July 20th, 2015

formerly ZymaX Forensics

Jim Nahach
Missouri DNR
2710 W Main
Jefferson City, MO 65109

RE: 152918, 152920, 152922
Project Number: ---

Pace Analytical received 3 sample(s) received on June 30th, 2015 for analysis labeled 152918, 152920, and 152922. Per client request, the following analyses were performed:

1. C8-C40 (ASTM 5739)
2. Oxygenates (EPA 1624)

The sample was performed in house under laboratory number **15999**.

Please call the lab at 412-826-4481, or you may email any questions or concerns to taryn.mancine@pacelabs.com regarding any analytical data reports.

Respectfully submitted,

Taryn Mancine

Taryn Mancine
Project Manager/Scientist

15999 PO Box - / jim.pahach@dnr.mo.gov /

MISSOURI DEPARTMENT OF NATURAL RESOURCES
FIELD SHEET AND CHAIN-OF-CUSTODY RECORD

Description of Delivery
- [x] Tape sealed and initialed
- [x] Shipped
- [ ] Hand Delivered

Total No. Of Containers: 7
Carrier: UPS Next Day Air
By:

Collector's Name: (Please Print) Transfer Chain of Custody to Pace Analytical

Affiliation: [ ] KCRO [ ] NERO [ ] SERO [ ] SLRO [ ] SWRO [ ] WPP [ ] MGS [ ] HWP [ ] ESP [ ] MoDOT [ ] MDC [ ] DHSS [ ] Other:

LAB USE ONLY!
Laboratory ID:
Location:

Sample Number	Sample Collected	Analyses Requested	Disinfect. Type (check one)	Field Parameters (include units)	Matrix (check one)	Container Type	Preservative Type	Number of Containers
152918 (Sample A) / For Lab Use Only	Date: 6/11/2015 Time: 0925	C8 - C40 Scan, Oxygenated Blending Agents, (Interpretived Report) 3 vials	[ ] None [ ] Chlorine [ ] UV [ ] Ozone [ ] Other:	D.O. Flow pH Cond. Temp. Other:	[ ] Water [ ] Soil [ ] Organic [ ] Sludge [ ] Other:			
152920 (Sample B) / For Lab Use Only	Date: 6/11/2015 Time: 0955	C8 - C40 Scan (Interpretive Report) 1 vials	[ ] None [ ] Chlorine [ ] UV [ ] Ozone [ ] Other:	D.O. Flow pH Cond. Temp. Other:	[ ] Water [ ] Soil [ ] Organic [ ] Sludge [ ] Other:			
152922 (Sample C) / For Lab Use Only	Date: 6/11/2015 Time: 1035	C8 - C40 Scan, Oxygenated Blending Agents, (Interpretived Report) 3 vials	[ ] None [ ] Chlorine [ ] UV [ ] Ozone [ ] Other:	D.O. Flow pH Cond. Temp. Other:	[ ] Water [ ] Soil [ ] Organic [ ] Sludge [ ] Other:			
(Sample D) / For Lab Use Only	Date: Time:		[ ] None [ ] Chlorine [ ] UV [ ] Ozone [ ] Other:	D.O. Flow pH Cond. Temp. Other:	[ ] Water [ ] Soil [ ] Organic [ ] Sludge [ ] Other:			

COC

Relinquished By: Lori Cummins	Received By: [signature]	Date: 6.30.15	Time: 1025
Relinquished By:	Received By:	Date:	Time:
Relinquished By:	Received By:	Date:	Time:

Cooler Receipt Form

Client Name: Missouri Project: Forensics Lab Work Order: 15999

A. Shipping/Container Information (circle appropriate response)

Courier: FedEx (UPS) USPS Client Other:_____ Air bill Present: (Yes) No

Tracking Number: 1Z 672 788 01 4478 6820

Custody Seal on Cooler/Box Present: Yes (No) Seals Intact: Yes No

Cooler/Box Packing Material: (Bubble Wrap) Absorbent Foam Other:_____

Type of Ice: Wet (Blue) None Ice Intact: (Yes) Melted

Cooler Temperature: 5°C Radiation Screened: Yes (No) Chain of Custody Present: (Yes) No

Comments:_____

B. Laboratory Assignment/Log-in (check appropriate response)

	YES	NO	N/A	Comment Reference non-Conformance
Chain of Custody properly filled out	✓			
Chain of Custody relinquished	✓			
Sampler Name & Signature on COC		✓		
Containers intact	✓			
Were samples in separate bags	✓			
Sample container labels match COC Sample name/date and time collected		✓		
Sufficient volume provided	✓			
PAES containers used			✓	
Are containers properly preserved for the requested testing? (as labeled)			✓	
If an unknown preservation state, were containers checked? Exception: VOA's coliform			✓	If yes, see pH form.
Was volume for dissolved testing field filtered, as noted on the COC? Was volume received in a preserved container?			✓	

Comments:_____

Cooler contents examined/received by: LY Date: 6.30.15

Project Manager Review: TM Date: 7/1/15

NON-CONFORMANCE FORM

PAES Work Order #: 15999

Date: 6.30.15 Time of Receipt: 1025 Receiver: LY

Client: Missouri DNR

REASON FOR NON-CONFORMANCE:

1. Did not receive 152920.

2. 7.1.15: Received 152920. Temp. upon receipt was 22°C. Blue ice all melted.

ACTION TAKEN:

Client name: Jim Nahach Date: 6/30/15 Time: 3:30

client found 152920 – shipped for delivery on 7/1/15 (1 vial only)

Customer Service Initials: TM Date: 6/30/15

F-PAE-Q-014-rev.00, 20 Nov2014

REPORT OF ANALYTICAL RESULTS

Client: Jim Nahach Missouri DNR 2710 W Main Jefferson City, MO 65109	**Lab Number:** 15999-1 **Collected:** 6/11/2015 **Received:** 6/30/2015 **Matrix:** Product
Project: - **Project Number:** - **Collected by:** -	**Sample Description:** 152918 **Analyzed:** 7/18/2015 **Method:** EPA 1624 GC/MS SIM

CONSTITUENT	PQL* mg/Kg	RESULT** mg/Kg
t-Amyl Methyl Ether (TAME)	100	ND
t-Butyl Alcohol (TBA)	10	ND
Diisopropyl Ether (DIPE)	100	ND
Ethanol	10	ND
Ethyl-t-Butyl Ether (ETBE)	50	ND
Methyl-t-Butyl Ether (MTBE)	50	ND
Percent Surrogate Recovery (MTBE-d3)		94

***PQL - Practical Quantitation Limit**
****Results listed as ND would have been reported if present at or above the listed PQL.**

15999-1.oxy.xls
RL

REPORT OF ANALYTICAL RESULTS

Client: Jim Nahach Missouri DNR 2710 W Main Jefferson City, MO 65109	**Lab Number:** 15999-3 **Collected:** 6/11/2015 **Received:** 6/30/2015 **Matrix:** Product
Project: - **Project Number:** - **Collected by:** -	**Sample Description:** 152922 **Analyzed:** 7/18/2015 **Method:** EPA 1624 GC/MS SIM

CONSTITUENT	PQL* mg/Kg	RESULT** mg/Kg
t-Amyl Methyl Ether (TAME)	100	ND
t-Butyl Alcohol (TBA)	10	ND
Diisopropyl Ether (DIPE)	100	ND
Ethanol	10	ND
Ethyl-t-Butyl Ether (ETBE)	50	ND
Methyl-t-Butyl Ether (MTBE)	50	ND
Percent Surrogate Recovery (MTBE-d3)		99

***PQL - Practical Quantitation Limit**
****Results listed as ND would have been reported if present at or above the listed PQL.**

15999-3.oxy.xls
RL

Total Oxygenates in Product
EPA 8260 - Direct Injection

Data File Information:			
File:	071709.D	Sampe Info:	15999-1
Operator:	S Lu		3ul, 10ml 10ml -121614
Date Acquired:	7/27/15	Instrument:	GC/MS Ins
Method File:	TOXY	Dilution Factor:	1.000

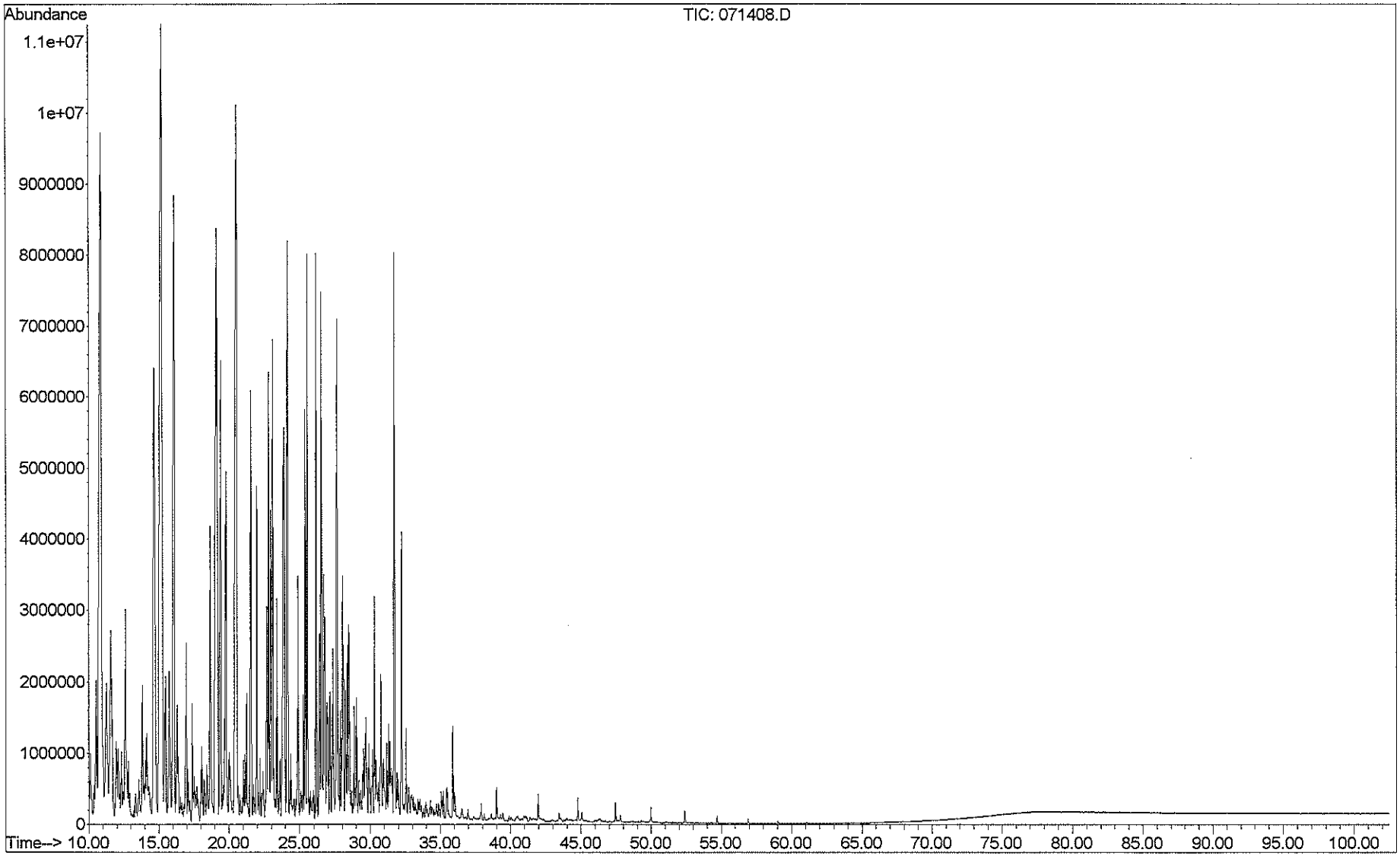
pk#	Compound	Ret Time	Area	PQL	Amount
2	DIPE (Diiospropyl ether)	1.56	350	100	2 mg/Kg
4	MTBE (methyl tert butyl ether)	1.39	1031	50	2 mg/Kg
5	ETBE (ethyl tert butyl ether)	1.43	515	50	3 mg/Kg
6	TAME (tert amyl methyl ether)	0.00	0	100	0 mg/Kg
8	TBA (tert butyl alcohol)	2.33	136	10	0 mg/Kg
10	Methyl Alcohol	2.31	274	50	0 mg/Kg
12	Ethyl Alcohol	2.53	686	10	1 mg/Kg
1	Diethyl Ether-d10	1.22	47620		100 mg/Kg
7	TBA-d10	2.19	153415		100 mg/Kg
9	MeOH-d4	2.18	69205		100 mg/Kg
11	EtOH-d5	2.42	93340		100 mg/Kg
3	MTBE-d3	1.38	9862		99 %

Total Oxygenates in Product
EPA 8260 - Direct Injection

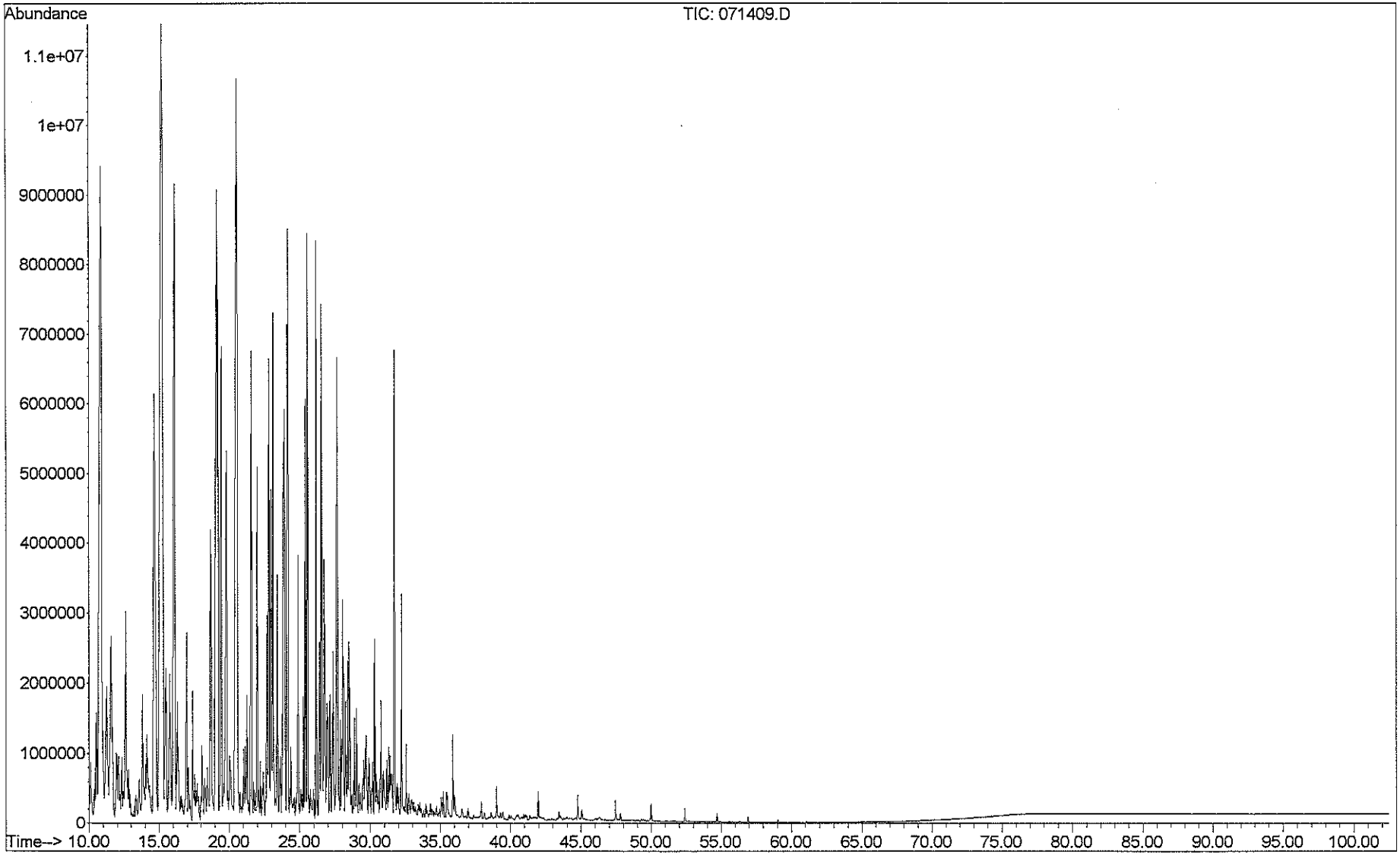
Data File Information:			
File:	071710.D	Sampe Info:	15999-3
Operator:	S Lu		3ul, 10ml 10ml -121614
Date Acquired:	7/27/15	Instrument:	GC/MS Ins
Method File:	TOXY	Dilution Factor:	1.000

pk#	Compound	Ret Time	Area	PQL	Amount
2	DIPE (Diiospropyl ether)	1.36	857	100	5 mg/Kg
4	MTBE (methyl tert butyl ether)	1.38	1206	50	3 mg/Kg
5	ETBE (ethyl tert butyl ether)	1.40	343	50	2 mg/Kg
6	TAME (tert amyl methyl ether)	0.00	0	100	0 mg/Kg
8	TBA (tert butyl alcohol)	2.30	114	10	0 mg/Kg
10	Methyl Alcohol	2.23	2958	50	3 mg/Kg
12	Ethyl Alcohol	2.53	344	10	0 mg/Kg
1	Diethyl Ether-d10	1.22	44443		100 mg/Kg
7	TBA-d10	2.19	159545		100 mg/Kg
9	MeOH-d4	2.18	74440		100 mg/Kg
11	EtOH-d5	2.42	87236		100 mg/Kg
3	MTBE-d3	1.38	8577		92 %

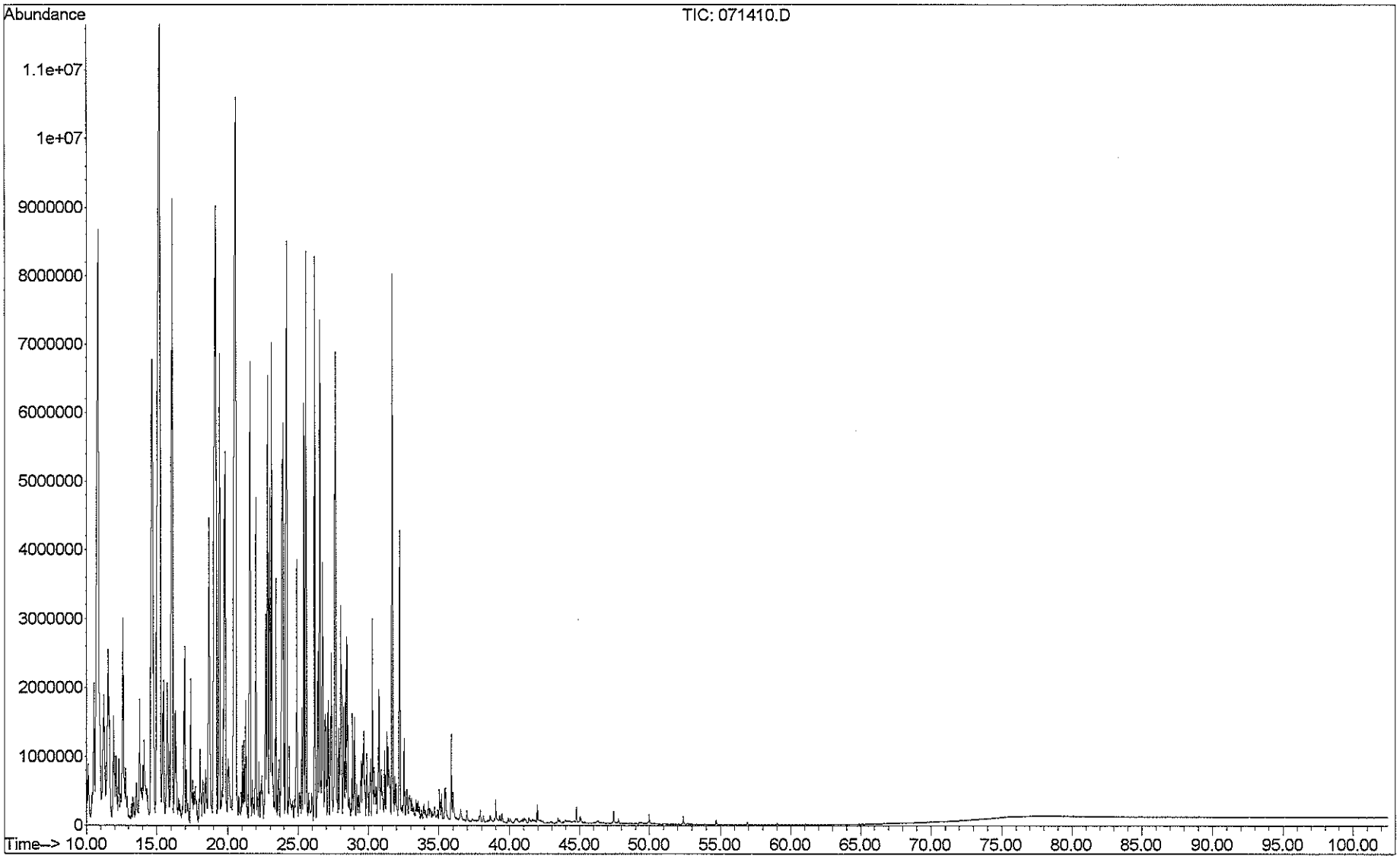
Sample Name: 152918 (15999-1)
Misc Info :



Sample Name: 152920 (15999-2)
Misc Info :



Sample Name: 152922 (15999-3)
Misc Info :

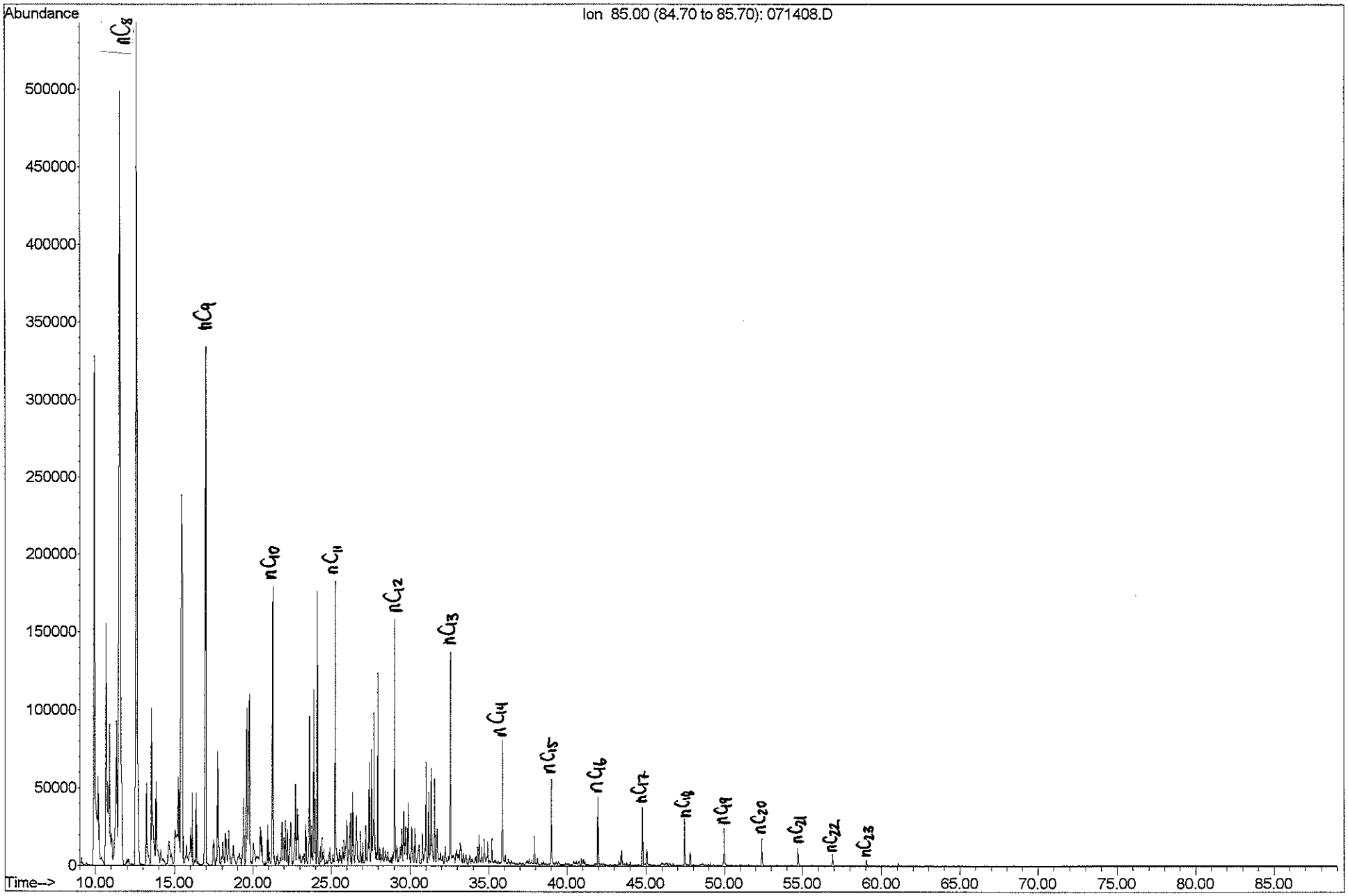


Table

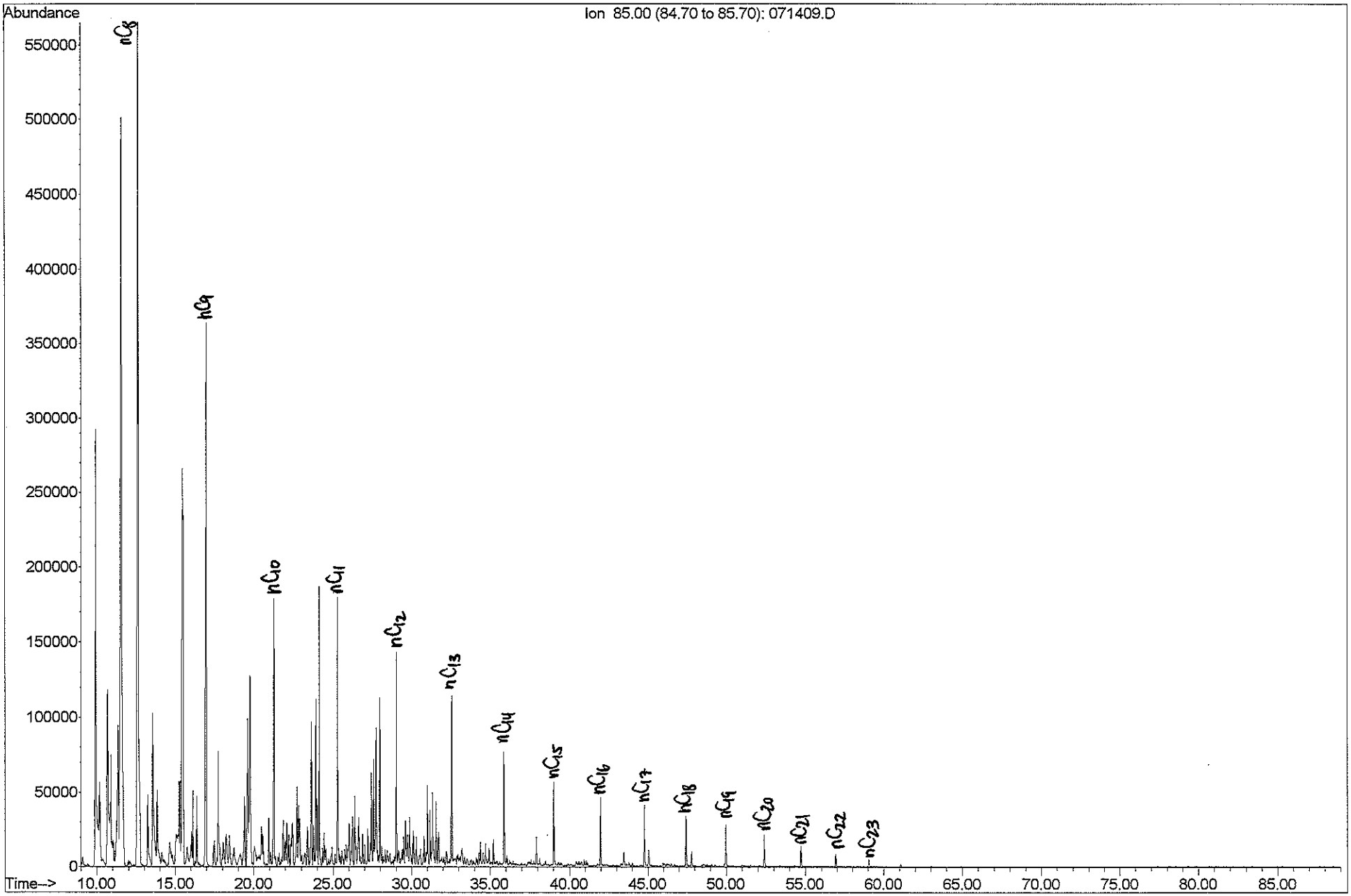
Key to Chromatogram Symbol Identification for m/z 85 and m/z 113 Paraffins and Isoparaffins

Symbol	Detail
i-10	Iso-alkane with 10 carbon atoms
i-15	Farnesane (isoprenoid with 15 carbon atoms)
i-16	Isoprenoid with 16 carbon atoms
Pr.	Pristane (isoprenoid with 19 carbon atoms)
Ph	Phytane (isoprenoid with 20 carbon atoms)
nC_8	n-C_8 normal alkane
nC_{15}	n-C_{15} normal alkane
i-8	2,5-(2,4)-Dimethylhexane
i-8'	2,3,4-Trimethylpentane
i-8"	2,3-Dimethylhexane
CH-*n*	Alkylcyclohexane (where *n* indicates number of carbon atoms in the side chain)

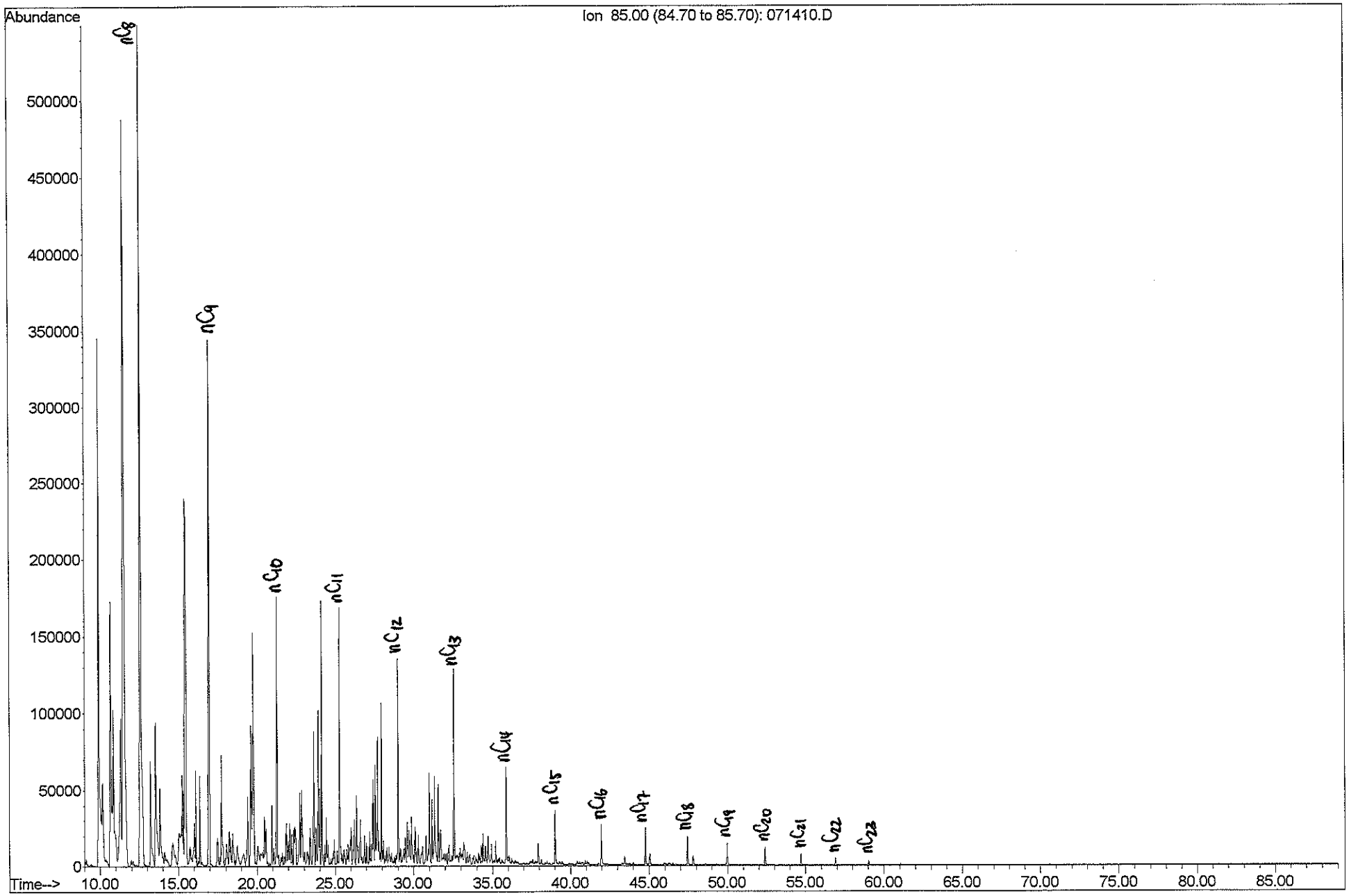
152918 (15999-1)



152920 (15999-2)



152922 (15999-3)



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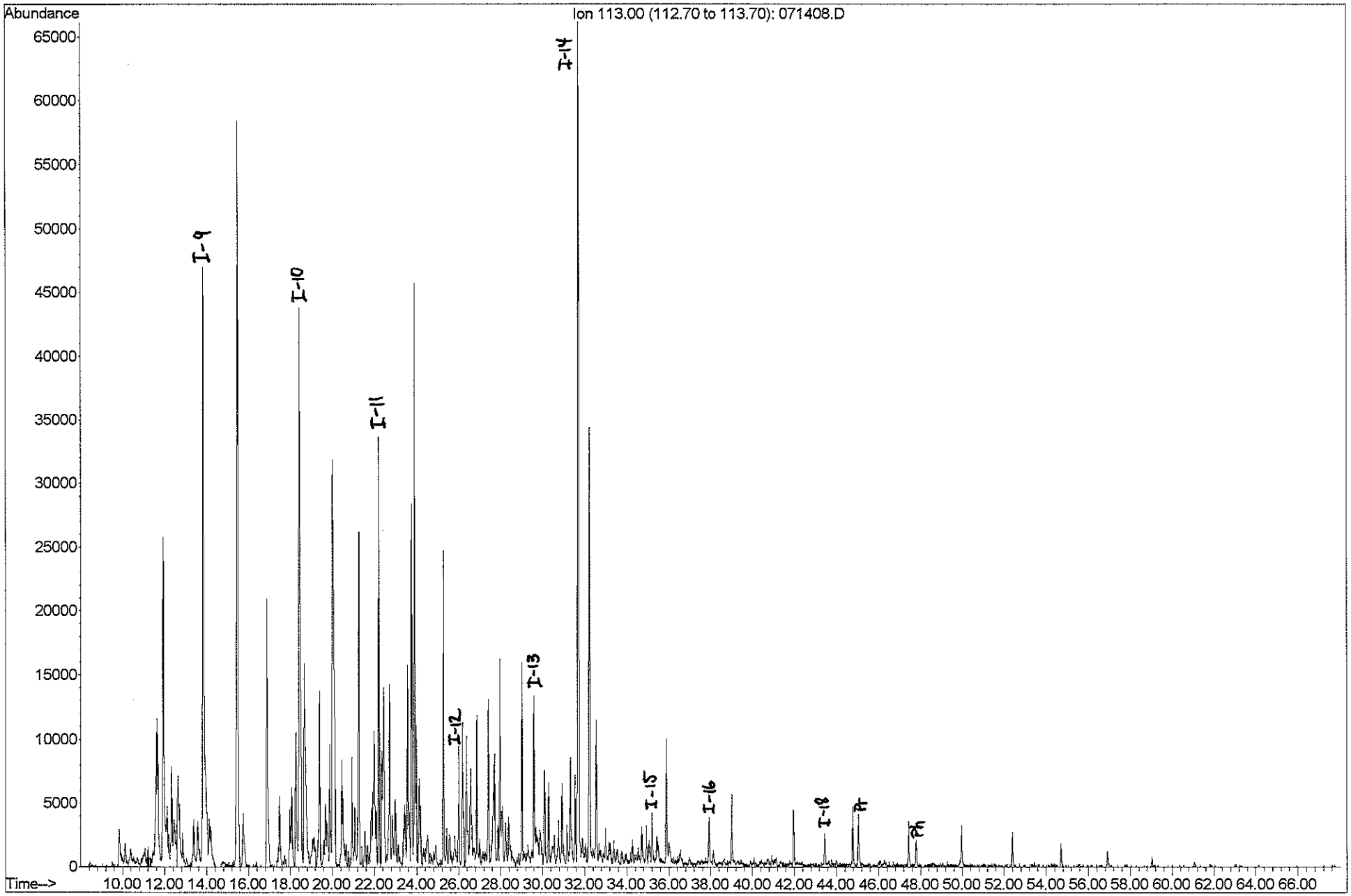

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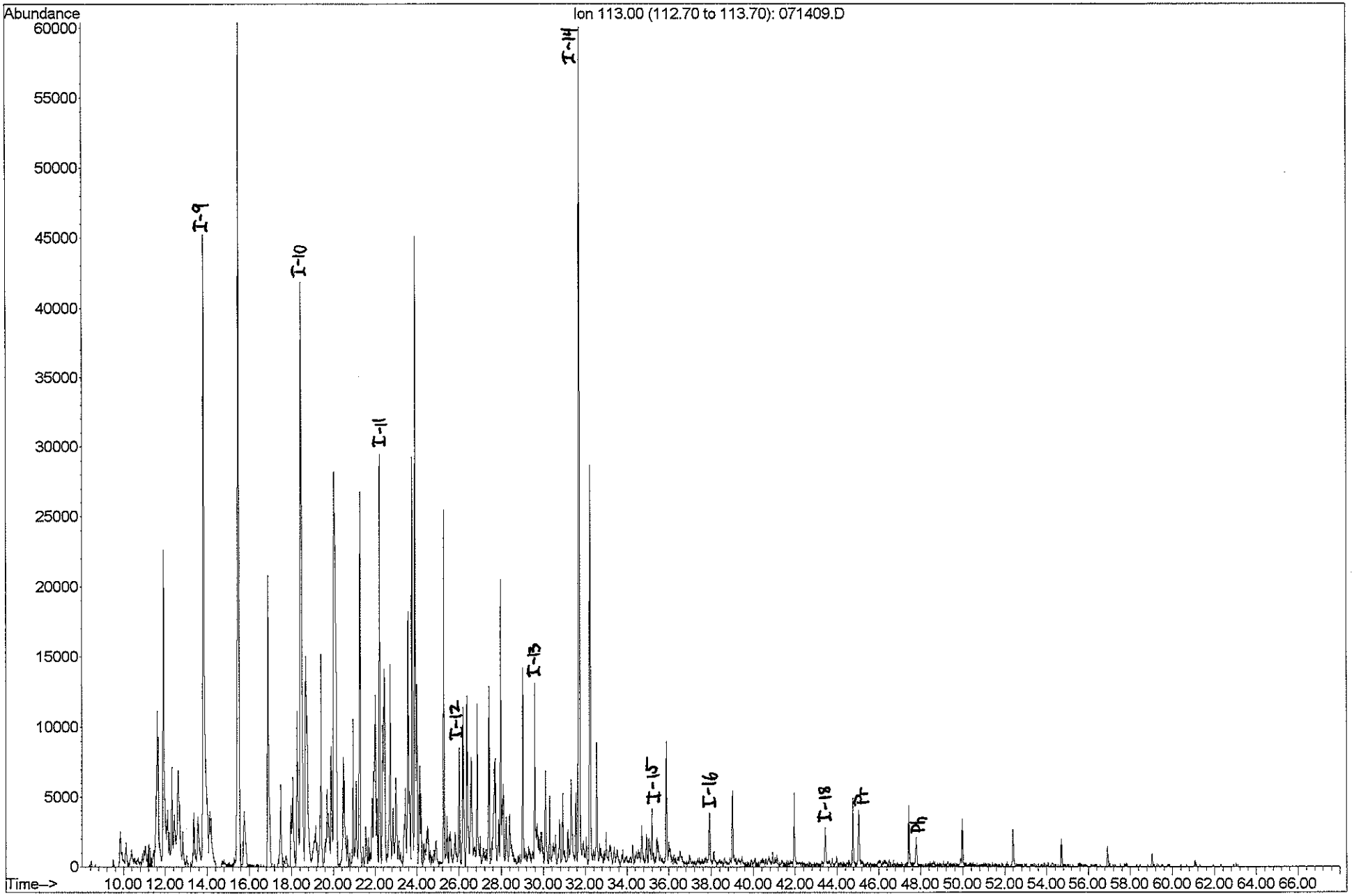

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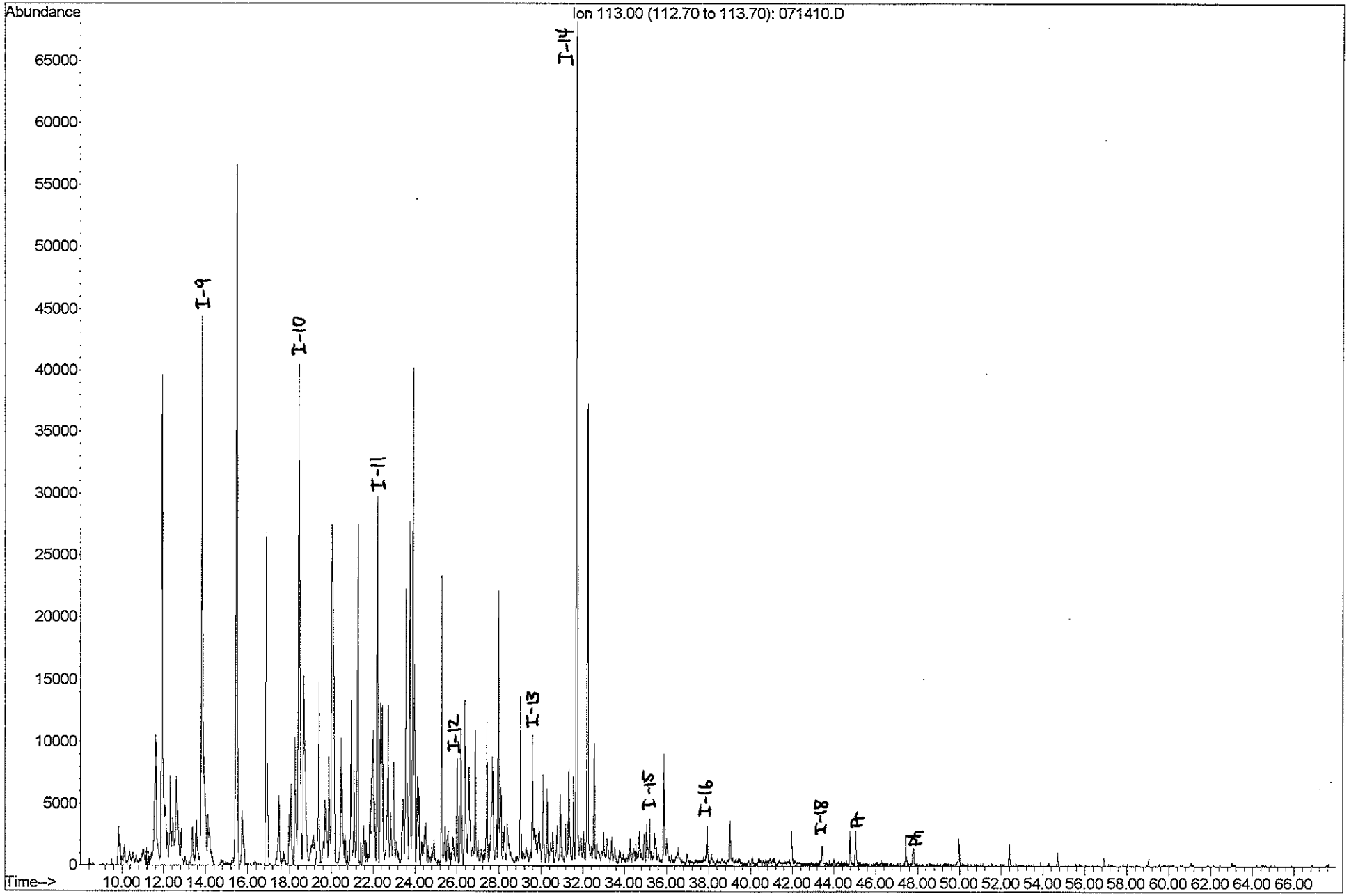
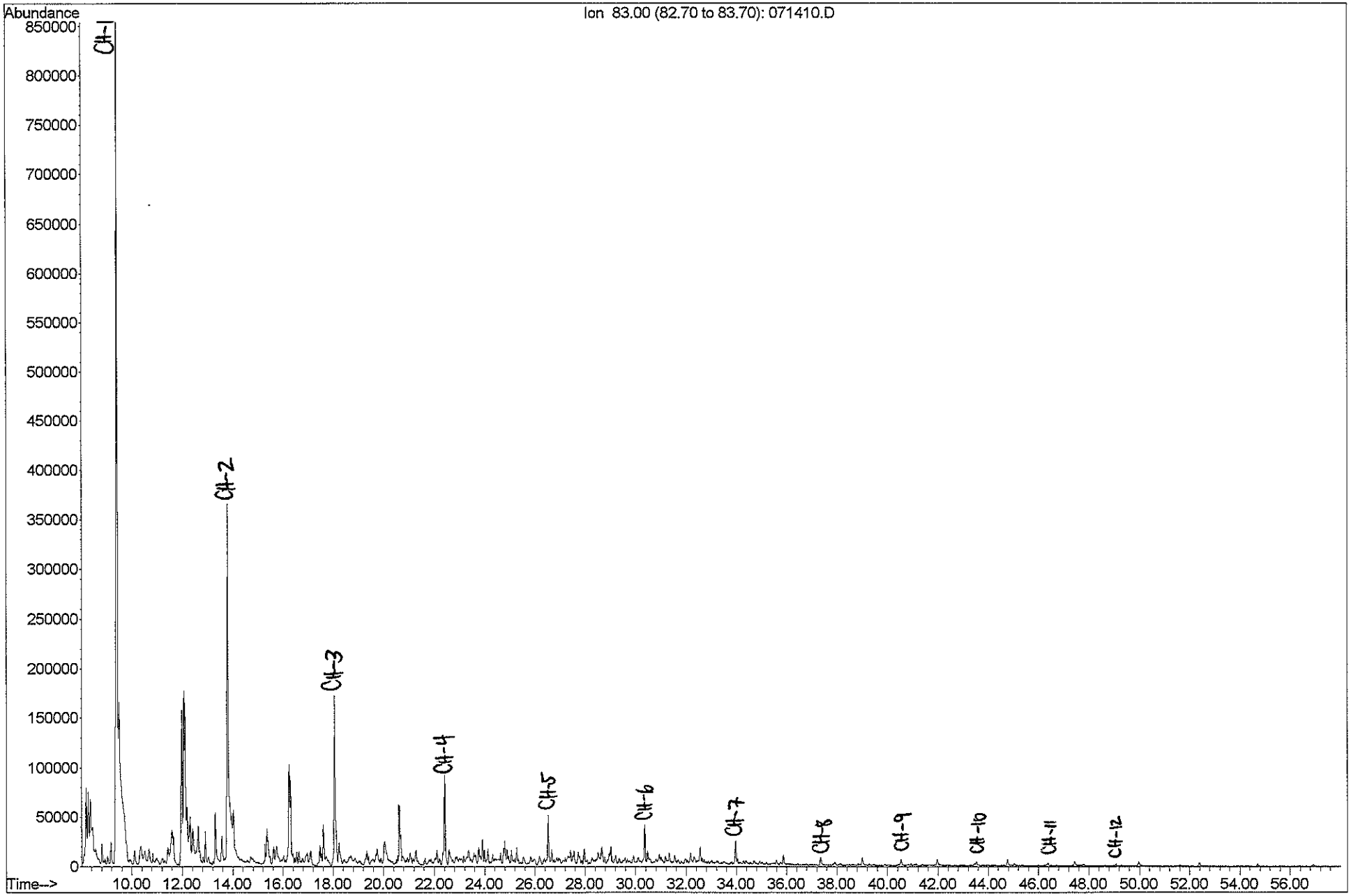


Table

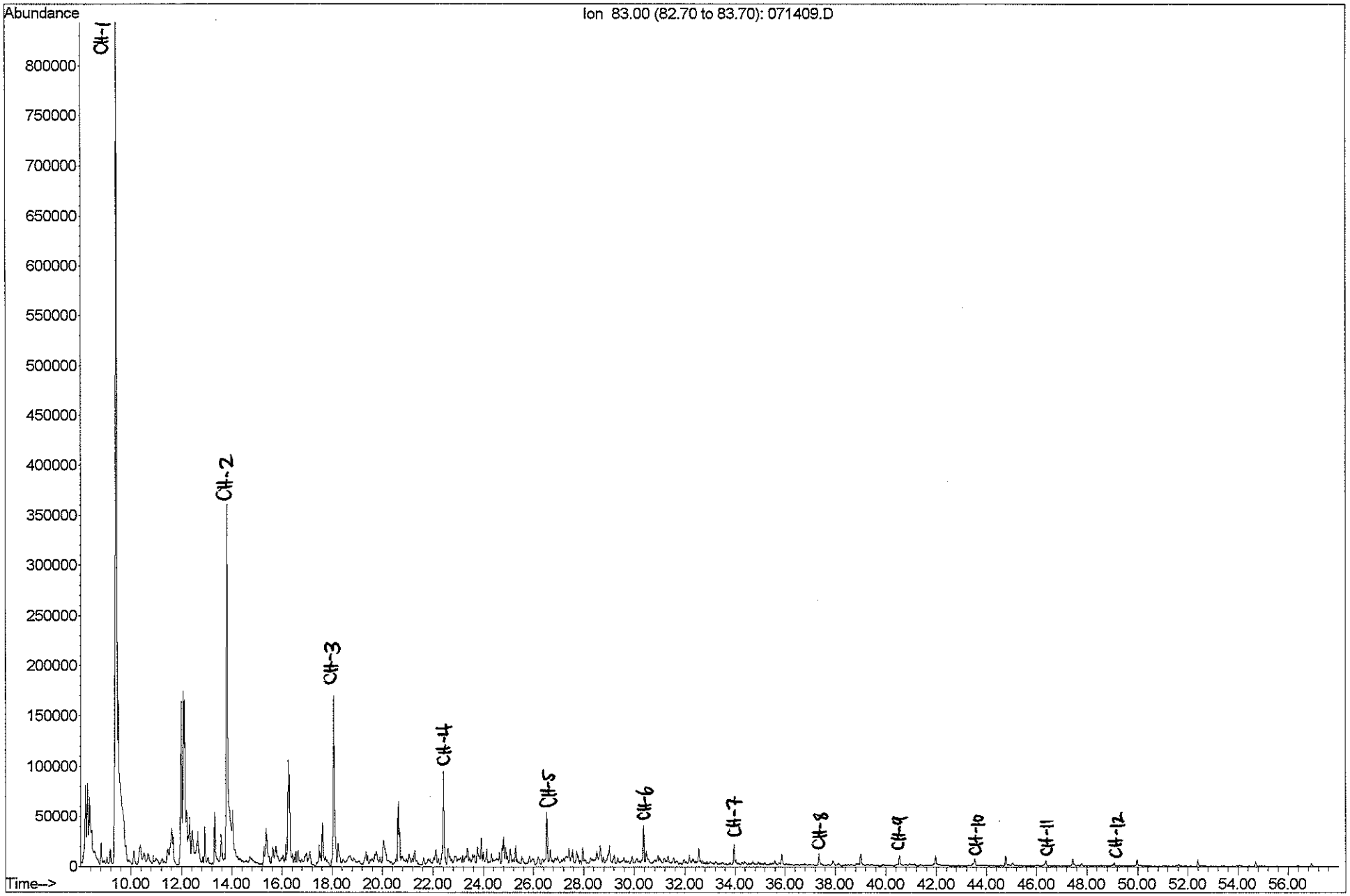
Key for Alkylcyclohexanes at m/z 83

Symbol	Detail
CH-1:	Methylcyclohexane
CH-2:	Ethylcyclohexane
CH-3:	Propylcylohexane
CH-4:	Butylcyclohexane
CH-5:	Pentylcyclohexane
CH-6:	Hexylcyclohexane
CH-7:	Heptylcyclohexane
CH-8:	Octylcyclohexane
CH-9:	Nonylcyclohexane
CH-10:	Decylcyclohexane
CH-11:	Undecylcyclohexane
CH-12:	Dodecylcyclohexane
CH-13:	Tridecylcyclohexane
CH-14:	Tetradecylcyclohexane

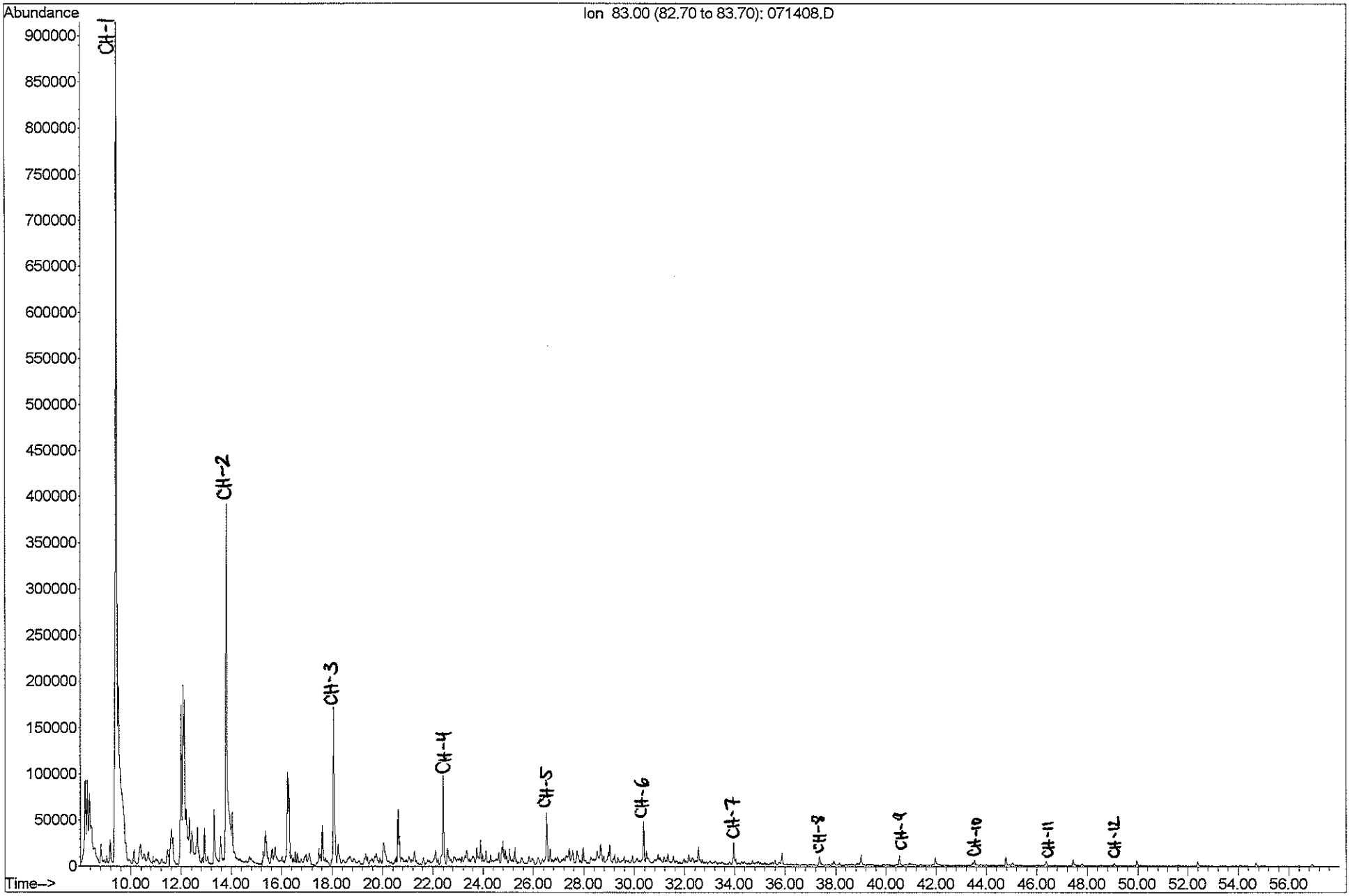
152922 (15999-3)



152920 (15999-2)



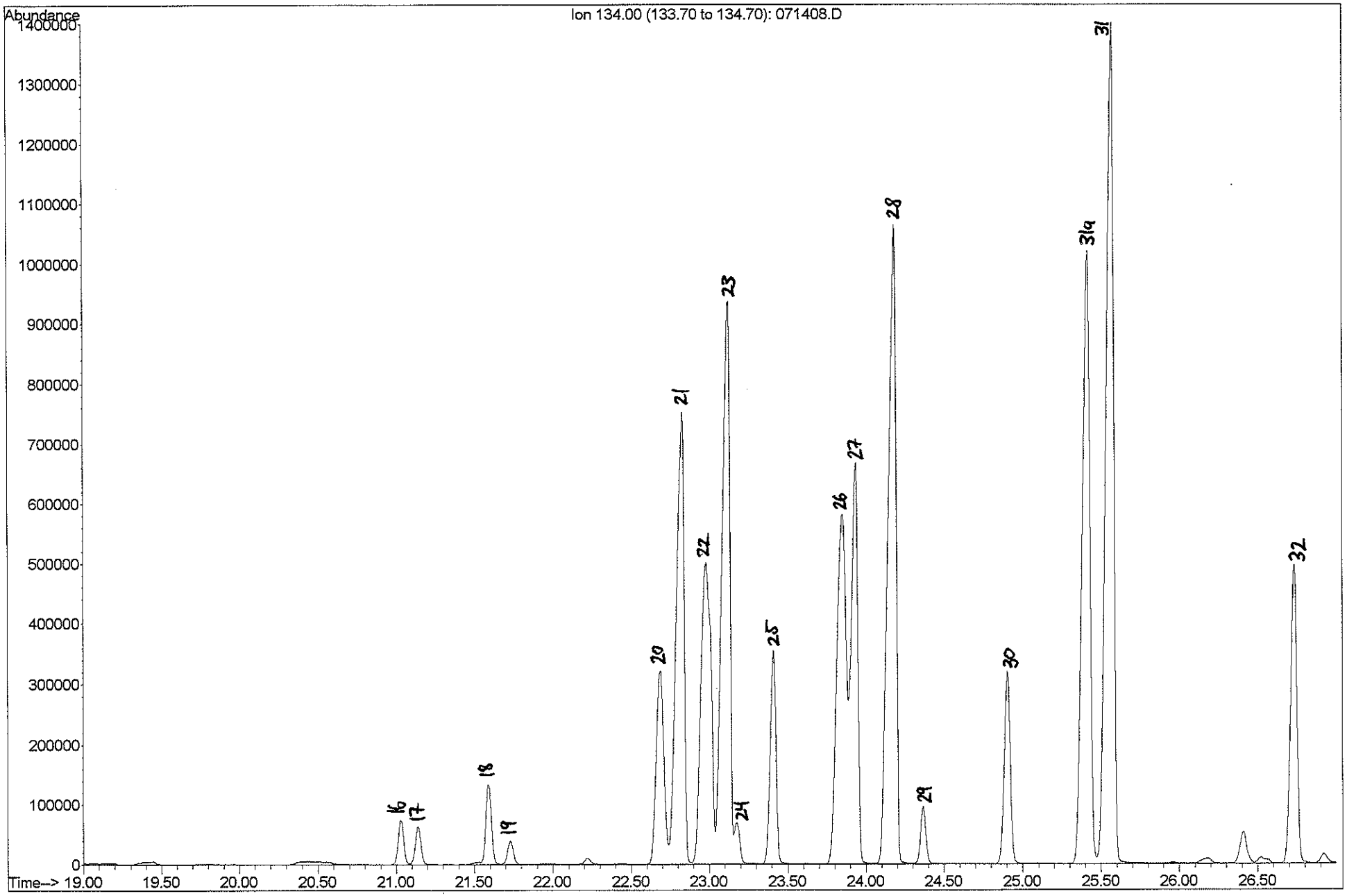
152918 (15999-1)



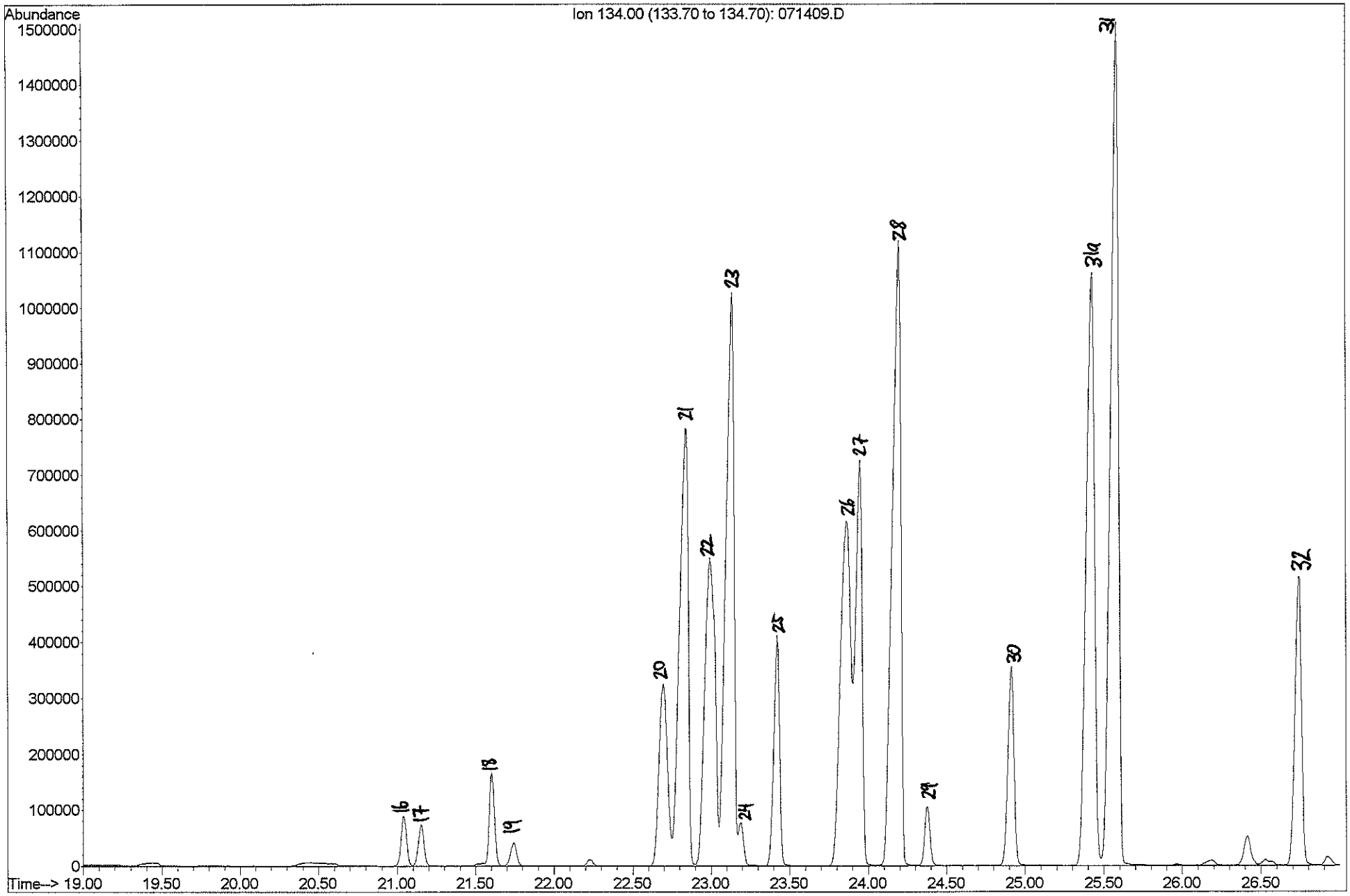
Key for C_4-Alkylbenzenes (m/z 134 mass chromatograms)

#	Compound
16	Sec-Butylbenzene
17	1-Methyl-3-Isopropylbenzene
18	1-Methyl-4-Isopropylbenzene
19	1-Methyl-2-Isopropylbenzene
20	1,3-Diethylbenzene
21	1-Methyl-3-Propylbenzene
22	Butylbenzene
23	1,3-Dimethyl-5-Ethylbenzene
24	1,2-Diethylbenzene
25	1-Methyl-2-Propylbenzene
26	1,4-Dimethyl-2-Ethylbenzene
27	1,3-Dimethyl-4-Ethylbenzene
28	1,2-Dimethyl-4-Ethylbenzene
29	1,3-Dimethyl-2-Ethylbenzene
30	1,2-Dimethyl-3-Ethylbenzene
31a	1,2,4,5-Tetramethylbenzene
31	1,2,3,5-Tetramethylbenzene
32	1,2,3,4-Tetramethylbenzene

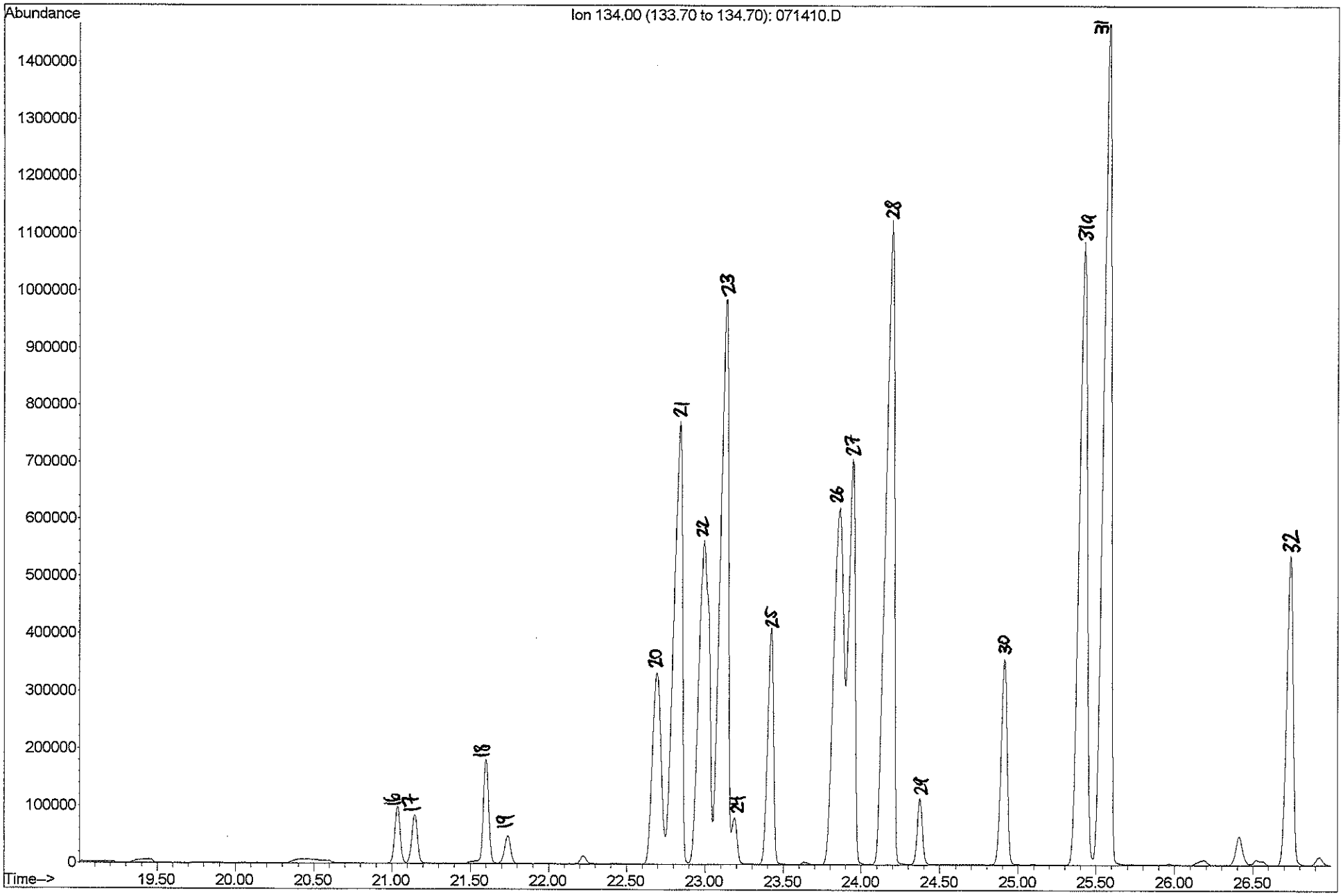
152918 (15999-1)



152920 (15999-2)



152922 (15999-3)

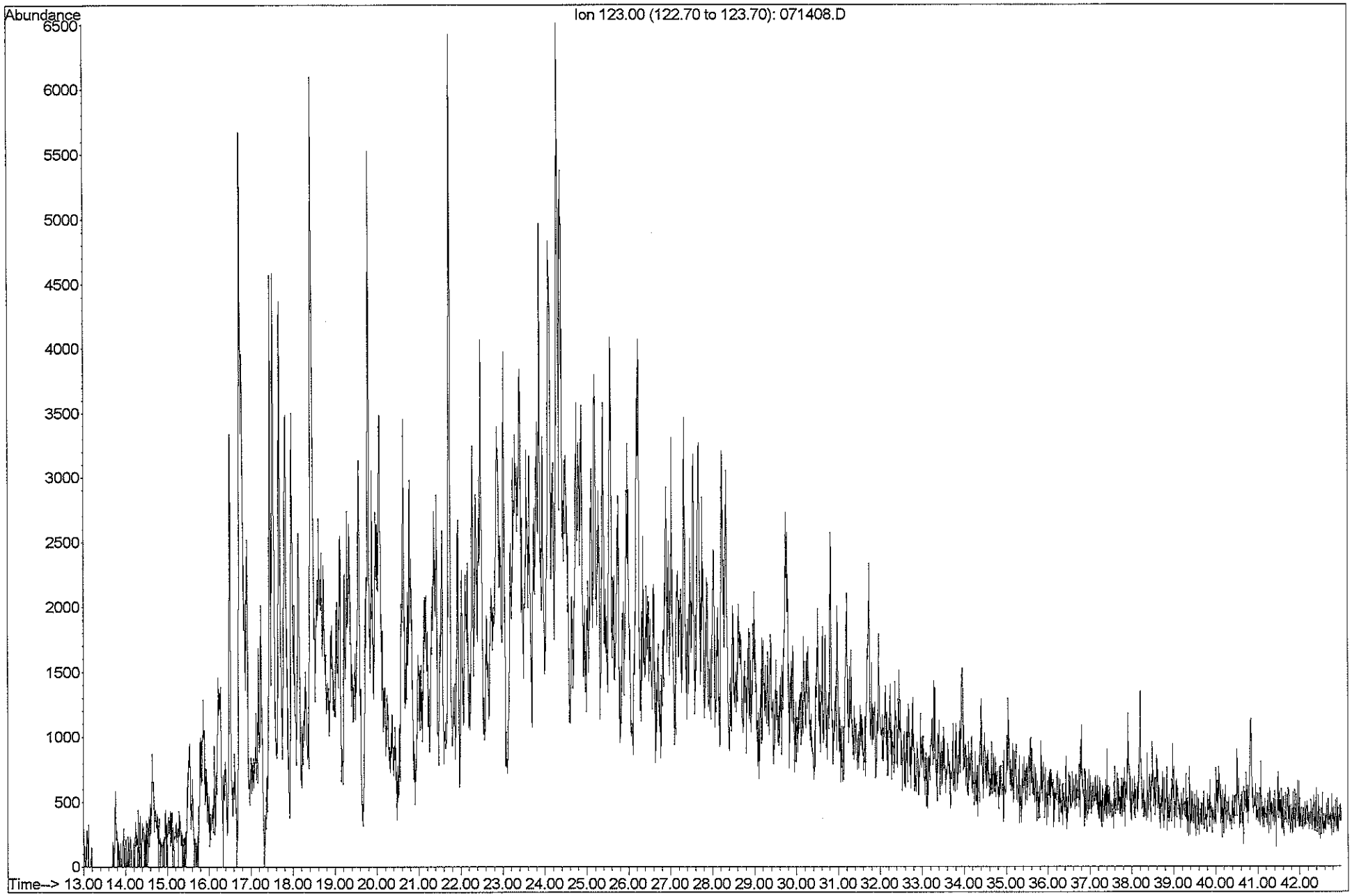


Table

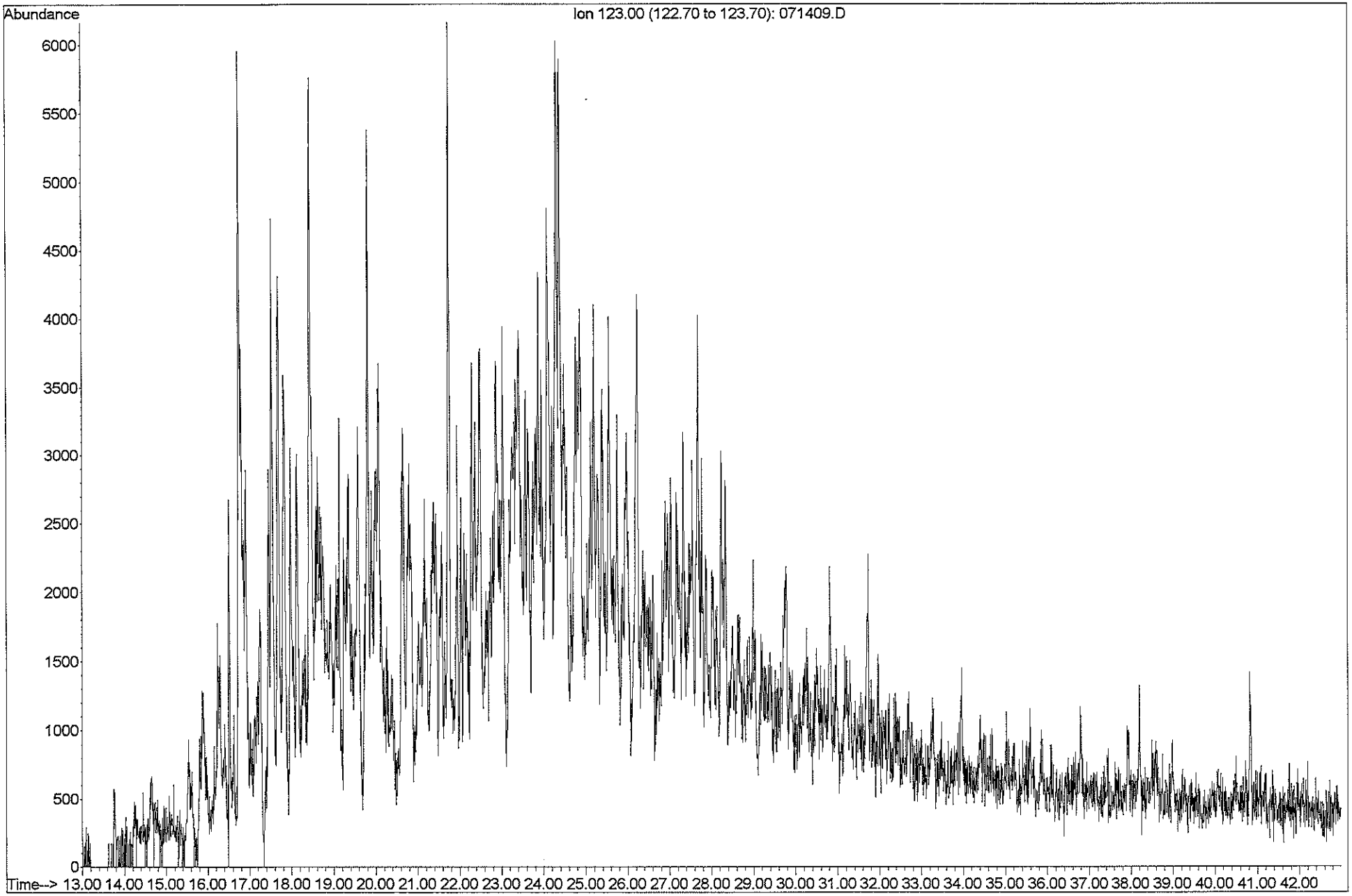
Key for identification of the Bicyclanes (m/z 123 mass chromatograms)

Peak No.	Identity	Formula	M.W.
a	2,2,3-Trimethylbicyloheptane	$C_{10}H_{18}$	138
b	C_{10} bicycloalkane	$C_{10}H_{18}$	138
c	3,3,7-Trimethylbicycloheptane	$C_{10}H_{18}$	138
d	C_{11} decalin	$C_{11}H_{20}$	152
f	Nordrimane	$C_{14}H_{26}$	194
g	Nordrimane	$C_{14}H_{26}$	194
h	Rearranged drimane	$C_{15}H_{28}$	208
j	Rearranged drimane	$C_{15}H_{28}$	208
k	Isomer of eudesmane	$C_{15}H_{28}$	208
l	4β(H) Eudesmane	$C_{15}H_{28}$	208
m	C_{15} bicyclic sesquiterpane	$C_{15}H_{28}$	208
n	8β(H) Drimane	$C_{15}H_{28}$	208
o	C_{15} bicyclic sesquiterpane	$C_{15}H_{28}$	208
p	C_{16} bicyclic sesquiterpane	$C_{16}H_{30}$	222
q	C_{16} bicyclic sesquiterpane	$C_{16}H_{30}$	222
r	8β(H) Homodrimane	$C_{16}H_{30}$	222

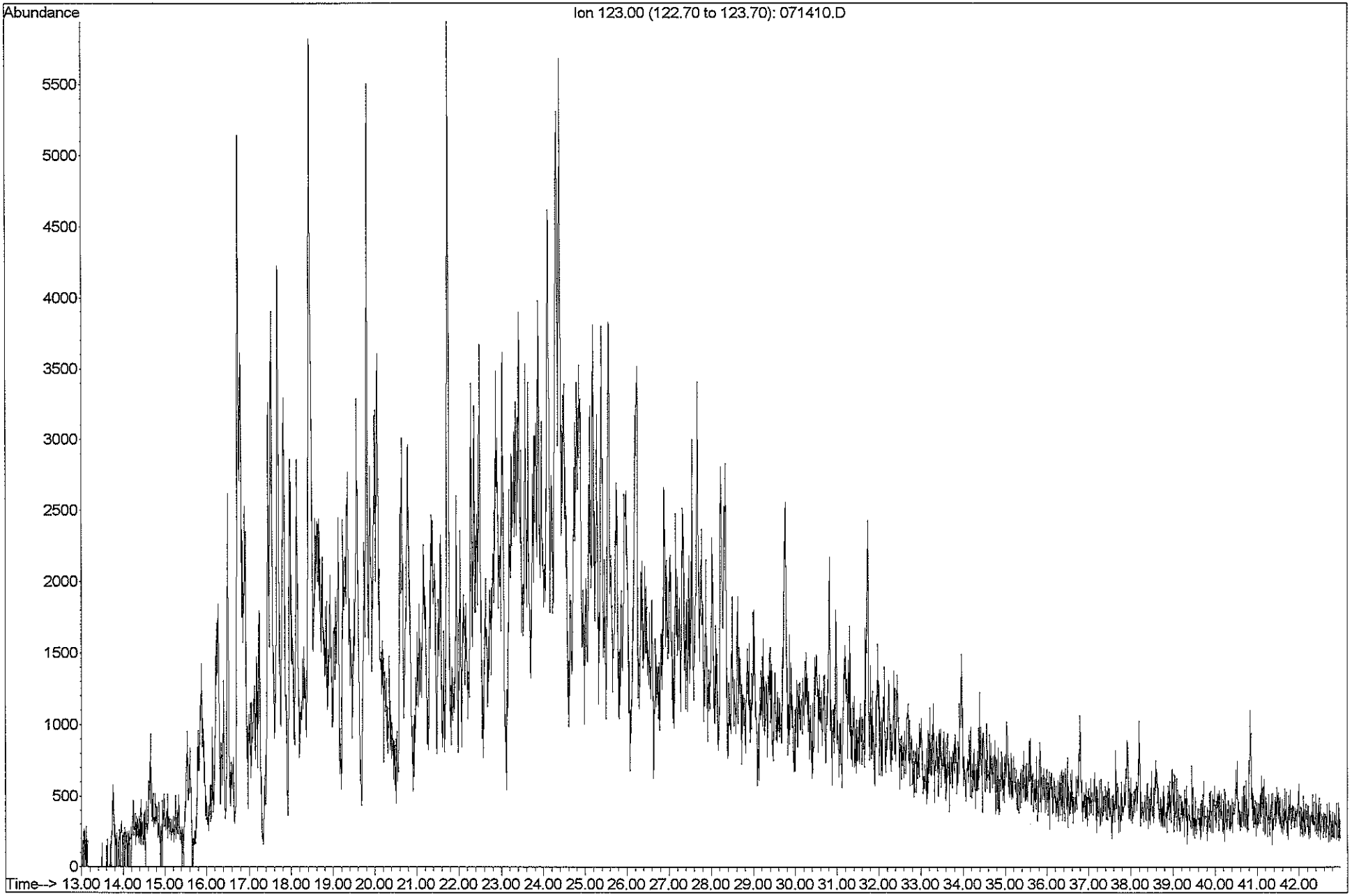
152918 (15999-1)

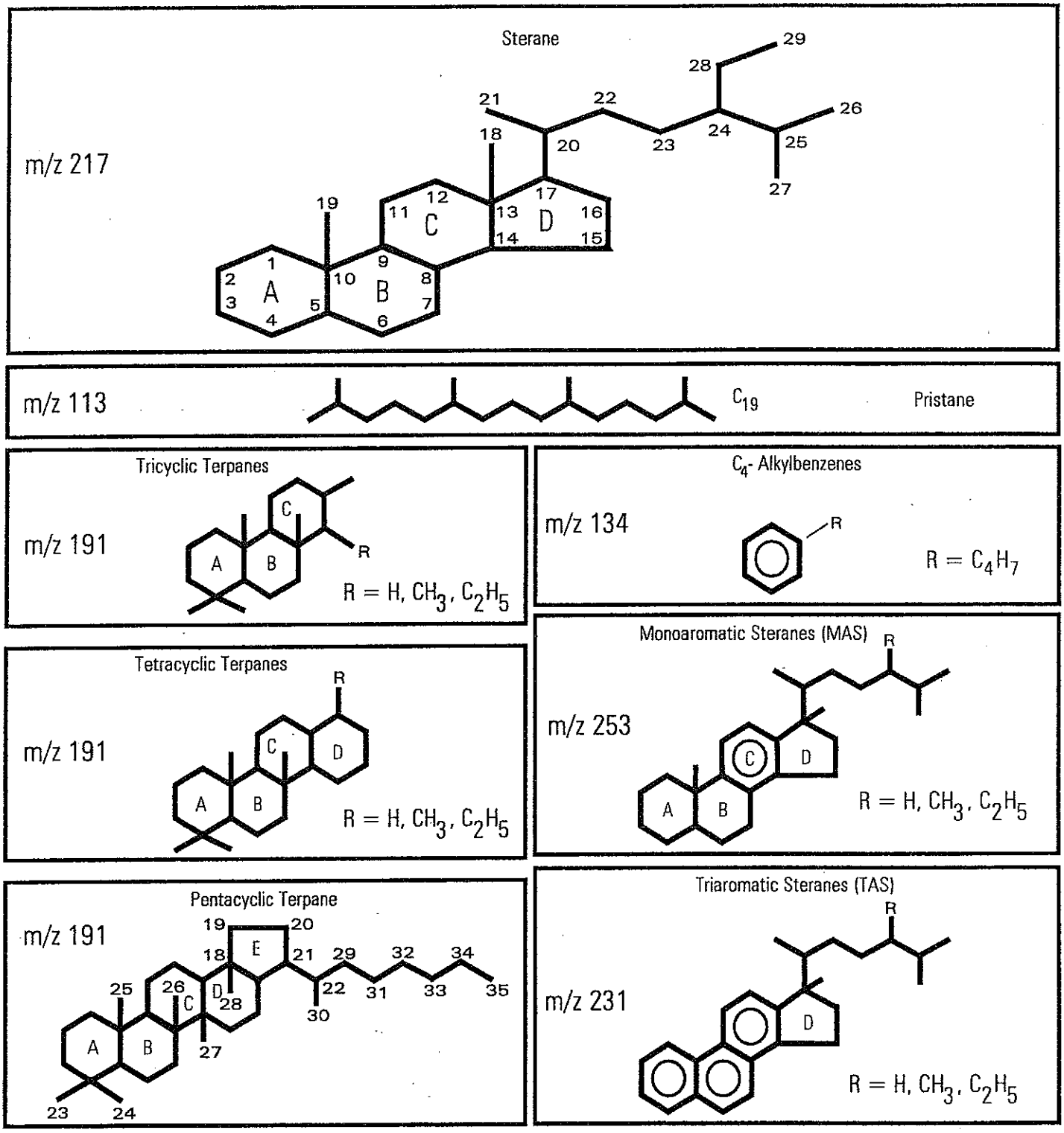


152920 (15999-2)



152922 (15999-3)





The compound structures of pristane, C_4-alkylbenzenes, sterane; terpanes; monoaromatic and triaromatic steranes

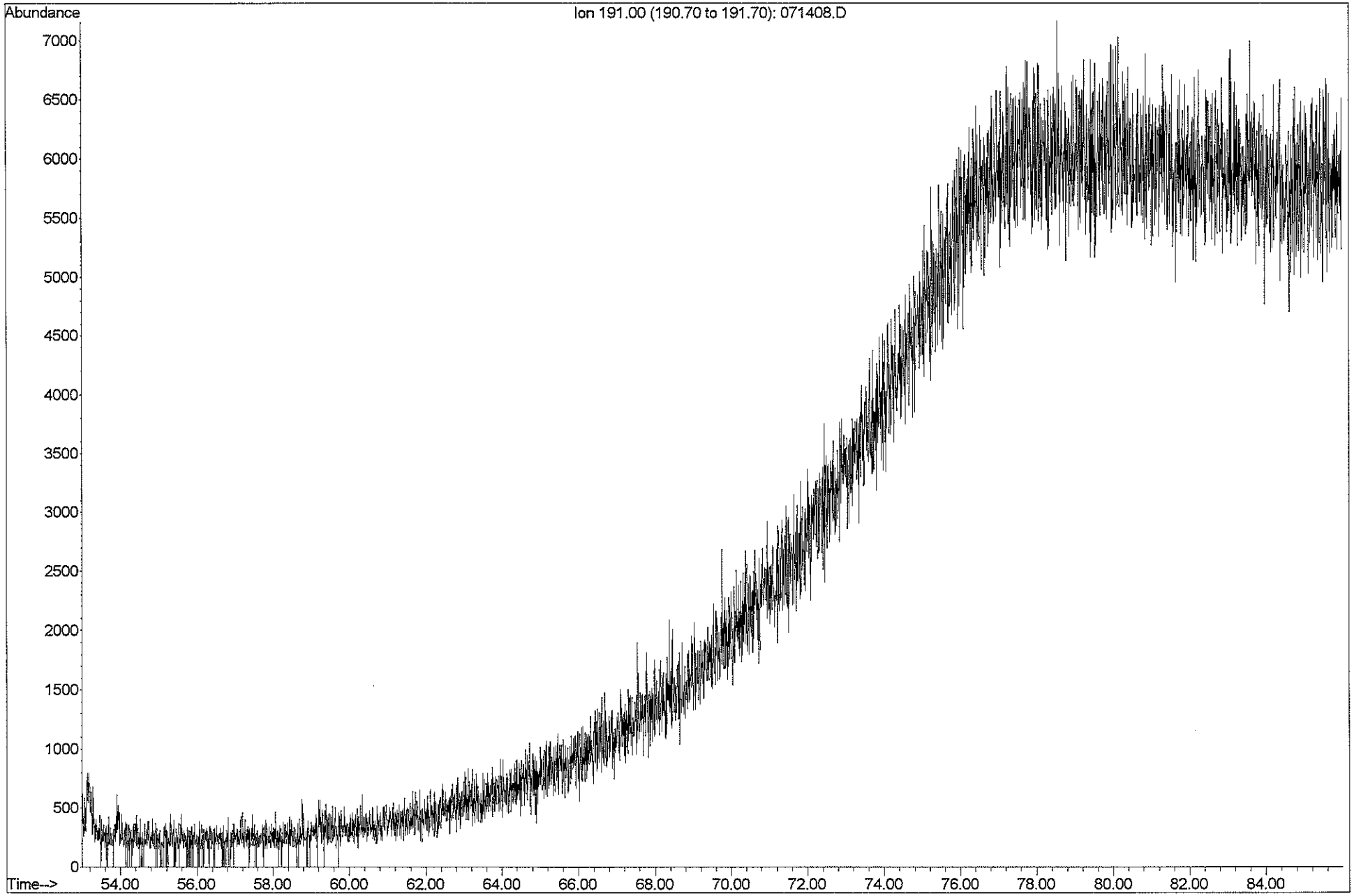
Table

ZymaX FORENSICS

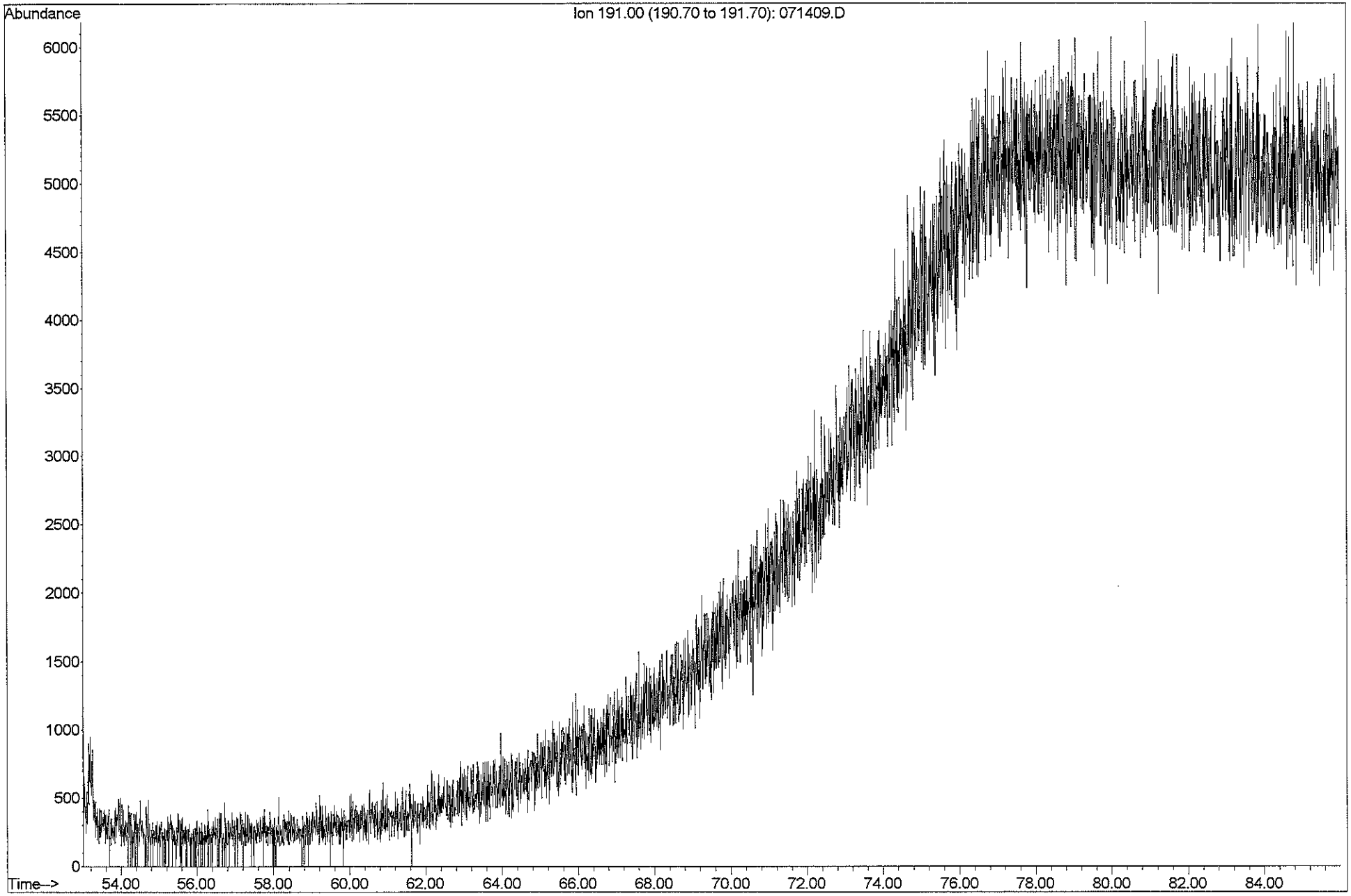
Key for Tricyclic, Tetracyclic, and Pentacyclic Terpanes Identification (m/z 191 mass chromatograms)

Code	Identity	Carbon #
0	C_{20}-Tricyclic Terpane	20
1	C_{21}-Tricyclic Terpane	21
2	C_{22}-Tricyclic Terpane	22
3	C_{23}-Tricyclic Terpane	23
4	C_{24}-Tricyclic Terpane	24
5	C_{25}-Tricyclic Terpane	25
Z4	C_{24}-Tetracyclic Terpane	24
6a	C_{26}-Tricyclic Terpane	26
6b	C_{26}-Tricyclic Terpane	26
7	C_{27}-Tricyclic Terpane	27
A	C_{28}-Tricyclic Terpane #1	28
B	C_{28}-Tricyclic Terpane #2	28
C	C_{29}-Tricyclic Terpane #1	29
D	C_{29}-Tricyclic Terpane #2	29
E	18α-22,29,30-Trisnorneohopane (Ts)	27
F	17α-22,29,30-Trisnorhopane (Tm)	27
G	17ß-22,29-30-Trisnorhopane	27
H	17α-23,28-Bisnorlupane	28
10a	C_{30}-Tricyclic Terpane #1	30
10b	C_{30}-Tricyclic Terpane #2	30
I	17α-28,30-Bisnorhopane	28
11a	C_{31}-Tricyclic Terpane #1	31
J	17α-25-Norhopane	29
11b	C_{31}-Tricyclic Terpane #2	31
K	17α,21ß-30-Norhopane	29
C_{29}Ts	18α-30-Norneohopane	29
C_{30}*	17α-Diahopane	30
L	17ß-21α-30-Normoretane	29
Ma	18α-Oleanane	30
Mb	18ß-Oleanane	30
N	17α,21ß-Hopane	30
O	17ß,21α-Moretane	30
13a	C_{33}-Tricyclic Terpane #1	33
13b	C_{33}-Tricyclic Terpane #2	33
P	22S-17α,21ß-30-Homohopane	31
Q	22R-17α,21ß-30-Homohopane	31
R	Gammacerane	30
14a	C_{34}-Tricyclic Terpane #1	34
S	17ß,21α-Homomoretane	31
14b	C_{34}-Tricyclic Terpane #2	34
T	22S-17α,21ß-30-Bishomohopane	32
U	22R-17α,21ß-30-Bishomohopane	32
15a	C_{35}-Tricyclic Terpane #1	35
15b	C_{35}-Tricyclic Terpane #2	35
V	17ß,21α-C_{32}-Bishomomoretane	32
WS	22S-17α,21ß-30,31,32-Trishomohopane	33
WR	22R-17α,21ß-30,31,32-Trishomohopane	33
16a	C_{36}-Tricyclic Terpane #1	36
16b	C_{36}-Tricyclic Terpane #2	36
XS	22S-17α,21ß-30,31,32,33-Tetrahomohopane	34
XR	22R-17α,21ß-30,31,32,33-Tetrahomohopane	34
YS	22S-17α,21ß-30,31,32,33,34-Pentahomohopane	35
YR	22R-17α,21ß-30,31,32,33,34-Pentahomohopane	35

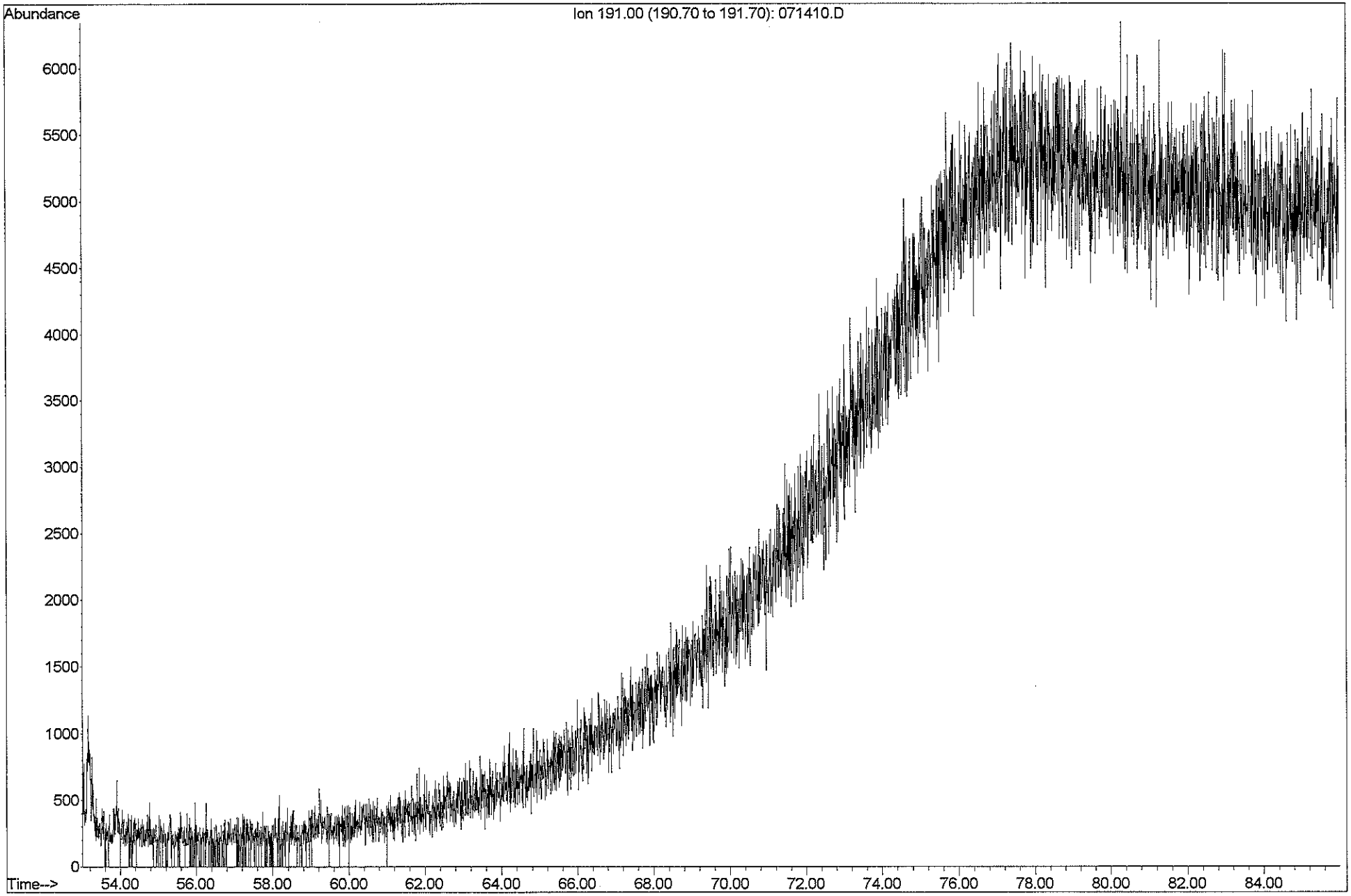
152918 (15999-1)



152920 (15999-2)



152922 (15999-3)



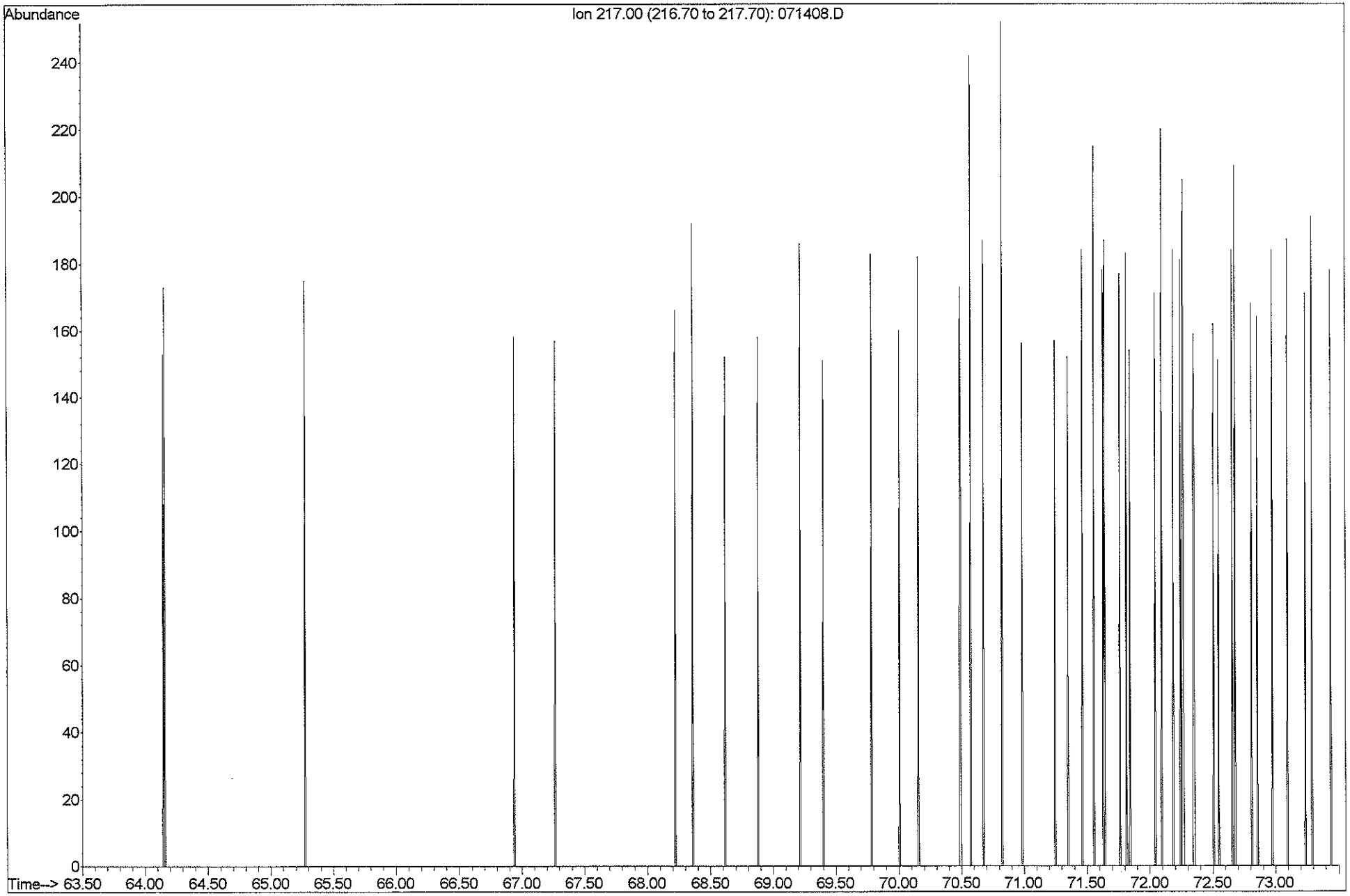
ZymaX FORENSICS

Table

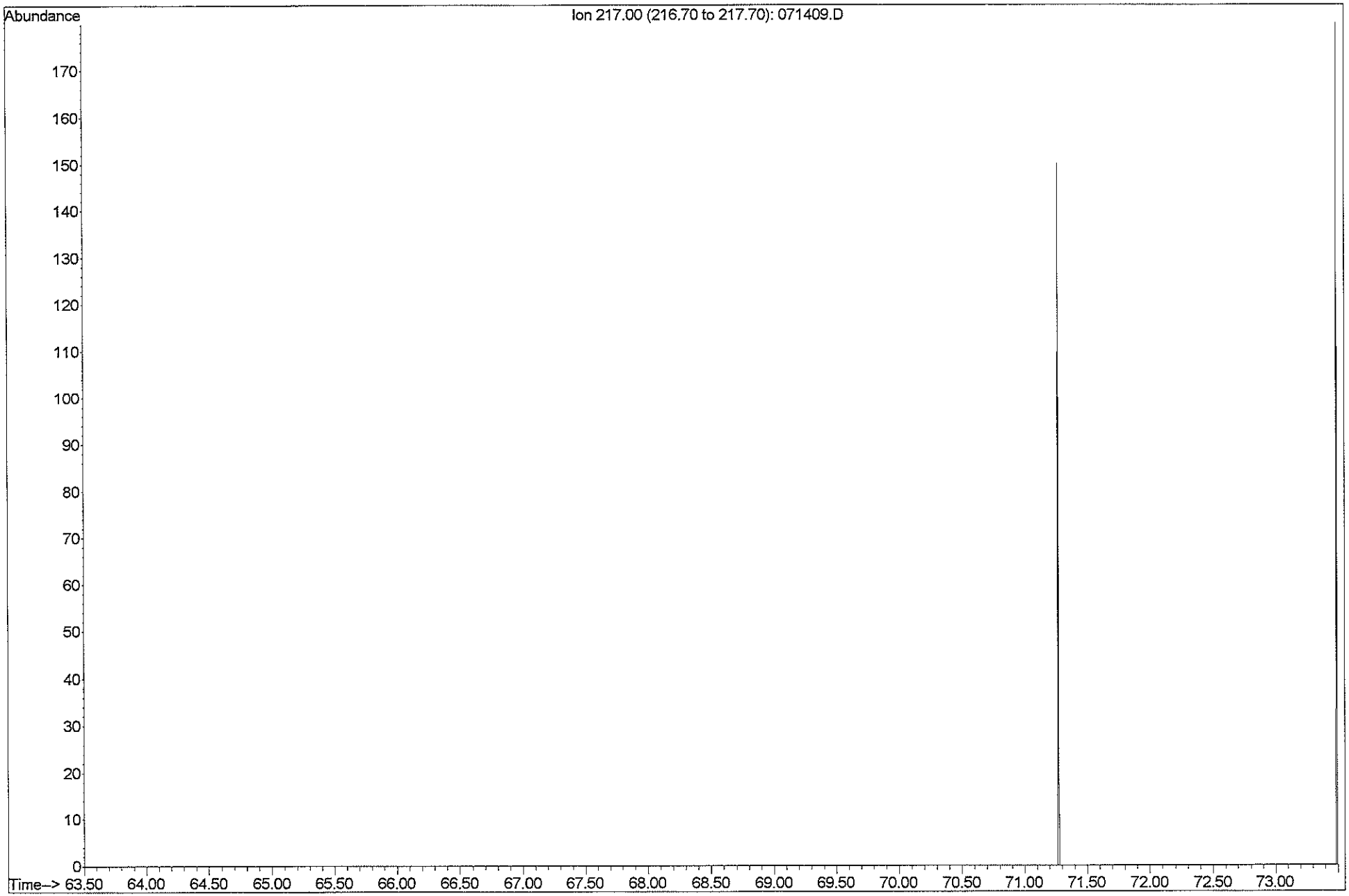
Key for Steranes Identification (m/z 217 Mass Chromatogram)

Code	Identity	Carbon #
1	13ß,17α-diacholestane (20S)	27
2	13ß,17α-diacholestane (20R)	27
3	13α,17ß-diacholestane (20S)	27
4	13α,17ß-diacholestane (20R)	27
5	24-methyl-13ß,17α-diacholestane (20S)	28
6	24-methyl-13ß,17α-diacholestane (20R)	28
7D	24-methyl-13α,17ß-diacholestane (20S)	28
7	14α,17α-cholestane (20S)	27
8D	24-ethyl-13ß,17α-diacholestane (20S)	29
8	14ß,17ß-cholestane (20R)	27
9	14ß,17ß-cholestane (20S)	27
9D	24-methyl-13α,17ß-diacholestane (20R)	28
10	14α,17α-cholestane (20R)	27
11	24-ethyl-13ß,17α-diacholestane (20R)	29
12	24-ethyl-13α,17ß-diacholestane (20S)	29
13	24-methyl-14α,17α-cholestane (20S)	28
14D	24-ethyl-13α,17ß-diacholestane (20R)	29
14	24-methyl-14ß,17ß-cholestane (20R)	28
15	24-methyl-14ß,17ß-cholestane (20S)	28
16	24-methyl-14α,17α-cholestane (20R)	28
17	24-ethyl-14α-cholestane (20S)	29
18	24-ethyl-14ß,17ß-cholestane (20R)	29
19	24-ethyl-14ß,17ß-cholestane (20S)	29
20	24-ethyl-14α,17α-cholestane (20R)	29
21A	24-n-Propylcholestane (20S)	30
21B	4-methyl-24-ethylcholestane (20S)	30
22A	4α-methyl-24-ethyl-14β,17β-cholestane(20S)	30
22B	24-n-propyl-14β,17β-cholestane (20S)	30
23A	4α-methyl-24-ethyl-14β,17β-cholestane(20R)	30
23B	24-n-propyl-14β,17β-cholestane (20R)	30
24A	4α-methyl-24-ethylcholestane(20R)	30
24B	24-n-propylcholestane (20R)	30

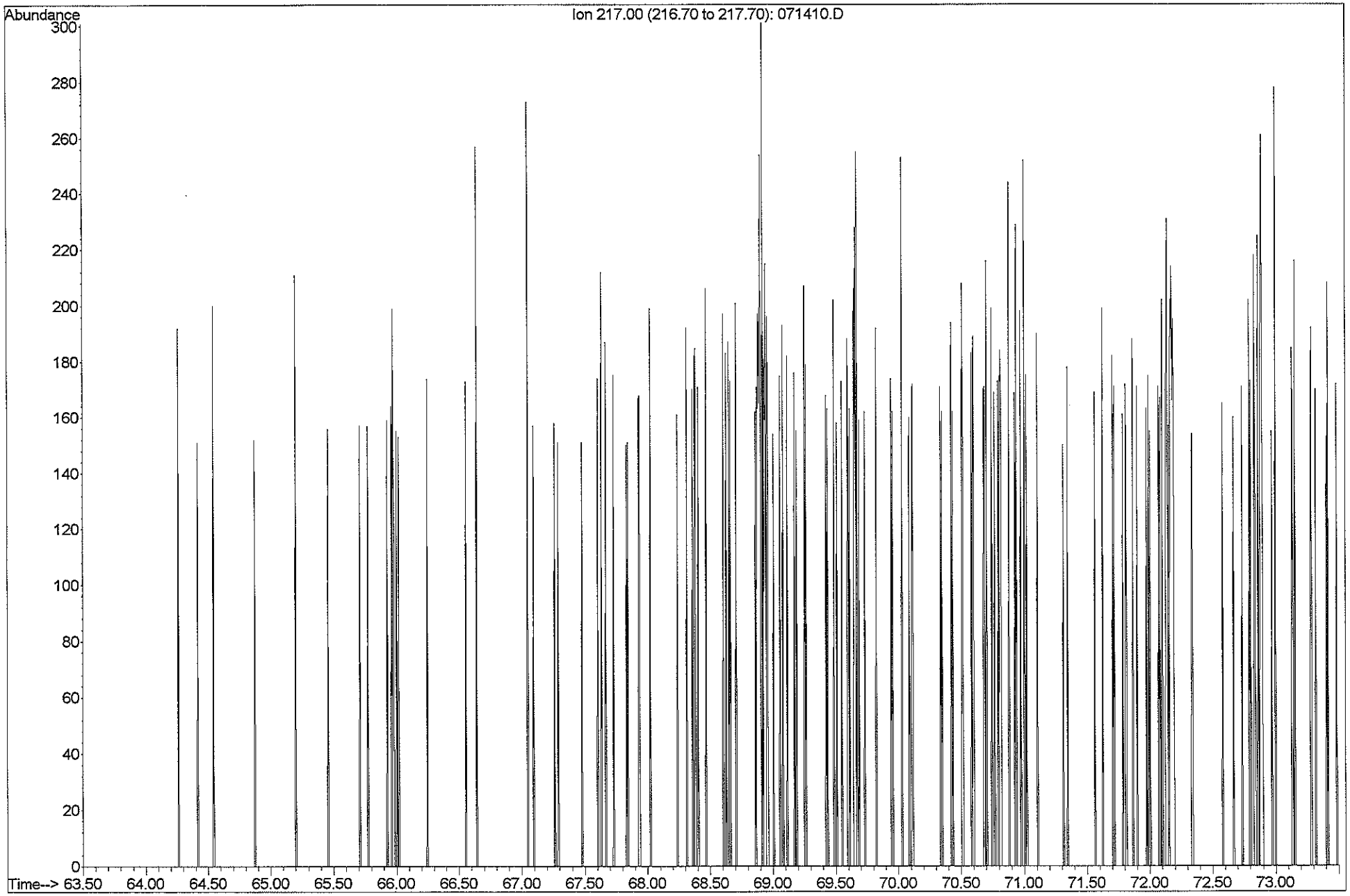
152918 (15999-1)



152920 (15999-2)



152922 (15999-3)

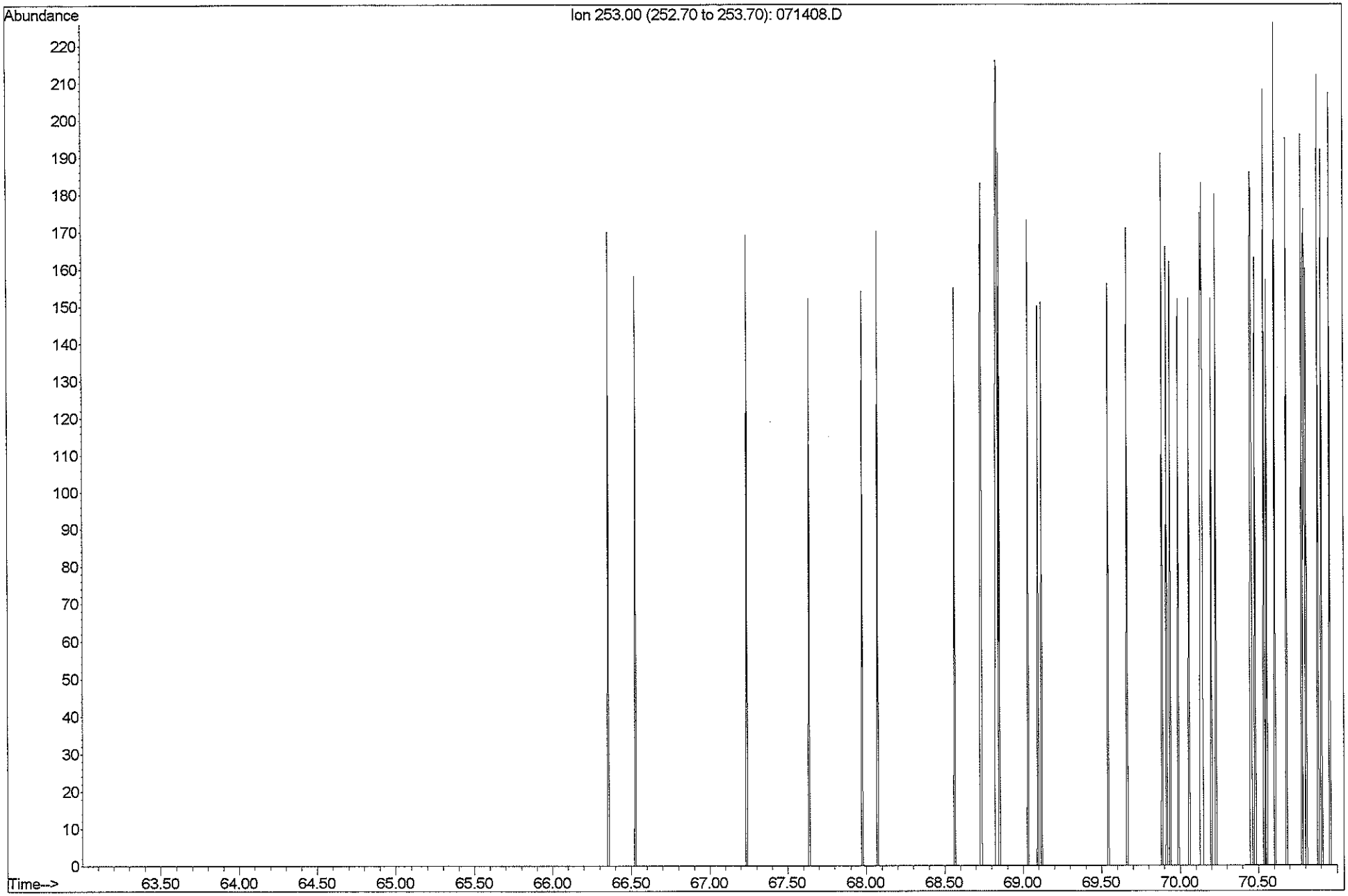


Table

Key for Monoaromatic Steranes Identification (m/z 253 mass chromatogram)

Code	Identity	Elemental Composition
a	20S, 5ß C_{27}-Monoaromatic sterane	$C_{27}H_{42}$
b	20S, dia C_{27}-Monoaromatic sterane	$C_{27}H_{42}$
c	20R, 5ß C_{27}-Monoaromatic sterane + 20R C_{27} dia MAS	$C_{27}H_{42}$
d	20S, 5α C_{27}-Monoaromatic sterane	$C_{27}H_{42}$
e	20S, 5ß C_{28}-Monoaromatic sterane + 20S C_{28} dia MAS	$C_{28}H_{44}$
f	20R, 5α C_{27}-Monoaromatic sterane	$C_{27}H_{42}$
g	20S, 5α C_{28}-Monoaromatic sterane	$C_{28}H4_4$
h	20R, 5ß C_{28}-Monoaromatic sterane + 20R C_{28} dia MAS	$C_{28}H_{44}$
i	20S, 5ß C_{29}-Monoaromatic sterane + 20S C_{29} dia MAS	$C_{29}H_{46}$
j	20S, 5α C_{29}-Monoaromatic sterane	$C_{29}H_{46}$
k	20R, 5α C_{28}-Monoaromatic sterane	$C_{28}H_{44}$
l	20R, 5ß C_{29}-Monoaromatic sterane + 20R C_{29} dia MAS	$C_{29}H_{46}$
m	20R, 5α C_{29}-Monoaromatic sterane	$C_{29}H_{46}$

152918 (15999-1)



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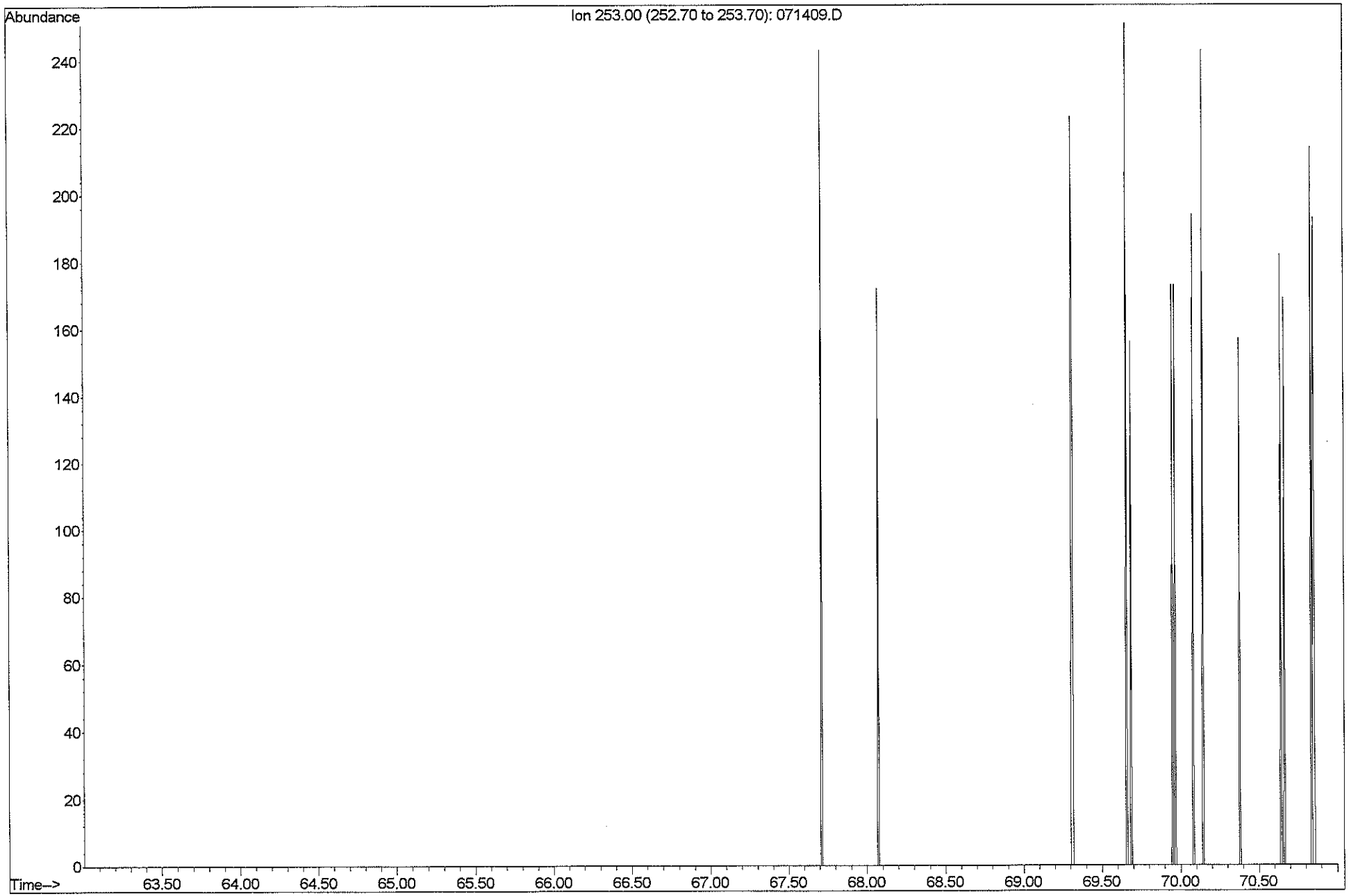
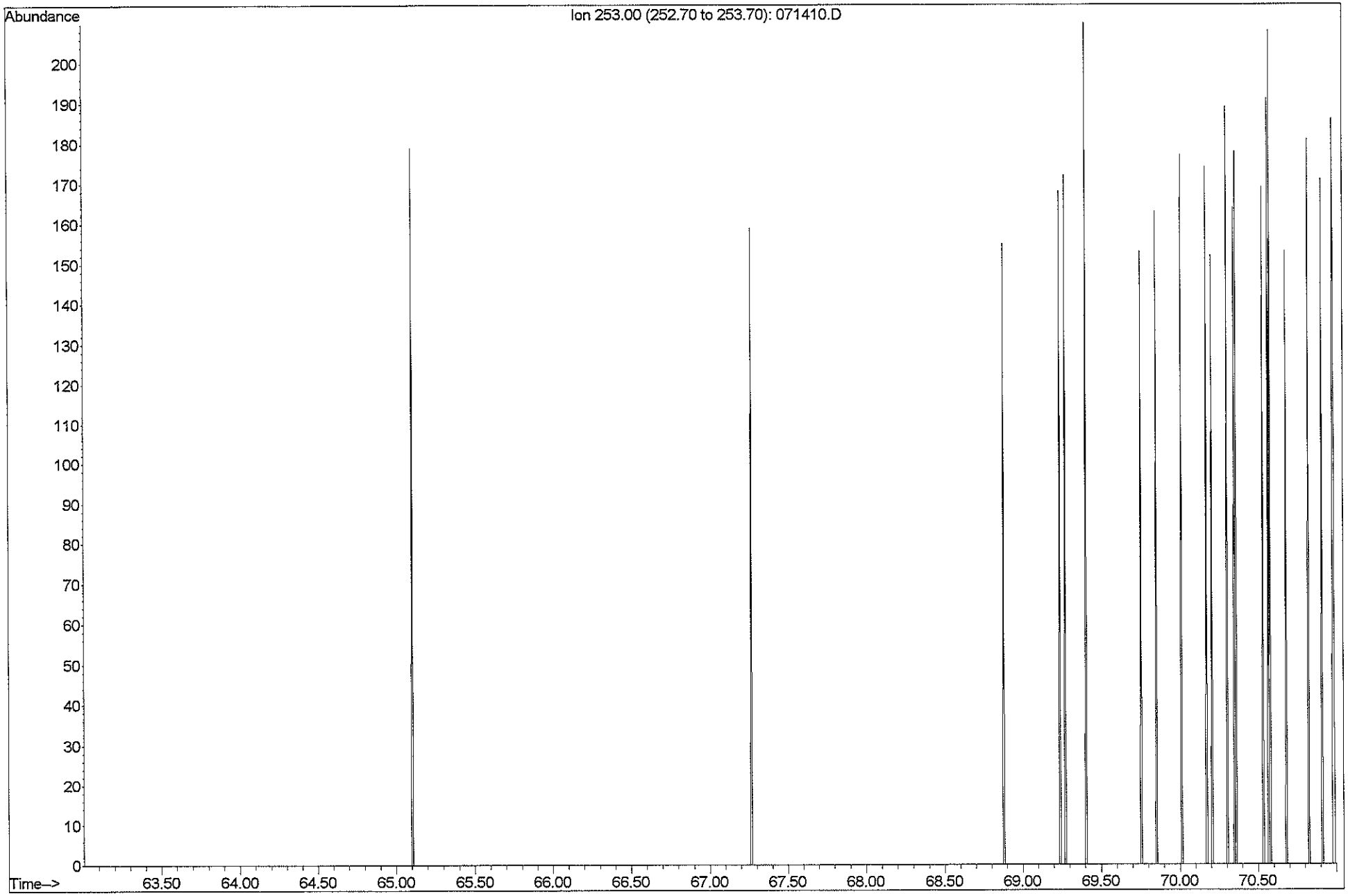


152922 (15999-3)



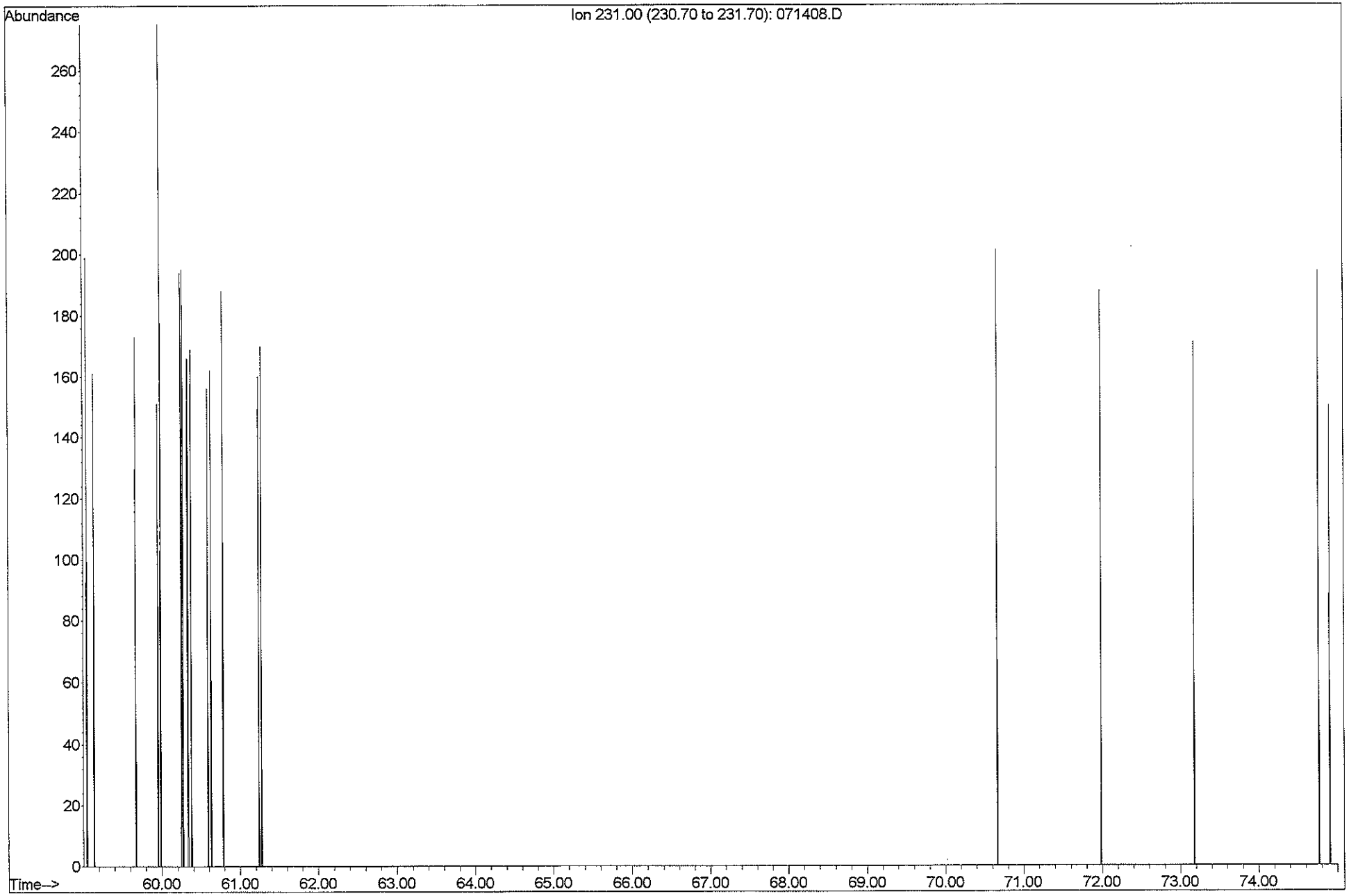
ZymaX FORENSICS

Table

Key for Triaromatic Steranes Identification (m/z 231 chromatogram)

Code	Identity	Elemental Composition
T1	C_{20} Triaromatic sterane	$C_{20}H_{20}$
T2	C_{21} Triaromatic sterane	$C_{21}H_{22}$
T3	20S C_{26} Triaromatic sterane	$C_{26}H_{32}$
T4	20R C_{26} + 20S C_{27}-Triaromatic steranes	$C_{26}H_{32}$ + $C_{27}H_{34}$
T5	20S C_{28}-Triaromatic sterane	$C_{28}H_{36}$
T6	20R C_{27}-Triaromatic sterane	$C_{27}H_{34}$
T7	20R C_{28}-Triaromatic sterane	$C_{28}H_{36}$

152918 (15999-1)



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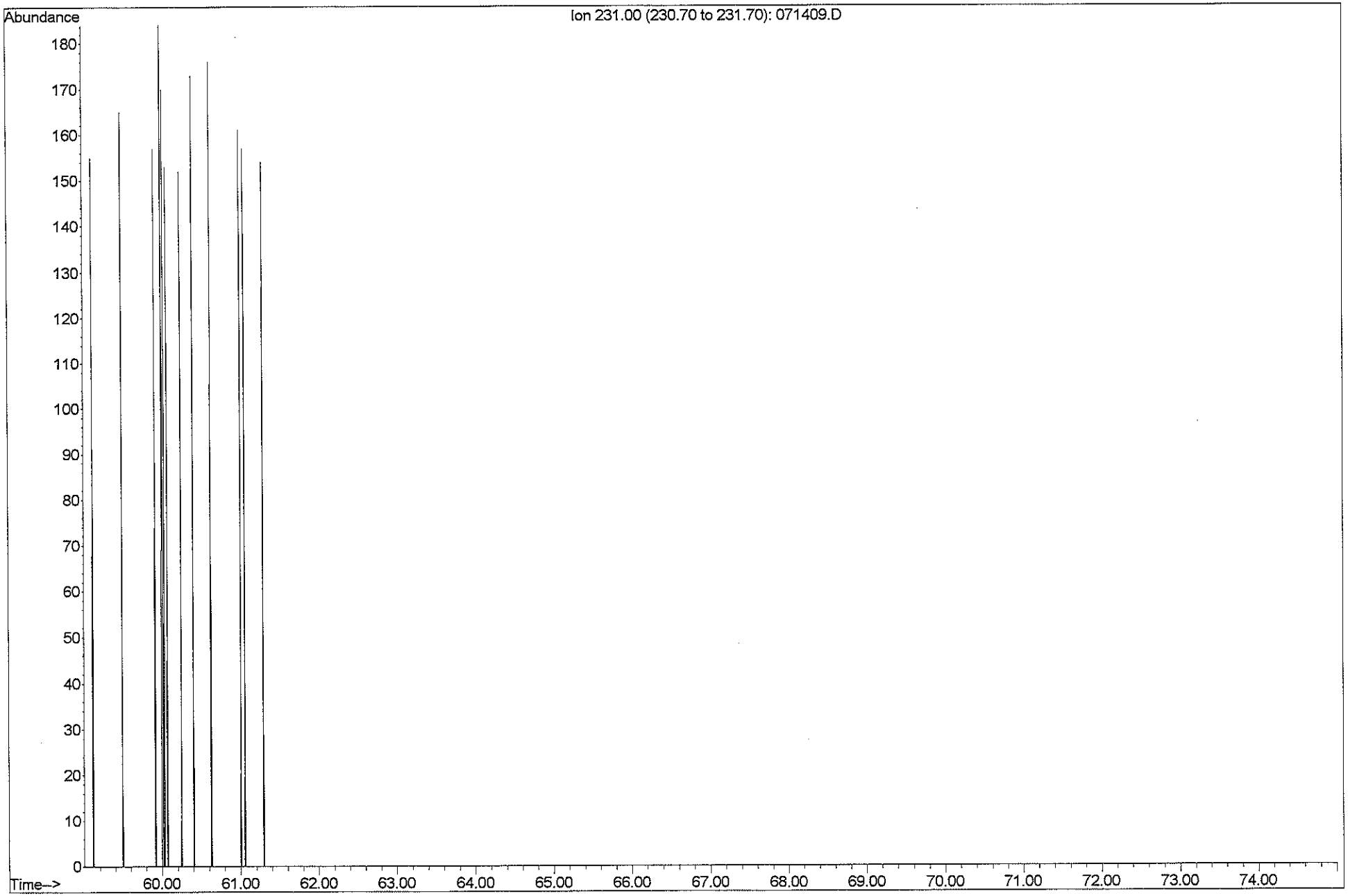
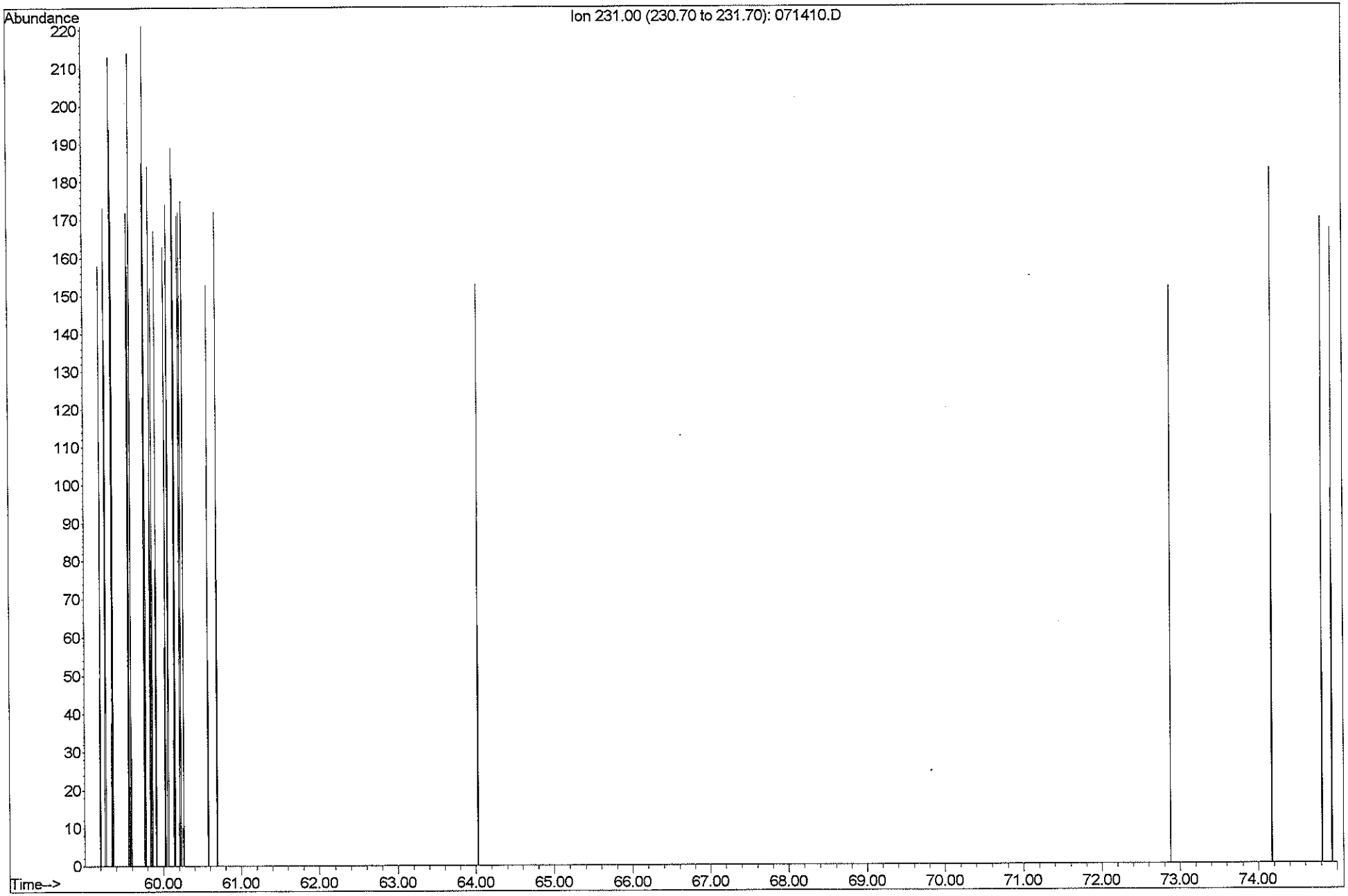


152922 (15999-3)



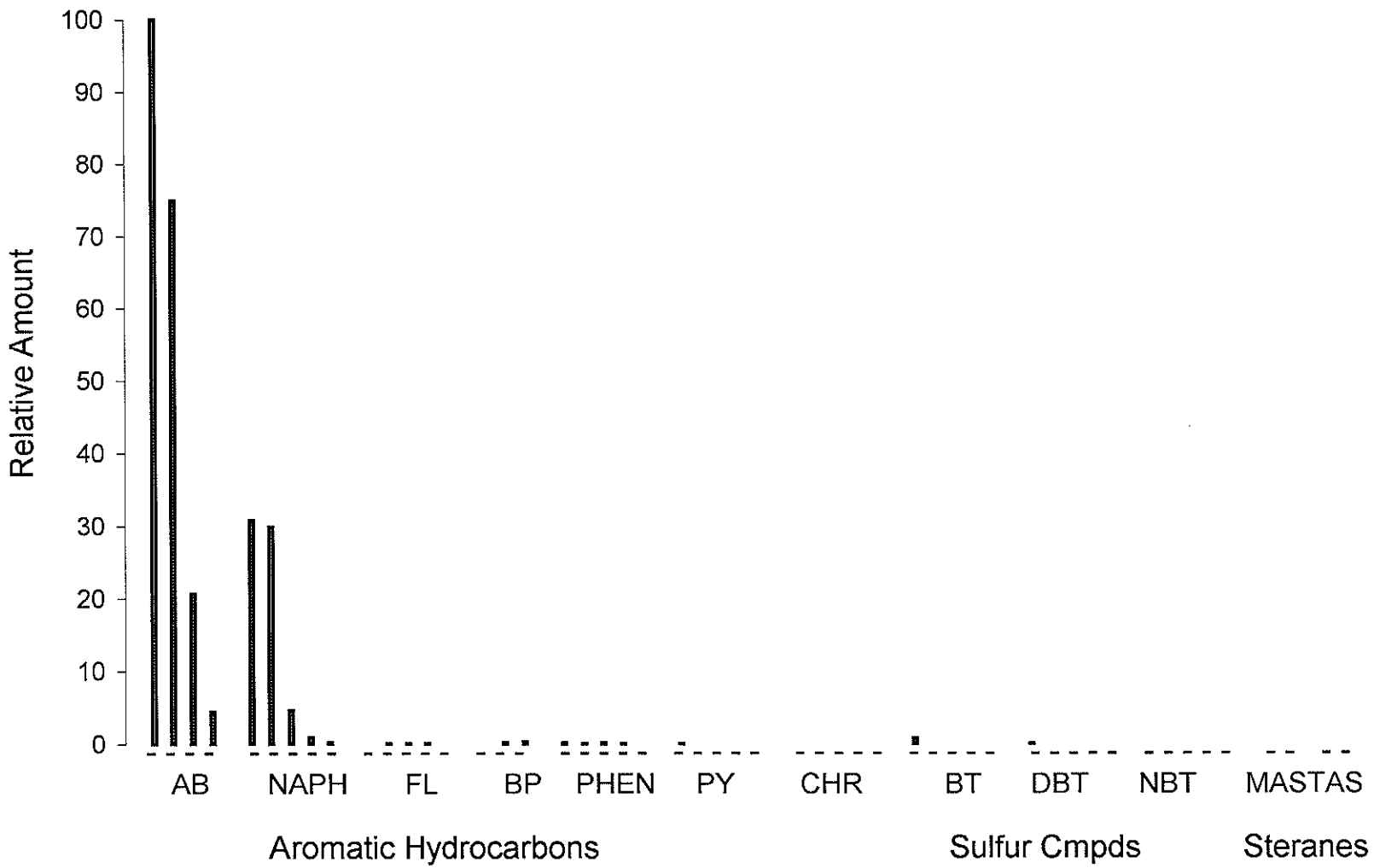
Table

Key for Identifying Aromatic Hydrocarbons

No.	m/z	Abbreviation	Compound
1	120	AB	C_3-alkylbenzenes
2	134		C_4-alkylbenzenes
3	148		C_5-alkylbenzenes
4	162		C_6-alkylbenzenes
5	128	NAPH	C_0-naphthalene
6	142		C_1-naphthalenes
7	156		C_2-naphthalenes
8	170		C_3-naphthalenes
9	184		C_4-naphthalenes
10	166	FL	C_0-fluorene
11	180		C_1-fluorenes
12	194		C_2-fluorenes
13	208		C_3-fluorenes
14	222		C_4-fluorenes
15	154	BP	C_0-biphenyl
16	168		C_1-biphenyls + dibenzofuran
17	182		C_2-biphenyls + C_1-dibenzofuran
18	178	PHEN	C_0-phenanthrene
19	192		C_1-phenanthrenes
20	206		C_2-phenanthrenes
21	220		C_3-phenanthrenes
22	234		C_4-phenanthrenes
23	202	PY	C_0-pyrene/fluoranthene
24	216		C_1-pyrenes/fluoranthenes
25	230		C_2-pyrenes/fluoranthenes
26	244		C_3-pyrenes/fluoranthenes
27	258		C_4-pyrenes/fluoranthenes
28	228	CHR	C_0-chrysene
29	242		C_1-chrysenes
30	256		C_2-chrysenes
31	270		C_3-chrysenes
32	284		C_4-chrysenes
33	148	BT	C_1-benzothiophenes
34	162		C_2-benzothiophenes
35	176		C_3-benzothiophenes
36	190		C_4-benzothiophenes
37	204		C_5-benzothiophenes
28	184	DBT	C_0-dibenzothiophene
39	198		C_1-dibenzothiophenes
40	212		C_2-dibenzothiophenes
41	226		C_3-dibenzothiophenes
42	240		C_4-dibenzothiophenes
43	234	NBT	C_0-naphthobenzothiophene
44	248		C_1-naphthobenzothiophenes
45	262		C_2-naphthobenzothiophenes
46	276		C_3-naphthobenzothiophenes
47	290		C_4-naphthobenzothiophenes
48	253	MAS	Monoaromatic steranes
49	267		Monoaromatic steranes
50	239		Monoaromatic steranes
51	231	TAS	Triaromatic steranes
52	245		Triaromatic steranes

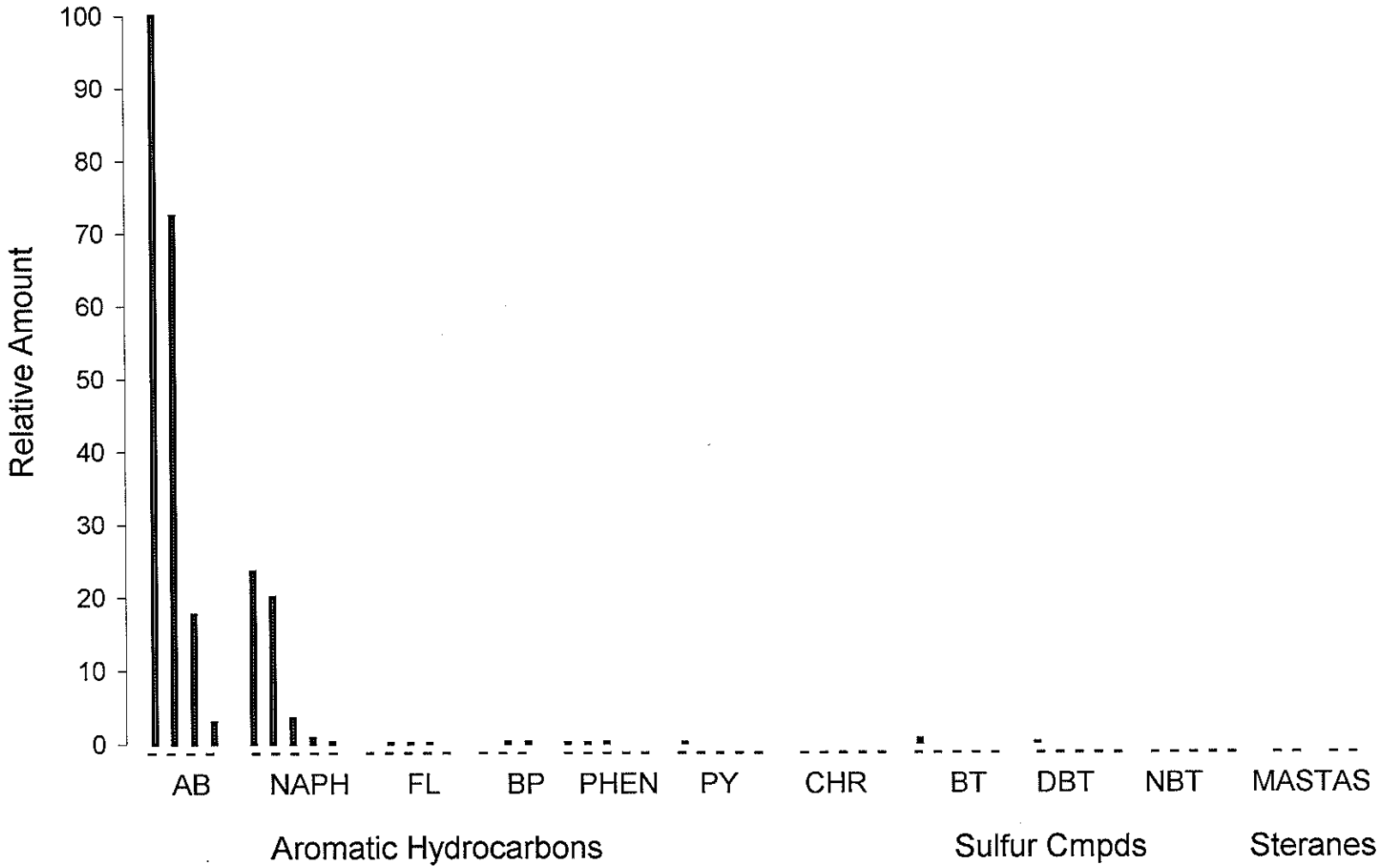
Aromatic Hydrocarbon Distribution

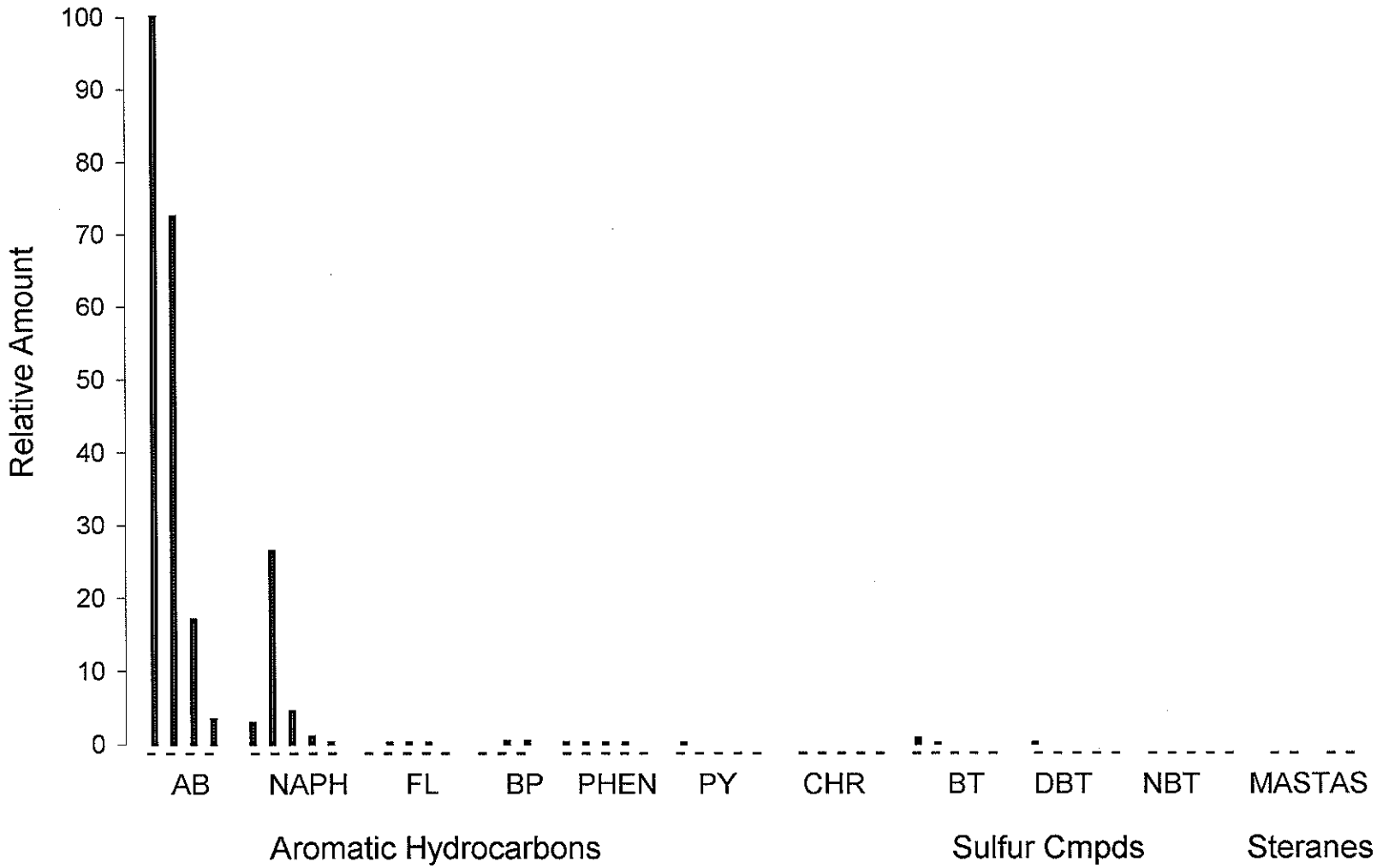
152918



Aromatic Hydrocarbon Distribution

152920



Aromatic Hydrocarbon Distribution

152922