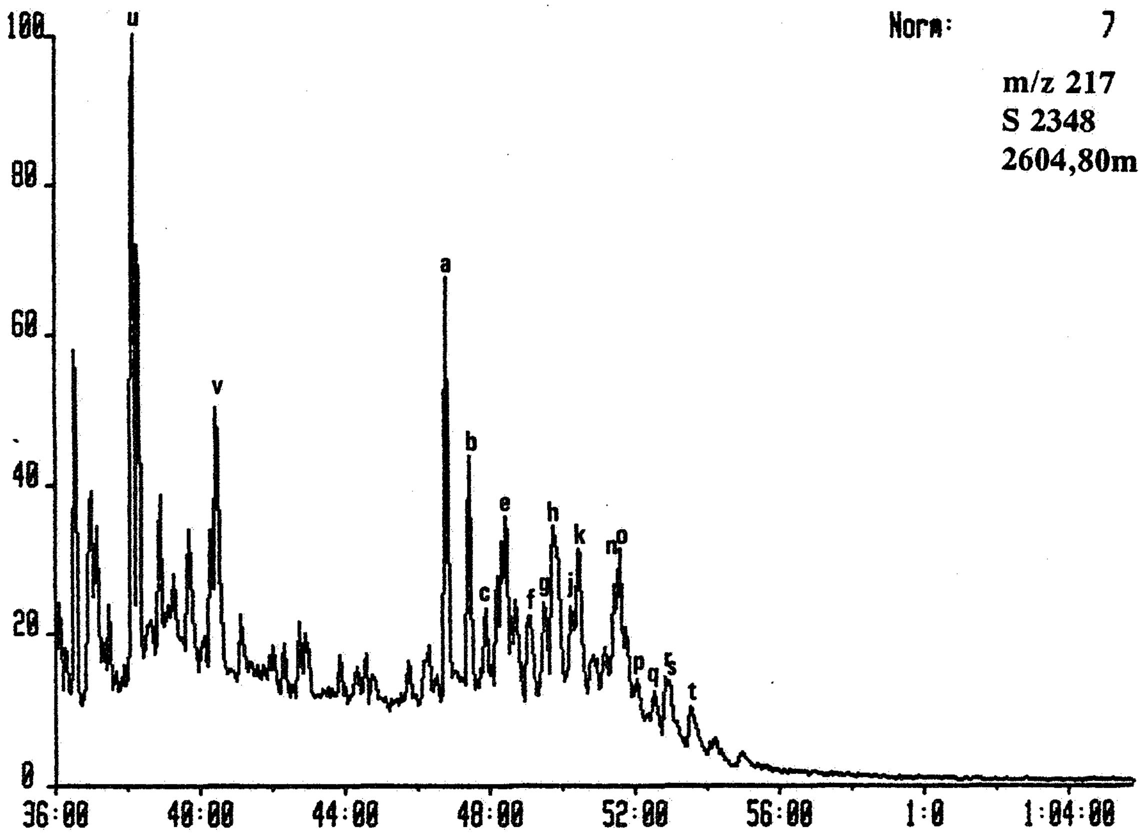
C6719SAT 7-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 217.1000
Text:



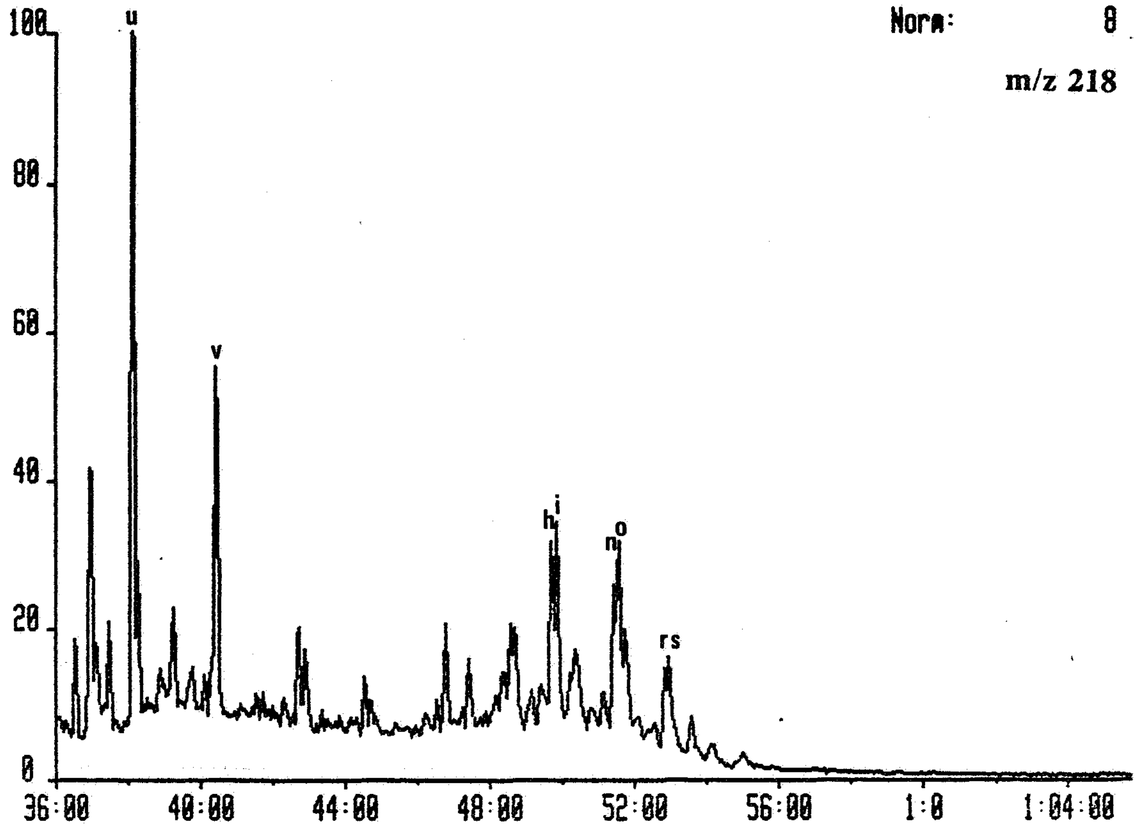
C6719SAT 7-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 218.1000
Text:



C6720SAT 7-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 217.1000
Text:

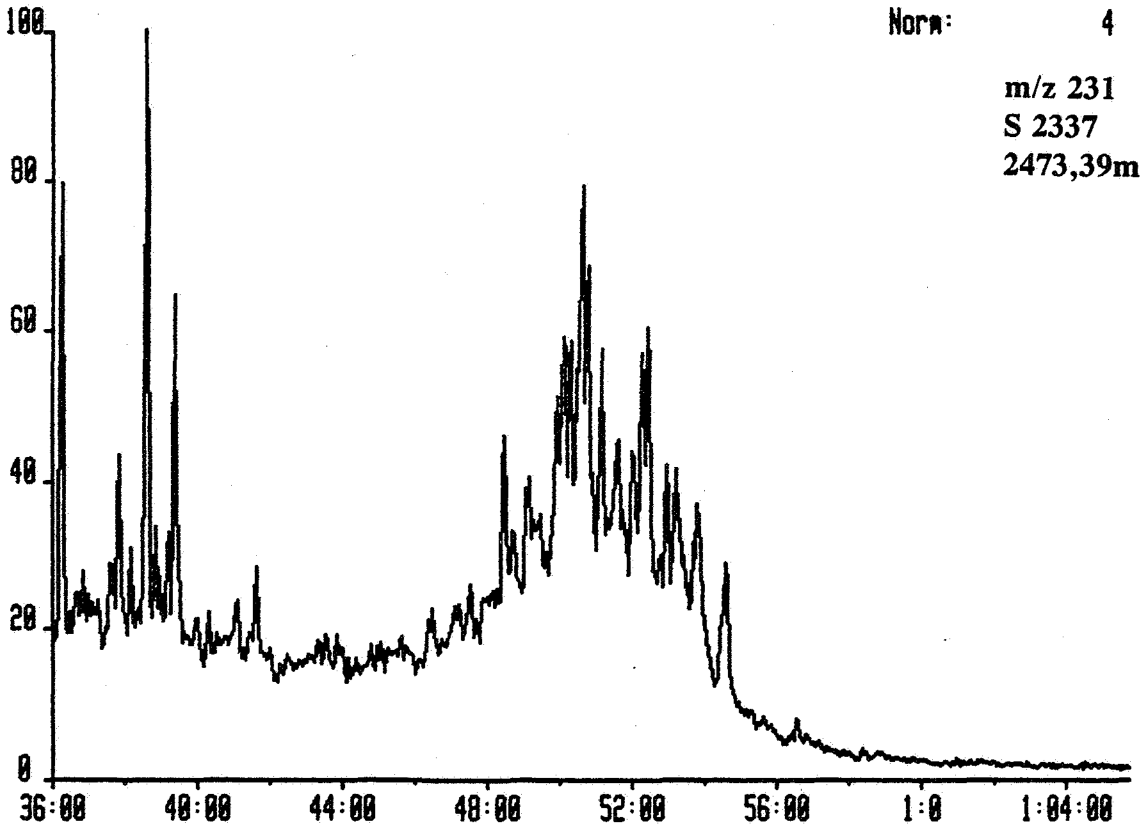


C6720SAT 7-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 218.1000
Text:

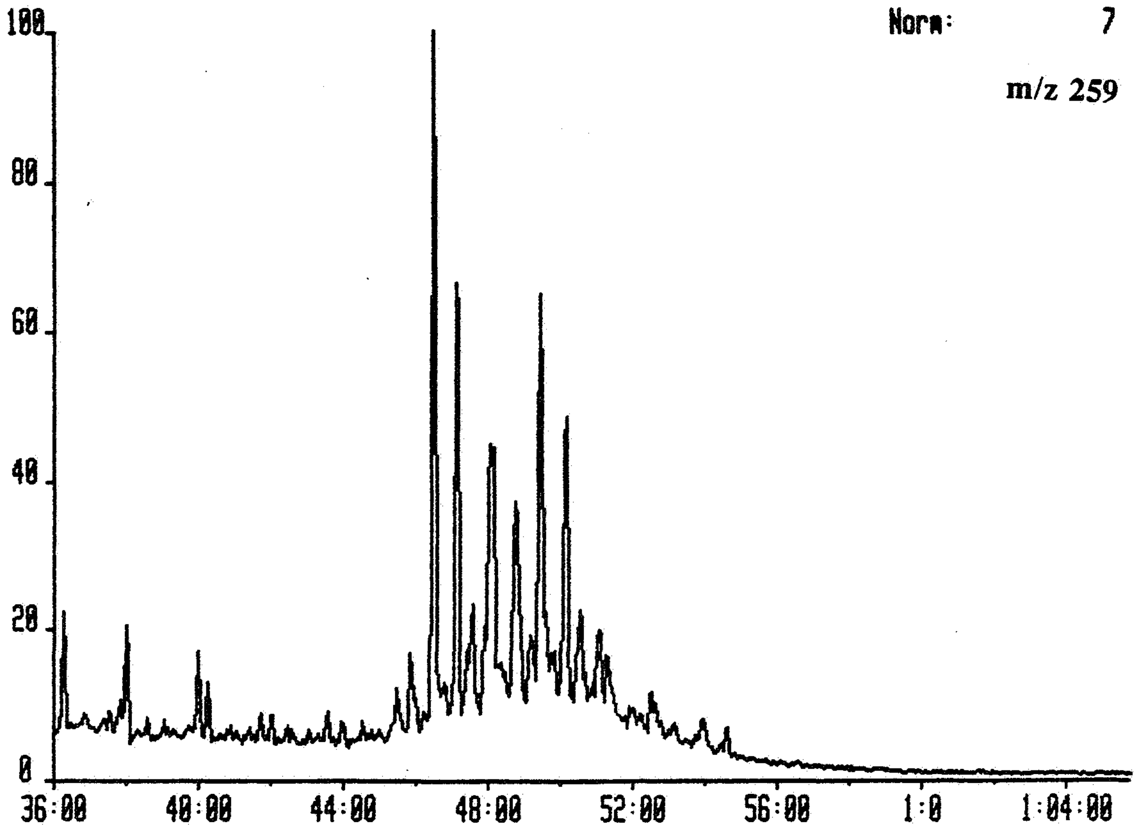


Sandstones

C6710SAT 2-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 231.1000
Text:

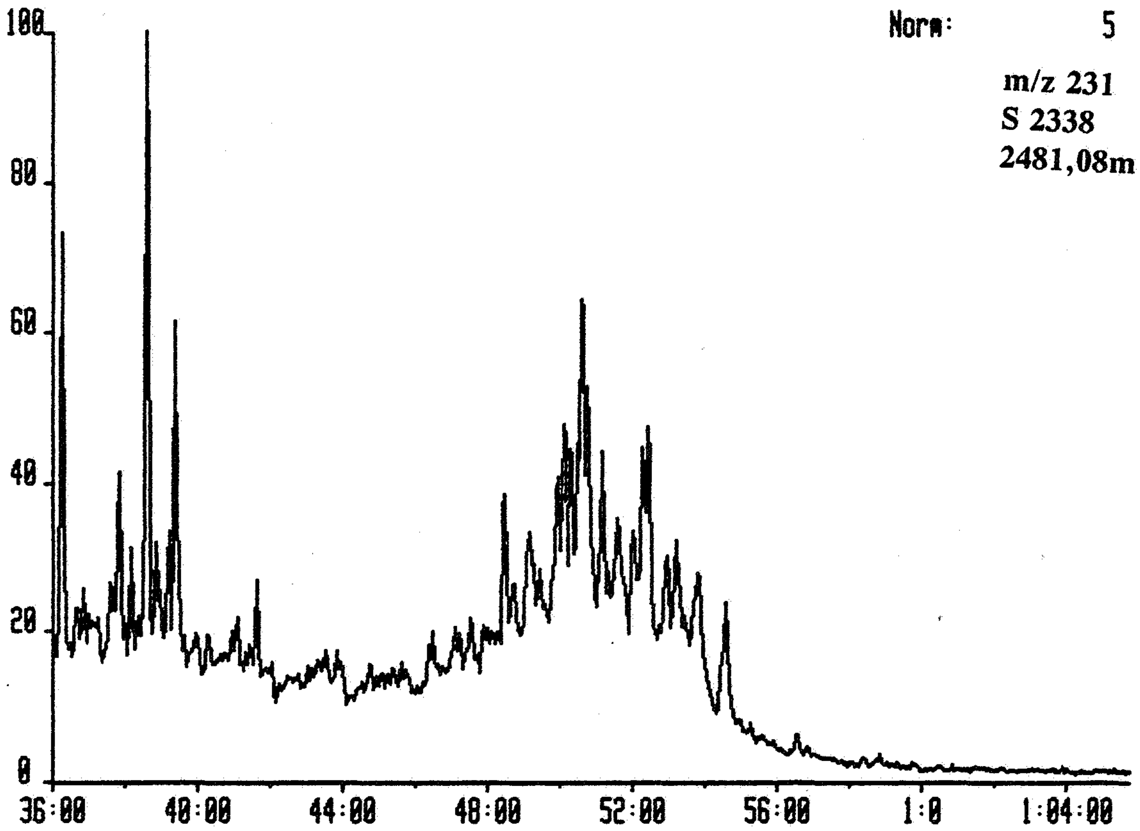


C6710SAT 2-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 259.1000
Text:

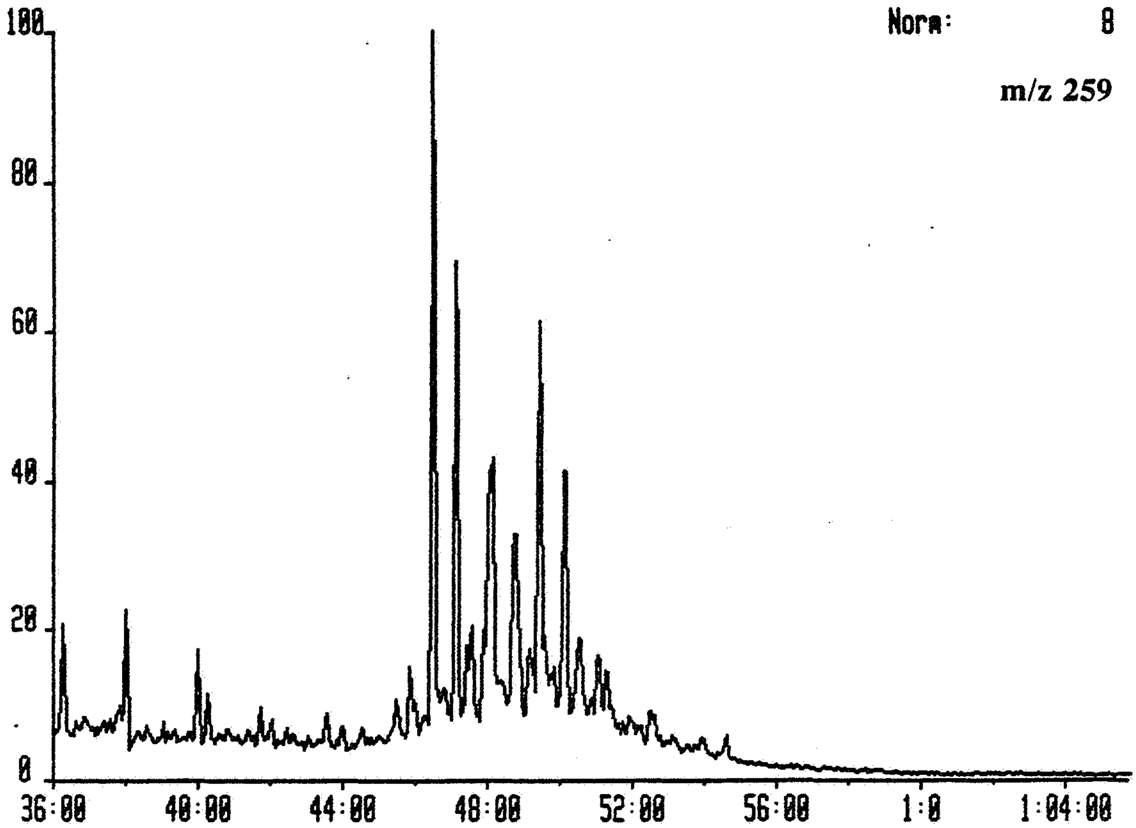


IKU SINTEF-GRUPPEN

C6711SAT 2-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 231.1000
Text:

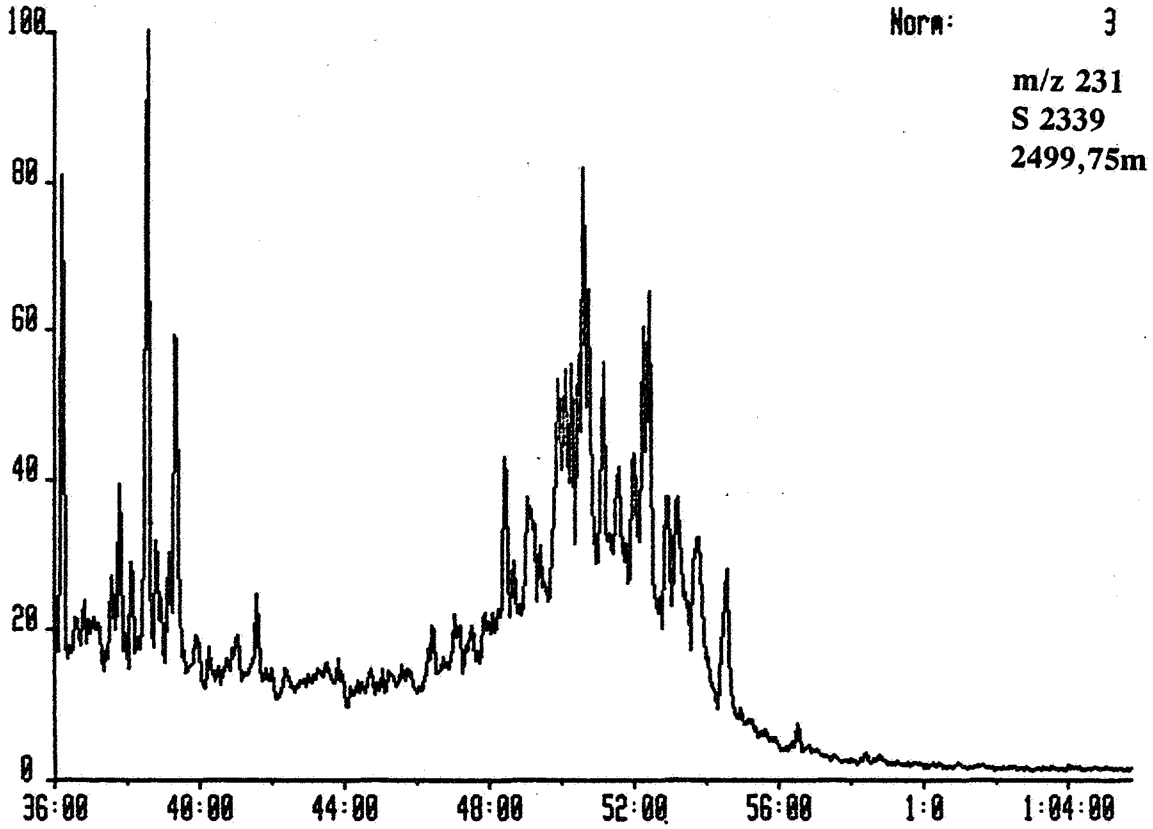


C6711SAT 2-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 259.1000
Text:

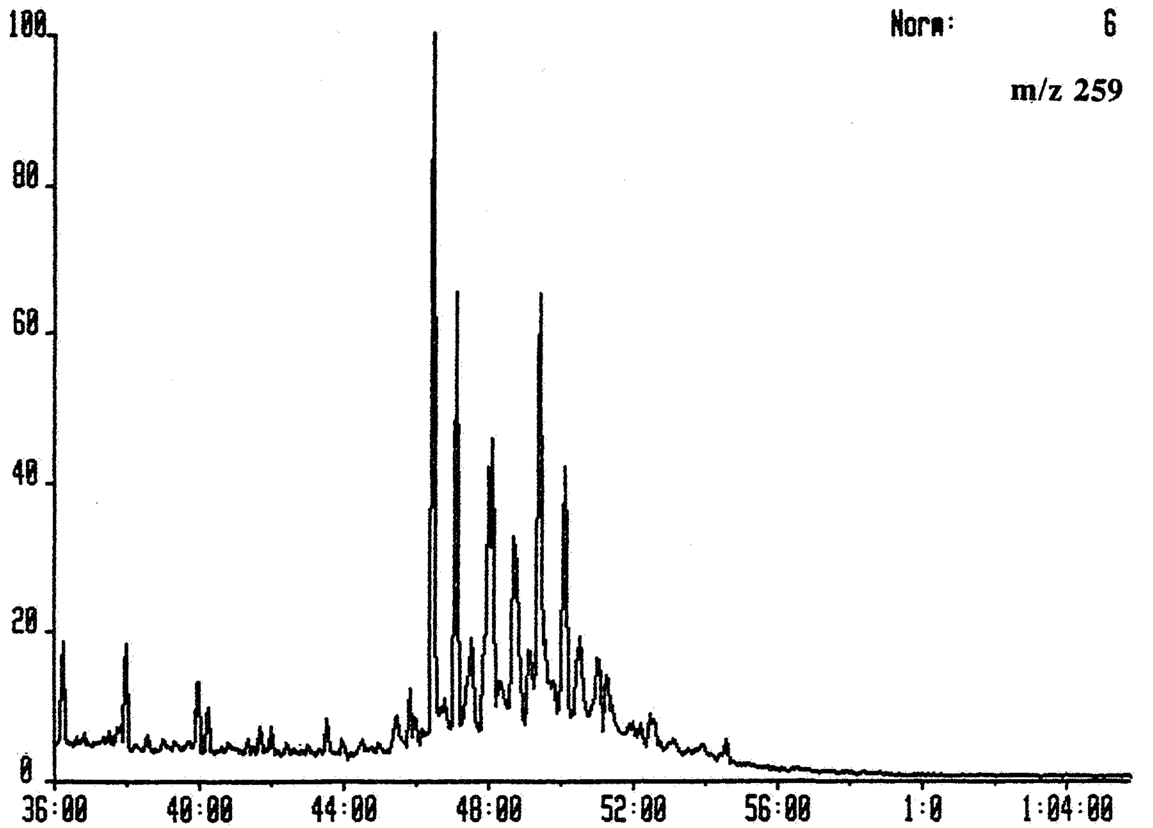


IKU SINTEF-GRUPPEN

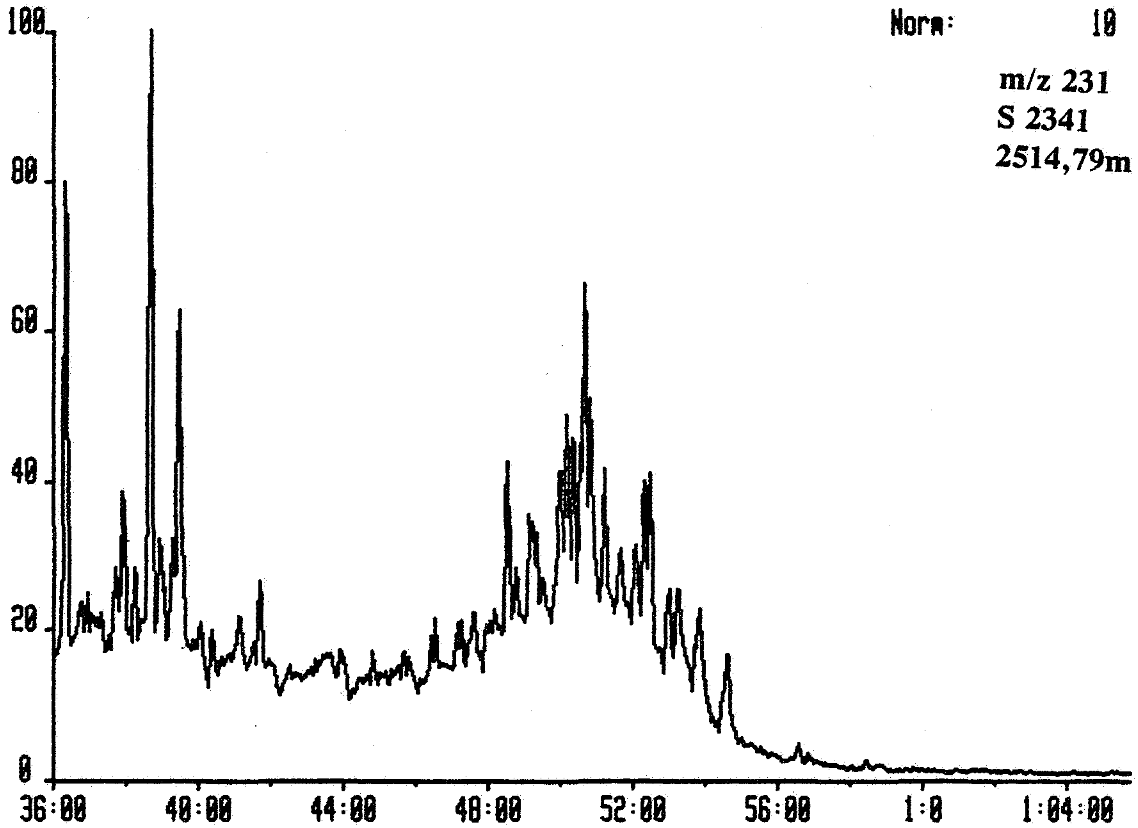
C6712SAT 2-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 231.1000
Text:



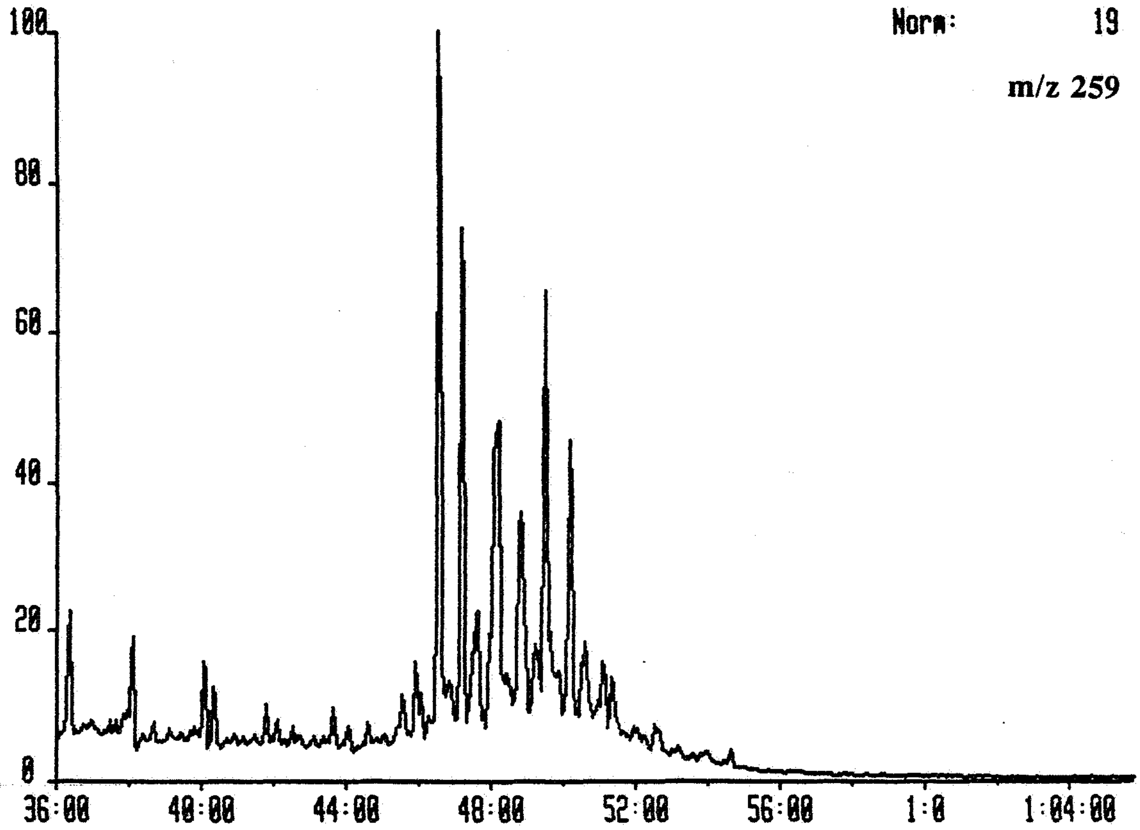
C6712SAT 2-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 259.1000
Text:



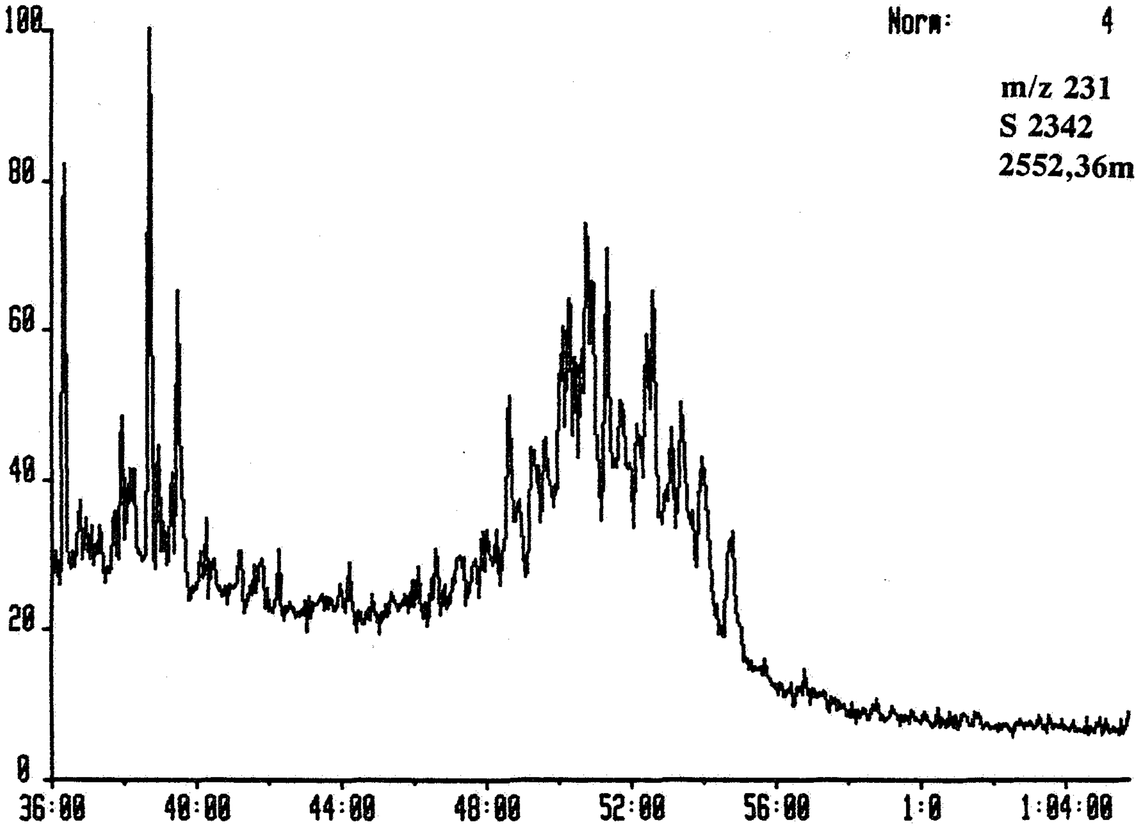
C6713SAT 2-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 231.1000
Text:



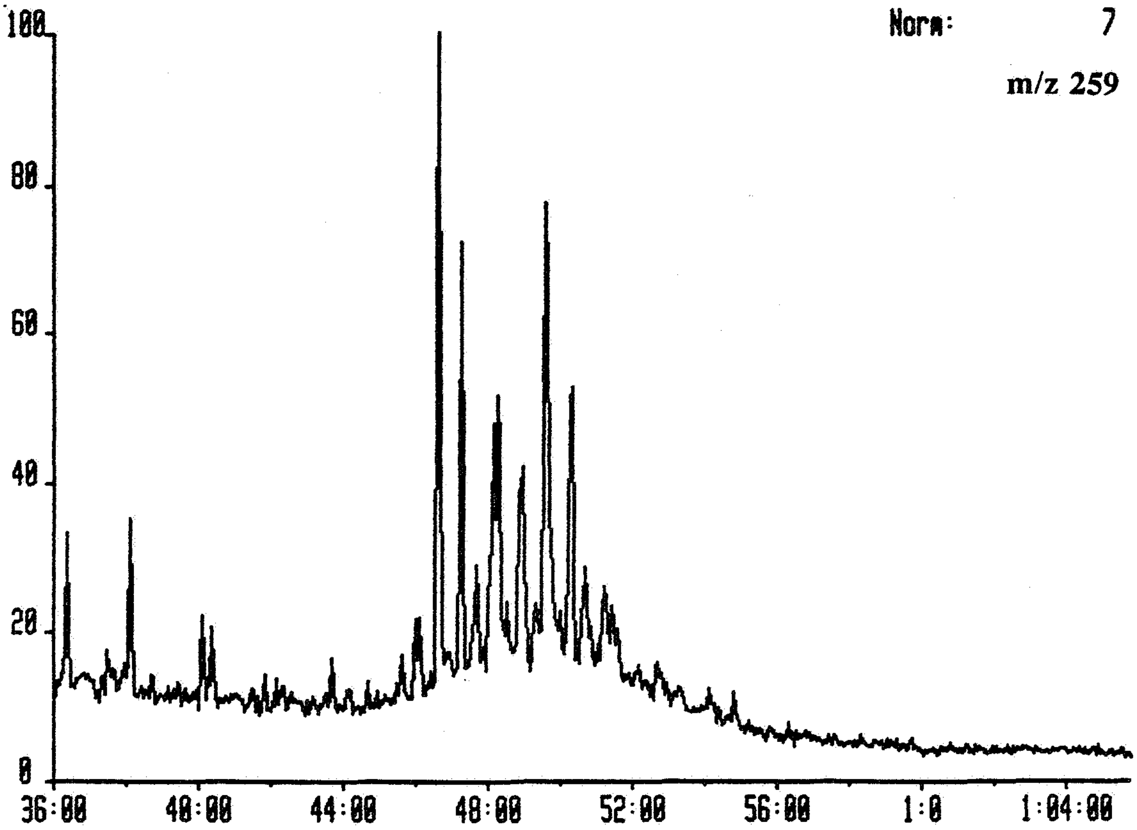
C6713SAT 2-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 259.1000
Text:



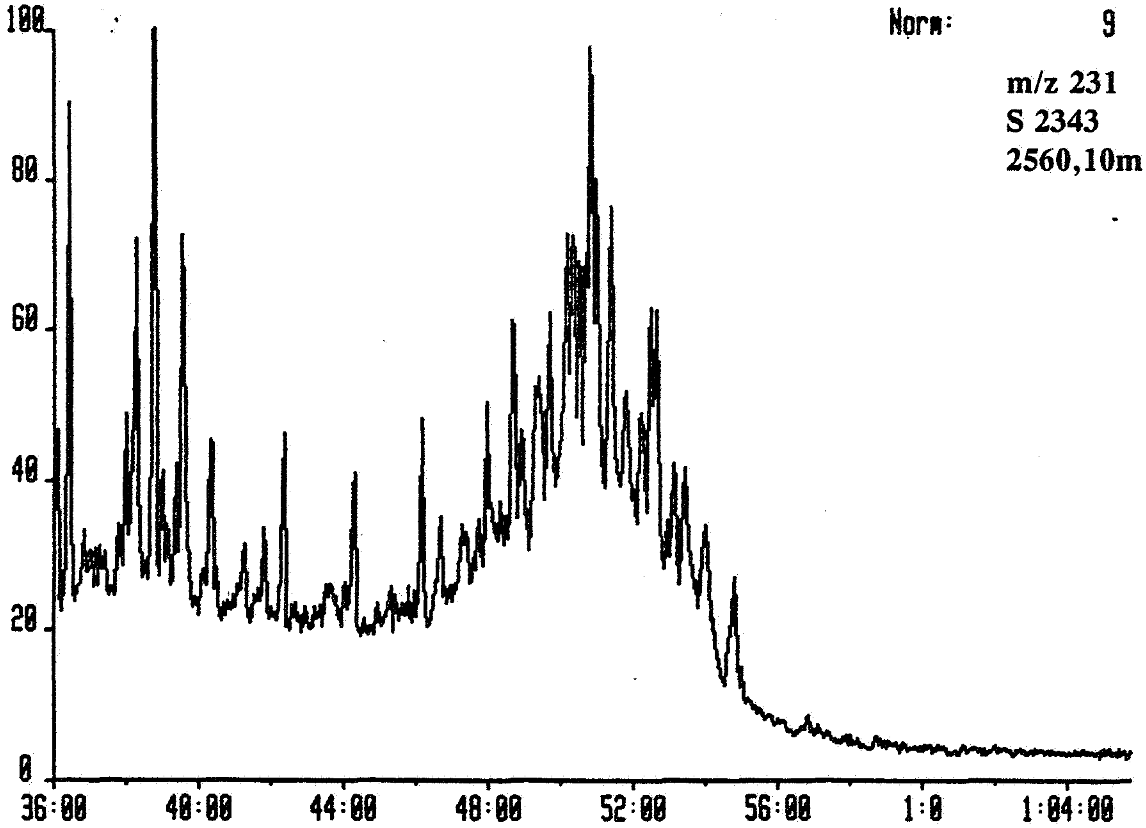
C6714SAT 5-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 231.1000
Text:



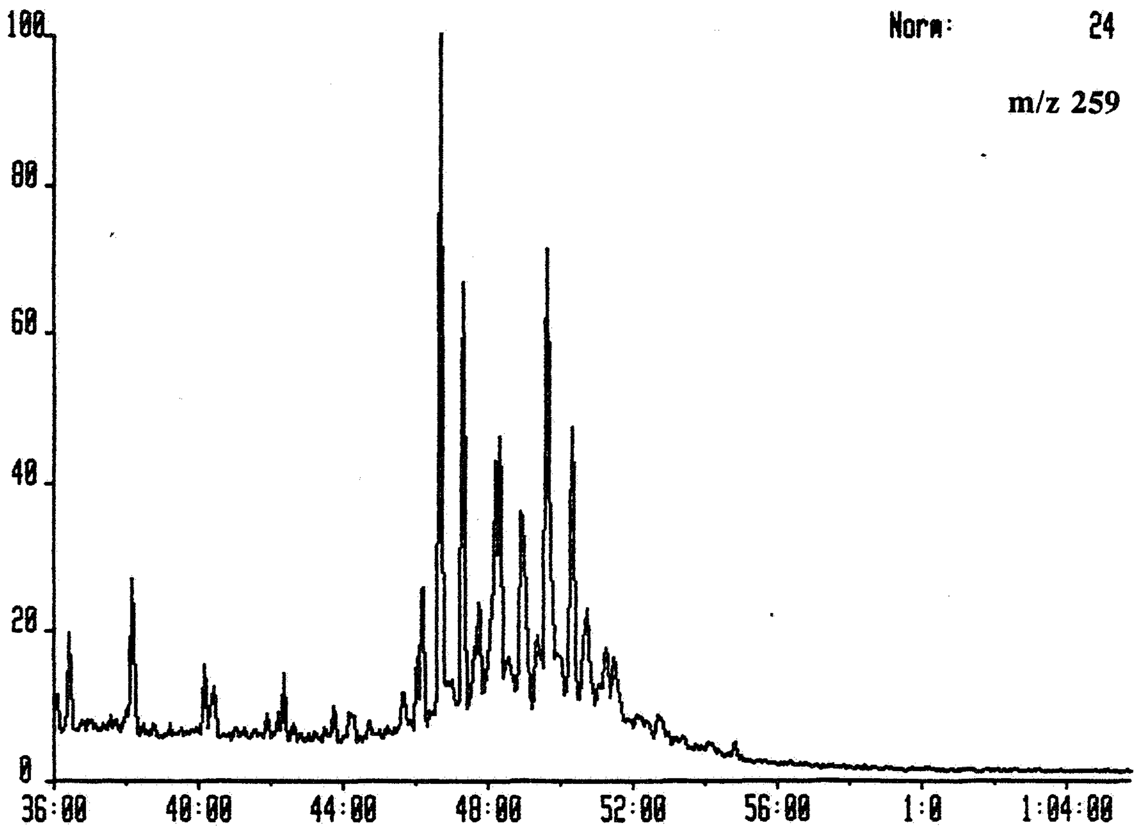
C6714SAT 5-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 259.1000
Text:



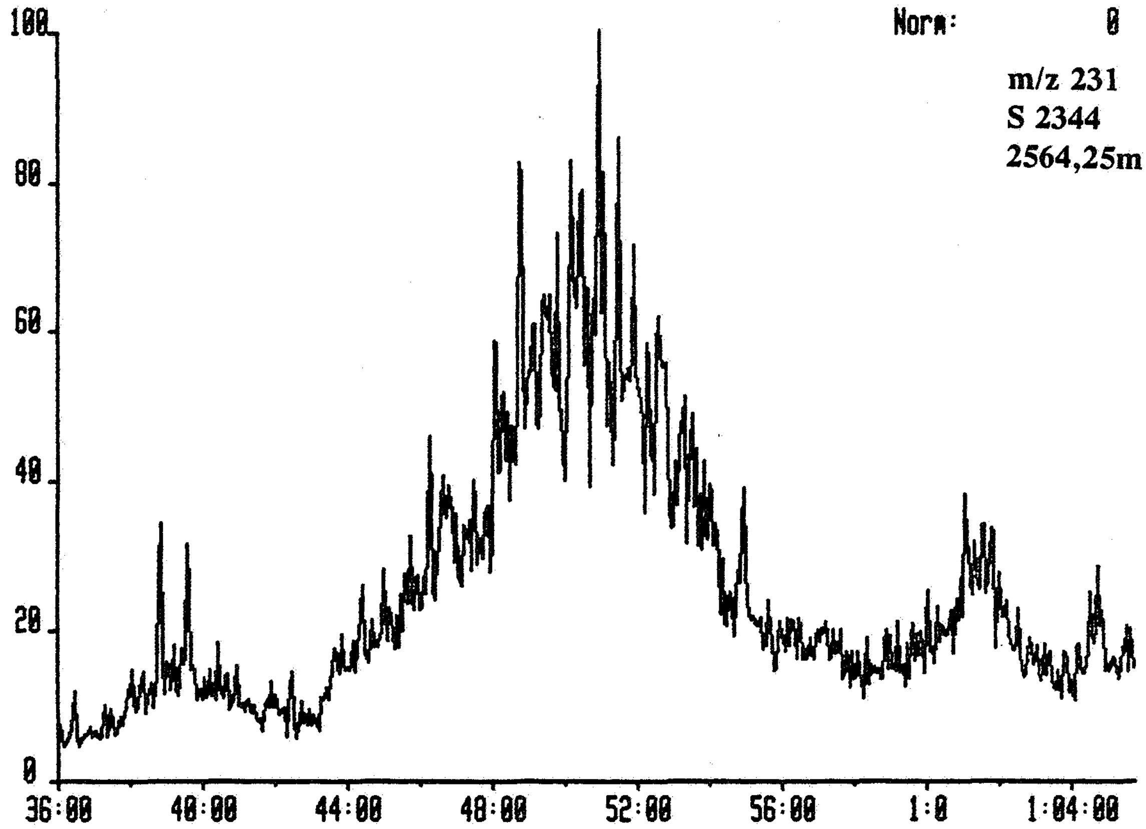
C6715SAT 5-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 231.1000
Text:



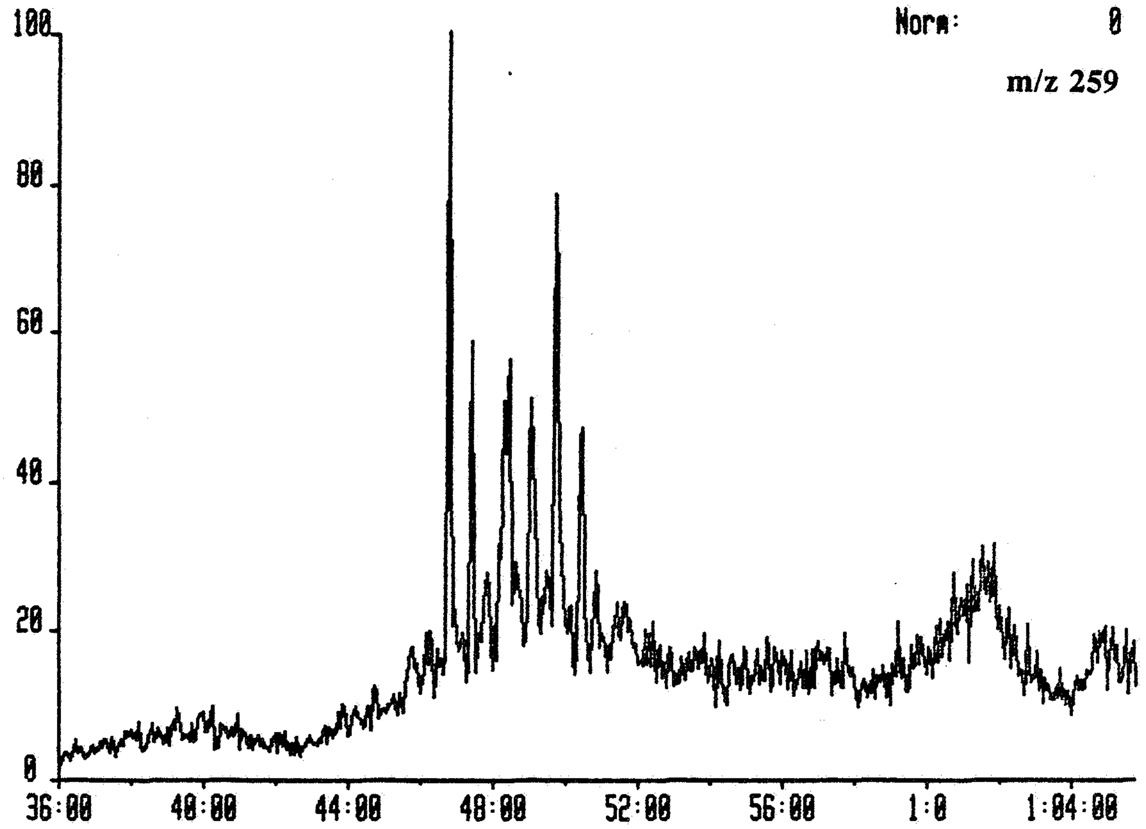
C6715SAT 5-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 259.1000
Text:



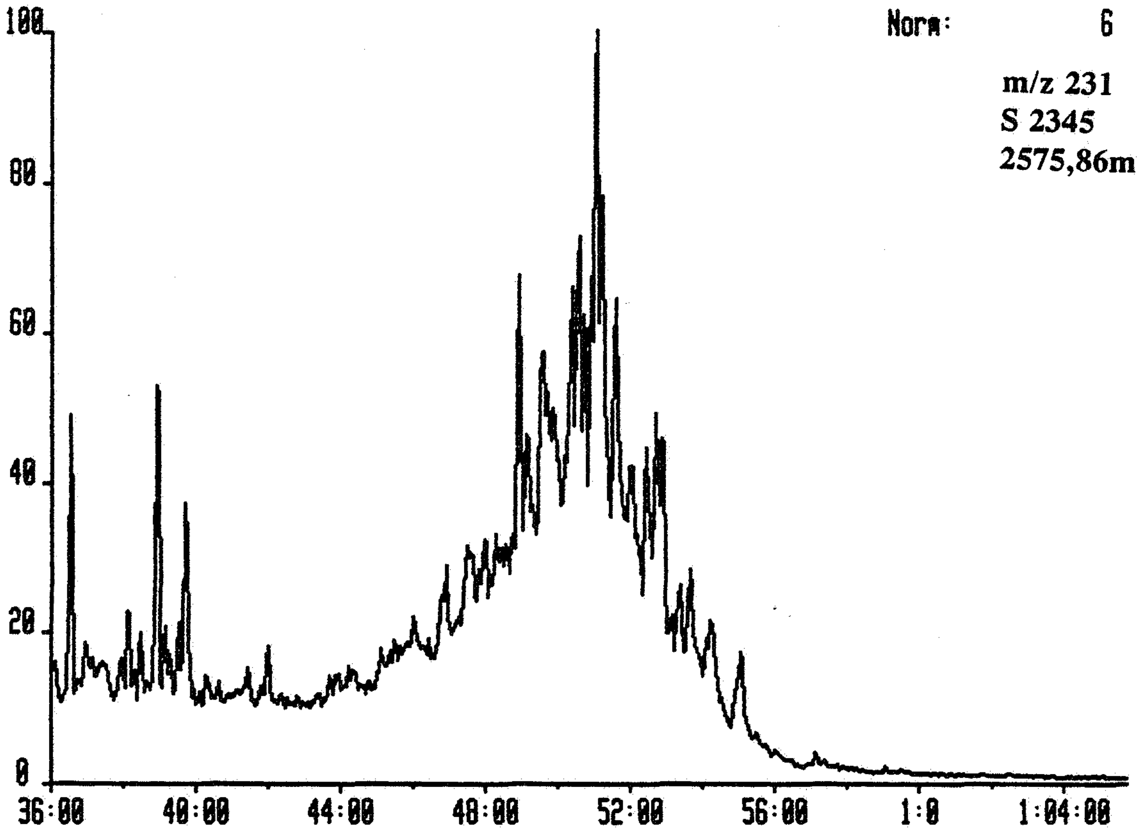
C6716SAT 6-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 231.1000
Text:



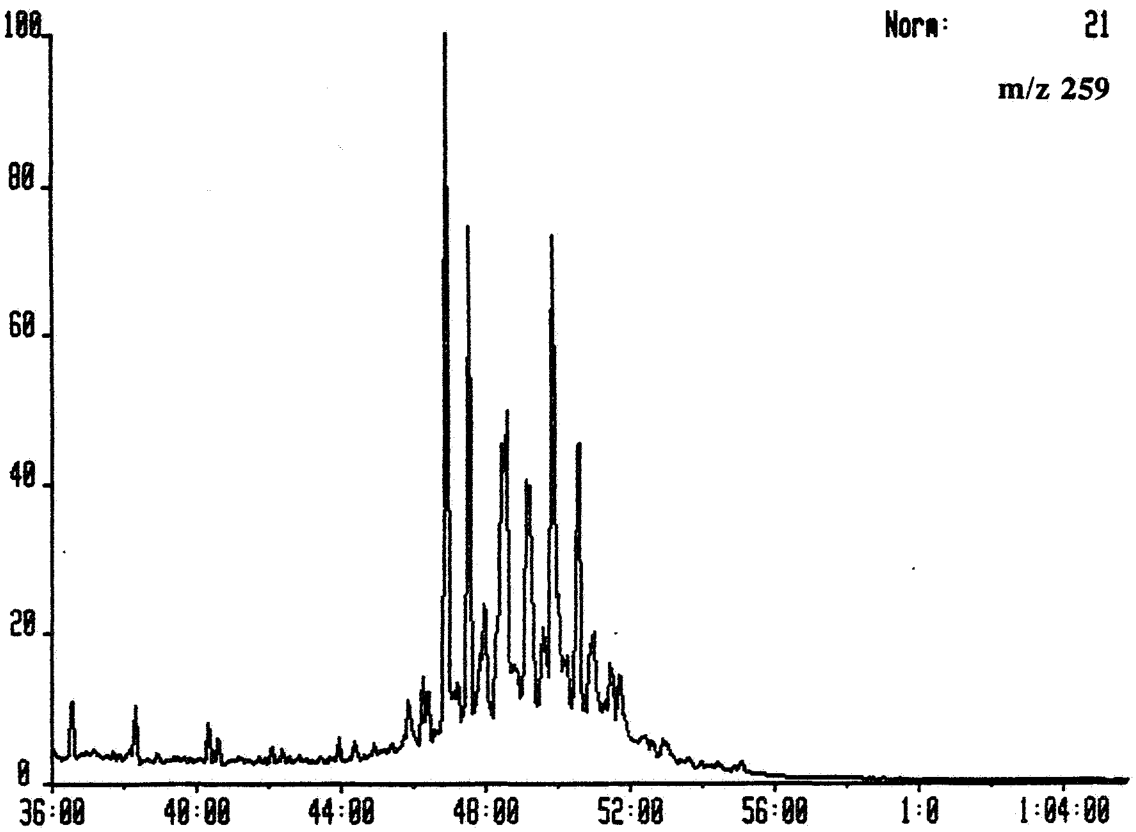
C6716SAT 6-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 259.1000
Text:



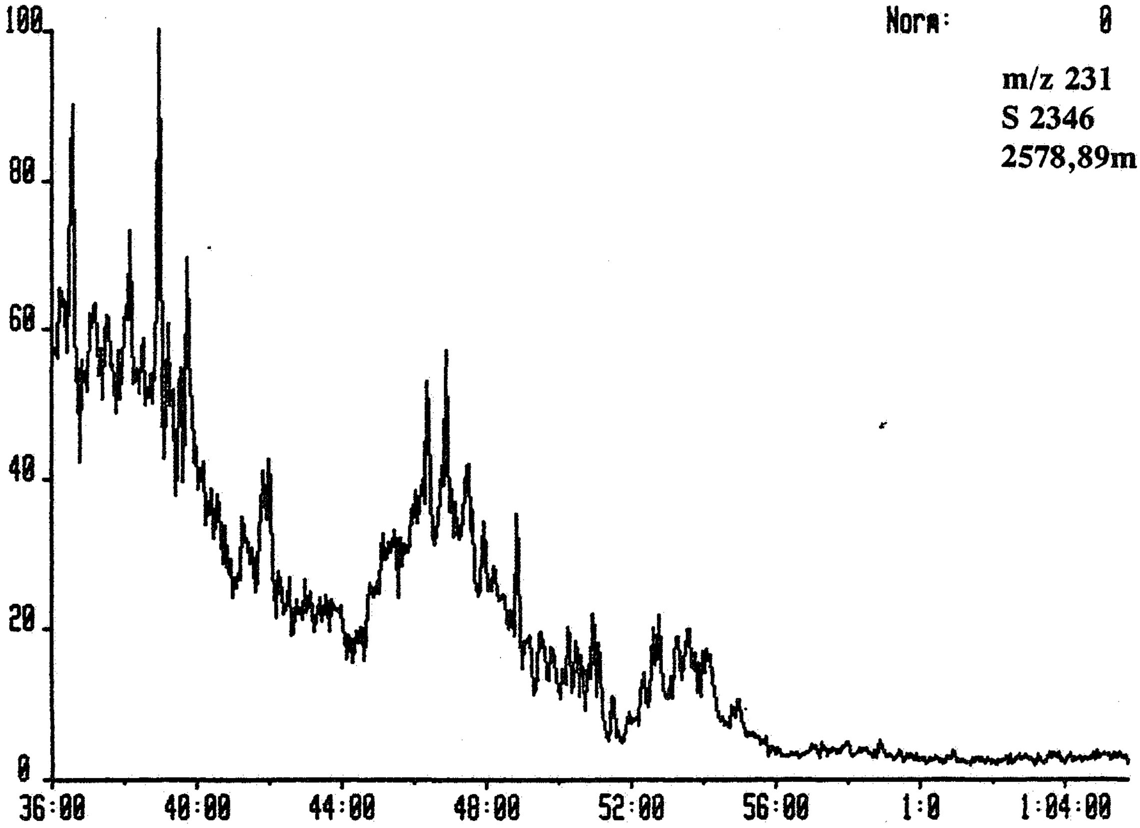
C6717SAT 7-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 231.1000
Text:



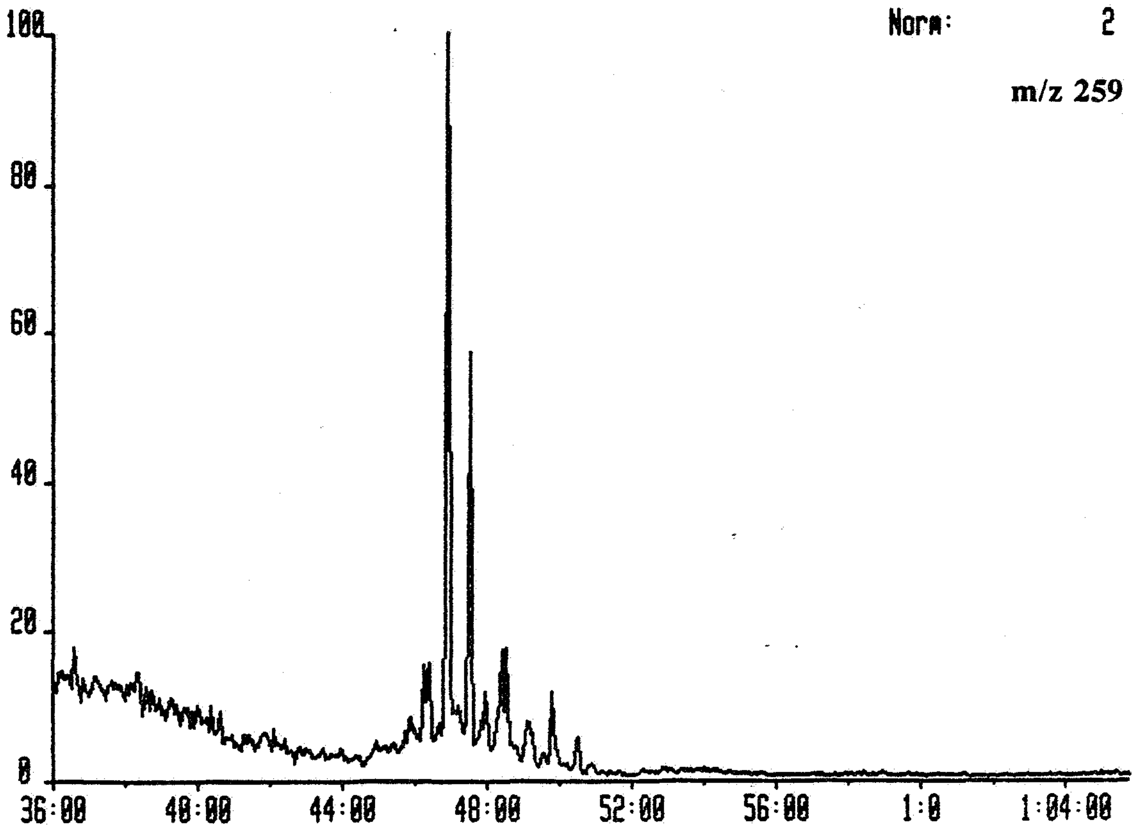
C6717SAT 7-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 259.1000
Text:



C6718SAT 6-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 231.1000
Text:

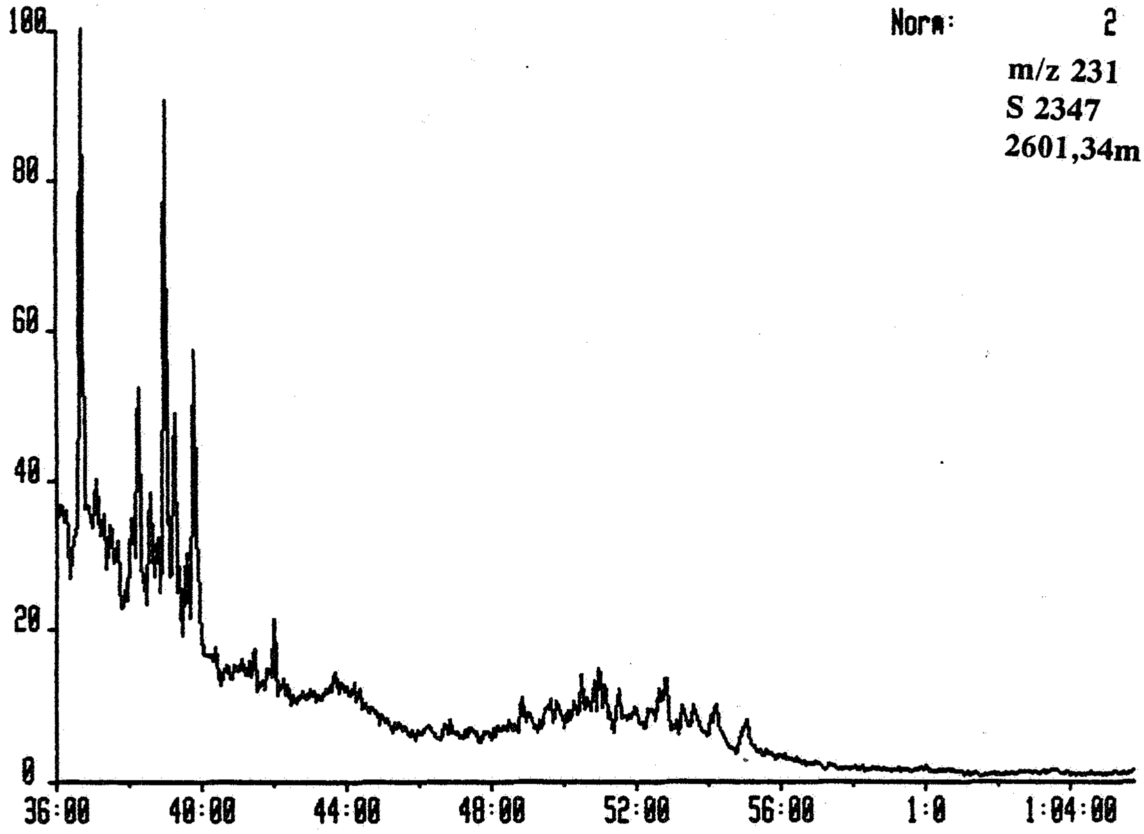


C6718SAT 6-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 259.1000
Text:

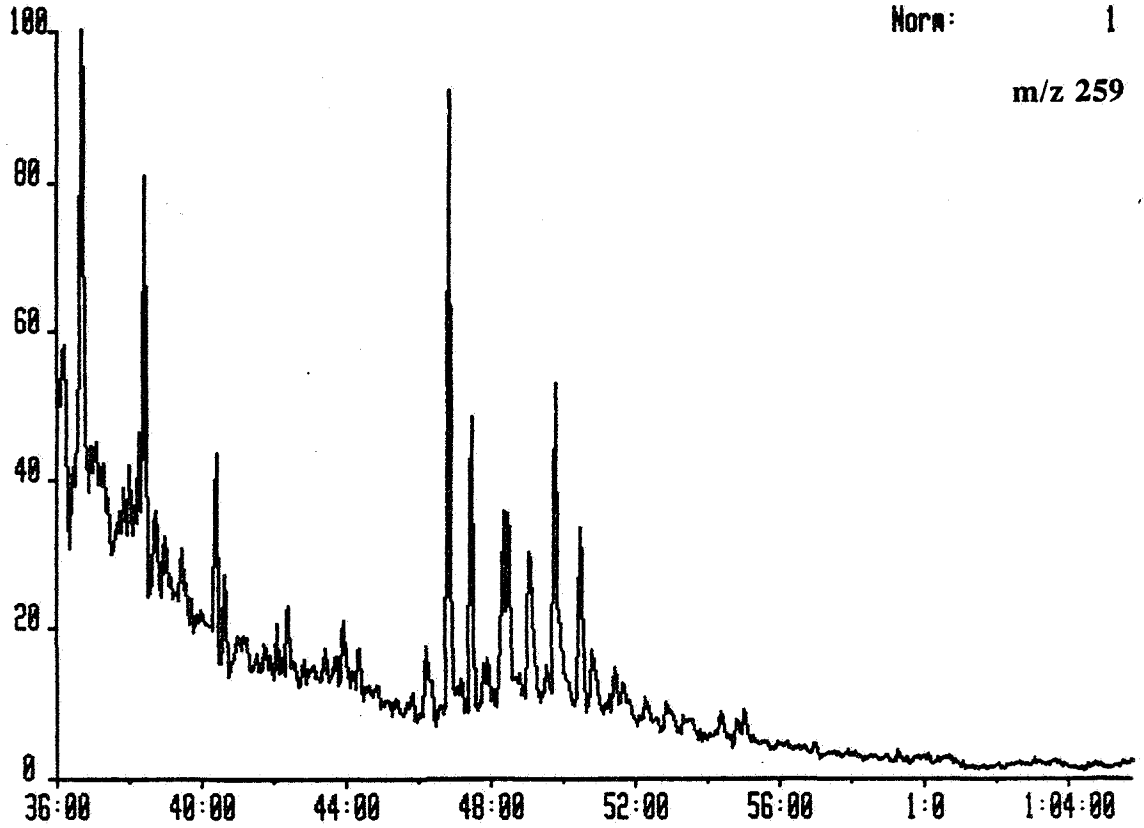


IKU SINTEF-GRUPPEN

C6719SAT 7-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 231.1000
Text:

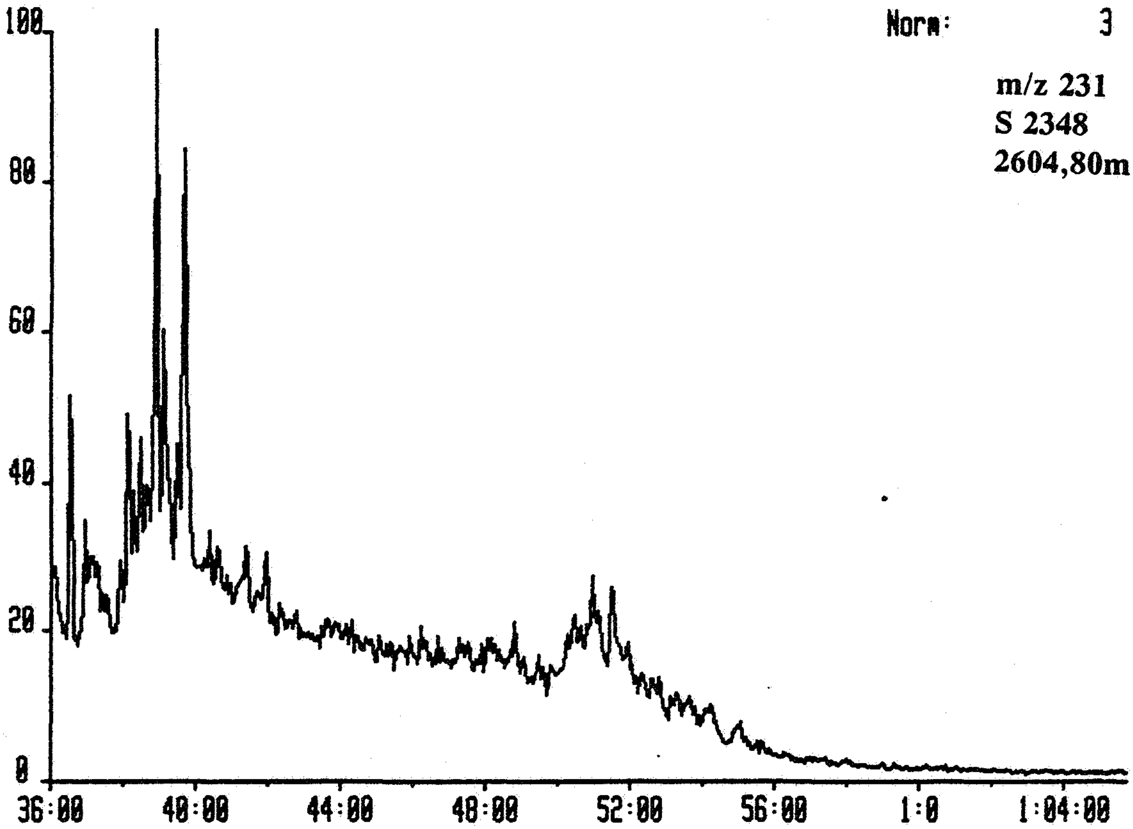


C6719SAT 7-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 259.1000
Text:

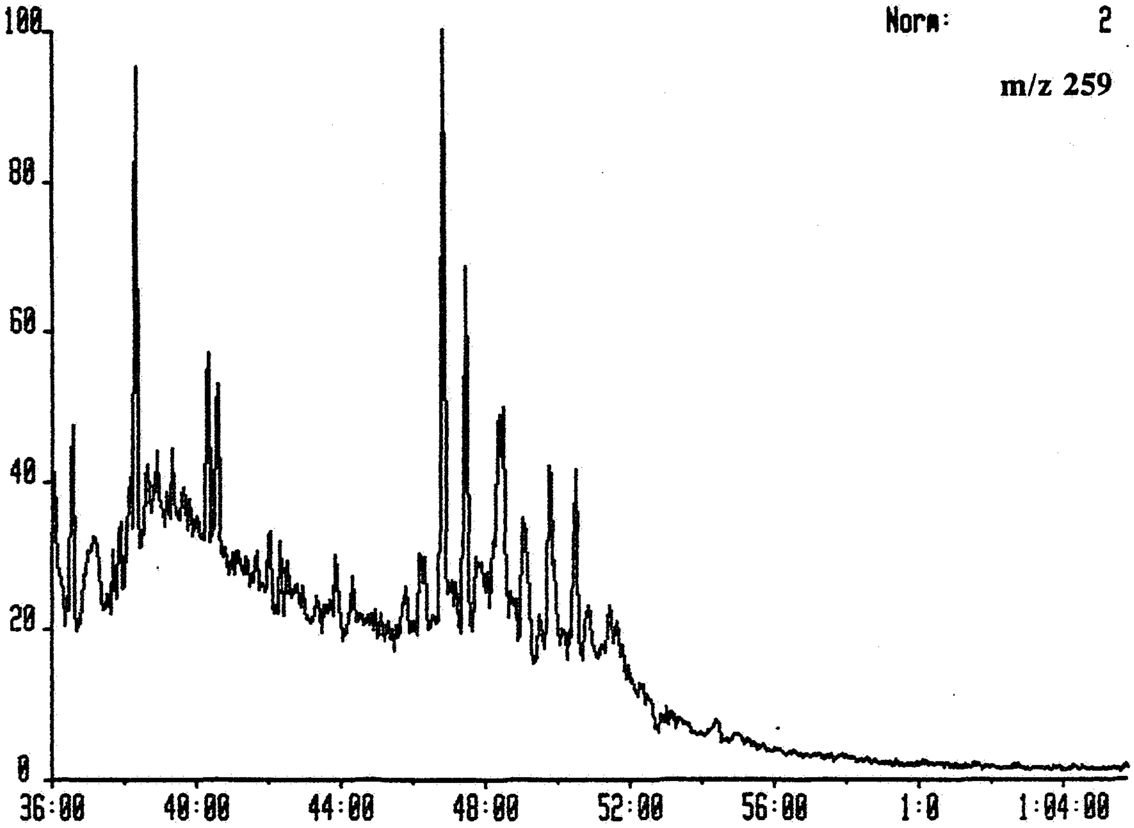


IKU SINTEF-GRUPPEN

C6720SAT 7-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 231.1000
Text:



C6720SAT 7-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 259.1000
Text:

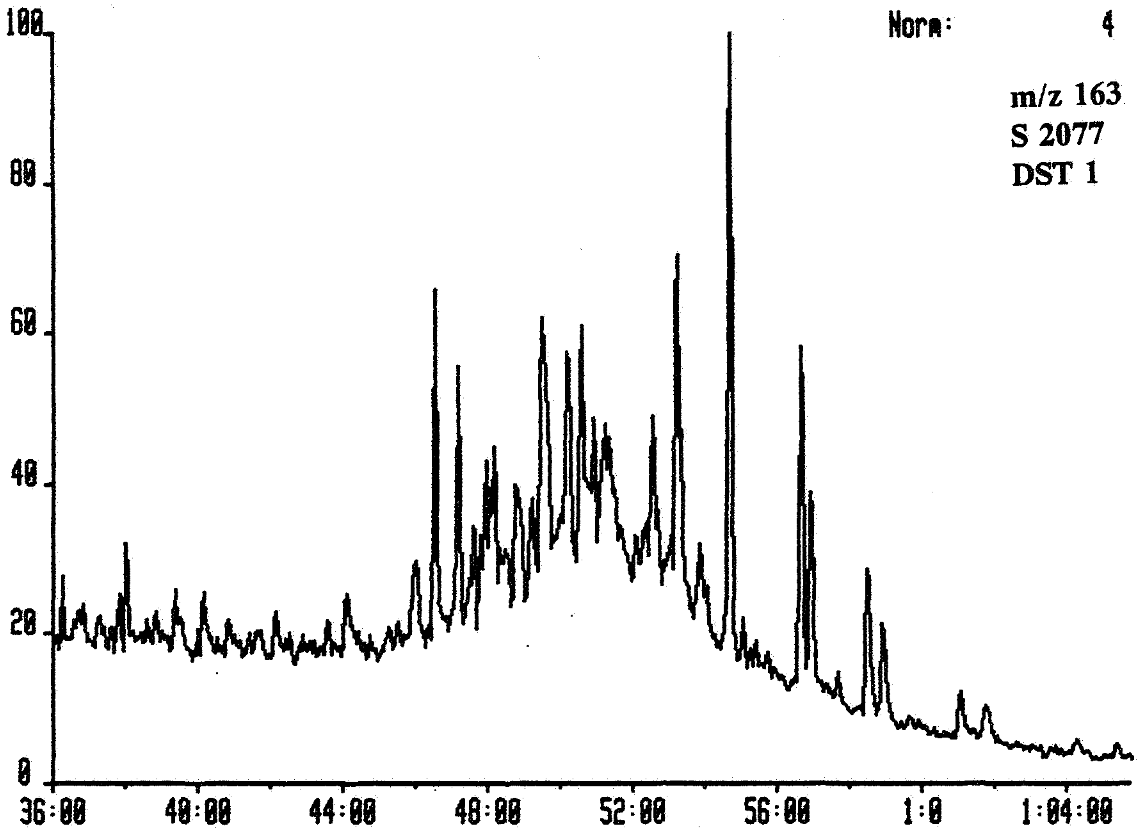


Appendix D
Test samples biomarkers

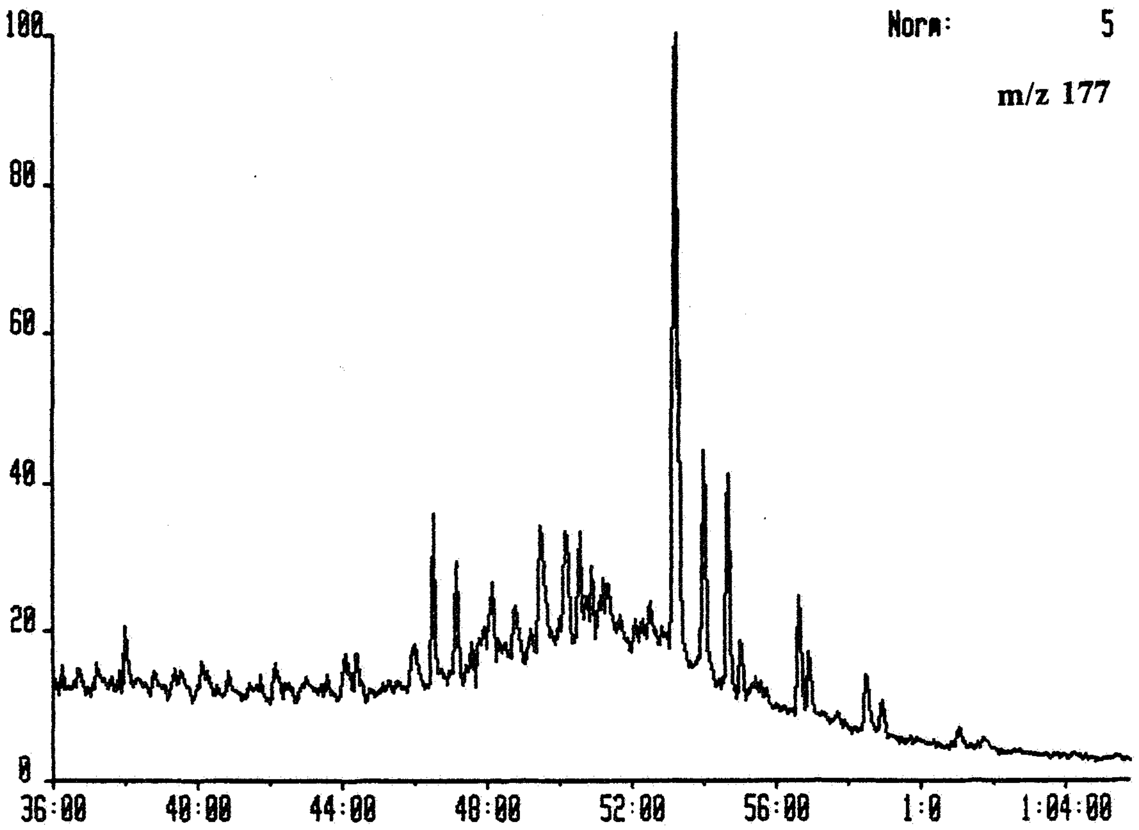
Oil samples

IKU SINTEF-GRUPPEN

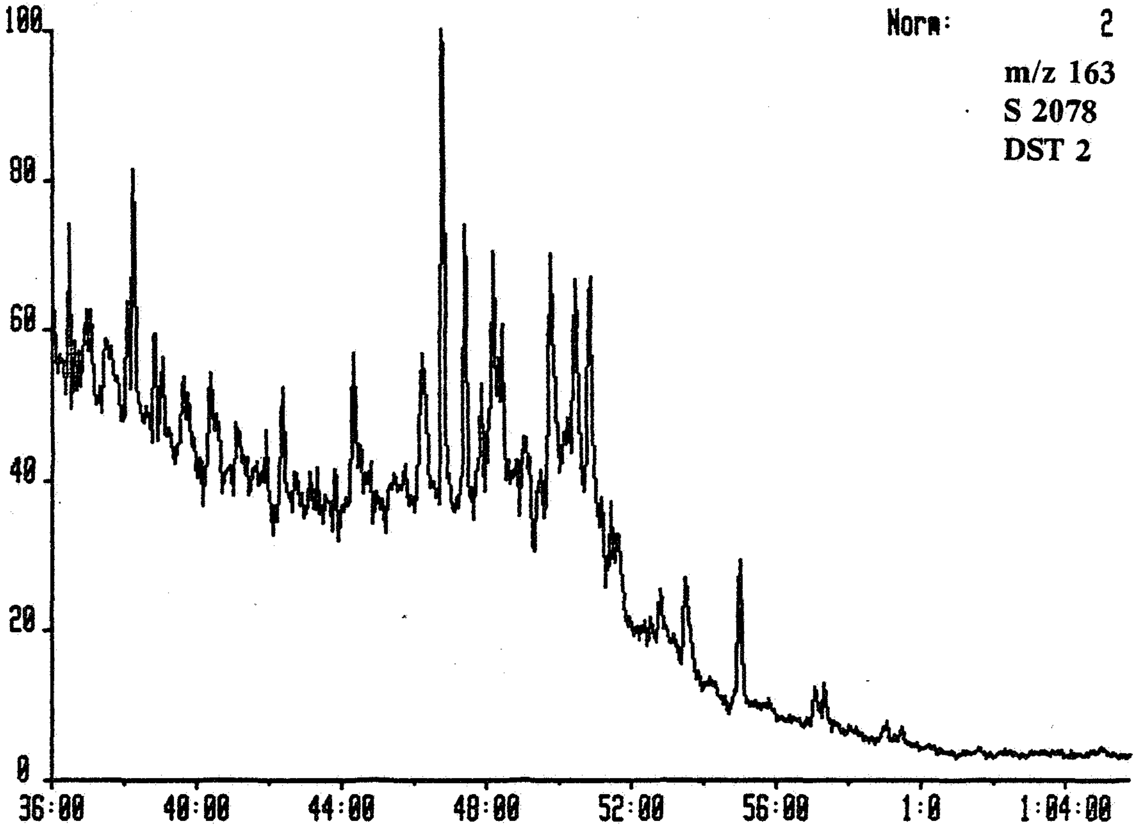
C6707 30-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 163.1000
Text:



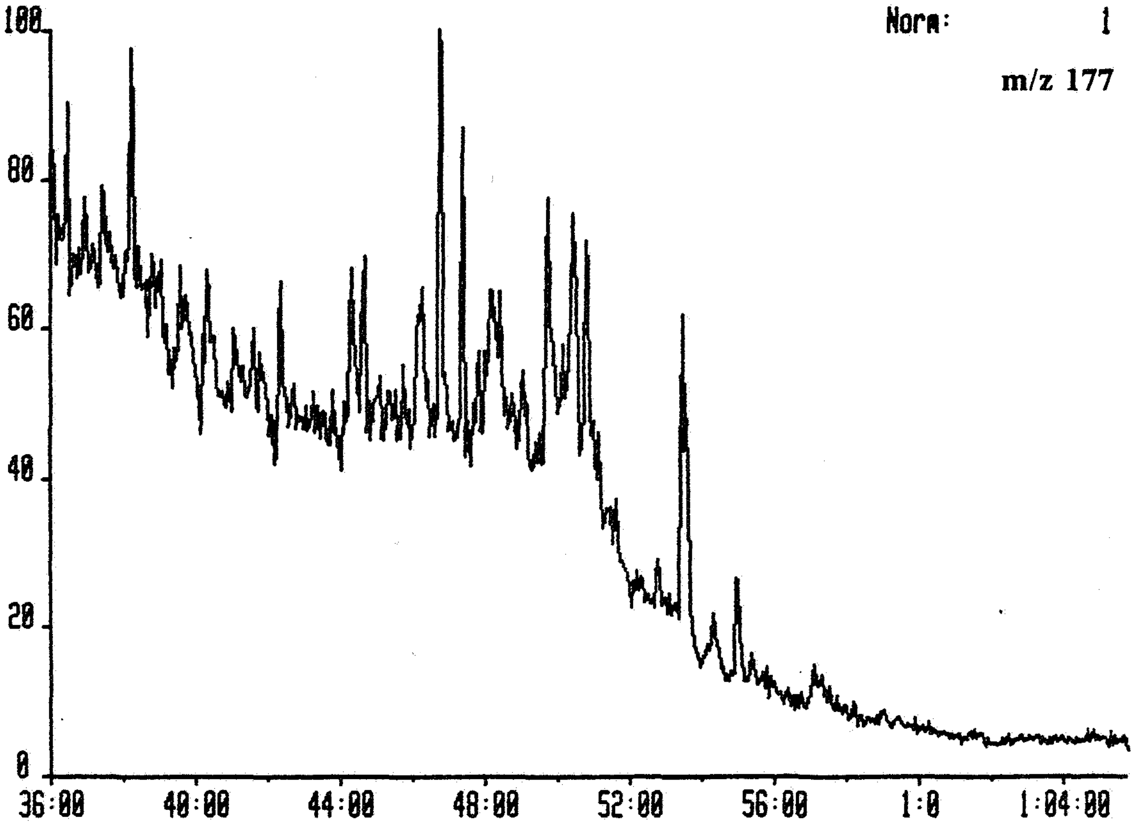
C6707 30-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 177.1000
Text:



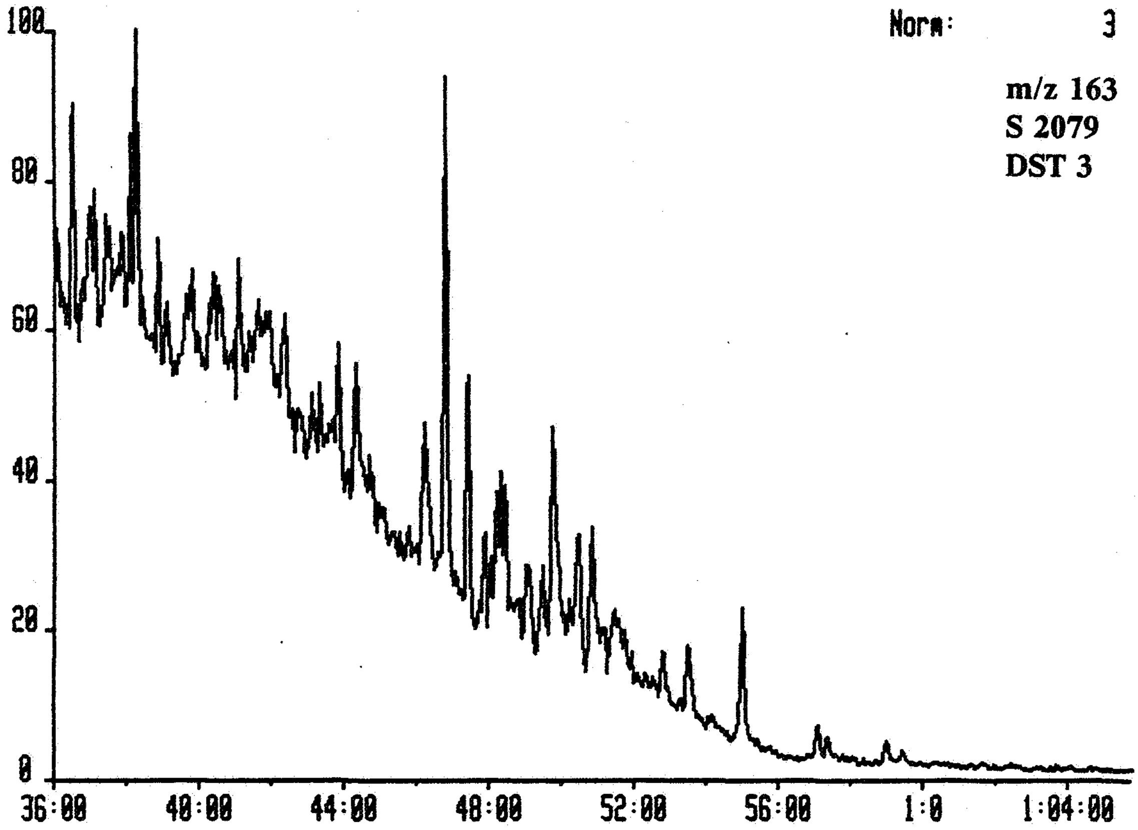
C6708 7-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 163.1000
Text:



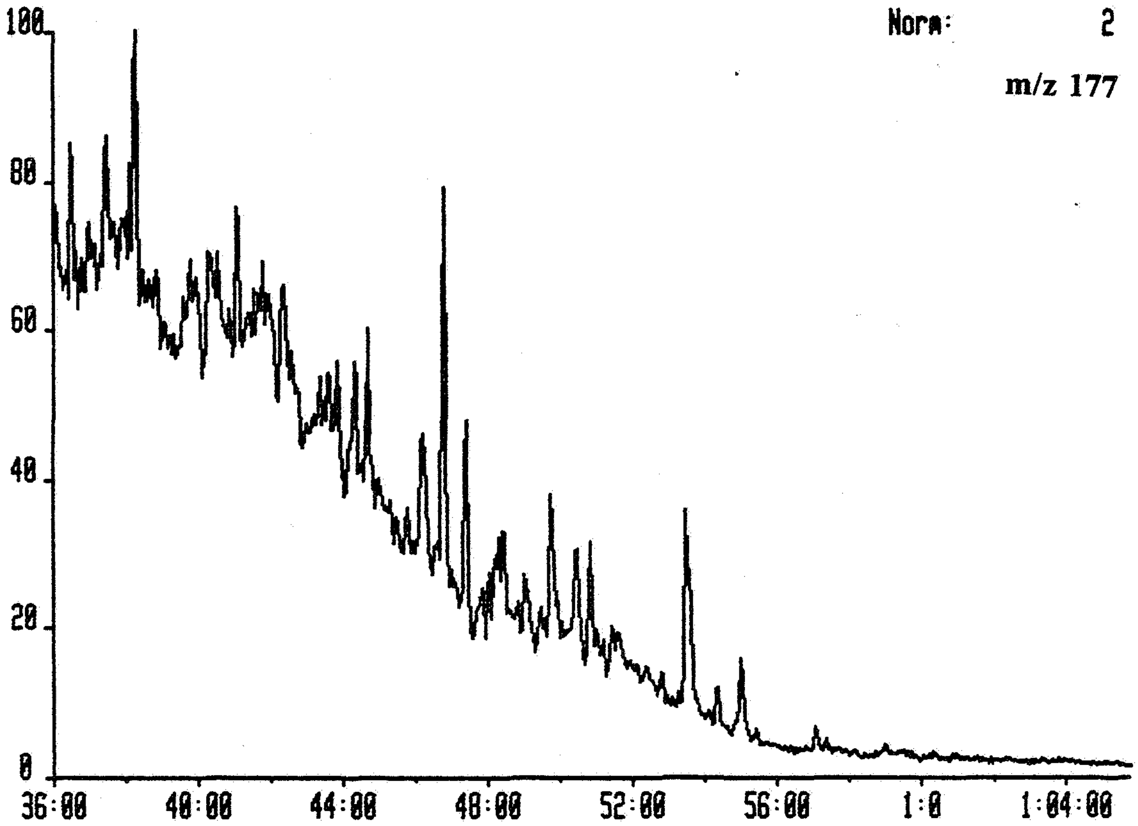
C6708 7-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 177.1000
Text:



C6709 7-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 163.1000
Text:



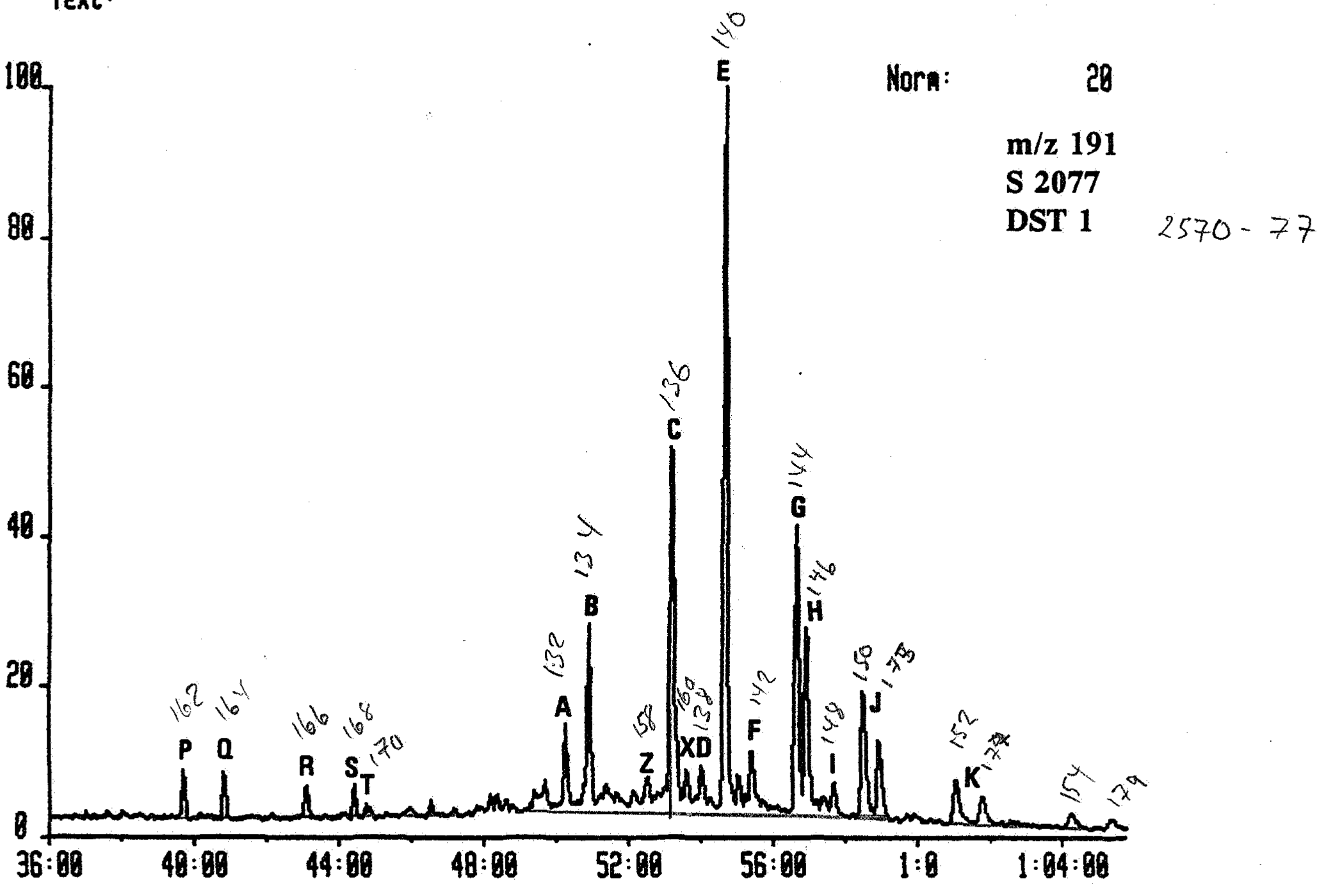
C6709 7-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 177.1000
Text:



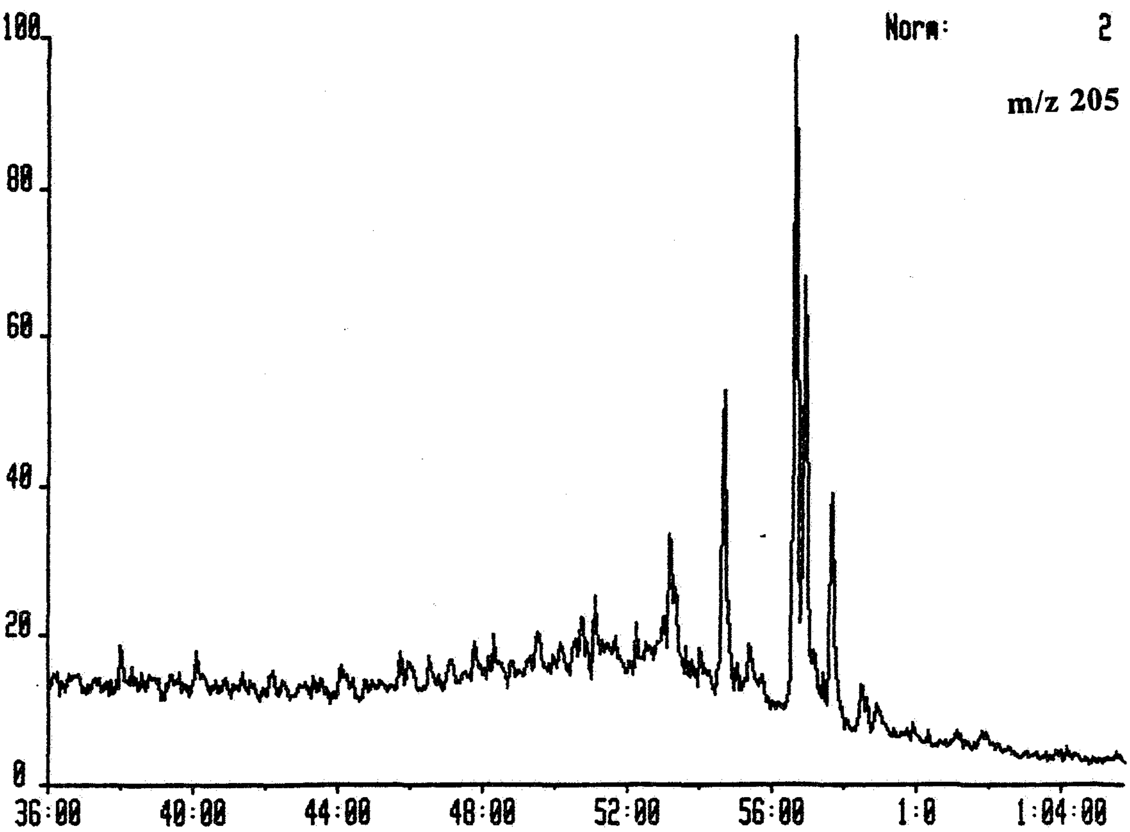
Oil samples

IKU
SINTEF-GRUPPEN

C6707 30-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 191.1000
Text:

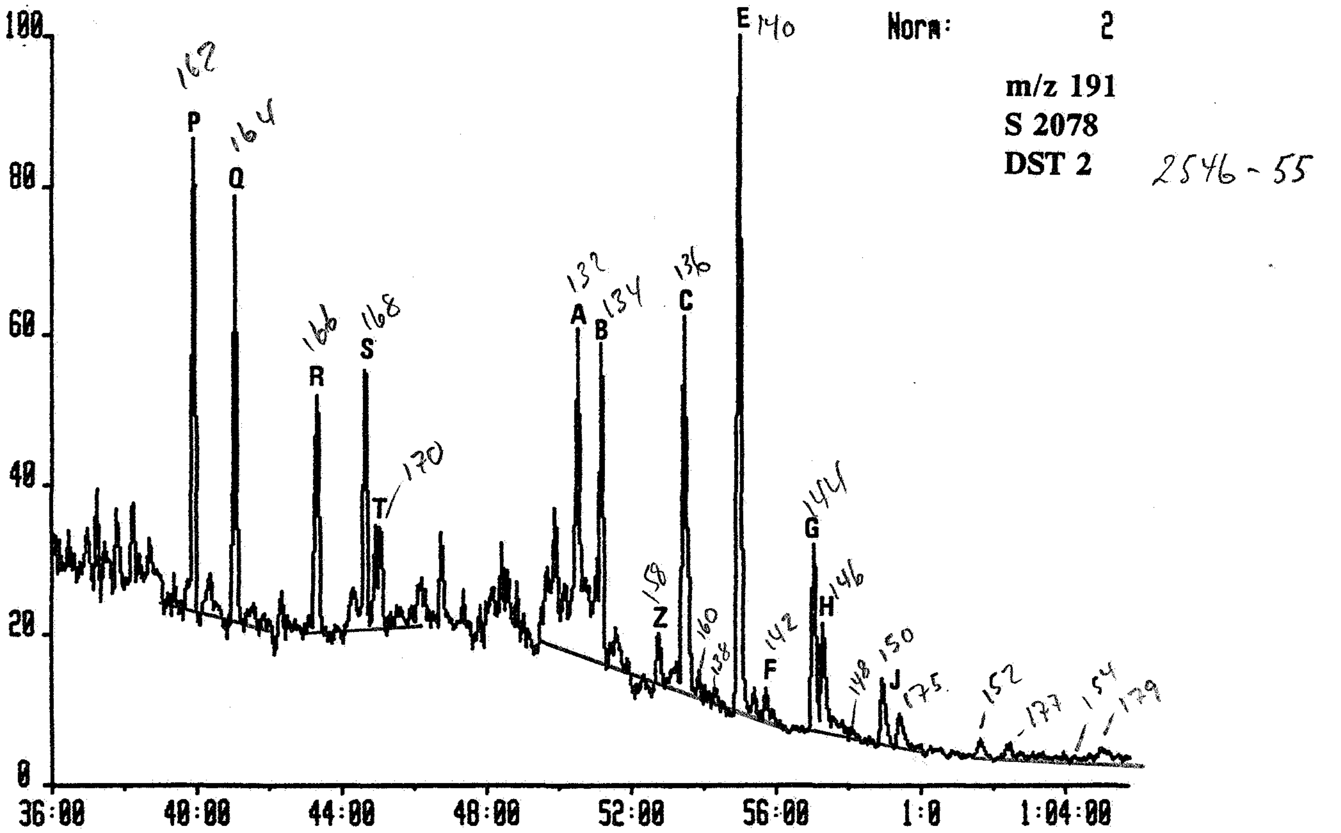


C6707 30-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 205.1000
Text:

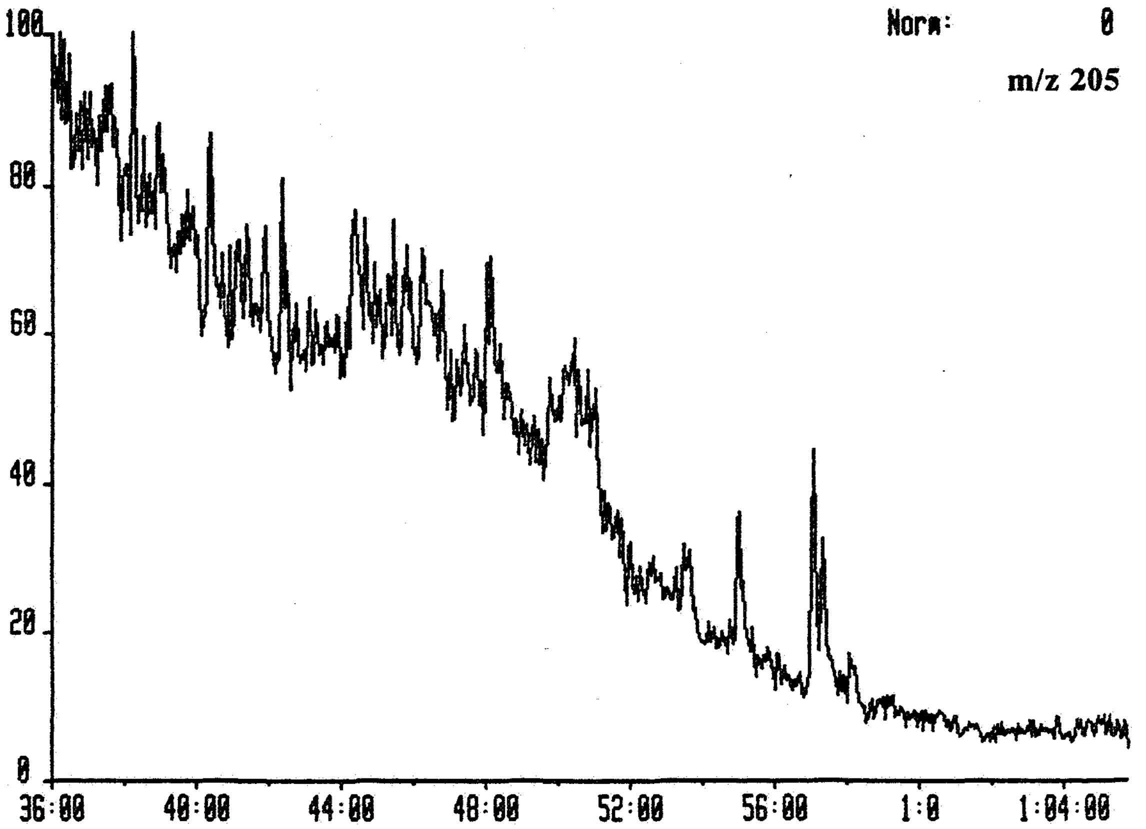


IKU
SINTEF-GRUPPEN

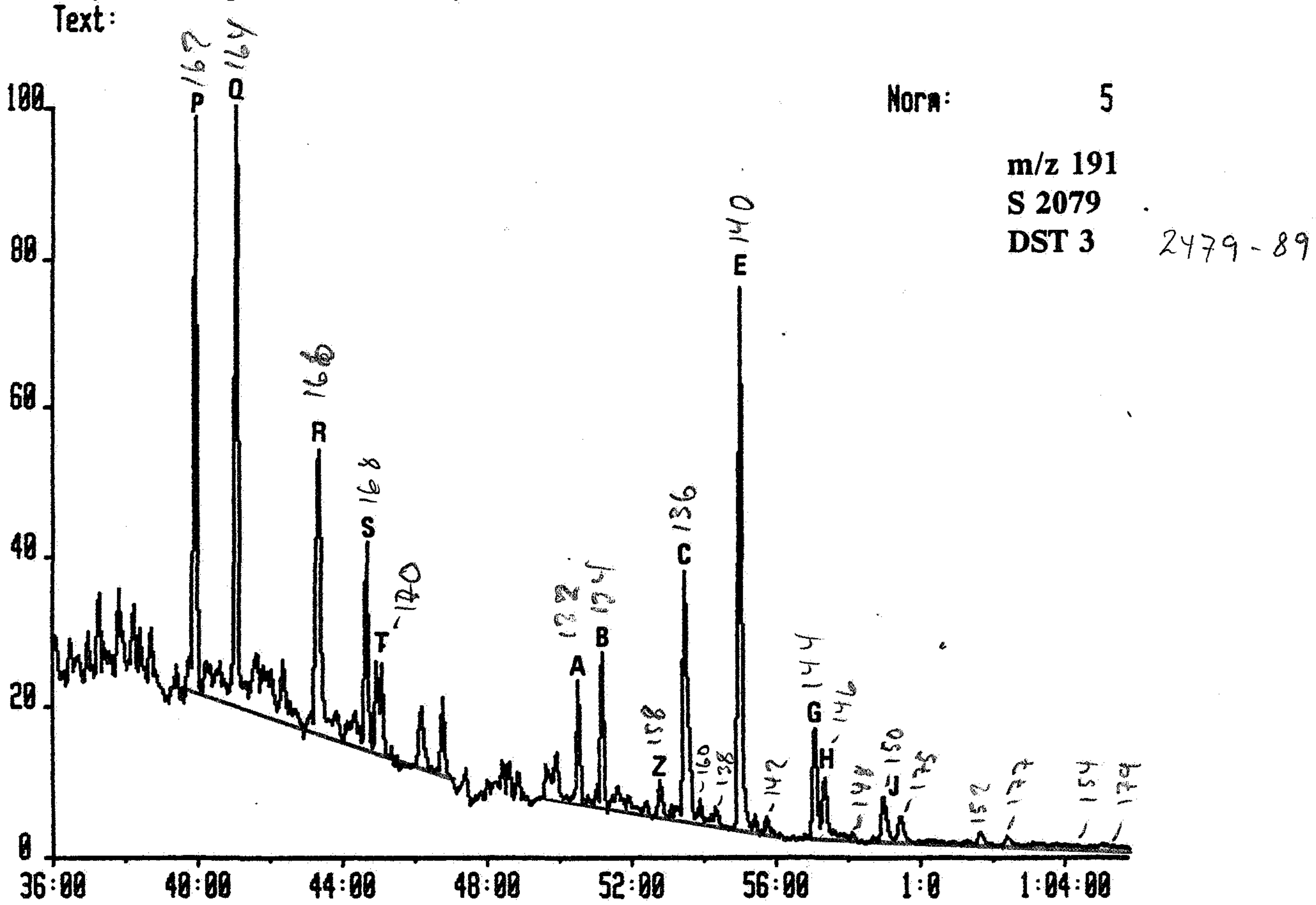
C6708 7-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 191.1000
Text:



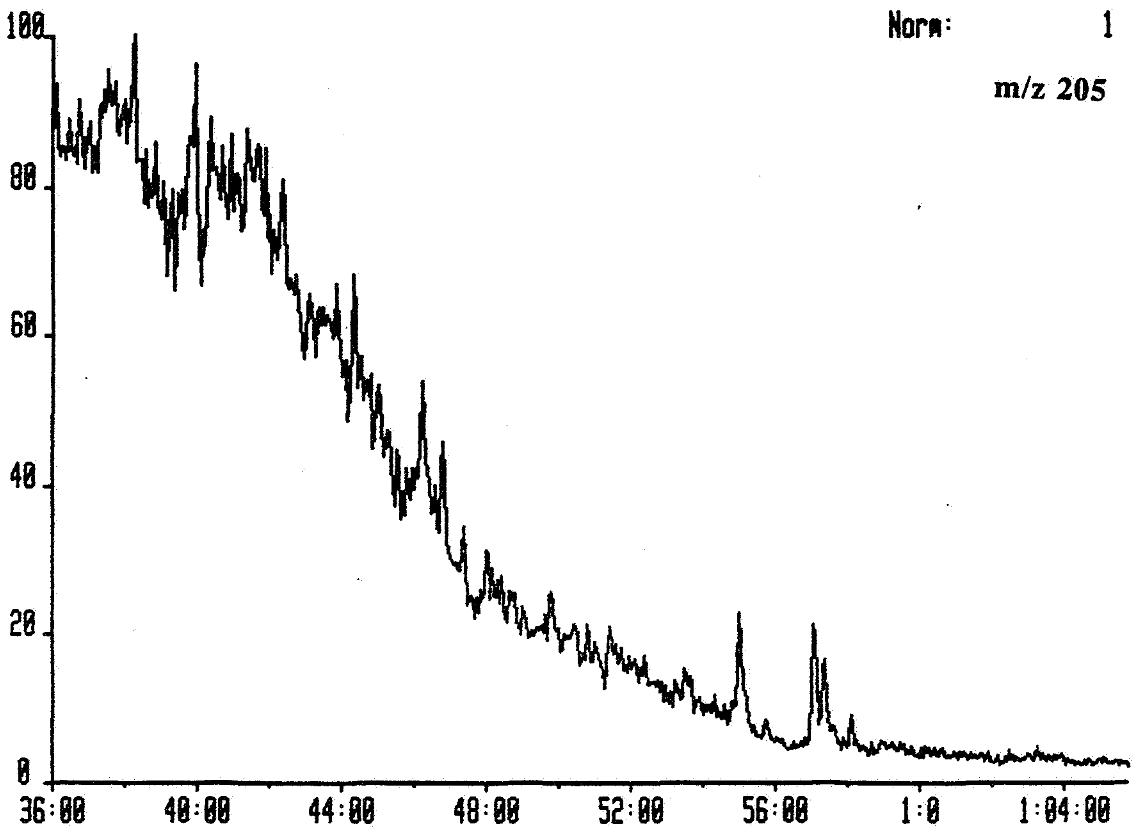
C6708 7-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 205.1000
Text:



C6709 7-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 191.1000
Text:



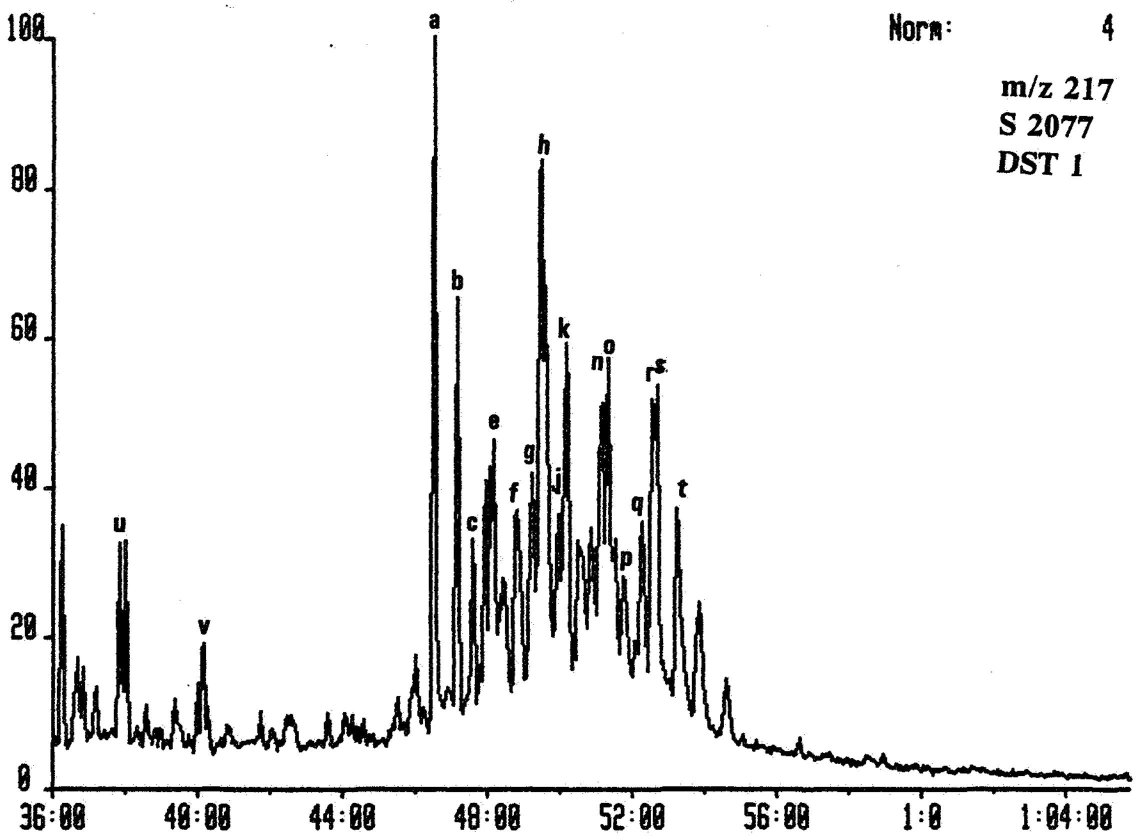
C6709 7-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 205.1000
Text:



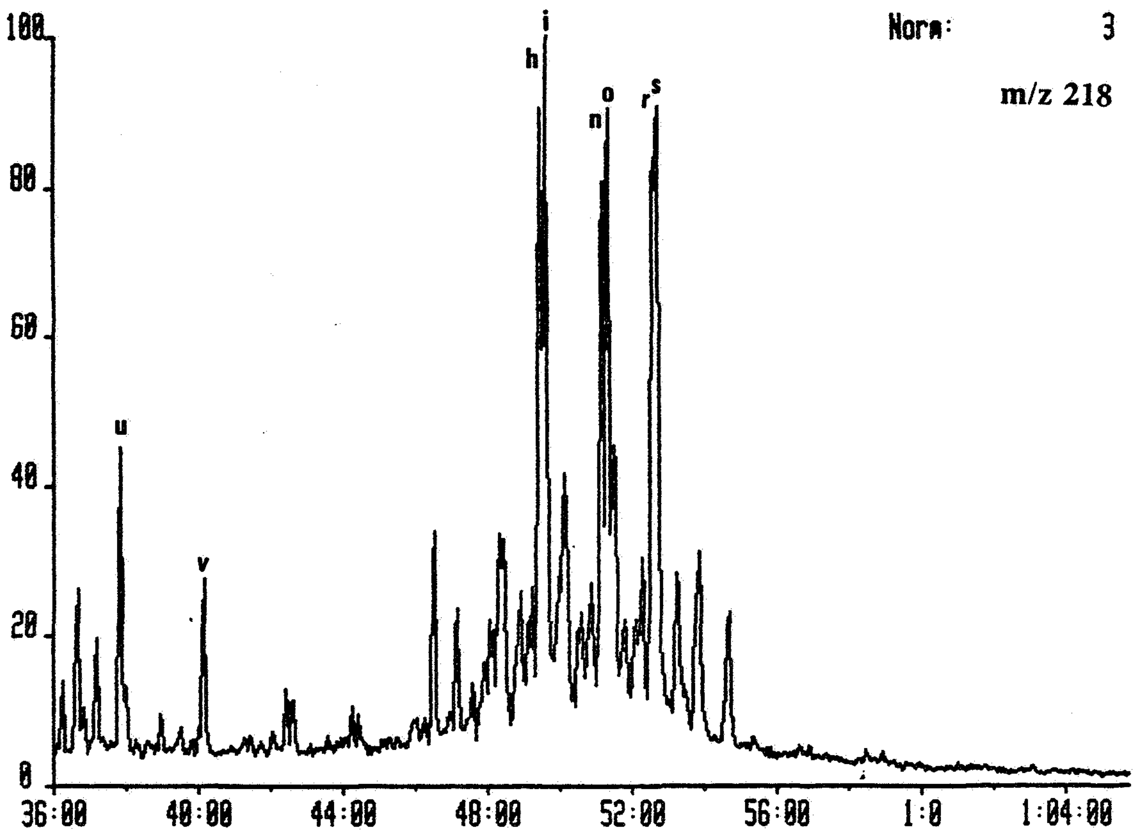
Oil samples

IKU SINTEF-GRUPPEN

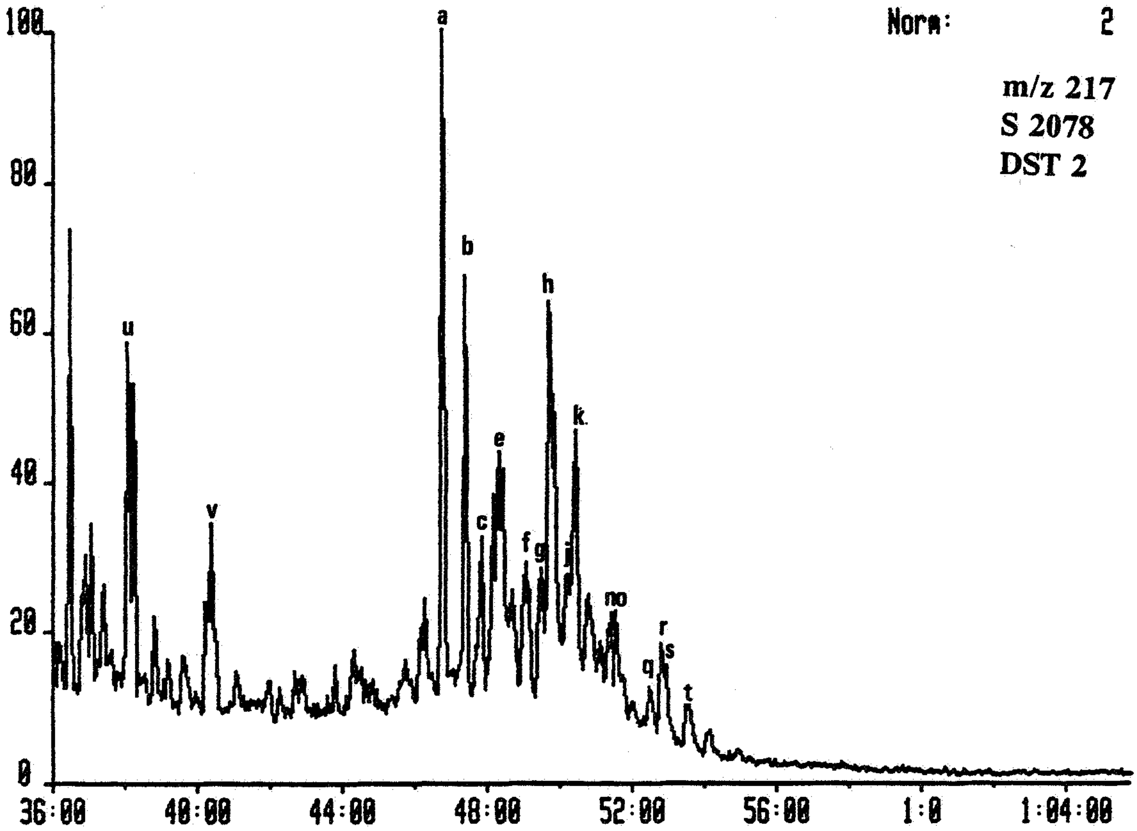
C6707 30-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 217.1000
Text:



C6707 30-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 218.1000
Text:



C6708 7-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 217.1000
Text:



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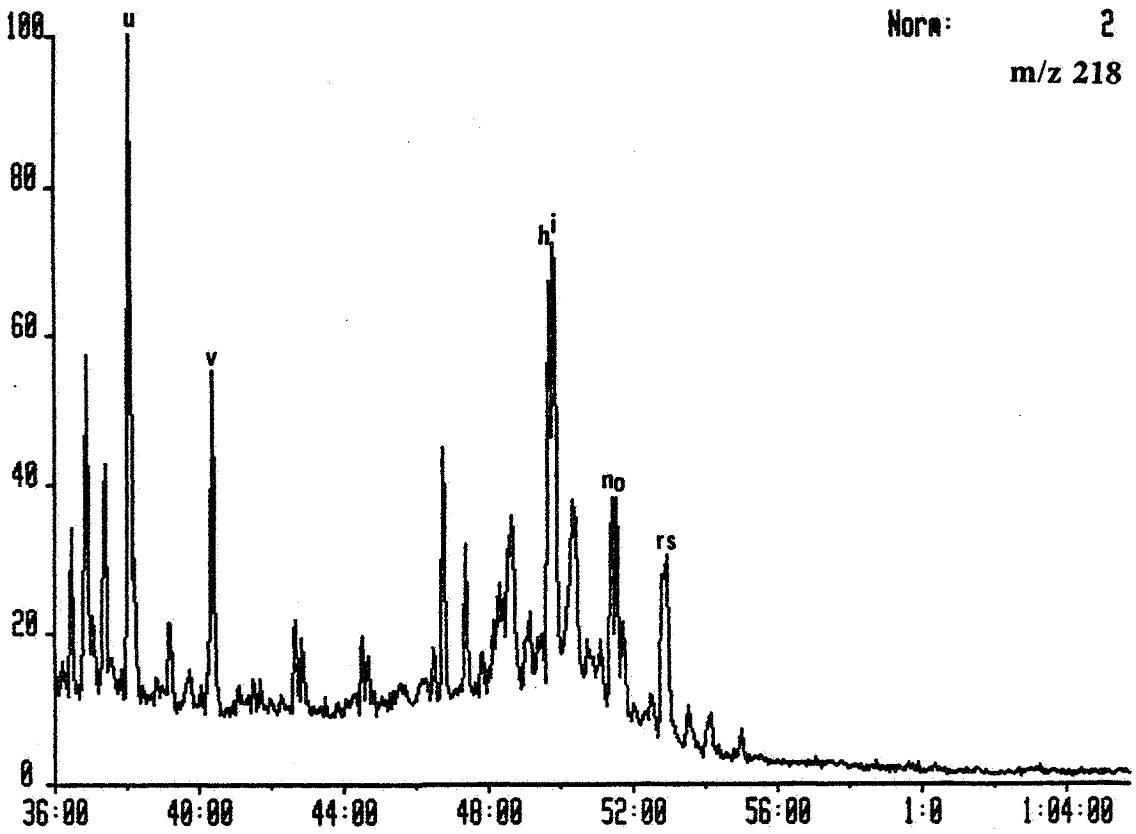
Sample 1 Injection 1 Group 1 Mass 218.1000
Text:



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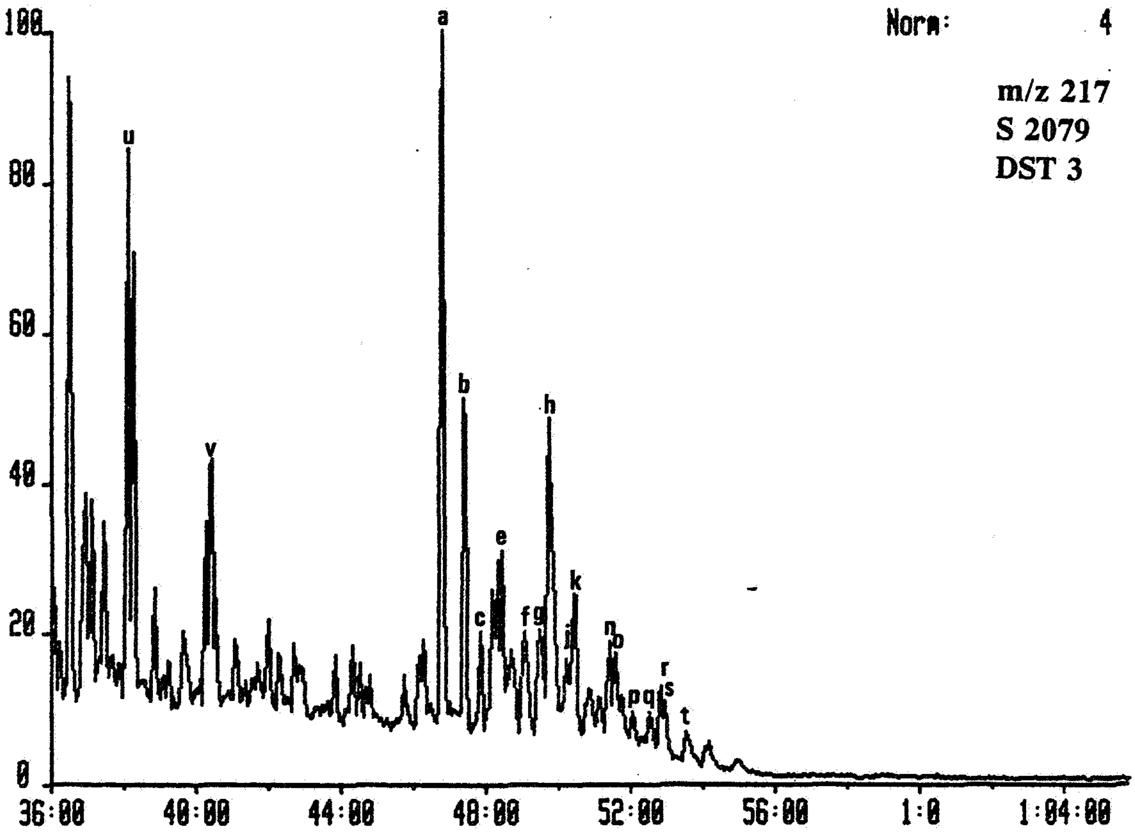
Sample 1 Injection 1 Group 1 Mass 217.1000
Text:



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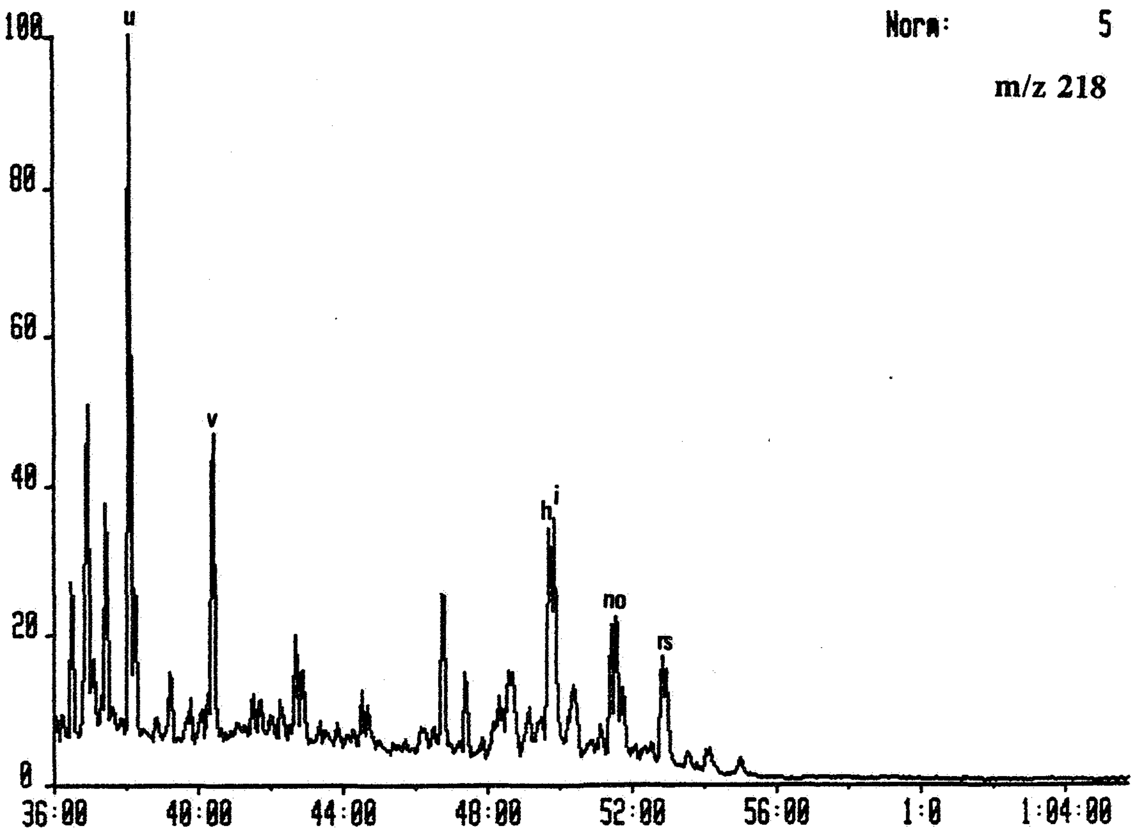
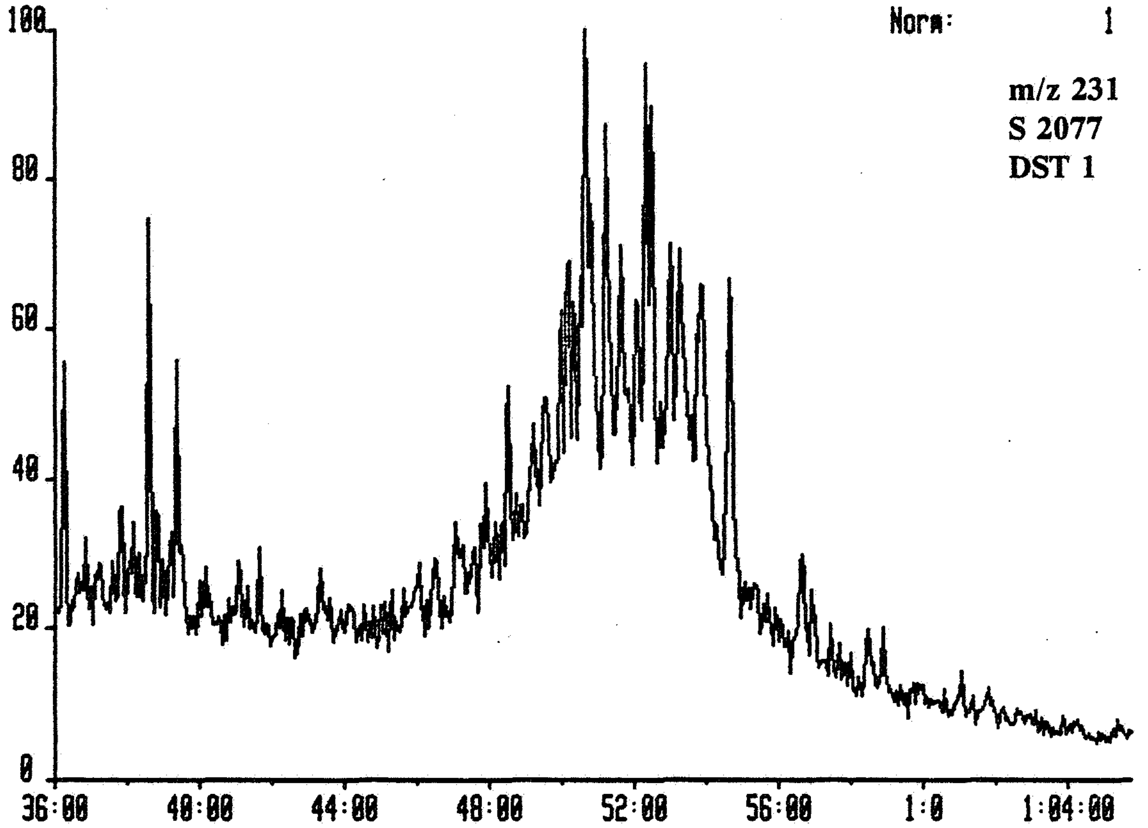
Sample 1 Injection 1 Group 1 Mass 218.1000
Text:

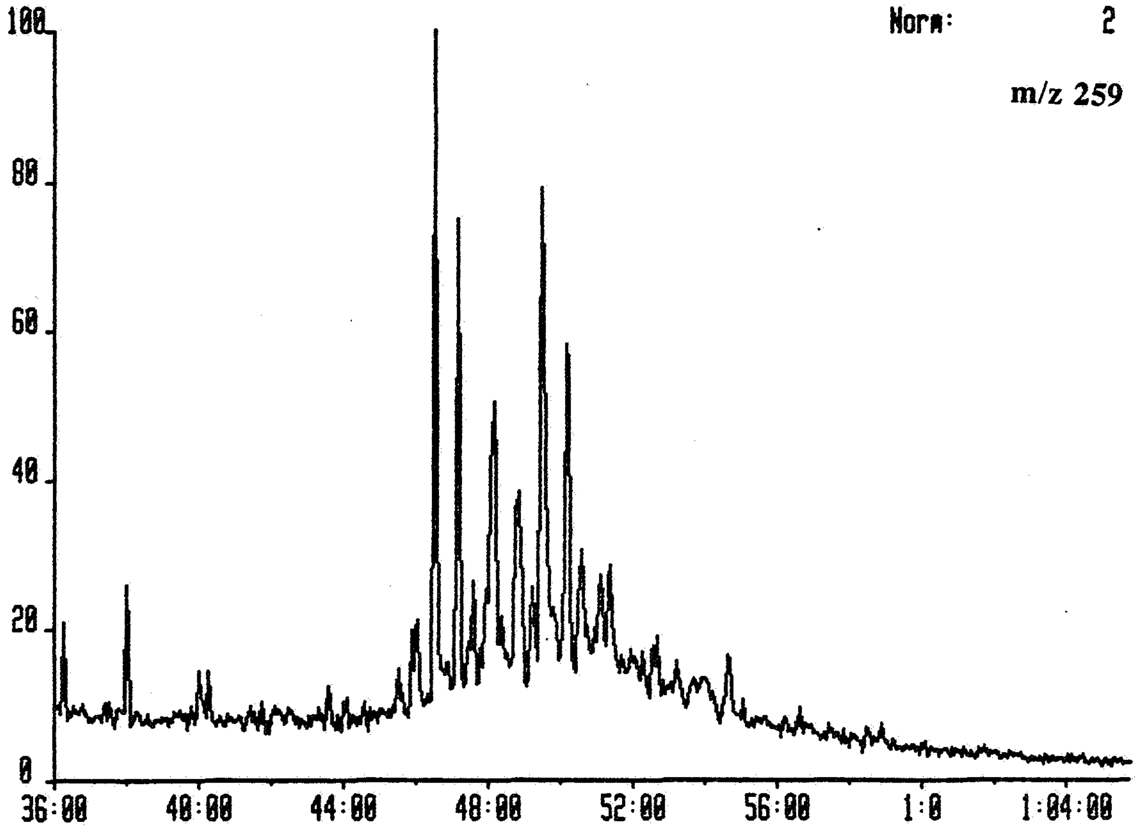


Oil samples

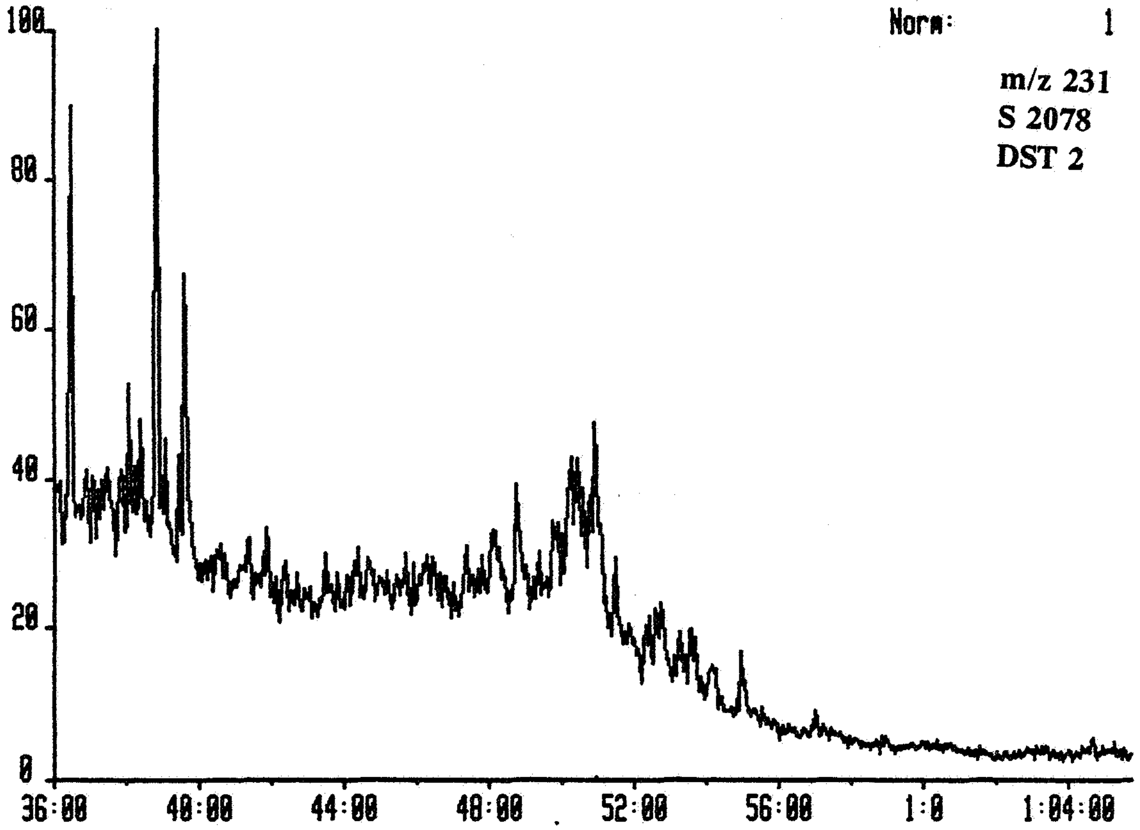
C6707 30-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 231.1000
Text:



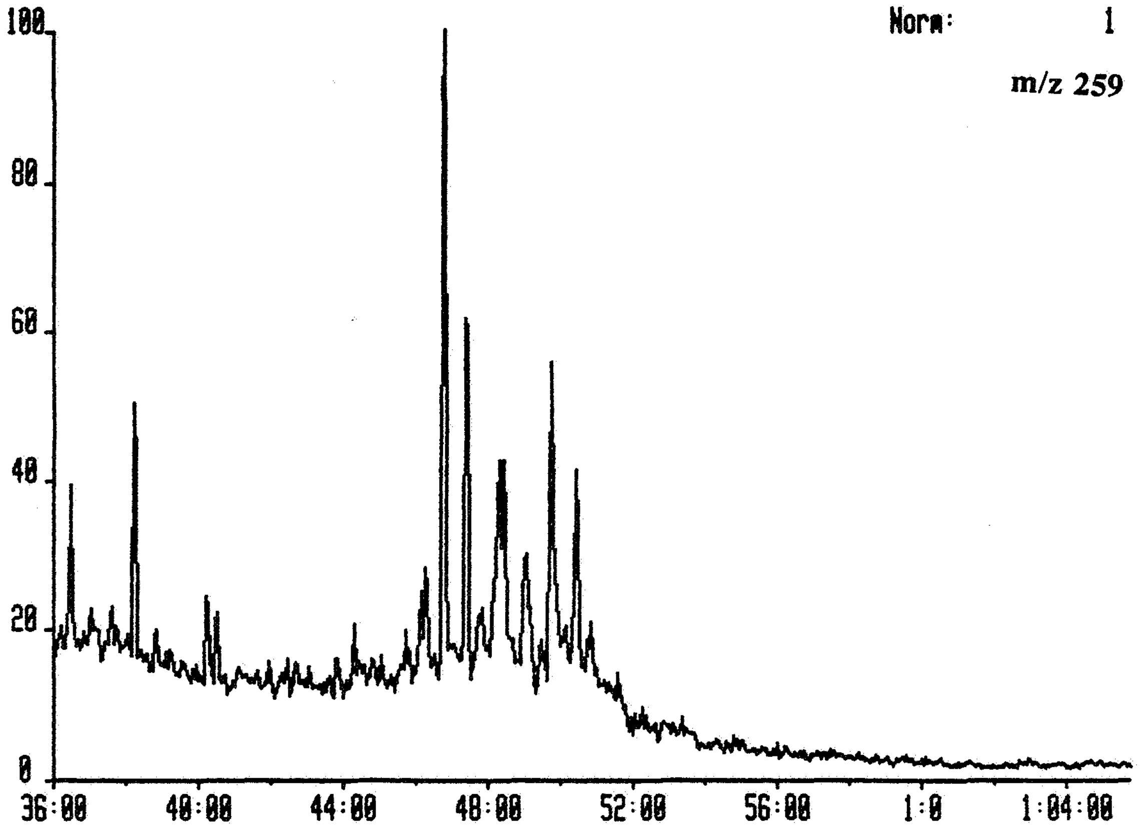
C6707 30-SEP-87 Sir:Voltage 12-250 Acnt:IKU System:QUADSAT
Sample 1 Injection 1 Group 1 Mass 259.1000
Text:



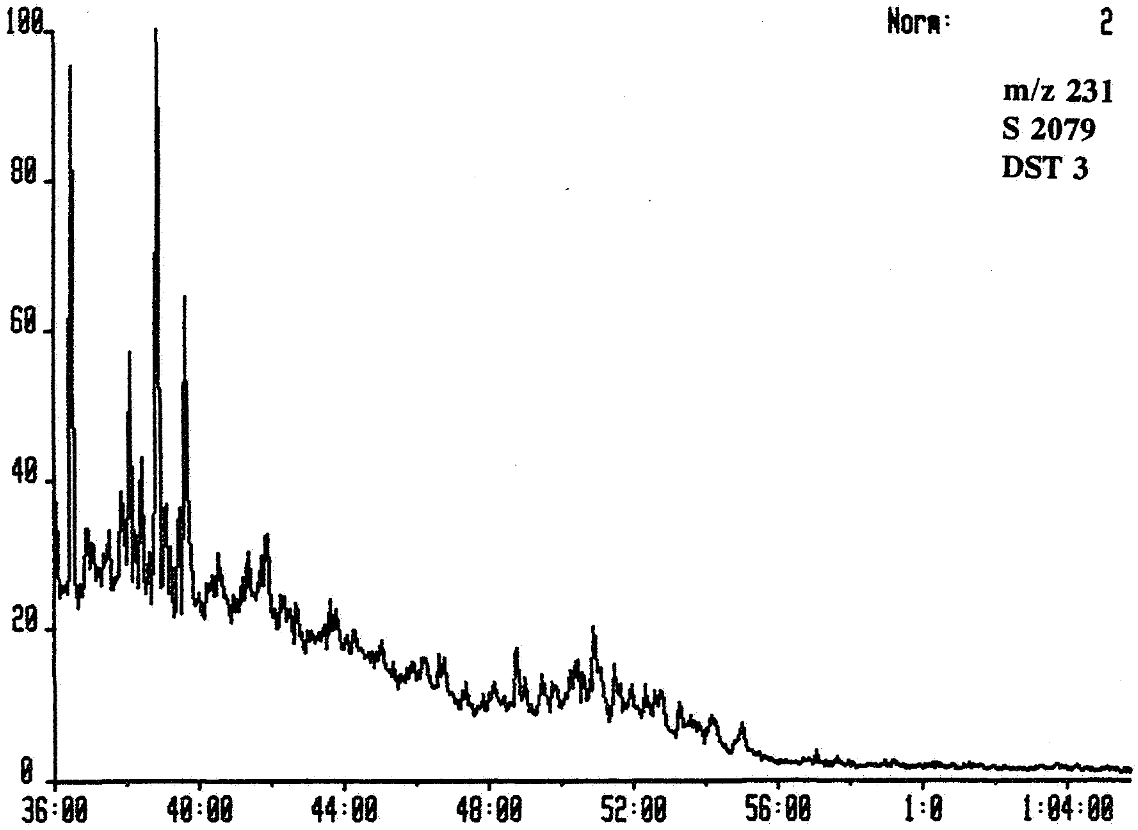
C6708 7-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 231.1000
Text:



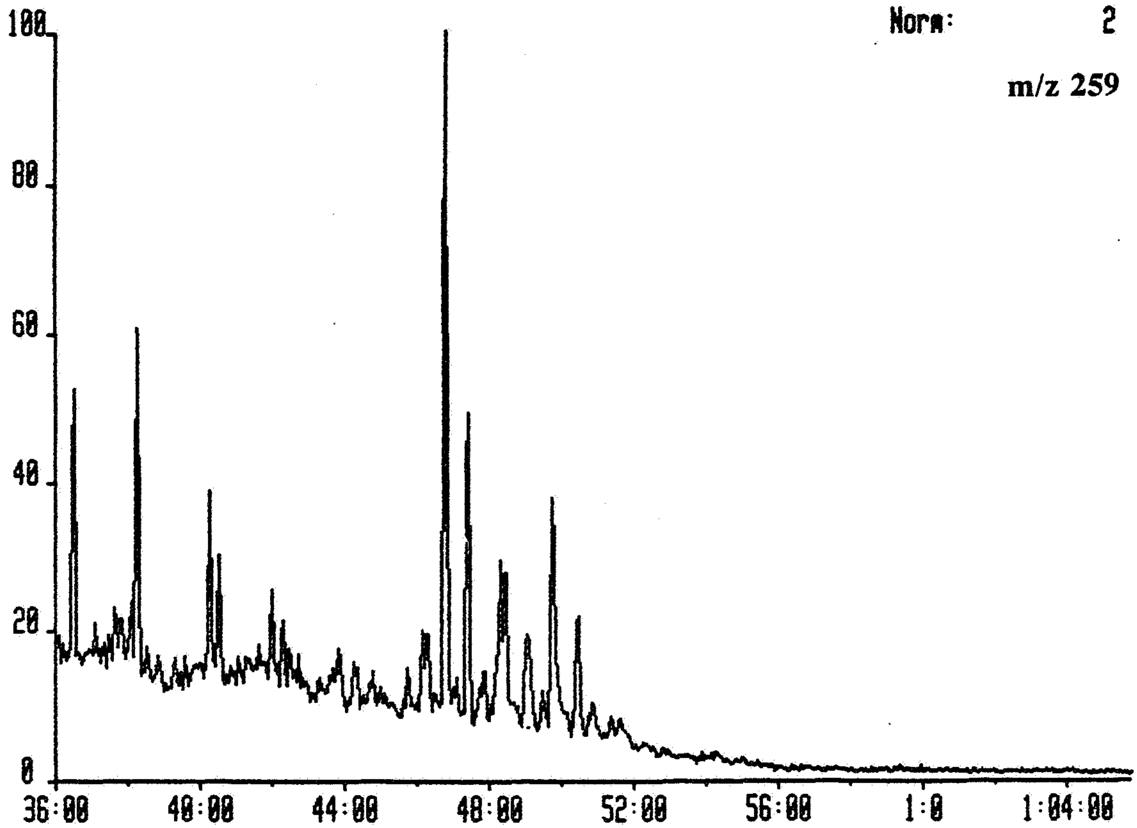
C6708 7-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 259.1000
Text:



C6709 7-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 231.1000
Text:



C6709 7-OCT-87 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
Sample 1 Injection 1 Group 1 Mass 259.1000
Text:



Appendix E
Biomarker analyses

Gas chromatography - mass spectrometry (GC-MS)

GC-MS analyses were performed on a VG Quadrupole 12-250 GC-MS system. The HP 5790A Series GC was fitted with a fused silica DB-5 capillary column (30 m x 0.32 mm i.d.). Helium (1.5 ml/min) was used as carrier gas and the injections were performed in split mode (1.5 µl, split ratio 1:15).

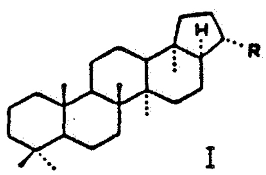
The GC oven was programmed from 120°C (2 min.) to 280°C at 4°C/min. for analysis of the saturated hydrocarbons.

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

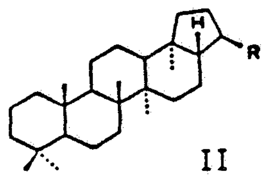
Peaks were identified by comparison with elution patterns in certain mass chromatograms. Peak ratios were calculated from peak heights in the appropriate mass chromatograms.

Mass chromatograms representing terpanes (m/z 191)

P	tricyclic terpane	$C_{23}H_{42}$	(IV,R=C_4H_9)
Q	tricyclic terpane	$C_{24}H_{44}$	(IV,R=C_5H_{11})
R	tricyclic terpane (17R,17S)	$C_{25}H_{46}$	(IV,R=C_6H_{13})
S	tetracyclic terpane	$C_{24}H_{42}$	(V)
T	tricyclic terpane (17R,17S)	$C_{26}H_{48}$	(IV,R=C_7H_{15})
A	T_s, 18α(H)-trisnorneohopane	$C_{27}H_{46}$	(III)
B	T_m, 17α(H)-trisnorhopane	$C_{27}H_{46}$	(I,R=H)
Z	bisnorhopane	$C_{28}H_{48}$	
C	17α(H)-norhopane	$C_{29}H_{50}$	(I,R=C_2H_5)
X	unknown triterpane	$C_{30}H_{52}$	
D	17β(H)-normoretane	$C_{29}H_{50}$	(II,R=C_2H_5)
E	17α(H)-hopane	$C_{30}H_{52}$	(I,R=C_3H_7)
F	17β(H)-moretane	$C_{30}H_{52}$	(II,R=C_3H_7)
G	17α(H)-homohopane (22S)	$C_{31}H_{54}$	(I,R=C_4H_9)
H	17α(H)-homohopane (22R)	$C_{31}H_{54}$	(I,R=C_4H_9)
	+ unknown triterpane (gammacerane?)		
I	17β(H)-homomoretane	$C_{31}H_{54}$	(II,R=C_4H_9)
J	17α(H)-bishomohopane (22S,22R)	$C_{32}H_{56}$	(I,R=C_5H_{11})
K	17α(H)-trishomohopane (22S,22R)	$C_{33}H_{58}$	(I,R=C_6H_{13})
L	17α(H)-tetrakishomohopane (22S,22R)	$C_{34}H_{60}$	(I,R=C_7H_{15})
M	17α(H)-pentakishomohopane (22S,22R)	$C_{35}H_{62}$	(I,R=C_8H_{17})



I



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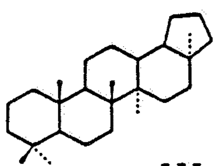

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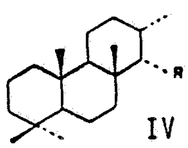
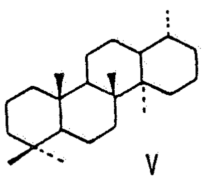


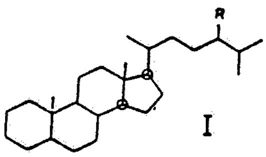
IV



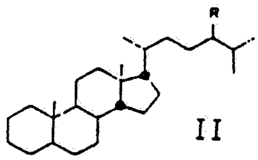
V

Mass chromatograms representing steranes (m/z 217 and 218)

128	u	5α(H)-sterane	$C_{21}H_{36}$	(V,R=C_2H_5)
130	v	5α(H)-sterane	$C_{22}H_{38}$	(V,R=C_3H_7)
	a	13β(H),17α(H)-diasterane (20S)	$C_{27}H_{48}$	(III,R=H)
	b	13β(H),17α(H)-diasterane (20R)	$C_{27}H_{48}$	(III,R=H)
	c	13α(H),17β(H)-diasterane (20S)	$C_{27}H_{48}$	(IV,R=H)
	d	13α(H),17β(H)-diasterane (20R)	$C_{27}H_{48}$	(IV,R=H)
	e	13β(H),17α(H)-diasterane (20S)	$C_{28}H_{50}$	(III,R=CH_3)
	f	13β(H),17α(H)-diasterane (20R)	$C_{28}H_{50}$	(III,R=CH_3)
	g	13α(H),17β(H)-diasterane (20S)	$C_{28}H_{50}$	(IV,R=CH_3)
		+ 14α(H),17α(H)-sterane (20S)	$C_{27}H_{48}$	(I,R=H)
	h	13β(H),17α(H)-diasterane (20S)	$C_{29}H_{52}$	(III,R=C_2H_5)
		+ 14β(H),17β(H)-sterane (20R)	$C_{27}H_{48}$	(II,R=H)
	i	14β(H),17β(H)-sterane (20S)	$C_{27}H_{48}$	(II,R=H)
		+ 13α(H),17β(H)-diasterane (20R)	$C_{28}H_{50}$	(IV,R=CH_3)
	j	14α(H),17α(H)-sterane (20R)	$C_{27}H_{48}$	(I,R=H)
	k	13β(H),17α(H)-diasterane (20R)	$C_{29}H_{52}$	(III,R=C_2H_5)
	l	13α(H),17β(H)-diasterane (20S)	$C_{29}H_{52}$	(IV,R=C_2H_5)
	m	14α(H),17α(H)-sterane (20S)	$C_{28}H_{50}$	(I,R=CH_3)
	n	13α(H),17β(H)-diasterane (20R)	$C_{29}H_{52}$	(IV,R=C_2H_5)
		+ 14β(H),17β(H)-sterane (20R)	$C_{28}H_{50}$	(II,R=CH_3)
	o	14β(H),17β(H)-sterane (20S)	$C_{28}H_{50}$	(II,R=CH_3)
	p	14α(H),17α(H)-sterane (20R)	$C_{28}H_{50}$	(I,R=CH_3)
	q	14α(H),17α(H)-sterane (20S)	$C_{29}H_{52}$	(I,R=C_2H_5)
	r	14β(H),17β(H)-sterane (20R)	$C_{29}H_{52}$	(II,R=C_2H_5)
		+ unknown sterane		
	s	14β(H),17β(H)-sterane (20S)	$C_{29}H_{52}$	(II,R=C_2H_5)
	t	14α(H),17α(H)-sterane (20R)	$C_{29}H_{52}$	(I,R=C_2H_5)



I



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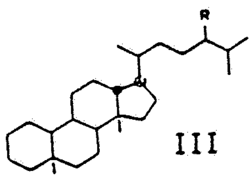
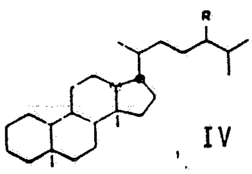


III



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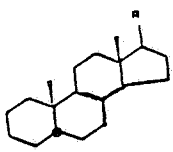

V

Table 4: Molecular ratios from terpane and sterane mass chromatograms.
Maturity and source characteristic ratios.

IKU code	Statoil no.	Q/E 1)	Tm/Ts 2)	X/E 3)	Z/E 4)	a/a+j 5)	Depth (m)
Source rocks							
C 6721	S 2351 I	-	22.3	0.03	-	0.43	2535.40
C 6722	S 2352 I	-	-	0.03	-	0.32	2540.32
C 6723	S 2367 I	-	-	0.08	0.15	0.34	2914
C 6724	S 2369 I	-	-	0.06	-	0.50	2926
C 6725	S 2370 I	-	-	0.04	-	0.56	2965
C 6726	S 2371 I	-	-	0.02	-	0.43	2983
C 6727	S 2372 I	0.08	7.8	0.08	0.08	0.51	2998
C 6728	S 2373 I	-	-	0.06	-	0.73	3028
C 6729	S 2374 AI	-	-	0.06	-	0.54	3055
C 6730	S 2374 BI	0.09	8.1	0.08	0.24	0.52	3055
C 6731	S 2377 I	-	14.1	0.05	0.09	0.60	3154
C 6732	S 2378 I	0.04	-	0.07	0.05	0.67	3193

1) Relative abundance of tricyclic terpanes (Q/E in m/z 191)
2) B/A in m/z 191
3) Relative abundance of unknown (X/E in m/z 191)
4) Relative abundance of bisnorhopane (Z/E in m/z 191)
5) Relative abundance of C27 rearranged steranes (a/a+j in m/z 217)

Table 4: Molecular ratios from terpane and sterane mass chromatograms.
Maturity and source characteristic ratios.

IKU code	Statoil no	Q/E 1)	Tm/Ts 2)	X/E 3)	Z/E 4)	a/a+j 5)	Depth (m)
Sandstones							
C 6710	S 2337	0.30	1.44	0.04	0.10	0.91	2473.39
C 6711	S 2338	0.27	1.27	0.04	0.09	0.88	2481.08
C 6712	S 2339	0.20	1.40	0.04	0.08	0.85	2499.75
C 6713	S 2341	0.30	1.38	0.04	0.11	0.87	2514.79
C 6714	S 2342	0.29	1.33	0.05	0.08	0.84	2552.36
C 6715	S 2343	0.36	1.39	0.06	0.08	0.87	2560.10
C 6716	S 2344	0.12	1.56	0.04	0.06	0.89	2564.25
C 6717	S 2345	0.23	1.53	0.05	0.08	0.88	2575.86
C 6718	S 2346	0.20	1.10	0.05	0.03	0.97	2578.89
C 6719	S 2347	0.62	0.92	0.03	0.12	0.86	2601.34
C 6720	S 2348	1.33	1.12	-	-	0.88	2604.80
Oil samples							
C 6707	S 2077, DST 1	0.07	2.27	0.04	0.03	0.87	
C 6708	S 2078, DST 2	0.64	1.06	-	0.09	0.92	
C 6709	S 2079, DST 3	1.07	1.21	-	0.06	0.94	

1) Relative abundance of tricyclic terpanes (Q/E in m/z 191)
2) B/A in m/z 191
3) Relative abundance of unknown (X/E in m/z 191)
4) Relative abundance of bisnorhopane (Z/E in m/z 191)
5) Relative abundance of C27 rearranged steranes (a/a+j in m/z 217)

Table 5

Peak heights in m/z 191 and m/z 217 mass chromatograms

Source rock samples

C-6721 SAT , S 2351I , 2535.40m

Peak heights from m/z 191 and 217 mass chromatograms.

m/z 191

Peak identities	Peak heights
P	
Q	
R	
S	3
T	
A	2
B	44,5
Z	
C	64
X	3
D	23
E	99
F	29
G	37,5
H	28
I	13
J_1	6
J_2	11
K_1	
K_2	
L_1	
L_2	
M_1	
M_2	

m/z 217

Peak identities	Peak heights
u	
v	
a	35
b	29
c	15
f	
g	
h	69
i	
j	47
k	51
n	32
o	20
p	24
q	17
r	41
s	23
t	88

C-6722 SAT , S 2352I , 2540.32m

Peak heights from m/z 191 and 217 mass chromatograms.

m/z 191

Peak identities	Peak heights
P	
Q	
R	
S	
T	
A	
B	49
Z	
C	61
X	3
D	26
E	98
F	31
G	45
H	32
I	
J_I	4,5
J_2	9
K_1	
K_2	
L_1	
L_2	
M_1	
M_2	

m/z 217

Peak identities	Peak heights
u	
v	
a	17
b	13
c	9
f	
g	
h	40
i	
j	35,5
k	34
n	
o	
p	22
q	14
r	28,5
s	
t	87,5

C-6723 SAT , S 2367I, 2914m

Peak heights from m/z 191 and 217 mass chromatograms.

m/z 191

Peak identities	Peak heights
P	
Q	
R	
S	
T	
A	
B	97
Z	13,5
C	86
X	7
D	27
E	88,5
F	22
G	40
H	24
I	12
J_I	11
J_2	8
K_1	2
K_2	1,5
L_1	
L_2	
M_1	
M_2	

m/z 217

Peak identities	Peak heights
u	
v	
a	7
b	4,5
c	5
f	
g	
h	86
i	
j	13,5
k	60
n	
o	
p	9
q	20
r	29
s	16
t	42,5

C-6724 SAT , S 2369I, 2926m

Peak heights from m/z 191 and 217 mass chromatograms.

m/z 191 Peak identities	m/z 191 Peak heights	m/z 217 Peak identities	m/z 217 Peak heights
P		u	
Q		v	
R		a	12
S		b	4,5
T		c	5
A		f	
B	100	g	
Z		h	85
C	77,5	i	
X	4	j	12
D	25,5	k	55
E	70	n	
F	27,5	o	
G	36,5	p	15
H	24	q	53
I	11,5	r	39
J_I	10	s	26
J_2	7,5	t	92
K_1	1,5		
K_2	1,0		
L_1			
L_2			
M_1			
M_2			

C-6725 SAT, S 2370I, 2965m

Peak heights from m/z 191 and 217 mass chromatograms.

m/z 191

Peak identities	Peak heights
P	
Q	
R	
S	
T	
A	
B	101,5
Z	
C	84
X	3
D	32
E	81
F	39
G	40,5
H	35
I	28
J_I	18,5
J_2	13
K_1	4
K_2	2,5
L_1	
L_2	
M_1	
M_2	

m/z 217

Peak identities	Peak heights
u	
v	
a	9
b	5,5
c	
f	
g	
h	57
i	
j	7
k	32
n	
o	
p	14
q	56
r	31
s	17
t	96

C-6726 SAT, S 2371I, 2983m

Peak heights from m/z 191 and 217 mass chromatograms.

m/z 191 Peak identities	m/z 191 Peak heights	m/z 217 Peak identities	m/z 217 Peak heights
P		u	
Q		v	
R		a	3
S		b	
T		c	
A		f	
B	99	g	
Z		h	45
C	101	i	
X	2	j	4
D	38	k	27
E	97,5	n	
F	36	o	
G	41	p	10
H	27,5	q	48
I	11	r	29
J_I	8	s	15
J_2	5	t	96
K_1			
K_2			
L_1			
L_2			
M_1			
M_2			

C-6727 SAT , S 2372I, 2998m

Peak heights from m/z 191 and 217 mass chromatograms.

m/z 191 Peak identities	Peak heights	m/z 217 Peak identities	Peak heights
P	17	u	
Q	7	v	
R	7	a	88,5
S	24	b	69
T	4,5	c	38
A	12	f	
B	94	g	
Z	7	h	64
C	67	i	
X	7	j	84
D	21	k	50
E	85	n	
F	20	o	
G	32,5	p	29
H	23	q	19,5
I	10	r	24
J_I	5,5	s	
J_2	6	t	59
K_1	2		
K_2	2		
L_1			
L_2			
M_1			
M_2			

C-6728 SAT , S 2373I , 3028m

Peak heights from m/z 191 and 217 mass chromatograms.

m/z 191 Peak identities	m/z 191 Peak heights	m/z 217 Peak identities	m/z 217 Peak heights
P		u	
Q		v	
R		a	18,5
S		b	11
T		c	9
A		f	
B	101	g	
Z		h	86
C	69,5	i	
X	3,5	j	7
D	23	k	45
E	62	n	
F	21	o	
G	24,5	p	13
H	17	q	49
I	8	r	29
J_1	7	s	14
J_2	4	t	75
K_1			
K_2			
L_1			
L_2			
M_1			
M_2			

C-6729 SAT , S 2374AI , 3055m

Peak heights from m/z 191 and 217 mass chromatograms.

m/z 191 Peak identities	m/z 191 Peak heights	m/z 217 Peak identities	m/z 217 Peak heights
P		u	
Q		v	
R		a	15
S		b	10
T		c	7,5
A		f	
B	101	g	
Z		h	86
C	98	i	
X	4,5	j	13
D	30	k	56
E	76	n	
F	25	o	
G	32	p	14,5
H	20	q	60
I	7,5	r	33,5
J_1	8	s	22
J_2	6	t	87,5
K_1			
K_2			
L_1			
L_2			
M_1			
M_2			

C-6730 SAT , S 2374BI , 3055m

Peak heights from m/z 191 and 217 mass chromatograms.

m/z 191 Peak identities	m/z 191 Peak heights	m/z 217 Peak identities	m/z 217 Peak heights
P	17	u	
Q	9	v	
R	8	a	93
S	27,5	b	72
T	6	c	37,5
A	11	f	
B	89	g	
Z	24	h	61
C	81	i	
X	8	j	85
D	27	k	43
E	98	n	
F	26	o	
G	41,5	p	24
H	29,5	q	16
I	14	r	22
J_1	8	s	
J_2	10	t	62
K_1	3		
K_2	3,5		
L_1			
L_2			
M_1			
M_2			

C-6731 SAT , S 2377I, 3154m

Peak heights from m/z 191 and 217 mass chromatograms.

m/z 191 Peak identities	m/z 191 Peak heights	m/z 217 Peak identities	m/z 217 Peak heights
P		u	
Q		v	
R		a	18
S	11	b	11
T		c	13,5
A	7	f	
B	99	g	
Z	7	h	85
C	98	i	
X	4	j	12
D	26	k	54
E	74	n	
F	23	o	
G	31,5	p	10
H	19	q	46,5
I	9,5	r	27
J_I	11	s	17,5
J_2	8,5	t	65
K_1	2,5		
K_2	1,5		
L_1			
L_2			
M_1			
M_2			

C-6732 SAT , S 2378I, 3193m

Peak heights from m/z 191 and 217 mass chromatograms.

m/z 191 Peak identities	Peak heights	m/z 217 Peak identities	Peak heights
P	2	u	
Q	3,5	v	
R		a	24,5
S	24	b	15
T		c	10
A		f	
B	85	g	
Z	4,5	h	79
C	99	i	
X	6	j	12
D	29	k	50
E	86,5	n	
F	37	o	
G	48	p	13,5
H	36	q	56
I	17	r	30
J_I	26	s	21
J_2	19	t	94
K_1	7		
K_2	5		
L_1	3,5		
L_2	2		
M_1			
M_2			

Sandstones

C-6710 SAT, S 2337, 2473.39m

Peak heights from m/z 191 and 217 mass chromatograms.

m/z 191 Peak identities	m/z 191 Peak heights	m/z 217 Peak identities	m/z 217 Peak heights
P	30,5	u	
Q	29	v	
R	17,5	a	92,5
S	14	b	60
T	7	c	24
A	22,5	f	
B	32,5	g	
Z	10	h	68
C	65	i	
X	4	j	9,5
D	3,5	k	40
E	97,5	n	
F	3	o	
G	24,5	p	9,5
H	14,5	q	13
I		r	28
J_I	6,5	s	23
J_2	3,5	t	12
K_1	2		
K_2	1		
L_1			
L_2			
M_1			
M_2			

C-6711 SAT , S 2338, 2481.08m

Peak heights from m/z 191 and 217 mass chromatograms.

m/z 191 Peak identities	m/z 191 Peak heights	m/z 217 Peak identities	m/z 217 Peak heights
P	29	u	
Q	26	v	
R	16	a	93
S	15	b	54
T	6	c	21,5
A	26	f	
B	33	g	
Z	9	h	59
C	64	i	
X	4	j	12,5
D	3	k	31
E	98	n	
F	4	o	
G	25	p	7
H	15,5	q	11,5
I		r	25
J_I	7,5	s	20,5
J_2	4,5	t	11
K_1	1,5		
K_2	1		
L_1			
L_2			
M_1			
M_2			

C-6712 SAT, S 2339, 2499.75m

Peak heights from m/z 191 and 217 mass chromatograms.

m/z 191 Peak identities	Peak heights	m/z 217 Peak identities	Peak heights
P	23	u	
Q	19,5	v	
R	13	a	95
S	11,5	b	60
T	4,5	c	24,5
A	21	f	
B	29,5	g	
Z	8	h	68
C	59	i	
X	4	j	17
D	3	k	39
E	99	n	
F	3	o	
G	23	p	10
H	12,5	q	15,5
I		r	29,5
J_I	6	s	24
J_2	3,5	t	13,5
K_1	1,5		
K_2	1		
L_1			
L_2			
M_1			
M_2			

C-6713 SAT, S 2341, 2514.79m

Peak heights from m/z 191 and 217 mass chromatograms.

m/z 191

Peak identities	Peak heights
P	40
Q	29,5
R	23,5
S	21
T	9
A	34
B	27,5
Z	11
C	67
X	4
D	4
E	100
F	3
G	25
H	14
I	
J_I	7,5
J_2	5
K_1	2
K_2	1
L_1	
L_2	
M_1	
M_2	

m/z 217

Peak identities	Peak heights
u	
v	
a	93
b	61
c	26
f	
g	
h	64
i	
j	14
k	36
n	
o	
p	8
q	11
r	23
s	17
t	10

C-6714 SAT, S 2342, 2552.36m

Peak heights from m/z 191 and 217 mass chromatograms.

m/z 191		m/z 217	
Peak identities	Peak heights	Peak identities	Peak heights
P	31	u	
Q	27,5	v	
R	17	a	90,5
S	15	b	57
T	7,5	c	23
A	24	f	
B	32	g	
Z	7,5	h	70
C	62,5	i	
X	5	j	17
D	3,5	k	37
E	95	n	
F	4	o	
G	26	p	8
H	20	q	12
I		r	26
J_1	8,5	s	21
J_2	6	t	15
K_1	2,5		
K_2	1,5		
L_1			
L_2			
M_1			
M_2			

C-6715 SAT, S 2343, 2560.10m

Peak heights from m/z 191 and 217 mass chromatograms.

m/z 191 Peak identities	m/z 191 Peak heights	m/z 217 Peak identities	m/z 217 Peak heights
P	37,5	u	
Q	34,5	v	
R	25	a	92,5
S	20	b	59
T	10	c	25
A	31	f	
B	43	g	
Z	7,5	h	65,5
C	67	i	
X	6	j	13,5
D	4	k	35
E	96,5	n	
F	3,5	o	
G	25,5	p	8
H	13,5	q	11
I		r	21
J_I	8	s	19
J_2	5	t	11
K_1	2,5		
K_2	1,5		
L_1			
L_2			
M_1			
M_2			

C-6716 SAT , S 2344, 2564.25m

Peak heights from m/z 191 and 217 mass chromatograms.

m/z 191 Peak identities	m/z 191 Peak heights	m/z 217 Peak identities	m/z 217 Peak heights
P	12,5	u	
Q	12	v	
R	7	a	94
S	11	b	51
T	5	c	21
A	32	f	
B	50	g	
Z	6	h	82
C	78	i	
X	4	j	12
D	3	k	32
E	98	n	
F	2	o	
G	22	p	7
H	11,5	q	8
I		r	13,5
J_1	5	s	13
J_2	4	t	8
K_1	5,5		
K_2	3		
L_1			
L_2			
M_1			
M_2			

C-6717 SAT, S 2345, 2575.86m

Peak heights from m/z 191 and 217 mass chromatograms.

m/z 191 Peak identities	m/z 191 Peak heights	m/z 217 Peak identities	m/z 217 Peak heights
P	20	u	
Q	22,5	v	
R	18,5	a	94
S	20,5	b	63
T	10,5	c	24
A	42,5	f	
B	65	g	
Z	8	h	72
C	64	i	
X	5	j	13
D	3	k	34
E	98	n	
F	2	o	
G	20	p	6
H	12	q	8,5
I		r	16
J_1	6	s	12,5
J_2	4	t	7
K_1	2		
K_2	1		
L_1			
L_2			
M_1			
M_2			

C-6718 SAT , S 2346, 2578.89m

Peak heights from m/z 191 and 217 mass chromatograms.

m/z 191

Peak identities	Peak heights
P	18
Q	20
R	25
S	36
T	13
A	14,5
B	16
Z	2,5
C	61
X	4,5
D	3
E	99
F	2
G	27,5
H	16
I	
J_1	13
J_2	7
K_1	4
K_2	2
L_1	
L_2	
M_1	
M_2	

m/z 217

Peak identities	Peak heights
u	
v	
a	96
b	50,5
c	14
f	
g	
h	20,5
i	
j	3
k	6,5
n	
o	
p	
q	
r	4
s	3
t	

C-6719 SAT, S 2347, 2601.34m

Peak heights from m/z 191 and 217 mass chromatograms.

m/z 191

Peak identities	Peak heights
P	83,5
Q	46
R	23,5
S	22
T	8
A	19,5
B	18
Z	9
C	48
X	2
D	5
E	74
F	3
G	11
H	19
I	
J_I	3,5
J_2	2,3
K_1	
K_2	
L_1	
L_2	
M_1	
M_2	

m/z 217

Peak identities	Peak heights
u	
v	
a	94
b	47
c	13,5
f	
g	
h	59
i	
j	15
k	31
n	
o	
p	7
q	9,5
r	22
s	19
t	11

C-6720 SAT, S 2348, 2604.80m

Peak heights from m/z 191 and 217 mass chromatograms.

m/z 191		m/z 217	
Peak identities	Peak heights	Peak identities	Peak heights
P	74	u	
Q	48	v	
R	21,5	a	83,5
S	23	b	48
T	10	c	15
A	17	f	
B	19	g	
Z		h	32,5
C	29,5	i	
X		j	11
D	2	k	27
E	36	n	
F	2	o	
G	7	p	7,5
H	11	q	7,5
I		r	12
J_1		s	10,5
J_2		t	9
K_1			
K_2			
L_1			
L_2			
M_1			
M_2			

Oil samples

C-6707 SAT, S 2077, DST 1

Peak heights from m/z 191 and 217 mass chromatograms.

m/z 191 Peak identities	Peak heights	m/z 217 Peak identities	Peak heights
P	6,5	u	
Q	6,5	v	
R	4,5	a	92
S	5	b	56,5
T	2	c	22,5
A	11	f	
B	25	g	
Z	3	h	66
C	47,5	i	
X	4	j	14
D	5	k	40
E	98	n	
F	6,5	o	
G	38,5	p	12
H	24,5	q	20
I	3,5	r	38
J_1	17	s	39
J_2	10,5	t	26,5
K_1	6		
K_2	3,5		
L_1			
L_2			
M_1			
M_2			

IKU SINTEF-GRUPPEN

C-6708 SAT, S 2078, DST 2

Peak heights from m/z 191 and 217 mass chromatograms.

m/z 191 Peak identities	m/z 191 Peak heights	m/z 217 Peak identities	m/z 217 Peak heights
P	65	u	
Q	59	v	
R	32	a	90
S	34	b	56
T	14	c	20
A	36	f	
B	38	g	
Z	8	h	49
C	49,5	i	
X		j	8
D		k	28
E	92,5	n	
F	4	o	
G	25	p	
H	14	q	6
I		r	13
J_1	9	s	9
J_2	4	t	7
K_1			
K_2			
L_1			
L_2			
M_1			
M_2			

C-6709 SAT, S 2079, DST 3

Peak heights from m/z 191 and 217 mass chromatograms.

m/z 191 Peak identities	m/z 191 Peak heights	m/z 217 Peak identities	m/z 217 Peak heights
P	78,5	u	
Q	79	v	
R	37	a	93
S	27	b	44
T	12	c	13
A	16,5	f	
B	20	g	
Z	4,5	h	40
C	33	i	
X		j	6
D		k	16
E	74	n	
F		o	
G	15	p	
H	13	q	5
I		r	9
J_I	6	s	7
J_2	3	t	4
K_1			
K_2			
L_1			
L_2			
M_1			
M_2			

Appendix F
Data report on isotopic analyses

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ISOTOPANALYSE BRØNN 6407/6-3

T-6269 NR. 102

1. INNLEDNING

123 helolje/ekstraktfraksjoner, 11 kerogenkonsentrat og 5 hermetiske bokser ble mottatt for isotopanalyse september/oktober 1987.

$\delta^{13}C$ er bestemt i helolje/ekstraktfraksjonene og i kerogenkonsentratene.

I de hermetiske boksene er headspace gassen kvantifisert, og $\delta^{13}C$ er bestemt på C_1-C_4 når det har vært mulig.
På grunn av for lav C_1-konsentrasjon har det ikke vært mulig med bestemmelse av δD på C_1.

2. ANALYSEPROSEDYRER

2.1 Helolje/ekstraktfraksjoner

2-3 mg (eller så mye som mulig) av prøven forbrennes i glassampuller med CuO ved 550°C i 1 time.

2.2 Kerogenkonsentrat

Prøven forbrennes med CuO ved 900°C i 5-10 min. i et separat lukket forbrenningssystem.

2.3 Hermetiske bokser

Headspace gassen er kvantifisert og separert i de forskjellige gasskomponenter av et Carlo Erba 4200 instrument. Denne gasskromatografen er utstyrt med en spesiell injeksjonsloop for oppkonsentrering av gassen ved lave konsentrasjoner av de forskjellige komponentene. De forskjellige komponentene er oksydert i separate CuO-ovner for å unngå krysskontaminering. Forbrenningsproduktene CO_2 og H_2O er separert før analyse.

Alle isotopbestemmelsene er foretatt på et Finnigan Mat 251 massespektrometer. Vår $\delta^{13}C$ verdi på NBS 22 er -29.77 ± 0.06 o/oo PDB.

3. RESULTATER

$^{13}C/^{12}C$ isotopverdiene for helolje/ekstraktfraksjoner er gitt i Tabell 1. Tabell 2 viser tilsvarende for kerogenkonsentrat. Volumsammensetningen av headspace gassen er gitt i Tabell 3. Resultatene er relativt til luft og normalisert. Isotopsammensetningen av headspace gassen er gitt i Tabell 4.

Usikkerheten i $\delta^{13}C$ verdien for headspace gassen er estimert til ± 0.3 o/oo og inkluderer alle forskjellige analysetrinn.

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<u>Tabell 1</u> $\delta^{13}C$ i helolje/ekstraktfraksjoner brønn 6407/6-3

			$\delta^{13}C$ PDB			
Prøve nr.	IFE nr.	Tot EOM	SAT	ARO	NSO	ASF
S 2337	6899	-29.3	-29.9	-	-28.5	-28.6
S 2338	6900	-29.3	-29.9	-28.6	-28.8	-28.6
S 2339	6901	-29.2	-29.8	-	-29.2	-28.5
S 2341	6902	-29.2	-29.9	-	-28.9	-28.9
S 2342	6903	-29.2	-29.6	-	-28.9	-28.4
S 2343	6904	-29.6	-29.7	-	-29.2	-28.7
S 2344	6905	-29.2	-29.8	-28.8	-28.9	-28.0
S 2345	6906	-29.4	-29.7	-29.0	-29.3	-29.3
S 2346	6907	-29.5	-29.8	-29.5	-29.3	-29.4
S 2347	6908	-29.5	-29.9	-28.8	-	-28.1
S 2348	6909	-29.3	-29.9	-	-29.2	-28.2
S 2077*	6910	-29.4	-29.7	-29.2	-29.1	-29.0
S 2078*	6911	-29.3	-29.4	-28.2	-28.5	-29.0
S 2079*	6912	-29.2	-29.3	-28.0	-27.8	-28.1
S 2351	6913	-27.8	-30.9	-25.8	-26.8	-26.2
S 2352	6914	-26.9	-28.9	-26.2	-27.9	-26.0
S 2367	6915	-26.4	-29.0	-27.2	-26.6	-25.7
S 2369	6916	-26.2	-28.2	-26.3	-26.2	-25.7
S 2370	6917	-25.6	-28.1	-26.7	-26.1	-25.1
S 2371	6918	-26.2	-28.6	-26.4	-26.4	-26.1
S 2372	6919	-28.9	-30.3	-29.1	-28.8	-27.8
S 2373	6920	-26.6	-29.2	-26.9	-26.7	-25.7
S 2374 A	6921	-26.8	-29.3	-27.0	-26.5	-26.3
S 2374 B	6922	-28.9	-31.5	-29.1	-29.1	-28.2
S 2377	6923	-28.7	-31.4	-28.7	-27.8	-28.0
S 2378	6924	-28.1	-32.7	-28.7	-28.1	-27.5

* helolje

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Tabell 2 $\delta^{13}C$ i kerogenkonsentrat, brønn 6407/6-3

IKU nr.	Statoil ID	IFE nr.	$\delta^{13}C_{PDB}$
C 6733	S 2351	6973	-24.3
C 6737	S 2367	6974	-26.0
C 6738	S 2369	6975	-25.5
C 6739	S 2370	6976	-24.9
C 6740	S 2371	6977	-25.3
C 6741	S 2372	6978	-27.8
C 6742	S 2373	6979	-26.0
C 6743	S 2374 A	6980	-26.0
C 6744	S 2374 B	6981	-27.2
C 6746	S 2377	6982	-27.8
C 6747	S 2378	6983	-27.8

Tabell 3 Volumsammensetning av headspace gass, brønn 6407/6-3, relativt til luft og normalisert

Prøve	IFE nr.	C_1 %	C_2 %	C_3 %	iC_4 %	nC_4 %	Våthet	$\frac{iC_4}{nC_4}$
2443-52 m	6968	43.10	18.97	24.57	4.31	9.05	0.57	0.48
2452-61 m	6969	50.34	17.79	20.81	3.69	7.38	0.50	0.50
2461-70 m	6970	51.72	14.78	19.21	4.68	9.61	0.48	0.49
2471-80 m	6971	62.50	3.13	12.50	6.25	15.63	0.38	0.40
2489-98 m	6972	58.35	11.27	18.71	3.82	7.85	0.42	0.49

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Tabell 4 Isotopsammensetning av headspace gass, brønn 6407/6-3

Prøve	IFE nr.	C_1 $\delta^{13}C$	C_2 $\delta^{13}C$	C_3 $\delta^{13}C$	iC_4 $\delta^{13}C$	nC_4 $\delta^{13}C$
2443-52 m	6968	-29.5	-26.7	-28.4	-29.0	-29.8
2452-61 m	6969	-46.4	-31.3	-30.6	-29.9	-30.6
2461-70 m	6970	-39.2	-30.9	-29.3	-28.9	-30.4
2471-80 m	6971	-35.5				
2489-98 m	6972	-23.9	-30.2	-30.0	-29.3	-30.1