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REPORT TITLE/ TITTEL

HYDROCARBON CHARACTERISATION OF WELL 31/5-2.

CLIENT/ OPPDRAGSGIVER

Saga Petroleum a.s.

RESPONSIBLE SCIENTIST/ PROSJEKTANSVARLIG

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SUMMARY/ SAMMENDRAG

One oil and one gas sample from 31/5-2 were analysed.

The oil (B-8116) is a mature biodegraded paraffinic oil.

The gas (B-8971) associated with the oil is 80% methane and shows depletion of n-alkanes of carbon number above C_4 (relative to branched and cyclic compounds of similar molecular weight).

KEY WORDS/ STIKKORD

31/5-2	TROLL
Hydrocarbon Characterisation	

141/A/anl/1

CONTENTS

INTRODUCTION

IKU was supplied with one oil and one gas sample from this well, the two samples together make up a representative reservoir fluid.

The following information on collection of the oil and gas samples was supplied by GECO.

Flash of reservoir fluid to stock tank conditions

Flash conditions	:	250 barg, 67.6^{o}C to atmosphere and 15^{o}C.
Gas oil ratio	:	60.5 sm^3/m^3.
Bo at 250 barg	:	1.158 m^3/m^3.
Bo at bubble point	:	1.170 m^3/m^3.
Density of oil at 15^{o}C	:	894.4 kg/m^3.
Molecular weight of oil	:	251.
Standard conditions	:	for gas volumes = 15^{o}C and 1 atm. for oil volumes = 15^{o}C and atmospheric pressure.

Saga supplied information on reservoir temperature (67.6^{o}C) and pressure 156 barg.

The following analyses were carried out on the oil sample:

- Measurement of API gravity of the oil.
- C_2-C_8 hydrocarbon characterisation.
- Measurement of the fraction boiling under 210^{o}C.
- Fractionation of the fraction boiling over 210^{o}C by MPLC (medium pressure liquid chromatography).
- Molecular sieving of the saturated fraction into normal and branched/cyclic alkanes.
- Gas chromatography of the saturated/branched and cyclic/aromatic fractions.
- GC-MS of saturated fraction (m/z 191, 217 and 218).
- GC-MS of aromatic fraction (m/z 231 and 253).
- δ^{13}C isotope analysis of saturated and aromatic hydrocarbon fractions.

EXPERIMENTAL PROCEDURES

C_2-C_8 analysis

C_4-C_{10} analysis was carried out on a HP 5880 A gas chromatograph equipped with a 50m x 0.2mm (I.D.) fused silica column coated with OV-101. Helium was used as carrier gas at 1ml/min. The inlet split ratio was 1:60. The temperature program was 35^{o}C (5 min) - 8^{o}C/min. - 200^{o}C (2 min.) which gave good resolution from C_3 upwards. Quantitation was carried out using the same standard gas as for C_1-C_5+ analysis.

Total organic carbon

Bulk samples were crushed in a mortar. Aliquots of the samples were then weighed into Leco crucibles and treated three times with hot 10% HCl to remove carbonate, and washed 4 times with distilled water to remove traces of HCl. The crucibles were then placed on a hot plate and dried for 24 hours. The total organic carbon (TOC) content of the dried samples was determined using a Leco CR12 carbon analyser.

Evaporation of the light components in fluid samples

Prior to chromatographic separation of oil/condensate samples, the fractions boiling below 210^{o}C were removed by heating the samples to constant weight at 210^{o}C is obtained. The heating is performed at atmospheric pressure.

The fraction of light components is determined as the weight difference between the original sample and the amount that is left after the heating.

Chromatographic separation

The fraction of the oil boiling above 210^{o}C 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 on a Buchi Rotavapor and transferred to glass vials and dried in stream of nitrogen.

Molecular sieve adsorption

The sample containing 2mg of n-alkanes was dissolved in 35ml of cyclohexane and 1gs of Molecular Sieve pellets (5A) which had been activated at 300^{o}C in 24 hours, were added. This mixture was then refluzed for about 24 hours. While the solution was still hot, the sieve pellets were removed from the solution by filtering. The solvent was then removed on a Buchi Rotavapor. GC analysis were performed on the samples, using the same conditions as for the other GC analysis.

The normal alkanes were recovered from the Molecular Sieve pellets by destruction of the pellets with hydrofluoric acid. The solution was extracted with boric acid and hexan, and the solvent was then removed on a Buchi Rotavapor. GC analysis were performed on the samples, using the same conditions as for the other GC analysis.

Gas chromatographic analysis

The C_2-C_8 hydrocarbons of the oil were determined on a Carlo Erba Fractovap GC. The column used was a 30m fused silica capillary column coated with SE-54. The temperature program applied was 50^{o}C (2min.) to 180^{o}C at 4^{o}C/min.

The saturated, the branched/cyclic and the aromatic hydrocarbon fractions were each diluted with n-hexane and analysed on a HP 5730A. The GC is equipped with a 15m DB-1 fused silica column and hydrogen (ca. 2.5 ml/min.) is used as carrier gas. Injections are performed in split mode (split ratio 1:10). The temperature program applied is 80^{o}C (2 min.) to 280^{o}C at 4^{o}C/min.

The data processing for all the GC analyses was performed on a VG Multichrom lab data system.

Gas chromatography - mass spectrometry (GC-MS)

GC-MS analyses were performed on a VG Micromass 70-70H GC-MS-DS system. The Varian Series 3700 GC was fitted with a fused silica OV-1 capillary column (30m x 0.3mm i.d.). Helium (0.7kg/cm^2) was used as carrier gas and the injections were performed in split mode (1.5μl, split ratio 1:15). The GC oven was programmed from 70^{o}C to 280^{o}C at 4^{o}C/min. after an initial isothermal period of 2 minutes.

The saturated hydrocarbons were analysed in multiple ion mode (MID) at a scan cycle time of approximately 2 secs. Full data collection was applied for the aromatic hydrocarbons at a scan time of 1 sec/decade. The mass spectrometer operated at 70eV electron energy and an ion source temperature of 200^{o}C. Data acquisition was done by VG data systems.

Peak identification was performed applying knowledge of elution patterns in certain mass chromatograms. Calculation of peak ratios was done from peak height in the appropriate mass chromatograms.

$\delta^{13}C$ isotope analysis

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

Analyses carried out on the gas sample

Gas analysis

C_1-C_{10} analysis was carried out on an HP 5880 gas chromatograph equipped with a 50m x 0.2mm (I.D.) column fused silica column coated with OV 101. Helium was used as a carrier gas at 1ml/min. The inlet split ratio was 1:50. The temperature program was -10^{o}C for 2mins., 10^{o}C/min to 160^{o}C, 160^{o}C for 5 mins.

Quantitation was carried out using a standard gas containing methane, ethane, propane, n-butane, n-pentane and n-hexane. In addition a natural gas standard obtained from Norsk Hydro was used.

RESULTS

API gravity

The specific gravity of B-8116 at $60^{o}F$ = 0.8934
API^{o} gravity = 26.8^{o}

This is a medium gravity oil. The gravity is probably higher now than it was originally due to biodegradation and consequent loss of lighter hydrocarbons.

Fraction boiling below $210^{o}C$ (see table 1)

Oil composition (see tables 2 and 3)

A biodegraded paraffinic oil.

C_2-C_8 hydrocarbons

The distribution of C_2-C_8 hydrocarbons shows a similar trend to that seen in the nC_{15}+ fraction. The n-alkanes have been depleted by biodegradation. Table 4 and figure 1 show the relative weights and percentage weights of C_2-C_8 compounds present in the sample. The light hydrocarbon ratios used by Thompson, 1979 to estimate type of source and maturity are probably not valid for this sample because it is biodegraded. In addition to this it has not been possible to determine some of the necessary compounds, e.g. heptane.

Gas analysis

The results have been tabulated (table 5). A similar trend of depletion of n-alkanes is also seen in the gas sample (above C_4). The iC_4/nC_4 ratio is approximately 6.5 and iC_5/nC_5 is 4.8. A similar predominance of branched pentanes over n-hexane, and branched hexanes over n-heptane is seen.

Isotopic analyses

The results (table 7) are rather unusual as it is normally the saturated fraction that is the more depleted of the two. The difference is fairly large and hard to account for. The samples were analysed twice to check but with the same result.

Gas chromatography results

Saturated fraction

The low abundance of lower molecular weight alkanes (below C_{16}) and predominance of isoprenoid alkanes suggests that the oil is biodegraded. The total alkane range is C_{13} to C_{38} with nC_{16} to nC_{30} being present in the greatest abundance. The pristane/nC_{17} ratio is high, 2.15 but this probably indicates biodegradation rather than low maturity. The abundance of higher i.e. over C_{20} alkanes is noteworthy. It is possible that the C_{30} plus alkanes are derived from the biodegrading microorganisms themselves. Another possibility is the presence of a high molecular weight additive although this seems unlikely and the absence of higher molecular weight compounds in the aromatic fraction chromatogram indicates that this is not the case. This range of alkanes is also seen in some of the immature source rock extracts from 31/5-2, e.g. from 1976m (B-226, p.68). Whether the abundance of high molecular weight alkanes persists to higher maturities in source rocks outside the area of the well is not known.

Branched and cyclic alkanes

The chromatogram is dominated by isoprenoid alkanes which are ubiquitous in extracts and oils and therefore give little specific information on source. The pristane/phytane ratio is fairly high 1.9 and is within the range to the ratio from the 31/5-2 rock extracts below 2000m (1.4-3.4).

Aromatic fraction

The chromatogram is dominated by methyl and dimethyl naphthalenes with relatively little higher molecular weight material. The distribution of the methyl naphthalenes (i.e. with 2 methyl naphthalene dominant) and the absence of high molecular weight material indicates that the oil is mature.

Molecular ratios from terpane and sterane mass chromatograms applied as maturity and source characteristic parameters

Geochemical fossils or biological marker components are characteristic of the type of organic matter present at the time the sediments were deposited. The biological isomers of these components undergo changes due to increased maturity in particular, but also to a certain degree caused by migration and weathering processes.

Source characteristic parameters

In the m/z 191 mass chromatograms, representing terpanes, the hopanes and moretanes are the major components in most extracts and oils. Of the hopanes the C_{27} and C_{29}-C_{35} homologs are ubiquitous, while the C_{28} bisnorhopane is believed to be typical of certain types of source rocks. This is also the case for the component, probably gammacerane, sometimes seen to coelute with the 22S isomer of the C_{31} 17α(H)-hopanes (H). In the sterane mass chromatograms, m/z 217 and m/z 218, the molecular weight distribution of the C_{27}-C_{29} regular steranes is believed to be representative of the original input of organic matter. The highest molecular weight compounds, the C_{29} steranes, represent organic matter of terrestrial origin, while the lower molecular weight analogs originate from more marine type environments.

Maturity dependant parameters

The biological isomers of the hopanes, the 17β(H), 21β(H)-hopanes, undergo structural changes during the maturation process. The isomerisation reactions are thought to be produced via the 17β(H), 21α(H)-hopanes (moretanes) to the most stable 17α(H), 21β(H)-hopanes. At equilibrium 100% of the 17α(H)-hopanes are seen. The ratio αβ/αβ+βα is used to describe this reaction. In the extended hopanes ($\geq C_{31}$), the thermally stable S configurations at C-22 become increasingly more abundant as compared to the biological preferred R configurations at increased maturity level. The equilibrium ratio is approximately 60% of the 22S configuration. Another ratio that is known to change with maturity is the Tm/Ts (Seifert et al., 1978) of the C_{27} hopanes. The maturable 18α(H)-trisnorneohopane (Tm) is reduced in intensity relative to the more stable 17α(H)-trisnorhopane (Ts), causing the Tm/Ts to decrease at increased maturity. This ratio is also believed to be source dependant, and this should be born in mind when applying the ratio for maturity comparison. The amount of tricyclic terpanes is also to a certain extent seen to be maturity dependant.

Two isomerisation reactions taking place in the steranes are most commonly applied for maturity assignments from the m/z 217 mass chromatograms. The biologically preferred 14α(H), 17α(H)-isomers of the regular steranes is transformed to the thermally stable 14β(H), 17β(H)-steranes, the %ββ approaching 75% at equilibrium. An equilibrium concentration of 50% is seen of the stable S configuration at C-20 as opposed to the 100% of the biological 20R epimer (Mackenzie et al., 1980). The abundance of rearranged steranes increased with increasingly maturity.

One of the reactions taking place at an early stage of diagenesis is the aromatisation of steranes, leading to the formation of mono- and tri-aromatic analogs. This process is measured as the abundance of tri-aromatic relative to mono-aromatic compounds (% tri/tri + mono) in the m/z 231 and 253 mass chromatograms, respectively. In addition the degree of side chain cracking, as $\%C_{20}/C_{26,\ 27}$ and $\%C_{21}/C_{28,29}$ respectively, is applied. These cracking processes are also taking place during early diagenesis, and are used for maturity assignment together with the previously mentioned ratios.

Migration and weathering

The effect on the geochemical fossils of migration and weathering, is less apparent than the maturity induced changes. Migration is believed to cause an increase in the relative amounts of rearranged and 14β(H), 17β(H) regular steranes (Seifert and Moldowan, 1978, 1981). Severe biological alteration leads to the formation of desmethyl-hopanes (Seifert and Moldowan, 1979).

<u>GC-MS analysis of saturated steranes and terpanes</u>

The oil sample was analysed for the relative distribution of steranes (m/z 217, 218) and terpanes (m/z 191). Mass chromatograms and tabulated data are presented in Figures 6 and 7 and Tables 8 and 9, respectively.

The oil is seen to contain biomarkers of high maturity, all the isomerisation reactions having reached equilibrium. A certain content of bisnorhopane (Z in m/z 191) is seen in the sample. This does not, however, necessarily mean that the source rock for this oil contains any bisnorhopane, since it is known that the relative abundance of this compound is also dependant on maturity. The relative molecular weight distribution of regular steranes, indicates a high proportion of terrestrial input from the high abundance of C_{29} steranes.

GC-MS analysis of aromatic hydrocarbons

Total ion and mass chromatograms representing aromatic hydrocarbons are presented in Figure 8, while maturity ratios from aromatic steranes are presented in Tables 8 and 9.

This oil sample contains a high proportion of low molecular weight naphthalenes compared to phenanthrenes. Front end biased distribution of alkylated mono-aromatic hydrocarbons is seen, and the relatively low abundance of aromatic steranes suggests mature hydrocarbons.

CONCLUSION

From the analyses carried out the sample provided appears to be a mature biodegraded paraffinic oil.

The associated gas sample is largely methane (80%) and is noticeably depleted in C_4+ n-alkanes also probably the effect of biodegradation. Some of the methane may be bacterial in origin but as isotopic study of the gas was not requested the relative proportions of biogenic v.s. thermogenic methane cannot be established.

Table 1. Fraction boiling below 210^{o}C.

Oil 31/5-2

Starting wt. (g)	after evaporation (g)	wt loss (mg)
2.0801	1.8713	84.0

% boiling under 210^{o}C = 4%

T A B L E : 2.

Relative weight of the main fractions in the oil sample

IKU-No	DEPTH (m)	Crude Oil (mg)	>210^{0} (mg)	Sat. (mg)	Aro. (mg)	HC (mg)	Non HC (mg)	TOC (%)
B 8116 Oljeproeve		2080.1	1871.3	829.8	423.0	1252.8	618.5	0.00

DATE : 1 - 11 - 84.

TABLE : 3.

Percentage composition of the main fractions in the oil sample

IKU-No	DEPTH (m)	Sat / EOM	Aro / EOM	HC / EOM	SAT / Aro	Non HC / EOM	HC / Non HC
B 8116 Oljeproeve	———	44.3	22.6	66.9	196.2	33.1	202.6

DATE : 1 - 11 - 84.

IKU

Table 4. C_2-C_8 hydrocarbons, µg and %.

B-8116
31/5-2 C_2 to C_8 hydrocarbons
ρ = 0.8934

	µg	%
C_2		
C_3		
MC_3	0.48	0.18
nC_4	0.30	0.11
MC_4	0.88	0.33
NC_5	0.32	0.12
CyC_5 + 2.3DMC_4	1.08	0.40
$2MC_5$	1.16	0.43
$3MC_5$	0.88	0.33
nC_6	2.72	1.01
$MCyC_5$	3.94	1.47
benzene	-	
CyC_6	6.16	2.30
$2MC_6$	-	
2.3DMC_5	0.73	0.27
$3MC_6$	1.26	0.47
$DMCyC_5$ (1.3, 1.2)	3.23	1.20
nC_7	-	
$MCyC_6$	12.45	4.65
toluene	0.44	0.16
$2MC_7$	0.40	0.14
$3MC_7$	0.79	0.29
$DMCyC_6$ (1.2)	2.47	0.92
nC_8	1.55	0.58
M/P-xylene	4.01	1.50
O-xylene	-	-

FIGURE 1

Gas chromatogram, C_2-C_8 hydrocarbons

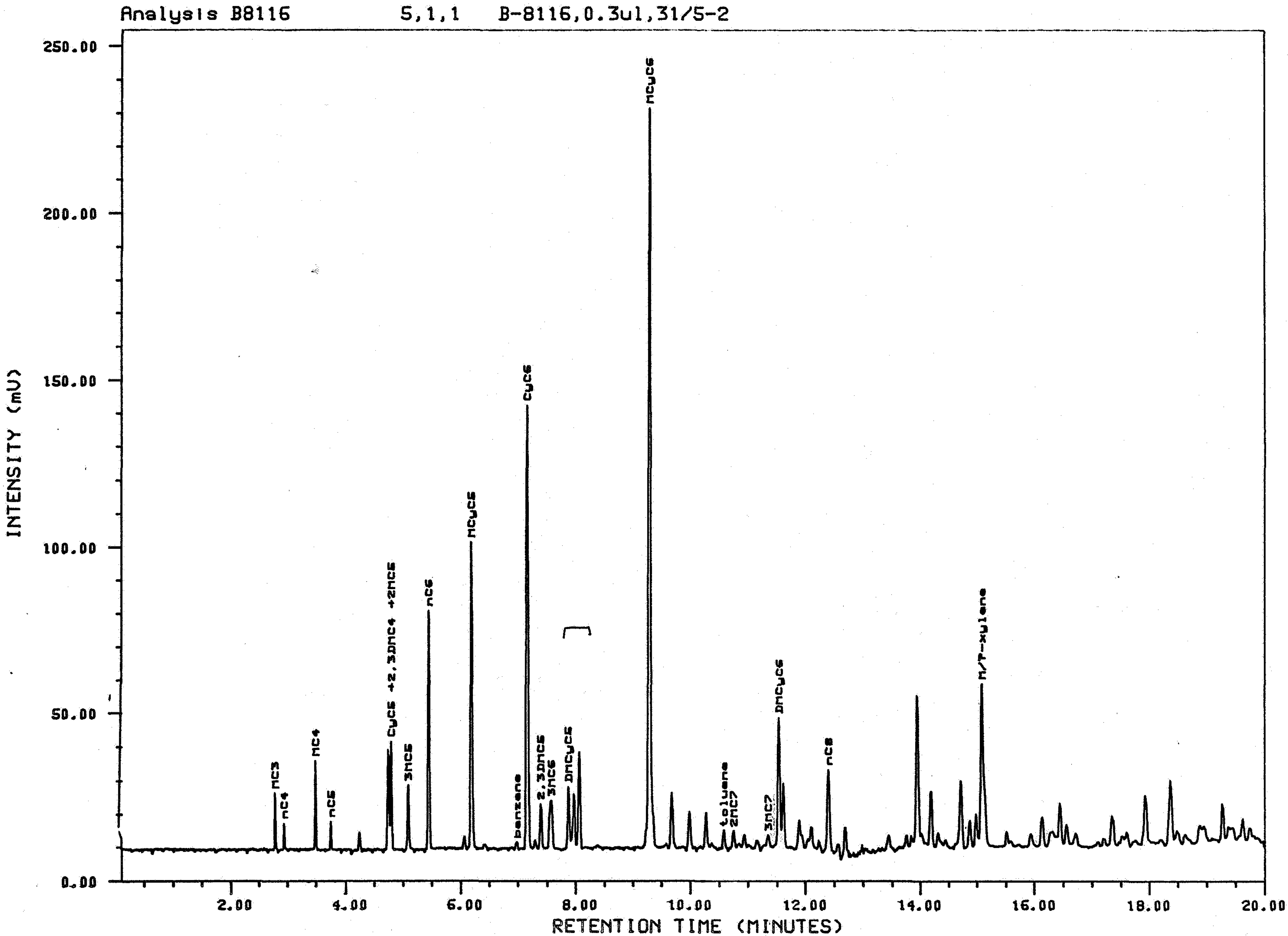

Analysis B8116 5,1,1 B-8116,0.3ul,31/5-2
INTENSITY (mU)
RETENTION TIME (MINUTES)
250.00
200.00
150.00
100.00
50.00
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
MC3
nC4
MC4
nC5
CyC5 +2,3DMC4 +2MC5
3MC5
nC6
MCyC5
benzene
CyC6
2,3DMC5
3MC6
DMCyC5
MCyC6
toluene
2MC7
3MC7
DMCyC6
nC8
M/P-xylene

Table 5. Results of gas analysis 31/5-2

B-8971

	Percentage composition	
C_1	80.7	
C_2	8.1	
C_3	1.5	
iC_4	1.5	$iC_4/nC_4 = 6.5$
nC_4	0.23	
iC_5	0.22	$iC_5/nC_5 = 4.8$
nC_5	0.046	
2.2DMeC_4	0.024	
2.3DMeC_4	0.049	
CyC_5	0.039	
2-MeC_5	0.077	
3-MeC_5	0.041	
nC_6	0.009	
MeCyC_5	0.10	
2.4-DMeC_5	0.01	
CyC_6	0.10	
nC_7	0.0002	
MeCyC_6	0.069	

Table 6. Data from gas analysis.

OV# STOP RUN

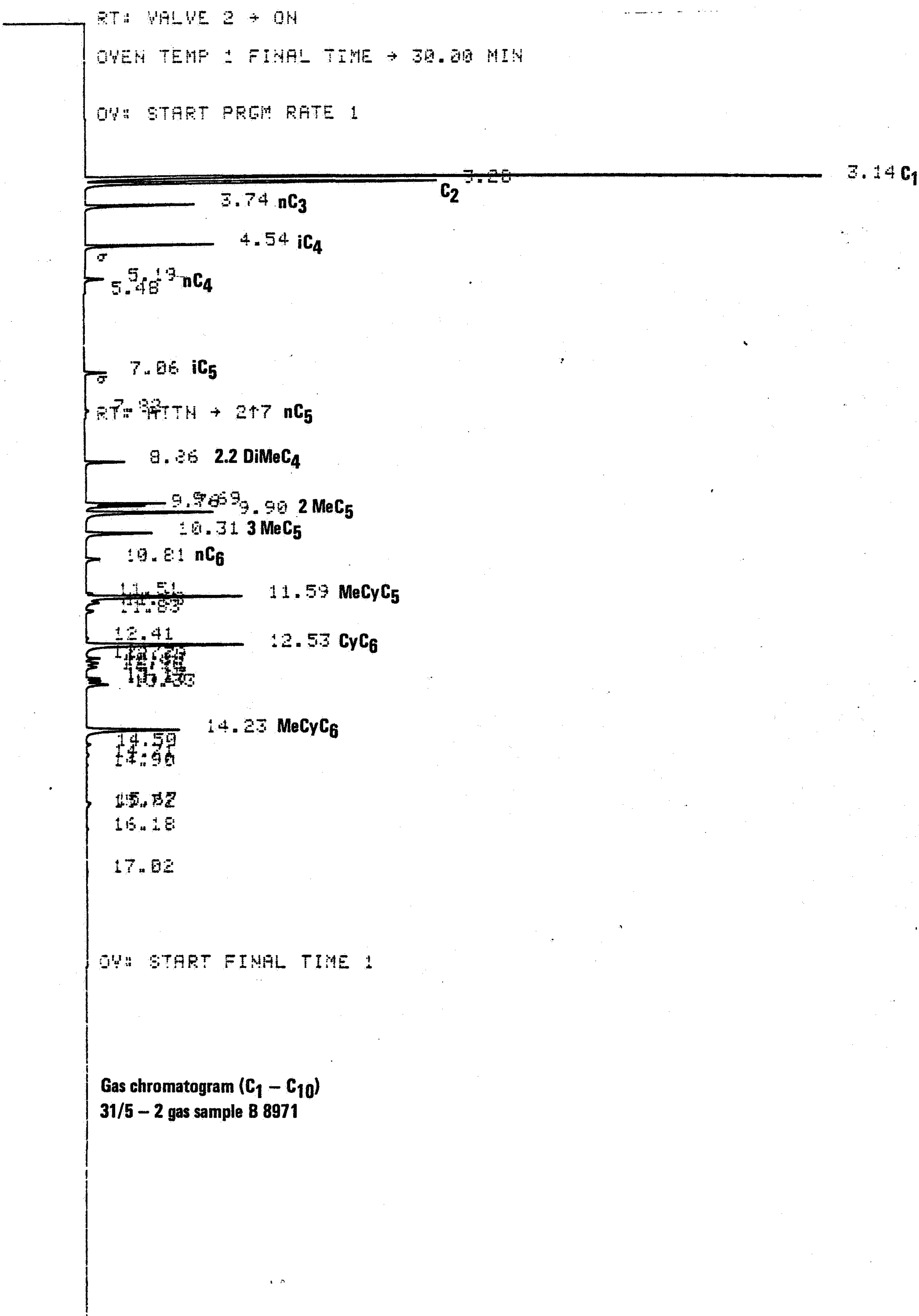
[hp] 5890A MANUAL INJECTION @ 11:31 NOV 22, 1984
AREA %

RT	AREA	TYPE	WIDTH	HEIGHT	BASELINE	AREA %
0.00			BASELINE @ START RUN = 69.85			
0.00			THRESHOLD @ START RUN = 3			
0.00			PEAK WIDTH @ START RUN = 0.04			
3.14	123777.00	BV	0.03	65140.60	69.93	70.600
3.28	24908.00	VB	0.03	14330.80	70.23	14.207
3.74	7562.13	BB	0.03	4493.47	70.23	4.313
4.54	9551.45	BV	0.03	5279.93	70.02	5.448
5.19	1501.21	BB	0.03	912.77	70.40	0.856
5.48	151.70	BB	0.031	77.77	70.47	0.087
7.06	1922.87	BV	0.03	909.20	70.13	1.097
7.82	397.66	BB	0.031	201.75	70.36	0.227
8.36	216.95	BB	0.033	101.88	70.28	0.124
9.69	435.15	BV	0.033	207.81	70.23	0.248
9.76	349.36	VV	0.035	155.35	70.37	0.199
9.90	686.91	VB	0.03	324.56	70.63	0.392
10.31	369.90	BB	0.033	173.41	70.39	0.211
10.81	81.62	BB	0.033	39.11	70.21	0.047
11.51	40.29	BV	0.031	20.67	70.18	0.023
11.59	895.30	VV	0.035	398.77	70.22	0.511
11.68	89.60	VV	-----	36.45	70.25	0.051
11.83	61.91	VB	0.043	22.60	70.31	0.035
12.41	20.46	BV	0.034	9.34	70.23	0.012
12.53	969.15	VV	0.038	401.20	70.26	0.553
12.72	15.70	VV	-----	7.50	70.30	0.009
12.79	84.66	VV	0.035	38.11	70.31	0.048
12.89	75.13	VV	0.034	34.55	70.32	0.043
12.96	68.53	VB	0.04	29.77	70.34	0.039
13.17	83.46	BV	0.034	38.83	70.24	0.048
13.25	91.91	VV	-----	39.97	70.31	0.052
13.33	140.22	VB	0.04	53.80	70.38	0.080
14.23	618.41	BB	0.040	239.62	70.29	0.353
14.50	34.41	VB	0.037	14.65	70.37	0.020
14.71	22.84	BB	0.036	9.84	70.17	0.013
14.90	17.43	BV	0.036	7.58	70.13	0.010
15.67	34.24	VV	-----	14.40	70.17	0.020
15.72	17.63	VB	-----	7.46	70.17	0.010
16.18	15.92	PV	0.037	6.65	70.19	0.009
17.02	12.44	VB	0.039	4.96	70.33	0.007

TOTAL AREA = 175322.00
MULTIPLIER = 1

FIGURE 2

Gas chromatogram of gas sample



Gas chromatogram ($C_1 - C_{10}$)
31/5 – 2 gas sample B 8971

FIGURE 3

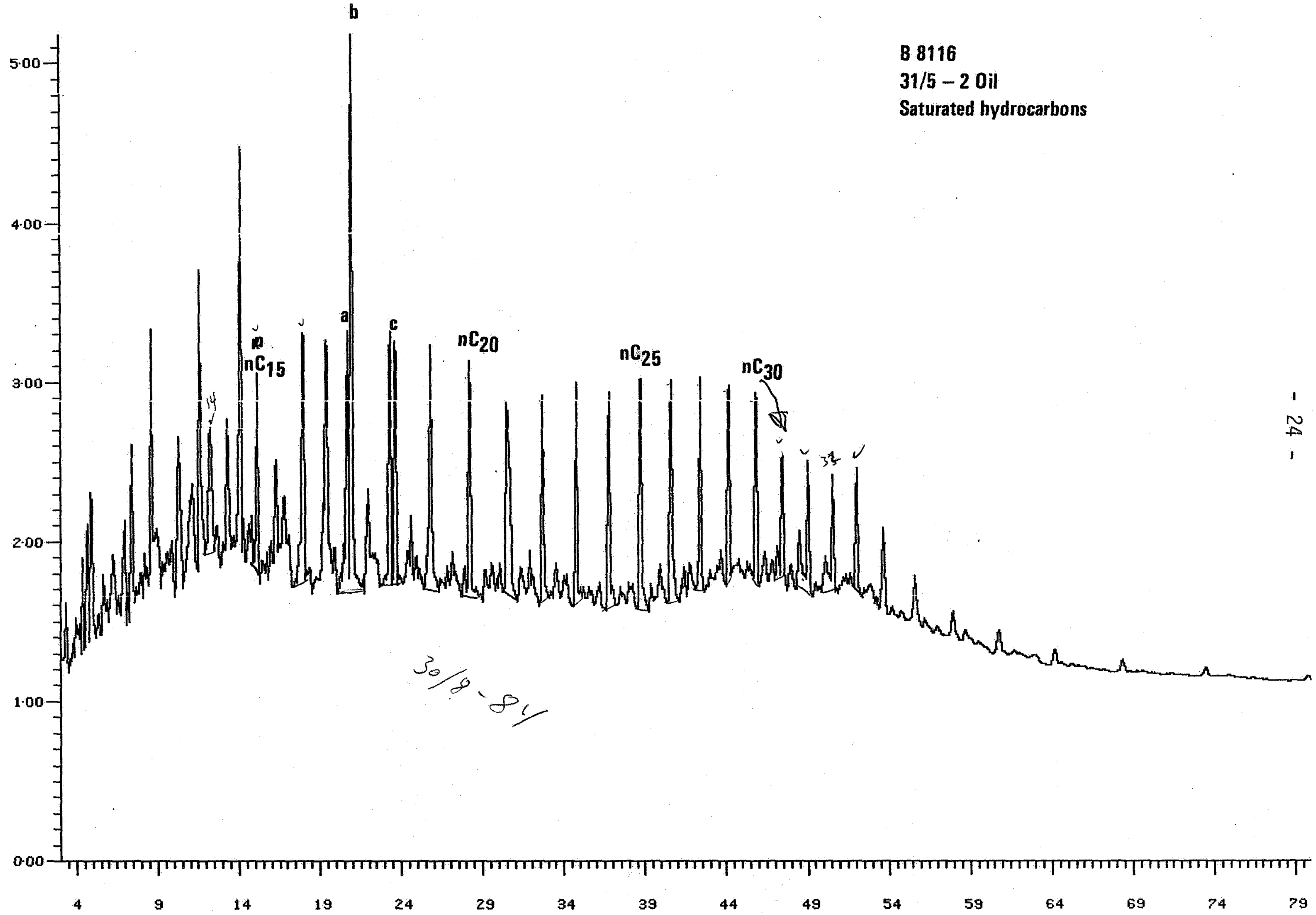
Saturated fraction gas chromatograms

a	-	nC_{17}
b	-	pristane
c	-	phytane
nC_x	-	n-alkane of that carbon number

reated at 12:37 on 31/Oct/84

DATA PLOT-CHANNEL 3
Data Scale Plot Box 1 of 1

Analysis :750B8116S Sample £: 1 Injection £: 1
Sample Name :B8116,SAT,31/5-2,GH Maximum signal (%) :5.179

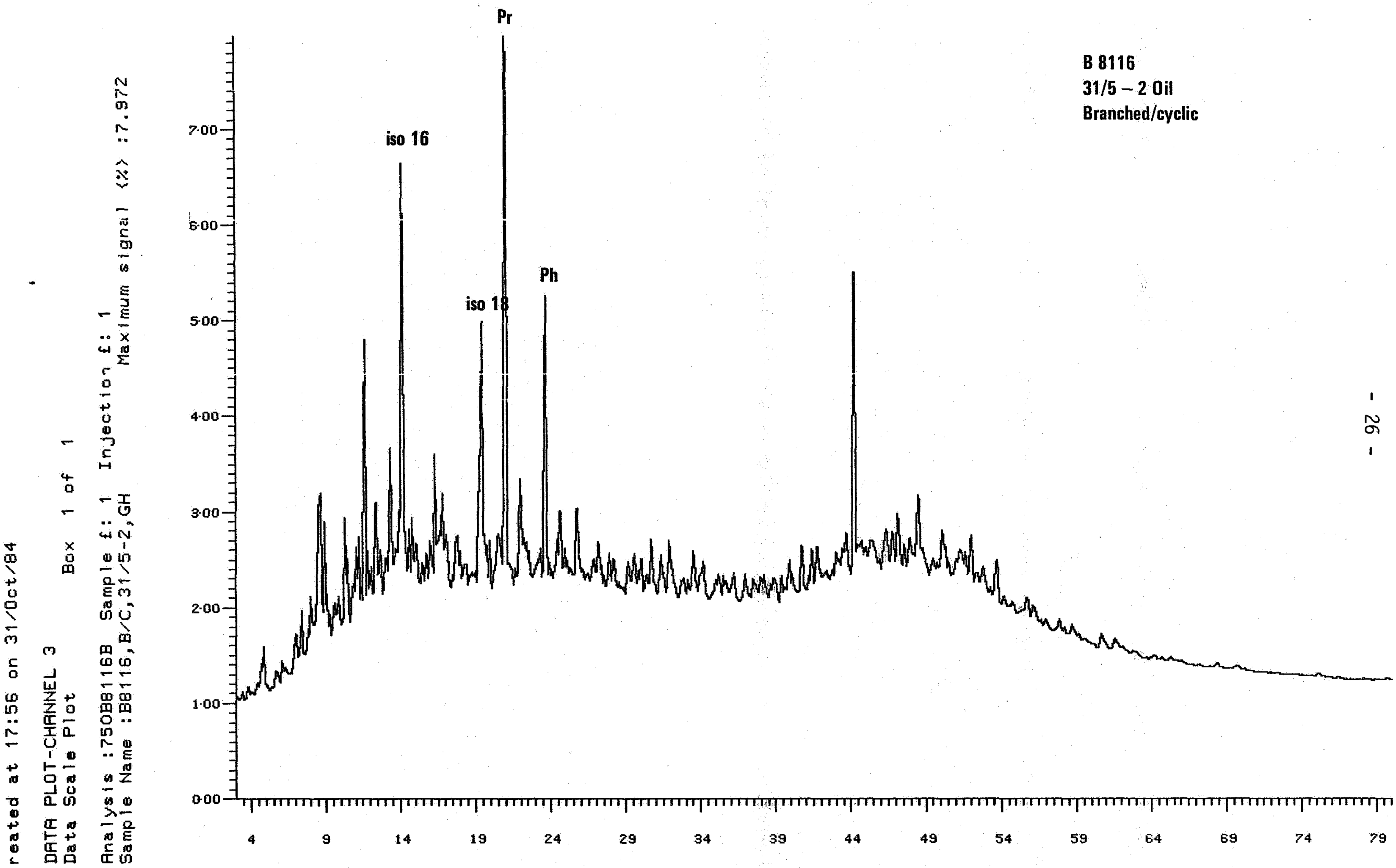


IKU

FIGURE 4

Branched and cyclic alkanes gas chromatogram

Pr	-	pristane
Ph	-	phytane
iso 16		Isoprenoid alkanes with 16 and 18
iso 18		carbon atoms respectively



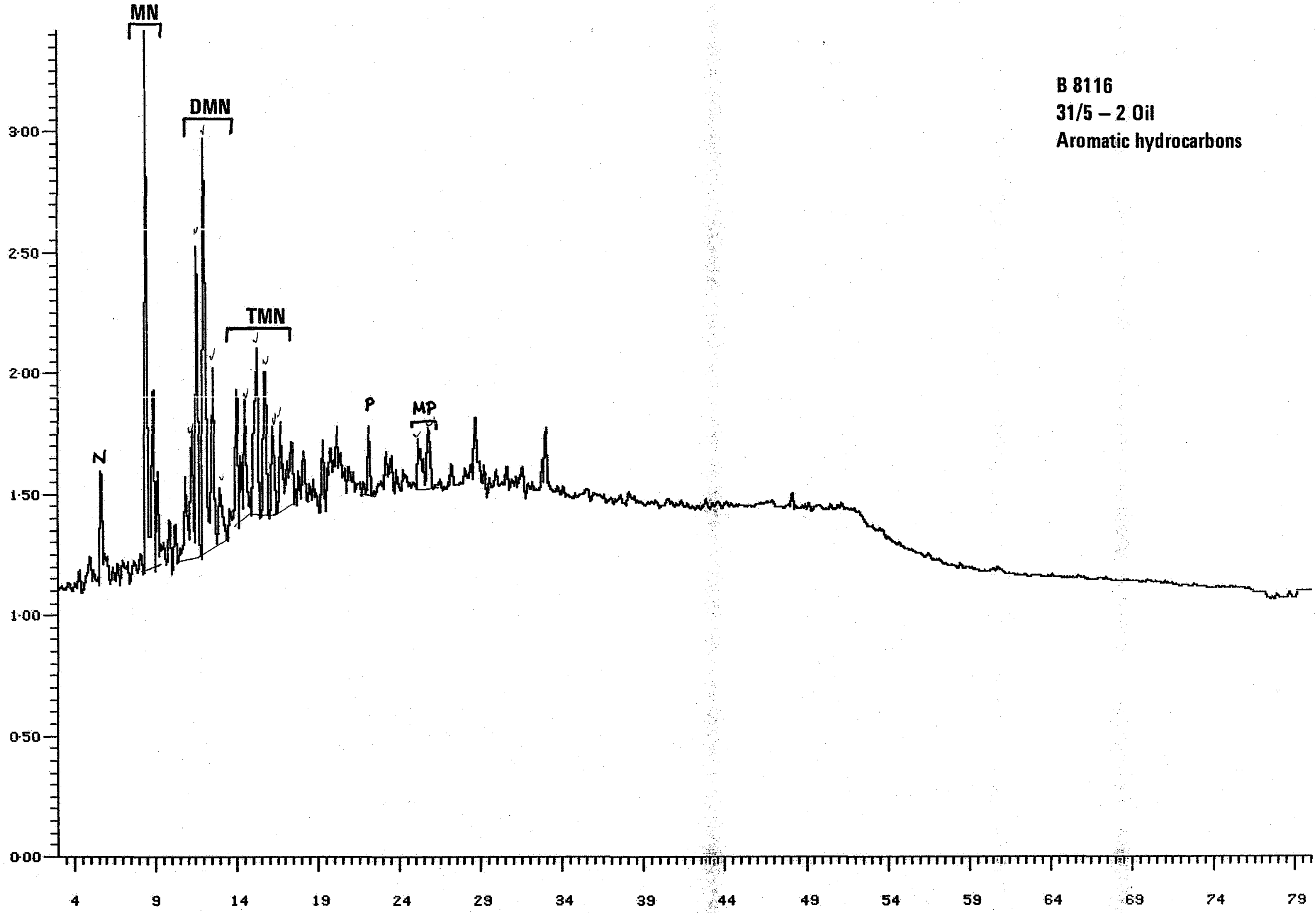
reated at 17:56 on 31/Oct/84
DATA PLOT-CHANNEL 3
Data Scale Plot
Box 1 of 1
Analysis :750B8116B Sample £: 1 Injection £: 1
Sample Name :B8116,B/C,31/5-2,GH
Maximum signal (%) :7.972
B 8116
31/5 – 2 Oil
Branched/cyclic
Pr
iso 16
iso 18
Ph
0·00
1·00
2·00
3·00
4·00
5·00
6·00
7·00
4
9
14
19
24
29
34
39
44
49
54
59
64
69
74
79

FIGURE 5

Aromatic fraction gas chromatogram

N	-	naphthalene
MN	-	methyl naphthalenes
DMN	-	dimethyl naphthalenes
TMN	-	trimethyl naphthalenes

B 8116
31/5 – 2 Oil
Aromatic hydrocarbons



reated at 12:41 on 31/Oct/84
DATA PLOT-CHANNEL 2 Box 1 of 1
Data Scale Plot
Analysis :750B8116A Sample £: 1 Injection £: 1
Sample Name :B8116,ARO,31/5-2,GH Maximum signal (%) :3.419

Table 7. Results of δ^{13} C analyses on saturated and aromatic fractions of 31/5-2 oil (B-8116).

Sat. ($^{13}\delta C$ $^{o}/oo$)	Arom. ($^{13}\delta C$ $^{o}/oo$)
-28.8	-31.1

Table 8.

Molecular ratios calculated from terpane
and sterane mass chromatograms.
Maturity ratios.

IKU No.	DEPTH (m)	1) αβ/αβ + βα	2) %22S	3) %ββ	4) %20S
B8116	0	0.89	60.0	73.9	54.5

1) E/E+F in m/z 191.
2) % distribution between first and second elution isomers of doublet J (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 9.

Molecular ratios calculated from terpane
and sterane mass chromatograms.
Source characteristic and maturity ratios.

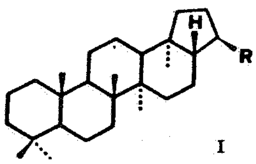
IKU No.	DEPTH (m)	Q/E 1)	Tm/Ts 2)	X/E 3)	a/a+j 4)	Z/E 5)
B8116	0	0.09	0.84	0.11	0.70	0.24

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 C27 rearranged steranes(a/a+j).
5) Relative abundance of bisnorhopane(Z/E in m/z 191).

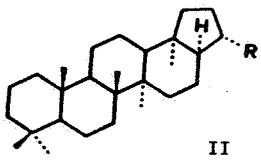
Figure 6.

Mass chromatograms representing terpanes (m/z 191)

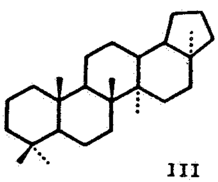
A	T_s, 18α(H)-trisnorneohopane	$C_{27}H_{46}$	(III)
B	T_m, 17α(H)-trisnorhopane	$C_{27}H_{46}$	(I,R=H)
C	17α(H)-norhopane	$C_{29}H_{50}$	(I,R=C_2H_5)
D	17β(H)-normoretane	$C_{29}H_{50}$	(II,R=C_2H_5)
E	17α(H)-hopane	$C_{30}H_{52}$	(I,R=C_3H_7)
F	17β(H)-moretane	$C_{30}H_{52}$	(II,R=C_3H_7)
G	17α(H)-homohopane (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})
Z	bisnorhopane	$C_{28}H_{48}$	
X	unknown triterpane	$C_{30}H_{52}$	
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})



I



II



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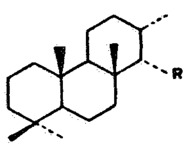


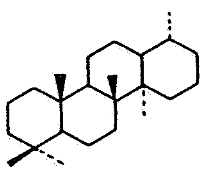
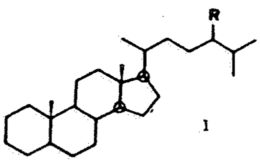


Figure 7.

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

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)	$C_{29}H_{52}$	(III,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)	$C_{29}H_{52}$	(III,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	14β(H),17β(H)-sterane (20R)	$C_{29}H_{52}$	(I,R=C_2H_5)
u	5α(H)-sterane	$C_{21}H_{36}$	(V,R=C_2H_5)
v	5α(H)-sterane	$C_{22}H_{38}$	(IV,R=C_3H_7)



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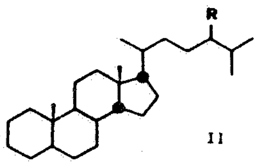

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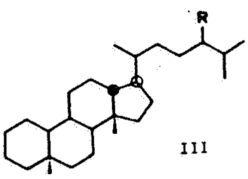

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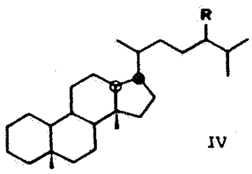

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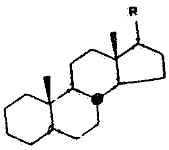
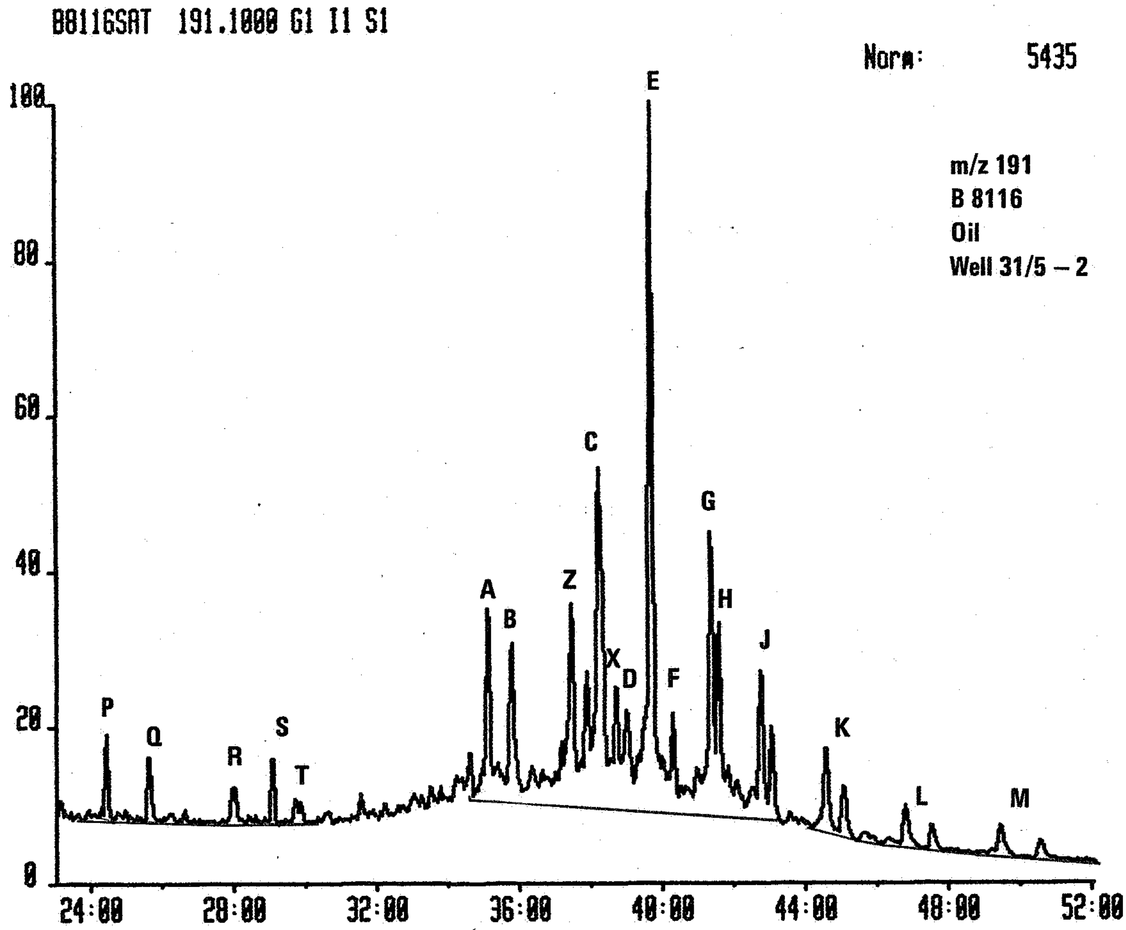
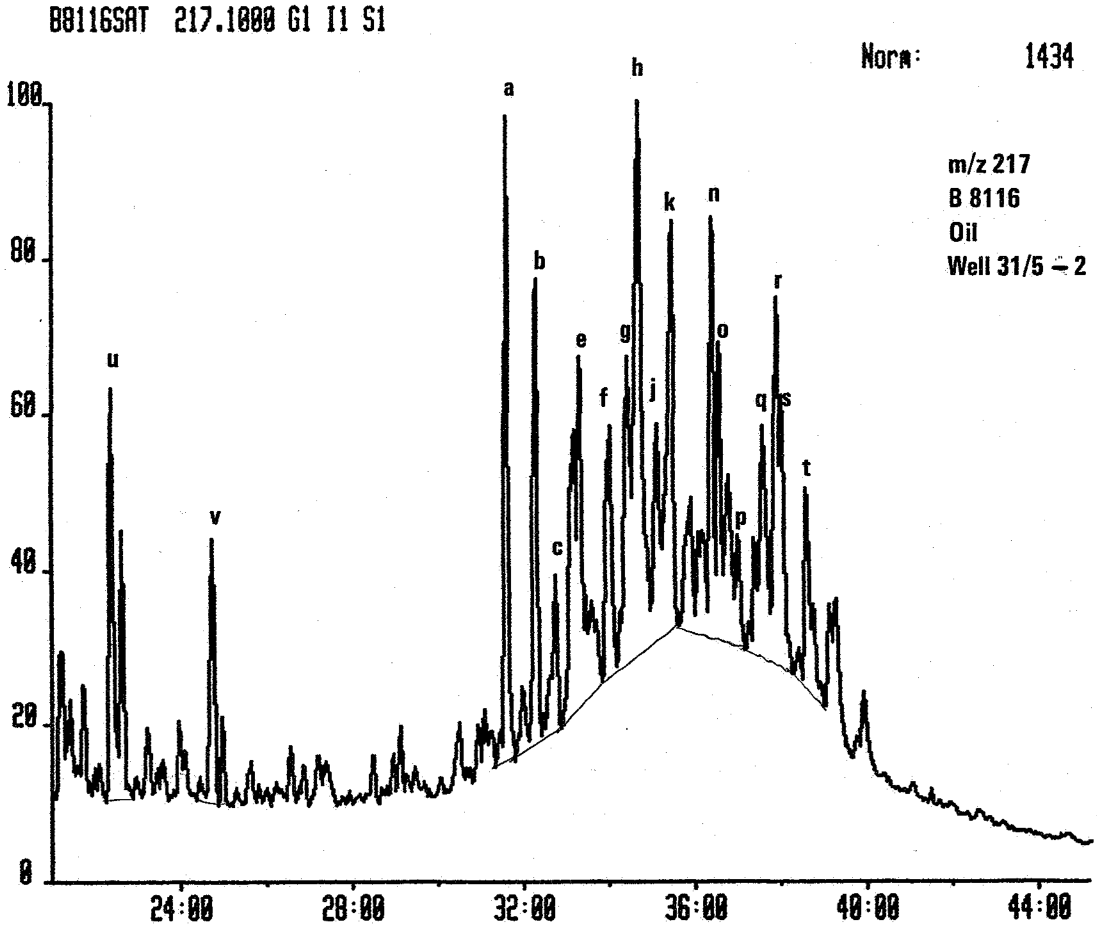


IKU


B8116SAT 191.1000 G1 I1 S1
Norm: 5435
m/z 191
B 8116
Oil
Well 31/5 – 2
100
80
60
40
20
0
24:00
28:00
32:00
36:00
40:00
44:00
48:00
52:00
P
Q
R
S
T
A
B
Z
C
X
D
E
F
G
H
J
K
L
M

IKU


B8116SAT 217.1000 G1 I1 S1
Norm: 1434
m/z 217
B 8116
Oil
Well 31/5 - 2
100
80
60
40
20
0
24:00
28:00
32:00
36:00
40:00
44:00
a
b
c
e
f
g
h
j
k
n
o
p
q
r
s
t
u
v

IKU

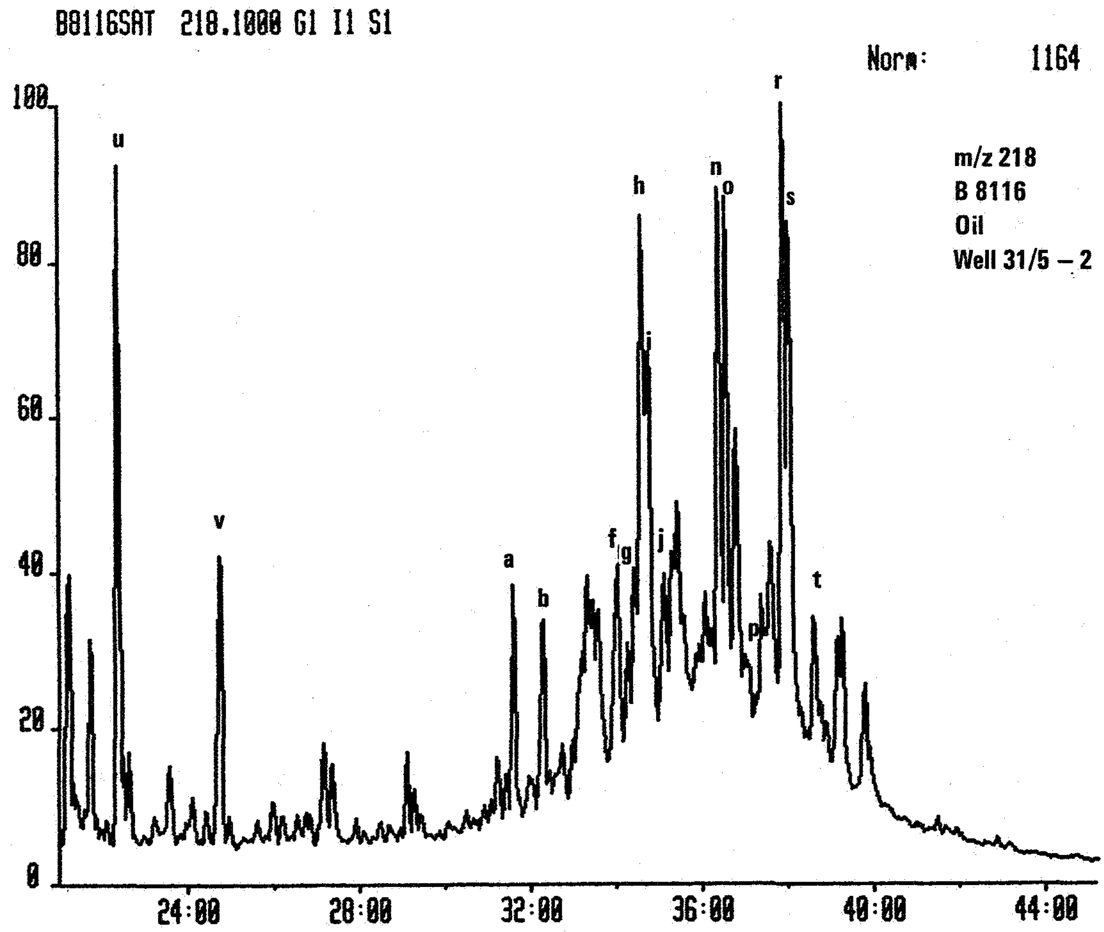
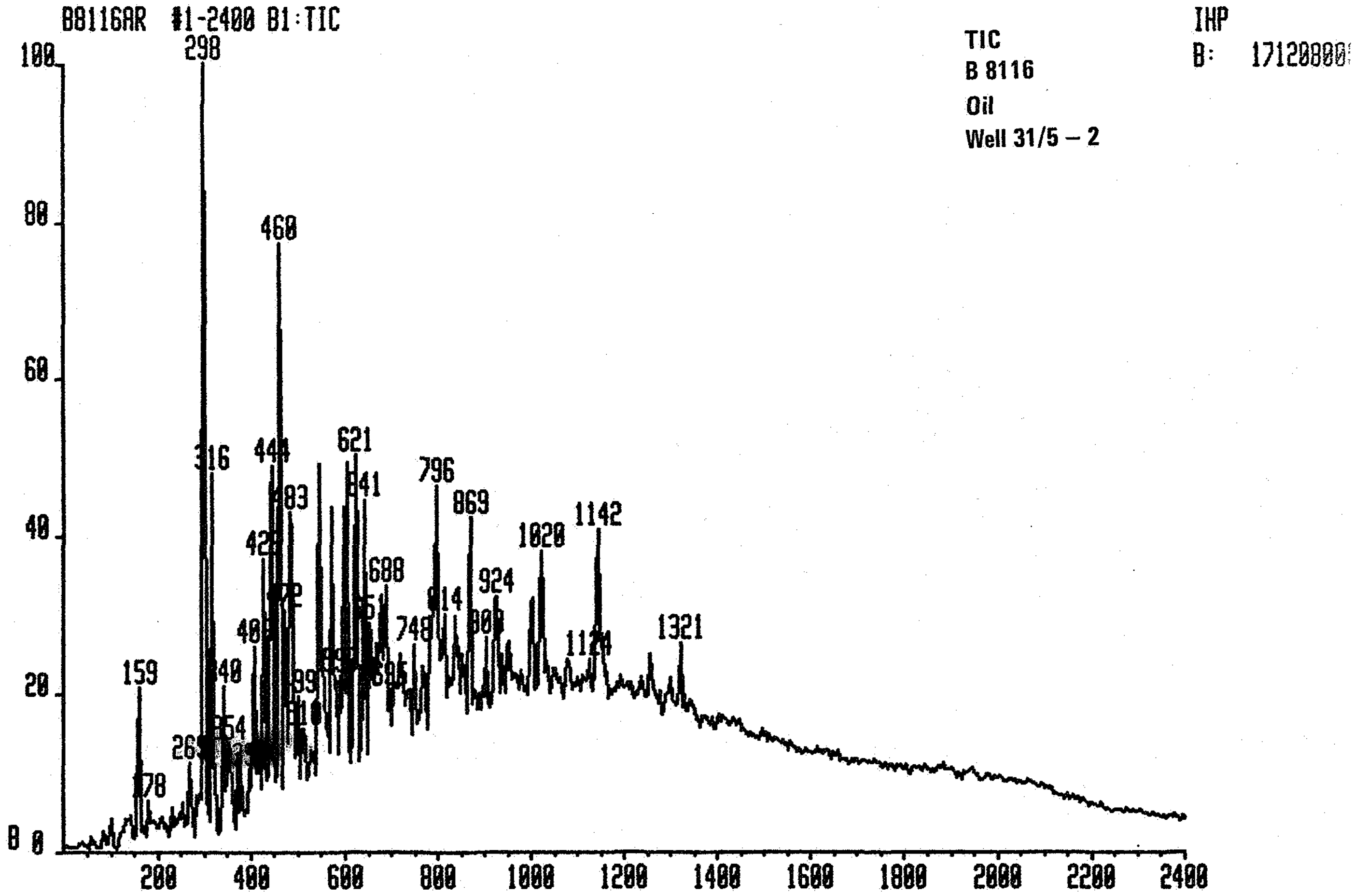

B8116SAT 218.1000 G1 I1 S1
Norm: 1164
m/z 218
B 8116
Oil
Well 31/5 – 2
100
80
60
40
20
0
24:00
28:00
32:00
36:00
40:00
44:00
u
v
a
b
f
g
h
i
j
n
o
p
r
s
t

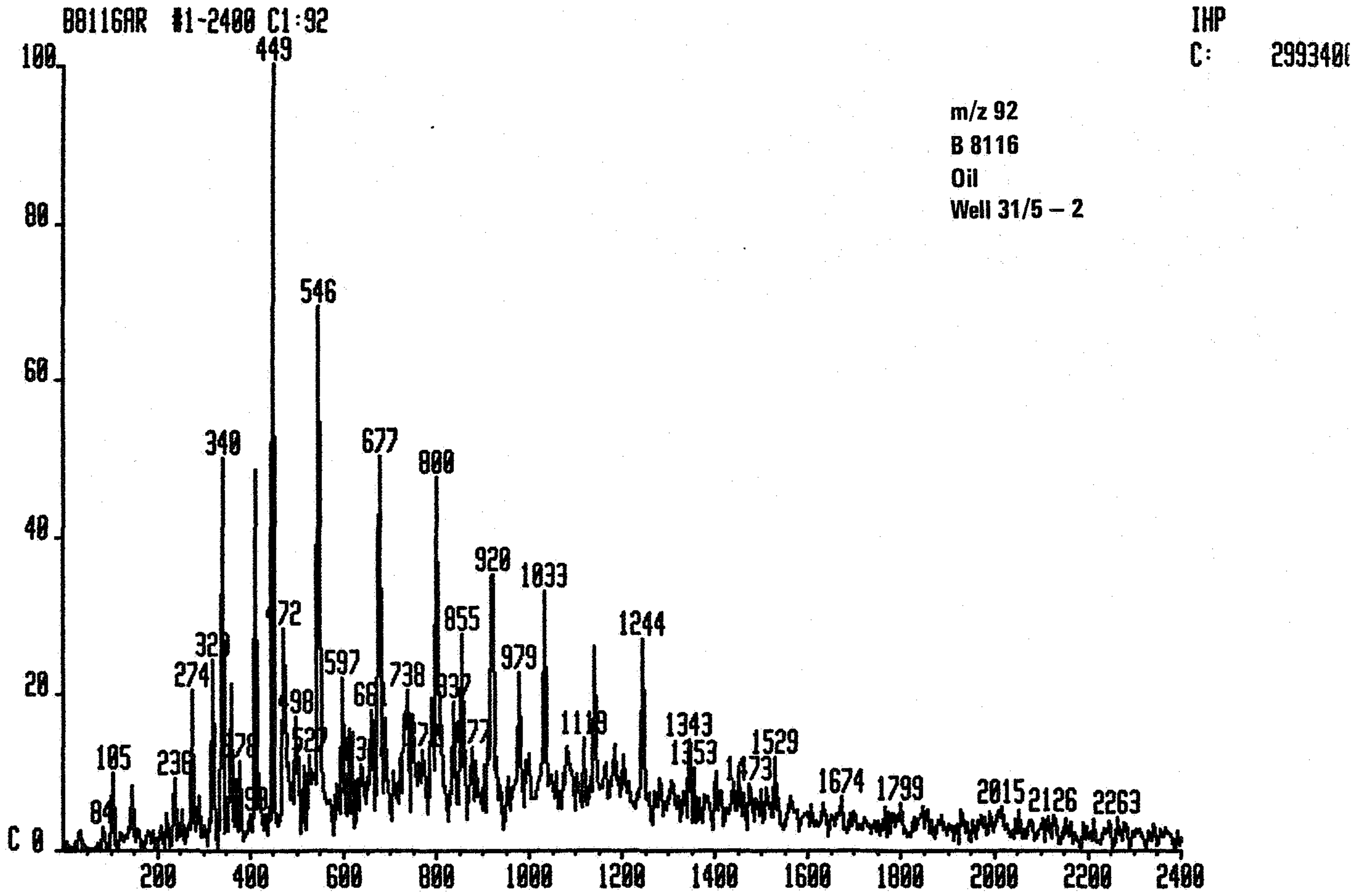
FIGURE 8

Mass chromatograms of aromatic hydrocarbons

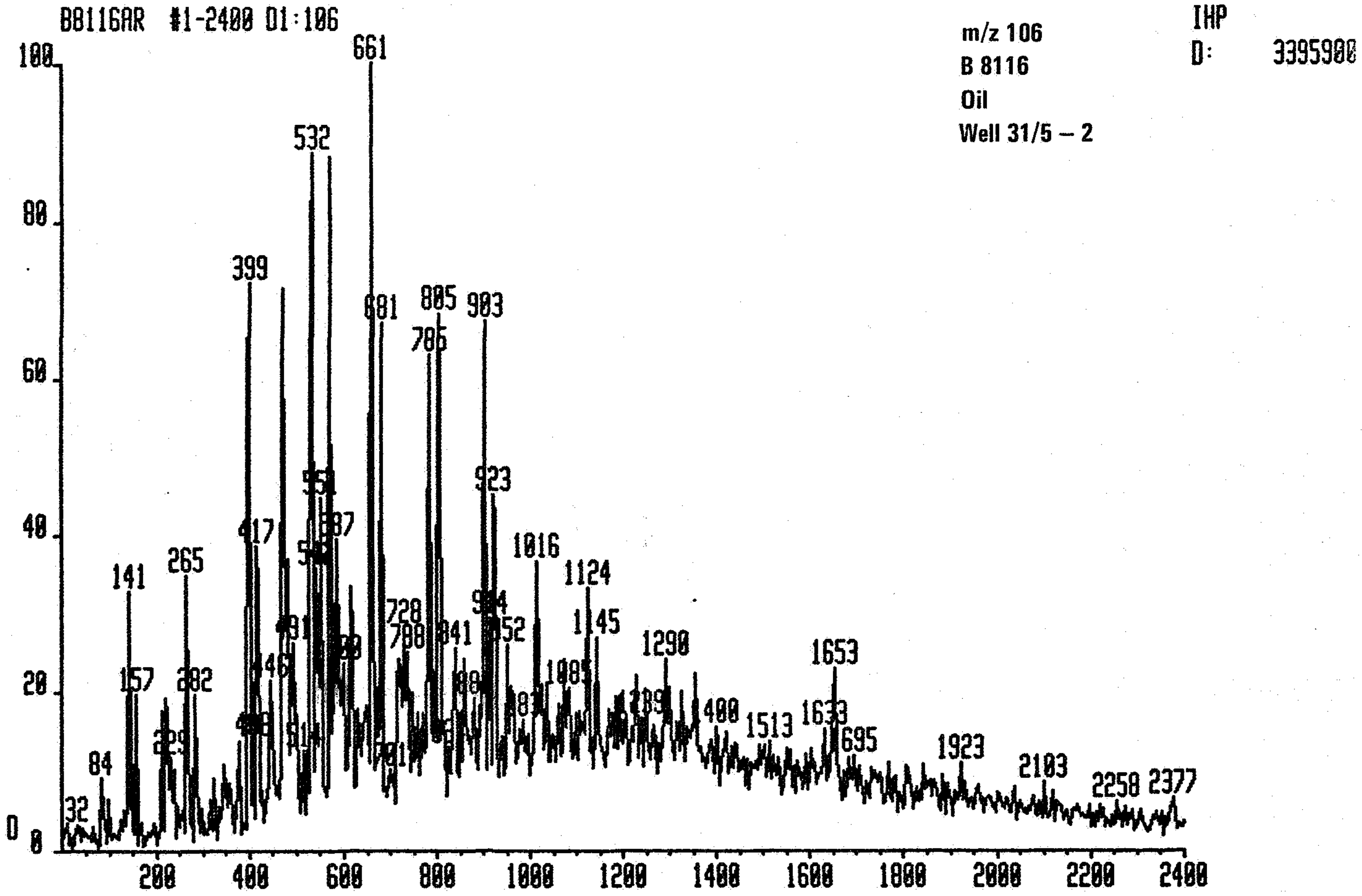
TIC	- total ion chromatograms
m/z 92,106	- monoaromatic hydrocarbons
m/z 142,156,170	- alkylated naphthalenes
m/z 178,192,206	- alkylated phenanthrenes
m/z 184,198,212	- alkylated dibenzothiophenes
m/z 231	- triaromatic steranes
m/z 253	- monoaromatic steranes
m/z 166,180	- fluorens
m/z 202	- pyrene, fluoranthen

IKU

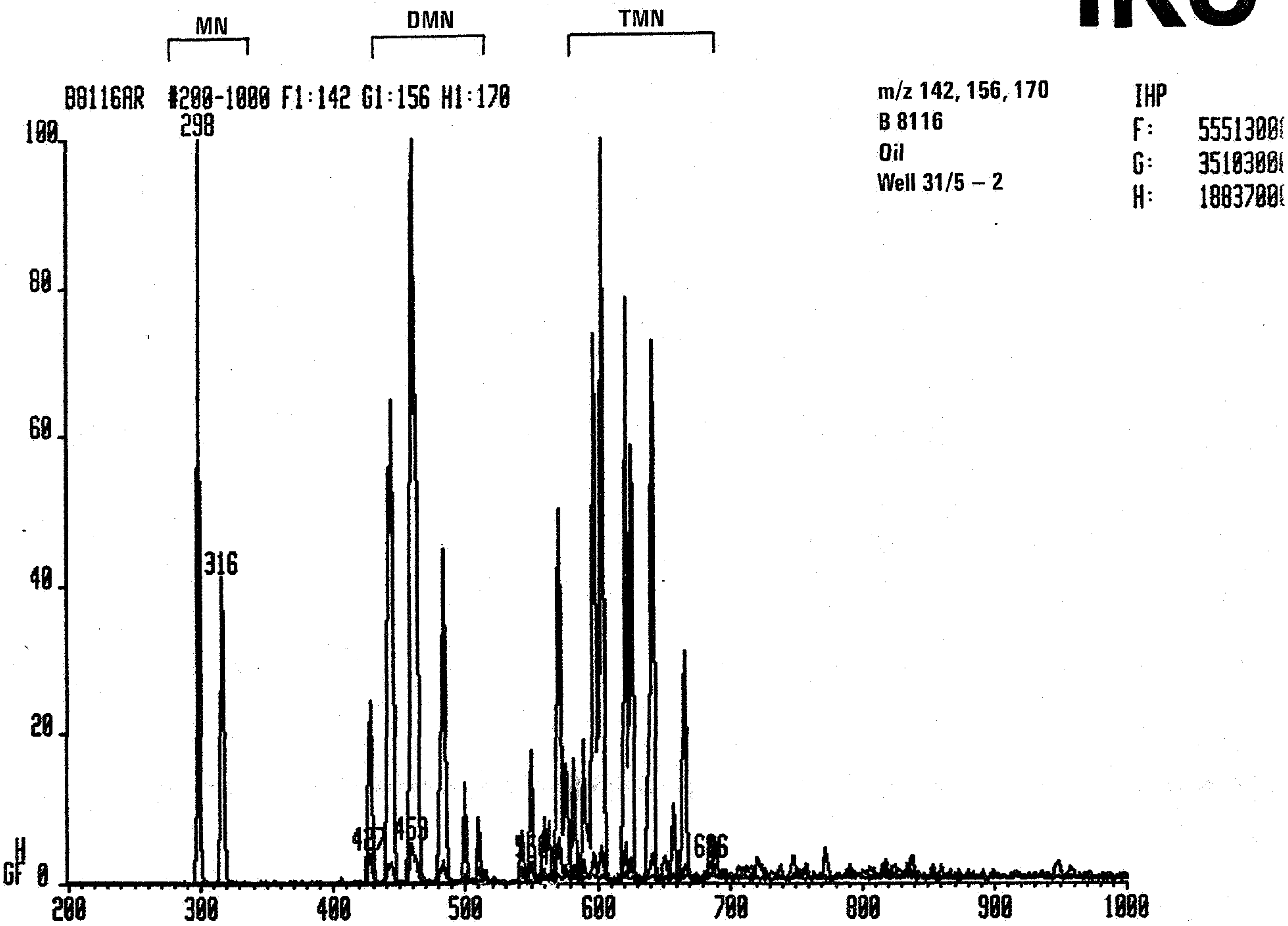

B8116AR #1-2400 B1:TIC
IHP
B: 17120800
TIC
B 8116
Oil
Well 31/5 – 2
298
460
316
444
621
641
483
796
869
1020
1142
688
924
159
1321
178
200 400 600 800 1000 1200 1400 1600 1800 2000 2200 2400


B8116AR #1-2400 C1:92
IHP
C: 2993400
m/z 92
B 8116
Oil
Well 31/5 – 2
449
546
340
677
800
920
1033
855
1244
979
597
738
274
105
236
84
1343
1353
1529
1674
1799
2015
2126
2263
200 400 600 800 1000 1200 1400 1600 1800 2000 2200 2400

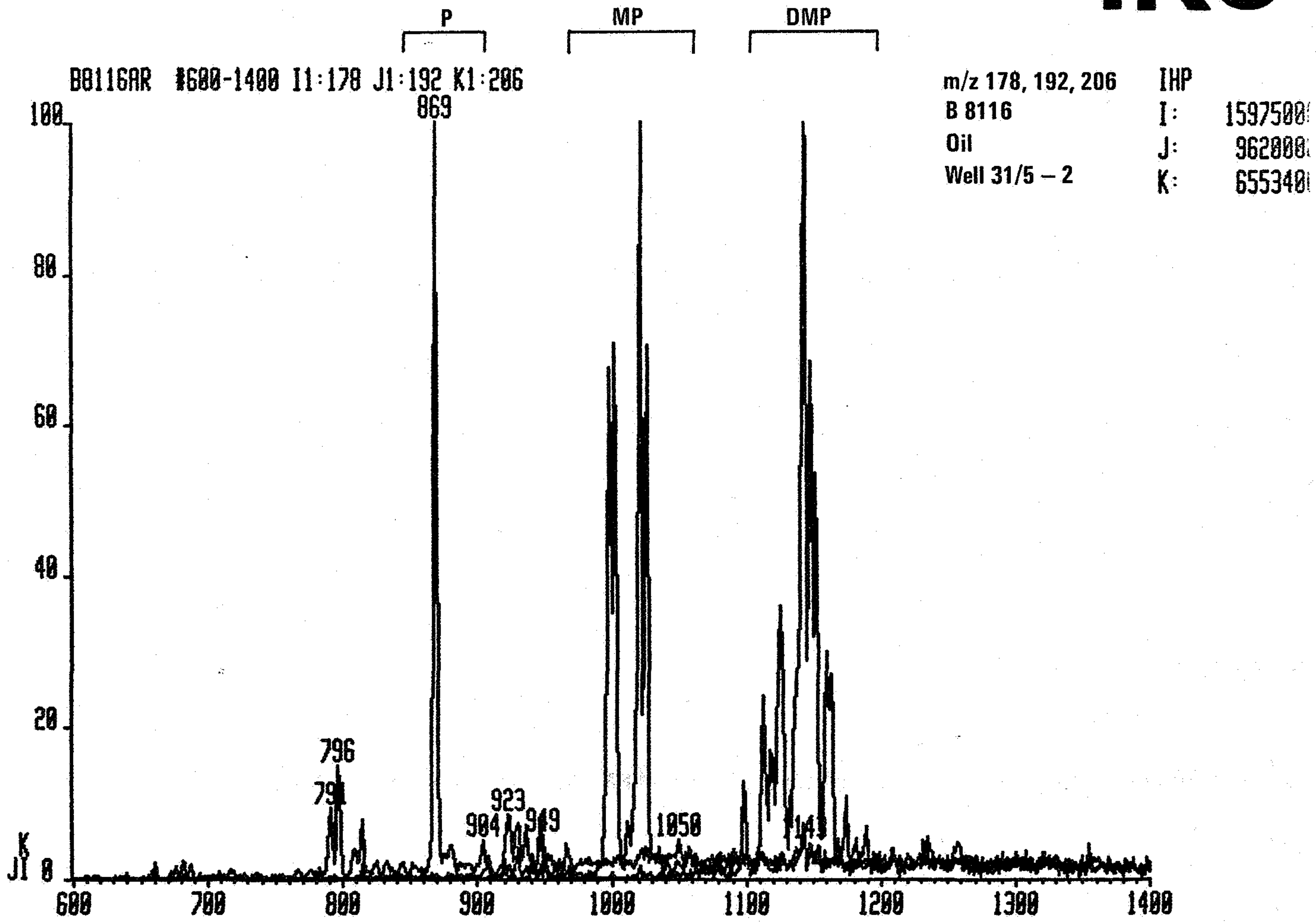
IKU


B8116AR #1-2400 D1:106
m/z 106
B 8116
Oil
Well 31/5 – 2
IHP
D: 3395900
661
532
399
681
805
903
786
923
417
1016
141
265
1124
728
1145
1290
1653
157
282
1513
1633
1695
84
1923
2103
2258
2377
32
100
80
60
40
20
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400

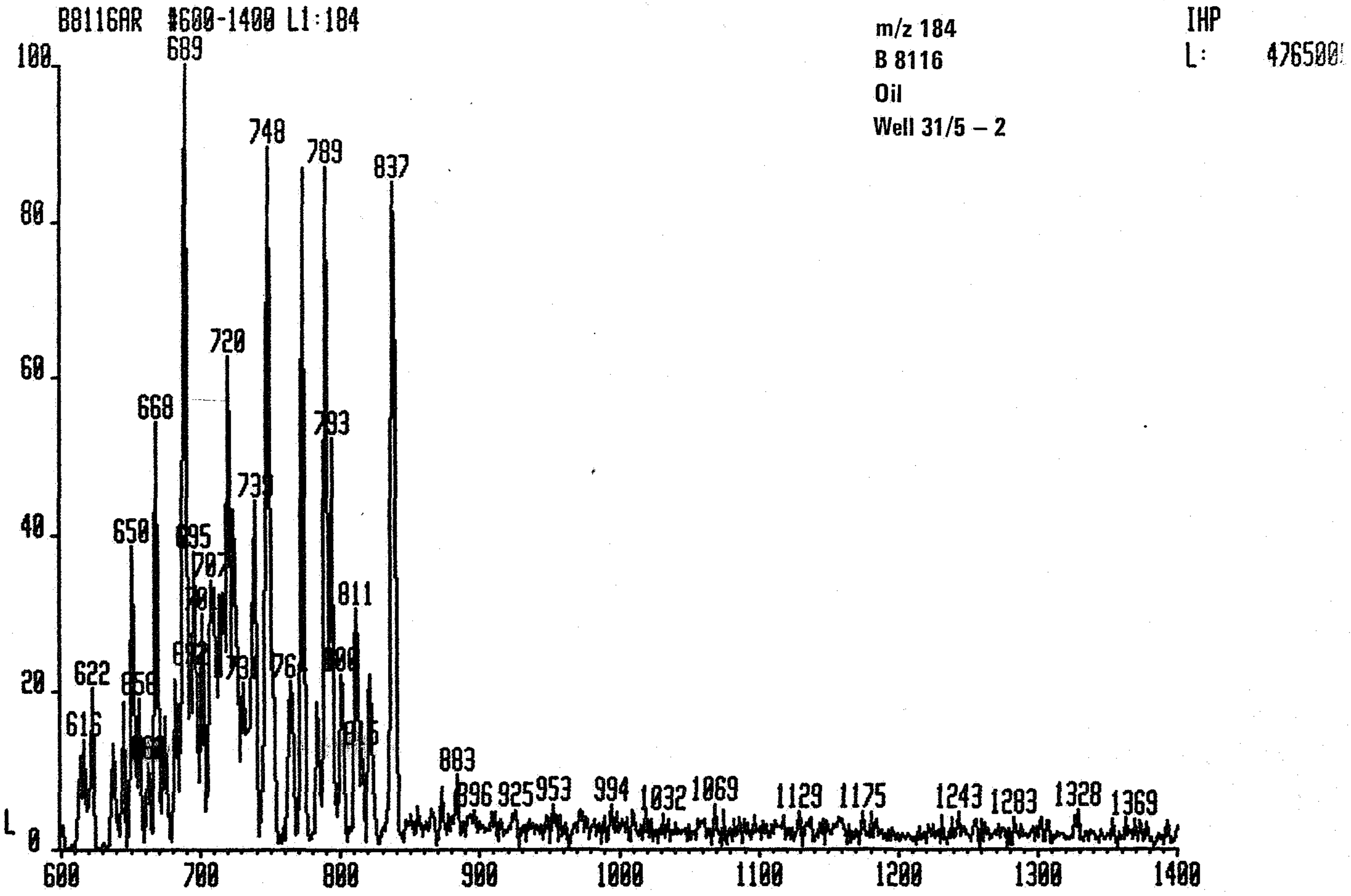
IKU

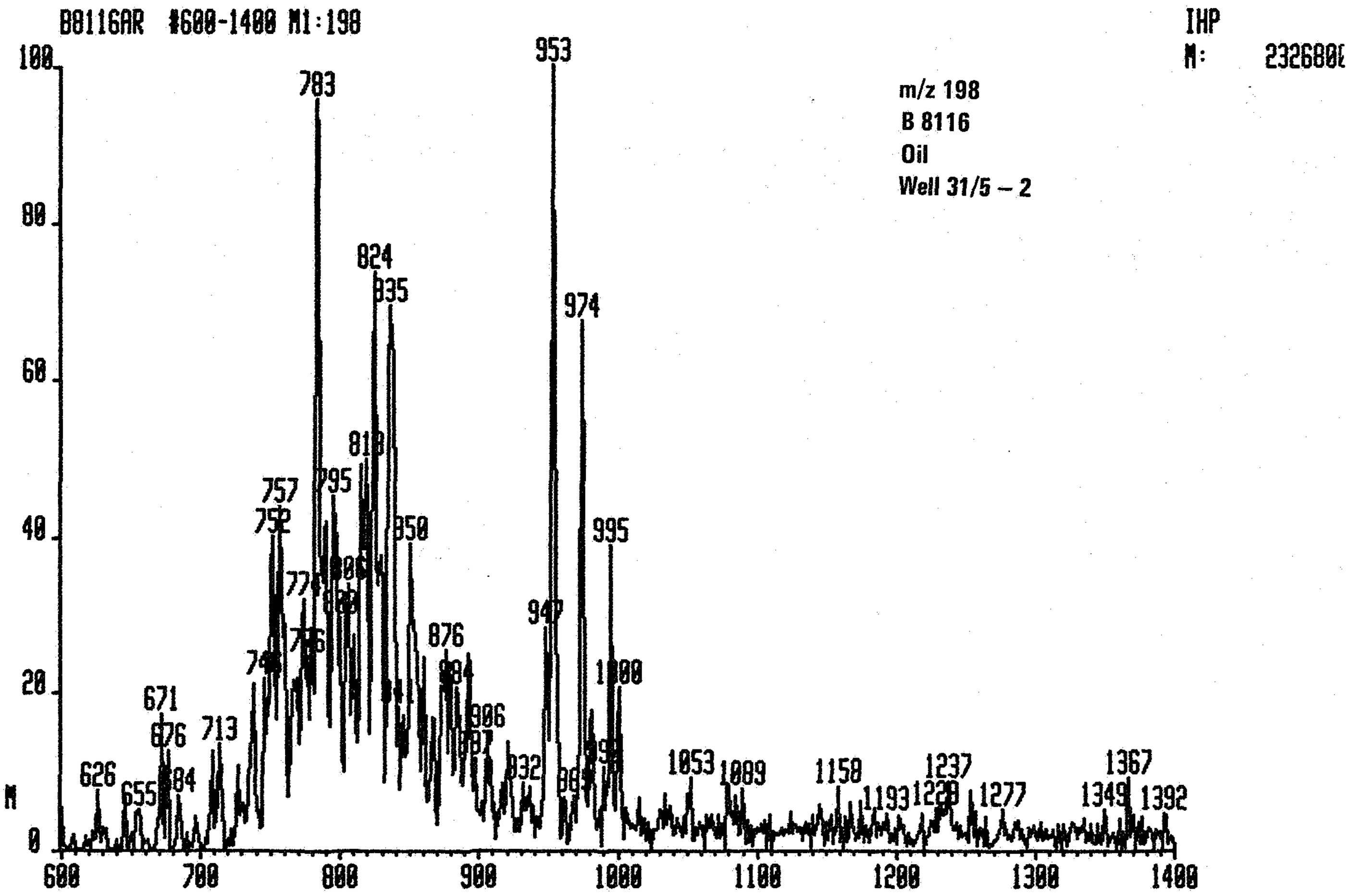

MN
DMN
TMN
B8116AR #200-1000 F1:142 G1:156 H1:170
m/z 142, 156, 170
B 8116
Oil
Well 31/5 – 2
IHP
F: 55513000
G: 35103000
H: 18837000
298
316
427
459
686
100
80
60
40
20
H
GF 0
200
300
400
500
600
700
800
900
1000

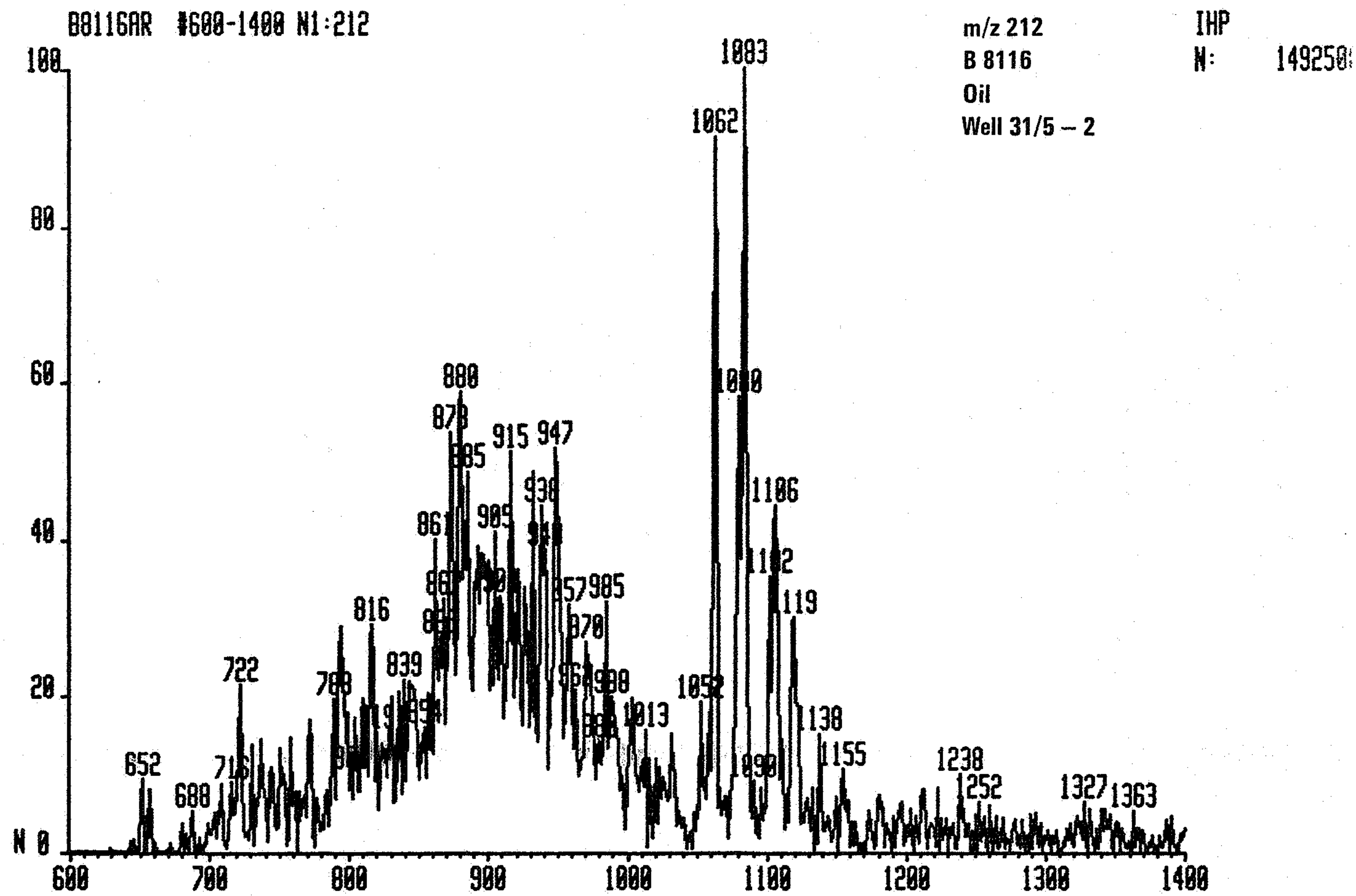
IKU


P
MP
DMP
B8116AR #600-1400 I1:178 J1:192 K1:206
869
796
923
904
949
1050
m/z 178, 192, 206
B 8116
Oil
Well 31/5 – 2
IHP
I: 1597500
J: 962000
K: 655340
100
80
60
40
20
0
600
700
800
900
1000
1100
1200
1300
1400

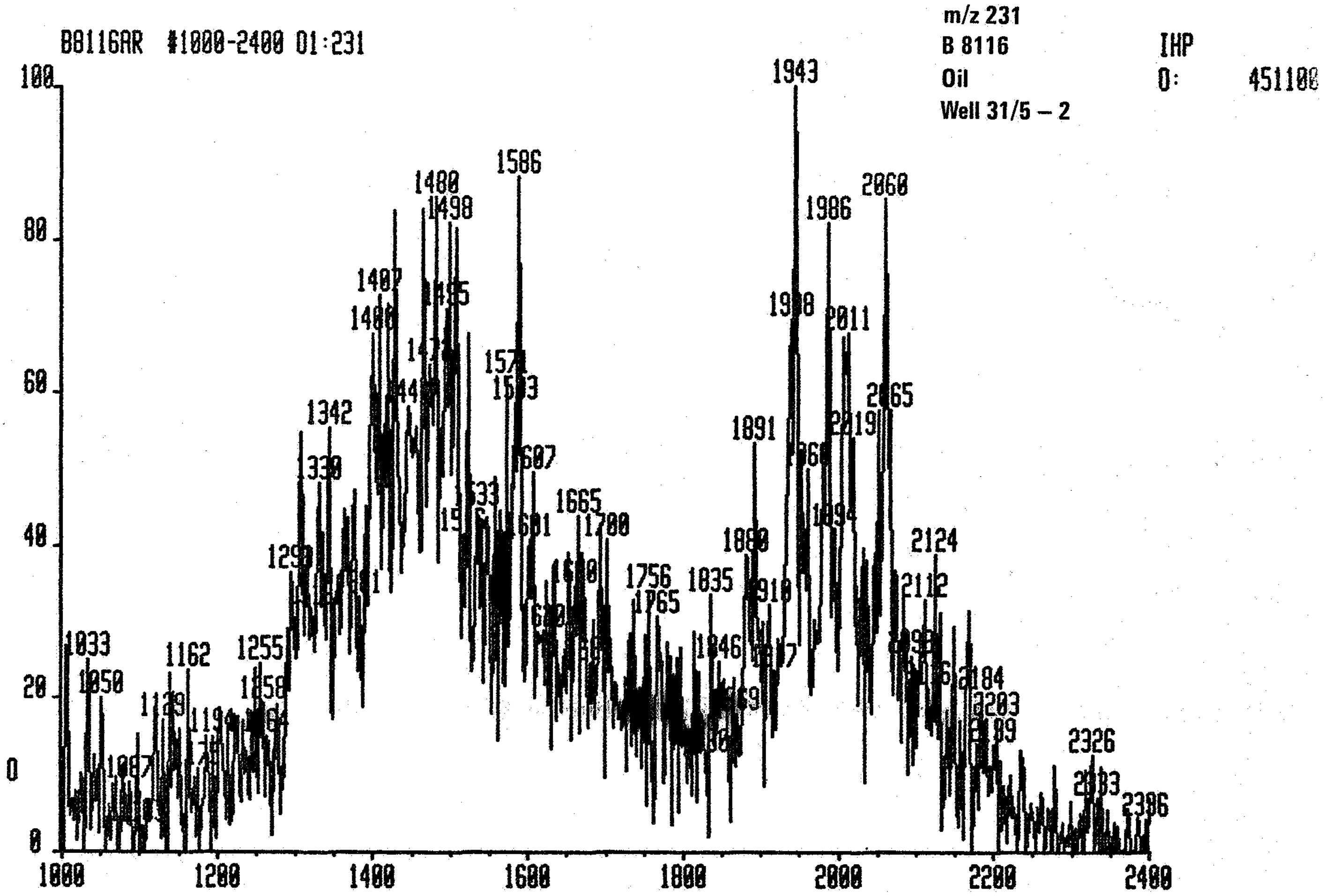
IKU

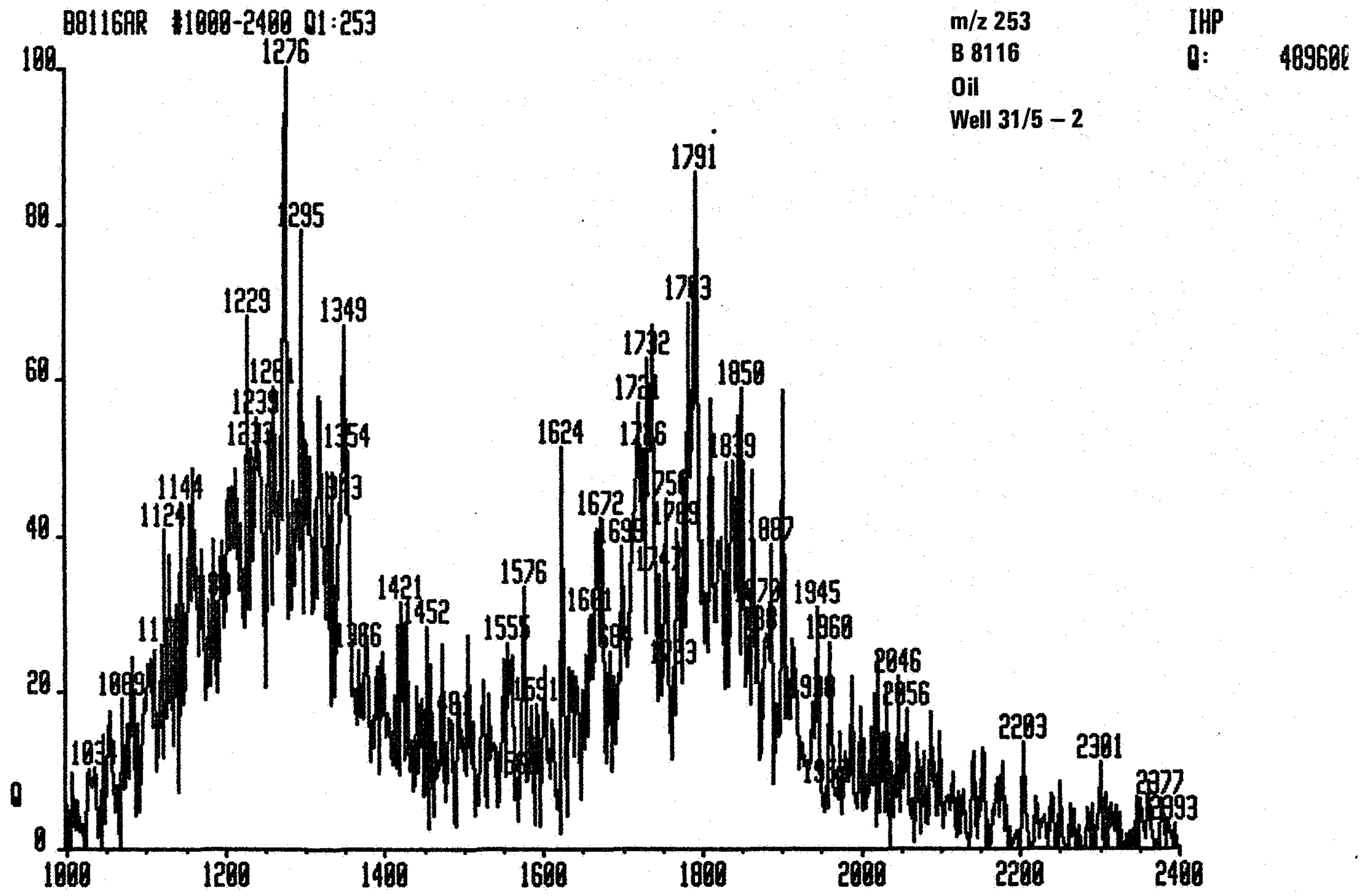

B8116AR #600-1400 L1:184
IHP
L: 476500
m/z 184
B 8116
Oil
Well 31/5 – 2
689
748
789
837
720
668
793
739
650
695
707
811
622
616
883
896 925 953 994 1032 1069 1129 1175 1243 1283 1328 1369
100
80
60
40
20
0
L
600 700 800 900 1000 1100 1200 1300 1400


B8116AR #600-1400 M1:198
IHP
M: 232680
m/z 198
B 8116
Oil
Well 31/5 – 2
953
783
824
835
974
757
752
795
850
995
947
876
671
676
713
626
655
684
906
932
1053 1089
1158
1193
1237
1277
1367
1349 1392
100
80
60
40
20
0
M
600 700 800 900 1000 1100 1200 1300 1400

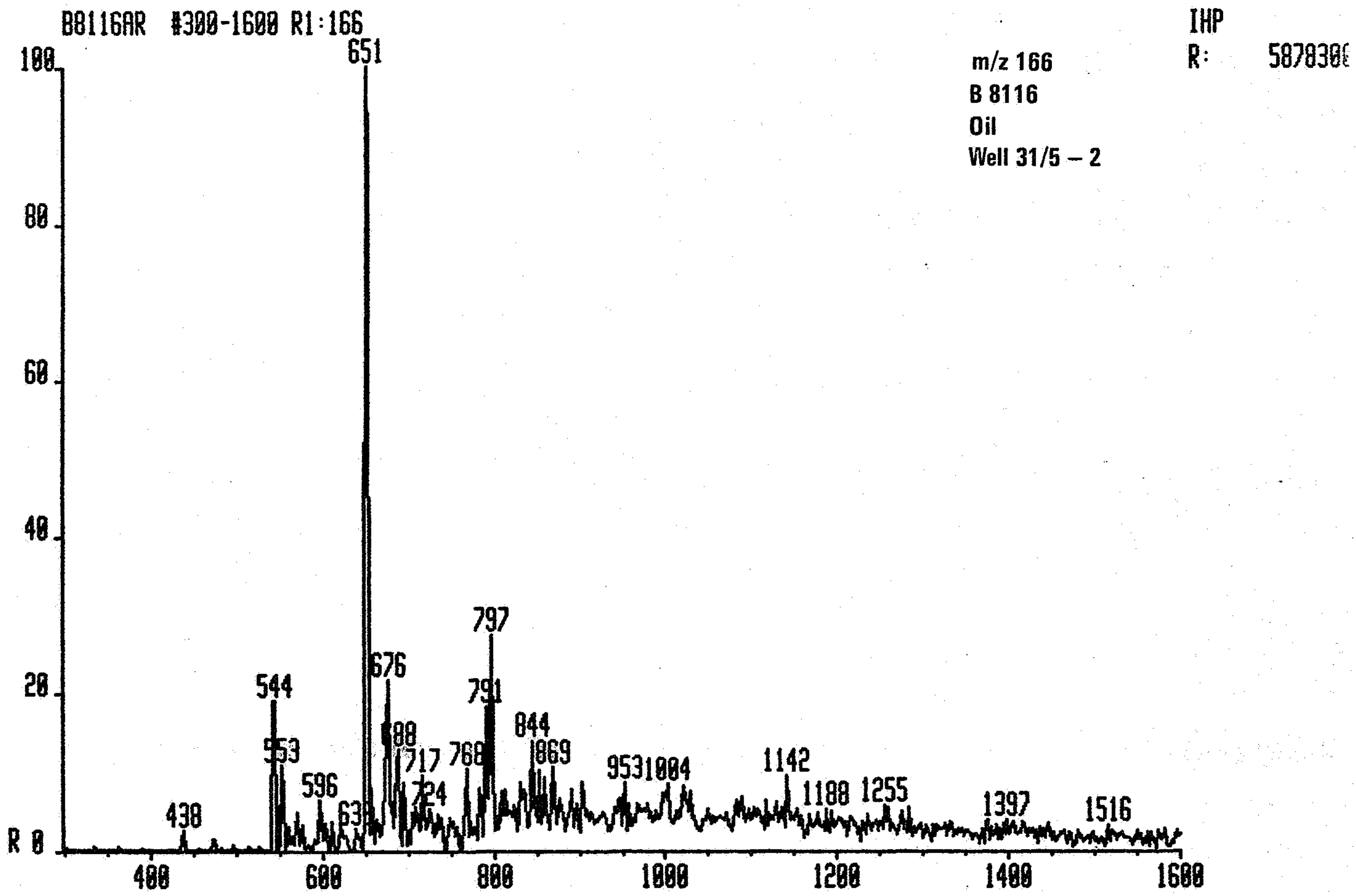

B8116AR #600-1400 N1:212
m/z 212
B 8116
Oil
Well 31/5 – 2
IHP
N: 149250
1083
1062
880
915
947
1106
816
722
652
688
1052
1138
1155
1238
1252
1327
1363
1013

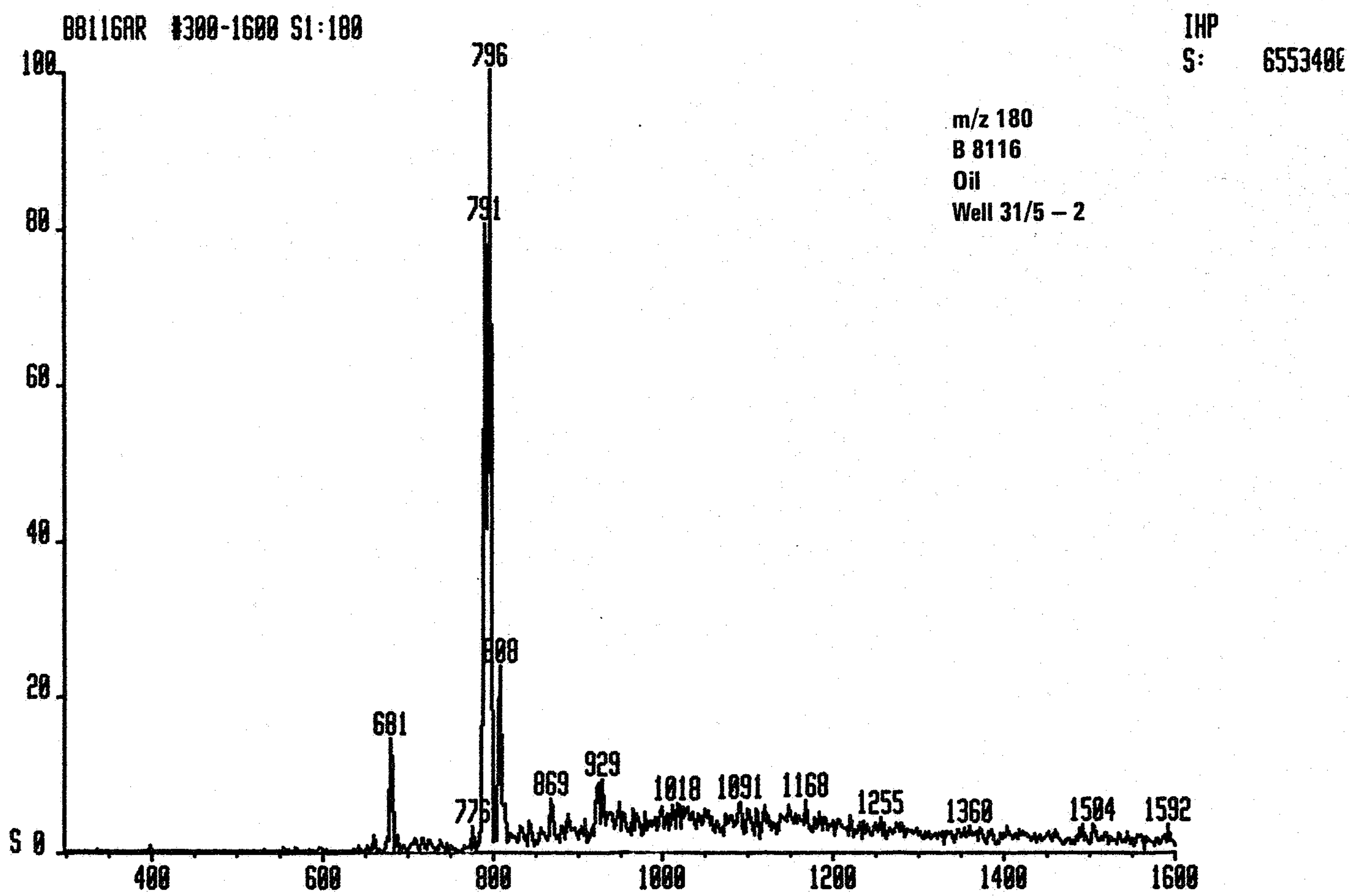
IKU


B8116AR #1000-2400 01:231
m/z 231
B 8116
Oil
Well 31/5 – 2
IHP
0: 451100

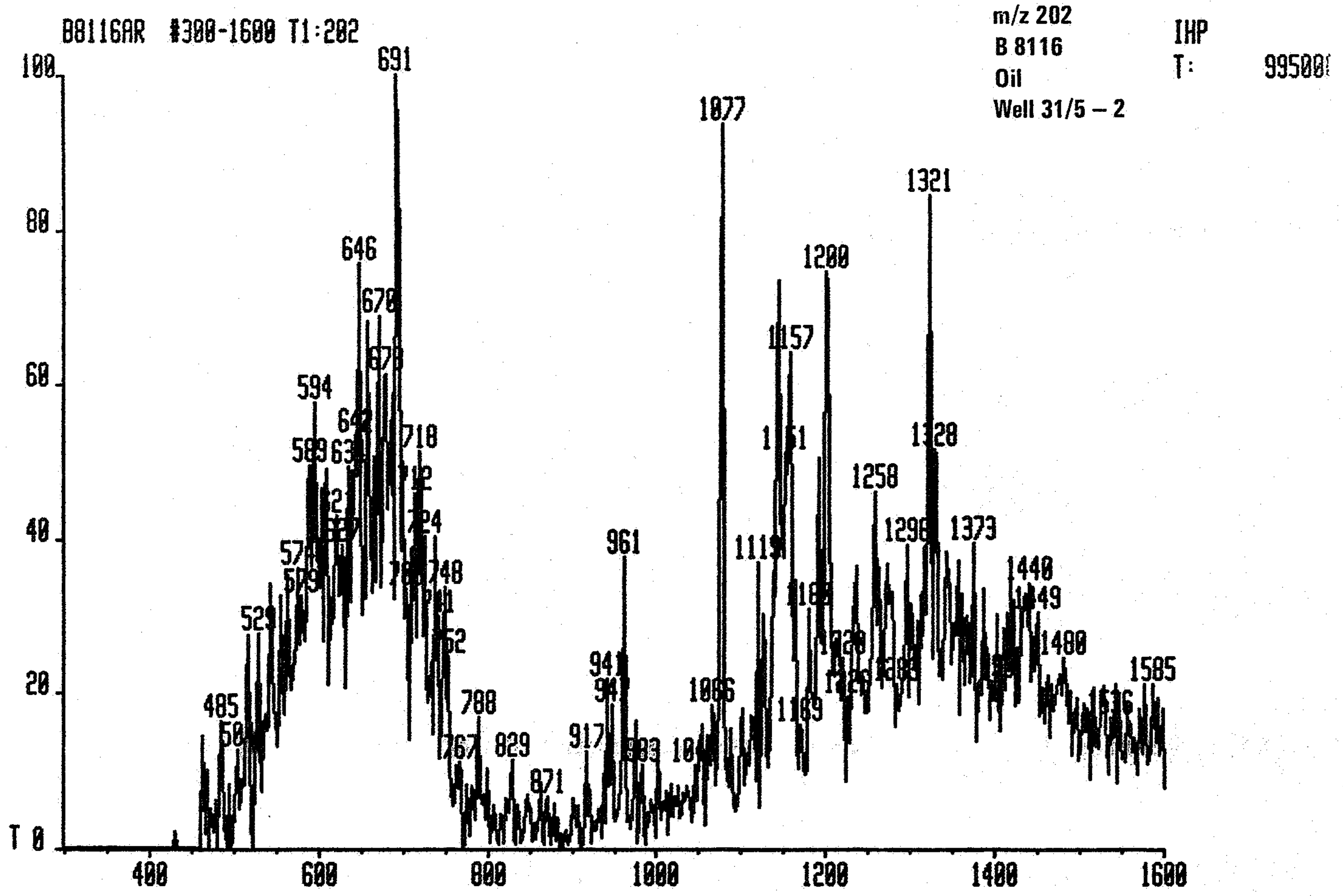

B8116AR #1000-2400 01:253
m/z 253
B 8116
Oil
Well 31/5 – 2
IHP
0: 409600

IKU


B8116AR #300-1600 R1:166
IHP
R: 5878300
m/z 166
B 8116
Oil
Well 31/5 – 2
651
797
676
544
791
844
553
717
768
869
953
1004
1142
596
724
1188
1255
438
1397
1516
R 0
400
600
800
1000
1200
1400
1600


B8116AR #300-1600 S1:180
IHP
S: 6553400
m/z 180
B 8116
Oil
Well 31/5 – 2
796
791
808
681
929
869
1018
1091
1168
1255
1360
1504
1592
776
S 0
400
600
800
1000
1200
1400
1600

IKU


B8116AR #300-1600 T1:202
m/z 202
B 8116
Oil
Well 31/5 – 2
IHP
T: 99500
100
80
60
40
20
T 0
691
1077
1321
1200
646
670
1157
594
718
1258
1373
961
1440
1480
1585
788
829
871
917
1066
400
600
800
1000
1200
1400
1600

IKU

Visual Kerogen Analysis

TABLE NO.: 9.
WELL NO.: 31/5-2

Sample	Depth (m)	Composition of residue	Particle size	Preservation palynomorphs	Thermal maturation index	Remarks
B-580	2052	C,W,WR!,Cut,S,P/Am,Cy Algal	F-M	good	1/1+,2-,2/2,2+	Abundant pyritic, coaly fragments and sapropelised woody fragments Botryococcus. Variable colouring.
B-583	2079	W,Cut,C,S,P/Am	F-M-L	good	1/1+, 2/2+	Abundant structured woody material and variably coloured spores.
B-587	2115	Cut,P,S,W,WR!/Am	F-M-L	good	1/1+, 2-/2, 2	Screening enriches particularly woody structured material Chasmatosporites.
B-591	2151	Cut,W,P,S,WR!/Am,Cy	F-M-L	good	1/1+	Tyttodiscus, Tasmanites, Nannoceratopsis gracilis.

ABBREVATIONS

Am	Amorphous	Cy	Cysts, algae	W	Woody material	F	Fine
He	Herbaceous	P	Pollen grains	C	Coal	M	Medium
Cut	Cuticles	S	Spores	R!	Reworked	L	Large

114/D/jbl/5

IKU

Visual Kerogen Analysis

TABLE NO.: 9.
WELL NO.: 31/5-2

Sample	Depth (m)	Composition of residue	Particle size	Preservation palynomorphs	Thermal maturation index	Remarks
B-595	2187	C,W,Cut,P,S/Am,Cy	F-M-L	good	1/1+	Callialasporites present in the ass. described above.
B-598	2214	C,Cut,P,S,W/Am		good	1+/2-, 2-	Pyritic residue, coaly fragments. Large very well preserved cuticles.

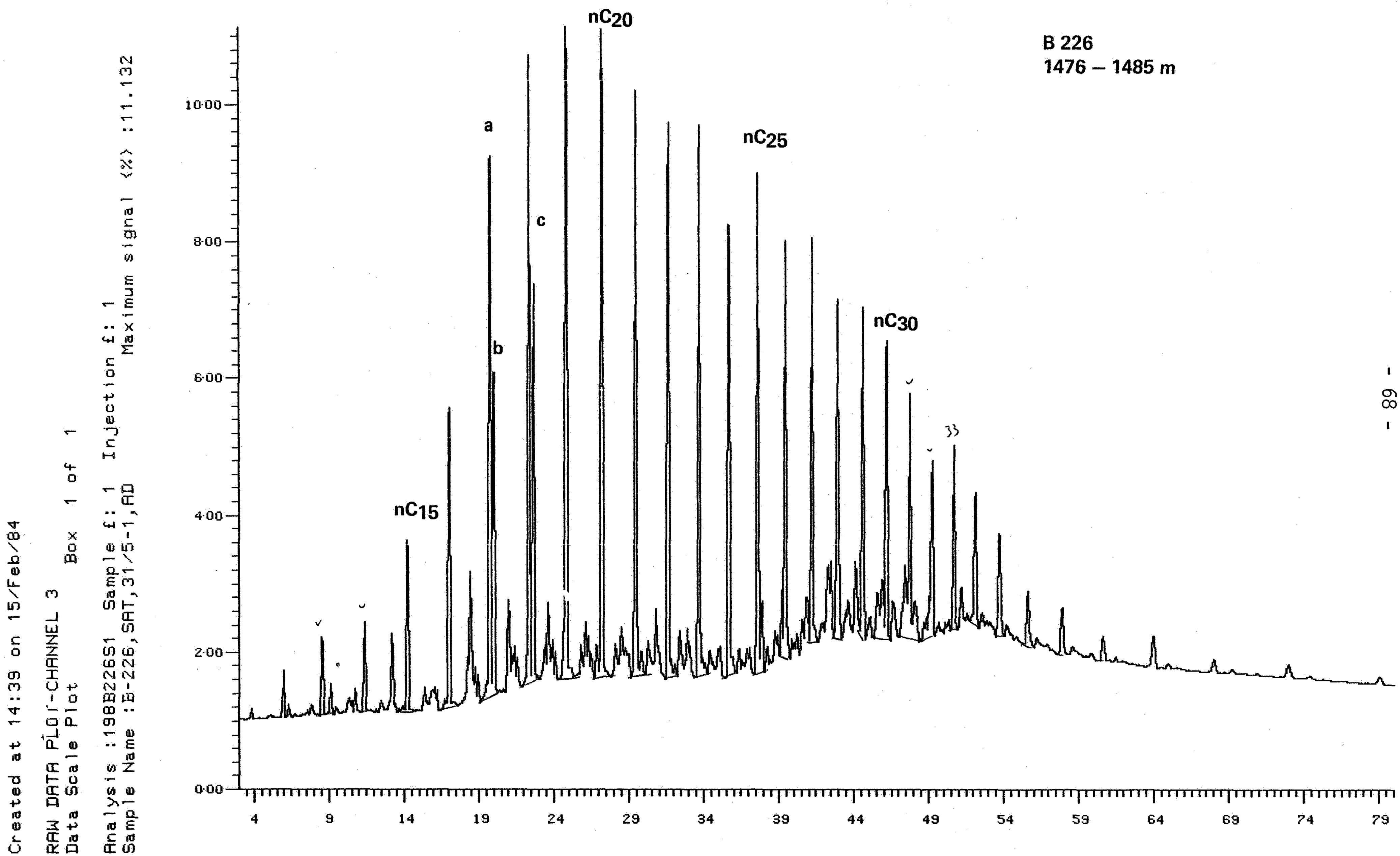
ABBREVATIONS

Am	Amorphous	Cy	Cysts, algae	W	Woody material	F	Fine
He	Herbaceous	P	Pollen grains	C	Coal	M	Medium
Cut	Cuticles	S	Spores	R!	Reworked	L	Large

FIGURE 1

Saturated hydrocarbon gas chromatograms

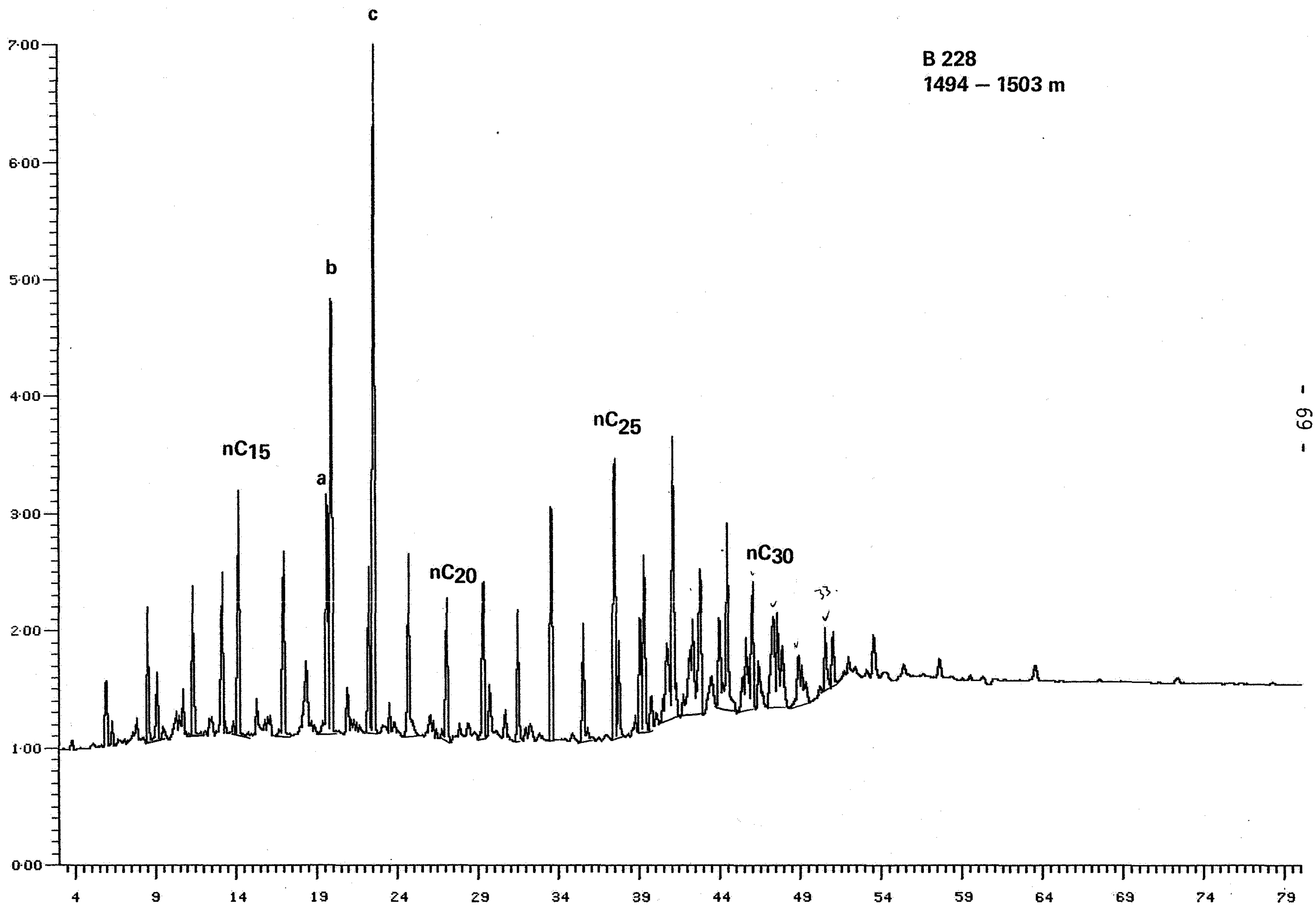
a	=	nC_{17}
b	=	pristane
c	=	phytane
nC_{15} etc.	=	n-alkane of that number
X	=	contaminants
Sq	=	squalane

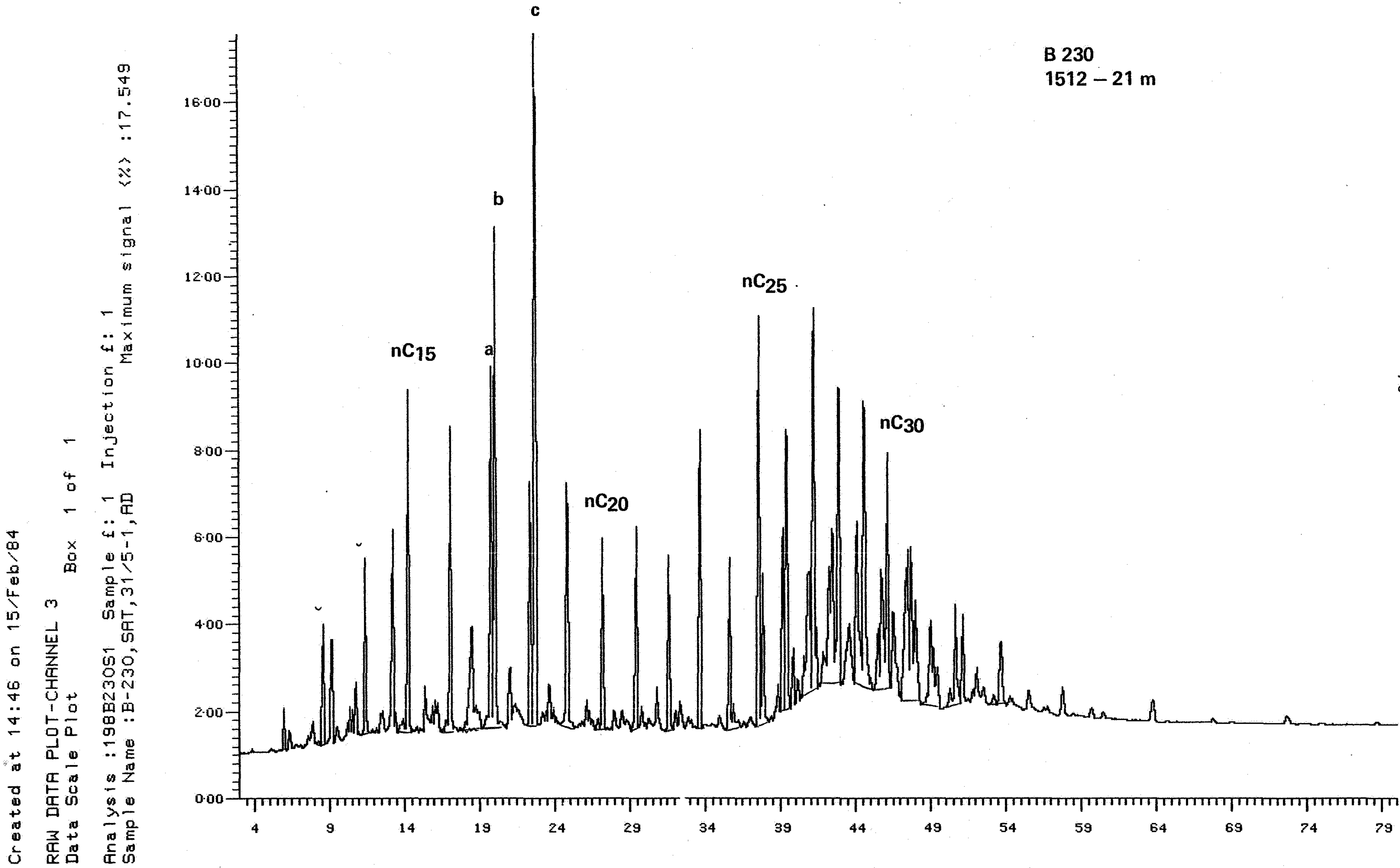

Created at 14:39 on 15/Feb/84
RAW DATA PLOT-CHANNEL 3
Data Scale Plot
Box 1 of 1
Analysis :198B22651 Sample £: 1 Injection £: 1
Sample Name :B-226,SAT,31/5-1,AD
Maximum signal (%) :11.132
B 226
1476 – 1485 m
nC15
nC20
nC25
nC30
a
b
c
33
0·00
2·00
4·00
6·00
8·00
10·00
4 9 14 19 24 29 34 39 44 49 54 59 64 69 74 79

Created at 14:43 on 15/Feb/84

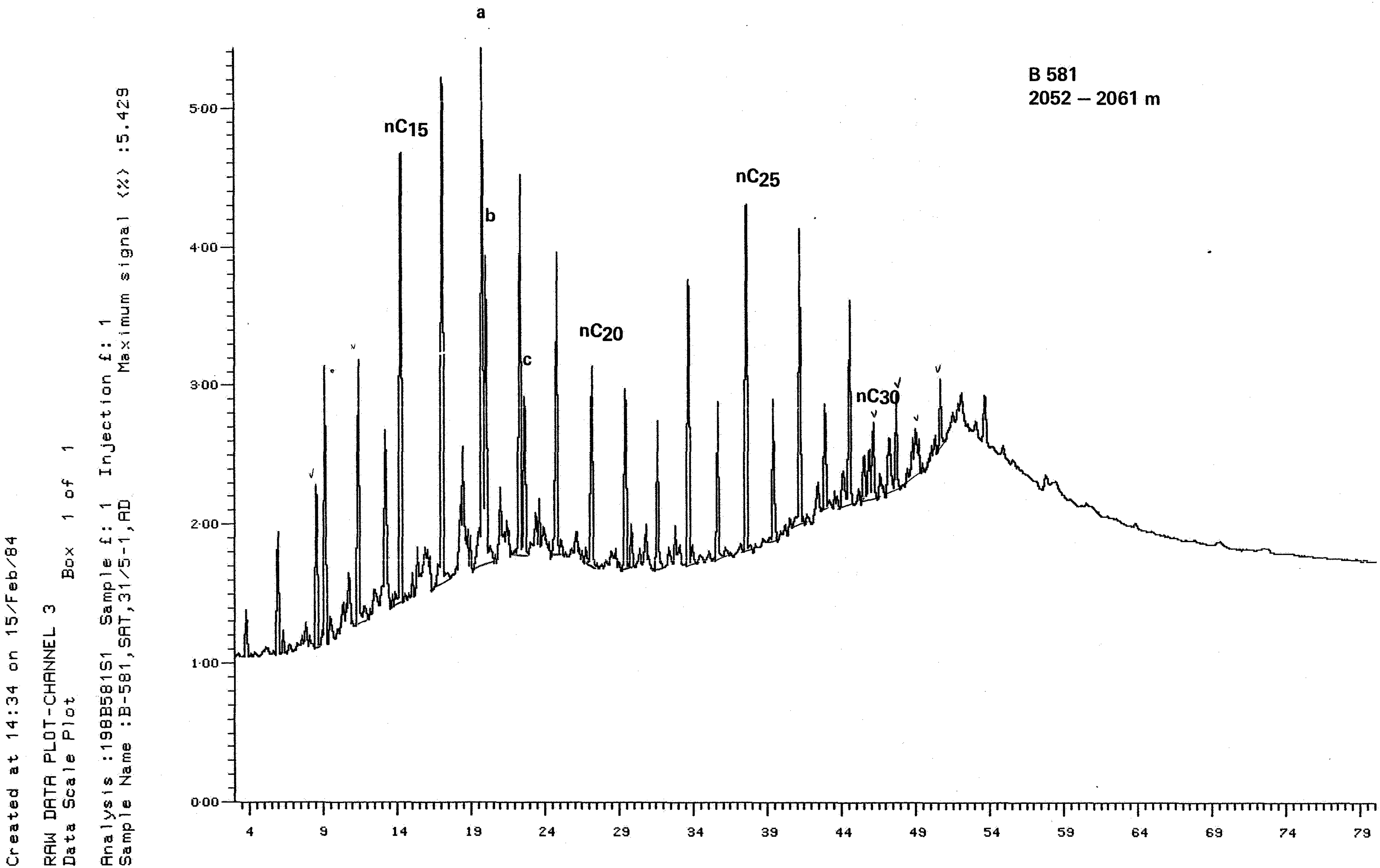
RAW DATA PLOT-CHANNEL 3
Data Scale Plot Box 1 of 1

Analysis :198B22851 Sample £: 1 Injection £: 1
Sample Name :B-228,SAT,31/5-1,AD Maximum signal (%) :7.003





B 230
1512 – 21 m
c
b
a
nC15
nC20
nC25
nC30
16·00
14·00
12·00
10·00
8·00
6·00
4·00
2·00
0·00
4
9
14
19
24
29
34
39
44
49
54
59
64
69
74
79
Created at 14:46 on 15/Feb/84
RAW DATA PLOT-CHANNEL 3
Data Scale Plot Box 1 of 1
Analysis :198B230S1 Sample £: 1 Injection £: 1
Sample Name :B-230,SAT,31/5-1,AD Maximum signal (%) :17.549



Created at 14:34 on 15/Feb/84
RAW DATA PLOT-CHANNEL 3
Data Scale Plot
Box 1 of 1
Analysis :198B581S1 Sample £: 1 Injection £: 1
Sample Name :B-581,SAT,31/5-1,AD
Maximum signal (%) :5.429
B 581
2052 – 2061 m
a
b
c
nC15
nC20
nC25
nC30
5·00
4·00
3·00
2·00
1·00
0·00
4
9
14
19
24
29
34
39
44
49
54
59
64
69
74
79

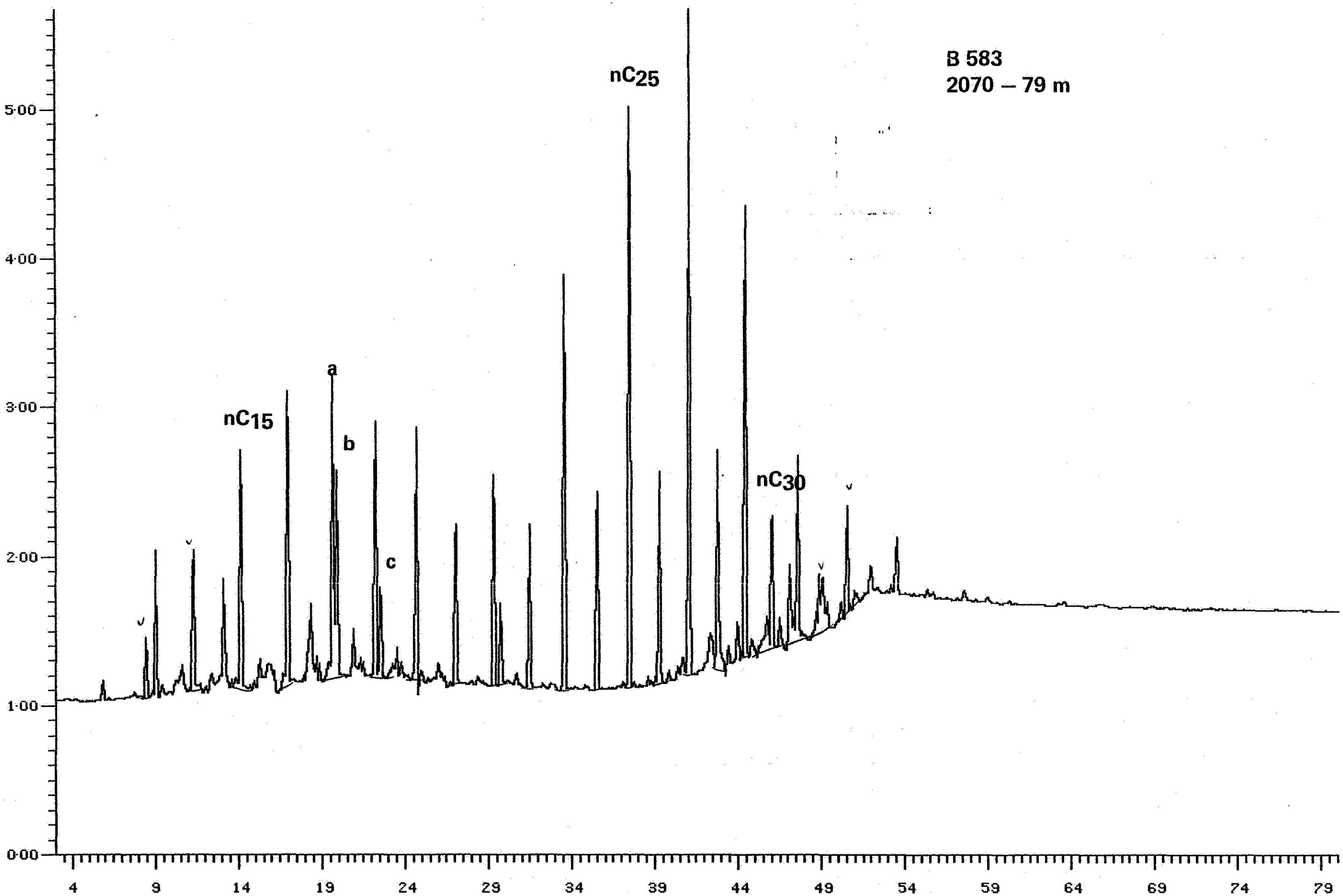
Created at 14:51 on 15/Feb/84

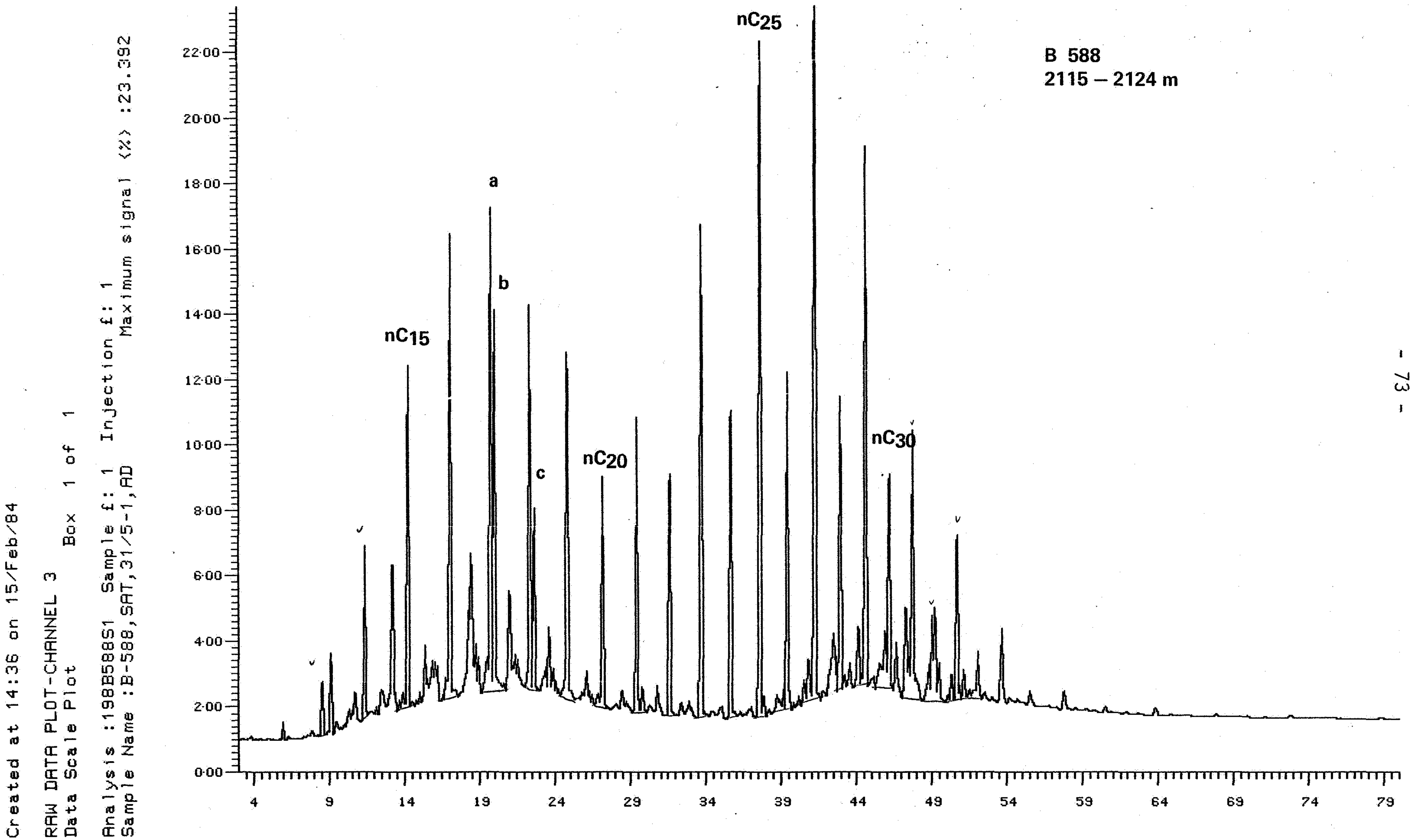
RAW DATA PLOT-CHANNEL 3

Data Scale Plot Box 1 of 1

Analysis :198B583S1 Sample £: 1 Injection £: 1

Sample Name :B-583,SAT,31/5-1,AD Maximum signal (%) :5.669

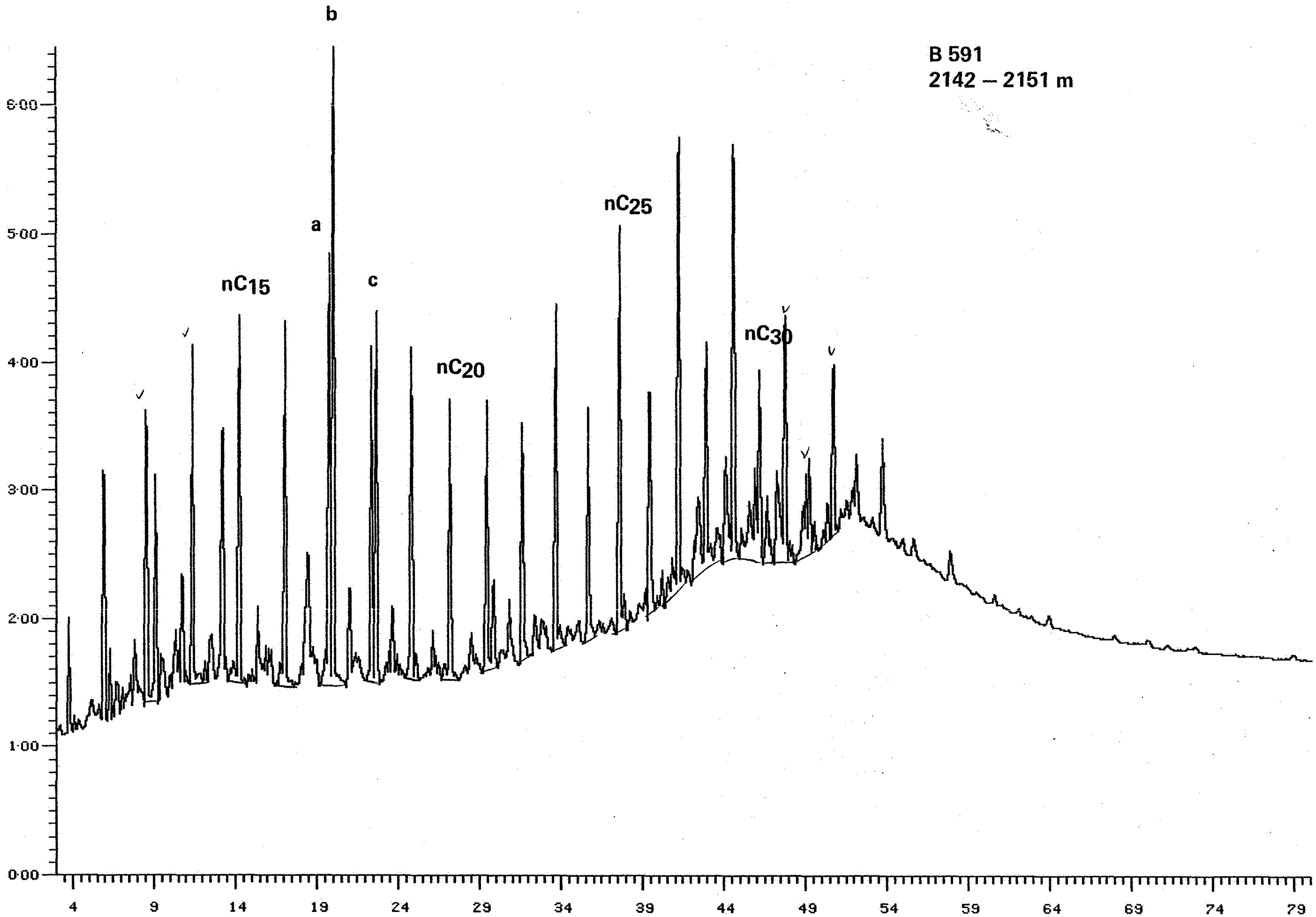



Created at 14:36 on 15/Feb/84
RAW DATA PLOT-CHANNEL 3
Data Scale Plot
Box 1 of 1
Analysis :198B588S1 Sample £: 1 Injection £: 1
Sample Name :B-588,SAT,31/5-1,AD
Maximum signal (%) :23.392
B 588
2115 – 2124 m
nC15
nC20
nC25
nC30
a
b
c
22.00
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
4
9
14
19
24
29
34
39
44
49
54
59
64
69
74
79

Created at 14:48 on 15/Feb/84

RAW DATA PLOT-CHANNEL 3
Data Scale Plot Box 1 of 1

Analysis :198B591S1 Sample £: 1 Injection £: 1
Sample Name :B-591,SAT,31/5-1,AD Maximum signal (%) :6.450

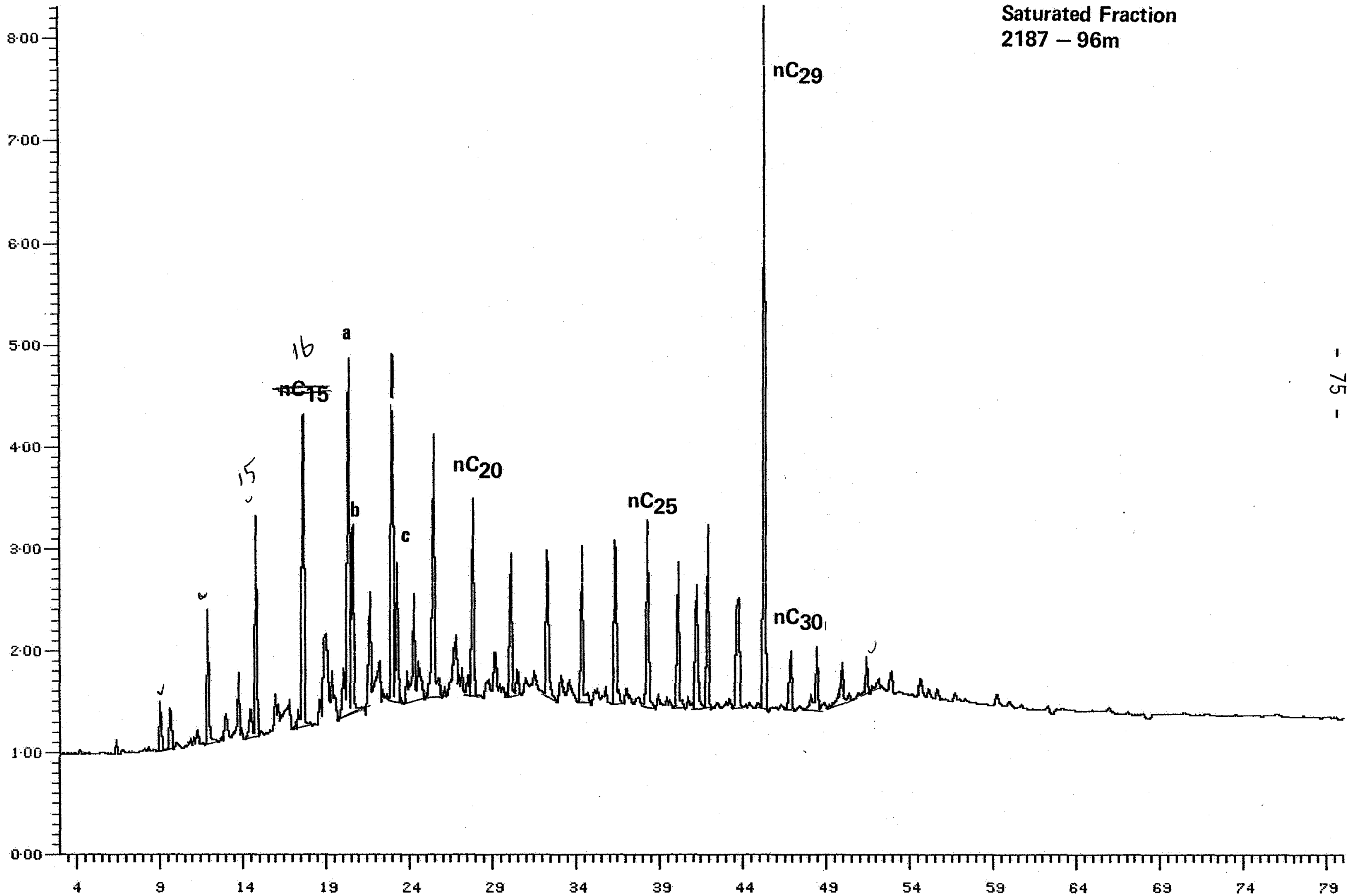


Created at 13:37 on 24/Feb/84

RAW DATA PLOT-CHANNEL 3
Data Scale Plot   Box 1 of 1

Analysis :198B596S1   Sample £: 1   Injection £: 1
Sample Name :B-596,SAT,31/5-1,AD   Maximum signal (%) :8.315

B 596
Saturated Fraction
2187 – 96m



Created at 08:40 on 15/Feb/84

RAW DATA PLOT-CHANNEL 3
Data Scale Plot   Box 1 of 1

Analysis :198B598S1   Sample £: 1   Injection £: 1
Sample Name :B-598,SAT,31/5-1,AD   Maximum signal (%) :3.605

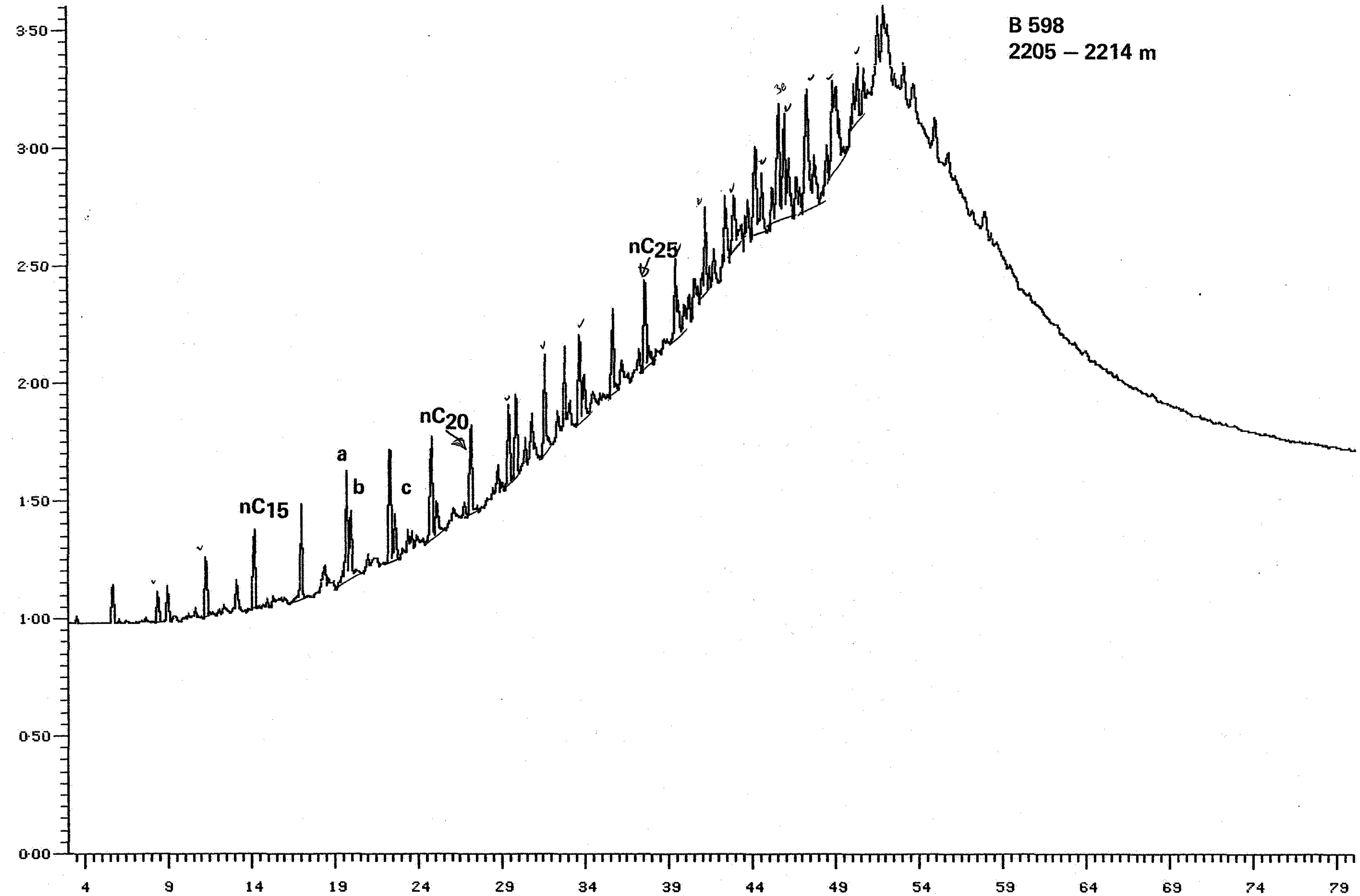


FIGURE 2

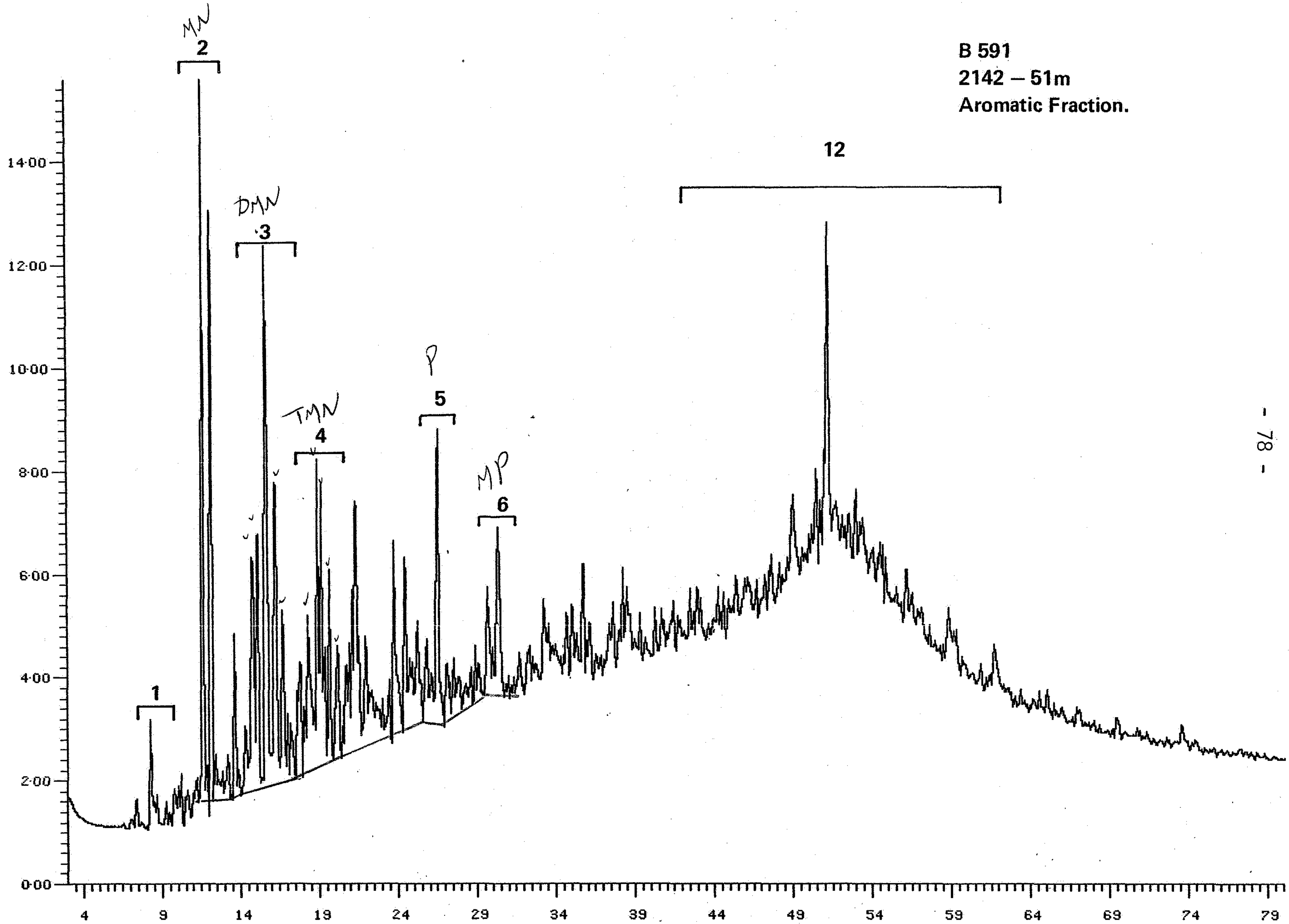
Aromatic hydrocarbon gas chromatograms

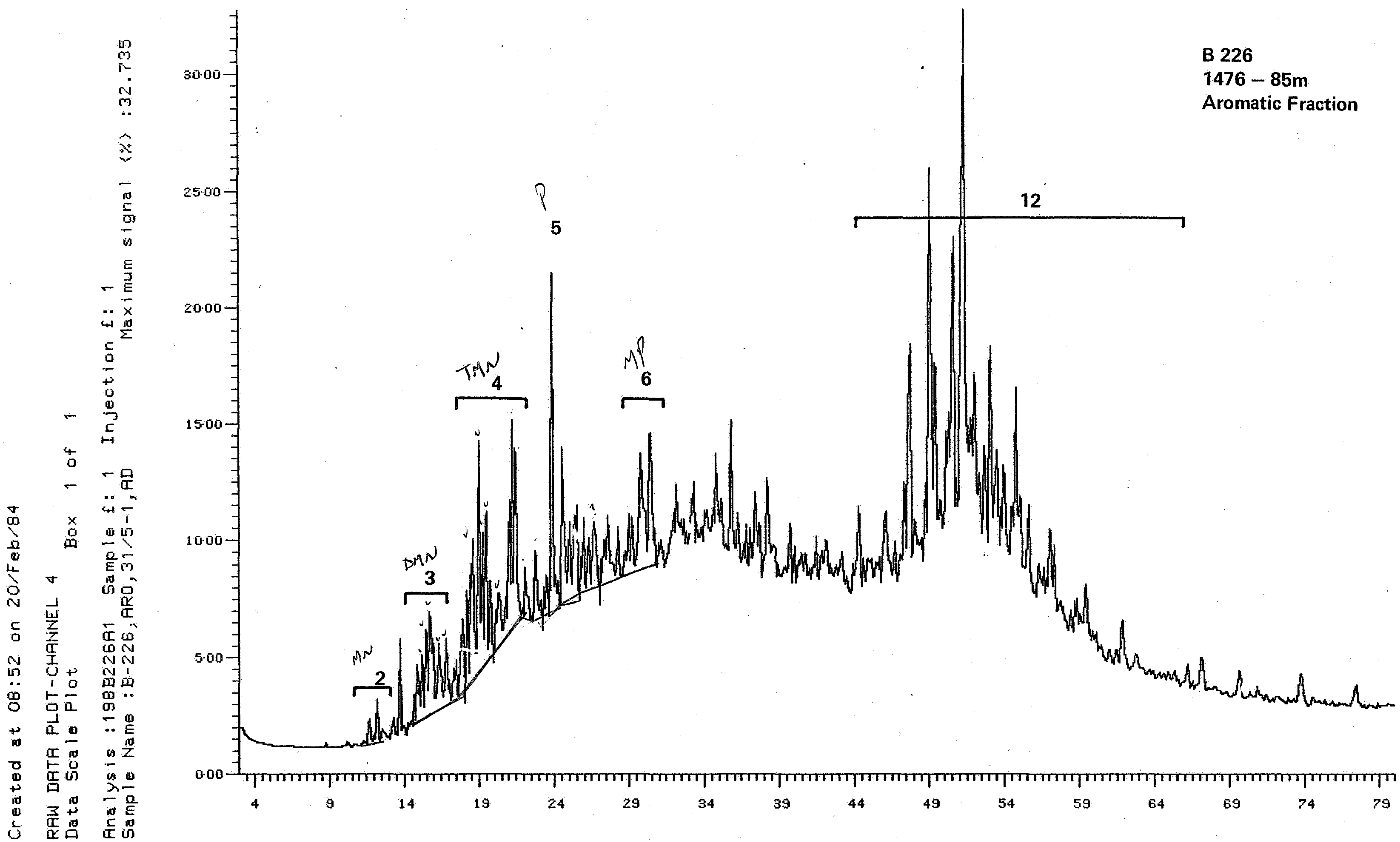
1 = naphthalene
2 = methyl naphthalenes
3 = dimethyl naphthalenes
4 = trimethyl naphthalenes
5 = phenanthrene
6 = methyl phenanthrenes

Created at 08:44 on 20/Feb/84

RAW DATA PLOT-CHANNEL 4
Data Scale Plot   Box 1 of 1

Analysis :198B591A1   Sample £: 1   Injection £: 1
Sample Name :B-591,ARO,31/5-1,AD   Maximum signal (%) :15.595

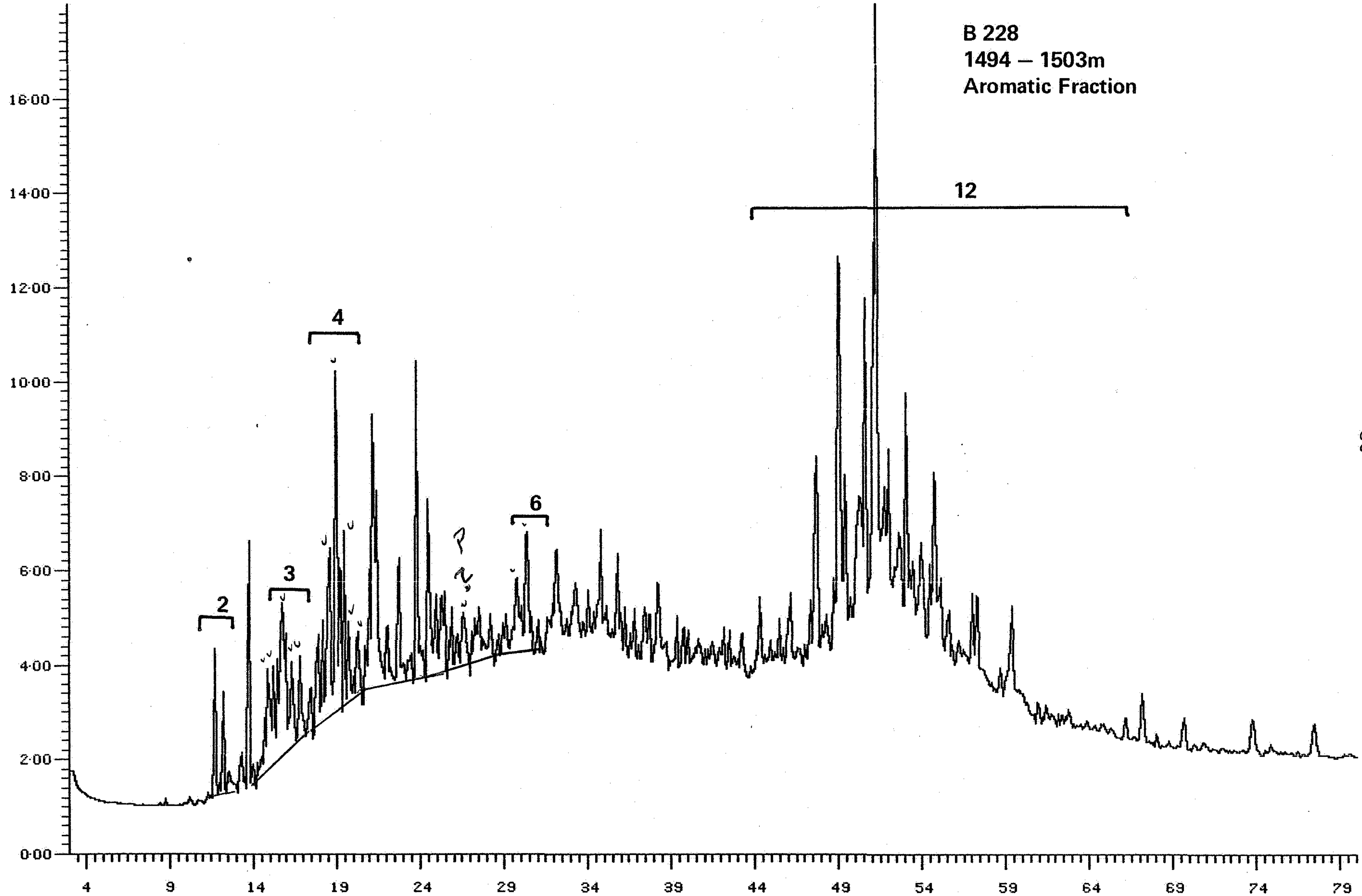



Created at 08:52 on 20/Feb/84
RAW DATA PLOT-CHANNEL 4
Data Scale Plot
Box 1 of 1
Analysis :198B226A1 Sample £: 1 Injection £: 1
Sample Name :B-226,ARO,31/5-1,AD
Maximum signal (%) :32.735
B 226
1476 – 85m
Aromatic Fraction
MN
2
DMN
3
TMN
4
P
5
MP
6
12
0·00
5·00
10·00
15·00
20·00
25·00
30·00
4
9
14
19
24
29
34
39
44
49
54
59
64
69
74
79

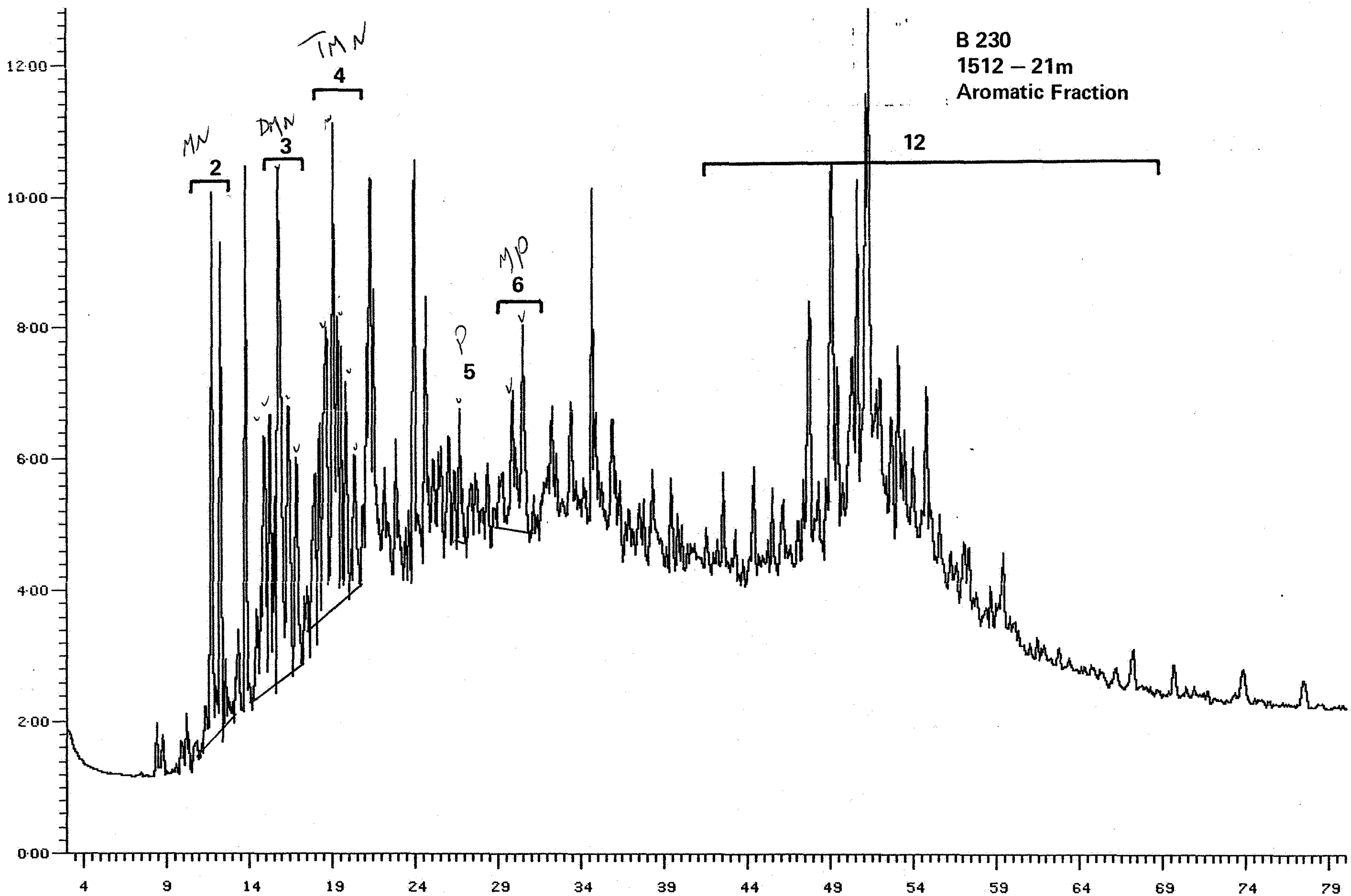
Created at 13:47 on 17/Feb/84

RAW DATA PLOT-CHANNEL 4
Data Scale Plot Box 1 of 1

Analysis :19BB228A1 Sample £: 1 Injection £: 1
Sample Name :B-228,ARO,31/5-1,AD Maximum signal (%) :17.999



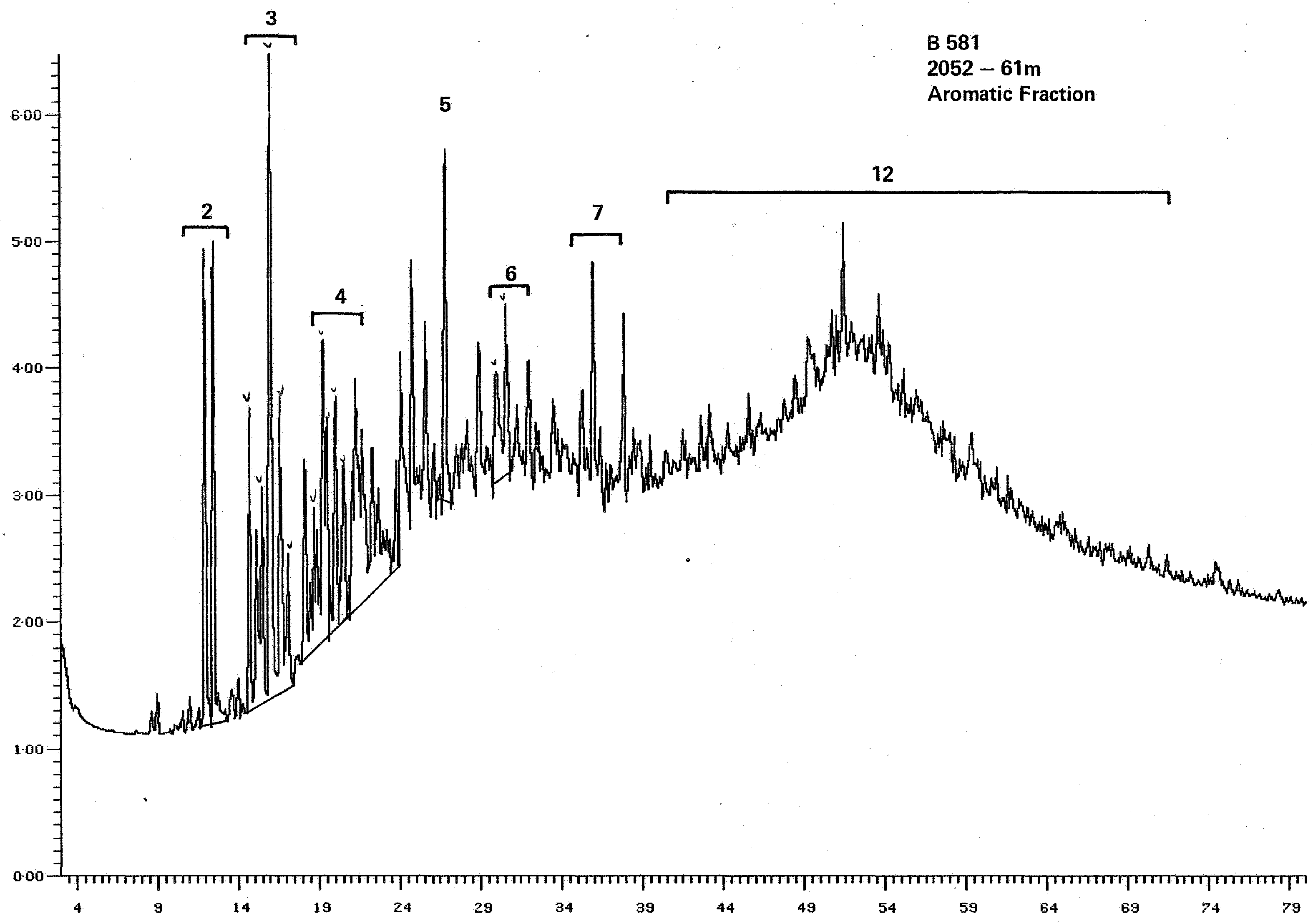
Created at 11:20 on 17/Feb/84
RAW DATA PLOT-CHANNEL 4
Data Scale Plot Box 1 of 1
Analysis :198B230A1 Sample £: 1 Injection £: 1
Sample Name :B-230,ARO,31/5-1,AD Maximum signal (%) :12.862

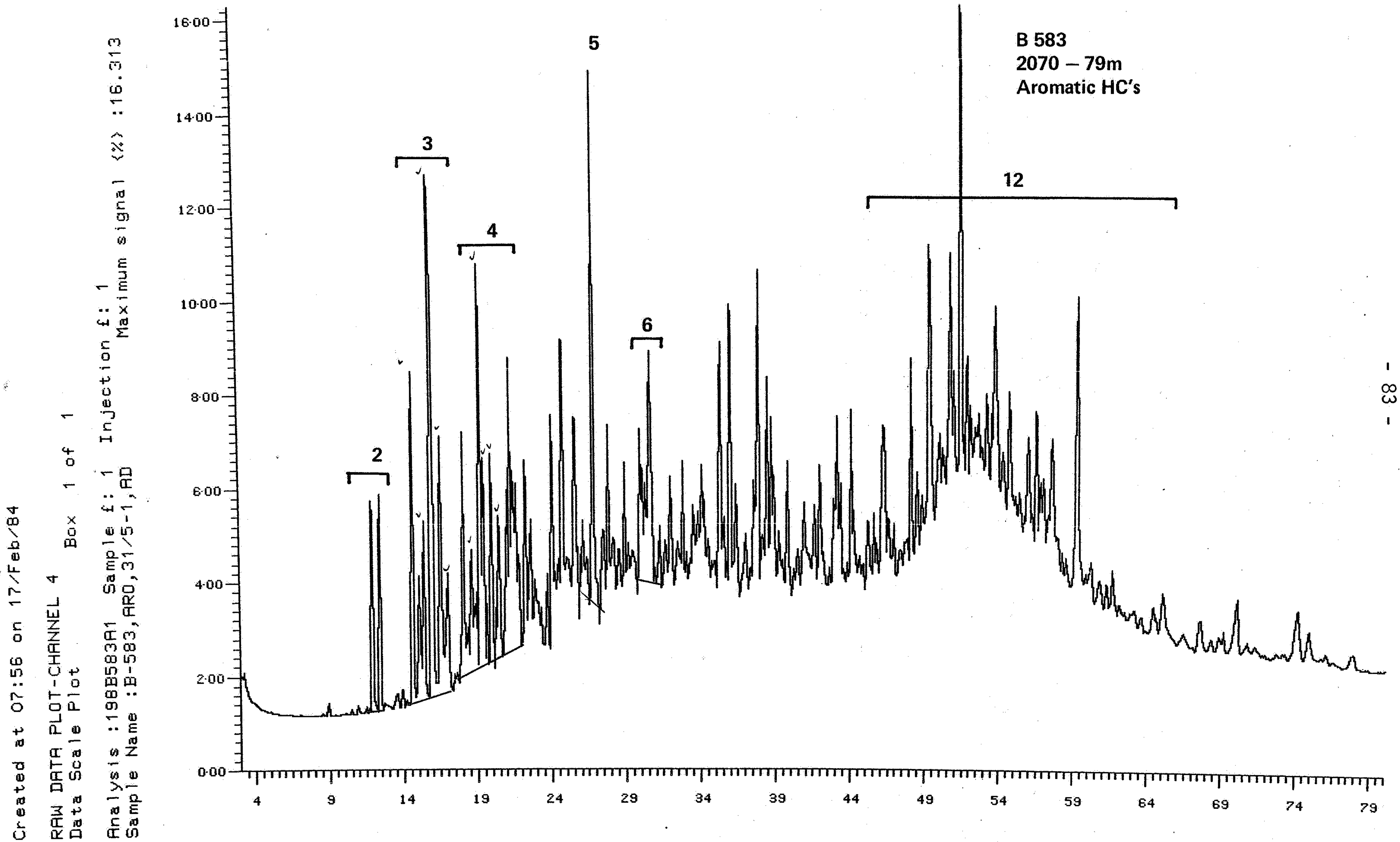


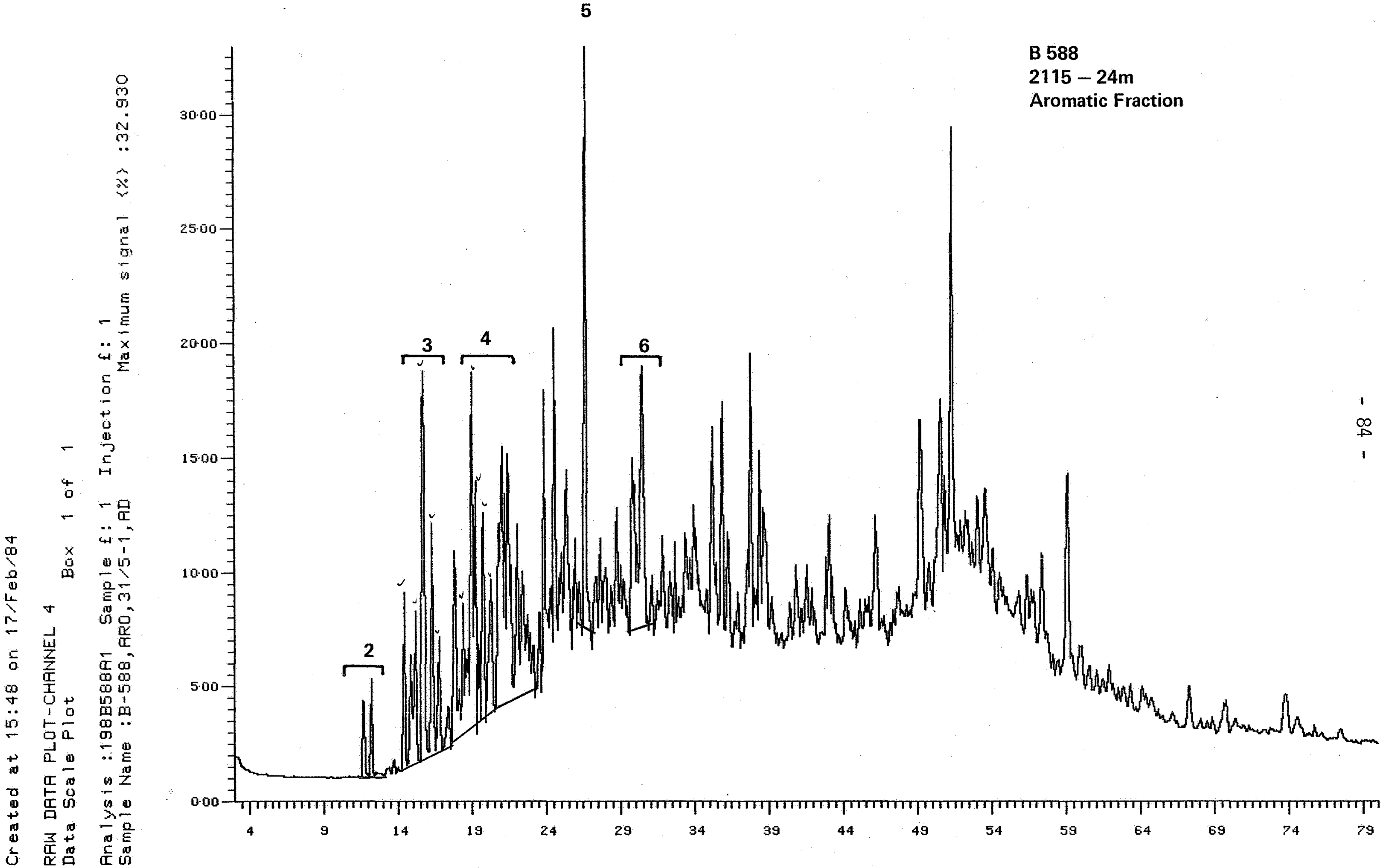
Created at 15:47 on 16/Feb/84

RAW DATA PLOT-CHANNEL 4
Data Scale Plot Box 1 of 1

Analysis :198B581A1 Sample £: 1 Injection £: 1
Sample Name :B-581,ARO,31/5-1,AD Maximum signal (%) :6.467



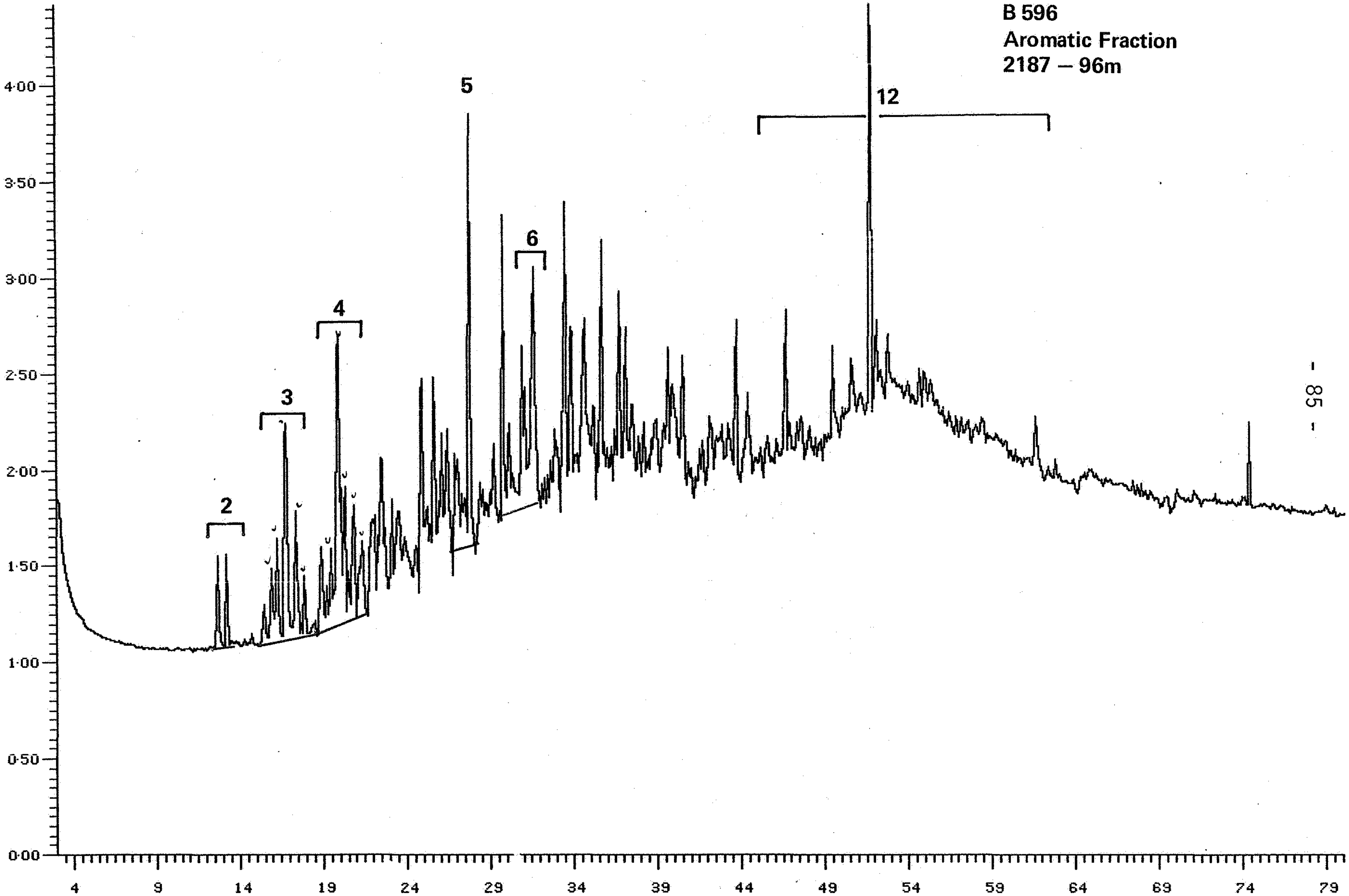

Created at 07:56 on 17/Feb/84
RAW DATA PLOT-CHANNEL 4
Box 1 of 1
Data Scale Plot
Analysis :198B583A1 Sample £: 1 Injection £: 1
Sample Name :B-583,ARO,31/5-1,AD
Maximum signal (%) :16.313
B 583
2070 – 79m
Aromatic HC's
2
3
4
5
6
12
16·00
14·00
12·00
10·00
8·00
6·00
4·00
2·00
0·00
4
9
14
19
24
29
34
39
44
49
54
59
64
69
74
79


Created at 15:48 on 17/Feb/84
RAW DATA PLOT-CHANNEL 4
Data Scale Plot
Box 1 of 1
Analysis :198B588A1 Sample £: 1 Injection £: 1
Sample Name :B-588,ARO,31/5-1,AD
Maximum signal (%) :32.930
B 588
2115 – 24m
Aromatic Fraction
2
3
4
5
6
0·00
5·00
10·00
15·00
20·00
25·00
30·00
4 9 14 19 24 29 34 39 44 49 54 59 64 69 74 79

Created at 13:34 on 24/Feb/84

RAW DATA PLOT-CHANNEL 4 Box 1 of 1
Data Scale Plot

Analysis :198B596A1 Sample f: 1 Injection f: 1
Sample Name :B-596,ARO,31/5-1,AD Maximum signal (%) :4.420



Created at 08:56 on 20/Feb/84

RAW DATA PLOT-CHANNEL 4 Box 1 of 1
Data Scale Plot

Analysis :198B598A1 Sample £: 1 Injection £: 1
Sample Name :B-598,ARO,31/2-1,AD Maximum signal (%) :6.496

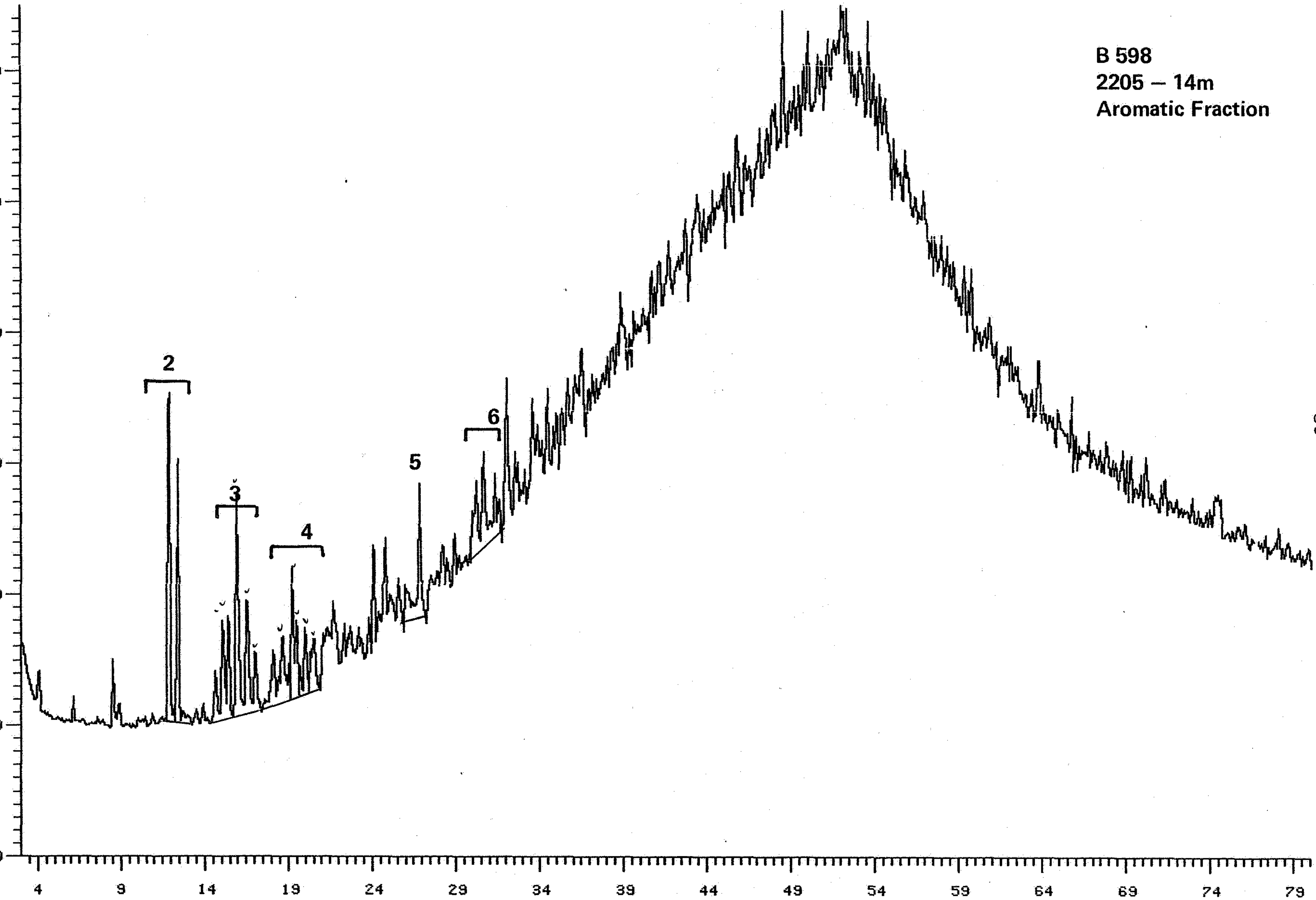
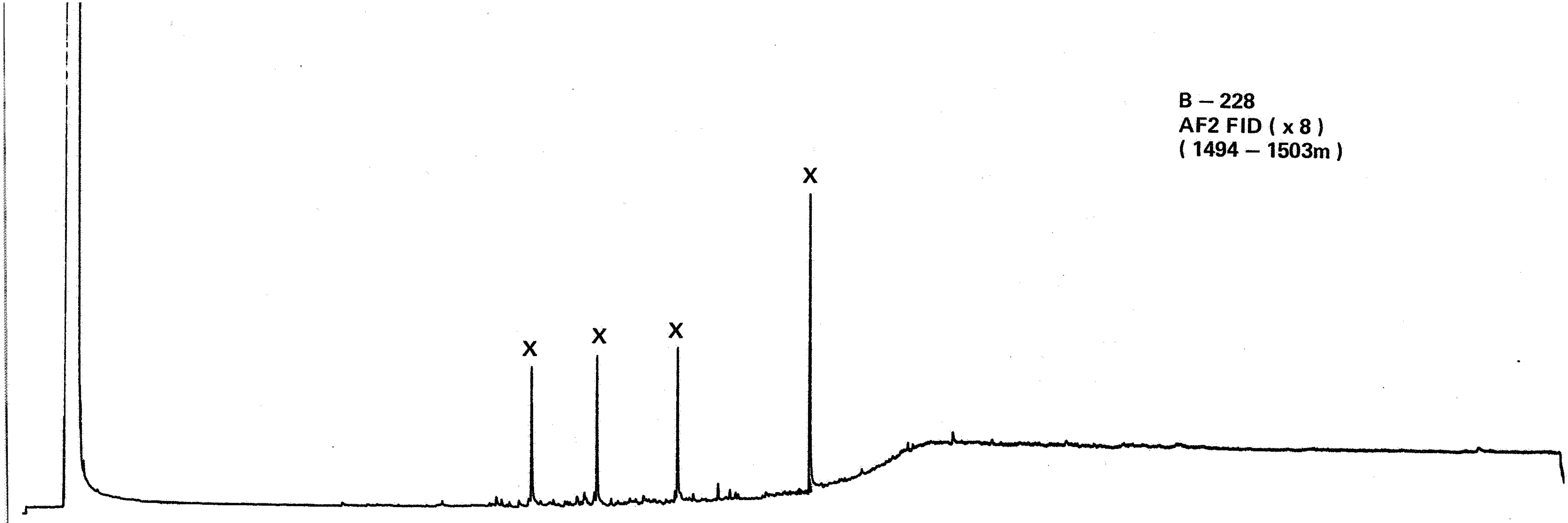
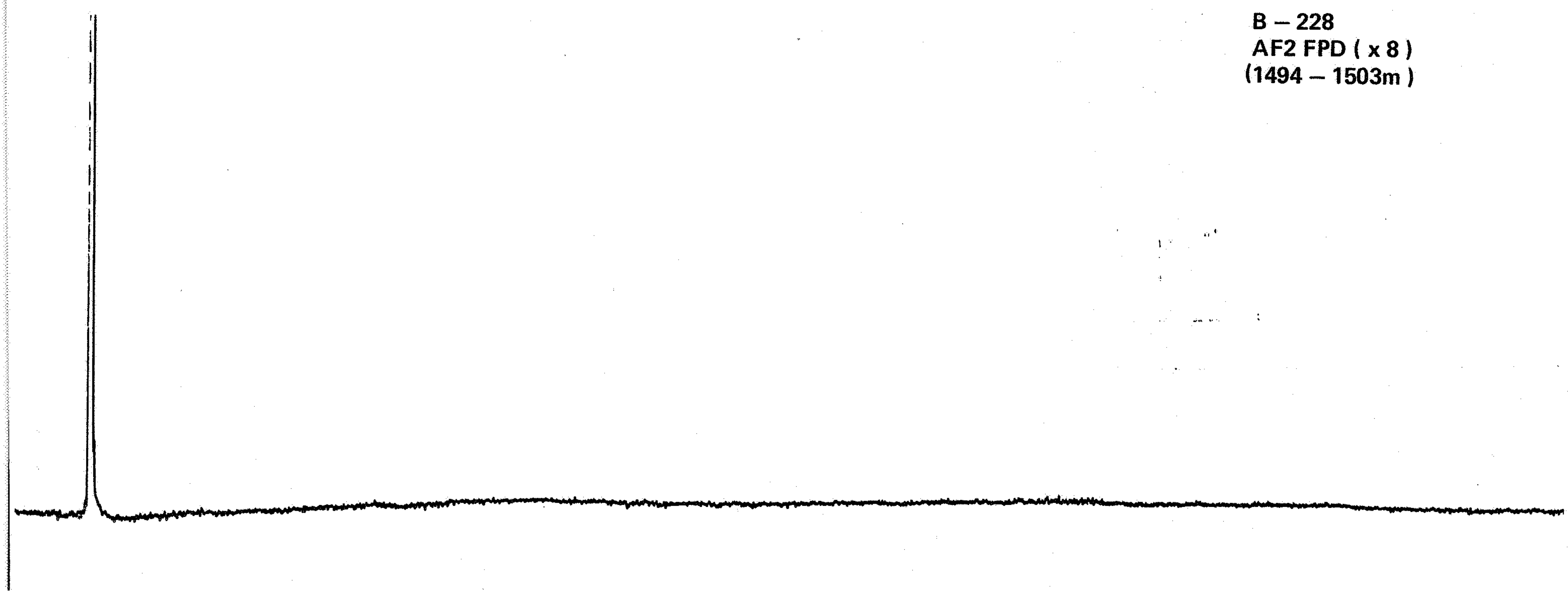


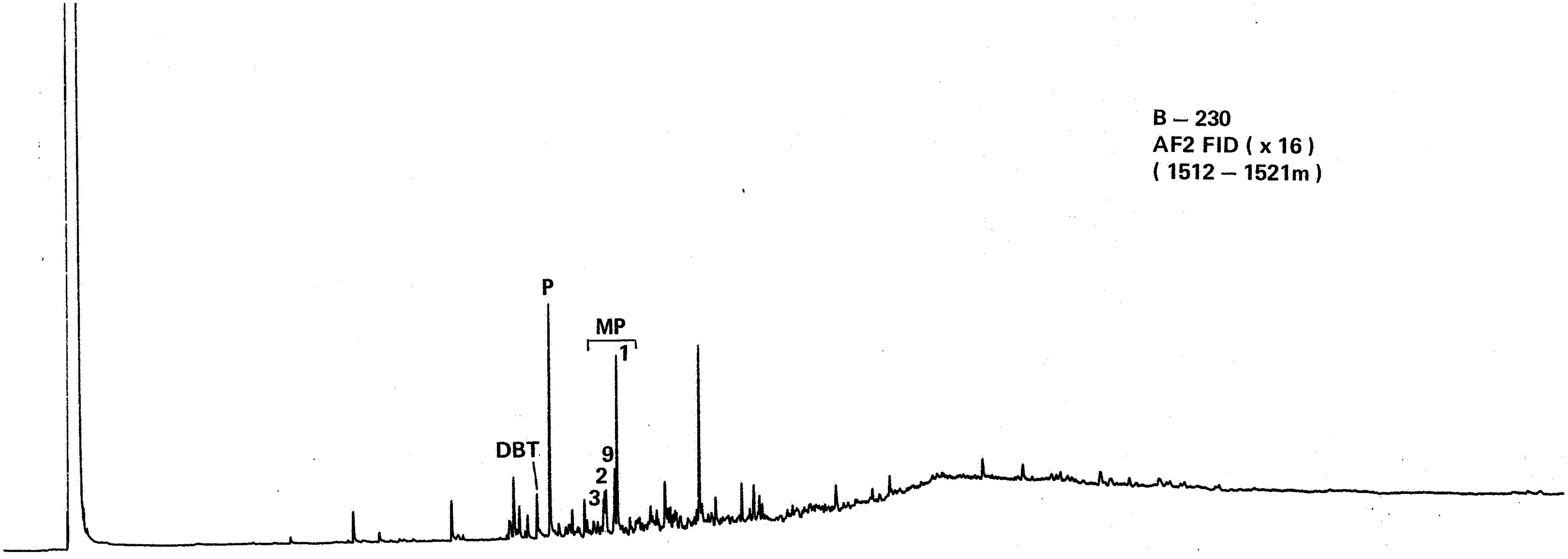
FIGURE 3

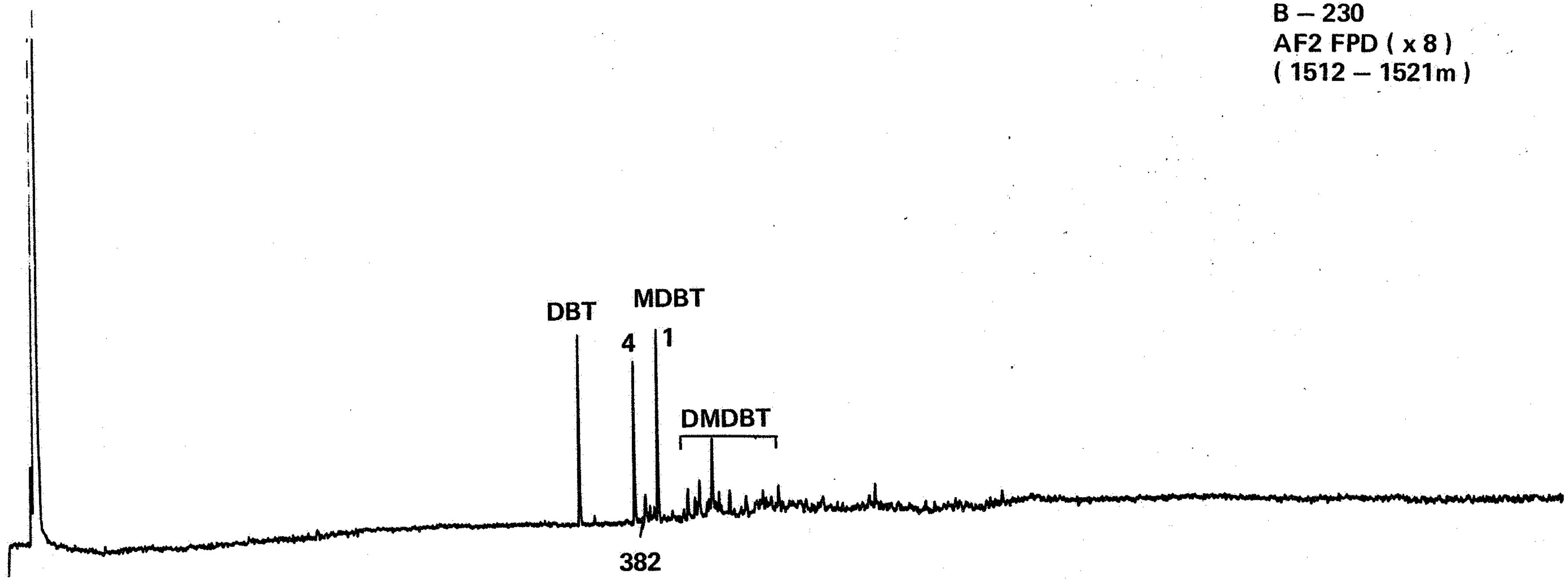
AF2 hydrocarbon chromatograms (FID and FPD)

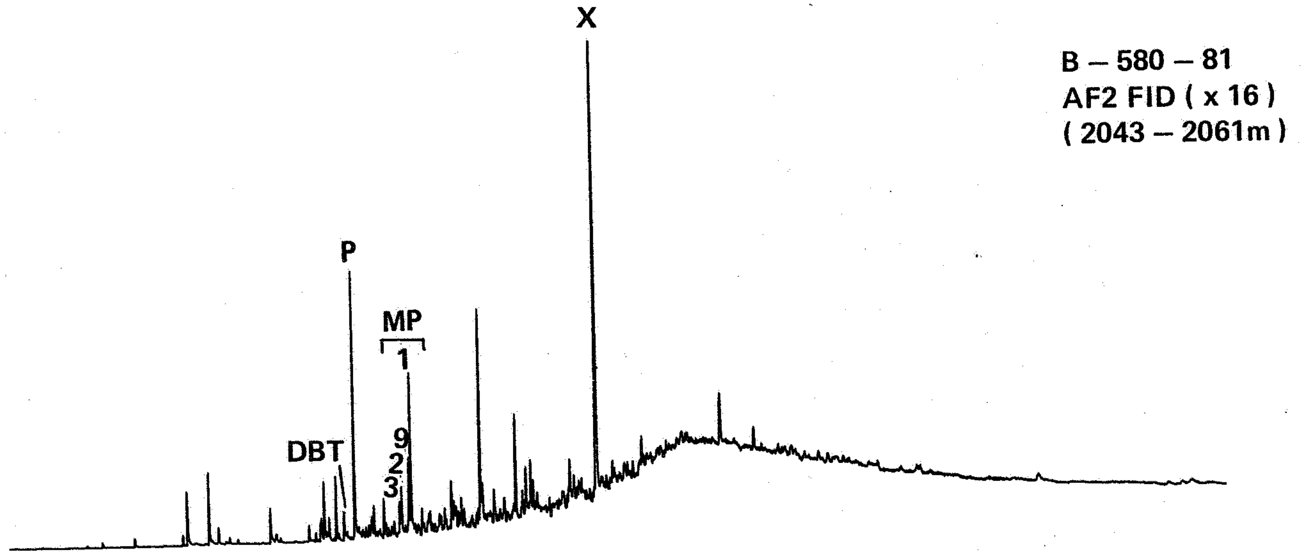
x	=	contaminant
P	=	phenanthrene
MP	=	methyl phenanthrene
DMP	=	dimethyl phenanthrene
DBT	=	dibenzothiophene
MDBT	=	methyldibenzothiophene
DMDBT	=	dimethyldibenzothiophene

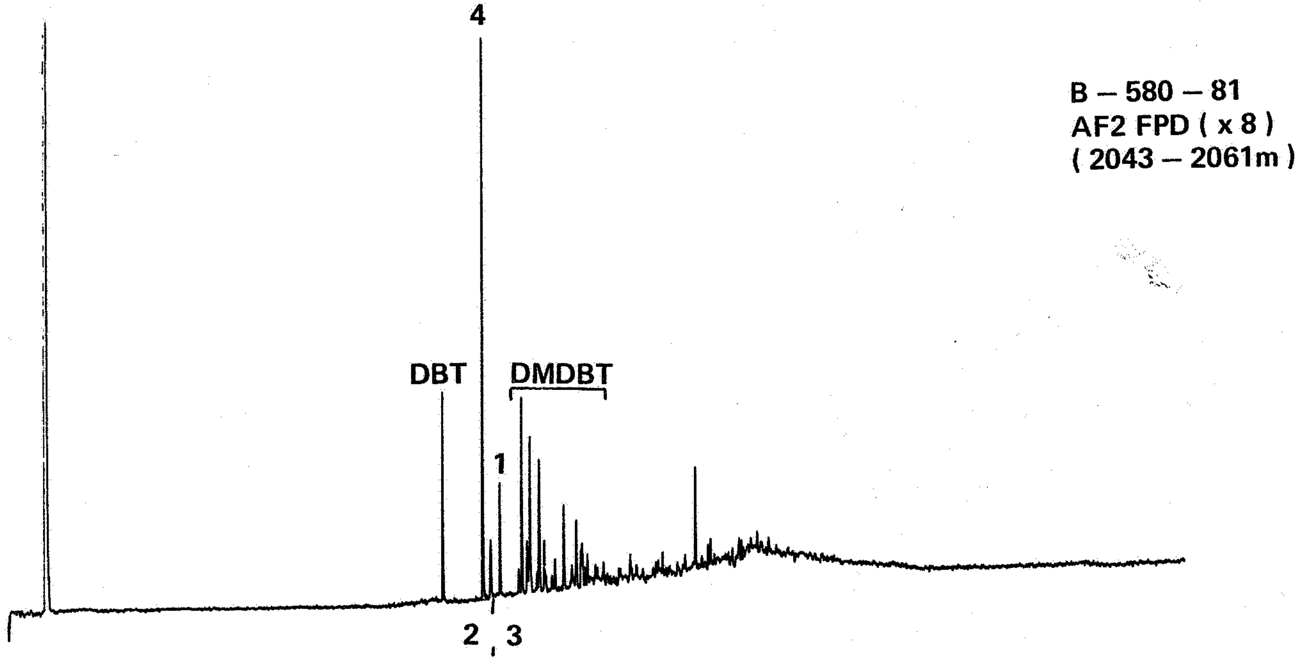

B – 228
AF2 FID (x 8)
(1494 – 1503m)
X
X
X
X

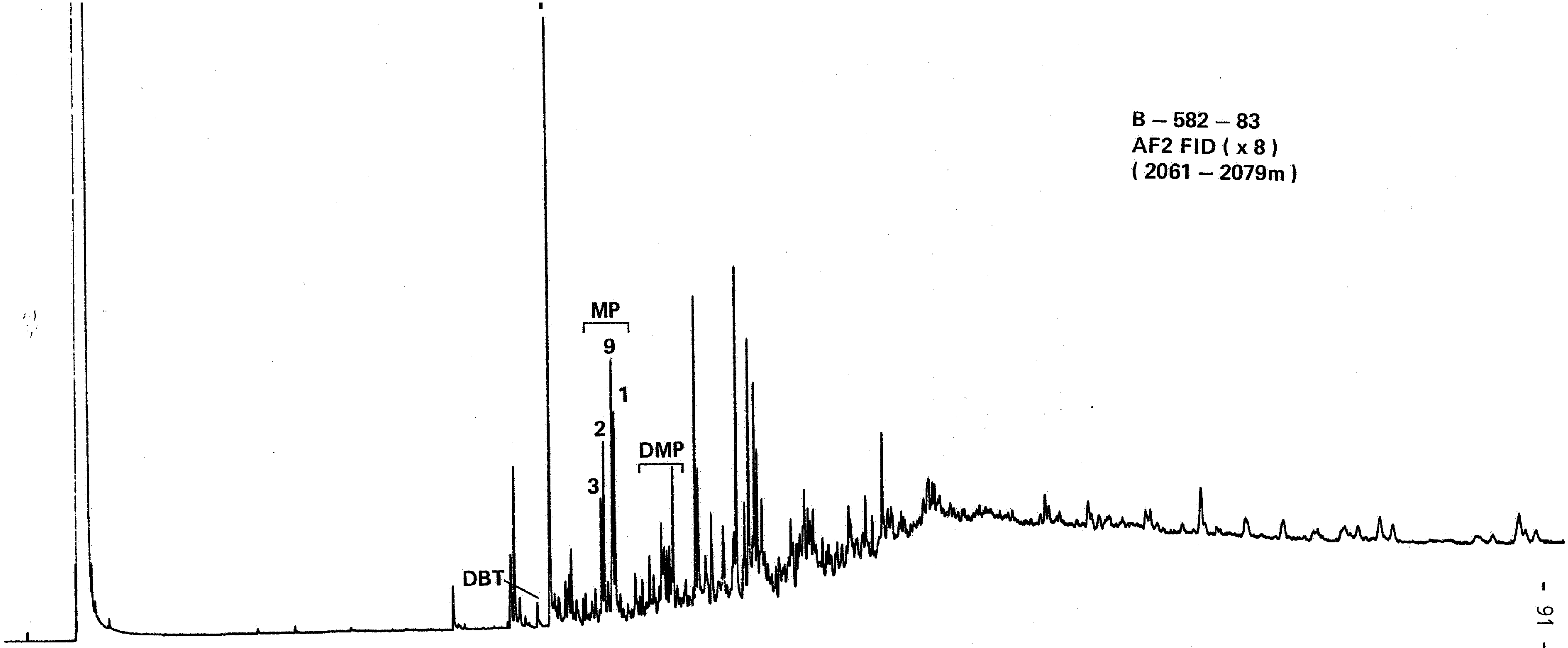

B – 228
AF2 FPD (x 8)
(1494 – 1503m)

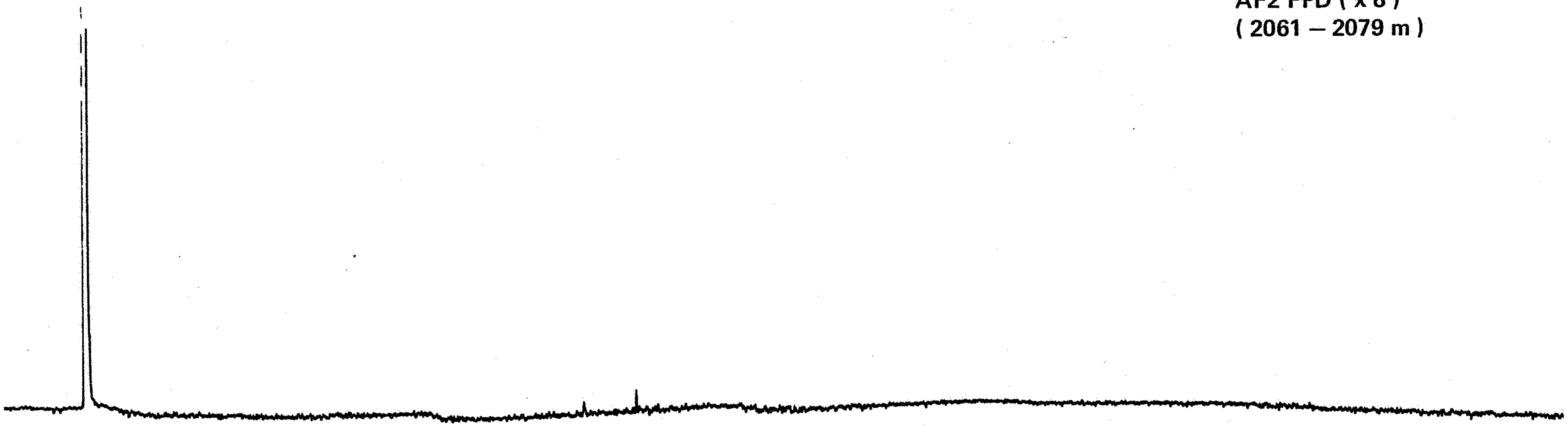

B – 230
AF2 FID (x 16)
(1512 – 1521m)
P
MP
1
DBT
9
2
3

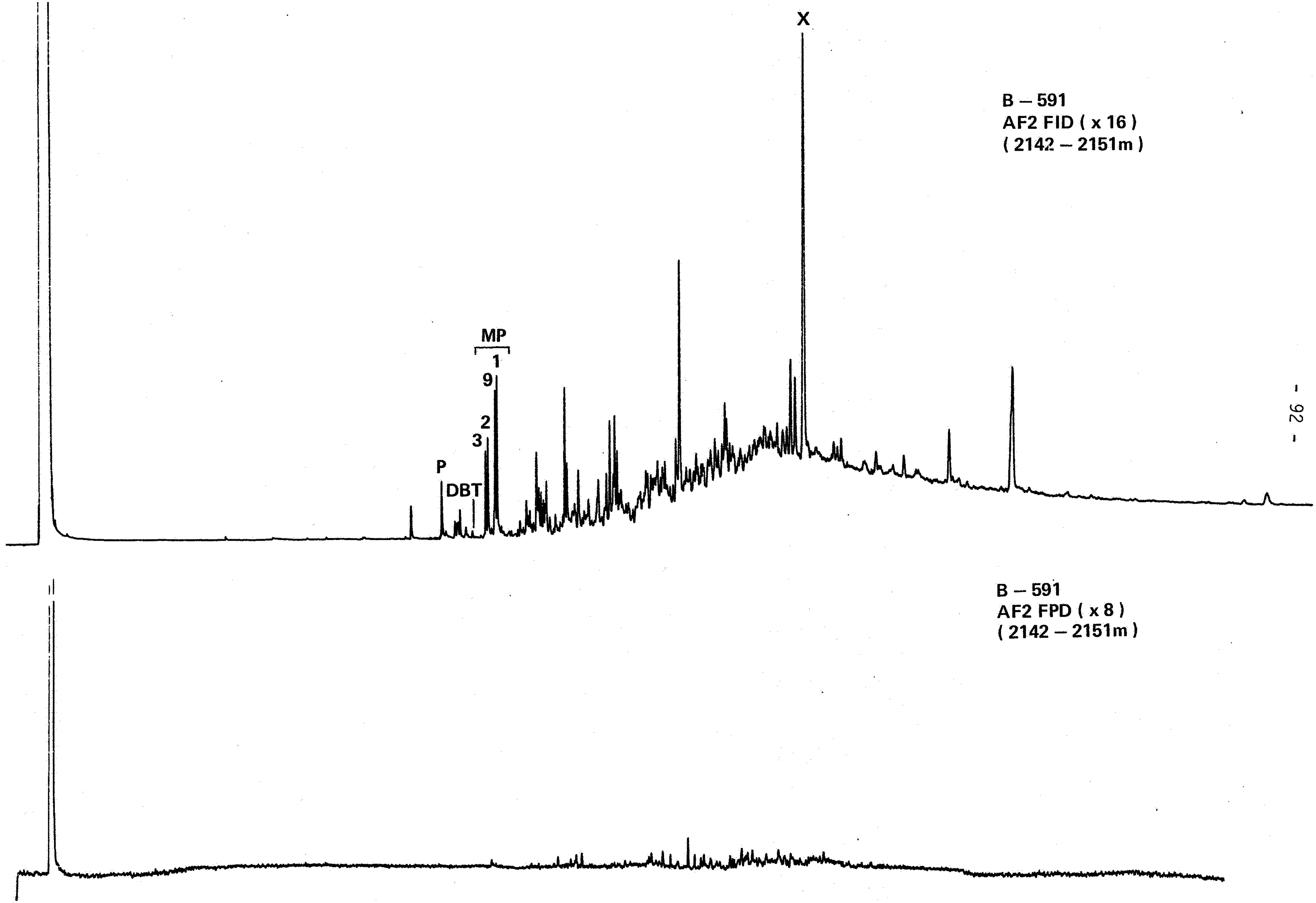

B – 230
AF2 FPD (x 8)
(1512 – 1521m)
DBT
MDBT
4
1
DMDBT
382

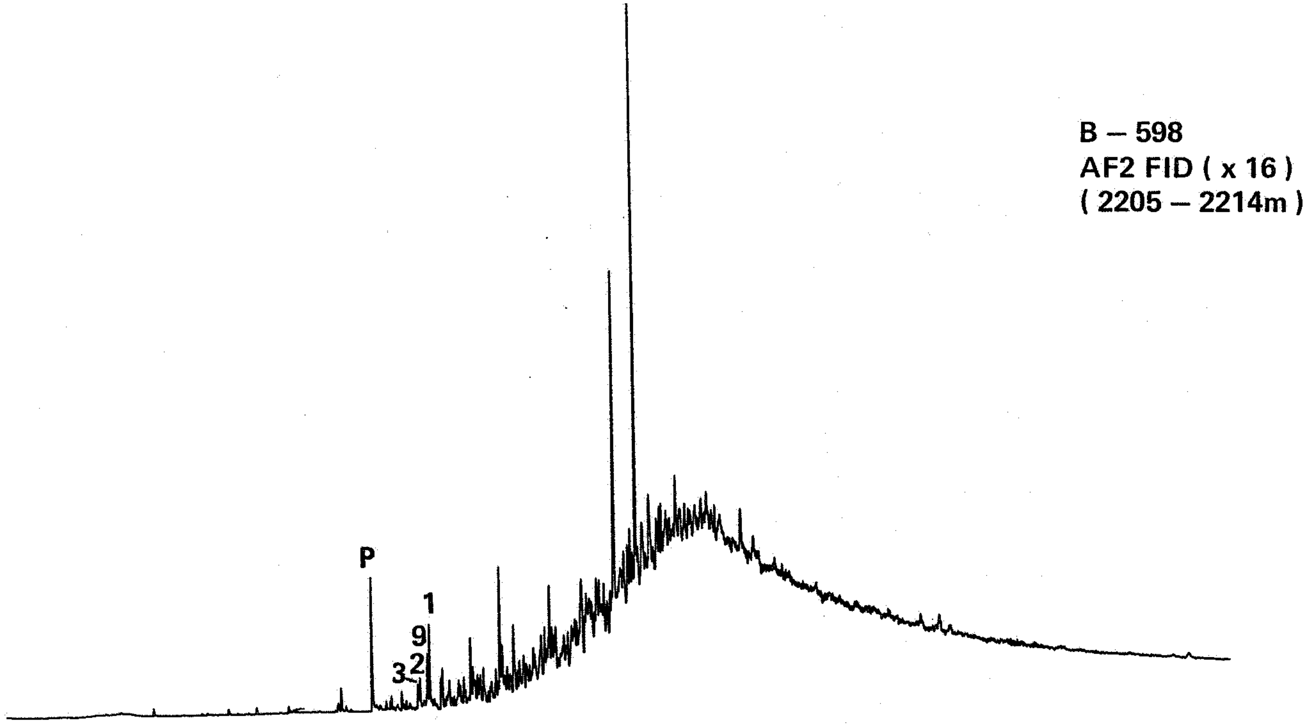

X
P
MP
1
DBT
9
2
3
B – 580 – 81
AF2 FID (x 16)
(2043 – 2061m)


4
DBT
DMDBT
1
2
3
B – 580 – 81
AF2 FPD (x 8)
(2043 – 2061m)


B – 582 – 83
AF2 FID (x 8)
(2061 – 2079m)
MP
9
1
2
3
DMP
DBT


B – 582 – 83
AF2 FPD (x 8)
(2061 – 2079 m)


X
MP
1
9
2
3
P
DBT
B – 591
AF2 FID (x 16)
(2142 – 2151m)
B – 591
AF2 FPD (x 8)
(2142 – 2151m)


B – 598
AF2 FID (x 16)
(2205 – 2214m)
P
1
9
2
3

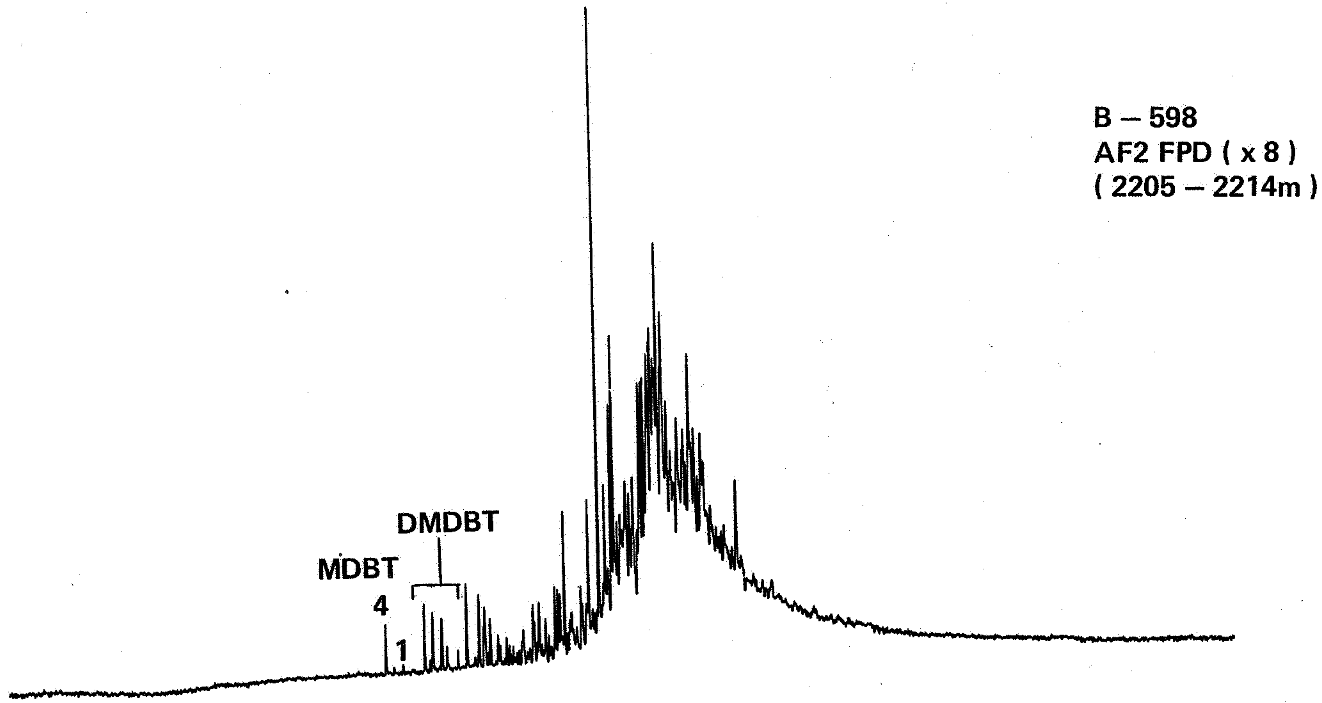
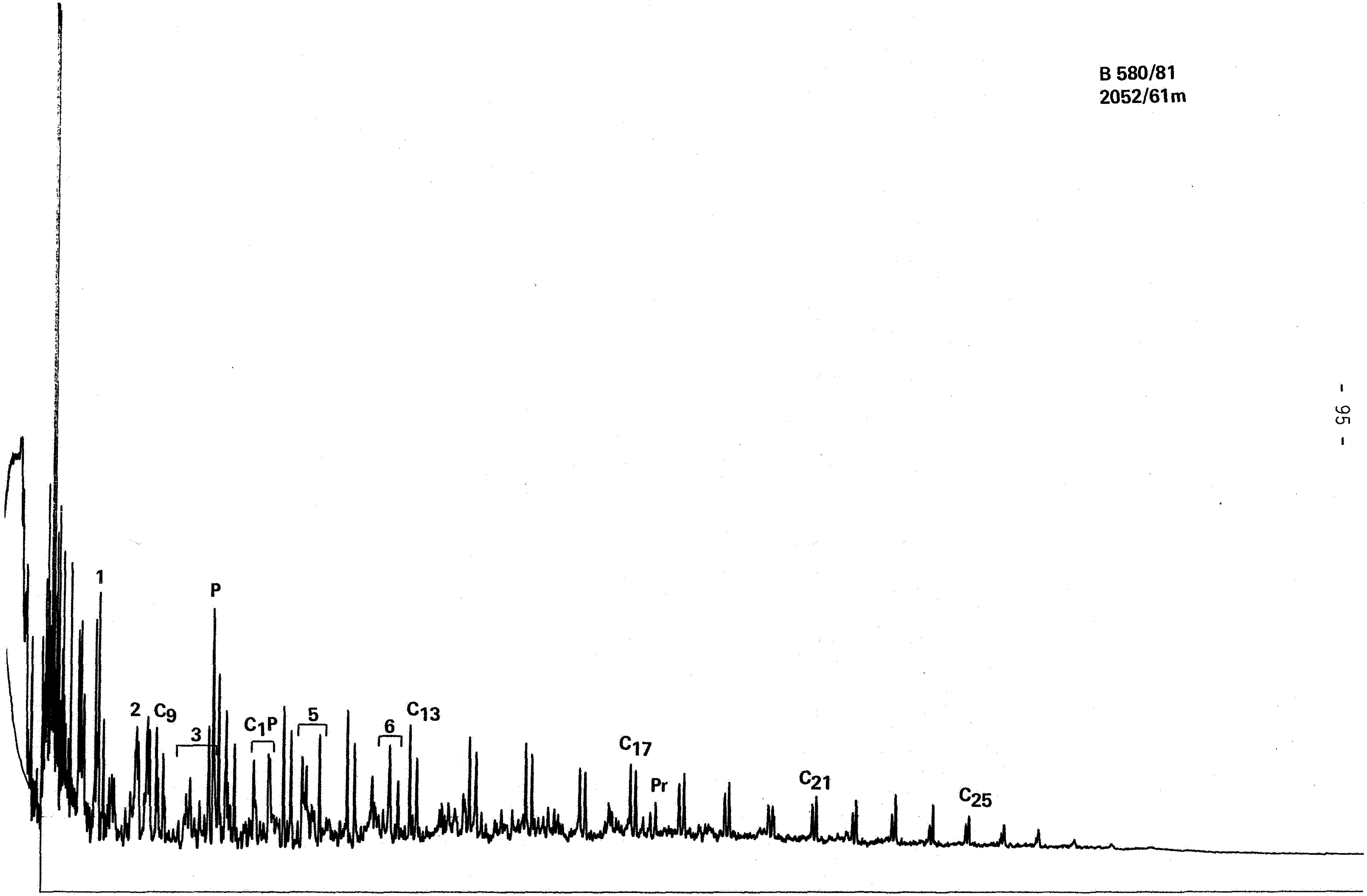
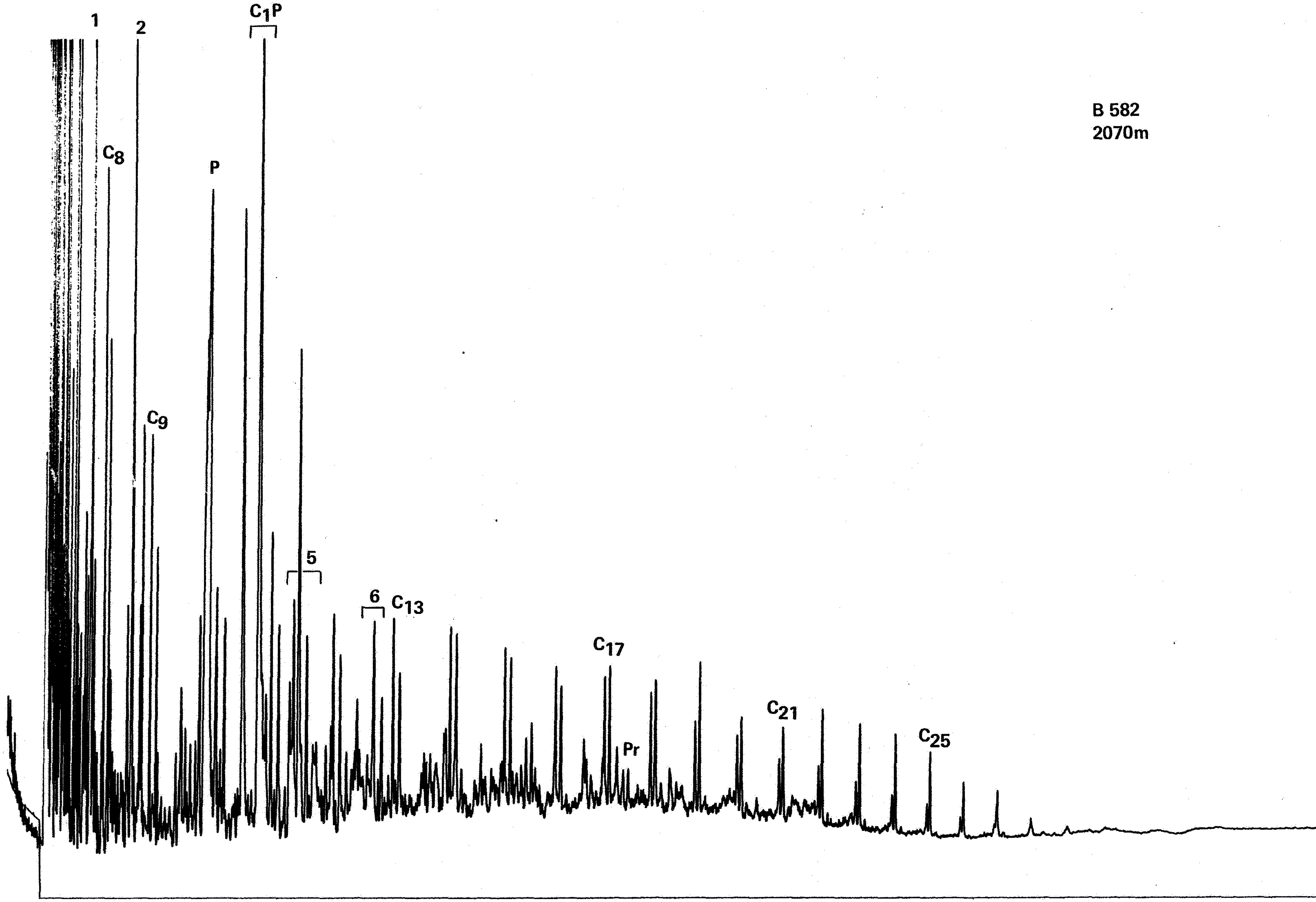
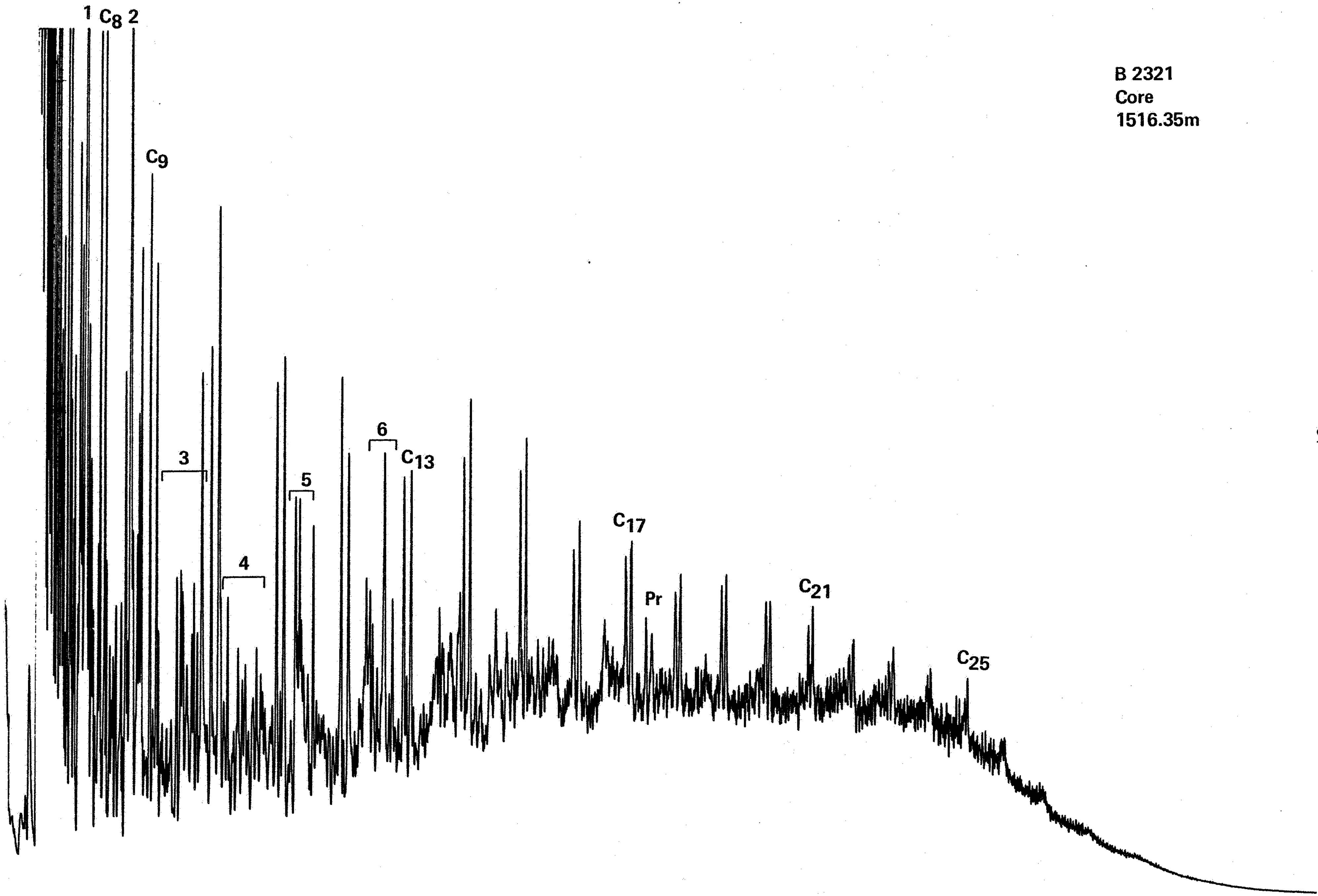

B – 598
AF2 FPD (x 8)
(2205 – 2214m)
DMDBT
MDBT
4
1

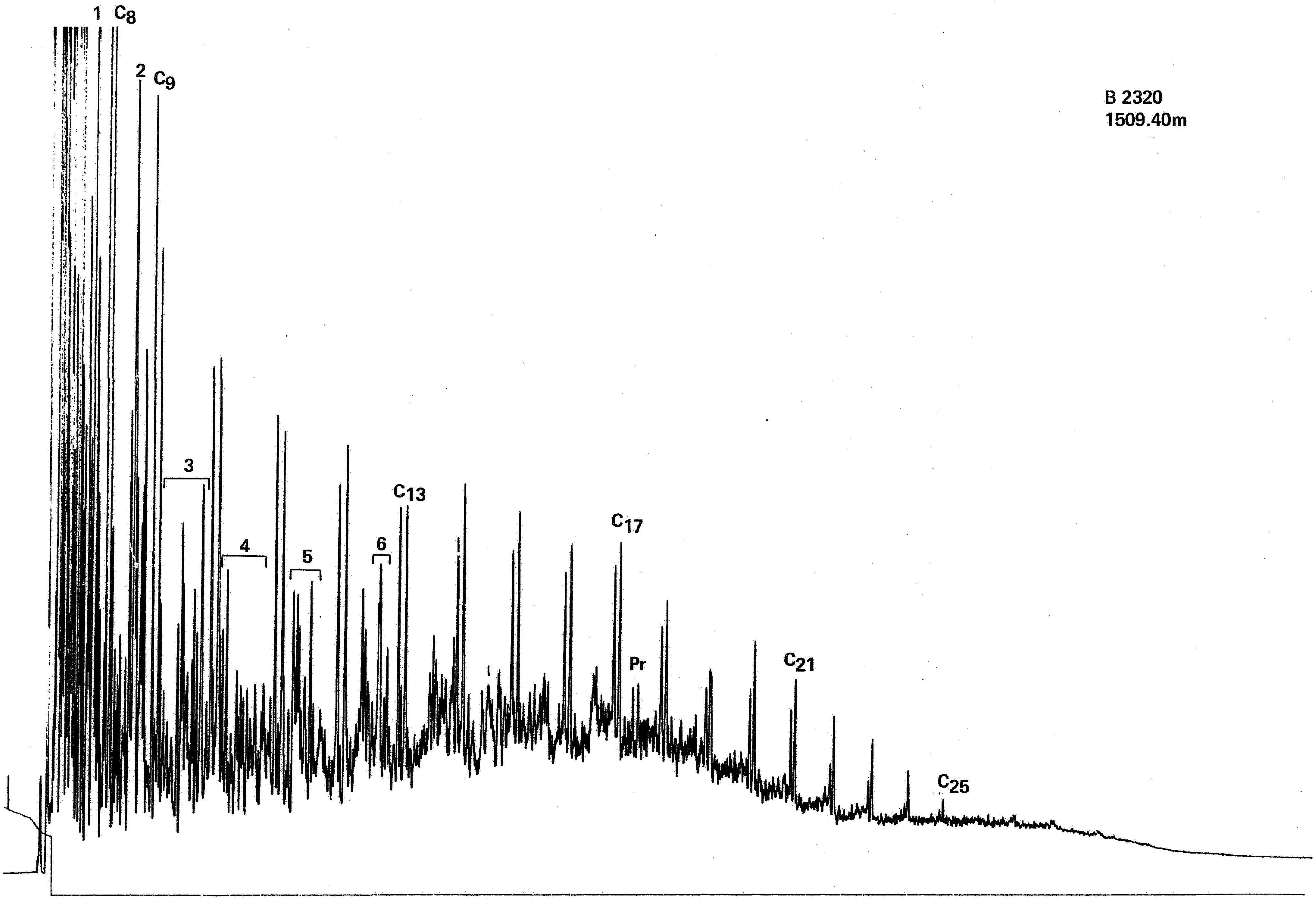
FIGURE 4

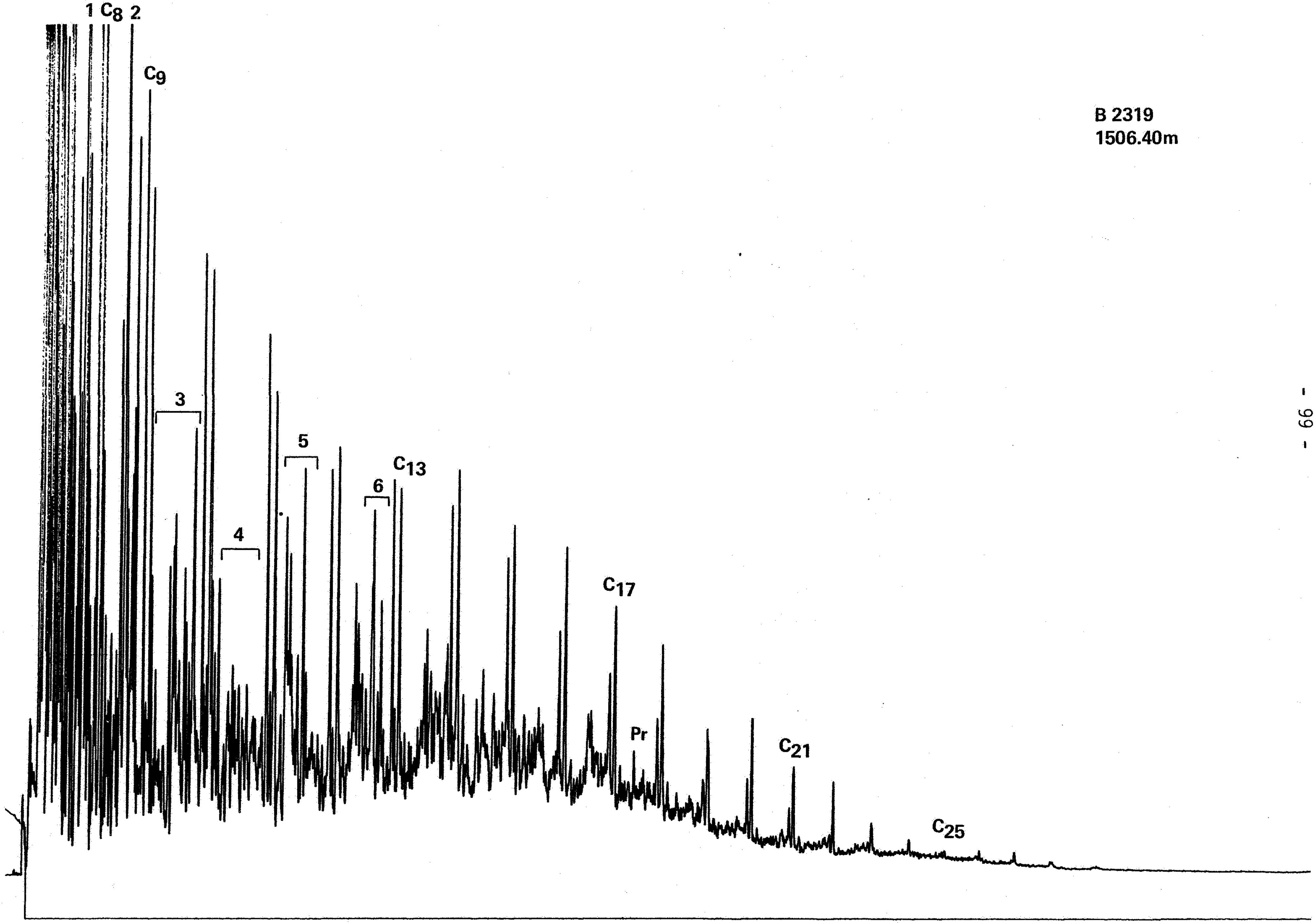
Pyrolysis-gc chromatograms

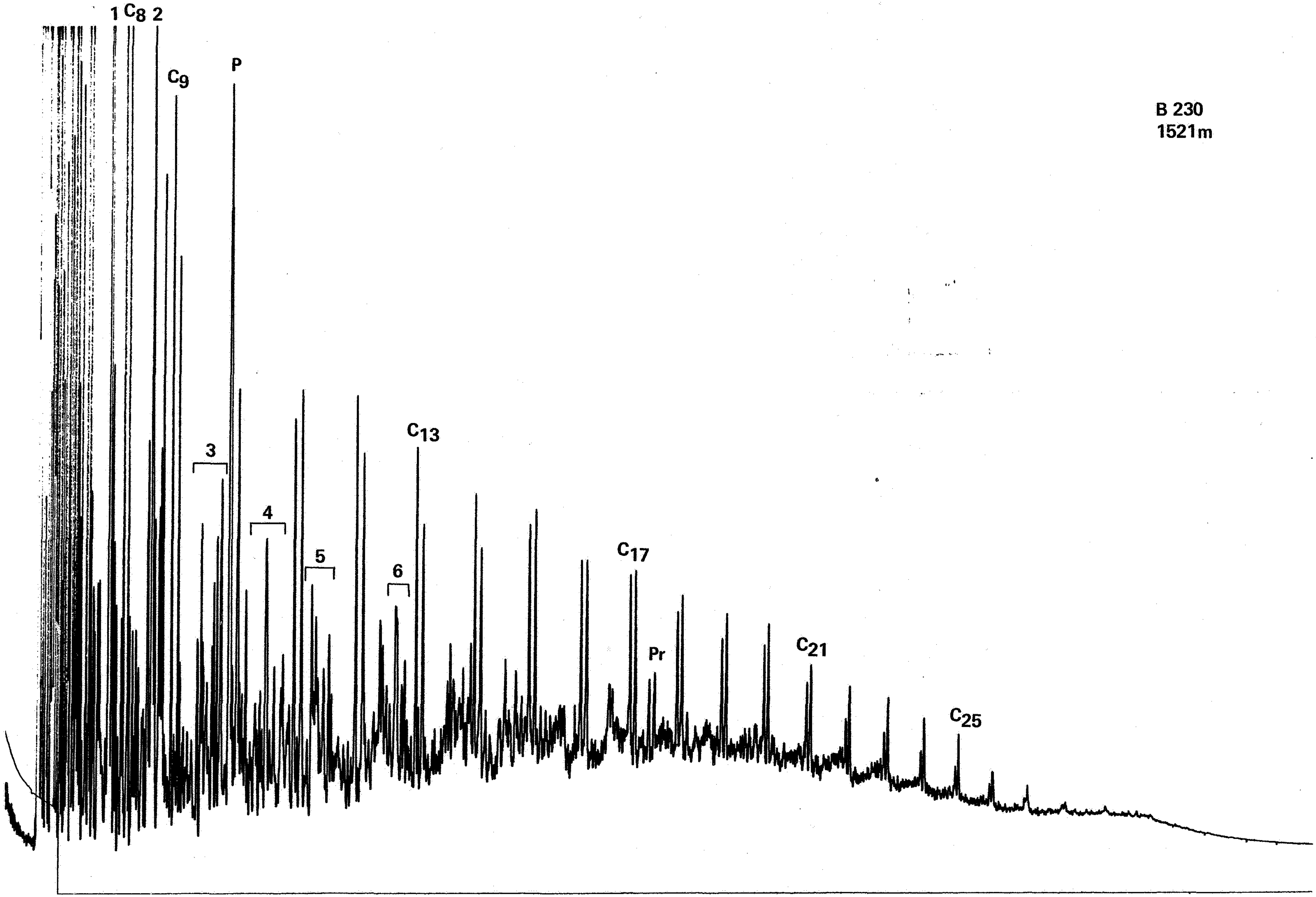

B 580/81
2052/61m
1
P
2
C9
3
C1P
5
6
C13
C17
Pr
C21
C25

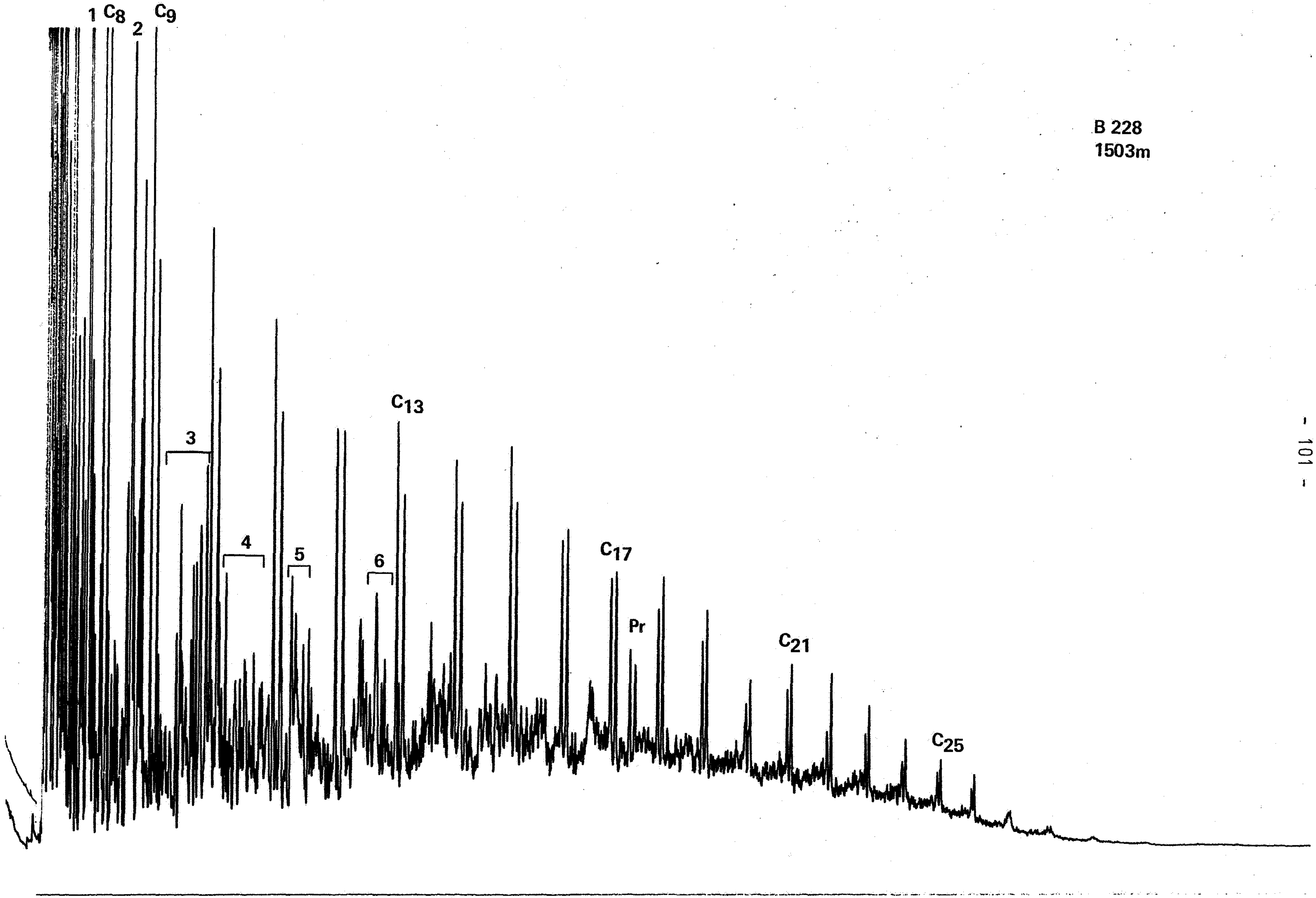

1
2
C1P
C8
P
C9
5
6
C13
C17
Pr
C21
C25
B 582
2070m

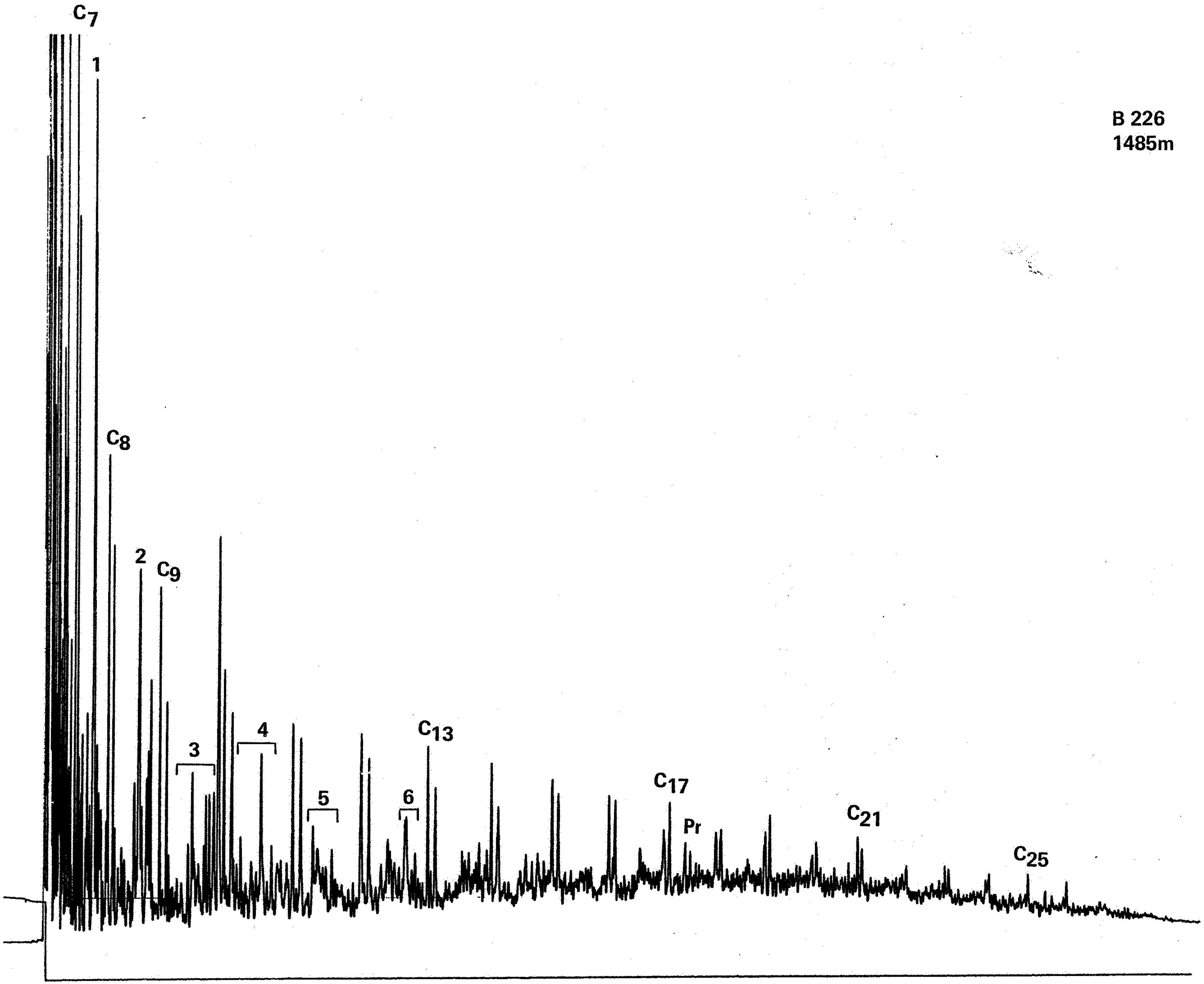

B 2321
Core
1516.35m
1
C8
2
C9
3
4
5
6
C13
C17
Pr
C21
C25

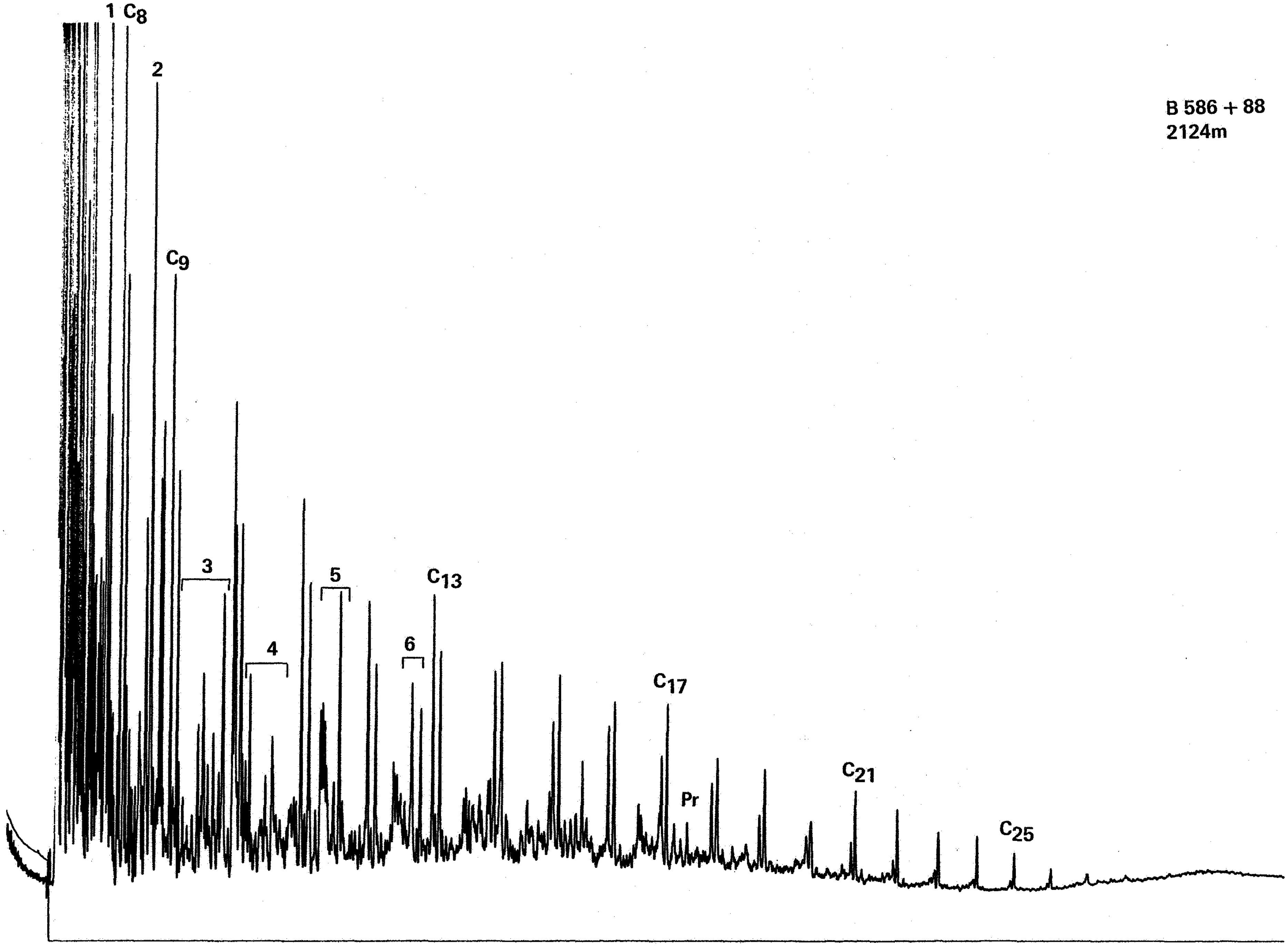

1
C_8
2
C_9
B 2320
1509.40m
3
4
5
6
C_{13}
C_{17}
Pr
C_{21}
C_{25}

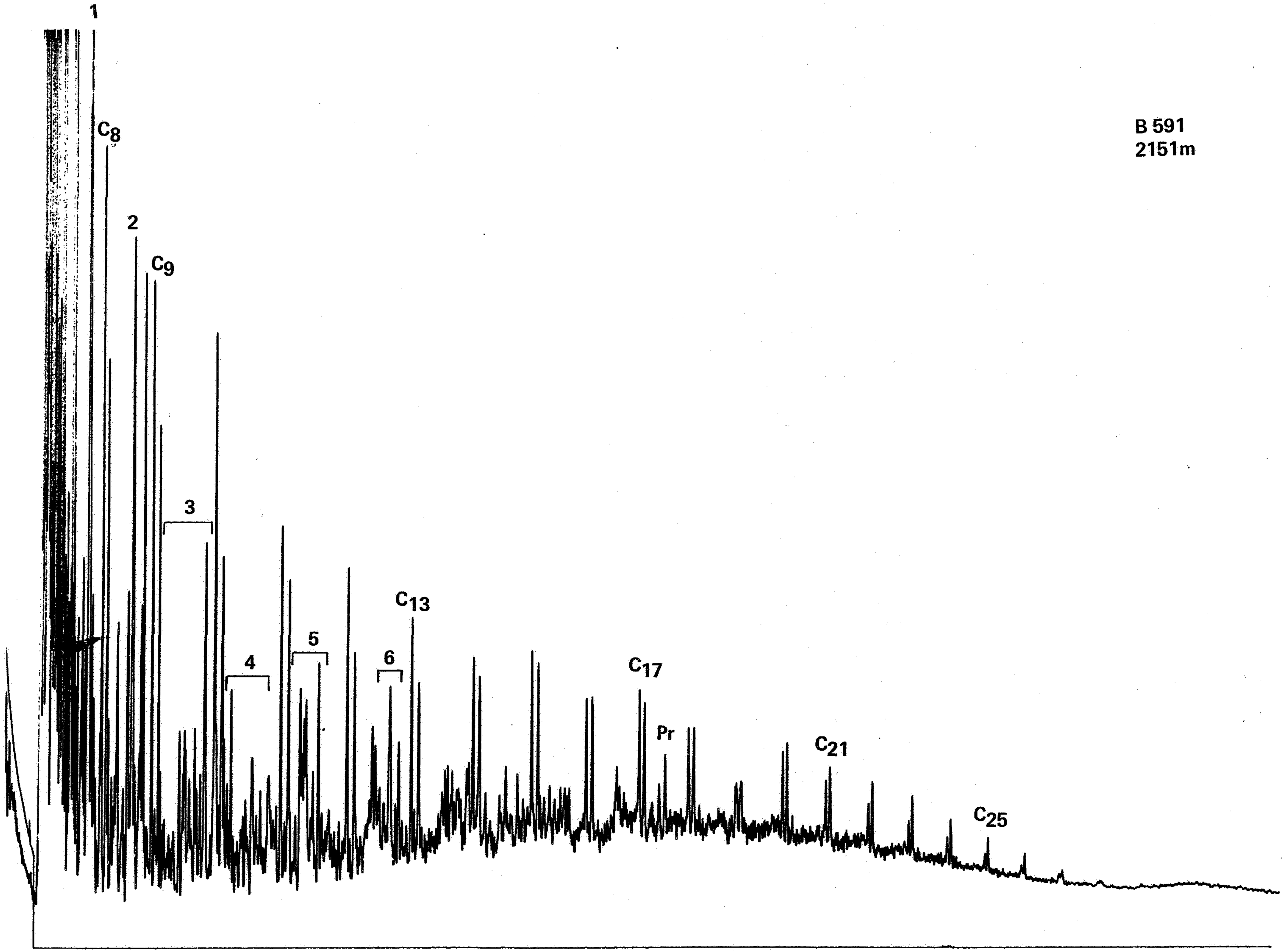

1
C8
2
C9
3
4
5
6
C13
C17
Pr
C21
C25
B 2319
1506.40m


1
C8
2
C9
P
3
4
5
6
C13
C17
Pr
C21
C25
B 230
1521m

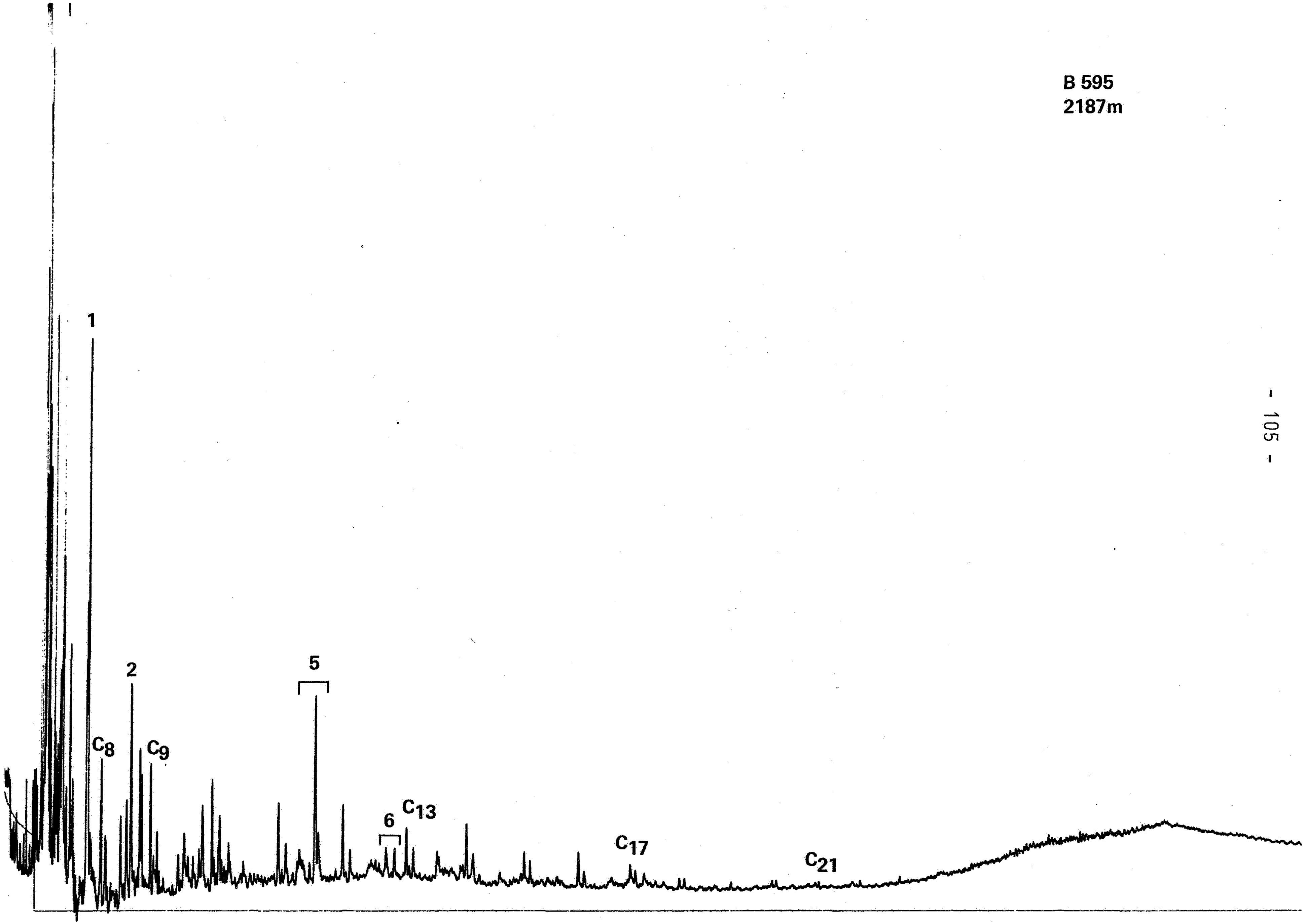

1
C_8
2
C_9
3
4
5
6
C_{13}
C_{17}
Pr
C_{21}
C_{25}
B 228
1503m

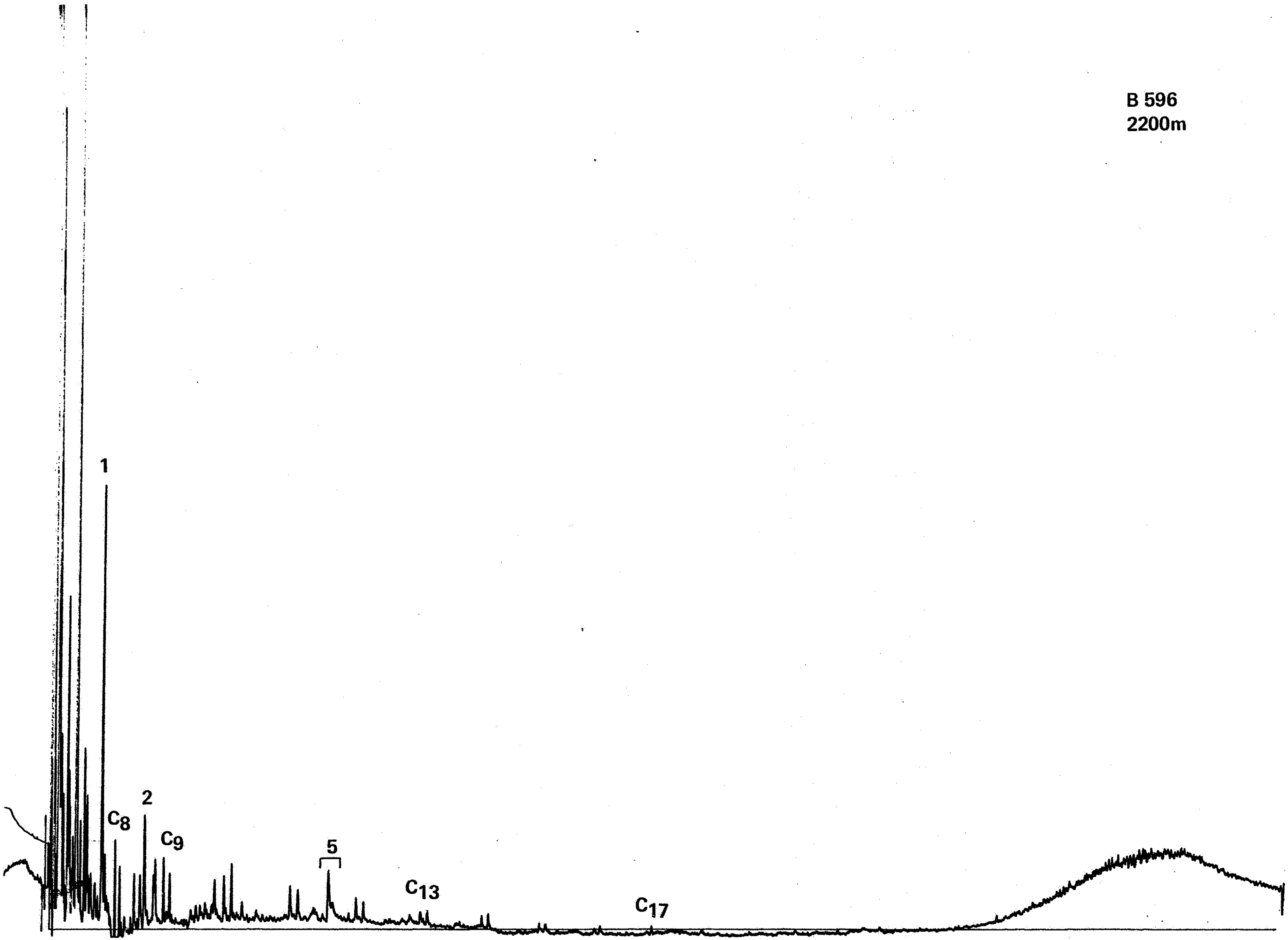

C7
1
C8
2
C9
3
4
5
6
C13
C17
Pr
C21
C25
B 226
1485m


1
C_8
2
C_9
3
4
5
6
C_{13}
C_{17}
Pr
C_{21}
C_{25}
B 586 + 88
2124m



1
C_8
2
C_9
3
4
5
6
C_{13}
C_{17}
Pr
C_{21}
C_{25}
B 591
2151m


B 595
2187m
1
2
5
6
C_8
C_9
C_{13}
C_{17}
C_{21}


B 596
2200m
1
2
C8
C9
5
C13
C17

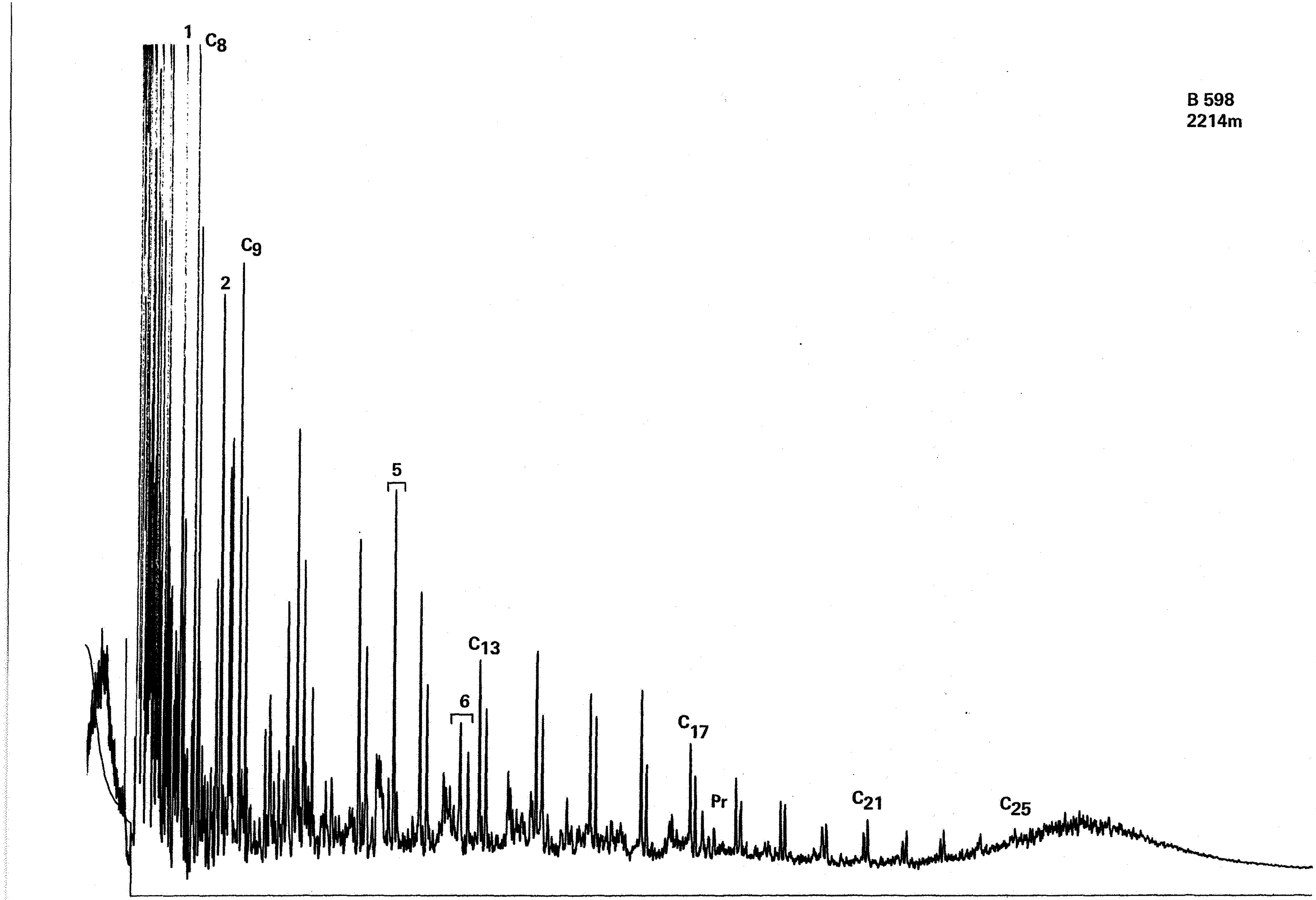

B 598
2214m
1
C_8
C_9
2
5
6
C_{13}
C_{17}
Pr
C_{21}
C_{25}

FIGURE 5

VITRINITE REFLECTANCE HISTOGRAMS

Key:-	A	=	Grey-black-brown claystone. Lower case letter is used when there is some uncertainty about whether the value is representative.
	PP	=	Primary population Y = Relevant population considered reasonably representative. N = Not representative (caving, reworked, contaminant, drilling effects).
	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
U = Severely liptinite stained

a,b etc. = same lithology as above but value not included in any population, possibly because suspected caving, reworking, contamination or other erroneous recordings.

115/q/ah/8

```
IKU# B 130    530.0M 31/5-1
    |
14-|
    |
12-|
    |
10-|
    |
 8-|
    |
 6-|
    |
 4-|
    |
 2-|
    |
 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
         OVERALL  0 0.00 0.00

ORDERED VALUES FOLLOW:
```

```
TKU# B 147     700.0M 31/5-1
    |
14- |
    |
12- |
    |
10- |
    |
 8- |
    |
 6- |
    |
 4- |
    |
 2- |
    |         A     f    d
 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 0.44 ALL     1 0.43 0.00
          OVERALL   3 0.66 0.23

ORDERED VALUES FOLLOW:

 0.43A 0.68f 0.88d
```

```
IKU# B 164    870.OM 31/5-1
   |
14-|
   |
12-|
   |
10-|
   |
 8-|
   |
 6-|
   |
 4-|
   |      d
 2-|      d D
   |     ddDDD
 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 0.37 0.46 ALL    4 0.43 0.04
          OVERALL  8 0.37 0.06

ORDERED VALUES FOLLOW:

 0.29d 0.32d 0.34d 0.34d 0.37D 0.44D 0.44D 0.45D
```

```
IKU# B 177    1000.0M 31/5-2
    I
14-I
    I
12-I
    I
10-I
    I
 8-I
    I
 6-I
    I
 4-I
    I
 2-I
    I      C  D       a
 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 0.32 0.47 ALL     2 0.39 0.10
         OVERALL  3 0.53 0.25

ORDERED VALUES FOLLOW:

 0.32C 0.46D 0.81a
```

```
    |
14-|
    |
12-|
    |
10-|
    |
 8-|
    |
 6-|
    |
 4-|
    |      D
 2-|      D
    |     DD
 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 0.32 0.40 ALL     4 0.36 0.03
          OVERALL  4 0.36 0.03
```

ORDERED VALUES FOLLOW:

0.32D 0.36D 0.37D 0.39D

```
     |
 14- |
     |
 12- |
     |
 10- |
     |
  8- |
     |
  6- |
     |
  4- |
     |
  2- |                D
     |      C    A    D
  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 0.30 0.60 ALL     4 0.49 0.14
         OVERALL    4 0.49 0.14
```

ORDERED VALUES FOLLOW:

0.30C 0.48A 0.59D 0.59D

```
    I
14- I
    I
12- I
    I
10- I
    I
 8- I
    I
 6- I
    I
 4- I
    I
 2- I
    I            D   d    d d
 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 0.61 0.62 ALL     1 0.61 0.00
          OVERALL   4 0.92 0.25
```

ORDERED VALUES FOLLOW:

 0.61D 0.82d 1.08d 1.15d

```
   |
14-|
   |
12-|
   |
10-|
   |
 8-|
   |
 6-|
   |
 4-|
   |
 2-|         B D         d
   |      D AA D  a d     a
 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 0.32 0.60 ALL     6 0.47 0.10
          OVERALL 10 0.66 0.28

ORDERED VALUES FOLLOW:

 0.32D 0.41A 0.45A 0.45B 0.58D 0.59D 0.72a 0.80d 1.11a 1.12d
```

```
     I
 14-I
     I
 12-I
     I
 10-I
     I
  8-I
     I
  6-I
     I
  4-I
     I
  2-I              b
     I     d  D   a    dd
  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 0.48 0.49 ALL     1 0.48 0.00
          OVERALL   6 0.63 0.21
```

ORDERED VALUES FOLLOW:

0.33d 0.48D 0.63b 0.63a 0.83d 0.89d

```
    |
14-|
    |
12-|
    |
10-|
    |
 8-|
    |
 6-|
    |
 4-|
    |
 2-|       KI
    |       KKA
 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 0.31 0.41 ALL     5 0.35 0.04
          OVERALL  5 0.35 0.04

ORDERED VALUES FOLLOW:

 0.31K 0.32K 0.37I 0.37K 0.40A
```

IKU# B 551   1791.0M 31/5-2


```
    |
14-|
    |
12-|
    |
10-|
    |
 8-|
    |
 6-|
    |
 4-|
    |         B
 2-|         D
    |    ccDDC C    c  c
 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 0.57 ALL        6 0.46 0.06
             OVERALL   10 0.51 0.22
```

ORDERED VALUES FOLLOW:

0.28c 0.32c 0.38D 0.41D 0.45D 0.46B 0.47C 0.56C 0.82c 0.97c

IKU# B559   1863.0M 31/5-2

```
    |
14- |
    |
12- |
    |
10- |
    |
 8- |
    |
 6- |
    |
 4- |
    |          A
 2- |          A
    |      d D A      a
 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 0.40 0.54 ALL    4 0.48 0.06
          OVERALL  6 0.52 0.18

ORDERED VALUES FOLLOW:

 0.31d 0.40D 0.50A 0.50A 0.53A 0.85a
```

```
IKU# B 571    1971.OM 31/5-2
     I
 14-I
     I
 12-I
     I
 10-I
     I
  8-I
     I
  6-I
     I
  4-I
     I
  2-I             A
     I             A a        k  a
  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 0.65 0.68 ALL     2 0.66 0.01
          OVERALL   5 0.92 0.30

ORDERED VALUES FOLLOW:

 0.65A 0.67A 0.79a 1.16k 1.32a
```

```
    |
14-|
    |
12-|
    |
10-|
    |
 8-|
    |
 6-|
    |
 4-|
    |
 2-|       MD
    |      dAAM     m    da   a
 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 0.49 ALL     5 0.41 0.05
          OVERALL 10 0.61 0.29

ORDERED VALUES FOLLOW:

 0.32d 0.36M 0.37A 0.41A 0.42D 0.48M 0.71m 0.92d 0.95a 1.11a
```

```
    |
14-|
    |
12-|
    |
10-|
    |
 8-|
    |
 6-|
    |
 4-|
    |
 2-|
    |         N     i id  c      i
 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 0.49 0.50 ALL    1 0.49 0.00
          OVERALL  6 0.92 0.31
```

ORDERED VALUES FOLLOW:

0.49N 0.77i 0.87i 0.90d 1.09c 1.41i

```
IKU# B 598   2214.0M 31/5-2
   |
14-|
   |
12-|
   |
10-|
   |
 8-|
   |
 6-|
   |
 4-|
   |        I
 2-|        I
   |        A M I       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 0.36 0.59 ALL    5 0.44 0.09
          OVERALL  6 0.54 0.27

ORDERED VALUES FOLLOW:

 0.36I 0.39I 0.39A 0.48M 0.58I 1.06k
```

```
IKU# B607     2295.0M 31/5-2
    I
14-I
    I
12-I
    I
10-I
    I
 8-I
    I
 6-I
    I
 4-I
    I          B  B
 2-I       b   B  B
    I       b   D BD
 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 0.64 ALL     7 0.54 0.07
          OVERALL   9 0.50 0.11

ORDERED VALUES FOLLOW:

 0.33b 0.34b 0.45D 0.48B 0.48B 0.55B 0.60D 0.60B 0.63B
```

```
IKU# B 613   2349.OM 31/5-2
    |
14-|
    |
12-|
    |
10-|
    |
 8-|
    |
 6-|
    |
 4-|
    |
 2-|      b     I
    |     bbb    II
 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 0.50 0.59 ALL    3 0.53 0.04
          OVERALL  7 0.39 0.14

ORDERED VALUES FOLLOW:

 0.24b 0.26b 0.29b 0.34b 0.50I 0.52I 0.58I
```

```
IKU# B 623   2439.OM 31/5-2
    |
14- |
    |
12- |
    |
10- |
    |
 8- |
    |
 6- |
    |
 4- |
    |
 2- |
    |                  a  a
 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
OVERALL 2 1.05 0.08

ORDERED VALUES FOLLOW:

0.99a 1.11a

```
IKU# B 629   2493.0M 31/5-2
     |
14-  |
     |
12-  |
     |
10-  |
     |
 8-  |
     |
 6-  |
     |
 4-  |
     |
 2-  |
     |         I
 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  0.44 0.45 ALL        1 0.44 0.00
             OVERALL    1 0.44 0.00
```

ORDERED VALUES FOLLOW:

0.44I