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GAS ANALYSIS AND SHOWS CHARACTERIZATION, WELL 30/9-5

by

B. Dahl and J. B. Olsen

Resyme Konklusjon Anbefaling
Summary Conclusion Recommendation

Twenty sediment samples from the Brent and Cook Formations have been analysed for migrated hydrocarbons.

Both formations contain small amounts of migrated oil-like hydrocarbons. The Brent Formation may contain a remnant oil column.

The analysed gas from the Cook Fm. is different from previously analysed gases from the same well. The newly analysed gas is derived from marine source rocks at condensate window maturity and is more in line with the regional "gas" trend in the area.

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Emnekategori Subject category
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Postal Address:
P.O. Box 4313
Nygårdstangen
N-5028 Bergen

Office Address:
Lars Hillesgt. 30
N-5008 Bergen

Phone:
Nat.: (05) 99 50 00
Intern.: +47 5 99 50 00

Telex:
40 920 hydro n

Telefax:
(05) 99 61 96

5515 1 88 5 000 Reklametrykk Grafisk A.s

CONTENTS PAGE

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1. INTRODUCTION

In a previous study (B. Dahl and J. B. Olsen, 1987), minor amounts of migrated hydrocarbons were encountered in the Brent and the Cook Fm's., Well 30/9-5. However, the sample coverage was rather sparse and it was agreed to evaluate an additional number of samples to confirm or reject the previous conclusions.

Two gas samples from the Brent and Cook Fms., were also analysed in the study mentioned above. Both samples showed an abnormal composition with respect to the established regional gas trend.

As this abnormality could be derived from analytical error or poor sample handling, it was decided to re-analyse these two samples.

2. SHOWS CHARACTERIZATION:

Reservoir Rock Extraction and Analysis

A suite of sandstone samples covering the Brent (6) and Cook (14) Formations have been solvent extracted. The extracts have been quantified and group type separated and the SAT and AROM fractions have been characterized by GC and GC-MS.

Extraction yields and results of group type separations are listed in Table II.1.

All samples gave low yields of extracts, however, the general impression is that the newly analysed sections within the Brent and Cook Fms. are slightly richer in extractable hydrocarbons (compared with Table II.2). These extracts, as in the former study, also contained a high abundance of non-hydrocarbons (NSO and asphaltenes), components that are abundant in shales or are preferentially retained during migration.

Most of the extracts and in particular those from core material in Cook Fm. have an oil like distribution similar to most extracts in the previous study (Appendix I).

The molecular parameters from aliphatic hydrocarbons (Table II 3 & 4) show more variations within each section than would be expected from a remnant oil column.

The biomarker data shows similar features to that of the previous samples (Table II. 5 & 6). However, in the new data set, the Brent samples are higher in sterane isomerisation maturity (20S). The maturity of the Cook samples is in the same range as for the earlier analysed samples and significantly less than in the Brent samples.

The source parameter C28/C28 + C29 is related to the C28 bisnorhopane, a significant feature of the Viking Graben crude oils. This parameter indicates minor influence of the C28 bisnorhopane component in two of the Brent samples and the uppermost two in Cook Fm. Consequently, these samples may have been influenced by migrated oils of Viking-Group origin.

The general conclusion from these analysis are that both the Brent and Cook Fms. contain a mixture of migrated and indigenous hydrocarbons. The Brent extracts contain more migrated hydrocarbons than the Cook extracts. (The sediments most influenced by migrated hydrocarbons will show the highest maturity as the mixture of migrated and indigenous hydrocarbons will be dominated by the mature oil). The migrated hydrocarbons in Brent are partly of Viking Group origin (plus the uppermost section in the Cook Fm.). Most of the Cook Fm. contained trace amounts of migrated hydrocarbons of non-Viking group origin.

None of the analysed sequences contain remnant oil columns.

3. GAS ANALYSIS

The interpretation in this section is based upon the publications by Schoell (1983) and James (1983). These publications contain diagrams from which genetic relationships and gas maturity can be derived.
The data from the reanalysed gas (2452m) from Cook Fm. are listed in Tables III. 1 & 2, and plotted in Figs. III 1-4, together with previous gas data.

In nearly all respects, the 2452m gas differs from the previously analysed gases. At least one of the two previously analysed gases are from the same formation as the 2452m gas. This implies an analytical error in either the previous or present analysis. If not, a high disproportionation must have occurred on or immediately after the sampling.

However, according to the plots in Figs. III 1-4, and general knowledge of the area, the newly analysed sample is more in line with the expected regional trends. It would appear to be derived from a marine source having at least reached condensate-window maturity. The gas is slightly more mature than expected for its location in the region.

This gas does not, according to Fig. III. 4, show signs of mixing, with respect to the heavier components.

4. IMPLICATIONS FOR THE J. SOUTH PROSPECT

This study of shows in the Brent and Cook Fms. is much in line with the previous study.

The results from that study suggested that the Brent reservoir could have received oils of Viking group origin before the gas influx. That oil was later displaced by gas, leaving remnant hydrocarbons of Viking Group

signature. Although Viking group oil may have entered before gas, a complete oil column with high oil saturation was probably not established at this position in the reservoir. Well 30/9-5 penetrates the Brent Fm. close to its crestal point. If gas and oil influx occurred approximately simultaneously and entered the reservoir at a more downflank position, a high oil saturation may not be expected at the crestal part of the reservoir.

With respect to the Cook Fm. the former results suggested that a considerable gas column was established before any oil entered the reservoir. This suggestion is supported by the new data.

The re-analysed gas from Cook Fm. is more in line with the regional gas trends, although slightly more mature than expected and have consequently most likely migrated from the Viking Graben. This migration may have occurred from the Viking Graben in such a way that gas has been separated from oil.

These results suggest that it is still possible that oil once entered the Brent reservoir and is now located downflank under the gas column.

The chance for an oil leg below the gas column in the Cook Fm. is less than that for the Brent Fm., as the oil then must have entered the reservoir downflank, after the gas column was established. The normal filling of reservoirs in the area seem to be by oil first or by oil and gas simultaneously. To have a situation as seen in the Cook Fm. of J-South, a complicated and "abnormal for the area" migration and accumulation history must have occurred. Another explanation for the situation in the Cook Fm. is that the accumulated gas is generated and migrated from another and deeper marine source, located away from the Viking Graben e.g. in the Stord Basin. The gas column may then have been established before significant oil of Viking Group origin entered the area from Viking Graben. Such oil may have accumulated below the gas leg.

However, this is a rather speculative suggestion, as proven hydrocarbon accumulations derived from the Stord basin have not yet been found. On the other hand, the possiblility cannot totally be excluded.

REFERENCES

Dahl, B. and Olsen, J.B. (1987), "Petroleum Geochemical Studies, PL104, Well 30/9-5." Internal Norsk Hydro report.

James, A.T. (1983), AAPG Bulletin, V67, No.7, pp.1176-1191.

Schoell, M. (1983), AAPG Bulletin, V67, No.12, pp.2225-2238.

TABLE II. 1 Extraction data Well 30/9-5, this study

0 DYP M	1 PRØVE TYPE	2 INNVEID STEIN(gr)	3 TOT. EOM(Mg)	4 %EOM	5 ASPH. (Mg)	6 ASPH. %
1 2235.00	DC (2mm)	22.11	4.6	0.02	2.2	47.8
2 2247.00	DC (2mm)	6.17	5.2	0.08	2.3	44.2
3 2250.00	DC (2mm)	6.58	5.3	0.08	2.5	47.2
4 2252.00	DC (2mm)	6.71	7.4	0.11	3.2	43.2
5 2255.00	DC (2mm)	17.16	19.6	0.11	8.1	41.3
6 2257.00	DC (2mm)	3.65	5.1	0.14	2.1	41.2
7 2447.00	DC (2mm)	6.14	5.4	0.09	2.3	42.6
8 2450.00	DC (2mm)	2.55	4.6	0.18	2.0	43.5
9 2455.00	DC (2mm)	8.03	1.9	0.02	0.7	36.8
10 2455.03	CORE	18.01	22.1	0.12	6.6	29.9
11 2455.97	CORE	17.84	29.8	0.17	9.3	31.2
12 2456.98	CORE	17.51	25.2	0.14	7.5	29.8
13 2457.96	CORE	19.20	19.5	0.10	5.6	28.7
14 2458.69	CORE	21.61	17.5	0.08	5.1	29.1
15 2460.05	CORE	20.96	15.3	0.07	3.8	24.8
16 2460.95	CORE	20.61	13.2	0.06	3.9	29.5
17 2461.96	CORE	19.29	16.8	0.09	4.5	26.8
18 2463.13	CORE	20.54	14.4	0.07	5.5	38.2
19 2463.95	CORE	20.35	9.7	0.05	3.2	33.0
20 2466.24	CORE	20.98	22.1	0.11	7.1	32.1

0 DYP M	7 SAT (Mg)	8 AROM. (Mg)	9 NSO (Mg)
1 2235.00	0.4	0.4	0.8
2 2247.00	0.3	0.5	1.0
3 2250.00	0.1	0.4	0.9
4 2252.00	0.6	0.6	1.3
5 2255.00	1.8	1.4	3.2
6 2257.00	0.4	0.5	0.6
7 2447.00	0.0	0.2	0.6
8 2450.00	0.1	0.4	0.9
9 2455.00	0.2	0.2	0.1
10 2455.03	1.1	1.1	0.7
11 2455.97	1.3	1.3	0.7
12 2456.98	1.1	1.1	0.7
13 2457.96	0.5	0.9	0.5
14 2458.69	0.5	1.2	0.7
15 2460.05	0.4	0.5	0.6
16 2460.95	0.4	0.3	0.4
17 2461.96	0.7	0.9	0.7
18 2463.13	0.3	0.5	0.6
19 2463.95	0.2	0.1	0.2
20 2466.24	0.6	0.6	1.0

TABLE II. 2 Extraction data from the previous study

EXTRACTION DATA I WELL 30/9-5

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Depth(m)	Group/Fm	EOM(mg)	EOM(%)	Hydrocarbons			Non Hydrocarbons		
				SAT(%)	ARO(%)	TOTAL(%)	NSO(%)	ASPH(%)	TOTAL(%)
2237.00	BRENT	9.50	0.04	30.00	10.00	40.00	32.00	28.40	60.40
2240.00		6.20	0.04	34.00	12.00	46.00	23.00	30.60	53.60
2242.00	BRENT	10.30	0.05	30.00	12.00	42.00	26.00	32.00	58.00
2245.00	BRENT	8.70	0.04	31.00	9.00	40.00	31.00	28.70	59.70
2452.00	COOK	6.10	0.05					34.40	34.40
2455.00	COOK	15.00	0.08	36.00	28.00	64.00	9.00	26.70	35.70
2608.00	STATFJORD	8.20	0.04	36.00	10.00	46.00	34.00	19.50	53.50
2615.00	STATFJORD	8.50	0.04					60.00	60.00
2624.65	STATFJORD	2.90	0.01					62.00	62.00

TABLE II. 3 Molecular parameters from aliphatic hydrocarbons, Well 30/9-5, this study

0 DYP	1 CPI 1	2 CPI 2	3 Pr/nC17	4 Ph/nC18	5 Pr/Ph	6 C17/C27
1 2235.00	1.15	0.89	0.88	0.60	1.26	11.51
2 2247.00	0.62	0.88	0.71	0.46	1.61	23.80
3 2250.00	0.75	0.94	0.77	0.48	1.73	15.10
4 2252.00	1.05	1.07	0.77	0.46	1.62	11.30
5 2255.00	0.90		0.69	0.48	1.25	7.00
6 2257.00	1.19	0.85	0.63	0.48	1.33	13.03
7 2447.00	1.15	0.98	0.71	0.55	1.19	30.40
8 2450.00	1.48	1.39	0.66	0.47	1.11	11.50
9 2455.00	1.39	1.01	0.60	0.51	0.24	2.01
10 2455.03	1.15	1.11	0.58	0.22	2.49	3.42
11 2455.97	1.17	0.99	0.57	0.20	3.15	11.30
12 2456.98	1.16	1.05	0.50	0.21	2.24	4.13
13 2457.96	1.54	1.61	0.50	0.19	2.69	2.20
14 2458.69	1.23	1.33	0.66	0.21	3.52	6.04
15 2460.05	1.35	1.34	0.52	0.22	2.53	7.63
16 2460.95		1.02	0.63	0.19	3.30	3.13
17 2461.96	1.16	0.99	0.54	0.23	2.37	5.68
18 2463.13	0.45	1.32	0.51	0.20	2.75	4.30
19 2463.95	0.73	2.17	0.41	0.17	2.70	5.19
20 2466.24	1.71	1.72	1.05	0.36	3.10	0.97

TABLE II.4 Molecular parameters from aliphatic hydrocarbons, Well 30/9-5, previous study

Fm	Depth	CPI-1	CPI-2	Pr/uC_{17}	Pr/uC_{18}	Pr/Ph	uC_{17}/uC_{27}
Brent	2237	1.00	0.79	0.73	0.53	1.61	4.80
Brent	2240	1.06	0.76	0.84	0.57	1.15	5.36
Brent	2242		1.10	0.75	0.55	1.15	2.33
Brent	2245	1.12	0.95	0.71	0.51	1.53	3.68
Cook	2455	1.10	1.03	0.53	0.19	2.54	2.55
Statfj.	2608	1.14	0.70	1.05	1.08	0.9	1.75

Table II.5. Biomarker parameters from sandstone extracts, this study

Fm	Depth (m)	TRITERPANES					STERANES	
		T_s/T_m	$\frac{C_{29}}{C_{29}+C_{30}}$	$\frac{C_{28}}{C_{28}+C_{29}}$	$\frac{C_{30}\beta\alpha}{C_{30}\alpha\beta}$	22S	αββ	20S
Brent	2235	1.06	0.40	0.22	0.13	61	39	51
Brent	2247							
Brent	2250							
Brent	2252							
Brent	2255							
Brent	2257	0.58	0.49	0.13	0.16	60	41	56
Cook	2447	0.41	0.53	0.11	0.32			
Cook	2450	0.44	0.46	0.07	0.28	60	30	32
Cook	2455							
Cook	2455.00-0.3	0.46	0.43		0.28	56	35	38
Cook	2455.97-00	0.40	0.46		0.27	57		
Cook	2456.98-00	0.43	0.45		0.27	57	30	28
Cook	2457.96-00	0.34	0.44		0.28	57	27	25
Cook	2458.65-69							
Cook	2460.00-05	0.34	0.46		0.27	59	24	28
Cook	2460.95-00							
Cook	2461.96-00	0.36	0.43		0.27	62	24	28
Cook	2463.07-13	0.28	0.43		0.28	60	28	28
Cook	2463.95-00					5		
Cook	2466.20-24	0.36	0.44		0.27	59	27	28
		Source maturity	Source	Source	Source maturity	Maturity	Maturity	Maturity

Table II.6. Biomarker results from the previous study

Fm	Depth (m)	TRITERPANES					STERANES	
		T_s/T_m	$\frac{C_{29}}{C_{29}+C_{30}}$	$\frac{C_{28}}{C_{28}+C_{29}}$	$\frac{C_{30}\beta\alpha}{C_{30}\alpha\beta}$	22S	αββ	20S
Brent	2237	0.65	0.36	0.32	0.19	0.55	0.46	0.37
Brent	2240	0.88	0.35	0.33	0.19	0.55	0.47	0.44
Brent	2242	0.81	0.40	0.26	0.19	0.55	0.47	0.44
Brent	2245	0.71	0.37	0.26	0.21	0.55	0.45	0.40
Cook	2452	0.50	0.44	0.08	0.30	0.78	0.34	0.29
Cook	2455	0.42	0.40	-	0.27	0.54	0.32	0.31
Statfj.	2608	0.56	0.47	0.13	0.10	0.60	0.51	0.53
Statfj.	2615	0.75	0.38	-	0.19	-	-	-
Statfj.	2624.6	0.55	0.54	0.13	0.14	0.61	0.51	0.49
		Source maturity	Source	Source	Source maturity	Maturity	Maturity	Maturity

Table III.I Molecular composition of natural gases

Sample	C_1	C_2	C_3	iC_4	nC_4	C_{2+}*	C_{5+}	$\frac{iC_4}{nC_4}$	$\frac{C_1}{C_{2+}}$	O_2	N_2	CO_2	CO
30/9-5 RFT	52.81	9.24	7.14	1.86	2.46	30.0	1.93	0.75	2.67	5.03	19.38	0.0137	0.002
30/9-5 RFT 1217	51.28	15.18	19.38	6.74	5.14	48.7	2.28	1.31	1.05	a.m.	n.m.	n.m.	n.m.
30/9-5 2452 mRKB	77.2	12.3	6.2	0.99	1.61	21.19	0	0.62	3.6			1.7	

* Based on HC content mormalized to 100 %.

Table III.2 Isotope composition of natural gases

SAMPLE	METHANE	ETHANE	PROPANE	BUTANE		D	CO_2	^{18}O
				iC_4	nC_4		Sc^{13}	
30/9-5 RFT	-38.39	-27.84	-23.64			-192		
30/9-5 RFT 1217	-41.0	-29.36	-27.71			-		
30/9-5 2452 mRKB	-42.3	-28.7	-27.1	-25.5	-26.1	-209	-10.8	-10.0

Fig. III. 1

30/9-5

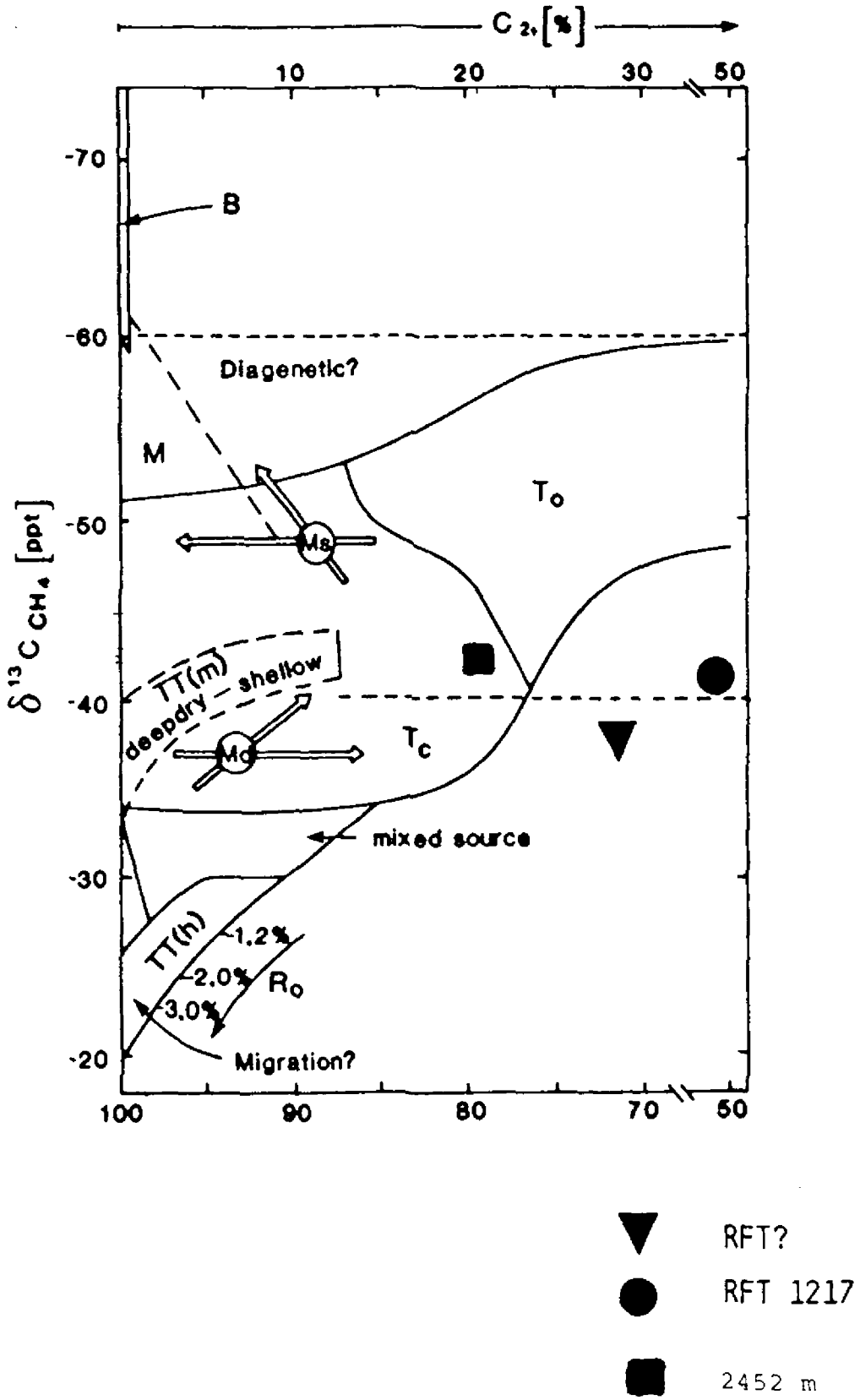


Fig. III. 2

30/9-5

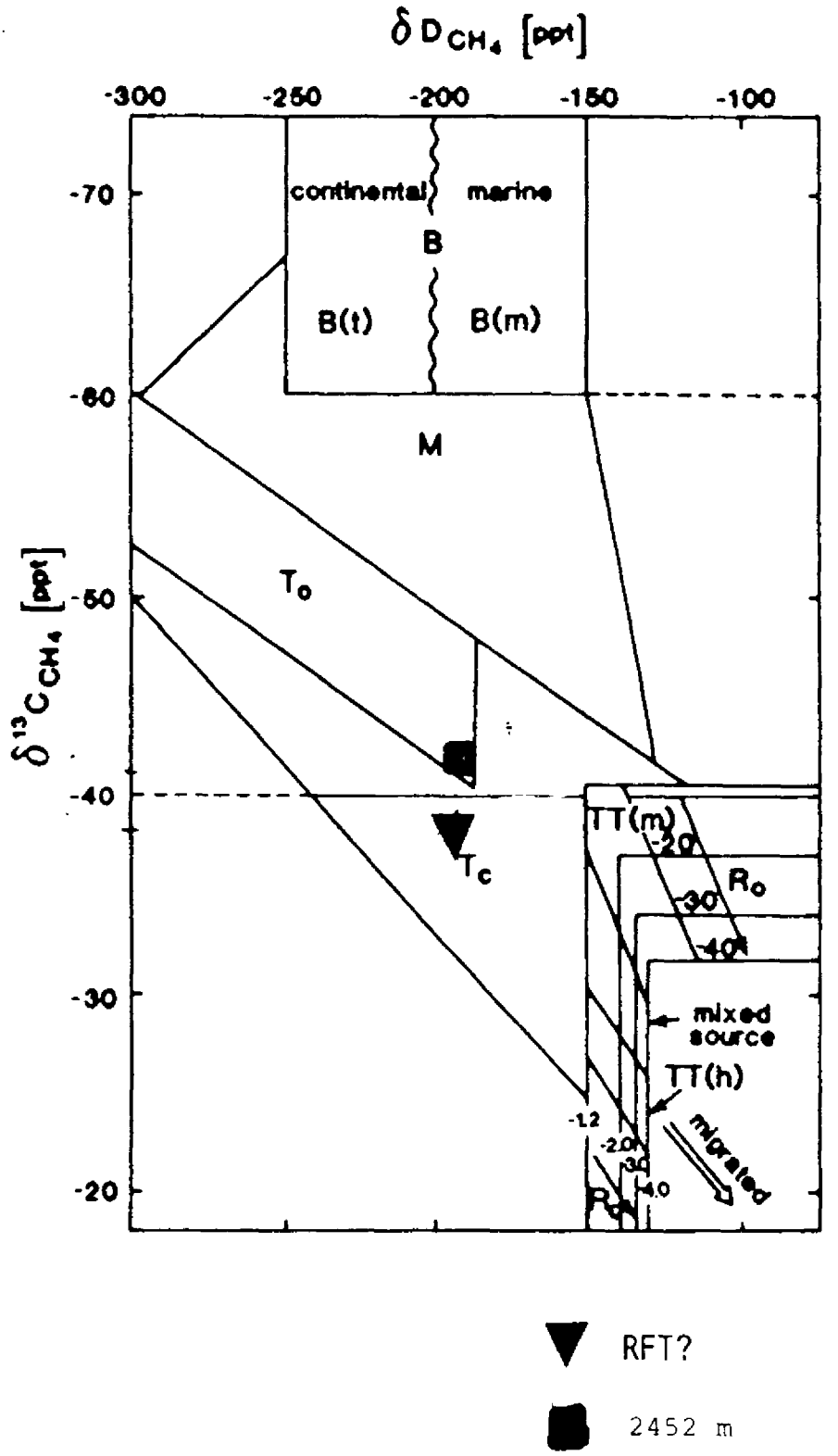


Fig. III. 3

30/9-5

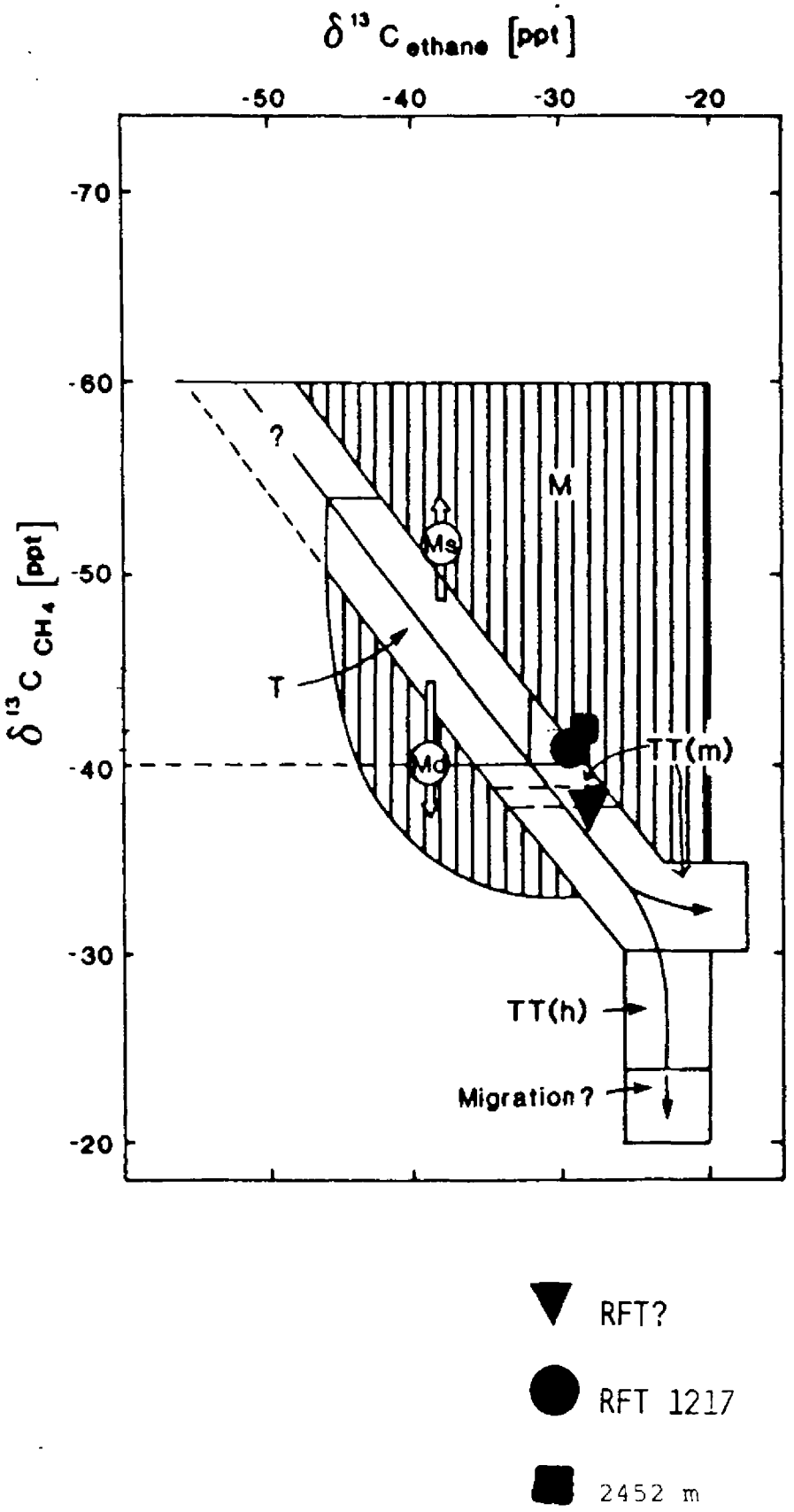
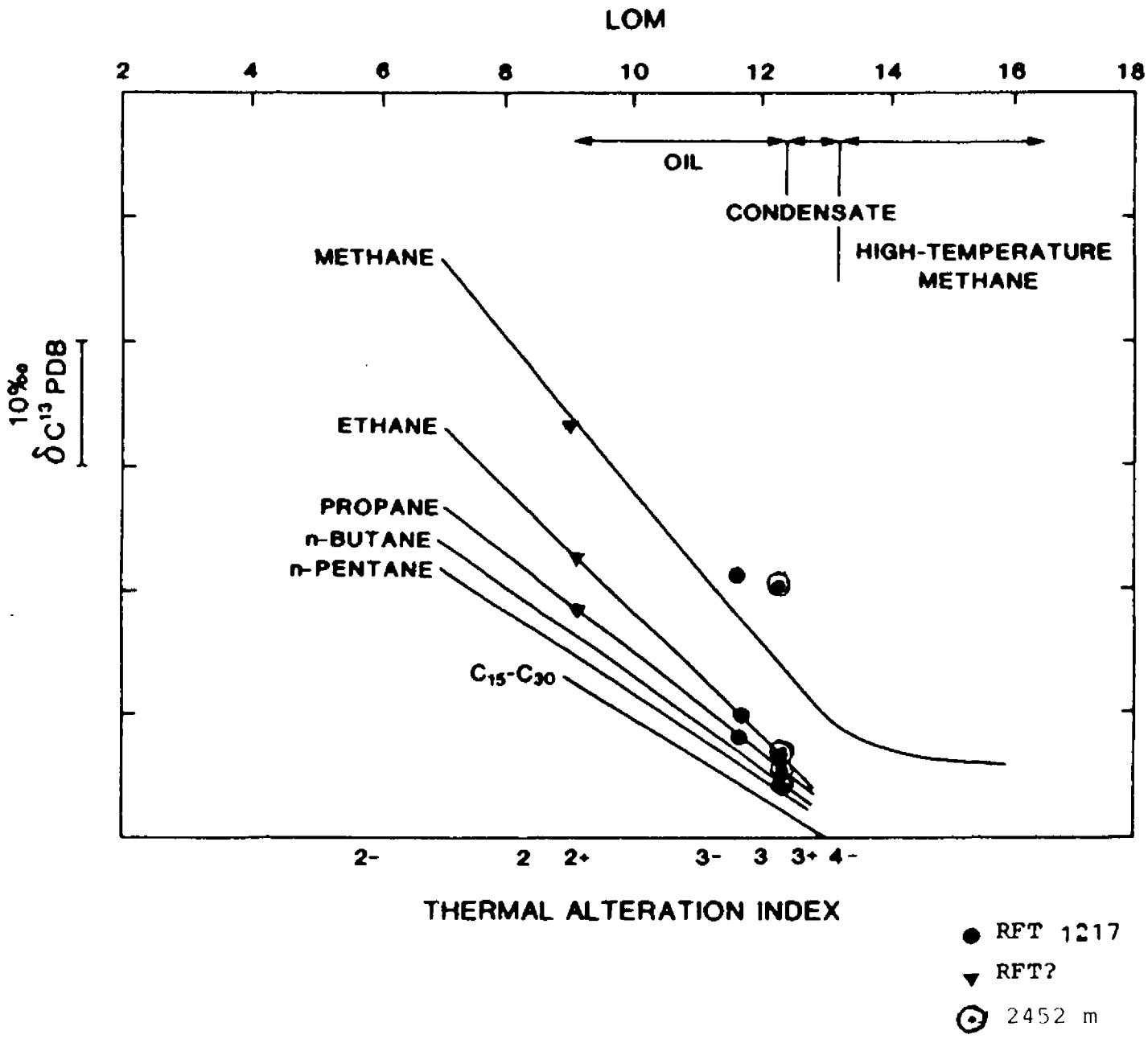


Fig. III. 4

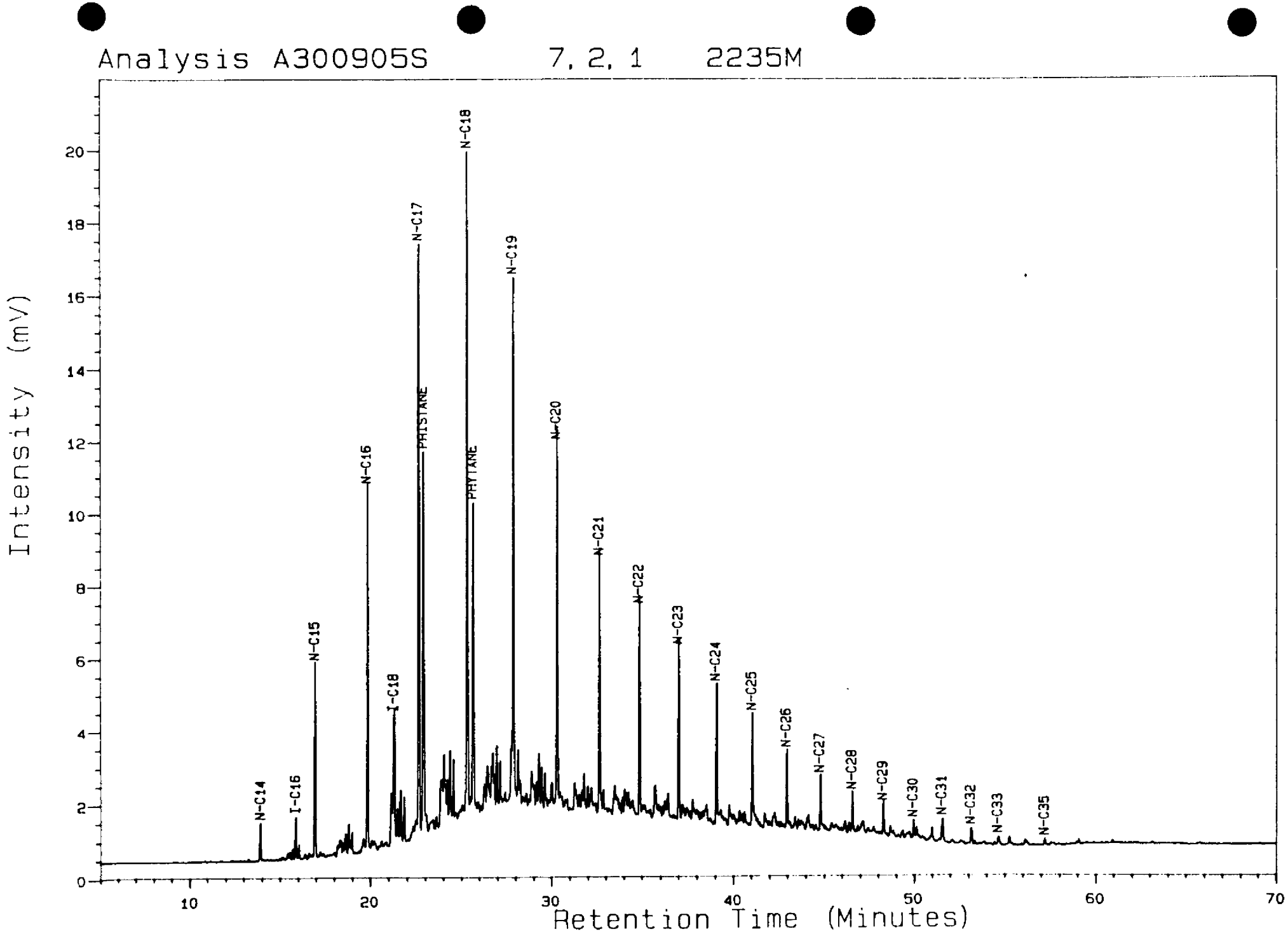
30/9-5



Tables and Figures

APPENDIX I

GC OF SATURATED FRACTIONS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N-C15
N-C16
I-C18
N-C17
PRISTANE
N-C18
PHYTANE
N-C19
N-C20
N-C21
N-C22
N-C23
N-C24
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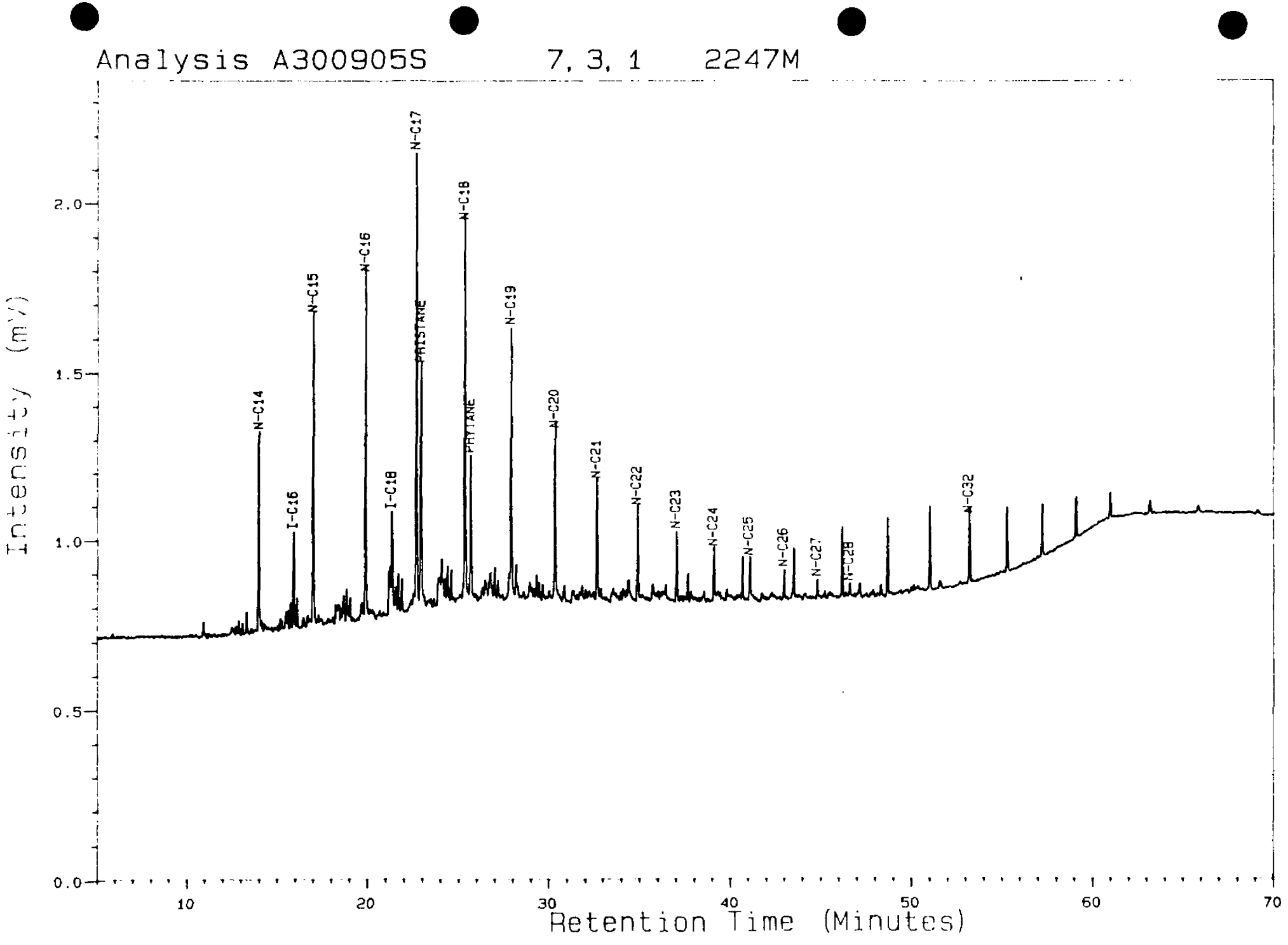
N-C35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N-C15
N-C16
I-C18
N-C17
PRISTANE
N-C18
PHYTANE
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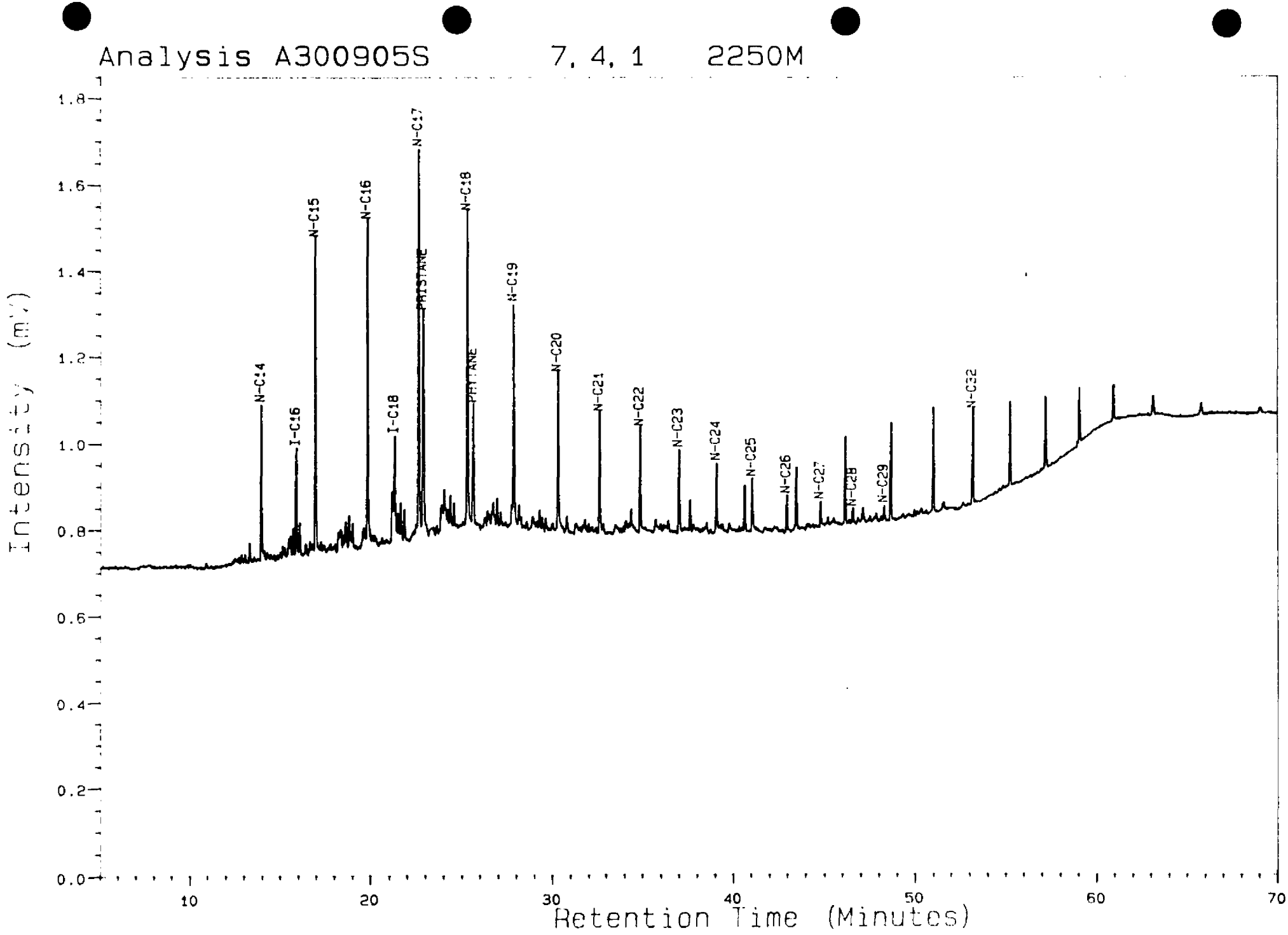
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0.2
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N-C15
N-C16
I-C18
N-C17
PRISTANE
N-C18
PHYTANE
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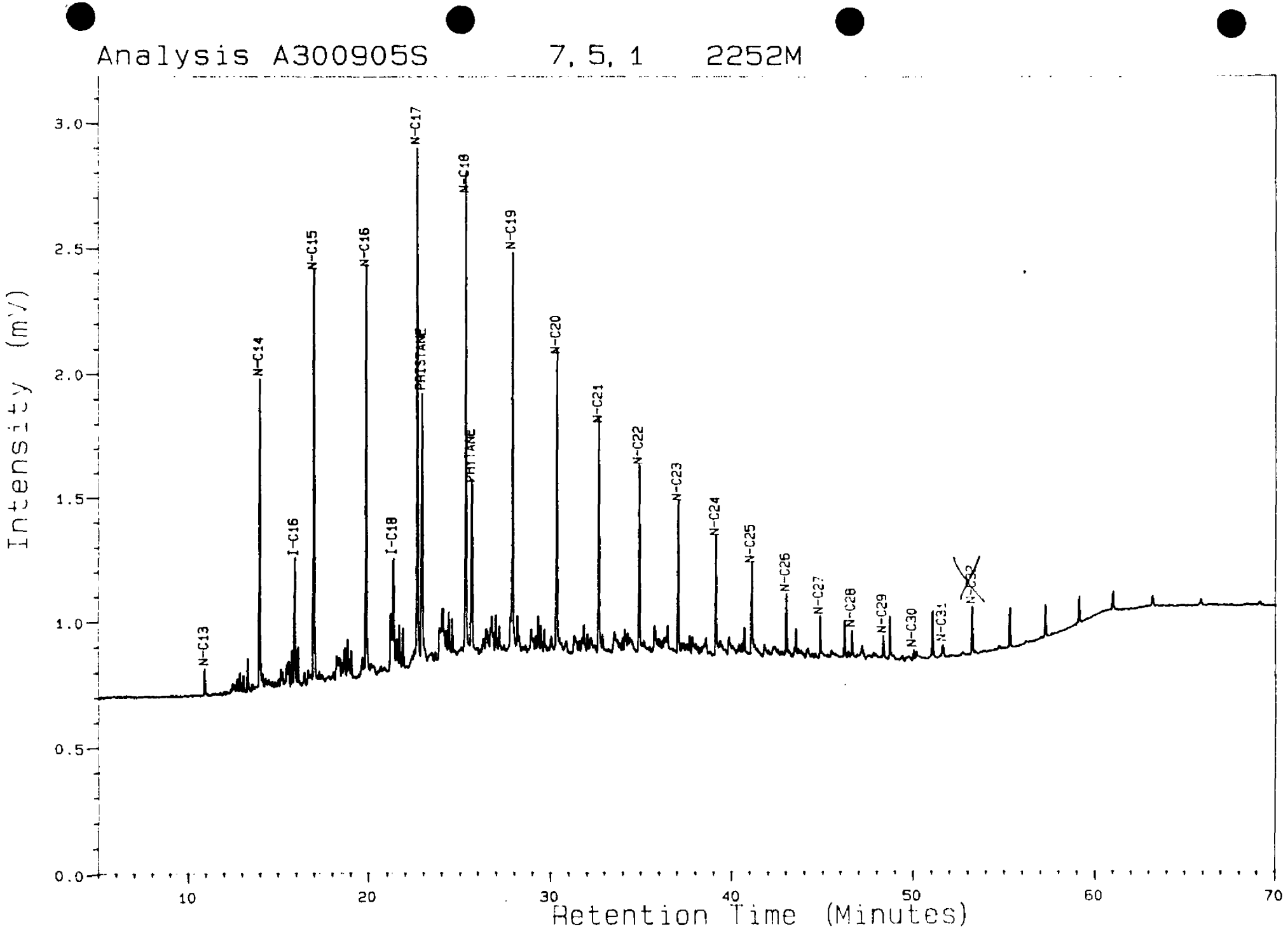
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N-C16
I-C18
N-C17
PRISTANE
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PHYTANE
N-C19
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10
20
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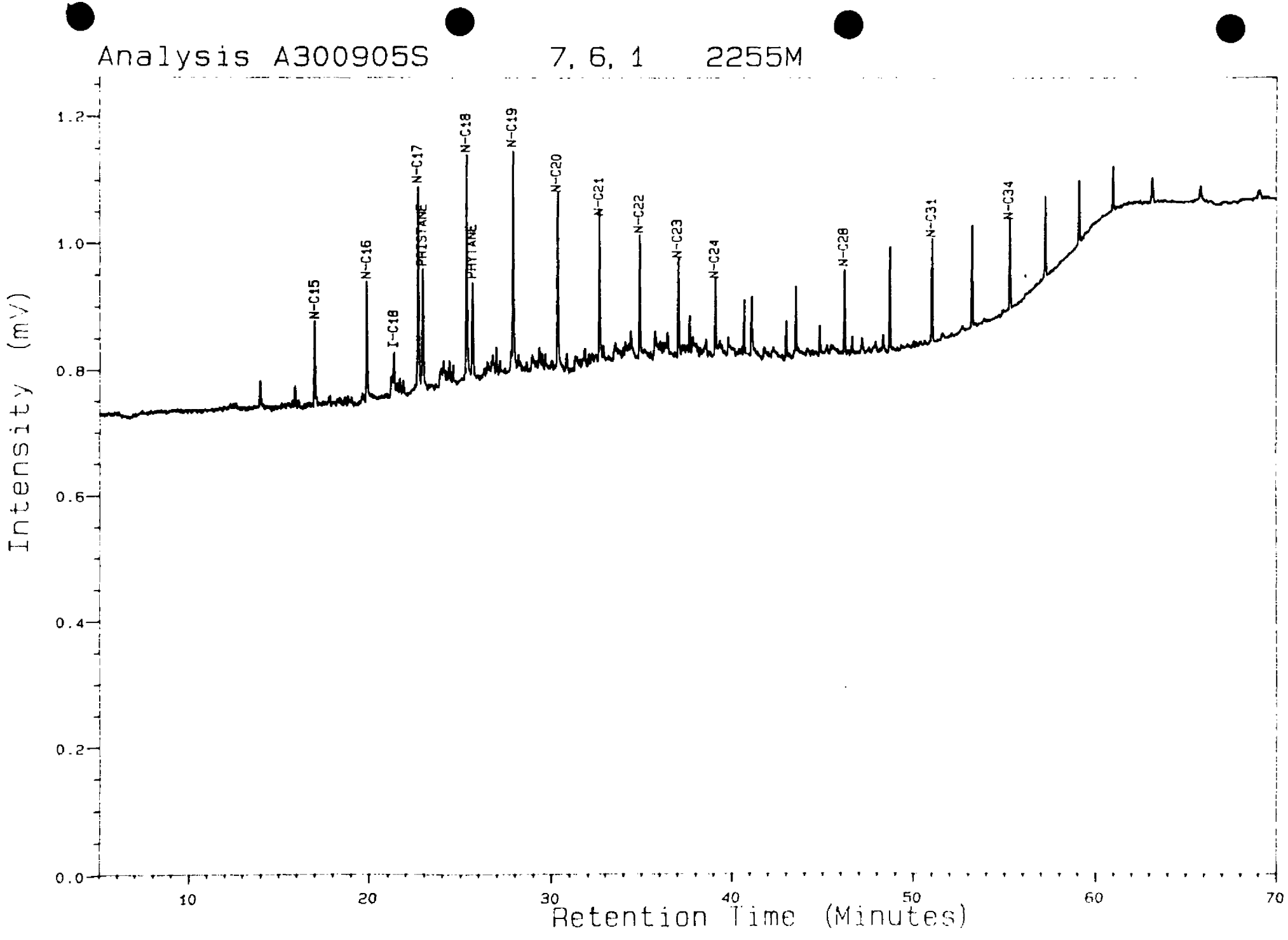
40
50
60
70
Retention Time (Minutes)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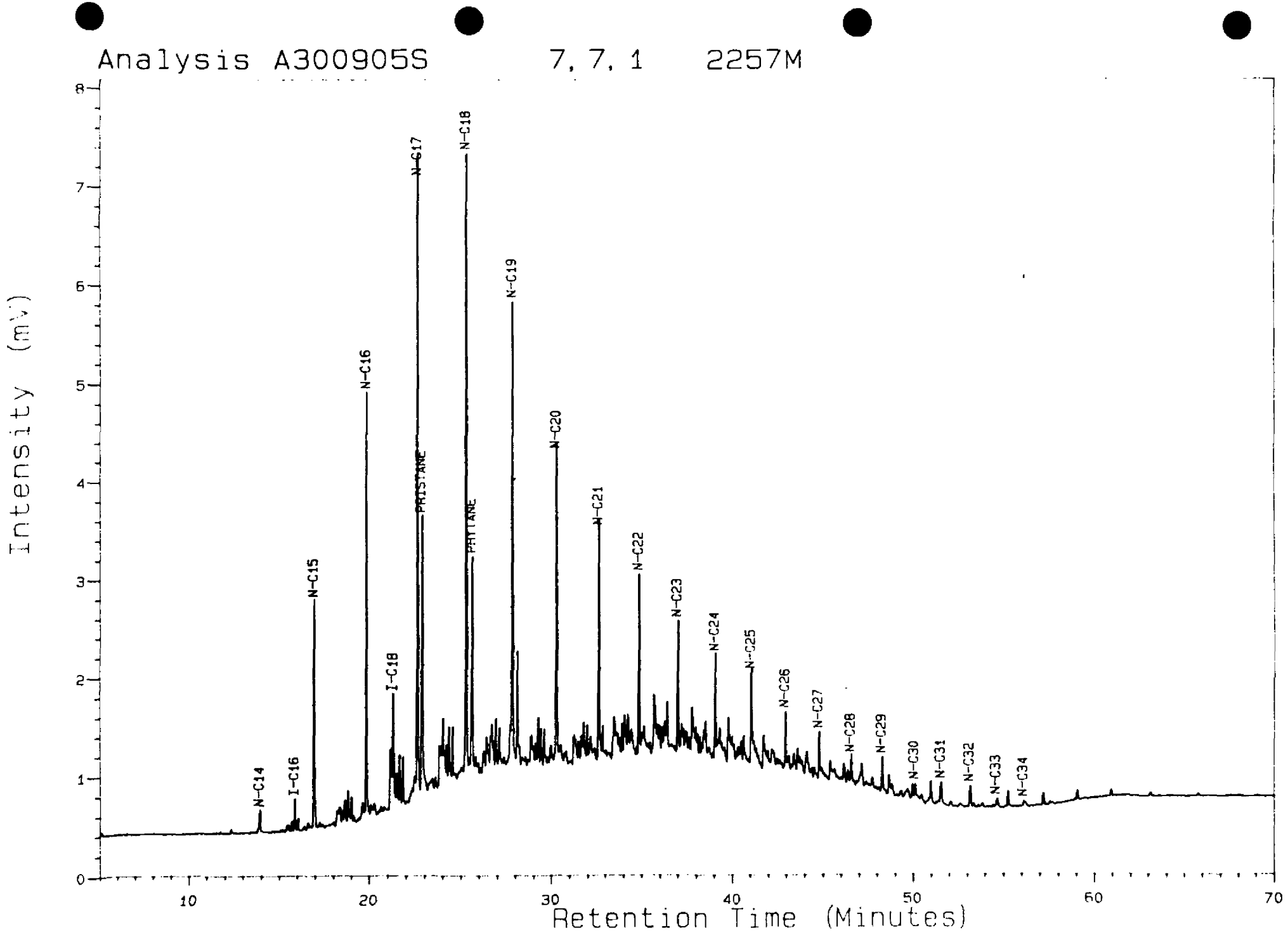
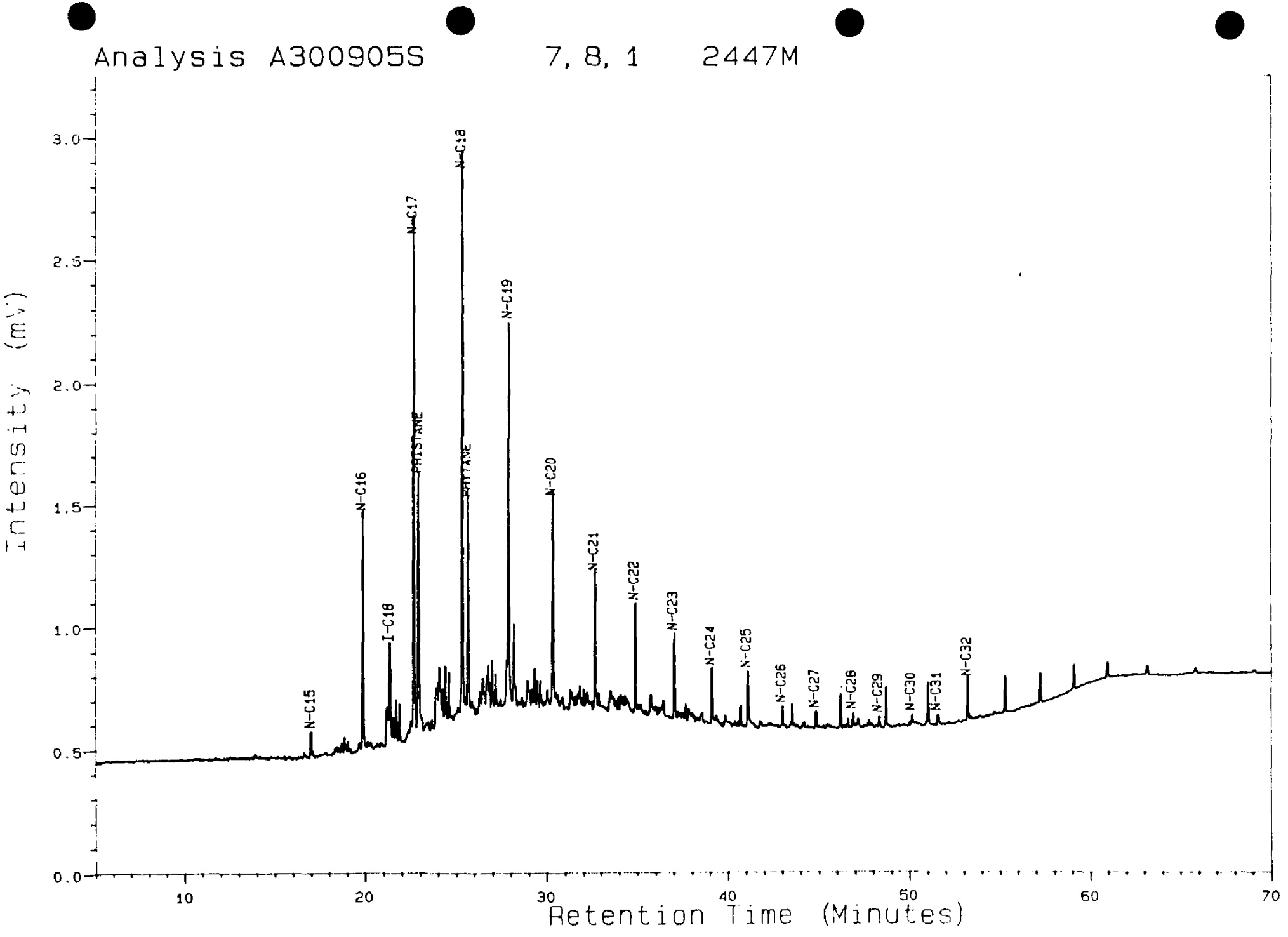
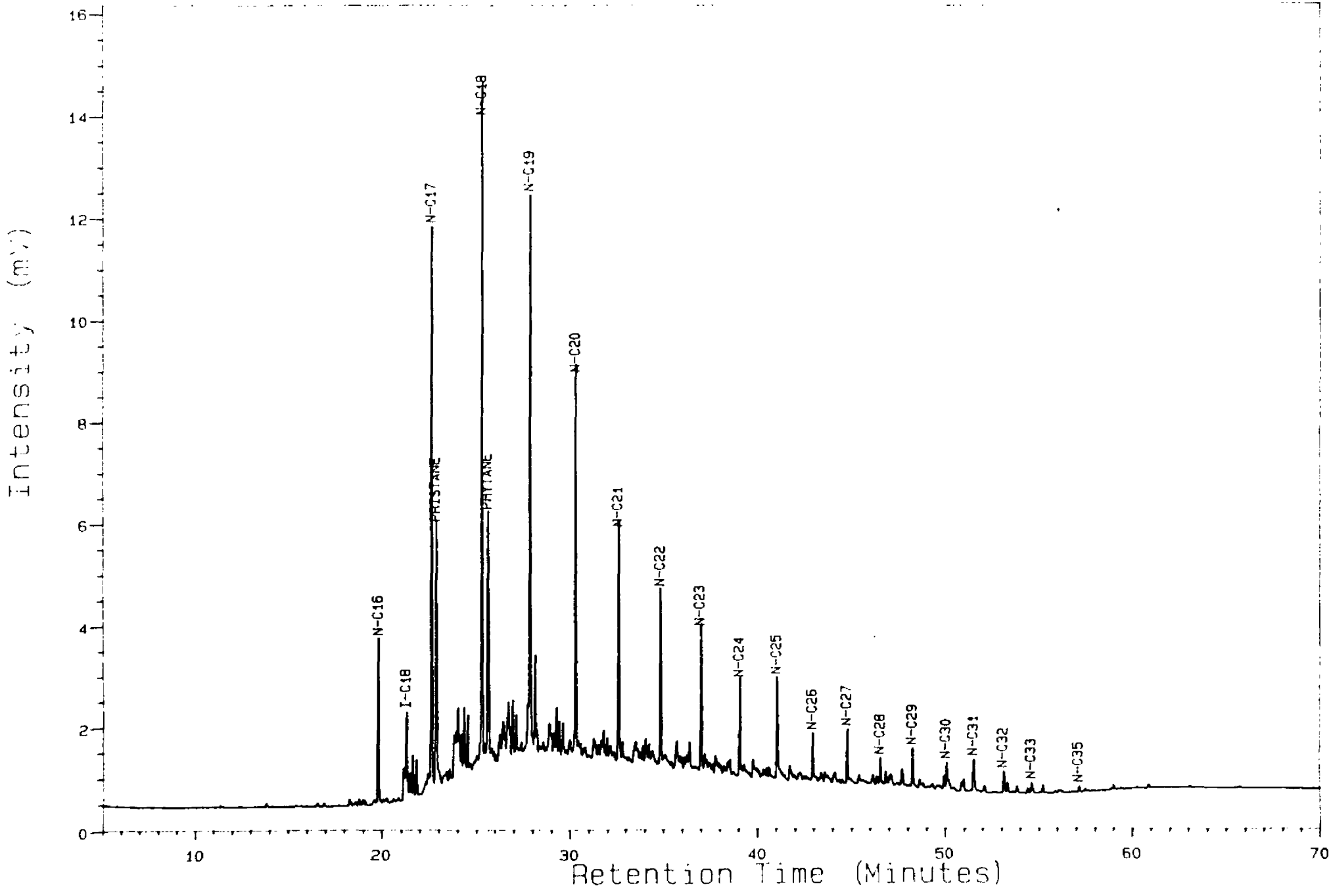
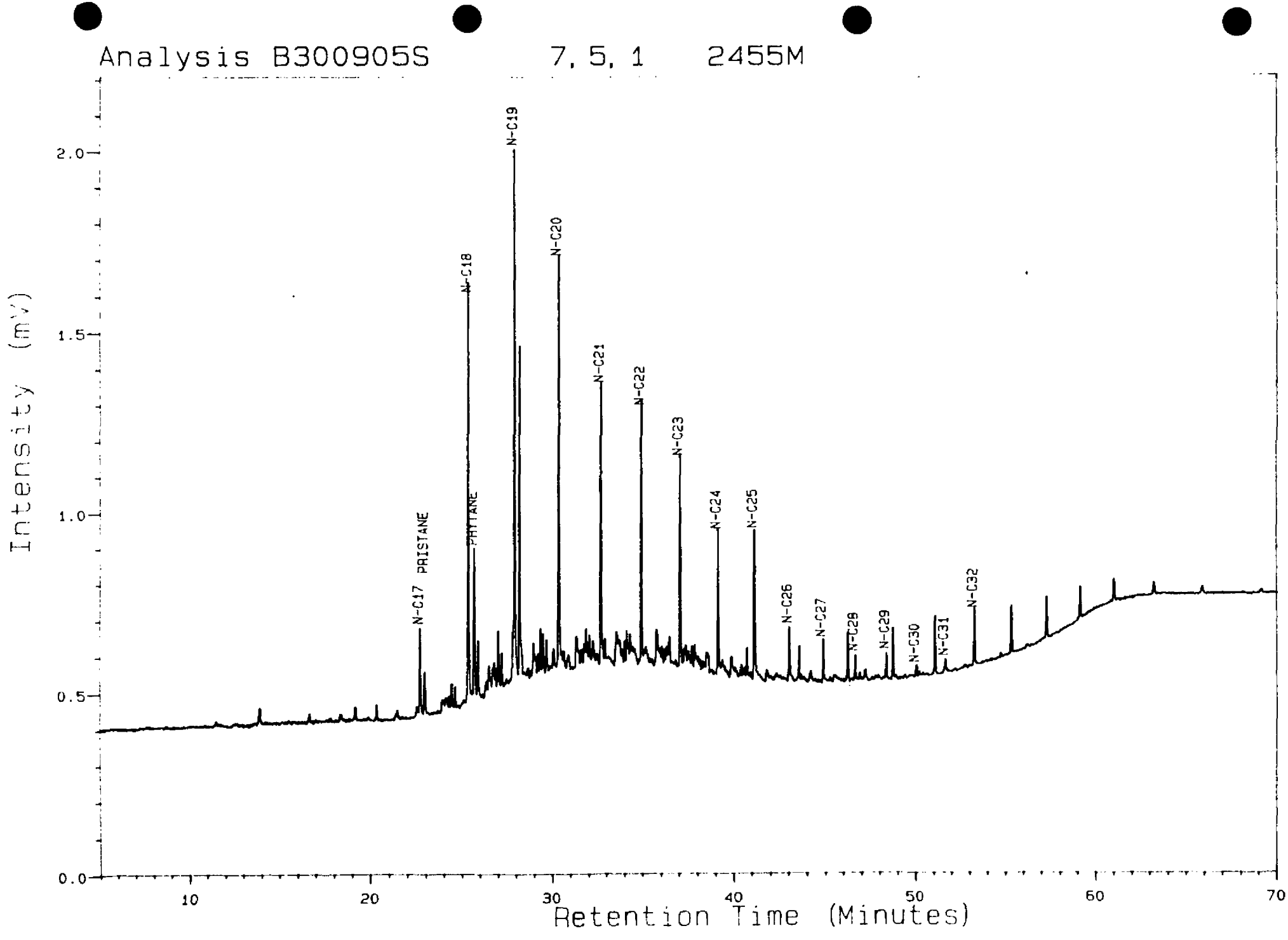
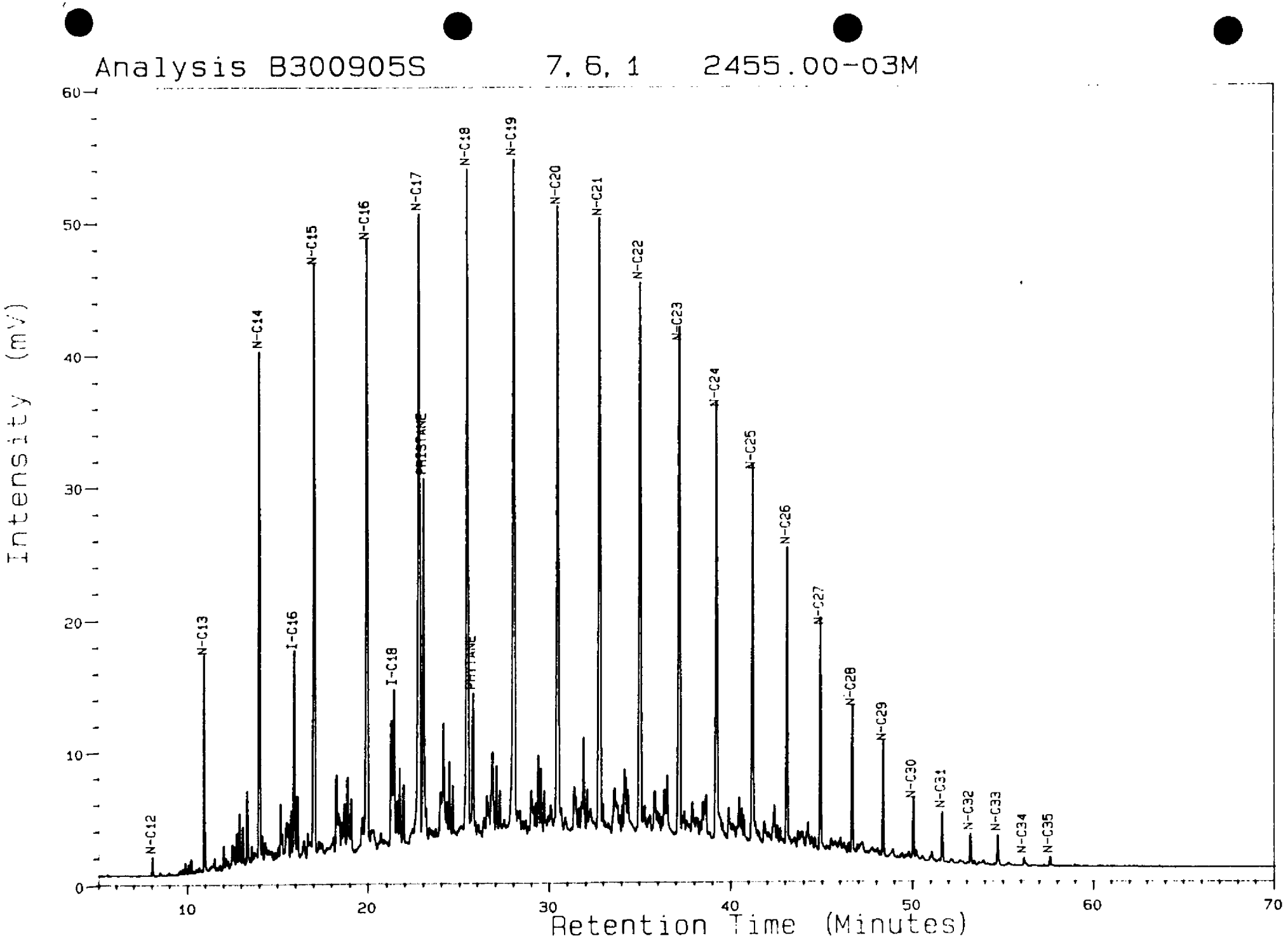
0.2
0.0
N-C15
N-C16
I-C18
N-C17
PRISTANE
N-C18
PHYTANE
N-C19
N-C20
N-C21
N-C22
N-C23
N-C24
N-C28
N-C31
N-C34
10
20
30
40
50
60
70
Retention Time (Minutes)

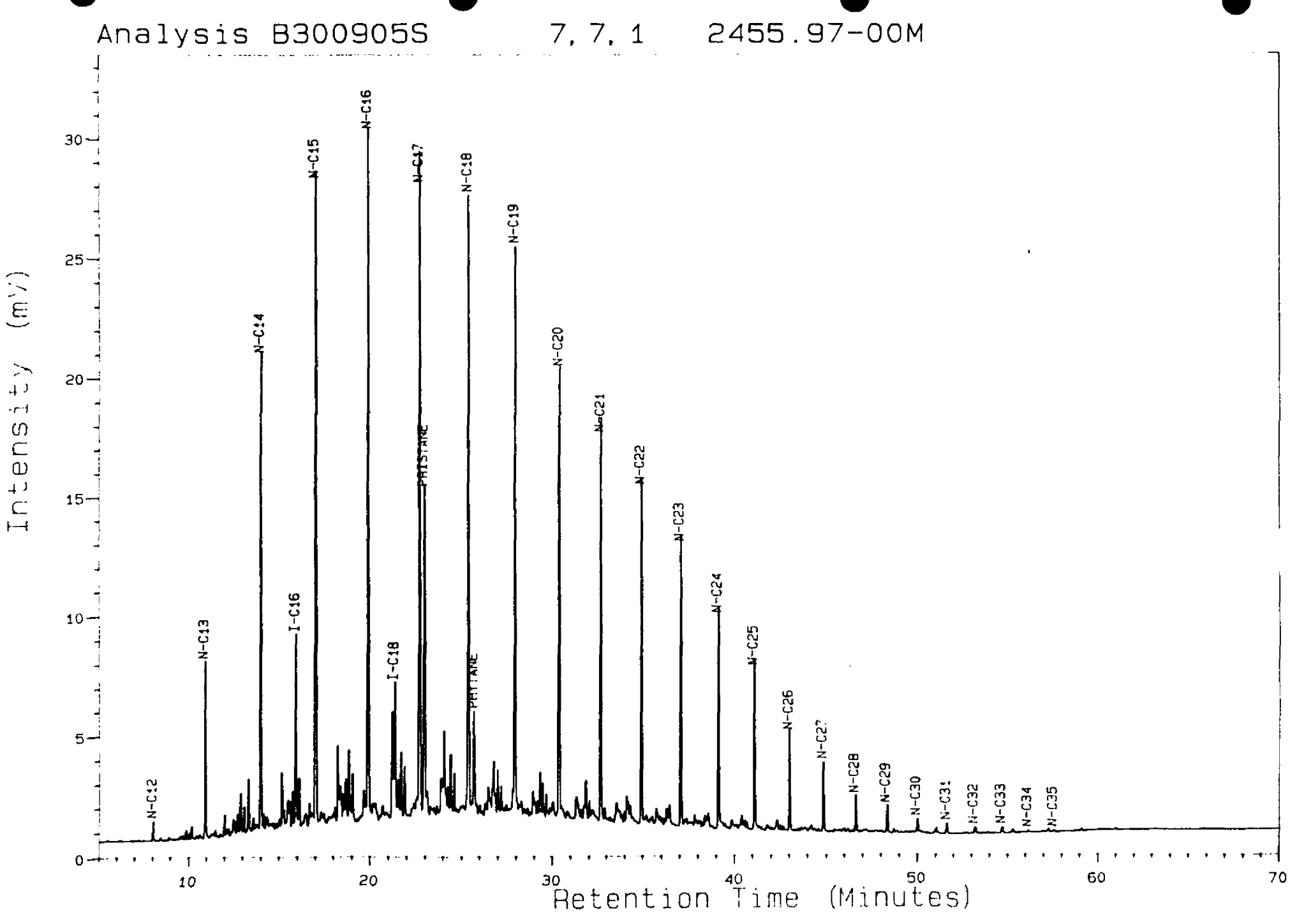

Analysis A300905S 7, 7, 1 2257M
Intensity (mV)
Retention Time (Minutes)
N-C14
I-C16
N-C15
N-C16
I-C18
N-C17
PRISTANE
N-C18
PHYTANE
N-C19
N-C20
N-C21
N-C22
N-C23
N-C24
N-C25
N-C26
N-C27
N-C28
N-C29
N-C30
N-C31
N-C32
N-C33
N-C34

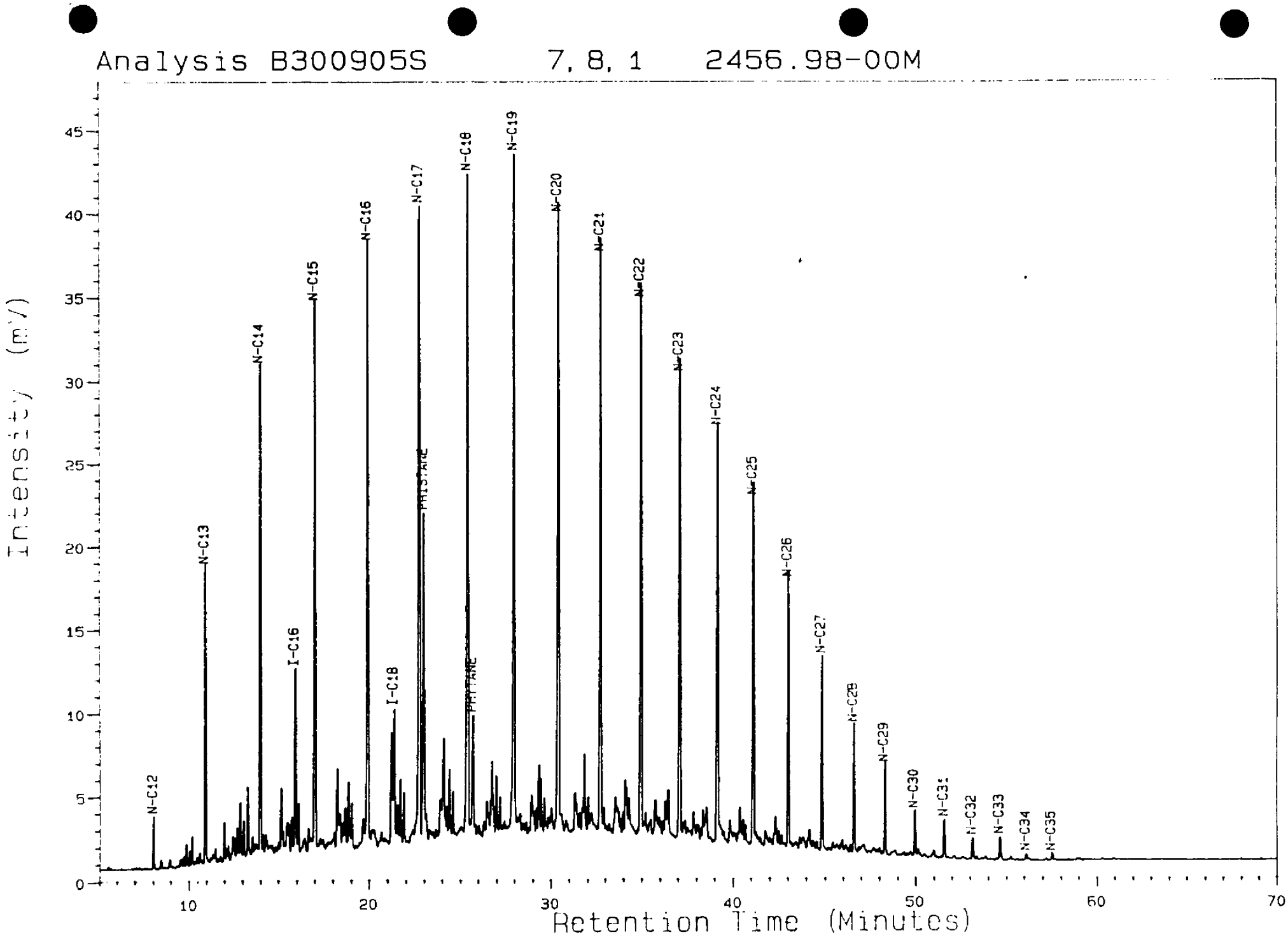

Analysis A300905S 7, 8, 1 2447M
Intensity (mV)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
N-C15
N-C16
I-C18
N-C17
PRISTANE
N-C18
PHYTANE
N-C19
N-C20
N-C21
N-C22
N-C23
N-C24
N-C25
N-C26
N-C27
N-C28
N-C29
N-C30
N-C31
N-C32
10
20
30
40
50
60
70
Retention Time (Minutes)

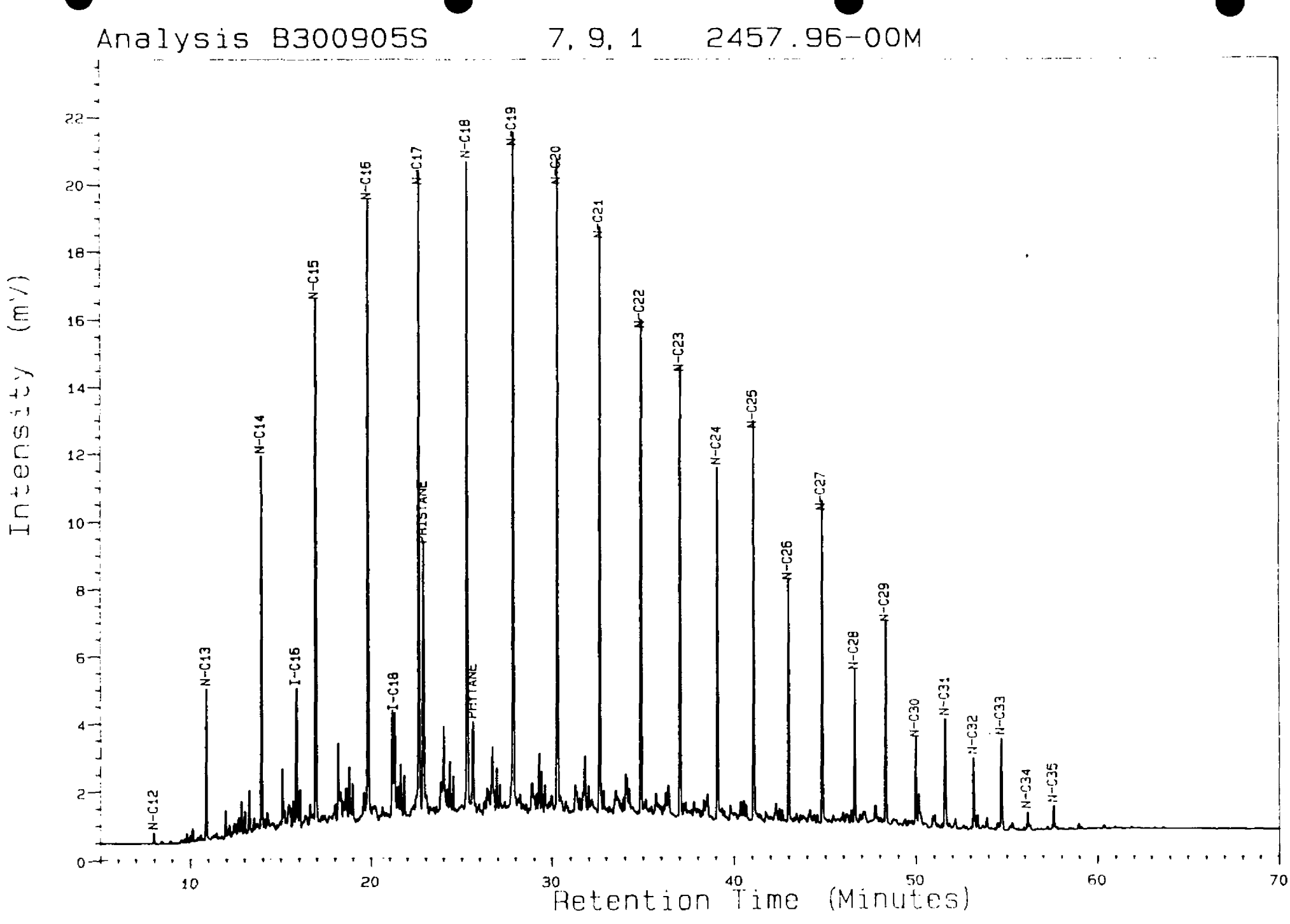

Analysis A300905S 7, 9, 1 2450M
Intensity (mV)
Retention Time (Minutes)
N-C16
I-C18
N-C17
PRISTANE
N-C18
PHYTANE
N-C19
N-C20
N-C21
N-C22
N-C23
N-C24
N-C25
N-C26
N-C27
N-C28
N-C29
N-C30
N-C31
N-C32
N-C33
N-C35

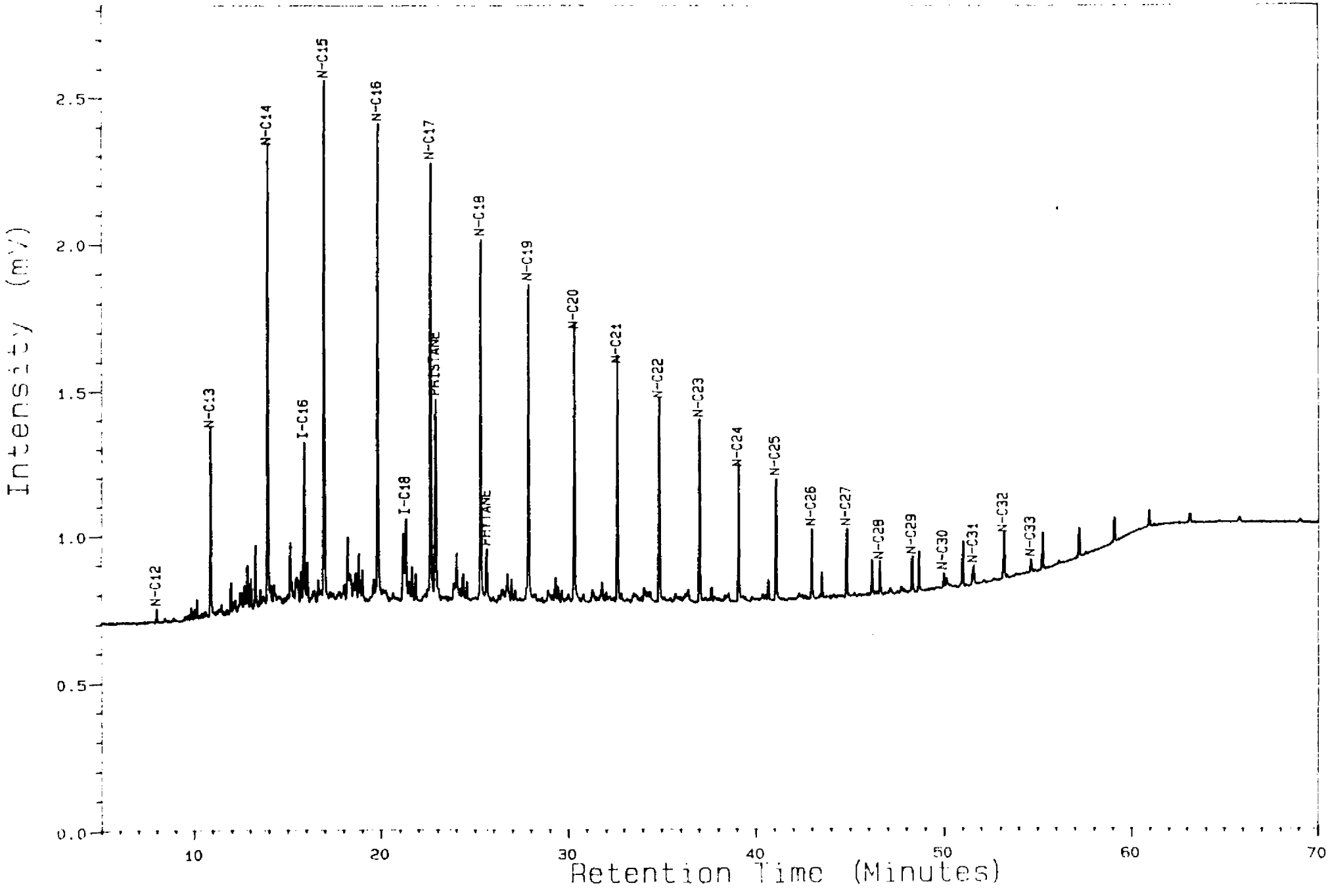

Analysis B300905S 7, 5, 1 2455M
Intensity (mV)
2.0
1.5
1.0
0.5
0.0
N-C17
PRISTANE
N-C18
PHYTANE
N-C19
N-C20
N-C21
N-C22
N-C23
N-C24
N-C25
N-C26
N-C27
N-C28
N-C29
N-C30
N-C31
N-C32
10
20
30
40
50
60
70
Retention Time (Minutes)

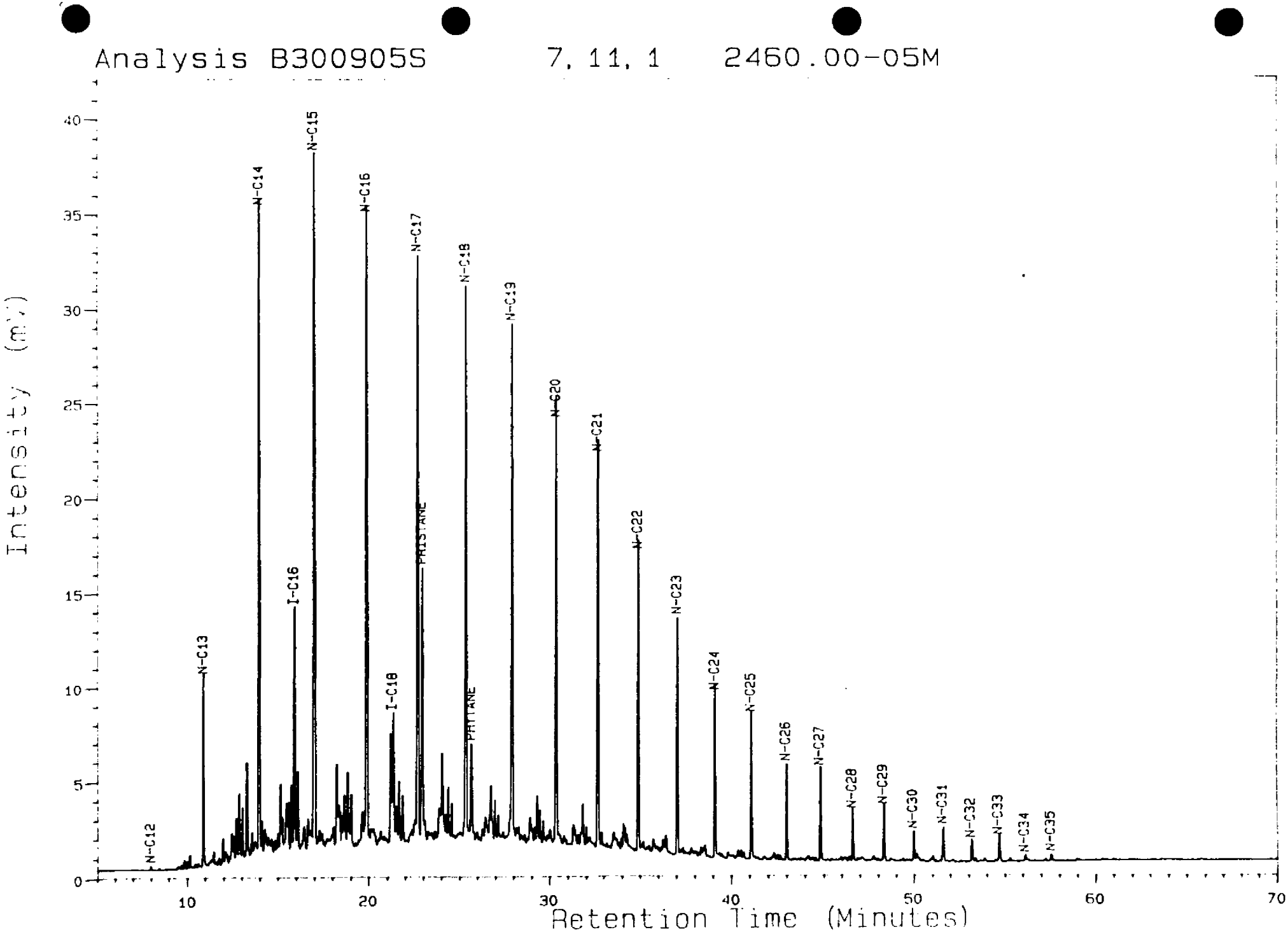

Analysis B300905S 7, 6, 1 2455.00-03M
Intensity (mV)
Retention Time (Minutes)
N-C12
N-C13
N-C14
I-C16
N-C15
N-C16
I-C18
N-C17
PRISTANE
N-C18
PHYTANE
N-C19
N-C20
N-C21
N-C22
N-C23
N-C24
N-C25
N-C26
N-C27
N-C28
N-C29
N-C30
N-C31
N-C32
N-C33
N-C34
N-C35

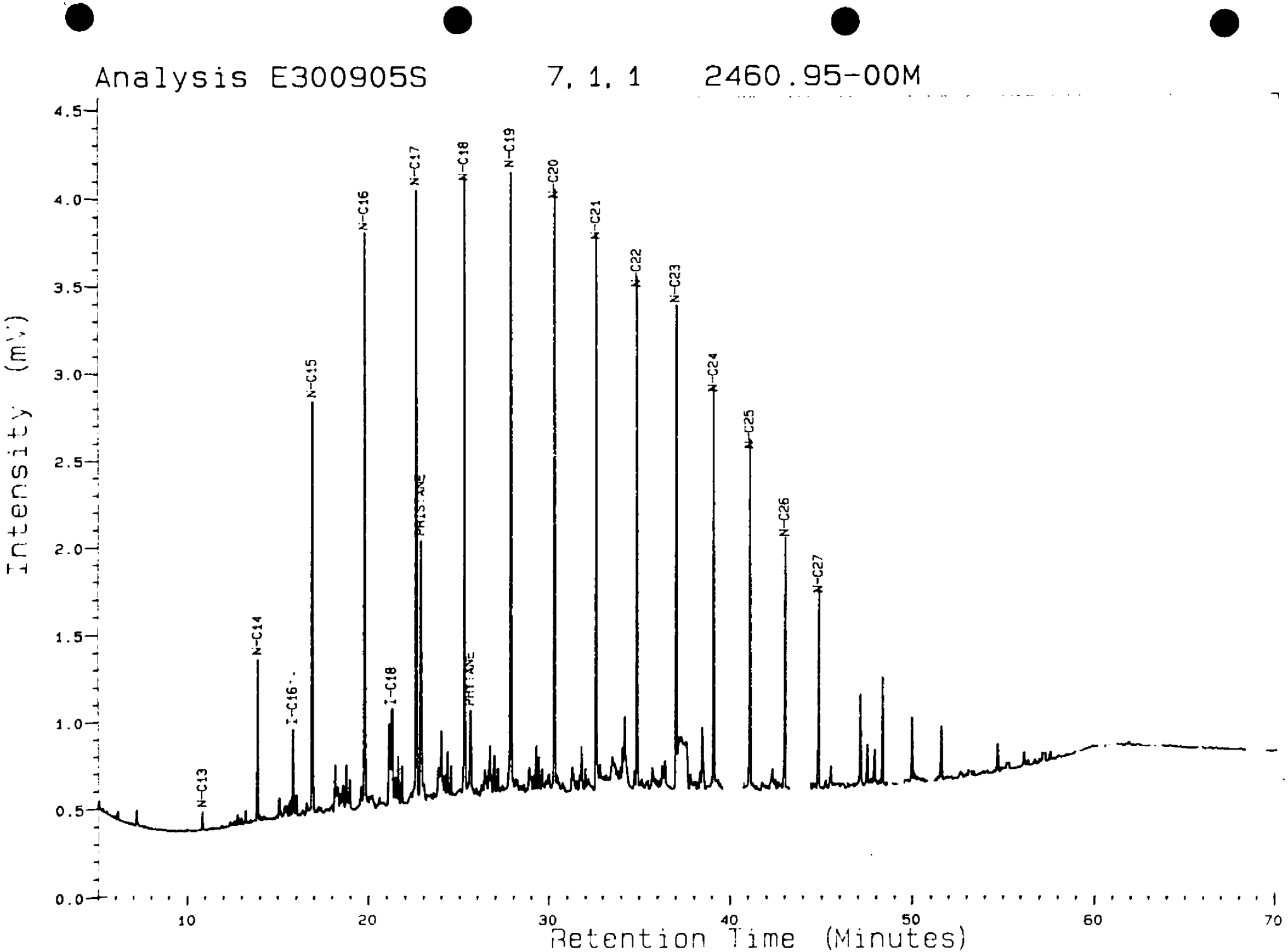

Analysis B300905S 7, 7, 1 2455.97-00M
Intensity (mV)
Retention Time (Minutes)
N-C12
N-C13
N-C14
I-C16
N-C15
N-C16
I-C18
N-C17
PRISTANE
PHYTANE
N-C18
N-C19
N-C20
N-C21
N-C22
N-C23
N-C24
N-C25
N-C26
N-C27
N-C28
N-C29
N-C30
N-C31
N-C32
N-C33
N-C34
N-C35


Analysis B300905S 7, 8, 1 2456.98-00M
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
N-C35

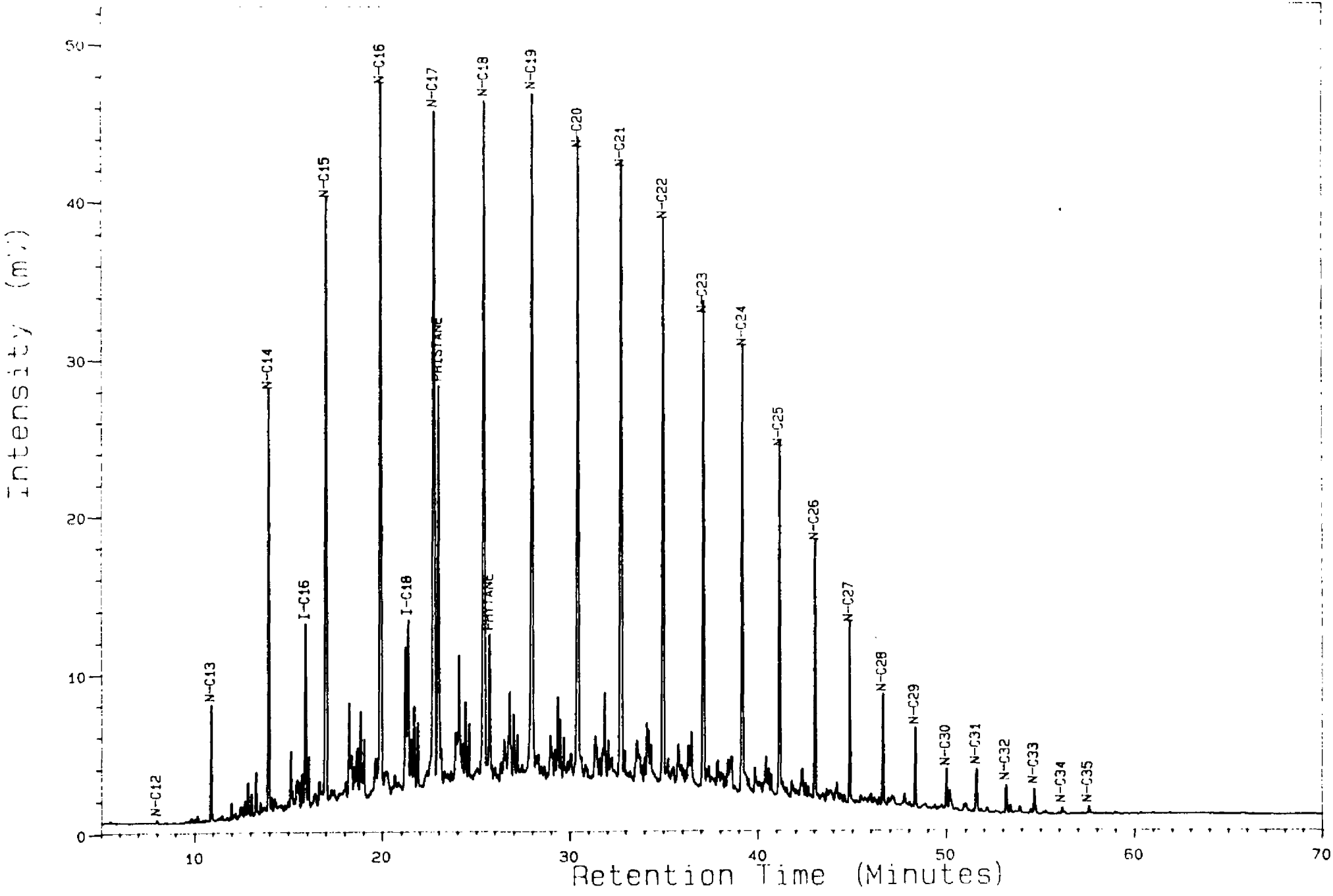

Analysis B300905S 7, 9, 1 2457.96-00M
Intensity (mV)
Retention Time (Minutes)
N-C12
N-C13
N-C14
I-C15
N-C15
I-C16
N-C16
I-C18
N-C17
PRISTANE
N-C18
PHYTANE
N-C19
N-C20
N-C21
N-C22
N-C23
N-C24
N-C25
N-C26
N-C27
N-C28
N-C29
N-C30
N-C31
N-C32
N-C33
N-C34
N-C35

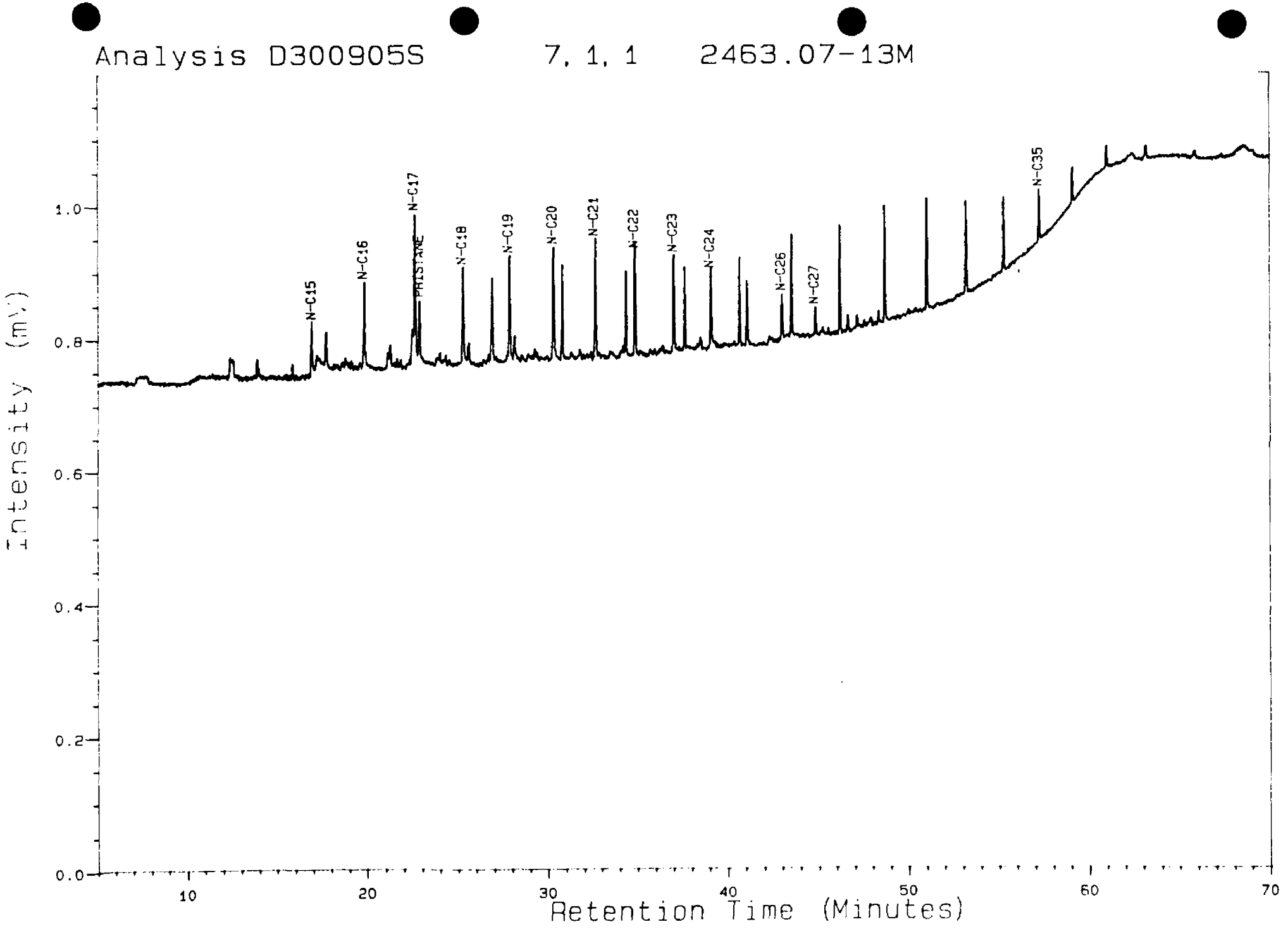

Analysis B300905S 7, 10, 1 2458.65-69M
Intensity (mV)
2.5
2.0
1.5
1.0
0.5
0.0
N-C12
N-C13
N-C14
N-C15
I-C16
N-C16
I-C18
N-C17
PRISTANE
PHYTANE
N-C18
N-C19
N-C20
N-C21
N-C22
N-C23
N-C24
N-C25
N-C26
N-C27
N-C28
N-C29
N-C30
N-C31
N-C32
N-C33
10
20
30
40
50
60
70
Retention Time (Minutes)

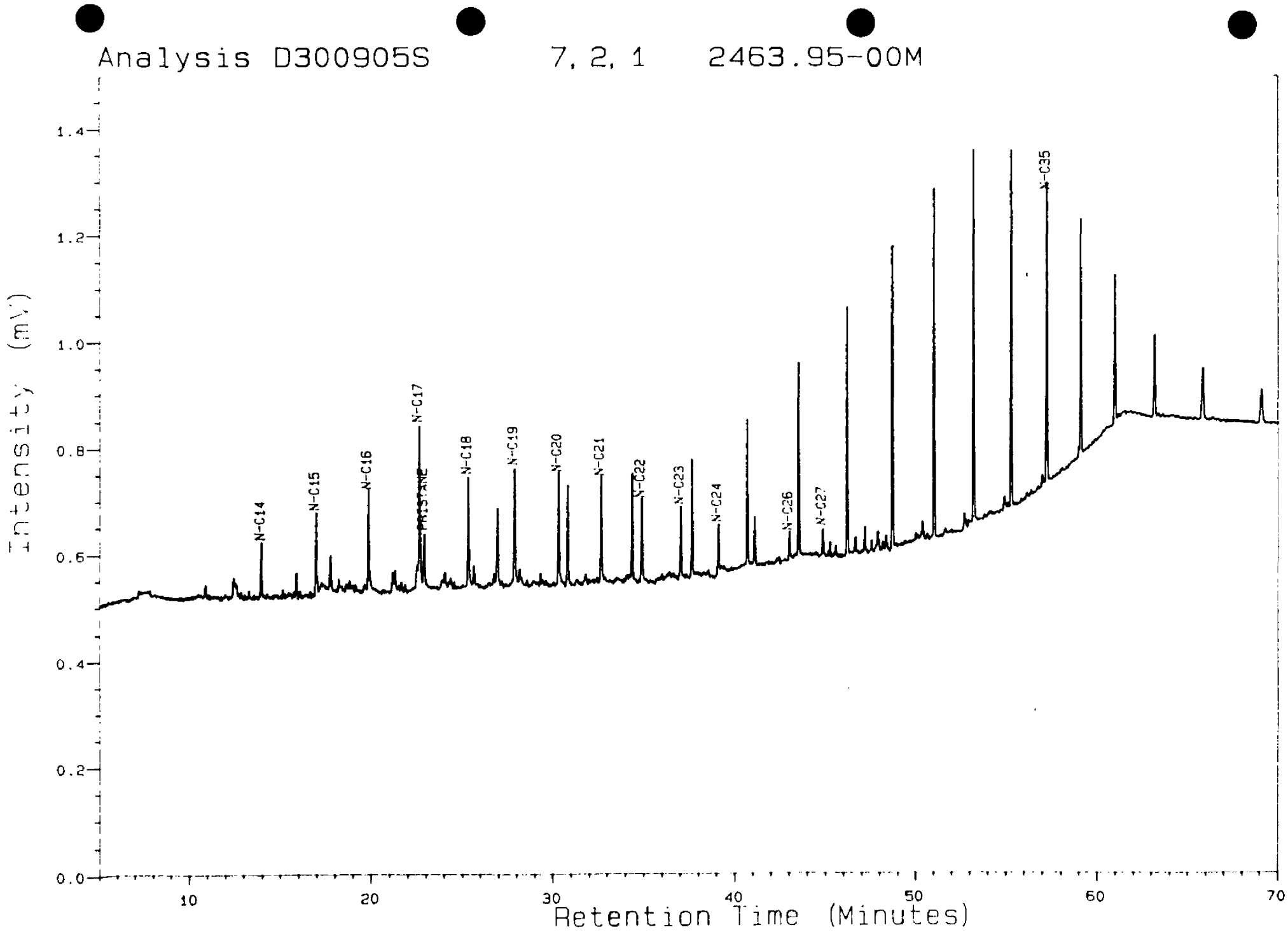

Analysis B300905S 7, 11, 1 2460.00-05M
Intensity (mV)
Retention Time (Minutes)
N-C12
N-C13
I-C16
N-C14
N-C15
N-C16
I-C18
N-C17
PRISTANE
PHYTANE
N-C18
N-C19
N-C20
N-C21
N-C22
N-C23
N-C24
N-C25
N-C26
N-C27
N-C28
N-C29
N-C30
N-C31
N-C32
N-C33
N-C34
N-C35

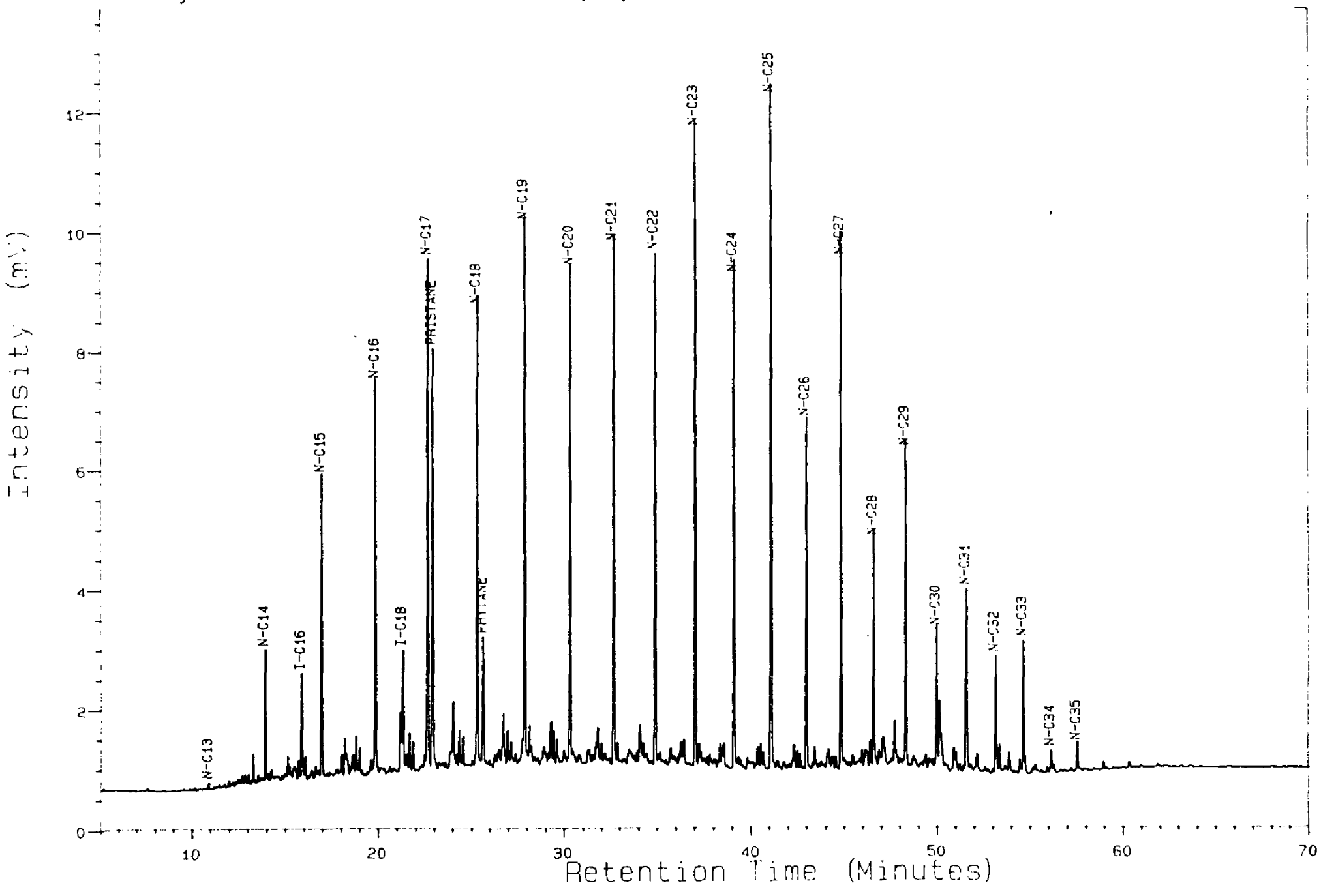

Analysis E300905S 7, 1, 1 2460.95-00M
Intensity (mV)
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
N-C13
N-C14
i-C16
N-C15
N-C16
i-C18
N-C17
PRISTANE
N-C18
PHYTANE
N-C19
N-C20
N-C21
N-C22
N-C23
N-C24
N-C25
N-C26
N-C27
10
20
30
40
50
60
70
Retention Time (Minutes)

Analysis B300905S 7, 13, 1 2461.96-00M




Analysis D300905S 7, 1, 1 2463.07-13M
N-C15
N-C16
PRISTANE
N-C17
N-C18
N-C19
N-C20
N-C21
N-C22
N-C23
N-C24
N-C26
N-C27
N-C35
Intensity (mV)
0.0
0.2
0.4
0.6
0.8
1.0
10
20
30
40
50
60
70
Retention Time (Minutes)


Analysis D300905S 7, 2, 1 2463.95-00M
Intensity (mV)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
N-C14
N-C15
N-C16
N-C17
PRISTANE
N-C18
N-C19
N-C20
N-C21
N-C22
N-C23
N-C24
N-C26
N-C27
N-C35
10
20
30
40
50
60
70
Retention Time (Minutes)

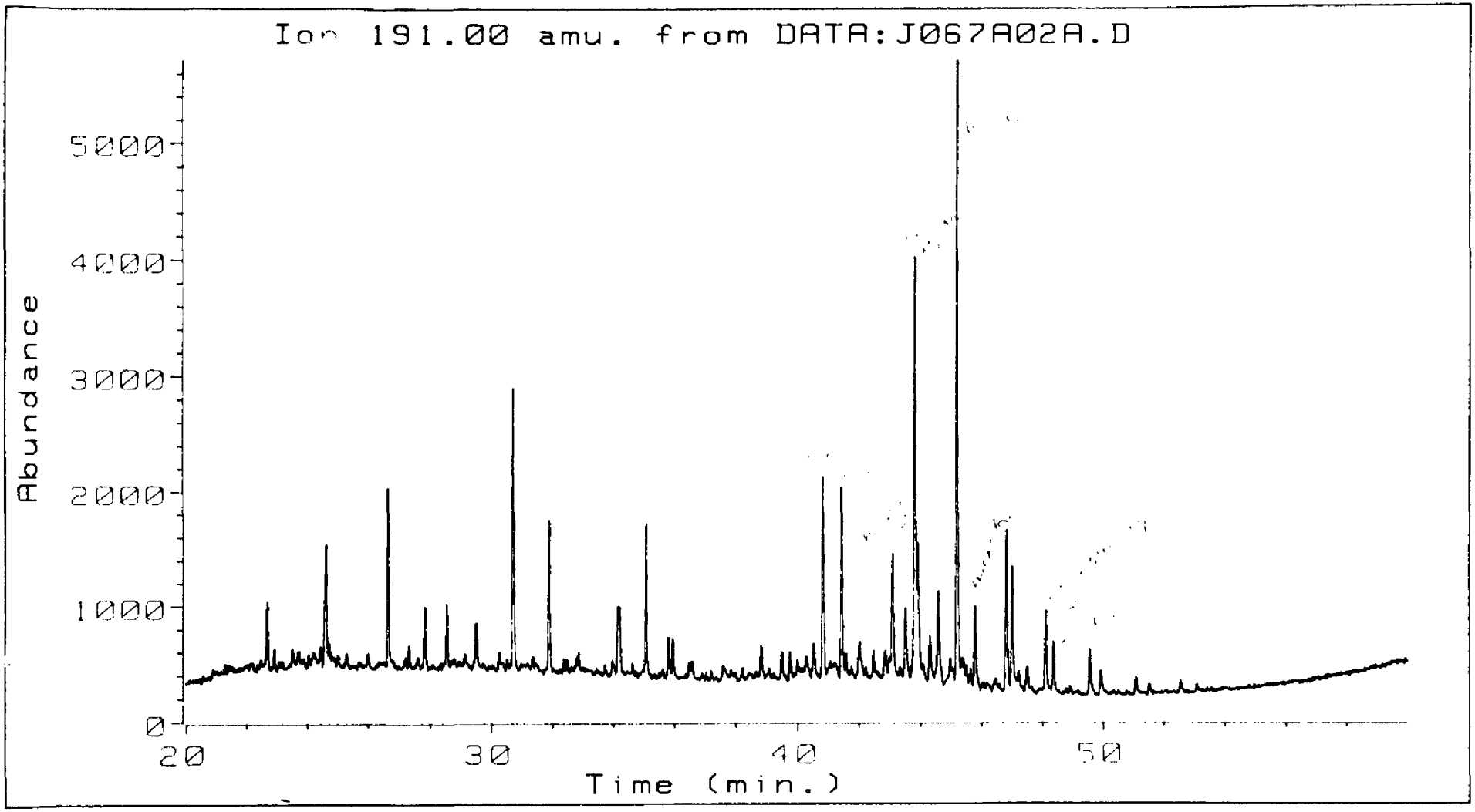

Analysis D300905S 7, 3, 1 2466.20-24M
Intensity (mV)
Retention Time (Minutes)
N-C13
N-C14
I-C16
N-C15
N-C16
I-C18
PRISTANE
N-C17
PHYTANE
N-C18
N-C19
N-C20
N-C21
N-C22
N-C23
N-C24
N-C25
N-C26
N-C27
N-C28
N-C29
N-C30
N-C31
N-C32
N-C33
N-C34
N-C35

APPENDIX II

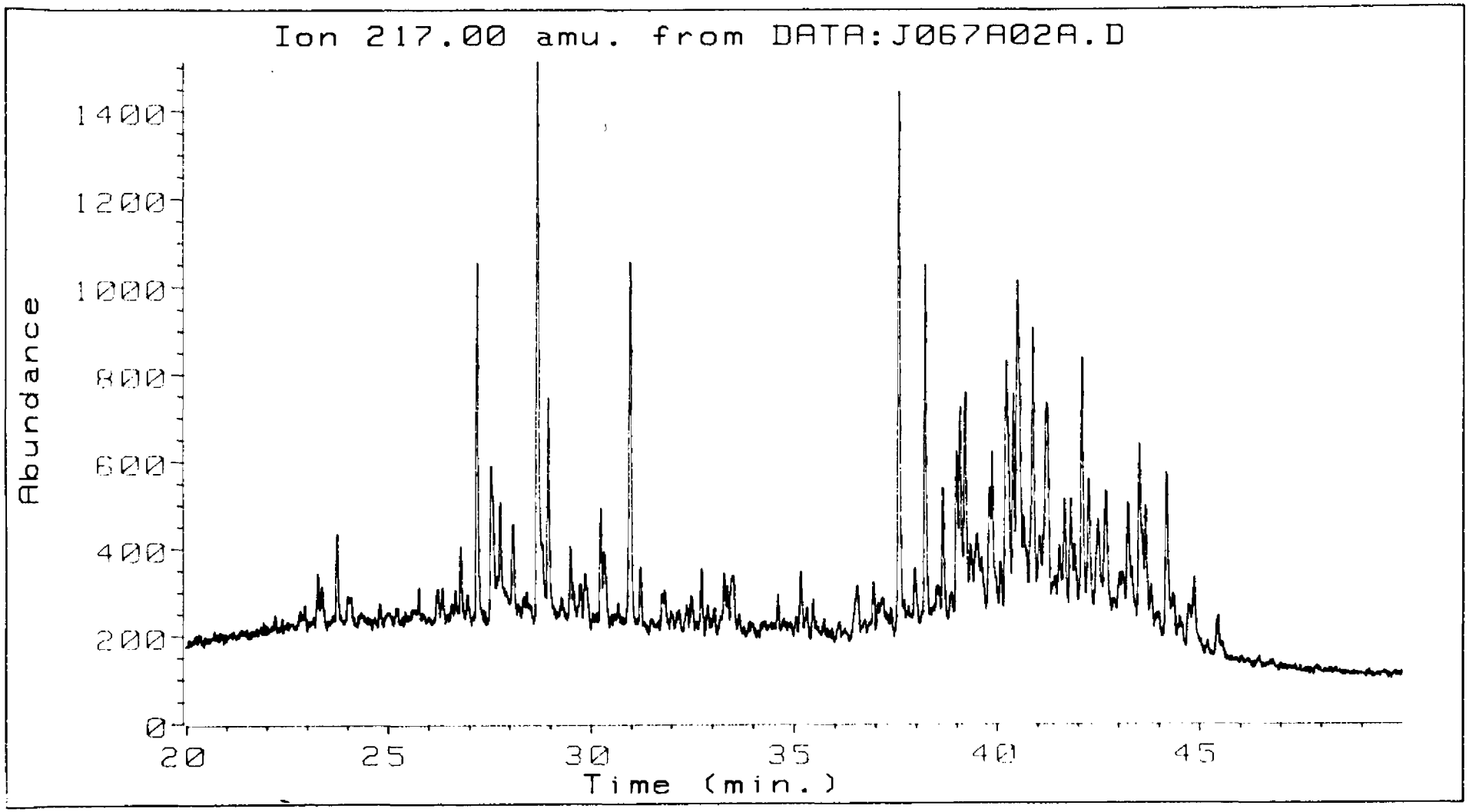
GC-MS Fragmentograms of Steranes and Triterpanes

THE FOLLOWING PAGES ARE

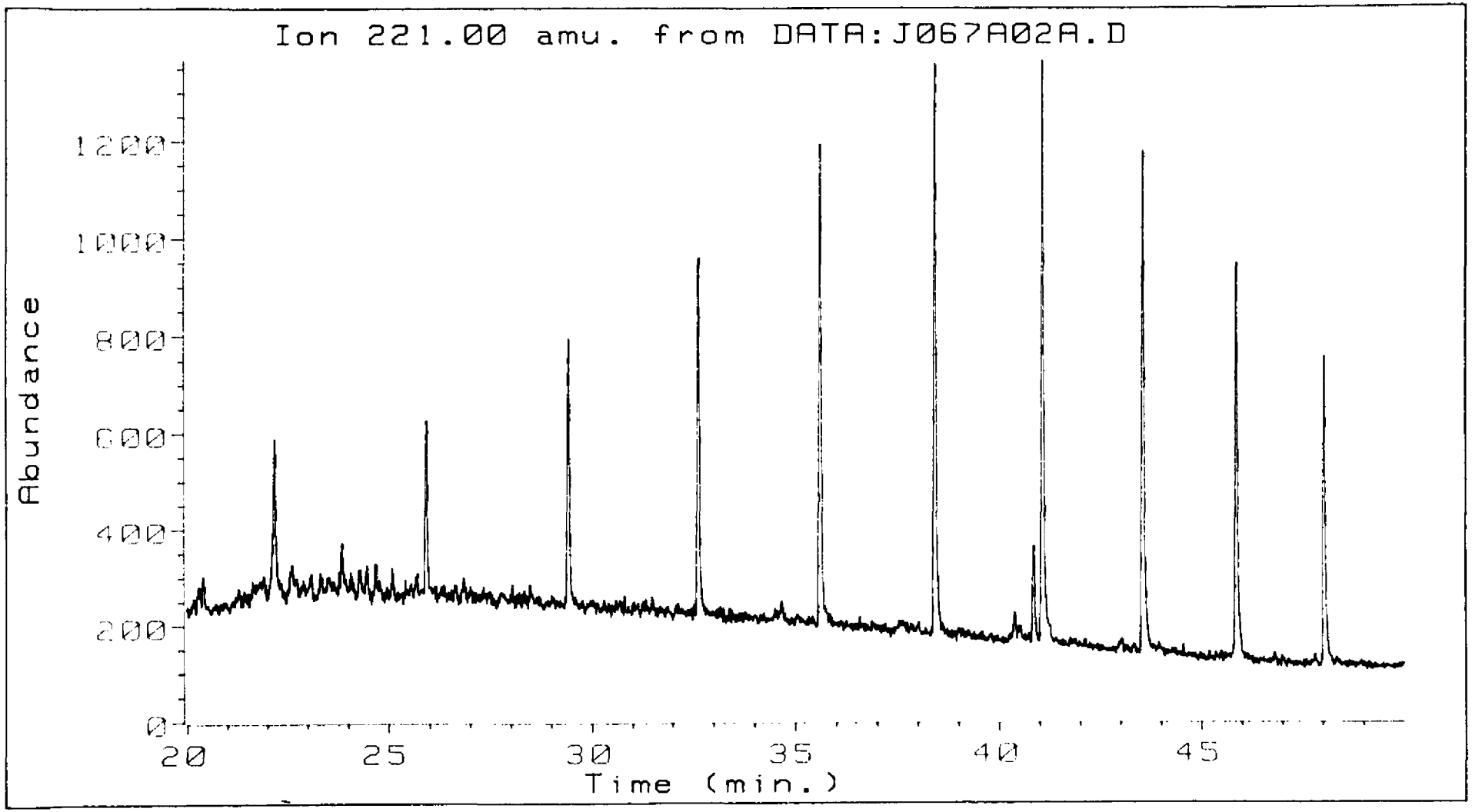
"POOR QUALITY ORIGINALS"



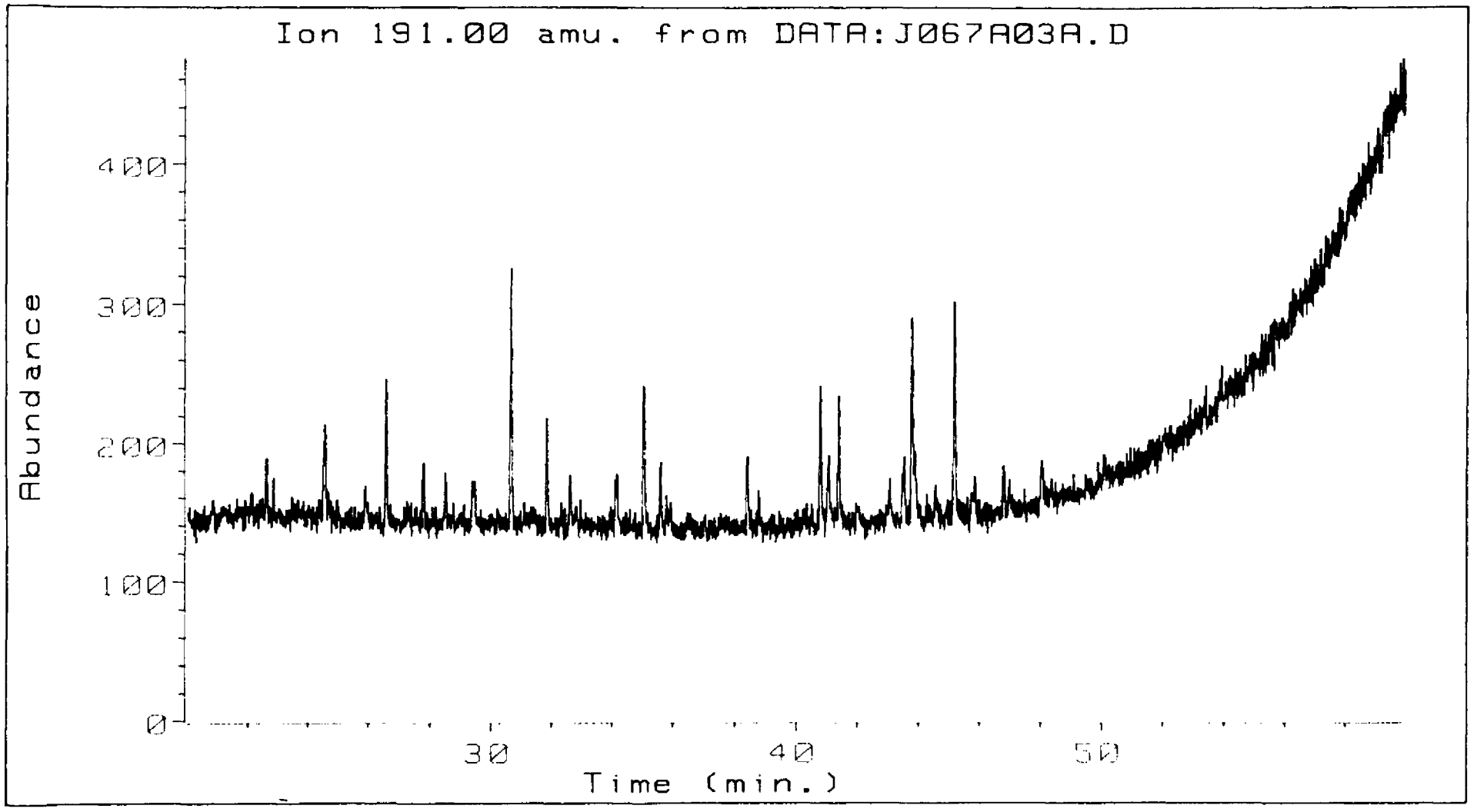
2235m


Ion 217.00 amu. from DATA:J067A02A.D
Abundance
1400
1200
1000
800
600
400
200
0
20
25
30
35
40
45
Time (min.)

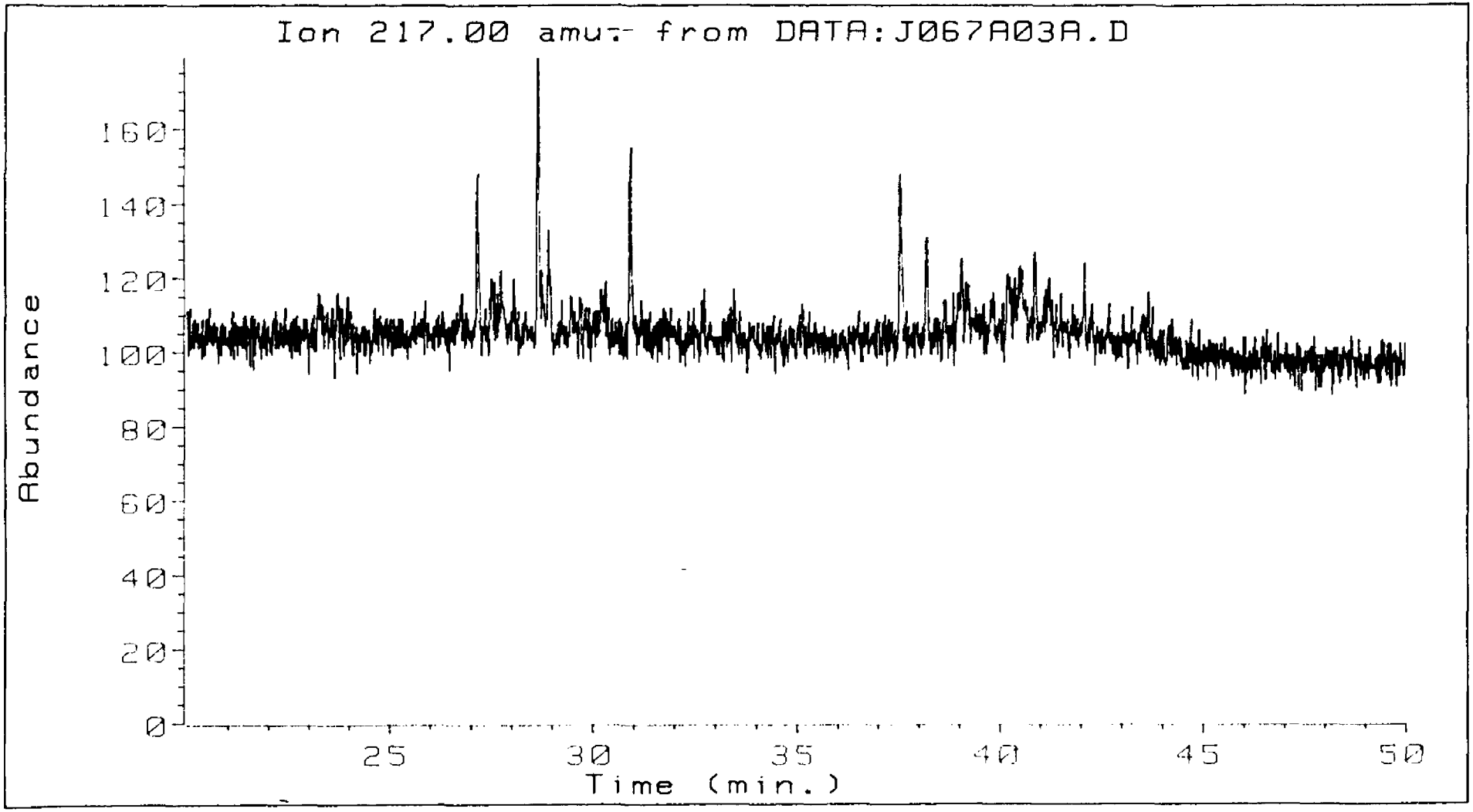
2235m


Ion 221.00 amu. from DATA:J067A02A.D
Abundance
1200
1000
800
600
400
200
0
20
25
30
35
40
45
Time (min.)

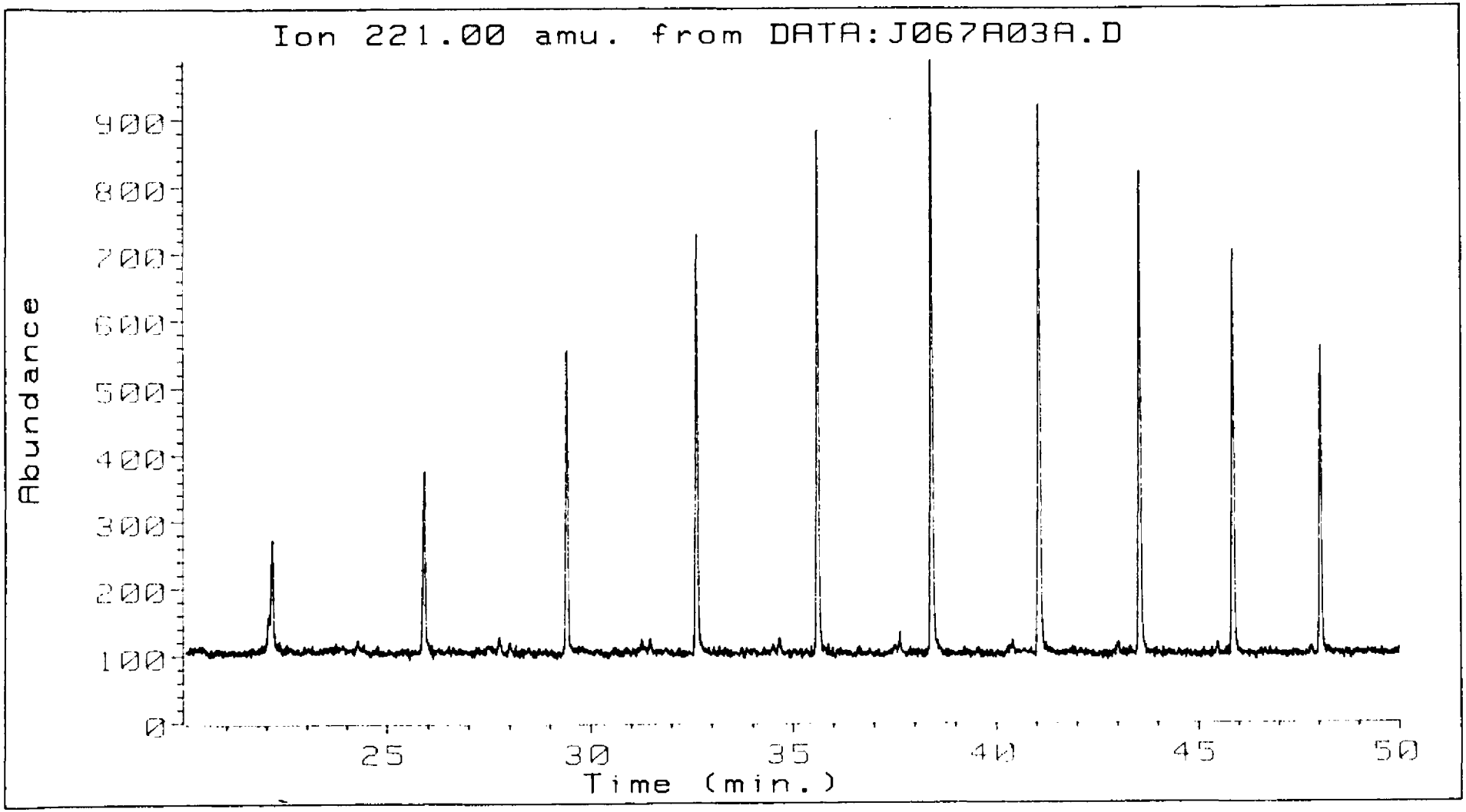
2235m


Ion 191.00 amu. from DATA:J067A03A.D
Abundance
400
300
200
100
0
30
40
50
Time (min.)

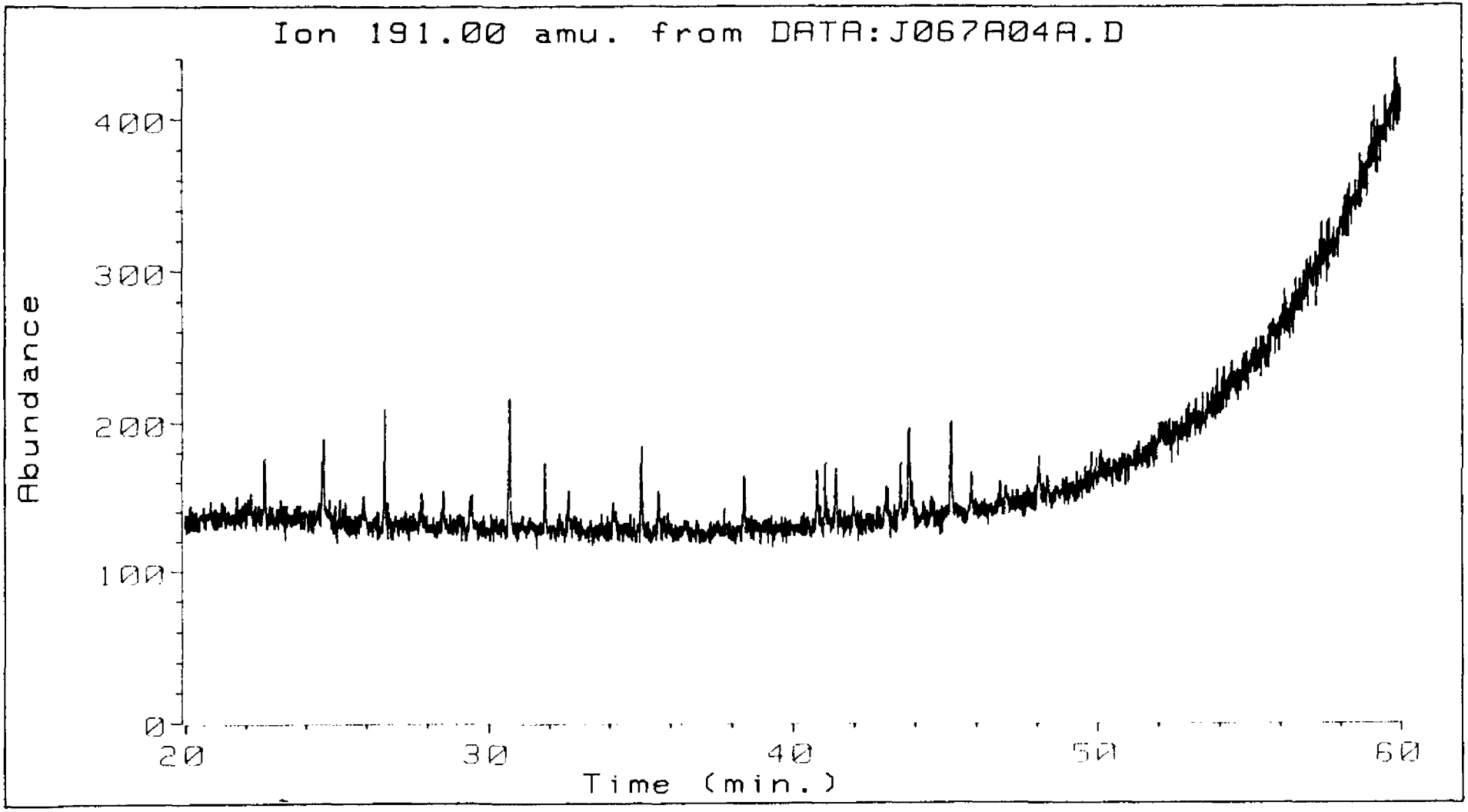
2247m


Ion 217.00 amu: from DATA:J067A03A.D
Abundance
160
140
120
100
80
60
40
20
0
25
30
35
40
45
50
Time (min.)

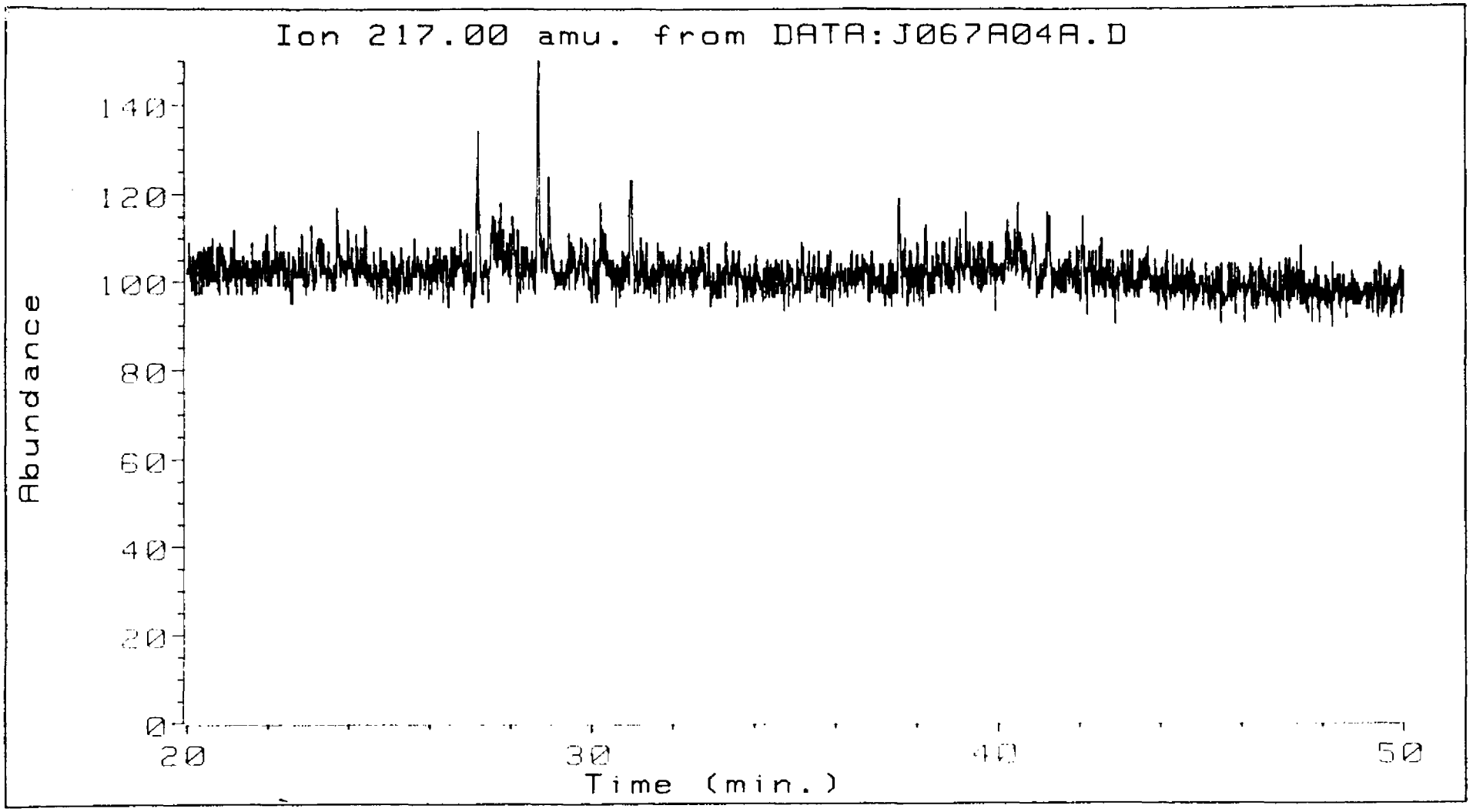
2247m


Ion 221.00 amu. from DATA:J067A03A.D
Abundance
900
800
700
600
500
400
300
200
100
0
25
30
35
40
45
50
Time (min.)

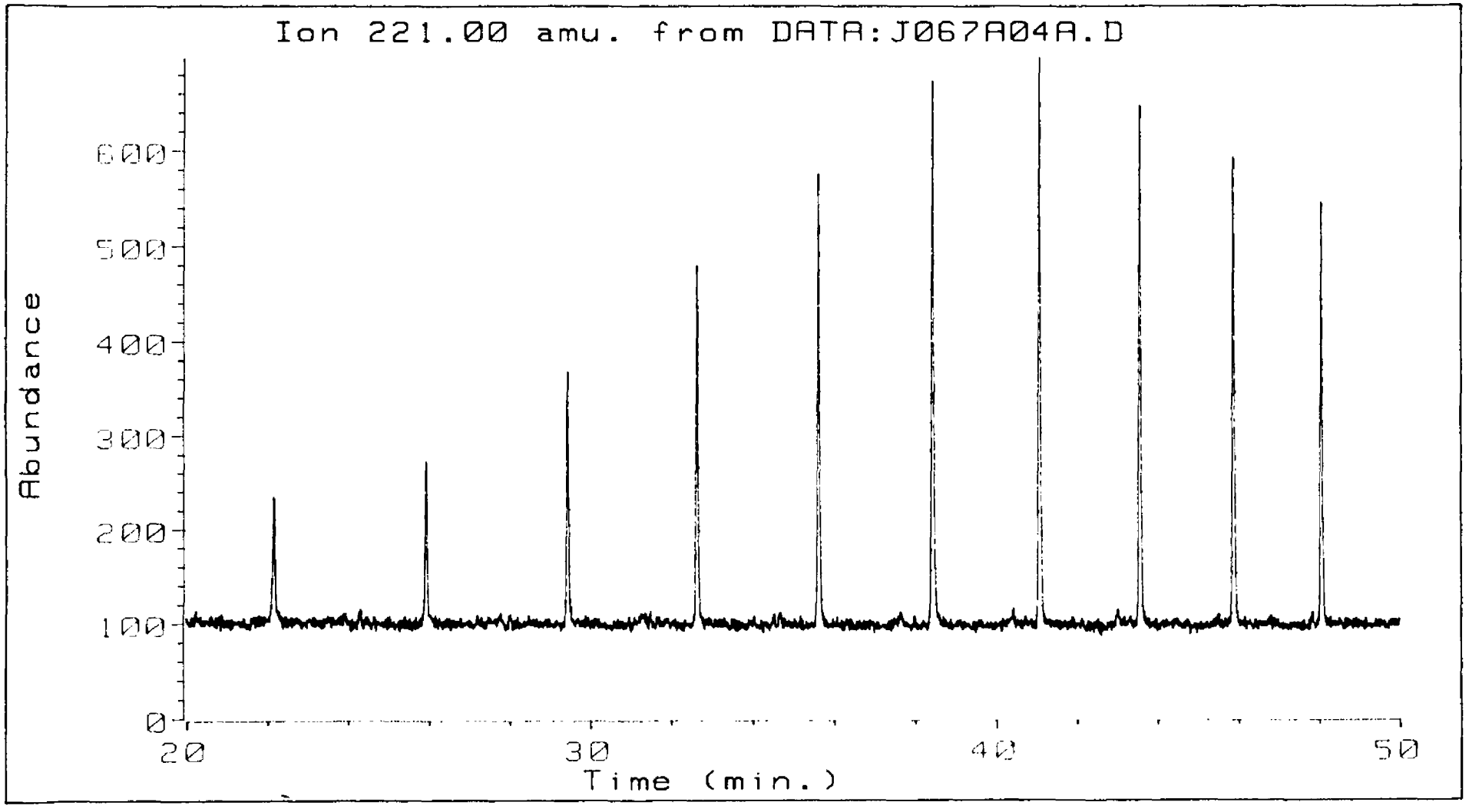
2247m


Ion 191.00 amu. from DATA:J067A04A.D
Abundance
400
300
200
100
0
20
30
40
50
60
Time (min.)

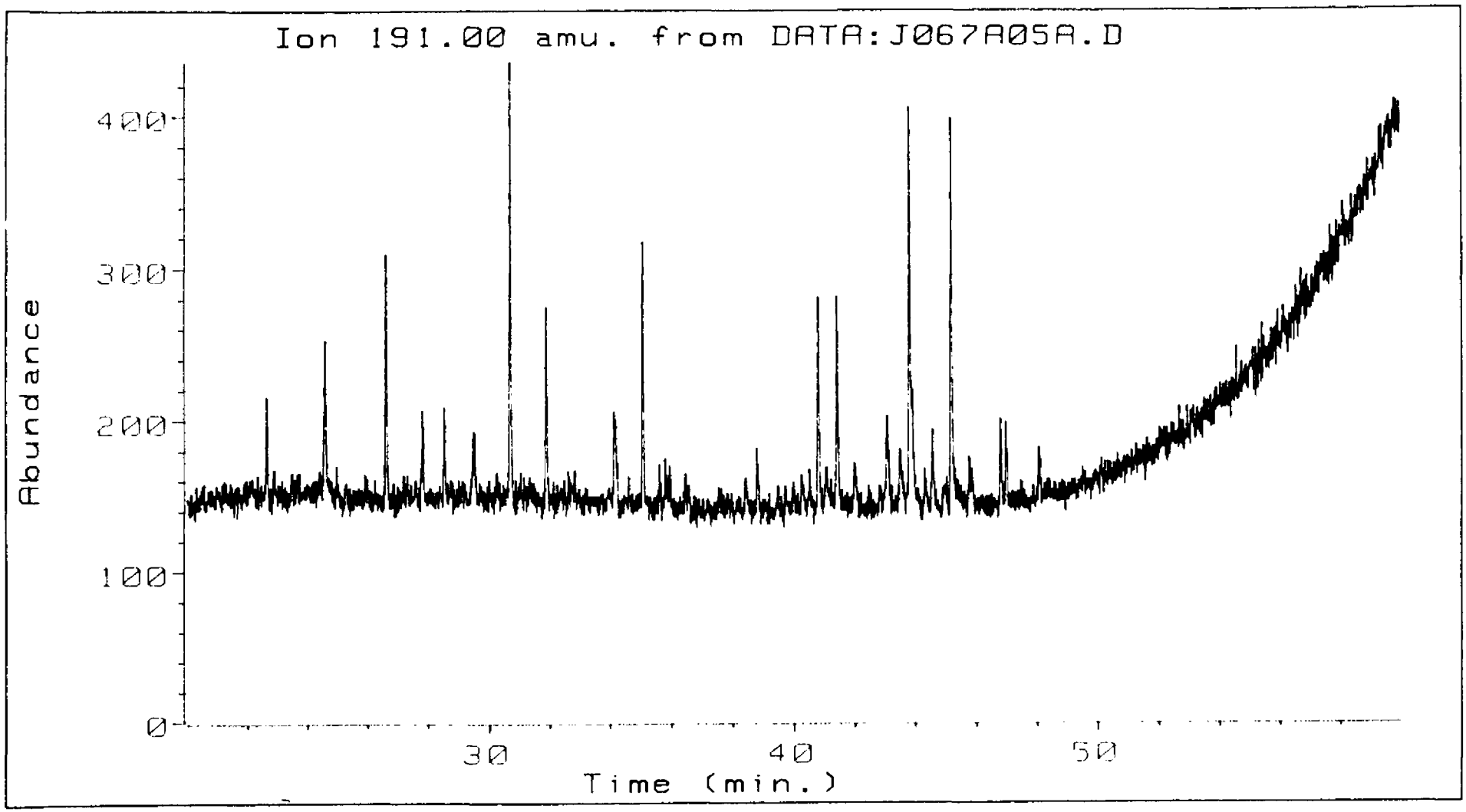
2250m


Ion 217.00 amu. from DATA:J067A04A.D
Abundance
140
120
100
80
60
40
20
0
20
30
40
50
Time (min.)

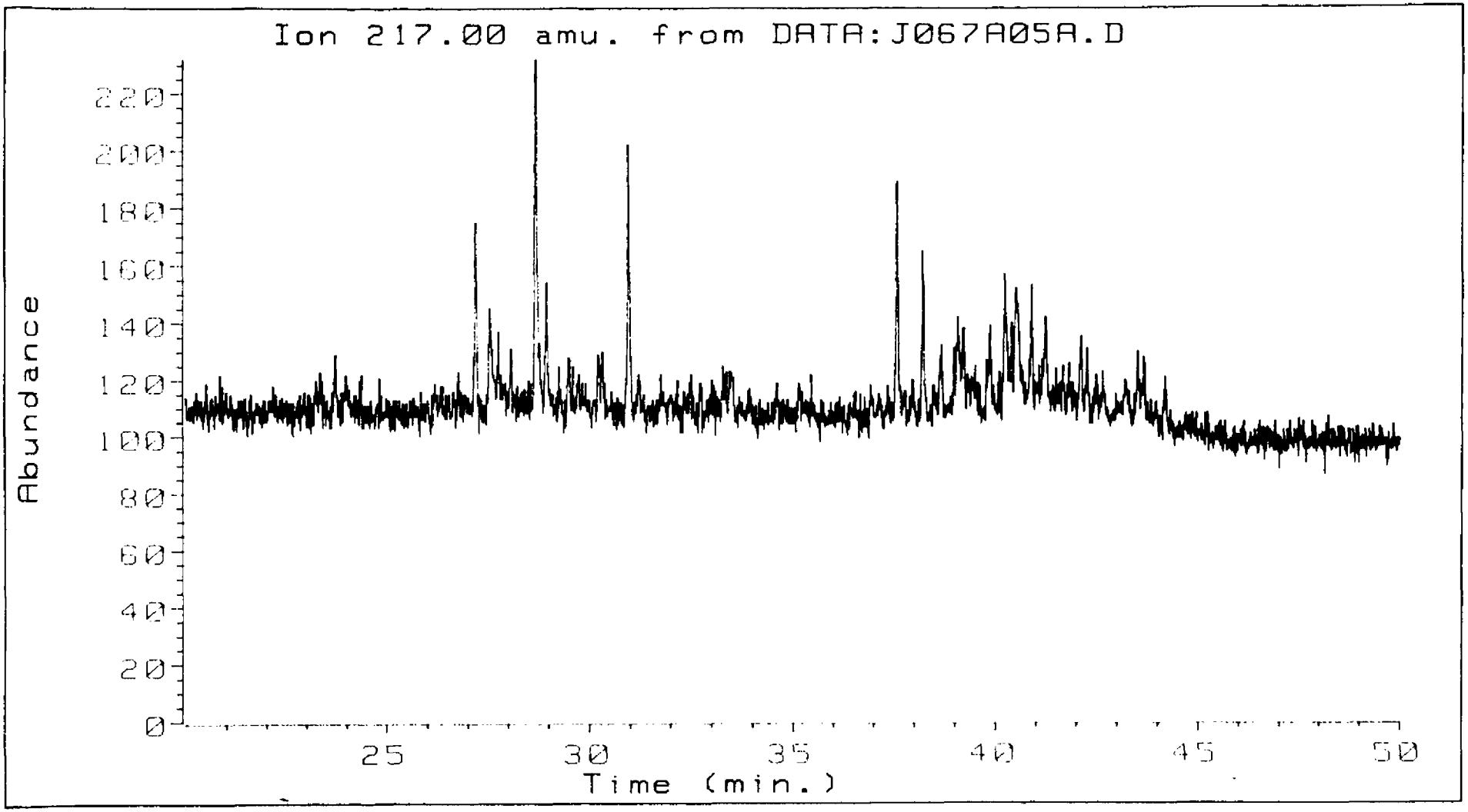
2250m


Ion 221.00 amu. from DATA:J067A04A.D
Abundance
600
500
400
300
200
100
0
20
30
40
50
Time (min.)

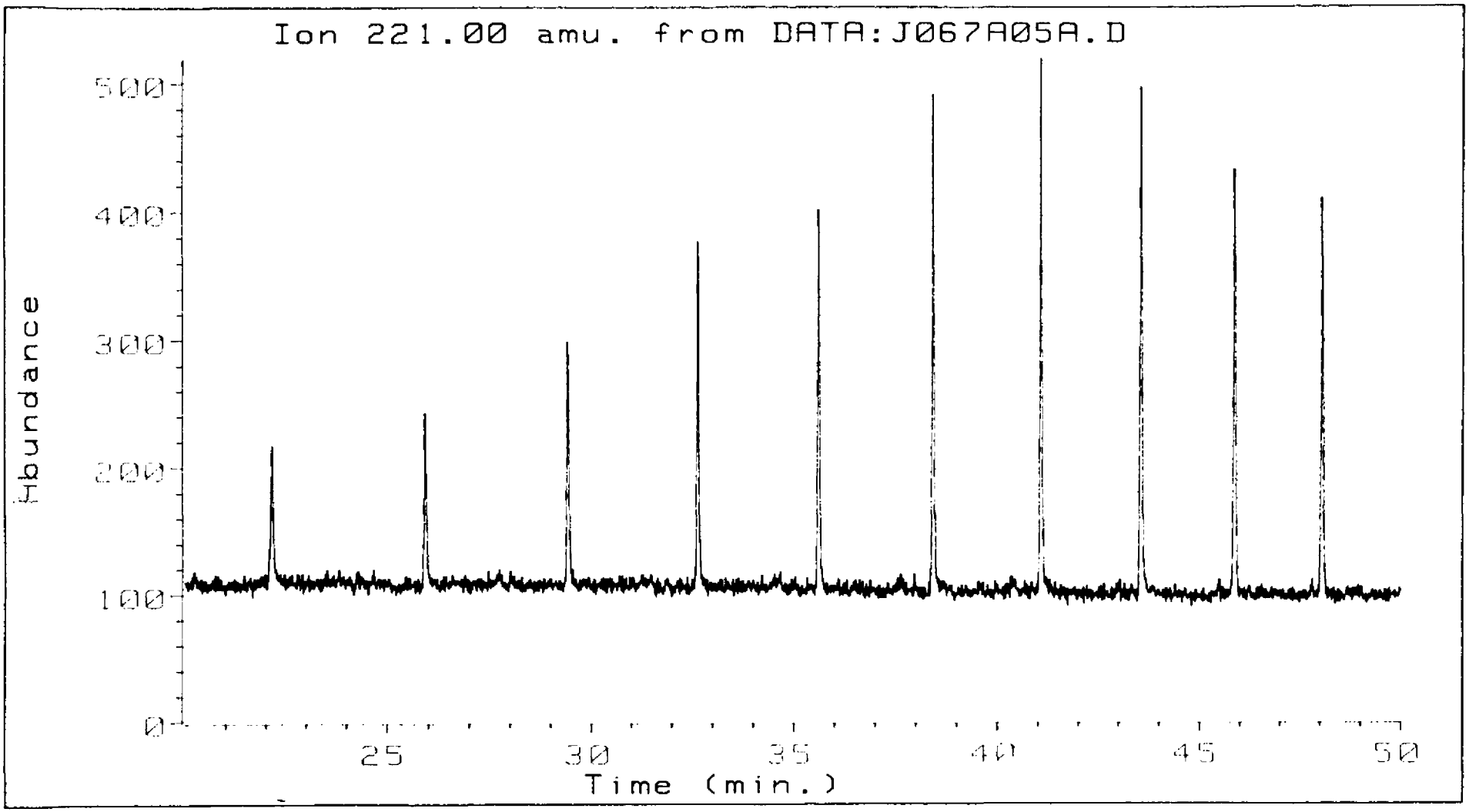
2250m


Ion 191.00 amu. from DATA:J067A05A.D
Abundance
400
300
200
100
0
30
40
50
Time (min.)

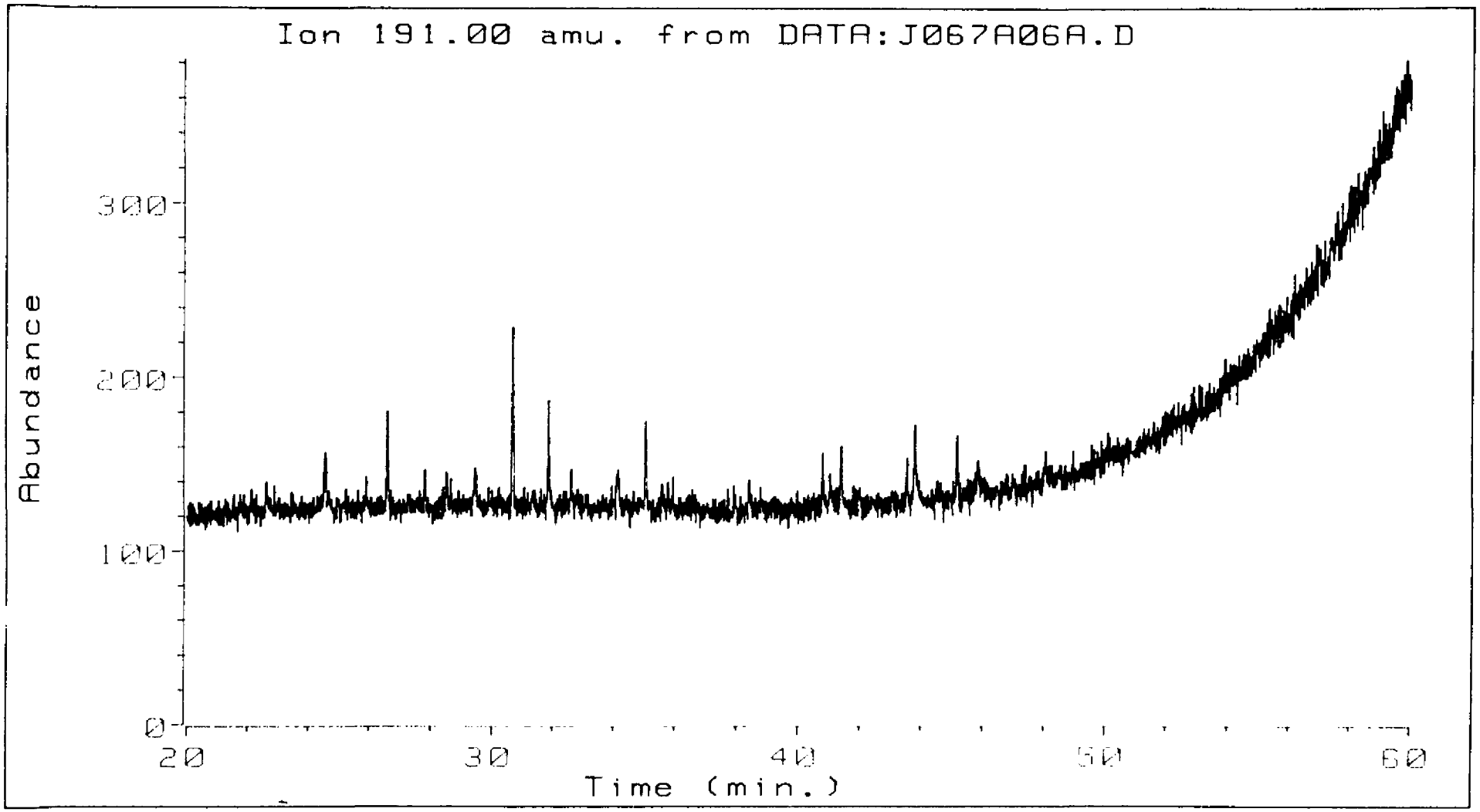
2252m


Ion 217.00 amu. from DATA:J067A05A.D
Abundance
220
200
180
160
140
120
100
80
60
40
20
0
25
30
35
40
45
50
Time (min.)

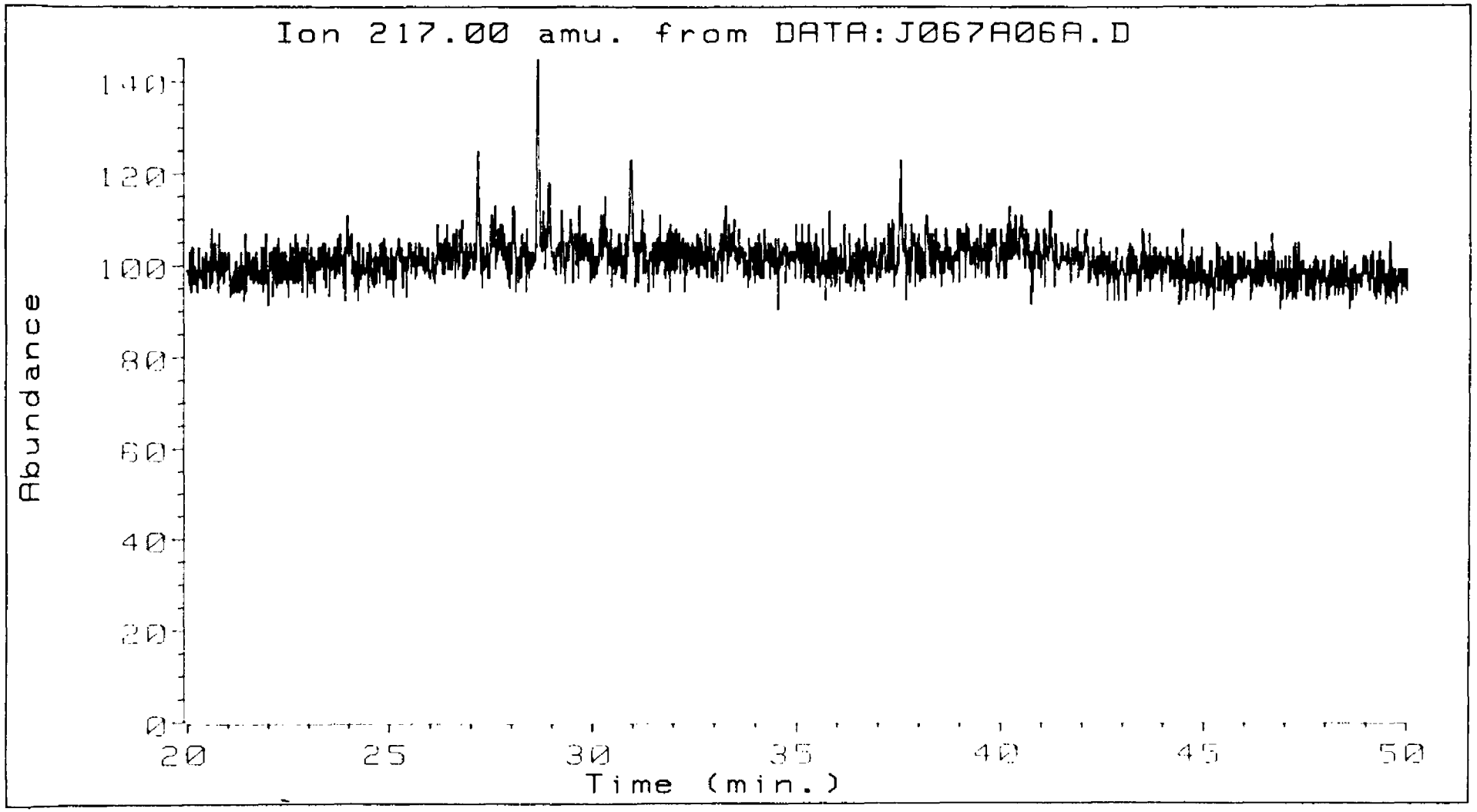
2252m


Ion 221.00 amu. from DATA:J067A05A.D
Abundance
500
400
300
200
100
0
25
30
35
40
45
50
Time (min.)

2252m


Ion 191.00 amu. from DATA:J067A06A.D
Abundance
300
200
100
0
20
30
40
50
60
Time (min.)

2255m


Ion 217.00 amu. from DATA:J067A06A.D
Abundance
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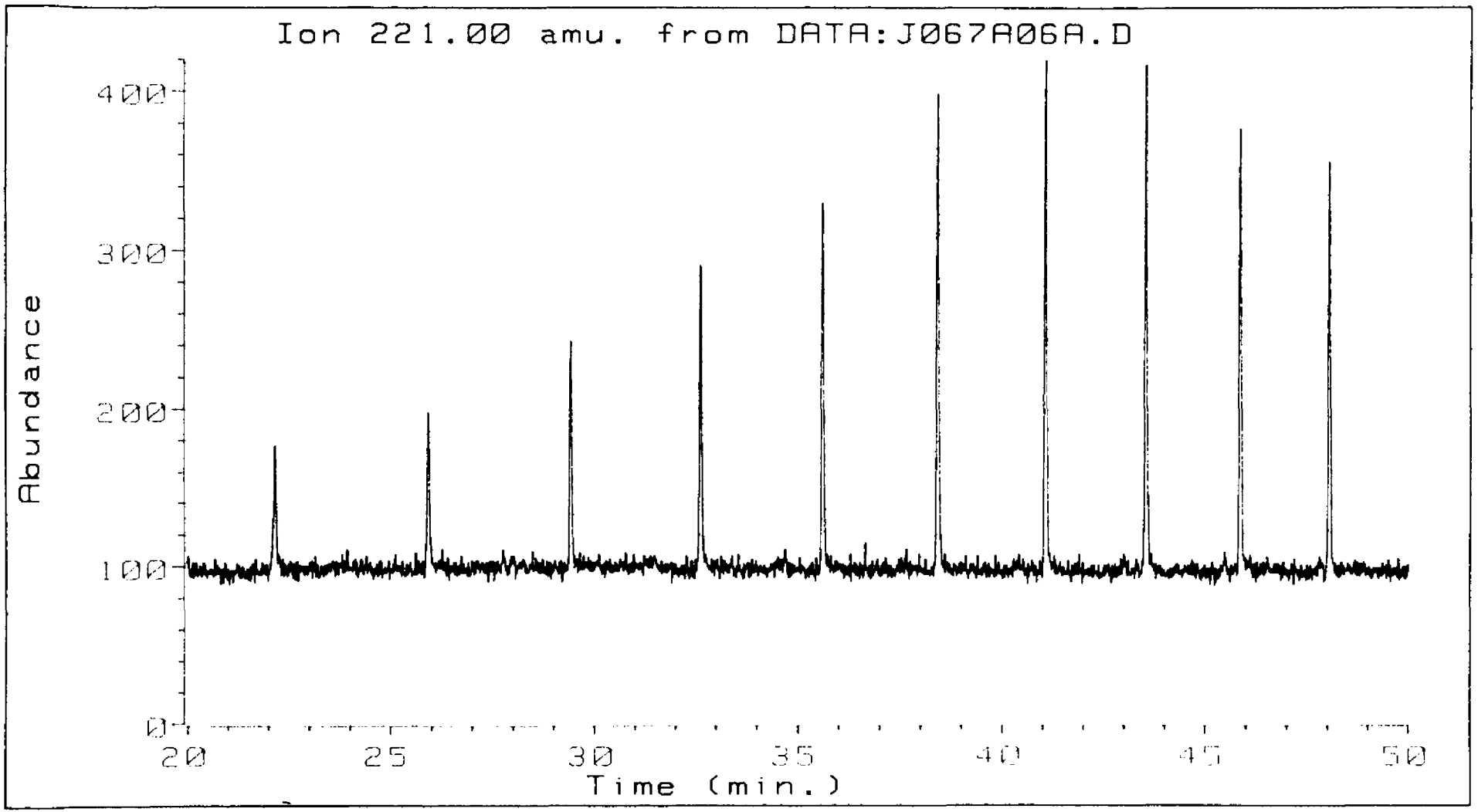
120
100
80
60
40
20
0
20
25
30
35
40
45
50
Time (min.)

2255m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Abundance
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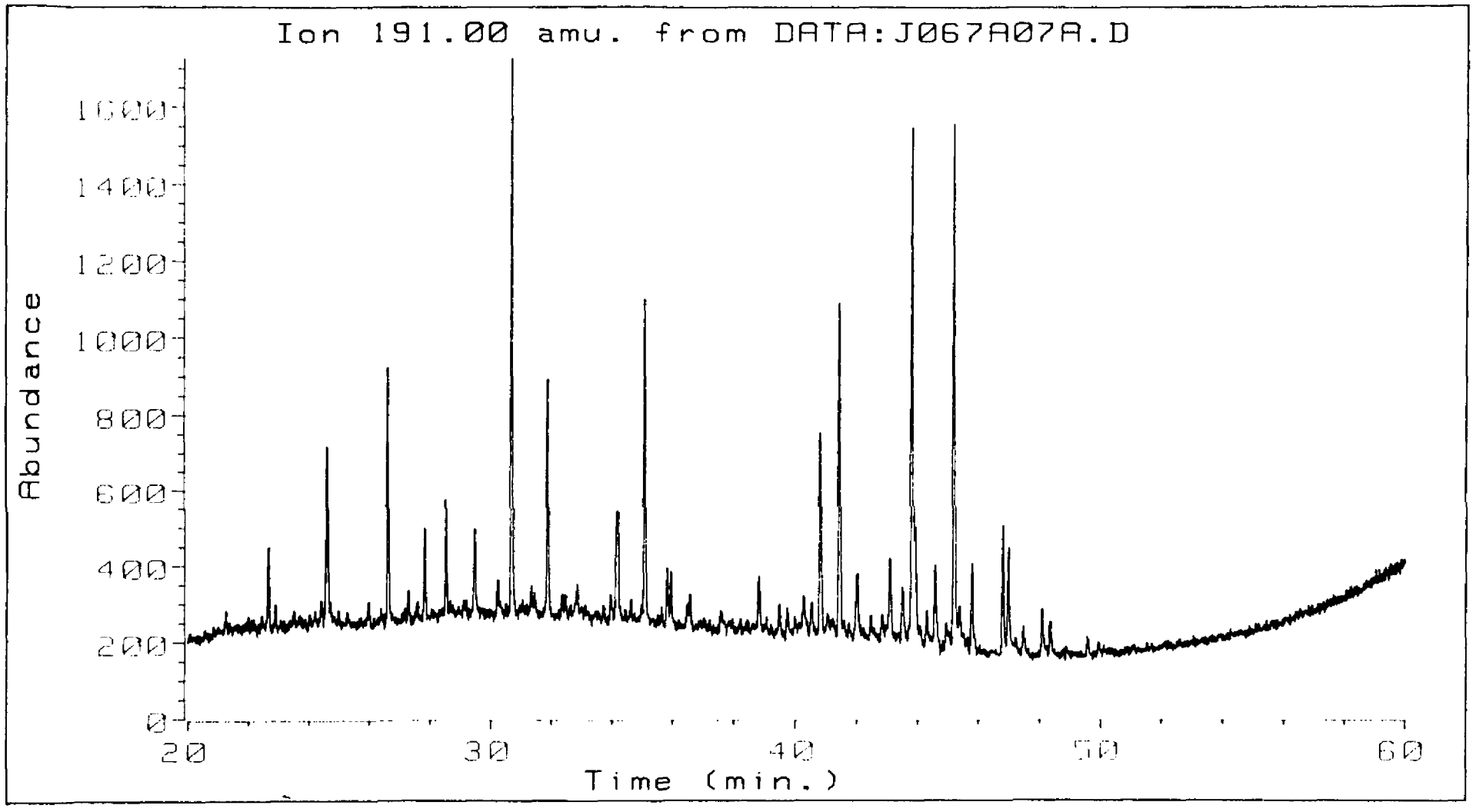
300
200
100
0
20
25
30
35
40
45
50
Time (min.)

2255m


Ion 191.00 amu. from DATA:J067A07A.D
Abundance
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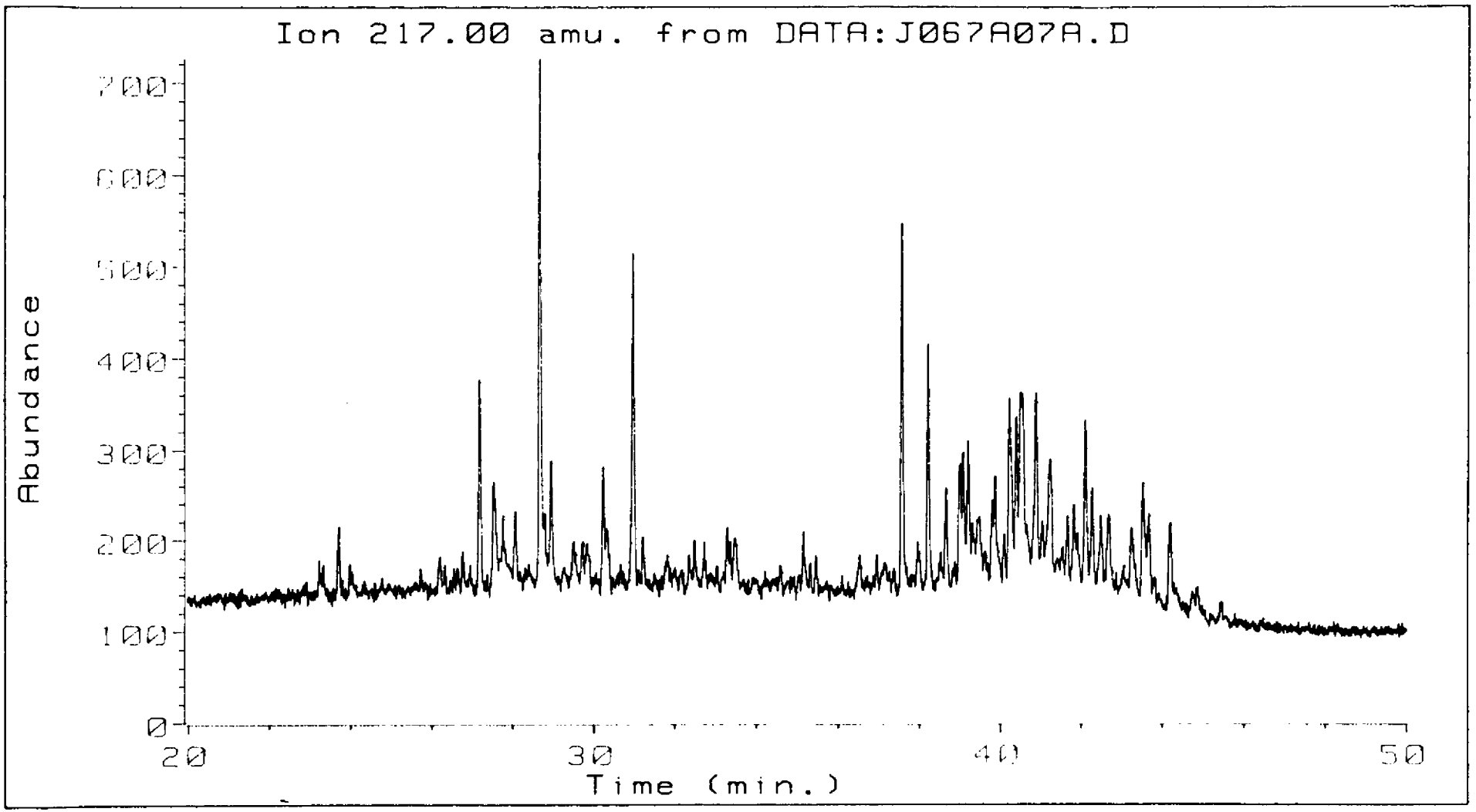
1200
1000
800
600
400
200
0
20
30
40
50
60
Time (min.)

2257m


Ion 217.00 amu. from DATA:J067A07A.D
Abundance
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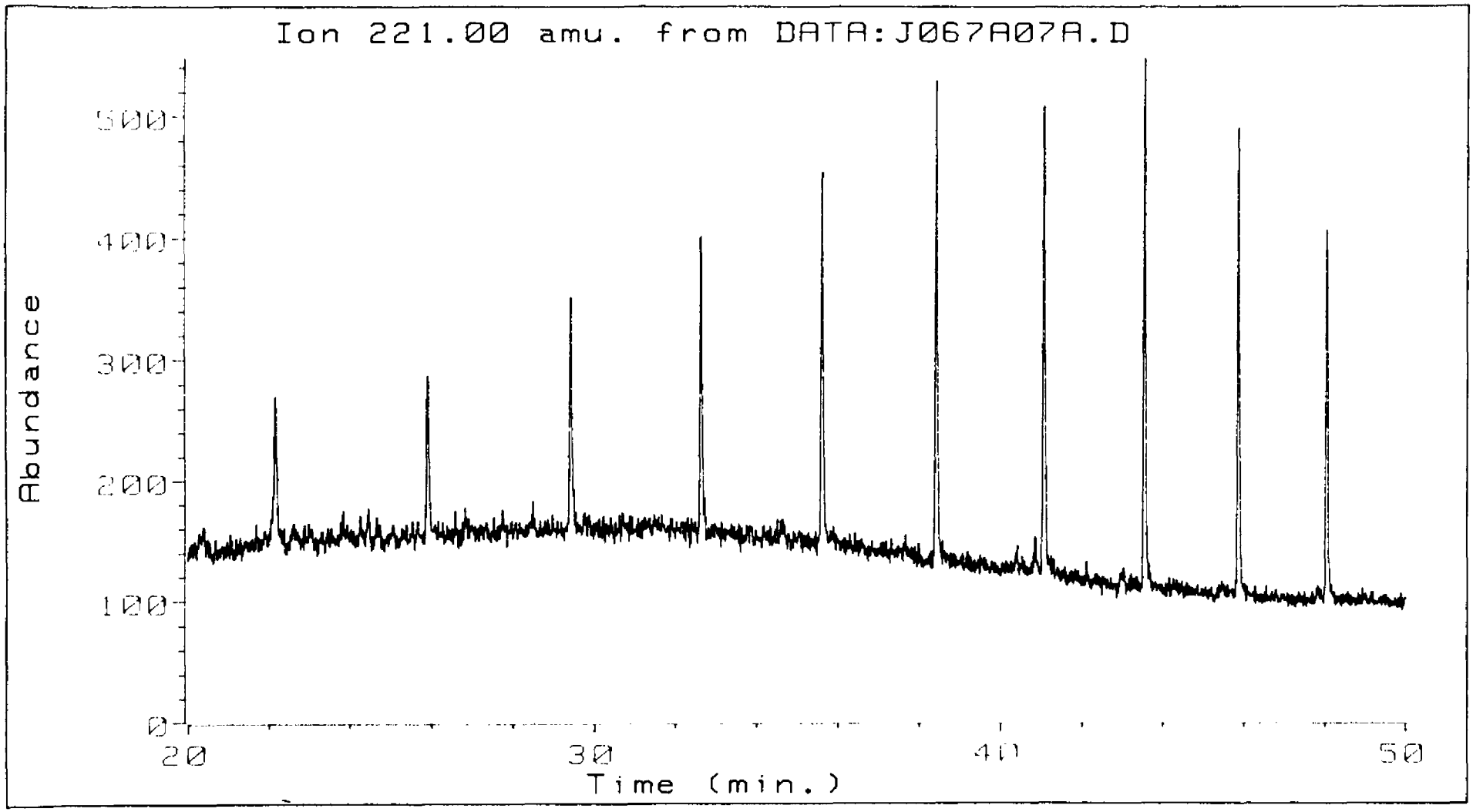
40
50
Time (min.)

2257m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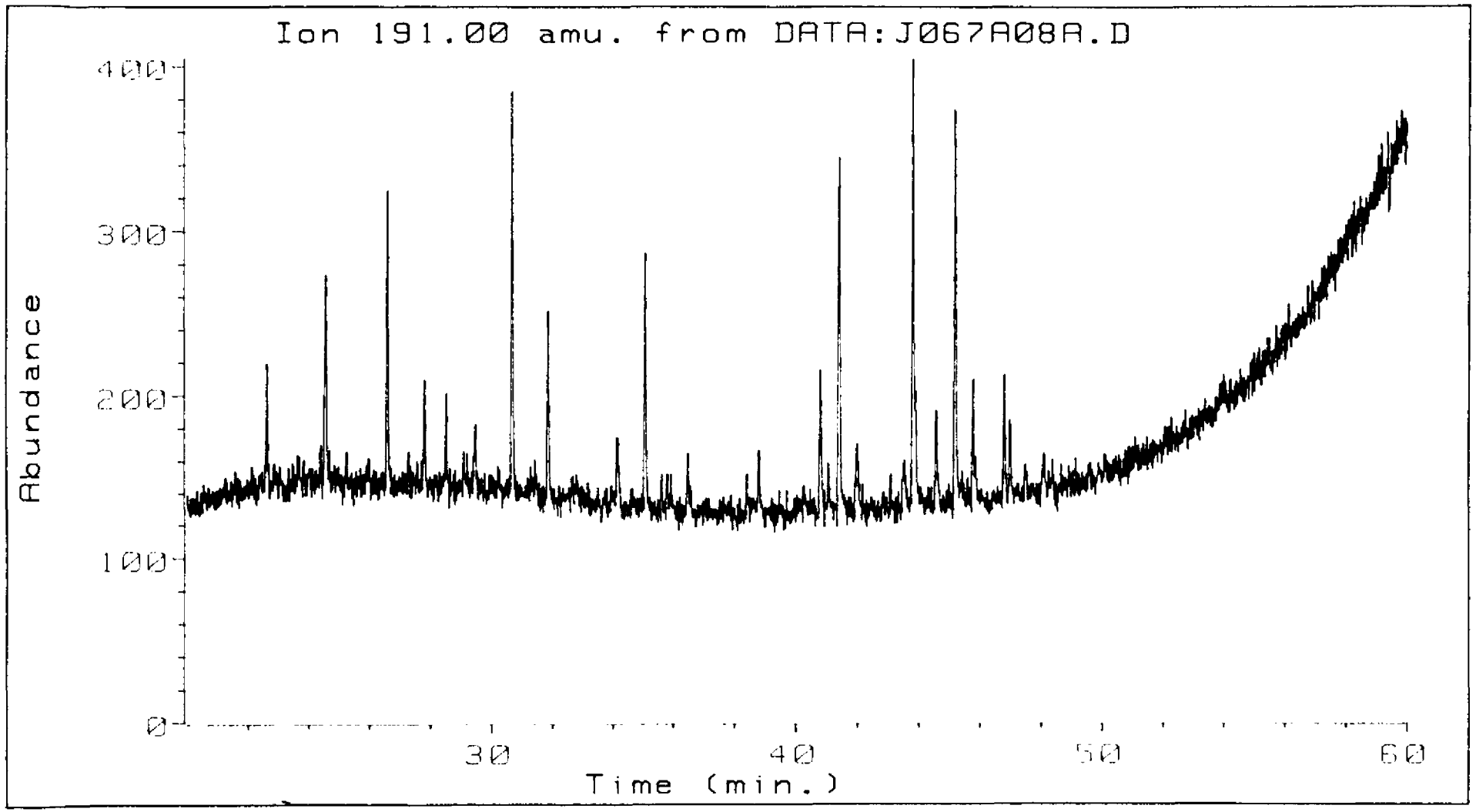
Time (min.)

2257m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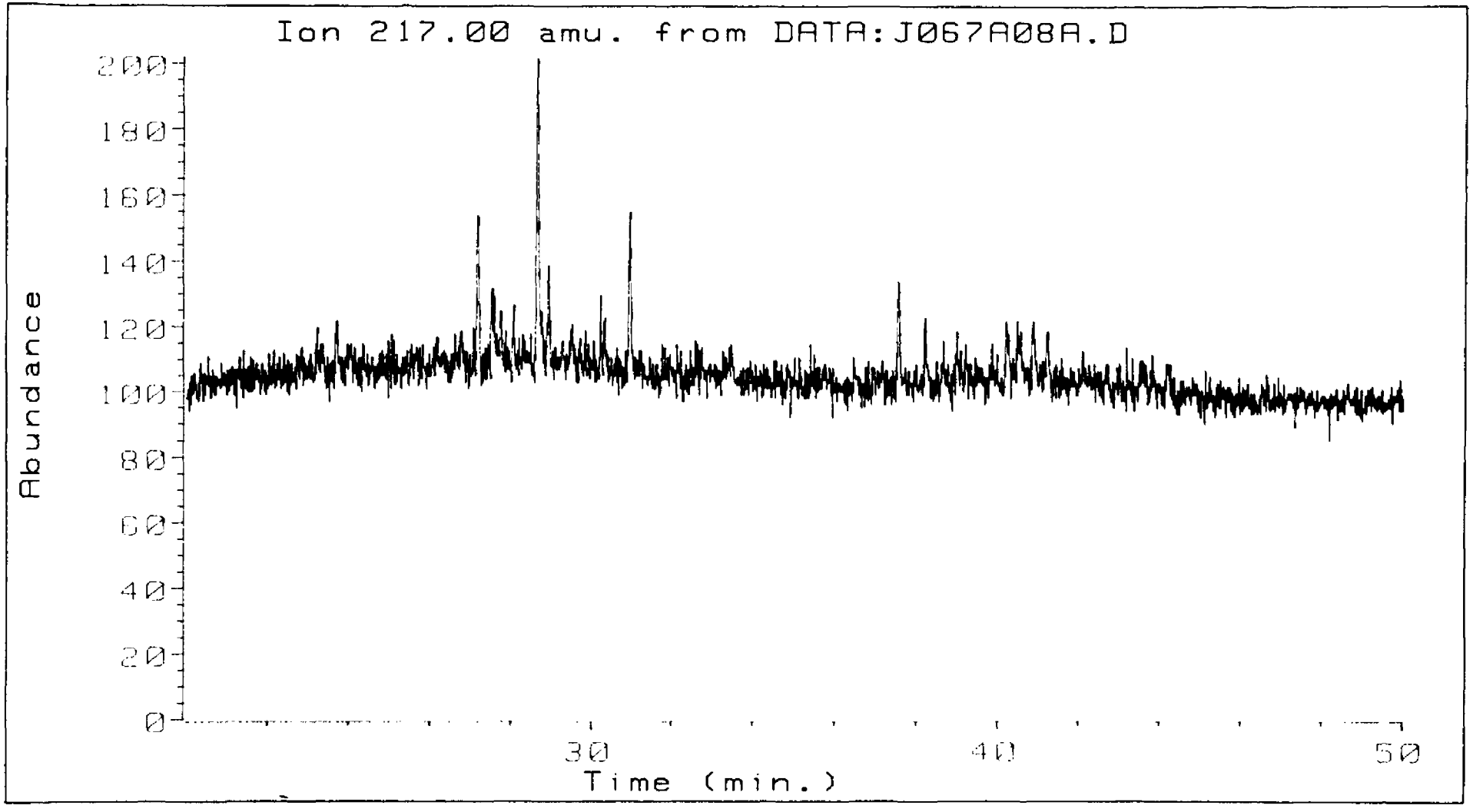
60
Time (min.)

2447m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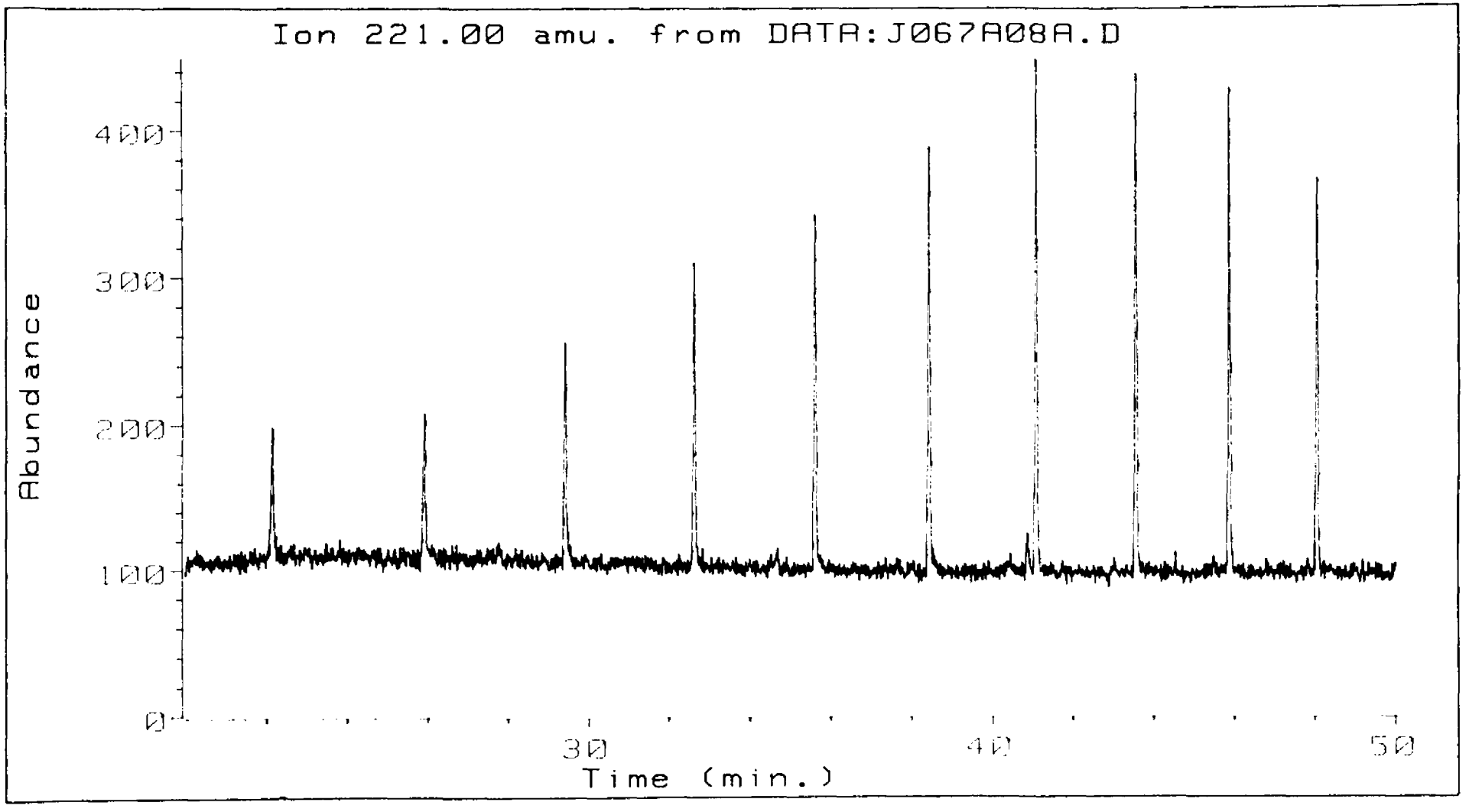
0
30
40
50
Time (min.)

2447m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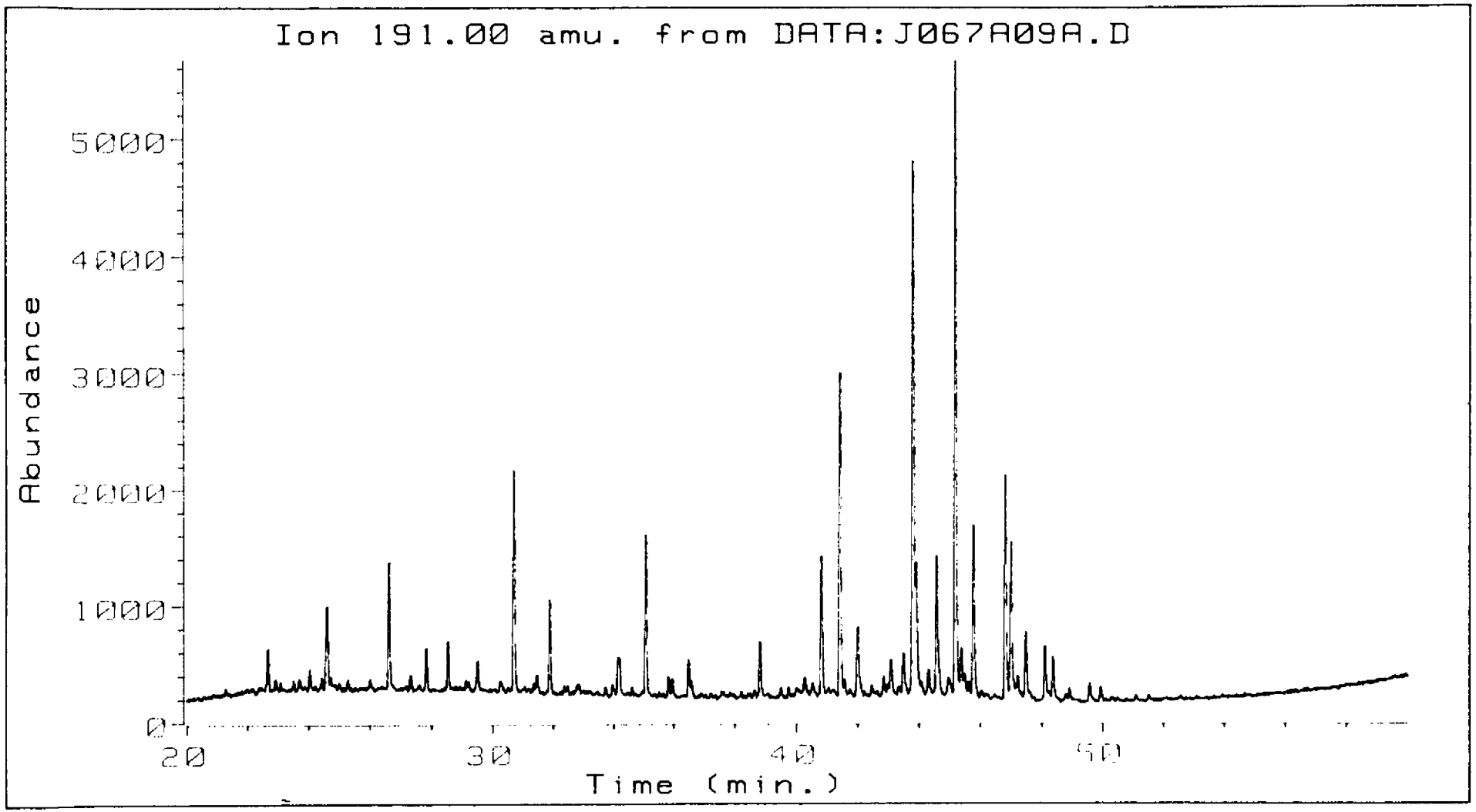
Time (min.)

2447m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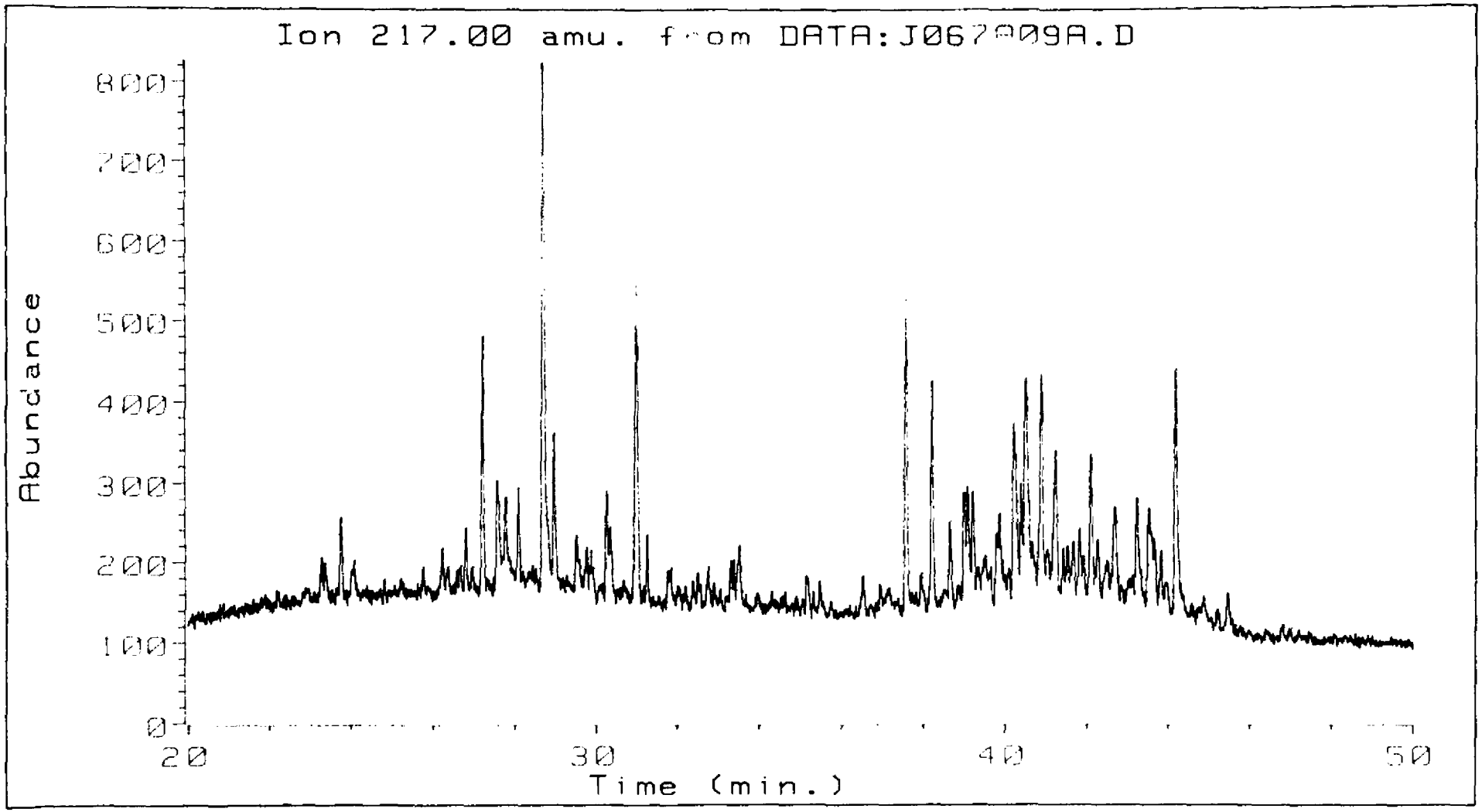
Time (min.)

2450m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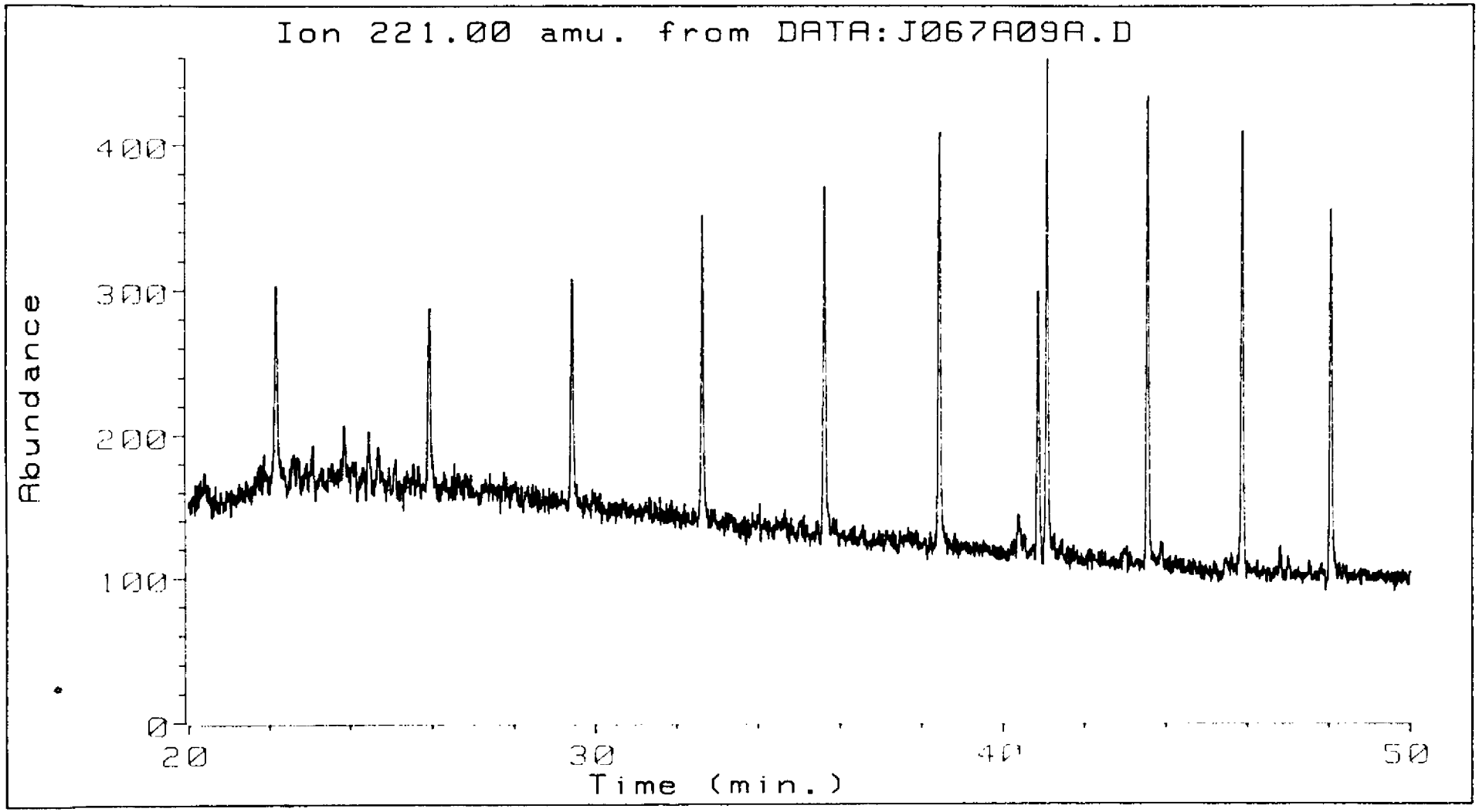
Time (min.)

2450m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Abundance
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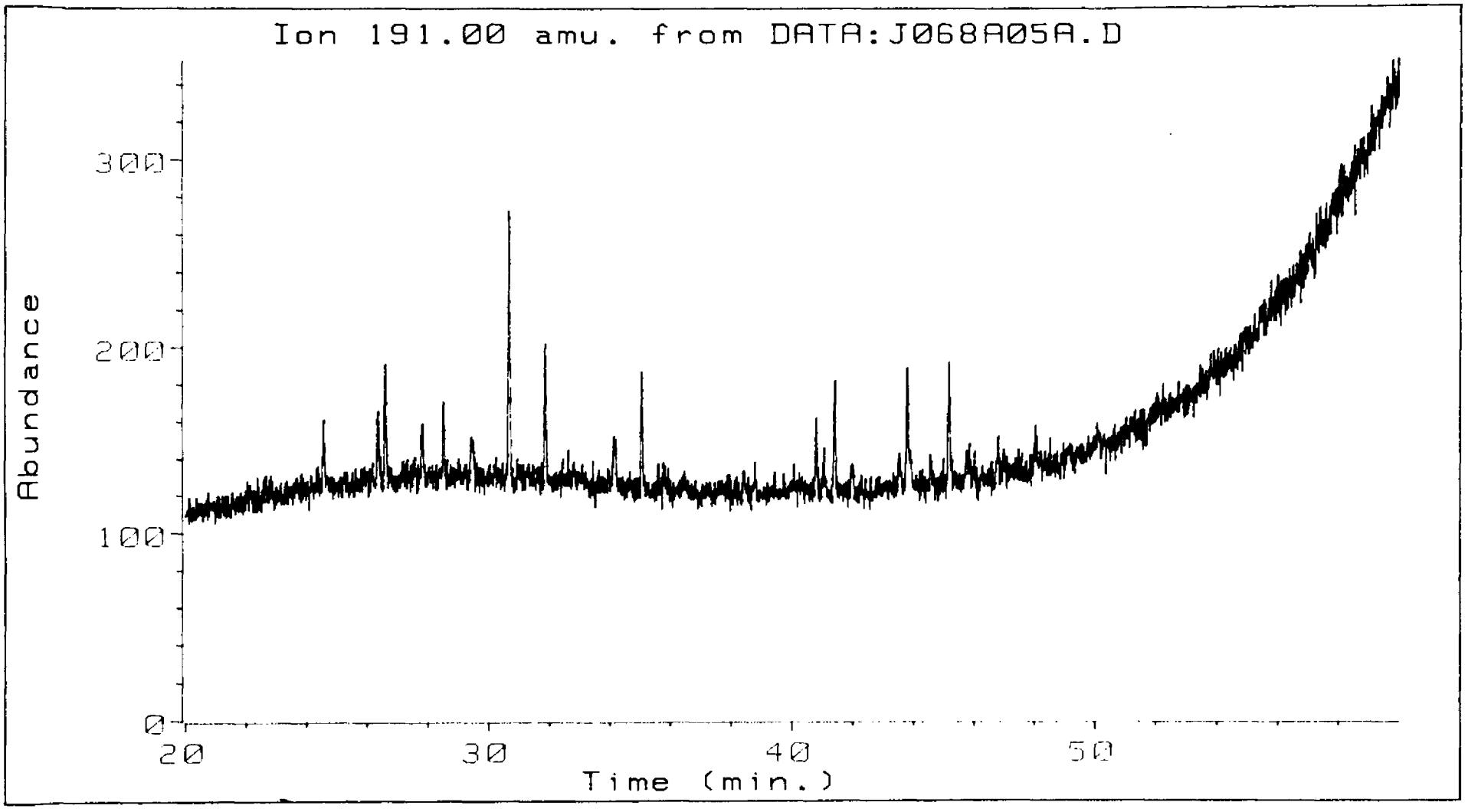
Time (min.)

2450m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Abundance
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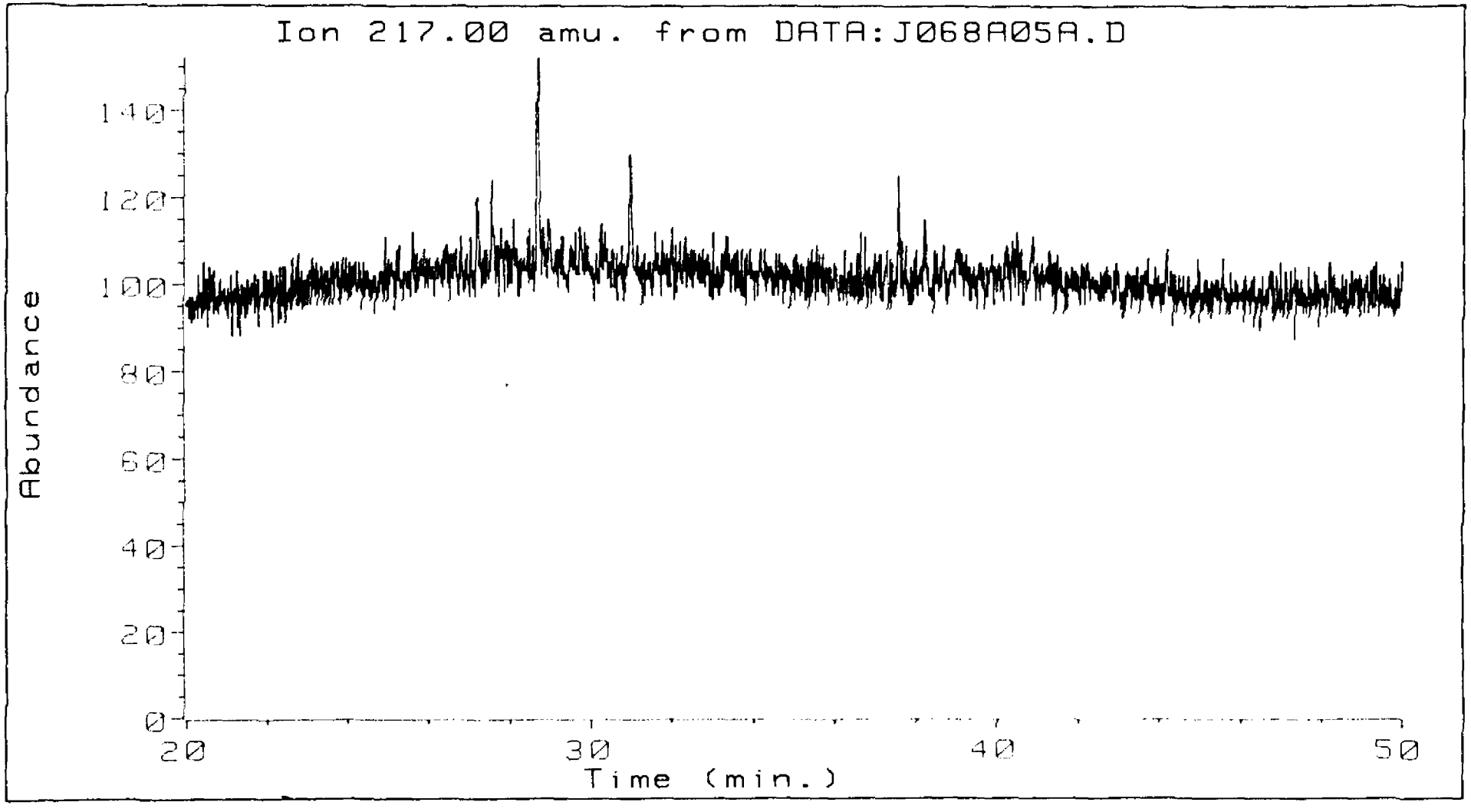
Time (min.)

2455m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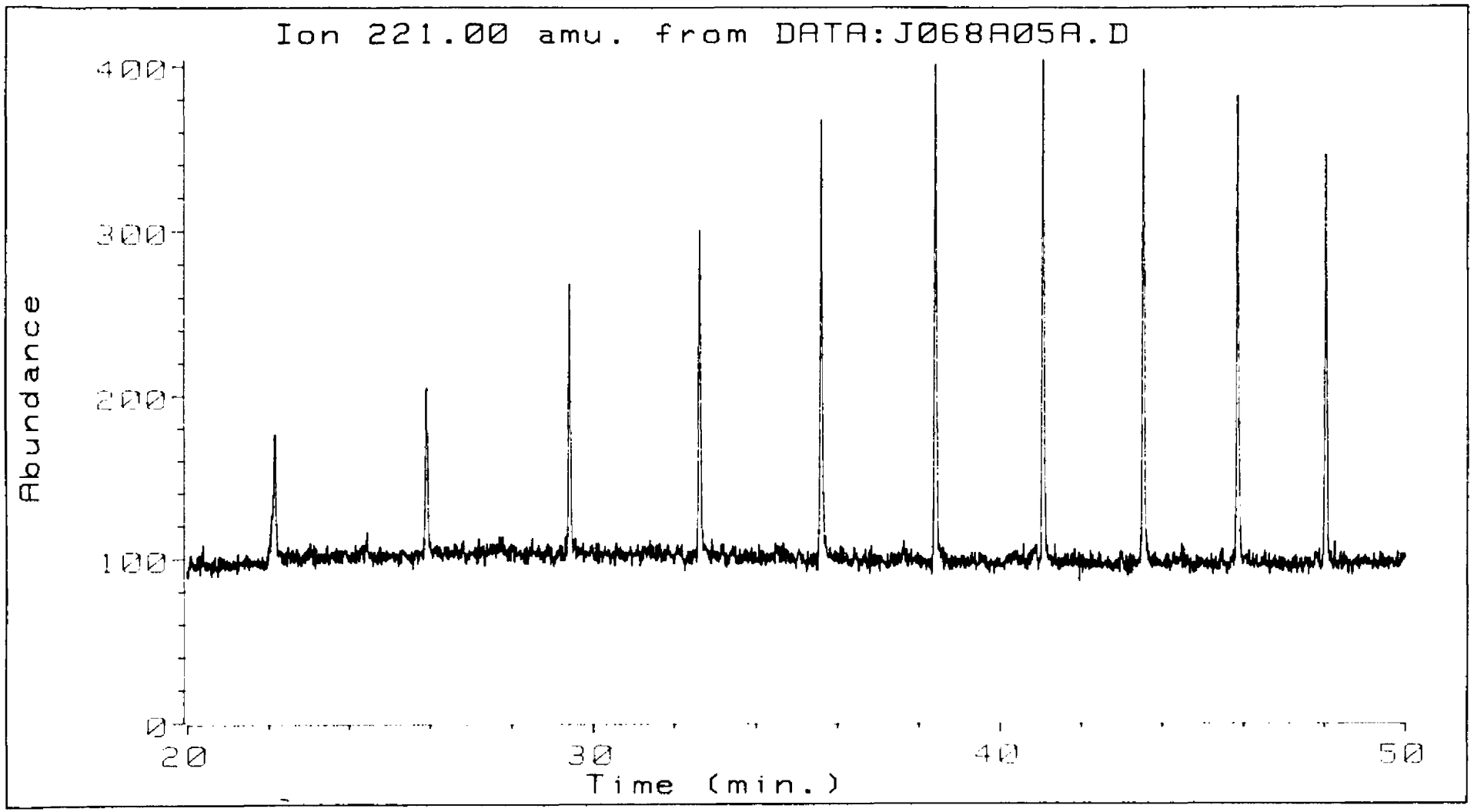
40
50
Time (min.)

2455m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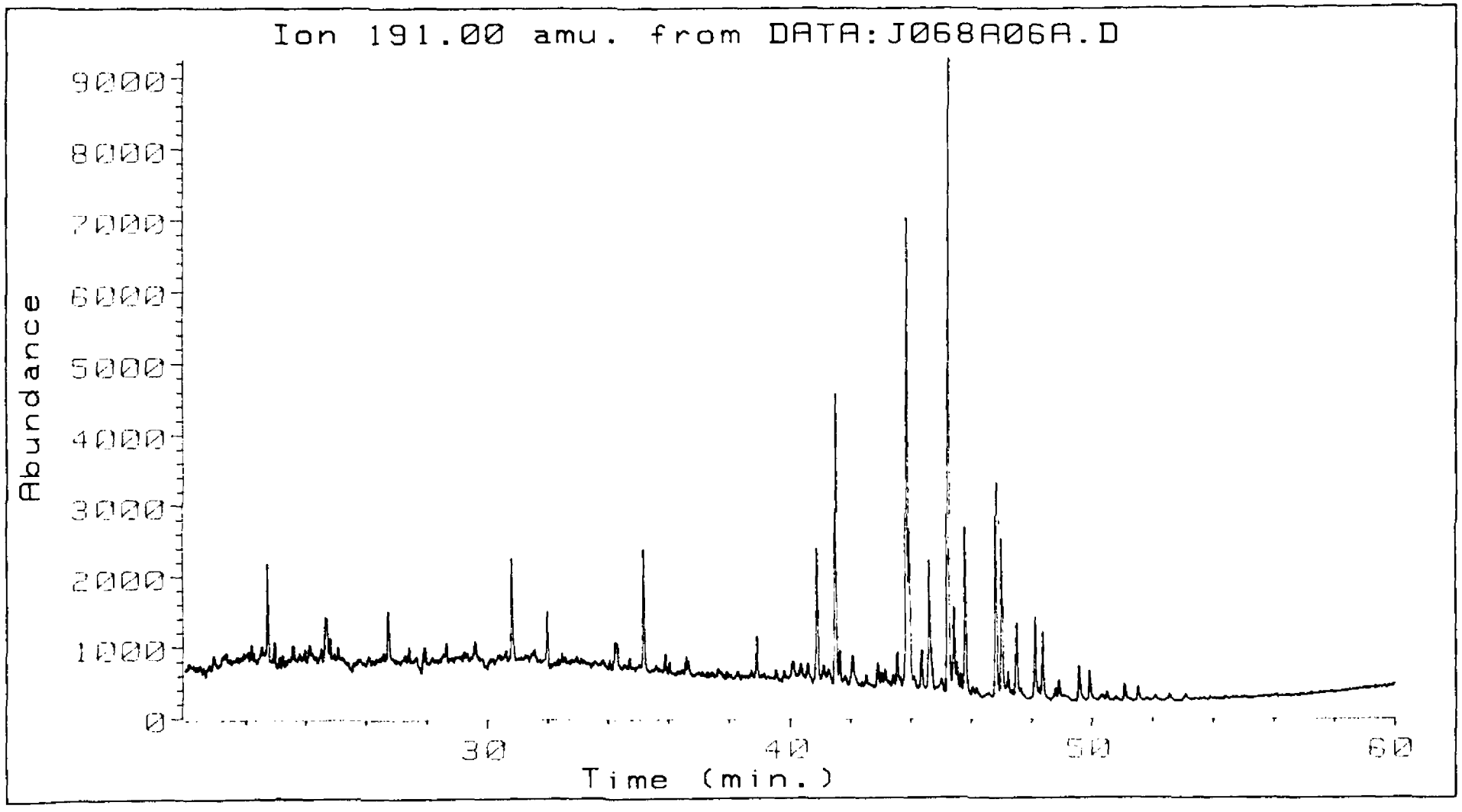
Time (min.)

2455m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5000
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1000
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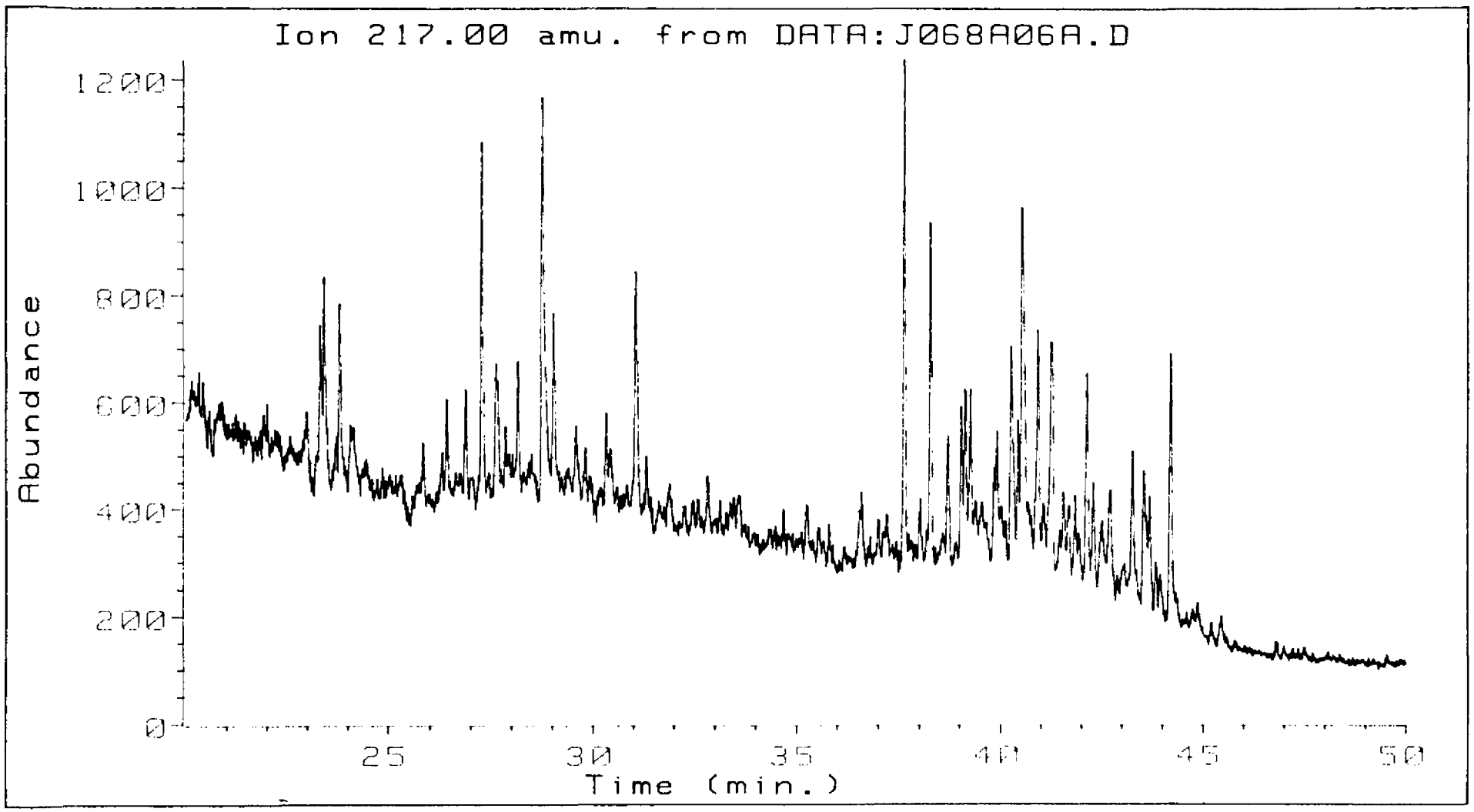
60
Time (min.)

2455.00 03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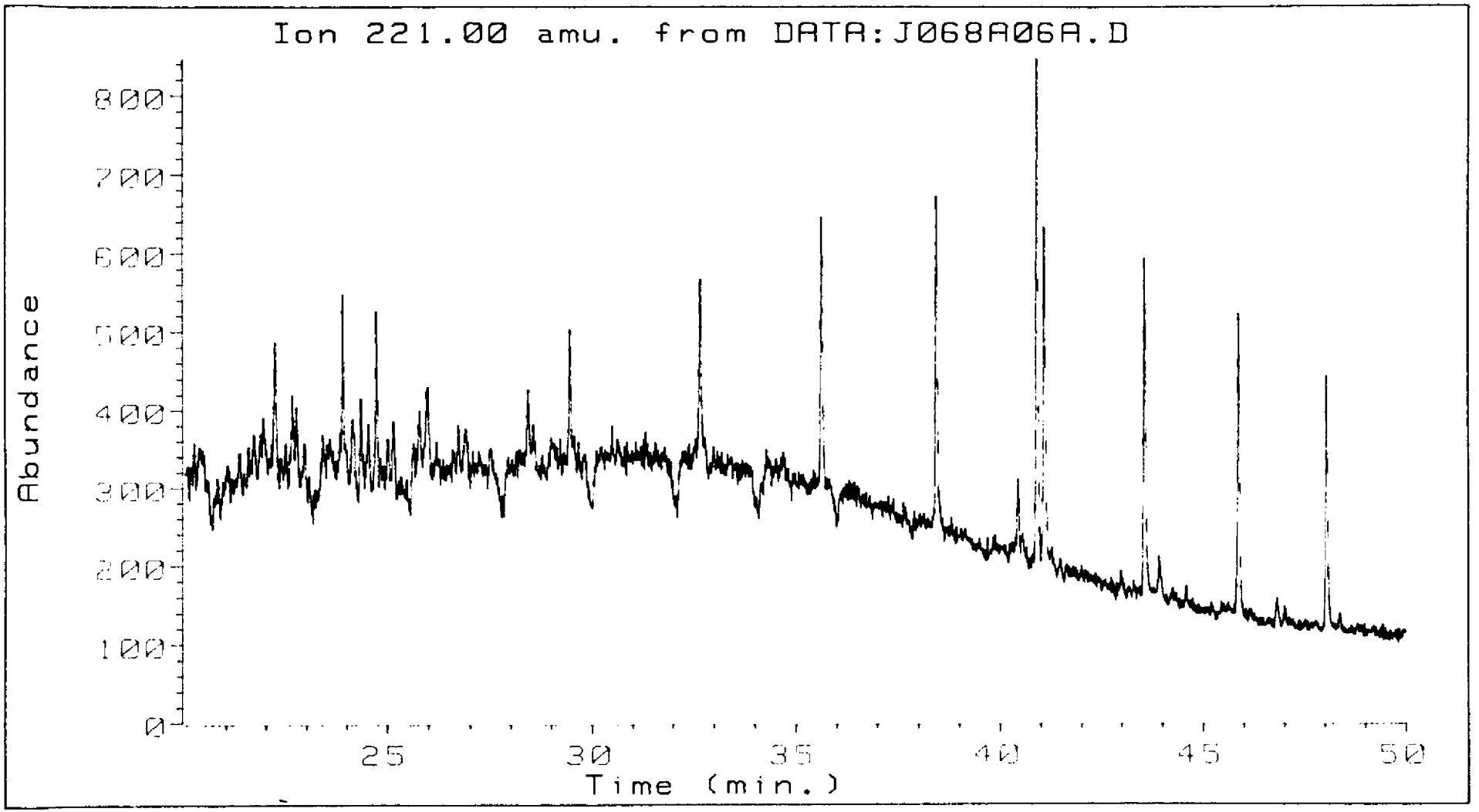
Time (min.)

2455.00 03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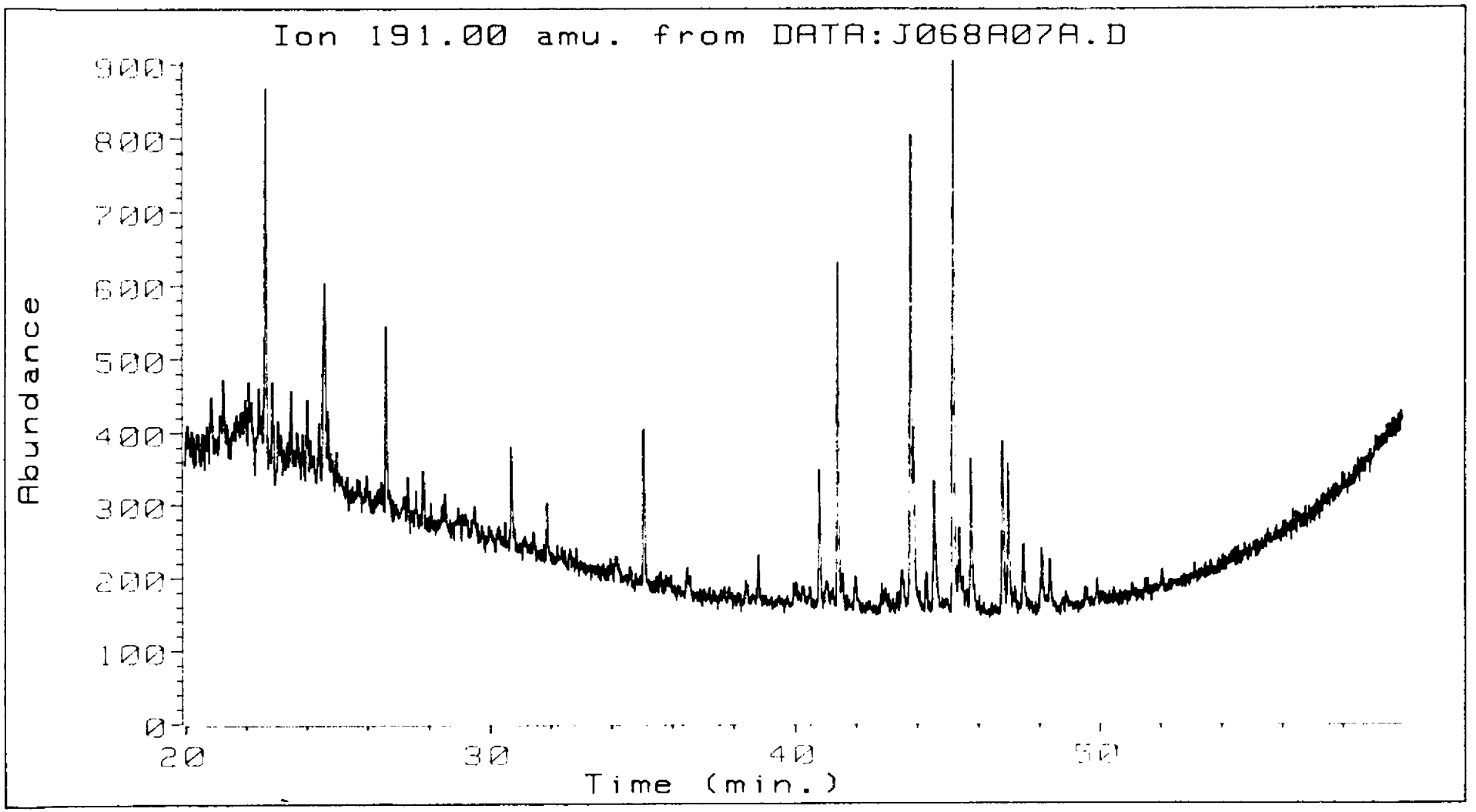
Time (min.)

2455.00 03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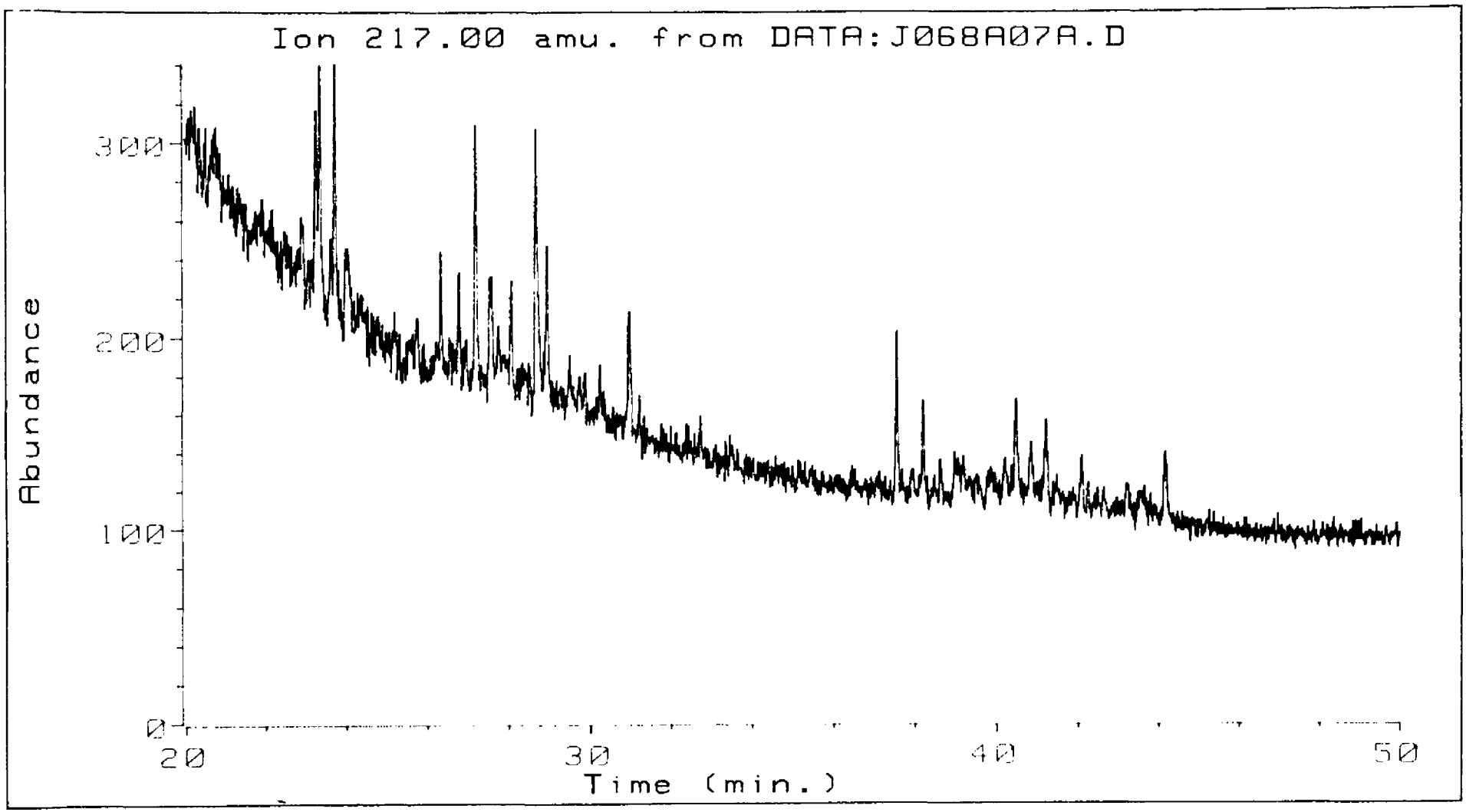
Time (min.)

2455.97 00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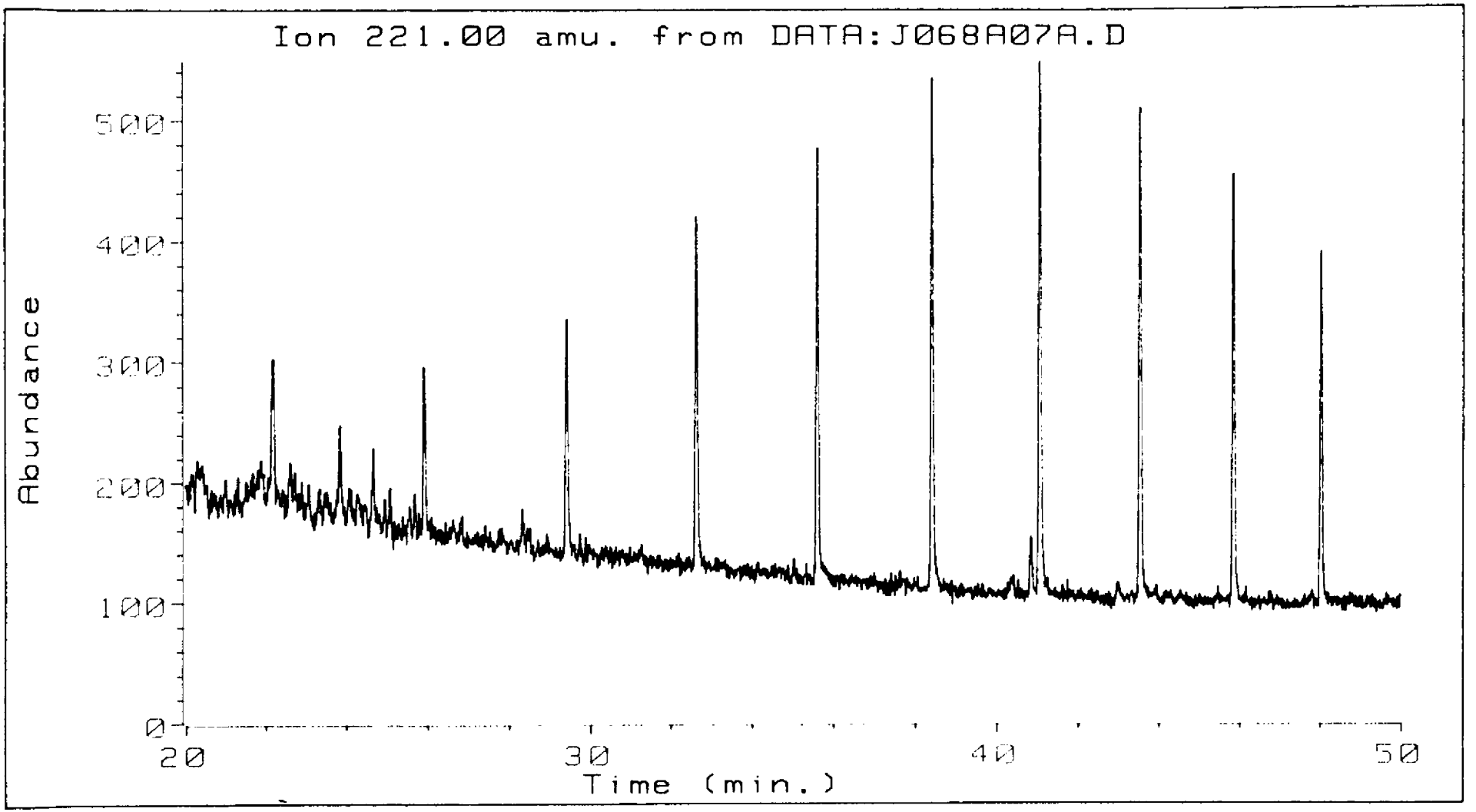
Time (min.)

2455.97 00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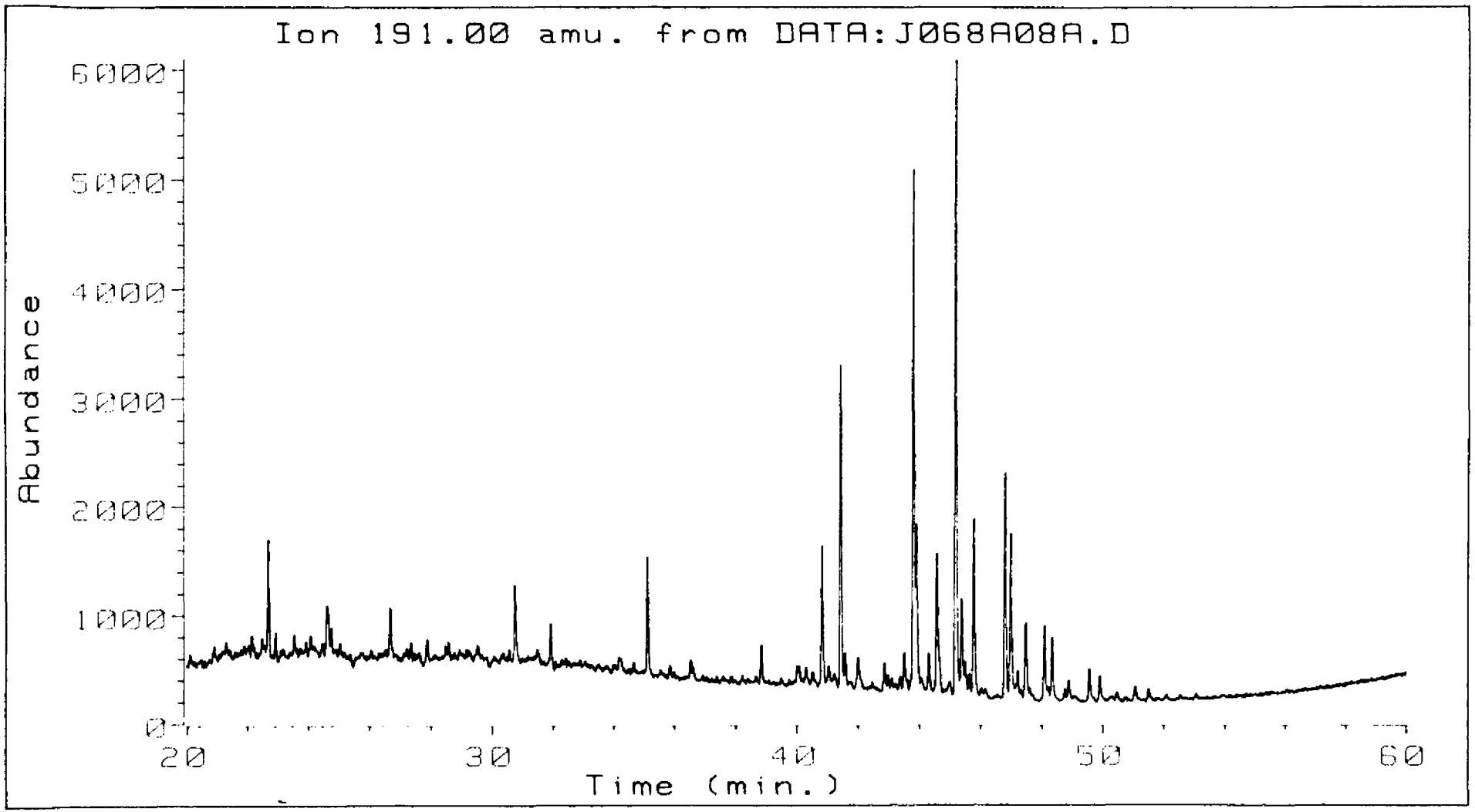
Time (min.)

2455.97 00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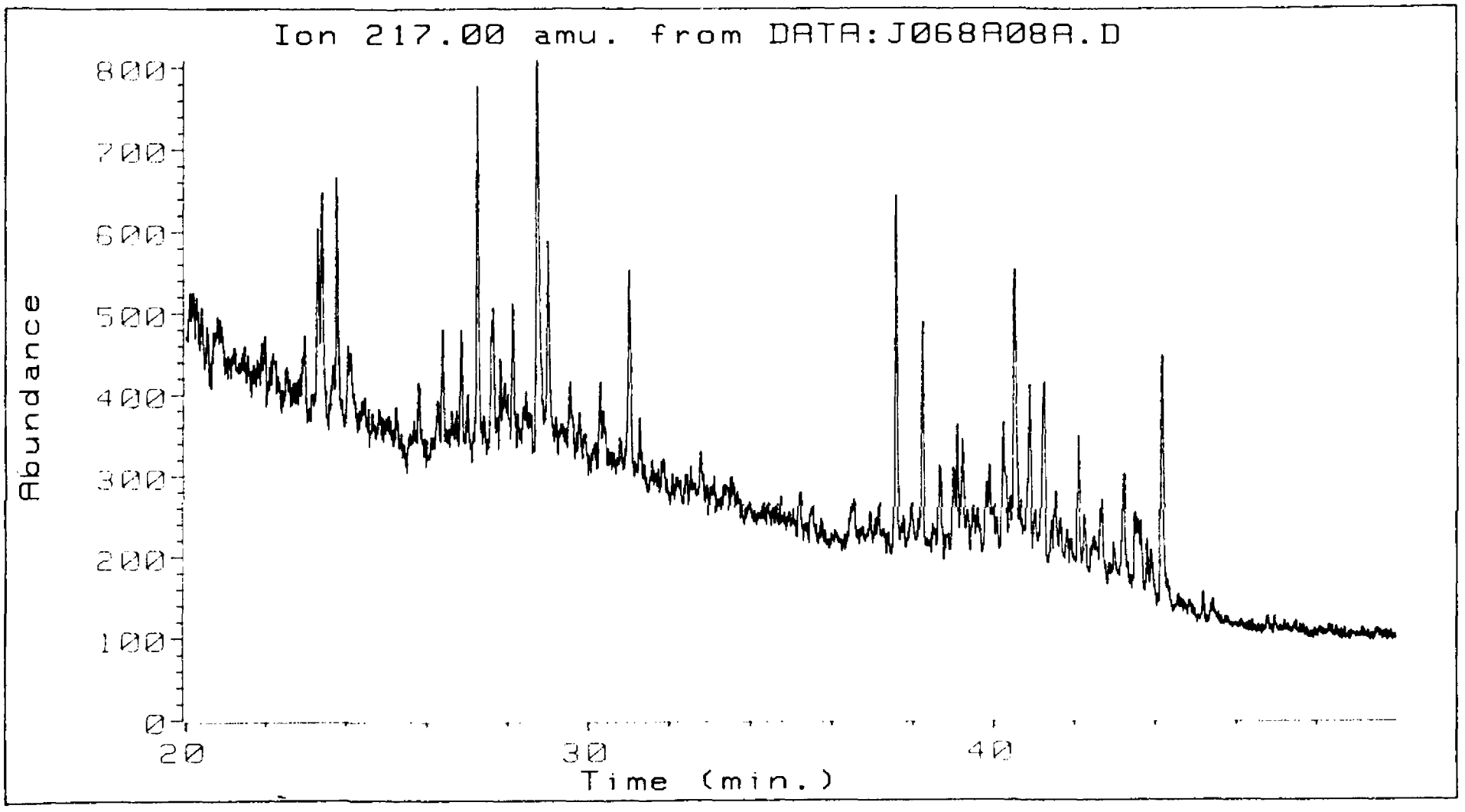
50
60
Time (min.)

2456.98 00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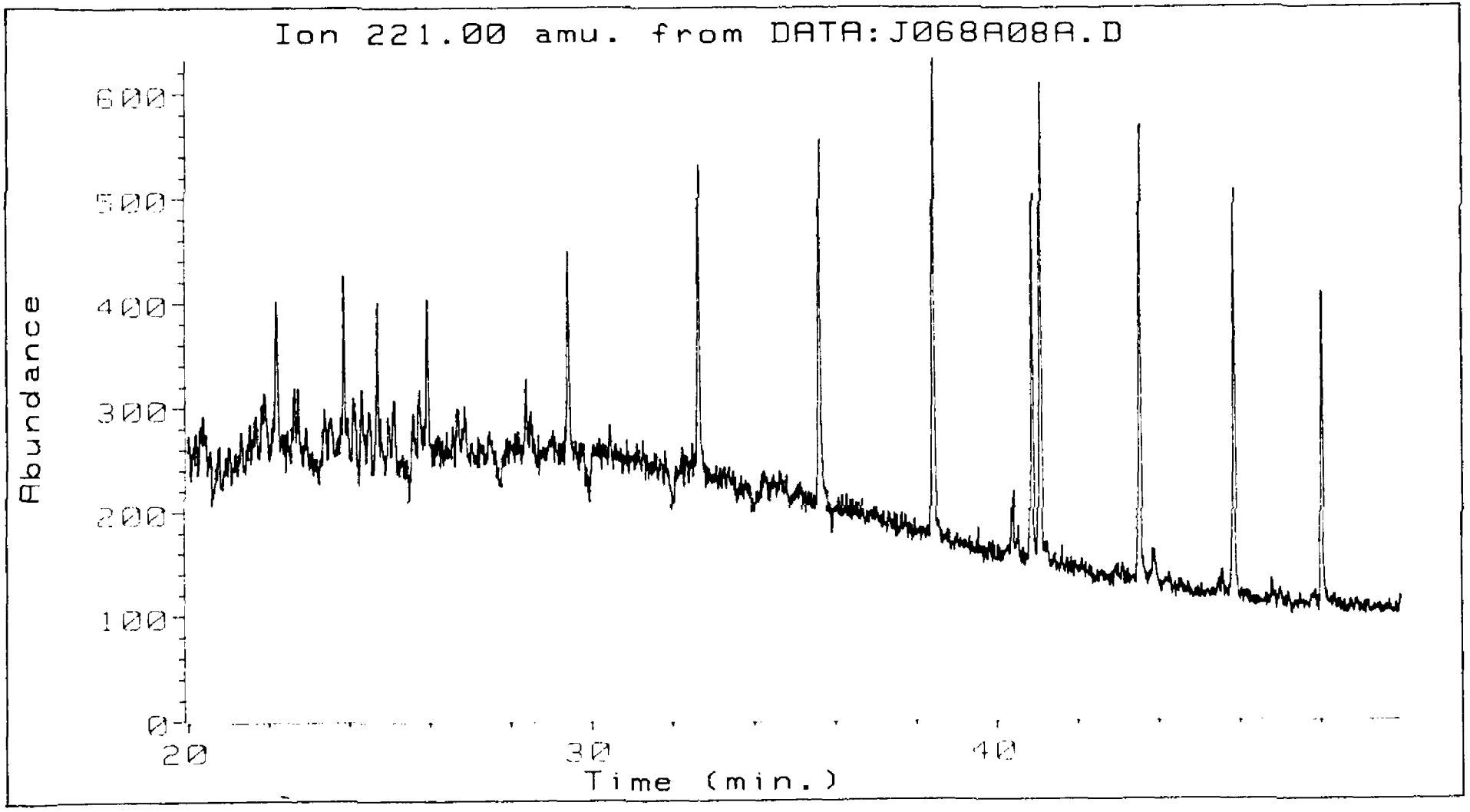
30
40
Time (min.)

2456.98 00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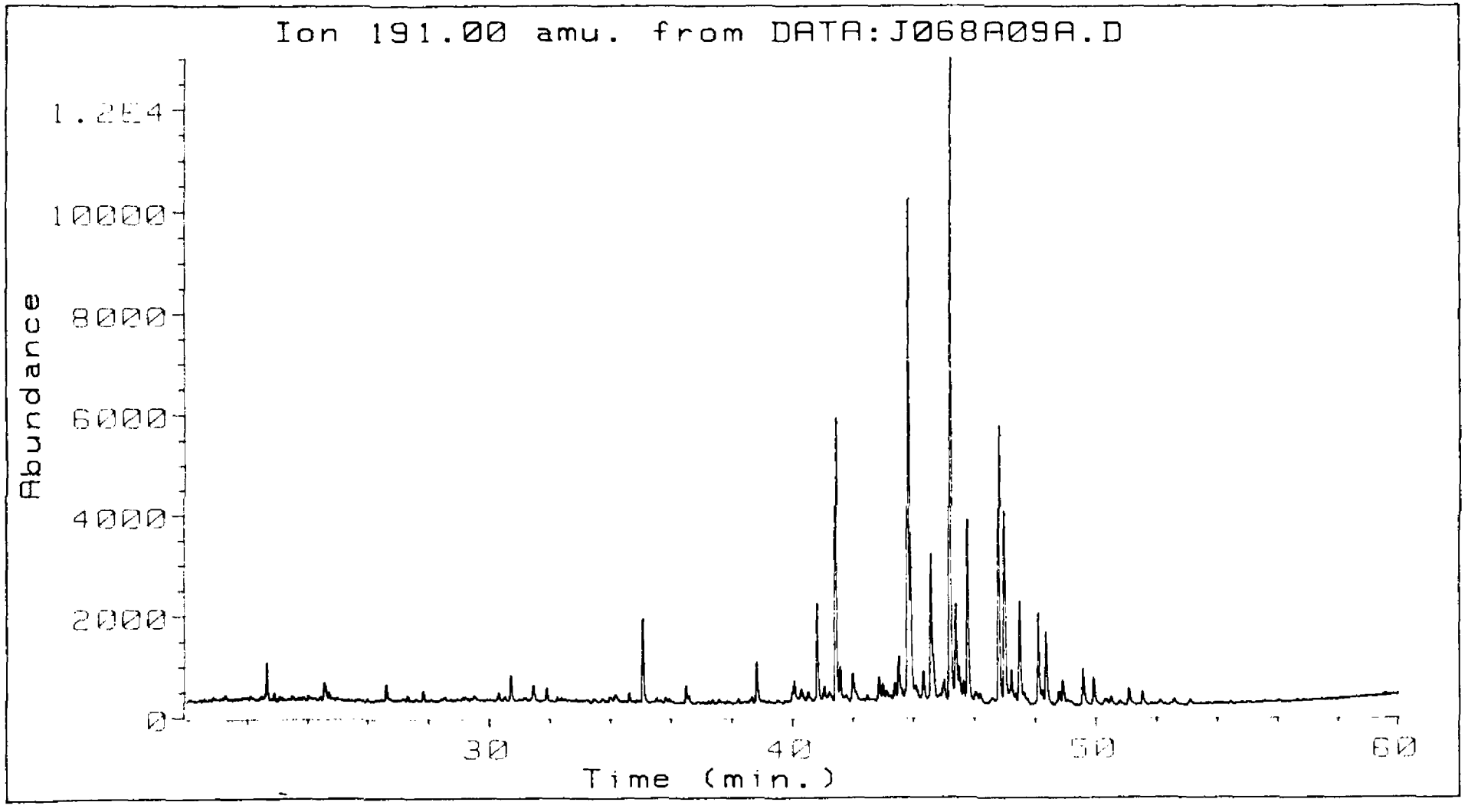
Time (min.)

2456.98 00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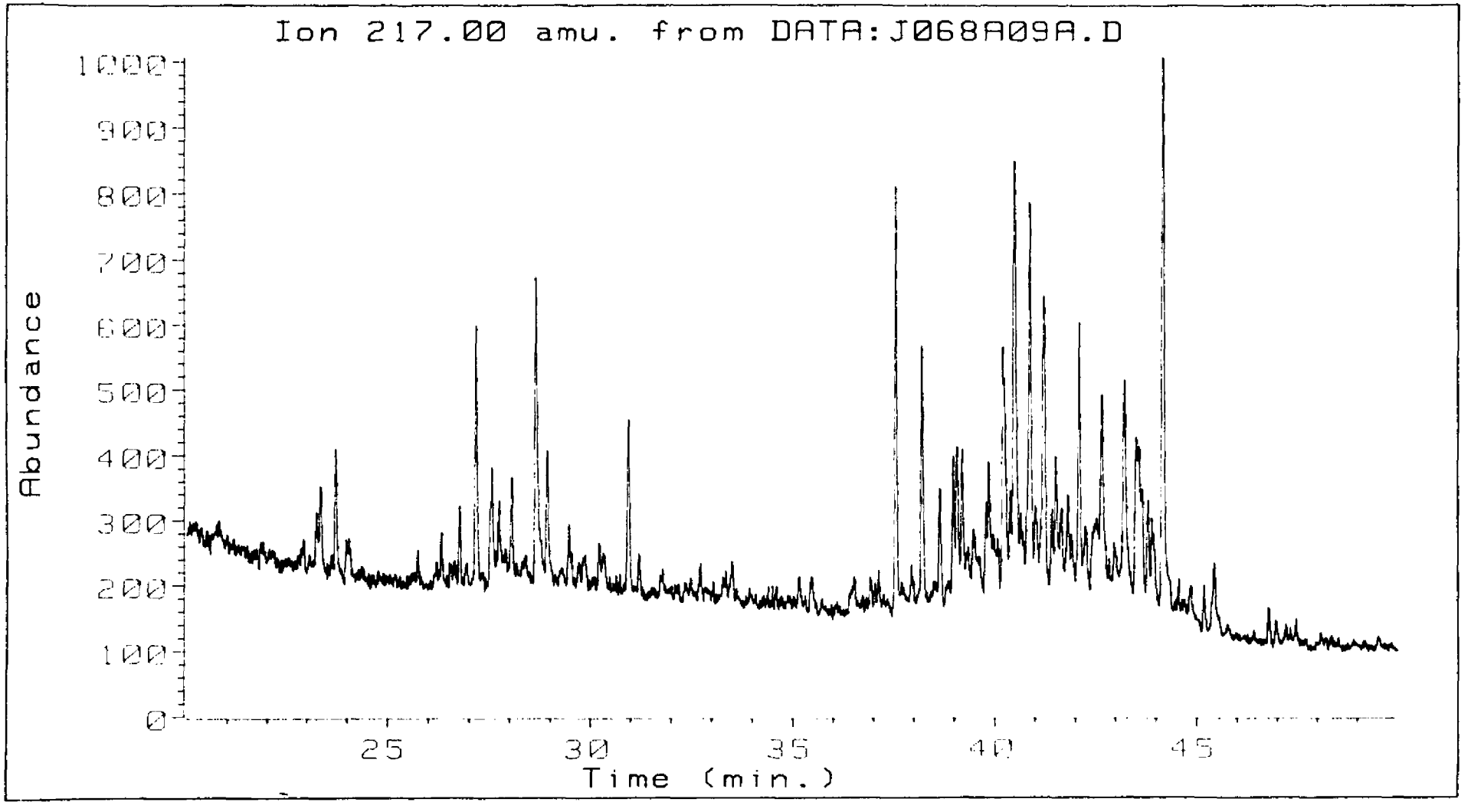
Time (min.)

2457.96 00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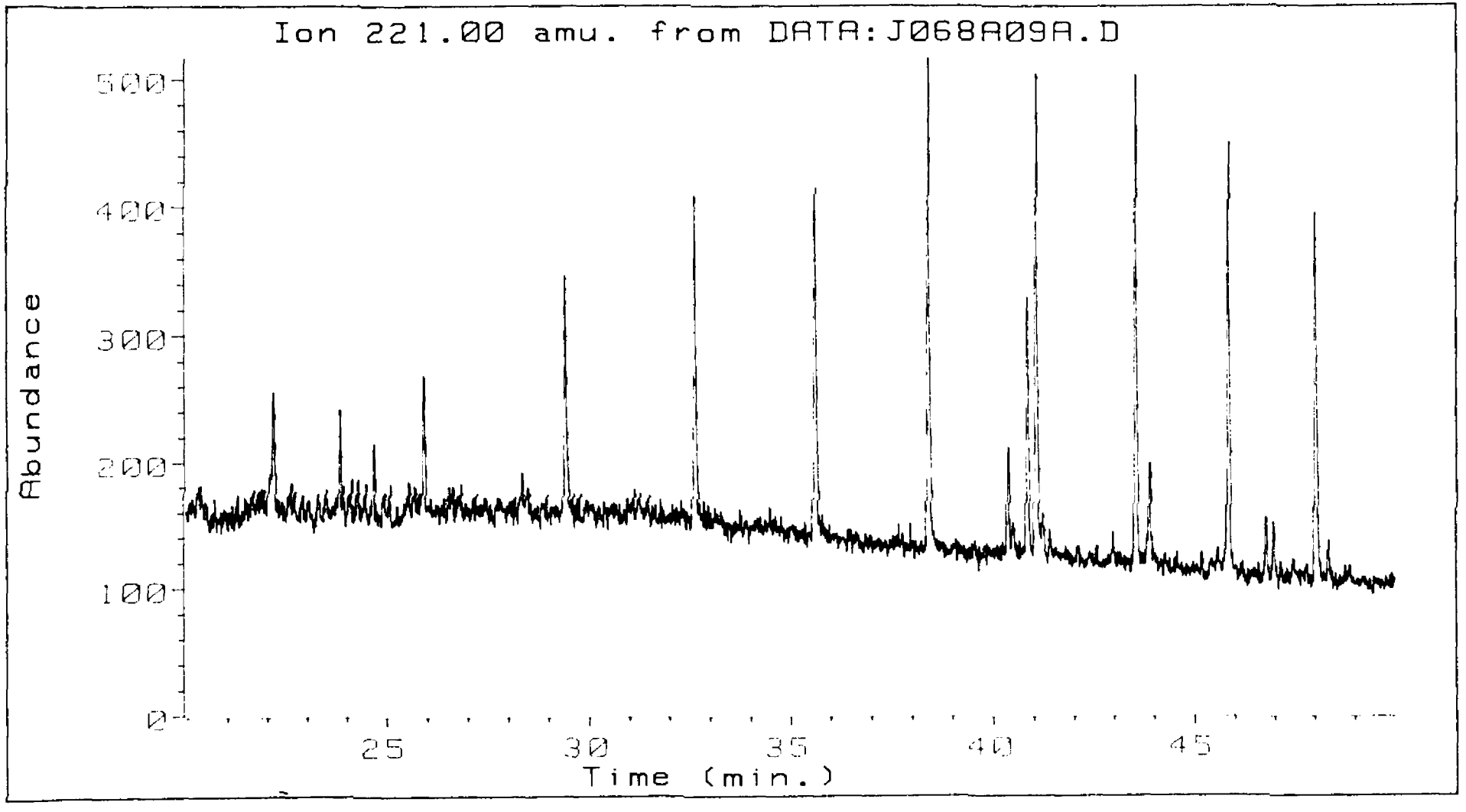
Time (min.)

2457.96 00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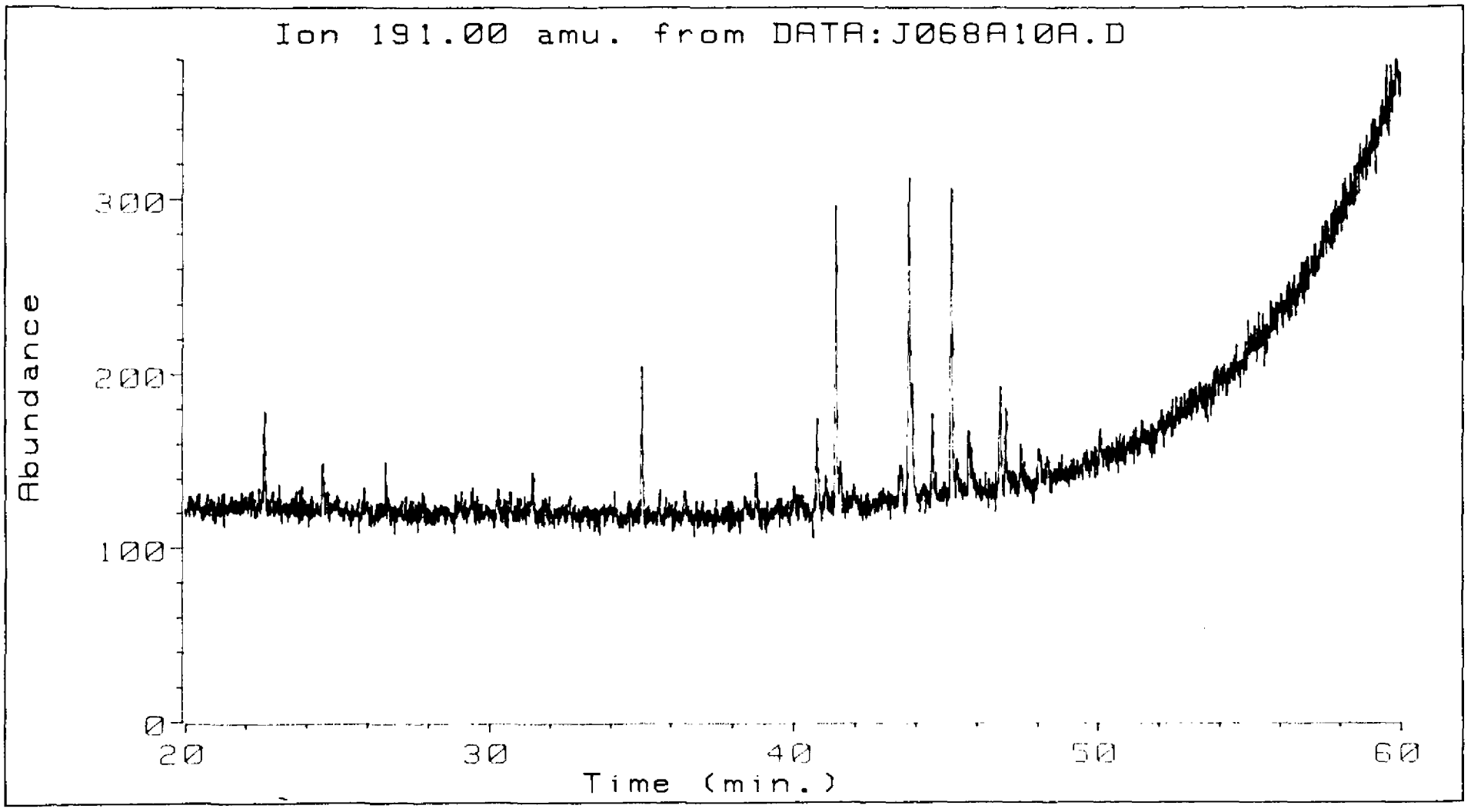
Time (min.)

2457.96 00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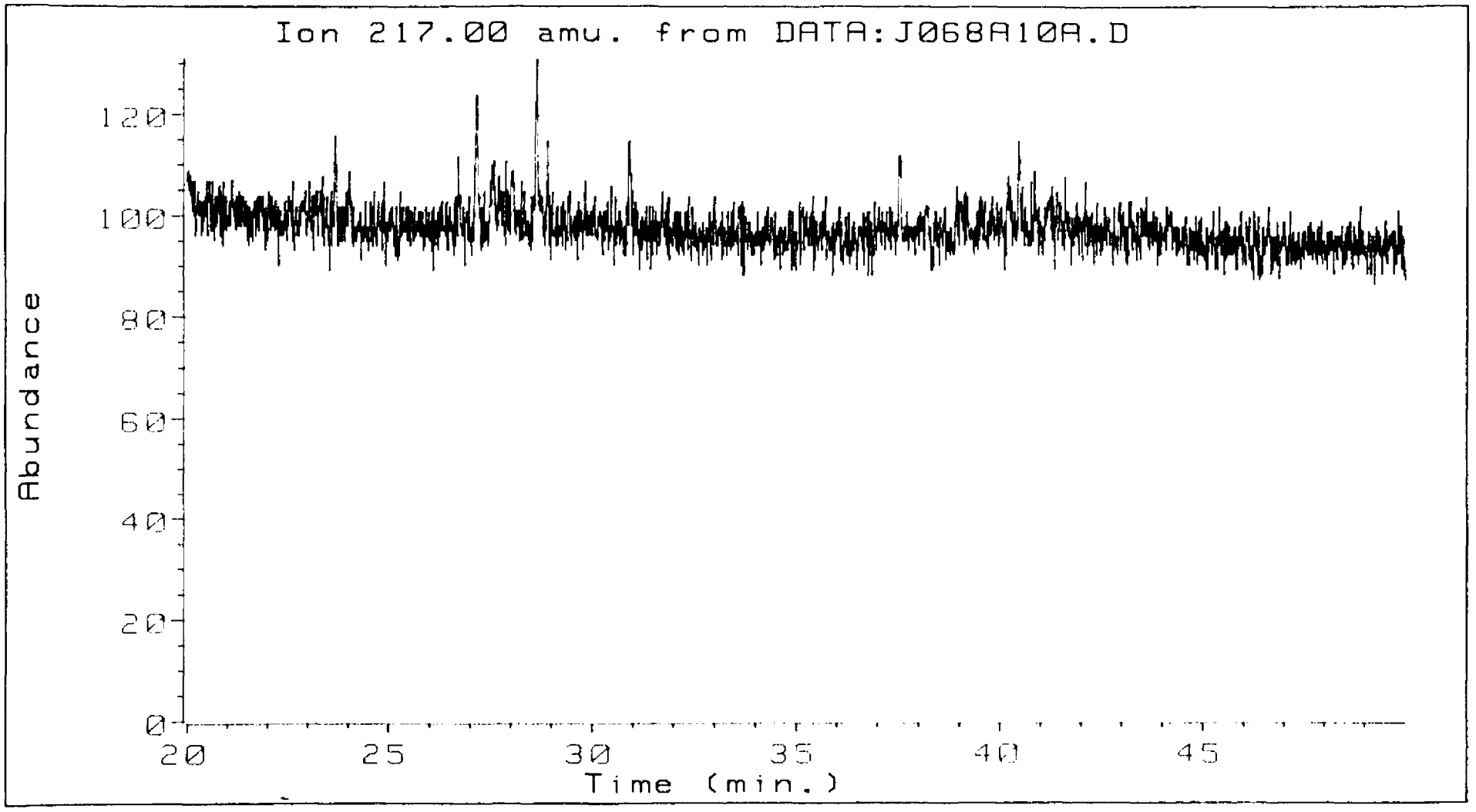
60
Time (min.)

2458.65 69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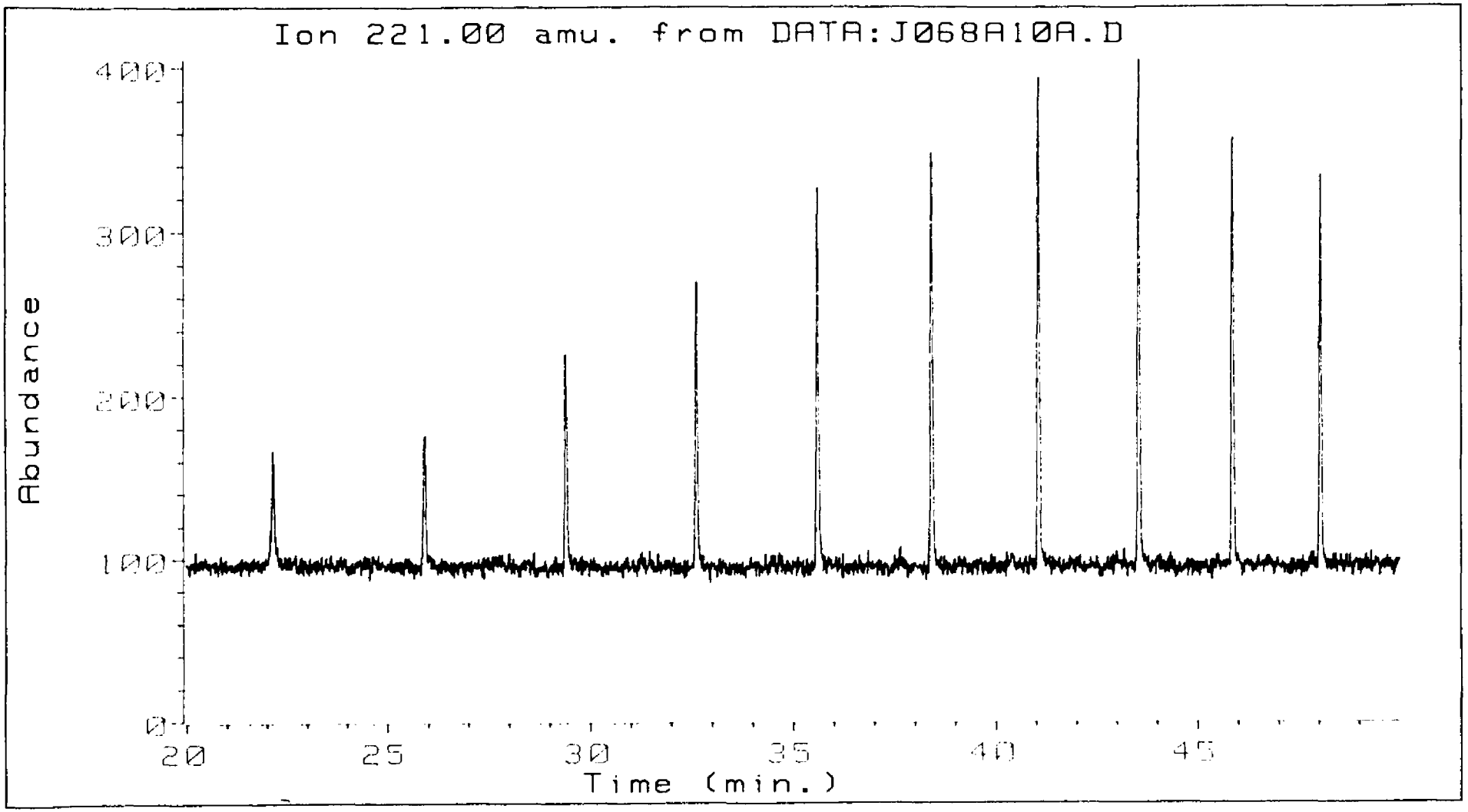
40
45
Time (min.)

2458.65 69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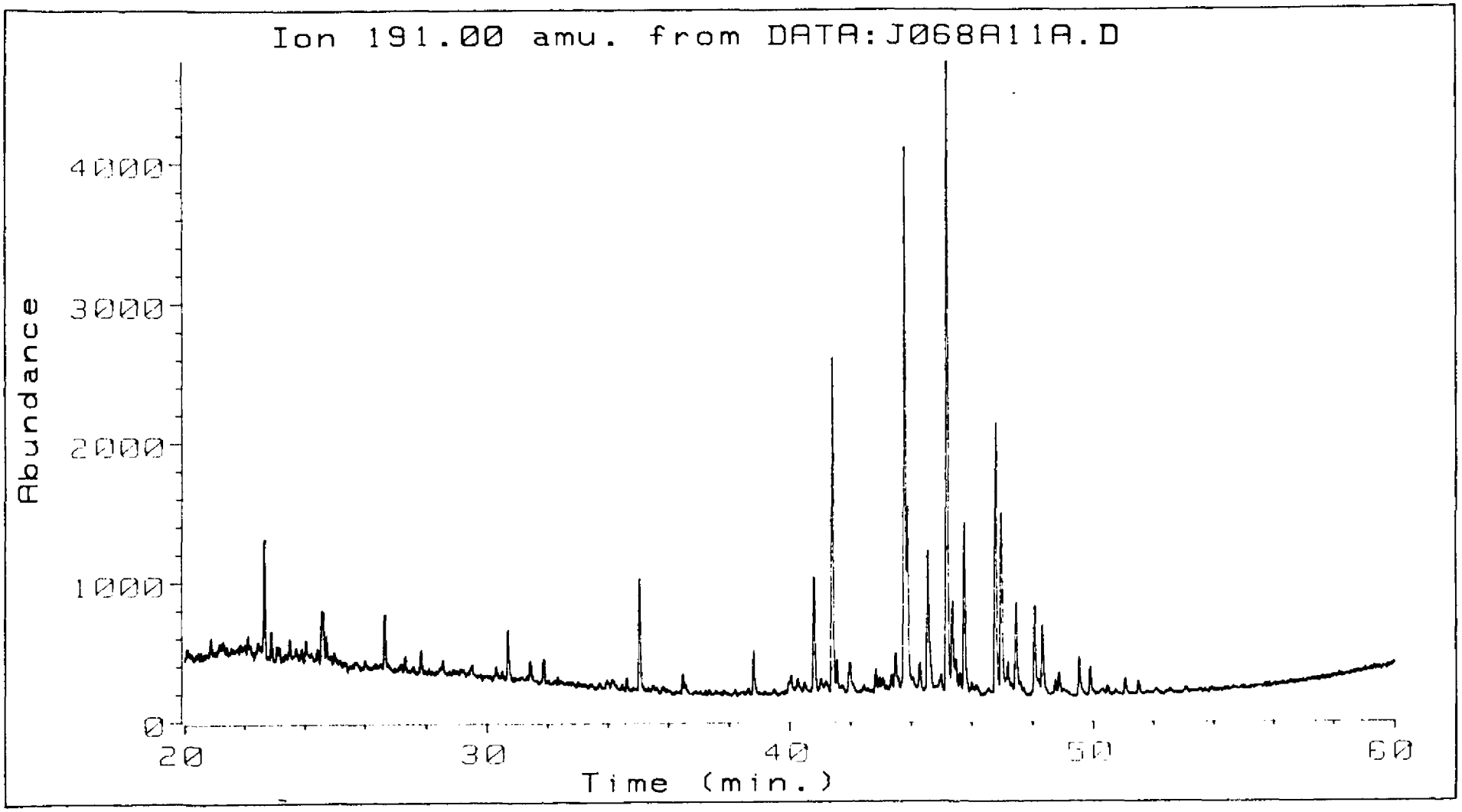
Time (min.)

2458.65 69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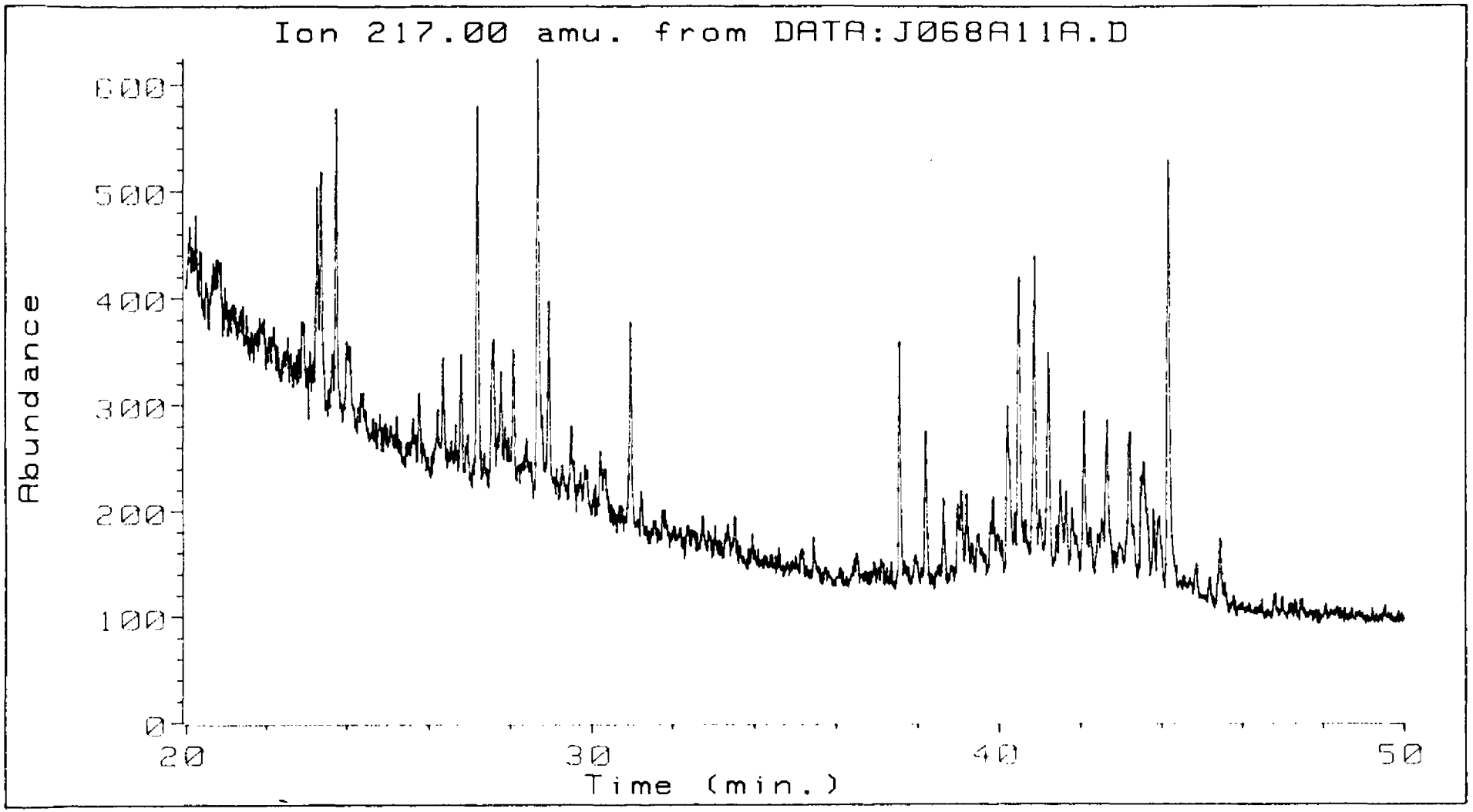
Time (min.)

2460.00 05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100
0
Abundance
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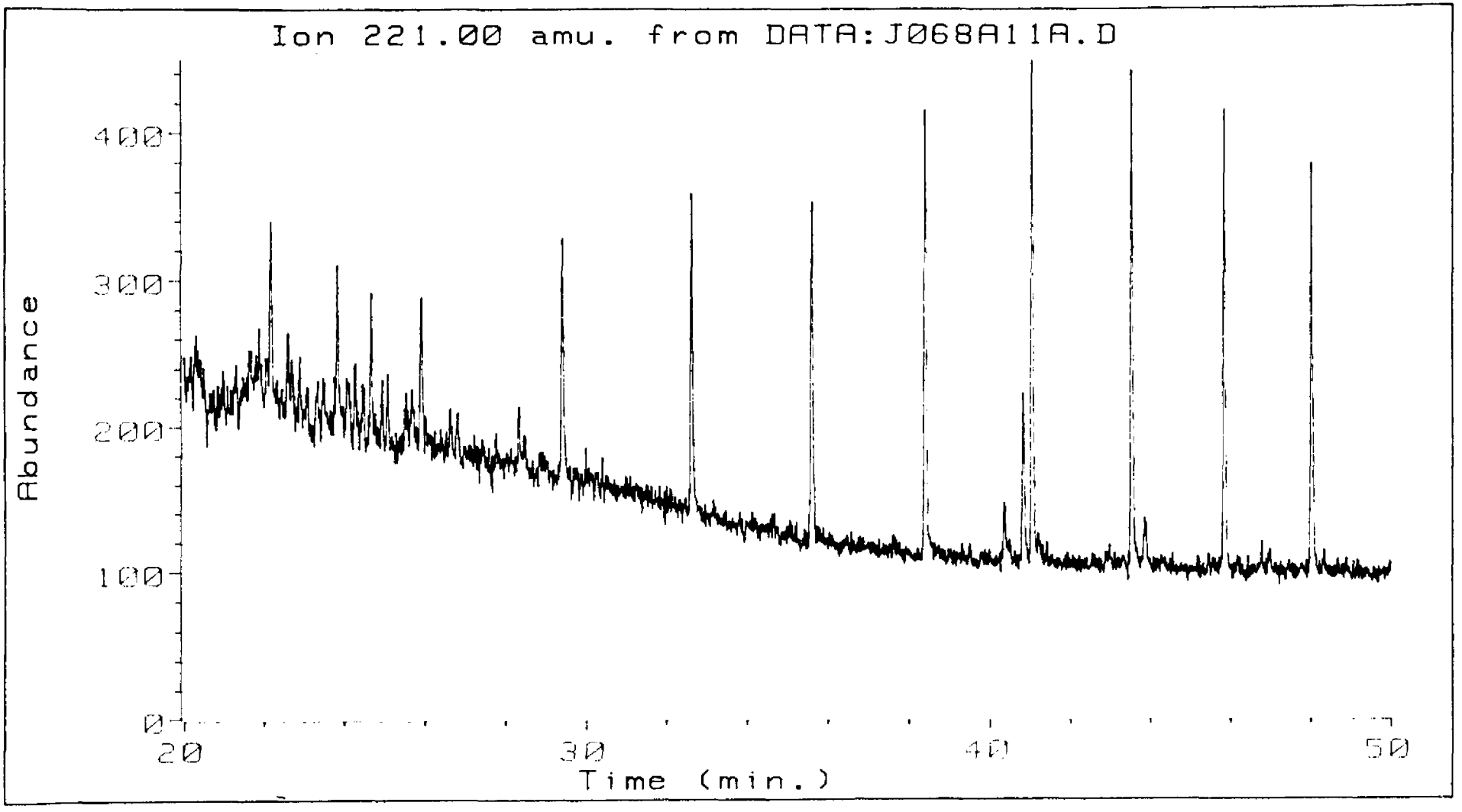
40
50
Time (min.)

2460.00 05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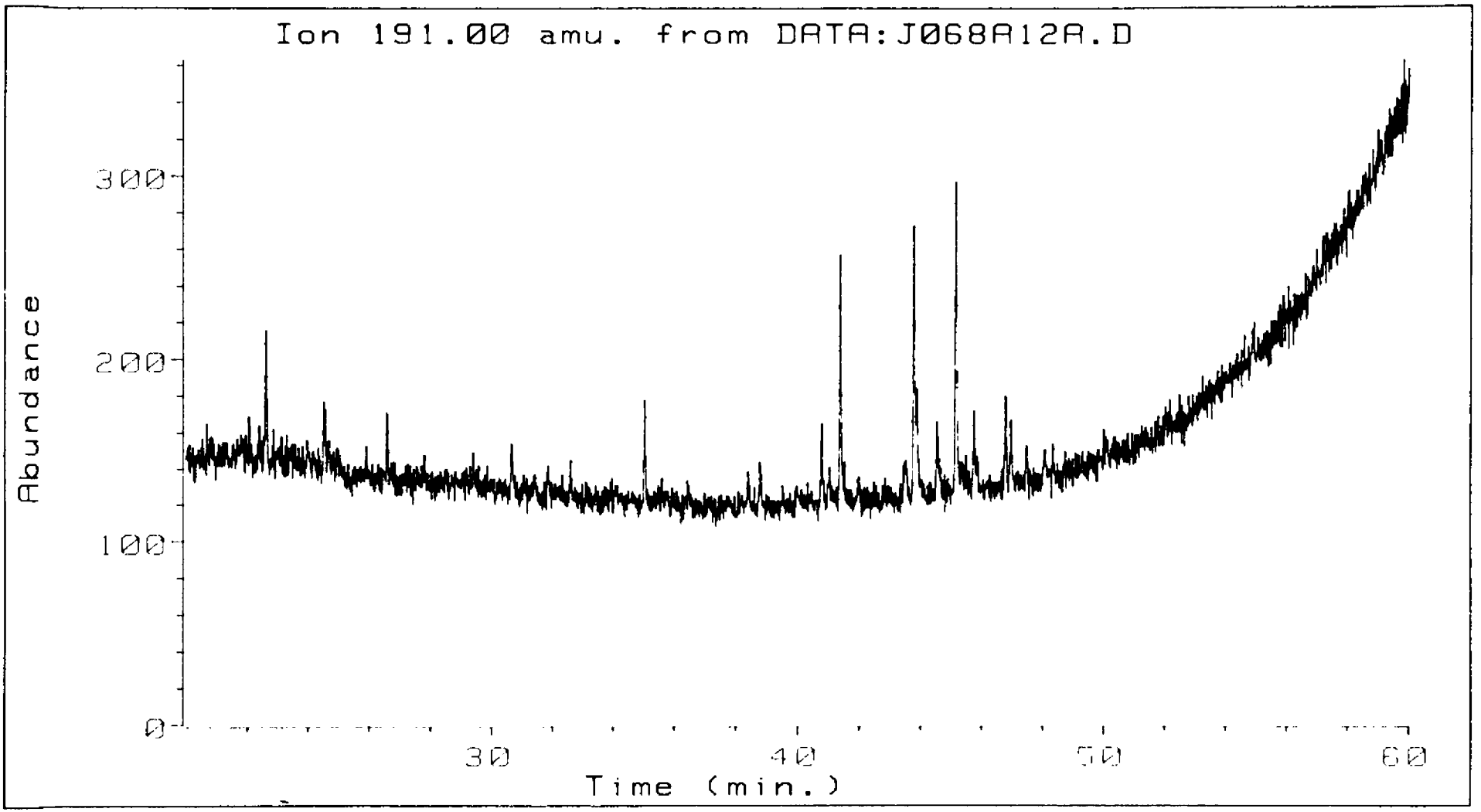
Time (min.)

2460.00 05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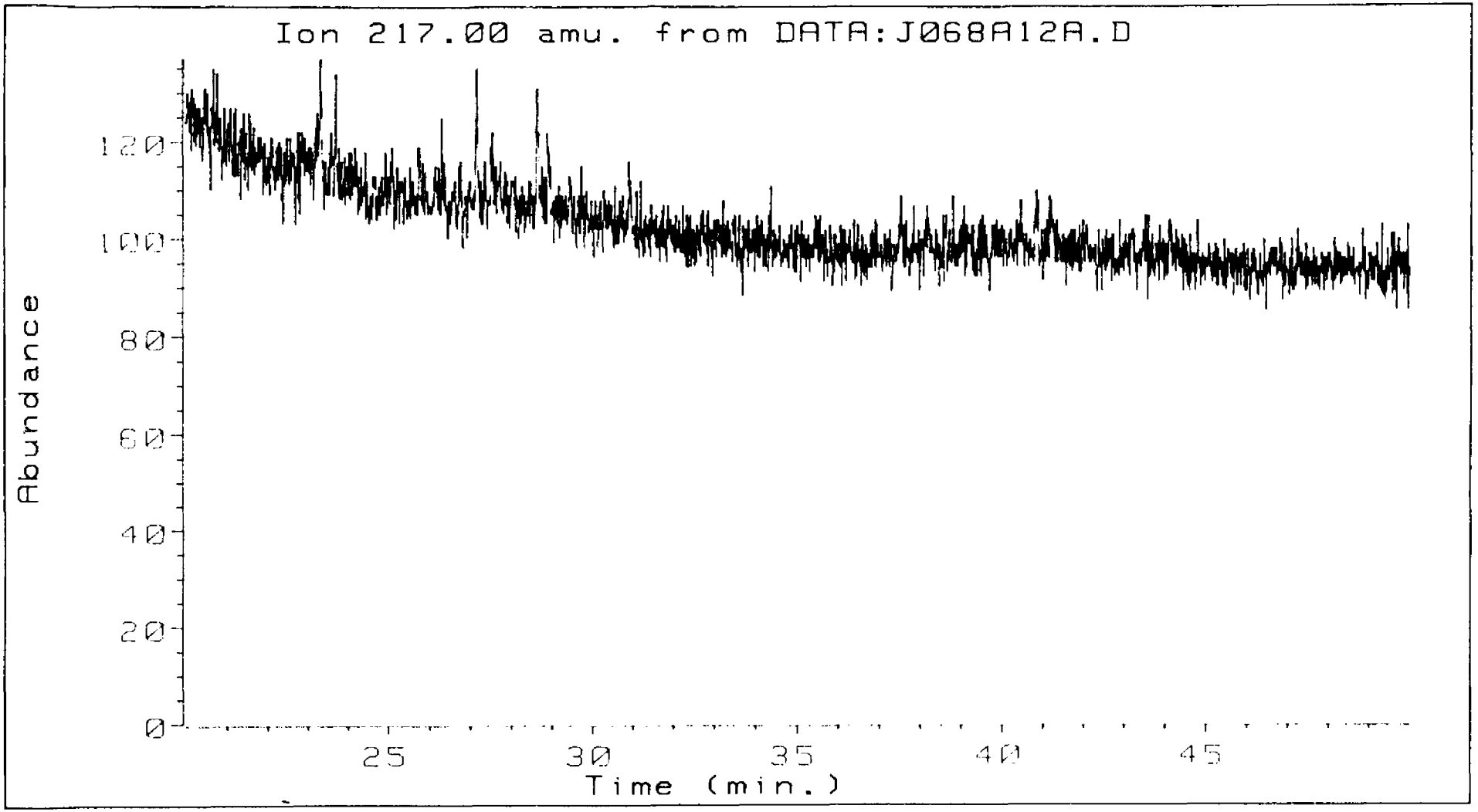
Time (min.)

2460.95 00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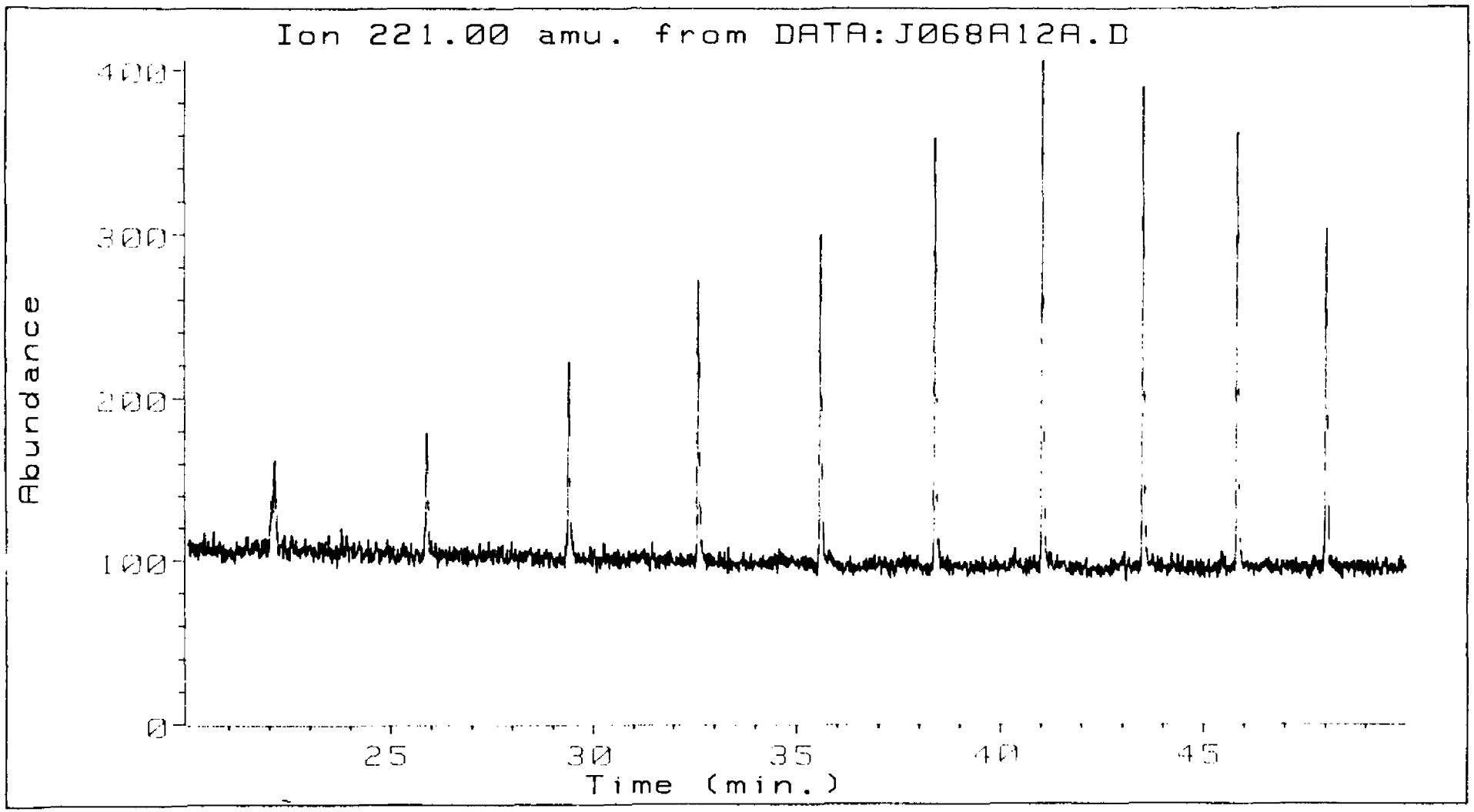
Time (min.)

2460.95 00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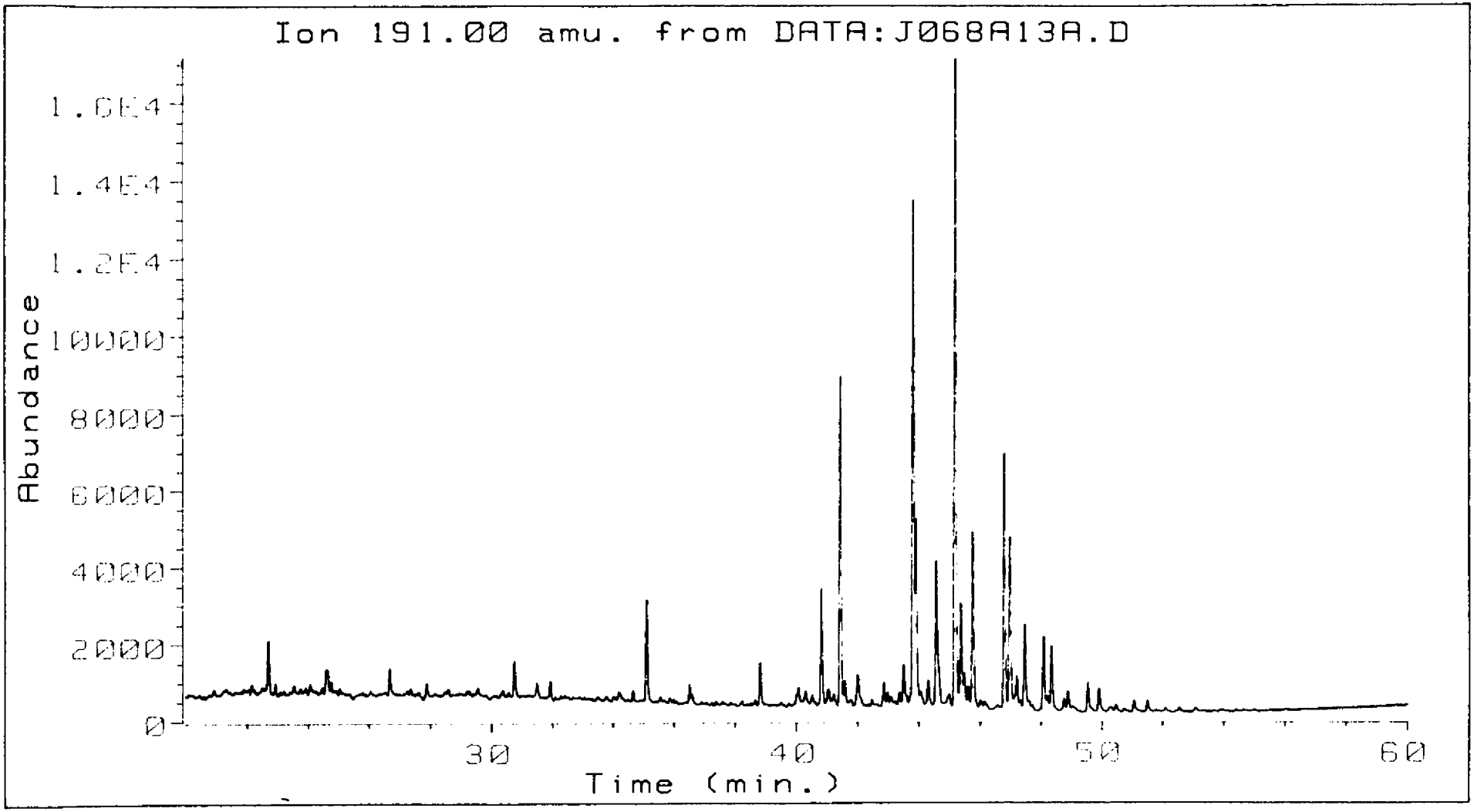
Time (min.)

2460.95 00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6000
4000
2000
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Abundance
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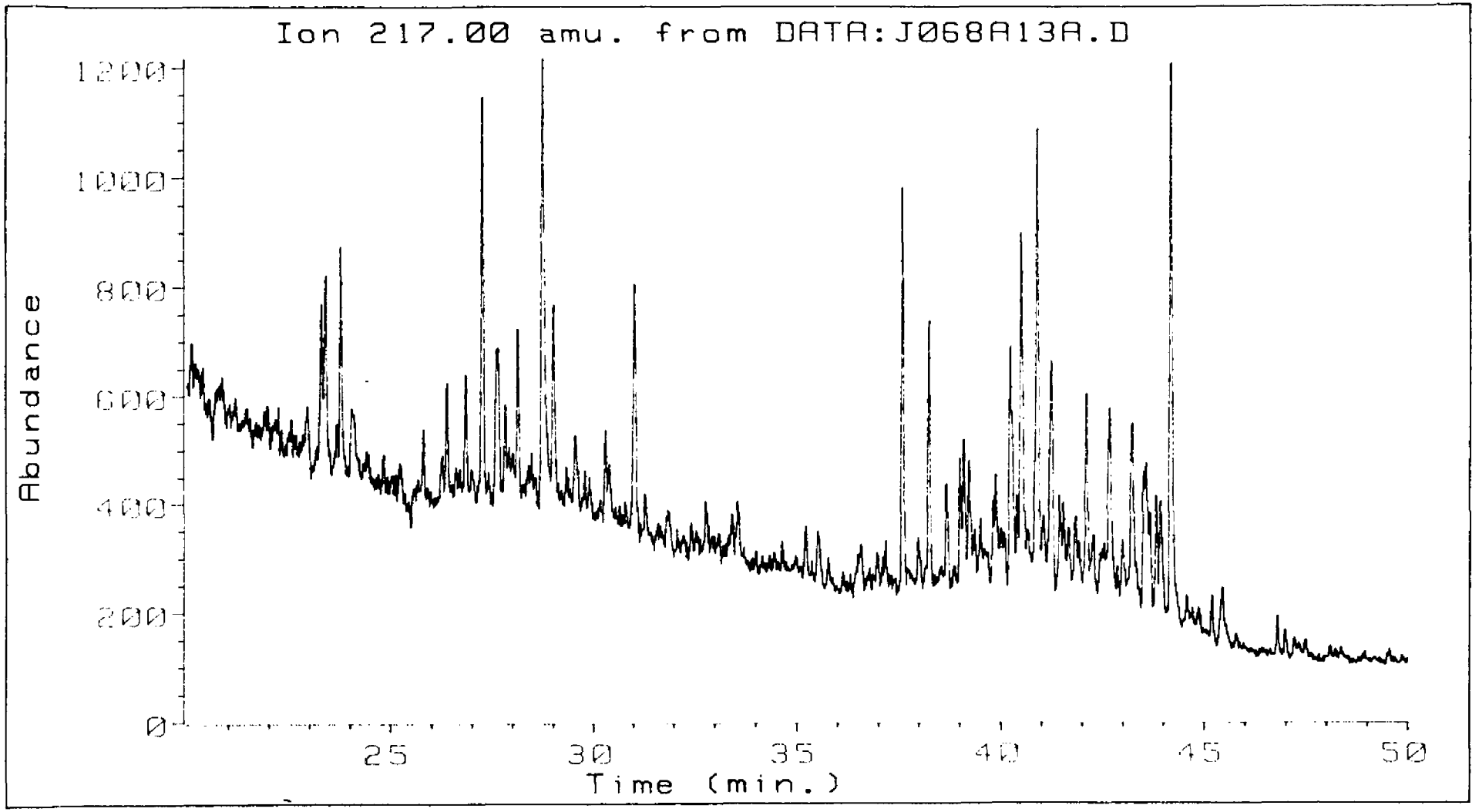
50
60
Time (min.)

2461.96 00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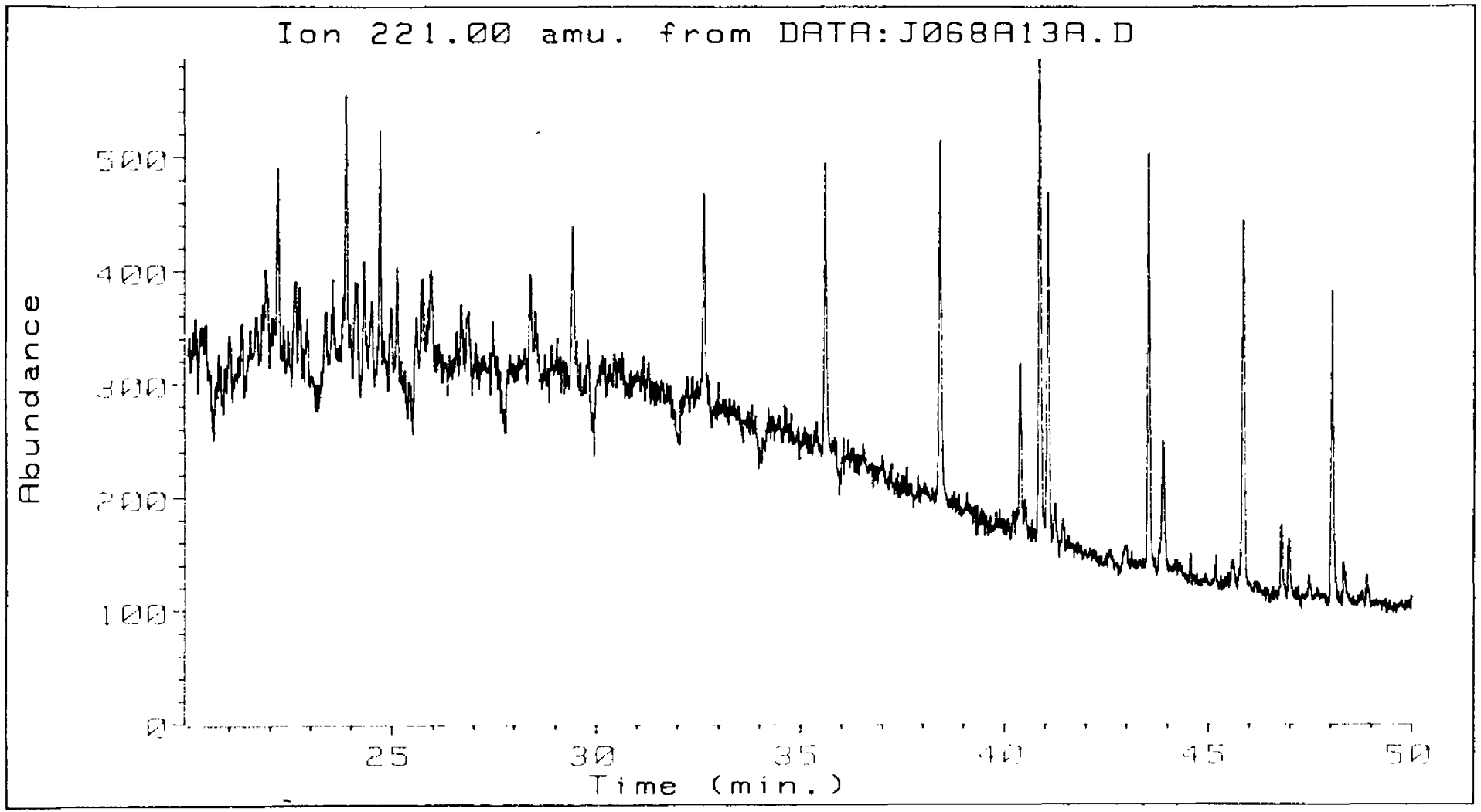
45
50
Time (min.)

2461.96 00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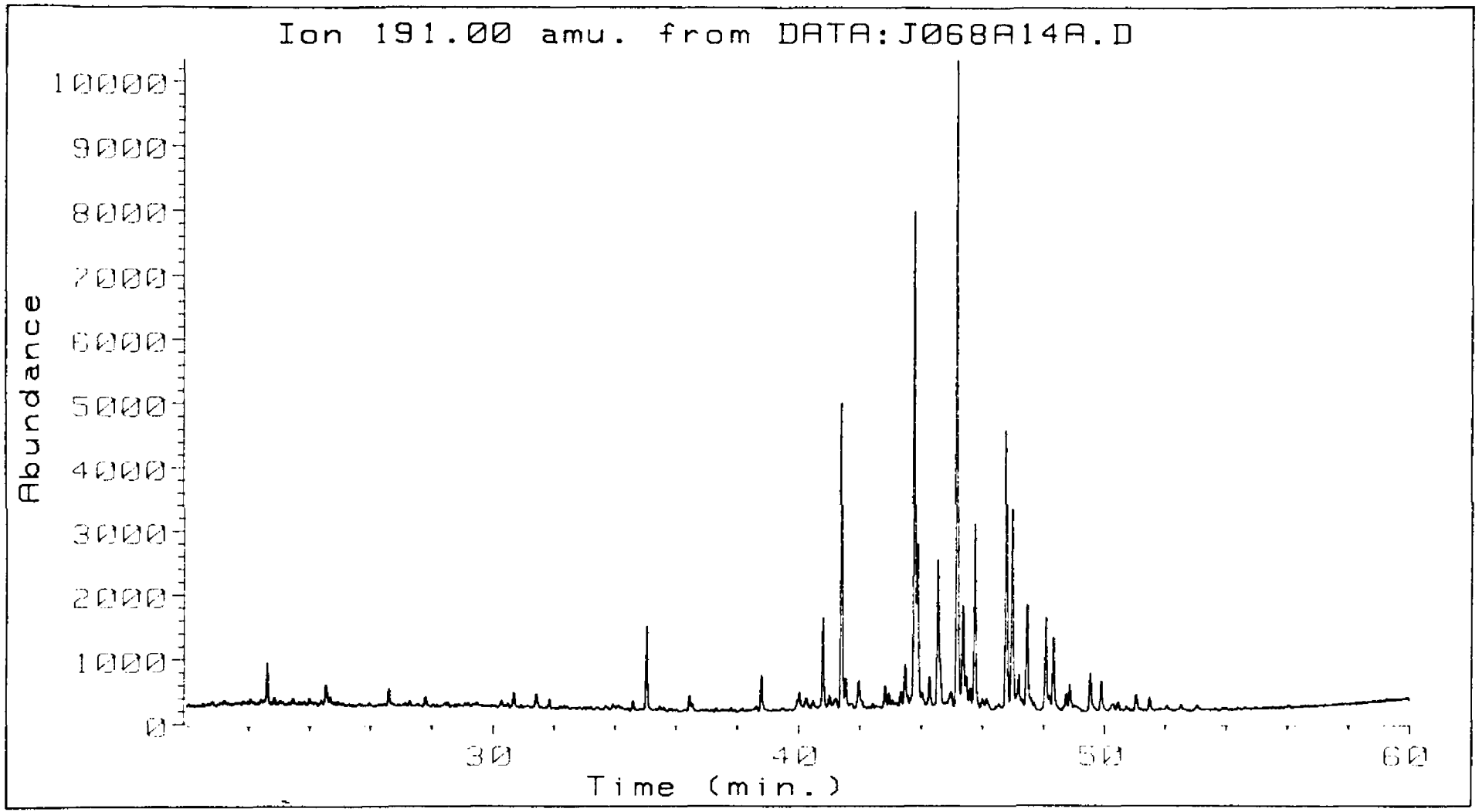
Time (min.)

2461.96 00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Abundance
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1000
0
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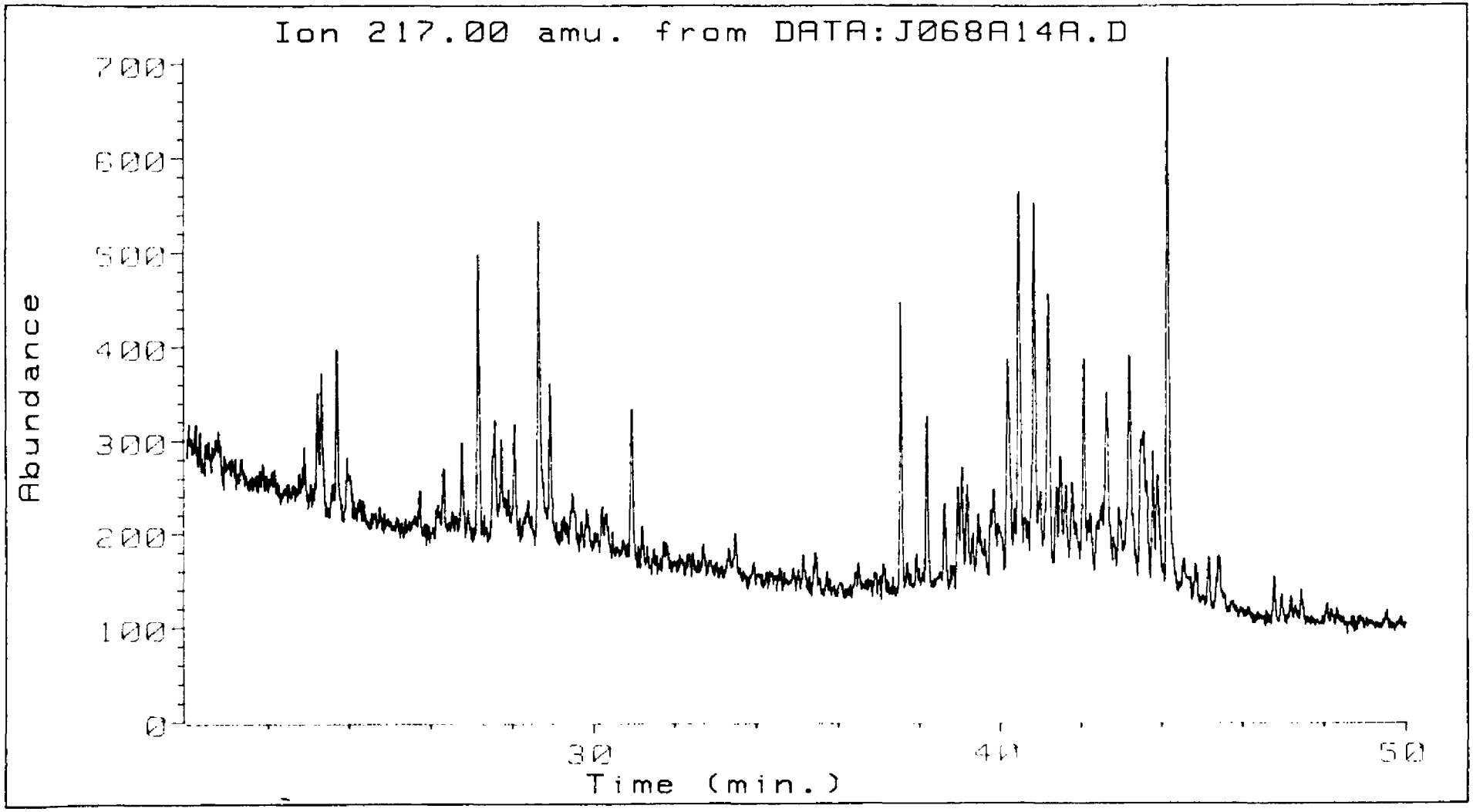
40
50
60
Time (min.)

2463.07 13


Ion 217.00 amu. from DATA:J068A14A.D
Abundance
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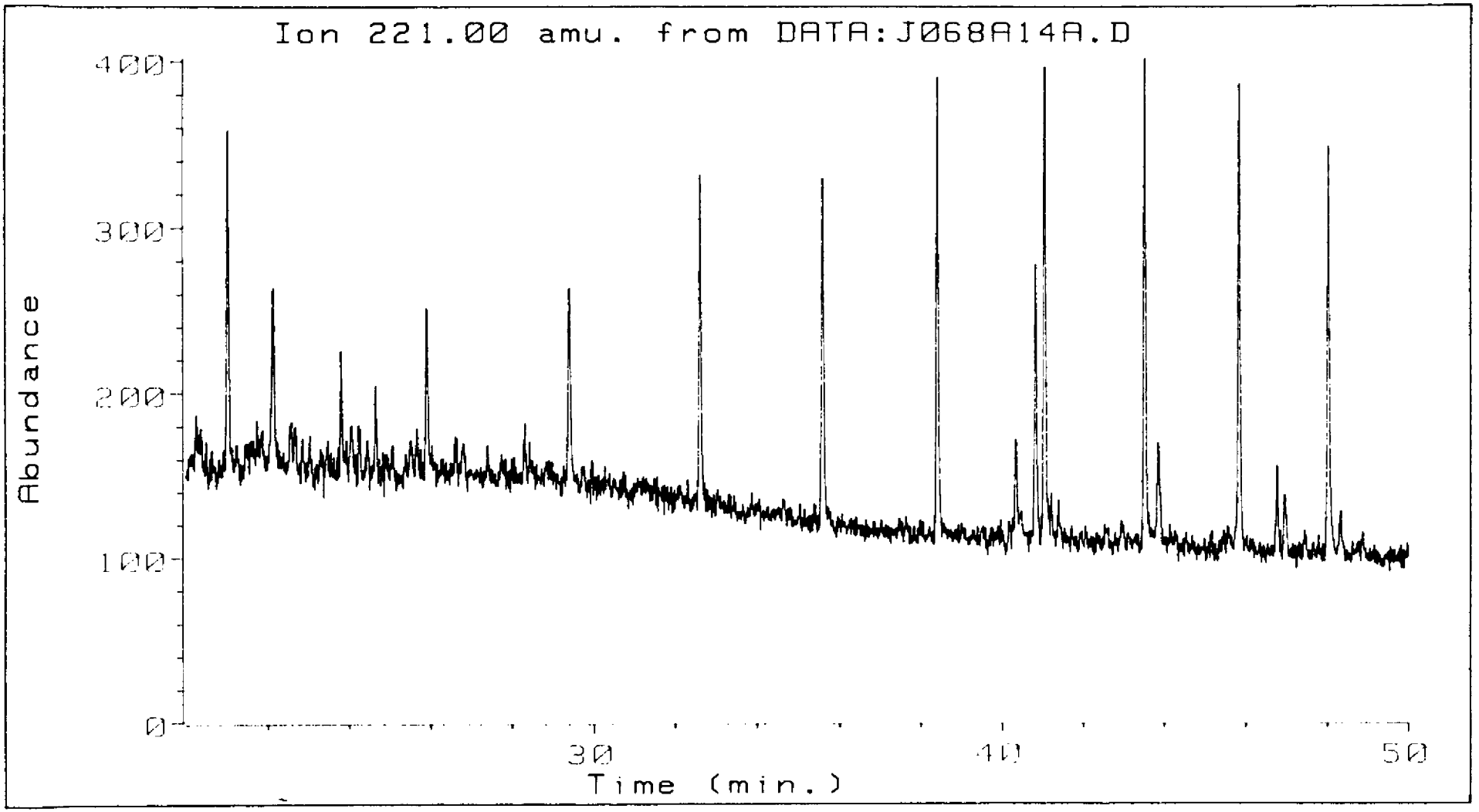
40
50
Time (min.)

2463.07 13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Abundance
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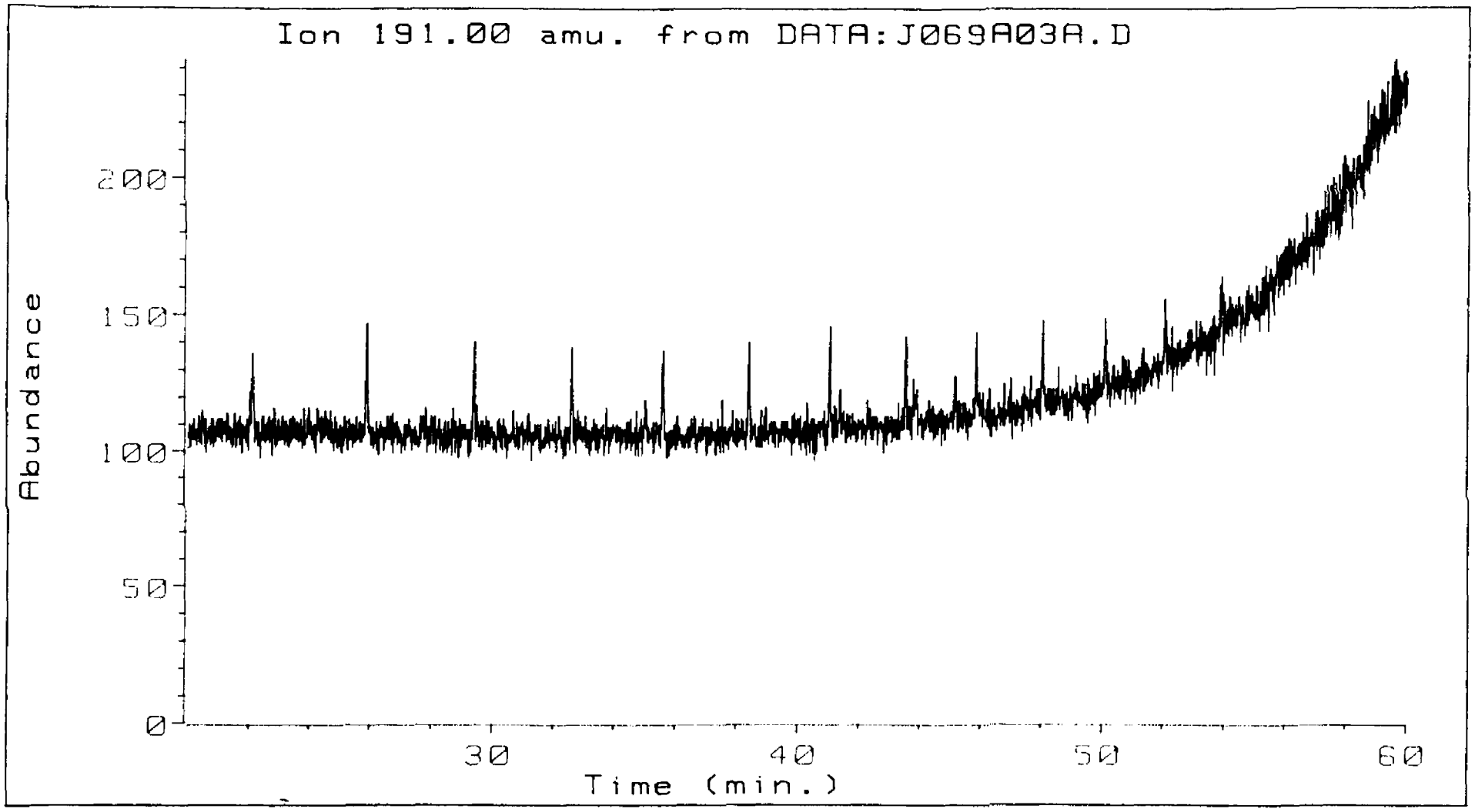
Time (min.)

2463.07 13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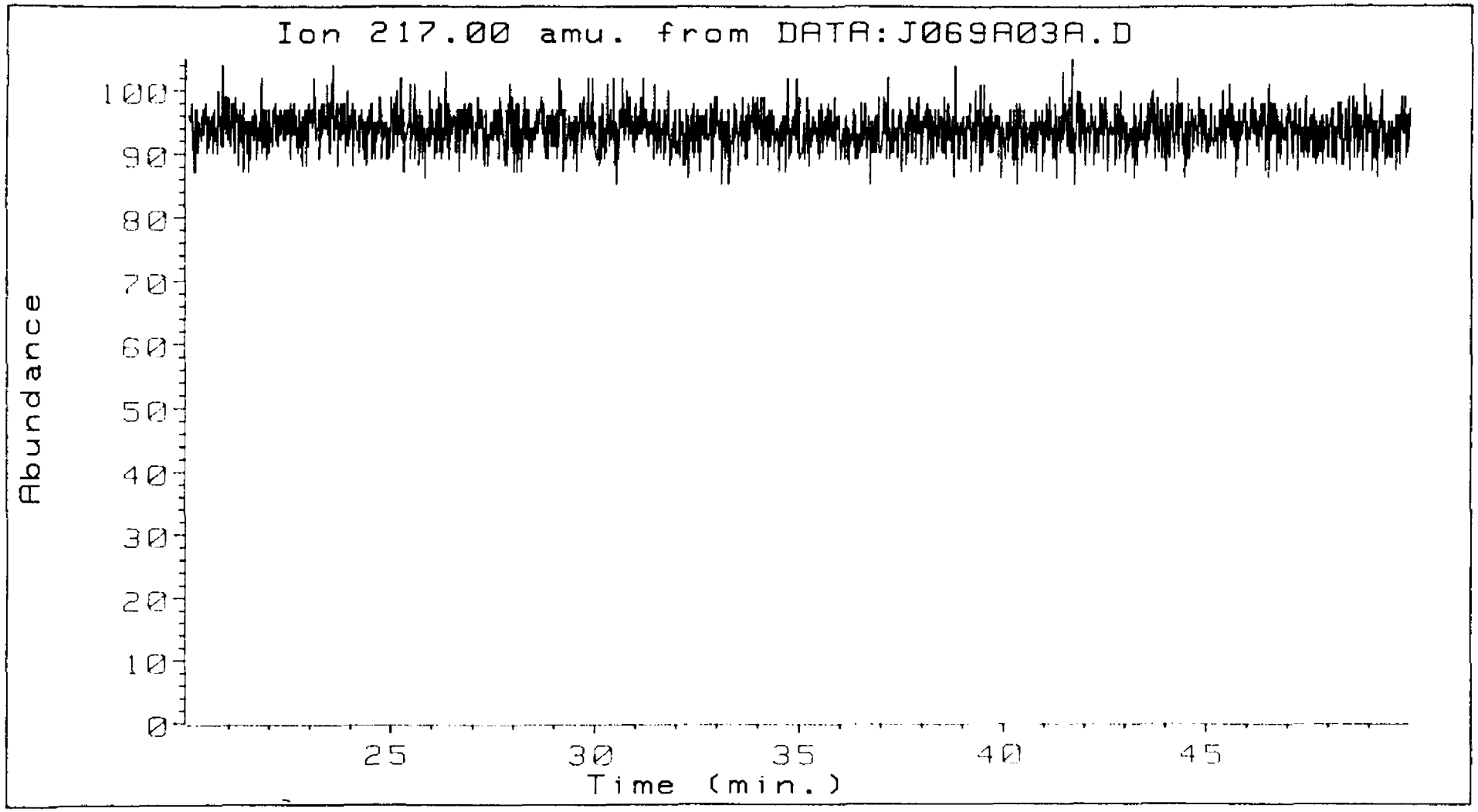
50
60
Time (min.)

2463.95 00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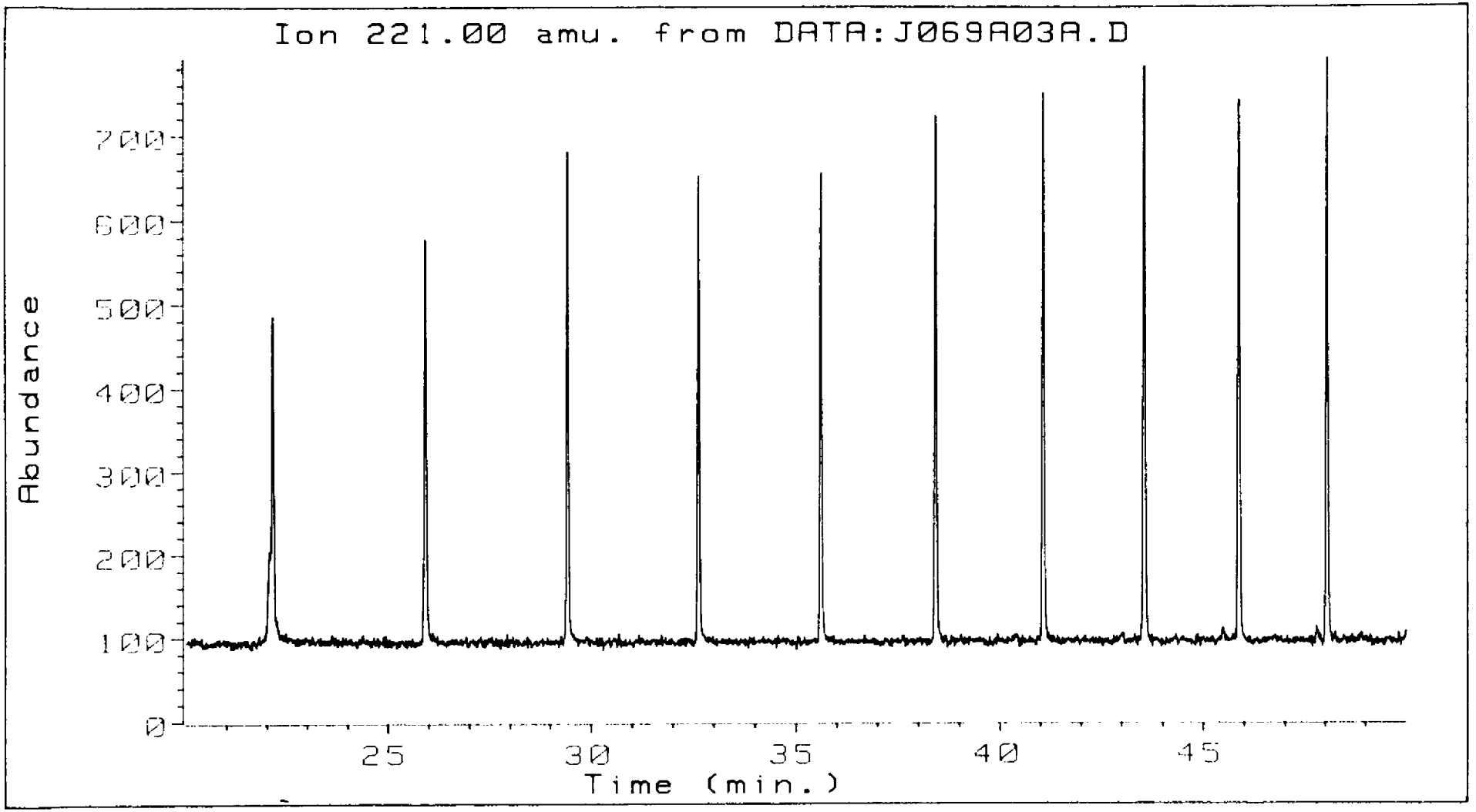
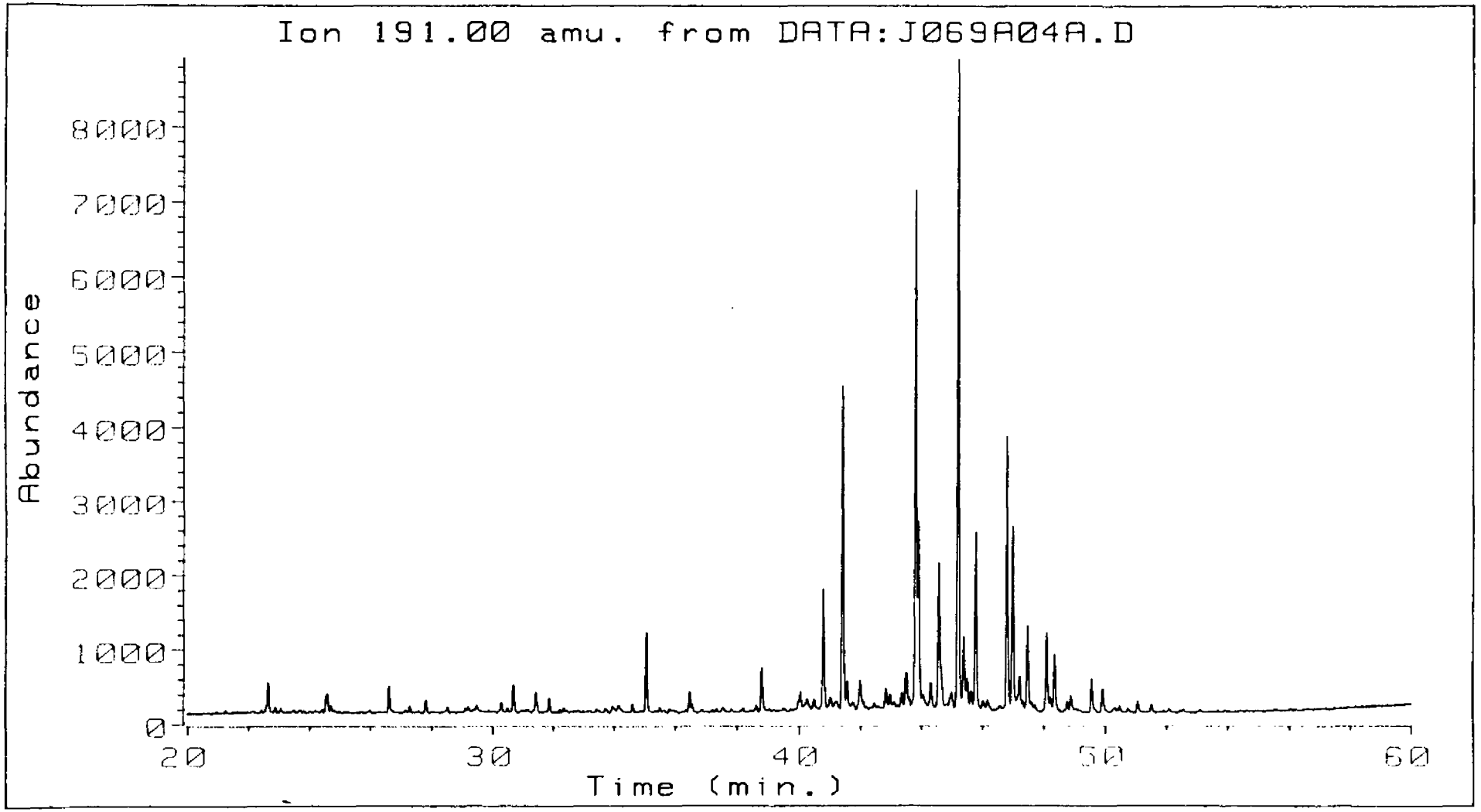
45
Time (min.)

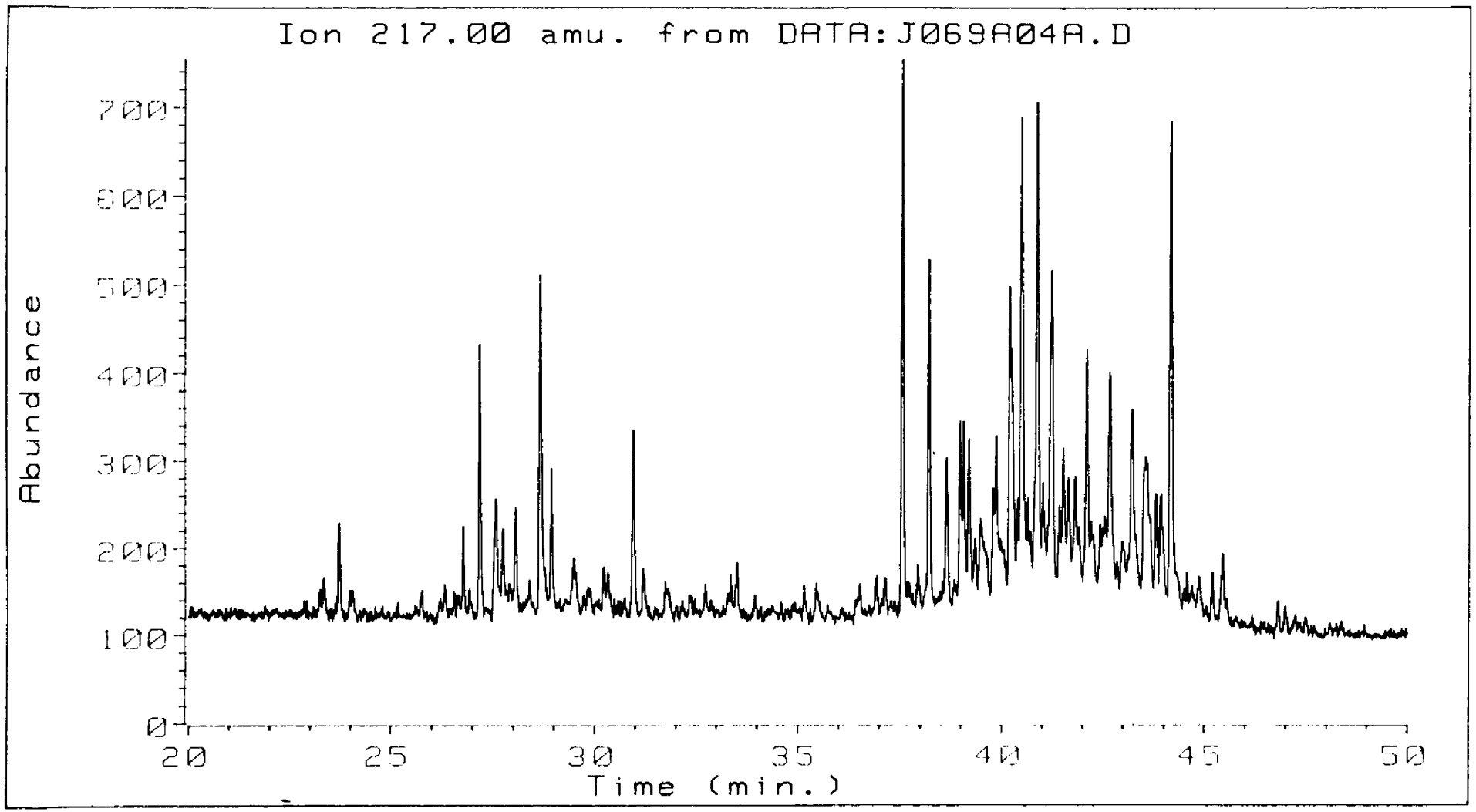
2463.95 00


Ion 221.00 amu. from DATA:J069A03A.D
Abundance
700
600
500
400
300
200
100
0
25
30
35
40
45
Time (min.)

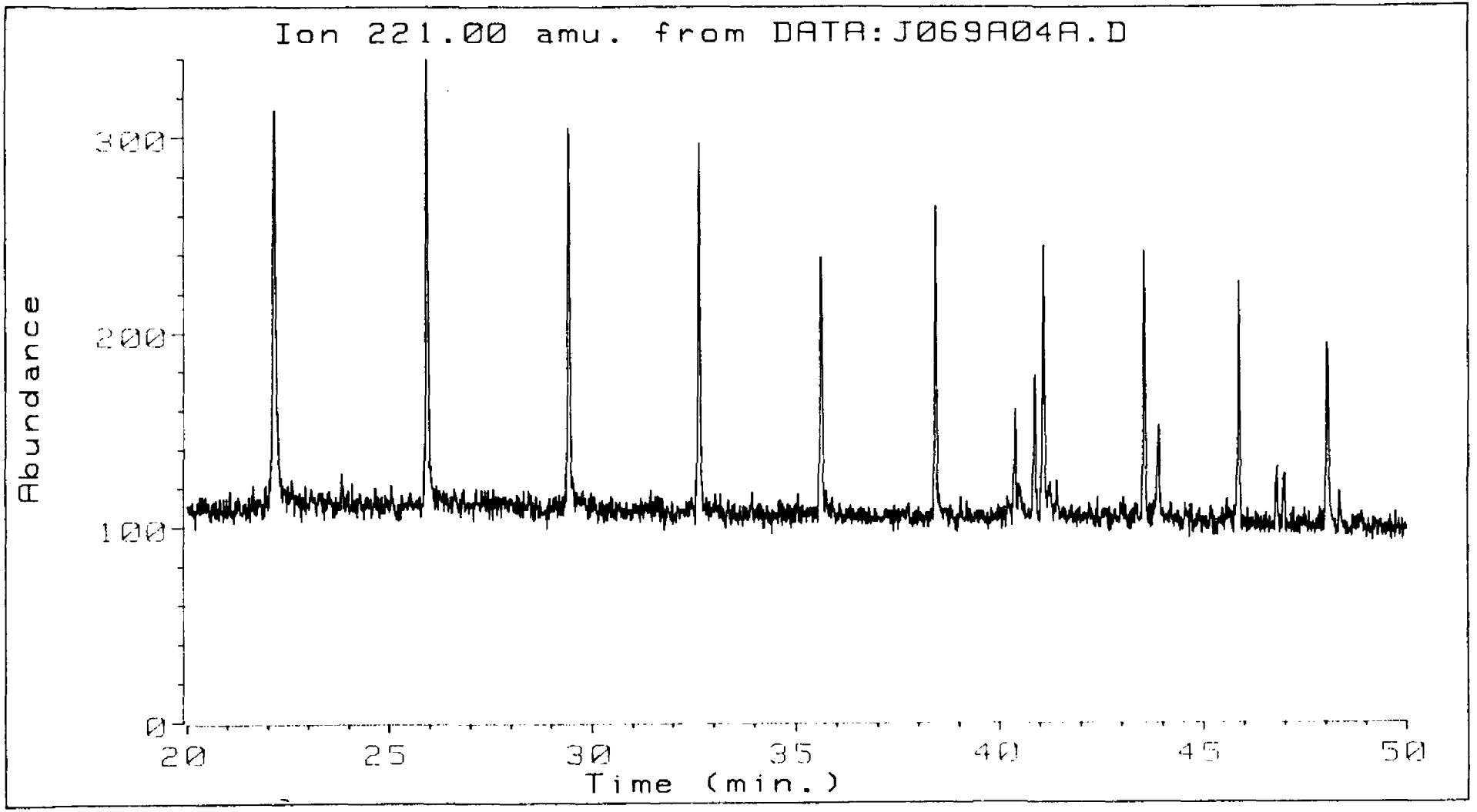
2463.95 00


Ion 191.00 amu. from DATA:J069A04A.D
Abundance
8000
7000
6000
5000
4000
3000
2000
1000
0
20
30
40
50
60
Time (min.)

2466.20 24


Ion 217.00 amu. from DATA:J069A04A.D
Abundance
700
600
500
400
300
200
100
0
20
25
30
35
40
45
50
Time (min.)

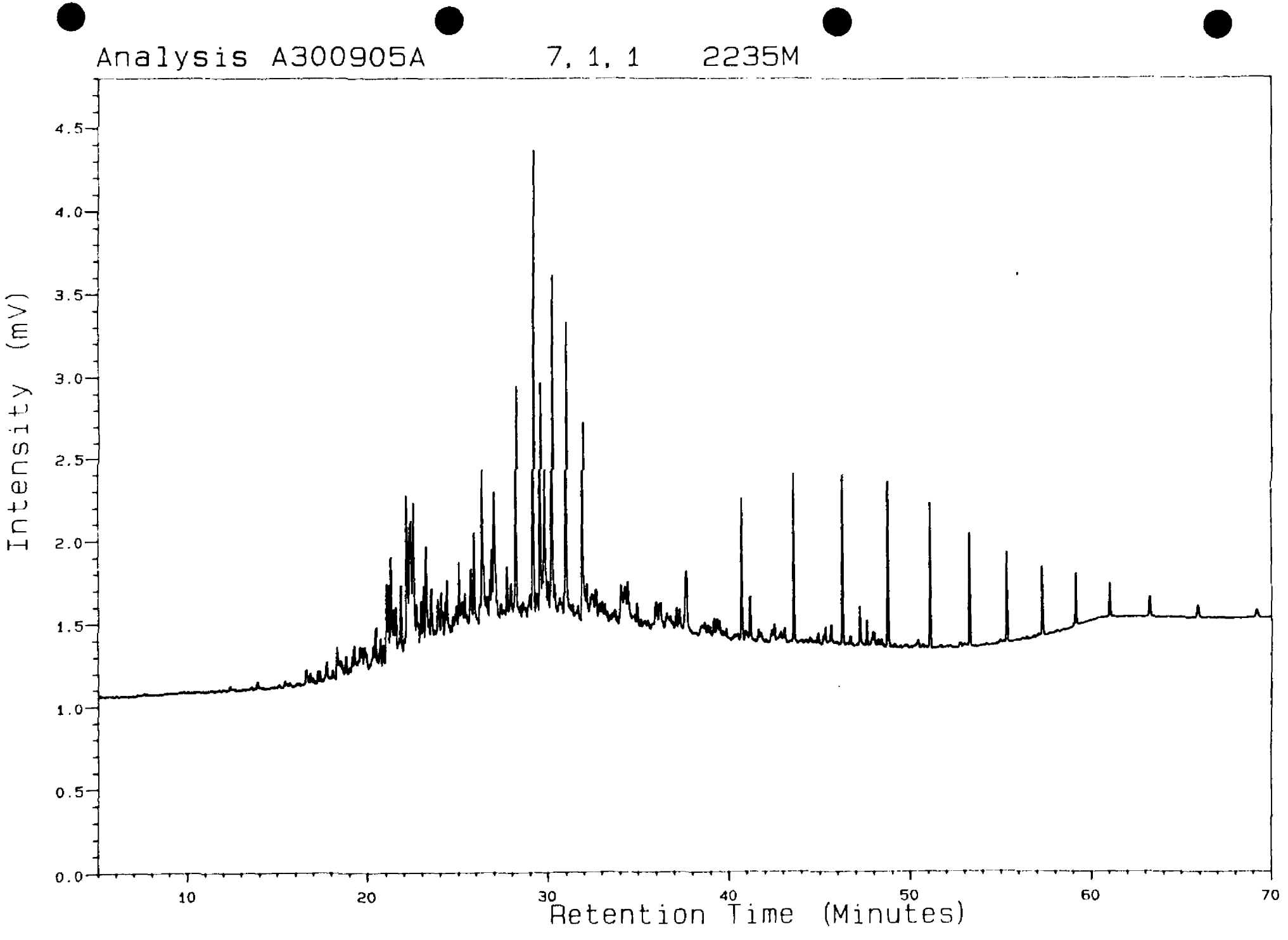
2466.20 24

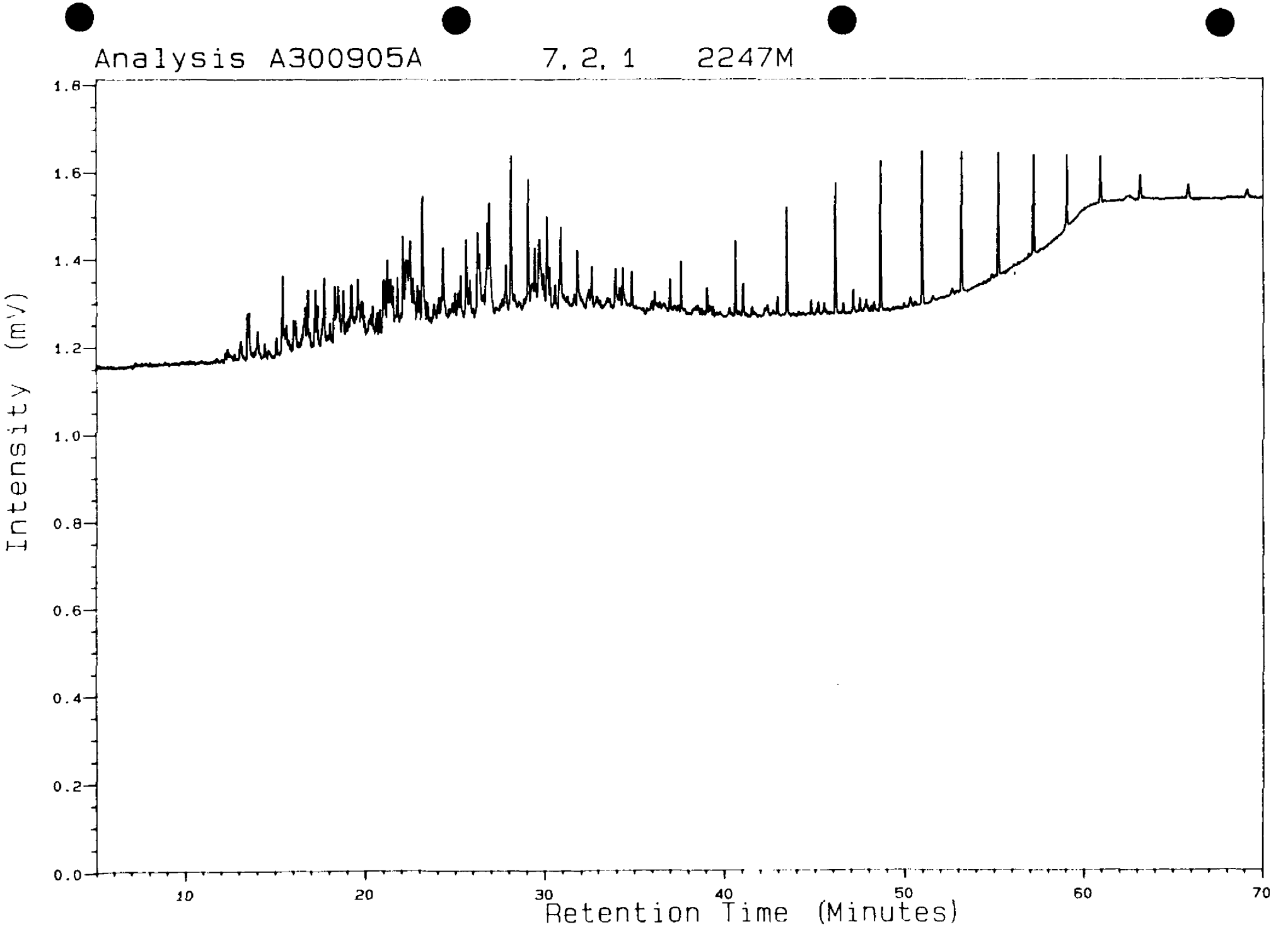

Ion 221.00 amu. from DATA:J069A04A.D
Abundance
300
200
100
0
20
25
30
35
40
45
50
Time (min.)

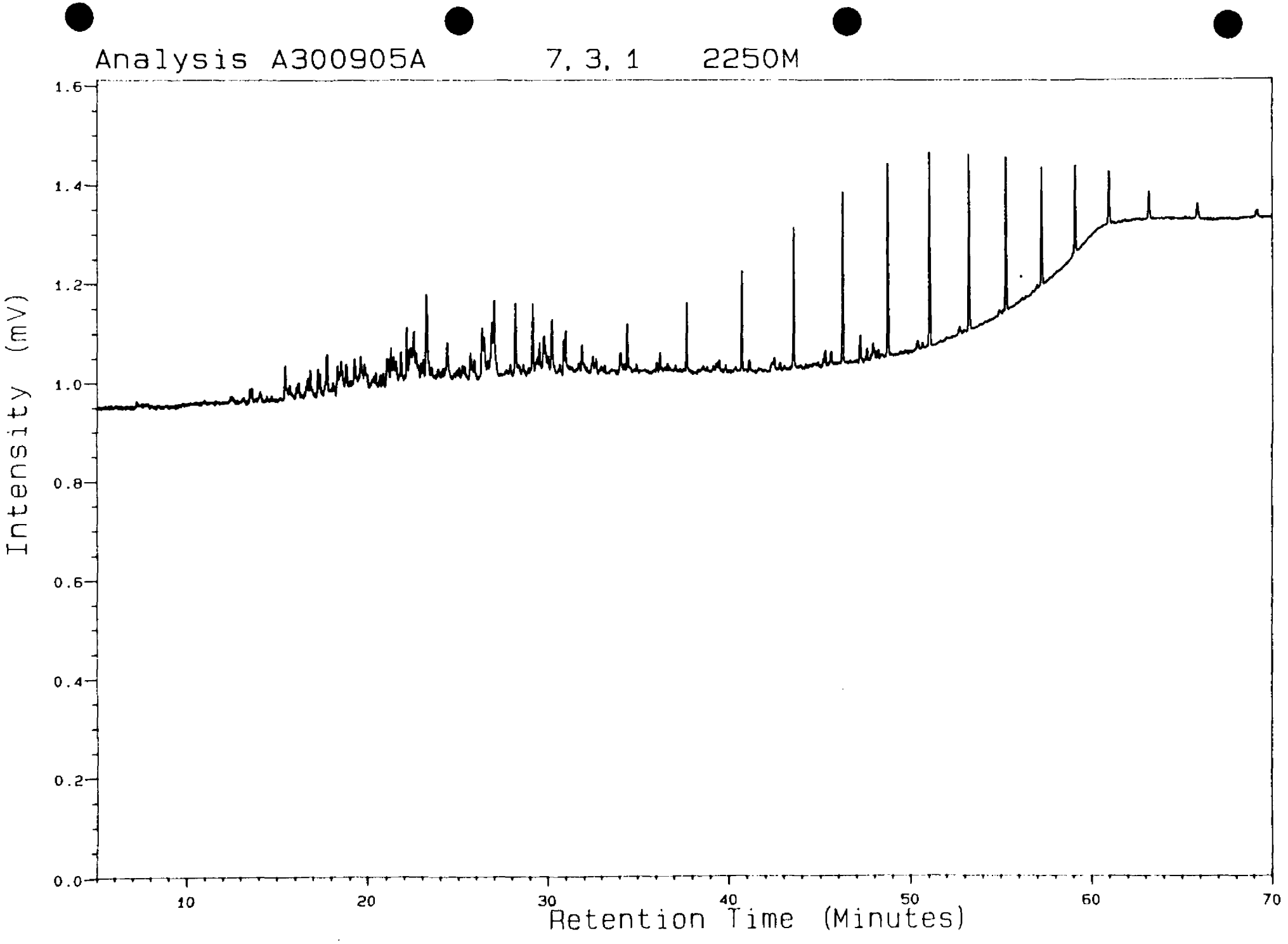
2466.20 24

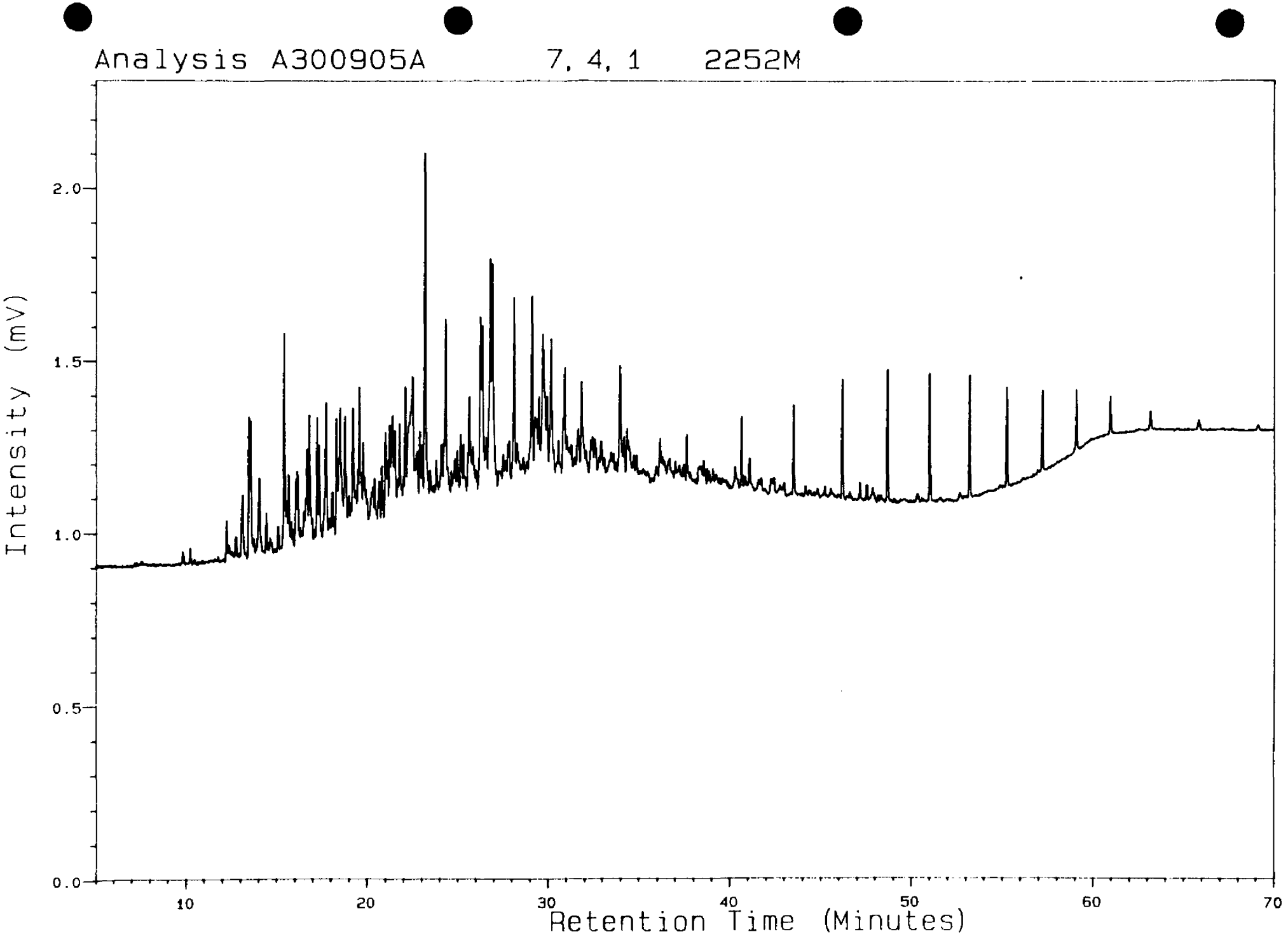
APPENDIX III

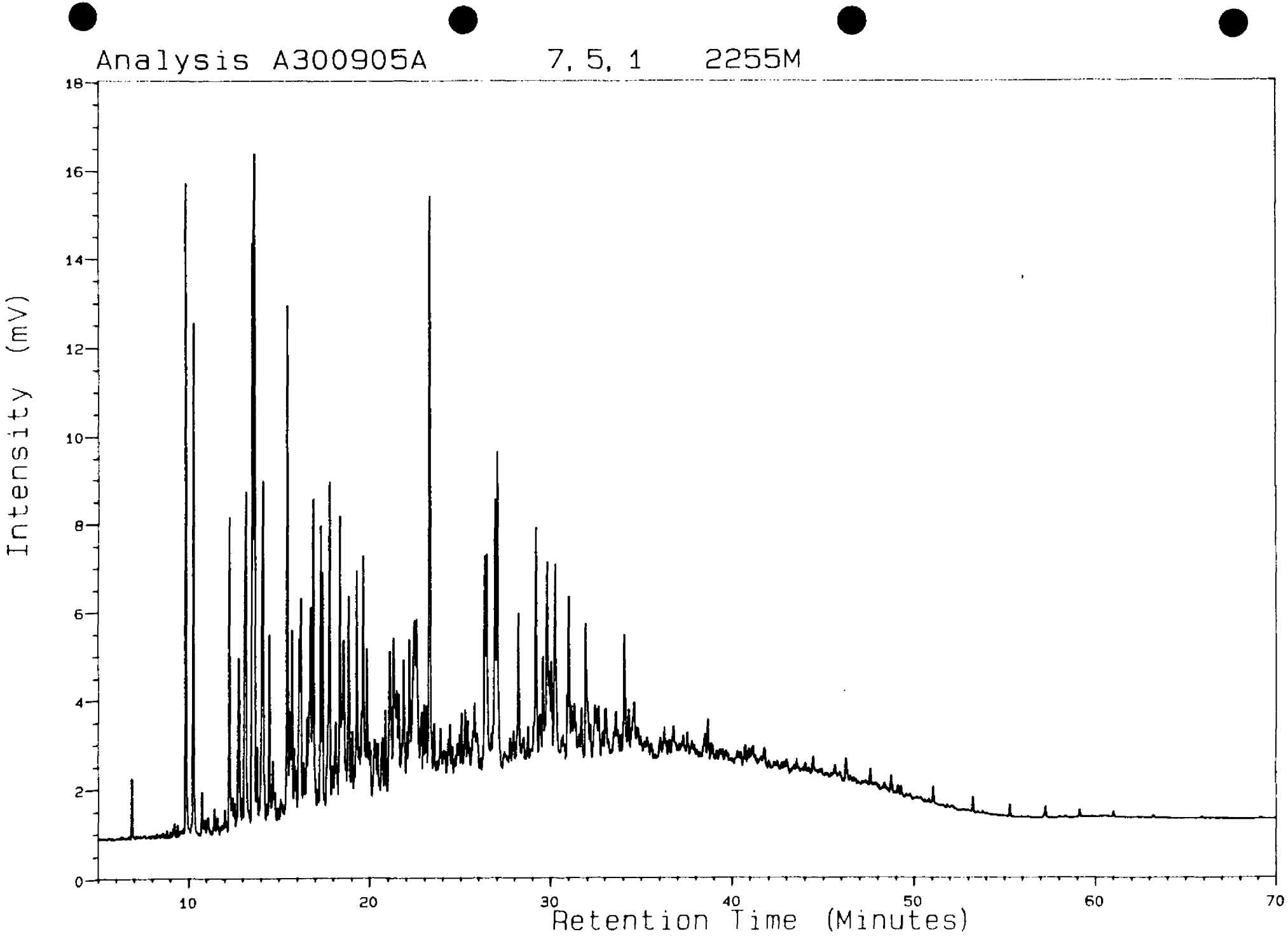
GC OF AROMATIC FRACTIONS

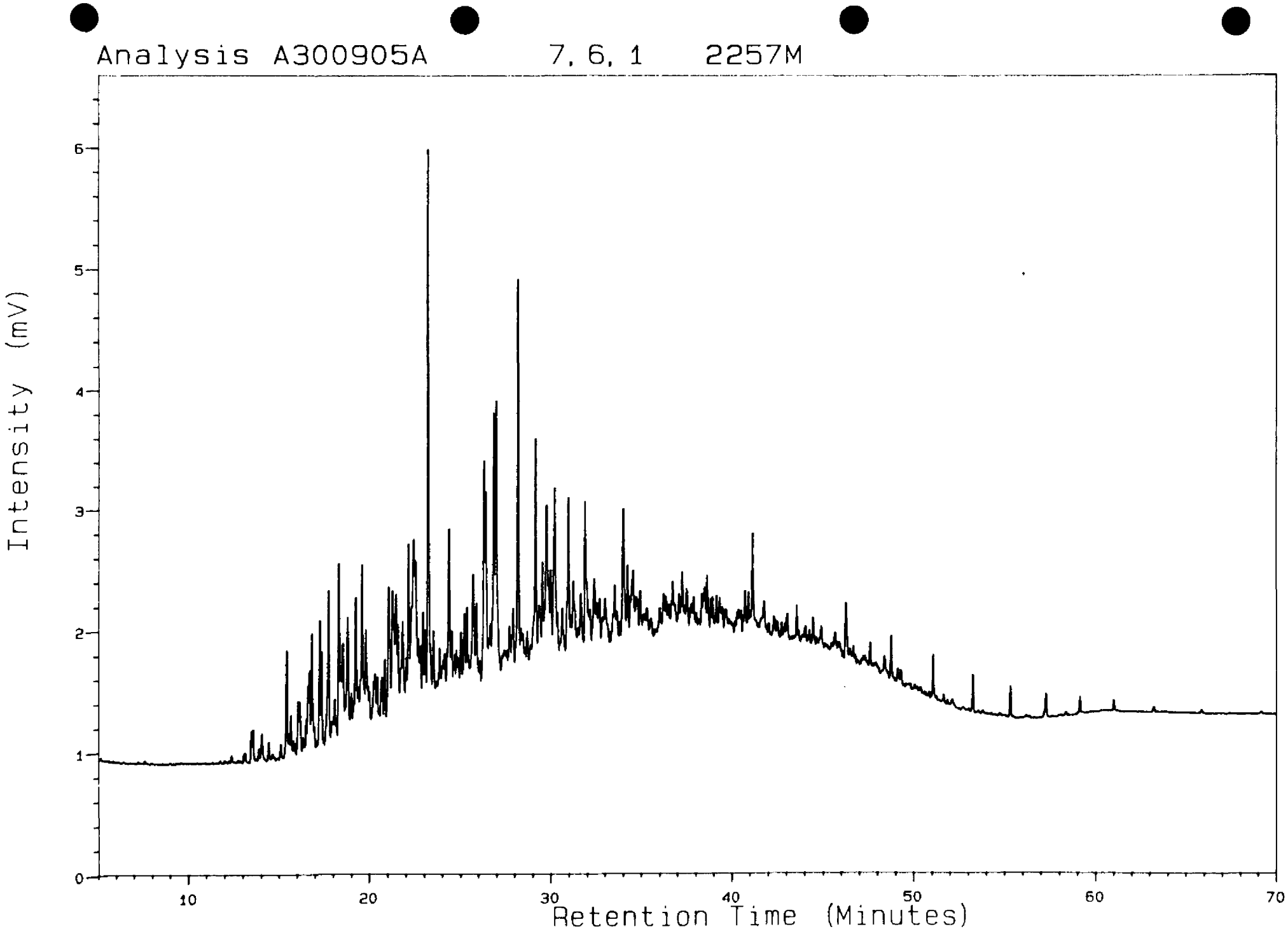

Analysis A300905A 7, 1, 1 2235M
Intensity (mV)
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
10
20
30
40
50
60
70
Retention Time (Minutes)

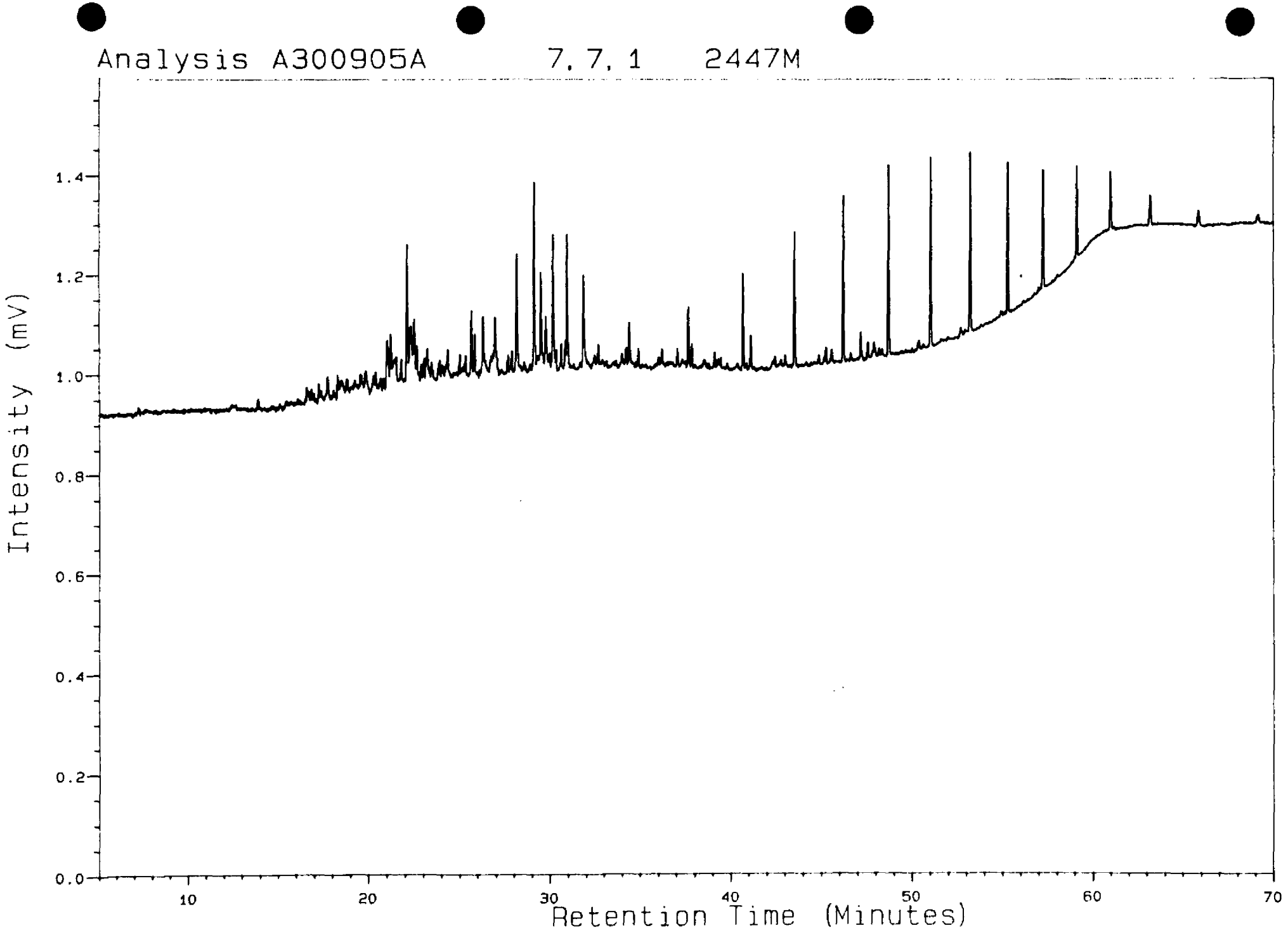

Analysis A300905A 7, 2, 1 2247M
Intensity (mV)
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
10
20
30
40
50
60
70
Retention Time (Minutes)

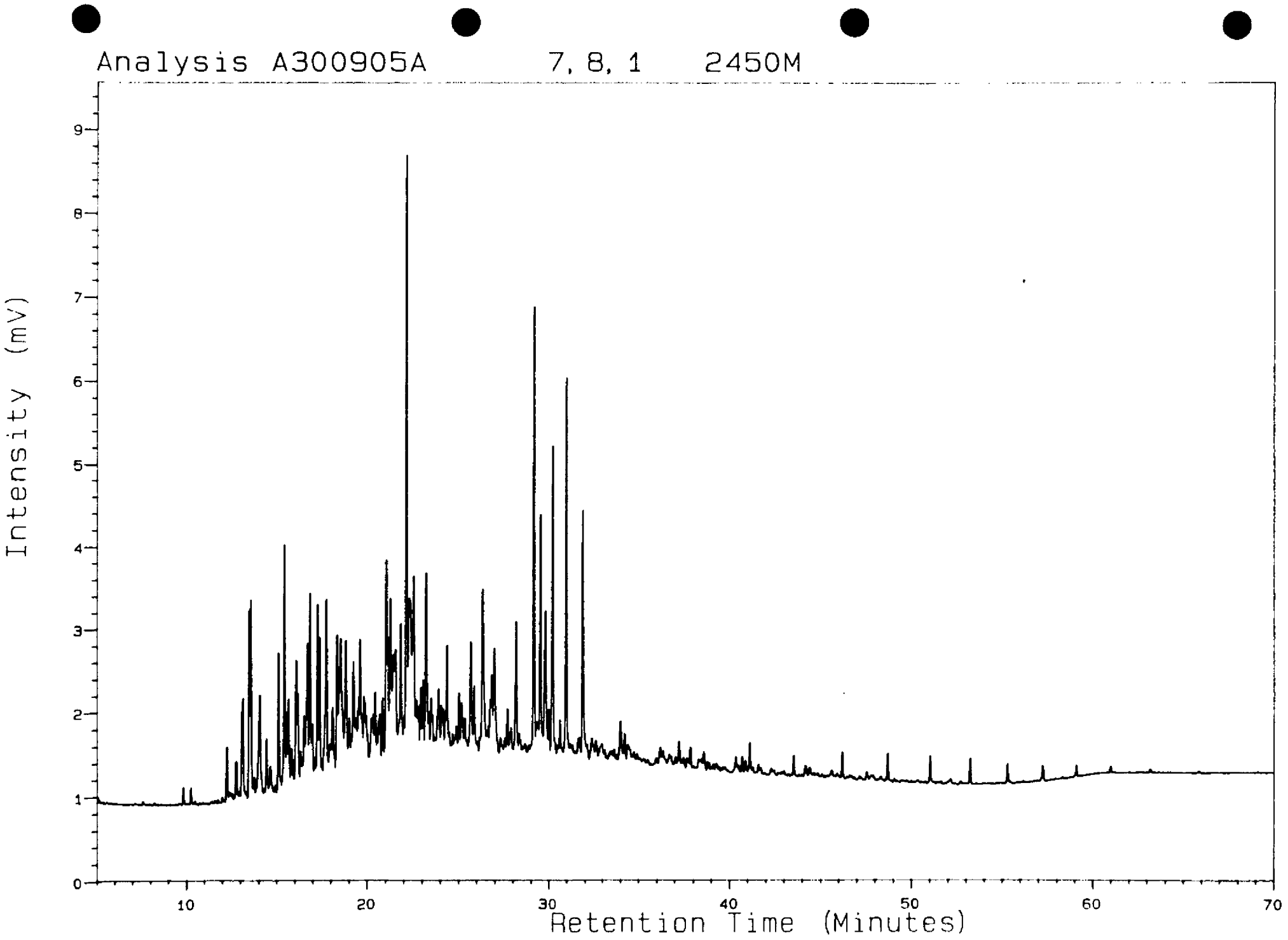

Analysis A300905A 7, 3, 1 2250M
Intensity (mV)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
10
20
30
40
50
60
70
Retention Time (Minutes)

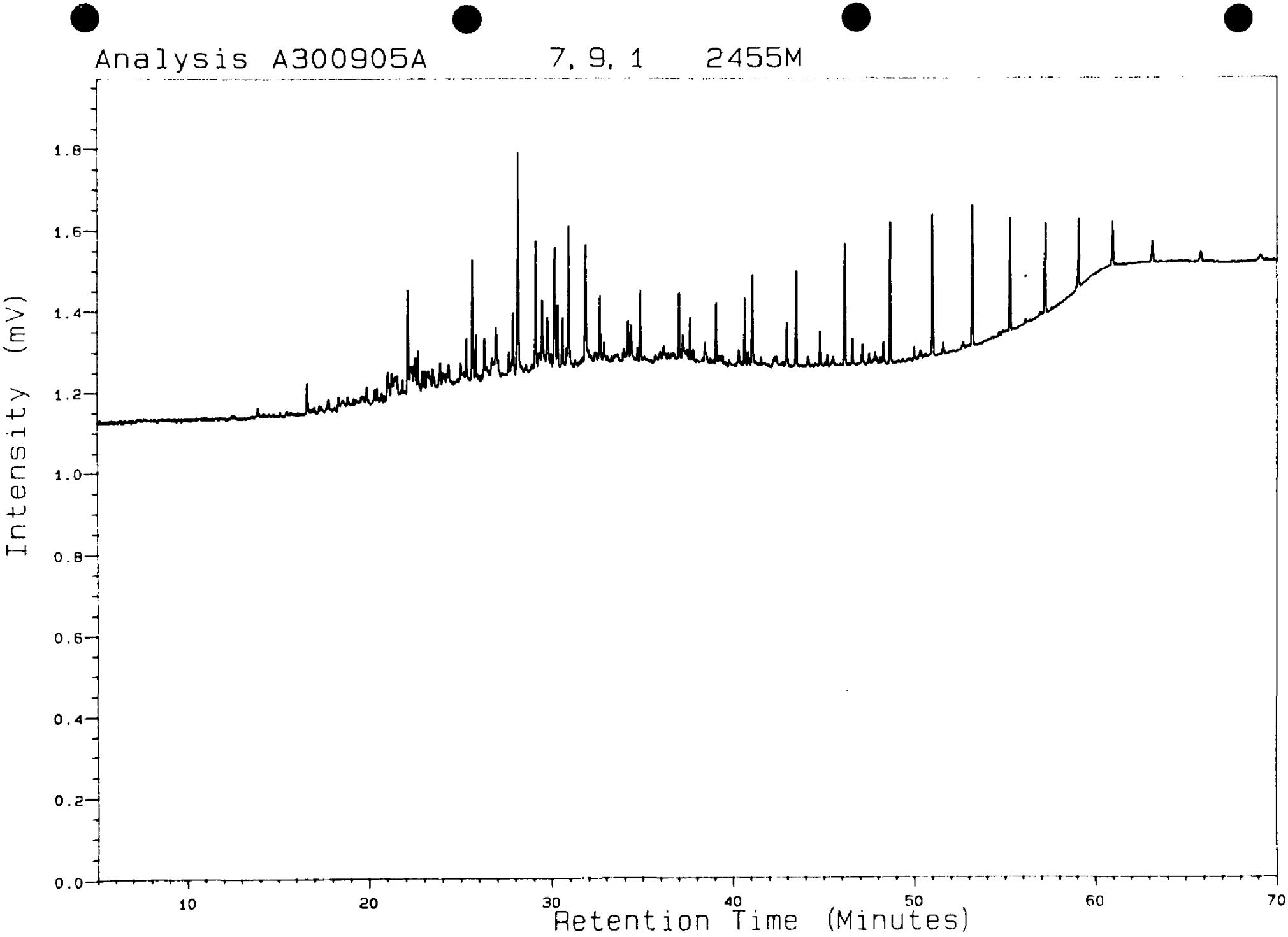

Analysis A300905A 7, 4, 1 2252M
Intensity (mV)
2.0
1.5
1.0
0.5
0.0
10
20
30
40
50
60
70
Retention Time (Minutes)

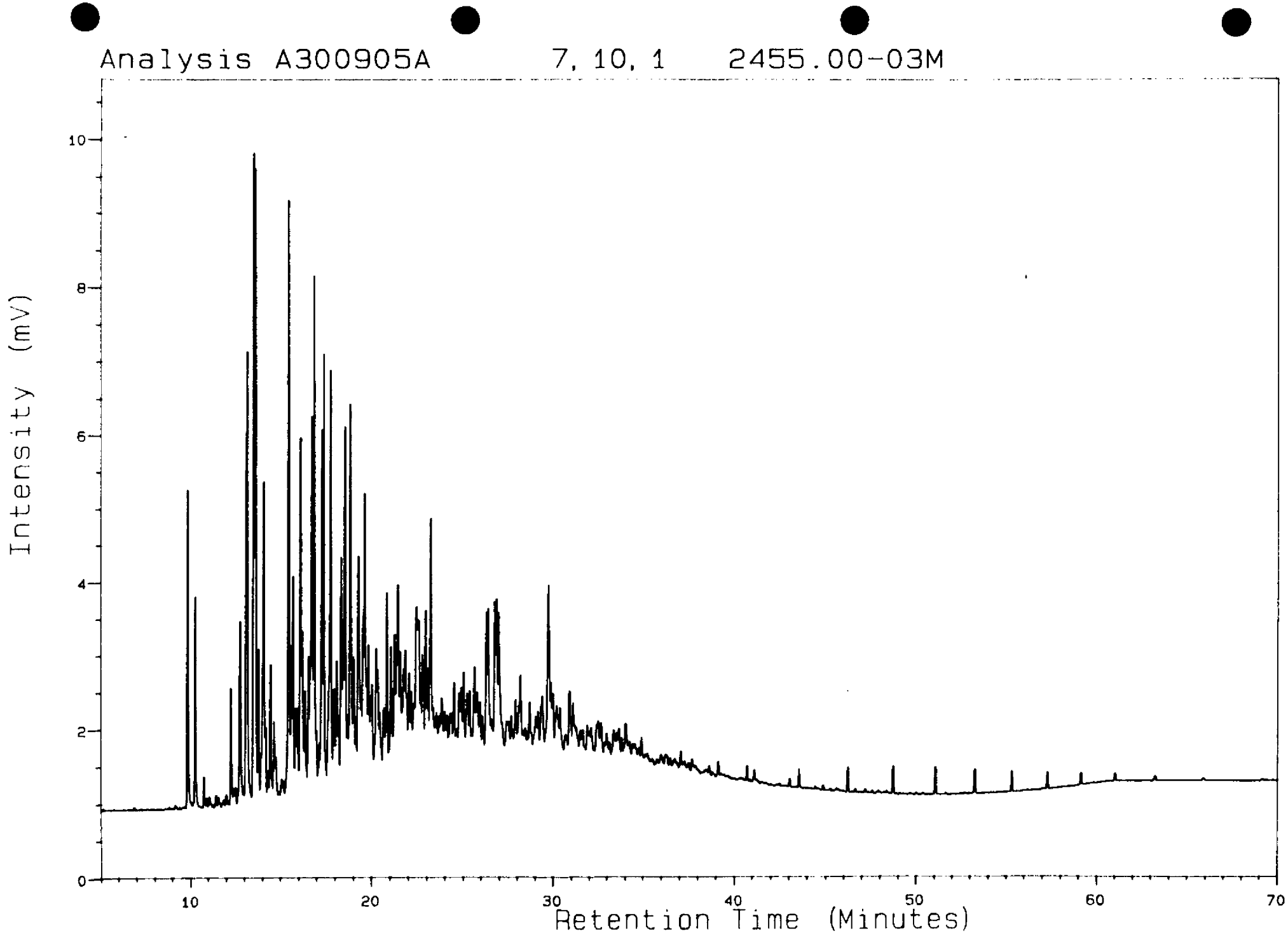

Analysis A300905A 7, 5, 1 2255M
Intensity (mV)
0
2
4
6
8
10
12
14
16
18
10
20
30
40
50
60
70
Retention Time (Minutes)

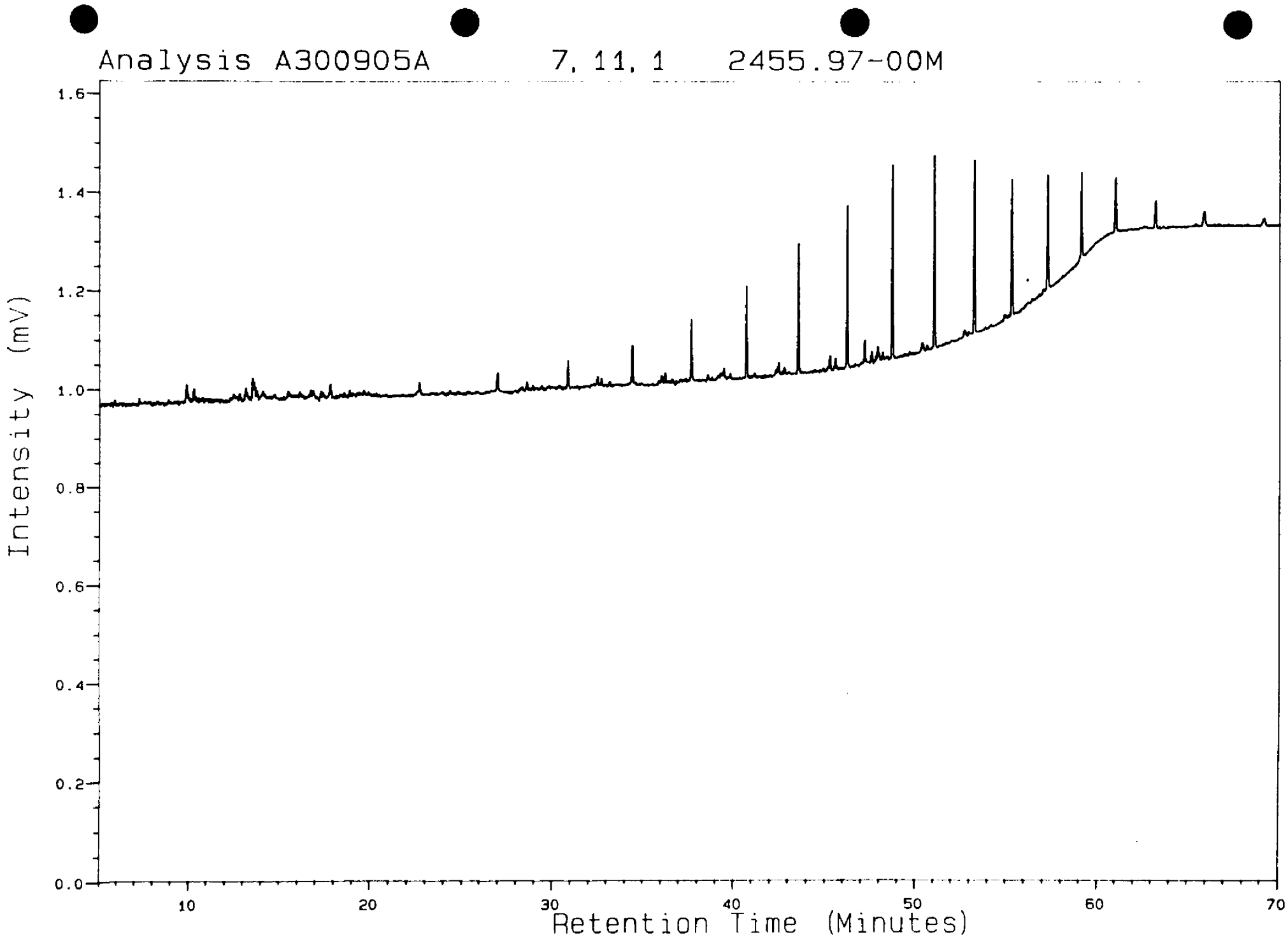

Analysis A300905A 7, 6, 1 2257M
Intensity (mV)
0
1
2
3
4
5
6
10
20
30
40
50
60
70
Retention Time (Minutes)

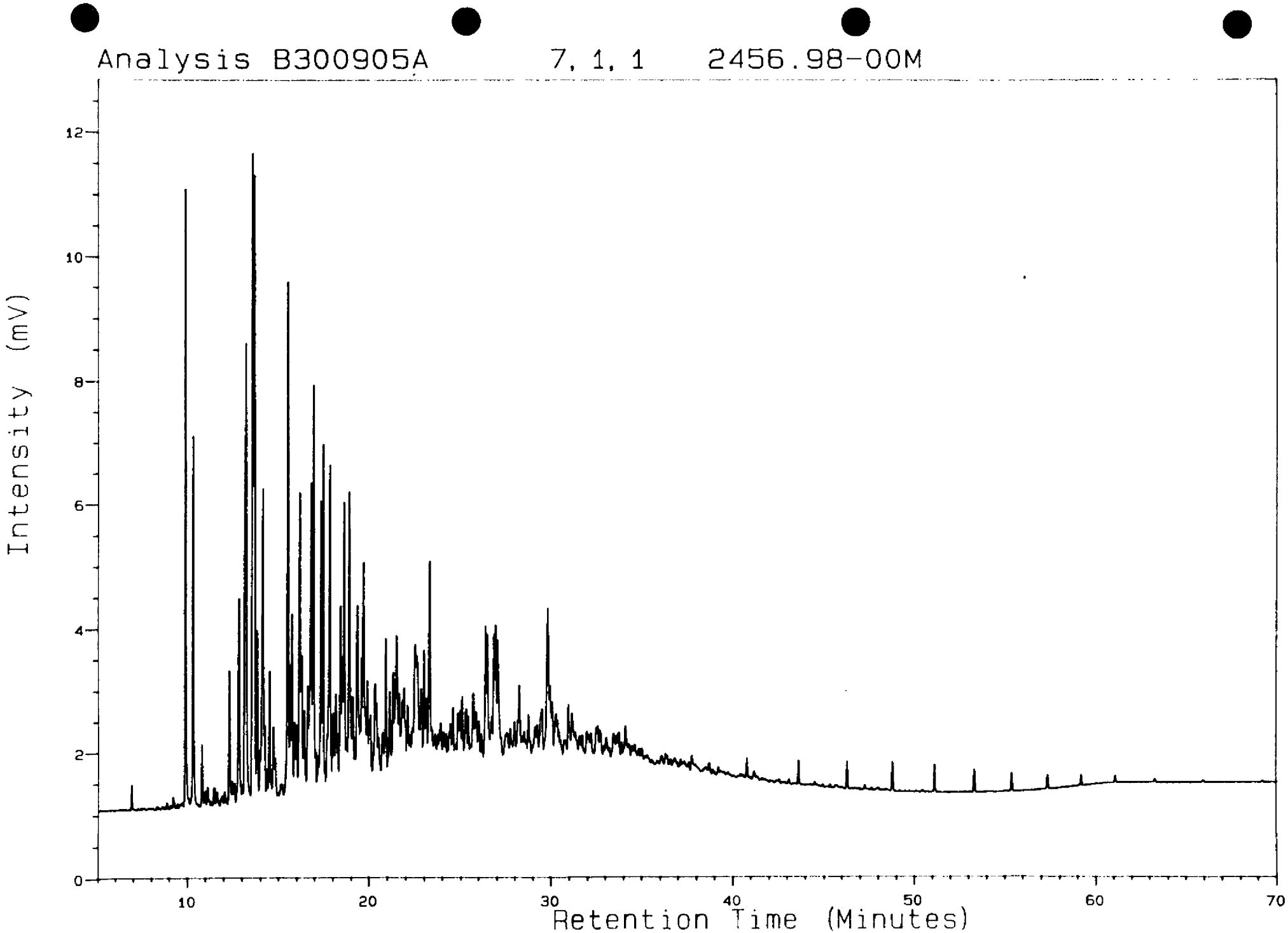

Analysis A300905A 7, 7, 1 2447M
Intensity (mV)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
10
20
30
40
50
60
70
Retention Time (Minutes)

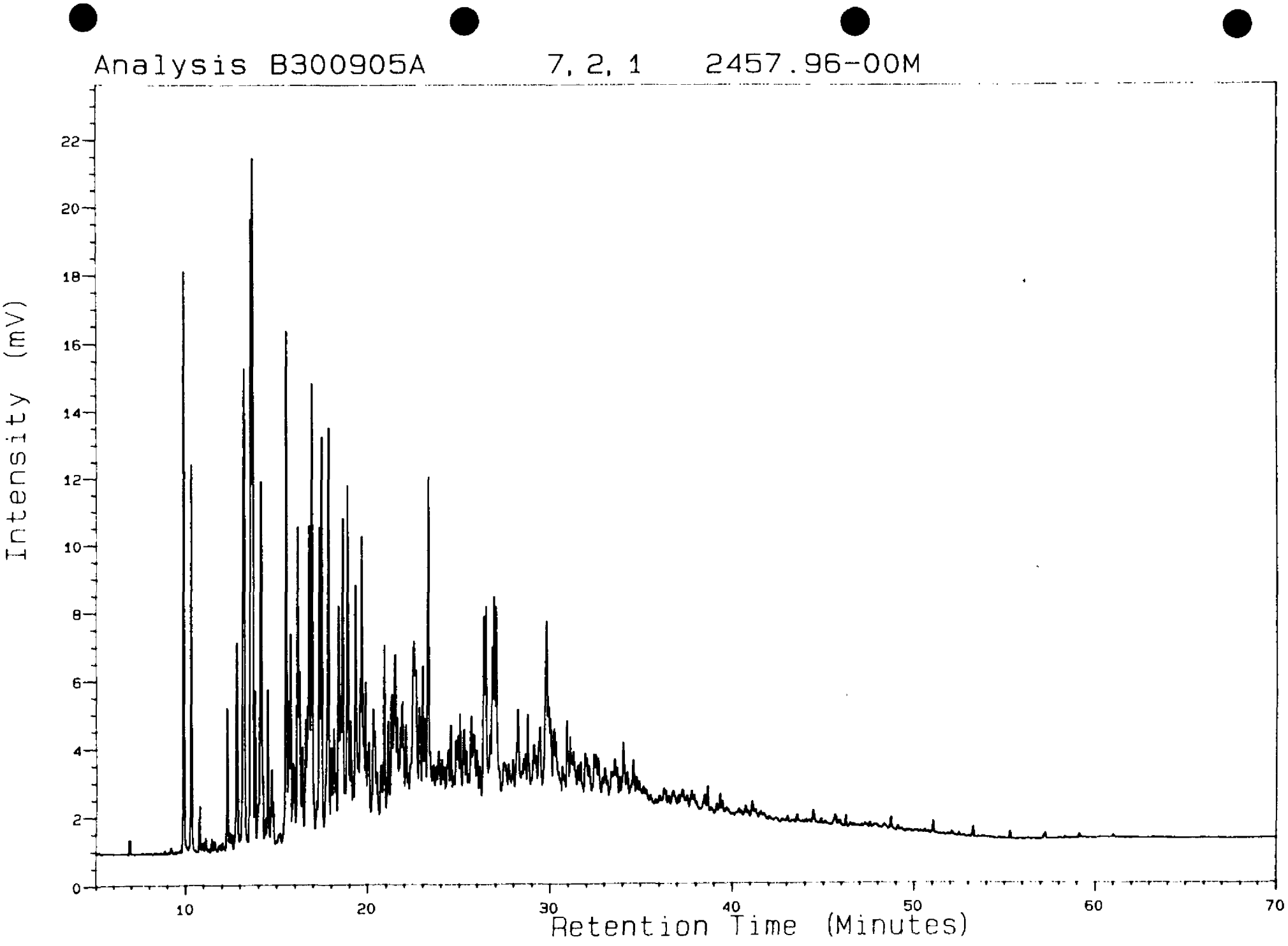

Analysis A300905A 7, 8, 1 2450M
Intensity (mV)
0
1
2
3
4
5
6
7
8
9
10
20
30
40
50
60
70
Retention Time (Minutes)

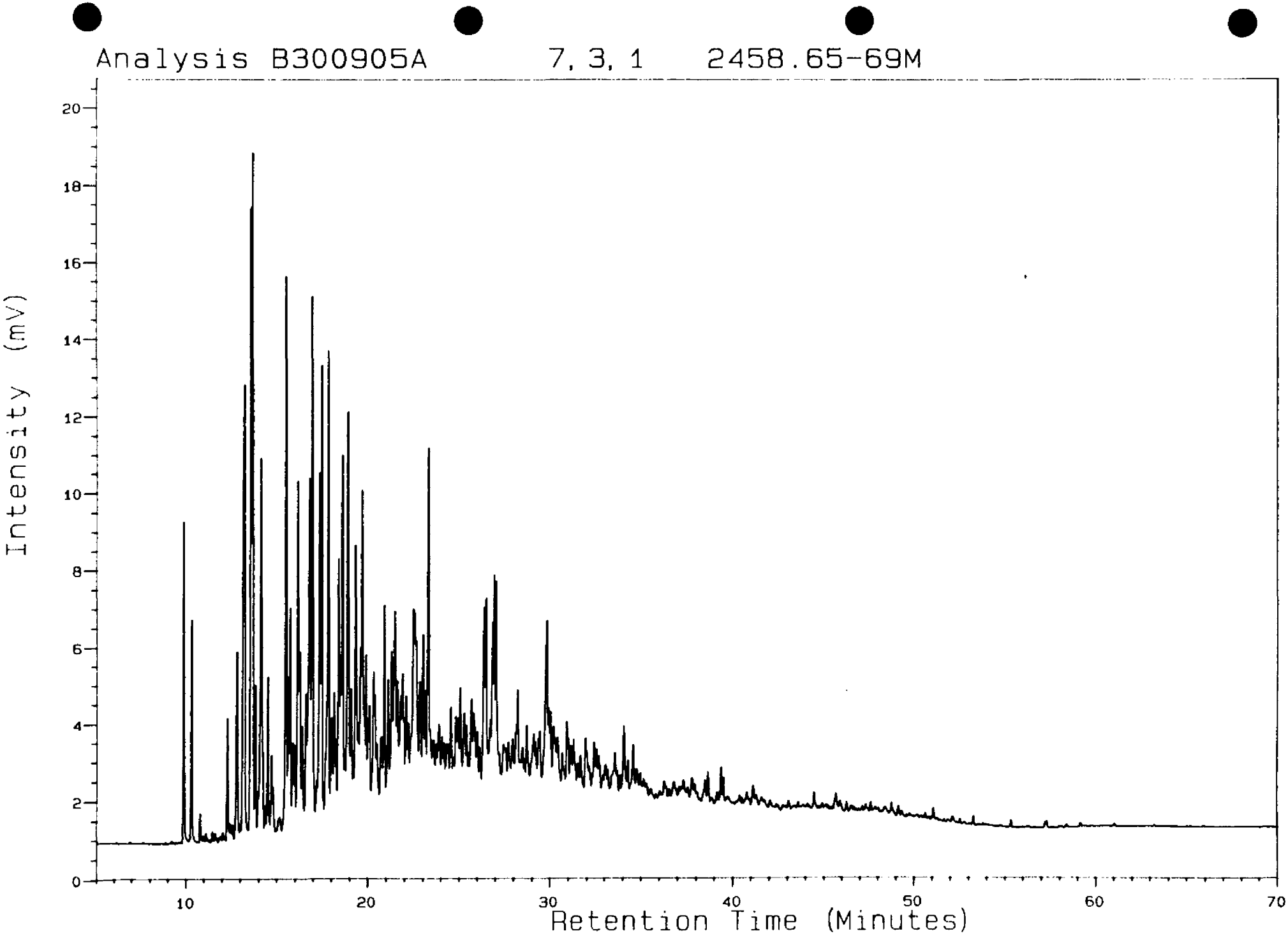

Analysis A300905A 7, 9, 1 2455M
Intensity (mV)
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
10
20
30
40
50
60
70
Retention Time (Minutes)

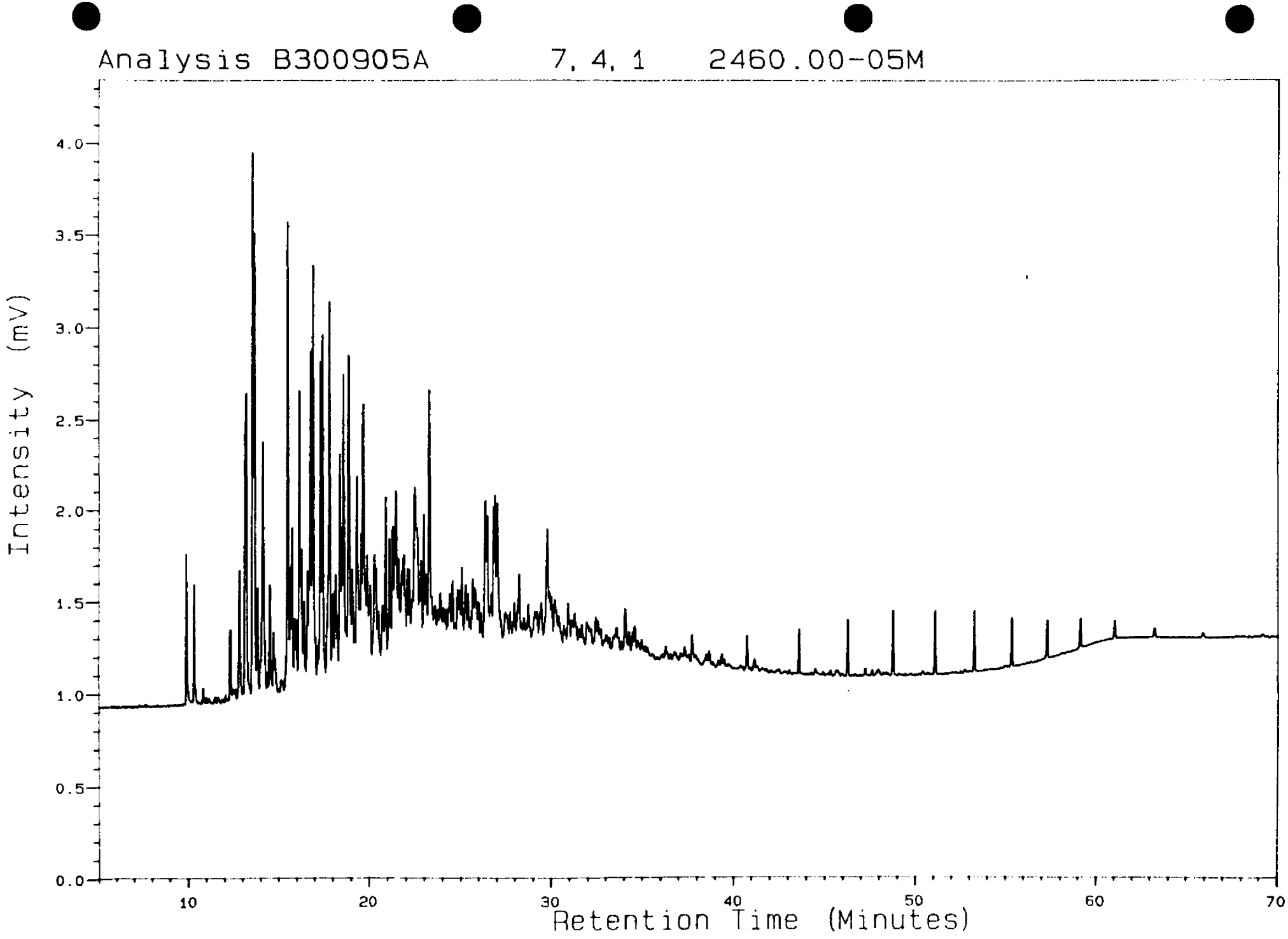

Analysis A300905A 7, 10, 1 2455.00-03M
Intensity (mV)
0
2
4
6
8
10
10
20
30
40
50
60
70
Retention Time (Minutes)

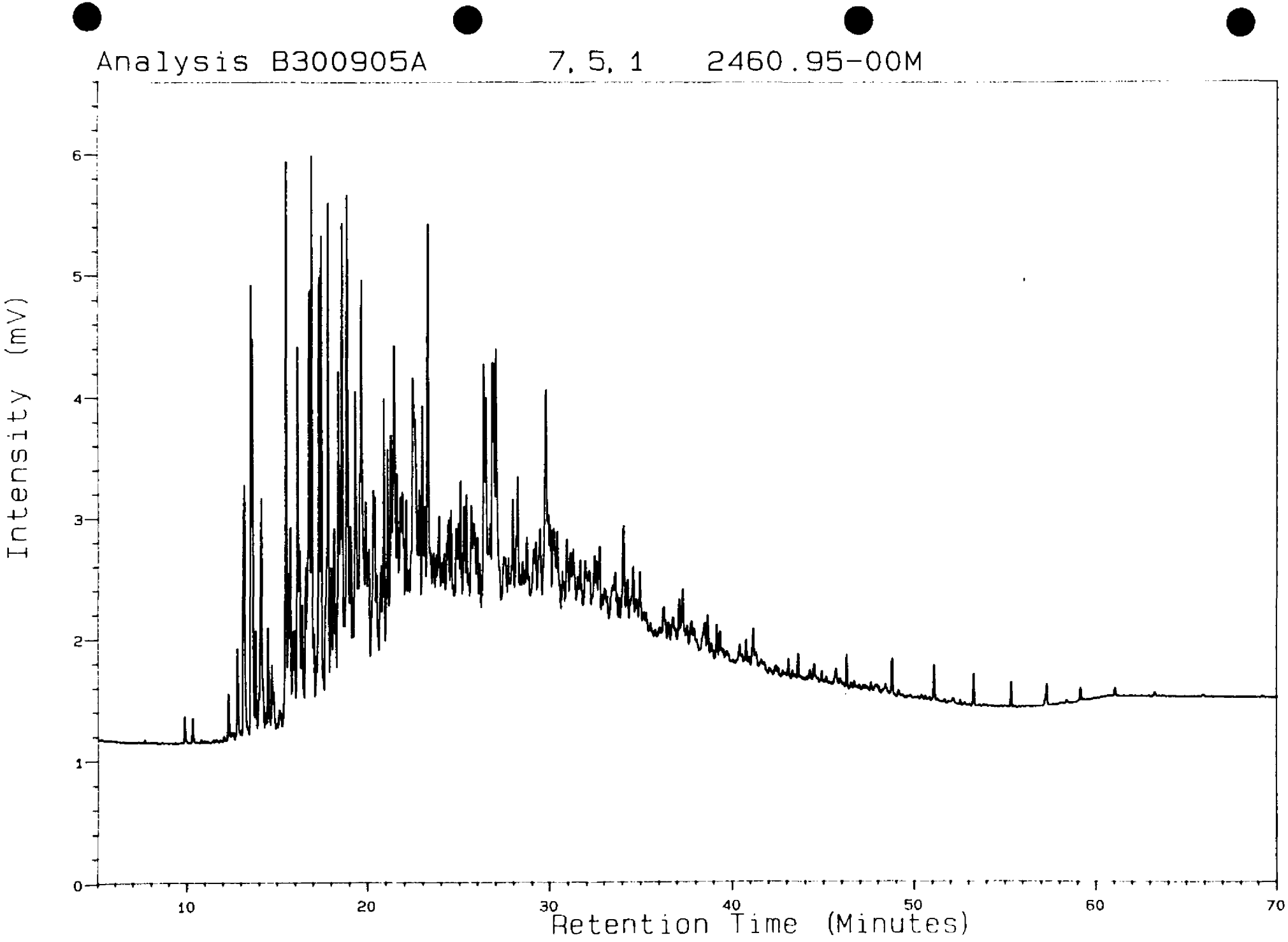

Analysis A300905A 7, 11, 1 2455.97-00M
Intensity (mV)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
10
20
30
40
50
60
70
Retention Time (Minutes)

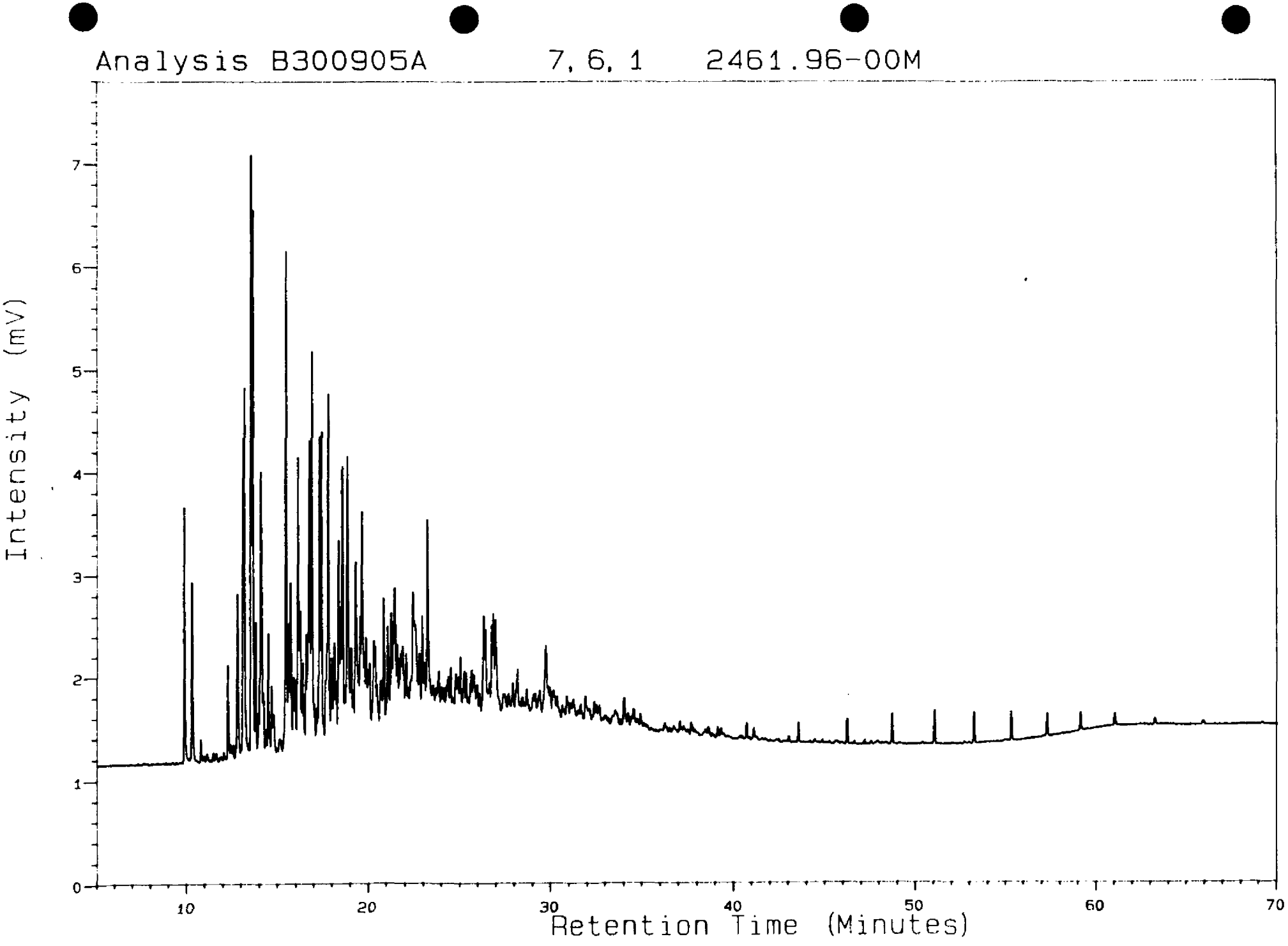

Analysis B300905A 7, 1, 1 2456.98-00M
Intensity (mV)
0
2
4
6
8
10
12
10
20
30
40
50
60
70
Retention Time (Minutes)

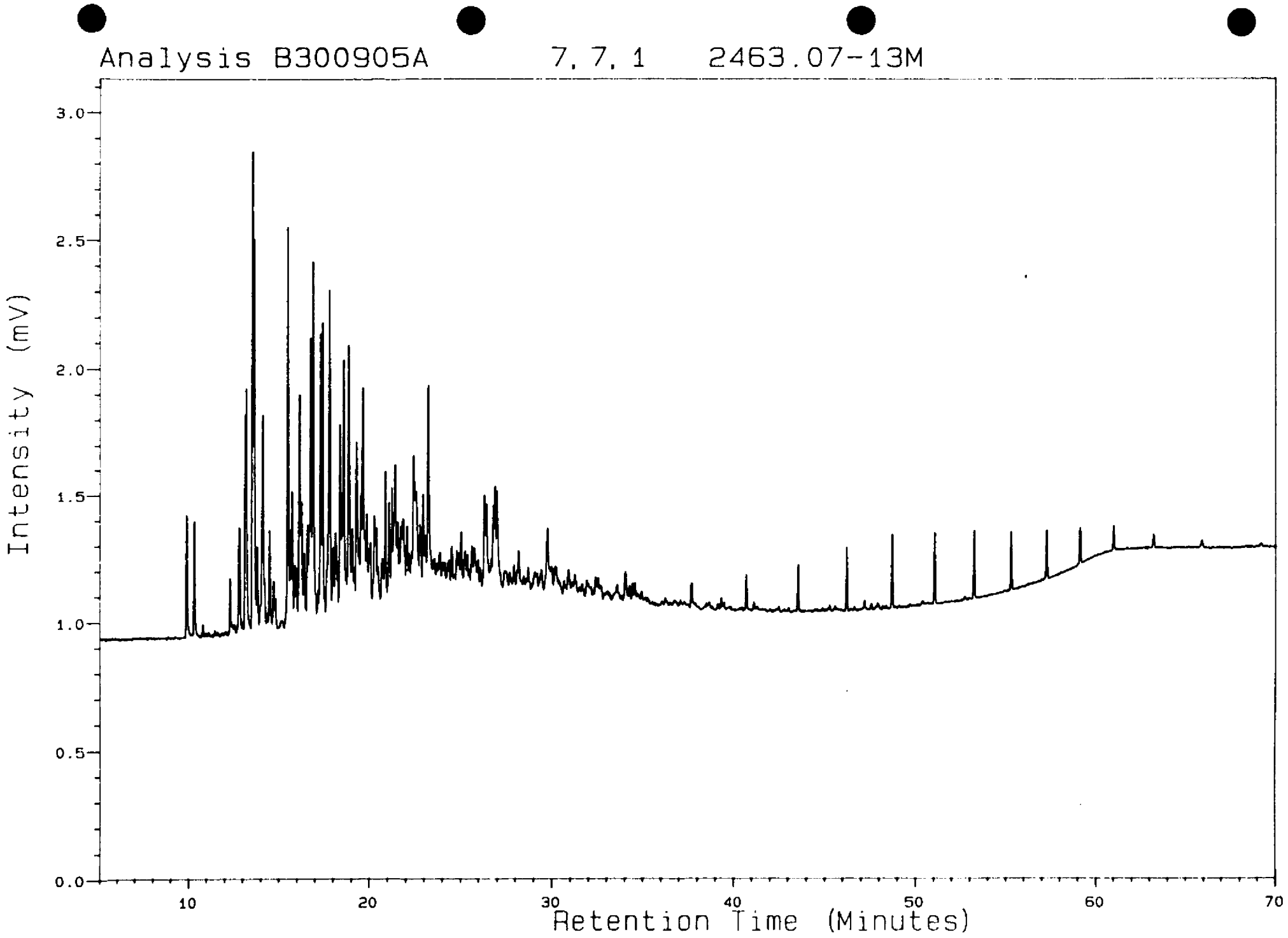

Analysis B300905A 7, 2, 1 2457.96-00M
Intensity (mV)
0
2
4
6
8
10
12
14
16
18
20
22
10
20
30
40
50
60
70
Retention Time (Minutes)

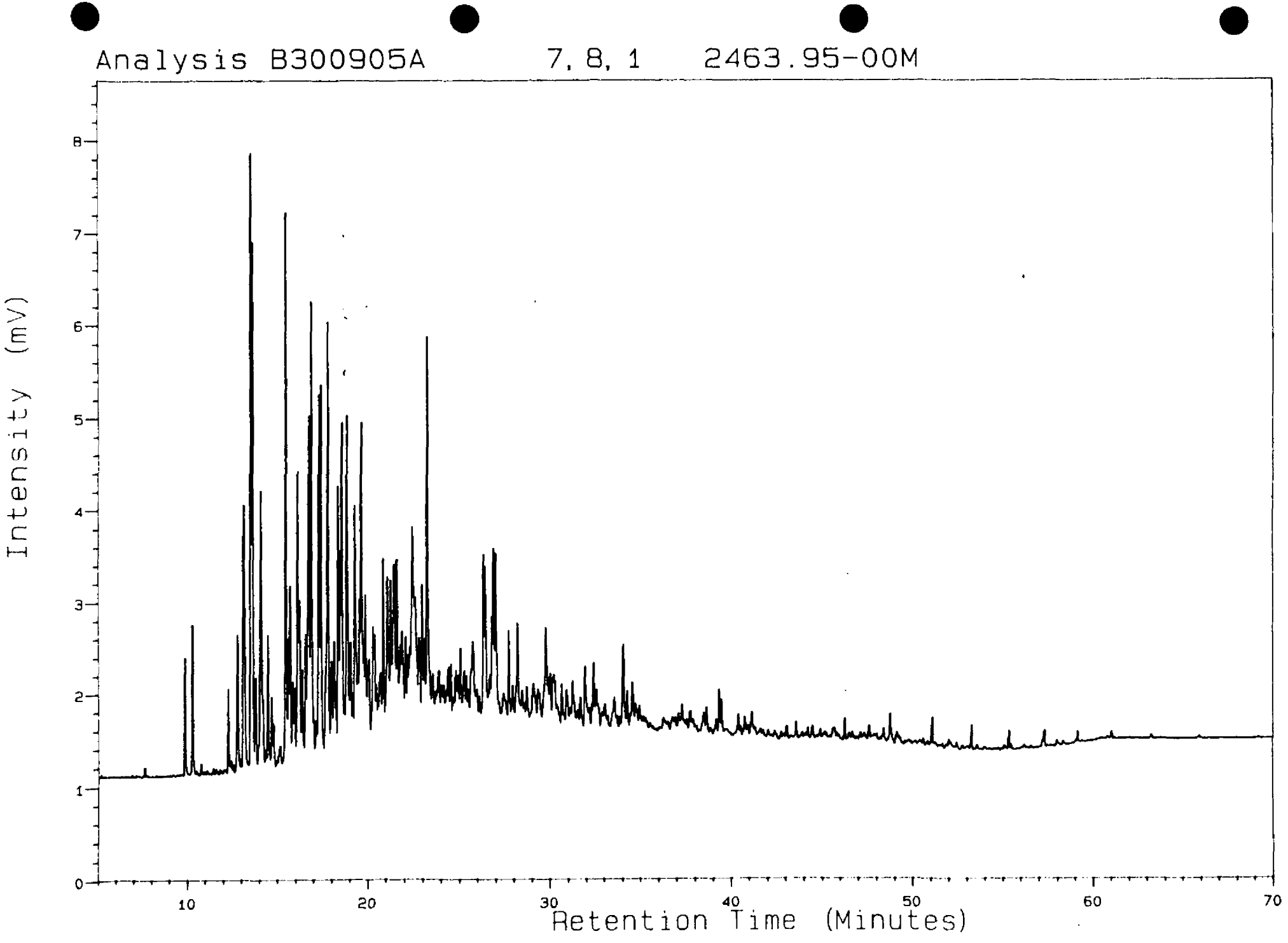

Analysis B300905A 7, 3, 1 2458.65-69M
Intensity (mV)
0
2
4
6
8
10
12
14
16
18
20
10
20
30
40
50
60
70
Retention Time (Minutes)

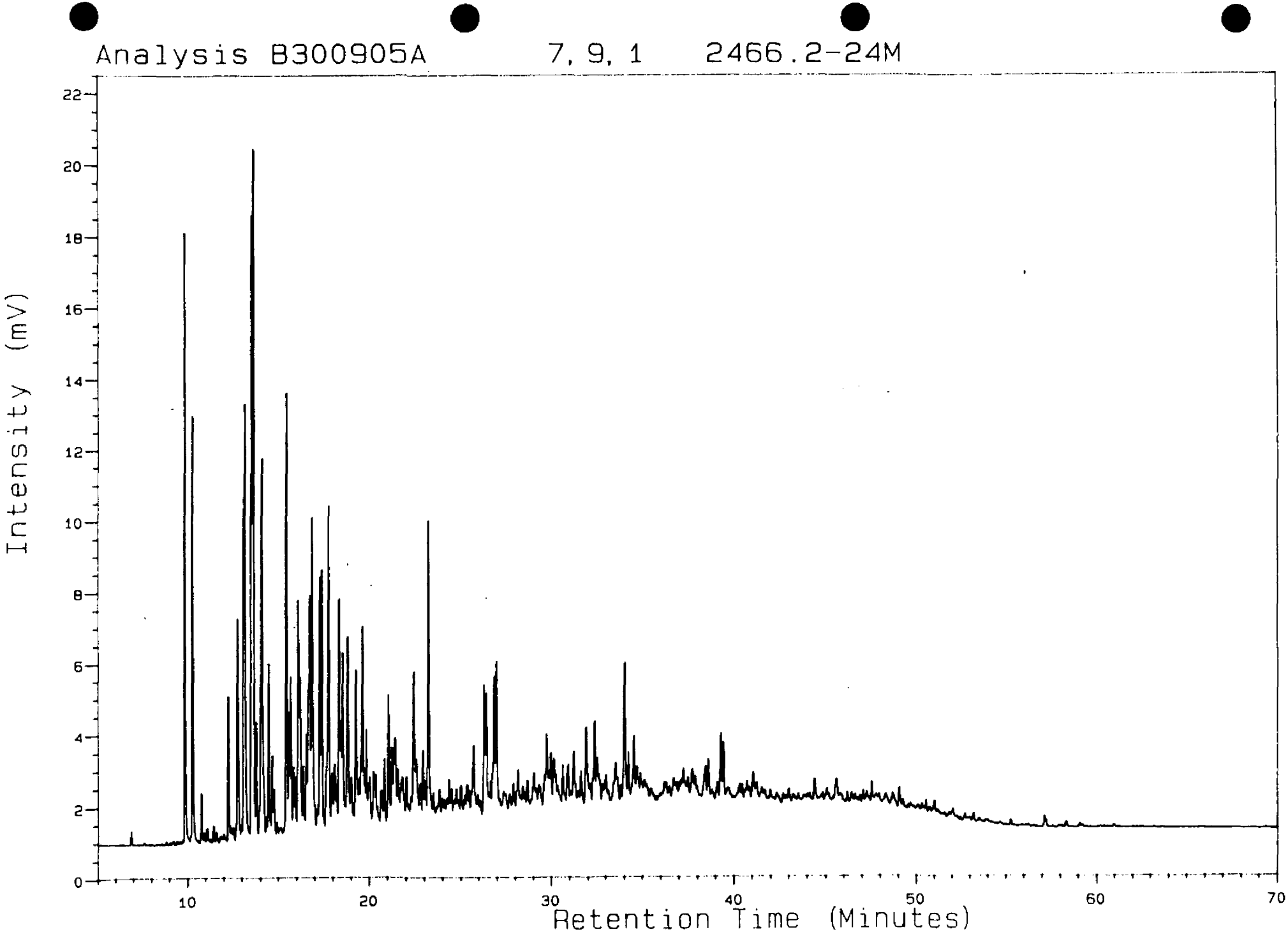

Analysis B300905A 7, 4, 1 2460.00-05M
Intensity (mV)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
10
20
30
40
50
60
70
Retention Time (Minutes)


Analysis B300905A 7.5.1 2460.95-00M
Intensity (mV)
0
1
2
3
4
5
6
10
20
30
40
50
60
70
Retention Time (Minutes)


Analysis B300905A 7, 6, 1 2461.96-00M
Intensity (mV)
0
1
2
3
4
5
6
7
10
20
30
40
50
60
70
Retention Time (Minutes)

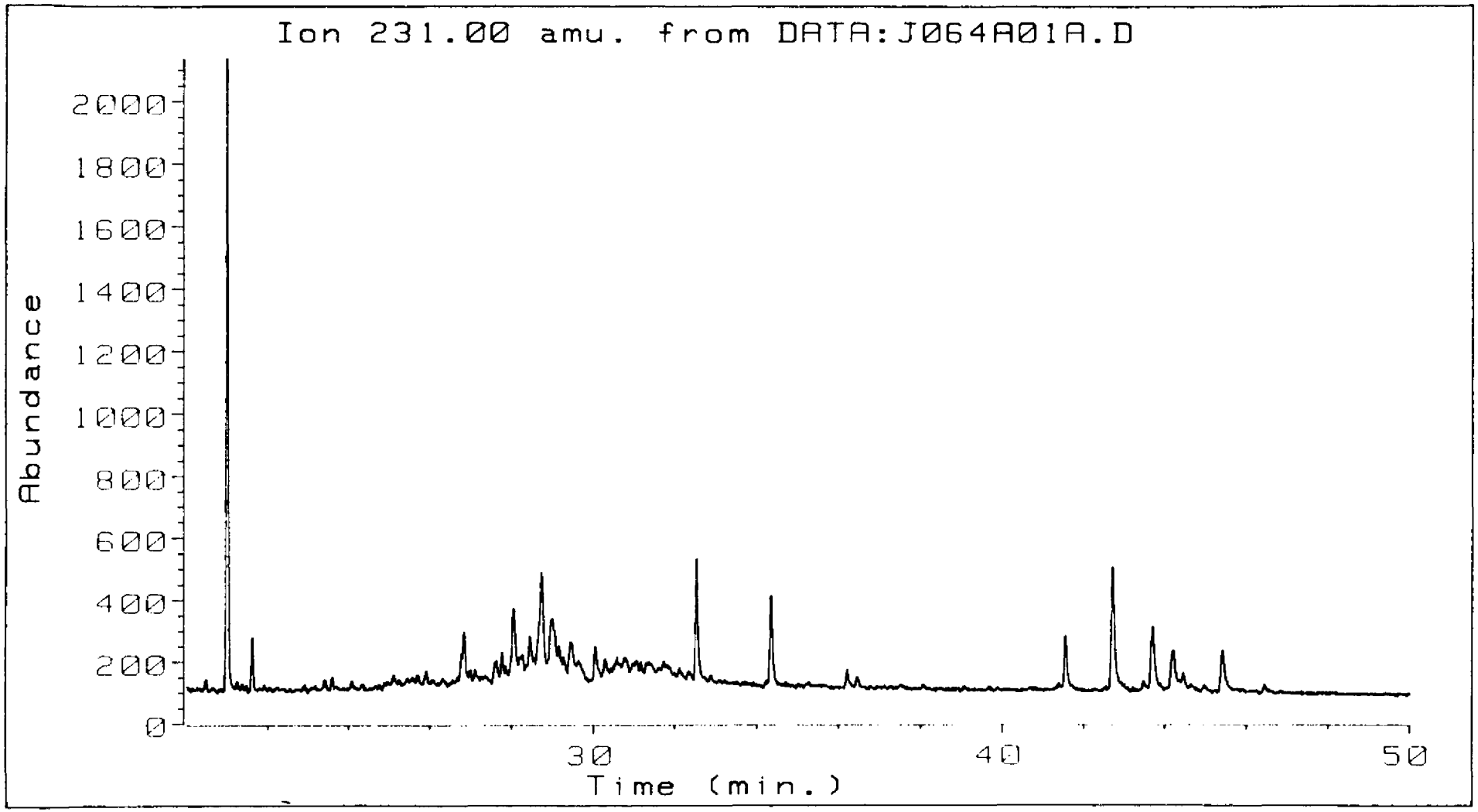

Analysis B300905A 7, 7, 1 2463.07-13M
Intensity (mV)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
10
20
30
40
50
60
70
Retention Time (Minutes)


Analysis B300905A 7, 8, 1 2463.95-00M
Intensity (mV)
0
1
2
3
4
5
6
7
8
10
20
30
40
50
60
70
Retention Time (Minutes)

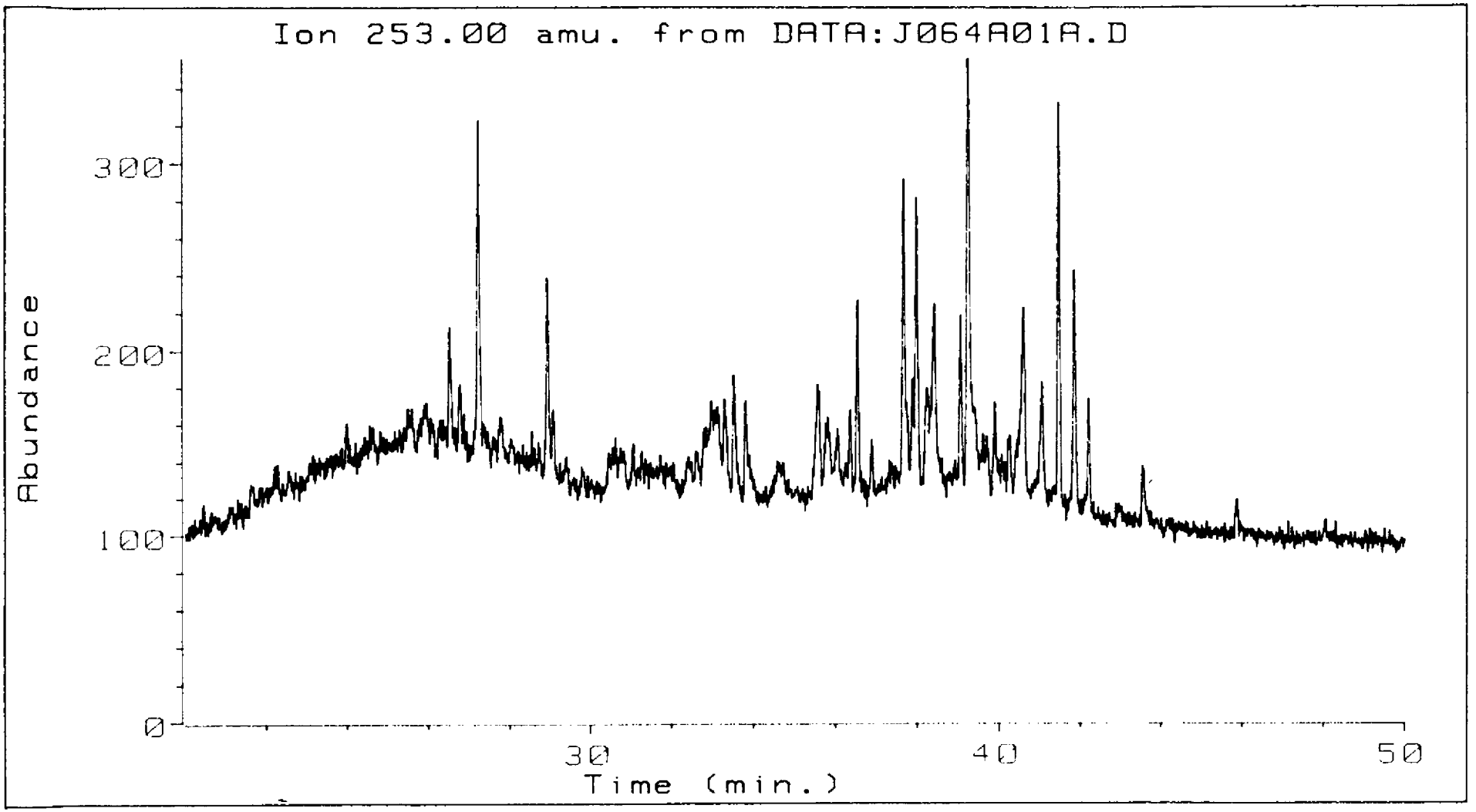

Analysis B300905A 7, 9, 1 2466.2-24M
Intensity (mV)
0
2
4
6
8
10
12
14
16
18
20
22
10
20
30
40
50
60
70
Retention Time (Minutes)

APPENDIX IV

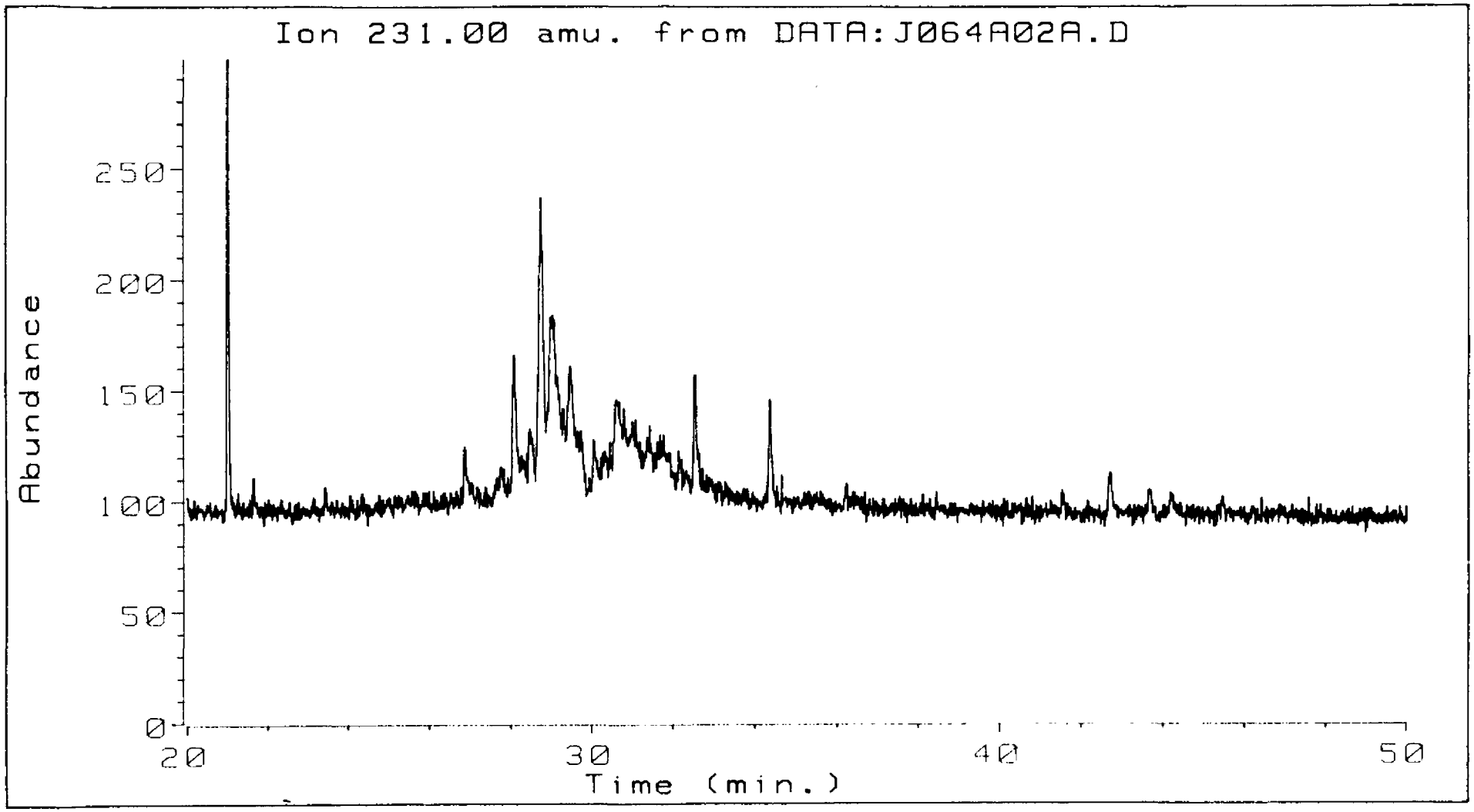
GC-MS Fragmentograms of Aromatized Steranes


Ion 231.00 amu. from DATA:J064A01A.D
Abundance
2000
1800
1600
1400
1200
1000
800
600
400
200
0
30
40
50
Time (min.)

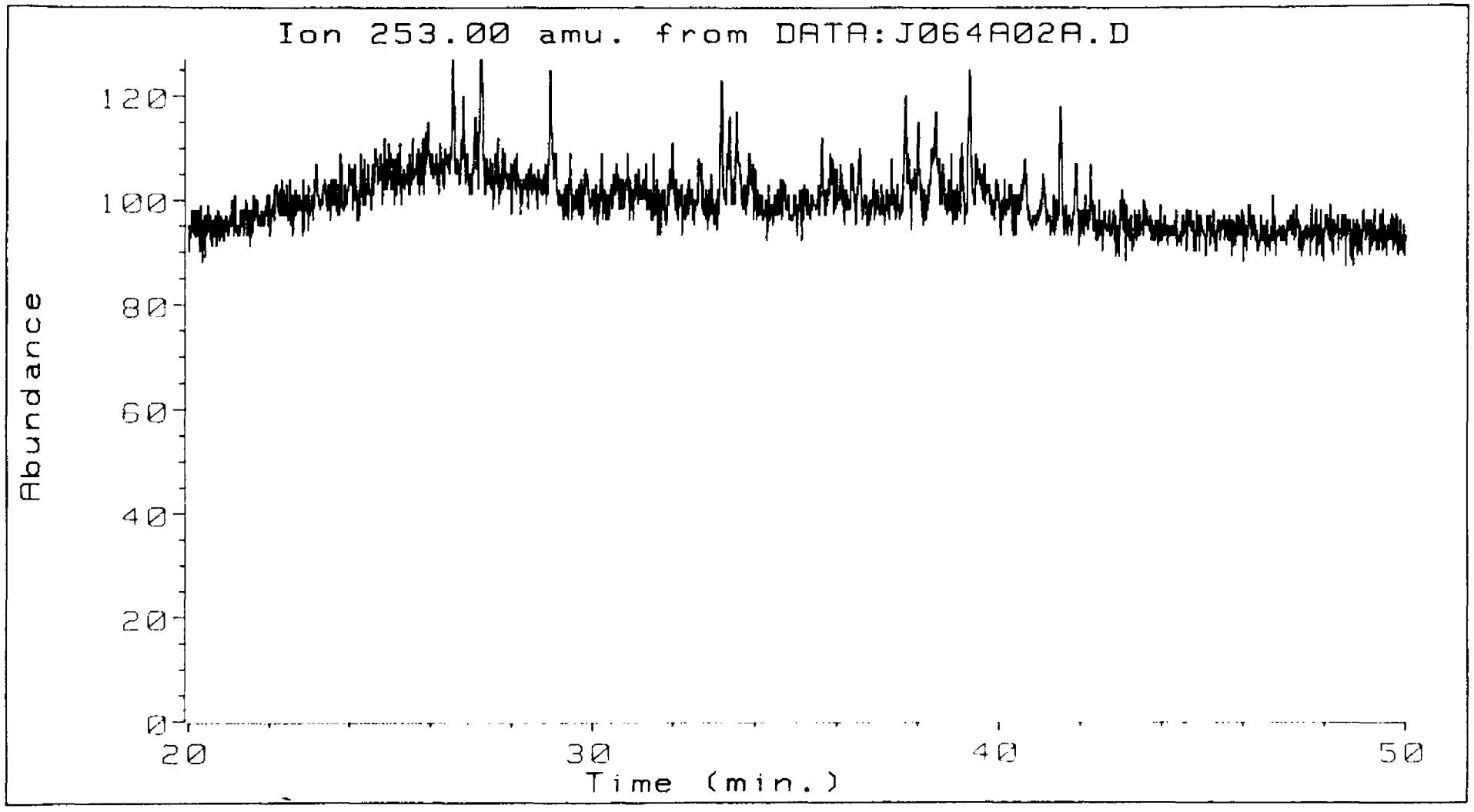
2235m


Ion 253.00 amu. from DATA:J064A01A.D
Abundance
300
200
100
0
30
40
50
Time (min.)

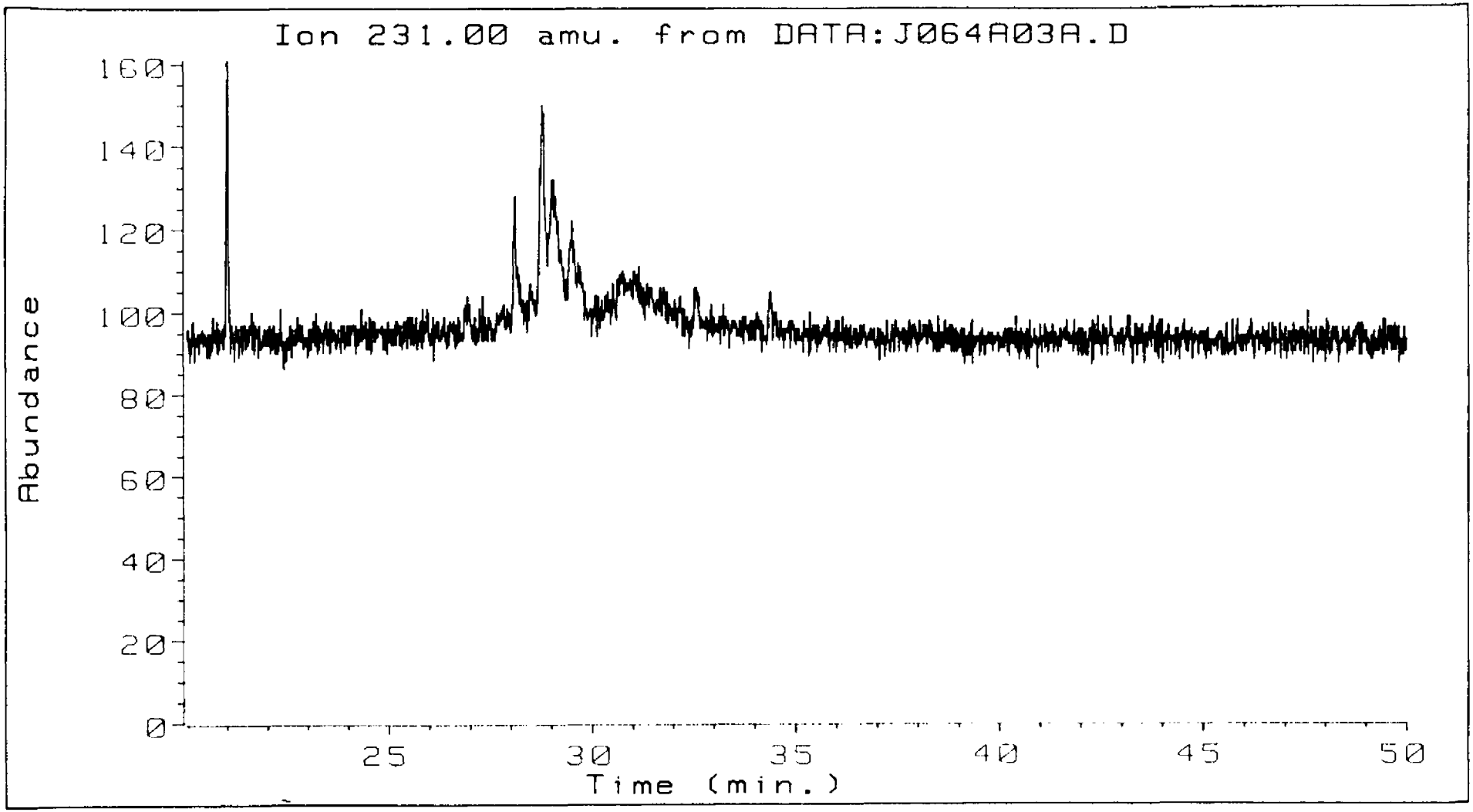
2235m


Ion 231.00 amu. from DATA:J064A02A.D
Abundance
250
200
150
100
50
0
20
30
40
50
Time (min.)

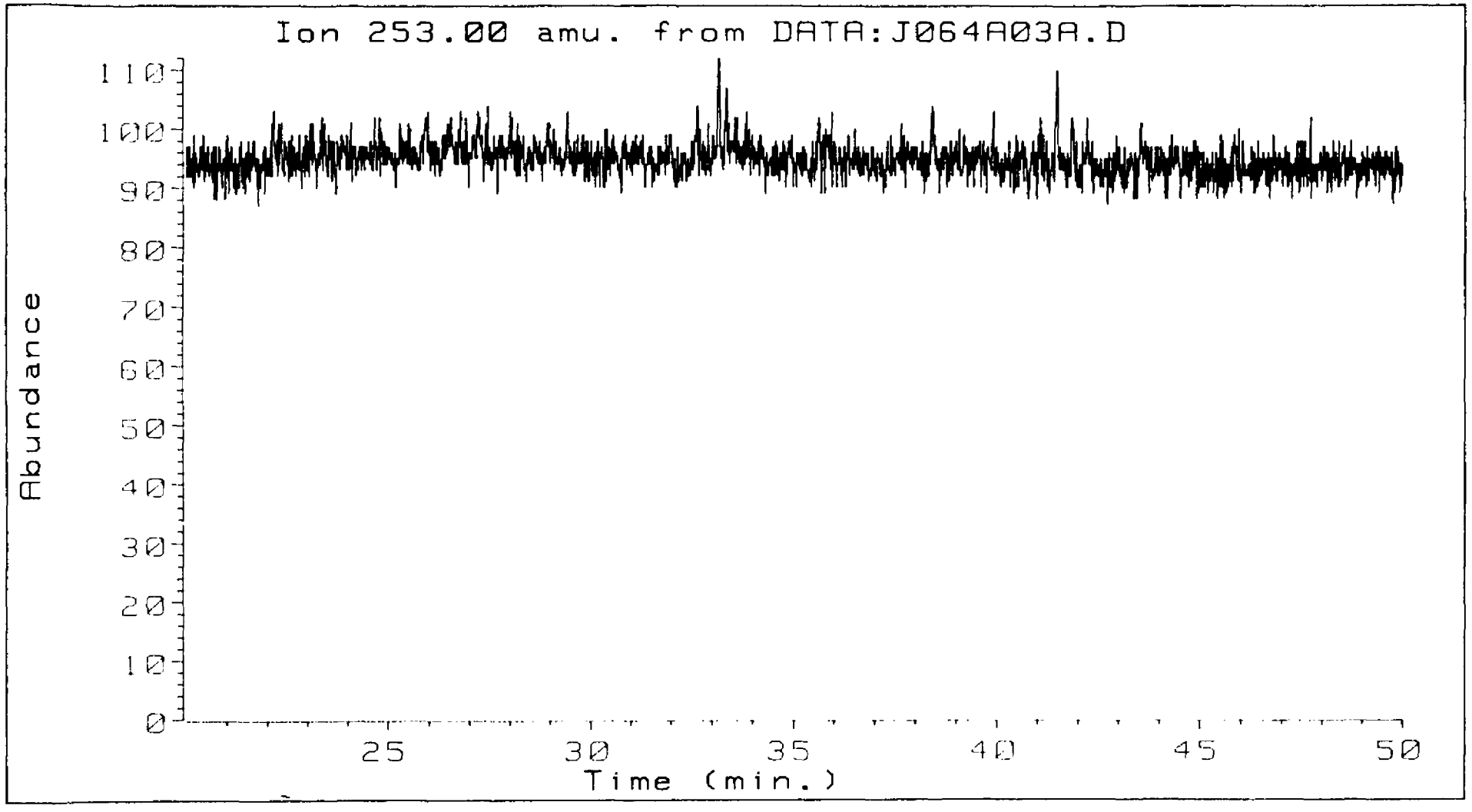
2247m


Ion 253.00 amu. from DATA:J064A02A.D
120
100
80
60
40
20
0
Abundance
20
30
40
50
Time (min.)

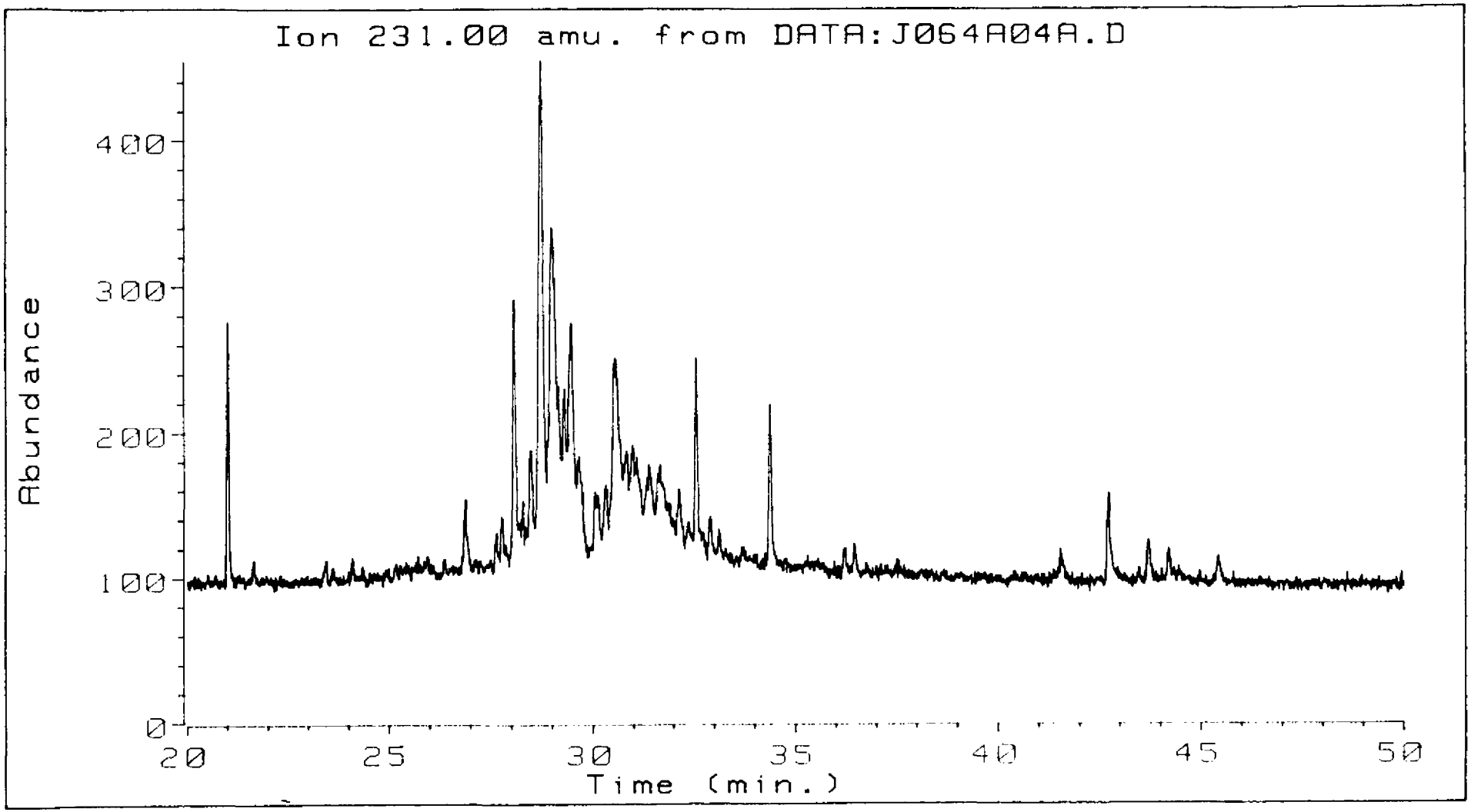
2247m


Ion 231.00 amu. from DATA:J064A03A.D
Abundance
160
140
120
100
80
60
40
20
0
25
30
35
40
45
50
Time (min.)

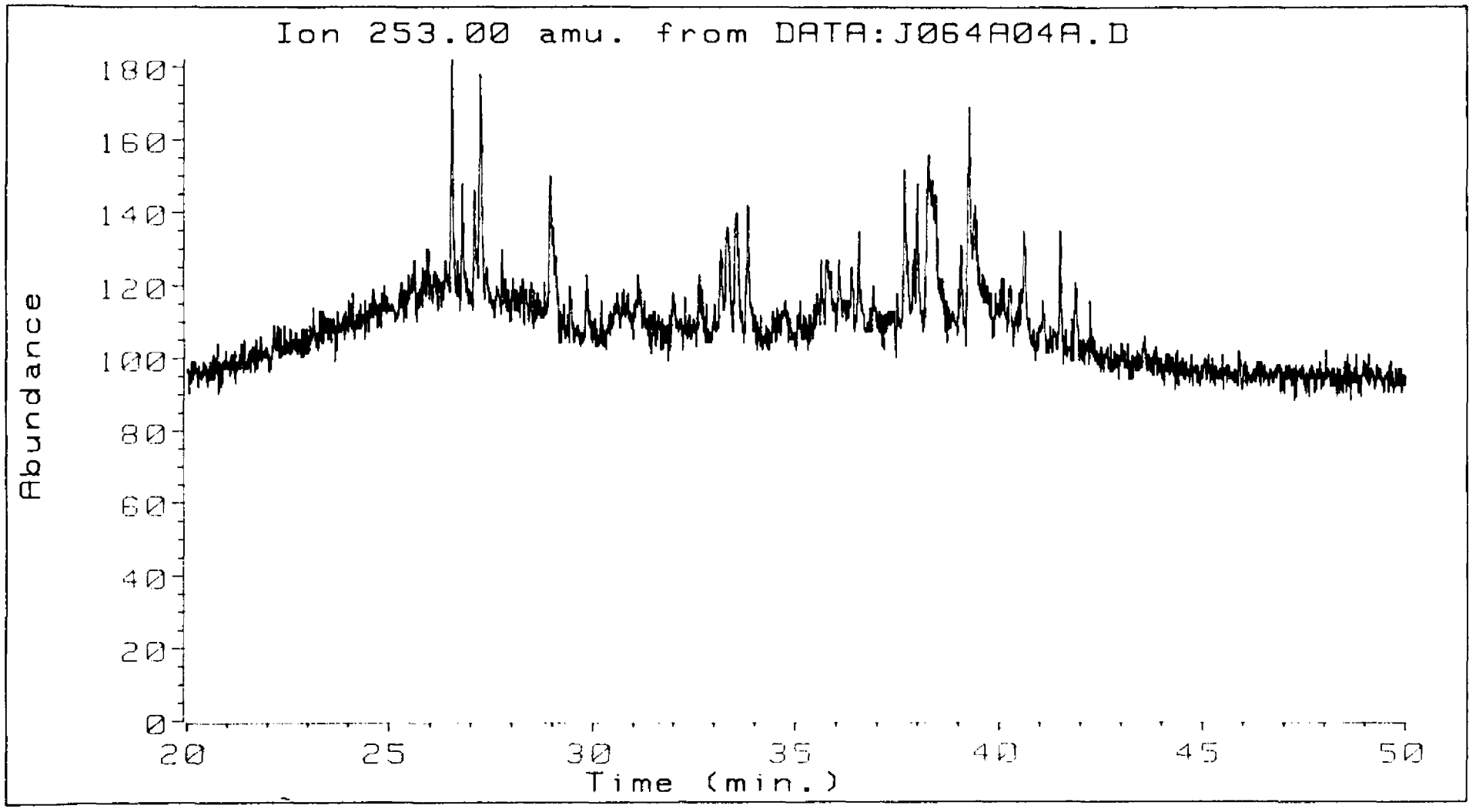
2250m


Ion 253.00 amu. from DATA:J064A03A.D
Abundance
110
100
90
80
70
60
50
40
30
20
10
0
25
30
35
40
45
50
Time (min.)

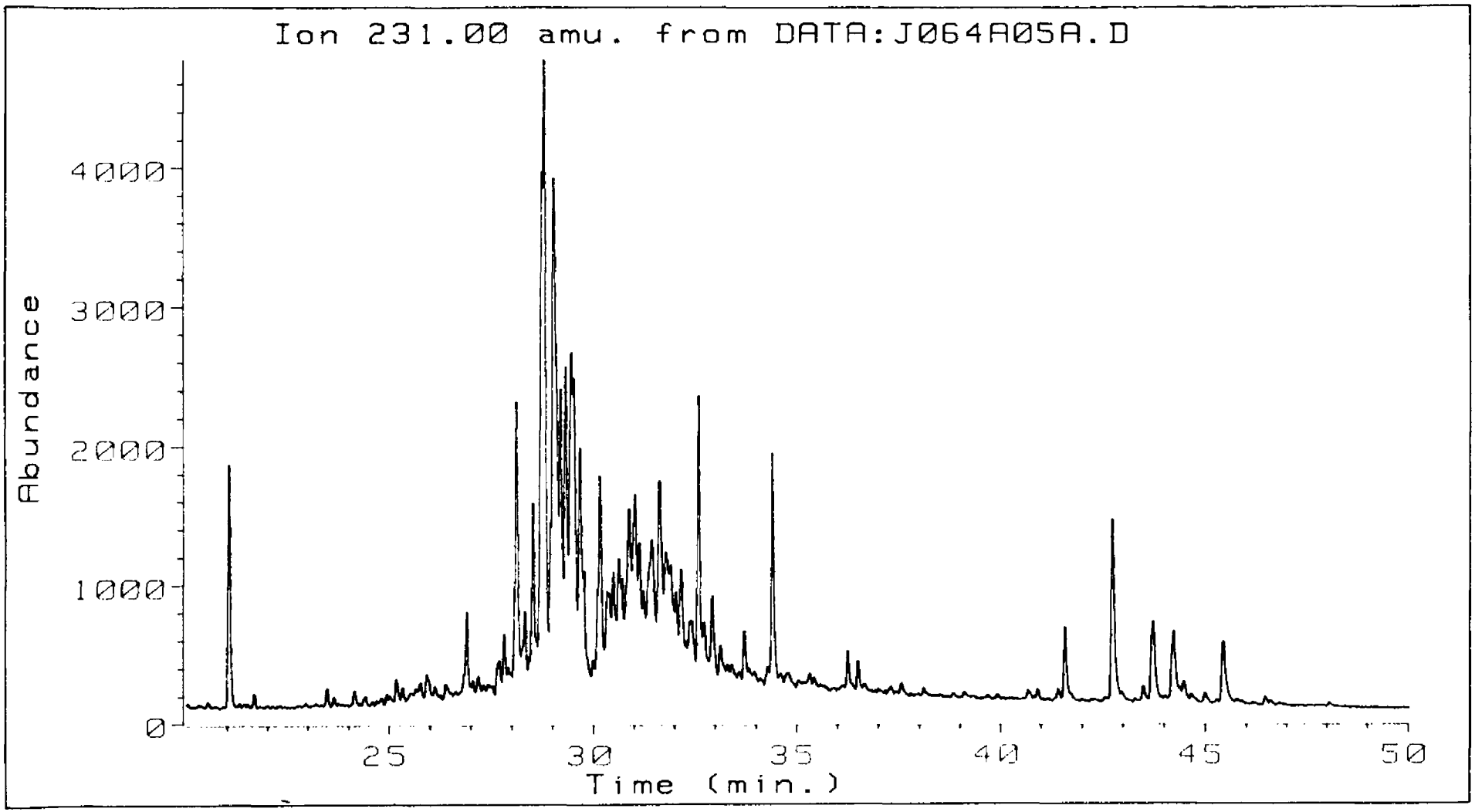
2250m


Ion 231.00 amu. from DATA:J064A04A.D
Abundance
400
300
200
100
0
20
25
30
35
40
45
50
Time (min.)

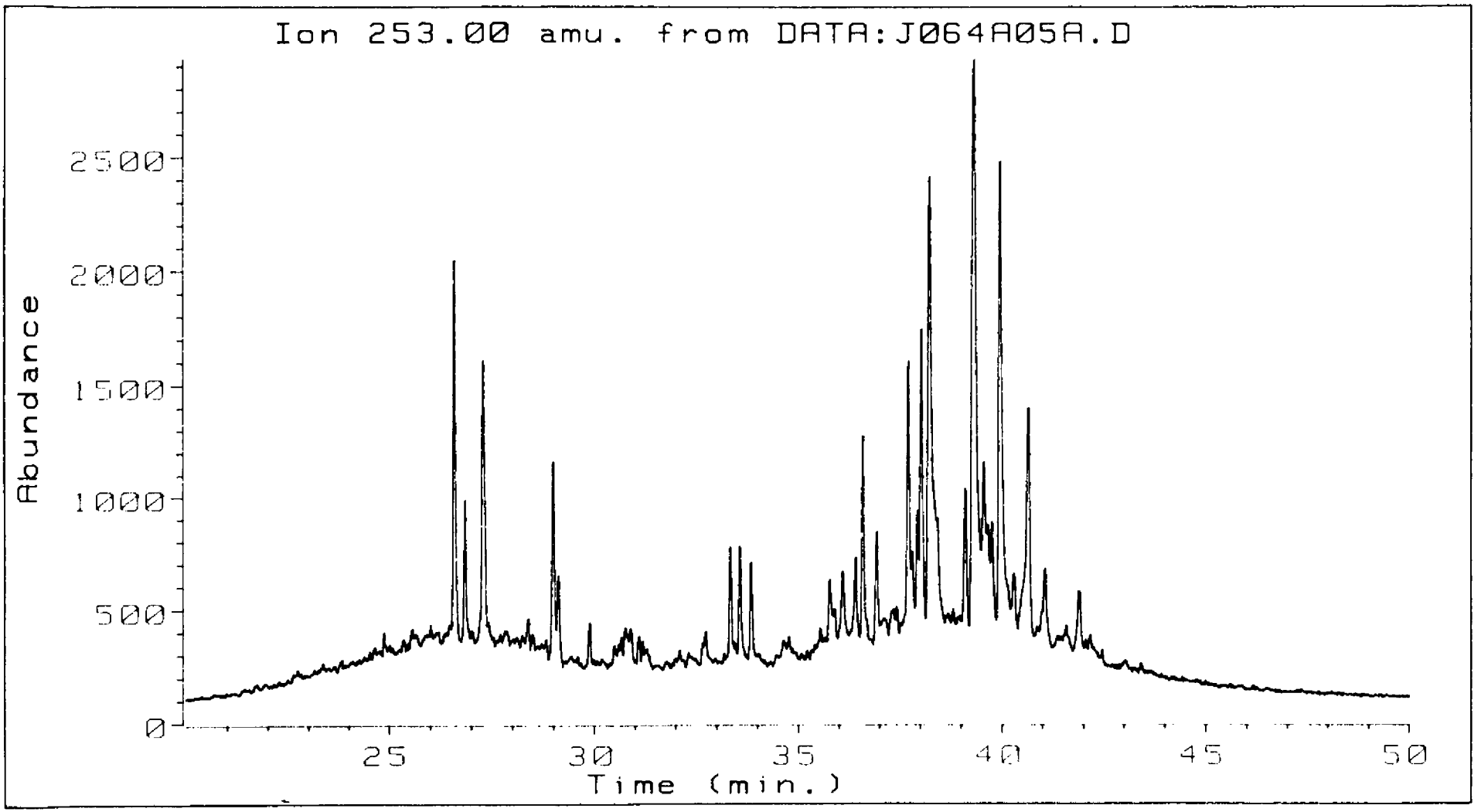
2252m


Ion 253.00 amu. from DATA:J064A04A.D
Abundance
180
160
140
120
100
80
60
40
20
0
20
25
30
35
40
45
50
Time (min.)

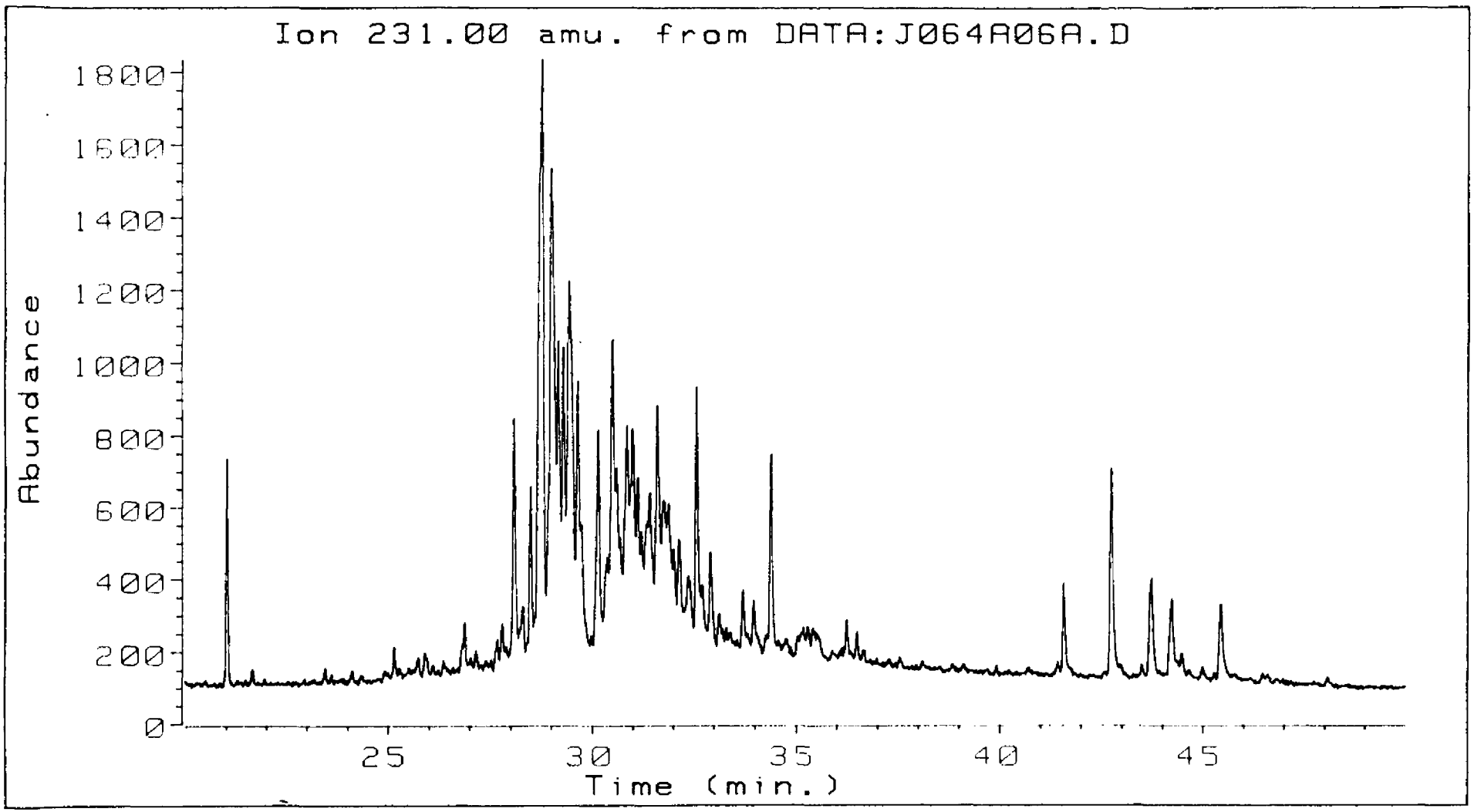
2252m


Ion 231.00 amu. from DATA:J064A05A.D
Abundance
4000
3000
2000
1000
0
25
30
35
40
45
50
Time (min.)

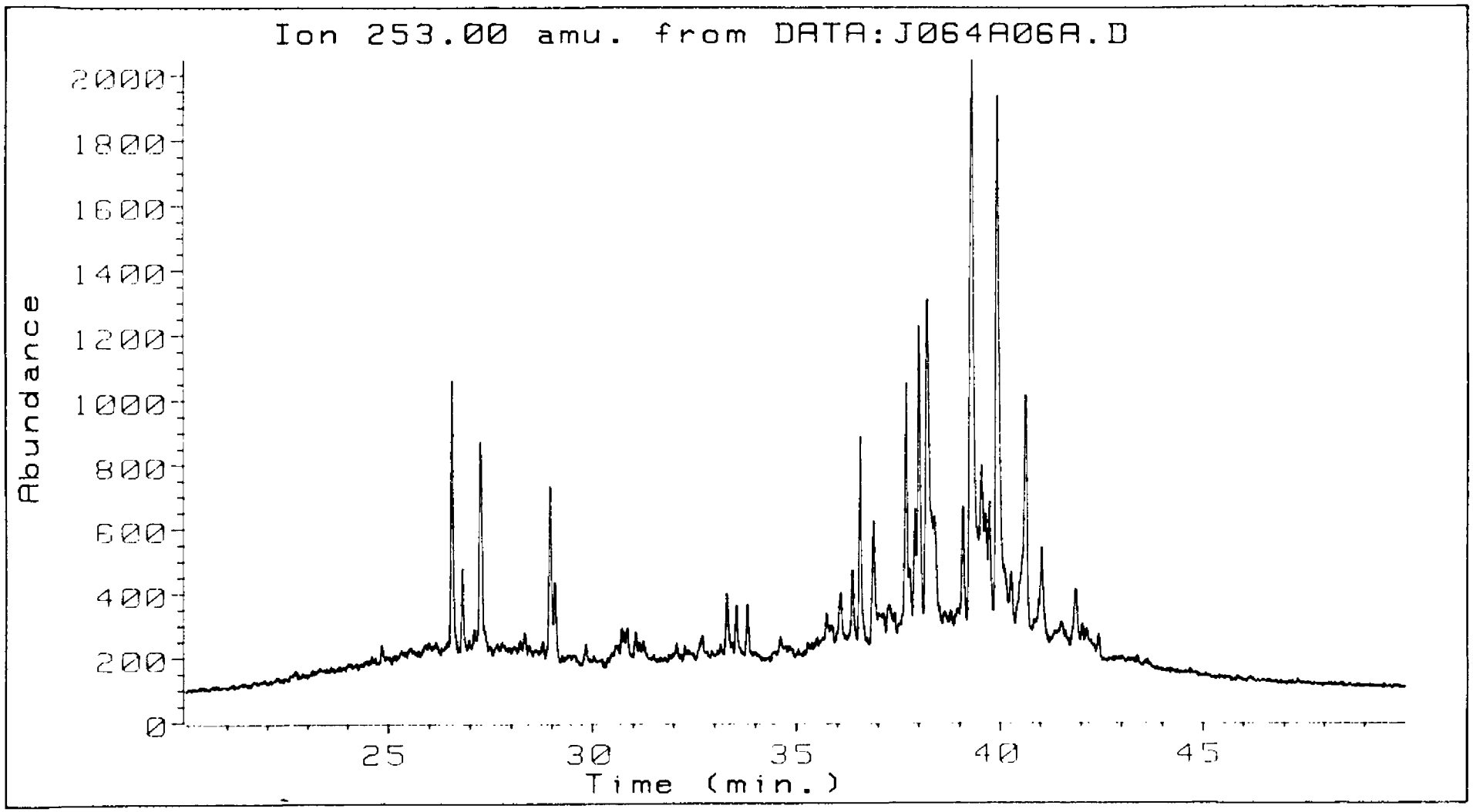
2255m


Ion 253.00 amu. from DATA:J064A05A.D
Abundance
2500
2000
1500
1000
500
0
25
30
35
40
45
50
Time (min.)

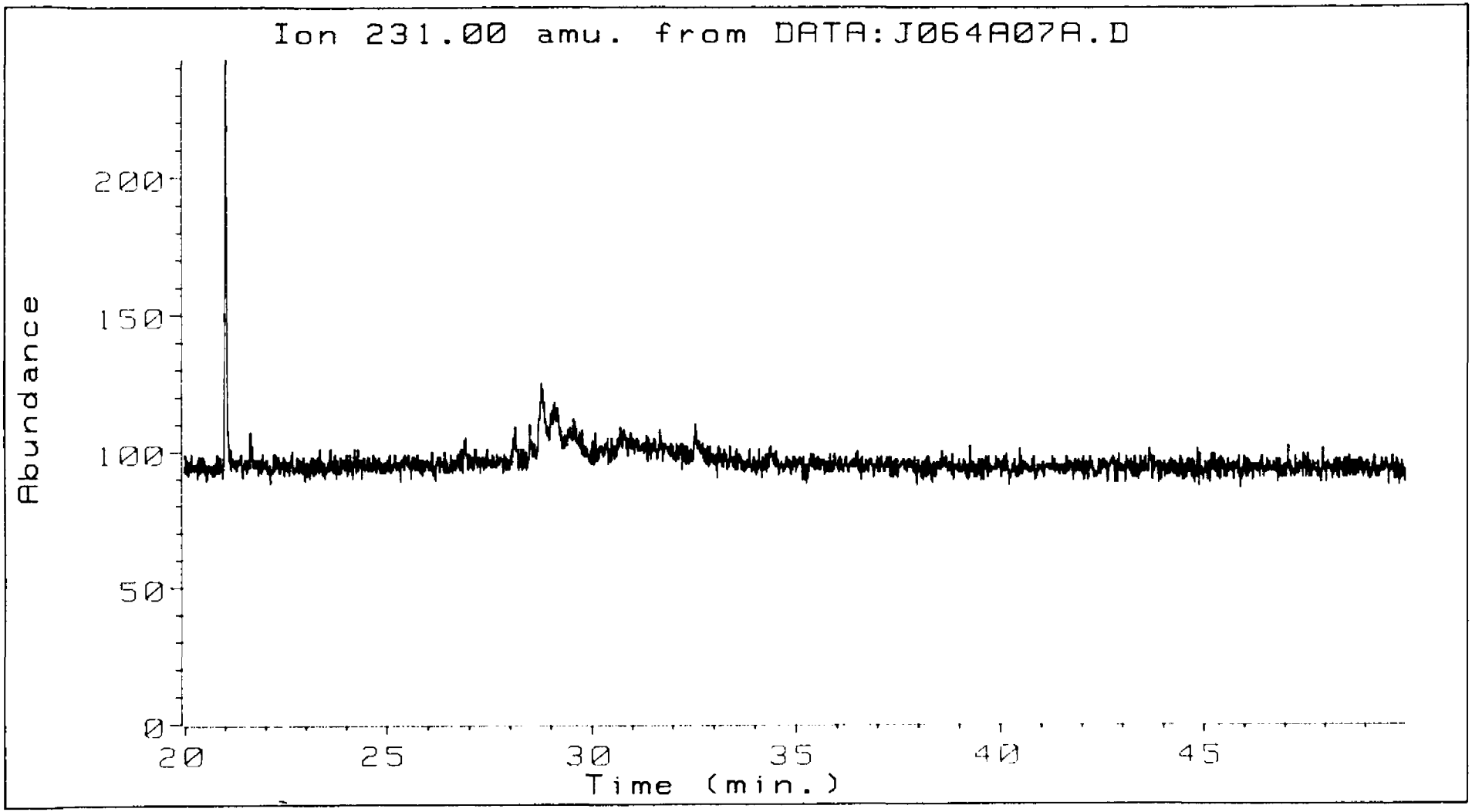
2255m


Ion 231.00 amu. from DATA:J064A06A.D
Abundance
1800
1600
1400
1200
1000
800
600
400
200
0
25
30
35
40
45
Time (min.)

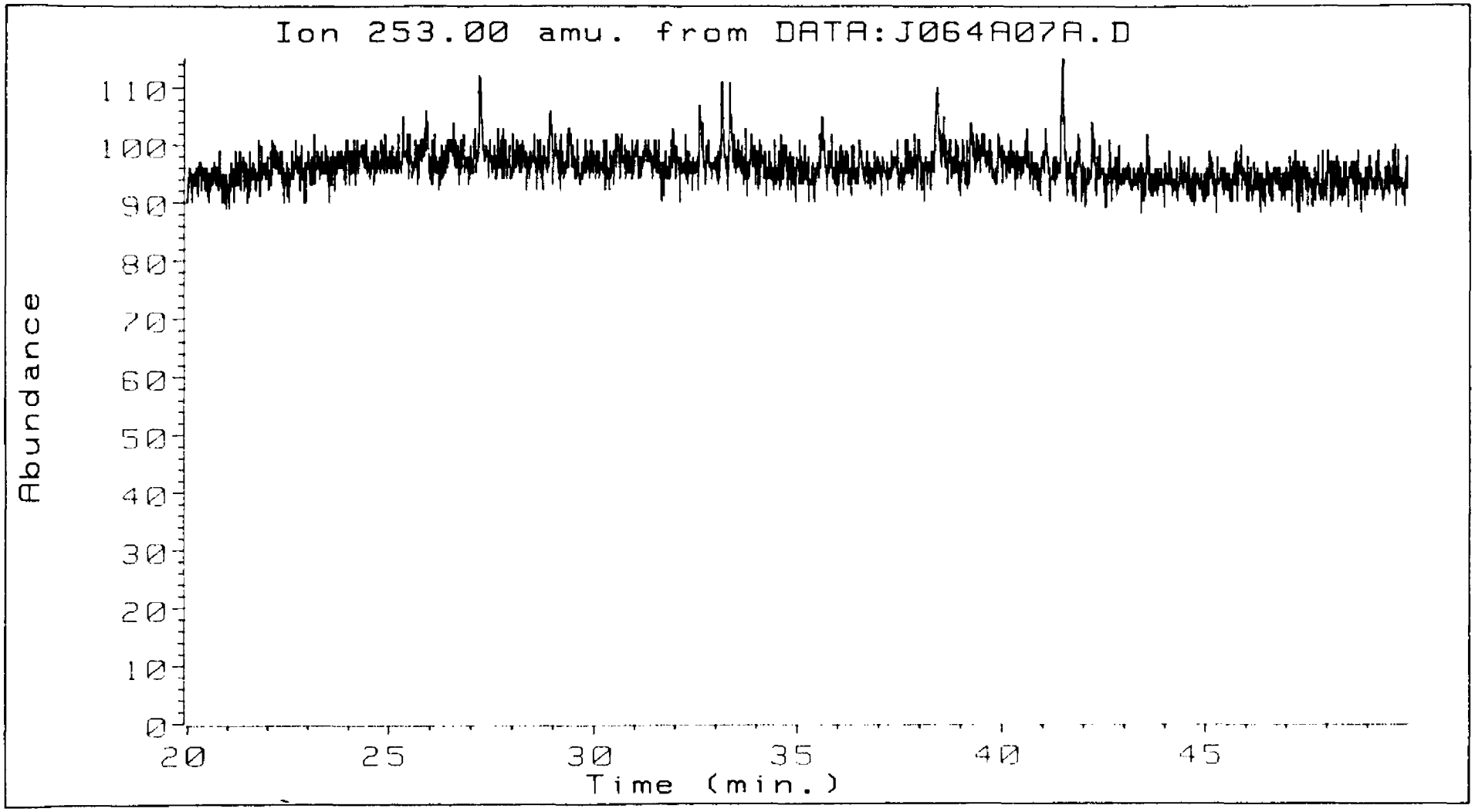
2257m


Ion 253.00 amu. from DATA:J064A06A.D
Abundance
2000
1800
1600
1400
1200
1000
800
600
400
200
0
25
30
35
40
45
Time (min.)

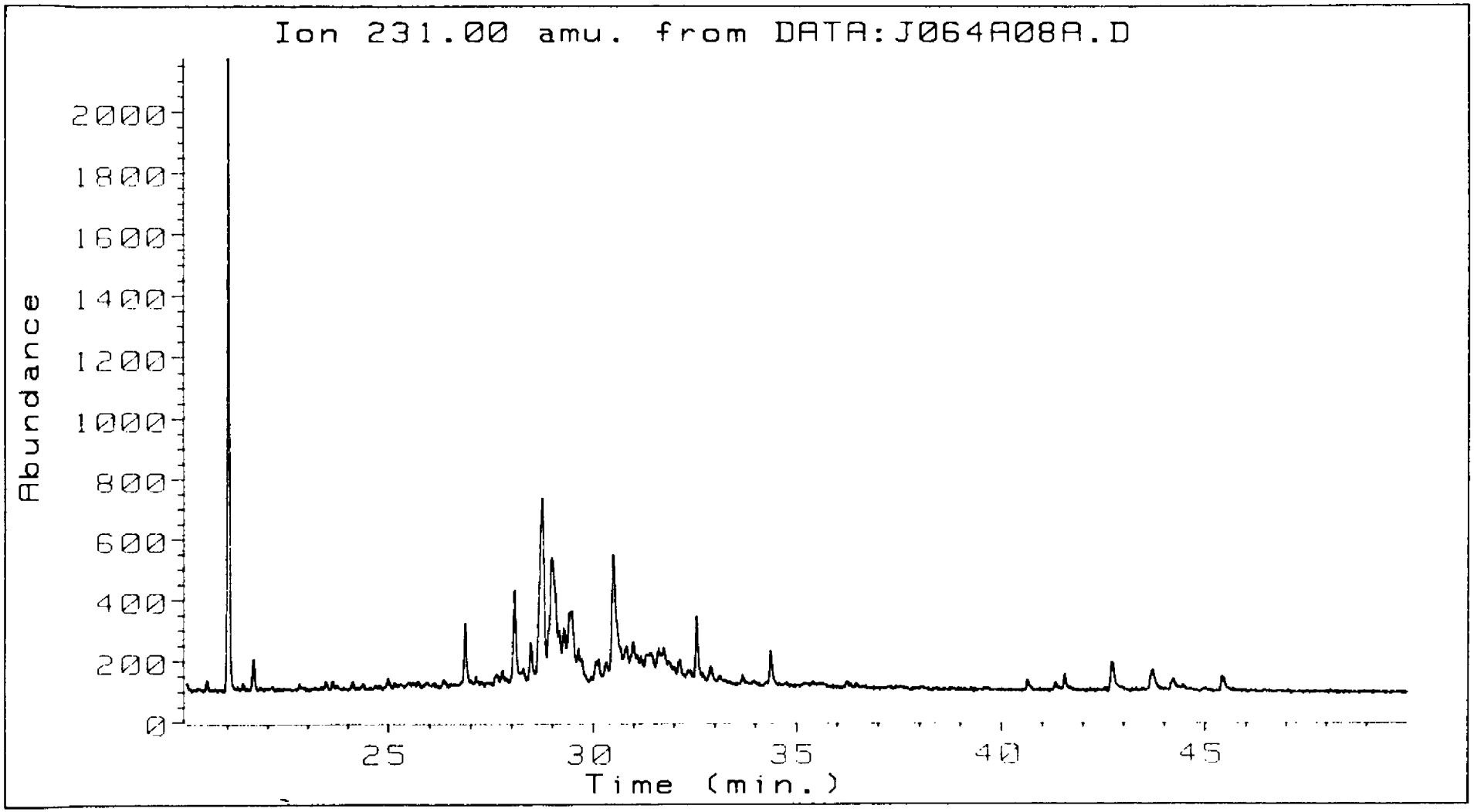
2257m


Ion 231.00 amu. from DATA:J064A07A.D
Abundance
200
150
100
50
0
20
25
30
35
40
45
Time (min.)

2447m


Ion 253.00 amu. from DATA:J064A07A.D
Abundance
110
100
90
80
70
60
50
40
30
20
10
0
20
25
30
35
40
45
Time (min.)

2447m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Abundance
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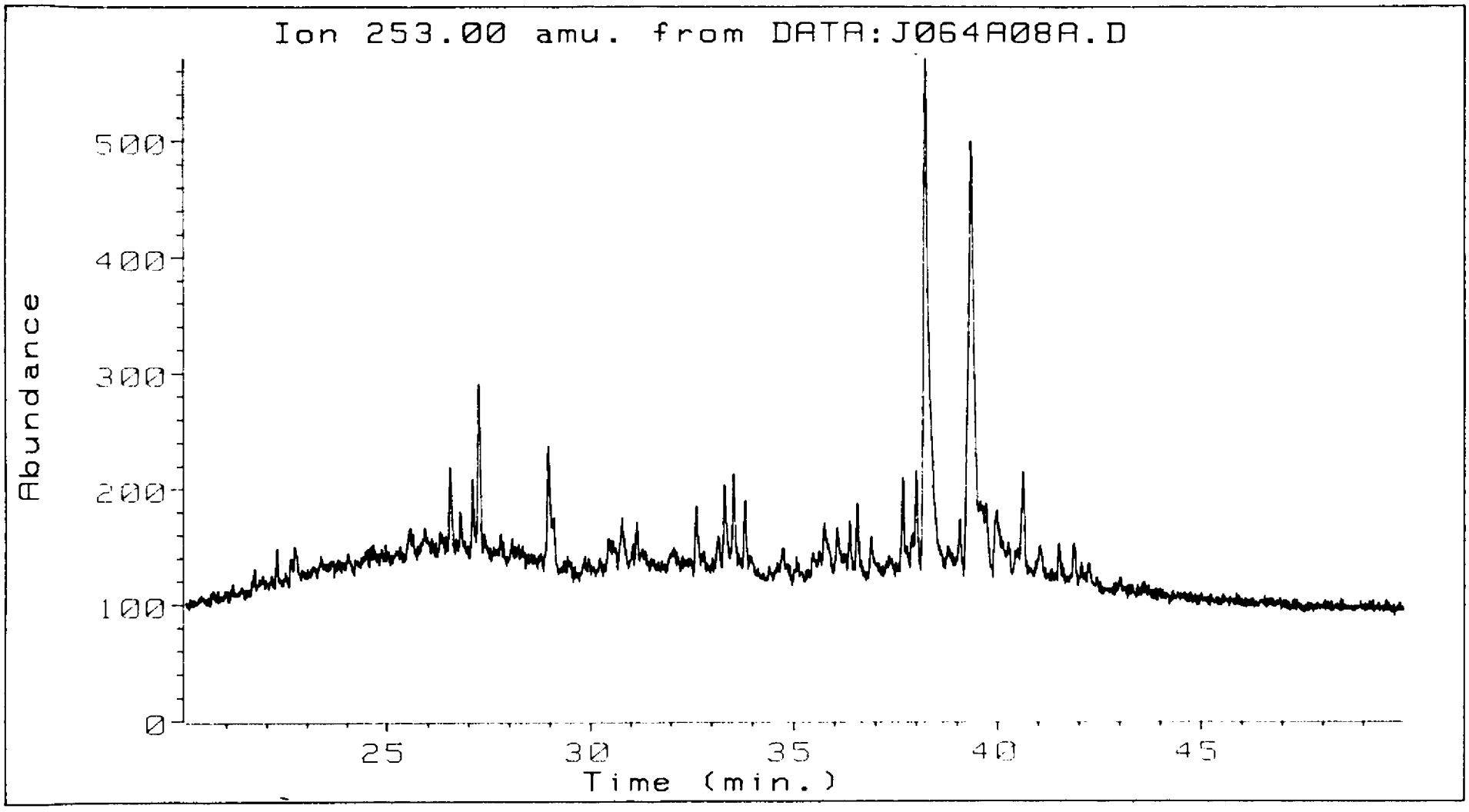
1000
800
600
400
200
0
25
30
35
40
45
Time (min.)

2450m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Abundance
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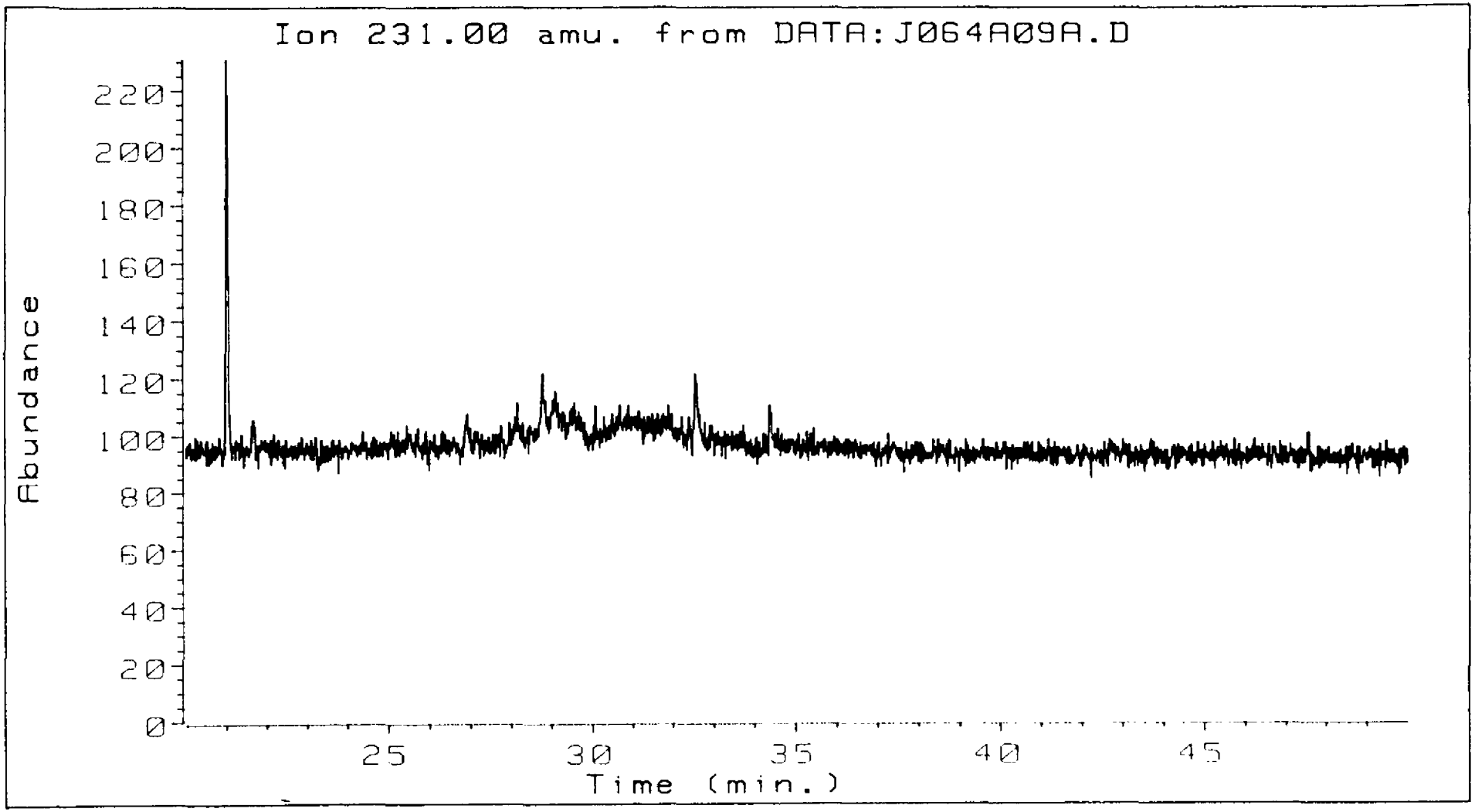
45
Time (min.)

2450m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Abundance
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100
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40
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0
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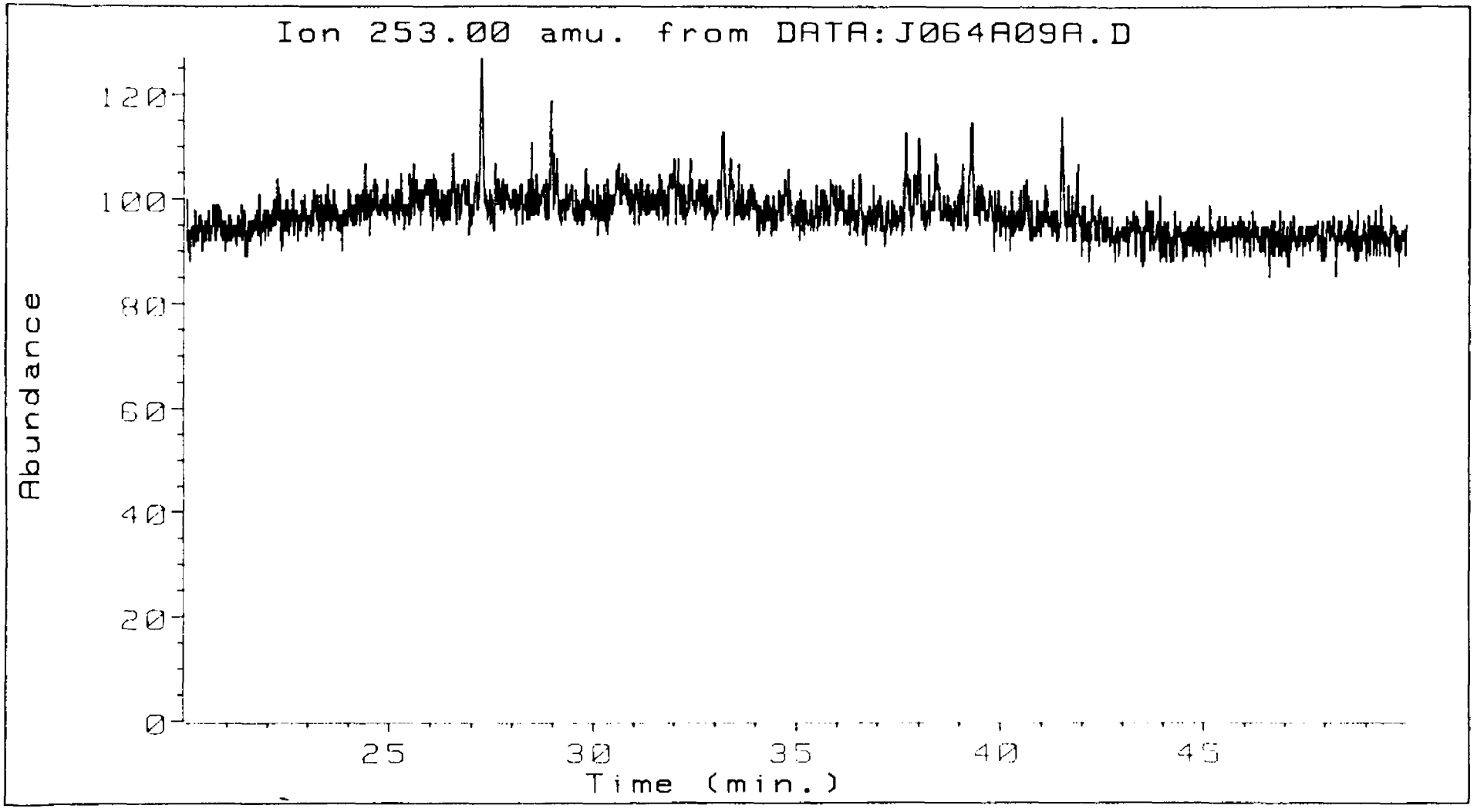
30
35
40
45
Time (min.)

2455m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0
Abundance
25
30
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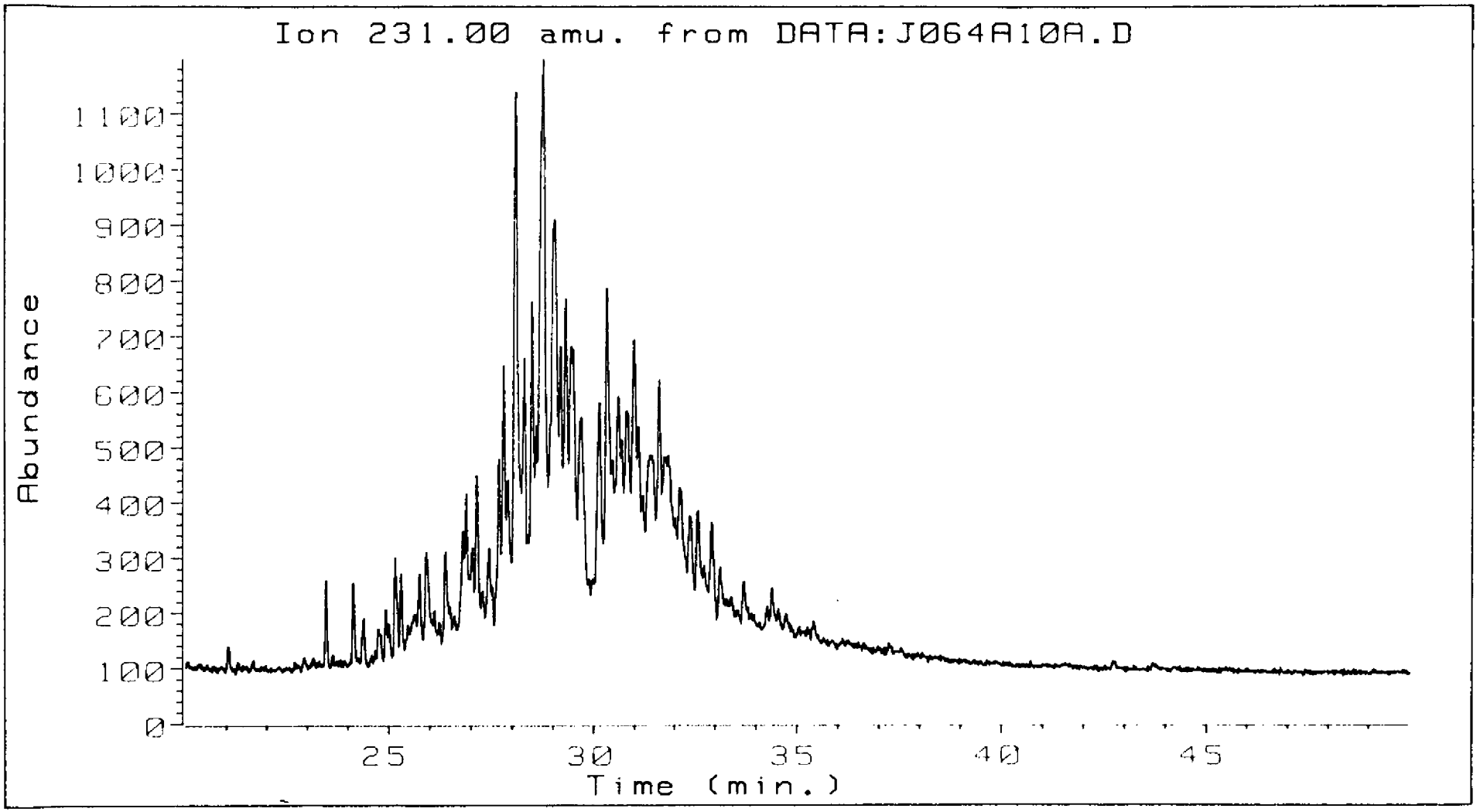
40
45
Time (min.)

2455m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Abundance
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400
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200
100
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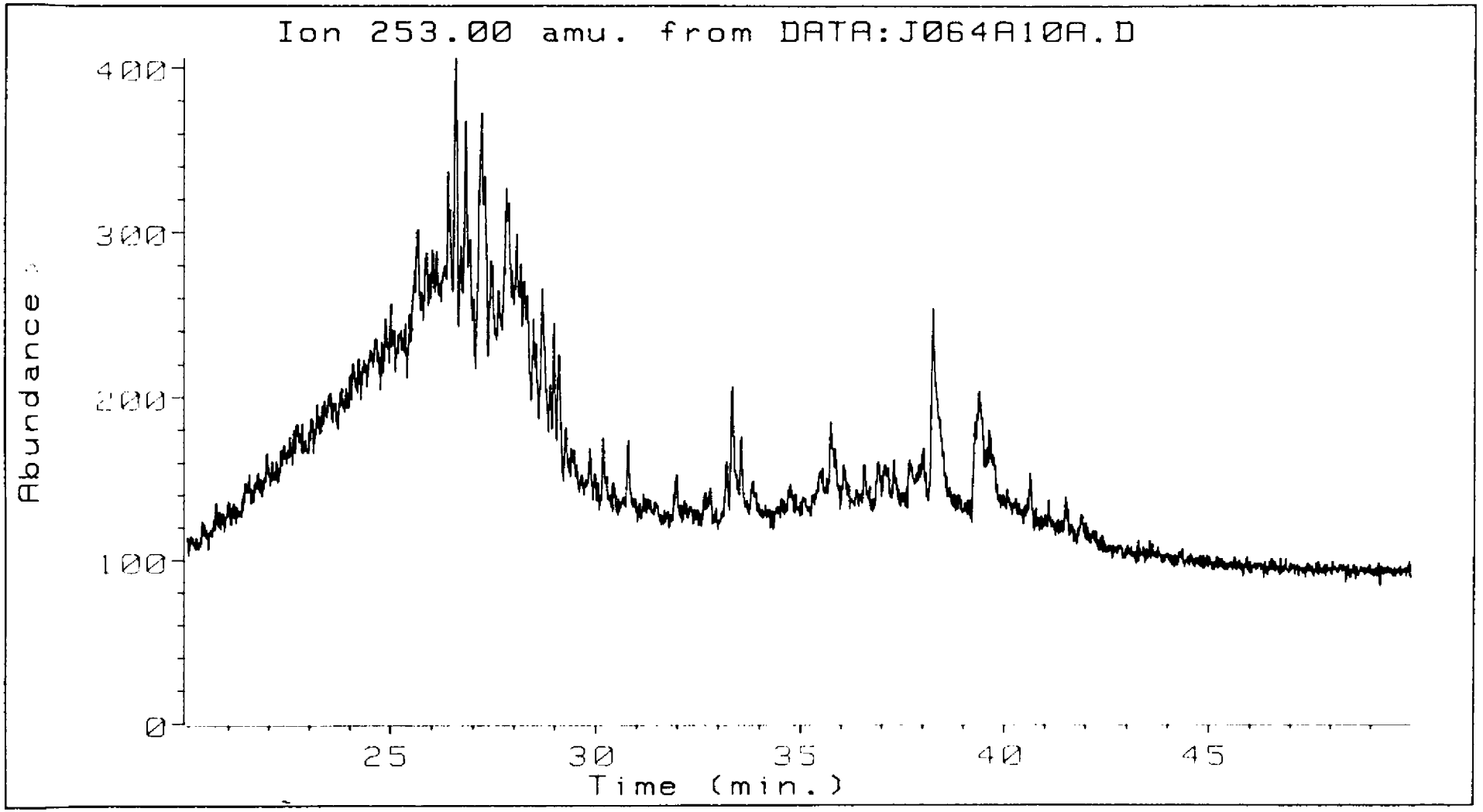
30
35
40
45
Time (min.)

;2455.00 03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Abundance
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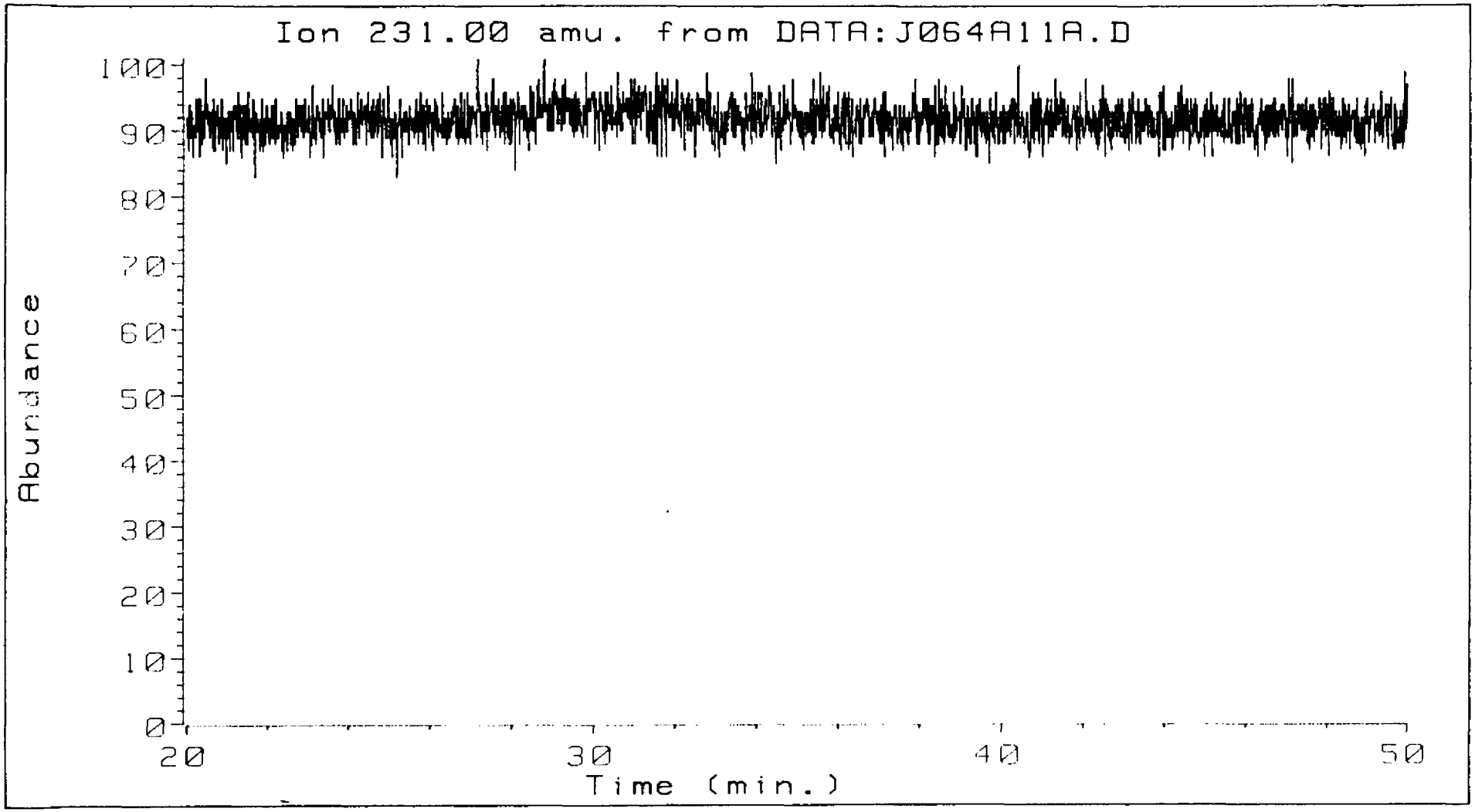
45
Time (min.)

2455.00 03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Abundance
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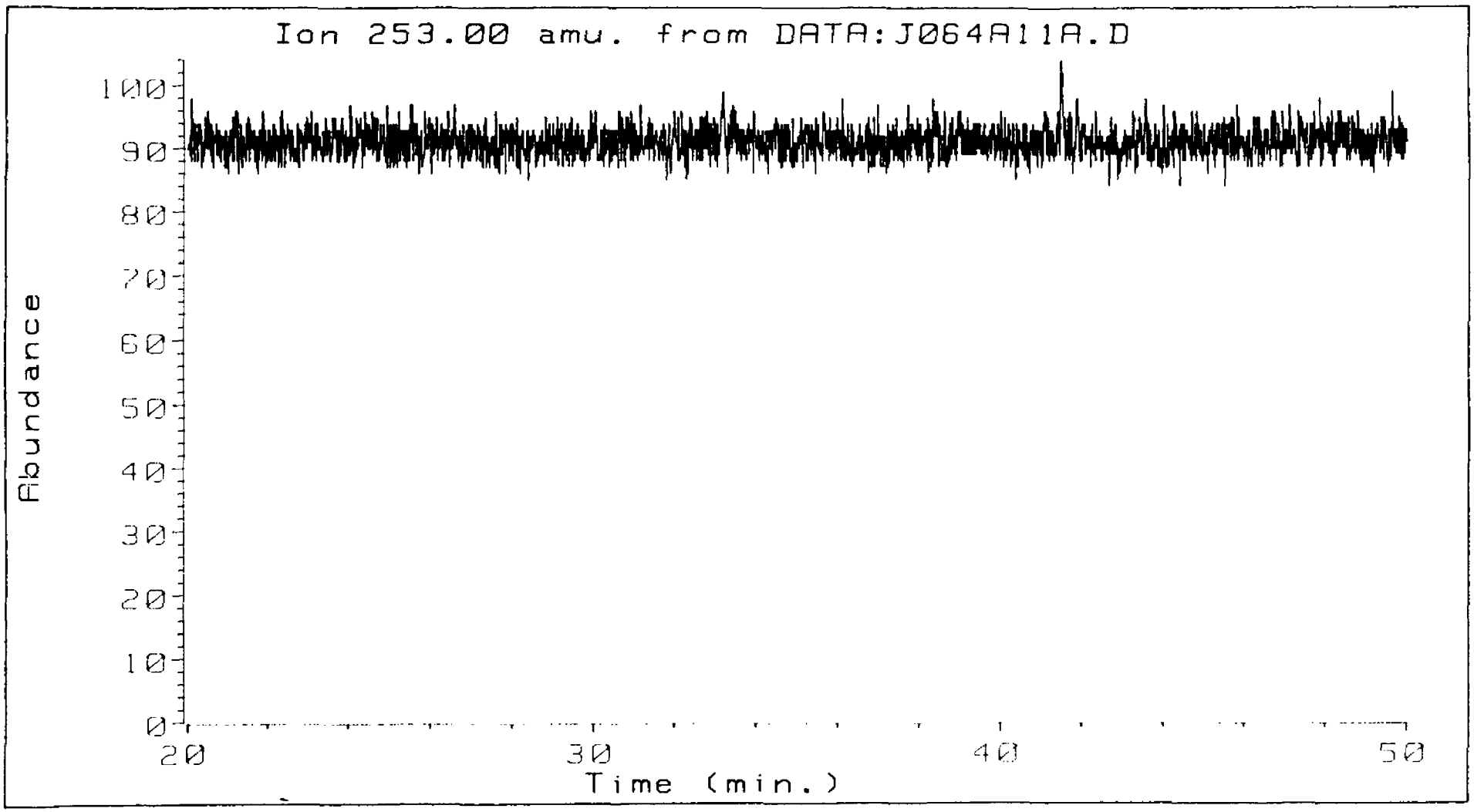
50
Time (min.)

2455.97 00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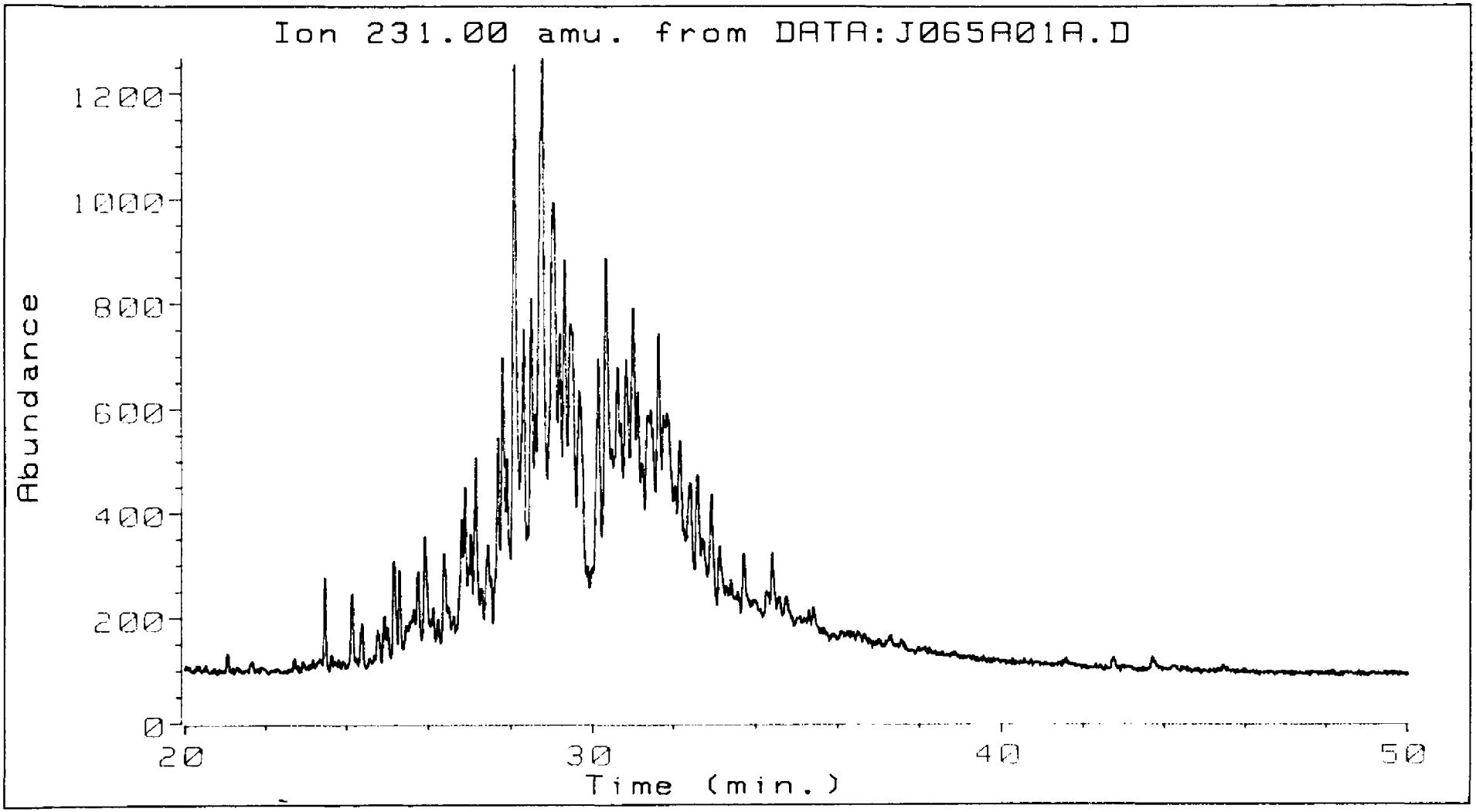
Time (min.)

2455.97 00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Abundance
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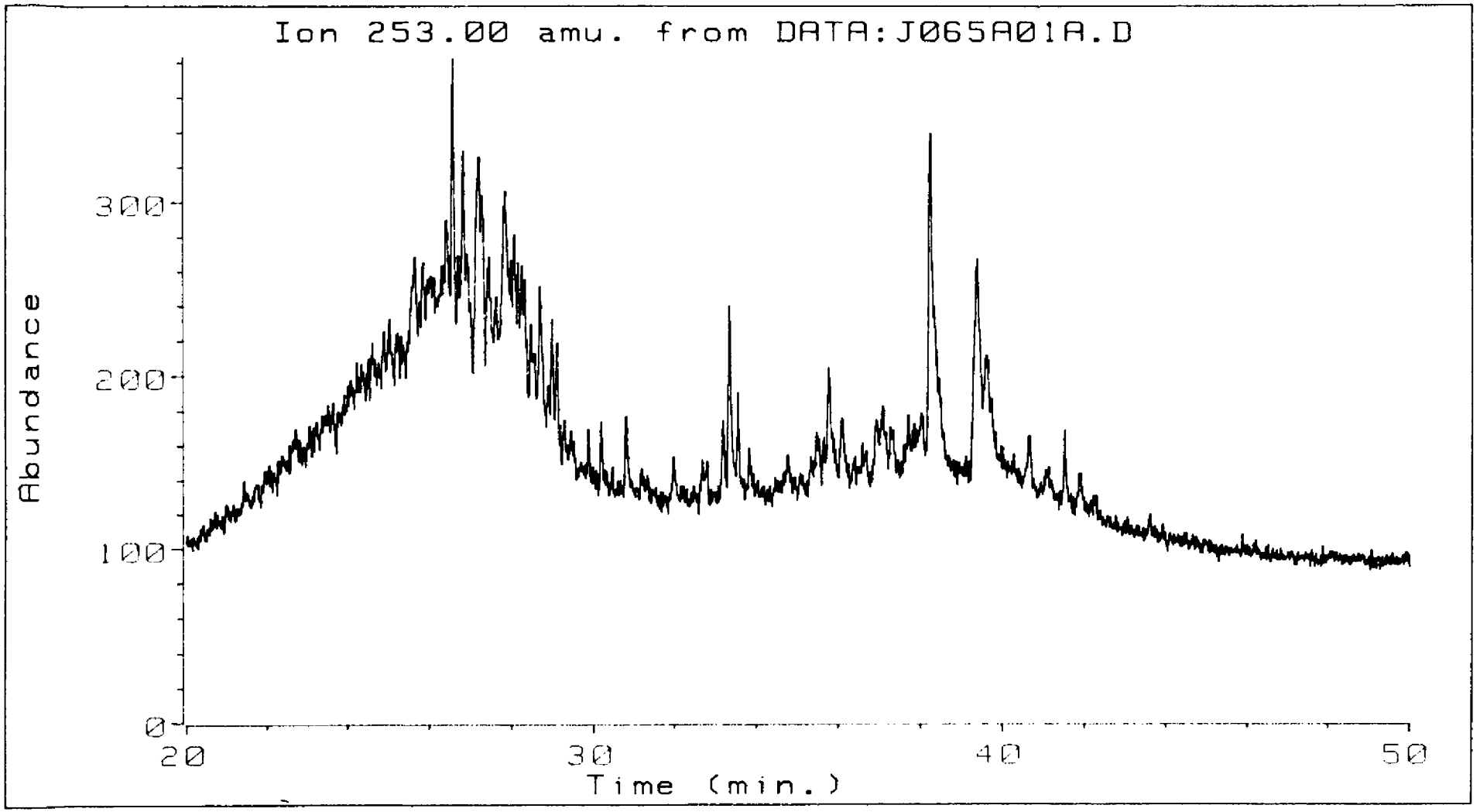
Time (min.)

2456.98 00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Abundance
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100
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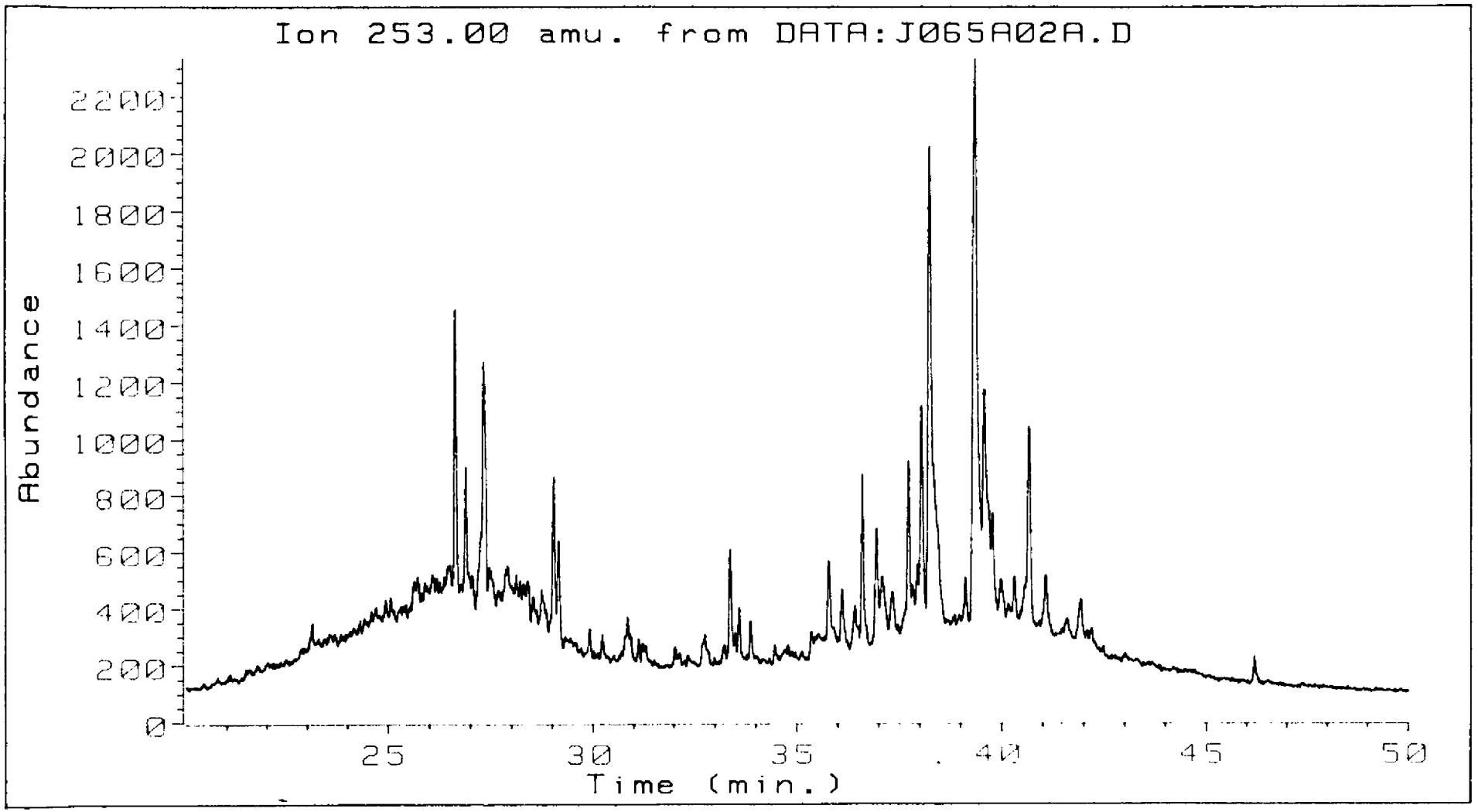
30
40
50
Time (min.)

2456.98 00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Abundance
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0
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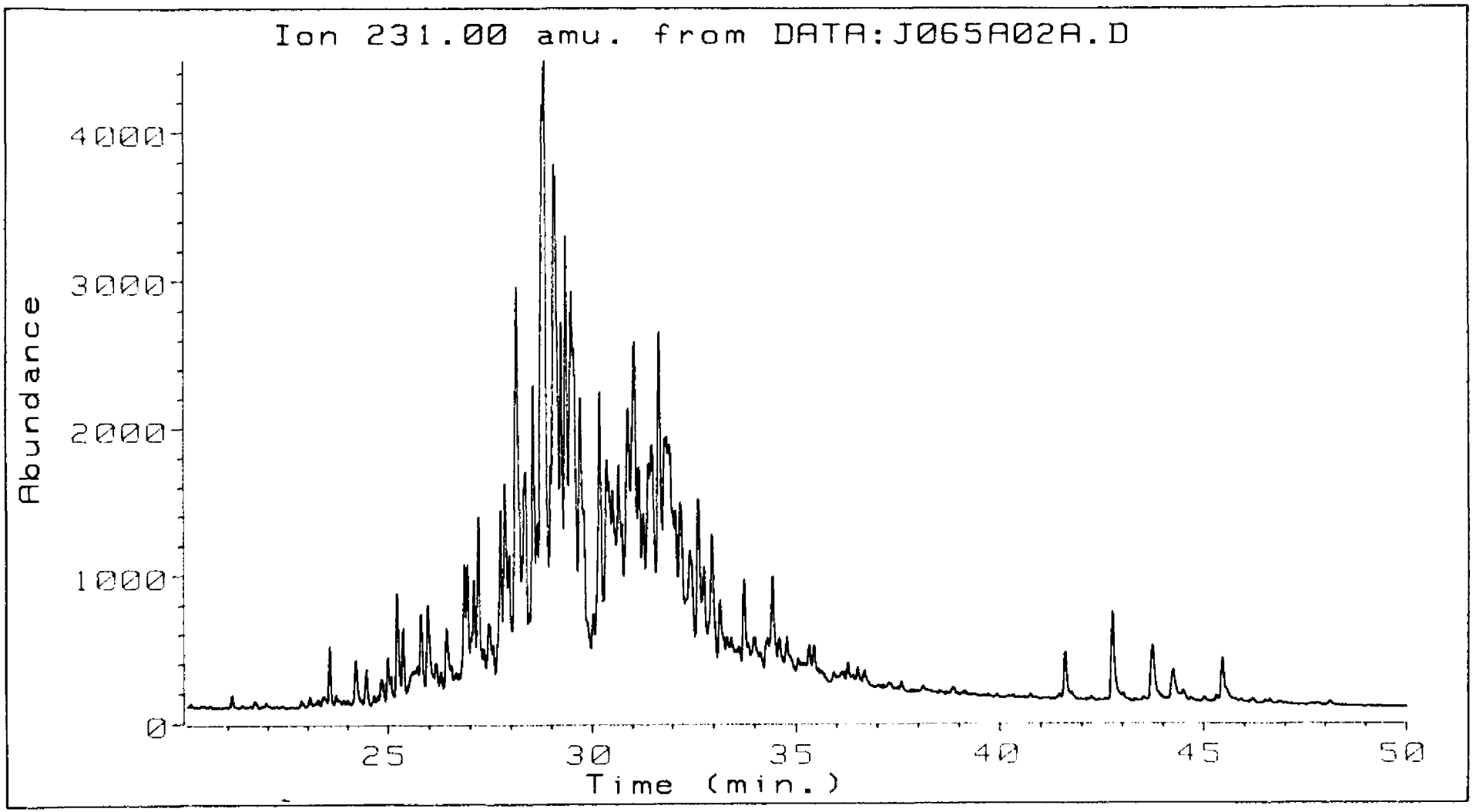
40
45
50
Time (min.)

2457.96 00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1000
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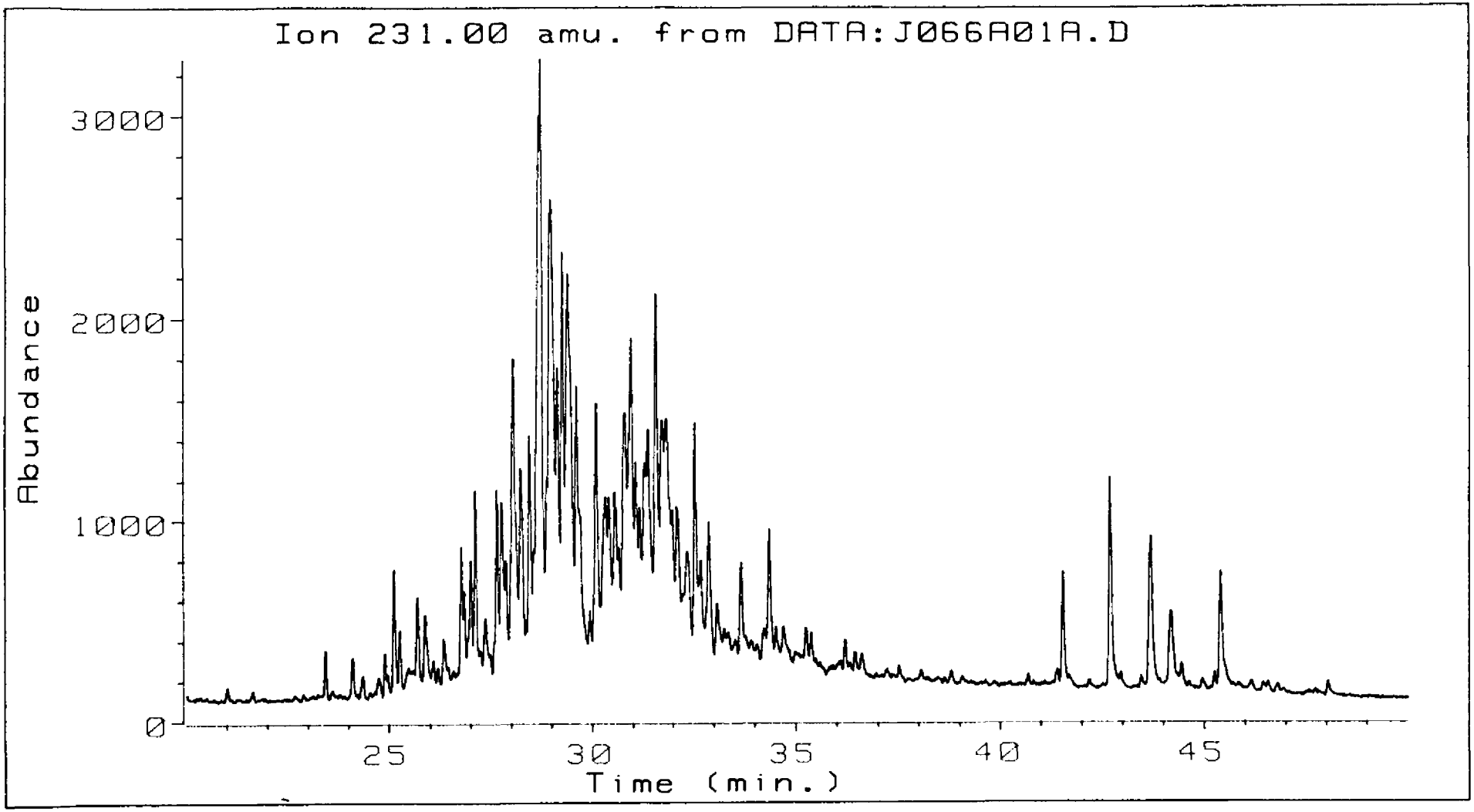
45
50
Time (min.)

2457.96 00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Abundance
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1000
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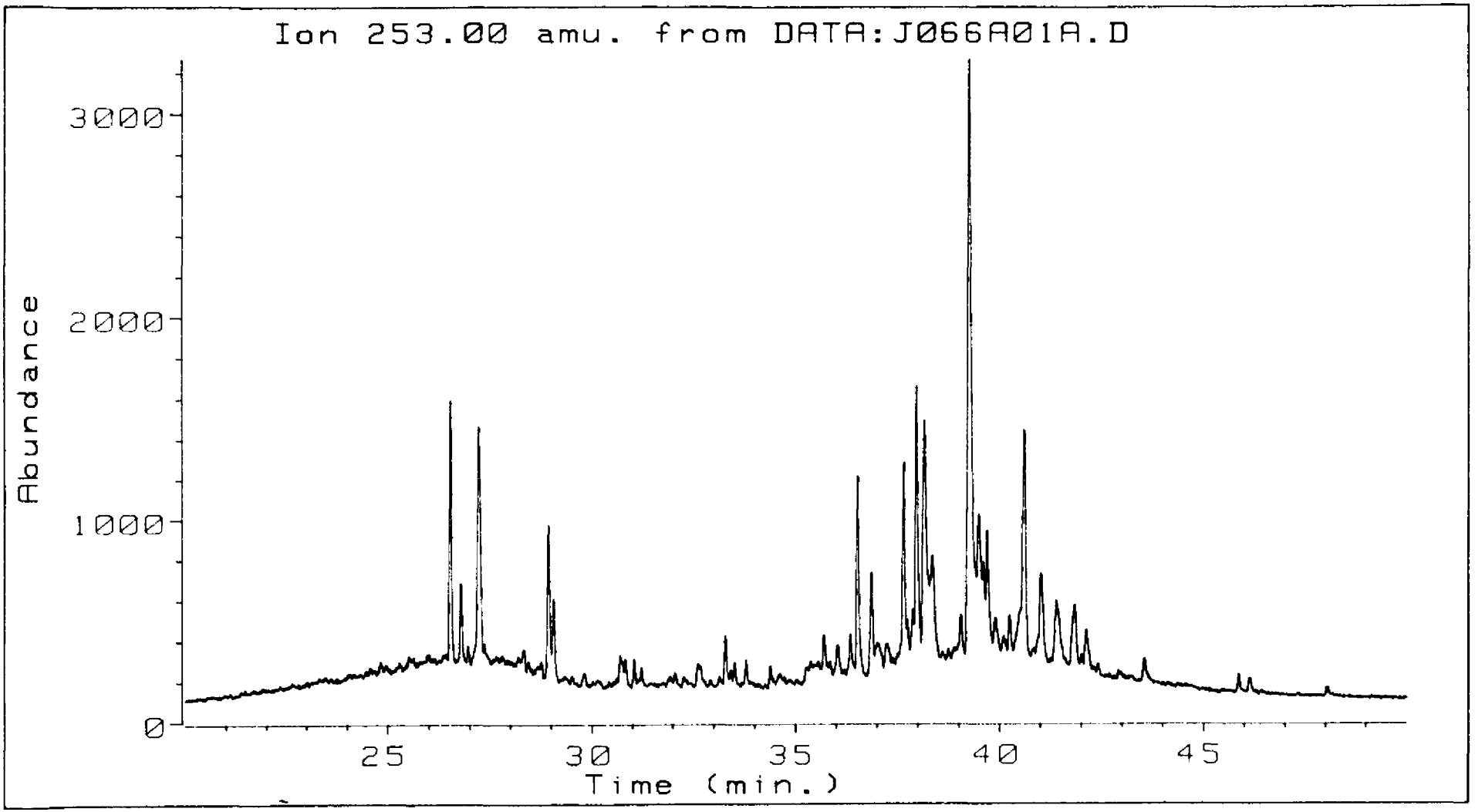
30
35
40
45
Time (min.)

2458.65 69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Abundance
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1000
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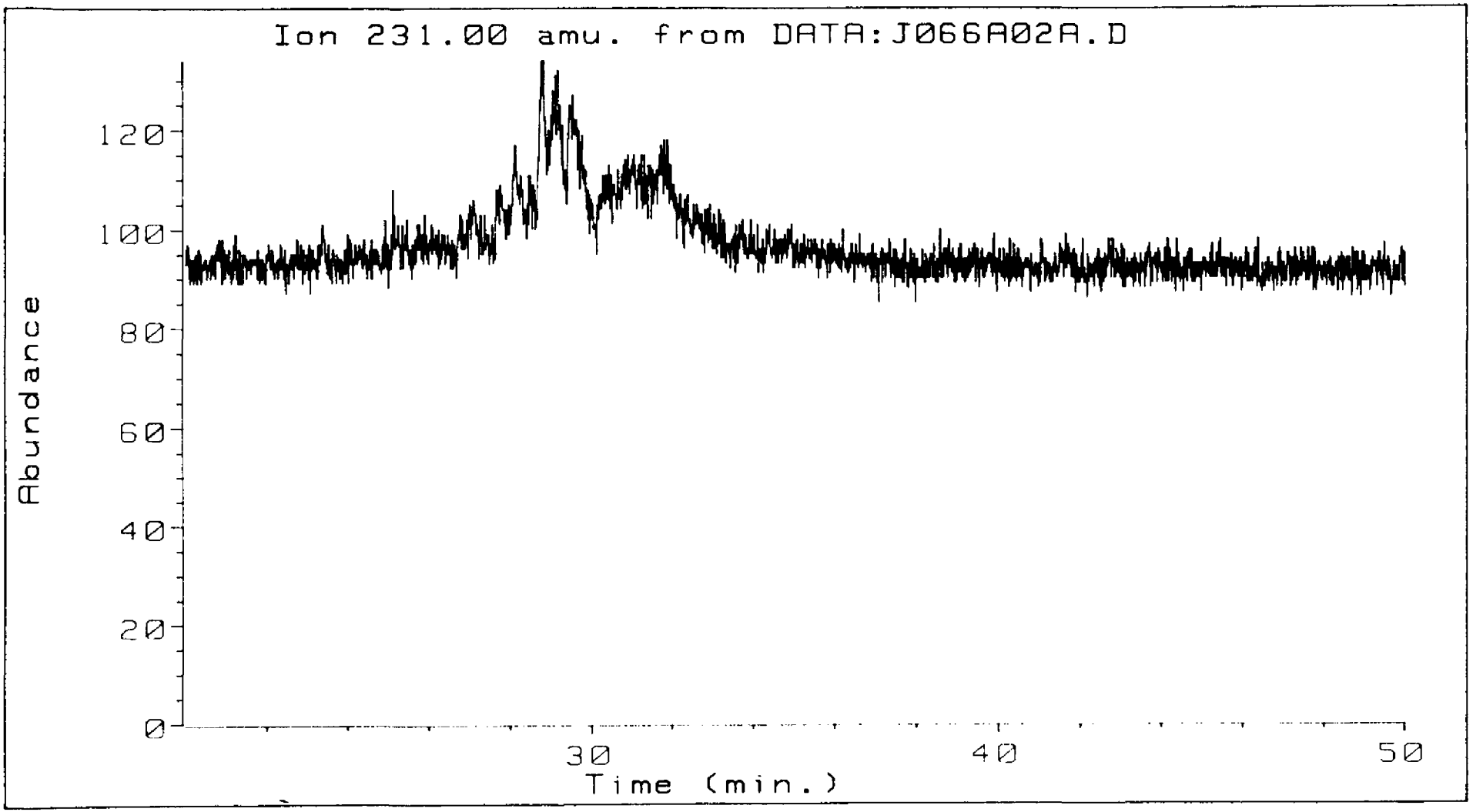
30
35
40
45
Time (min.)

2458.65 69


Ion 231.00 amu. from DATA:J066A02A.D
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60
40
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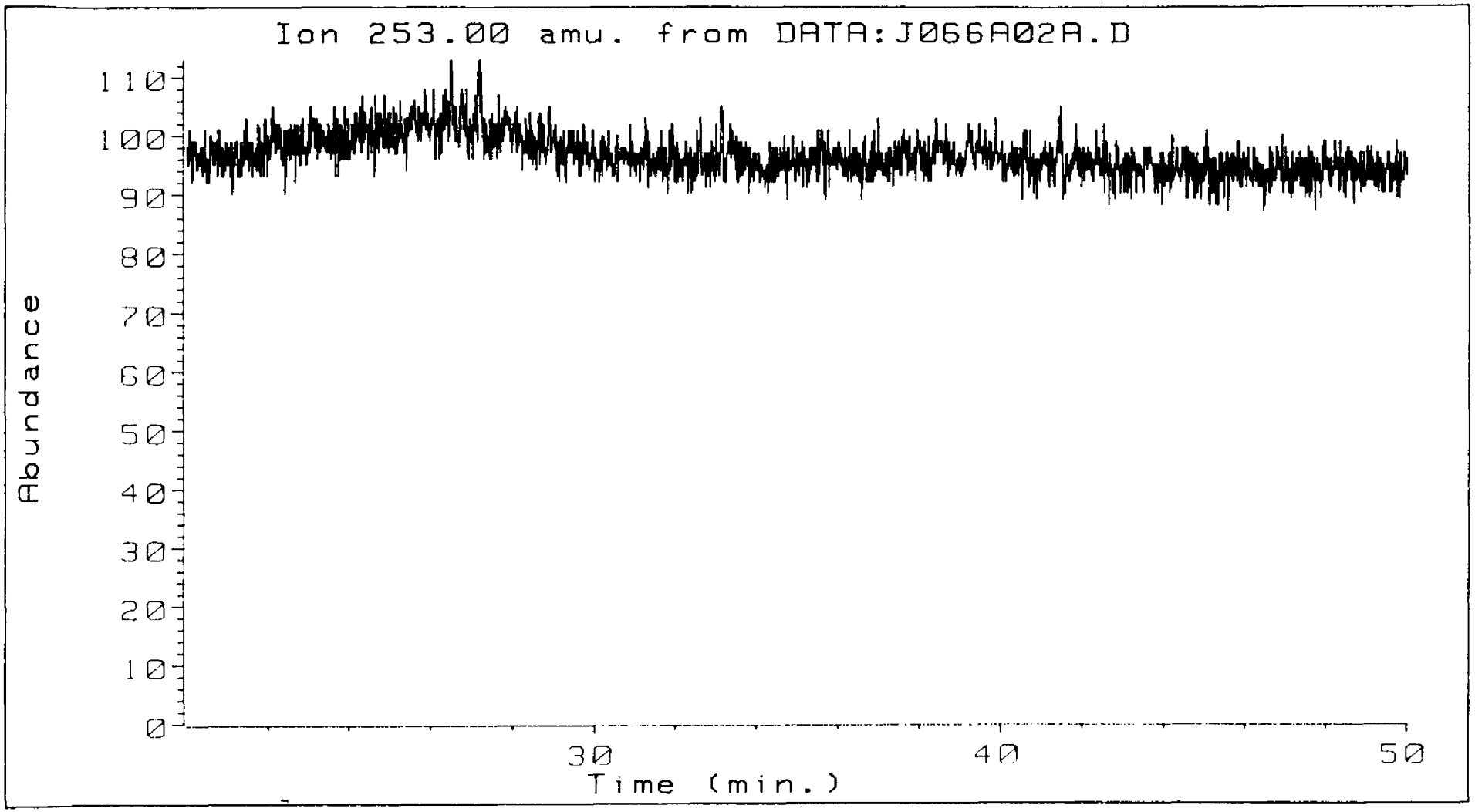
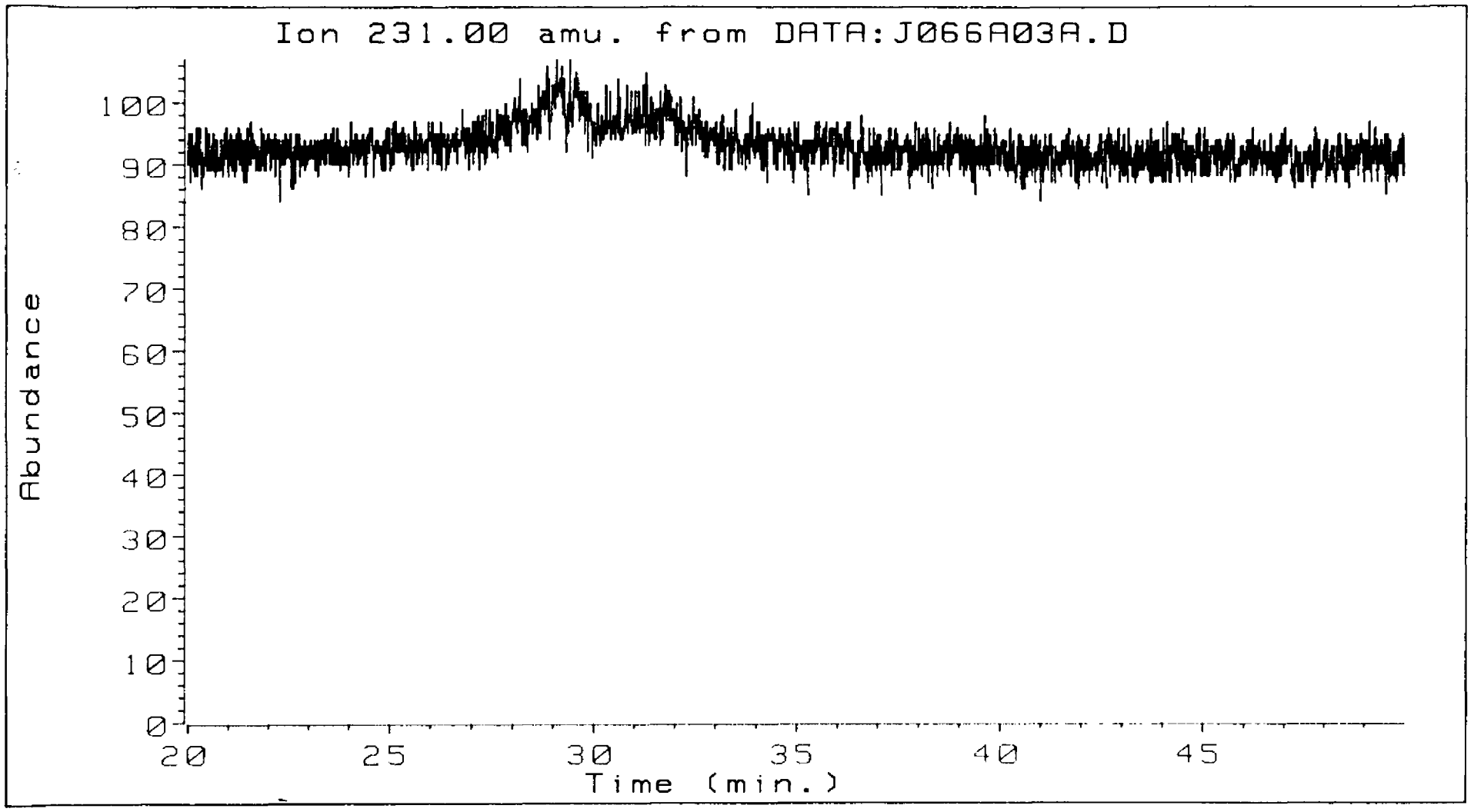
0
Abundance
30
40
50
Time (min.)

2460.00 05


Ion 253.00 amu. from DATA:J066A02A.D
110
100
90
80
70
60
50
40
30
20
10
0
Abundance
30
40
50
Time (min.)

2460.00 05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Abundance
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10
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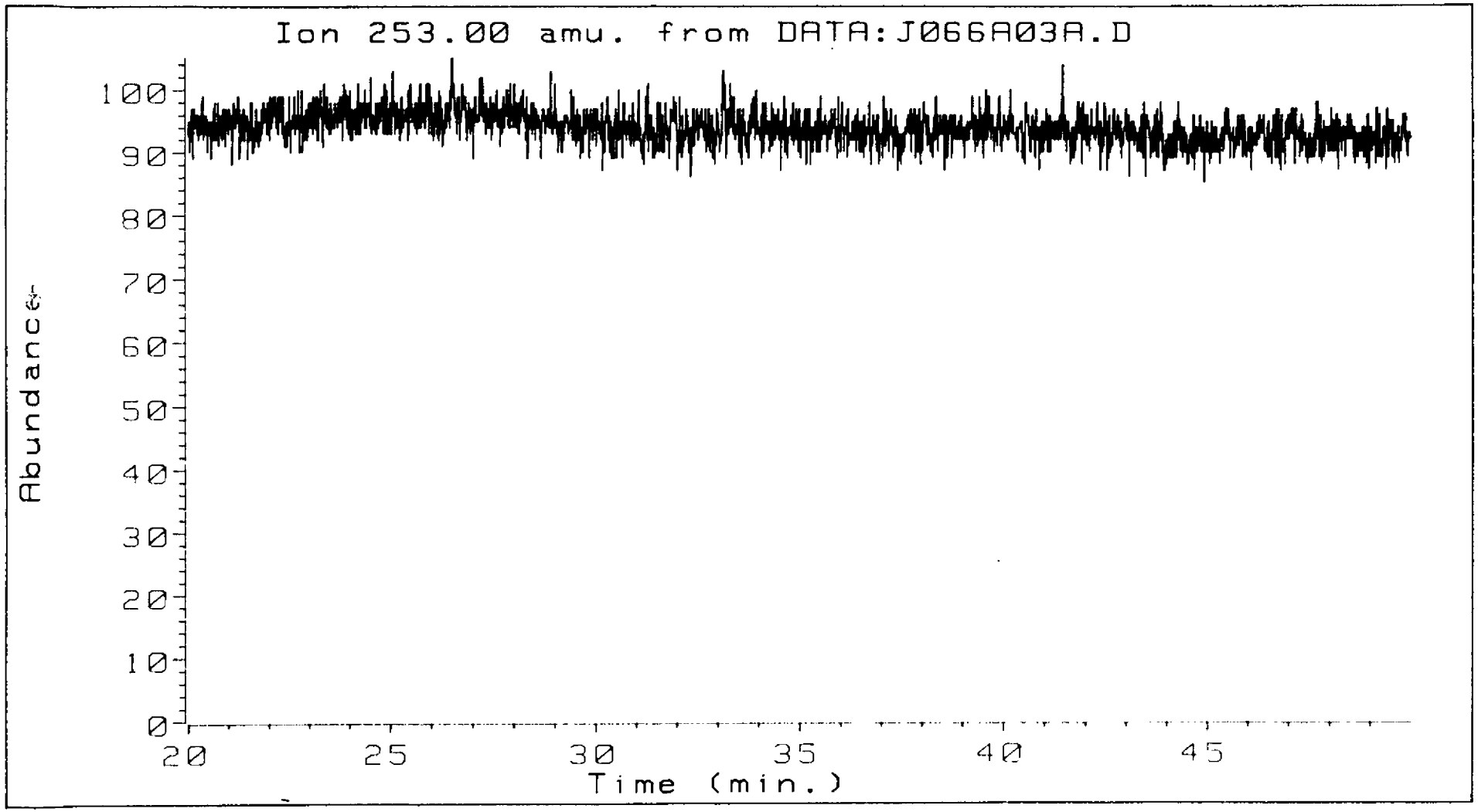
30
35
40
45
Time (min.)

2460.95 00


Ion 253.00 amu. from DATA:J066A03A.D
Abundance
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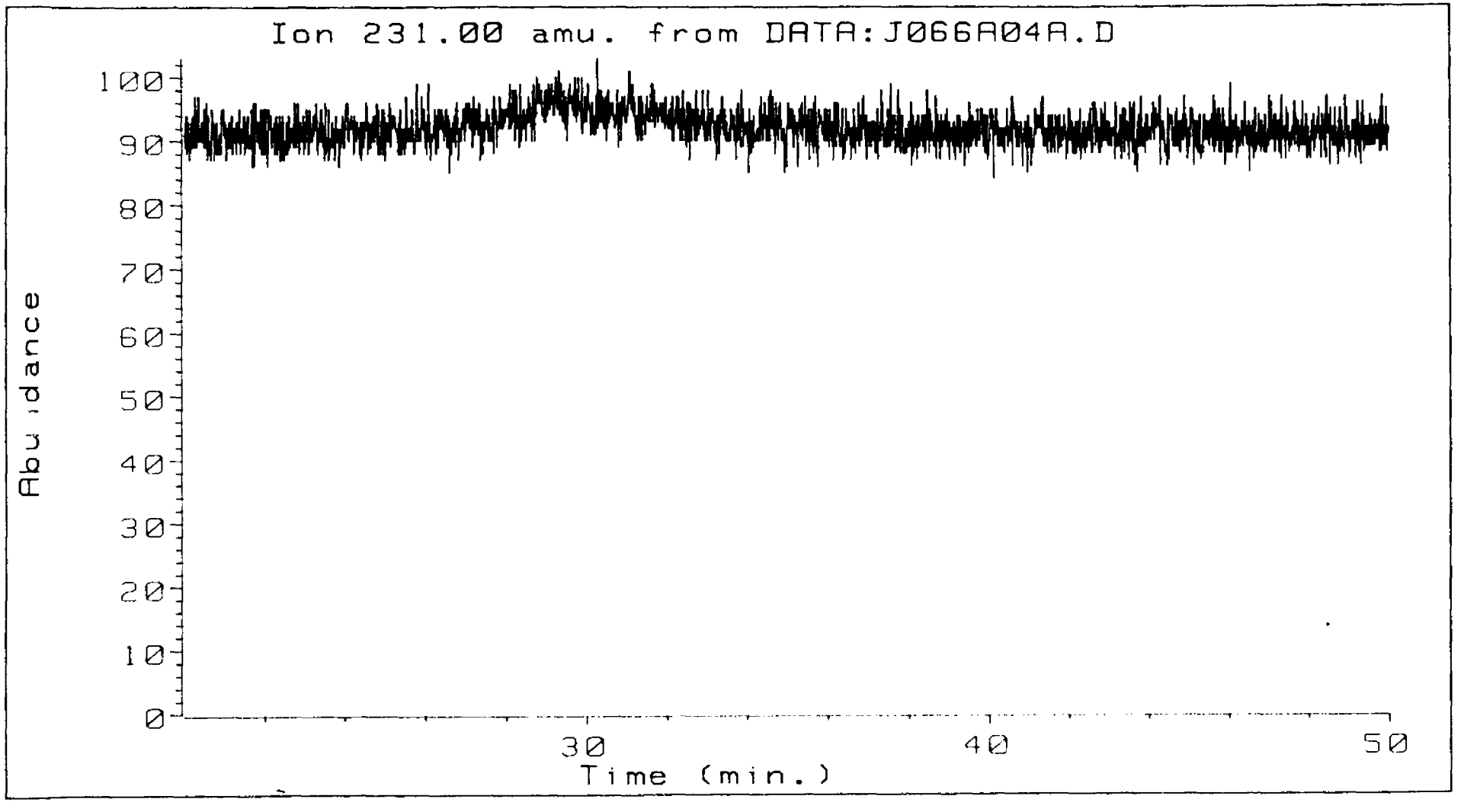
40
45
Time (min.)

2460.95 00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20
10
0
Abundance
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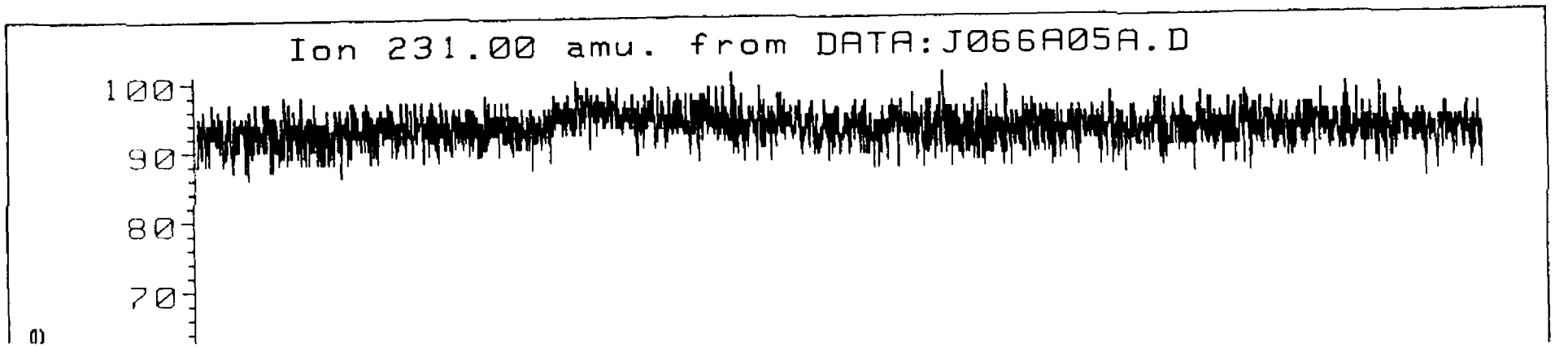
50
Time (min.)

2461.96 00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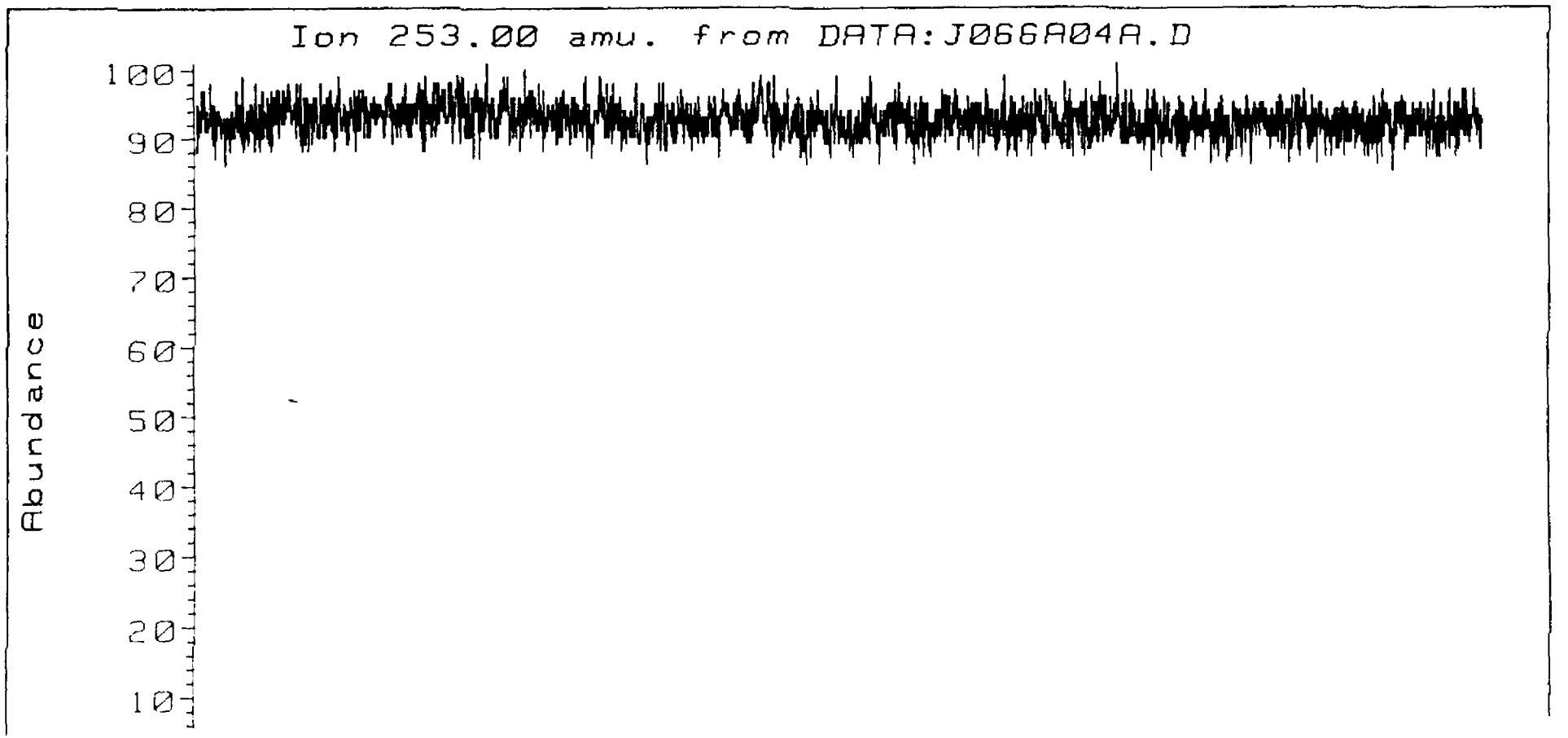
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Abundance
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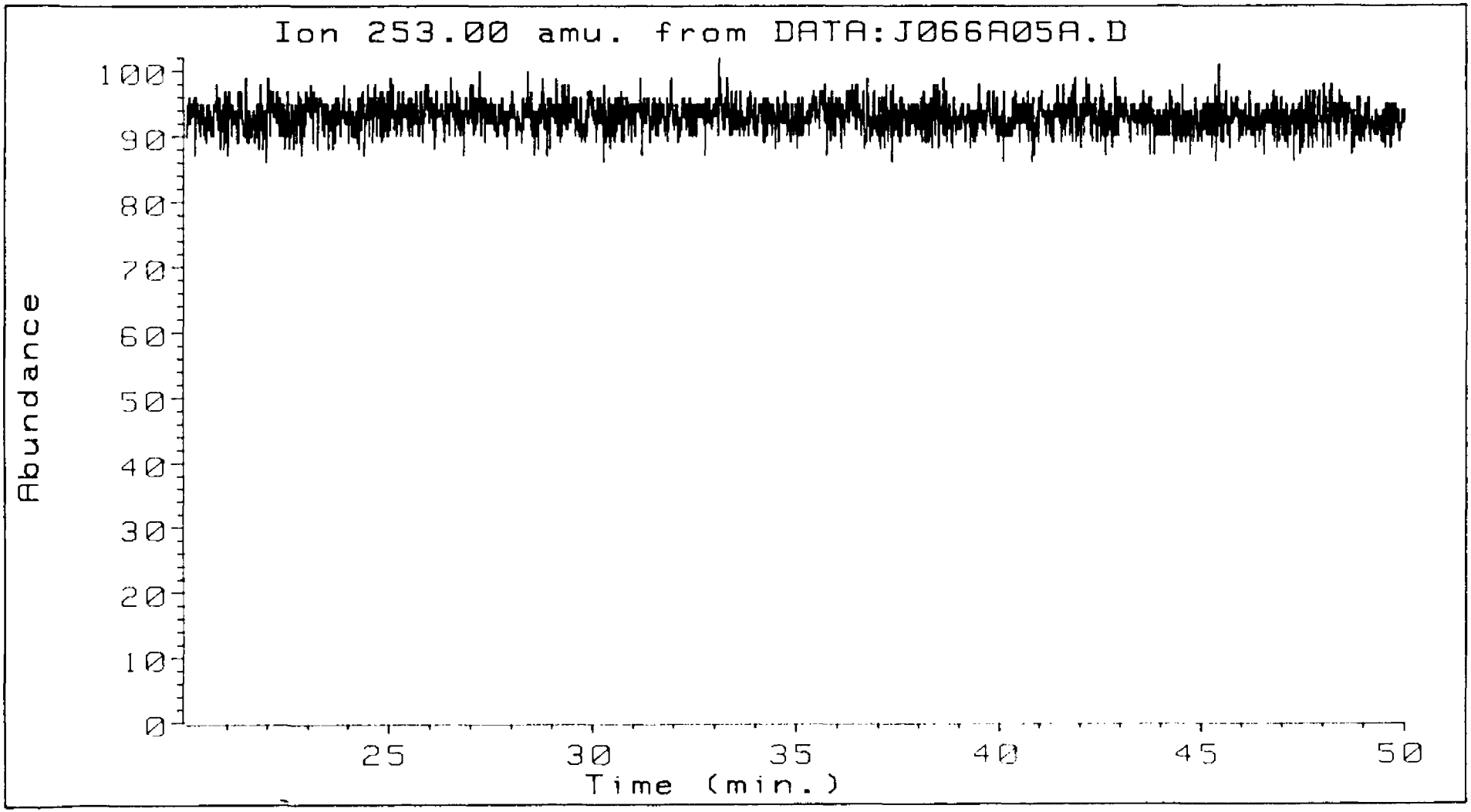
10


Ion 253.00 amu. from DATA:J066A05A.D
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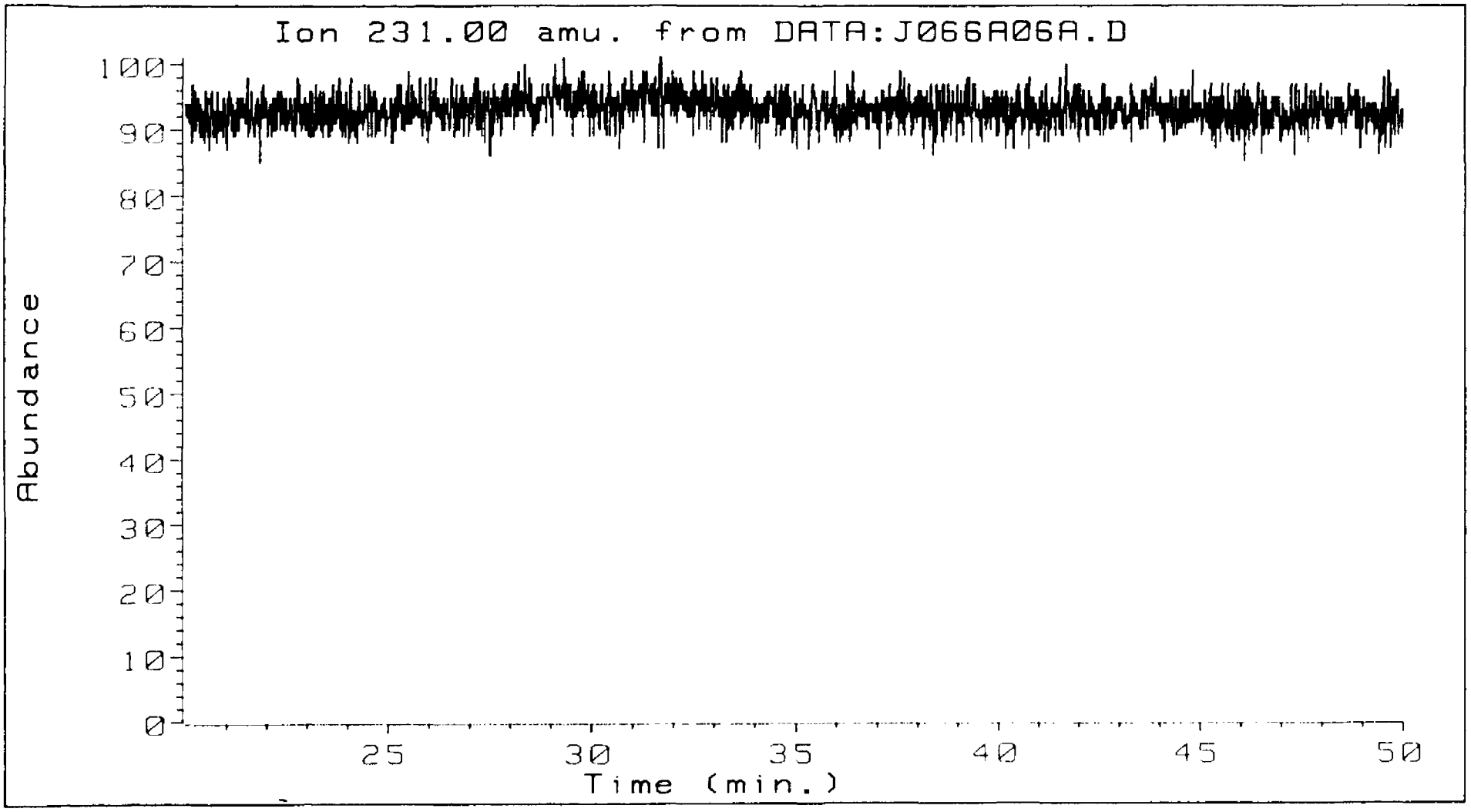
45
50
Time (min.)

2463.07 13


Ion 231.00 amu. from DATA:J066A06A.D
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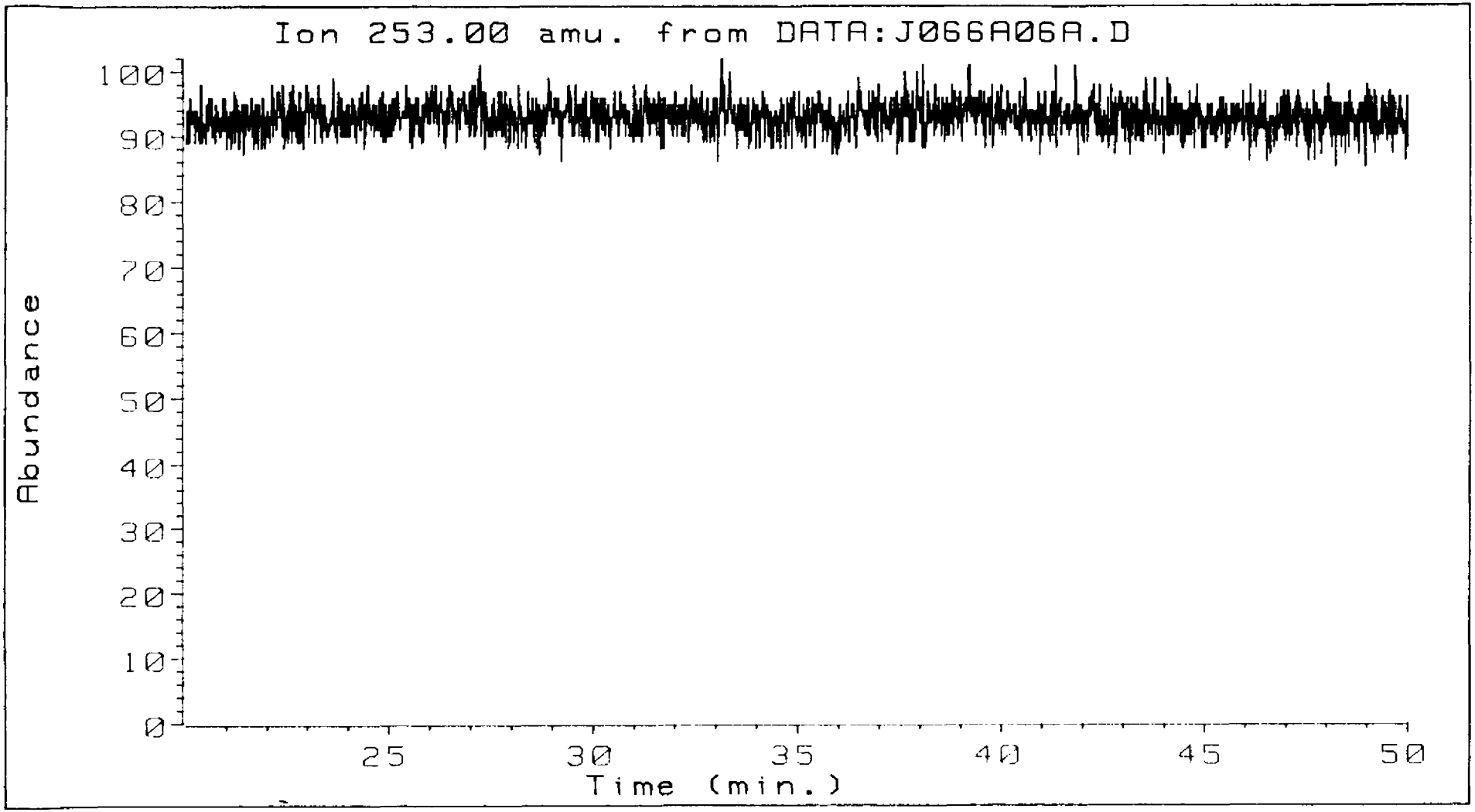
Time (min.)

2463.95 00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35
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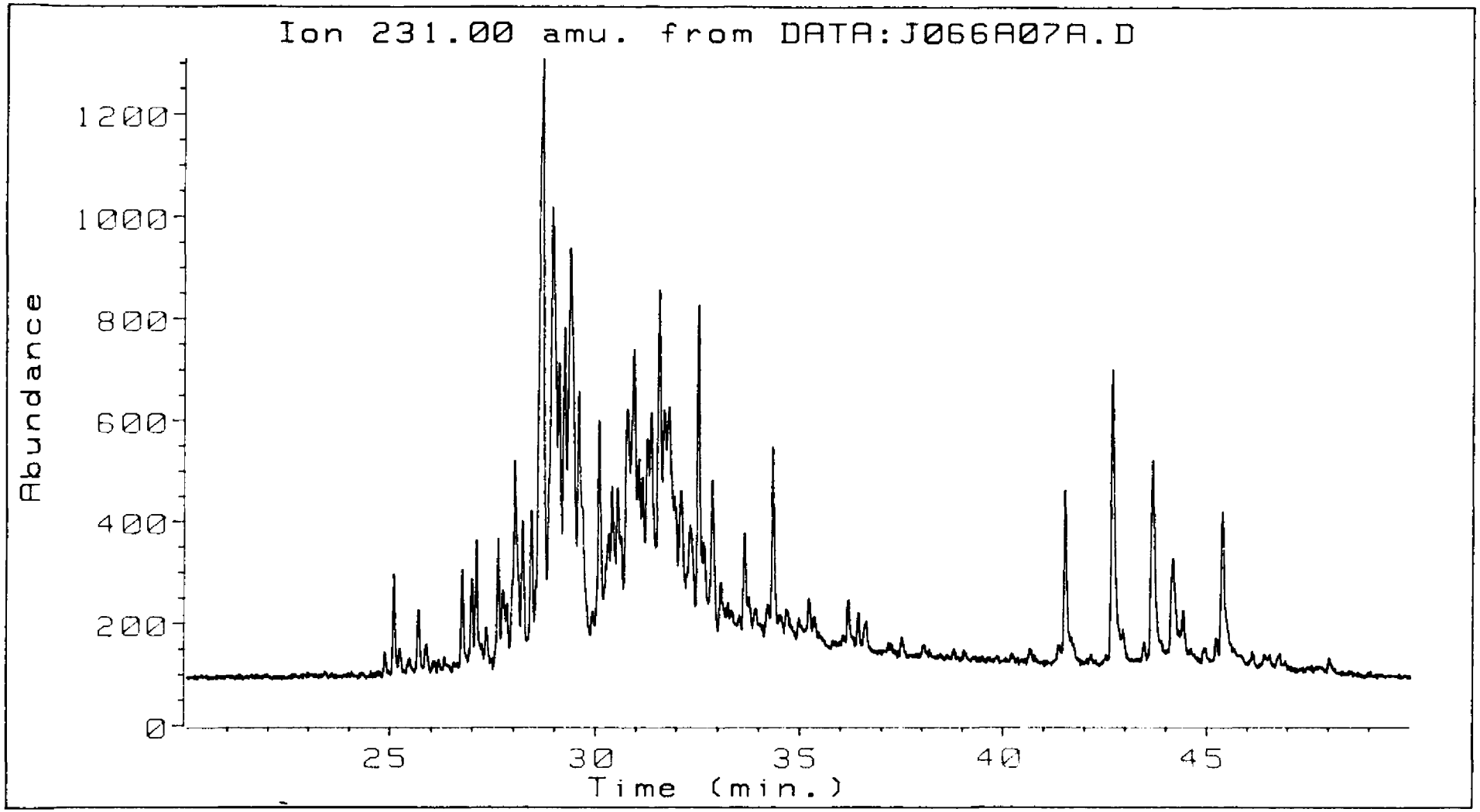
Time (min.)

2463.95 00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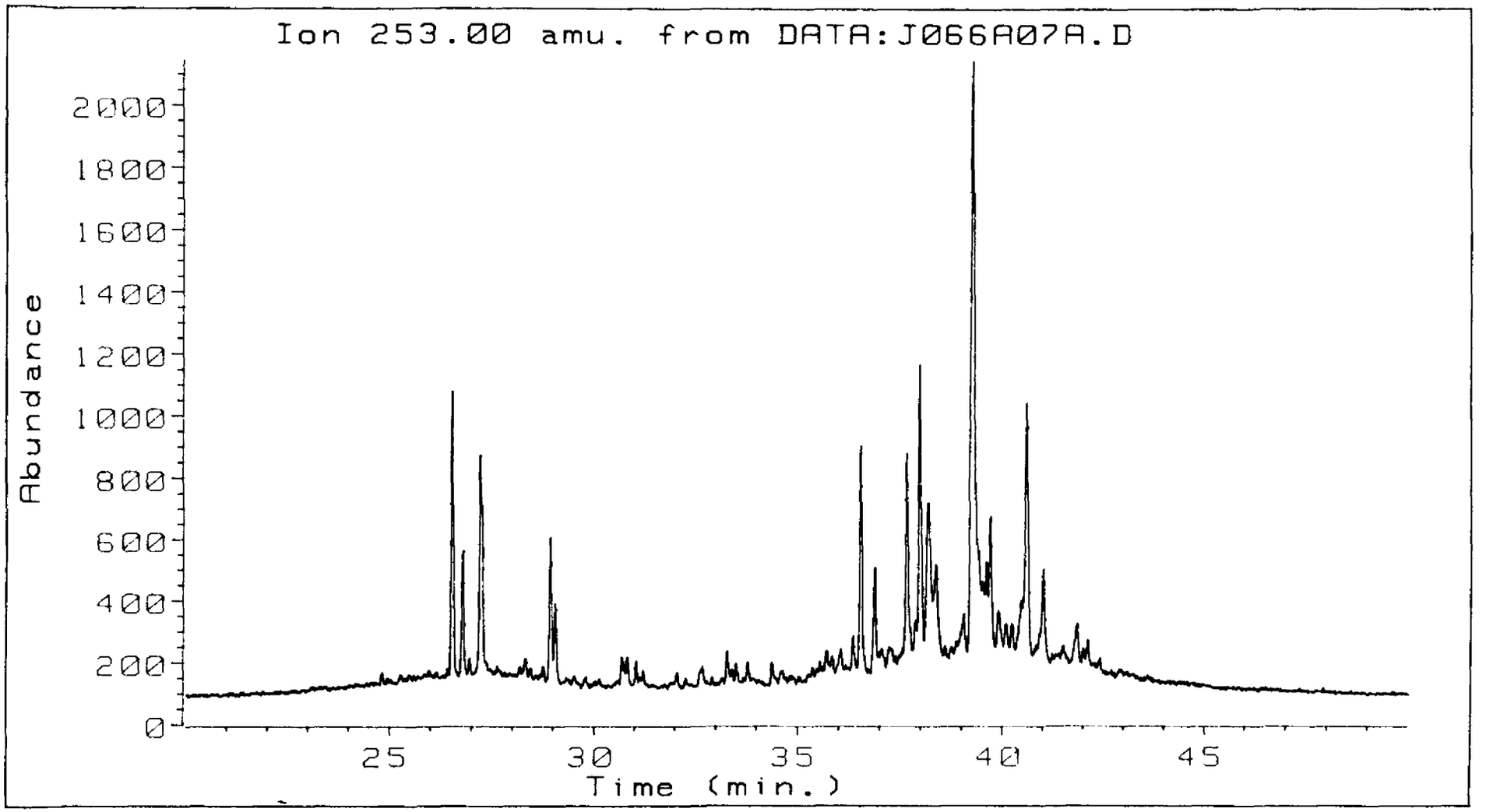
Time (min.)

2466.20 24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Abundance
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30
35
40
45
Time (min.)

2466.20 24