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Source Rock/Oil Correlation for Well 30/6-4.			
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SUMMARY/ SAMMENDRAG

Two oils and samples from five source rock horizons were analysed. The source rock horizons were immature to moderate mature and as a result there were considerable differences in biomarker patterns in comparison with the oils. A tentative correlation with oils could be made for the two samples from the section between 2415-2565 metres, which is also the richest oil-prone source rock sequence in the well.

KEY WORDS/ STIKKORD

Source Rocks	Oil Correlation
Biomarkers	Isotopes

077/c/1

Skipnes Offsettrykkeri A/S

CONTENTS

SOURCE ROCK - CRUDE OIL CORRELATION, WELL 30/6-4

EXPERIMENTAL

Extraction

Five cuttings samples were extracted in a flow through system (Radke et al., Anal. Chem. 49, 663-665) for 10 min. using dichloromethane (DCM) as solvent. The DCM used as solvent was distilled in an all glass apparatus to remove contaminants.

Activated copper fillings were used to remove any free sulphur from the samples.

After extraction, the solvent was removed on a Buchi Rotavapor and transferred to a 50ml flask. The rest of the solvent was then removed and the amount of extractable organic matter (EOM) determined.

Chromatographic Separation

The extractable organic matter (EOM) was separated into saturated fraction, aromatic fraction and non hydrocarbon fraction using a MPLC system with hexane as eluant (Radke et al., Anal. Chem., 1980). The various fractions were evaporated to low bulk on a Buchi Rotavapor and transferred to glass vials and dried in stream of nitrogen. The two oils were separated using the same system.

Gas chromatographic analyses

The saturated and aromatic hydrocarbon fractions were diluted with n-hexane and analysed on a HP 5730A gas chromatograph, fitted with a 25 m OV-101 glass capillary column and an automatic injection system. Hydrogen (0.7 ml/min.) was used as carrier gas and the injection was performed in the split mode (1:20). The oven temperature was program from 60-260^{o}C at 4^{o}/min. The oils were analysed on the same gas chromatograph system. Saturated and aromatic hydrocarbon gas chromatograms are shown in Appendix 1.

GC/MS Analysis

Seven saturated and aromatic hydrocarbon fractions were analysed by Selected Ion Monitoring (SIM) and Sequential Scanning using a VG-Micromass 70-70 double focusing magnetic mass spectrometer coupled directly to a Varian 3700 gas chromatograph via an all-glass line. A 20 metre by 0.3 mm I.D. glass capillary column coated with OV-1 was temperature programmed from 120^{o}C to 260^{o}C at 4^{o}C/min. with helium carrier gas at a flow rate of 1ml/minute. Data aquisition was by a VG data system. The sequential scanning was performed at 1 sec/decade and SIM recording at 200m/sec dwell time per ion.

Mass fragmentograms for m/z 191, 205, 217, 218 and 231 from saturated hydrocarbon fractions of oils and extracts are shown in appendix 2a. Mass fragmentograms for TOC and m/z 91, 105, 148, 239 and 253 from aromatic hydrocarbon fractions of oils and extracts are shown in appendix 2b.

Isotope Analyses

The samples were burned in a steam of pure oxygen at 800 or 1000^{o}C (kerogen and asphalthenes) at a pressure of 160 torr. The combustion products were passed over copper oxide heated at 900^{o}C to insure complete combustion and over silver wool (450^{o}C) to remove impurities. The resulting water and carbon dioxide were frozen out using a dry ice/methanol mixture and liquid nitrogen respectively at a pressure of approximately 1 torr. The carbon isotopic composition of the CO_2 was measured on a VG 903 mass spectrometer. The water was first reduced to hydrogen by passing it over uranium turnings heated to 700^{o}C and frozen onto activated charcoal at liquid nitrogen temperatures. The hydrogen gas was subsequently analyzed for its deuterium content on a VG 602 mass spectrometer.

All isotope data is reported in the usual delta notation, where

$$\delta = \frac{R_{sample} - R_{standard}}{R_{standard}} \times 1000 \text{ (o/oo)}$$

and where R = D/H or R = $^{13}C/^{12}C$. All values are reported against SMOW and PDB respectively. Sample reproducibility for the interval laboratory standard, Ortland Oil 2.8 o/oo. The $\delta^{13}C$ value of the international standard NBS 22 lubricating oil is -29.8o/oo.

DISCUSSION

The various oils and samples in the well 30/6-4 are each discussed in turn. Any distinct points of similarity of the various sample hydrocarbons to the two oils is stressed.

Oils M-3143 depth interval 2630 - 2638 metres
M-6647 depth interval 2655 - 2665 metres

Both the oils show very similar "fingerprints" (compare gas chromatograms of saturated and aromatic hydrocarbons), and the differences in aromatic hydrocarbons is possibly due to the work-up procedure. The oils are very similar also to the saturate and aromatic hydrocarbon gas chromatogram traces obtained from the extract of sandstone M-3068 (which indicates that useful information can be obtained from oil shows in potential reservoir rocks). See appendix 1.

The saturated hydrocarbon gas chromatograms of the oils have a prominent shoulder of n-alkanes between nC_{20} - nC_{30}, which suggests a waxy source such as cuticular and other herbaceous material. Pristane/phytane ratios of 1.6 for the oils suggests a source which was probably not deposited in a terrestrial environment. High wax oils with high (i.e. 3 or more) pristane/phytane ratio could come from source rocks deposited in terrestrial environments. The relatively low pristane/phytane ratio suggests an origin from a more anoxic - reducing environment - i.e. probably a marine source for these oils.

The aromatic hydrocarbon gas chromatograms of these two oils show some unusual features. Typical aromatic fractions of oils tend to be dominated by the alkyl naphthalenes, including methyl (C_1-), di-alkyl (C_2-) naphthalenes. The aromatic hydrocarbons in this case are dominated by higher molecular weight components, which suggests there has been a loss of low molecular weight components by some alteration process e.g. waterwashing.

Further detail on biomarkers in oils is not discussed here but is included in the conclusions where a comparison is made of the biomarkers of the oils and source rocks.

Before discussion of the various rock extracts it should be emphasised that correlation of mature oils with immature source rocks can only be done on parameters which are not maturity controlled. The "fingerprint" of the common fragmentograms e.g. m/z 217 (steranes) or m/z 191 (triterpanes) changes considerably with increasing maturity. Generally, useful parameters will be 1) unusual compound types in an oil and one source rock, not seen in other potential source rocks or 2) in oils, amounts of stable compound types relative to total fraction e.g. ratio of organic sulphur compounds to total aromatics in the aromatic hydrocarbon fraction.

The fragmentograms used on the aromatic fractions of the oils and potential source rocks were m/z 91, 105 (characteristic for alkyl benzenes), m/z 198 (characteristic of C_1 - dibenzothiophenes) and m/z 239 and 253 (characteristic for aromatised steranes). Other ions were also tried including m/z 184 and 212 (characteristic ions for, amongst other compounds, dibenzothiophene and C_2-dibenzothiophenes) and m/z 192 (characteristic ion for C_1 (methyl) phenanthrenes and anthracenes). These fragmentograms were not very useful in this case. The most useful ions were m/z 91 and 105 fragmentograms, whereas the m/z 198, 239 and 253 fragmentograms are more affected by differences in maturity. The aromatic hydrocarbon fragmentograms for each sample are discussed in detail below.

<u>M-2233</u> (2415 - 2430m)

Peak Z (C_{28} bisnorhopane) which is characteristic of the oils is absent in this sample although the m/z 191 fragmentogram is otherwise fairly similar. The m/z 217 fragmentogram is similar in some respects to the oils in that C_{27} - C_{29} sterane distributions show a tendency to C_{27} compound dominance (see figure 1). The ions employed on the aromatics fraction were: 91, 105, 198, 239 and 253. The homologous series present in the m/z 91 (a characteristic ion for mono-alkyl benzenes) mass fragmentogram is similar to the oils. However the m/z 105 fragmentogram (characteristic for di-alkyl benzenes) is slightly different in that two peaks of the homologous series are particularly prominent in the oils not in M-2233 (marked by asterisk - appendix 2b). The ion characteristic for methyldibenzothiophenes, m/z 198, also indicates differences between M-2233 and the oils. In m/z 198 fragmentogram of M-2233, the 1-methyldibenzothiophene (marked MDBT) is very prominent, but not in the oils. This may be due either to differences in the maturity of the kerogens of M-2233 and the original source of the oil, or to differences in source, but the former is most probable. The m/z 239 mass fragmentogram of oils and this sample are unlike, with the lower molecular weight material dominant in the oils. This is, again, probably a function of maturity. The m/z 253 fragmentogram of M-2233 is similar in number and arrangement of peaks however, in the oils a higher molecular weight compound (one carbon more) dominates.

M-2241 (2535 - 2550m)
The m/z 191 mass fragmentogram shows several features which indicate immaturity including prominent moretanes (peaks D, F and I) and the $C_{32}\alpha\beta$hopane epimers J<K. However, as in the oils, peak Z - the C_{28} bisnorhopane - is present and is the major peak in this fragmentogram. The m/z 217 mass fragmentogram of M-2241 as well as M-2233 is the most similar of all the samples, in some respects, to the oils. Thus the C_{27} sterane (marked i) and diasteranes (a and b) are more prominent in these samples. In the other samples the C_{29} sterane (marked t) is more prominent (figure 1).

The homologous series present in m/z 91 and particularly the m/z 105 fragmentograms (equivalent to alkyl benzenes) is very similar to that of the oils. In the m/z 105 fragmentograms two peaks in the homologous series are more prominent in both the oils and one peak in this sample (the other peak is probably low due to loss on work-up procedures). The m/z 198 fragmentogram of this sample is similar to M-2233 but not similar to the same fragmentogram in the oils. Thus in the m/z 198 fragmentogram the 1-methyldibenzothiophene is larger than the 4-methyl compound, and there is a prominent earlier eluting peak in the samples compared to the oils. This is probably related to the low maturity of the samples. The m/z 239 fragmentogram is quite unlike the oils in that high molecular weight compounds dominate in this sample. The m/z 253 fragmentograms are dissimilar, with several additional peaks present in the extract sample, probably due to maturity difference between the actual source of the oil and the sample analysed rather than any source difference.

M-2245 (2595 - 2610m)
The m/z 191 mass fragmentogram shows several dissimilar features. In the oils the $\alpha\beta C_{30}$ hopane (E) is very prominent, whereas in M-2245 the $C_{29}\alpha\beta$ (C) and the $C_{31}\alpha\beta$ (G and H) hopanes are almost as abundant.

The moretanes (D, F and I) are more prominent in the samples than in the oils as also is the C_{27} 17α(H) trisnorhopane (B). Peak Z is virtually absent in the sample. The differences are mainly maturity-related, except for the absence of peak Z.

The m/z 217 mass fragmentogram shows at least two dissimilar features which are partly maturity effects, partly input differences. The C_{29} sterane (peak t) is the dominant sterane in these samples unlike the oils and samples above this section. The diasteranes are relatively minor components (e.g. a and b) unlike both the oils and the samples M-2233 and M-2241. Diasteranes become more prominent with increasing maturity, however, the diasteranes are less abundant in this sample than in M-2233 and M-2241, which are slightly less mature, and is related to input differences and perhaps also to differences in the depositional environments.

The alkyl benzene mass fragmentogram m/z 91 is quite different to the oils and shows a much less well developed homology (short range, dominated by non-homologous peaks). The m/z 105 mass fragmentogram shows a clearer homologous series. The m/z 198 fragmentogram of M-2245 shows slightly more similarity to the oils than the samples above. The m/z 239 and 253 mass fragmentograms are dissimilar to the oils in that lower molecular weight compounds dominate in the samples unlike the oils.

M-2256 and M-2264, (2775 - 2790m, 2895 - 2910m)
Show many similarities to each other and are discussed together. The m/z 191 fragmentograms are similar in pattern to the oils except that peak Z (the C_{28} hopane) is absent. The m/z 217 mass fragmentogram is unlike those of the oils, in that the C_{29} compounds dominate.

The m/z 91 mass fragmentogram of these samples is fairly similar to the oils in the general range of the homology. The m/z 105 mass fragmentograms are somewhat different to the oils in that there are at least 3 homologies prominent in the samples. The m/z 198 mass fragmentogram shows that 1-methyldibenzothiophene is more prominent than in the oils. The differences are in part due to the lower maturity of the samples, rather than to source differences. The m/z 239 mass fragmentograms of the extracts are not unlike the oils in the general fingerprint but the dominant peaks are different. The m/z 253 mass fragmentograms of the extracts are very similar to the oils in pattern and general relative abundance of the different peaks. This is due mostly to increased maturity of these samples compared to samples higher in the well rather than a good source match.

CONCLUSIONS

It has been shown for type II kerogens that particular compound ratios are useful maturation parameters (Mackenzie papers on the Toarcian of the Paris Basin), included in this are many of the compound types which might be also useful from a source viewpoint. Ratios such as %22S (17α(H) hopanes) and also %20S C_{29} steranes used as maturation parameters indicate (table 1) that the analysed sequence section is mostly moderate mature/early mature. Therefore it is unlikely that the various fragmentograms of the samples would be exactly similar to the oils.

Generally, in the extracts, the dominant peaks in the m/z 191 fragmentograms are the C_{29} (Peak C), C_{30} (Peak E) and C_{31} (Peaks G and H) 17α(H), 21α(H) hopanes. One difference between the oils and the extracts is that the C_{29}, C_{30} and C_{31} moretanes (17β(H), 21α(H) compounds (peaks D, F and I respectively), are more prominent in the extracts than in the oils, see table 1. A clear demonstration of this can be seen from the m/z 205 mass fragmentograms (compare peaks G and H with I for oils and extracts) in appendix 2a. Also another difference between the oils and the extracts is that the ratio of peak A (stable trisnorhopane) to peak B (maturable trisnorhopane) is larger in the oils than in any of the potential source rocks (see table 1). Both differences mentioned above are essentially due to differences in maturity of the samples and oils. Also indicative of the low maturity of the samples compared to the oils is the lower %22S (17α(H), 21β(H) hopanes) of the samples, except for M-2256 and M-2264, (see table I).

The dominant compounds in what can be classed as sterane fragmentograms, m/z 217, 218 and 231 are in part affected by maturity. The oils are dominated by the diasteranes particularly those marked a and b (which are C_{27} 13β(H) 17α(H) 20S and 20R compounds), and the 14β(H) 17β(H) compounds marked on the m/z 218 fragmentograms with the carbon number of the different compounds (i.e. C_{27}, C_{28} and C_{29} - both R and S epimers). The "biogenic" sterane isomers (i.e. 5α(H), 14α(H) 17α(H) (20R)) peaks i, p and t (C_{27}, C_{28} and C_{29} compounds) are relatively minor components. In the extracts the opposite is found; the "biogenic" or immature sterane isomers are dominant. A useful maturity indicator is the percentage of the compounds 5α(H), 14α(H), 17α(H) C_{29} (20S) compound (q) to the C_{29} (20R) compound (t) i.e. q/q + t. The differences in this value (table 1) suggests that the maturity of any of the potential source rocks is not sufficient for oils to have been generated from them.

There are variations between the sample extracts in the relative amounts of steranes of different carbon number. This is clear in the m/z 217 and 218 fragmentograms of M-2245 particularly, where C_{29} compounds are dominant over C_{27} and C_{28} compounds, and makes this sample a less likely source for the oils (see figure 1).

The m/z 231 mass fragmentogram is particularly characteristic of 4-methyl steranes in saturated hydrocarbon fractions. The sample extracts, except for M-2264, have only four or five major peaks in the m/z 231 fragmentograms. The three peaks marked C_{28} C_{29} and C_{30} are tentatively identified as the 4-β methyl steranes of that carbon number. The most mature sample M-2264 and the oils are much more complex. In the kerogen type III sample, M-2245 the C_{28} compound appears to be relatively less prominent than in the other samples. The difference in complexity between oils and potential source rocks is most probably related to maturity rather than source differences, whereas the difference in relative distribution of C_{28}, C_{29}, C_{30} compounds may reflect a source difference.

The occurrence of the C_{28} hopane (peak Z) only in M-2241 (Heather formation?) and in the oils suggests that a major single source could be from more deeply buried equivalents of the silty claystones in this section of the well. It is probable that lateral equivalents of the dark claystones (Kimmeridge?) above this sample may also be a part source, based on the richness of the section rather than on any direct correlation. Other horizons which may be part sources are the claystones/siltstones from deeper in the section, below 2760 metres (e.g. M-2256 is a possibility), but no direct correlation can be made. Ion intensities of particular ions in part representative of common organic sulphur compounds m/z 184, 198 and 212 versus total ion intensities allow a certain classification of these analysed samples (table 1).

The most probable sources for the oils, if more mature, would be the claystones between 2415 - 2565 metres, if the latter were more mature.

ISOTOPE ANALYSIS

1. Introduction

Isotope analyses have been performed on kerogens, extracts and oils. The results of the isotope analyses are discussed in this report with respect to the organic geochemical results of this well. Table 2 presents the values obtained.

2. Results and discussion

The results of the isotope analyses are graphically compiled in figure 2 together with visual kerogen and organic geochemical investigations. Only carbon isotope analyses on kerogens and the saturate fraction of extracts and oils will be discussed. Only a few hydrogen isotope analyses and carbon isotope analyses on aromatics are available which do not permit conclusive interpretation.

The kerogens and saturated fraction of the extracts revealed remarkably parallel isotope variations with depth. The extracts are all more depleted in the heavy isotope than the kerogens and follow isotopically the variations of the kerogens. This indicates that the extracts are indigenous to the kerogens and are not migrated hydrocarbons.

The kerogens show distinct differences in isotopic composition. The samples M-2233 and M-2256 are isotopically more depleted in ^{13}C than the rest of the samples (3 to 4 per mil difference).

A comparison with the visual kerogen analyses does not reveal a straight forward correlation between the isotopic composition of the kerogens and types. Likewise, no clear correlation between isotopic composition and amount of extractable organic matter (table 3-7) can be found. The main characteristic difference is the type of organic matter as distinguished partly by Rock-Eval pyrolysis (table 8) and by the saturated hydrocarbon patterns. Samples M-2245 and M-2264 consist of type III kerogens which have good potential as source rocks for gas. Both of these are relatively enriched in ^{13}C. Samples M-2233 and M-2256 have type II or mixed type II/III kerogens, and are therefore good/rich oil source rocks, these two are relatively depleted in ^{13}C.

Sample M-2241, also contains mixed type II/III kerogen and is a good oil source, however the ^{13}C value is similar to the two gas source rock samples. The saturated hydrocarbon patterns allow us to distinguish a group with two extremes: M-2233, front-end biased maximum at nC_{15} with a pristane/phytane ratio of 1.6 and a CPI of 1.1 and M-2245 dominated by high molecular weight n-alkanes with a maximum at nC_{25}, a pristane/phytane ratio of 5.6 and a CPI of 1.5. The former sample indicates the presence of mostly marine organic matter, the latter mostly terrestrial organic matter. Intermediate between the two extremes are the other samples (see table 7).

Conclusions

Isotope variations in extracts and kerogens suggest that the soluble bitumens are indigenous. The kerogens in the well exhibit a considerable change in isotopic composition and can be roughly correlated to kerogen type. This correlation appears to be opposite to the generally observed trend, i.e. that isotopically higher values are found in terrestrial material (Galimov 1980 in Kerogen, edited by B. Durand, 1980). No explanation of this contradiction can be advanced at the present.

The isotope data make it unlikely that samples M-2233 and M-2256 alone could be the source rocks (even if more mature) since these kerogens are isotopically lighter than the oils, and it would be expected that oils derived from such kerogens would be even lighter than the kerogen. The considerable variation in the ^{13}C isotope values of the aromatic hydrocarbon fractions of the two oils cannot be explained. However, the gas chromatograms of the aromatic fractions of the two oils also are different. M-3143 has a much larger unresolved hump and has less of the alkyl naphthalenes (A, B and C) than M-6647. It may indicate that there has been some process affecting the composition of the oils such as water washing of the upper oil sample.

CONCLUSIONS FROM BOTH BIOMARKER AND ISOTOPE ANALYSIS

1. The oils are very similar in many parameters and the differences, in the patterns of the aromatic hydrocarbon gas chromatograms and in the ^{13}C of the aromatic fractions might be due to water washing or some other physico-chemical process. Therefore the source for both oils is probably the same.

2. Many biomarker parameters favour samples M-2233 and M-2241 (e.g. abundance of bisnorhopane in M-2241, abundance of C_{27} steranes, organic sulphur abundance, pristane/phytane ratios) as the most probable sources of the oils.

3. Rock-Eval analysis (table 8) indicates that samples M-2245 and M-2264 contain type III kerogens and are less promising sources than the other three source rock samples, and biomarker ratios rule out these two as sources for the oil. The best samples in terms of kerogen quality are M-2233 and M-2241.

   M-2233 and M-2241 are probably from the Humber Group. These are also the most probable source rocks if they were mature enough to generate oil. The isotope data does not allow any definite conclusions.

Table 1. Biomarker Ratios

	HOPANE RATIOS					STERANE RATIOS		
Sample code	Trisnorhopane A/B	$\frac{C_{29}\alpha\beta}{C_{30}\alpha\beta}$ $\frac{C}{E}$	$\frac{C_{29}\beta\alpha+C_{30}\beta\alpha}{C_{29}\alpha\beta+C_{30}\alpha\beta}$ $\frac{D+F}{C+E}$	$\frac{\text{Bisnorhopane}}{C_{29}\alpha\beta\text{hopane}}$ $\frac{Z}{C}$	%22S 17α(H) Hopanes C_{31-33} compounds	%20S C_{29} steranes (q/q+t) peak height	%20S C_{29} steranes (q/q+t) peak area	ion intensity of $\frac{m/z184+198+212}{\text{total ion intensity}}$
Oils								
M-3143	1.07	0.49	0.16	0.63	60%	63%	62%	0.12
M-6647	1.33	0.43	0.17	0.66	59%	54%	61%	0.13
Source rocks								
M-2233	0.38	0.46	0.28	<0.05	49%	30%	33%	0.13
M-2241	0.14	0.65	0.39	1.6	54%	29%	26%	0.16
M-2245	0.05	0.72	0.40	0.09	56%	35%	36%	0.25
M-2256	0.26	0.73	0.26	<0.05	60%	32%	33%	0.07
M-2264	0.29	0.72	0.28	<0.05	58%	32%	39%	0.07

Table 2 ISOTOPE RATIOS

IKU no.	Saturates $^{13}C/^{12}C$	Saturates D/H	Aromatics $^{13}C/^{12}C$	Aromatics D/H	Kerogens $^{13}C/^{12}C$
Source Rocks					
M-2233	-31.7	-163	N.D.	-153	-29.2
M-2241	-29.4	-154	-28.9	-134	-25.2
M-2246	-27.7	N.D.	N.D.	N.D.	-25.0
M-2256	-30.6	N.D.	-31.5	N.D.	-29.4
M-2264	-29.1	N.D.	N.D.	N.D.	-26.2
Oils					
M-3143	-28.9	-135	-30.4	N.D.	-
M-6647	-28.5	-128	-28.3	-127	-

Table 3. Weight of EOM and Chromatographic fractions.

IKU no.	Depth (m)	Rock Extr. (g)	EOM (mg)	Sat. (mg)	Aro. (mg)	HC (mg)	Non HC (mg)	TOC (%)
M-2233	2430	12.6	40.5	7.3	7.6	14.9	25.6	4.9
M-2241	2550	17.7	25.4	4.4	5.0	9.4	16.0	4.3
M-2245	2610	10.2	44.3	10.3	18.9	29.2	15.1	13.0
M-2256	2790	20.1	8.4	2.3	2.3	4.6	3.8	1.7
M-2264	2910	9.5	6.7	1.9	1.8	3.7	3.0	1.5
Oils								
M-3143	2638		106.3	26.4	9.4	35.8	70.5	
M-6647	2665		109.7	27.4	11.3	38.7	71.0	

Table 4. Concentration of EOM and chromatographic fractions (Weight ppm of rock).

IKU no	Depth (m)	EOM	Sat.	Aro.	HC	Non HC
M-2233	2430	3214	579	603	1183	2032
M-2241	2550	1435	249	282	531	904
M-2245	2610	4343	1010	1853	2863	1480
M-2256	2790	418	114	114	229	189
M-2264	2910	705	200	189	389	316

Table 5. Concentration of EOM and chromatographic fractions (mg/g TOC)

IKU no	Depth (m)	EOM	Sat.	Aro.	HC	Non HC
M-2233	2430	65.6	11.8	12.3	24.1	41.5
M-2241	2550	33.4	5.8	6.6	12.4	21.0
M-2245	2610	33.4	7.8	14.3	22.0	11.4
M-2256	2790	24.6	6.7	6.7	13.5	11.1
M-2264	2910	47.0	13.3	12.6	26.0	21.1

Table 6. Composition in % of the material extracted from the rock

IKU no.	Depth (m)	Sat. EOM	Aro. EOM	HC EOM	Sat. Aro.	Non HC EOM	HC Non HC
M-2233	2430	18.0	18.8	36.8	96.1	63.2	58.2
M-2241	2550	17.3	19.7	37.0	88.0	63.0	58.7
M-2245	2610	23.3	42.7	65.9	54.5	34.1	193.4
M-2256	2790	27.4	27.4	54.8	100.0	45.2	121.1
M-2264	2910	28.4	26.9	55.2	105.6	44.8	123.3
Oils							
M-3143	2638	24.8	8.8	33.6	281.8	66.4	50.6
M-6647	2665	25.0	10.3	35.3	242.7	64.7	54.6

Table 7. Tabulation of data from the gas chromatograms

IKU no.	Depth (m)	Pristane / $n-C_{17}$	Pristane / Phytane	CPI
M-2233	2430	1.4	1.6	1.1
M-2241	2550	1.9	2.5	1.4
M-2245	2610	2.1	5.6	1.5
M-2256	2790	1.1	2.7	1.4
M-2264	2910	0.8	3.0	1.6
Oils				
M-3143	2638	0.6	1.5	1.0
M-6647	2665	0.6	1.5	1.0

Table 8. Rock-Eval Pyrolysis Data

IKU no.	Depth	S1	S2	S3	% TOC	Hydrogen Index	Oxygen Index	Petroleum Potential S1+S2	Prod. Index S1/S1+S2	T_{max}
M-2233	2430	0.51	22.93	0.40	4.85	473	8	23.44	0.02	424
M-2241	2550	0.52	13.03	0.36	5.18	348	7	18.55	0.03	426
M-2245	2610	3.62	40.82	0.70	20.74	197	3	14.44	0.08	433
M-2256	2790	0.33	5.51	0.46	1.57	351	29	5.84	0.06	432
M-2264	2910	0.24	3.17	0.72	1.52	209	47	3.41	0.07	443

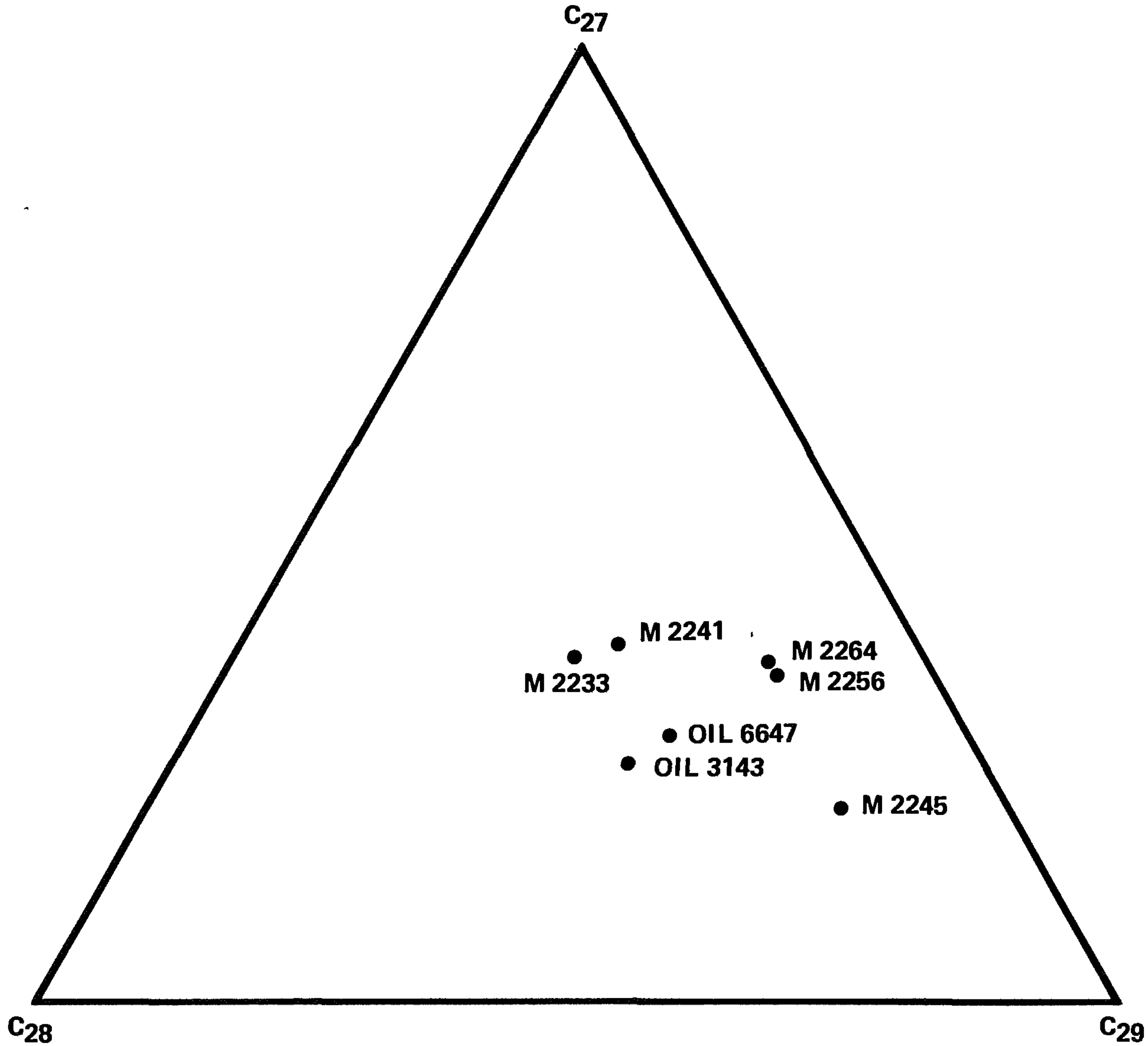
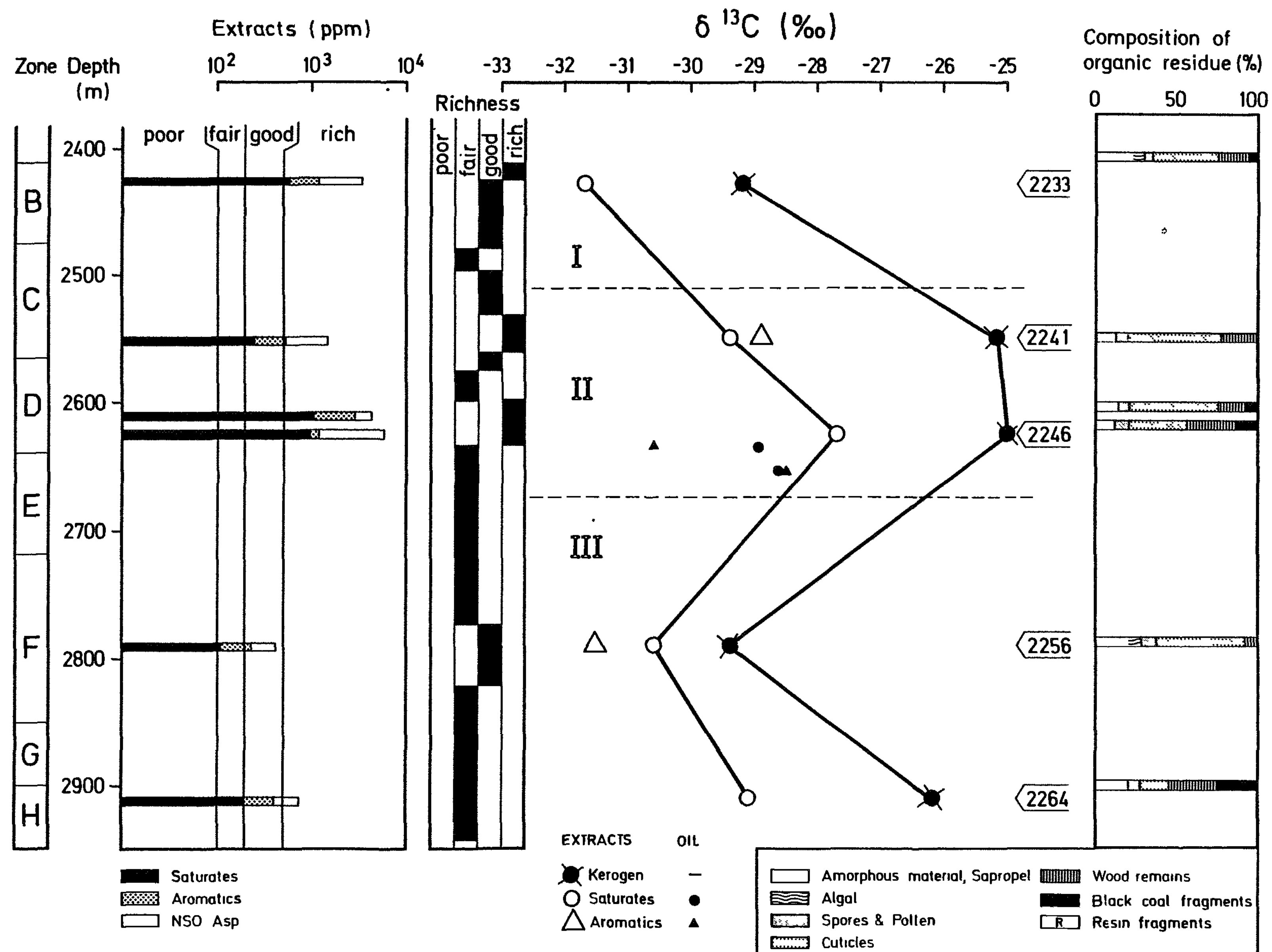


Figure 1 Plot of C_{27}, C_{28} and C_{29} 5α 14α 17α 20R steranes.

Figure 2 ISOTOPE GEOCHEMISTRY WELL 30/6-4



Appendix 1

Saturated and Aromatic Hydrocarbon gas chromatograms of oils and extracts

KEY TO GAS CHROMATOGRAMS

Saturated Hydrocarbons

a = nC_{17}

b = pristane

c = phytane

Aromatic Hydrocarbons

A = Methyl naphthalenes

B = Dimethyl naphthalenes

C = Tri- and other alkyl naphthalenes

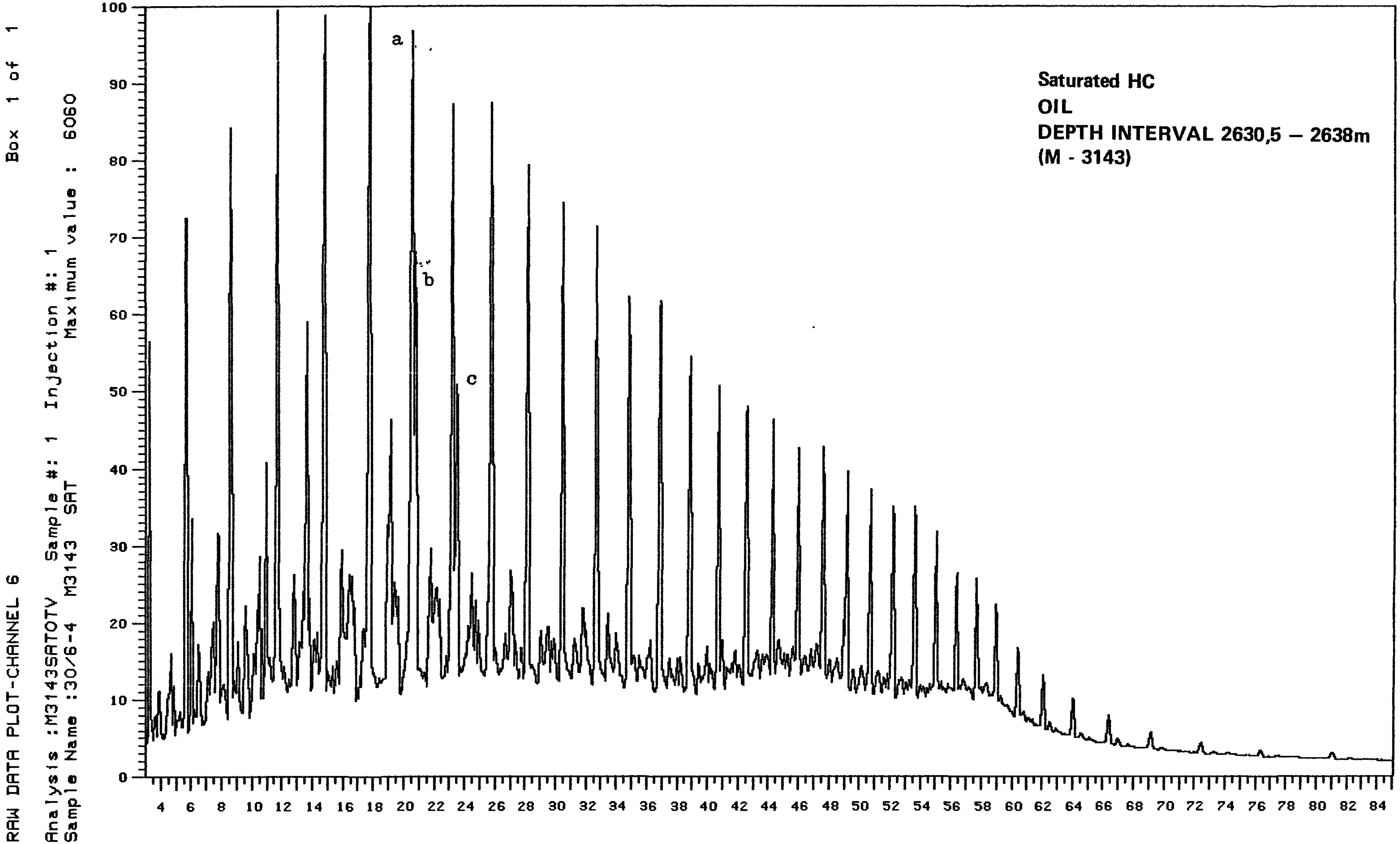
P = Phenanthrene

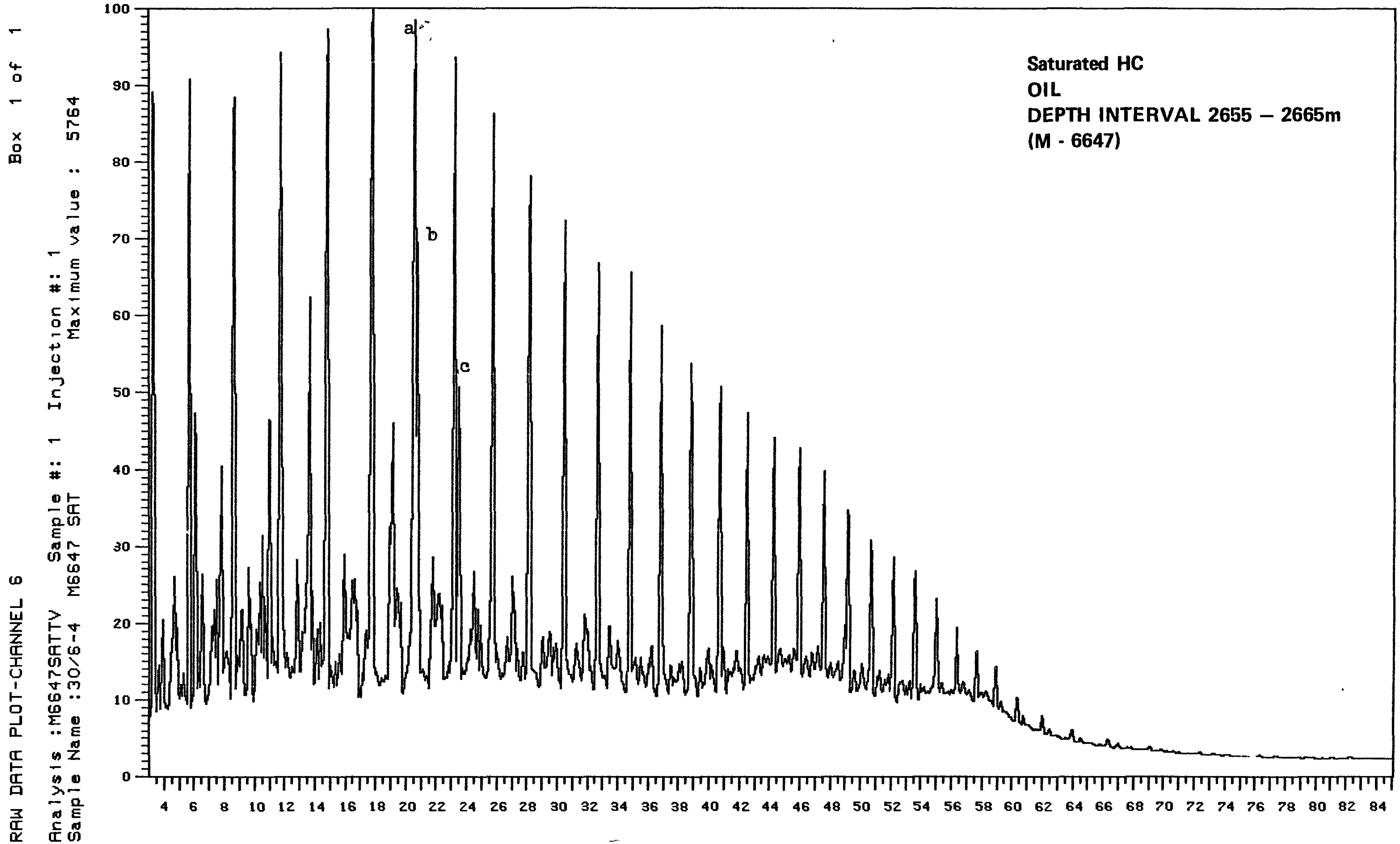
D = Methylphenanthrenes

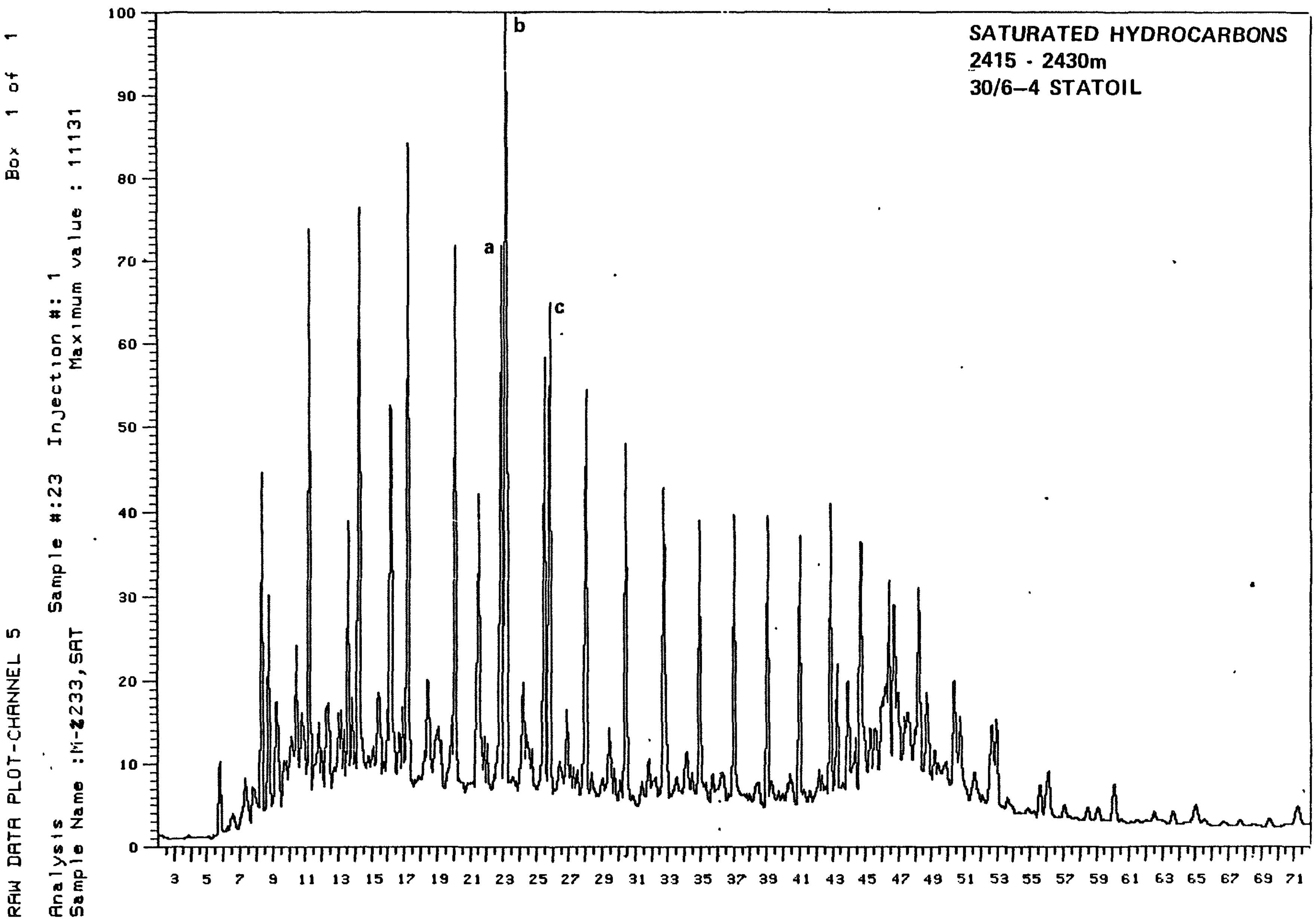
E = Dimethylphenanthrene

F = Compounds include aromatised steranes and triterpanes

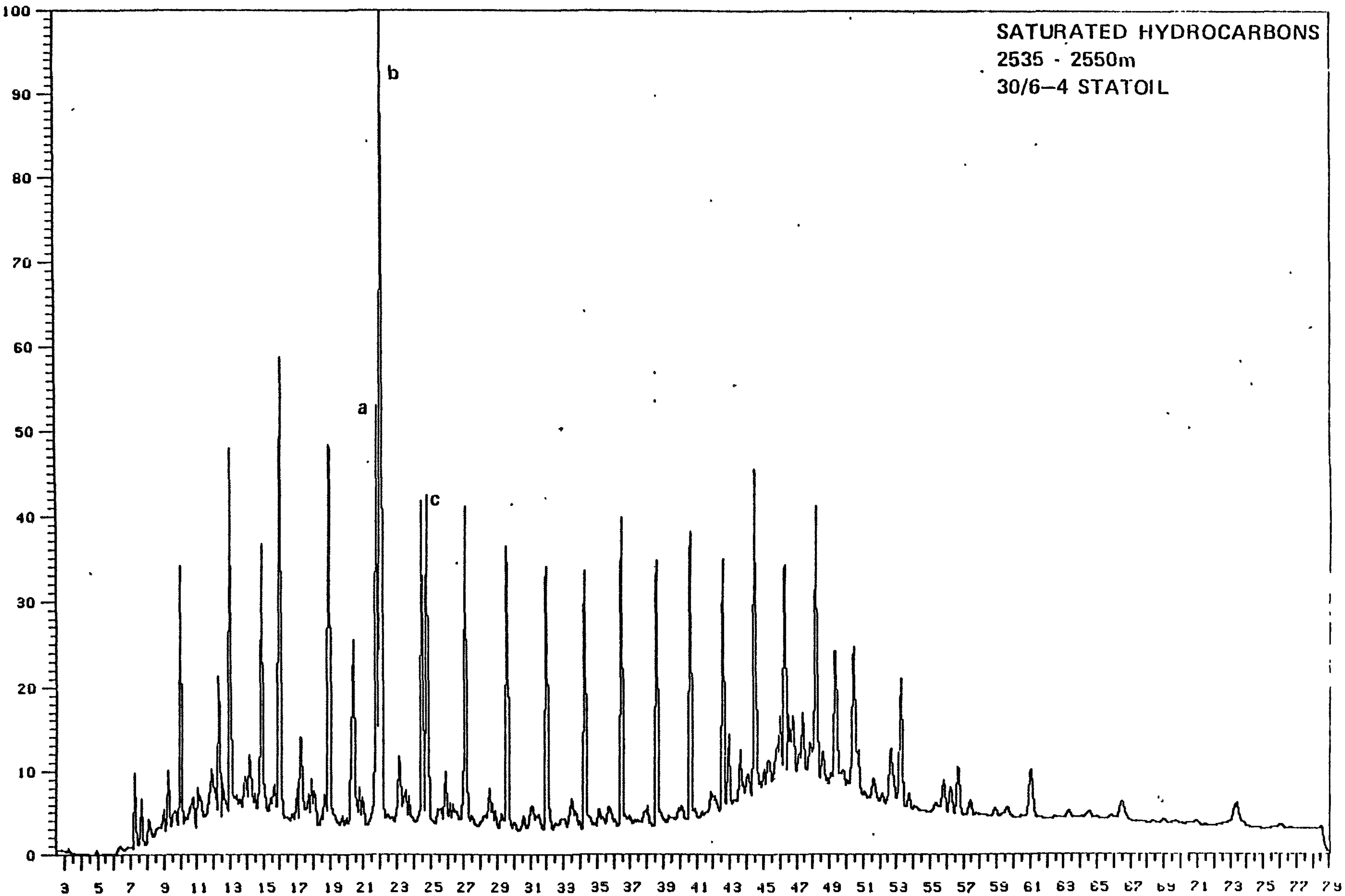
X,Y,Z and Q = Unknowns

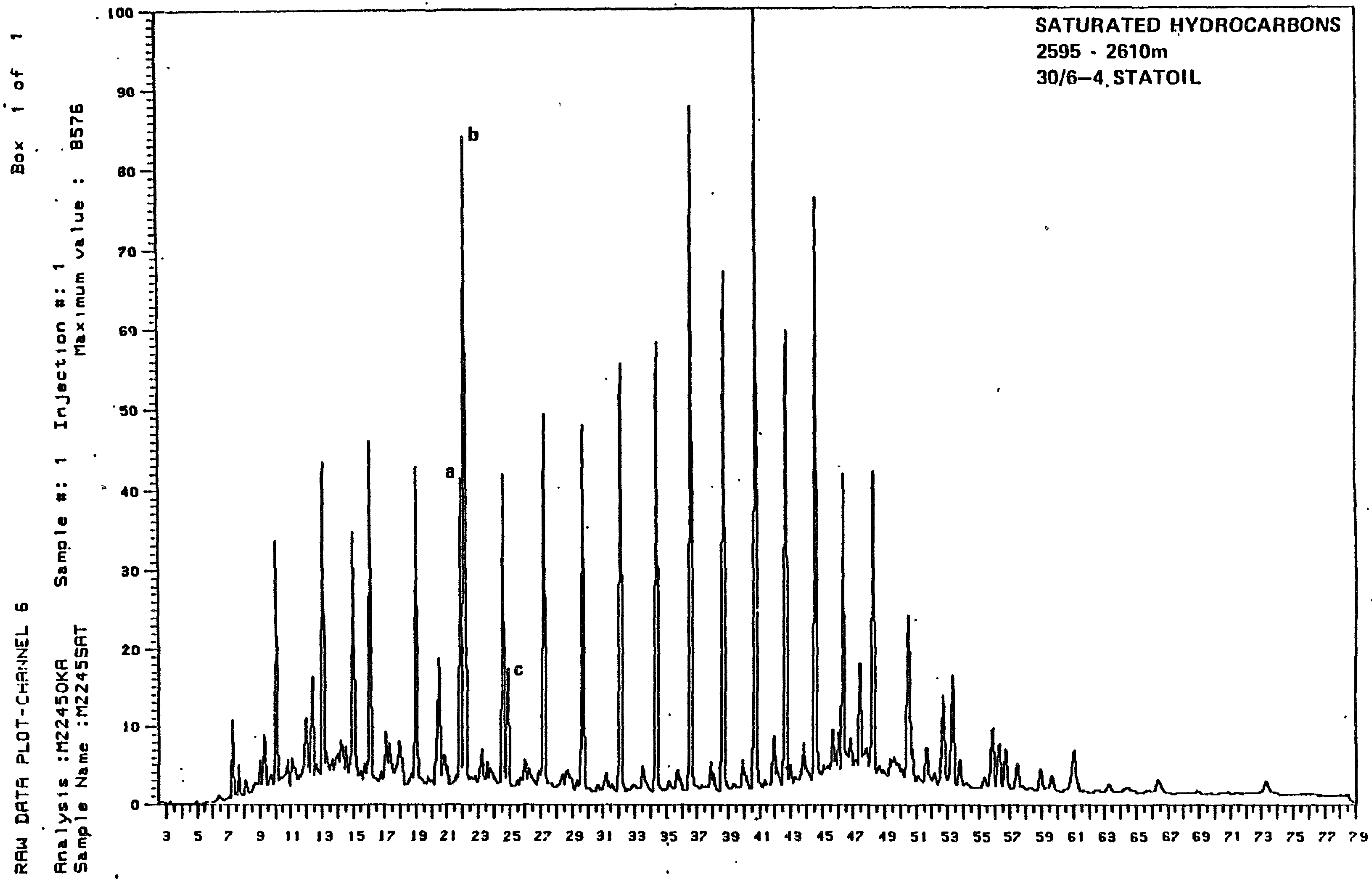

RAW DATA PLOT-CHANNEL 6
Box 1 of 1
Analysis :M3143SATOTV Sample #: 1 Injection #: 1
Sample Name :30/6-4 M3143 SAT Maximum value : 6060
Saturated HC
OIL
DEPTH INTERVAL 2630,5 – 2638m
(M - 3143)
a
b
c

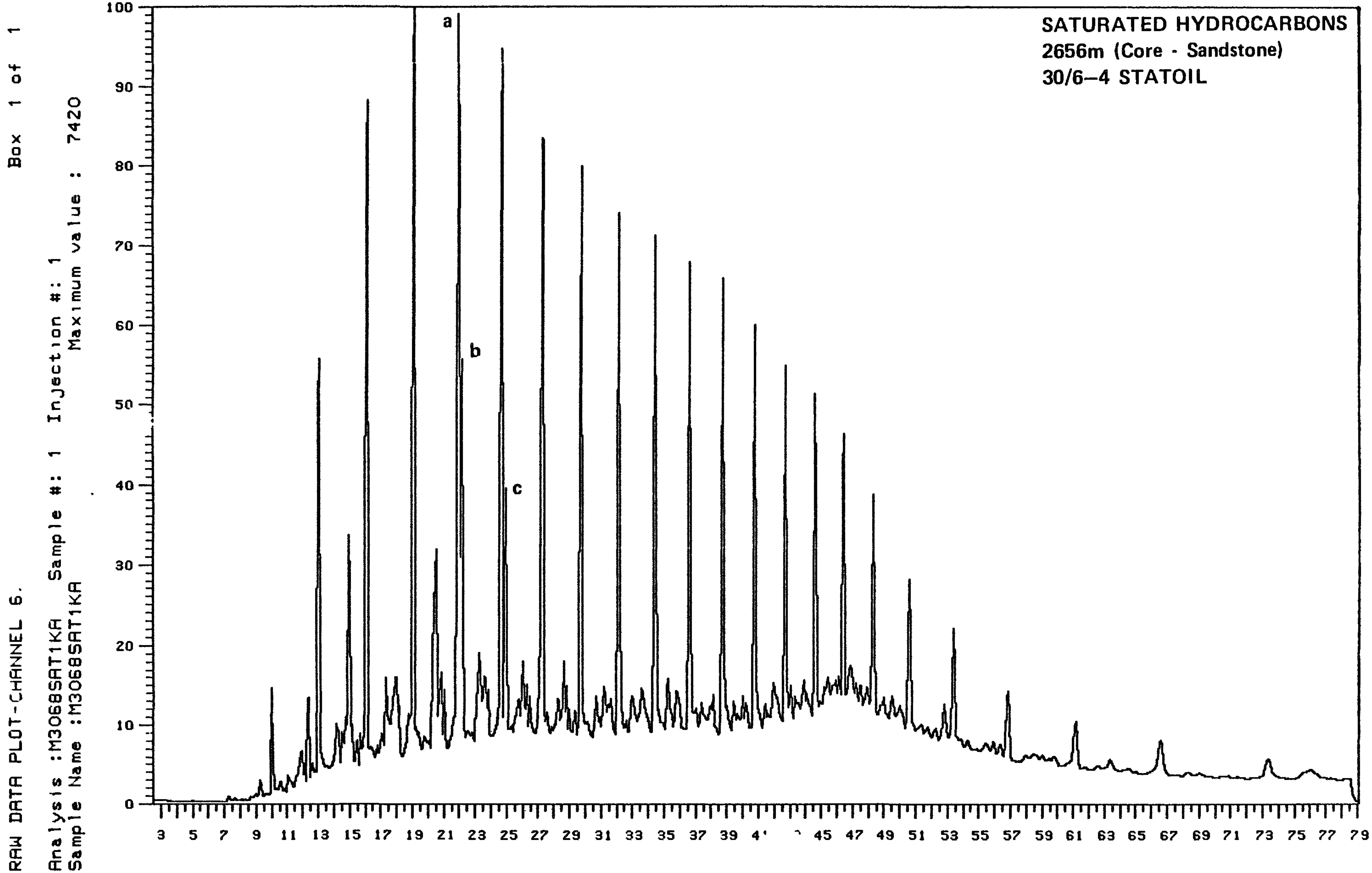

RAW DATA PLOT-CHANNEL 6
Box 1 of 1
Analysis :M6647SATTV
Sample #: 1
Injection #: 1
Sample Name :30/6-4
M6647 SAT
Maximum value : 5764
Saturated HC
OIL
DEPTH INTERVAL 2655 – 2665m
(M - 6647)
a
b
c

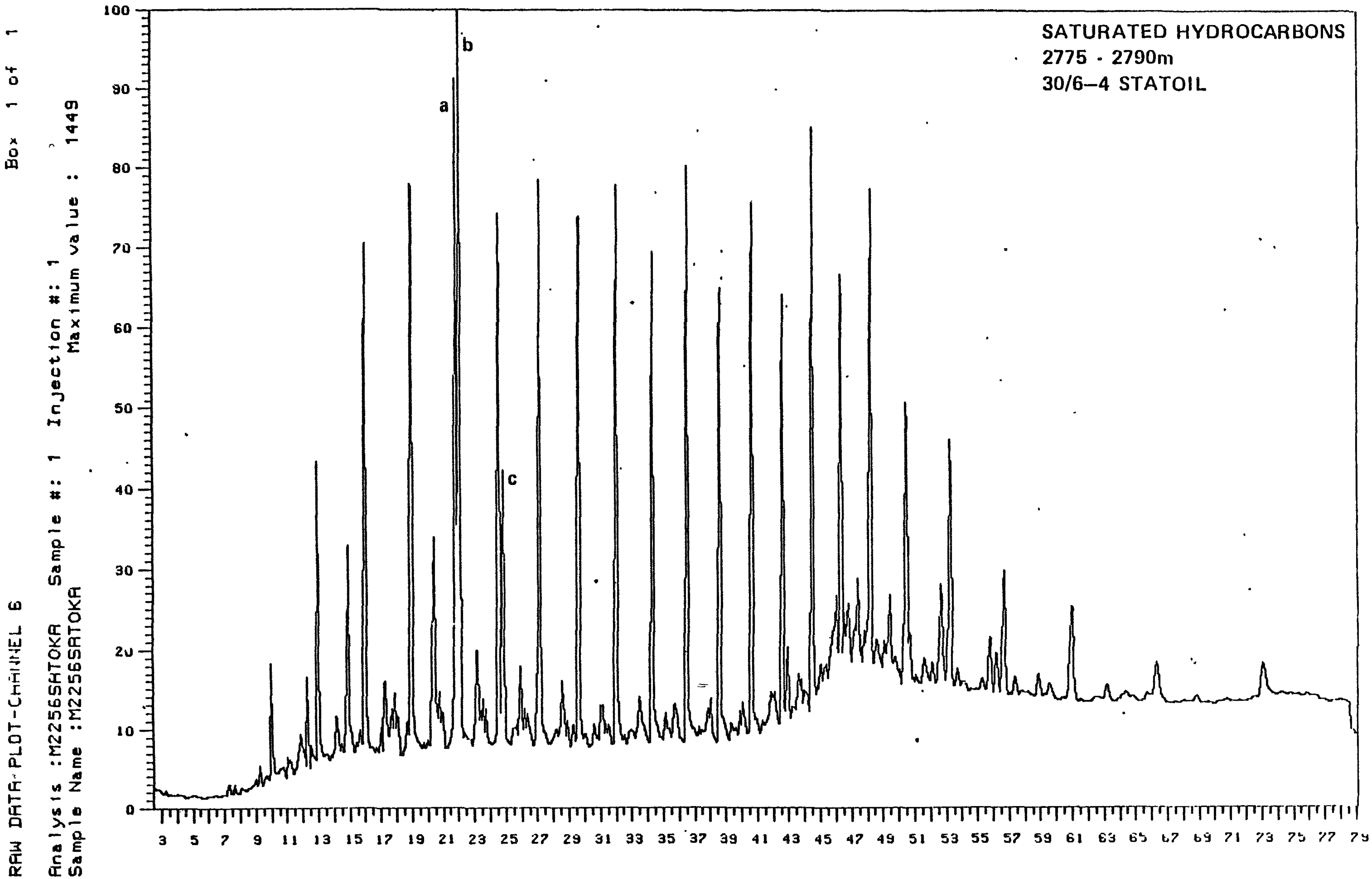

SATURATED HYDROCARBONS
2415 - 2430m
30/6-4 STATOIL
RAW DATA PLOT-CHANNEL 5
Box 1 of 1
Analysis
Sample #:23
Injection #: 1
Sample Name :M-2233,SAT
Maximum value : 11131
a
b
c
0
10
20
30
40
50
60
70
80
90
100
3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55 57 59 61 63 65 67 69 71

RAW DATA PLOT-CHANNEL 6   Box 1 of 1
Analysis :M2241OKA   Sample #: 1   Injection #: 1
Sample Name :M2241SAT   Maximum value : 3098




SATURATED HYDROCARBONS
2595 - 2610m
30/6-4 STATOIL
a
b
c
RAW DATA PLOT-CHANNEL 6
Analysis :M22450KA
Sample Name :M22455AT
Sample #: 1 Injection #: 1 Box 1 of 1
Maximum value : 8576


SATURATED HYDROCARBONS
2656m (Core - Sandstone)
30/6-4 STATOIL
a
b
c
RAW DATA PLOT-CHANNEL 6.
Box 1 of 1
Analysis :M3068SAT1KA Sample #: 1 Injection #: 1
Sample Name :M3068SAT1KA Maximum value : 7420
0
10
20
30
40
50
60
70
80
90
100
3
5
7
9
11
13
15
17
19
21
23
25
27
29
31
33
35
37
39
45
47
49
51
53
55
57
59
61
63
65
67
69
71
73
75
77
79

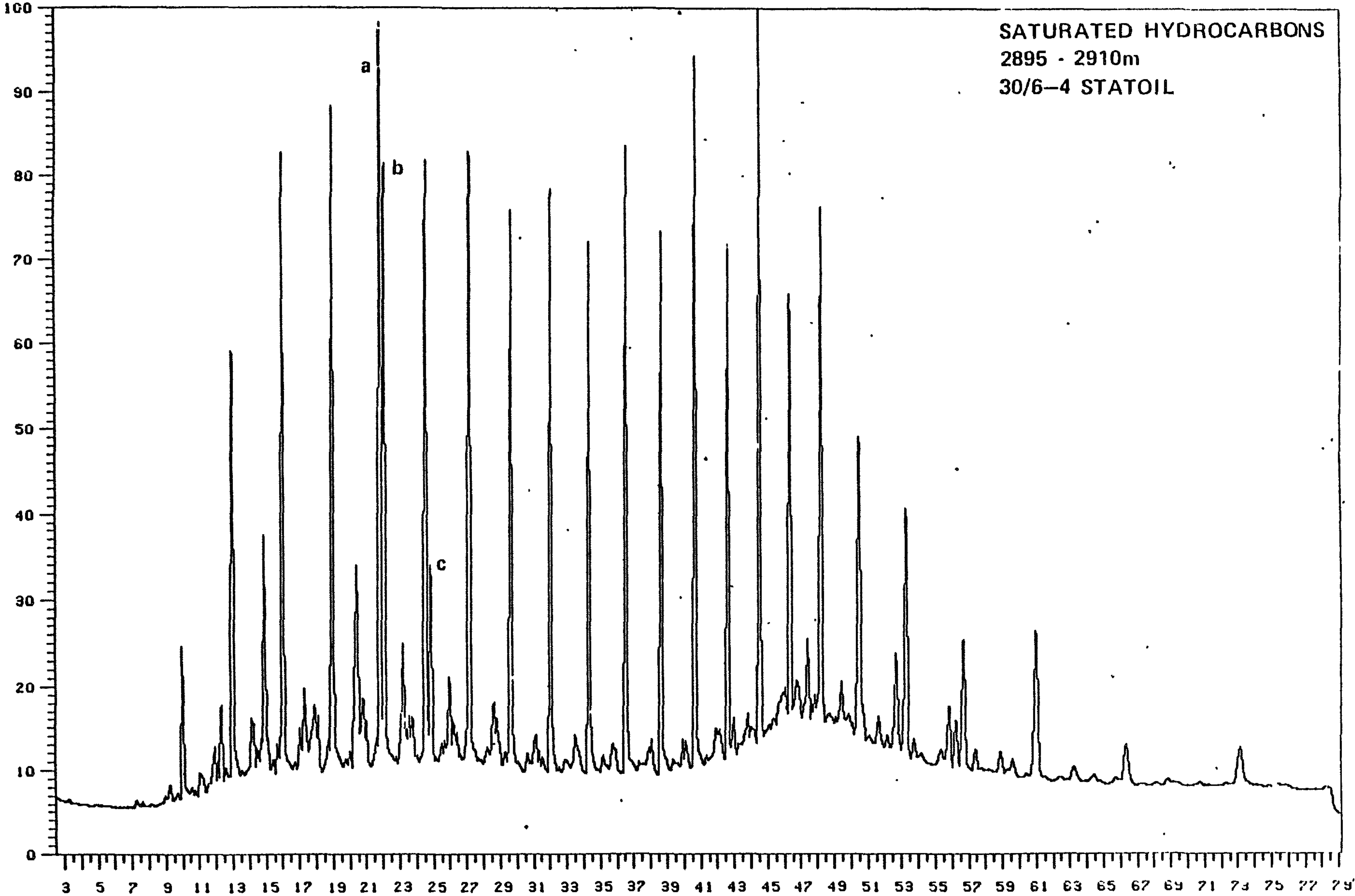

SATURATED HYDROCARBONS
2775 - 2790m
30/6–4 STATOIL
a
b
c
0
10
20
30
40
50
60
70
80
90
100
3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55 57 59 61 63 65 67 69 71 73 75 77 79
Box 1 of 1
RAW DATA-PLOT-CHANNEL 6
Analysis :M2256SATOKA Sample #: 1 Injection #: 1
Sample Name :M2256SATOKA Maximum value : 1449

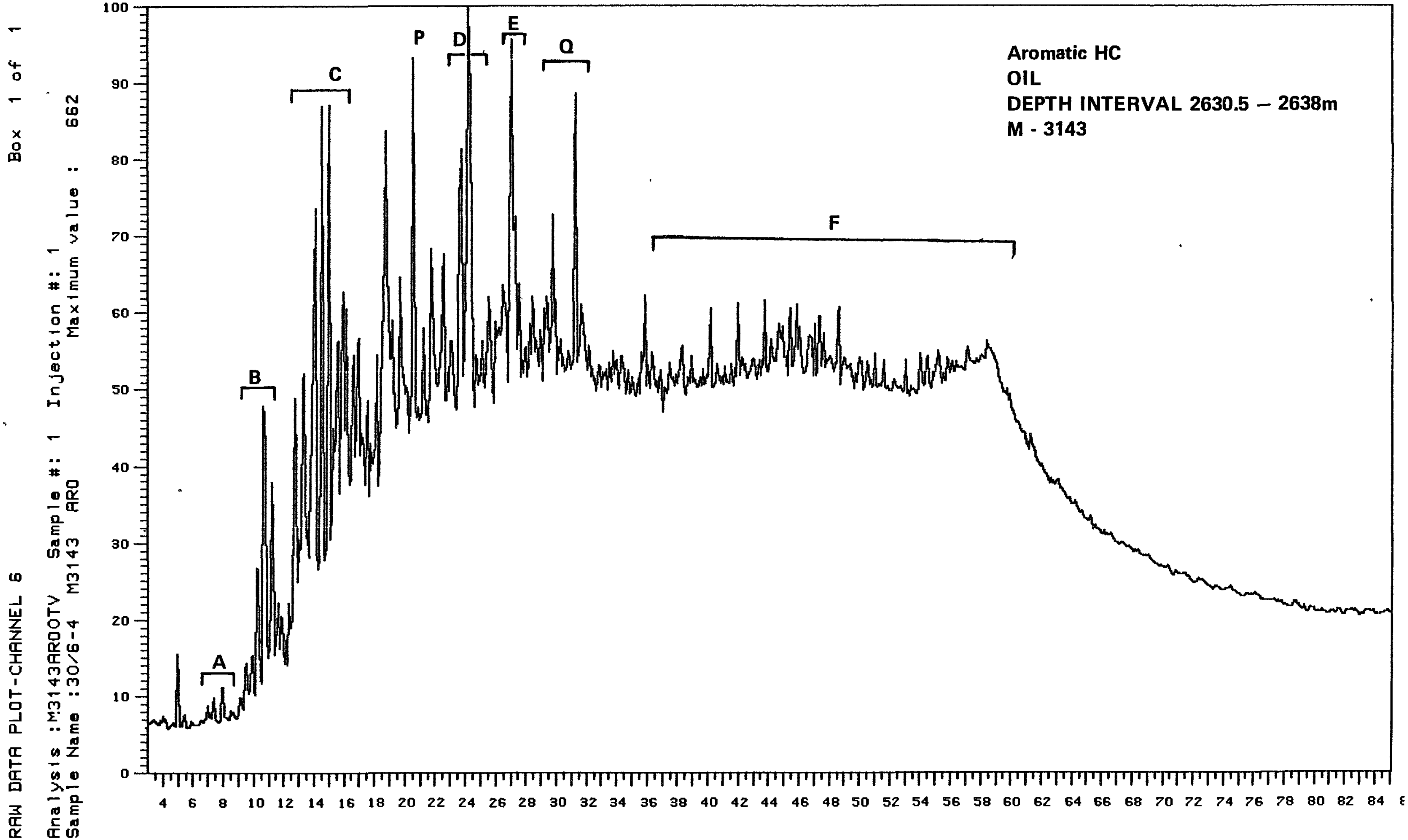
RAW DATA PLOT-CHANNEL 6

Analysis :M2264SATOKA Sample #: Injection #: 1

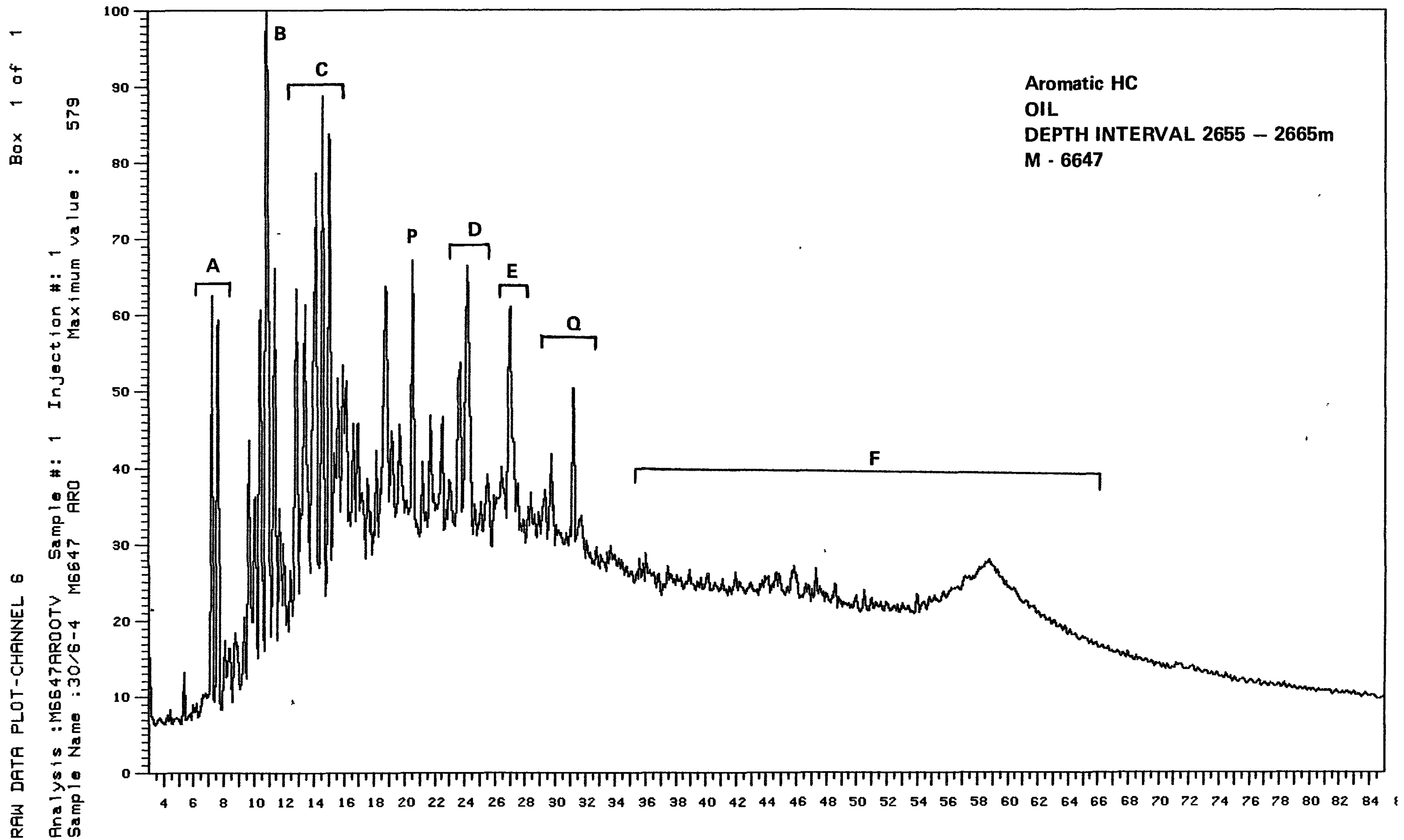
Sample Name :M2264SATOKA Maximum Value : 2319

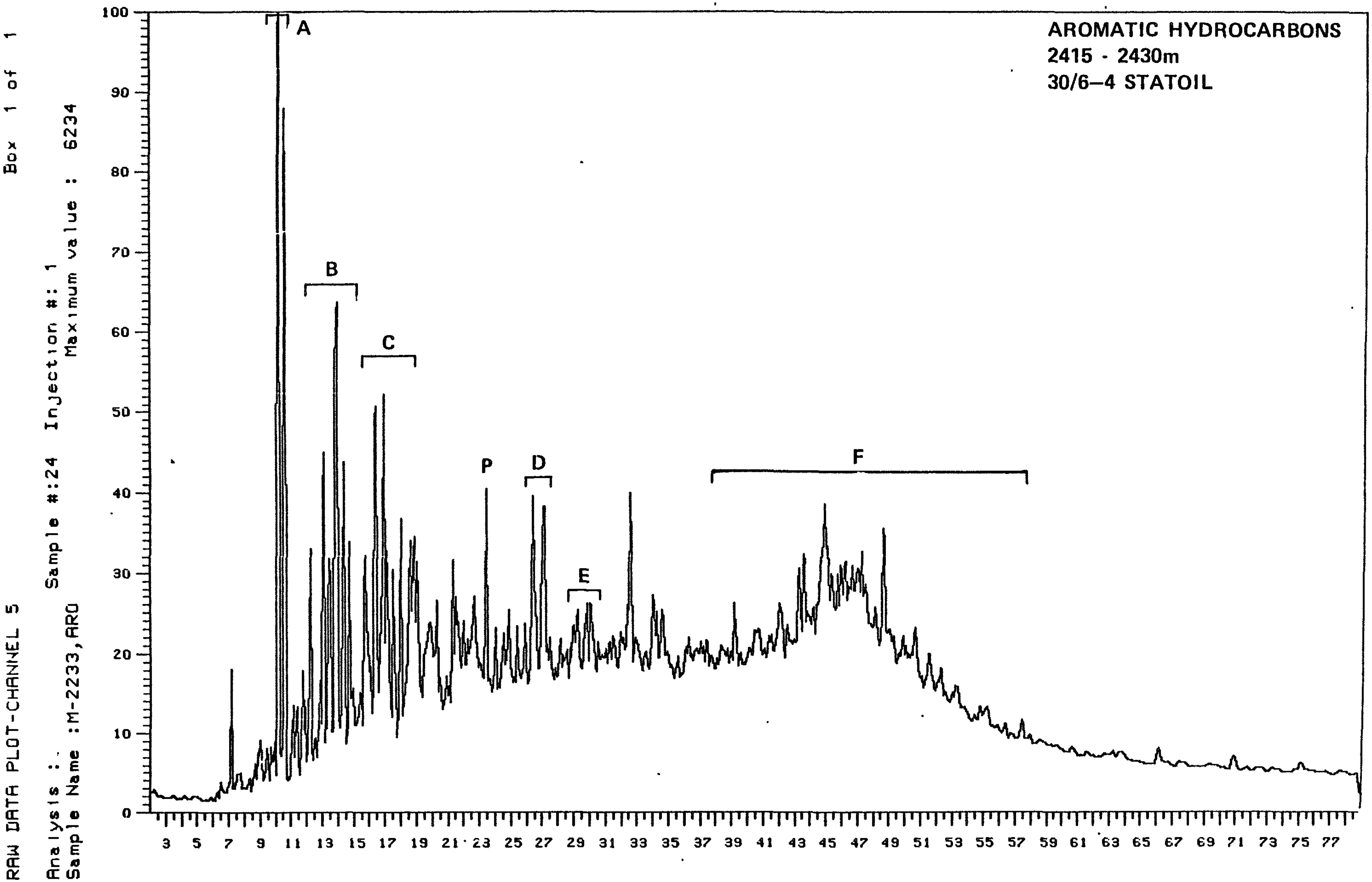
Box





RAW DATA PLOT-CHANNEL 6
Analysis :M3143AROOTV Sample #: 1 Injection #: 1
Sample Name :30/6-4 M3143 ARO Maximum value : 662
Box 1 of 1
Aromatic HC
OIL
DEPTH INTERVAL 2630.5 – 2638m
M - 3143
A
B
C
P
D
E
Q
F

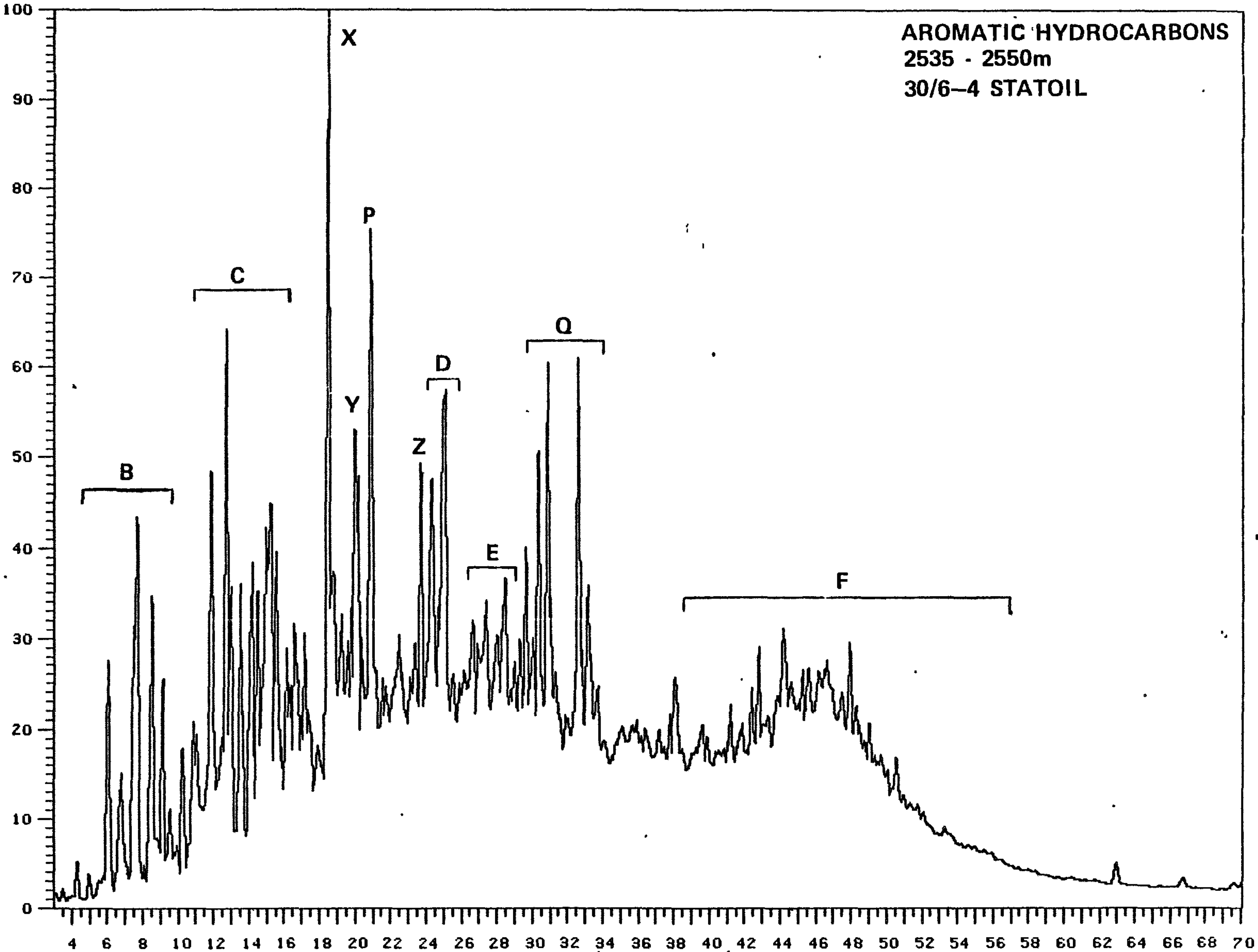

RAW DATA PLOT-CHANNEL 6
Box 1 of 1
Analysis :M6647ARDOTV Sample #: 1 Injection #: 1
Sample Name :30/6-4 M6647 ARO
Maximum value : 579
Aromatic HC
OIL
DEPTH INTERVAL 2655 – 2665m
M - 6647
A
B
C
P
D
E
Q
F


AROMATIC HYDROCARBONS
2415 - 2430m
30/6-4 STATOIL
A
B
C
P
D
E
F
RAW DATA PLOT-CHANNEL 5
Analysis :
Sample Name :M-2233,ARO
Sample #:24 Injection #: 1
Maximum value : 6234
Box 1 of 1

RAW DATA PLOT-CHANNEL 6

Analysis :M2241ARO2KA Sample #: 1 Injection #: 1 Box 1 of 1

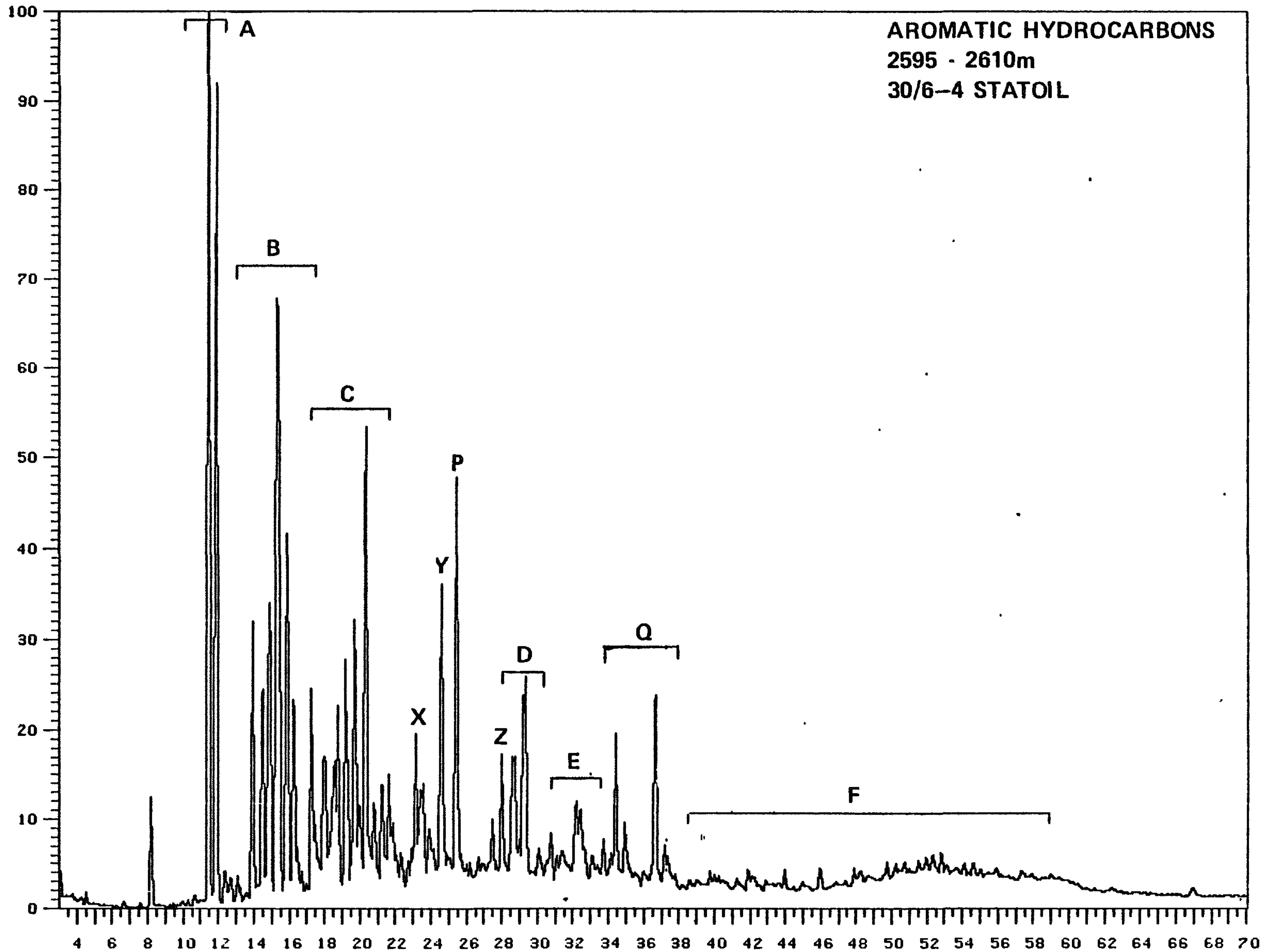
Sample Name :M2241ARO Maximum value : 3110

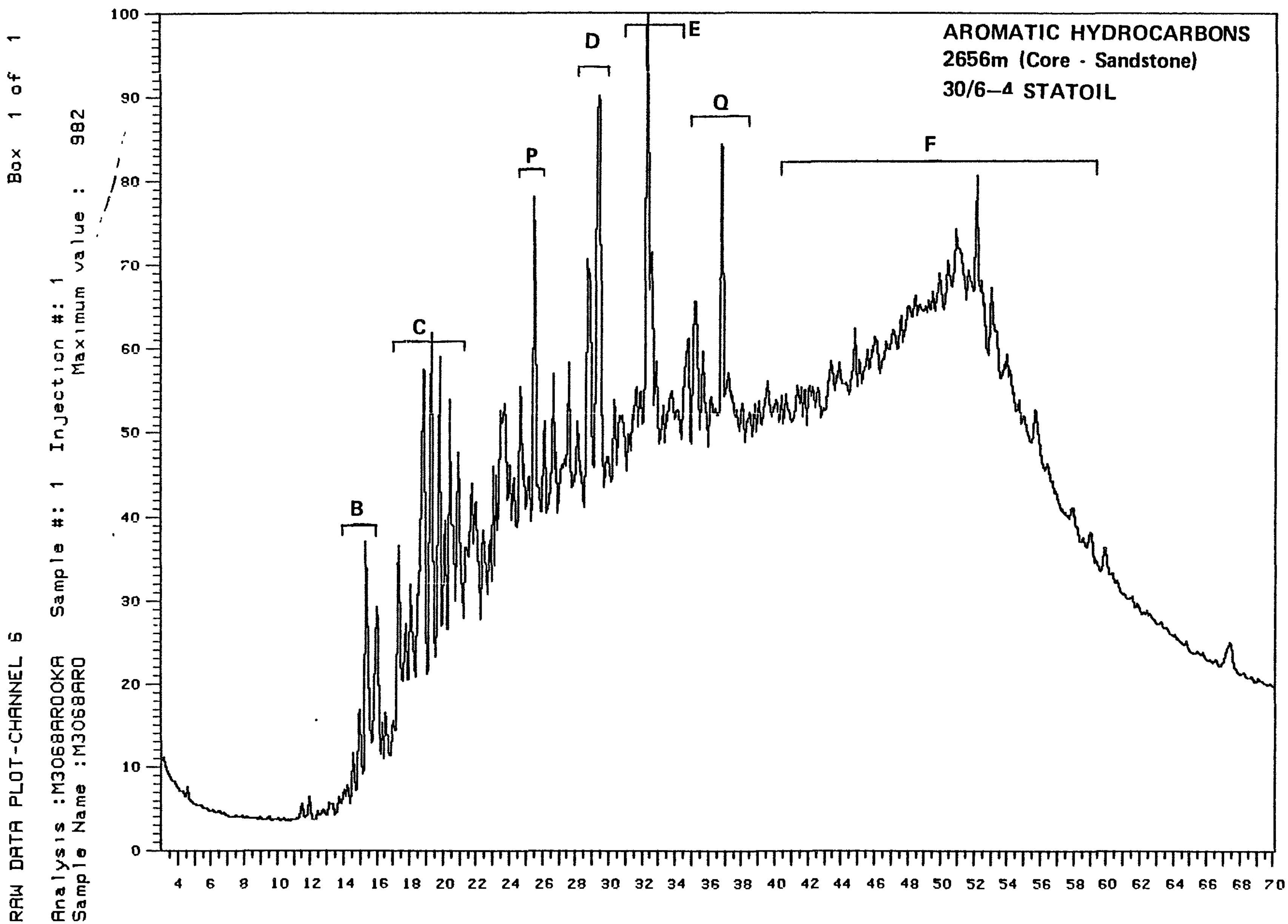


RAW DATA PLOT-CHANNEL 6 Box 1 of 1

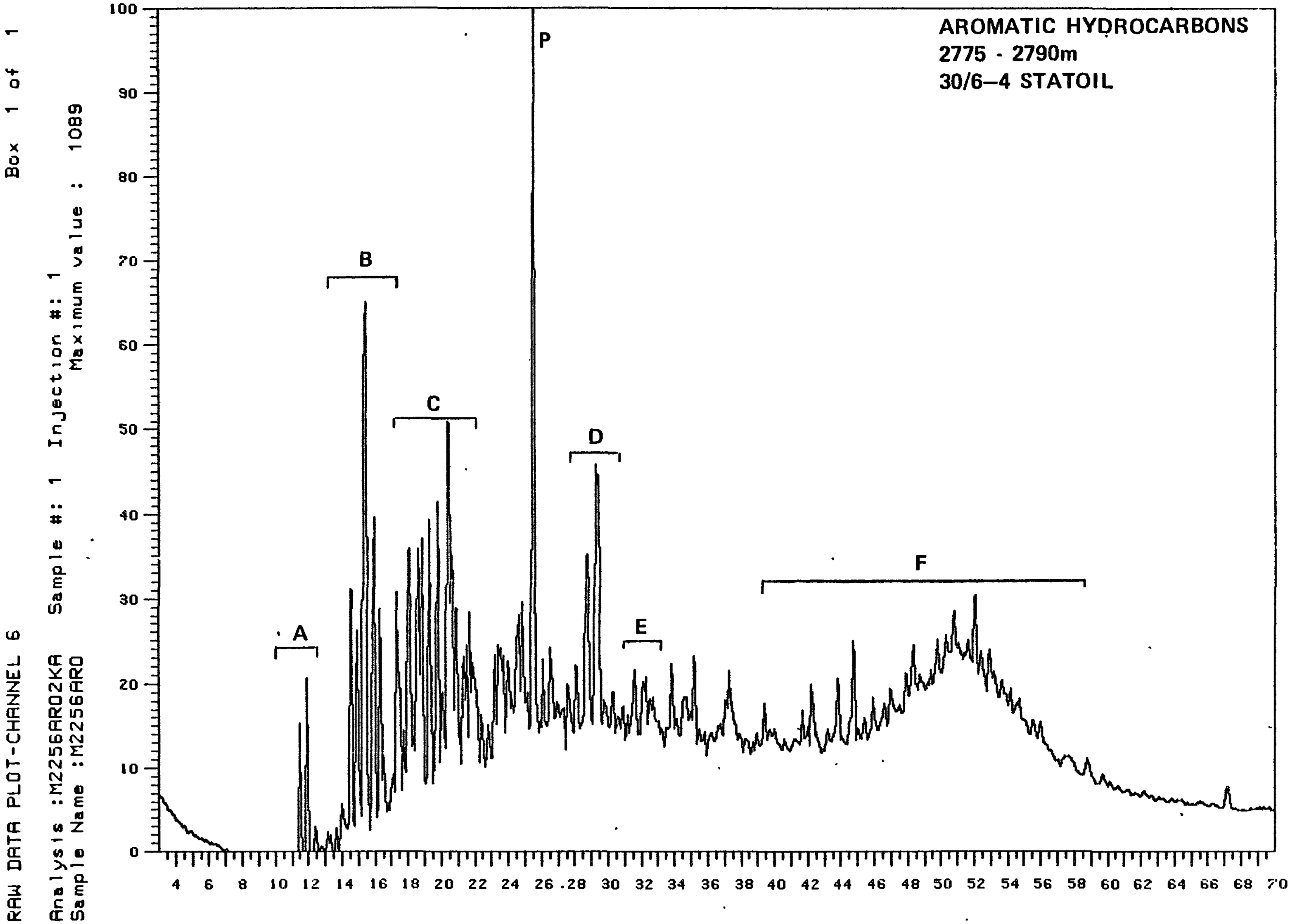
Analysis :M2245ARO2KA Sample #: 1 Injection #: 1

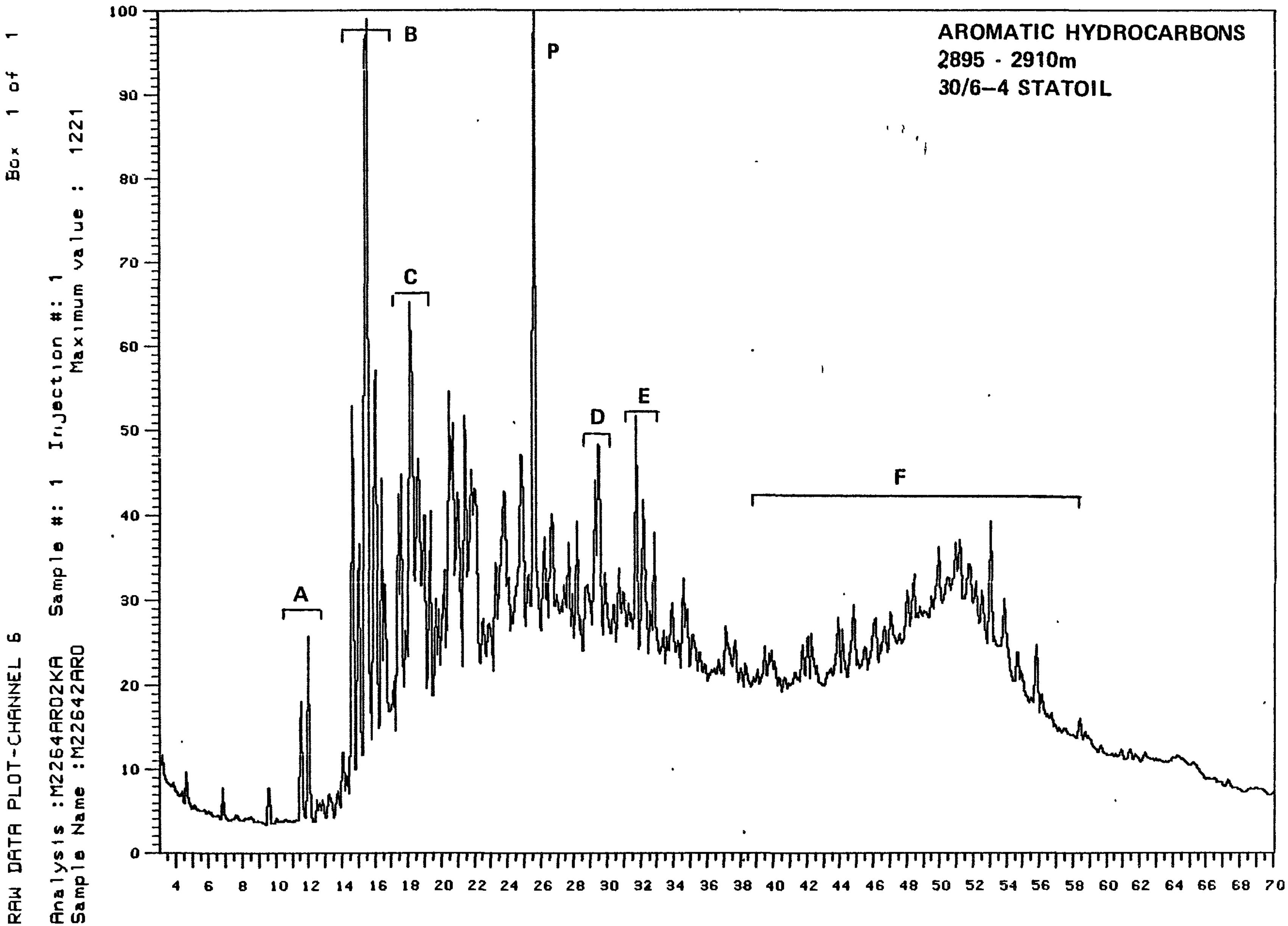
Sample Name :M2245ARO Maximum value : 3256





AROMATIC HYDROCARBONS
2656m (Core - Sandstone)
30/6–4 STATOIL
B
C
P
D
E
Q
F
RAW DATA PLOT-CHANNEL 6
Analysis :M3068AROOKA
Sample Name :M3068ARO
Sample #: 1
Injection #: 1
Maximum value : 982
Box 1 of 1
0
10
20
30
40
50
60
70
80
90
100
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
48
50
52
54
56
58
60
62
64
66
68
70


AROMATIC HYDROCARBONS
2775 - 2790m
30/6-4 STATOIL
P
A
B
C
D
E
F
RAW DATA PLOT-CHANNEL 6
Box 1 of 1
Analysis :M2256ARO2KA
Sample Name :M2256ARO
Sample #: 1
Injection #: 1
Maximum value : 1089
0
10
20
30
40
50
60
70
80
90
100
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
48
50
52
54
56
58
60
62
64
66
68
70



RAW DATA PLOT-CHANNEL 6
Analysis :M2264AR02KA
Sample Name :M22642ARO
Sample #: 1
Injection #: 1
Maximum value : 1221
Box 1 of 1
AROMATIC HYDROCARBONS
2895 - 2910m
30/6-4 STATOIL
A
B
C
D
E
F
P

IKU

Appendix 2a

Saturated Hydrocarbon Mass Fragmentograms
(m/z 191, 205, 217, 218, 231)

Key to mass fragmentograms m/z 191 and 205 fragmentograms (triterpanes)

Code	Compound	Elemental composition
A	Ts C_{27} 18α(H) Trisnorneohopane	$C_{27}H_{46}$
B	Tm C_{27} 17α(H) Trisnorhopane	$C_{27}H_{46}$
C	17α(H)-norhopane	$C_{29}H_{50}$
D	normoretane	$C_{29}H_{50}$
E	17α(H)-hopane	$C_{30}H_{52}$
F	moretane	$C_{30}H_{52}$
G	17α(H)-homohopane (22S)	$C_{31}H_{54}$
H	17α(H)-homohopane (22R)	$C_{31}H_{54}$
I	homomoretane	$C_{31}H_{54}$
J	17α(H)-bishomohopane 22S	$C_{32}H_{56}$
K	17α(H)-bishomohopane 22R	$C_{32}H_{56}$
L	17α(H)-trishomohopane 22S	$C_{33}H_{58}$
M	17α(H)-trishomohopane 22R	$C_{33}H_{58}$
N	17α(H)-tetrakishomohopane 22S	$C_{34}H_{60}$
O	17α(H)-tetrakishomohopane 22R	$C_{34}H_{60}$
P	17α(H)-pentakishomohopane 22S	$C_{35}H_{62}$
Q	17α(H)-pentakishomohopane 22R	$C_{35}H_{62}$
Z	17α(H), 28,30-bisnorhopane	$C_{28}H_{48}$

[0.0000] M3143S .SD RUN - 1 TRITERPANER STERANER
A181S #191S C205S D217S E218S F231S G239S H253S

RETN.TIME	HEIGHT	AREA	UNCALIBRATED.
0:23: 6	62.20	405.34	

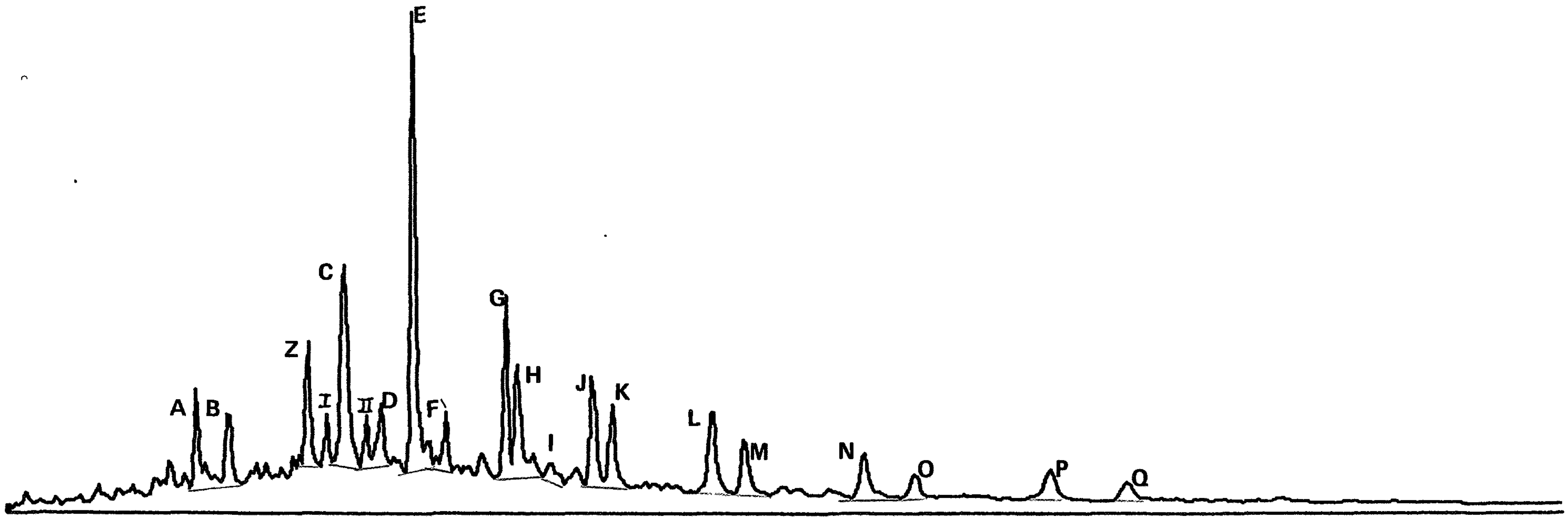
M - 3143
OIL
DEPTH INTERVAL 2630,5 – 38m
m/z 191

0 HRS 23 MINS 6 SECS

0 HRS 51 MINS 6 SECS

[0.0000] M6647S .SD RUN - 1 TRITERPANER STERANER
A181S #191S C205S D217S E218S F231S G239S H253S
RETN.TIME HEIGHT AREA UNCALIBRATED.
0:24:11 193.31 1251.39

M - 6647
OIL
DEPTH INTERVAL 2655 – 65m
m/z 191



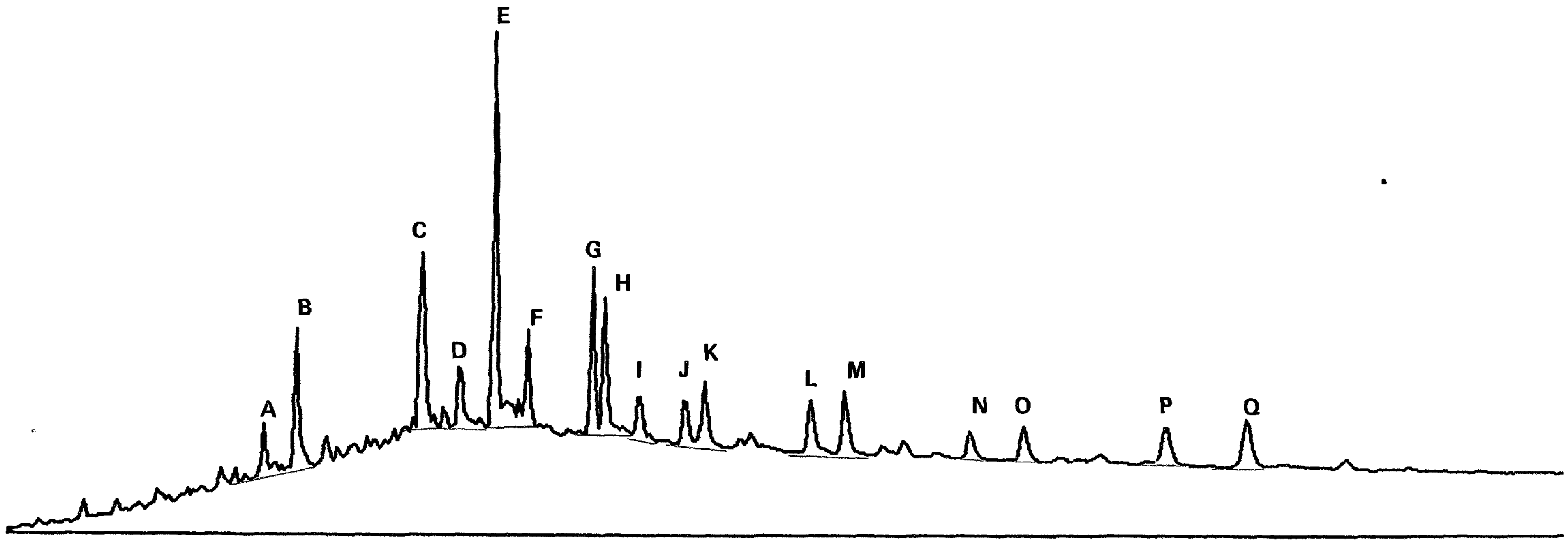
0 HRS 24 MINS 8 SECS

0 HRS 52 MINS 8 SECS

[0.0000] M2233S .SD RUN - 1 TRITERPANER STERANER
A181S #191S C205S D217S E218S F231S G239S H253S

RETN.TIME HEIGHT AREA UNCALIBRATED.
0:22:39 123.94 764.64

M - 2233
DEPTH 2415 – 30m
m/z 191



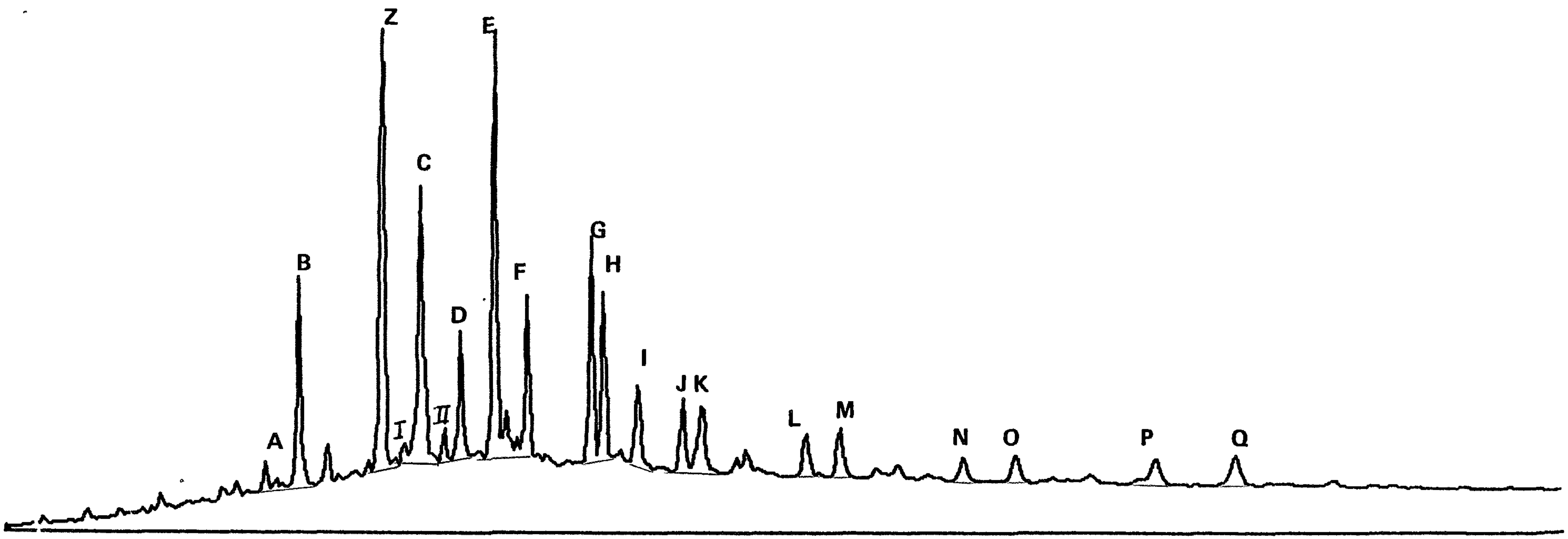
0 HRS 22 MINS 39 SECS

0 HRS 48 MINS 59 SECS

[0.0000] M2241S .SD RUN - 1 TRITERPANER STERANER
A181S #191S C205S D217S E218S F231S G239S H253S

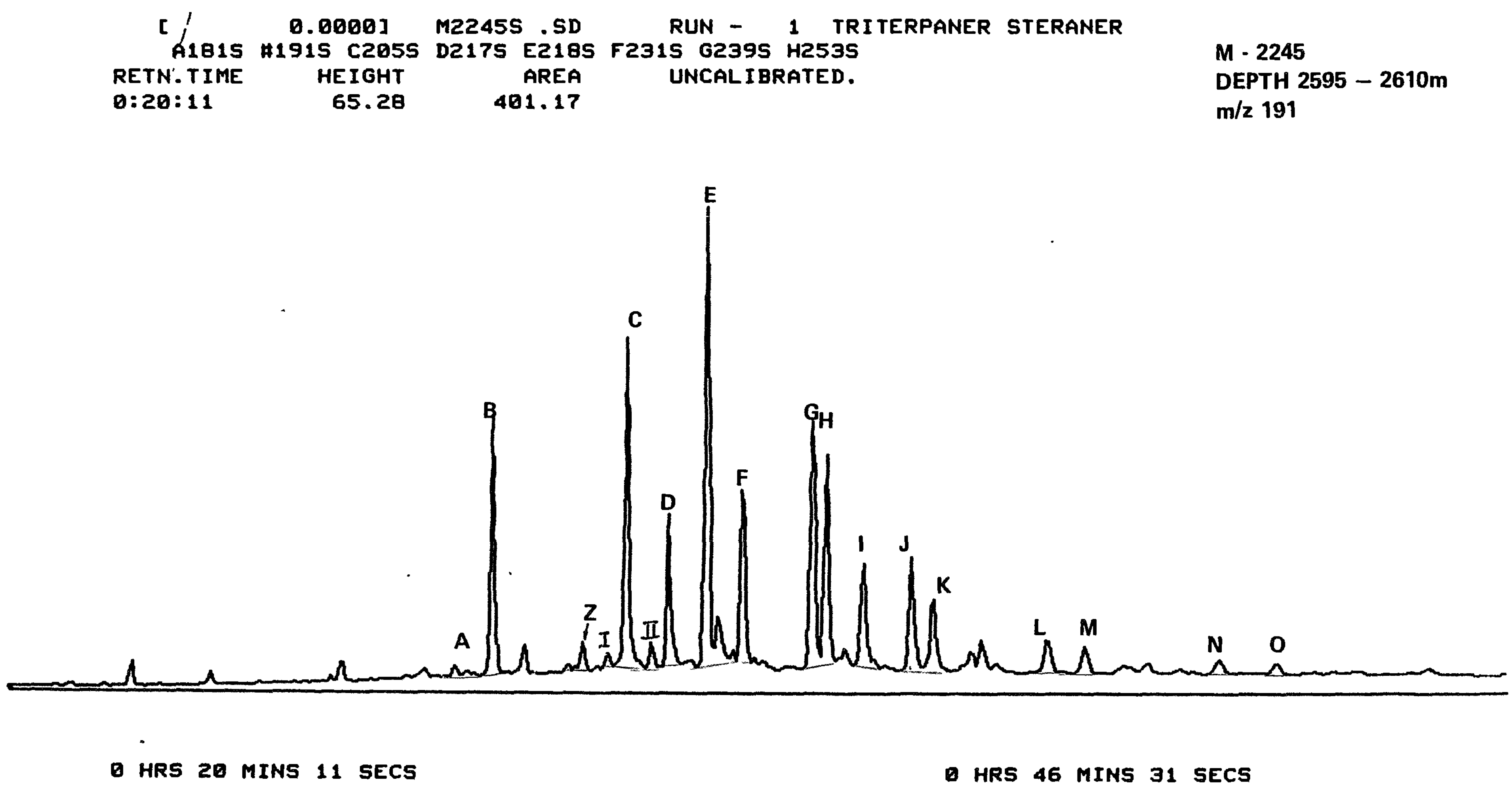
RETN.TIME	HEIGHT	AREA	UNCALIBRATED.
0:22:58	83.50	501.18	

M - 2241
DEPTH 2535 – 50m
m/z 191



0 HRS 22 MINS 58 SECS

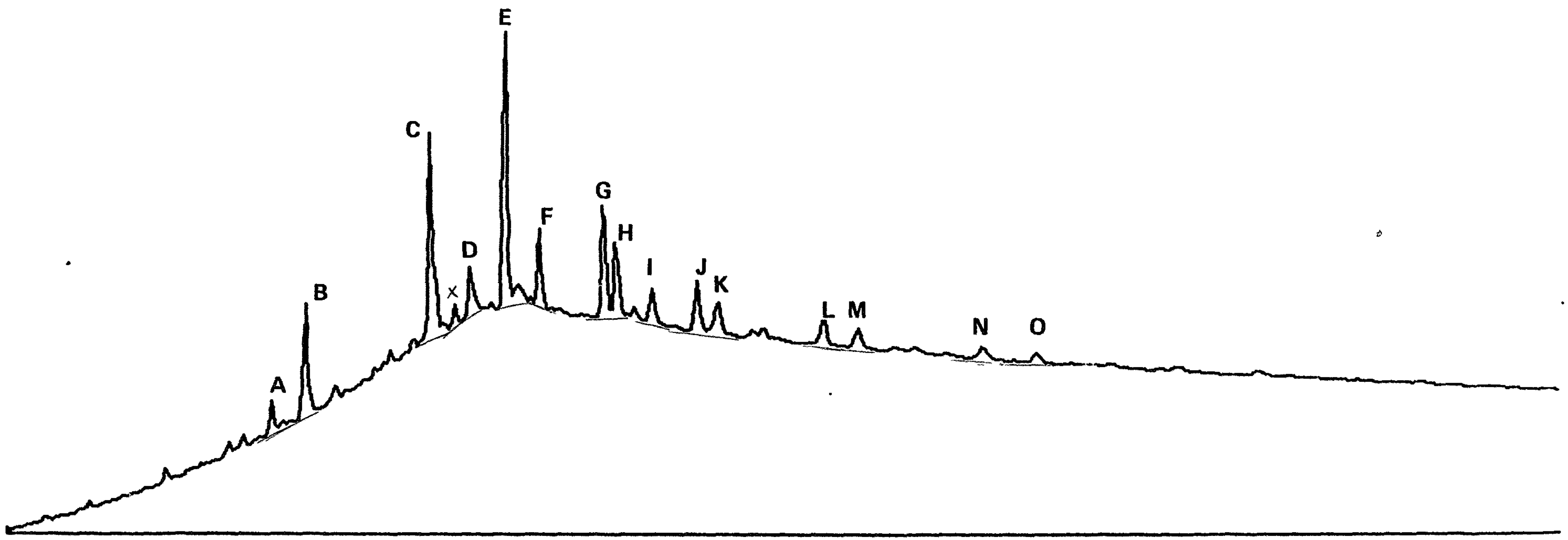
0 HRS 49 MINS 18 SECS



[/ 0.0000] M2245S .SD RUN - 1 TRITERPANER STERANER
A181S #191S C205S D217S E218S F231S G239S H253S
RETN.TIME HEIGHT AREA UNCALIBRATED.
0:20:11 65.28 401.17
M - 2245
DEPTH 2595 – 2610m
m/z 191
A
B
Z
I
C
II
D
E
F
G
H
I
J
K
L
M
N
O
0 HRS 20 MINS 11 SECS
0 HRS 46 MINS 31 SECS

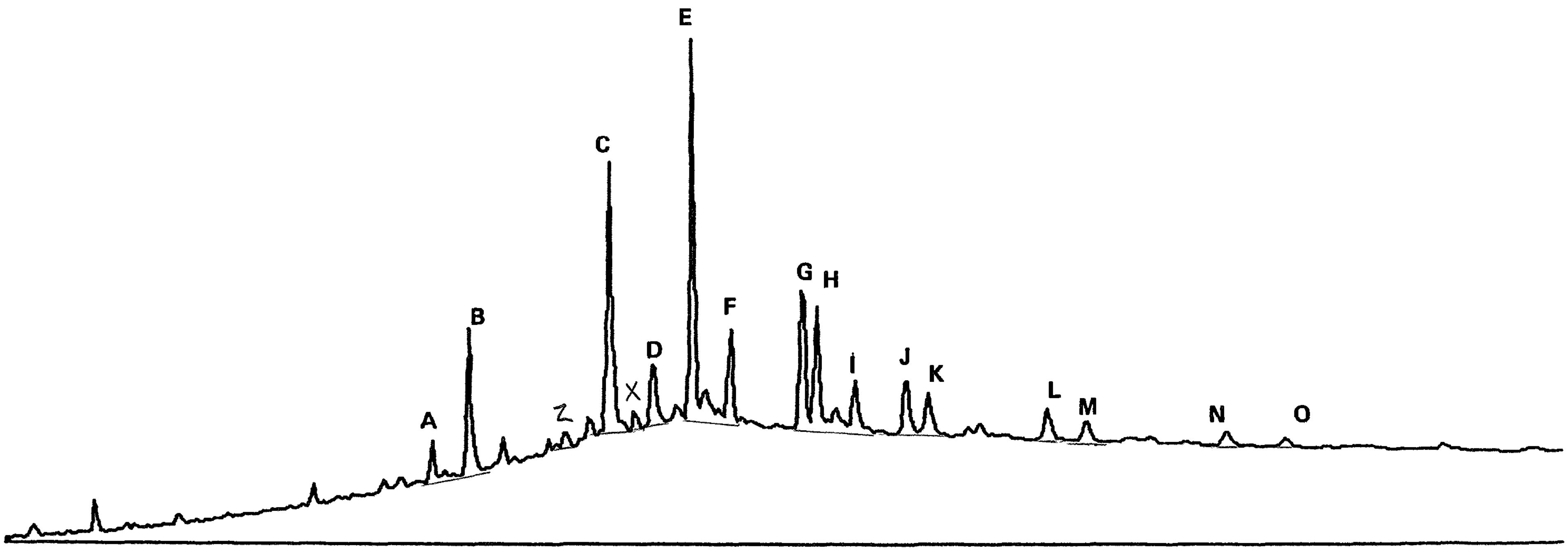
[0.0000] M2256S .SD RUN - 1 TRITERPANER STERANER
A181S #191S C205S D217S E218S F231S G239S H253S
RETN.TIME HEIGHT AREA UNCALIBRATED.
0:22:24 72.08 440.71

M - 2256
DEPTH 2775 – 90m
m/z 191



```
[          0.0000]    M2264S .SD      RUN -    1  TRITERPANER STERANER
  A181S #191S C205S D217S E218S F231S G239S H253S
RETN.TIME       HEIGHT          AREA       UNCALIBRATED.
0:20: 9          56.84        350.59
```

M - 2264
DEPTH 2895 – 2910m
m/z 191



0 HRS 20 MINS 9 SECS

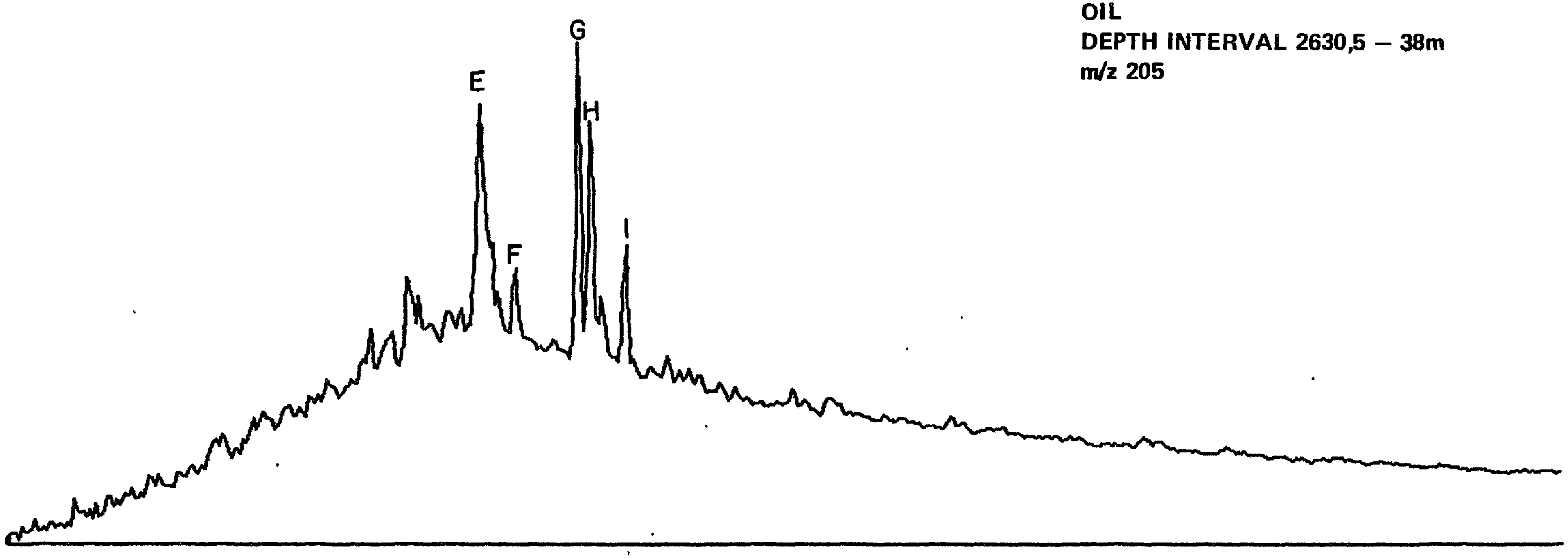
0 HRS 46 MINS 29 SECS

[0.0000]   M3143S .SD   RUN -   1 TRITERPANER STERANER

A181S B191S #205S D217S E218S F231S G239S H253S

RETN.TIME	HEIGHT	AREA	UNCALIBRATED.
0:23: 9	43.09	280.60	

M - 3143
OIL
DEPTH INTERVAL 2630,5 – 38m
m/z 205

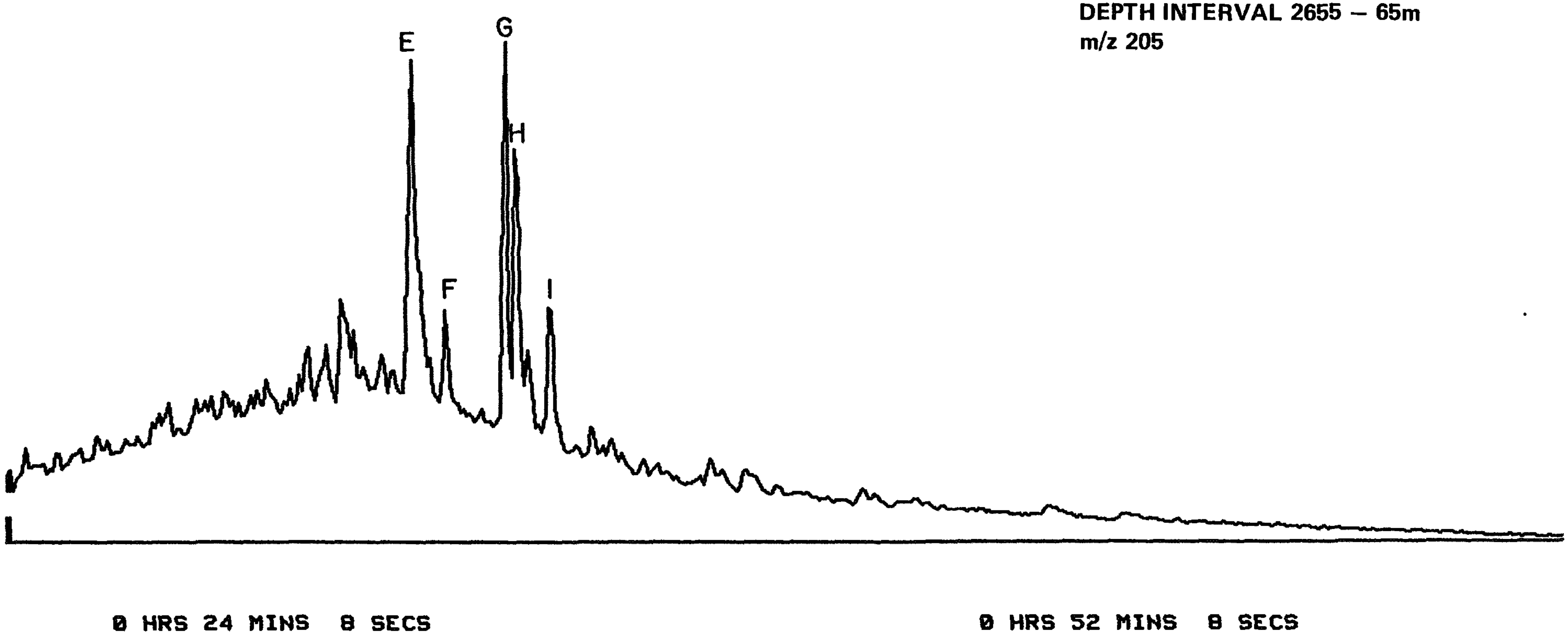


0 HRS 23 MINS   6 SECS   0 HRS 51 MINS   6 SECS

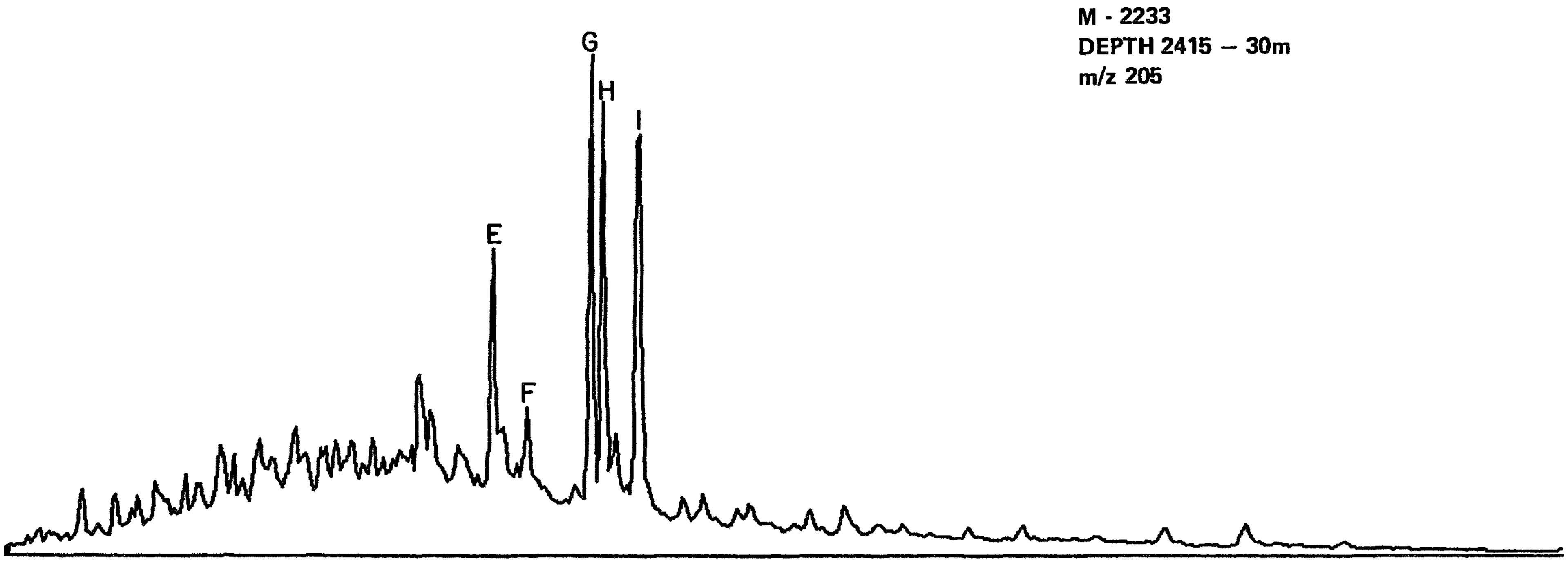
[0.0000] M6647S .SD RUN - 1 TRITERPANER STERANER
A181S B191S #205S D217S E218S F231S G239S H253S

RETN.TIME	HEIGHT	AREA	UNCALIBRATED.
0:24:11	134.28	869.84	

M - 6647
OIL
DEPTH INTERVAL 2655 – 65m
m/z 205



[0.0000] M2233S .SD RUN - 1 TRITERPANER STERANER
A181S B191S #205S D217S E218S F231S G239S H253S
RETN.TIME HEIGHT AREA UNCALIBRATED.
0:22:42 33.32 203.72

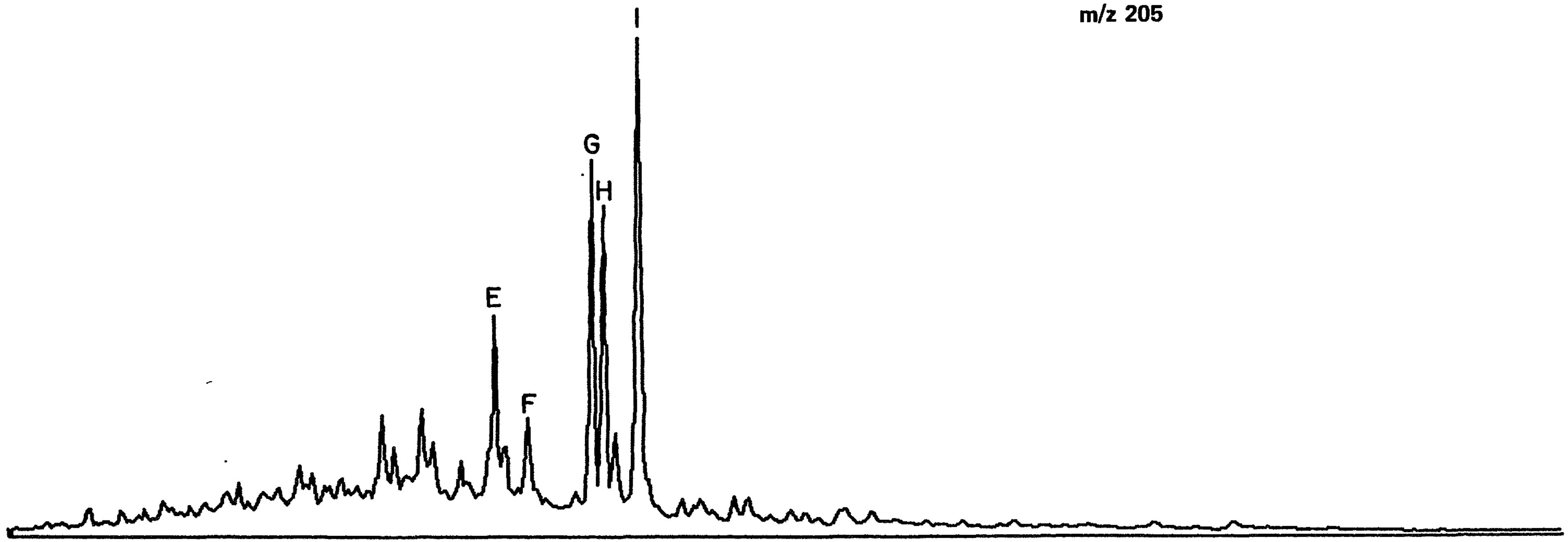


0 HRS 22 MINS 39 SECS

0 HRS 48 MINS 59 SECS

```
[          0.0000]   M2241S .SD       RUN -    1  TRITERPANER STERANER
   A181S B191S #205S D217S E218S F231S G239S H253S
RETN.TIME      HEIGHT          AREA      UNCALIBRATED.
0:22:58          25.05       153.04
```

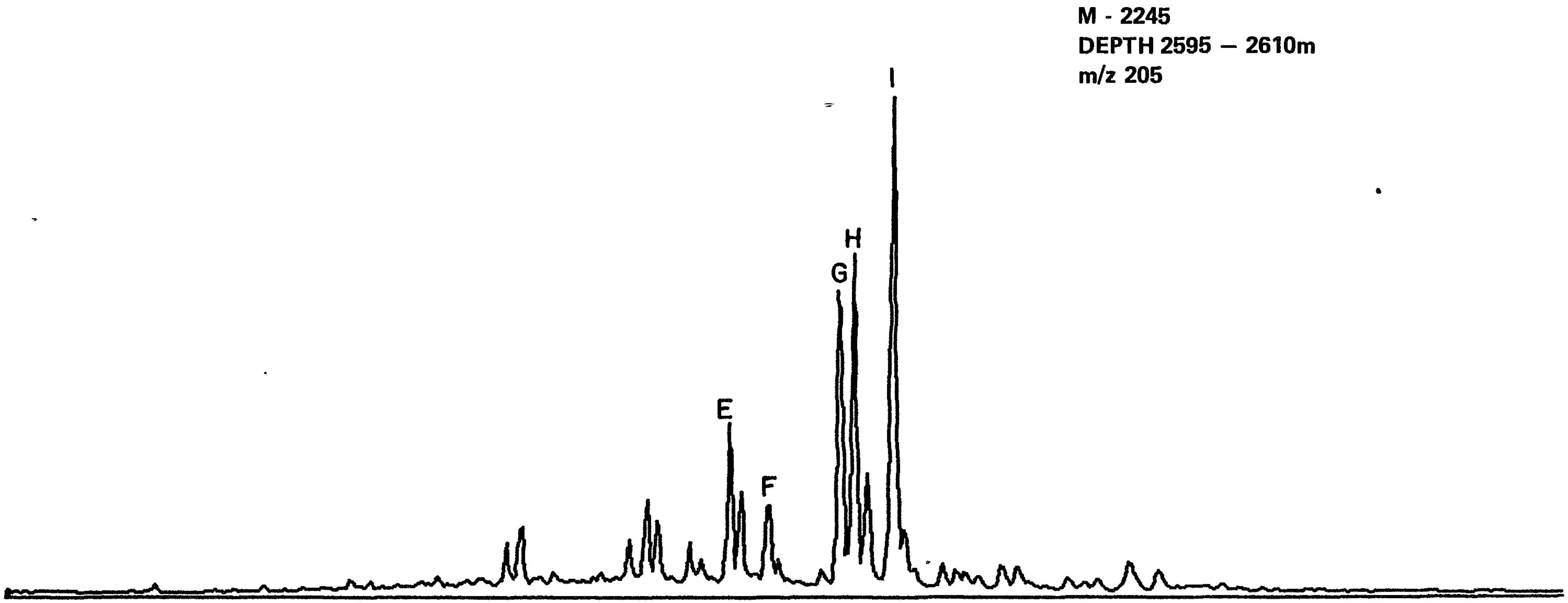
M - 2241
DEPTH 2535 – 50m
m/z 205



0 HRS 22 MINS 58 SECS

0 HRS 49 MINS 18 SECS

[0.0000] M2245S .SD RUN - 1 TRITERPANER STERANER
A181S B191S #205S D217S E218S F231S G239S H253S
RETN.TIME HEIGHT AREA UNCALIBRATED.
0:20:14 35.35 213.39



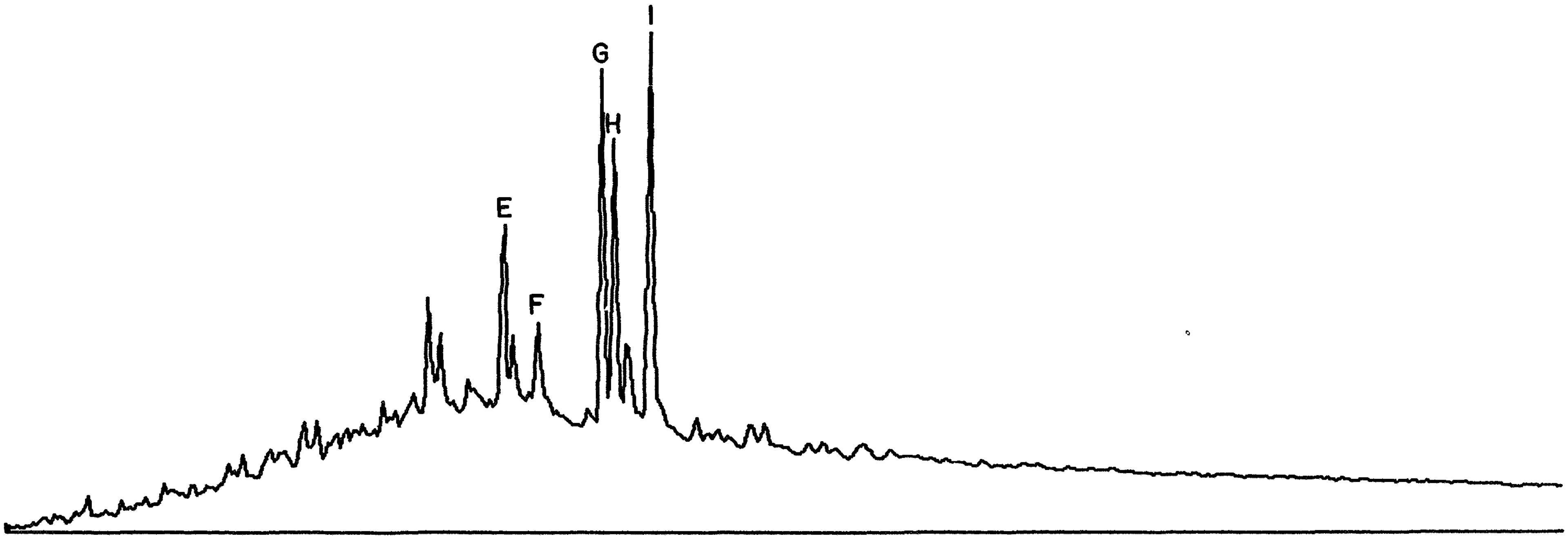
0 HRS 20 MINS 11 SECS 0 HRS 46 MINS 31 SECS

0 HRS 22 MINS 24 SECS 0 HRS 48 MINS 44 SECS

[0.0000] M2256S .SD RUN - 1 TRITERPANER STERANER
A181S B191S #205S D217S E218S F231S G239S H253S

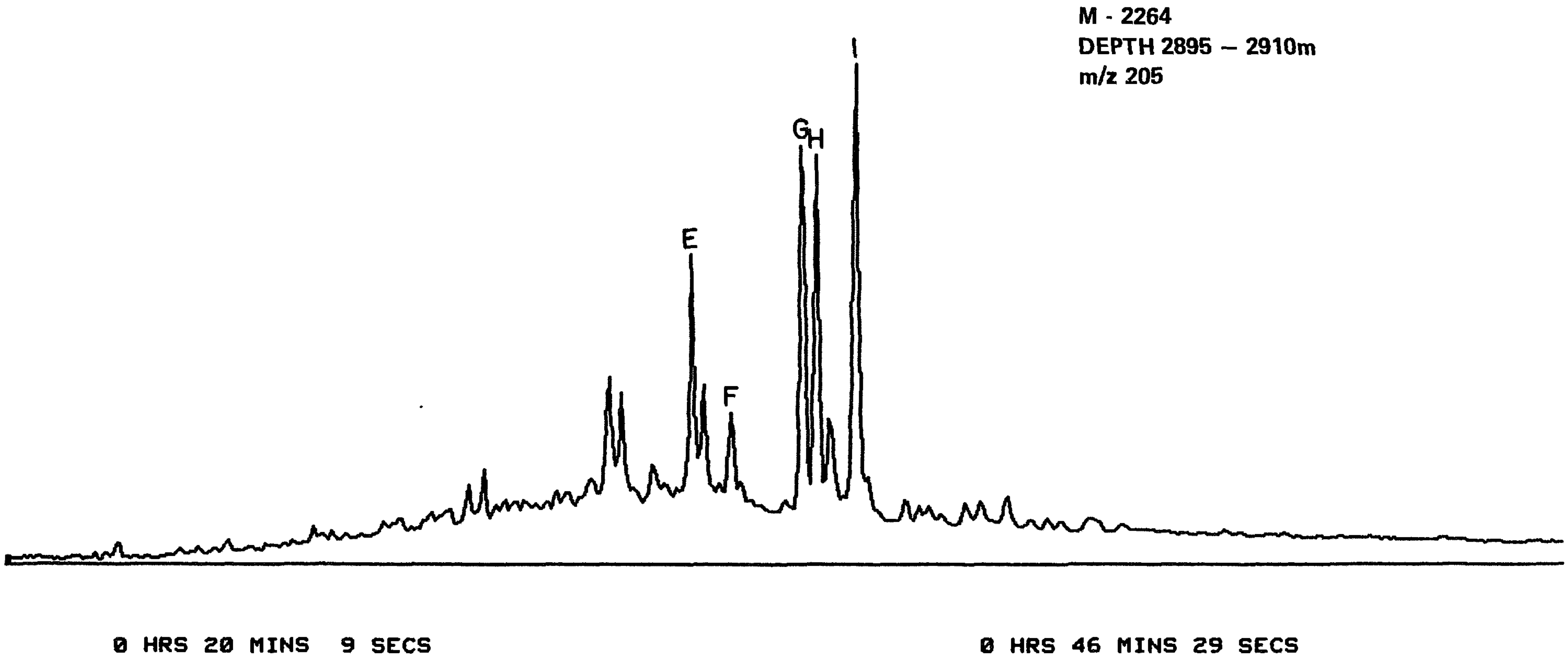
RETN.TIME	HEIGHT	AREA	UNCALIBRATED.
0:22:24	19.30	118.74	

M - 2256
DEPTH 2775 – 90m
m/z 205



0 HRS 22 MINS 24 SECS 0 HRS 48 MINS 44 SECS

```
[          0.0000]    M2264S .SD        RUN -    1   TRITERPANER STERANER
     A181S B191S #205S D217S E218S F231S G239S H253S
RETN.TIME       HEIGHT          AREA        UNCALIBRATED.
0:20: 9          24.20        148.37
```



-- Key to mass fragmentograms, m/z 217, 218, 231 (steranes).

	Compound	Elemental composition
a	13ß,17α-diacholestane (20S)	$C_{27}H_{48}$
b	13ß,17α-diacholestane (20R)	$C_{27}H_{48}$
c	13α,17ß-diacholestane (20S)	$C_{27}H_{48}$
d	13α,17ß-diacholestane (20R)	$C_{27}H_{48}$
e	24-methyl-13ß,17α-diacholestane (20S)	$C_{28}H_{50}$
f	24-methyl-13ß,17α-diacholestane (20R)	$C_{28}H_{50}$
g	24-methyl-13α,17ß-diacholestane (20S)	$C_{28}H_{50}$
	+ 14α,17α-cholestane (20S)	$C_{27}H_{48}$
h	24-ethyl-13ß,17α-diacholestane (20S)	$C_{29}H_{52}$
	+ 14ß,17ß-cholestane (20R)	$C_{27}H_{48}$
i	14ß,17ß-cholestane (20S)	$C_{27}H_{48}$
	+ 24-methyl-13α,17ß-diacholestane (20R)	$C_{28}H_{50}$
j	14α,17α-cholestane (20R)	$C_{27}H_{48}$
k	24-ethyl-13ß,17α-diacholestane (20R)	$C_{29}H_{52}$
l	24-ethyl-13α,17ß-diacholestane (20S)	$C_{29}H_{52}$
m	24-methyl-14α,17α-cholestane (20S)	$C_{28}H_{50}$
n	24-ethyl-13α,17ß-diacholestane (20R)	$C_{29}H_{52}$
	+ 24-methyl-14ß,17ß-cholestane (20R)	$C_{28}H_{50}$
o	24-methyl-14ß,17ß-cholestane (20S)	$C_{28}H_{50}$
p	24-methyl-14α,17α-cholestane (20R)	$C_{28}H_{50}$
q	24-ethyl-14α,17α-cholestane (20S)	$C_{29}H_{52}$
r	24-ethyl-14ß,17ß-cholestane (20R)	$C_{29}H_{52}$
s	24-ethyl-14ß,17ß-cholestane (20S)	$C_{29}H_{52}$
t	24-ethyl-14α,17α-cholestane (20R)	$C_{29}H_{52}$

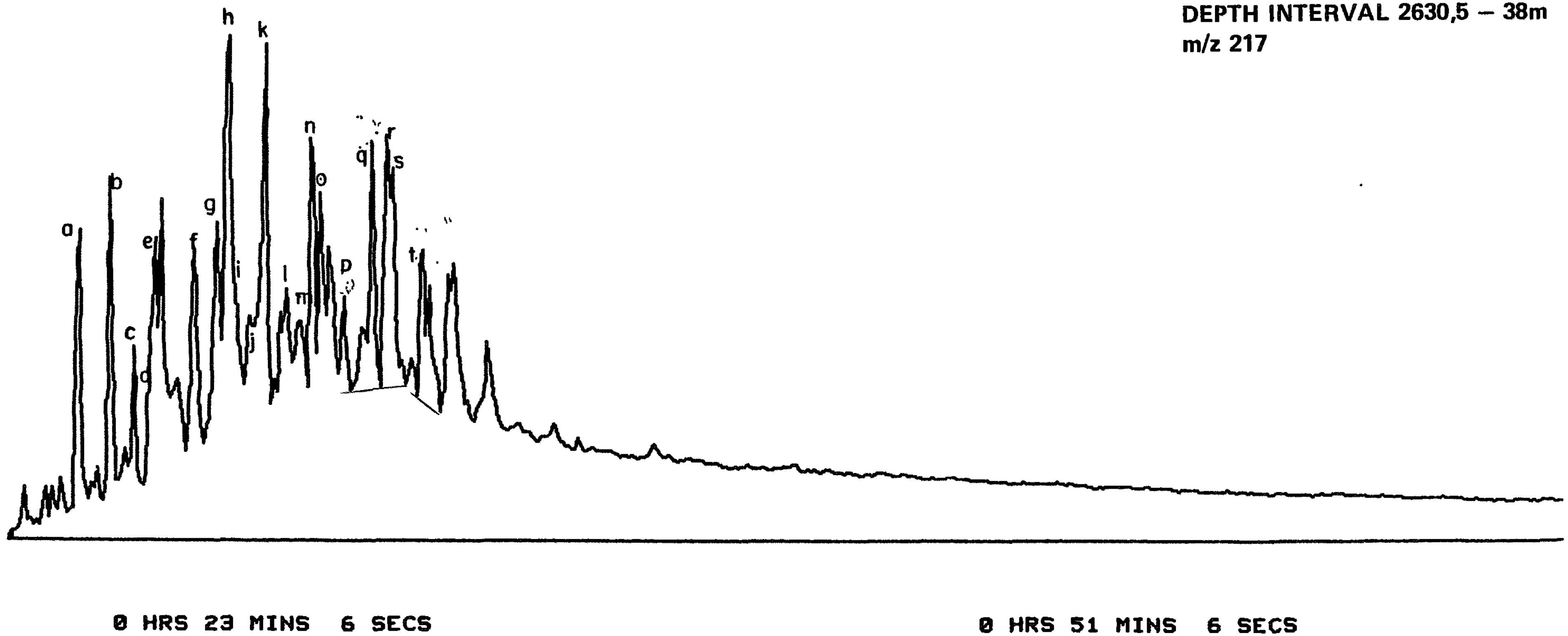
[0.0000] M3143S .SD RUN - 1 TRITERPANER STERANER

A181S B191S C205S #217S E218S F231S G239S H253S

RETN.TIME HEIGHT AREA UNCALIBRATED.

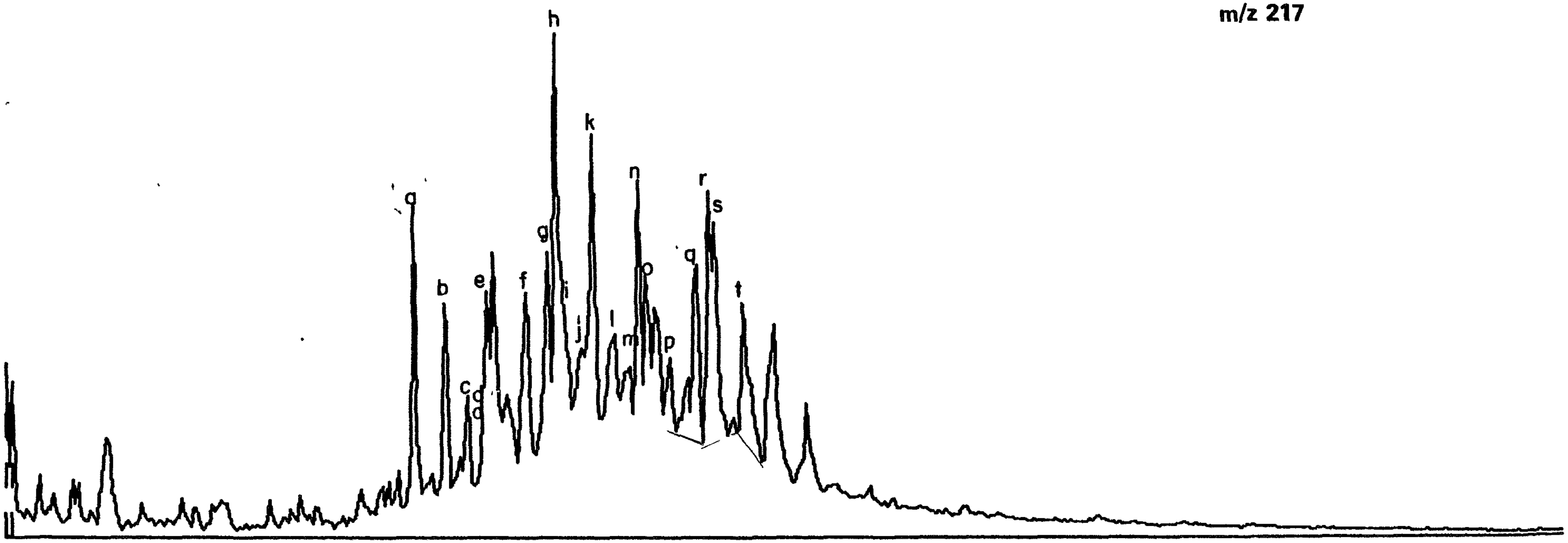
0:23: 9 28.65 182.70

M - 3143
OIL
DEPTH INTERVAL 2630,5 – 38m
m/z 217



[0.0000] M6647S .SD RUN - 1 TRITERPANER STERANER
A181S B191S C205S #217S E218S F231S G239S H253S
RETN.TIME HEIGHT AREA UNCALIBRATED.
0:16:10 298.87 2377.88

M - 6647
OIL
DEPTH INTERVAL 2655 – 65m
m/z 217



0 HRS 16 MINS 10 SECS

0 HRS 44 MINS 10 SECS

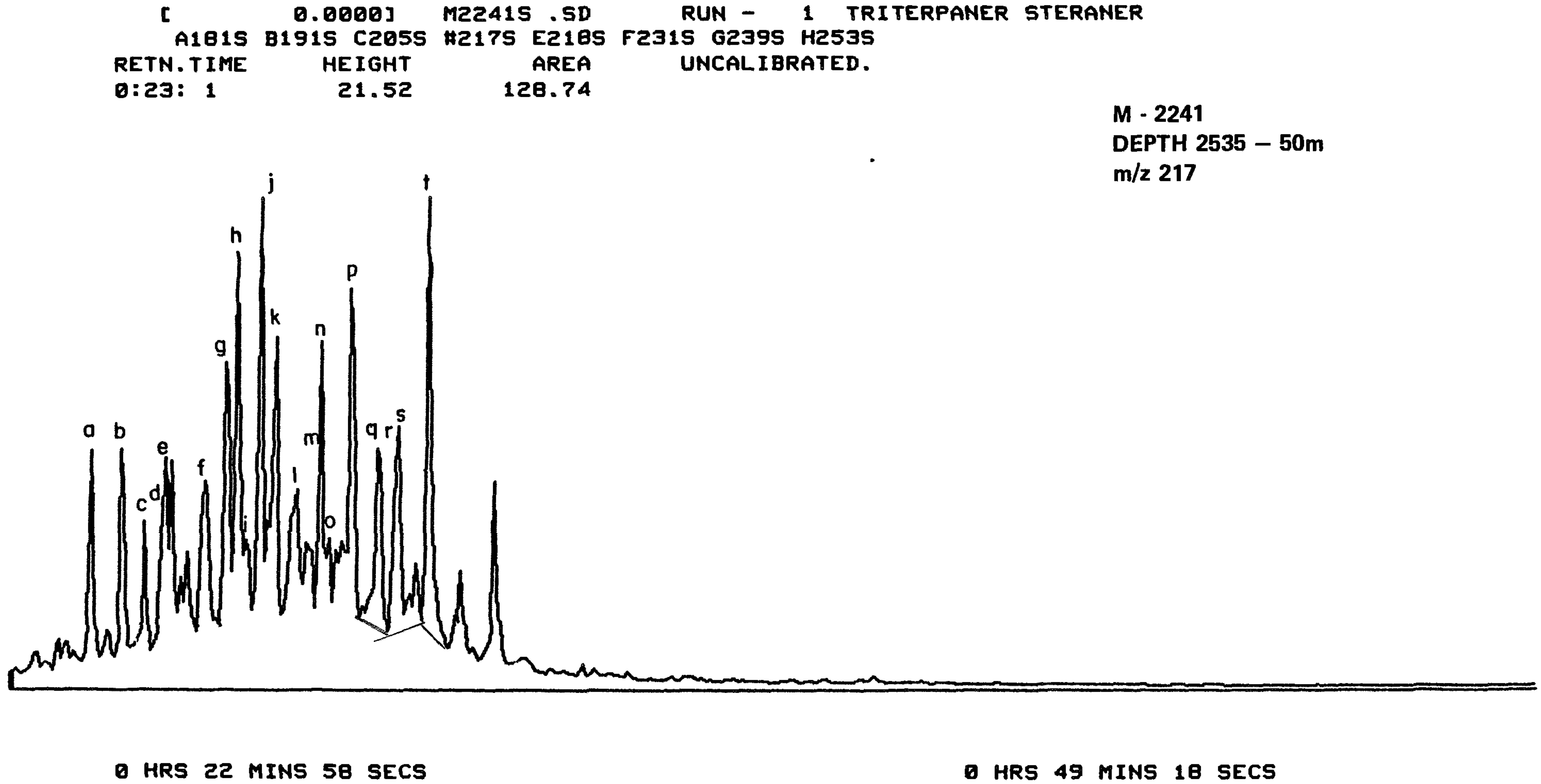
[0.0000] M2233S .SD RUN - 1 TRITERPANER STERANER
A181S B191S C205S #217S E218S F231S G239S H253S

RETN.TIME	HEIGHT	AREA	UNCALIBRATED.
0:22:39	32.60	183.59	

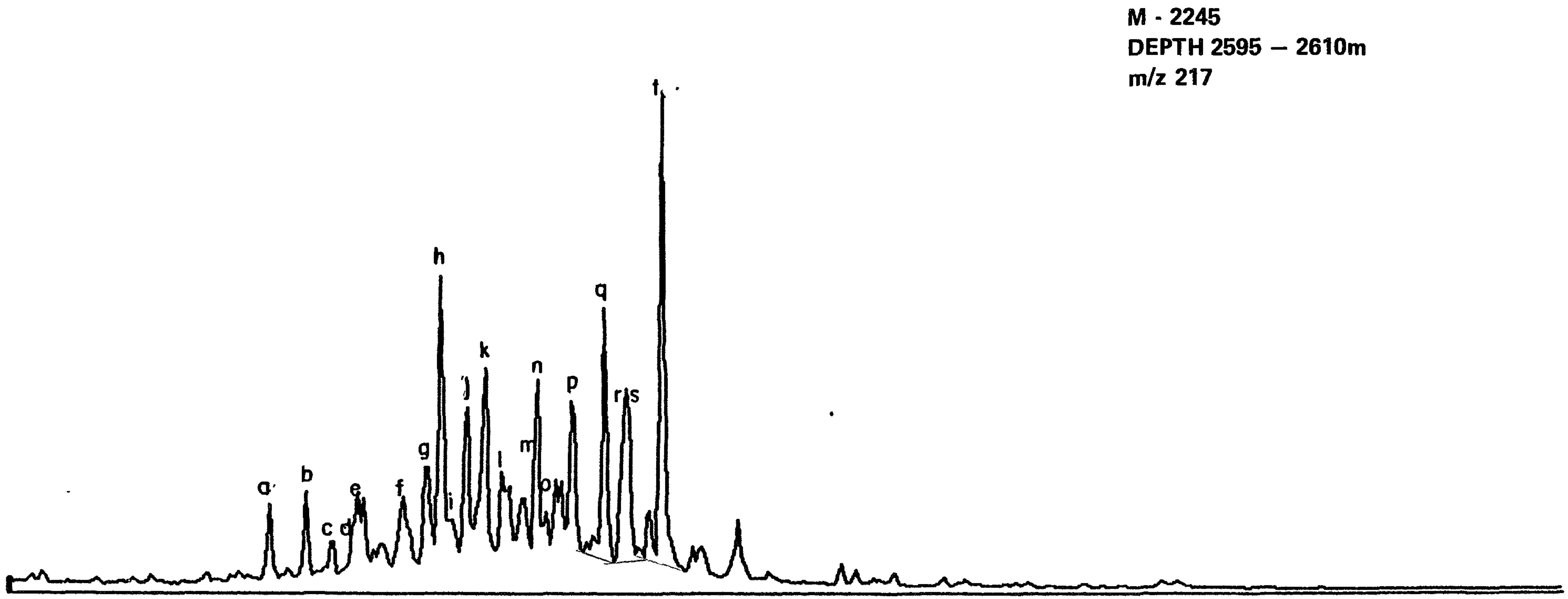
M - 2233
DEPTH 2415 – 30m
m/z 217

0 HRS 22 MINS 39 SECS

0 HRS 48 MINS 59 SECS


[0.0000] M2241S .SD RUN - 1 TRITERPANER STERANER
A181S B191S C205S #217S E218S F231S G239S H253S
RETN.TIME HEIGHT AREA UNCALIBRATED.
0:23: 1 21.52 128.74
M - 2241
DEPTH 2535 – 50m
m/z 217
a
b
c
d
e
f
g
h
i
j
k
l
m
n
o
p
q
r
s
t
0 HRS 22 MINS 58 SECS
0 HRS 49 MINS 18 SECS

[0.0000] M2245S .SD RUN - 1 TRITERPANER STERANER
A181S B191S C205S #217S E218S F231S G239S H253S
RETN.TIME HEIGHT AREA UNCALIBRATED.
0:20:14 31.84 195.81



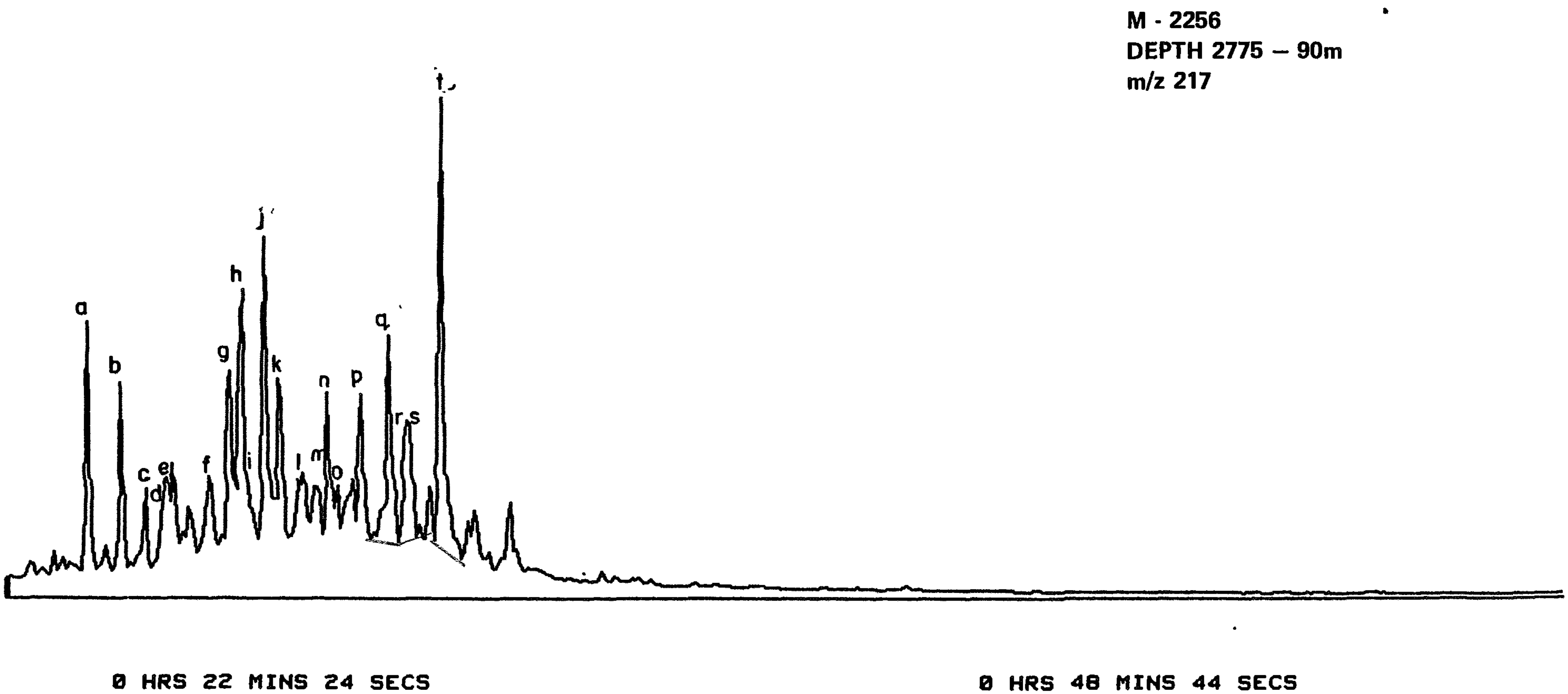
0 HRS 20 MINS 11 SECS

0 HRS 46 MINS 31 SECS

[0.0000] M2256S .SD RUN - 1 TRITERPANER STERANER

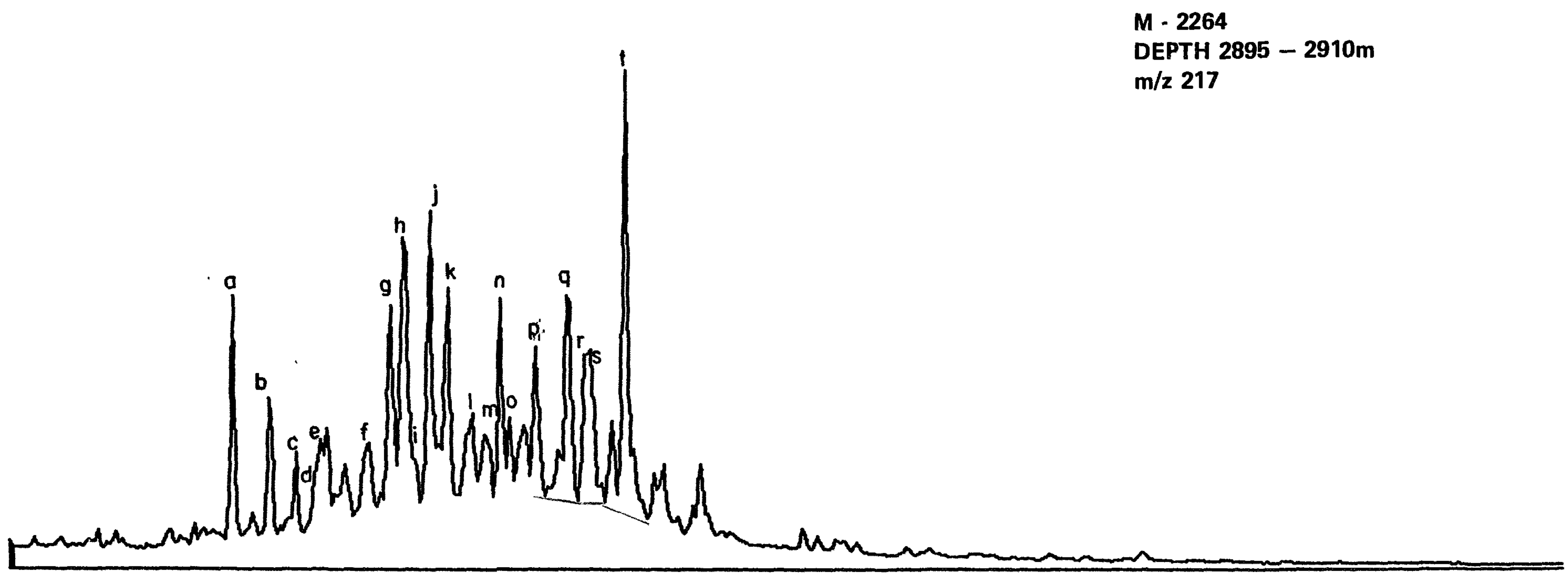
A181S B191S C205S #217S E218S F231S G239S H253S

RETN.TIME	HEIGHT	AREA	UNCALIBRATED.
0:22:27	13.17	80.39	



[0.0000] M2264S .SD RUN - 1 TRITERPANER STERANER
A181S B191S C205S #217S E218S F231S G239S H253S

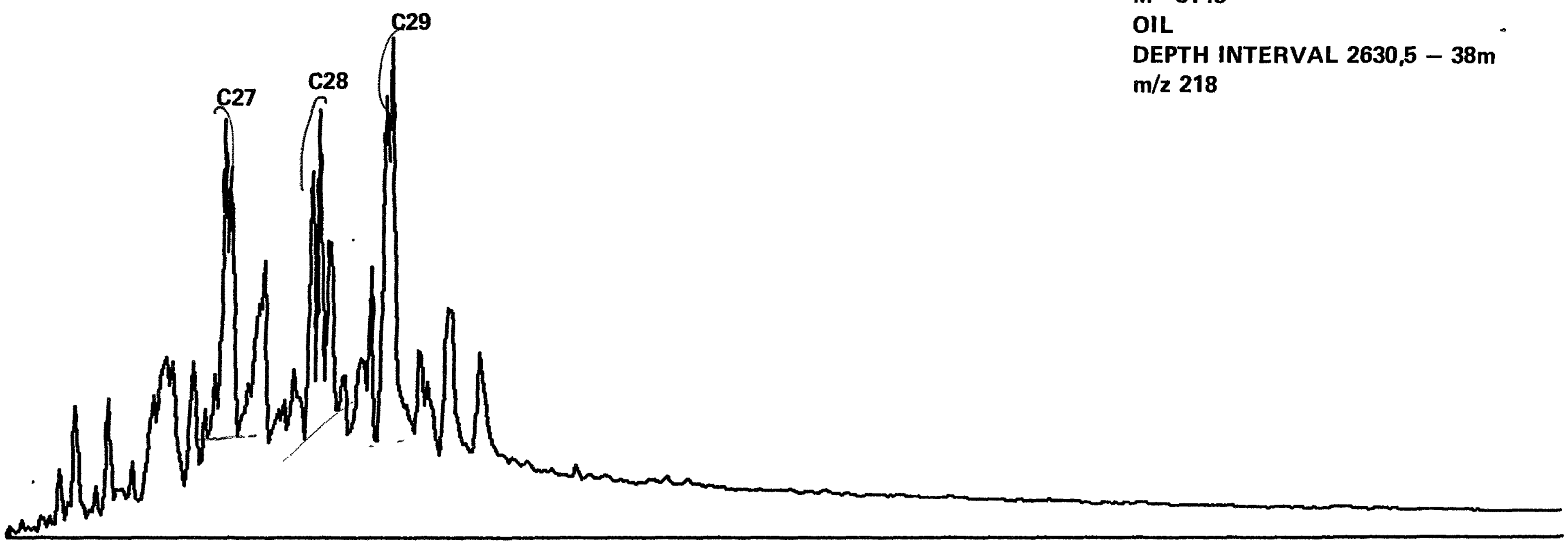
RETN.TIME	HEIGHT	AREA	UNCALIBRATED.
0:20: 9	16.89	100.64	



[0.0000] M3143S .SD RUN - 1 TRITERPANER STERANER
A181S B191S C205S D217S #218S F231S G239S H253S

RETN.TIME	HEIGHT	AREA	UNCALIBRATED.
0:23: 9	17.87	111.78	

M - 3143
OIL
DEPTH INTERVAL 2630,5 – 38m
m/z 218



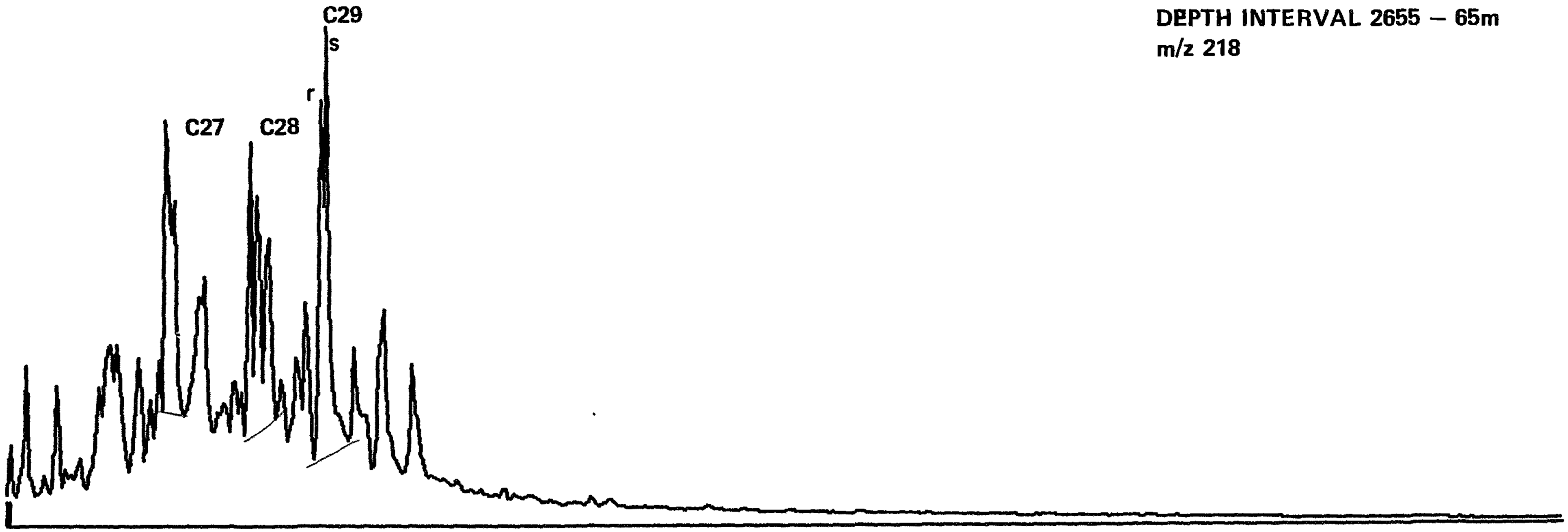
0 HRS 23 MINS 6 SECS

0 HRS 51 MINS 6 SECS

[0.0000] M6647S .SD RUN - 1 TRITERPANER STERANER
A181S B191S C205S D217S #218S F231S G239S H253S

RETN.TIME	HEIGHT	AREA	UNCALIBRATED.
0:24:11	123.55	618.67	

M - 6647
OIL
DEPTH INTERVAL 2655 – 65m
m/z 218



[0.0000]   M2233S .SD   RUN -   1 TRITERPANER STERANER
A181S B191S C205S D217S #218S F231S G239S H253S
RETN.TIME   HEIGHT   AREA   UNCALIBRATED.
0:22:39   19.20   113.28

M - 2233
DEPTH 2415 – 30m
m/z 218

0 HRS 22 MINS 39 SECS   0 HRS 48 MINS 59 SECS

[0.0000] M2241S .SD RUN - 1 TRITERPANER STERANER
A181S B191S C205S D217S #218S F231S G239S H253S

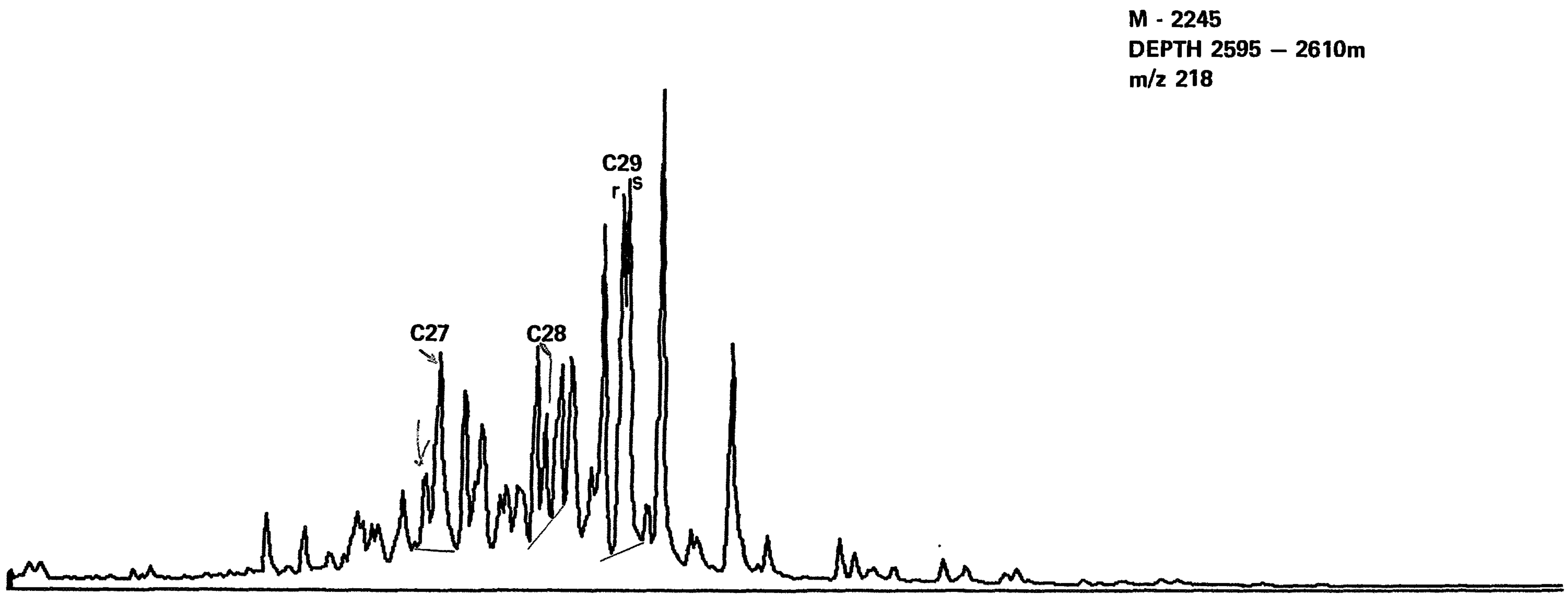
RETN.TIME	HEIGHT	AREA	UNCALIBRATED.
0:23: 1	12.99	80.13	

M - 2241
DEPTH 2535 – 50m
m/z 218

0 HRS 22 MINS 58 SECS

0 HRS 49 MINS 18 SECS

[0.0000] M2245S .SD RUN - 1 TRITERPANER STERANER
A181S B191S C205S D217S #218S F231S G239S H253S
RETN.TIME HEIGHT AREA UNCALIBRATED.
0:20:14 21.77 128.40



0 HRS 20 MINS 11 SECS

0 HRS 46 MINS 31 SECS

[0.0000] M2256S .SD RUN - 1 TRITERPANER STERANER
A181S B191S C205S D217S #218S F231S G239S H253S

RETN.TIME	HEIGHT	AREA	UNCALIBRATED.
0:22:27	9.11	55.90	

M - 2256
DEPTH 2775 – 90m
m/z 218

0 HRS 22 MINS 24 SECS

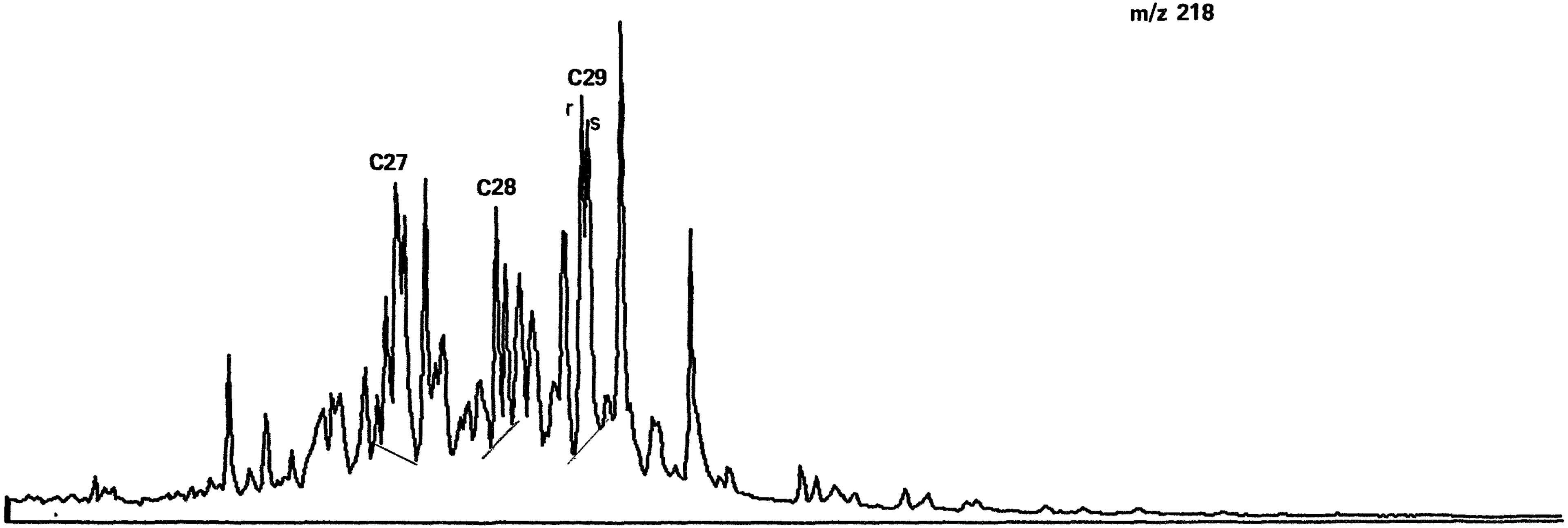
0 HRS 48 MINS 44 SECS

0 HRS 20 MINS 9 SECS 0 HRS 46 MINS 29 SECS

[0.0000] M2264S .SD RUN - 1 TRITERPANER STERANER
A181S B191S C205S D217S #218S F231S G239S H253S

RETN.TIME	HEIGHT	AREA	UNCALIBRATED.
0:20: 9	10.70	64.66	

M - 2264
DEPTH 2895 – 2910m
m/z 218

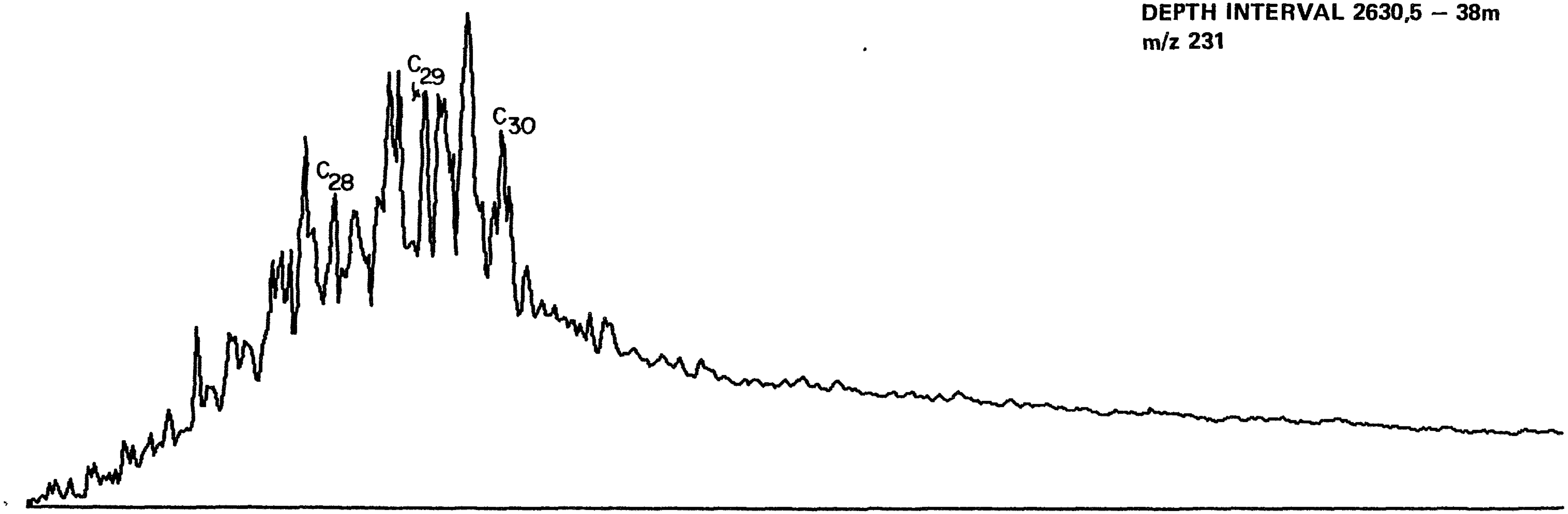


0 HRS 20 MINS 9 SECS 0 HRS 46 MINS 29 SECS

[0.0000] M3143S .SD RUN - 1 TRITERPANER STERANER
A181S B191S C205S D217S E218S #231S G239S H253S

RETN.TIME	HEIGHT	AREA	UNCALIBRATED.
0:23: 9	38.98	255.73	

M - 3143
OIL
DEPTH INTERVAL 2630,5 – 38m
m/z 231

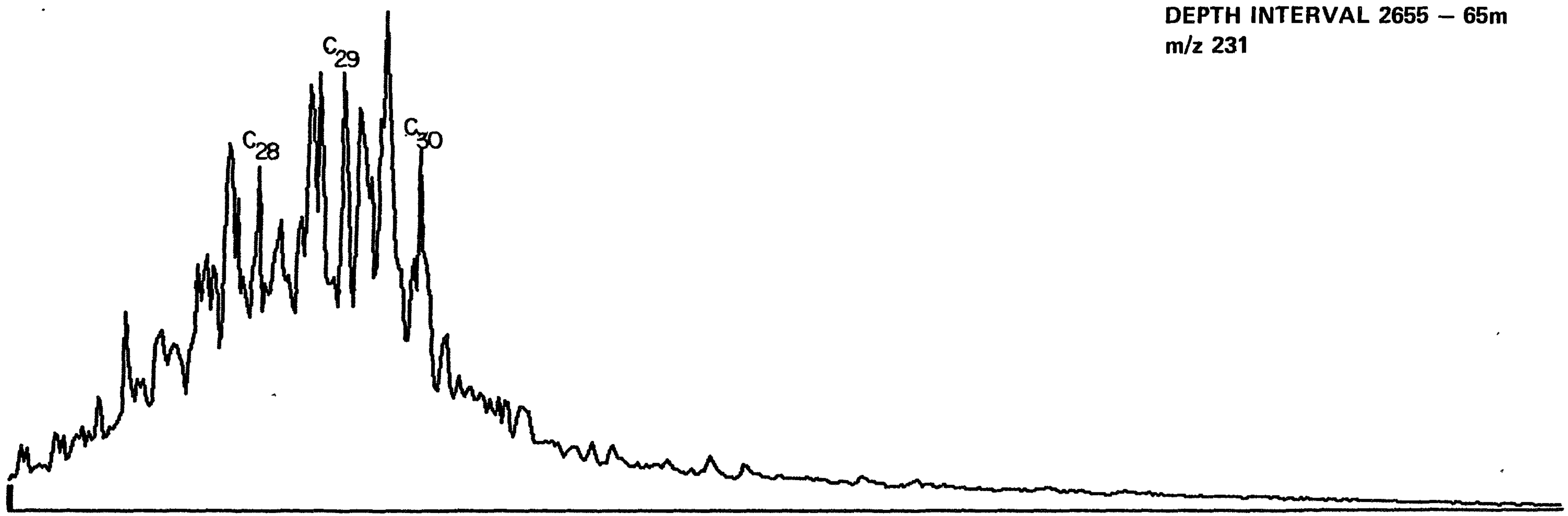


0 HRS 23 MINS 6 SECS   0 HRS 51 MINS 6 SECS

0 HRS 24 MINS 8 SECS 0 HRS 52 MINS 8 SECS

[0.0000] M6647S .SD RUN - 1 TRITERPANER STERANER
A181S B191S C205S D217S E218S #231S G239S H253S
RETN.TIME HEIGHT AREA UNCALIBRATED.
0:24:11 59.09 381.29

M - 6647
OIL
DEPTH INTERVAL 2655 – 65m
m/z 231

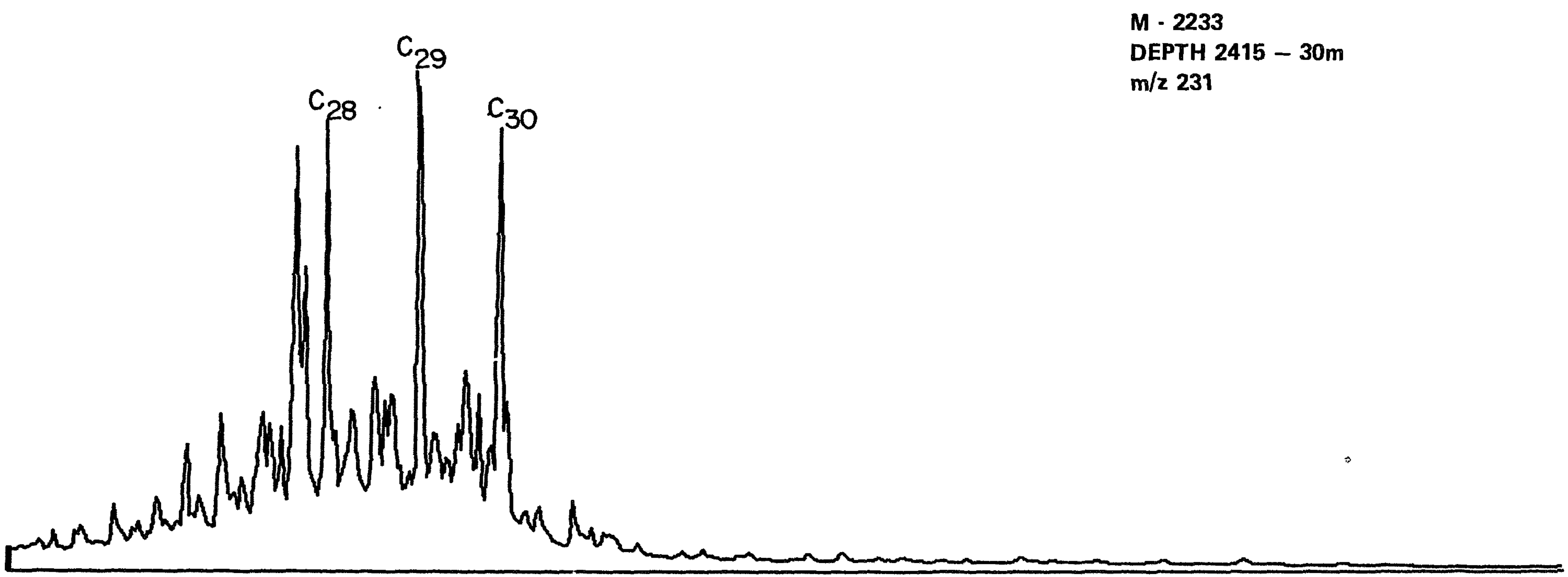


0 HRS 24 MINS 8 SECS 0 HRS 52 MINS 8 SECS

[0.0000] M6647S .SD RUN - 1 TRITERPANER STERANER
A181S B191S C205S D217S E218S F231S #239S H253S
RETN.TIME HEIGHT AREA UNCALIBRATED.
0: 0:12 2.25 29.51

[0.0000] M2233S .SD RUN - 1 TRITERPANER STERANER
A181S B191S C205S D217S E218S #231S G239S H253S

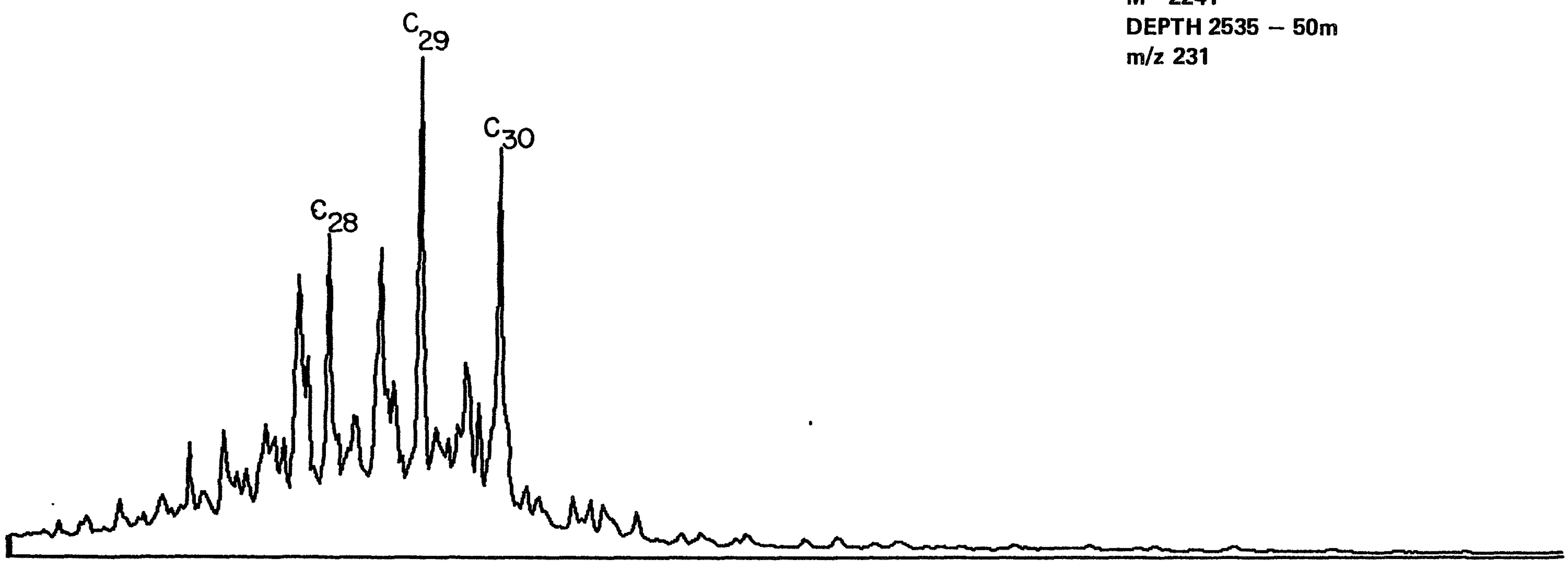
RETN.TIME	HEIGHT	AREA	UNCALIBRATED.
0:22:39	33.45	206.08	



0 HRS 22 MINS 39 SECS 0 HRS 48 MINS 59 SECS

[0.0000] M2241S .SD RUN - 1 TRITERPANER STERANER
A181S B191S C205S D217S E218S #231S G239S H253S
RETN.TIME HEIGHT AREA UNCALIBRATED.
0:22:58 23.66 145.45

M - 2241
DEPTH 2535 – 50m
m/z 231

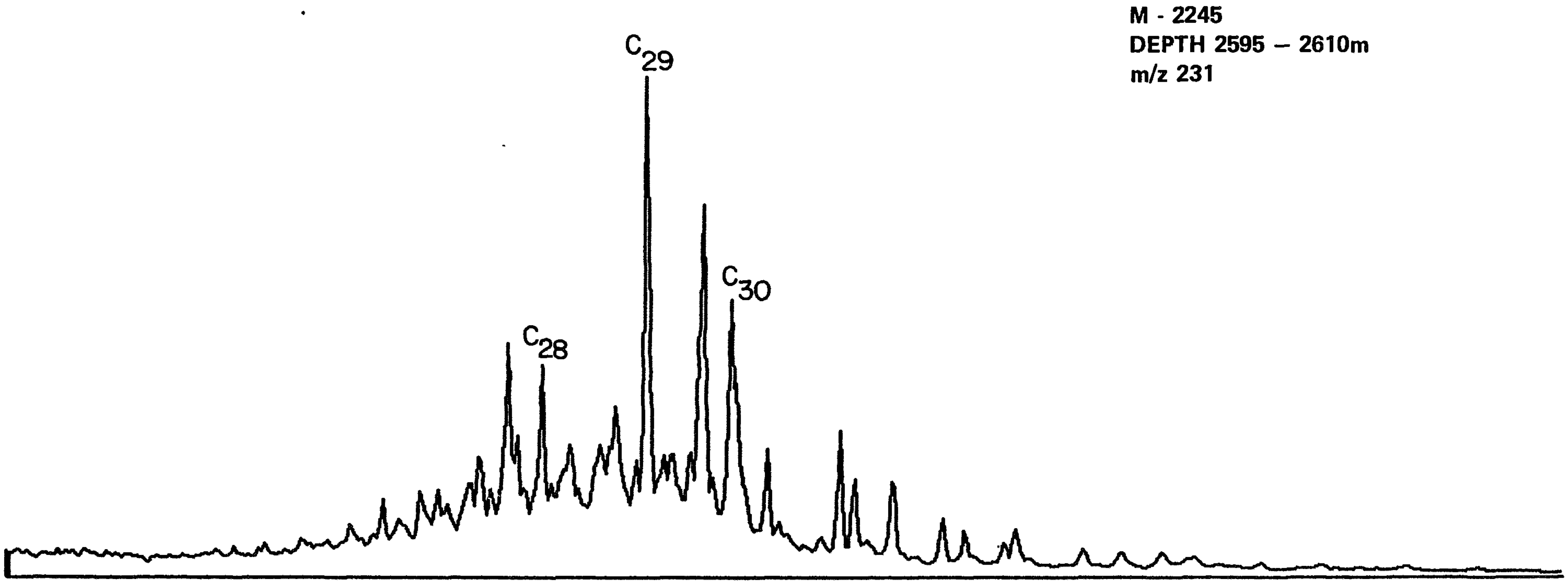


0 HRS 22 MINS 58 SECS

0 HRS 49 MINS 18 SECS

[0.0000] M2245S .SD RUN - 1 TRITERPANER STERANER
A181S B191S C205S D217S E218S #231S G239S H253S

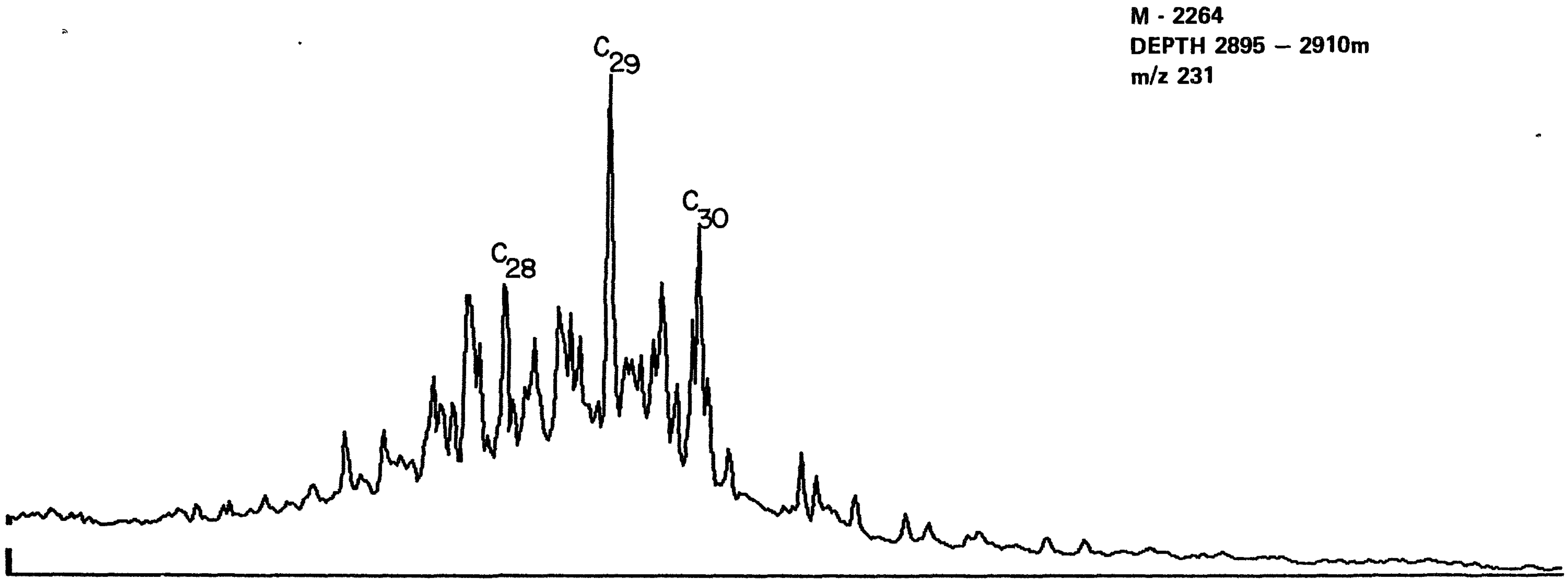
RETN.TIME	HEIGHT	AREA	UNCALIBRATED.
0:20:11	35.52	217.41	



0 HRS 20 MINS 11 SECS

0 HRS 46 MINS 31 SECS

[0.0000] M2264S .SD RUN - 1 TRITERPANER STERANER
A181S B191S C205S D217S E218S #231S G239S H253S
RETN.TIME HEIGHT AREA UNCALIBRATED.
0:20: 9 29.09 179.18

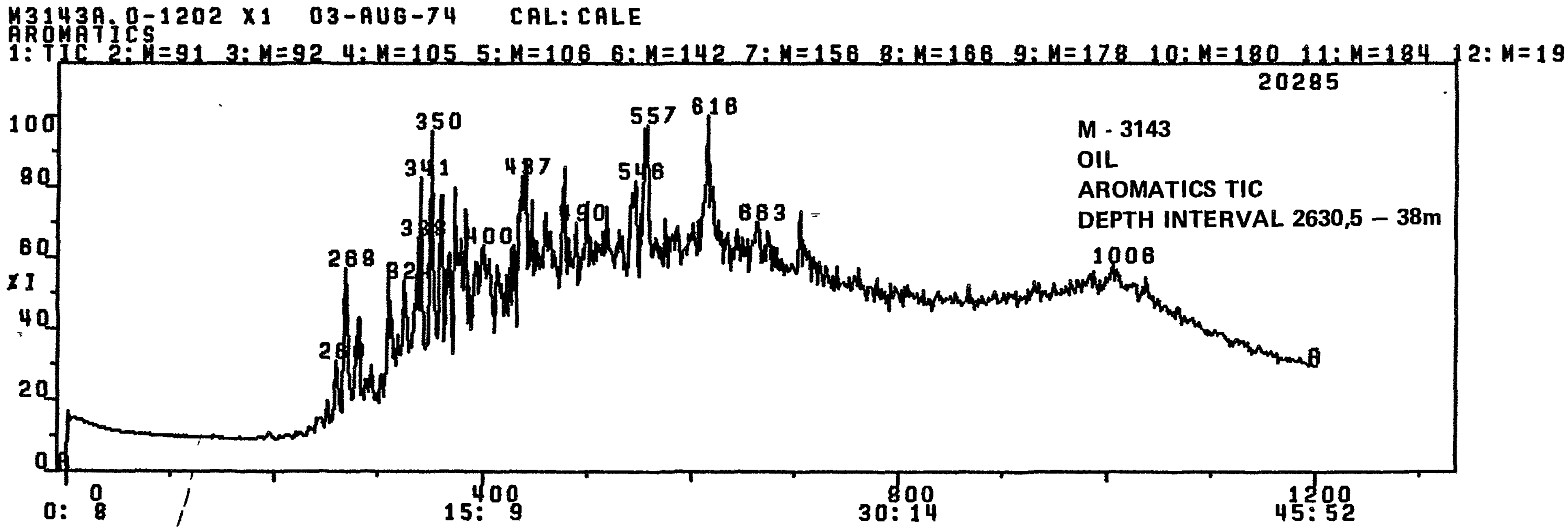


0 HRS 20 MINS 9 SECS

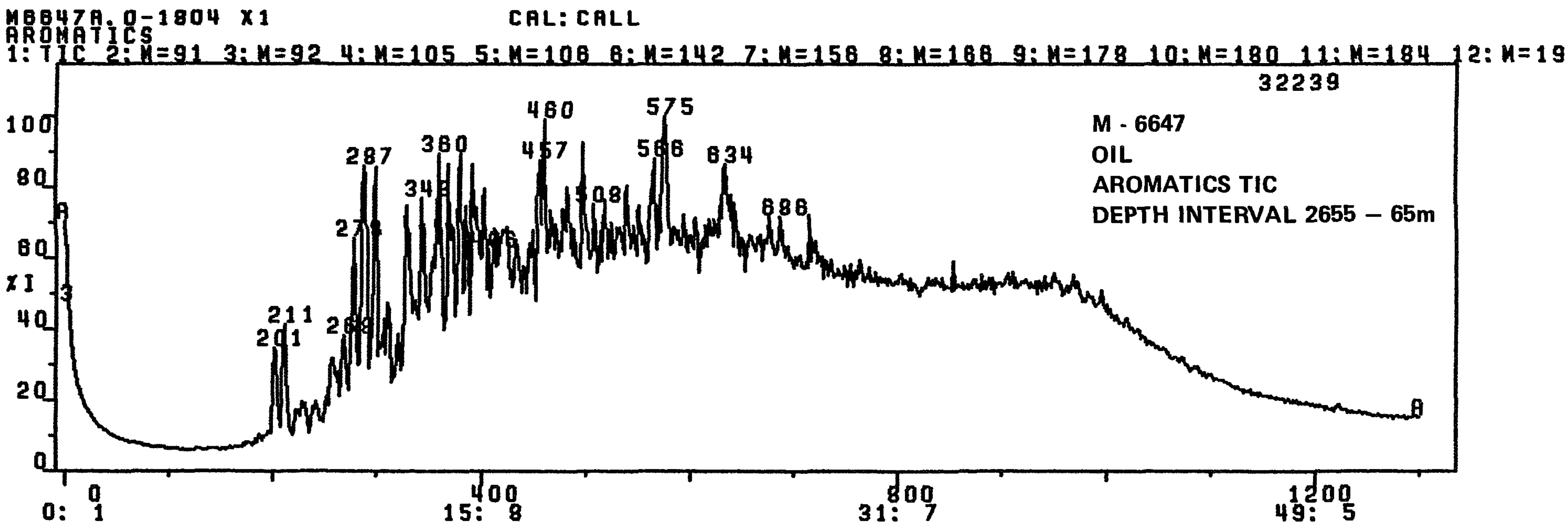
0 HRS 46 MINS 29 SECS

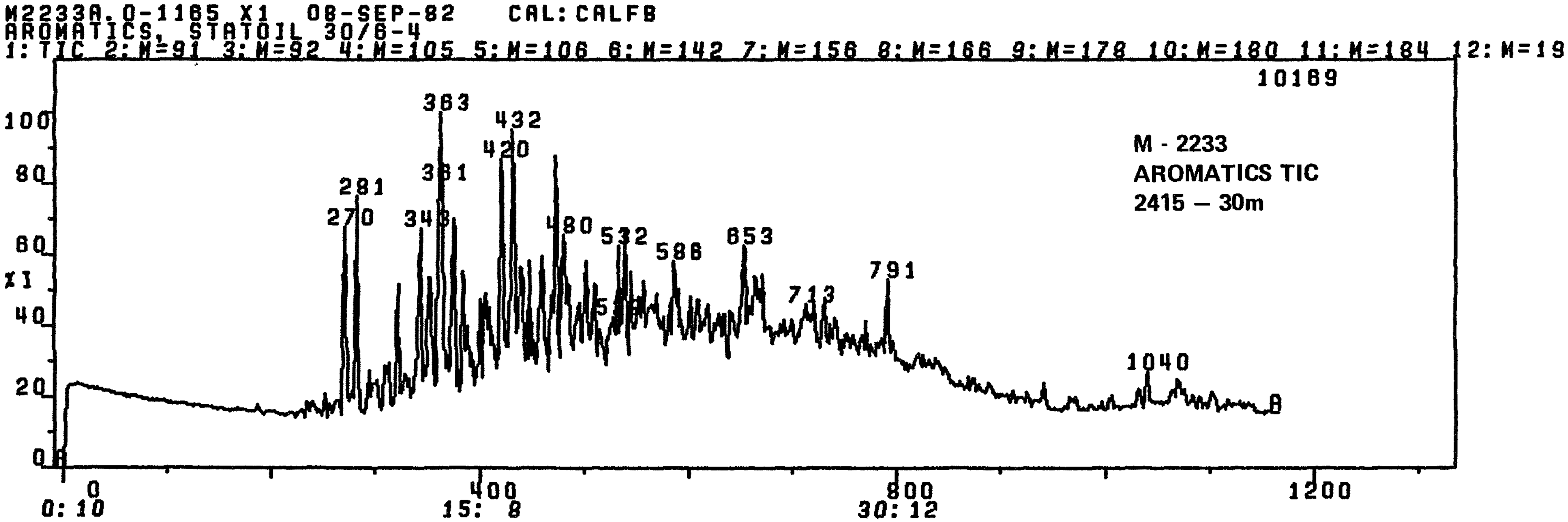
Appendix 2b

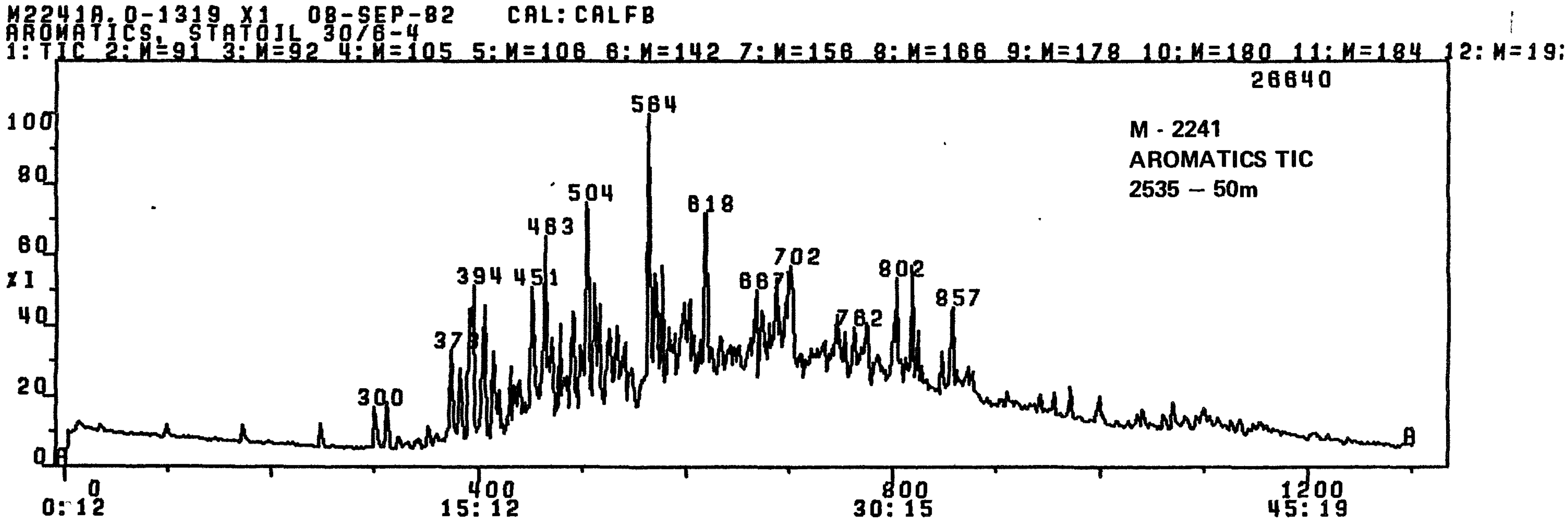
Aromatic Hydrocarbon Mass Fragmentogram
TIC, m/z 91, 105, 198, 239 and 253

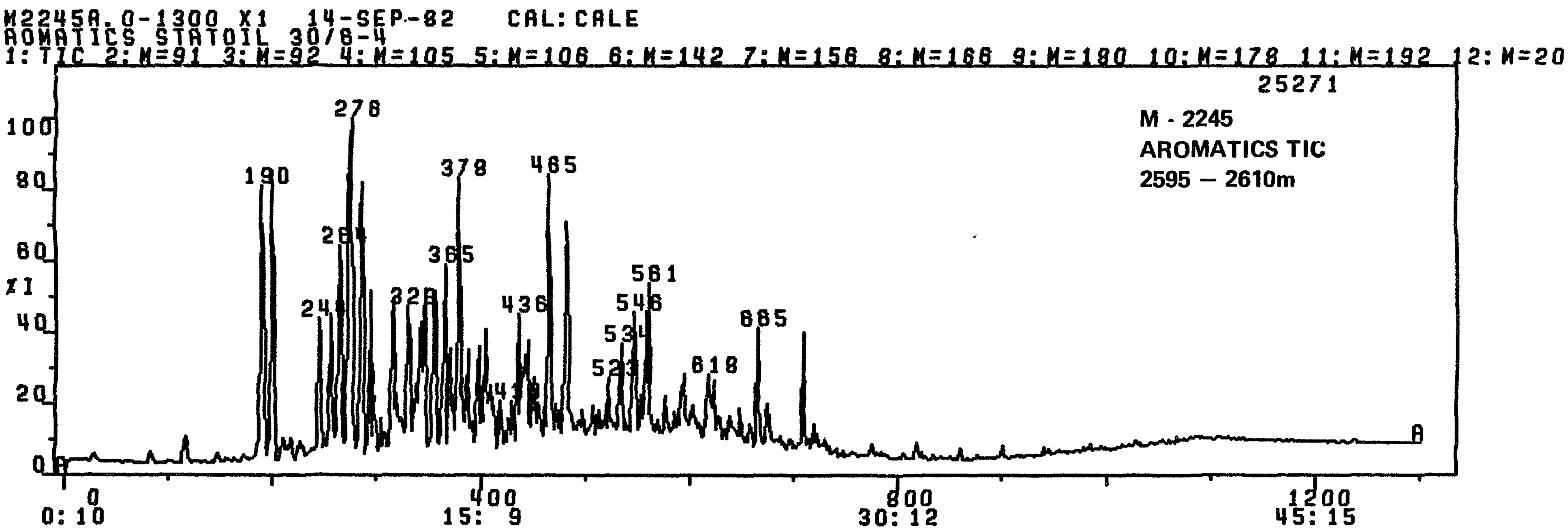


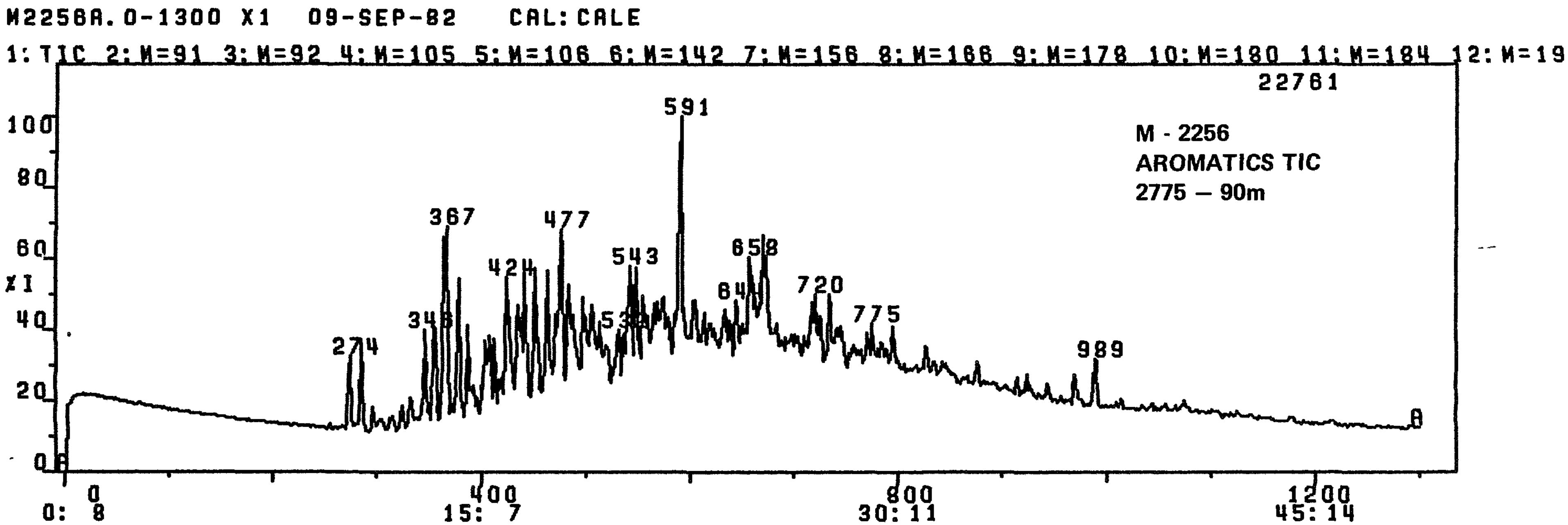
M3143A.0-1202 X1 03-AUG-74 CAL: CALE
AROMATICS
1: TIC 2: M=91 3: M=92 4: M=105 5: M=106 6: M=142 7: M=156 8: M=166 9: M=178 10: M=180 11: M=184 12: M=19:
20285
M - 3143
OIL
AROMATICS TIC
DEPTH INTERVAL 2630,5 – 38m
350
557
616
341
546
663
400
268
1006
100
80
60
40
20
0
0
400
800
1200
0: 8
15: 9
30: 14
45: 52


M6647A.D-1804 X1
CAL:CALL
AROMATICS
1:TIC 2:M=91 3:M=92 4:M=105 5:M=106 6:M=142 7:M=156 8:M=166 9:M=178 10:M=180 11:M=184 12:M=19
32239
M - 6647
OIL
AROMATICS TIC
DEPTH INTERVAL 2655 – 65m
100
80
60
%I
40
20
0
0
0: 1
400
15: 8
800
31: 7
1200
49: 5
201
211
287
380
460
457
575
586
634
686
508
342

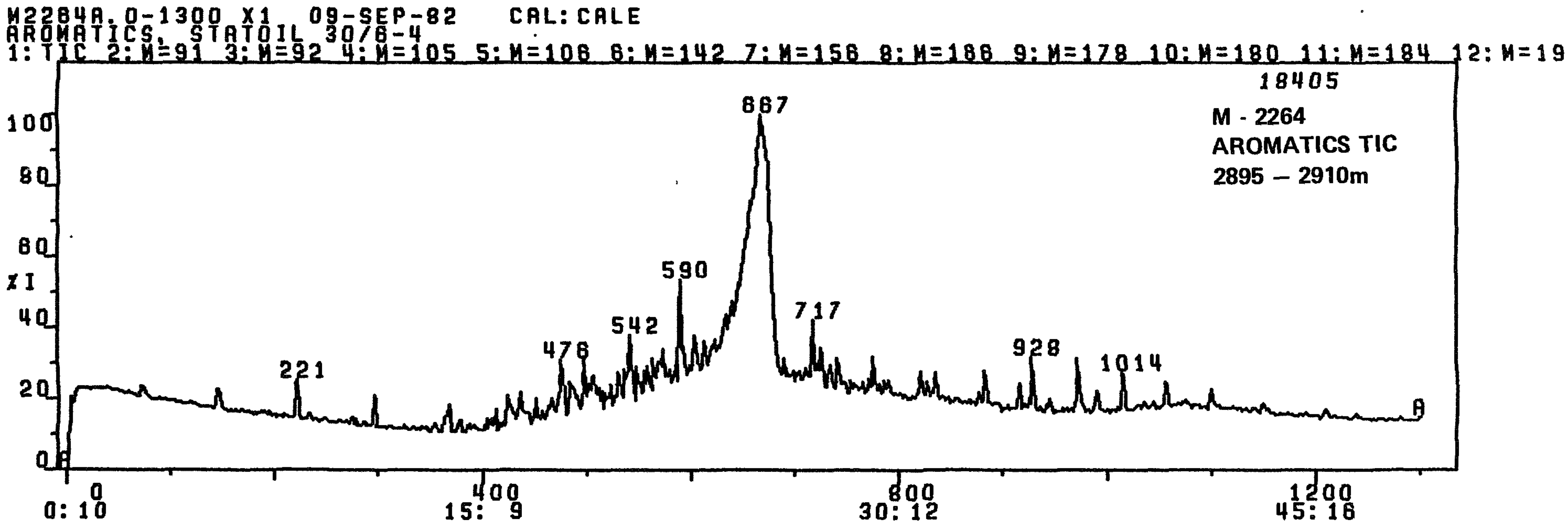

M2233A.0-1165 X1 08-SEP-82 CAL:CALFB
AROMATICS, STATOIL 30/6-4
1: TIC 2: M=91 3: M=92 4: M=105 5: M=106 6: M=142 7: M=156 8: M=166 9: M=178 10: M=180 11: M=184 12: M=19:
10189
M - 2233
AROMATICS TIC
2415 — 30m
%I
0:10
15: 8
30:12


M2241A.D-1319 X1 08-SEP-82 CAL:CALFB
AROMATICS, STATOIL 30/6-4
1:TIC 2:M=91 3:M=92 4:M=105 5:M=106 6:M=142 7:M=156 8:M=166 9:M=178 10:M=180 11:M=184 12:M=19:
26640
M - 2241
AROMATICS TIC
2535 – 50m
%I
0:12
15:12
30:15
45:19

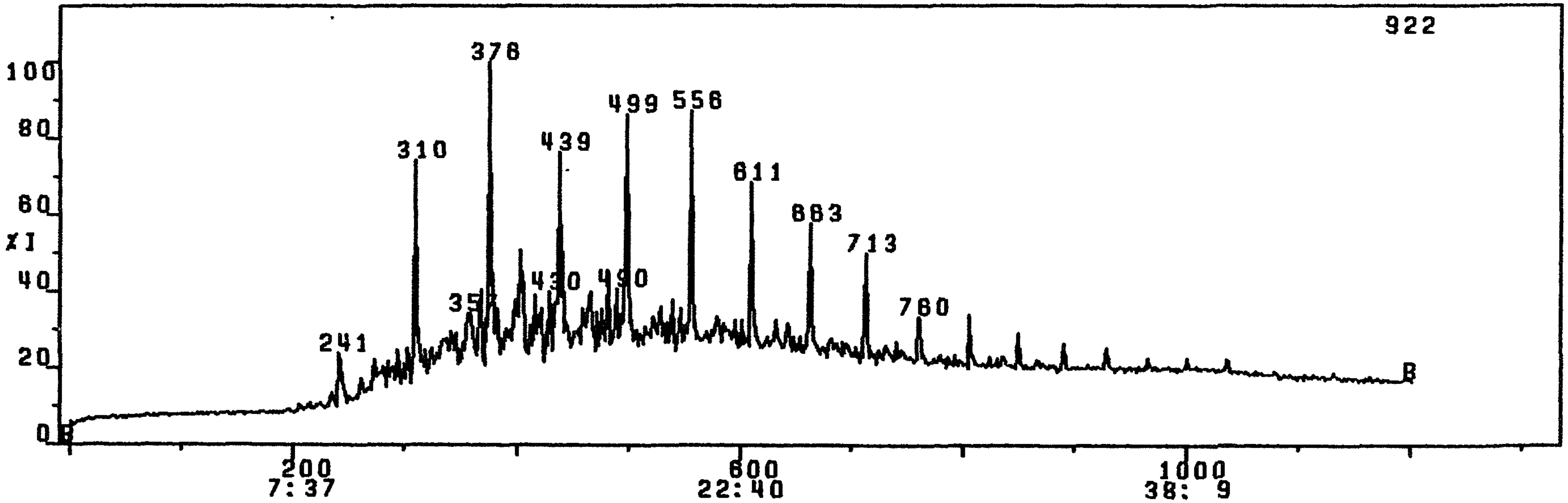

M2245A.0-1300 X1 14-SEP-82 CAL:CALE
AROMATICS STATOIL 30/6-4
1: TIC 2: M=91 3: M=92 4: M=105 5: M=106 6: M=142 7: M=156 8: M=166 9: M=180 10: M=178 11: M=192 12: M=20
25271
M - 2245
AROMATICS TIC
2595 – 2610m
190
278
264
241
328
365
378
436
465
523
534
546
561
618
665
100
80
60
%I
40
20
0
0
0:10
400
15: 9
800
30:12
1200
45:15



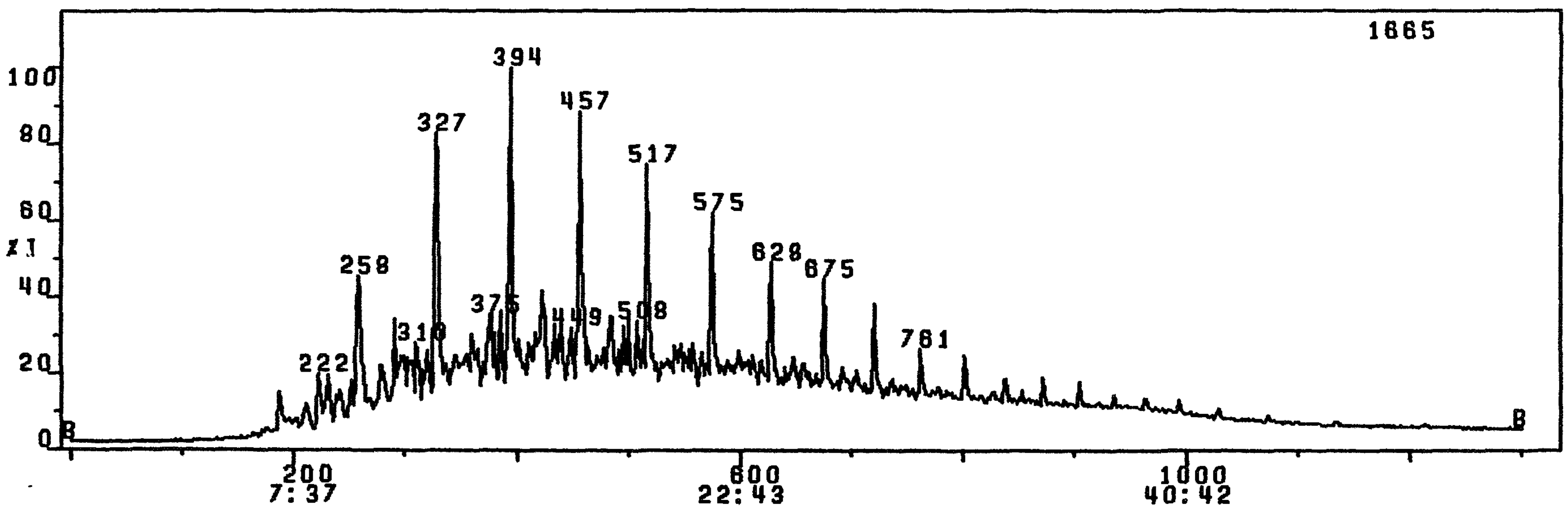
M2256A.0-1300 X1 09-SEP-82 CAL:CALE
1: TIC 2: M=91 3: M=92 4: M=105 5: M=106 6: M=142 7: M=156 8: M=166 9: M=178 10: M=180 11: M=184 12: M=19:
22761
M - 2256
AROMATICS TIC
2775 — 90m
591
367
477
424
543
658
720
775
989
274
%I
0: 8
15: 7
30: 11
45: 14


M2284A.0-1300 X1 09-SEP-82 CAL: CALE
AROMATICS, STATOIL 30/6-4
1: TIC 2: M=91 3: M=92 4: M=105 5: M=106 6: M=142 7: M=156 8: M=186 9: M=178 10: M=180 11: M=184 12: M=19:
18405
M - 2264
AROMATICS TIC
2895 – 2910m
%I
100
80
60
40
20
0
221
476
542
590
667
717
928
1014
0
0: 10
400
15: 9
800
30: 12
1200
45: 16

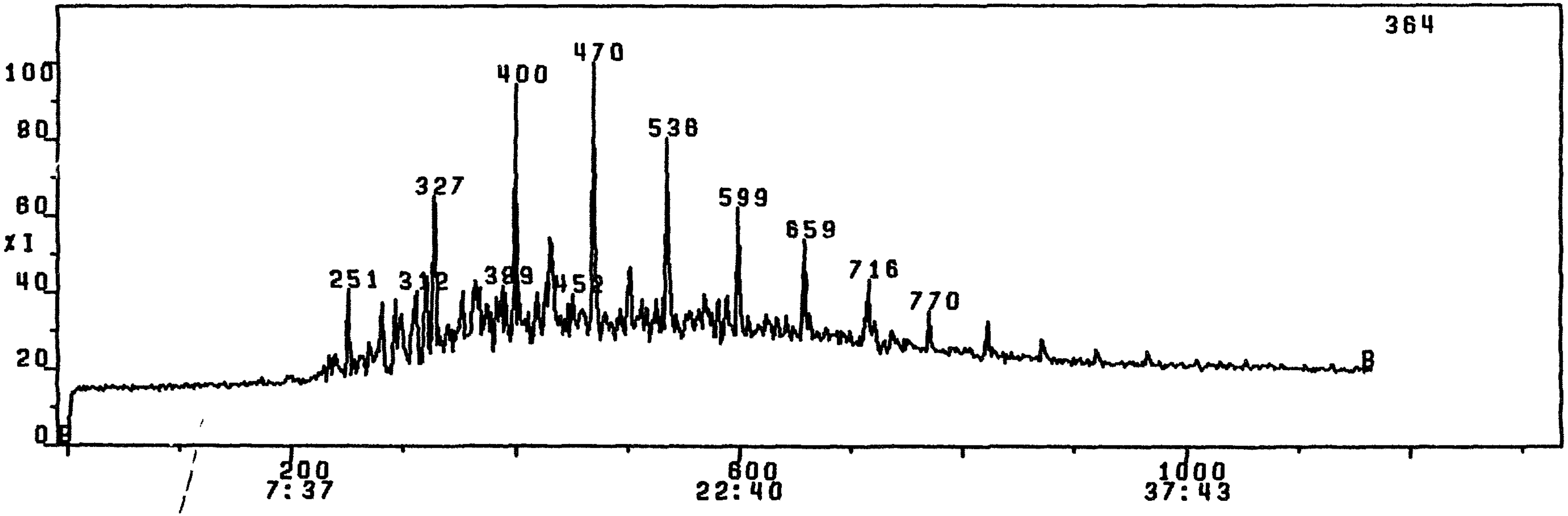
M - 3143
OIL
DEPTH INTERVAL 2630.5 – 38m
m/z 91



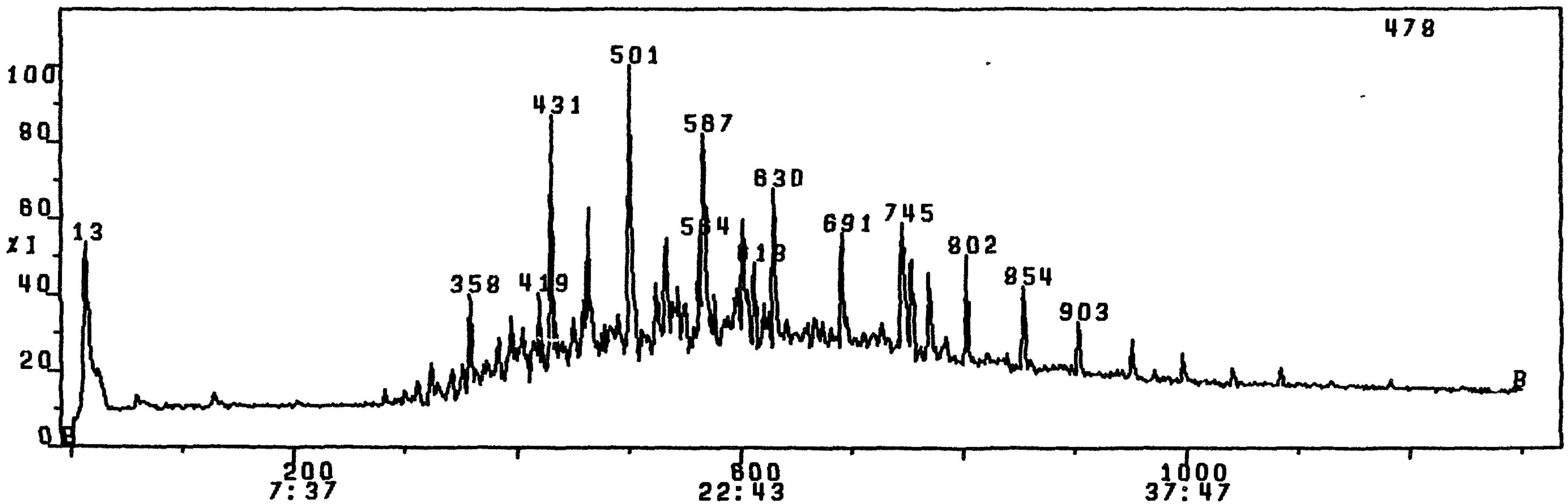
M - 6647
OIL
DEPTH INTERVAL 2655 – 65m
m/z 91



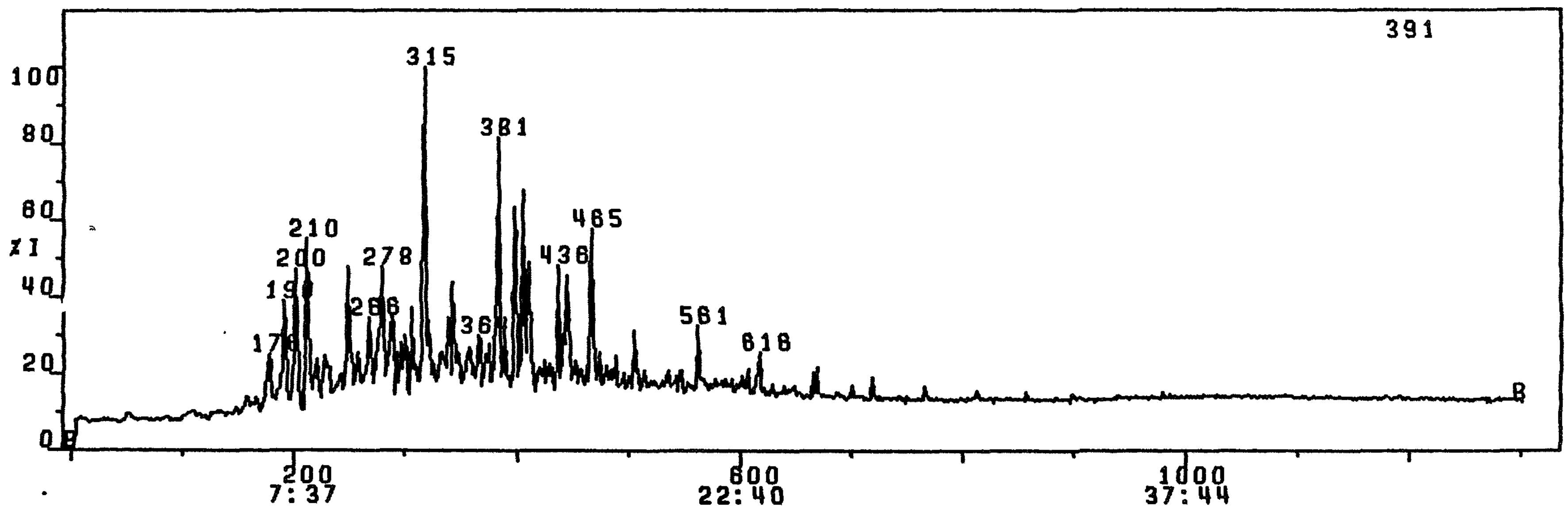
M - 2233
DEPTH 2415 – 30m
m/z 91



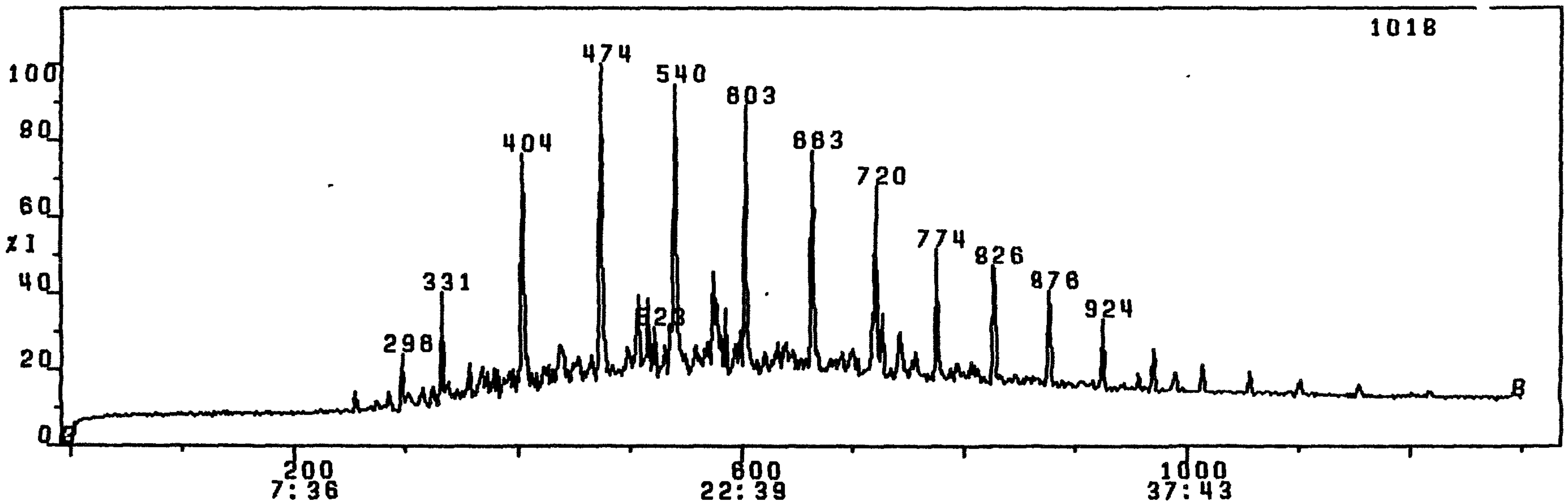
M - 2241
DEPTH 2535 – 50m
m/z 91



M - 2245
DEPTH 2595 — 2610m
m/z 91

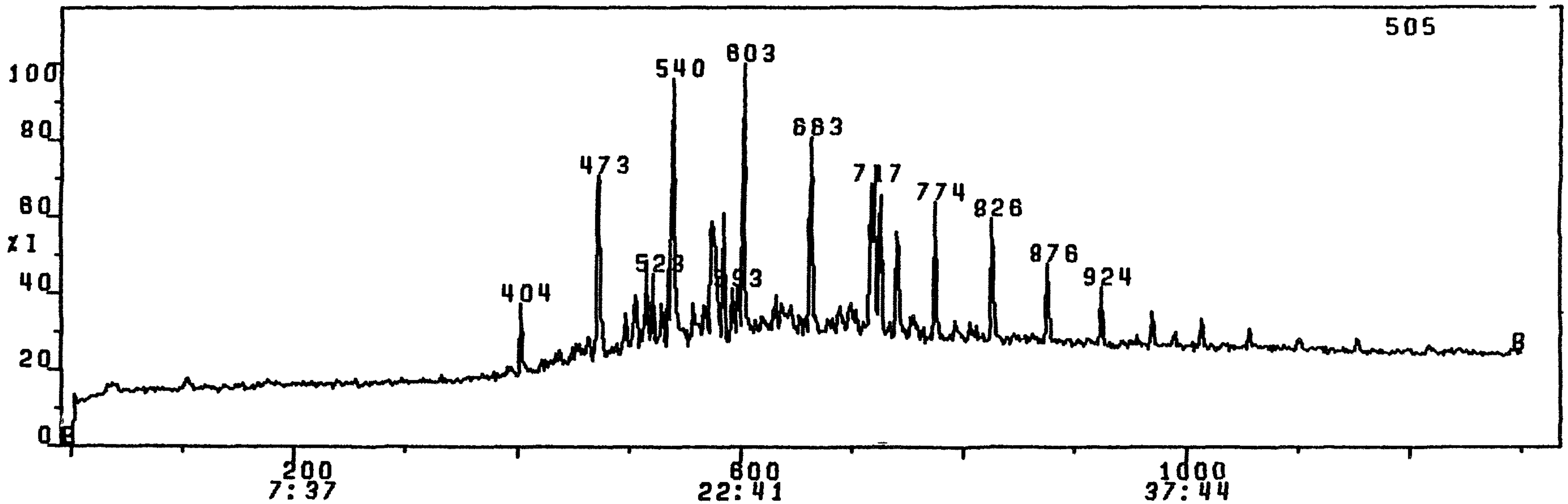


M - 2256
DEPTH 2775 – 90m
m/z 91

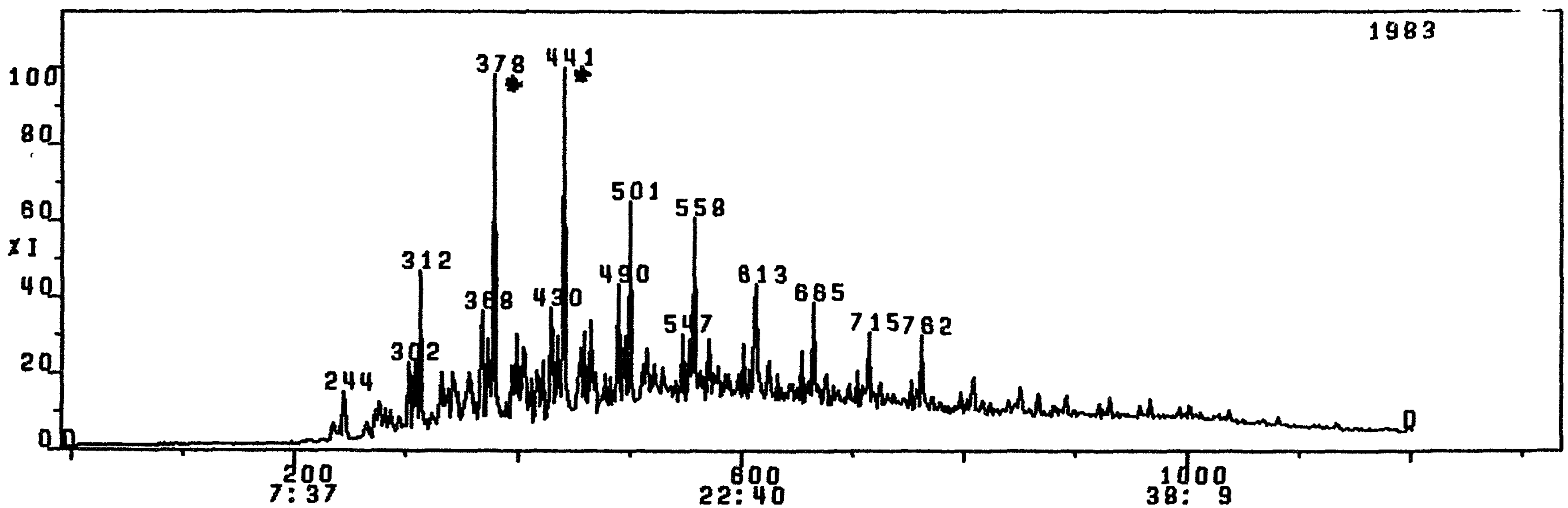


L.L64

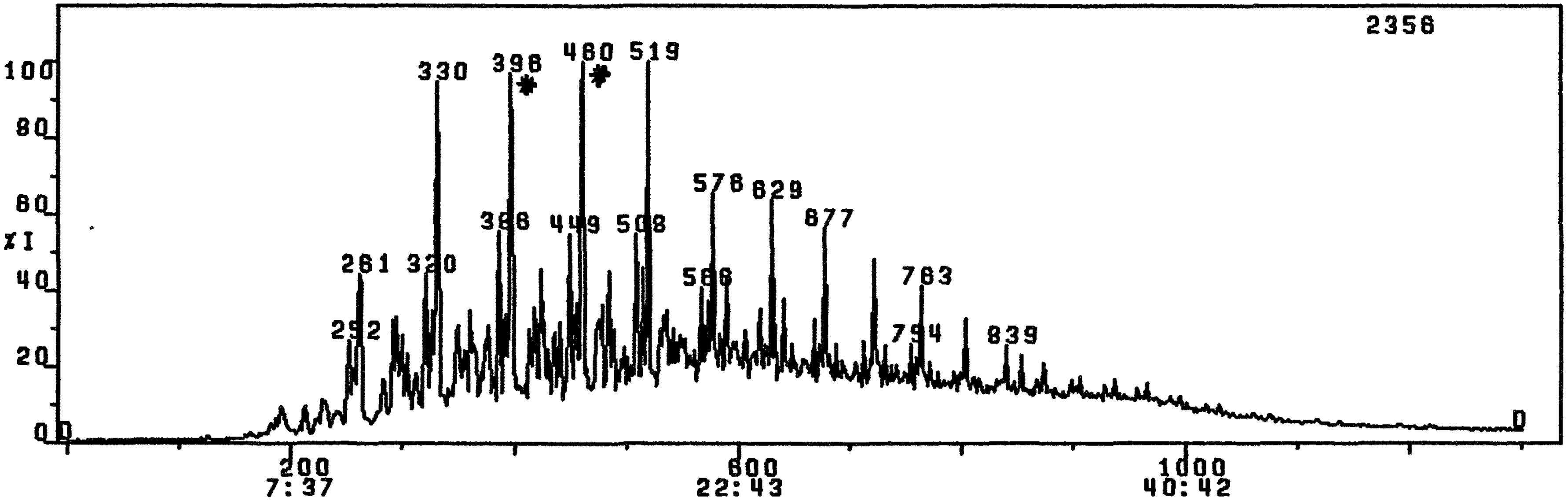
M - 2264
DEPTH 2895 – 2910m
m/z 91



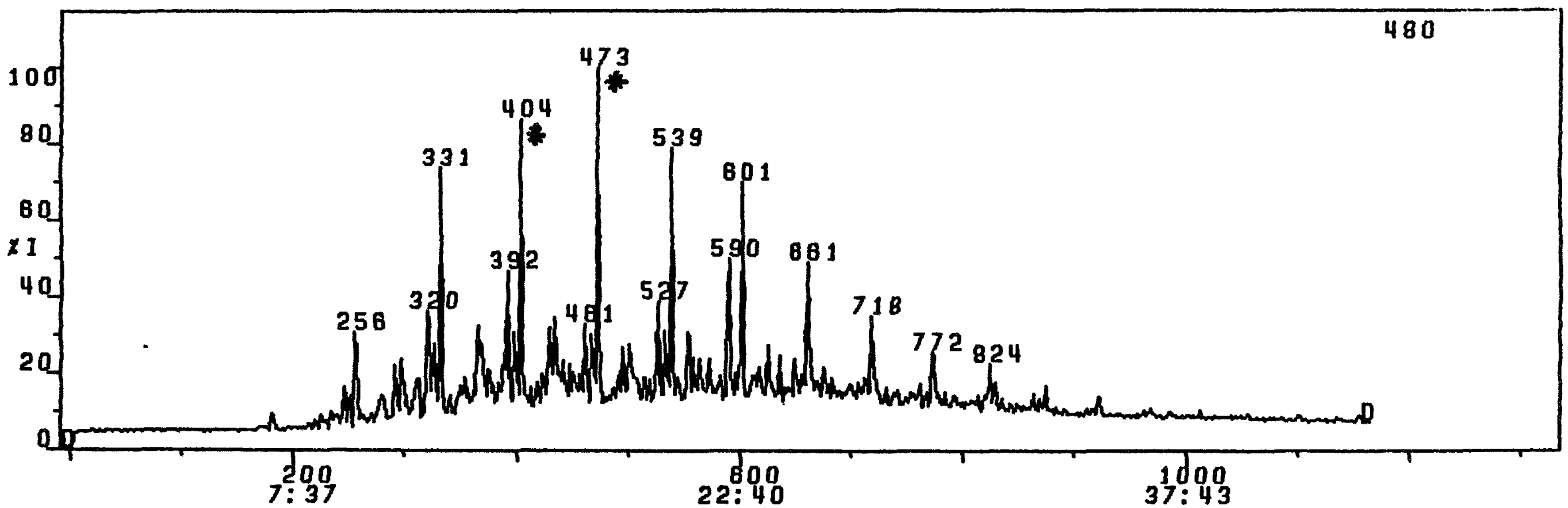
M - 3143
OIL
DEPTH INTERVAL 2630,5 — 30m
m/z 105



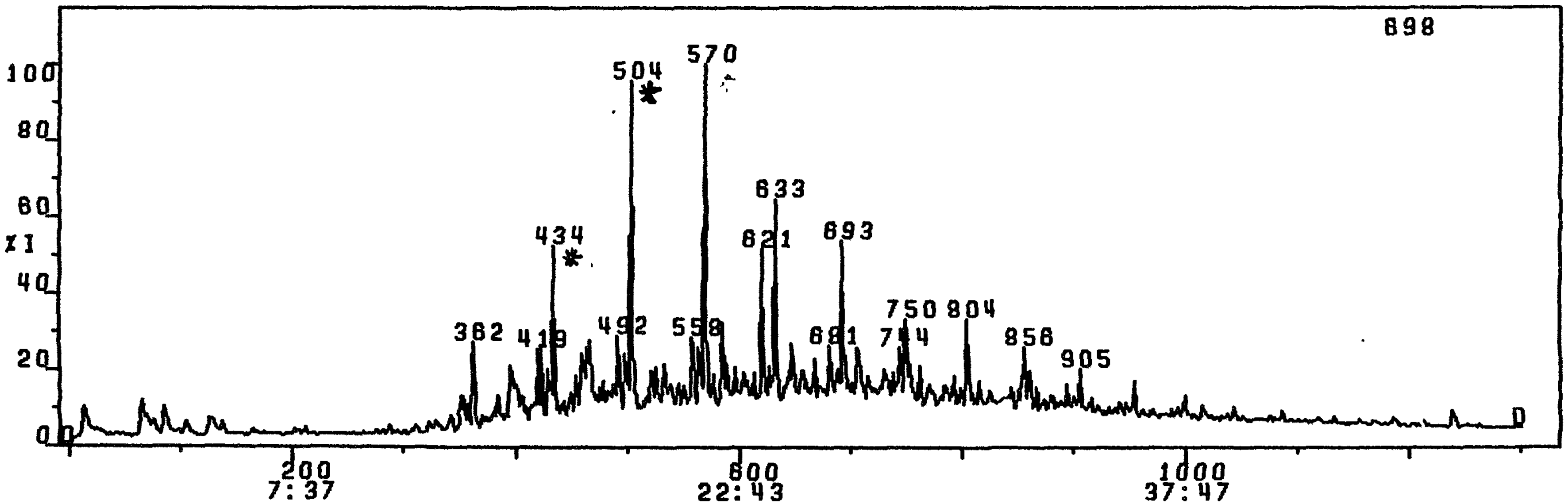
M - 6647
OIL
DEPTH INTERVAL 2655 – 65m
m/z 105



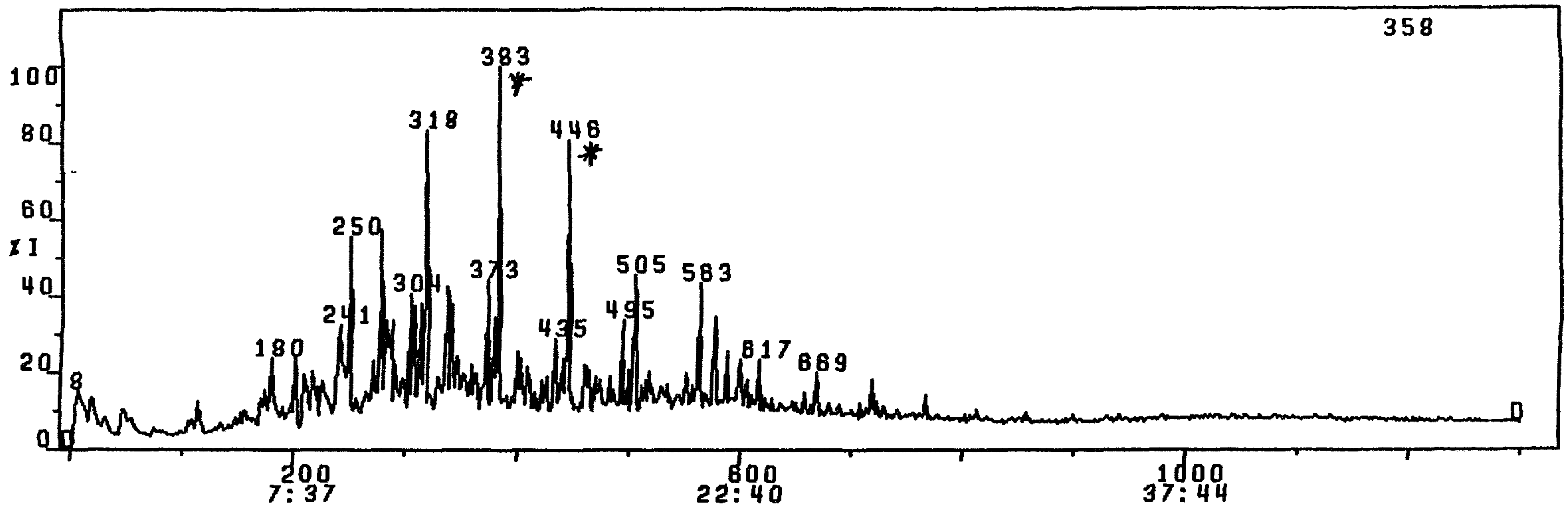
M - 2233
DEPTH 2415 – 30m
m/z 105



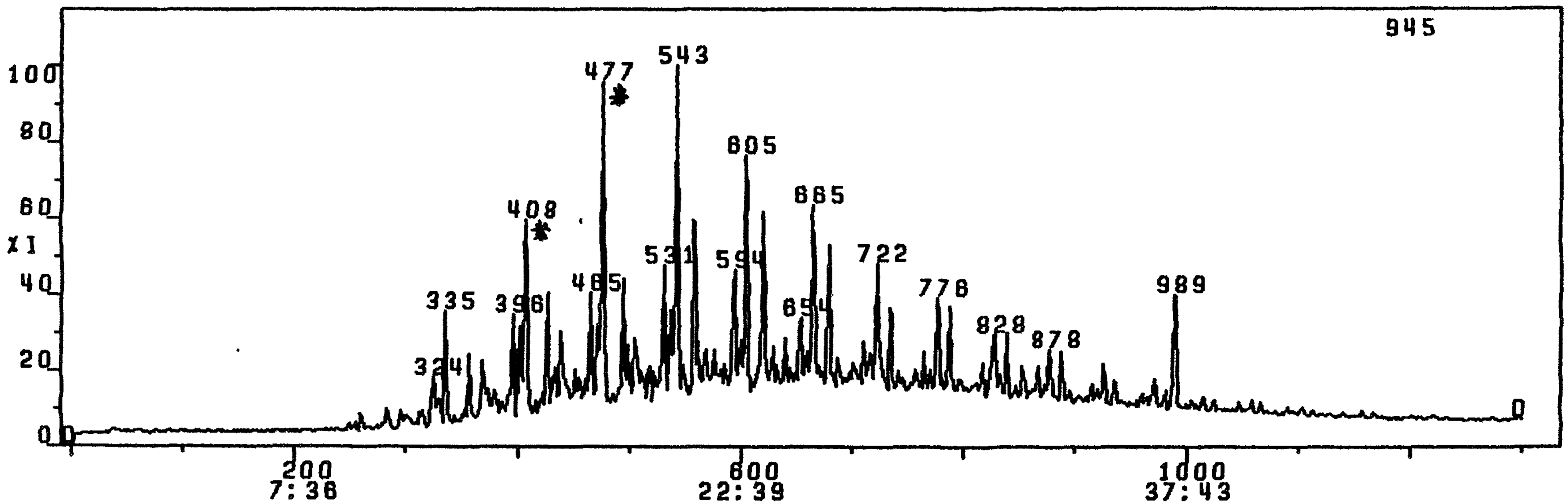
M - 2241
DEPTH 2535 – 50m
m/z 105



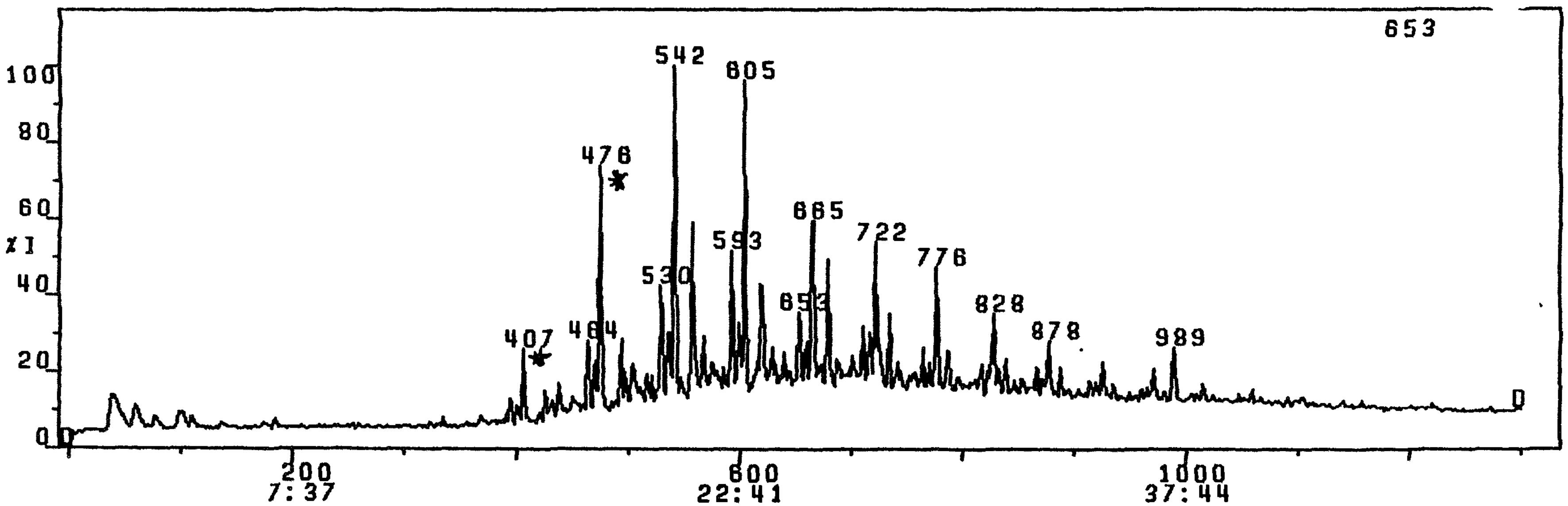
M - 2245
DEPTH 2595 – 2610m
m/z 105



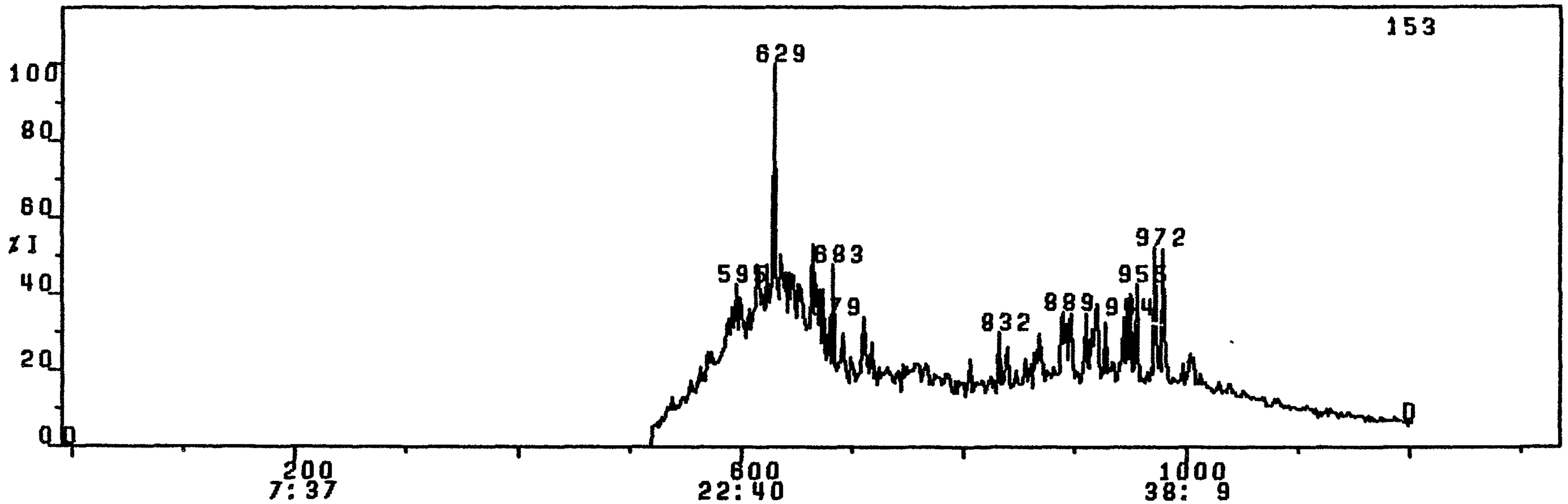
M - 2256
DEPTH 2775 — 90m
m/z 105



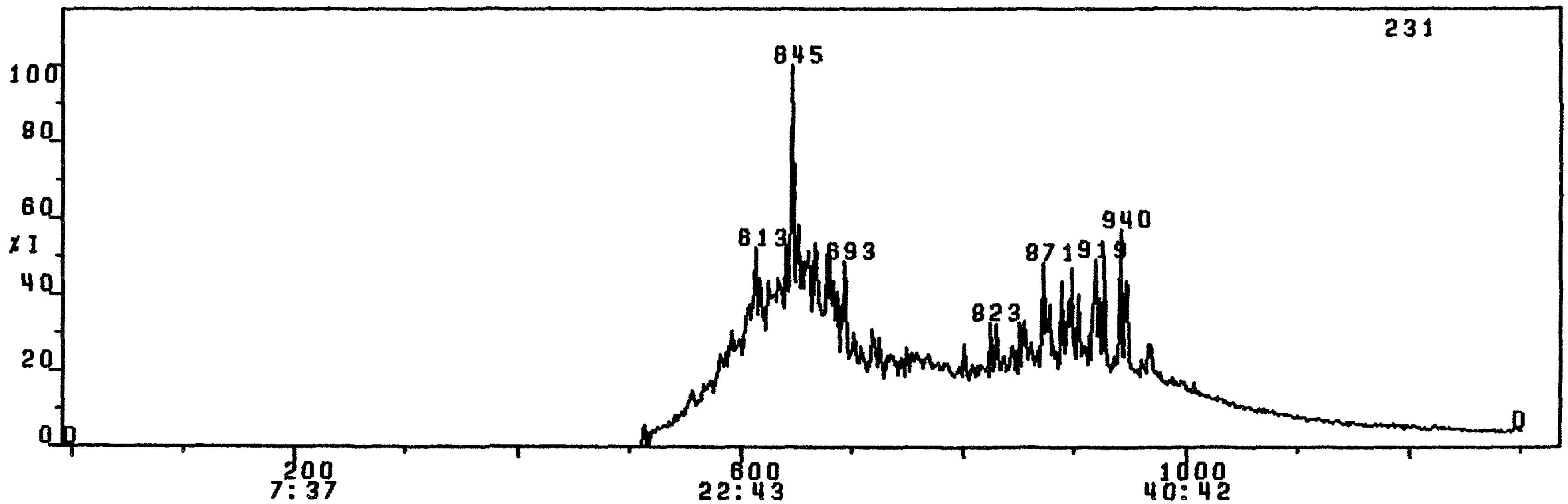
M - 2264
DEPTH 2895 – 2910m
m/z 105



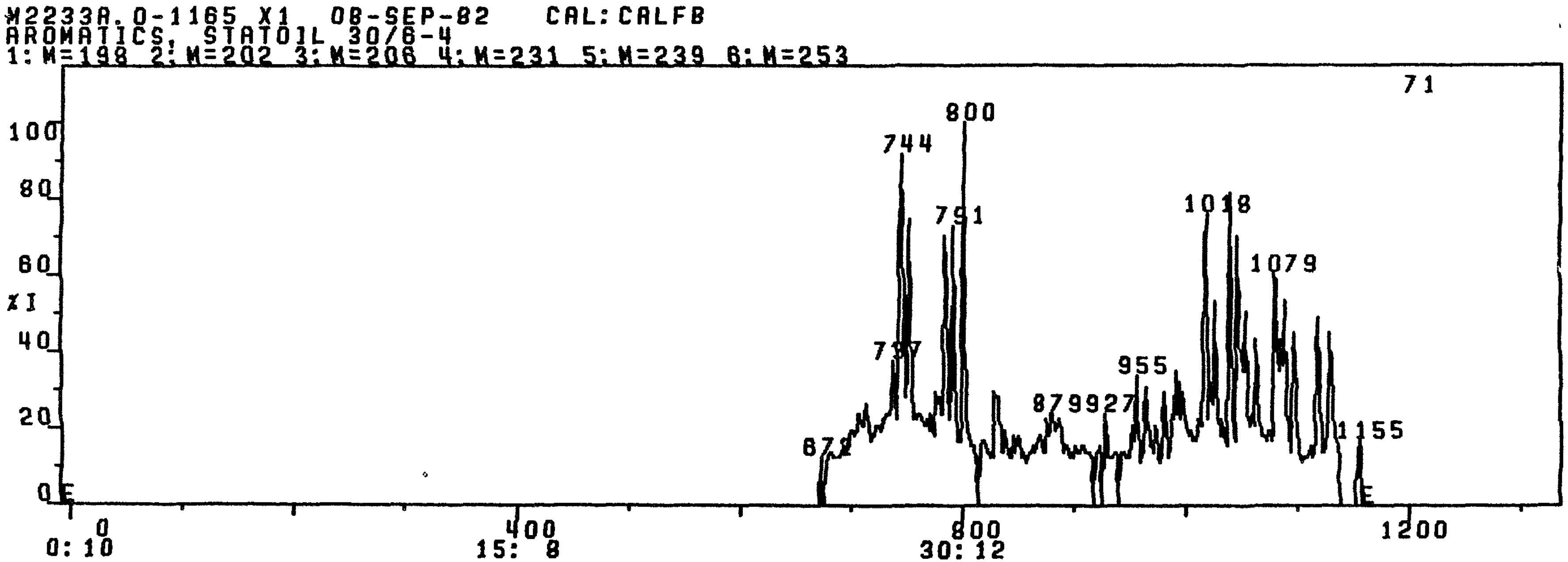
M - 3143
OIL
DEPTH INTERVAL 2630,5 – 38m
m/z 239



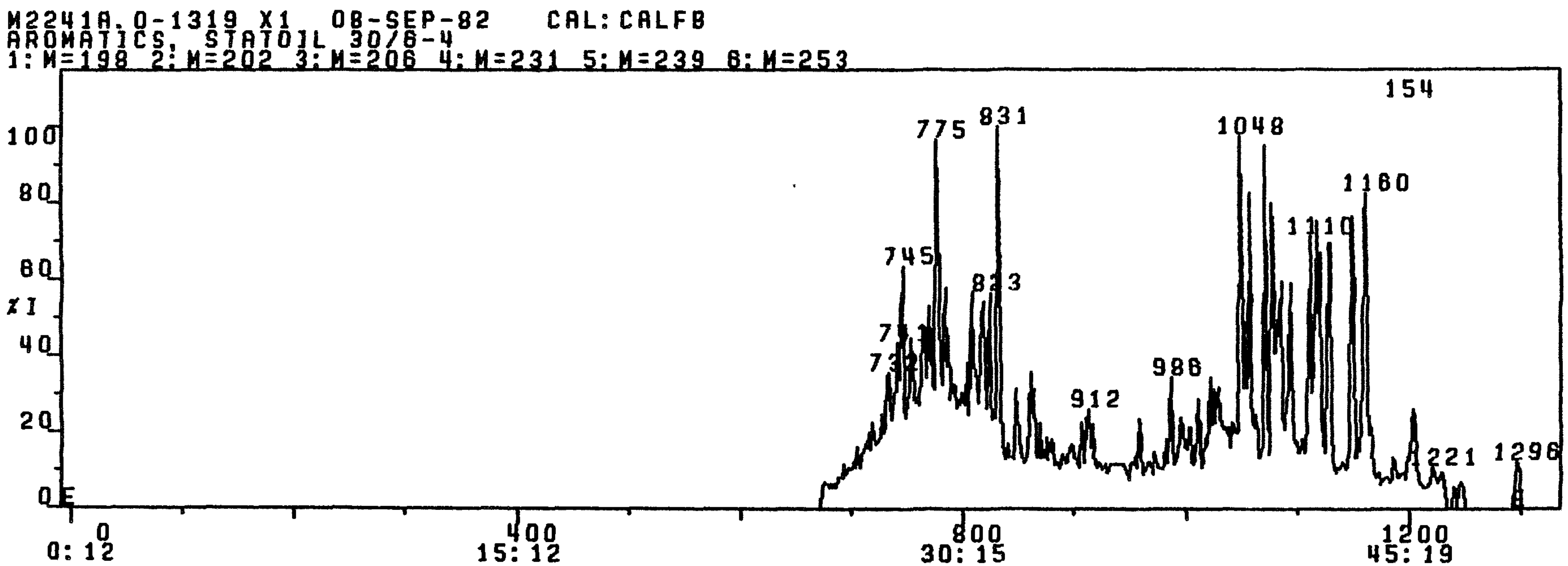
M - 6647
OIL
DEPTH INTERVAL 2655 – 65m
m/z 239



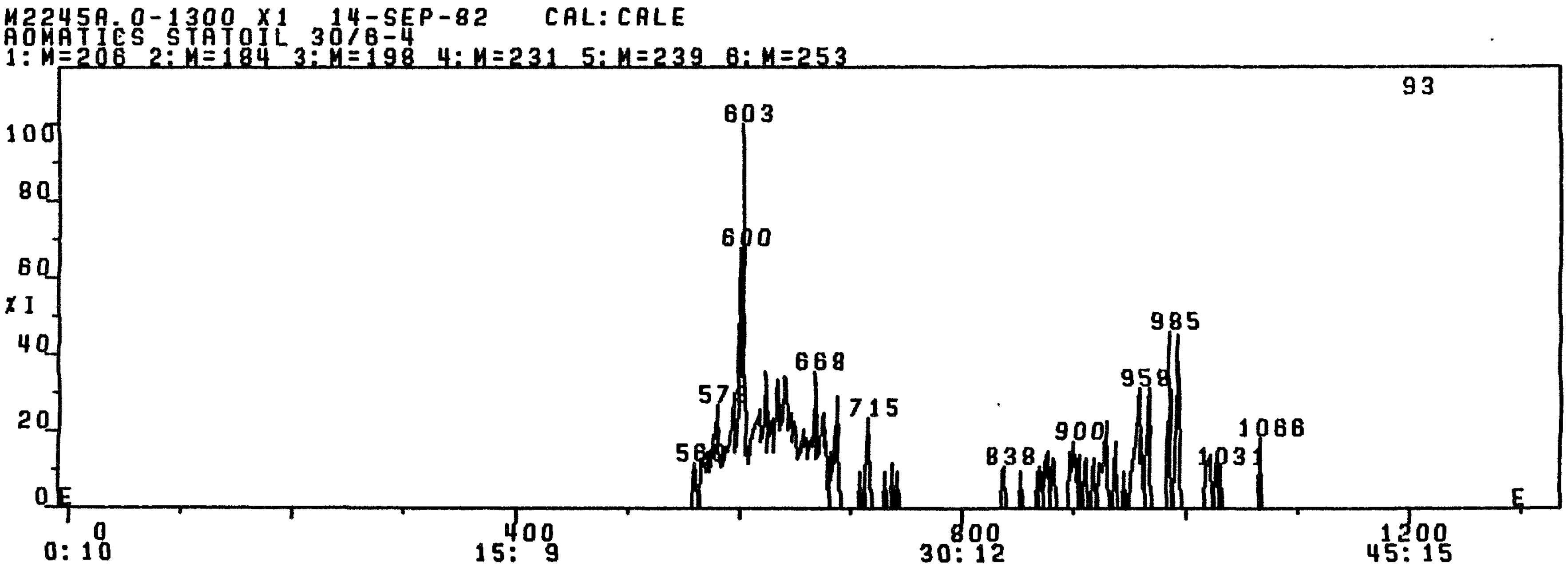
M - 2233
DEPTH 2415 — 30m
m/z 239



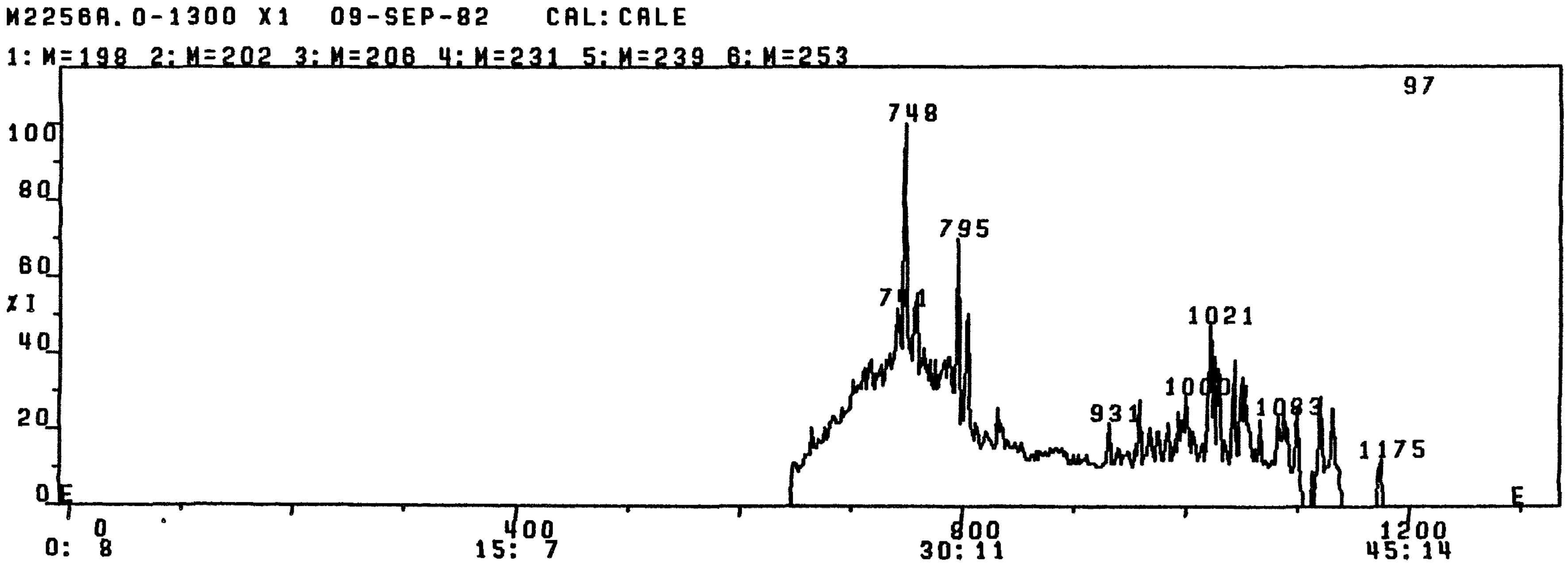
M - 2241
DEPTH 2535 – 50m
m/z 239



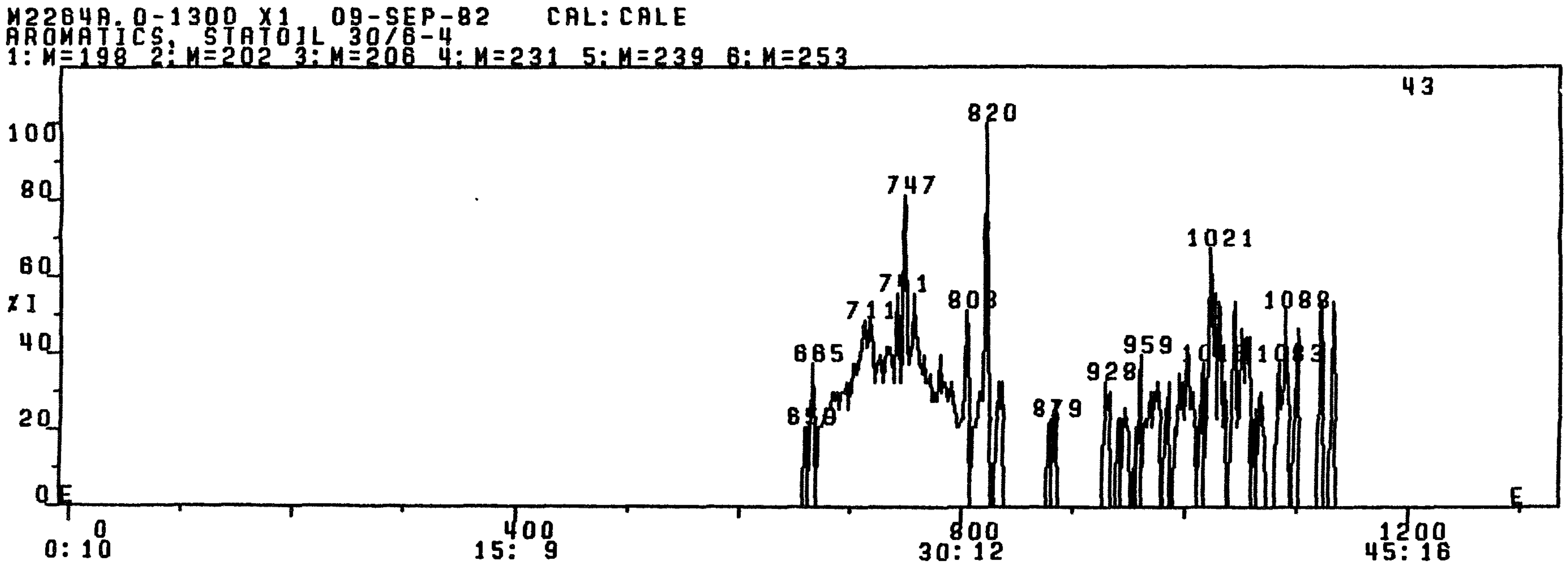
M - 2245
DEPTH 2595 – 2610m
m/z 239



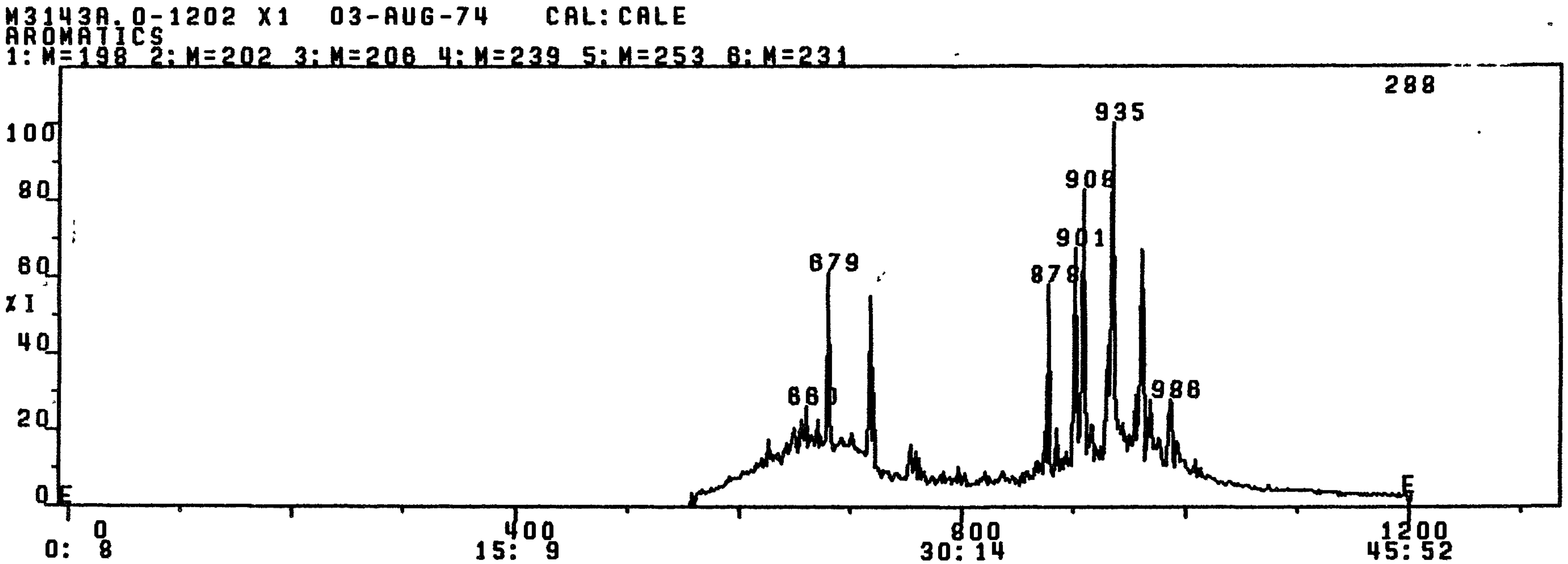
M - 2256
DEPTH 2775 — 90m
m/z 239



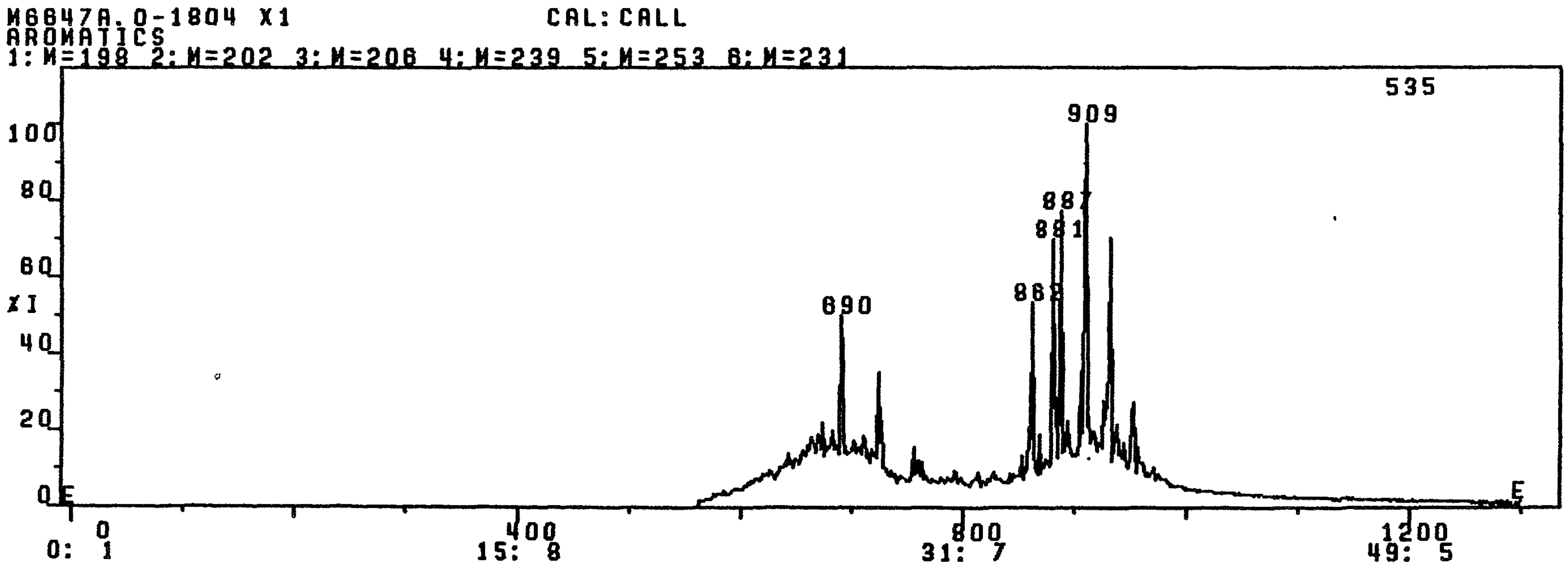
M - 2264
DEPTH 2895 – 2910m
m/z 239



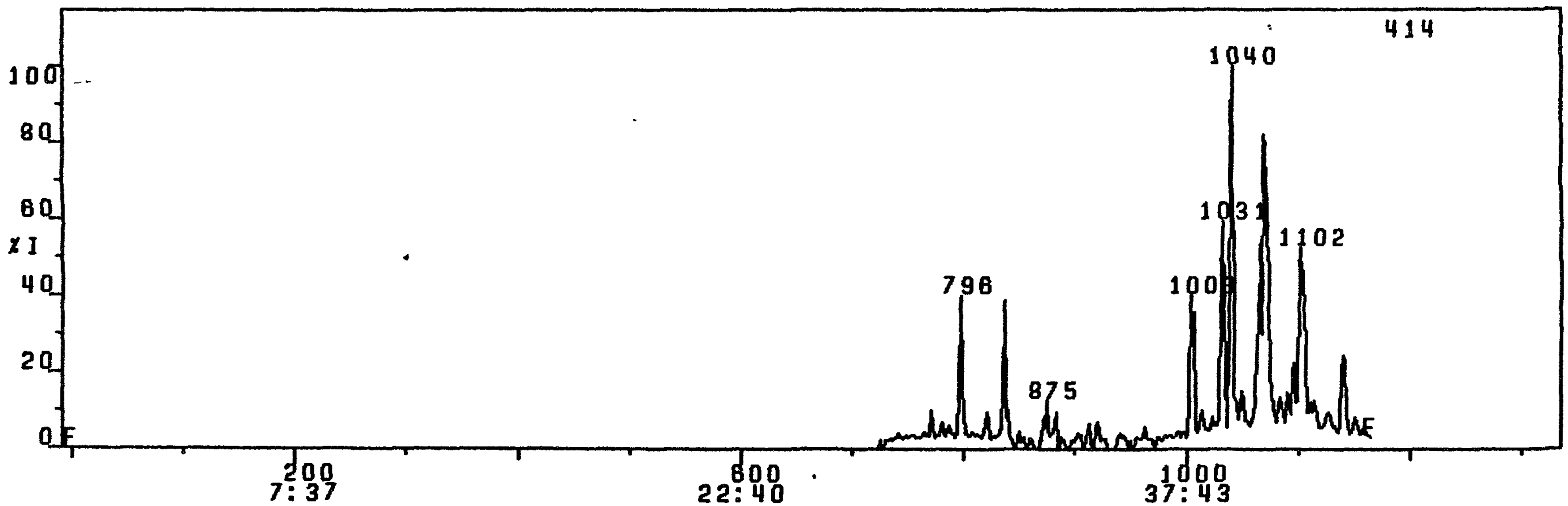
M - 3143
OIL
DEPTH INTERVAL 2630,5 – 38m
m/z 253



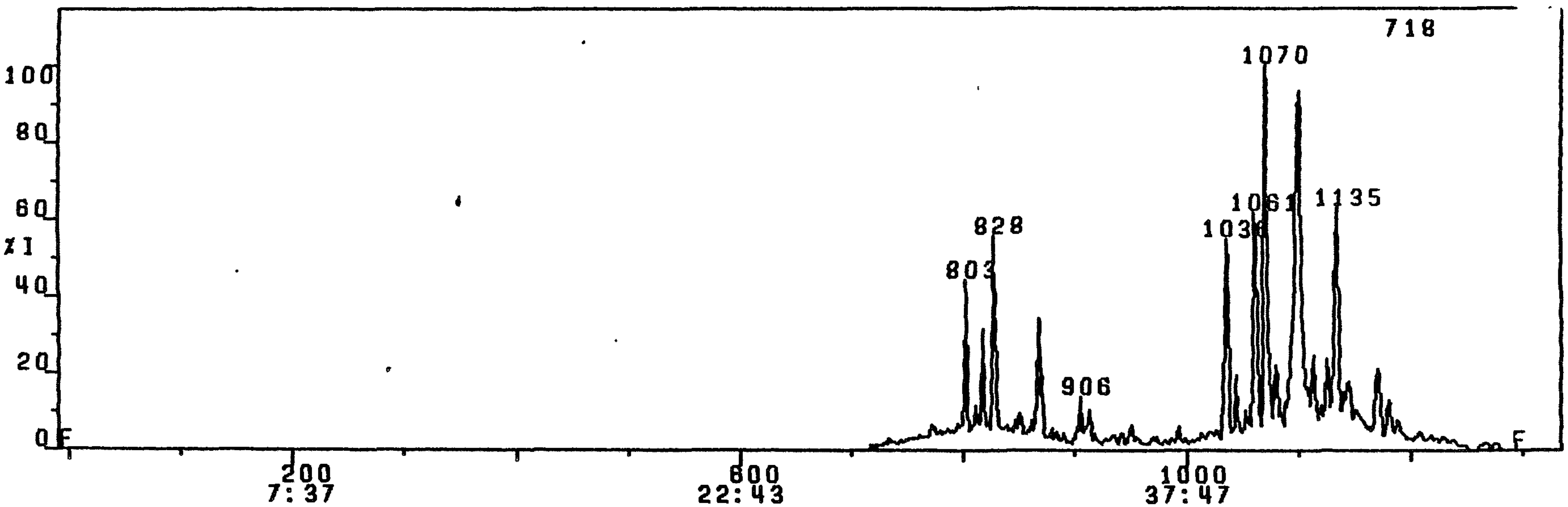
M - 6647
OIL
DEPTH INTERVAL 2655 – 65m
m/z 253



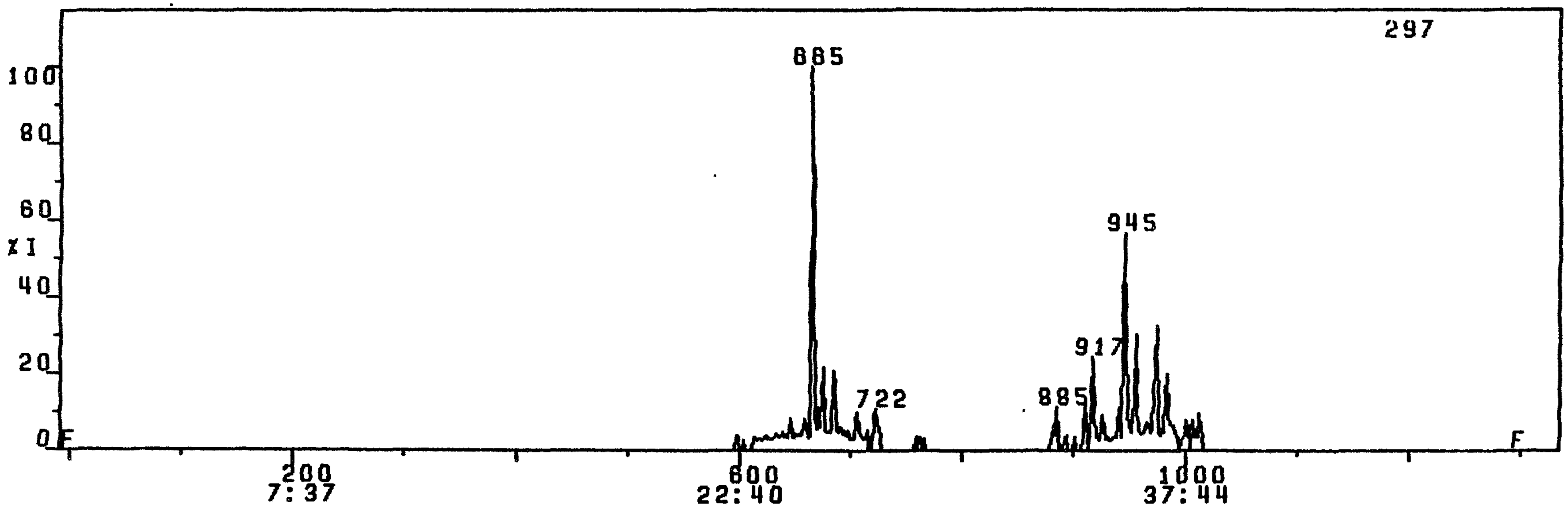
M - 2233
DEPTH 2415 – 30m
m/z 253



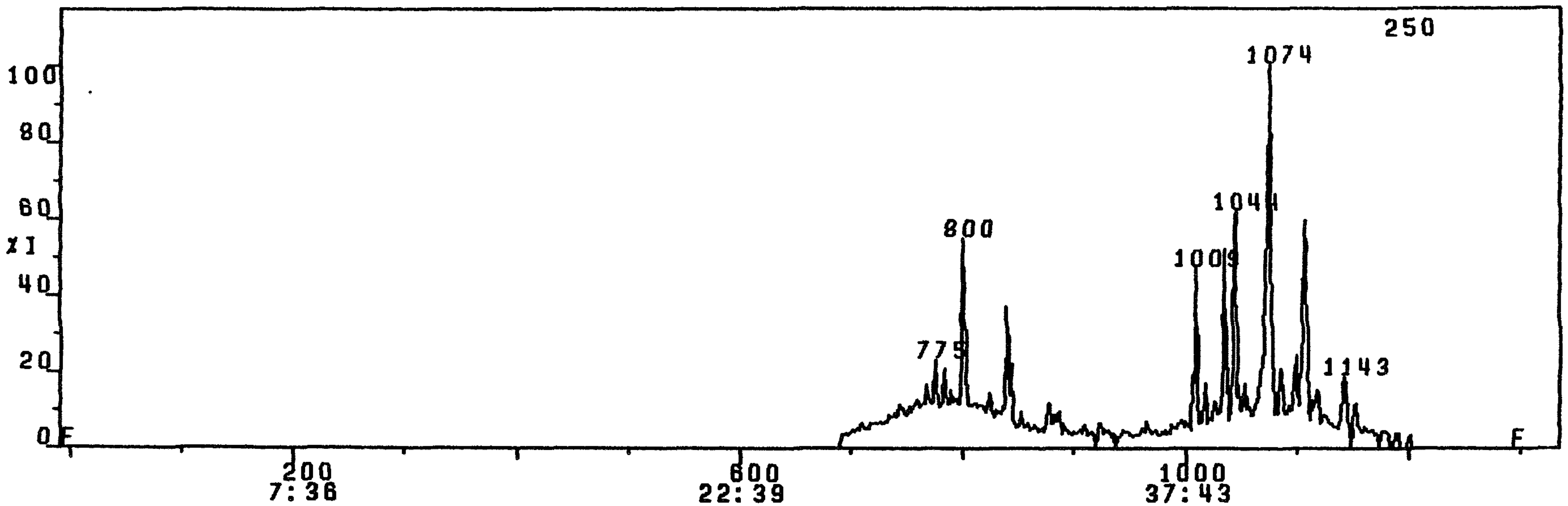
M 2241
DEPTH 2535 – 50m
m/z 253



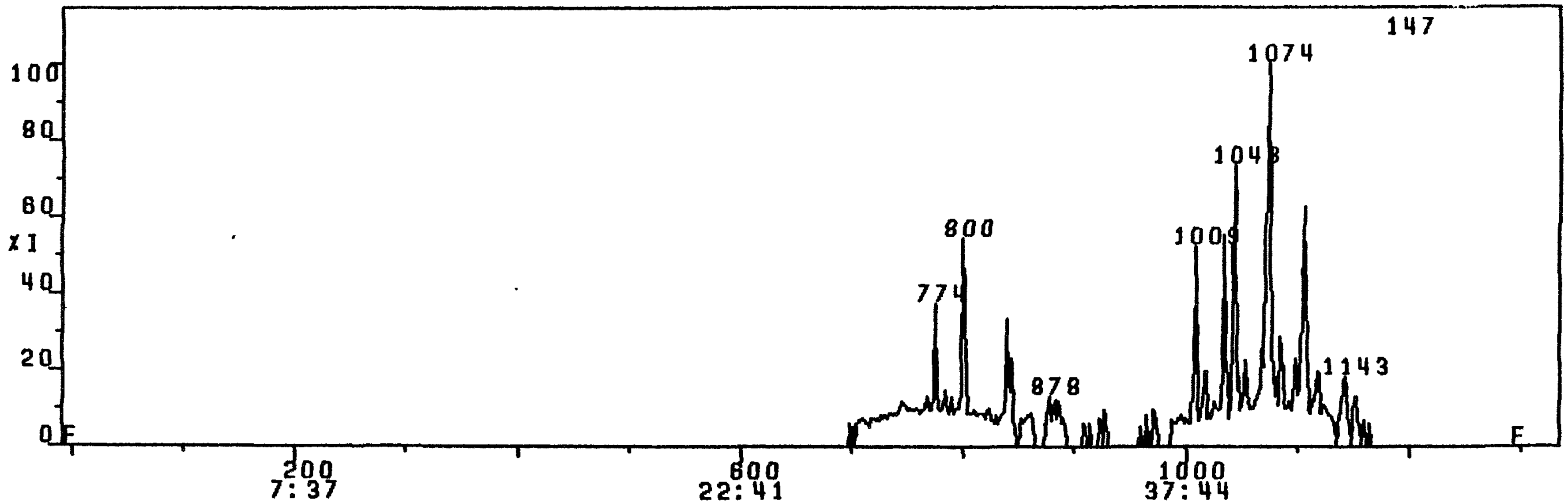
M - 2245
DEPTH 2595 – 2610m
m/z 253



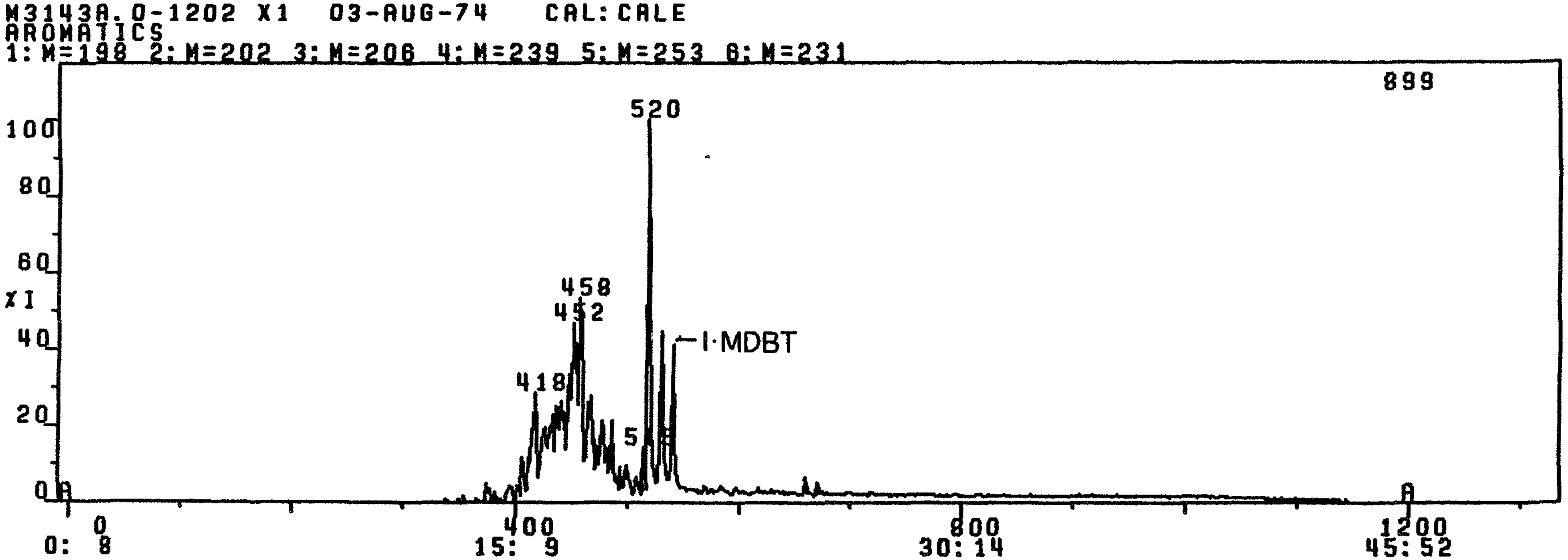
M - 2256
DEPTH 2775 –90m
m/z 253



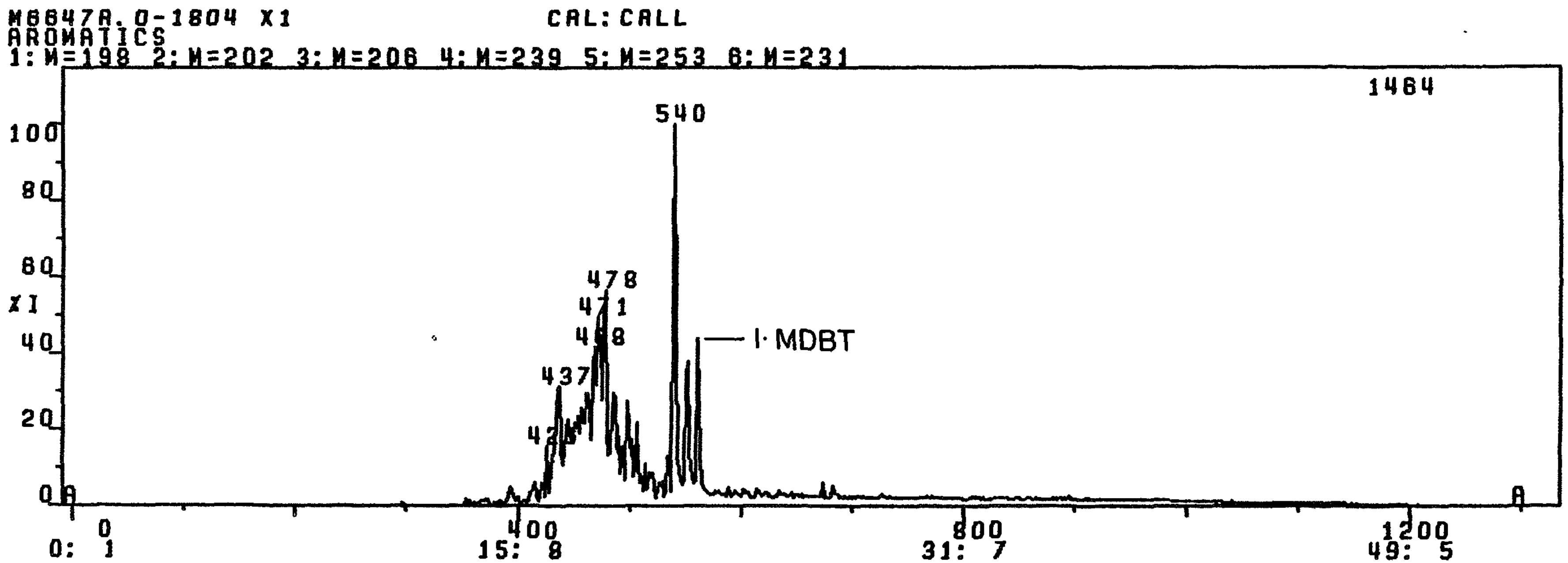
M - 2264
DEPTH 2895 – 2910m
m/z 253



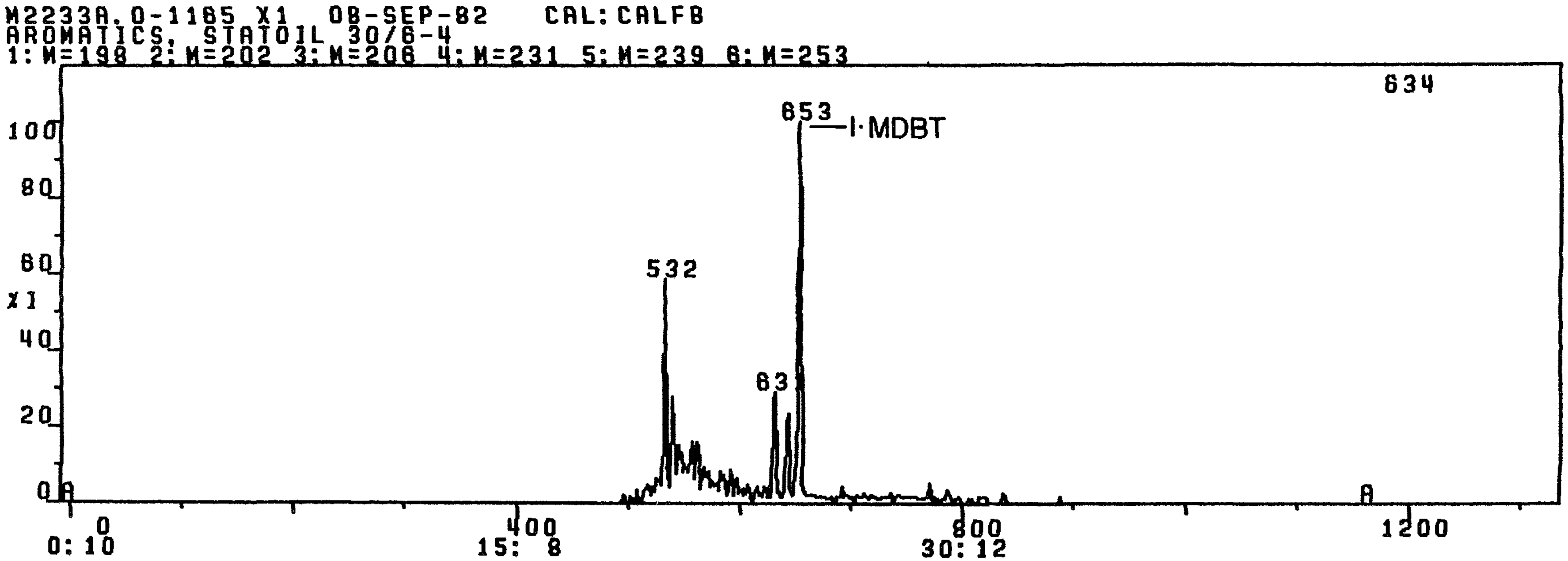
M - 3143
OIL
DEPTH INTERVAL 2630,5 — 38m
m/z 198



M - 6647
OIL
DEPTH INTERVAL 2655 - 65m
m/z 198

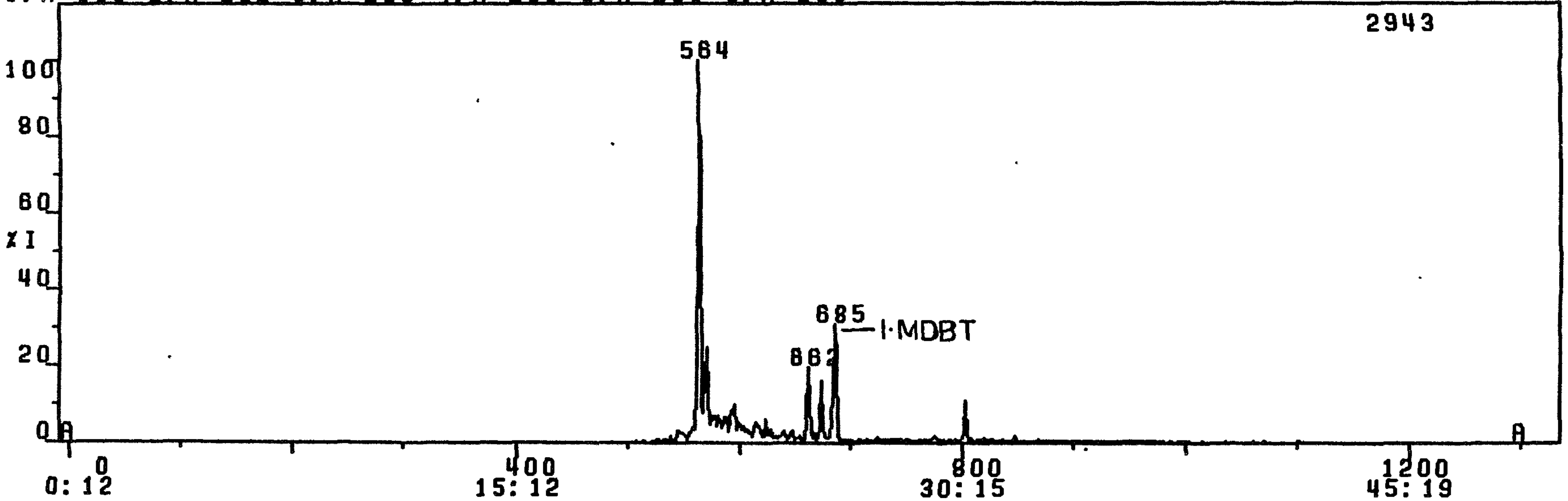


M - 2233
DEPTH 2415 — 30m
m/z 198

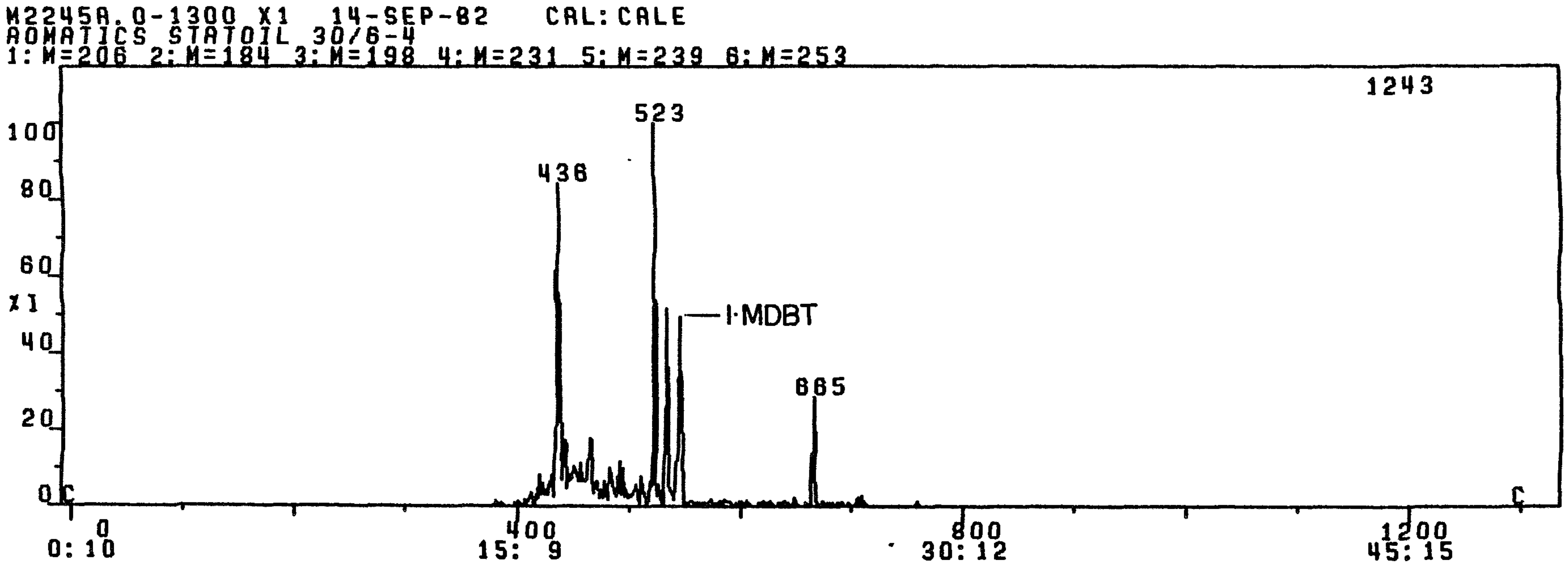


M - 2241
DEPTH 2535 – 50m
m/z 198

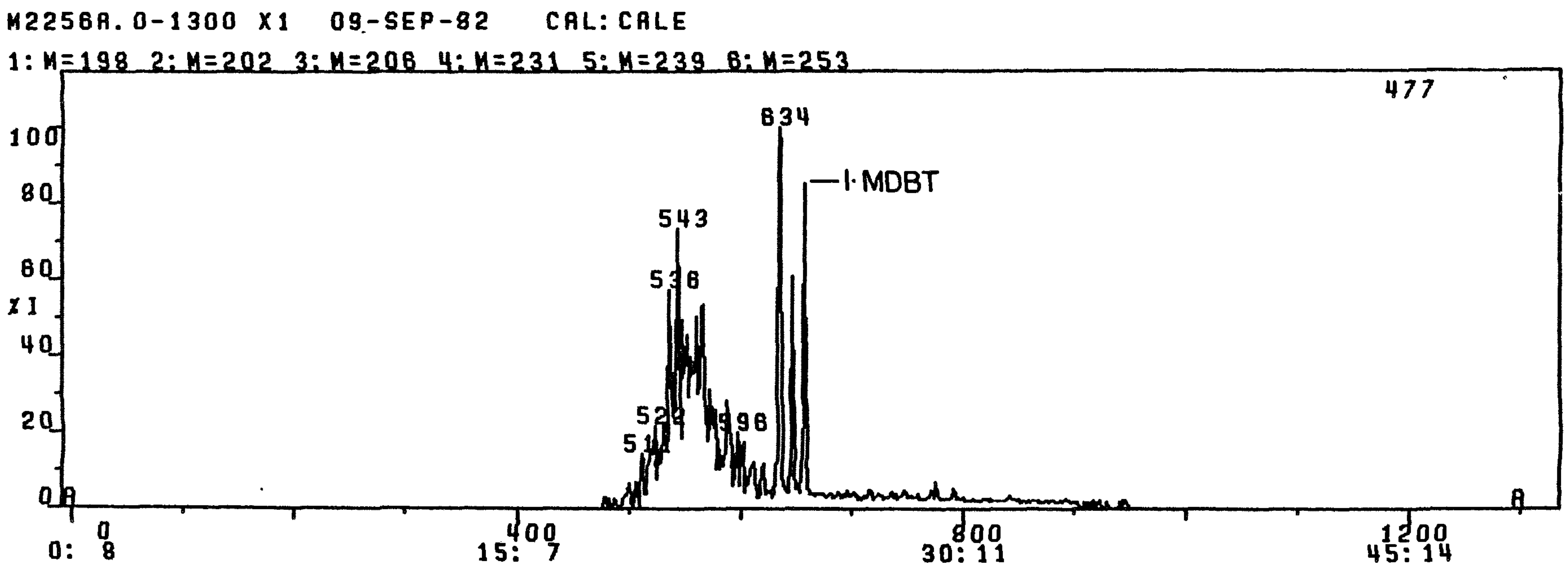
M2241A.0-1319 X1 08-SEP-82 CAL: CALFB
AROMATICS, STATOIL 30/6-4
1: M=198 2: M=202 3: M=206 4: M=231 5: M=239 6: M=253



M - 2245
DEPTH 2595 – 2610m
m/z 198



M - 2256
DEPTH 2775 – 90m
m/z 198



M - 2264
DEPTH 2895 — 2910m
m/z 198