



TEXAS A&M UNIVERSITY
Geochemical and Environmental Research Group
College of Geosciences and Maritime Studies

APPLIED GAS HYDRATE RESEARCH PROGRAM

GAS HYDRATE-RELATED CRUDE OIL, ATWATER BLOCK 425

BIOMARKERS AND WHOLE-OIL ISOTOPIC ANALYSIS

May 27, 1999
GERG TECHNICAL REPORT 99-010



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Quantitative Saturate Biomarker Data

STERANE AND TRITERPANE BIOMARKERS

Project: HYDRATE: GULF OF MEXICO

Lab Sample ID: OIL

Sample Descriptor: L51576

Analysis Date: 5/11/1999

No.	COMPOUND NAME	RT	ION	AREA	PPM	%
TERPANES						
H	C19 TRICYCLIC TERPANE	29.62	191	11527	3	0.3
A	C20 TRICYCLIC TERPANE	31.45	191	15897	4	0.5
B	C21 TRICYCLIC TERPANE	33.41	191	35087	9	1.1
C	C22 TRICYCLIC TERPANE	35.30	191	10790	3	0.3
D	C23 TRICYCLIC TERPANE	37.63	191	71510	19	2.1
E	C24 TRICYCLIC TERPANE	38.91	191	44973	12	1.3
1	C25 TRICYCLIC TERPANE	41.65	191	54827	14	1.6
4	C24 TETRACYCLIC TERPANE	43.56	191	32521	9	1.0
5	C26 TRICYCLIC TERPANE (22R)	43.58	191	20694	5	0.6
6	C26 TRICYCLIC TERPANE (22S)	43.77	191	21114	6	0.6
9	C28 TRICYCLIC TERPANE (22R)	45.99	191	13378	4	0.4
10	C28 TRICYCLIC TERPANE (22S)	46.11	191	6556	2	0.2
11	C29 TRICYCLIC TERPANE (22R)	48.25	191	32115	8	1.0
12	C29 TRICYCLIC TERPANE (22S)	48.54	191	28870	8	0.9
13	C27 18a-22,29,30-TRISNORNEOHOPANE (Ts)	51.86	191	93143	24	2.8
I	C27 PENTACYCLIC TERPANE (Y)	52.50	191	26822	7	0.8
14	C27 17a-22,29,30-TRISNORHOPANE (Tm)	52.83	191	27963	7	0.8
15	C30 TRICYCLIC TERPANE (22R)	52.97	191	20041	5	0.6
16	C30 TRICYCLIC TERPANE (22S)	53.28	191	37899	10	1.1
17	C28 17a,21b-28,30-BISNORHOPANE	54.00	191	19955	5	0.6
J	C29 17a,21b-25-NORHOPANE	54.21	191	21132	6	0.6
19	C29 17a,21b-30-NORHOPANE	54.70	191	284334	75	8.5
20	C29 18a-NORNEOHOPANE (29Ts)	54.78	191	80661	21	2.4
F	C30 DIAHOPANE	55.11	191	49875	13	1.5
21	C29 17b,21a-30-NORMORETANE	55.77	191	44833	12	1.3
22	C30 18a-OLEANANE	56.26	191	0	0	0.0
23	C30 17a,21b-HOPANE	56.45	191	600903	158	18.0
24	C30 17b,21a-MORETANE	57.29	191	91101	24	2.7
27	C31 17a,21b-HOMOHOPANE (22S)	58.49	191	318784	84	9.6
28	C31 17a,21b-HOMOHOPANE(22R)	58.73	191	203984	54	6.1
G	C30 GAMMACERANE	59.08	191	1101	0	0.0
30	C32 17a,21b-HOMOHOPANE (22S)	60.11	191	210260	55	6.3
31	C32 17a,21b-HOMOHOPANE (22R)	60.42	191	159214	42	4.8
34	C33 17a,21b-HOMOHOPANE (22S)	62.01	191	173395	46	5.2
35	C33 17a,21b-HOMOHOPANE (22R)	62.46	191	116708	31	3.5
36	C34 17a,21b-HOMOHOPANE (22S)	64.01	191	112520	30	3.4
37	C34 17a,21b-HOMOHOPANE (22R)	64.58	191	75994	20	2.3
38	C35 17a,21b-HOMOHOPANE (22S)	66.21	191	101459	27	3.0
39	C35 17a,21b-HOMOHOPANE (22R)	67.01	191	63900	17	1.9

STERANE AND TRITERPANE BIOMARKERS

Project: HYDRATE: GULF OF MEXICO

Lab Sample ID: OIL

Sample Descriptor: L51576

Analysis Date: 5/11/1999

No.	COMPOUND NAME	RT	ION	AREA	PPM	%
STERANES						
A	C21 DIAPREGNANE	33.90	217	49684	18	2.3
1	C21 PREGNANE	35.70	217	82791	29	3.8
B	C22 DIAHOMOPREGNANE	35.80	217	33589	12	1.6
2	C22 HOMOPREGNANE	38.31	217	53714	19	2.5
3	C27 13b,17a DIASTERANE (20S)	45.99	217	137928	46	6.0
4	C27 13b,17a DIASTERANE (20R)	46.71	217	99649	33	4.3
8	C27 13a,17b DIASTERANE (20S)	47.33	217	44933	15	2.0
9	C27 13a,17b DIASTERANE (20R)	47.70	217	57135	19	2.5
10	C28 13b,17a DIASTERANE (20S) (24R/24S ?)	47.95	217	73843	25	3.2
11	C28 13b,17a DIASTERANE (20S) (24R/24S ?)	48.09	217	56395	19	2.5
14+15	C28 13b,17a DIASTERANE (20R) (24R/24S ?)	48.81	217	49192	16	2.1
16	C28 13a,17b DIASTERANE (20S)	49.39	217	34796	11	1.4
17	C27 5a,14a,17a STERANE (20S)	49.45	217	105135	33	4.3
18	C27 5a,14b,17b ISOSTERANE (20R) + C29 13b,17a DIASTERANE (20S)	49.63	217	120241	38	5.0
19	C27 5a,14b,17b ISOSTERANE (20S)	49.86	217	115202	37	4.8
20	C28 13a,17b DIASTERANE (20R)	50.00	217	16917	5	0.7
22	C27 5a,14a,17a STERANE (20R)	50.27	217	99194	32	4.1
23	C29 13b,17a DIASTERANE (20R)	50.52	217	121837	39	5.0
24	C29 13a,17b DIASTERANE (20S)	51.14	217	32243	10	1.3
26	C28 5a,14a,17a STERANE (20S)	51.38	217	43149	13	1.7
27	C29 13a,17b DIASTERANE (20R)	51.53	217	28610	9	1.1
28	C28 5a,14b,17b ISOSTERANE (20R)	51.65	217	57620	18	2.3
29	C28 5a,14b,17b ISOSTERANE (20S)	51.82	217	109082	33	4.4
31	C28 5a,14a,17a STERANE (20R)	52.58	217	83787	26	3.3
33	C29 5a,14a,17a STERANE (20S)	53.28	217	146566	43	5.7
34	C29 5a,14b,17b ISOSTERANE (20R)	53.63	217	178223	53	6.9
35	C29 5a,14b,17b ISOSTERANE (20S)	53.81	217	114917	34	4.4
37	C29 5a,14a,17a STERANE (20R)	54.47	217	137198	41	5.3
38	C30 5a,14a,17a STERANE (20S)	54.68	217	31341	9	1.2
39	C30 5a,14b,17b ISOSTERANE (20R)	55.11	217	38652	11	1.5
40	C30 5a,14b,17b ISOSTERANE (20S)	55.28	217	43583	13	1.7
41	C30 5a,14a,17a STERANE (20R)	56.06	217	26999	8	1.0

Percent composition data for saturated biomarkers are based on concentration data

STERANE AND TRITERPANE BIOMARKERS

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PARAMETERS

A:LEVEL OF MATURITY

<u>Steranes</u>		<u>Terpanes</u>	
% 20S C29 STERANES	51.7	% 22S C31 HOMOHOPEANE	61.0
% C29 ISOSTERANES (abb)	50.8	% C30 HOPANE	86.8
% REGULAR STERANES	26.7	% TS/TS+TM (C27)	76.9
% ISOSTERANES	28.4	TS/TM (C27)	3.33
% DIASTERANES	34.8	% C30 MORETANE	13.2
% SHORT-CHAIN STERANES	10.2	% C29 NORMORETANE	13.6
		DIAHOPANE INDEX (%)	7.7
		% TRICYCLIC TERPANES	12.7

B:ORGANIC FACIES AND DEPOSITIONAL ENVIRONMENT

% TOTAL C20+C21	10.2	OLEANANE INDEX (%)	0.0
% TOTAL C27	30.5	GAMMACERANE INDEX (%)	0.2
% TOTAL C28	21.7	BISNORHOPANE INDEX (%)	3.2
% TOTAL C29	32.2	25-NORHOPANE INDEX (%)	3.4
% TOTAL C30	5.4	DIAHOPANE INDEX (%)	7.7
HOPANES/STERANES	1.1	% TRICYCLIC TERPANES	12.7
% DIASTERANES	34.8	% C24 TETRACYCLIC TERPANE	5.1
TOTAL STERANES (ppm)	769	% MORETANES	13.3
<u>Other Biological Markers</u>		% TOTAL C31 PENTACYCLICS	34.0
b-Carotane (ppm)	19	% TOTAL C32 PENTACYCLICS	24.1
		% TOTAL C33 PENTACYCLICS	18.9
		% TOTAL C34 PENTACYCLICS	12.3
		% TOTAL C35 PENTACYCLICS	10.8
		C35/C34 HOMOHOPEANES	0.88
		29/30 HOPANES	0.47
		TOTAL TRITERPANES (ppm)	877

All ratios based on concentrations

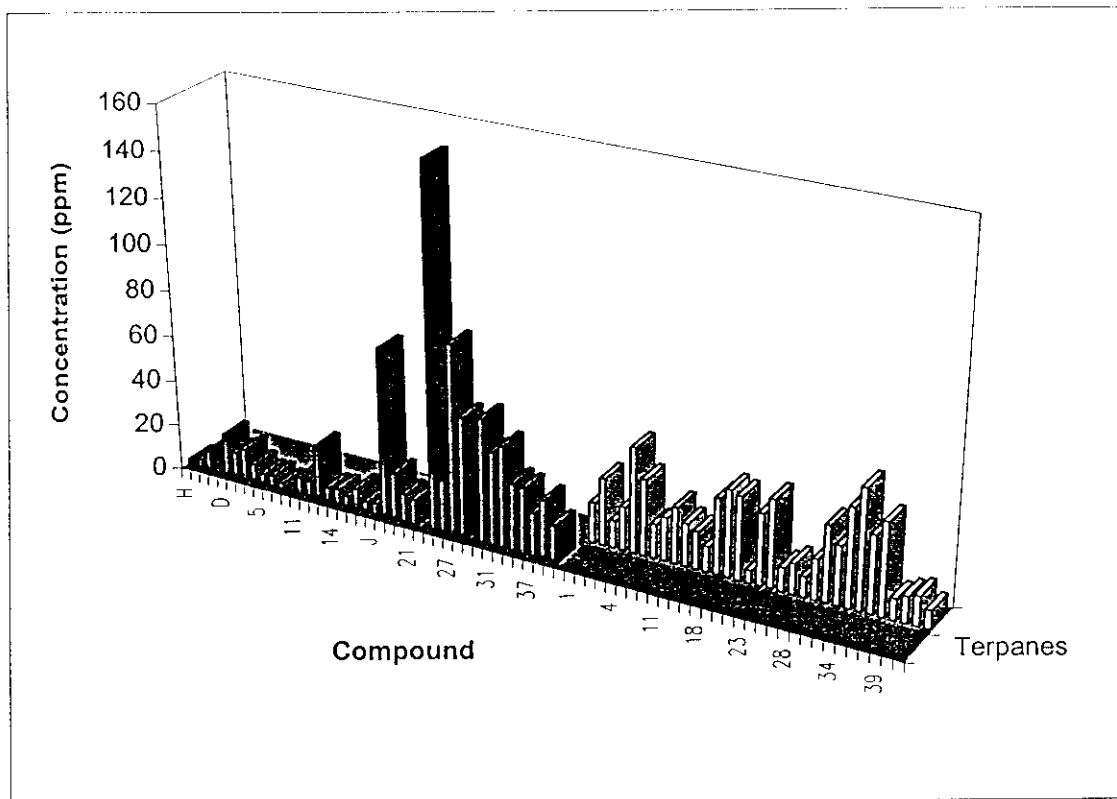
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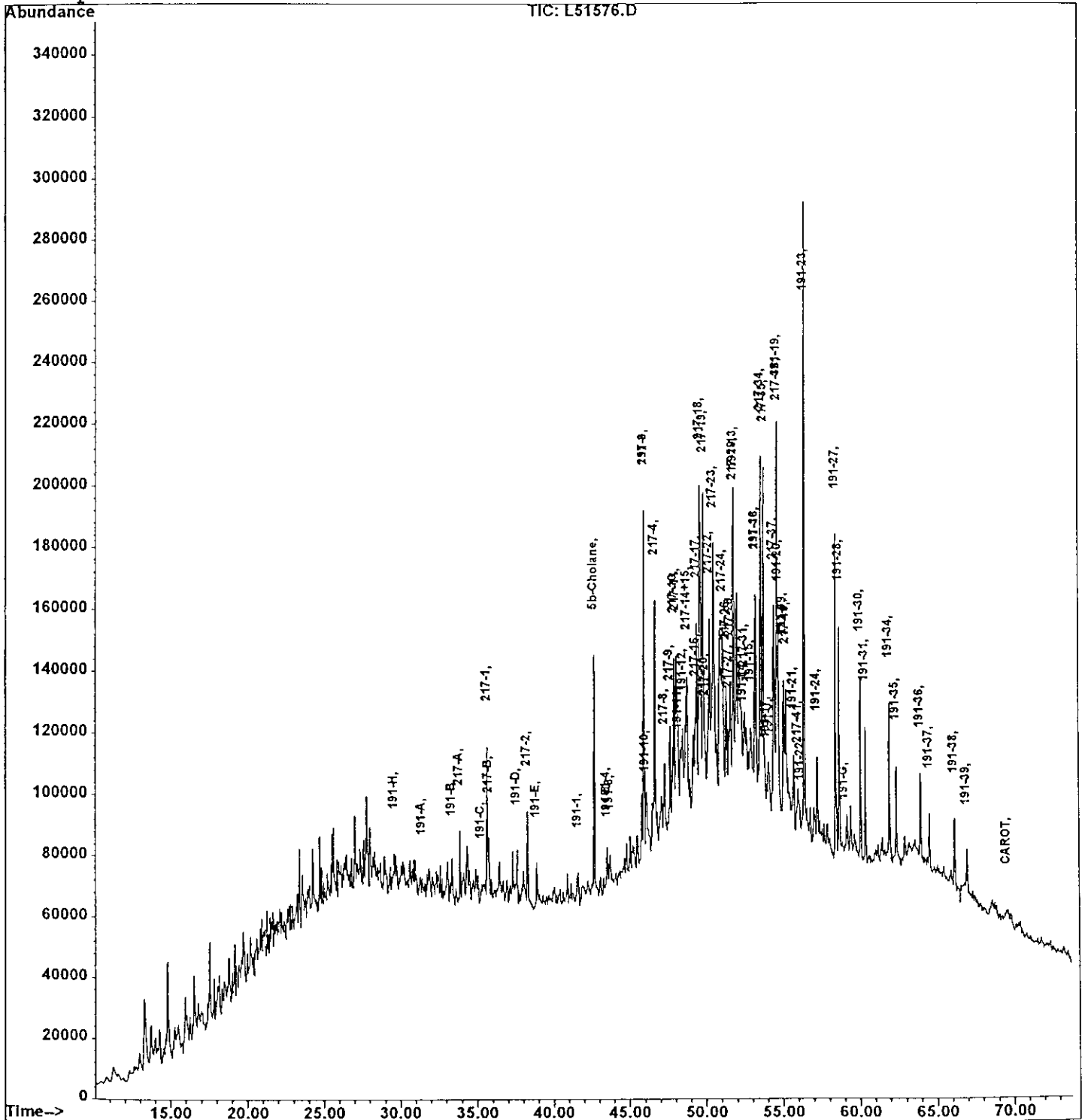
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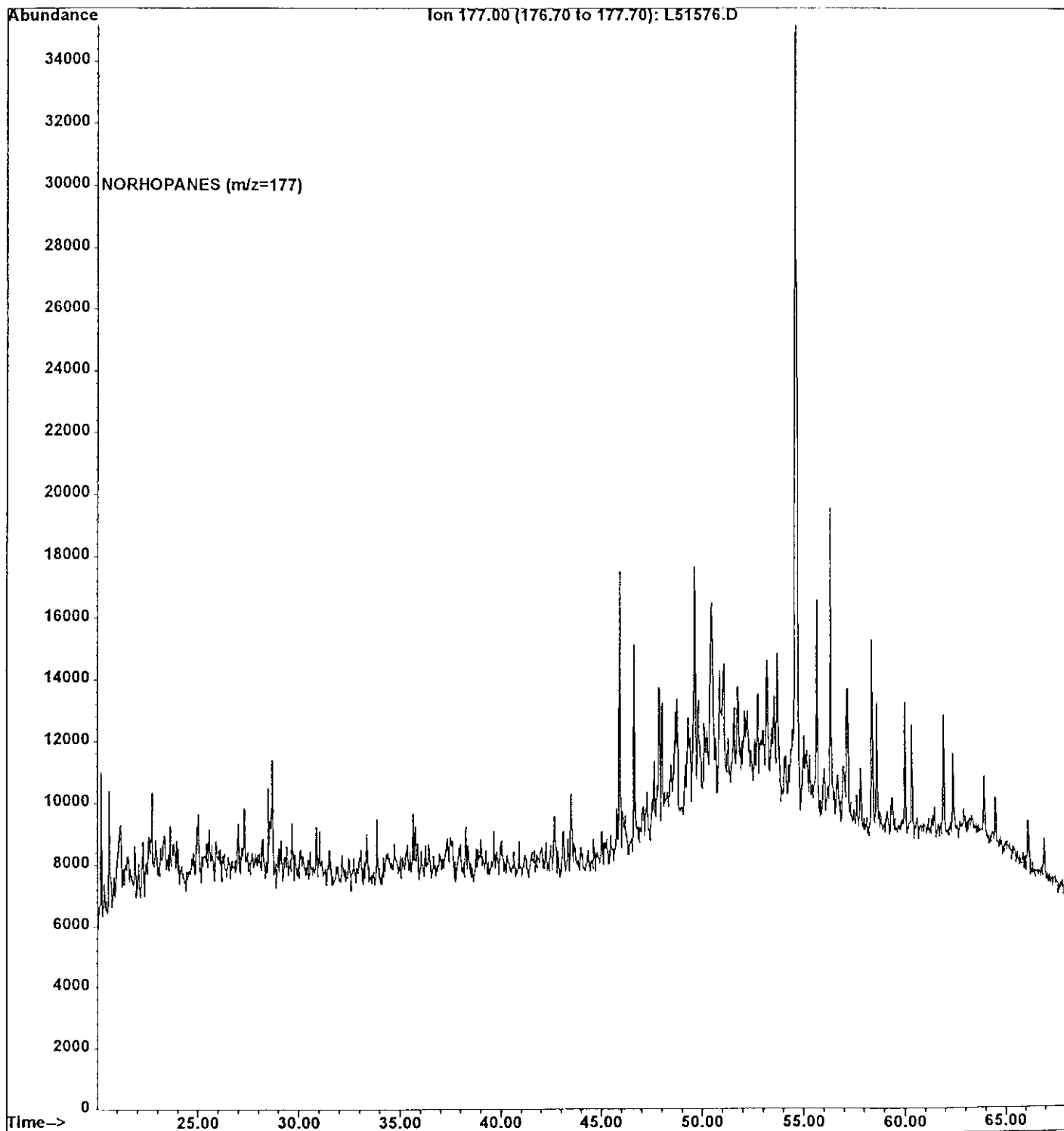
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Operator: ALCALA-HERRE
Inst : M6-HP5890
Multiplr: 1.00

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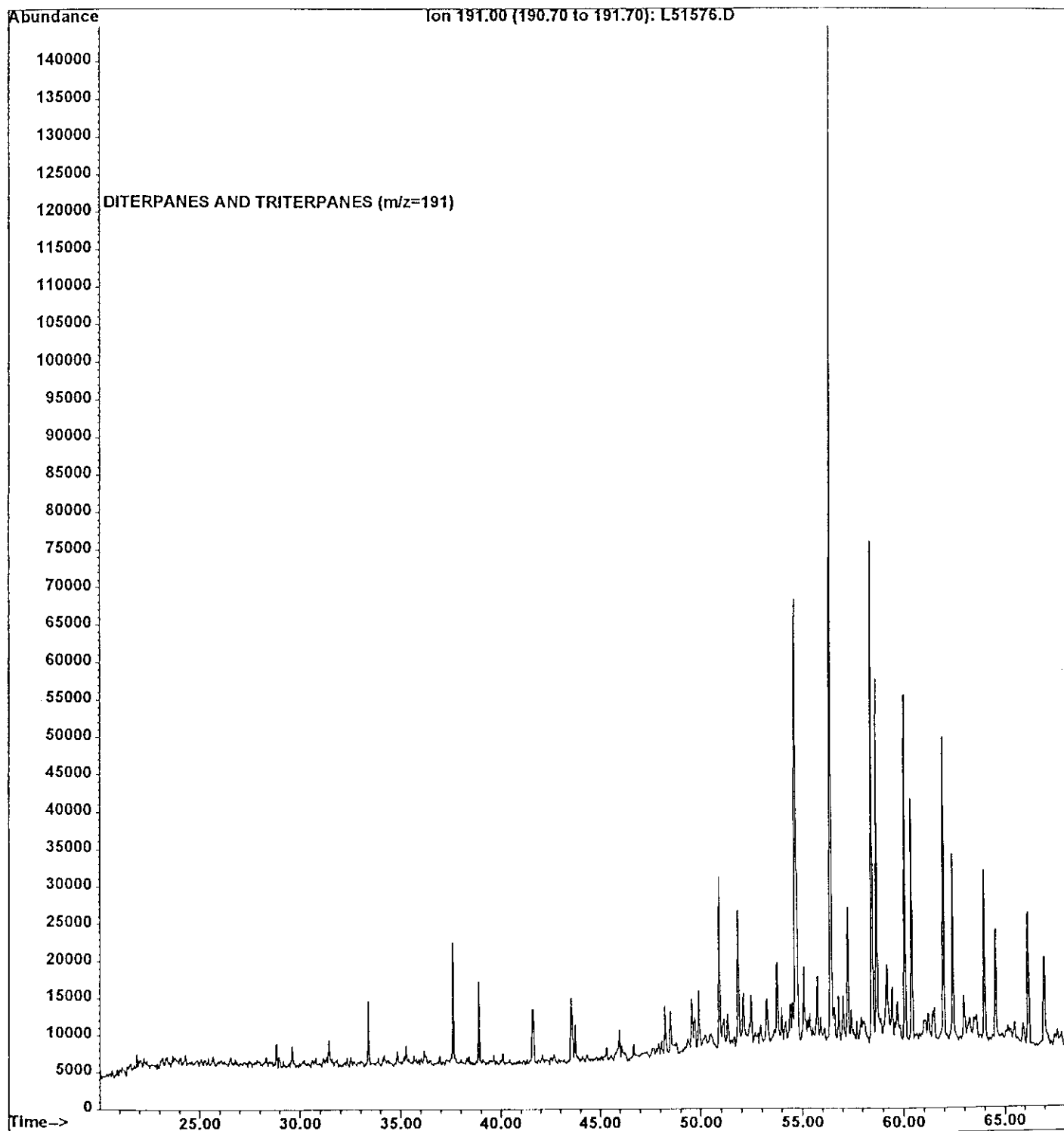
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Last Update :
Response via : Initial Calibration



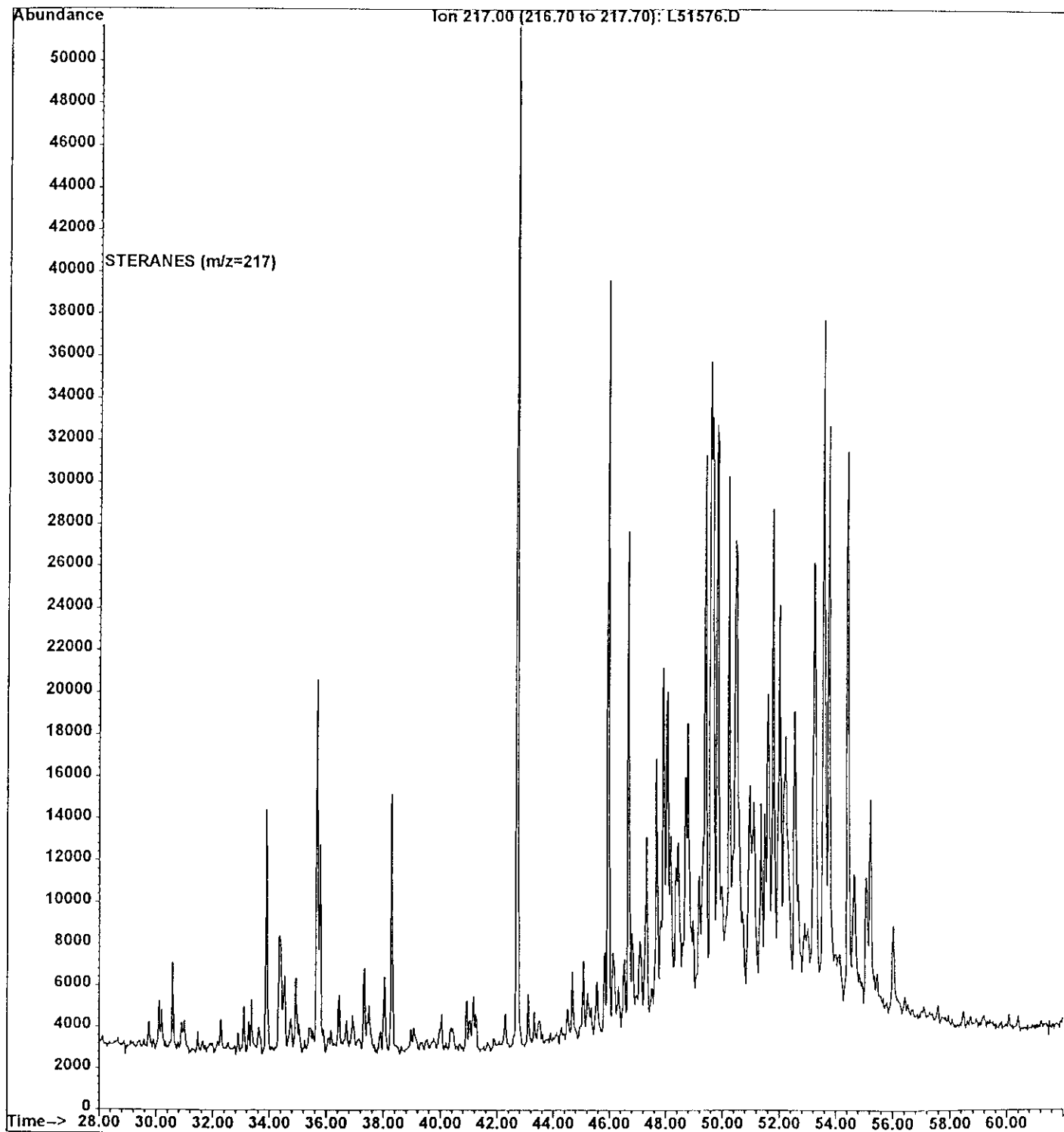
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Instrument : M6-HP5890
Sample Name: L51576
Misc Info : Saturated Biomarker
Vial Number: 5



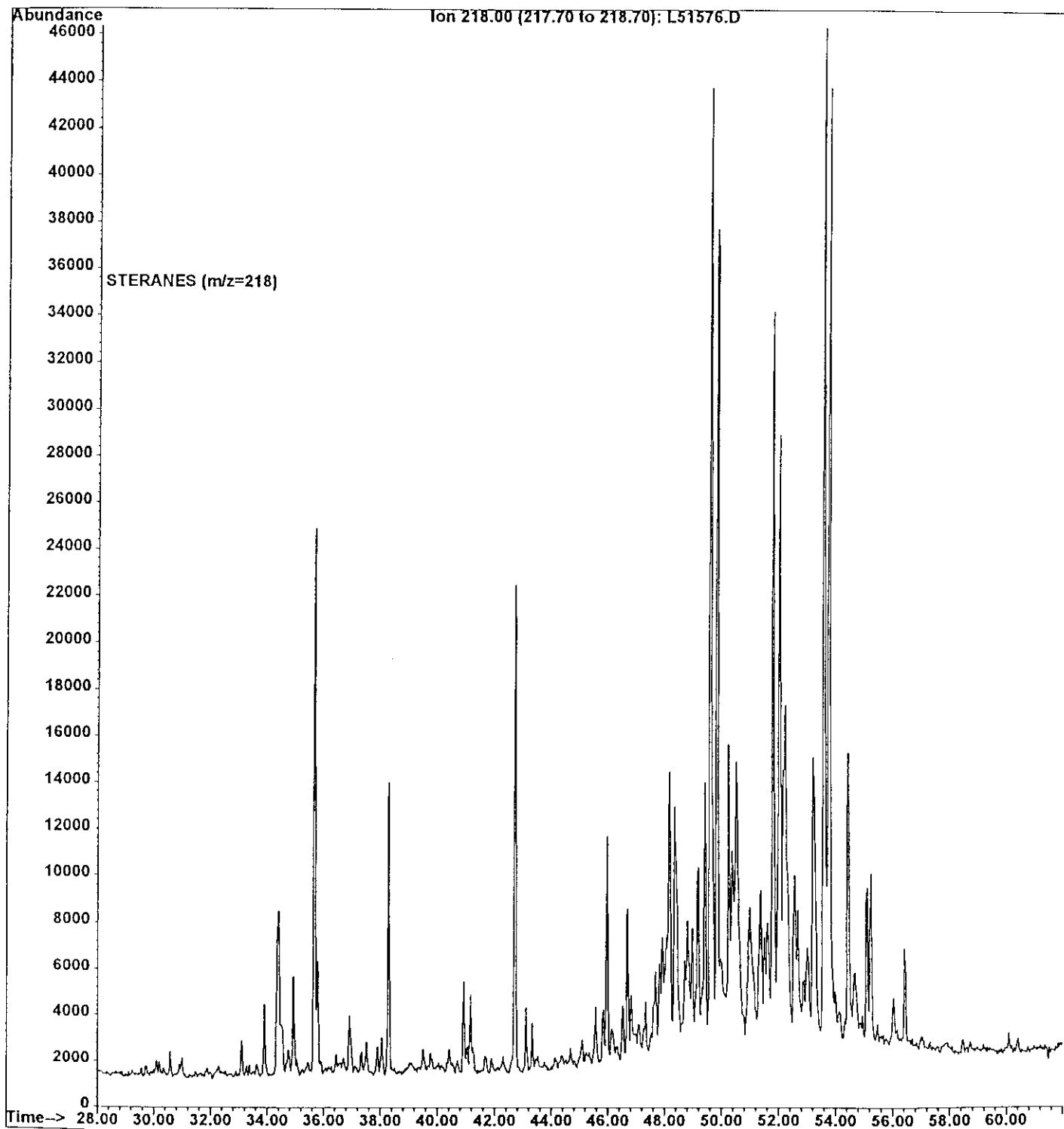
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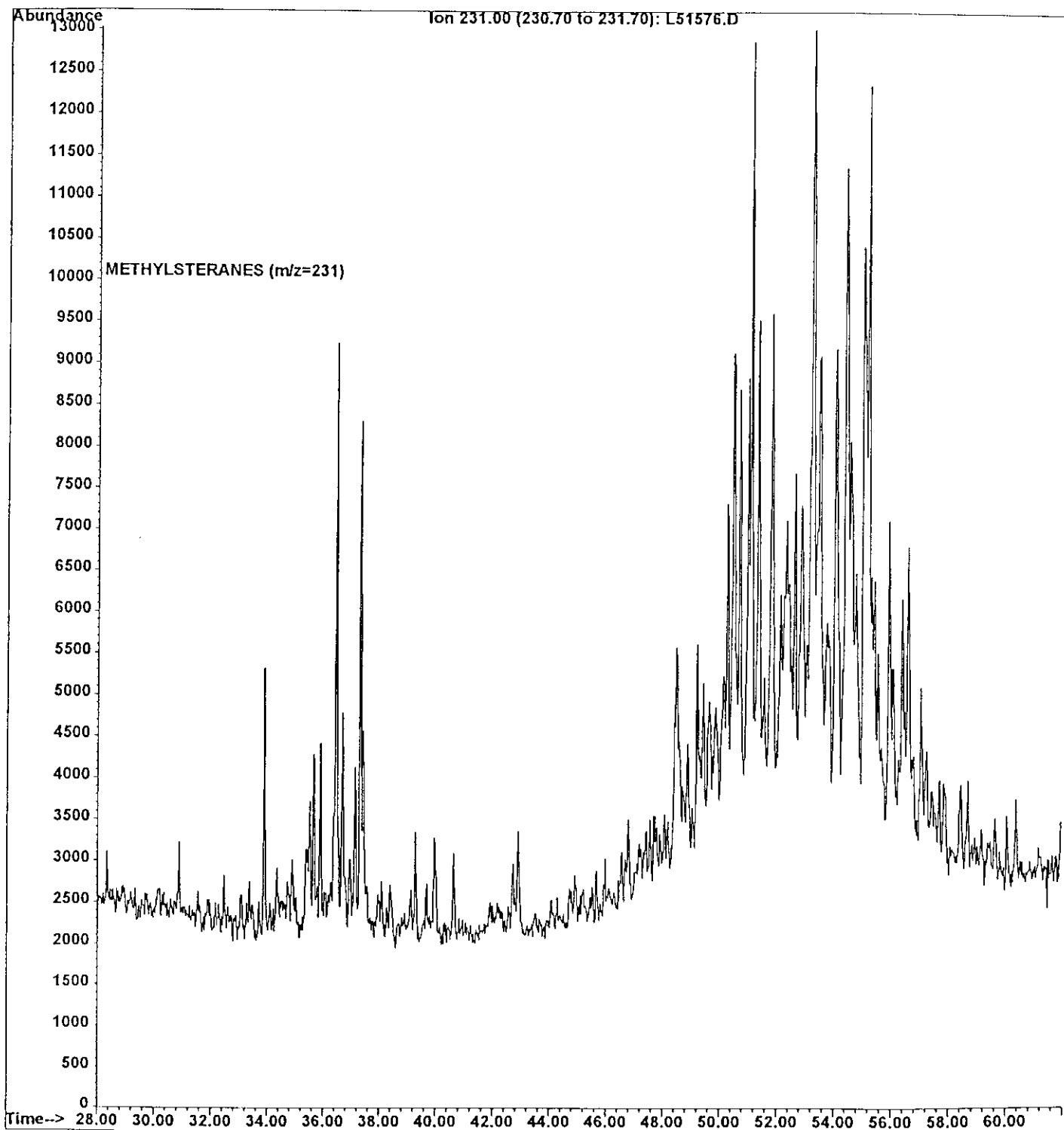
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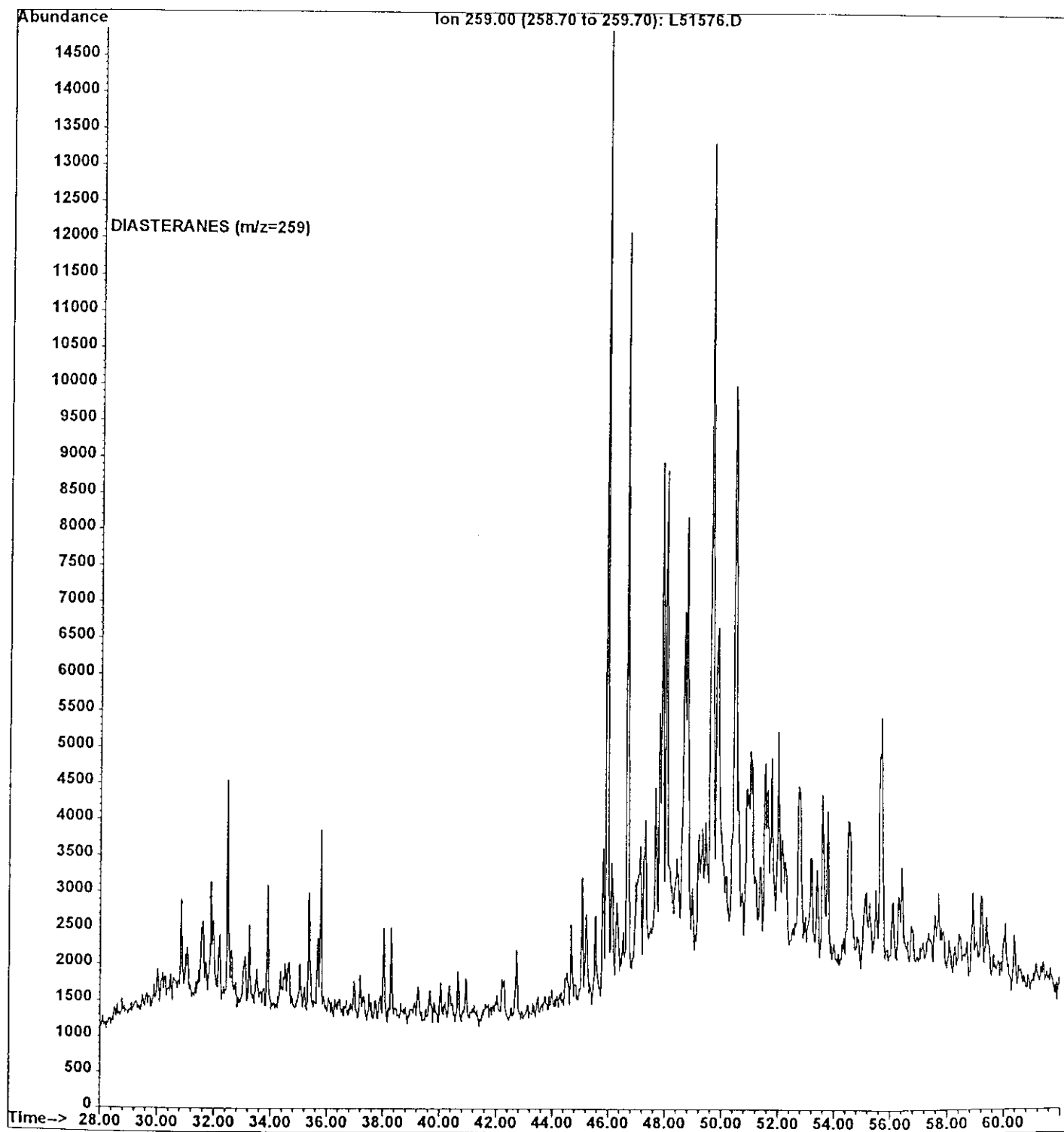
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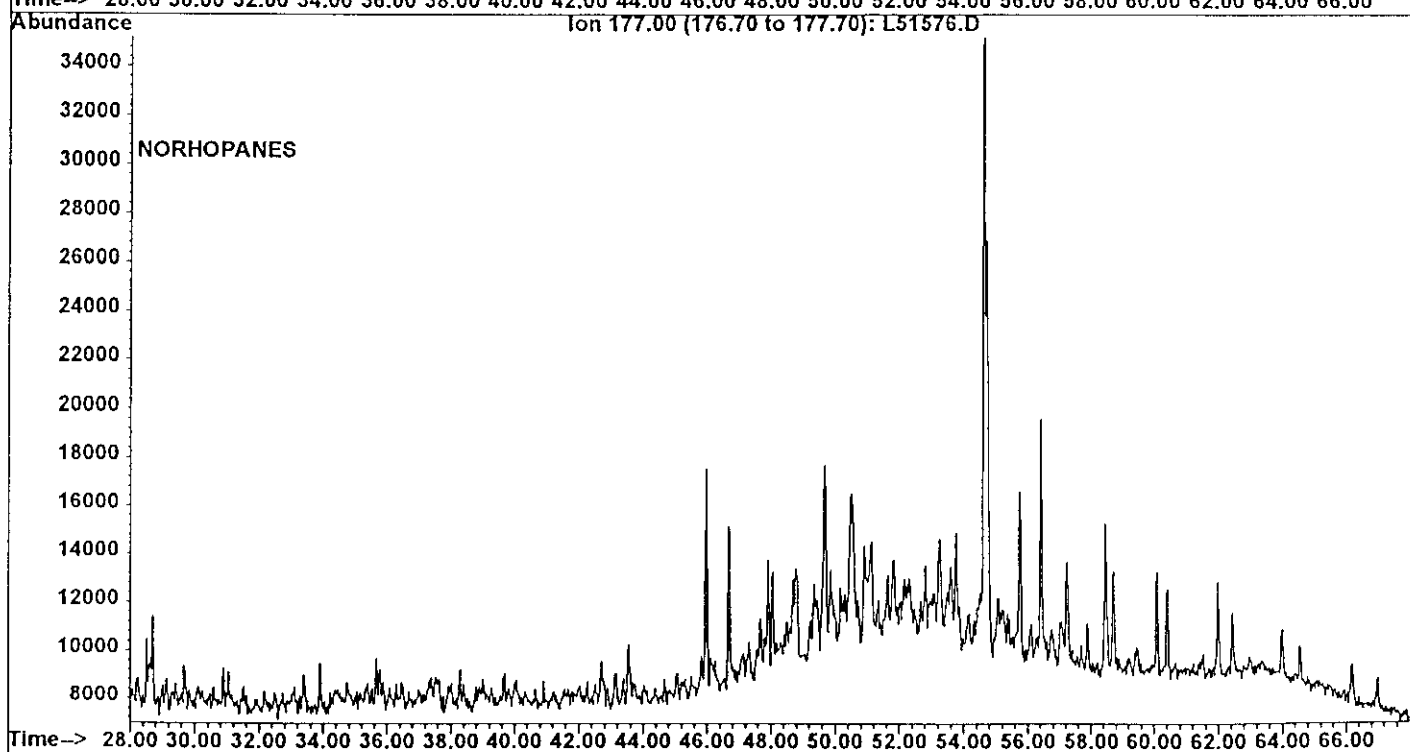
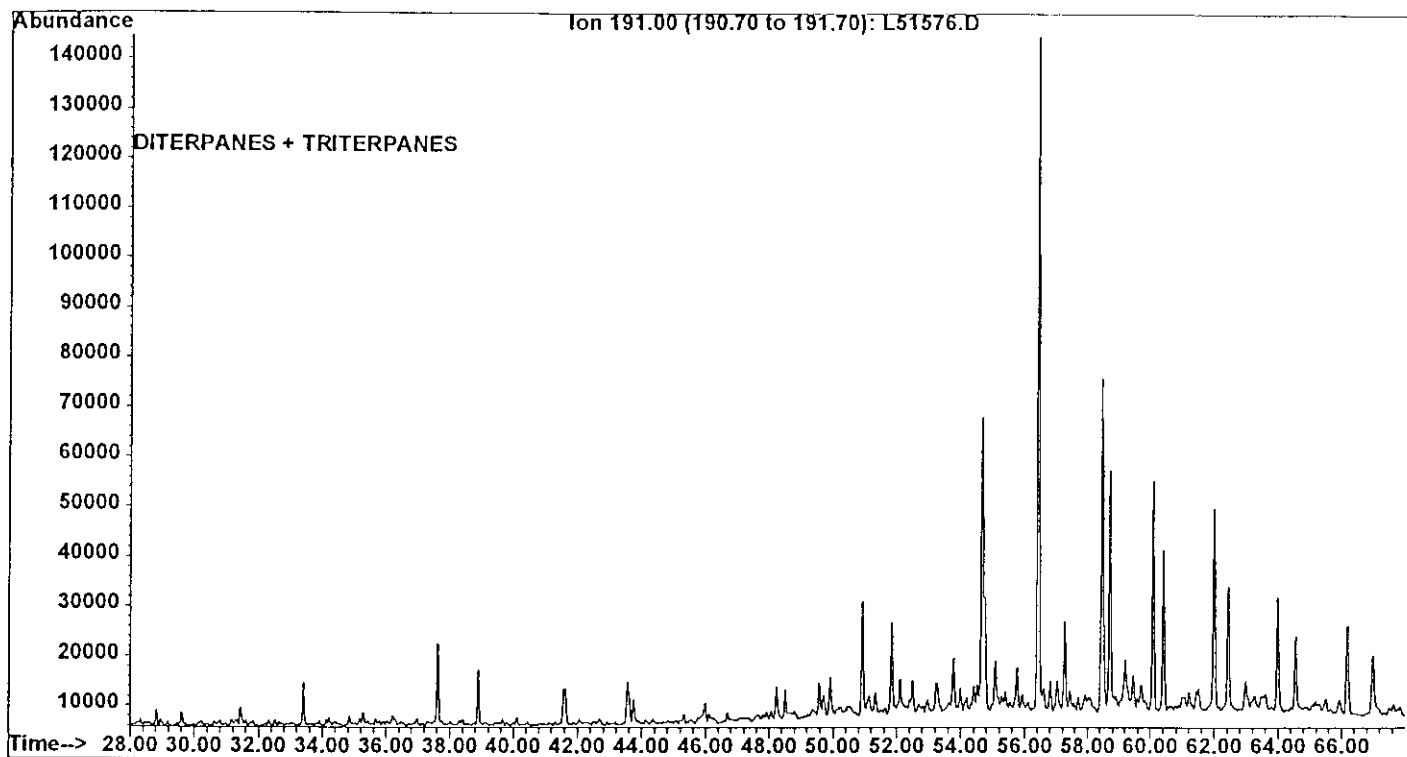
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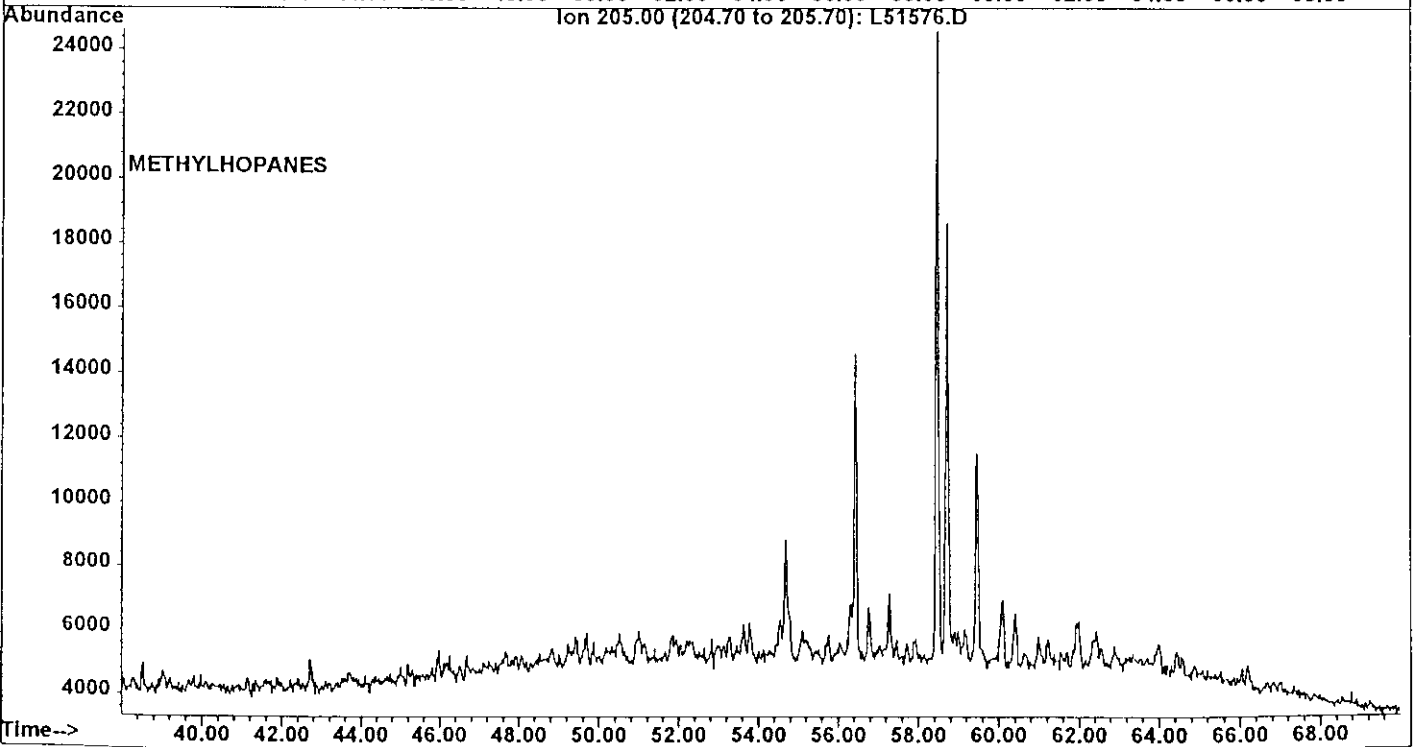
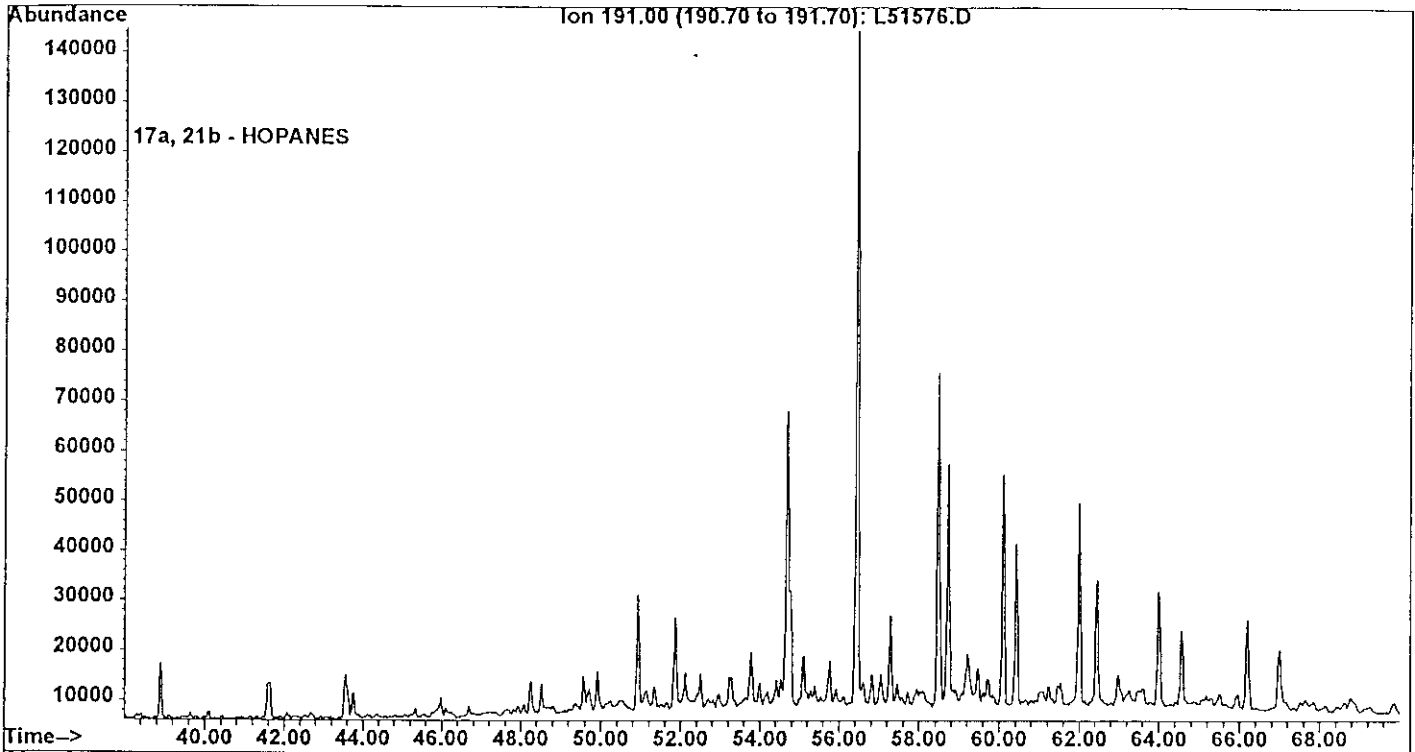
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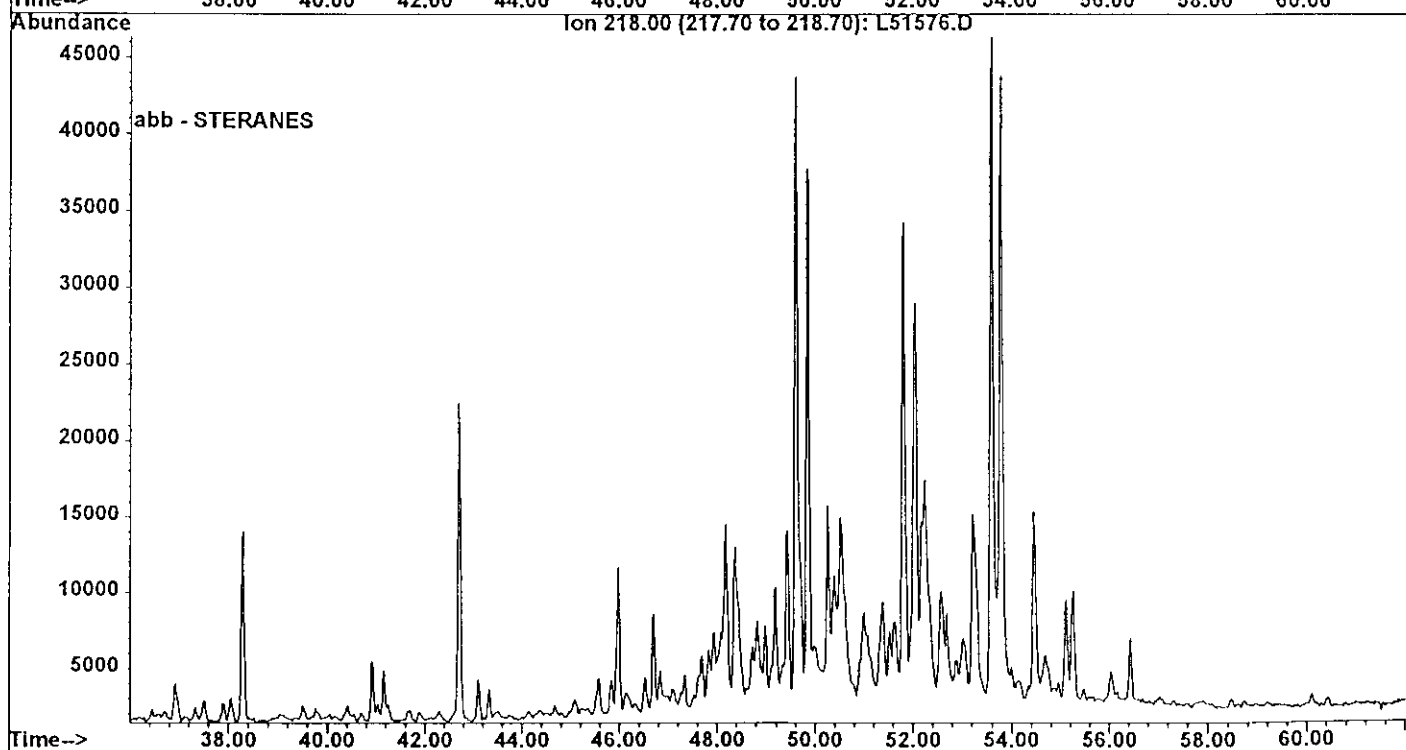
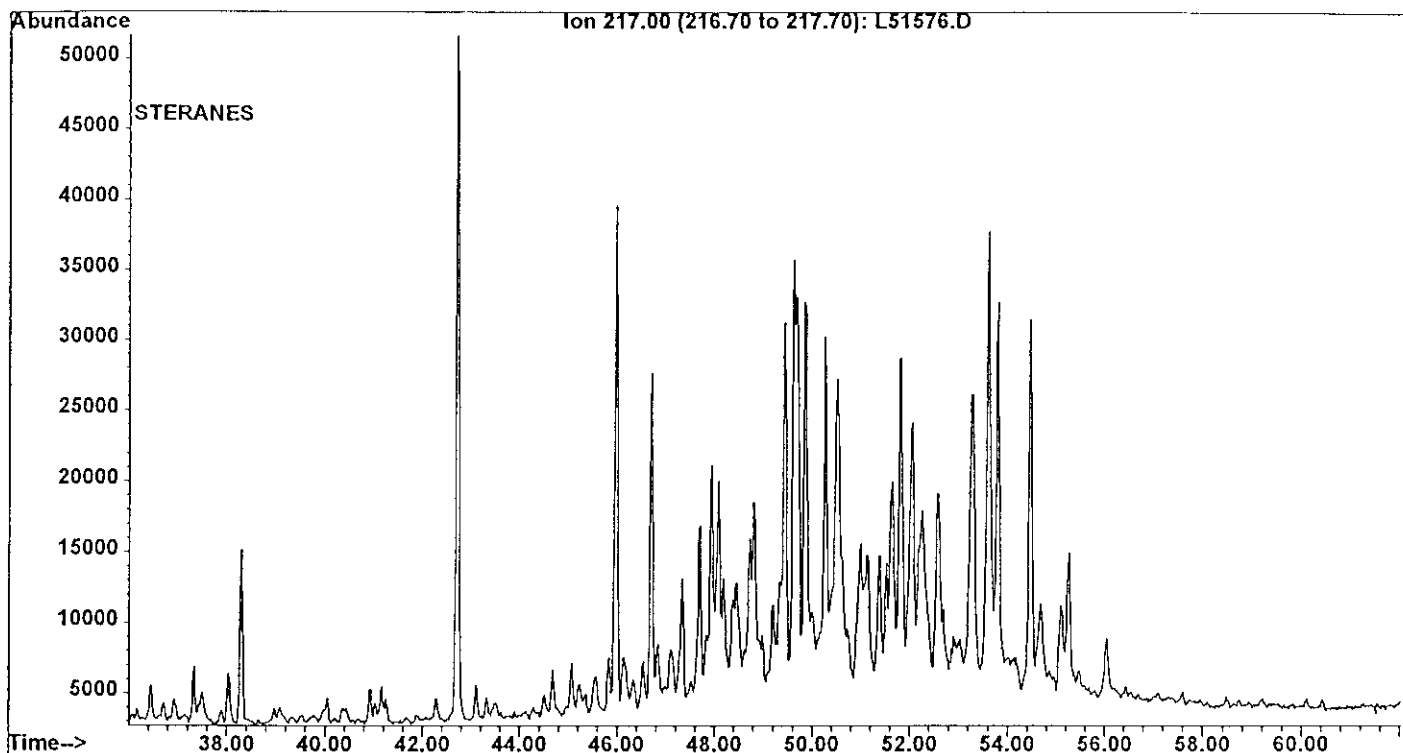
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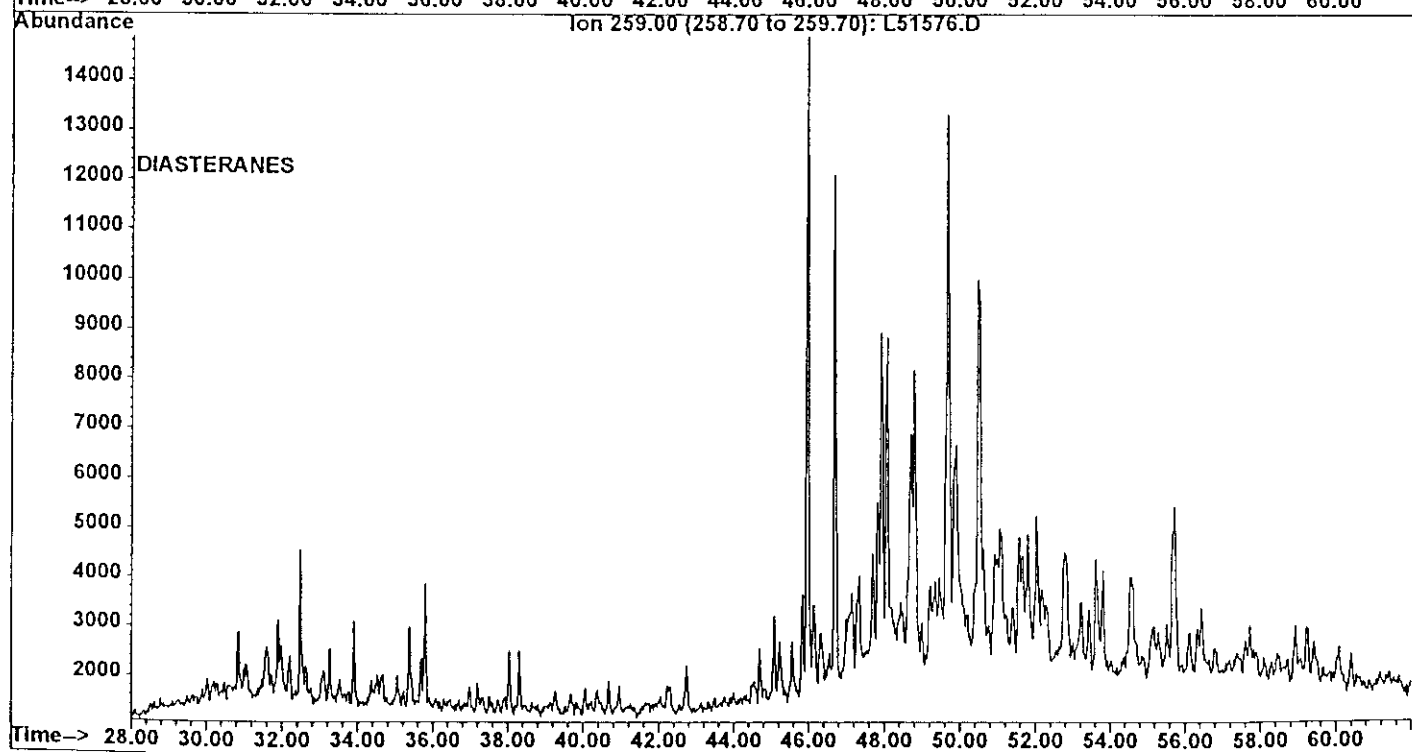
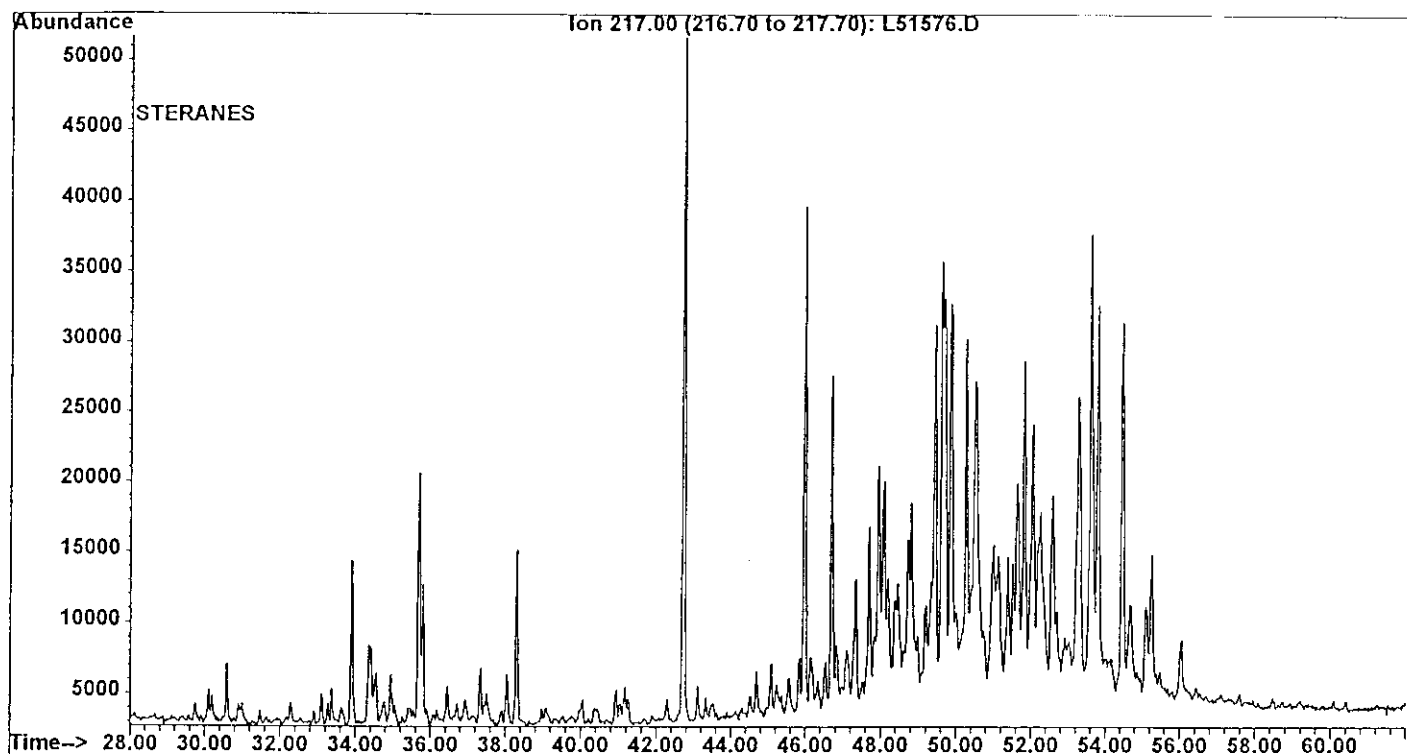
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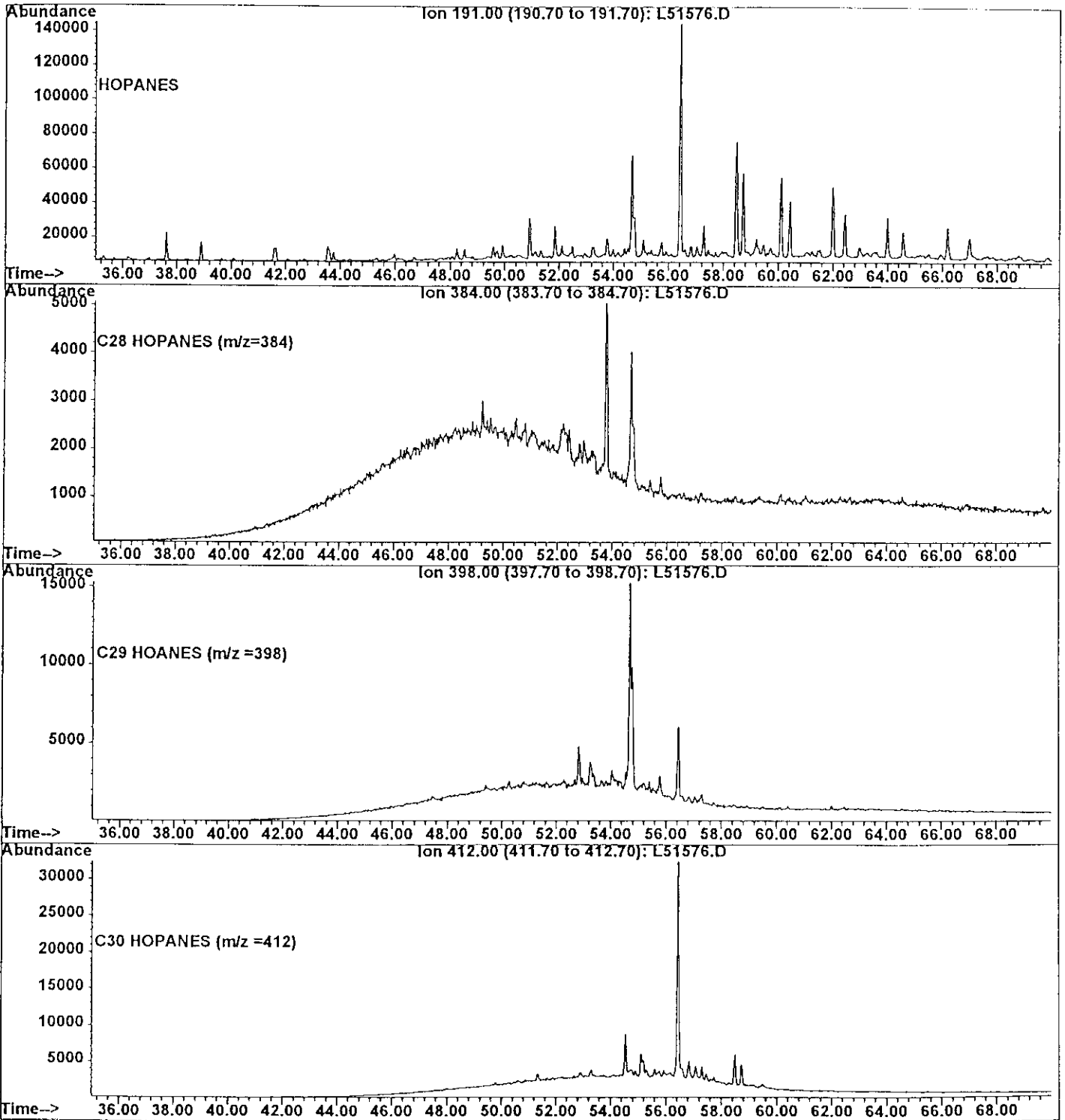
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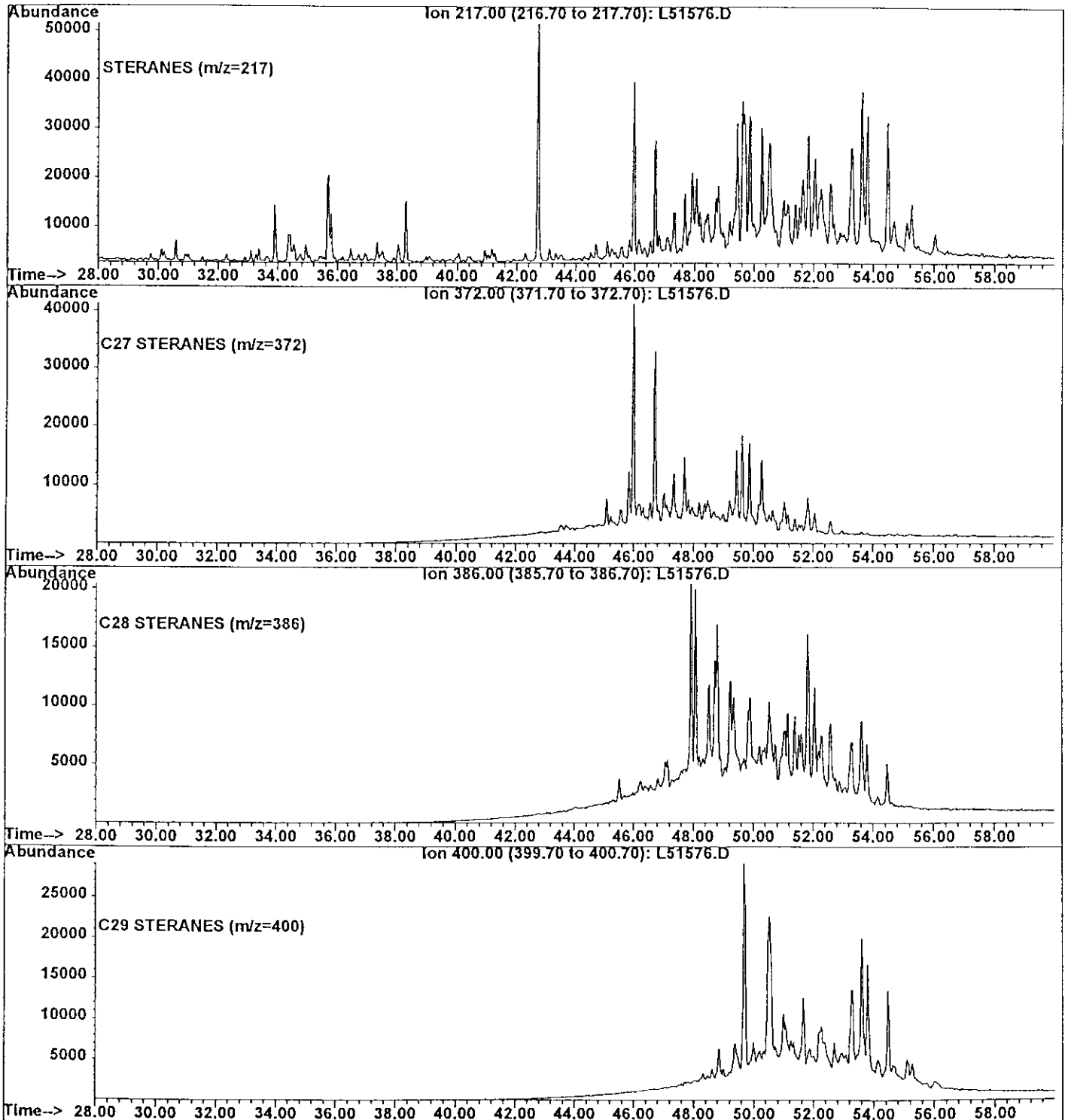
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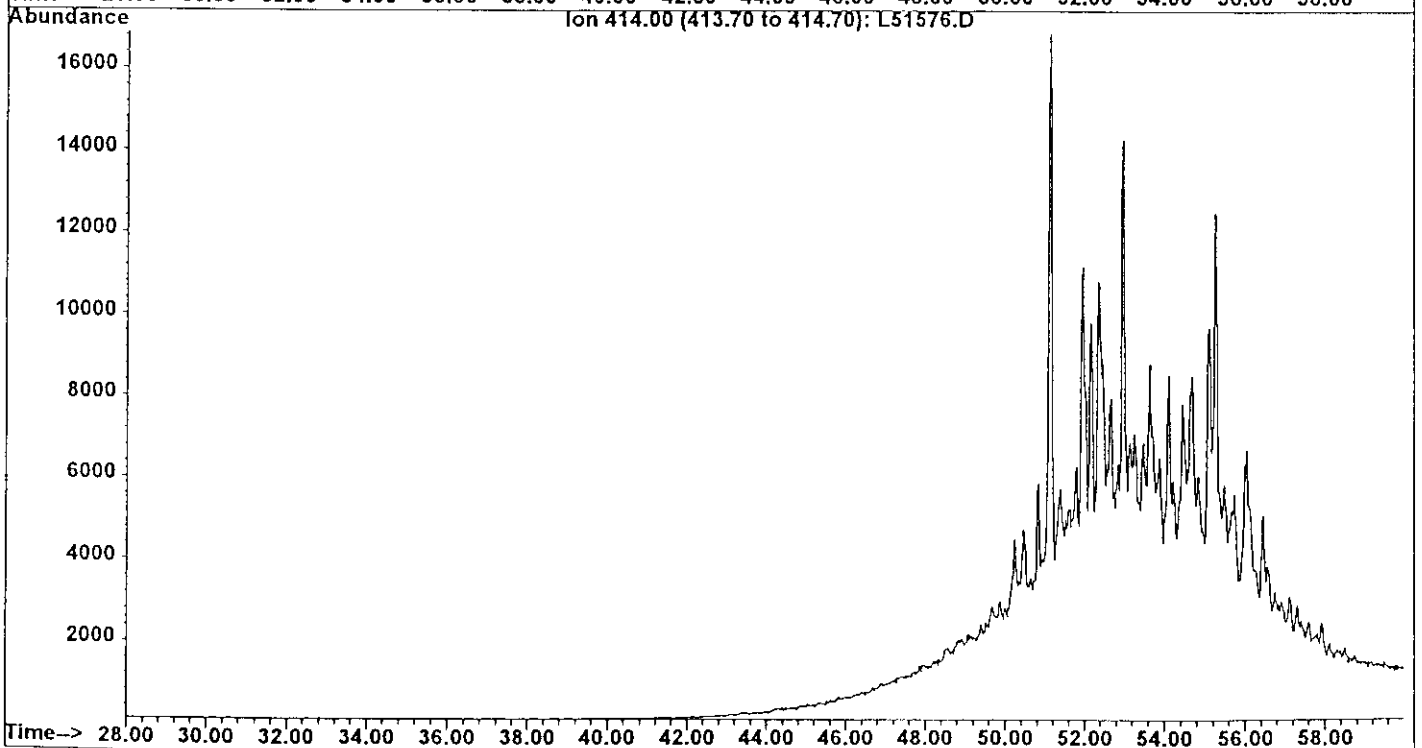
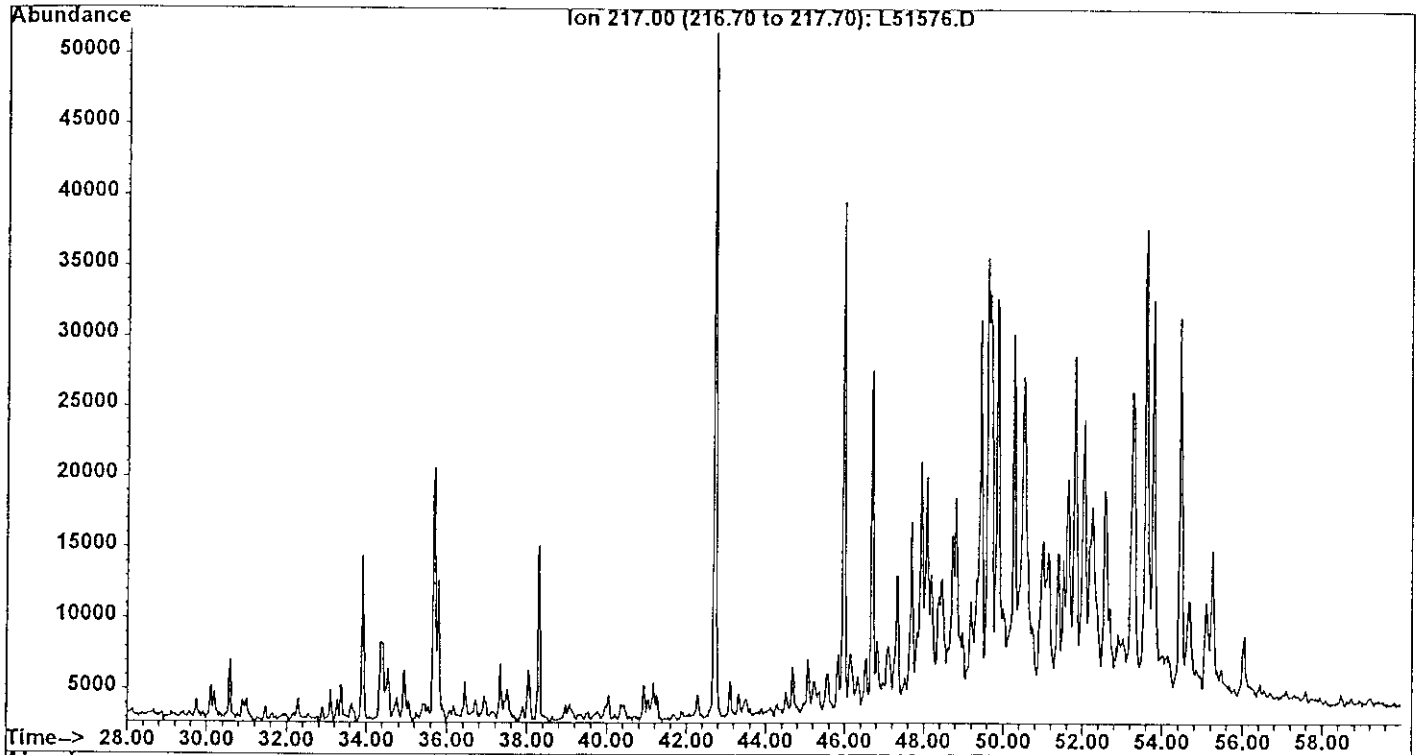
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Vial Number: 5



Quantitative Aromatic Biomarker Data

AROMATIC HYDROCARBONS AND AROMATIZED STERANES

Project: HYDRATE: GULF OF MEXICO

Lab Sample ID: L51576

Sample Descriptor: 4X Dilution

Analysis Date: 5/19/1999

No.	COMPOUND NAME	RT	ION	AREA	PPM	%
2- AND 3-RING AROMATIC HYDROCARBONS						
1	2-ETHYLNAPHTHALENE	15.57	156	1833	110.4	0.2
2	1-ETHYLNAPHTHALENE	15.80	156	22681	1365.7	2.9
3	2,6+2,7-DIMETHYLNAPHTHALENE	16.19	156	45498	2739.5	5.8
4	1,3+1,7-DIMETHYLNAPHTHALENE	16.55	156	84332	5077.8	10.7
5	1,6-DIMETHYLNAPHTHALENE	16.68	156	53849	3242.4	6.8
6	1,4+2,3-DIMETHYLNAPHTHALENE	17.16	156	40533	2440.6	5.1
7	1,5-DIMETHYLNAPHTHALENE	17.20	156	18445	1110.6	2.3
8	1,2-DIMETHYLNAPHTHALENE	17.59	156	15364	925.1	1.9
9	1,3,7-TRIMETHYLNAPHTHALENE	19.60	170	25066	1872.1	3.9
10	1,3,6-TRIMETHYLNAPHTHALENE	19.69	170	25443	1900.2	4.0
11	1,4,6+1,3,5-TRIMETHYLNAPHTHALENE	20.31	170	53237	3976.1	8.4
12	2,3,6-TRIMETHYLNAPHTHALENE	20.44	170	13234	988.4	2.1
13	1,2,7+1,6,7+1,2,6-TRIMETHYLNAPHTHALENE	20.80	170	36307	2711.6	5.7
14	1,2,4-TRIMETHYLNAPHTHALENE	21.25	170	8931	667.0	1.4
15	1,2,5-TRIMETHYLNAPHTHALENE	21.48	170	9513	710.5	1.5
16	BIPHENYL	15.22	154	7239	271.6	0.6
17	3-METHYLBIPHENYL	18.53	168	9272	542.5	1.1
18	4-METHYLBIPHENYL	18.72	168	9158	535.8	1.1
19	FLUORENE	21.35	166	26272	1097.1	2.3
20	METHYLFLUORENE-1	24.43	180	1333	89.9	0.2
21	METHYLFLUORENE-2	24.52	180	4576	308.7	0.6
22	METHYLFLUORENE-3	24.62	180	1973	133.1	0.3
23	1-METHYLFLUORENE	24.75	180	5259	354.8	0.7
24	METHYLFLUORENE-4	25.20	180	3819	257.7	0.5
25	PHENANTHRENE	26.79	178	10188	284.9	0.6
26	3-METHYLPHENANTHRENE	29.71	192	8649	353.7	0.7
27	2-METHYLPHENANTHRENE	29.85	192	7988	326.7	0.7
28	9-METHYLPHENANTHRENE	30.28	192	24696	1010.0	2.1
29	1-METHYLPHENANTHRENE	30.42	192	10595	433.3	0.9
30	2+9-ETHYL+3,6-DIMETHYLPHENANTHRENE	32.61	206	2019	82.6	0.2
31	1-E+3,5-DIMETHYLPHENANTHRENE	32.77	206	920	37.6	0.1
32	2,6+2,7-DIMETHYLPHENANTHRENE	32.85	206	2537	103.8	0.2
33	1,3+3,9+2,10+3,10-DIMETHYLPHENANTHRENE	32.99	206	14844	607.1	1.3
34	1,6+2,9+2,5-DIMETHYLPHENANTHRENE	33.15	206	7710	315.3	0.7
35	1,7-DIMETHYLPHENANTHRENE	33.28	206	4752	194.3	0.4
36	2,3-DIMETHYLPHENANTHRENE	33.45	206	2314	94.6	0.2
37	4,10+1,9+4,9-DIMETHYLPHENANTHRENE	33.50	206	3864	158.0	0.3
38	1,8-DIMETHYLPHENANTHRENE	33.85	206	4132	169.0	0.4
39	DIBENZOTHIOPHENE	25.92	184	3723	115.7	0.2
40	4-METHYLDIBENZOTHIOPHENE	28.64	198	8769	328.9	0.7
41	3+2-METHYLDIBENZOTHIOPHENE	29.17	198	1626	61.0	0.1
42	1-METHYLDIBENZOTHIOPHENE	29.93	198	545	20.4	0.0

AROMATIC HYDROCARBONS AND AROMATIZED STERANES

Project: HYDRATE: GULF OF MEXICO

Lab Sample ID: L51576

Sample Descriptor: 4X Dilution

Analysis Date: 5/19/1999

No.	COMPOUND NAME	RT	ION	AREA	PPM	%
	2- AND 3-RING AROMATICS Cont.					
43	DIBENZOFURAN	17.00	168	17467	553	1.2
44	EUDALENE	20.89	184	13955	900	1.9
45	1,4,6,7-TETRAMETHYLNAPHTHALENE	24.20	184	7057	455	1.0
46	CADELENE	23.94	198	5549	480	1.0
47	RETENE	37.40	234	667	127	0.3
48	4-ETHYLDIBENZOTHIOPHENE	30.90	212	3497	187	0.4
49	4,6-DIMETHYLDIBENZOTHIOPHENE	31.09	212	8292	443	0.9
50	DIMETHYLDIBENZOTHIOPHENE-4	31.47	212	3582	191	0.4
51	DIMETHYLDIBENZOTHIOPHENE-5	31.66	212	5965	319	0.7
52	DIMETHYLDIBENZOTHIOPHENE-6	31.99	212	440	24	0.0
53	1,4-DIMETHYLDIBENZOTHIOPHENE	32.18	212	8196	438	0.9
54	DIMETHYLDIBENZOTHIOPHENE-7	32.50	212	1220	65	0.1
55	DIMETHYLDIBENZOTHIOPHENE-8	32.58	212	781	42	0.1
56	2,3'-DIMETHYLBIPHENYL	18.40	182	4845	283	0.6
57	2,5-DIMETHYLBIPHENYL	18.66	182	5605	328	0.7
58	2,4 & 2,4'-DIMETHYLBIPHENYL	19.04	182	18477	1081	2.3
59	2,3-DIMETHYLBIPHENYL	19.37	182	5577	326	0.7
60	3-ETHYLBIPHENYL	20.89	182	6045	354	0.7
61	3,5-DIMETHYLBIPHENYL	21.15	182	7135	417	0.9
62	3,3'-DIMETHYLBIPHENYL	21.38	182	3313	194	0.4
63	4-ETHYLBIPHENYL	21.51	182	4715	276	0.6
64	3,4'-DIMETHYLBIPHENYL	21.74	182	12781	748	1.6
65	4,4'-DIMETHYLBIPHENYL	21.90	182	6413	375	0.8
66	3,4-DIMETHYLBIPHENYL + 4 METHYLDDBF	22.22	182	5006	293	0.6
67	3+2-METHYLDIBENZOFURAN	22.58	182	3293	193	0.4
68	1-METHYLDIBENZOFURAN	23.36	182	6368	373	0.8

AROMATIC HYDROCARBONS AND AROMATIZED STERANES

Project: HYDRATE: GULF OF MEXICO

Lab Sample ID: L51576

Sample Descriptor: 4X Dilution

Analysis Date: 5/19/1999

No.	COMPOUND NAME	RT	ION	AREA	PPM	%
MONOAROMATIC STERANES						
1	C21 MONOAROMATIC STERANE	35.75	253	49604	1978.5	12.0
2	C22 MONOAROMATIC STERANE	37.50	253	29096	1160.5	7.1
5	5b C27 MONOAROMATIC STERANE (20S)	45.00	253	48537	1935.9	11.8
7	5b C27 MONOAROMATIC STERANE (20R)	46.05	253	57922	2310.2	14.1
8	5a C27 MONOAROMATIC STERANE (20S)	46.35	253	50006	1994.5	12.1
9	5b C28 MONOAROMATIC STERANE (20S)	46.40	253	115703	4614.8	28.1
10	5a C27 (20R)+					
	5a C28 (20S) MONOAROMATIC STERANES	47.97	253	16397	414.7	2.5
11 + 12	5b C28 (20R)+					
	5b C29 (20S) MONOAROMATIC STERANES	48.05	253	33843	855.9	5.2
15	5a C29 (20S) MONOAROMATIC STERANE	49.32	253	30201	763.8	4.6
16	5a C28 (20R)+					
	5bC29 (20R) MONOAROMATIC STERANES	49.51	253	14659	370.7	2.3
17	5a C29 (20R) MONOAROMATIC STERANE	50.98	253	1449	36.6	0.2
TRIAROMATIC STERANES						
1	C20 TRIAROMATIC STERANE	41.56	231	10506	266.6	5.8
2	C21 TRIAROMATIC STERANE	43.43	231	9939	252.2	5.4
3	C26 TRIAROMATIC STERANE (20S)	50.51	231	64463	960.9	20.8
4	C26 (20R)+C27 (20S) TRIAROMATIC STERANES	51.81	231	64534	962.0	20.8
5	C28 TRIAROMATIC STERANE (20S)	53.11	231	95968	1430.6	30.9
6	C27 TRIAROMATIC STERANE (20R)	53.68	231	41193	614.0	13.3
7	C28 TRIAROMATIC STERANE (20R)	54.82	231	9647	143.8	3.1

AROMATIC HYDROCARBONS AND AROMATIZED STERANES

Project: HYDRATE: GULF OF MEXICO

Lab Sample ID: L51576

Sample Descriptor: 4X Dilution

Analysis Date: 5/19/1999

PARAMETERS

2- and 3-Ring Aromatic Hydrocarbons

	Ion	
<u>Ratios based on concentrations</u>		
ENR	156	0.08
DNR 1	156	2.47
TNR 1	170	0.25
TNR 2	170	0.49
DPI 1	178 & 206	0.16
P/MP	178 & 192	0.13
MDR 1	198	16.09
P/DIBENZOTHIOPHENE	178, 184, 192 & 198	4.58
% 1,2,5-TMN	170	5.54
<u>Ratios based on concentrations</u>		
MPI 1	178 & 192	0.59
MPI 3	192	0.47

Aromatized Steranes

	Ion	
<u>Ratios based on concentrations</u>		
% TOTAL TRIAROMATICS	231 & 253	23.6
% C28 TRIAROMATIC	231 & 253	26.1
% SHORT-CHAIN TRIAROMATICS	231	11.2
% C20/(C20+C28) TRIAROMATICS	231	65.0
% SHORT CHAIN MONOAROMATICS	253	19.1
% C21/(C21+C28) MONOAROMATICS	253	30.0

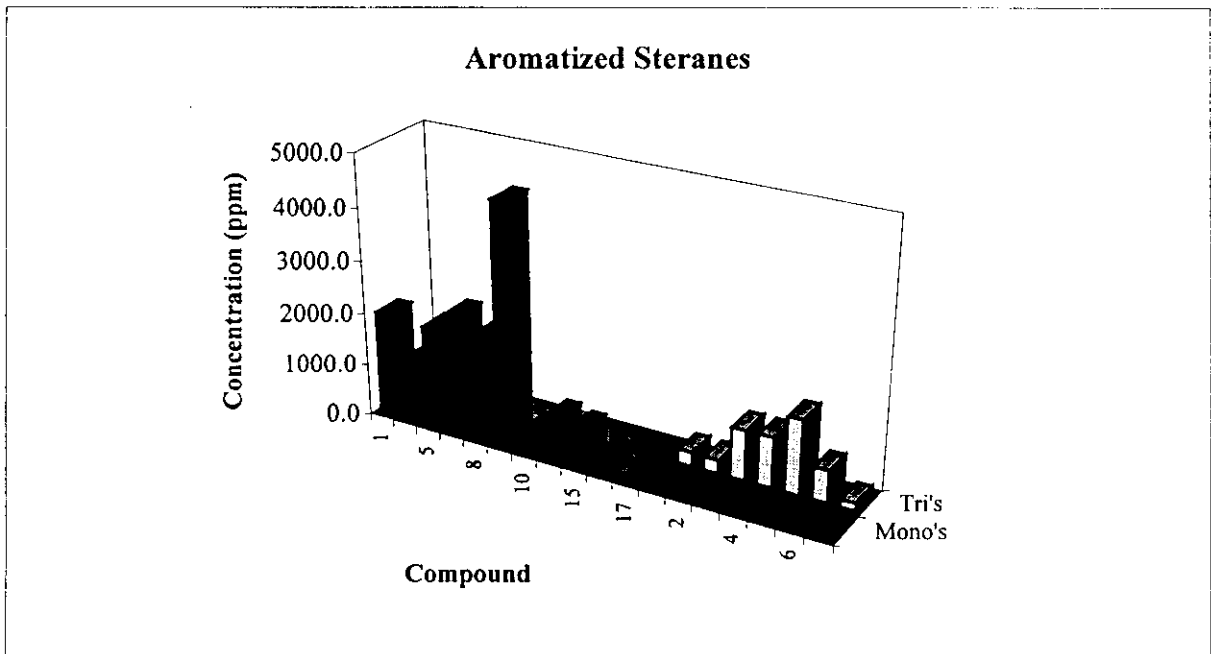
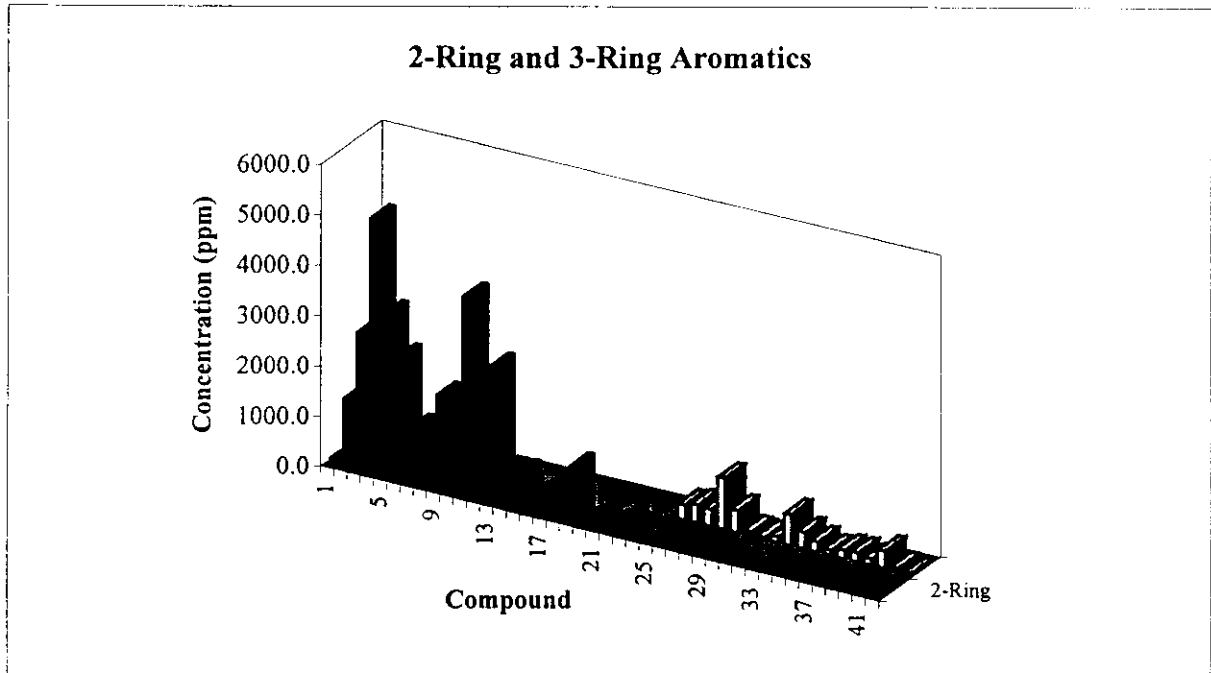
AROMATIC HYDROCARBONS AND AROMATIZED STERANES

Project: HYDRATE: GULF OF MEXICO

Lab Sample ID: L51576

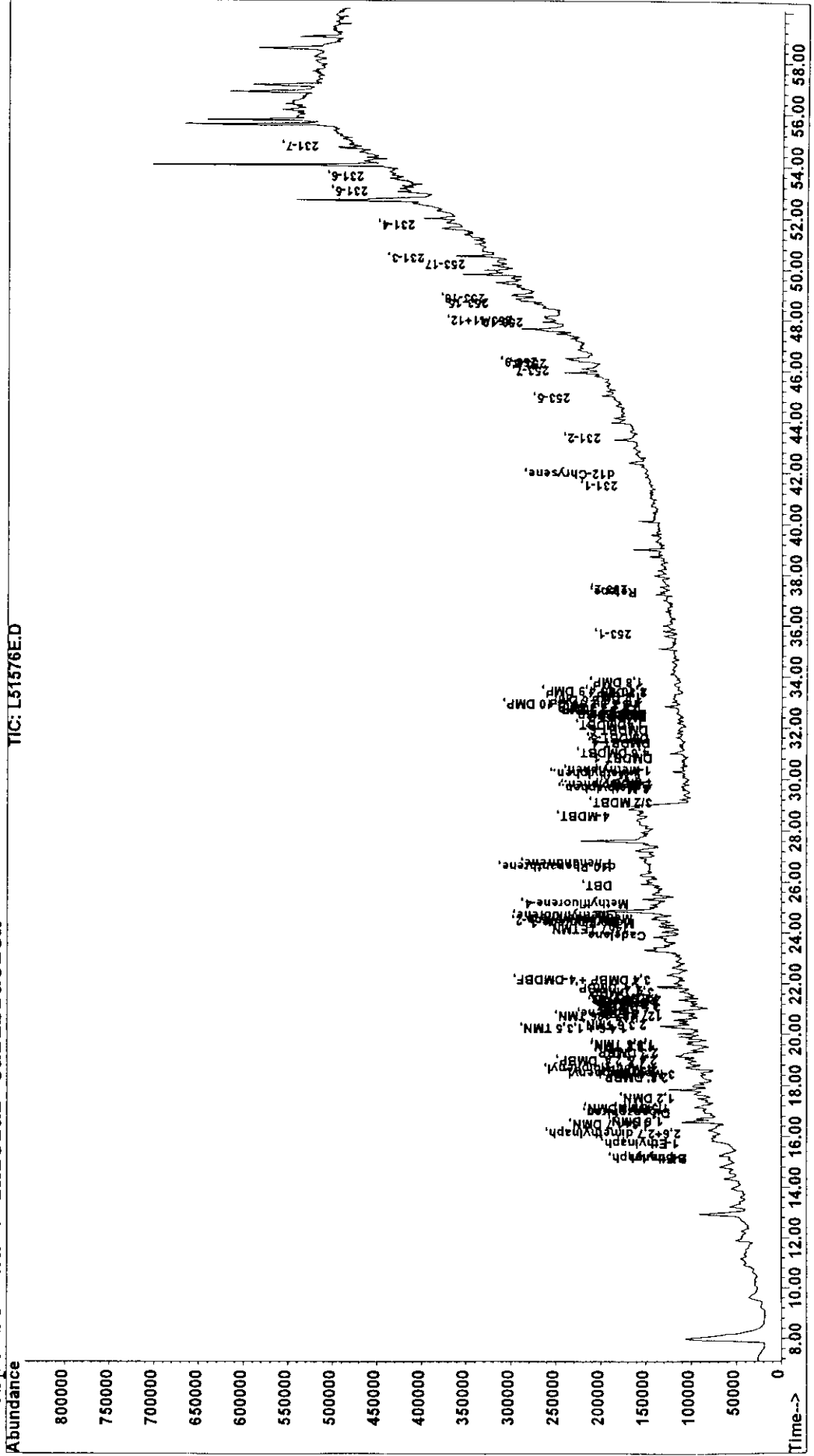
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Analysis Date: 5/19/1999

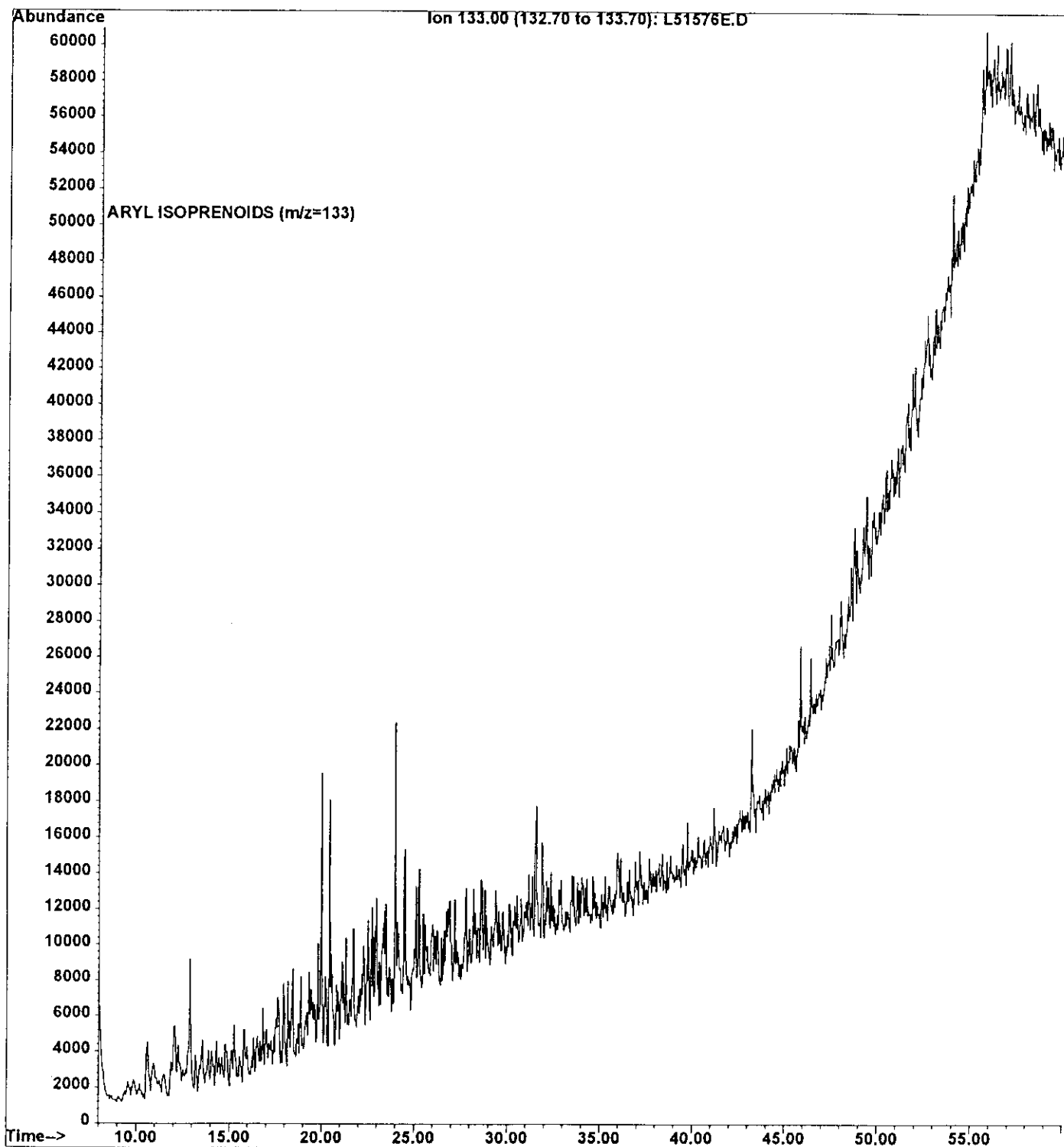


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 Acq On : 19 May 1999 1:58 pm Operator: ALCALA-HERRERA
 Sample : L51576 4X DIL Inst : M6-HP5890
 Misc : Aromatic Hydrocarbons and Aromatic Stera Multiplr: 222.22
 MS Integration Params: rteint.p
 Quant Time: May 20 9:38 1999 Quant Results File: AROSAM1.RES

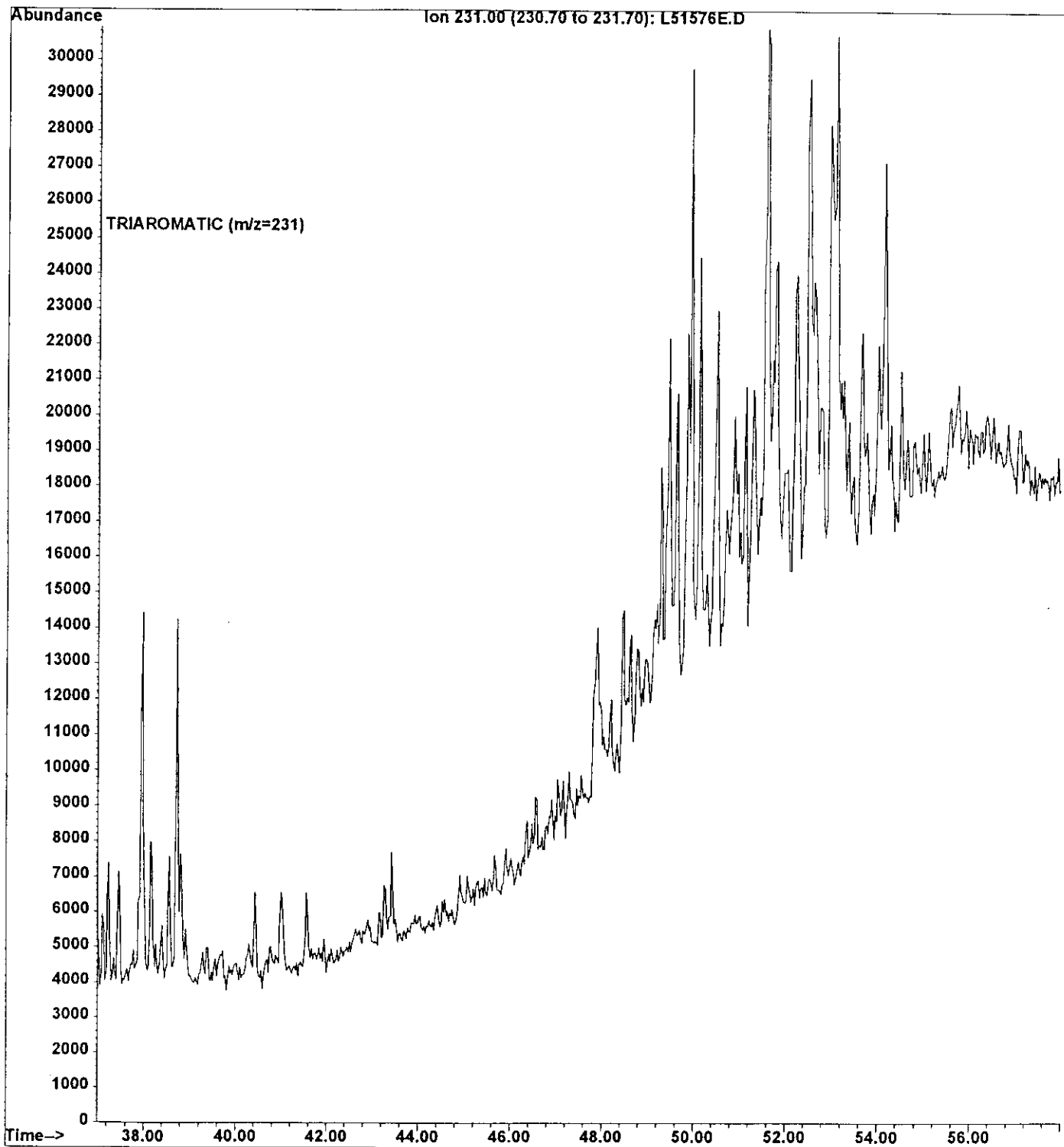
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 Title : Aromatic Biological Markers
 Last Update : Thu Oct 22 10:19:27 1998
 Response via : Initial Calibration



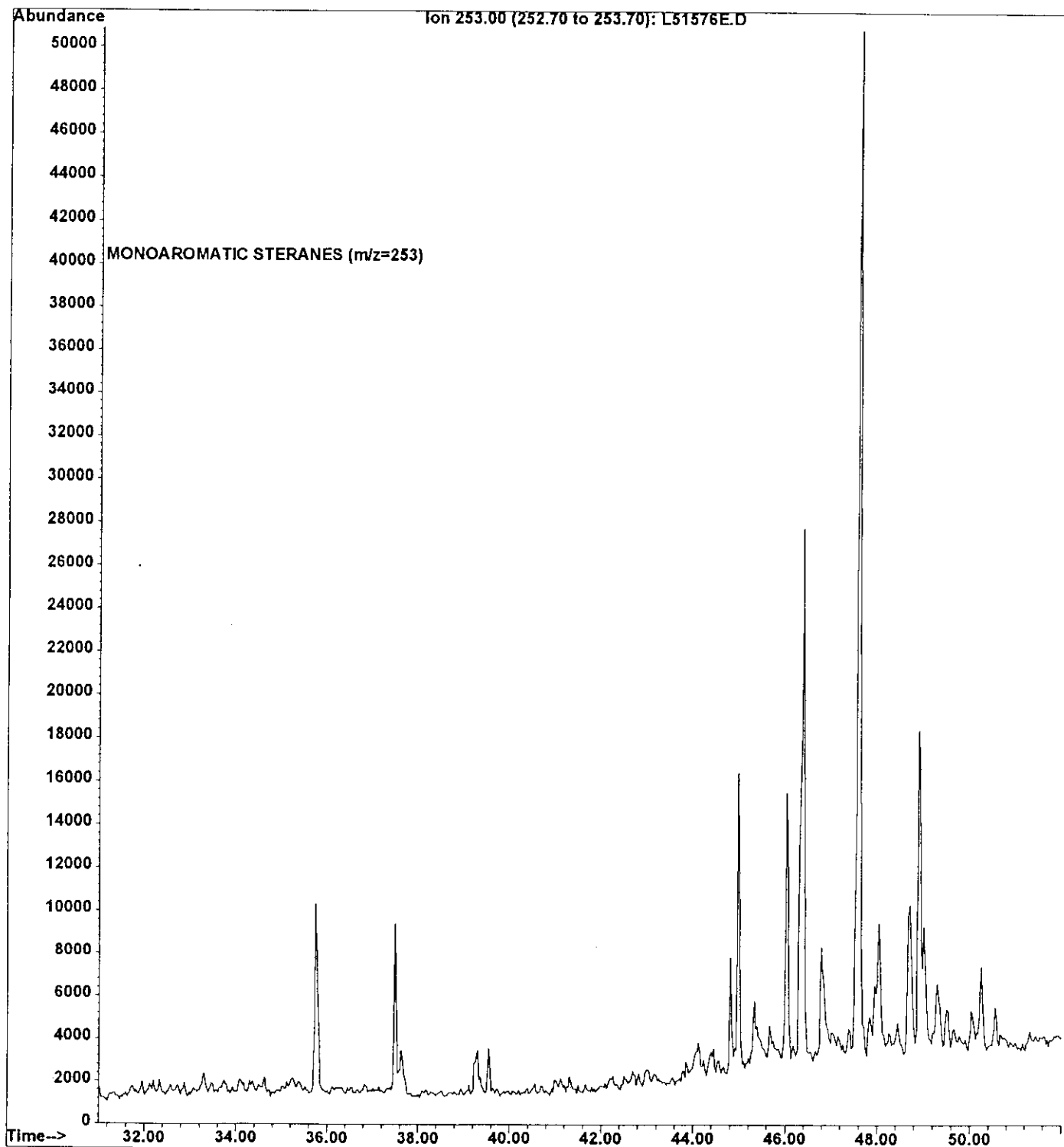
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Operator : ALCALA-HERRERA
Acquired : 19 May 1999 1:58 pm using AcqMethod AROSAM1
Instrument : M6-HP5890
Sample Name: L51576 4X DIL
Misc Info : Aromatic Hydrocarbons and Aromatic Steranes
Vial Number: 4



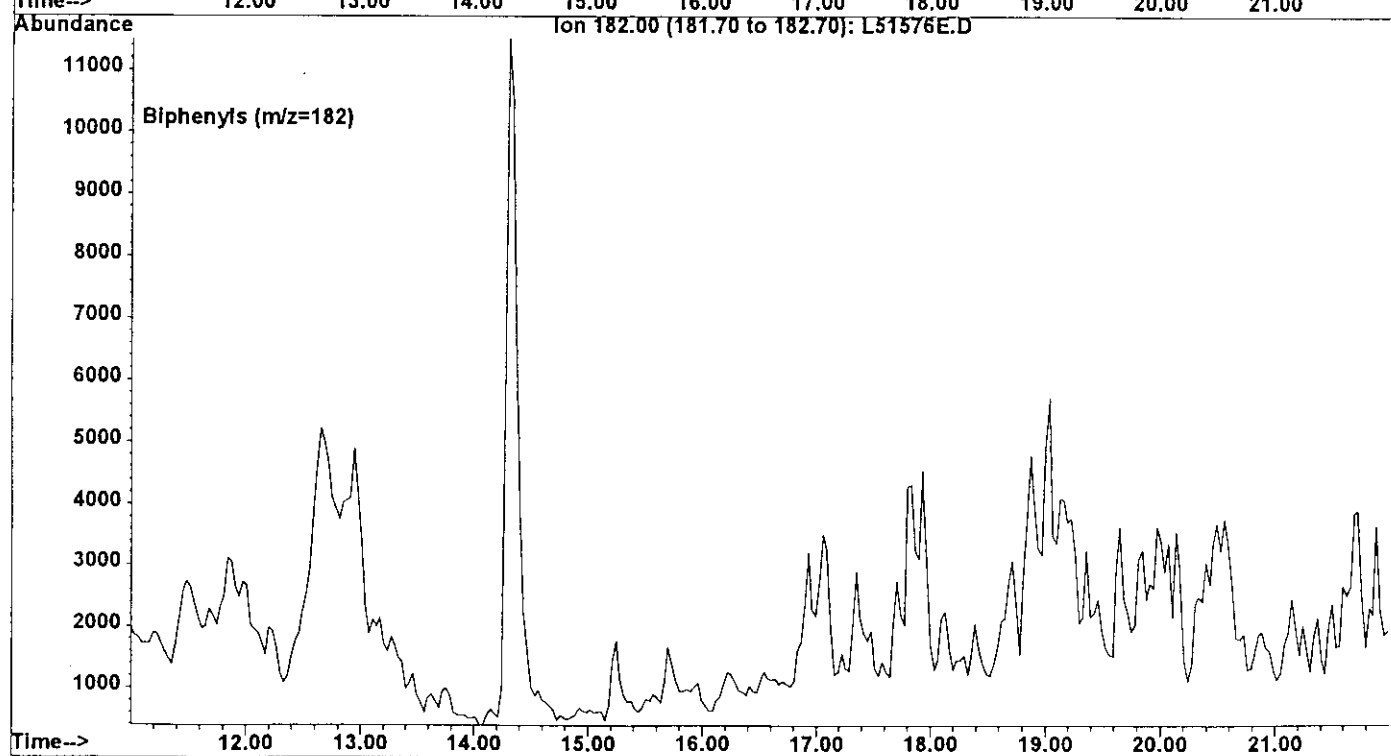
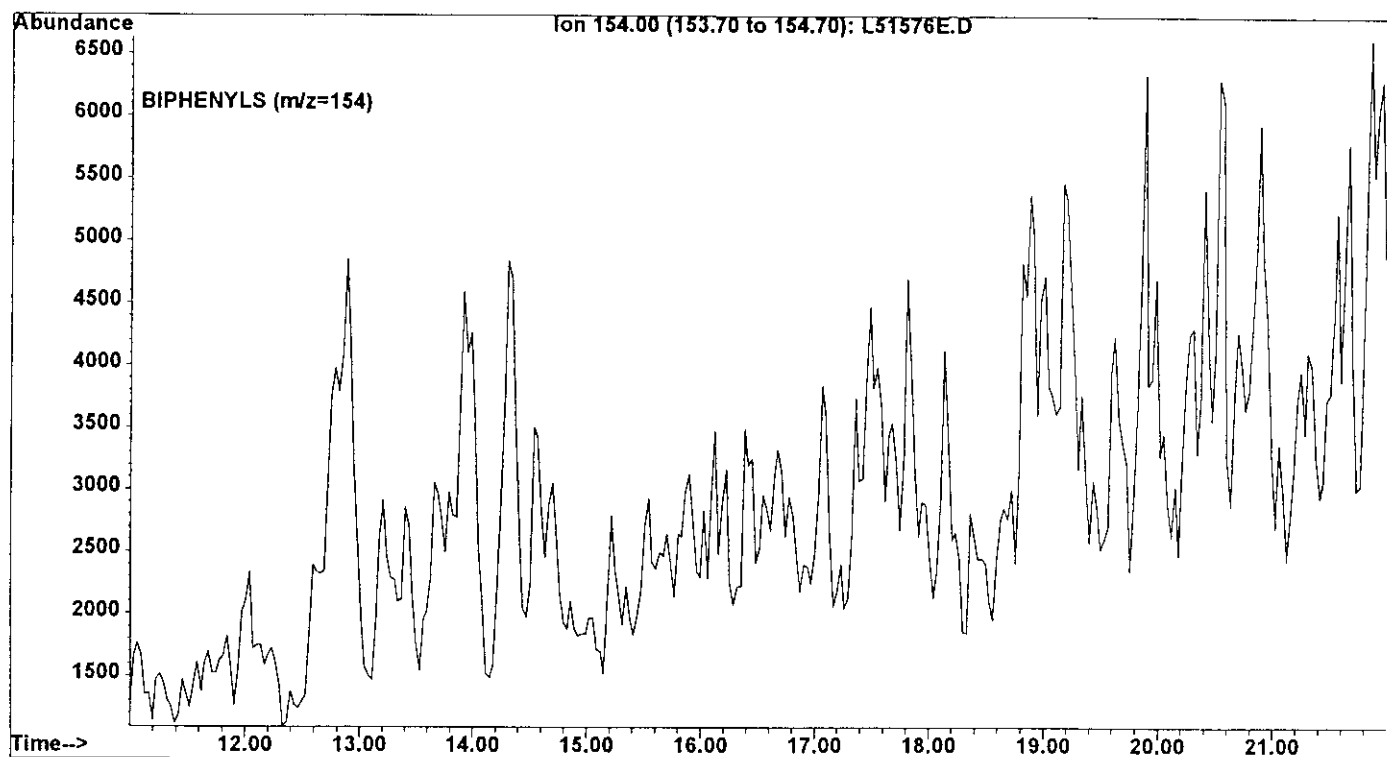
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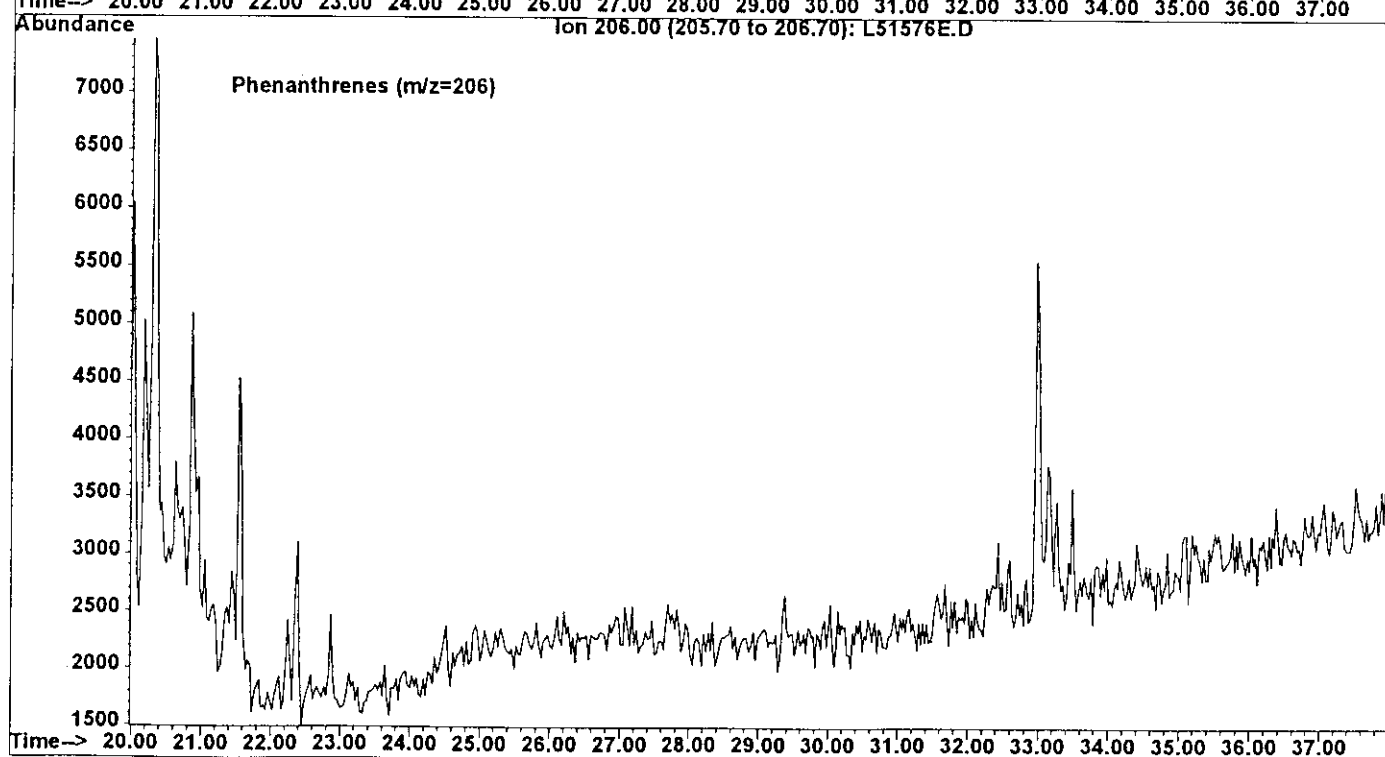
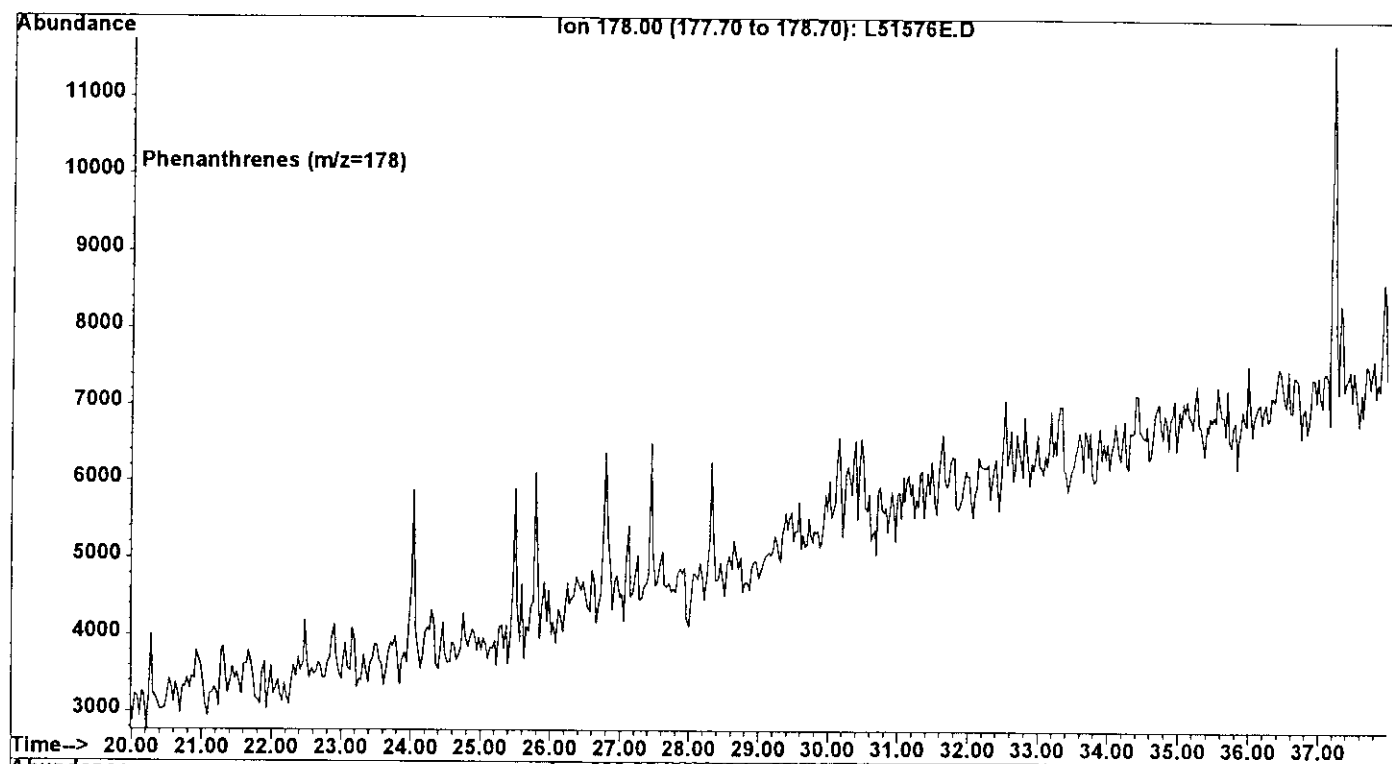
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Vial Number: 4



Stable Carbon Isotope Data
 GE-00003 - GERG

		Whole Oil/Extract	
HARC Sample #	Customer Sample	Run #	$\delta^{13}\text{C}$
GE-99-RN8-005	RN8-005	6400	-27.00

All values expressed as $\delta^{13}\text{C}$ vs PDB
 INS - Insufficient sample for analysis

GE-00003 - GERG		
NBS-22 Control Standards		
Whole Oil/Extract		
	Std. Dev.	#DIV/0!
	Average	-29.74
Sample	Run #	$\delta^{13}\text{C}$
NBS-22	6399	-29.74

Reported values for NBS-22 range from -29.61 to -29.81