HYDRO

Bergen

U-592 3

Rapport/Report

Fortrolig/Confidential ☐

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GEOCHEMICAL EVALUATION OF WELL 30/9-7

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Sign

Resymé/Konklusjon/Anbefaling
Summary Conclusion Recommendation

The analysed section comprises the basal Shetland Formation (3samples) and the Draupne Formation (2788-2803m,4 samples) overlying a sequence including the coal-bearing Tarbert Formation, (2835-2898m); 'dead oil'stain is recorded at 2880-2885m (2 samples).
The section is just within the principal maturity zone for oil generation (Ro 0.49 to 0.63%). The Draupne Fm. is a rich oil-source rock. Oil stain is frequent in the section.It is present as small amounts of biodegraded oil and as larger amounts of live light oil mixed with biodegraded oil, and as flushed oil.The presence of biodegraded oil suggests that oil was in place and being altered in the Cretaceous,and that its source rock at that time was at a depth of some 2.5-3000m.

The oils from 30/9-7 have the same origin as the oil from 30/9-3A but have a higher thermal maturity.

Emneord/Key words
source rock evaluation, maturity

Emnekategori Subject category
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CONTENT

I MATURITY

Vitrinite reflectivity has been determined on five samples (2827 m, 2833 m, 2862.65 m, 2879.98 m and 2942.0 m) all of which contained adequate amounts of measurable vitrinite. Nevertheless, the apparent changes in reflectivity, from Ro 0.49 to 0.63% over an interval of 115m, suggests that there is at least one unconformity in analysed sequence.(Fig 3)

The measurements show that the analysed sequence is just fully mature, that is, close to the top of the principal zone of maturity for oil generation.(Fig 4)

II OIL STAIN

Minor oil stain is frequent though the section (2775 m to 2787.5 m, Shetland Gr.; 2805 to 2810 m, Brent Gr. and 2883.5 to 2887.82 m, Brent Gr.) but sufficient to affect the interpretation of the source rock parameters. It has been recognised by enhanced values of production index, extractability, saturate to aromatic ratio and hydrocarbon to non-hydrocarbon ratio, and also by pronounced baseline shift in gas chromatography of alkanes and aromatics. (Fig 5)

Volatile hydrocarbons (PI>0.2) are present in samples from 2805 and 2810, and their alkane gas chromatograms show that they contain light oil and biodegraded oil. Although the light oil of 2810 is similar to that of the produced oil, the live oil in 2805 is more like a condensate in its n-alkane distribution. The sterane and terpane distribution of the extract from 2805m is very similar to those found in the interval 2775 to 2787.5 m. They are characterised by substantial amounts of C-27 diasteranes and C-20 to C-22 steranes, tricyclics and extended hopanes. (Appendix I-IV)

Biodegraded migrated hydrocarbons are found in extracts from 2775, 2783 and 2787.5m, as shown by the dominance of unresolved components in their alkane gas chromatograms. The biodegradation may have been sufficient to alter sterane isomer ratios but has not introduced demethylated hopanes. The terpanes do however show low amounts of 28,30-bisnorhopane and high contents of tricyclics.

At 2883.5, a sample from a zone logged as containing 'dead oil', appears to be an undegraded oil which has lost its volatile content by water- or gas-flushing. Its alkane gc is very similar to that of the coals above but in addition contains extra peaks between C-18 and C-19, its terpane components are also similar to those of the coals, but its sterane content, although similar in distribution to that of the coals, is quite low.

The Draupne Fm. is not believed to be affected by oil stain, but the coals of the Tarbert Fm. at 2862, 2870 an 2879m show more elevated baselines in their alkane gcs compared with that from 2842m, and may be stained by small amounts of biodegraded oil which may account for their rather variable sterane isomer ratios.

There appears to be three types of migrated hydrocarbons present in the analysed section:

1) The biodegraded hydrocarbons encountered above the Draupne Fm. and in the sample from 2805 m. The biomarker distribution of these samples can not be correlated with known source rocks in the area. An alternative explanation is that the unusual biomarker distributions in these samples may be attributed to the effects of biodegradation or contamination, since the extraction yields are low.

2) The hydrocarbons in the sample at 2810 m looking similar to a normal Oseberg oil.

3) The hydrocarbons in the sandstones at 2883.5 which could originate from expulsion of small amount of liquid hydrocarbons from the coals in the sequence.

III SOURCE ROCKS

The Draupne Fm. is a rich source rock as shown by its values of

TOC,	5.8 - 6.8%,	av 6.4%
S2,	27.8 -32.2kg/tn,	av 30kg/tn,
HI,	407 - 491	av 460

This source rock is unusual in giving extracts in which hydrocarbons amount to 40-55% of the extracts which is very high. The alkane gcs show slightly elevated baselines and pristane/n-C17 and phytane/n-C18 ratios greater than one. GC-MS analyses of the alkanes show that this source rock is characterised by enhanced quantities of extended hopanes, particularly at C-33 and C-35, and the absence of 28,30 bisnorhopane. Sterane contents are relatively high and show significant amounts of C-27 diasteranes and C-20 to C-22 steranes. The terpanes indicate a marine, hypersaline, anoxic environment of deposition.
The isomerisation of steranes have not yet reached equilibrium, suggesting that the samples are only marginally mature with respect to oil generation.(Fig 6)

The source rocks in the Draupne Fm. have an excellent potential for liquid hydrocarbons, and are deposited in a marine, hypersaline, anoxic environment. Typical is the absence of the 28,30-bisnorhopane in these source rock extracts.

IV OIL CORRELATIONS

The oils, from stock tank and bottom hole test, are essentially similar. Their alkane contents show only moderate amounts of pristane and phytane, but the terpanes include 28,30 bisnorhopane and extended hopanes but in moderate amounts; the sterane content is dominated by C-27 diasteranes and C-20 to C-22 steranes suggesting a marine origin for these oils.
Both samples contain small quantities of 25-norhopane, suggesting that an early pulse of oil has been heavily biodegraded, and unaltered, fresh oil has migrated in at a later stage.

The oil samples from 30/9-7 are very similar to the oil sample from 30/9-3A and other Oseberg oils (including the presence of 28,30-bisnorhopane) and suggests that these oils have a similar source. The oil samples from 30/9-7 appear to be of a higher maturity than the sample from 30/9-3A. This is shown by the higher relative amounts of diasteranes and low molecular steranes in the 30/9-7 samples, and an increase in the cracking of mono- and triaromatic steroids (m/z 253 and m/z 231 respectively). (Table 7.1)
The oil samples from 30/9-7 can be correlated to the 30/9-3A oil and other Oseberg oils and probably have the same source. The oils contain a mixture of an early, heavily biodegraded oil and fresh, unaltered oil. The oil from 30/9-7 is of a higher thermal maturity than the oil from 30/9-3A.

V TIMING OF OIL GENERATION

Live oils are biodegraded when they come into contact with meteoric waters containing bacteria. Since the bacteria are only active below 60 degC, then biodegradation can only take place down to depths of 1500- 2000m. The amount of biodegradation is measured by the order in which the different hydrocarbon groups are consumed and depends on the availabilities of dissolved oxygen and sulphate. The amount of biodegradation can therefore be expected to diminish with depth.

In the well section, it is estimated that the biodegraded oils were formed from live oils when the overburden was less than 500m. Since meteoric waters can only enter the section during a period of uplift, marked by an unconformity, the biodegradation probably took place during or at the end of the Cretaceous. It may therefore be concluded that oil was migrating through the section in the early Creataceous. At this time the source rocks in the section were not mature and the oil was generated from their equivalents off-structure.

TABLE 1.1: SAMPLE ANALYSED

SAMPLE ANALYSED

DEPTH	SAMPLE TYPE	SAMPLE LITH.	FORMATION
2775.00	SWC		Shetland fm.
2783.00	"		"
2787.50	"		Cromer Knoll fm.
2792.50	"		Draupne fm.
2795.00	"		"
2798.00	"		"
2800.00	"		"
2805.00	"		Tarbert fm.
2810.00	"		"
2827.00	"	slst.sst	"
2833.00	"	sst	"
2841.98	CC	coal	"
2862.65	"	coal	"
2870.98	"	coal	"
2879.98	"	coal	"
2883.50	"	sst	"
2887.82	"	sst	"
2942.00	DC	sh/coal	Ness fm.

TABLE 1.2: GEOLOGICAL SUMMARY

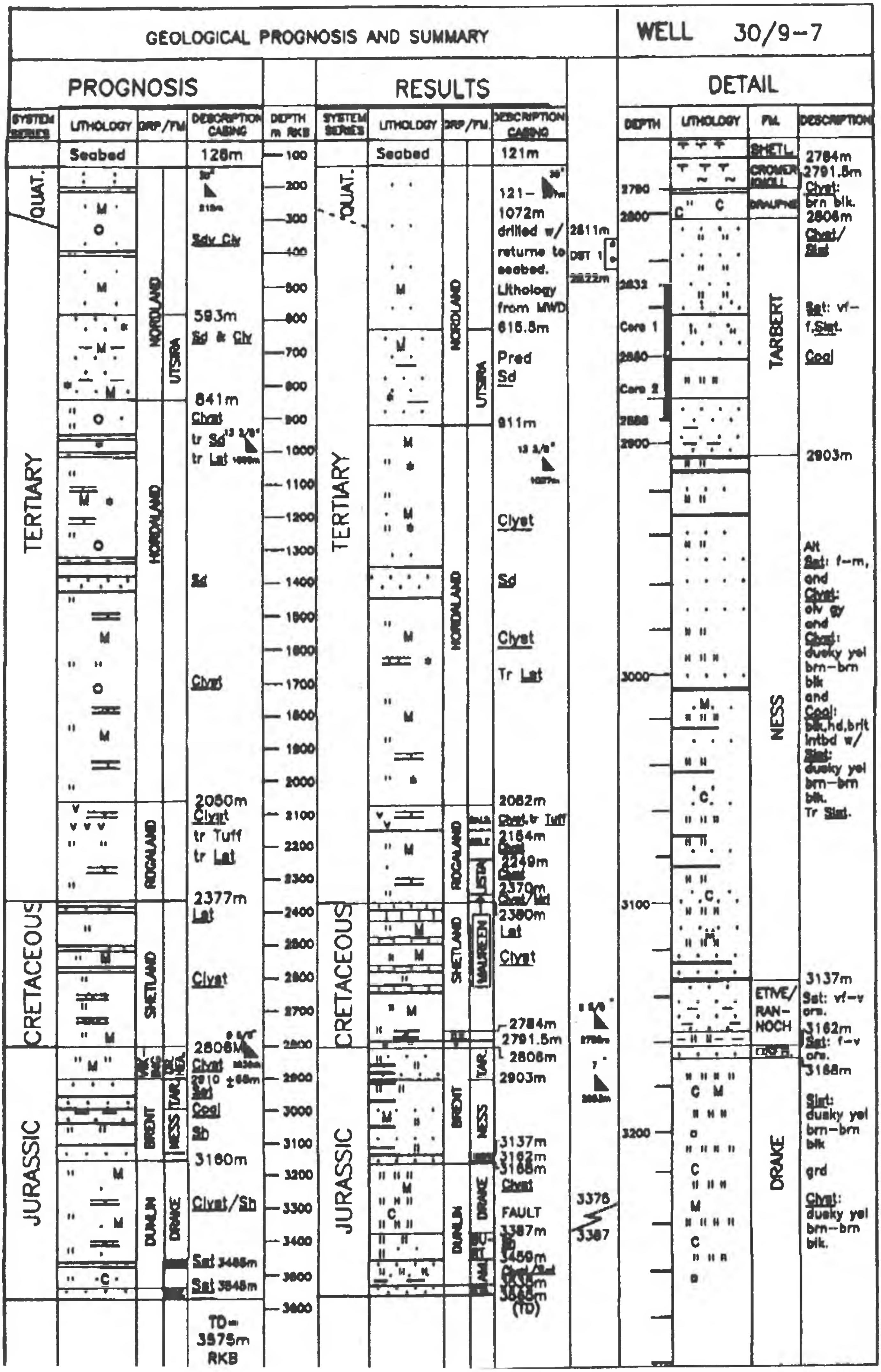

GEOLOGICAL PROGNOSIS AND SUMMARY
WELL 30/9-7
PROGNOSIS
RESULTS
DETAIL
SYSTEM SERIES
LITHOLOGY
GRP/FM
DESCRIPTION CASING
DEPTH m RKB
Seabed
128m
121m
QUAT.
TERTIARY
CRETACEOUS
JURASSIC
NORDLAND
UTSIRA
HORDALAND
ROGALAND
SHETLAND
MAUREEN
LISTA
BRENT
NESS
TAR.
DUNLIN
DRAKE
Sdy Cly
593m
Sd & Cly
841m
Clyst
tr Sd
tr Lst
Sd
Clyst
2060m
Clyst
tr Tuff
tr Lst
2377m
Lst
Clyst
2806m
Clyst
2910 ±68m
Coal
Sh
3160m
Clyst/Sh
TD=
3575m
RKB
121-
1072m
drilled w/
returns to
seabed.
Lithology
from MWD
615.5m
Pred
Sd
911m
Clyst
Sd
Clyst
Tr Lst
2062m
2164m
2249m
2370m
2380m
Lst
Clyst
2784m
2791.5m
2806m
2903m
3137m
3162m
3168m
Clyst
FAULT
3387m
3459m
(TD)
2811m
DST 1
2822m
3376
3387
2790
2800
2832
Core 1
2850
Core 2
2888
2900
3000
3100
3200
SHETL.
CROMER KNOLL
DRAUPNE
TARBERT
NESS
ETIVE/
RAN-
NOCH
DRAKE
2784m
2791.5m
Clyst:
brn blk.
2806m
Clyst/
Slst
Sst: vf-
f.Slst.
Coal
2903m
Alt
Sst: f-m,
and
Clyst:
olv gy
and
Clyst:
dusky yel
brn-brn
blk
and
Coal:
blk,hd,brit
intbd w/
Slst:
dusky yel
brn-brn
blk.
Tr Slst.
3137m
Sst: vf-v
crs.
3162m
Sst: f-v
crs.
3168m
Slst:
dusky yel
brn-brn
blk
grd
Clyst:
dusky yel
brn-brn
blk.

TABLE 5.1: SOURCE ROCK SCREENING DATA

Table 5.1. **SOURCE ROCK SCREENING DATA WELL 30/9-7**

Petroleum Geochemistry Group
Research Center Bergen

HYDRO

Depth (m)	Group/Fm	%	Lithology	Sample	S1 Kg/t	S2 Kg/t	S3 Kg/t	TOC %	HI	OI	PI	Tmax Deg.c	Company
2775.00				SWC	0.0	0.6	1.2	0.7	95	188	0.00	588	F-BG
2783.00				SWC	0.1	3.9	1.1	1.1	368	103	0.02	595	F-BG
2787.50				SWC	0.2	5.9	0.5				0.04	579	F-BG
2792.50				SWC	3.0	29.2	0.4	6.3	466	7	0.09	432	F-BG
2795.00				SWC	3.5	27.8	0.3	6.8	407	4	0.11	428	F-BG
2798.00				SWC	2.4	32.2	0.5	6.6	490	7	0.07	431	F-BG
2800.00				SWC	3.1	28.4	0.6	5.8	491	10	0.10	433	F-BG
2805.00				SWC	0.1	0.3	1.6	0.8	41	195	0.23	592	F-BG
2810.00				SWC	2.3	1.9	0.8	1.2	164	66	0.54	432	F-BG
2883.52			SST	CC	0.1	0.9	0.2	0.4	236	47	0.08	447	F-BG
2887.84			SST	CC	0.0	0.7	0.2	0.1	618	209	0.04	537	F-BG

TABLE 5.2: SOURCE ROCK EXTRACTION DATA I

Table 5.2. **SOURCE ROCK EXTRACTION DATA I WELL 30/9-7**

Petroleum Geochemistry Group
Research Center Bergen
HYDRO

Depth(m)	Group/Fm	EOM(mg)	EOM(%)	Hydrocarbons			Non Hydrocarbons		
				SAT(%)	ARO(%)	TOTAL(%)	NSO(%)	ASPH(%)	TOTAL(%)
2775.00		4.80	0.05	39	14	53	35	13	48
2783.00		2.90	0.09	46	10	56	30	14	44
2787.50		3.30	0.06	50	16	66	25	9	34
2792.50		32.00	0.83	24	29	53	29	18	47
2795.00		46.60	0.85	24	28	52	30	18	48
2798.00		65.90	0.74	21	20	42	28	30	58
2800.00		98.80	0.72	18	24	42	36	22	58
2805.00		9.50	0.18	14	24	38	23	39	62
2810.00		26.30	0.31	34	20	54	28	18	46
2842.00		8.30	3.61	2	16	18	16	66	82
2862.67		16.20	3.86	6	15	21	10	69	79
2870.98		6.20	1.63	11	30	41	17	42	59
2879.98		9.40	2.04	7	19	26	13	61	74
2883.52		13.50	0.10	1	4	5	5	90	95
2887.84		1.00	0.01	20	10	30	20	50	70

TABLE 5.3: SOURCE ROCK EXTRACTION DATA II

Table 5.3. **SOURCE ROCK EXTRACTION DATA II WELL 30/9-7**

Petroleum Geochemistry Group
Research Center Bergen
HYDRO

Depth(m)	Group/Fm	TOC (%)	EOM(%)/TOC(%)	SAT(%)/TOC(%)	SAT(%)/ARO(%)	HC/non HC
2775.00		0.66	0.08	58.33	2.75	1.11
2783.00		1.06	0.09	43.05	4.50	1.26
2787.50					3.02	1.96
2792.50		6.27	0.13	3.80	0.82	1.13
2795.00		6.84	0.12	3.51	0.85	1.10
2798.00		6.58	0.11	3.22	1.03	0.71
2800.00		5.78	0.12	3.17	0.77	0.73
2805.00		0.82	0.22	17.07	0.58	0.62
2810.00		1.17	0.26	28.64	1.67	1.16
2842.00					0.14	0.22
2862.67					0.39	0.26
2870.98					0.36	0.69
2879.98					0.38	0.36
2883.52		0.36	0.27	3.34	0.33	0.05
2887.84		0.11	0.07	181.82	2.00	0.43

TABLE 5.4: MOLECULAR RATIOS SATURATED FRAC.

Table 5.4. **SATURATED FRAC., MOLECULAR RATIOS WELL 30/9-7**

Petroleum Geochemistry Group
Research Center Bergen
HYDRO

Depth	Group/Fm	Pr/n-C17	Pr/Ph	CPI-I	CPI-II	n-C15+/Total	n-C20/n-C25
2775.00		1.05	0.77	0.88	0.63		
2783.00		0.80	1.16	0.99	0.69		
2787.50		1.26	1.14	1.09	0.55		
2792.50		1.56	1.55	1.26	0.66		
2795.00		1.52	1.72	1.11	0.65		
2798.00		1.63	1.69	1.13	0.66		
2800.00		1.65	1.45	1.03	0.67		
2805.00		0.93	0.66	0.98	0.72		
2810.00		0.90	1.53	1.04	0.83		
2842.00		21.07	9.27	1.00	0.91		
2862.67		10.97	4.44	0.88	0.52		
2870.98		17.79	7.06	1.11	0.77		
2879.98		20.73	6.77	0.99	0.51		
2883.52		7.75	5.19	0.91	1.02		
2887.84		1.62	1.96	1.08	0.83		

TABLE 3.1.1: VITRINITE REFLECTANCE DATA

Table 3.1.1. **VITRINITE REFLECTANCE DATA WELL 30/9-7**
Average values

Petroleum Geochemistry Group
Research Center Bergen
HYDRO

Depth	Group/Fm	Population I	Population II	Population III	SCI
2827.00		0.52 (21)			
2833.00		0.49 (24)			
2862.67		0.53 (23)			
2879.98		0.57 (21)			
2942.00		0.63 (25)			

TABLE 7.1: BIOMARKER RATIOS

BIOMARKERRATIOS

WELL: 30/9-7

DEPTH m	A	B	C	D	E	F	G
2775.0	0.87	0.47	0.13	0.12	60	51	57
2783.0	0.90	0.52	0.10	0.11	62	49	57
2787.5	0.86	0.51	0.10	0.09	64	48	57
2792.5	0.63	0.34	0.07	0.20	59	29	28
2795.0	0.54	0.34	0.05	0.18	58	30	28
2798.0	0.57	0.38	0.07	0.17	59	33	33
2800.0	0.52	0.35	0.05	0.19	54	33	29
2805.0	0.95	0.40	0.08	0.13	60	38	42
2810.0	1.00	0.33	0.33	0.13	61	45	57
2841.98	0.06	0.38	0.52	0.35	59	44 *	34 *
2862.65	0.09	0.44	0.65	0.37	60	48 *	30 *
2870.98	0.10	0.47	0.43	0.32	60	50 *	36 *
2879.98	0.20	0.53	0.54	0.28	61	50 *	45 *
2883.50	0.10	0.41	0.31	0.31	60	47 *	41 *
2887.82	0.66	0.46	0.20	0.17	59	44 *	54 *
BHS	1.08	0.33	0.39	0.12	62	48	58
STO	1.04	0.35	0.38	0.12	60	51	57
30/9-3A	1.28	0.31	0.34	0.12	57	49	60

A = Ts/Tm
B = Norhopane/(Norhopane + Hopane)
C = Bisnorhopane/(Bisnorhopane + Norhopane)
D = Moretan/Hopane
E = %22S
F = %aaa20S
G = %abb

* = Not reliable data. Bisnorhopane coeluating with C29aaa2S makes these ratios unreliabel.

FIGURE 1: WELL LOCATION MAP

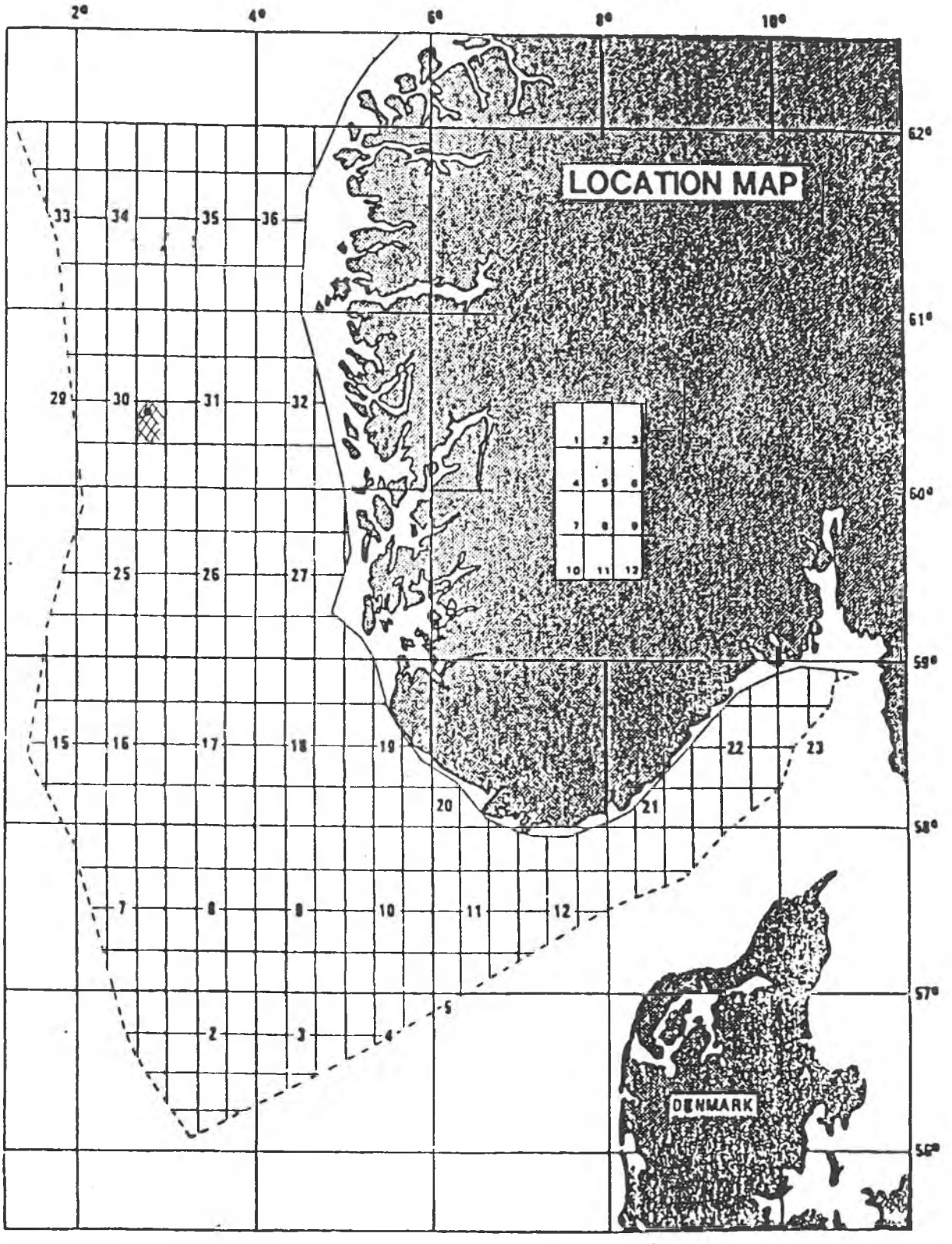
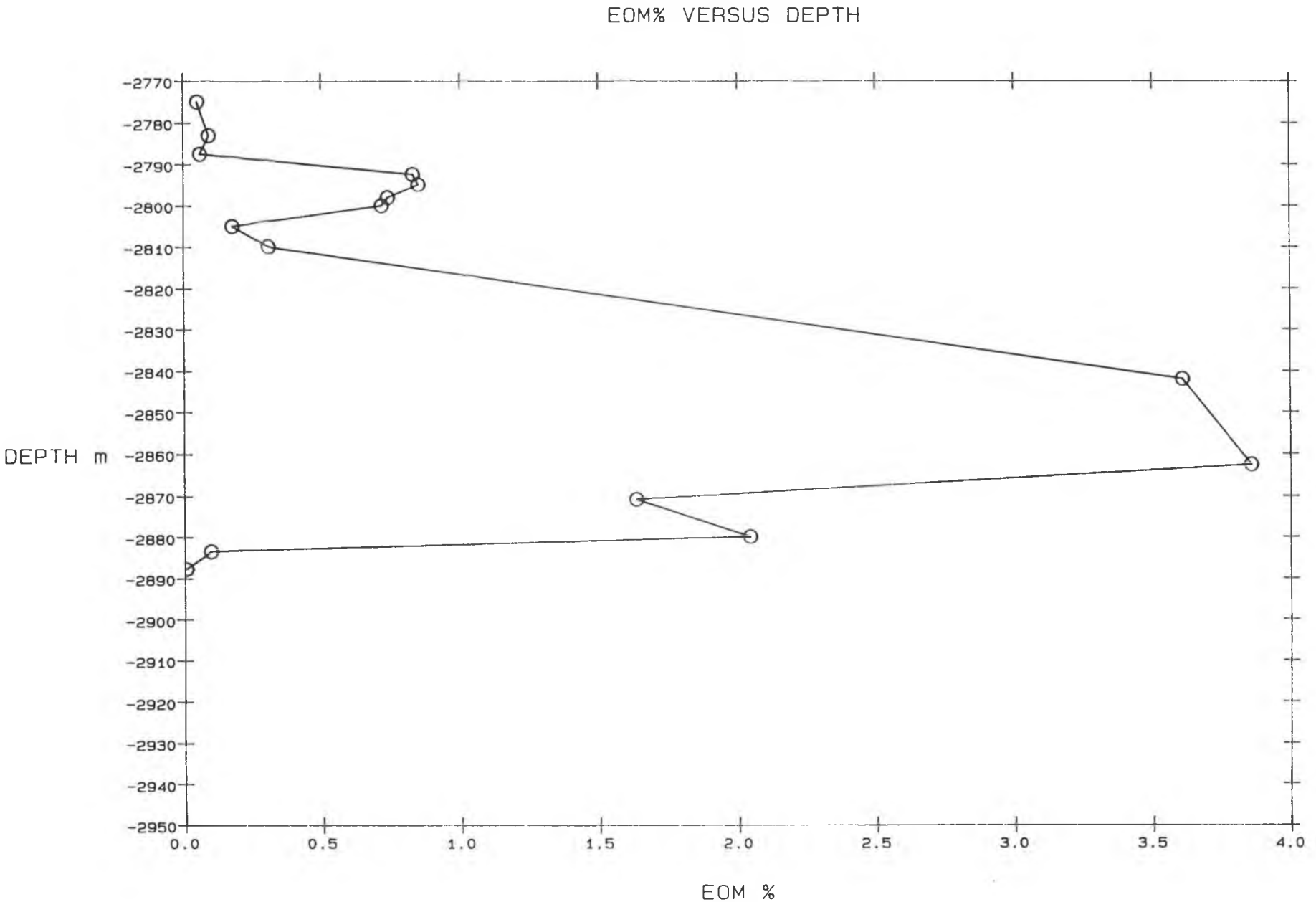


Fig. 1.1 Well location map.

FIGURE 2: EOM VERSUS DEPTH


EOM% VERSUS DEPTH
DEPTH m
-2770
-2780
-2790
-2800
-2810
-2820
-2830
-2840
-2850
-2860
-2870
-2880
-2890
-2900
-2910
-2920
-2930
-2940
-2950
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
EOM %

coal

FIGURE 3: VITRINITE REFLECTANCE VERSUS DEPTH

VITRINITE REFLECTANCE

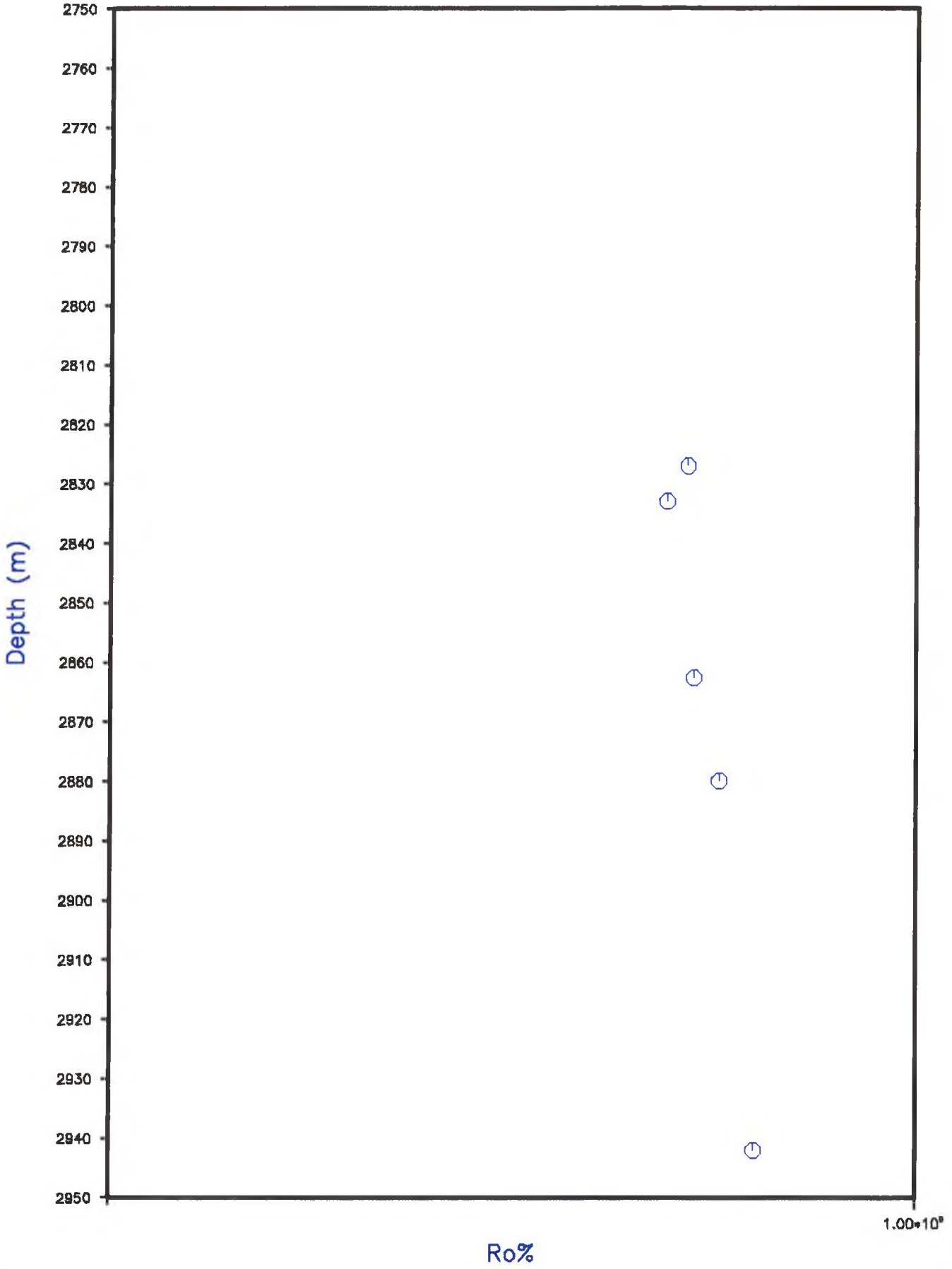


FIGURE 4: TMAX VERSUS HYDROGEN INDEX

WELL: 30/9-7

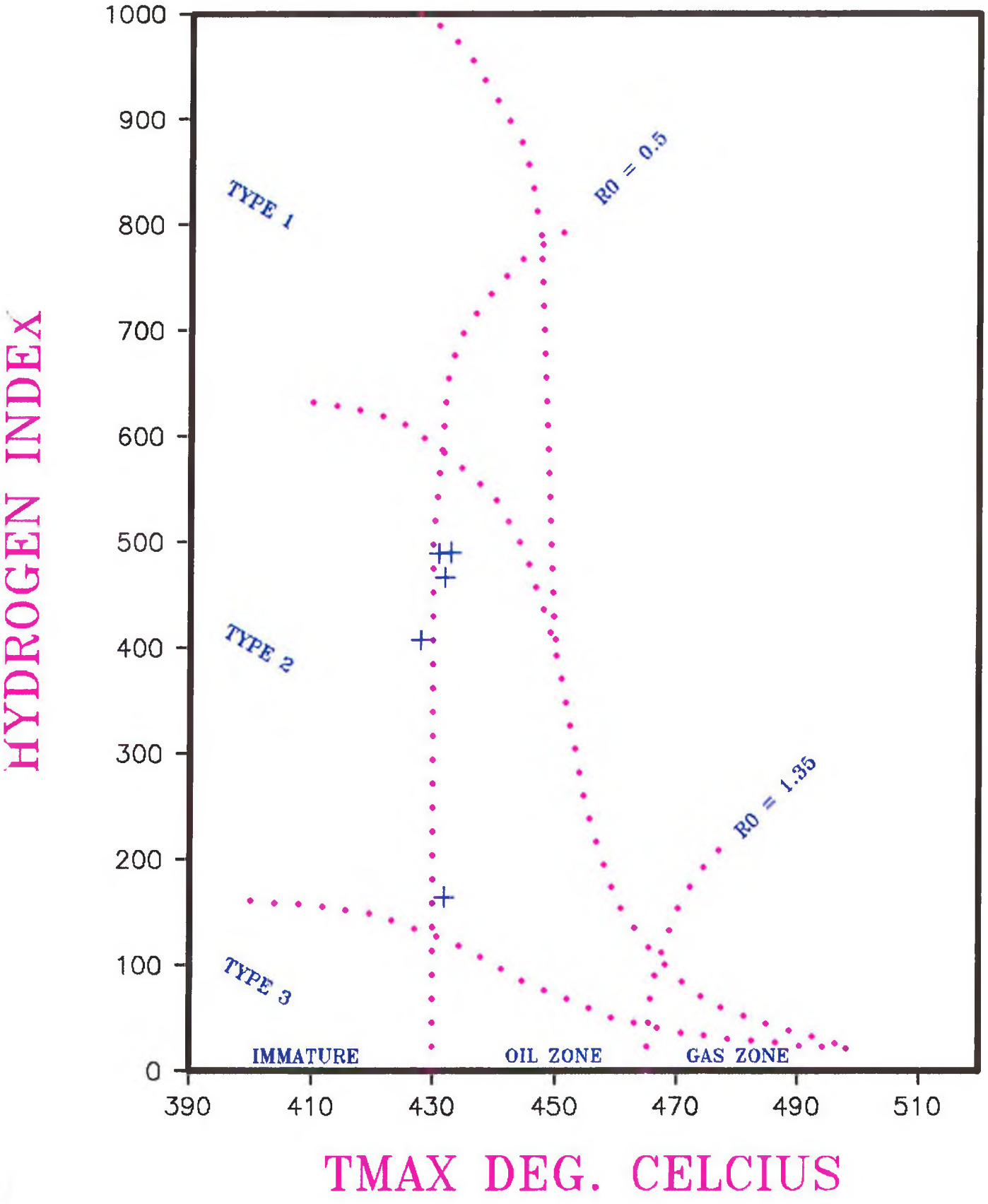

HYDROGEN INDEX
1000
900
800
700
600
500
400
300
200
100
0
TYPE 1
TYPE 2
TYPE 3
R0 = 0.5
R0 = 1.35
IMMATURE
OIL ZONE
GAS ZONE
390
410
430
450
470
490
510
TMAX DEG. CELCIUS

FIGURE 5: TOC VERSUS C15+ HYDROCARBONS

WELL: 30/9-7

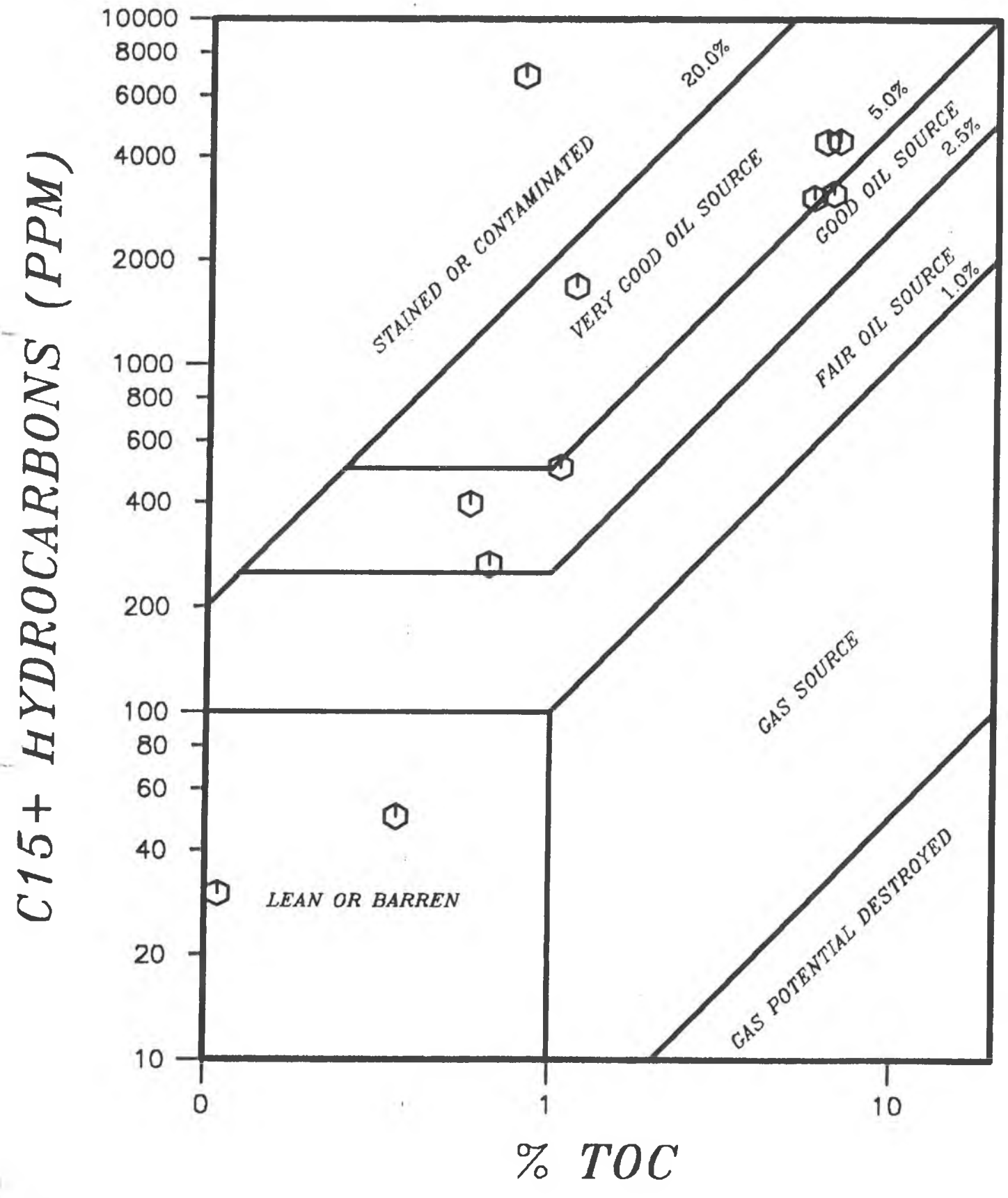
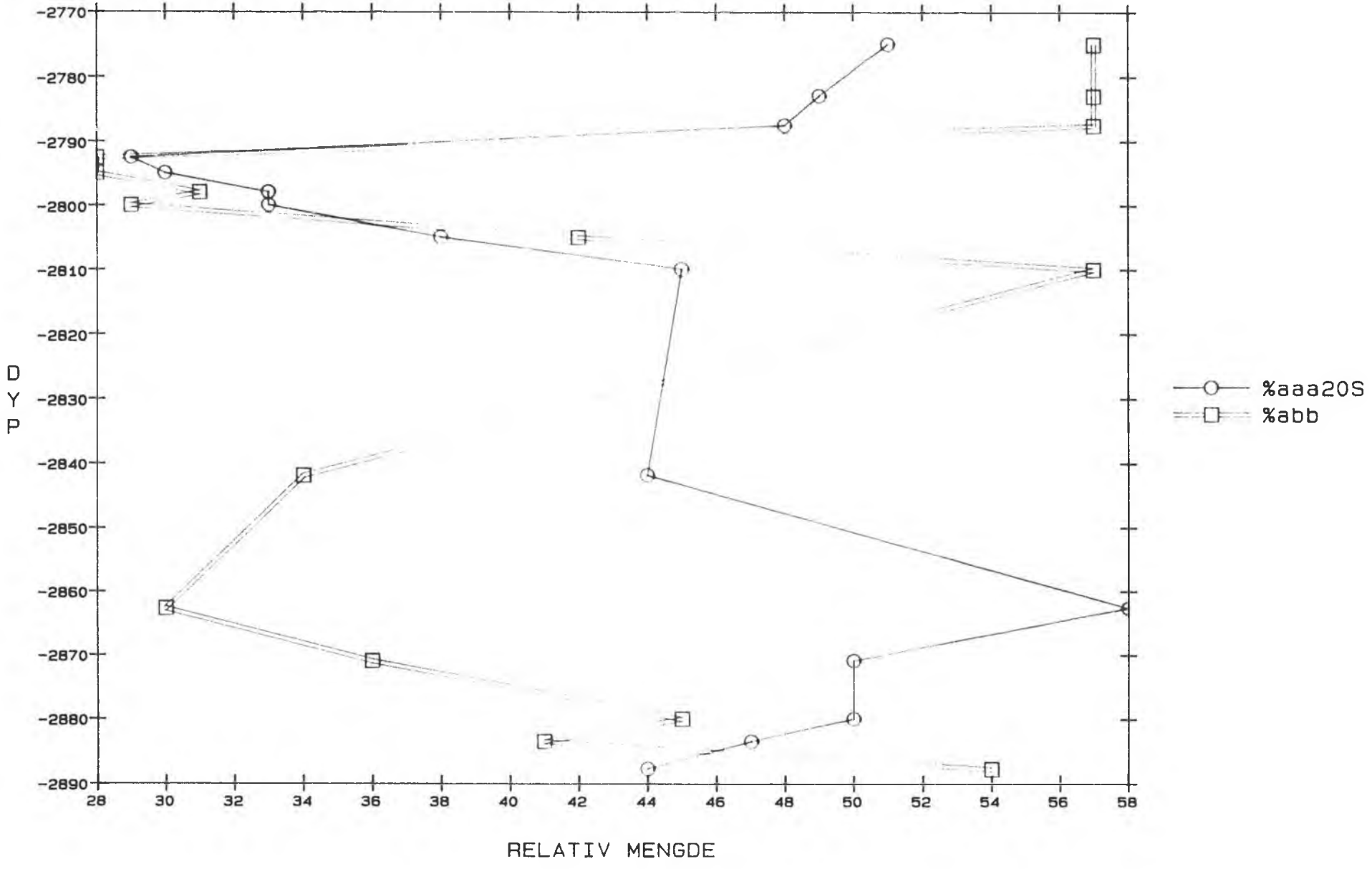
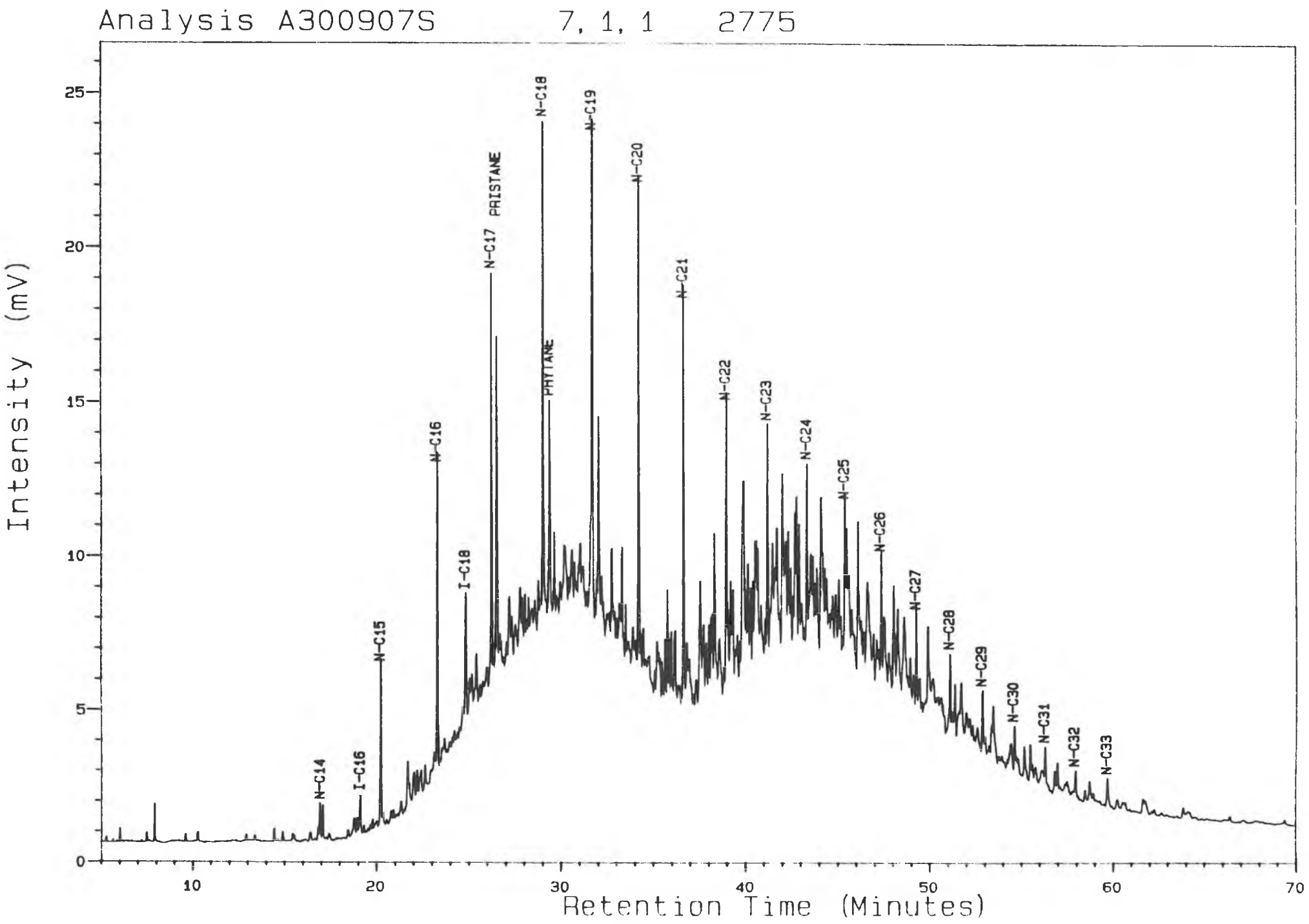

C15+ HYDROCARBONS (PPM)
10000
8000
6000
4000
2000
1000
800
600
400
200
100
80
60
40
20
10
0
1
10
% TOC
20.0%
5.0%
2.5%
1.0%
STAINED OR CONTAMINATED
VERY GOOD OIL SOURCE
GOOD OIL SOURCE
FAIR OIL SOURCE
GAS SOURCE
LEAN OR BARREN
GAS POTENTIAL DESTROYED

FIGURE 6: STERAN ISOMERISATION

STERANISOMERISERING
30/9-7



APPENDIX I: GC SATURATED FRACTION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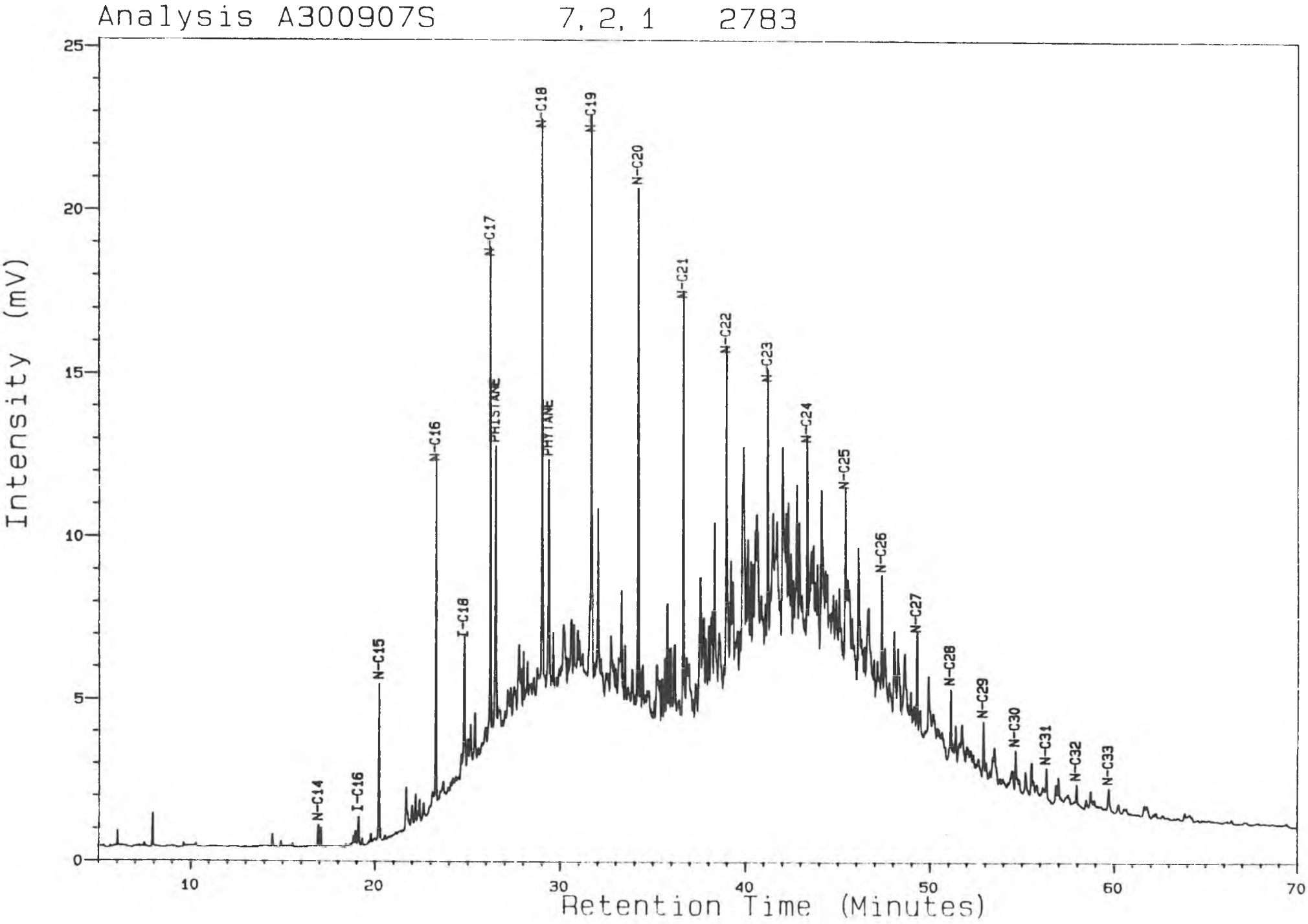
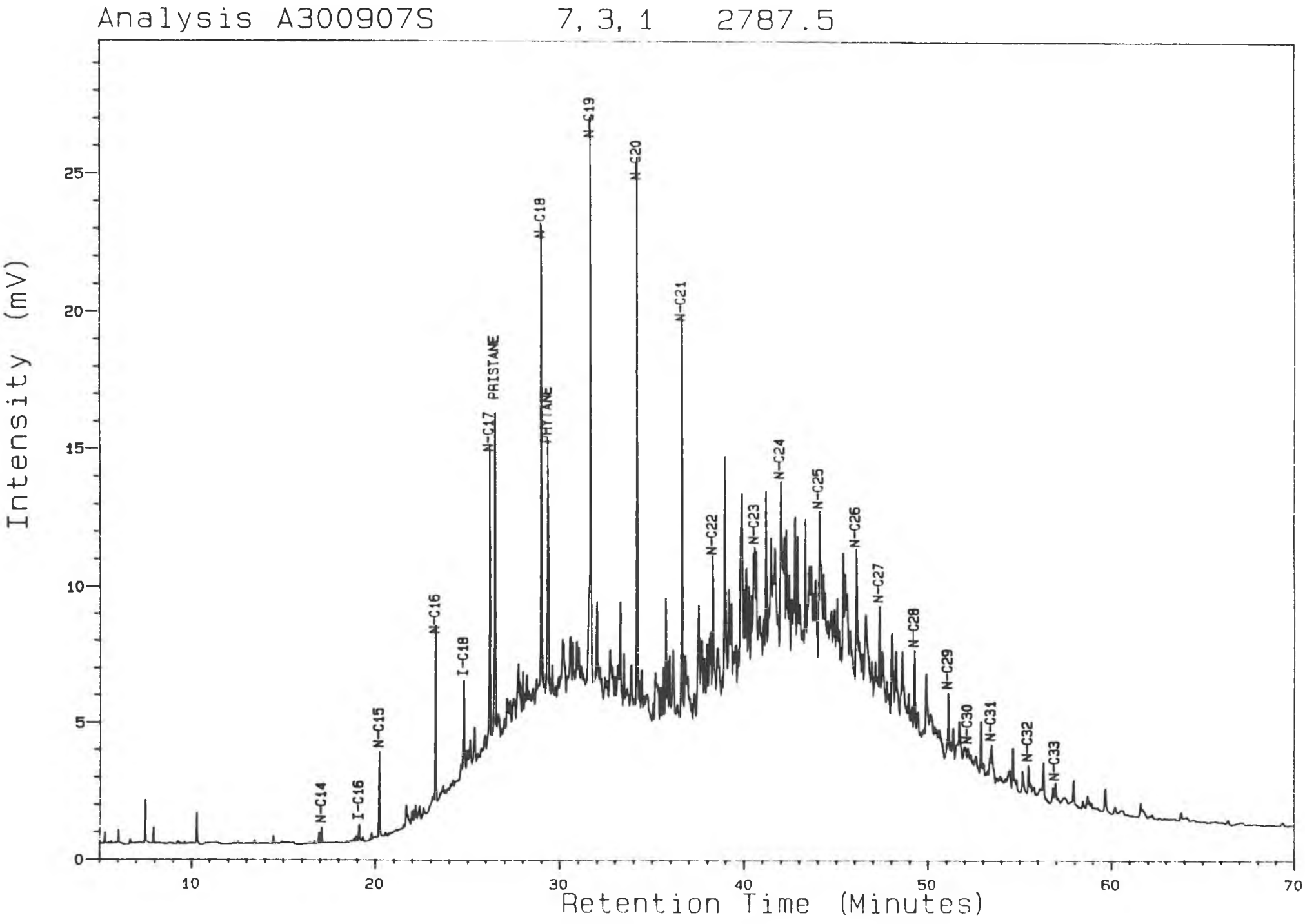
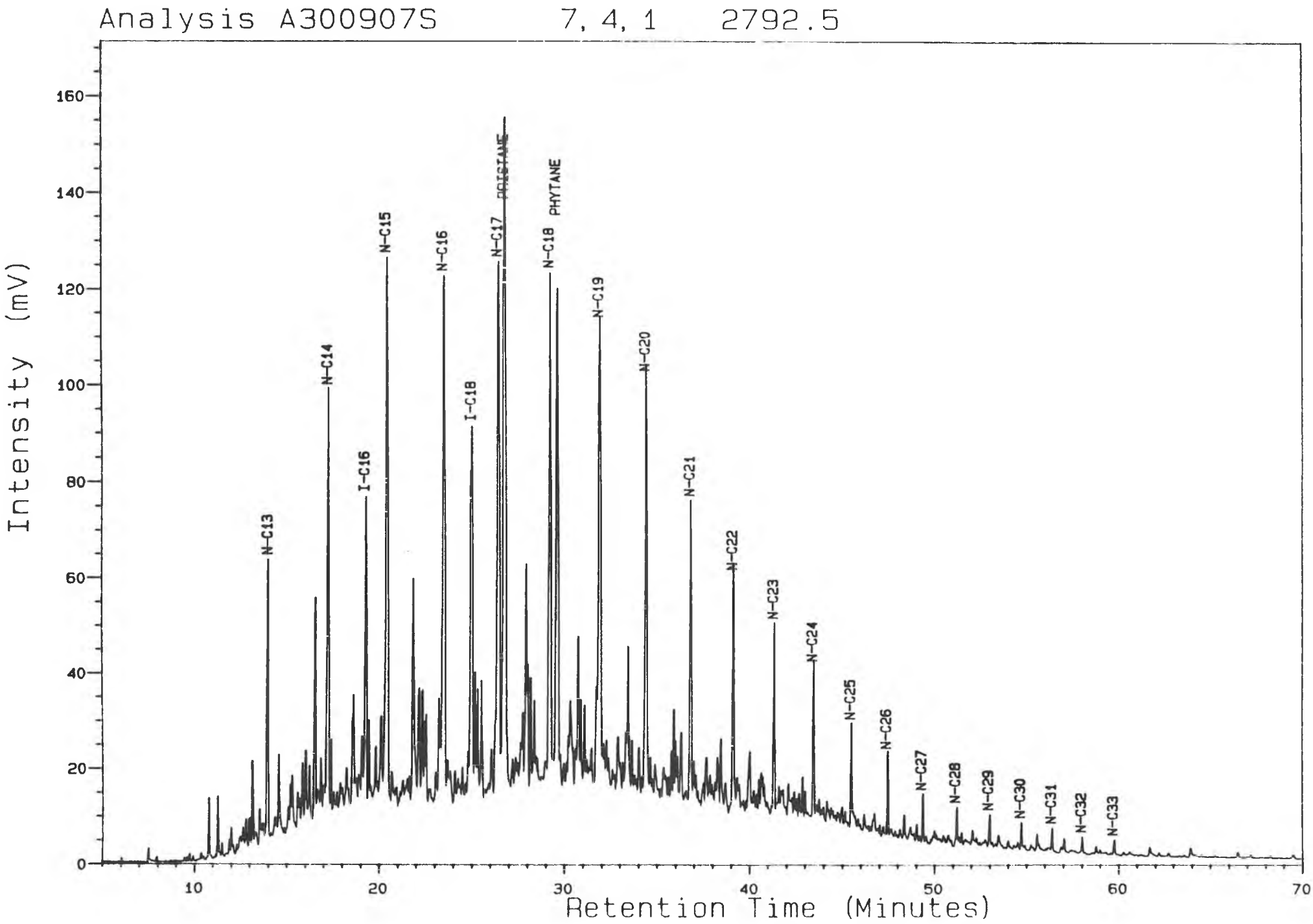
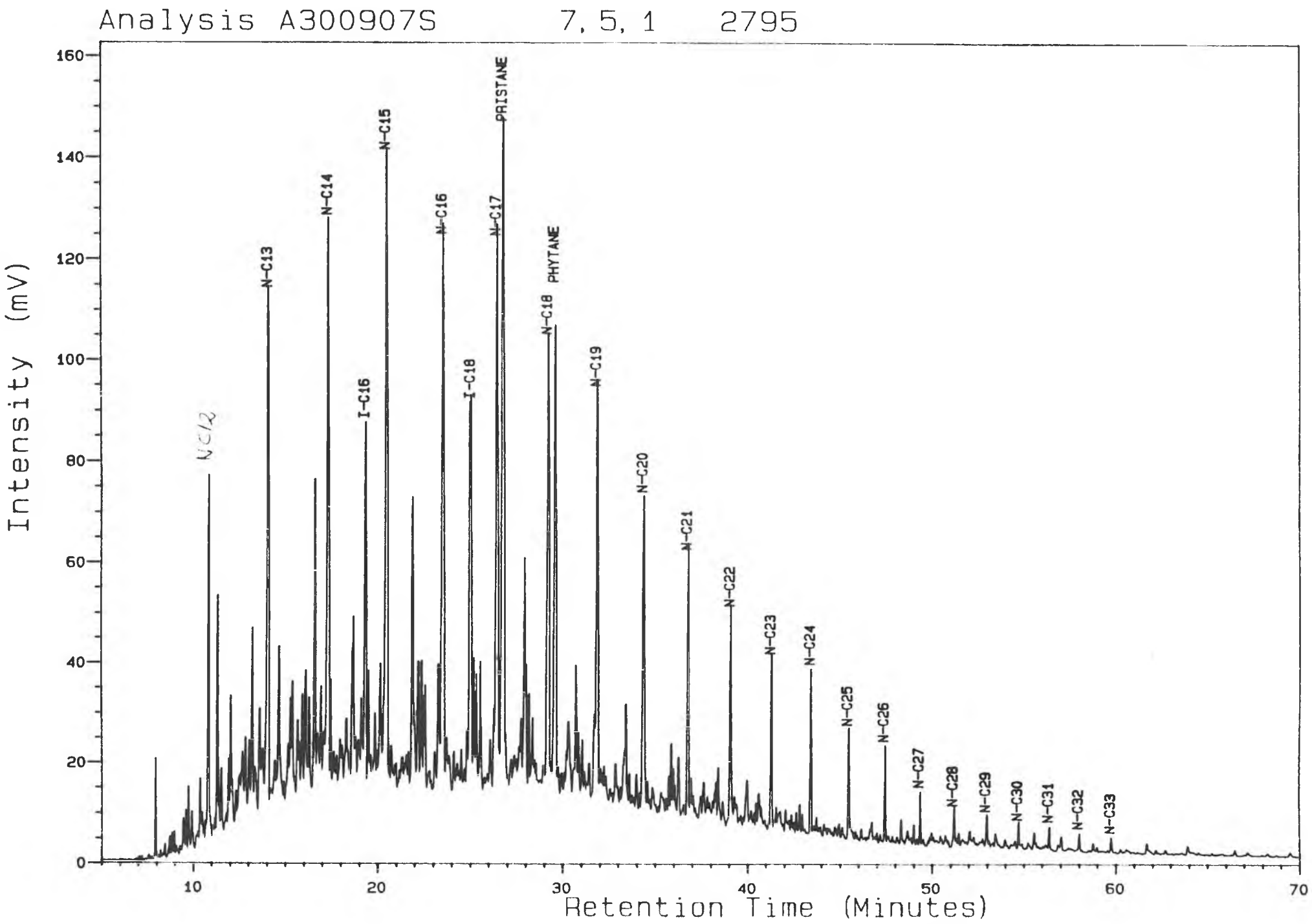
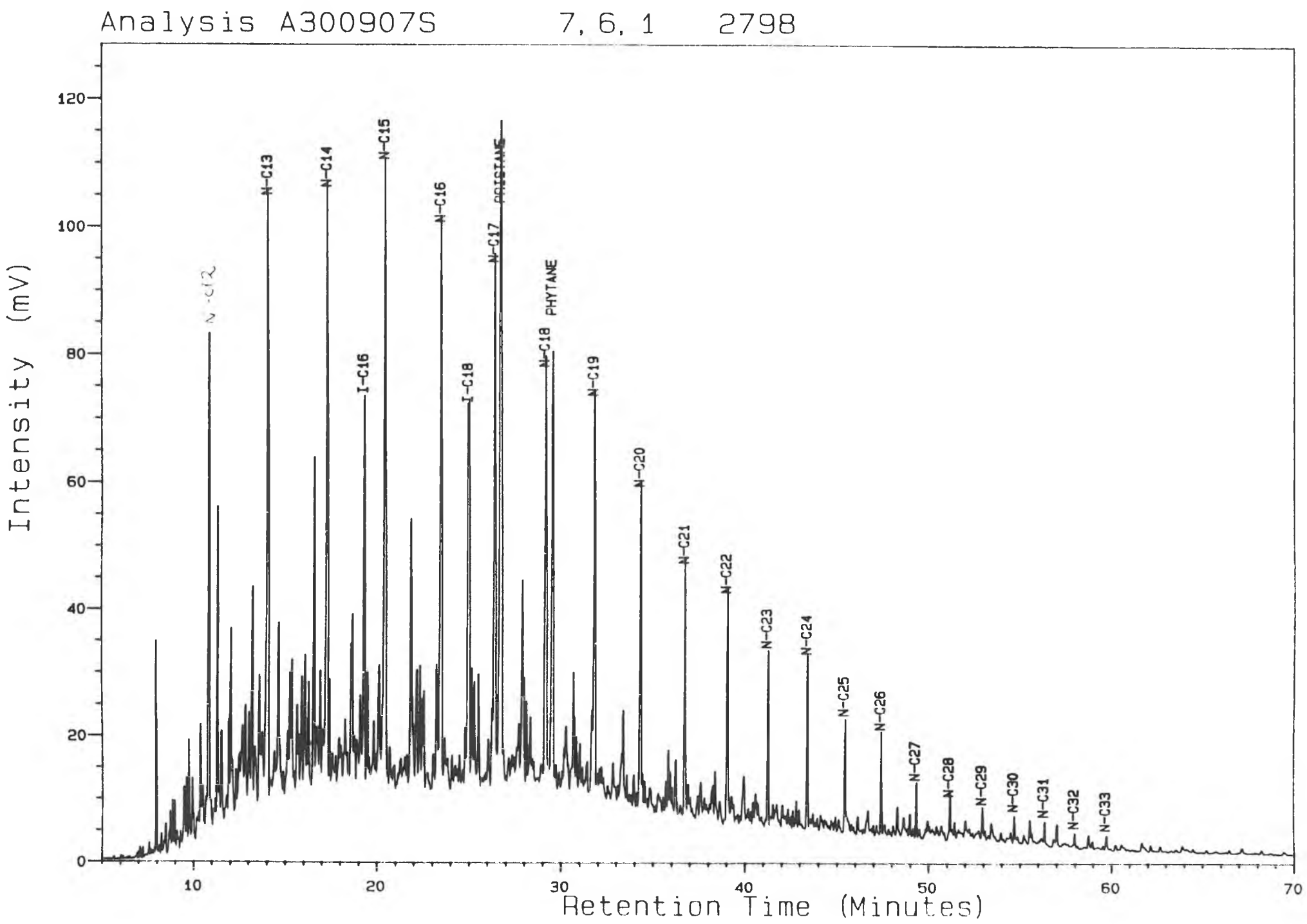
Intensity (mV)
Retention Time (Minutes)
N-C14
I-C16
N-C15
N-C16
I-C18
N-C17
PRISTANE
PHYTANE
N-C18
N-C19
N-C20
N-C21
N-C22
N-C23
N-C24
N-C25
N-C26
N-C27
N-C28
N-C29
N-C30
N-C31
N-C32
N-C33

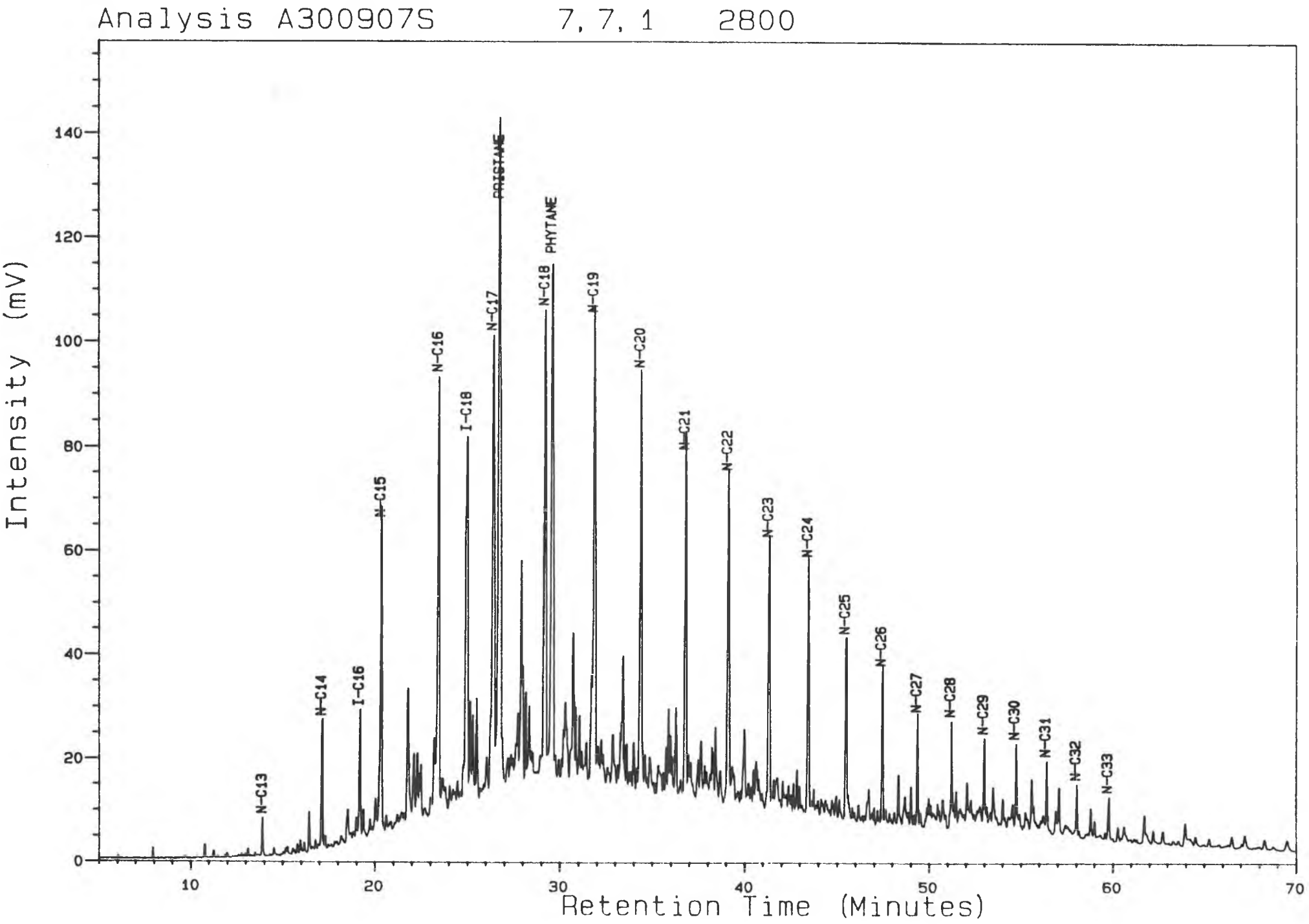

Analysis A300907S 7, 2, 1 2783
Intensity (mV)
Retention Time (Minutes)
N-C14
I-C16
N-C15
N-C16
I-C18
N-C17
PRISTANE
N-C18
PHYTANE
N-C19
N-C20
N-C21
N-C22
N-C23
N-C24
N-C25
N-C26
N-C27
N-C28
N-C29
N-C30
N-C31
N-C32
N-C33

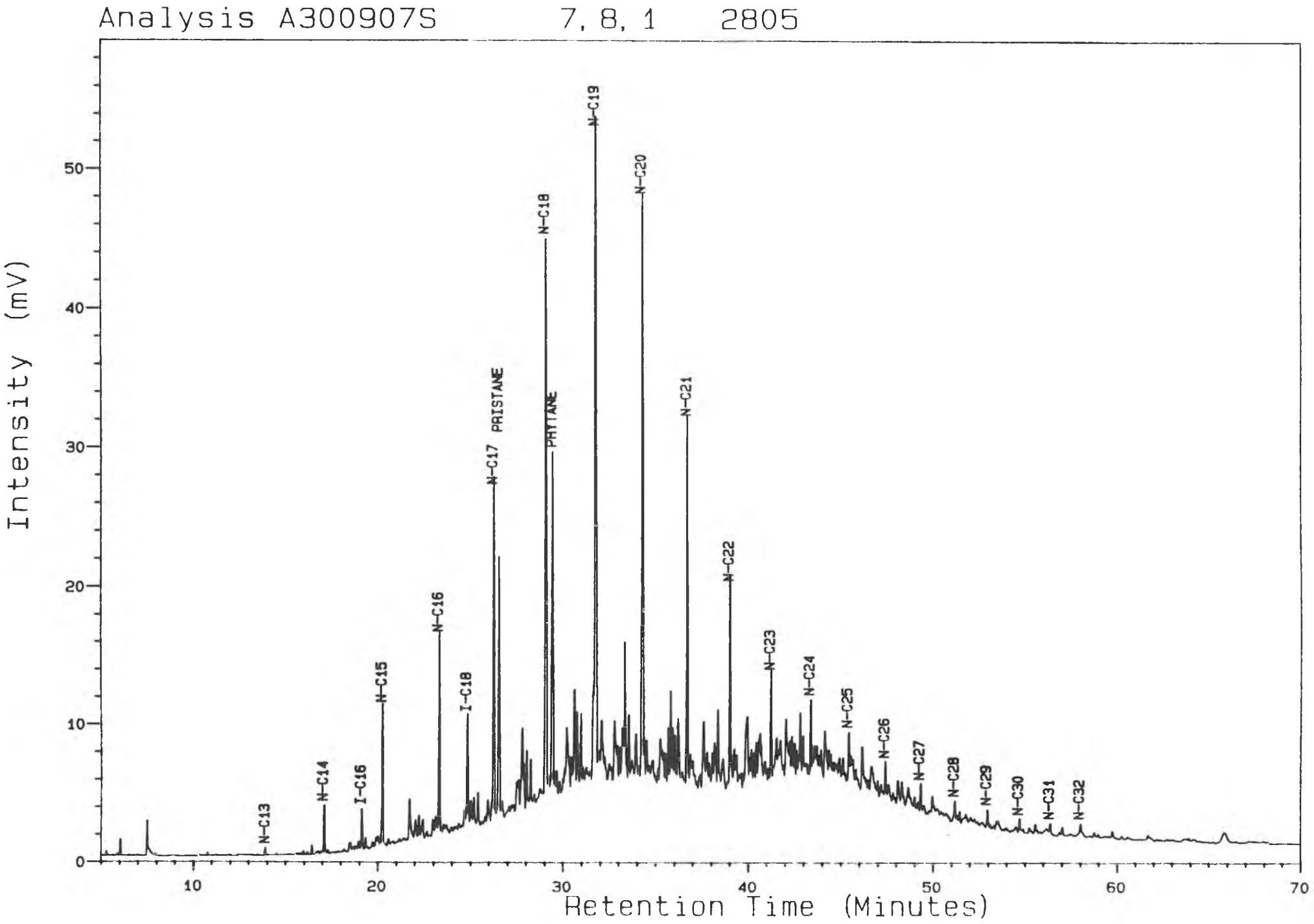

Analysis A300907S 7, 3, 1 2787.5
Intensity (mV)
0
5
10
15
20
25
10
20
30
40
50
60
70
Retention Time (Minutes)
N-C14
I-C16
N-C15
N-C16
I-C18
N-C17
PRISTANE
N-C18
PHYTANE
N-C19
N-C20
N-C21
N-C22
N-C23
N-C24
N-C25
N-C26
N-C27
N-C28
N-C29
N-C30
N-C31
N-C32
N-C33

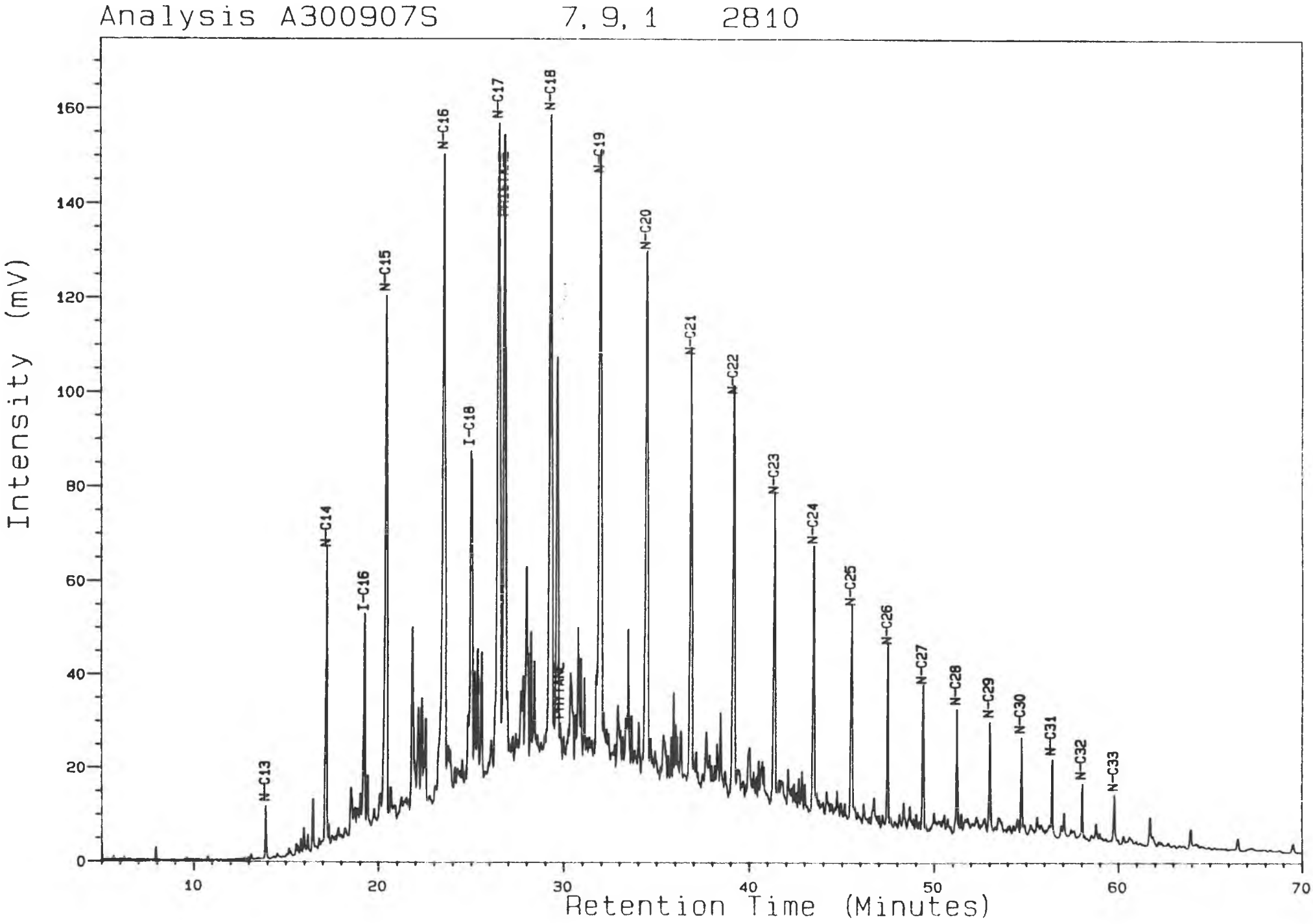

Analysis A300907S 7, 4, 1 2792.5
Intensity (mV)
Retention Time (Minutes)
N-C13
N-C14
I-C16
N-C15
N-C16
I-C18
N-C17
PRISTANE
N-C18
PHYTANE
N-C19
N-C20
N-C21
N-C22
N-C23
N-C24
N-C25
N-C26
N-C27
N-C28
N-C29
N-C30
N-C31
N-C32
N-C33

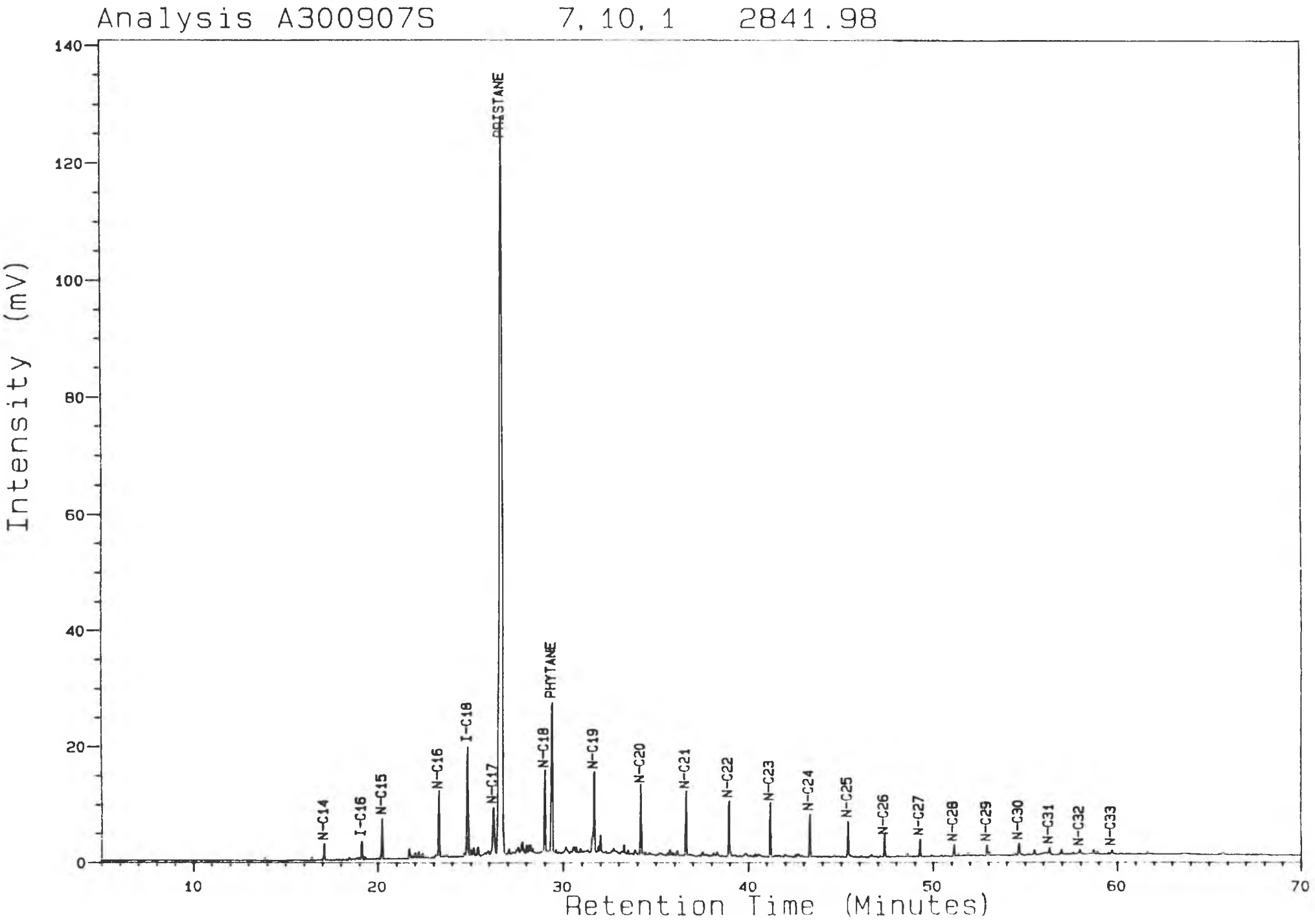

Analysis A300907S 7, 5, 1 2795
Intensity (mV)
Retention Time (Minutes)
N-C12
N-C13
N-C14
N-C15
N-C16
N-C17
PRISTANE
I-C16
I-C18
N-C18
PHYTANE
N-C19
N-C20
N-C21
N-C22
N-C23
N-C24
N-C25
N-C26
N-C27
N-C28
N-C29
N-C30
N-C31
N-C32
N-C33

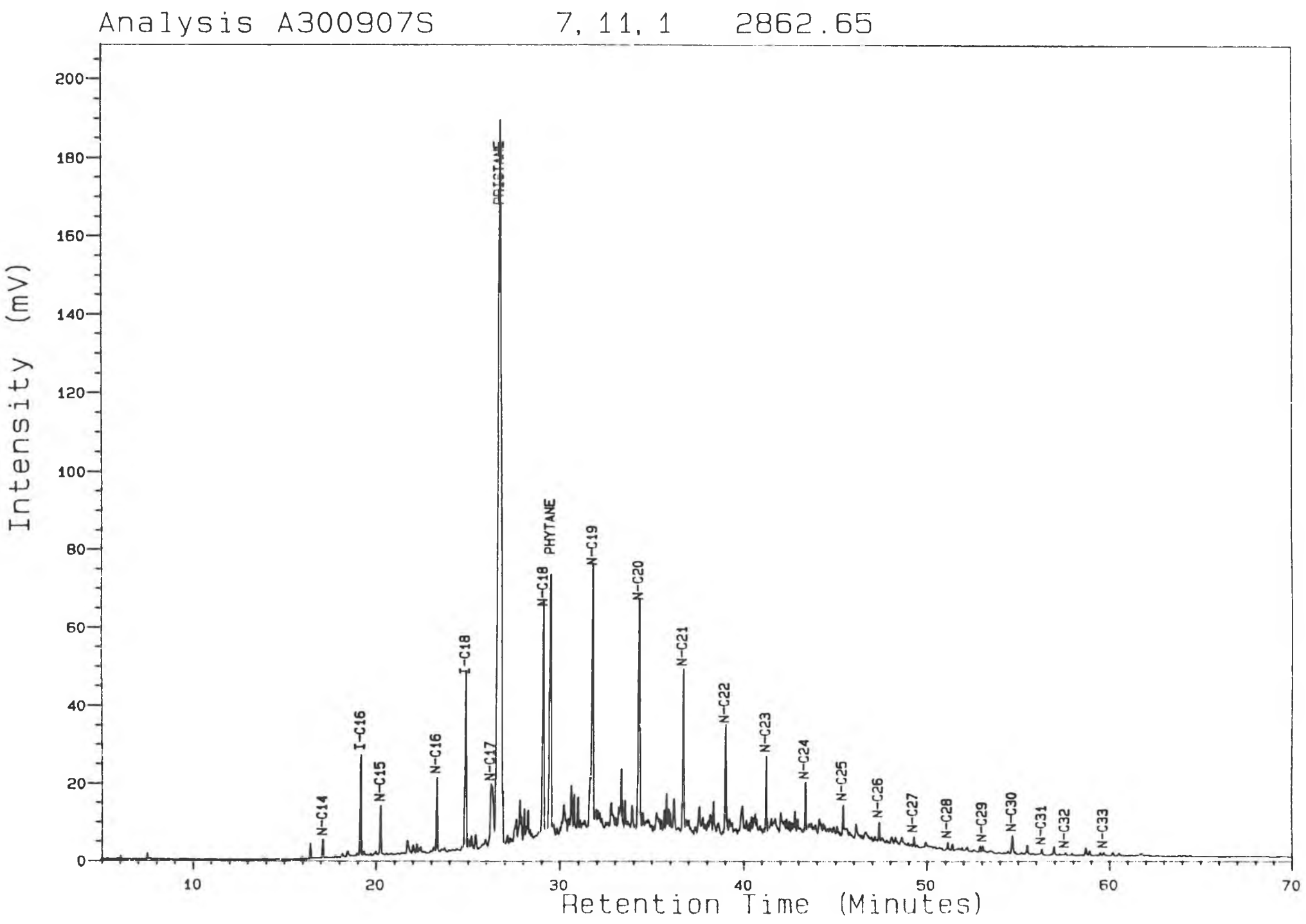

Analysis A300907S 7, 6, 1 2798
Intensity (mV)
Retention Time (Minutes)
N-C12
N-C13
N-C14
I-C16
N-C15
N-C16
I-C18
N-C17
PRISTANE
N-C18
PHYTANE
N-C19
N-C20
N-C21
N-C22
N-C23
N-C24
N-C25
N-C26
N-C27
N-C28
N-C29
N-C30
N-C31
N-C32
N-C33

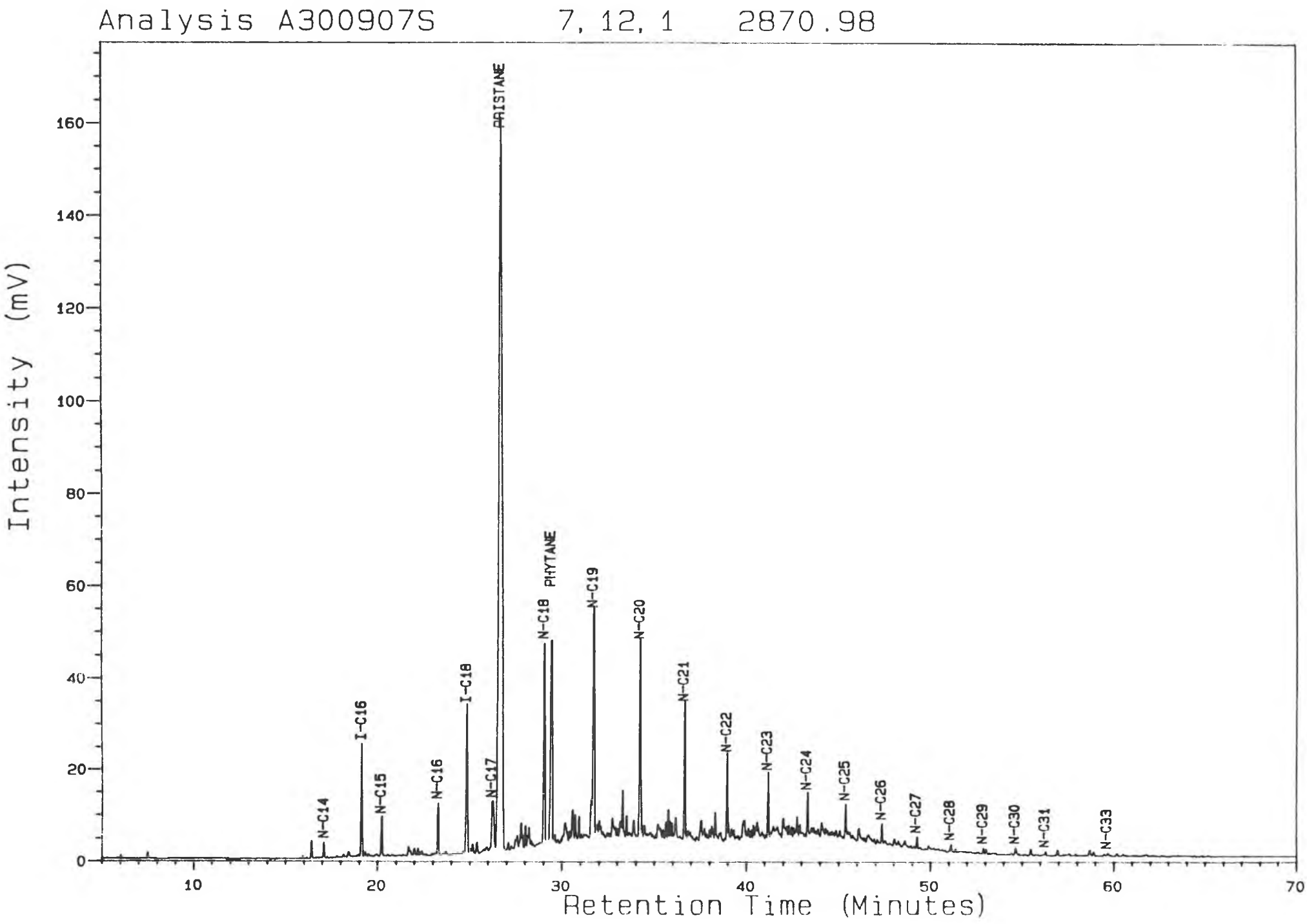

Analysis A300907S 7, 7, 1 2800
Intensity (mV)
Retention Time (Minutes)
0
20
40
60
80
100
120
140
10
20
30
40
50
60
70
N-C13
N-C14
I-C16
N-C15
N-C16
I-C18
N-C17
PRISTANE
N-C18
PHYTANE
N-C19
N-C20
N-C21
N-C22
N-C23
N-C24
N-C25
N-C26
N-C27
N-C28
N-C29
N-C30
N-C31
N-C32
N-C33

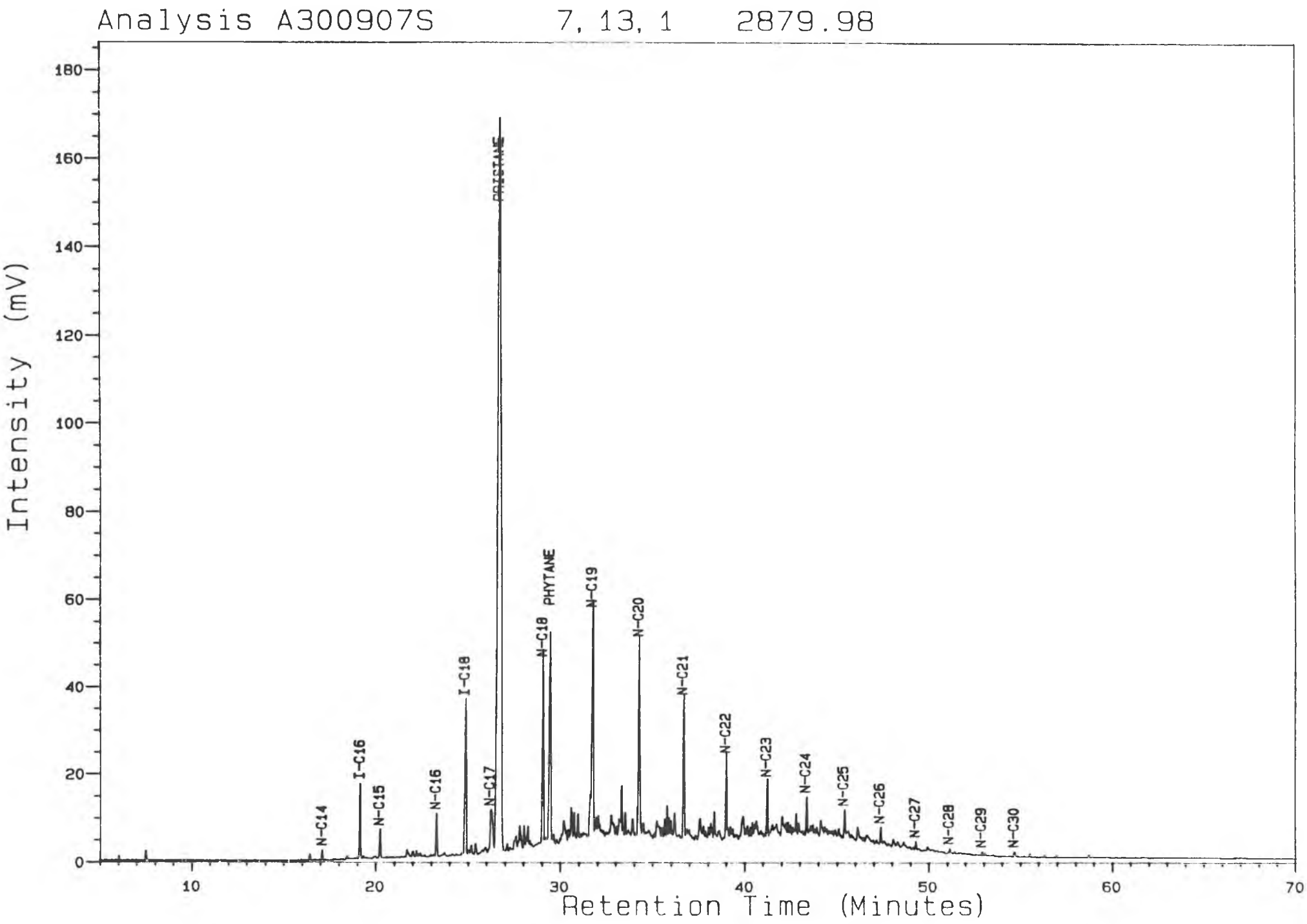

Analysis A300907S 7, 8, 1 2805
Intensity (mV)
0
10
20
30
40
50
N-C13
N-C14
I-C16
N-C15
N-C16
I-C18
N-C17
PRISTANE
PHYTANE
N-C18
N-C19
N-C20
N-C21
N-C22
N-C23
N-C24
N-C25
N-C26
N-C27
N-C28
N-C29
N-C30
N-C31
N-C32
10
20
30
40
50
60
70
Retention Time (Minutes)

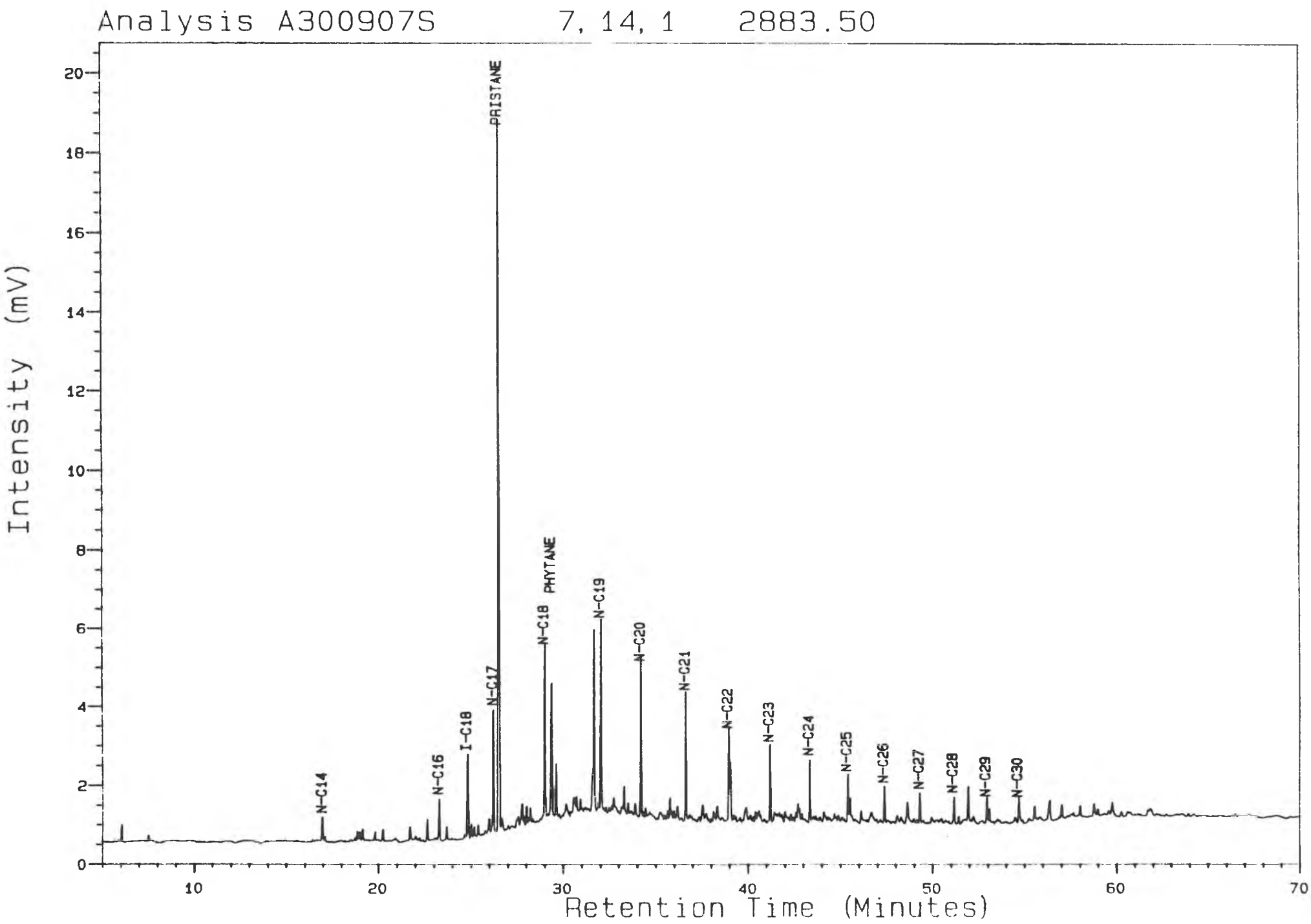

Analysis A300907S 7, 9, 1 2810
Intensity (mV)
Retention Time (Minutes)
N-C13
N-C14
I-C16
N-C15
N-C16
I-C18
N-C17
PRISTANE
N-C18
PHYTANE
N-C19
N-C20
N-C21
N-C22
N-C23
N-C24
N-C25
N-C26
N-C27
N-C28
N-C29
N-C30
N-C31
N-C32
N-C33

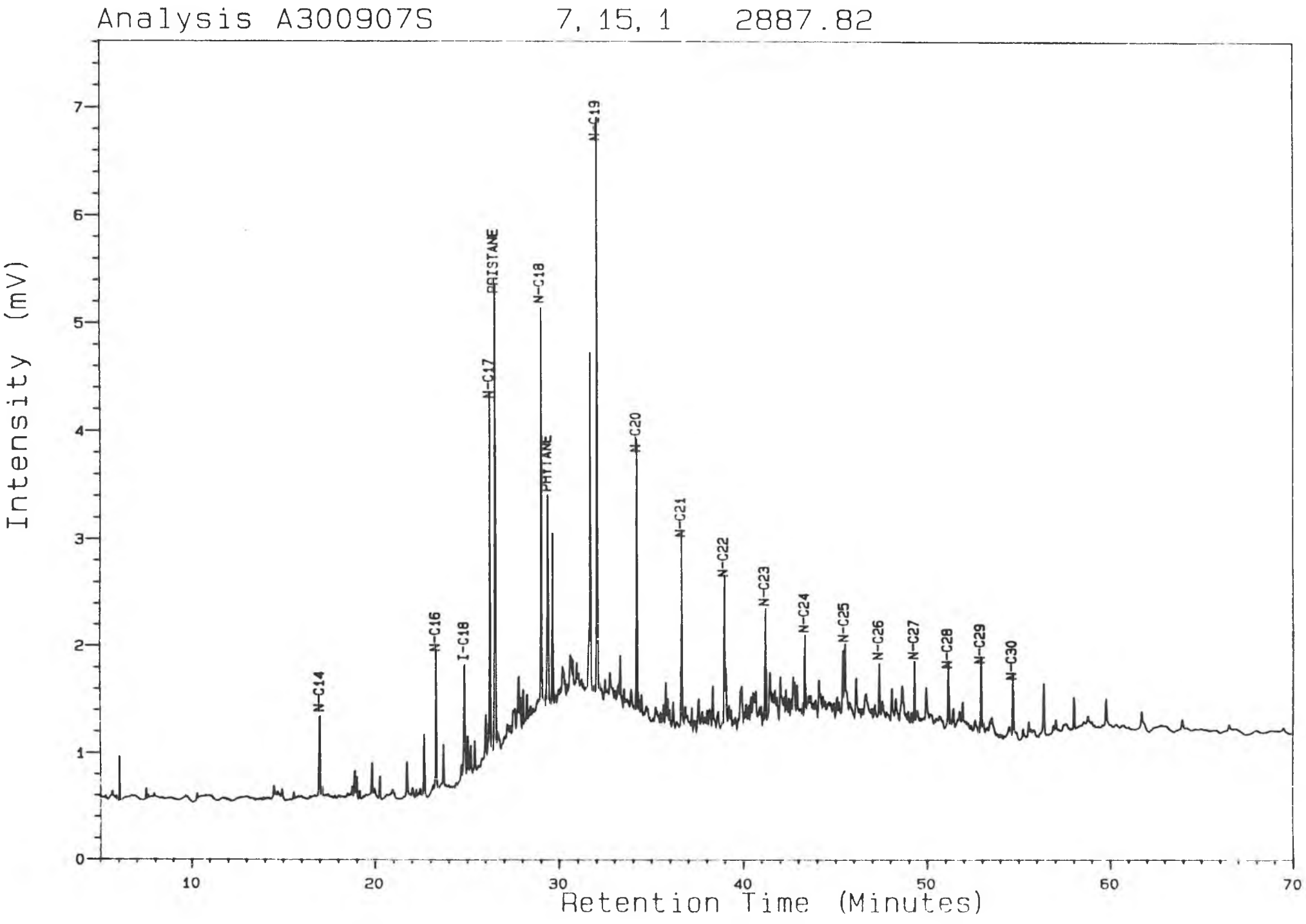

Analysis A300907S 7, 10, 1 2841.98
Intensity (mV)
Retention Time (Minutes)
N-C14
I-C16
N-C15
N-C16
I-C18
N-C17
PRISTANE
N-C18
PHYTANE
N-C19
N-C20
N-C21
N-C22
N-C23
N-C24
N-C25
N-C26
N-C27
N-C28
N-C29
N-C30
N-C31
N-C32
N-C33


Analysis A300907S 7, 11, 1 2862.65
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

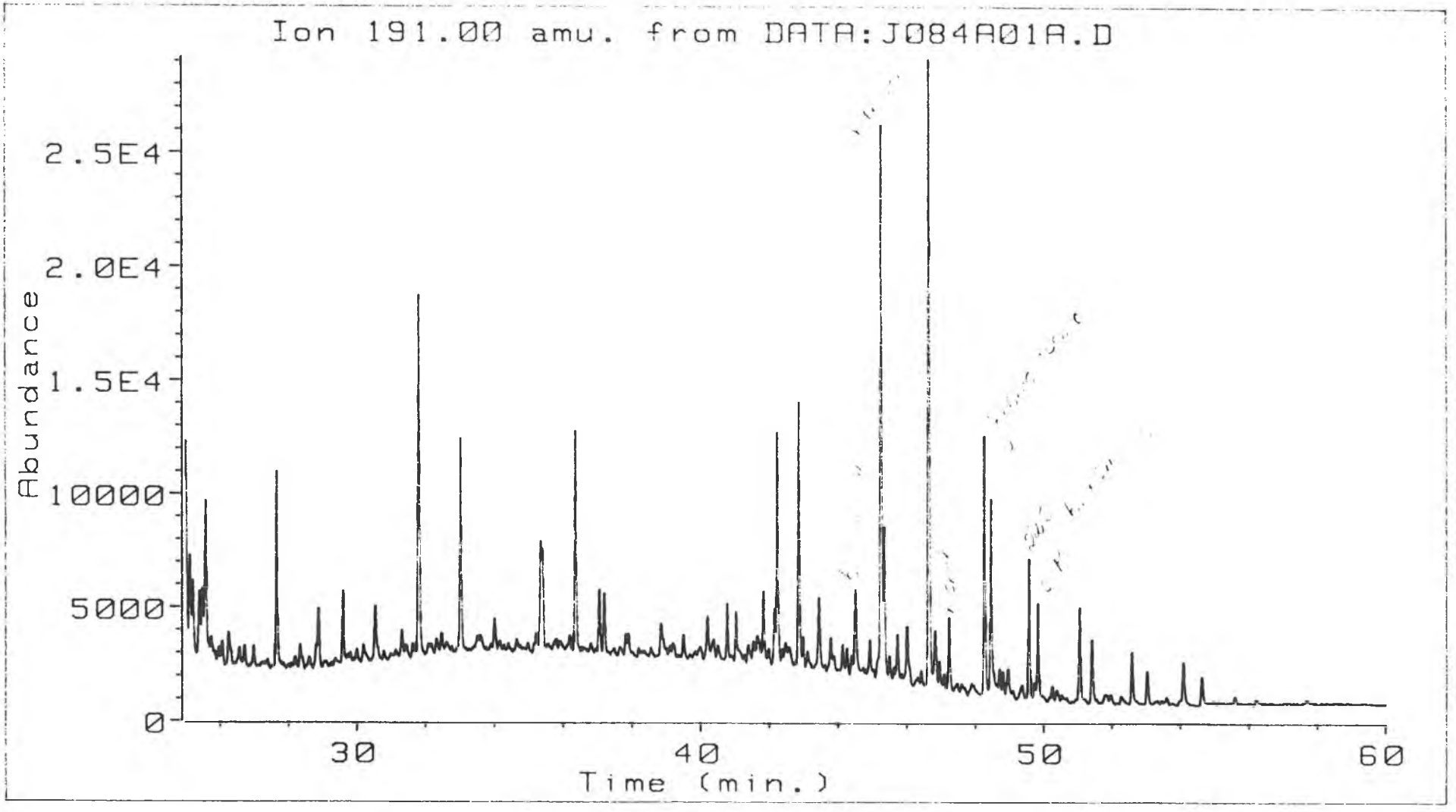

Analysis A300907S 7, 12, 1 2870.98
Intensity (mV)
Retention Time (Minutes)
0
20
40
60
80
100
120
140
160
10
20
30
40
50
60
70
N-C14
I-C16
N-C15
N-C16
I-C18
N-C17
PRISTANE
N-C18
PHYTANE
N-C19
N-C20
N-C21
N-C22
N-C23
N-C24
N-C25
N-C26
N-C27
N-C28
N-C29
N-C30
N-C31
N-C33

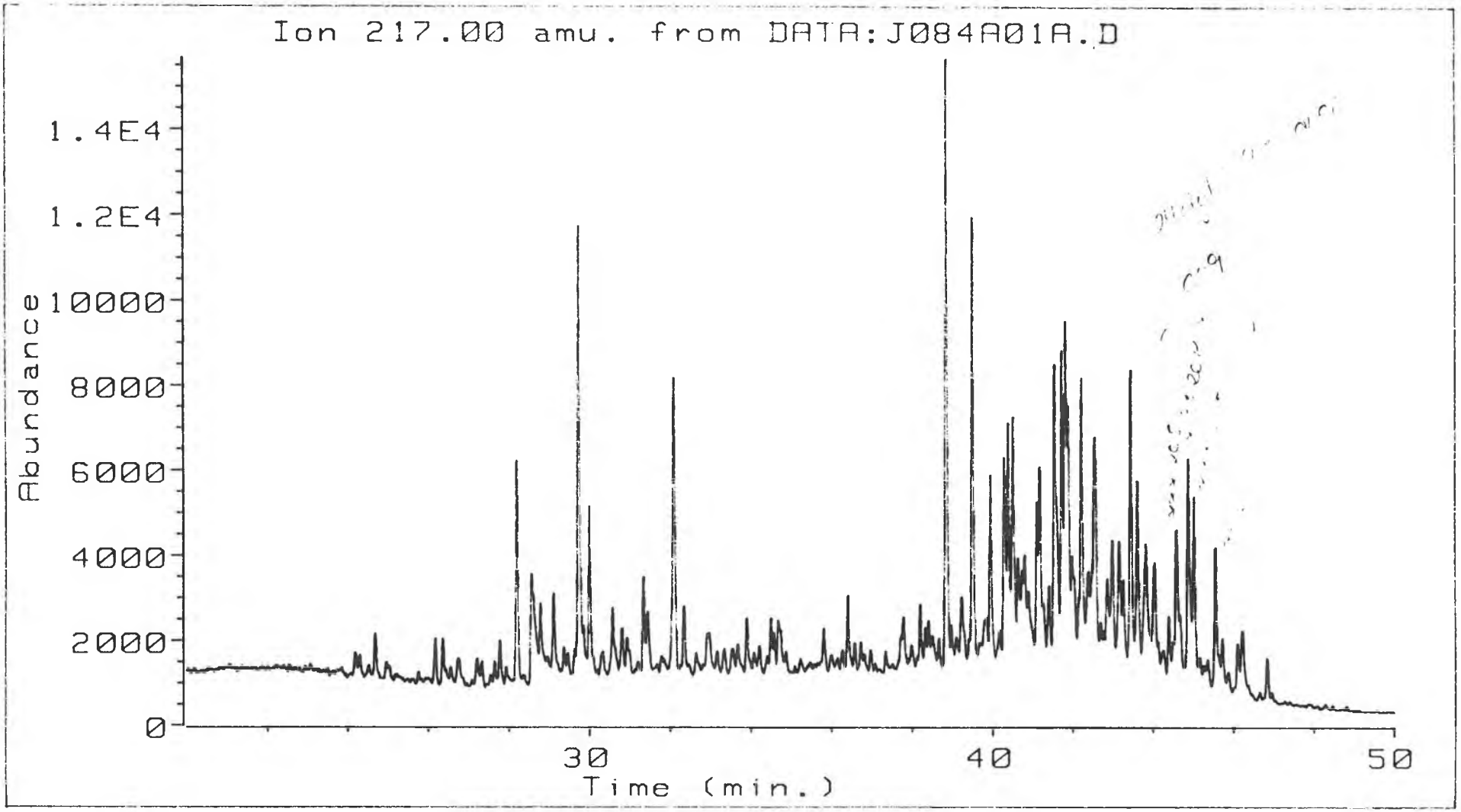

Analysis A300907S 7, 13, 1 2879.98
Intensity (mV)
Retention Time (Minutes)
N-C14
I-C16
N-C15
N-C16
I-C18
N-C17
PRISTANE
N-C18
PHYTANE
N-C19
N-C20
N-C21
N-C22
N-C23
N-C24
N-C25
N-C26
N-C27
N-C28
N-C29
N-C30

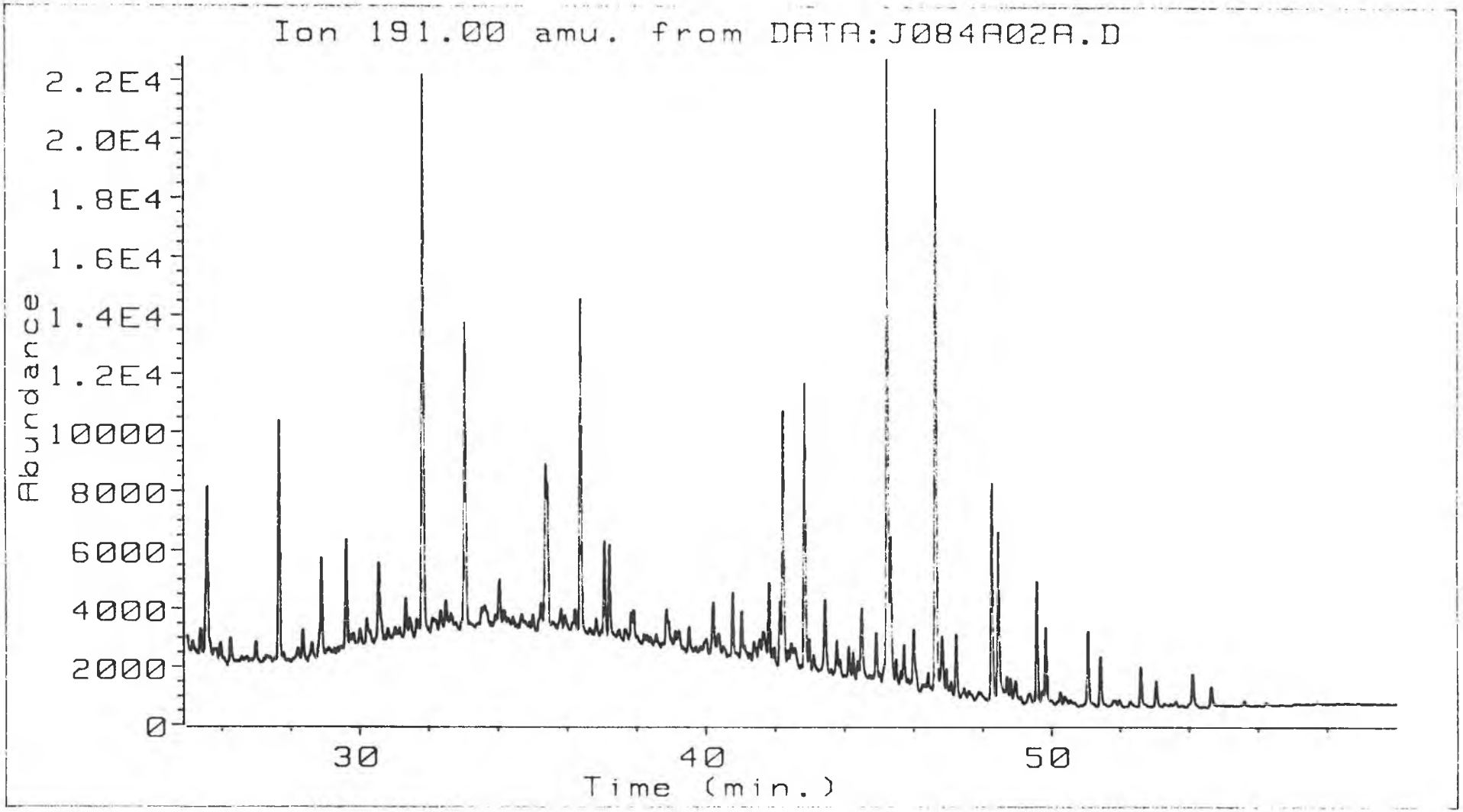

Analysis A300907S 7, 14, 1 2883.50
Intensity (mV)
Retention Time (Minutes)
N-C14
N-C16
I-C18
N-C17
PRISTANE
N-C18
PHYTANE
N-C19
N-C20
N-C21
N-C22
N-C23
N-C24
N-C25
N-C26
N-C27
N-C28
N-C29
N-C30

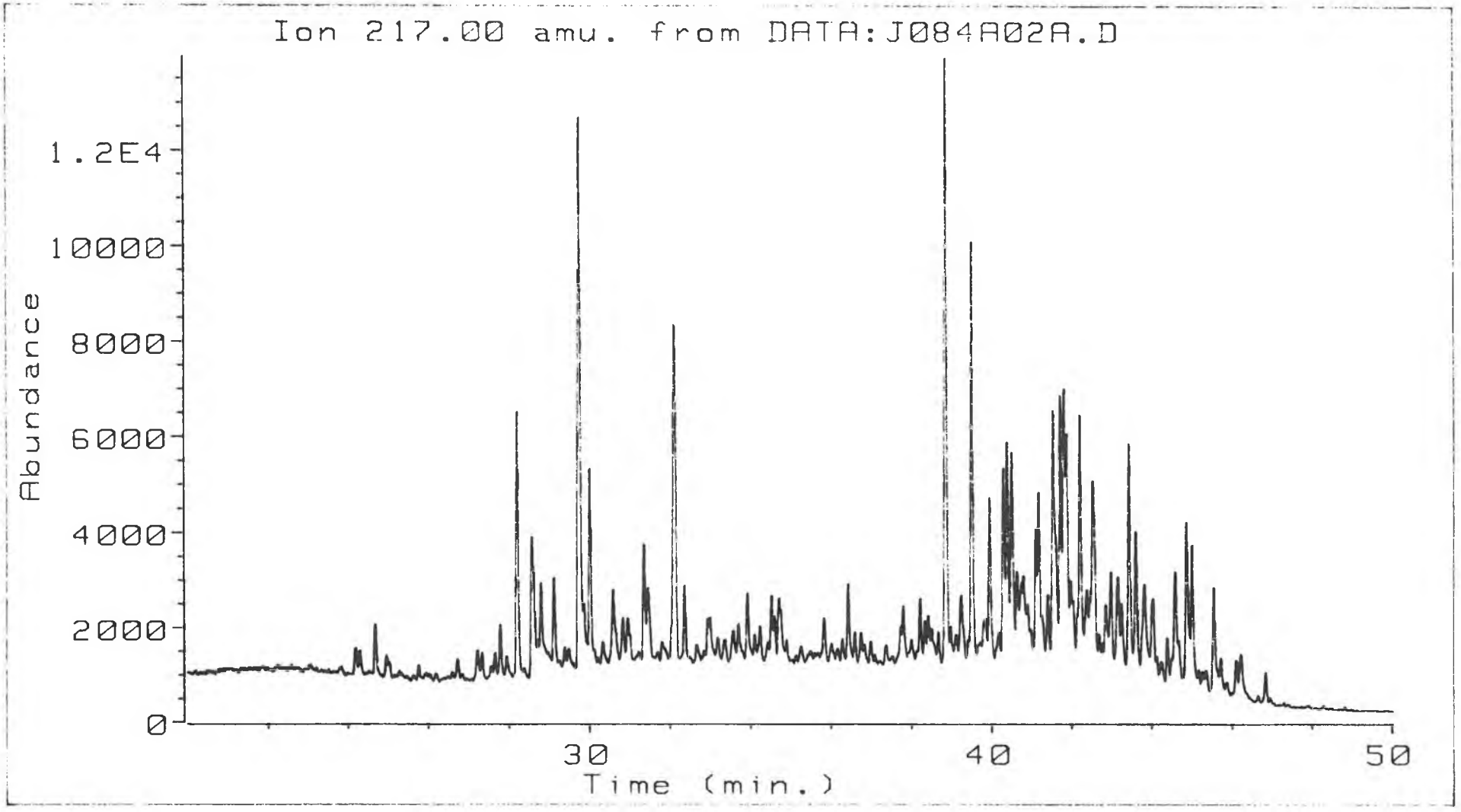

Analysis A300907S 7, 15, 1 2887.82
Intensity (mV)
Retention Time (Minutes)
N-C14
N-C16
I-C18
N-C17
PRISTANE
N-C18
PHYTANE
N-C19
N-C20
N-C21
N-C22
N-C23
N-C24
N-C25
N-C26
N-C27
N-C28
N-C29
N-C30

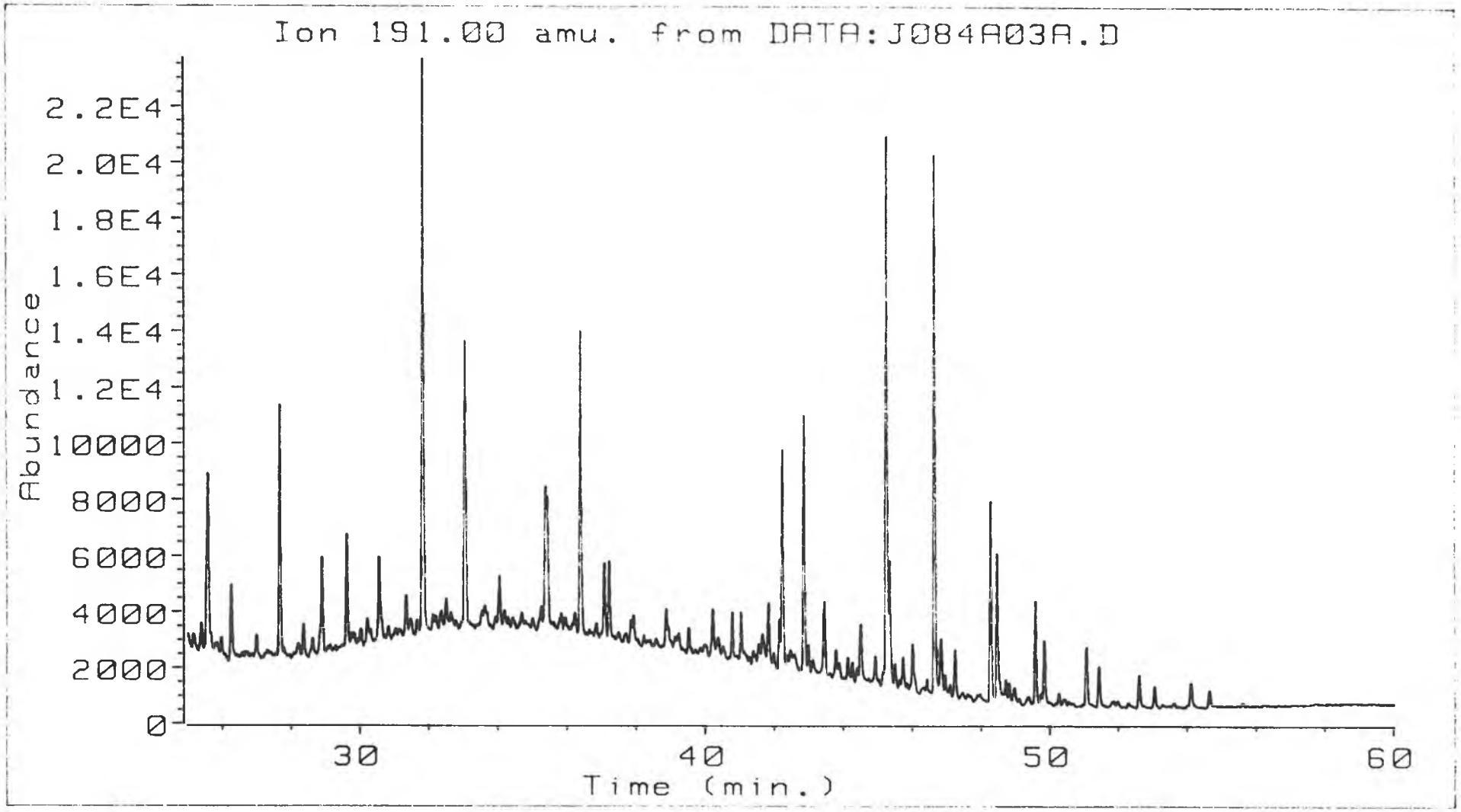
APPENDIX II: M/Z 191 AND 217 OF SATURATED FRACTION

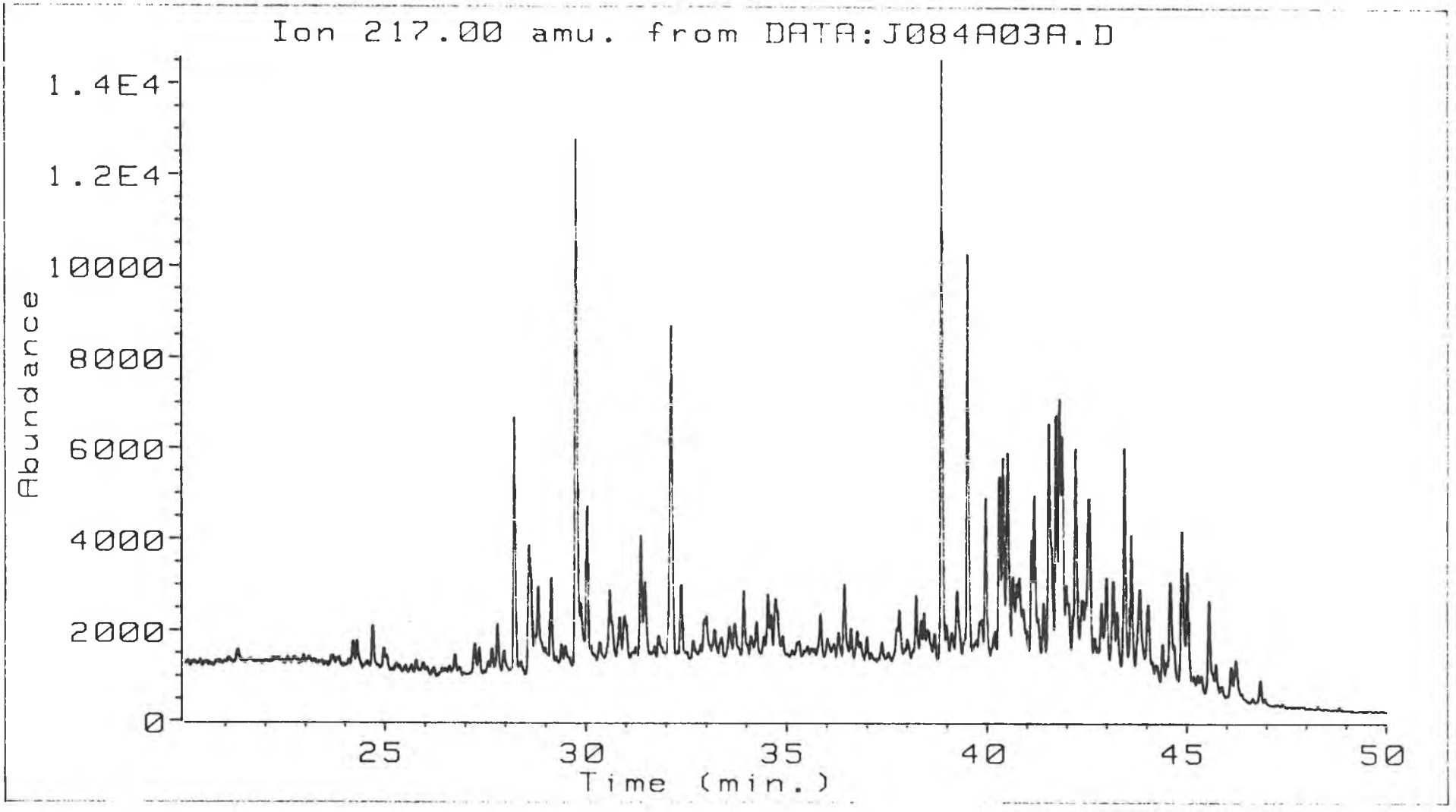

Ion 191.00 amu. from DATA:J084A01A.D
Abundance
2.5E4
2.0E4
1.5E4
10000
5000
0
30
40
50
60
Time (min.)

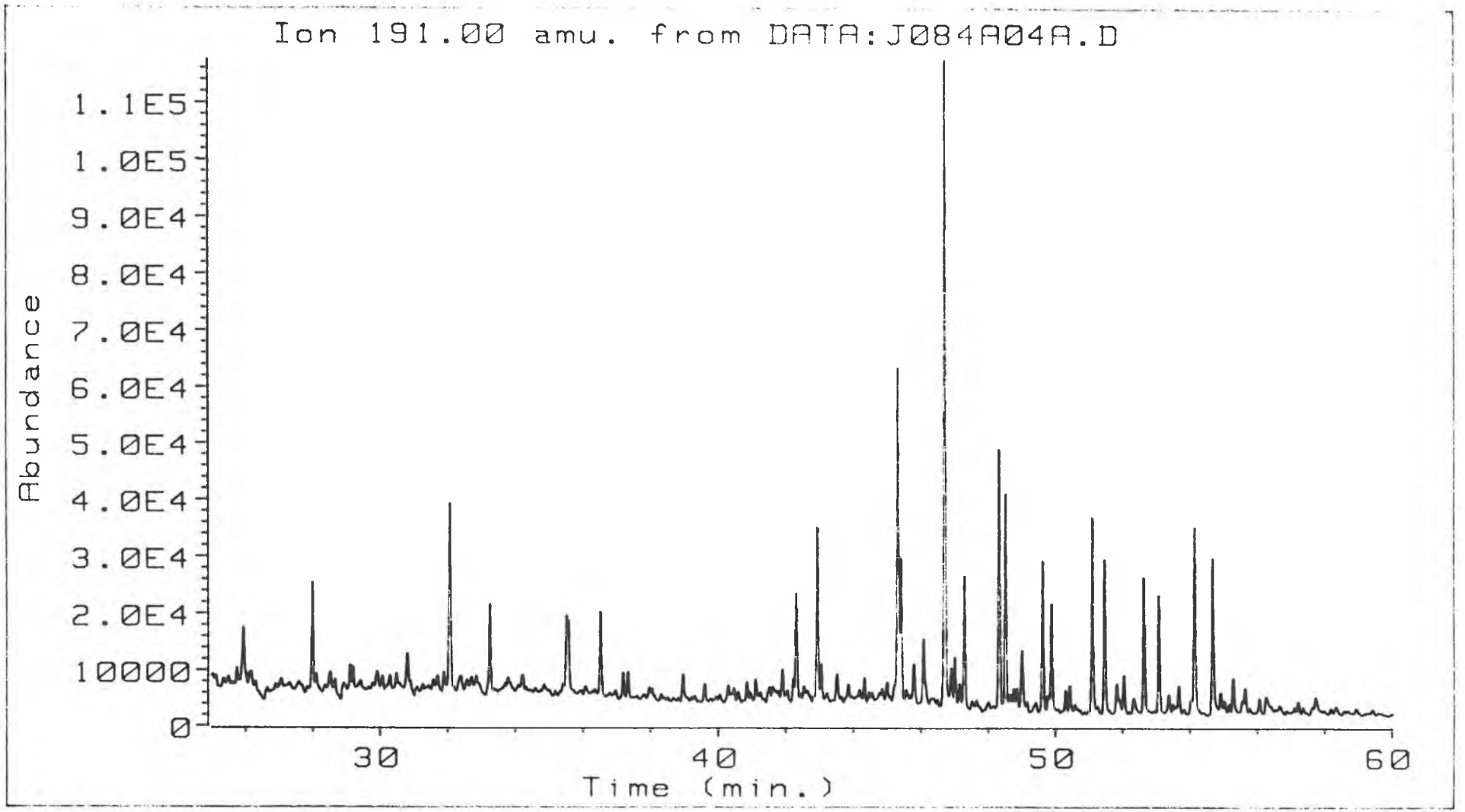

Ion 217.00 amu. from DATA:J084A01A.D
Abundance
1.4E4
1.2E4
10000
8000
6000
4000
2000
0
30
40
50
Time (min.)

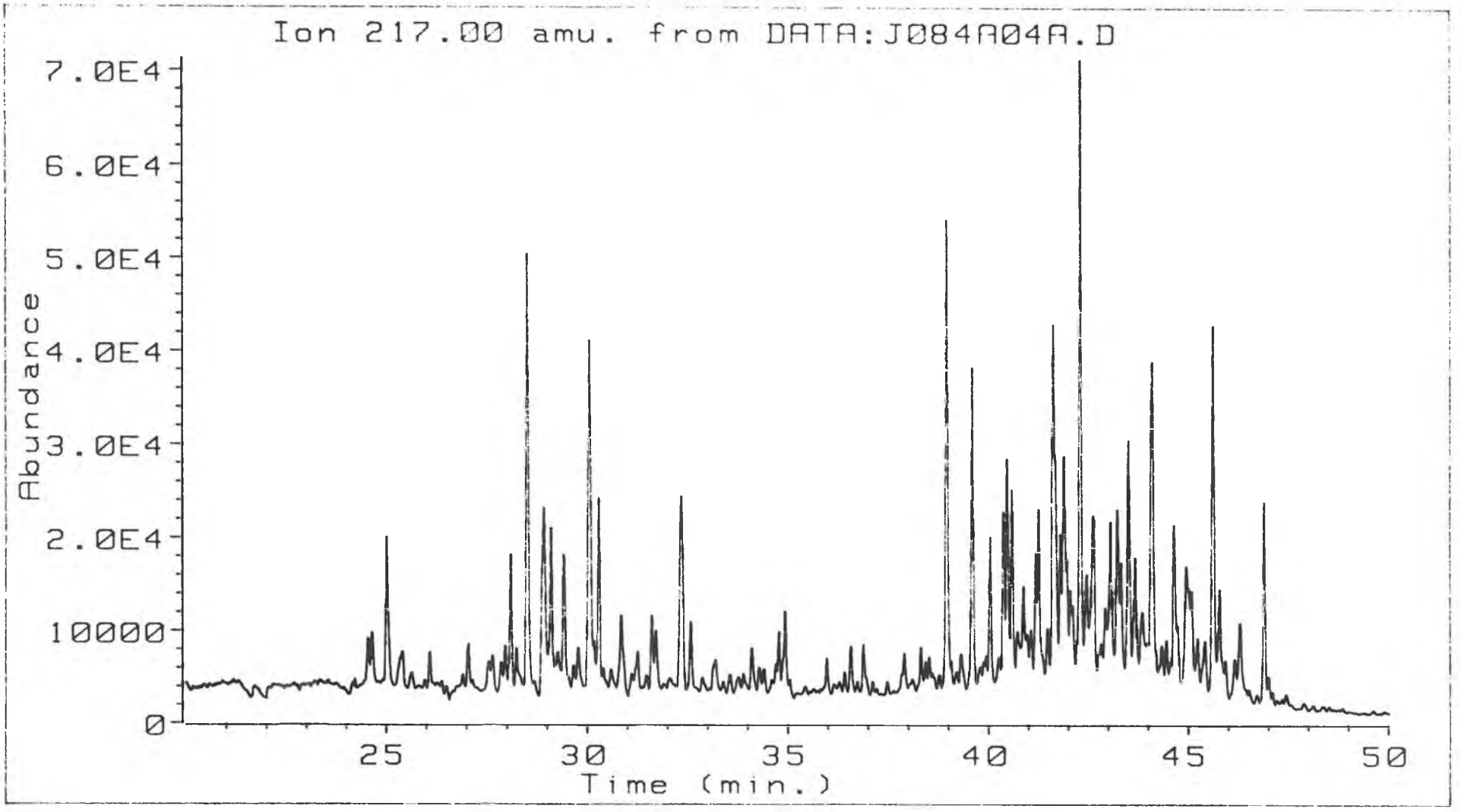

Ion 191.00 amu. from DATA:J084A02A.D
Abundance
2.2E4
2.0E4
1.8E4
1.6E4
1.4E4
1.2E4
10000
8000
6000
4000
2000
0
30
40
50
Time (min.)

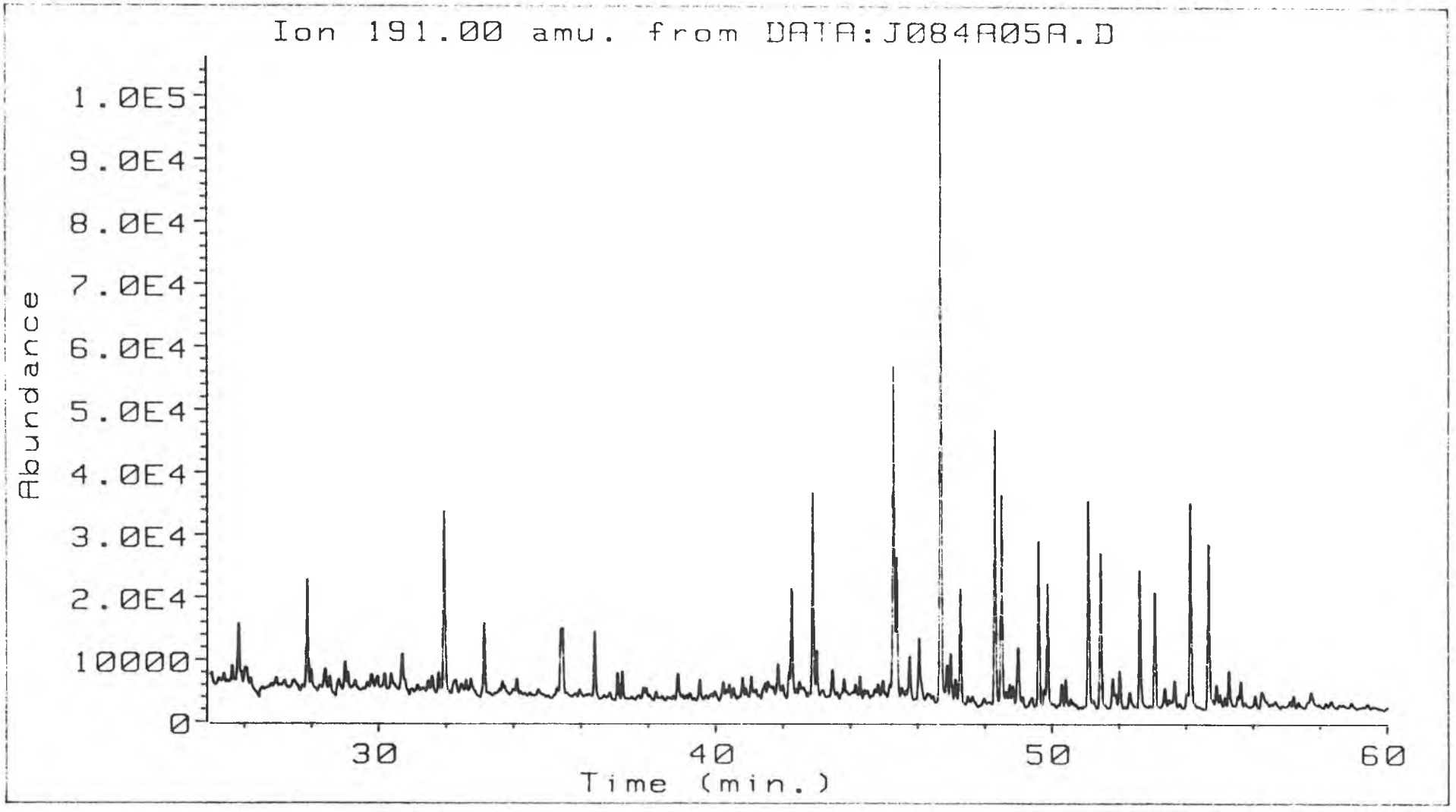

Ion 217.00 amu. from DATA:J084A02A.D
Abundance
1.2E4
10000
8000
6000
4000
2000
0
30
40
50
Time (min.)

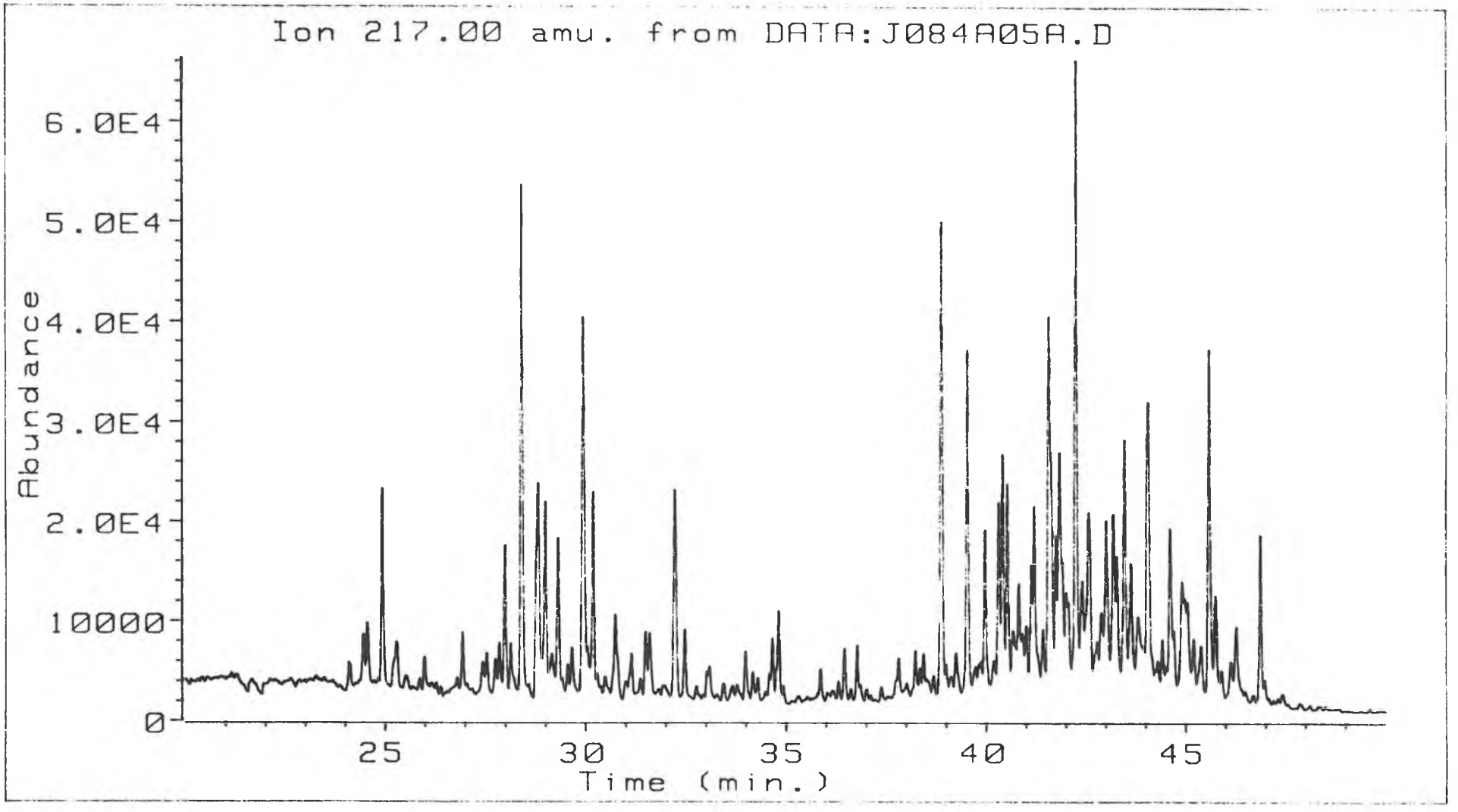

Ion 191.00 amu. from DATA:J084A03A.D
Abundance
2.2E4
2.0E4
1.8E4
1.6E4
1.4E4
1.2E4
10000
8000
6000
4000
2000
0
30
40
50
60
Time (min.)

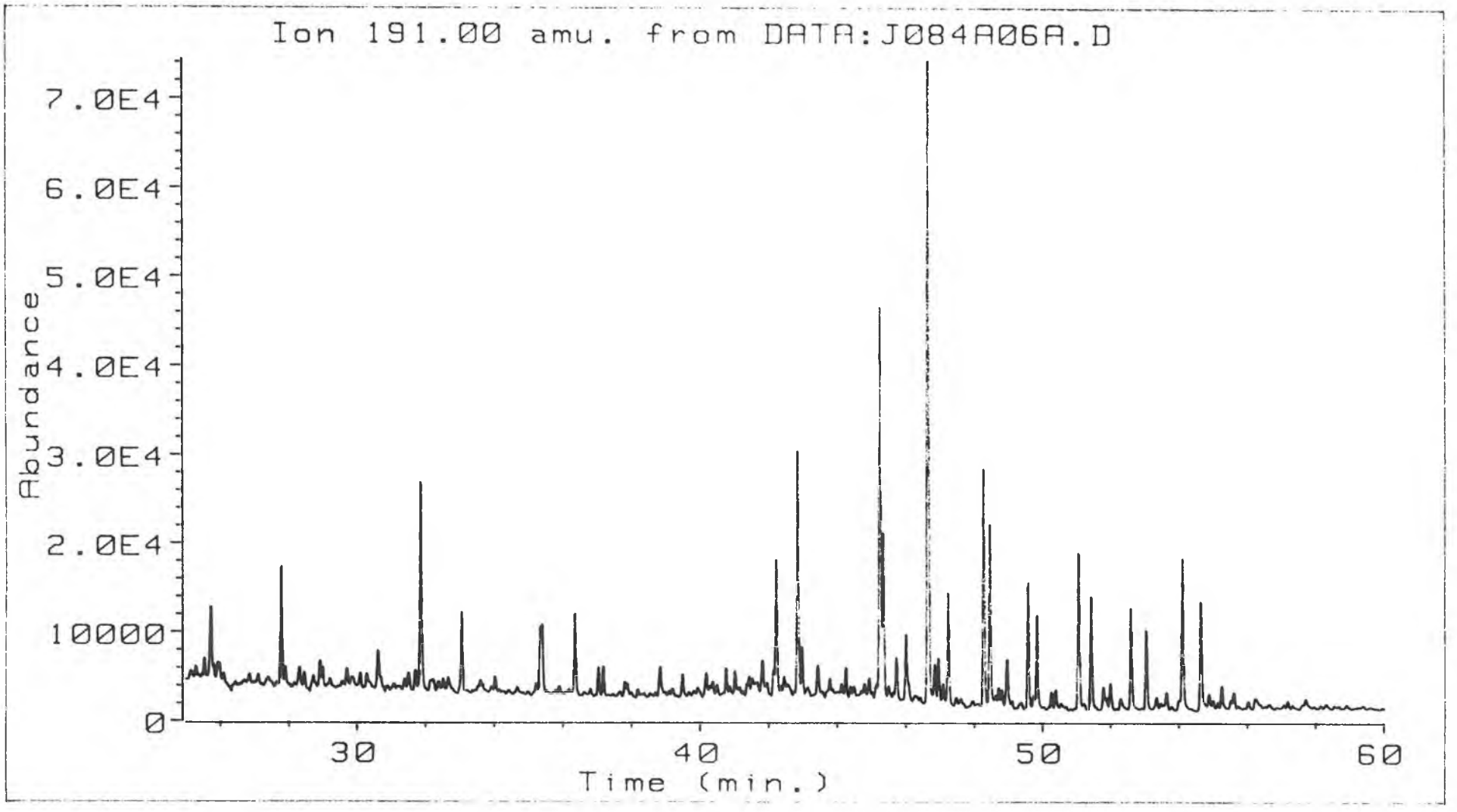

Ion 217.00 amu. from DATA:J084A03A.D
Abundance
1.4E4
1.2E4
10000
8000
6000
4000
2000
0
25
30
35
40
45
50
Time (min.)

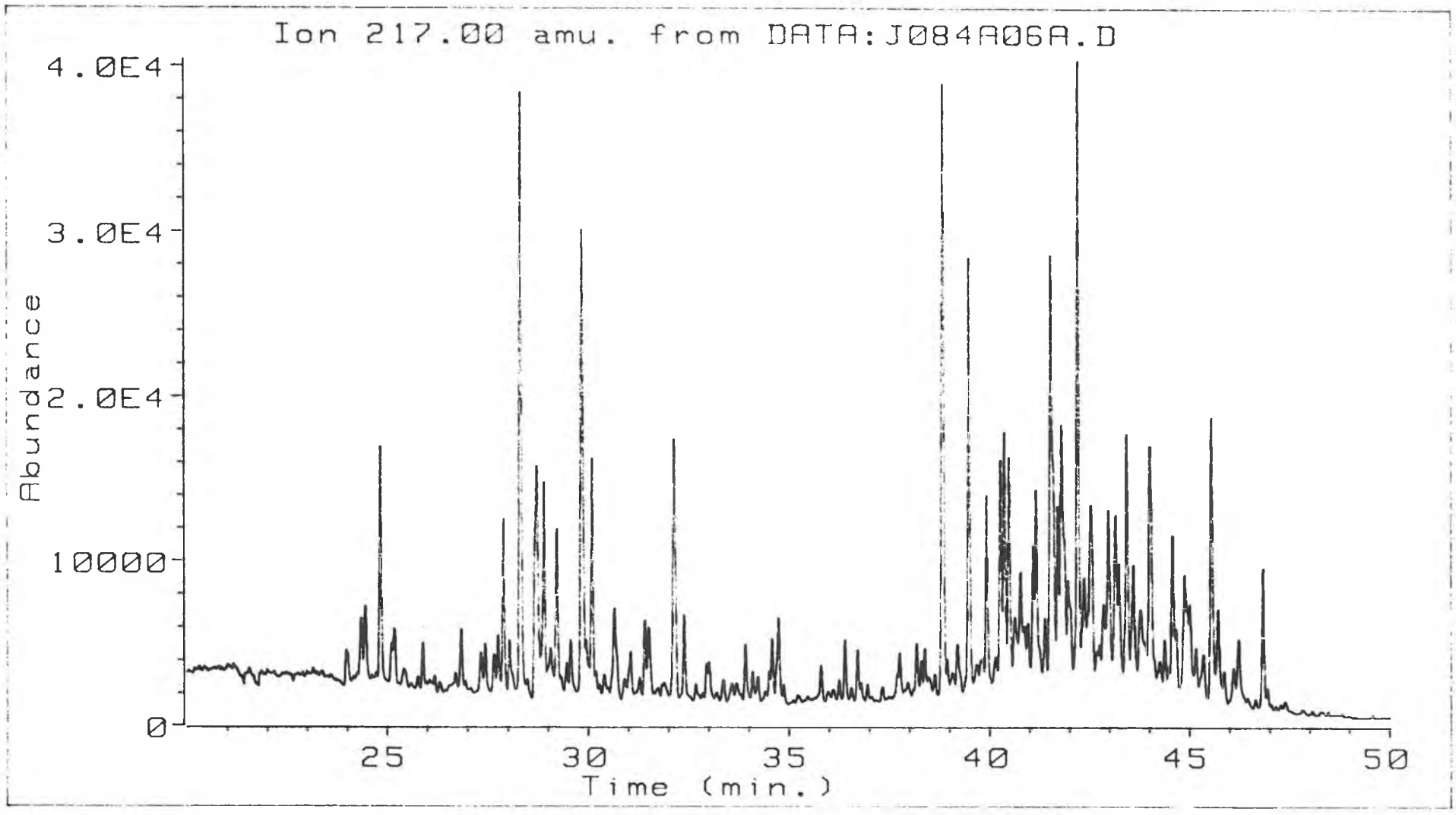

Ion 191.00 amu. from DATA:J084A04A.D
Abundance
1.1E5
1.0E5
9.0E4
8.0E4
7.0E4
6.0E4
5.0E4
4.0E4
3.0E4
2.0E4
10000
0
30
40
50
60
Time (min.)

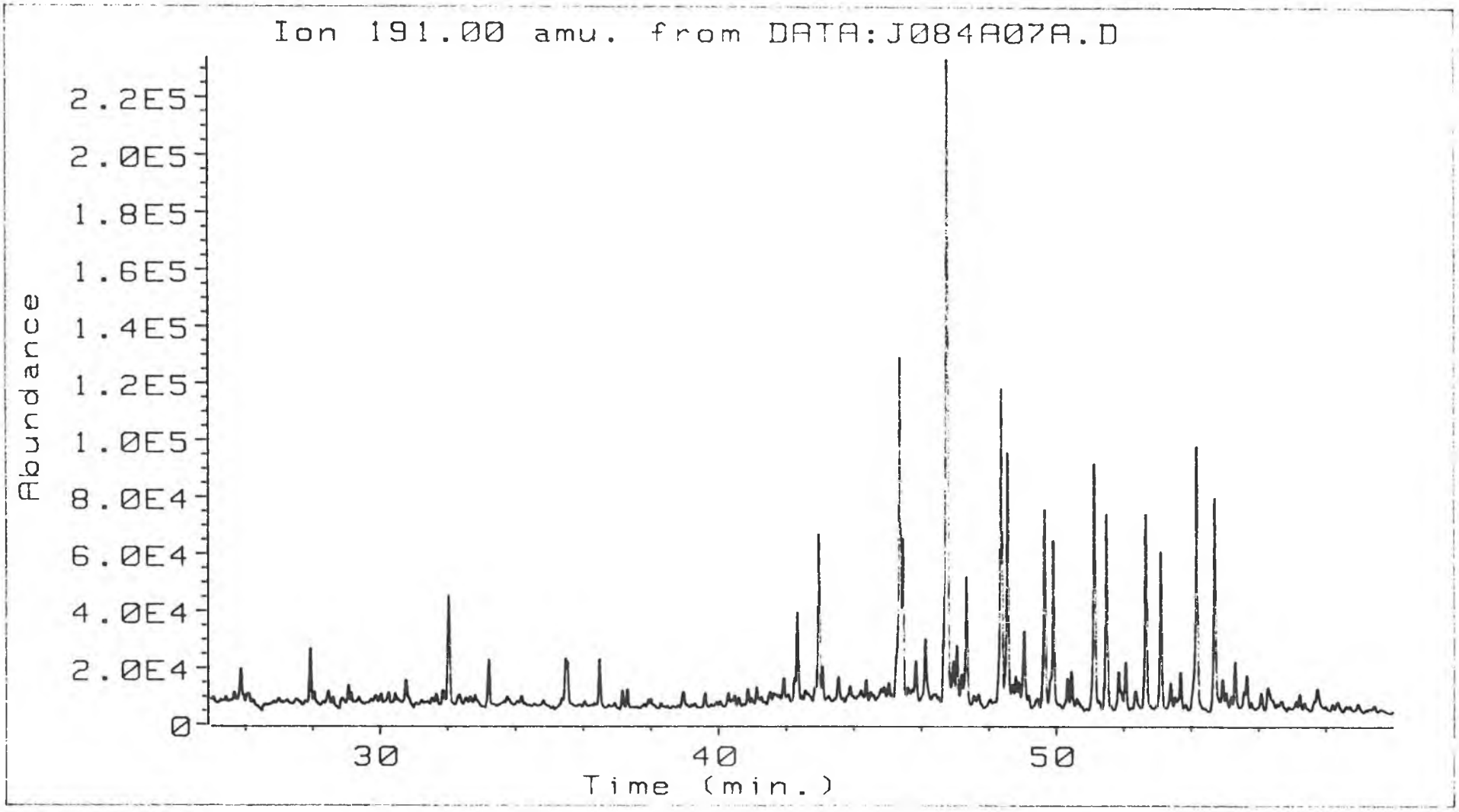

Ion 217.00 amu. from DATA:J084A04A.D
7.0E4
6.0E4
5.0E4
4.0E4
3.0E4
2.0E4
10000
0
Abundance
25
30
35
40
45
50
Time (min.)

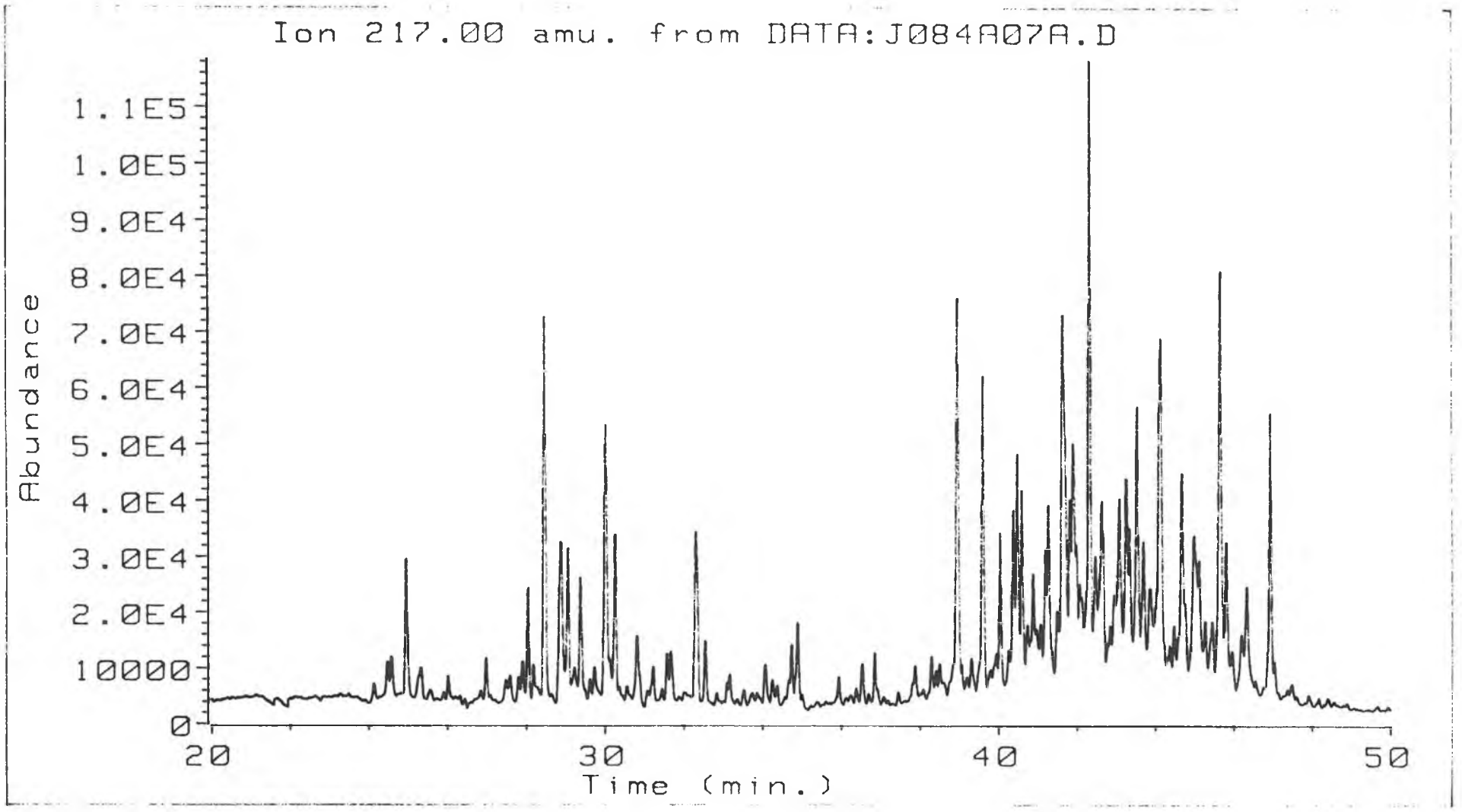

Ion 191.00 amu. from DATA:J084A05A.D
Abundance
1.0E5
9.0E4
8.0E4
7.0E4
6.0E4
5.0E4
4.0E4
3.0E4
2.0E4
10000
0
30
40
50
60
Time (min.)

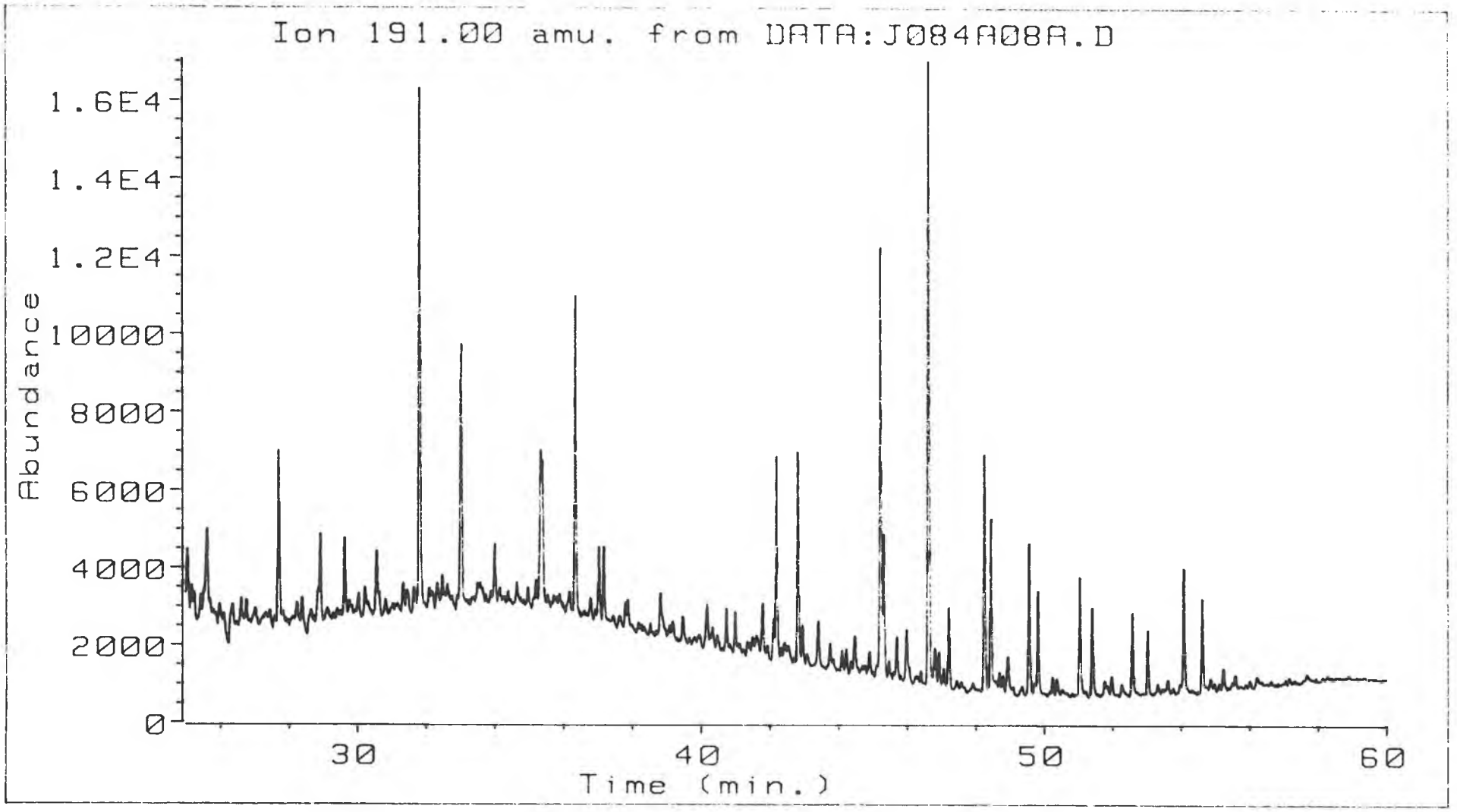

Ion 217.00 amu. from DATA:J084A05A.D
Abundance
6.0E4
5.0E4
4.0E4
3.0E4
2.0E4
10000
0
25
30
35
40
45
Time (min.)

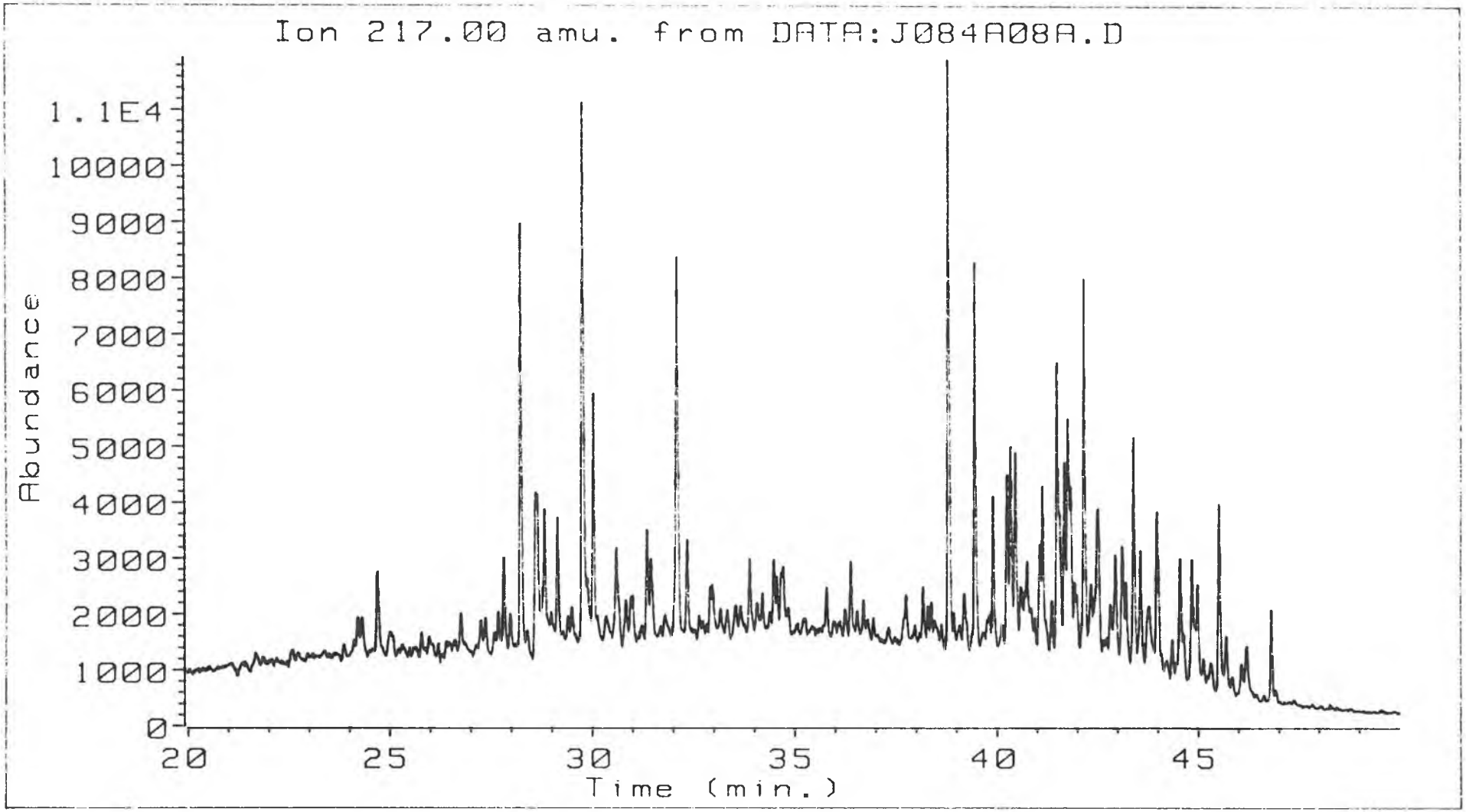

Ion 191.00 amu. from DATA:J084A06A.D
7.0E4
6.0E4
5.0E4
4.0E4
3.0E4
2.0E4
10000
0
Abundance
30
40
50
60
Time (min.)

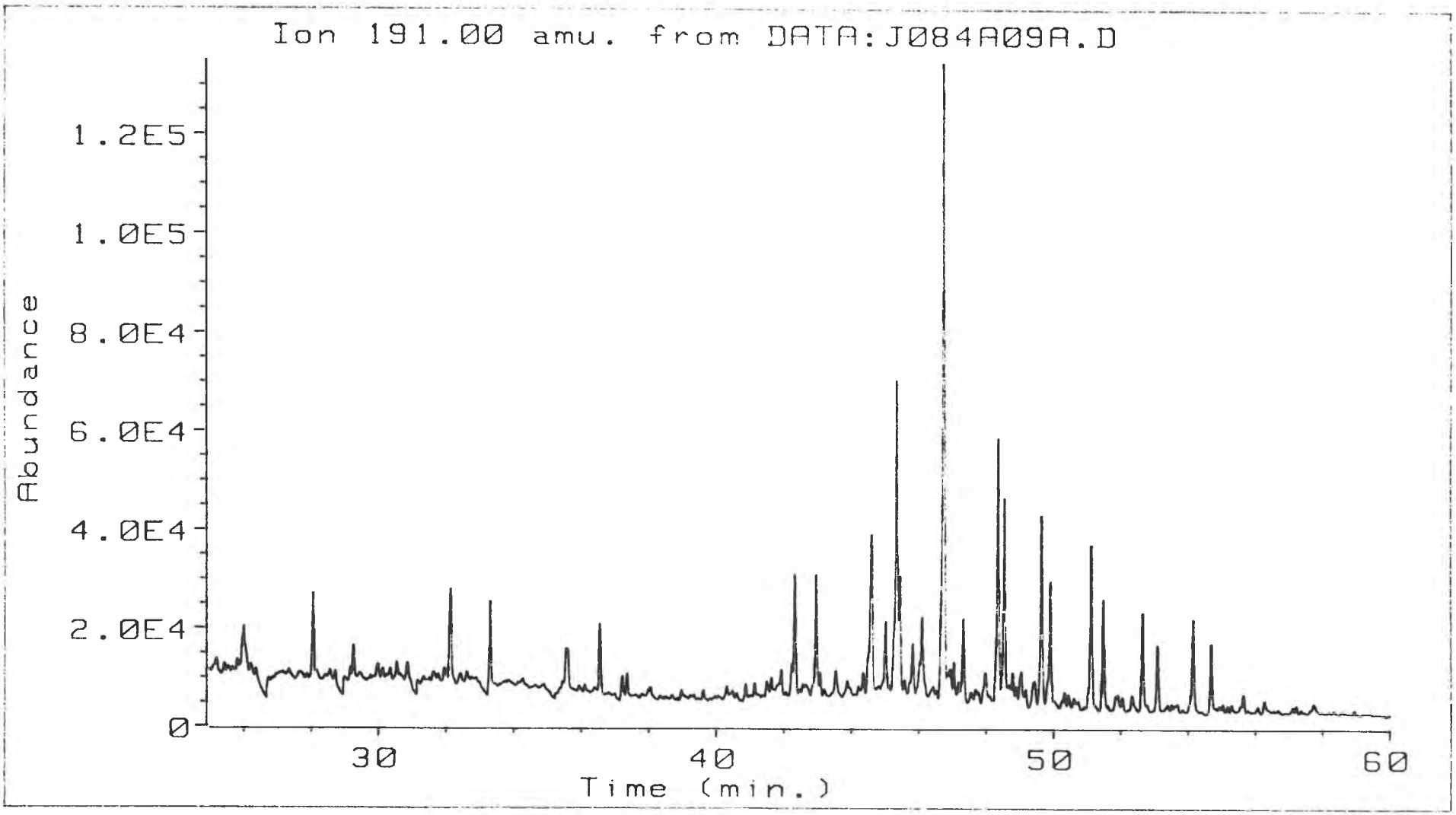

Ion 217.00 amu. from DATA:J084A06A.D
4.0E4
3.0E4
2.0E4
10000
0
Abundance
25
30
35
40
45
50
Time (min.)

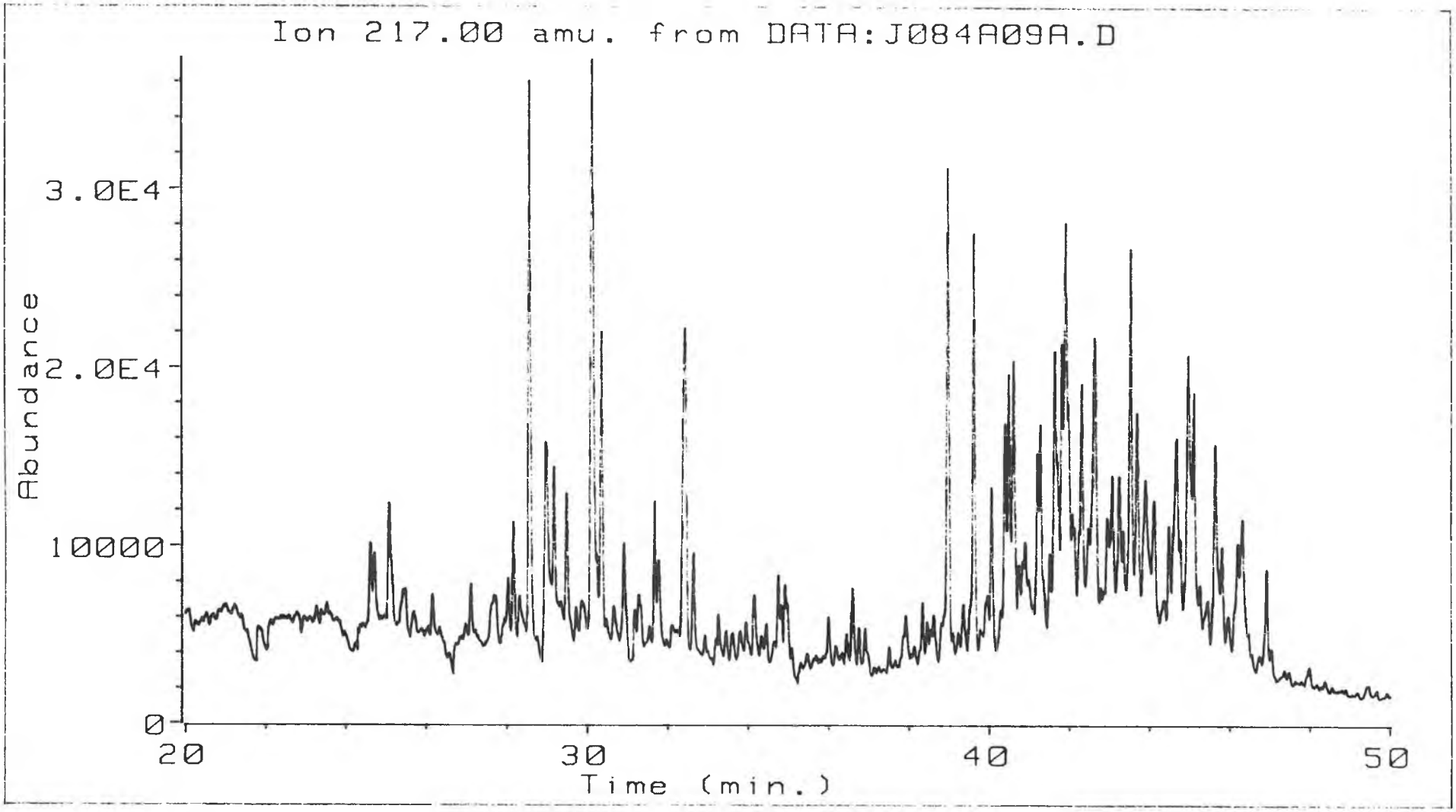

Ion 191.00 amu. from DATA:J084A07A.D
Abundance
2.2E5
2.0E5
1.8E5
1.6E5
1.4E5
1.2E5
1.0E5
8.0E4
6.0E4
4.0E4
2.0E4
0
30
40
50
Time (min.)

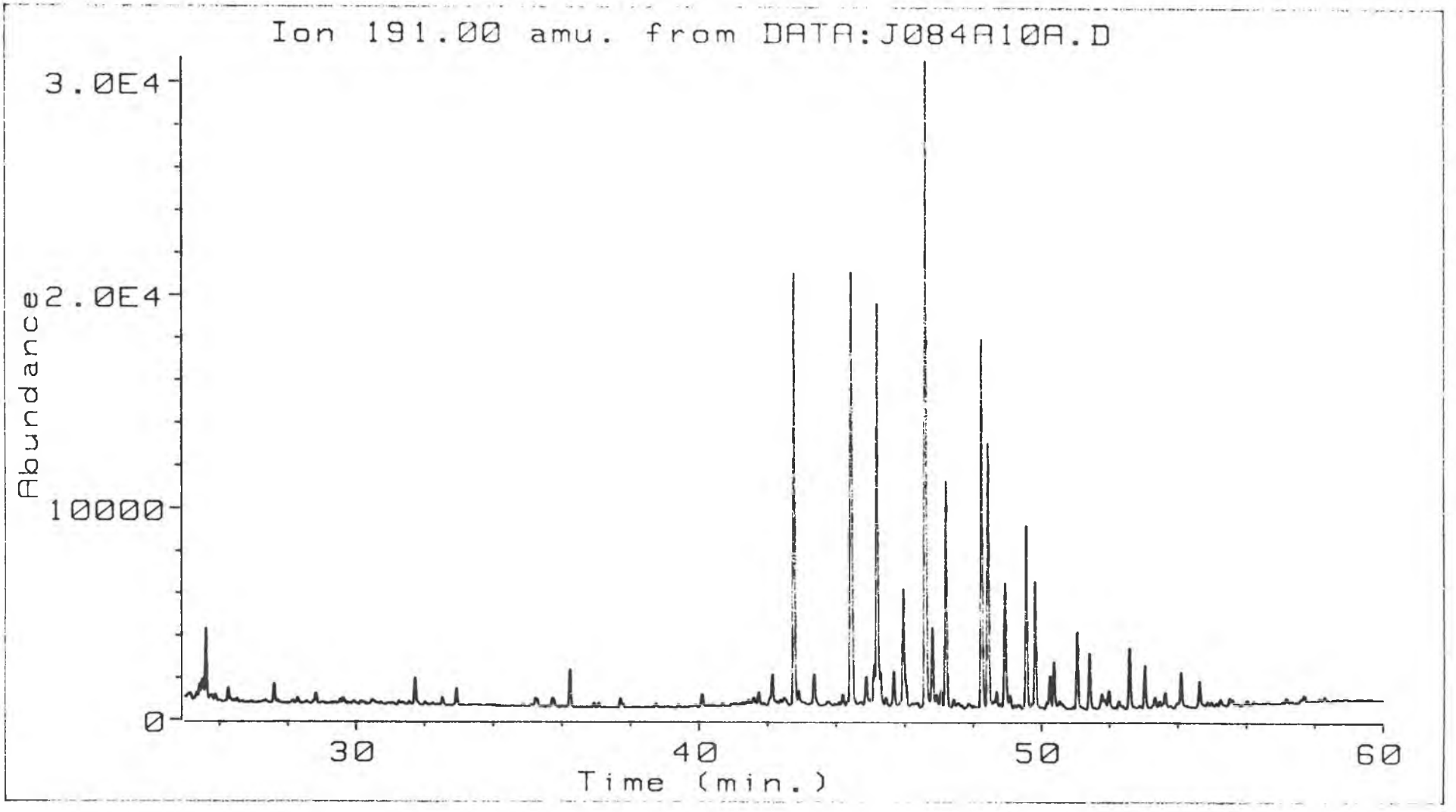

Ion 217.00 amu. from DATA:J084A07A.D
Abundance
1.1E5
1.0E5
9.0E4
8.0E4
7.0E4
6.0E4
5.0E4
4.0E4
3.0E4
2.0E4
10000
0
20
30
40
50
Time (min.)

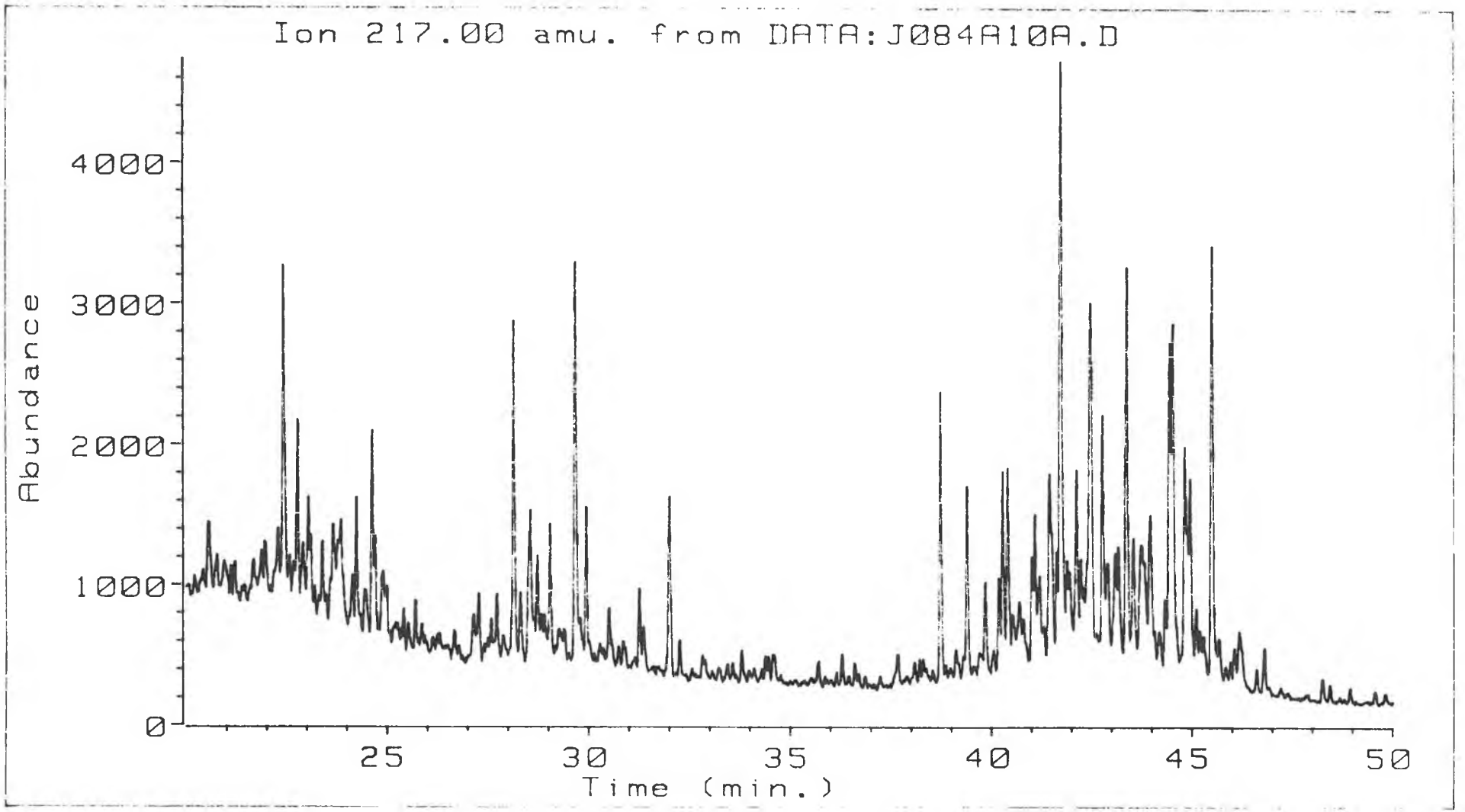

Ion 191.00 amu. from DATA:J084A08A.D
Abundance
1.6E4
1.4E4
1.2E4
10000
8000
6000
4000
2000
0
30
40
50
60
Time (min.)

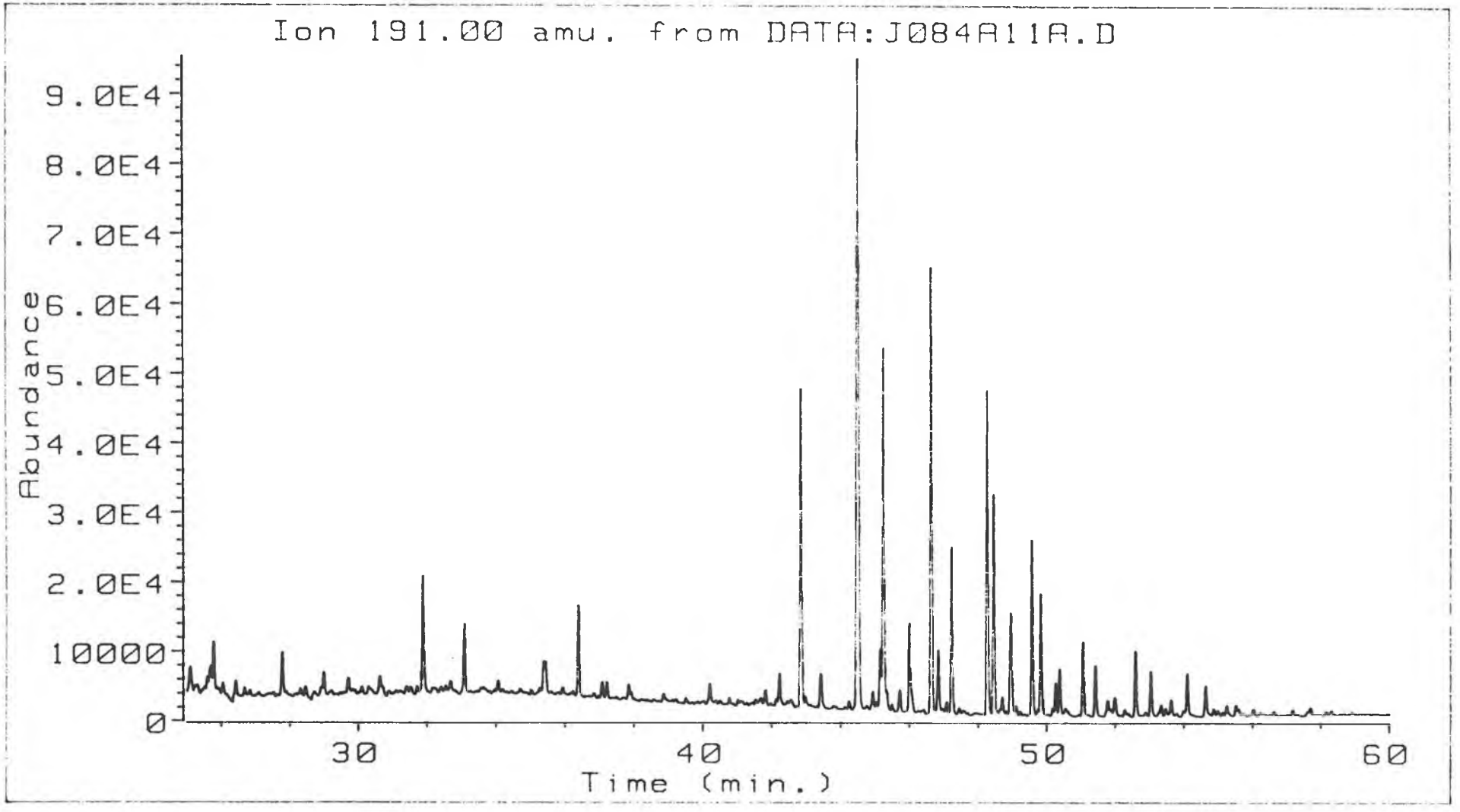

Ion 217.00 amu. from DATA:J084A08A.D
Abundance
1.1E4
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
20
25
30
35
40
45
Time (min.)

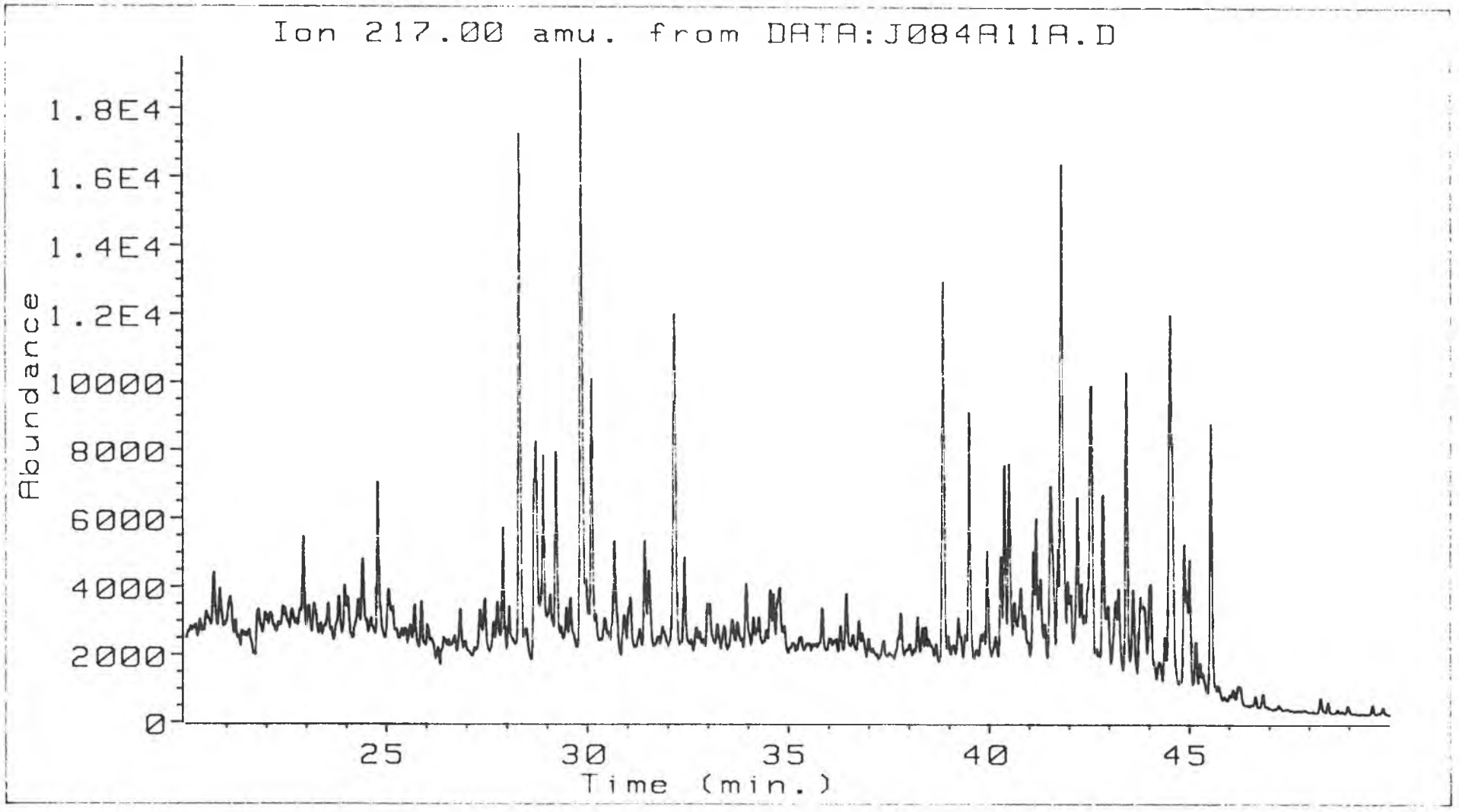

Ion 191.00 amu. from DATA:J084A09A.D
Abundance
1.2E5
1.0E5
8.0E4
6.0E4
4.0E4
2.0E4
0
30
40
50
60
Time (min.)

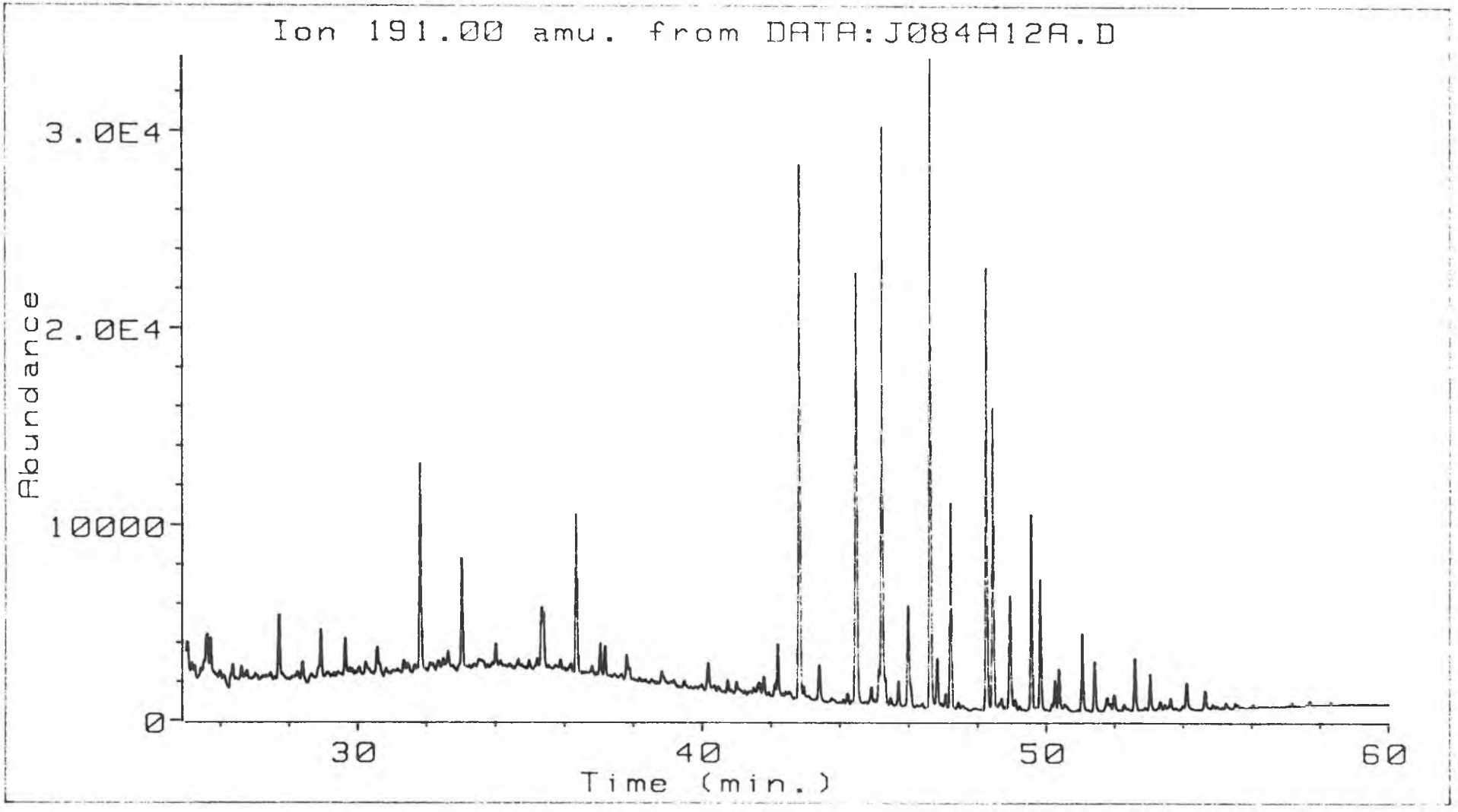

Ion 217.00 amu. from DATA:J084A09A.D
Abundance
3.0E4
2.0E4
10000
0
20
30
40
50
Time (min.)

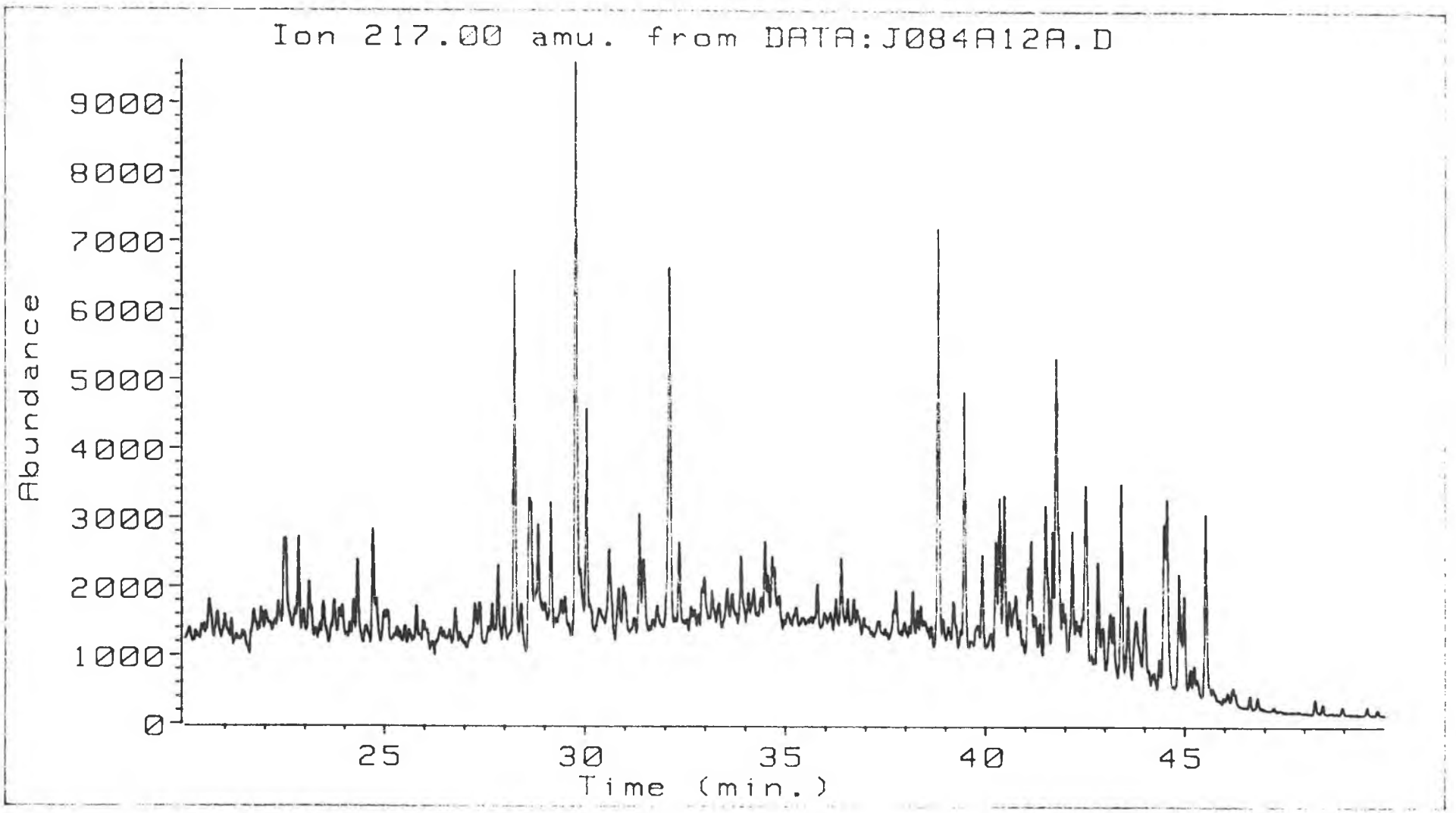

Ion 191.00 amu. from DATA:J084A10A.D
3.0E4
2.0E4
10000
0
Abundance
30
40
50
60
Time (min.)

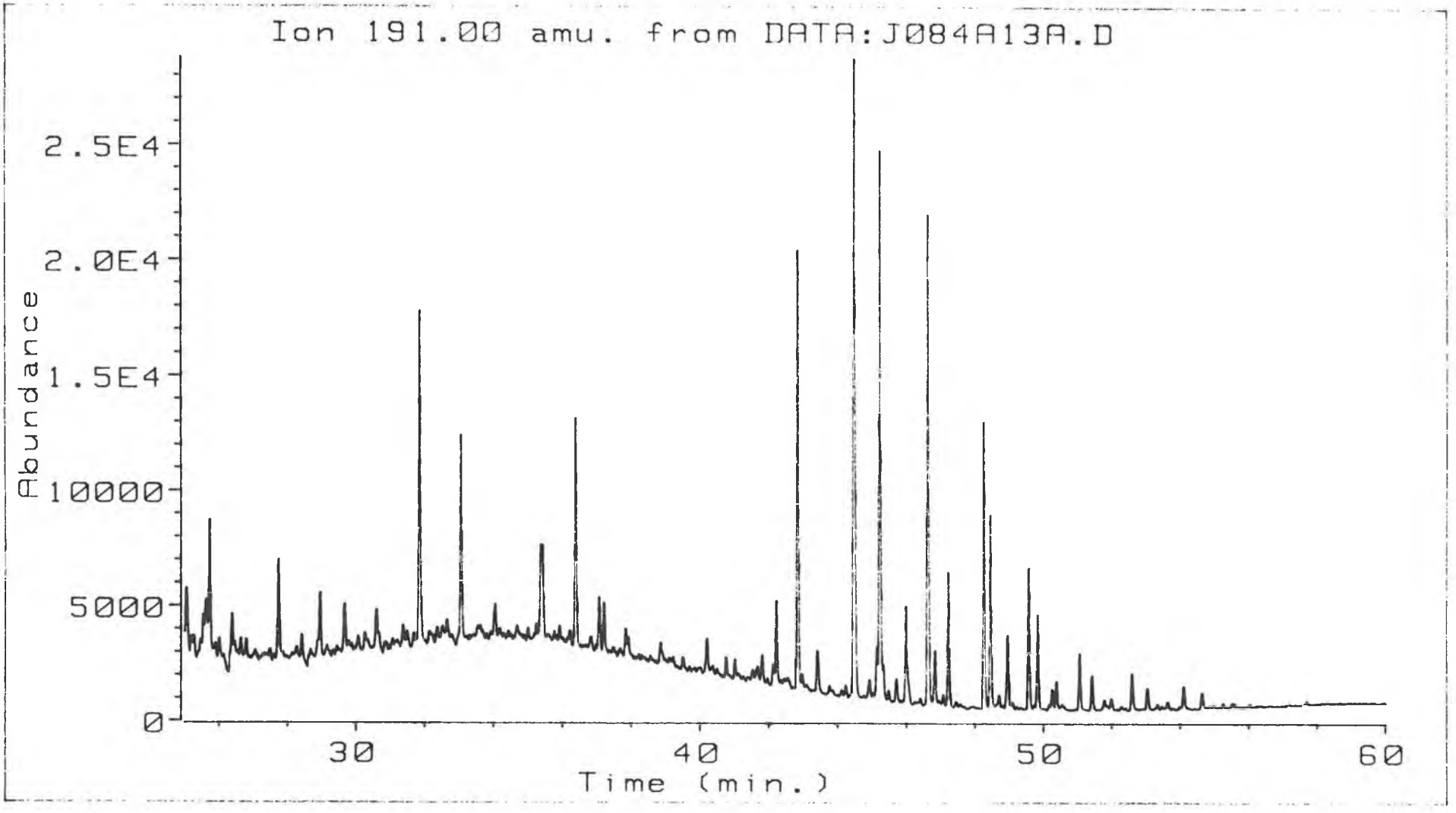

Ion 217.00 amu. from DATA:J084A10A.D
Abundance
4000
3000
2000
1000
0
25
30
35
40
45
50
Time (min.)

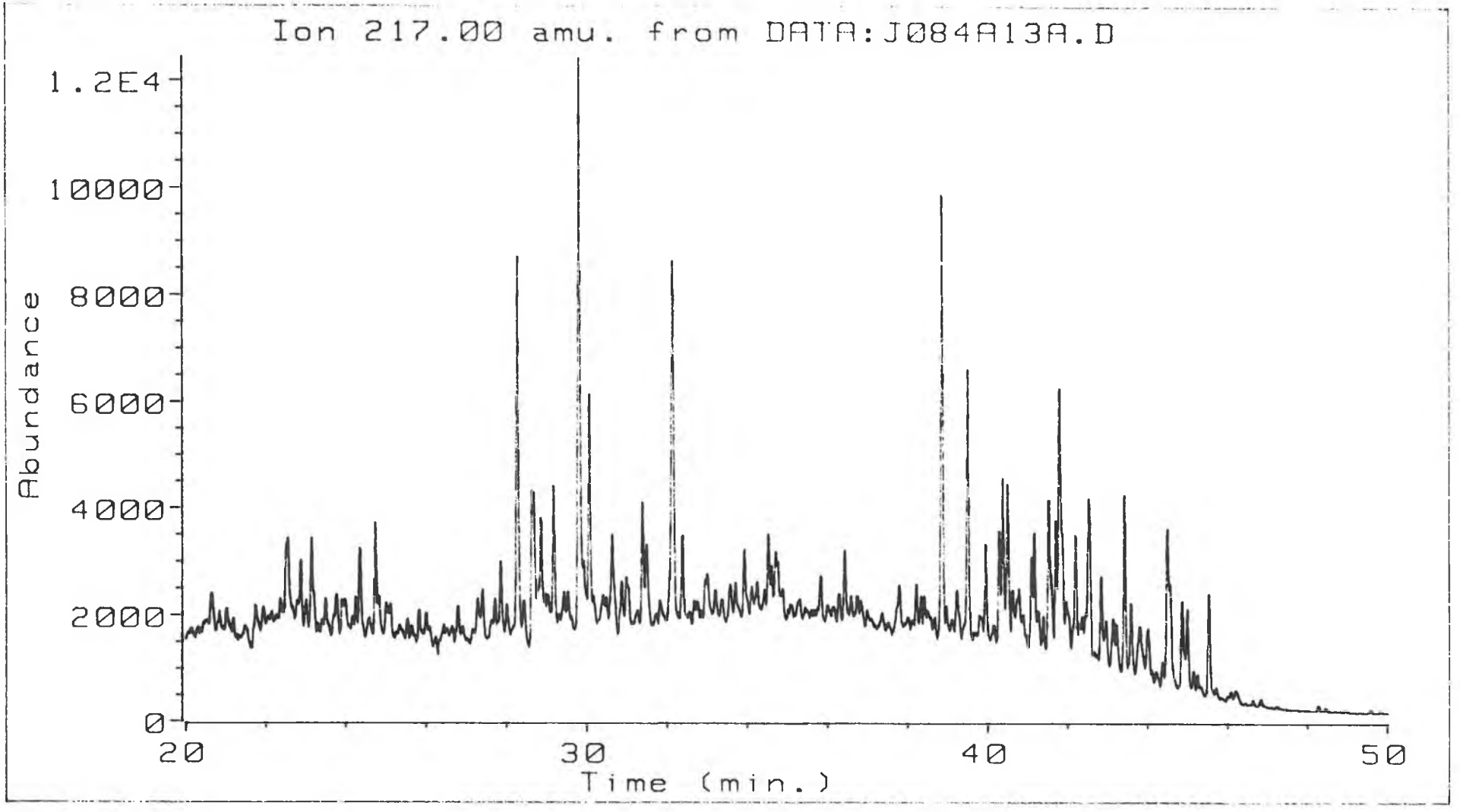

Ion 191.00 amu. from DATA:J084A11A.D
Abundance
9.0E4
8.0E4
7.0E4
6.0E4
5.0E4
4.0E4
3.0E4
2.0E4
10000
0
30
40
50
60
Time (min.)

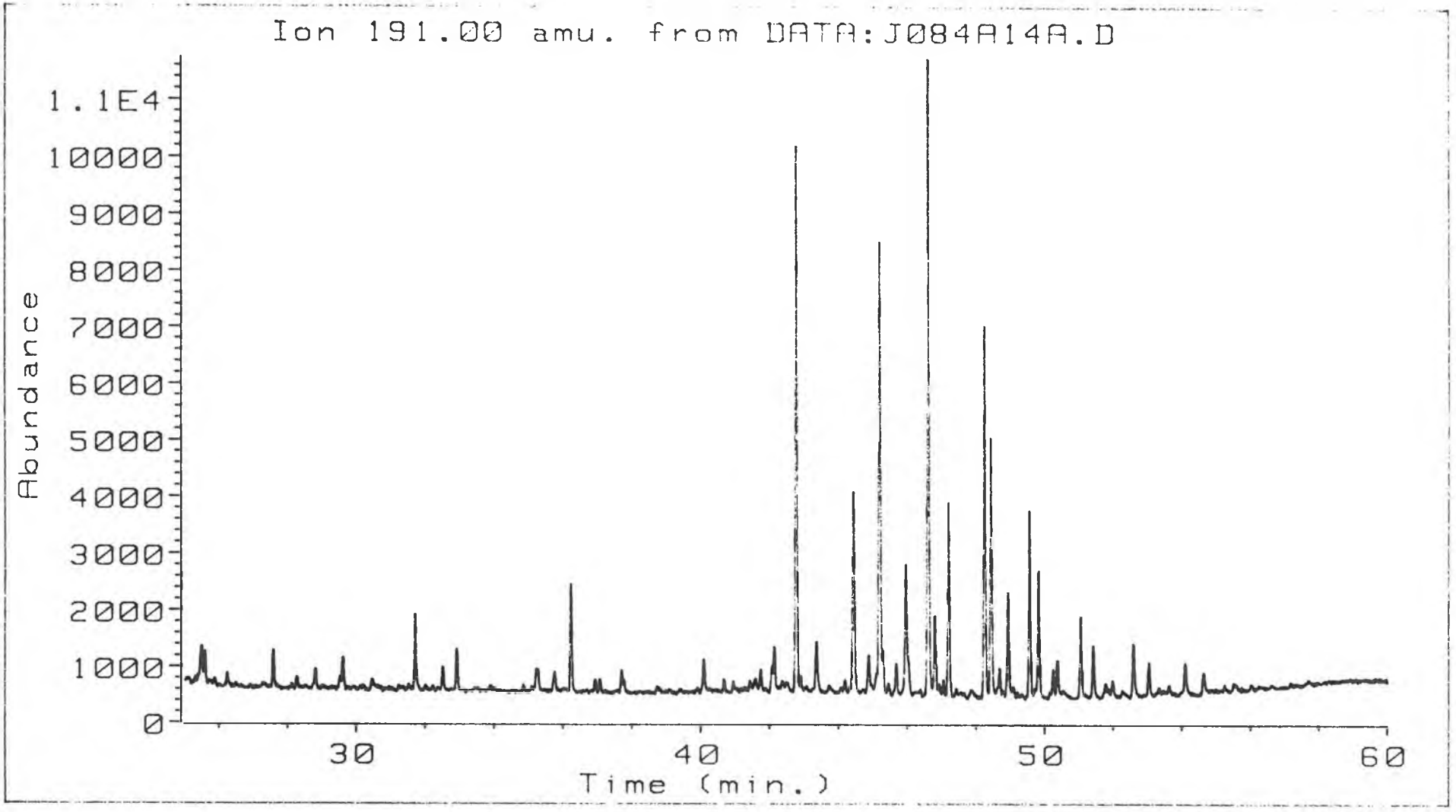

Ion 217.00 amu. from DATA:J084A11A.D
Abundance
1.8E4
1.6E4
1.4E4
1.2E4
10000
8000
6000
4000
2000
0
25
30
35
40
45
Time (min.)

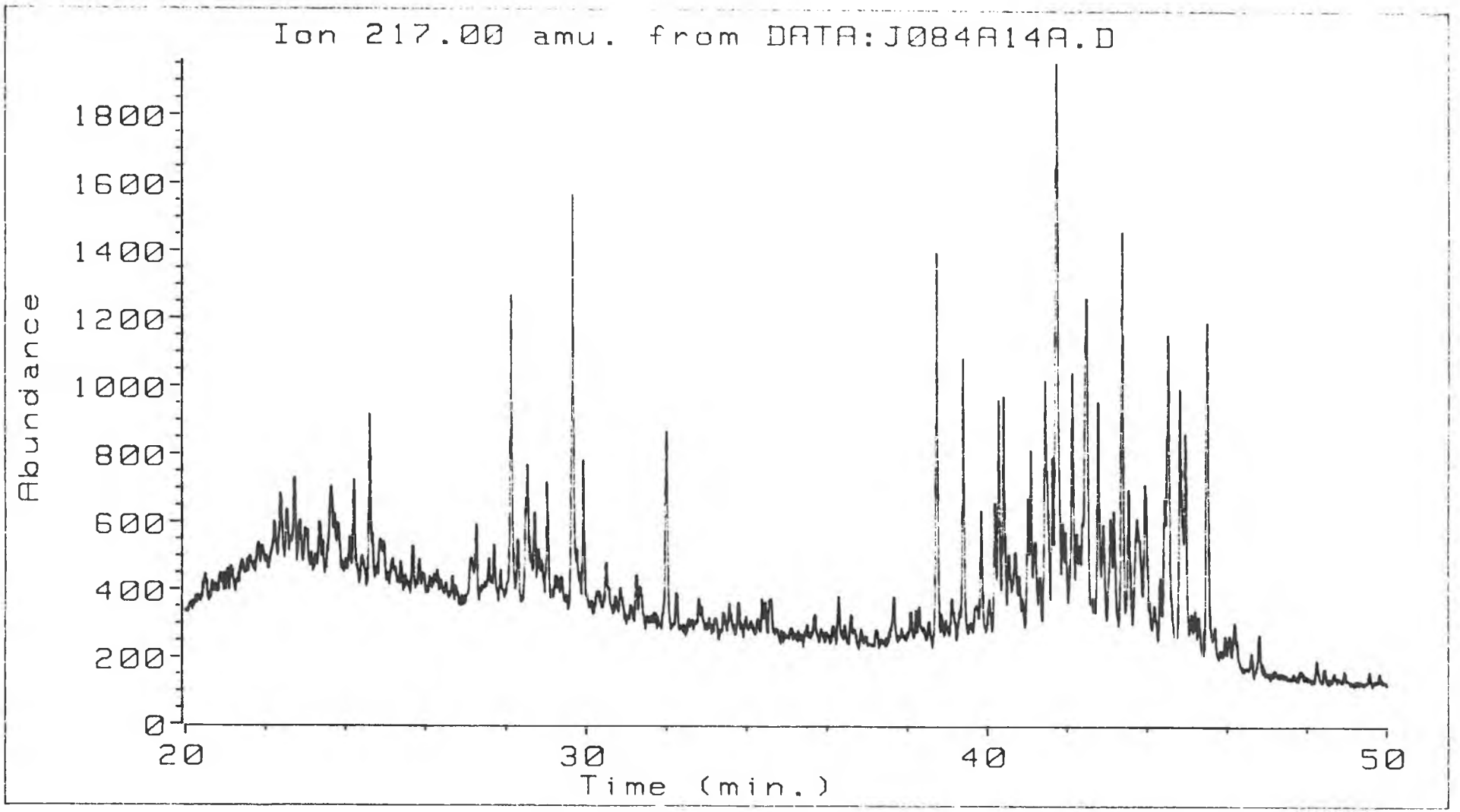

Ion 191.00 amu. from DATA:J084A12A.D
Abundance
3.0E4
2.0E4
10000
0
30
40
50
60
Time (min.)

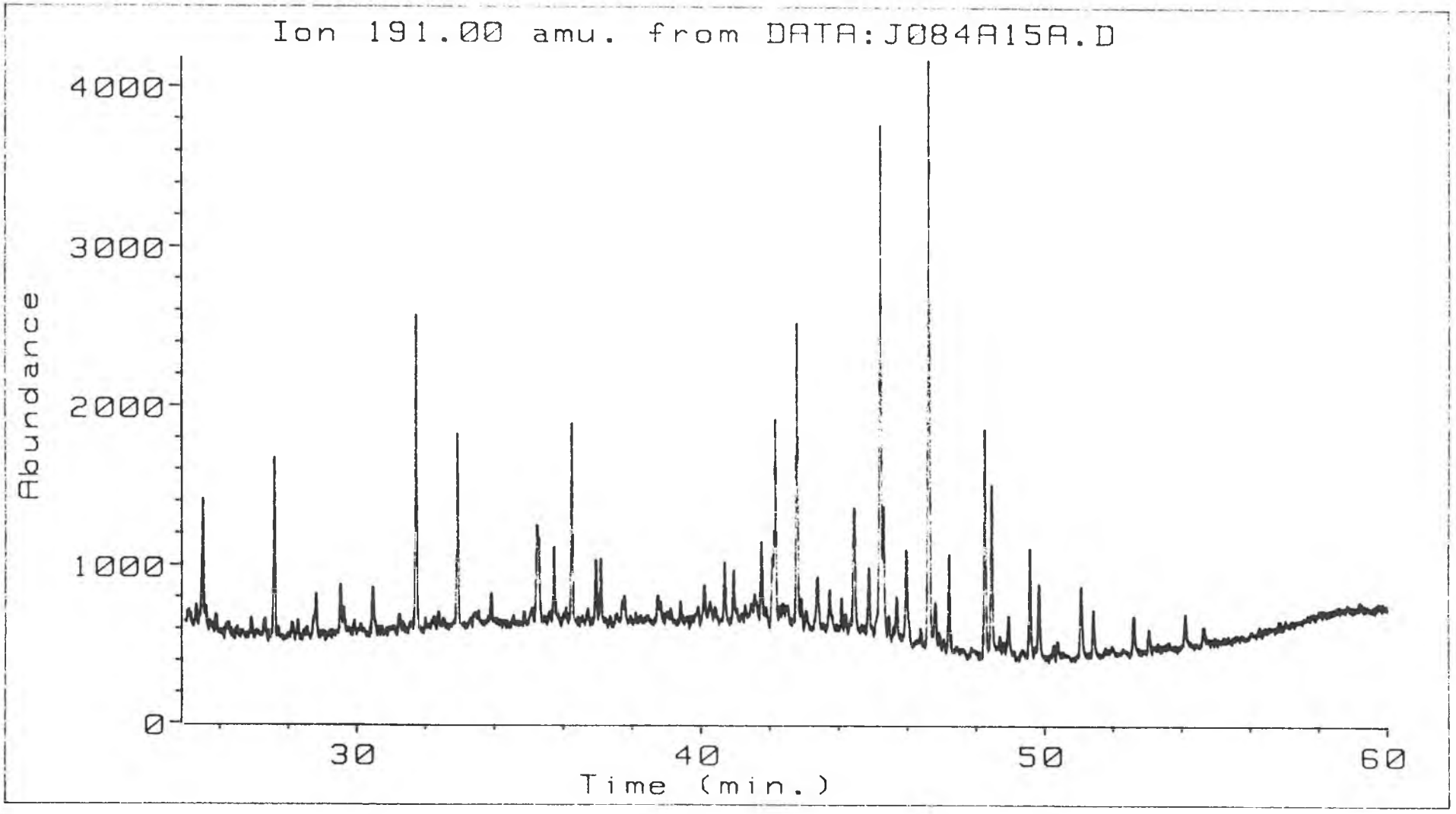

Ion 217.00 amu. from DATA:J084A12A.D
Abundance
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
25
30
35
40
45
Time (min.)

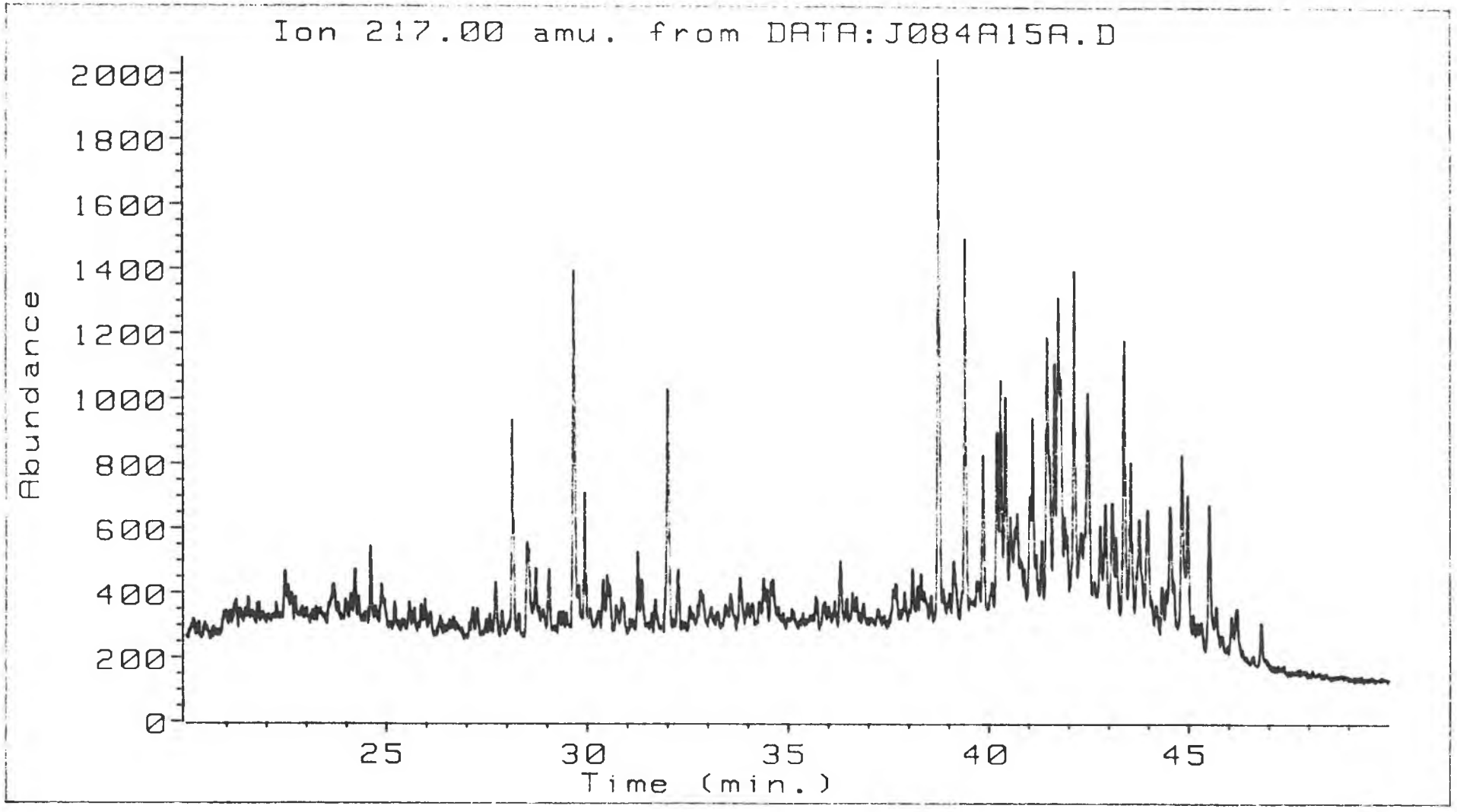

Ion 191.00 amu. from DATA:J084A13A.D
Abundance
2.5E4
2.0E4
1.5E4
10000
5000
0
30
40
50
60
Time (min.)


Ion 217.00 amu. from DATA:J084A13A.D
1.2E4
10000
8000
6000
4000
2000
0
Abundance
20
30
40
50
Time (min.)

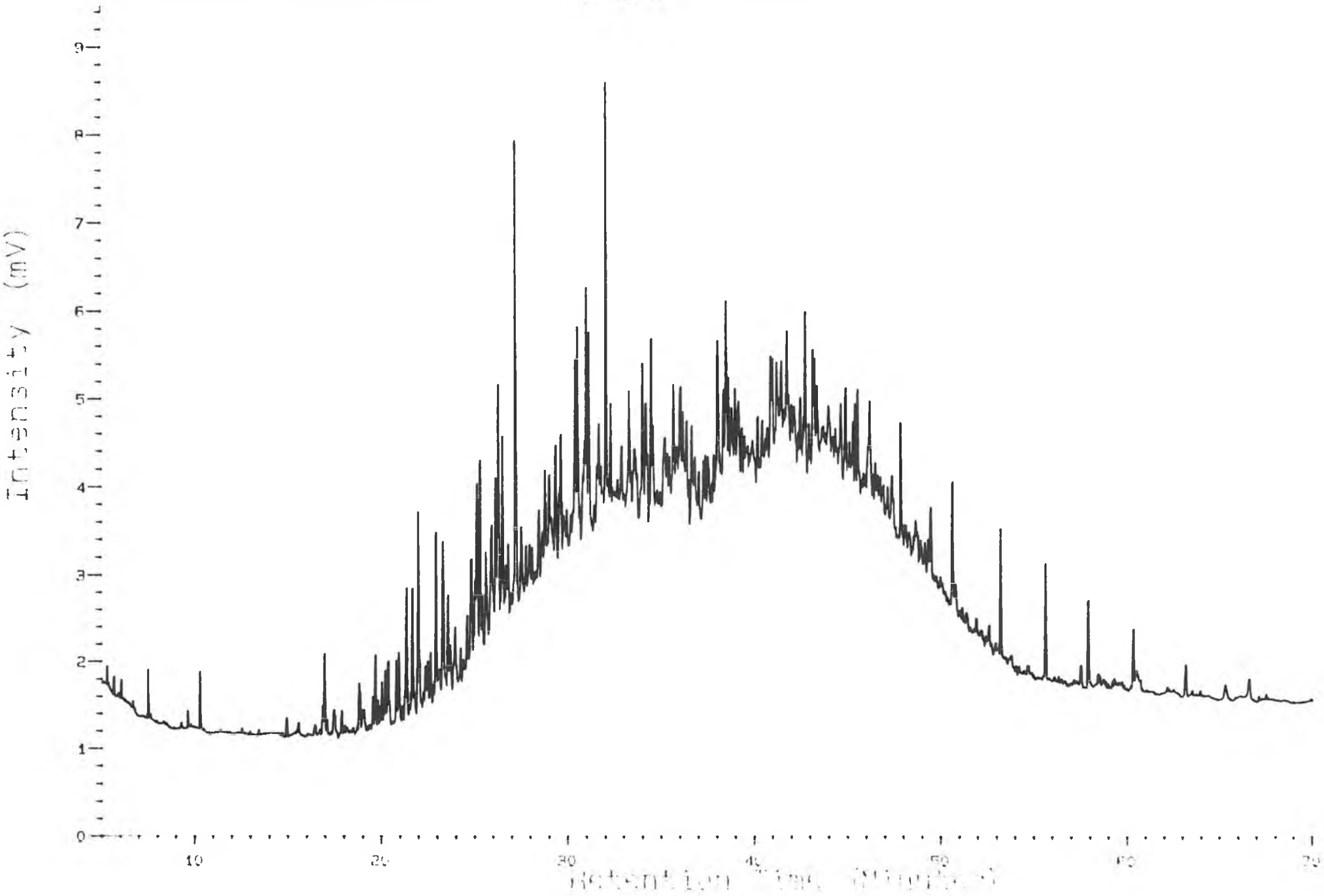

Ion 191.00 amu. from DATA:J084A14A.D
Abundance
1.1E4
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
30
40
50
60
Time (min.)

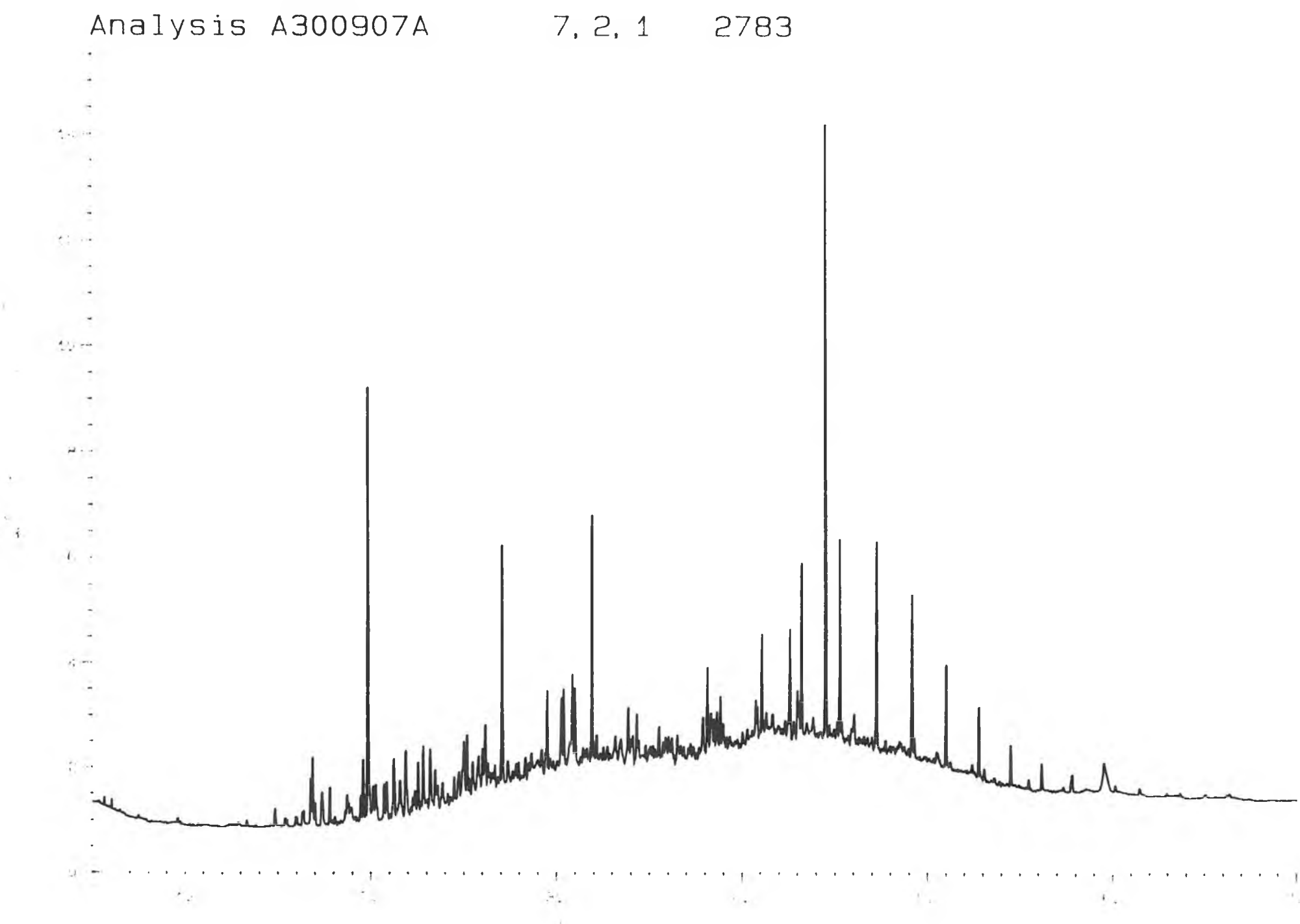

Ion 217.00 amu. from DATA:J084A14A.D
Abundance
1800
1600
1400
1200
1000
800
600
400
200
0
20
30
40
50
Time (min.)

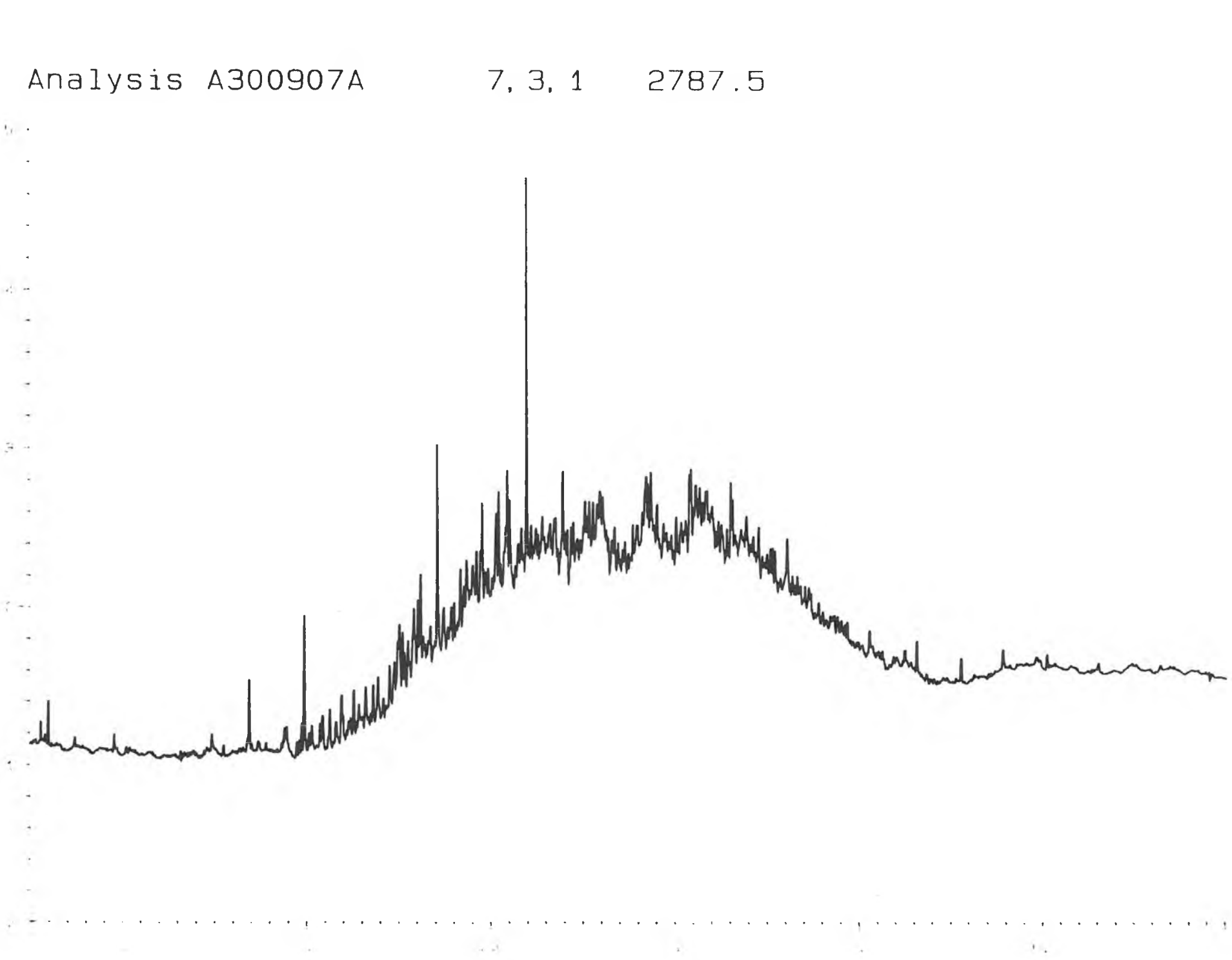

Ion 191.00 amu. from DATA:J084A15A.D
Abundance
4000
3000
2000
1000
0
30
40
50
60
Time (min.)

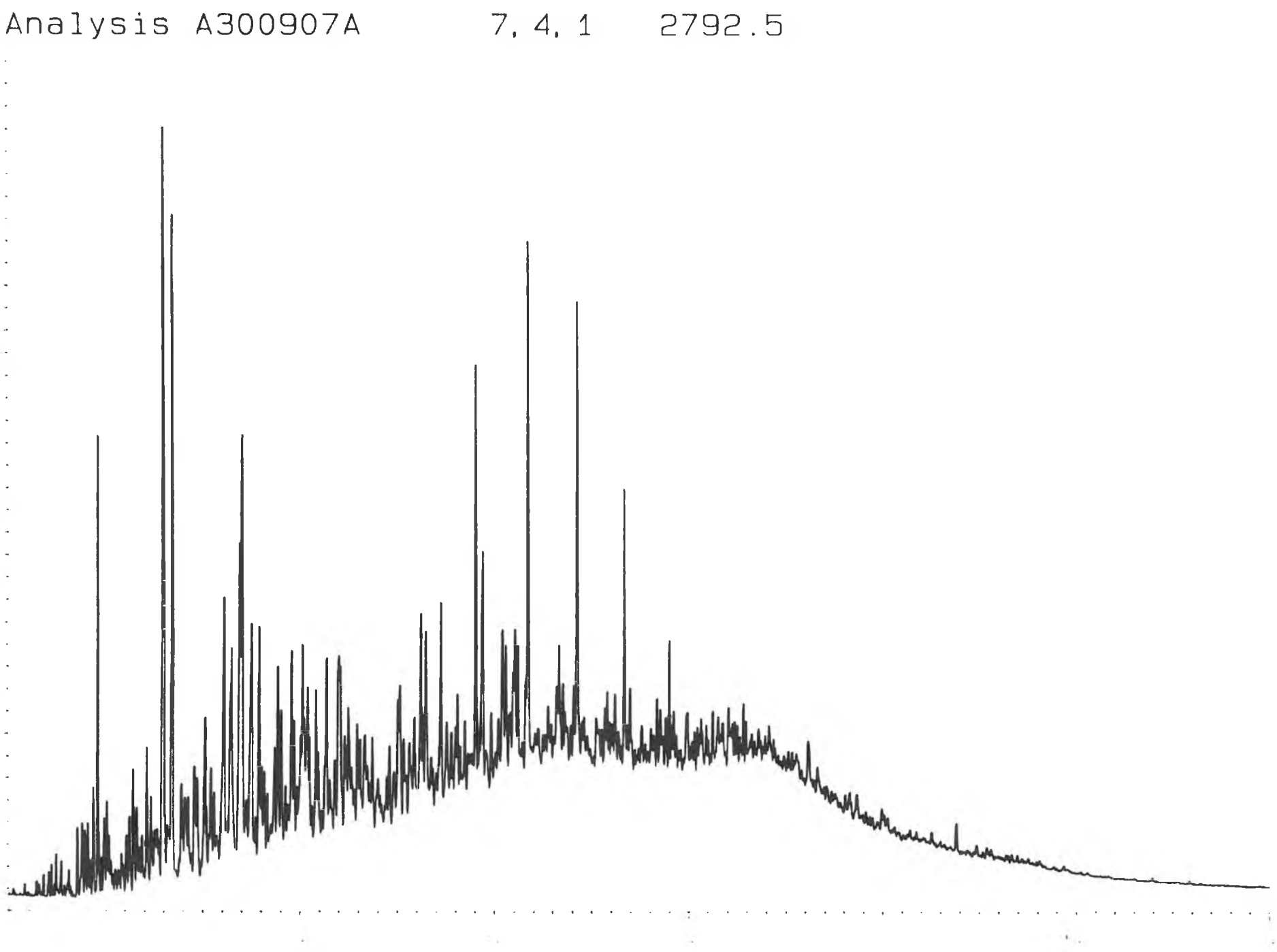

Ion 217.00 amu. from DATA:J084A15A.D
Abundance
2000
1800
1600
1400
1200
1000
800
600
400
200
0
25
30
35
40
45
Time (min.)

APPENDIX III: GC AROMATIC FRACTION

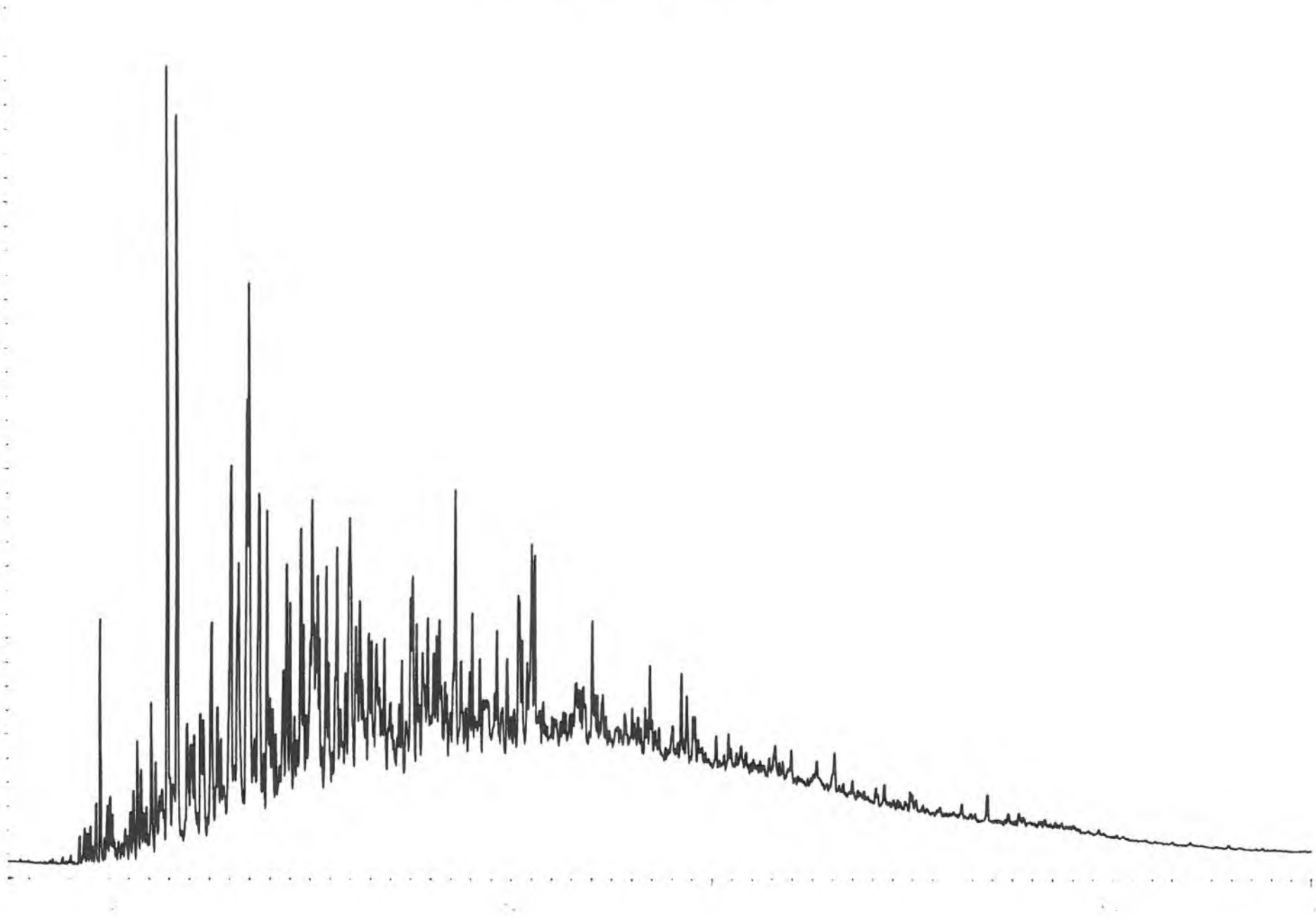

Analysis A300907A 7, 1, 1 2775
Intensity (mV)
0
1
2
3
4
5
6
7
8
9
10
20
30
40
50
60
70


Analysis A300907A 7, 2, 1 2783

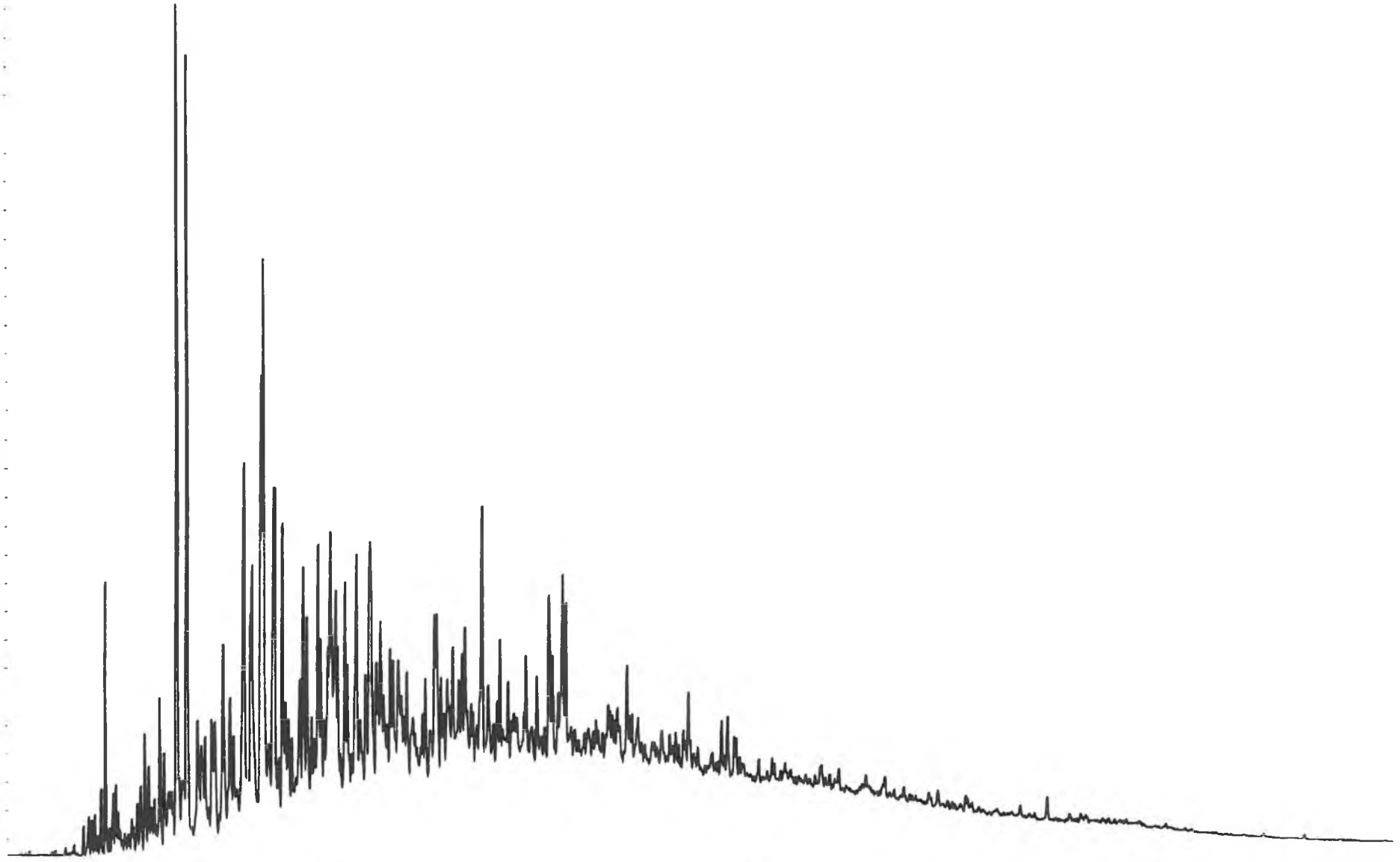

Analysis A300907A 7, 3, 1 2787.5


Analysis A300907A 7, 4, 1 2792.5

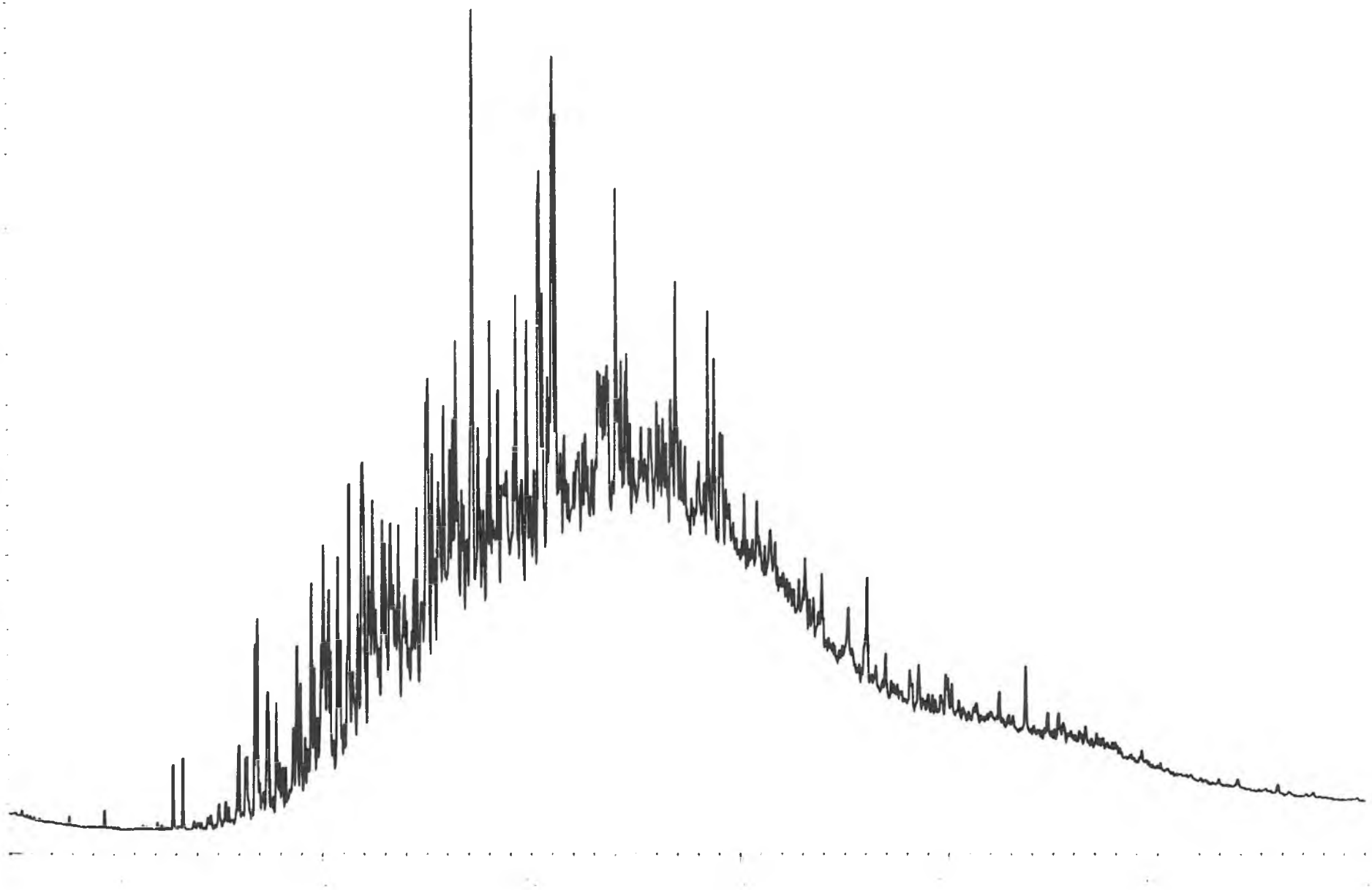
Analysis A300907A 7.5.1 2795



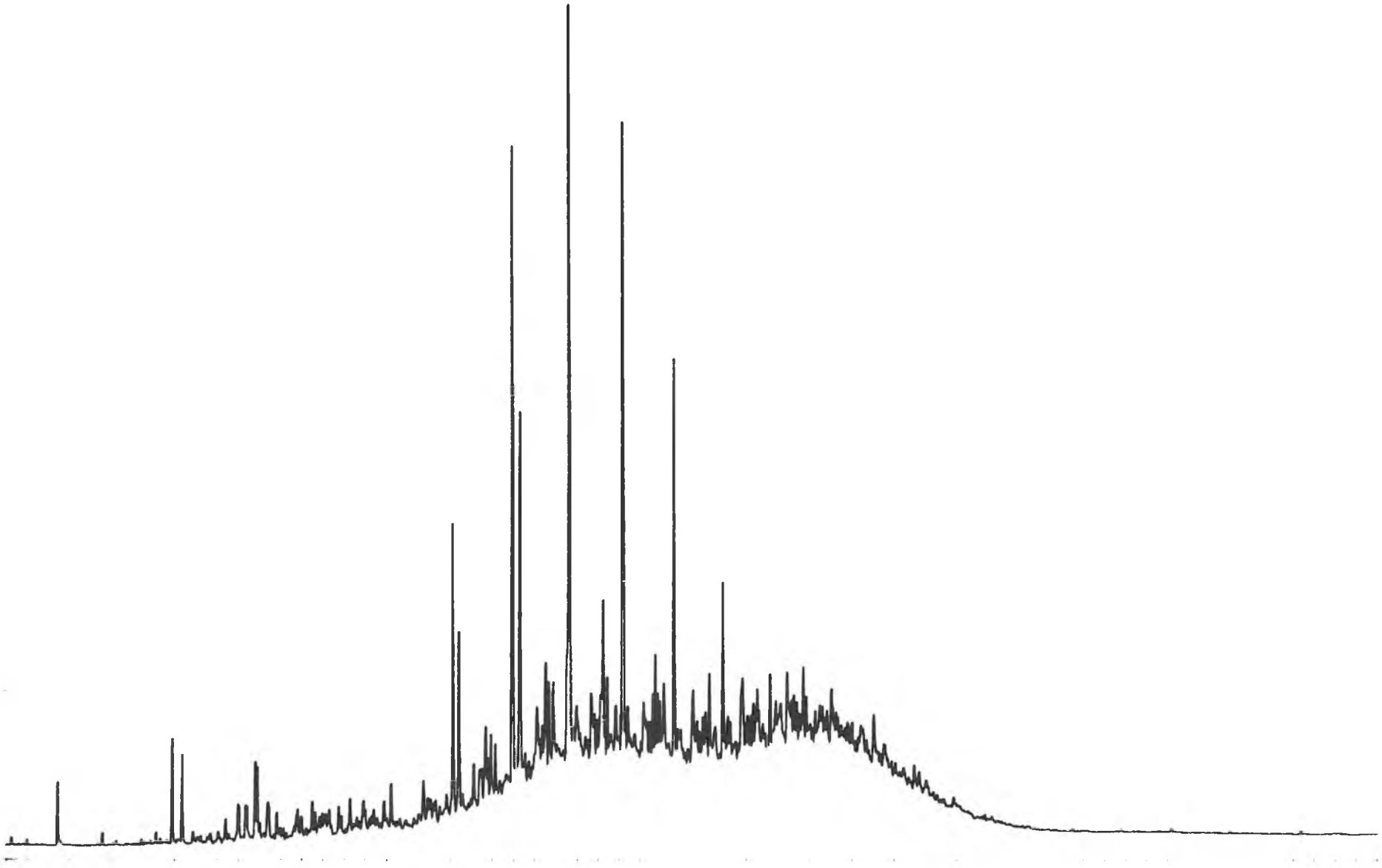
Analysis A300907A 7, 6, 1 2798



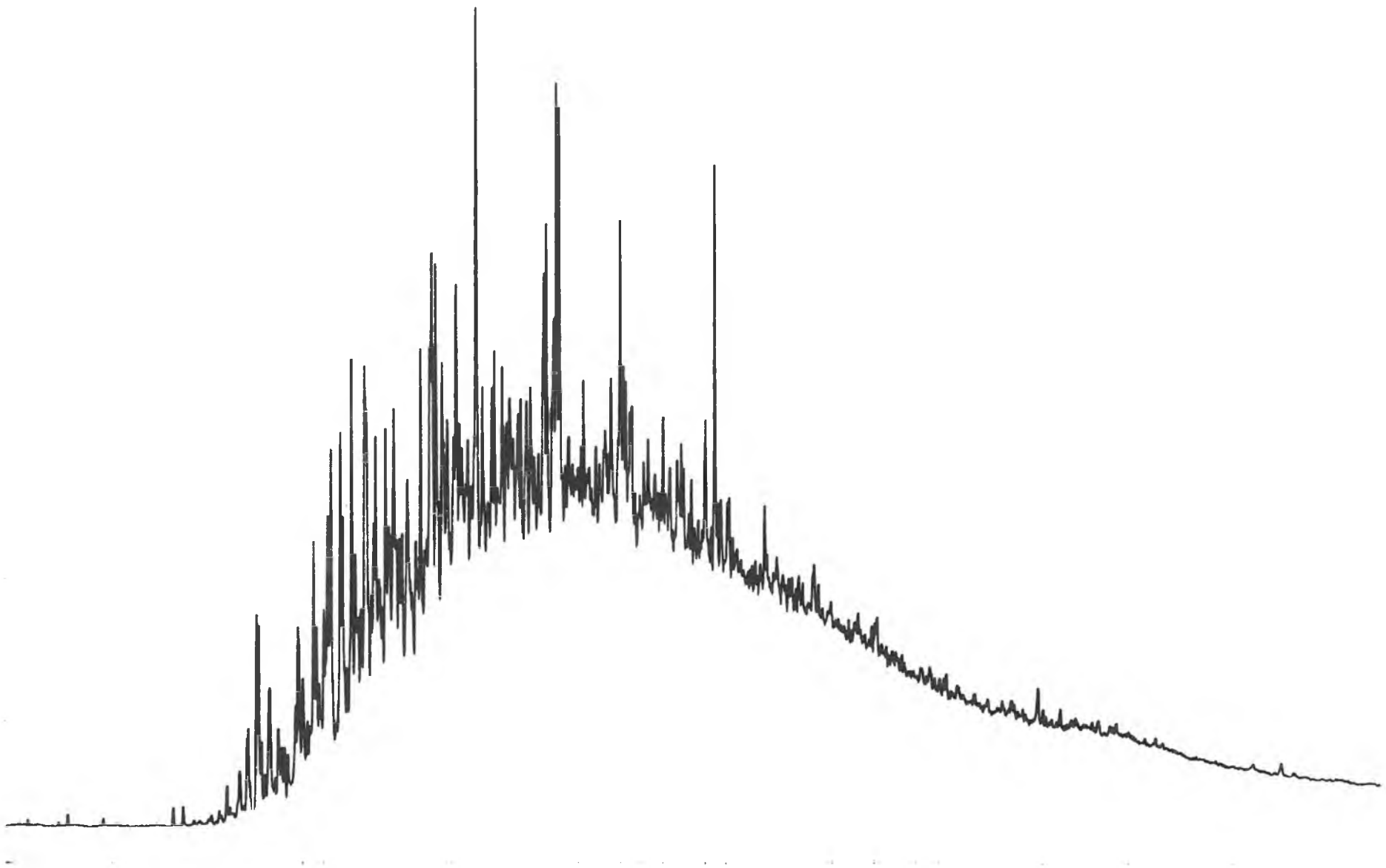
Analysis A300907A 7, 7, 1 2800



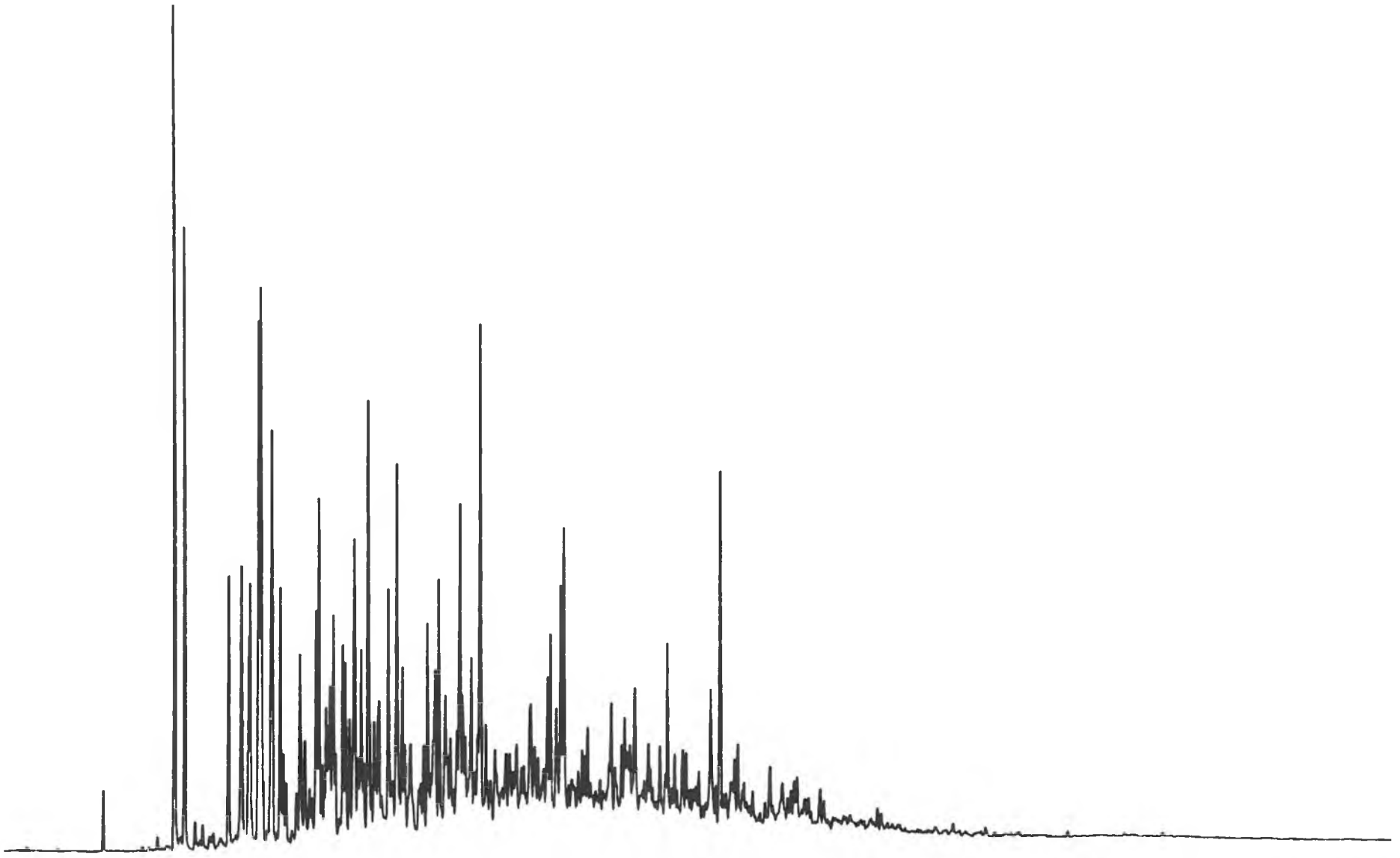
Analysis A300907A 7, 8, 1 2805



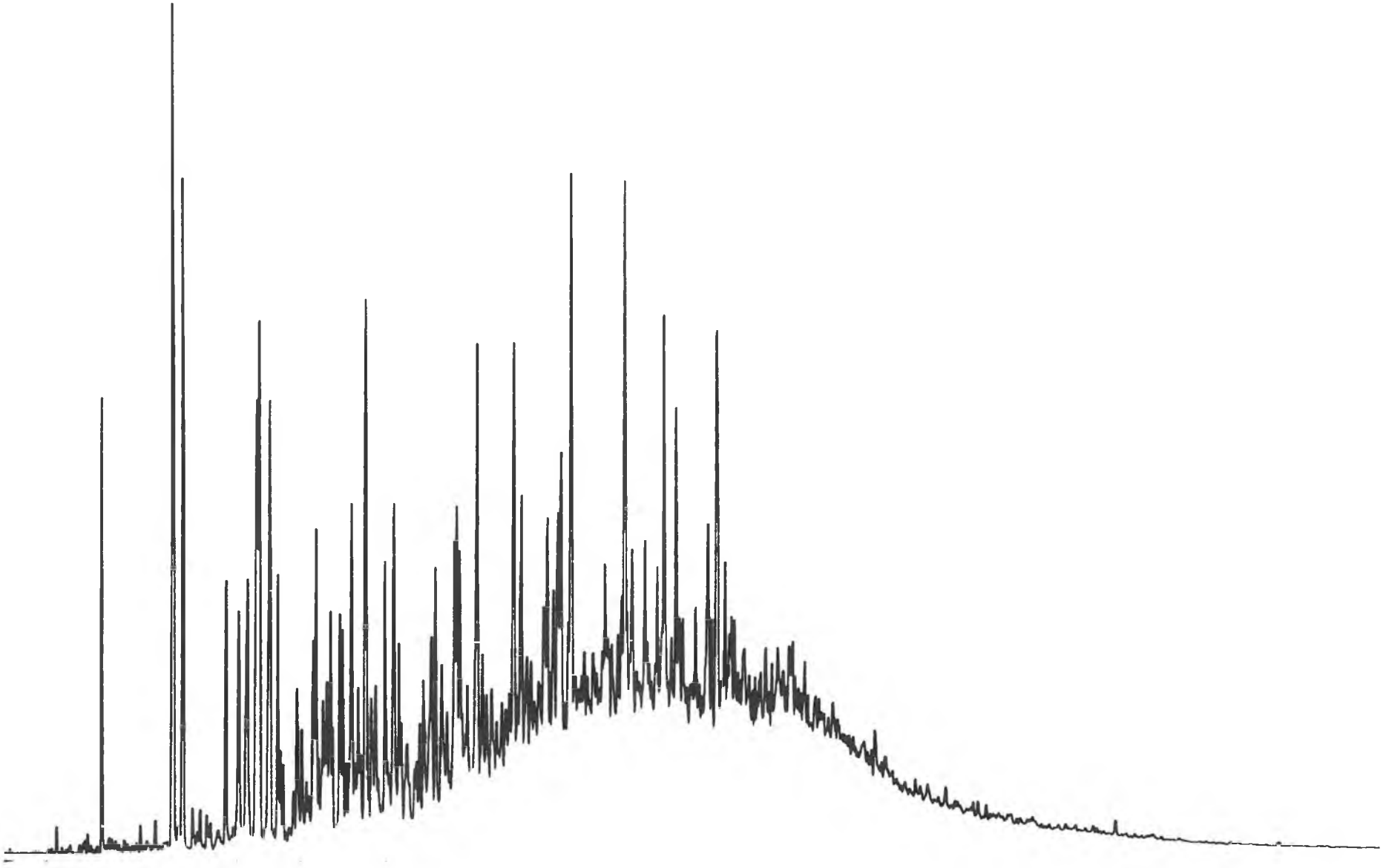
Analysis A300907A 7, 9, 1 2810



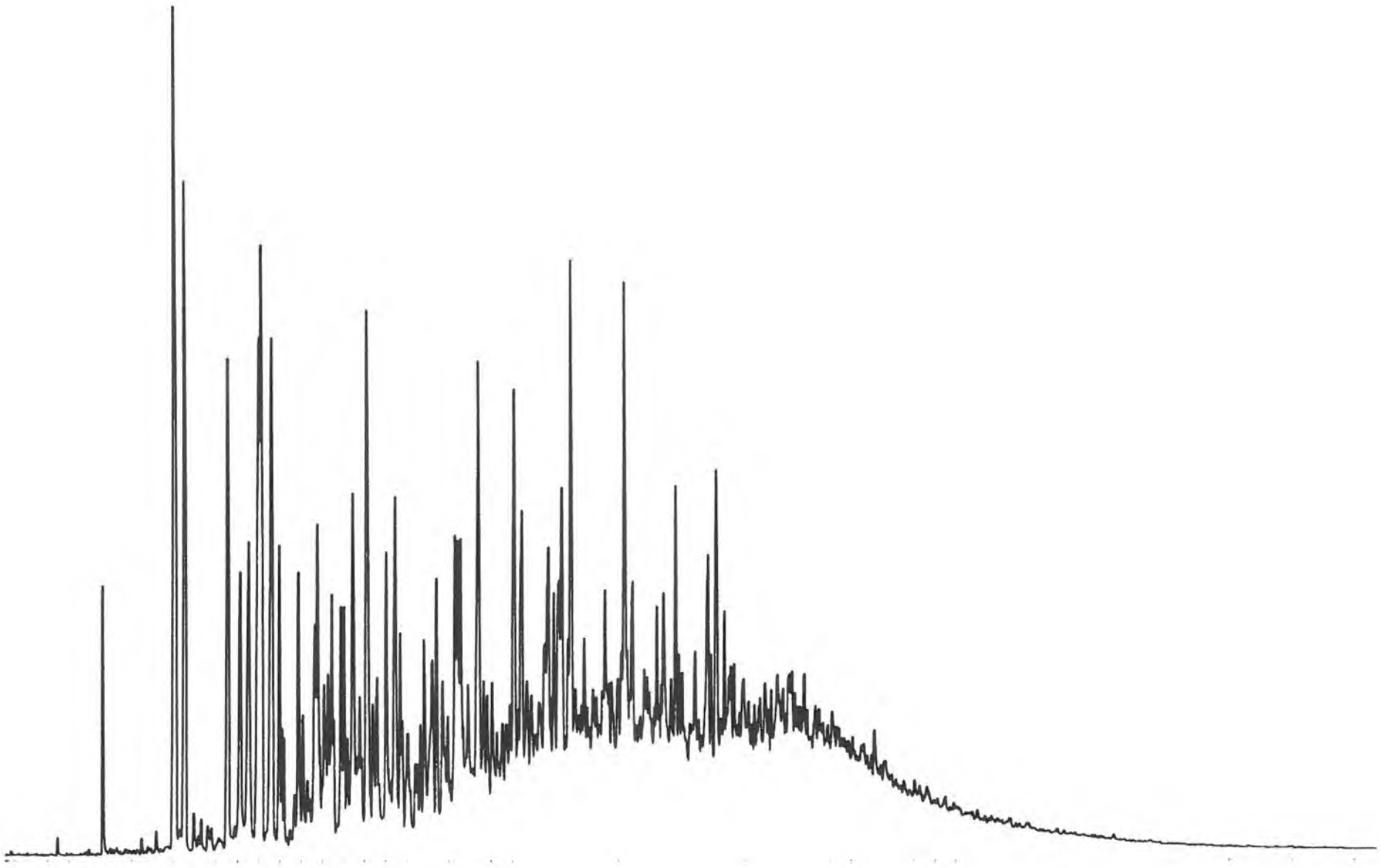
Analysis A300907A 7, 10, 1 2841.98



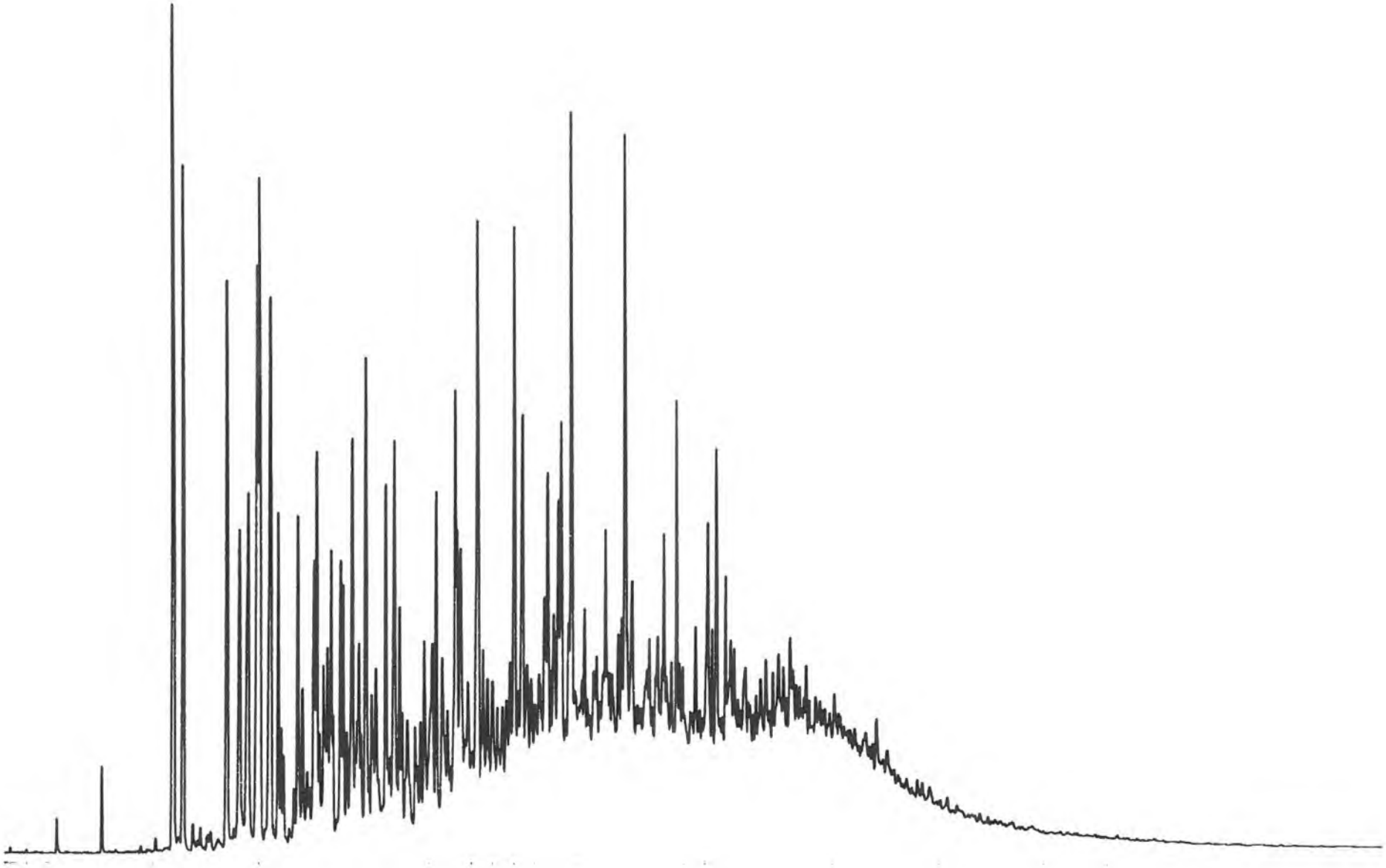
Analysis A300907A 7, 11, 1 2862.65



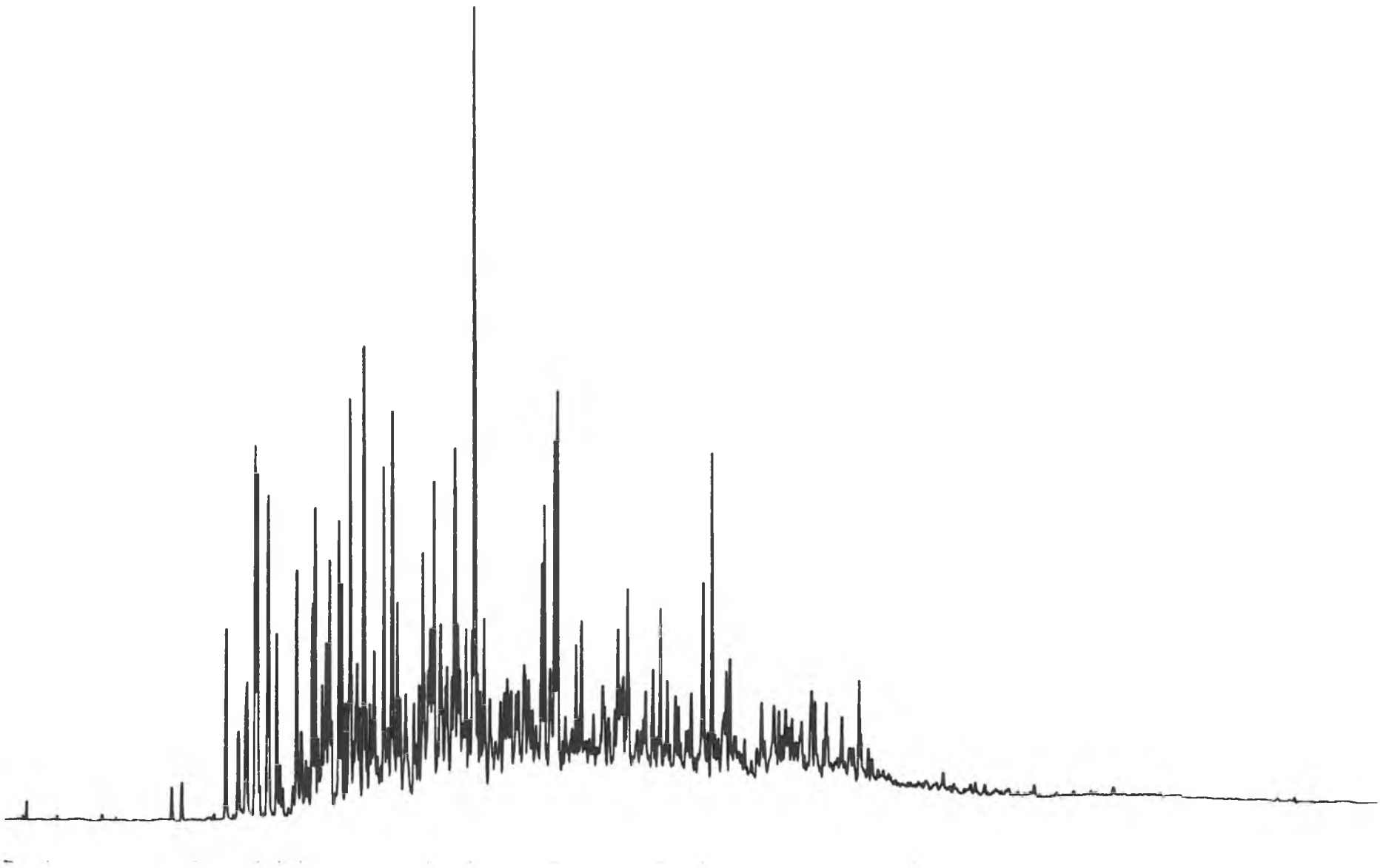
Analysis A300907A 7, 12, 1 2870.98

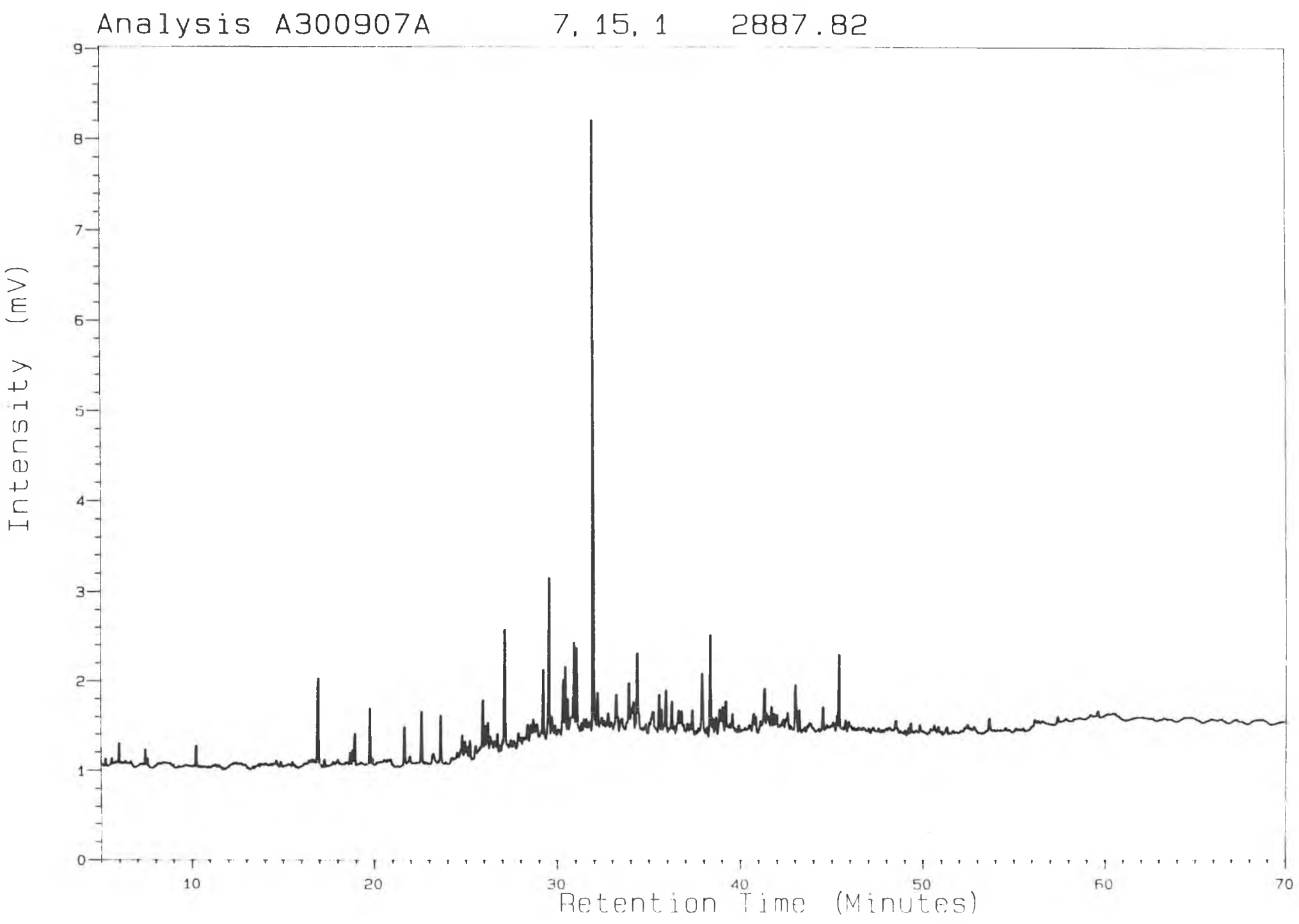


Analysis A300907A 7, 13, 1 2879.98

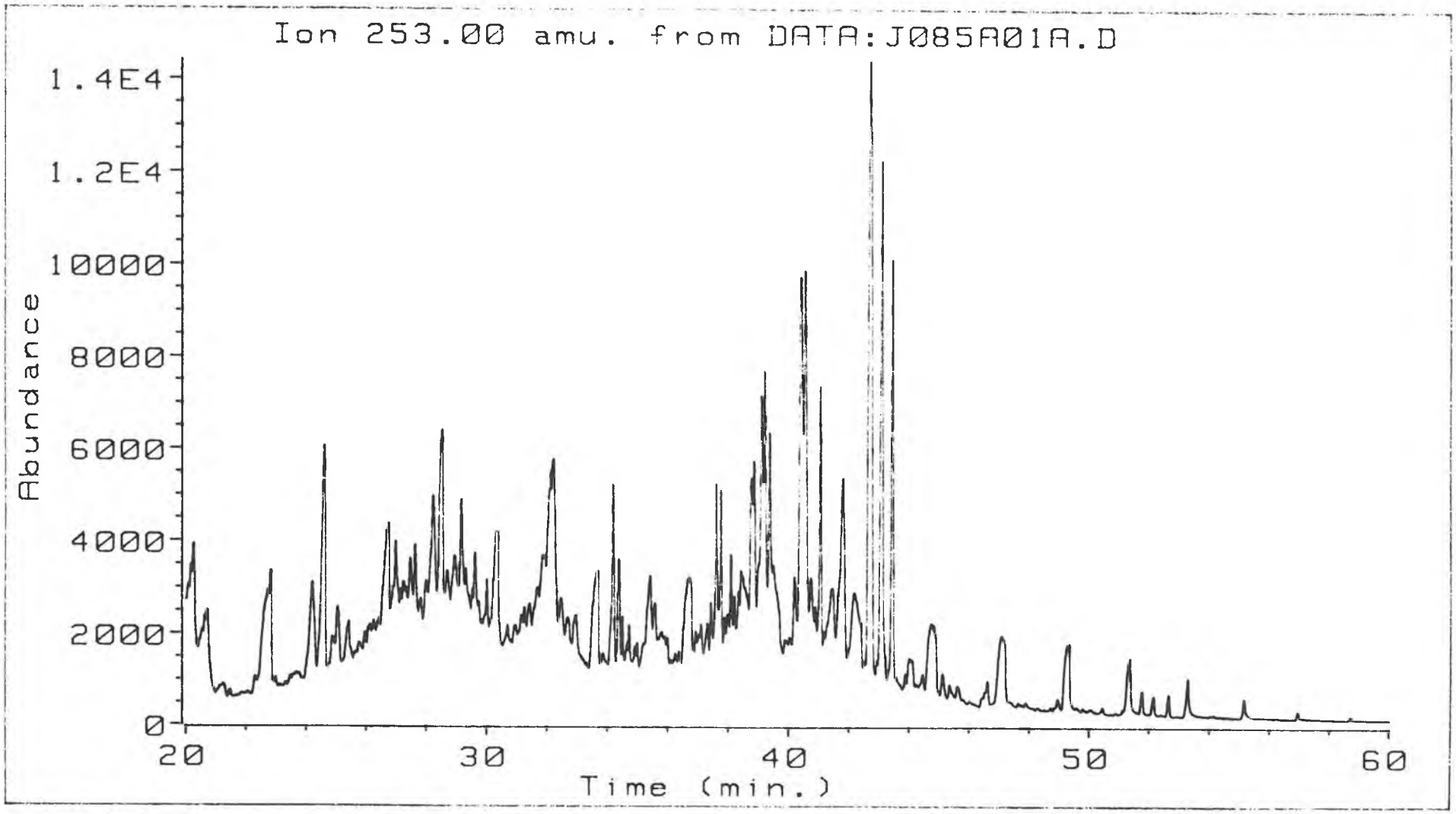


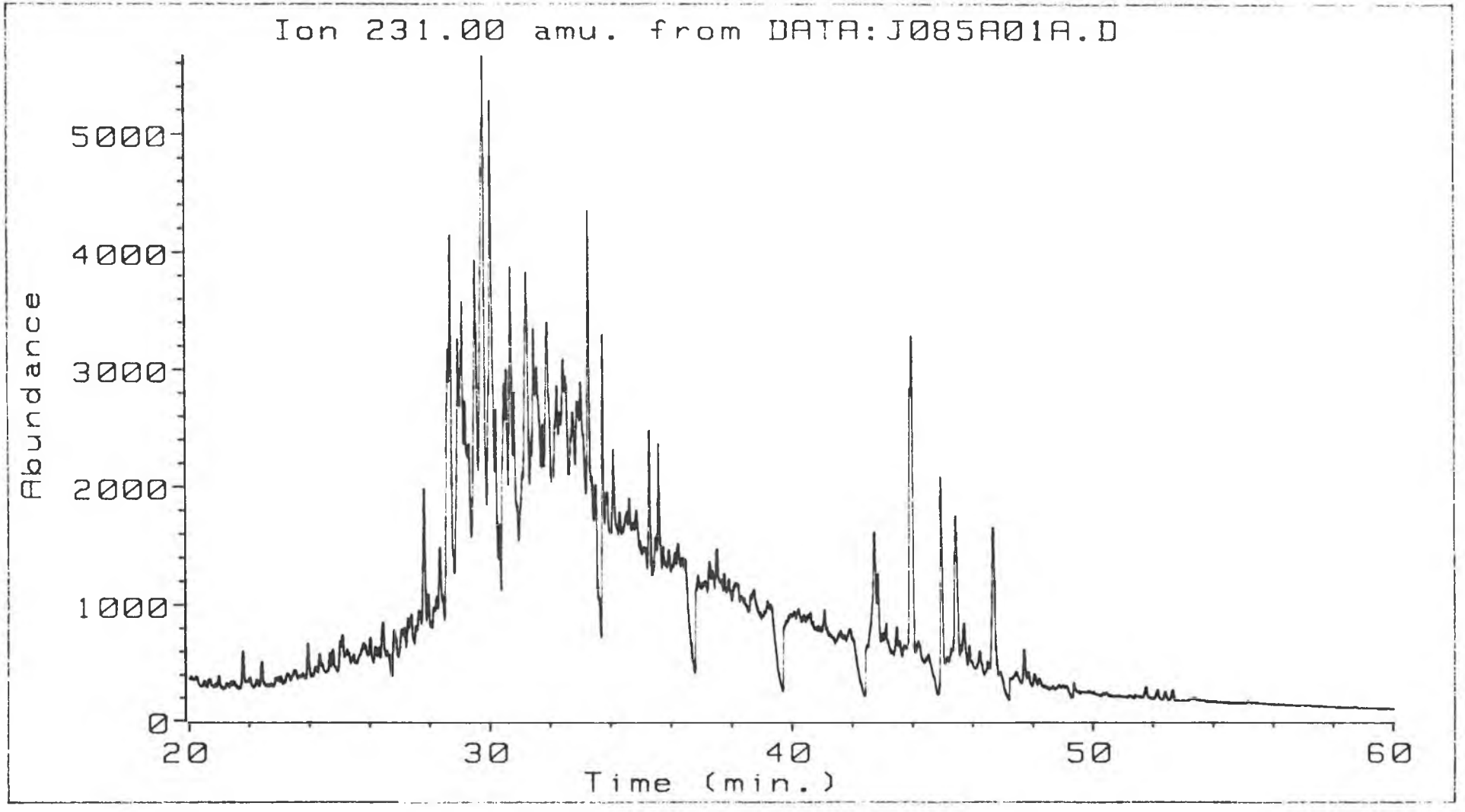
Analysis A300907A 7, 14, 1 2883.5



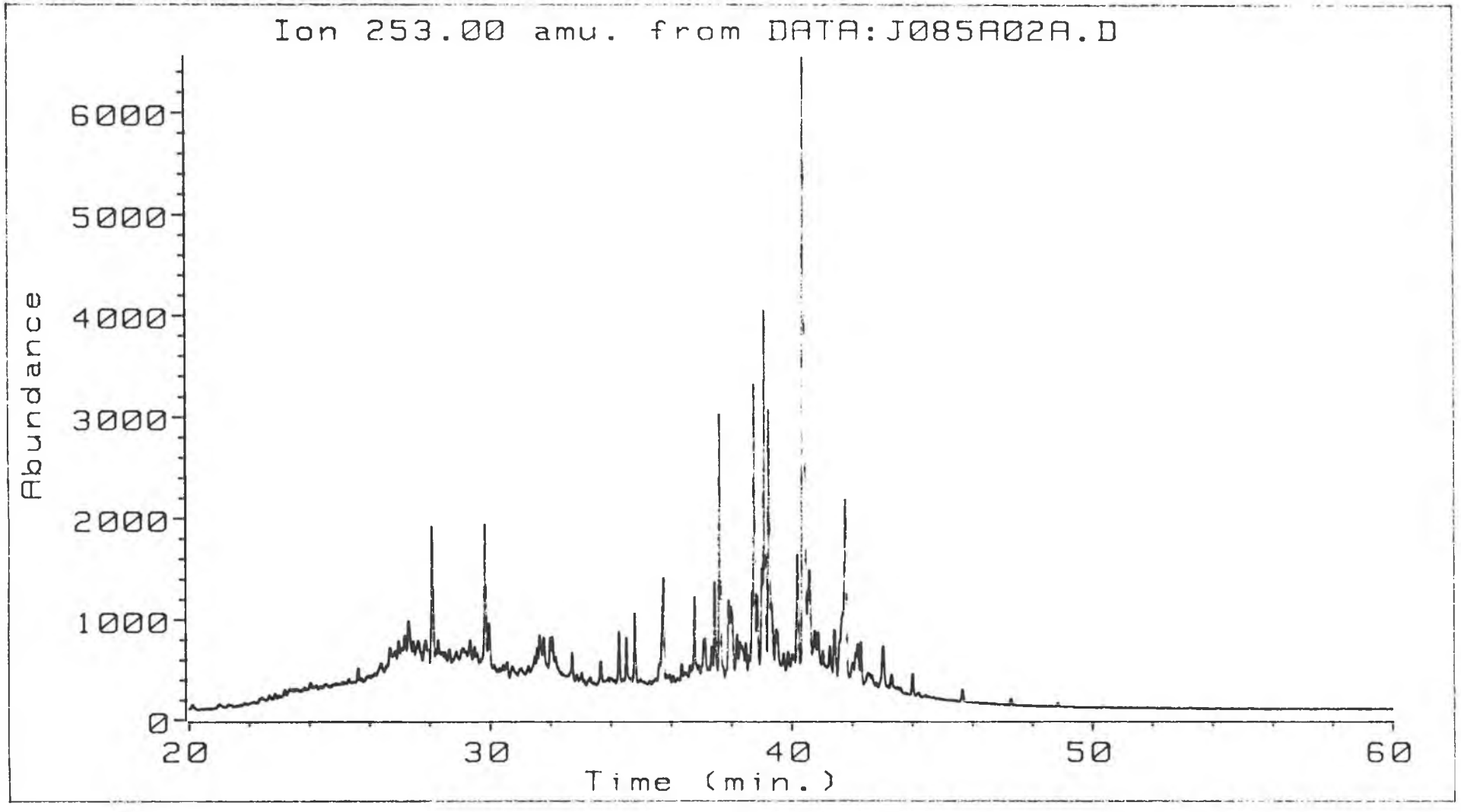

Analysis A300907A 7, 15, 1 2887.82
Intensity (mV)
0
1
2
3
4
5
6
7
8
9
10
20
30
40
50
60
70
Retention Time (Minutes)

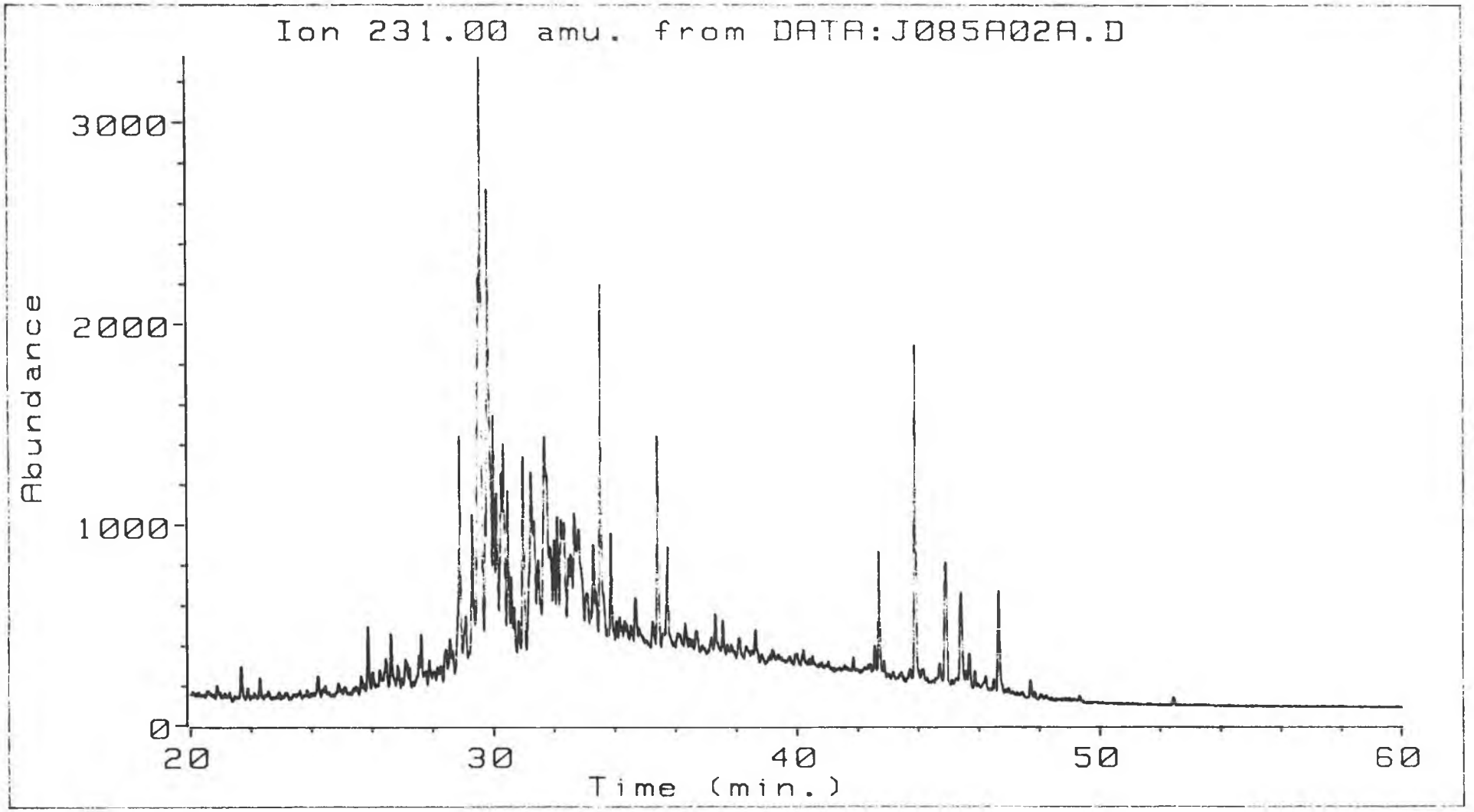
APPENDIX IV: M/Z 252 AND 231 OF AROMATIC FRACTION


Ion 253.00 amu. from DATA:J085A01A.D
Abundance
1.4E4
1.2E4
10000
8000
6000
4000
2000
0
20
30
40
50
60
Time (min.)

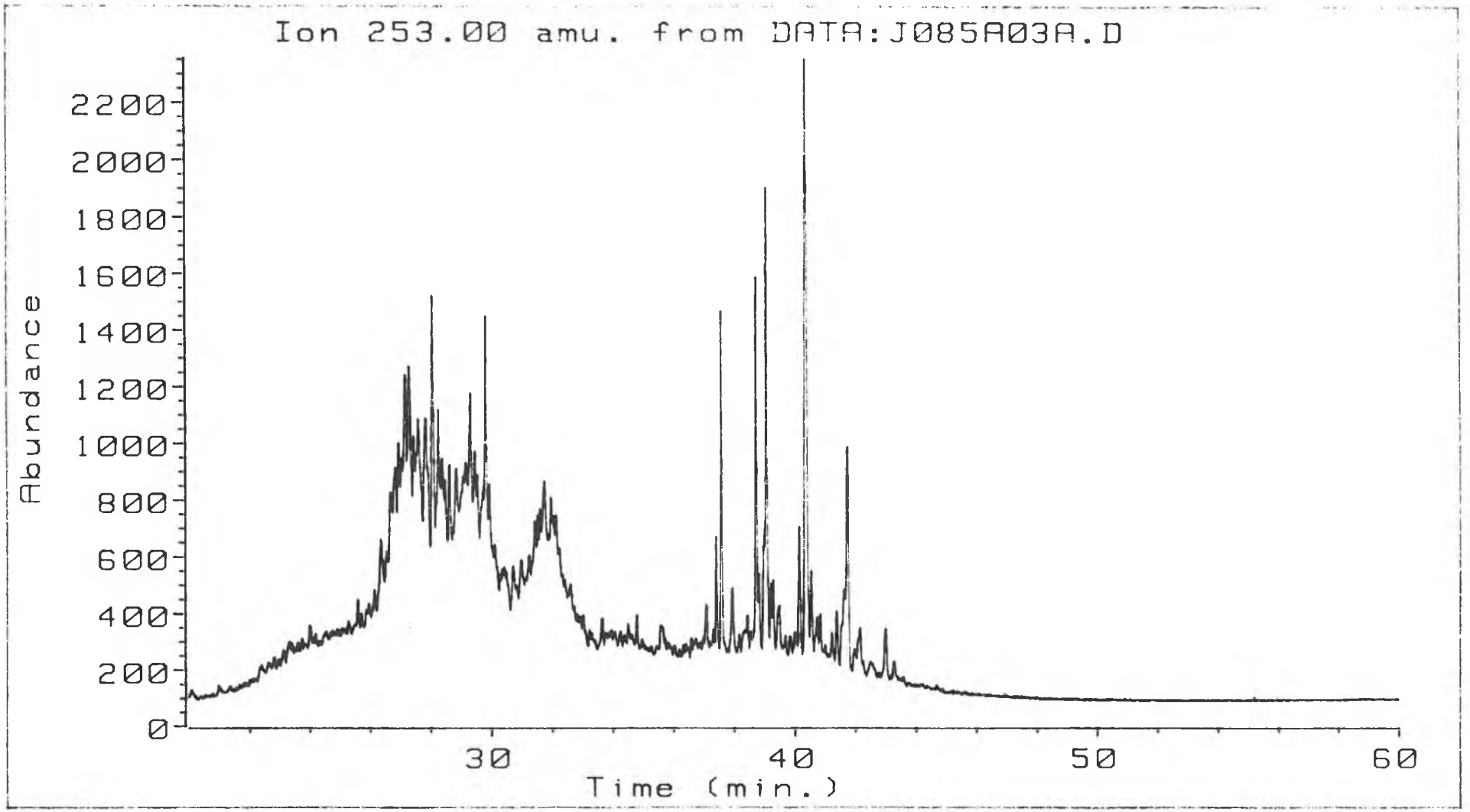

Ion 231.00 amu. from DATA:J085A01A.D
Abundance
5000
4000
3000
2000
1000
0
20
30
40
50
60
Time (min.)

2183.

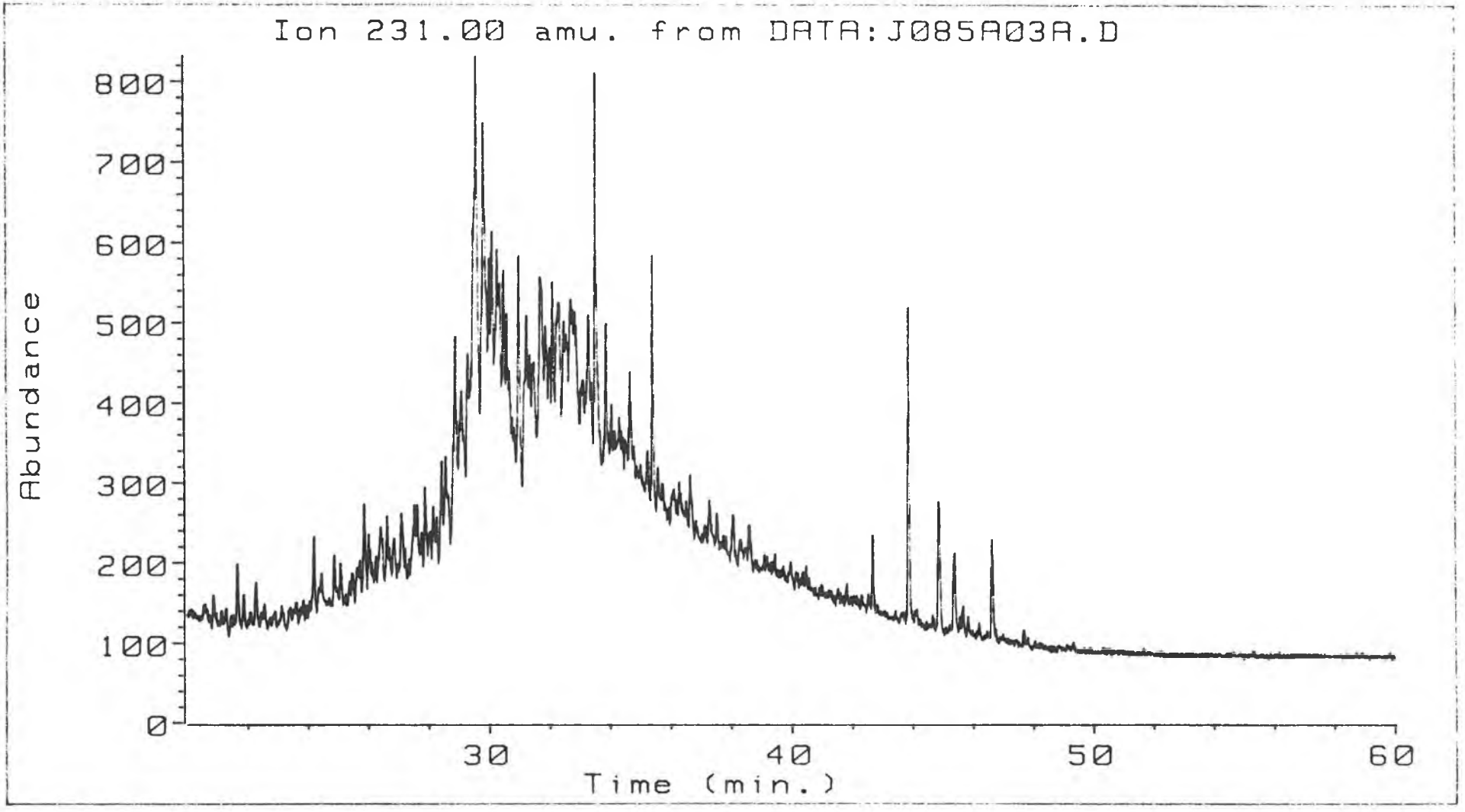

Ion 253.00 amu. from DATA:J085A02A.D
Abundance
6000
5000
4000
3000
2000
1000
0
20
30
40
50
60
Time (min.)

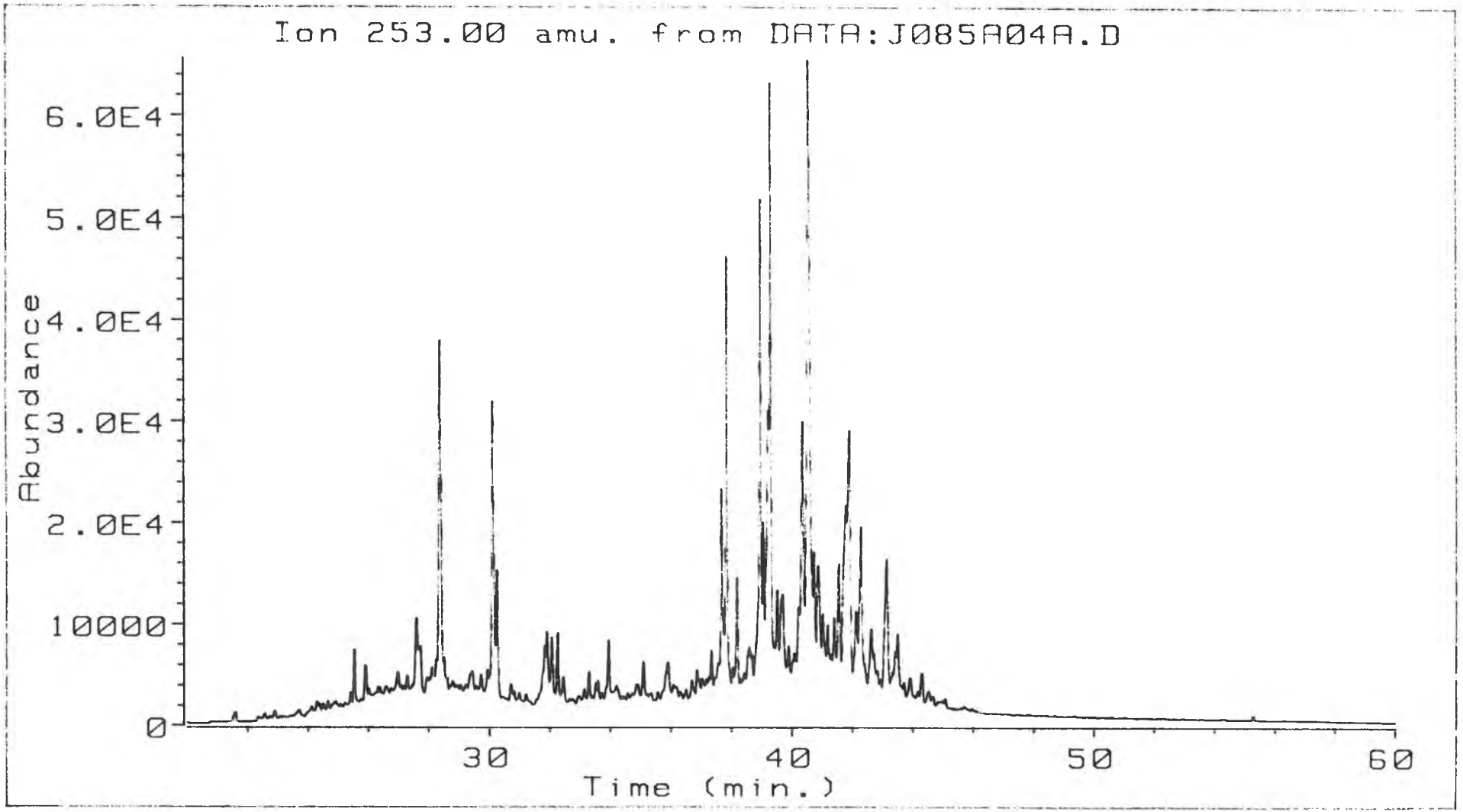

Ion 231.00 amu. from DATA:J085A02A.D
Abundance
3000
2000
1000
0
20
30
40
50
60
Time (min.)

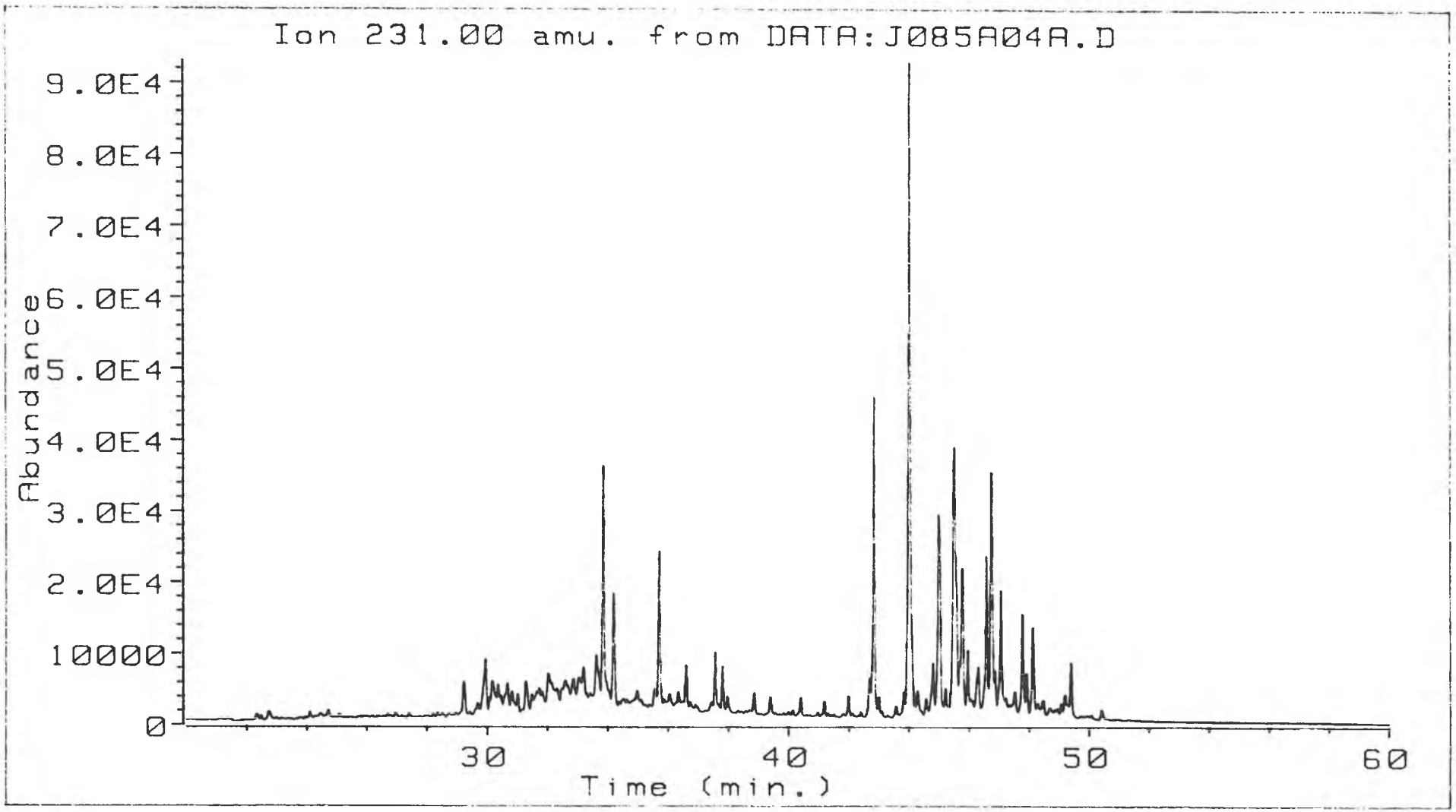
2787.5n,


Ion 253.00 amu. from DATA:J085A03A.D
Abundance
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
30
40
50
60
Time (min.)

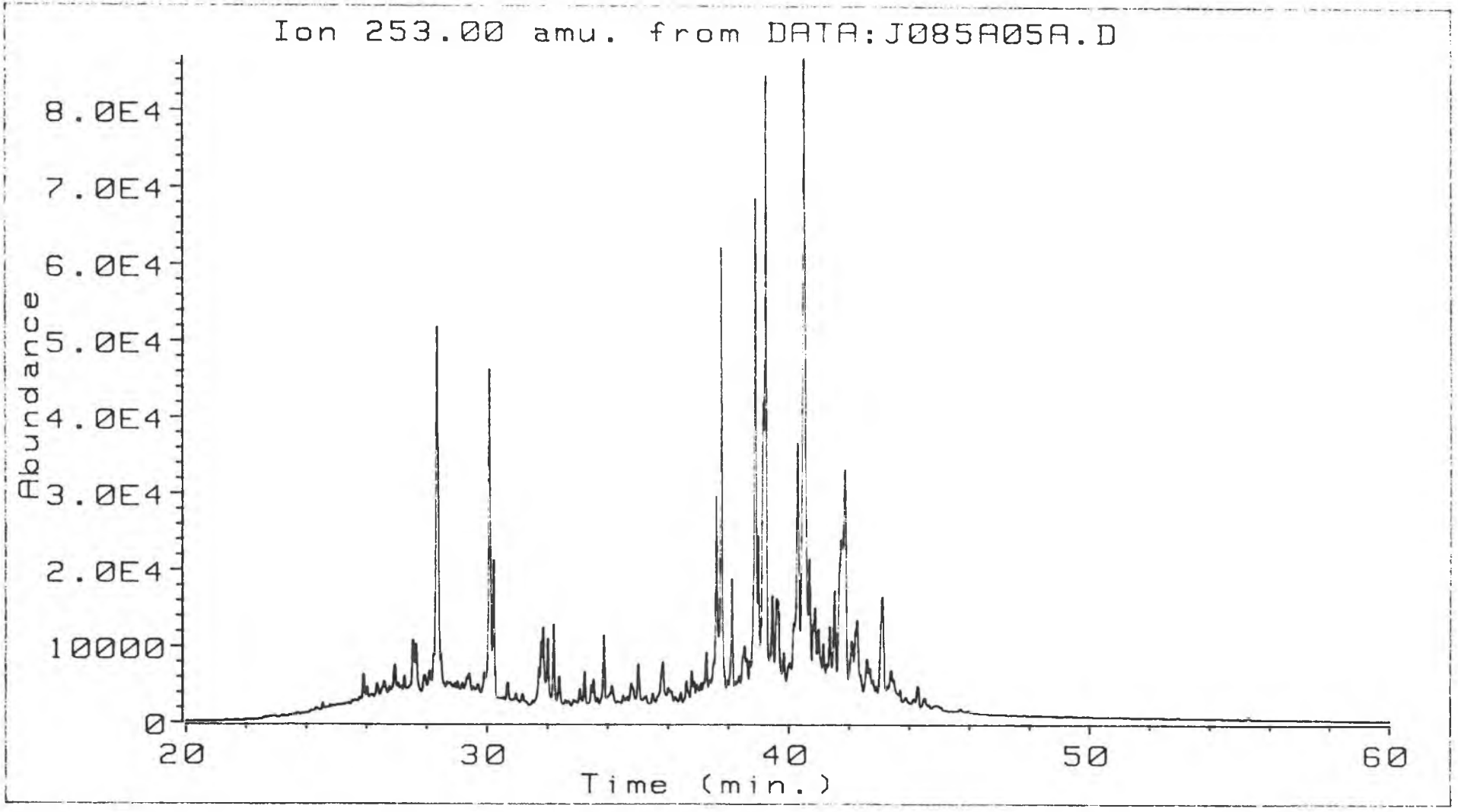
J187.5m

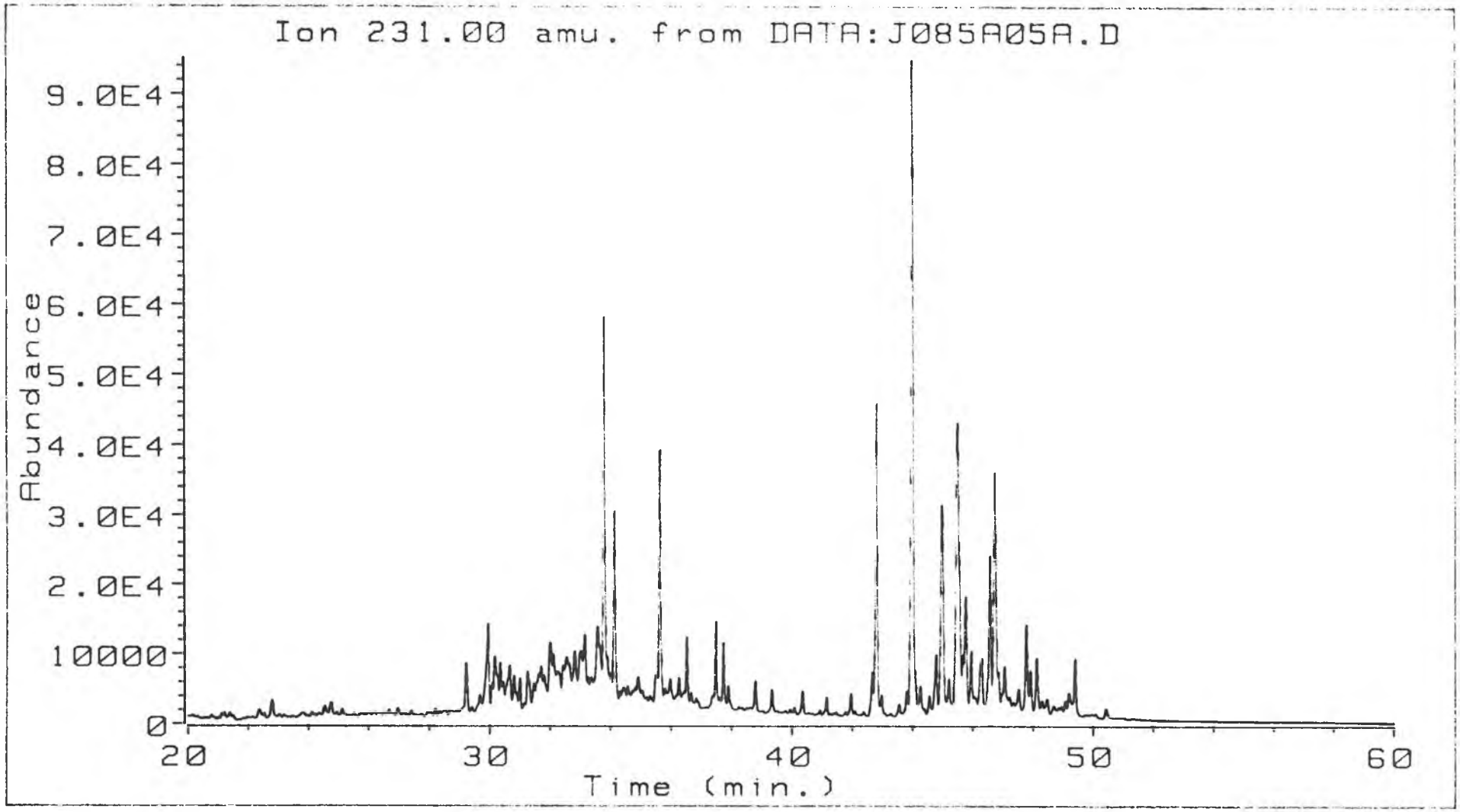

Ion 231.00 amu. from DATA:J085A03A.D
Abundance
800
700
600
500
400
300
200
100
0
30
40
50
60
Time (min.)


Ion 253.00 amu. from DATA:J085A04A.D
Abundance
6.0E4
5.0E4
4.0E4
3.0E4
2.0E4
10000
0
30
40
50
60
Time (min.)

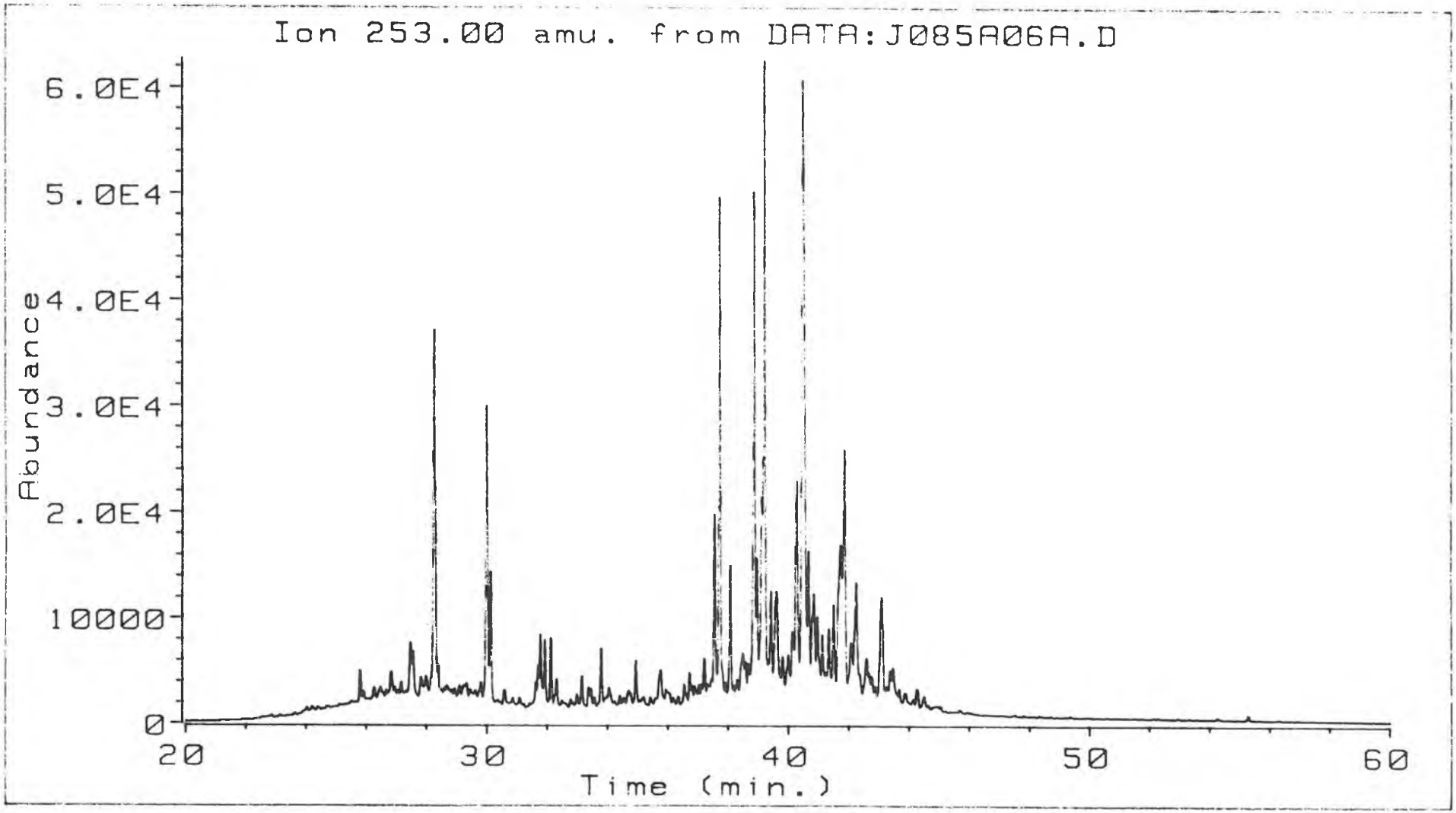

Ion 231.00 amu. from DATA:J085A04A.D
9.0E4
8.0E4
7.0E4
6.0E4
5.0E4
4.0E4
3.0E4
2.0E4
10000
0
Abundance
30
40
50
60
Time (min.)

2195n.

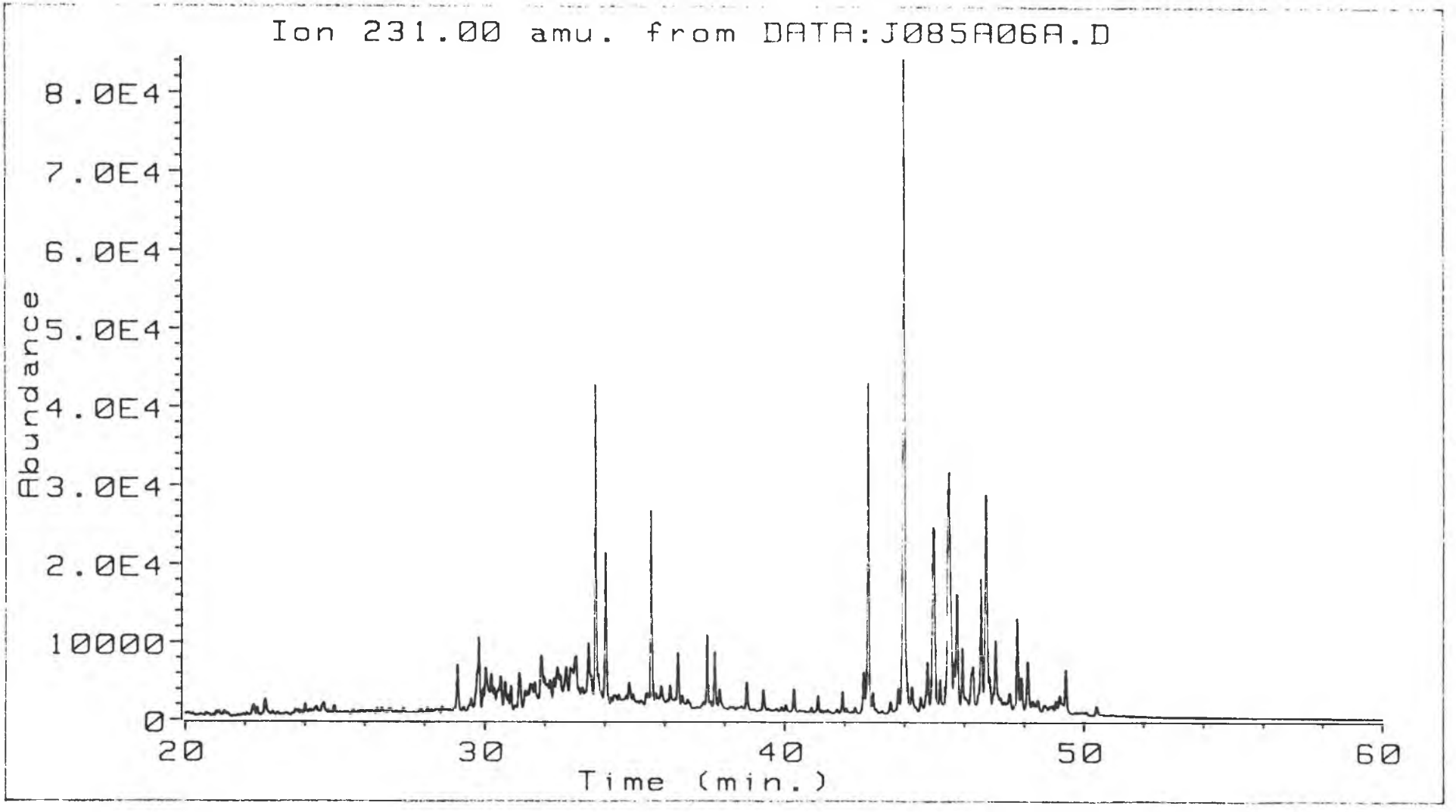

Ion 253.00 amu. from DATA:J085A05A.D
Abundance
8.0E4
7.0E4
6.0E4
5.0E4
4.0E4
3.0E4
2.0E4
10000
0
20
30
40
50
60
Time (min.)


Ion 231.00 amu. from DATA:J085A05A.D
Abundance
9.0E4
8.0E4
7.0E4
6.0E4
5.0E4
4.0E4
3.0E4
2.0E4
10000
0
20
30
40
50
60
Time (min.)

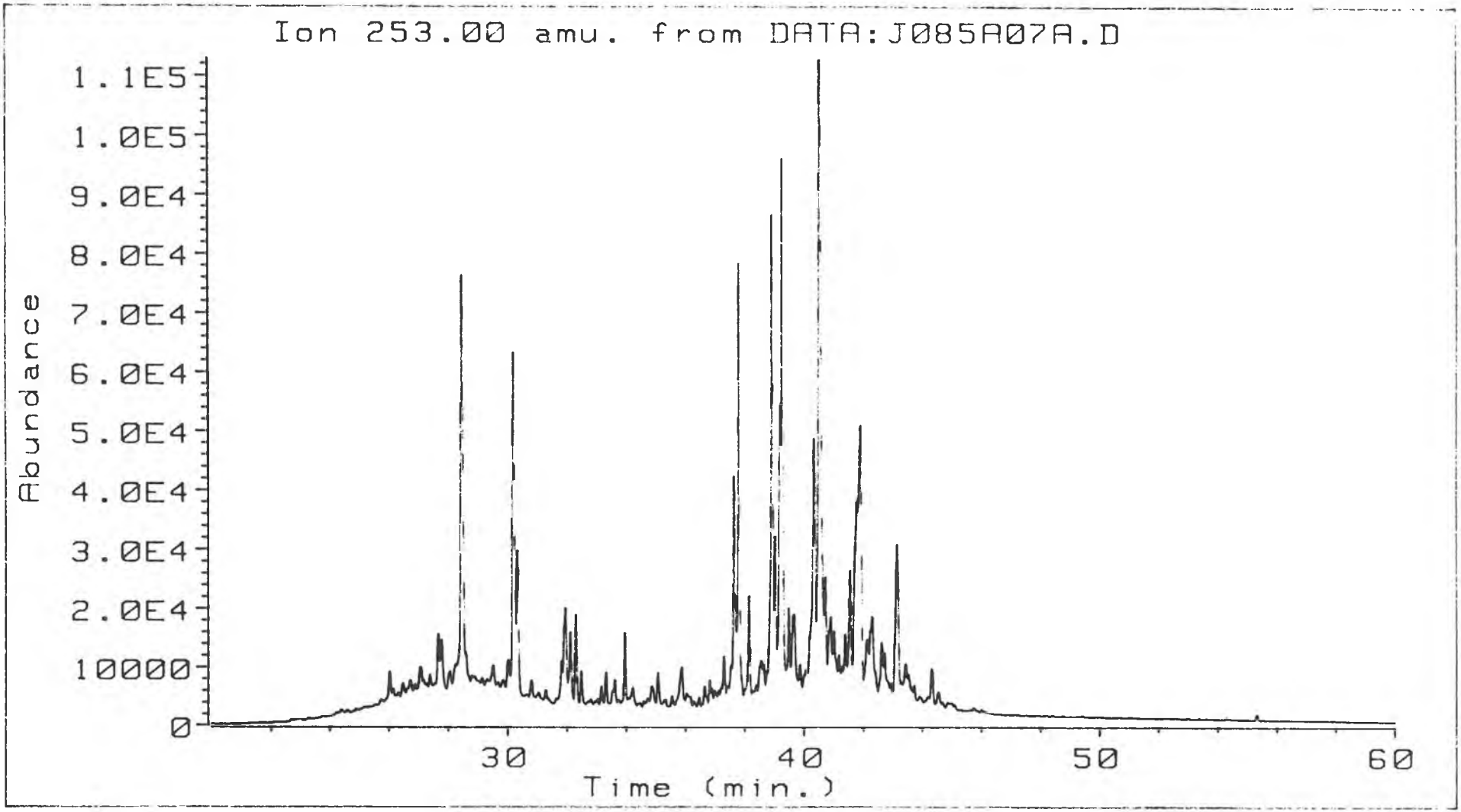
2798

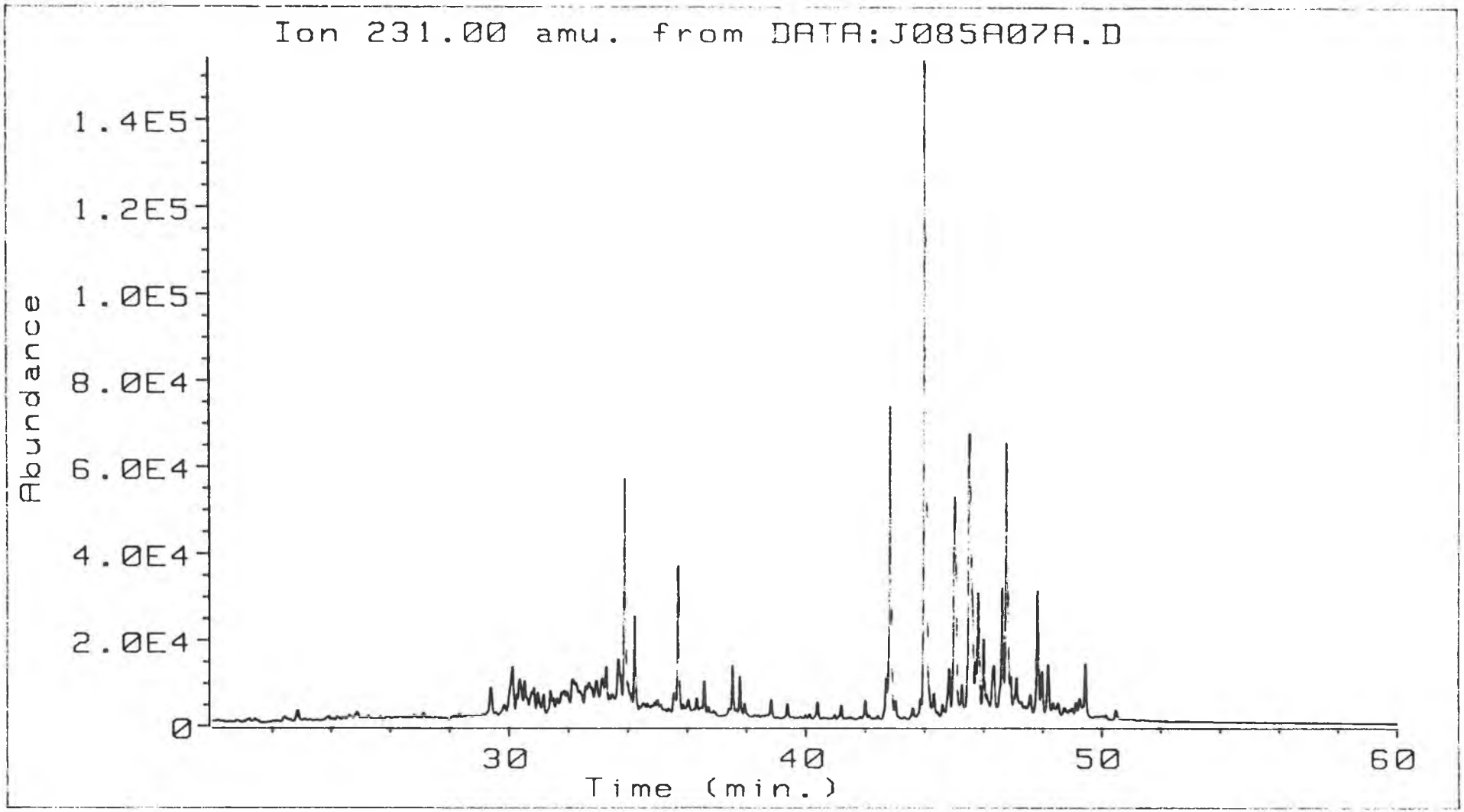

Ion 253.00 amu. from DATA:J085A06A.D
Abundance
6.0E4
5.0E4
4.0E4
3.0E4
2.0E4
10000
0
20
30
40
50
60
Time (min.)

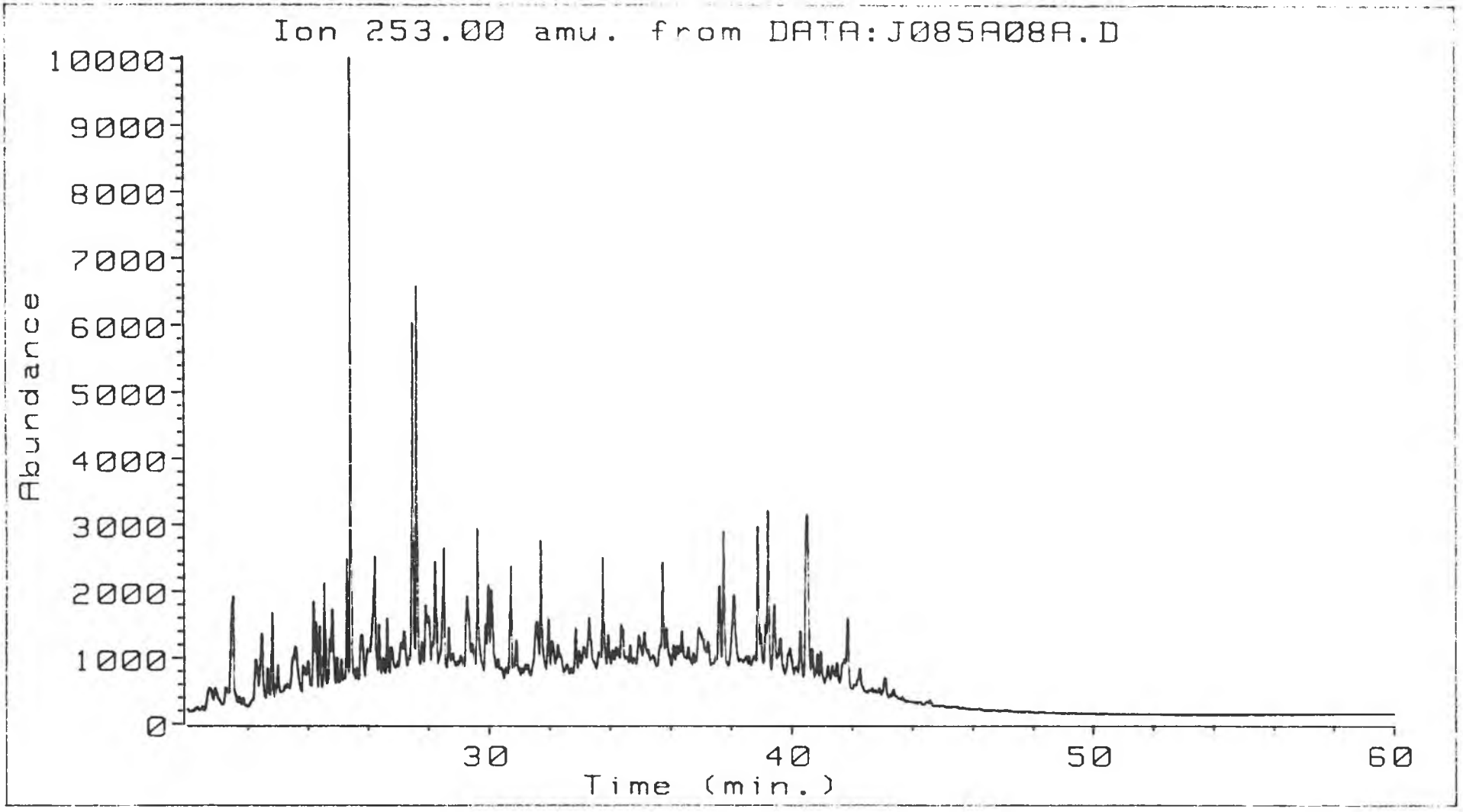
J 92n

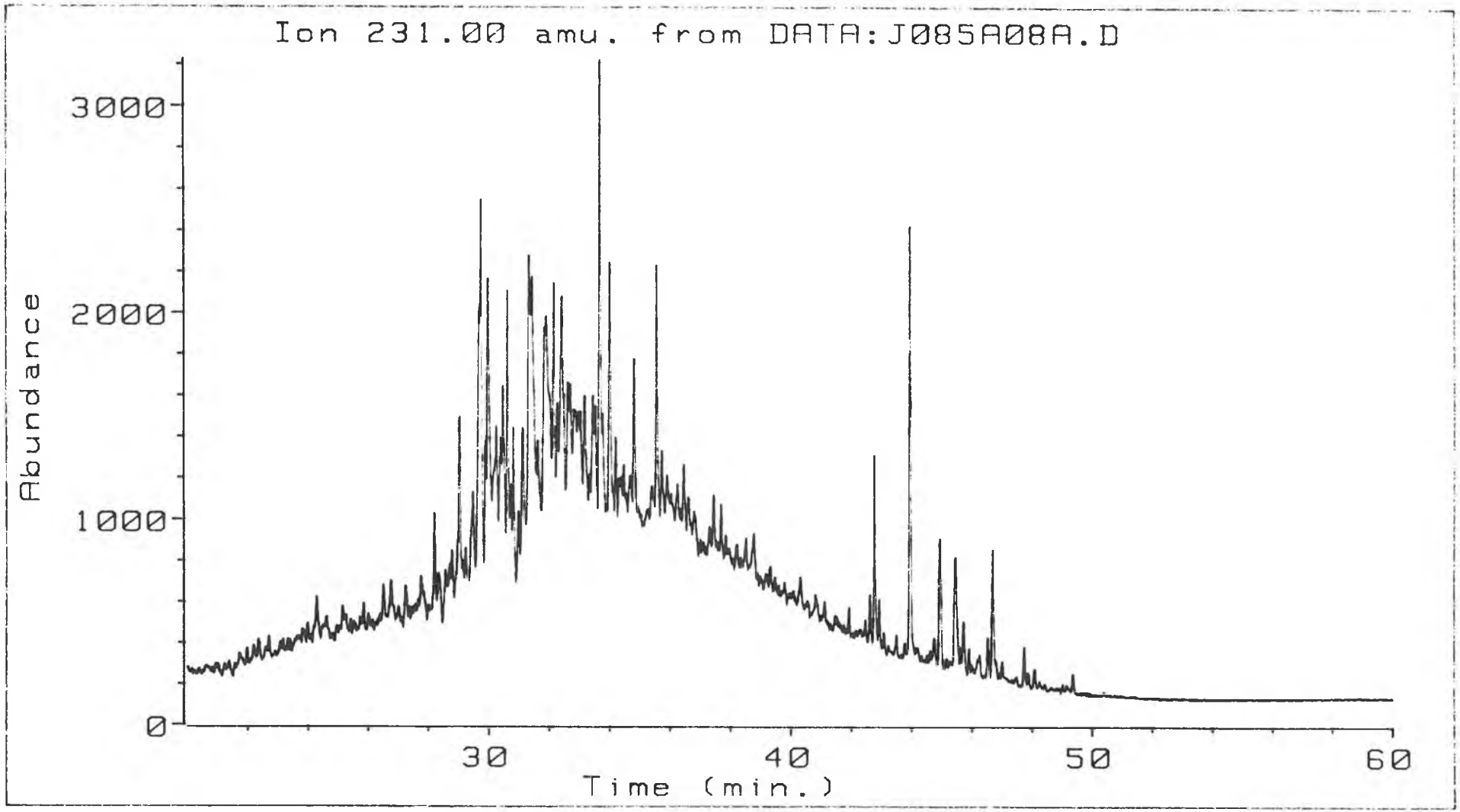

Ion 231.00 amu. from DATA:J085A06A.D
Abundance
8.0E4
7.0E4
6.0E4
5.0E4
4.0E4
3.0E4
2.0E4
10000
0
20
30
40
50
60
Time (min.)

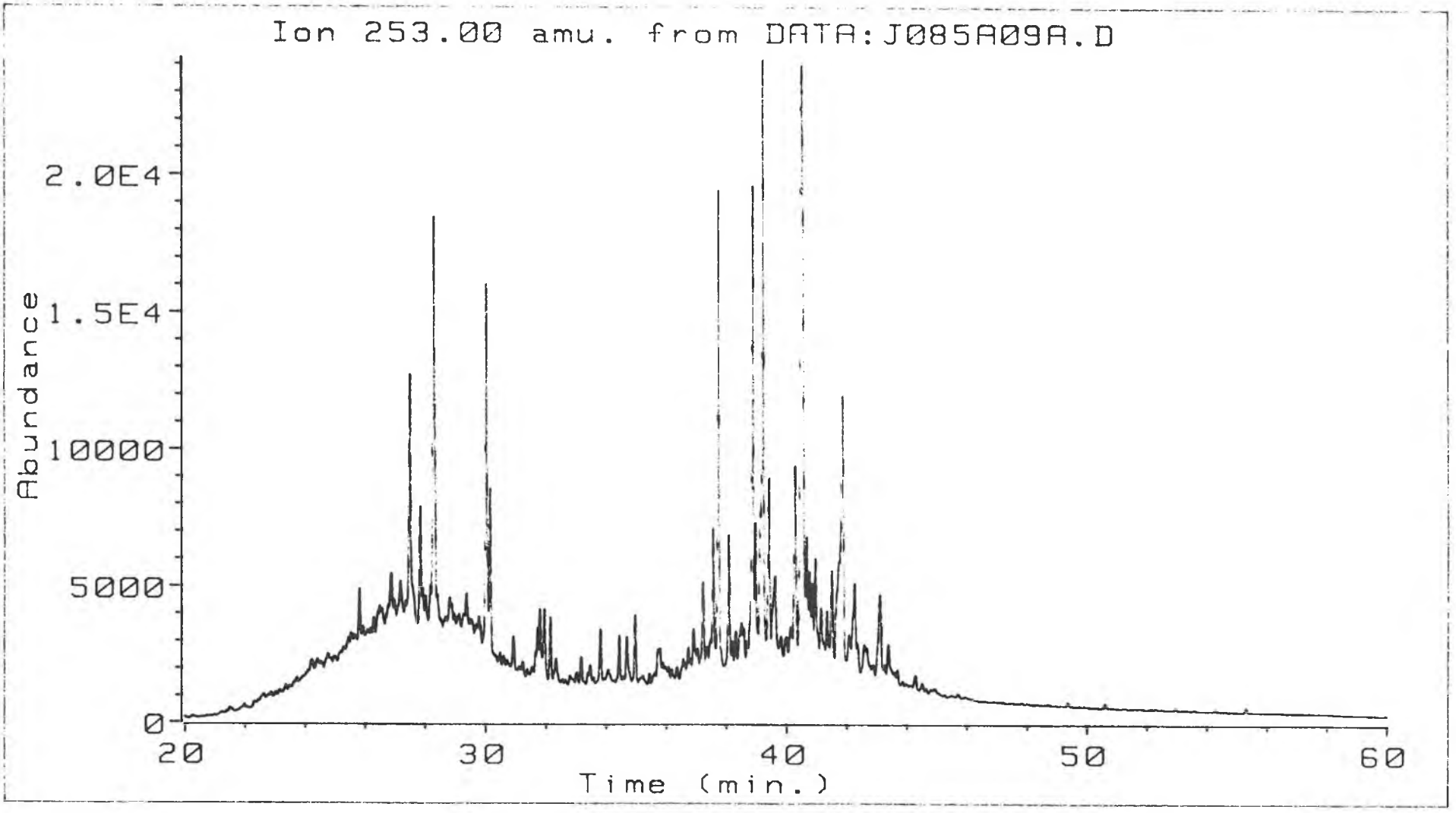
2800m

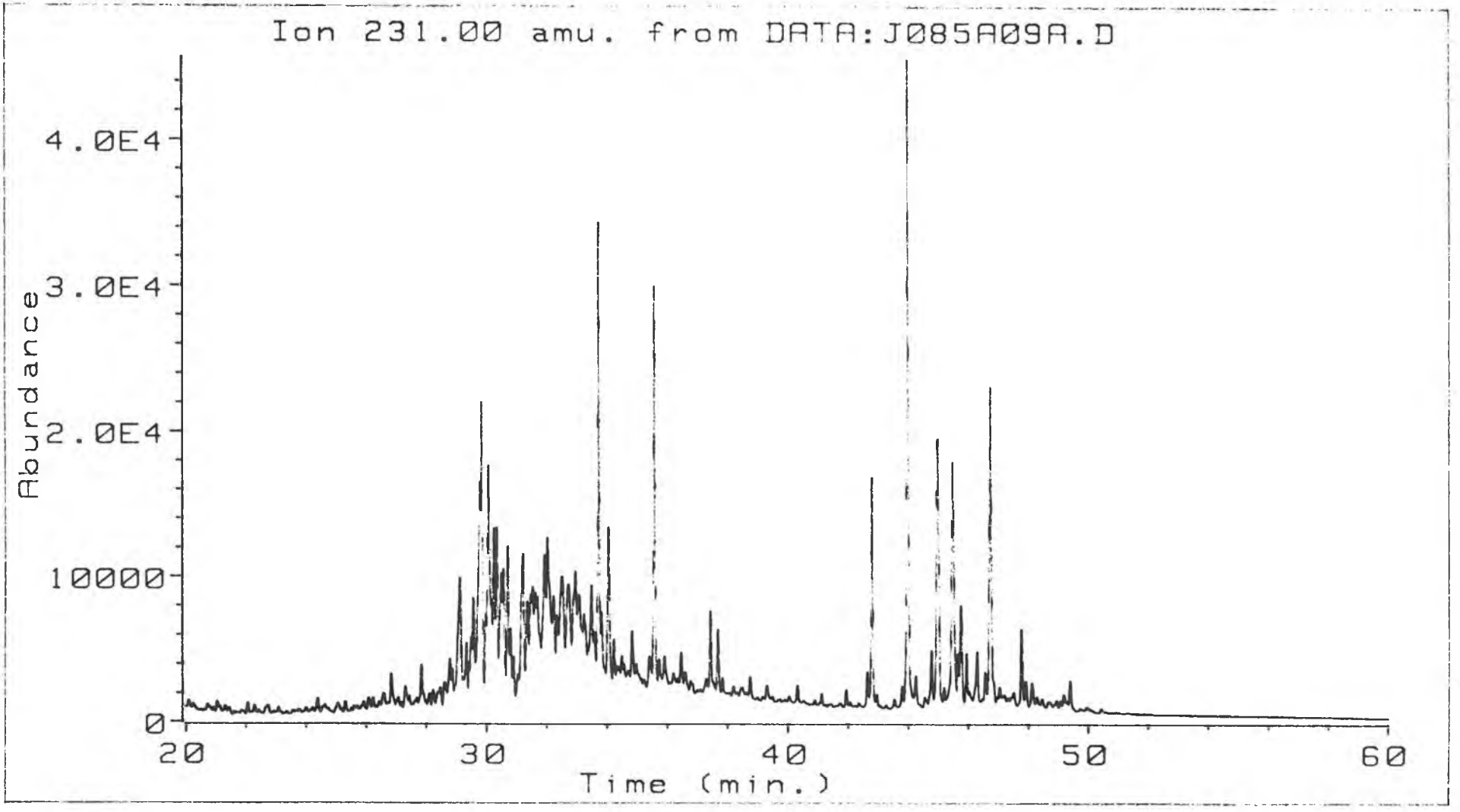

Ion 253.00 amu. from DATA:J085A07A.D
Abundance
1.1E5
1.0E5
9.0E4
8.0E4
7.0E4
6.0E4
5.0E4
4.0E4
3.0E4
2.0E4
10000
0
30
40
50
60
Time (min.)

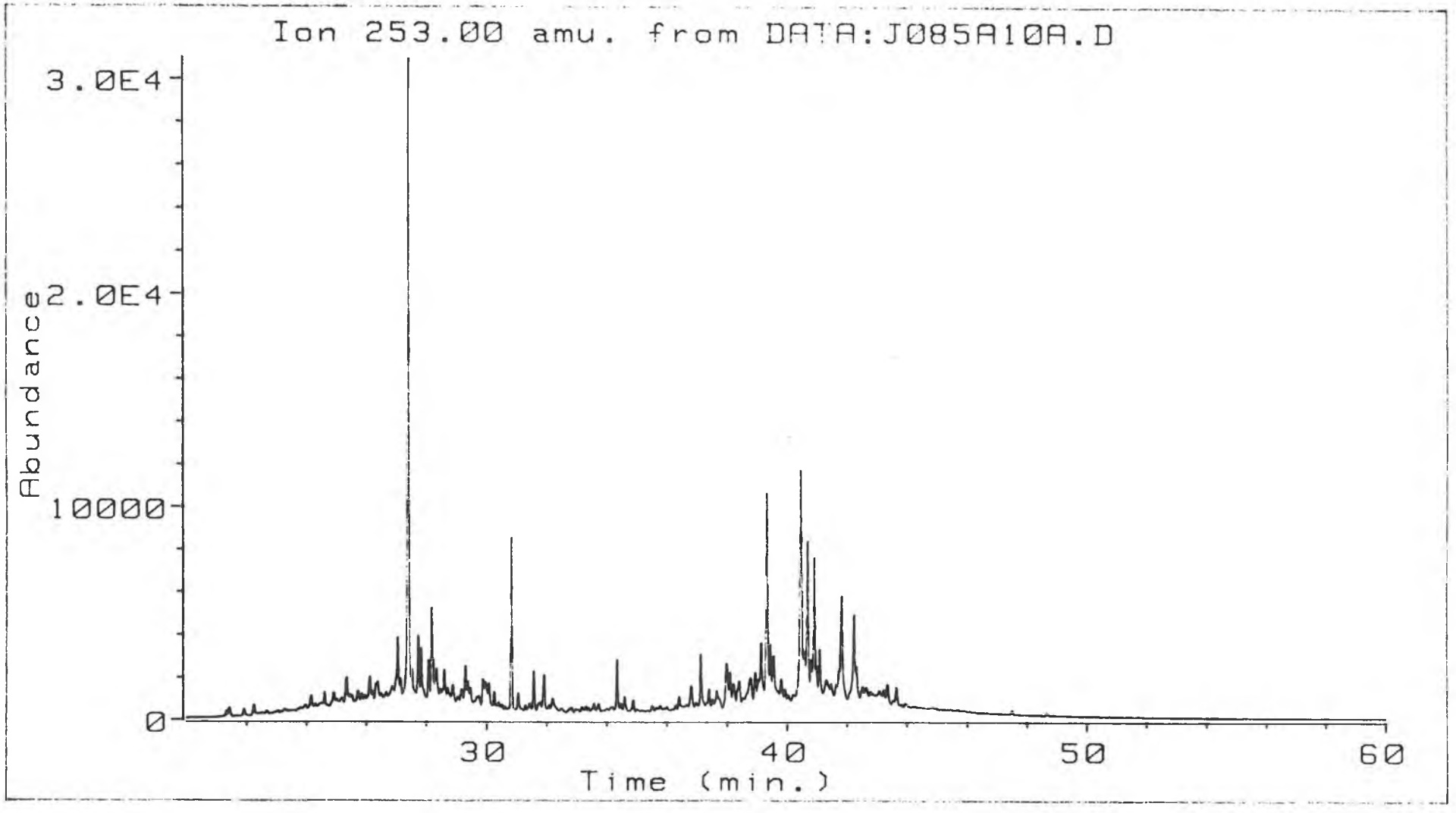

Ion 231.00 amu. from DATA:J085A07A.D
Abundance
1.4E5
1.2E5
1.0E5
8.0E4
6.0E4
4.0E4
2.0E4
0
30
40
50
60
Time (min.)

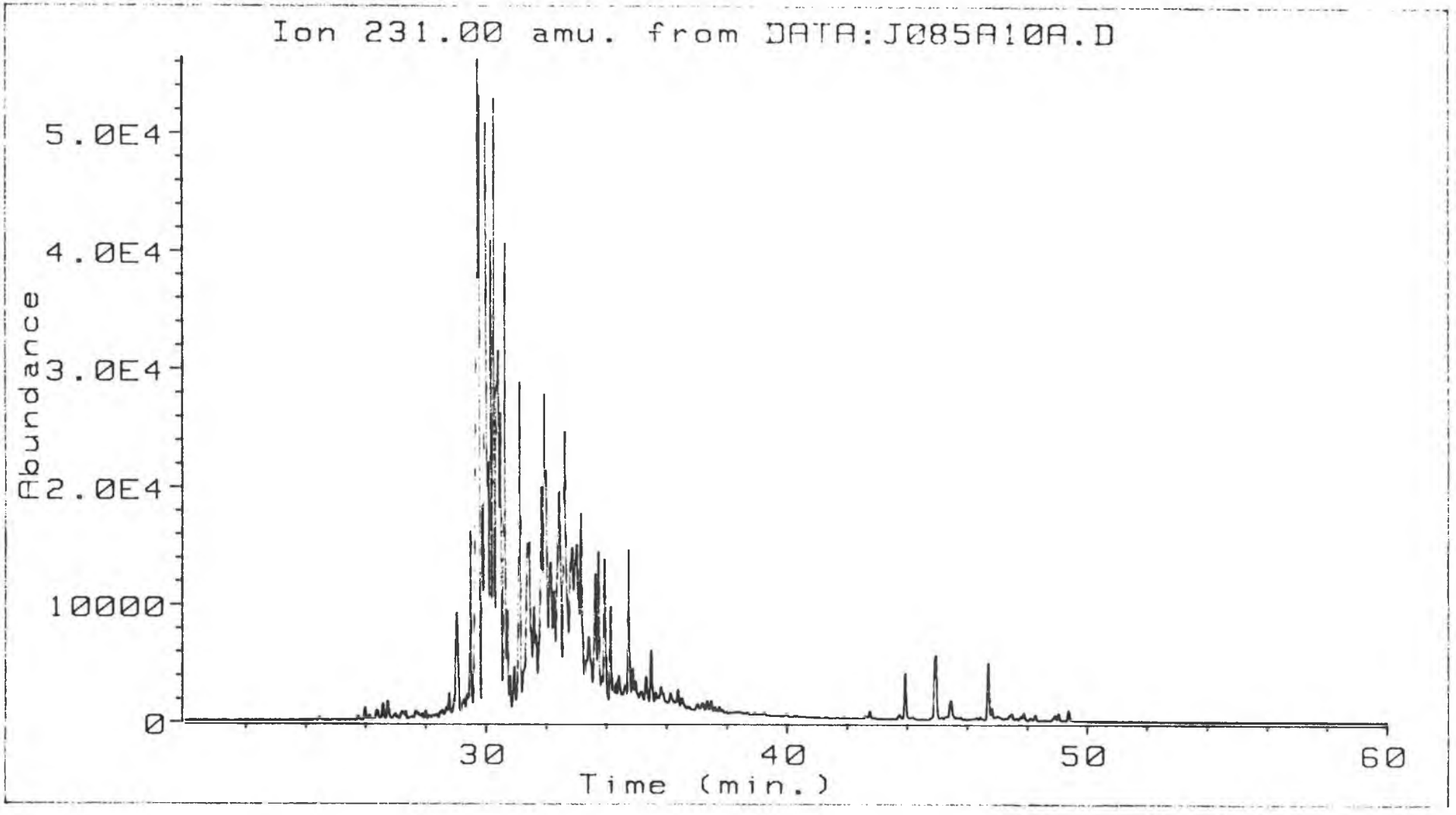

Ion 253.00 amu. from DATA:J085A08A.D
Abundance
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
30
40
50
60
Time (min.)

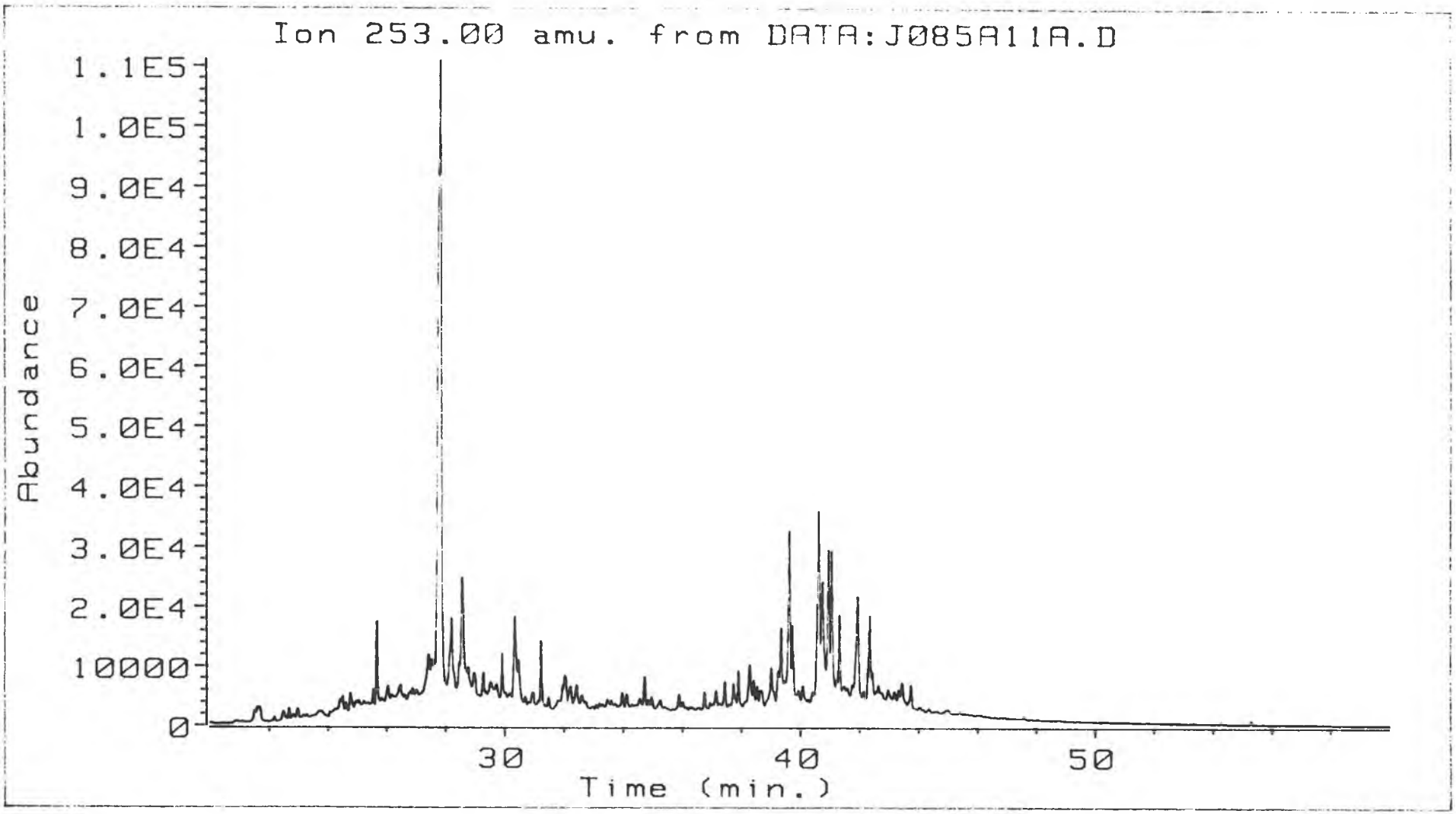

Ion 231.00 amu. from DATA:J085A08A.D
Abundance
3000
2000
1000
0
30
40
50
60
Time (min.)

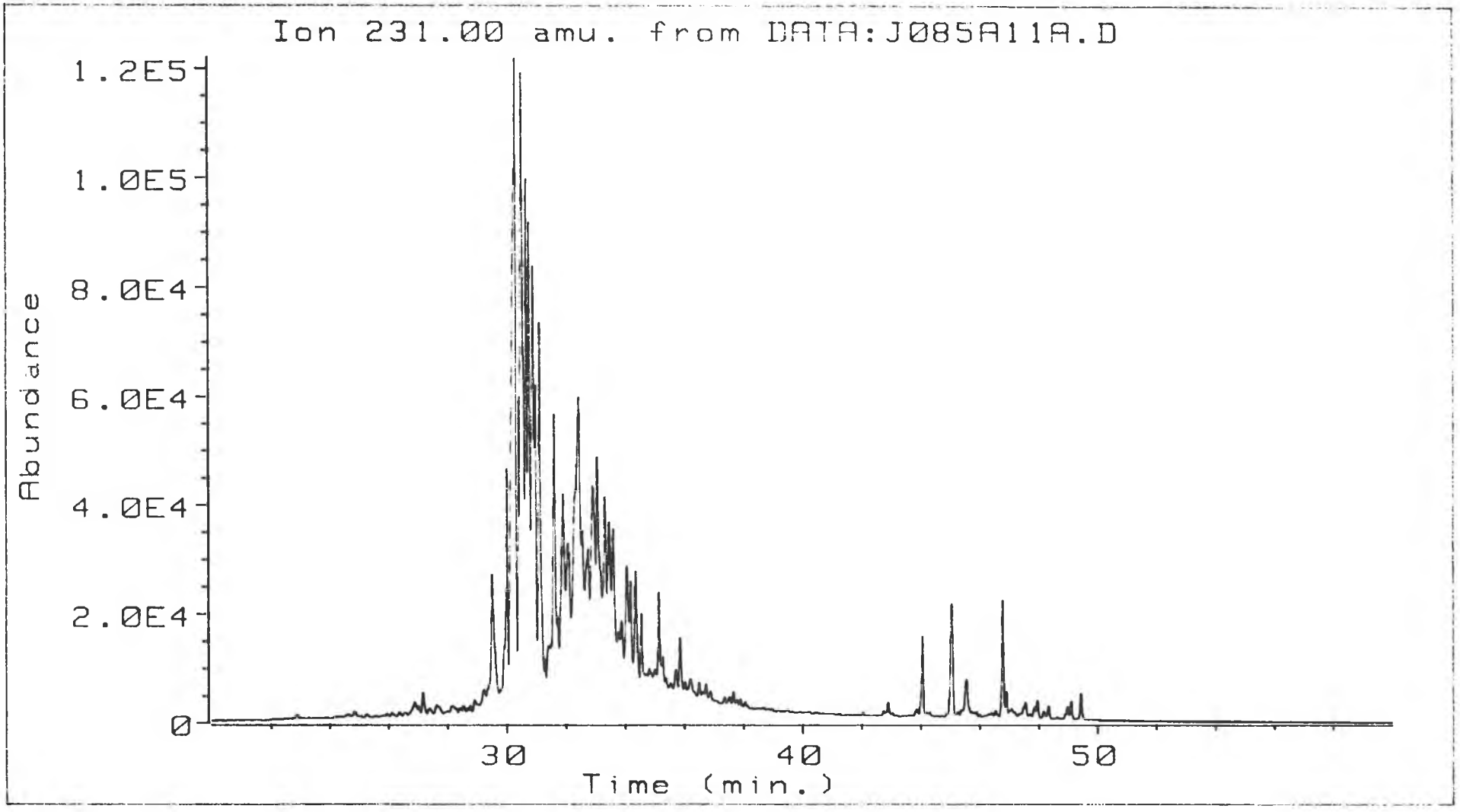

Ion 253.00 amu. from DATA:J085A09A.D
Abundance
2.0E4
1.5E4
10000
5000
0
20
30
40
50
60
Time (min.)

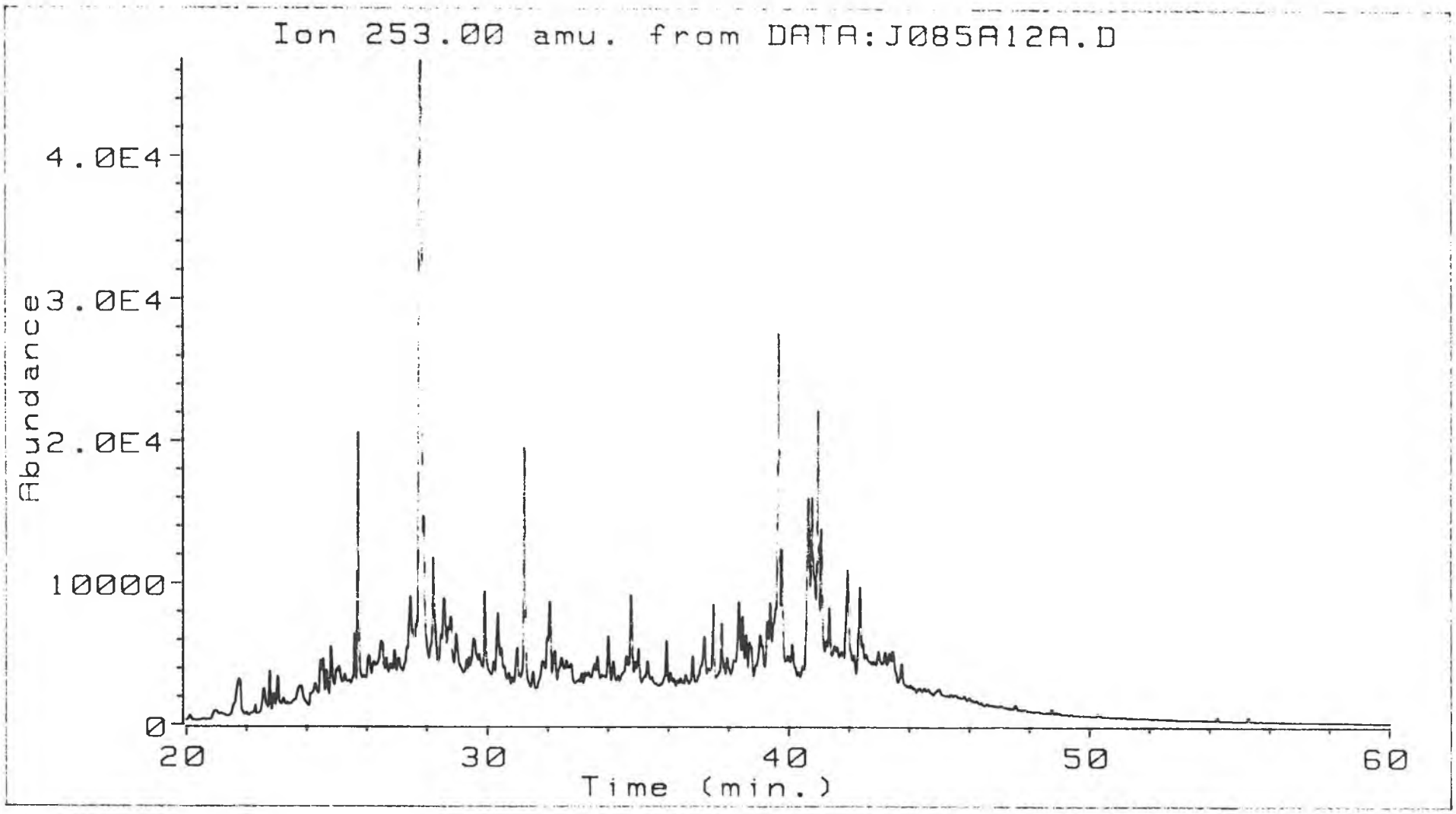

Ion 231.00 amu. from DATA:J085A09A.D
Abundance
4.0E4
3.0E4
2.0E4
10000
0
20
30
40
50
60
Time (min.)

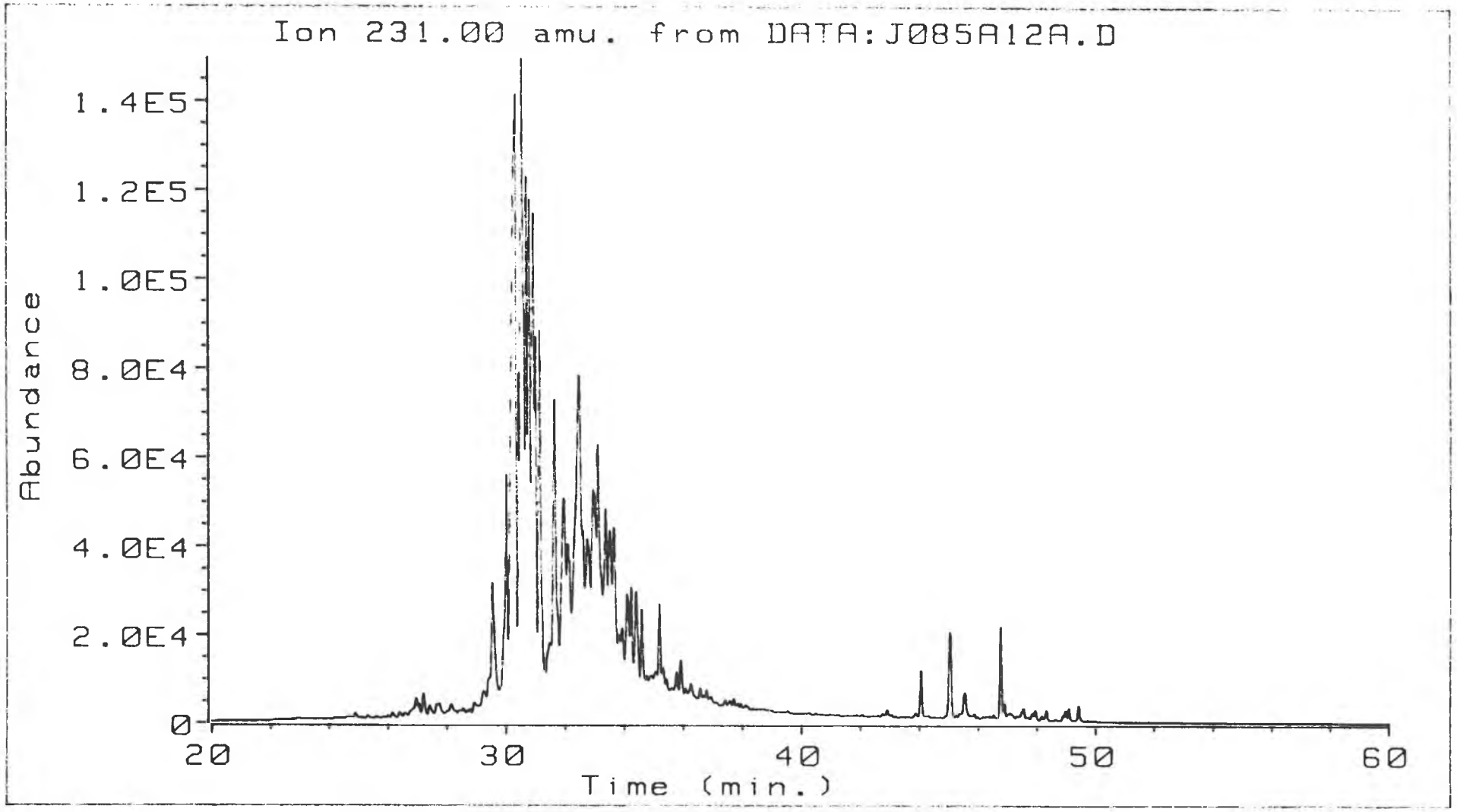

Ion 253.00 amu. from DATA:J085A10A.D
3.0E4
2.0E4
10000
0
Abundance
30
40
50
60
Time (min.)

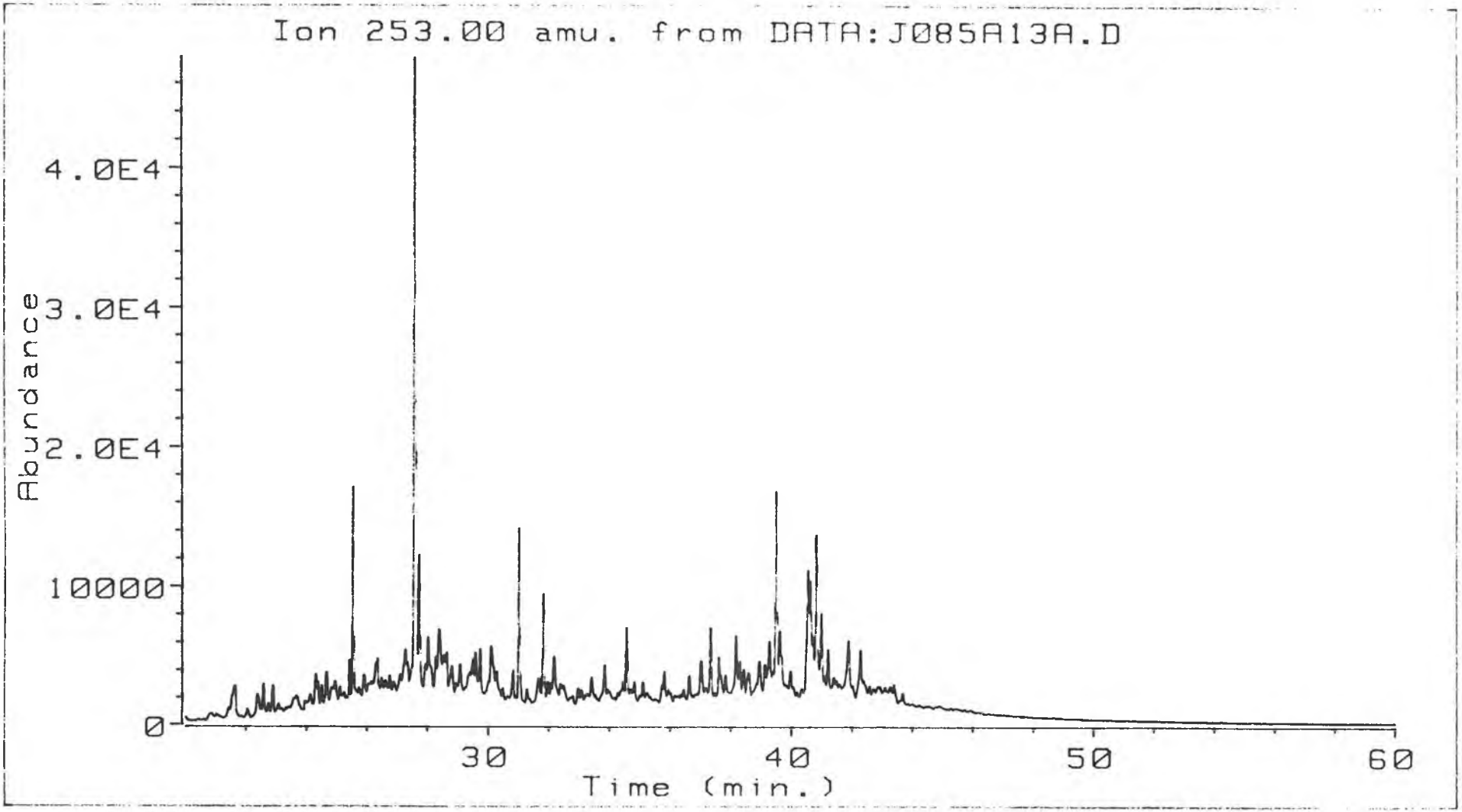

Ion 231.00 amu. from DATA:J085A10A.D
Abundance
5.0E4
4.0E4
3.0E4
2.0E4
10000
0
30
40
50
60
Time (min.)

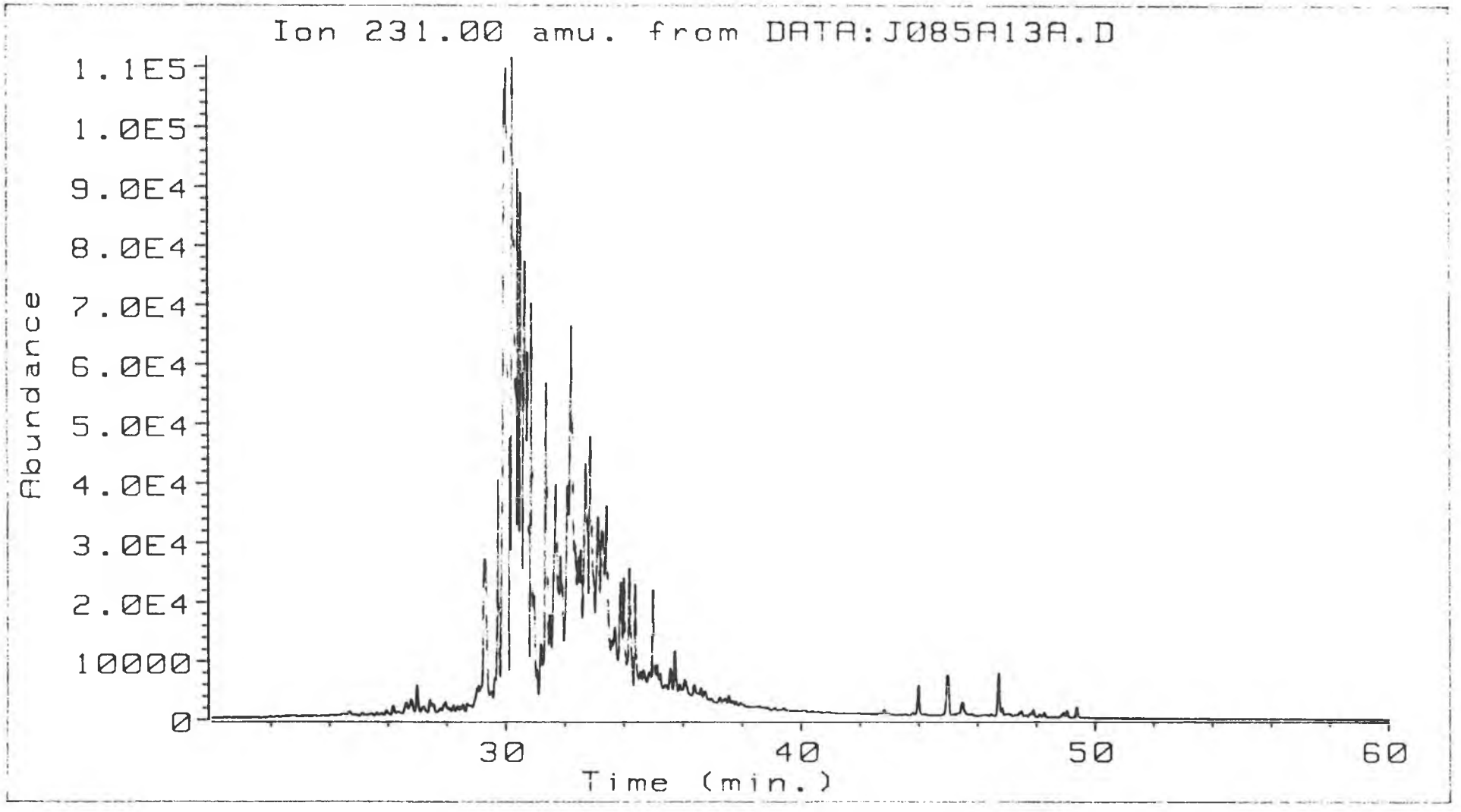

Ion 253.00 amu. from DATA:J085A11A.D
Abundance
1.1E5
1.0E5
9.0E4
8.0E4
7.0E4
6.0E4
5.0E4
4.0E4
3.0E4
2.0E4
10000
0
30
40
50
Time (min.)

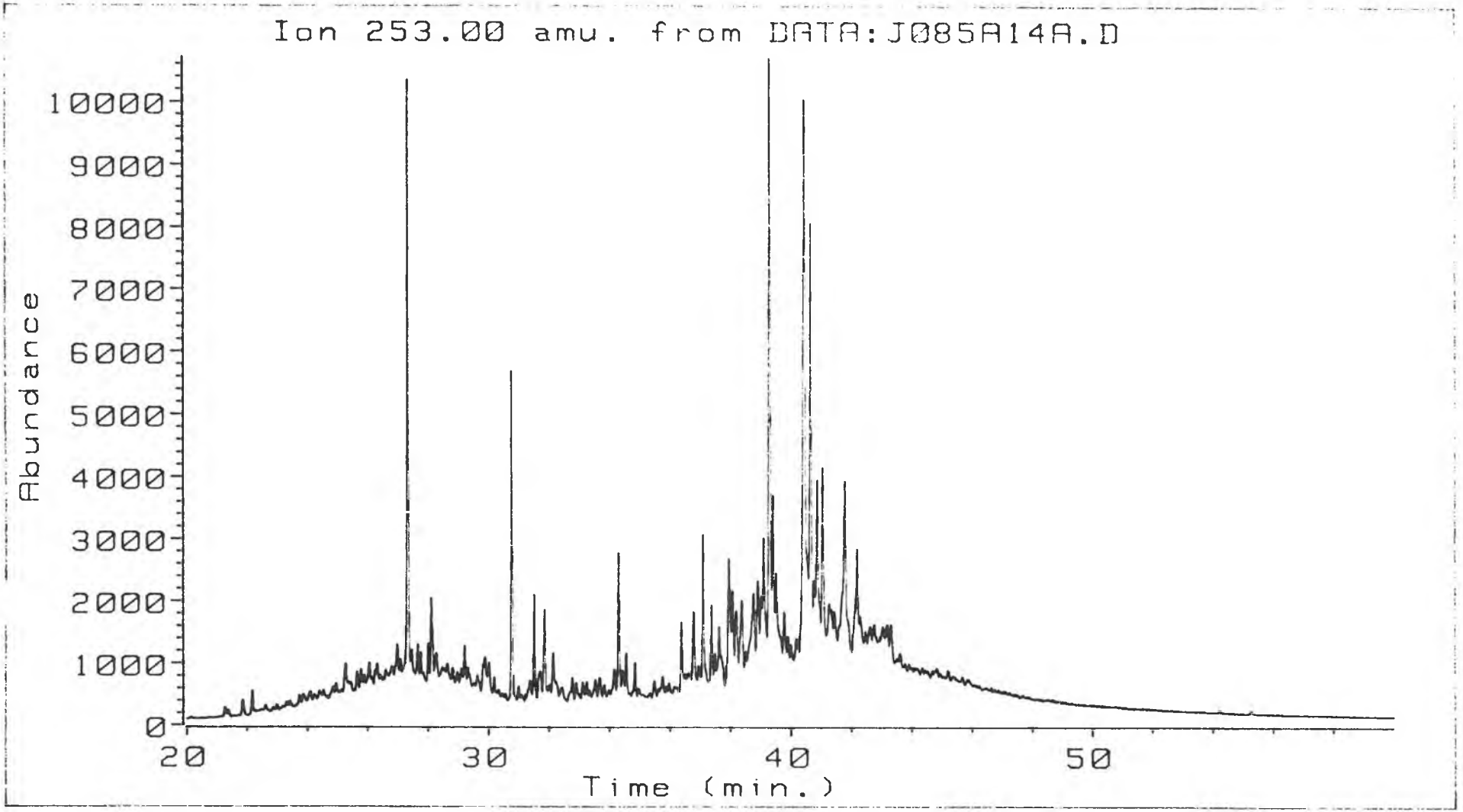

Ion 231.00 amu. from DATA:J085A11A.D
1.2E5
1.0E5
8.0E4
6.0E4
4.0E4
2.0E4
0
Abundance
30
40
50
Time (min.)

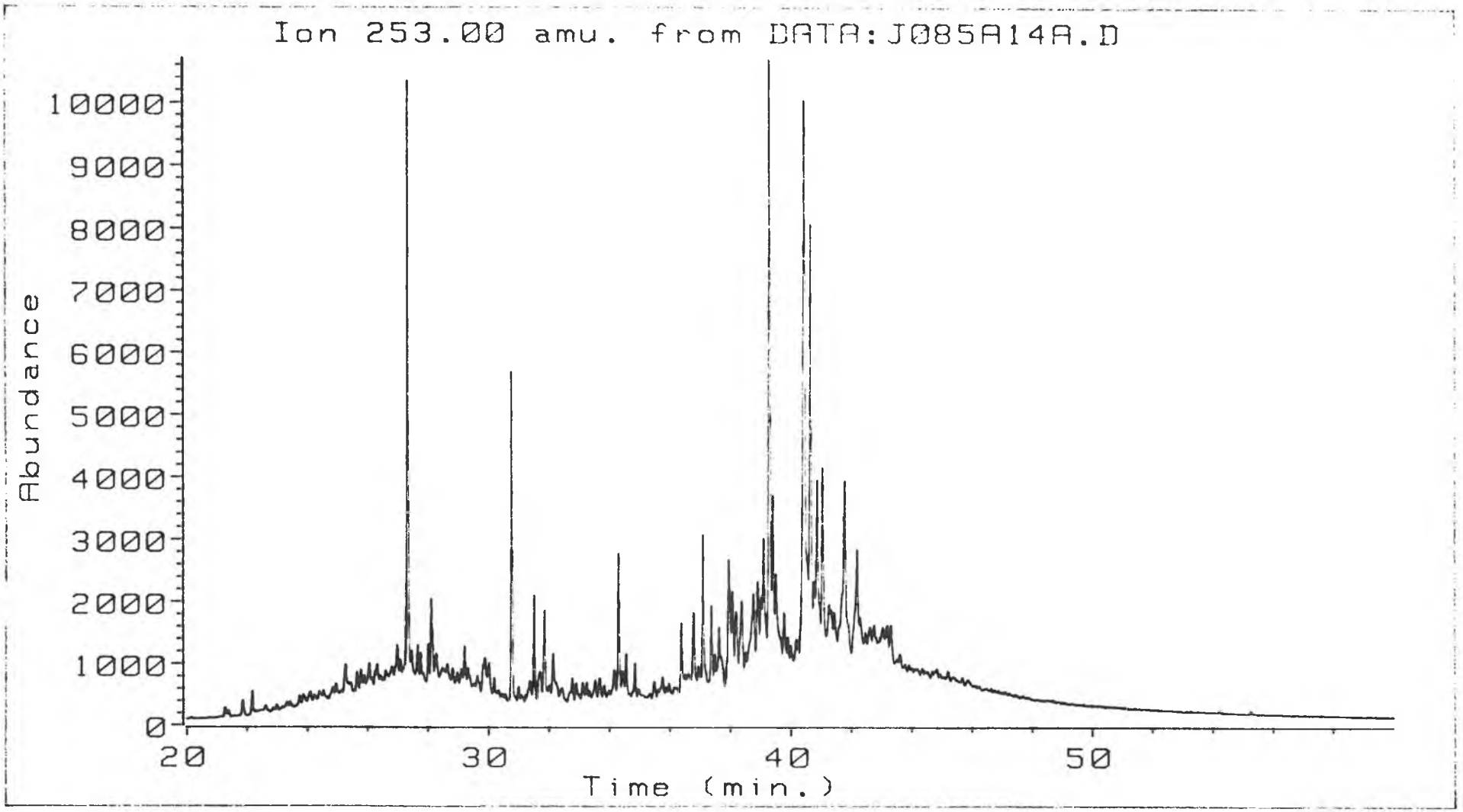

Ion 253.00 amu. from DATA:J085A12A.D
Abundance
4.0E4
3.0E4
2.0E4
10000
0
20
30
40
50
60
Time (min.)

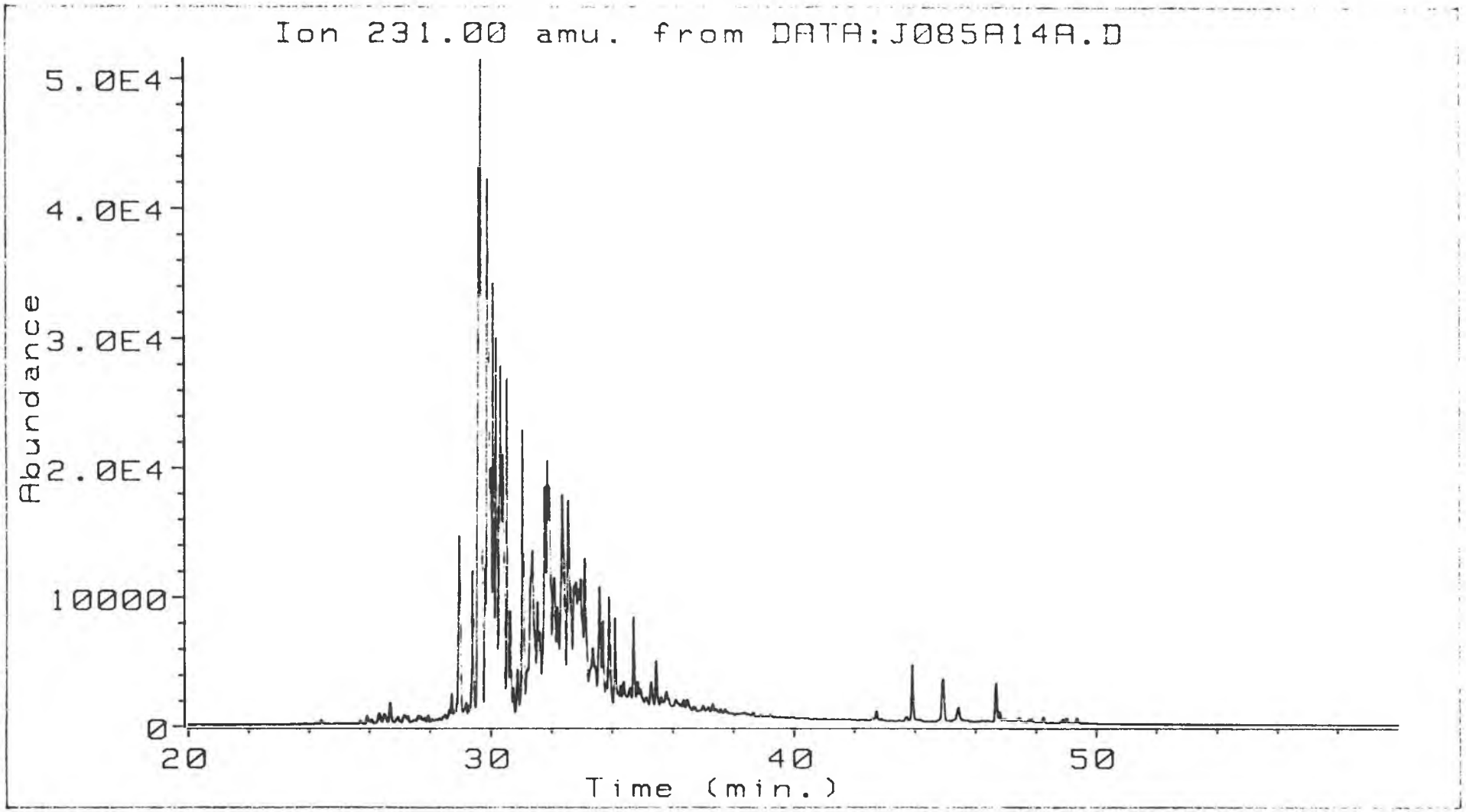

Ion 231.00 amu. from DATA:J085A12A.D
Abundance
1.4E5
1.2E5
1.0E5
8.0E4
6.0E4
4.0E4
2.0E4
0
20
30
40
50
60
Time (min.)

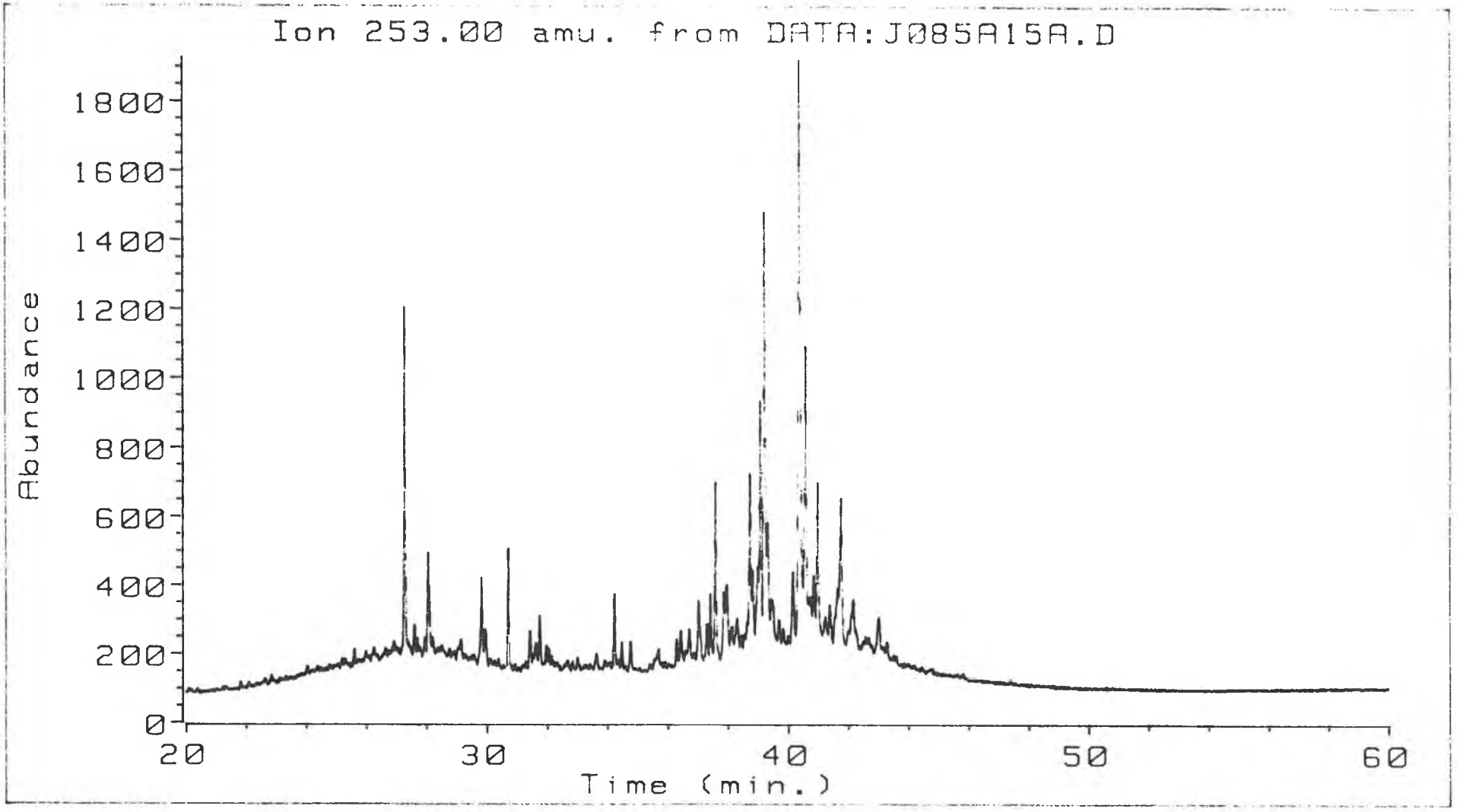

Ion 253.00 amu. from DATA:J085A13A.D
Abundance
4.0E4
3.0E4
2.0E4
10000
0
30
40
50
60
Time (min.)

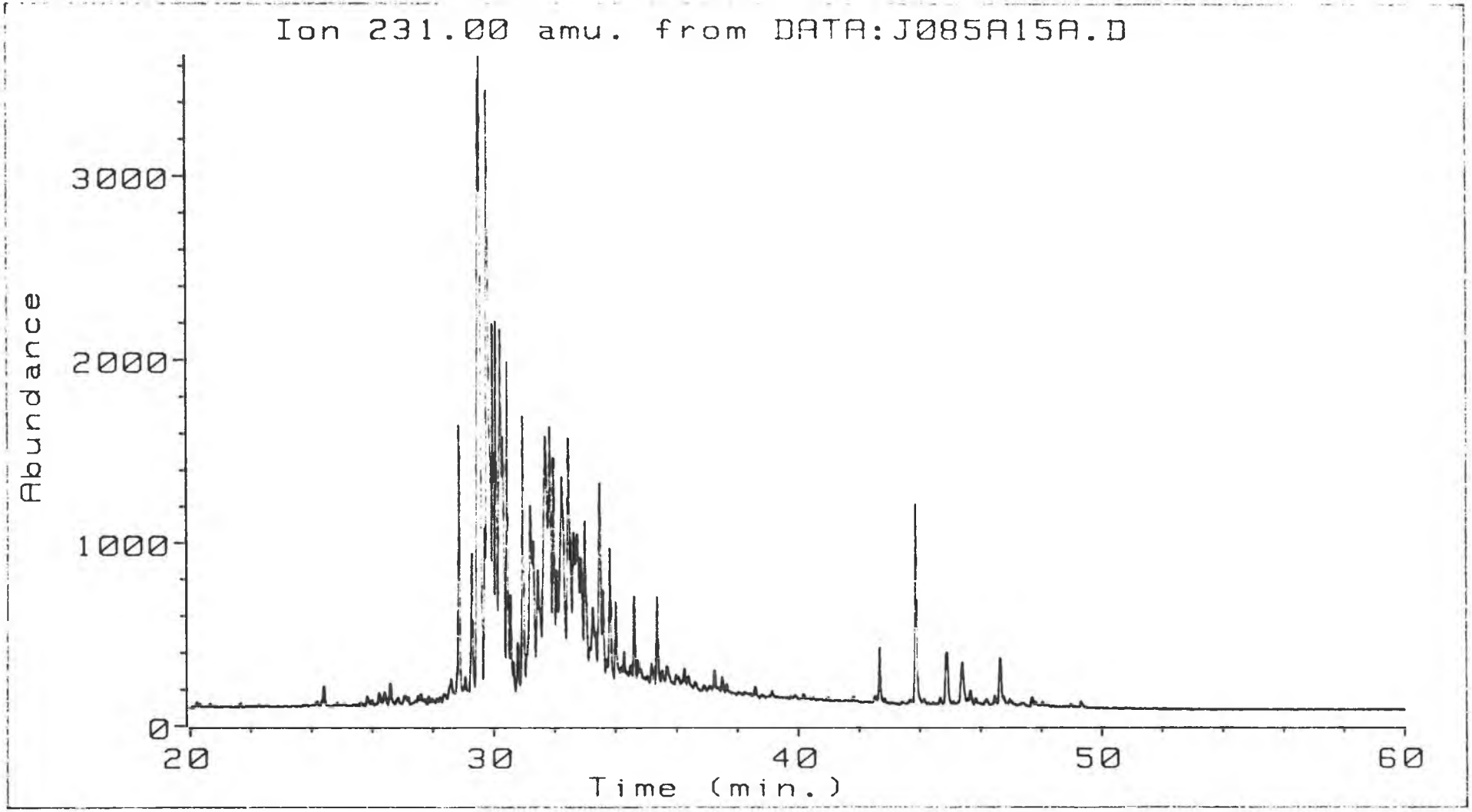

Ion 231.00 amu. from DATA:J085A13A.D
1.1E5
1.0E5
9.0E4
8.0E4
7.0E4
6.0E4
5.0E4
4.0E4
3.0E4
2.0E4
10000
0
Abundance
30
40
50
60
Time (min.)


Ion 253.00 amu. from DATA:J085A14A.D
Abundance
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
20
30
40
50
Time (min.)

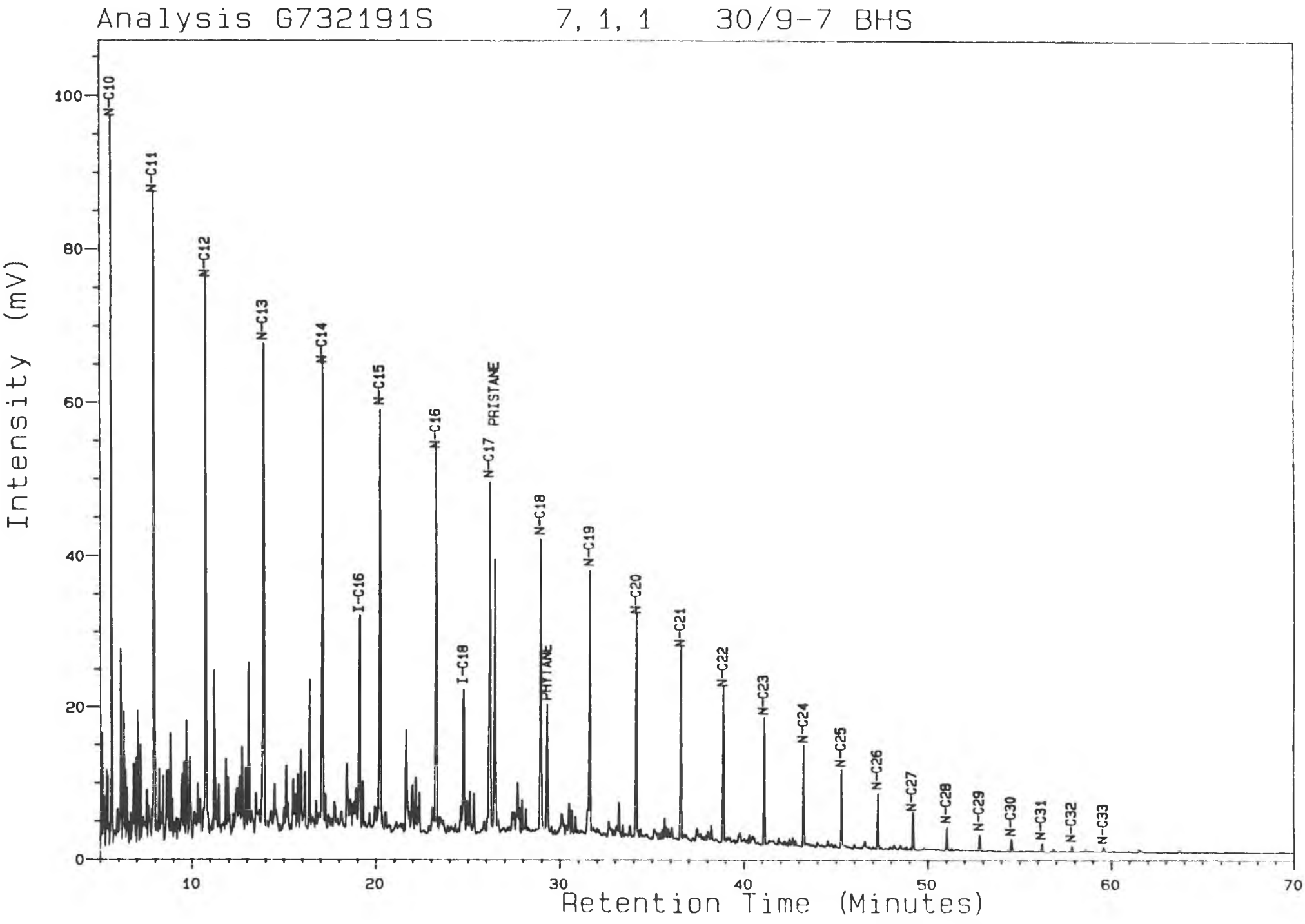

Ion 253.00 amu. from DATA:J085A14A.D
Abundance
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
20
30
40
50
Time (min.)

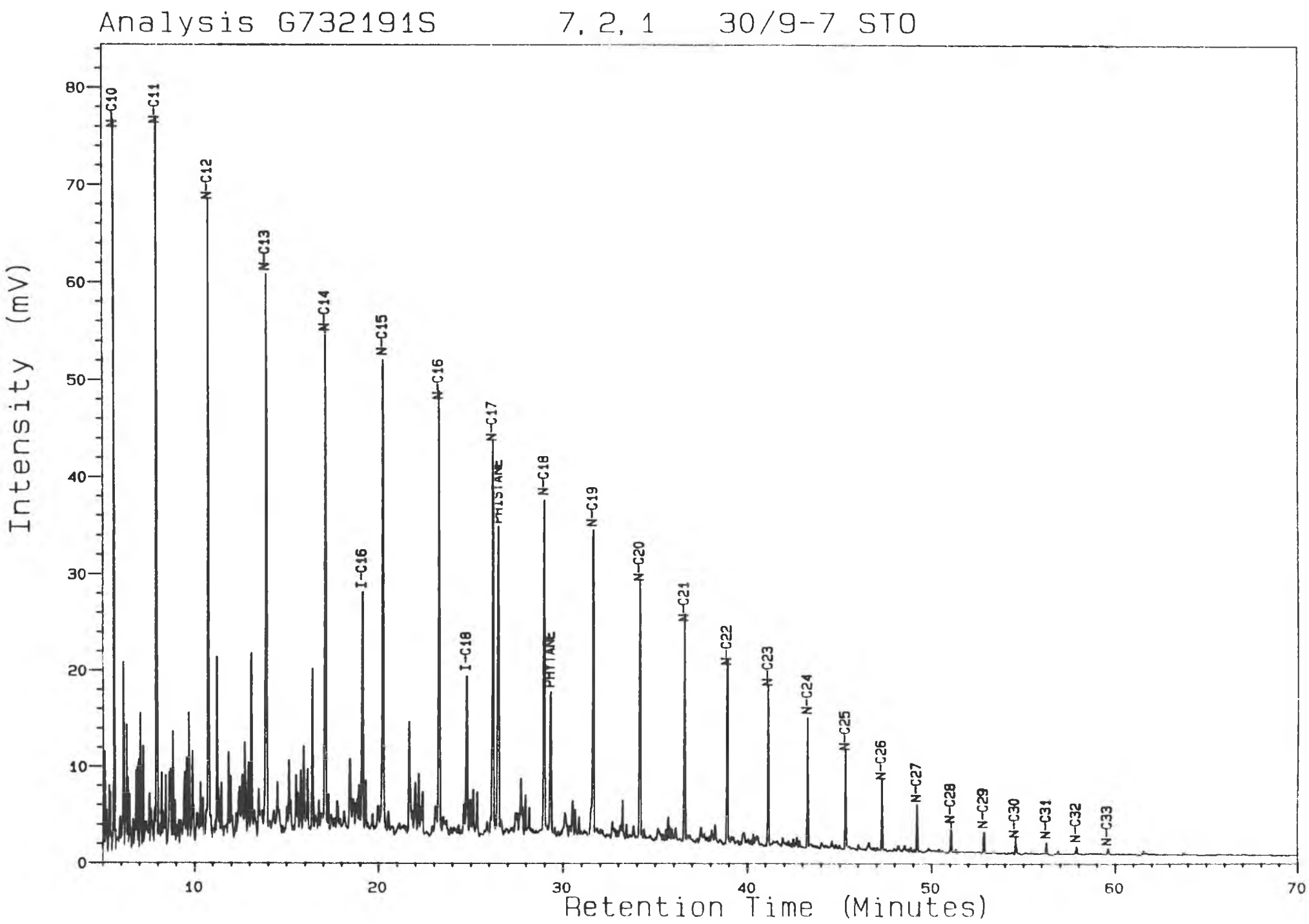

Ion 231.00 amu. from DATA:J085A14A.D
5.0E4
4.0E4
3.0E4
2.0E4
10000
0
Abundance
20
30
40
50
Time (min.)

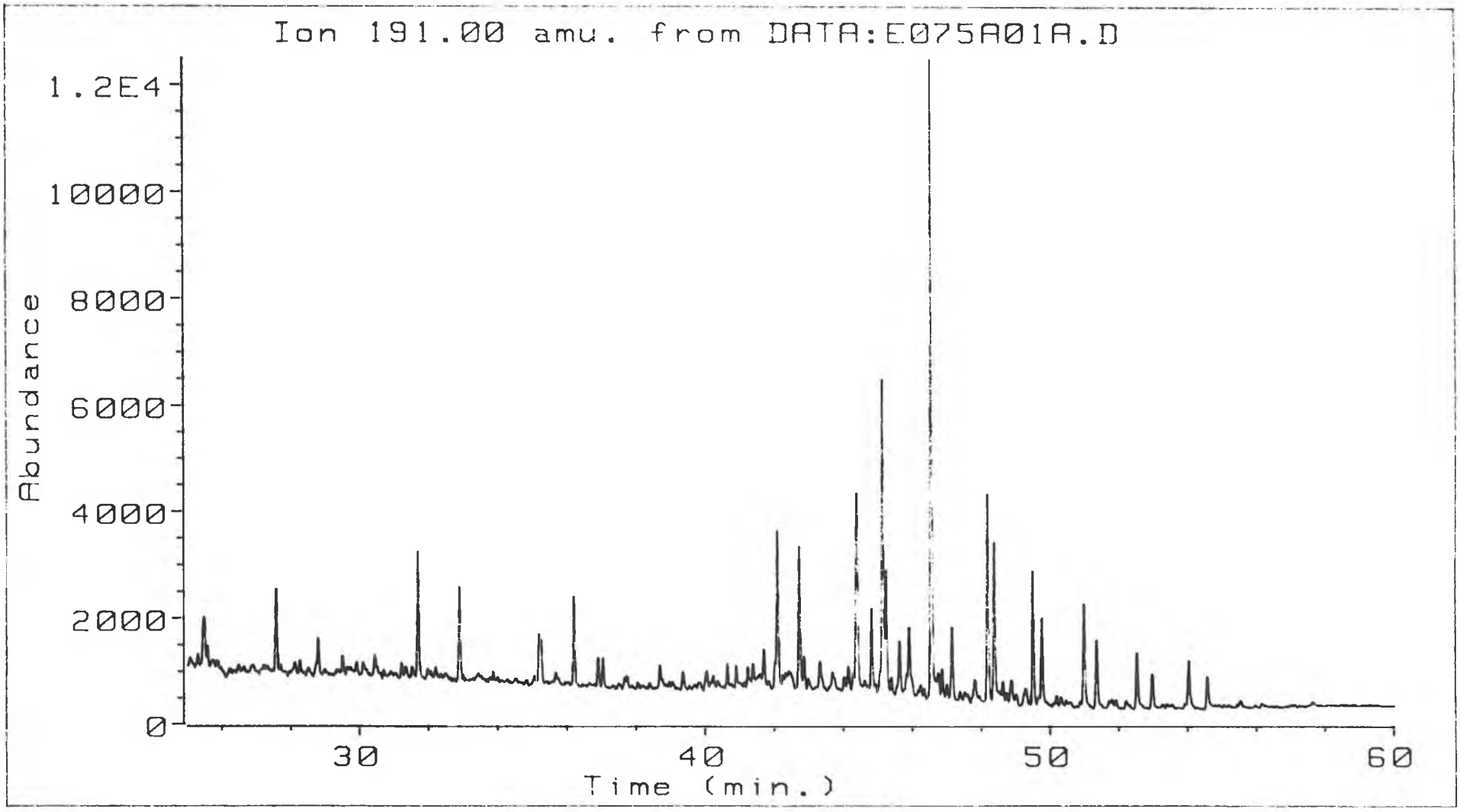

Ion 253.00 amu. from DATA:J085A15A.D
Abundance
1800
1600
1400
1200
1000
800
600
400
200
0
20
30
40
50
60
Time (min.)

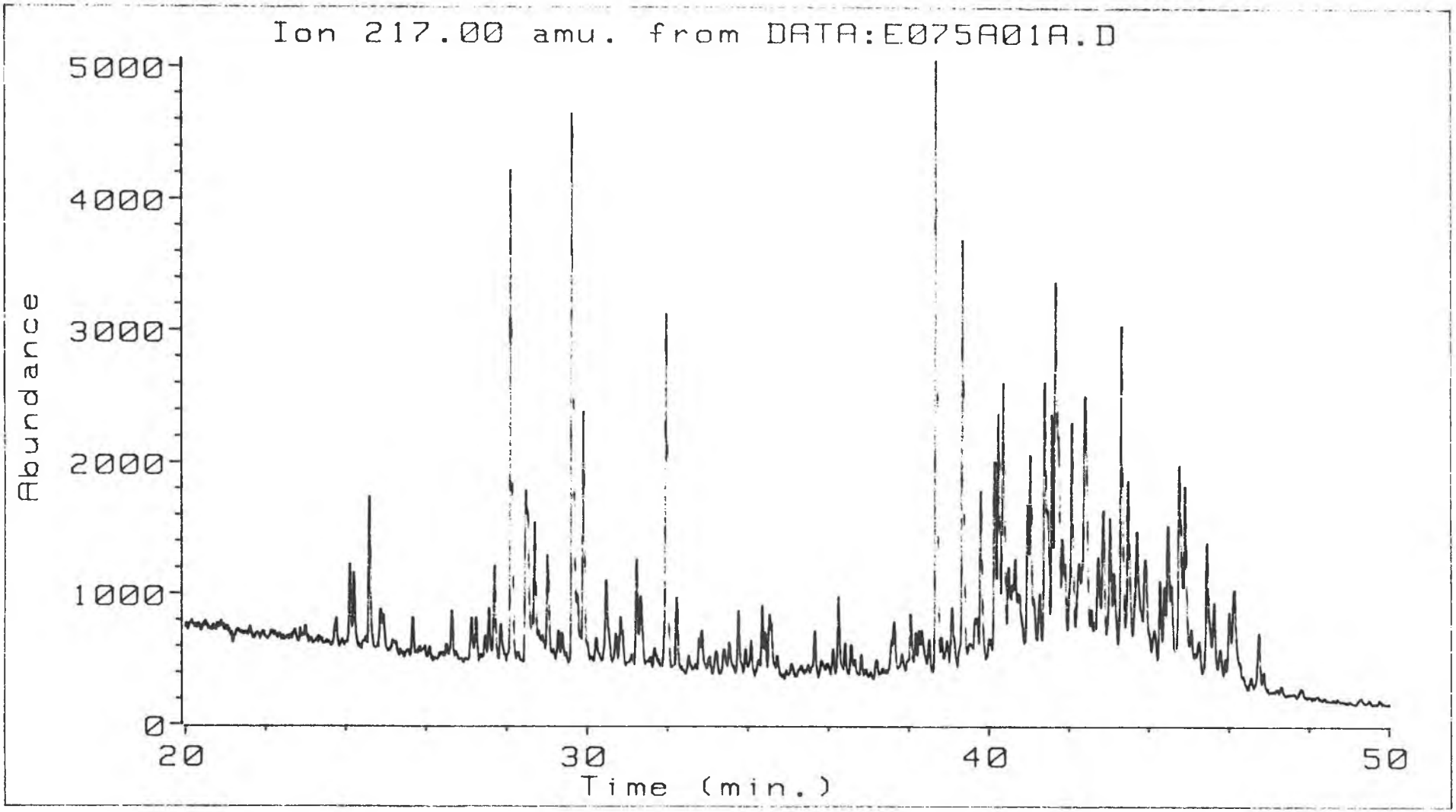

Ion 231.00 amu. from DATA:J085A15A.D
Abundance
3000
2000
1000
0
20
30
40
50
60
Time (min.)

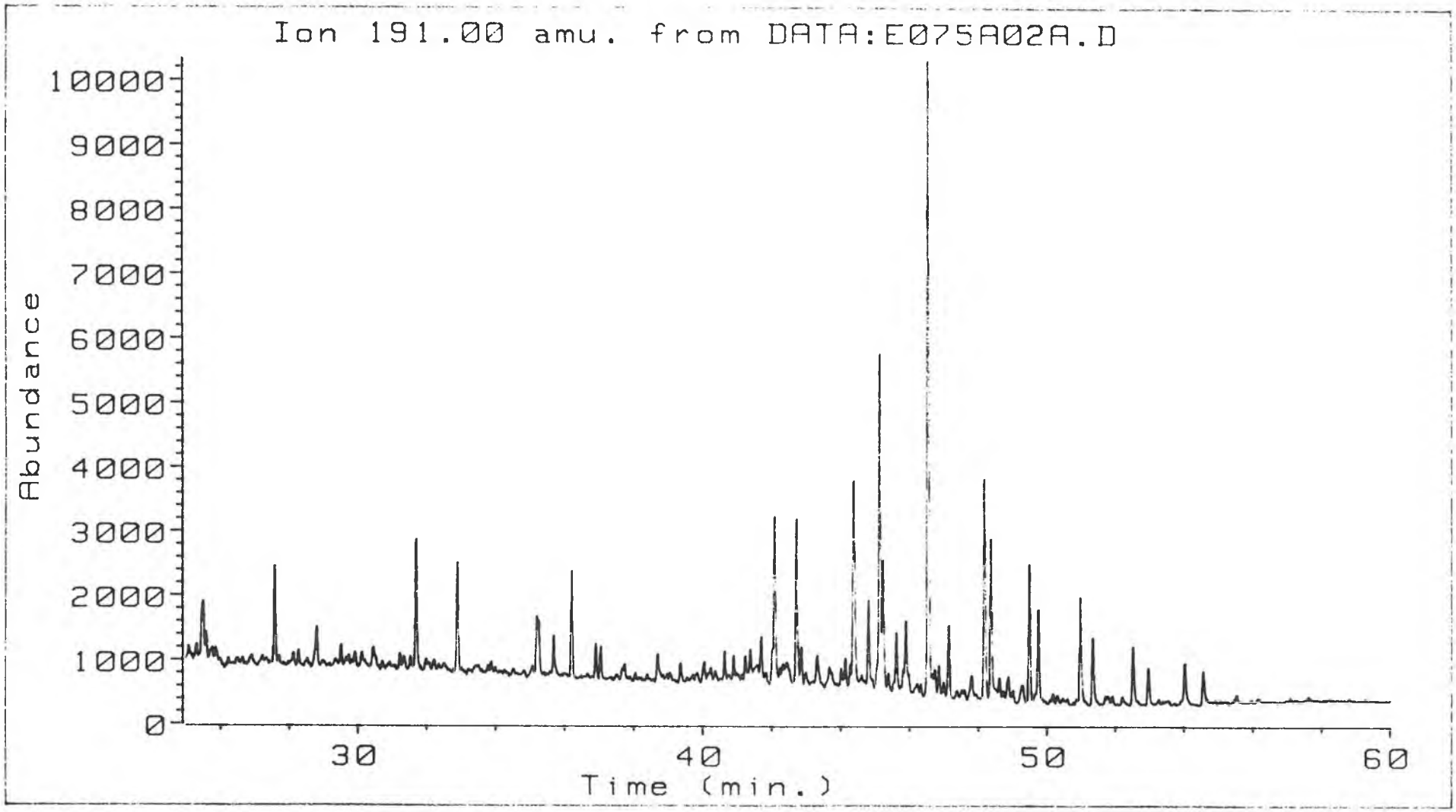
APPENDIX V: GC AND MASSFRAGMENTOGRAMS OF 30/9-7 BHS AND STO

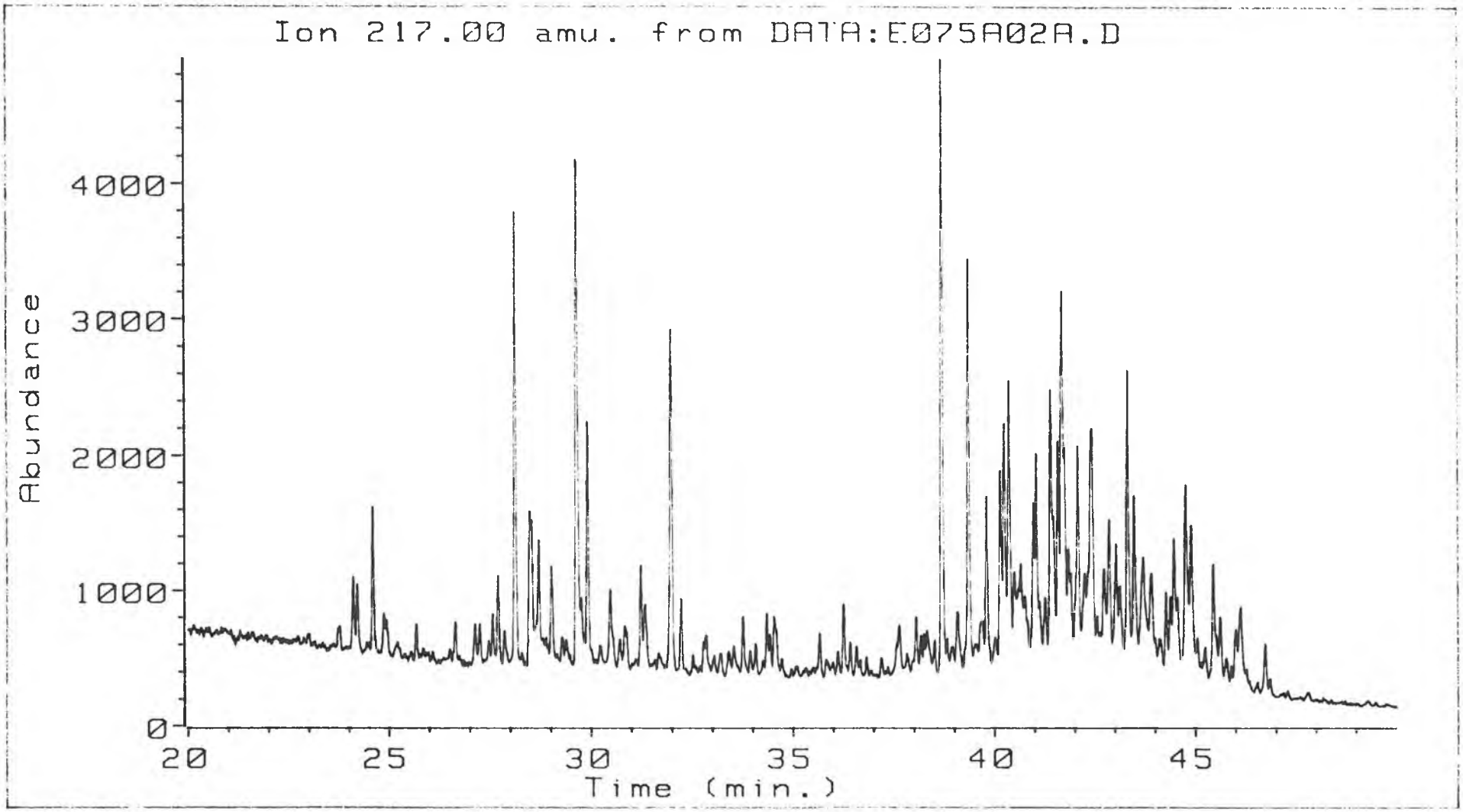

Analysis G732191S 7, 1, 1 30/9-7 BHS
Intensity (mV)
Retention Time (Minutes)
N-C10
N-C11
N-C12
N-C13
N-C14
I-C16
N-C15
N-C16
I-C18
N-C17
PRISTANE
N-C18
PHYTANE
N-C19
N-C20
N-C21
N-C22
N-C23
N-C24
N-C25
N-C26
N-C27
N-C28
N-C29
N-C30
N-C31
N-C32
N-C33

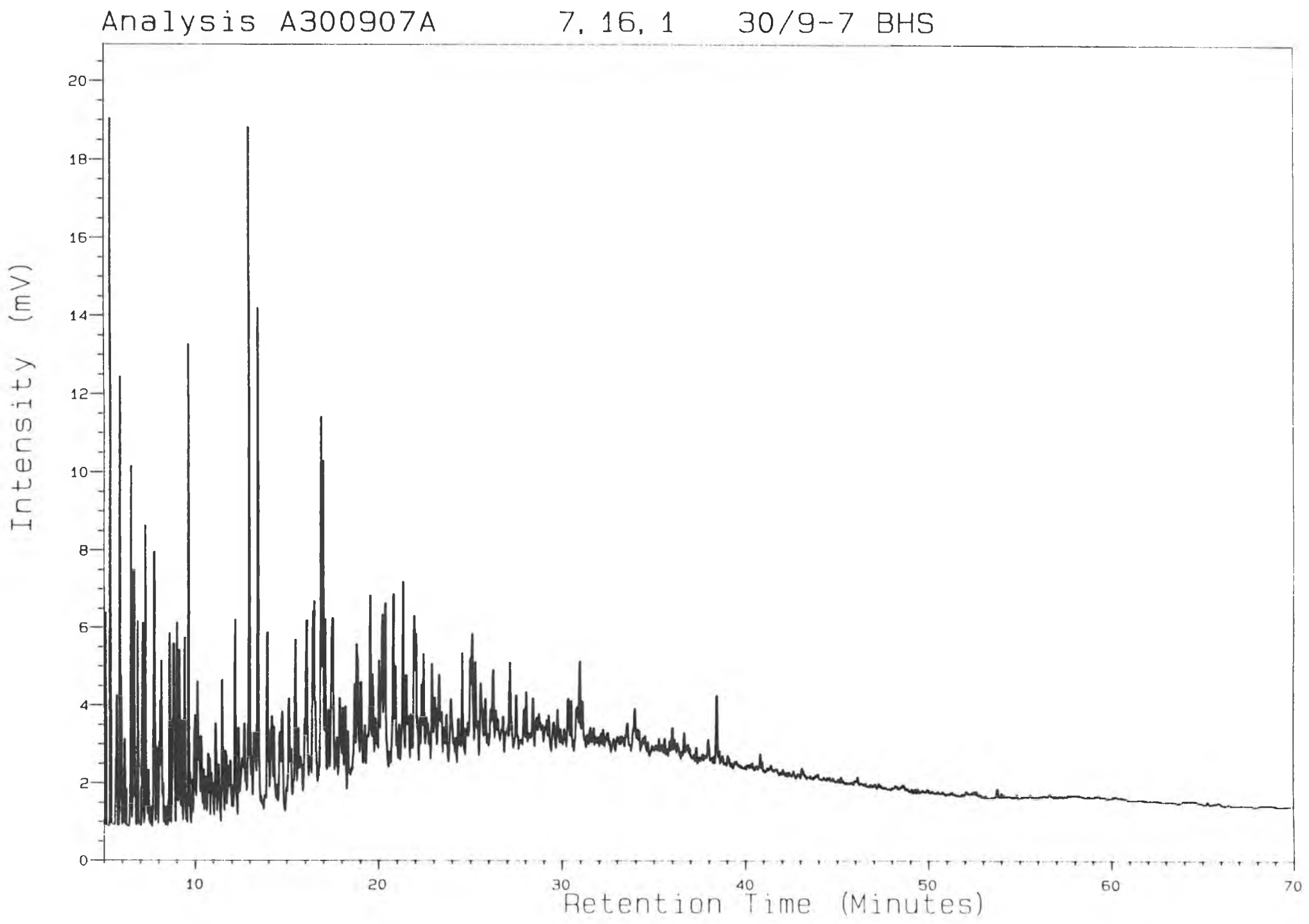

Analysis G732191S 7, 2, 1 30/9-7 STO
Intensity (mV)
Retention Time (Minutes)
N-C10
N-C11
N-C12
N-C13
N-C14
I-C16
N-C15
N-C16
I-C18
N-C17
PRISTANE
N-C18
PHYTANE
N-C19
N-C20
N-C21
N-C22
N-C23
N-C24
N-C25
N-C26
N-C27
N-C28
N-C29
N-C30
N-C31
N-C32
N-C33

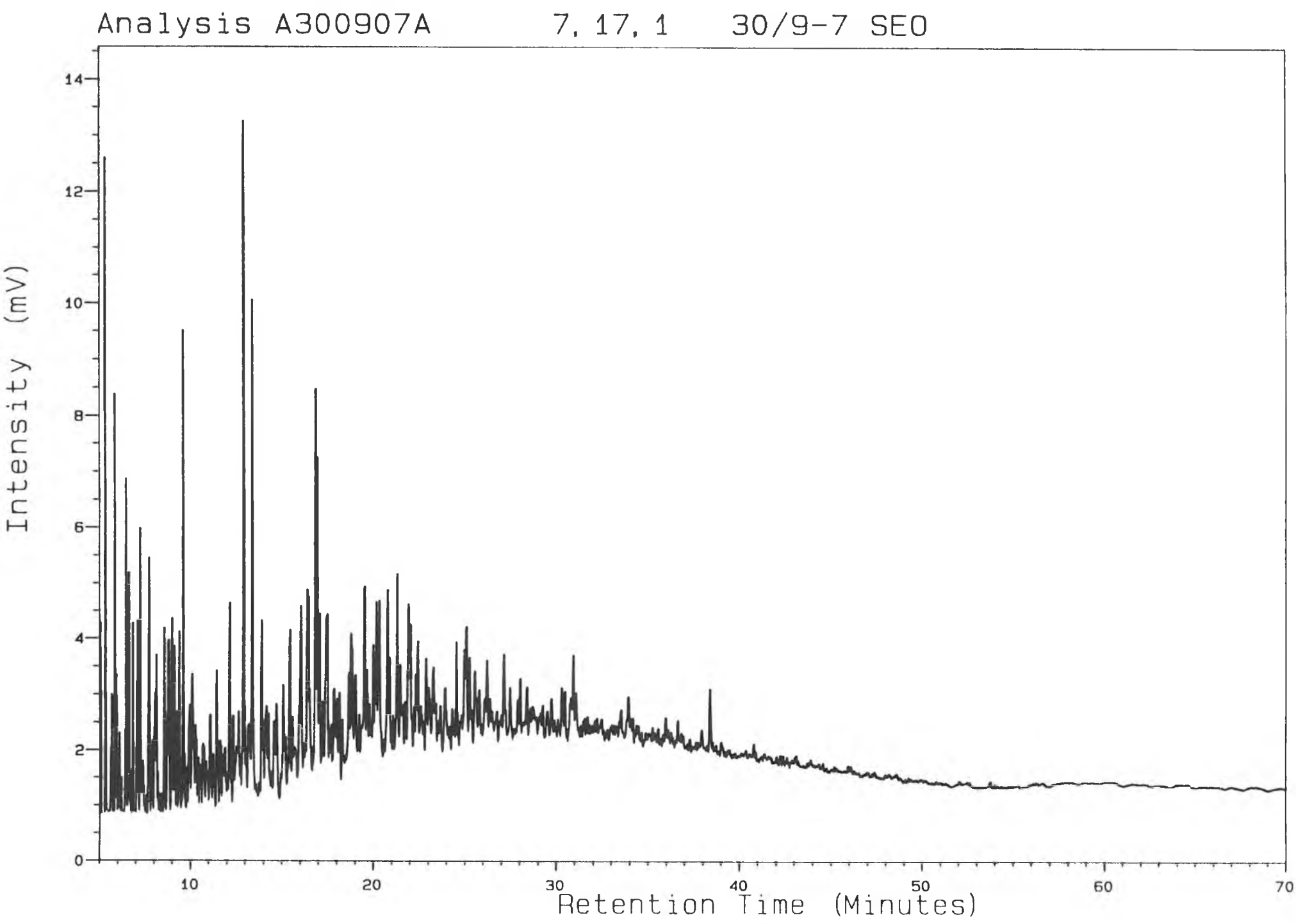

Ion 191.00 amu. from DATA:E075A01A.D
1.2E4
10000
8000
6000
4000
2000
0
Abundance
30
40
50
60
Time (min.)

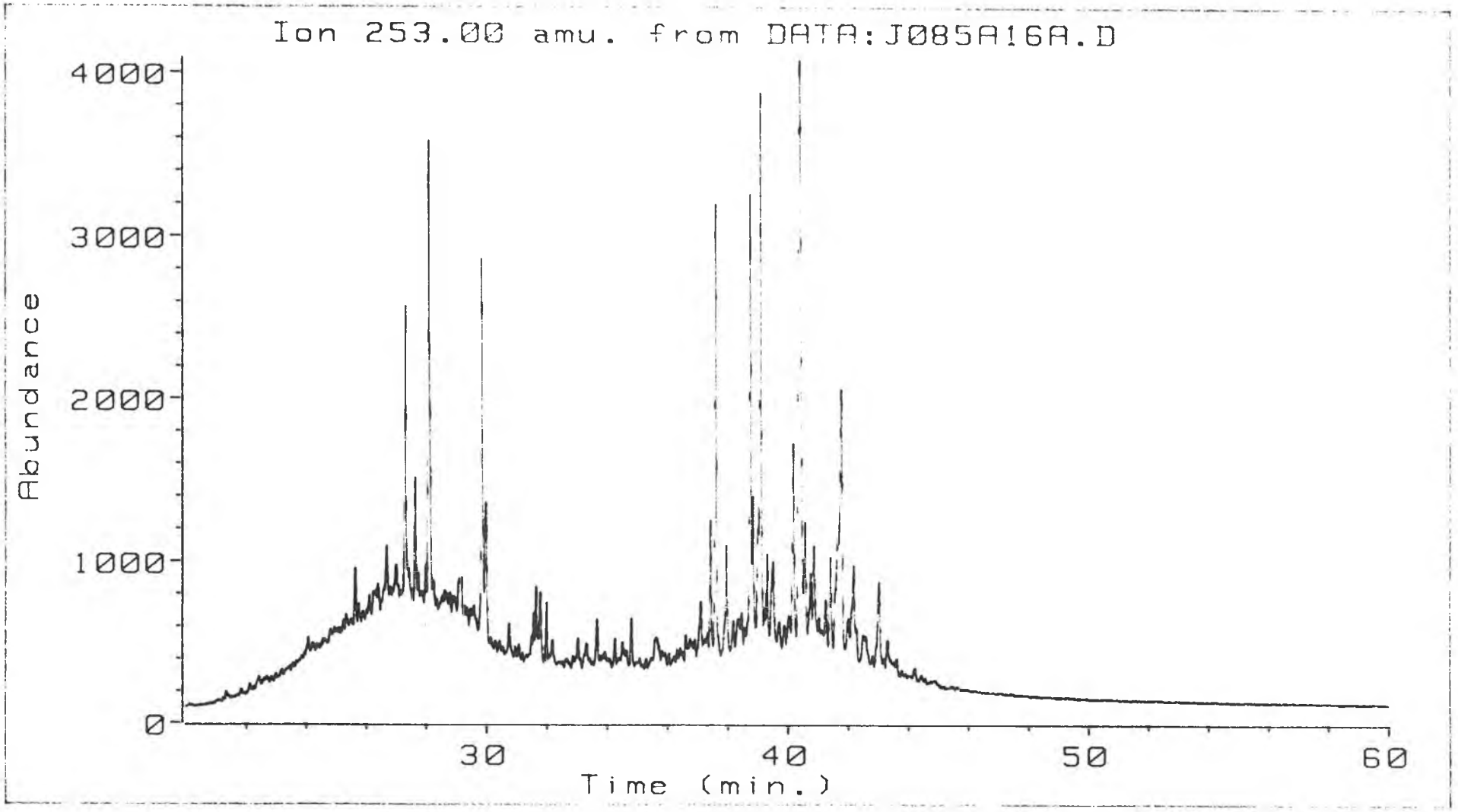

Ion 217.00 amu. from DATA:E075A01A.D
Abundance
5000
4000
3000
2000
1000
0
20
30
40
50
Time (min.)

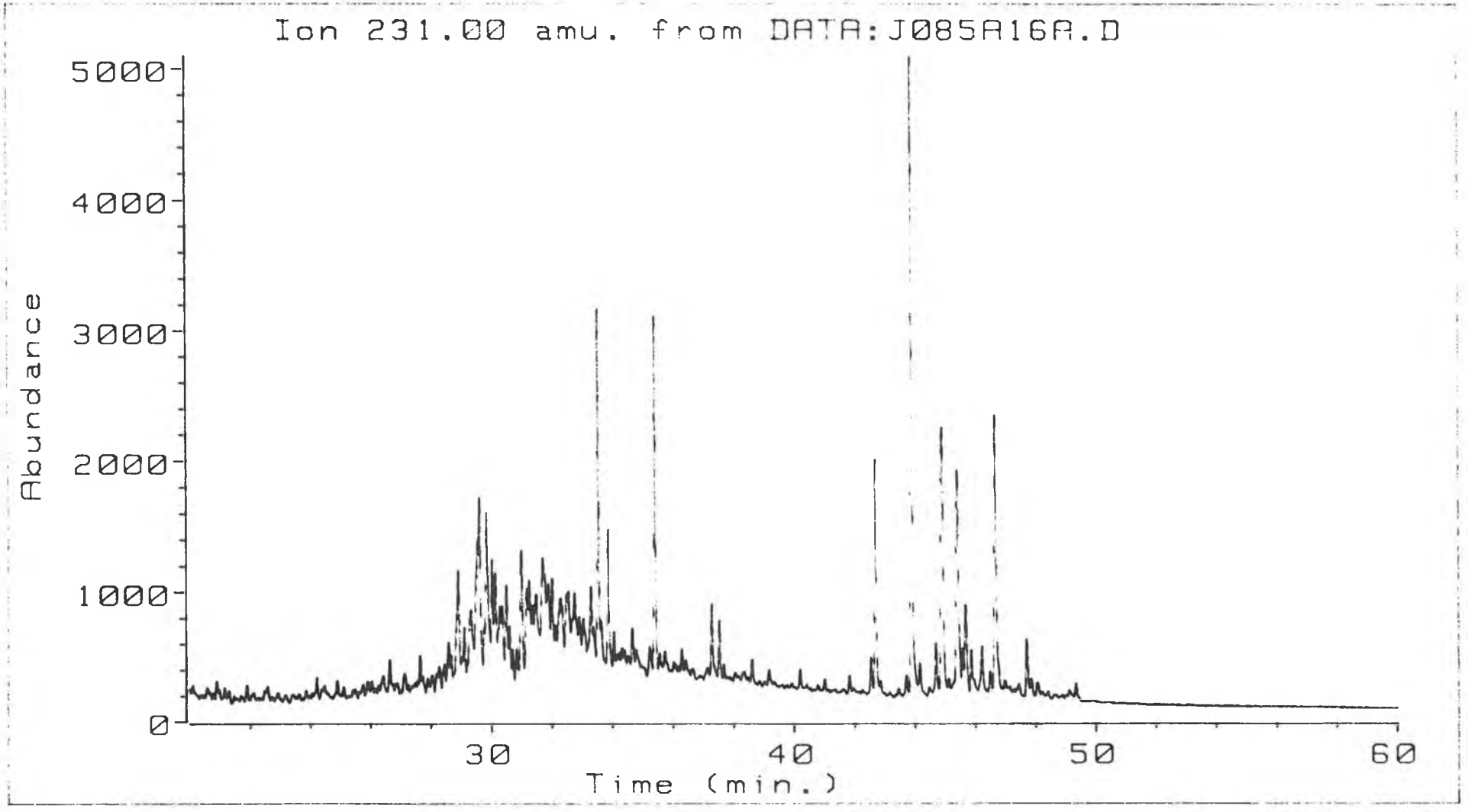

Ion 191.00 amu. from DATA:E075A02A.D
Abundance
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
30
40
50
60
Time (min.)

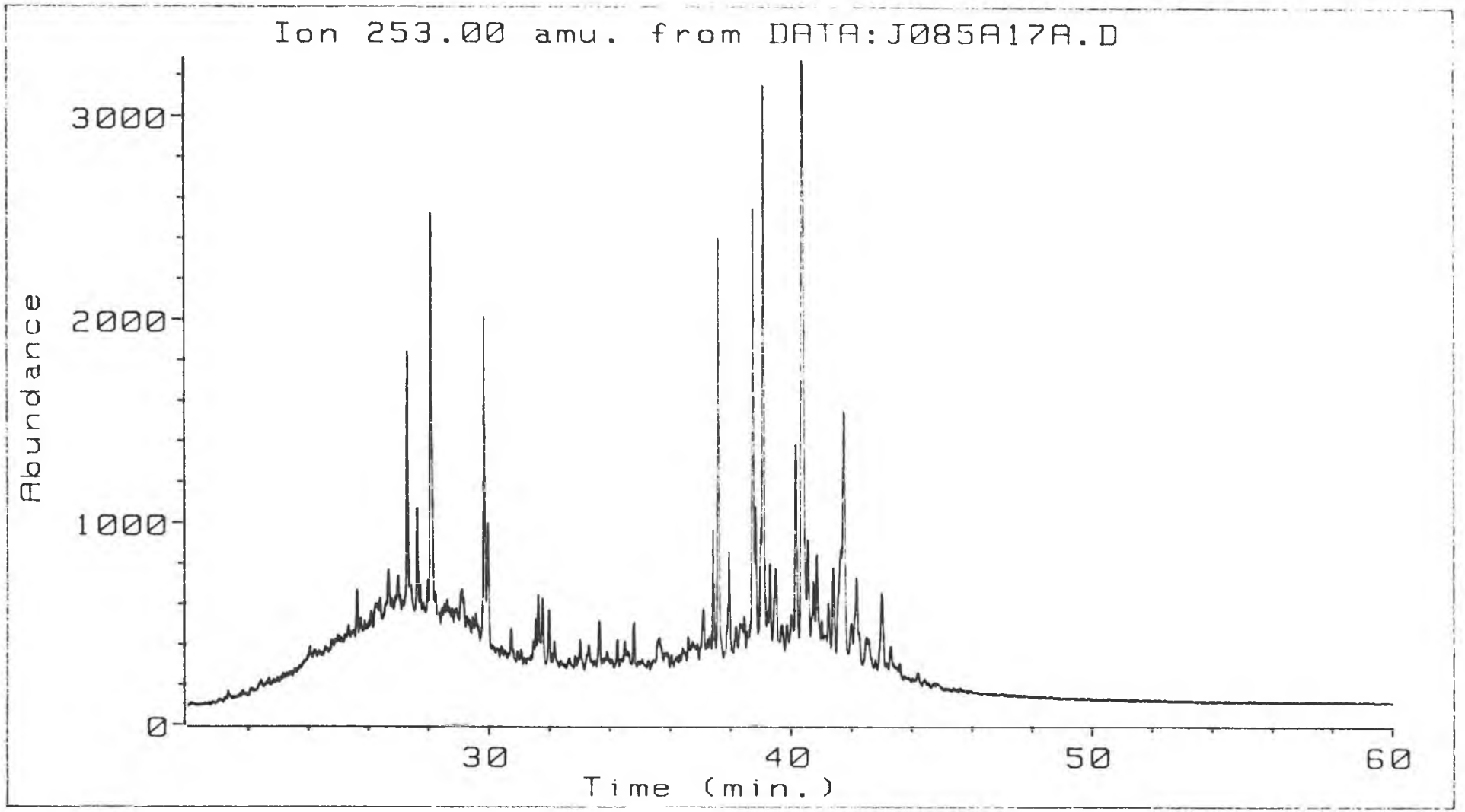

Ion 217.00 amu. from DATA:E075A02A.D
Abundance
4000
3000
2000
1000
0
20
25
30
35
40
45
Time (min.)

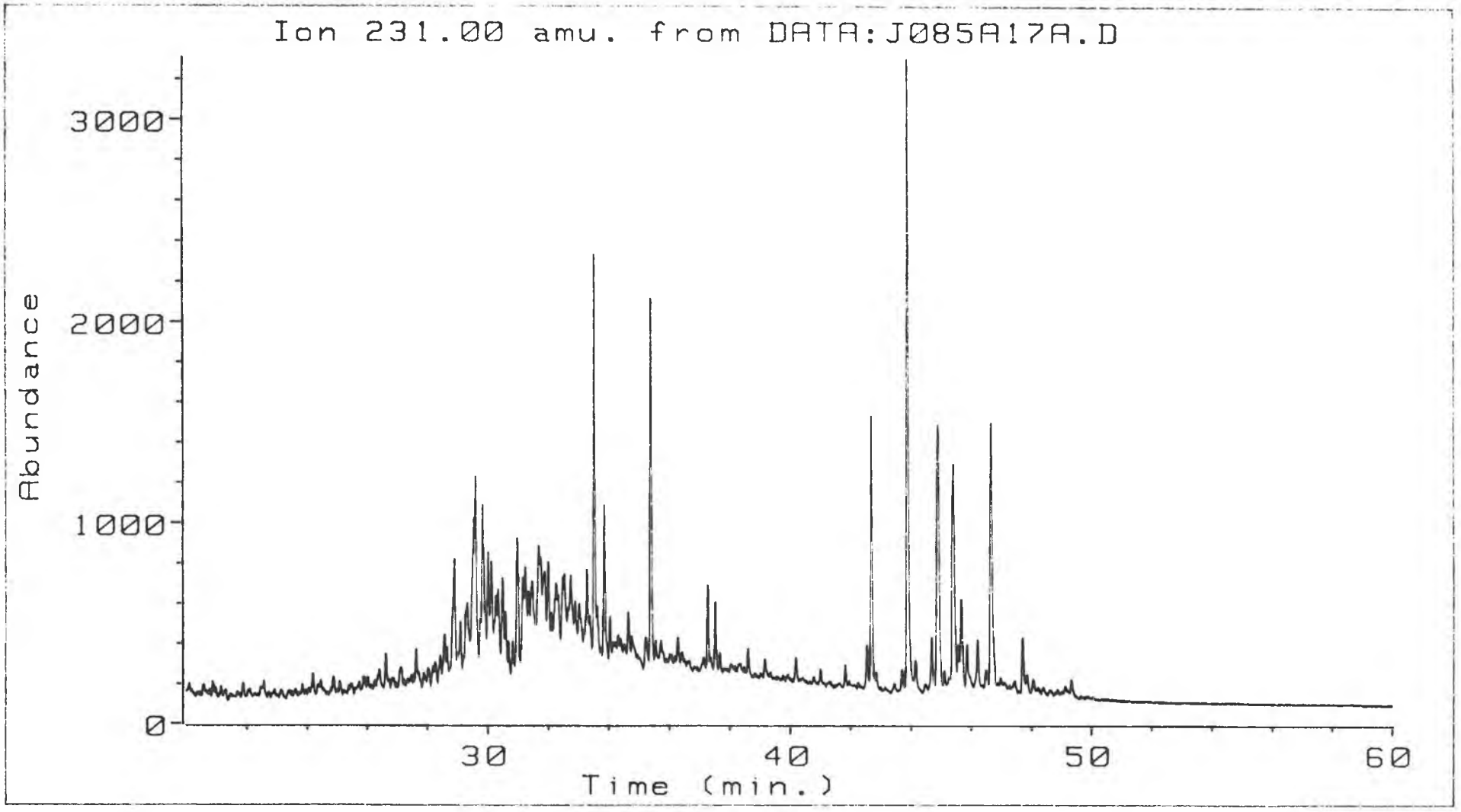

Analysis A300907A 7, 16, 1 30/9-7 BHS
Intensity (mV)
0
2
4
6
8
10
12
14
16
18
20
10
20
30
40
50
60
70
Retention Time (Minutes)


Analysis A300907A 7, 17, 1 30/9-7 SEO
Intensity (mV)
0
2
4
6
8
10
12
14
10
20
30
40
50
60
70
Retention Time (Minutes)

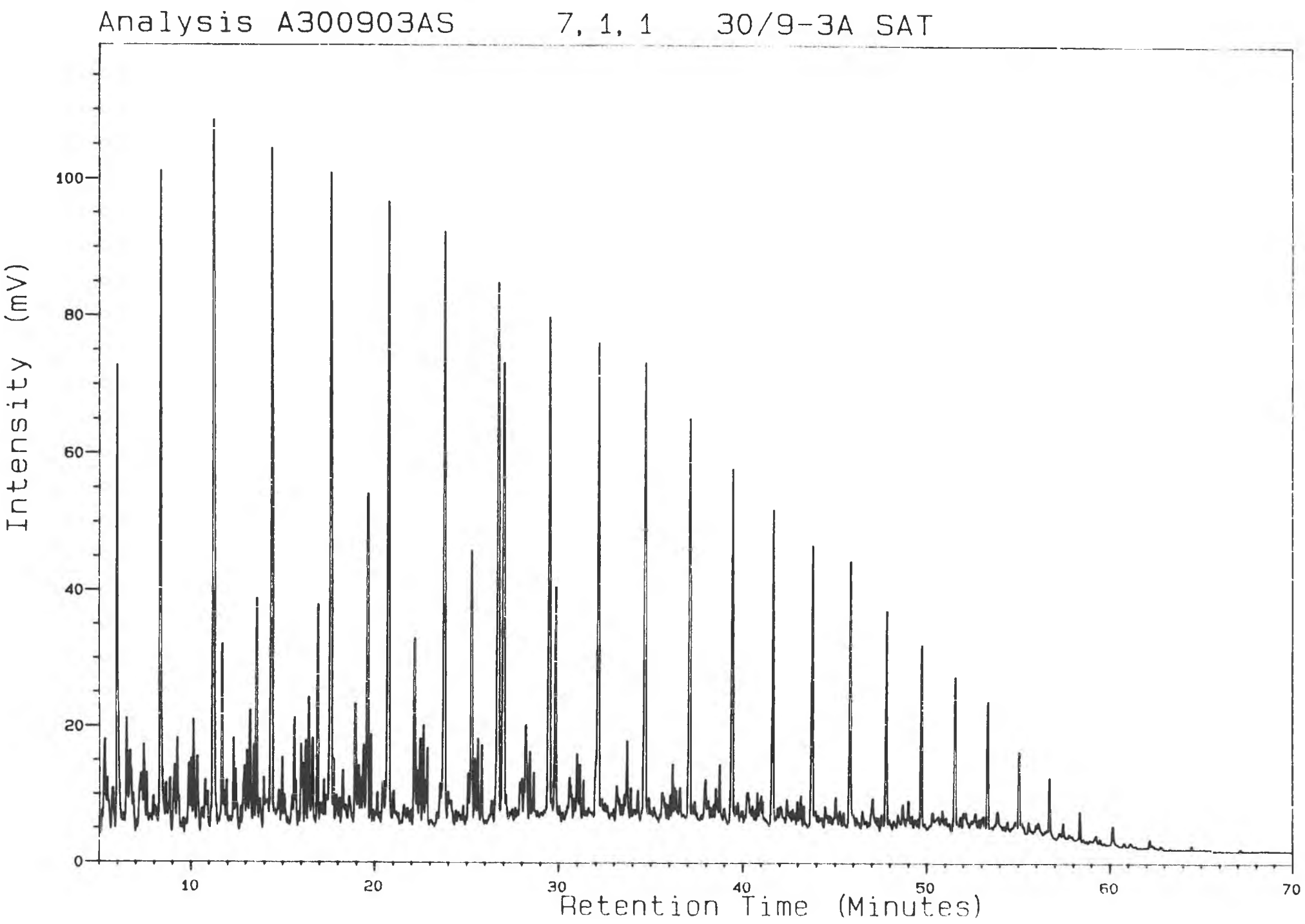

Ion 253.00 amu. from DATA:J085A16A.D
Abundance
4000
3000
2000
1000
0
30
40
50
60
Time (min.)

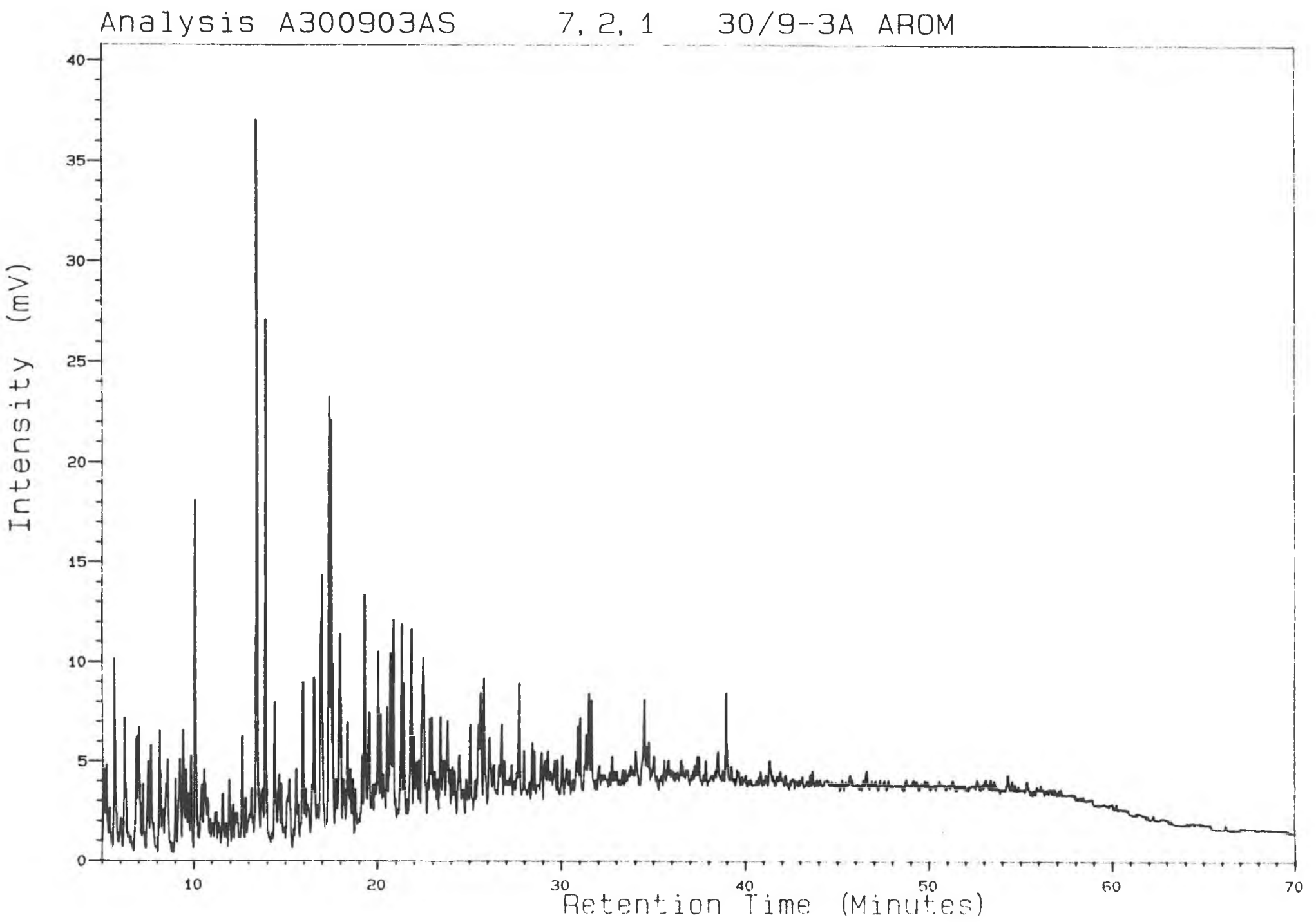

Ion 231.00 amu. from DATA:J085A16A.D
5000
4000
3000
2000
1000
0
Abundance
30
40
50
60
Time (min.)

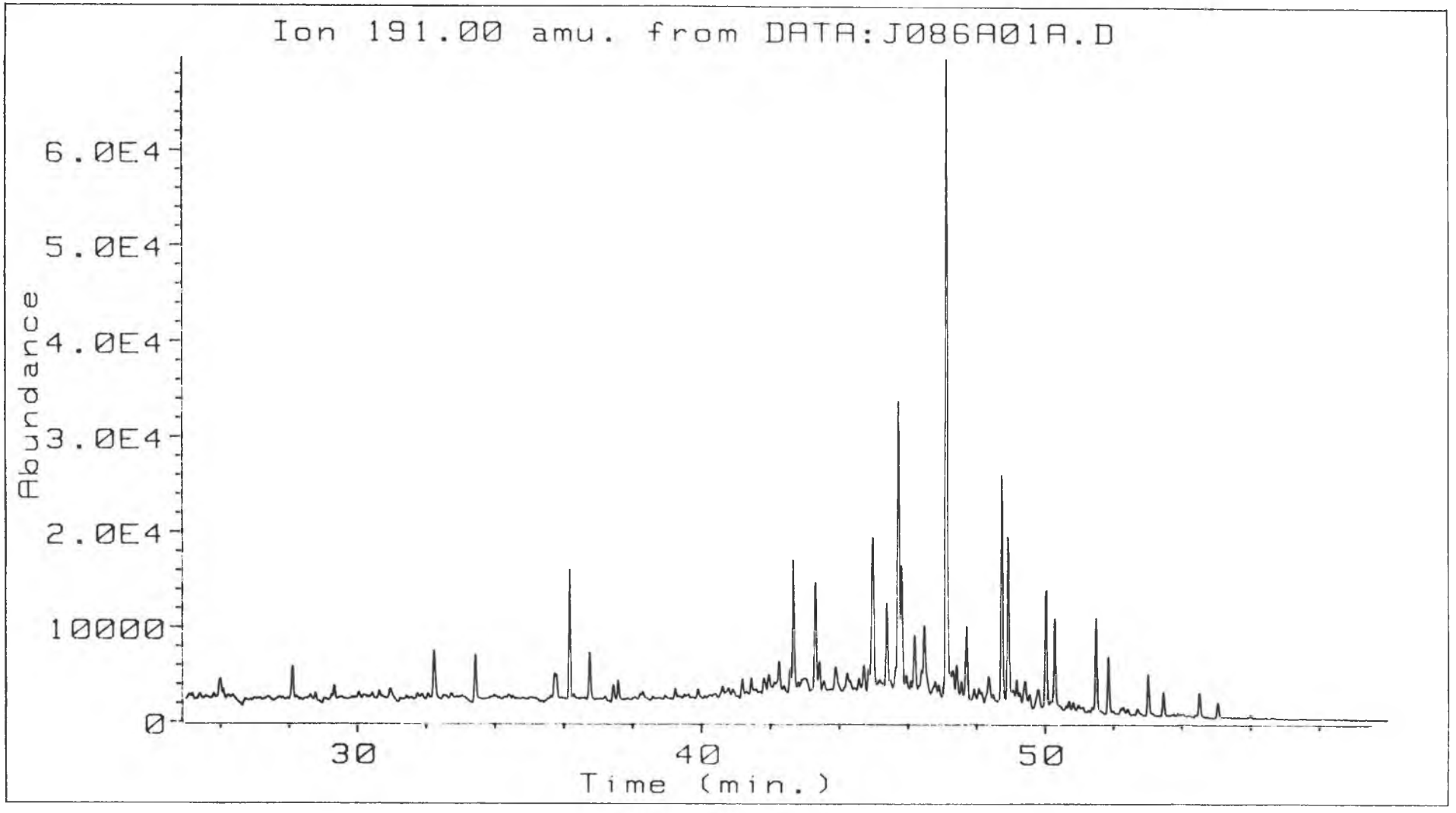

Ion 253.00 amu. from DATA:J085A17A.D
Abundance
3000
2000
1000
0
30
40
50
60
Time (min.)

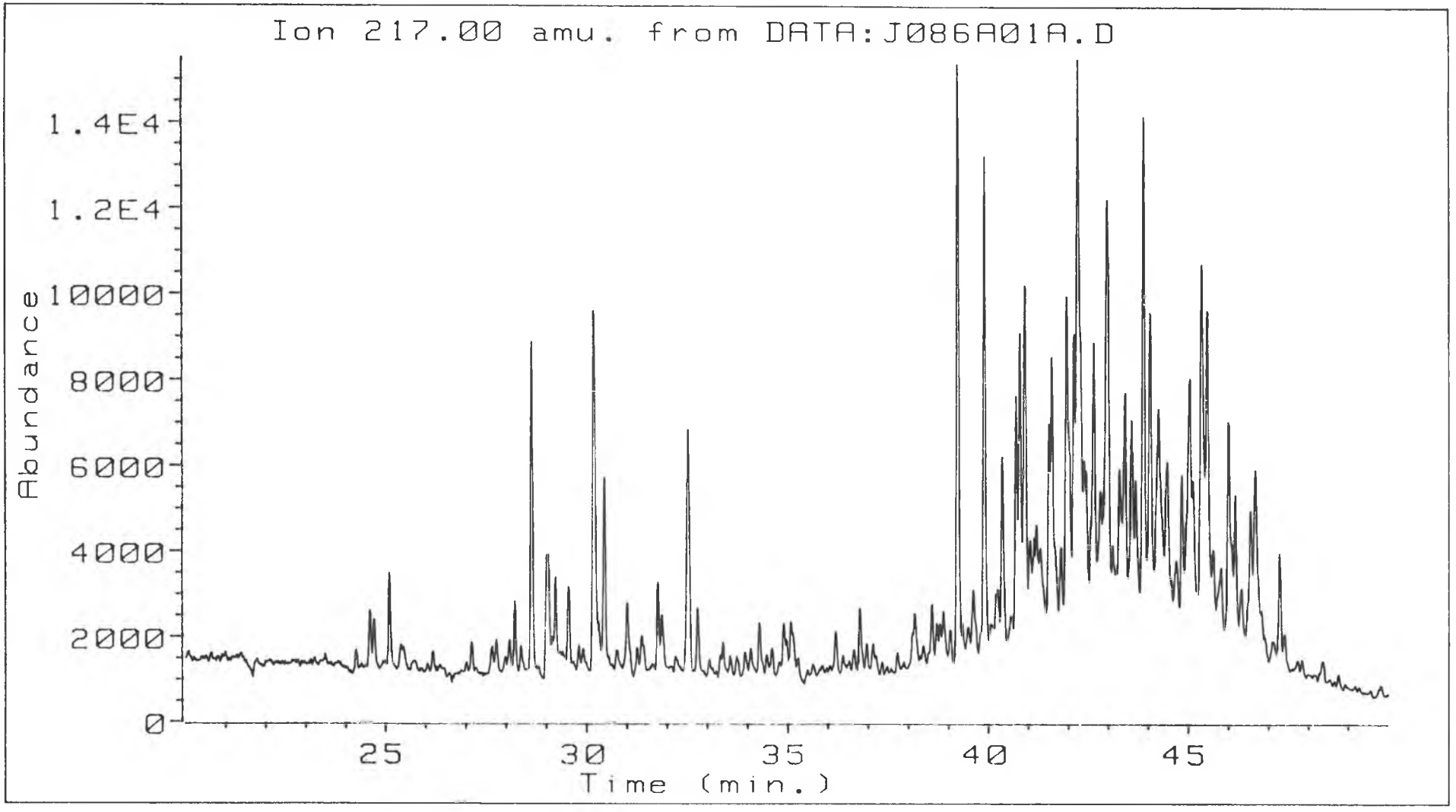

Ion 231.00 amu. from DATA:J085A17A.D
Abundance
3000
2000
1000
0
30
40
50
60
Time (min.)

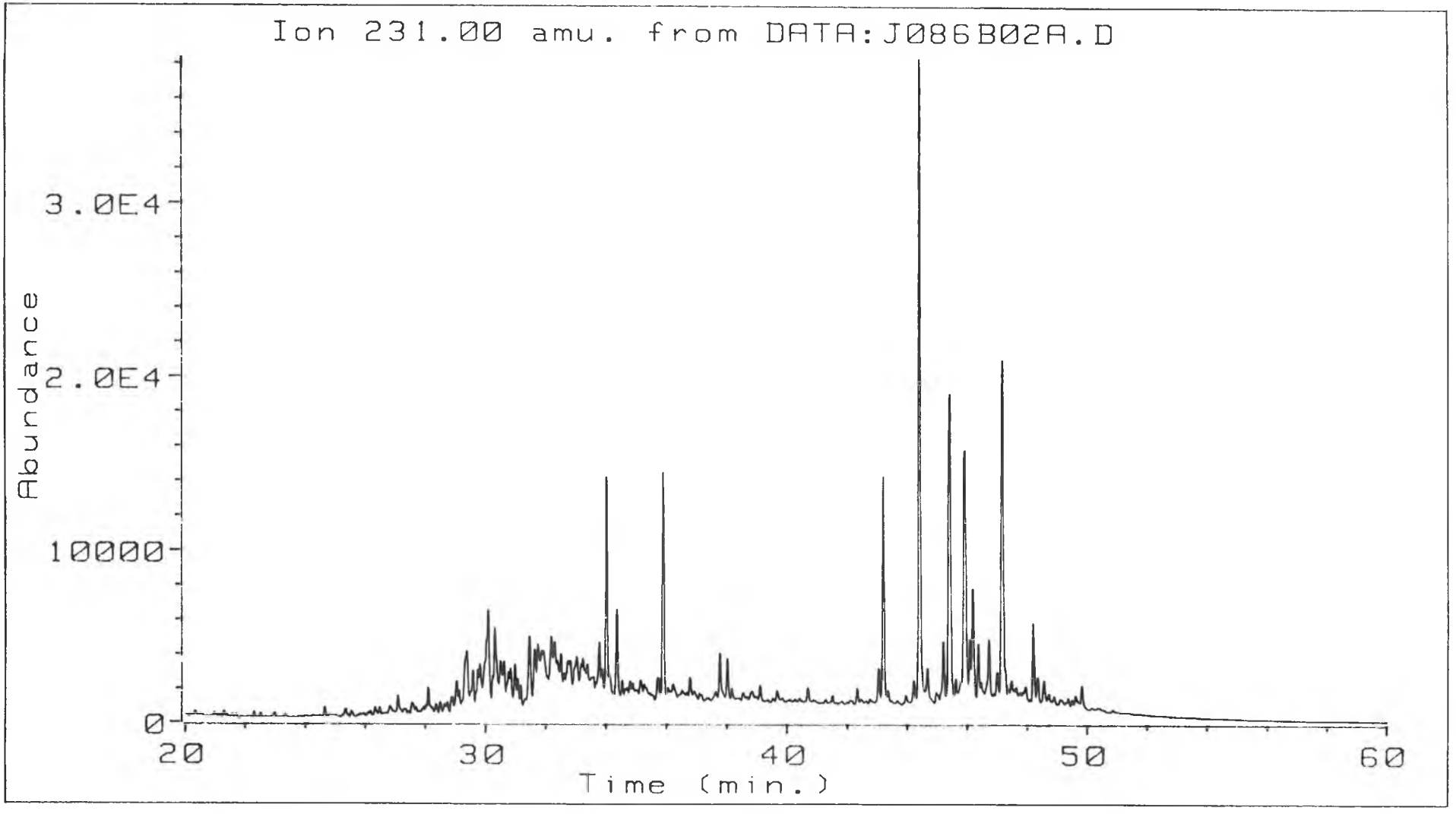
APPENDIX VI: GC AND MASSFRAGMENTOGRAM OF OIL FROM 30/9-3A

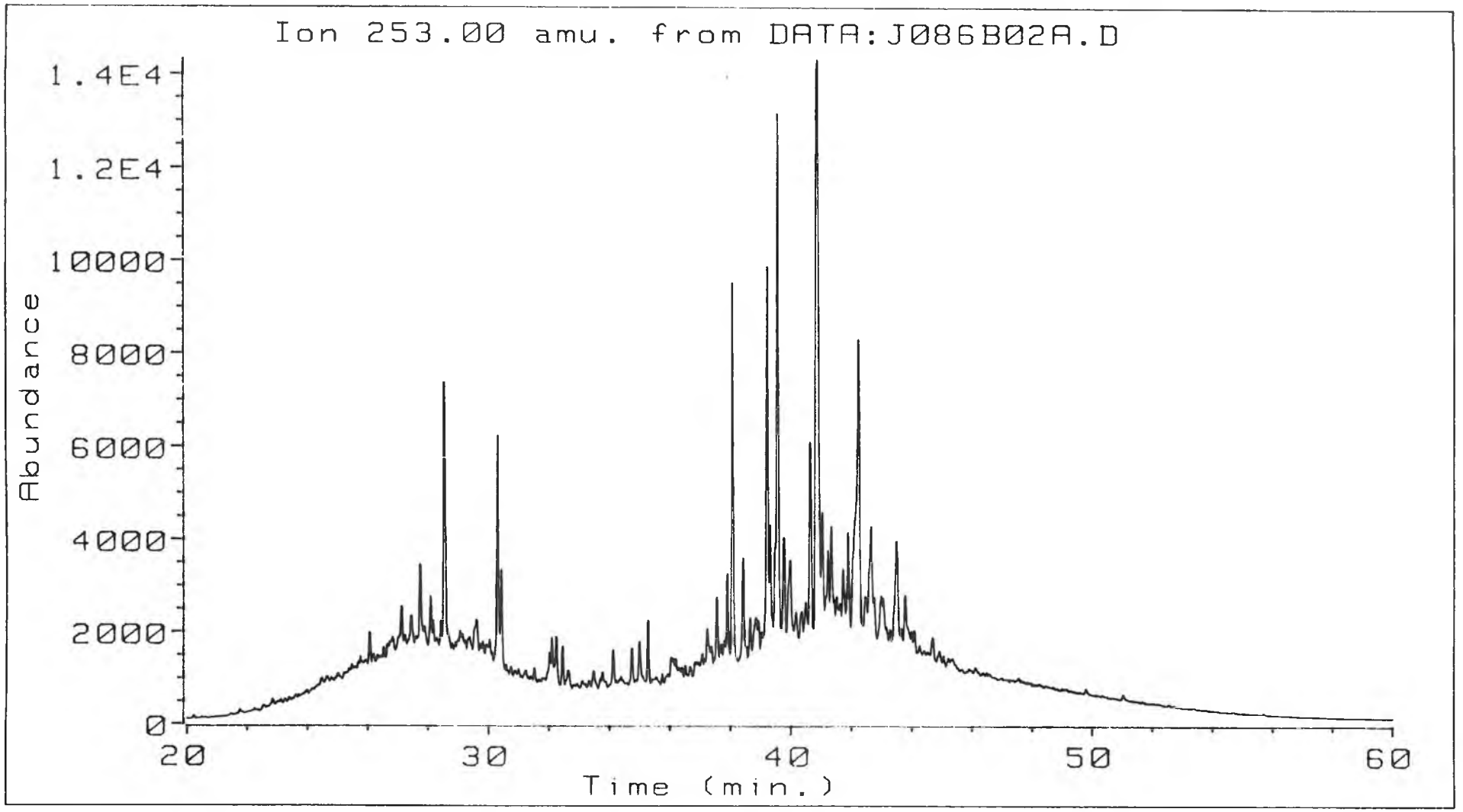

Analysis A300903AS 7, 1, 1 30/9-3A SAT
Intensity (mV)
0
20
40
60
80
100
10
20
30
40
50
60
70
Retention Time (Minutes)


Analysis A300903AS 7, 2, 1 30/9-3A AROM
Intensity (mV)
0
5
10
15
20
25
30
35
40
10
20
30
40
50
60
70
Retention Time (Minutes)


Ion 191.00 amu. from DATA:J086A01A.D
Abundance
6.0E4
5.0E4
4.0E4
3.0E4
2.0E4
10000
0
30
40
50
Time (min.)


Ion 217.00 amu. from DATA:J086A01A.D
Abundance
1.4E4
1.2E4
10000
8000
6000
4000
2000
0
25
30
35
40
45
Time (min.)


Ion 231.00 amu. from DATA:J086B02A.D
Abundance
3.0E4
2.0E4
10000
0
20
30
40
50
60
Time (min.)


Ion 253.00 amu. from DATA:J086B02A.D
1.4E4
1.2E4
10000
8000
6000
4000
2000
0
Abundance
20
30
40
50
60
Time (min.)