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## REGISTRERT

Report

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A. Bjørseth R. Steel Arkiv H. Nes (Væ) Partners N. Telnæs T. Bockelie J.B. Olsen	<p style="text-align: center;">SOURCE ROCK EVALUATION OF WELL 6407/7-1</p> <p style="text-align: center;">BY</p> N. Telnæs (Proj. leader) T. Bockelie J.B. Olsen	

Summary/Conclusion/Recommendation

In this report are summarised the results of a source rock evaluation of well 6407/7-1 based on organic geochemical and petrological techniques.

MATURITY	KEROGEN	PETROLEUM POTENTIAL
2000M		1980M POOR-FAIR
EARLY MATURE	II (DEGRADED III) LARGE AMOUNTS OF WOOD	POOR
2590M	2590M PYRITIZED WOOD III	
2697M	II LARGE AMOUNTS OF AMORPHOUS MATERIAL	VERY GOOD
2713M	III/IV 2780M	
3000M	II III/IV (CUTICULA FRAGMENTS)	NO TO EXCELLENT
MIDDLE MATURE		
3200M		

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Division/Section/Dept Geology, F-Bergen	Field/Block/Well 6407/7-1	Pages Report <input checked="" type="checkbox"/> Note <input type="checkbox"/>
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INTRODUCTION

In this report the results of extraction and chromatographic analyses of 66 Sidewall Core and Core samples from well 6407/7-1 are reported together with the results of the vitrinite reflectance measurements and the visual kerogen analyses.

The samples are collected from the interval 1189 (Oligocene) to 3081.50 m (Lower Jurassic) based on the Exlog rigsite geochemistry results.

The well location is given in Fig. 1.

RIG SITE GEOCHEMISTRY

A geochemical evaluation log based on the Exlog rig site geochemistry is given in Fig. 2. This is based on all available samples including ditch cuttings, sidewall cores and core samples.

The results of the rigsite geochemistry are reported in "Norsk Hydro Geochemical Report Well 6407/7-1" produced by Exlog.

## RESULTS AND DISCUSSION

### Extraction and group type separation:

34 side wall cores and 32 core samples were extracted in the interval 1189.91 m to 3081.50 m with special emphasis on the interval from 2699 (Ryazanian) to 2730 m (Late Bajocian/Early Bathonian)

The results of the extractions are listed in Table 1.

The yields ranges from 80 to 31000 ppm with the richer samples corresponding to the main reservoir sandstones. The amount of extractable organic material (EOM) is plotted versus depth in Fig. 3, and in Fig. 4 EOM/TOC (total organic carbon) is plotted versus depth.

The high EOM/TOC values in the interval from 2760 to approx 3000 m are a result of the migrated hydrocarbons in the sandstone intervals.

There appears to be an increase in the EOM in the interval from 1700 to 1850 m (Paleocene) and in the intervals 2699 to 2714 m and 3000 to 3100 m (Lower Jurassic).

The interval from 2699 to 2705 m (Ryazanian) have an average EOM of 3080 ppm indicating a very good source rock potential.

Some of the coaly samples in the interval 3000 to 3100 m also have EOM values indicating very good to excellent source potential.

Some of the extracts from the shallow samples are very low in EOM and are analysed further as whole extracts.

The results of the deasphalting and the group type separation are listed in Table 2.

The ratio of saturated to aromatic hydrocarbons are plotted versus depth in Fig. 5.

The Sat/Arom ratio is quite uniform in the interval from 2699 to 2723 m. The two samples at 2723.12 m and 2724.10 m have very high Sat/Arom ratios. The deeper samples have varying Sat/Arom ratios due to some of the coaly horizons with low values interbedded with sandstones impregnated with migrated hydrocarbons with a higher Sat/Arom value.

### Gas chromatographic analysis:

The gas chromatograms of the saturated hydrocarbons are given in Appendix I.

The Pristane/Phytane and Pristane/n-C<sub>17</sub> ratios are listed in Table 3, and are plotted versus depth in Fig. 6.

The Pristane/Phytane ratio is almost constant in the interval from 2699 to 2707 m. Some of the coaly sequences in the interval from 3000 to 3100 m show high Pristane/Phytane ratios, indicating a more oxidizing depositional environment.

Some of the gas chromatograms from the shallower samples appears to be very immature and since these are analysed as total extracts the CPI (Carbon Preference Index) is difficult to calculate. The samples in the interval from 1990 m to 2170 m appear immature with CPIs ranging from 1.42 to 1.31. Most of the deeper samples all have a CPI close to 1.0 reflecting the increasing maturity with depth.

The saturated gas chromatograms in the interval from 2699 to 2713.23 m all seems to be dominated by marine algal material. The deeper samples show varying amounts of terrigenous input, i.e. the sample at 3017.20 m appears to be dominated by terrestrially derived organic matter.

The gas chromatograms of the aromatic fractions are given in Appendix II.

MPI-1 (Methylphenanthrene Index 1) and MPI-2 are listed in Table 4.

There is a general increase in the ratio of the 3- and 2-methylphenanthrenes relative to the 9- and 1- isomers with increasing depth.

Analysis of biomarkers:

The m/z 191 (triterpanes) and m/z 217 (steranes) fragmentograms are given in Appendix III.

Different biomarker ratios used in this report are listed in Table 5.

The isomerisation (%  $\alpha\beta\beta$ ) and epimerisation (% 20S) of the C<sub>29</sub> steranes appears to be increasing with depth reflecting the increase in maturity.

The ratio of steranes to triterpanes varies from 0.03 in some of the coaly intervals to 0.99 in the sample from 2725.07 m.

The ratio of T<sub>m</sub> to T<sub>s</sub> also shows strong variations from 0.44 to 24.70. There is a good correlation between the high T<sub>m</sub>/T<sub>s</sub> values and low sterane/triterpane values.

The epimerisation of the extended hopanes (% 22S) appears to have reached equilibrium in all the analysed samples.

Pyrolysis gas chromatography:

The results of the pyrolysis gas chromatography are given in Appendix IV, and the quantitative results are listed in Table 6.

The two samples at 1824.82 m and (Late Paleocene) and 2085.50 m (Campanian) are mainly gas/condensate prone.

The samples from 2700 m (Ryazanian) to 2722 m (Late Bajocian /Early Bathonian) all contains significant amounts of liptinitic material with increasing contents of humic material with depth. The potential changes from a good source for oil to a condensate prone source.

The samples at 2725.07 and 2726.05 meters are mainly gas prone.

The sample from from 2757 m (late Bajocian/Early Bathonian) is very rich in algal material and is an excellent source for oil. The samples from 2837 m (Early Toarcian/Late Pliensbachian) to 3000.50 m (Pliensbachian-Sinemurian) all contains varying amounts of liptinitic material and are oil/condensate or condensate prone.

The deeper samples are mainly dominated by humic material and are considered condensate and/or gas prone.

## MATURITY BASED ON VITRINITE REFLECTANCE EVALUATIONS

The mean vitrinite reflectance ( $R_o$  %) values for 34 measured samples (exclusively sidewall cores and core chips) are shown in Fig. 7; Tab. 7.

In the upper and middle part of the section (1180 to 3113 m) there is a marked spread in the values. It is especially apparent between about 1900 and 2550 m where most of the values are above  $R_o$  0.5%. The relatively high reflecting vitrinite material in this part of the well is considered to be reworked from older deposits. In addition, a coal sample from 3039.4 metres show an exceptionally high reflectivity. This is considered to be due to oxidation of the vitrinite.

An evaluation of type of woody material, the spread in reflectivity values, and the number of counts in each sample has been performed. Based on this, samples which are considered to represent the most reliable reflectivity values have been selected. These samples are designated with green coloured circles in the diagram (Fig. 7). A best fit curve is calculated for the values, and give a regression of 0.88 which is considered to be significant.

Provided there exist no major loss in the sedimentary succession, the regression line should show a reflection value at the sea bottom of about 0.1 to 0.2 %  $R_o$ . In this case the value is 0.12 %  $R_o$ .

**Maturity:** According to the interpreted  $R_o$  % values, a middle mature stage is reached at about 3000 m depth in this well. The sediments between 1100 and about 2200 metres are organically immature, whereas the succession from here down to about 3000 m is in a early mature stage.

SOURCE ROCK QUALITY BASED ON VISUAL KEROGEN DESCRIPTIONS

A total of 38 (SWC and CC) samples have been analysed semi-quantitatively in a microscope. The histograms in Fig 8 and Table 8, show the results of the analyses.

Commonly a simple classification of kerogen types, i.e. Type I to III or IV is used to describe the kerogen content of sediments. Type I consists of algal material (Tasmanites sp. Botrycoccus sp.) and resinite. Type II: palynomorphs (spores, pollen, dinocysts, acritarchs), cuticula fragments, and a varying amount of woody material from land plants. Type III usually defines material of brown to black wood (dense or structured i.e. vitrinite). Type IV consists exclusively of opaque wood (inertinite).

According to this, the sedimentary succession in the well could be divided into six main parts. As seen from the summary below, based on semi-quantitative optical kerogen studies, there is not always a clearcut separation of the kerogen types II and III) as often interpreted in the literature.

**Kerogen types:**

1800 - 1927 m: Type II with degraded material of type III.

1946 - 2425 m: Type II with large amounts of wood.

2590 - 2649 m: Type III (contains pyritized wood) with small amounts of palynomorphs.

2670 - 2711 m: Type II with palynomorphs, wood and opaque wood. Considerable amounts of amorphous material derived from palynomorphs.

2713 - 2781 m: Type III with a small amount of palynomorphs.

2781 - 3092 m: Both type II, III and IV are present here.

### Hydrocarbon potential

The hydrocarbon potential of the succession (based on visual kerogen analyses) is as follows:

1800 - 1927 m: Partly, the kerogen content points to a good potential, but the amount of degraded woody material lowers the potential significantly.

1946 - 2425 m: This interval is dominated by woody material. Opaque wood constitutes a major part: Poor potential.

2590 - 2649 m: Pyritized wood and woody material dominate. Palynomorphs are present. The potential is very poor.

2670 - 2711 m: Dominating content of palynomorphs, but wood is present in varying amounts. Large amounts of amorphous material derived from palynomorphs characterize this sequence. The potential is regarded to be very good.

2713 - 2781 m: Characterized by woody material with considerable amounts of opaque wood. Some samples have larger amounts of palynomorphs and cuticula fragments (oil prone). A sample from 2830.03 m is remarkable because it contains large amounts of palynomorphs, cuticula fragments, and amorphous material of palynomorph origin.

The interpretation of hydrocarbon potentials (based on visual kerogen analyses) is in most cases comparable with the hydrogen indices.

Figure 9 shows a comparison between the relative amount of palynomorphs in each sample versus the hydrogen index (HI).

In general, the comparison shows that when the HI is high, the palynomorph content is high, and vice versa.

Some anomalies are apparent, however, most of which could be explained when other kerogen components than palynomorphs are considered.

## CONCLUSIONS

The main conclusions from this report are summarised in Fig. 10.

### Maturity:

The interpreted vitrinite measurements indicate onset of oil generation ( $R_o$  0.55 %) at approx. 3000 m in this well.

This observation is supported by the biomarker analysis.

The interval from 2200 m to 3000 m is considered early mature ( $R_o$  0.35 - 0.55 %), while the shallower sections are immature.

### Kerogen type:

The interval from 2000 m to 2590 m consists mainly of type II kerogen with degraded type III, and contains large amounts of woody material.

The interval from 2590 m to 2697 m is rich in pyritized wood and consists of type III kerogen.

The interval from 2697 m to 2713 m contains large amounts of amorphous material, and is mainly a type II kerogen.

The interval from 2713 m to 2780 m contains inertinite and is considered a type III/IV kerogen.

The interval from 2780 m to 3200 m consists of varying kerogen types from samples containing a lot of woody material to samples dominated by palynomorphs.

Some samples contain cuticular fragments.

### Petroleum potential:

The interval down to 2697 m has a poor to fair potential mainly for gas/condensate.

The section from 2697 m to 2713 m has an excellent potential for oil/condensate. The quality decreases with depth within this interval.

The interval from 2780 m to 3200 m has a varying petroleum potential ranging from no to excellent, and from oil prone to gas prone source rocks.

## EXPERIMENTAL

### **Sample preparation:**

SWC and core samples were rinsed to remove contaminants. Samples from the 1-2 mm fraction were handpicked from drill cuttings.

### **Extractable organic matter (EOM):**

The samples were Soxhlet extracted for 24 hours with 93:7 DCM/Methanol. Activated copper was added to the flask during extraction to remove elemental sulphur.

### **Desphalting:**

The EOM was heated overnight in hexane (60 ul/mg) and the hexane insoluble fraction reported as asphaltenes.

### **Group Type separation:**

The hexane soluble part of the EOM was separated into saturate, aromatic and polar fractions using MPLC with a cyano/amino modified silica as precolumn and a silica main column. The fractions were quantified using a Pye LCM2 moving wire detector.

### **Gas chromatographic analysis:**

The saturate fractions were analysed on a HP 5880 gas chromatograph using a 30 meter DB-1 (J&W) fused silica column with helium as carrier gas. The temperature program was 80°C initial temperature for 2 min. followed by 6°/min. to 300°C and held for 15 min.. The aromatic fractions were analysed on a HP 5880 gas chromatograph using a 25 meter 5% crosslinked methyl-phenyl silicone fused silica column (HP). The temperature program was an initial hold at 2 min. at 80°C followed by programming at 4°/min. to 300°C and held for 15 min.

### **Gas chromatography-mass spectrometry (GCMS):**

Selected saturated alkane fractions were analysed in the voltage selected ion recording (VSIR) mode using a VG 7070E mass spectrometer coupled to a HP 5790 gas chromatograph.

### **Pyrolysis gas chromatography:**

The pre extracted samples were pyrolysed in an oven programmed from 300 to 550°C. The first part of the column was cooled in liquid nitrogen during the pyrolysis and then programmed from 35°C to 300°C at 4°/min.

### **Vitrinite reflectance:**

Samples were washed on a sieve with warm water to remove drilling mud. After drying, they were mounted in Bakelite resin blocks. The samples were then ground on a diamond lap

and subsequently polished with two grades of Corundum paper. The grinding and polishing was carried out using isopropyl alcohol as a lubricant. The samples were finally polished using three grades of alumina, 5/20, 3/50 and Gamma. Reflectance measurements were carried out on a Leitz M.P.V. microphotometer under oil immersion, R.I. 1.516 at a wavelength of 546 nm.

**Visual kerogen analysis:**

Samples for visual kerogen analysis were selected from Rock-Eval screening analyses. The samples were crushed and demineralised with HCl and HF and mounted on slides for subsequent microscopic study.

# TABLES

## EXTRACTION YIELDS

DEPTH m	EOM ppm	EOM/TOC mg/g TOC	DEPTH m	EOM ppm	EOM/TOC mg/g TOC
1189.91	400	16.3	2718.04	300	26.5
1209.94	500	14.5	2719.10	400	17.2
1299.99	100	10.2	2720.05	400	13.9
1419.92	80	5.7	2721.10	700	16.0
1639.93	100	7.0	2722.03	500	15.2
1739.88	400	25.6	2723.12	200	23.3
1824.82	1500	60.0	2724.10	160	25.8
1939.00			2725.07	500	43.1
1990.00	200	22.7	2726.05	200	11.0
2085.50	200	28.6	2747.00	100	6.2
2155.00	200	19.8	2757.00	600	5.0
2170.00	80	11.1	2765.04	7500	238.1
2270.00	100	11.5	2780.60	6000	600.0
2370.00	80	8.5	2837.00	31000	
2446.50	100	8.8	2840.00	3000	
2699.00	1700	38.3	2877.00	11000	846.2
2700.00	5000	83.1	2905.00	13000	849.7
2702.00	2400	60.9	2915.00	13000	1171.2
2703.00	3000	65.8	2956.00	8000	740.7
2704.00	3400	72.8	2966.00	13000	1203.7
2704.50	3000		3000.50	3500	42.7
2705.50	600		3017.20	1100	41.7
2706.00	800		3024.00	10000	126.4
2707.50	2000		3027.83	11000	24.5
2709.00	700		3032.30	20000	63.4
2710.50	300		3034.20	8000	32.4
2711.00	1400	27.1	3039.40	7000	20.8
2712.00	800		3064.37	7500	87.7
2712.50	1700		3071.57	14000	32.1
2713.00	1700		3075.45	4000	36.9
2713.25	300	61.2	3081.50	200	26.3
2714.20	500	40.3			
2715.05	500	104.2			
2716.23	300	24.8			
2716.97	500	29.9			

Table 1: Extraction yields in ppm of dry sediment and in mg/ g TOC.

## GROUP TYPE SEPARATION

DEPTH m	ASPHALTENES %	SAT %	AROM. %	NSO %
1189.91	39.50			
1209.94	37.50			
1299.99	41.70			
1419.92	33.30			
1639.93	17.60			
1739.88	30.60	16.7	16.7	66.6
1824.82	66.25	29.2	12.5	58.3
1939.00		40.8	44.2	14.9
1990.00	20.00			
2085.50	25.80			
2155.00	30.00	12.3	19.3	68.4
2170.00	33.30	7.8	36.8	55.4
2270.00	34.80	7.4	38.8	53.7
2370.00	38.50			
2446.50	20.00			
2699.00	9.70	27.0	41.7	31.2
2700.00	10.70	20.5	34.3	45.2
2702.00	7.90	29.5	36.7	33.8
2703.00	19.00	22.5	31.8	45.7
2704.00	7.10	34.4	31.2	34.4
2704.50	27.10	30.5	37.9	31.6
2705.50	40.00	31.2	25.3	43.3
2706.00	24.10			
2707.50	33.90	31.6	45.0	23.4
2709.00	28.00	50.3	28.1	21.7
2710.50	33.30	53.2	25.0	21.8
2711.00	47.60	28.2	39.7	32.1
2712.00	39.50	47.3	25.9	26.7
2712.50	52.00	28.2	36.5	35.3
2713.00	56.60	31.8	37.2	30.9
2713.25	33.30	50.3	21.9	27.8
2714.20	35.30			
2715.05	9.70			

Table 2: Results from deasphalting and group type separation. Saturates, aromatics and NSO- compounds are reported as % of deasphalted material.

DEPTH m	ASPHALTENES %	SAT %	AROM. %	NSO %
2716.23	34.60	34.1	30.9	35.0
2716.97	49.50	23.1	36.7	40.3
2718.04	28.20	32.7	34.1	33.2
2719.10	73.90	16.2	40.7	43.1
2720.05	54.90	20.4	36.3	43.3
2721.10	42.40	25.1	34.6	40.4
2722.03	30.90	27.3	35.2	37.5
2723.12	7.80	74.1	2.2	23.7
2724.10	29.50	68.6	3.2	28.1
2725.07	23.80	50.0	29.6	20.4
2726.05	56.70	22.2	33.1	44.7
2747.00	55.60	13.4	29.1	57.5
2757.00	22.20	23.2	39.5	37.3
2765.04	0.60	77.6	17.3	4.9
2780.60	0.50	76.4	18.2	5.4
2837.00	15.80	24.2	47.6	28.2
2840.00	7.20	65.2	22.3	12.4
2877.00	0.50	74.3	18.9	6.8
2905.00	0.20	74.6	17.1	8.3
2915.00	0.20	72.4	18.9	8.7
2956.00	0.20	73.5	18.3	8.2
2966.00		81.2	10.4	8.4
3000.50	26.70	28.6	39.7	31.8
3017.20	38.30	34.4	44.8	20.9
3024.00	7.50	70.5	13.1	16.4
3027.83	10.60	66.9	16.3	16.7
3032.30	34.10	57.4	30.5	12.1
3034.20	65.70	14.9	54.1	30.9
3039.40	96.00	7.5	45.5	46.9
3064.37	58.60	42.4	39.8	17.8
3071.57	42.30	21.4	46.5	32.2
3075.45	30.10	27.5	47.1	25.3
3081.50	13.00	55.6	20.2	24.2

Table 2 continued

DEPTH m	Pr/Ph	Pr/nC17	CPI-1 <sup>1</sup>	CPI-3 <sup>2</sup>
1189.91	0.56	0.52	1.044	1.042
1209.94	0.61	0.57	0.924	0.834
1299.99	0.30	1.35	1.153	1.167
1419.92	0.47	1.09	1.114	0.819
1639.93	1.70	2.30	0.727	0.579
1739.88	4.60	8.70	1.138	0.670
1824.82	2.70	6.00		
1939.00	1.40	0.70	1.046	0.863
1990.00	0.98	0.88	1.099	1.271
2085.50	0.78	0.76	0.766	0.422
2155.00	3.70	3.40	1.312	1.957
2170.00	2.90	1.20	1.461	2.122
2270.00	2.90	1.40	1.395	1.947
2370.00	2.54	0.90	1.270	1.688
2446.50	2.88	1.00	1.281	1.638
2699.00	3.20	2.40	1.042	0.880
2700.00	2.40	2.50	1.241	1.120
2702.00	2.90	2.90	0.952	0.814
2703.00	2.60	2.40	1.021	0.800
2704.00	2.60	2.90	1.001	0.900
2704.50	2.70	1.90	0.896	0.701
2705.50	2.40	0.90	1.102	1.072
2706.00	2.70	1.00	1.001	0.950
2707.50	2.80	1.10	1.082	1.006
2709.00	2.90	1.20	1.055	1.055
2710.50	3.10	2.30	1.089	1.120
2711.00	3.30	2.00	1.126	1.116
2712.00	4.00	2.20	1.098	1.133
2712.50	3.90	1.90	1.121	1.089
2713.00	3.70	1.80	1.104	1.403
2713.25	1.50	0.90	1.129	1.120
2714.20	1.51	1.10	1.059	1.095
2715.05	2.39	1.03	1.080	1.052
2716.23	2.90	1.00	1.118	1.091
2716.97	5.60	2.80	1.256	1.447
2718.04	4.00	1.30	1.257	1.605
2719.10	5.30	2.30	1.353	1.650
2720.05	3.80	1.30	1.289	1.511
2721.10	3.30	1.20	1.316	1.594

Table 3: Molecular ratios from the gas chromatograms of the saturated hydrocarbons.

DEPTH m	Pr/Ph	Pr/nC17	CPI-1	CPI-3
2722.03	3.20	1.40	1.288	1.530
2723.12	2.70	0.70	1.093	1.028
2724.10	2.90	0.70	1.102	1.000
2725.07	3.30	0.80	1.143	1.071
2726.05	3.70	2.50	1.097	1.173
2747.00	2.10	0.70	1.171	1.271
2757.00	3.70	0.80	1.257	1.373
2765.04	2.00	0.70	1.031	0.997
2780.60	1.90	0.70	1.002	1.016
2837.00	1.90	0.50	0.993	0.958
2840.00	1.80	0.80	0.989	1.039
2877.00	1.90	0.80	0.994	1.000
2905.00	1.70	0.80	0.989	1.011
2915.00	1.90	0.80	0.965	0.948
2956.00	1.90	0.80	0.938	0.996
2966.00	1.90	0.80	0.978	0.912
3000.50	8.50	3.30	1.286	1.366
3017.20	5.40	3.80	1.429	1.767
3024.00	1.80	0.80	0.964	0.941
3027.83	1.70	0.70	1.036	0.983
3032.30	2.10	0.60	0.997	0.941
3034.20	8.10	1.70	1.161	1.271
3039.40	4.70	0.30	1.365	1.143
3064.37	1.80	0.60	0.950	1.007
3071.57	9.10	1.90	1.289	1.367
3075.45	10.50	4.90	1.221	1.330
3081.50	1.80	0.80	1.001	1.016

$$1) \text{ CPI-1} = \frac{1}{2} \frac{25+27+29+31}{24+26+28+30} + \frac{25+27+29+31}{26+28+30+32}$$

$$2) \text{ CPI-3} = 2 \times 27 / 26 + 28$$

Table 3 continued

DEPTH m	MPI-1 <sup>1</sup>	MPI-2 <sup>2</sup>	DEPTH m	MPI-1	MPI-2
1189.91			2716.23	0.586	0.428
1209.94			2716.97	0.542	0.372
1299.99			2718.04	0.548	0.399
1419.92			2719.10	0.581	0.474
1639.93			2720.05	0.598	0.488
1739.88			2721.10	0.777	0.624
1824.82			2722.03	0.573	0.445
1939.00	0.794	0.918	2723.12	0.636	0.592
1990.00			2724.10	0.572	0.543
2085.50			2725.07	0.626	0.524
2155.00	0.783	0.929	2726.05	0.557	0.499
2170.00	0.618	0.692	2747.00	0.558	0.552
2270.00	0.459	0.503	2757.00	0.683	0.617
2370.00			2765.04	0.649	0.605
2446.50			2780.60	0.673	0.654
2699.00	0.716	0.421	2837.00	0.649	0.557
2700.00	0.645	0.376	2840.00	0.629	0.525
2702.00	0.697	0.388	2877.00	0.638	0.627
2703.00	0.719	0.416	2905.00	0.657	0.665
2704.00	0.660	0.382	2915.00	0.625	0.615
2704.50	0.615	0.393	2956.00	0.658	0.655
2705.50	0.689	0.568	2966.00	0.598	0.553
2706.00			3000.50	0.551	0.516
2707.50	0.553	0.404	3017.20	0.597	0.490
2709.00	0.610	0.483	3024.00	0.622	0.539
2710.50	0.638	0.588	3027.83	0.609	0.506
2711.00	0.600	0.396	3032.30	0.527	0.491
2712.00	0.587	0.458	3034.20	0.515	0.436
2712.50	0.549	0.373	3039.40	0.555	0.530
2713.00	0.589	0.390	3064.37	0.641	0.593
2713.25	0.567	0.491	3071.57	0.478	0.434
2714.20			3075.45	0.512	0.470
2715.05			3081.50	0.982	1.091

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

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

Table 4: Molecular ratios from the gas chromatograms of the aromatic hydrocarbons.

20  
BIOMARKER RATIOS

DEPTH (m)	% 22S	Tm/Ts	N/N+H	% 20S	% abb	STR/TRIT.
1736.88				22	13	0.07
1824.84						0.19
1939.00	58	1.10	0.46	51	54	0.71
2155.00	67					0.56
2170.00						
2270.00	12		0.34			0.05
2699.00	58	2.30	0.40	31	25	0.39
2700.00	58	2.00	0.36	31	26	0.44
2702.00	63	2.10	0.35	30	26	0.37
2703.00	58	1.90	0.38	32	26	0.33
2704.00	58	1.80	0.38	31	27	0.38
2704.50	59	1.70	0.37	34	29	0.37
2705.50	59	2.10	0.37			
2706.00	60	2.40	0.37	38	32	0.43
2707.50	58	3.60	0.38	34	28	0.21
2709.00	58	3.40	0.37	37	27	0.28
2710.50	61	2.80	0.37	37	33	0.29
2711.00	59	4.60	0.37	38	27	0.17
2712.00	59	3.50	0.38	38	32	0.22
2713.35	59	2.90	0.38	40	40	0.21
2716.23	60	3.70	0.36	34	31	0.15
2716.97	60	16.00	0.41	29	30	0.06
2718.04	58	7.10	0.39	33	29	0.06
2719.10	61	22.00	0.44	26	26	0.09
2720.05	60	14.80	0.45	32	33	0.11
2721.10	58	10.00	0.42	31	29	0.11
2722.03	58	10.30	0.43	31	28	0.12
2723.12	63	2.60	0.39	38	42	0.28
2724.10	63	2.30	0.40	46	48	0.21
2725.07	61	2.90	0.40	41	38	0.99
2726.05	57	8.00	0.29	35	33	0.15
3017.20	61	7.30	0.37	52	42	0.08
3024.00	62	3.90	0.27	57	65	0.43
3027.83	65	5.30	0.27	63	67	0.39
3032.30	60	4.80	0.46	52	45	0.08
3034.20	59		0.48	47	33	0.05
3039.40						0.35
3064.37	61	0.44	0.33			0.40
3071.57	58	24.70	0.48	45	32	0.05
3075.45	59	22.00	0.57	48	38	0.03
3081.50	62	3.50	0.31	62	68	0.40

- |                                |                             |
|--------------------------------|-----------------------------|
| 1) %22S homohopane             | 4) %abb 24-ethylcholestanes |
| 2) norhopane/norhopane+hopane  | 5) steranes/triterpanes     |
| 3) %20S aaa 24-ethylcholestane |                             |

Table 5 : Biomarker ratios from m/z 191 and 217 fragmentograms.

## PYROLYSIS GC RESULTS

DEPTH (m)	METHANE	C2-C5	C6-C14	C15+
1824.82	6.9	19.6	45.3	28.2
2085.50	4.2	16.3	43.1	36.4
2700.00	2.6	11.7	26.4	59.2
2703.00	2.8	14.1	30.7	52.3
2709.00	5.2	15.8	42.6	36.4
2711.00	3.3	11.7	27.8	57.2
2713.00	3.7	12.8	33.0	50.4
2718.04	3.3	15.6	36.4	44.8
2725.07	8.1	18.8	45.6	27.5
2726.05	8.1	24.3	63.1	4.5
2757.00	2.9	13.1	30.3	53.7
2837.00	5.9	12.1	23.0	59.0
2840.00	2.1	9.9	28.3	59.7
2877.00	6.1	18.4	36.8	38.8
3000.50	3.8	10.6	29.1	56.6
3027.83	3.7	6.7	24.0	65.6
3039.40	6.0	16.1	36.6	41.3
3064.37	6.9	12.8	23.5	56.7
3075.45	0.5	10.6	31.9	57.0

Table 6: Results from the pyrolysis-GC in % of total area.

Table 7: Results of vitrinite reflectance measurements.

### VITRINITE REFLECTANCE

DEPTH (m)	R <sub>o</sub> %	No OF PARTICLES	DEPTH (m)	R <sub>o</sub> %	No OF PARTICLES
1189.91	0.24	6	2550.00	0.40	1
1209.94	0.26	4	2590.00	0.52	2
1249.96	0.44	4	2590.00	0.50	4
1299.99	0.29	1	2700.00	0.44	23
1419.92	0.29	2	2702.00	0.45	11
1639.93	0.37	7	2703.00	0.43	21
1739.88	0.34	10	2704.00	0.40	20
1824.82	0.29	20	2719.10	0.51	6
1844.94	0.29	20	2747.00	0.47	5
1939.00	0.69	4	2757.00	0.50	8
1990.00	0.58	13	2837.00	0.52	21
2083.50	0.59	20	2994.55	0.46	23
2170.00	0.57	4	3037.60	0.63	20
2270.00	0.62	8	3039.40	0.96	20
2370.00	0.58	4	3071.57	0.66	20
2446.00	0.63	2	3113.00	0.67	2
2446.50	0.54	4			

Tab.8: Relative amount of 6 kerogen types,  
amorphous material, total amount of  
organic carbon (TOC), hydrogen indices  
(HI), and maximum temperature (pyrolysis)  
T max. Well 6407/7-1.

# VISUAL KEROGEN ANALYSIS

DEPTH IN M	OPAQUE WOOD	DENSE WOOD	STRUCT. WOOD	PALYNO- MORPHS	PYRIT. WOOD	CUTICULA	AMORPH. MATERIAL	SAMPLE TYPE	TOC	HI	T. MAX	DEPTH IN M
1	1805.15	1.3	9.1					100 SWC	2.46	149	416	1805.15
2	1824.82	0.5	1.0	4.6				100 SWC	2.50	200	425	1824.82
3	1844.84	1.7		0.8				70 SWC	2.15	188	415	1844.84
4	1898.08	17.6	3.9	3.9				SWC	0.48	400		1898.08
5	1927.00	15.6	7.8	6.3				SWC	0.66	195		1927.00
6	1946.00	90.0	10.0					SWC		0		1946.00
7	1981.00	67.8		9.2				SWC	0.63	167		1981.00
8	2121.00	60.5	3.2	6.0				SWC	1.05	290	430	2121.00
9	2190.00	75.9	3.0	7.8				SWC	0.80	224	453	2190.00
10	2276.50	31.5	5.5	18.2				SWC	2.01	116		2276.50
11	2314.00	100.0						SWC	0.98	228		2314.00
12	2425.00	48.3	6.9	8.0				SWC	1.17	136		2425.00
13	2590.00			5.7				SWC	0.94	106	446	2590.00
14	2630.00			2.5				SWC	1.10	100	439	2630.00
15	2649.00			3.4				SWC	0.95	80	441	2649.00
16	2670.00	47.7	12.0	8.6				SWC	0.61	144		2670.00
17	2699.00	17.2	27.6	6.9		2.3		15 SWC	4.44	368	427	2699.00
18	2702.00	13.3		6.7				50 SWC	3.94	379	423	2702.00
19	2704.00	21.0	10.5	10.5				30 SWC	4.67	367	424	2704.00
20	2711.00	46.6		6.7				100 SWC	5.17	329	424	2711.00
21	2713.25	75.3	1.4	13.7				CC	0.49	88	426	2713.25
22	2720.05	66.3		26.5				CC	2.88	70	435	2720.05
23	2747.00	78.4	1.0	13.4				SWC	1.62	59	430	2747.00
24	2757.00	32.3		15.6				SWC	12.11	515	424	2757.00
25	2774.00	62.5	10.9	14.1				CC	1.27	160	437	2774.00
26	2781.00	90.0		6.0				CC	0.90	150	440	2781.00
27	2790.00	20.3	3.4	28.8				CC	1.63	339	440	2790.00
28	2821.80	4.6	3.8	30.8				CC	1.30	467	438	2821.80
29	2830.03							80 CC	2.53	633	436	2830.03
30	2837.00	100.0						SWC		0		2837.00
31	2871.00	8.0	12.0	14.7				CC	1.58	163	433	2871.00
32	2890.00	21.3	9.0	9.0				CC	1.18	196	422	2890.00
33	2911.00	31.9	10.6	6.4				CC	1.75	263	441	2911.00
34	2992.00	60.0	40.0					CC	1.04	122		2992.00
35	3037.60	75.0	25.0					CC	1.78	88	456	3037.60
36	3040.85	10.0						CC	2.19	326	445	3040.85
37	3045.00	100.0						SWC	26.18	239	442	3045.00
38	3092.40	73.3	22.2					CC	1.61	226	434	3092.40

NOTE: The amount of cuticula fragments is not representative for the total because the larger fragments are not included in the slide material.

# FIGURES

# HALTENBANKEN

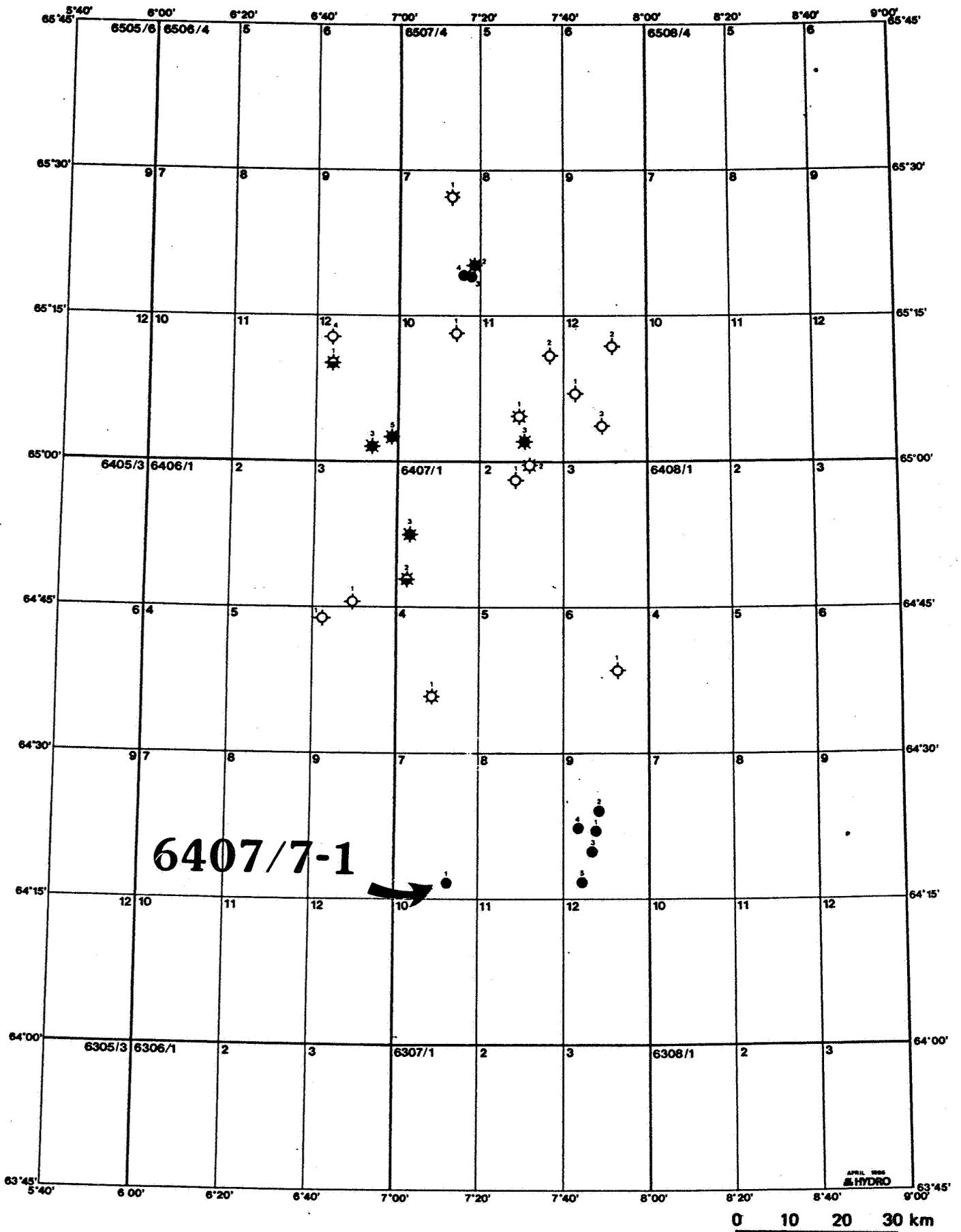


Figure 1: Well location map.



Well : 6407/7-1

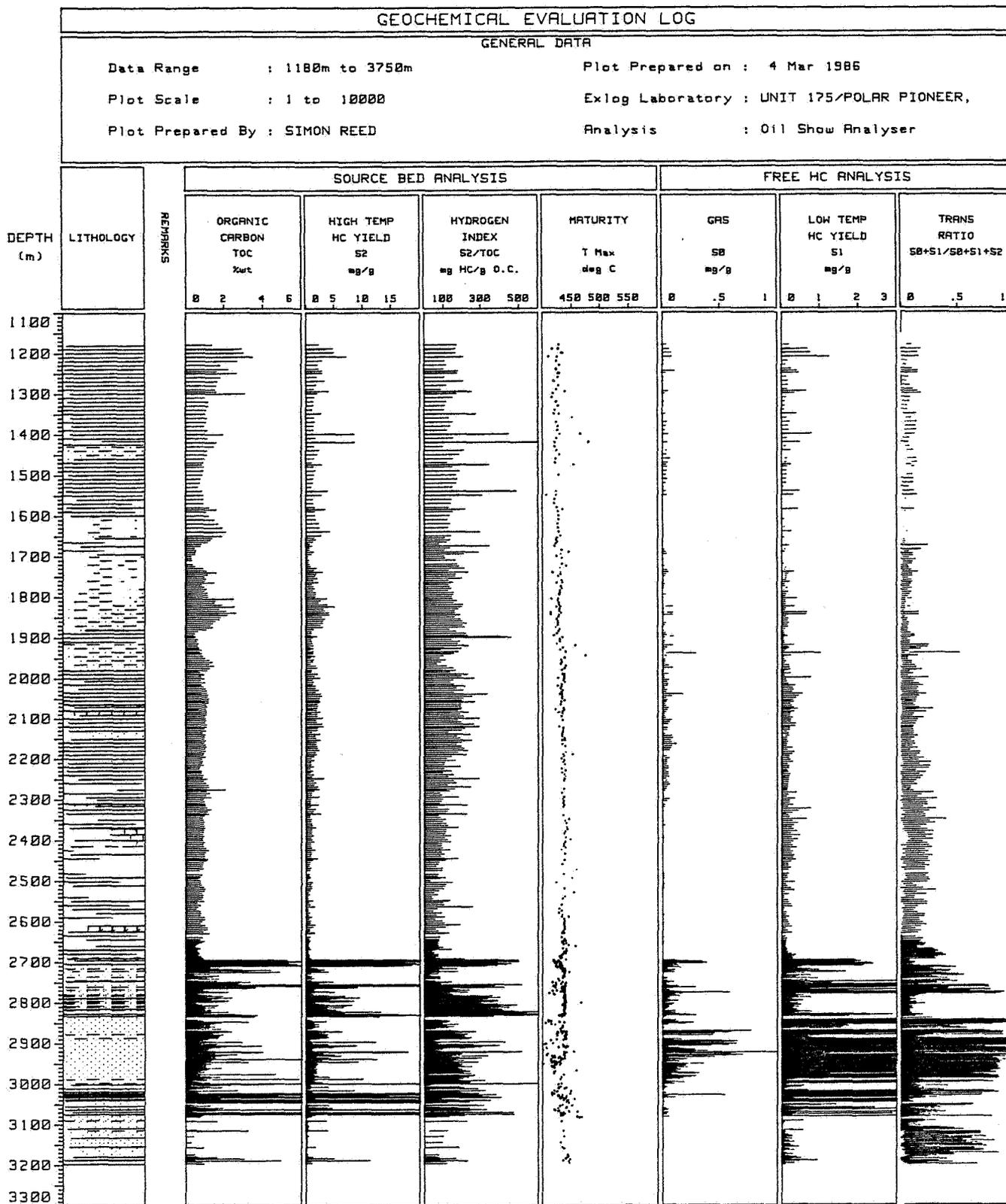


Figure 2: Geochemical Evaluation log well 6407/7-1.

Figure 3: EOM (ppm) plotted versus depth.



Figure 4: EOM/TOC plotted versus depth

WELL: 6407/7-1 EOM/TOC

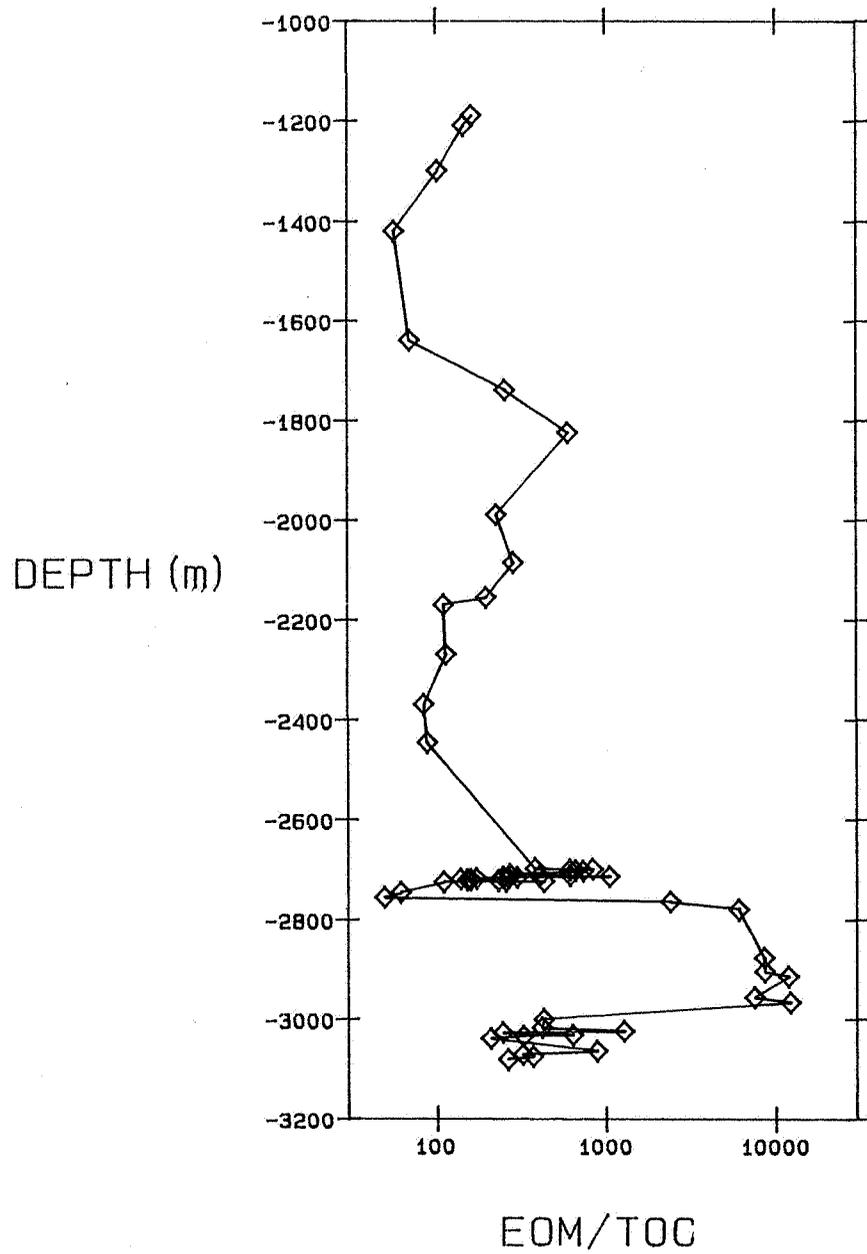
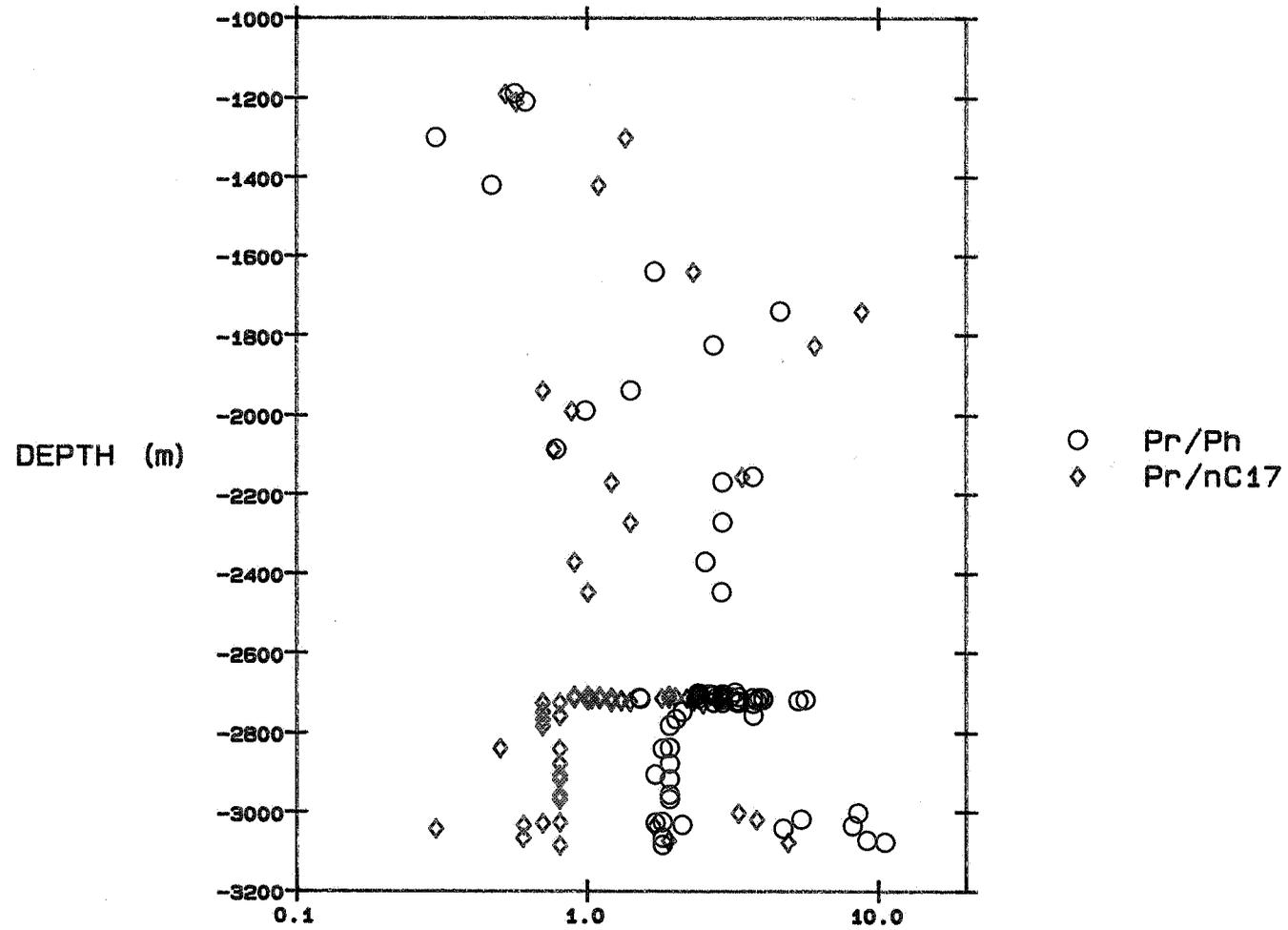


Figure 5: Saturates/aromatic hydrocarbons plotted versus depth.



Figure 6: Pristane/phytane and pristane/n-C<sub>17</sub> plotted versus depth.

GC DATA 6407/7-1



GC DATA 6407/7-1

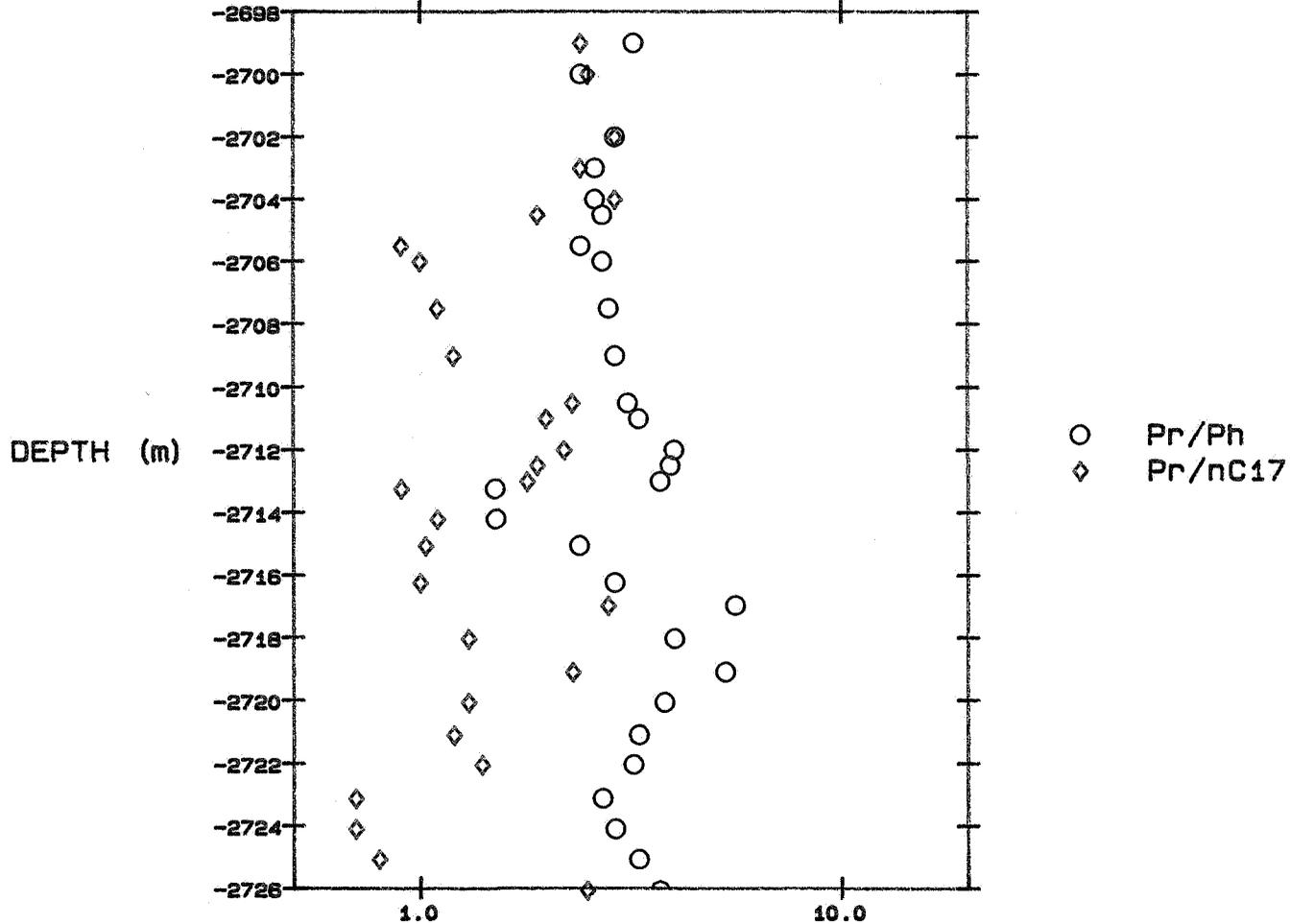
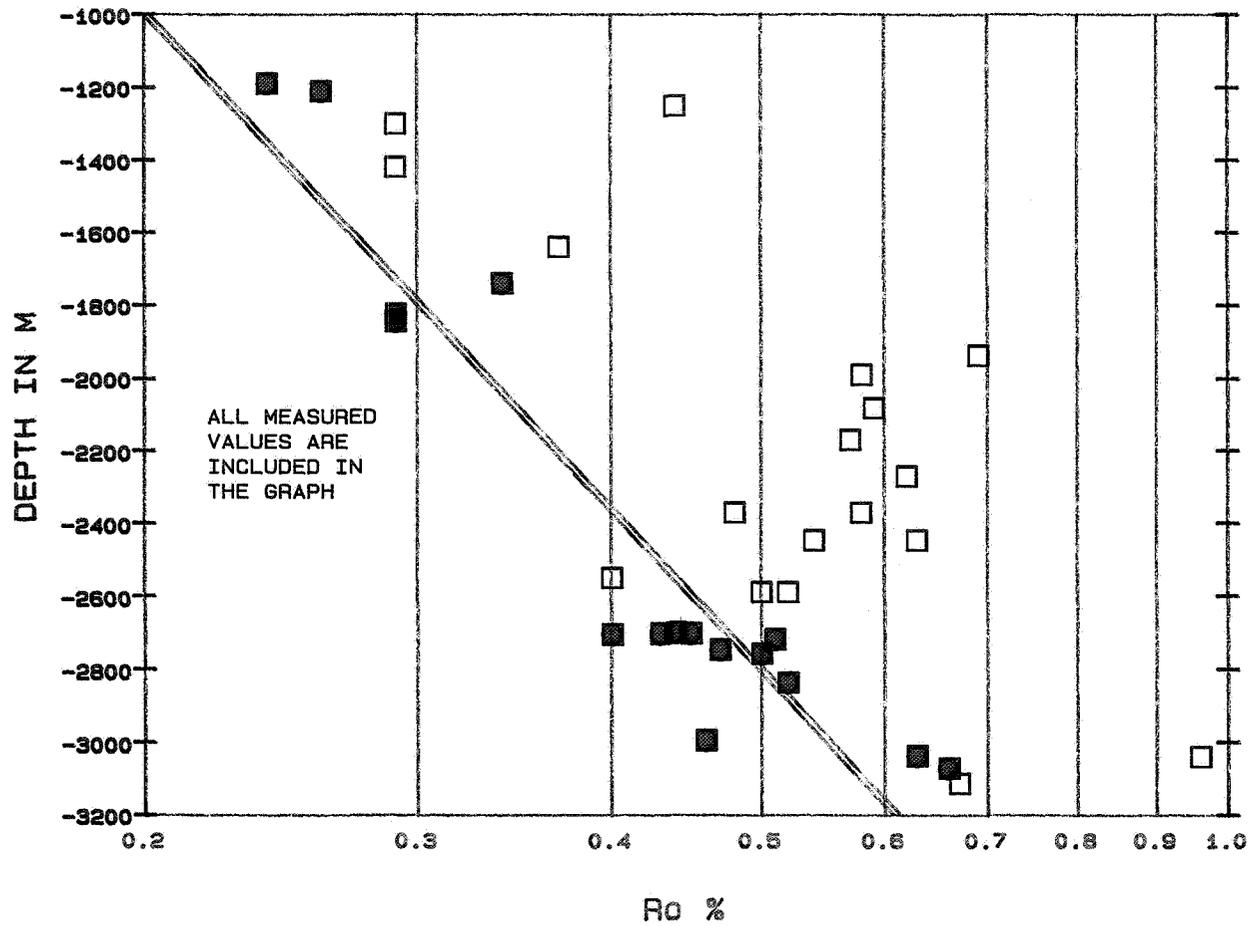


Fig.7: Vitrinite reflectance (mean Ro%) versus depth, well 6407/7-1.

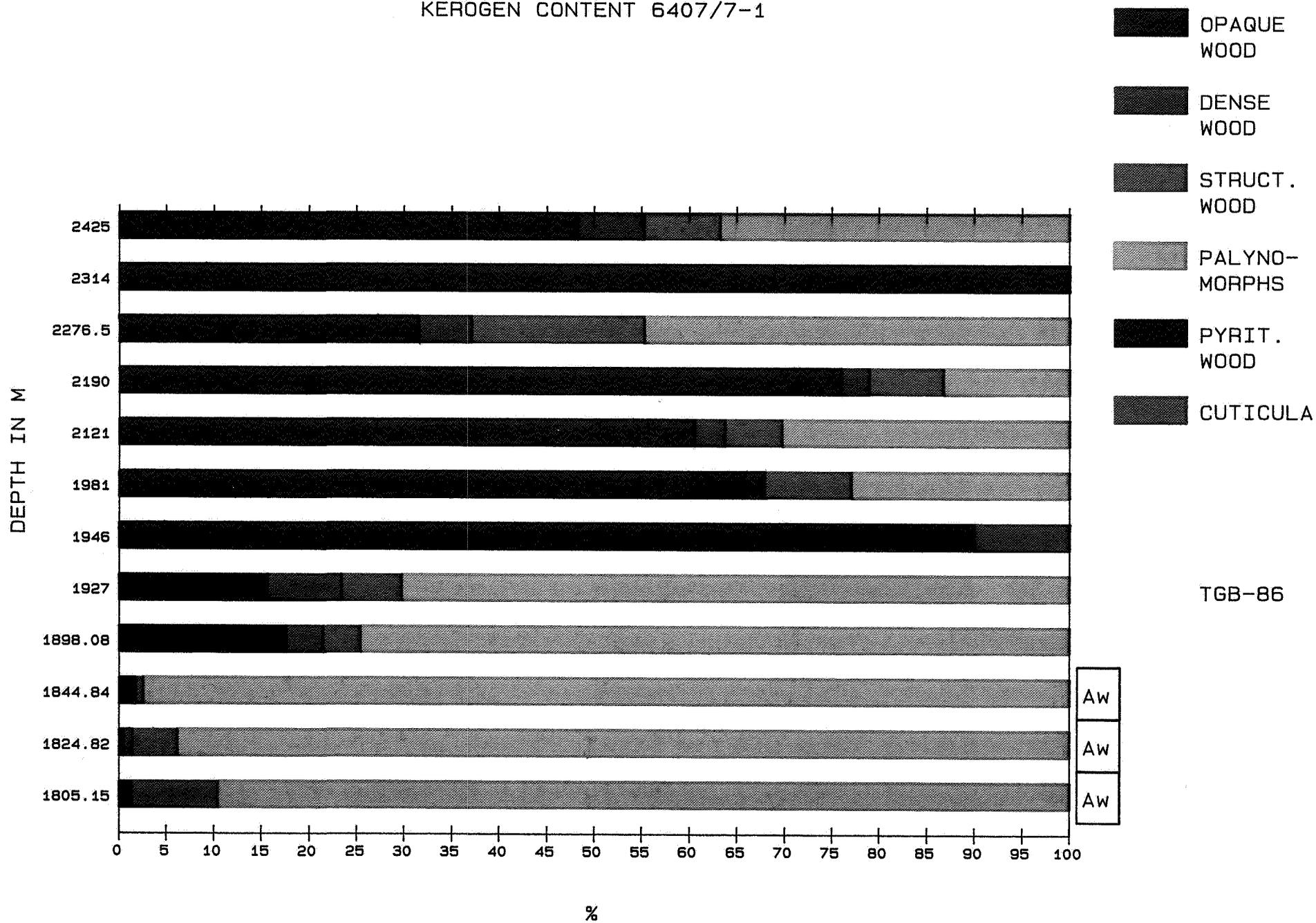
VITRINITE REFLECTANCE  
6407/7-1



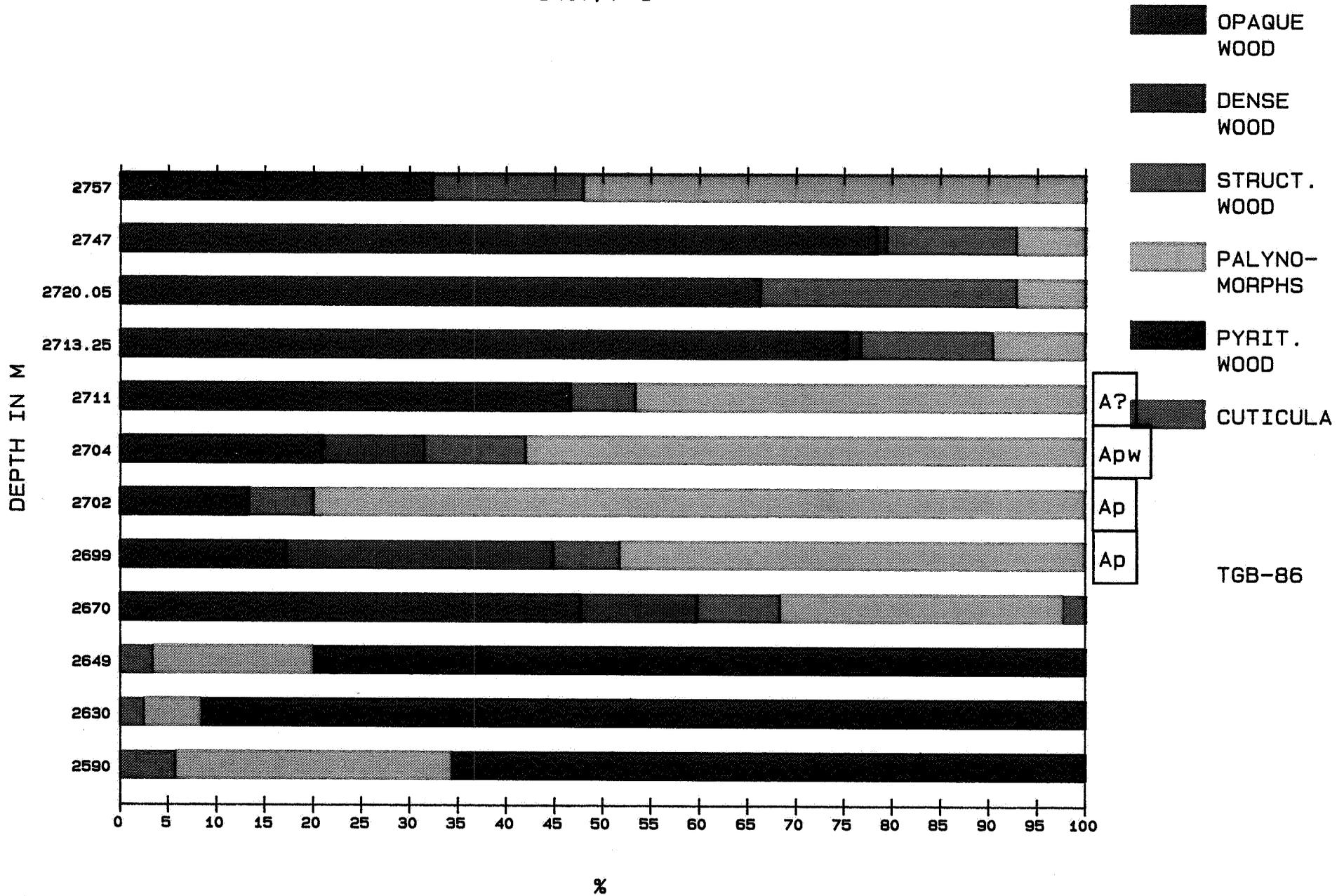
● INTERPRETED DATA: MULT.R SQ.=0.88

Fig.8: Relative amount of kerogen types in  
each sample, well 6407/7-1.

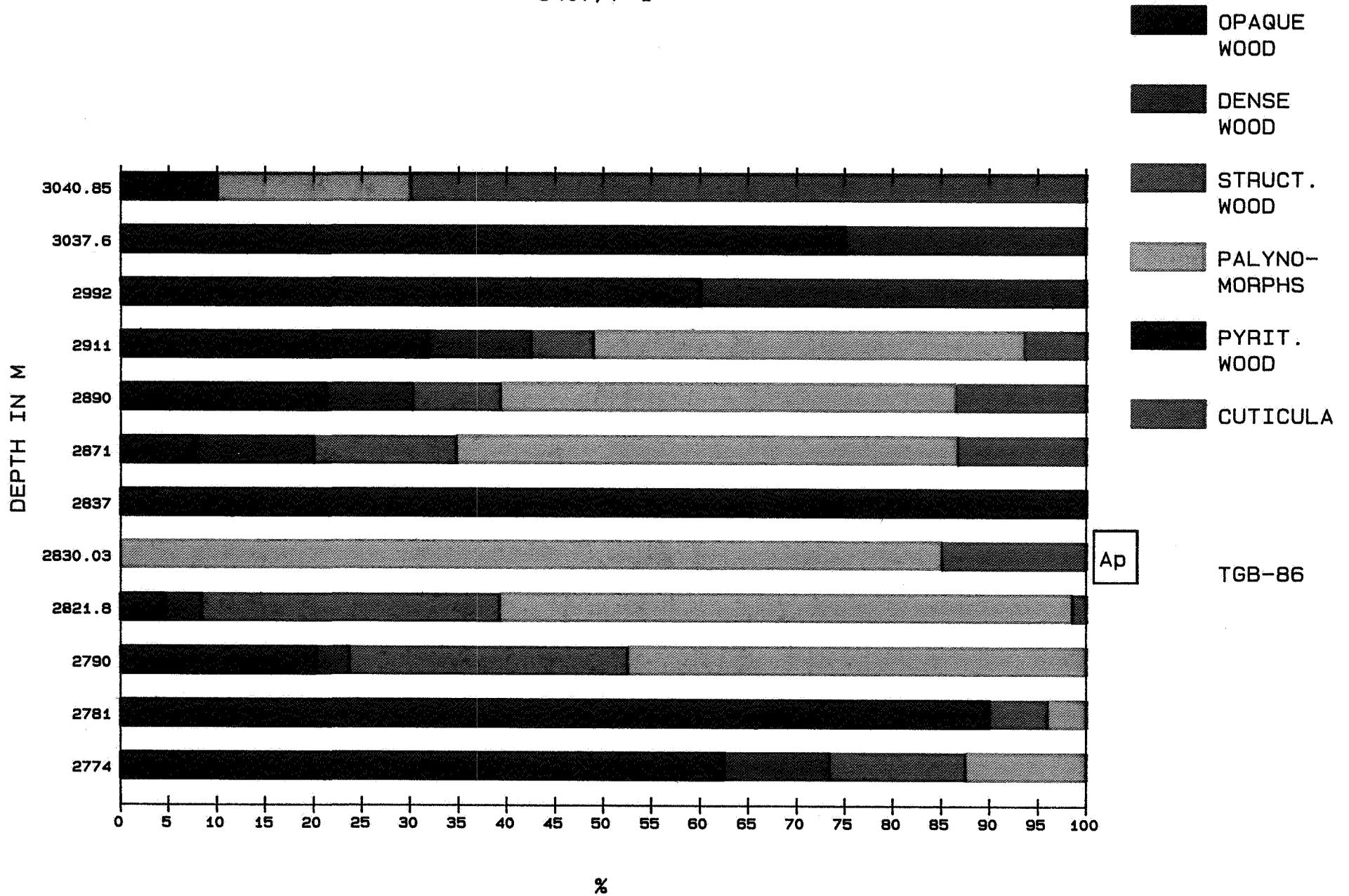
KEROGEN CONTENT 6407/7-1



KEROGEN CONTENT  
6407/7-1



KEROGEN CONTENT  
6407/7-1



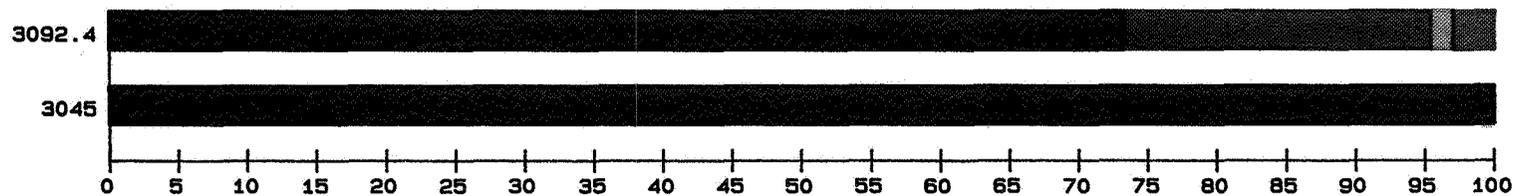
KEROGEN CONTENT  
6407/7-1

A=amorphous material  
p=material derived from palynomorphs  
w=material derived from wood

-  OPAQUE WOOD
-  DENSE WOOD
-  STRUCT. WOOD
-  PALYNO-MORPHS
-  PYRIT. WOOD
-  CUTICULA

DEPTH IN M

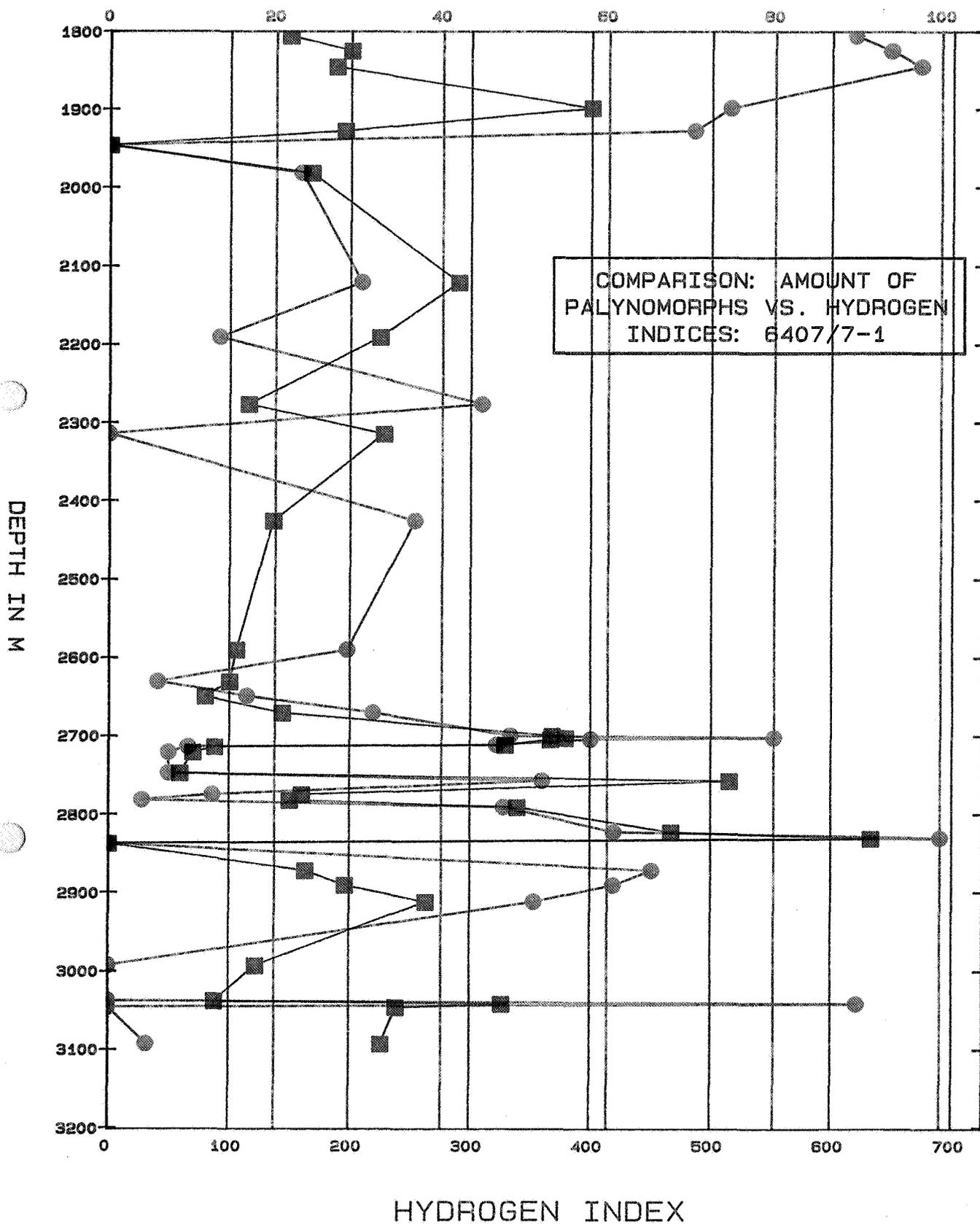
TGB-86



%

Fig.9: Relation between hydrogen indices (HI) and amount of palynomorphs (and cuticula fragments) versus depth, well 6407/7-1.

# PALYNOMORPHS (& CUTICULA)



MATURITY	KEROGEN	PETROLEUM POTENTIAL
<u>2000M</u>		<u>1980M POOR-FAIR</u>
EARLY MATURE	II (DEGRADED III) LARGE AMOUNTS OF WOOD	POOR
	<u>2590M</u>	
<u>2697M</u>	PYRITIZED WOOD III	
	II LARGE AMOUNTS OF AMORPHOUS MATERIAL	VERY GOOD
<u>2713M</u>		
	III/IV <u>2780M</u>	
<u>3000M</u>		
MIDDLE MATURE	II III/IV (CUTICULA FRAGMENTS)	NO TO EXCELLENT
<u>3200M</u>		

Figure 10: Summary of the source rock evaluation of well  
6407/7-1.

**APPENDIX**

## APPENDIX I

### GAS CHROMATOGRAMS OF SATURATED HYDROCARBONS AND SOME TOTAL EXTRACTS

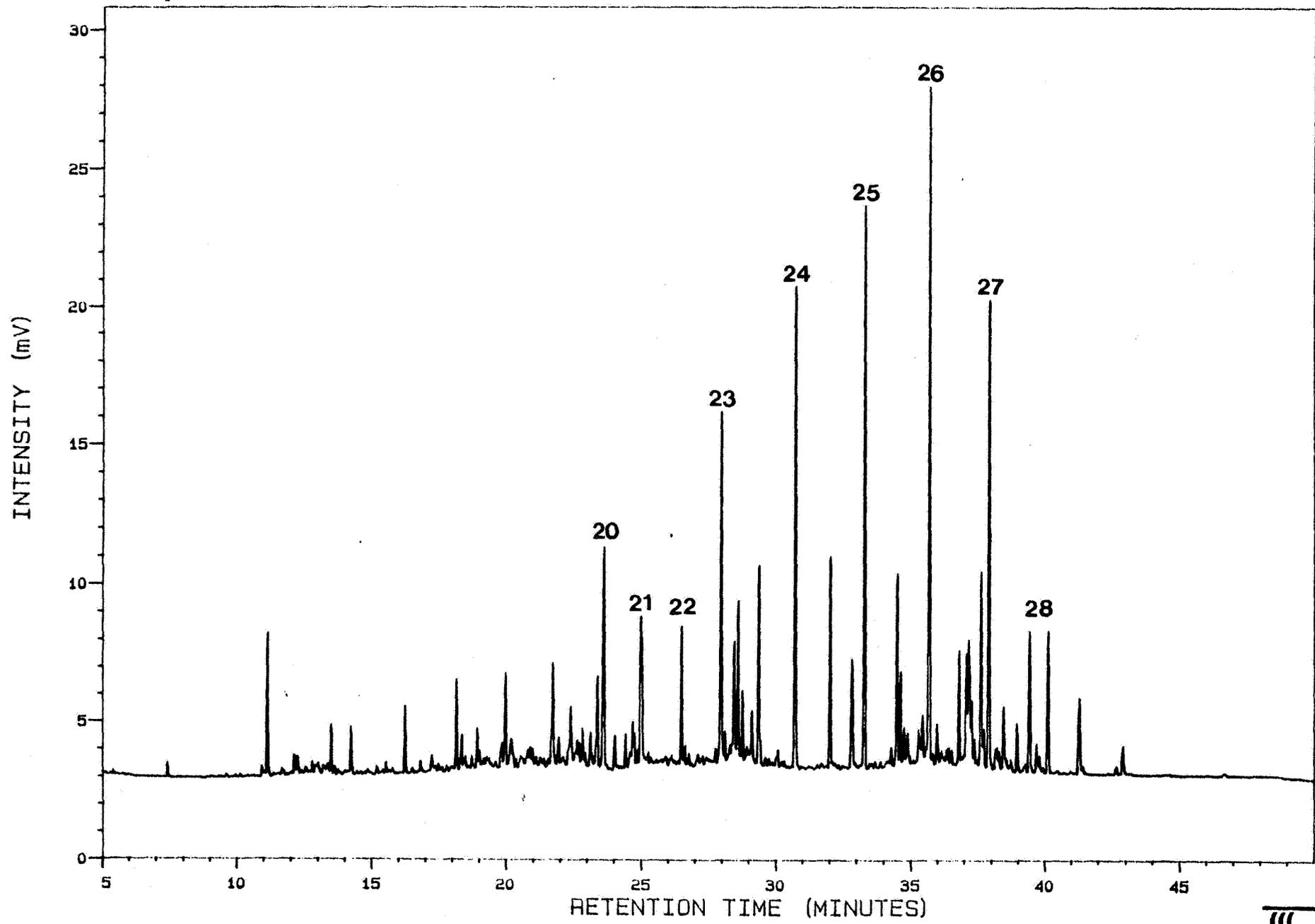
Pr - pristane

Ph - phytane

Numbers correspond to n-alkanes with the same  
carbon number.

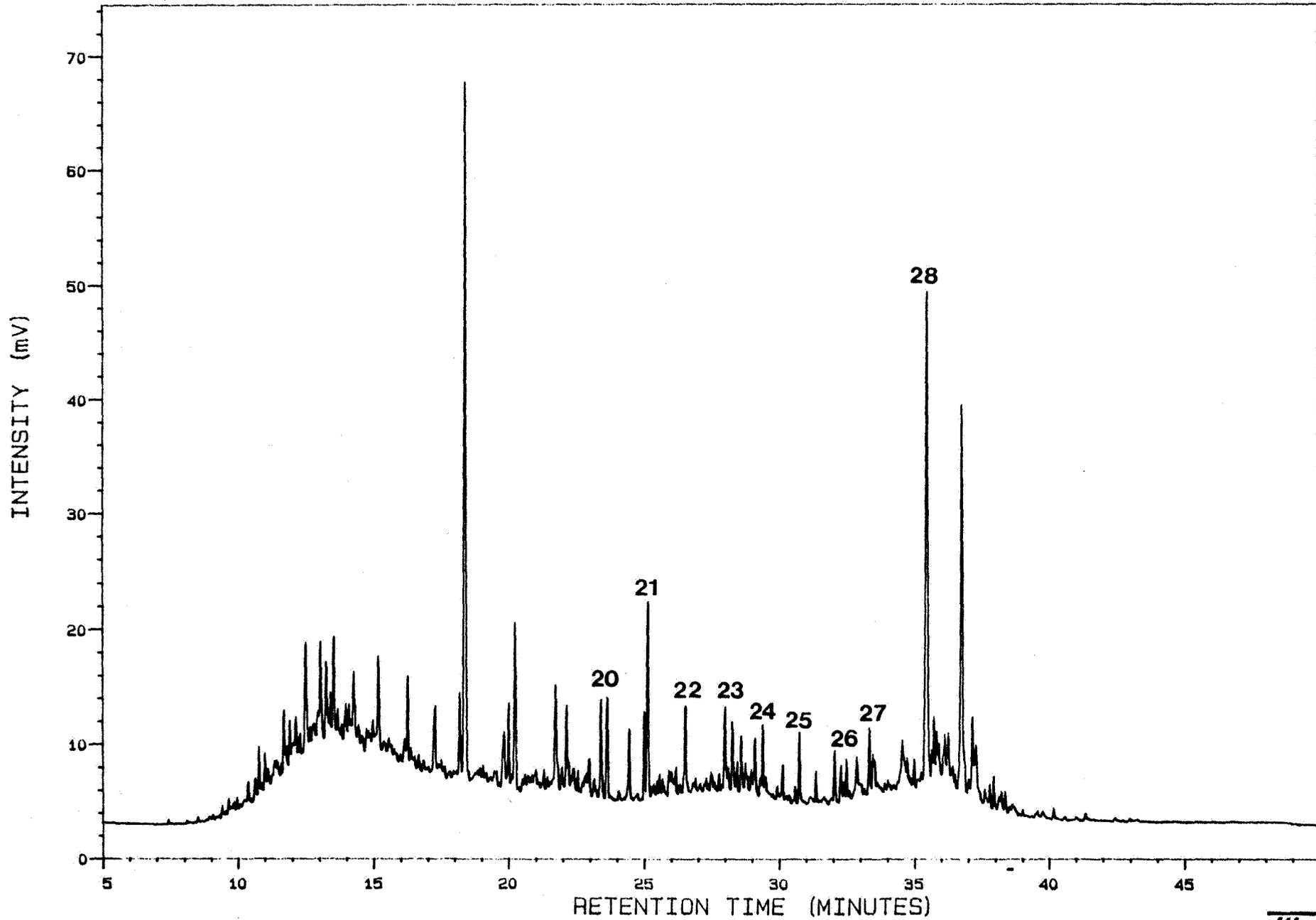
Analysis N640771

7. 2. 1 1189.91



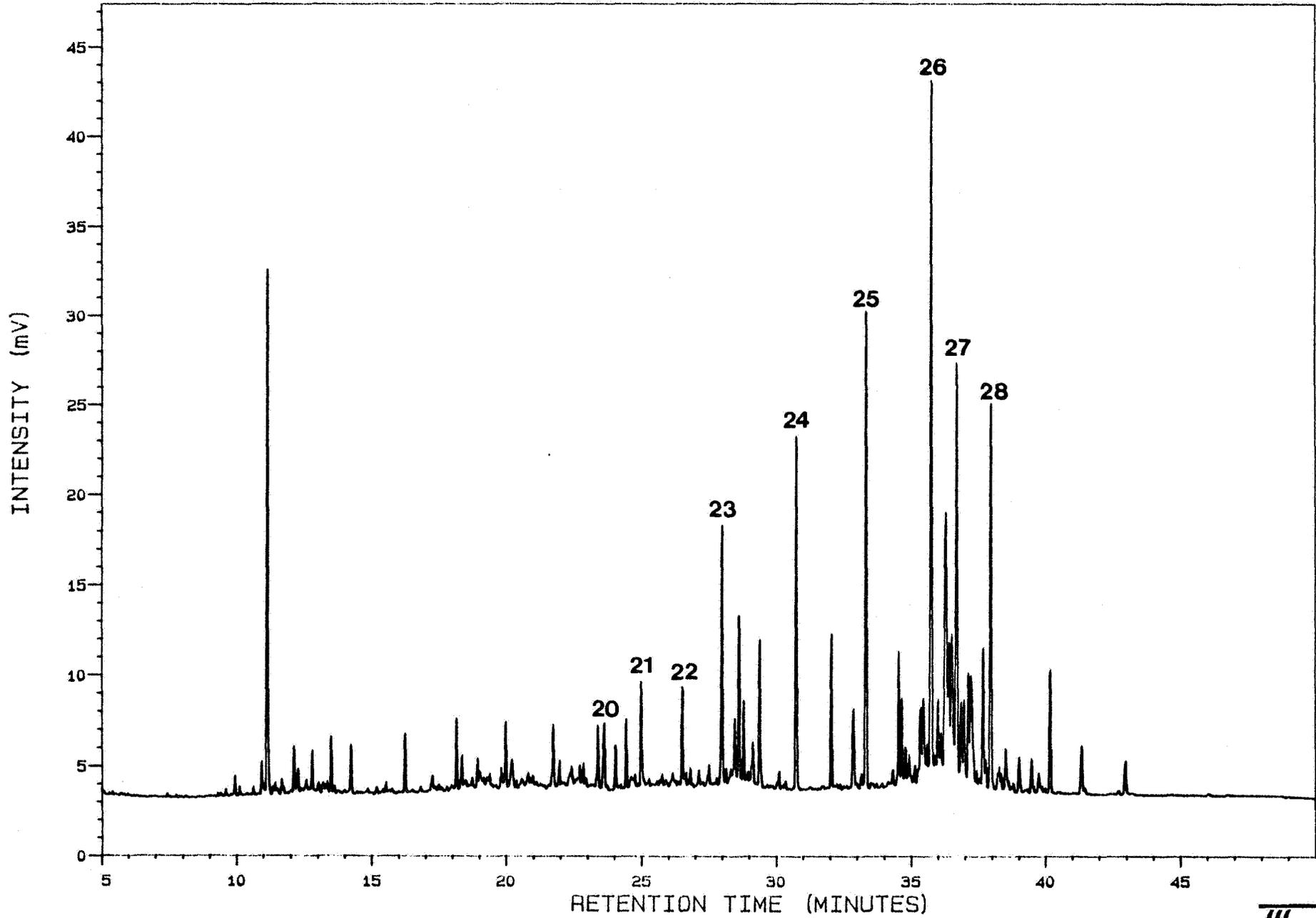
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7.7.1 1736.88



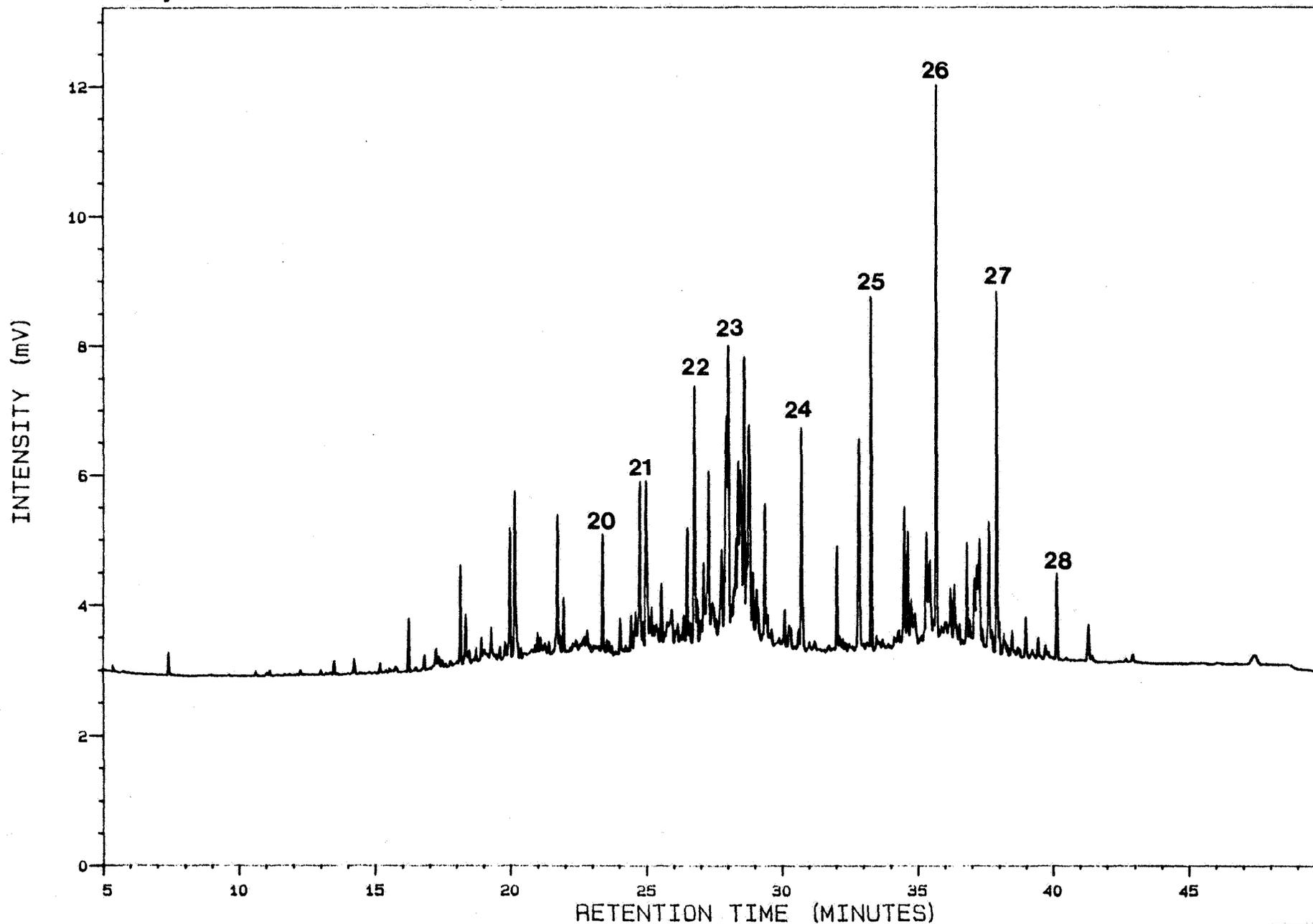
Analysis N640771

7.3.1 1209.94



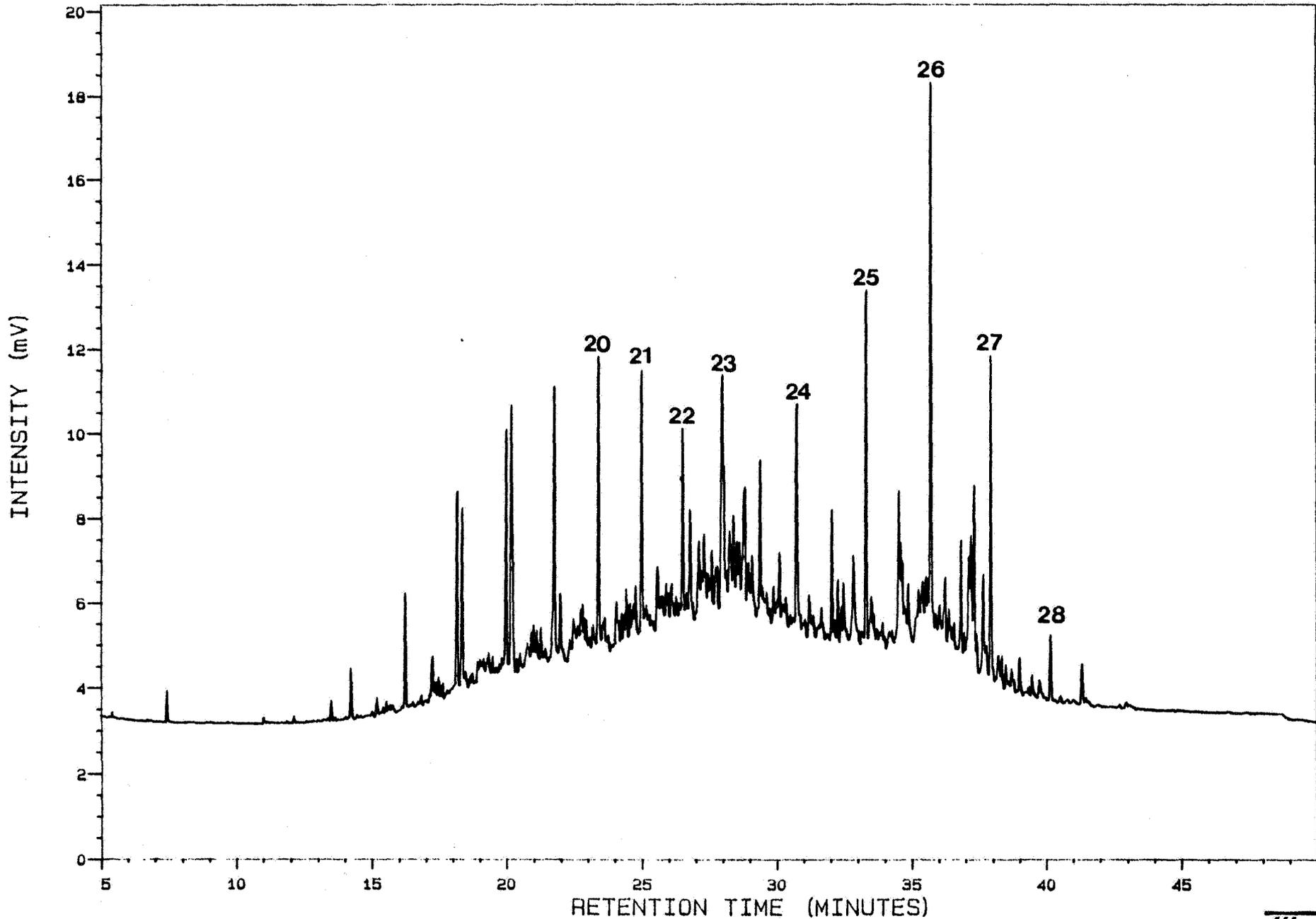
Analysis N640771

7. 4. 1 1299.99



Analysis N640771

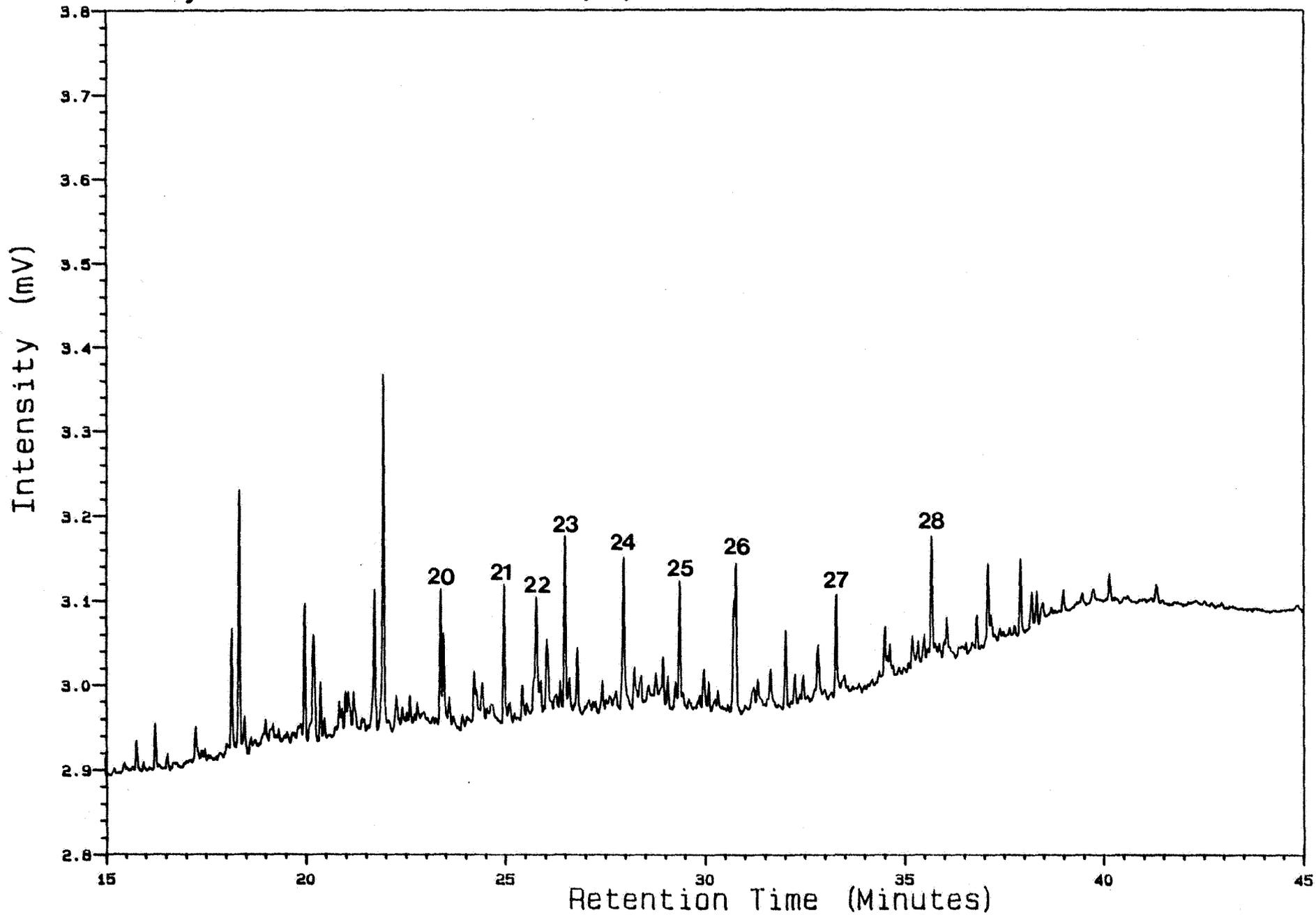
7.5, 1 1419.92



Analysis N640771

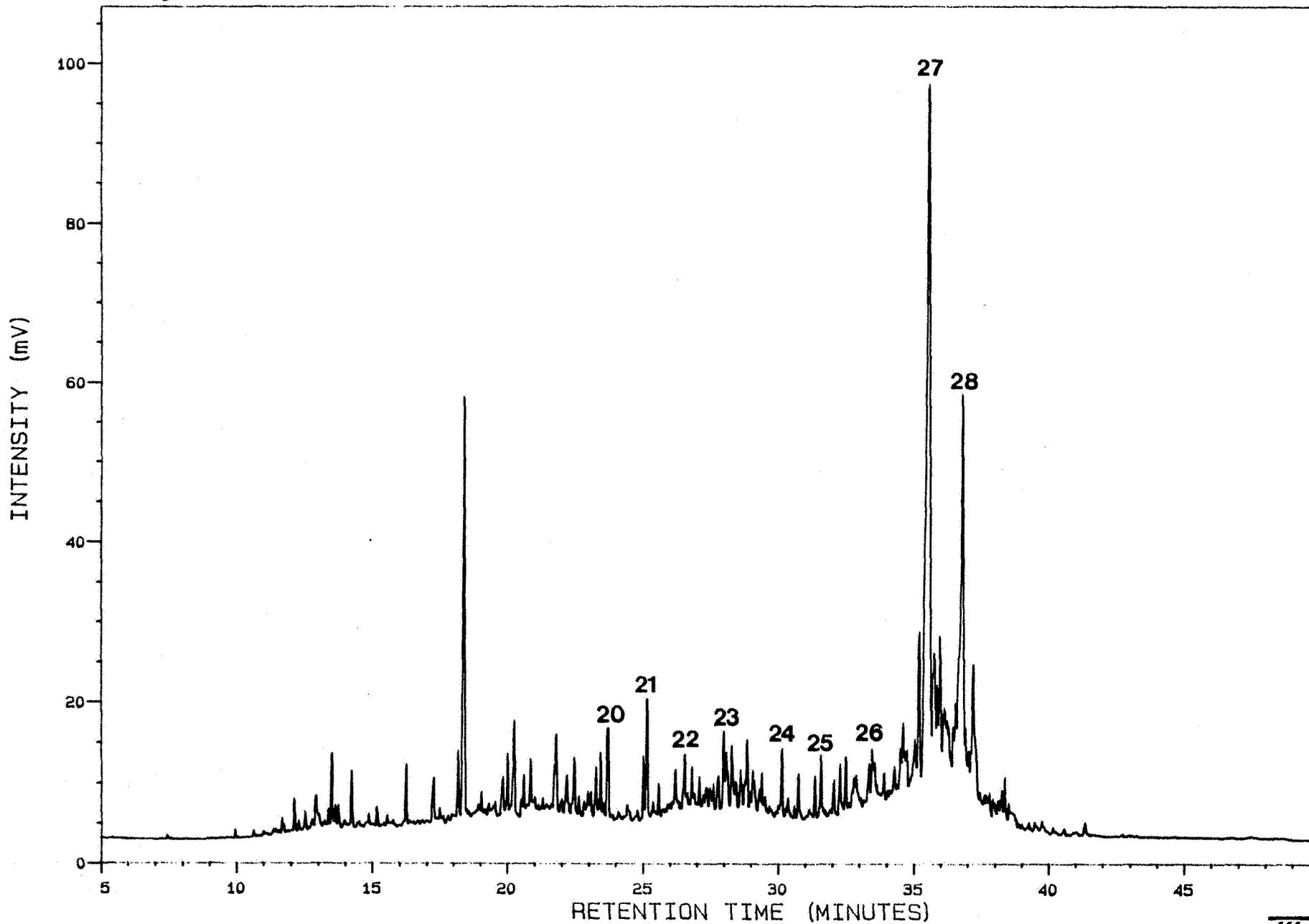
7. 6. 1

1689.93



Analysis N640771

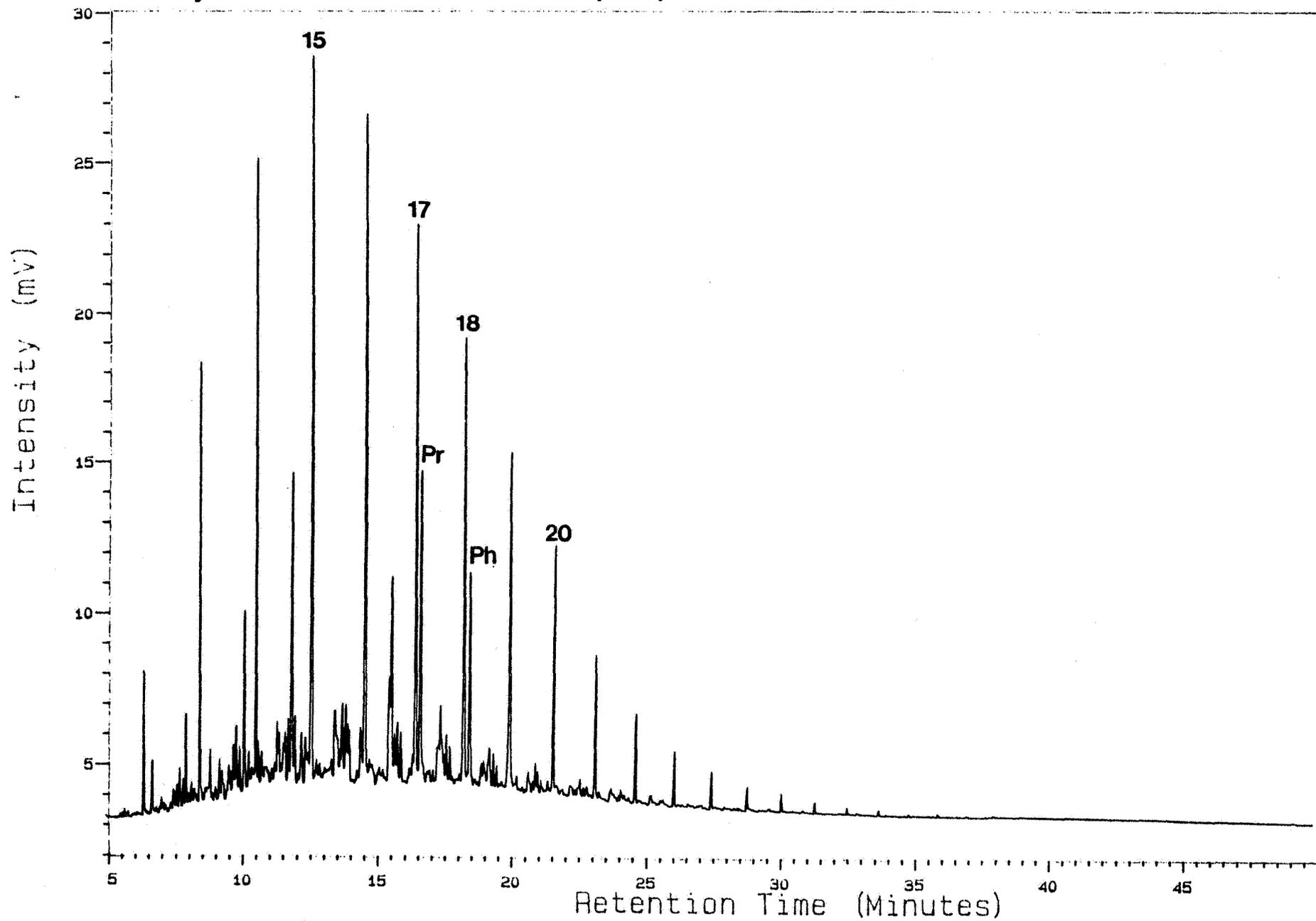
7. 8. 1 1824.84



Analysis B640771S

7, 12, 1

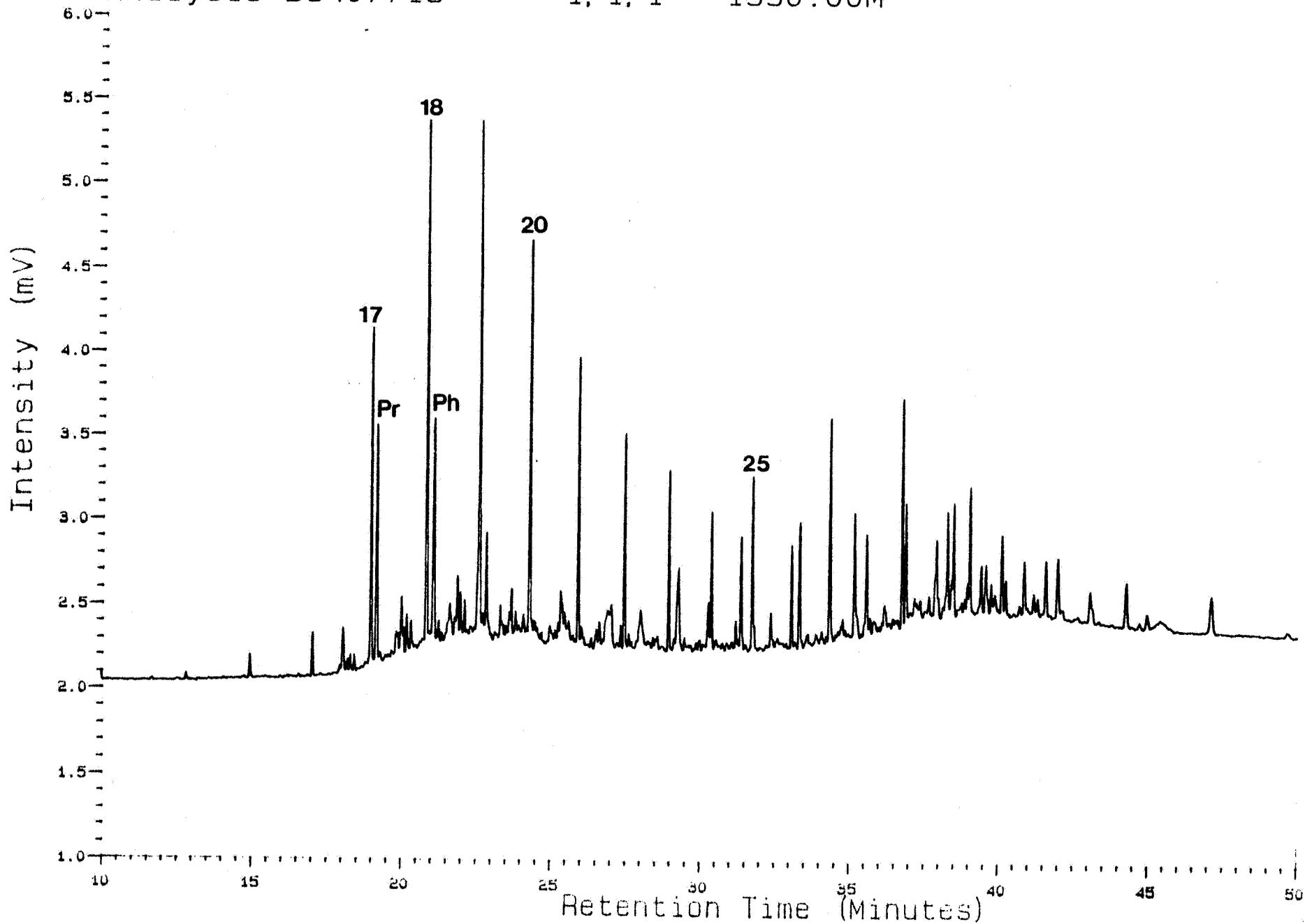
1939.00 M



Analysis B640771S

1. 1. 1

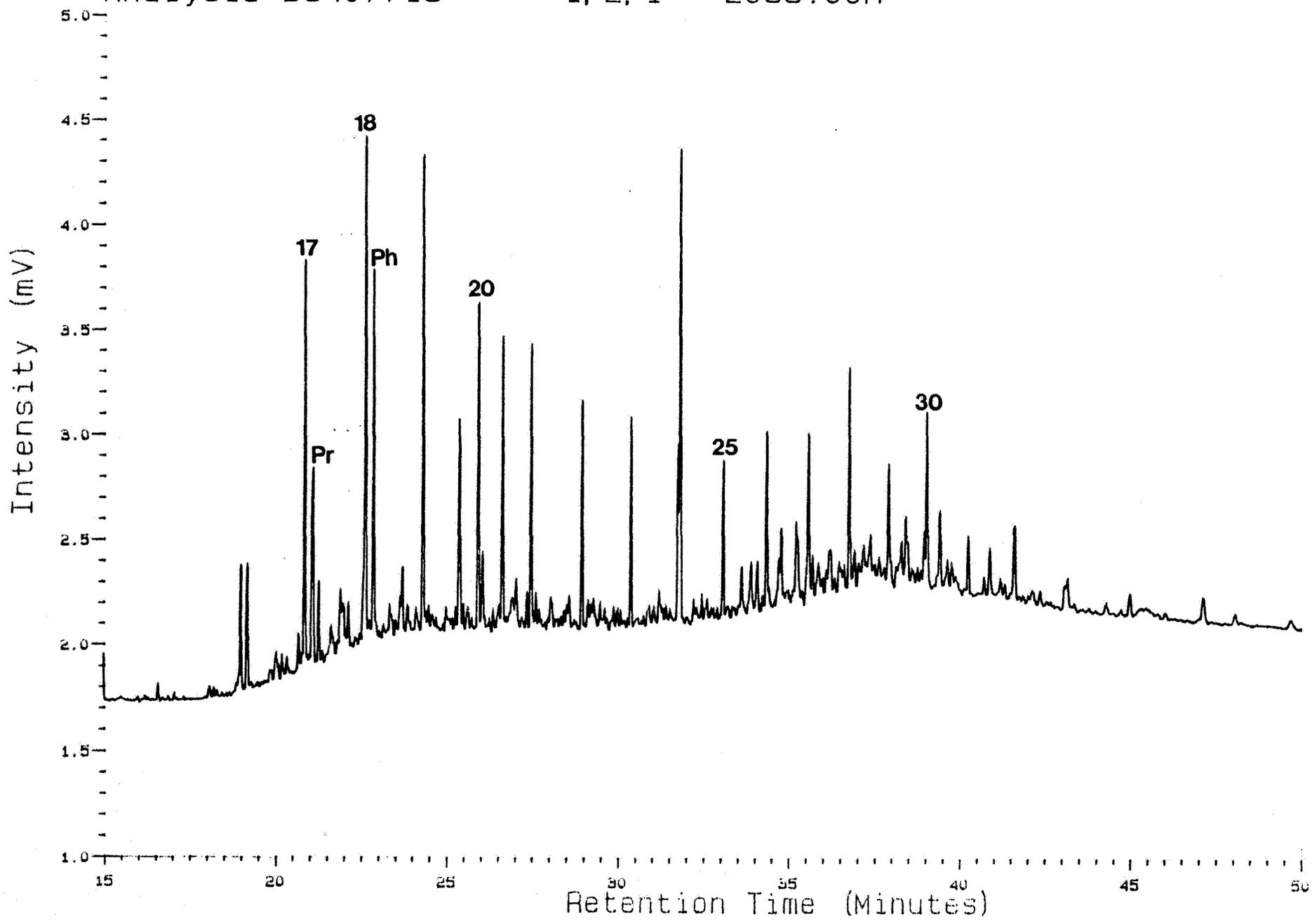
1990.00M



Analysis B640771S

1, 2, 1

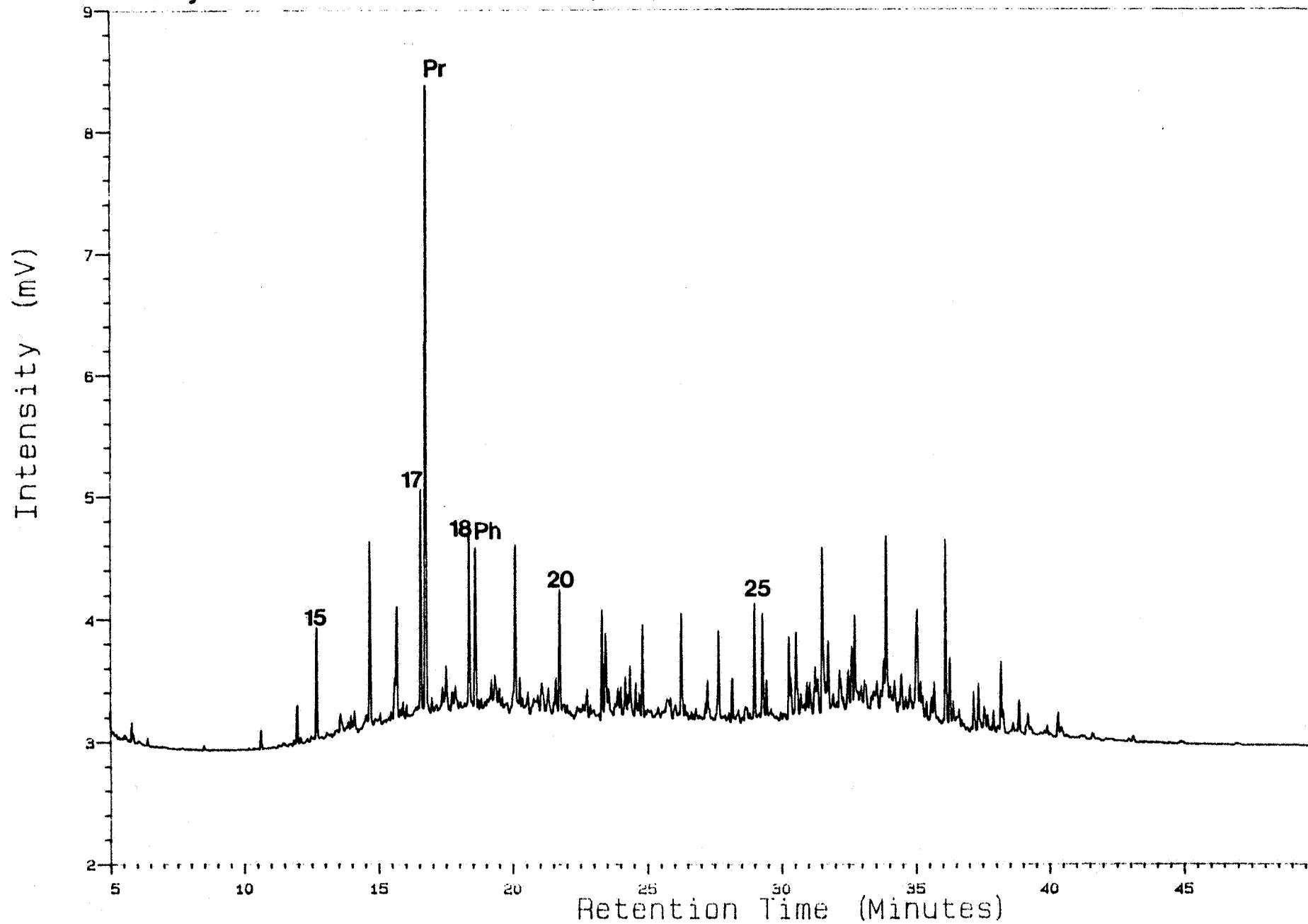
2085.00M



Analysis B640771S

7, 13, 1

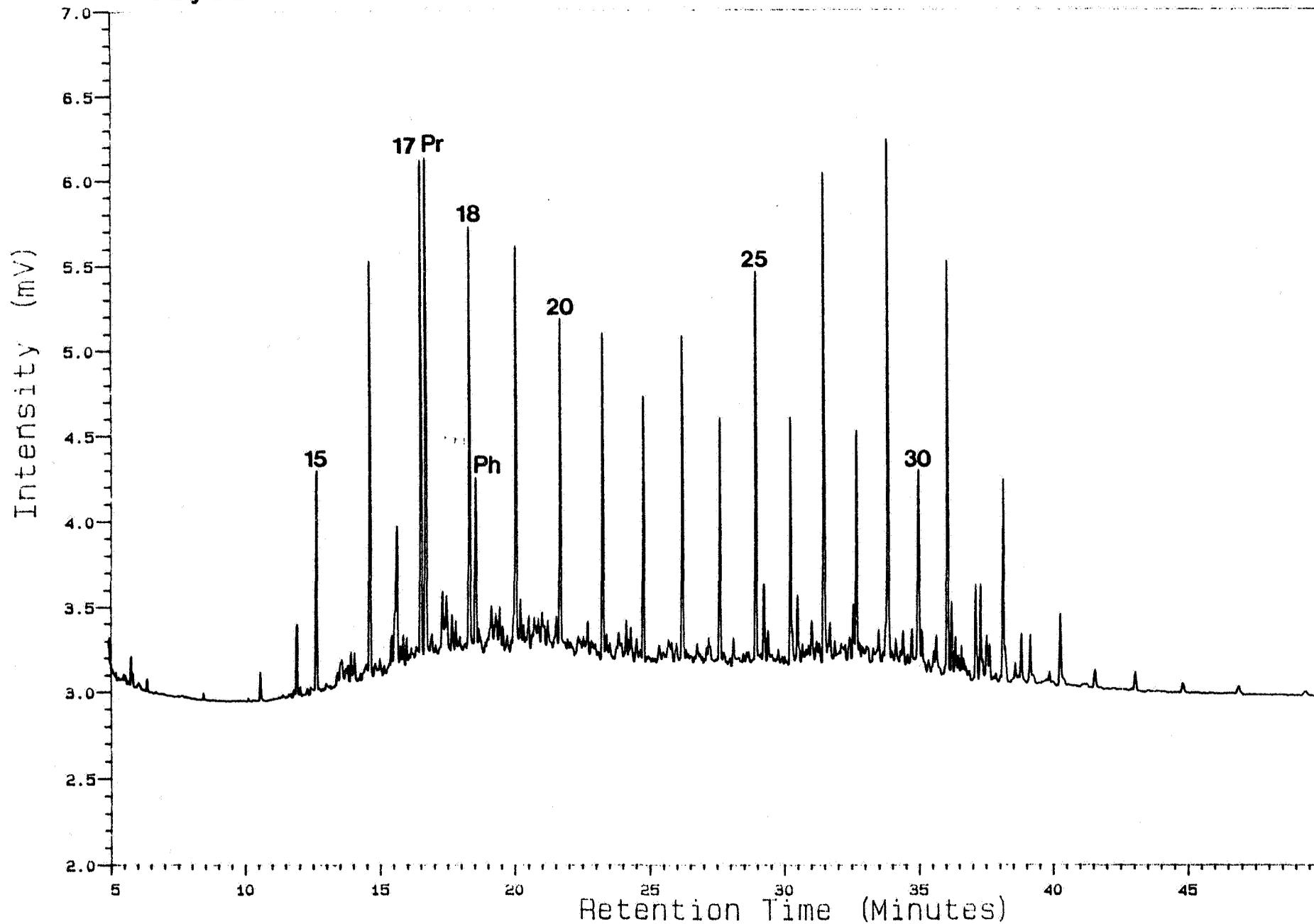
2155.00M



Analysis B640771S

7.14.1

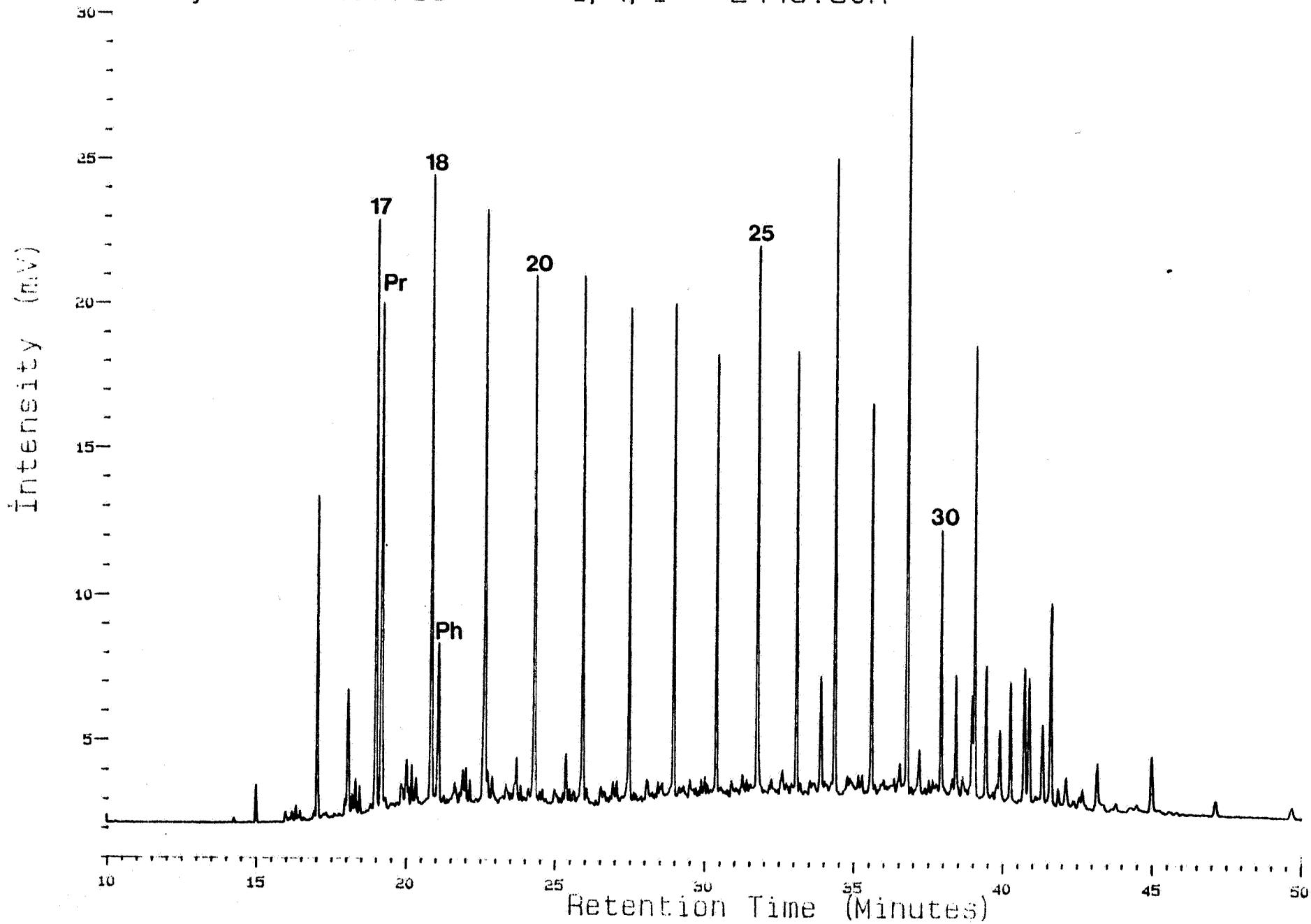
2170.00M



Analysis B640771S

1, 4, 1

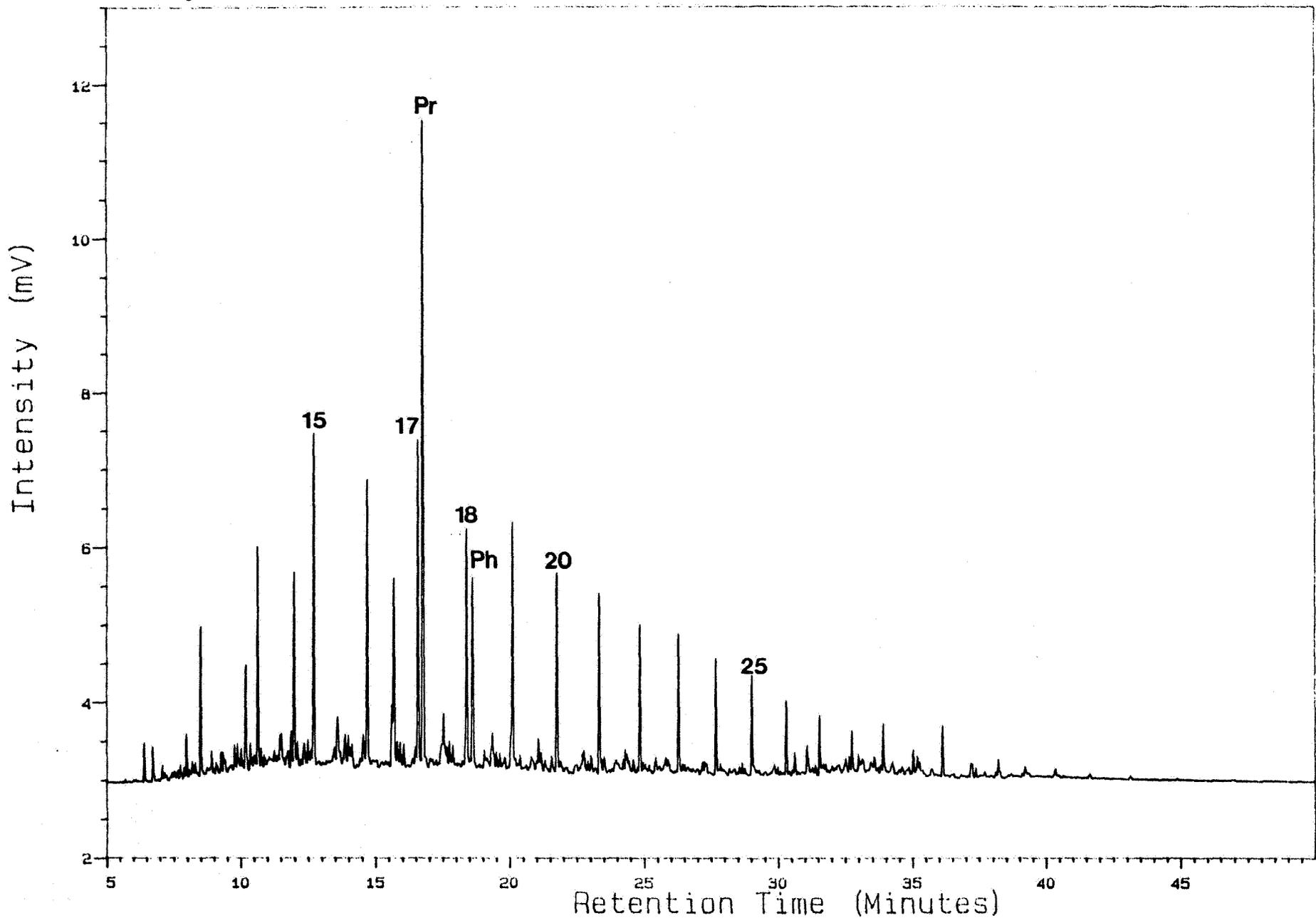
2446.50M



Analysis B640771S

7. 6. 1

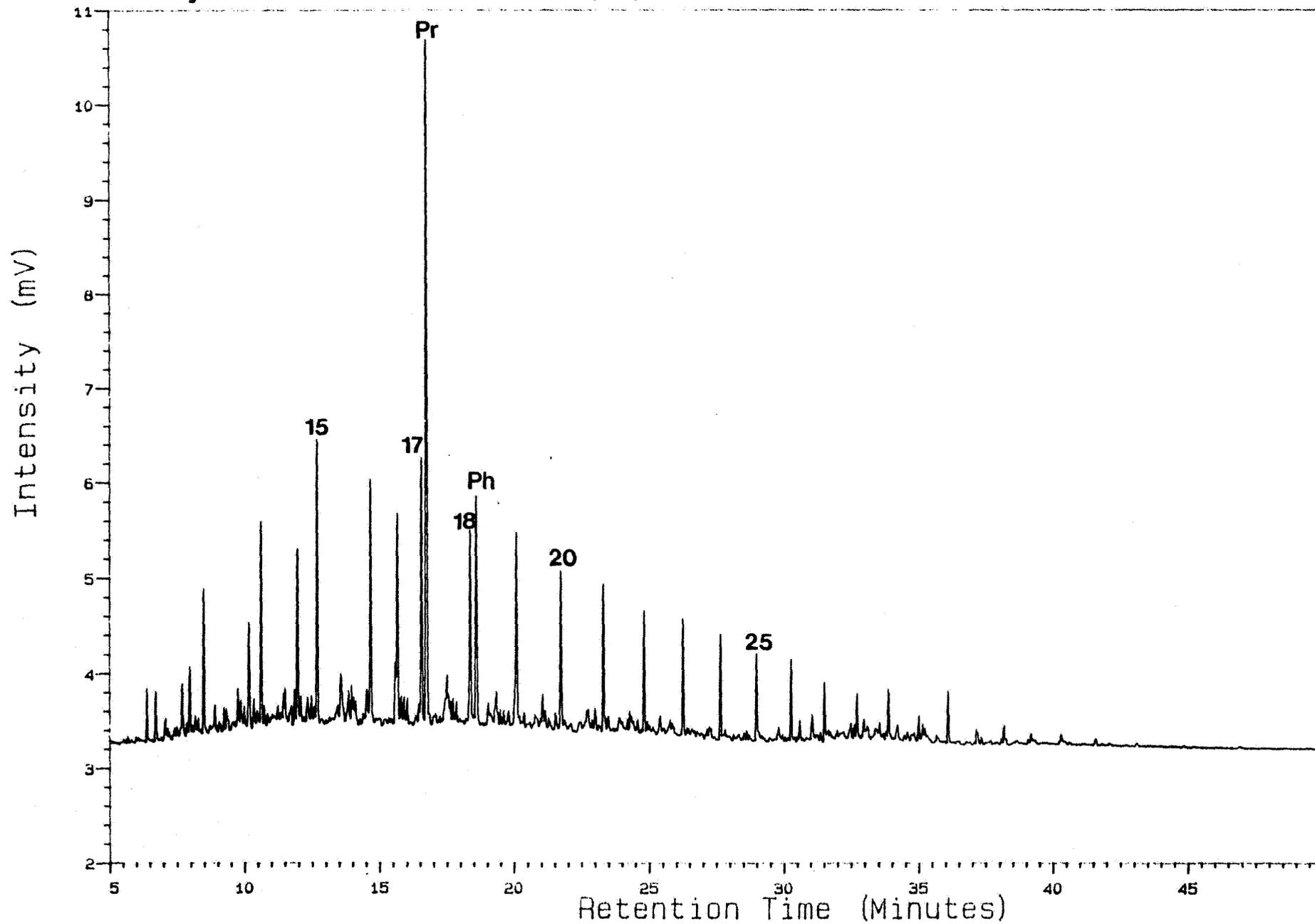
2699 M



Analysis B640771S

7. 8. 1

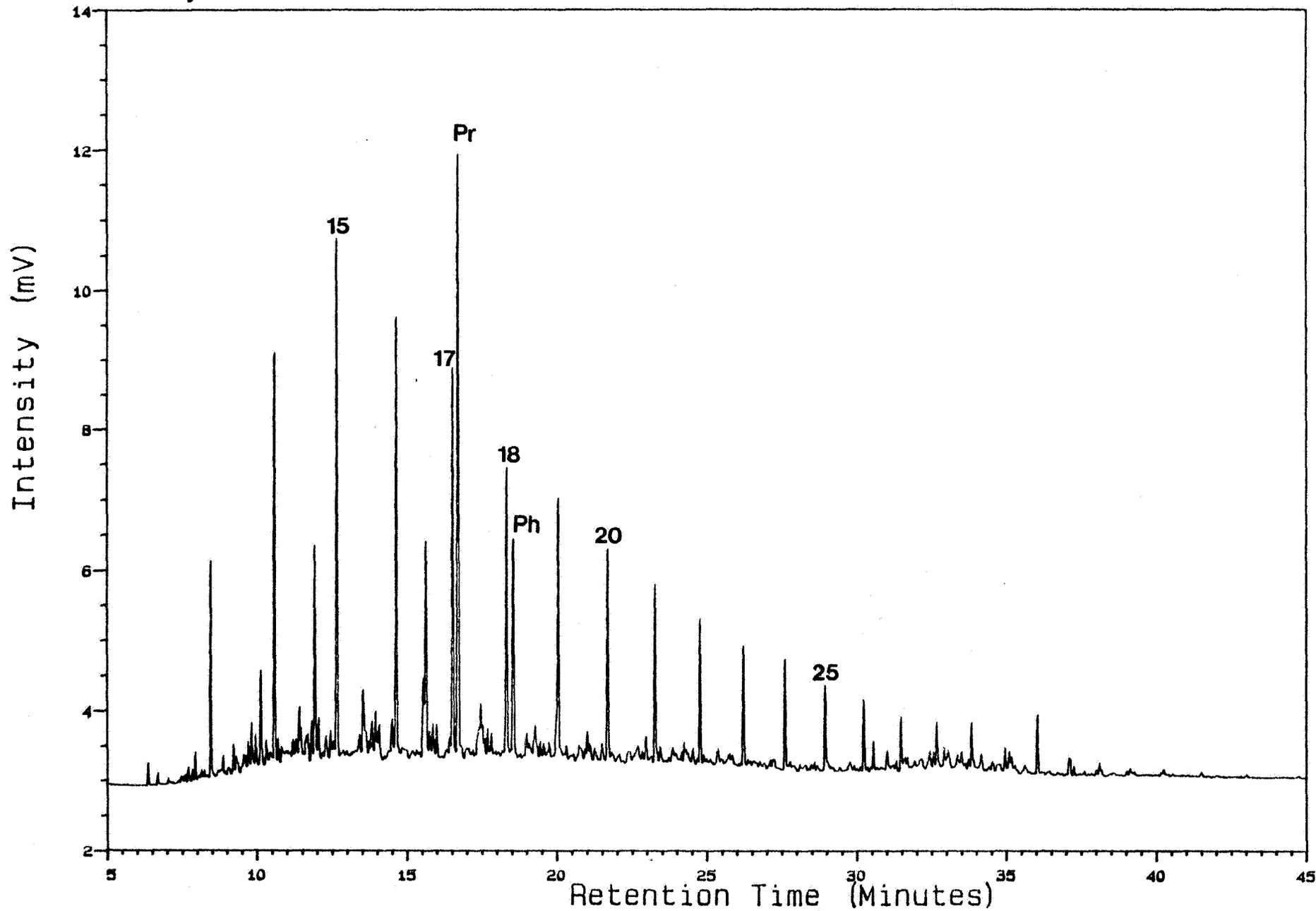
2702 M



Analysis H640771

7.3.1

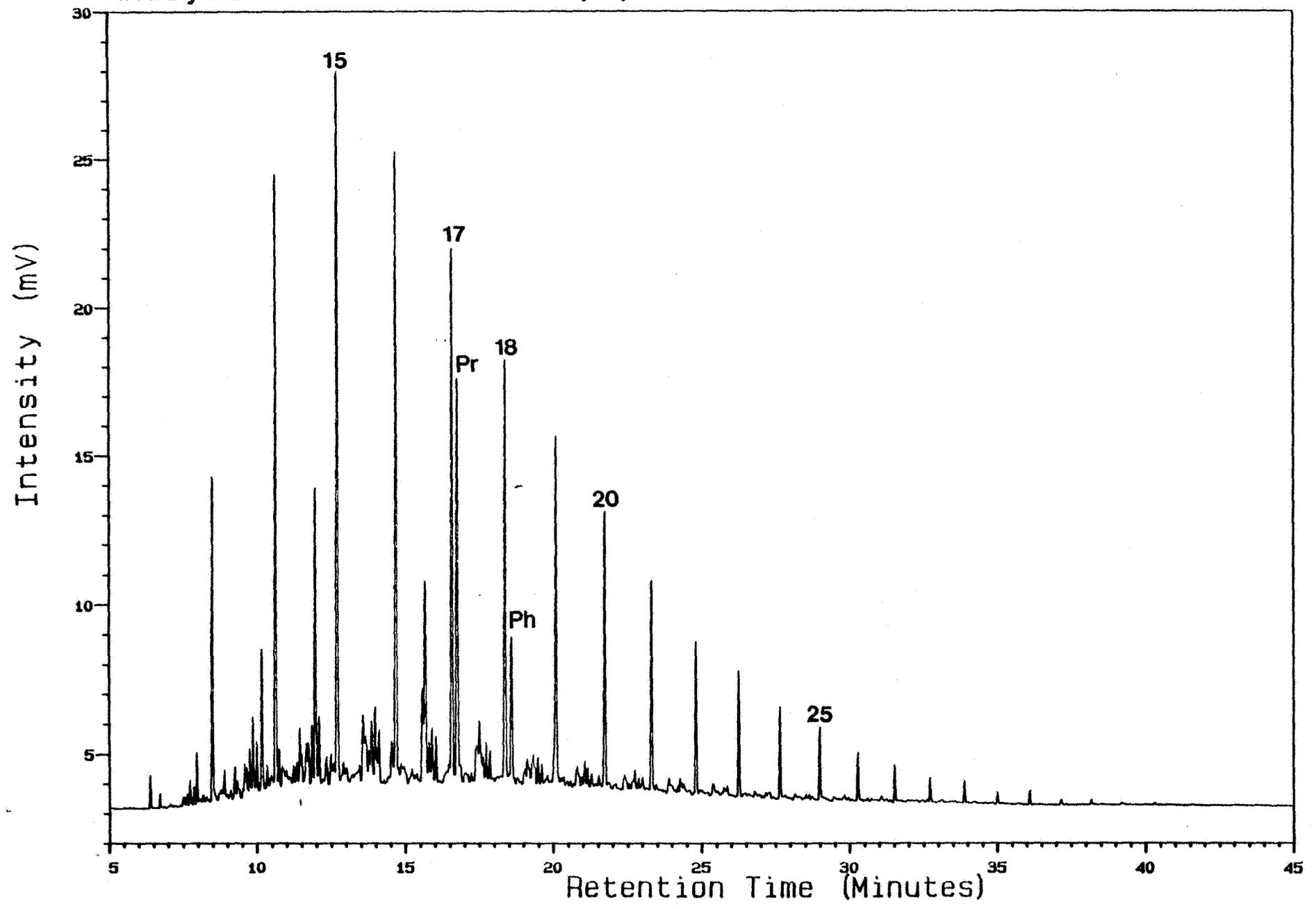
2704.50M



Analysis H640771

7, 5, 1

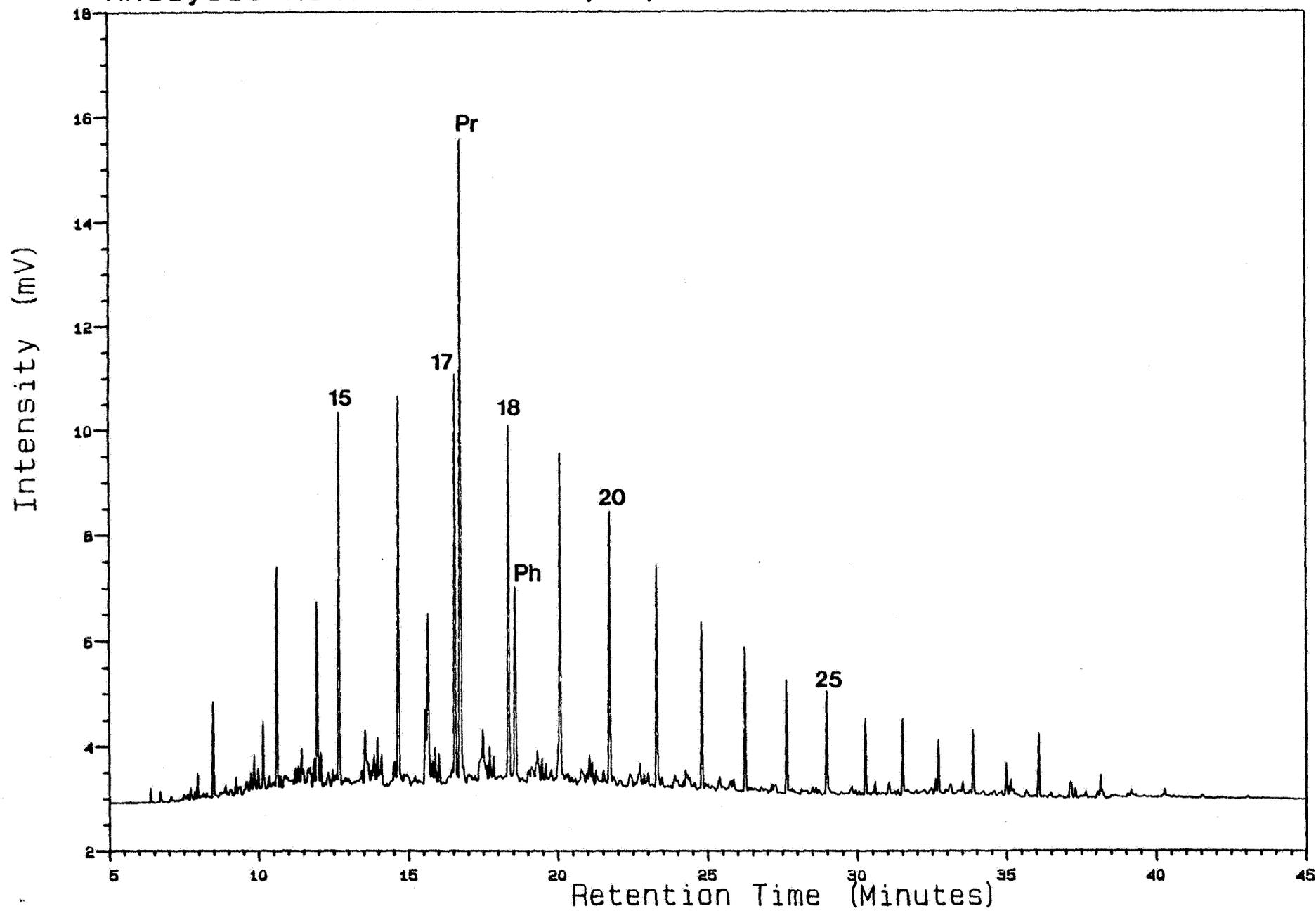
2706.00M



Analysis H640771

7, 10, 1

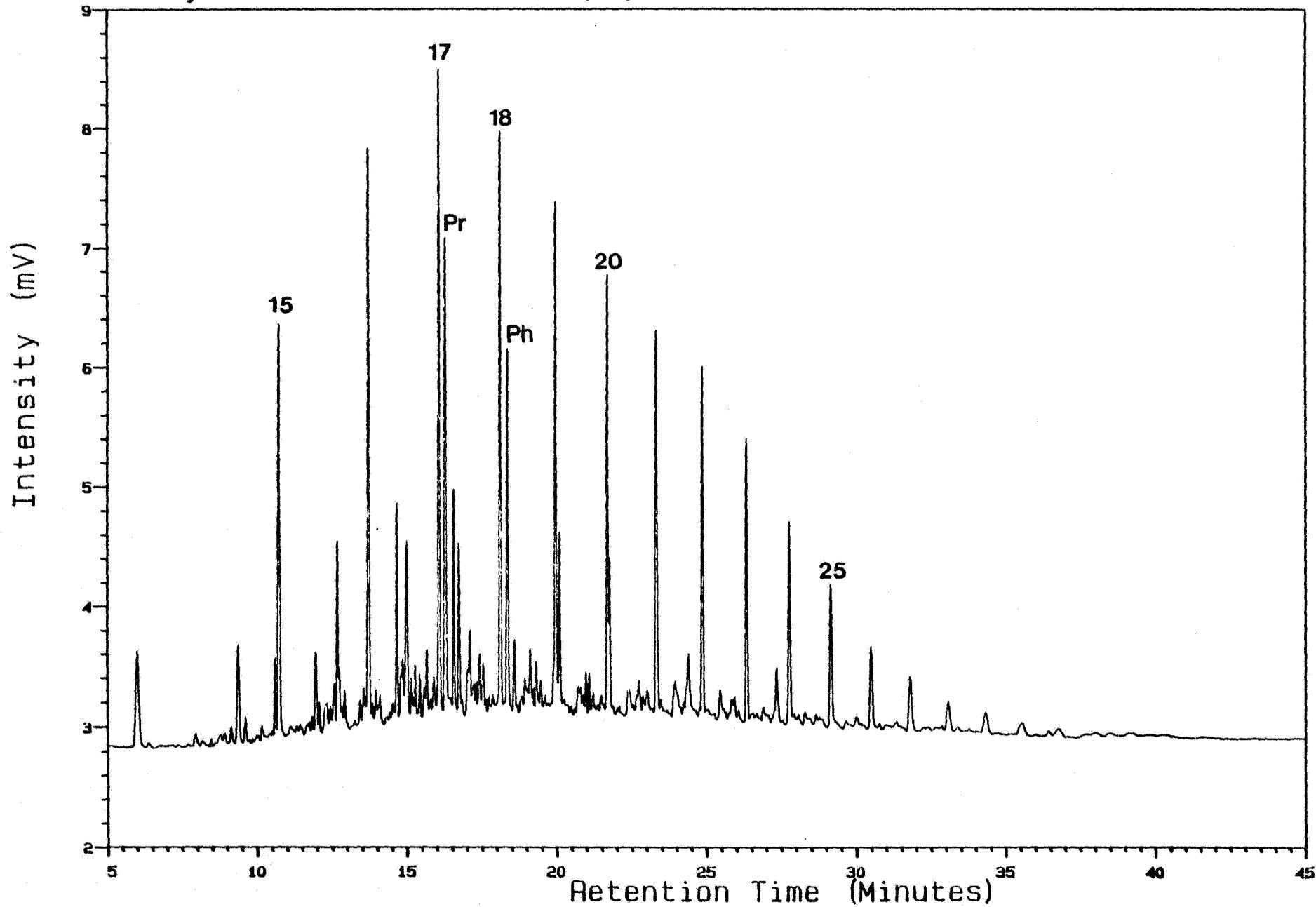
2711.00M



Analysis F640771

7. 1. 1

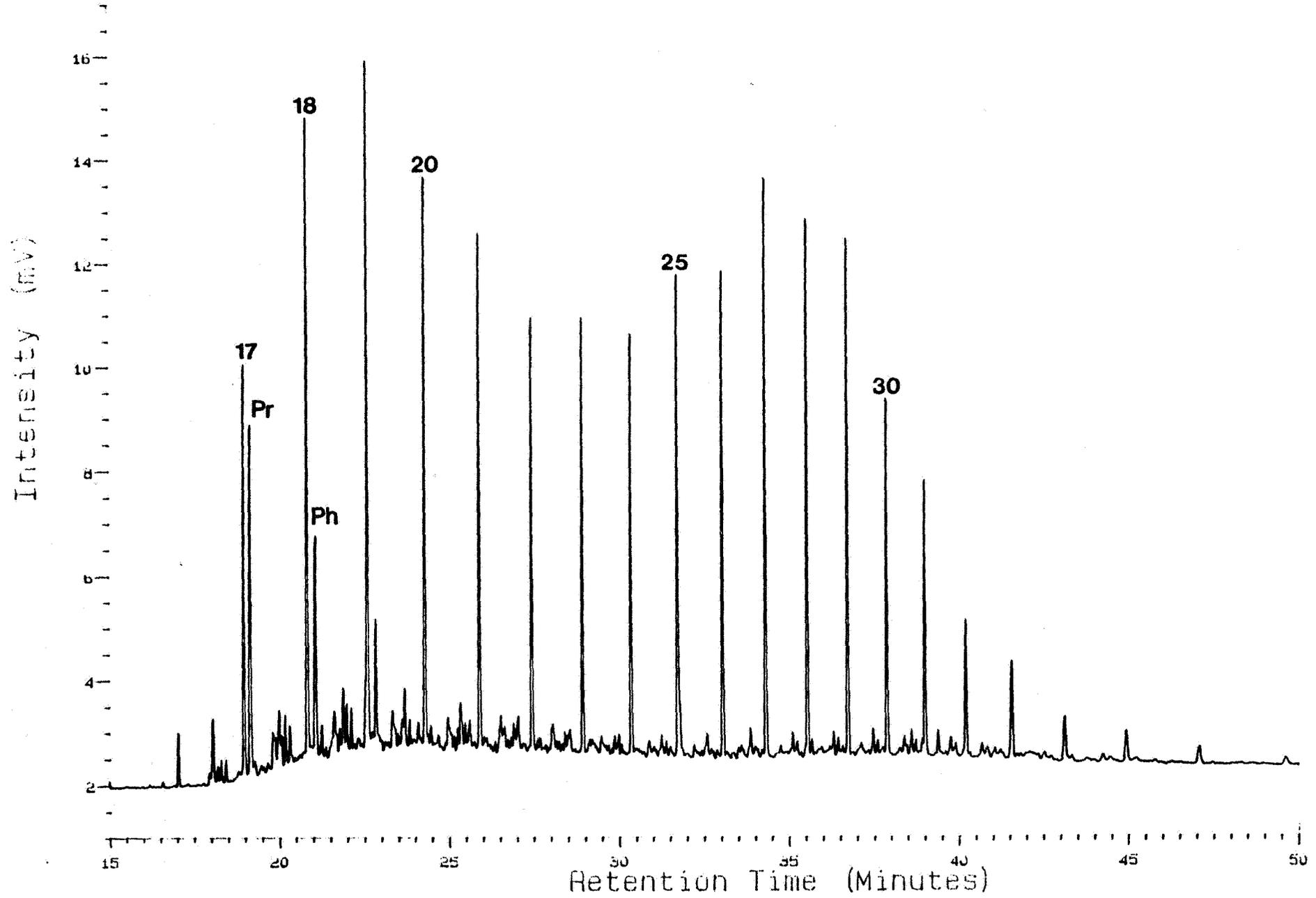
2713.23



Analysis B640771S

1, 5, 1

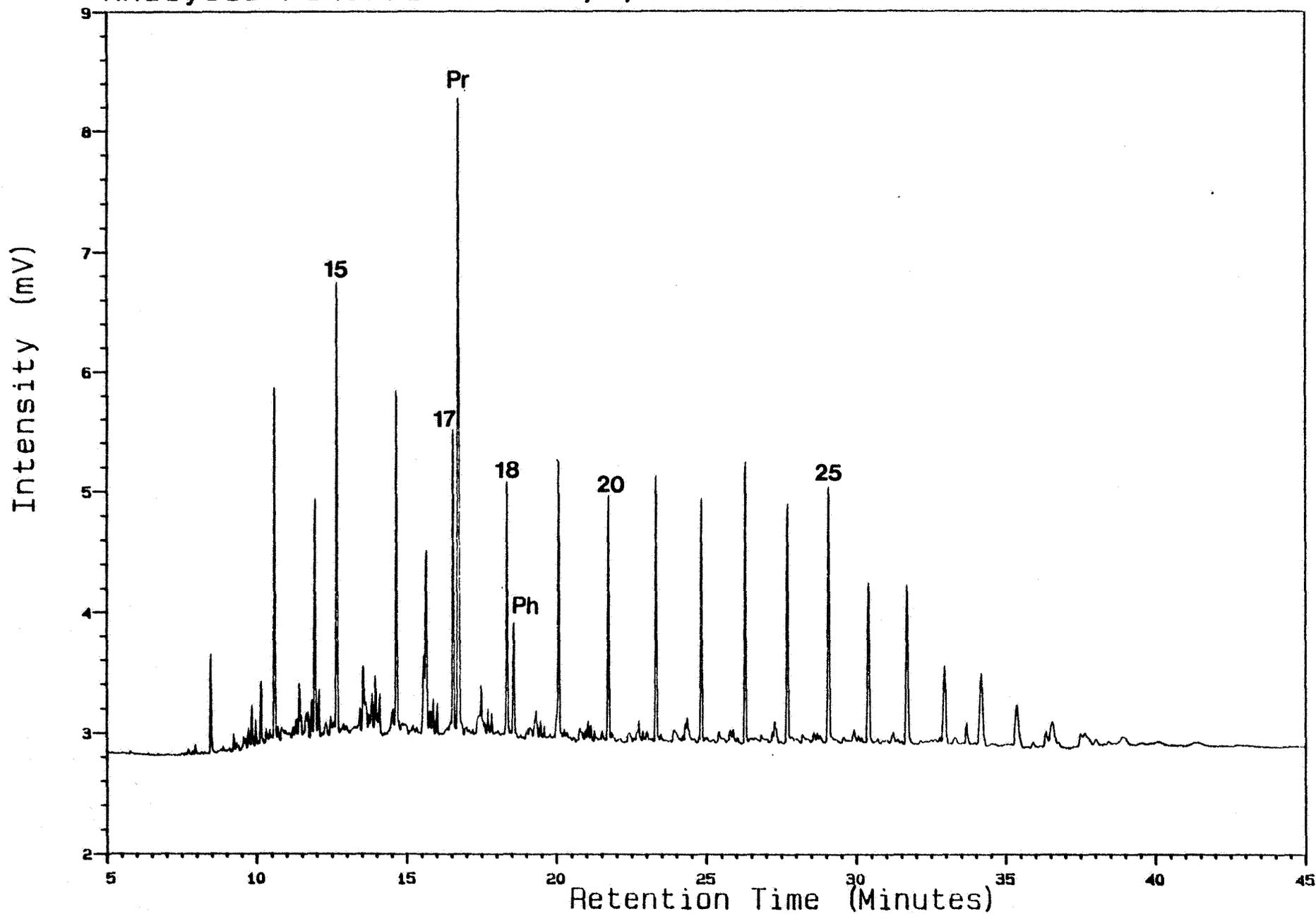
2714.20M



Analysis F640771

7. 3. 1

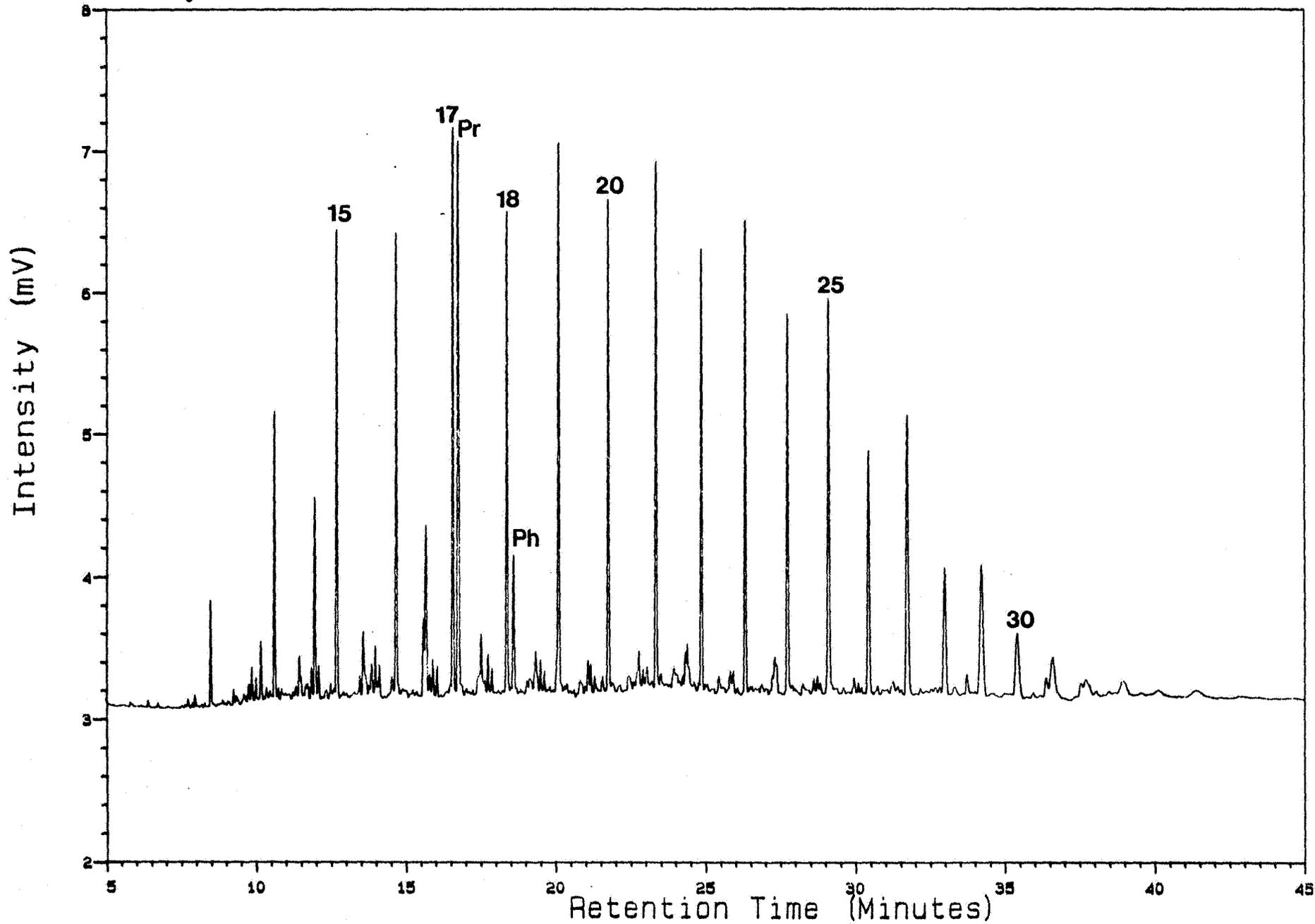
2716.97



Analysis F640771

7, 5, 1

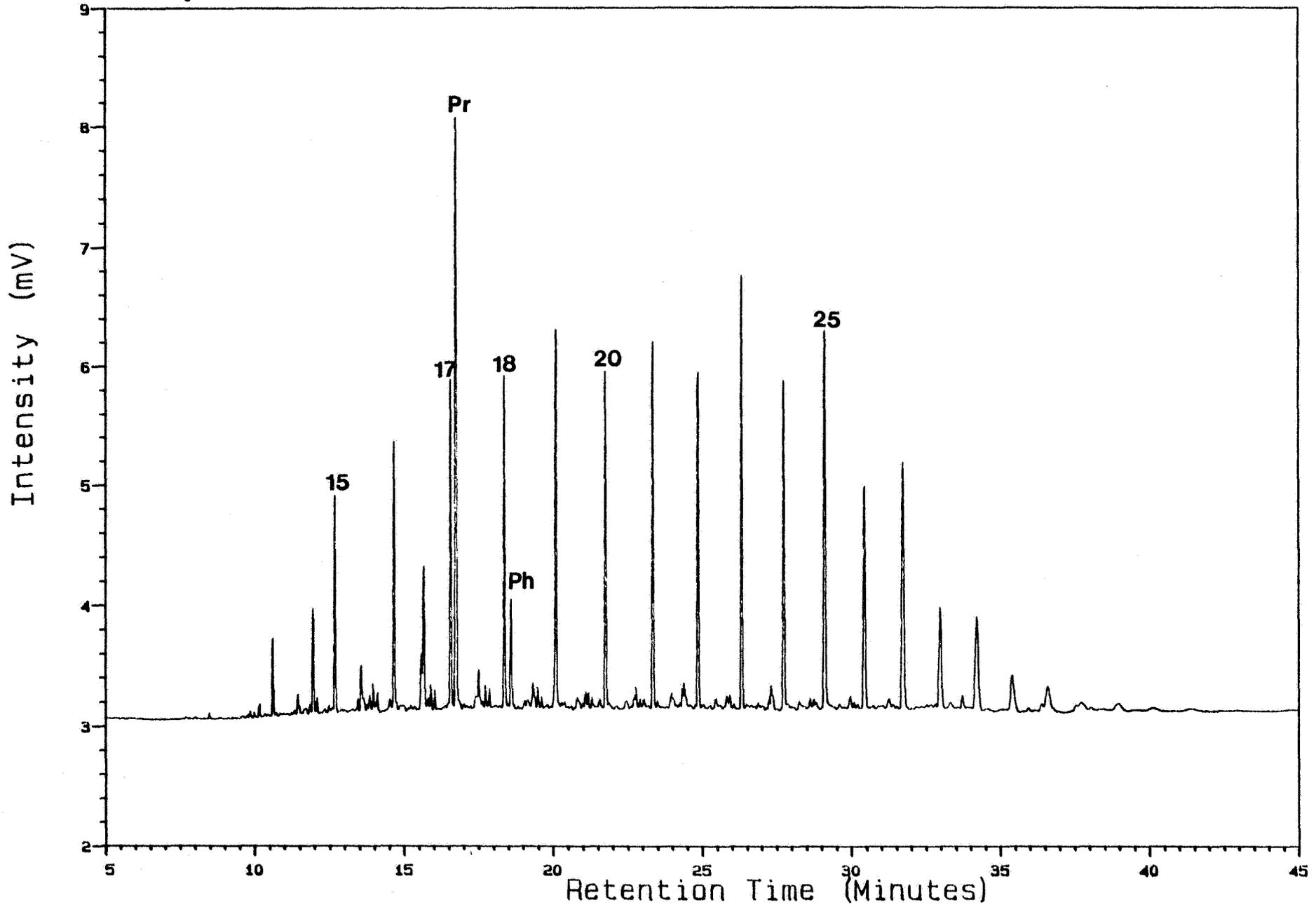
2718.04



Analysis F640771

7, 6, 1

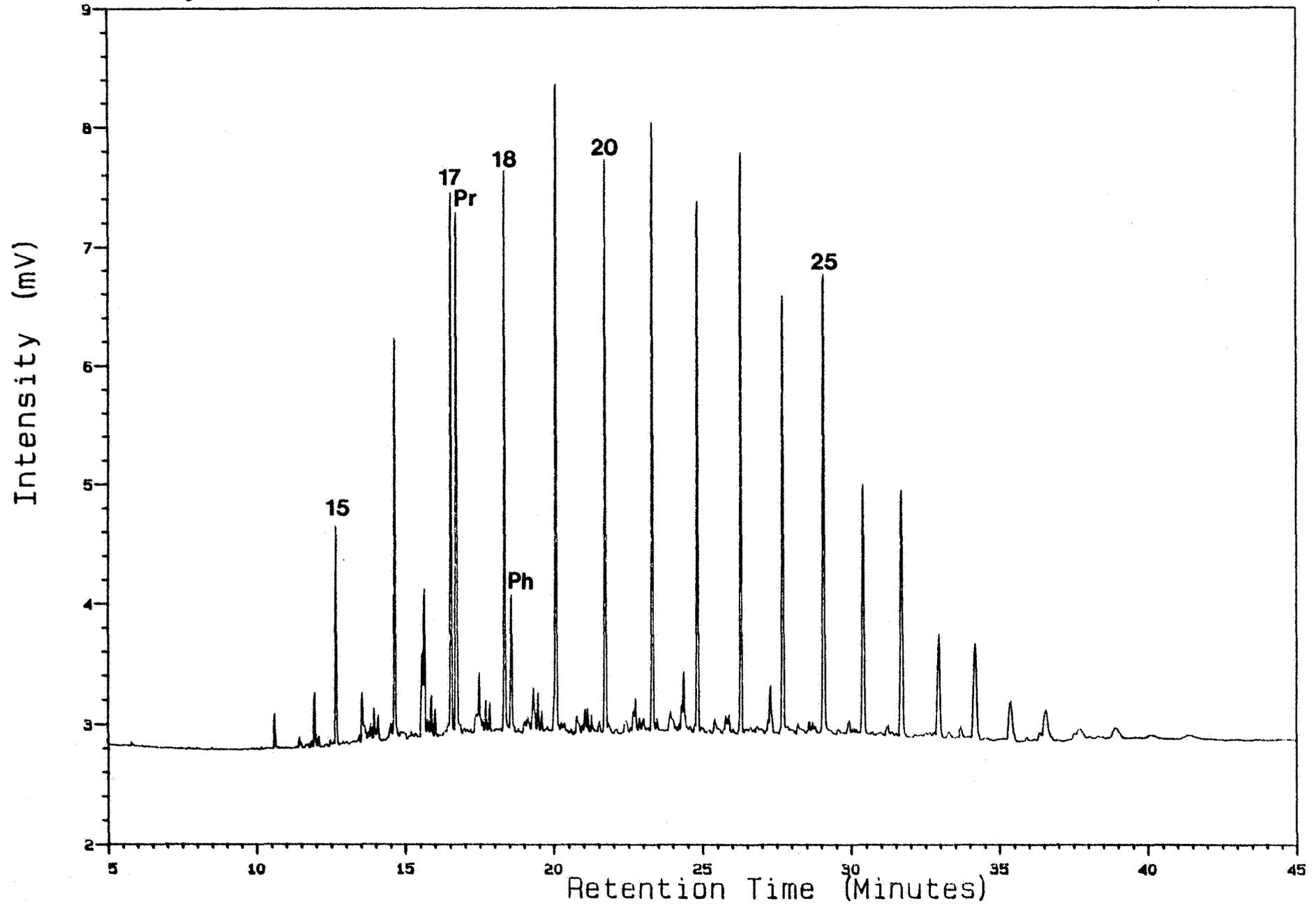
2719.10



Analysis F640771

7. 7. 1

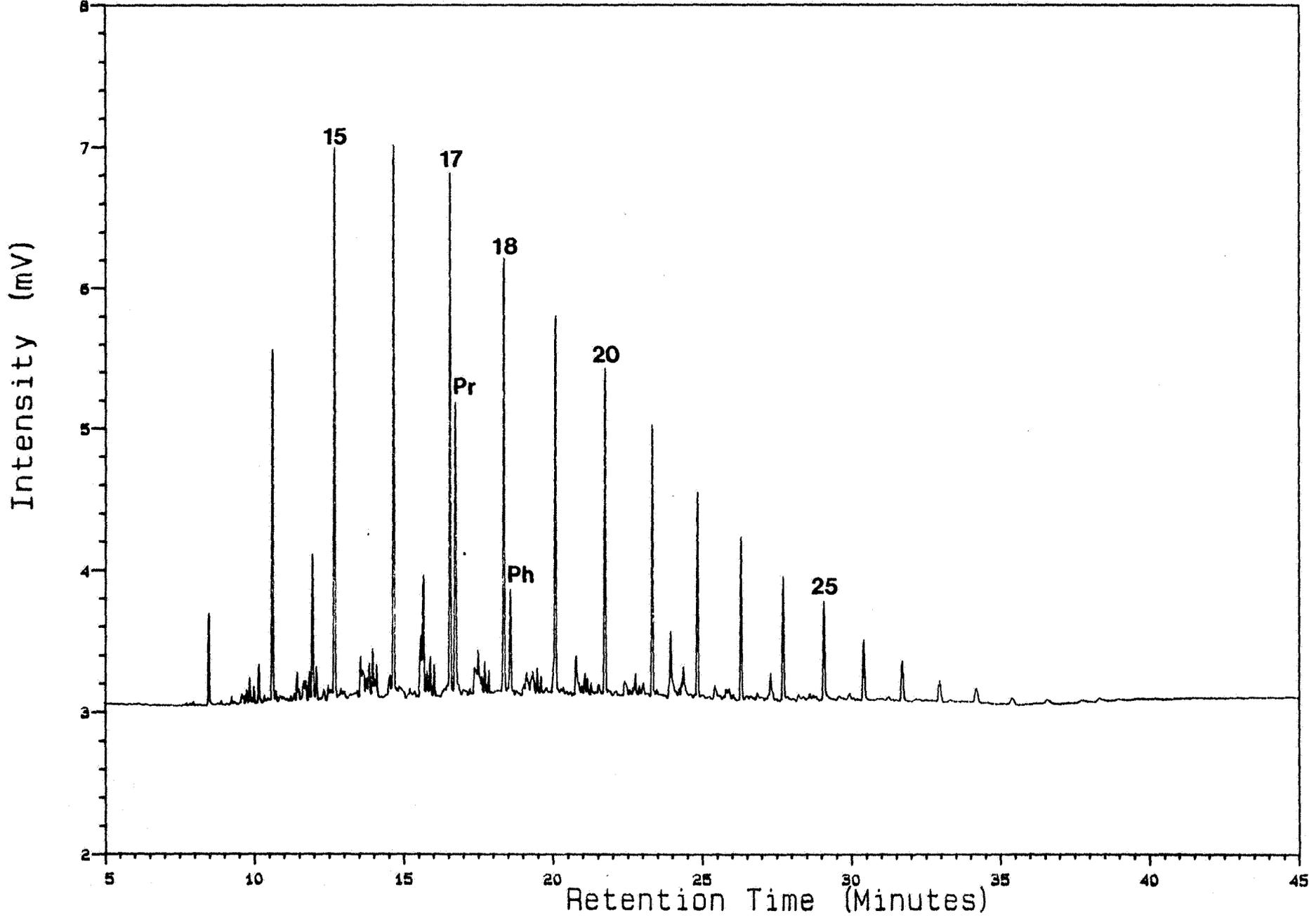
2720.05



Analysis F640771

7. 11. 1

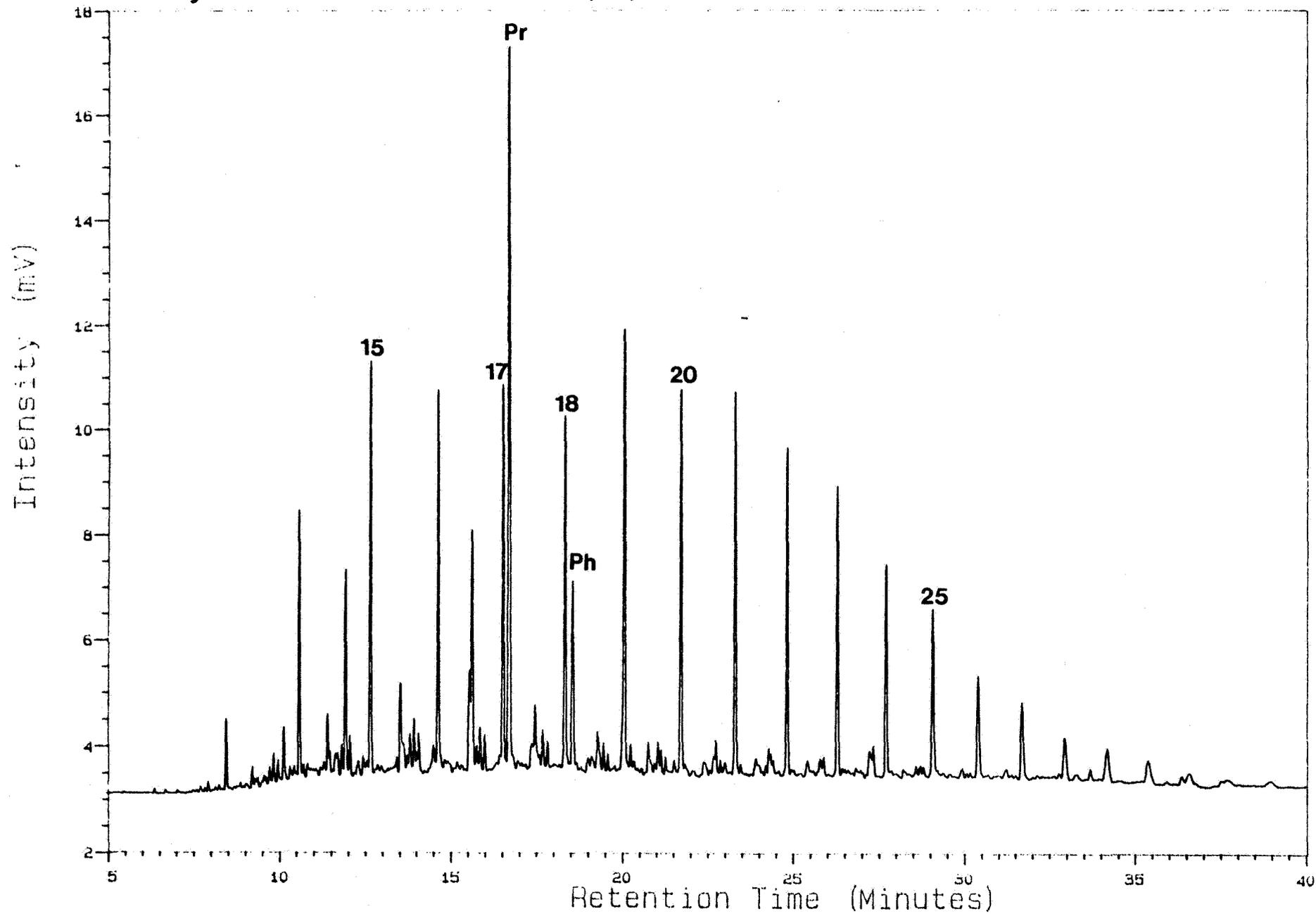
2723.12



Analysis G640771

7. 2. 1

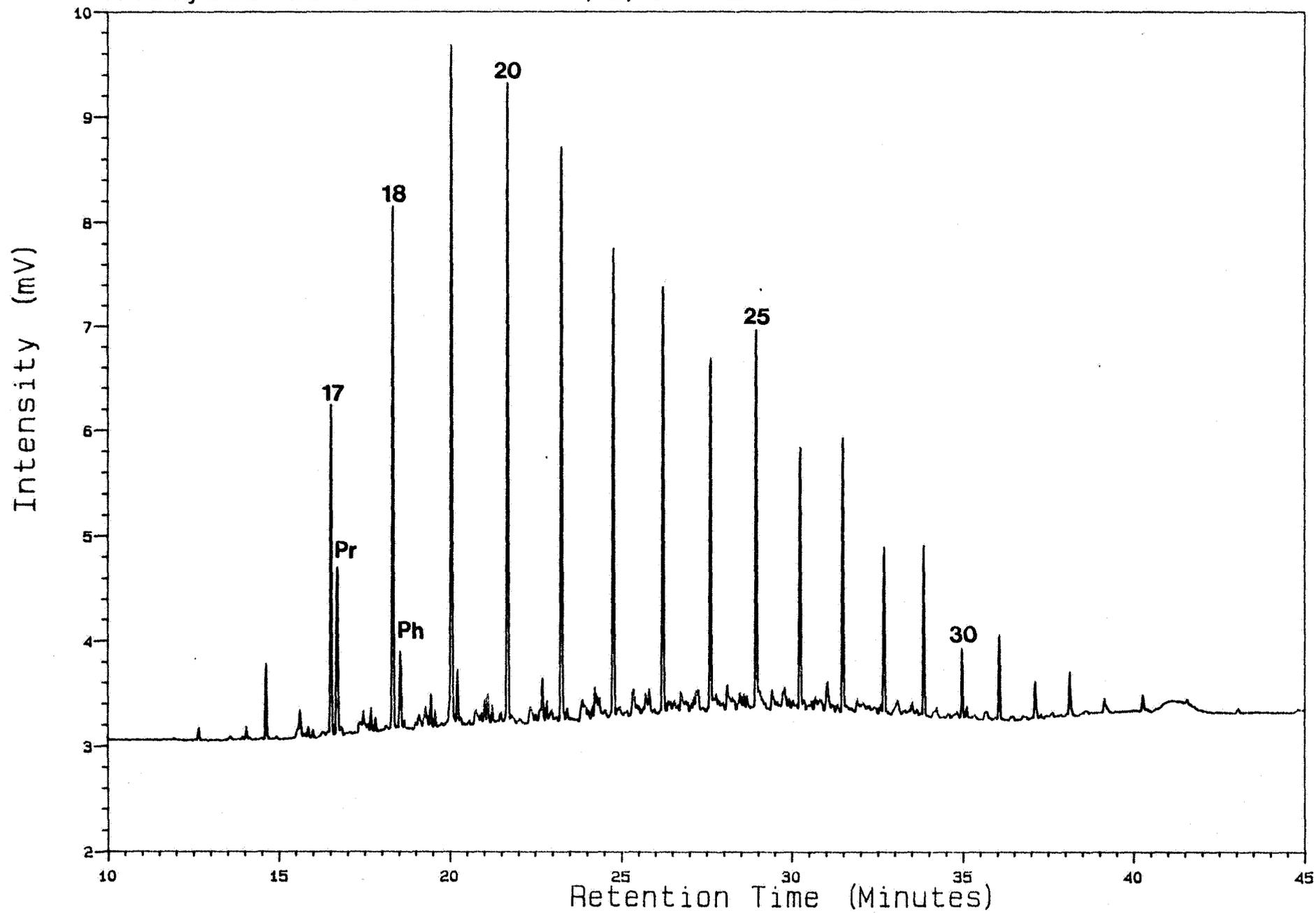
2726.05M



Analysis I640771

7, 3, 1

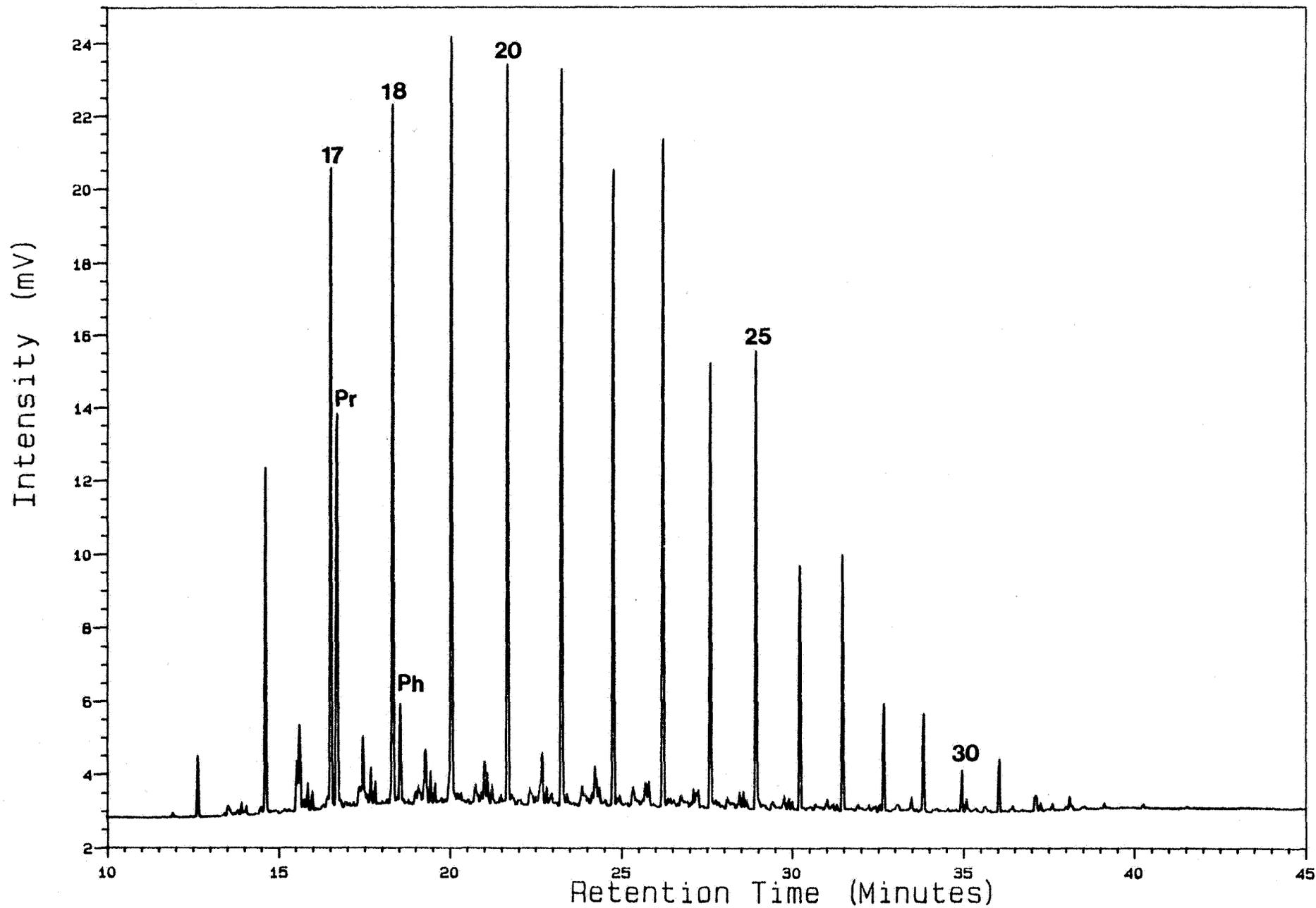
2747.00M



Analysis I640771

7, 4, 1

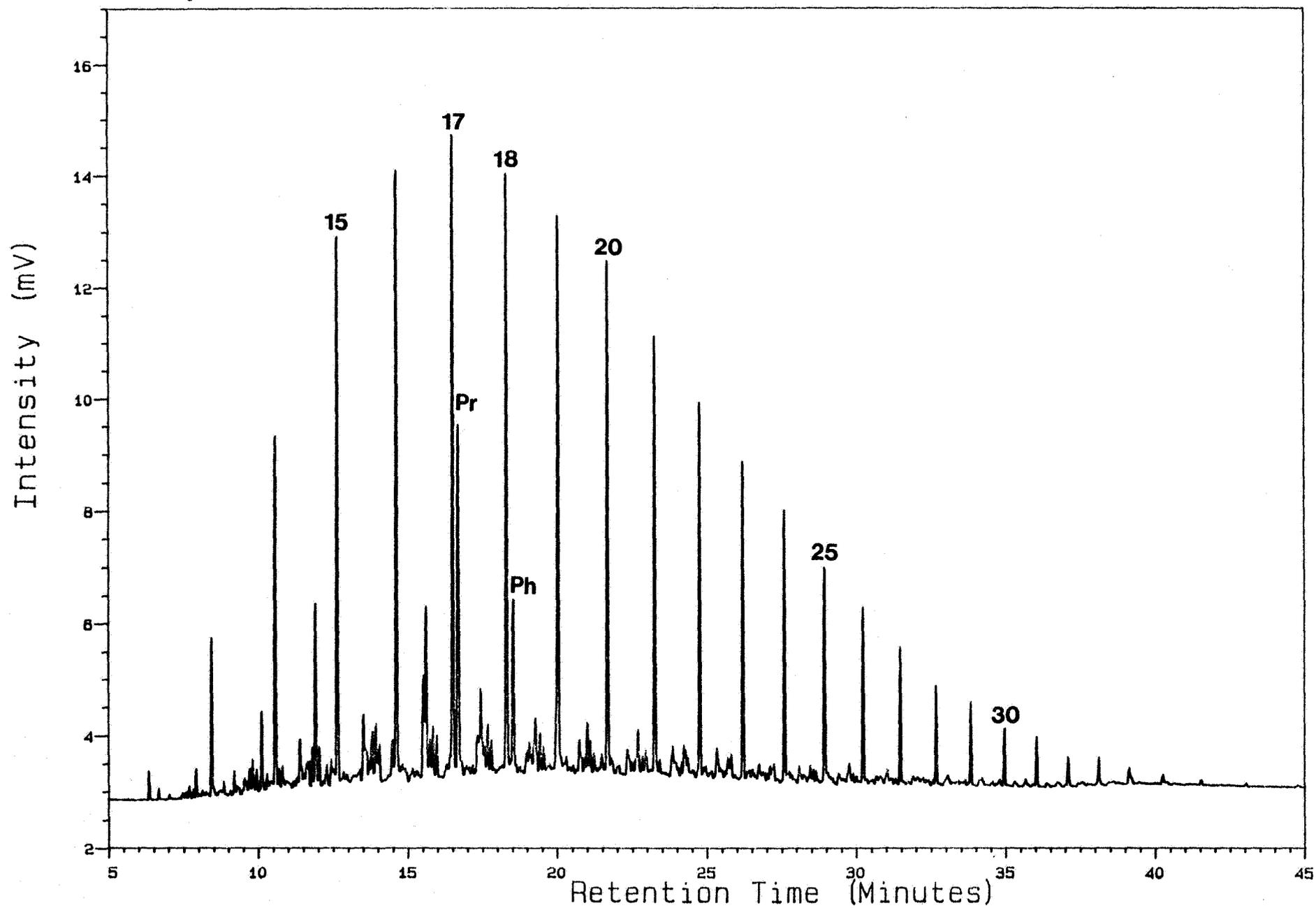
2757.00M



Analysis I640771

7, 6, 1

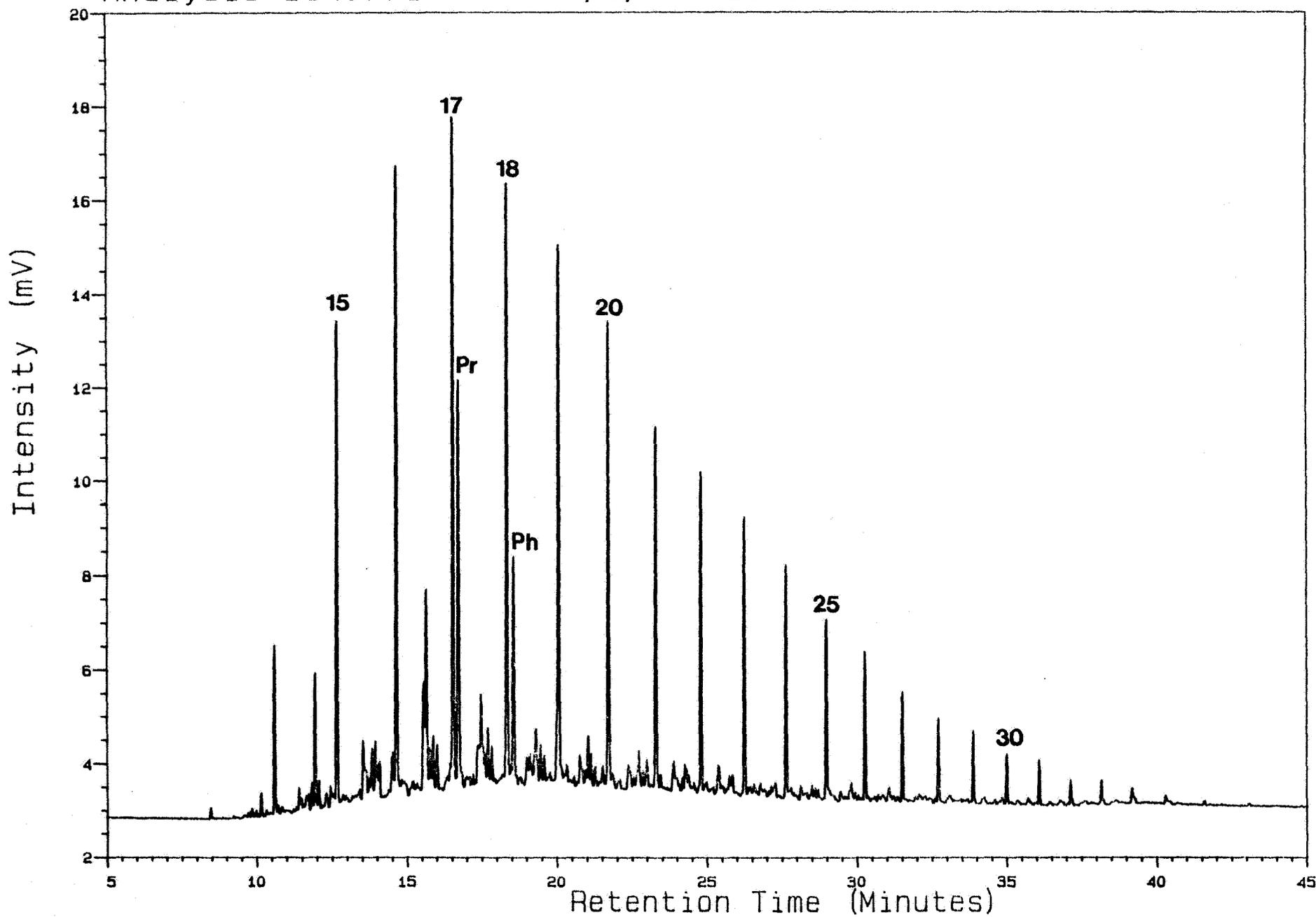
2780.60M



Analysis I640771

7, 9, 1

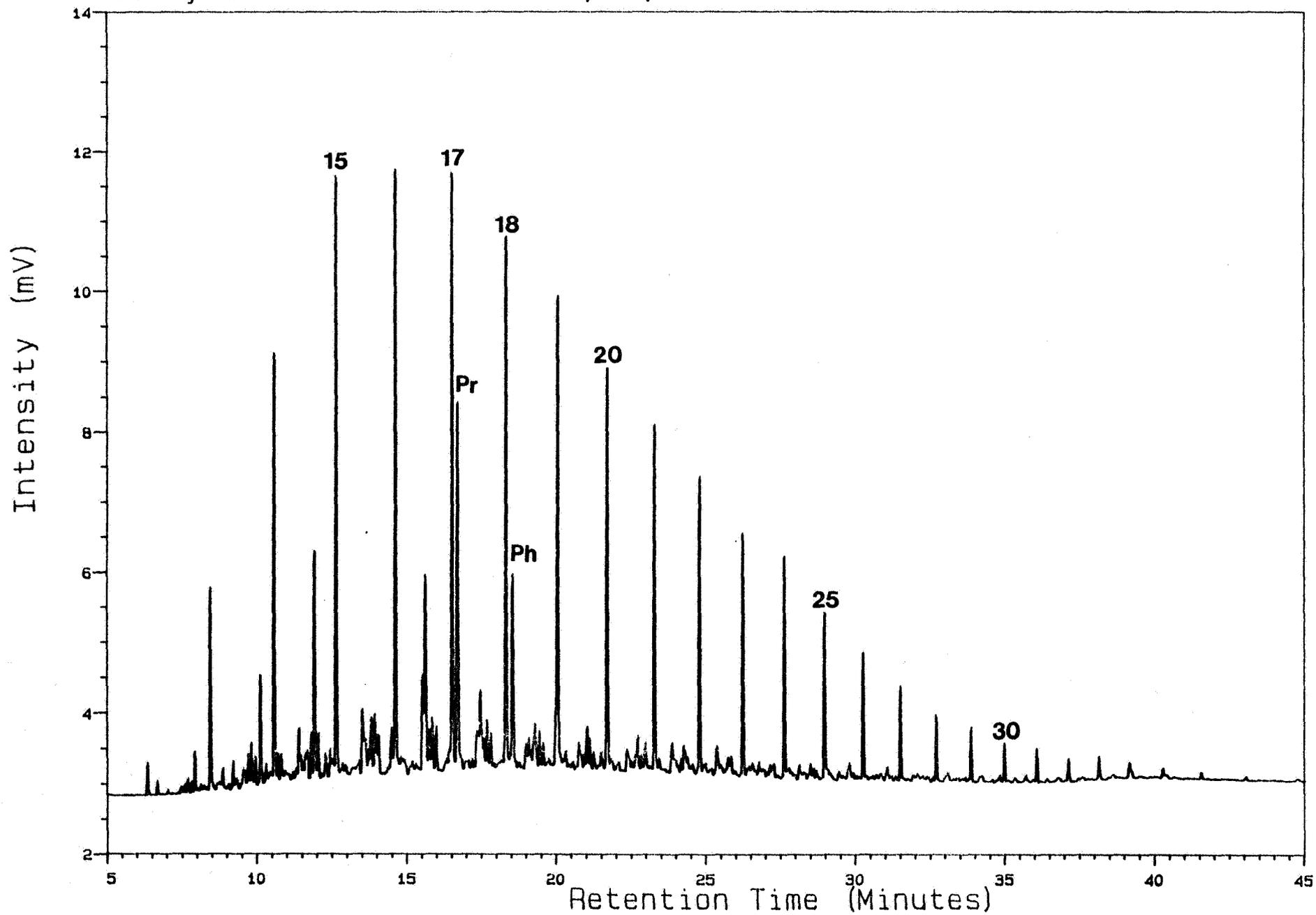
2840.00M



Analysis I640771

7, 13, 1

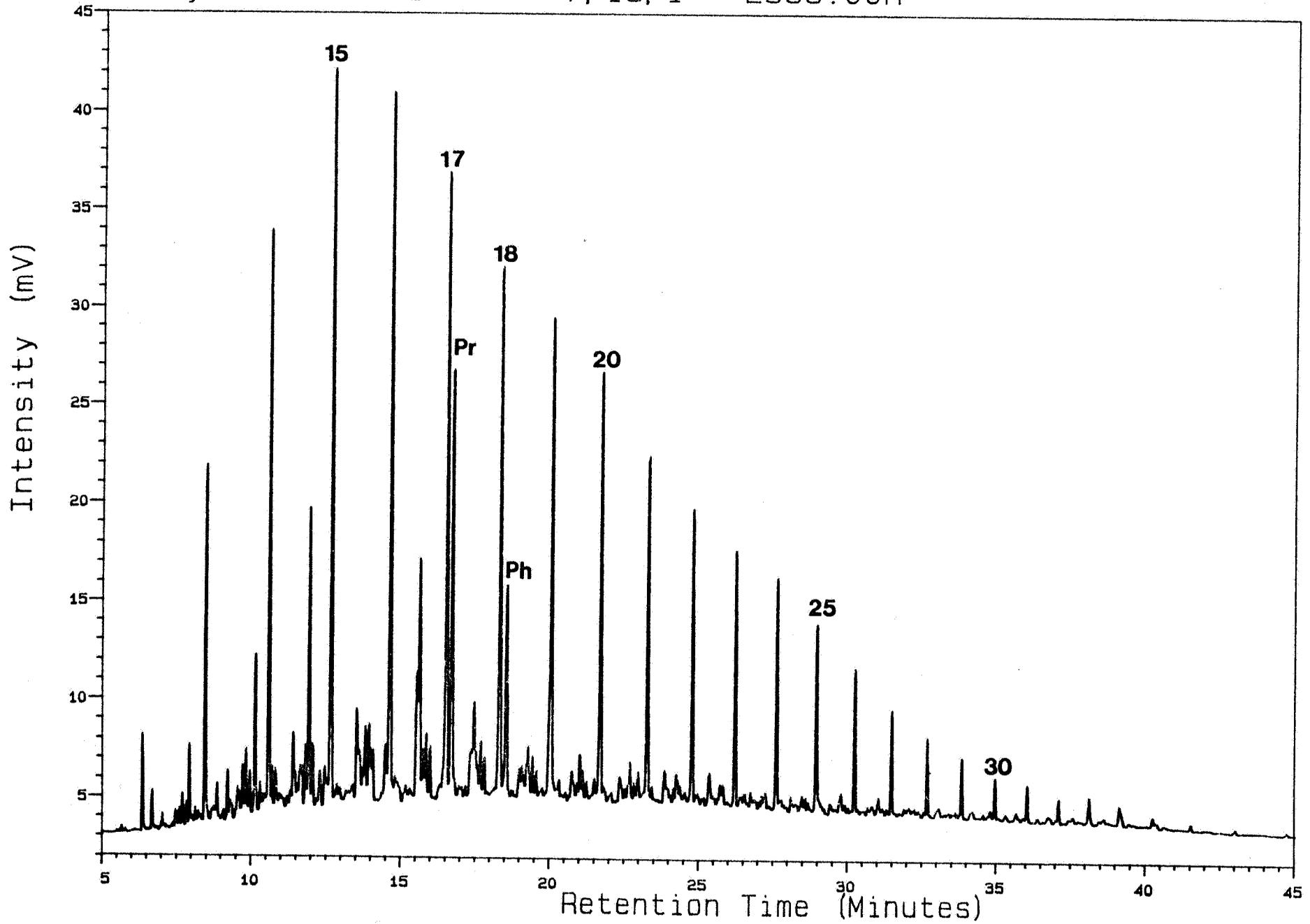
2915.00M



Analysis I640771

7, 15, 1

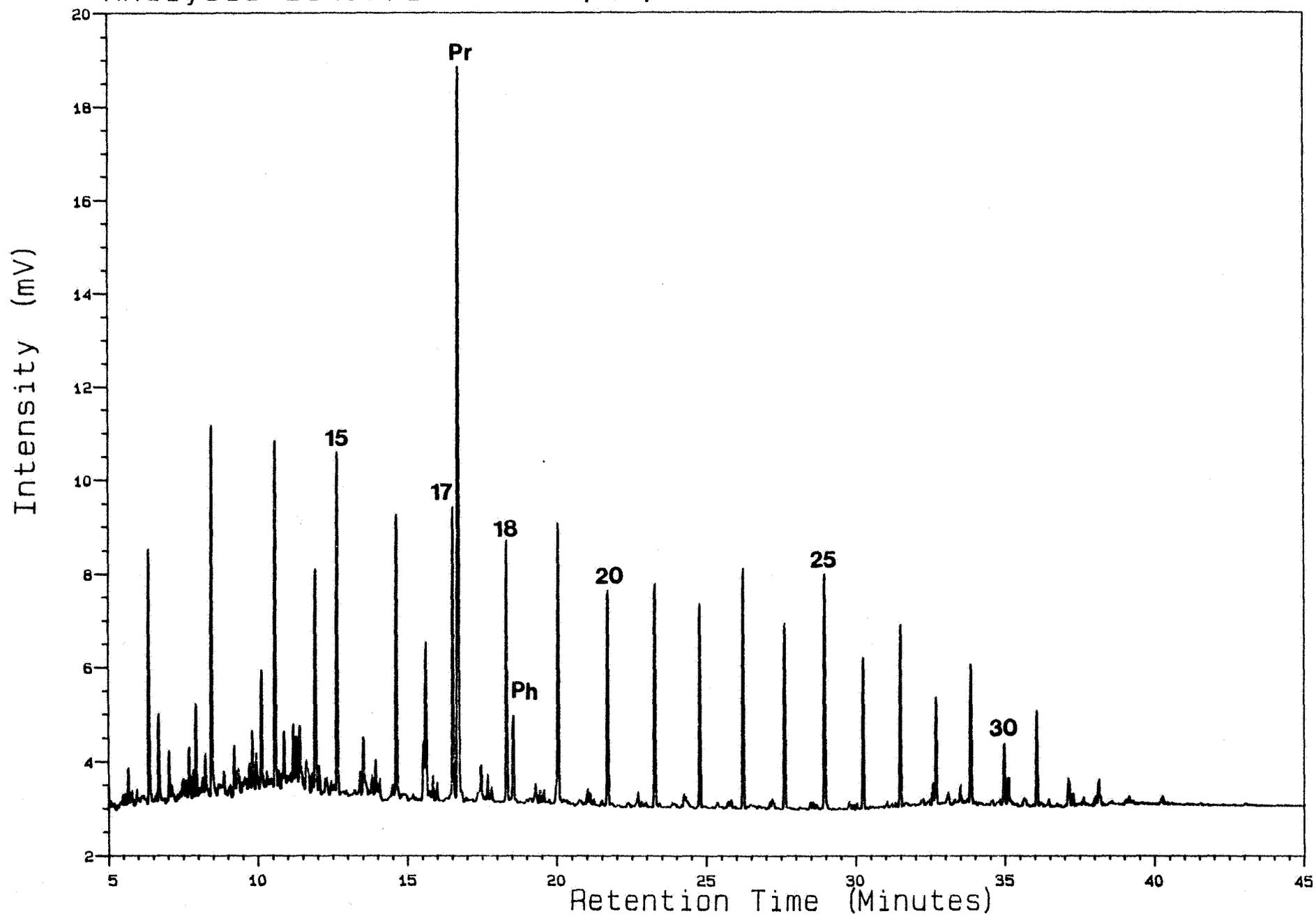
2966.00M



Analysis I640771

7, 18, 1

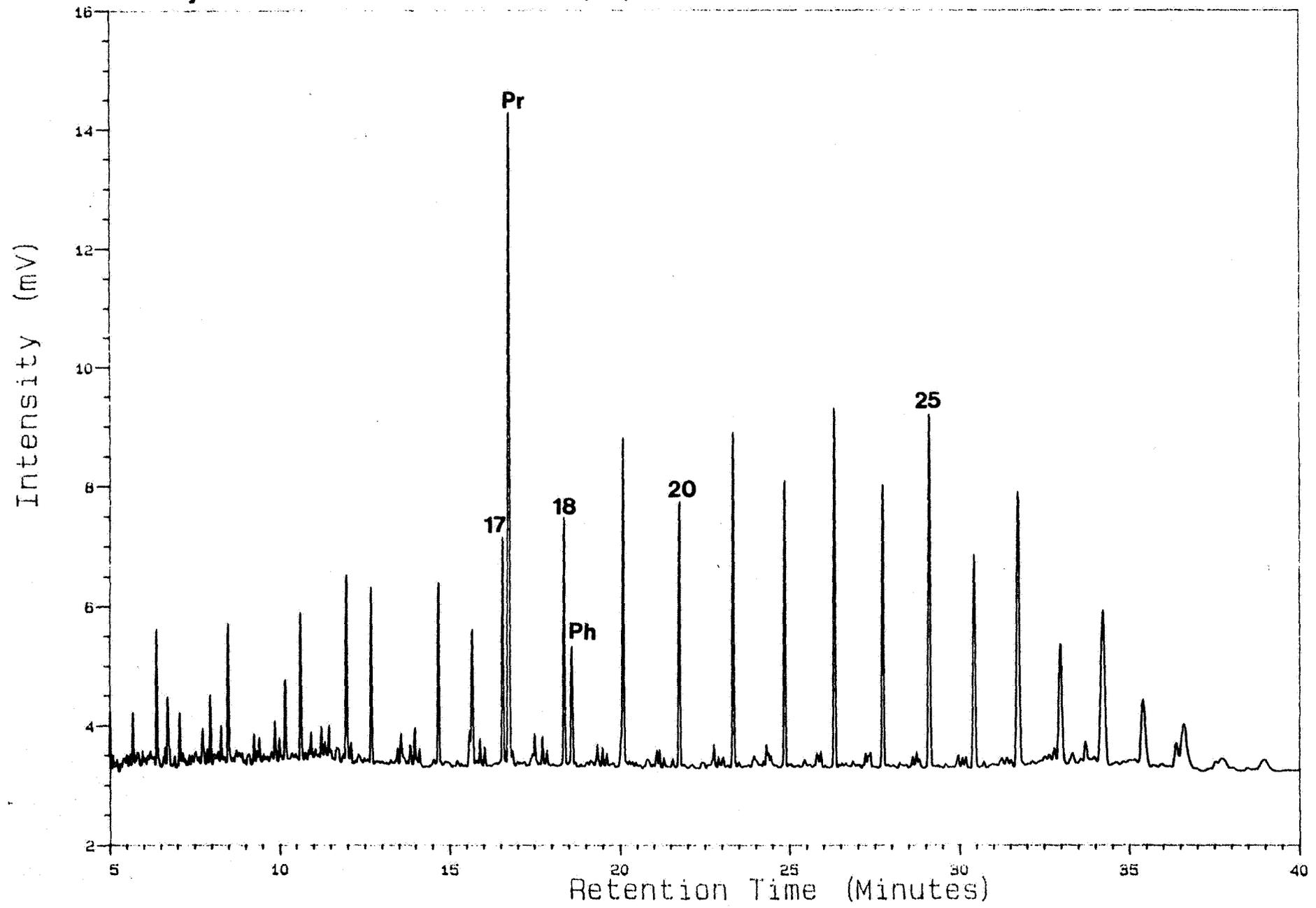
3000.50M



Analysis G640771

7.3.1

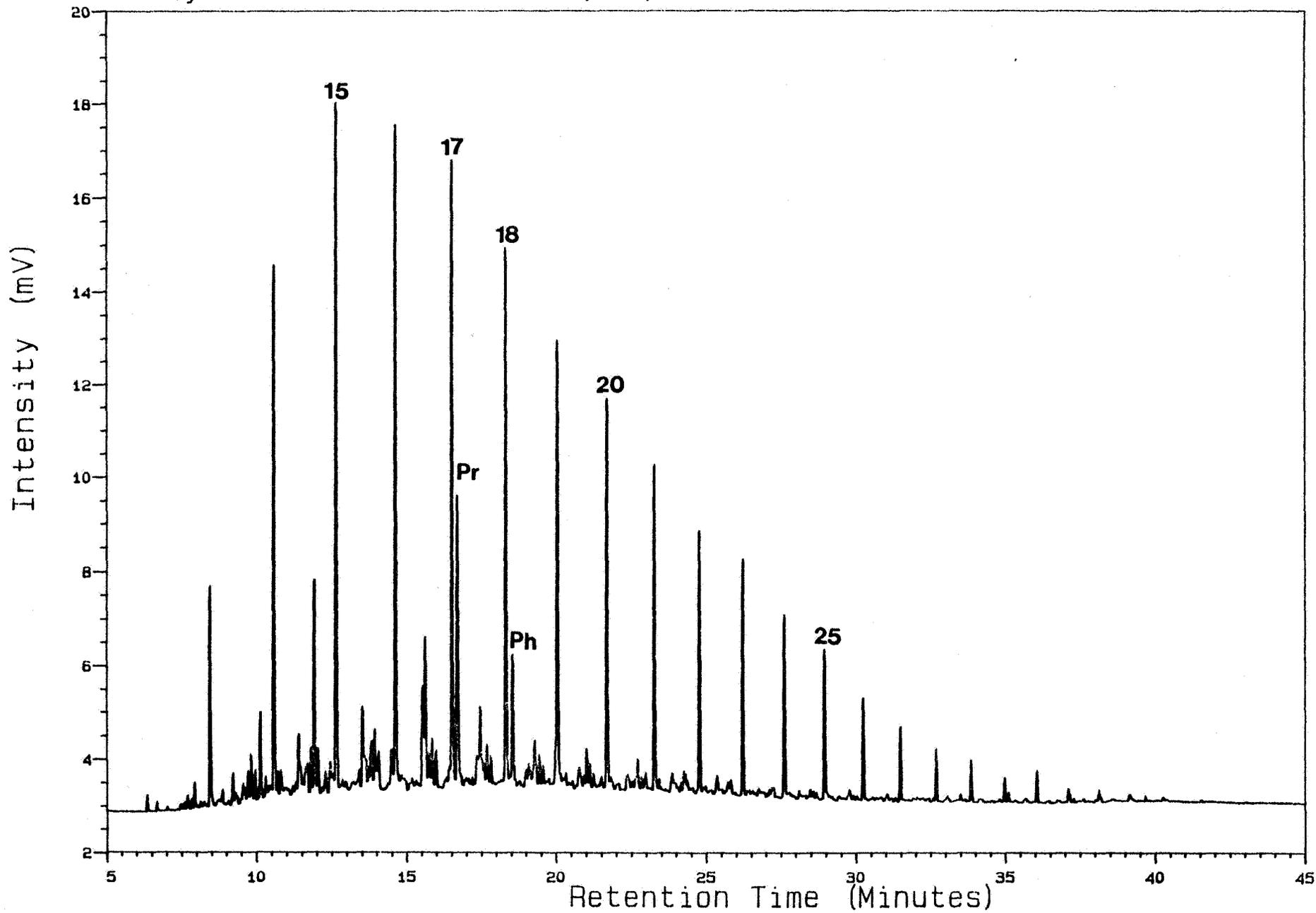
3017.20M



Analysis I640771

7, 23, 1

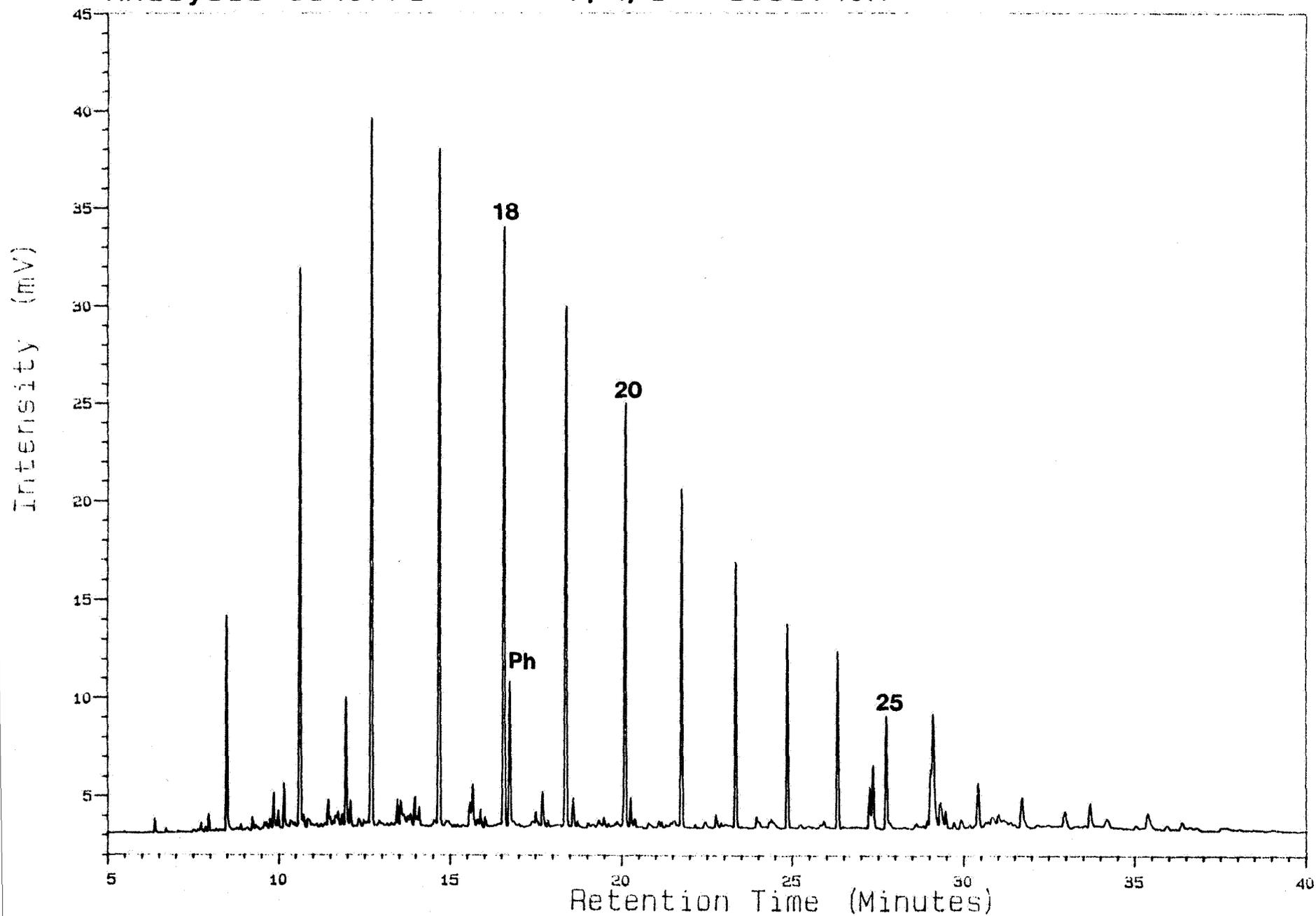
3032.30M



Analysis G640771

7, 4, 1

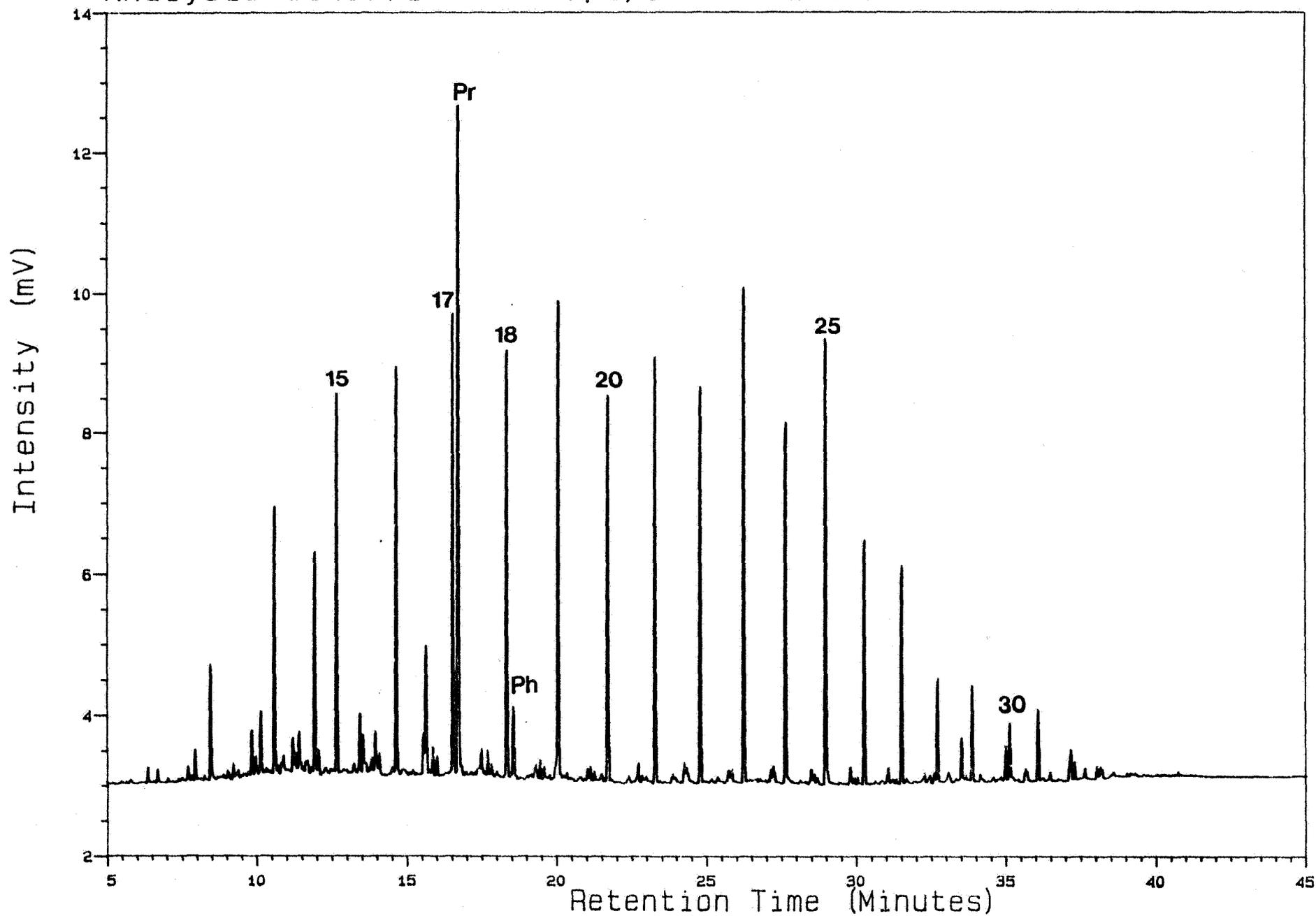
3039.40M



Analysis J640771

7, 3, 1

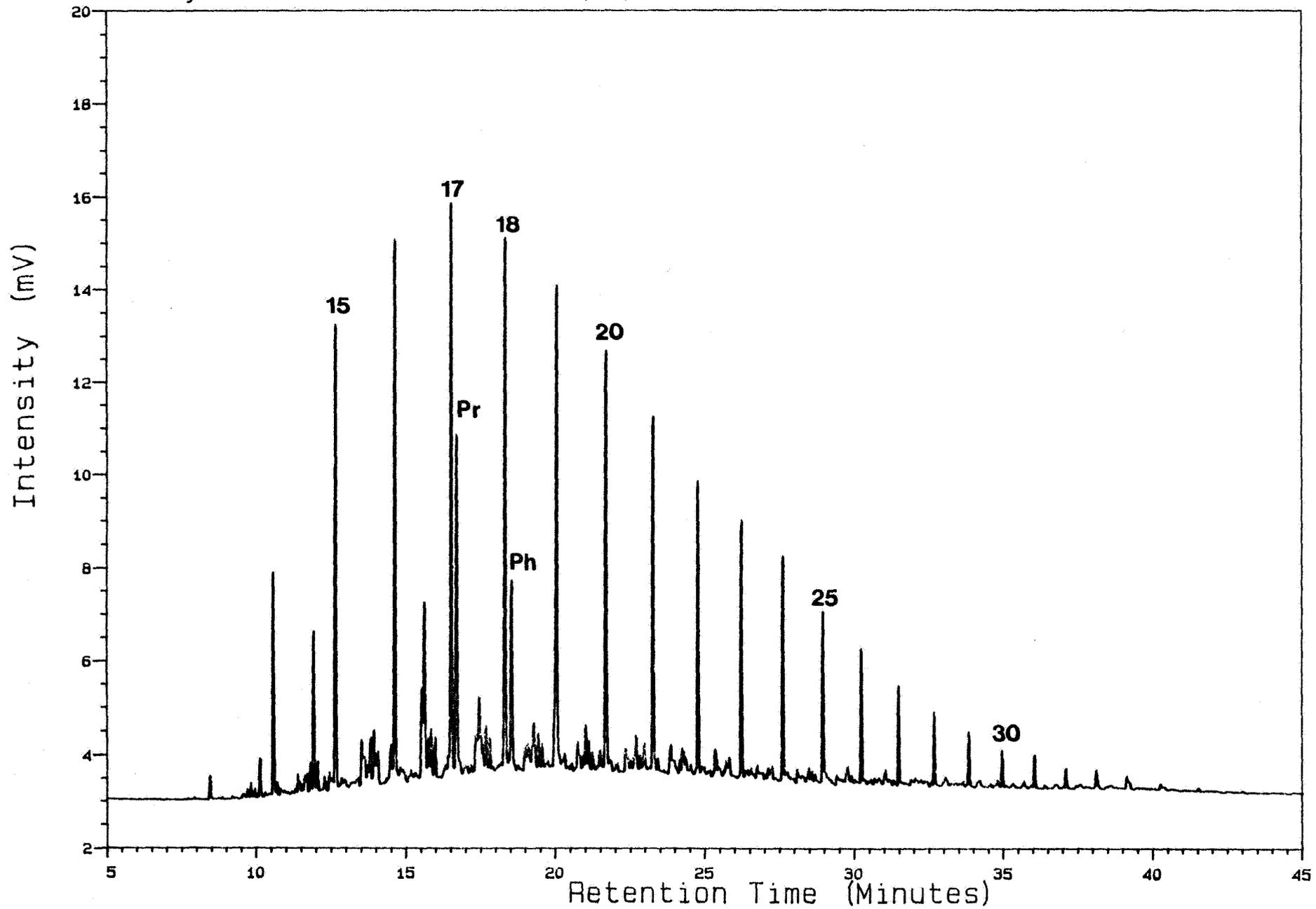
3071.57M



Analysis J640771

7, 5, 1

3081.50M



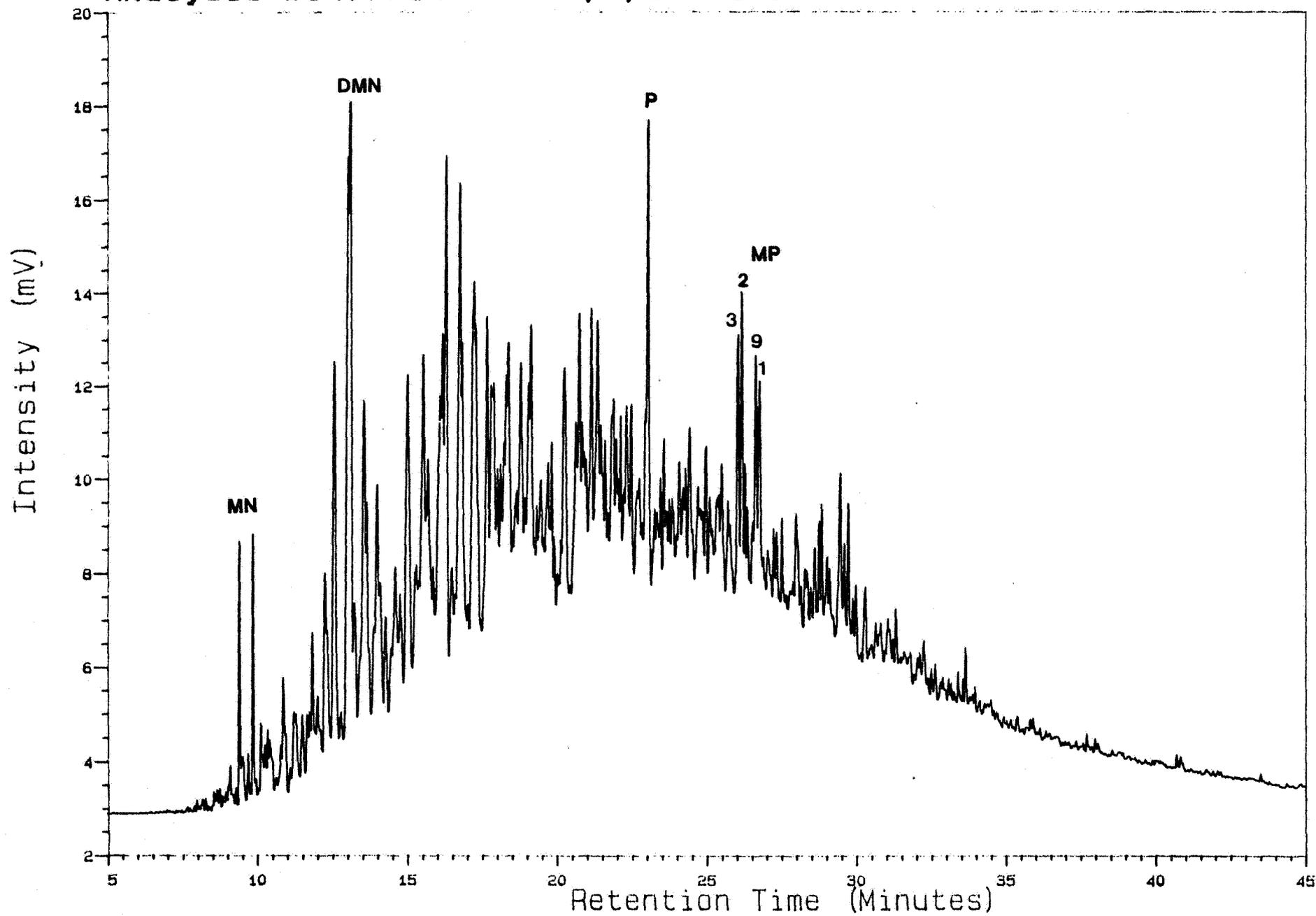
## APPENDIX II

### GAS CHROMATOGRAMS OF AROMATIC HYDROCARBONS

- MN - methylnaphtalenes
- DMN - dimethylnaphtalenes
- P - phenanthrene
- 3 - 3-methylphenanthrene
- 2 - 2-methylphenanthrene
- 9 - 9-methylphenanthrene
- 1 - 1-methylphenanthrene

Analysis B640771A

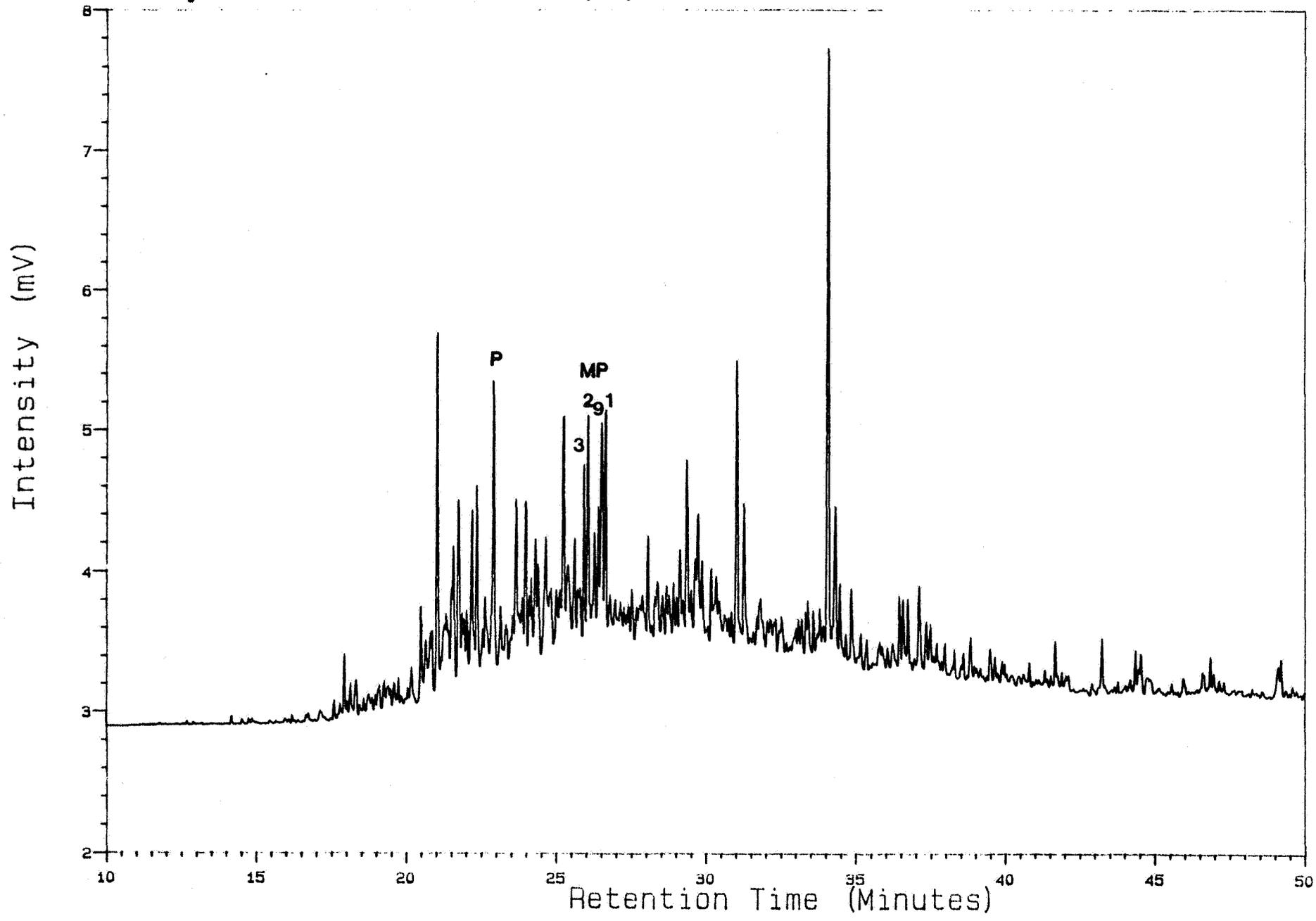
3, 2, 1 1939 M



Analysis C640771A

3, 1, 1

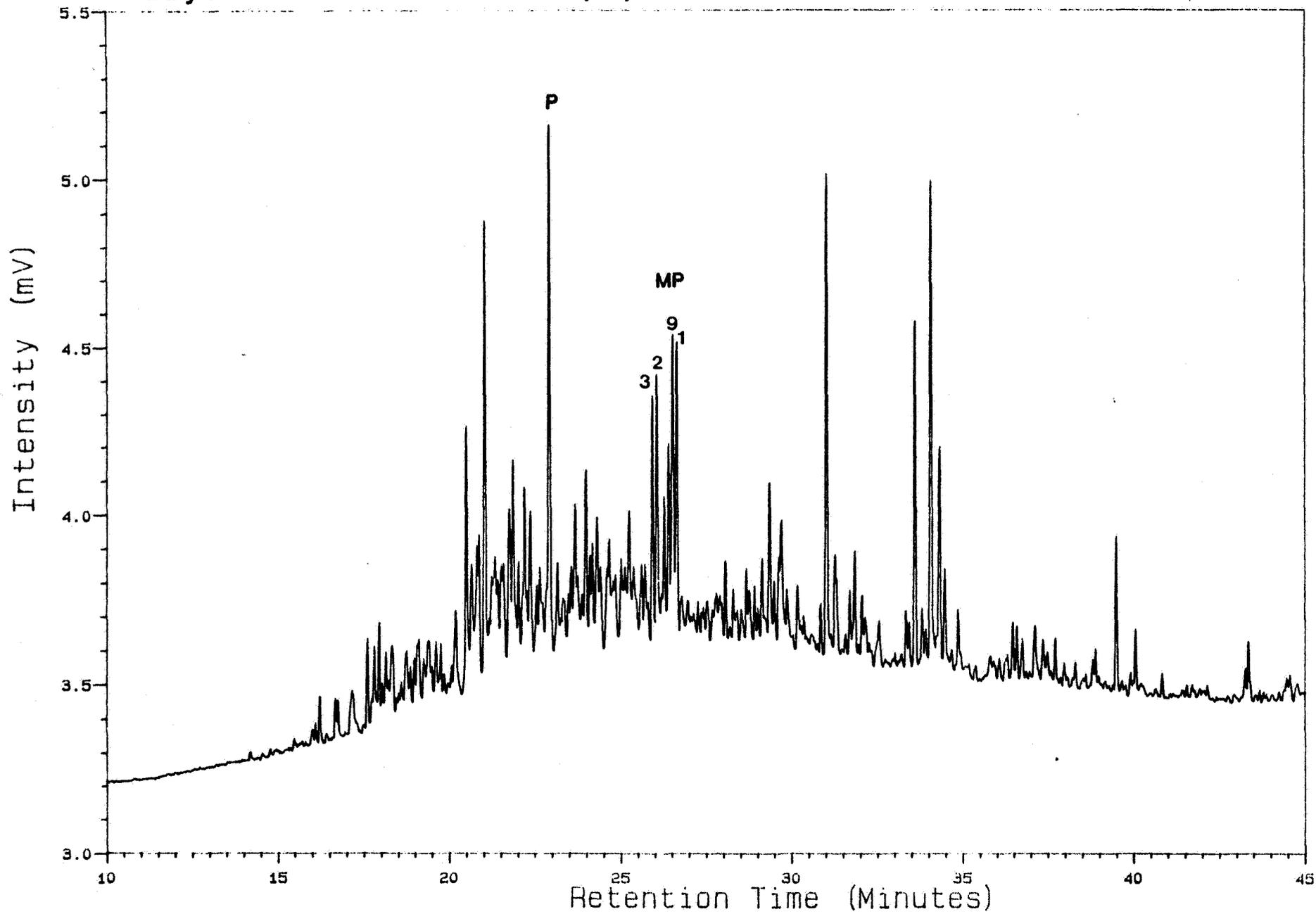
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Analysis B640771A

3, 4, 1

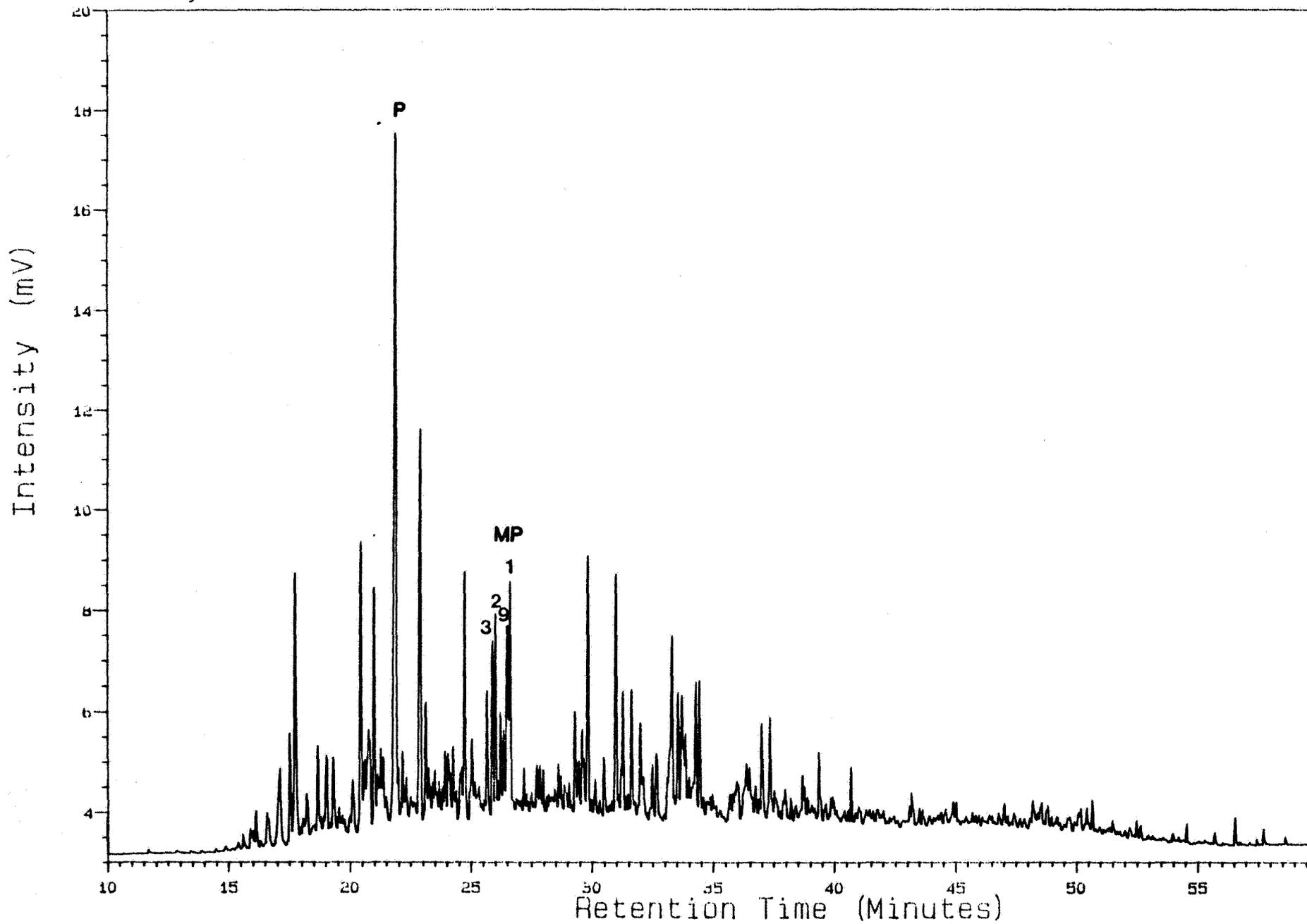
2170 M



Analysis B340801A

3, 24, 1

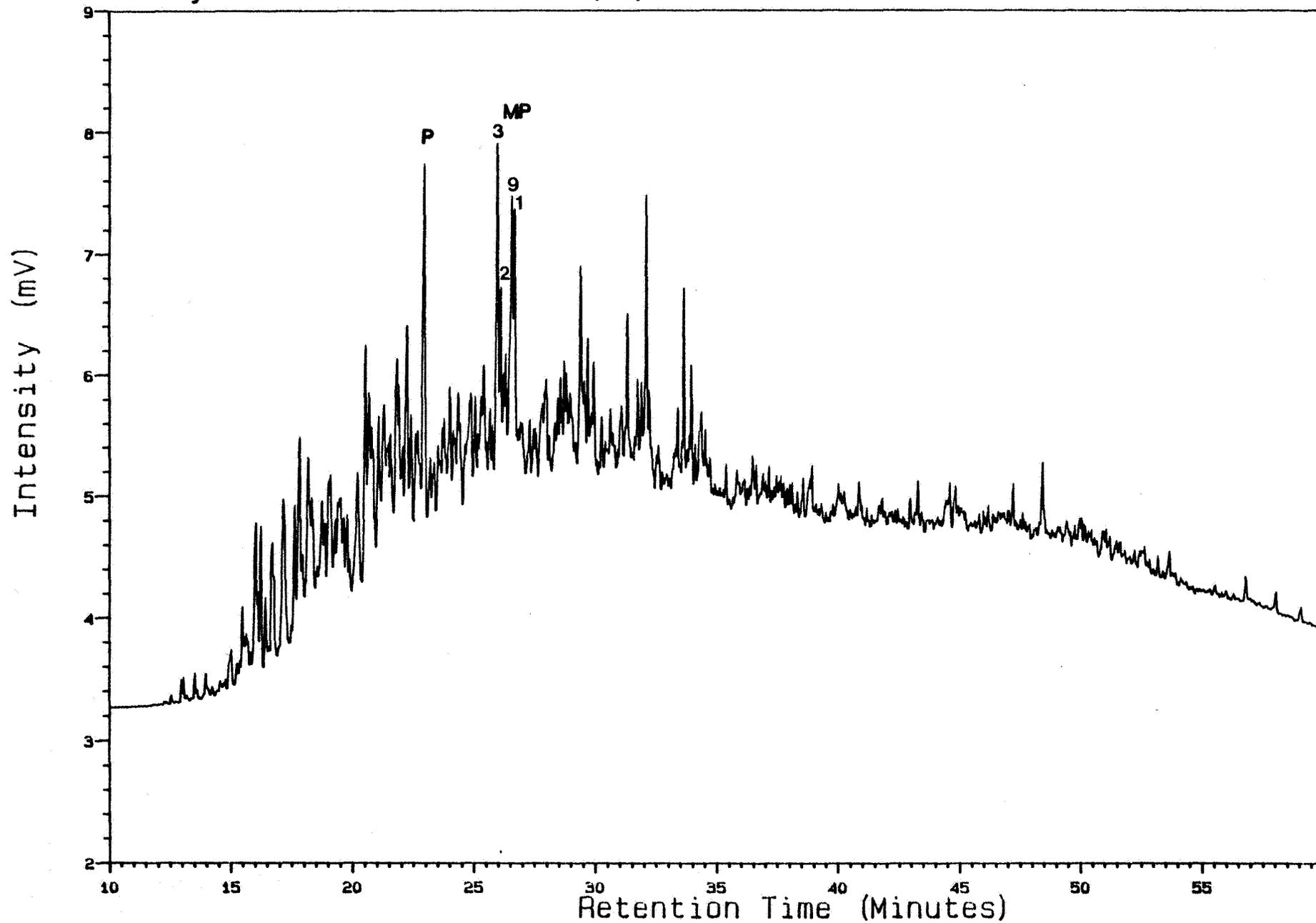
640771, 2446.5



Analysis B640771A

3, 8, 1

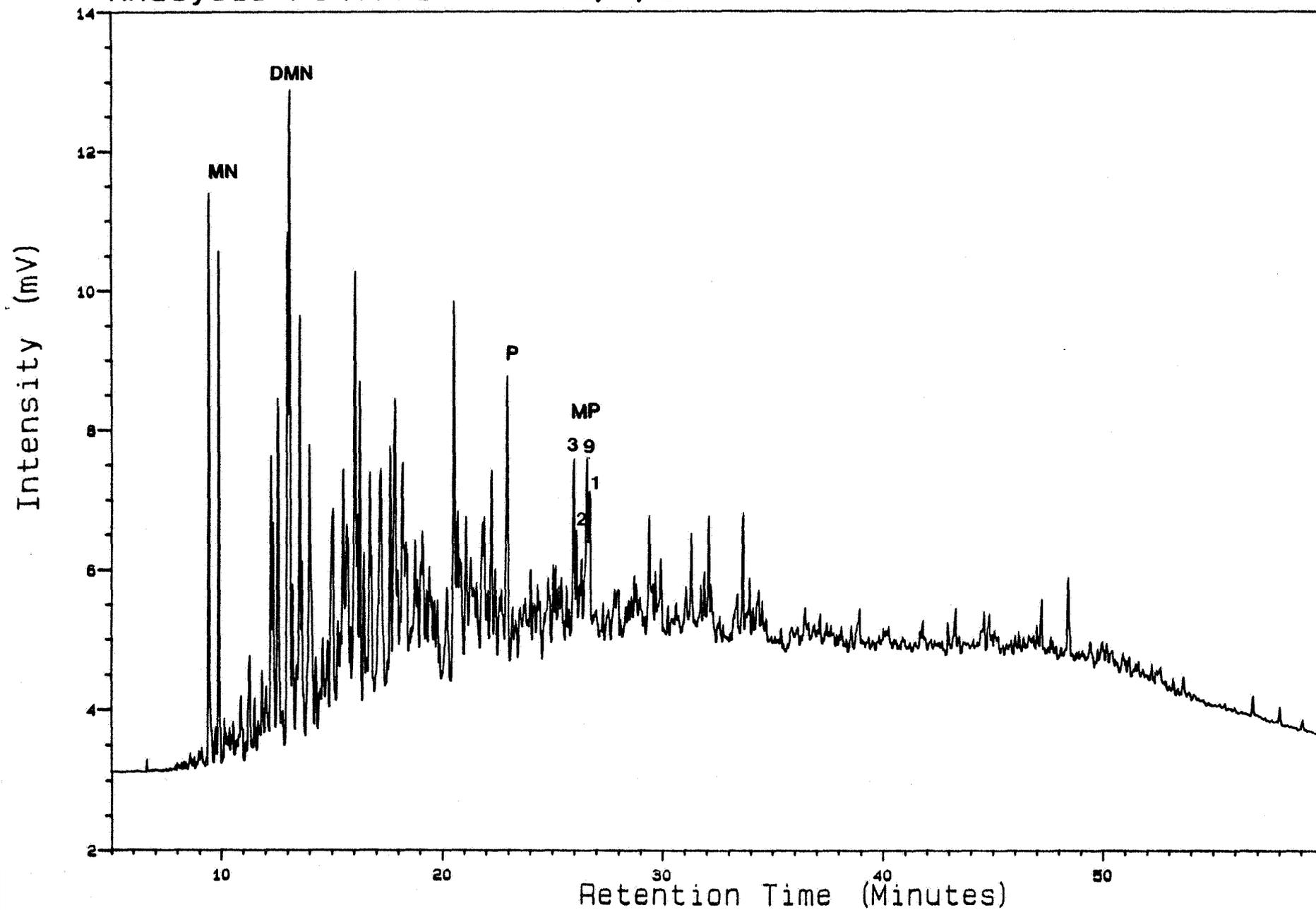
2702 M



Analysis F640771

3, 4, 1

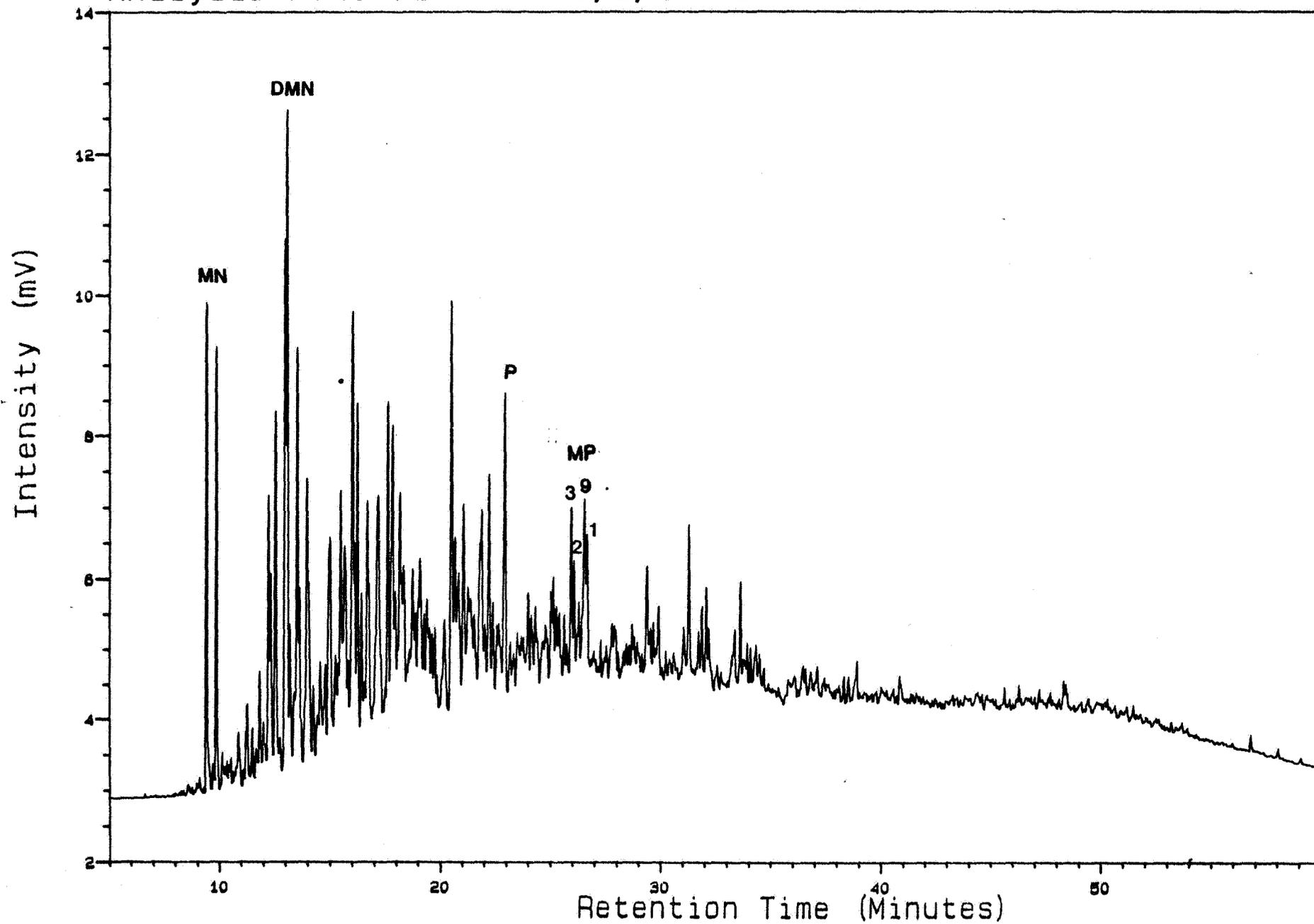
2704.50M



Analysis F640771

3, 6, 1

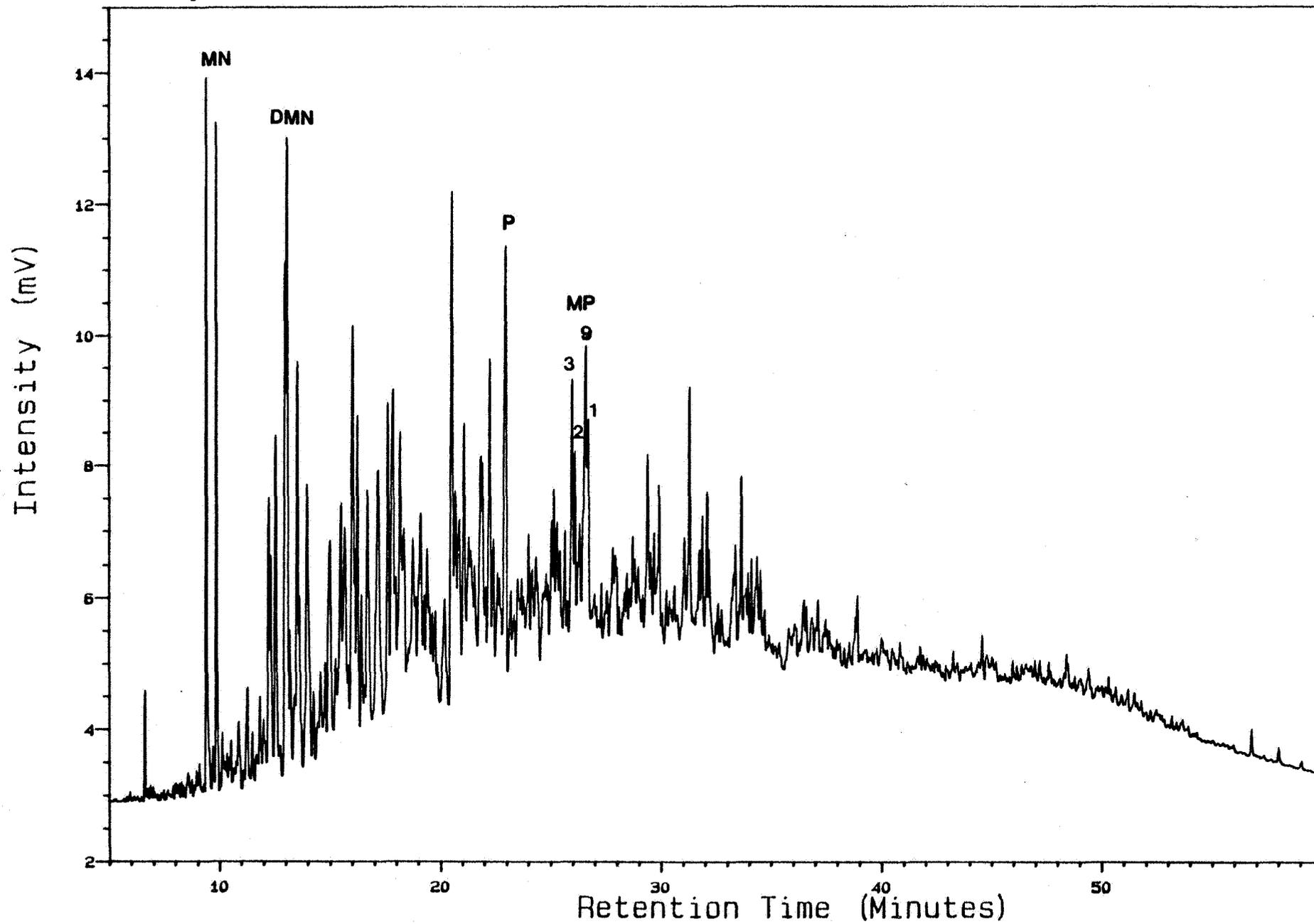
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Analysis F640771

3. 10. 1

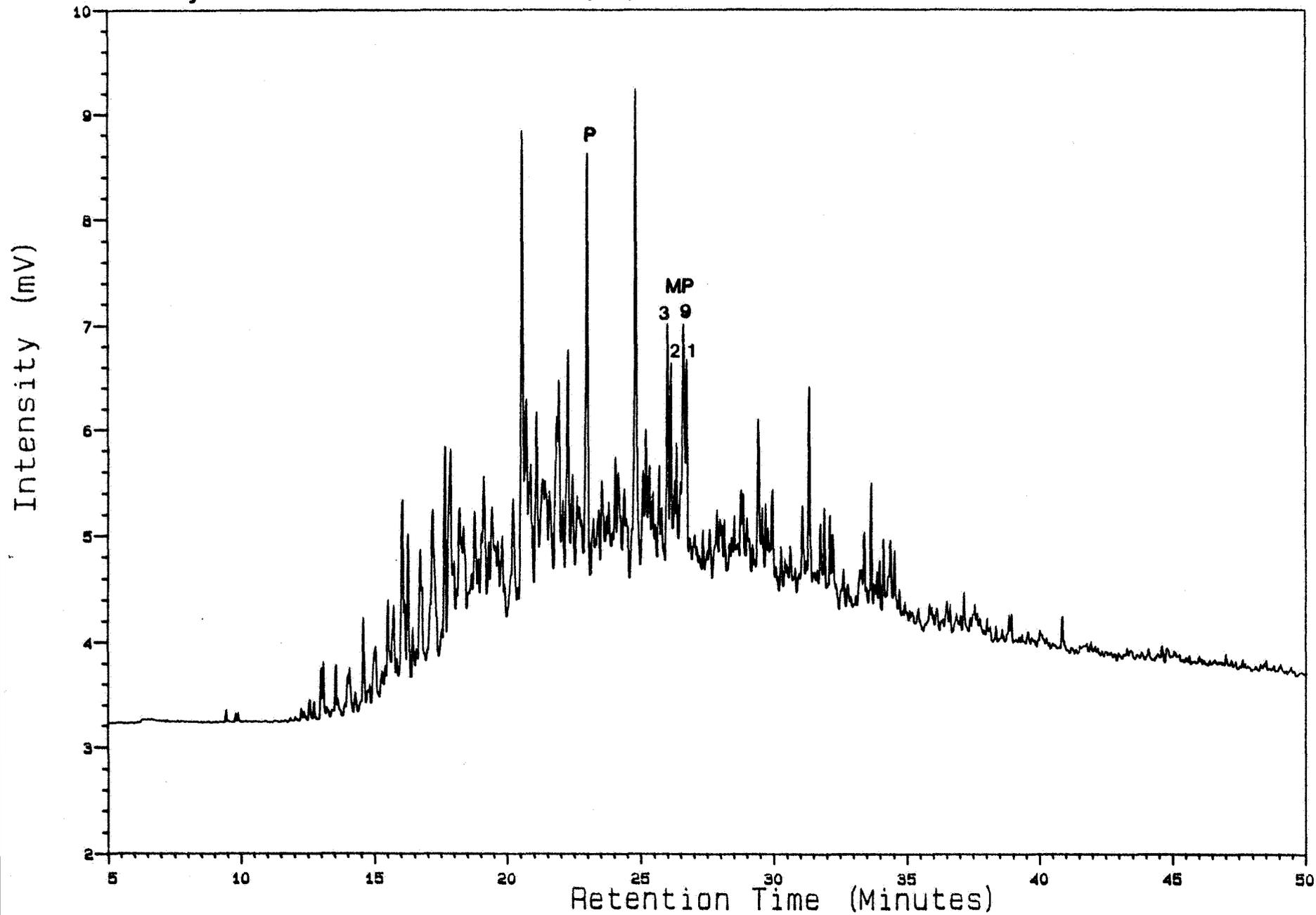
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Analysis D640771

3. 1. 1

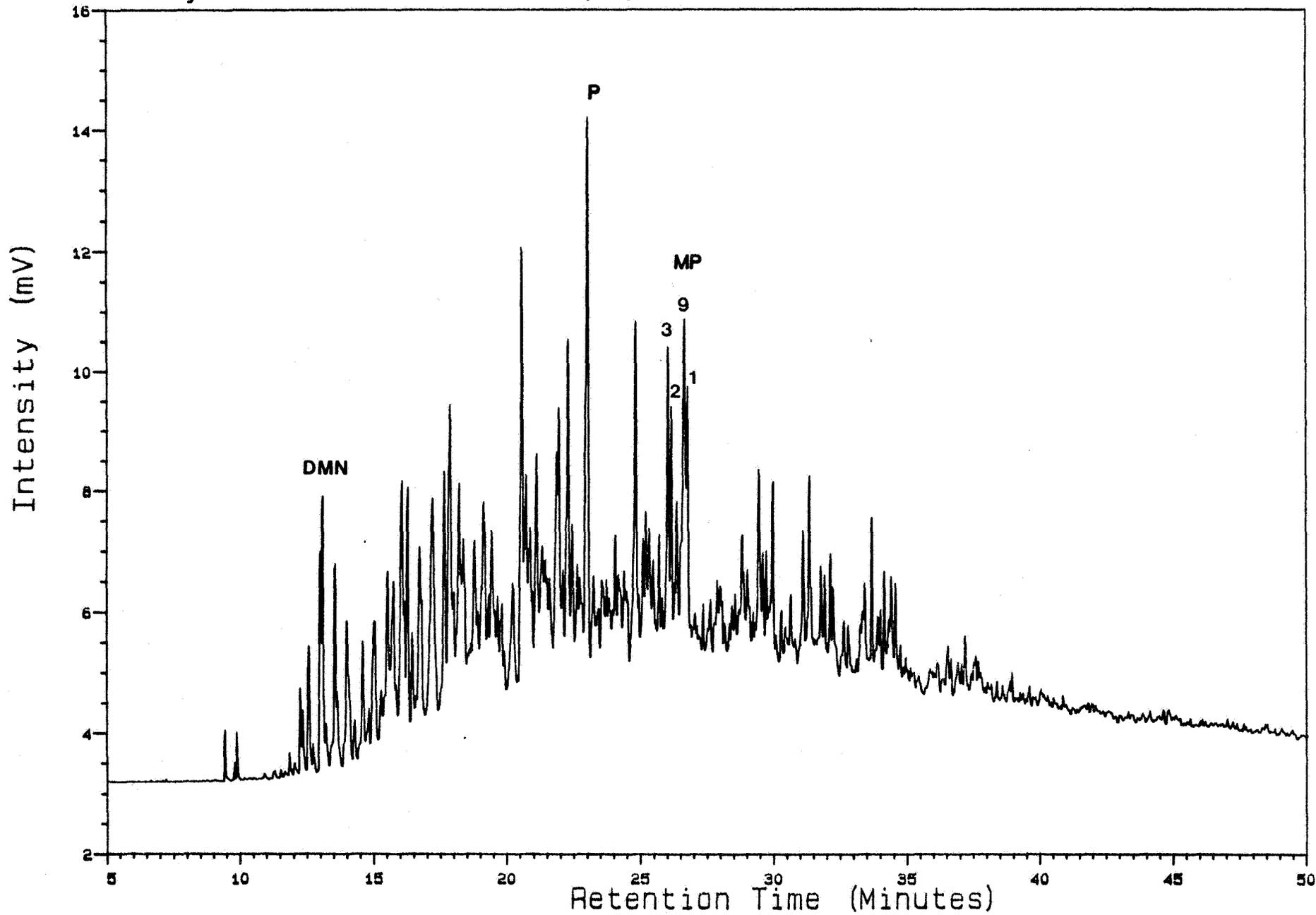
2713.25



Analysis D640771

3, 2, 1

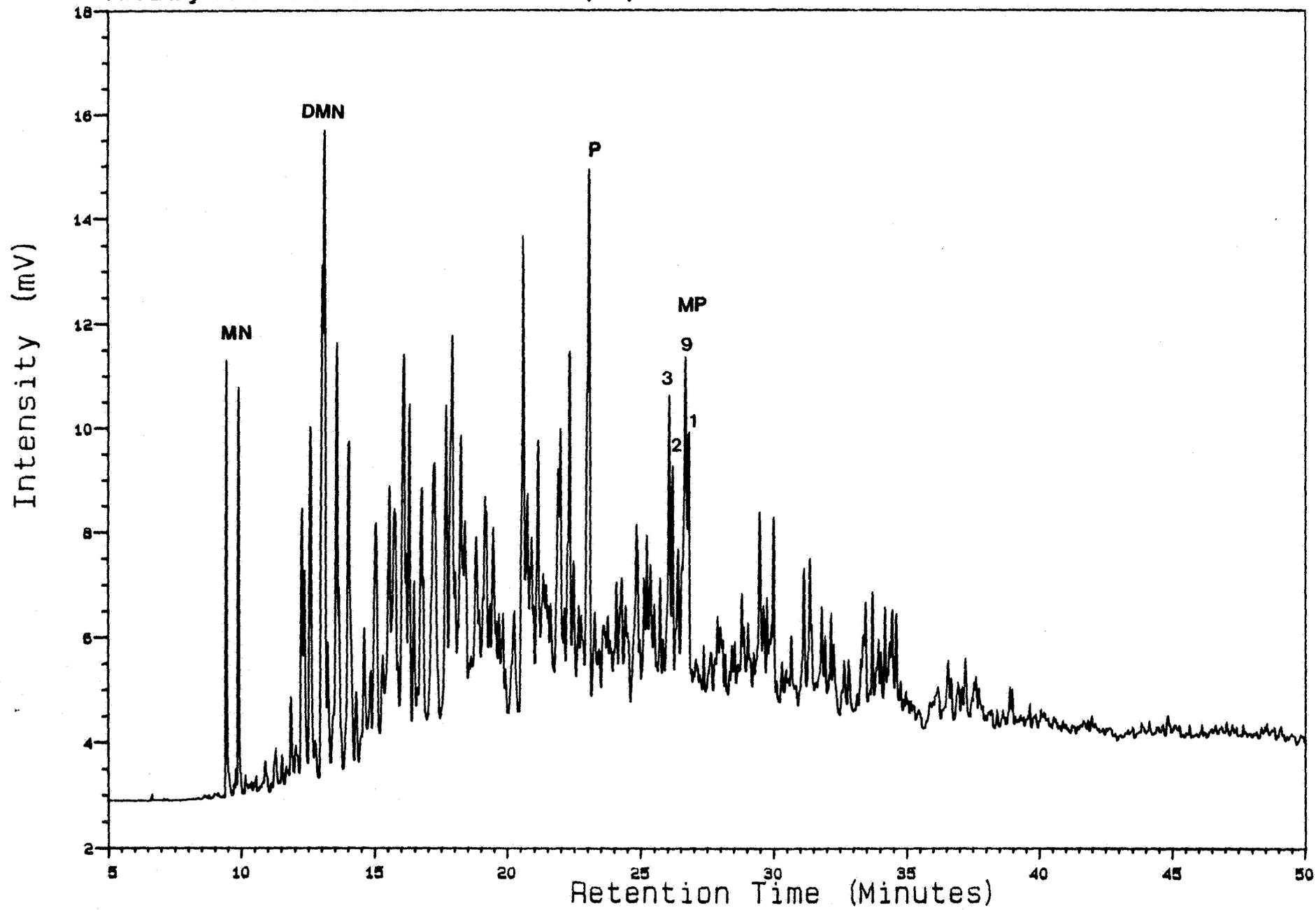
2716.23



Analysis D640771

3, 3, 1

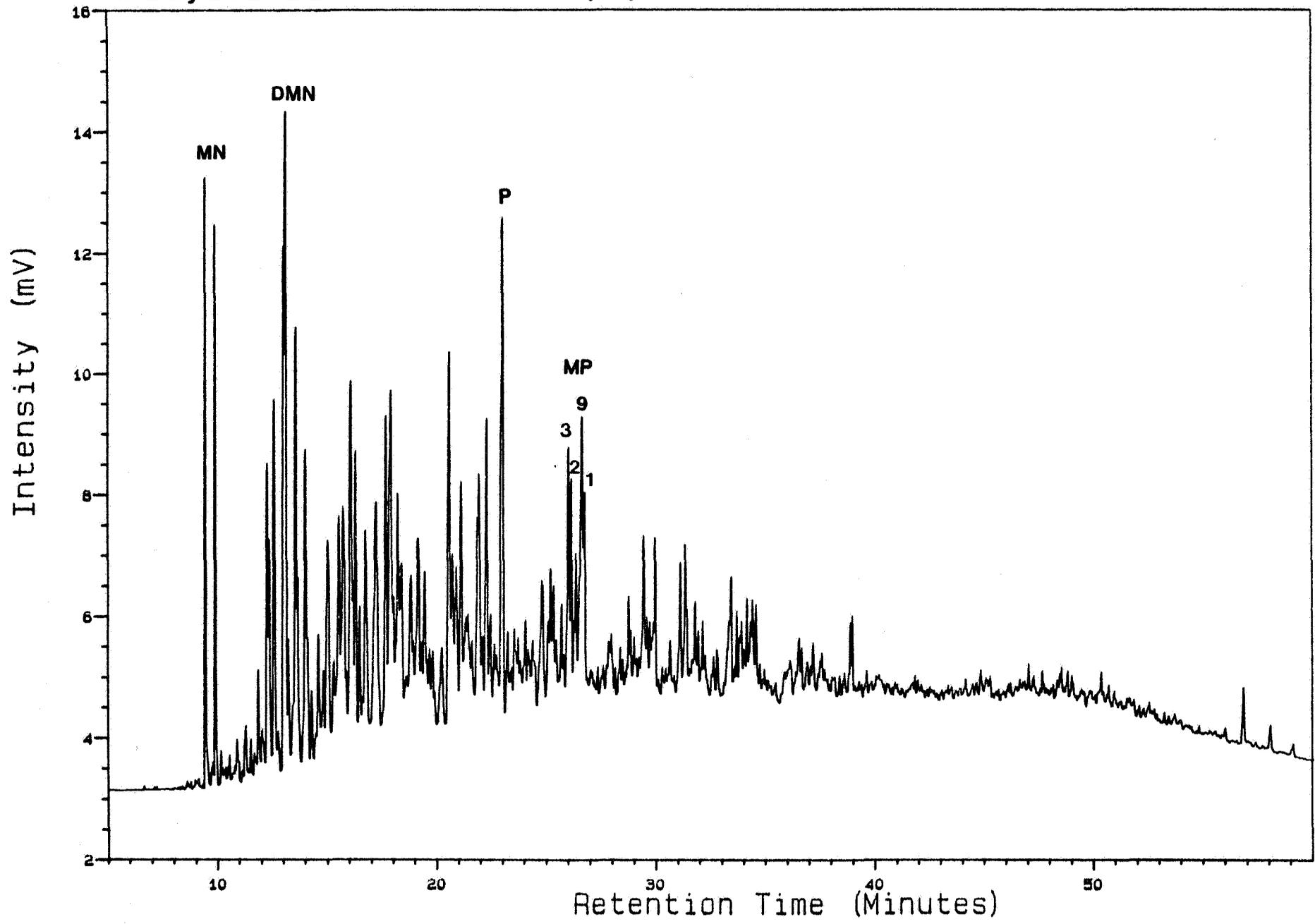
2716.97



Analysis D640771

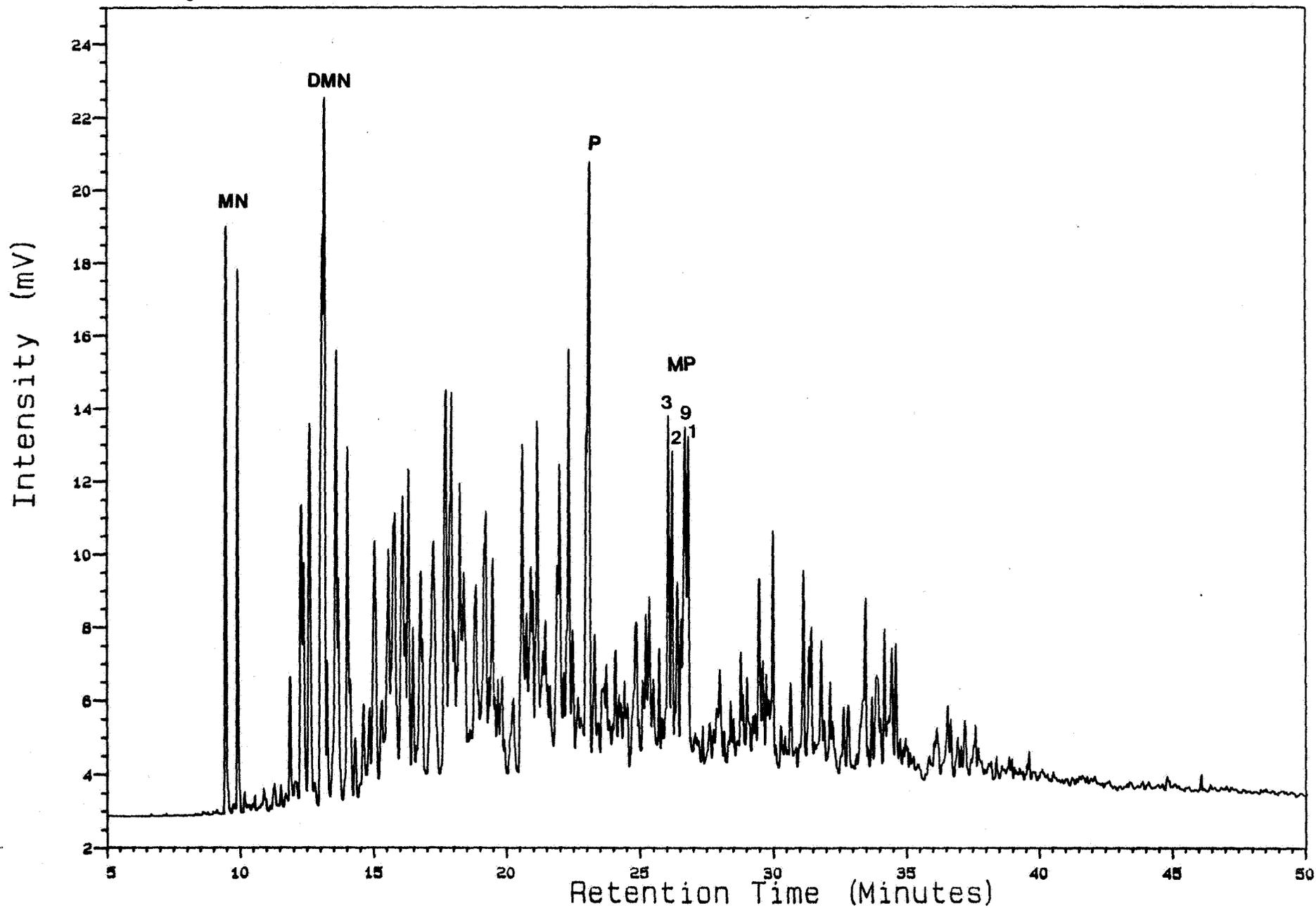
3, 5, 1

2718.04



Analysis D640771

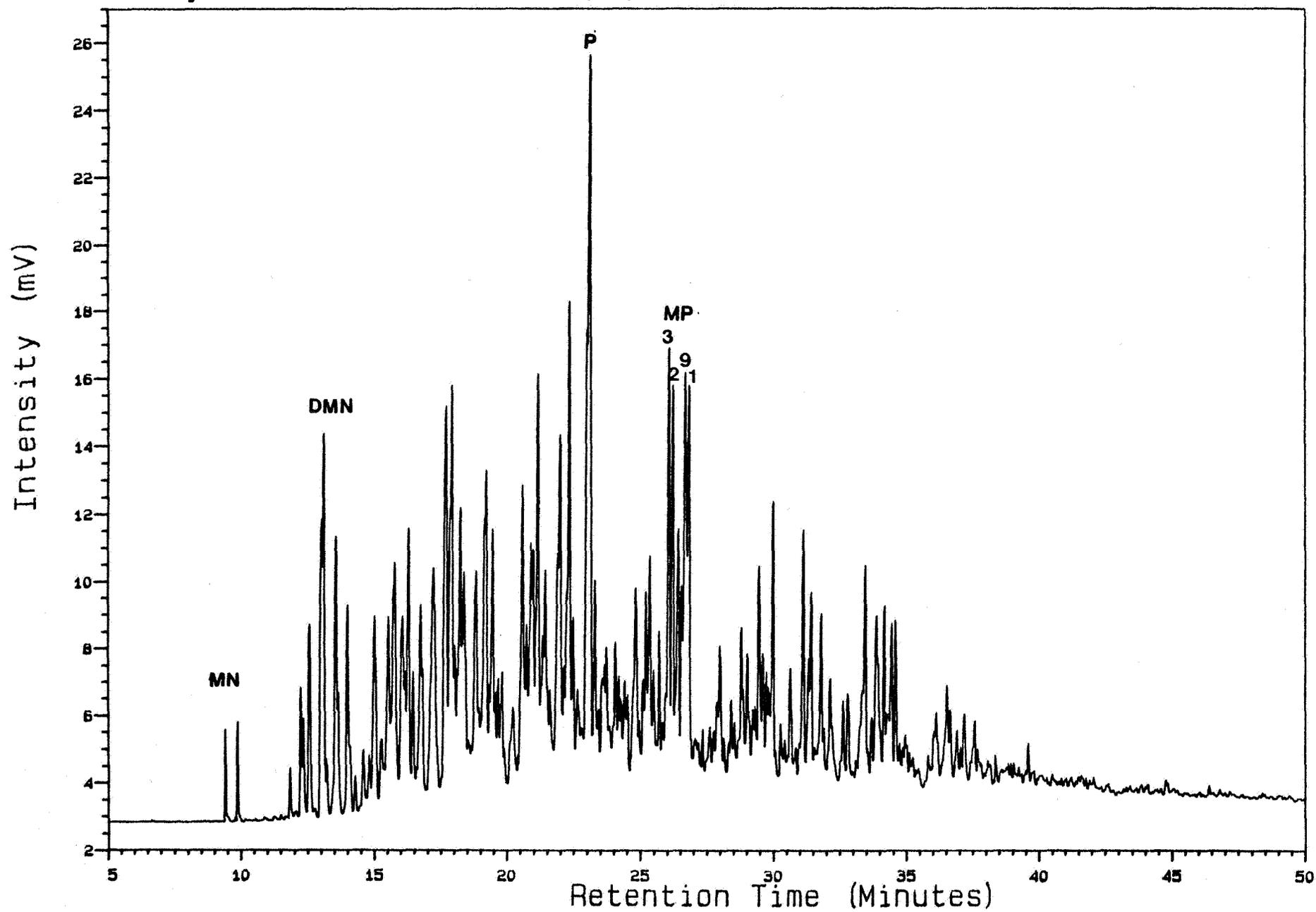
3, 6, 1 2719.10



Analysis D640771

3, 7, 1

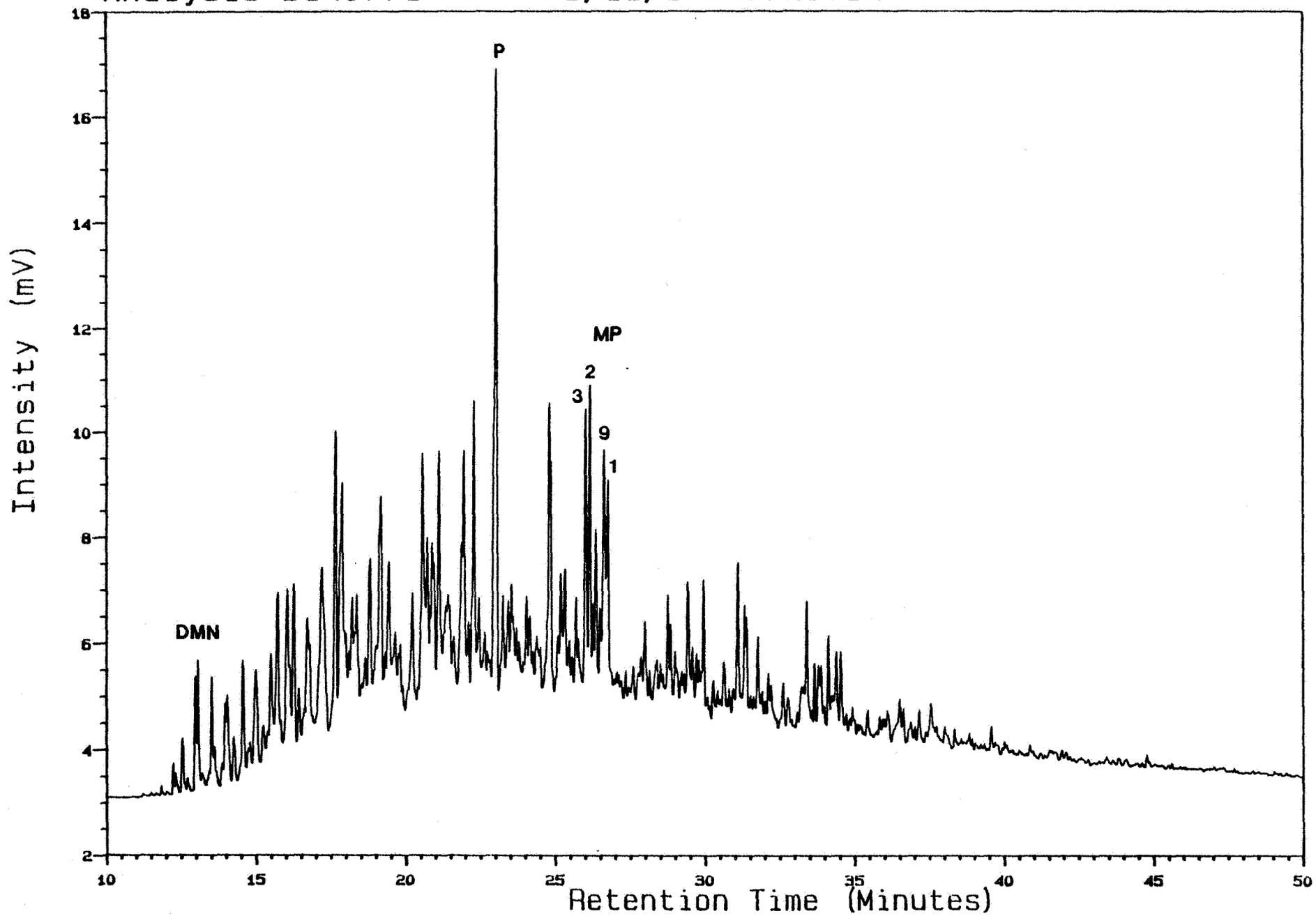
2720.05



Analysis D640771

3, 11, 1

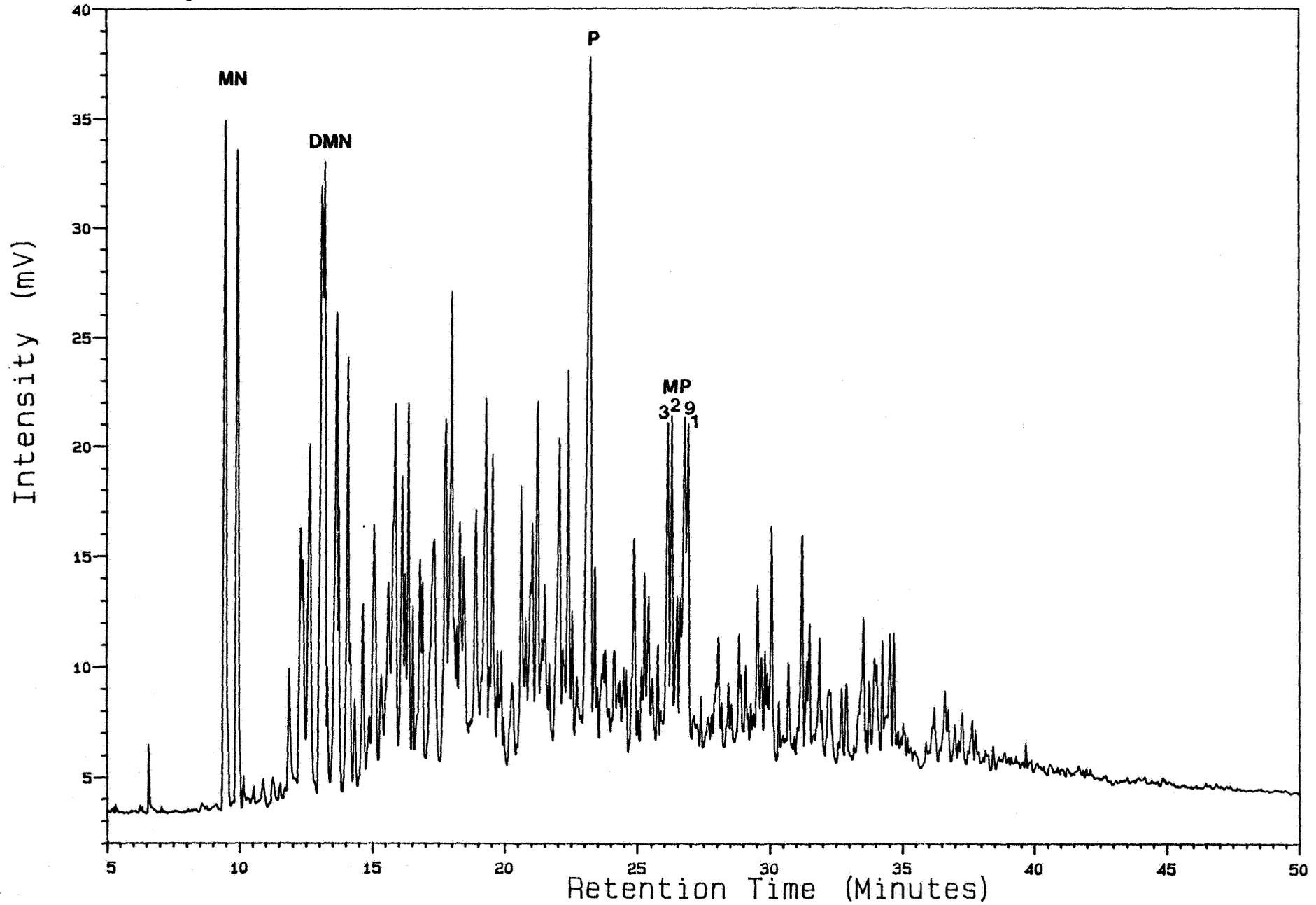
2723.12



Analysis L640771

3, 19, 1

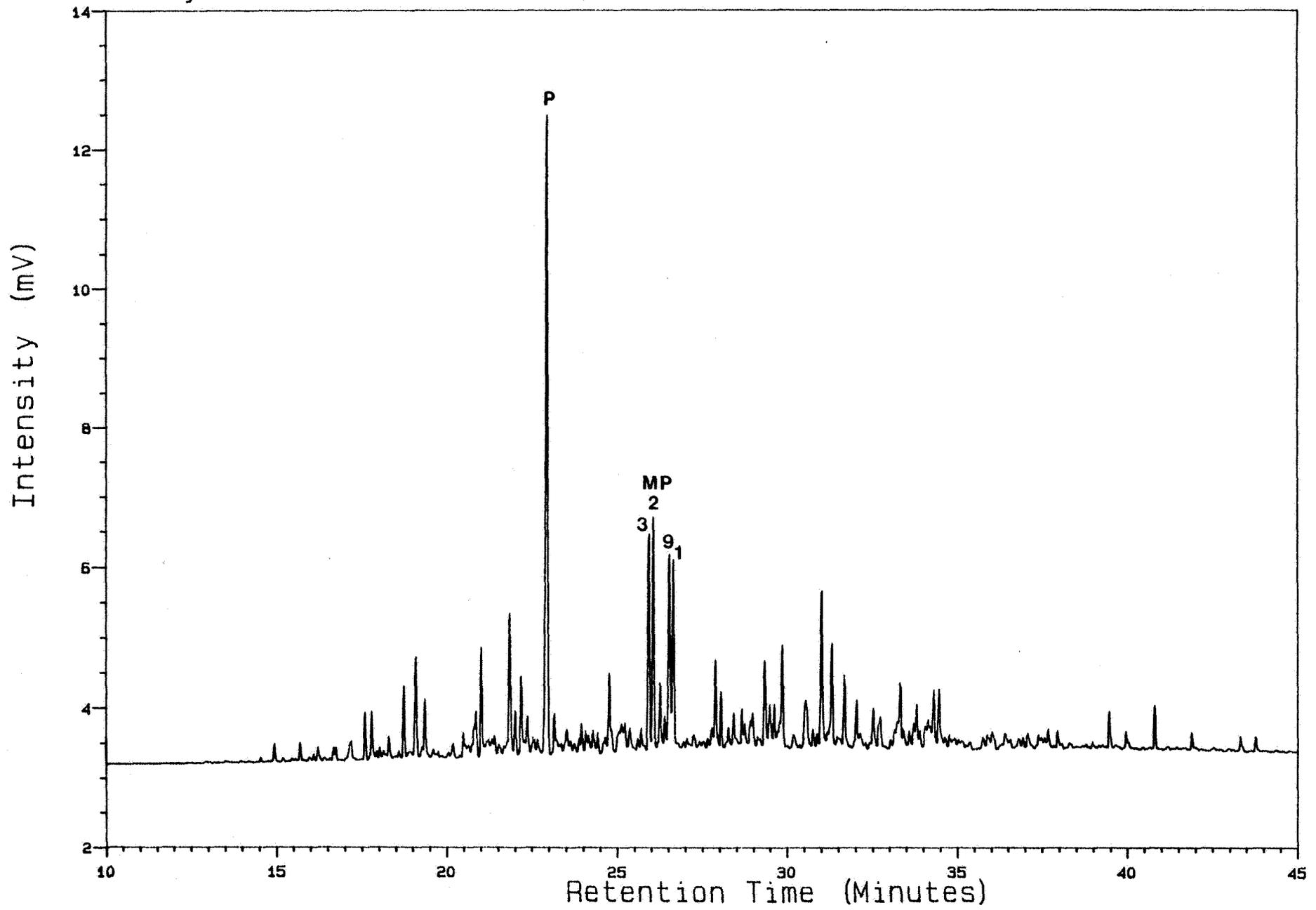
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Analysis K640771

3, 3, 1

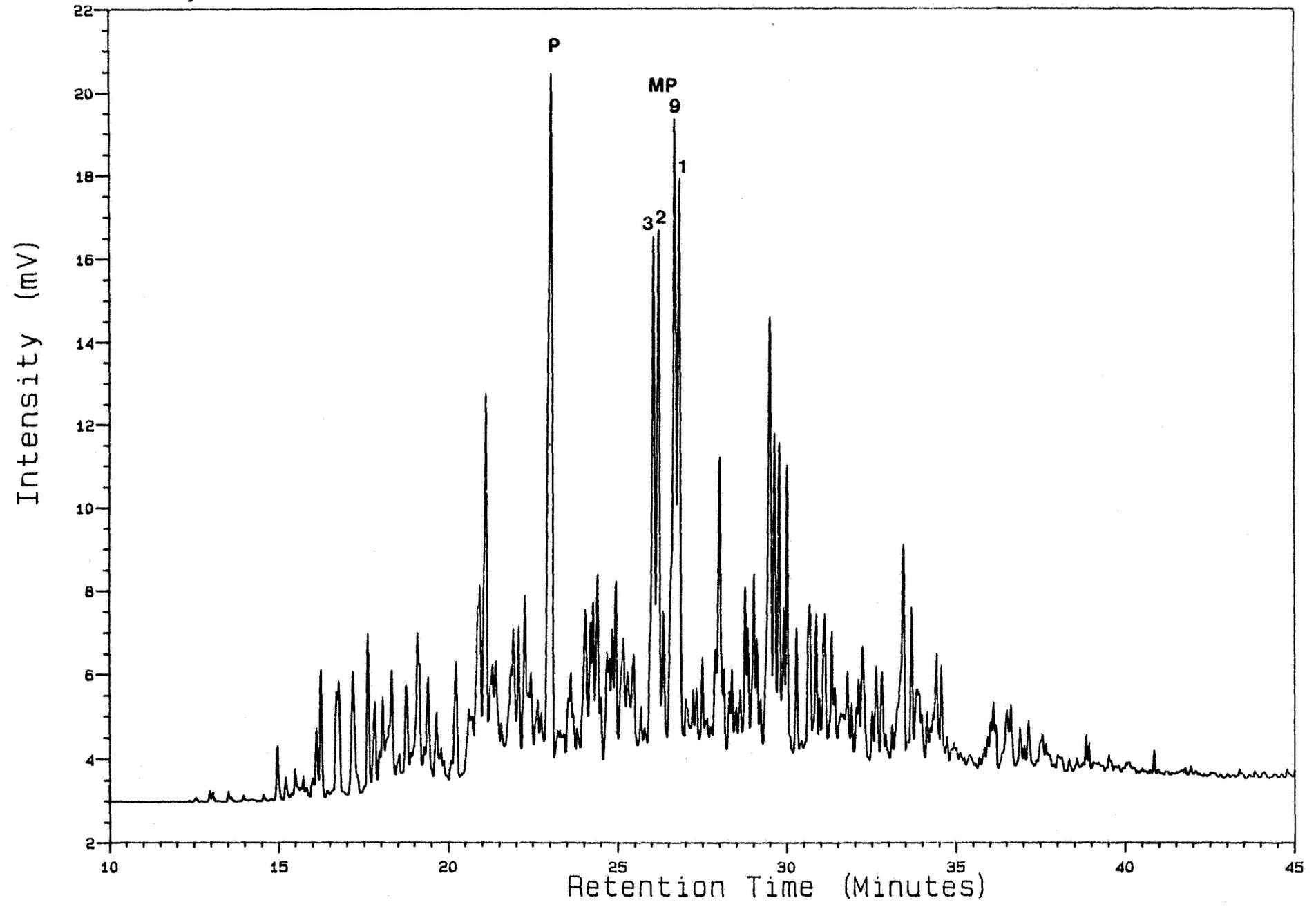
2747.00M



Analysis K640771

3, 4, 1

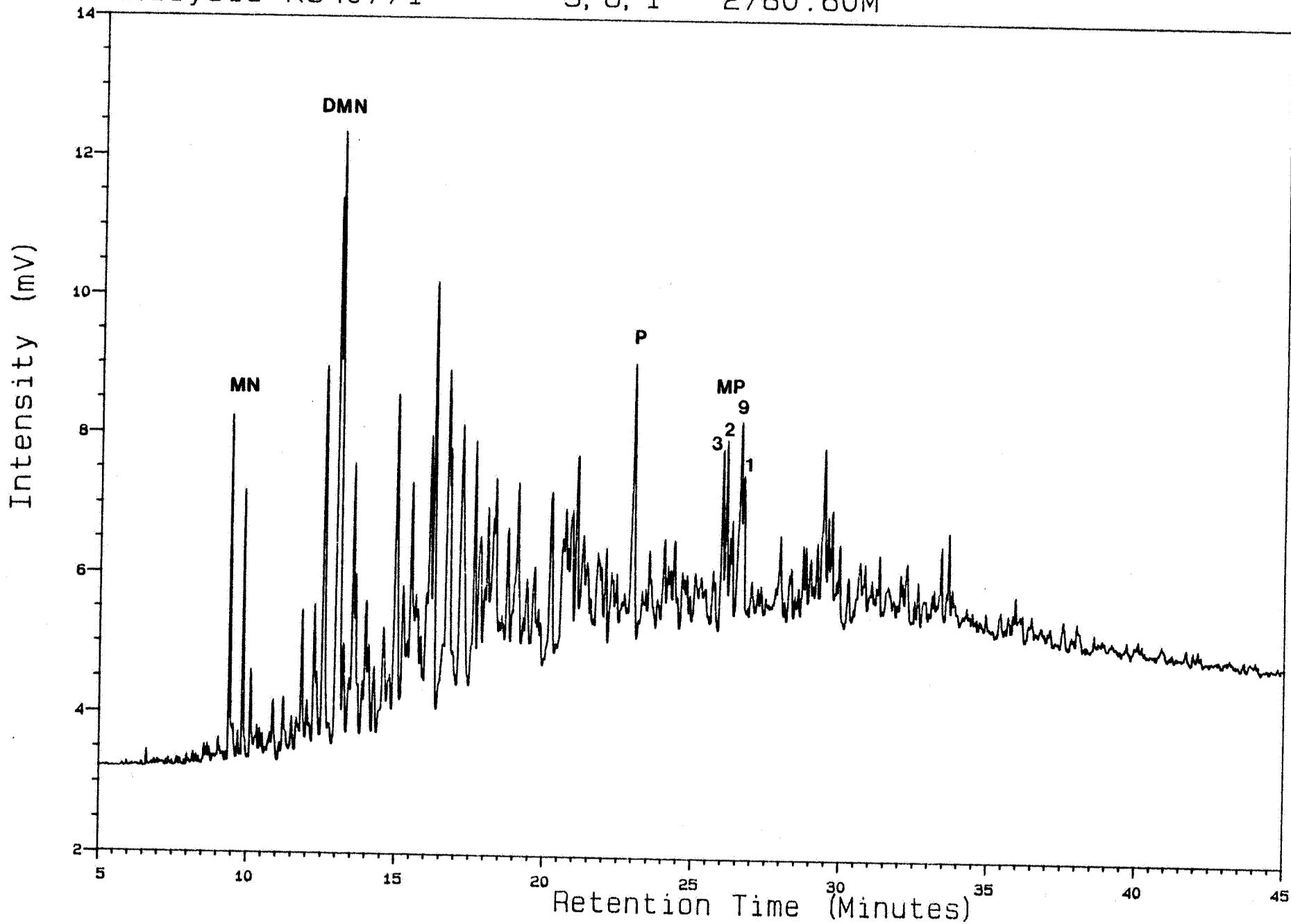
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Analysis K640771

3, 6, 1

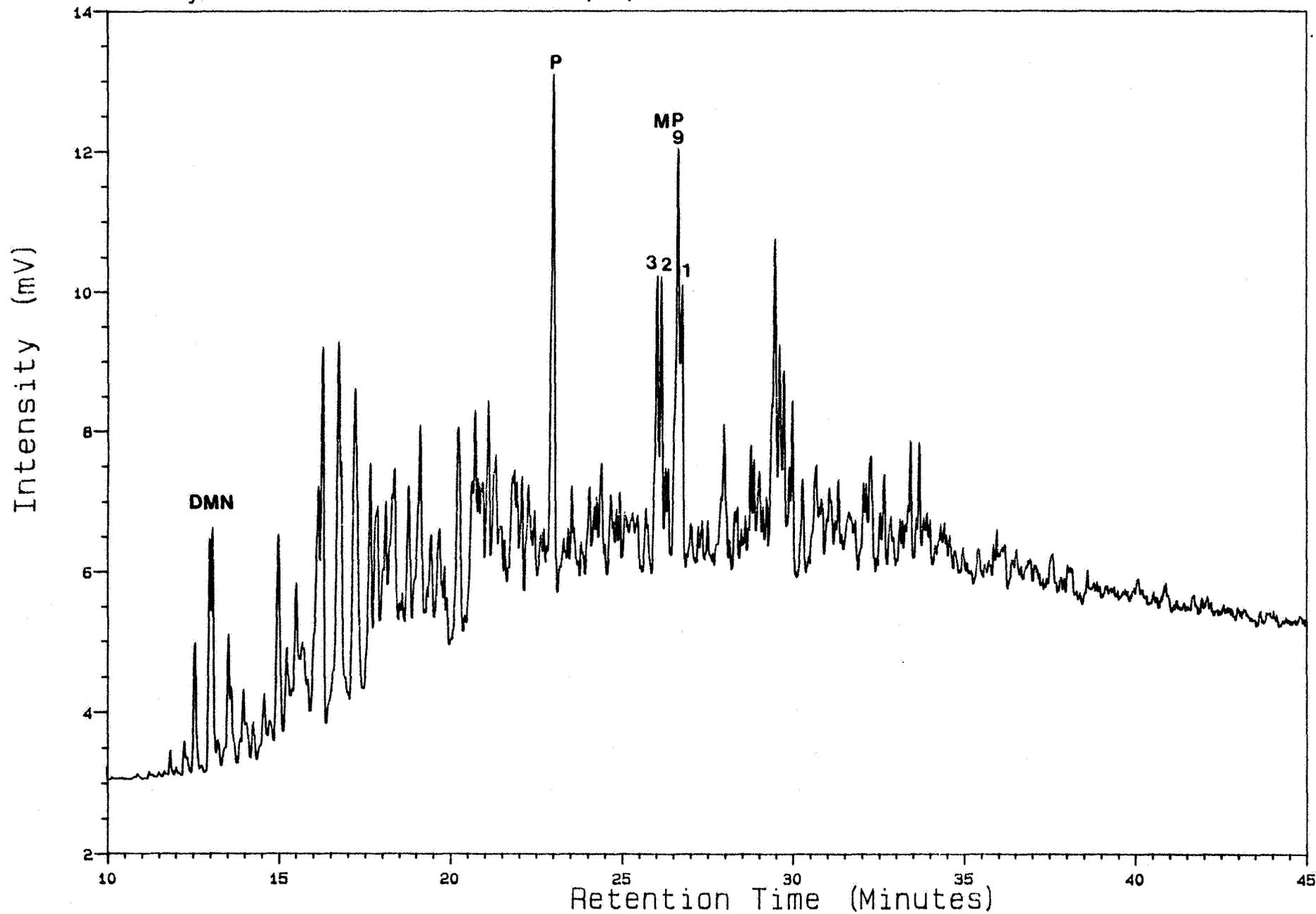
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Analysis K640771

3, 9, 1

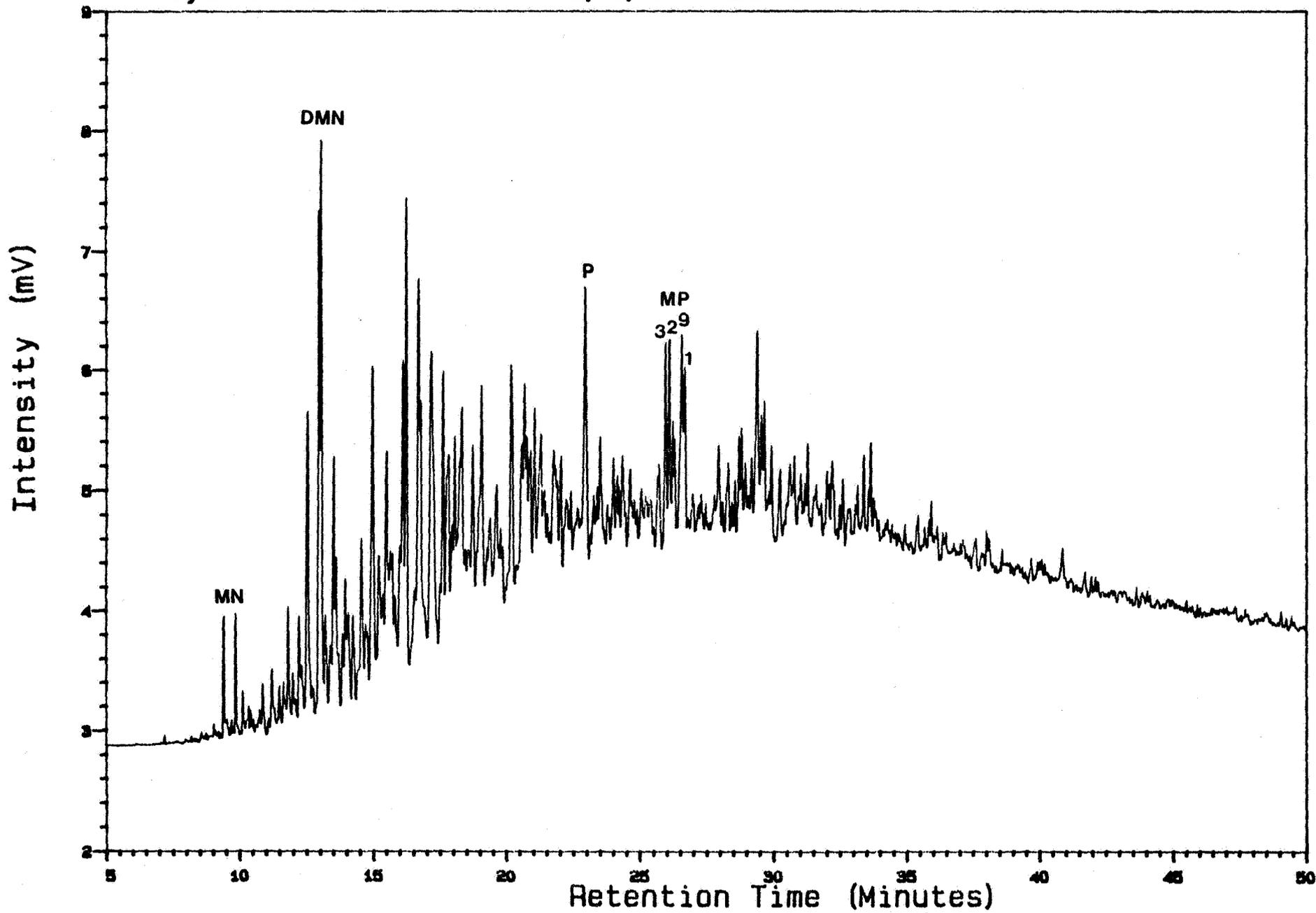
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Analysis L640771

3, 3, 1

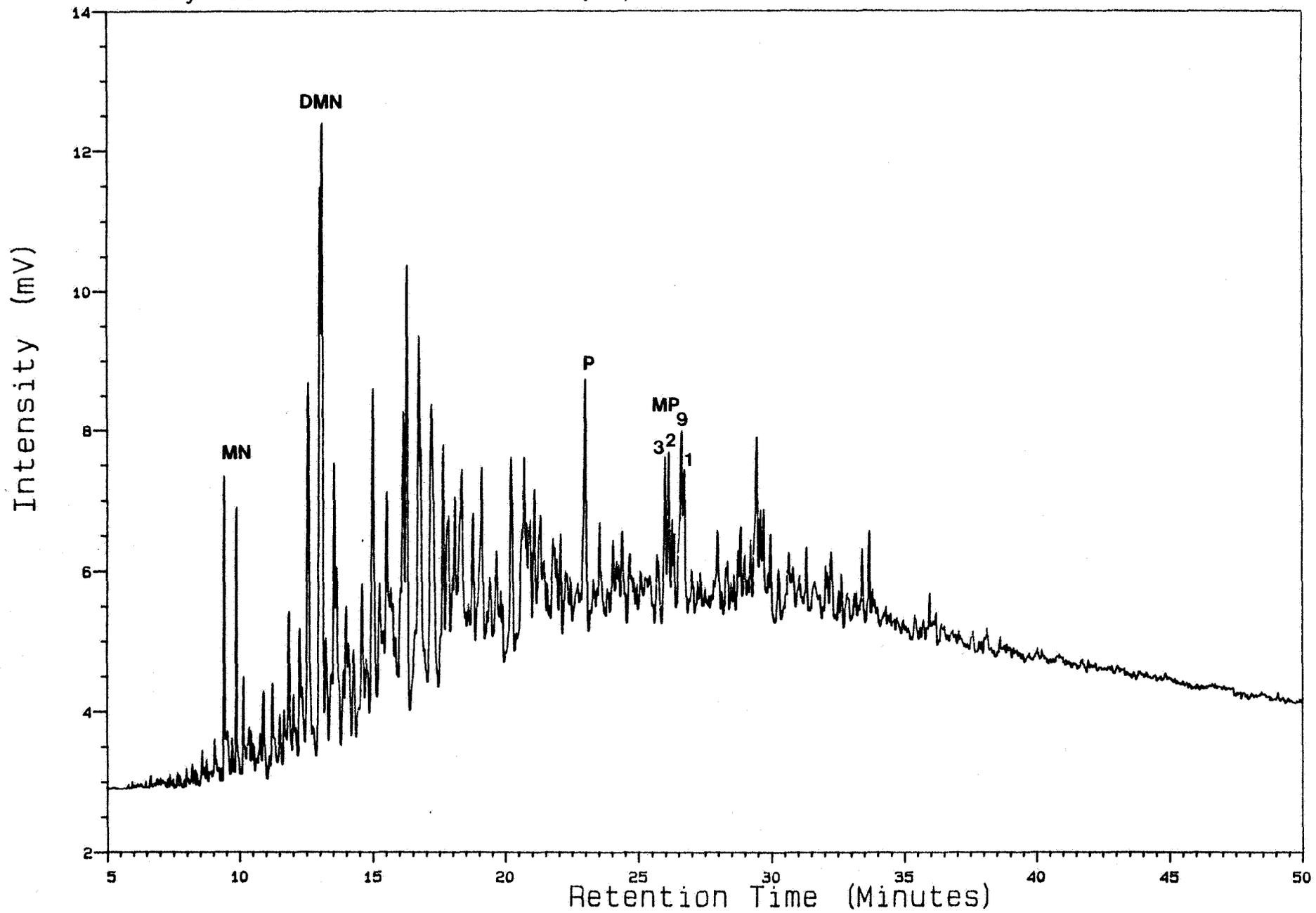
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Analysis L640771

3, 5, 1

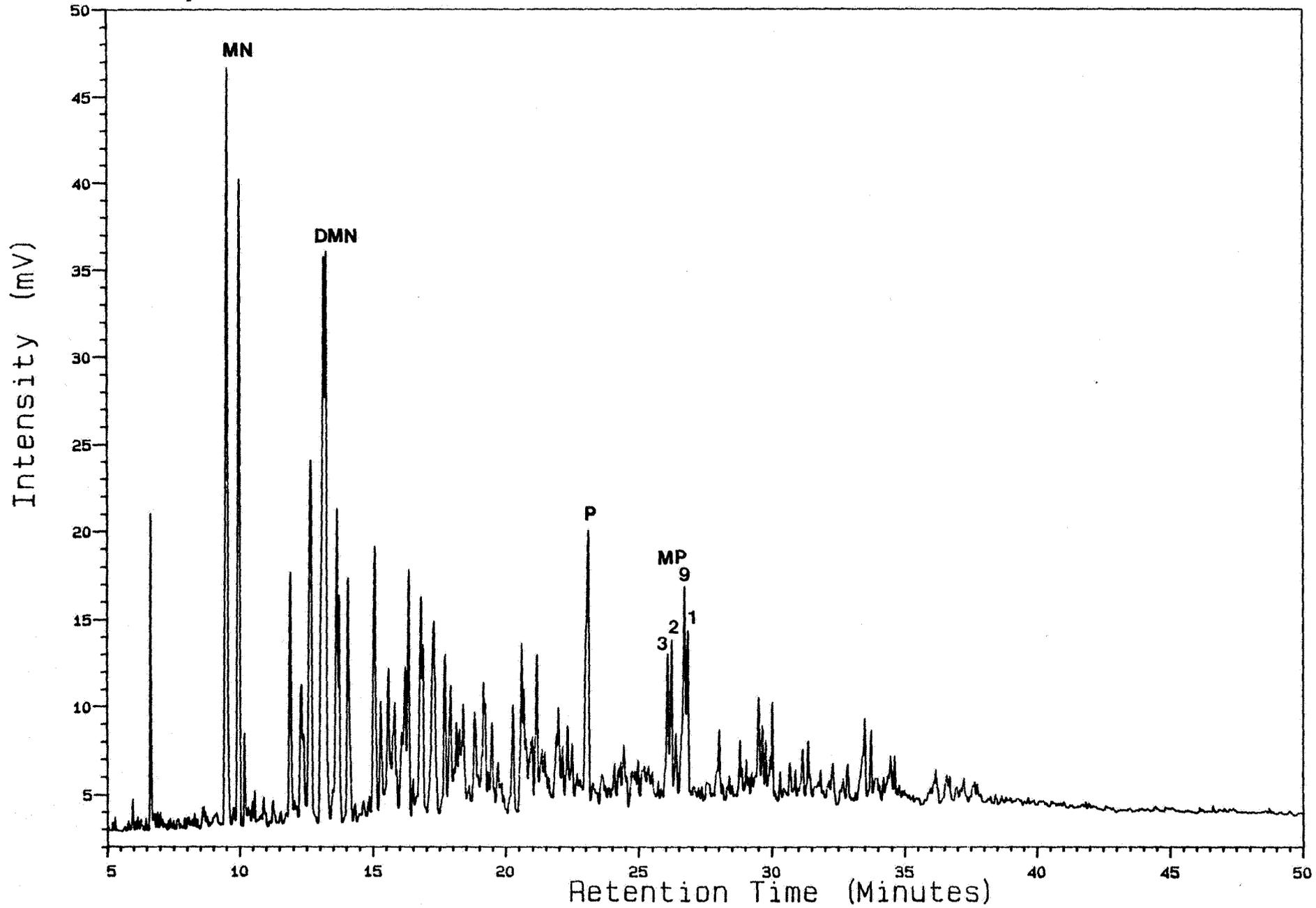
2966.00M



Analysis L640771

3, 8, 1

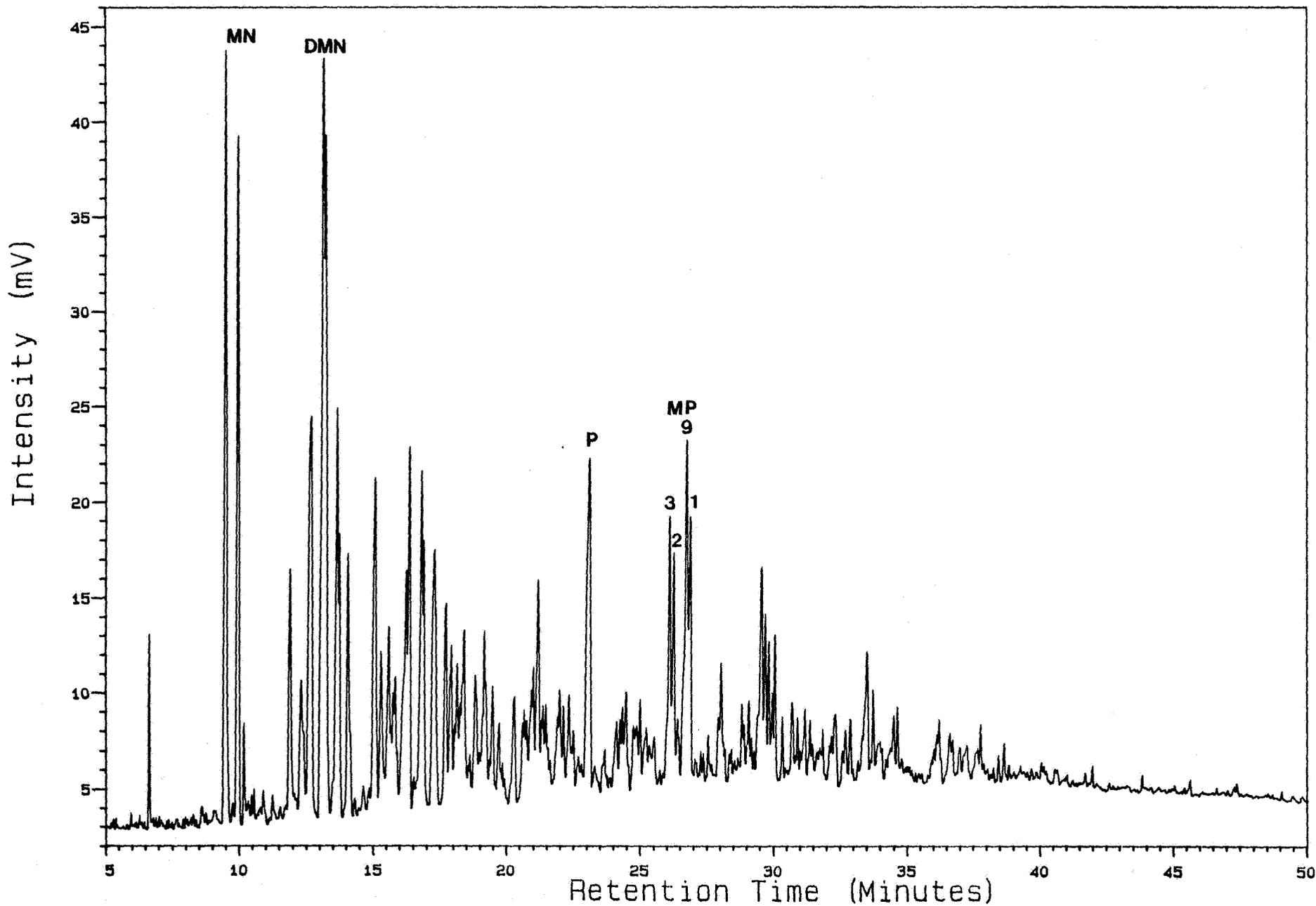
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Analysis L640771

3, 20, 1

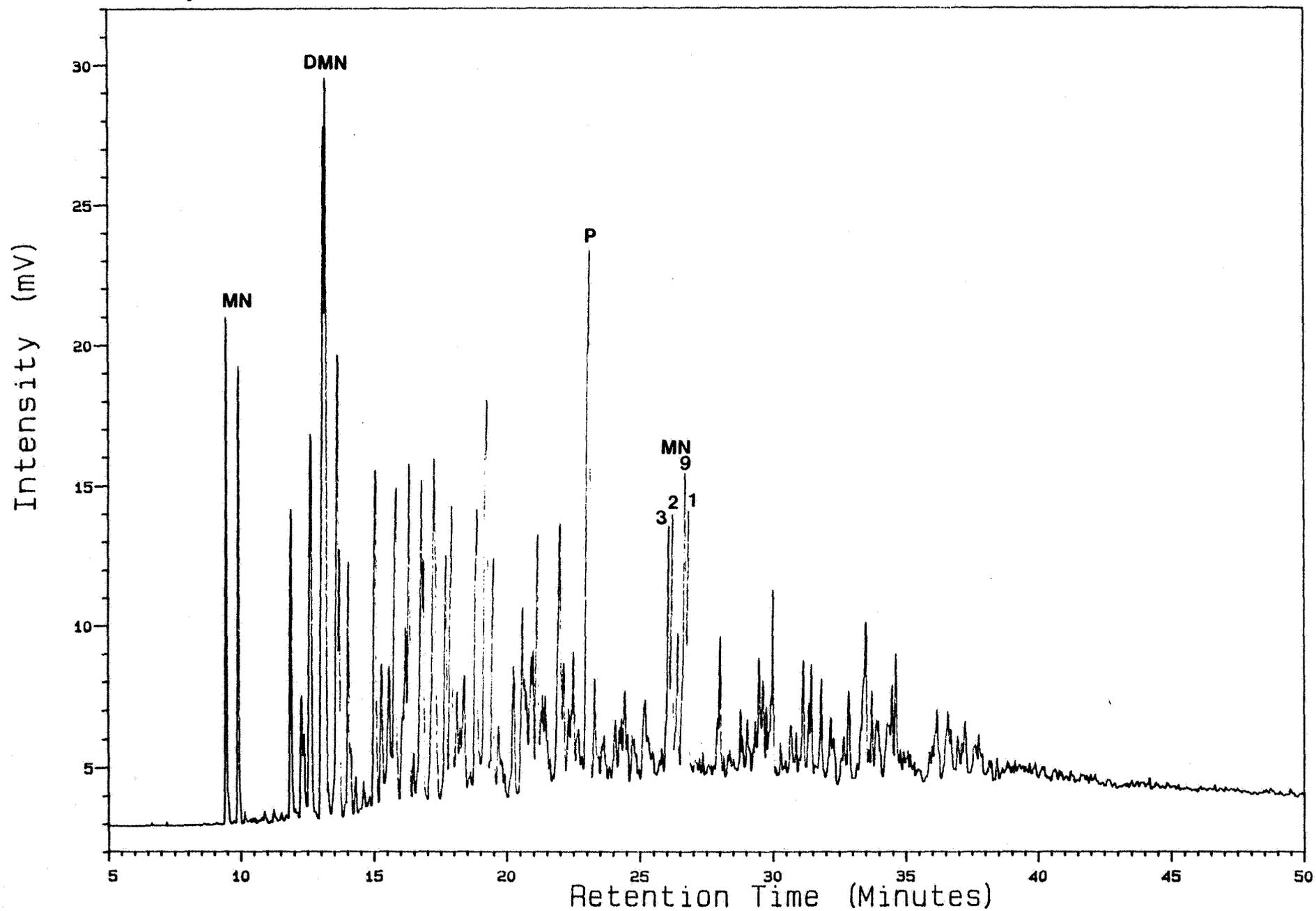
3017.20M



Analysis L640771

3, 11, 1

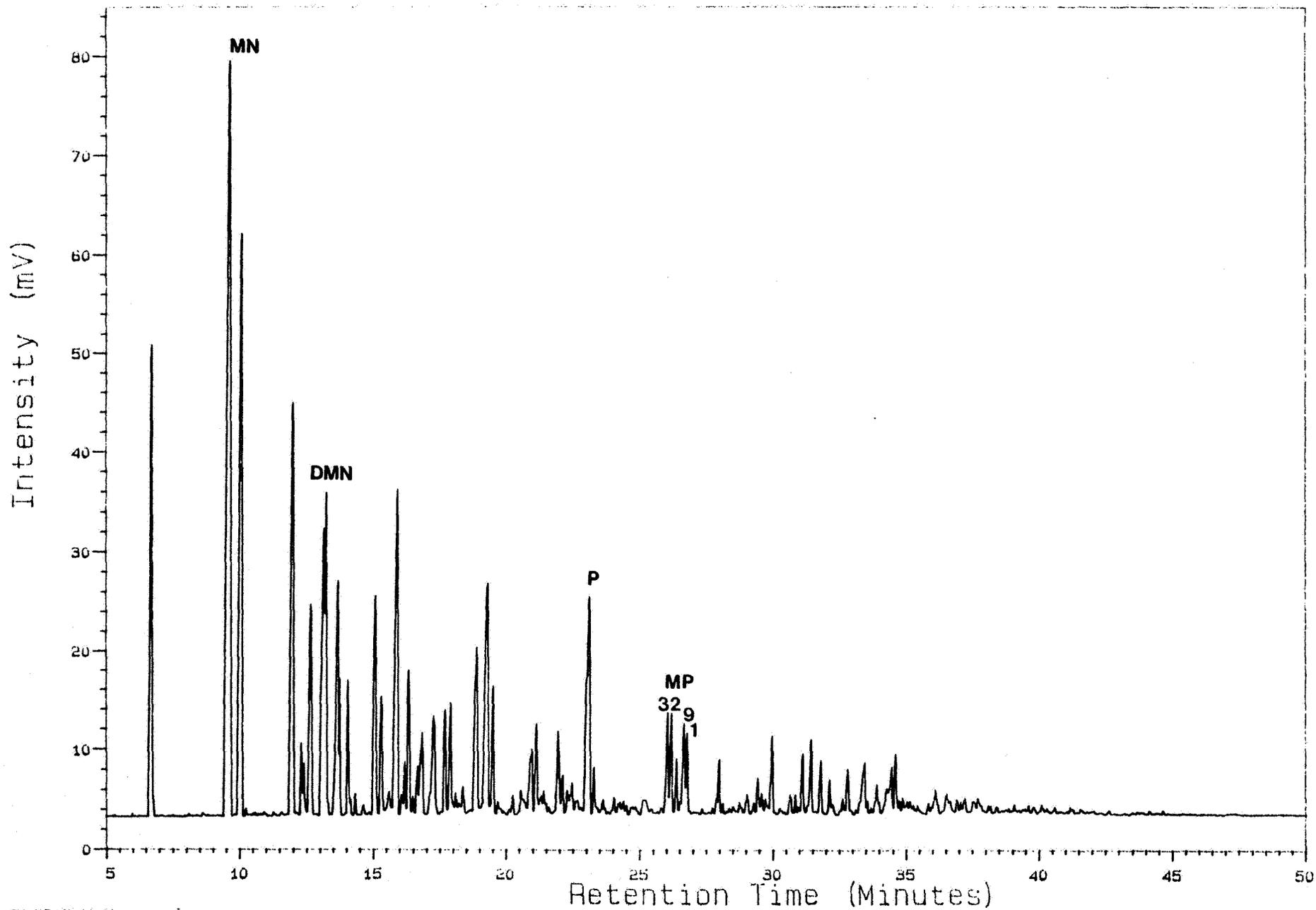
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Analysis E640771

3. 4. 1

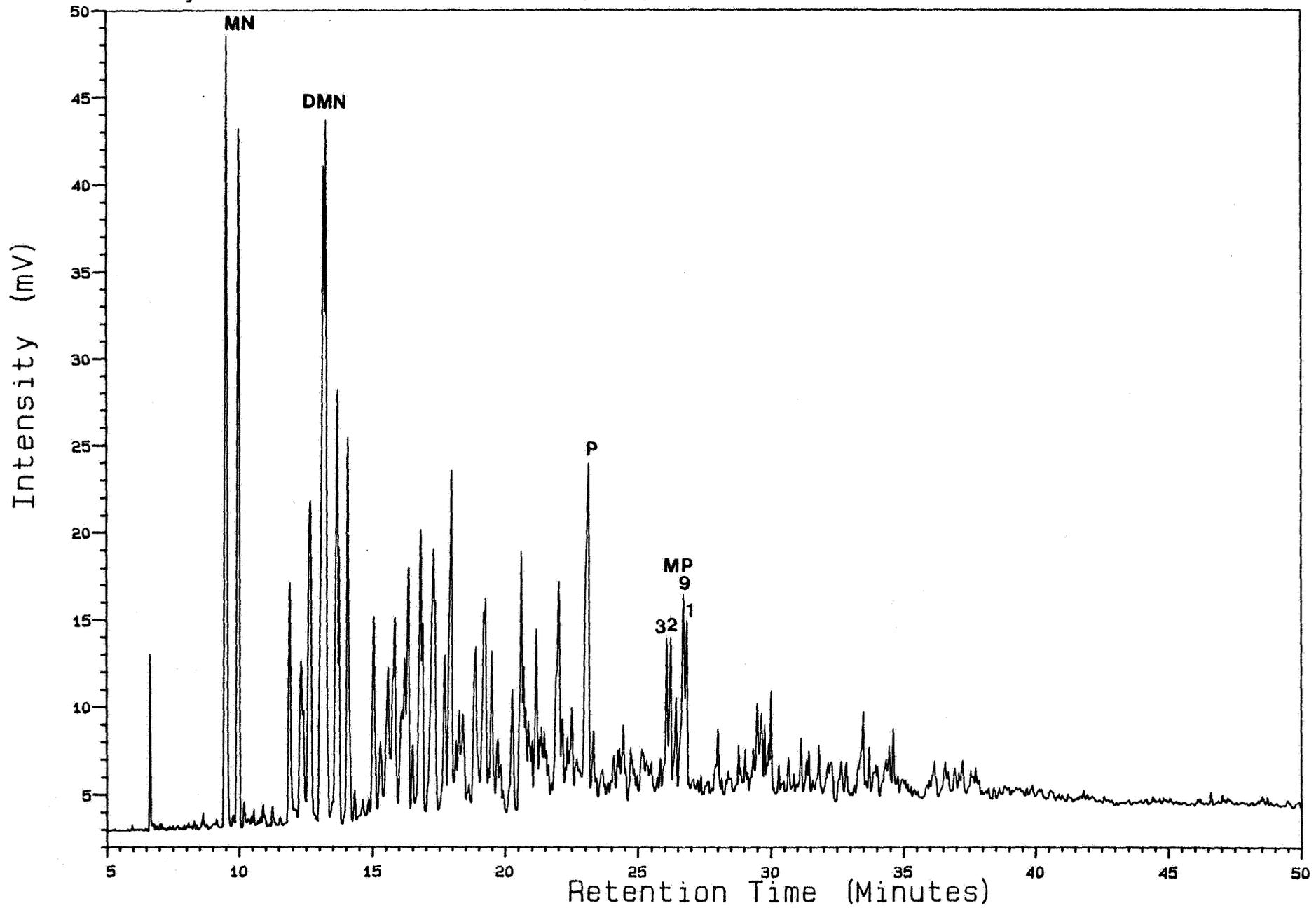
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Analysis L640771

3, 14, 1

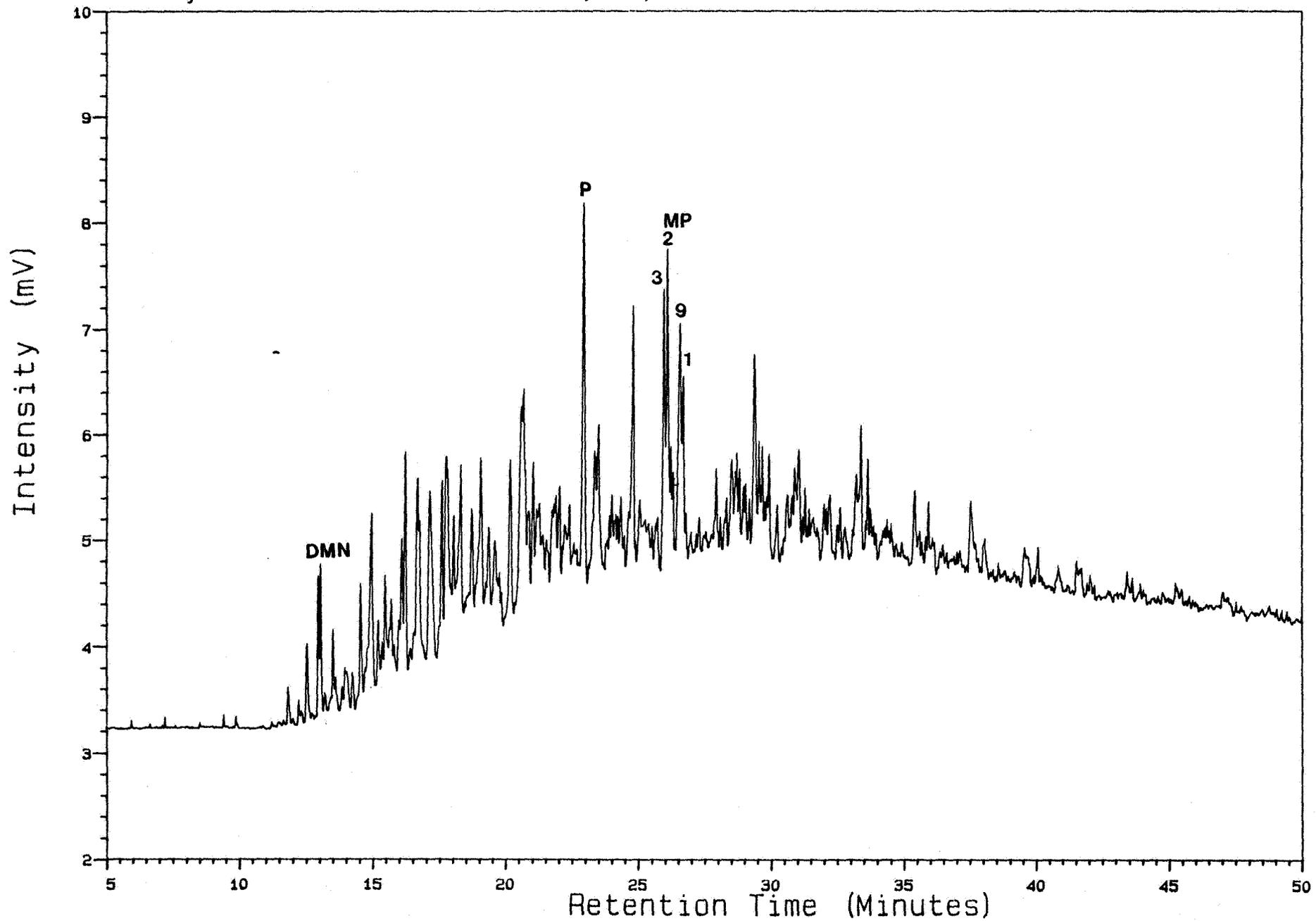
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Analysis L640771

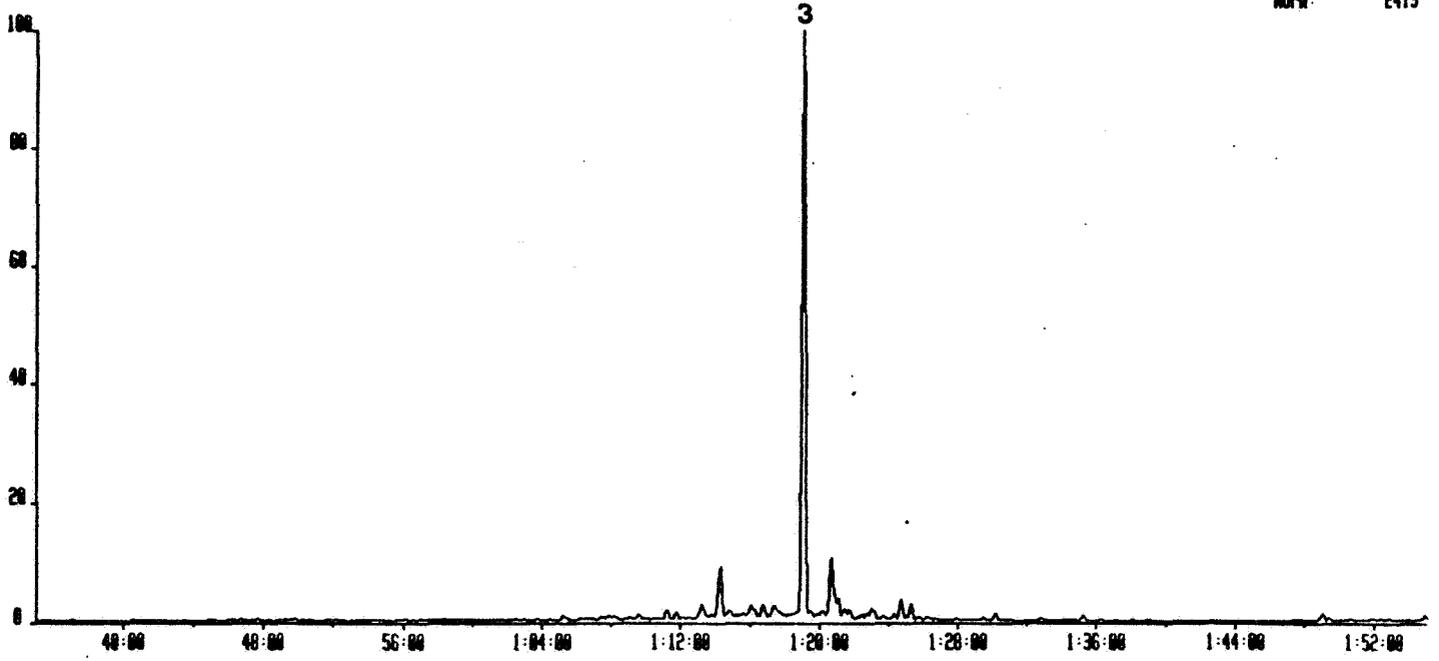
3, 16, 1

3081.50M

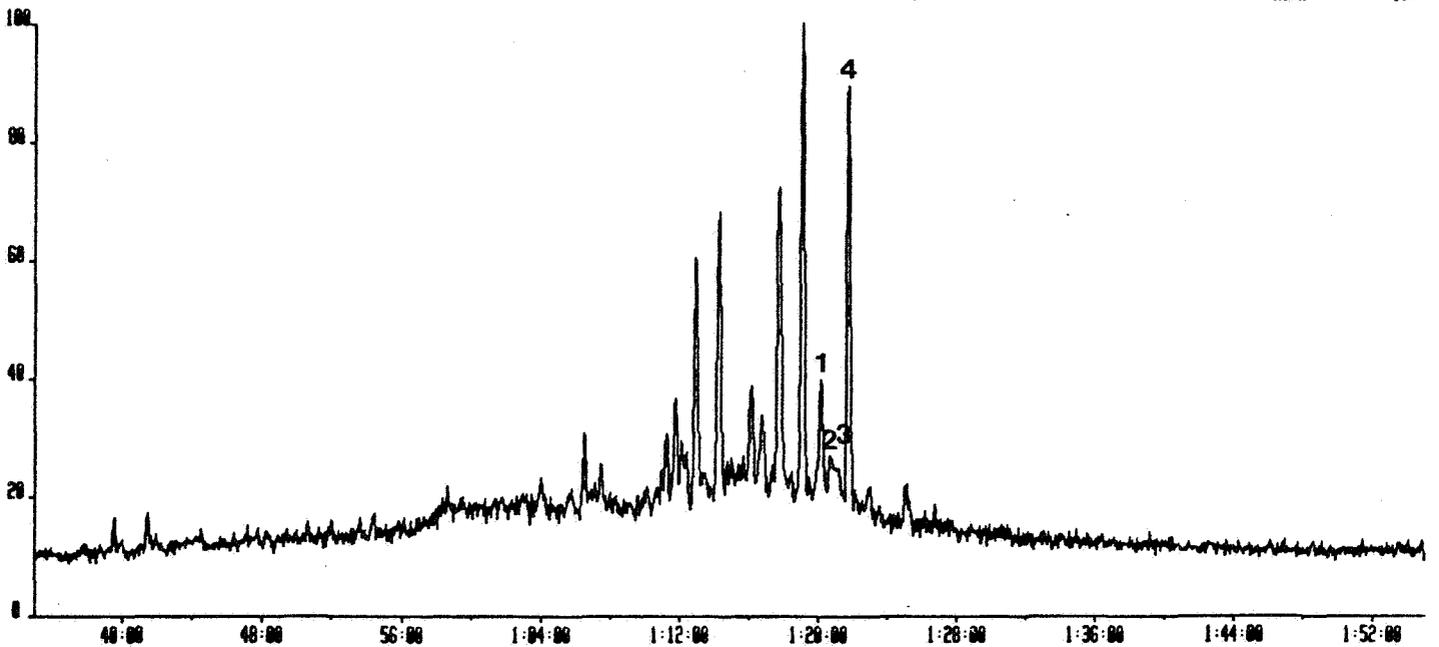


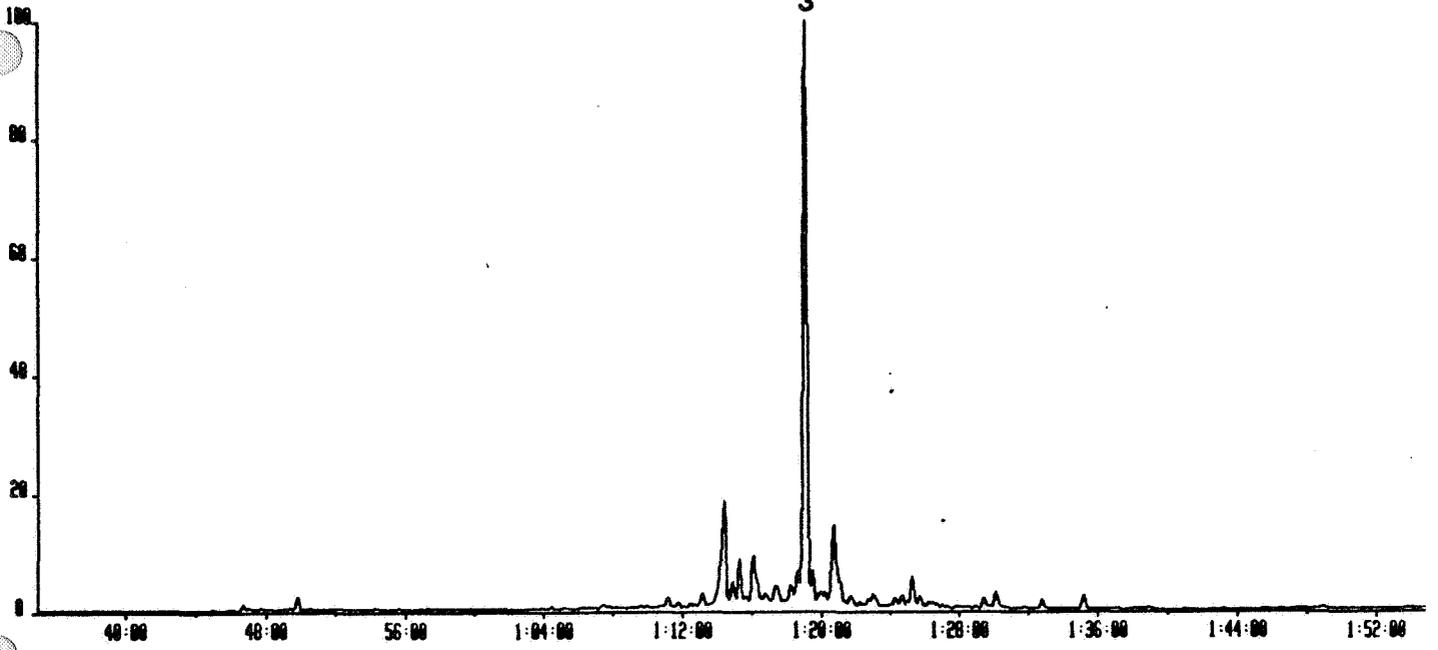
APPENDIX III

M/Z 191 (TRITERPANES) AND M/Z 217 (STERANES) FRAGMENTOGRAMS

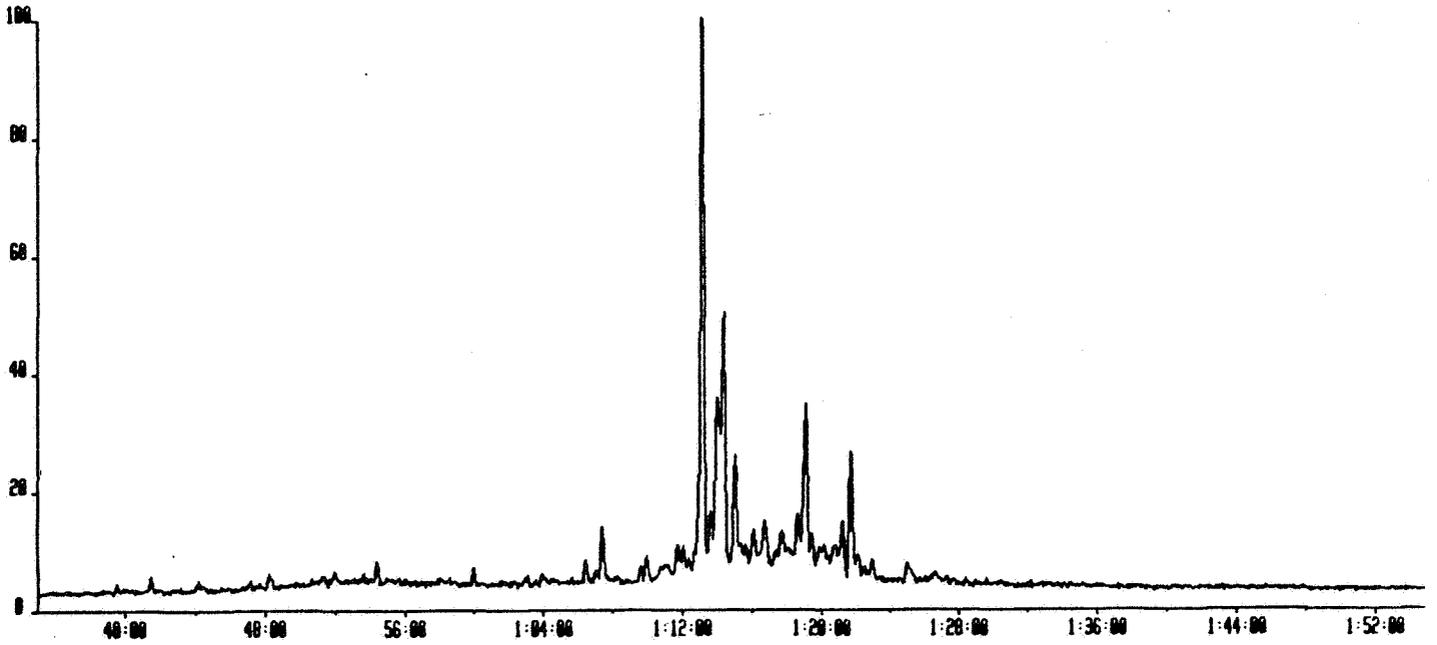


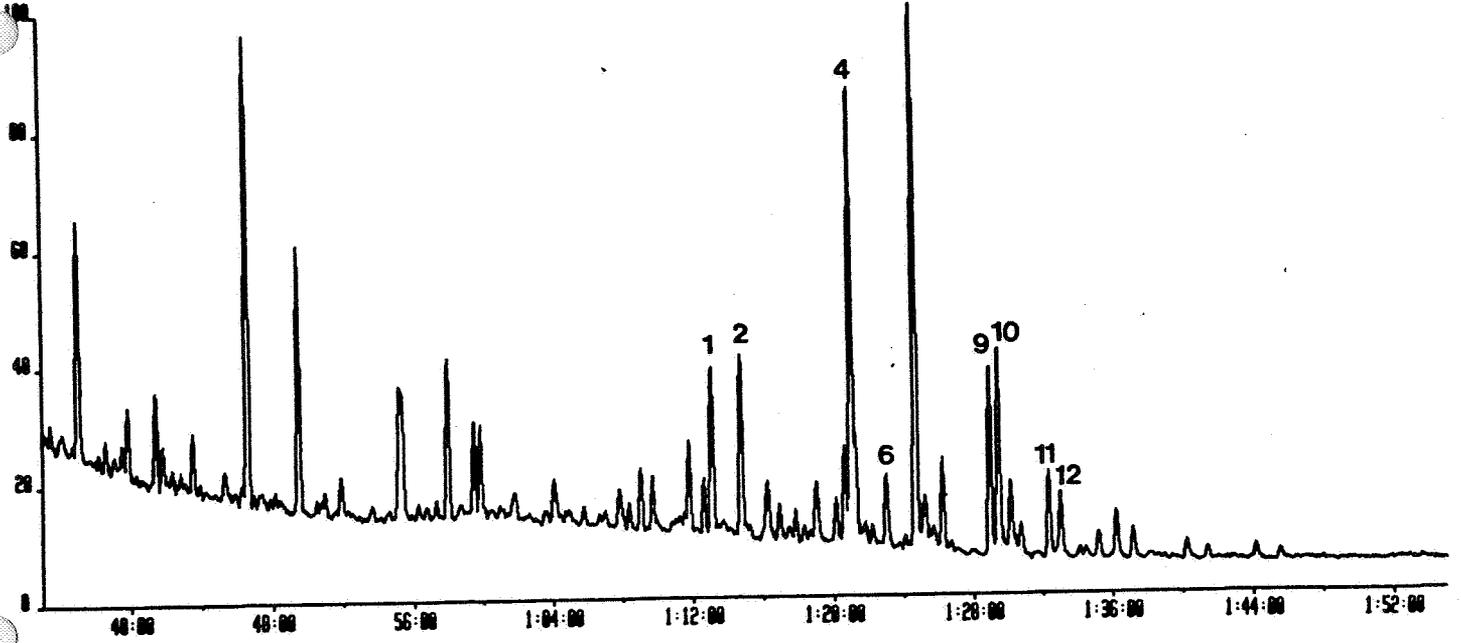
1736.88 m



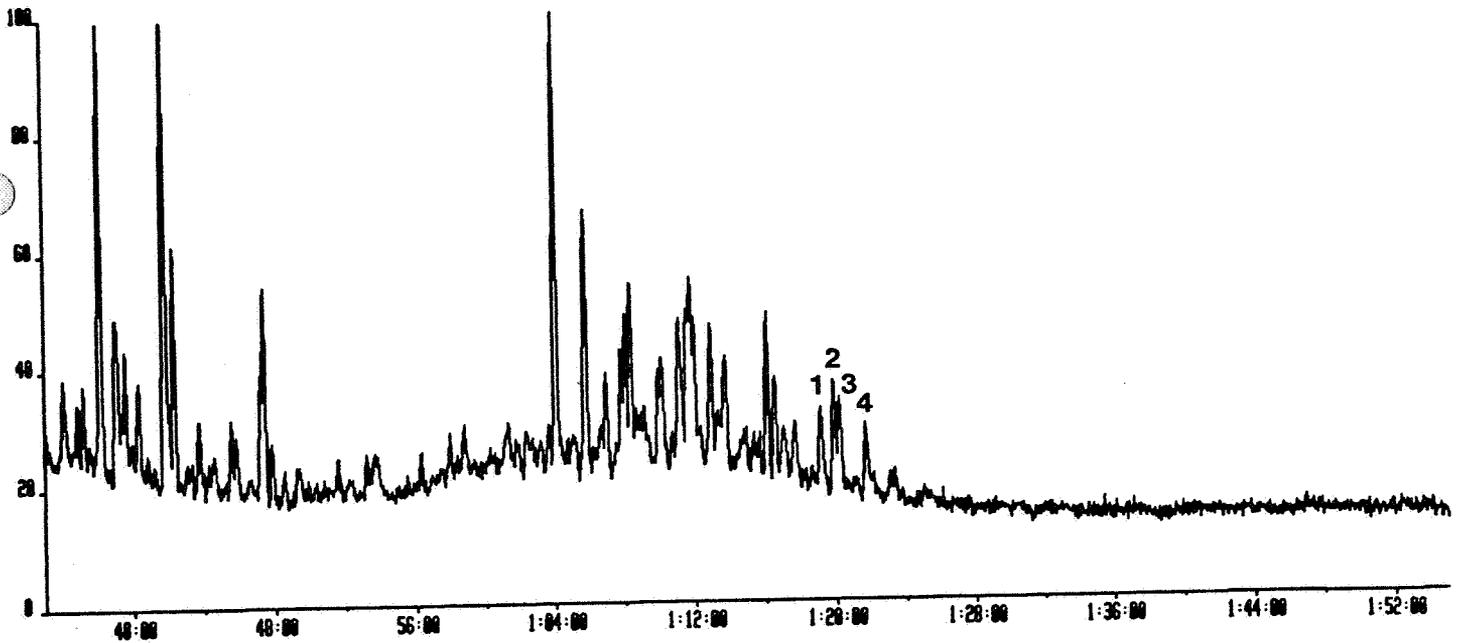


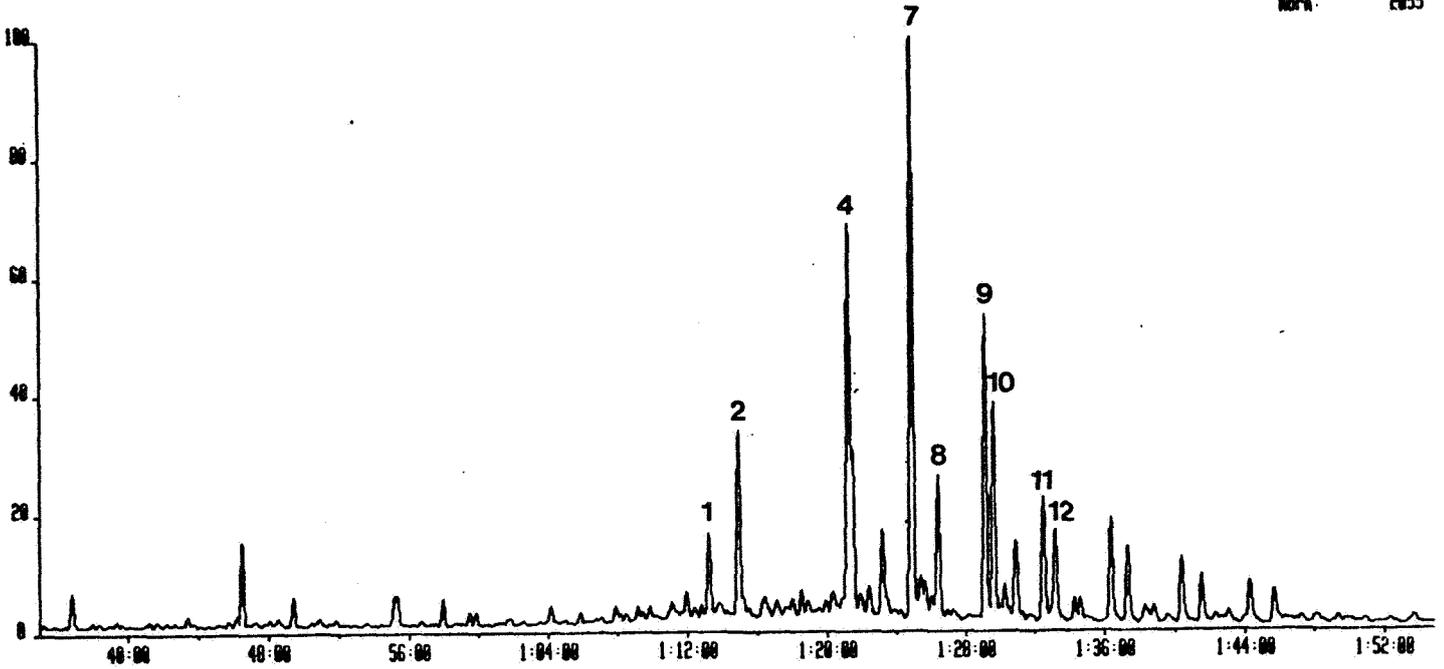
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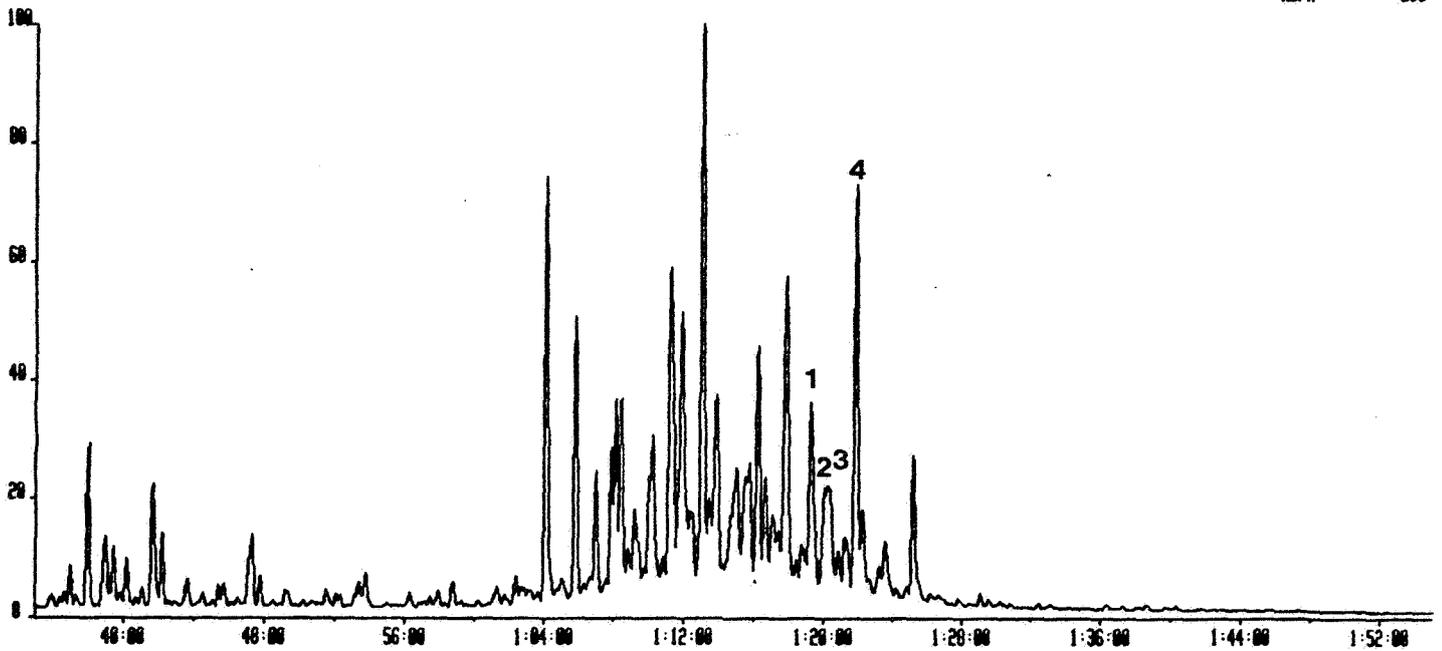


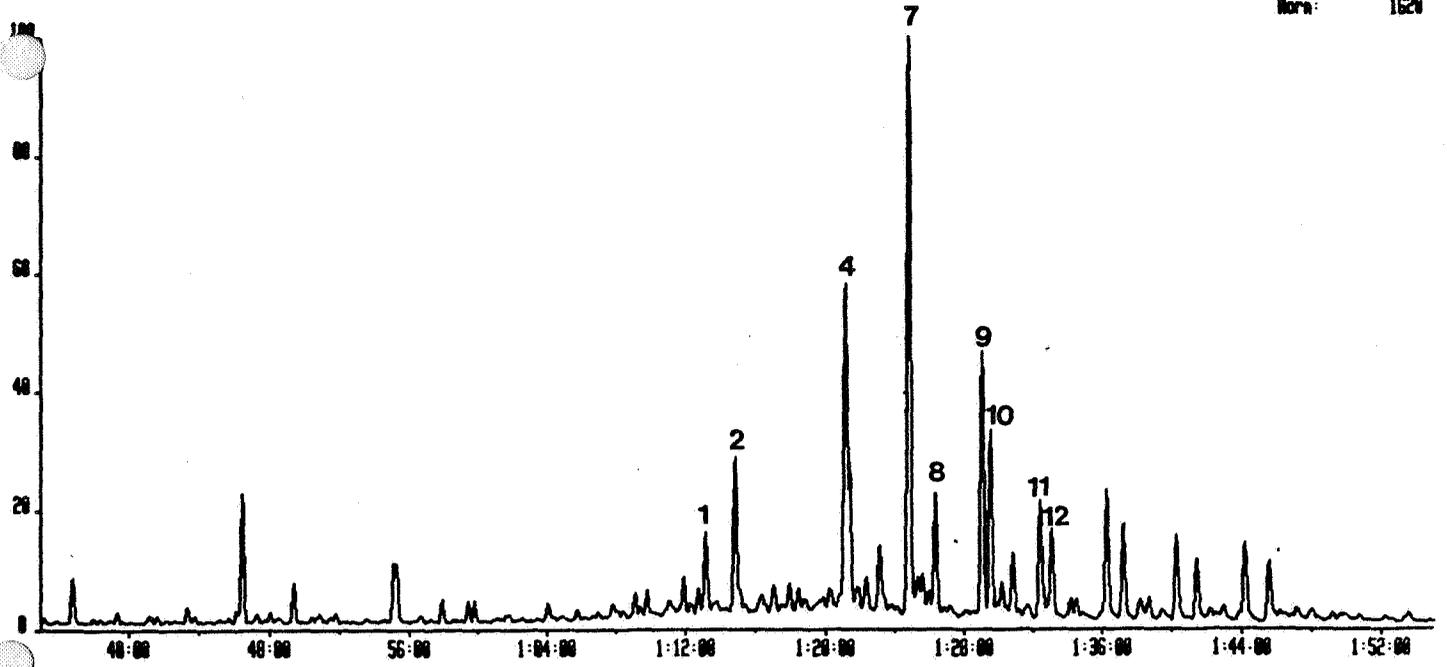
1939.00 m



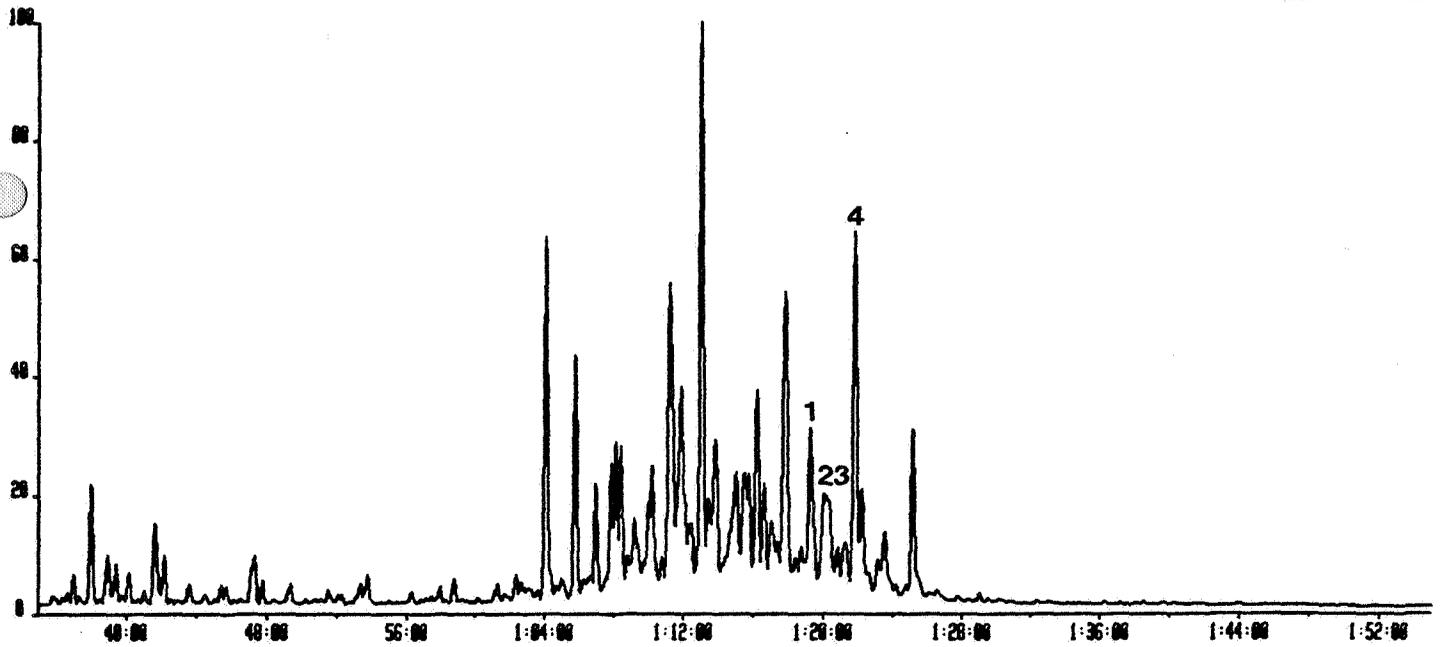


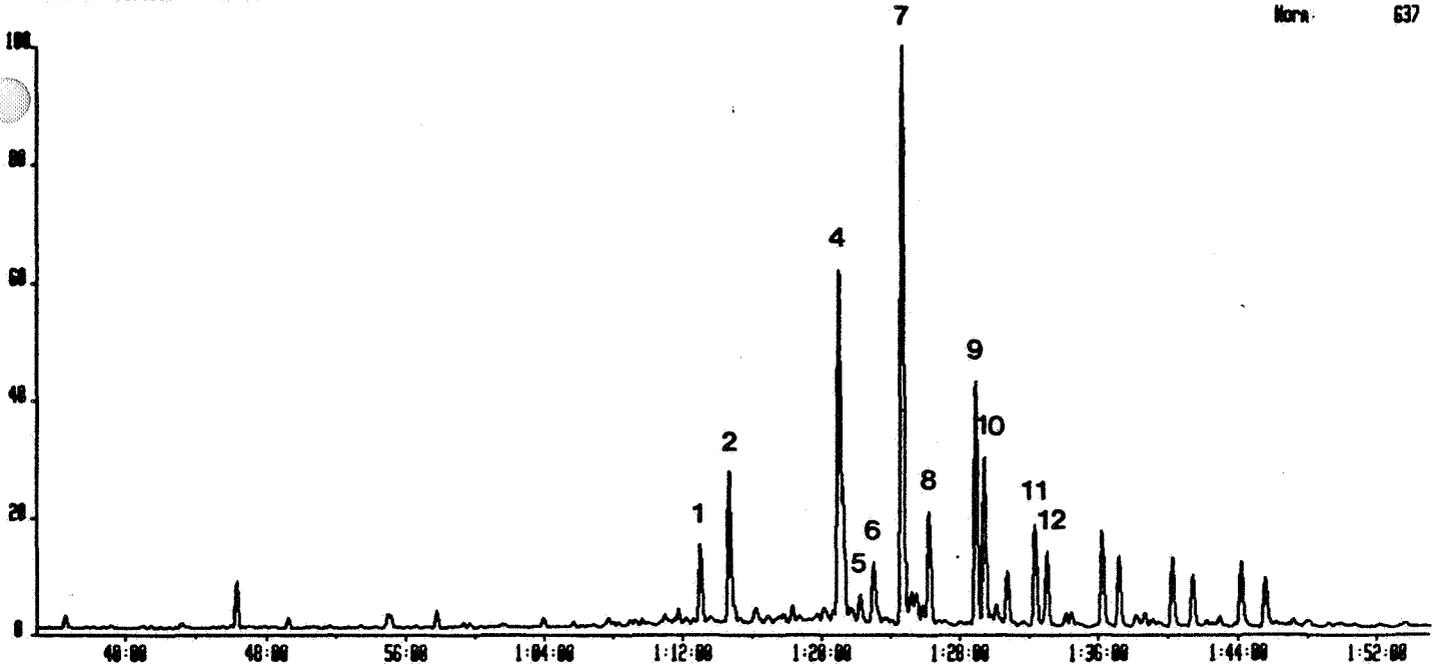
2699.00 m



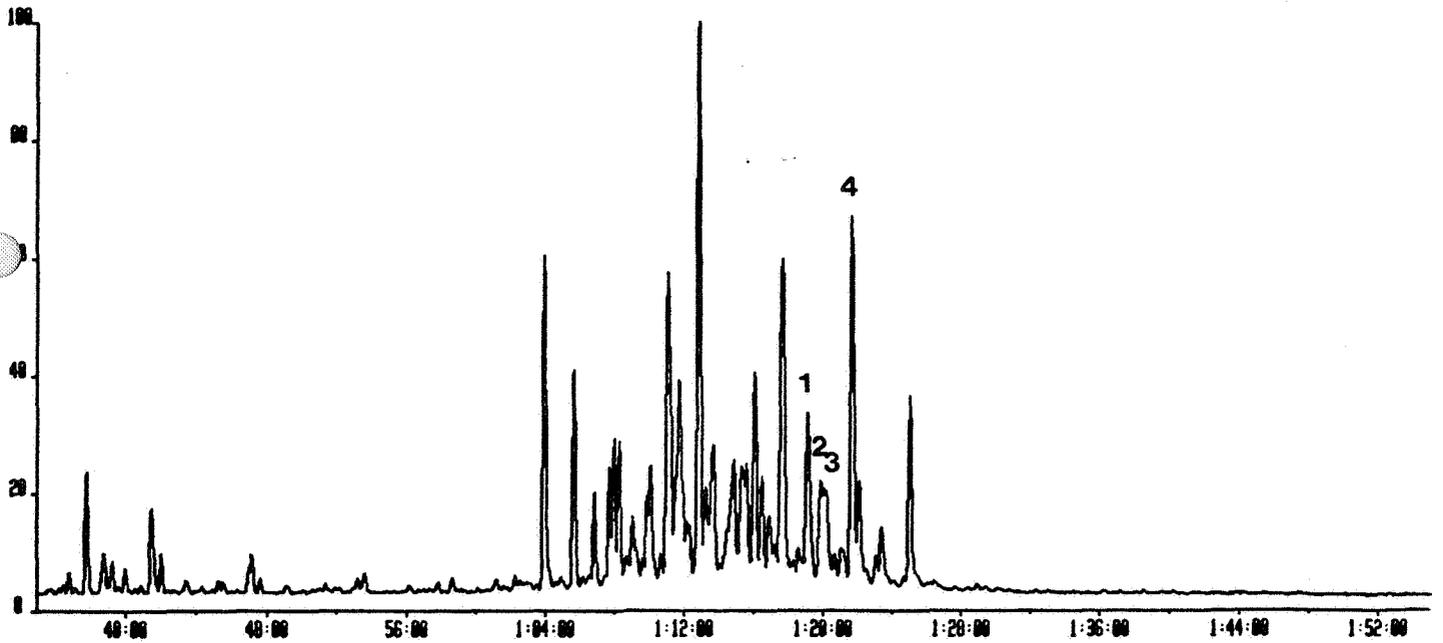


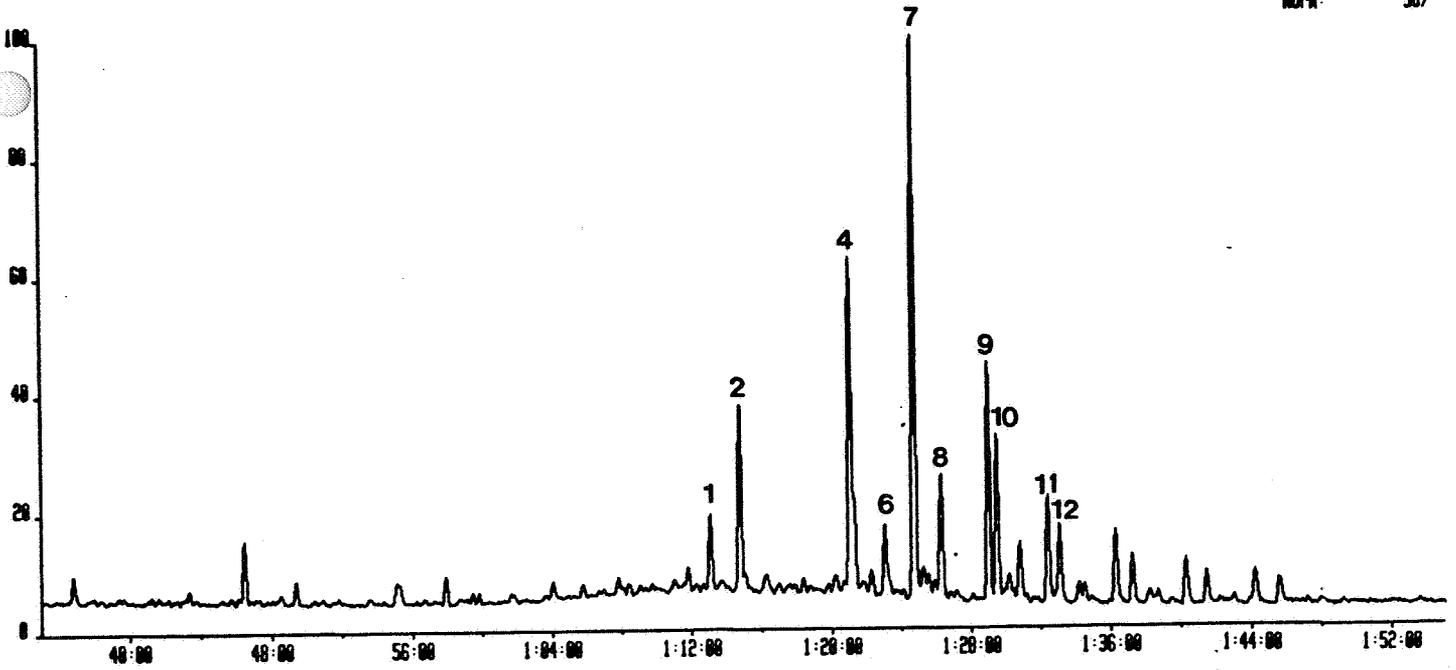
2700.00 m



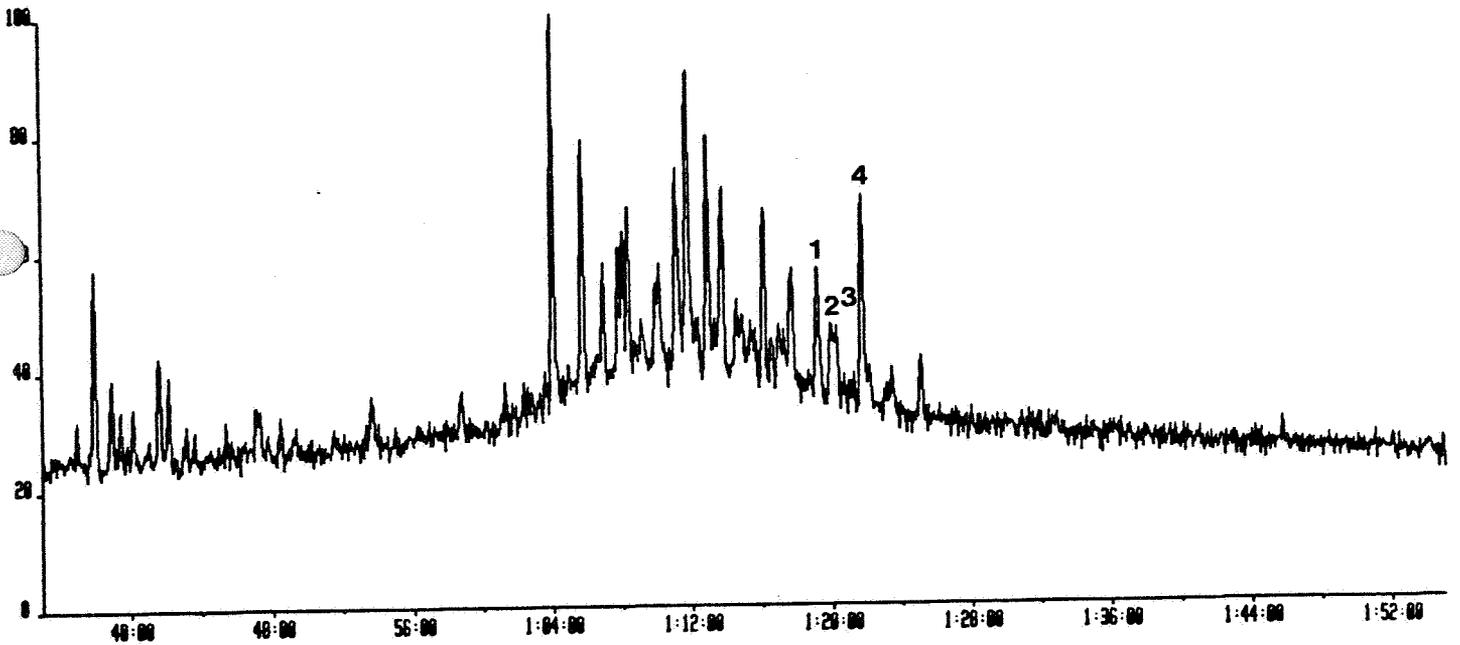


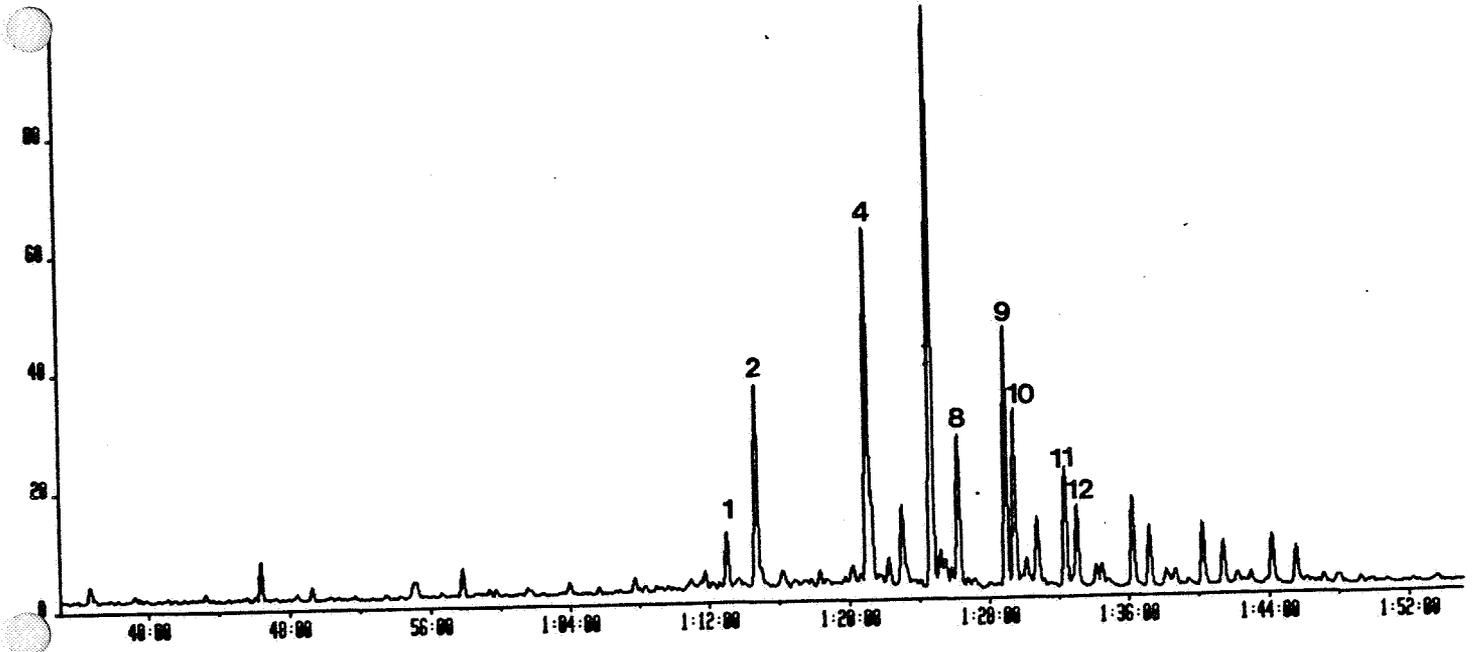
2703.00 m



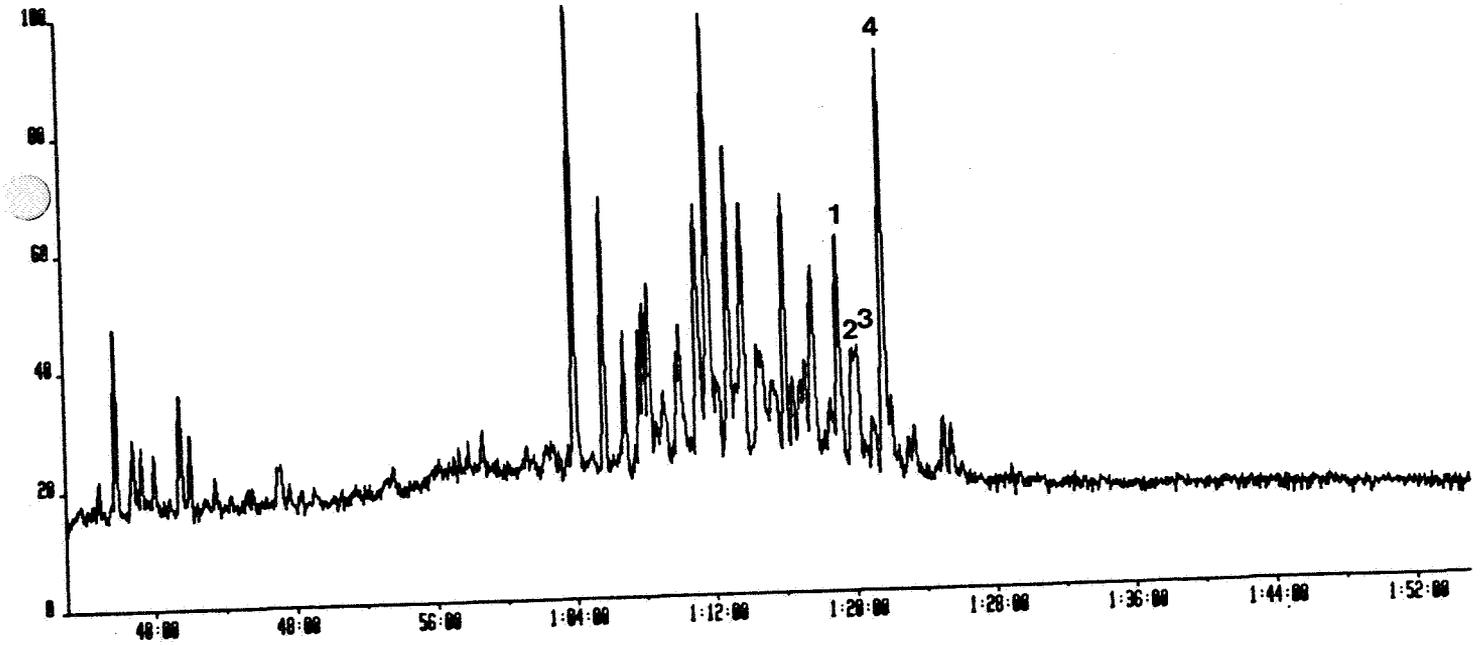


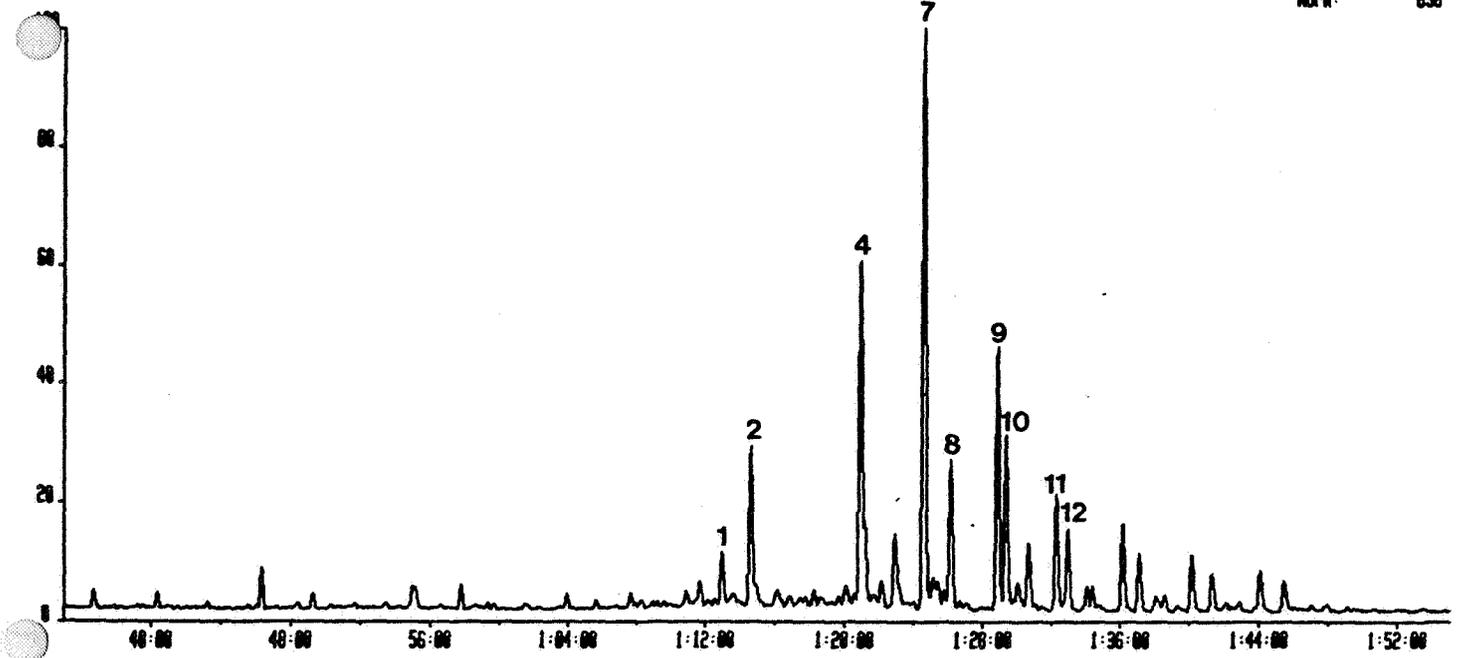
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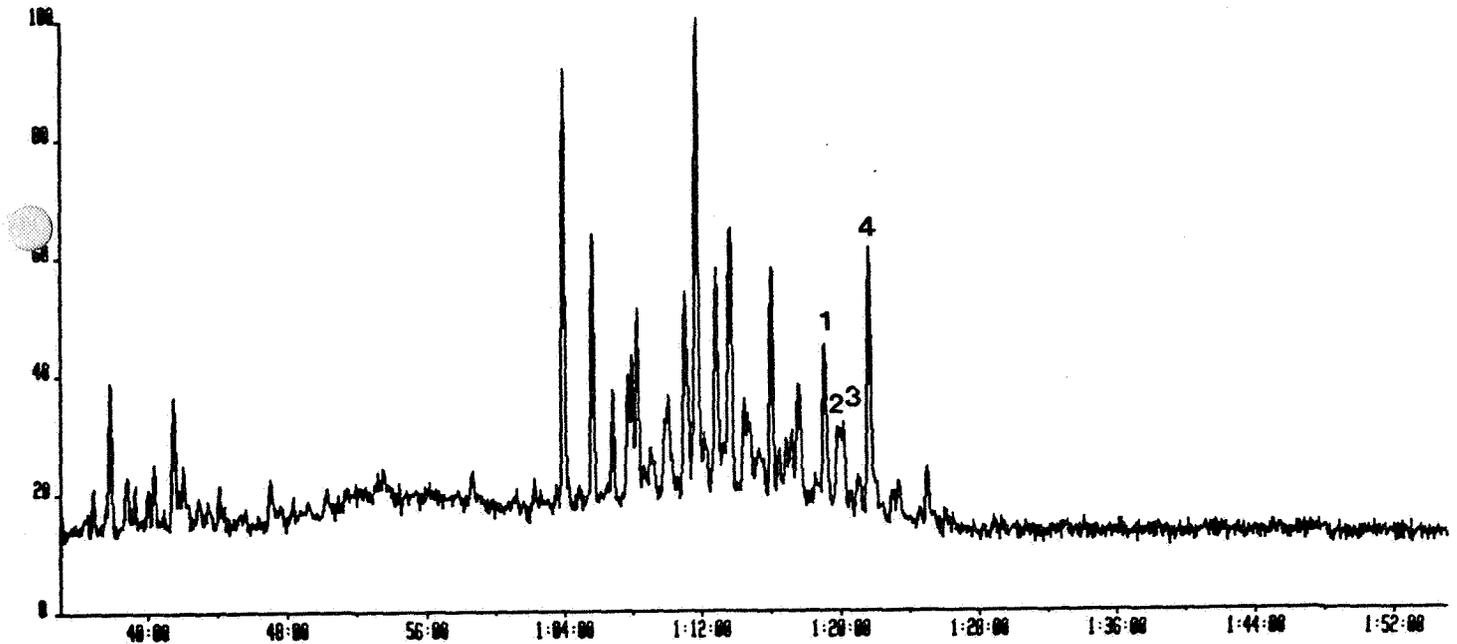


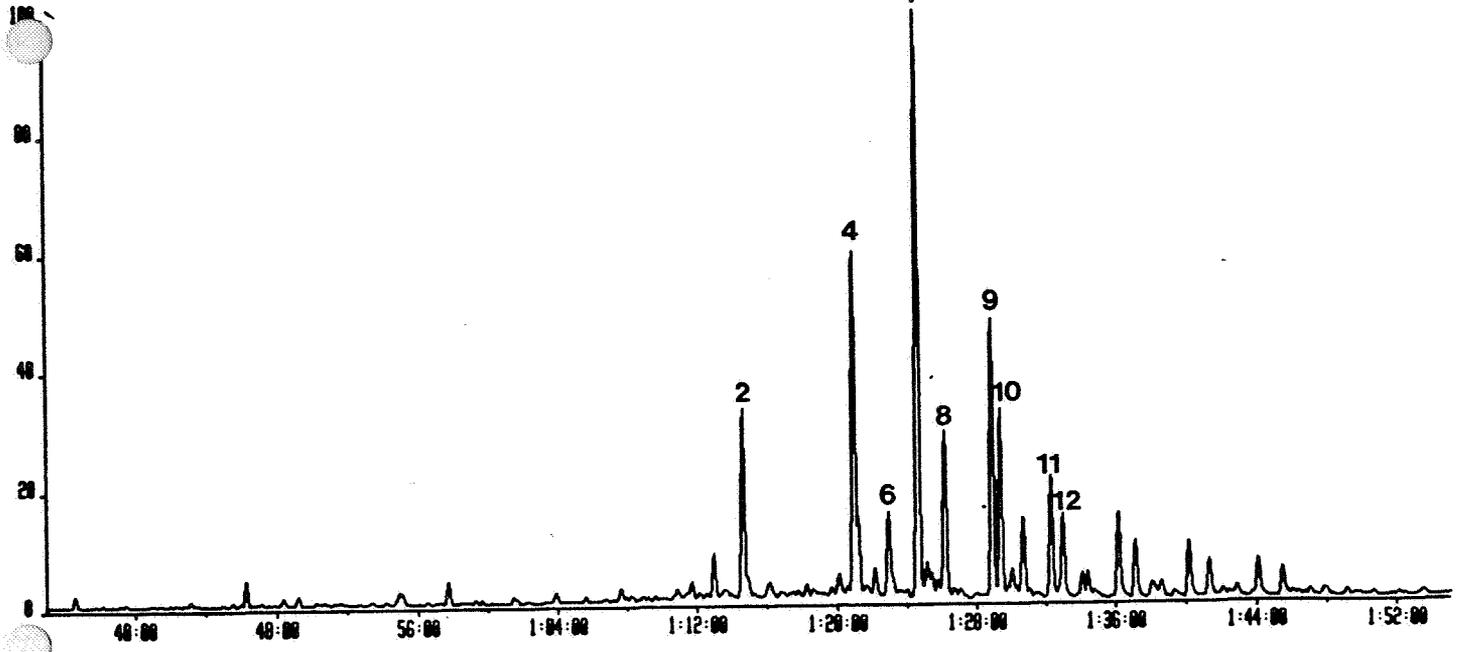
2707.50 m



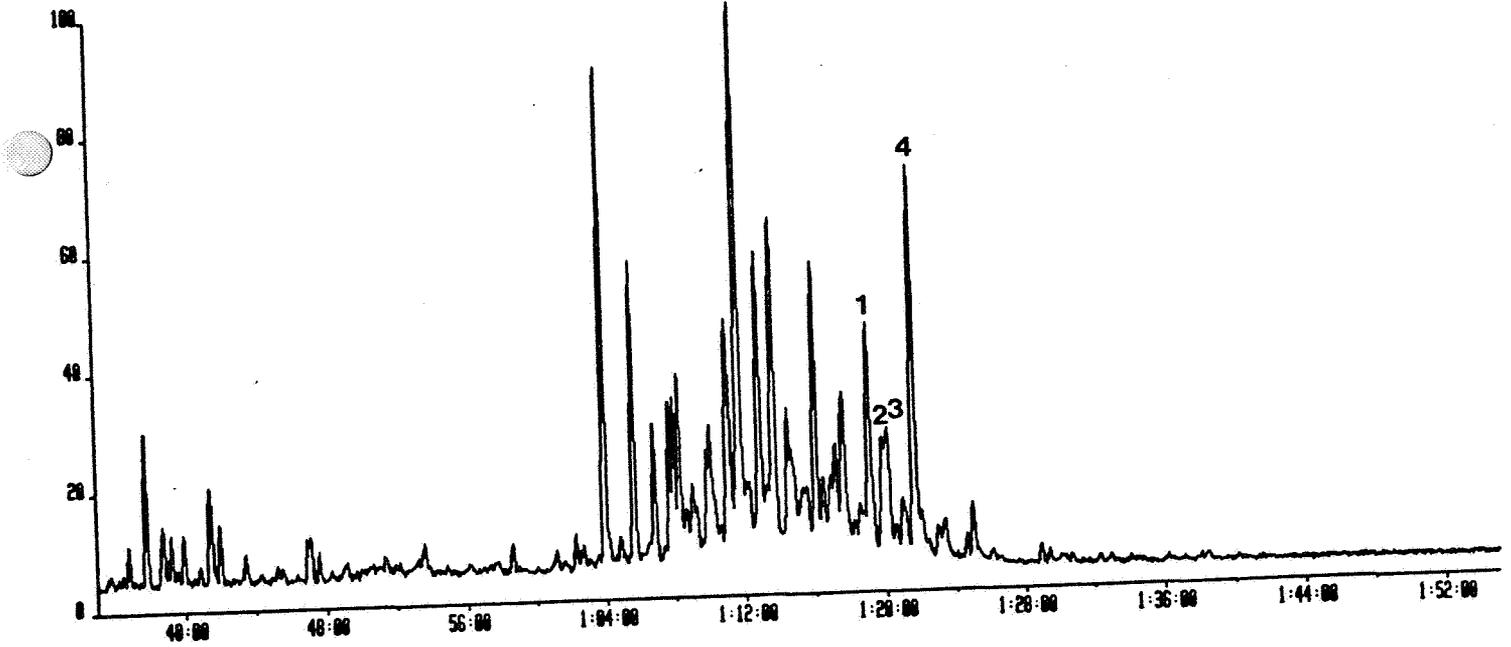


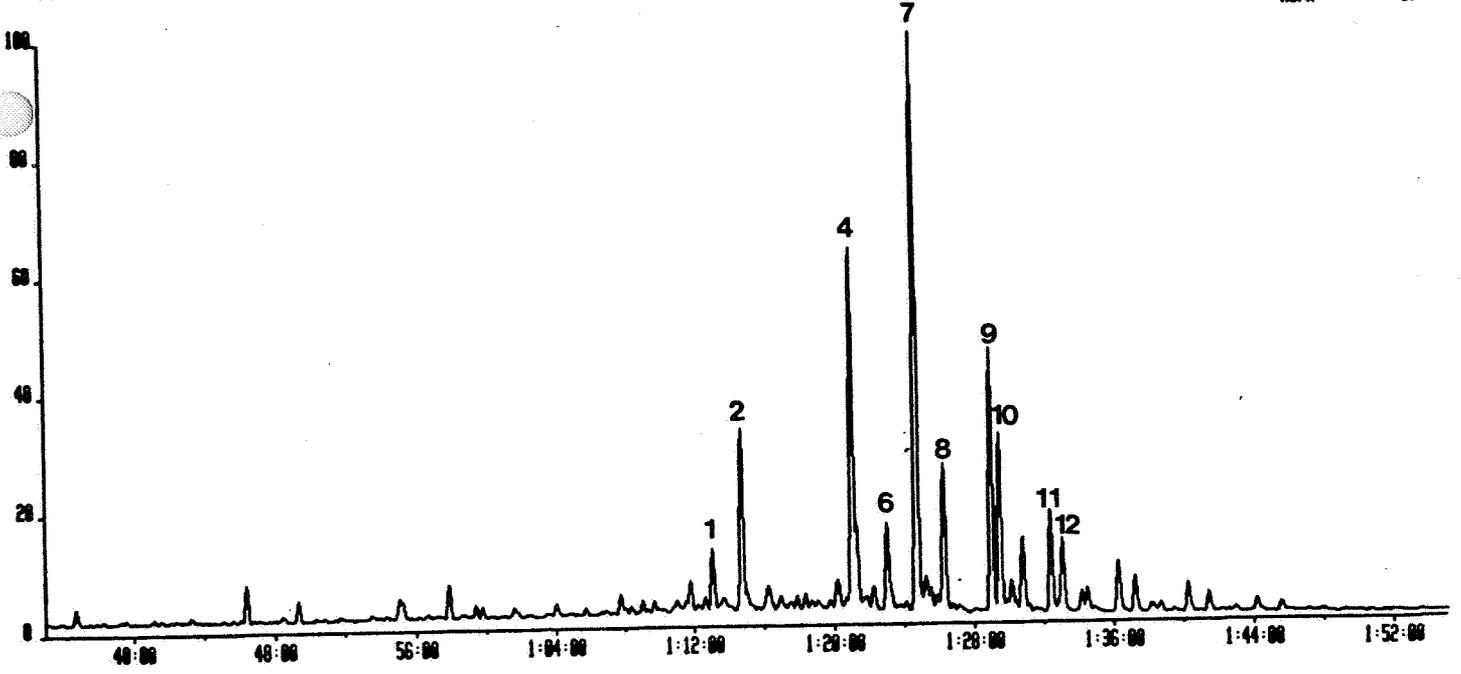
2709.00 m



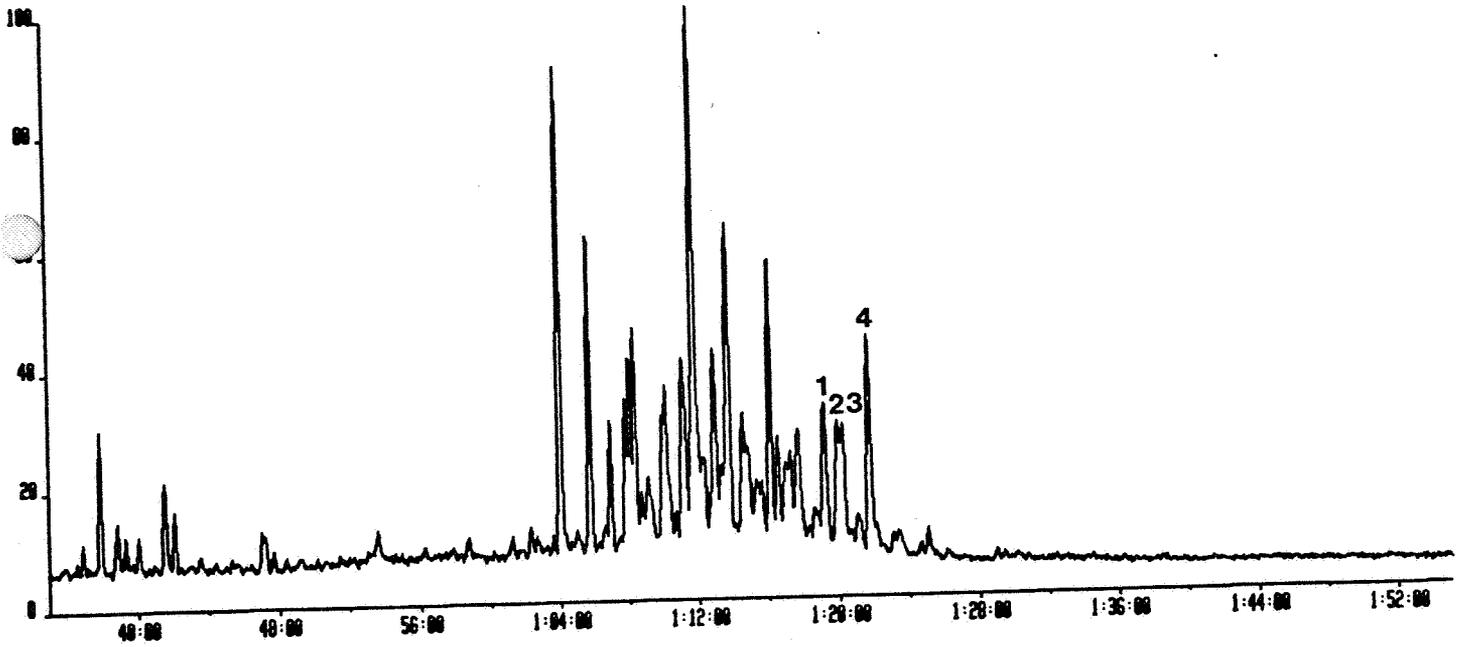


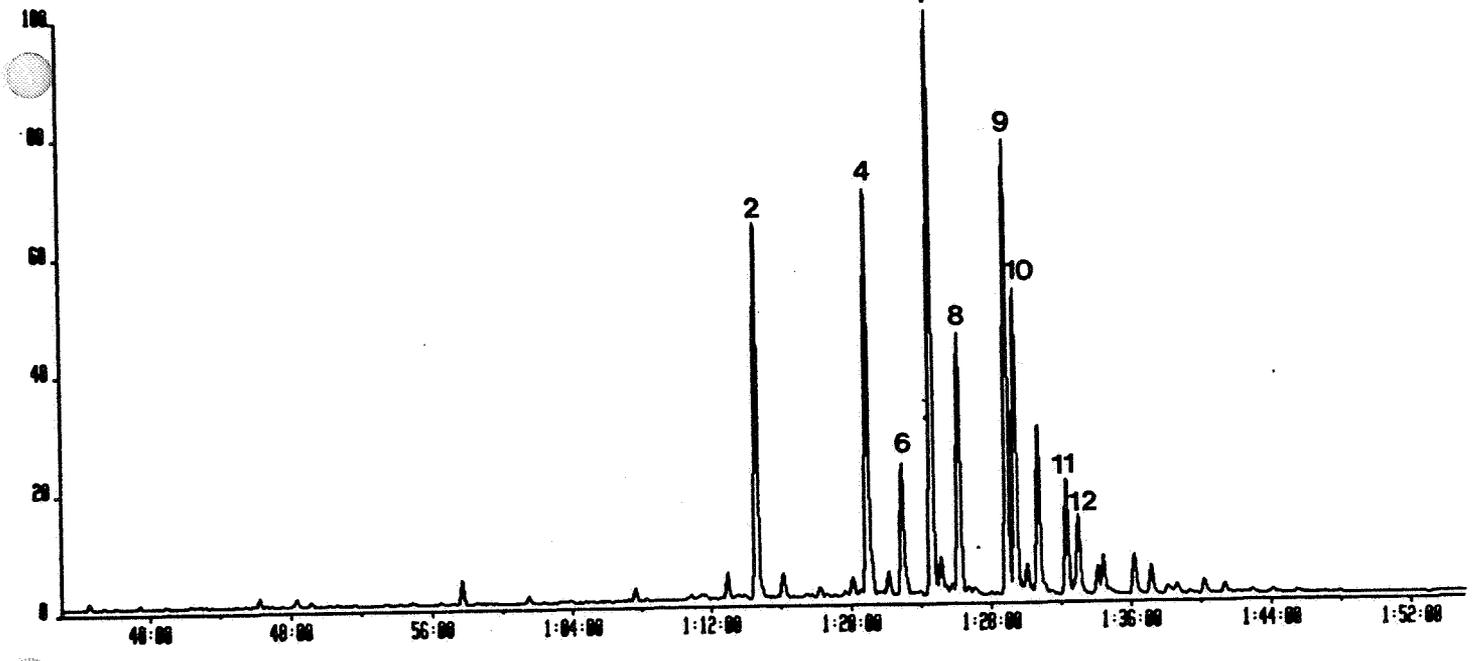
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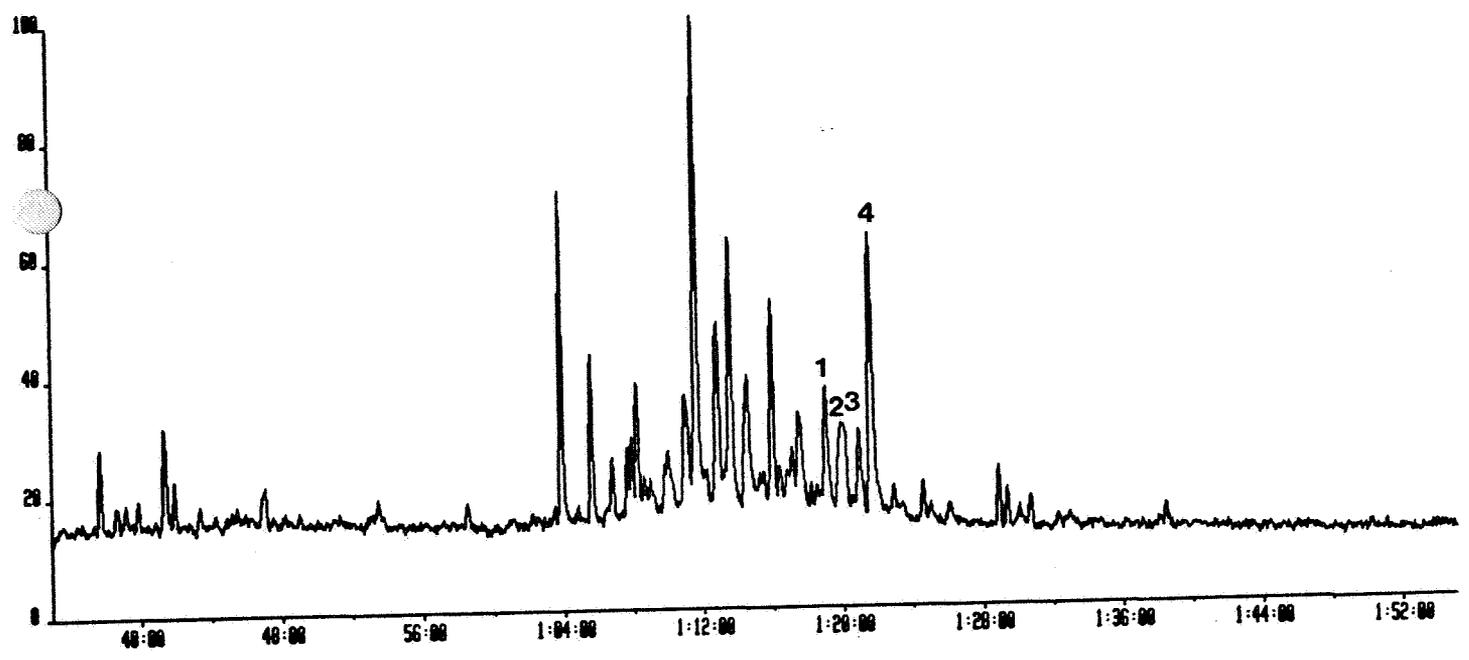


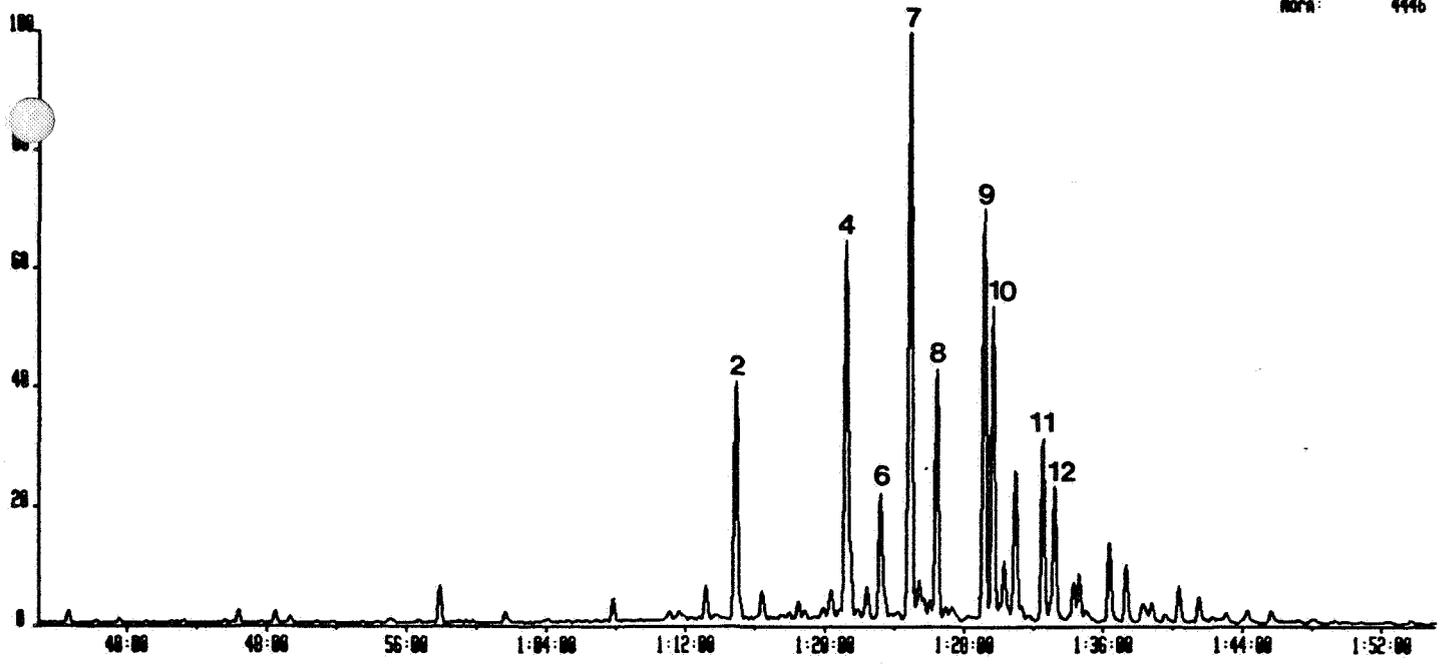
2713.35 m



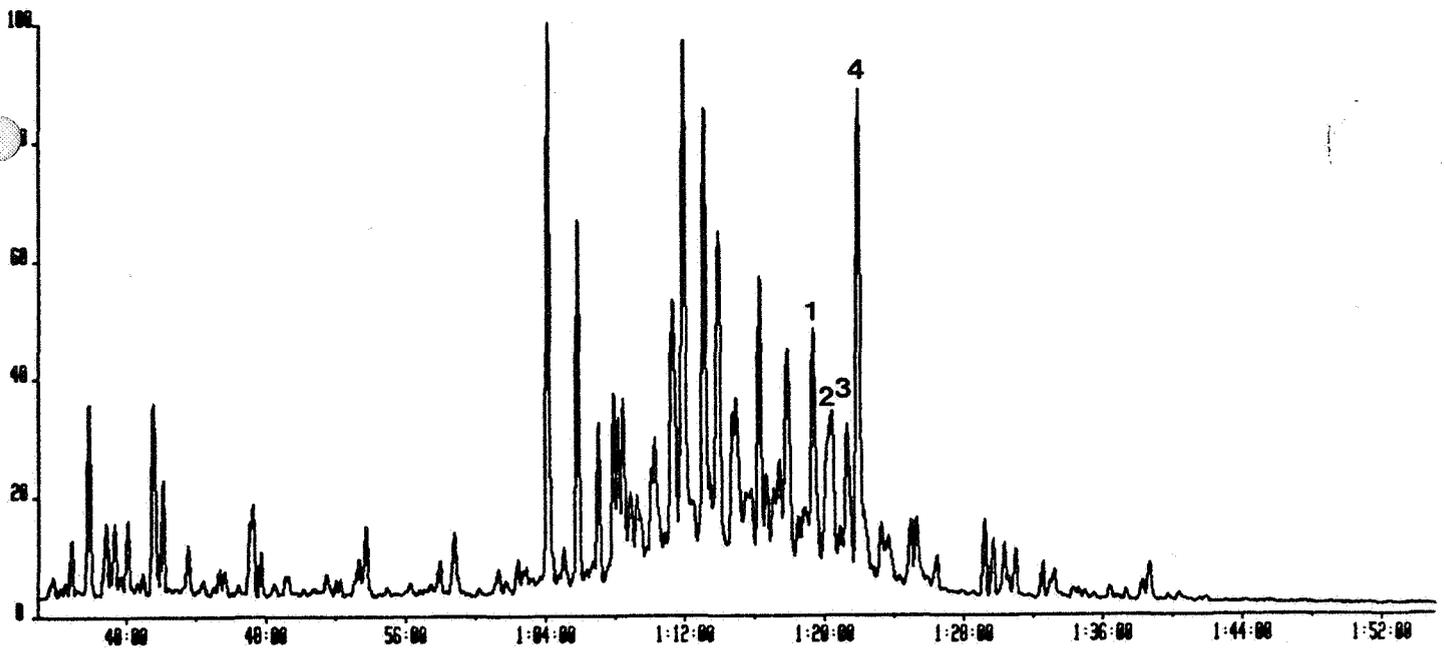


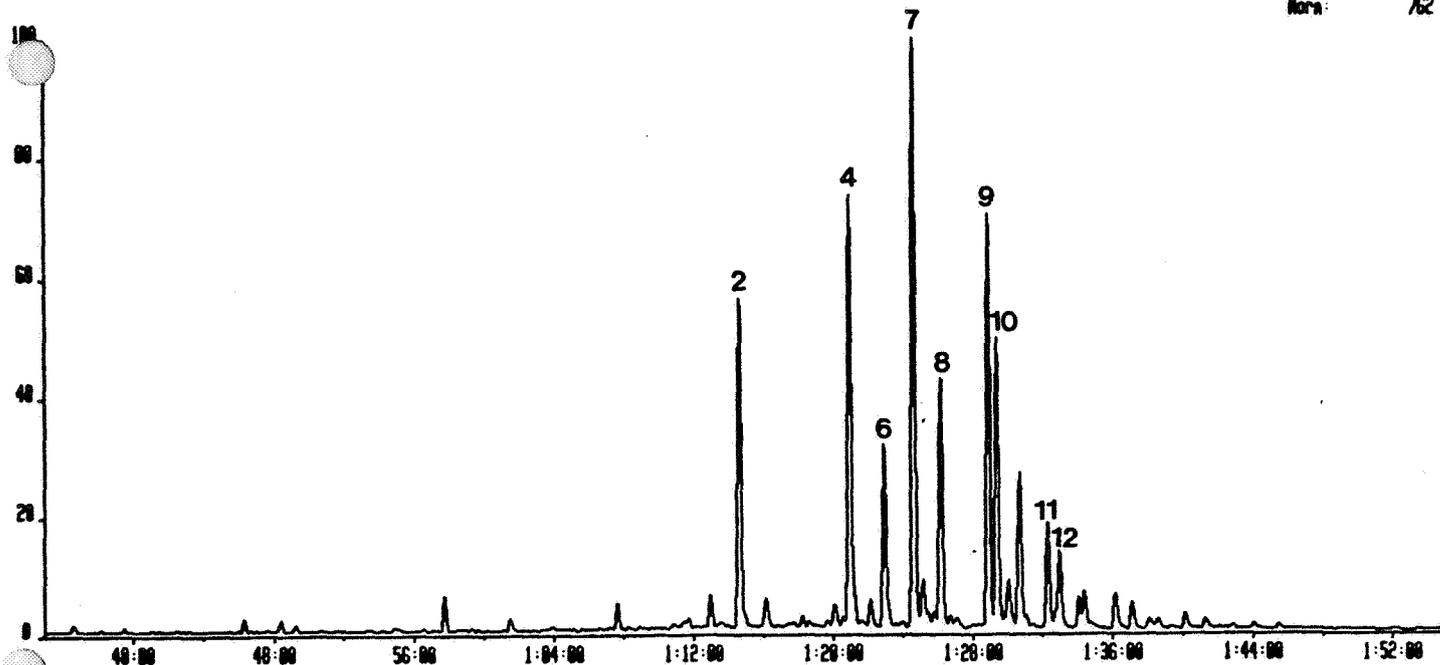
2716.97 m



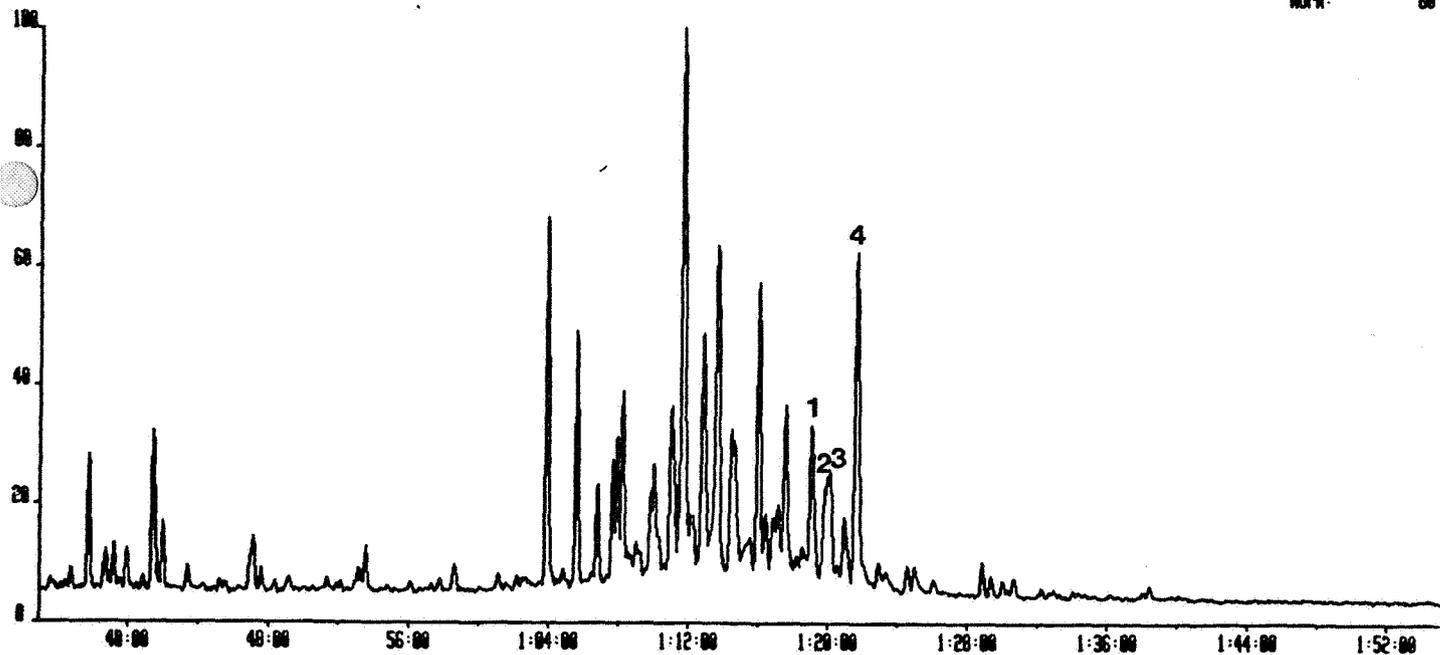


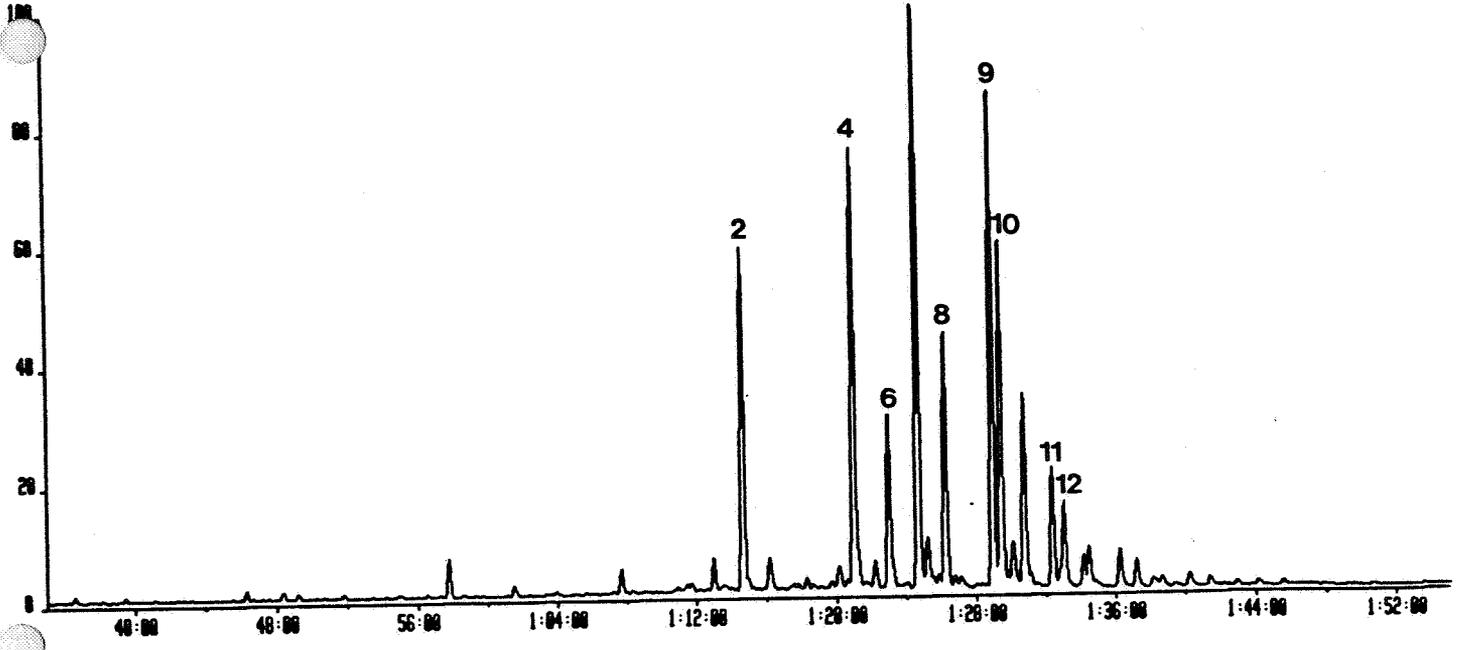
2718.04 m



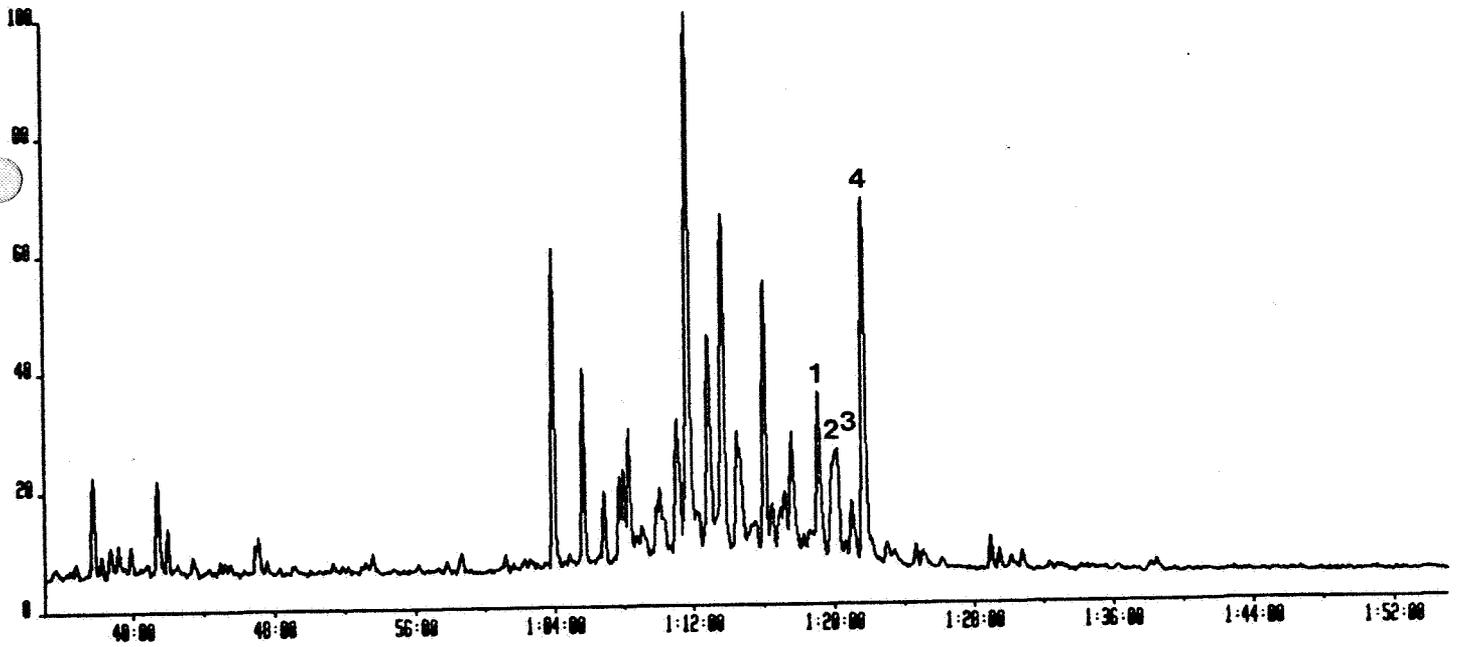


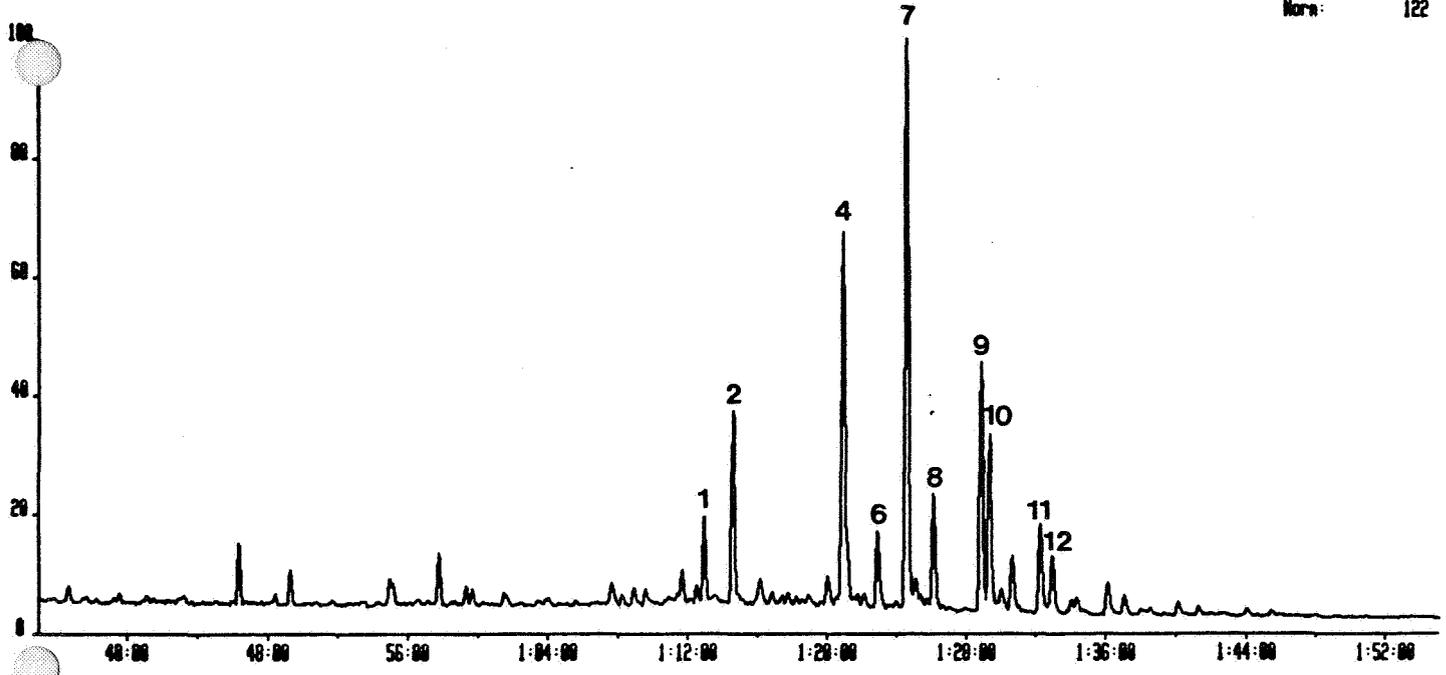
2721.10 m



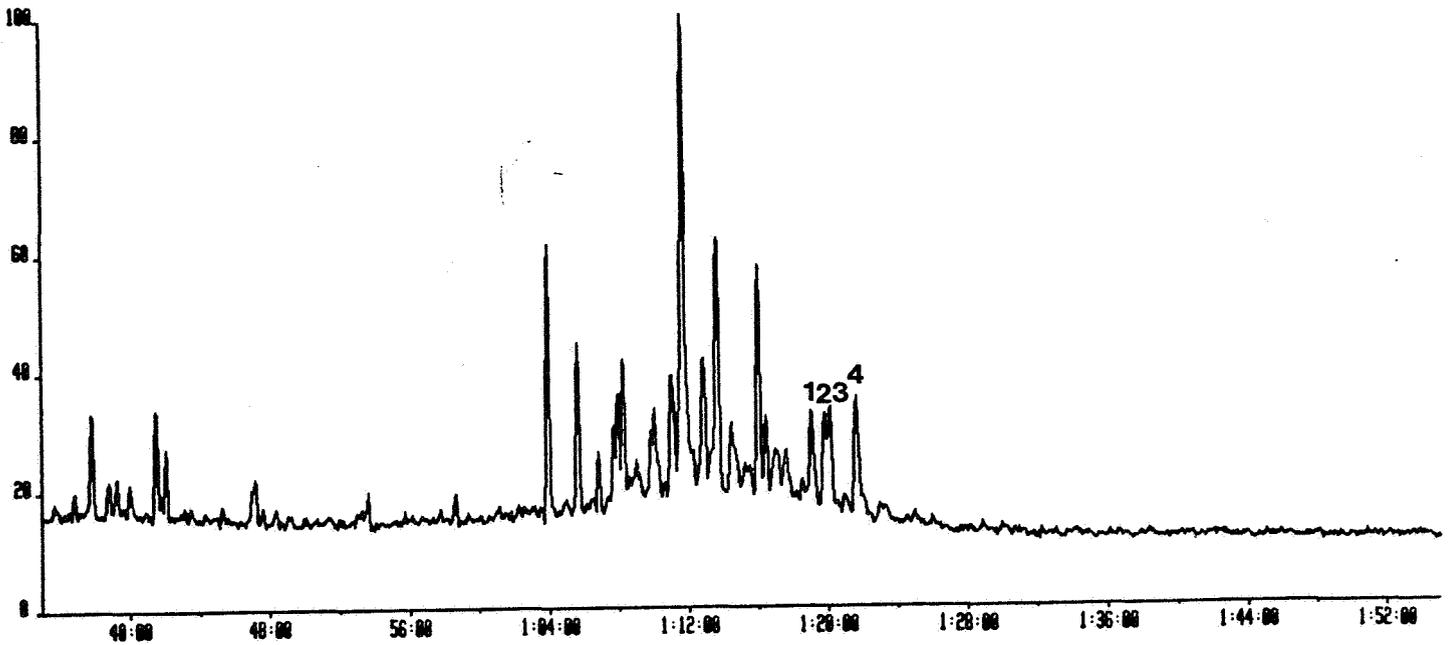


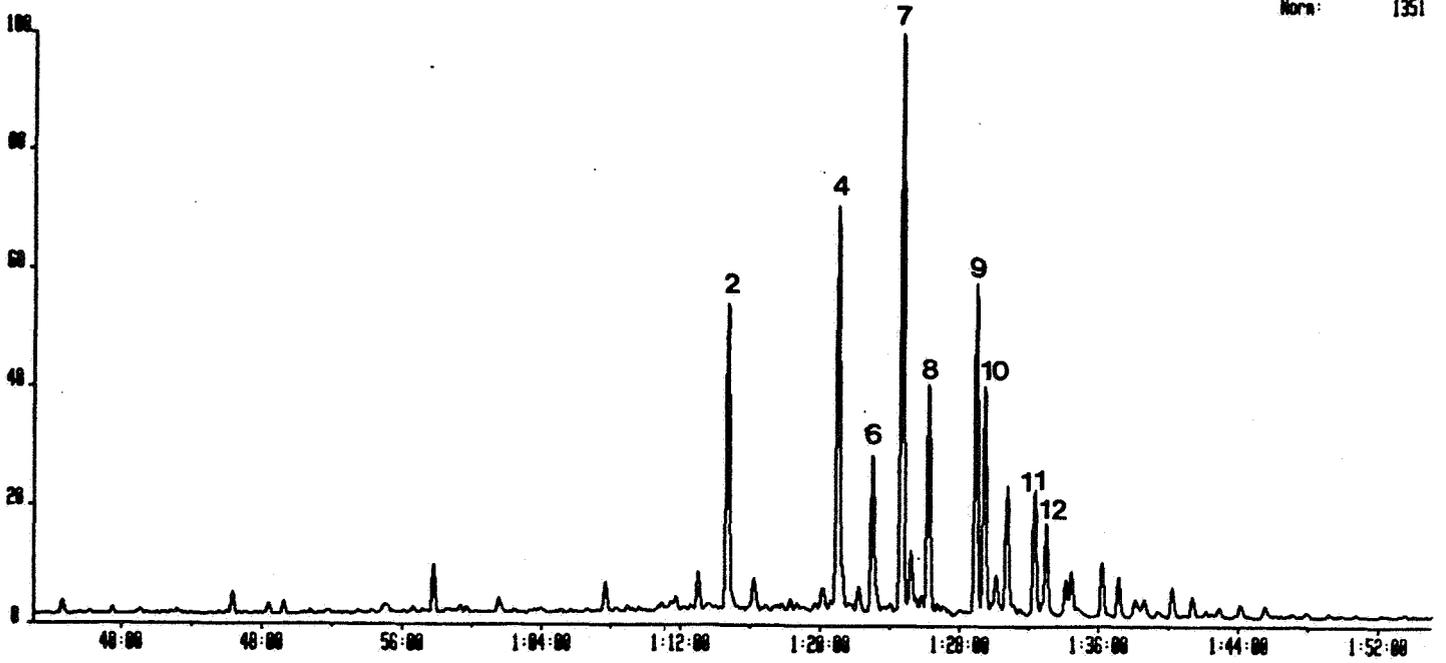
2722.03 m



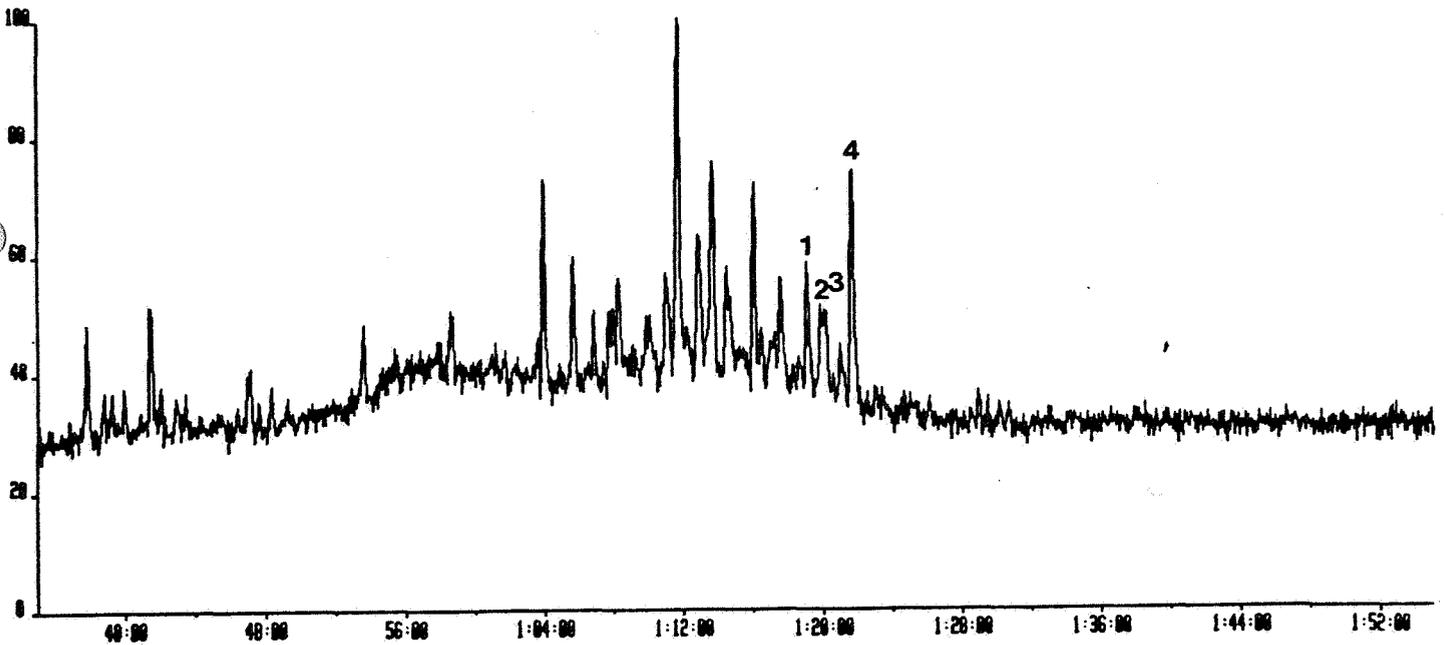


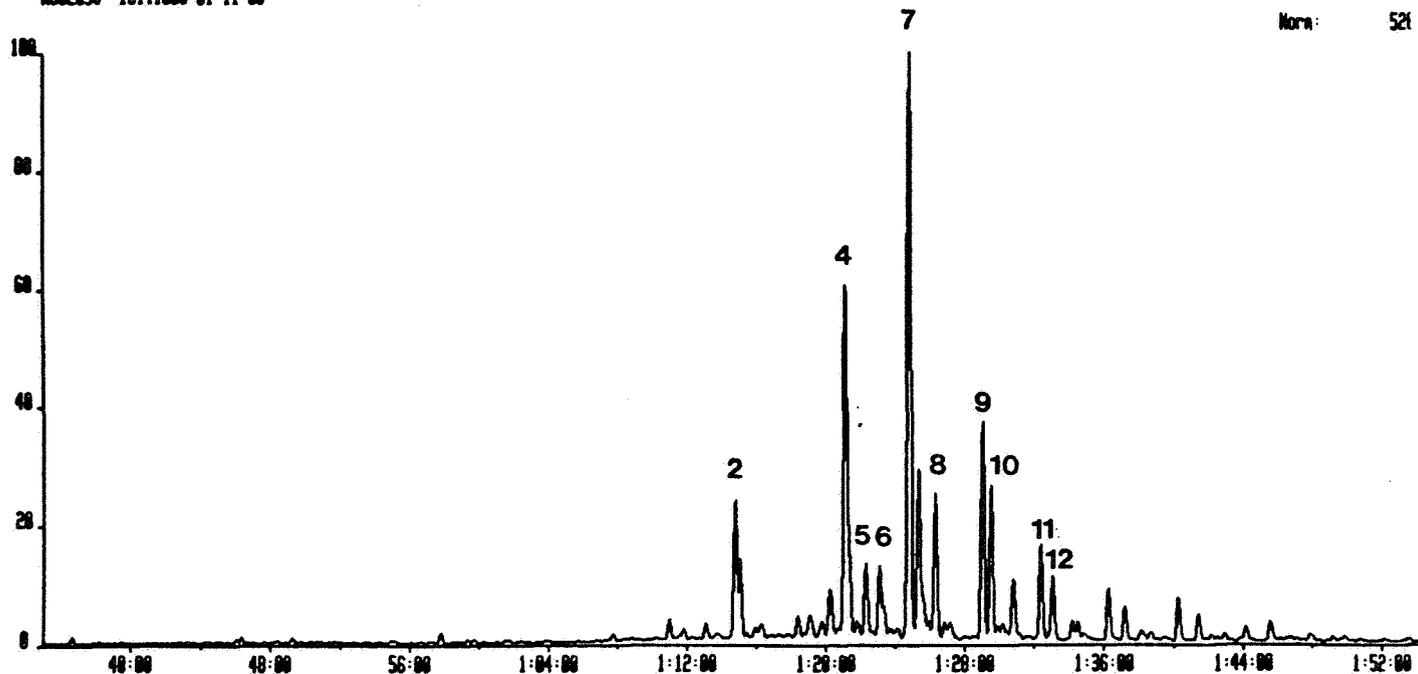
2724.10 m



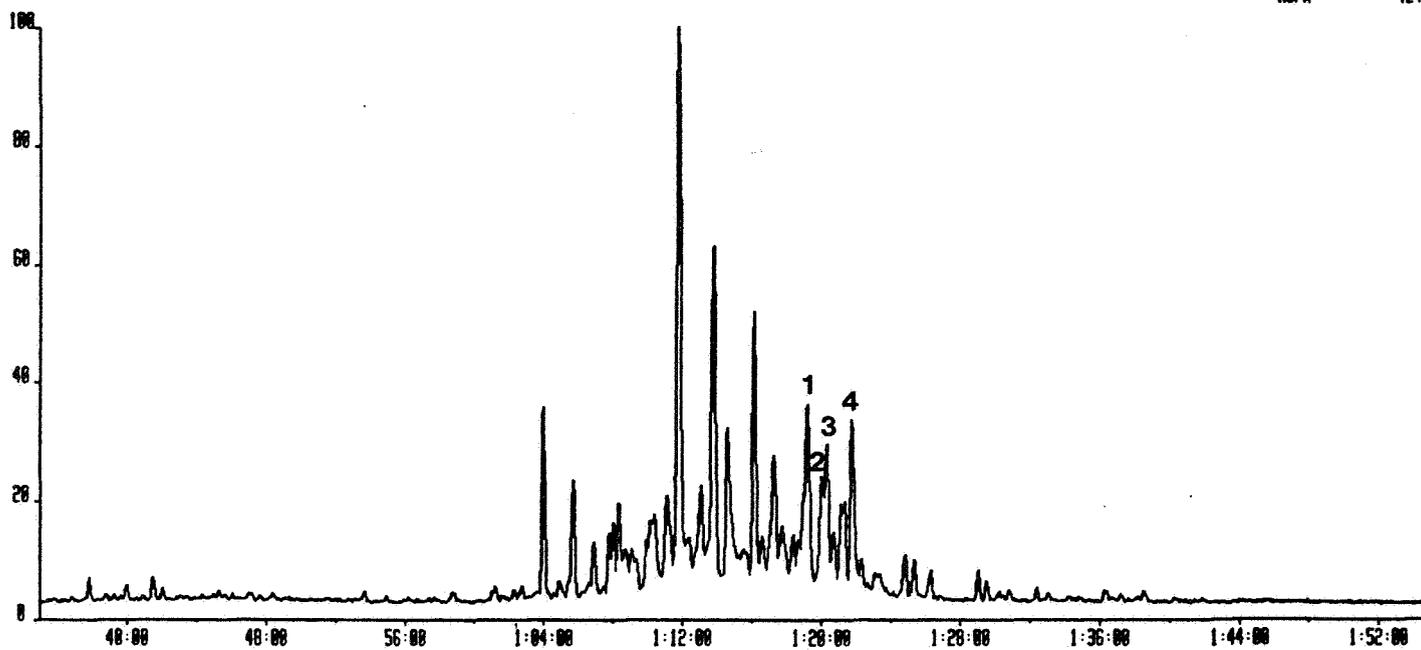


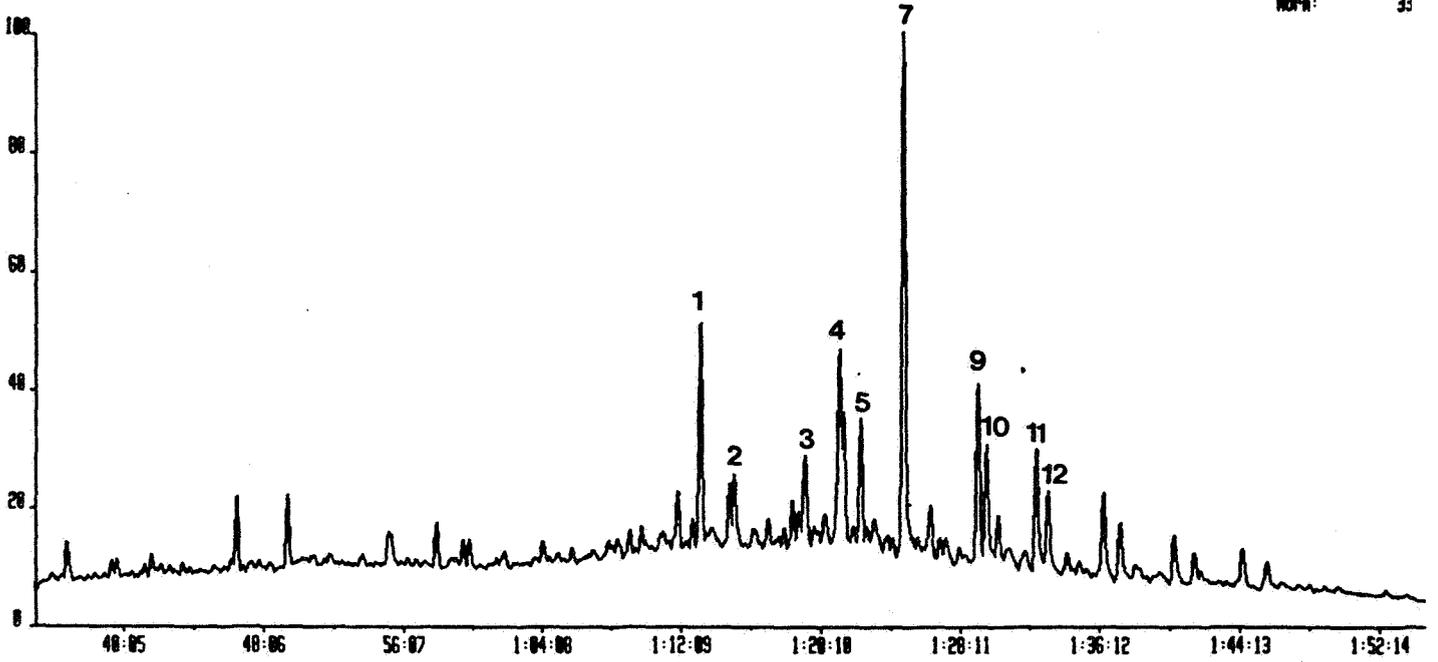
2726.05 m



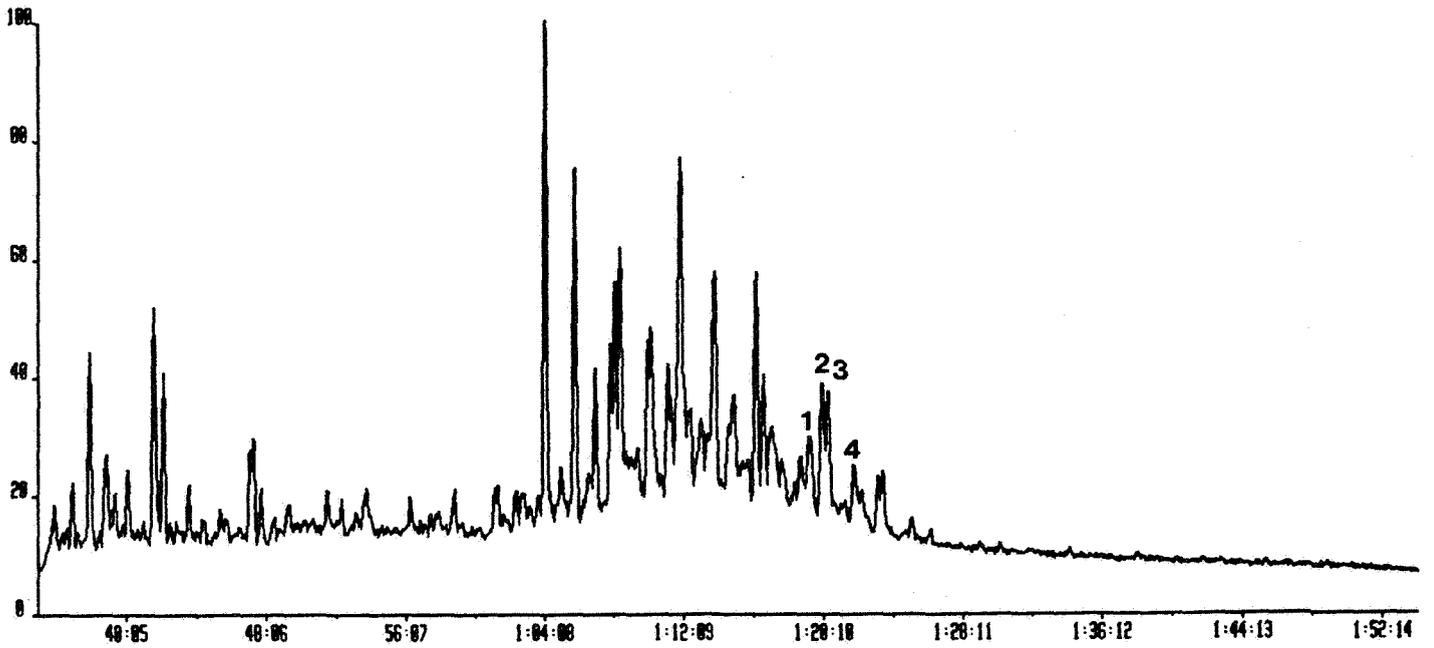


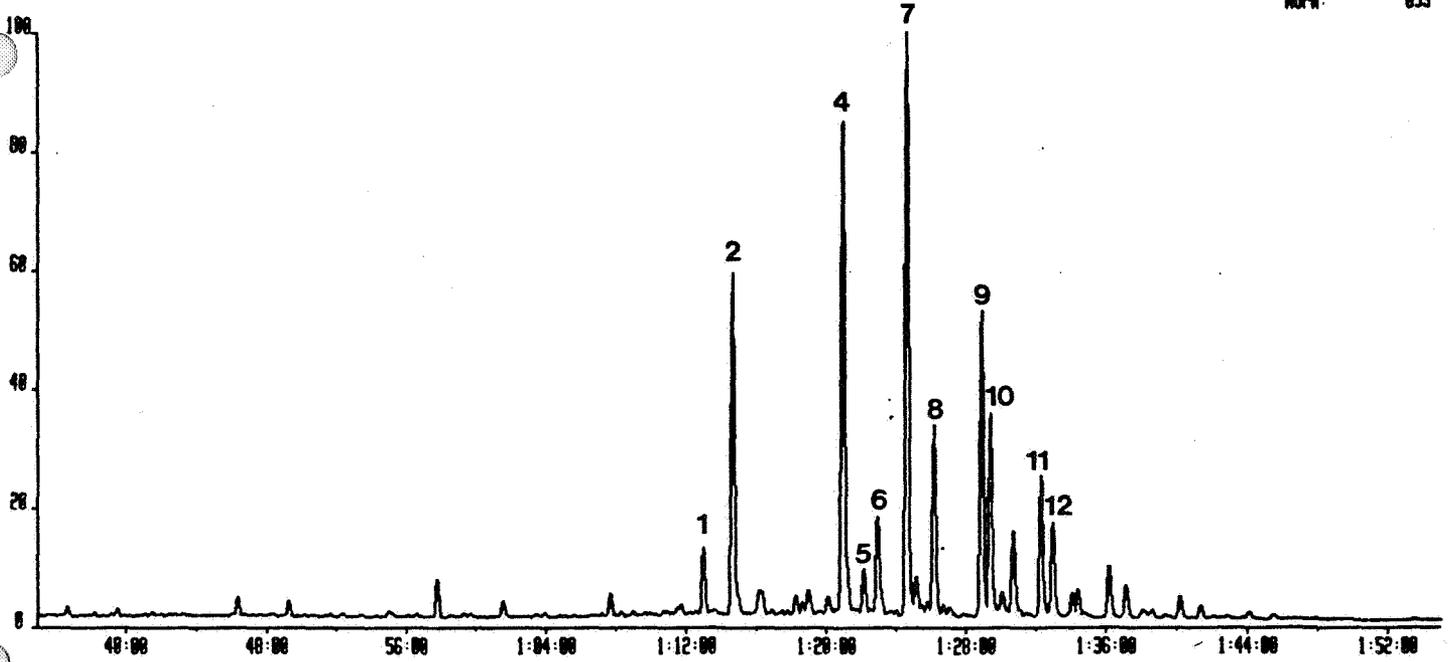
3017.20 m



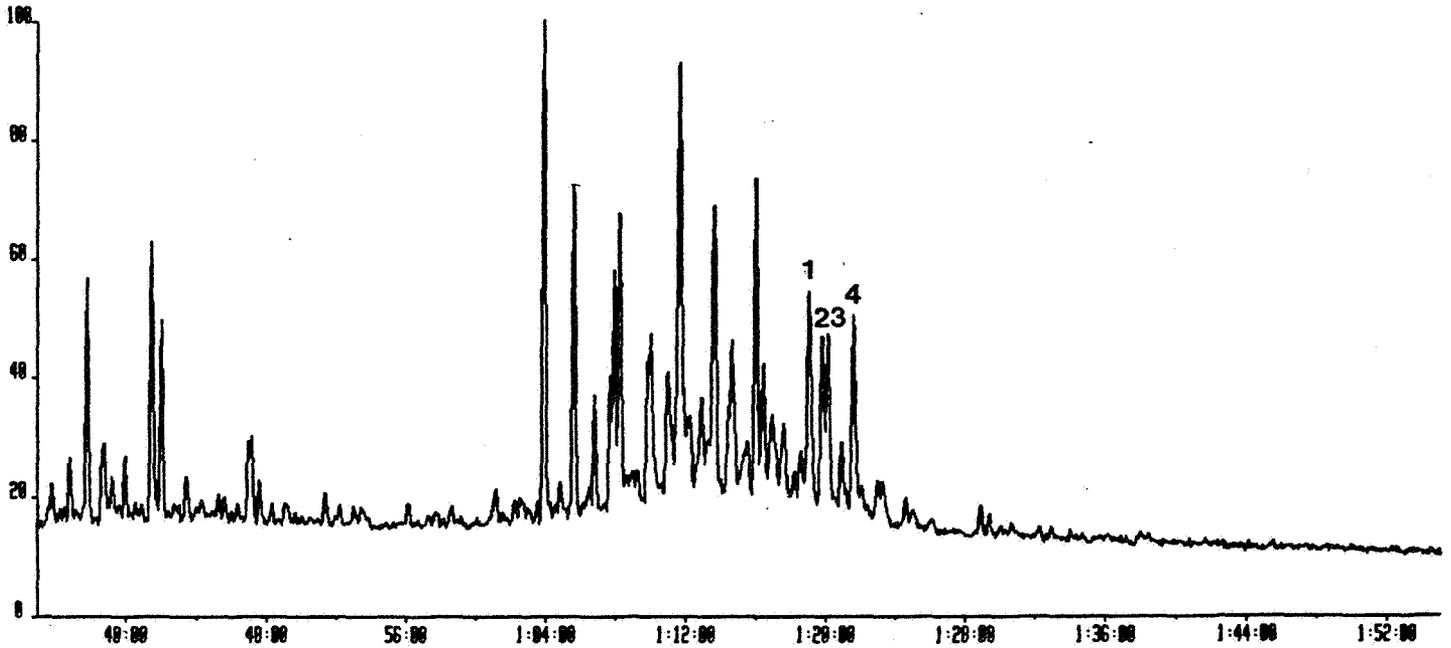


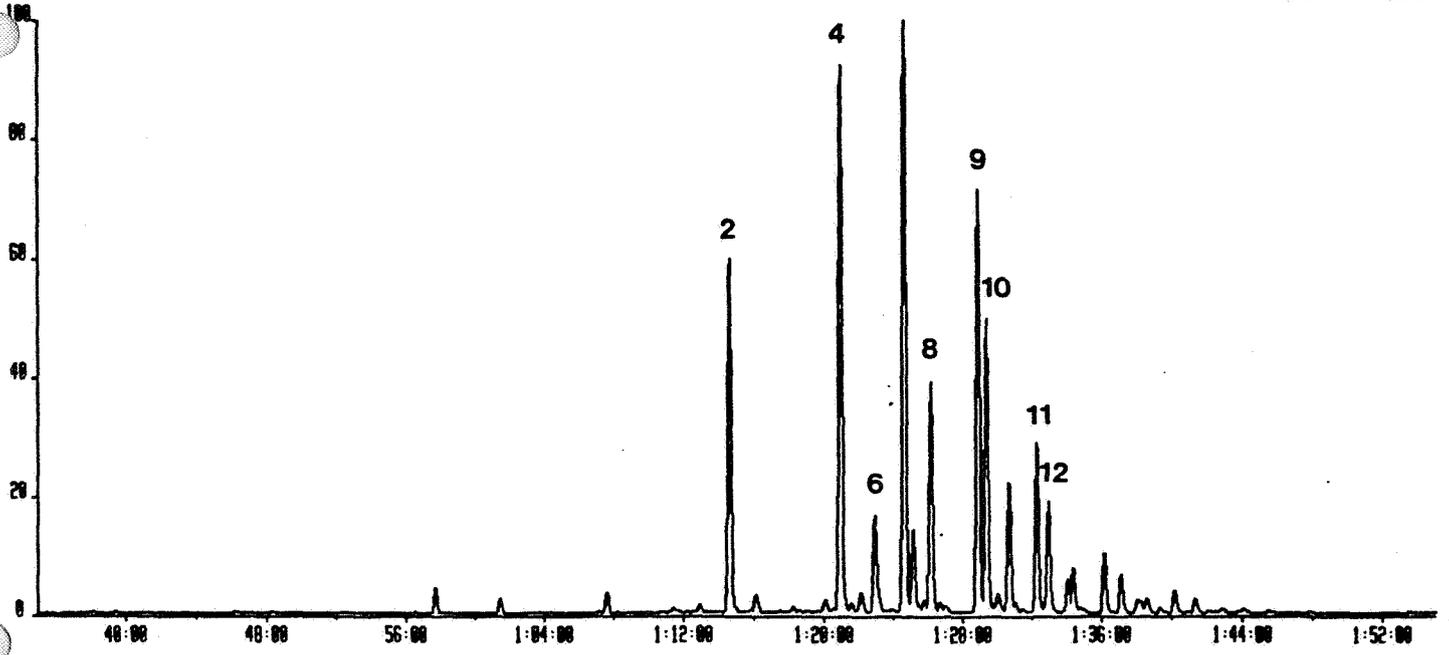
3024.00 m



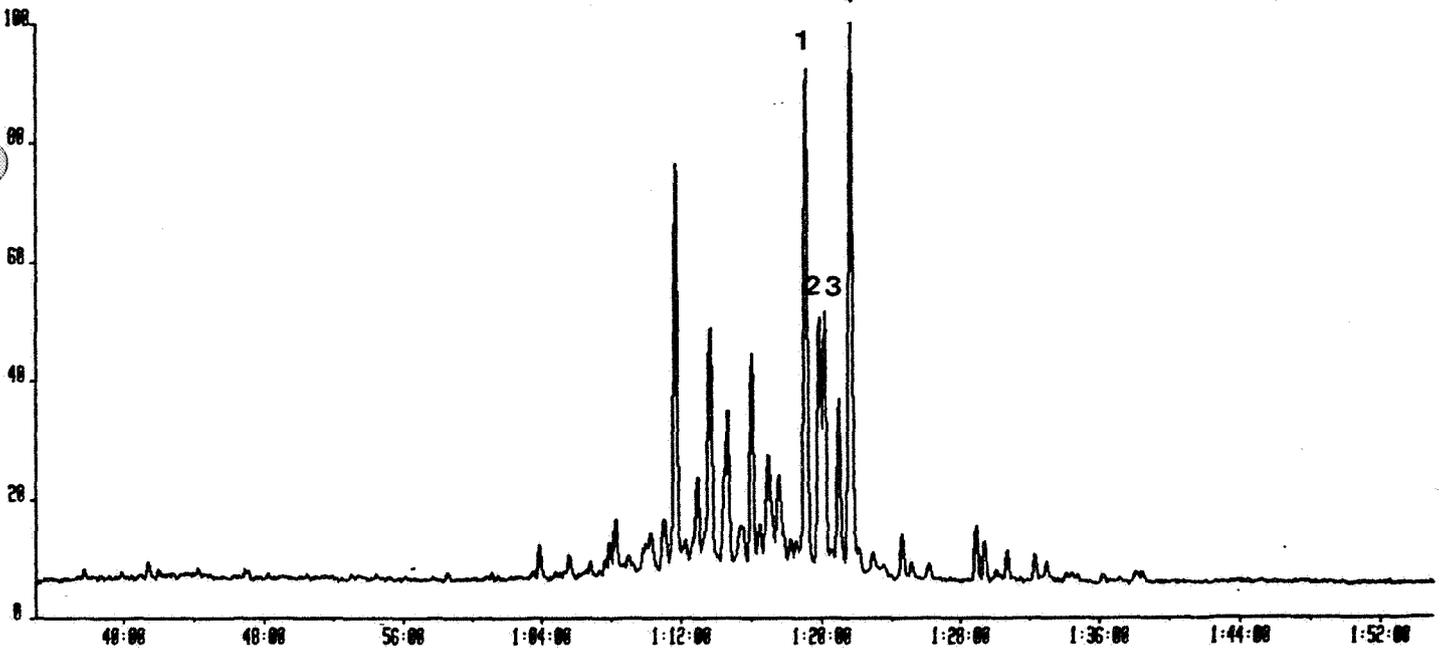


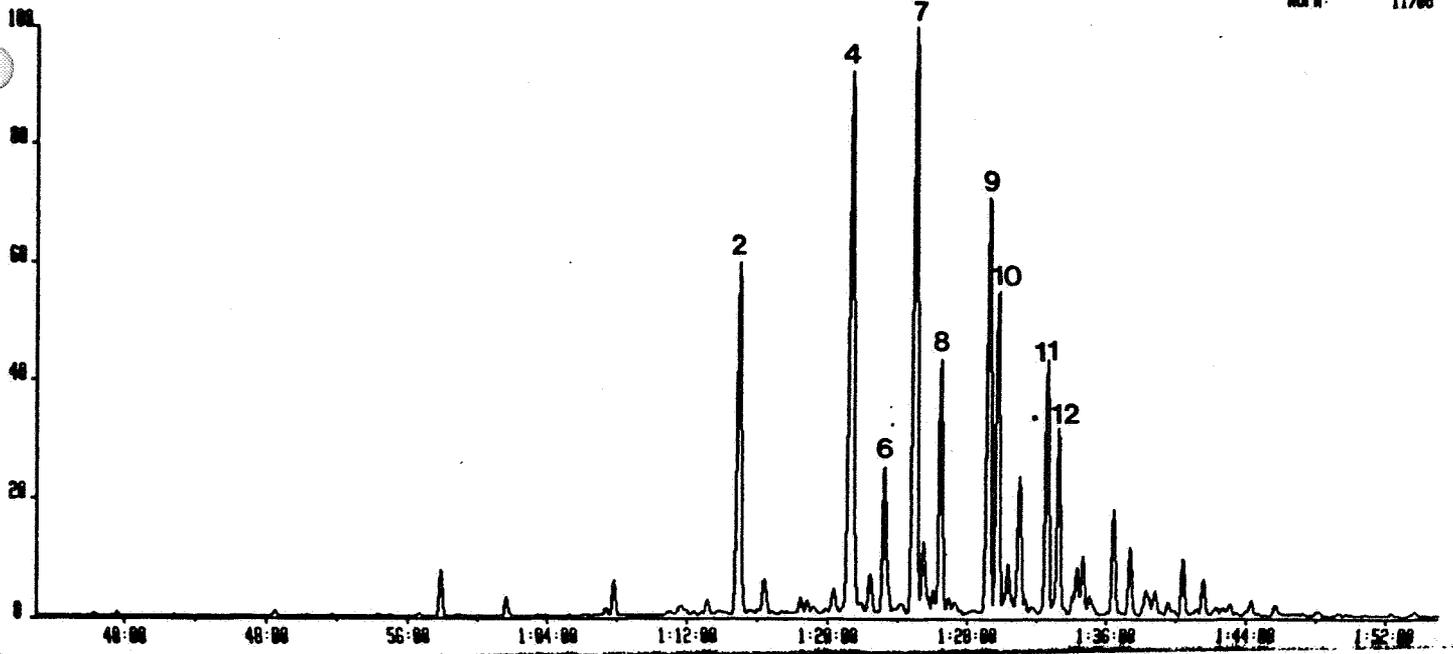
3032.30 m



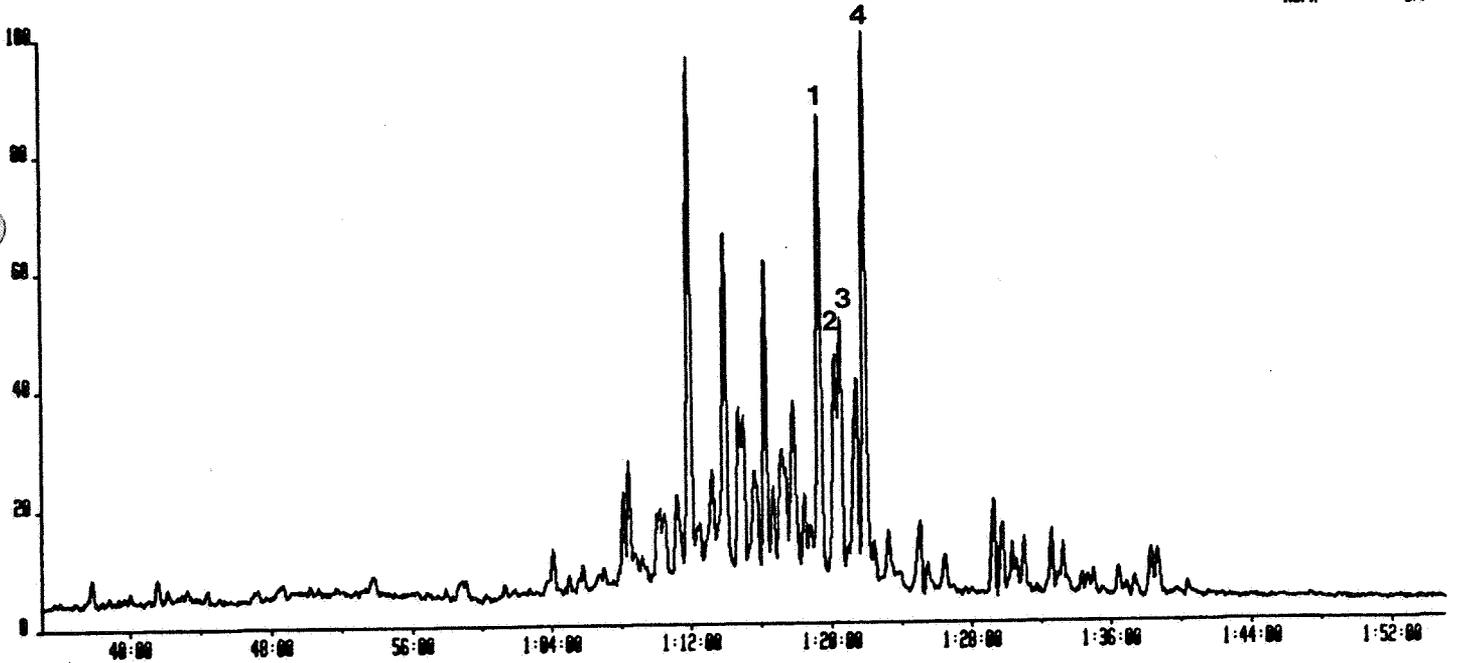


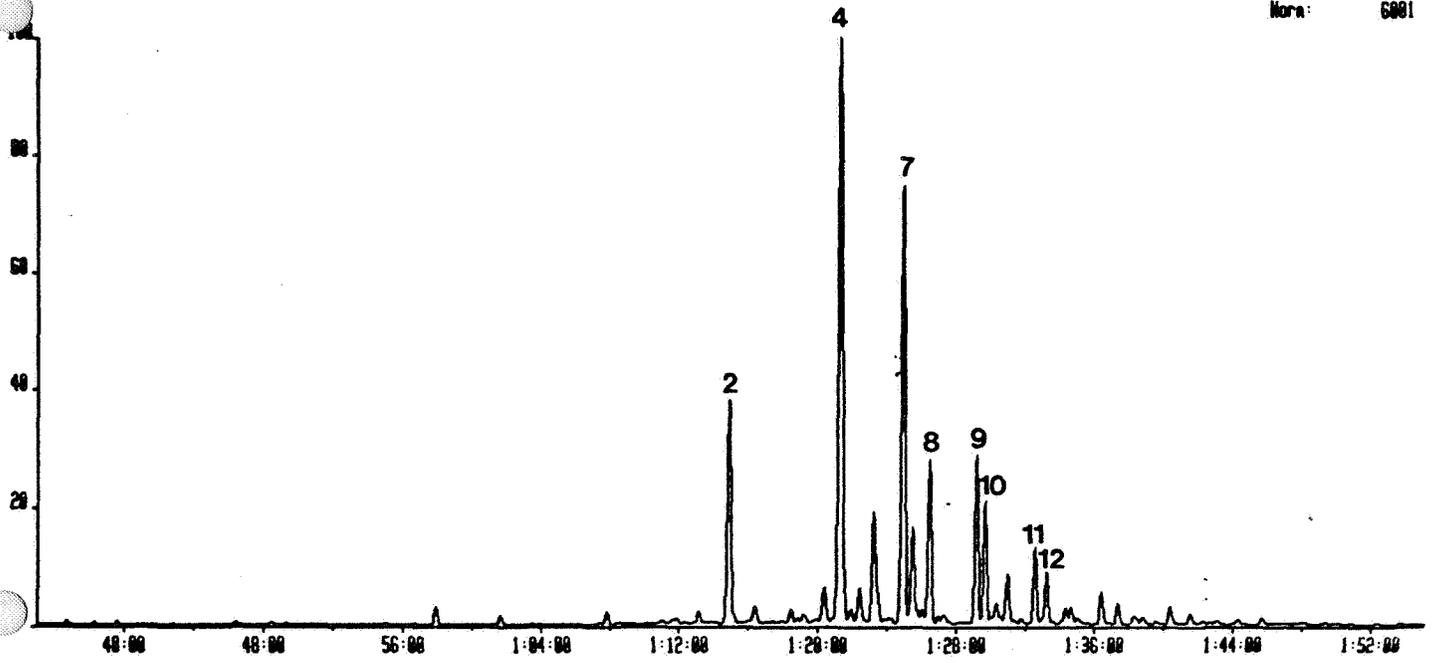
3034.20 m



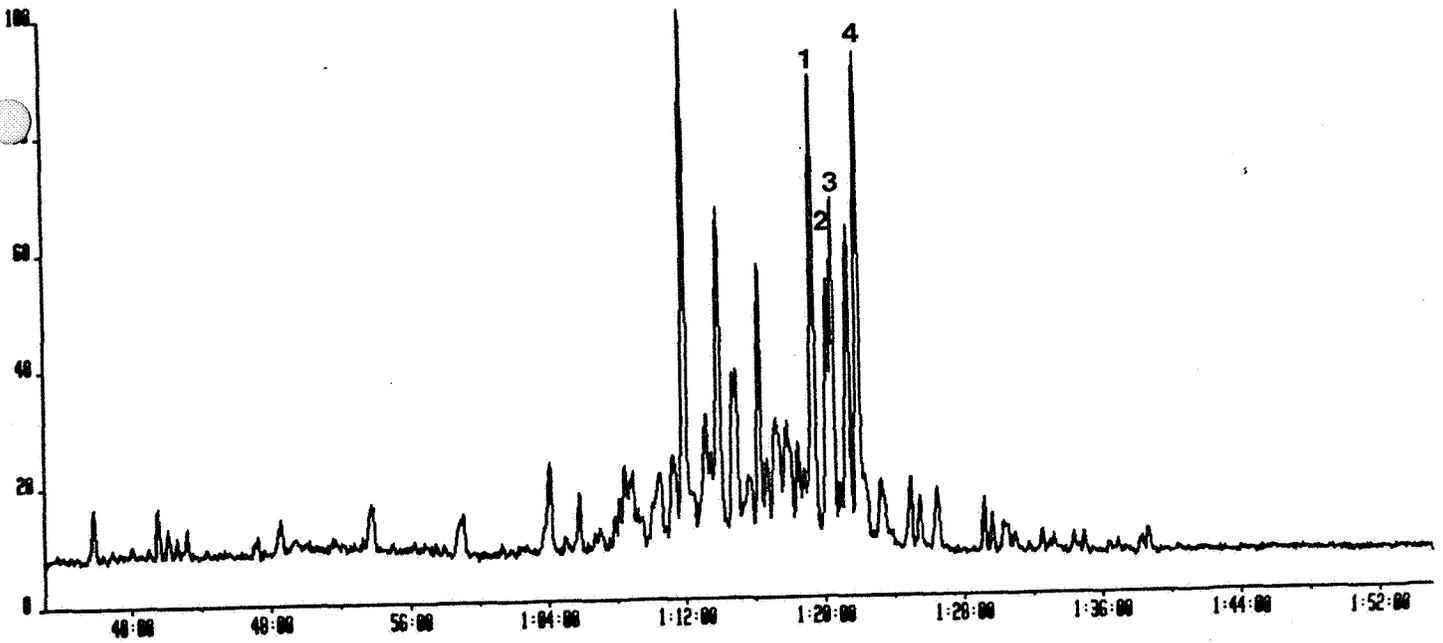


3071.57 m



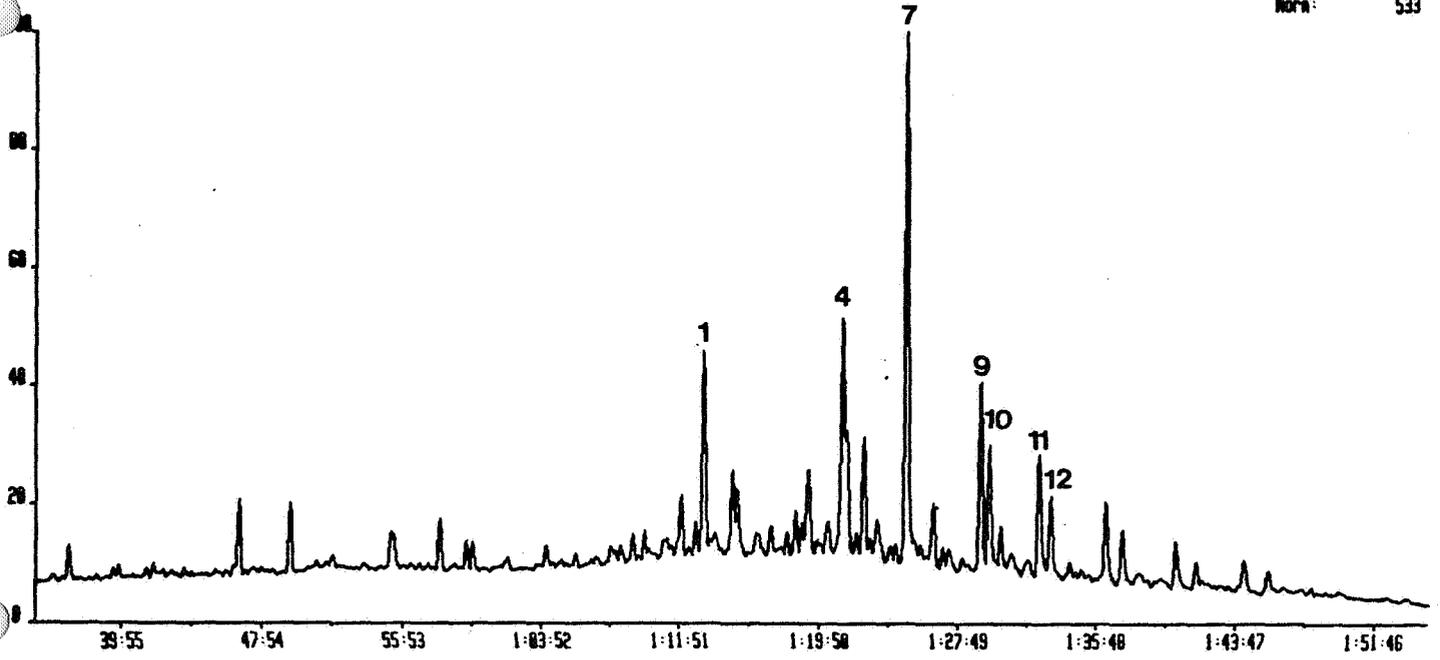


3075.45 m



MS82056 191.1000 61 11 57

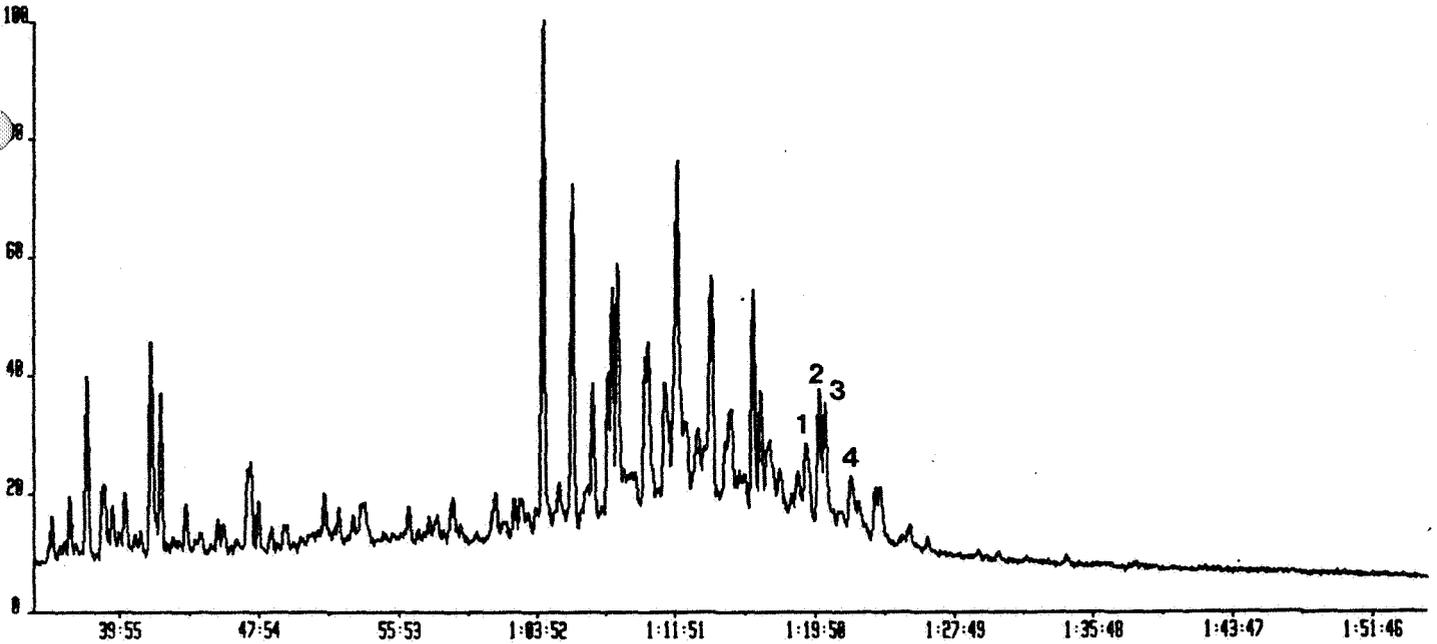
Norm: 533



3081.50 m

MS82056 217.1956 61 11 57

Norm: 213



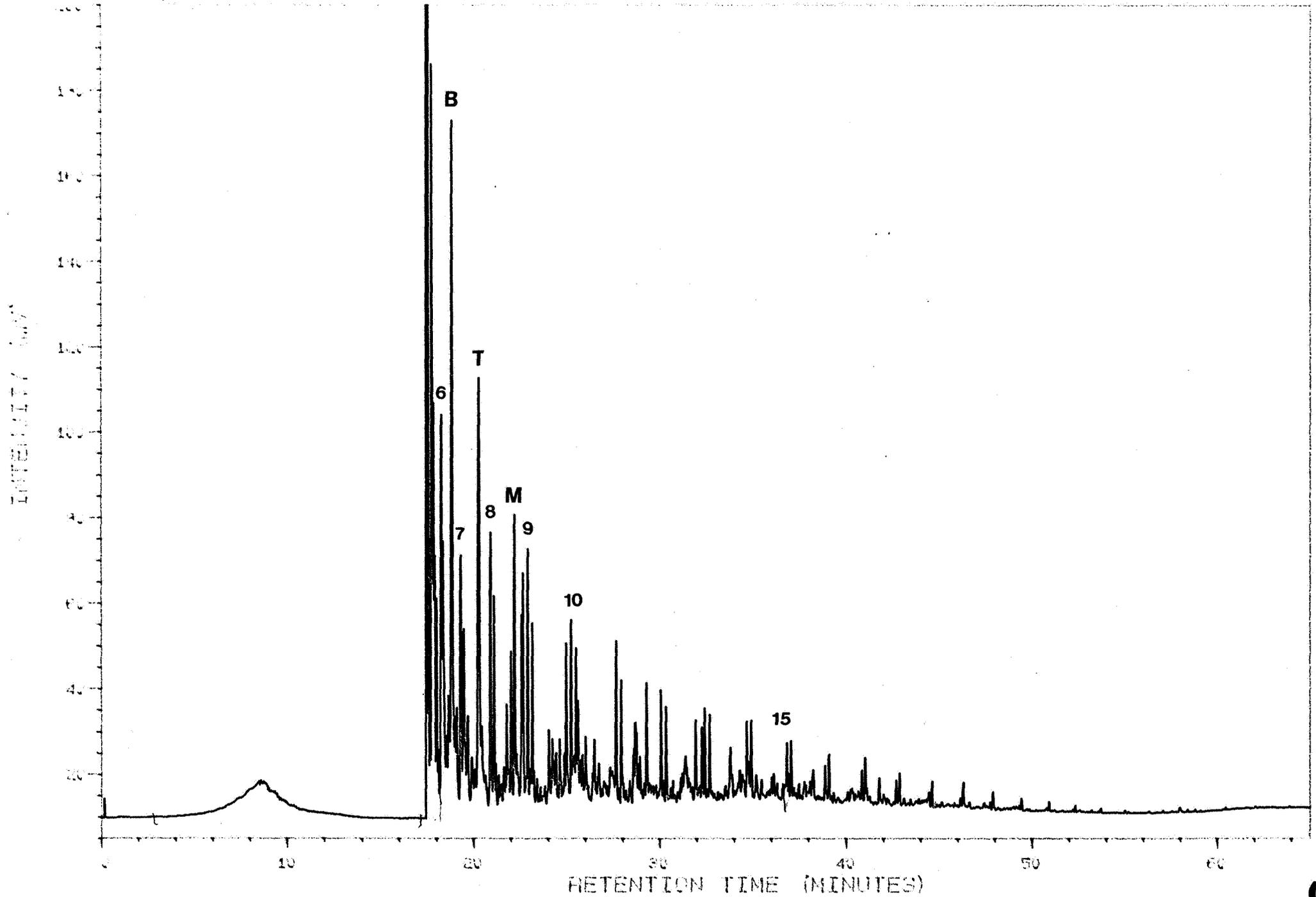
## APPENDIX IV

### RESULTS FROM PYROLYSIS-GAS CHROMATOGRAPHY.

- B - benzene
- T - toluene
- M - m- + p-xylene
- 6 - hexene
- 7 - heptene
- 8 - octene
- 9 - nonene
- 10 - decene
- 15 - pentadecene

Analysis S640771P

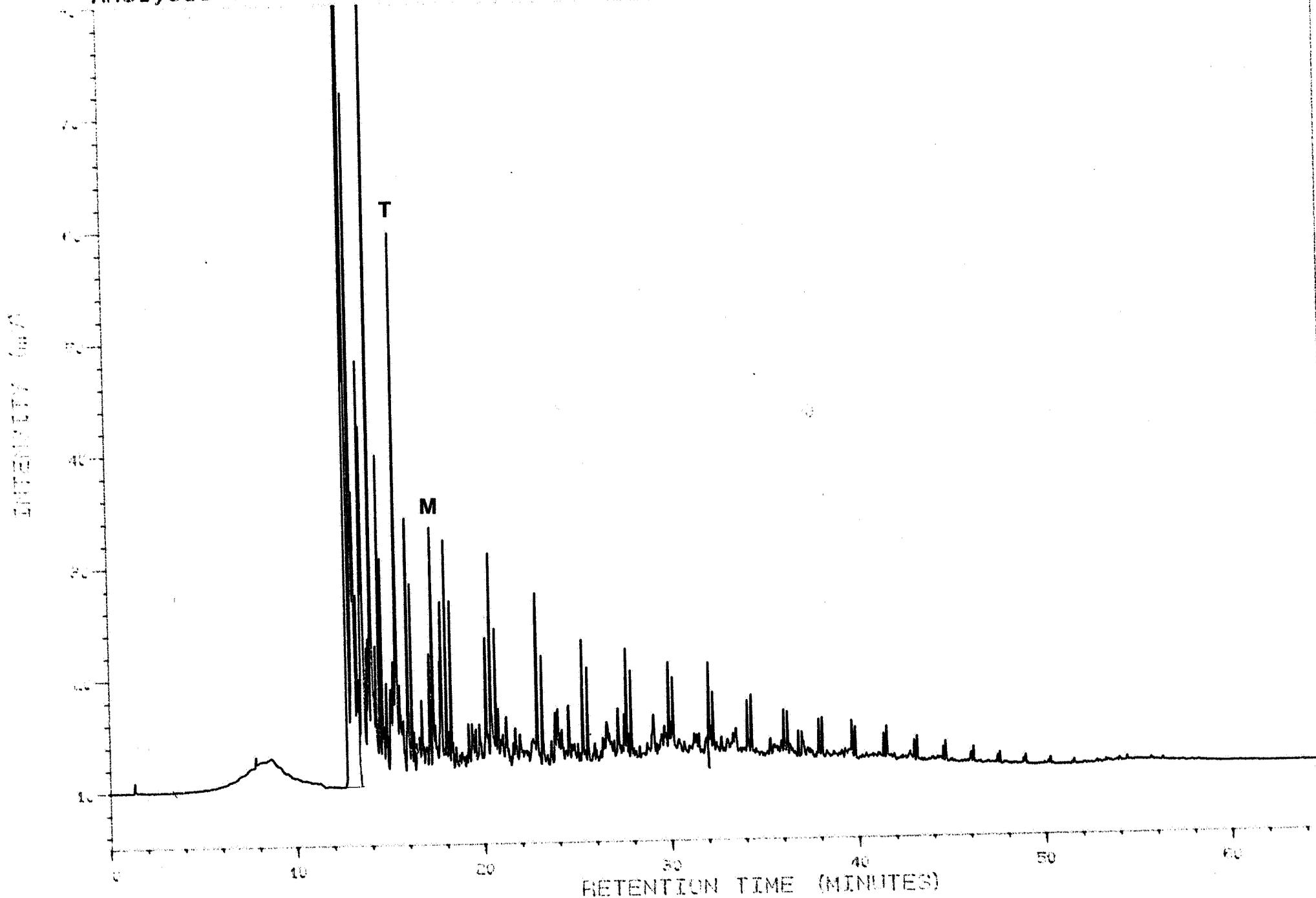
4, 1, 1 1824.82 M SWC



Analysis S640771P

4.2.1

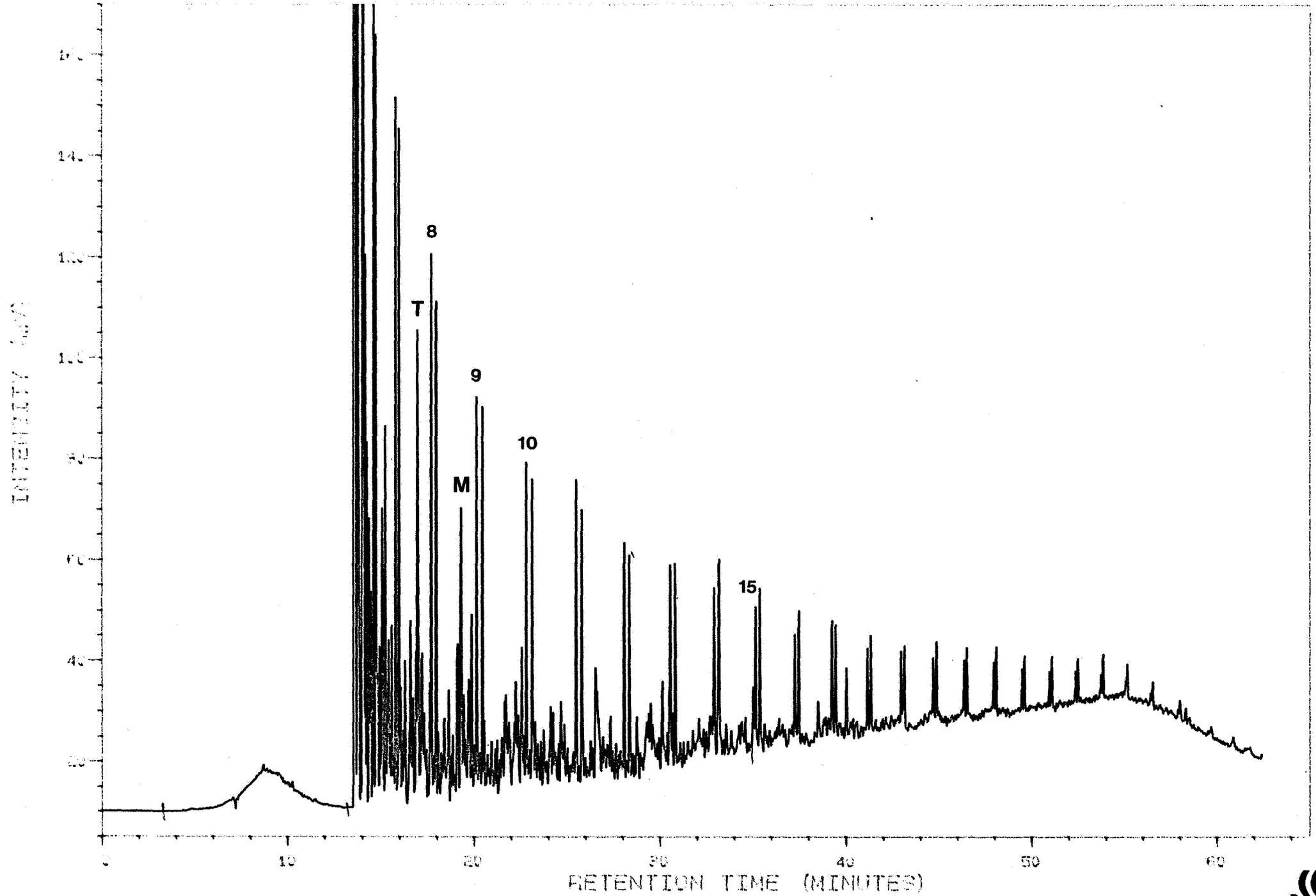
2085.50 M SWC



Analysis W640771P

5, 1, 1

2700.00 M SWC



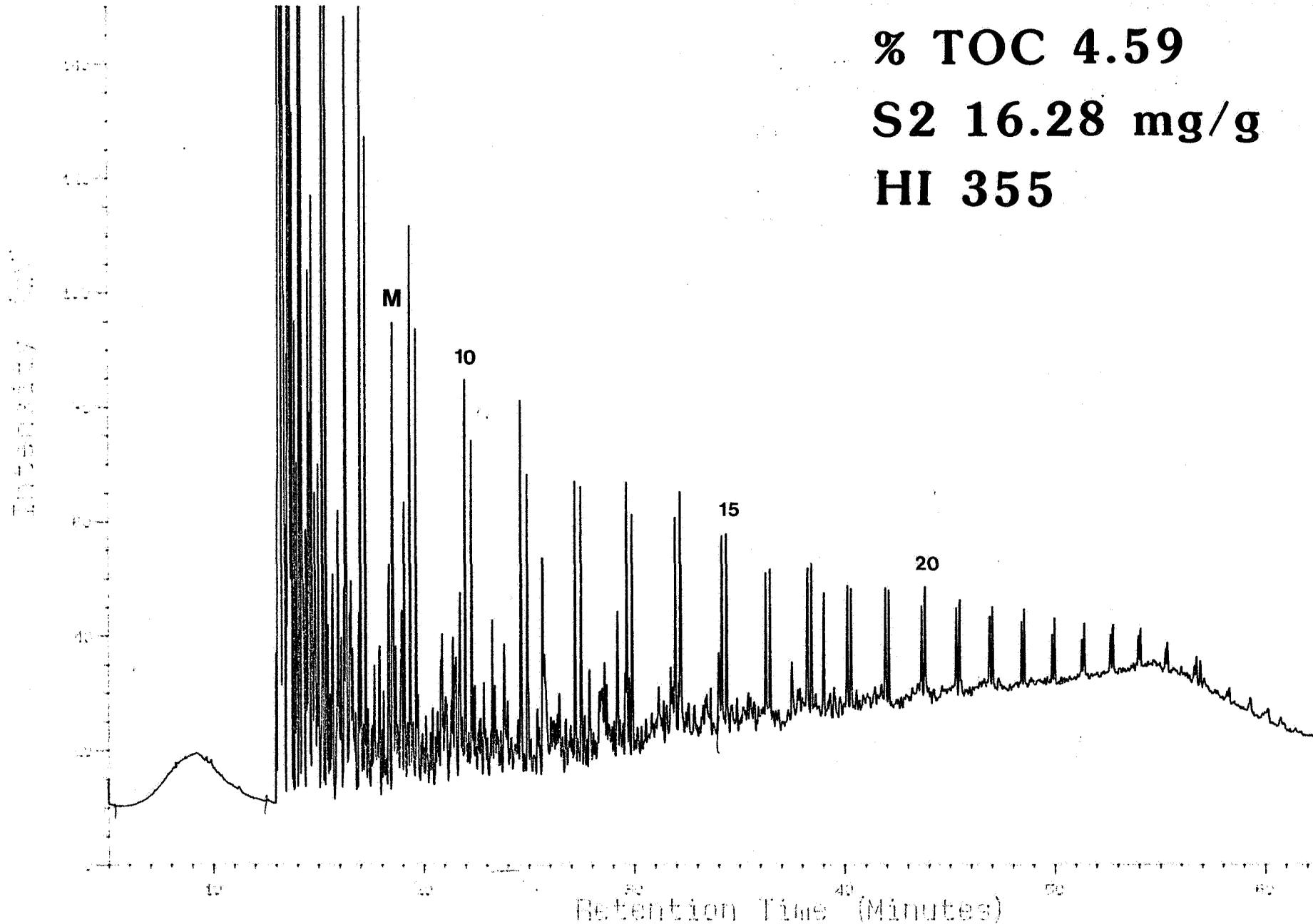
Analysis B640771

5, 1, 1 2703 M CC

**% TOC 4.59**

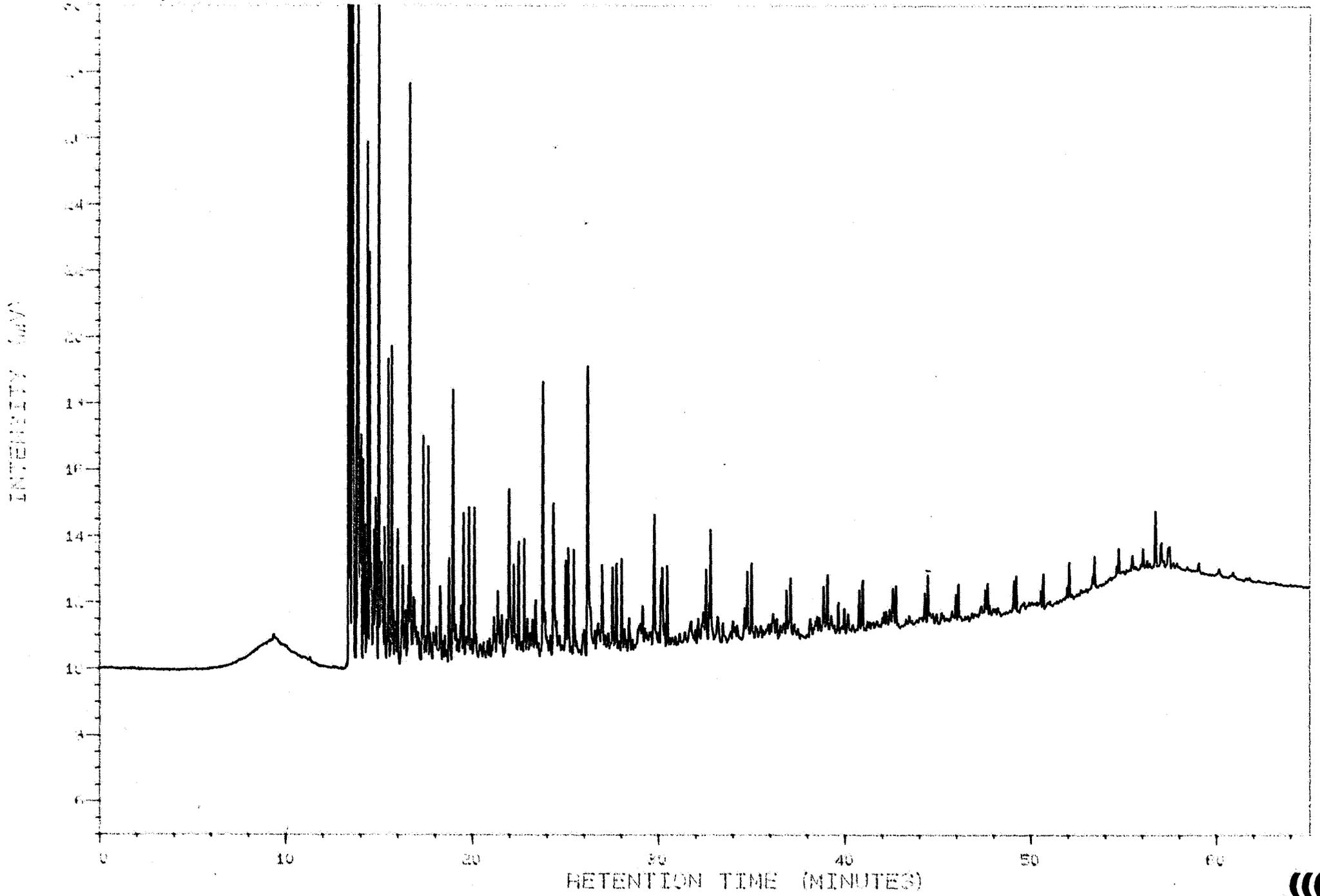
**S2 16.28 mg/g**

**HI 355**



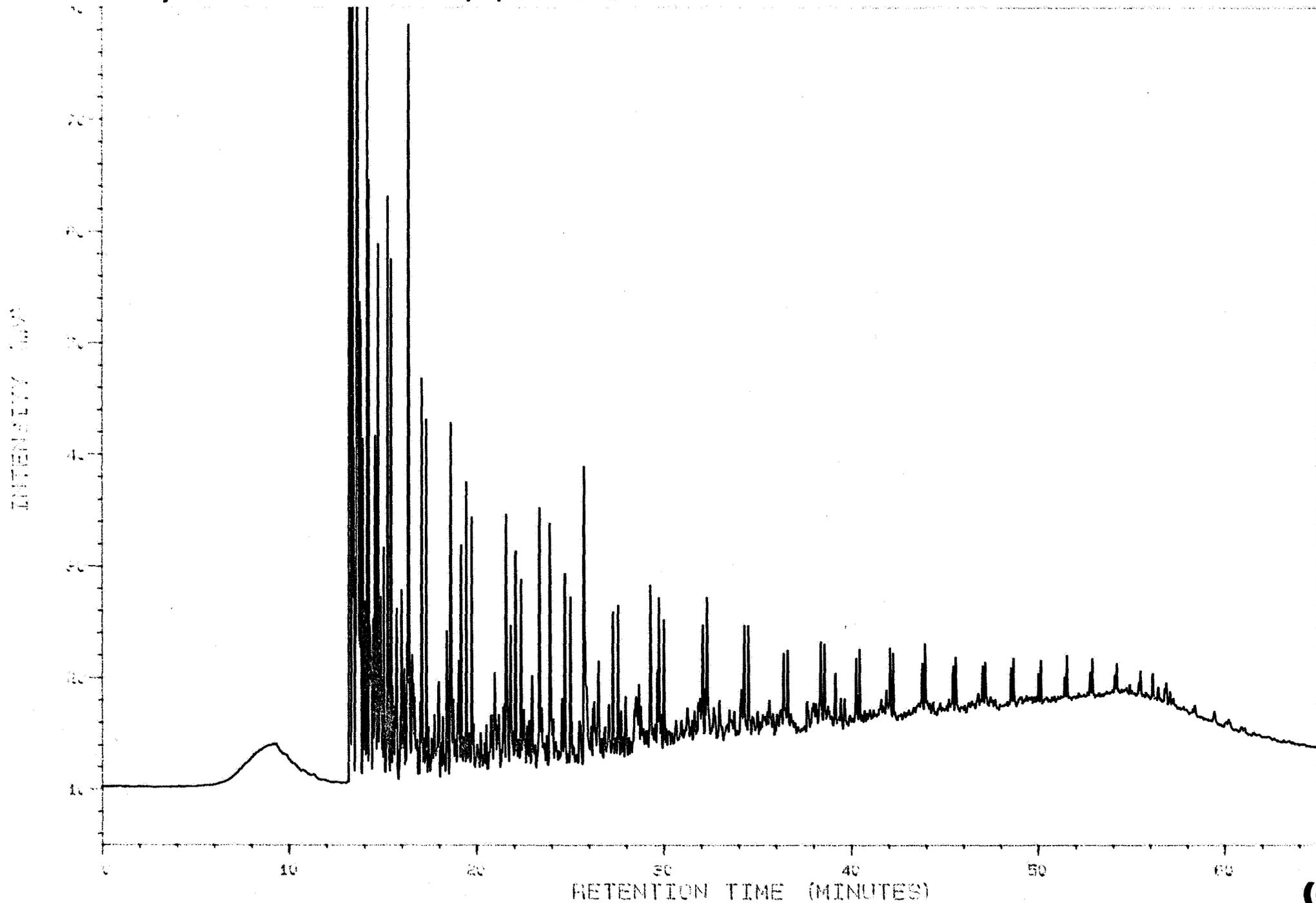
Analysis C640771P

5.3.1 2709 M



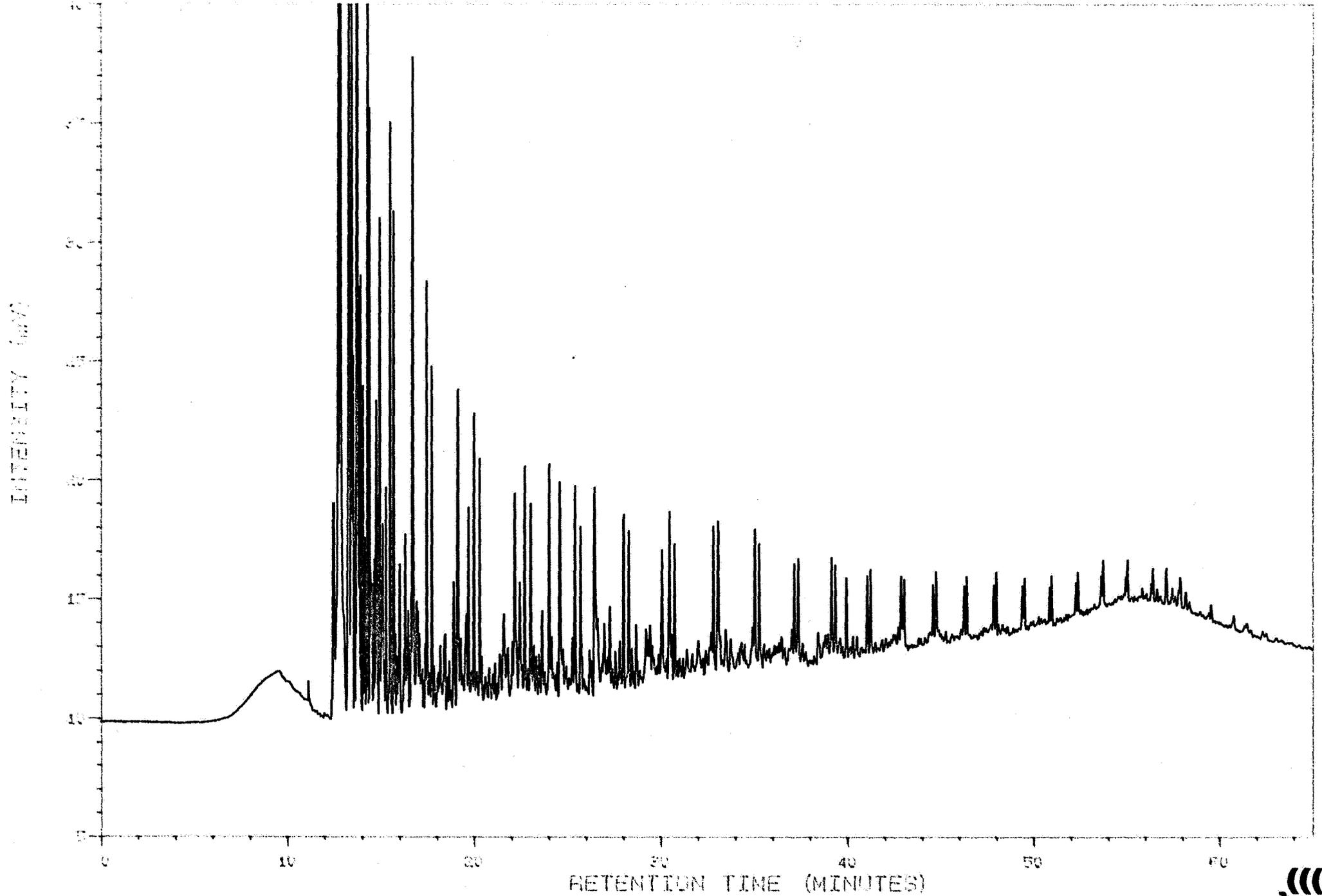
Analysis C640771P

5.4.1 2711 M



Analysis C640771P

5, 5, 1 2713 M



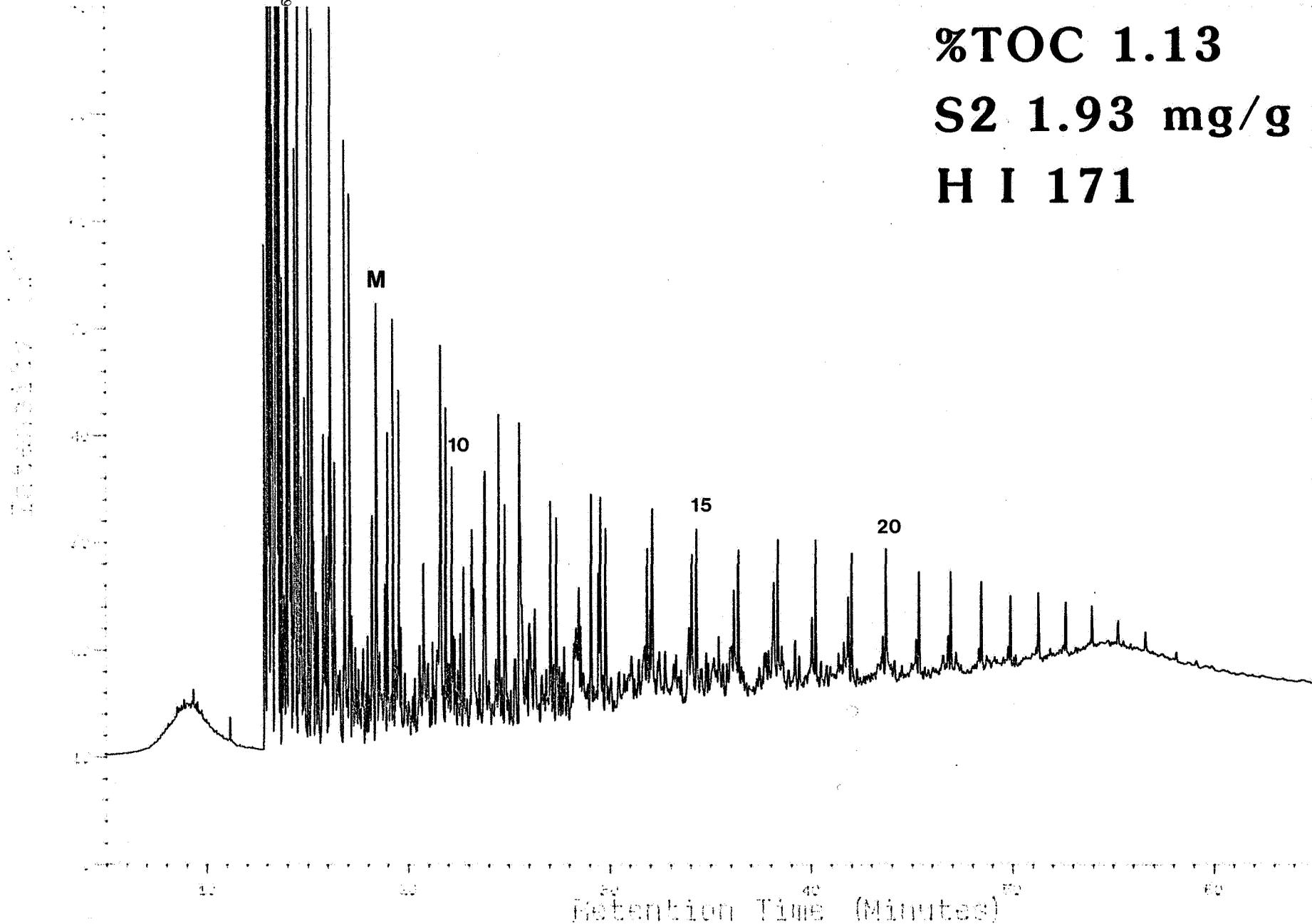
Analysis B640771

5, 2, 1 2718.04 M CC

**%TOC 1.13**

**S2 1.93 mg/g**

**H I 171**



Analysis C640771

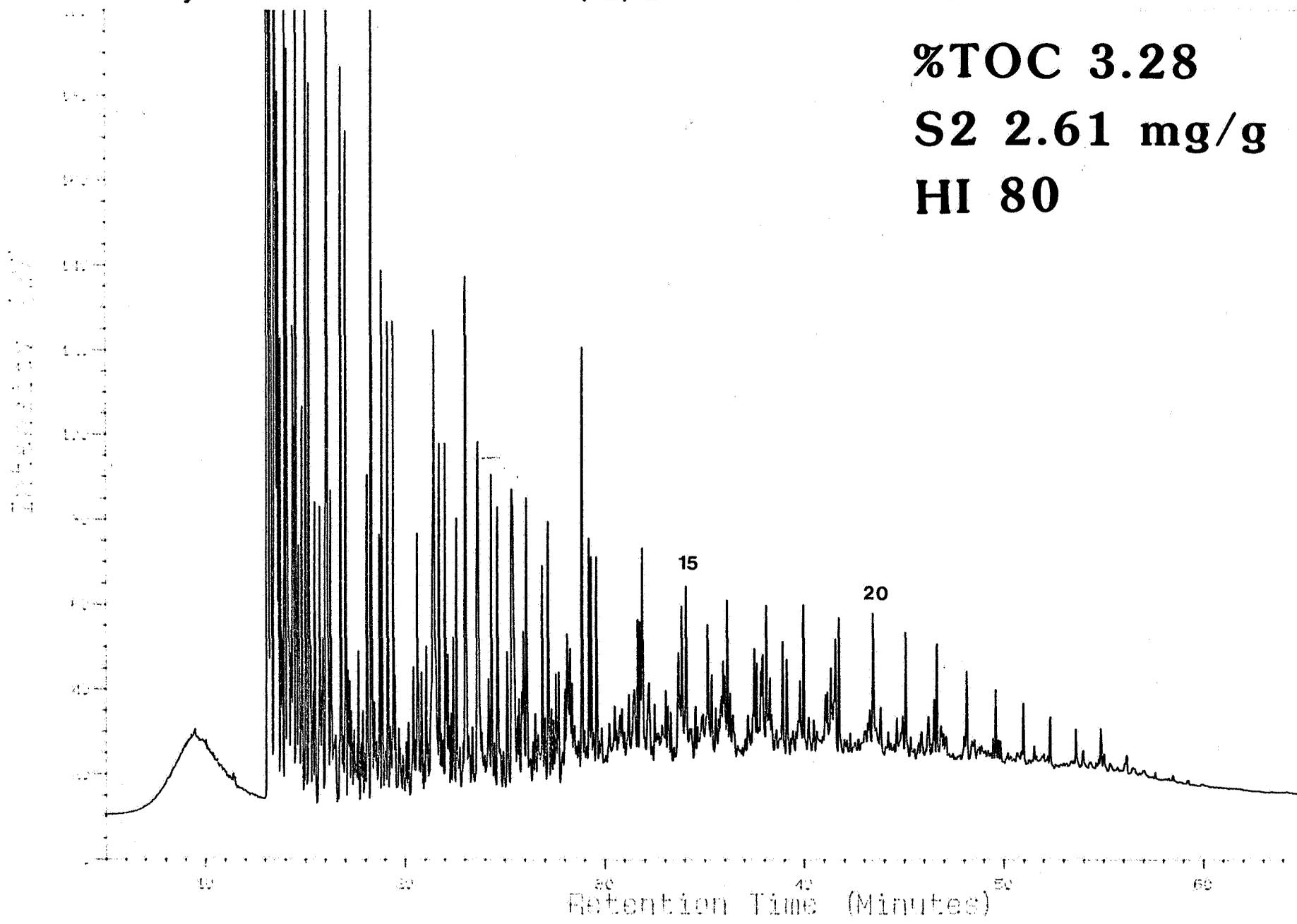
5, 1, 1

2722.03 M CC

**%TOC 3.28**

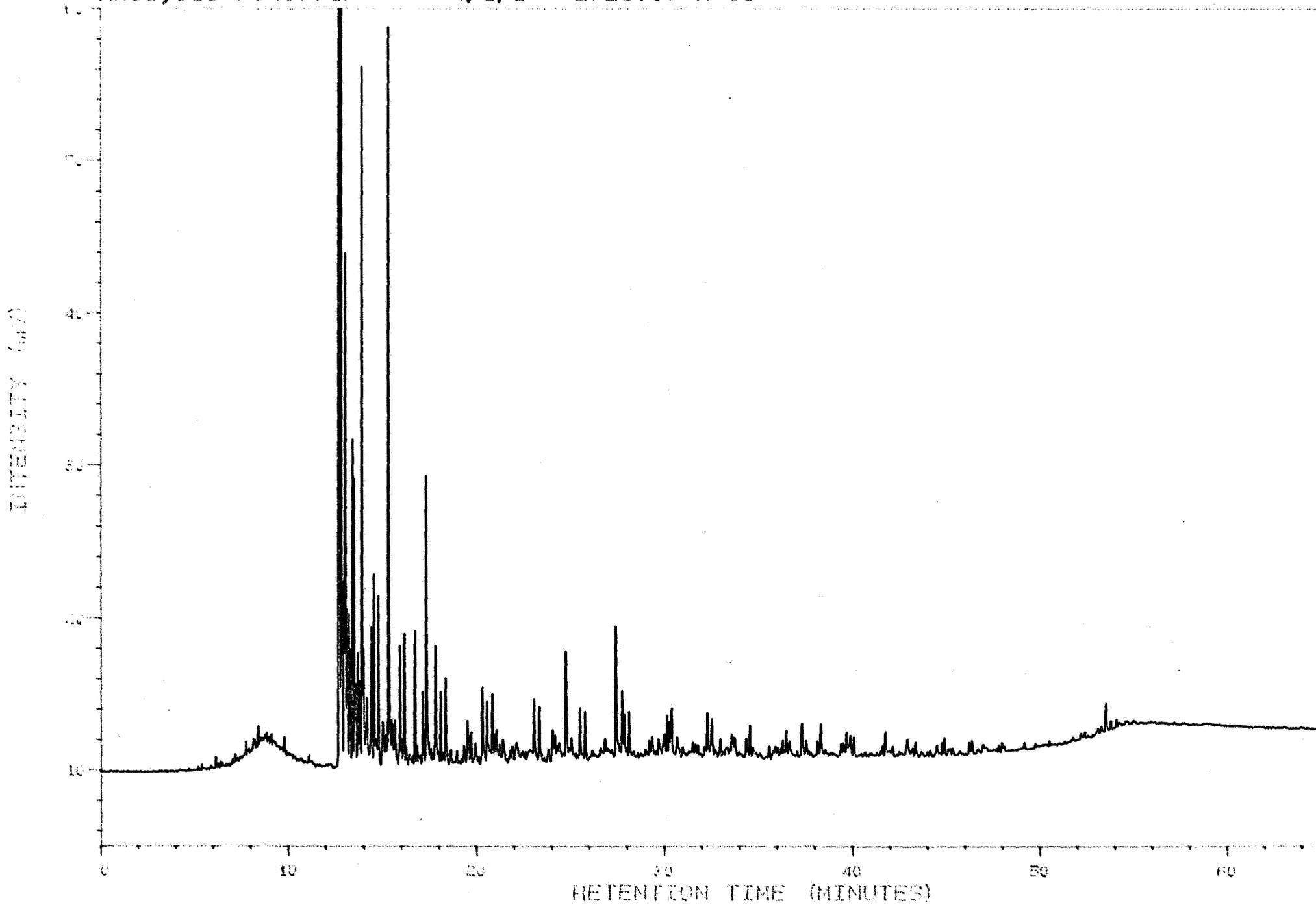
**S2 2.61 mg/g**

**HI 80**



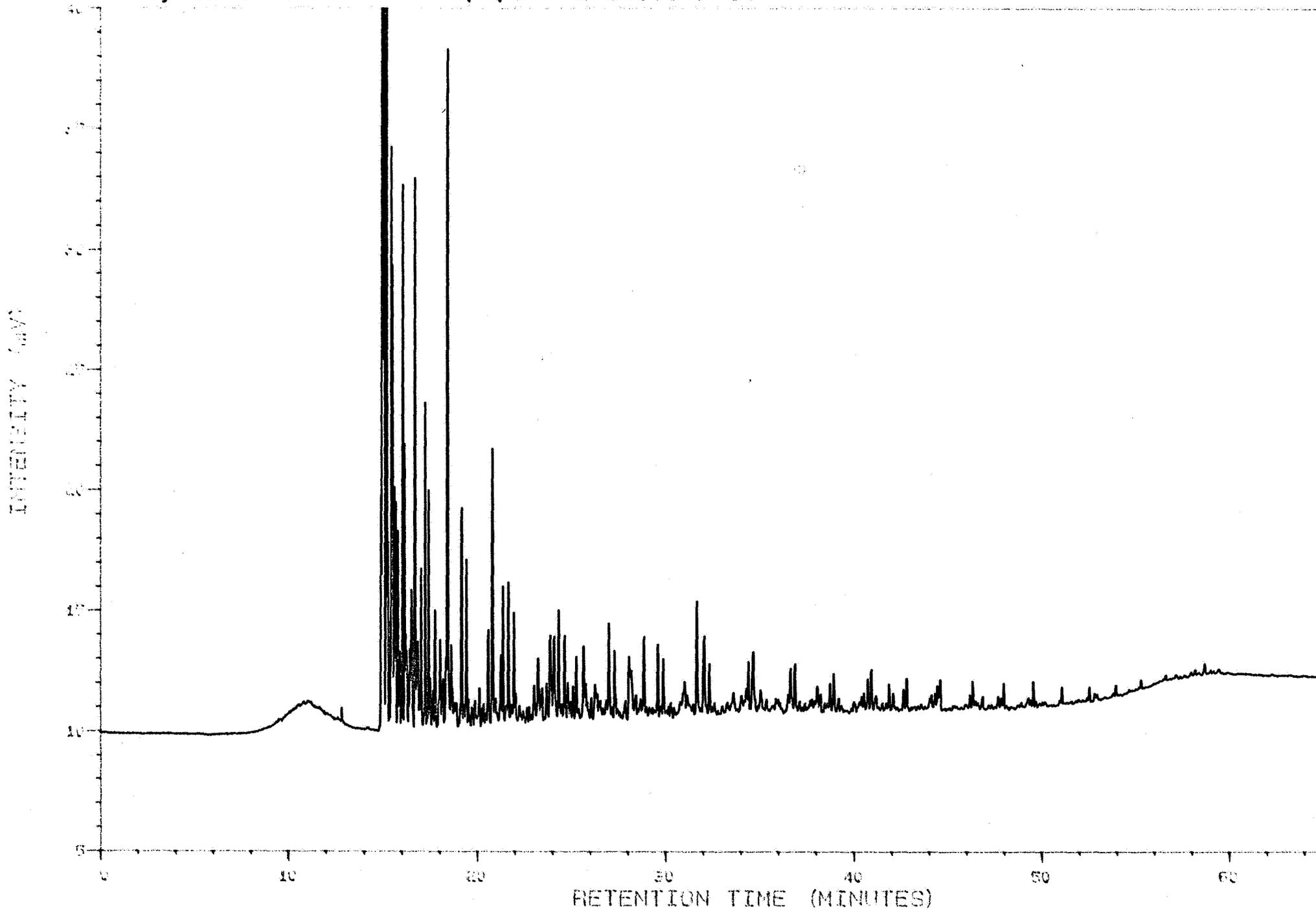
Analysis P640771P

4. 1. 1 2725.07 M CC



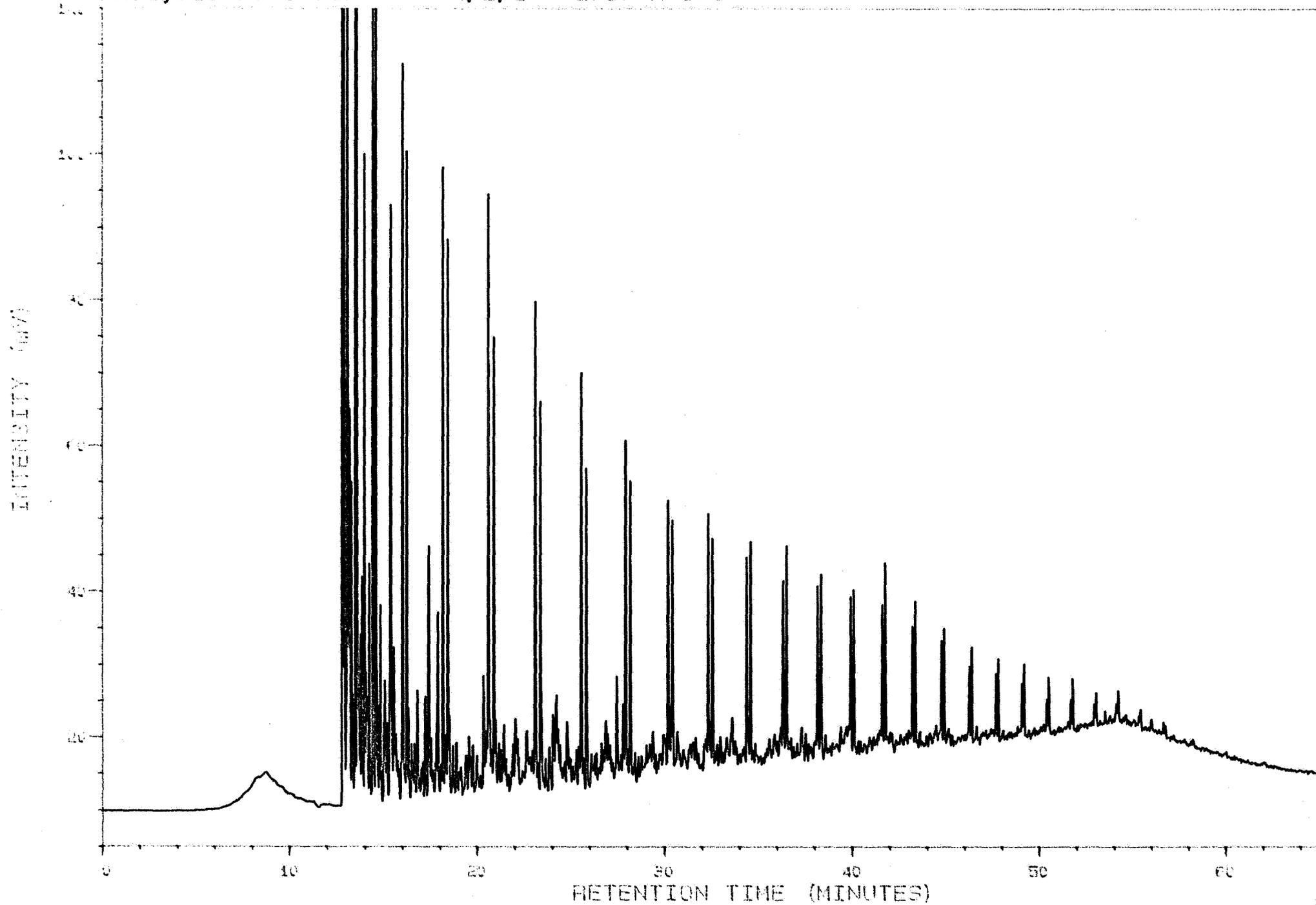
Analysis C640771P

5, 6, 1 2726.05 M CC



Analysis P640771P

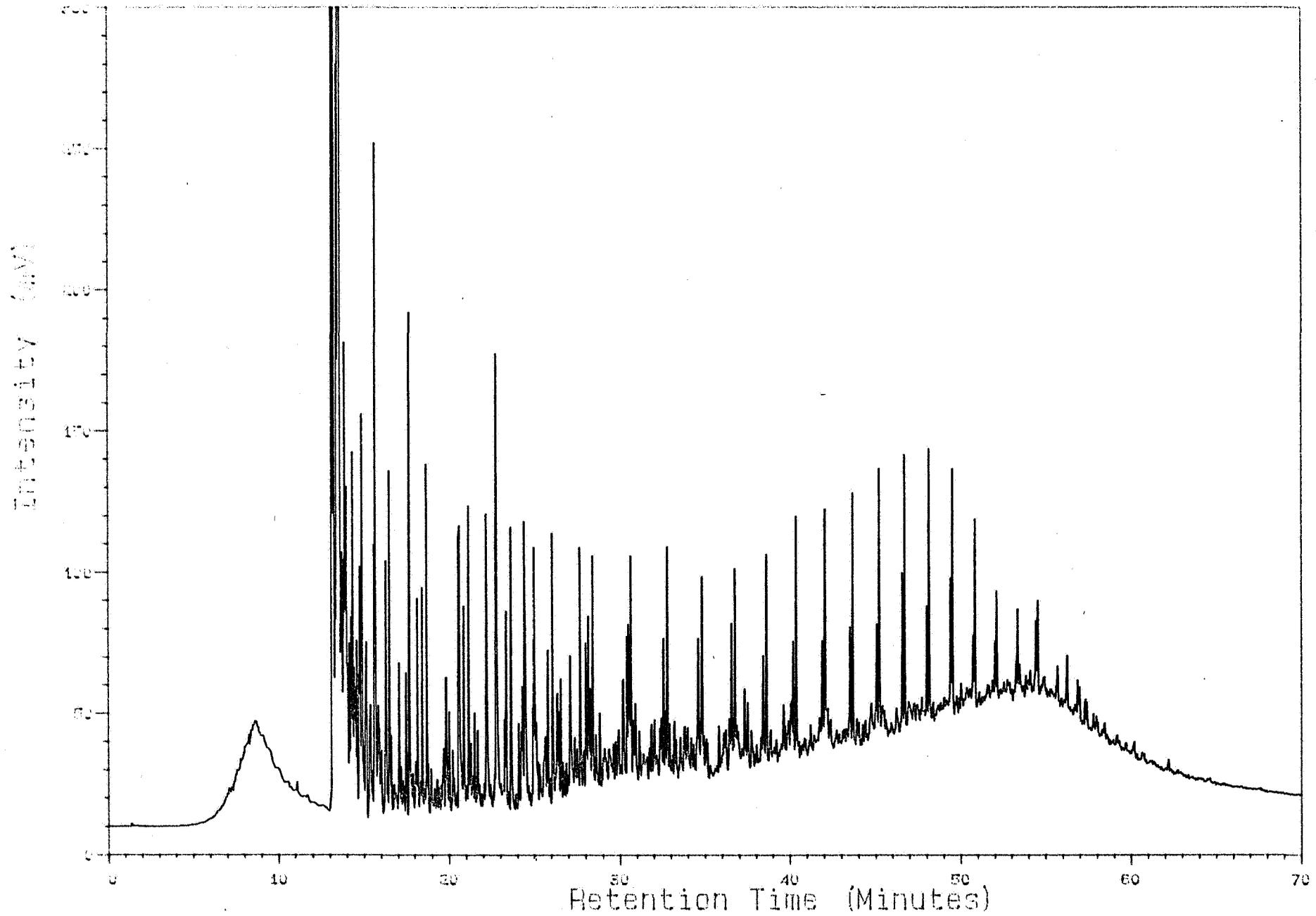
4. 2. 1 2757 M SWC



Analysis T640771P

4, 7, 1

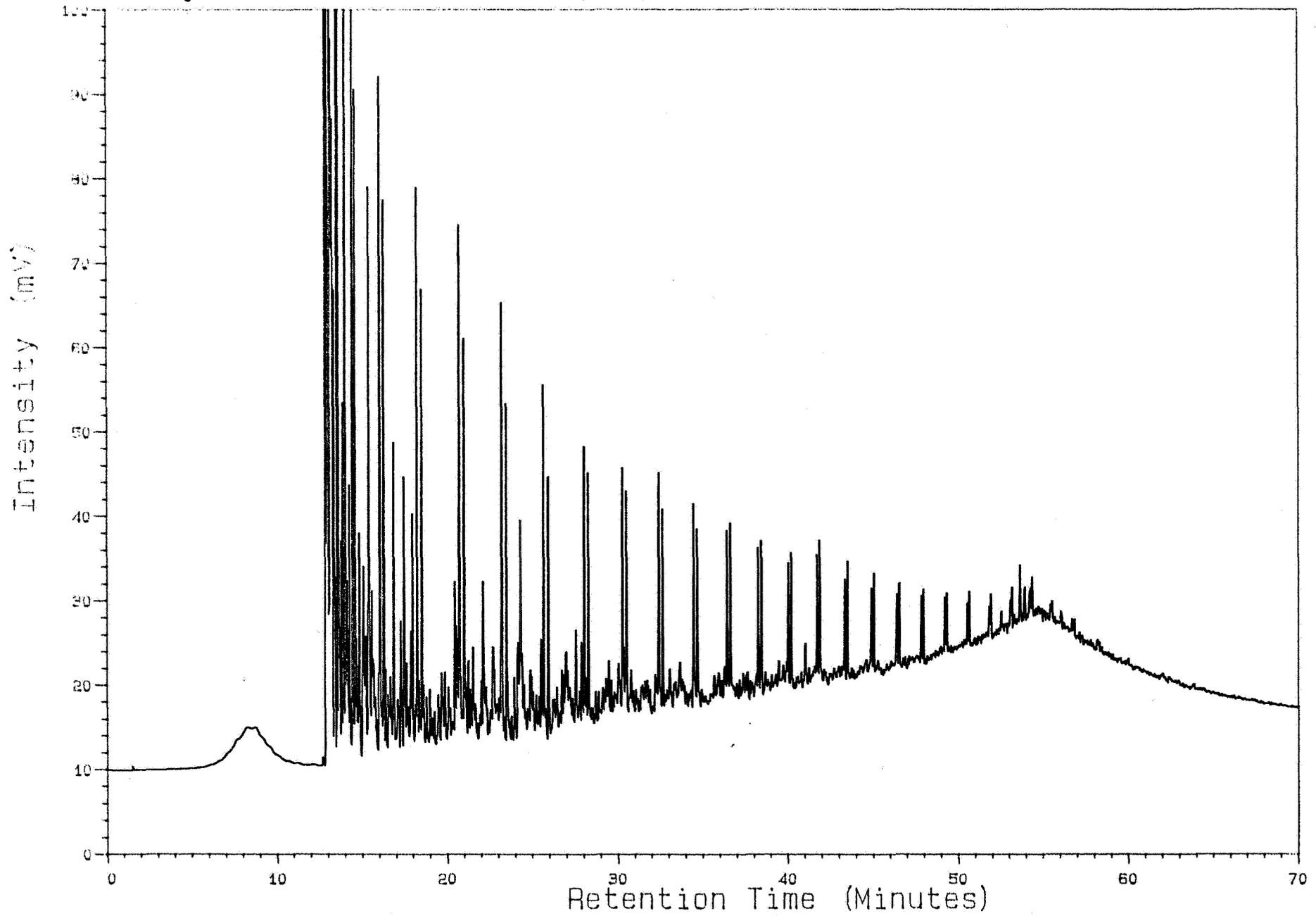
2837.00 M



Analysis T640771P

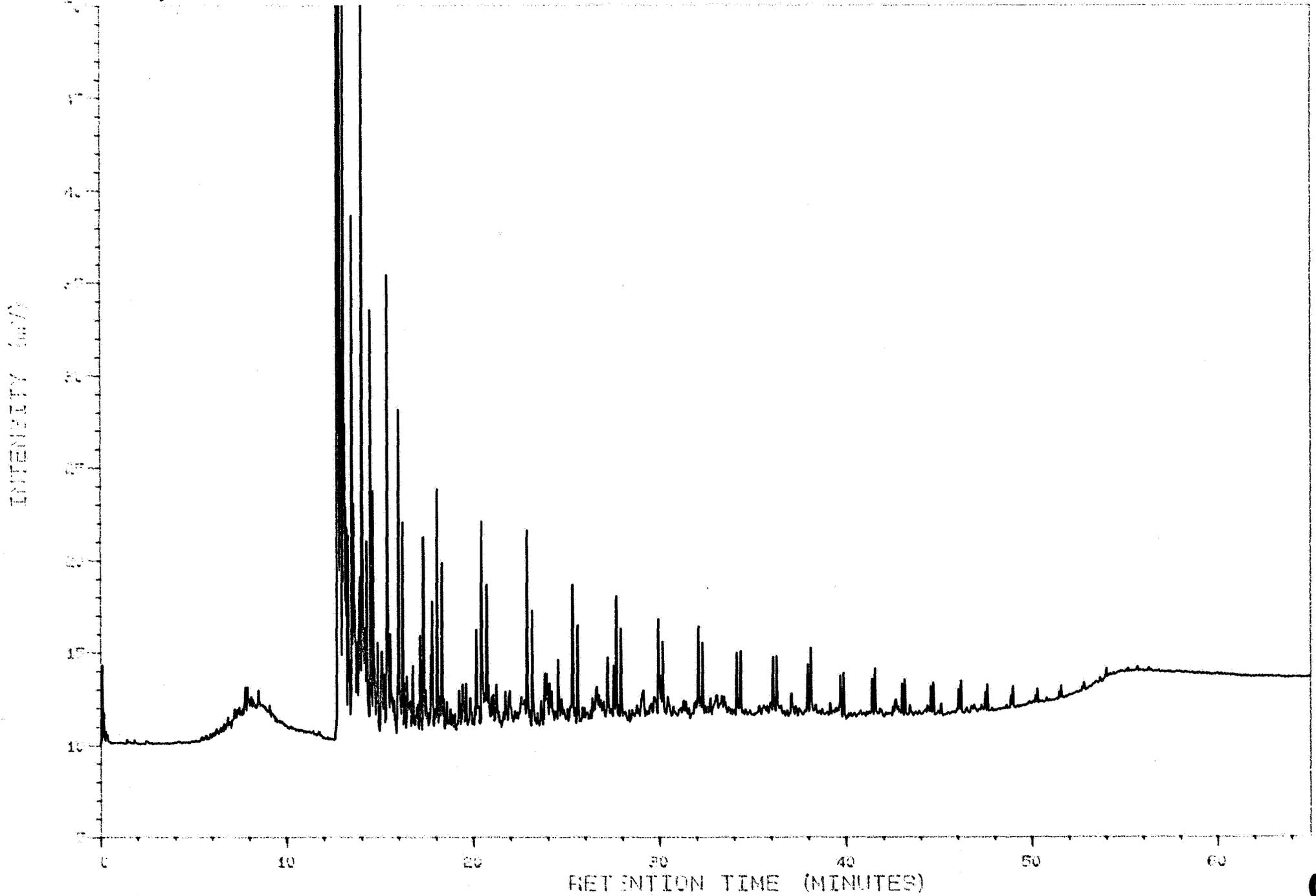
4, 10, 1

2840.00 M



Analysis R640771P

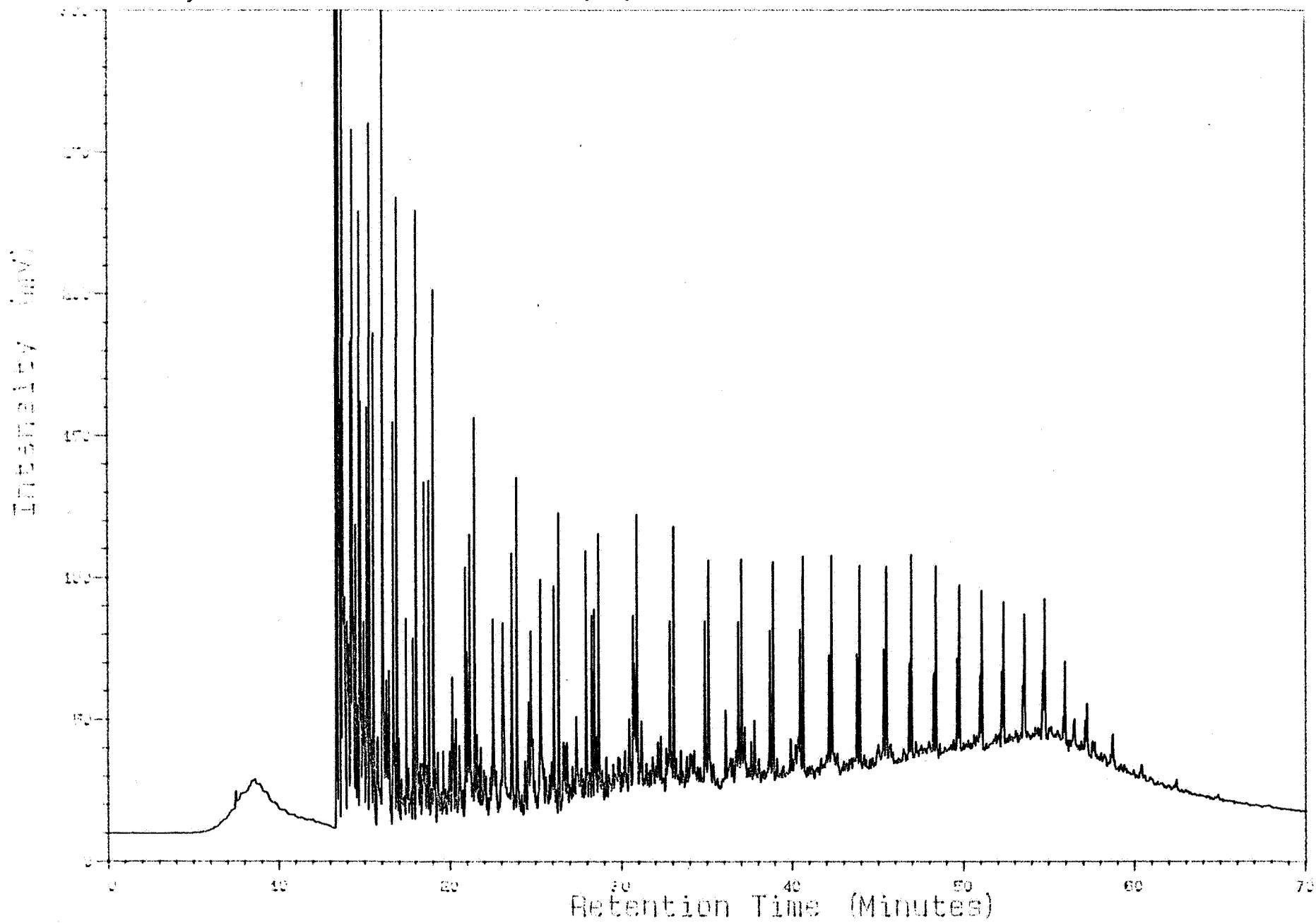
4, 1, 1 2877.0 M CC



Analysis T640771P

4, 2, 1

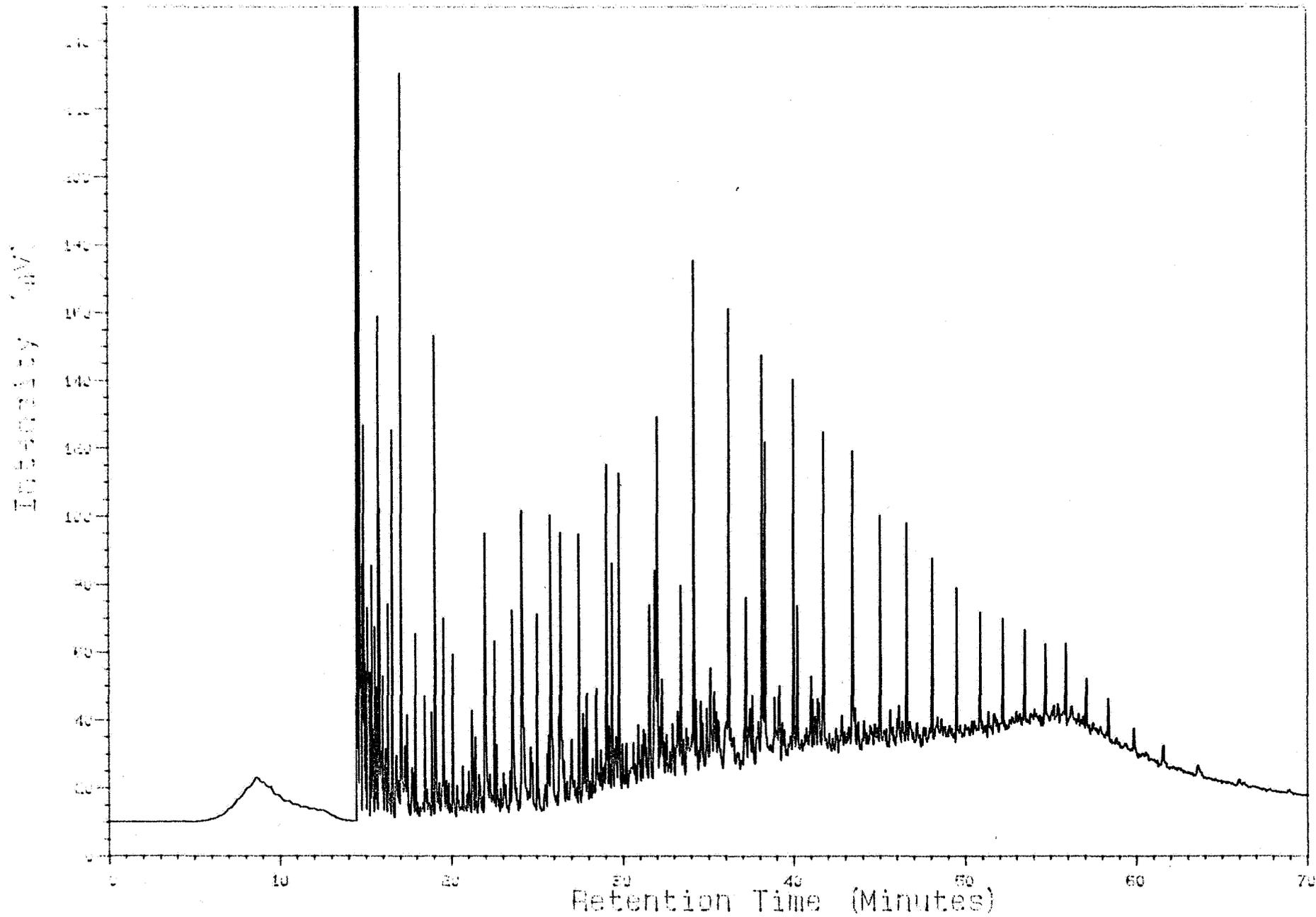
3000.50 M



Analysis T640771P

4, 3, 1

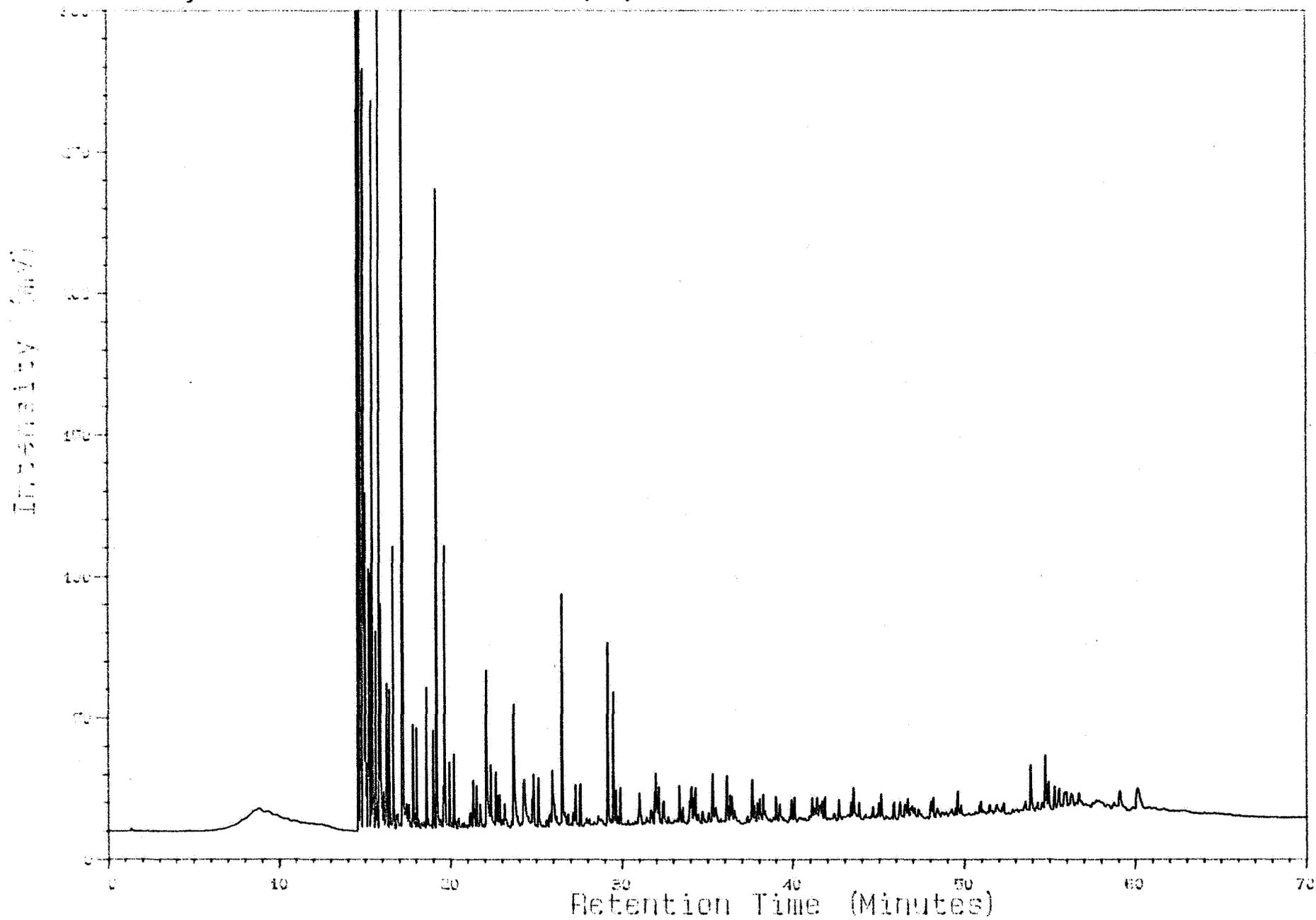
3027.83 M



Analysis T640771P

4, 5, 1

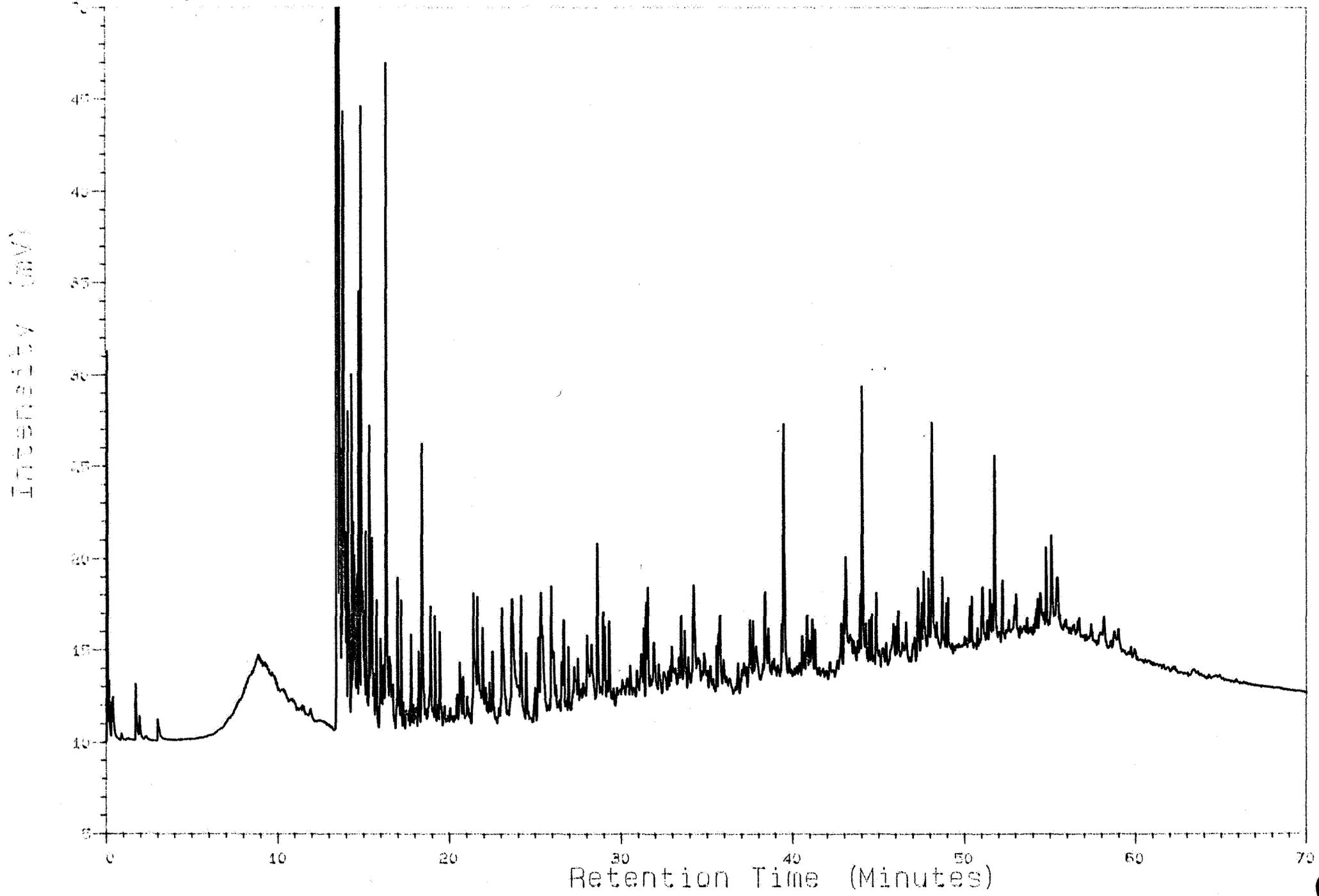
3039.40 M



ANALYSIS MB40771P

4, 1, 1

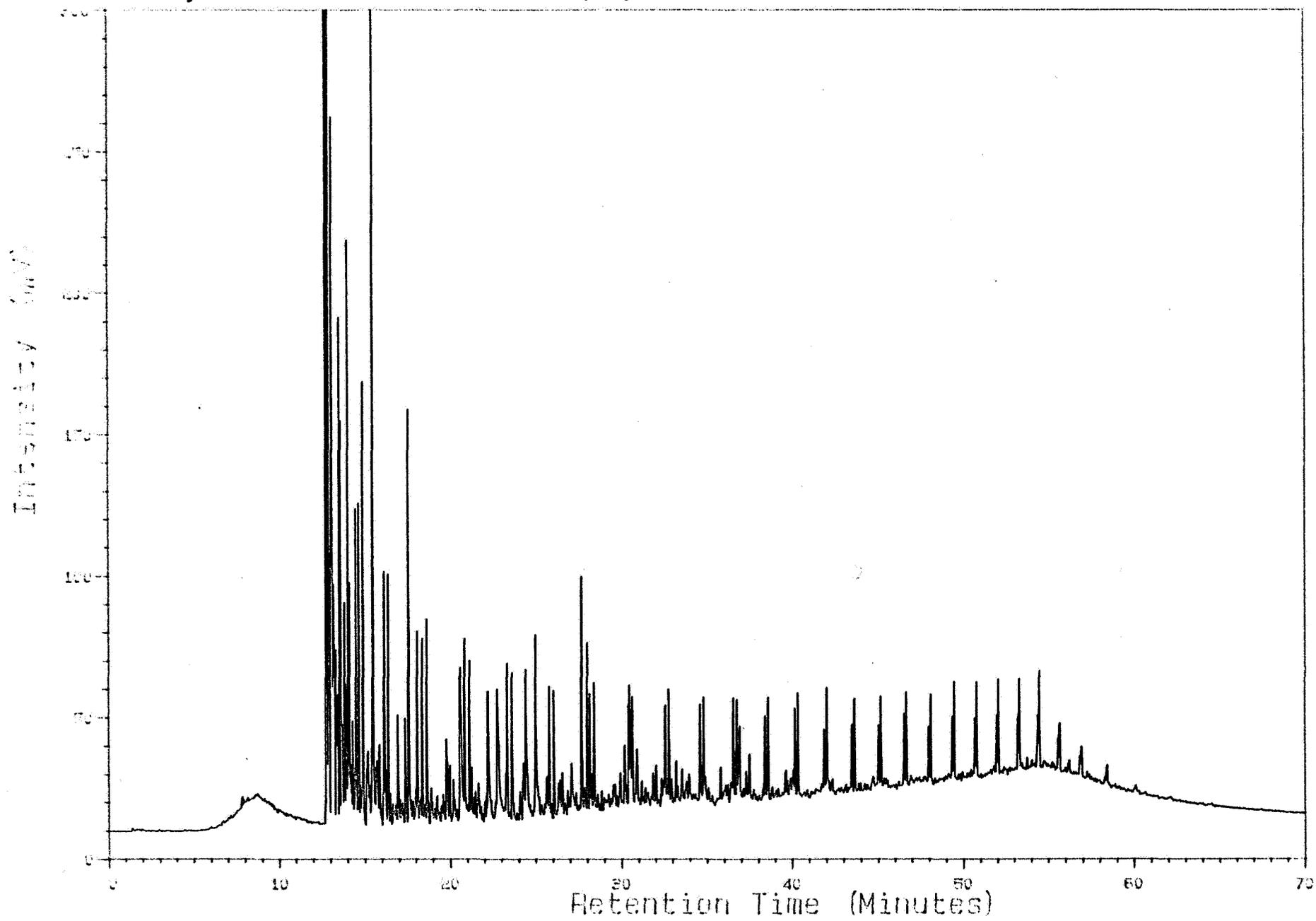
3064.37 M LL



Analysis T640771P

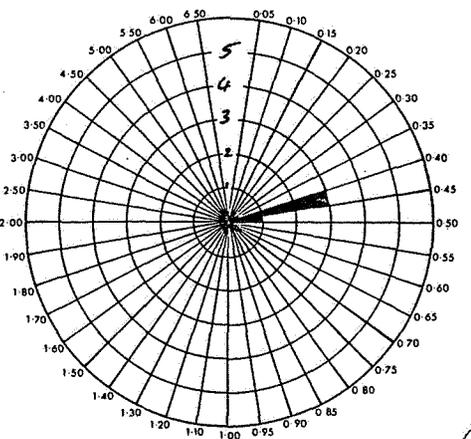
4, 4, 1

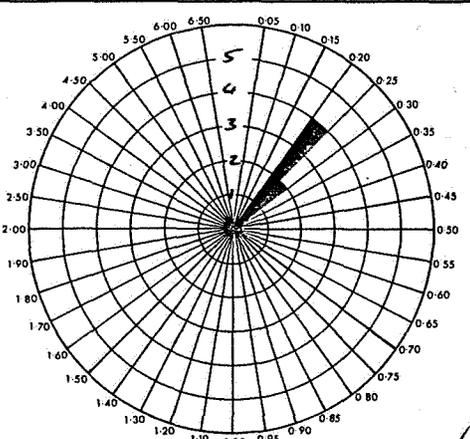
3075.45 M

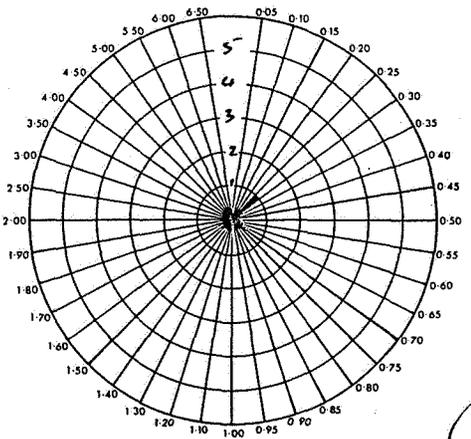


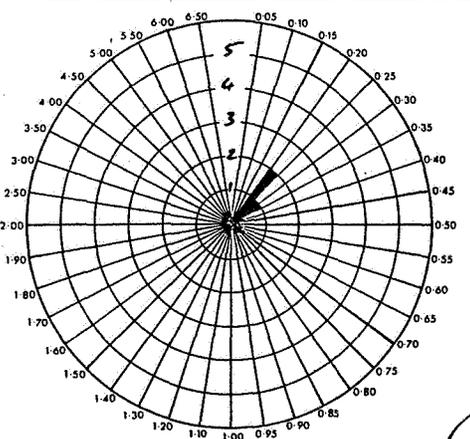
APPENDIX V

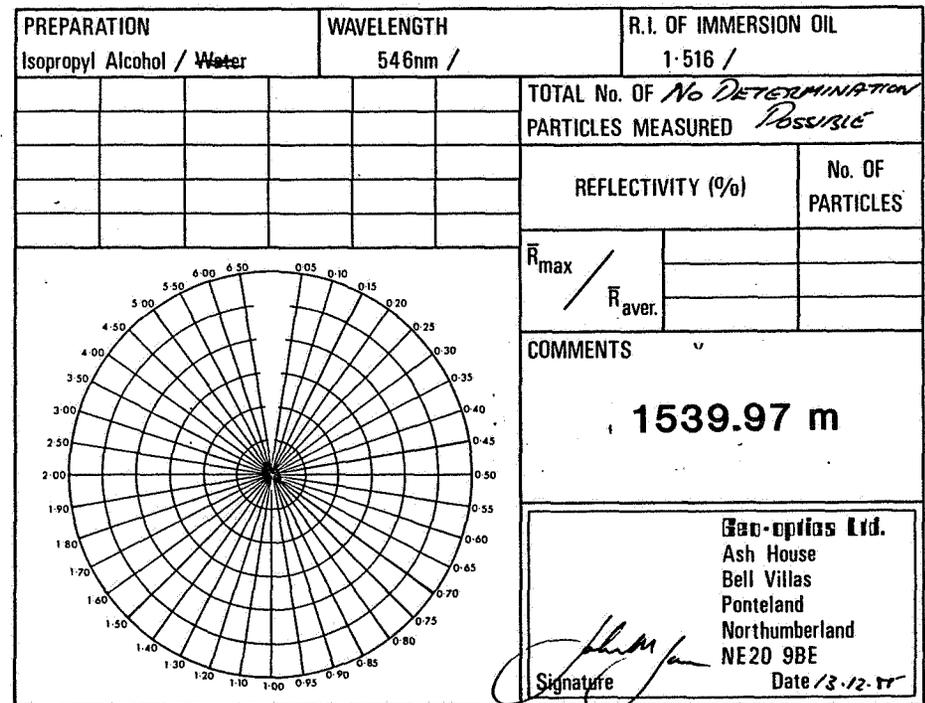
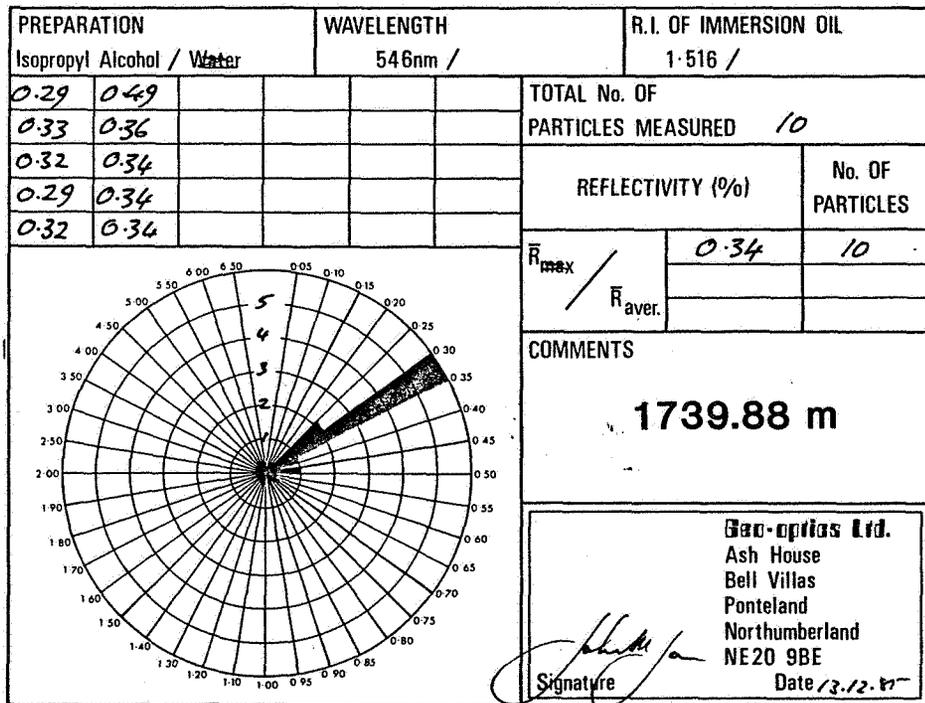
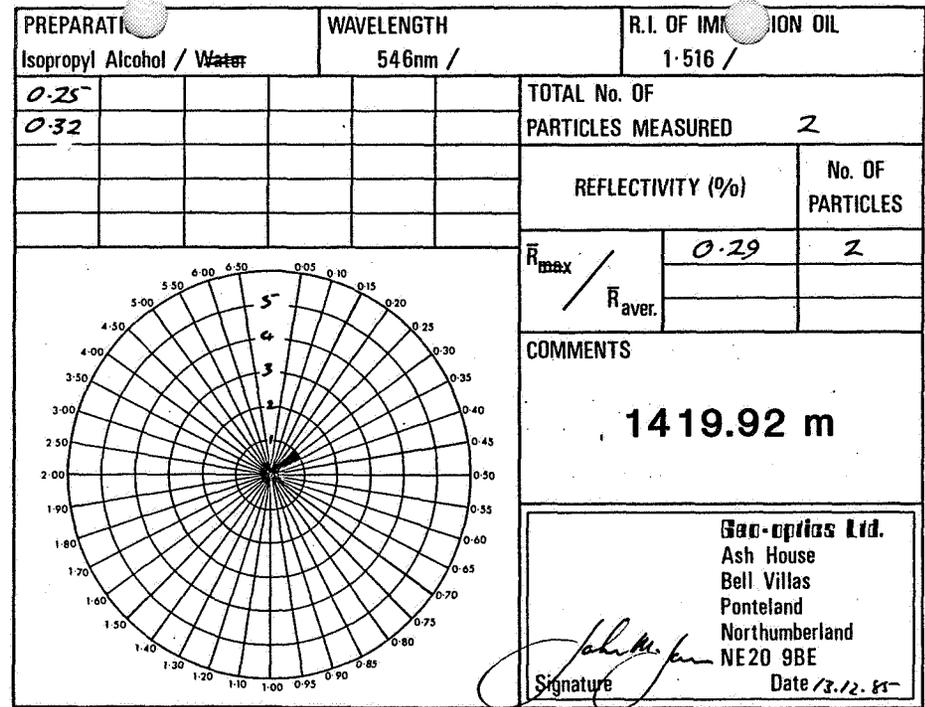
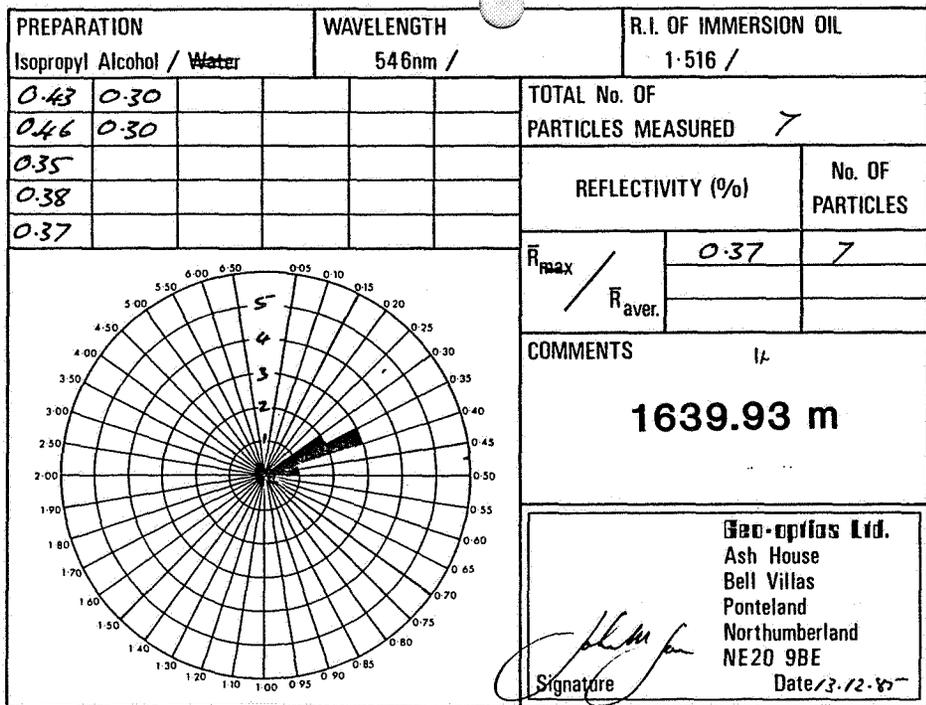
DISTRIBUTION OF VITRINITE REFLECTANCE READINGS

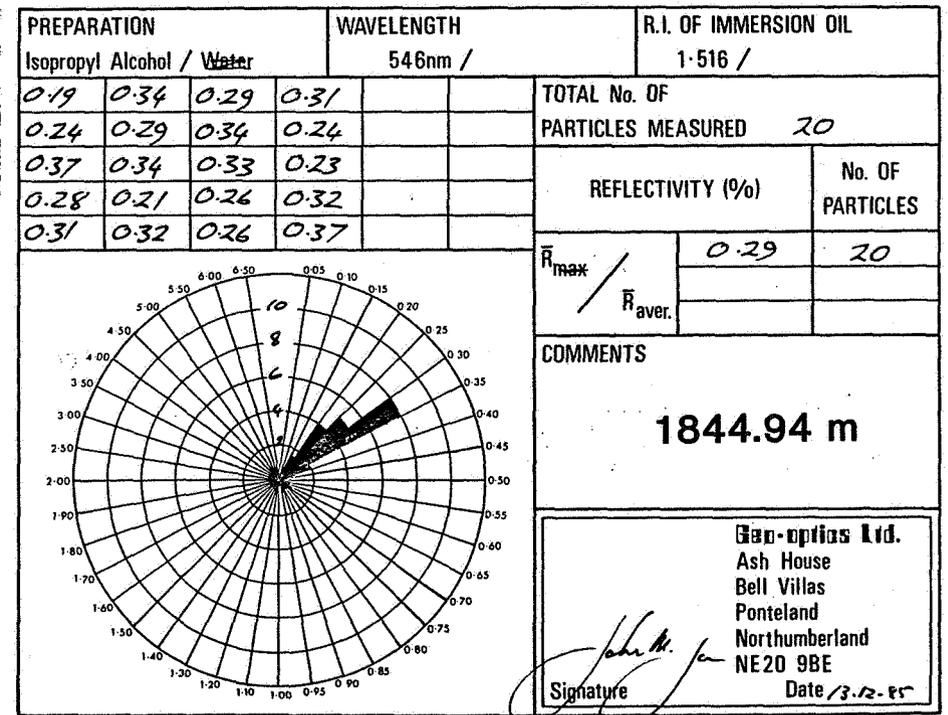
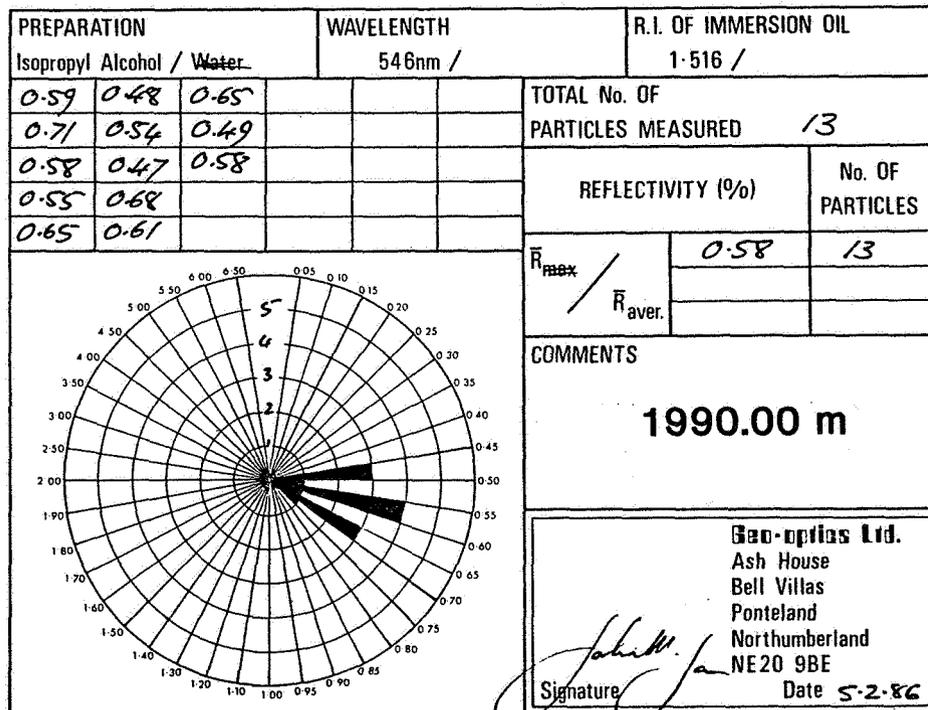
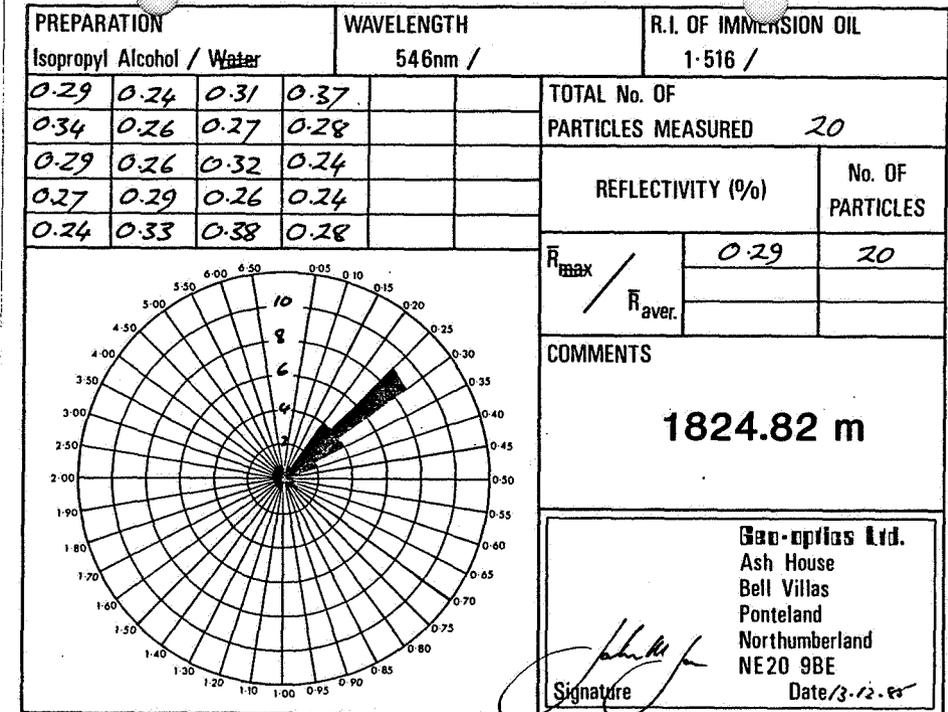
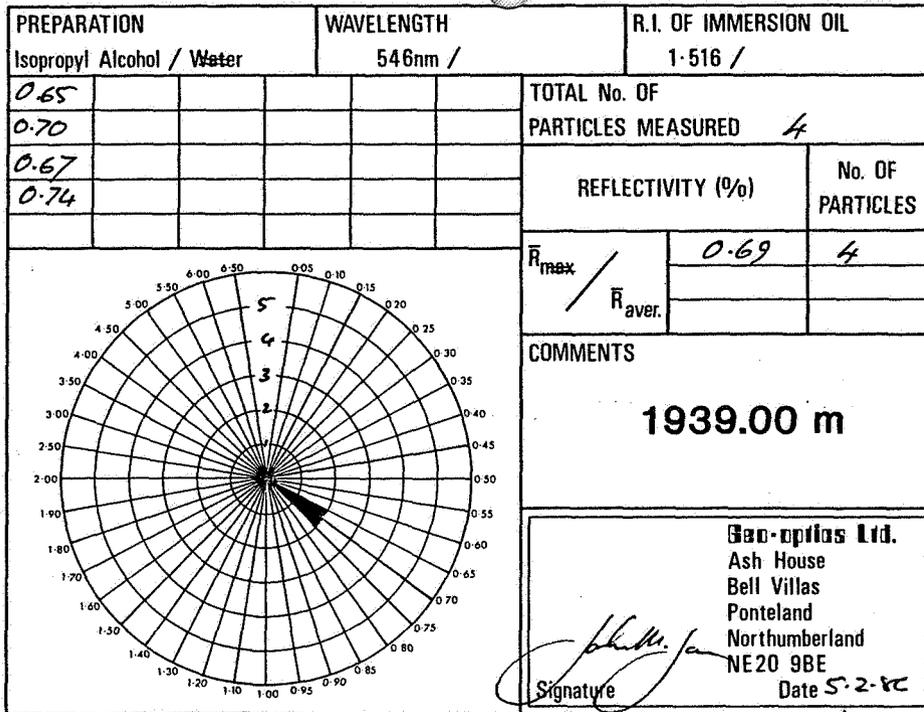
PREPARATION Isopropyl Alcohol / Water		WAVELENGTH 546nm /		R.I. OF IMMERSION OIL 1.516 /	
0.42		TOTAL No. OF PARTICLES MEASURED 4			
0.46		REFLECTIVITY (%)		No. OF PARTICLES	
0.44		0.44		4	
0.42		COMMENTS <b>1249.96 m</b>			
					
<p>Geo-optics Ltd. Ash House Bell Villas Ponteland Northumberland NE20 9BE</p> <p>Signature: <i>John M. Jan</i> Date: 13.12.85</p>					

PREPARATION Isopropyl Alcohol / Water		WAVELENGTH 546nm /		R.I. OF IMMERSION OIL 1.516 /	
0.24	0.25	TOTAL No. OF PARTICLES MEASURED 6			
0.25		REFLECTIVITY (%)		No. OF PARTICLES	
0.23		0.24		6	
0.21		COMMENTS <b>1189.91 m</b>			
0.28					
<p>Geo-optics Ltd. Ash House Bell Villas Ponteland Northumberland NE20 9BE</p> <p>Signature: <i>John M. Jan</i> Date: 13.12.85</p>					

PREPARATION Isopropyl Alcohol / Water		WAVELENGTH 546nm /		R.I. OF IMMERSION OIL 1.516 /	
0.29		TOTAL No. OF PARTICLES MEASURED 1			
		REFLECTIVITY (%)		No. OF PARTICLES	
		0.29		1	
COMMENTS <b>1299.99 m</b>					
					
<p>Geo-optics Ltd. Ash House Bell Villas Ponteland Northumberland NE20 9BE</p> <p>Signature: <i>John M. Jan</i> Date: 13.12.85</p>					

PREPARATION Isopropyl Alcohol / Water		WAVELENGTH 546nm /		R.I. OF IMMERSION OIL 1.516 /	
0.22		TOTAL No. OF PARTICLES MEASURED 4			
0.34		REFLECTIVITY (%)		No. OF PARTICLES	
0.24		0.26		4	
0.25		COMMENTS <b>1209.94 m</b>			
					
<p>Geo-optics Ltd. Ash House Bell Villas Ponteland Northumberland NE20 9BE</p> <p>Signature: <i>John M. Jan</i> Date: 13.12.85</p>					



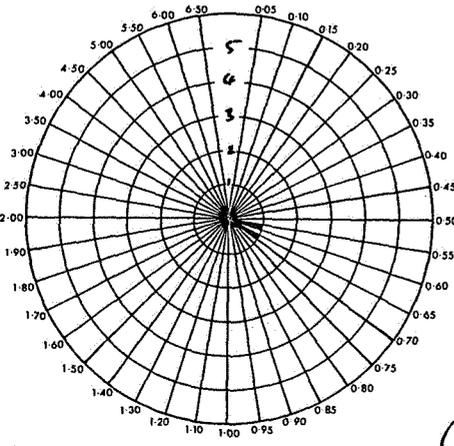


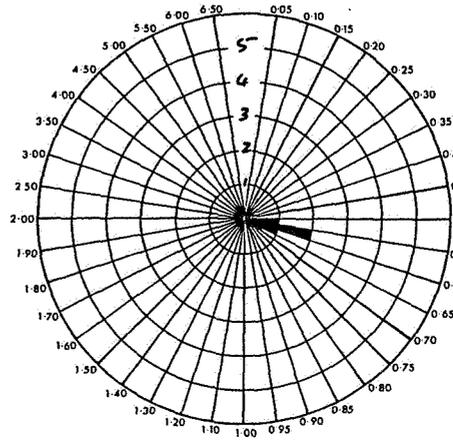
PREPARATION		WAVELENGTH	R.I. OF IMMERSION OIL
Isopropyl Alcohol / Water		546nm /	1.516 /
0.61	0.60		
0.66	0.54		
0.63	0.57		
0.76			
0.60			
TOTAL No. OF PARTICLES MEASURED		8	
REFLECTIVITY (%)		No. OF PARTICLES	
$R_{max} / R_{aver.}$		0.62 / 8	
COMMENTS			
2270.00 m			
Geo-optics Ltd. Ash House Bell Villas Ponteland Northumberland NE20 9BE Date 5-2-88			
Signature <i>John M. Ja</i>			

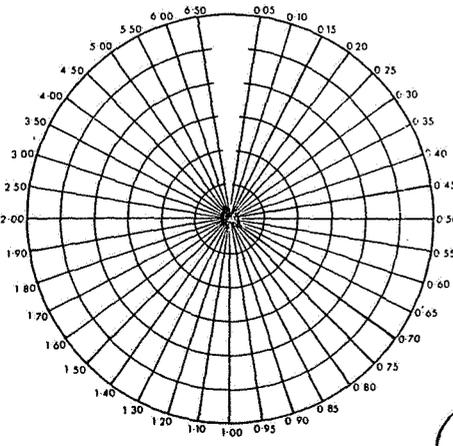
PREPARATION		WAVELENGTH	R.I. OF IMMERSION OIL
Isopropyl Alcohol / Water		546nm /	1.516 /
0.66	0.62	0.67	0.50
0.76	0.55	0.48	0.57
0.70	0.75	0.49	0.69
0.53	0.43	0.57	0.66
0.55	0.52	0.53	0.50
TOTAL No. OF PARTICLES MEASURED		20	
REFLECTIVITY (%)		No. OF PARTICLES	
$R_{max} / R_{aver.}$		0.59 / 20	
COMMENTS			
2083.50 m			
Geo-optics Ltd. Ash House Bell Villas Ponteland Northumberland NE20 9BE Date 5-2-88			
Signature <i>John M. Ja</i>			

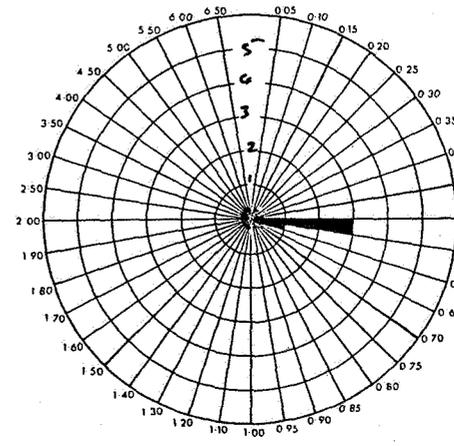
PREPARATION		WAVELENGTH	R.I. OF IMMERSION OIL
Isopropyl Alcohol / Water		546nm /	1.516 /
0.48			
TOTAL No. OF PARTICLES MEASURED		1	
REFLECTIVITY (%)		No. OF PARTICLES	
$R_{max} / R_{aver.}$		0.48 / 1	
COMMENTS			
2370.00 m			
Geo-optics Ltd. Ash House Bell Villas Ponteland Northumberland NE20 9BE Date 4.3.88			
Signature <i>John M. Ja</i>			

PREPARATION		WAVELENGTH	R.I. OF IMMERSION OIL
Isopropyl Alcohol / Water		546nm /	1.516 /
0.61			
0.51			
0.46			
0.68			
TOTAL No. OF PARTICLES MEASURED		4	
REFLECTIVITY (%)		No. OF PARTICLES	
$R_{max} / R_{aver.}$		0.57 / 4	
COMMENTS			
2170.00 m			
Geo-optics Ltd. Ash House Bell Villas Ponteland Northumberland NE20 9BE Date 5-2-88			
Signature <i>John M. Ja</i>			

PREPARATION		WAVELENGTH		R.I. OF IMMERSION OIL	
Isopropyl Alcohol / Water		546nm /		1.516 /	
0.67				TOTAL No. OF PARTICLES MEASURED 2	
0.58					
				REFLECTIVITY (%)	No. OF PARTICLES
				$\bar{R}_{max}$ / $\bar{R}_{aver.}$	0.63 / 2
					
COMMENTS <b>2446.00 m</b>					
Geo-optics Ltd. Ash House Bell Villas Ponteland Northumberland NE20 9BE Signature: <i>John M. Ja</i> Date 5.2.88					

PREPARATION		WAVELENGTH		R.I. OF IMMERSION OIL	
Isopropyl Alcohol / Water		546nm /		1.516 /	
0.53				TOTAL No. OF PARTICLES MEASURED 4	
0.60					
0.58				REFLECTIVITY (%)	No. OF PARTICLES
0.59				$\bar{R}_{max}$ / $\bar{R}_{aver.}$	0.58 / 4
					
COMMENTS <b>2370.00 m</b>					
Geo-optics Ltd. Ash House Bell Villas Ponteland Northumberland NE20 9BE Signature: <i>John M. Ja</i> Date 5.2.88					

PREPARATION		WAVELENGTH		R.I. OF IMMERSION OIL	
Isopropyl Alcohol / Water		546nm /		1.516 /	
				TOTAL No. OF PARTICLES MEASURED <i>No DETERMINATION POSSIBLE</i>	
				REFLECTIVITY (%)	No. OF PARTICLES
				$\bar{R}_{max}$ / $\bar{R}_{aver.}$	
					
COMMENTS <b>2493.50 m</b>					
Geo-optics Ltd. Ash House Bell Villas Ponteland Northumberland NE20 9BE Signature: <i>John M. Ja</i> Date 4.3.88					

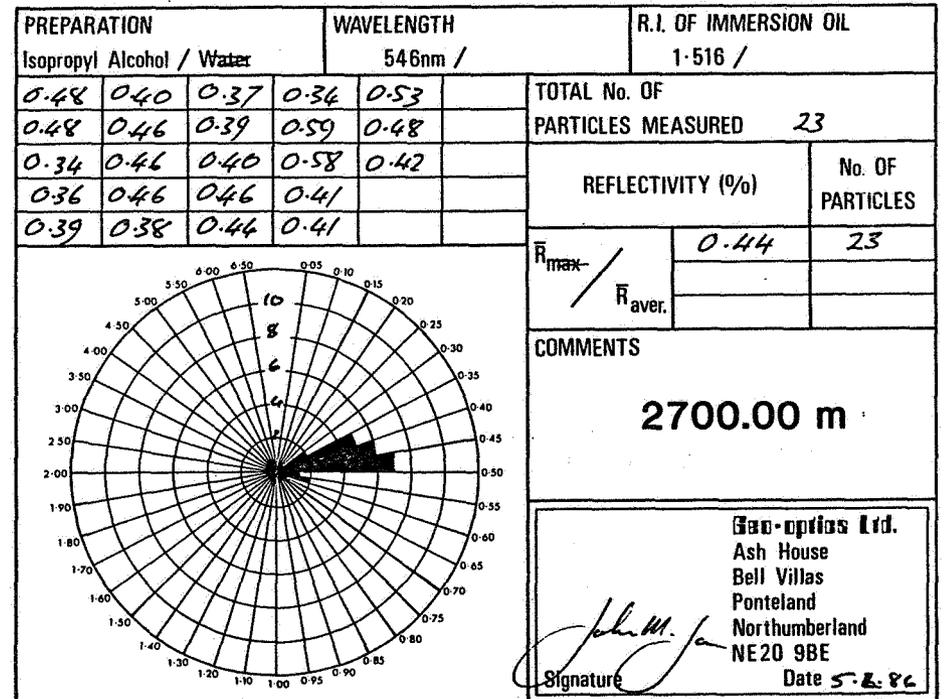
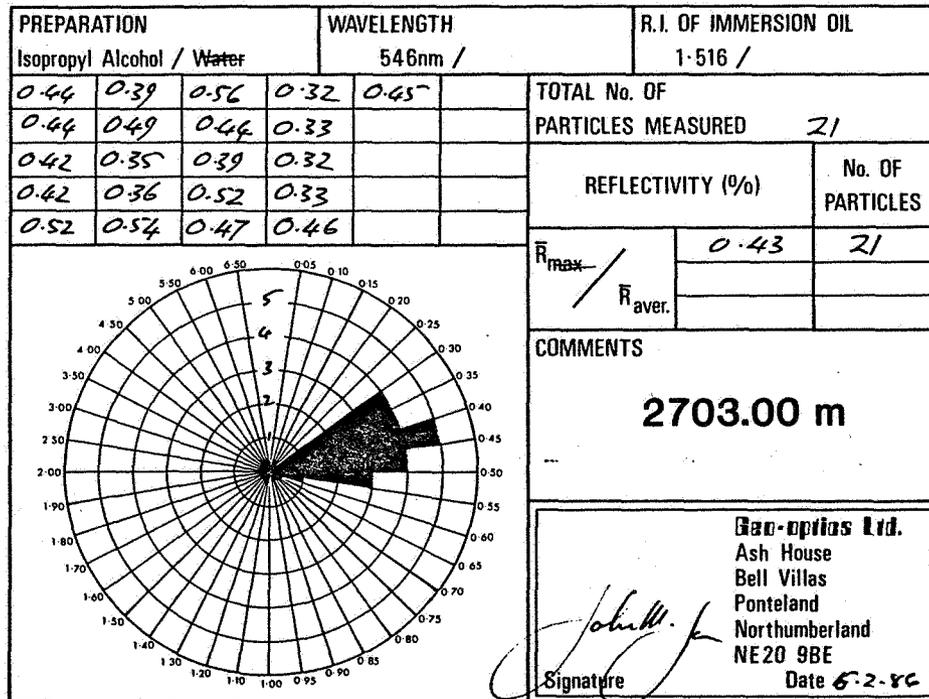
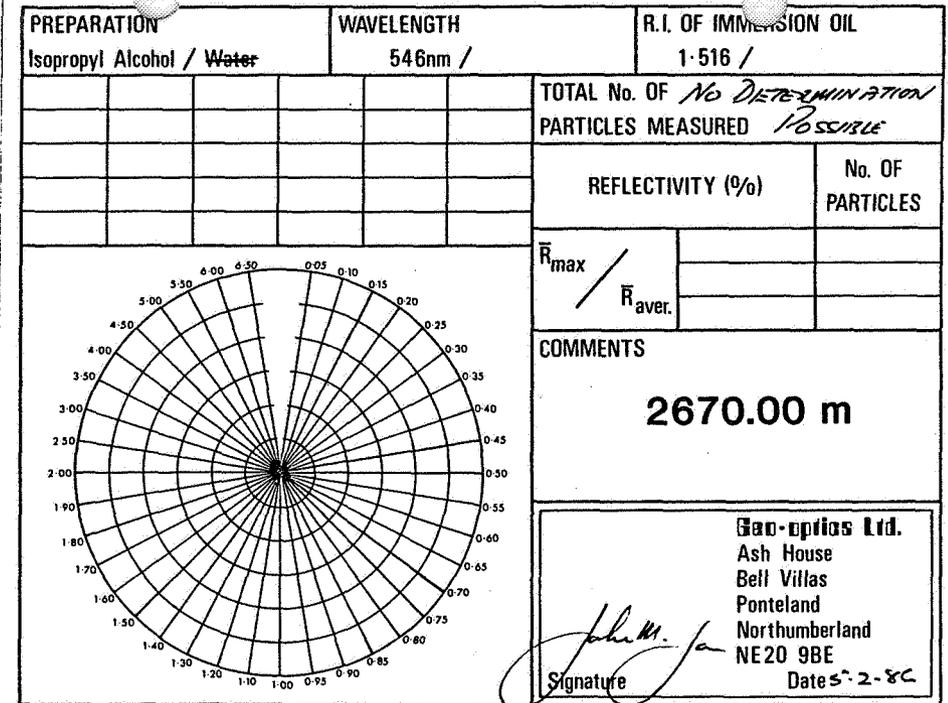
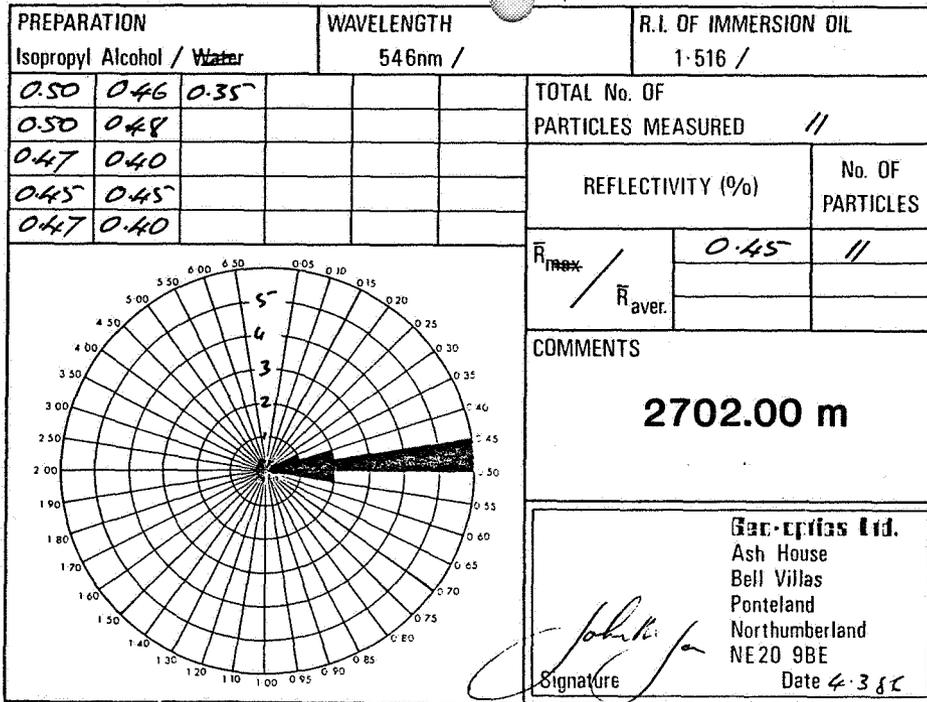
PREPARATION		WAVELENGTH		R.I. OF IMMERSION OIL	
Isopropyl Alcohol / Water		546nm /		1.516 /	
0.55				TOTAL No. OF PARTICLES MEASURED 4	
0.54					
0.53				REFLECTIVITY (%)	No. OF PARTICLES
0.54				$\bar{R}_{max}$ / $\bar{R}_{aver.}$	0.54 / 4
					
COMMENTS <b>2446.50 m</b>					
Geo-optics Ltd. Ash House Bell Villas Ponteland Northumberland NE20 9BE Signature: <i>John M. Ja</i> Date 4.3.88					

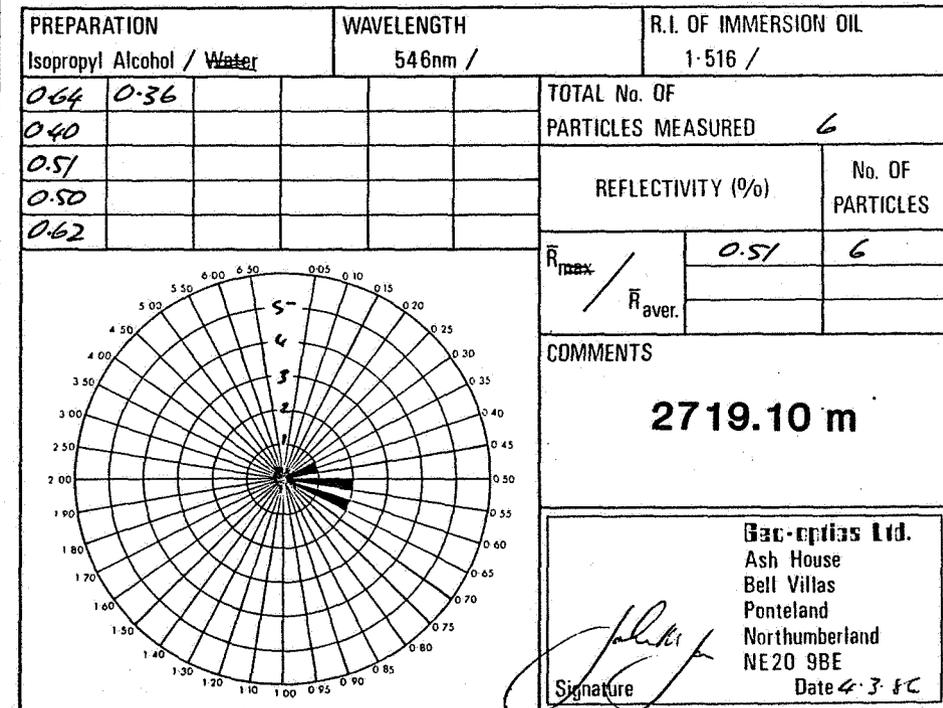
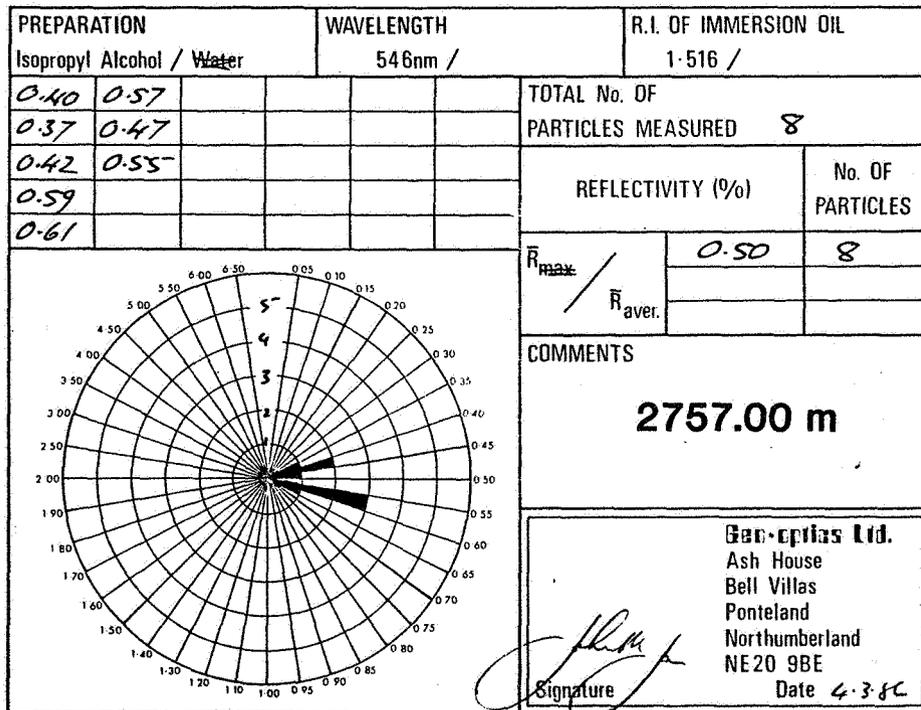
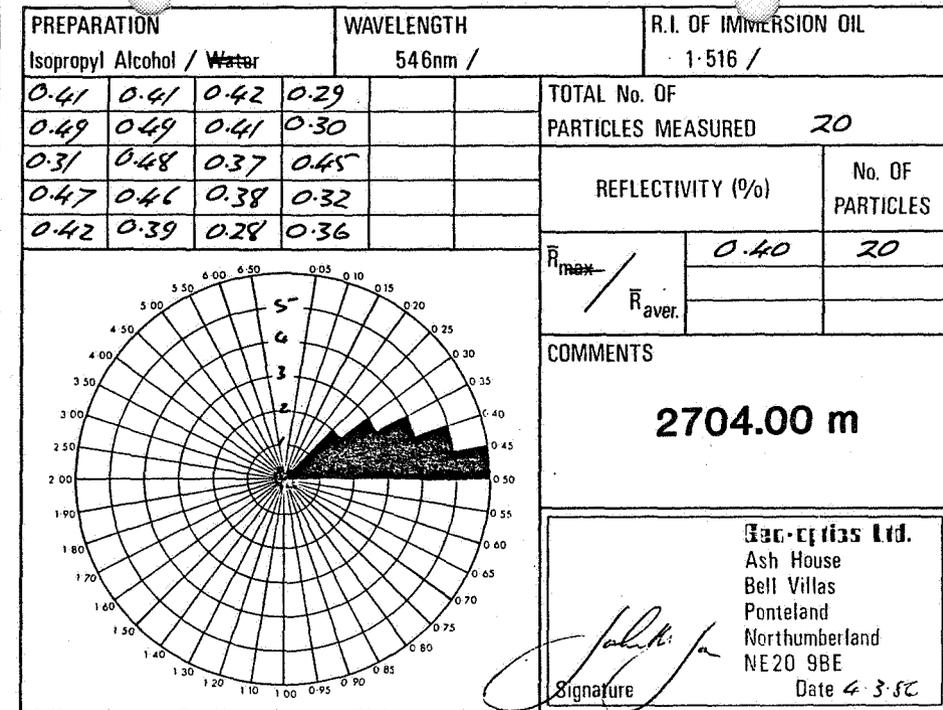
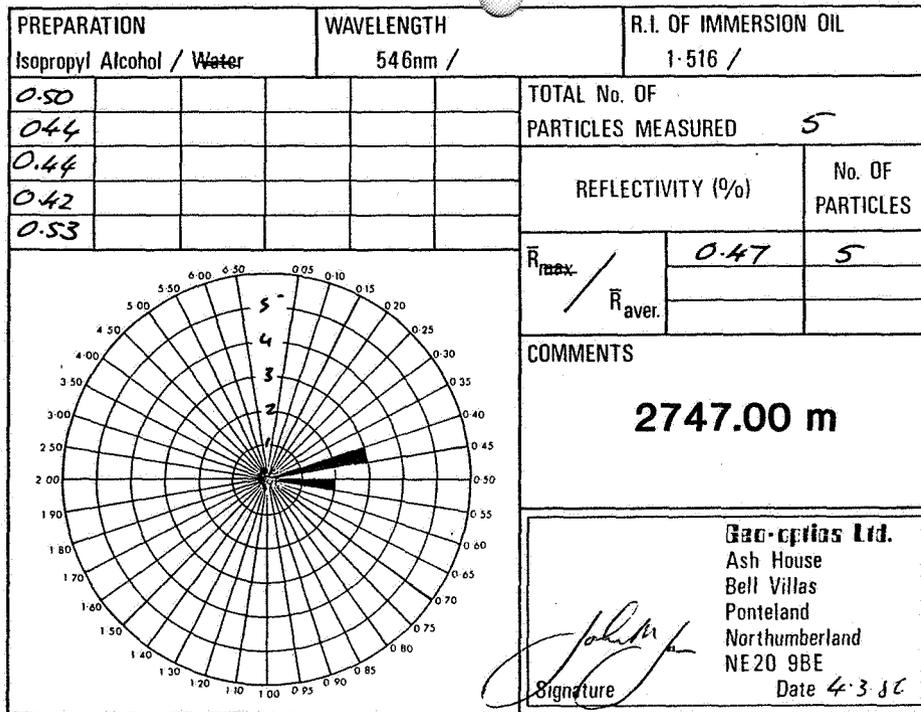
PREPARATION	WAVELENGTH	R.I. OF IMMERSION OIL
Isopropyl Alcohol / Water	546nm /	1.516 /
0.52		
0.51		
TOTAL No. OF PARTICLES MEASURED		2
REFLECTIVITY (%)		No. OF PARTICLES
$\bar{R}_{max}$ / $\bar{R}_{aver.}$	0.52	2
COMMENTS		
2590.00 m		
Geo-optics Ltd. Ash House Bell Villas Ponteland Northumberland NE20 9BE		
Signature		Date 4.3.86

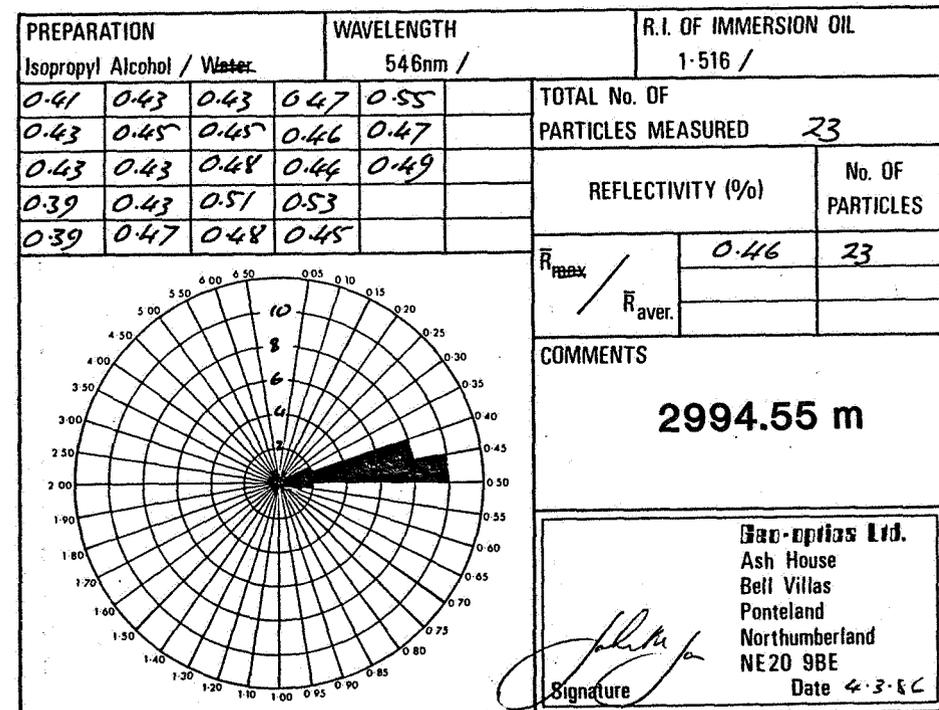
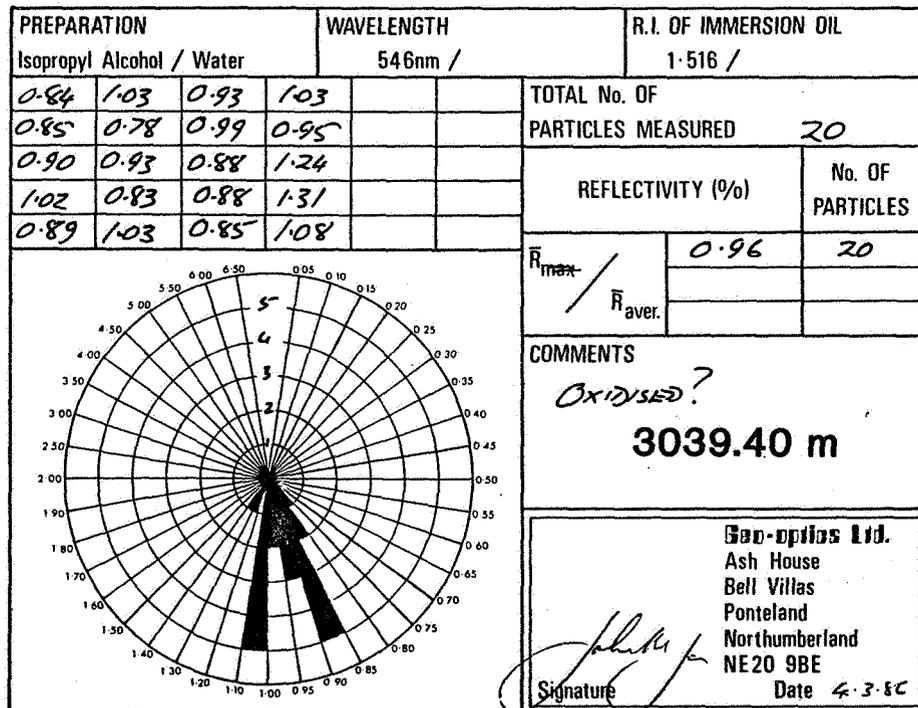
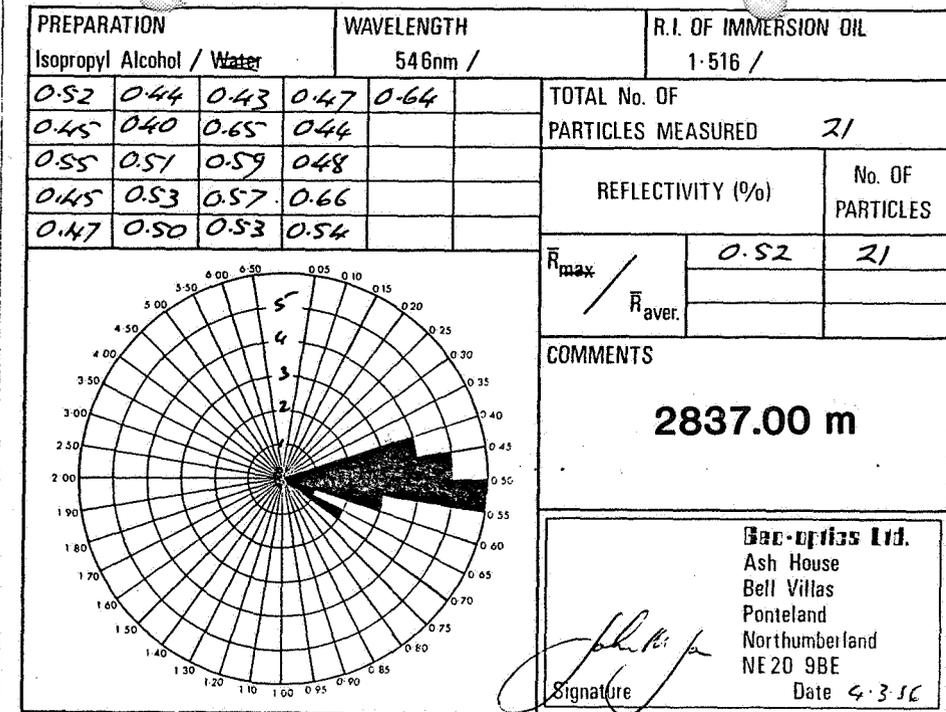
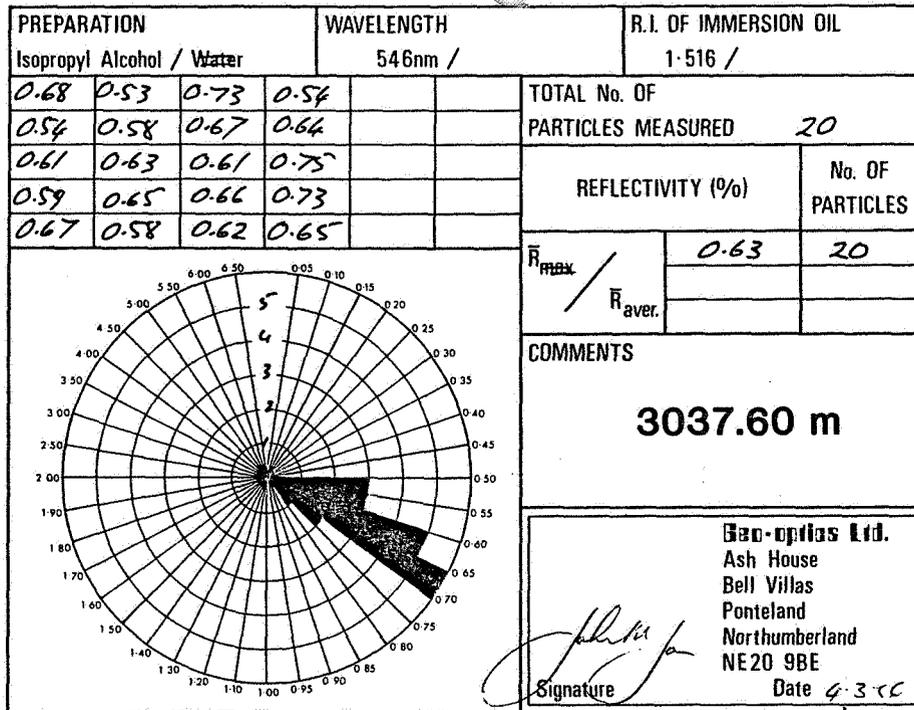
PREPARATION	WAVELENGTH	R.I. OF IMMERSION OIL
Isopropyl Alcohol / Water	546nm /	1.516 /
TOTAL No. OF PARTICLES MEASURED		No DETERMINATION POSSIBLE
REFLECTIVITY (%)		No. OF PARTICLES
$\bar{R}_{max}$ / $\bar{R}_{aver.}$		
COMMENTS		
2493.00 m		
Geo-optics Ltd. Ash House Bell Villas Ponteland Northumberland NE20 9BE		
Signature		Date 5.2.86

PREPARATION	WAVELENGTH	R.I. OF IMMERSION OIL
Isopropyl Alcohol / Water	546nm /	1.516 /
0.51		
0.46		
0.51		
0.50		
TOTAL No. OF PARTICLES MEASURED		4
REFLECTIVITY (%)		No. OF PARTICLES
$\bar{R}_{max}$ / $\bar{R}_{aver.}$	0.50	4
COMMENTS		
2590.00 m		
Geo-optics Ltd. Ash House Bell Villas Ponteland Northumberland NE20 9BE		
Signature		Date 5.2.86

PREPARATION	WAVELENGTH	R.I. OF IMMERSION OIL
Isopropyl Alcohol / Water	546nm /	1.516 /
0.40		
TOTAL No. OF PARTICLES MEASURED		1
REFLECTIVITY (%)		No. OF PARTICLES
$\bar{R}_{max}$ / $\bar{R}_{aver.}$	0.40	1
COMMENTS		
2550.00 m		
Geo-optics Ltd. Ash House Bell Villas Ponteland Northumberland NE20 9BE		
Signature		Date 4.3.86







PREPARATION				WAVELENGTH		R.I. OF IMMERSION OIL	
Isopropyl Alcohol / Water				546nm /		1.516 /	
0.62	0.62	0.73	0.72			TOTAL No. OF PARTICLES MEASURED 20	
0.57	0.64	0.68	0.66			REFLECTIVITY (%)	
0.69	0.65	0.67	0.68			No. OF PARTICLES	
0.67	0.64	0.72	0.67			R <sub>max</sub> / R <sub>aver.</sub>	
0.64	0.52	0.70	0.61			0.66 / 20	
						COMMENTS	
						3071.57 m	
						Geo-optics Ltd. Ash House Bell Villas Ponteland Northumberland NE20 9BE Signature: <i>John H. J.</i> Date: 4.3.88	

PREPARATION				WAVELENGTH		R.I. OF IMMERSION OIL	
Isopropyl Alcohol / Water				546nm /		1.516 /	
0.73						TOTAL No. OF PARTICLES MEASURED 2	
0.61						REFLECTIVITY (%)	
						No. OF PARTICLES	
						R <sub>max</sub> / R <sub>aver.</sub>	
						0.67 / 2	
						COMMENTS	
						3113.00 m	
						Geo-optics Ltd. Ash House Bell Villas Ponteland Northumberland NE20 9BE Signature: <i>John H. J.</i> Date: 4.3.88	