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REPORT TITLE:

ANALYSIS OF FLUID AND GAS SAMPLES FROM
WELL 34/7-7

REPORT NO.: 22.1805.00/01/86

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CLIENT:

Saga Petroleum a.s.

SUMMARY:

An oil and a gas sample from each of drill stem tests (DST) 1a and 2 of well 34/7-7 were geochemically characterised.

The DST samples have very similar compositions and a common upper Jurassic source is suggested for the DST samples. The 34/7-7 fluids are similar in composition to other DST fluids from 34/7 wells previously described at IKU. The DST gases consist mostly of C₂-C₅ components (~70%), and lesser amounts of methane (~22-24%). The oils are mature, paraffinic-naphthenic oils. The geochemical data suggest that the 34/7-7 DST fluids are amongst the most mature analysed from block 34/7.

KEY WORDS: Organic geochemistry	Snorre field
DST fluids	
34/7-7	

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1. INTRODUCTION

Two oil and two gas samples from drill stem tests (DST) 1a and 2 in well 34/7-7 were sent to IKU for organic geochemical characterisation by Saga Petroleum a.s. The samples were received from Core Lab Norsk. No additional data were received with the samples, other than that the samples were 'O'-flash reservoir fluid and gas.

The gas and oil samples were analysed using the following analyses; according to the instructions of Saga Petroleum a.s.

Gas samples:

- Gas chromatography of C₁-C₈ hydrocarbons
- $\delta^{13}\text{C}$ stable isotope ratios of C₁, C₂, C₃ and C₄ components
- D/H isotope ratio of C₁

Oil samples:

- API gravity
- Sulphur content
- Ni and V content
- Gas chromatography of C₂-C₈ hydrocarbons for recombination
- Gas chromatography of whole oil
- Liquid chromatography (MPLC) with asphaltene precipitation
- Urea adduction of saturated hydrocarbons
- Gas chromatography of saturated, branched/cyclic and aromatic hydrocarbons
- GC-MS of saturated hydrocarbons (m/z 191, 217, 218)
- GC-MS of aromatic hydrocarbons
- $\delta^{13}\text{C}$ stable isotope ratio for saturates, aromatics, NSO and asphaltenes

The DST samples were analysed and reported under IKU project number: 22.1805.00. The samples were assigned the following IKU codes:

DST 1a gas : B-3931
oil : B-3930

DST 2 gas : B-3978
oil : B-3977

A preliminary report was sent to Saga Petroleum a.s. (Att. E.S. Mo) for approval. On approval, ten copies of the final report were sent to Saga Petroleum a.s. and ten copies are stored at IKU.

2.2 Crude oil characterisation

2.2.1 API gravity

The two DST oils have similar API gravities of 37.0⁰ (DST 1a) and 36.3⁰ (DST 2). These gravities are shown in table 4 and are similar to values described from the 34/7-6 DST samples. These API gravities would suggest moderately light oils.

2.2.2 Sulphur, nickel and vanadium content

The two DST oils may be considered as low sulphur oils on the basis of sulphur contents of around 0.3% (Table 5). Similar sulphur contents have been reported from other 34/7 oils; e.g. DST 2 in 34/7-6.

The content of Ni and V is low in both oils, slightly lower values being observed in the DST 2 oil (Table 2). Low Ni and V contents are typical of low sulphur oils according to Tissot and Welte (1984). Similar Ni and V contents were reported from the 34/7-6 DST samples analysed at IKU.

2.2.3 Gross composition of the crude oil samples

Low molecular weight components comprise about 40% of the two DST oil samples (Table 6). The remaining 60% of the DST oils is composed of components in the >210⁰ oil fraction. The percentage content of low molecular weight compounds in the 34/7-7 DST oils is nearly twice that described from the 34/7-6 DST oils.

The two DST oils have similar asphaltene contents of 3.4 (DST 1a) and 4.5 (DST 2), shown in table 7, with NSO contents of 6.6% and 4.1%, respectively.

The asphaltene contents of the 34/7-7 DST oils are similar to those of the 34/7-5 DST oil, but are up to four times greater than was described from the 34/7-4 and 34/7-6 DST oils. The NSO content of the 34/7-7 DST samples is similar to values obtained from the 34/7-4, 34/7-5 and 34/7-6 DST samples analysed at IKU.

Hydrocarbon compounds account for about 70% of the $>210^{\circ}\text{C}$ fraction in the two DST samples (Table 8). Saturated hydrocarbons account for about 60% of the hydrocarbon compound fraction and 42-45% of the total $>210^{\circ}\text{C}$ oil fraction. These compositions are similar to other 34/7 DST oils analysed at IKU.

2.2.4 Gas chromatography of the DST oils

a) Whole oil gas chromatography

The whole oil gas chromatograms of the two oils are shown in figure 4. The oils have similar n-alkane distributions showing a smooth, unimodal peak envelope with a maximum at C_5 and a minimum at C_{30} . The whole oil gas chromatograms suggest fairly light, thermally mature oils. The chromatograms resemble that of the 34/7-5 DST oil, the 34/7-6 DST oils tending to be more depleted in lower molecular weight n-alkanes.

b) Saturated hydrocarbons

The saturated hydrocarbon gas chromatograms are shown in figure 5. The gas chromatograms of both samples are similar, with smooth, unimodal n-alkane envelopes reaching a maximum at nC_{17} - nC_{18} . The higher peak maximum in the saturated hydrocarbon gas chromatograms, relative to the whole oil chromatograms, is a function of the different preparation procedures. There appears to be a slight 'hump' under the nC_{33} - nC_{35} hydrocarbons which may be due to the presence of polycyclic terpanes and steranes. Both samples have similar pristane/phytane ratios of 1.3 and 1.4 (Table 9), suggesting a marginally oxidising depositional environment. Similar CPI values of 1.0 (Table 9) suggest that the oils are thermally mature. The saturated hydrocarbon gas chromatograms are similar to those of other 34/7 oils, with only a few exceptions; e.g. 34/7-6, DST 3b.

c) Branched/cyclic hydrocarbons

The branched/cyclic hydrocarbon gas chromatograms are shown in figure 6. The gas chromatograms are dominated by a relatively small suite of isoprenoid compounds. The main isoprenoid peaks are those representing pristane and phytane, especially the former. These gas chromatograms show a more restricted development of branched/cyclic hydrocarbons than is seen in other 34/7 oils analysed at IKU.

d) Aromatic hydrocarbons

The aromatic hydrocarbon gas chromatograms are shown in figure 7. Both gas chromatograms show significant 'humps' of unresolved, high molecular weight compounds. The DST 1a oil shows a relatively good development of naphthalene and phenanthrene compounds, dominated by the alkyl-naphthalene compounds. The DST 2 oil shows only a poor suite of resolved naphthalene and phenanthrene compounds. MPI ratio values of around 1 (Table 10) suggest that the oils are thermally mature in accordance with the other maturity data which have been previously discussed.

The 34/7-7 DST aromatic gas chromatograms show the most prominent UCM 'humps' of any of the 34/7 oils, although similar, less well-developed 'humps' are described from DST samples in 34/7-1, 34/7-5 and 34/7-6. The MPI values from the 34/7-7 oils are the highest currently recorded from 34/7 oils. The nearest values of around 0.8 to 0.9 are found in the 34/7-5 and 34/7-6 oils.

2.2.5 Gas chromatography-mass spectrometry (GC-MS)

The mass chromatograms of the terpane, sterane and aromatic biomarker compounds are shown in figures 8,9 and 10, respectively. The source- and maturity-dependant ratios from these mass chromatograms are given in tables 11 and 12.

The distribution of the maturity-dependant peaks suggests thermal maturity. The maturity-dependant peak ratios have thermally stable values indicative of thermal maturity. These ratios suggest a mid-'oil window' maturity, which would agree with the other maturity data so far considered. A high abundance of 28,30-bisnorhopane (Z/E in m/z 191) suggests an Upper Jurassic source for these oils, this compound being commonly encountered in samples from the upper Jurassic Draupne and Heather formations. The two DST oils have very similar biomarker distributions, suggesting a common source.

The mass chromatograms of the aromatic hydrocarbons show a distribution of compounds which is typical of early mid-'oil window' maturity. This is shown in the distribution of methylphenanthrenes (m/z 192), methyl-dibenzothiophenes (m/z 198) and in the relatively high abundance of

aromatic steranes. The differences observed in the TIC profiles of the two oil samples are probably caused by the work-up procedure.

2.2.6 $\delta^{13}\text{C}$ stable isotope composition of the DST oils

The $\delta^{13}\text{C}$ isotope ratios for the saturate, aromatic, NSO and asphaltene fractions of the DST oils are shown in table 13. Both oils have similar $\delta^{13}\text{C}$ ratios for all of the fractions, with values of about $-30^{\circ}/\text{oo}$. The similarity in the values suggests that the oils probably share a common source and are of similar thermal maturity.

These $\delta^{13}\text{C}$ values are similar to the values reported from most of the other 34/7 DST oils analysed at IKU.

3. ANALYTICAL PROCEDURES

Gas analyses

C_1 - C_{10} analysis

C_1 - C_{10} analysis was carried out on a HP 5880 A gas chromatograph equipped with a 50 m x 0.2 mm (I.D.) fused silica column coated with OV-101, 0.5 μ m. Helium was used as carrier gas at 1 ml/min. The inlet split ratio was 1:60. The temperature program was -30 $^{\circ}$ C (1 min.) - 8 $^{\circ}$ C/min. - 130 $^{\circ}$ C (10 min.). Quantitation was carried out using a standard gas as for C_1 - C_5 + analysis.

Evaporation of the light components in fluid samples

Prior to chromatographic separation of oil/condensate samples, the fractions boiling below 210 $^{\circ}$ C were removed by heating the samples until constant weight at 210 $^{\circ}$ 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 extractable organic matter (EOM) was separated into saturated fraction, aromatic fraction and non hydrocarbon fraction using a MPLC system with hexane as eluant (Radke et al., Anal. Chem., 1980) after precipitation of asphaltenes with pentane in large excess (>30:1). The various fractions were evaporated on a Buchi Rotavapor and transferred to glass vials and dried in a stream of nitrogen. The amount of asphaltenes were recorded by weighing after drying at 50 $^{\circ}$ C for 12 hours.

The same separation procedure was applied to the fractions of oil/condensate samples boiling above 210 $^{\circ}$ C.

Urea adduction

Urea-adduction was performed on the saturated hydrocarbon fraction. The sample containing 5 mg of n-alkanes was dissolved in 2 ml of n-hexane and 1 ml of acetone was added. A saturated solution of urea in methanol (1 ml) was then added dropwise. The solvent was removed (N_2) and the adduction step repeated twice. The white crystals were rinsed (3x5 ml hexane) and the combined extract filtered (cotton wool plug covered with Al_2O_3), to afford a non-adduct. GC analyses were performed on the samples after the urea adduction, using the same conditions as for the other GC analyses.

Gas chromatographic analysis

Whole oil samples were analysed on a HP5730A GC, applying a temperature program from $-50^{\circ}C$ (2 min.) to $280^{\circ}C$ at $4^{\circ}C/min$. The GC was fitted with a 15 m DB-1 fused silica column. Hydrogen (2.5ml/min.) was used as carrier gas, and 0.02 μ l was injected in split mode (split ratio 1:10).

The C_2 - C_8 hydrocarbon fractions were determined by hydrogen stripping on a Carlo Erba Fractovap GC. The column used was a 50 m x 0.2 mm (I.D.) fused silica column coated with OV-101, 0.5 μ m. The column oven was held isothermally at $50^{\circ}C$ for the analysis time. Backflushing was applied to remove higher boiling components.

The saturated and the branched/cyclic hydrocarbon fractions were each diluted with n-hexane and analysed on a HP 5730A or a HP 5790 GC. Both GC's are equipped with 15 m DB-1 fused silica columns 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 $80^{\circ}C$ (2 min.) to $280^{\circ}C$ at $4^{\circ}C/min$.

The total aromatic fractions were, after dilution with n-hexane, analysed on a Carlo Erba Fractovap Series 2150 GC or a HP 5730 A GC. Both GC's are equipped with 30m DB-5 fused silica columns, and hydrogen (2.5 ml/min.) is used as carrier gas. The temperature program applied is $80^{\circ}C$ (2 min.) to $280^{\circ}C$ at $4^{\circ}C/min$. on both systems. Injections are performed splitless on the Carlo Erba GC, while split injections (split ratio 1:10) are used on the HP 5730 A GC.

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 (30 m x 0.3 mm i.d.). Helium (0.7 kg/cm^2) was used as carrier gas and the injections were performed in split mode (1.5 μl , split ratio 1:15). The GC oven was programmed from 70°C to 280°C at 4°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°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.

$\delta^{13}\text{C}$ isotope analysis

The $\delta^{13}\text{C}$ 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.

4. CONCLUSIONS

The gas and oil samples from drill stem tests (DST) 1a and 2 in well 34/7-7 were analysed. The gases and oils from both DST's have very similar compositions, and a common upper Jurassic source is suggested for these DST fluids. The 34/7-7 DST fluids are similar in composition to those described from other 34/7 wells previously analysed by IKU.

The 34/7-7 DST fluids are considered to be thermally mature, with a maturity equivalent to the mid-'oil window', i.e. about 0.9% Ro. Some of the geochemical data suggest that the 34/7-7 fluids are amongst the most mature of the 34/7 oils.

REFERENCES

THOMPSON, K.F.M., 1978: Light hydrocarbons in subsurface sediments. Geochim. Cosmochim. Acta., Vol. 93, pp.657-672.

TISSOT, B.P. and WELTE, D.H., 1984: Petroleum formation and occurrence (2nd Ed.). Springer-Verlag. Berlin-Heidelberg-New York.

Previous IKU reports referred to in text.

05.1725.00/02/84: Fluid characterisation of well 34/7-1.

05.1728.00/02/85: Hydrocarbon characterisation for well 34/7-3.

22.1767.00/03/85: Hydrocarbon characterisation of well 34/7-4.

22.1771.00/03/85: Analysis of fluid and gas sample from well 34/7-5.

22.1779.00/03/85: Analysis of fluid and gas samples from well 34/7-6
(DST 2 and DST 3b).

Table 1a

DST 1a.

C1-C8 YIELD

WELL NO:34/7-7

IKU NO,GAS: C-3931

IKU NO,OIL: C-3930

GOR = 68.7 SM3/M3

COMPOUND	GAS MG/ML	GAS MG/68.7ML	OIL MG/ML	TOTAL HC IN MG/ML OF RESERVOIR FLUID
Methane	0.331	22.740	0.000	22.740
Ethane	0.187	12.847	0.000	12.847
Propane	0.360	24.732	0.240	24.972
i-Butane	0.068	4.672	0.501	5.173
n-Butane	0.211	14.496	3.123	17.619
i-Pentane	0.055	3.779	5.112	8.891
n-Pentane	0.062	4.259	9.469	13.728
Cyclo-C5+				
2,3-diMeC4	0.007	0.481	1.895	2.376
2-MeC5	0.014	0.962	5.396	6.358
3-MeC5	0.008	0.550	3.277	3.827
n-Hexane	0.017	1.168	10.187	11.355
MeCyC5	0.010	0.687	7.342	8.029
triMeC4	0.002	0.137	0.000	0.137
Benzene	0.001	0.069	1.897	1.966
CycloC6	0.006	0.412	7.045	7.457
2-MeC6	0.002	0.137	3.310	3.447
2,3-diMeC5	0.002	0.137	1.538	1.675
3-MeC6	0.002	0.137	5.173	5.310
diMeCyC5	0.004	0.275	8.157	8.432
n-Heptane	0.004	0.275	9.738	10.013
MeCyC6	0.005	0.344	12.305	12.649
EtCyC5+				
2,5-diMeC6	0.000	0.000	1.953	1.953
2,4-diMeC6	0.000	0.000	1.231	1.231
triMeCyC5	0.000	0.000	1.412	1.412
Toluene	0.000	0.000	4.648	4.648
2-MeC7+				
4-MeC7	0.000	0.000	5.398	5.398
3-MeC7	0.000	0.000	2.945	2.945
diMeCyC6	0.000	0.000	6.562	6.562
n-Octane	0.000	0.000	9.730	9.730
2,4-diMeC7+				
diMeCyC6	0.000	0.000	1.884	1.884
EtCyC6	0.000	0.000	3.362	3.362
EtBenzene	0.000	0.000	1.970	1.970
m+p-xylene	0.000	0.000	4.881	4.881
2-MeC8+				
4-MeC8	0.000	0.000	2.689	2.689
O-Xylene	0.000	0.000	1.726	1.726
SUM	1.358	93.296	146.096	239.392

Table 1b.

DST 2

C1-C8 YIELD

WELL NO:34/7-7

IKU NO,GAS: C-3978

IKU NO,OIL: C-3977

GOR = 62.5 SM3/M3

COMPOUND	GAS MG/ML	GAS MG/62.5ML	OIL MG/ML	TOTAL HC IN MG/ML OF RESERVOIR FLUID
Methane	0.228	14.250	0.000	14.250
Ethane	0.133	8.313	0.000	8.313
Propane	0.253	15.813	0.000	15.813
i-Butane	0.047	2.938	0.000	2.938
n-Butane	0.211	13.188	0.131	13.319
i-Pentane	0.055	3.438	0.369	3.807
n-Pentane	0.042	2.625	5.301	7.926
Cyclo-C5+				
2,3-diMeC4	0.004	0.250	2.054	2.304
2-MeC5	0.009	0.563	5.123	5.686
3-MeC5	0.005	0.313	3.443	3.756
n-Hexane	0.011	0.688	9.741	10.429
MeCyC5	0.007	0.438	8.160	8.598
Benzene	0.000	0.000	1.210	1.210
CycloC6	0.004	0.250	6.320	6.570
2-MeC6	0.001	0.063	2.976	3.039
2,3-diMeC5	0.001	0.063	1.287	1.350
3-MeC6	0.002	0.125	4.801	4.926
diMeCyC5	0.003	0.188	7.946	8.134
n-Heptane	0.003	0.188	9.585	9.773
MeCyC6	0.003	0.188	12.138	12.326
EtCyC5+				
2,5-diMeC6	0.000	0.000	2.016	2.016
2,4-diMeC6	0.000	0.000	1.237	1.237
triMeCyC5	0.000	0.000	1.359	1.359
Toluene	0.000	0.000	4.193	4.193
2-MeC7+				
4-MeC7	0.000	0.000	5.048	5.048
3-MeC7	0.000	0.000	2.623	2.623
diMeCyC6	0.000	0.000	6.177	6.177
n-Octane	0.000	0.000	9.681	9.681
2,4-diMeC7+				
diMeCyC6	0.000	0.000	2.058	2.058
EtCyC6	0.000	0.000	3.633	3.633
EtBenzene	0.000	0.000	2.195	2.195
m+p-xylene	0.000	0.000	4.151	4.151
2-MeC8+				
4-MeC8	0.000	0.000	3.200	3.200
O-Xylene	0.000	0.000	1.782	1.782
SUM	1.022	63.882	129.938	193.820

Table Ic. Ratios obtained from C₁-C₈ gas/oil compositions

IKU no.	DST No.	Sample	iC ₄ /nC ₄	Gas Wetness (%)	Paraffinicity Index-1
C-3931	1a	Gas	0.32	71.24	
C-3978	2	Gas	0.22	73.70	
C-3930	1a	Oil			0.87
C-3977	2	Oil			0.84

Paraffinicity Index 1 = $2MeC_6 + 3MeC_6 / diMeCyC_5$ (3 isomers)

C₂-C₈ composition of DST 1a oil.

C 3930	area	ug	mg/ml	% of t.oil
nC3	8860	.072	.240	.028
iso-C4	18491	.150	.501	.059
nC4	115144	.937	3.123	.372
iso-C5	188428	1.533	5.112	.608
nC5	349032	2.840	9.469	1.127
CyC5+2,3diMeC4	69877	.568	1.895	.225
2MeC5	198895	1.618	5.396	.642
3MeC5	120825	.983	3.277	.390
nC6	375495	3.056	10.187	1.213
MeCyC5	270629	2.202	7.342	.874
benzene	69951	.569	1.897	.226
CyC6	259698	2.113	7.045	.839
2MeC6	122030	.993	3.310	.394
2,3diMeC5	56718	.461	1.538	.183
3MeC6	190691	1.552	5.173	.616
DiMeCyC5	300671	2.447	8.157	.971
nC7	358948	2.921	9.738	1.159
MeCyC6	453565	3.691	12.305	1.465
EtCyC5+2,5diMeC6	72005	.586	1.953	.232
2,4diMeC6	45375	.369	1.231	.146
triMeCyC5	52054	.423	1.412	.168
toluene	171348	1.394	4.648	.553
2+4MeC7	198996	1.619	5.398	.643
3MeC7	108566	.883	2.945	.350
DiMeCyC6	241874	1.968	6.562	.781
nC8	358649	2.919	9.730	1.158
2,4diMeC7+diMeCyC6	69471	.565	1.884	.224
EtCyC6	123934	1.008	3.362	.400
EtBenzene	72635	.591	1.970	.234
m,p-Xylene	179918	1.464	4.881	.581
2+4MeC8	99146	.806	2.689	.320
o-xylene	63638	.517	1.726	.205
sum		43.833	146.110	17.402

tot.oil - ant ug inj.: 251.880ug

%C₂-C₈(tot.area)in tot.oil: 20.224%

C₂-C₈ composition of DST 2 oil.

C 3977	area	ug	mg/ml	% of t.oil
nC3	0	.000	.000	.000
iso-C4	0	.000	.000	.000
nC4	5110	.039	.131	.015
iso-C5	14317	.110	.369	.043
nC5	205594	1.590	5.301	.628
CyC5+2,3diMeC4	79695	.616	2.054	.243
2MeC5	198713	1.537	5.123	.607
3MeC5	133546	1.033	3.443	.408
nC6	377800	2.922	9.741	1.155
MeCyC5	316479	2.448	8.160	.967
benzene	46947	.363	1.210	.143
CyC6	245134	1.896	6.320	.749
2MeC6	115447	.893	2.976	.352
2,3diMeC5	49944	.386	1.287	.152
3MeC6	186197	1.440	4.801	.569
DiMeCyC5	308179	2.383	7.946	.942
nC7	371752	2.875	9.585	1.136
MeCyC6	470760	3.641	12.138	1.439
EtCyC5+2,5diMeC6	78190	.604	2.016	.239
2,4diMeC6	48011	.371	1.237	.146
triMeCyC5	52730	.407	1.359	.161
toluene	162640	1.258	4.193	.497
2+4MeC7	195784	1.514	5.048	.598
3MeC7	101745	.787	2.623	.311
DiMeCyC6	239591	1.853	6.177	.732
nC8	375461	2.904	9.681	1.147
2,4diMeC7+diMeCyC6	79835	.617	2.058	.244
EtCyC6	140928	1.090	3.633	.430
EtBenzene	85159	.658	2.195	.260
m,p-Xylene	161003	1.245	4.151	.492
2+4MeC8	124108	.960	3.200	.379
o-xylene	69133	.534	1.782	.211
sum		38.986	129.956	15.408

tot.oil - ant ug inj.: 253.020ug

%C₂-C₈(tot.area)in tot.oil: 18.054%

Table 3: $\delta^{13}\text{C}$ isotope data for the DST gases

IKU No.	DST No.	nC ₁	nC ₂	nC ₃	iC ₄	nC ₄
C-3931	1a	-51.0	-35.7	-33.3	-32.7	-33.1
C-3978	2	-49.1	-35.3	-32.7	-32.7	-32.5

Project no.: 22.1805
 DATE : 29 - 4 - 86.

T A B L E : 4.

API GRAVITY OF OIL SAMPLE

IKU-No	CODE	API GRAVITY (DENSITY)	
Crude oil : >210°C			
34/7-7			
C 3930	DST 1A	37.0 (0.8396)	25.3 (0.9023)
C 3977	DST 2	36.3 (0.8434)	24.0 (0.9101)

Project no.: 22.1805

DATE : 29 - 4 - 86.

T A B L E : 5.

CONTENT OF SULFUR, NICKEL AND VANADIUM IN OIL >210'

IKU-No	CODE	S	Ni	V
		%	(mg/kg)	(mg/kg)
34/7-7				
C 3930	DST 1A	0.29	3.16-3.20	3.76-3.65
C 3977	DST 2	0.36	2.98	2.25

Project no.: 22.1805
 DATE : 29 - 4 - 86.

T A B L E : 7.

AMOUNT OF ASPHALTENES AND NSO IN OIL

IKU-No	CODE	Crude oil (mg)	Asphaltenes (mg)	(%)	NSO (mg)	(%)
34/7-7						
C 3930	DST 1A	373.3	12.6	3.4	24.6	6.6
C 3977	DST 2	419.3	19.0	4.5	17.0	4.1

T A B L E 9.

TABULATION OF DATA FROM THE GASCHROMATOGRAMS

IKU No.	CODE	PRISTANE	PRISTANE	CPI-1	CPI-2
		n-C17	PHYTANE		
C 3930	DST 1A	0.7	1.4	1.0	1.0
C 3977	DST 2	0.8	1.3	1.0	1.0

DATE : 29 - 4 - 86.

Table 10. Methylphenanthrene ratios obtained from aromatic gas chromatograms

IKU No.	DST No.	MPI-1	MPI-2
B-3930	1a	0.98	1.21
B-3977	2	1.05	0.98

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

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

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

IKU code	Sample code	$\alpha\beta/\alpha\beta+\beta\alpha$ ¹⁾	%22S ²⁾	%20S ³⁾	% $\beta\beta$ ⁴⁾
C-3930	DST 1a	0.96	61.4	80.4	47.4
C-3977	DST 2	0.97	57.4	79.8	47.4

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

Table 12. Molecular ratios from terpane and sterane mass chromatograms.
Maturity and source characteristic ratios.

IKU no.	Sample code	Q/E ¹⁾	T _m /T _s ²⁾	X/E ³⁾	Z/E ⁴⁾	a/a+j ⁵⁾
C-3930	DST 1a	0.09	0.73	0.05	0.41	0.83
C-3977	DST 2	0.11	0.75	0.04	0.40	0.85

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

Table 13. $\delta^{13}\text{C}$ isotope data for crude oils fraction

IKU No.	DST No.	SAT	AROM	NSO	ASF
C-3930	1a	-30.4	-29.7	-29.5	-30.1
C-3977	2	-30.9	-29.9	-29.6	-30.1

FIGURE 1

Gas chromatograms of C_1 - C_8 hydrocarbons
in DST gases

OVEN TEMP FINAL TIME 10

06T

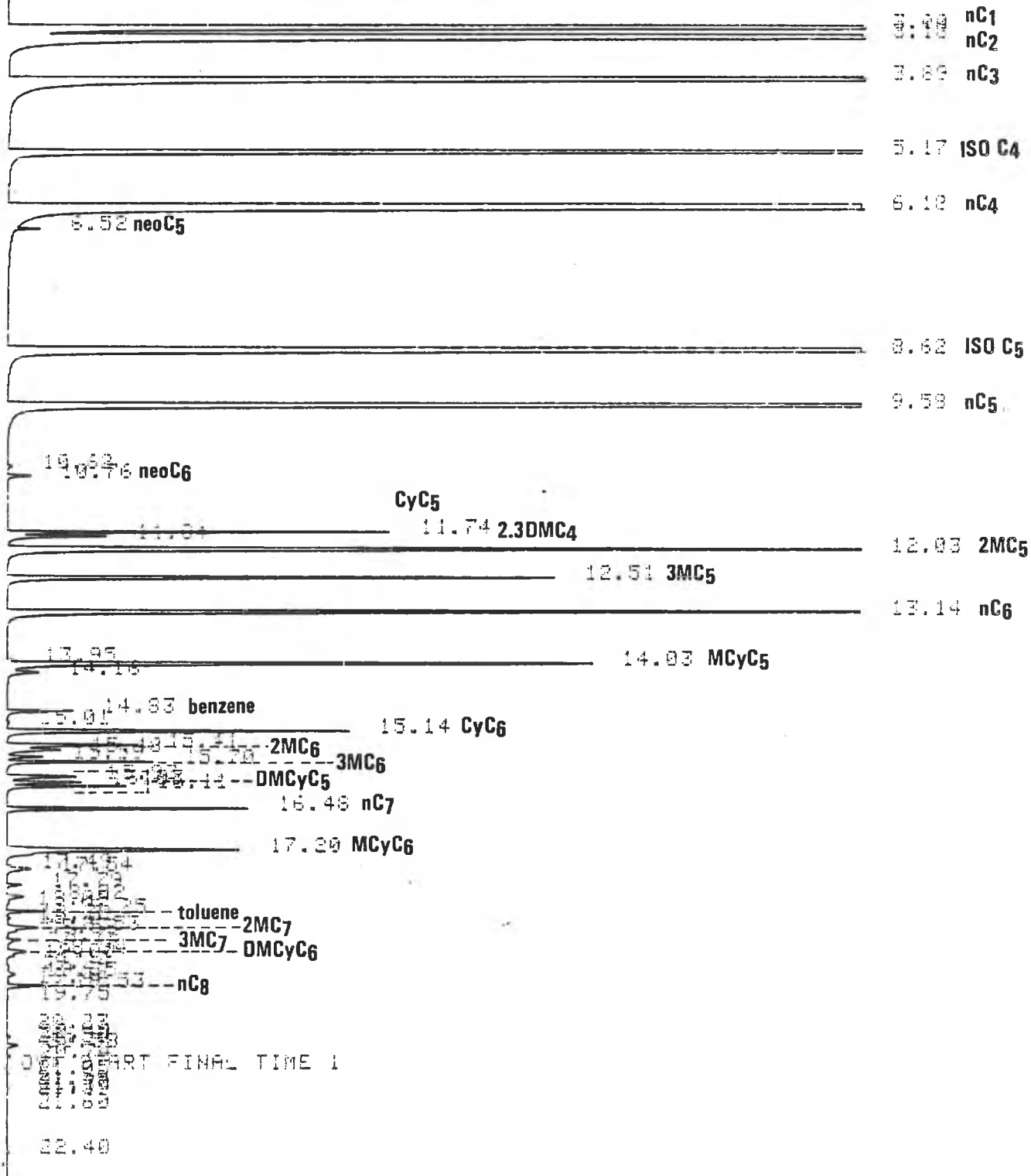
LIST OVEN TEMP

OVEN TEMP=-29°C SETPT=-30°C LIMIT=405°C

SAGA 34/7-7
C 3978

RT: VALVE 2 + ON

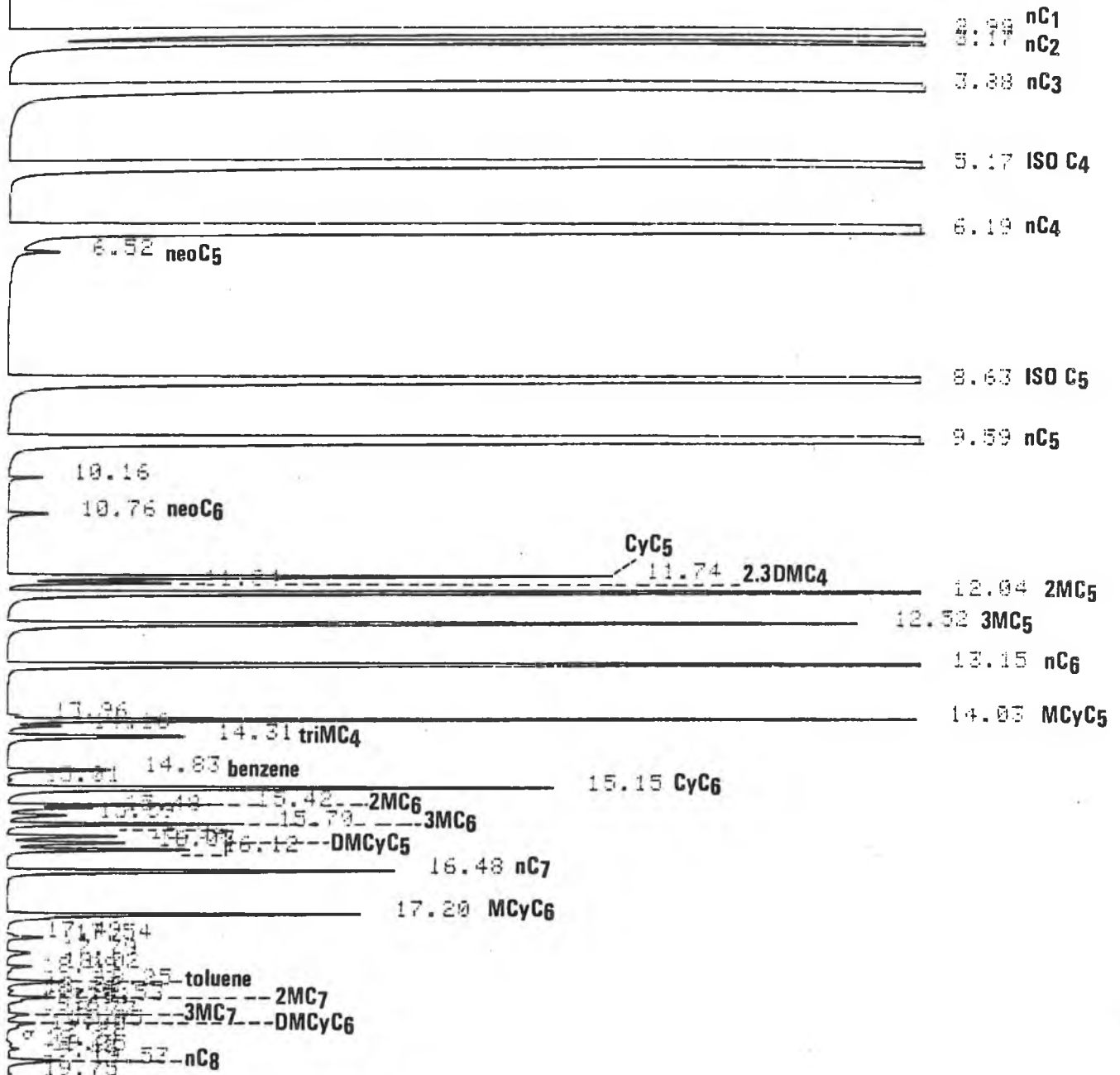
OV: START PRGM RATE 1



OVEN TEMP FINAL TIME 1

RT: VALVE 2 + ON
OVEN TEMP 1 FINAL TIME + 30.00 MIN
OV: START PRGM RATE 1

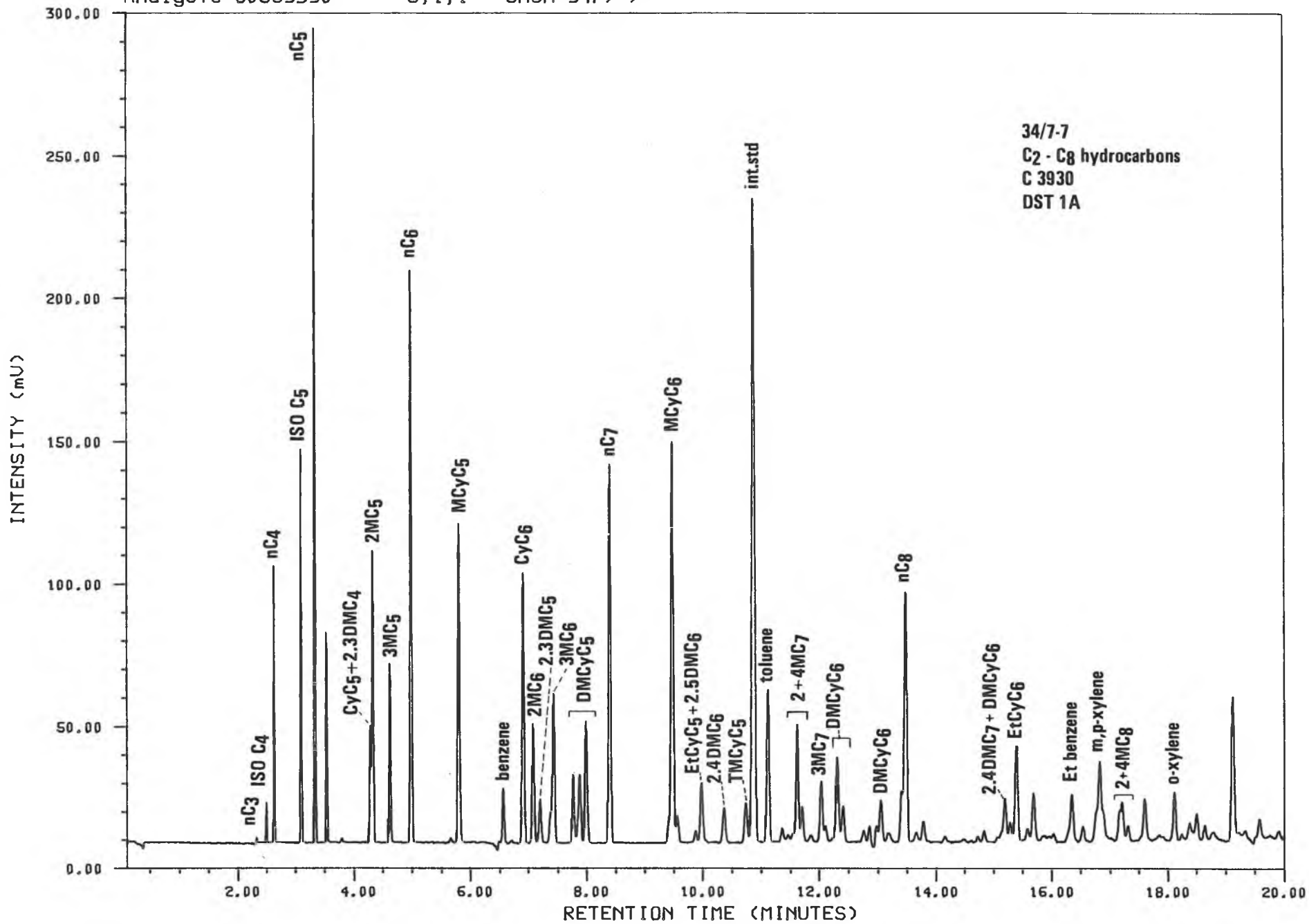
SAGA 34/7-7
C3931

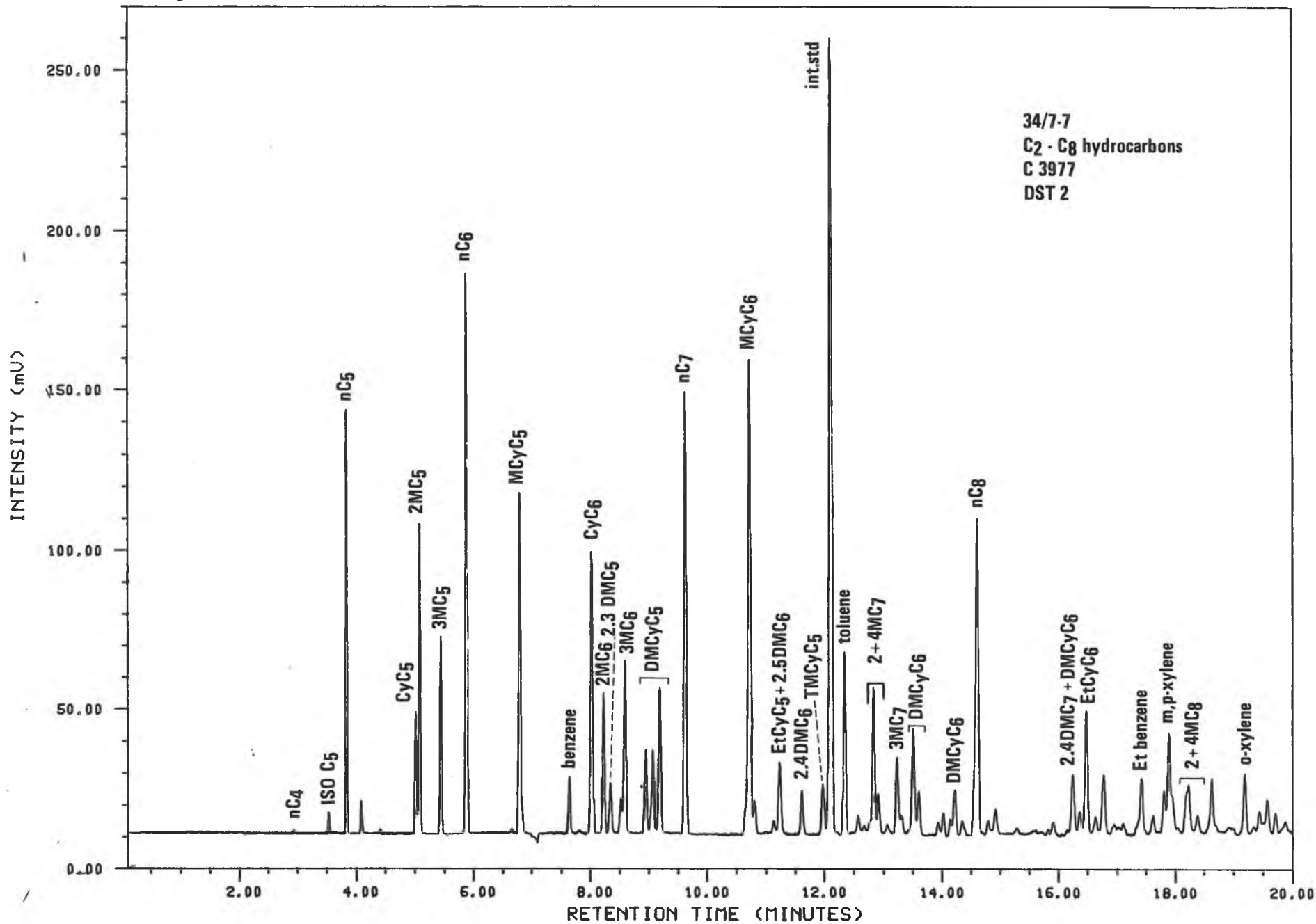


OV: START FINAL TIME 1
30.00
30.40

FIGURE 2

Gas chromatograms of C₂-C₈ hydrocarbons
from DST oils





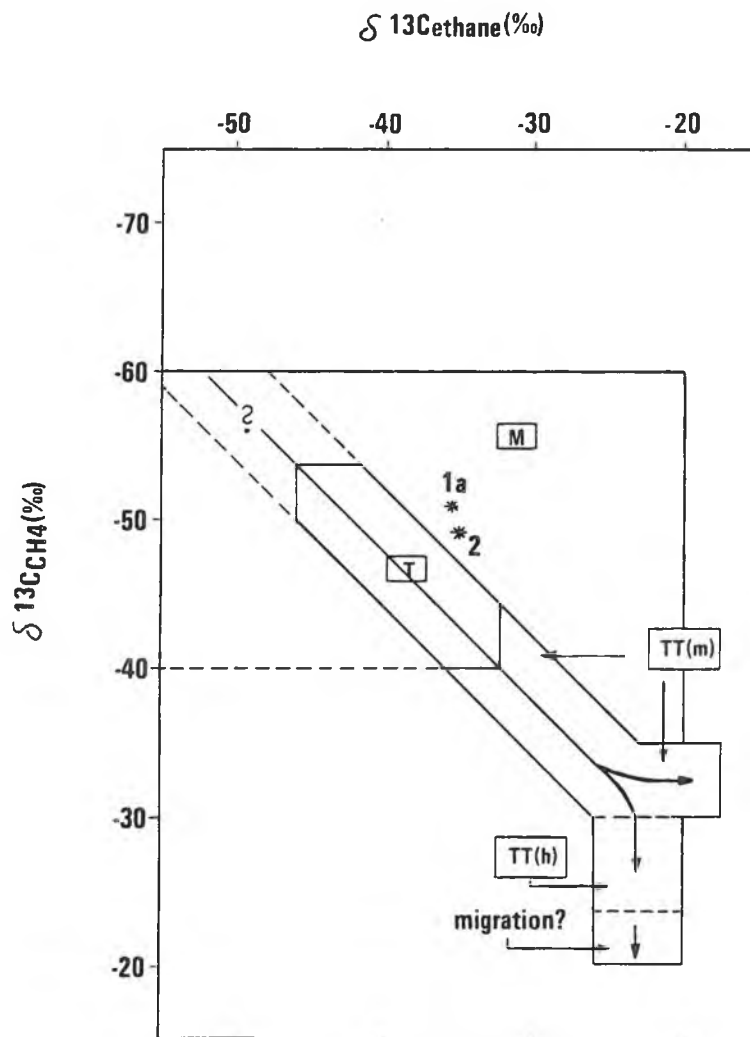
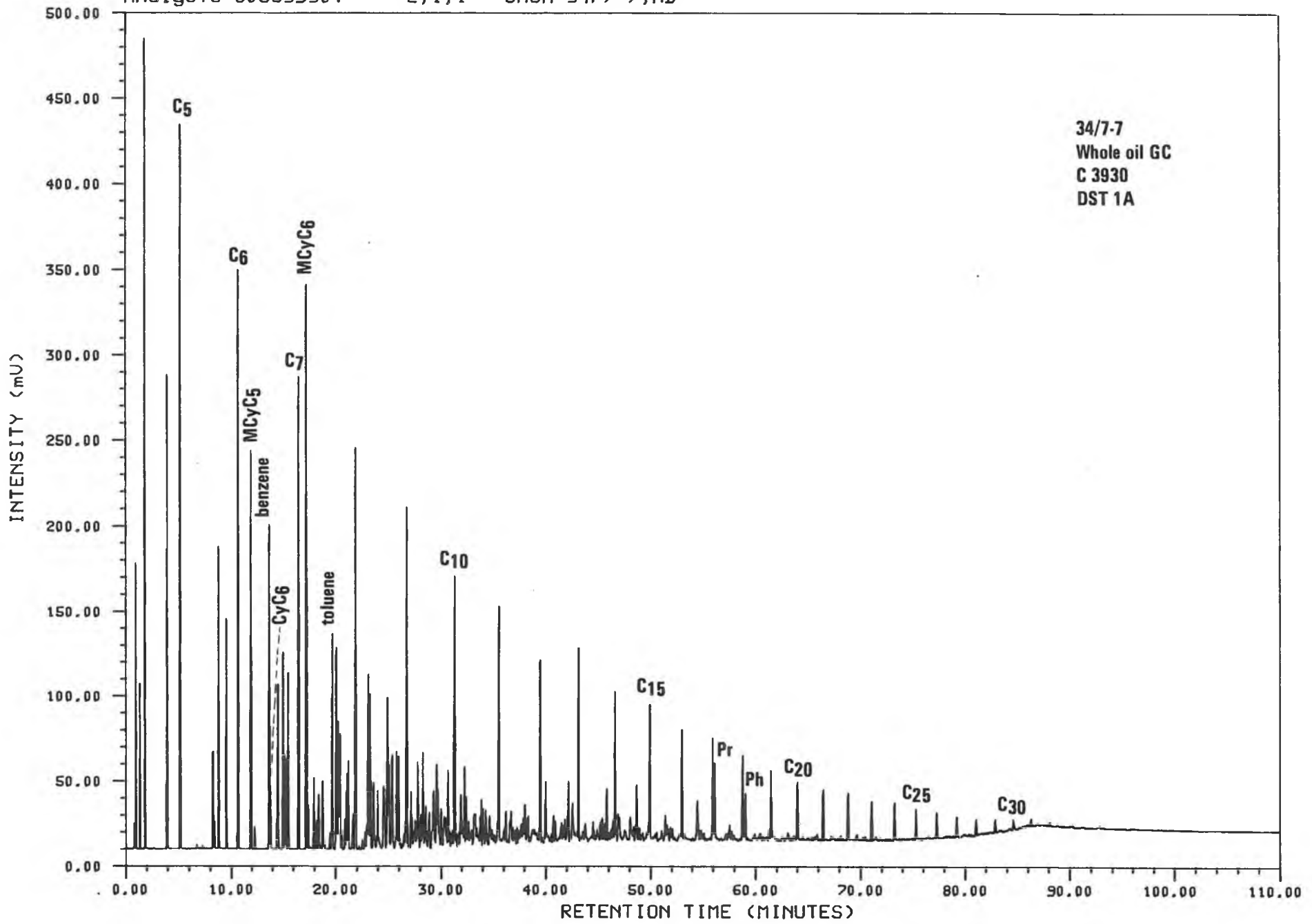


FIGURE 3: The two DST gas samples have $\delta^{13}\text{C}$ isotope values plot close to the zone of gases associated with oil/condensate, but lie just inside the zone normally associated with mixed catagenic/biogenic gases. Schoell (1983).

FIGURE 4

Whole oil gas chromatograms of DST oils



34/7-7
Whole oil GC
C 3930
DST 1A

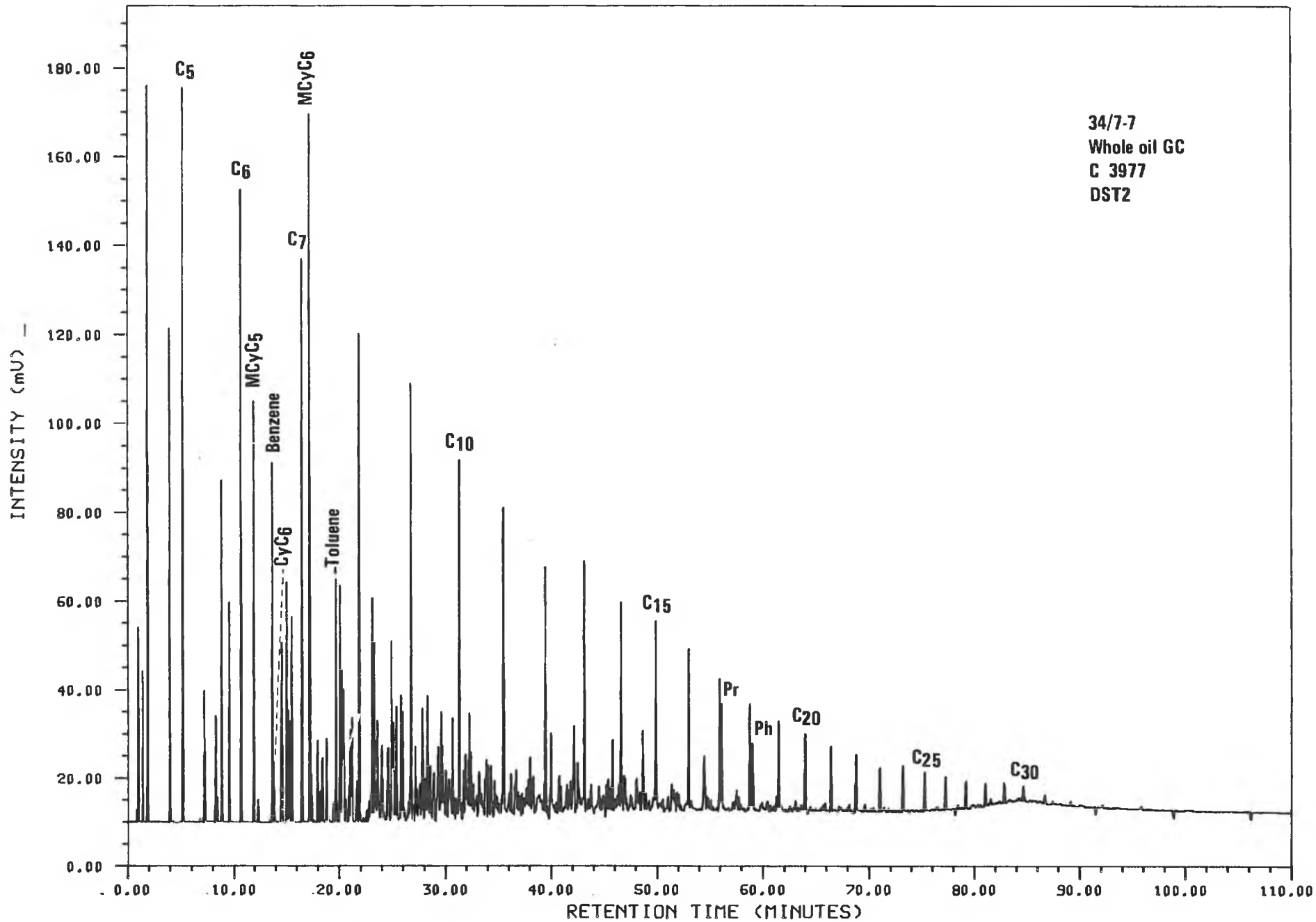
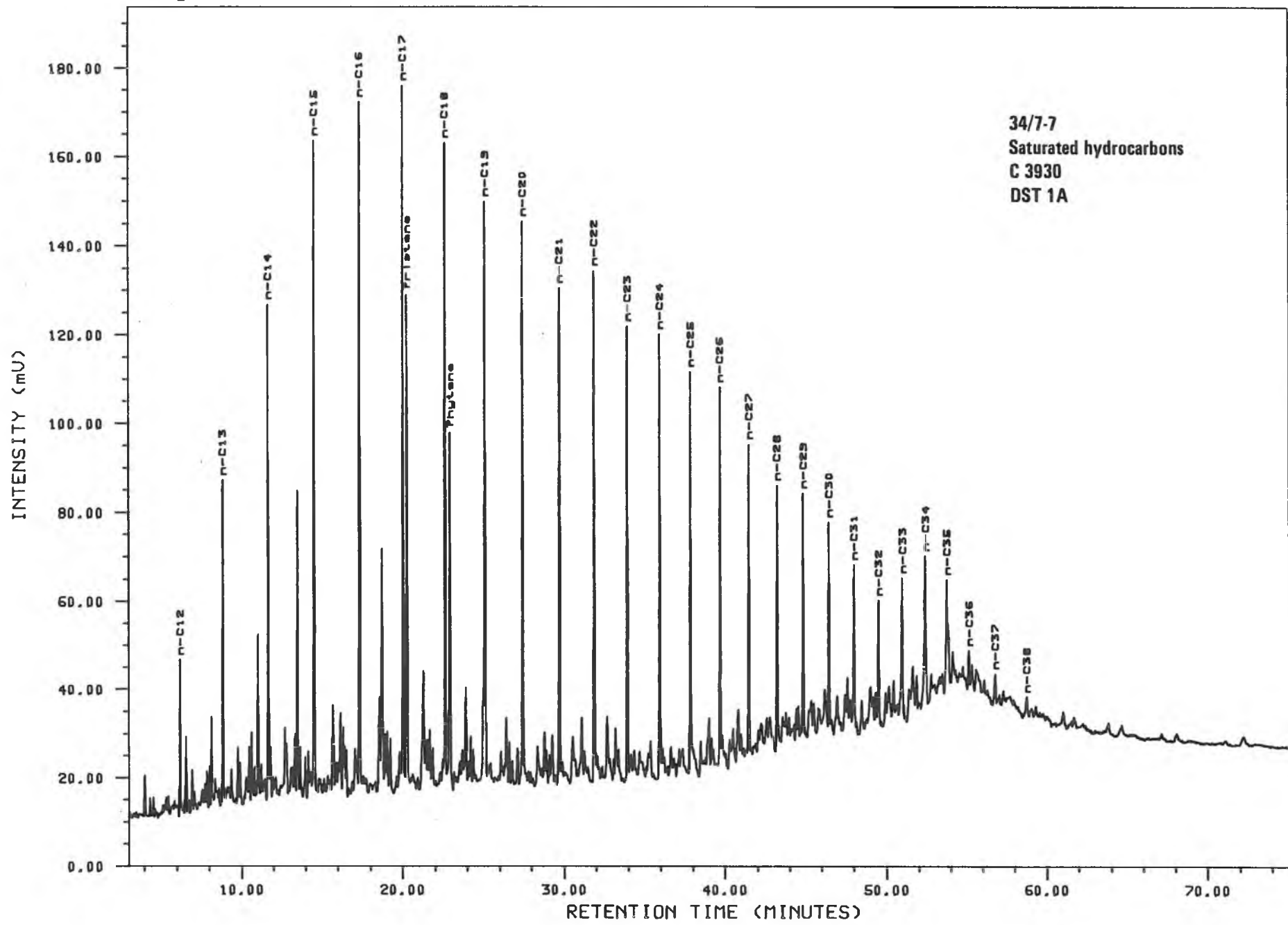


FIGURE 5

Gas chromatograms of saturated hydrocarbons



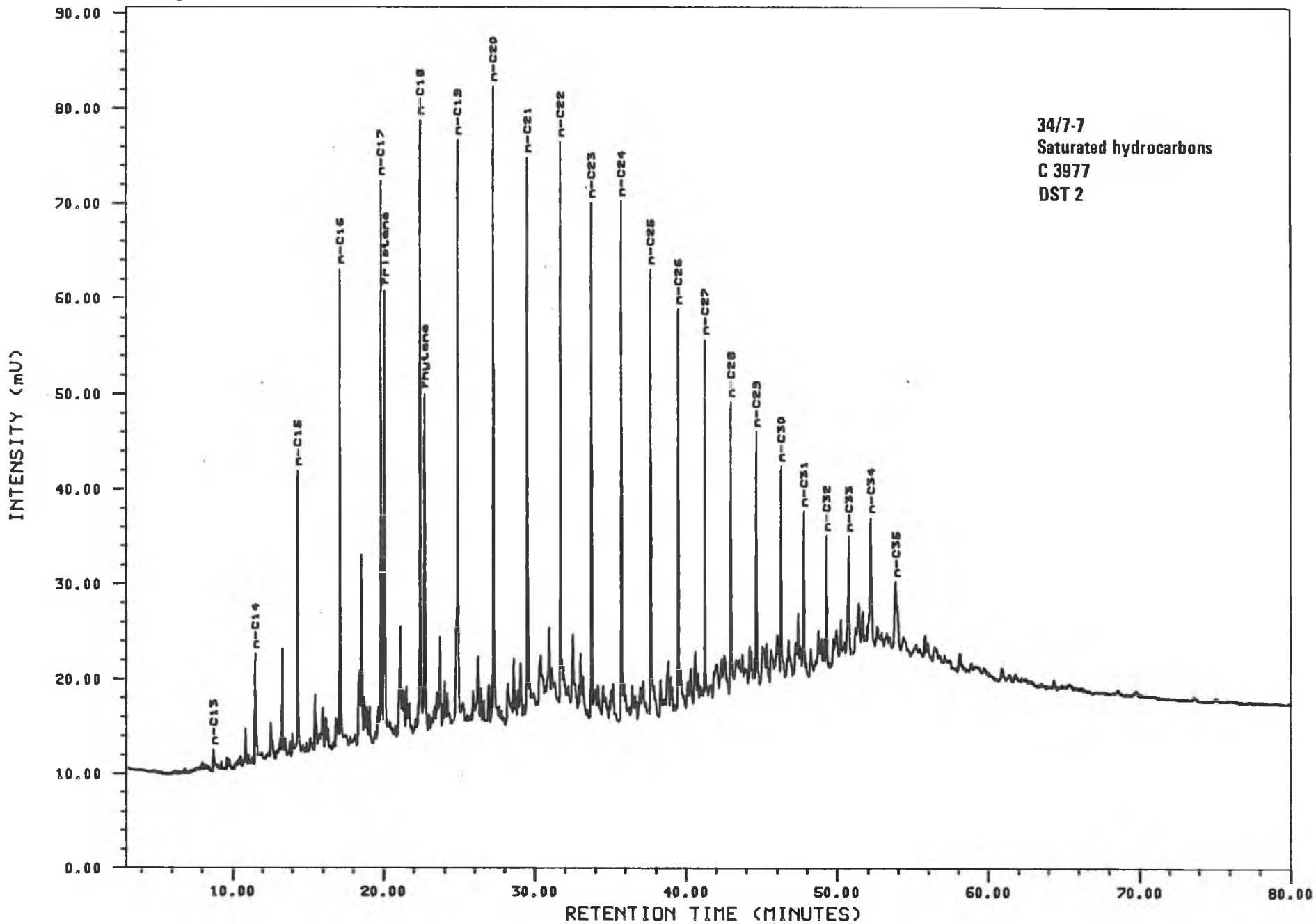
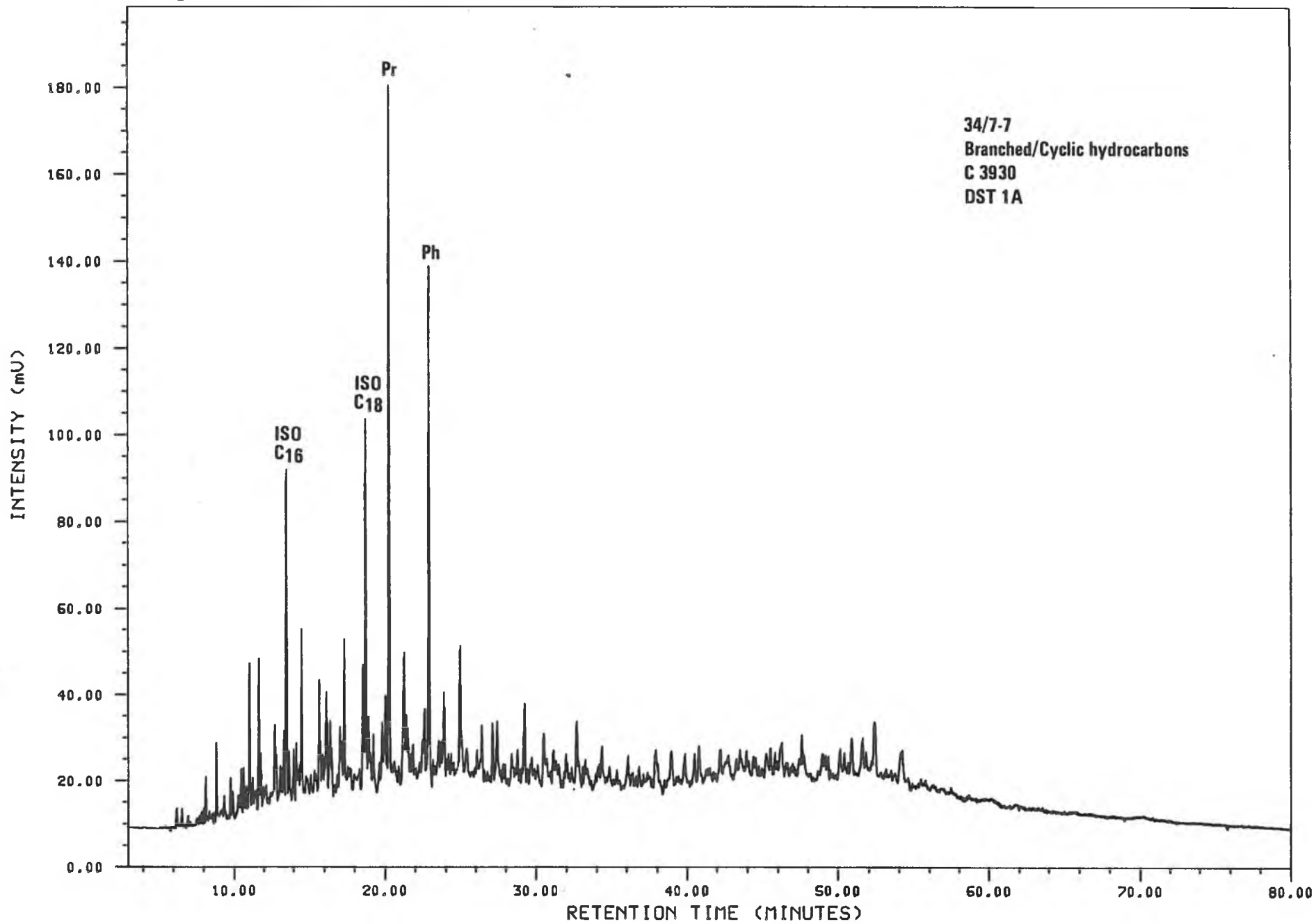
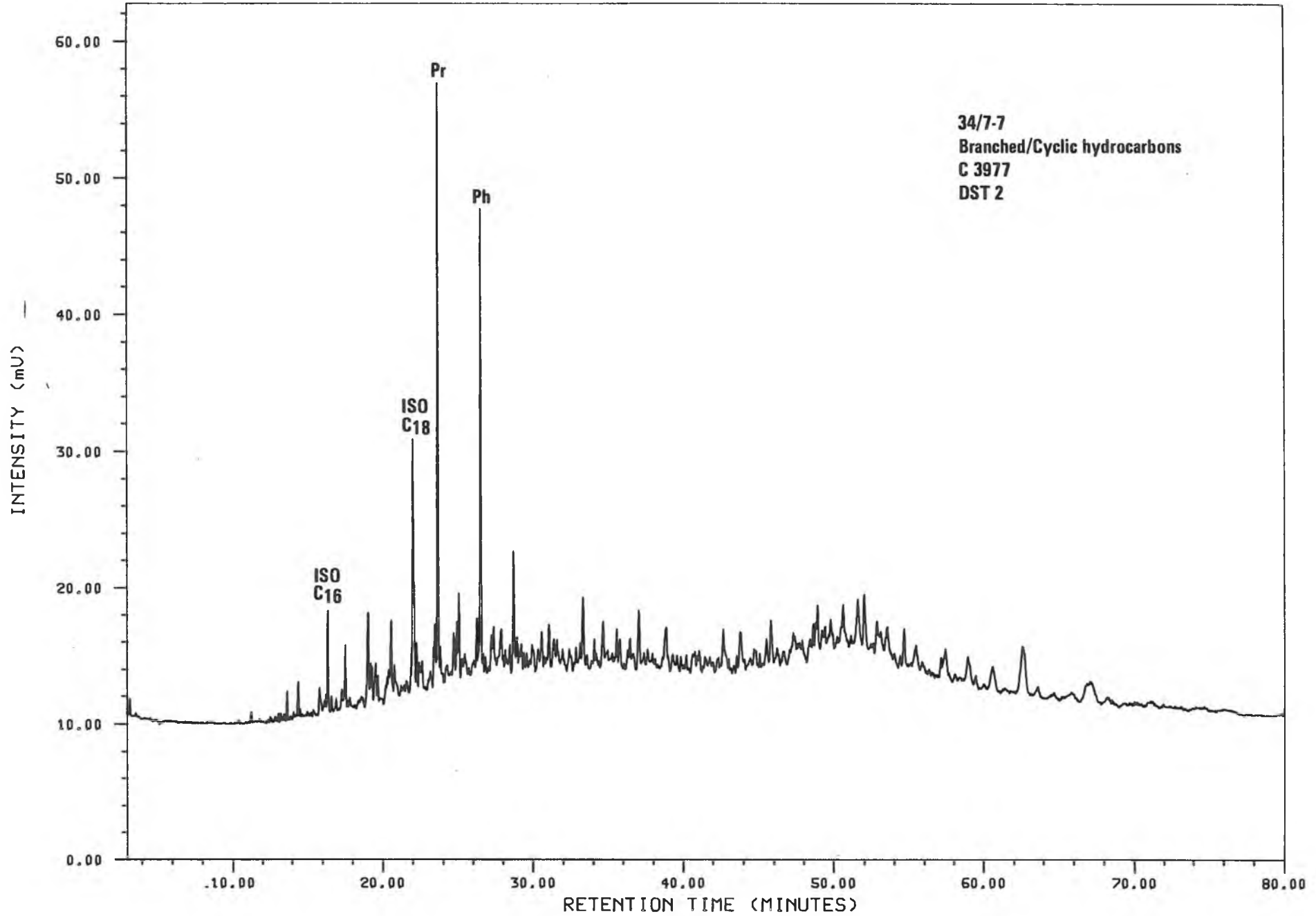


FIGURE 6

Gas chromatograms of branched/cyclic hydrocarbons



34/7-7
Branched/Cyclic hydrocarbons
C 3930
DST 1A



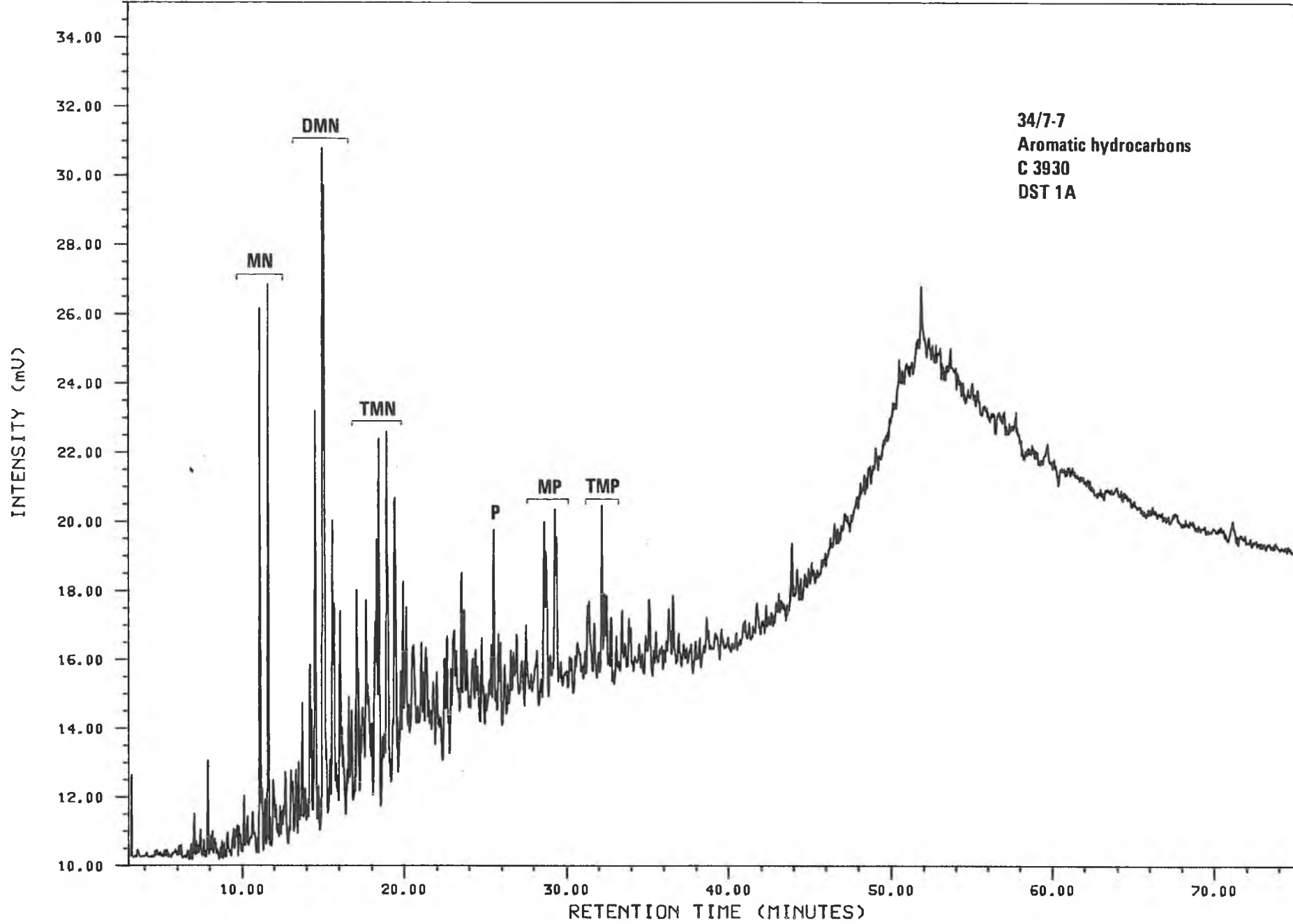
34/7-7
Branched/Cyclic hydrocarbons
C 3977
DST 2

FIGURE 7

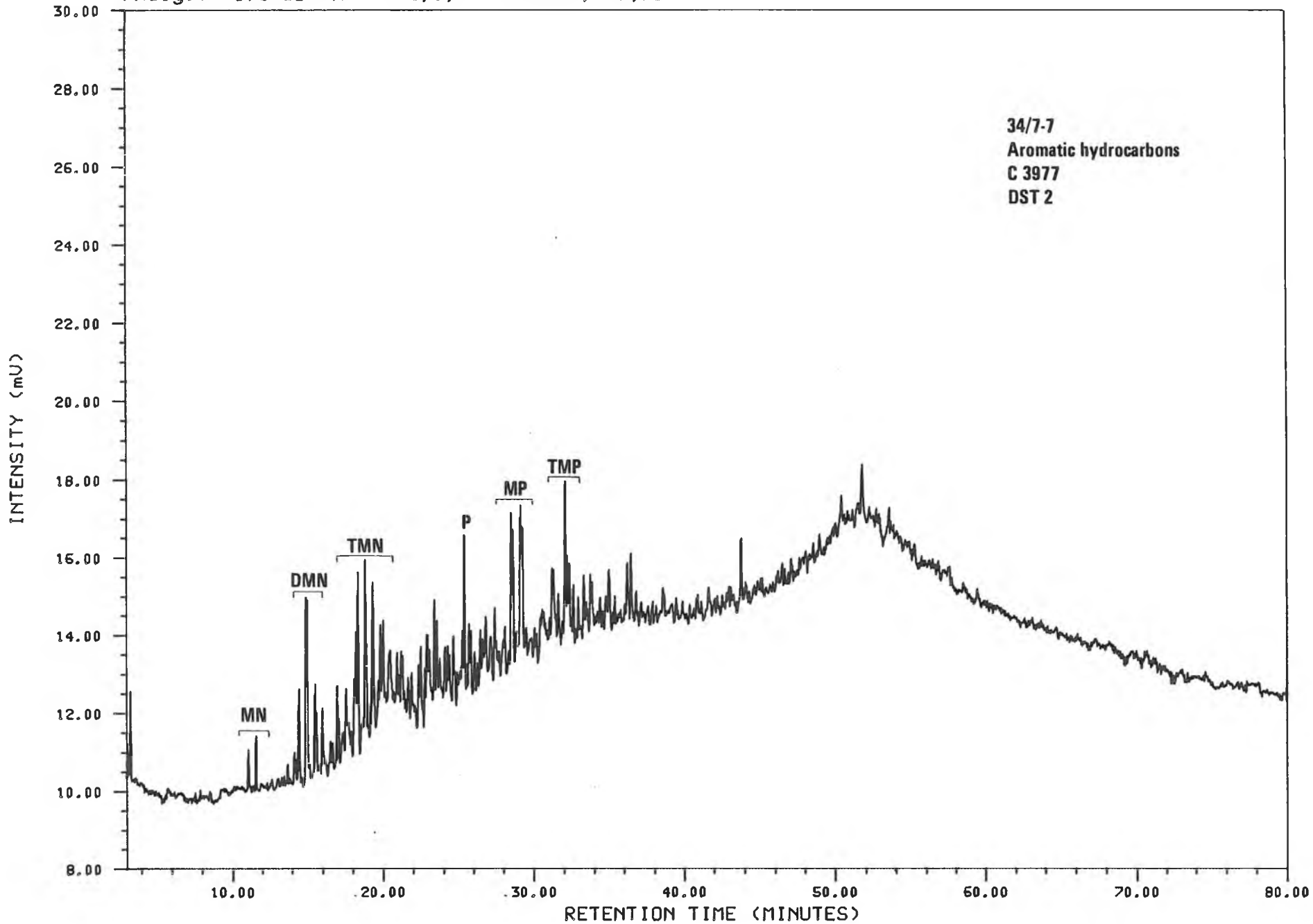
Gas chromatograms of aromatic hydrocarbons

N,MN,DMN,TMN = Naphthalene and alkylated homologs

P,MP,DMP = Phenanthrene and alkylated homologs



34/7-7
Aromatic hydrocarbons
C 3930
DST 1A



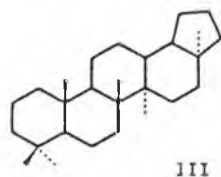
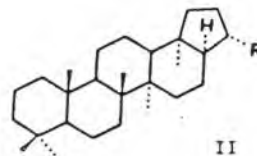
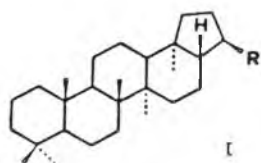
34/7-7
Aromatic hydrocarbons
C 3977
DST 2

FIGURE 8

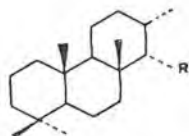
Mass chromatograms of terpanes
(m/z 191)

Mass chromatograms representing terpanes (m/z 191)

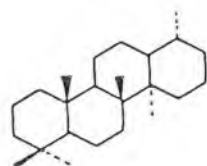
A	T _S , 18 α (H)-trisorneohopane	C ₂₇ H ₄₆	(III)
B	T _m , 17 α (H)-trisorhopane	C ₂₇ H ₄₆	(I, R=H)
C	17 α (H)-norhopane	C ₂₉ H ₅₀	(I, R=C ₂ H ₅)
D	17 β (H)-normoretane	C ₂₉ H ₅₀	(II, R=C ₂ H ₅)
E	17 α (H)-hopane	C ₃₀ H ₅₂	(I, R=C ₃ H ₇)
F	17 β (H)-moretane	C ₃₀ H ₅₂	(II, R=C ₃ H ₇)
G	17 α (H)-homohopane (22S)	C ₃₁ H ₅₄	(I, R=C ₄ H ₉)
H	17 α (H)-homohopane (22R)	C ₃₁ H ₅₄	(I, R=C ₄ H ₉)
	+ unknown triterpane (gammacerane?)		
I	17 β (H)-homomoretane	C ₃₁ H ₅₄	(II, R=C ₄ H ₉)
J	17 α (H)-bishomohopane (22S,22R)	C ₃₂ H ₅₆	(I, R=C ₅ H ₁₁)
K	17 α (H)-trishomohopane (22S,22R)	C ₃₃ H ₅₈	(I, R=C ₆ H ₁₃)
L	17 α (H)-tetrakishomohopane (22S,22R)	C ₃₄ H ₆₀	(I, R=C ₇ H ₁₅)
M	17 α (H)-pentakishomohopane (22S,22R)	C ₃₅ H ₆₂	(I, R=C ₈ H ₁₇)
Z	bisorhopane	C ₂₈ H ₄₈	
X	unknown triterpane	C ₃₀ H ₅₂	
P	tricyclic terpane	C ₂₃ H ₄₂	(IV, R=C ₄ H ₉)
Q	tricyclic terpane	C ₂₄ H ₄₄	(IV, R=C ₅ H ₁₁)
R	tricyclic terpane (17R,17S)	C ₂₅ H ₄₆	(IV, R=C ₆ H ₁₃)
S	tetracyclic terpane	C ₂₄ H ₄₂	(V)
T	tricyclic terpane (17R,17S)	C ₂₆ H ₄₈	(IV, R=C ₇ H ₁₅)



IV

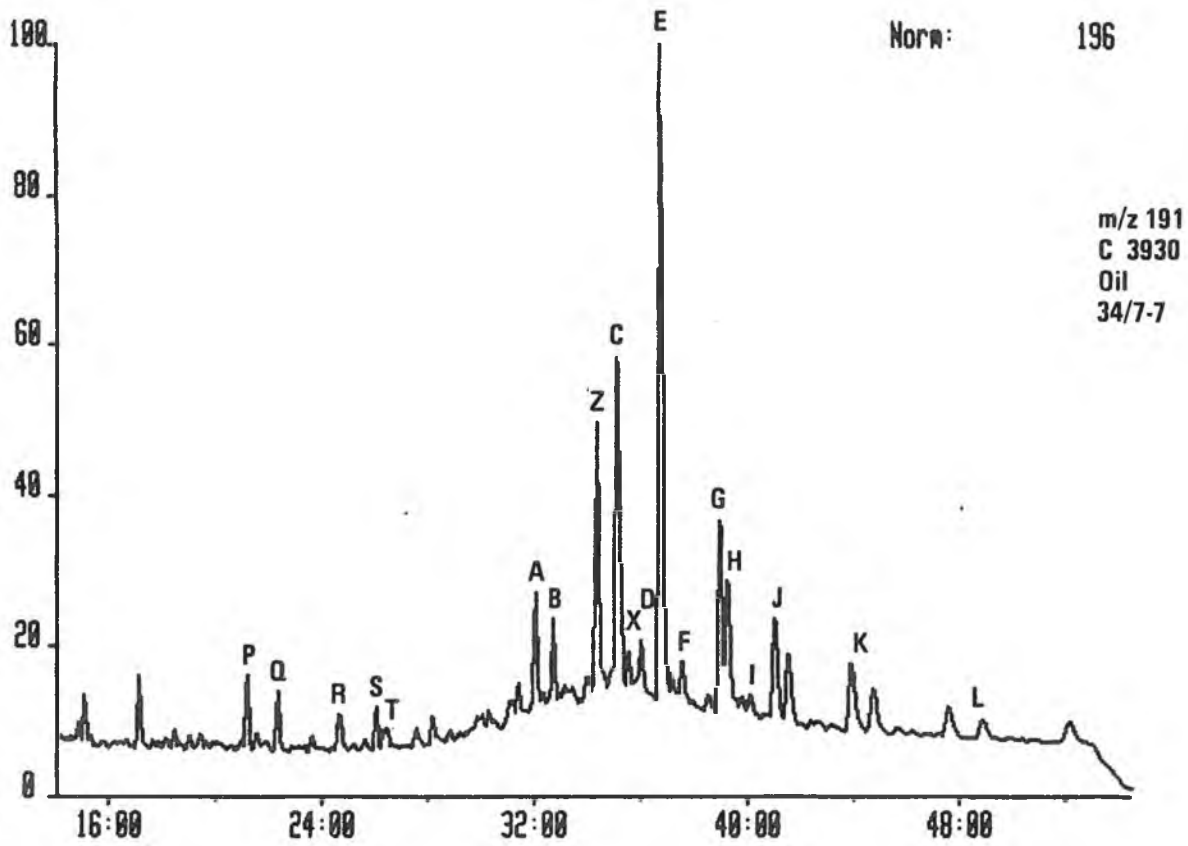


V



C3930SAT 3-APR-06 Sir:Voltage 12-250 Acnt:IKU
Sample 1 Injection 1 Group 1 Mass 191.1000
Text:

System:QUAMID



C3977SAT 15-APR-86 Sir:Voltage 12-250 Acnt:IKU
Sample 1 Injection 1 Group 1 Mass 191.1000
Text:

System:QUAMID

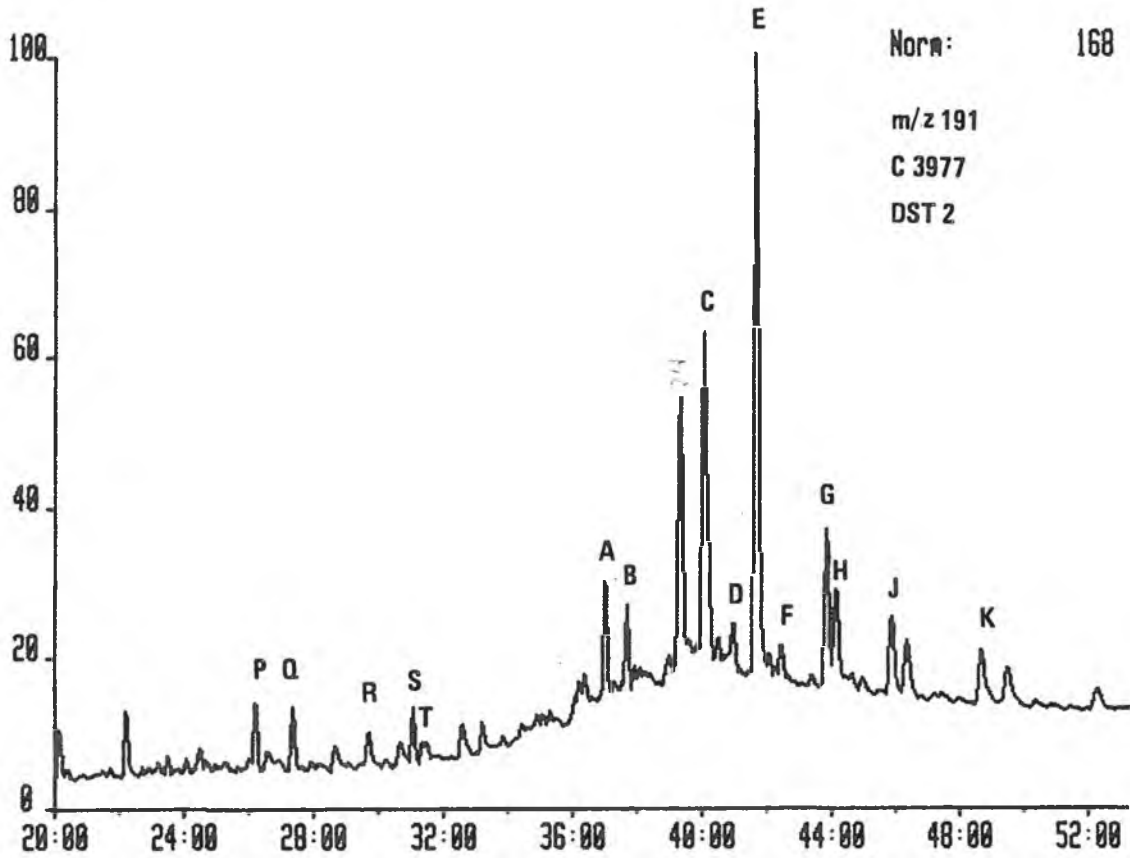
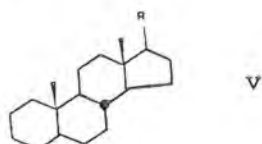
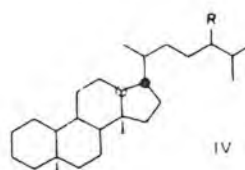
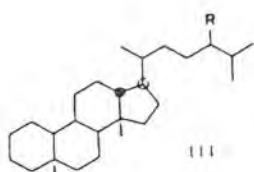
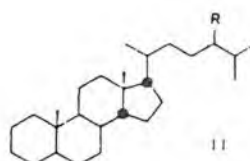
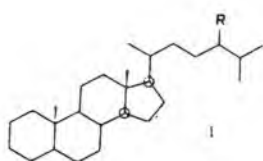


FIGURE 9

Mass chromatograms of steranes
(m/z 217, 218)

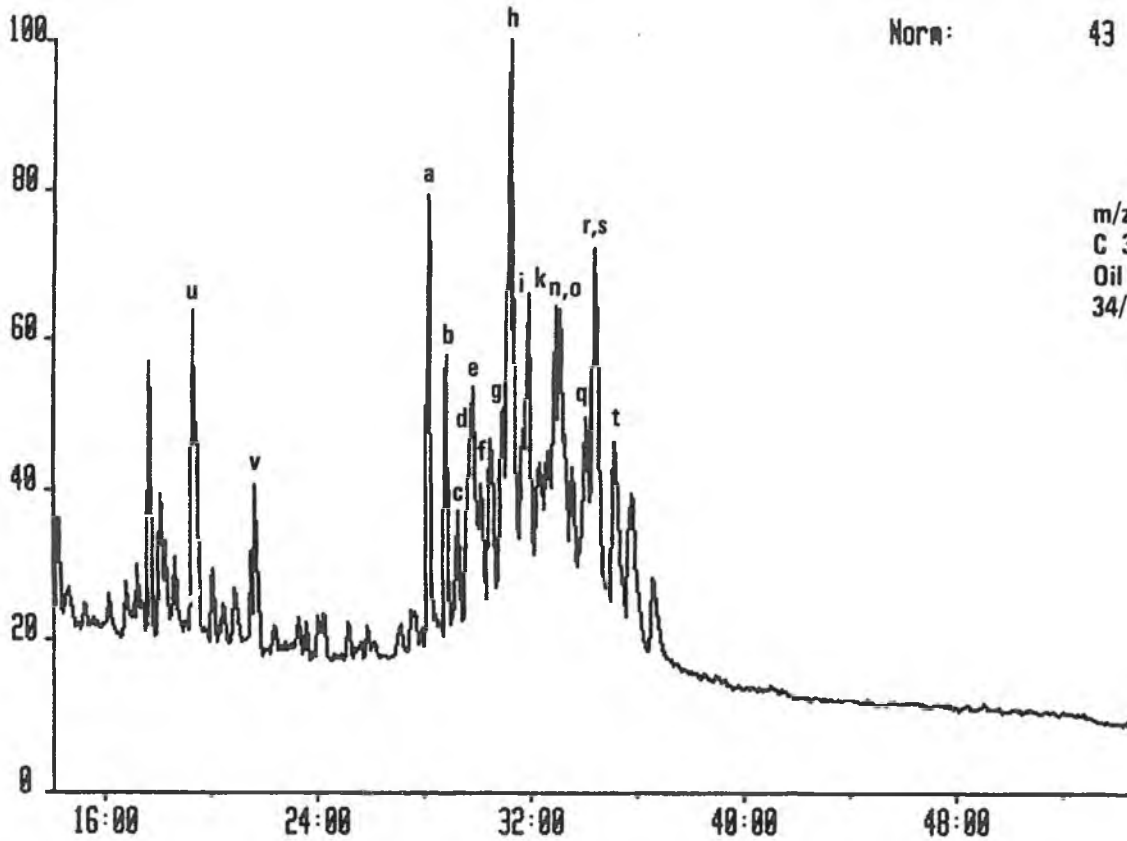
Mass chromatograms representing steranes (m/z 217 and 218)

a	13 β (H),17 α (H)-diasterane (20S)	C ₂₇ H ₄₈	(III,R=H)
b	13 β (H),17 α (H)-diasterane (20R)	C ₂₇ H ₄₈	(III,R=H)
c	13 α (H),17 β (H)-diasterane (20S)	C ₂₇ H ₄₈	(IV,R=H)
d	13 α (H),17 β (H)-diasterane (20R)	C ₂₇ H ₄₈	(IV,R=H)
e	13 β (H),17 α (H)-diasterane (20S)	C ₂₈ H ₅₀	(III,R=CH ₃)
f	13 β (H),17 α (H)-diasterane (20R)	C ₂₈ H ₅₀	(III,R=CH ₃)
g	13 α (H),17 β (H)-diasterane (20S)	C ₂₈ H ₅₀	(IV,R=CH ₃)
	+ 14 α (H),17 α (H)-sterane (20S)	C ₂₇ H ₄₈	(I,R=H)
h	13 β (H),17 α (H)-diasterane (20S)	C ₂₉ H ₅₂	(III,R=C ₂ H ₅)
	+ 14 β (H),17 β (H)-sterane (20R)	C ₂₇ H ₄₈	(II,R=H)
i	14 β (H),17 β (H)-sterane (20S)	C ₂₇ H ₄₈	(II,R=H)
	+ 13 α (H),17 β (H)-diasterane (20R)	C ₂₈ H ₅₀	(IV,R=CH ₃)
j	14 α (H),17 α (H)-sterane (20R)	C ₂₇ H ₄₈	(I,R=H)
k	13 β (H),17 α (H)-diasterane (20R)	C ₂₉ H ₅₂	(III,R=C ₂ H ₅)
l	13 α (H),17 β (H)-diasterane (20S)	C ₂₉ H ₅₂	(III,R=C ₂ H ₅)
m	14 α (H),17 α (H)-sterane (20S)	C ₂₈ H ₅₀	(I,R=CH ₃)
n	13 α (H),17 β (H)-diasterane (20R)	C ₂₉ H ₅₂	(III,R=C ₂ H ₅)
	+ 14 β (H),17 β (H)-sterane (20R)	C ₂₈ H ₅₀	(II,R=CH ₃)
o	14 β (H),17 β (H)-sterane (20S)	C ₂₈ H ₅₀	(II,R=CH ₃)
p	14 α (H),17 α (H)-sterane (20R)	C ₂₈ H ₅₀	(I,R=CH ₃)
q	14 α (H),17 α (H)-sterane (20S)	C ₂₉ H ₅₂	(I,R=C ₂ H ₅)
r	14 β (H),17 β (H)-sterane (20R)	C ₂₉ H ₅₂	(II,R=C ₂ H ₅)
	+ unknown sterane		
s	14 β (H),17 β (H)-sterane (20S)	C ₂₉ H ₅₂	(II,R=C ₂ H ₅)
t	14 α (H),17 α (H)-sterane (20R)	C ₂₉ H ₅₂	(I,R=C ₂ H ₅)
u	5 α (H)-sterane	C ₂₁ H ₃₆	(V,R=C ₂ H ₅)
v	5 α (H)-sterane	C ₂₂ H ₃₈	(IV,R=C ₃ H ₇)



C3930SAT 3-APR-86 Sir:Voltage 12-250 Acnt:IKU
 Sample 1 Injection 1 Group 1 Mass 217.1000
 Text:

System:QUAMID

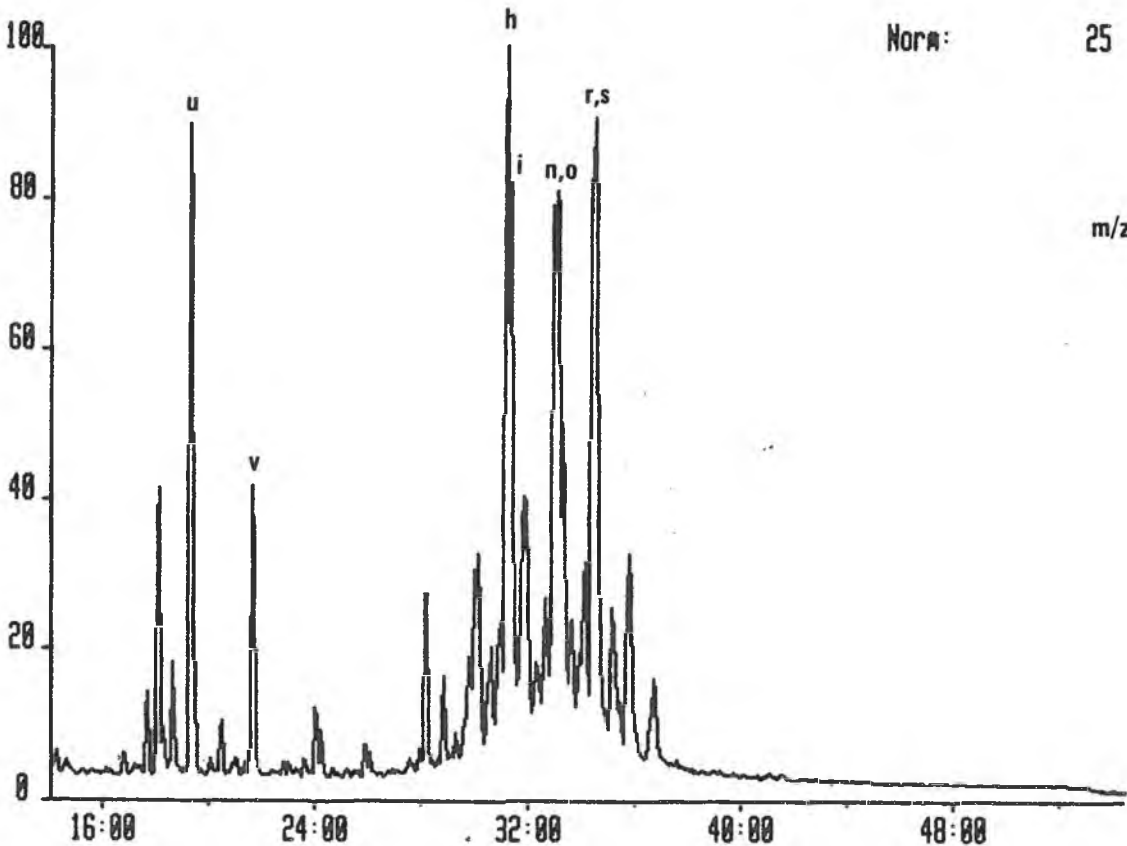


Norm: 43

m/z 217
 C 3930
 Oil
 34/7-7

C3930SAT 3-APR-86 Sir:Voltage 12-250 Acnt:IKU
 Sample 1 Injection 1 Group 1 Mass 218.1000
 Text:

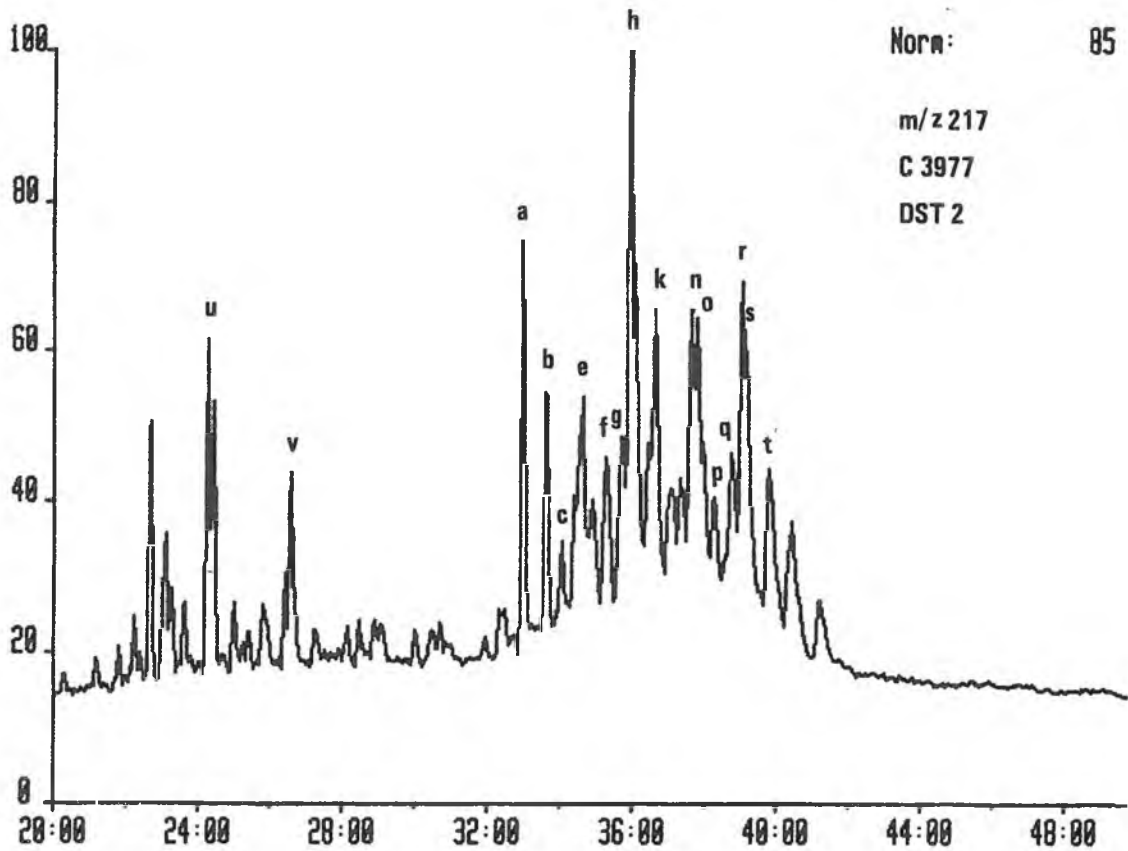
System:QUAMID



Norm: 25

m/z 218

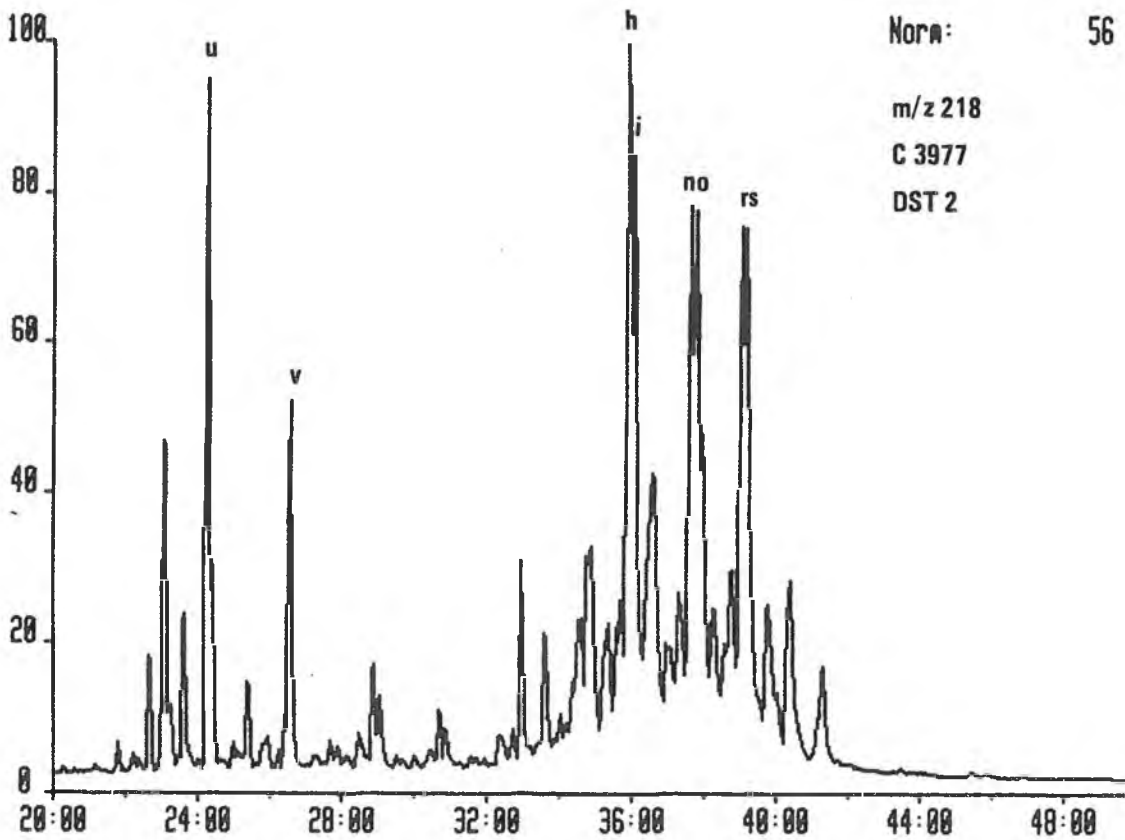
C3977SAT 15-APR-86 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
 Sample 1 Injection 1 Group 1 Mass 217.1000
 Text:



Norm: 85

m/z 217
 C 3977
 DST 2

C3977SAT 15-APR-86 Sir:Voltage 12-250 Acnt:IKU System:QUAMID
 Sample 1 Injection 1 Group 1 Mass 218.1000
 Text:



Norm: 56

m/z 218
 C 3977
 DST 2

FIGURE 10

Mass chromatograms of aromatic hydrocarbons

TIC

m/z 92,106

m/z 142,156,170

m/z 178,192,206

m/z 184,198,212

m/z 231

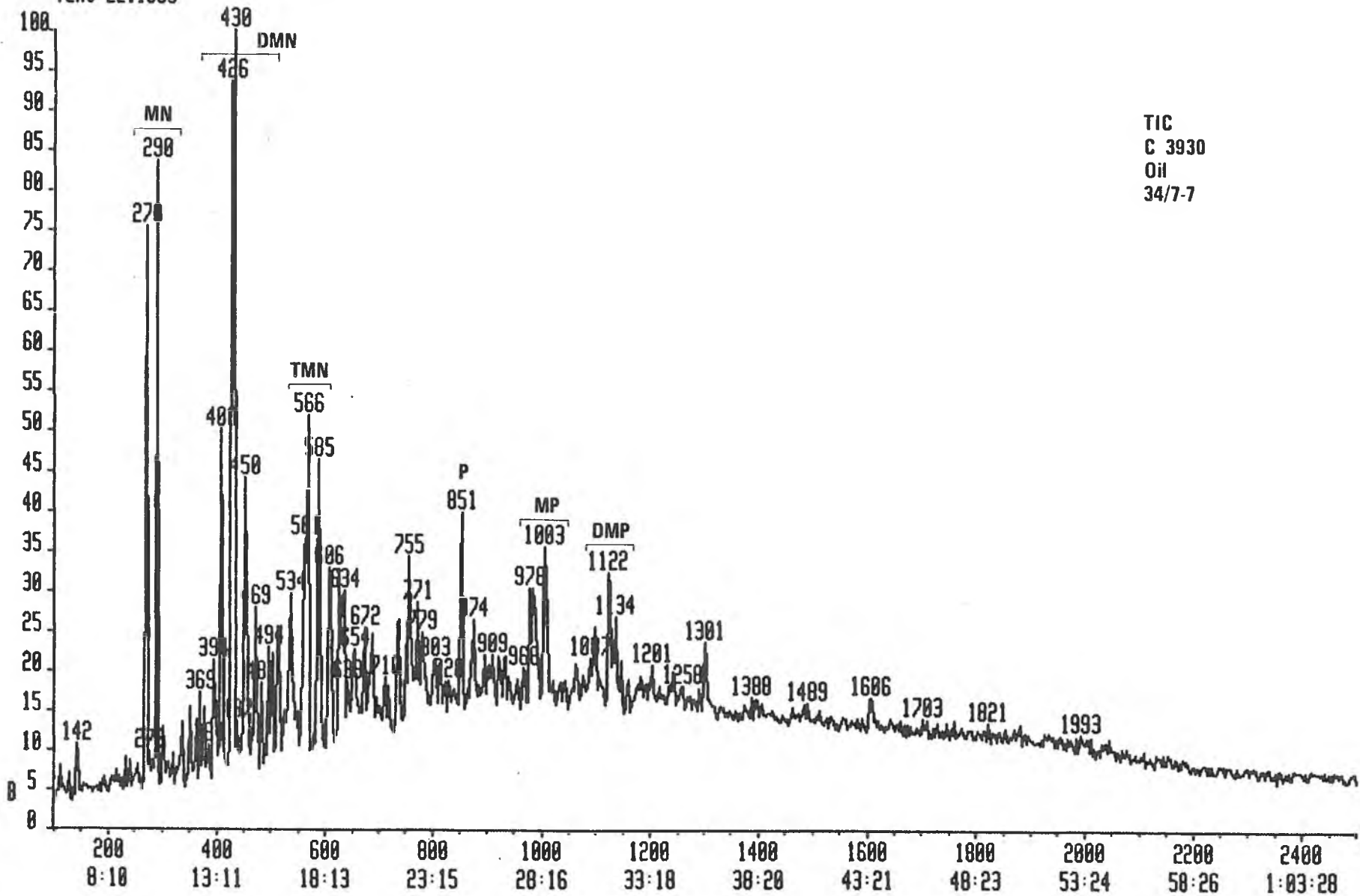
m/z 239,253

C3930ARD #100-2500 4-APR-86 14:16 12250
Chromatogram Identifiers : B1:TIC
Text:22.1005

acnt:IKU

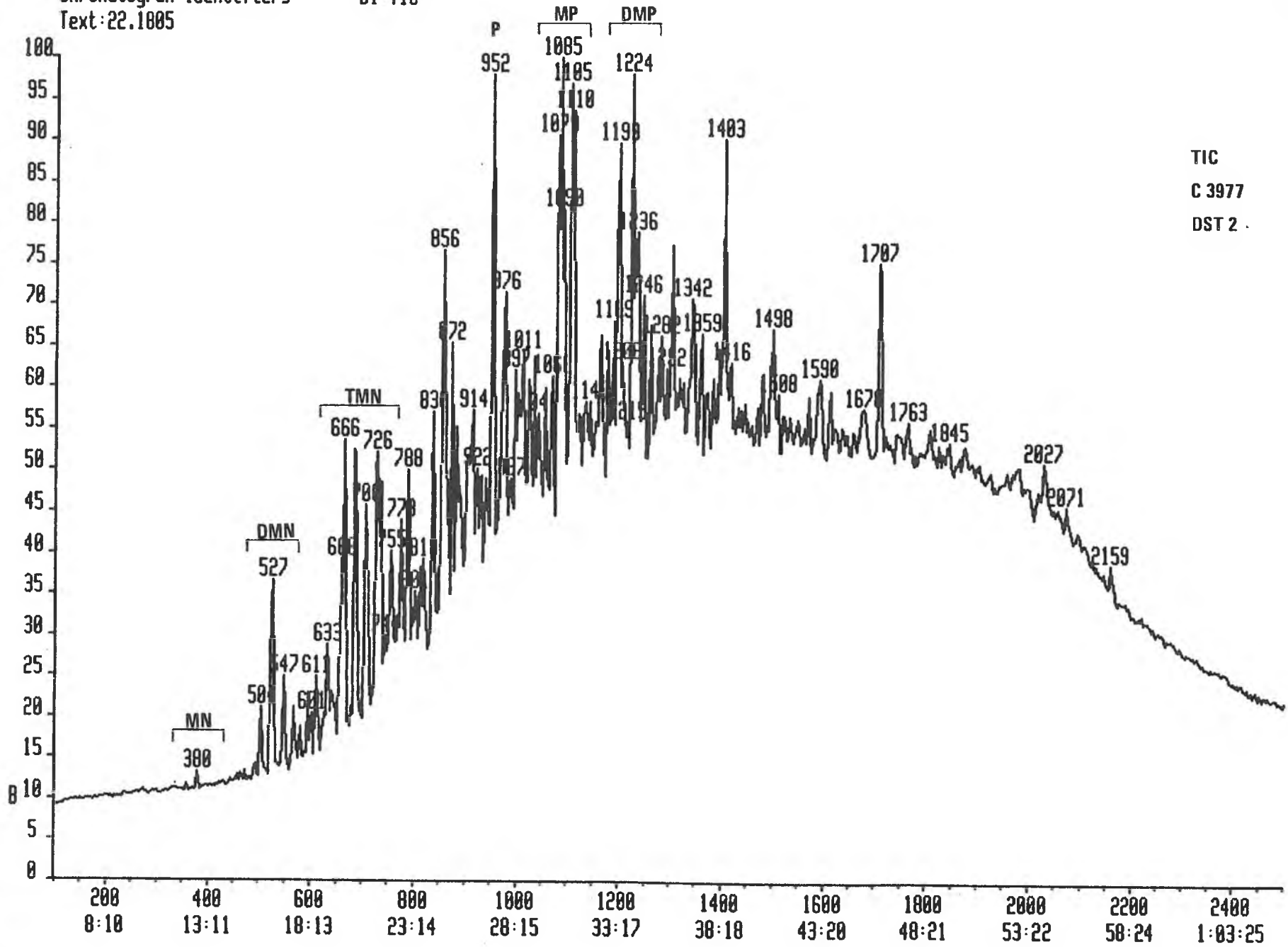
System:AROMATICs

IHP
B: 15720000



- 60 -

SCAN
TIME

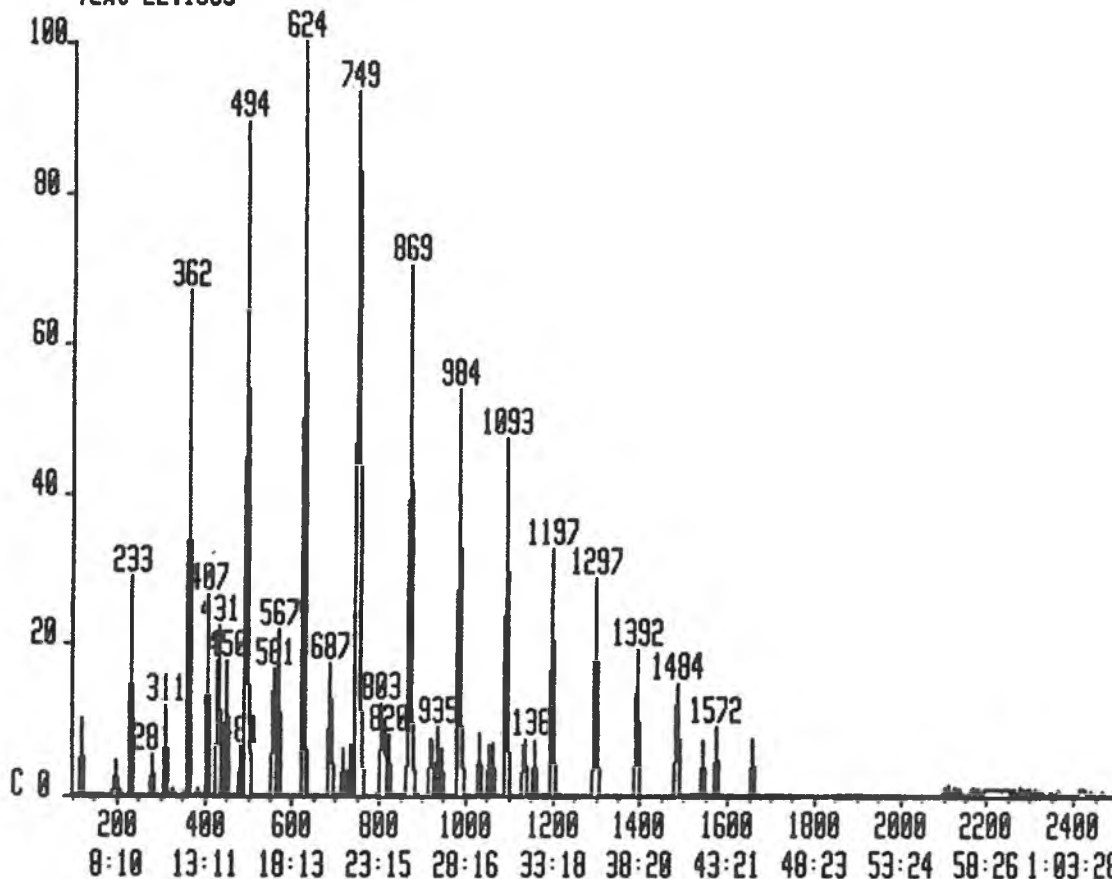


C3930ARO #100-2500 4-APR-86 14:16 12250
Chromatogram Identifiers : C1:92
Text:22.1005

acnt:IKU

System:AROMAPCS

C: 659000



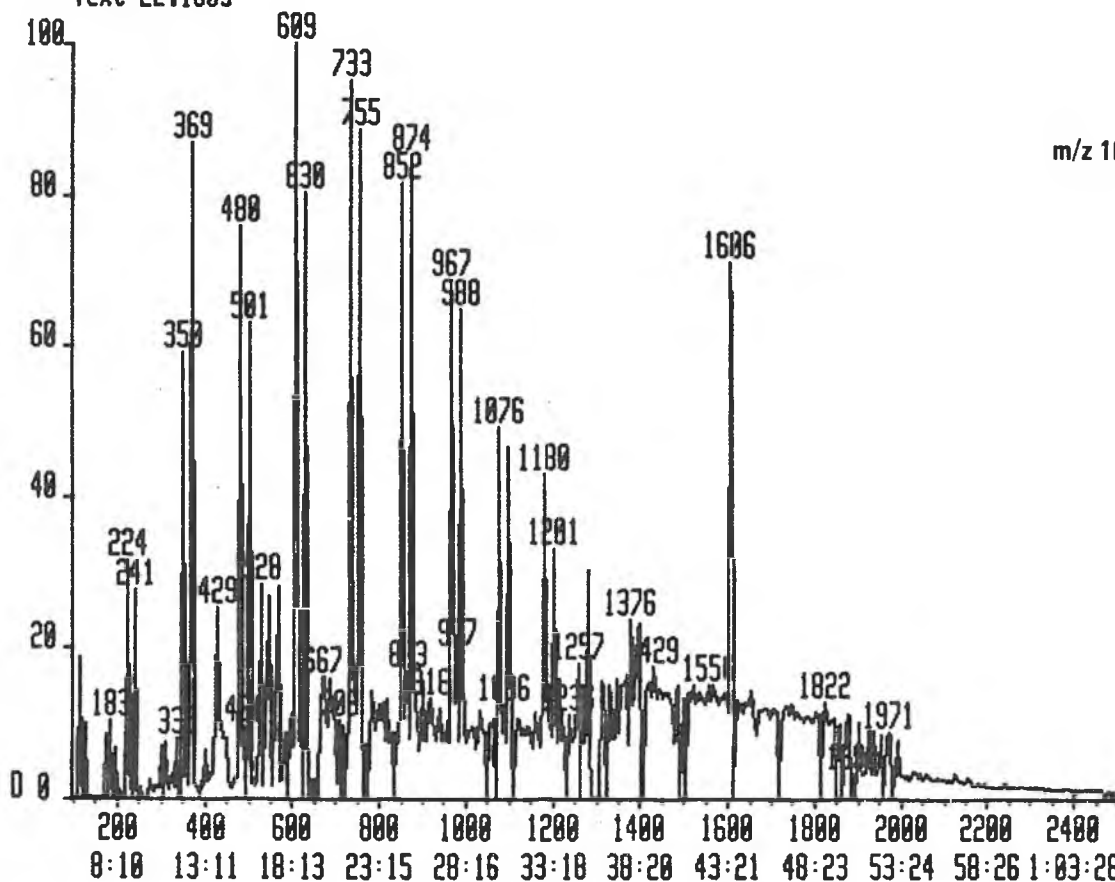
m/z 92
C 3930
Oil
34/7-7

C3930ARO #100-2500 4-APR-86 14:16 12250
Chromatogram Identifiers : O1:106
Text:22.1005

acnt:IKU

System:AROMAPCS

D: 494000

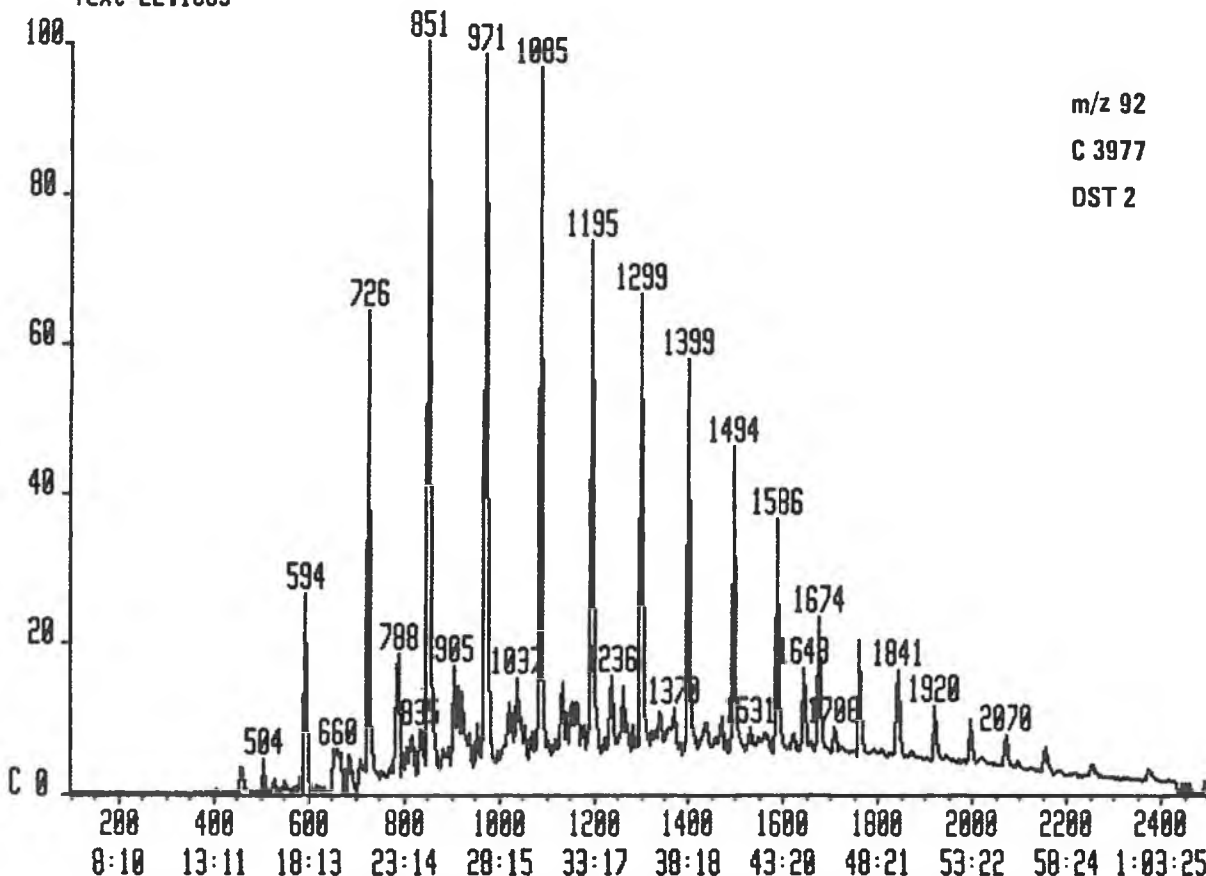


m/z 106

C3977ARO #100-2500 18-APR-86 09:54 12250
 Chromatogram Identifiers : C1:92
 Text:22.1005

acct:IKU

System:AROMATICS IHP
 C: 2225000

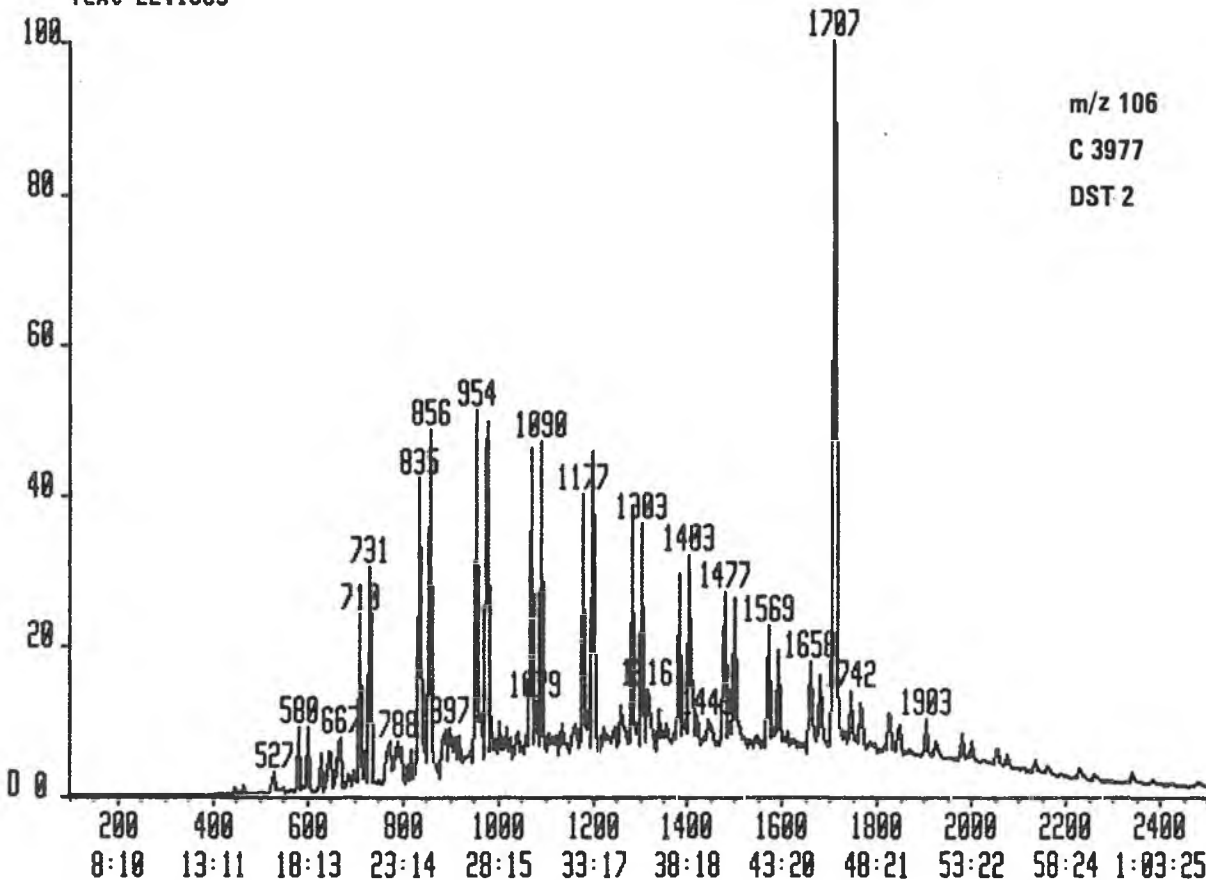


SCAN
 TIME

C3977ARO #100-2500 18-APR-86 09:54 12250
 Chromatogram Identifiers : D1:106
 Text:22.1005

acct:IKU

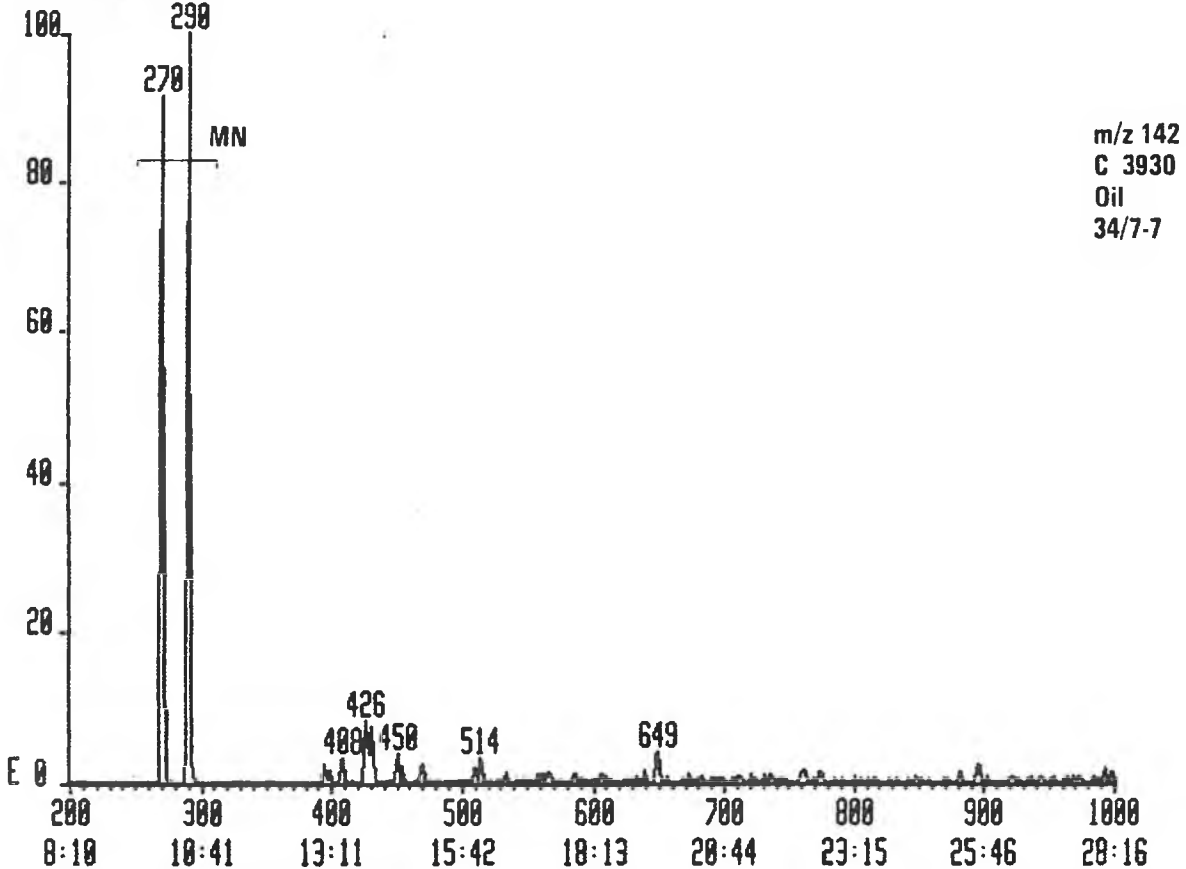
System:AROMATICS IHP
 D: 3463000



SCAN
 TIME

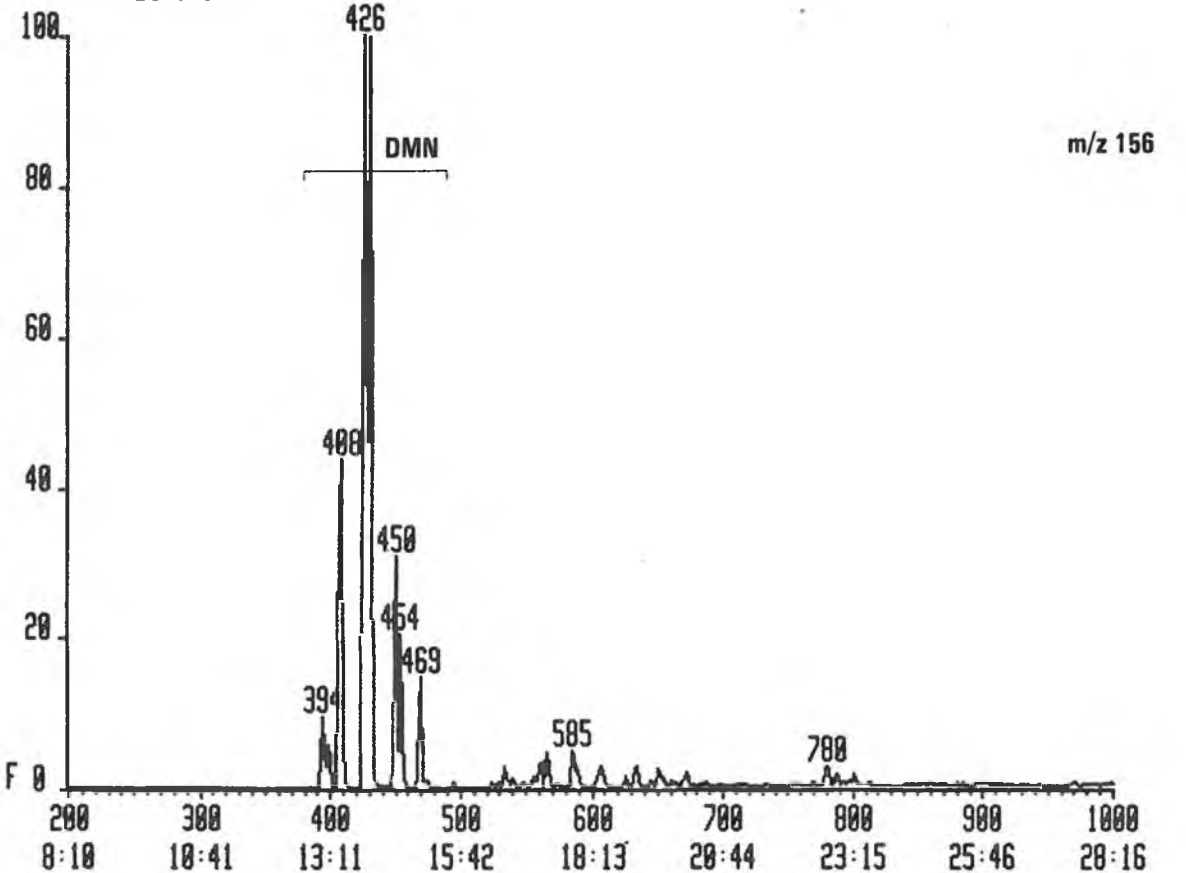
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 Chromatogram Identifiers : E1:142
 Text:22.1005

System:AROMATEPCS
 E: 3070000



C3930ARO #200-1000 4-APR-86 14:16 12250 acnt:IKU
 Chromatogram Identifiers : F1:156
 Text:22.1005

System:AROMATEPCS
 F: 3057000

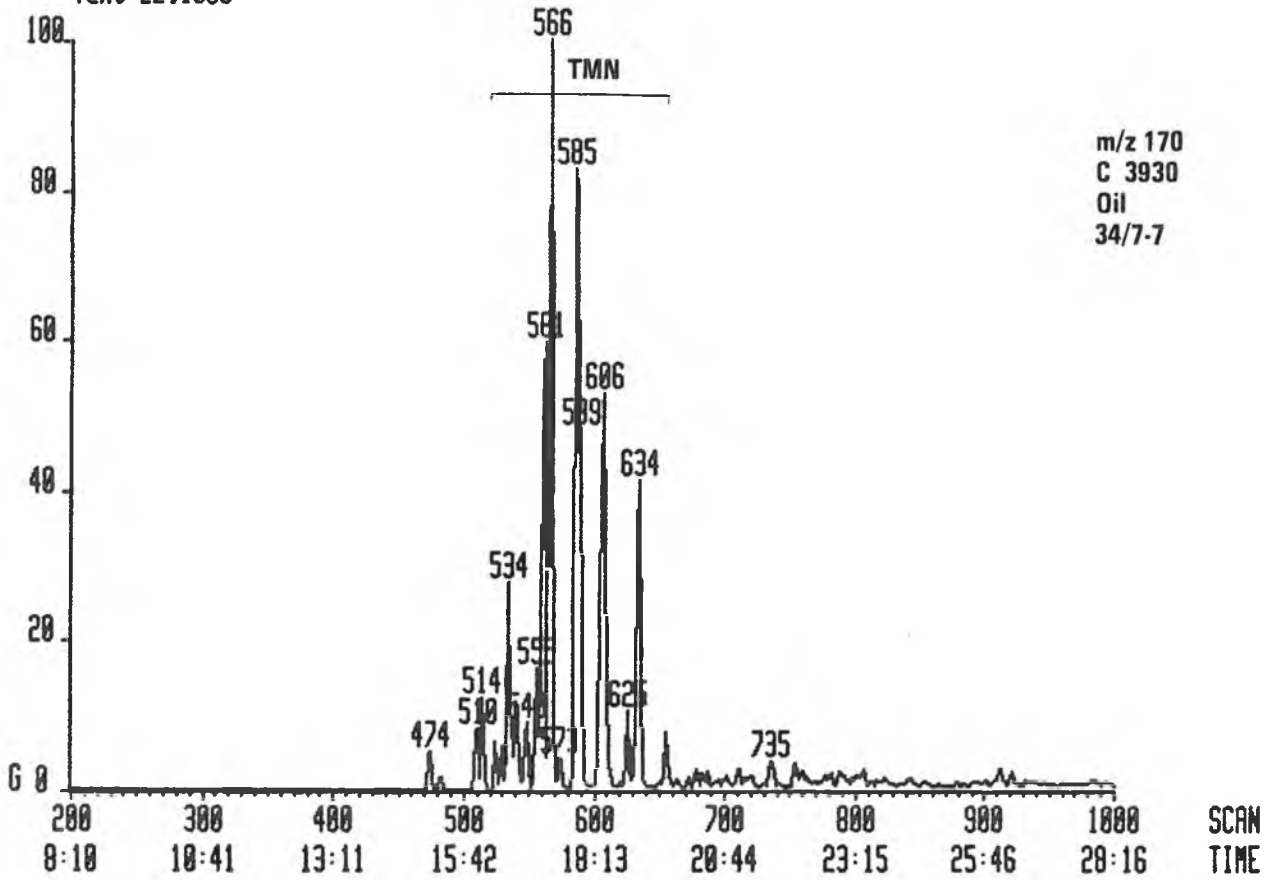


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 Text:22.1005

acnt:IKU

System:AROMATECS

G: 1157000

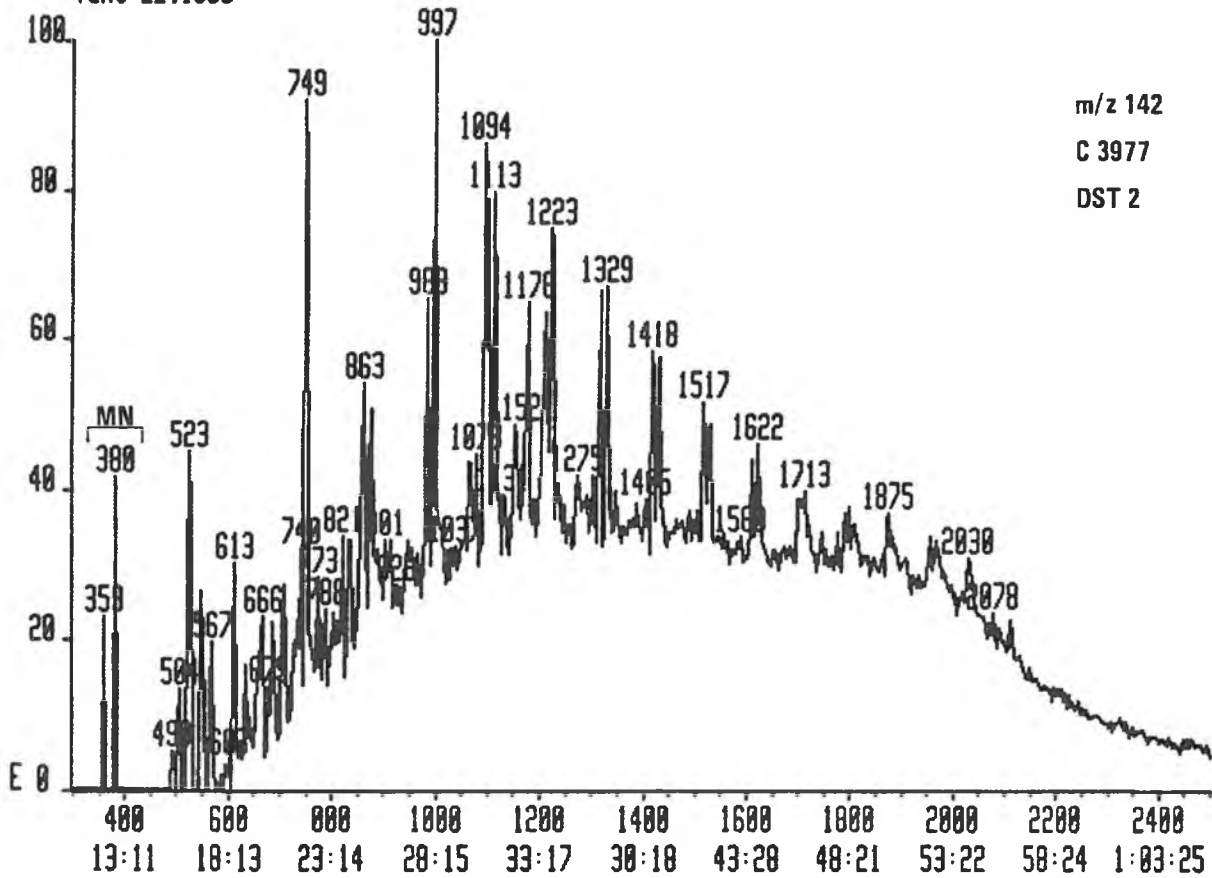


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 Text:22.1005

acnt:IKU

System:AROMATICS IHP

E: 200000



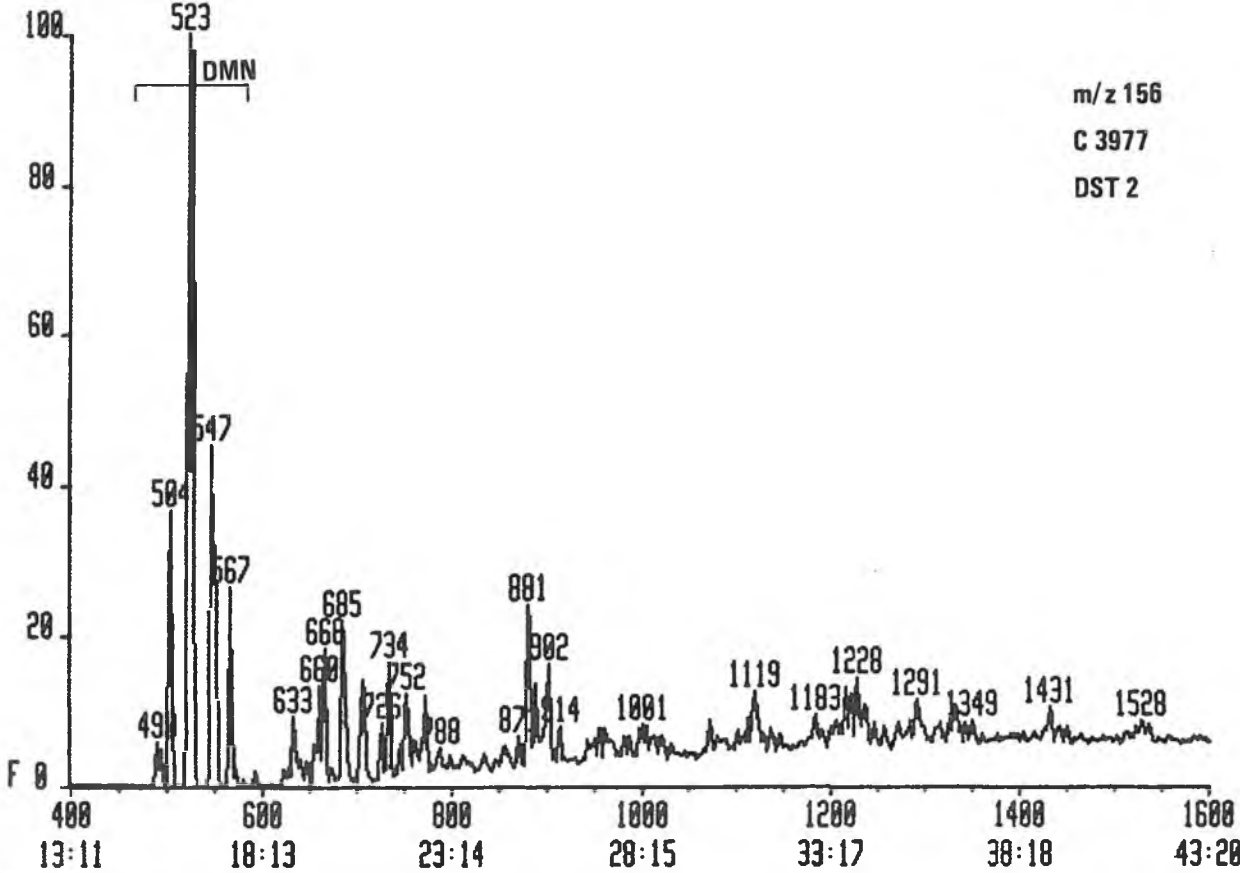
SCAN
TIME

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 Chromatogram Identifiers : F1:156
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acnt:IKU

System:AROMATICS IHP

F: 1000000

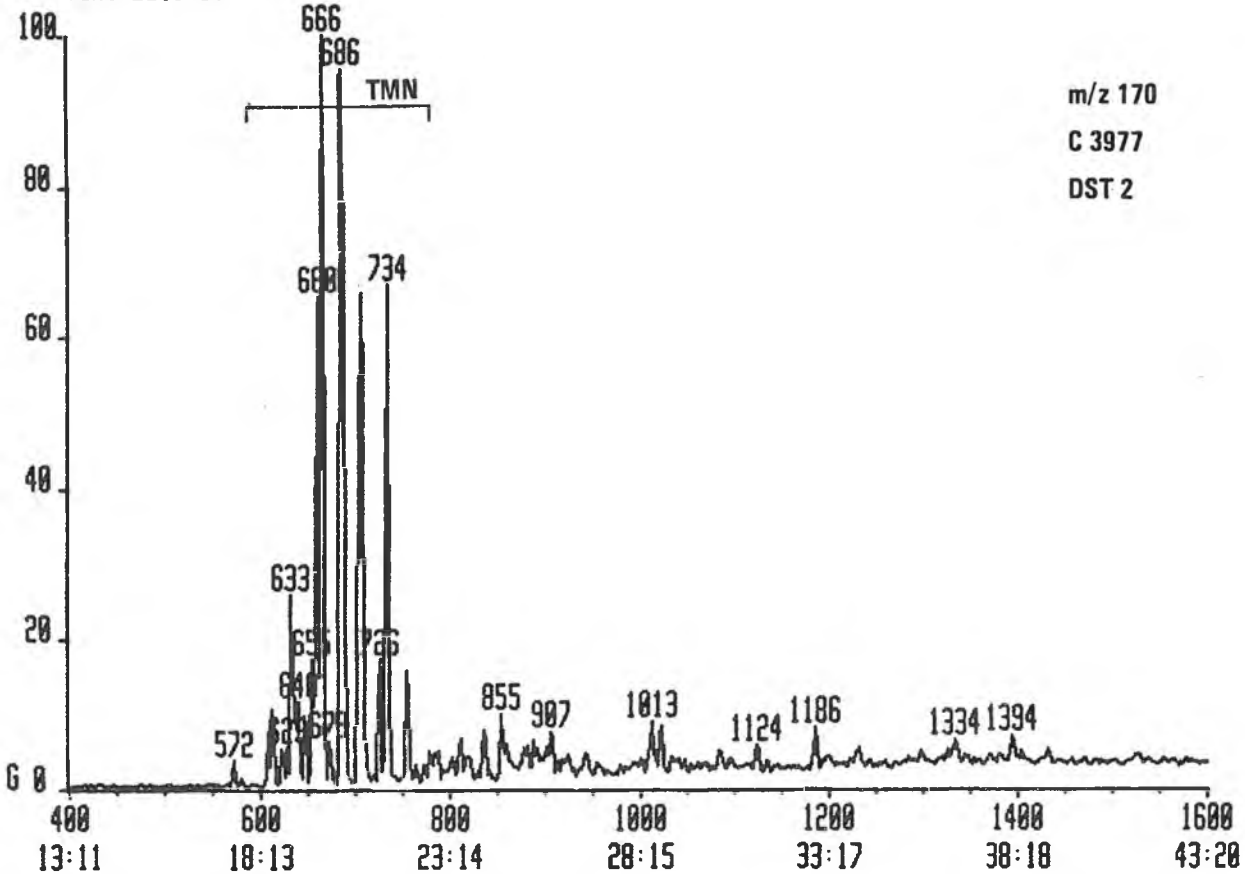


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acnt:IKU

System:AROMATICS IHP

G: 1561000

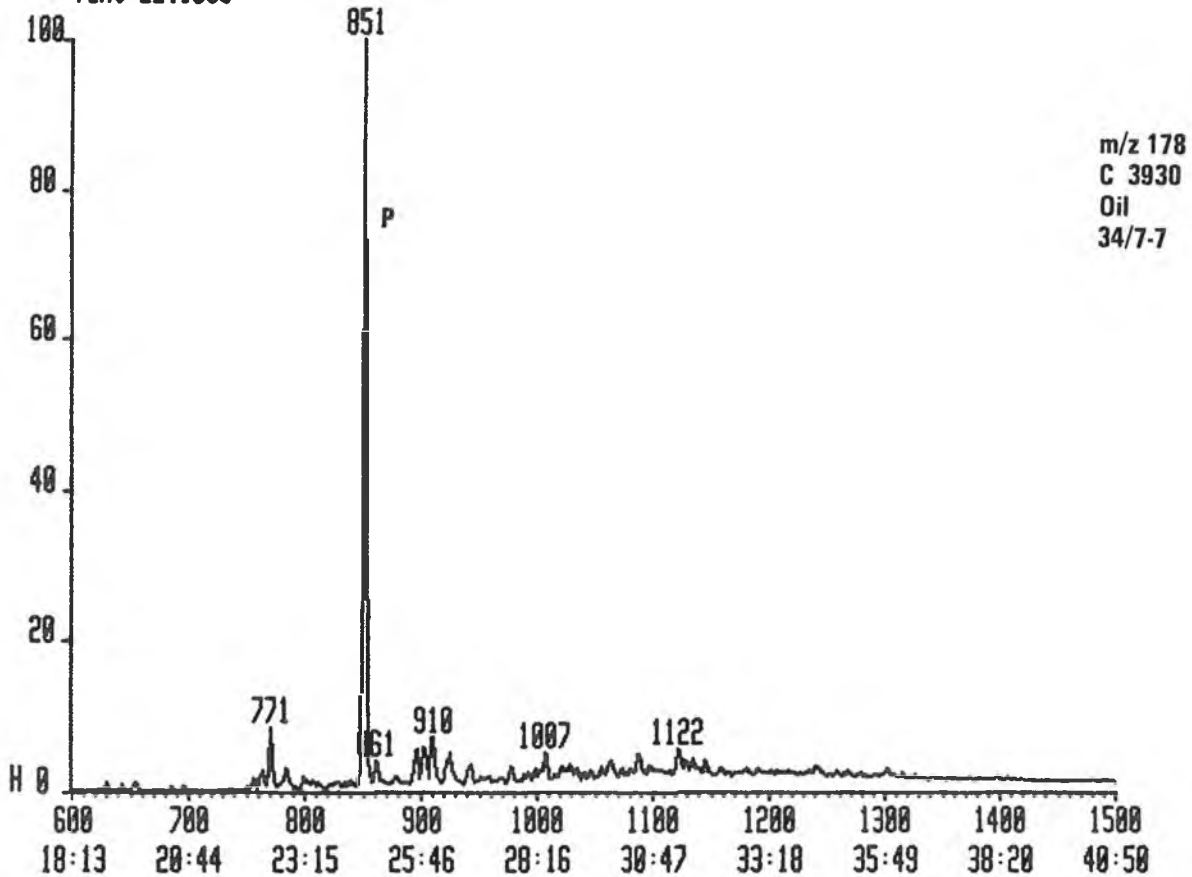


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acnt:IKU

System:AROMAFPCS

H: 1195000

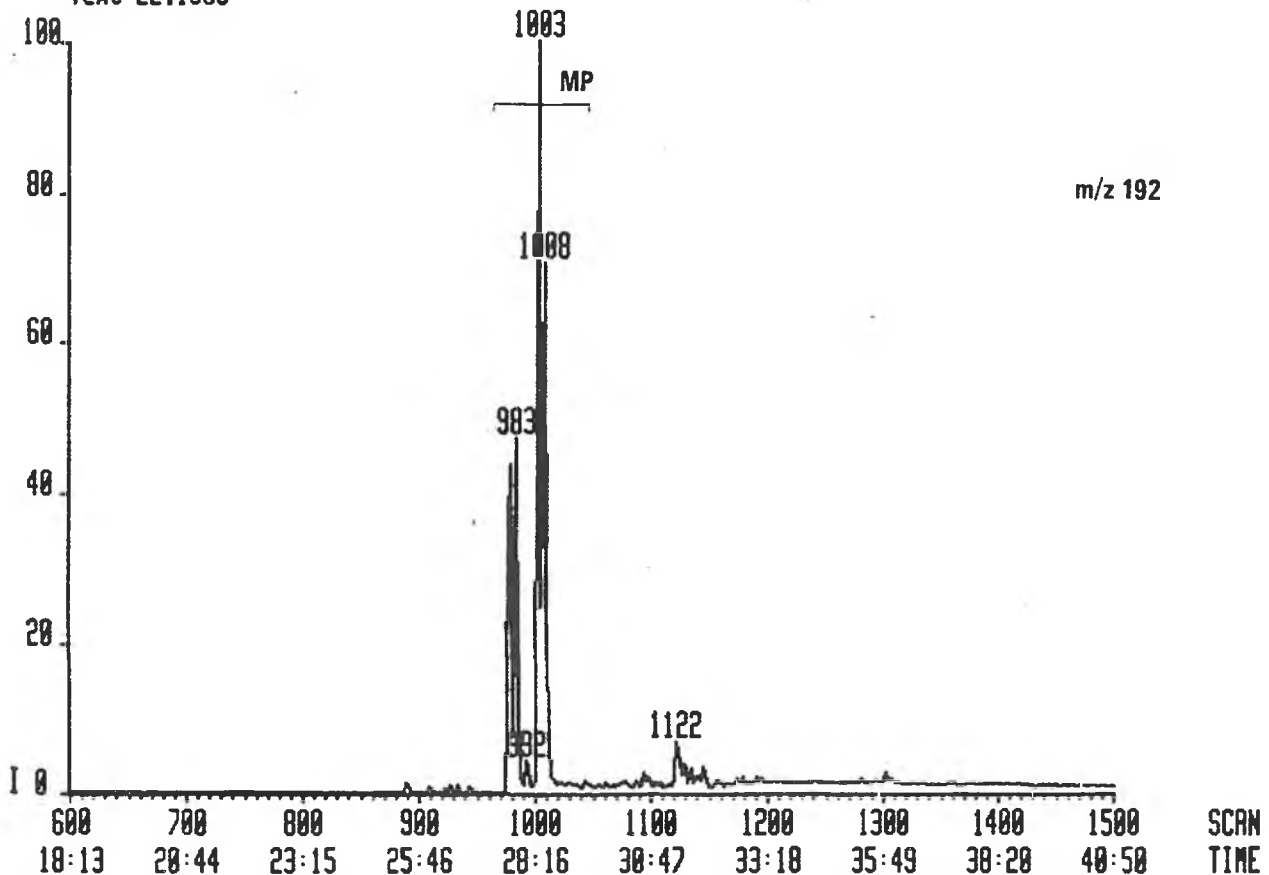


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 Chromatogram Identifiers : I1:192
 Text:22.1005

acnt:IKU

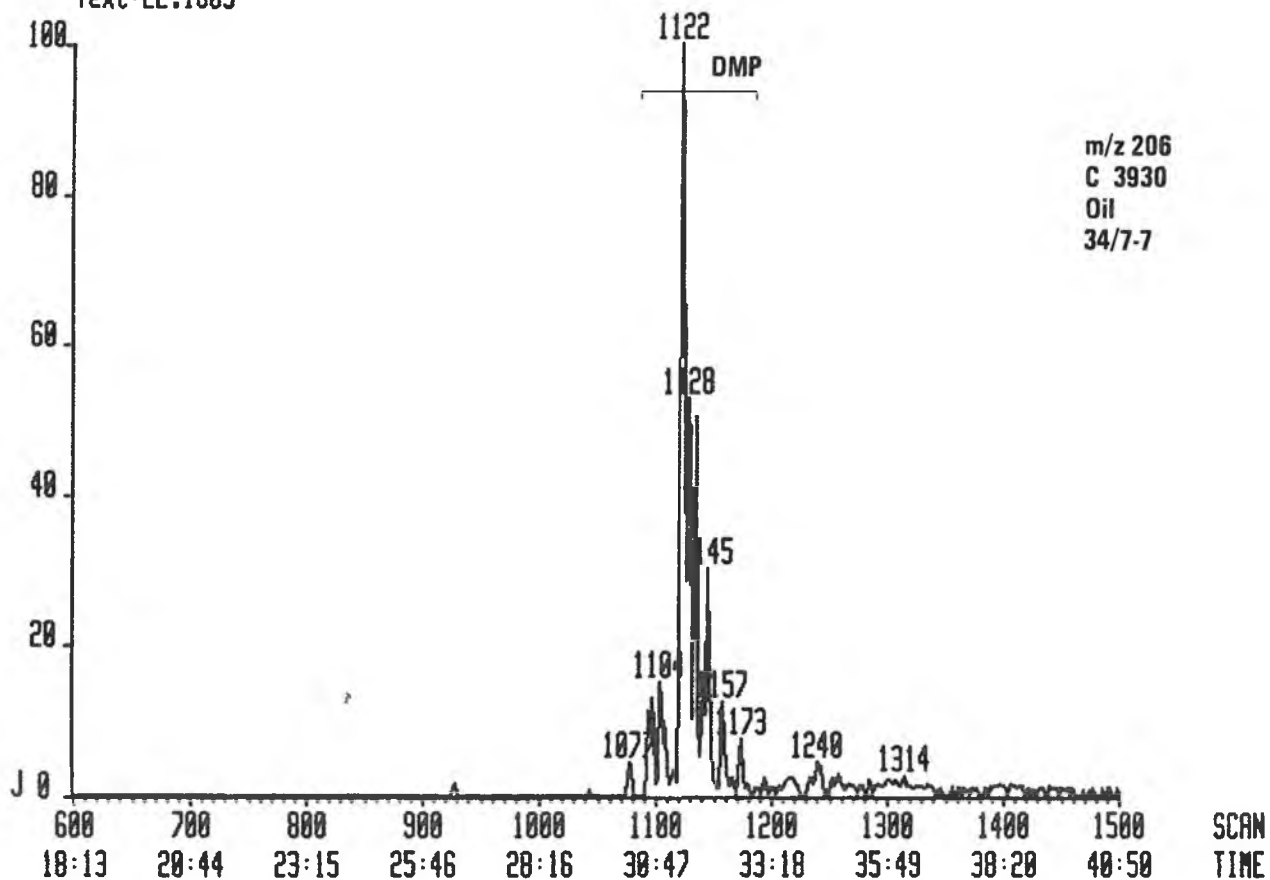
System:AROMAFPCS

I: 840000



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 Text:22.1005

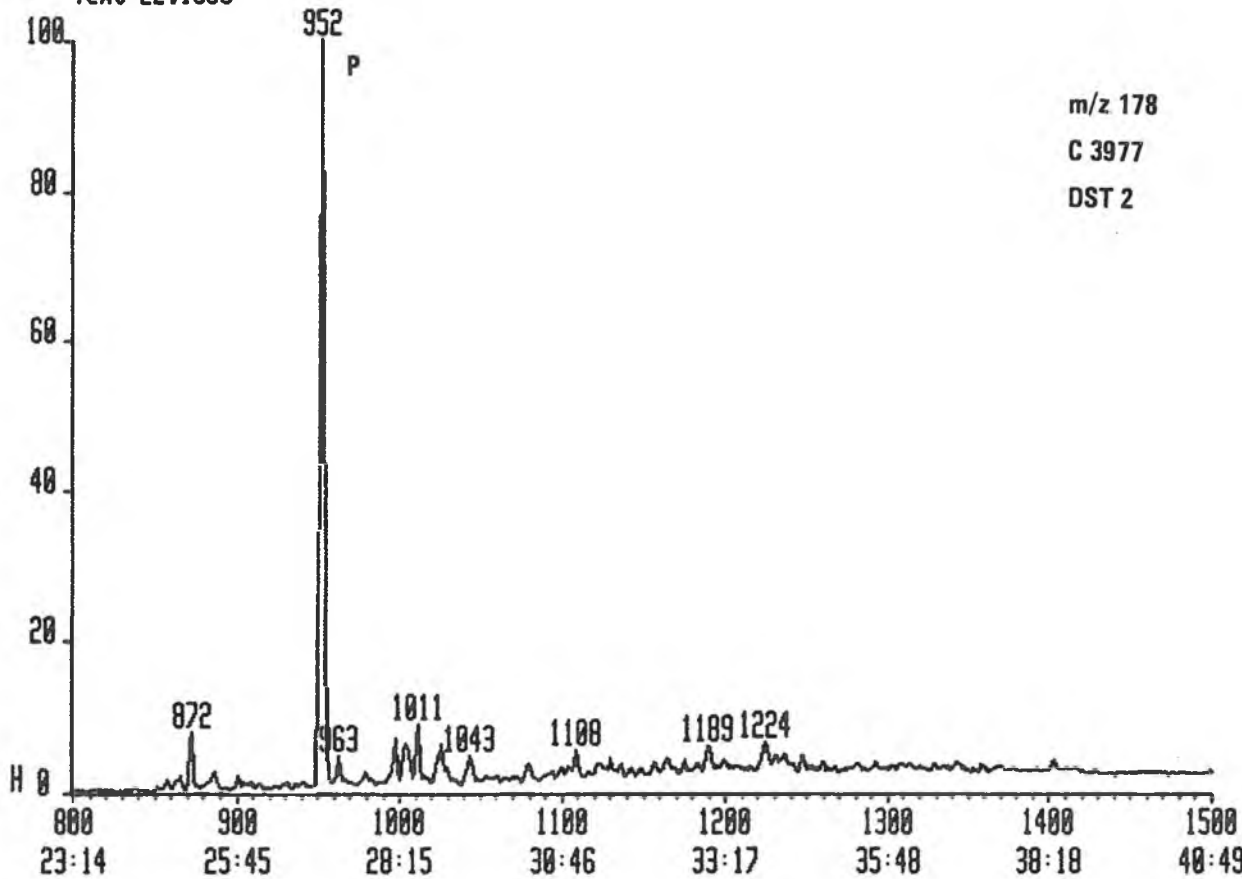
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 J: 490000



C3977AR0 1800-1500 18-APR-86 09:54 12250
 Chromatogram Identifiers : H1:178
 Text:22.1005

acnt:IKU

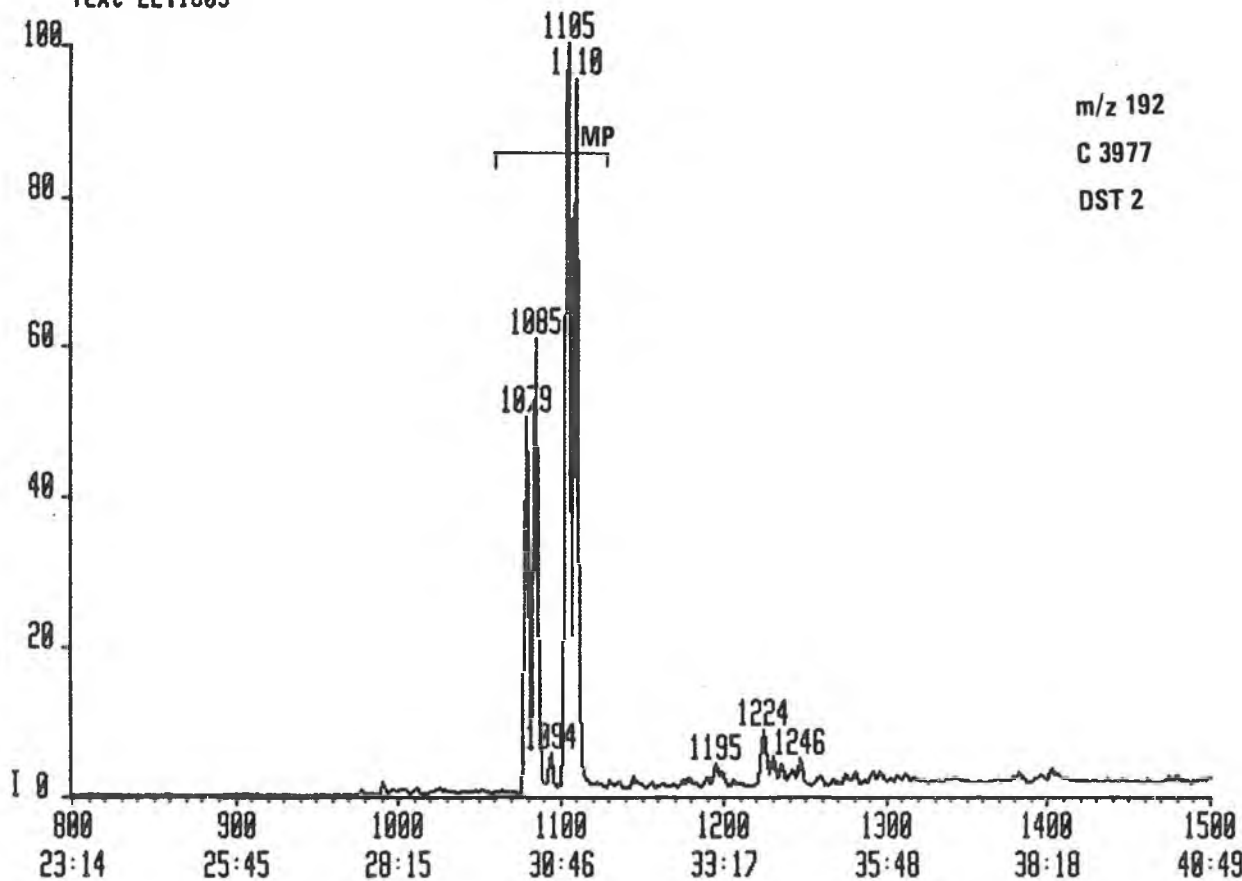
System:AROMATICS IHP
 H: 4448000



C3977AR0 1800-1500 18-APR-86 09:54 12250
 Chromatogram Identifiers : I1:192
 Text:22.1005

acnt:IKU

System:AROMATICS IHP
 I: 2985000

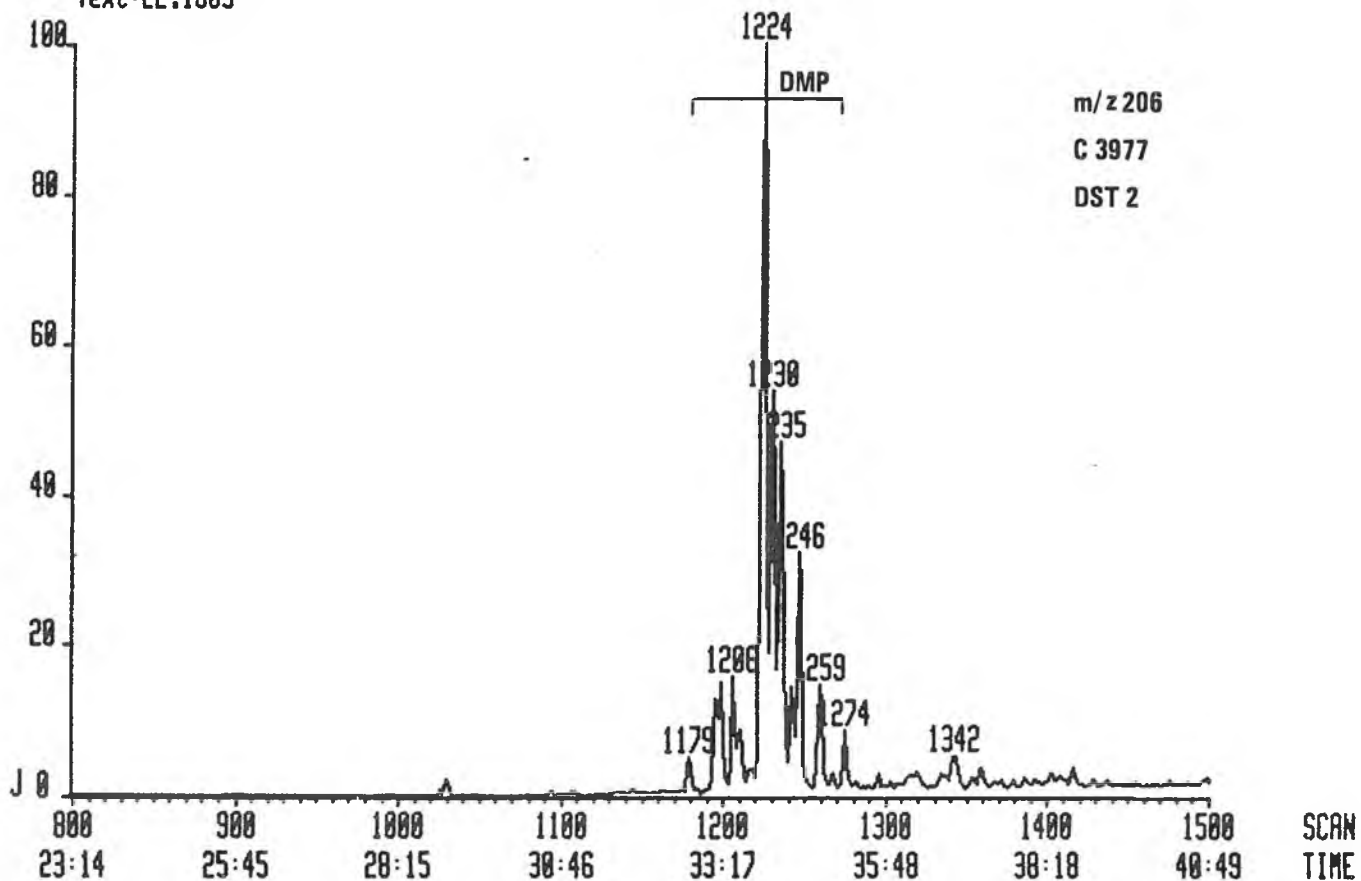


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 Chromatogram Identifiers : J1:206
 Text:22.1805

acnt:IKU

System:AROMATICS IHP

J: 1827000

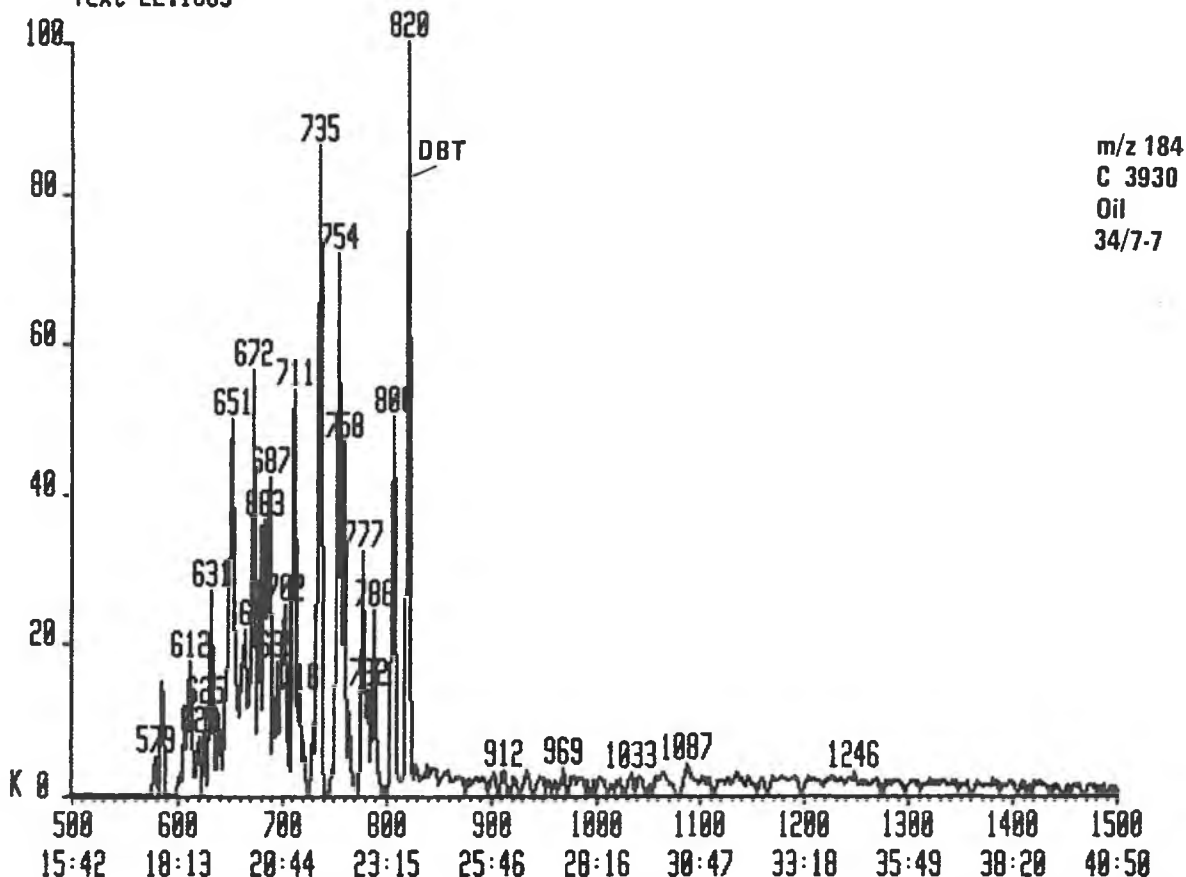


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 Chromatogram Identifiers : K1:184
 Text:22.1005

acnt:IKU

System:AROMAFACS

K: 287000

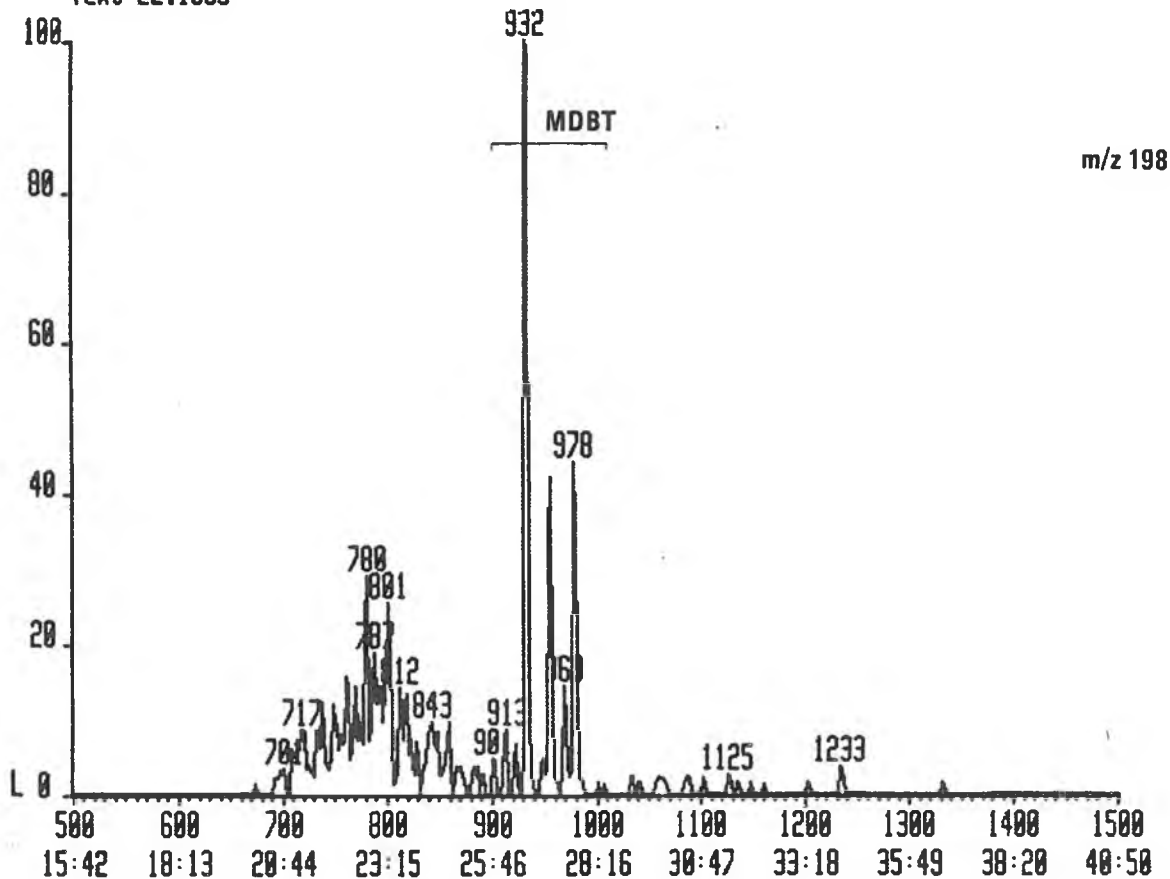


C3930ARO #500-1500 4-APR-86 14:16 12250
 Chromatogram Identifiers : L1:198
 Text:22.1005

acnt:IKU

System:AROMAFACS

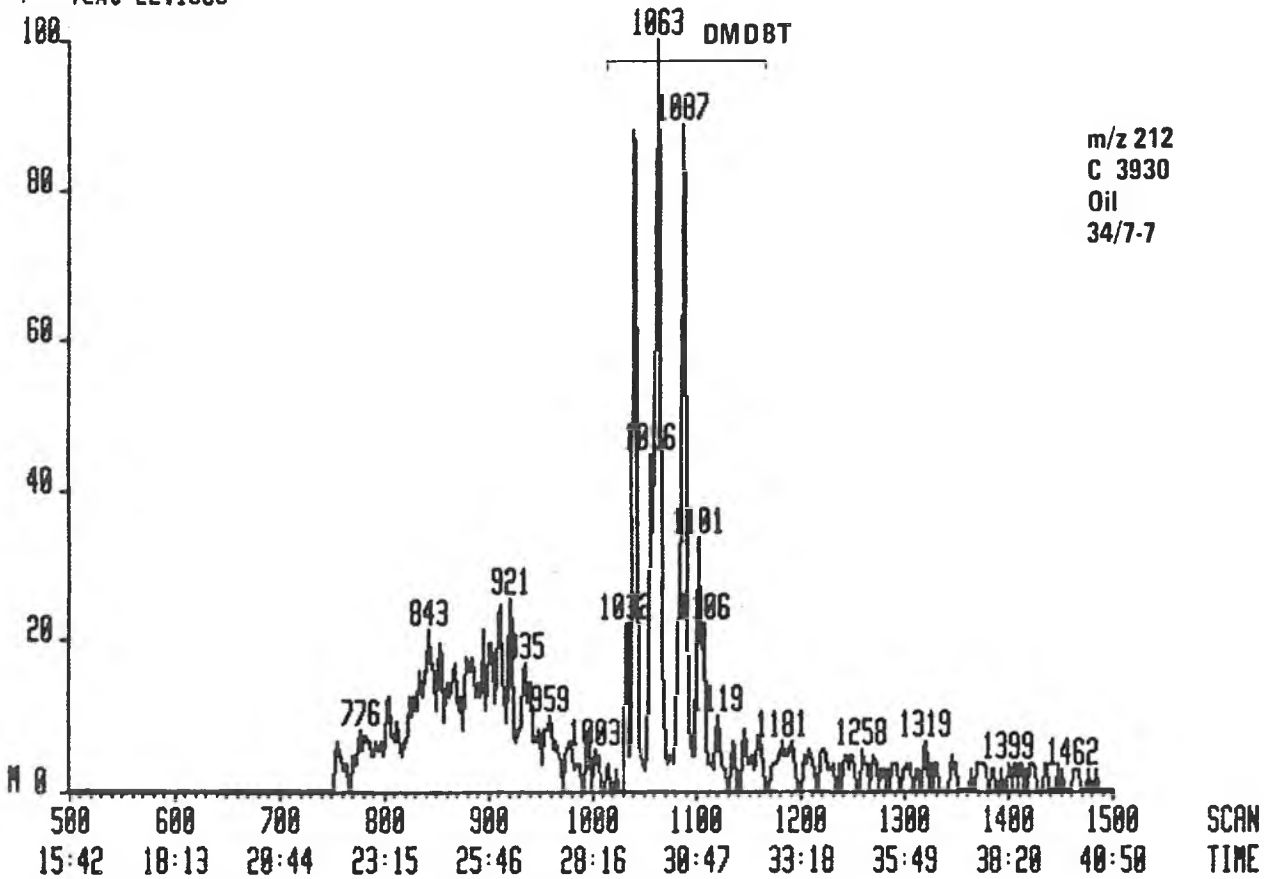
L: 299000



C3930ARO 1500-1500 4-APR-86 14:16 12250 acct:IKU
 Chromatogram Identifiers : M1:212
 Text:22.1005

System:AROMAPCS

M: 114000

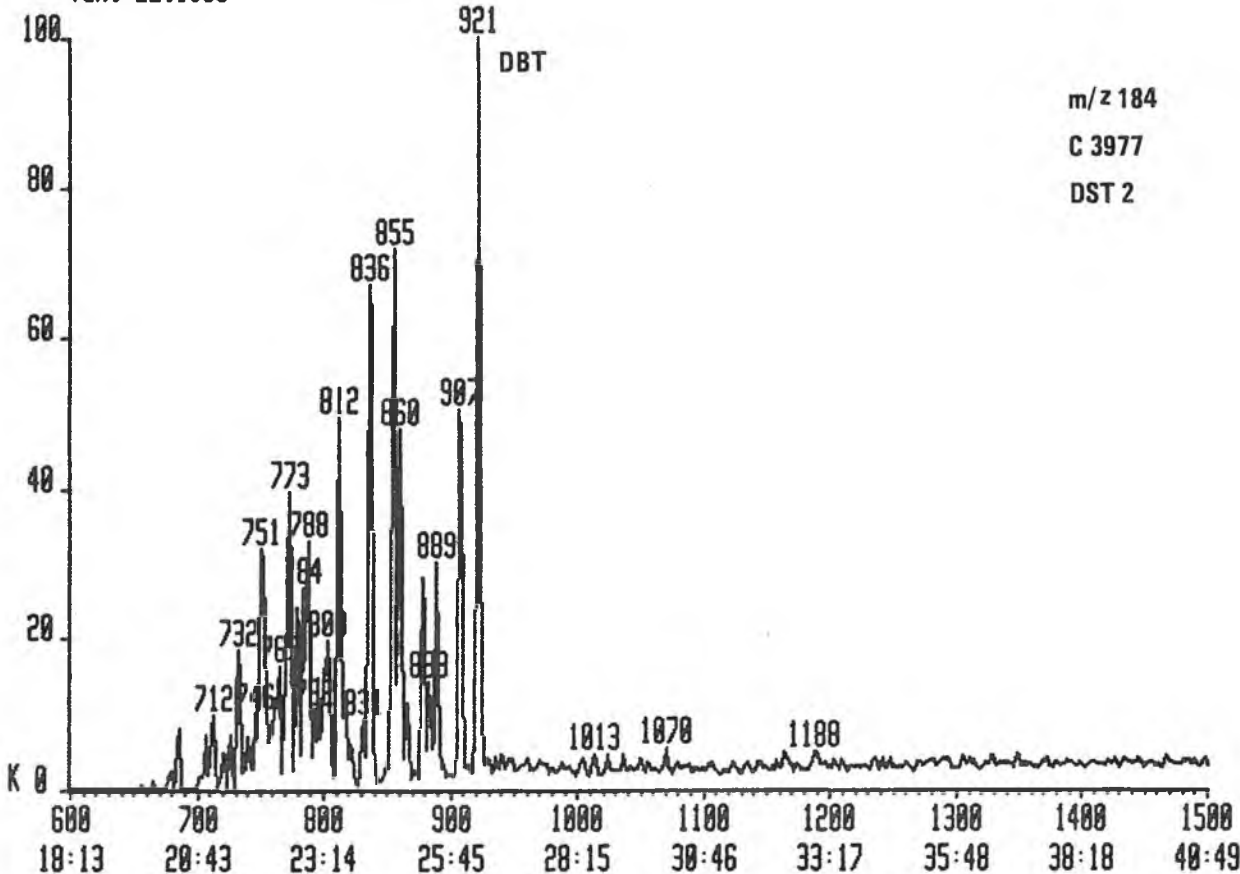


C3977ARD #600-1500 18-APR-06 09:54 12250
 Chromatogram Identifiers : K1:184
 Text:22.1805

acnt:IKU

System:AROMATICICS IHP

K: 1206000



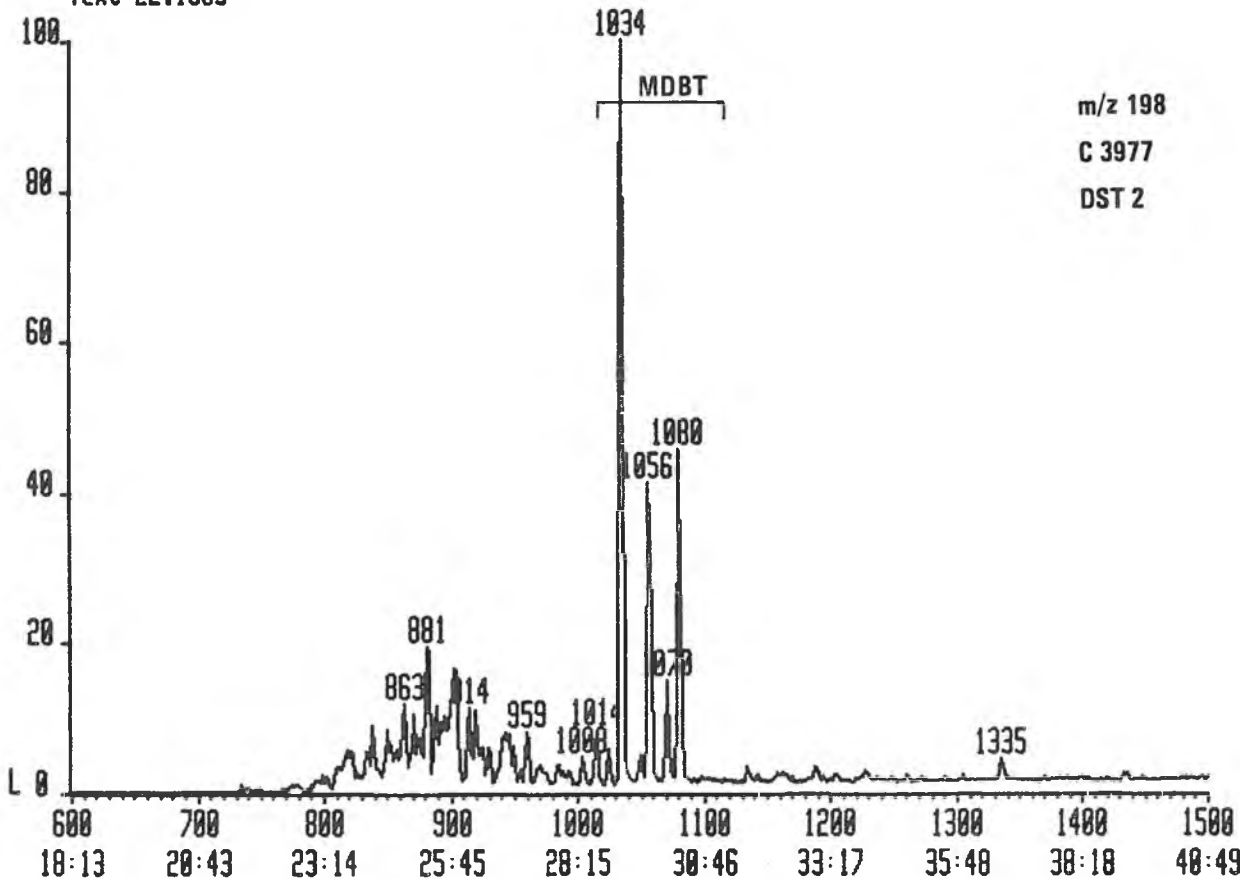
m/z 184
 C 3977
 DST 2

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 Chromatogram Identifiers : L1:198
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acnt:IKU

System:AROMATICICS IHP

L: 1323000



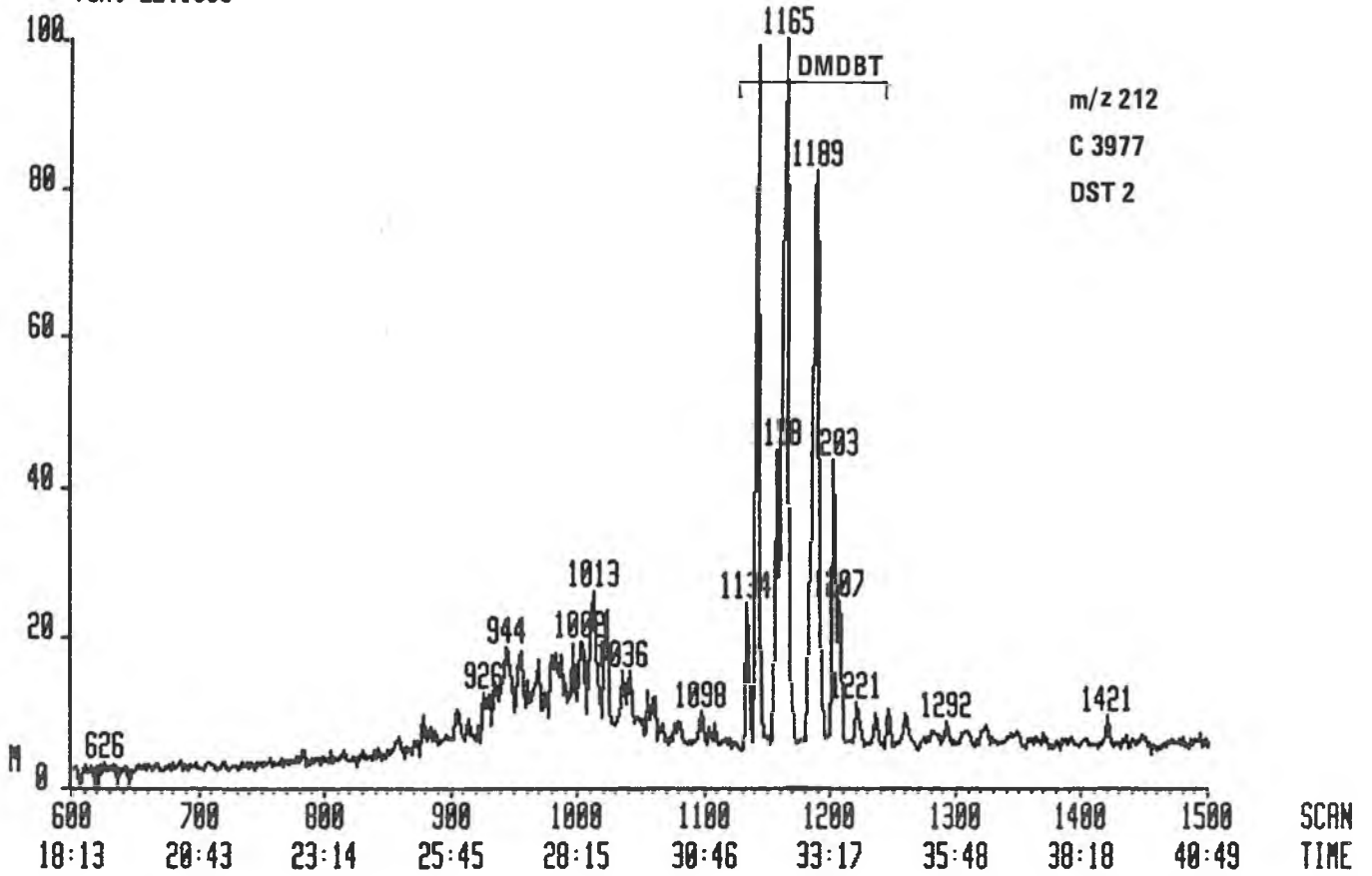
m/z 198
 C 3977
 DST 2

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acnt:IKU

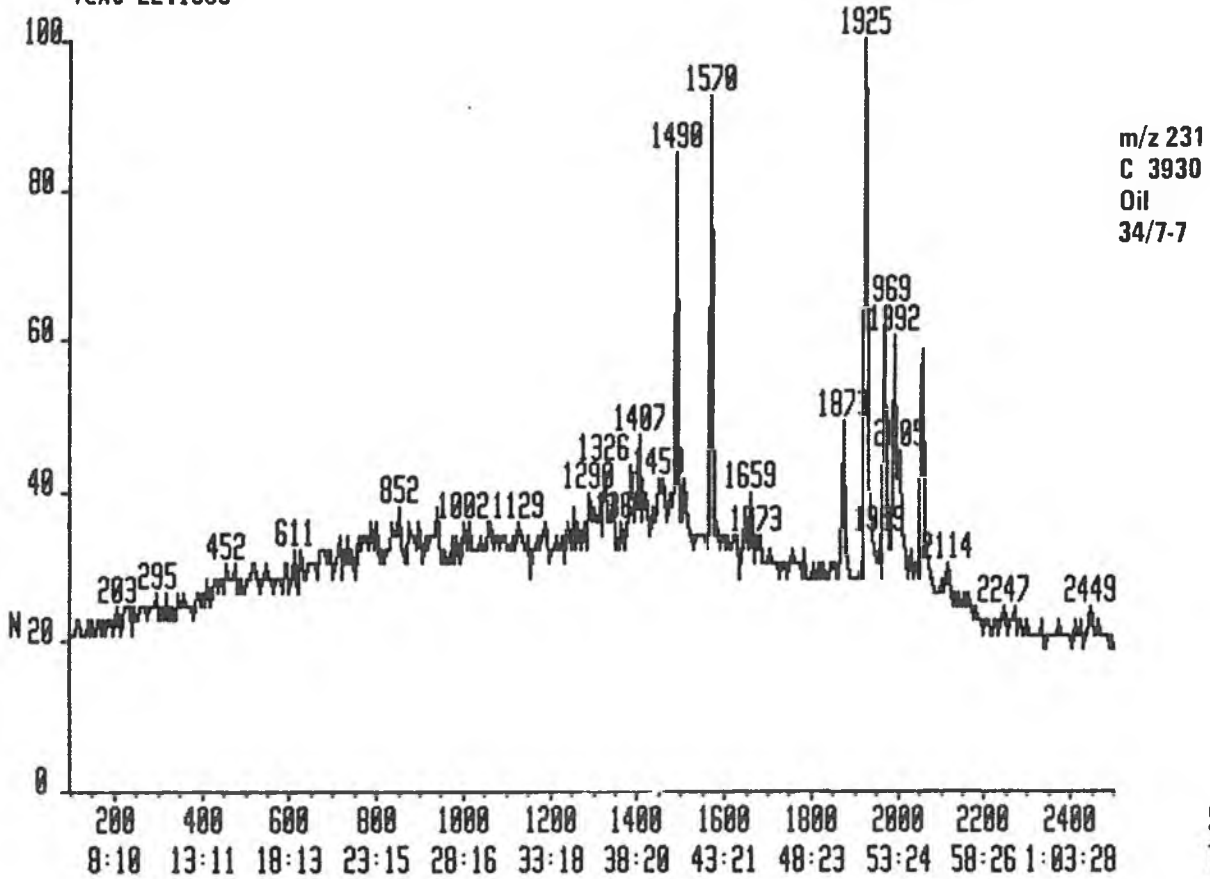
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M: 350000



C3930AR0 #100-2500 4-APR-86 14:16 12250 acct:IKU
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 Text:22.1005

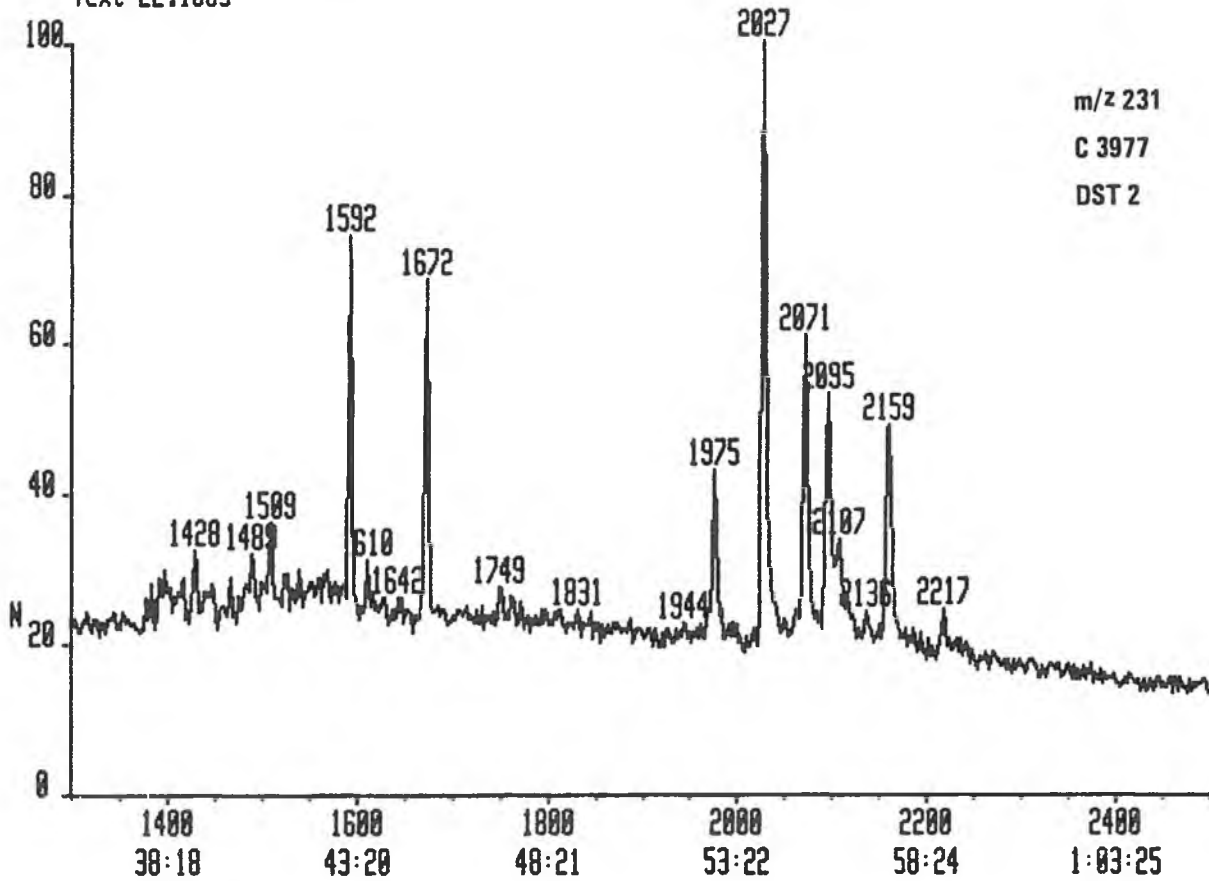
System:AROMATECS
 N: 53000



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 Text:22.1805

acnt:IKU

System:AROMATICS IHP
 N: 219000

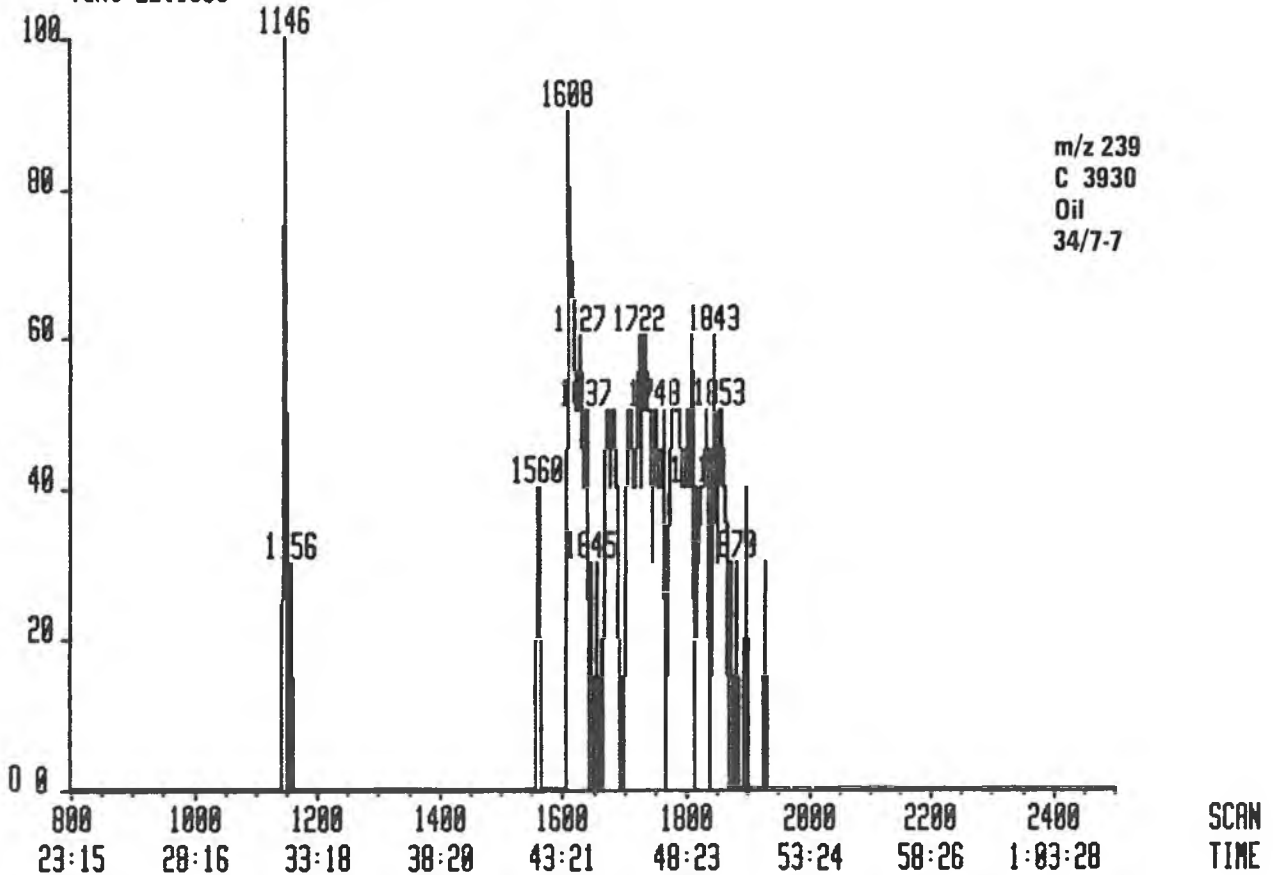


m/z 231
 C 3977
 DST 2

SCAN
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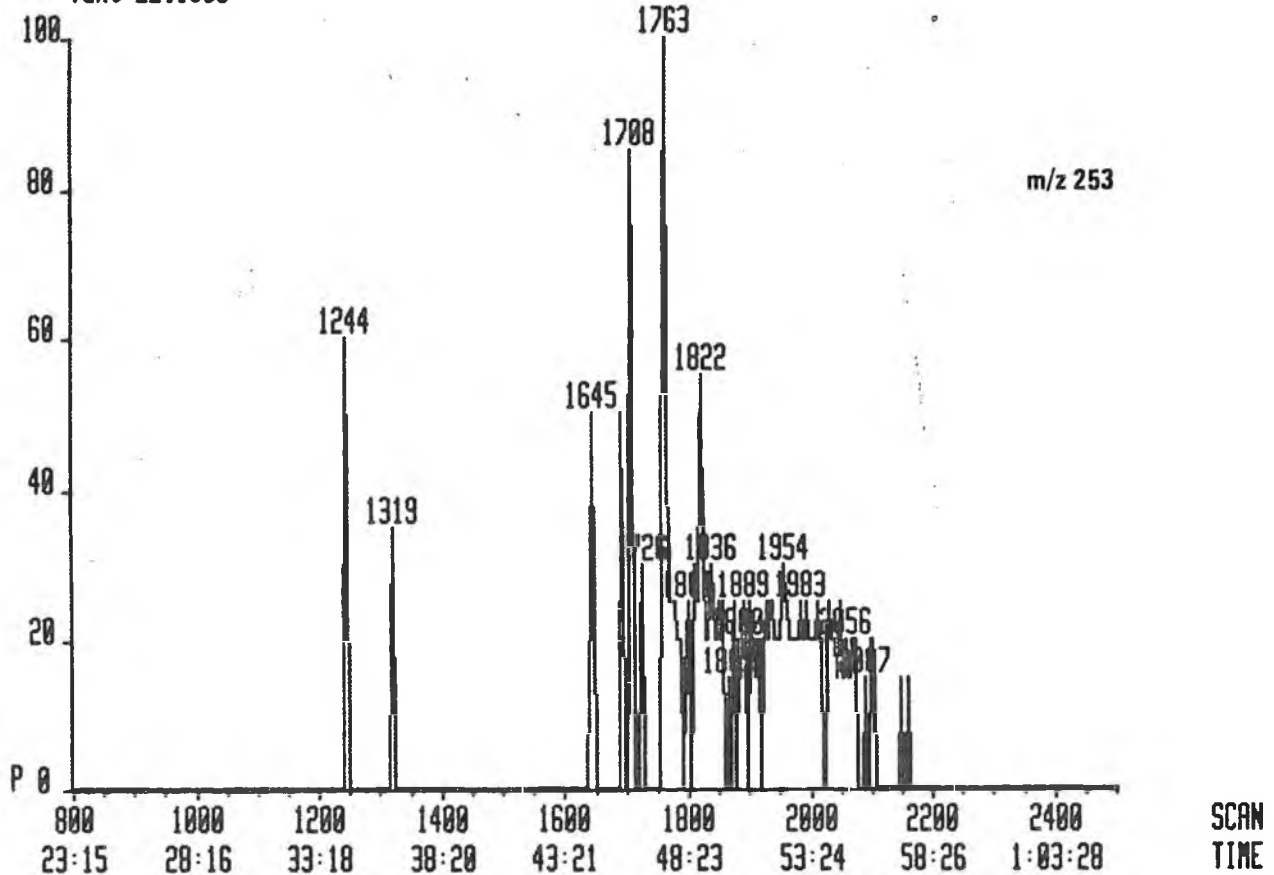
C3930ARO #800-2500 4-APR-86 14:16 12250 acct:IKU
 Chromatogram Identifiers : 01:239
 Text:22.1805

System:AROMATEPCS
 0: 10000



C3930ARO #800-2500 4-APR-86 14:16 12250 acct:IKU
 Chromatogram Identifiers : P1:253
 Text:22.1805

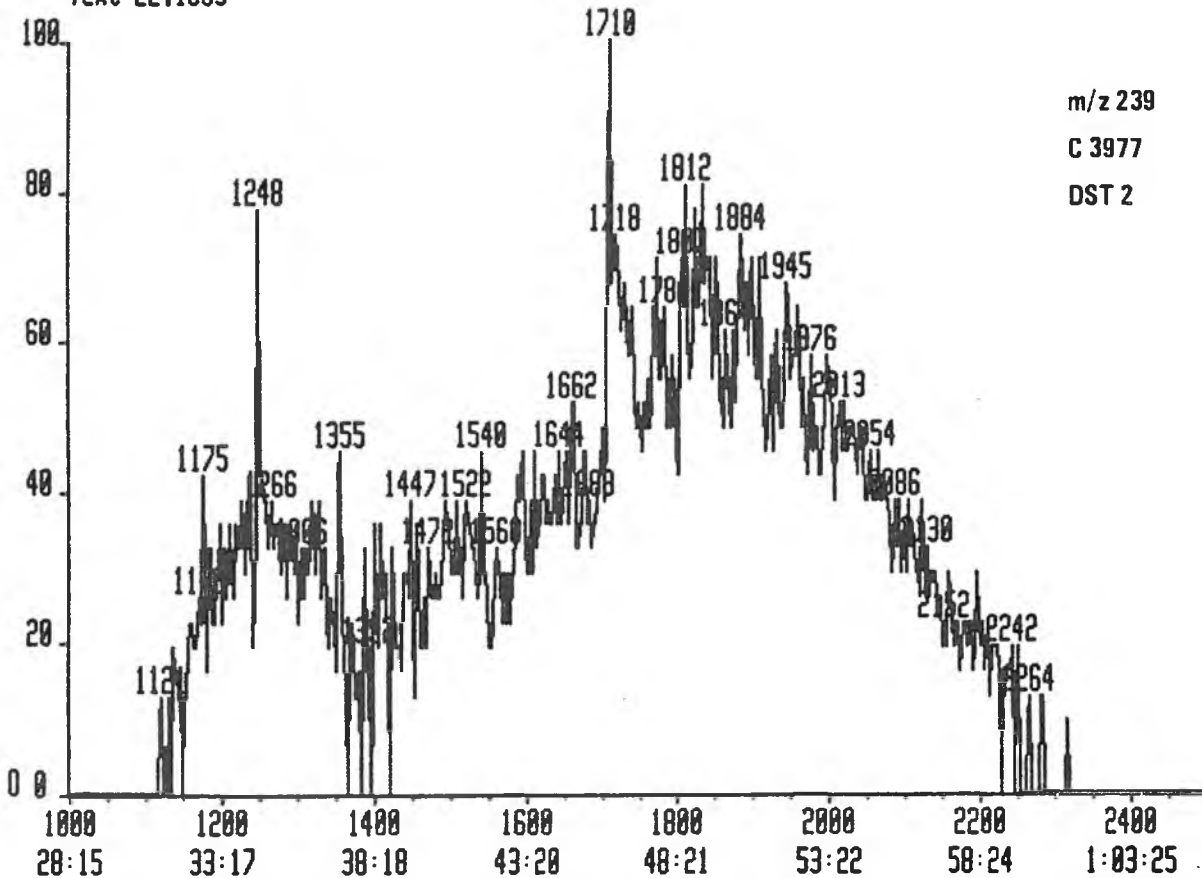
System:AROMATEPCS
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C3977ARO #1000-2500 18-APR-86 09:54 12250
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 Text:22.1005

acnt:IKU

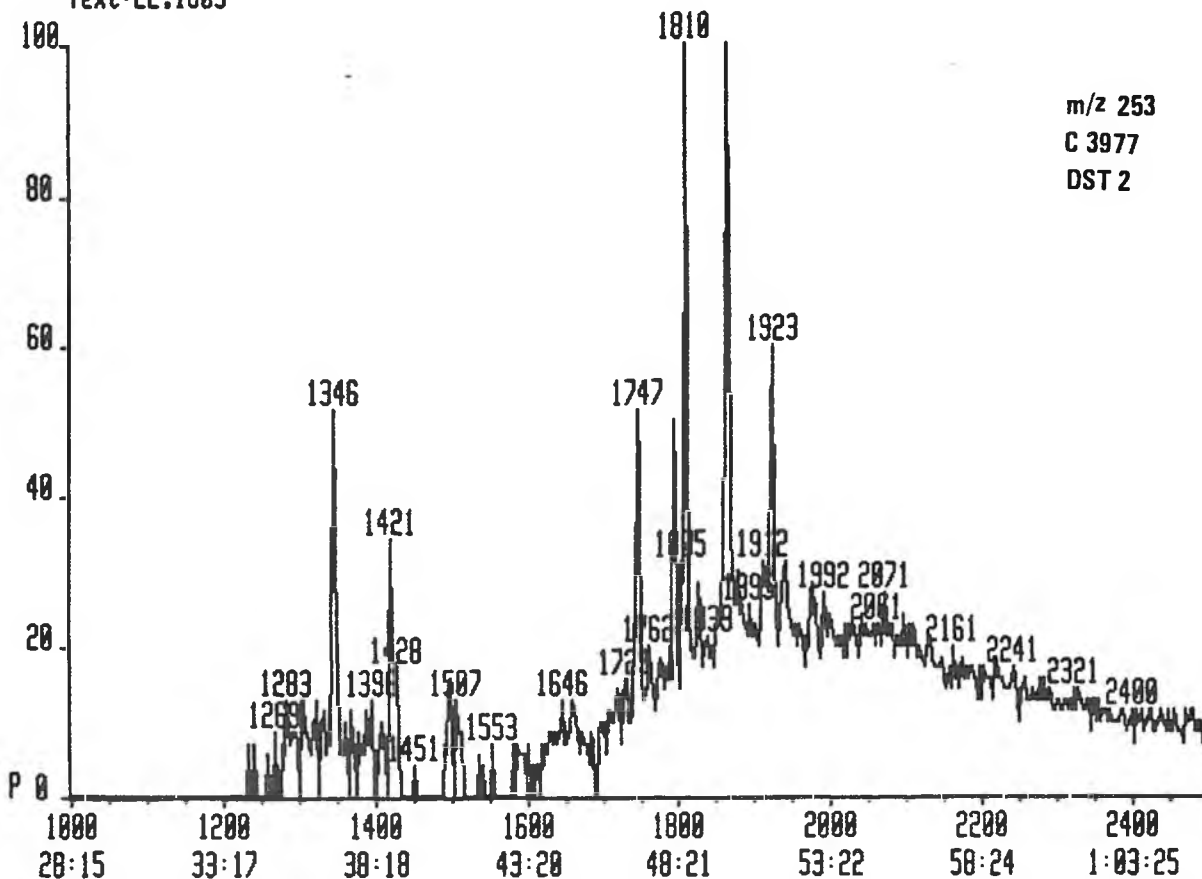
System:AROMATICs IHP
 O: 31000



C3977ARO #1000-2500 18-APR-86 09:54 12250
 Chromatogram Identifiers : P1:253
 Text:22.1005

acnt:IKU

System:AROMATICs IHP
 P: 70000



1000 1200 1400 1600 1800 2000 2200 2400
 28:15 33:17 38:18 43:20 48:21 53:22 58:24 1:03:25

 SCAN
 TIME

 SCAN
 TIME

APPENDIX

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 which represent the terpanes, the hopanes and moretanes are the major components in most extracts and oils. Of the hopanes the C₂₇ and C₂₉-C₃₅ homologs are ubiquitous, while the C₂₈ bisnorhopane is believed to be typical of certain types of source rocks. This is also the case for the component, probably gamma-cerane, sometimes seen to coelute with the 22S isomer of the C₃₁ 17 α (H)-hopanes (H). In the sterane mass chromatograms, m/z 217 and m/z 218, the molecular weight distribution of the C₂₇-C₂₉ regular steranes is believed to be representative of the original input of organic matter. The highest molecular weight compounds, the C₂₉ 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 17 β (H), 21 β (H)-hopanes, undergo structural changes during the maturation process. The isomerisation reactions are thought to be produced via the 17 β (H), 21 α (H)-hopanes (moretanes) to the most stable 17 α (H), 21 β (H)-hopanes. At equilibrium 100% of the 17 α (H)-hopanes are seen. The ratio $\alpha\beta/\alpha\beta+\beta\alpha$ is used to describe this reaction. In the extended hopanes (\geq C₃₁), the thermally stable S configurations at C-22 become increasingly more abundant as compared to the biologically 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 T_m/T_s (Seifert et al., 1978) of the C₂₇ hopanes. The maturable 18 α (H)-trisnorhopane (T_m) is reduced in intensity relative to the more stable

17 α (H)-trishomoneohopane (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 14 α (H), 17 α (H)-isomers of the regular steranes is transformed to the thermally stable 14 β (H), 17 β (H)-steranes, the % $\beta\beta$ 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 increasing 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 %C₂₀/C_{26, 27} and %C₂₁/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 14 β (H), 17 β (H) regular steranes (Seifert and Moldowan, 1978, 1981). Severe biological alteration leads to the formation of desmethyl-hopanes (Seifert and Moldowan, 1979).

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		TRANSP.	PRINT
	<u>Well 34/7-6</u> IKU - Drainage Capillary Pressure Measurement on Core Plugs		1
	<u>Well 34/7-7</u> IKU - Analysis of Fluid and Gas Samples transmitted on 30.6.86, correction on page 21. Please insert the enclosed sticker		1
	<u>Well 34/7-8</u> PETROTECH - Sampling and Analysis of Trace Components		1
	<u>Snorre</u> OIL PLUS - Core Studies for Snorre Field		1

SENT BY: Grete Gluppe

RECEIVED BY: E. Østlind

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DATE: 16.07.86

Analysis of fluid and gas
Samples from well 34/7-7

Table 3: $\delta^{13}\text{C}$ isotope data for the DST gases

IKU No.	DST No.	nC ₁	nC ₂	nC ₃	iC ₄	nC ₄
C-3931	1a	-51.0	-35.7	-33.3	-32.7	-33.1
C-3978	2	-49.1	-35.3	-32.7	-32.7	-32.5

D/H Isotope data for the DST gases

IKU no.	DST no.	D/H (smow)
C-3931	1a	-190
C-3978	2	-188

86-5197-BA
 16 JULI 1986
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