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COMPARISON OF CRUDE OILS FROM WELLS 30/6-19 AND 30/6-22 ON THE BETA STRUCTURE, OSEBERG AREA.

Elin Rein

Resyme Konklusjon Anbefaling
Summary Conclusion Recommendation

The five analysed samples are highly paraffinic crude oils typical for the Upper Jurassic sourced oils in the North Sea.

Based on the biomarker patterns and the C15+ saturated hydrocarbon distributions these oils are correlated to each other, but they are significantly different from the Oseberg alpha oil (30/6-13), used as a laboratory reference sample. This observation indicates that the oils from 30/6-19 and 30/6-22 have a different source than the Oseberg alpha oil.

Molecular parameters are not separating the oils from 30/6-19 and 30/6-22.

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Wells 30/6-19 and 30/6-22

Emnekategori Subject category
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1. INTRODUCTION.

This study involves analysis of 5 stabilized reservoir fluids from two Oseberg wells. A list of samples is given in Table 1 and the well locations are shown on the map in Figure 1.

Table 1: Sample list

WELL	TEST	FORMATION	DEPTH
30/6-19	DST1	MIDDLE OSEBERG	2945-2954 m
30/6-19	DST2	ETIVE/UPPER OSEBERG	2907-2932.3 m
30/6-19	DST3	NESS	2897.6-2884 m
30/6-22	DST1	ETIVE	2917.2-2936.2 m
30/6-22	DST2	NESS	2908.5-2912.0 m

The purpose of this study is to compare these oils using petroleum geochemical parameters and thereby determine possible differences in the source and migration history.

In this study biological marker compounds of the sterane and triterpane types have been used for correlation of the oils. These studies have been supported by distributions of saturated hydrocarbons.The whole oil hydrocarbon distribution, light hydrocarbon (C1-C9) distribution and asphaltene content have also been investigated.

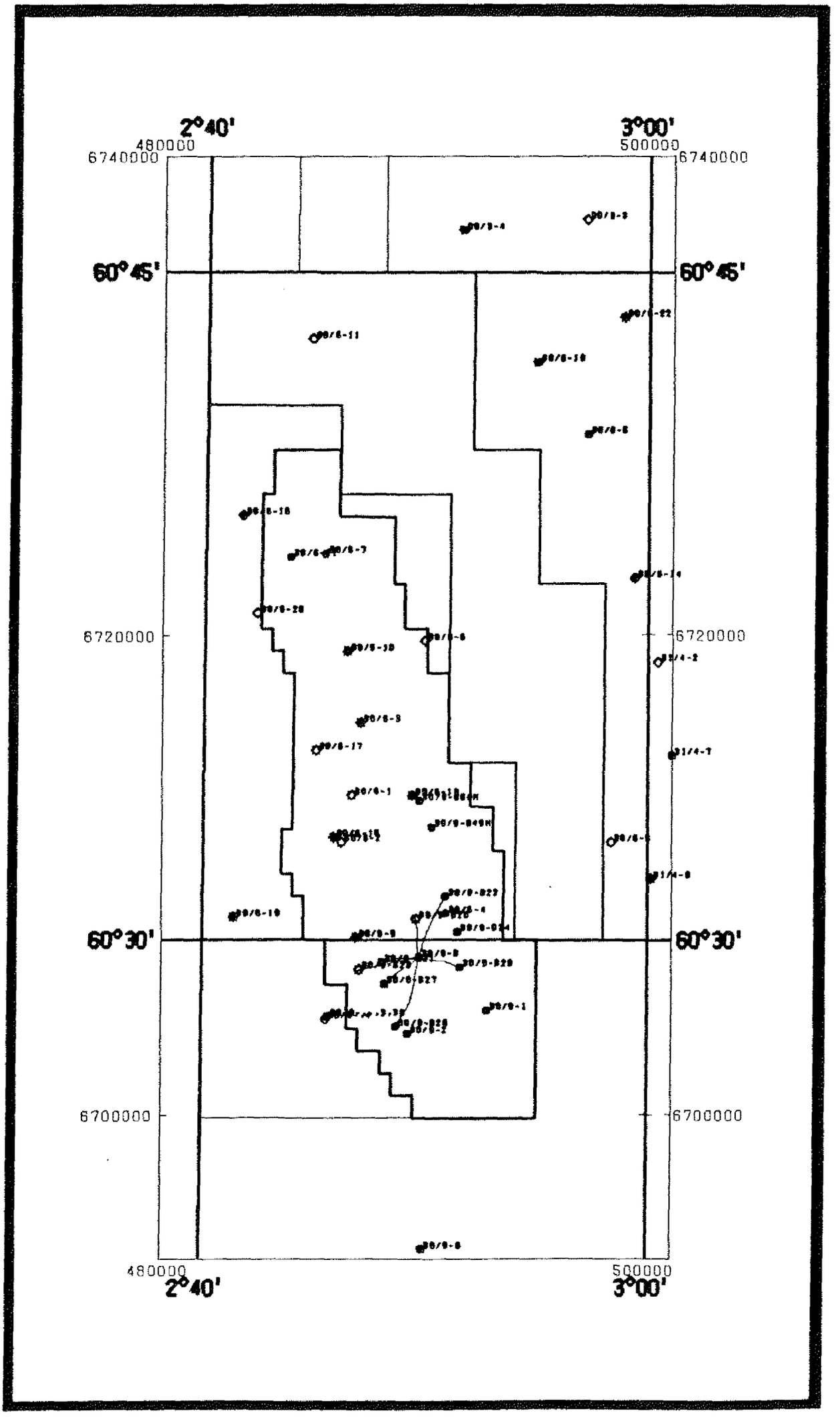


Figure 1: Well location map.

2. EXPERIMENTAL PROCEDURES

The whole oil was analysed by split injection on a HP5890 gas chromatograph equipped with a 50m unpolar capillary column.

The light end of whole oil (C1 - C9) was analysed on a HP5880 gas chromatograph with backflushing of the C12+ fraction. Isooctane was used as an internal standard and the column used was a 50m unpolar capillary column.

A part of the oils was deasphalted in n-pentane. The soluble part was group type separated in saturated hydrocarbons (SAT), aromatic hydrocarbons (ARO) and polar compounds by Medium Pressure Liquid Chromatography (MPLC). The SAT- and ARO-fractions of the oils were analysed by a HP5880 gas chromatograph equipped with two parallel 30m capillary columns leading to a simultaneous mass selective- and flame ionization detection. In addition, the SAT-fraction was analysed by Selected Metastable Ion Monitoring (SMIM) using a VG 7070E mass spectrometer.

These analytical procedures are standard procedures used in petroleum geochemical analysis at Norsk Hydro Research Centre.

3. RESULTS AND DISCUSSION.

3.1: Asphaltene content.

The amount of asphaltenes in the oils is given in Table 2.

Table 2: Asphaltene content.

WELL	TEST	FORMATION	ASPHALTENE CONTENT %
30/6-19	DST1	MIDDLE OSEBERG	3.1
30/6-19	DST2	ETIVE/U. OSEBERG	2.0
30/6-19	DST3	NESS	1.1
30/6-22	DST1	ETIVE	2.0
30/6-22	DST2	NESS	1.2

The variation of the asphaltene content is significant and seems to correlate with the different formations. The oil from the Middle Oseberg Fm. (30/6-19 DST1) has the largest amount of asphaltenes, 3.0%, while the oils from the Etive Fm. (30/6-19 DST2 and 30/6-22 DST1) both contains 2.0%. The oils from Ness Fm. (30/6-19 DST3 and 30/6-22 DST2) contains 1.0% and 1.1% respectively.

3.2: Whole oil.

The whole oil chromatograms are given in Appendix I. These chromatograms show a highly paraffinic oil typical for the Upper Jurassic sourced oils in the North Sea. The chromatograms show some variation in the relative amount of light hydrocarbons (eluting at retention times less than 10 minutes). Encountering the results from the light hydrocarbons (C1-C9) described below, this variation is probably due to not controllable loss of volatile compounds.

3.3: Light hydrocarbon analysis (C1-C9).

The chromatograms and the analysis reports of the light hydrocarbons (C1-C9) are given in appendix II. Quantified amounts of selected compounds in the C7-C8 region are listed in Table 3. Both normal alkanes, branched alkanes, cyclic alkanes and aromatics are present.

Table 3: Relative amounts (weight-%) of selected compounds in the C7-C8 region.

SAMPLE	N-C7	MCC6	ECC5	TOL	2MC7	4MC7	3MC7
30/6-19 DST1	1.15	1.25	0.12	0.44	0.44	0.14	0.51
30/6-19 DST2	1.15	1.37	0.12	0.49	0.45	0.15	0.51
30/6-19 DST3	1.13	1.29	0.11	0.40	0.43	0.13	0.48
30/6-22 DST1	1.17	1.33	0.11	0.50	0.41	0.13	0.50
30/6-22 DST2	1.23	1.42	0.12	0.56	0.45	0.14	0.51

N-C7 :n-heptane
MC-C6 :methylcyclohexane
ECC5 :ethylcyclopentane
TOL :toluene
2MC7 :2,methylheptane
4MC7 :4,methylheptane
3MC7 :3,methylheptane

The weight-% of the selected compounds show no significant variation for the samples encountered in this study.

3.4: Aromatic C15+ hydrocarbons.

The fragmentograms of the monoaromatic steranes (Ion 253 m/z) and the triaromatic steranes (Ion 231 m/z) are given in Appendix III. The analysed sampled are not separated by these biomarker signatures.

3.5: Saturated C15+ hydrocarbons.

The gas chromatograms of the saturated fraction are given in Appendix IV. The chromatogram of our laboratory standard an oil from 30/6-13 is also included for comparison.
Calculated molecular ratios are listed in table 4.

Table 4: Molecular ratios, saturated fraction.

WELL	SAMPLE	CPI1	CPI2	PR/N-C17	PH/N-C18	PR/PH
30/6-19	DST1	1.07	0.95	0.91	0.76	1.36
30/6-19	DST2	1.11	1.08	0.89	0.75	1.39
30/6-19	DST3	1.18	1.10	0.90	0.75	1.37
30/6-22	DST1	1.13	1.09	0.80	0.64	1.28
30/6-22	DST2	1.09	1.03	0.86	0.73	1.39
LAB REF.		1.00	1.06	0.60	0.48	1.50

$$CPI1 = \frac{1}{2}\left(\frac{C25+C27+C29+C31}{C24+C26+C28+C30} + \frac{C25+C27+C29+C31}{C26+C28+C30+C32}\right)$$

$$CPI2 = \frac{2 * (C27)}{C26 + C28}$$

PR = Pristane
PH = Phytane

The 30/6-22 DST1 sample can be differentiated from the other samples by visual inspection of the gas chromatograms of the saturated fractions. This differentiation is most likely due to evaporational loss of C15-C20 hydrocarbons during the analytical workup procedures.

The molecular ratios calculated from peak areas does not separate the analysed samples. The LAB REF. sample, an Oseberg alpha oil is separated from the other samples by the Pristane/N-C17, Phytane/N-C18 and Pristane/Phytane ratios. This is probably due to the fact that the Oseberg Alpha oil is from a different source area than the 30/6-19 and 30/6-22 oils.

The molecular ratios listed in Table 4 show no significant variation for the oils from 30/6-19 and 30/6-22.

3.6: Biological markers.

The fragmentograms of the steranes (Ion 217 m/z), triterpanes (Ion 191 m/z) and plots of the bargraphs indicating the relative distribution of products from metastable transitions are given in Appendix V.

The sterane and triterpane distribution of all analysed samples show that these samples are mature oils of an Upper Jurassic origin. A significant difference is again found between the Oseberg alpha oil and the samples from 30/6-19 and 30/6-22, all the oils except the Oseberg alpha oil show a lack of the rare C_{28} bisnorhopane. This peak is marked with X on the 191 fragmentogram and is denoted 28N on the plots of the metastable trasitions. Based on this observation the 30/6-19 and 30/6-22 oils are believed to have a different source than the Oseberg alpha oil.

The 30/6-22 DST1 sample shows a different biomarker pattern than the other samples. This is probably due to experimental variations and will be further investigated.

Other minor variations in the biomarker patterns of the oils from 30/6-19 and 30/6-22 are detected, but these are not significant to separate the oils.

4. CONCLUSION

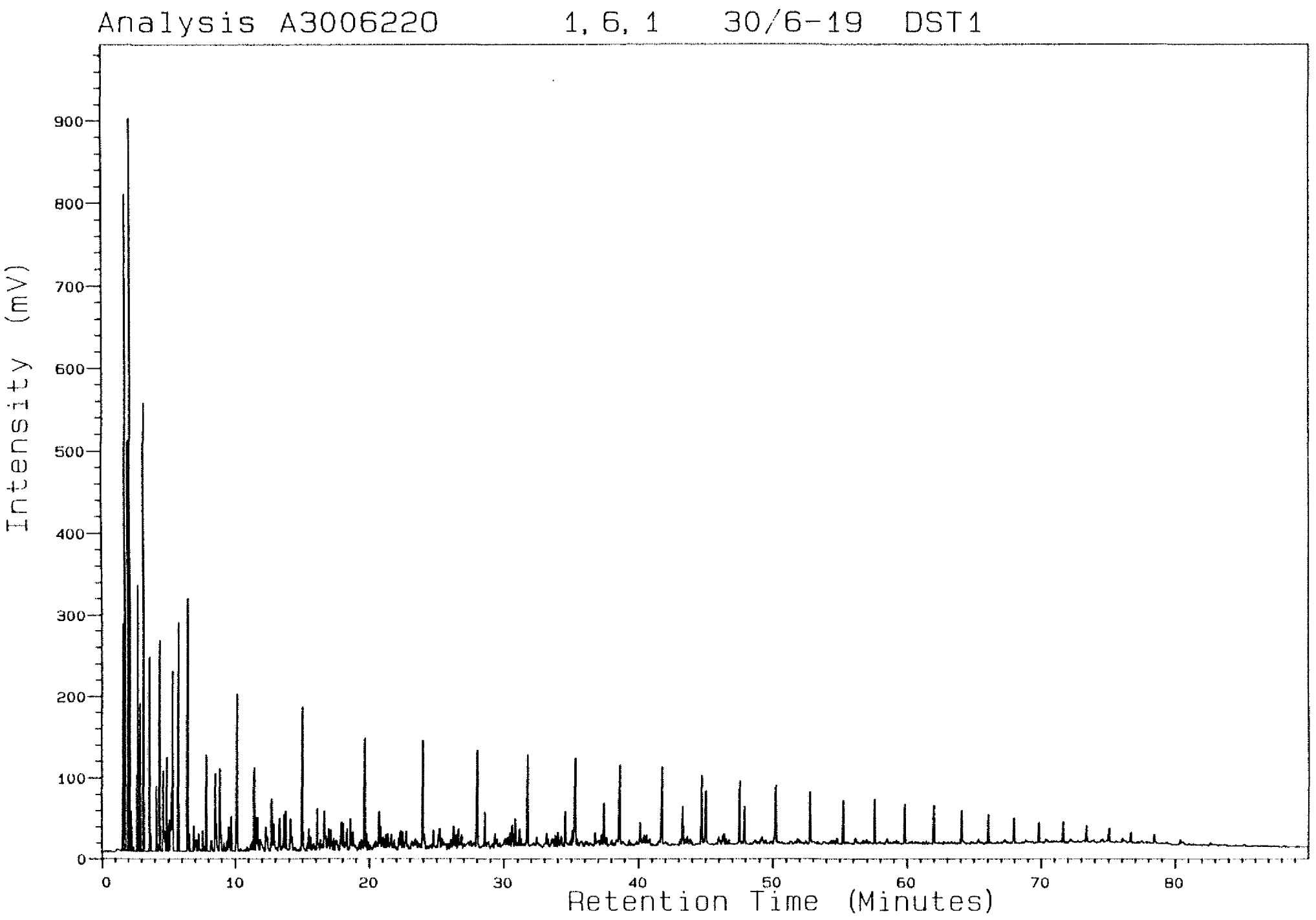
The five analysed samples are highly paraffinic crude oils typical for the Upper Jurassic sourced oils in the North Sea.

Based on the biomarker patterns and the C15+ saturated hydrocarbon distributions these oils are correlated to each other, but they are significantly different from the Oseberg alpha oil (30/6-13), used as a laboratory reference sample. This observation indicates that the oils from 30/6-19 and 30/6-22 have a different source than the Oseberg alpha oil.

Molecular parameters are not separating the oils from 30/6-19 and 30/6-22.

APPENDIX I

Whole oil chromatograms.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50
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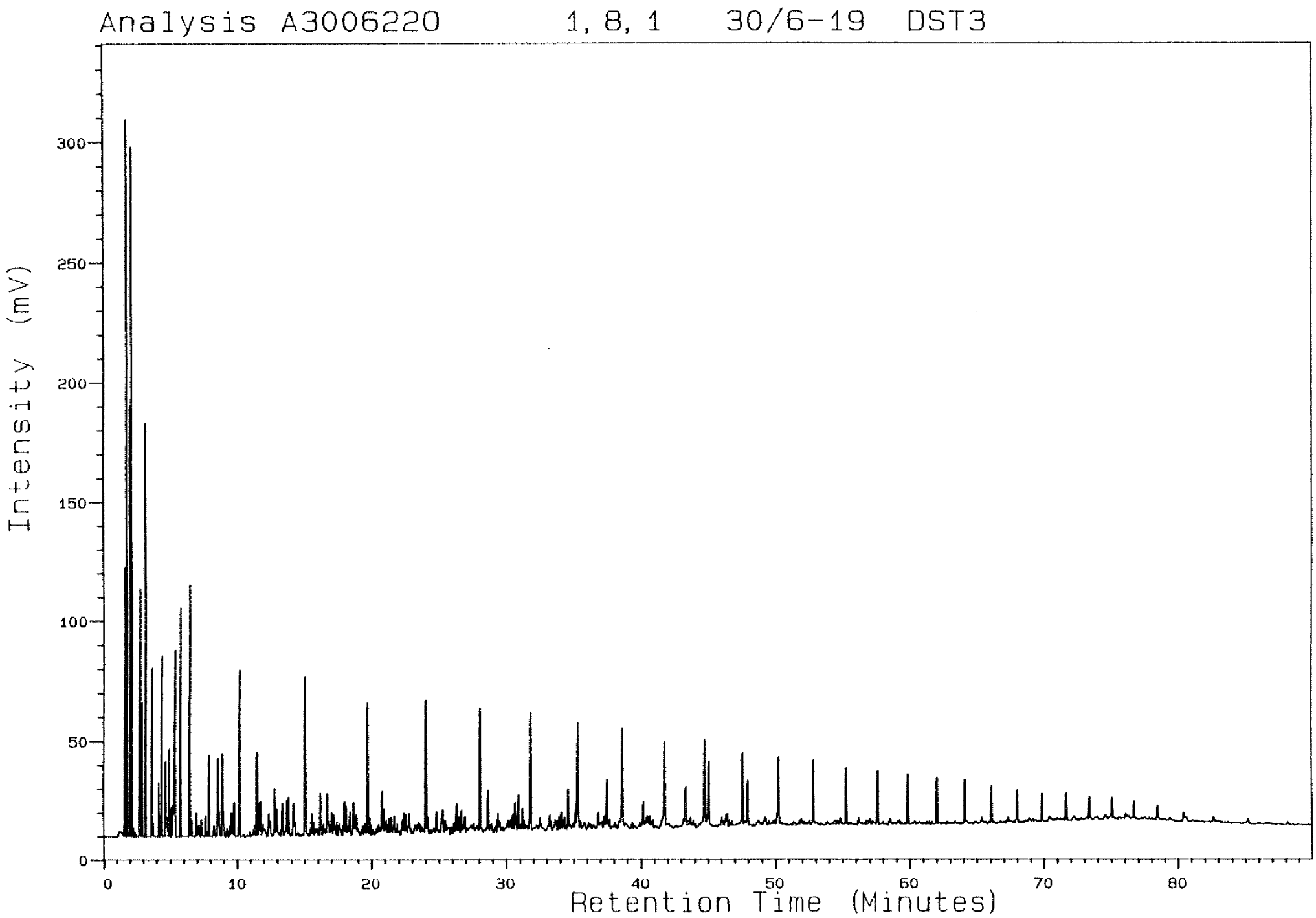
Retention Time (Minutes)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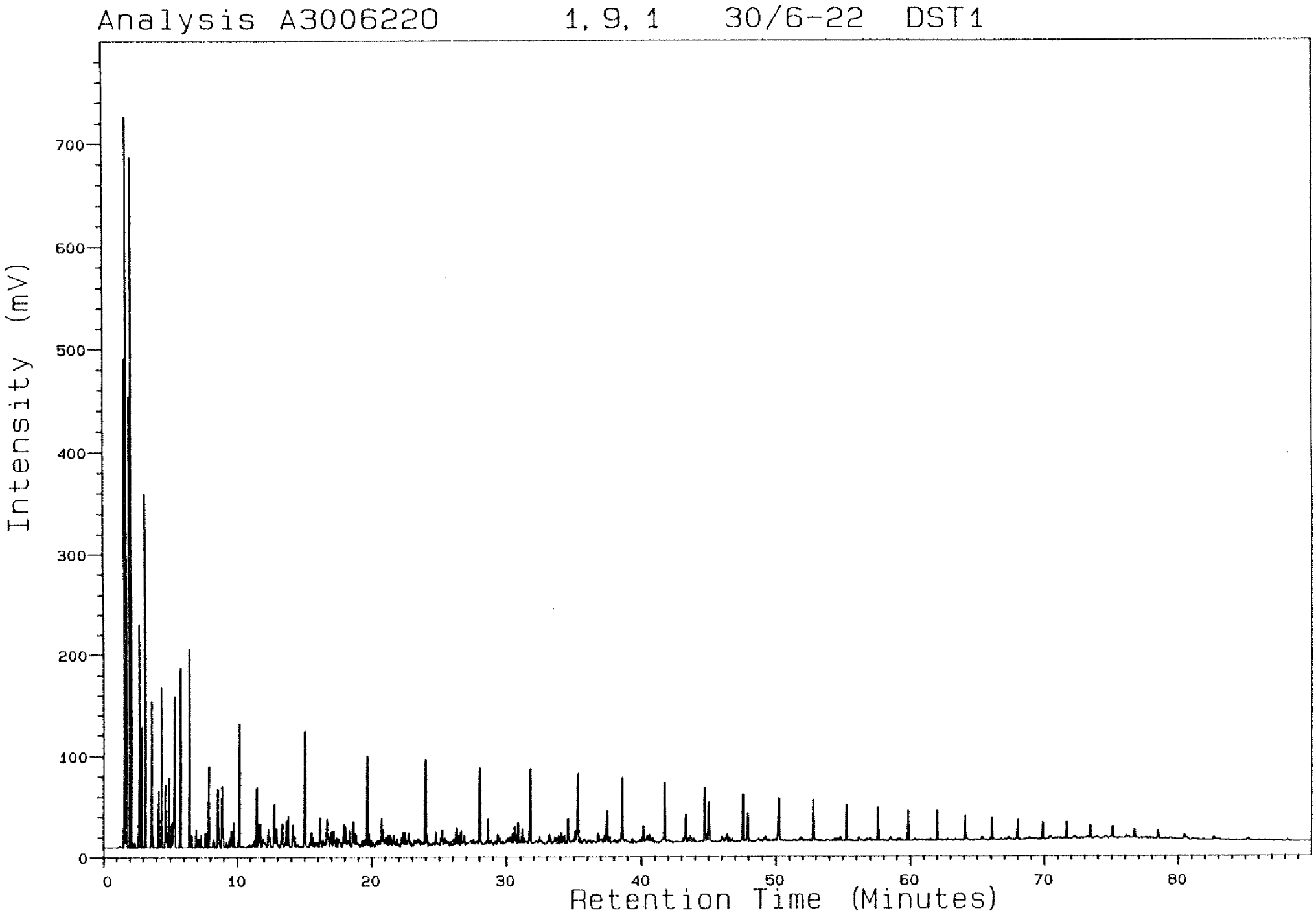
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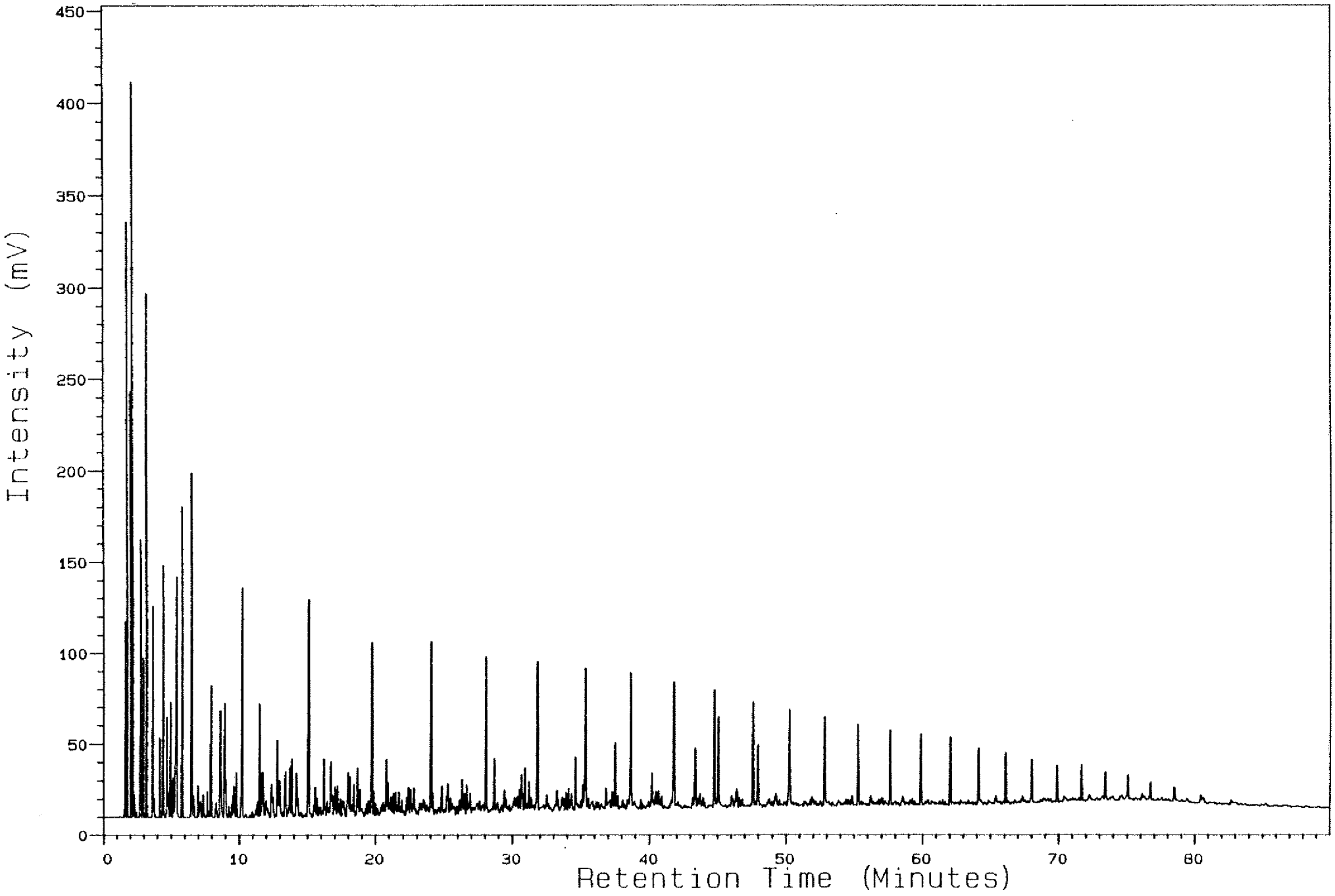
Retention Time (Minutes)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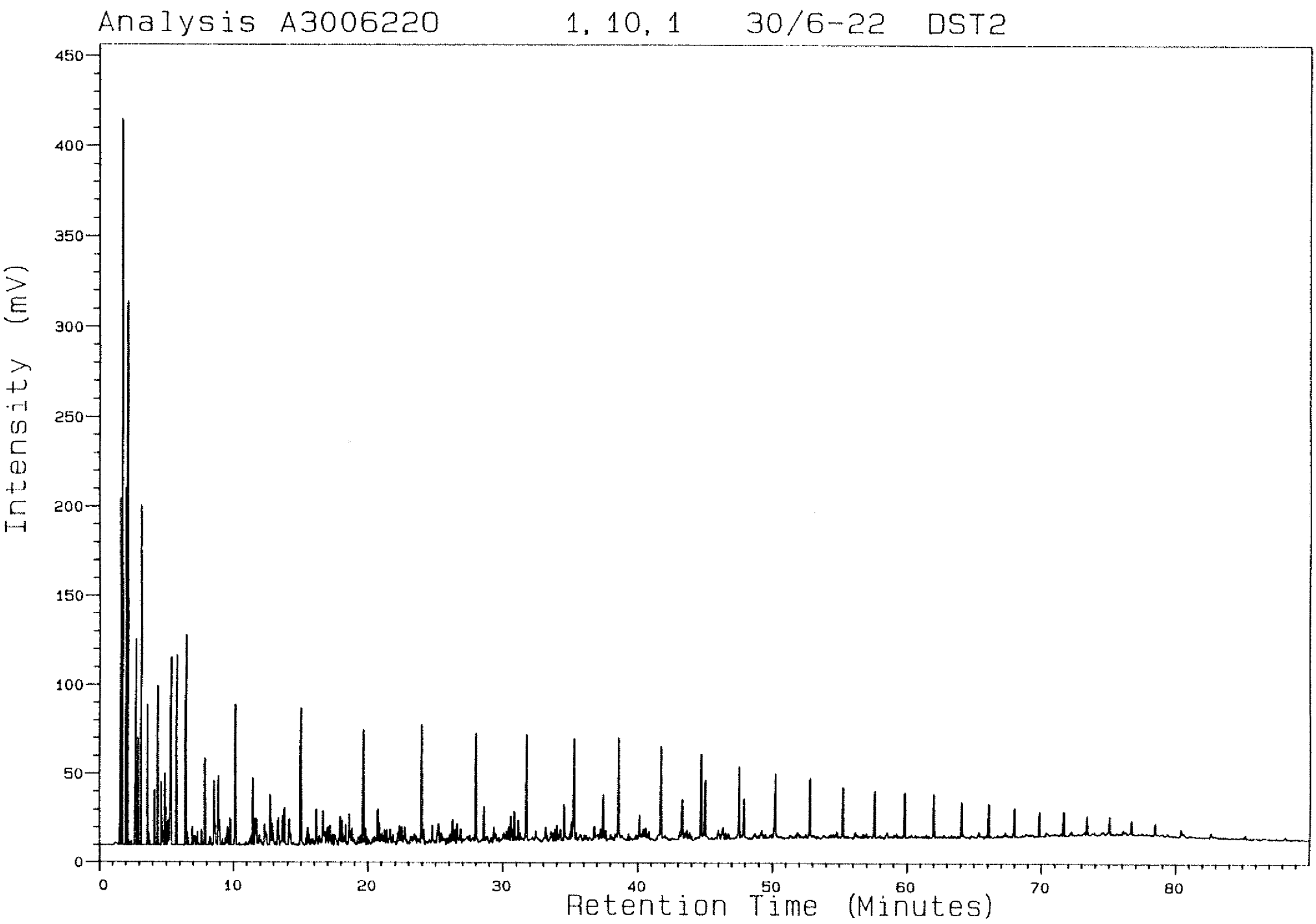
Retention Time (Minutes)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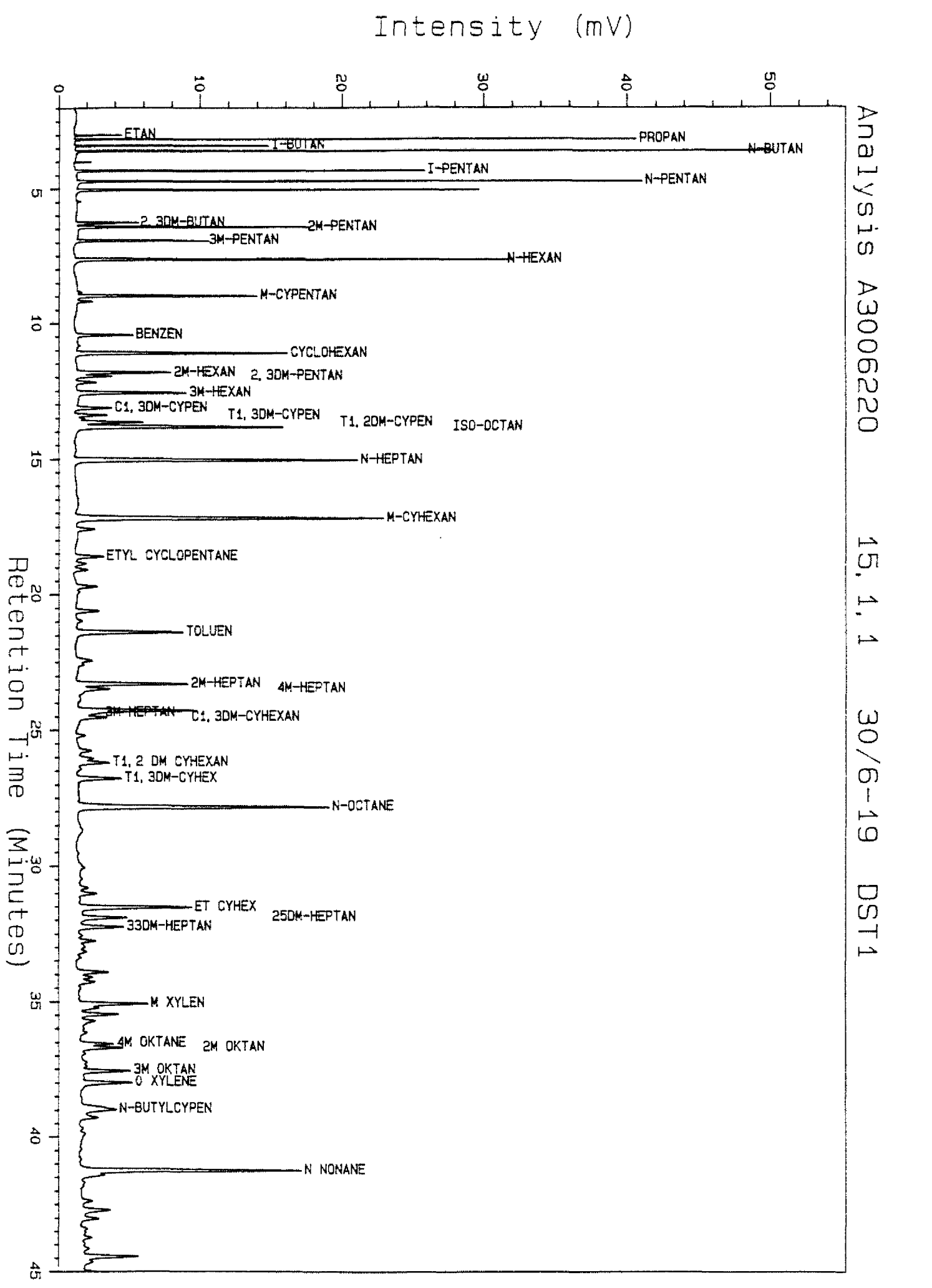
Retention Time (Minutes)

APPENDIX II

Gas chromatograms of light hydrocarbons.

Analysis reports, light hydrocarbons.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N-BUTAN
I-PENTAN
N-PENTAN
2, 3DM-BUTAN
2M-PENTAN
3M-PENTAN
N-HEXAN
M-CYPENTAN
BENZEN
CYCLOHEXAN
2M-HEXAN
2, 3DM-PENTAN
3M-HEXAN
C1, 3DM-CYPEN
T1, 3DM-CYPEN
T1, 2DM-CYPEN
ISO-OCTAN
N-HEPTAN
M-CYHEXAN
ETYL CYCLOPENTANE
TOLUEN
2M-HEPTAN
4M-HEPTAN
3M-HEPTAN
C1, 3DM-CYHEXAN
T1, 2 DM CYHEXAN
T1, 3DM-CYHEX
N-OCTANE
ET CYHEX
25DM-HEPTAN
33DM-HEPTAN
M XYLEN
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O XYLENE
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N NONANE
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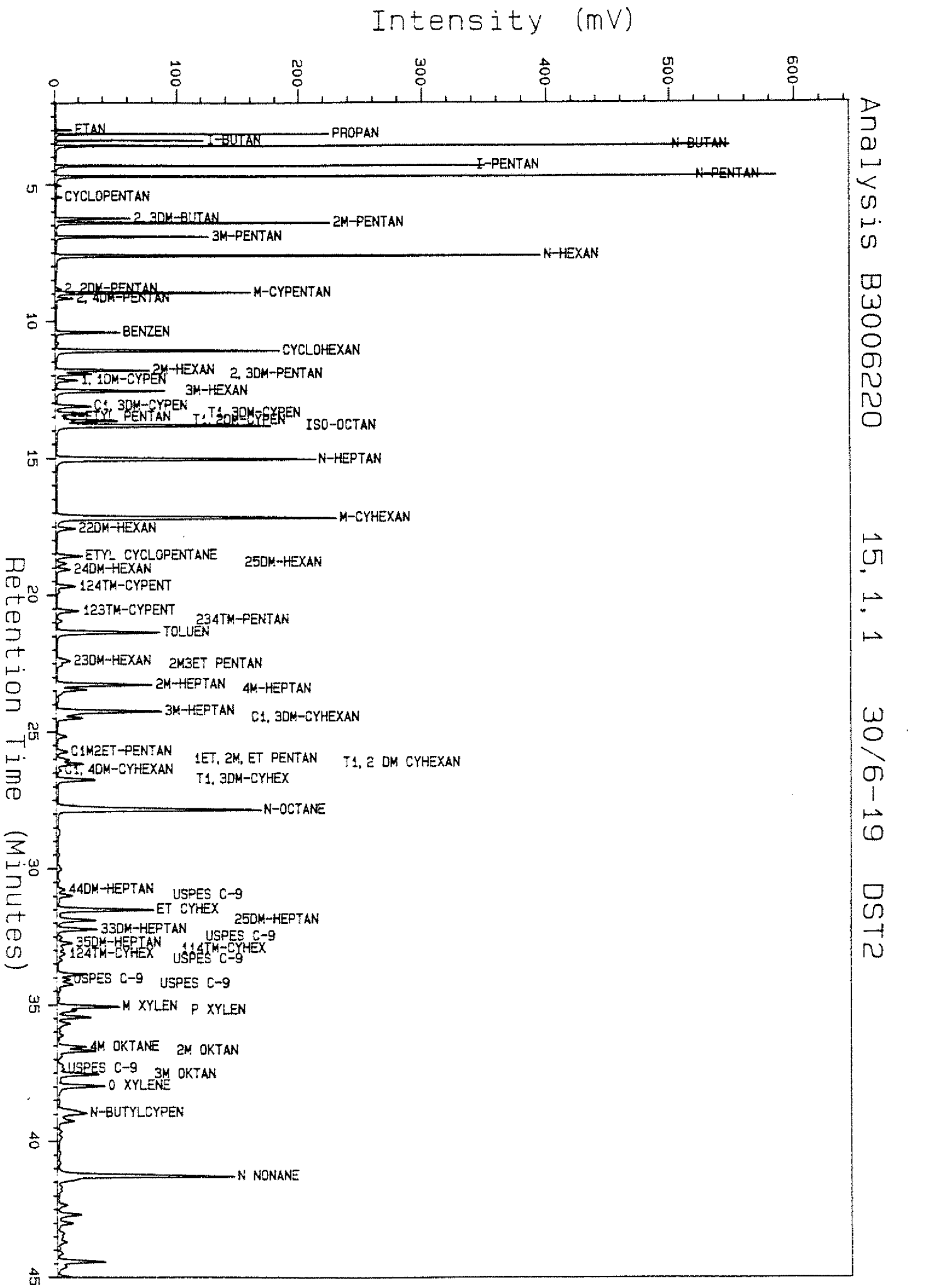
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N-BUTAN
I-PENTAN
N-PENTAN
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3M-HEXAN
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T1, 3DM-CYPEN
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M-CYHEXAN
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ETYL CYCLOPENTANE
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24DM-HEXAN
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123TM-CYPENT
234TM-PENTAN
TOLUEN
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2M3ET PENTAN
2M-HEPTAN
4M-HEPTAN
3M-HEPTAN
C1, 3DM-CYHEXAN
C1M2ET-PENTAN
1ET, 2M, ET PENTAN
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C1, 4DM-CYHEXAN
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ET CYHEX
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USPES C-9
35DM-HEPTAN
114TM-CYHEX
124TM-CYHEX
USPES C-9
USPES C-9
USPES C-9
M XYLEN
P XYLEN
4M OKTANE
2M OKTAN
USPES C-9
3M OKTAN
O XYLENE
N-BUTYLCYPEN
N NONANE
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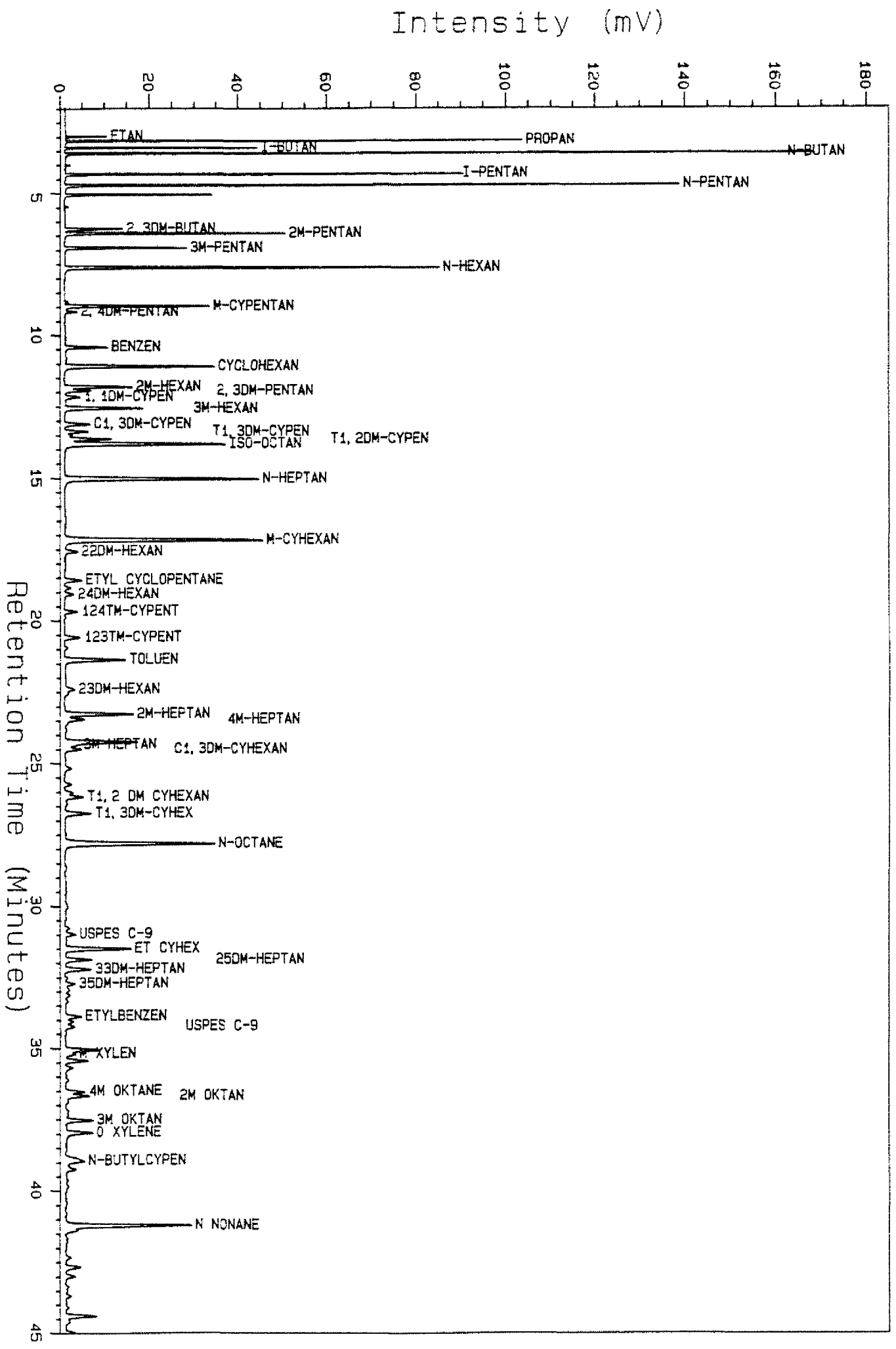
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35
40
45
ETAN
PROPAN
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I-PENTAN
N-PENTAN
2, 3DM-BUTAN
2M-PENTAN
3M-PENTAN
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ISO-OCTAN
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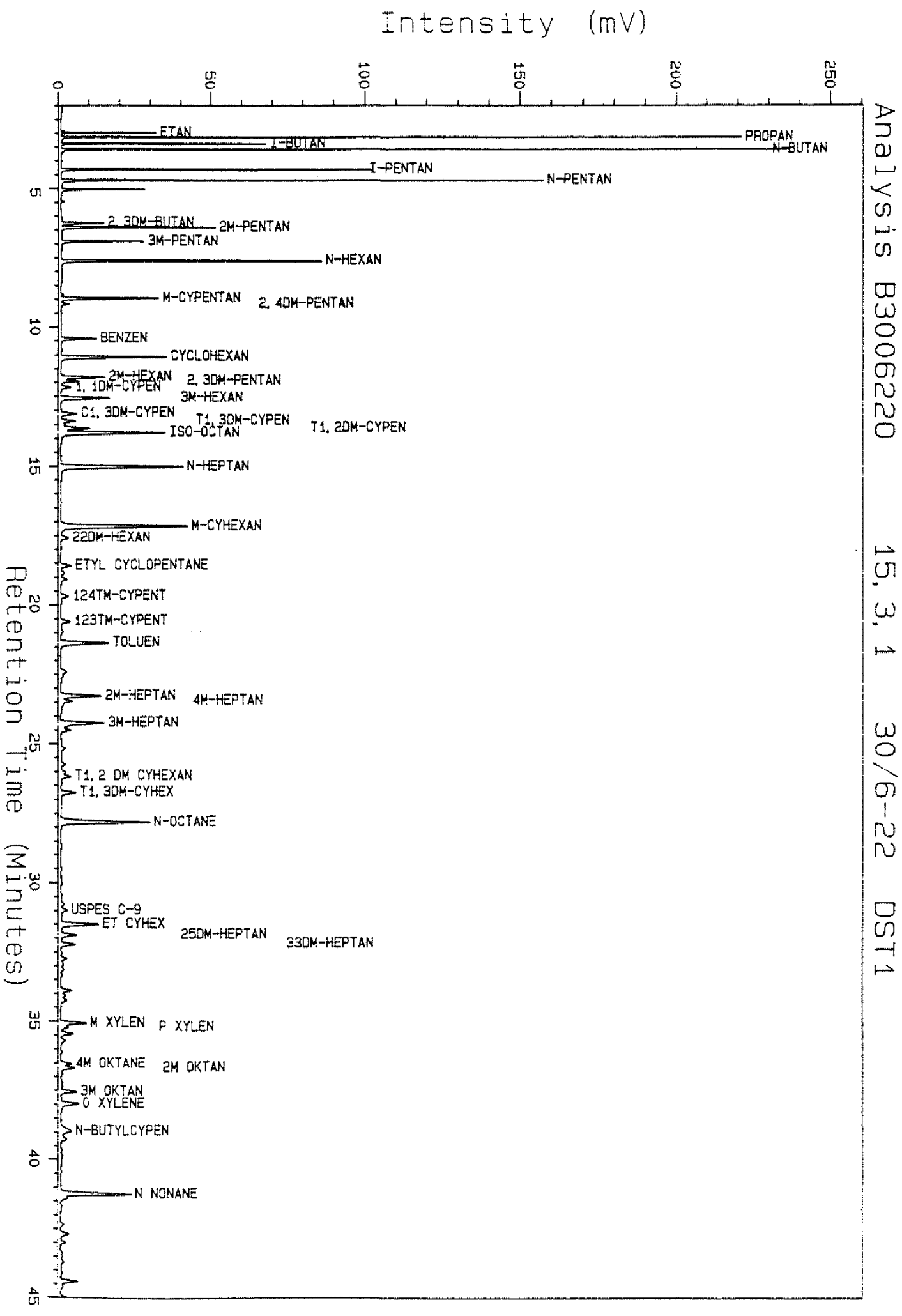
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M-CYPENTAN
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CYCLOHEXAN
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ISO-OCTAN
N-HEPTAN
M-CYHEXAN
22DM-HEXAN
ETYL CYCLOPENTANE
124TM-CYPENT
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TOLUEN
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USPES C-9
ET CYHEX
25DM-HEPTAN
33DM-HEPTAN
M XYLEN
P XYLEN
4M OKTANE
2M OKTAN
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O XYLENE
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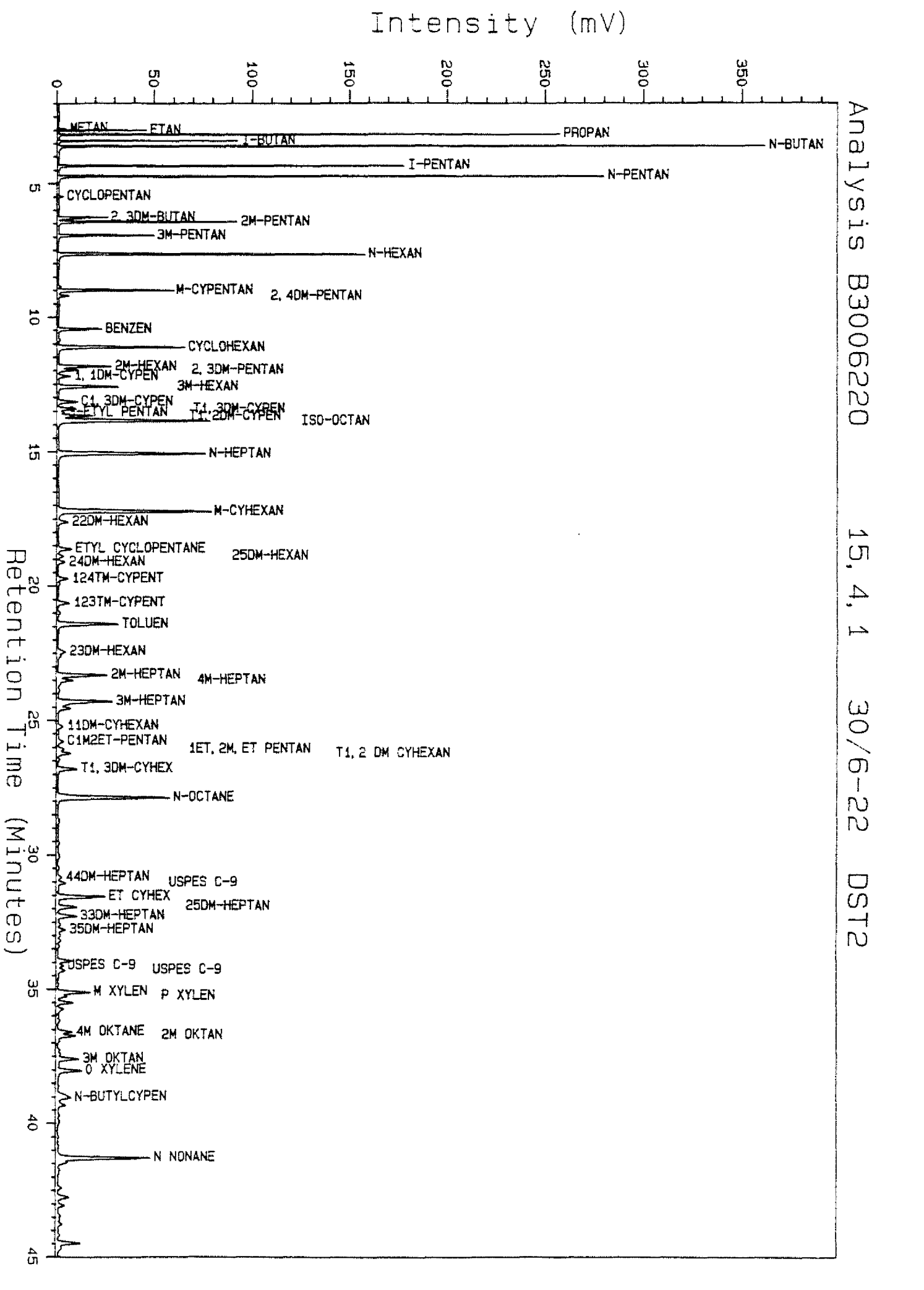
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2M-PENTAN
3M-PENTAN
N-HEXAN
M-CYPENTAN
2, 4DM-PENTAN
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CYCLOHEXAN
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3M-HEXAN
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T1, 3DM-CYPEN
ETYL PENTAN
T1, 2DM-CYPEN
ISO-OCTAN
N-HEPTAN
M-CYHEXAN
22DM-HEXAN
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24DM-HEXAN
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11DM-CYHEXAN
C1M2ET-PENTAN
1ET, 2M, ET PENTAN
T1, 2 DM CYHEXAN
T1, 3DM-CYHEX
N-OCTANE
44DM-HEPTAN
USPES C-9
ET CYHEX
25DM-HEPTAN
33DM-HEPTAN
35DM-HEPTAN
USPES C-9
USPES C-9
M XYLEN
P XYLEN
4M OKTANE
2M OKTAN
3M OKTAN
O XYLENE
N-BUTYLCYPEN
N NONANE
Retention Time (Minutes)
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10
15
20
25
30
35
40
45
Analysis B3006220 15, 4, 1 30/6-22 DST2

Analysis:IS A3006220.1.1
Reported on 06-Dec-88 at 15:17

M U L T I C H R O M V3.0

Analyst Name :ØLIN . Analysis ID:
Information :ØLJER ERA 30/6-19 ØG 30/6-20

ØLJEANALYSR VED PVT, RESERVOAR. COPYRIGHT.

Channel:IS Title: CHANNEL IS Date 23-Nov-88 Time 9:50
Analysis:A3006220 Sample Name:30/6-19 DST1 Sample ID: 9 Rollin:1
Sample 1 Injection 1

Peak	R/T m.	Pl Corr	%MOLE	Identity
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2	3.160	3.179	0.150	PROPAN
3	3.397	3.418	0.169	I-BUTAN
4	3.597	3.619	0.633	N-BUTAN
5	3.686	3.711	0.002	NEO-PENTAN
7	4.331	4.328	0.399	I-PENTAN
8	4.723	4.707	0.692	N-PENTAN
10	5.469	5.468	0.007	CYCLOPENTAN
11	6.261	6.275	0.135	2,3DM BUTAN
12	6.419	6.436	0.393	2M-PENTAN
13	6.935	6.952	0.242	3M-PENTAN
14	7.616	7.656	0.852	N-HEXAN
16	8.827	8.882	0.010	2,2DM-PENTAN
17	8.968	9.025	0.423	N-CYPENTAN
18	9.173	9.233	0.039	2,4DM-PENTAN
19	10.424	10.500	0.155	BENZEN
20	10.827	10.900	0.009	3,3DM-PENTAN
21	11.091	11.163	0.615	CYCLOHEXAN
22	11.811	11.892	0.277	2M-HEXAN
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24	12.173	12.259	0.052	1,1DM-CYPEN
25	12.557	12.648	0.348	3M-HEXAN
26	13.117	13.203	0.117	C1,3DM-CYPEN
27	13.370	13.458	0.108	T1,3DM-CYPEN
28	13.515	13.595	0.033	3-ETYL PENTAN
29	13.640	13.719	0.340	T1,2DM-CYPEN
30	13.808	13.885		ISO-OCTAN
31	15.031	15.200	1.053	N-HEPTAN
33	17.168	17.300	1.248	M-CYHEXAN
34	17.573	17.691	0.073	22DM-HEXAN
35	18.587	18.730	0.118	ETYL CYCLOPENTANE
36	18.843	18.988	0.056	25DM-HEXAN
37	19.061	19.208	0.056	24DM-HEXAN
38	19.683	19.834	0.087	124TM-CYPENT
39	19.875	20.028	0.011	33DM-HEXAN
40	20.582	20.748	0.093	123TM-CYPENT
41	20.955	21.116	0.023	234TM-PENTAN
42	21.368	21.533	0.440	TOLUEN
43	22.413	22.584	0.082	23DM-HEXAN
44	22.559	22.635	0.031	2M3ET PENTAN
45	23.273	23.302	0.415	2M-HEPTAN
46	23.453	23.470	0.141	4M-HEPTAN
49	24.347	24.300	0.060	3M-HEPTAN
50	24.504	24.468	0.134	C1,3DM-CYHEXAN
53	24.627	24.599	0.039	C1,4DM CYHEXAN
55	26.029	26.097	0.078	TE1,2M,E3 PENTAN
56	26.181	26.259	0.116	T1,2 DM CYHEXAN
57	26.421	26.515	0.023	C1,4DM-CYHEXAN
58	26.760	26.877	0.120	T1,3DM-CYHEX
60	27.821	28.010	1.108	N-OCTANE
61	30.443	30.632	0.013	22DM-HEPTAN
66	31.000	31.178	0.071	USPES C-9
67	31.512	31.688	0.478	CE CYHEX
68	31.893	32.057	0.187	25DM-HEPTAN
69	32.337	32.391	0.108	33DM-HEPTAN
70	32.547	32.690	0.012	USPES C-9
71	32.737	32.881	0.076	35DM-HEPTAN
72	32.960	33.091	0.055	1141M-CYHEX
73	33.140	33.271	0.053	124TM-CYHEX
74	33.357	33.475	0.013	USPES C-9
77	34.005	34.101	0.071	USPES C-9
78	34.252	34.348	0.090	USPES C-9
79	34.491	34.573	0.013	N-9
80	35.080	35.144	0.392	M XYLEN
81	35.237	35.290	0.084	P XYLEN
84	35.987	36.049	0.023	34DM-HEPTAN
86	36.519	36.610	0.133	4M OKTANE
87	36.699	36.759	0.175	2M OKTAN
88	36.907	36.967	0.016	3-ET HEPTAN
90	37.365	37.425	0.023	USPES C-9
91	37.552	37.611	0.209	3M OKTAN
92	37.987	38.050	0.253	O XYLENE
94	38.972	39.053	0.373	N-BUTYLCYPEN
96	39.667	39.749	0.015	USPES C-9
97	39.867	39.951	0.035	USPES C-9
98	40.461	40.552	0.004	123TM-CYHEX
99	41.251	41.350	0.940	N NONANE
Residual		3.430		
Total		98.519		

Sample type: SA Scale Factor: 1.000 Amount: 1.000 ISTD : 0.780
Method: OIL Calibration: OIL Type: IS Using:Area
ND type: next peak

MULTICHROM 93.2

Analyst Name :ERLIN Analysis ID:
Information :DB.IEP [9A 30/6-12 06 30/6-22

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Channel:15 Title: CHANNEL 15 Date 23-Nov-88 Time 13:50
Analysis:B3006220 Sample Name:30/6 17 WST2 Sample ID: 0 Bottle:1
Sample 1 Injection 1

Peak	R/T m.	RT Corr	%MIX	Identity
1	2.930	2.956	0.000	UKTAN
2	3.008	3.036	0.016	ETAN
3	3.160	3.179	0.267	PROPAN
5	3.397	3.418	0.152	I-BUTAN
6	3.592	3.613	0.731	N-BUTAN
7	3.697	3.717	0.006	NEO-PENTAN
10	4.331	4.338	0.374	I-PENTAN
12	4.723	4.707	1.030	N-PENTAN
13	4.930	4.907	0.000	SUBSUBNS. AV BCH
16	5.473	5.467	0.003	CYCLOPENTAN
17	6.264	6.271	0.189	2,3DM-BUTAN
18	6.424	6.433	0.545	2M-PENTAN
19	6.938	6.941	0.335	3M-PENTAN
21	7.629	7.656	1.111	N-HEXAN
23	8.832	8.879	0.013	2,2DM-PENTAN
24	8.976	9.025	0.529	M-CYPENTAN
25	9.176	9.238	0.053	2,4DM-PENTAN
28	10.427	10.500	0.201	BENZEN
30	10.824	10.889	0.008	3,3DM-PENTAN
31	11.104	11.163	0.753	CYCLOHEXAN
33	11.824	11.892	0.317	2M-HEXAN
34	11.952	12.033	0.130	2,3DM-PENTAN
35	12.173	12.246	0.078	1,1DM-CYPEN
36	12.521	12.648	0.302	3M-HEXAN
38	13.123	13.185	0.135	C1,3DM-CYPEN
39	13.387	13.442	0.127	T1,3DM-CYPEN
40	13.520	13.571	0.036	3-ETYL PENTAN
41	13.653	13.701	0.260	T1,2DM-CYPEN
42	13.843	13.885		ISO-OCTAN
44	15.075	15.200	0.150	N-HEPTAN
45	15.293	15.415	0.004	1,1DM-CYPEN
46	17.213	17.300	1.363	M-CYHEXAN
47	17.581	17.691	0.088	2,2DM-HEXAN
49	18.587	18.694	0.116	ETIL CYCLOPENTANE
50	18.853	18.963	0.046	2,5DM-HEXAN
51	19.069	19.184	0.062	2,4DM-HEXAN
53	19.685	19.809	0.086	1,1,3TM-CYPENT
54	19.880	20.007	0.013	3,3DM-HEXAN
55	20.380	20.506	0.105	1,2,3TM-CYPENT
56	20.953	21.075	0.034	2,3,4TM-PENTAN
57	21.381	21.533	0.423	TOLUEN
59	22.419	22.527	0.091	2,3DM HEXAN
60	22.585	22.658	0.035	2M,3ET PENTAN
61	23.299	23.362	0.446	2M-HEPTAN
62	23.461	23.531	0.135	4M-HEPTAN
65	24.264	24.390	0.515	3M-HEPTAN
67	24.501	24.544	0.122	C1,3DM-CYHEXAN
68	24.709	24.757	0.000	T1,3DM CYHEXAN
71	25.736	25.810	0.050	C1M3ET-PENTAN
72	26.024	26.106	0.062	3ET,3M,PT PENTAN
73	26.181	26.267	0.130	T1,2 DM CYHEXAN
74	26.411	26.502	0.017	C1,4DM-CYHEXAN
75	26.760	26.861	0.187	T1,3DM-CYHEX
78	27.880	28.010	1.104	N OCTANE
79	28.056	28.108	0.005	USP C-9
81	28.720	28.858	0.007	C1,2DM-CYHEXAN
84	29.496	29.640	0.009	2,4DM-HEPTAN
85	29.944	30.092	0.006	USPES C-9
86	30.443	30.576	0.010	2,2DM-HEPTAN
89	30.771	30.927	0.036	4,4DM-HEPTAN
90	30.995	31.153	0.074	USPES C-9
91	31.200	31.360	0.009	USPES C-9
92	31.525	31.688	0.482	ET CYHEX
93	31.728	31.885	0.006	USPES C-9
94	31.901	32.056	0.198	2,5DM-HEPTAN
95	32.235	32.378	0.130	3,3DM-HEPTAN
96	32.531	32.685	0.021	USPES C-9
97	32.741	32.870	0.073	3,5DM-HEPTAN
98	32.963	33.085	0.030	1,1,4TM-CYHEX
99	33.133	33.251	0.040	1,2,4TM-CYHEX
100	33.352	33.464	0.020	USPES C-9
103	34.077	34.169	0.061	USPES C-9
104	34.251	34.338	0.084	USPES C-9
106	34.707	34.869	0.005	USPES C-9
107	35.080	35.144	0.306	M XYLEN
108	35.216	35.279	0.084	P XYLEN
113	36.595	36.613	0.132	4M OKTANE
114	36.699	36.756	0.178	2M OKTAN
117	37.355	37.409	0.039	USPES C-9
118	37.957	37.611	0.311	3M OKTAN
120	37.981	38.040	0.238	O XYLENE
124	38.981	39.041	0.247	N-BUTYLCYPEN
126	39.413	39.471	0.004	USPES C-9
129	40.541	40.595	0.001	1,3,5TM-CYHEX
132	41.301	41.350	0.016	N NONANE

Residual	1.235	
Total	19.447	

Sample Type: SA Scale Factor: 1.000 Amount: 1.000 ISTD : 0.894
Method: OIL Calibration: OIL Type: IS Using:Area
UC type: next peak

M U L T I C H R O M V3.2

Analyst Name :ELIN Analysis ID:
Information :OLJER ERA 30/6-19 DS 30/6-22

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Channel:15 Title: CHANNEL 15 Date 23-Nov-88 Time 11:44
Analysis:K3006220 Sample Name:30/6-19 DST3 Sample ID: 0 Bottle:1
Sample 2 Injection 1

Peak	R/T m.	Pt Corr	WGT%	Identity
1	2.936	2.954	0.001	METAN
2	3.003	3.021	0.054	ETAN
3	3.157	3.176	0.611	PROPAN
5	3.395	3.415	0.204	I-BUTAN
6	3.597	3.619	1.161	N BUTAN
7	3.689	3.717	0.004	NEO-PENTAN
9	4.331	4.328	0.767	I-PENTAN
10	4.723	4.707	1.255	N-PENTAN
11	4.867	4.854	0.000	FORUREN5. AV BCH
14	5.472	5.469	0.002	CYCLOPENTAN
15	6.361	6.275	0.207	2,2DM-BUTAN
16	6.431	6.435	0.614	2M-PENTAN
17	6.928	6.751	0.358	3M-PENTAN
19	7.621	7.656	1.172	N-HEXAN
21	8.823	8.881	0.014	2,2DM-PENTAN
22	8.973	9.027	0.546	M-CYPENTAN
23	9.179	9.235	0.055	2,4DM-PENTAN
25	10.437	10.500	0.181	BENZEN
26	10.821	10.892	0.008	3,3DM-PENTAN
27	11.099	11.163	0.609	CYCLOHEXAN
29	11.813	11.892	0.321	2M-HEXAN
30	11.947	12.024	0.135	2,3DM-PENTAN
31	12.176	12.251	0.080	1,1DM-CYPEN
33	12.565	12.648	0.393	3M-HEXAN
34	13.123	13.199	0.137	C1,3DM-CYPEN
35	13.384	13.458	0.129	T1,3DM-CYPEN
36	13.503	13.595	0.040	3-ETYL PENTAN
37	13.645	13.716	0.263	T1,2DM-CYPEN
38	13.816	13.885		DM OKTAN
40	15.032	15.200	1.131	N-HEPTAN
41	15.311	15.379	0.010	1,1DM-CYPEN
42	17.176	17.300	1.205	M-CYHEXAN
44	17.529	17.691	0.089	22DM-HEXAN
45	18.587	18.713	0.108	ETYL CYCLOPENTANE
46	18.851	18.980	0.038	25DM-HEXAN
47	19.069	19.201	0.056	24DM-HEXAN
48	19.683	19.833	0.082	124TM-CYPENT
49	19.883	20.025	0.010	33DM-HEXAN
50	20.582	20.731	0.101	123TM-CYPENT
51	20.955	21.112	0.032	2341M-PENTAN
52	21.371	21.533	0.397	TOLUEN
53	22.413	22.583	0.076	23DM-HEXAN
54	22.585	22.635	0.023	2M3ET PENTAN
55	23.373	23.382	0.430	2M-HEPTAN
56	23.156	23.474	0.133	4M-HCPTAN
59	24.344	24.300	0.051	3M-HEPTAN
60	24.501	24.468	0.108	C1,3DM-CYHEXAN
62	25.299	25.319	0.002	11DM-CYHEXAN
64	26.027	26.097	0.058	1ET,2M,ET PENTAN
65	26.176	26.256	0.131	T1,2 DM CYHEXAN
66	26.408	26.504	0.021	C1,4DM CYHEXAN
67	26.752	26.871	0.174	T1,3DM-CYHEX
68	27.819	28.010	1.030	N-OCTANE
70	28.645	28.836	0.015	C1,2DM-CYHEXAN
71	29.493	29.683	0.007	24DM-HEPTAN
73	30.435	30.623	0.010	23DM-HEPTAN
74	30.771	30.958	0.035	44DM-HEPTAN
75	30.989	31.177	0.078	USPES C-9
78	31.501	31.688	0.451	ET CYHEX
79	31.883	32.044	0.180	25DM-HEPTAN
81	32.319	32.358	0.178	33DM-HCPTAN
82	32.525	32.645	0.017	USPES C-9
83	32.731	32.837	0.067	35DM-HEPTAN
84	32.947	33.039	0.040	1141M-CYHEX
85	33.136	33.215	0.039	124TM-CYHEX
87	33.888	33.918	0.112	ETYLBENZEN
89	34.240	34.247	0.070	USPES C-9
90	34.461	34.454	0.006	USPES C-9
92	35.200	35.144	0.066	M XYLEN
94	35.608	35.661	0.053	1131M-CYHEX
96	36.130	36.118	0.030	24DM-HEPTAN
97	36.531	36.553	0.117	4M OKTANE
98	36.675	36.705	0.161	2M OKTAN
101	37.339	37.408	0.017	USPES C-9
102	37.531	37.611	0.172	3M OKTAN
104	37.971	38.050	0.186	O XYLENE
107	38.960	39.052	0.220	N-BUTYLCYPEN
109	39.637	39.738	0.035	USPES C-9
110	39.843	39.946	0.032	USPES C-9
111	40.427	40.537	0.010	123TM-CYHEX
113	41.229	41.350	0.804	N NONANE
Residual			3.026	
Total			30.272	

Sample Type: SA Scale Factor: 1.000 Amount: 1.000 ISTD : 0.938
Method: OIL Calibration: OIL Type: IS Using:Area
WC type: next peak

MULTICHROM 93.2

Analyst Name :ERLIN Analysis ID:
Information :ULJER ERA 30/6-19 08 30/6-22

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Channel:15 Title: CHANNEL 15 Date 23-Nov-08 Time 16:05
Analysis:H3006220 Sample Name:30/6-22 DSTJ Sample ID: 0 Bottle:1
Sample 3 Injection 1

Peak	R/T m.	RT Corr	Area%	Identity
1	2.936	2.954	0.007	METAN
2	3.003	3.021	0.102	ETAN
3	3.157	3.176	1.100	PROPAN
4	3.375	3.415	0.465	I-BUTAN
5	3.597	3.617	1.738	N-BUTAN
6	3.699	3.717	0.008	NEO-PENTAN
7	4.331	4.338	0.929	I-PENTAN
8	4.723	4.707	1.530	N-PENTAN
9	4.861	4.851	0.000	FORUREINS. AV DCM
12	5.472	5.469	0.013	CYCLOPENTAN
13	6.267	6.276	0.238	2,3DM-BUTAN
14	6.424	6.436	0.673	2M-PENTAN
15	6.931	6.951	0.397	3M-PENTAN
16	7.624	7.656	1.308	N HEXAN
17	8.035	8.801	0.016	2,2DM-PENTAN
18	8.976	9.024	0.595	M-CYPENTAN
19	9.181	9.232	0.056	2,4DM-PENTAN
21	10.435	10.500	0.245	BENZEN
23	10.832	10.895	0.009	3,3DM-PENTAN
24	11.101	11.163	0.791	CYCLOHEXAN
25	11.824	11.895	0.336	2M-HEXAN
26	11.957	12.030	0.139	2,3DM-PENTAN
27	12.181	12.257	0.088	1,1DM-CYPEN
29	12.568	12.649	0.399	3M-HEXAN
30	13.128	13.200	0.141	C1,3DM-CYPEN
31	13.389	13.457	0.132	T1,3DM-CYPEN
32	13.535	13.591	0.040	3-ETYL PENTAN
33	13.653	13.717	0.266	T1,2DM CYPEN
34	13.824	13.885		ISO-OCTAN
36	15.040	15.300	1.171	N HEPTAN
37	17.184	17.300	1.335	M-CYHEXAN
39	17.589	17.691	0.084	23DM-HEXAN
40	18.505	18.711	0.113	ETYL CYCLOPENTANE
41	18.856	18.976	0.050	25DM-HEXAN
42	19.077	19.201	0.060	24DM HEXAN
43	19.693	19.836	0.072	124TM CYPENT
44	19.891	20.026	0.013	33DM-HEXAN
45	20.597	20.740	0.095	123TM-CYPENT
46	20.963	21.114	0.021	234TM-PENTAN
47	21.376	21.533	0.504	TOLUEN
48	22.412	22.535	0.075	23DM-HEXAN
49	22.557	22.668	0.024	2M3EL PENTAN
50	23.280	23.362	0.412	2M-HEPTAN
51	23.464	23.539	0.130	4M-HEPTAN
53	23.573	23.644	0.016	C1C3DM-CYHEXAN
53	24.056	24.300	0.469	3M-HEPTAN
56	25.101	25.261	0.040	113M-CYHEXAN
58	25.744	25.845	0.046	C1M3ET-PENTAN
59	26.035	26.147	0.057	1ET,2M,ET PENTAN
60	26.184	26.302	0.113	T1,3 DM CYHEXAN
61	26.413	26.540	0.013	C1,4DM-CIHEXAN
62	26.763	26.903	0.164	T1,3DM-CYHEX
63	27.839	28.010	0.291	N-OCTANE
64	27.975	28.175	0.004	UNK C-9
65	28.613	28.833	0.007	C1,2DM-CYHEXAN
67	29.507	29.686	0.007	24DM-HEPTAN
70	30.281	30.360	0.033	44DM-HEPTAN
71	31.000	31.179	0.059	USPES C-9
72	31.509	31.688	0.419	ET CYHEX
73	31.821	32.057	0.165	25DM HEPTAN
74	33.239	33.385	0.157	33DM-HEPTAN
75	32.542	32.693	0.015	USPES C 9
76	33.241	33.881	0.067	35DM HEPTAN
78	33.136	33.264	0.041	134TM-CYHEX
79	33.355	33.475	0.017	USPES C-9
81	34.080	34.178	0.061	USPES C-9
82	34.256	34.348	0.086	USPES C-9
84	34.531	34.614	0.001	N-9
85	34.725	34.870	0.001	USPES C-9
86	35.077	35.144	0.287	M XYLEN
87	35.231	35.288	0.090	P XYLEN
92	36.541	36.607	0.112	4M OKTANE
93	36.688	36.753	0.155	2M OKTAN
94	36.901	36.966	0.017	3-ET HEPTAN
96	37.360	37.425	0.017	USPES C-9
97	37.547	37.611	0.163	3M OKTAN
99	37.981	38.050	0.313	O XYLENE
100	38.973	39.055	0.207	N-NONYLCYPEN
102	39.657	39.741	0.011	USPES C-9
103	39.864	39.957	0.023	USPES C-9
104	40.415	40.546	0.001	123TM-CYHEX
105	40.813	40.918	0.008	USPES C-9
106	41.240	41.350	0.773	N NONANE
Residual			1.456	
Total			13.890	

Sample Type: SA Scale Factor: 1.000 Amount: 1.000 ISTD : 0.980
Method: OIL Calibration: OIL Type: IS Using:Area
UC type: next peak

B U L C H E M 93.3

Analyst Name :ELIN Analysis ID:
Information :OLJER ERA 30/6-19 06 30/6-22

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Channel:1S Title: CHANNEL 1S Date 24-Nov-08 Time 8:00
Analysis:H3006330 Sample Name:30/6-22 DST2 Sample ID: 0 Bottle:1
Sample 1 Injection 1

Peak	R/T m.	RT Corr		VERIF Identity
1	3.340	3.356	0.015	METAN
2	3.016	3.033	0.156	ETAN
3	3.171	3.178	0.012	PROPAN
5	3.408	3.416	0.755	I-BUTAN
6	3.611	3.619	1.477	N-BUTAN
7	3.712	3.717	0.007	NEO-PENTAN
9	4.314	4.326	0.894	I-PENTAN
10	4.739	4.287	1.512	N PENTAN
11	4.888	4.859	0.000	FORUREN. OV MCH
12	5.488	5.468	0.014	CYCLOPENTAN
13	6.280	6.272	0.241	2,3DM BUTAN
14	6.440	6.435	0.681	2M-PENTAN
15	6.247	6.242	0.329	3M-PENTAN
17	7.640	7.656	1.349	N-HEXAN
19	8.857	8.882	0.016	2,2DM-PENTAN
20	8.995	9.025	0.611	M-CYPENTAN
21	9.300	9.338	0.056	2,4DM-PENTAN
23	10.451	10.500	0.262	BENZEN
24	10.851	10.895	0.010	3,3DM-PENTAN
25	11.123	11.163	0.892	CYCLOHEXAN
26	11.848	11.895	0.351	2M-HEXAN
27	11.979	12.027	0.136	2,3DM-PENTAN
28	12.205	12.255	0.002	1,1DM-CYPEN
29	12.595	12.648	0.429	3M-HEXAN
31	13.152	13.195	0.142	C1,3DM-CYPEN
33	13.416	13.453	0.134	T1,3DM-CYPEN
34	13.552	13.587	0.039	3-ETYL PENTAN
35	13.689	13.715	0.274	T1,2DM-CYPEN
36	13.856	13.885		ISO-OCTAN
38	15.072	15.200	1.337	N-HEPTAN
39	15.275	15.308	0.008	1,1DM-CYPEN
40	17.219	17.300	1.417	M CYHEXAN
41	17.619	17.691	0.094	22DM-HEXAN
42	18.624	18.718	0.119	ETYL CYCLOPENTANE
43	18.888	18.985	0.042	25DM-HEXAN
44	19.107	19.205	0.061	24DM-HEXAN
45	19.722	19.837	0.098	124TM-CYPENT
46	19.999	20.036	0.017	33DM HEXAN
47	20.632	20.745	0.103	123TM-CYPENT
48	20.997	21.111	0.022	2234M-PENTAN
49	21.413	21.533	0.563	TOLUEN
51	22.451	22.530	0.082	23DM-HEXAN
52	22.595	22.660	0.028	2M3E PENTAN
53	23.315	23.360	0.449	2M-HEPTAN
54	23.501	23.539	0.142	4M-HEPTAN
55	23.608	23.642	0.018	C12DM-CYHEXAN
57	24.293	24.300	0.511	3M-HEPTAN
61	25.216	25.256	0.043	11DM CYHEXAN
63	25.779	25.809	0.048	C1M3ET-PENTAN
64	26.067	26.137	0.052	1T1,2M,E1 PENTAN
65	26.221	26.300	0.132	T1,2 DM CYHEXAN
66	26.456	26.540	0.014	C1,4DM-CYHEXAN
67	26.737	26.891	0.183	T1,3DM-CYHEX
70	27.875	28.010	1.096	N-OKTANE
71	28.045	28.101	0.008	USPES C-9
73	29.544	29.659	0.008	34DM-HEPTAN
75	30.488	30.622	0.011	22DM-HEPTAN
76	30.834	30.958	0.042	14DM-CPTAN
77	31.035	31.168	0.077	USPES C-9
79	31.505	31.688	0.464	ET CYHEX
80	31.701	31.833	0.009	USPES C-9
81	31.931	32.053	0.121	25DM-HEPTAN
83	32.377	32.389	0.105	33DM-HEPTAN
84	32.581	32.684	0.027	USPES C-9
85	32.781	32.881	0.075	35DM HEPTAN
86	33.000	33.099	0.034	114TM-CYHEX
87	33.184	33.269	0.031	134TM-CYHEX
89	33.377	33.475	0.017	USPES C-9
89	34.123	34.179	0.055	USPES C-9
90	34.299	34.350	0.010	USPES C-9
91	34.523	34.567	0.010	N-9
92	34.802	34.867	0.002	USPES C-9
93	35.117	35.144	0.309	M XYLEN
94	35.264	35.290	0.085	P XYLEN
99	36.587	36.602	0.126	4M OKTANE
100	36.731	36.753	0.177	2M OKTAN
103	37.403	37.432	0.030	USPES C-9
104	37.592	37.611	0.205	3M OKTAN
106	38.021	38.050	0.233	O XYLENE
109	39.019	39.052	0.216	N NUYLCYPEN
111	39.603	39.731	0.013	USPES C-9
113	40.196	40.589	0.008	1331M-CYHEX
114	40.861	40.907	0.008	USPES C-9
115	41.301	41.350	0.870	N NONANE

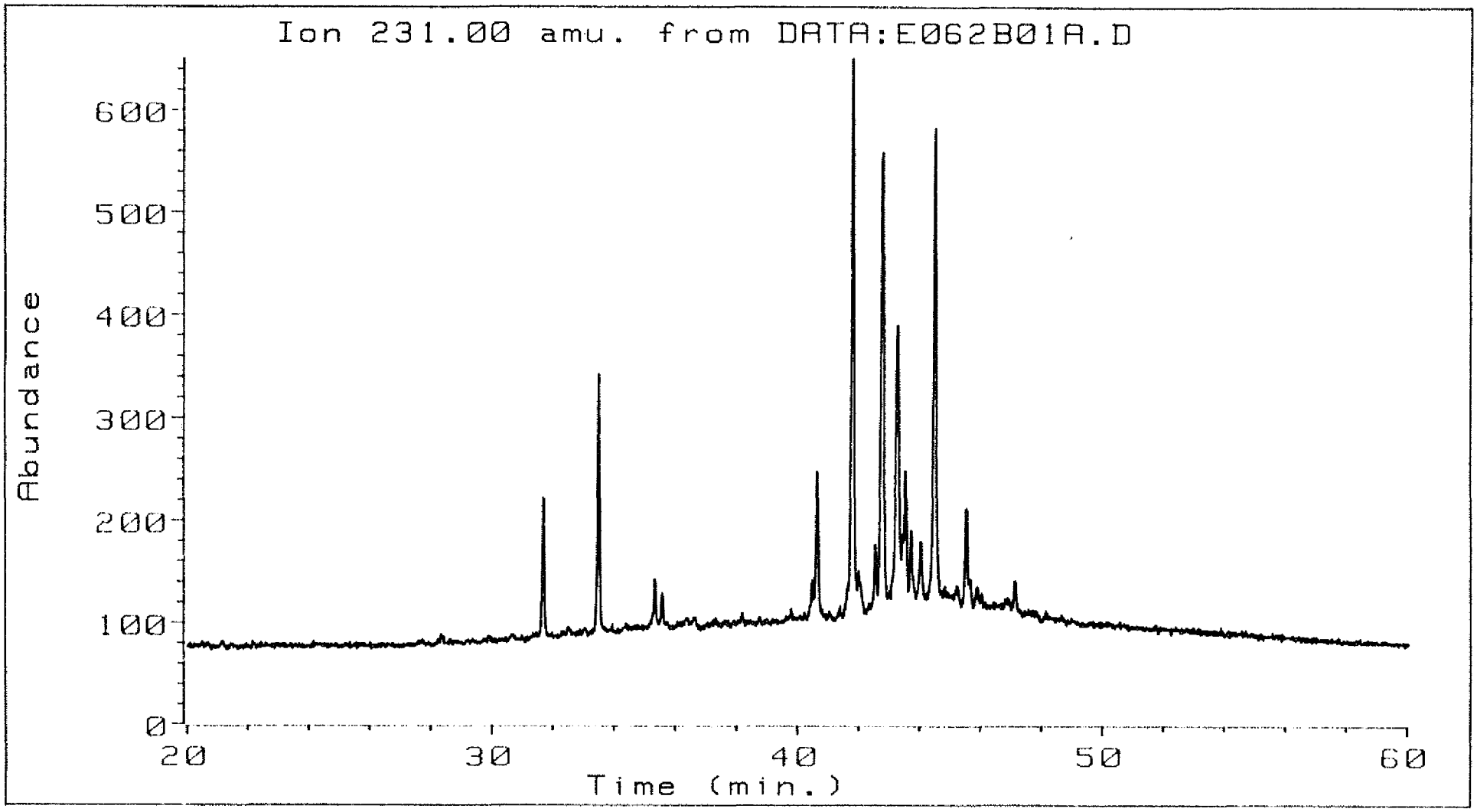
Residual	1.242	
Total	33.729	

Sample Type: SA Scale Factor: 1.000 Amount: 1.000 ISTD : 1.233
Method: OIL Calibration: OIL Type: IS Using:Area
OK type: next peak

APPENDIX III

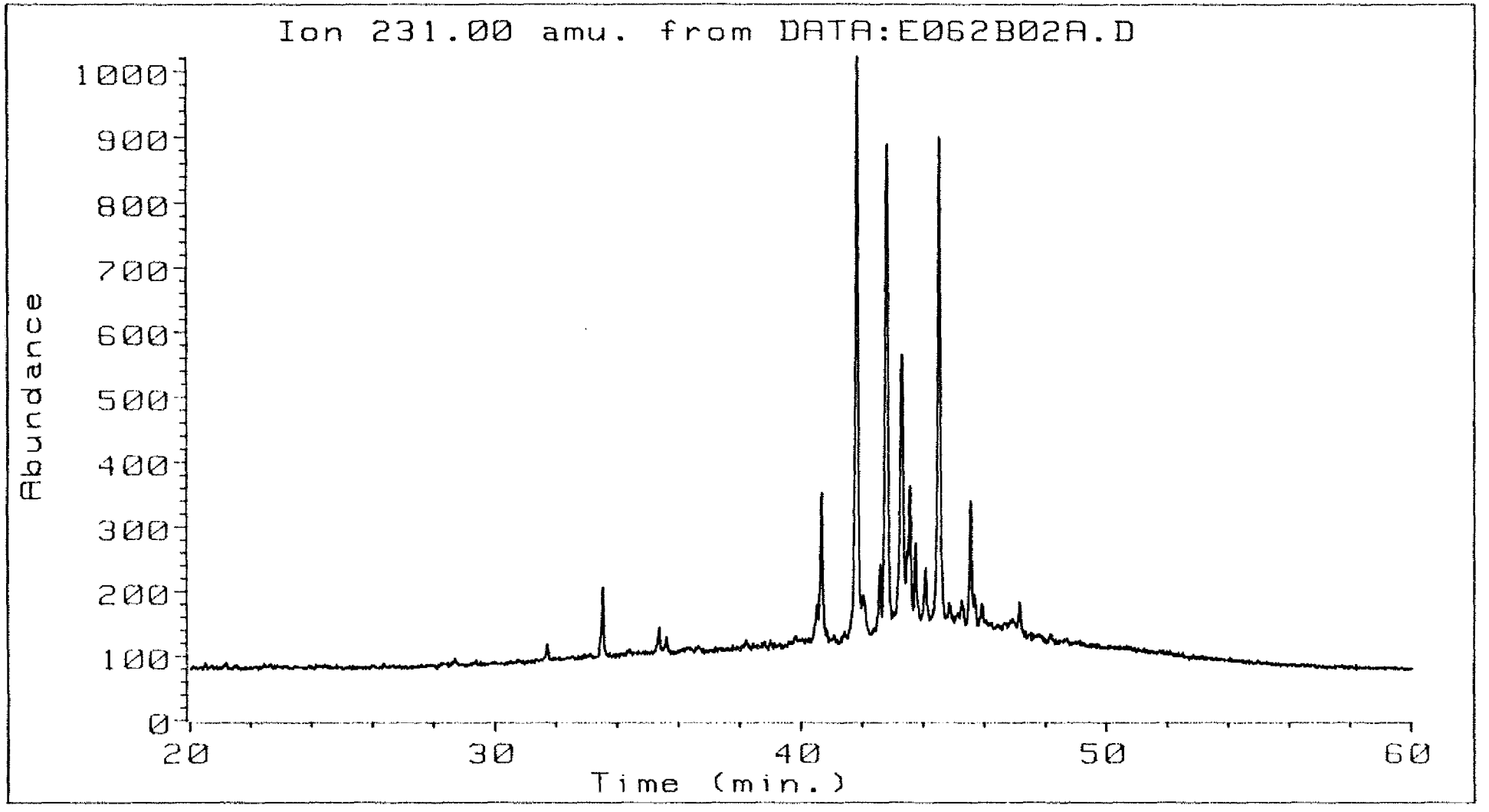
Fragmentograms of triaromatic steranes (Ion 231 m/z).

Fragmentograms of monoaromatic steranes (Ion 253 m/z).


Ion 231.00 amu. from DATA:E062B01A.D
Abundance
600
500
400
300
200
100
0
20
30
40
50
60
Time (min.)

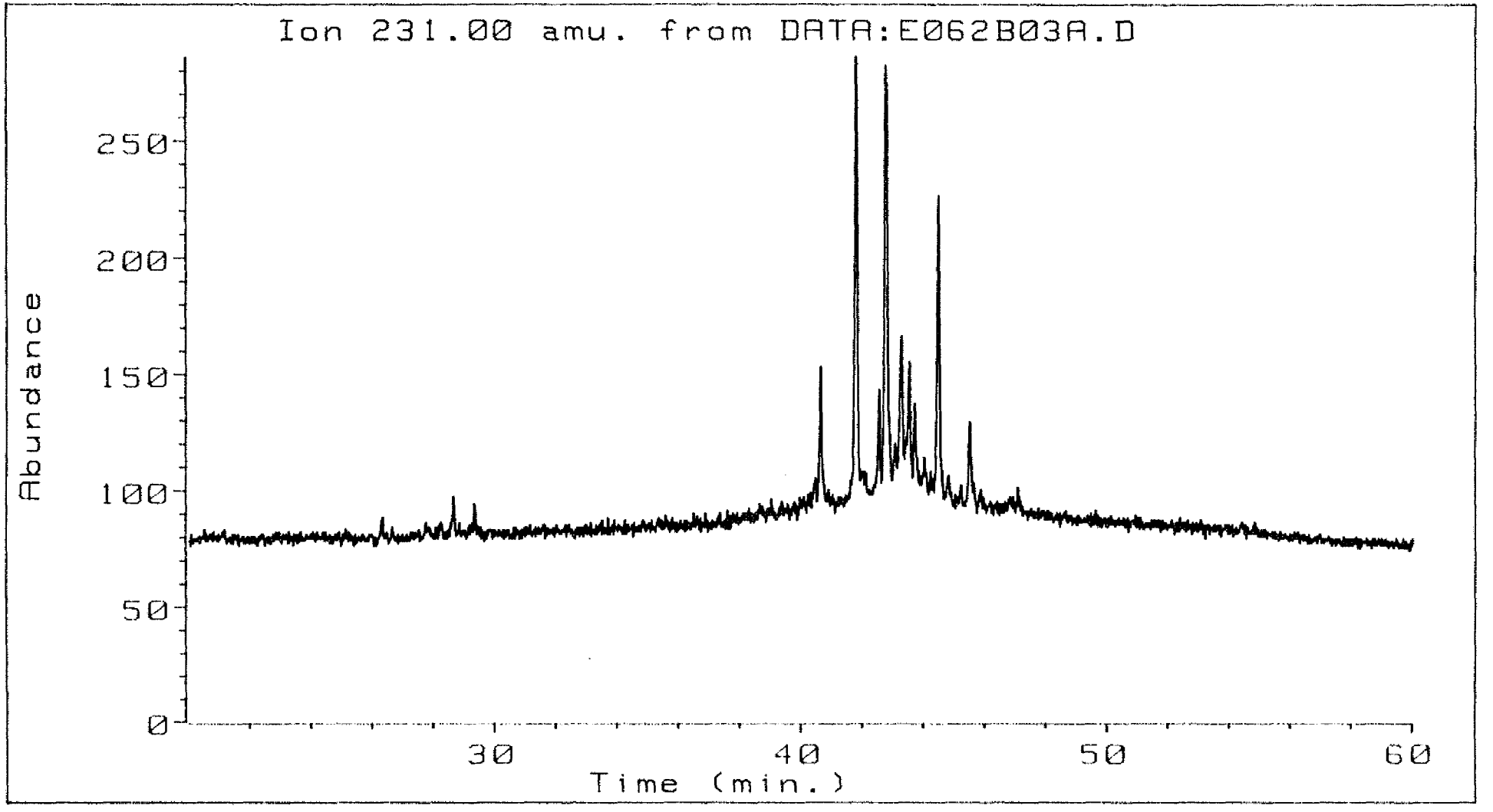
30/6-19

dst 1


Ion 231.00 amu. from DATA:E062B02A.D
Abundance
1000
900
800
700
600
500
400
300
200
100
0
20
30
40
50
60
Time (min.)

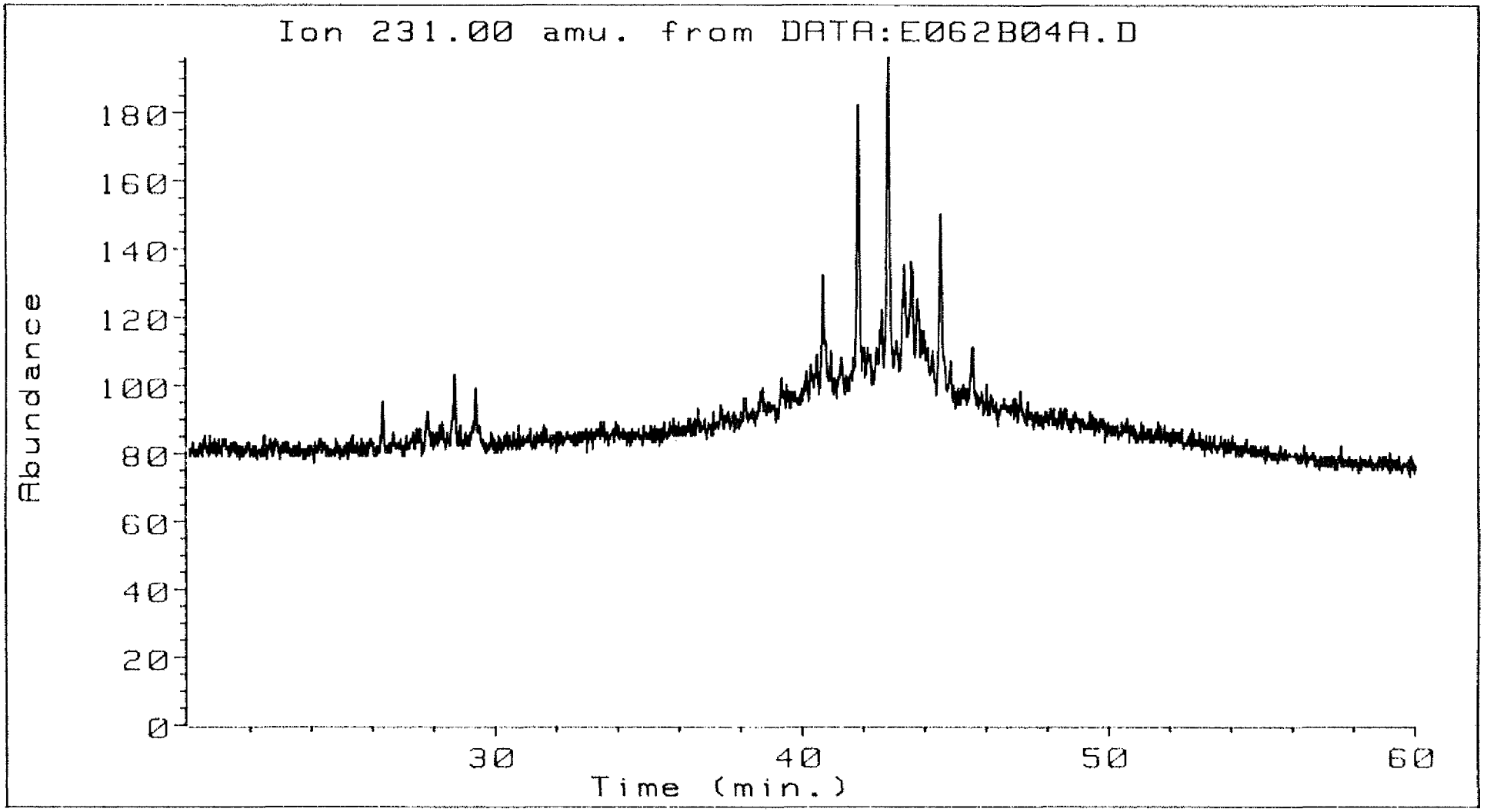
30/6-19

dst 2


Ion 231.00 amu. from DATA:E062B03A.D
Abundance
250
200
150
100
50
0
30
40
50
60
Time (min.)

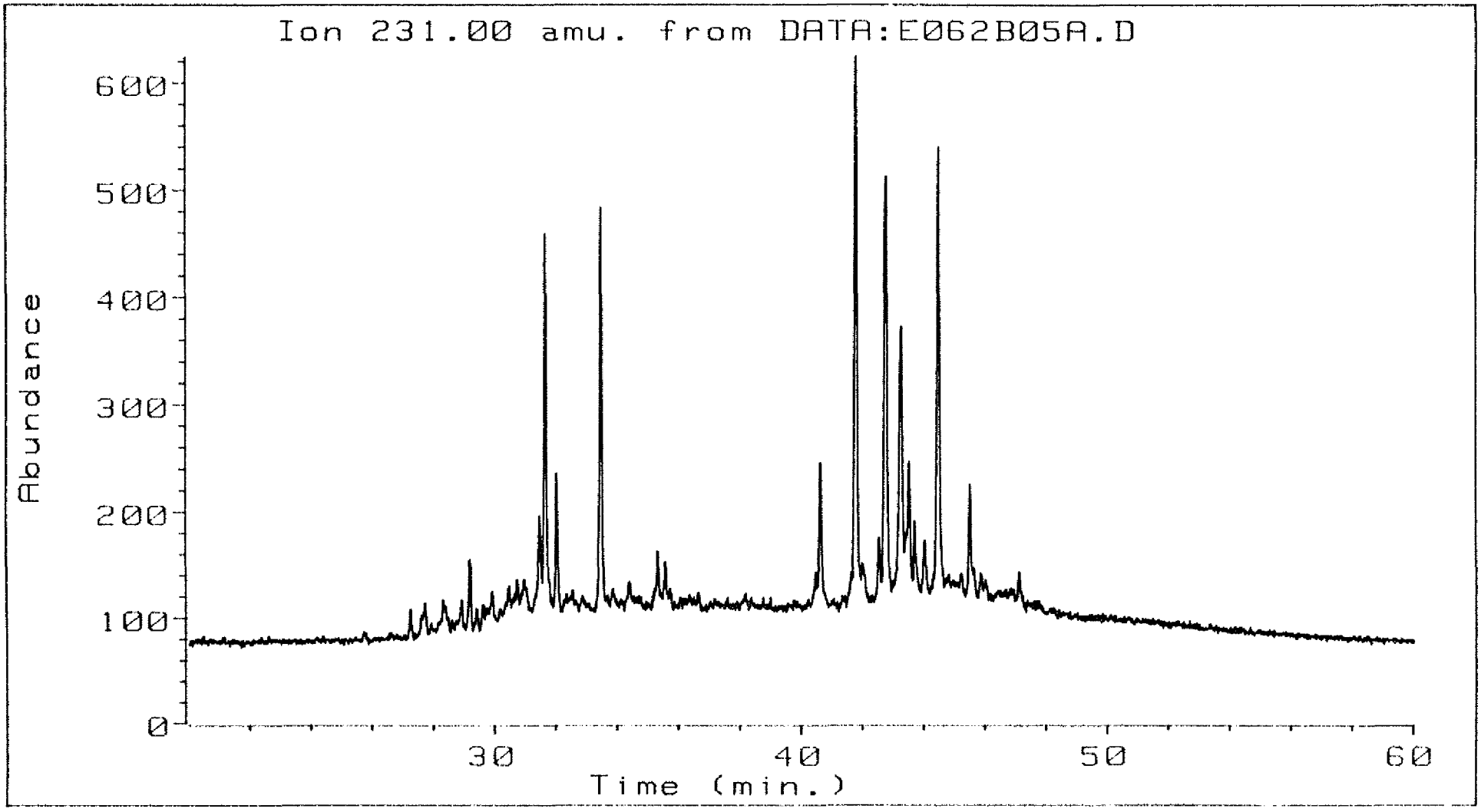
30/6-19

dst 3


Ion 231.00 amu. from DATA:E062B04A.D
Abundance
180
160
140
120
100
80
60
40
20
0
30
40
50
60
Time (min.)

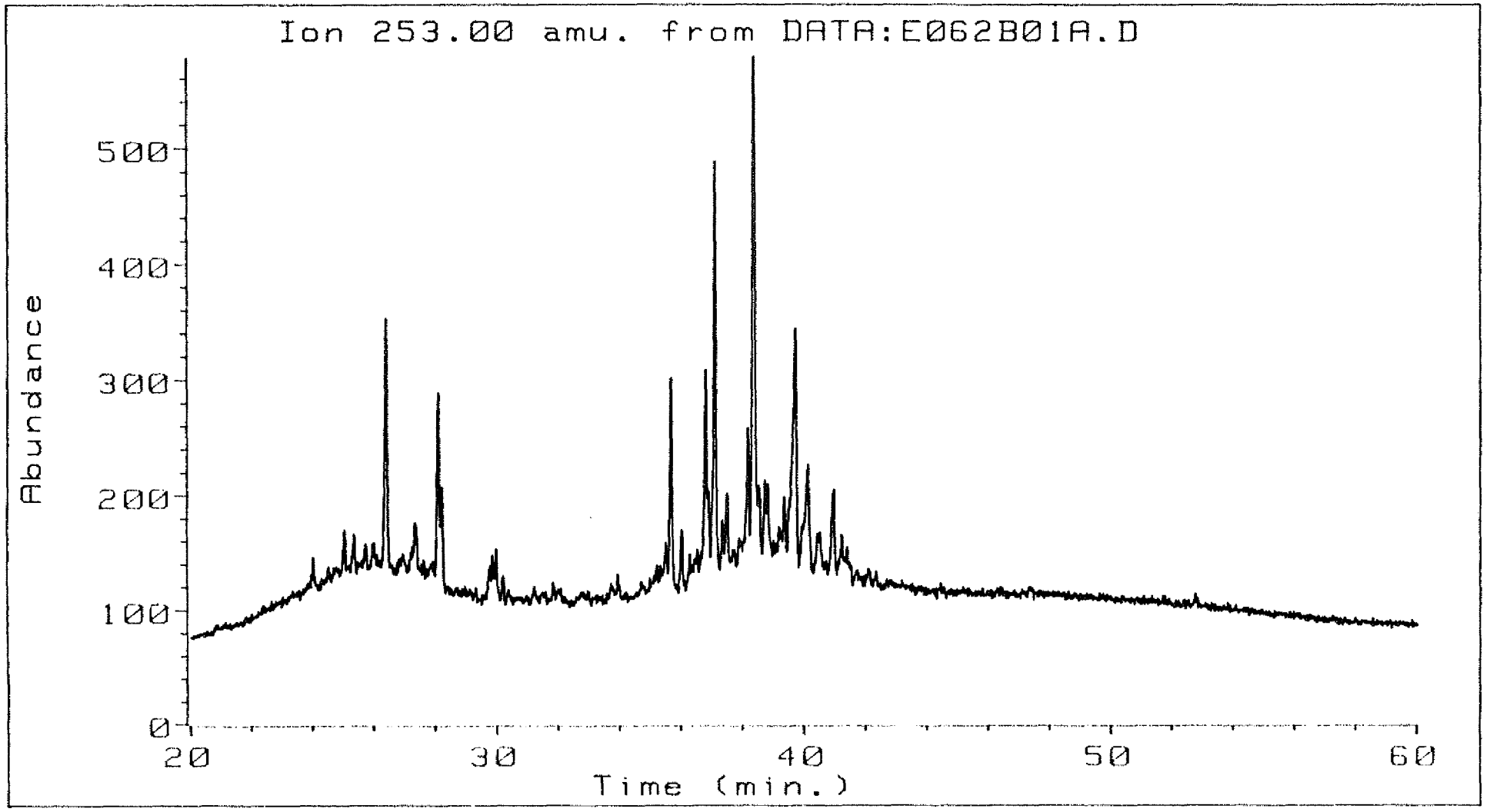
30/6-22

dst 1


Ion 231.00 amu. from DATA:E062B05A.D
Abundance
600
500
400
300
200
100
0
30
40
50
60
Time (min.)

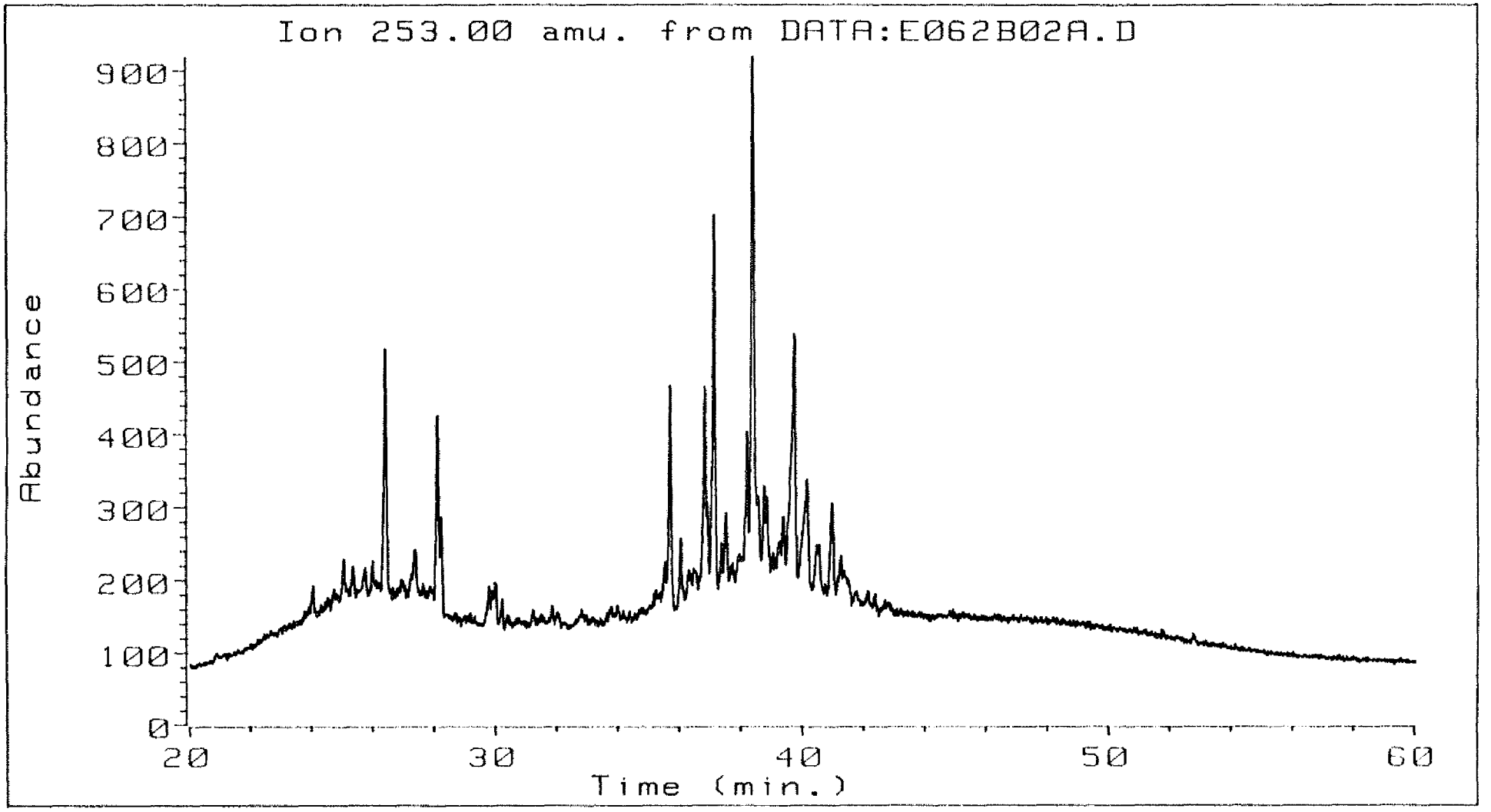
30/6-22

dst 2


Ion 253.00 amu. from DATA:E062B01A.D
Abundance
500
400
300
200
100
0
20
30
40
50
60
Time (min.)

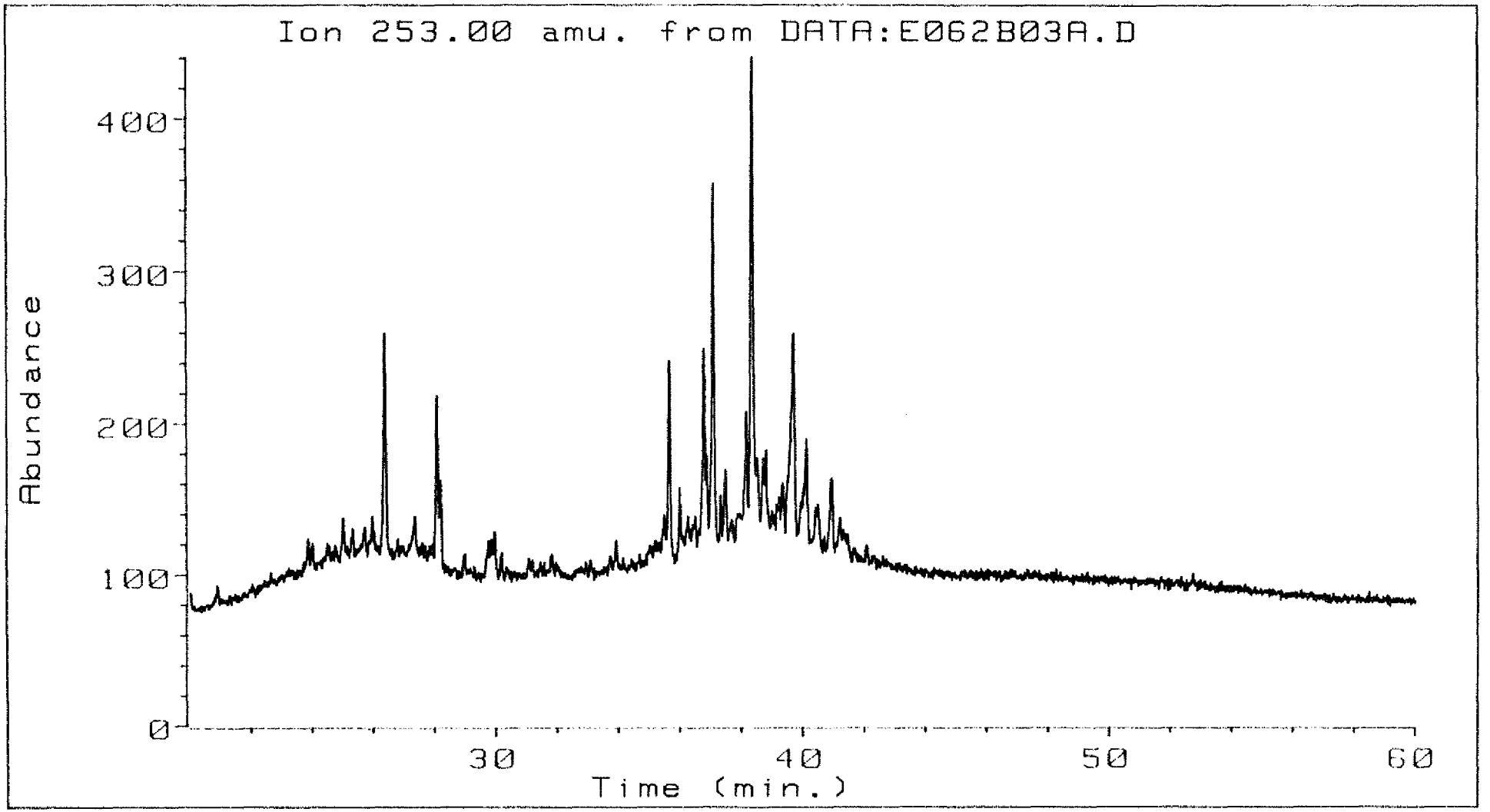
30/6-19

dst 1


Ion 253.00 amu. from DATA:E062B02A.D
Abundance
900
800
700
600
500
400
300
200
100
0
20
30
40
50
60
Time (min.)

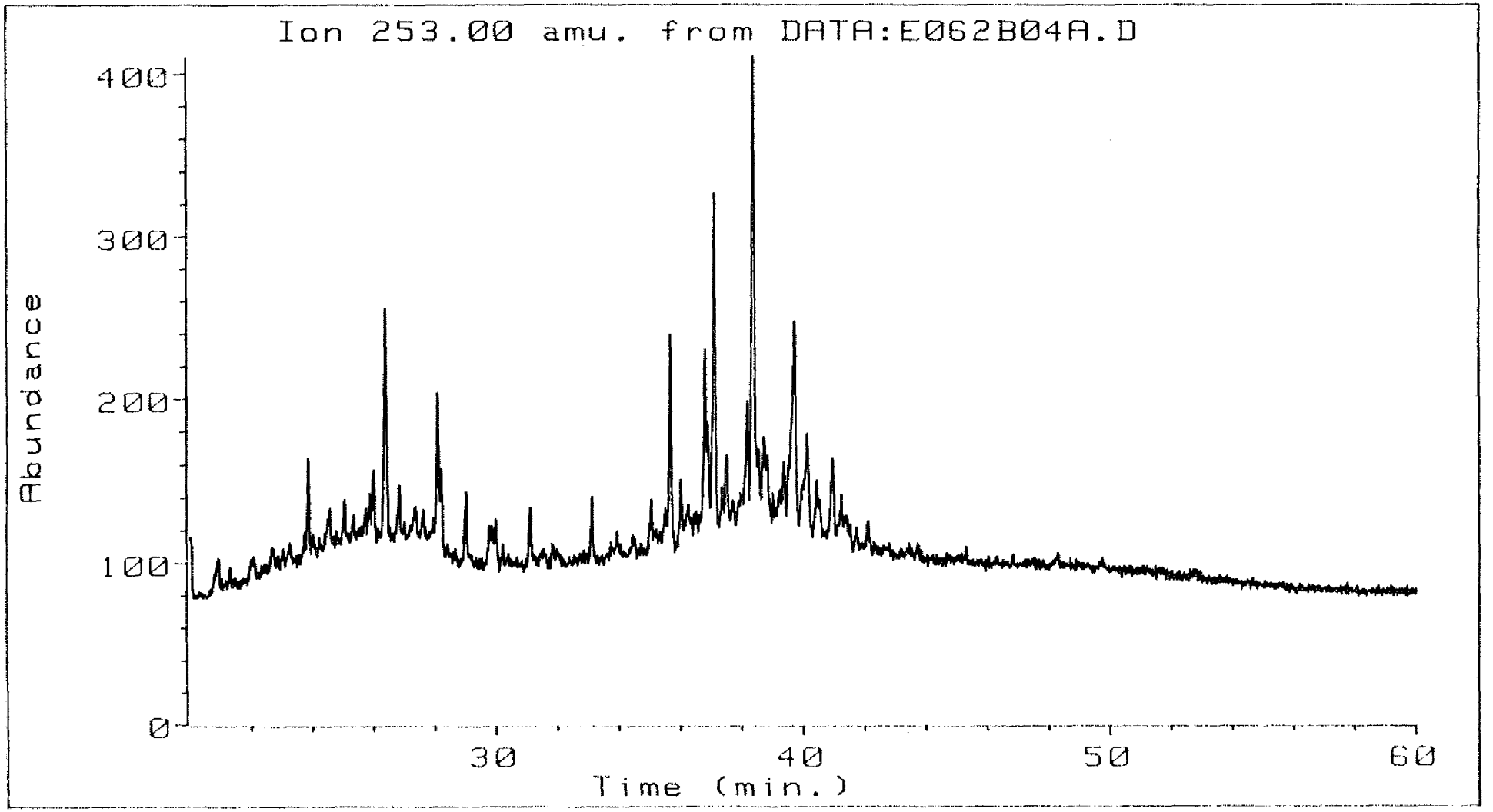
30/6-19

dst 2


Ion 253.00 amu. from DATA:E062B03A.D
Abundance
400
300
200
100
0
30
40
50
60
Time (min.)

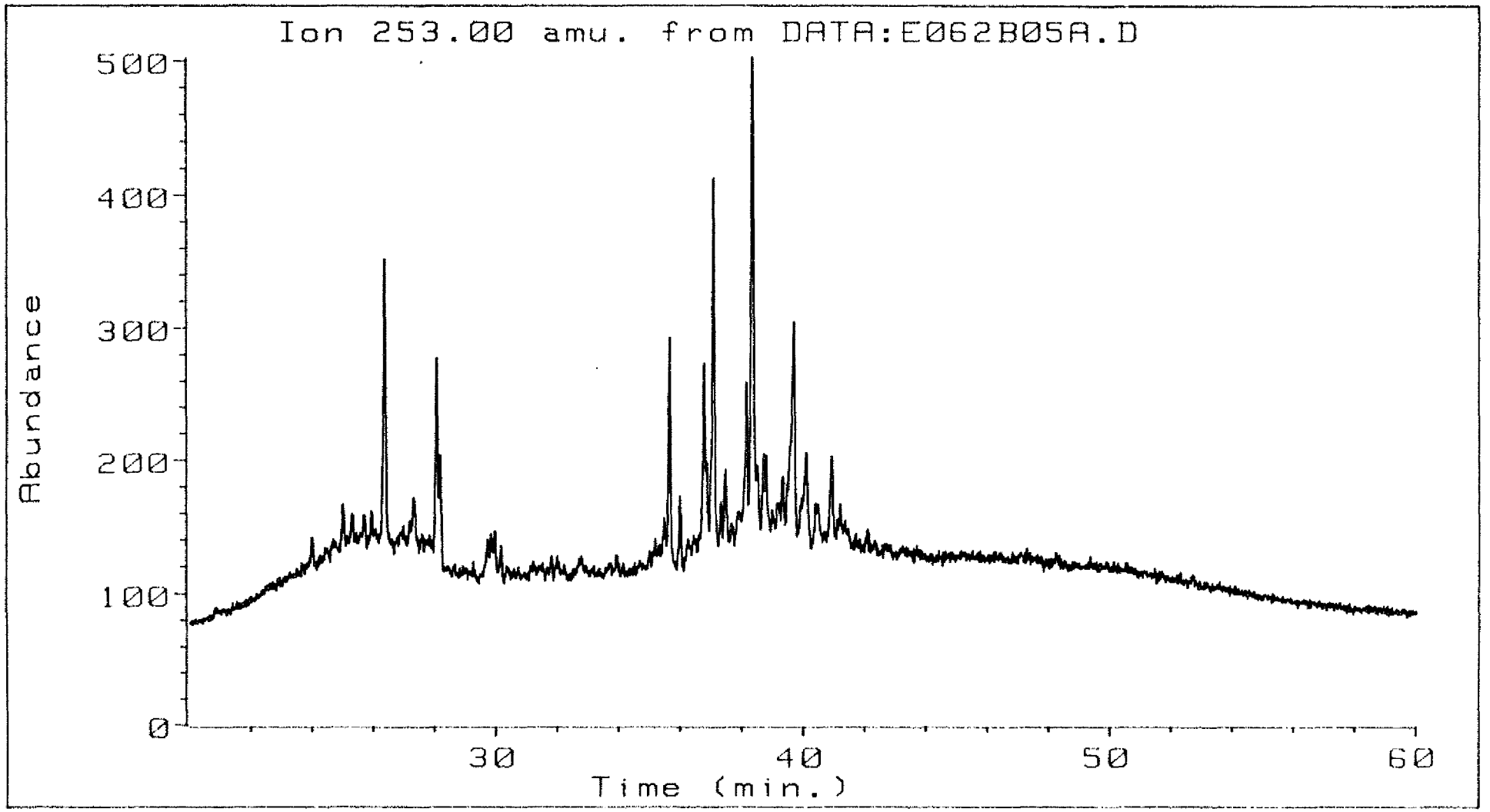
30/6-19

dst 3


Ion 253.00 amu. from DATA:E062B04A.D
Abundance
400
300
200
100
0
30
40
50
60
Time (min.)

30/6-22

dst 1

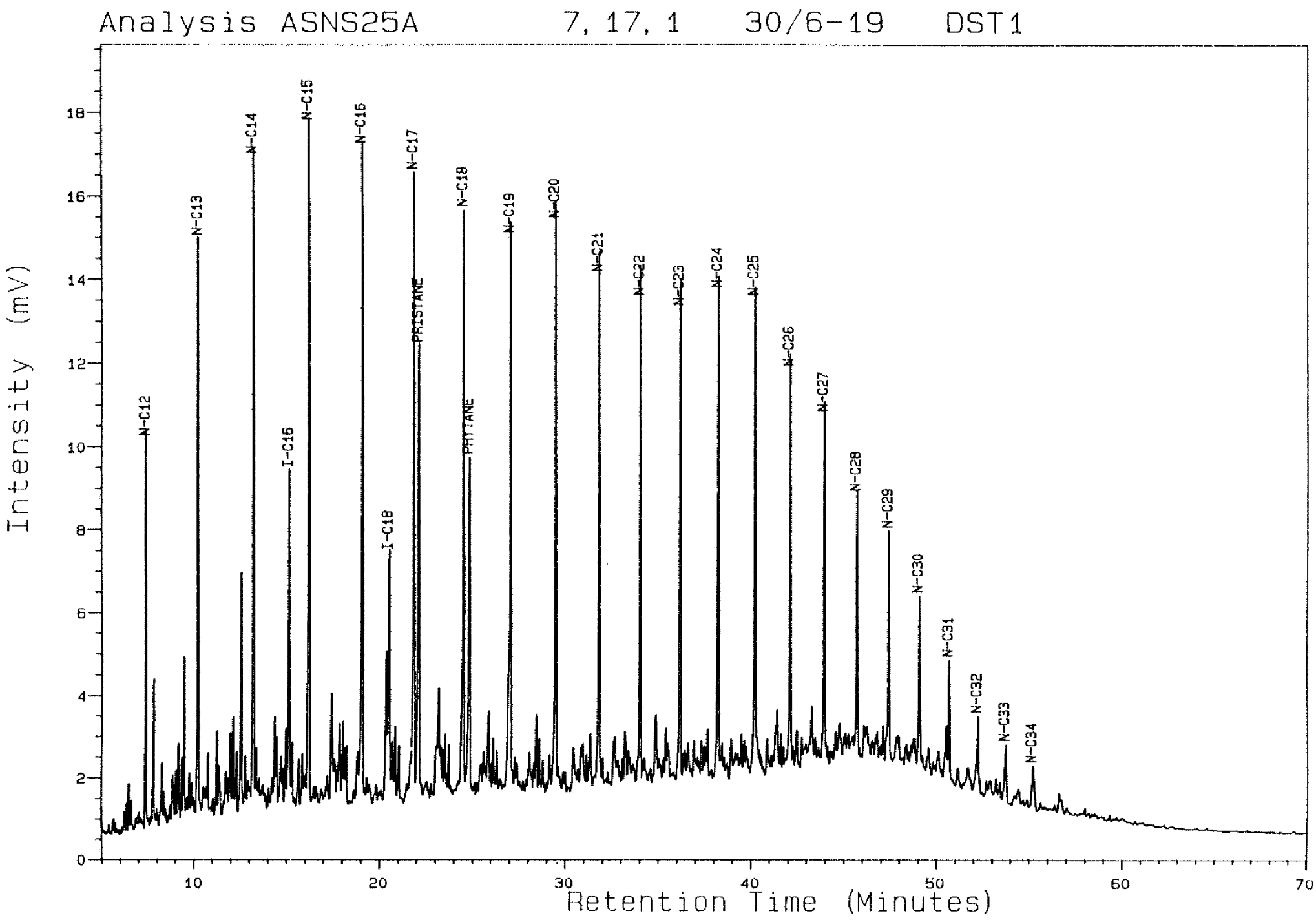

Ion 253.00 amu. from DATA:E062B05A.D
Abundance
500
400
300
200
100
0
30
40
50
60
Time (min.)

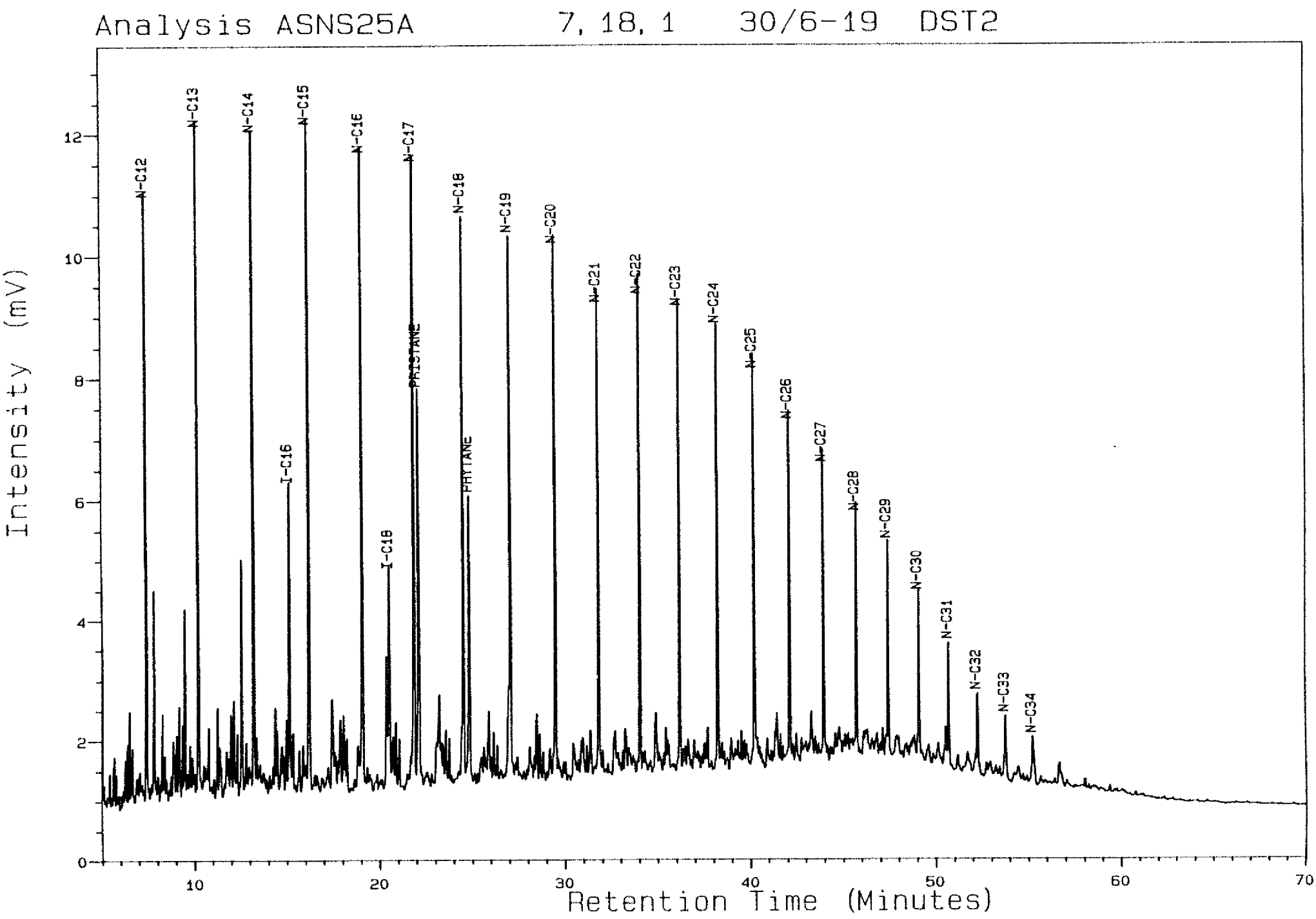
30/6-22

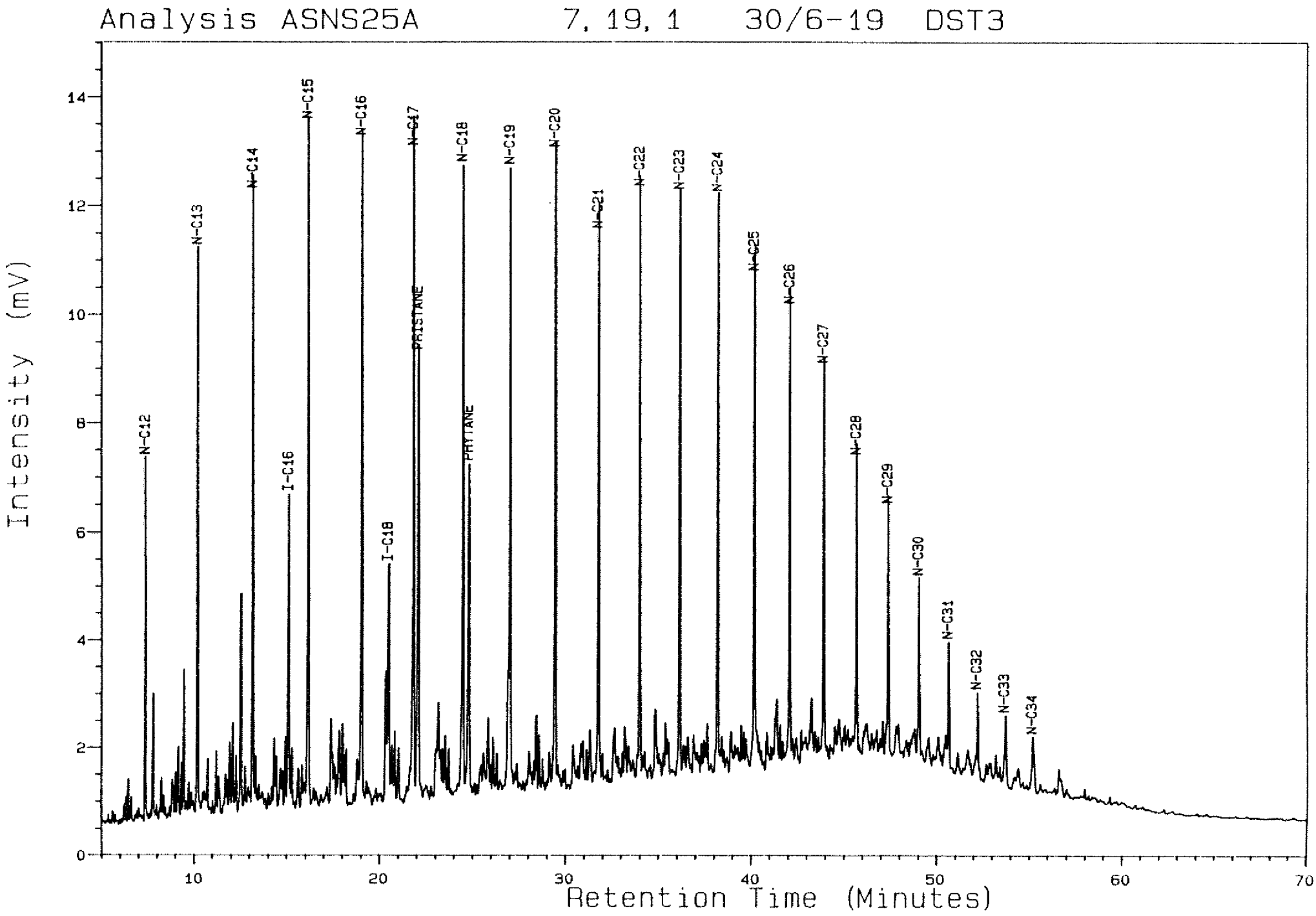
dst 2

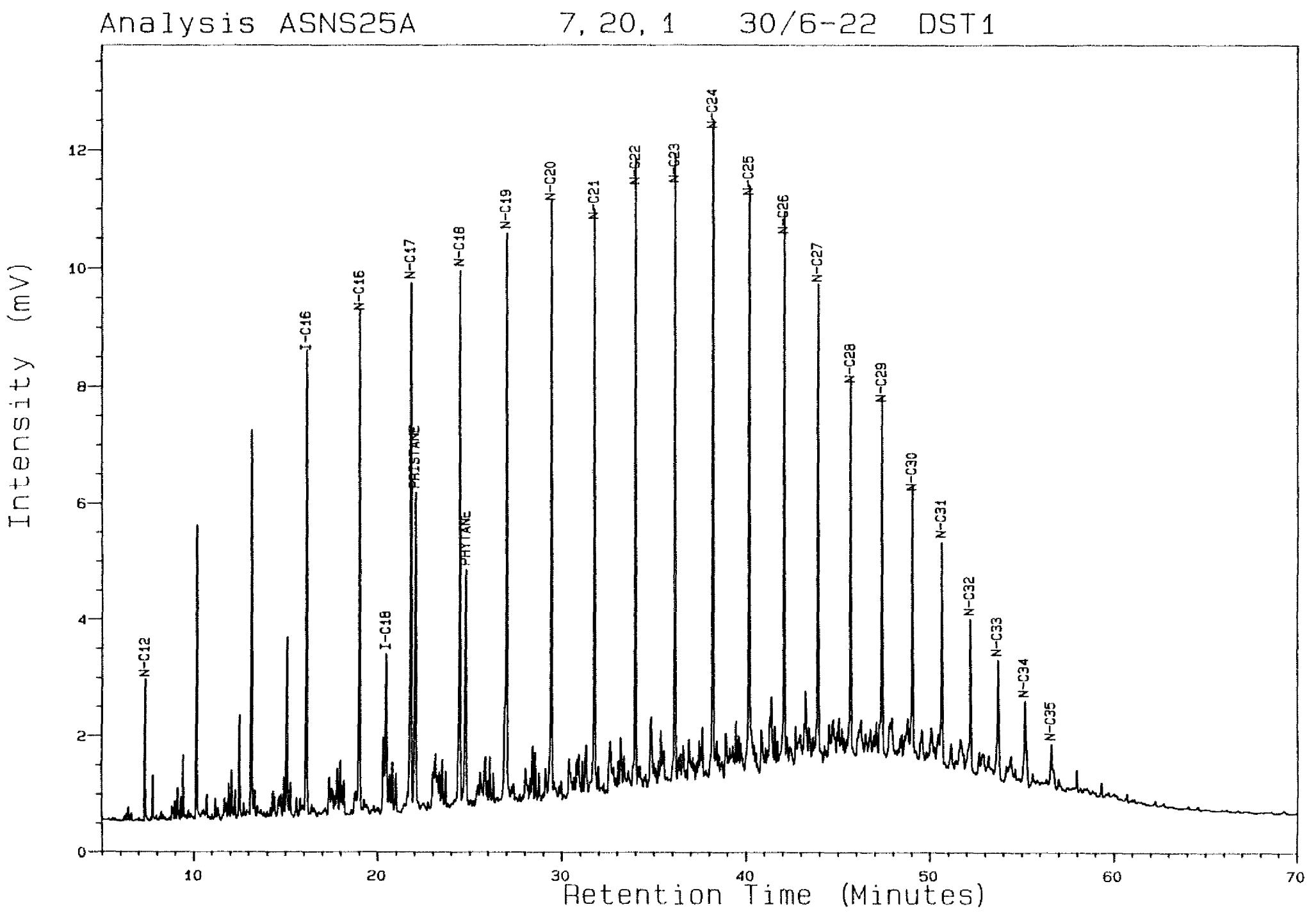
APPENDIX IV

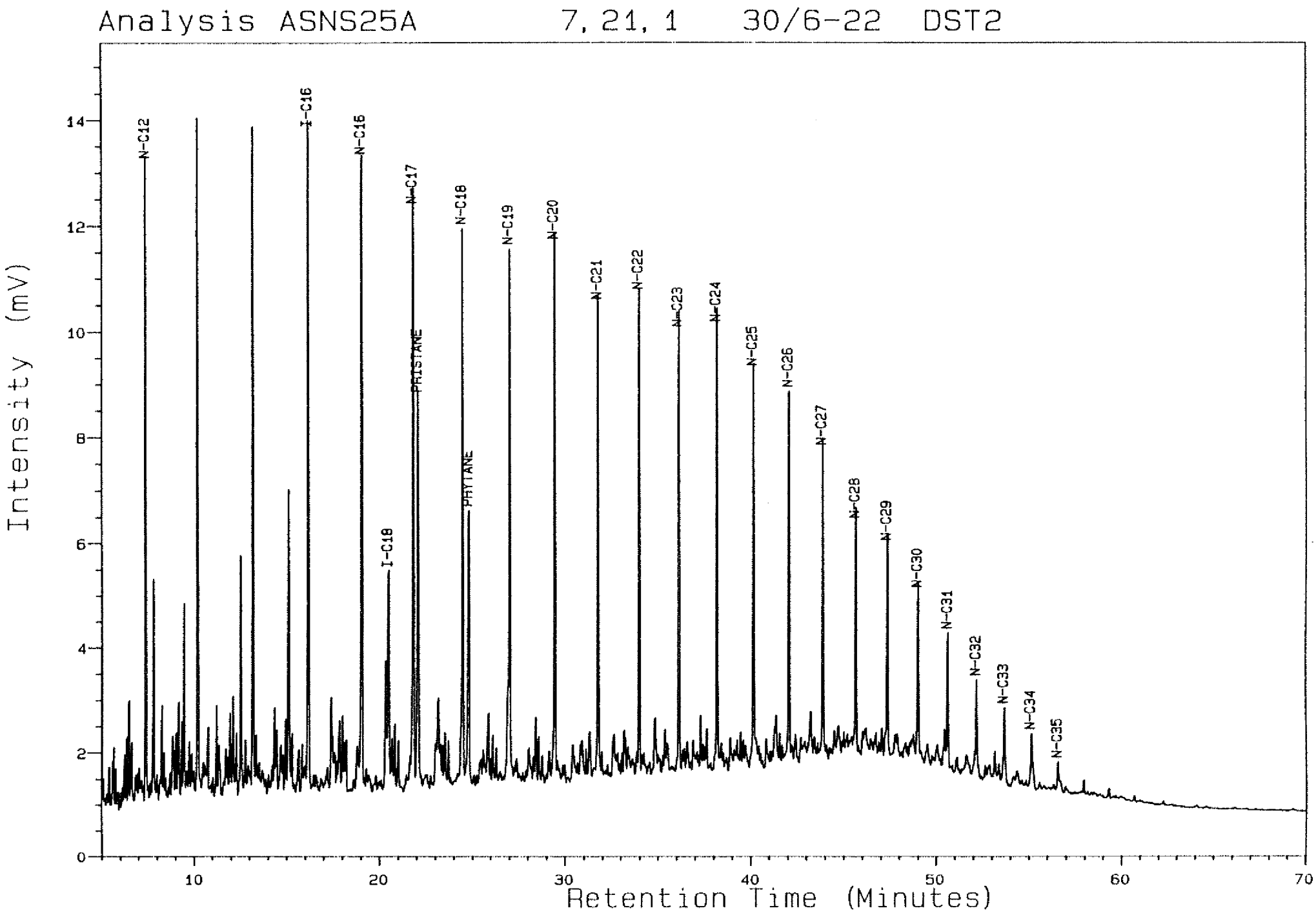
Gas chromatograms of the saturated fraction. fragmentograms m/z 191 and m/z 217.

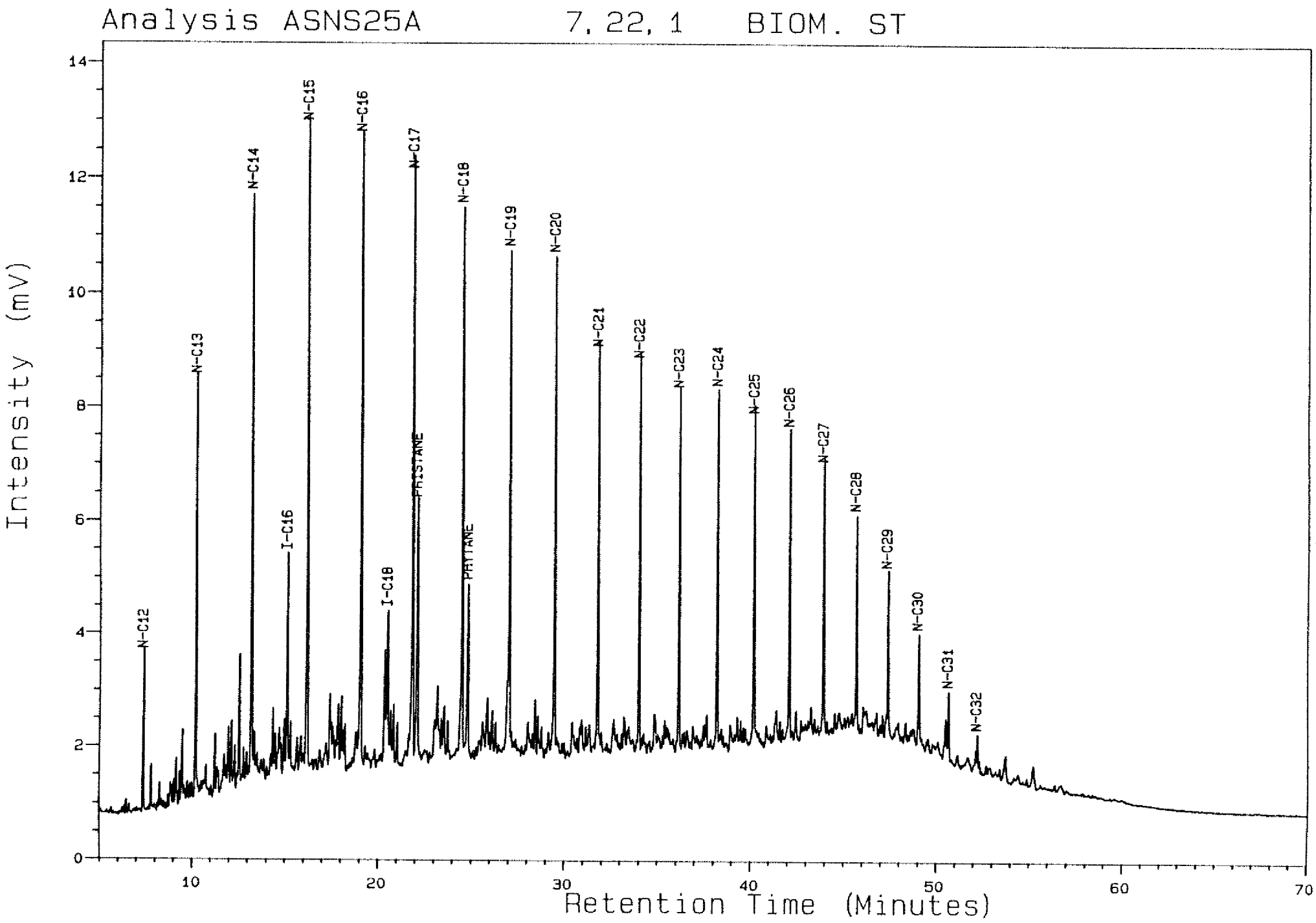

Analysis ASNS25A 7, 17, 1 30/6-19 DST1
Intensity (mV)
Retention Time (Minutes)
N-C12
N-C13
N-C14
I-C16
N-C15
N-C16
I-C18
N-C17
PRISTANE
N-C18
PHYTANE
N-C19
N-C20
N-C21
N-C22
N-C23
N-C24
N-C25
N-C26
N-C27
N-C28
N-C29
N-C30
N-C31
N-C32
N-C33
N-C34


Analysis ASNS25A 7, 18, 1 30/6-19 DST2
Intensity (mV)
Retention Time (Minutes)
N-C12
N-C13
N-C14
N-C15
I-C16
N-C16
I-C18
PRISTANE
N-C17
PHYTANE
N-C18
N-C19
N-C20
N-C21
N-C22
N-C23
N-C24
N-C25
N-C26
N-C27
N-C28
N-C29
N-C30
N-C31
N-C32
N-C33
N-C34


Analysis ASNS25A 7, 19, 1 30/6-19 DST3
Intensity (mV)
Retention Time (Minutes)
N-C12
N-C13
N-C14
N-C15
I-C16
N-C16
I-C18
N-C17
PRISTANE
N-C18
PHYTANE
N-C19
N-C20
N-C21
N-C22
N-C23
N-C24
N-C25
N-C26
N-C27
N-C28
N-C29
N-C30
N-C31
N-C32
N-C33
N-C34


Analysis ASNS25A 7, 20, 1 30/6-22 DST1
Intensity (mV)
Retention Time (Minutes)
N-C12
I-C16
N-C16
I-C18
PRISTANE
N-C17
PHYTANE
N-C18
N-C19
N-C20
N-C21
N-C22
N-C23
N-C24
N-C25
N-C26
N-C27
N-C28
N-C29
N-C30
N-C31
N-C32
N-C33
N-C34
N-C35


Analysis ASNS25A 7, 21, 1 30/6-22 DST2
Intensity (mV)
Retention Time (Minutes)
N-C12
I-C16
N-C16
N-C17
I-C18
PRISTANE
N-C18
PHYTANE
N-C19
N-C20
N-C21
N-C22
N-C23
N-C24
N-C25
N-C26
N-C27
N-C28
N-C29
N-C30
N-C31
N-C32
N-C33
N-C34
N-C35

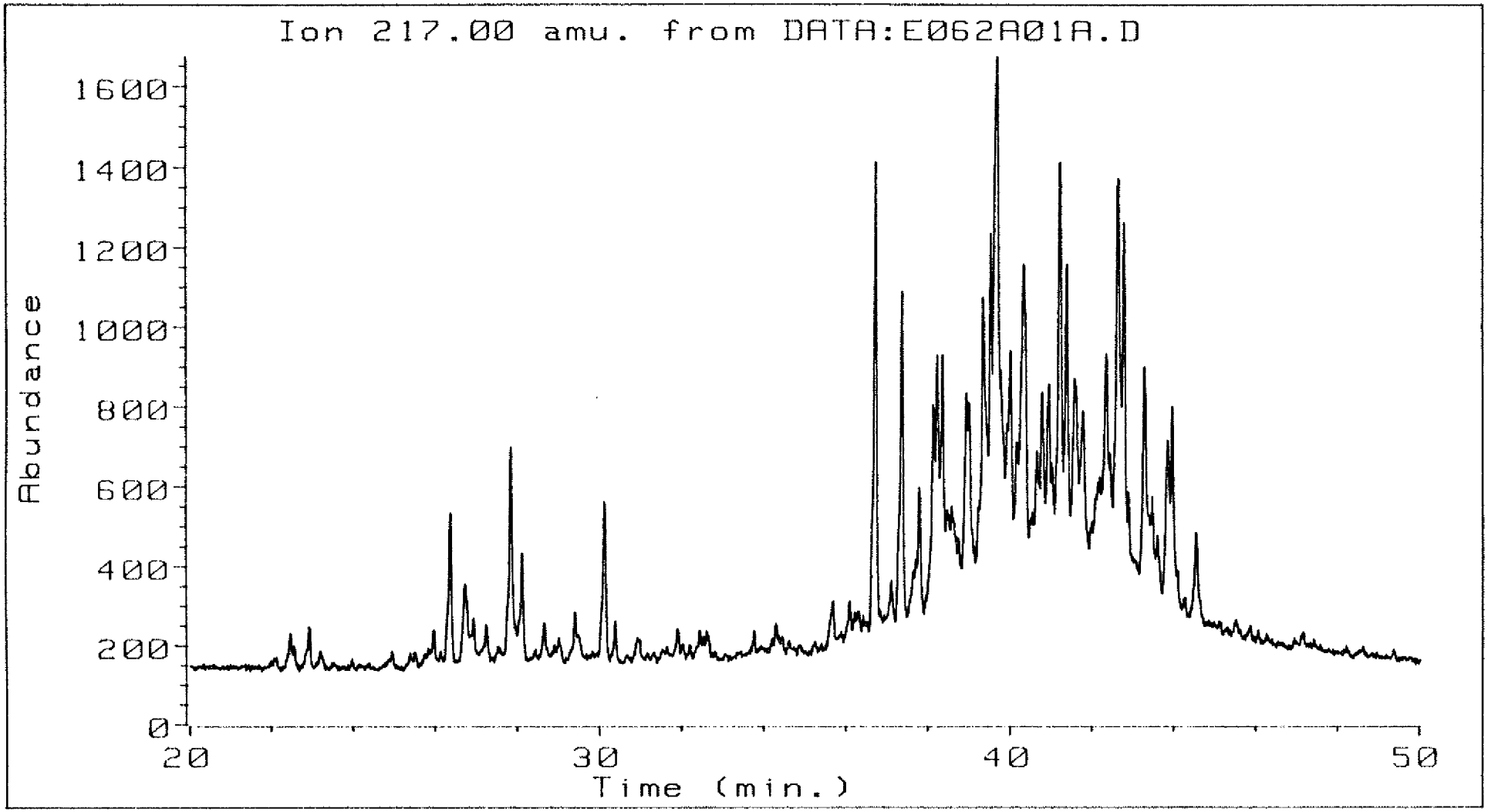

Analysis ASNS25A 7, 22, 1 BIOM. ST
Intensity (mV)
Retention Time (Minutes)
N-C12
N-C13
N-C14
I-C16
N-C15
N-C16
I-C18
N-C17
PRISTANE
N-C18
PHYTANE
N-C19
N-C20
N-C21
N-C22
N-C23
N-C24
N-C25
N-C26
N-C27
N-C28
N-C29
N-C30
N-C31
N-C32

APPENDIX V

Fragmentograms of Steranes (Ion 217 m/z).

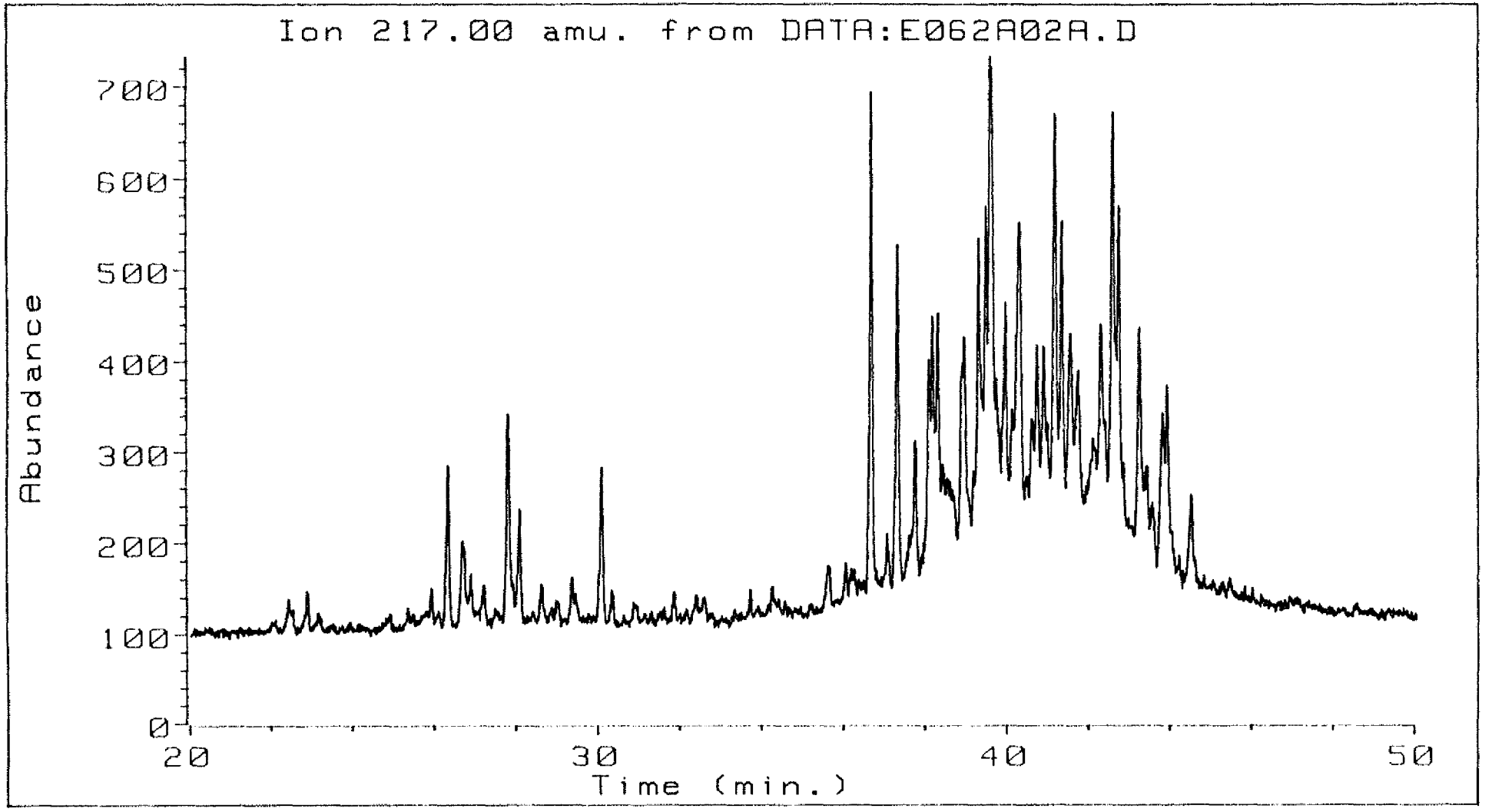
Fragmentograms of Triterpanes (Ion 191 m/z).

Bargraphs indicating the relative distribution of products from metastable transitions.


Ion 217.00 amu. from DATA:E062A01A.D
Abundance
1600
1400
1200
1000
800
600
400
200
0
20
30
40
50
Time (min.)

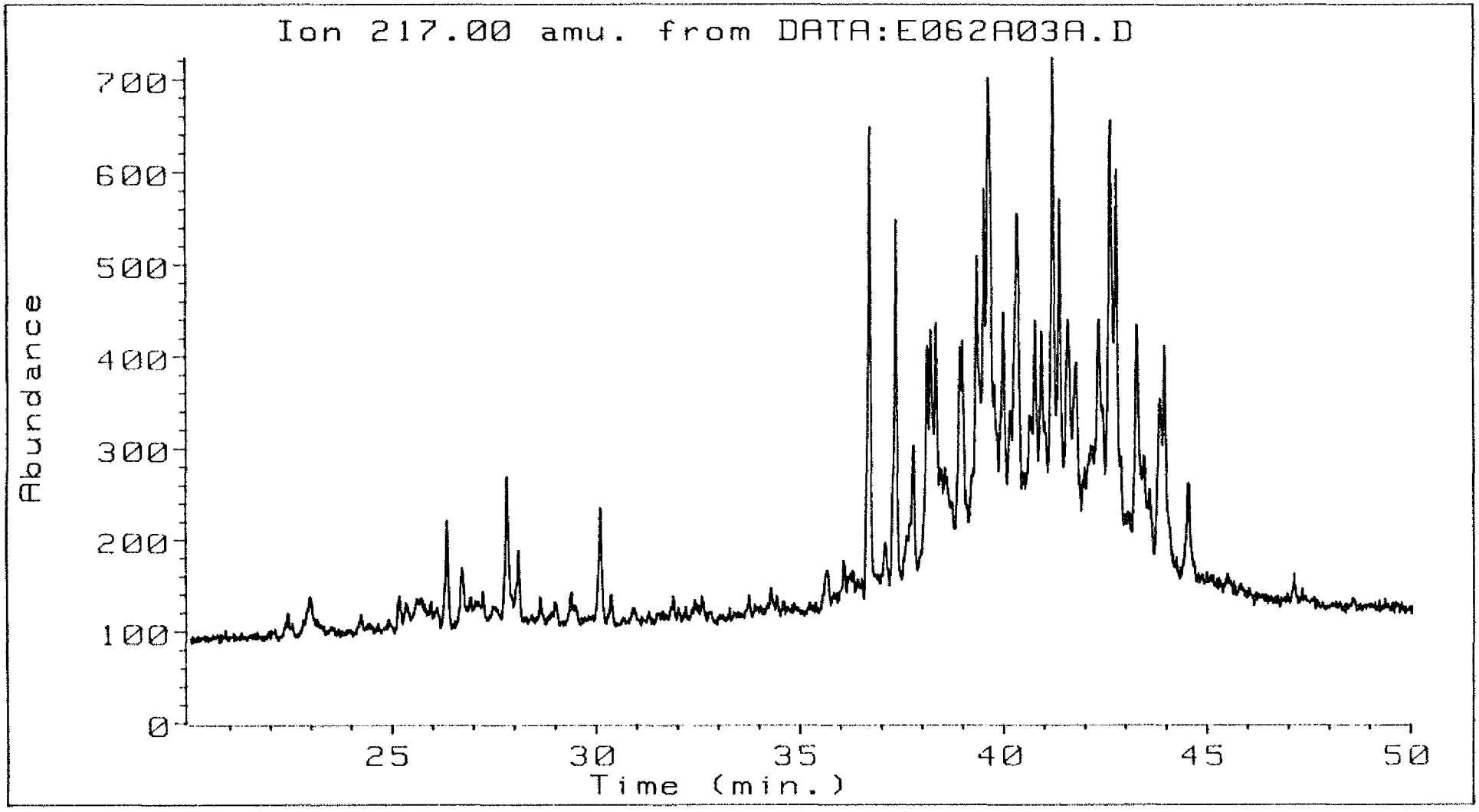
30/6-19

dst 1


Ion 217.00 amu. from DATA:E062A02A.D
Abundance
700
600
500
400
300
200
100
0
20
30
40
50
Time (min.)

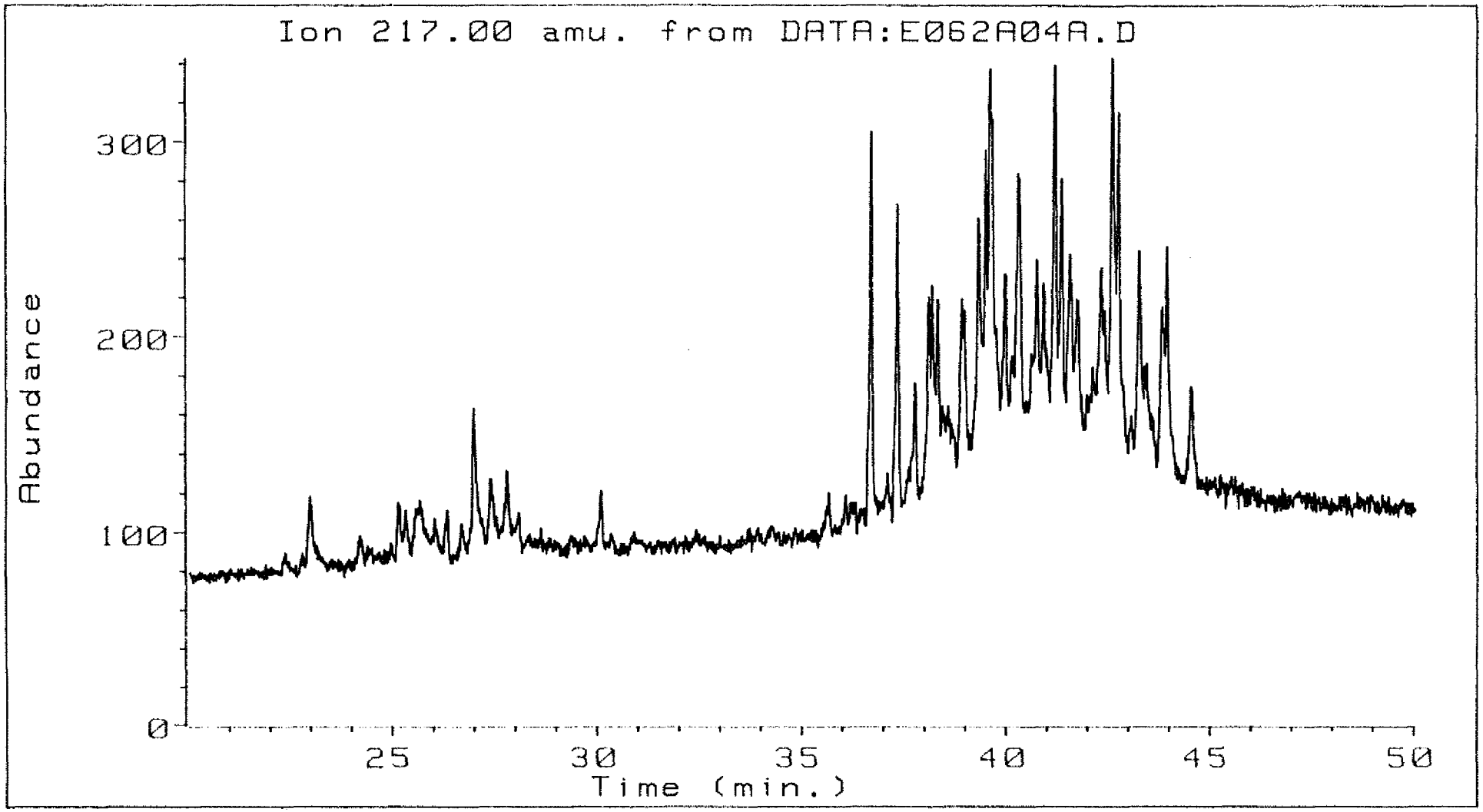
30/6-19

dst 2


Ion 217.00 amu. from DATA:E062A03A.D
Abundance
700
600
500
400
300
200
100
0
25
30
35
40
45
50
Time (min.)

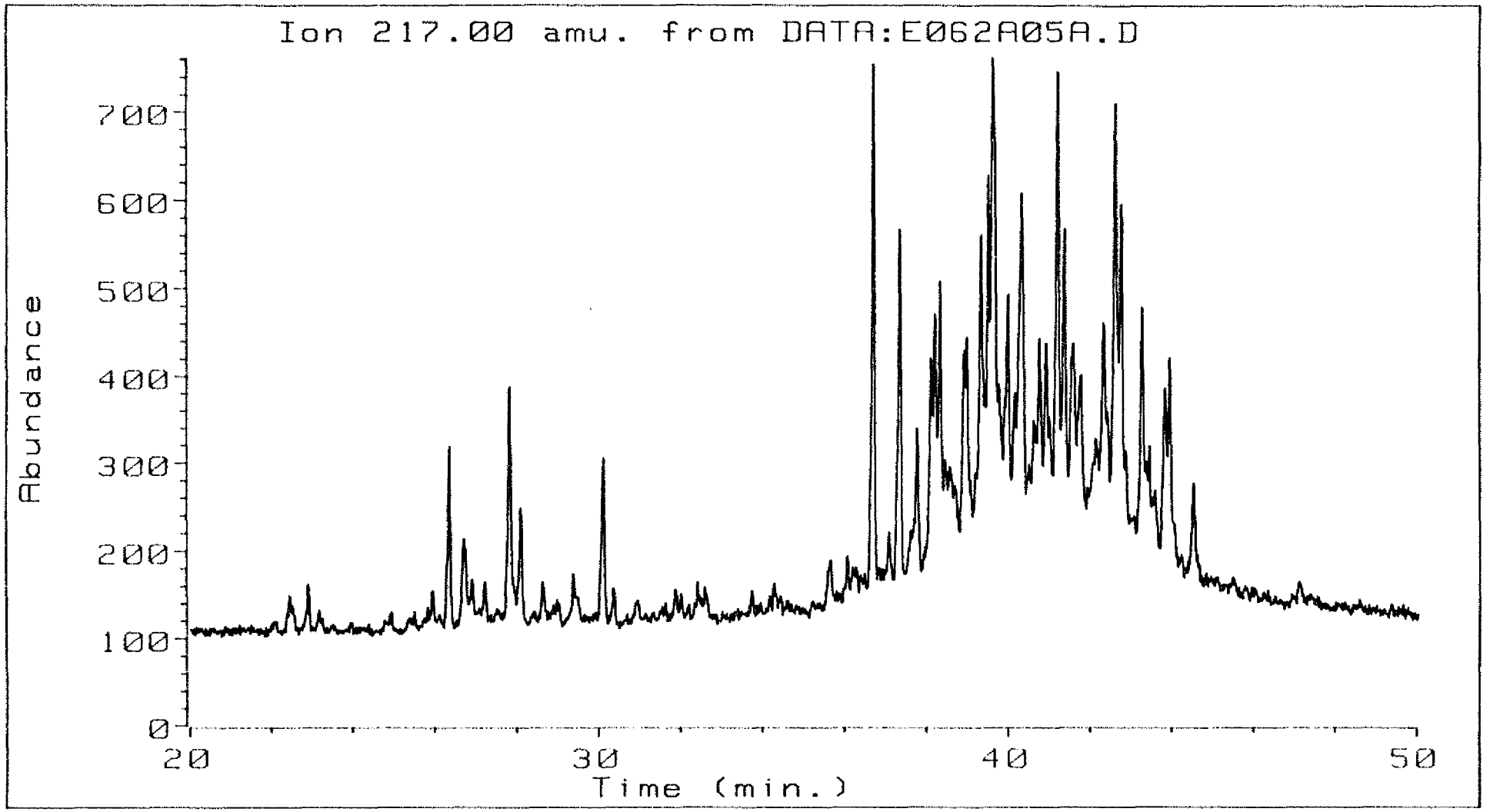
30/6-19

dst 3


Ion 217.00 amu. from DATA:E062A04A.D
Abundance
300
200
100
0
25
30
35
40
45
50
Time (min.)

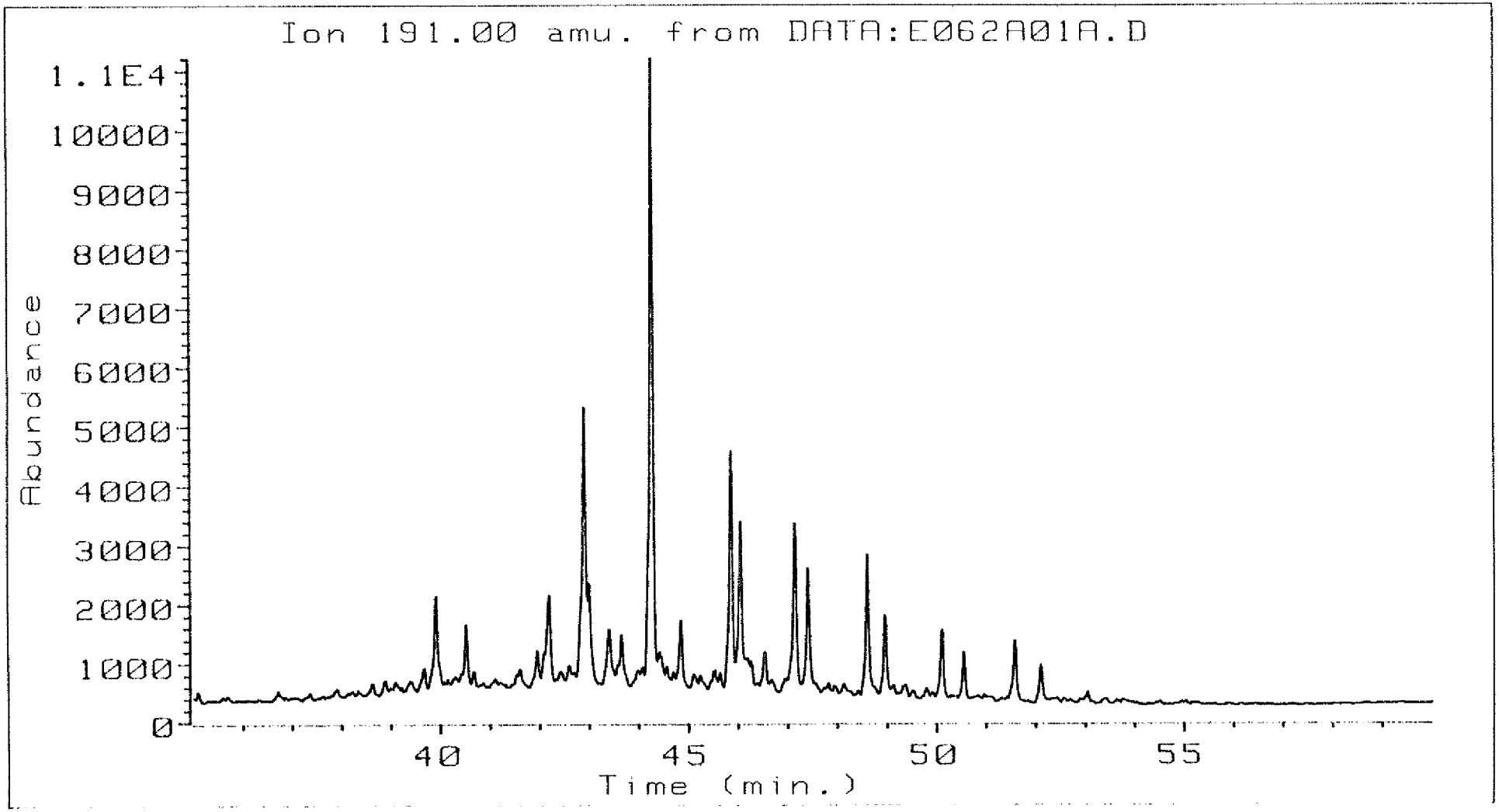
30/6-22

dst 1


Ion 217.00 amu. from DATA:E062A05A.D
Abundance
700
600
500
400
300
200
100
0
20
30
40
50
Time (min.)

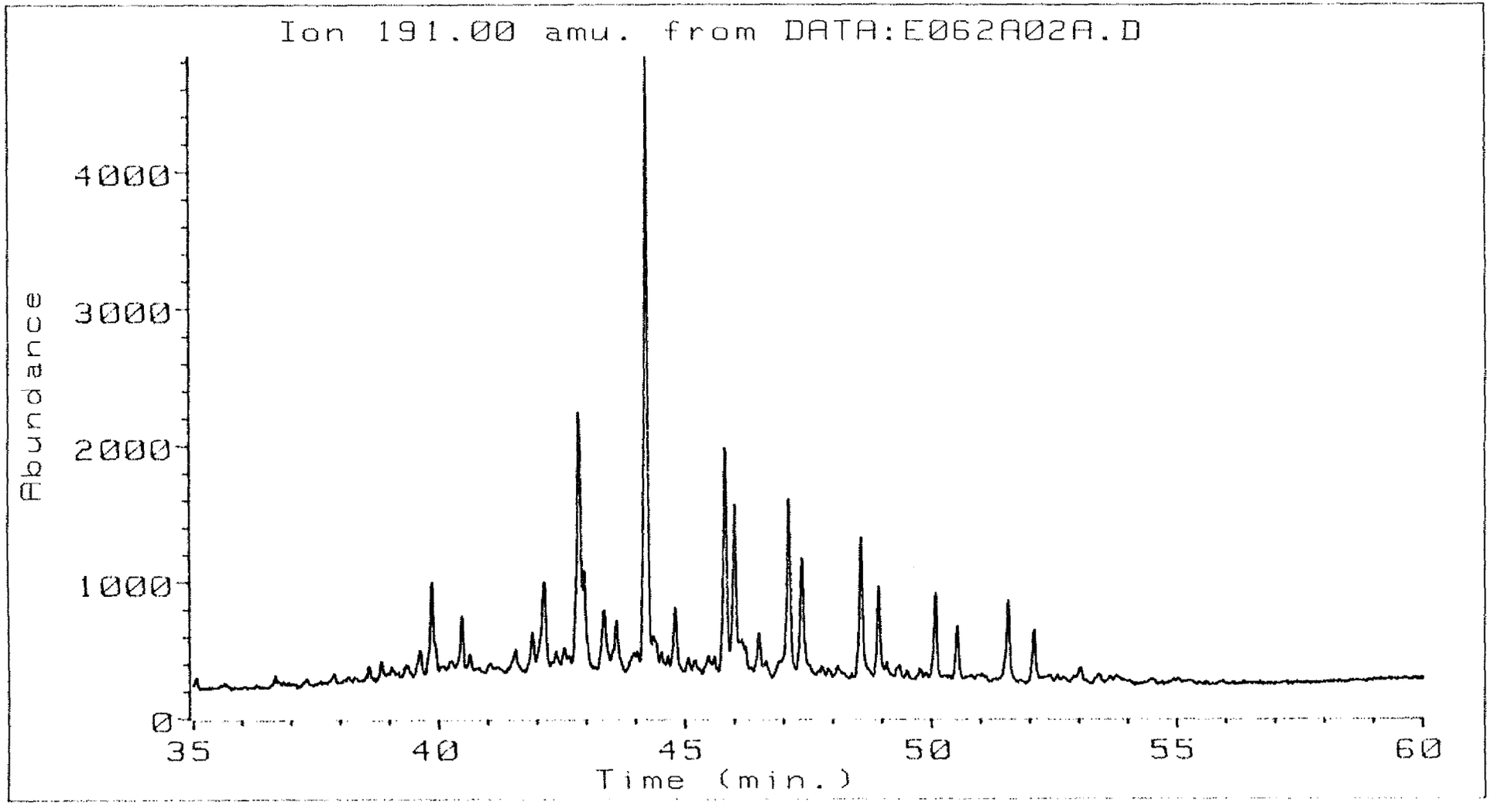
30/6-22

dst 2


Ion 191.00 amu. from DATA:E062A01A.D
1.1E4
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Abundance
40
45
50
55
Time (min.)

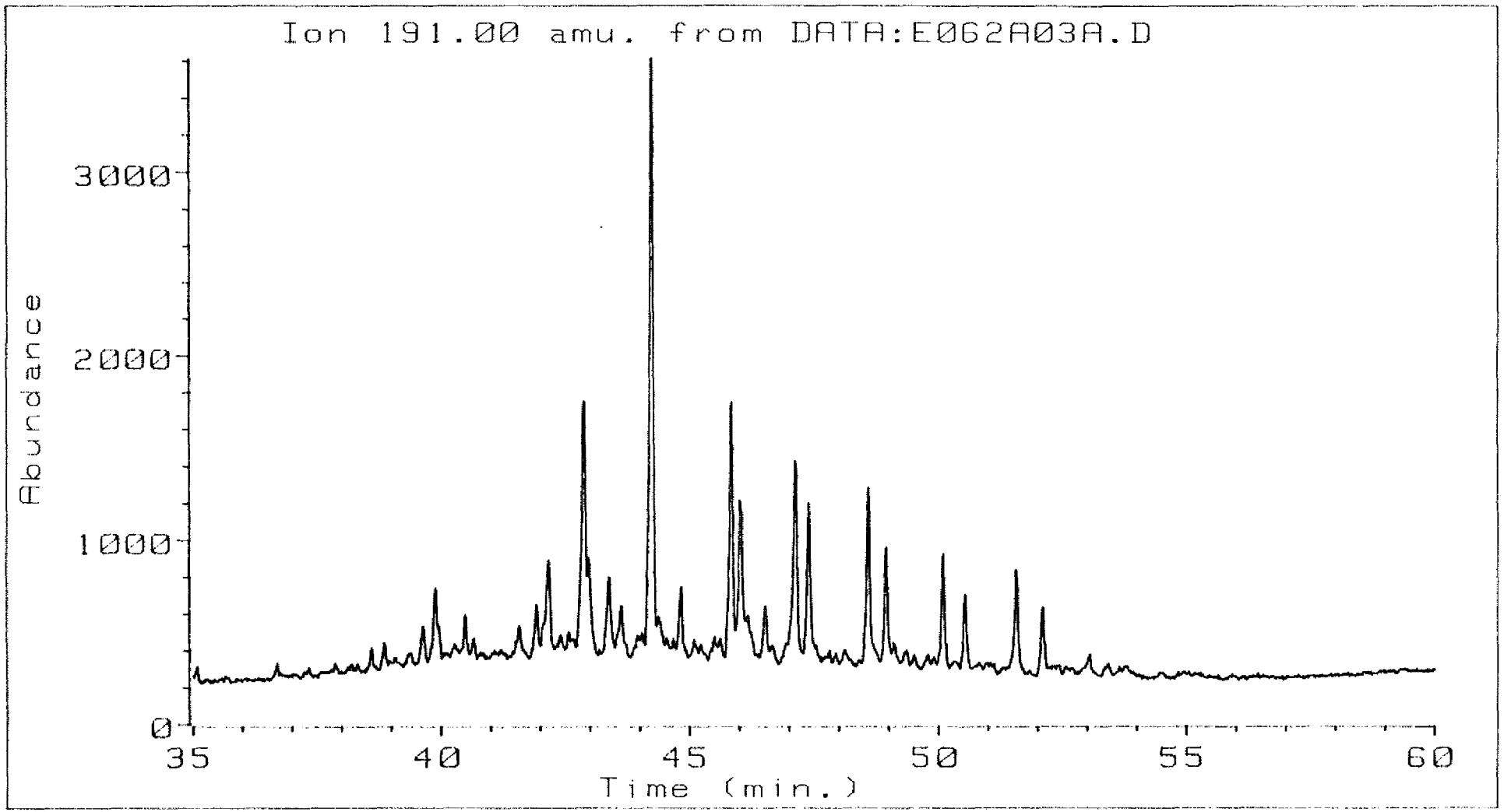
30/6-19

dst 1


Ion 191.00 amu. from DATA:E062A02A.D
Abundance
4000
3000
2000
1000
0
35
40
45
50
55
60
Time (min.)

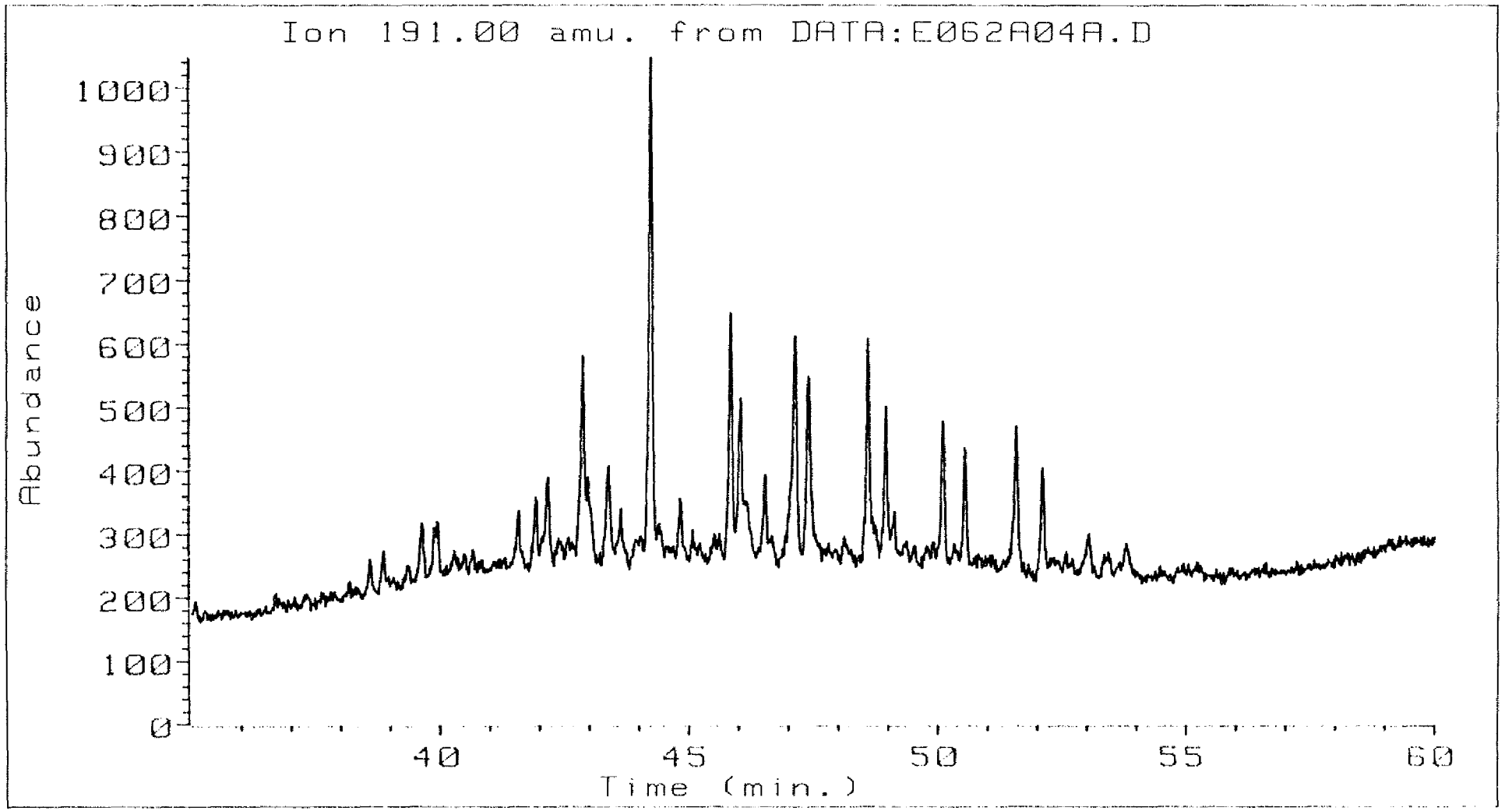
30/6-19

dst 2


Ion 191.00 amu. from DATA:E062A03A.D
Abundance
3000
2000
1000
0
35
40
45
50
55
60
Time (min.)

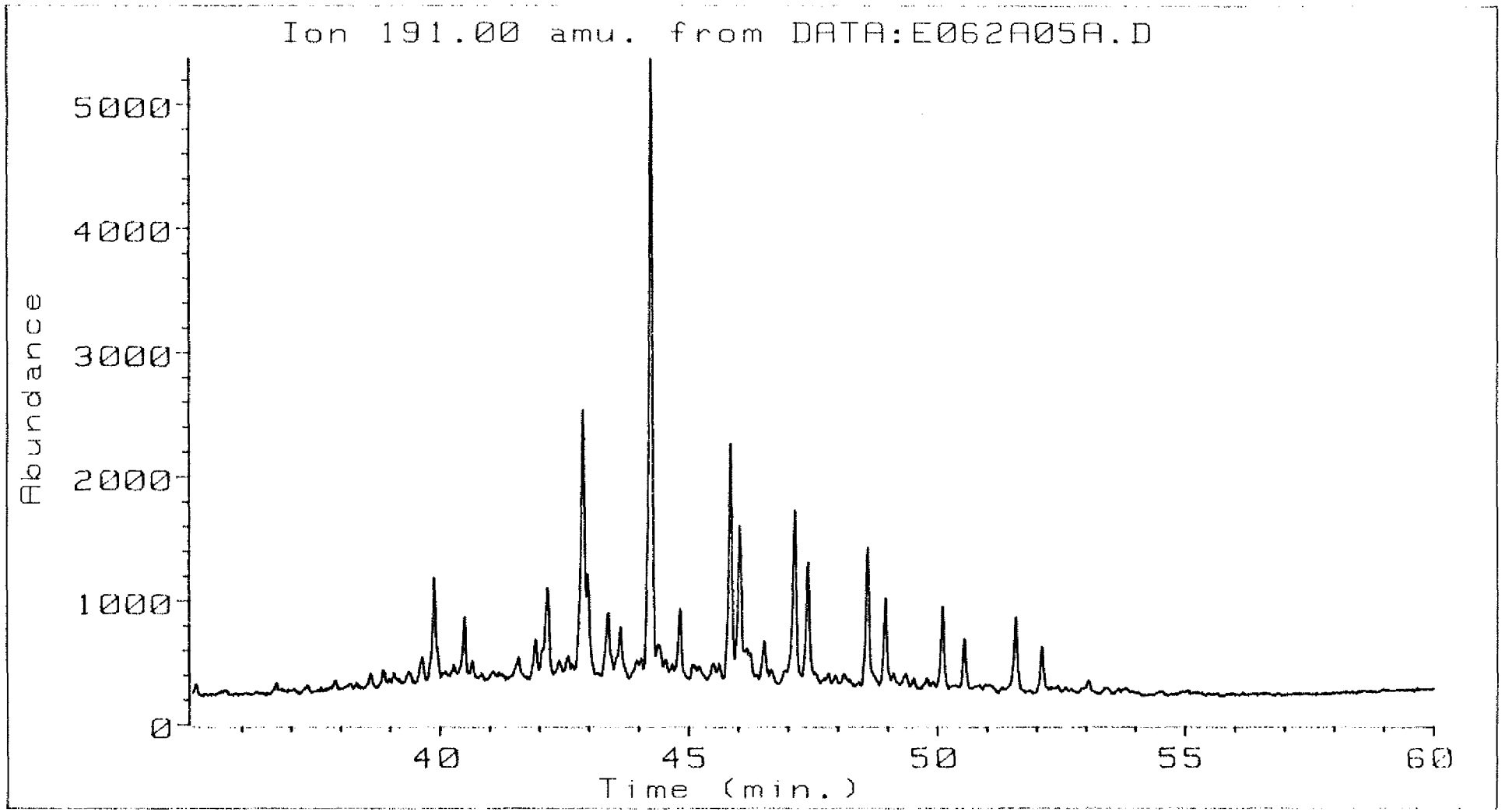
30/6-19

dst 3


Ion 191.00 amu. from DATA:E062A04A.D
Abundance
1000
900
800
700
600
500
400
300
200
100
0
40
45
50
55
60
Time (min.)

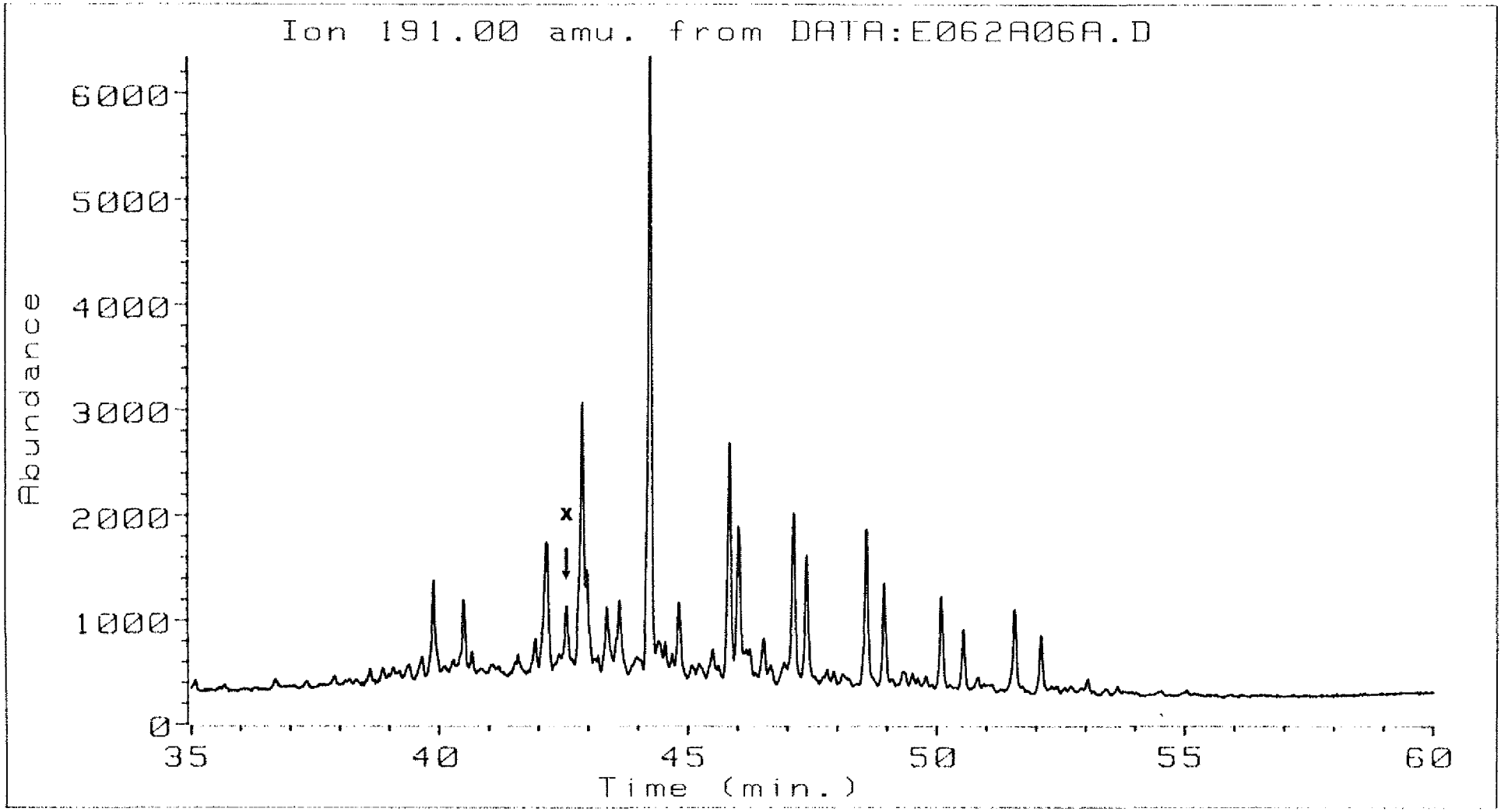
30/6-22

dst 1


Ion 191.00 amu. from DATA:E062A05A.D
Abundance
5000
4000
3000
2000
1000
0
40
45
50
55
60
Time (min.)

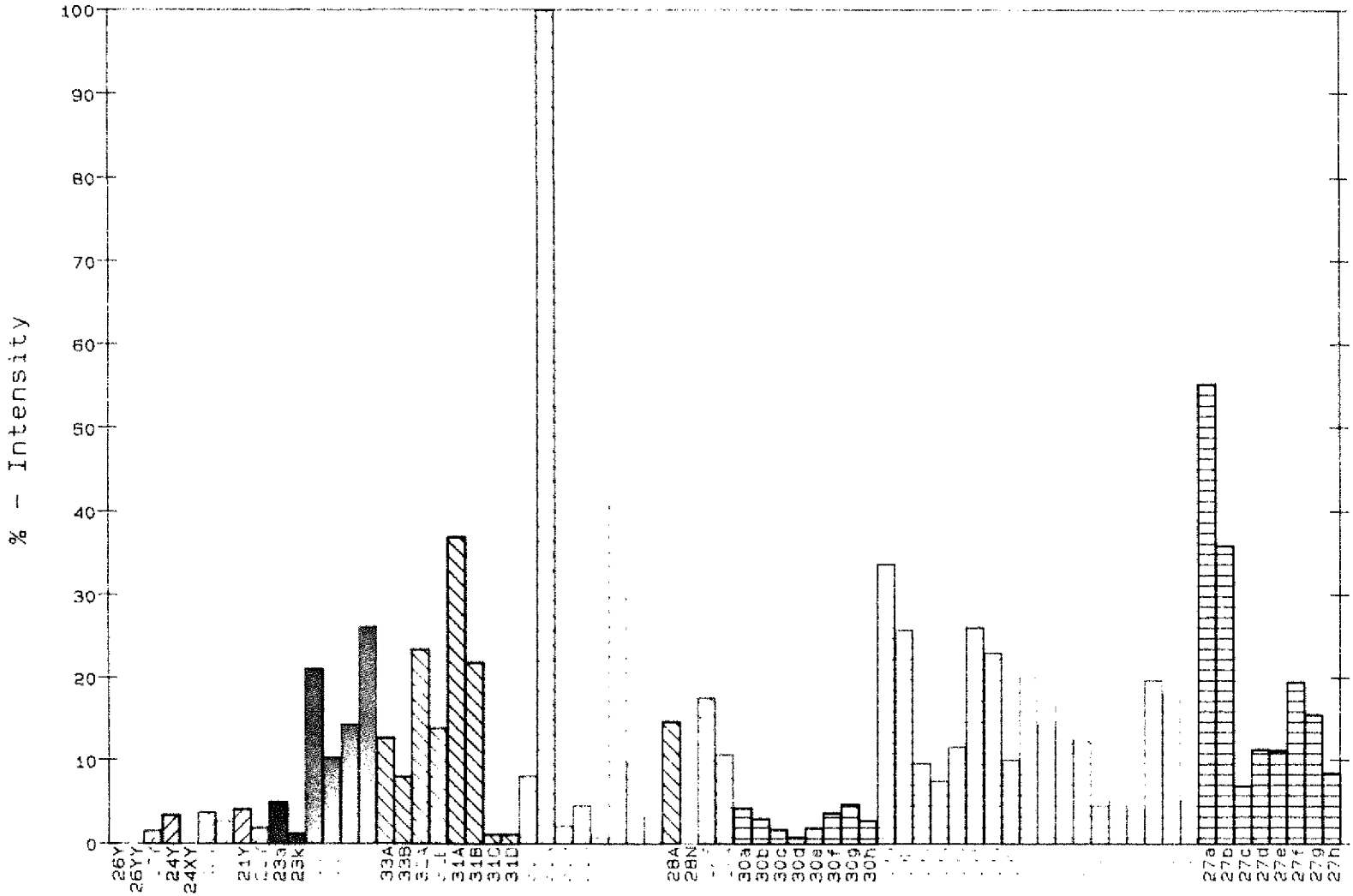
30/6-22

dst 2

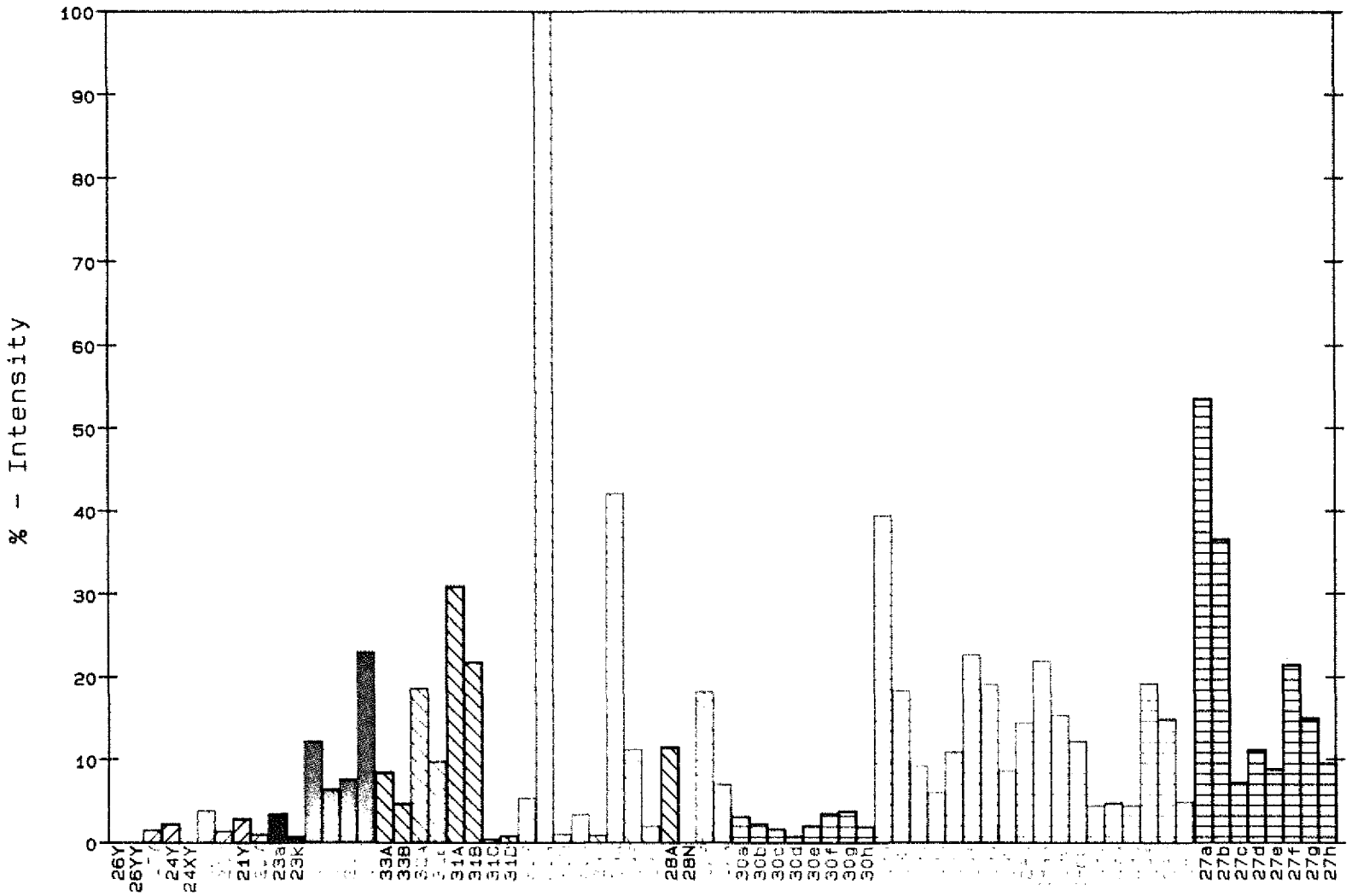


OSEBERG ALPHA OIL

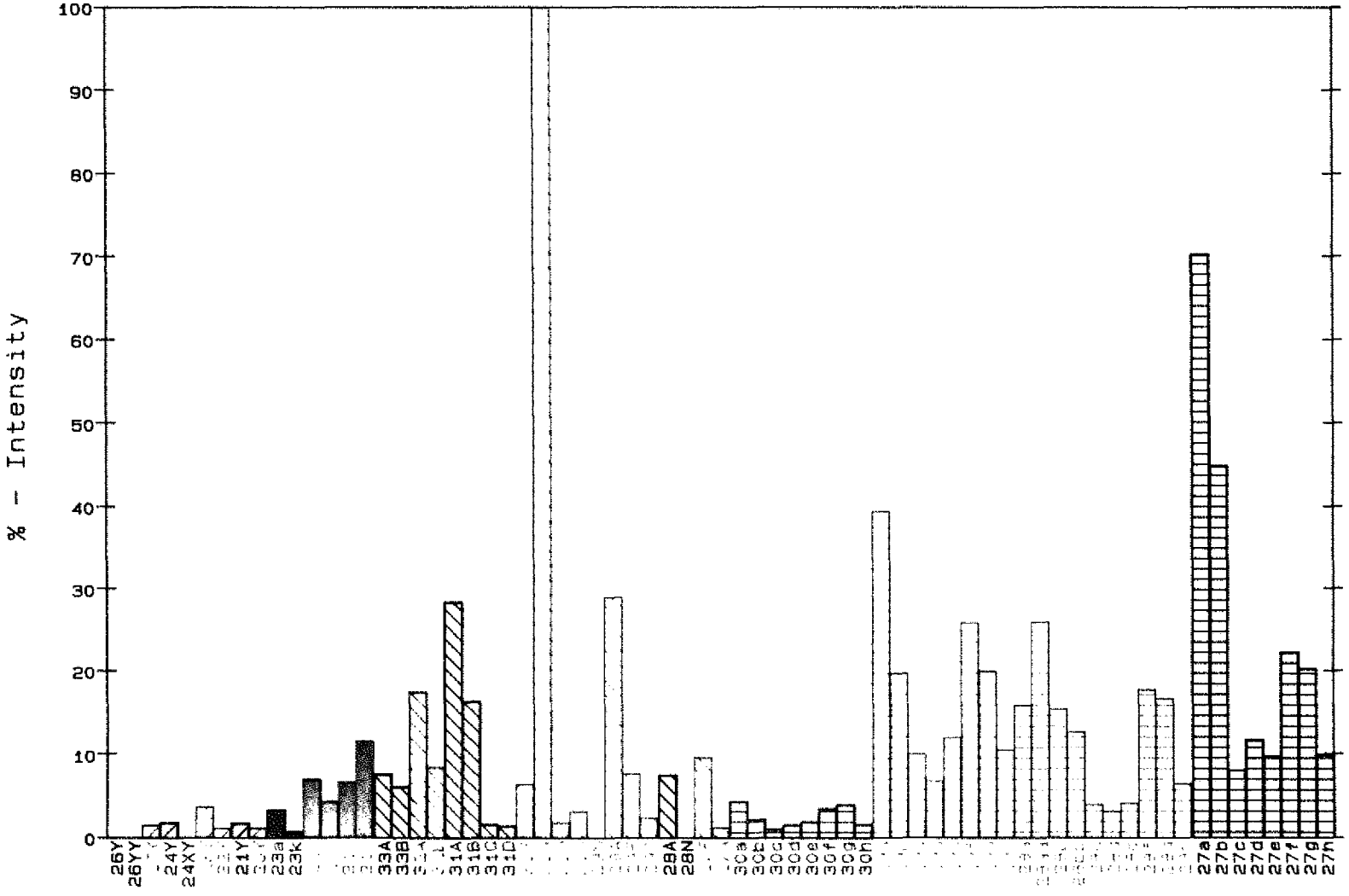
Biomarker pattern, SAT-fraction
Well: 30_6_19, DST1
ms-file: ES24118.DAT, norm. factor: 155305.8



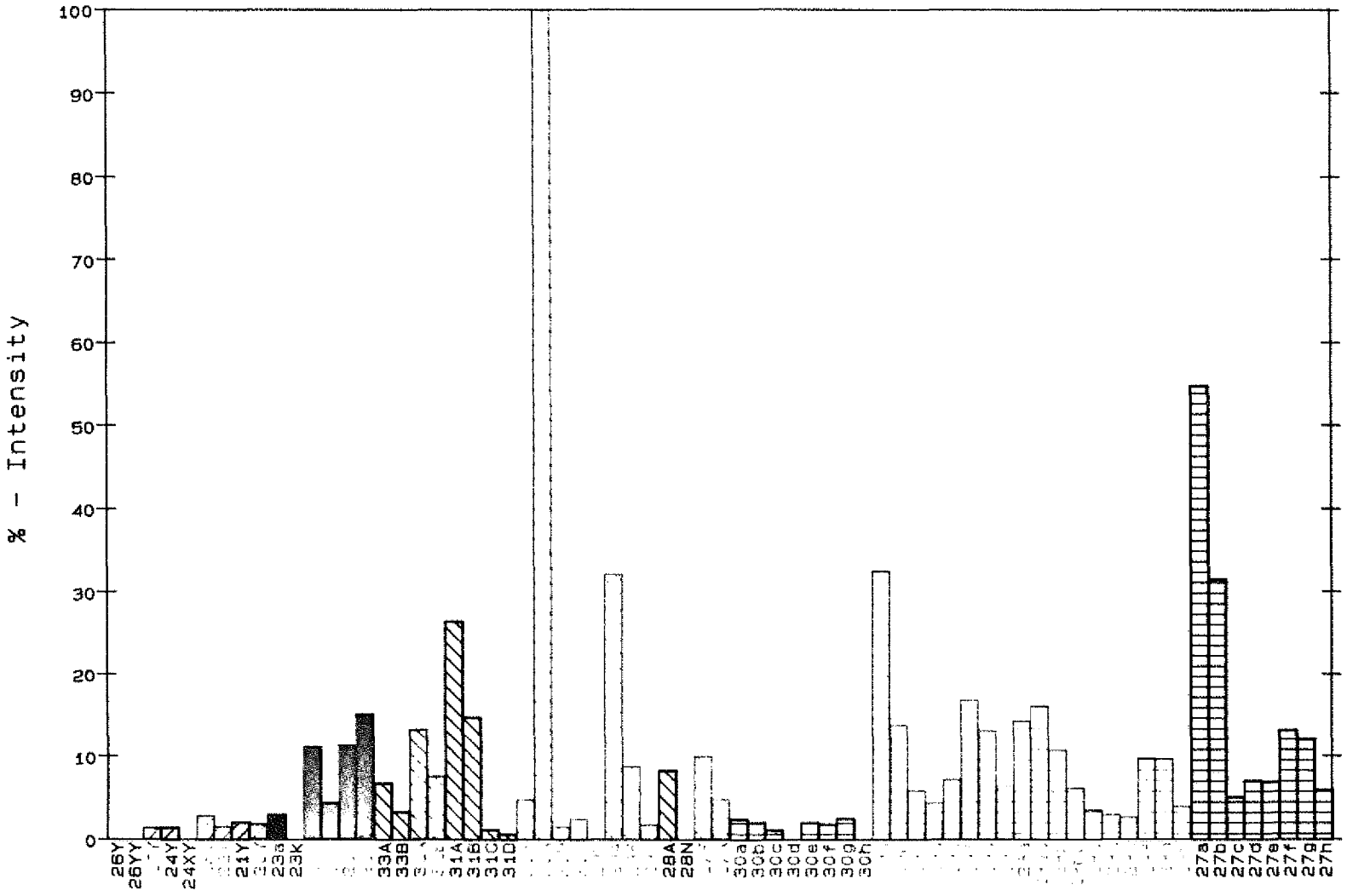
Biomarker pattern, SAT-fraction
Well: 30_6_19, DST2
ms-file: ES24118.DAT, norm. factor: 86570.3



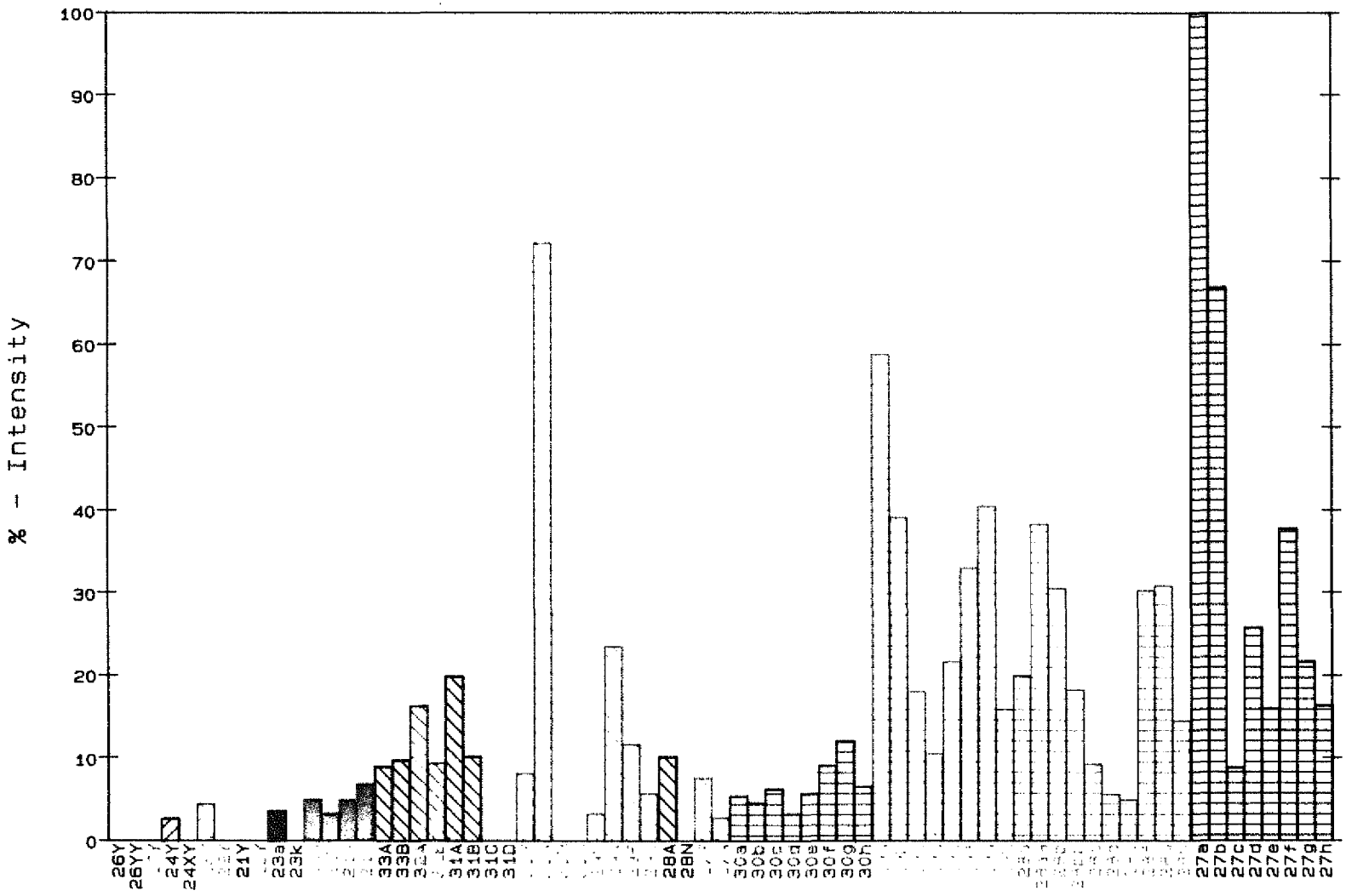
Biomarker pattern, SAT-fraction
Well: 30_6_19, DST3
ms-file: ES24118.DAT, norm. factor: 33724



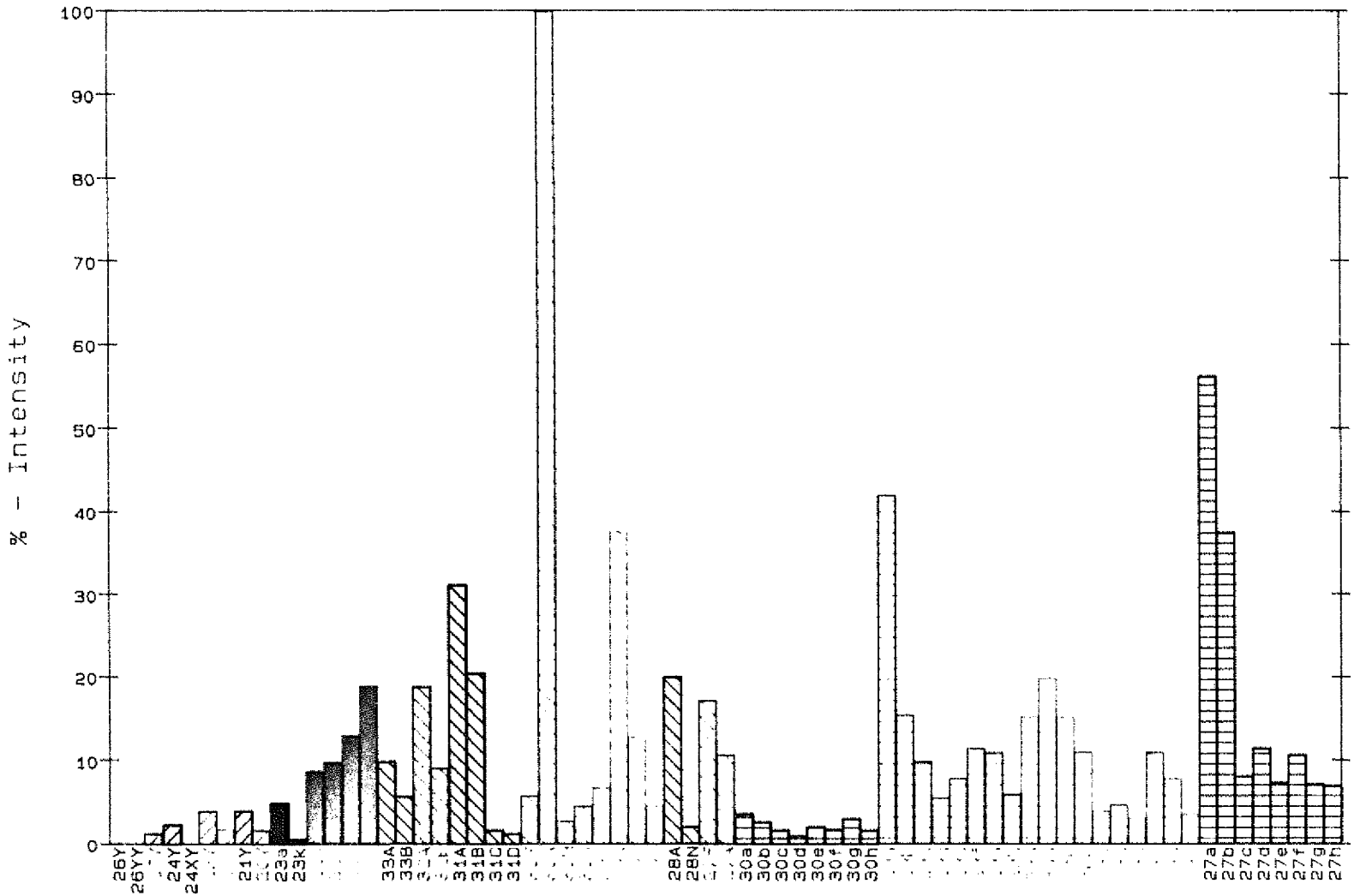
Biomarker pattern, SAT-fraction
Well: 30_6_22, DST2
ms-file: ES24118.DAT, norm. factor: 43309



Biomarker pattern, SAT-fraction
Well: 30_6_22, DST1
ms-file: ES24118.DAT, norm. factor: 8736.2



Biomarker pattern, SAT-fraction
BIOM1
ms-file: ES24118.DAT, norm. factor: 85015.7



Biomarker pattern, SAT-fraction
BIOM2
ms-file: ES24118.DAT, norm. factor: 45502.6