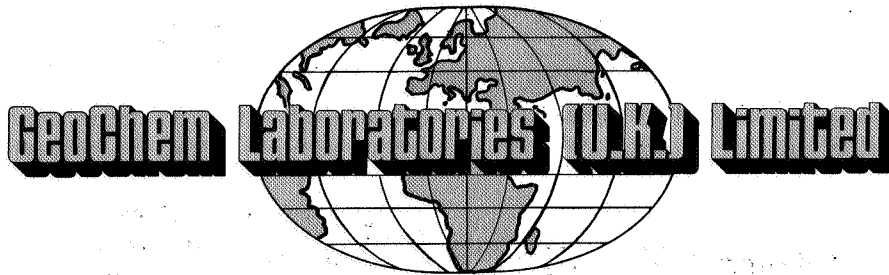


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GEOCHEMICAL SERVICE REPORT

Prepared for

STATOIL

CORRELATION STUDY INVOLVING DST FLUIDS AND SANDSTONES
FROM THE STATOIL 7121/4-1 WELL, TROMS CONCESSION
OFFSHORE NORWAY

January 1985

CHESTER STREET · CHESTER CH4 8RD · ENGLAND

COMPANY PROPRIETARY

CORRELATION STUDY INVOLVING DST FLUIDS AND SANDSTONES
FROM THE STATOIL 7121/4-1 WELL, TROMS CONCESSION
OFFSHORE NORWAY

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REGISTRERT
OLJEDIREKTORATET

SUMMARY

Oils extracted from the sandstone cores at 2429.5-2485± metres and the DST-3 crude belong to a single family of mature medium gravity crude oils. They correlate with the shows occurring between 2330± metres and 2570± metres and have their source in more mature equivalents of the rich mudstones and clays of the Upper Jurassic (T3) unit.

The DST-2 and DST-4 condensates resemble the hydrocarbons detected at 2300-2330± metres and have a source which is similar, but slightly less mature, than of the DST-3 crude oil.

M.J. Sauer
GEOCHEM LABORATORIES (UK) LIMITED

7121/4-1

DST-2:	2465.93 - 2471.93 metres	975-008
DST-3:	2419.85 - 2434.85 "	975-009
DST-4:	2353.0 - 2385.0 "	975-010

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INTRODUCTION

This report presents a correlation study based upon DST fluids and oil stained sandstone cores from the 7121/4-1 well, drilled by Statoil in offshore Norwegian waters.

The study was designed to correlate the fluids with shows and source rocks previously described (Geochem 1984).

This project was authorised by Mr. T. Meyer, Statoil, Stavanger.

A. ANALYTICAL

Small samples of the DST-2, DST-3 and DST-4 fluids, together with six sidewall core and one core samples from the 2429.5-2485 metres interval, have been received and assigned the Geochem job number 975.

The samples have been analysed in accordance with contract T6192 No. 4 and telexed (12.10.84) instructions from the client. Due to low fraction weights certain analyses could not be run. They include the sandstone total extract isotope ratios, isotope ratios on the aromatic hydrocarbons at 2470± metres and of the saturates at 2468.5 metres and the mass fragmentograms at 2470 metres. The aromatics mass fragmentograms of the DST-2 and DST-4 condensates, and their branched cyclic alkanes analyses, are absent for the same reason. A total of three whole oil chromatograms, three detailed gasoline range hydrocarbons analyses, ten C₁₅₊ chromatographic separations, ten C₁₅₊ paraffin-naphthene analyses, ten C₁₅₊ aromatics analyses, ten eight-ion mass fragmentograms and twenty one carbon isotope ratio determinations were performed in this study.

The data are listed in tables 1 to 8 and presented graphically in figures 1 to 11.

B. GENERAL INFORMATION

Ten (10) copies of this report have been forwarded to Mr. T. Meyer at Statoil, Stavanger.

A copy of the data has been retained by Geochem for future consultation with authorised Statoil personnel.

The remaining sample material will be handled as directed.

The results of this study are proprietary to Statoil.

RESULTS AND DISCUSSION

The three DST fluids are first described separately and then compared, by means of their corresponding parameters, with the hydrocarbons extracted from the sidewall cores at 2429-2485 metres. These parameters are then used in an oil to source rock correlation study which incorporates data from the Geochem (December 1984) report on the well.

EVALUATION OF DST FLUIDS

DST-2 and DST-4 as received are mobile light coloured condensates whereas DST-3 is darker coloured and resembles a crude oil.

The difference in their bulk properties is reflected in the whole oil chromatograms, which reveal an extended range (to nC_{35}) of paraffins in the DST-3 oil. Negligible amounts of C_{20+} hydrocarbons are, however, present in the DST-2 and DST-4 condensates. Interestingly, detailed analyses of the C_4-C_7 hydrocarbons fraction show that all three fluids have an almost identical composition. Loss of butanes and pentanes is attributed to evaporative losses from the liquids; very small samples were supplied. All three fluids have high aromatics (15.2-19.4%) and naphthenes (32.3-35.6%) contents, whereas the abundance of isoparaffins, compared to normal paraffins suggests that the fluids are not very mature.

The proportion of C_{15+} species (chiefly hydrocarbons) in the DST fluids ranges from 12.2% in DST-4, 17.6% in DST-2 up to 76.7% in the DST-3 oil. Of the C_{15+} fraction the hydrocarbons, however, constitute a relatively constant 92.6-94.3% of the total extract. The DST-3 oil has a low (0.19%) sulphur content in the C_{15+} fractions but the DST-2 and DST-4 condensates have values of 1.03 and 1.28% respectively.

A far greater abundance of C_{15+} paraffins in the DST-3 oil distinguishes it from the DST-2 and DST-4 condensates. If however the distributions of isoparaffins, particularly the isoprenoids pristane and phytane, are compared all three fluids possess an underlying similarity; which suggests a common source.

Heavy aromatic hydrocarbons, judging by the size of the baseline hump etc. are relatively sparse in the DST-2 and DST-4 fluids. There is nonetheless a

similarity in the ratios of the dimethyl, and in DST-2 and DST-3, the trimethyl naphthalenes which suggests a single source type.

CORRELATION OF DST FLUIDS AND CORE EXTRACTS

Hydrocarbons extracted from a suite of seven core and sidewall core samples between 2429.5 metres and 2485 metres have been analysed and, in this section, their properties are compared to those of the tested fluids.

With one exception the sandstones yielded 624-3802 ppm C_{15+} hydrocarbons, amounting to 54.9-77.4% of the total extract. The sidewall core sample at 2470 metres was very small (4.4 g) and only 1.5 mg total extract were recovered from it. For this reason the analytical record is incomplete and some of the analyses attempted gave anomalous results. In the remaining samples, however, there can be little doubt concerning the presence of migrated hydrocarbons (hydrocarbon yield and high hydrocarbon to total extract ratios).

Minor differences are apparent in the C_{15+} paraffin naphthene chromatograms but overall they possess a degree of similarity which suggests that the oil extracted from the sands at 2429.5-2485± metres is from a common source. The differences in these traces lies principally in the size of the baseline hump which, enhanced by low extract weights, suggests drilling introduced contaminants (grease from SWC bullets etc.). If these baseline humps are excluded then the hydrocarbons extracted from the sands have paraffin-naphthene chromatograms which are virtually identical to that of the DST-3 oil. The isoparaffin fingerprints, including pristane and phytane, differ minimally between the samples and confirm this correlation.

Chromatograms of the corresponding aromatic hydrocarbons extracted from the sands also suggest the presence of a single oil family. Naphthalene and the methyl naphthalenes are relatively sparse in the hydrocarbons extracted from the sands but are more abundant in the DST-3 oil fraction. Low sample weights and resultant evaporative losses are believed to be responsible for the lower naphthalenes content of the sandstone extracts. In all other aspects there is little difference between the DST-3 oil and the sandstone extracts.

Detailed correlations between hydrocarbon shows, oils etc. are based upon mass-fragmentograms of the triterpanes and steranes. At m/z 191 fragmentograms of the pentacyclic triterpanes extracted from the sandstones and DST fluids differ minimally from each other. This is confirmed by the near constancy of selected triterpane ratios in table 6. A slight increase in the T_m/T_s ratio for the DST-2 and DST-4 condensates suggests that their source is

marginally less mature than that of the other hydrocarbons. The condensates are slightly richer in to C_{23} - C_{26} tricyclic and tetracyclic terpanes (peaks P-T) but this is believed to be related to the differences in boiling range of the DST fluids.

At m/z 217, 218 and 259 the distribution of steranes shows little variation from sample to sample and supports the concept of a common source. The two condensates are differentiated from the oils by a lower abundance (compared to C_{27}) of the C_{29} steranes (see table 6 and figures 5,6). Differences in boiling range are believed to be responsible for this difference since most of the mass spectrometric data points to a single source type for both oils and condensates.

Two series of aromatic hydrocarbons have been analysed in all but the DST-2 and DST-4 condensates, and sandstone extract at 2470 feet. Mass fragmentograms at m/z 178, 192, 206 and 220 correspond to phenanthrene and the methyl substituted phenanthrenes whilst m/z 184, 198 and 212 are due to dibenzothiophene and its methyl substituents. An inspection of these traces confirms that the oil extracted from the sands belongs to the same family as the DST-3 crude.

Carbon isotope ratios were measured on the C_{15+} hydrocarbons extracted from the sands (excluding the saturates at 2468.5 metres and aromatics at 2470 metres) and the DST fluids. Insufficient sample material was available for measurements on the total extracts although these analyses were possible on the DST "whole oil" samples. Slight differences are apparent in the δ values for the C_{15+} saturates (-29.2 to -26.5 $^{\circ}$ /oo) and aromatics (-27.5 to -27.9 $^{\circ}$ /oo) extracted from the sands. The only exception being the aromatics at 2480 metres where an anomalous value of -29.0 $^{\circ}$ /oo was obtained. This ratio when compared to that of the corresponding saturates (-29.3 $^{\circ}$ /oo) fraction appears to be too light by 1 $^{\circ}$ /oo. Lack of sample material precluded a duplicate analysis. When plotted the carbon isotope ratios of the core extracts form a compact group and are approximately 1 $^{\circ}$ /oo heavier (more positive) than the corresponding values (-30.2 to -30.6 $^{\circ}$ /oo and -28.4 to -28.5 $^{\circ}$ /oo) for the DST fluids, the DST-3 oil being marginally heavier than the condensates. The difference between the crude oil isotope ratios and the mean values for the core extract hydrocarbons is less than 1 $^{\circ}$ /oo and confirms that the hydrocarbons for both "sources" are generically related. The core extract values may be effected by traces of drilling introduced contaminants.

OIL TO SOURCE ROCK CORRELATION

The relationship between the (T3) Jurassic mudstones and clays at 2225-2330± metres and the shows of oil at 2330-2570± metres in the T2 unit has previously been discussed (Geochem December 1984). Briefly there appears to be a correlation between the richer T3 clays/mudstones and the oil shows at, for example, 2480± metres.

When the present set of analyses, particularly the C₁₅₊ saturates and aromatic hydrocarbon chromatograms, and the mass fragmentograms, are compared to those previously reported there is clear evidence of a single crude oil within the 2429-2485± metres interval. There is however, a difference of nearly 2⁰/oo between the DST-3 crude oil the hydrocarbons from the sandstone cores and the Jurassic (T3) kerogen isotope ratios. This difference is greater than that normally considered acceptable for a good oil-source rock correlation. However, since the remaining data indicated that a correlation does exist the actual source of the T2 oils must, therefore, be a facies variant of the analysed T3 clays and mudstones; within the drainage area of the structure.

From the C₁₅₊ saturates and aromatic hydrocarbons traces and the m/z 191 and 217 mass fragmentograms there is evidence of a correlation between the DST-2 and DST-4 condensates (depths unspecified), and the show of condensate/light oil at 2300-2330 metres. Carbon isotope data indicate that the source of these shows is not the host sediments but could well be their off structure lateral equivalents.

CONCLUSIONS

Three fluids DST-2, DST-3 and DST-4 have been analysed and their properties are compared to those of hydrocarbons extracted from a suite of sidewall cores at 2429.5-2485 metres. These analyses are then compared to those reported earlier (Geochem December 1984) in an attempt to define the source of the migrated hydrocarbons.

DST-2 and DST-4 (depths unspecified) are light coloured mobile condensates whereas the DST-3 liquid is a crude oil. The condensates have a preponderance of C_{20-} hydrocarbons although detailed analyses of the C_4-C_7 fractions show that they have the same composition as the DST-3 crude oil. The C_{15+} fraction amounts to 12.2-17.6% of the condensates but increases to 76.7% of the DST-3 oil. Despite these variations the C_{15+} hydrocarbons content is relatively constant at 92.6-94.3% of the total extract. The condensates contain 1.03-1.28% sulphur in the C_{15+} fraction but this figure is much lower (0.19%) in the DST-3 crude. Detailed analyses of the C_{15+} hydrocarbons, however, indicate that a single source type is involved.

Minor differences in the detailed analyses of the C_{15+} saturated and aromatic hydrocarbons are apparent but, in general, they correlate the DST-3 crude oil with the hydrocarbons extracted from the sands at 2429.5-2485 metres. Mass fragmentograms of the triterpanes and steranes display small sample to sample variations; some of which are due to differences in the boiling range of the condensates. There is nonetheless a degree of uniformity which supports the concept of a single source type. Molecular ratios (e.g. the Tm/Ts ratio) suggest that the condensate source has a marginally lower inferred maturity than that of the DST-3 crude. Mass fragmentograms of phenanthrene, dibenzothiophene, and their methyl substituents are also closely similar and point to a single source. Carbon isotope ratios of the DST fluids differ slightly from the sandstone extract hydrocarbons. Sample history, or possibly drilling introduced contaminants may be responsible for the (small) scatter in the values.

Detailed analyses of the DST-3 crude oil and of the DST-2 and DST-4 condensates correlate these fluids with the shows at 2330-2570± metres and at 2300-2330± metres respectively. The relationship between the rich Upper Jurassic (T3) clays and mudstones has been reported (Geochem December 1984). Carbon isotope data from the present study however, suggest that the actual

source of tested hydrocarbons may not be the T3 sediments but rather their off structure lateral equivalents.

TABLE 1
ORGANIC CARBON RESULTS AND GROSS LITHOLOGIC DESCRIPTIONS

GEOCHEM SAMPLE NUMBER	DEPTH	GROSS LITHOLOGIC DESCRIPTION	G S A Colour Code	TOTAL ORGANIC CARBON (Wt. % of Rock)
975-001	2429.5m SWC	A 98% Sandstone (with plant rootlets ?), fine grained, well sorted, milky C., white	N9	
975-002	2443m SWC	A 98% Sandstone, as 975-001A, milky C.	N9	
975-003	2468m SWC	A 98% Sandstone, as 975-001A, milky C.	N9	
975-004	2470m SWC	A 98% Sandstone, as 975-001A, milky C.	N9	
975-005	2474m SWC	A 98% Sandstone, as 975-001A, milky C.	N9	
975-006	2480m SWC	A 98% Sandstone, with organic material, med. to coarse grained, poorly sorted, milky C., white	N9 N9	
975-007	2485m	A 98% Sand, fine grained, mod. sorted, oil stained(?), milky C., olive grey	5Y4/1	

Abbreviations = arenaceous, argillaceous, calcareous, Cut, dolomitic, Fluorescence, foraminifera, fossiliferous
Lost Circulation Material, moderately, occasionally, slightly, very

TABLE 2

DETAILED GASOLINE (C4-C7) ANALYSIS

GEOCHEM SAMPLE NUMBER	008	009	010
DEPTH	DST 2	DST 3	DST 4
isobutane	0.37	0.71	0.45
n-butane	1.98	1.87	1.79
isopentane	3.35	3.22	4.28
n-pentane	5.13	5.04	6.72
2,2-dimethylB	0.37	0.37	0.47
cyclopentane(CP)	1.70	1.81	1.49
2,3-dimethylB	0.08	0.07	0.05
2-methylP	5.80	5.44	6.85
3-methylP	2.79	2.62	3.17
n-hexane	8.12	7.47	9.25
methylCP(MCP)	5.64	5.84	6.09
2,2-dimethylP	0.14	0.53	0.13
2,4-dimethylP	0.04	0.18	0.04
2,2,3-trimethylB	0.01	0.06	0.01
benzene	4.42	5.23	5.18
cyclohexane(CH)	6.79	6.94	6.67
3,3-dimethylP	0.00	0.00	0.00
1,1-dimethylCP	0.00	0.00	0.00
2-methylH	5.45	4.62	5.13
2,3-dimethylP	0.46	0.66	0.38
3-methylH	4.10	3.34	3.83
1,c,3-dimethylCP	1.05	1.18	0.93
1,t,3-dimethylCP	1.03	0.59	0.94
1,t,2-dimethylCP	2.52	2.22	2.31
3-ethylP	0.00	0.00	0.00
n-heptane	10.97	9.26	9.95
methylCH(MCH)	16.67	16.60	13.89
1,c,2-dimethylCP	0.00	0.00	0.00
toluene	11.01	14.16	9.99
ABUNDANCE			
nC7/C7nap x100	51.60	45.00	55.07
MCP/Bz	1.28	1.12	1.18
MH/DMCP	2.08	2.00	2.15
nC6/MCP	1.44	1.28	1.52
%n-PARAFFINS	26.20	23.64	27.71
%iso-PARAFFINS	22.97	21.80	24.80
% NAPHTHENES	35.39	35.17	32.32
% AROMATICS	15.43	19.39	15.17

TABLE 3a
CONCENTRATION (PPM) OF EXTRACTED C₁₅₊ MATERIAL IN ROCK

GEOCHEM SAMPLE NUMBER	DEPTH	TOTAL EXTRACT	HYDROCARBONS			NON HYDROCARBONS			
			Paraffin Naphthenes	Aromatics	TOTAL	Precipitd. Asphaltenes	Eluted NSO's	Non-eluted NSO's	Sulphur
975-001	2429.5	4915	3209	594	3803	574	296	243	0
975-002	2443	1053	482	142	624	195	91	127	15
975-003	2468.5	1163	497	141	639	318	124	82	0
975-004	2470	875	170	48	218	539	61	57	0
975-005	2474	4259	2629	612	3242	369	455	194	0
975-006	2480	2386	1056	395	1450	537	210	140	48
975-007	2485	3381	1522	642	2164	871	285	61	0

TABLE 3b
COMPOSITION (NORMALISED %) OF C₁₅₊ MATERIAL EXTRACTED FROM ROCK

GEOCHEM SAMPLE NUMBER	DEPTH	HYDROCARBONS		NON HYDROCARBONS			
		Paraffin – Naphthenes	Aromatics	Preciptd. Asphaltenes	Eluted NSO's	Non eluted NSO's	Sulphur
975-001	2429.5	65.29	12.08	11.68	6.01	4.94	0.00
975-002	2443	45.82	13.44	18.53	8.69	12.08	1.43
975-003	2468.5	42.77	12.15	27.37	10.65	7.06	0.00
975-004	2470	19.48	5.45	61.56	7.01	6.49	0.00
975-005	2474	61.73	14.38	8.65	10.68	4.56	0.00
975-006	2480	44.24	16.53	22.52	8.81	5.87	2.02
975-007	2485	45.02	18.98	25.76	8.43	1.81	0.00
975-008	DST 2	72.66	21.33	1.27	1.56	2.13	1.03
975-009	DST 3	68.59	24.01	3.63	2.40	1.17	0.19
975-010	DST 4	75.06	19.21	1.73	1.50	1.23	1.28

**TABLE 4:
SIGNIFICANT RATIOS (%) OF C₁₅₊ FRACTIONS AND ORGANIC CARBON**

GEOCHEM SAMPLE NUMBER	DEPTH	ORGANIC CARBON (wt. %)	HYDROCARBONS	HYDROCARBONS	TOTAL EXTRACT	P-NAPHTHENES
			TOTAL EXTRACT	ORG. CARBON	ORG. CARBON	AROMATICS
975-001	2429.5	0.27	77.37	140.85	182.06	5.41
975-002	2443	0.33	59.27	18.91	31.91	3.41
975-003	2468.5	0.24	54.92	26.61	48.45	3.52
975-004	2470	0.11	24.94	19.83	79.55	3.57
975-005	2474	0.11	76.11	294.69	387.19	4.29
975-006	2480	0.31	60.77	46.78	76.98	2.68
975-007	2485	0.52	64.00	41.62	65.02	2.37

TABLE 5
COMPOSITION (NORMALISED %) OF C₁₅₊ PARAFFIN – NAPHTHENE HYDROCARBONS

GEOCHEM SAMPLE NUMBER	-001 0010	-002 0011	-003 0012	-004 0013	-005 0014	-006 0015	-007 0016	-008 0017
DEPTH	2429.5m SWC	2443m SWC	2468m SWC	2470m SWC	2474m SWC	2480m SWC	2485m SWC	DST 2
SAMPLE TYPE								
nC ₁₅	0.84	0.59	2.07	0.94	1.76	2.12	2.29	21.85
nC ₁₆	1.93	1.44	3.96	2.10	3.10	2.89	3.16	15.81
nC ₁₇	3.31	2.65	5.39	3.21	4.17	4.20	4.19	12.58
nC ₁₈	4.39	3.99	6.20	3.90	5.05	4.52	5.00	9.61
nC ₁₉	6.28	5.93	7.66	5.64	6.92	6.40	6.40	9.11
nC ₂₀	6.29	5.79	6.30	5.92	6.45	5.98	6.06	6.36
nC ₂₁	6.43	6.18	6.28	6.65	6.13	6.49	6.06	4.78
nC ₂₂	6.70	6.92	6.31	7.69	6.33	6.65	6.33	4.49
nC ₂₃	6.85	7.81	6.33	7.56	6.50	7.66	6.56	3.68
nC ₂₄	7.14	8.26	6.70	9.67	6.81	7.36	7.01	2.64
nC ₂₅	8.13	9.43	6.85	10.67	7.39	8.87	7.57	3.07
nC ₂₆	6.51	6.91	6.05	8.74	6.44	7.07	6.56	1.74
nC ₂₇	7.06	6.84	6.04	6.83	6.68	6.35	6.56	1.24
nC ₂₈	5.65	5.88	4.85	5.82	5.28	5.52	5.20	0.95
nC ₂₉	5.36	5.27	4.06	4.58	5.12	4.76	5.09	0.63
nC ₃₀	4.54	3.89	3.52	2.83	4.04	3.18	4.26	0.41
nC ₃₁	3.09	2.90	2.53	1.53	2.82	2.59	2.88	0.29
nC ₃₂	2.06	1.71	1.73	0.65	2.05	1.33	1.98	0.18
nC ₃₃	2.85	2.96	2.79	1.92	2.80	2.51	2.79	0.20
nC ₃₄	2.84	2.97	3.08	2.17	2.62	2.48	2.56	0.20
nC ₃₅	1.75	1.69	1.28	0.97	1.53	1.07	1.51	0.18
PARAFFIN	20.24	28.83	15.91	26.33	26.72	25.17	22.99	22.77
ISOPRENOID	1.26	1.73	1.46	1.61	1.88	1.78	1.56	4.41
NAPHTHENE	78.49	69.44	82.63	72.06	71.40	73.05	75.45	72.82
CPI INDEX A	1.08	1.08	1.04	0.99	1.05	1.09	1.05	1.07
CPI INDEX B	1.13	1.15	1.06	1.09	1.11	1.15	1.09	1.26
PRISTANE/PHYTANE	1.12	1.03	1.19	1.25	1.21	1.39	1.28	2.00
PRISTANE/nC ₁₇	1.00	1.15	0.93	1.06	0.93	0.98	0.91	1.03

TABLE 5
COMPOSITION (NORMALISED %) OF C₁₅₊ PARAFFIN – NAPHTHENE HYDROCARBONS

GEOCHEM SAMPLE NUMBER	-009	-010
DEPTH	0019 DST 3	0019 DST 4
SAMPLE TYPE		
nC ₁₅	7.03	13.62
nC ₁₆	6.56	16.84
nC ₁₇	6.48	15.00
nC ₁₈	6.81	13.02
nC ₁₉	7.05	10.62
nC ₂₀	7.10	8.20
nC ₂₁	5.89	5.86
nC ₂₂	6.13	4.61
nC ₂₃	6.00	3.46
nC ₂₄	7.37	2.97
nC ₂₅	6.75	2.32
nC ₂₆	4.99	1.25
nC ₂₇	4.47	0.86
nC ₂₈	3.59	0.55
nC ₂₉	3.10	0.29
nC ₃₀	2.40	0.16
nC ₃₁	2.00	0.13
nC ₃₂	1.27	0.10
nC ₃₃	1.93	0.08
nC ₃₄	1.87	0.05
nC ₃₅	1.21	0.03
PARAFFIN	25.81	27.40
ISOPRENOID	2.59	6.59
NAPHTHENE	71.60	66.01
CPI INDEX A	0.98	1.03
CPI INDEX B	1.11	1.24
PRISTANE/PHYTANE	1.60	1.80
PRISTANE/nC ₁₇	0.95	1.03

TABLE 6

MOLECULAR MATURATION PARAMETERS

GEOCHEM SAMPLE NO.	DEPTH	STERANES M/Z 217 (259)			Tm Ts	TERPANES M/Z 191				
		$\frac{C_{29} \text{ 20S (20S)}}{C_{29} \text{ 20R (20R)}}$	$\frac{C_{29} \text{ 20R (20R)}}{C_{29} \text{ 20R (20R)}}$	$\frac{C_{27} \text{ (20S) Diasteranes}}{C_{27} \text{ (20R) Diasteranes}}$		$\frac{C_{30} \text{ Moretane}}{C_{30} \text{ Hopane}}$	$\frac{C_{29} \text{ normoretane}}{C_{29} \text{ norhopane} + C_{29} \text{ normoretane}}$	$\frac{\text{Bisnorhopane (C}_{28}\text{)}}{Tm + \text{Bisnorhopane} + C_{29} \text{ norhopane}}$	$\frac{C_{31} \text{ (20S)}}{C_{31} \text{ (20S)} + C_{31} \text{ (20R)}}$	x 100
975-001	2429.5m SWC	0.76	1.12	1.29	1.05	0.05	0.05	0.24	60%	
975-002	2443m SWC	0.78	1.16	1.42	0.86	0.06	0.03	0.25	61%	
975-003	2468m SWC	0.69	0.90	1.44	1.11	0.05	0.05	0.24	61%	
975-005	2474m SWC	0.81	1.27	1.46	0.99	0.05	0.04	0.26	61%	
975-006	2480m SWC	0.84	1.25	1.36	1.06	0.05	0.05	0.28	60.5%	
975-007	2485m SWC	0.77	1.25	1.45	1.09	0.06	0.05	0.26	62%	
975-008	DST 2	0.86	1.26	1.42	1.25	0.03	0.05	0.17	60.4%	
975-009	DST 3	0.82	1.12	1.55	1.07	0.04	0.04	0.22	60.90%	
975-010	DST 4	1.03	1.61	1.40	1.35	0.05	0.03	0.15	61.24%	

TABLE 7

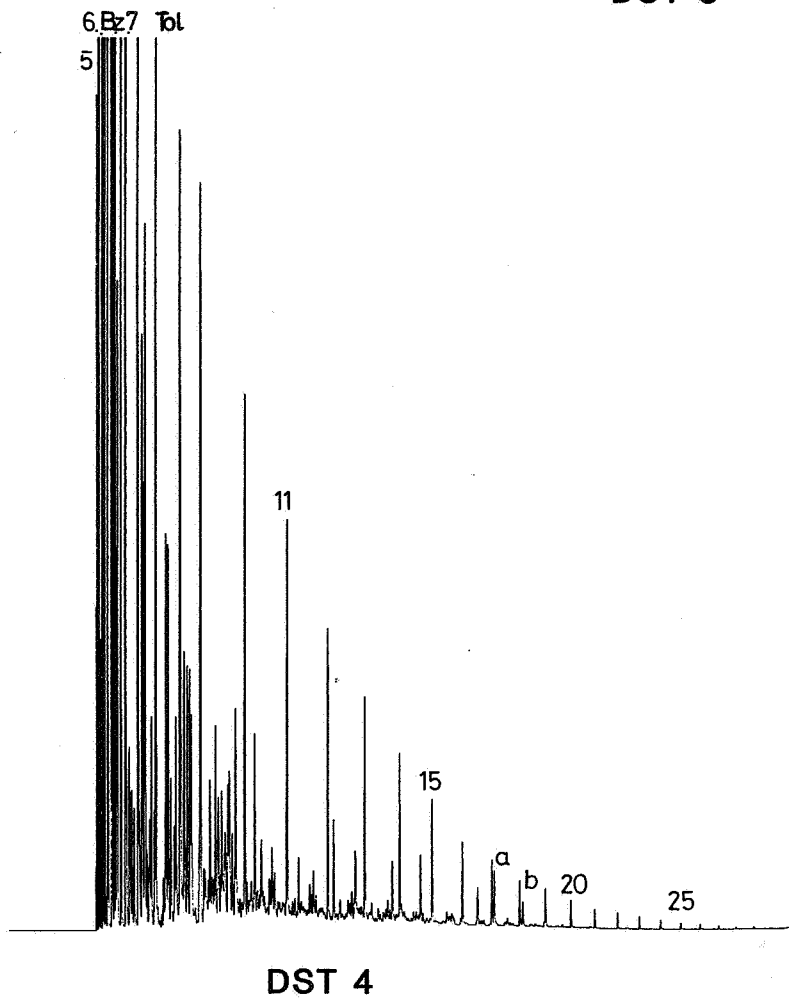
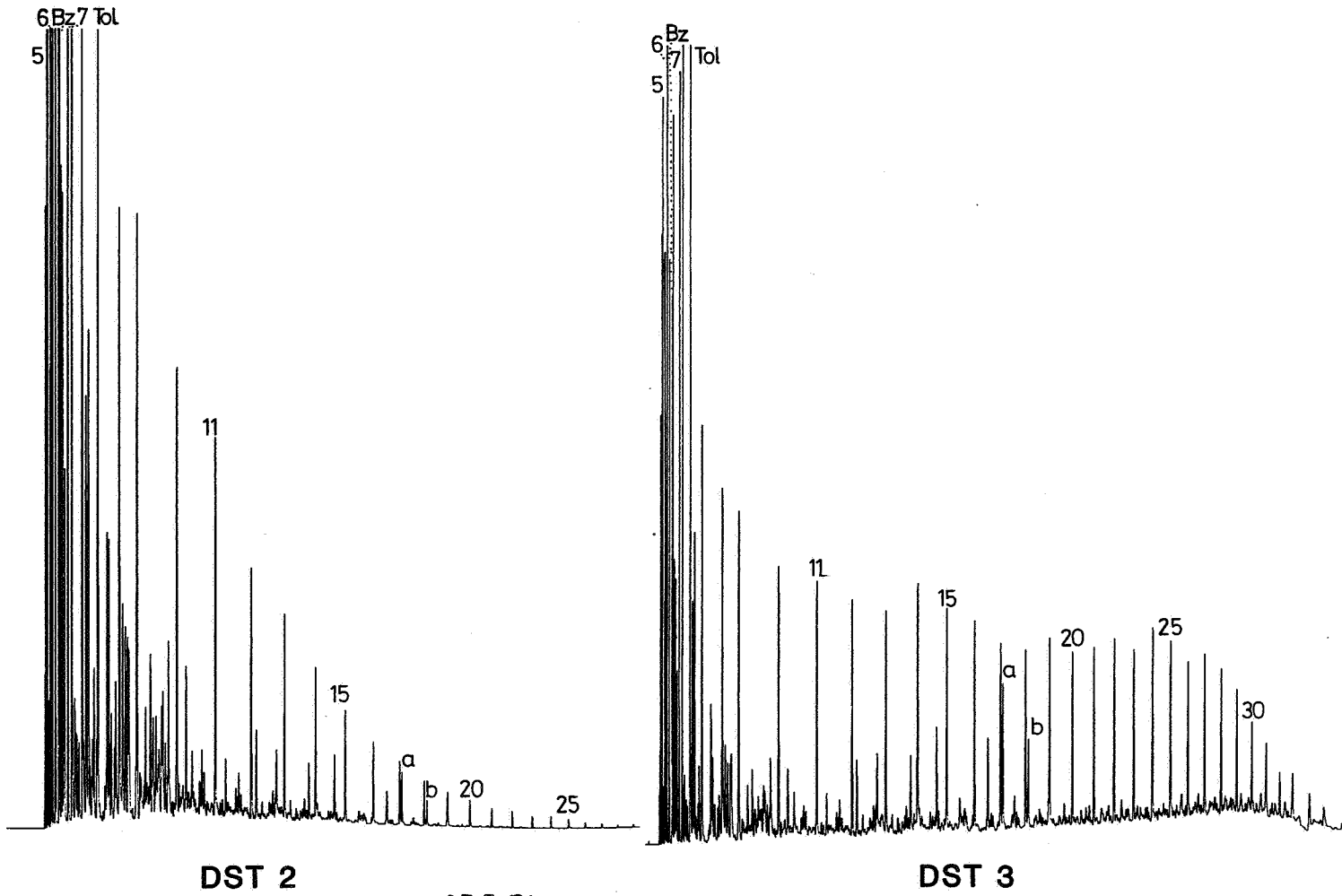
CARBON ISOTOPES (PDB ‰/‰)

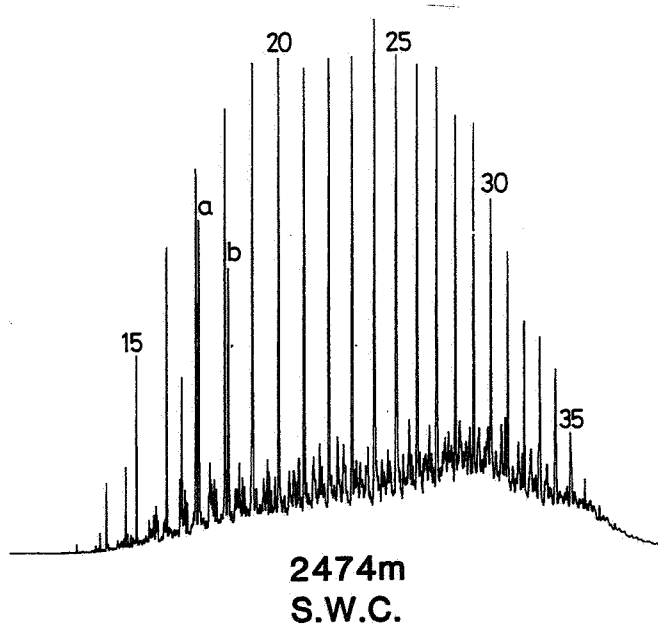
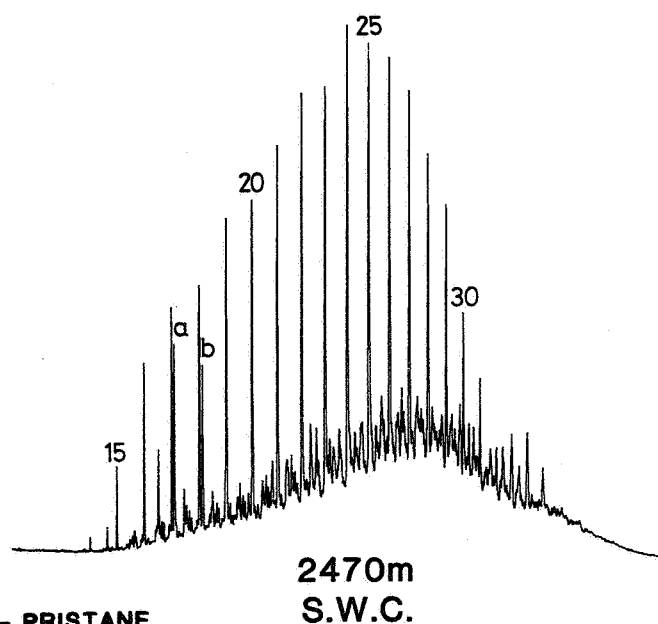
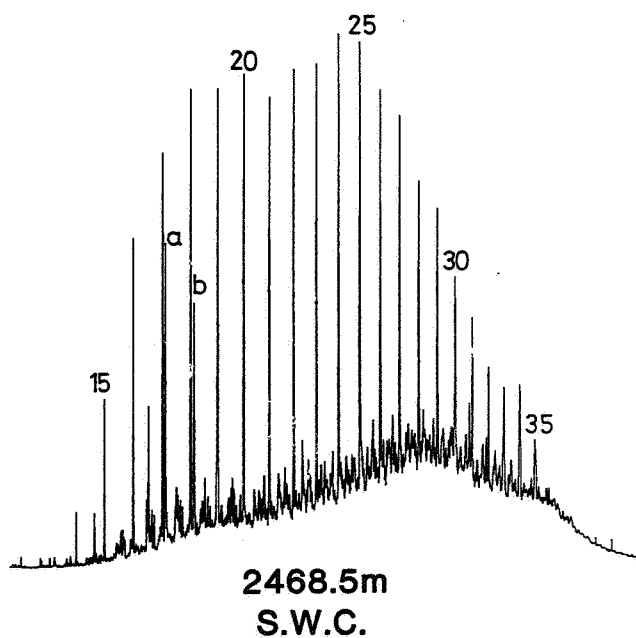
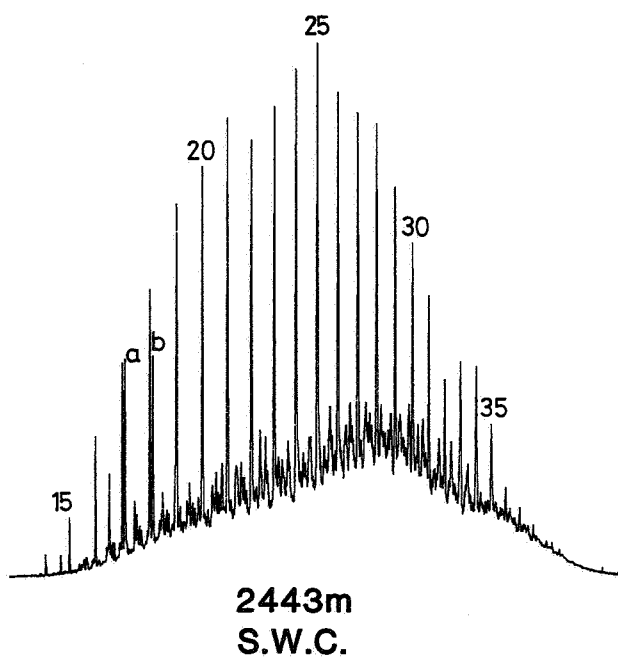
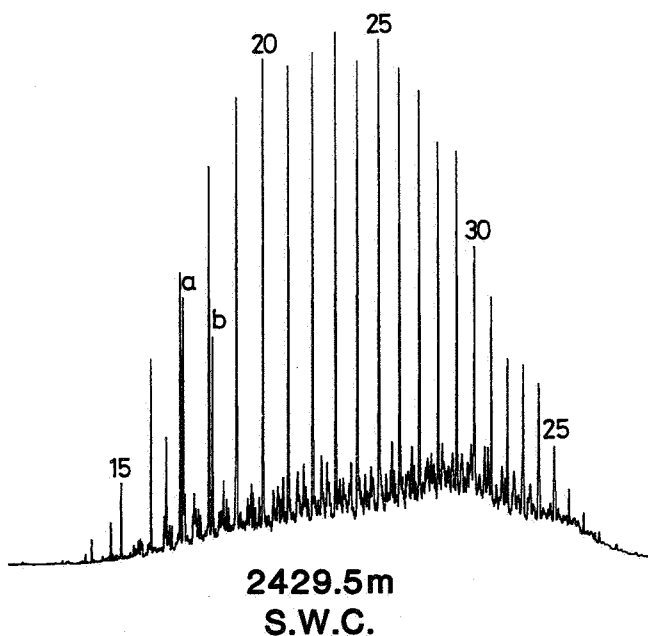
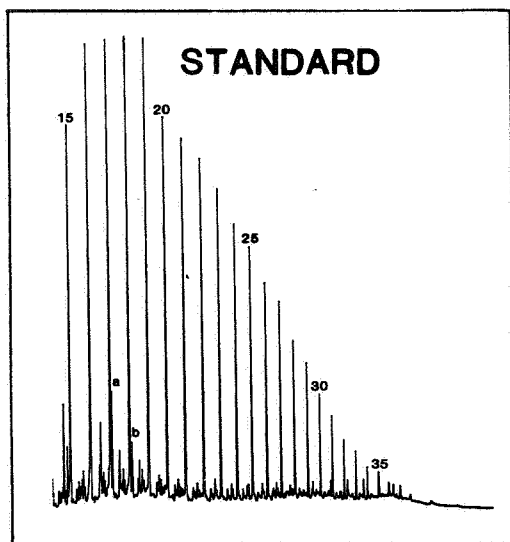
<u>GEOCHEM SAMPLE NUMBER</u>	<u>DEPTH</u>	<u>EXTRACT</u>	<u>PARAFFIN- NAPTHENE</u>	<u>AROMATICS</u>	<u>WHOLE OIL</u>
975-001	2429.5m SWC	N/A	-29.35	-27.78	-
975-002	2443m SWC	N/A	-29.48	-27.53	-
975-003	2468m SWC	N/A	N/A	-27.91	-
975-004	2470m SWC	N/A	-29.29	N/A	-
975-005	2474m SWC	N/A	-29.18	-28.85	-
975-006	2480m SWC	N/A	-29.30	-28.98	-
975-007	2485m SWC	N/A	-29.50	-27.73	-
<u>OILS</u>					
975-008	DST 2	-	-30.54	-28.38	-29.46
975-009	DST 3	-	-30.15	-28.48	-28.95
975-010	DST 4	-	-30.59	-28.35	-29.55

TABLE 8

METHYL PHENANTHRENE INDEX

<u>GEOCHEM SAMPLE NUMBER</u>	<u>DEPTH</u>	<u>MPI (HEIGHT)</u>	<u>MPI (AREA)</u>	<u>MPI (MS)</u>
975-001	2429.5m	0.80	0.74	0.60
975-002	2443m	0.64	0.73	0.66
975-003	2468.5m	0.75	0.70	-
975-004	2470m	0.82	1.15	-
975-005	2474m	0.73	0.74	0.64
975-006	2480m	0.64	0.72	0.56
975-007	2485m	0.71	0.69	0.59
975-008	DST 2	-	-	0.67
975-009	DST 3	-	-	0.70
975-010	DST 4	-	-	0.69





a - PRISTANE
b - PHYTANE

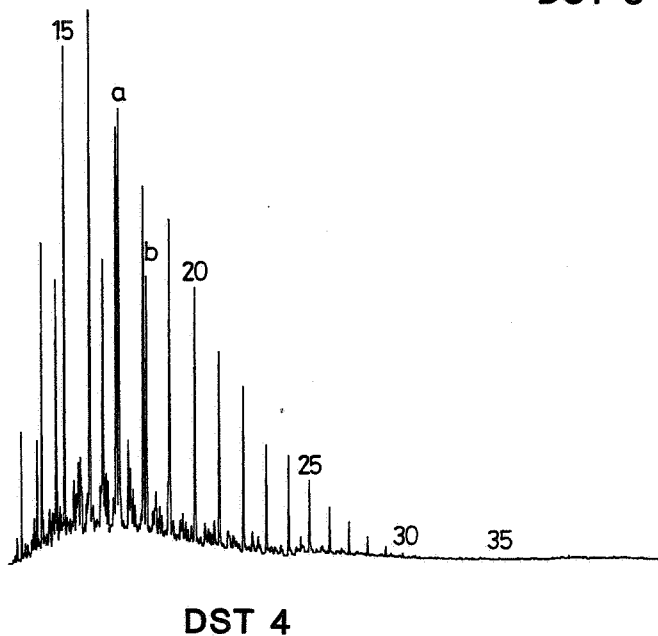
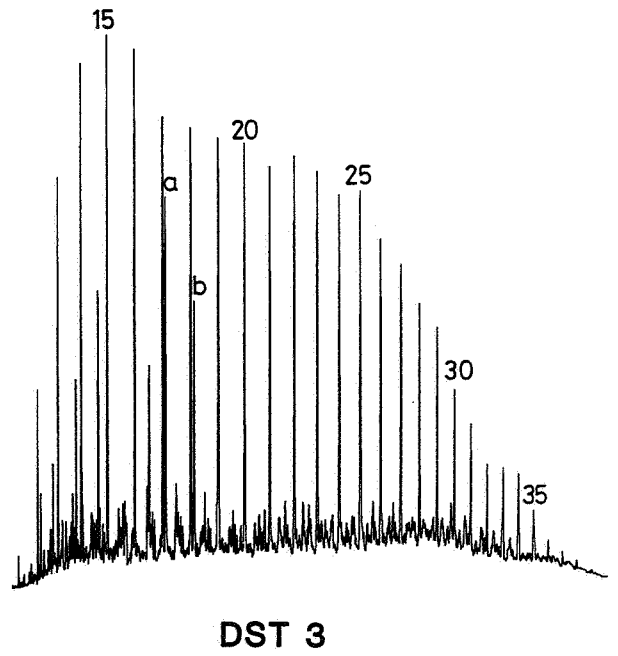
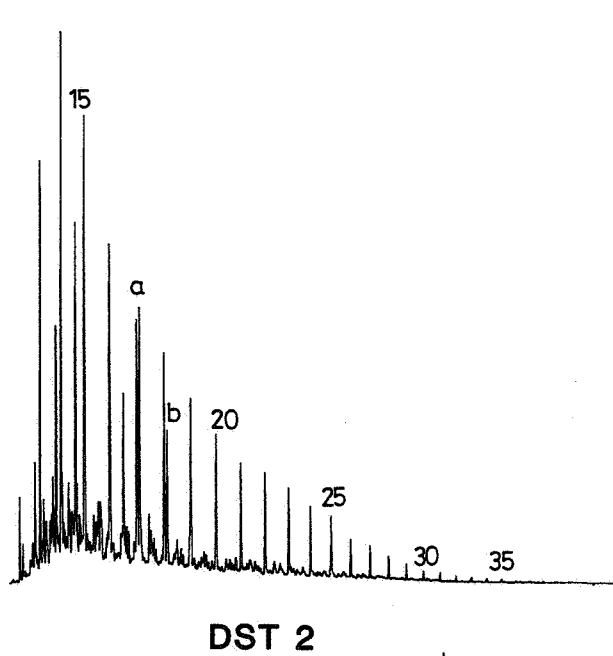
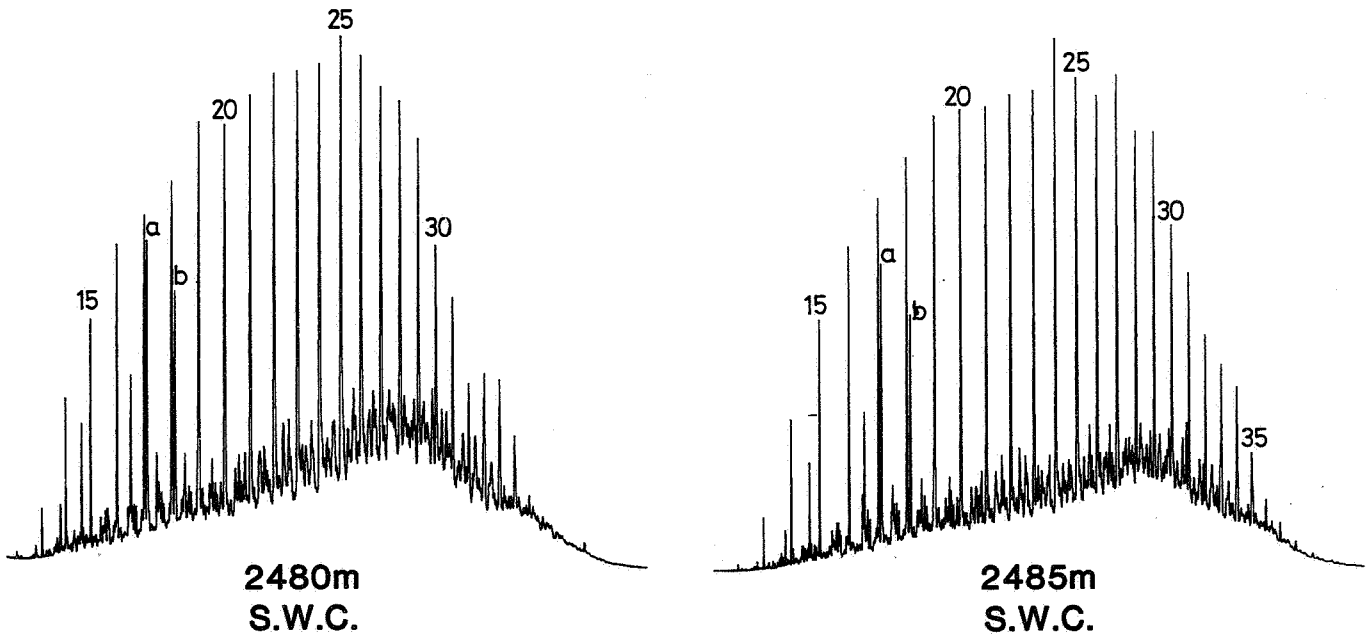
CARBON NUMBERS OF NORMAL PARAFFINS INDICATED (20 - nC₂₀)

FIGURE 2b

C₁₅₊ PARAFFIN - NAPHTHENES

WELL

7121/4-1



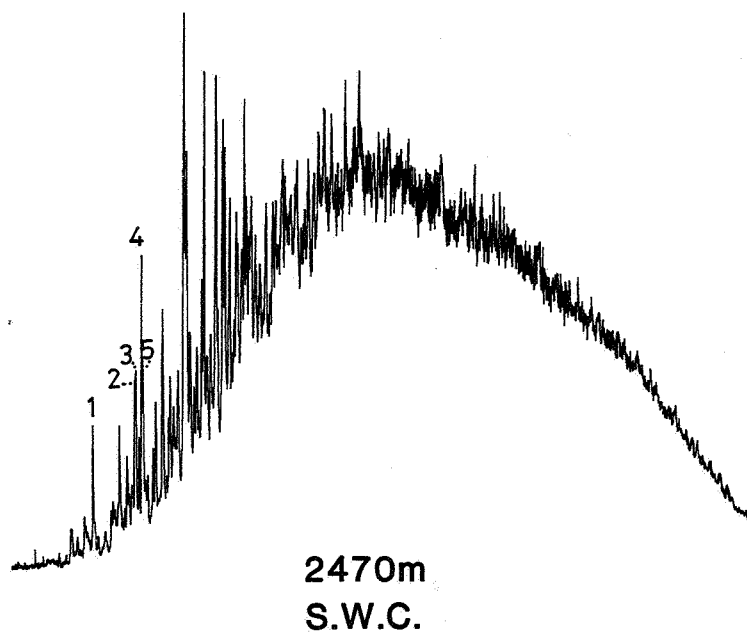
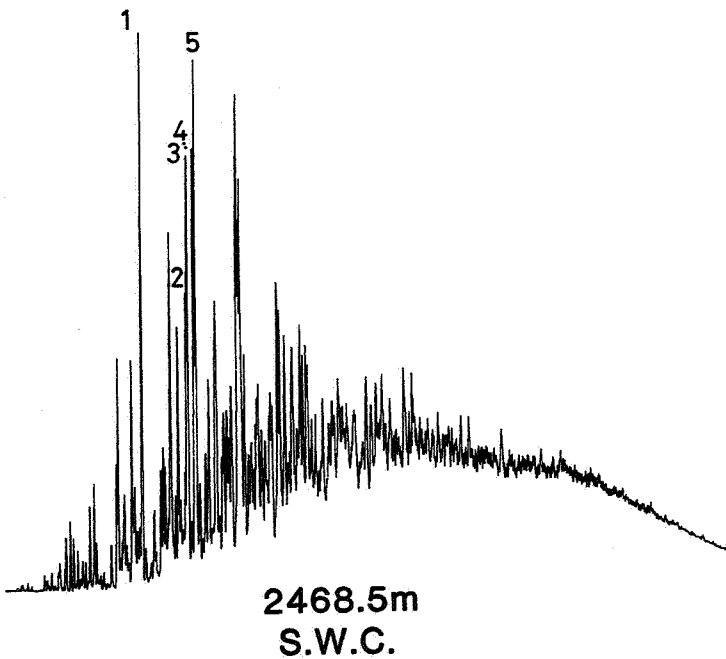
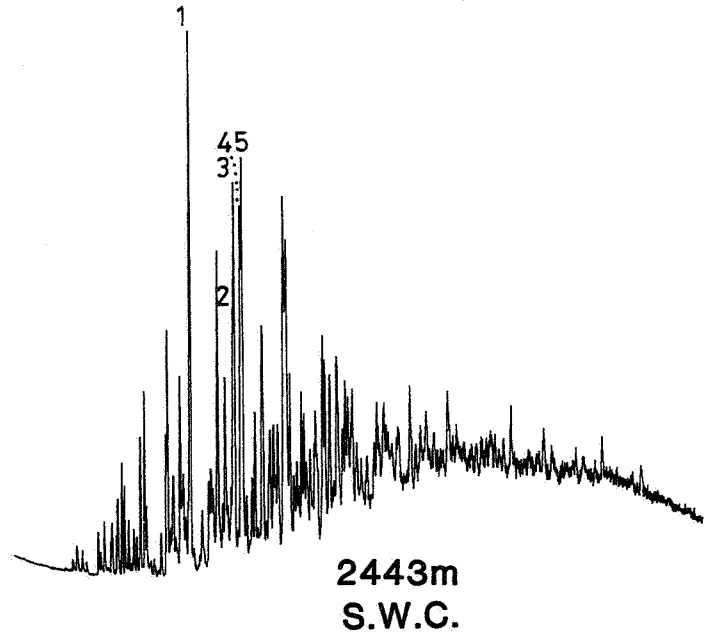
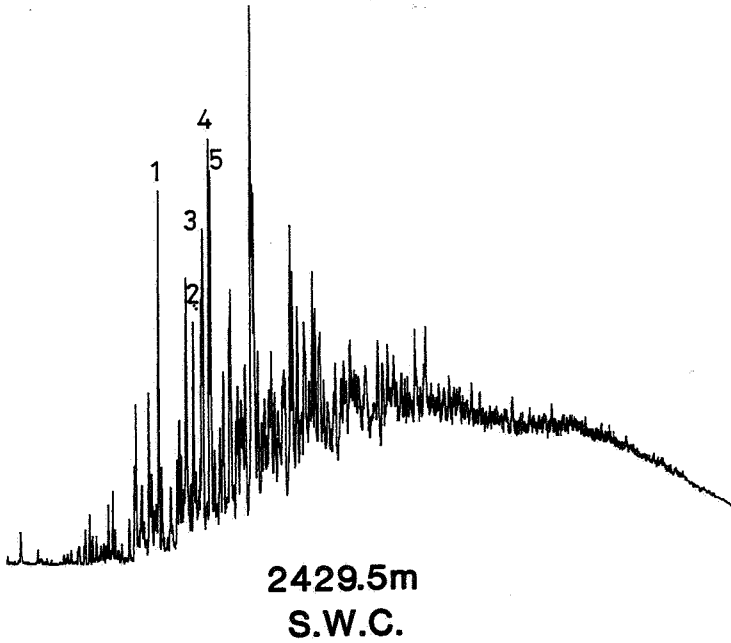
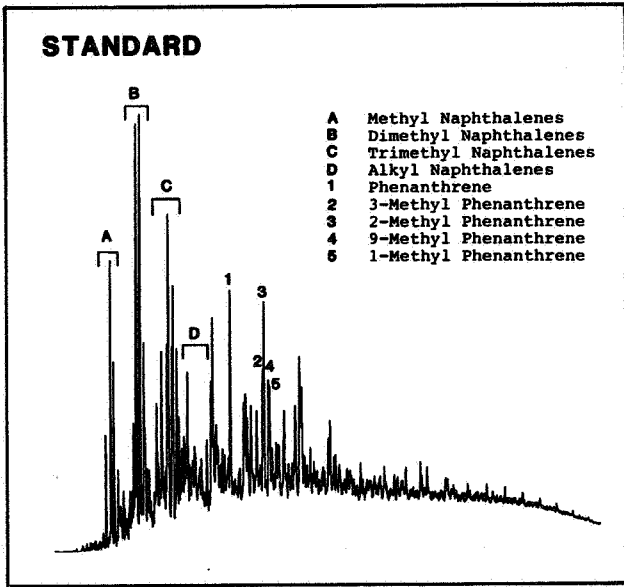
a - PRISTANE
b - PHYTANE

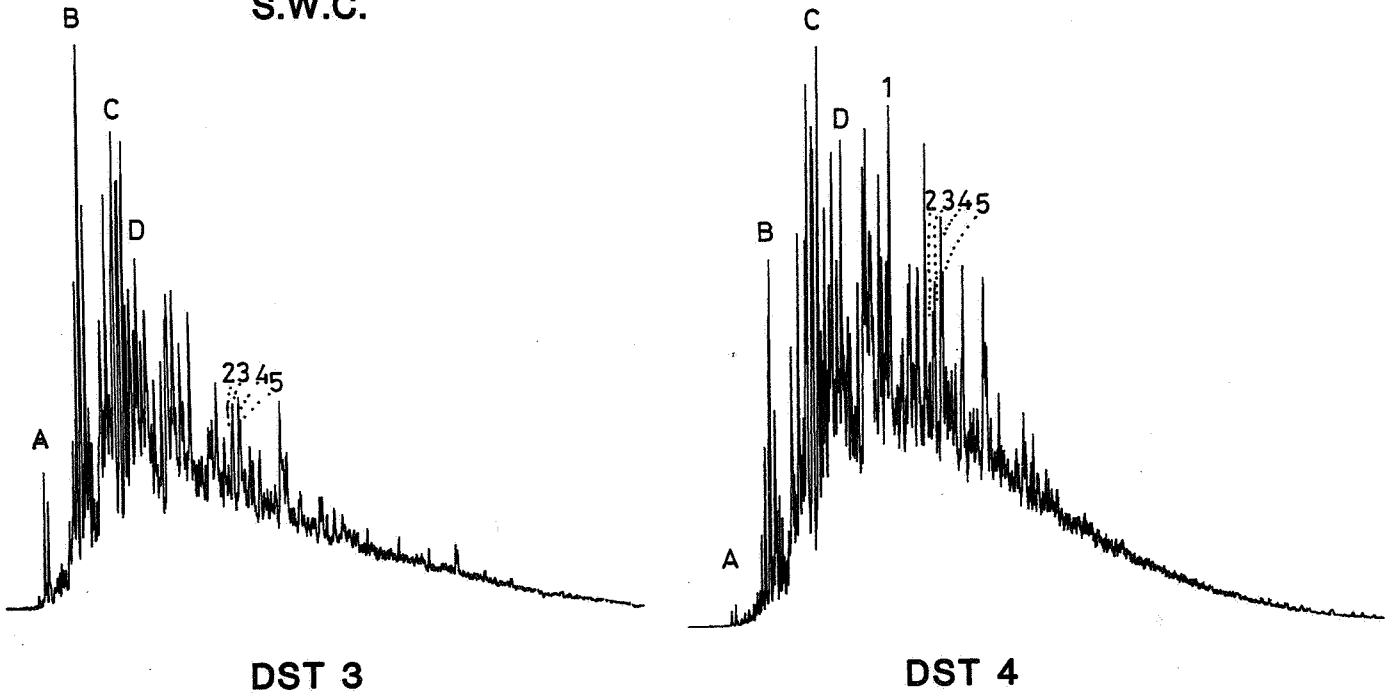
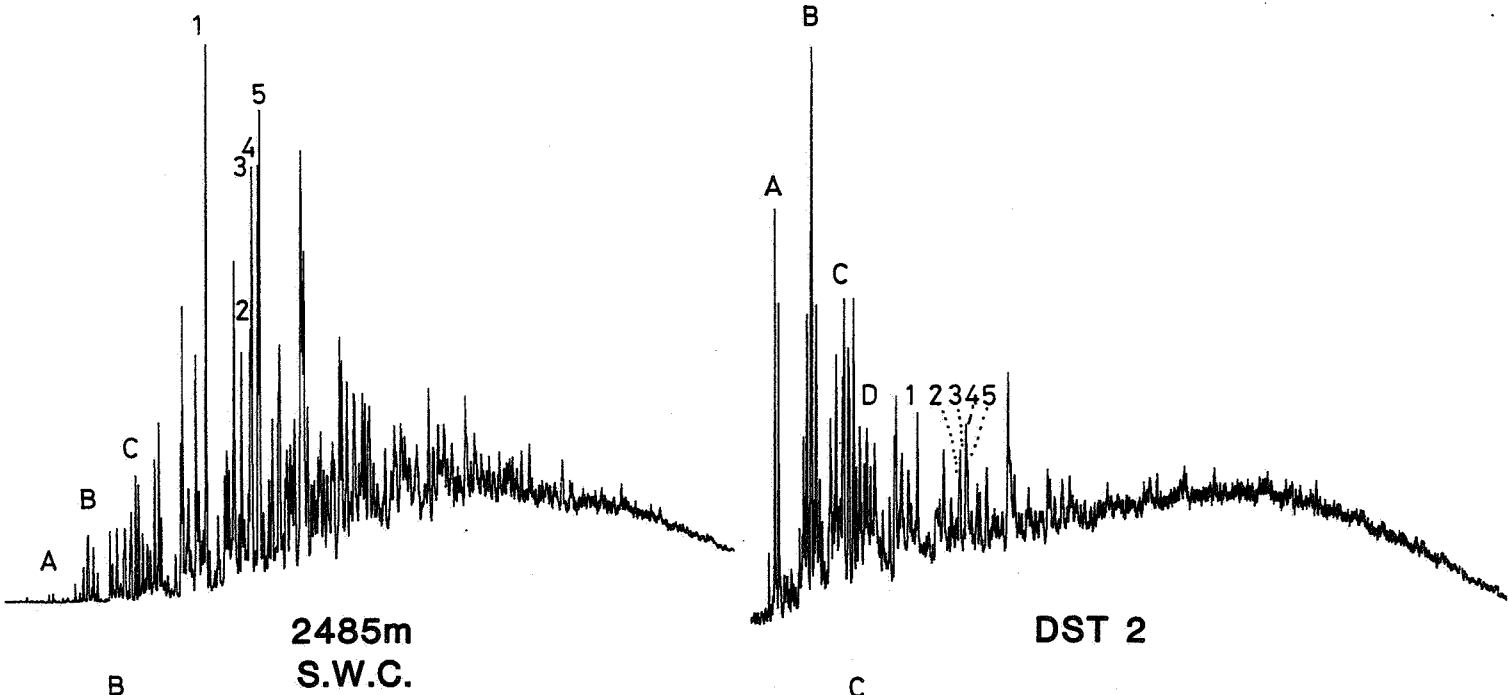
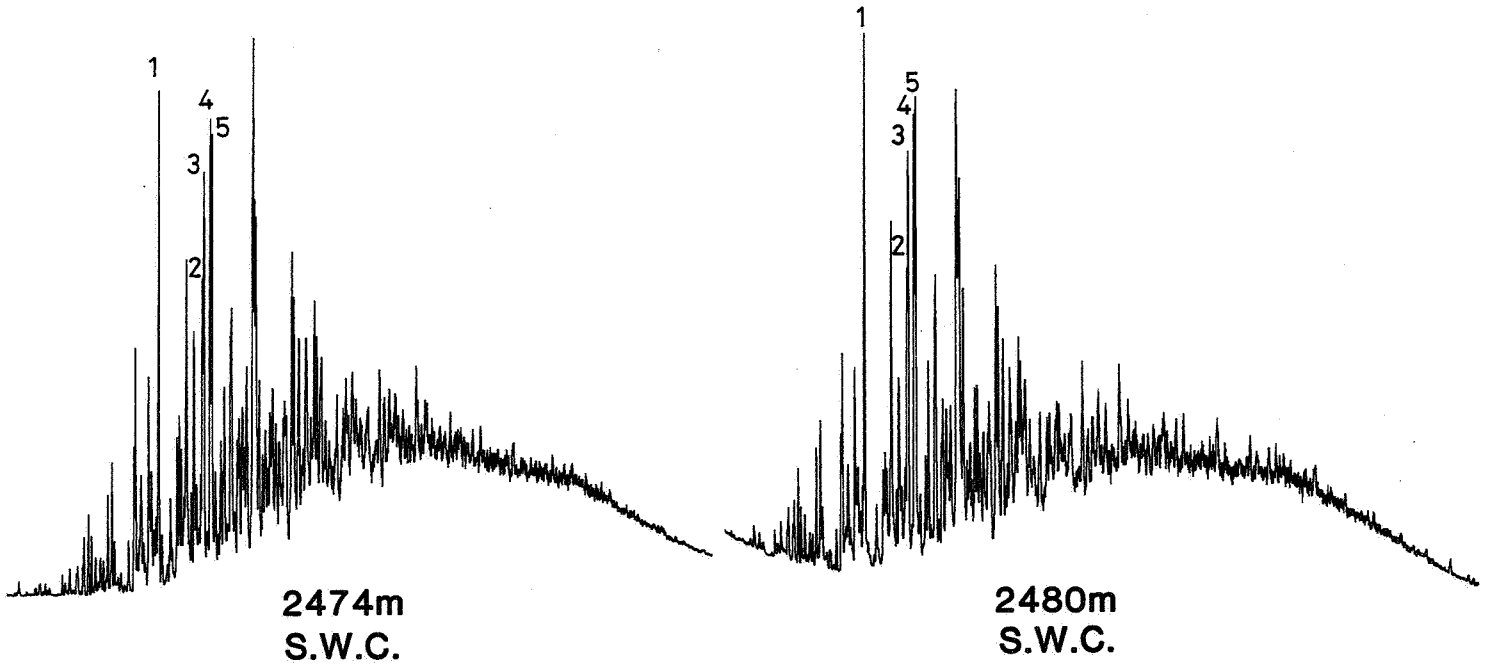
CARBON NUMBERS OF NORMAL PARAFFINS INDICATED (20 - nC₂₀)

FIGURE 3a

AROMATIC CHROMATOGRAMS

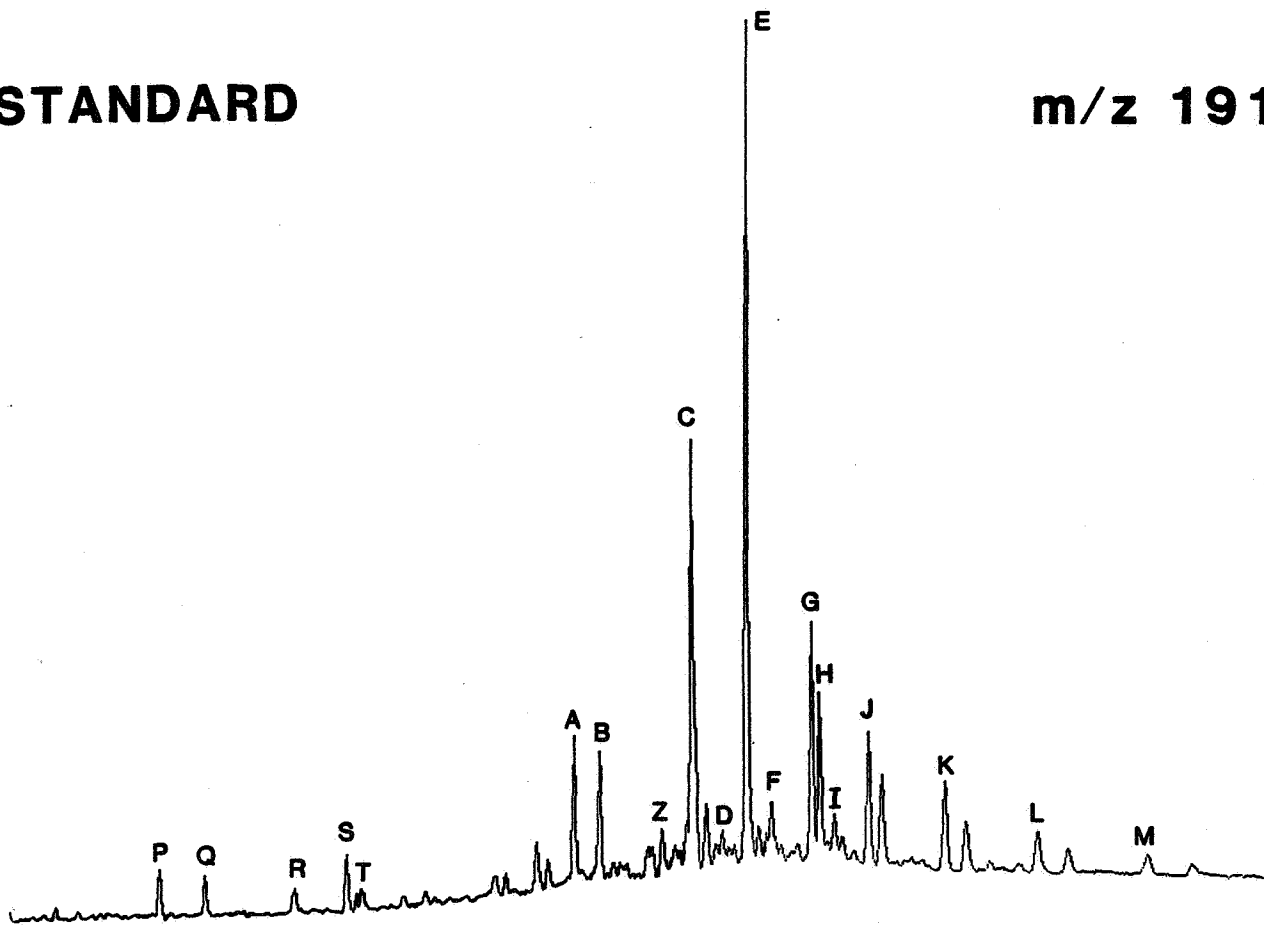
WELL 7121/4-1





STANDARD

m/z 191



TRITERPANE IDENTIFICATION

(M/Z 191 FRAGMENTOGRAM)

<u>COMPOUND</u>	<u>ELEMENTAL COMPOSITION</u>
A 18 (H), 21 (H)-trisnorneohopane (Ts)	C ₂₇ H ₄₆
B 17 (H), 21 (H)-trisnorhopane (Tn)	C ₂₇ H ₄₆
C 17 (H), 21 (H)-norhopane	C ₂₉ H ₅₀
D 17 (H), 21 (H)-norhopane (normoretane)	C ₂₉ H ₅₀
E 17 (H), 21 (H)-hopane	C ₃₀ H ₅₂
F 17 (H), 21 (H)-hopane (moretane)	C ₃₀ H ₅₂
G 17 (H), 21 (H)-homohopane (22S)	C ₃₁ H ₅₄
H 17 (H), 21 (H)-homohopane (22R)	C ₃₁ H ₅₄
I 17 (H), 21 (H)-homohopane (homomoretane)	C ₃₁ H ₅₄
J 17 (H), 21 (H)-bishomohopane (22S and 22R)	C ₃₂ H ₅₆
K 17 (H), 21 (H)-trishomohopane (22S and 22R)	C ₃₃ H ₅₈
L 17 (H), 21 (H)-tetrakishomohopane (22S and 22R)	C ₃₄ H ₅₈
M 17 (H), 21 (H)-pentakishomohopane (22S and 22R)	C ₃₅ H ₆₀
Z = C ₂₈ bisnorhopane	

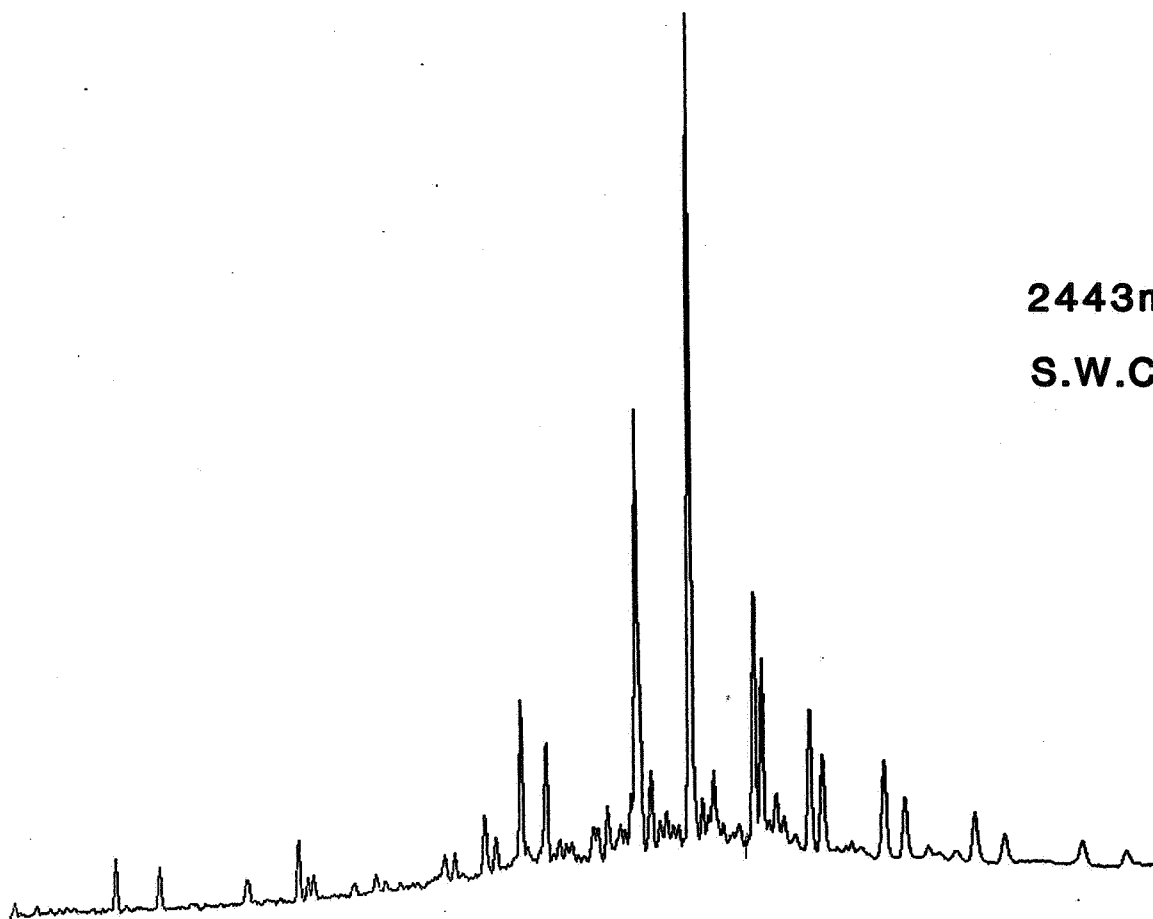
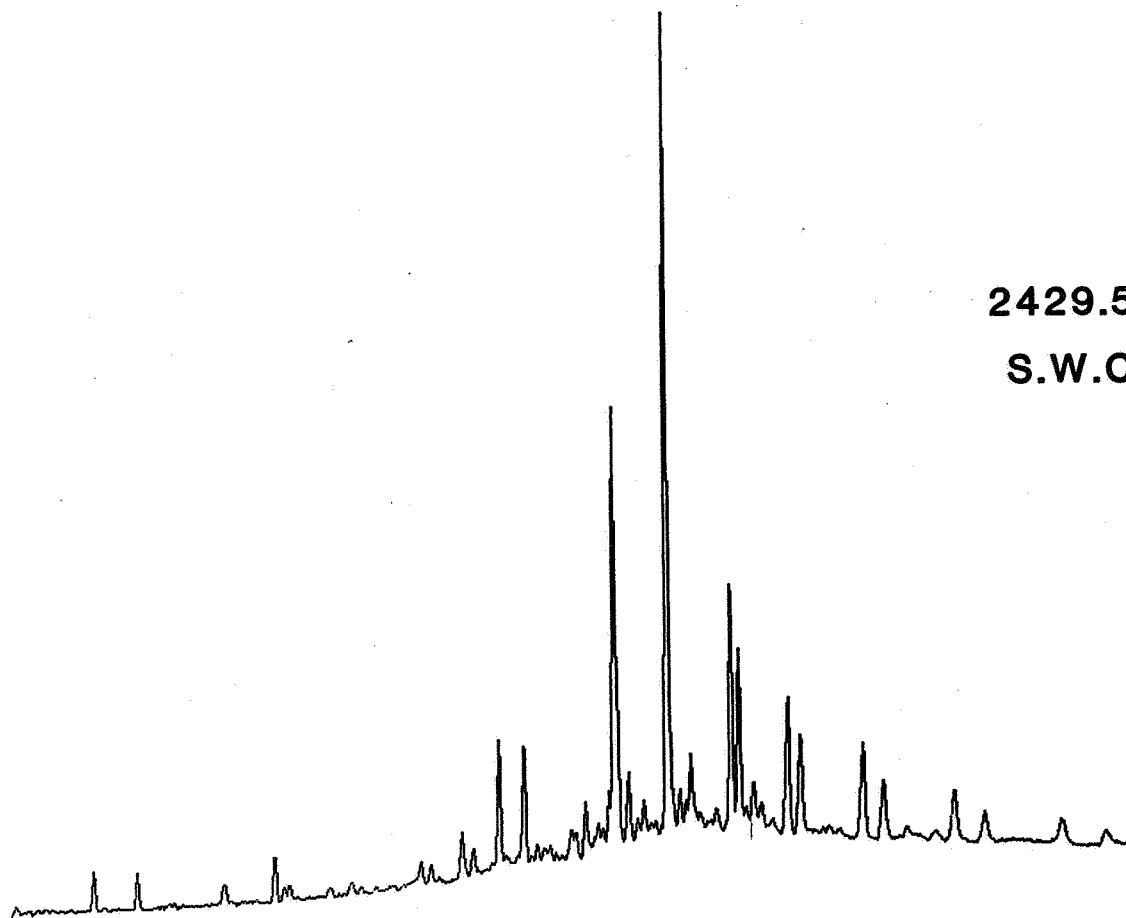
TRICYCLIC AND TETRACYCLIC TERPANES (M/Z 191)

P	C ₂₃ H ₄₂
Q	C ₂₄ H ₄₄
R	C ₂₅ H ₄₆
S	C ₂₄ H ₄₂
T	C ₂₆ H ₄₈

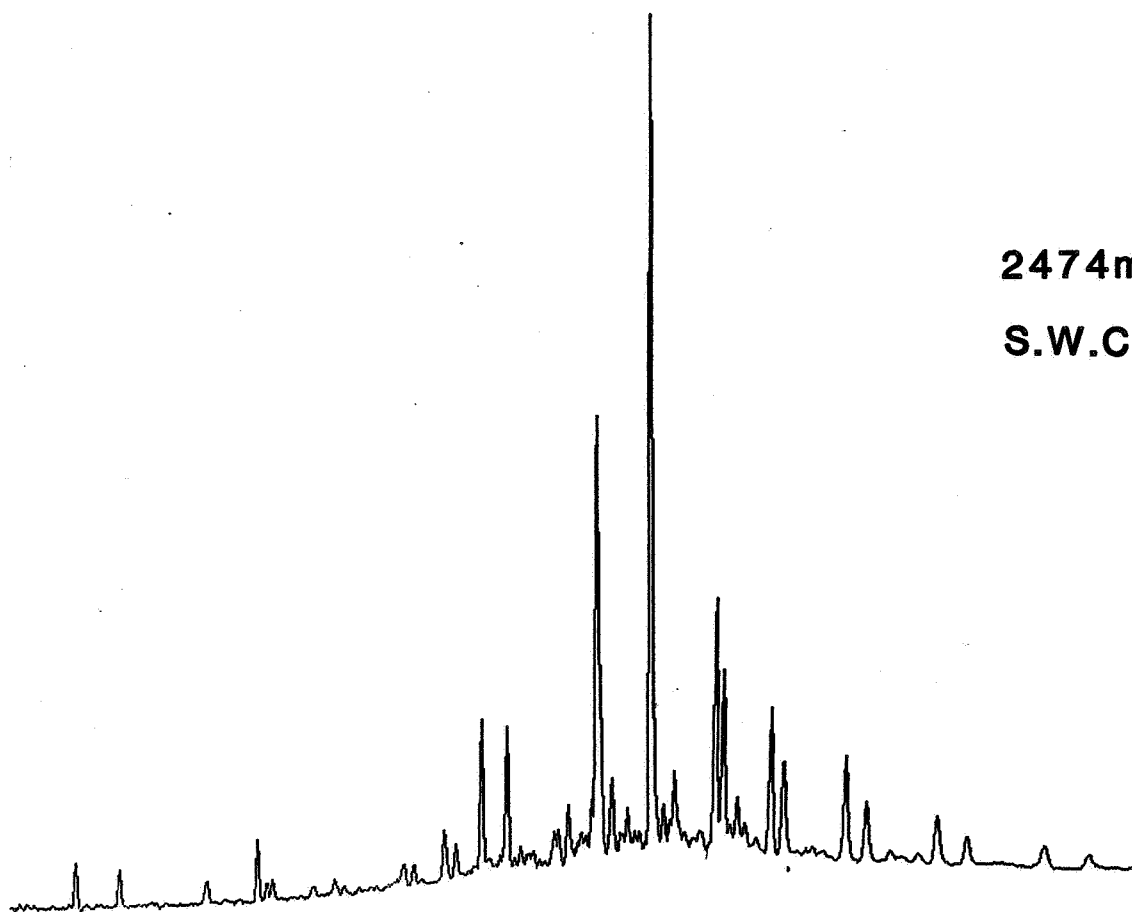
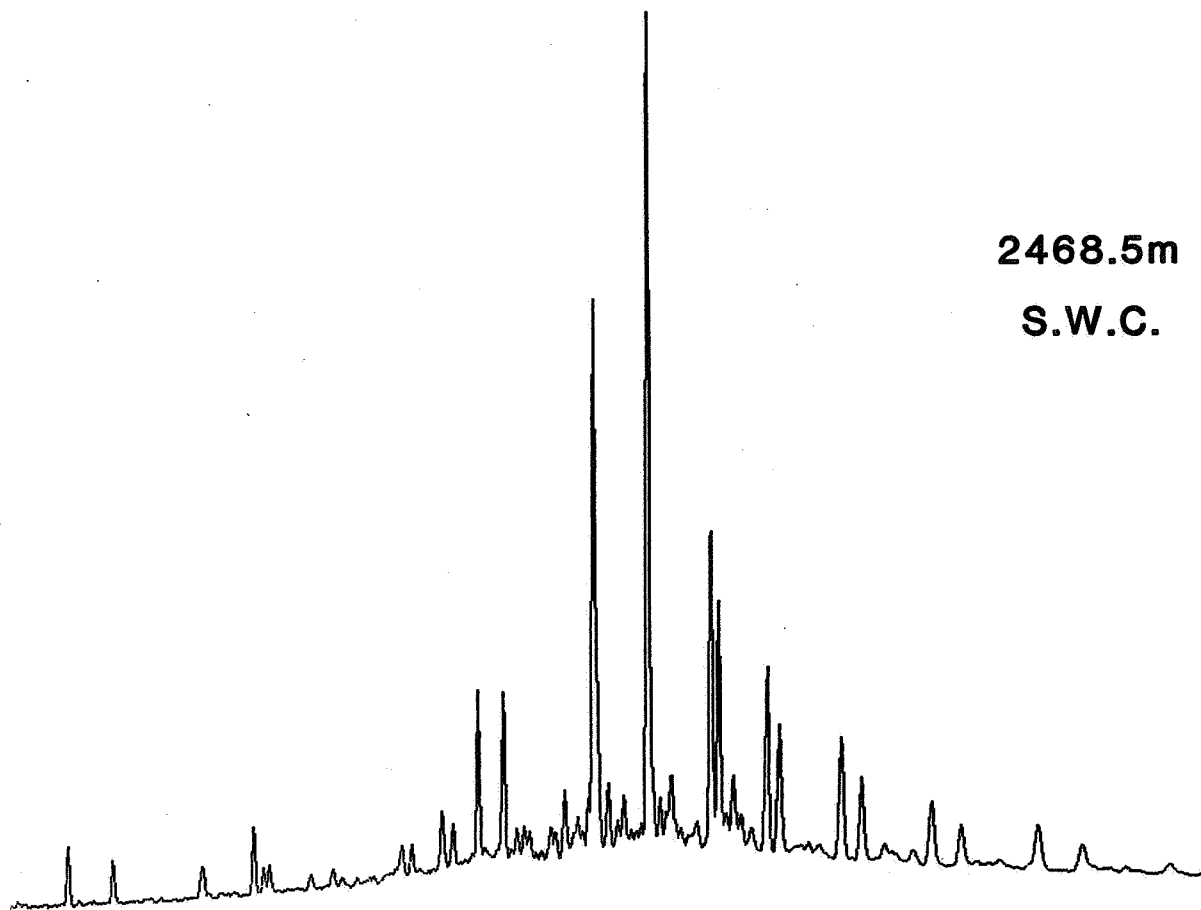
TRITERPANES m/z 191

2429.5m
S.W.C.

2443m
S.W.C.



TRITERPANES m/z 191



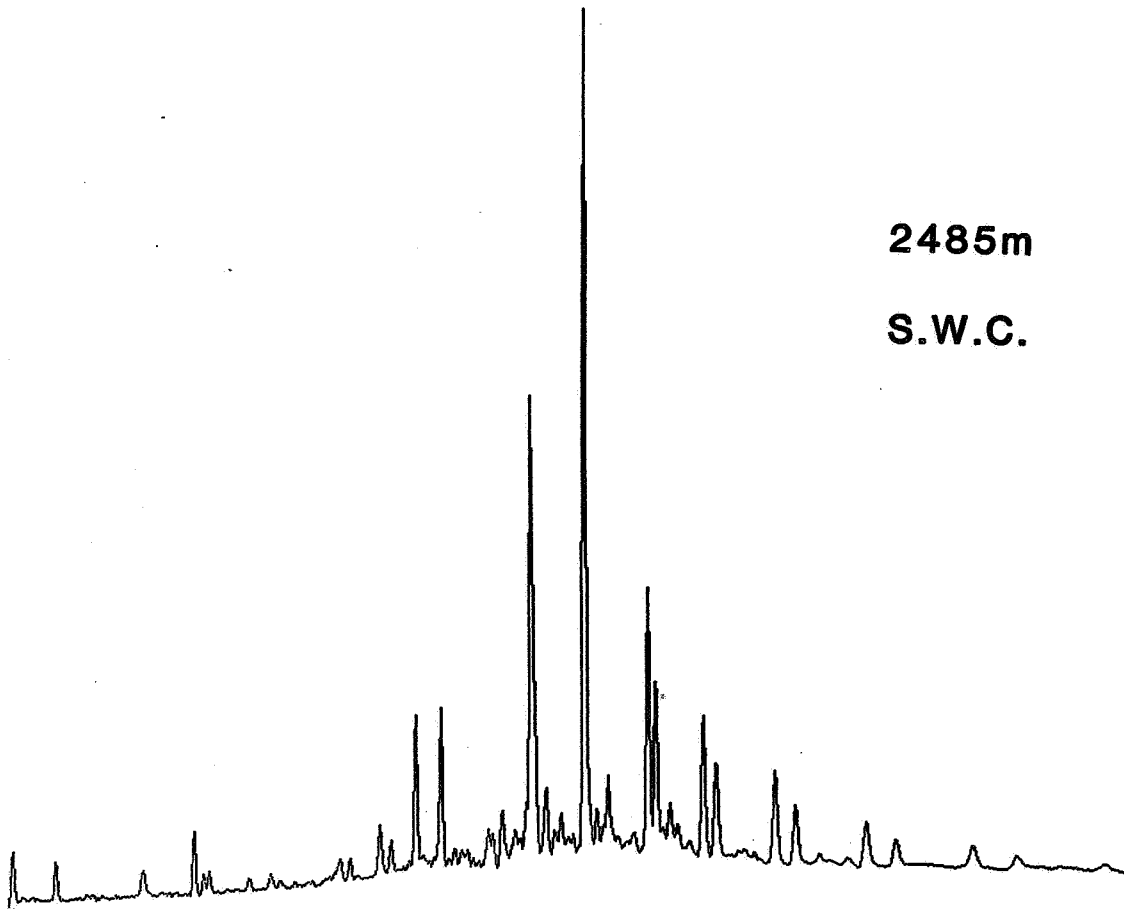
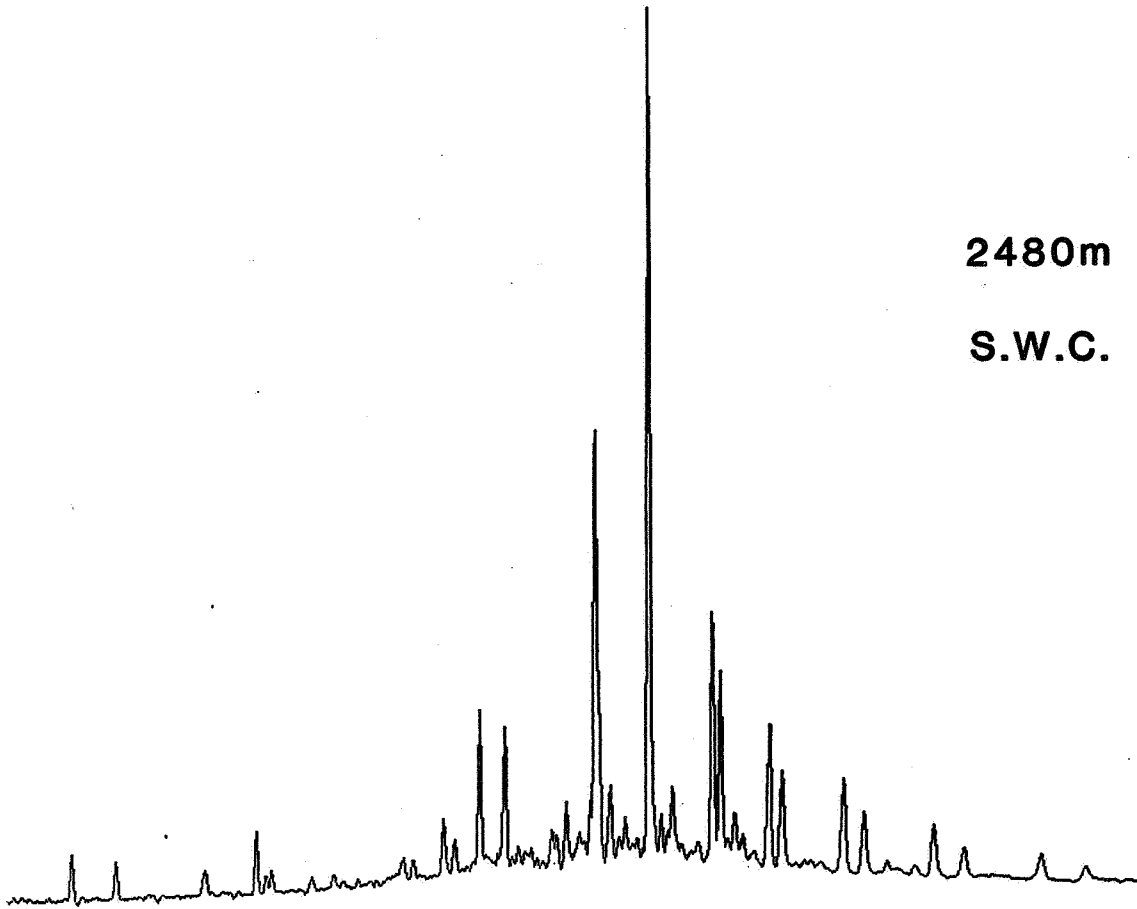
TRITERPANES m/z 191

2480m

S.W.C.

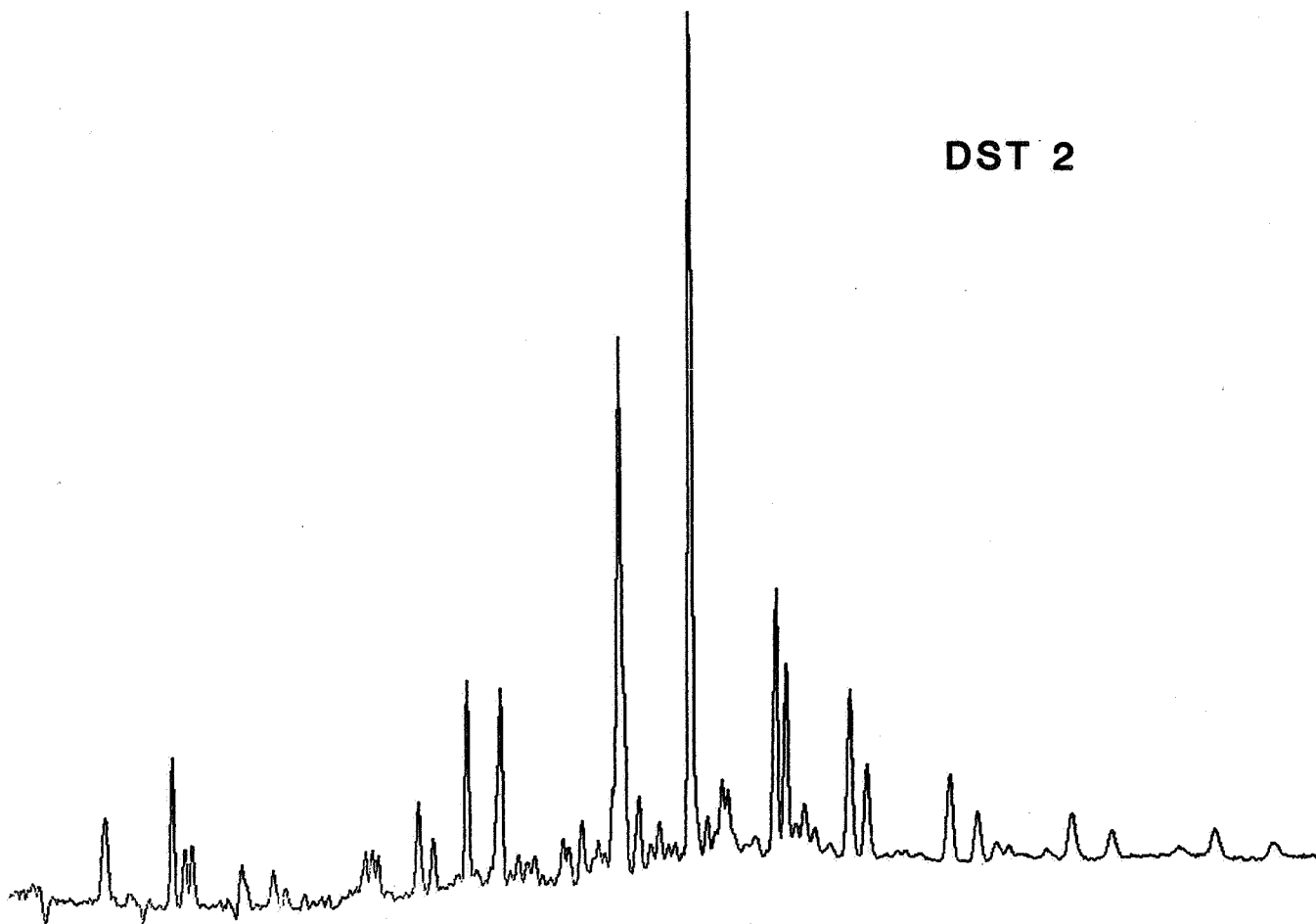
2485m

S.W.C.

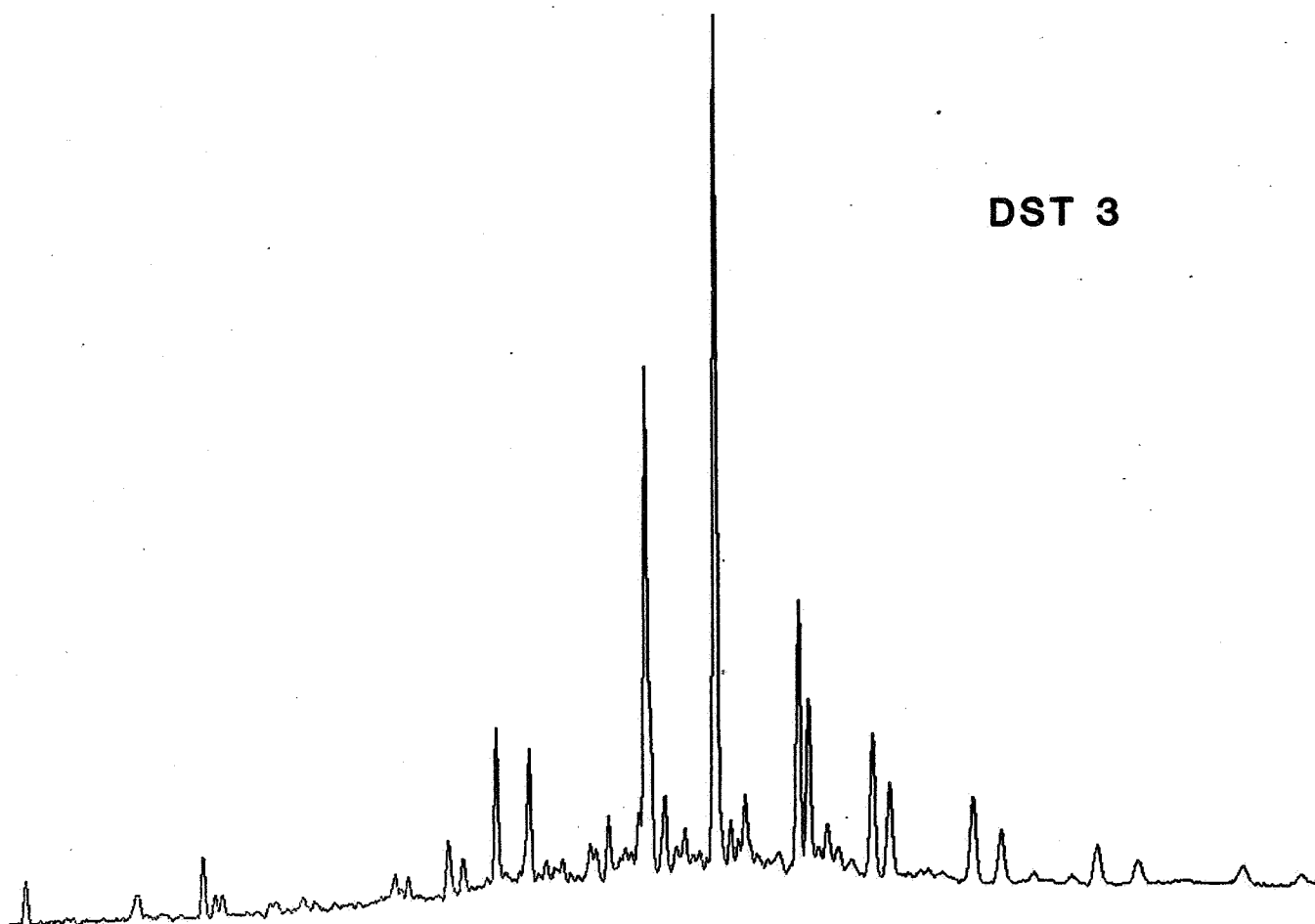


TRITERPANES m/z 191

DST 2

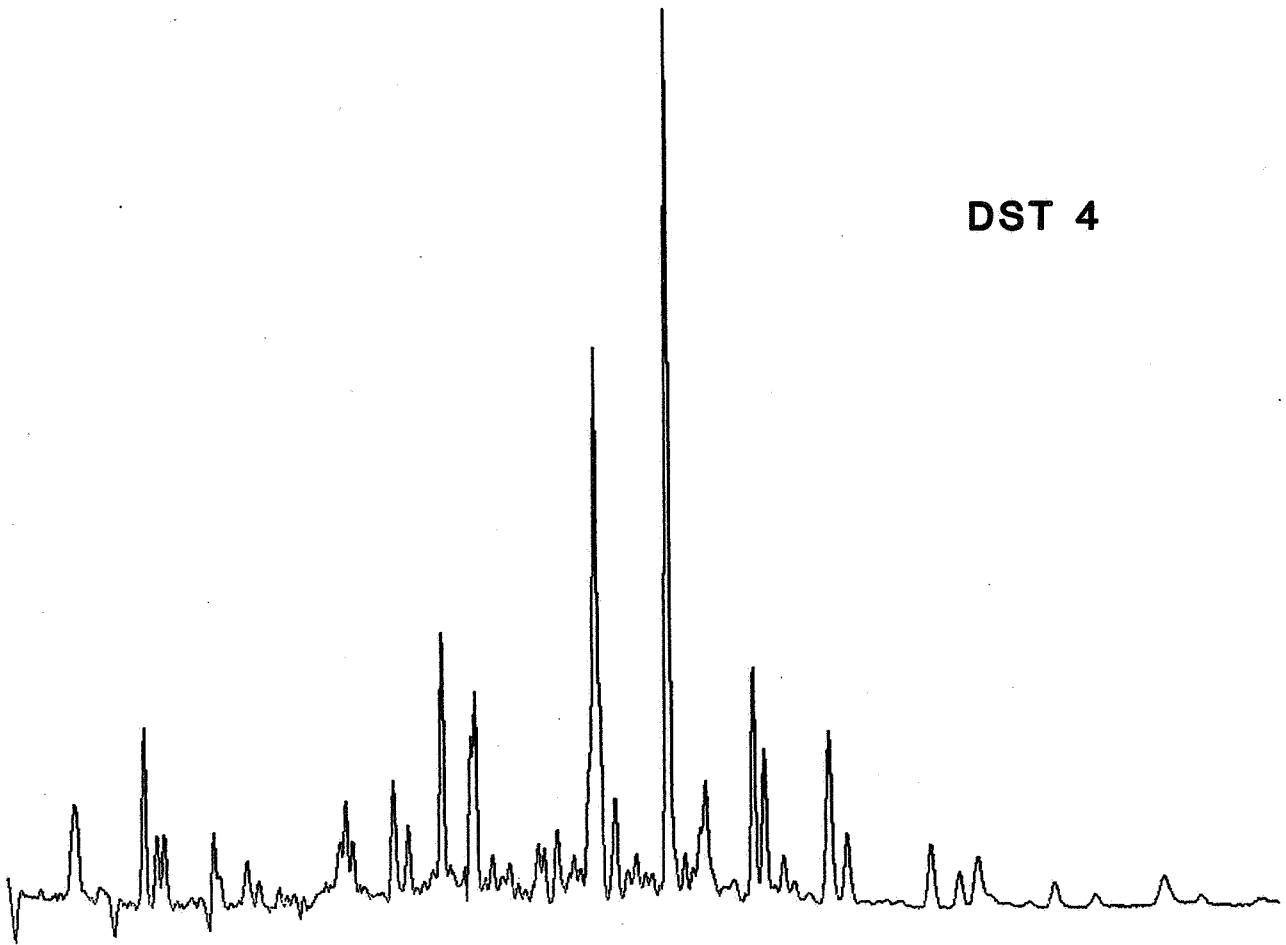


DST 3



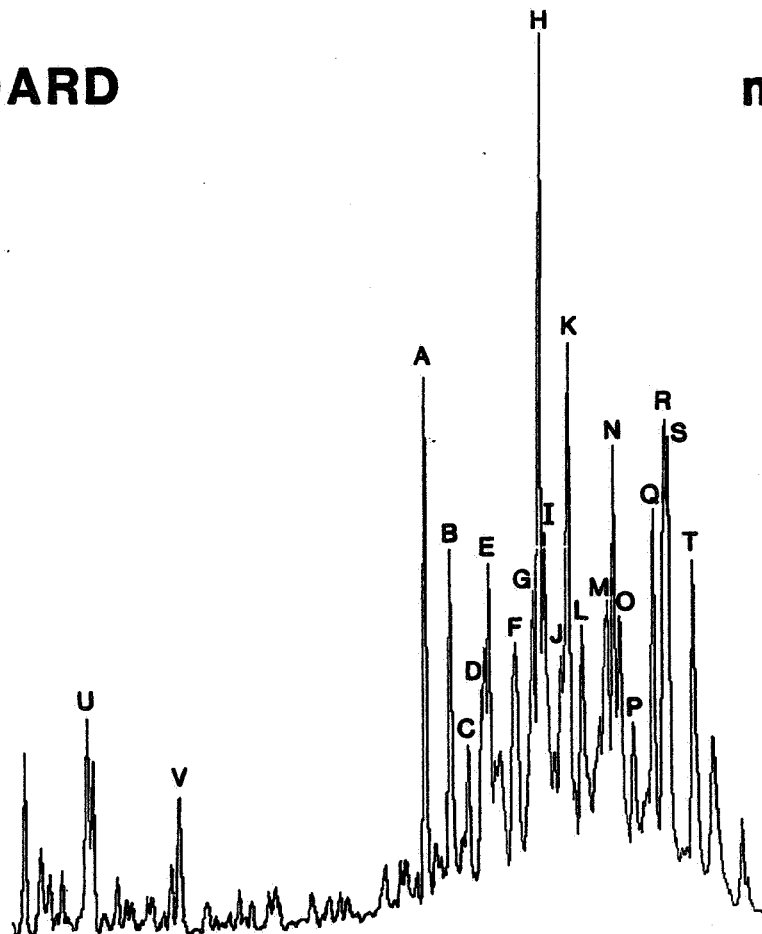
TRITERPANES m/z 191

DST 4



STANDARD

m/z 217

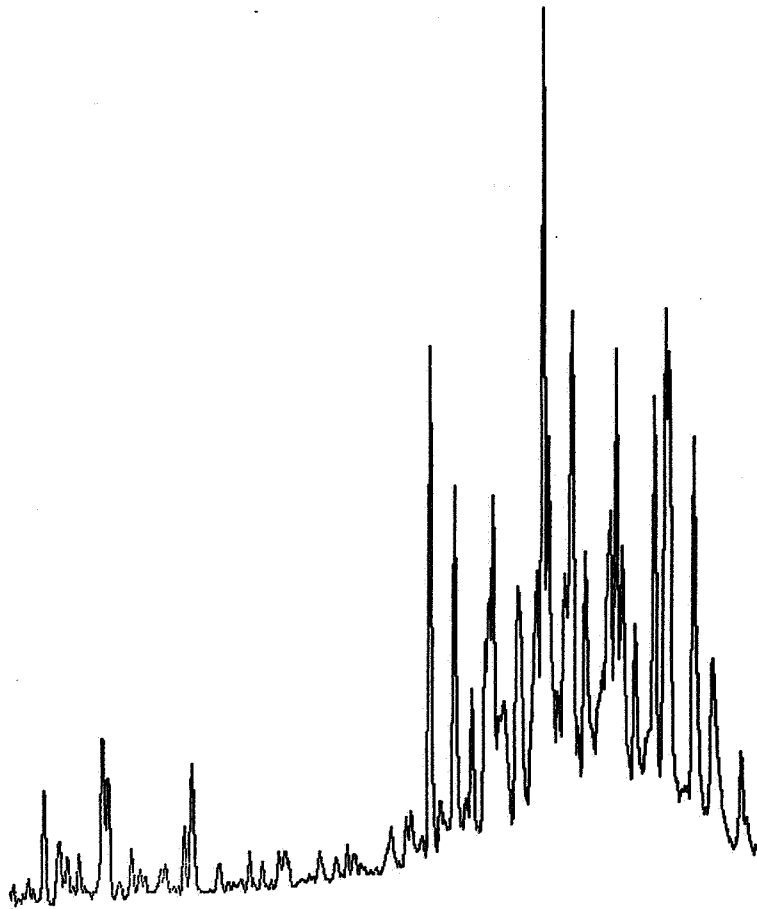


STERANE IDENTIFICATION

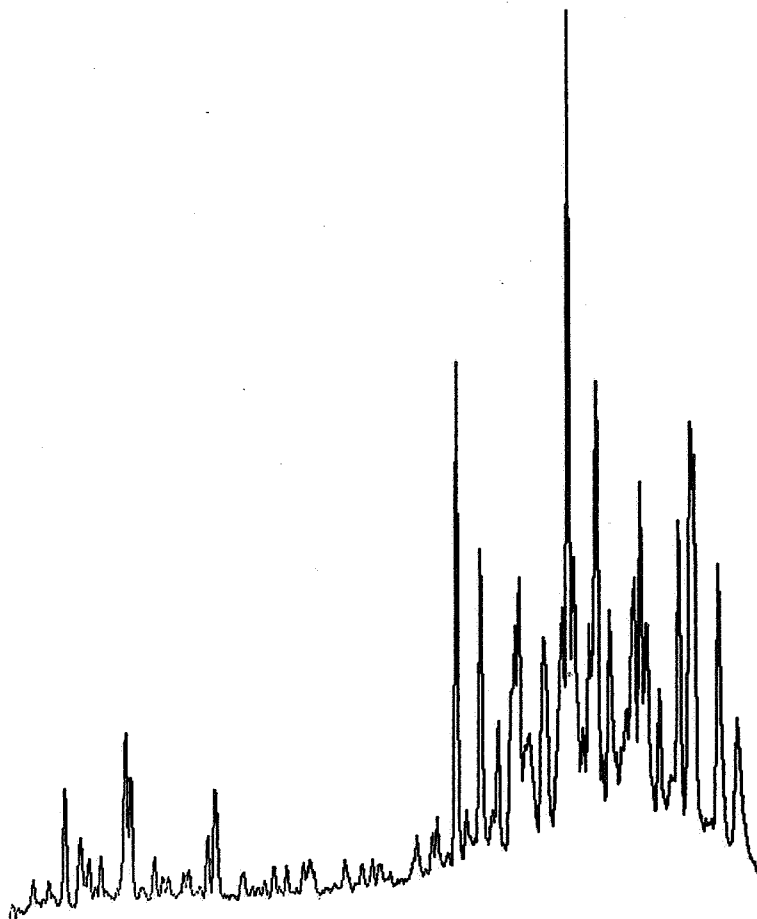
(M/Z 217 FRAGMENTOGRAM)

COMPOUND	(M/Z 217 FRAGMENTOGRAM)	ELEMENTAL COMPOSITION
A	13 β ,17 α -diacholestane (20S)	C ₂₇ H ₄₈
B	13 β ,17 α -diacholestane (20R)	C ₂₇ H ₄₈
C	13 α ,17 β -diacholestane (20S)	C ₂₇ H ₄₈
D	13 α ,17 β -diacholestane (20R)	C ₂₇ H ₄₈
E	24-methyl-13 β ,17 α -diacholestane (20S)	C ₂₈ H ₅₀
F	24-methyl-13 β ,17 α -diacholestane (20R)	C ₂₈ H ₅₀
G	24-methyl-13 α ,17 β -diacholestane (20S)	C ₂₈ H ₅₀
+	14 α ,17 α -cholestane (20S)	C ₂₇ H ₄₈
H	24-ethyl-13 β ,17 α -diacholestane (20S)	C ₂₉ H ₅₂
+	14 β ,17 β -cholestane (20R)	C ₂₇ H ₄₈
I	14 β ,17 β -cholestane (20S)	C ₂₇ H ₄₈
+	24-methyl-13 α ,17 β -diacholestane (20R)	C ₂₈ H ₅₀
J	14 α ,17 α -cholestane (20R)	C ₂₇ H ₄₈
K	24-ethyl-13 β ,17 α -diacholestane (20R)	C ₂₉ H ₅₂
L	24-ethyl-14 α ,17 β -diacholestane (20S)	C ₂₉ H ₅₂
M	24-methyl-13 α ,17 α -cholestane (20S)	C ₂₈ H ₅₀
N	24-ethyl-13 α ,17 β -diacholestane (20R)	C ₂₉ H ₅₂
+	24-methyl-14 β ,17 β -cholestane (20R)	C ₂₈ H ₅₀
O	24-methyl-14 β ,17 β -cholestane (20S)	C ₂₈ H ₅₀
P	24-methyl-14 α ,17 α -cholestane (20R)	C ₂₈ H ₅₀
Q	24-ethyl-14 α ,17 α -cholestane (20S)	C ₂₉ H ₅₂
R	24-ethyl-14 β ,17 β -cholestane (20R)	C ₂₉ H ₅₂
+	UNKNOWN STERANE	
S	24-ethyl-14 β ,17 β -cholestane (20S)	C ₂₉ H ₅₂
T	24-ethyl-14 α ,17 α -cholestane (20R)	C ₂₉ H ₅₂
U	5 α (H)-pregnane	C ₂₁ H ₃₆
V	5 α (H)-bisanorcholane	C ₂₂ H ₃₈

STERANES m/z 217

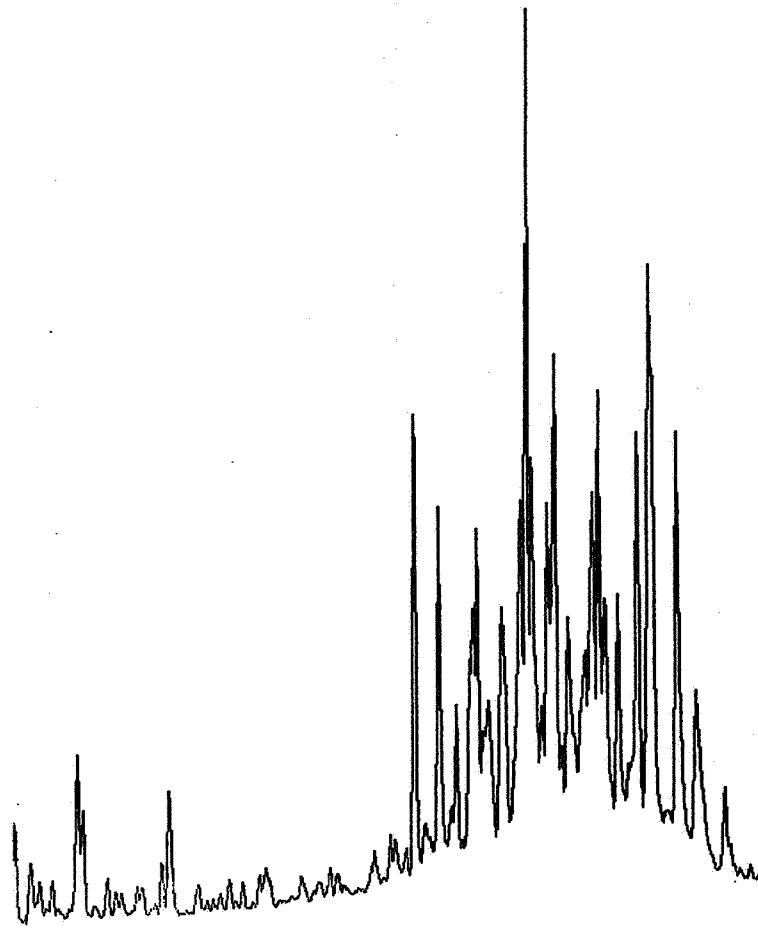


2429.5m
S.W.C.

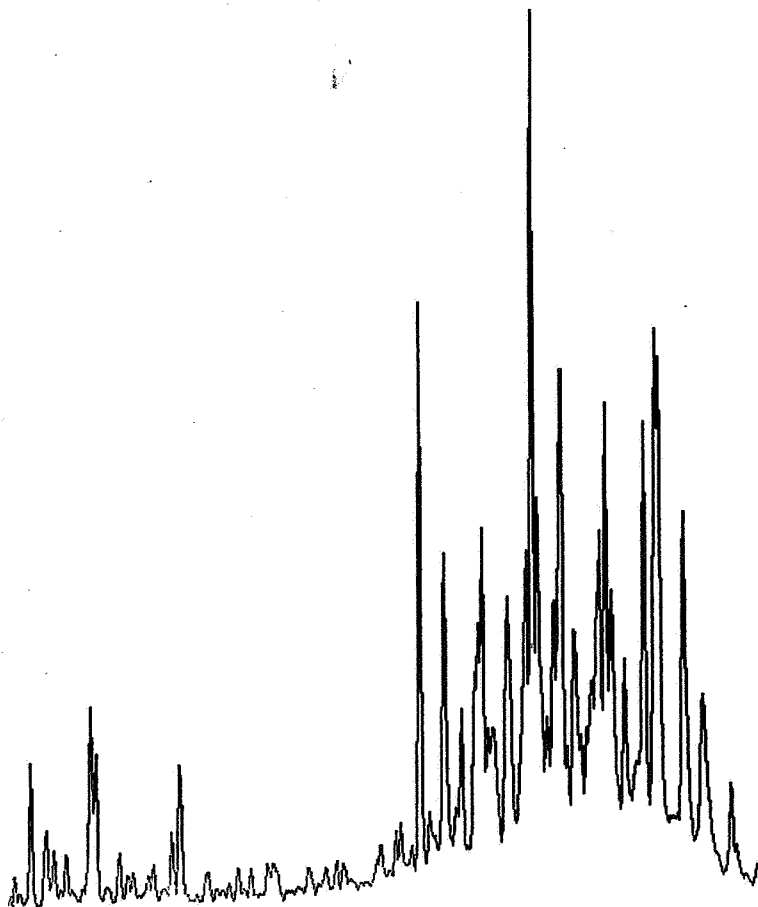


2443m
S.W.C.

STERANES m/z 217

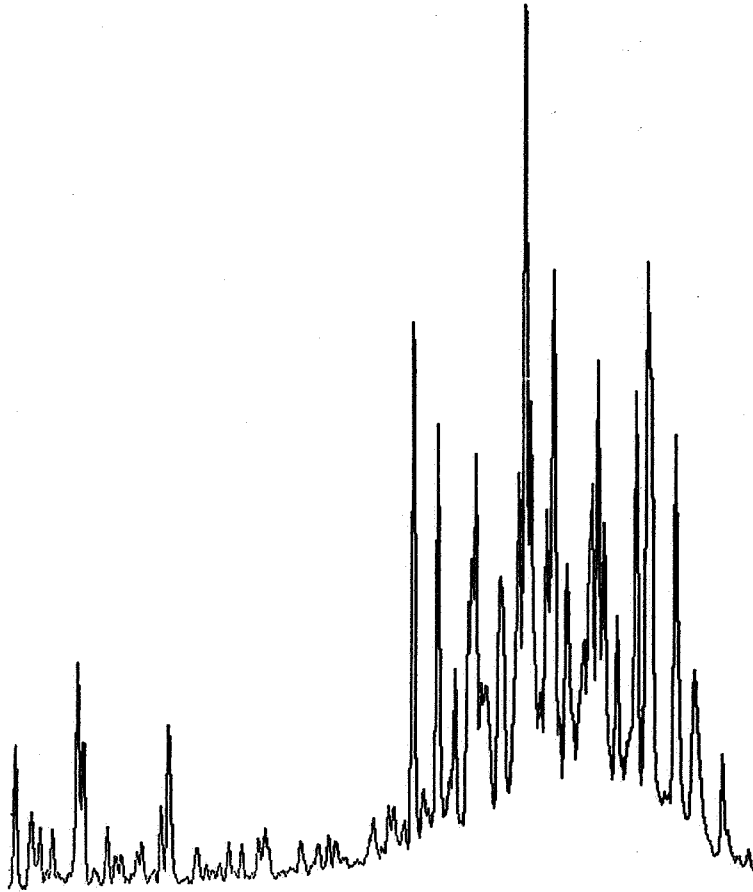


2468.5m
S.W.C.

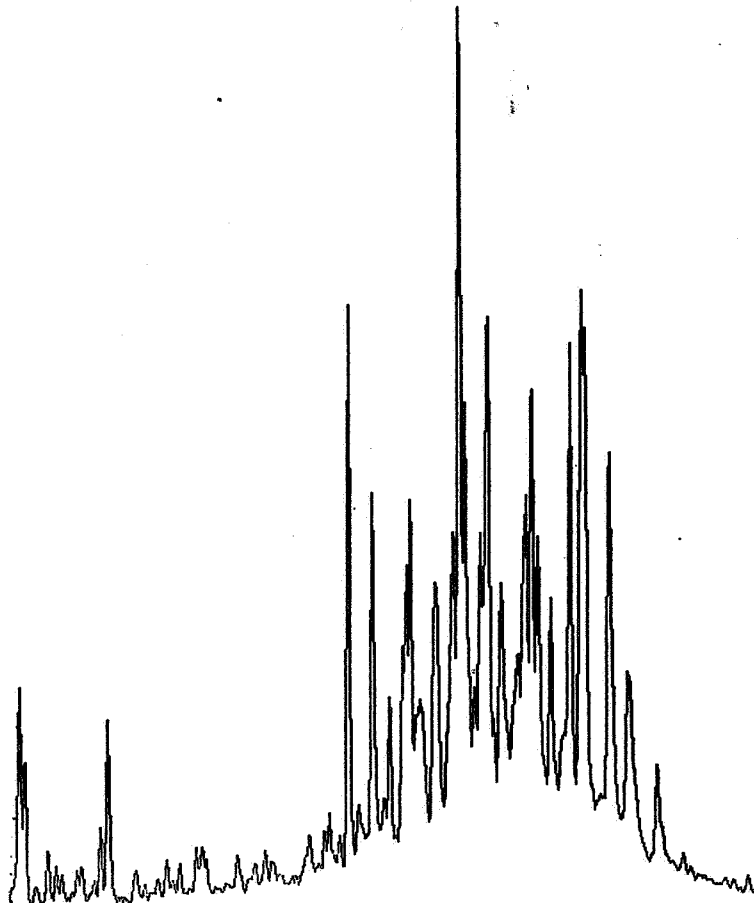


2474m
S.W.C.

STERANES m/z 217

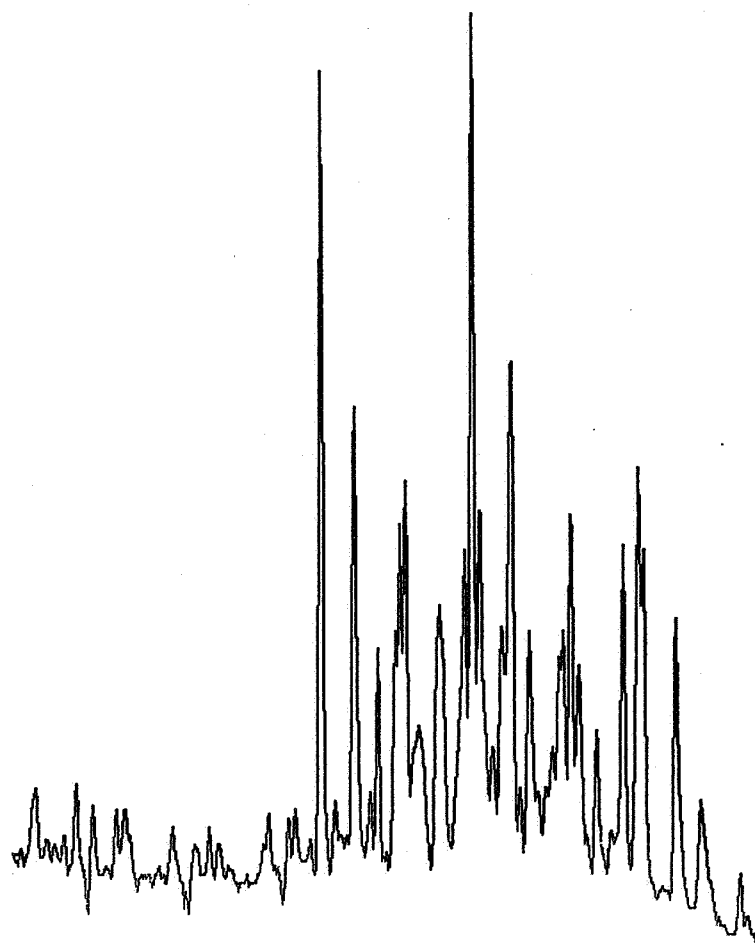


2480m
S.W.C.

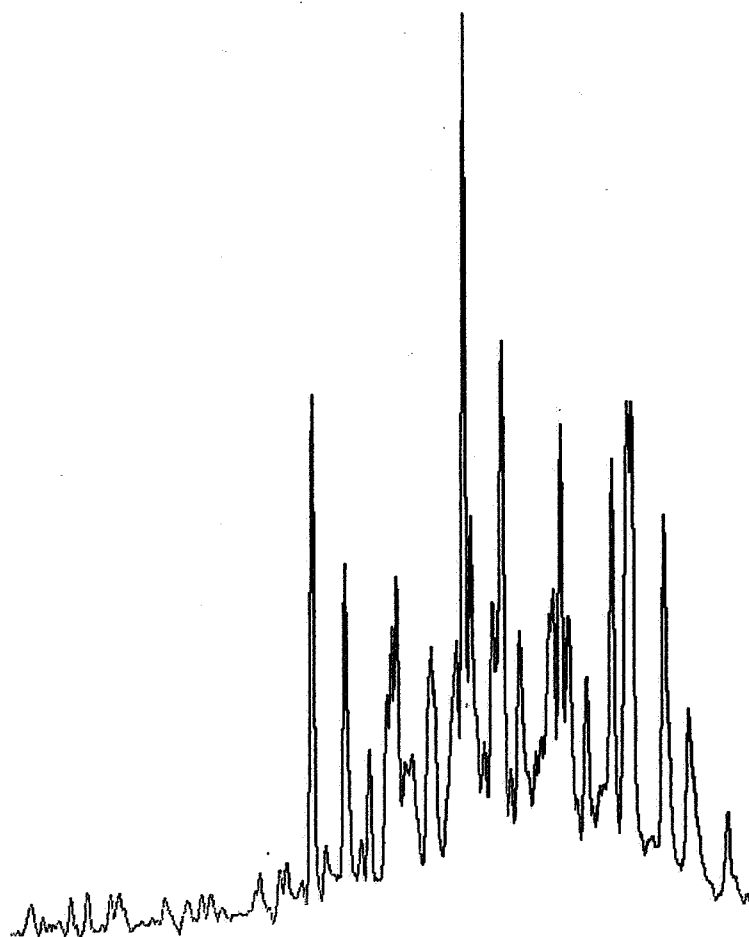


2485m
S.W.C.

STERANES m/z 217

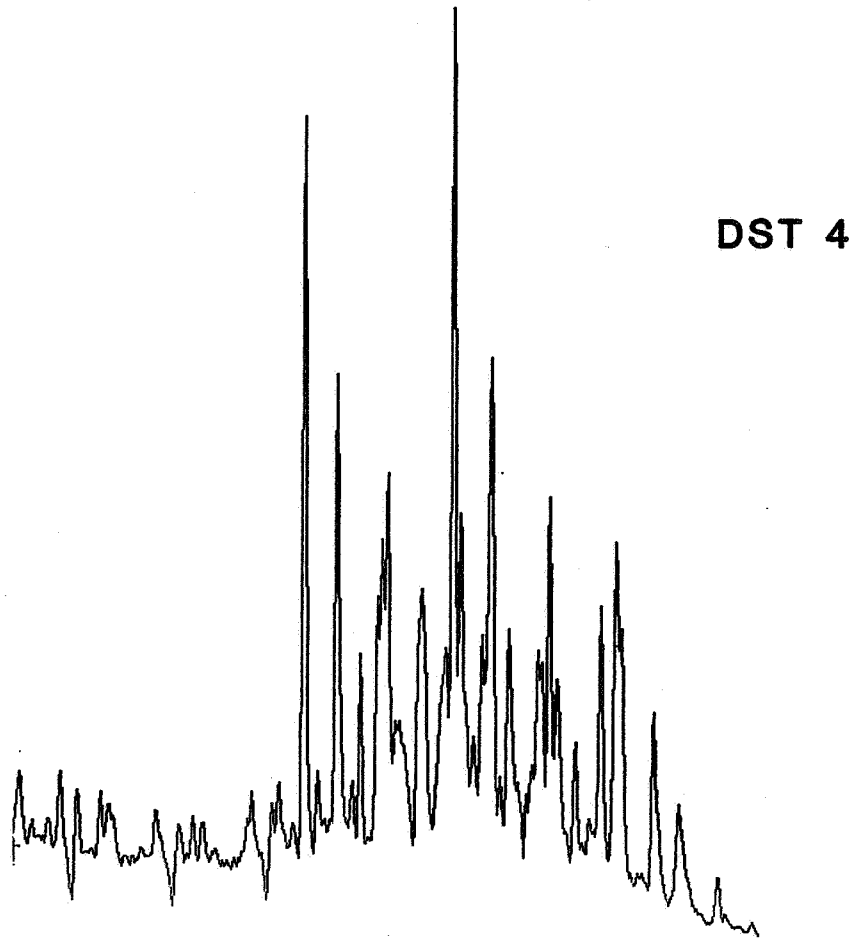


DST 2



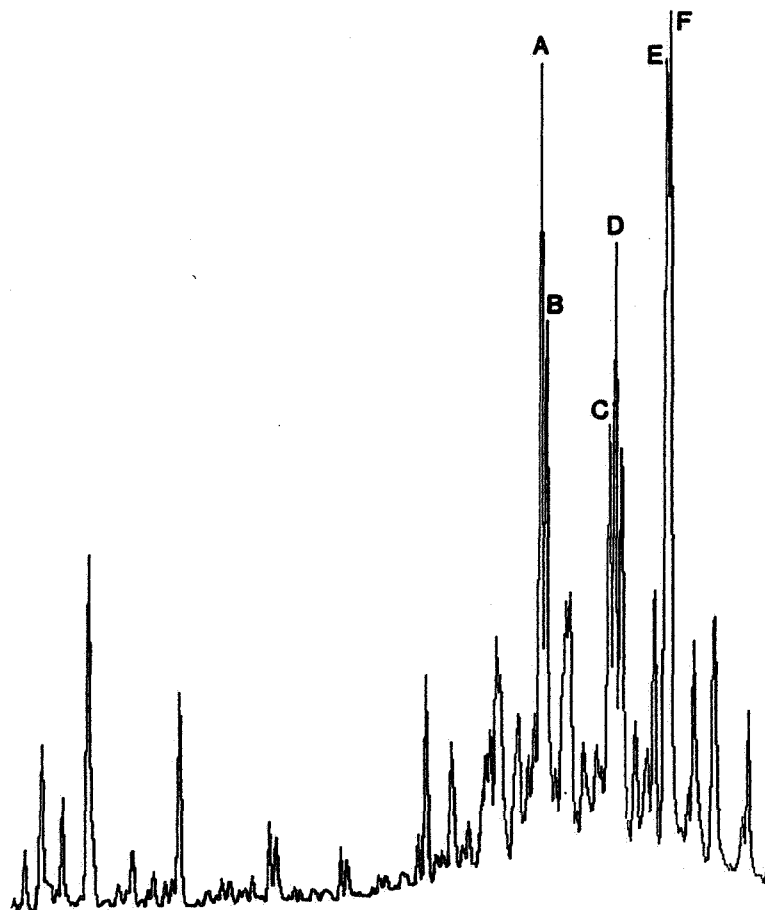
DST 3

STERANES. m/z 217



STANDARD

m/z 218

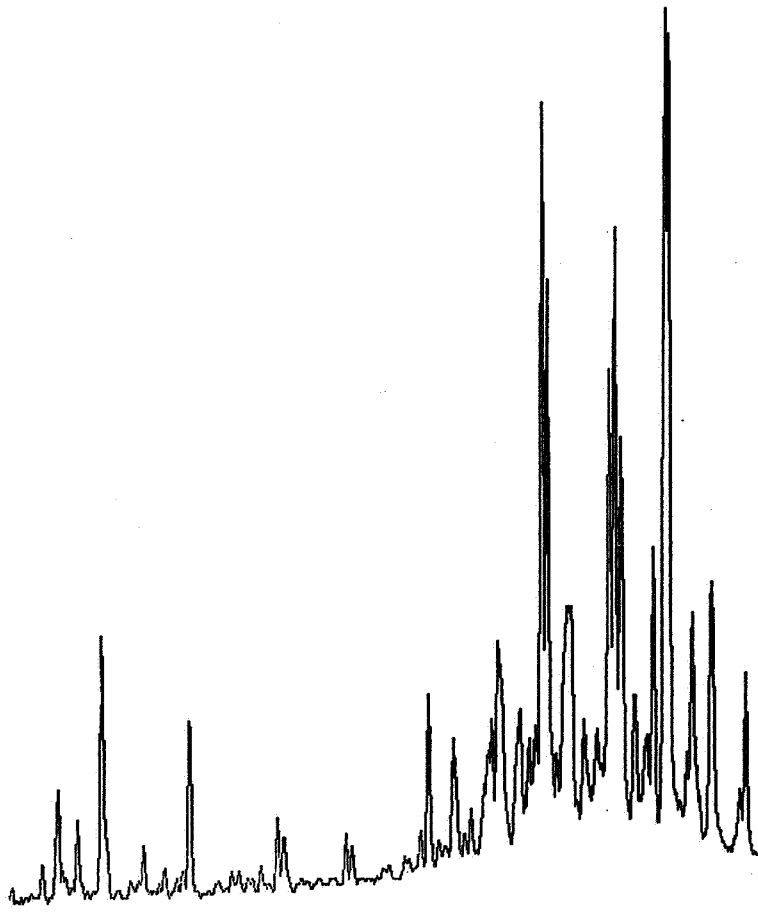


STERANE IDENTIFICATION

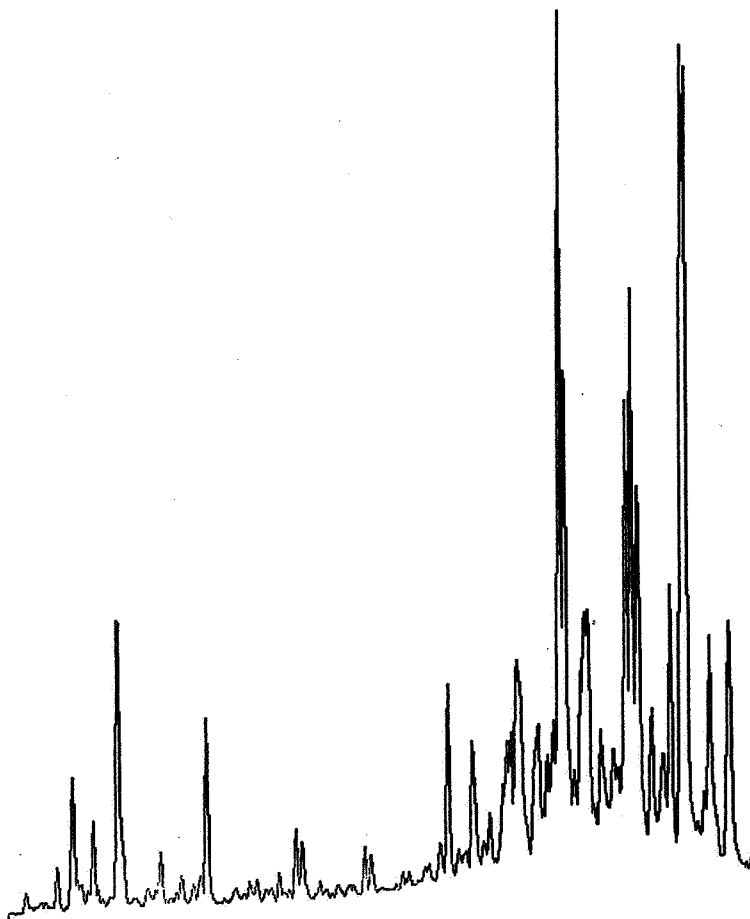
(M/Z 218 FRAGMENTOGRAM)

<u>COMPOUND</u>	<u>ELEMENTAL COMPOUND</u>
A 14 β ,17 β -cholestane (20R)	C ₂₇ H ₄₈
B 14 β ,17 β -cholestane (20S)	C ₂₇ H ₄₈
C 24-methyl-14 β ,17 β -cholestane (20R)	C ₂₈ H ₅₀
D 24-methyl-14 β ,17 β -cholestane (20S)	C ₂₈ H ₅₀
E 24-ethyl-14 β ,17 β -cholestane (20R)	C ₂₉ H ₅₂
F 24-ethyl-14 β ,17 β -cholestane (20S)	C ₂₉ H ₅₂

STERANES m/z 218

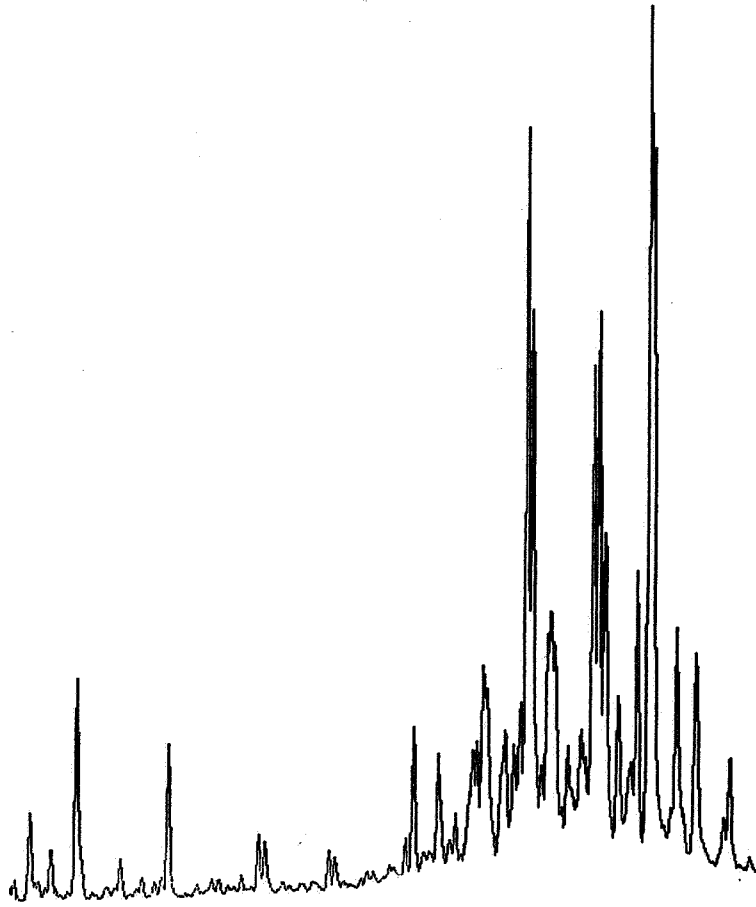


2429.5m
S.W.C.



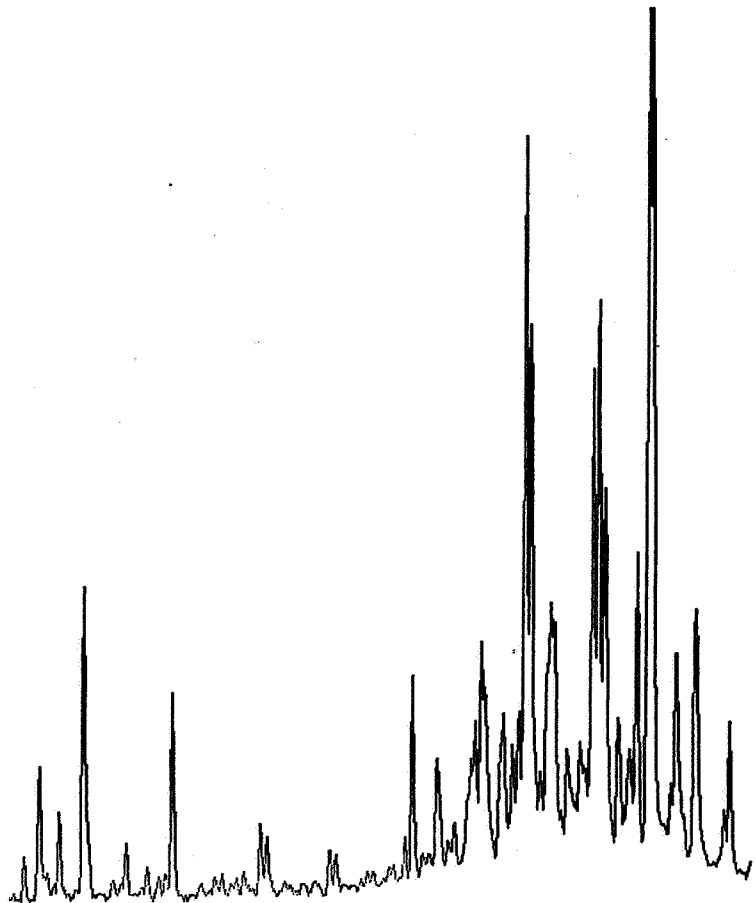
2443m
S.W.C.

STERANES m/z 218



2468.5m

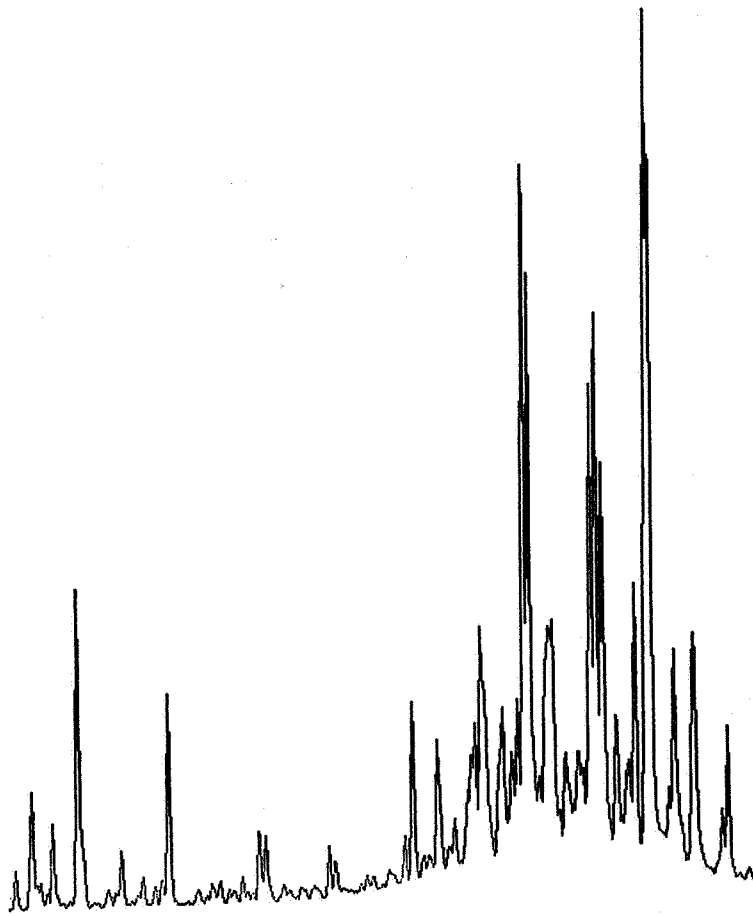
S.W.C.



2474m

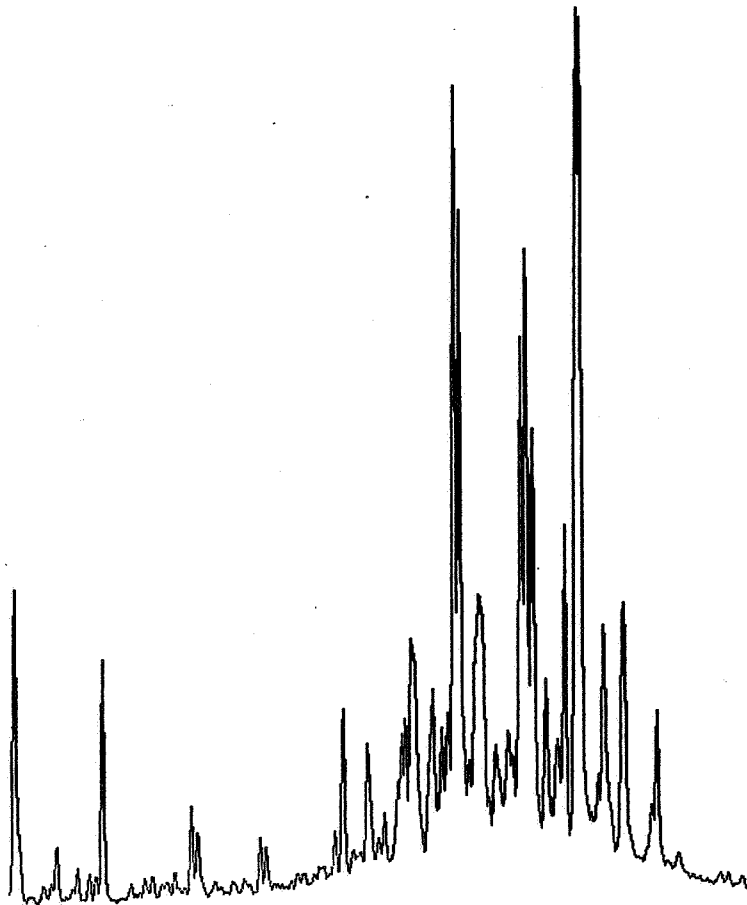
S.W.C.

STERANES m/z 218



2480m

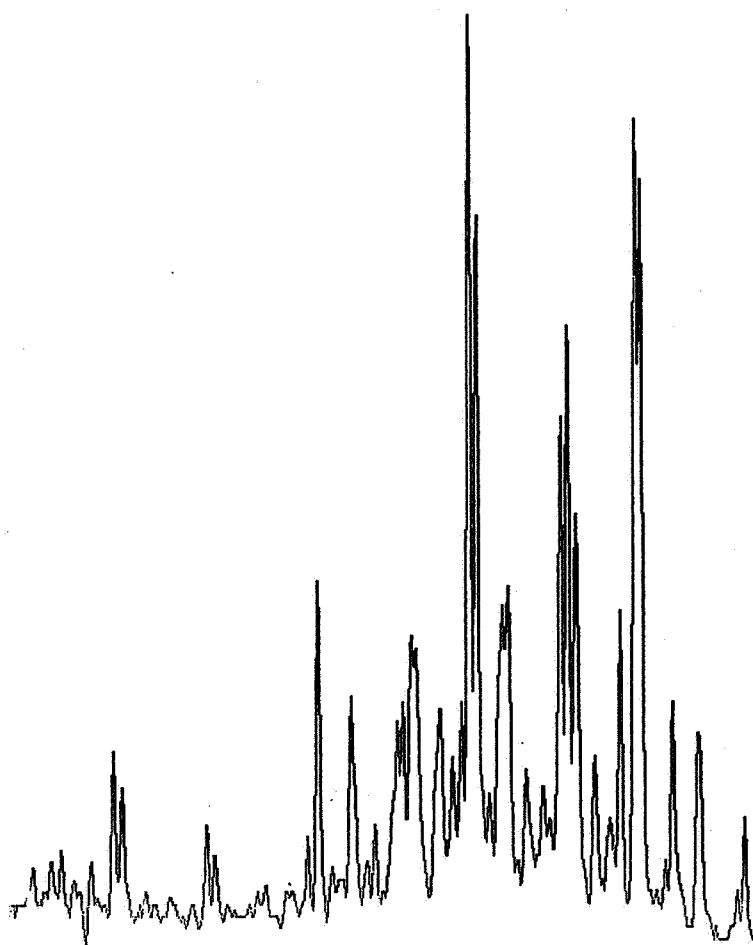
S.W.C.



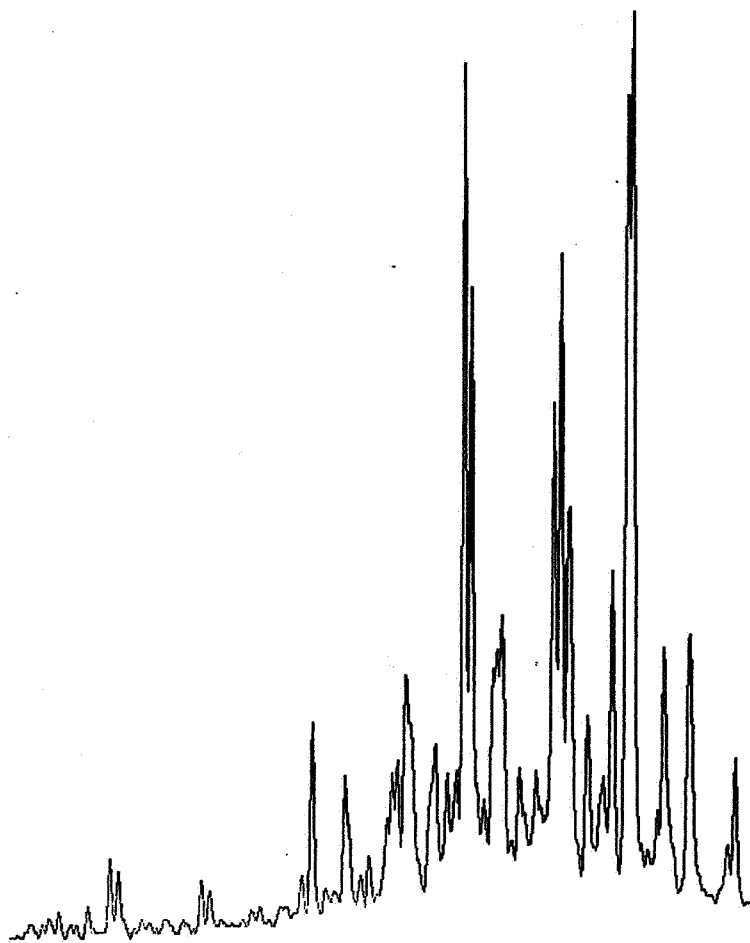
2485m

S.W.C.

STERANES m/z 218

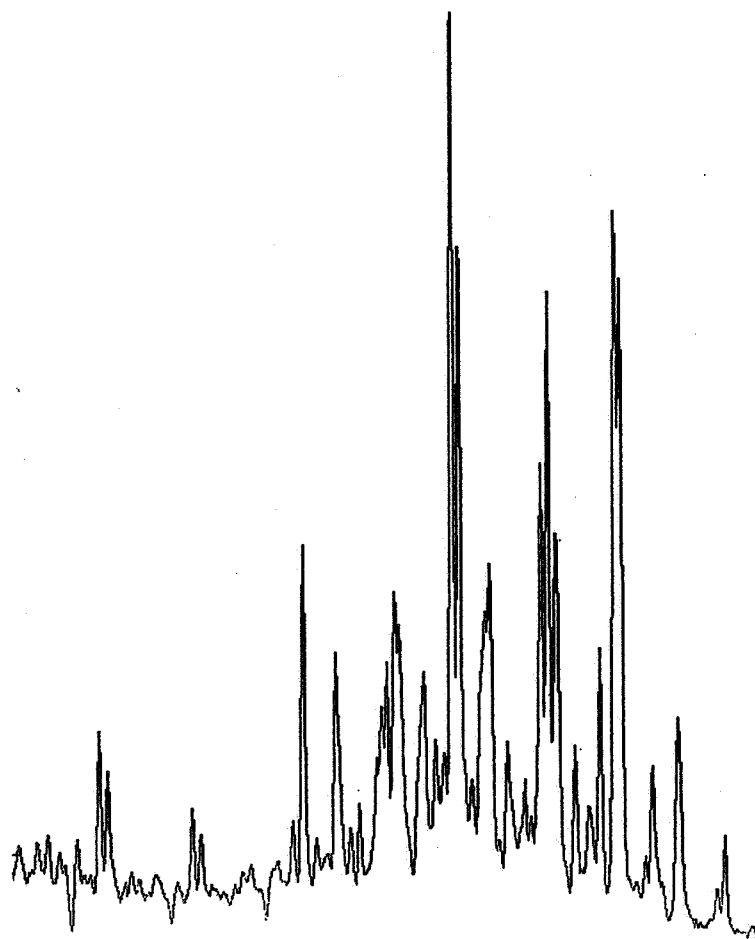


DST 2



DST 3

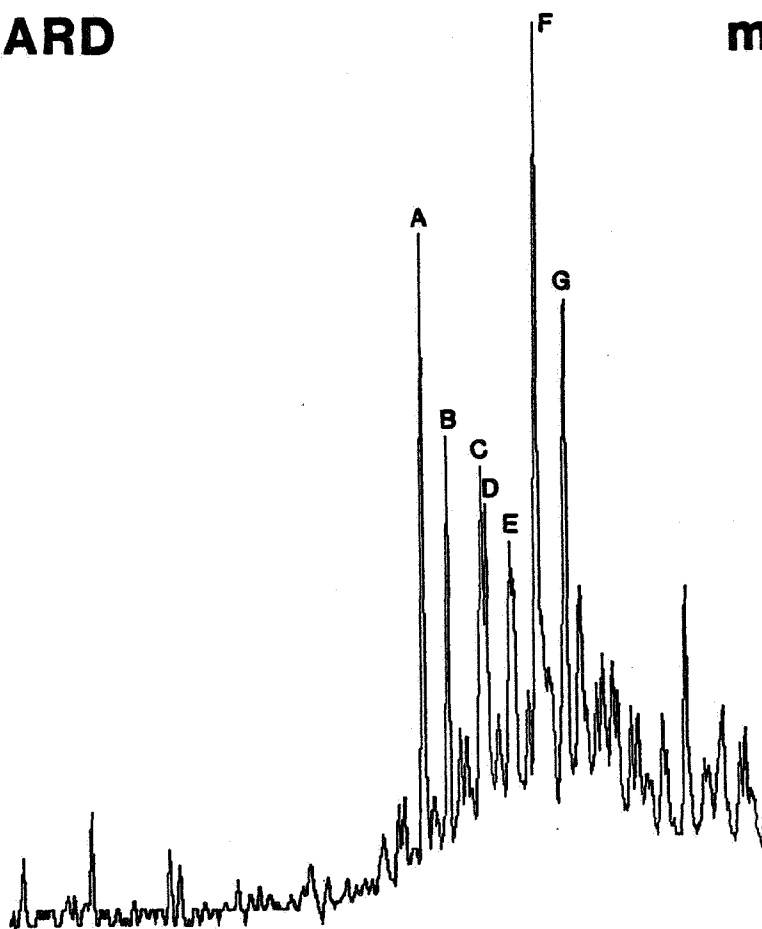
STERANES m/z 218



DST 4

STANDARD

m/z 259

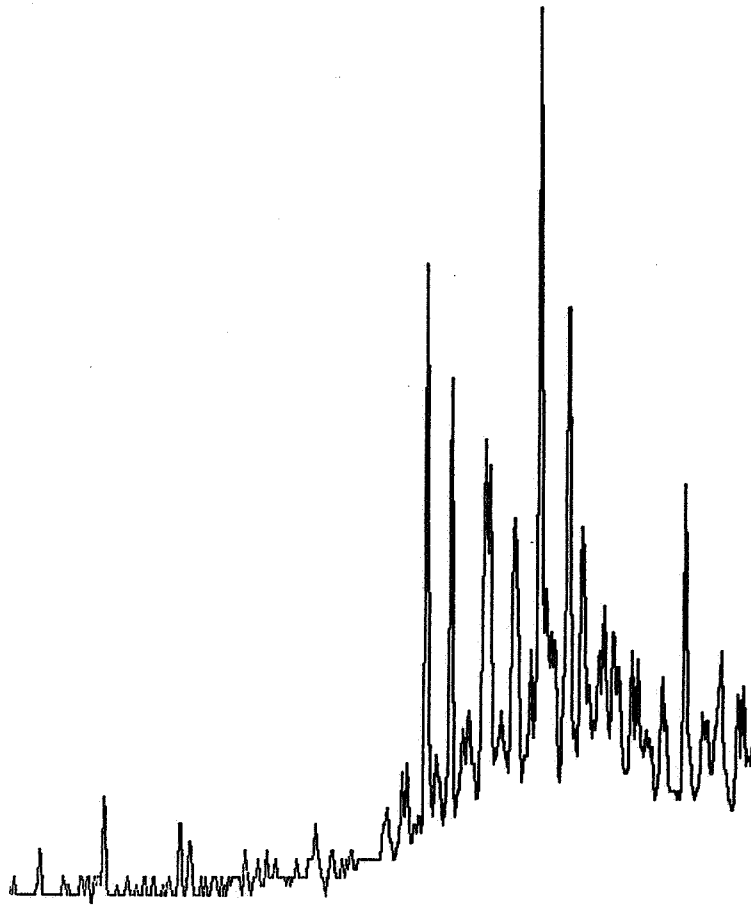


STERANE IDENTIFICATION

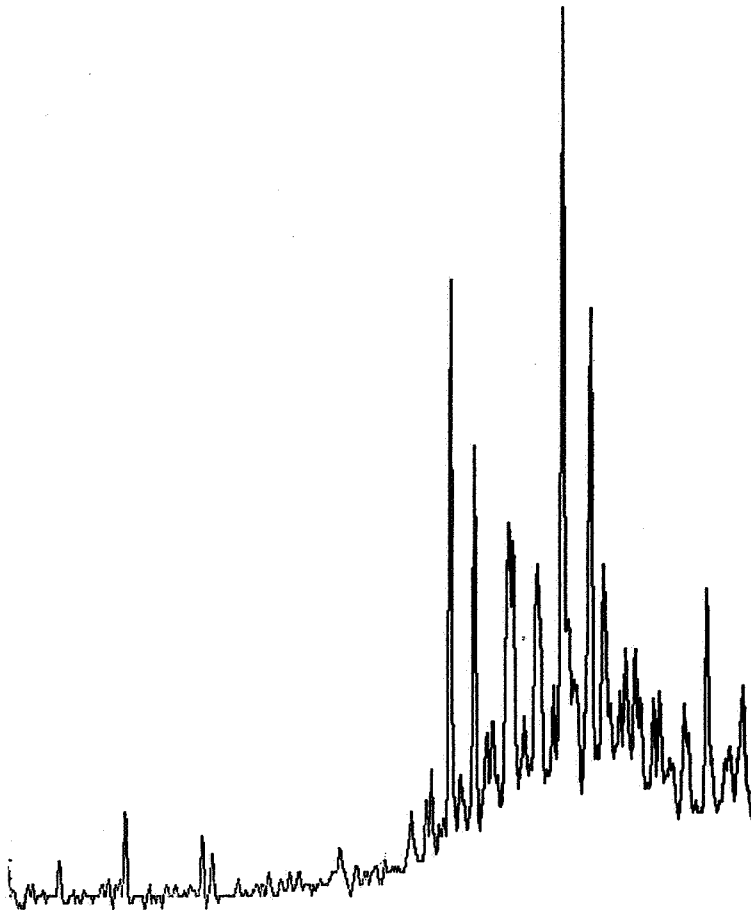
(M/Z 259 FRAGMENTOGRAM)

<u>COMPOUND</u>	<u>ELEMENTAL COMPOSITION</u>
A 13 β ,17 α -diacholestane (20S)	C ₂₇ H ₄₈
B 13 β ,17 α -diacholestane (20R)	C ₂₇ H ₄₈
C 13 α ,17 β -diacholestane (20R)	C ₂₇ H ₄₈
D 24,-methyl-13 β ,17 α -diacholestane (20S)	C ₂₈ H ₅₀
E 24,-methyl-13 β ,17 α -diacholestane (20R)	C ₂₈ H ₅₀
F 24,-ethyl-13 β ,17 α -diacholestane (20S)	C ₂₉ H ₅₂
G 24,-ethyl-13 β ,17 α -diacholestane (20R)	C ₂₉ H ₅₂

REARRANGED STERANES m/z 259

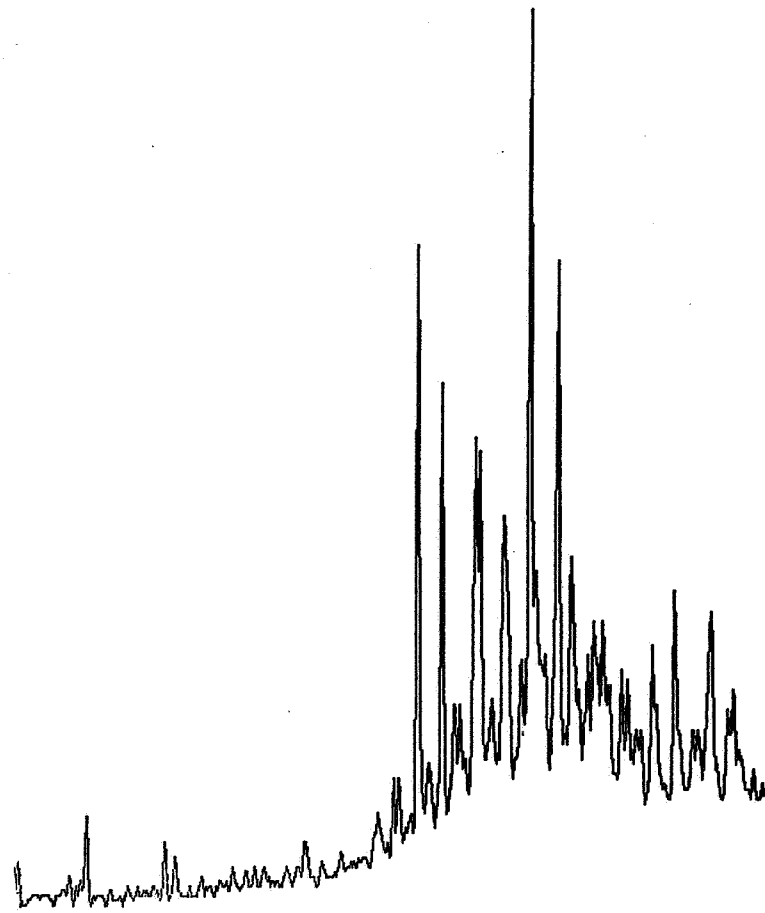


2429.5m
S.W.C.

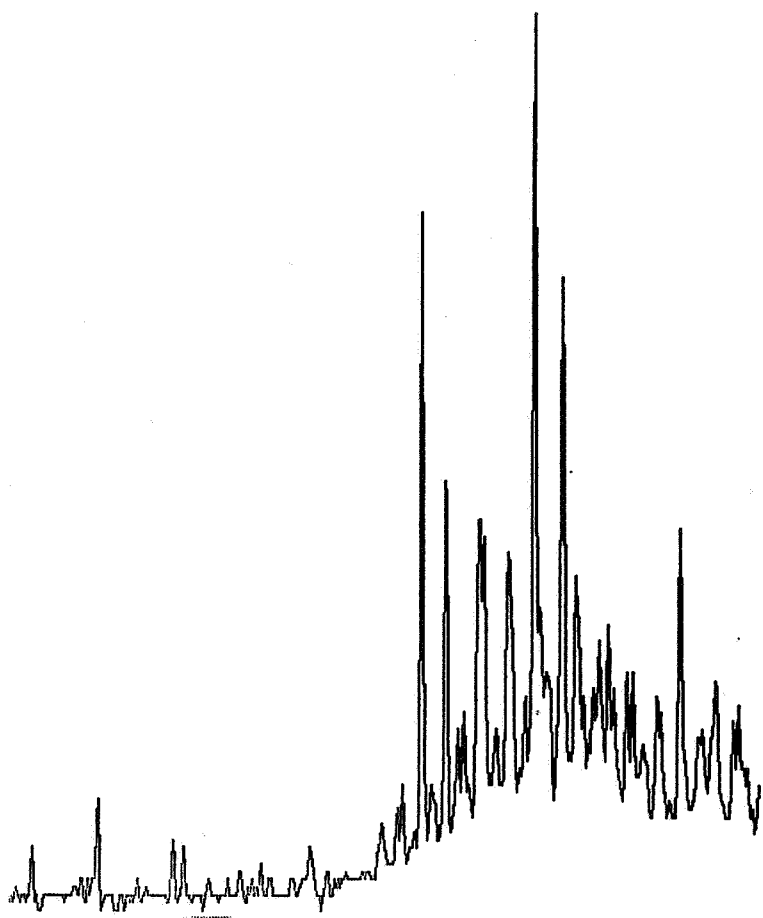


2443m
S.W.C.

REARRANGED STERANES m/z 259

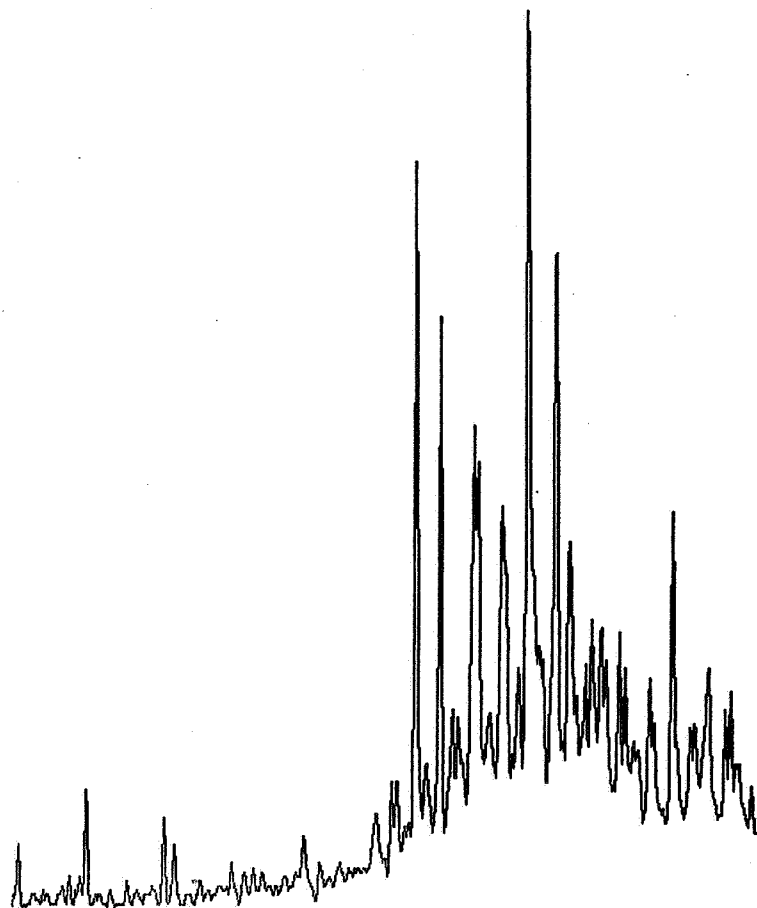


2468.5m
S.W.C.



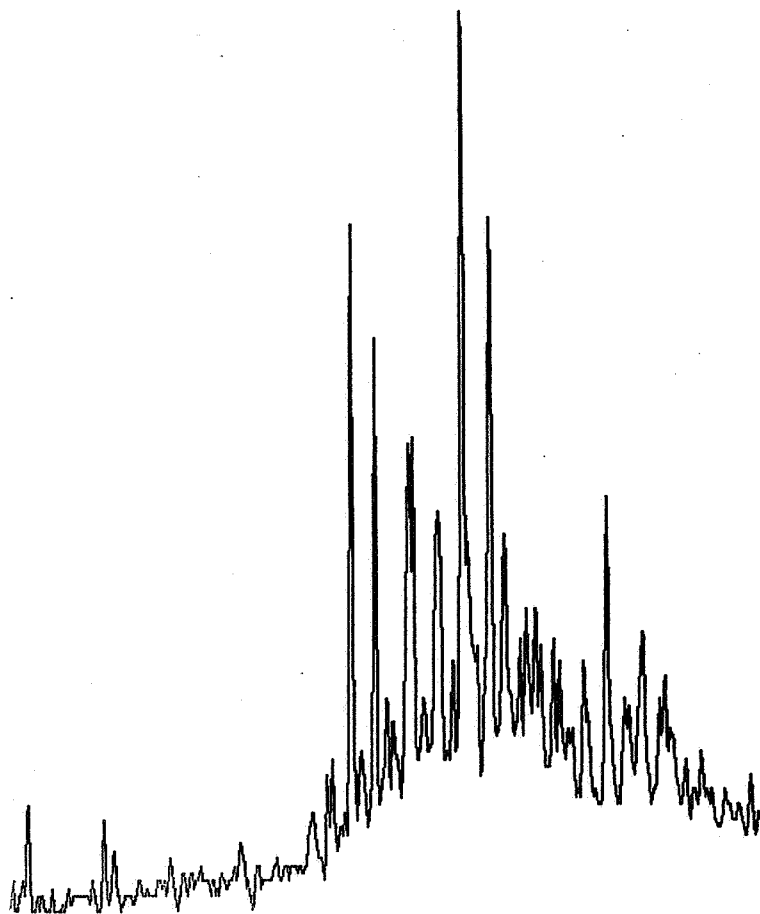
2474m
S.W.C.

REARRANGED STERANES m/z 259



2480m

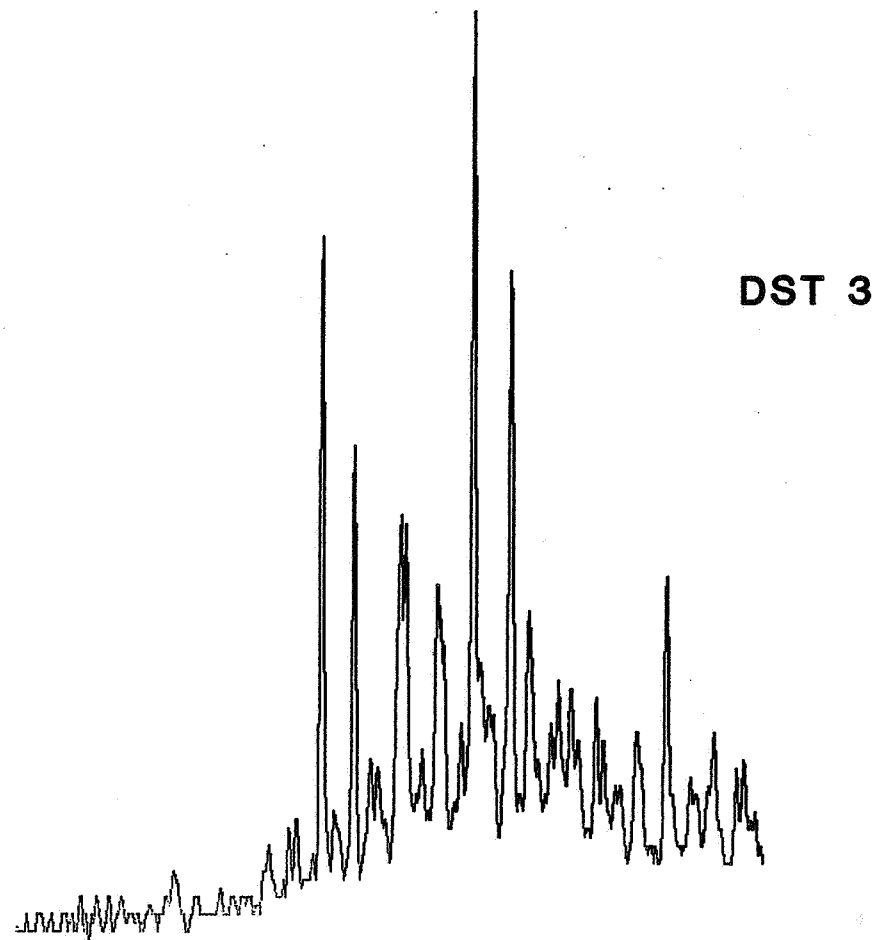
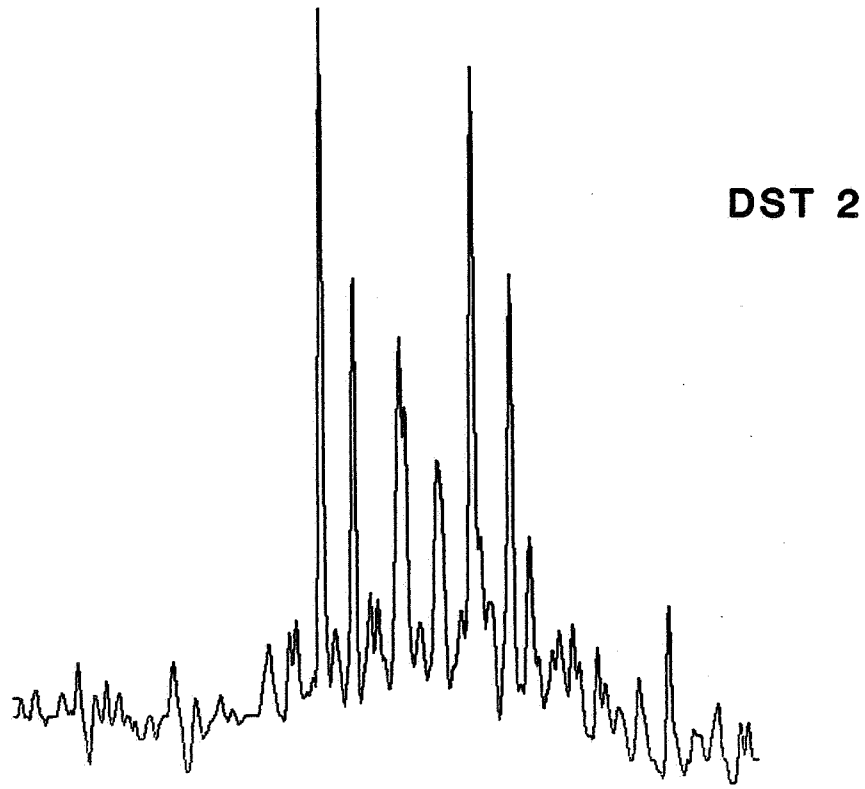
S.W.C.



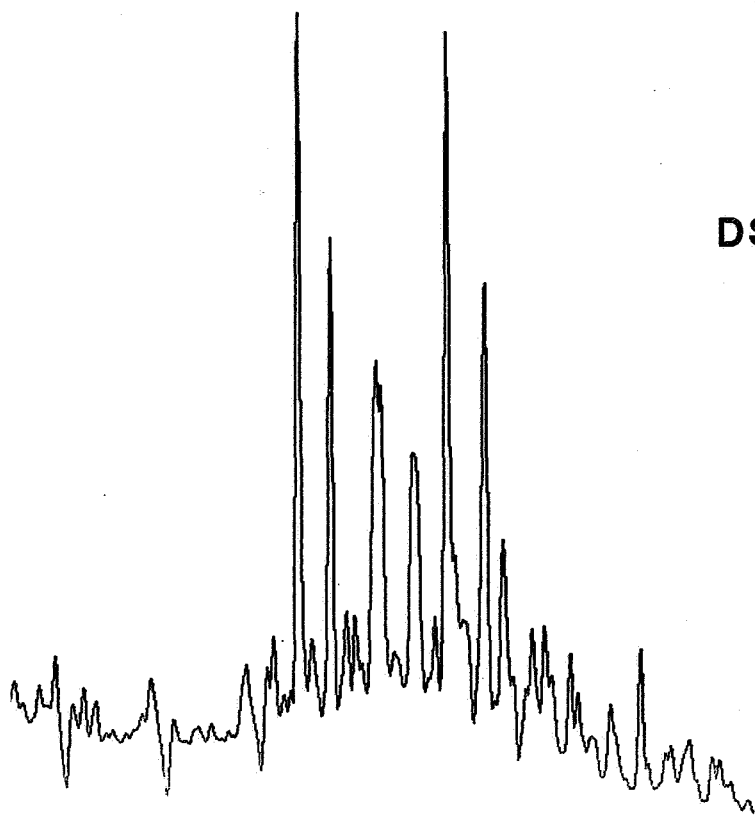
2485m

S.W.C.

REARRANGED STERANES m/z 259



REARRANGED STERANES m/z 259



DST 4

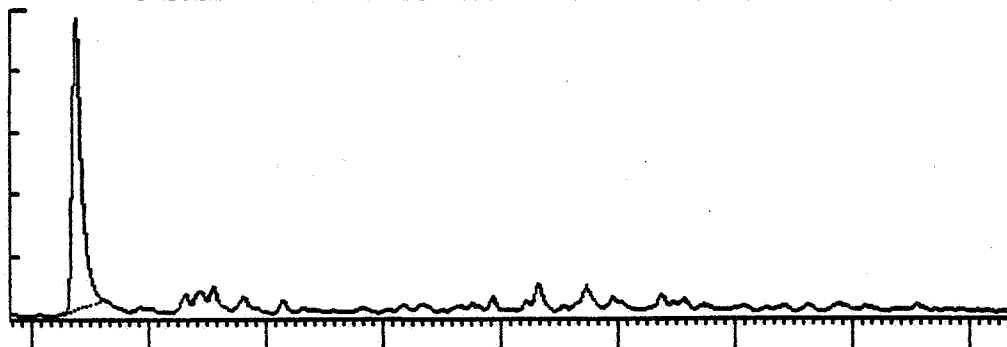
AROMATIC MASS FRAGMENTOGRAMS

PHENANTHRENE SERIES

SIR REPORT. FILE - STD. .SD RUN - 1

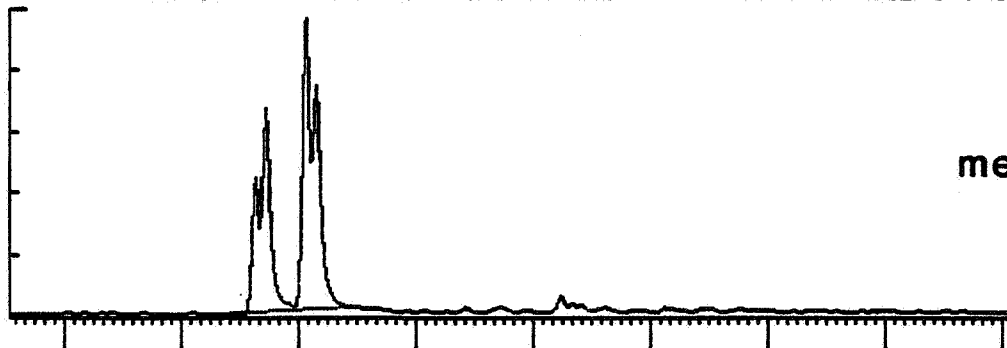
UNCALIBRATED.

MASS	RETENTION TIME	HEIGHT	AREA	CONC. (H)	CONC. (A)
178.00	0 HRS 12 MINS 17 SECS	9885.1530	52863.6900	0.0000	0.0000



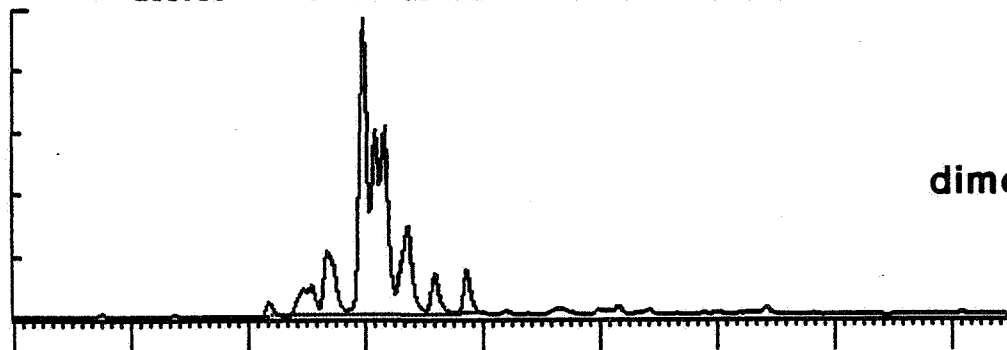
phenanthrene

192.00	0 HRS 14 MINS 41 SECS	9491.7360	122714.4000	0.0000	0.0000
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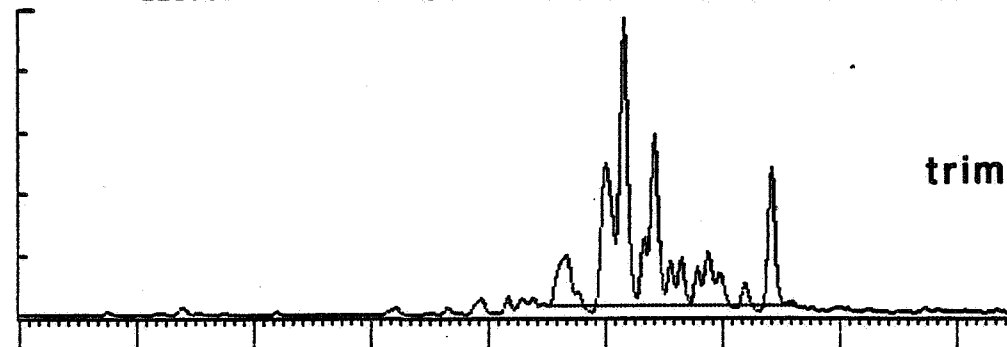
methyl phenanthrenes

206.00	0 HRS 16 MINS 31 SECS	7513.8950	112294.6000	0.0000	0.0000
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dimethyl phenanthrenes

220.00	0 HRS 18 MINS 21 SECS	3435.1420	68707.8400	0.0000	0.0000
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trimethyl phenanthrenes

0 HRS 13 MINS 59 SECS

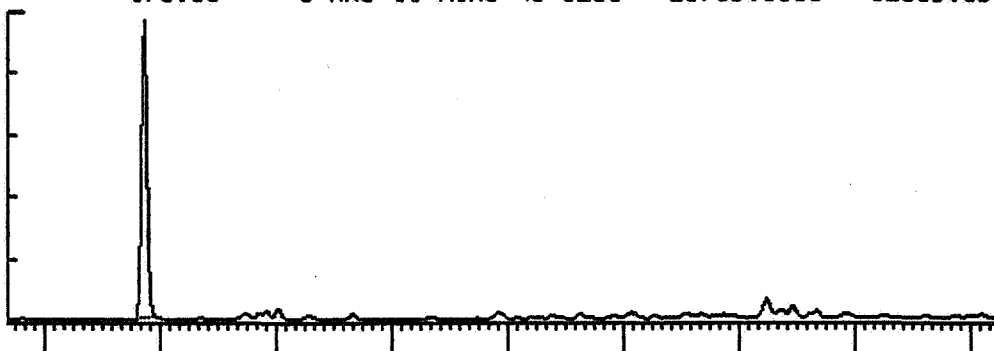
0 HRS 22 MINS 10 SECS

PHENANTHRENE SERIES

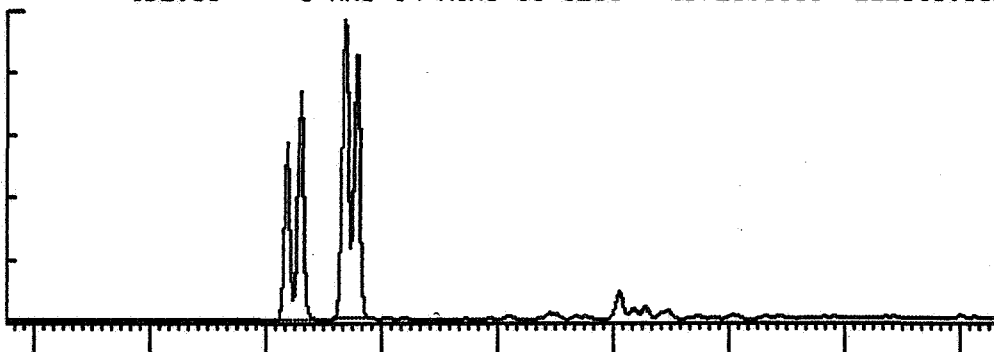
SIR REPORT. FILE - 975001 .SD RUN - 1

UNCALIBRATED.

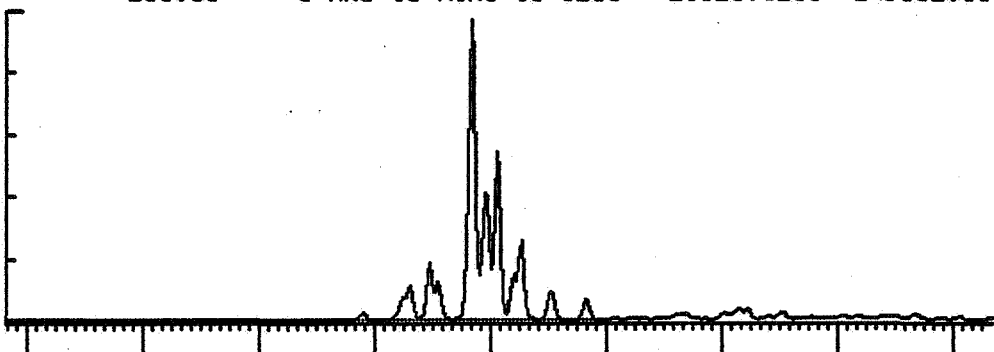
MASS	RETENTION TIME	HEIGHT	AREA	CONC. (H)	CONC. (A)
178.00	0 HRS 11 MINS 40 SECS	25789.0500	82889.8900	0.0000	0.0000



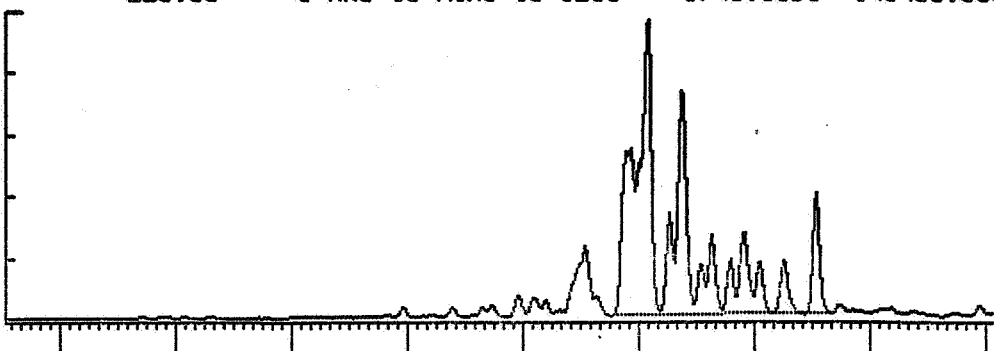
192.00	0 HRS 14 MINS 13 SECS	19726.5600	222616.5000	0.0000	0.0000
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206.00	0 HRS 16 MINS 13 SECS	21328.1200	249032.8000	0.0000	0.0000
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220.00	0 HRS 18 MINS 15 SECS	6746.5890	145460.3000	0.0000	0.0000
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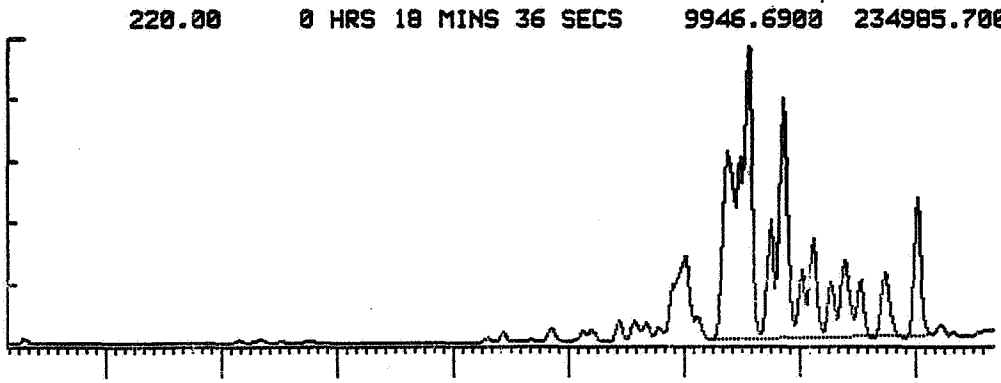
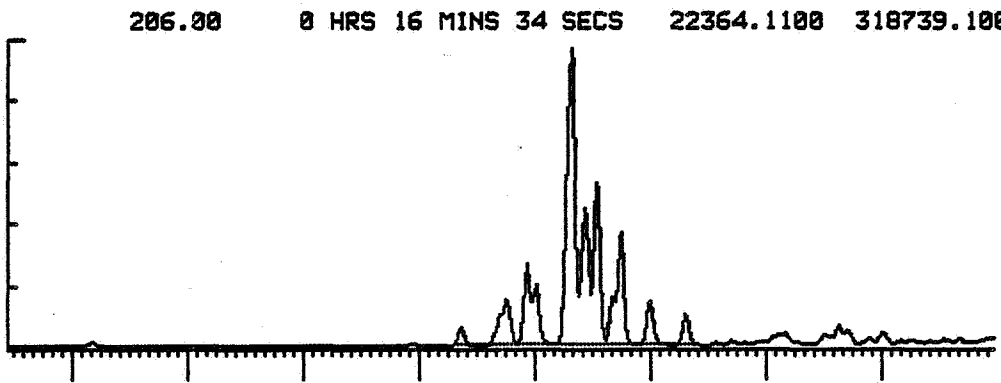
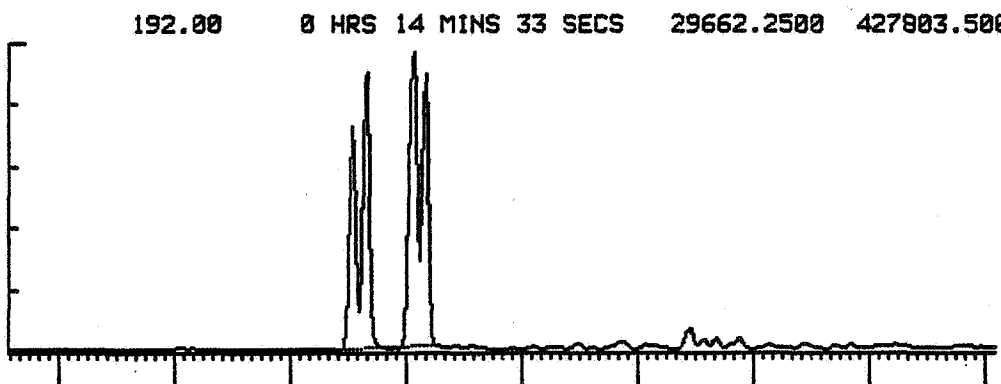
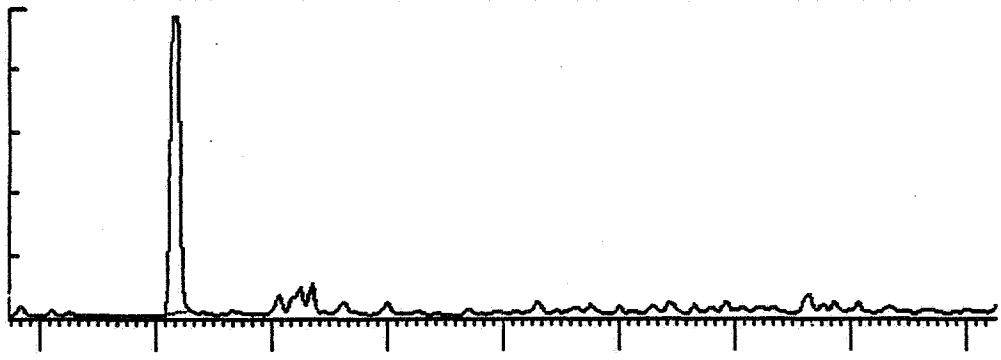


PHENANTHRENE SERIES

SIR REPORT. FILE - 973002 .SD RUN - 1

UNCALIBRATED.
MASS

RETENTION TIME	HEIGHT	AREA	CONC. (H)	CONC. (A)
178.00	31515.6200	172559.7000	0.0000	0.0000
192.00	29662.2500	427803.5000	0.0000	0.0000
206.00	22364.1100	318739.1000	0.0000	0.0000
220.00	9946.6900	234985.7000	0.0000	0.0000

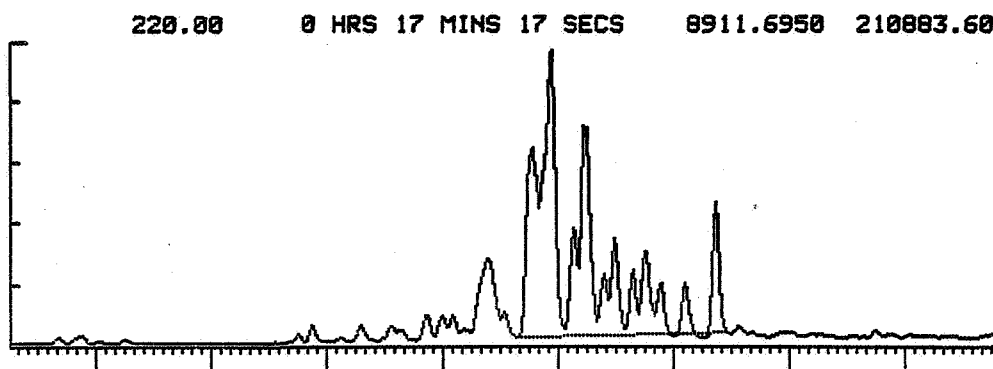
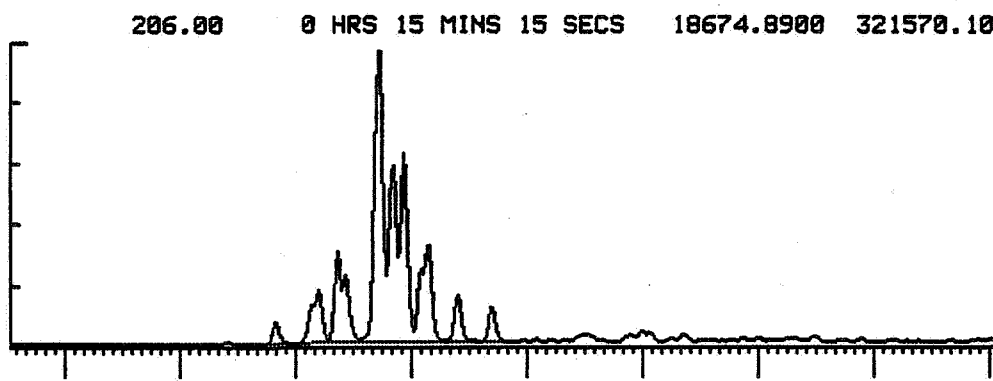
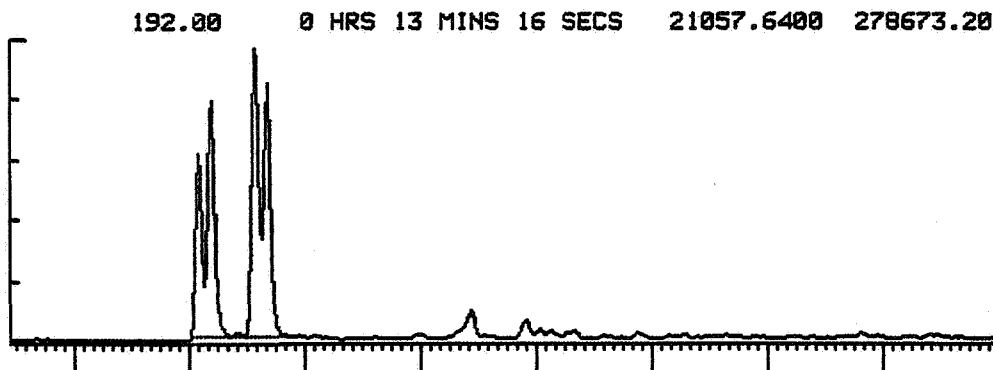
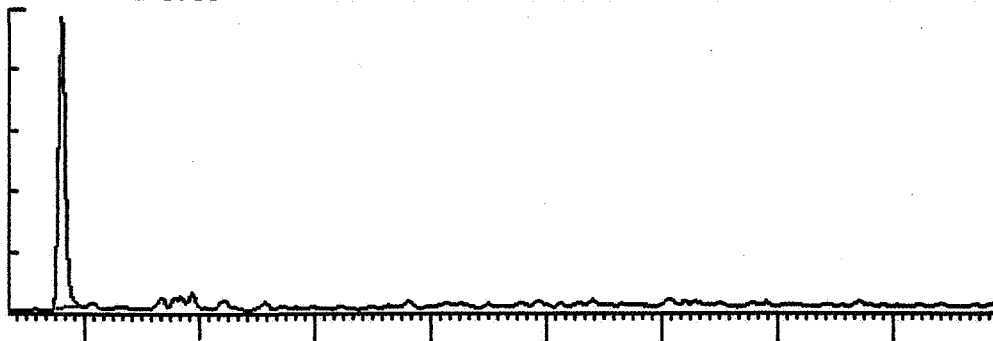


PHENANTHRENE SERIES

SIR REPORT. FILE - 975003 .SD RUN - 1

UNCALIBRATED.
MASS

RETENTION TIME	HEIGHT	AREA	CONC. (H)	CONC. (A)
178.00	28816.9500	112991.0000	0.0000	0.0000
192.00	21057.6400	278673.2000	0.0000	0.0000
206.00	18674.8900	321570.1000	0.0000	0.0000
220.00	8911.6950	210003.6000	0.0000	0.0000

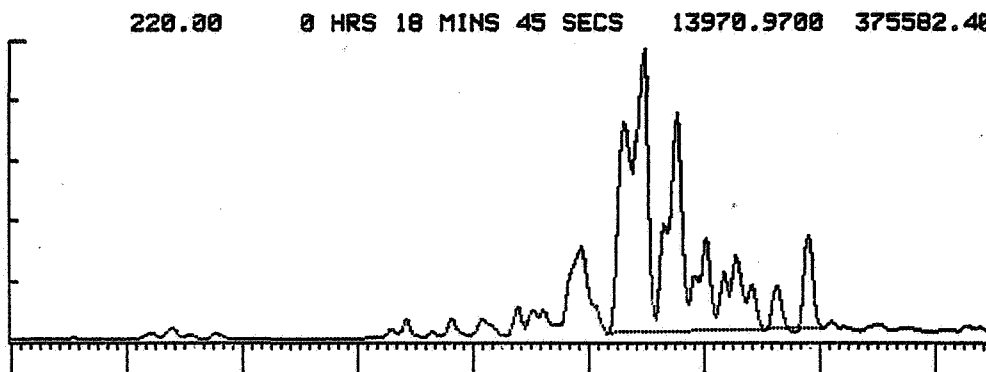
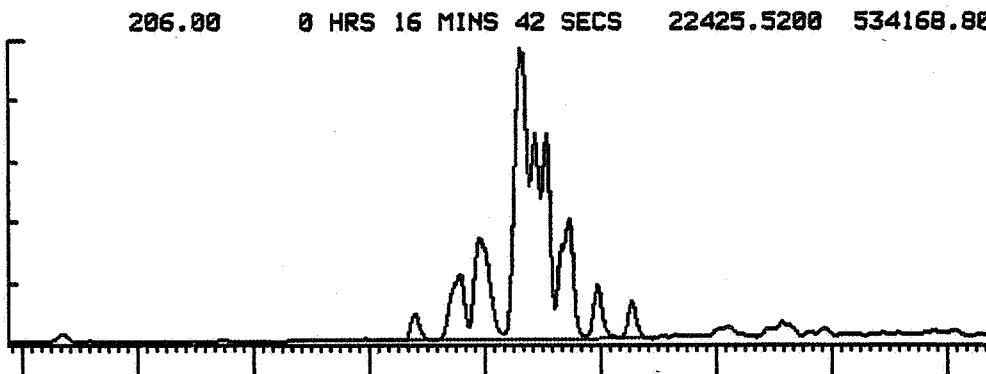
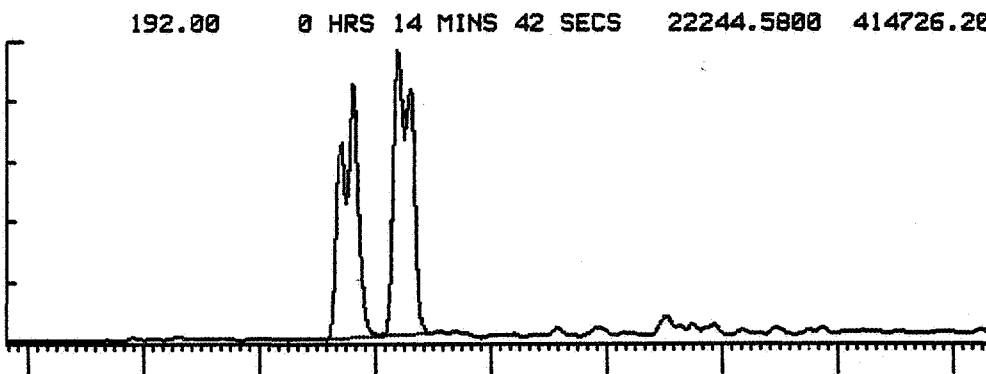
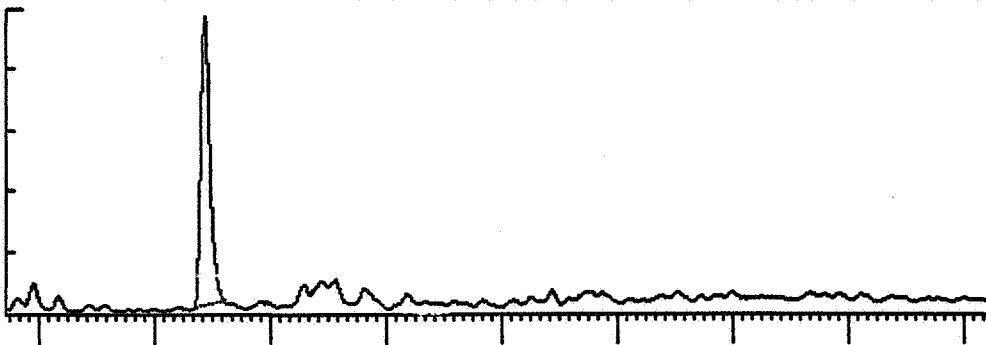


PHENANTHRENE SERIES

SIR REPORT. FILE - 975005 .SD RUN - 1

UNCALIBRATED.
MASS

RETENTION TIME	HEIGHT	AREA	CONC. (H)	CONC. (A)
178.00 0 HRS 12 MINS 11 SECS	26541.6500	140549.7000	0.0000	0.0000
192.00 0 HRS 14 MINS 42 SECS	22244.5800	414726.2000	0.0000	0.0000
206.00 0 HRS 16 MINS 42 SECS	22425.5200	534168.8000	0.0000	0.0000
220.00 0 HRS 18 MINS 45 SECS	13970.9700	375582.4000	0.0000	0.0000

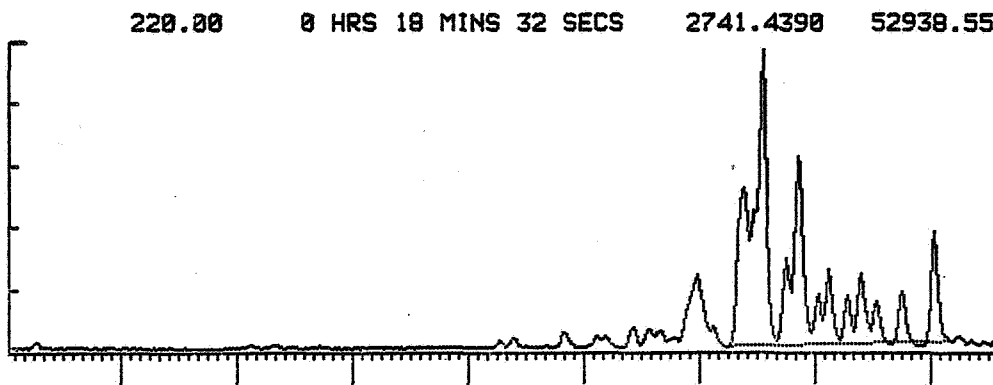
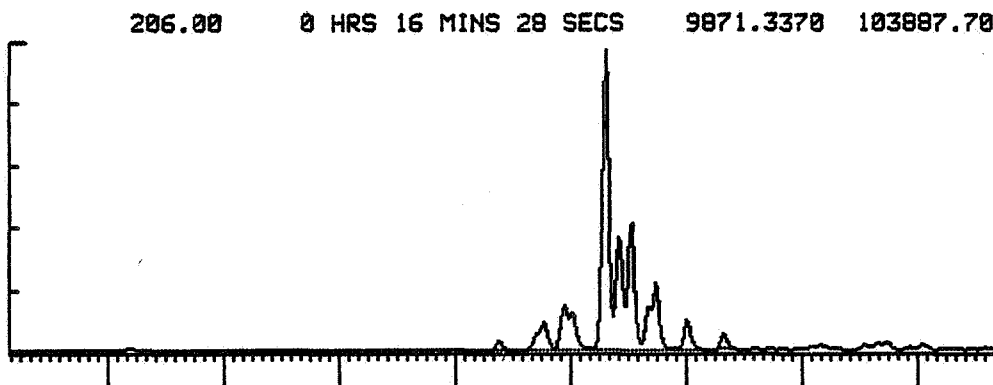
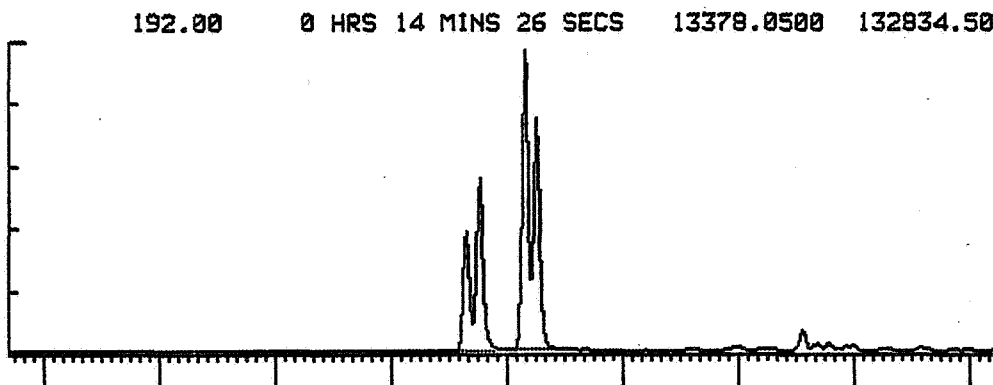
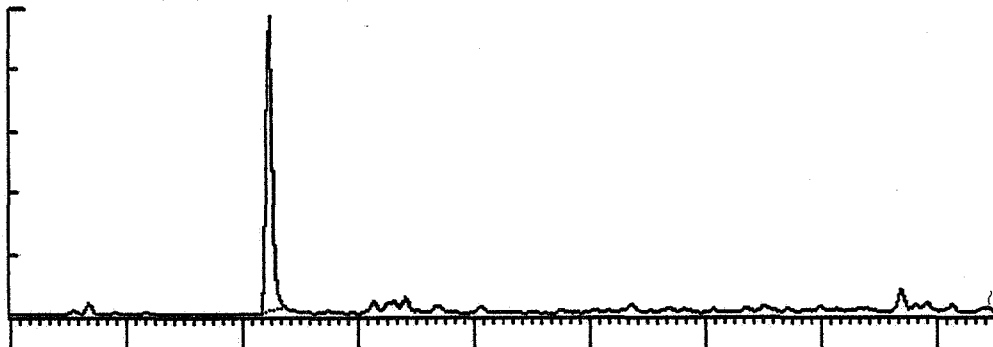


PHENANTHRENE SERIES

SIR REPORT. FILE - 975006 .SD RUN - 1

UNCALIBRATED.
MASS

RETENTION TIME	HEIGHT	AREA	CONC. (H)	CONC. (A)	
178.00	0 HRS 11 MINS 53 SECS	12537.2500	44729.9100	0.0000	0.0000
192.00	0 HRS 14 MINS 26 SECS	13378.0500	132834.5000	0.0000	0.0000
206.00	0 HRS 16 MINS 28 SECS	9871.3370	103887.7000	0.0000	0.0000
220.00	0 HRS 18 MINS 32 SECS	2741.4390	52938.5500	0.0000	0.0000

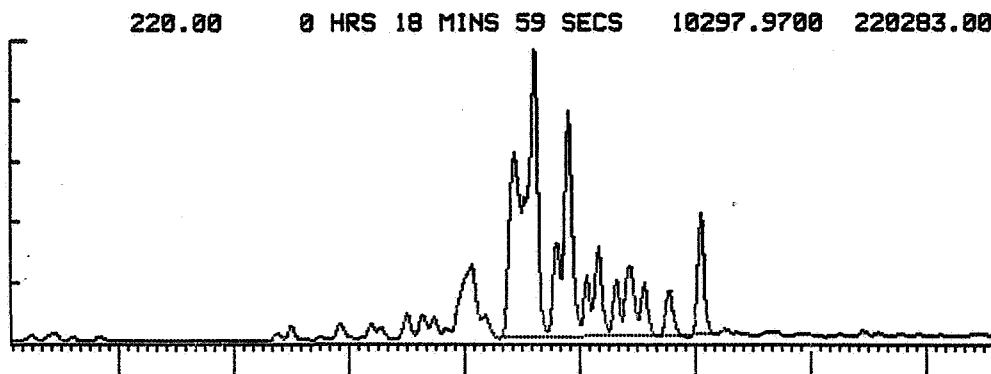
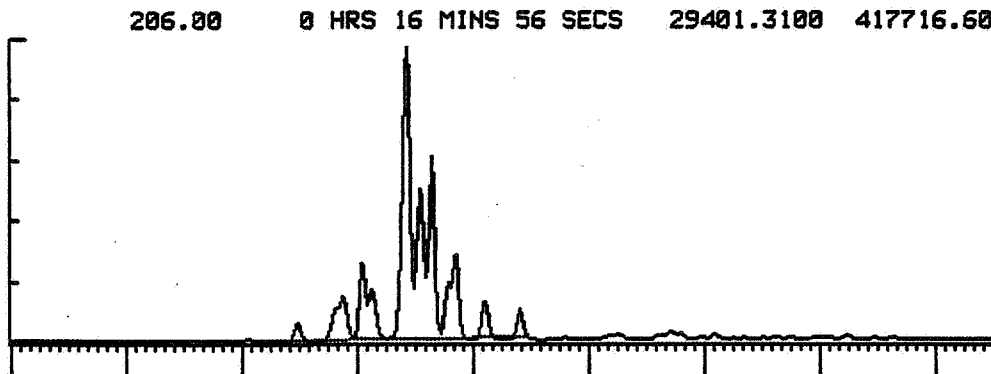
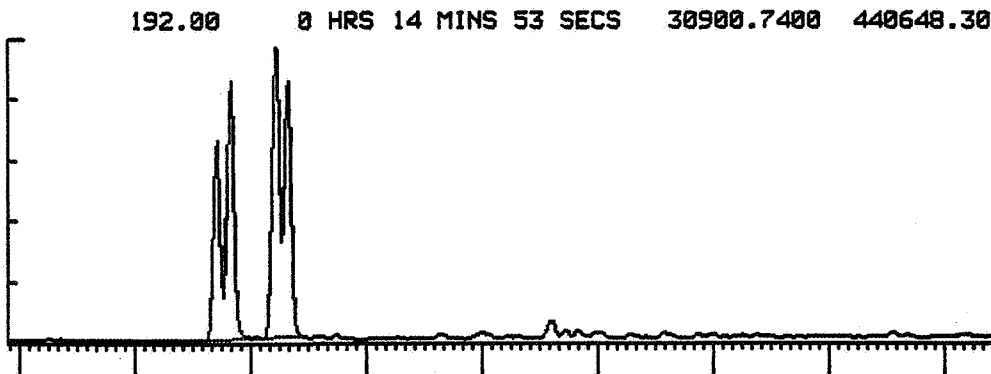
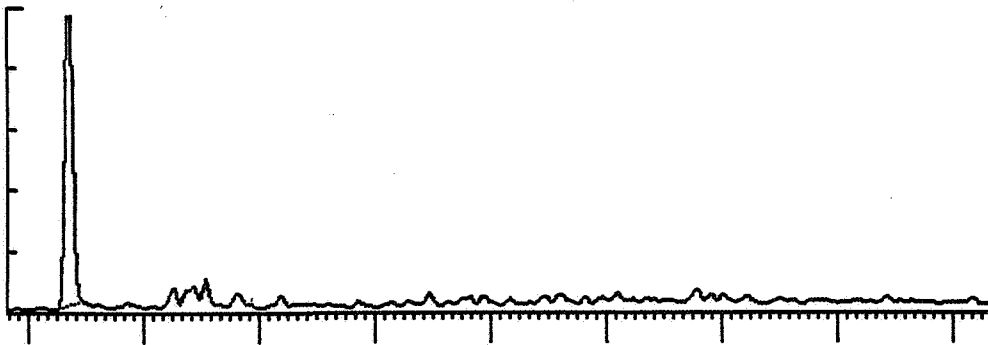


PHENANTHRENE SERIES

SIR REPORT. FILE - 975007 .SD RUN - 1

UNCALIBRATED.
MASS

RETENTION TIME	HEIGHT	AREA	CONC. (H)	CONC. (A)	
178.00	0 HRS 12 MINS 15 SECS	31170.6500	153419.7000	0.0000	0.0000
192.00	0 HRS 14 MINS 53 SECS	30900.7400	440648.3000	0.0000	0.0000
206.00	0 HRS 16 MINS 56 SECS	29401.3100	417716.6000	0.0000	0.0000
220.00	0 HRS 18 MINS 59 SECS	10297.9700	220283.0000	0.0000	0.0000

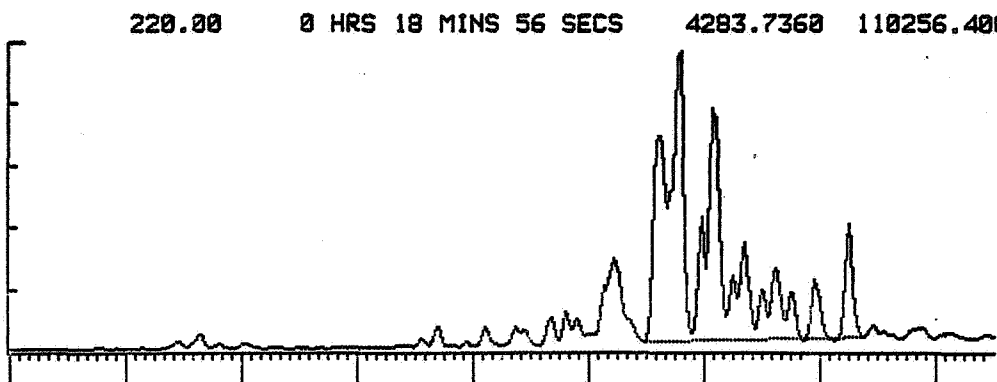
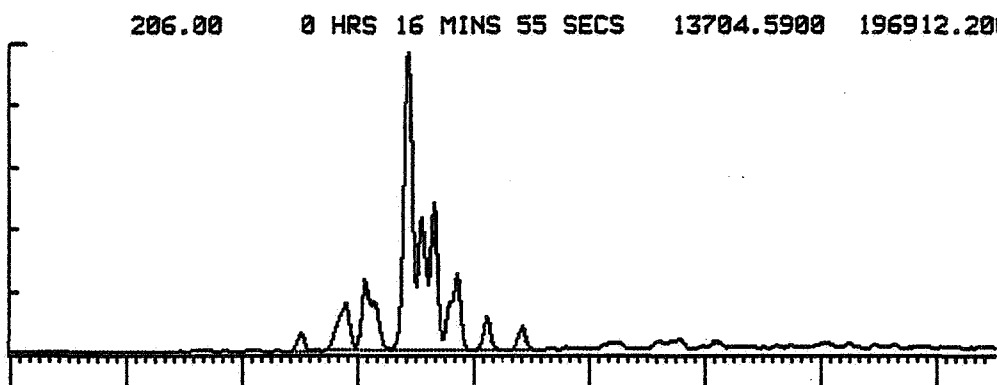
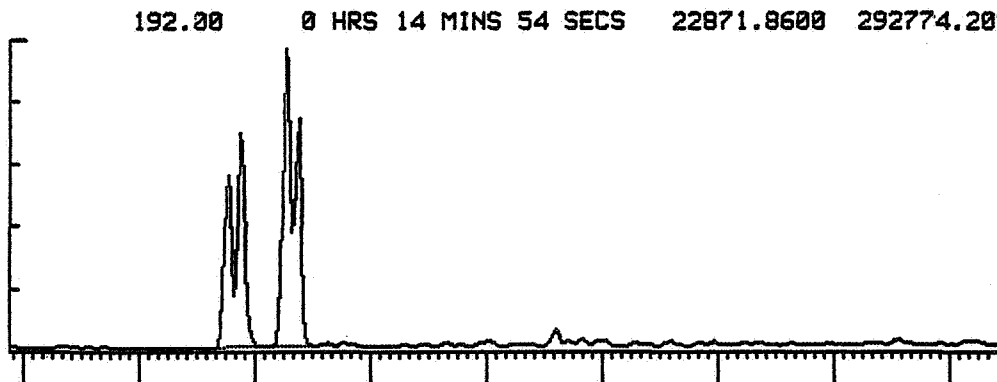
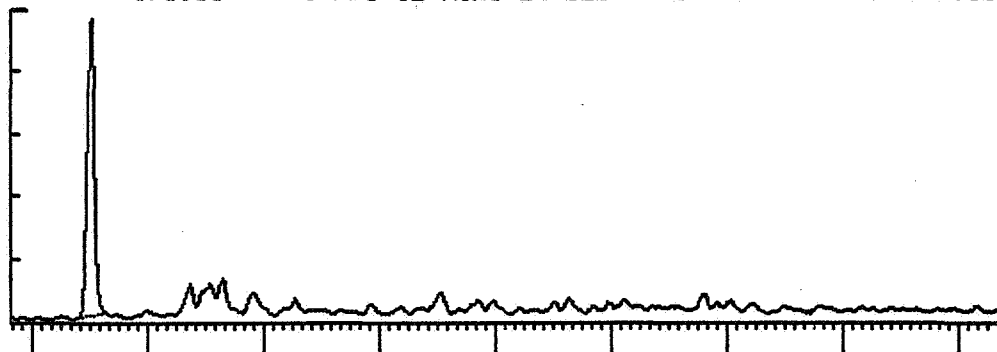


PHENANTHRENE SERIES

SIR REPORT. FILE - 975009 .SD RUN - 1

UNCALIBRATED.

MASS	RETENTION TIME	HEIGHT	AREA	CONC. (H)	CONC. (A)
178.00	0 HRS 12 MINS 24 SECS	24085.9300	100987.3000	0.0000	0.0000
192.00	0 HRS 14 MINS 54 SECS	22871.8600	292774.2000	0.0000	0.0000
206.00	0 HRS 16 MINS 55 SECS	13704.5900	196912.2000	0.0000	0.0000
220.00	0 HRS 18 MINS 56 SECS	4283.7360	110256.4000	0.0000	0.0000



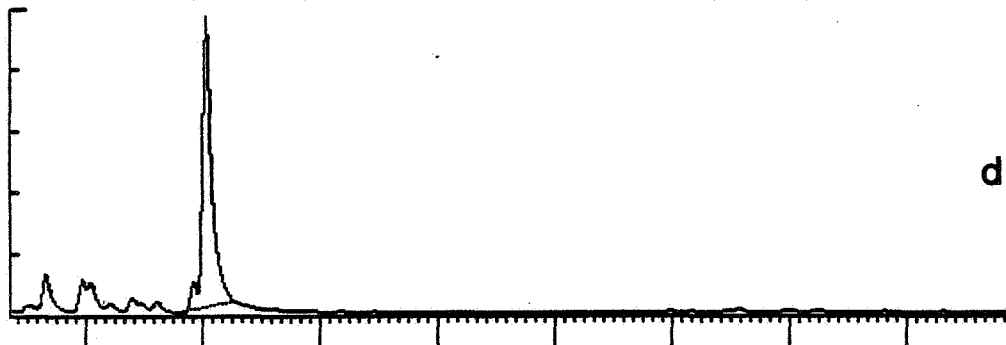
AROMATIC MASS FRAGMENTOGRAMS

DIBENZOTHIOPHENE SERIES

SIR REPORT. FILE - STD. .SD RUN - 1

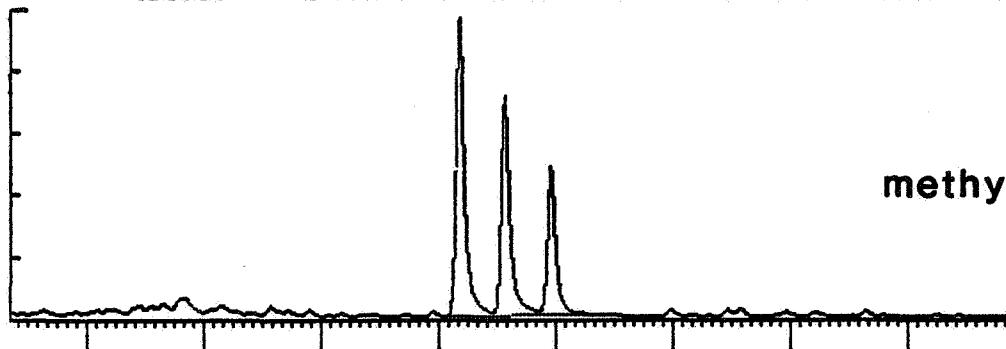
UNCALIBRATED.

MASS	RETENTION TIME	HEIGHT	AREA	CONC. (H)	CONC. (A)
184.00	0 HRS 11 MINS 47 SECS	26003.8900	144753.9000	0.0000	0.0000



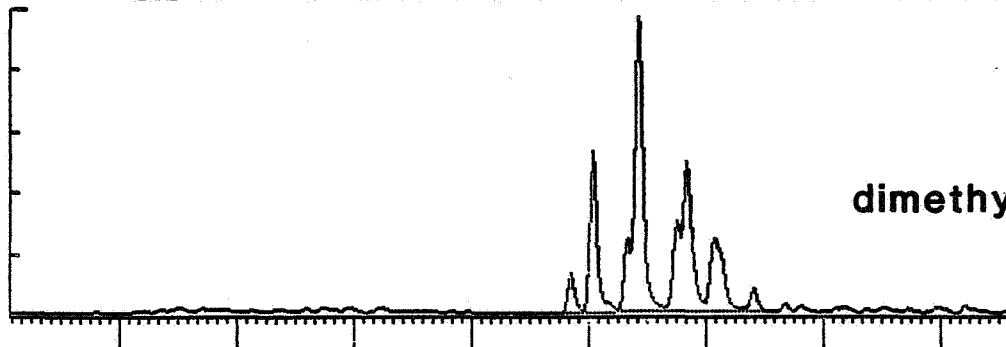
dibenzothiophene

196.00	0 HRS 13 MINS 36 SECS	16054.6700	187694.7000	0.0000	0.0000
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methyl dibenzothiophenes

212.00	0 HRS 15 MINS 36 SECS	14042.6900	200491.3000	0.0000	0.0000
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dimethyl dibenzothiophenes

0 HRS 11 MINS 4 SECS

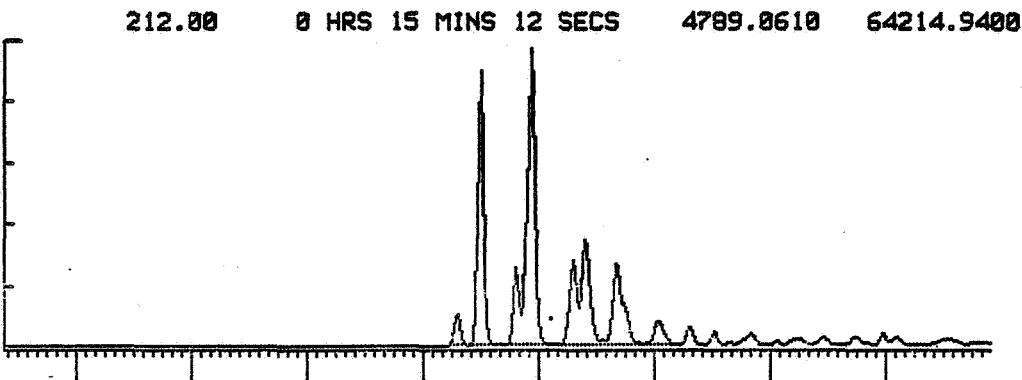
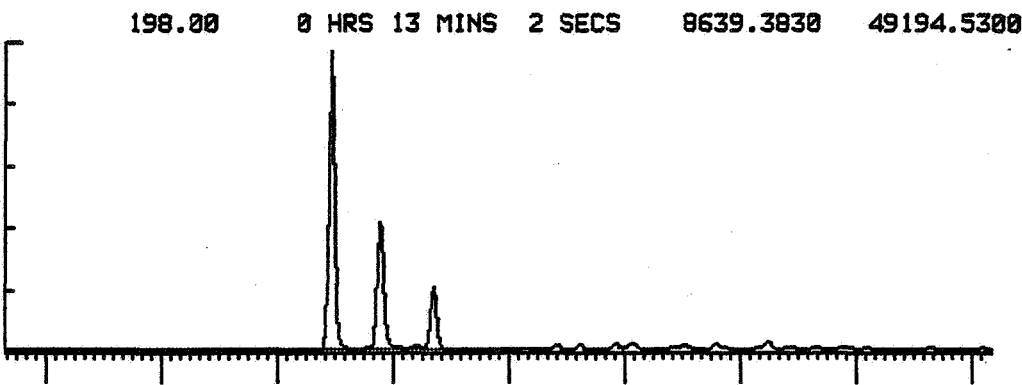
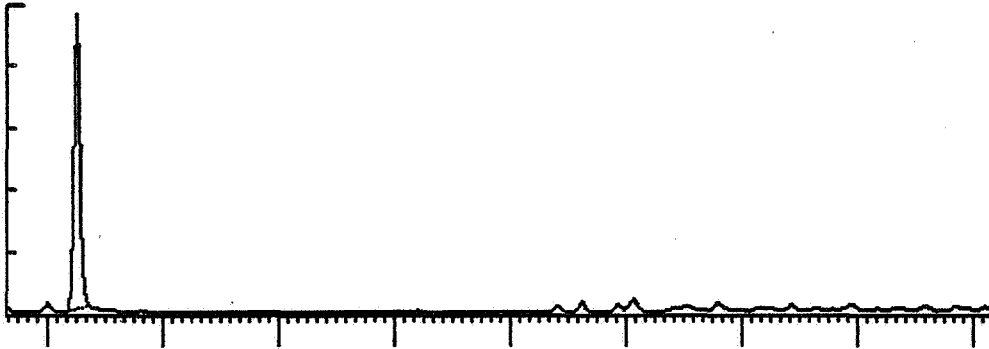
0 HRS 19 MINS 16 SECS

FIGURE 9a AROMATIC MASS FRAGMENTOGRAMS WELL 7121/4-1
DIBENZOTHIOPHENE SERIES

SIR REPORT. FILE - 975001 .SD RUN - 1

UNCALIBRATED.
MASS

RETENTION TIME	HEIGHT	AREA	CONC. (H)	CONC. (A)
0 HRS 11 MINS 10 SECS	5281.2490	17999.9800	0.0000	0.0000
0 HRS 13 MINS 2 SECS	8639.3830	49194.5300	0.0000	0.0000
0 HRS 15 MINS 12 SECS	4789.8610	64214.9400	0.0000	0.0000



0 HRS 11 MINS 22 SECS

0 HRS 19 MINS 34 SECS

2429.5m

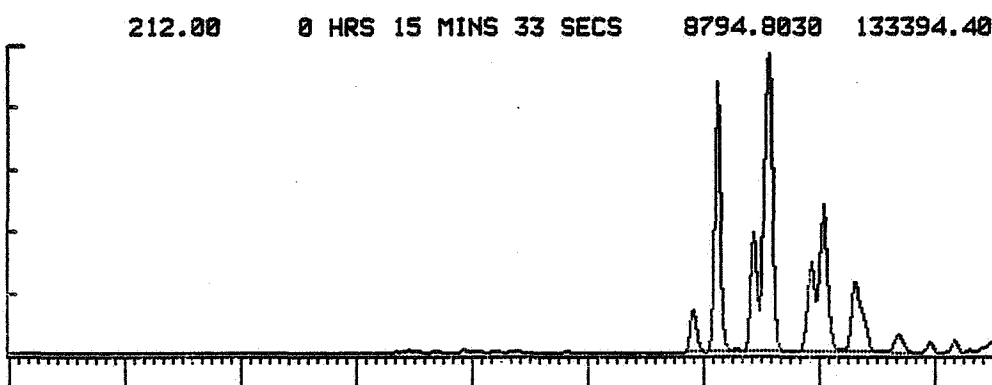
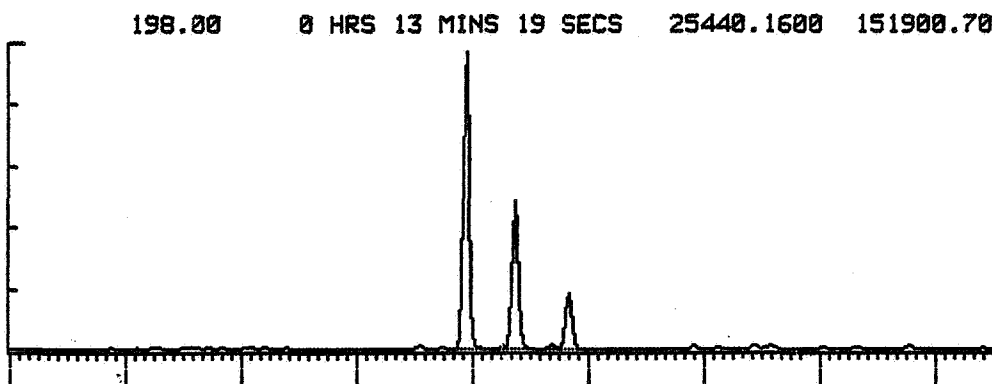
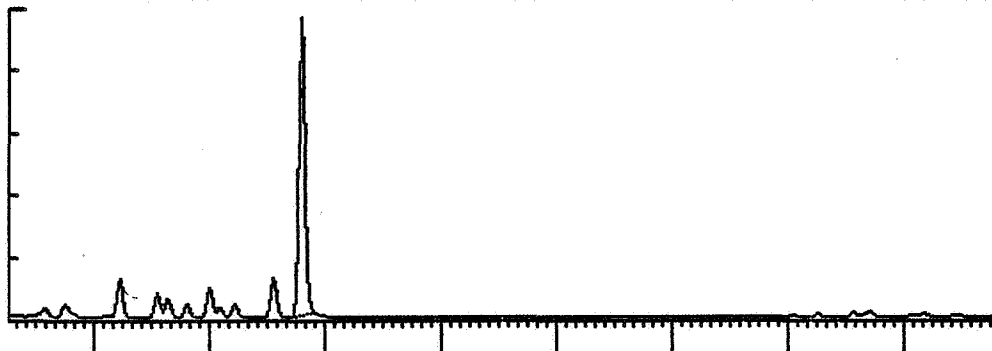
S.W.C.

FIGURE 9b AROMATIC MASS FRAGMENTOGRAMS WELL 7121/4-1
DIBENZOTHIOPHENE SERIES

SIR REPORT. FILE - 975002 .SD RUN - 1

UNCALIBRATED.
MASS

RETENTION TIME	HEIGHT	AREA	CONC. (H)	CONC. (A)
184.00 0 HRS 11 MINS 23 SECS	24070.9400	83621.1300	0.0000	0.0000
198.00 0 HRS 13 MINS 19 SECS	25440.1600	151900.7000	0.0000	0.0000
212.00 0 HRS 15 MINS 33 SECS	8794.8030	133394.4000	0.0000	0.0000



0 HRS 9 MINS 59 SECS

0 HRS 18 MINS 10 SECS

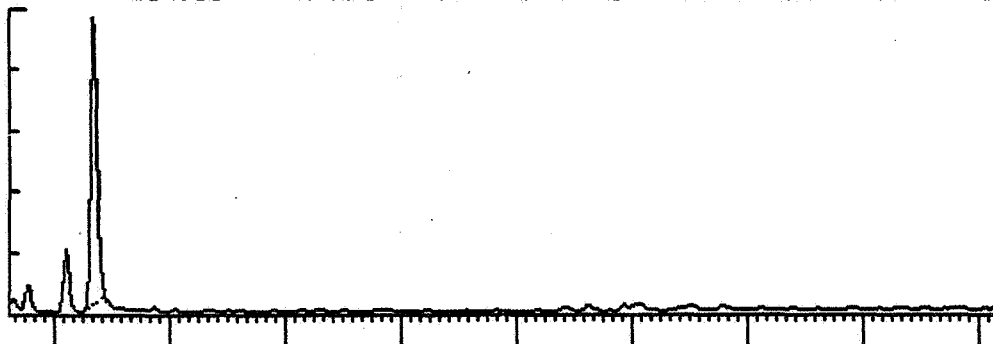
2443m

S.W.C.

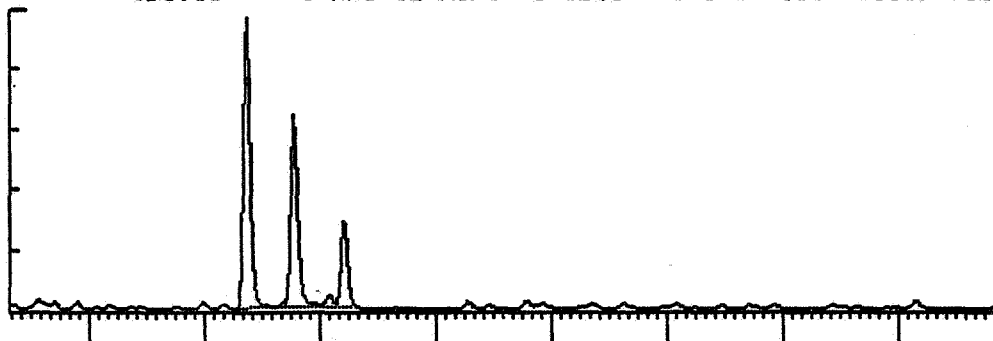
FIGURE 9c AROMATIC MASS FRAGMENTOGRAMS WELL 7121/4-1
 DIBENZOTHIOPHENE SERIES

SIR REPORT. FILE - 975003 .SD RUN - 1

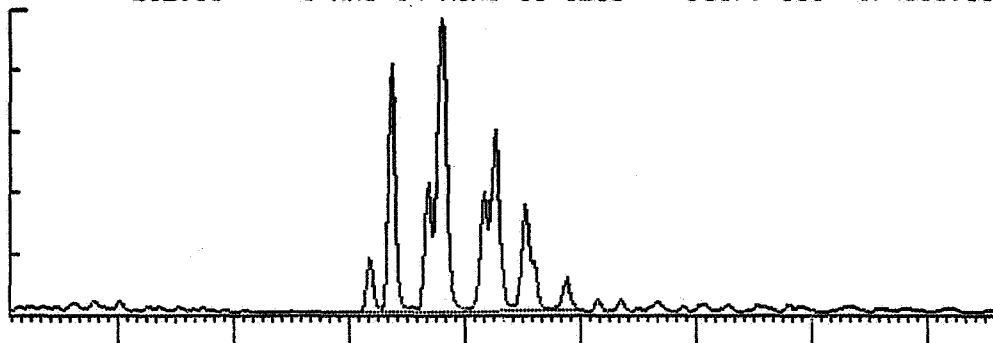
UNCALIBRATED. MASS	RETENTION TIME	HEIGHT	AREA	CONC. (H)	CONC. (A)
184.00	0 HRS 10 MINS 14 SECS	9503.1230	34589.9500	0.0000	0.0000



198.00	0 HRS 12 MINS 6 SECS	14546.3500	115597.0000	0.0000	0.0000
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212.00	0 HRS 14 MINS 16 SECS	9007.7160	174088.8000	0.0000	0.0000
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0 HRS 11 MINS 4 SECS

0 HRS 19 MINS 16 SECS

2468.5m

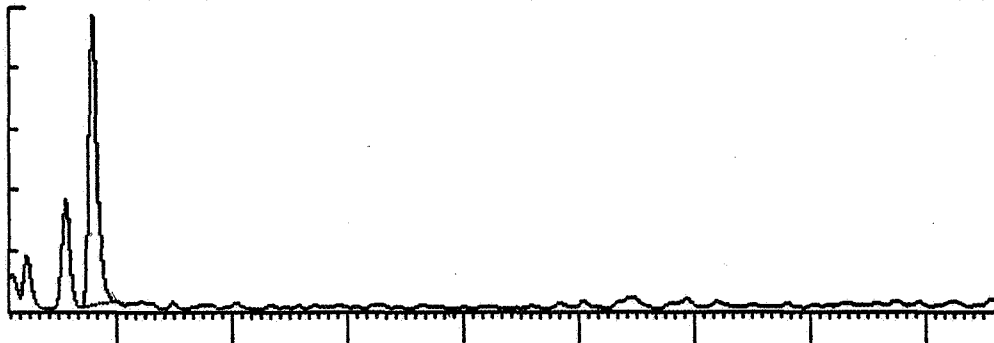
S.W.C.

FIGURE 9d AROMATIC MASS FRAGMENTOGRAMS WELL 7121/4-1
DIBENZOTHIOPHENE SERIES

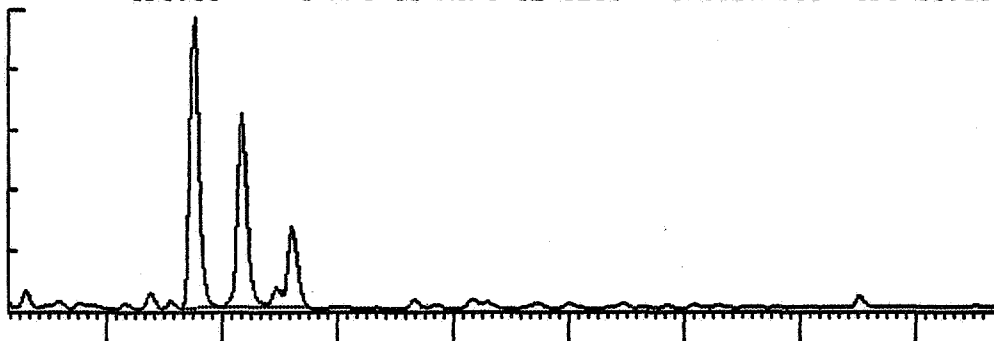
SIR REPORT. FILE - 975005 .SD RUN - 1

UNCALIBRATED.

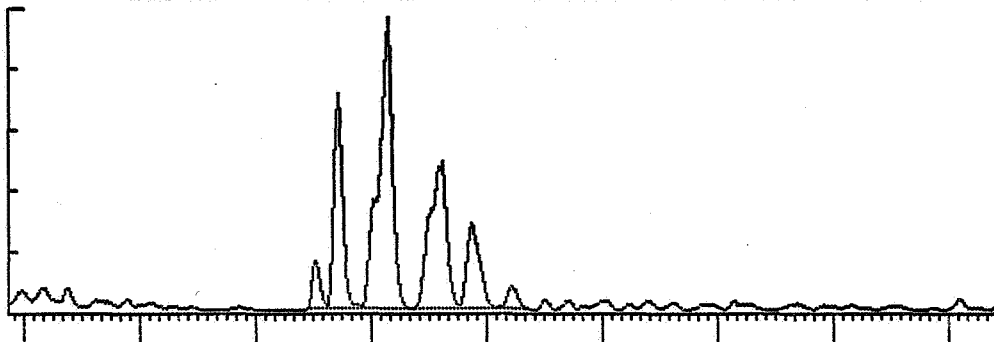
MASS	RETENTION TIME	HEIGHT	AREA	CONC. (H)	CONC. (A)
184.00	0 HRS 11 MINS 40 SECS	10433.3500	51014.9000	0.0000	0.0000



198.00	0 HRS 13 MINS 32 SECS	17552.3900	193401.6000	0.0000	0.0000
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212.00	0 HRS 15 MINS 42 SECS	14546.8700	294667.1000	0.0000	0.0000
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0 HRS 12 MINS 52 SECS

0 HRS 21 MINS 3 SECS

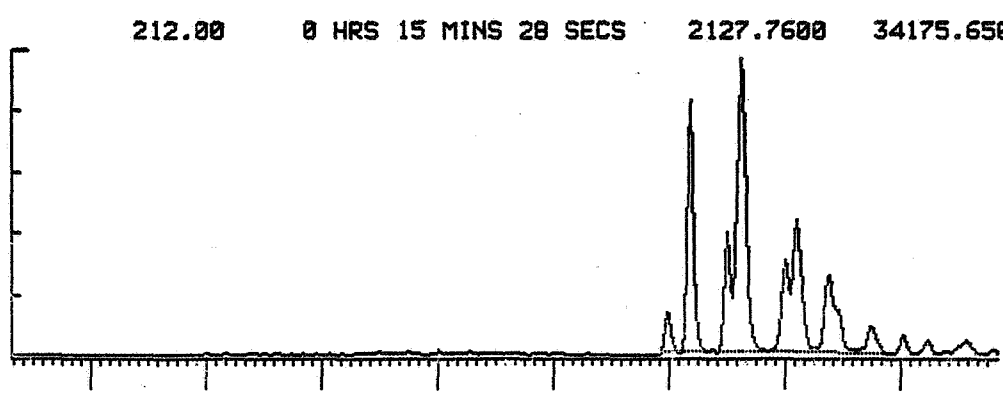
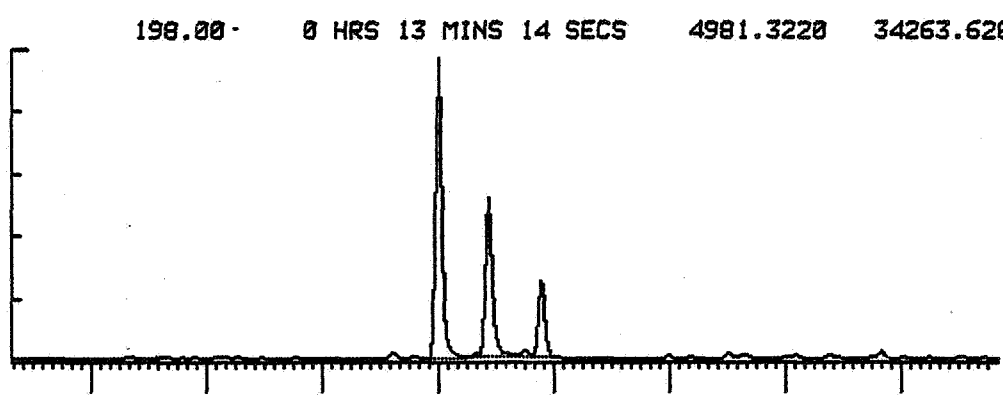
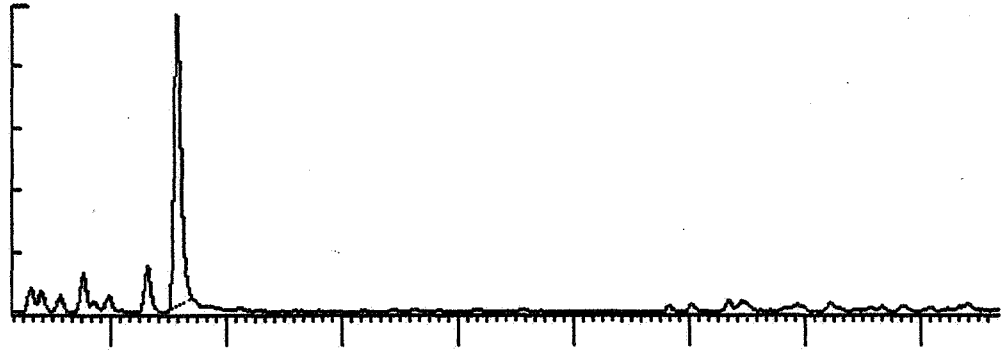
2474m

S.W.C.

DIBENZOTHIOPHENE SERIES

SIR REPORT. FILE - 975006 .SD RUN - 1

UNCALIBRATED. MASS	RETENTION TIME	HEIGHT	AREA	CONC. (H)	CONC. (A)
184.00	0 HRS 11 MINS 20 SECS	2861.9770	11508.7200	0.0000	0.0000
198.00	0 HRS 13 MINS 14 SECS	4981.3220	34263.6200	0.0000	0.0000
212.00	0 HRS 15 MINS 28 SECS	2127.7600	34175.6500	0.0000	0.0000



0 HRS 10 MINS 18 SECS

0 HRS 18 MINS 30 SECS

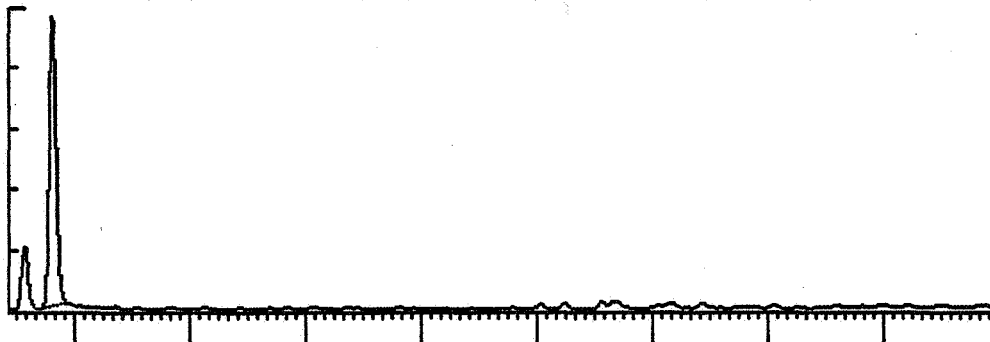
2480m
S.W.C.

FIGURE 9f AROMATIC MASS FRAGMENTOGRAMS WELL 7121/4-1
DIBENZOTHIOPHENE SERIES

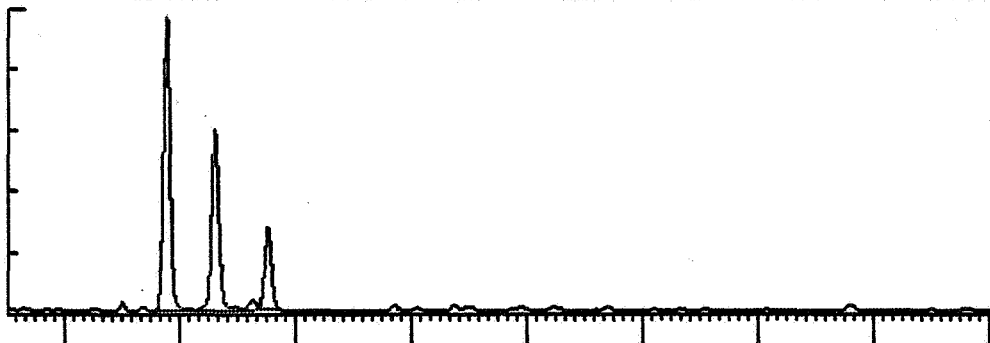
SIR REPORT. FILE - 975007 .SD RUN - 1

UNCALIBRATED.
MASS

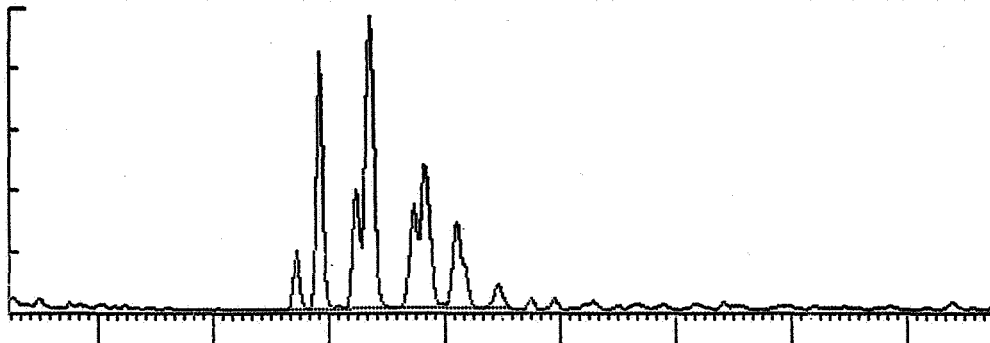
RETENTION TIME	HEIGHT	AREA	CONC. (H)	CONC. (A)
184.00 0 HRS 11 MINS 43 SECS	16895.8300	66903.6300	0.0000	0.0000



198.00 0 HRS 13 MINS 40 SECS	23949.4400	189779.1000	0.0000	0.0000
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212.00 0 HRS 15 MINS 54 SECS	12957.3300	220221.0000	0.0000	0.0000
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0 HRS 13 MINS 14 SECS

0 HRS 21 MINS 25 SECS

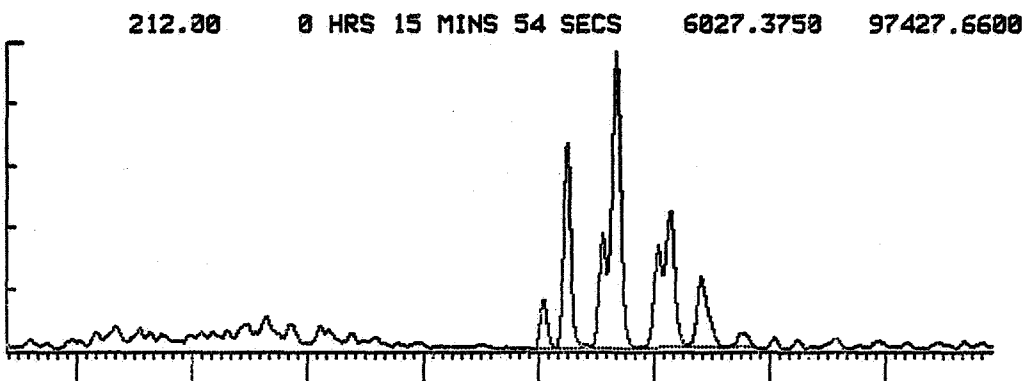
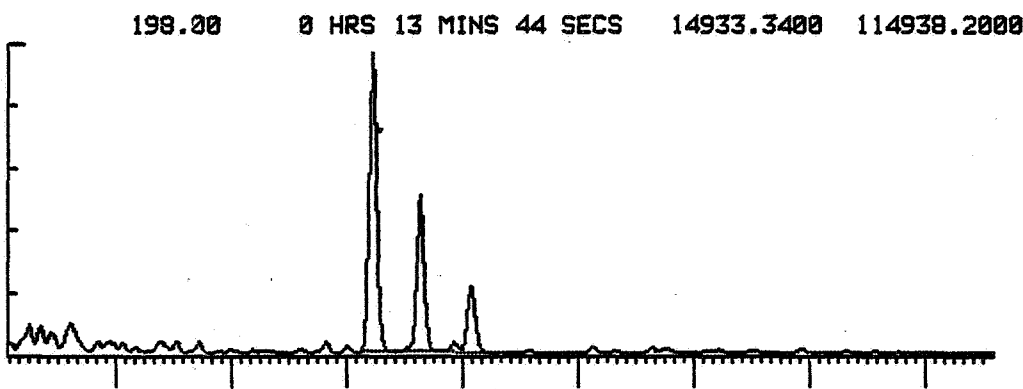
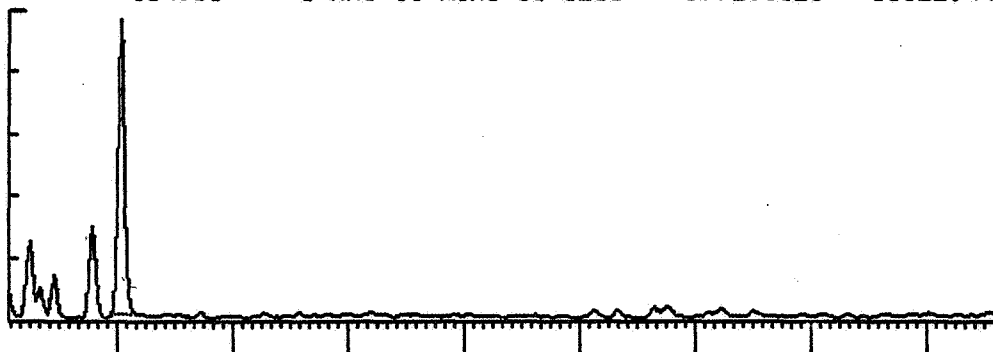
2485m
S.W.C.

DIBENZOTHIOPHENE SERIES

SIR REPORT. FILE - 975009 .SD RUN - 1

UNCALIBRATED.
MASS

RETENTION TIME	HEIGHT	AREA	CONC. (H)	CONC. (A)
184.00	9772.1320	36022.4400	0.0000	0.0000
198.00	14933.3400	114938.2000	0.0000	0.0000
212.00	6027.3750	97427.6600	0.0000	0.0000



0 HRS 11 MINS 24 SECS

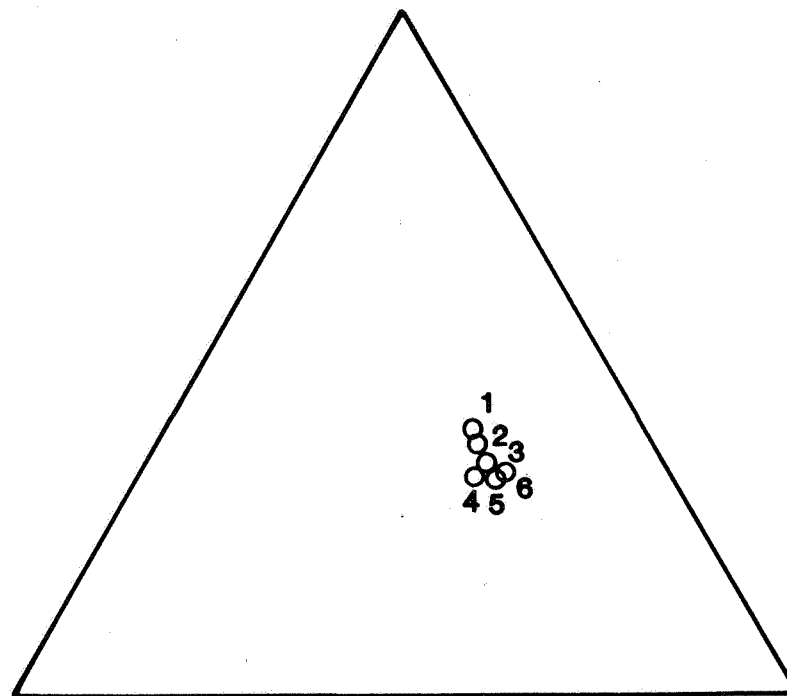
0 HRS 19 MINS 36 SECS

DST 3

FIGURE 10

TERTIARY DIAGRAM SHOWING RELATIVE
ABUNDANCE OF C₂₇, C₂₈ and C₂₉
5 α (H), 14 β (H), 17 β (H) STERANES

WELL 7121/4-1

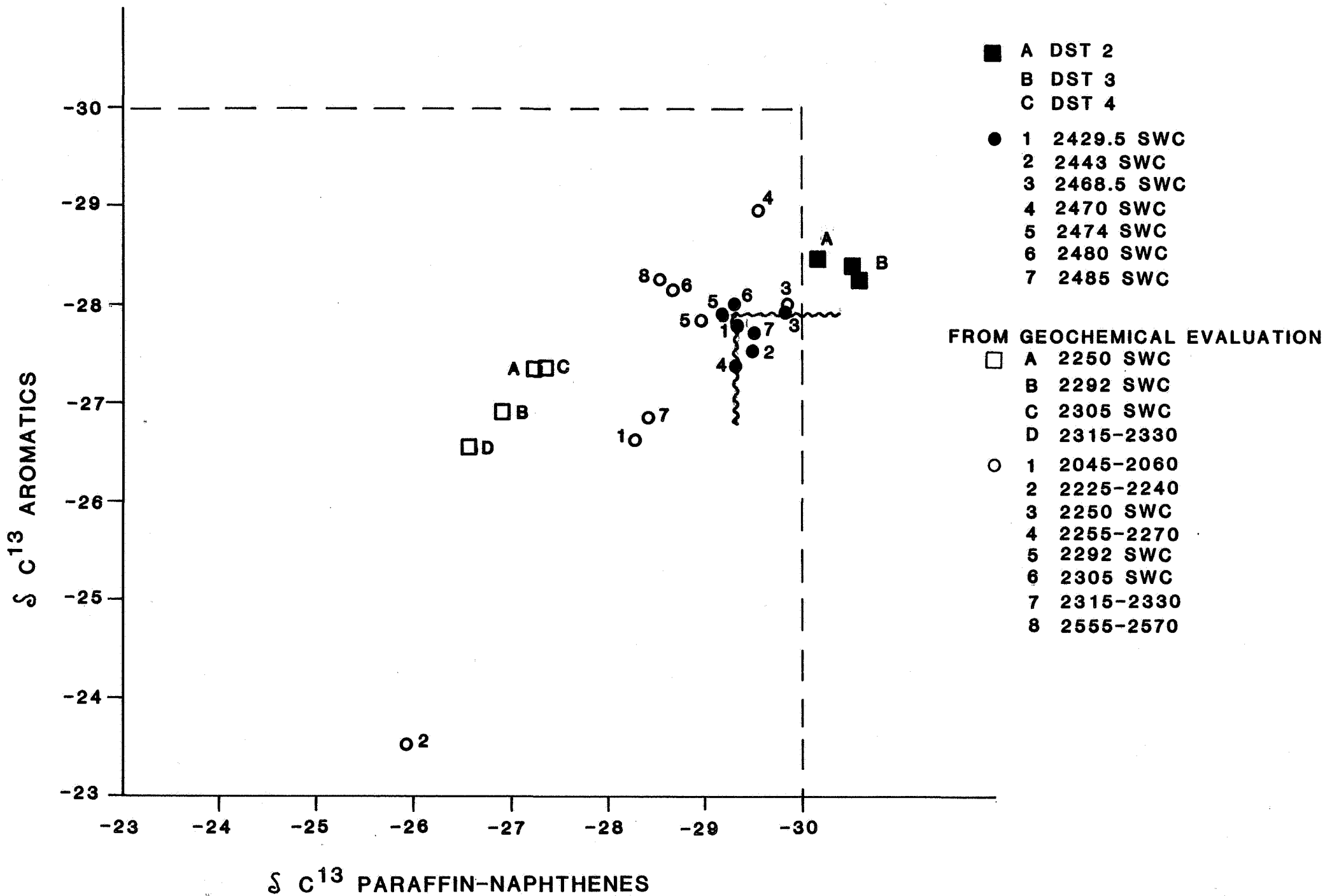


- 1 ○ DST 4
- 2 ○ DST 2
- 3 ○ (2470, 2480, 2485) SWC & DST 3
- 4 ○ 2468.5 SWC
- 5 ○ 2443 SWC
- 6 ○ 2474 SWC

FIGURE 11

STABLE CARBON ISOTOPE RATIOS
(‰, PDB)

WELL 7121/4-1



BRIEF DESCRIPTION OF THE ANALYSES PERFORMED BY GEOCHEM

"Screen Analyses" are described in sections A, C and D, "Sample Preparation" in section B, "Follow-up Analyses" in sections E through K and "Correlation Studies" in section L. The analyses can be run on either core or cuttings material with the proviso that samples must be canned for the C₁-C₇ analysis and should be canned (or at least wet) for the C₄-C₇ analysis. The other analyses can be run on both canned and bagged samples.

A) C₁-C₇ LIGHT HYDROCARBON ANALYSIS

The abundance and composition of the C₁-C₇ hydrocarbons in sediments reflects their source richness, maturity and the character of the hydrocarbons they can yield. Most importantly, it is extremely sensitive to the presence of migrated hydrocarbons and is an excellent method for their detection. As it provides the information on most of the critical parameters and is also economical, this analysis is excellent for screening samples to decide which of them merit further analysis.

During the time which elapses between the collection of the sample at the wellsite and its analysis in the laboratory, a fraction of the total gas passes from the rock to the air space at the top of the can. For this reason, both the air space and the cuttings are analysed.

The analysis involves the gas chromatographic separation of the individual C₁-C₄ gaseous hydrocarbons (methane, ethane, propane, isobutane and normal butane) and a partial resolution of the C₅-C₇ gasoline-range hydrocarbons (for their complete resolution see Section E). The ppm abundance of the five gases and of the total C₅-C₇ hydrocarbons are calculated from their electronically integrated peak areas (not from peak height) by comparison with a standard.

In the report, the following data are tabulated: the abundance and composition of the air space gas, of the cuttings gas and of the combined air space and cuttings gases. The combined results are also presented graphically.

B) SAMPLE WASHING AND HAND PICKING

All of the analyses described in subsequent sections are run on washed and hand picked samples.

Cuttings are washed to remove the drilling mud, care being taken not to remove soft clays and fine sand during the washing procedure. Using the C₁-C₇ hydrocarbon data profile of the well, or the organic carbon profile (if this analysis is used for screening), electric logs (if supplied) and the appearance of the cuttings under the binocular microscope, samples are selected to represent the lithological and geochemical zones penetrated by the well. These samples are then carefully hand picked and the lithology of the uncaved material is described. It is these samples which are submitted for further analysis.

Sample material remaining after analysis is retained for six months. Unless instructions are received to the contrary, Geochem Laboratories may then destroy the samples.

Our reports incorporate a gross lithological description of all the samples which have been analysed and litho percentage logs. As screen analyses are recommended at narrow intervals, a complete lithological profile is obtained.

C) ORGANIC CARBON ANALYSIS

The organic carbon content of a rock is a measure of its total organic richness. Combined with the visual kerogen, C₁-C₇, C₄-C₇, pyrolysis and C₁₅+ analyses, the organic carbon content is used to evaluate the potential (not necessarily actual) hydrocarbon source richness of the sediment. This analysis is an integral part of a total evaluation and it can also be used as an economical screen analysis for dry samples (when the C₁-C₇ analysis cannot be used).

Hand picked samples are dried, crushed and then acidised to remove the inorganic calcium and magnesium carbonates. The actual analysis involves combustion in a Leco carbon analyser. Blanks, standards and duplicates are run routinely for purposes of quality control at no extra cost to the client.

The data are tabulated and presented diagrammatically in our reports in a manner which facilitates comparison with the gross lithology (see Section B) of the samples.

D) MINI-PYROLYSIS

An ideal screen analysis which provides a definitive measure of potential source richness upon those samples whose organic carbon contents suggest fair or good source potential. This is described in detail in section K.

E) DETAILED C₄-C₇ HYDROCARBON ANALYSIS

The abundance and composition of the C₄-C₇ gasoline-range hydrocarbons in sediments reflects their source quality, level of thermal maturation and organic facies. In addition, the data also reveal the presence of migrated hydrocarbons and can be used for crude oil-parent source rock correlation studies.

This powerful analysis, performed upon hand picked lithologies, is employed as a follow-up to confirm the potential of samples which have been selected using the initial screen analysis. It is used in conjunction with the organic carbon, visual kerogen and C₁₅+ analyses.

The individual normal paraffins, isoparaffins, naphthenes and aromatics with between four and seven carbon atoms in the molecule (but also including toluene) are resolved by capillary gas chromatography and their peak areas electronically integrated.

Normalised compositions, selected ratios and the ppm abundance of the total gasoline-range fraction are tabulated in the report and also presented graphically.

F) KEROGEN TYPE AND MATURATION

Kerogen is the insoluble organic matter in rocks. Visual examination of the kerogen gives a direct measure of thermal maturity and of the composition of the organic matter (organic facies) and indicates the source quality of the sediment - which is confirmed using the organic carbon, light hydrocarbon, pyrolysis and C₁₅+ analyses.

The type of hydrocarbon (oil or gas) generated by a source rock is a function of the types and level of thermal maturation of the organic matter which are present. Both of these parameters are measured directly by this method.

Kerogen is separated from the inorganic rock matrix by acid digestion and flotation methods which avoid oxidation of the organic matter. It is then mounted on a glass slide and examined at high and low magnifications with a Leitz microscope. Chemical methods measure the total kerogen population but, with this technique, individual particles can be selected for examination and spurious material identified. This is particularly valuable in reworked, contaminated and turbodrilled sediments.

The following data are generated: the types of the organic matter present and their relative abundances, an estimate of the proportion of reworked material, preservation state, the thermal maturity of the non-reworked organic matter using the spore colouration technique.

Our maturation scale has been developed to digitise small but recognisable changes in organic matter colouration resulting from increasing maturity and to place particular emphasis upon the immature to mature transition. In the absence of a universal colouration scale, the most significant points on our scale have been calibrated against equivalent vitrinite reflectance values. The following maturation stages are recognised at the low end of the scale:-

- a) immature; thermal index less than 2- (0.45% Ro)
- b) marginally mature; indices between 2- and 2.
Minor hydrocarbon generation from amorphous and herbaceous (\pm algal) organic matter
- c) mature; indices between 2 (0.53% Ro) and 2 to 2+ (0.72% Ro),
significant generation from amorphous, algal and herbaceous organic matter but wood only marginally mature
- d) oil window; indices of 2 to 2+ (0.72% Ro) through to 3 (1.2% Ro). Peak hydrocarbon generation.

The condensate zone starts at a thermal index of 3 whilst indices of 3+ (2.0% Ro) and higher indicate the eometamorphic dry gas stage.

A total of fourteen types of organic matter are sought based upon the major categories of algal, amorphous, herbaceous (spore, pollen, cuticle), wood, inertinite and resin. This detail is essential for a proper understanding of hydrocarbon source potential as the different sub-groups within each category have different properties.

Upon completion of the study, the kerogen slides are sent to the client.

G) VITRINITE REFLECTANCE

Vitrinite reflectance is an alternative/confirmatory method for evaluating thermal maturation which is used in conjunction with the visual kerogen analysis. The reflectivity of vitrinite macerals increases in response to thermal alteration and is used to define maturation levels and, by projection, to predict maturity at depth or the thicknesses of section removed by erosion.

Measurements are made upon kerogen separations in conjunction with polished whole rock samples. In general, this analysis is performed upon the same samples as the visual kerogen analysis, thus facilitating a direct comparison of the two sets of results.

If possible, forty to fifty measurements are taken per sample - unless the sediments are organically lean, vitrinite is sparse or only a single uniform population is present. The data are plotted in a histogram which

distinguishes the indigenous vitrinite from possible reworked or caved material. Averages are calculated for each population. Comments upon exinite fluorescence and upon the character of the phytoclasts are noted on the histograms. The reports contain the tabulated data, histograms and the reflectivities plotted against depth.

The vitrinite and visual kerogen techniques provide mutually complementary information upon maturity, organic matter type and diagenesis.

H) C₁₅₊ EXTRACTION, DEASPHALTENING AND CHROMATOGRAPHIC SEPARATION

Sections "A" and "E" dealt with analyses covering the light end of the hydrocarbon spectrum. This section is concerned with the solvent extractable organic material in the rock with more than fourteen carbon atoms in the molecule (i.e. the heavy end). The amount and composition of this extract indicates source richness and type, the level of thermal maturation and the possible presence of migrated hydrocarbons.

These results are integrated with those derived from the pyrolysis, visual kerogen, organic carbon and light hydrocarbon analyses.

The techniques involved in this analysis employ pure solvents and have been designed to give reproducible results. Hand picked samples are ground and then solvent extracted in a soxhlet apparatus, or by blending, with dichloromethane (the solvent system can be adapted to client's specifications). After asphaltene precipitation, the total extract is separated by column chromatography or high pressure liquid chromatography into the following fractions: paraffin-naphthene hydrocarbons, aromatic hydrocarbons, eluted NSO's (nitrogen-, sulphur-, and oxygen- containing non-hydrocarbons) and non-eluted NSO's. Note that the non-hydrocarbons are split into three fractions and not reported as a gross value. These fractions can be submitted for further analyses (carbon isotopes, gas chromatography, mass spectroscopy) including correlation studies.

For convenience and thoroughness, the data are reported in three formats: the weights of the fractions, ppm abundances and normalised percentage compositions. The data are also presented diagrammatically.

J) GC ANALYSIS OF C₁₅₊ PARAFFIN-NAPHTHENE HYDROCARBONS

The gas chromatographic configurations of the heavy C₁₅₊ paraffin-naphthene hydrocarbons reflect source type, the degree of thermal maturation and the presence and character of migrated hydrocarbons or contamination.

Not only is this analysis an integral part of any source rocks study but it also provides a fingerprint for correlation purposes and helps to define the geochemical/palynological environmental character of the source rocks from which crude oils were derived.

The paraffin-naphthene hydrocarbons obtained by column chromatography are separated by high resolution capillary chromatography. Excellent resolution of the individual normal paraffins, isoprenoids and significant individual isoparaffins and naphthenes is achieved. Runs are normally terminated at nC₃₅. A powerful in-house microprocessor system is being introduced to correct for the change in response factor with chain length.

The normal paraffin carbon preference indices (C.P.I.) indicate if odd (values in excess of 1) or even (values less than 1) normal paraffins are dominant.

Strong odd preferences (\pm strong pristane peaks) are characteristic of immature land plant organic matter whilst even preferences (\pm strong phytane peaks) suggest a reducing environment of deposition. With increasing maturity, values approach 1.0 and oils are typically close to 1.0. The indices are calculated using the following formulae:

$$C.P.I._A = \frac{C_{21} + C_{23} + C_{25} + C_{27}}{C_{20} + C_{22} + C_{24} + C_{26}} + \frac{C_{21} + C_{23} + C_{25} + C_{27}}{C_{22} + C_{24} + C_{26} + C_{28}}$$

$$C.P.I._B = \frac{C_{25} + C_{27} + C_{29} + C_{31}}{C_{24} + C_{26} + C_{28} + C_{30}} + \frac{C_{25} + C_{27} + C_{29} + C_{31}}{C_{26} + C_{28} + C_{30} + C_{32}}$$

Chromatograms are reproduced in the report for use as visual fingerprints and in addition, the following data are tabulated: normalised normal paraffin distributions; proportions of paraffins, isoprenoids and naphthenes in the total paraffin-naphthene fraction; C.P.I._A and C.P.I._B; pristane to phytane ratio; pristane to nC₁₇ ratio.

K) PYROLYSIS

The process of thermal maturation can be simulated in the laboratory by pyrolysis, which involves heating the sample under specified conditions and measuring the oil-like material which is freed/generated from the rock. With this analysis, the potential richness of immature sediments can be determined and, by coupling the pyrolysis unit to a gas chromatograph, the liberated material can be characterised. These results are correlated with those obtained from the organic carbon, kerogen and C₁₅₊ analyses.

Small amounts of powdered sample are heated in helium to release the thermal bitumen (up to 340°C) and pyrolysate (340-550°C). The thermal bitumen correlates with the solvent extractable material (see above) whilst the pyrolysate fraction does not exist in a "free" state but is generated from the kerogen, thus simulating maturation in the subsurface. Abundances (weight ppm of rock) are measured with a flame ionisation detector against a standard. Thermal bitumen includes source indigenous, contaminant and migrated hydrocarbons but the pyrolysate abundance is a measure of ultimate source richness. The capillary gas chromatogram of the pyrolysate is used to evaluate the character of the parent organic matter and whether it is oil or gas prone. Peak temperature(s) of pyrolysate evolution is recorded. Carbon dioxide can be measured if requested but is normally ignored as the separation of the organic and inorganic species has been found to be artificial and unreliable.

Pyrolysate yields provide a definitive measure of potential source richness which avoids the ambiguities of the organic carbon data and the problem of contamination. This analysis is also used to evaluate the quality and character of the organic matter and the degree to which it has realised its ultimate hydrocarbon potential. Geochem does not employ the pyrolysis technique to evaluate maturation, preferring the kerogen and vitrinite reflectance analyses which avoid the problem of reworking and hence, are more reliable.

Capillary chromatograms produced for the pyrolysate hydrocarbons range from C₁ (methane) out towards C₃₅ but exhibit considerable variations. They are used to define whether a source rock will yield oil, condensate or gas. With this new technique, it is now possible to complete the evaluation of a source rock.

The data are tabulated and presented graphically. MINI-PYROLYSIS includes ppm thermal bitumen and ppm pyrolysate. PYROLYSIS also provides the above together with the temperature of peak pyrolysate evolution. The capillary chromatograms of the pyrolysate obtained by PYROLYSIS-GC are reproduced in the report. The Mini-Pyrolysis analysis is recommended as a screening technique.

L) CORRELATION STUDY ANALYSES

Oil to oil and oil to parent source rock correlation studies require high resolution analytical techniques. This requirement is satisfied by some of the analyses discussed above but others have been selected specifically for correlation work. Many of these analyses also provide information upon the character of the environment of deposition of the parent source rocks.

- detailed C₄-C₇ hydrocarbon (gasoline range) analysis. See Section E. Although these hydrocarbons can be affected by migrational/alteration processes, they commonly provide a very useful correlation parameter.
- capillary gas chromatography of the C₁₅₊ paraffin-naphthenes. See section J. The branched/normal paraffin distributions are used to "fingerprint" the samples.
- capillary chromatograms of whole oils and of the C₄₊ fraction of source rocks.
- capillary gas chromatography of C₁₅₊ aromatic hydrocarbons. Separate chromatograms of the hydrocarbons and of the sulphur-bearing species are reproduced.
- high pressure liquid chromatograms.
- mass spectrometric carbon isotope analyses of crude oil and rock extract fractions and of kerogen separations. A powerful tool for comparing hydrocarbons and correlating hydrocarbons to organic matter. With this technique the problem of source rock contamination can be avoided. The data are recorded on x-y or Galimov plots.
- mass fragmentograms (mass chromatograms) of fragment ions characteristic of selected hydrocarbon groups such as the steranes and terpanes. The fragmentograms provide a convenient and simple means of presenting detailed mass spectrometric data and are used as a sophisticated fingerprinting technique. This provides the ultimate resolution for correlating hydrocarbons and facilitates the examination of hydrocarbon classes.
- vanadium and nickel contents.

Suites of (rather than single) analyses are employed in correlation studies, the actual selection depending upon the complexity of the problem. See also section N.

M) ANALYSES FOR SPECIAL CASES

M-1) ELEMENTAL KEROGEN ANALYSIS

This analysis evaluates source quality, whether the sediments are oil or gas prone, the character of the organic matter and its level of thermal maturation. It is the chemical equivalent of the visual kerogen analysis. The pyrolysis analysis is generally preferred to this technique, both methods providing similar information.

M-2) SULPHUR ANALYSIS

The abundance of sulphur in source rocks and crude oils.

M-3) CARBONATE CONTENT

The mineral carbonate content of sediments is determined by acid treatment. These data are particularly useful when used in conjunction with organic carbon contents as a screening technique.

M-4) NORMAL PARAFFIN ANALYSIS

Following the removal of the branched paraffins and naphthenes from the total paraffin-naphthene fraction, a chromatogram of the normal paraffins is obtained. The resulting less complicated chromatogram facilitates the examination of normal paraffin distributions.

M-5) SOLID BITUMEN EVALUATION

Residual solid bitumen after crude oil is generated by three prime processes; the action of waters, gas deasphalting, thermal alteration. Thus it provides a means of determining the reservoir history of a crude and of evaluating whether adjacent traps will or will not be prospective for oil. In carbonate sections, where organic matter is sometimes sparse, this technique is also used to evaluate thermal maturation levels.

The analysis involves the determination of the solubility (in CS₂) of the solid bitumen and of the atomic hydrogen to carbon ratio of the insoluble fraction.

N) CRUDE OIL ANALYSIS

N-1) API GRAVITY

This can be performed upon large (hydrometer) and small (SG bottle, pycnometer) samples and even upon stains extracted from sediments (refractive index).

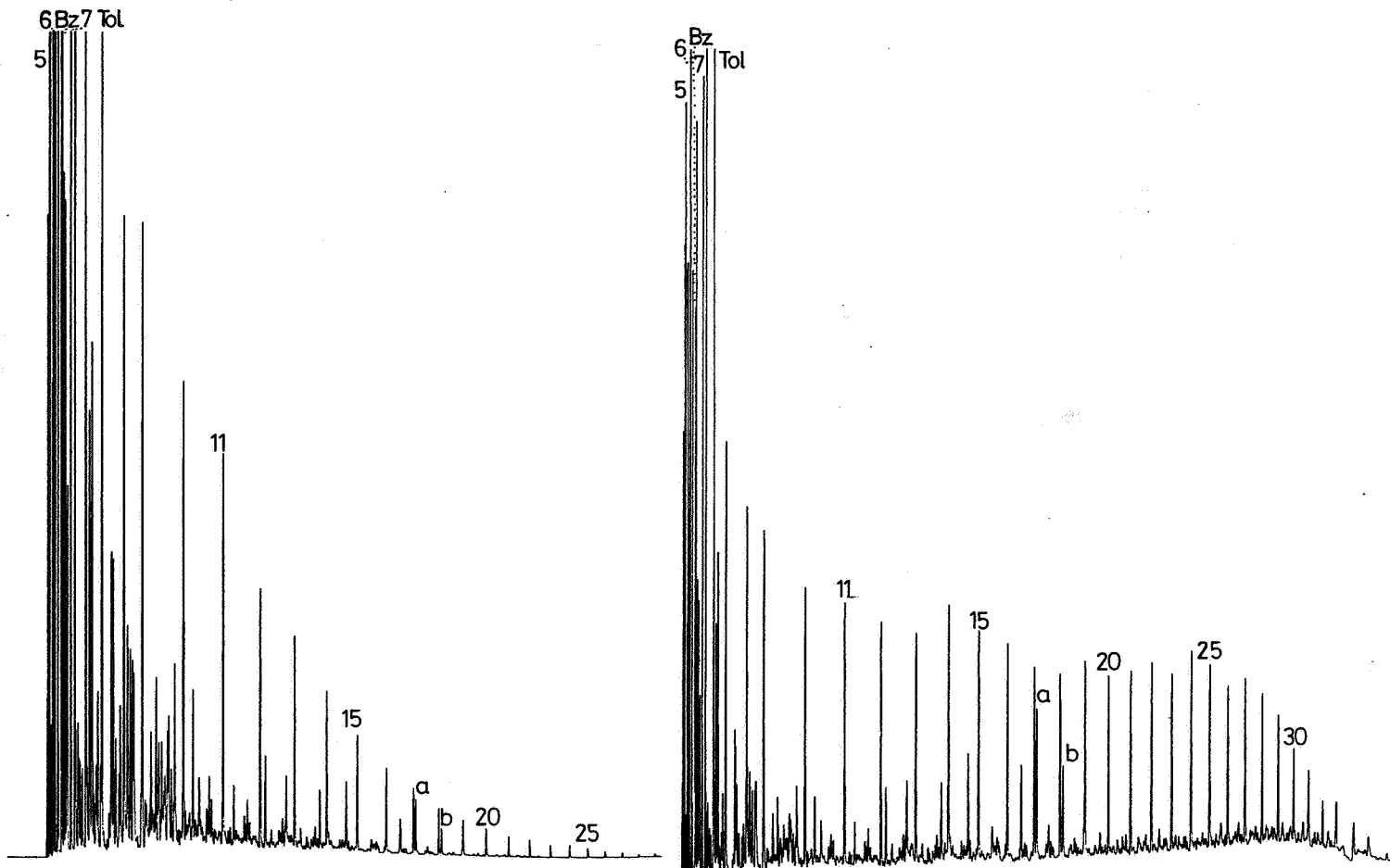
N-2) SULPHUR CONTENTS (ASTM E30-47)

N-3) POUR POINT (ASTM D97-66, IP15/67)

N-4) VISCOSITY (ASTM D445-72, IP71/75).

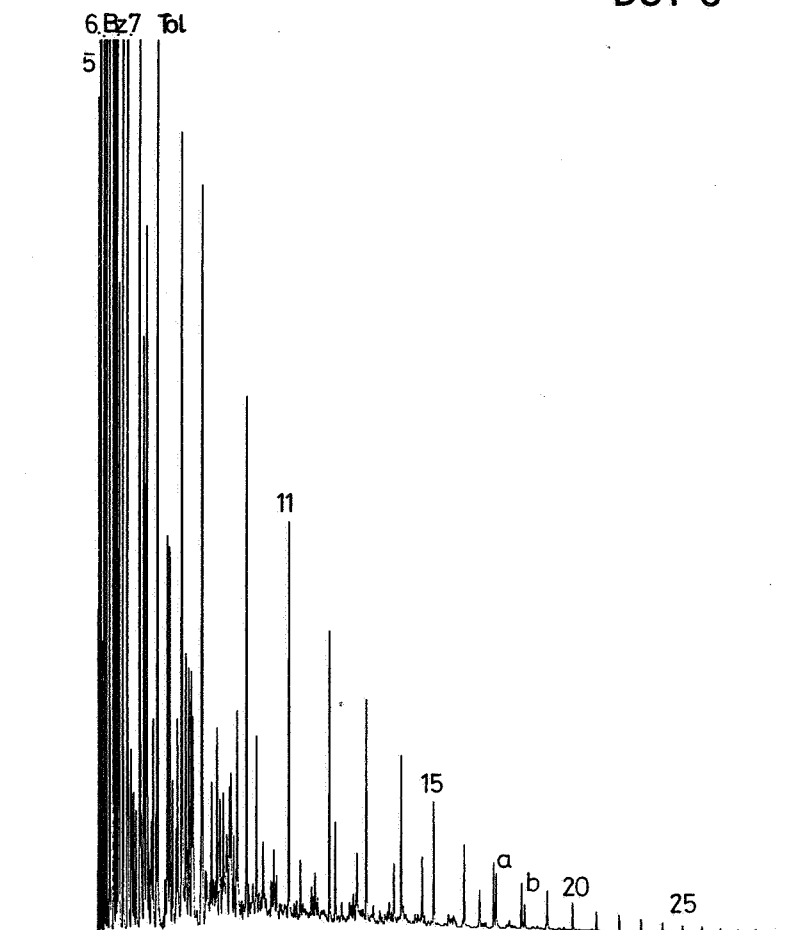
N-5) FRACTIONAL DISTILLATION

Graph of cumulative distillation yield against temperature. Five percent cuts taken for further analysis. Mass spectrometric studies of these fractions provide a detailed picture of the distribution of paraffins and of the various naphthene and aromatic groups within a crude, which is useful both for correlation and for refinery evaluation purposes.

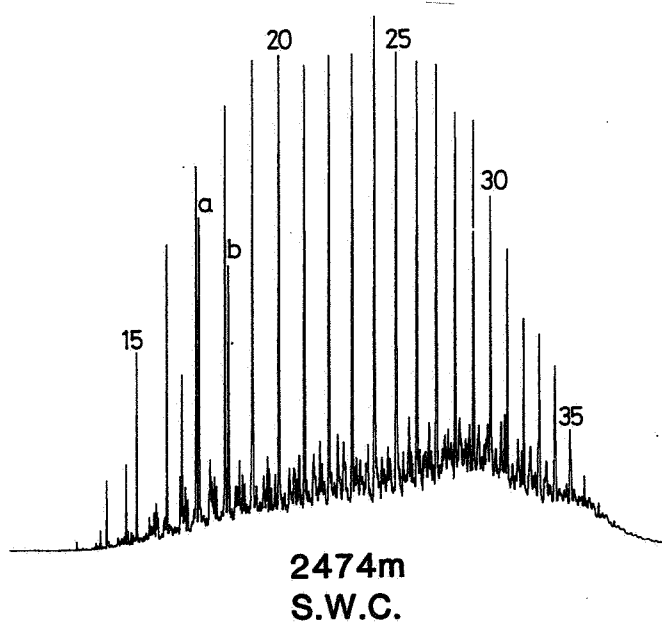
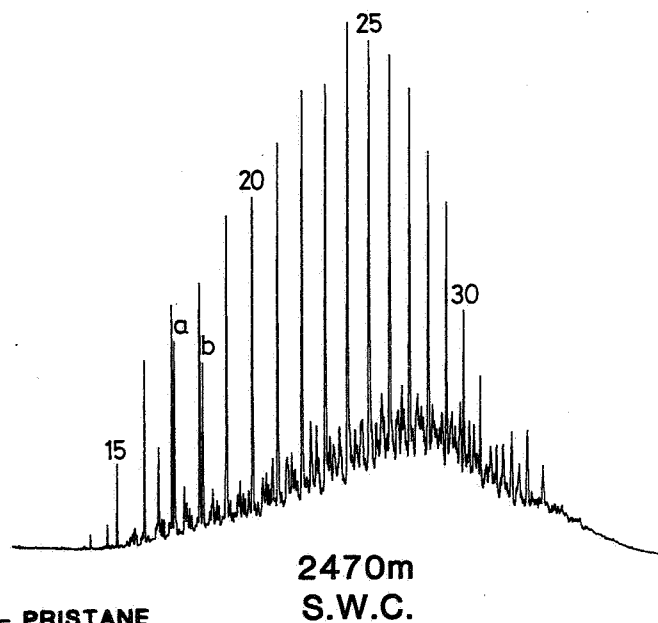
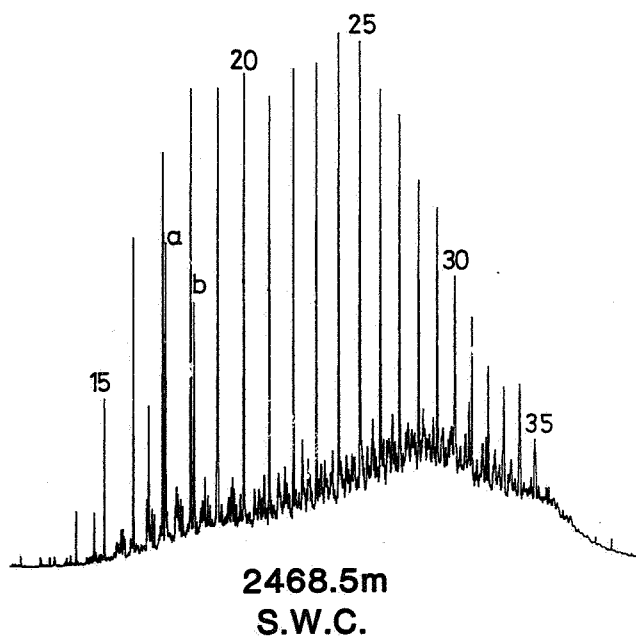
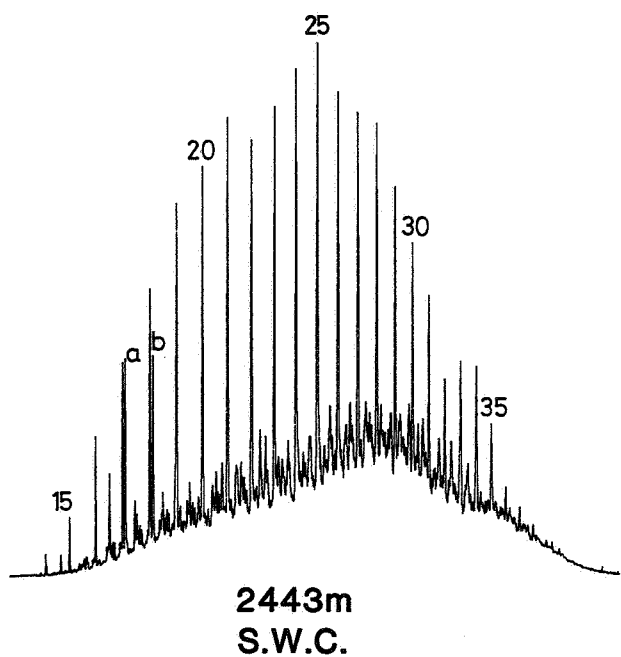
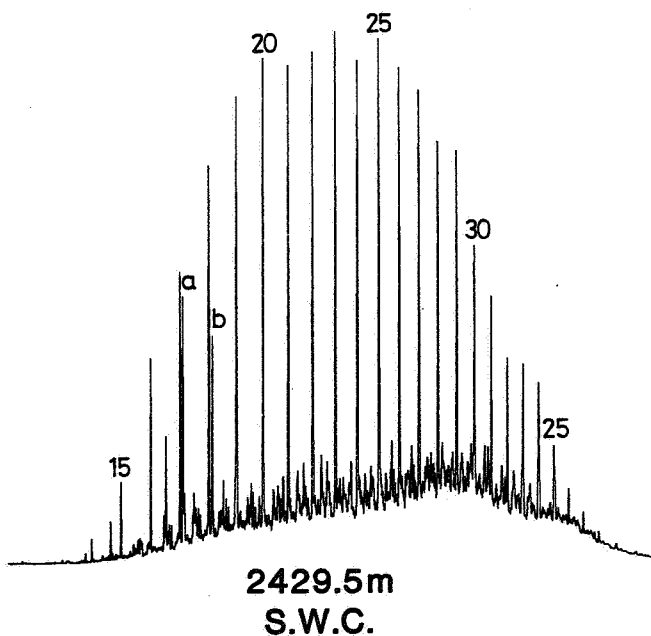
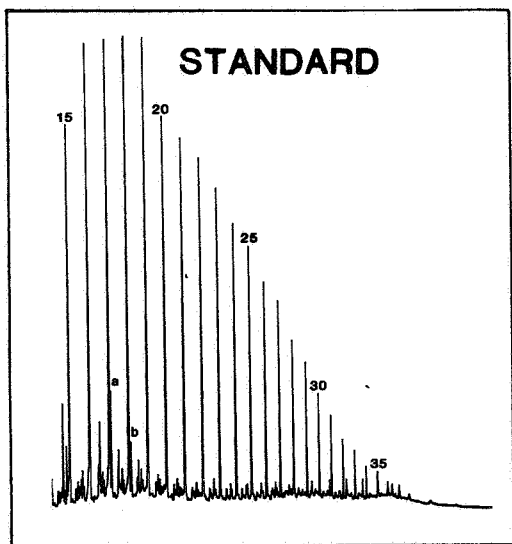


DST 2

DST 3

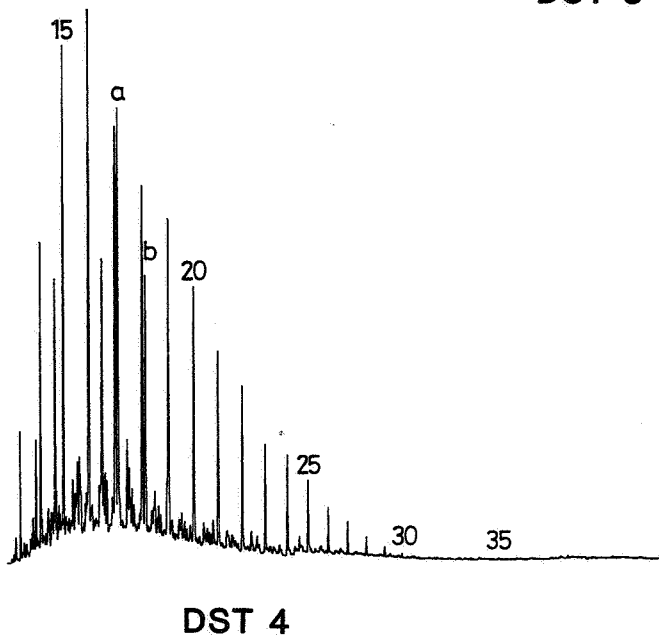
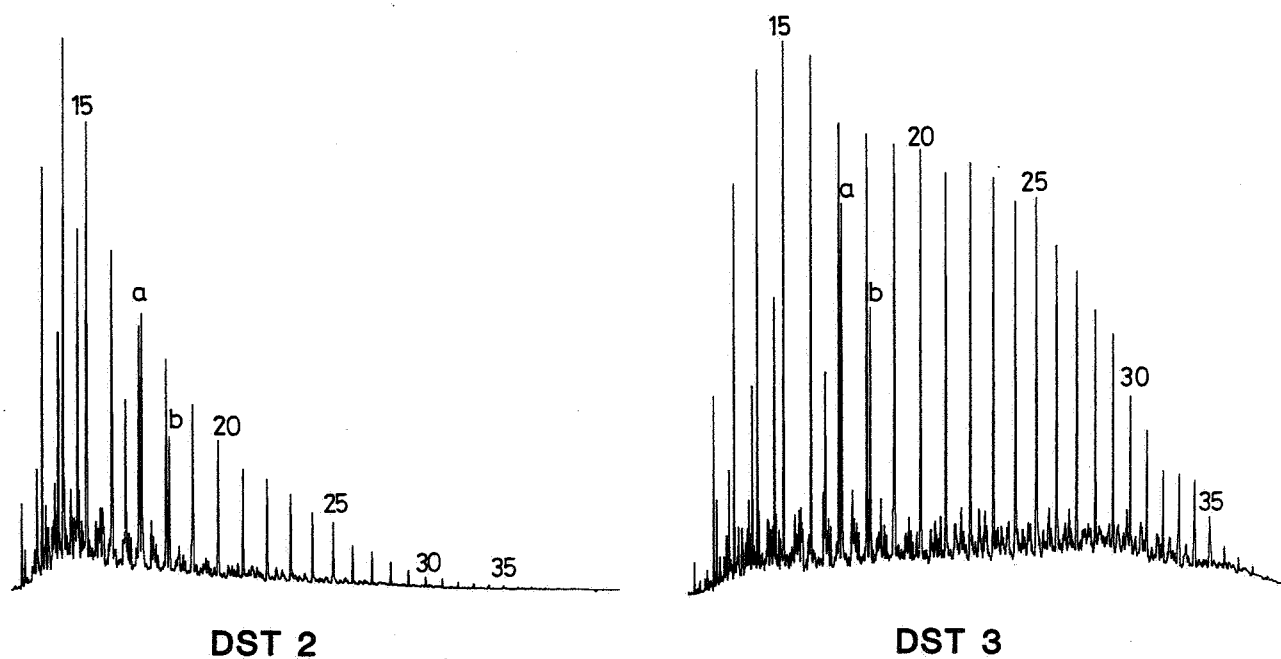
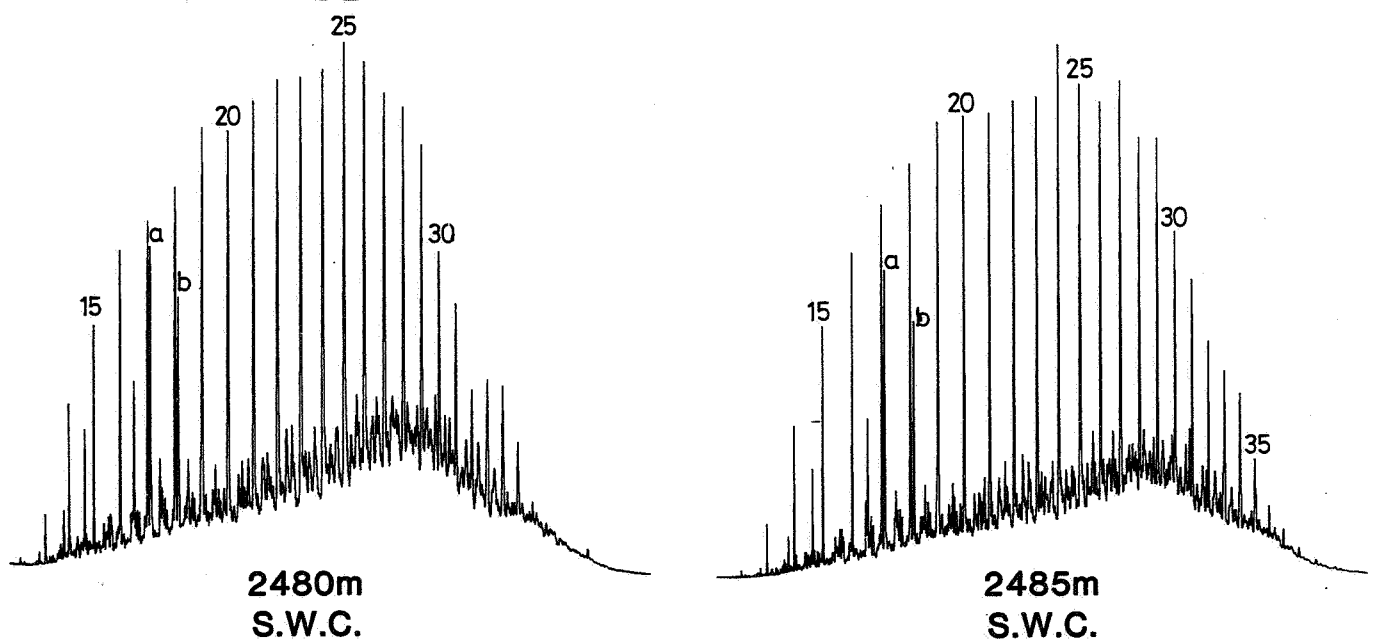


DST 4



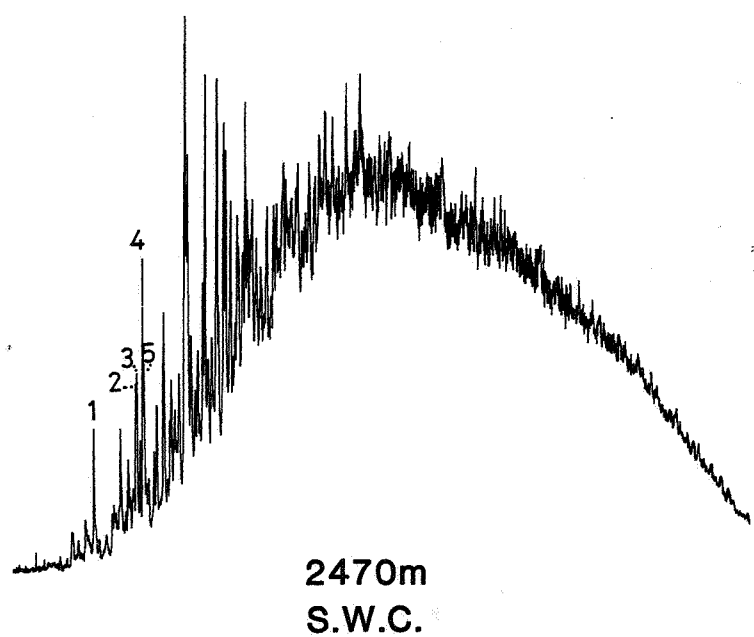
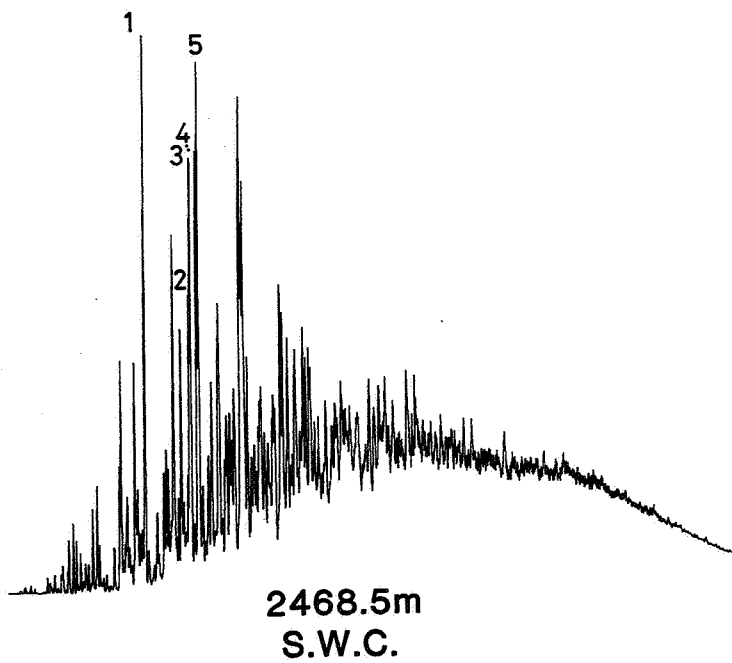
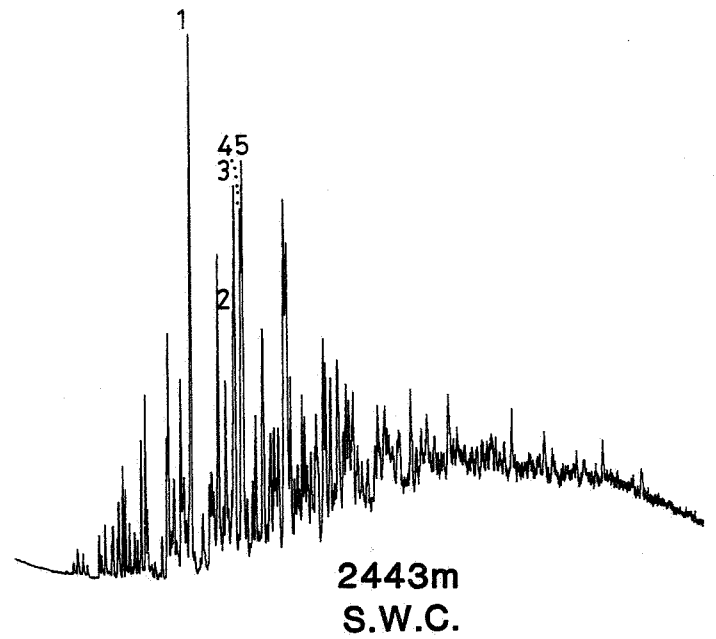
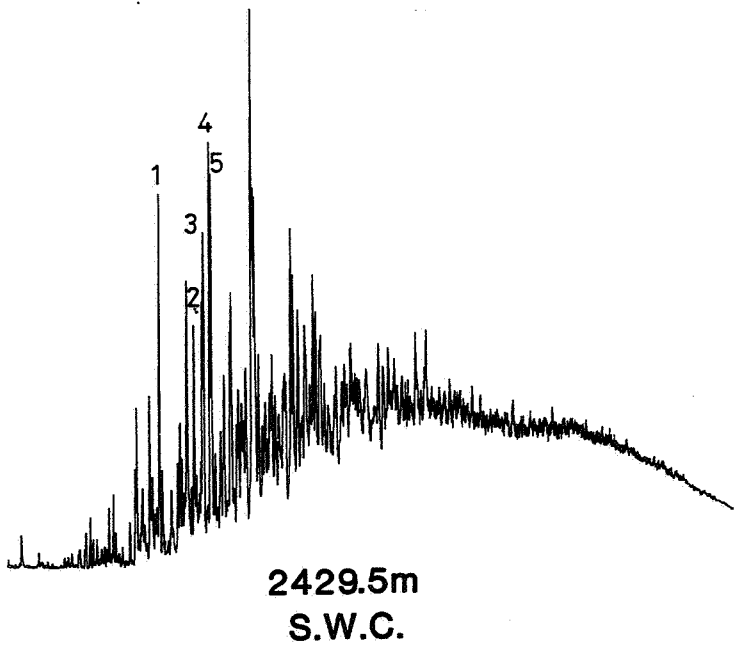
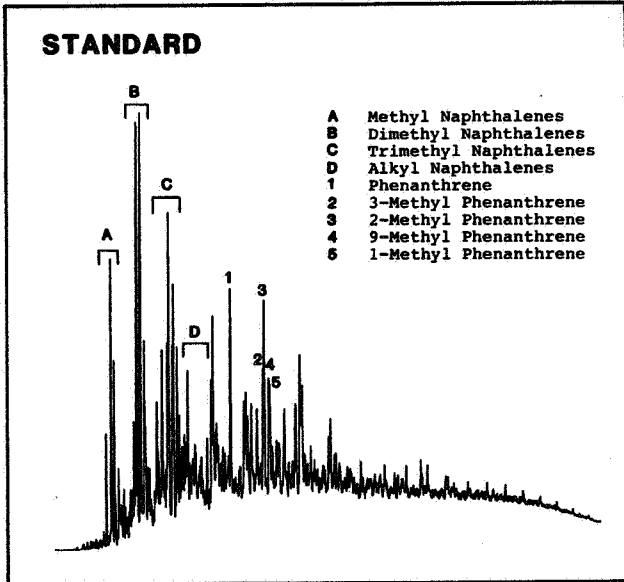
a - PRISTANE
b - PHYTANE

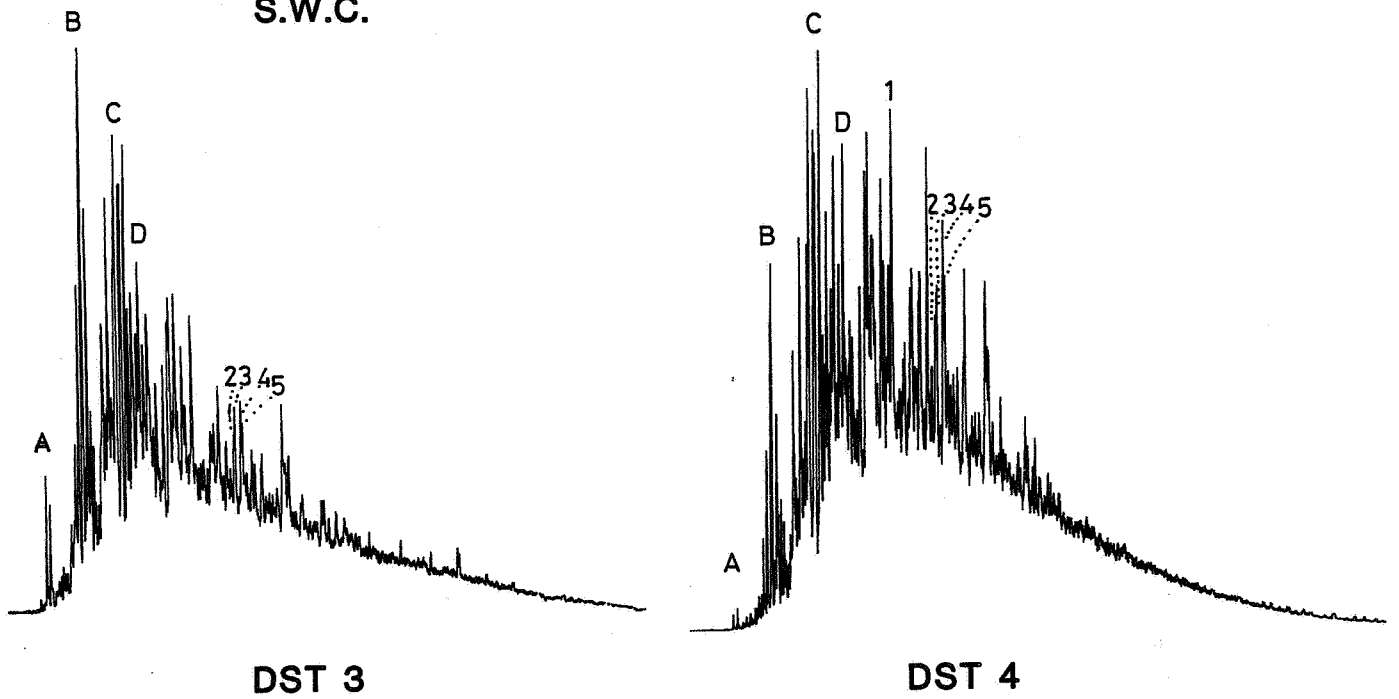
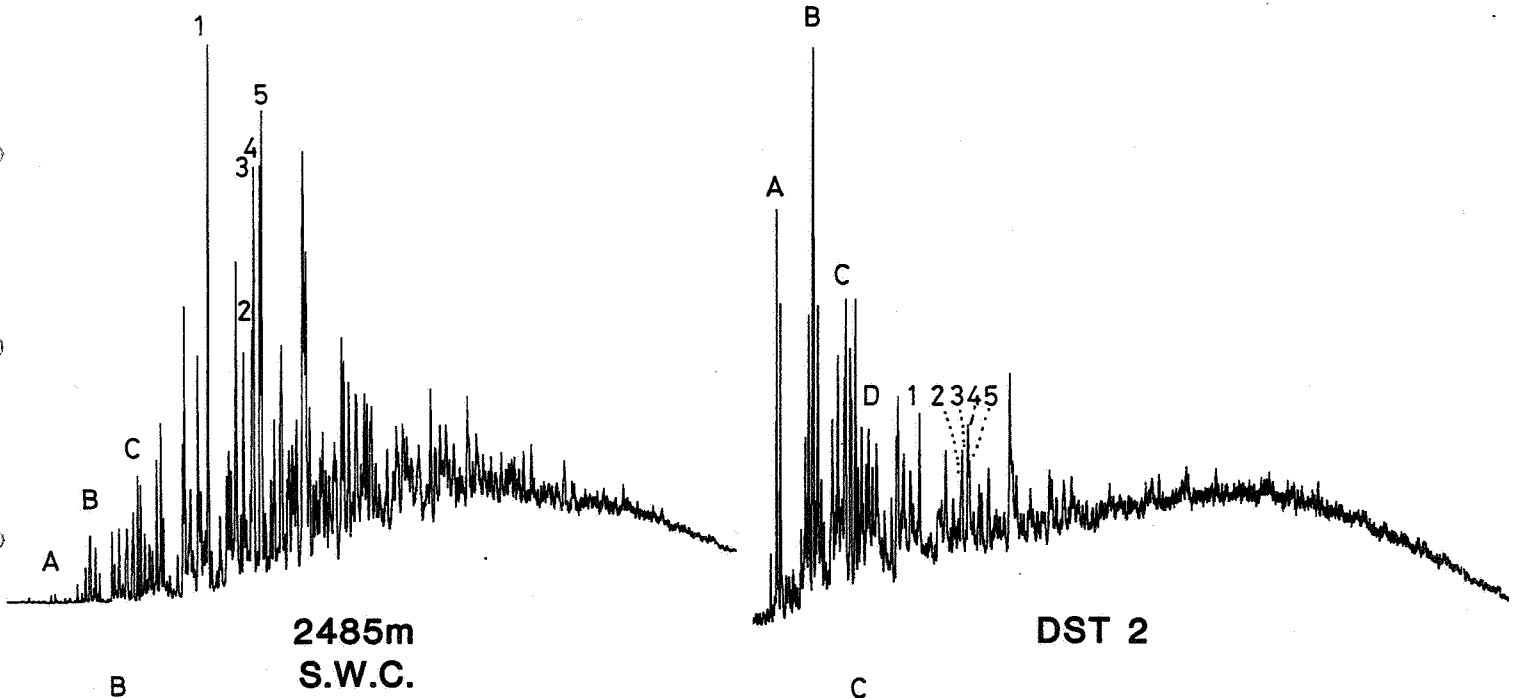
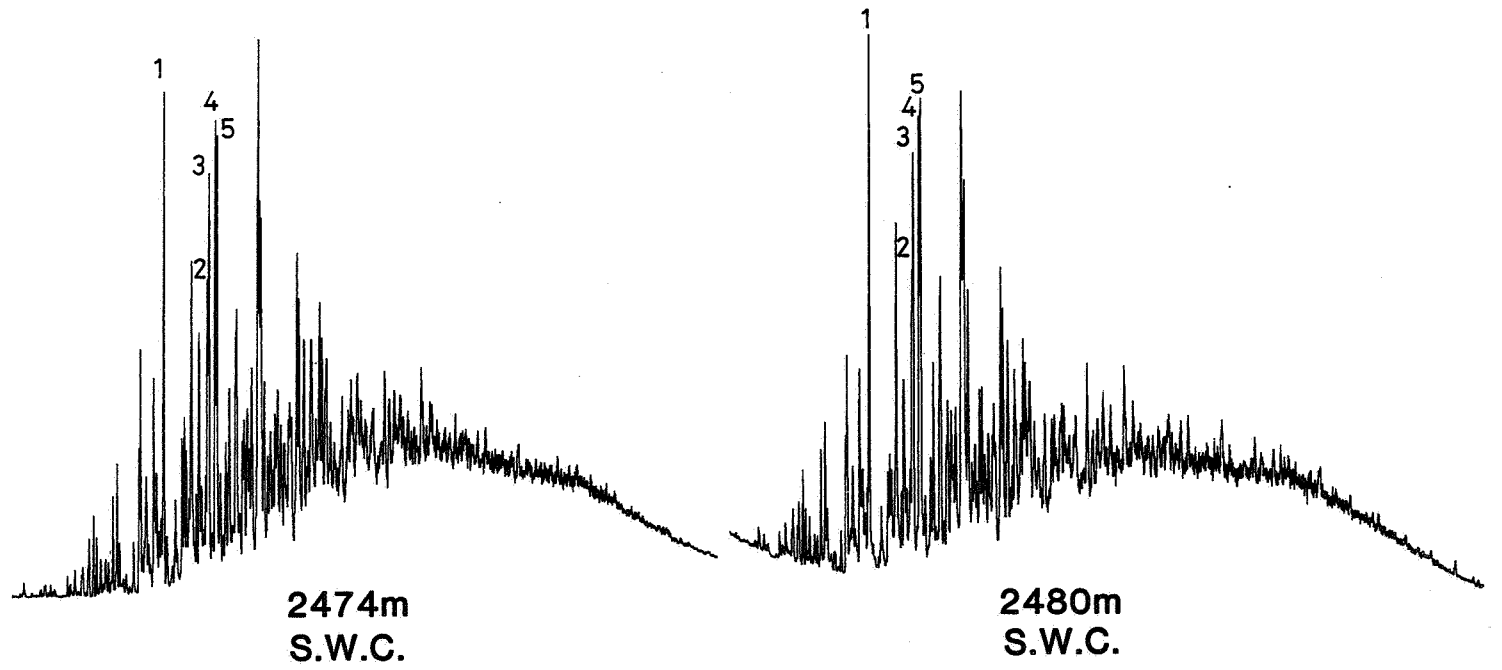
CARBON NUMBERS OF NORMAL PARAFFINS INDICATED (20 - nC₂₀)



a - PRISTANE
b - PHYTANE

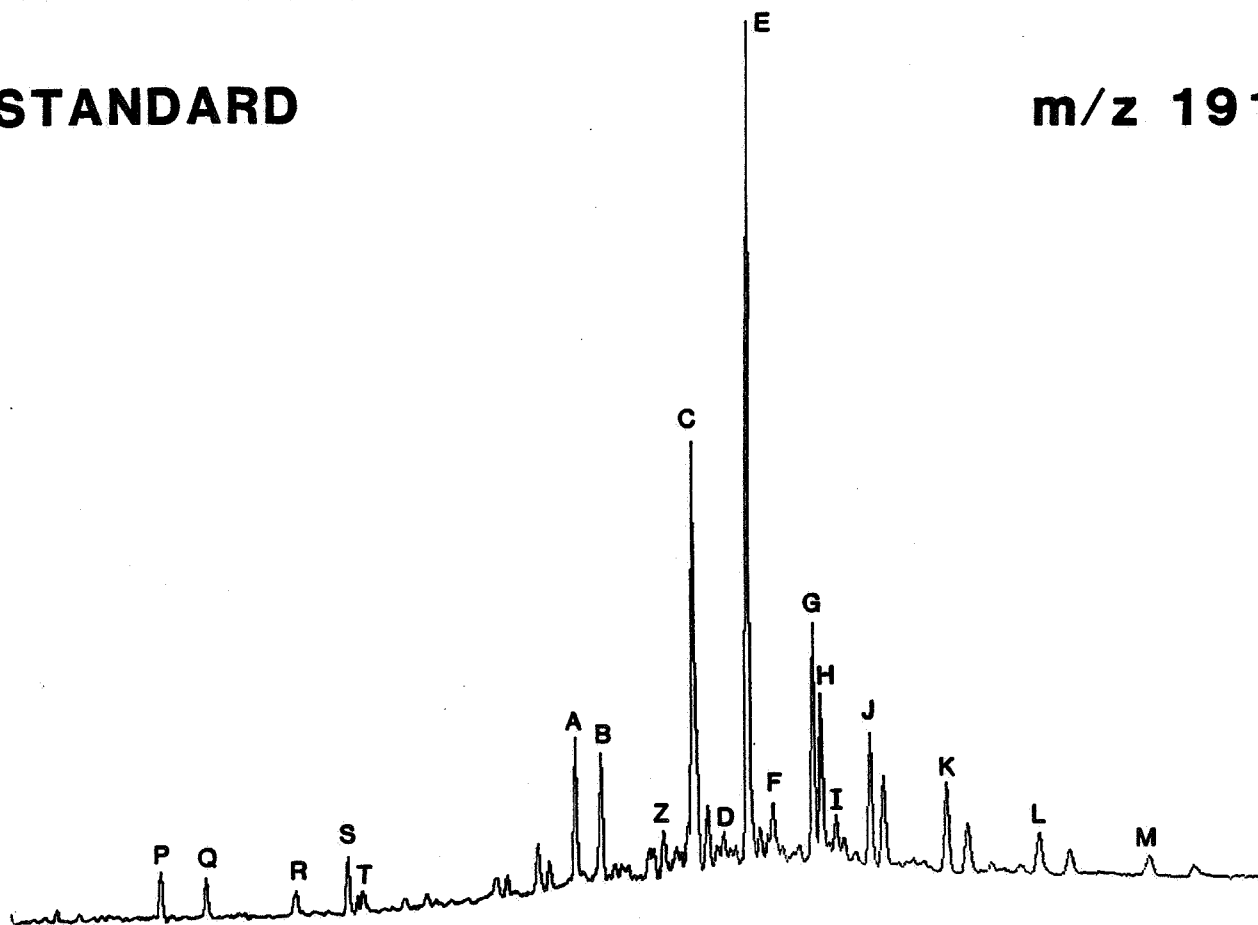
CARBON NUMBERS OF NORMAL PARAFFINS INDICATED (20 - nC₂₀)





STANDARD

m/z 191



TRITERPANE IDENTIFICATION

(M/Z 191 FRAGMENTOGRAM)

<u>COMPOUND</u>	<u>ELEMENTAL COMPOSITION</u>
A 18 (H),21 (H)-trisorneohopane (Ts)	C ₂₇ H ₄₆
B 17 (H),21 (H)-trisnorhopane (Tm)	C ₂₇ H ₄₆
C 17 (H),21 (H)-norhopane	C ₂₉ H ₅₀
D 17 (H),21 (H)-norhopane (normoretane)	C ₂₉ H ₅₀
E 17 (H),21 (H)-hopane	C ₃₀ H ₅₂
F 17 (H),21 (H)-hopane (moretane)	C ₃₀ H ₅₂
G 17 (H),21 (H)-homohopane (22S)	C ₃₁ H ₅₄
H 17 (H),21 (H)-homohopane (22R)	C ₃₁ H ₅₄
I 17 (H),21 (H)-homohopane (homomoretane)	C ₃₁ H ₅₄
J 17 (H),21 (H)-bishomohopane (22S and 22R)	C ₃₂ H ₅₆
K 17 (H),21 (H)-trishomohopane (22S and 22R)	C ₃₃ H ₅₈
L 17 (H),21 (H)-tetrakishomohopane (22S and 22R)	C ₃₄ H ₅₈
M 17 (H),21 (H)-pentakishomohopane (22S and 22R)	C ₃₅ H ₆₀
Z = C ₂₈ bisnorhopane	

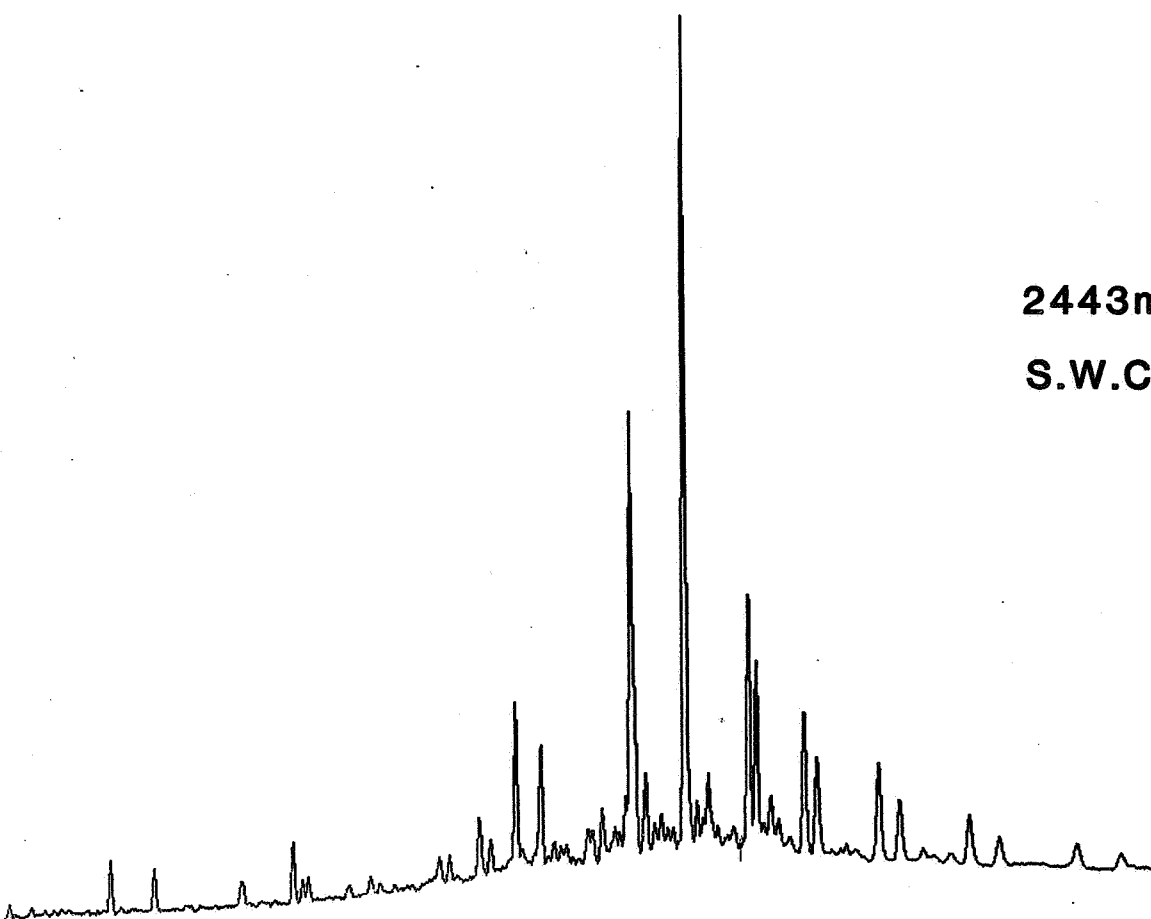
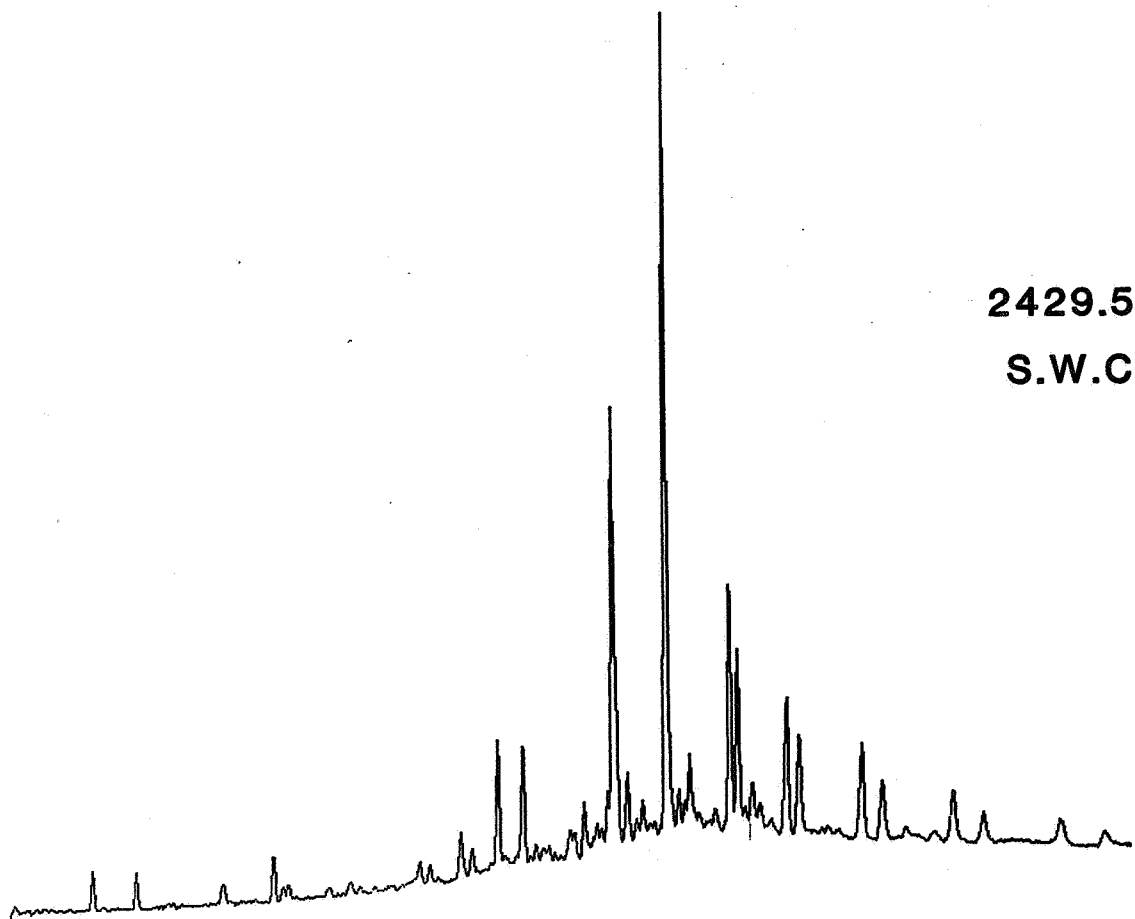
TRICYCLIC AND TETRACYCLIC TERPANES (M/Z 191)

P	C ₂₃ H ₄₂
Q	C ₂₄ H ₄₄
R	C ₂₅ H ₄₆
S	C ₂₄ H ₄₂
T	C ₂₆ H ₄₈

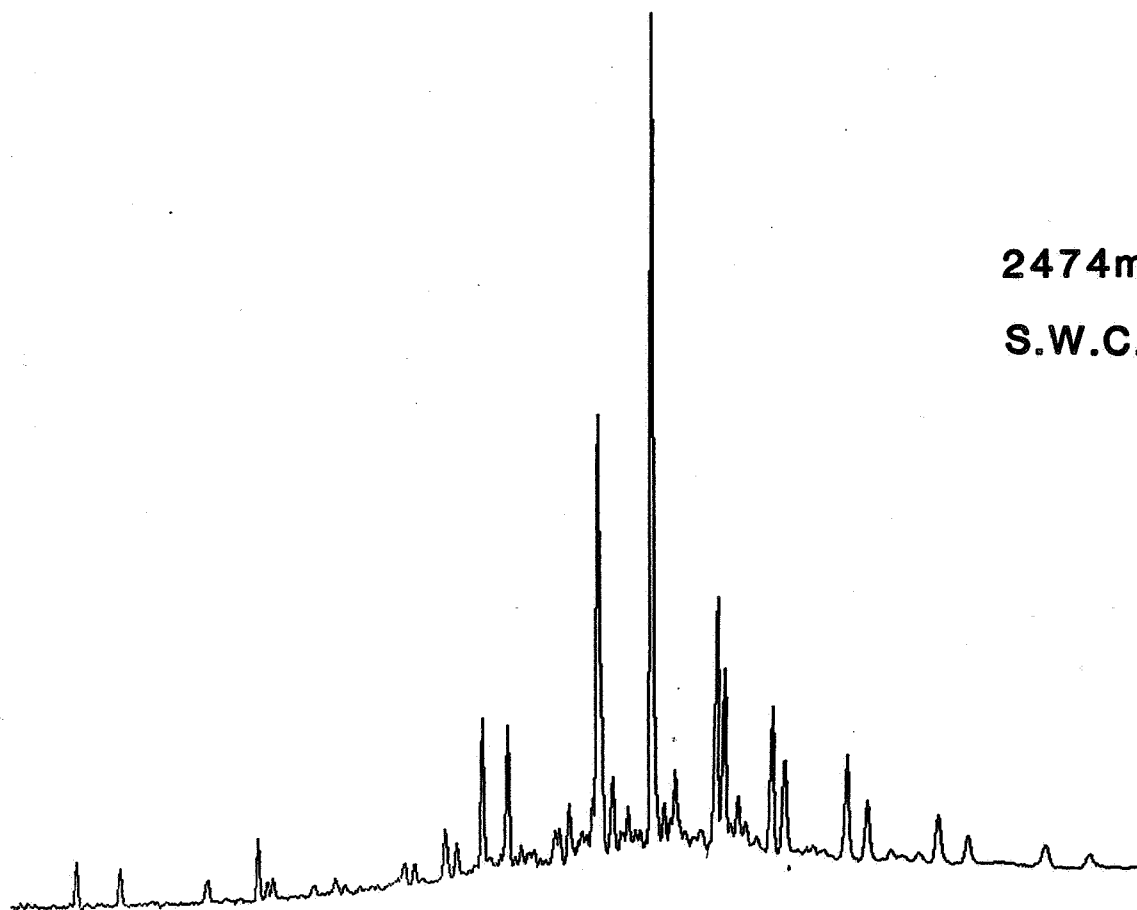
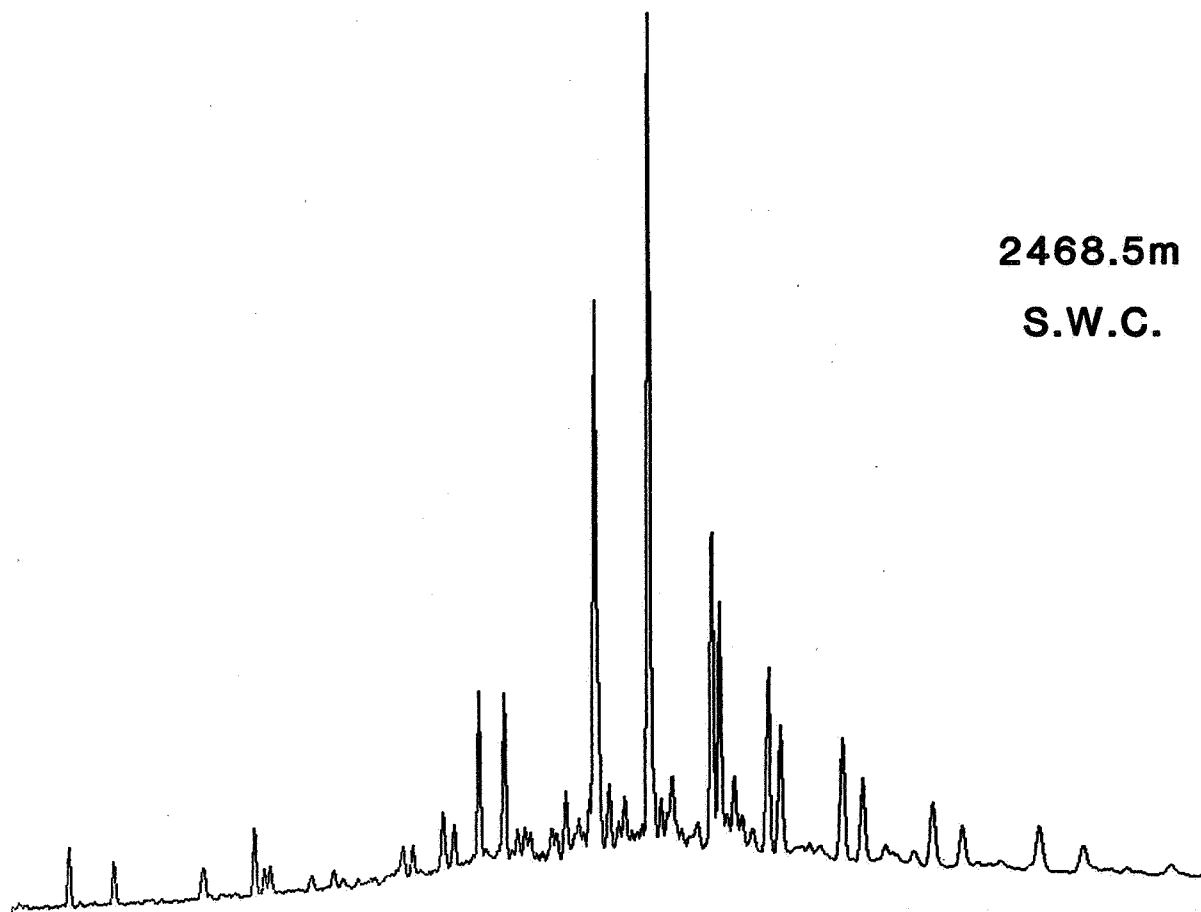
TRITERPANES m/z 191

2429.5m
S.W.C.

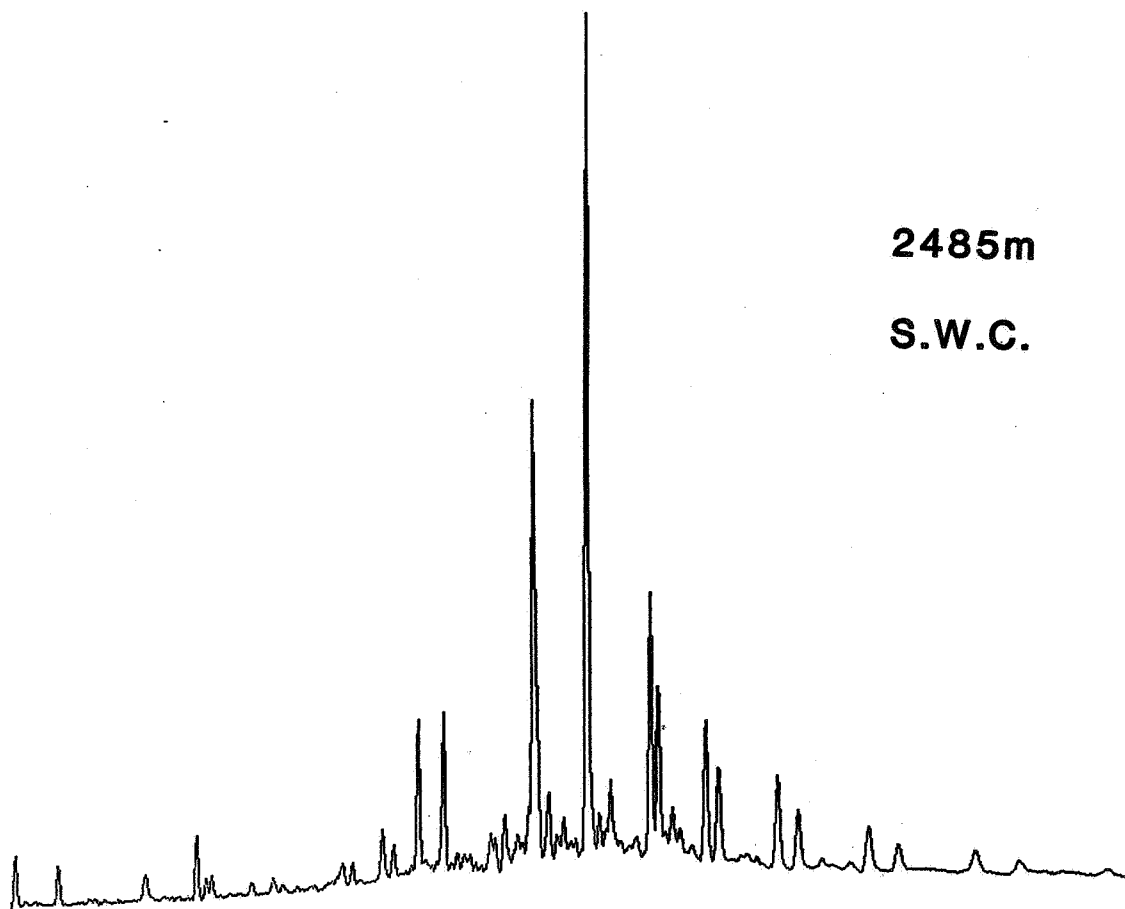
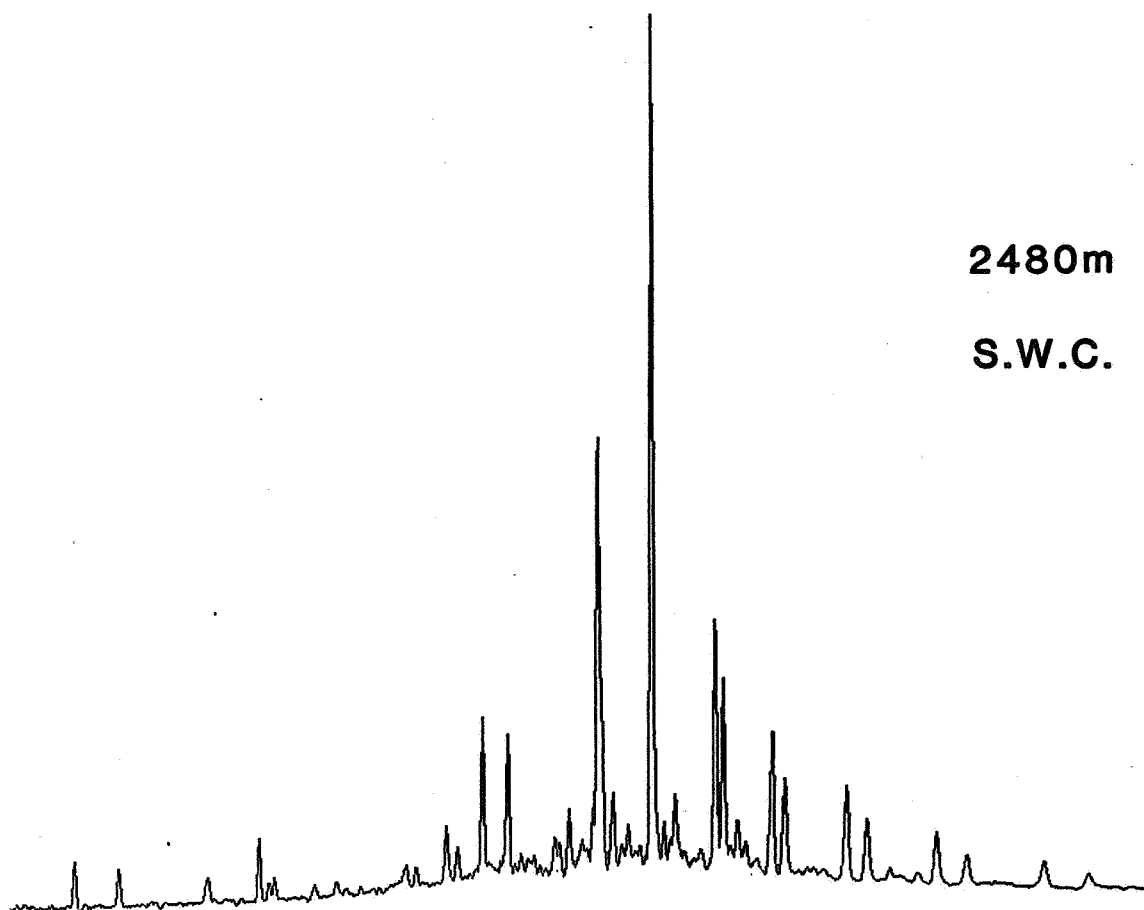
2443m
S.W.C.



TRITERPANES m/z 191



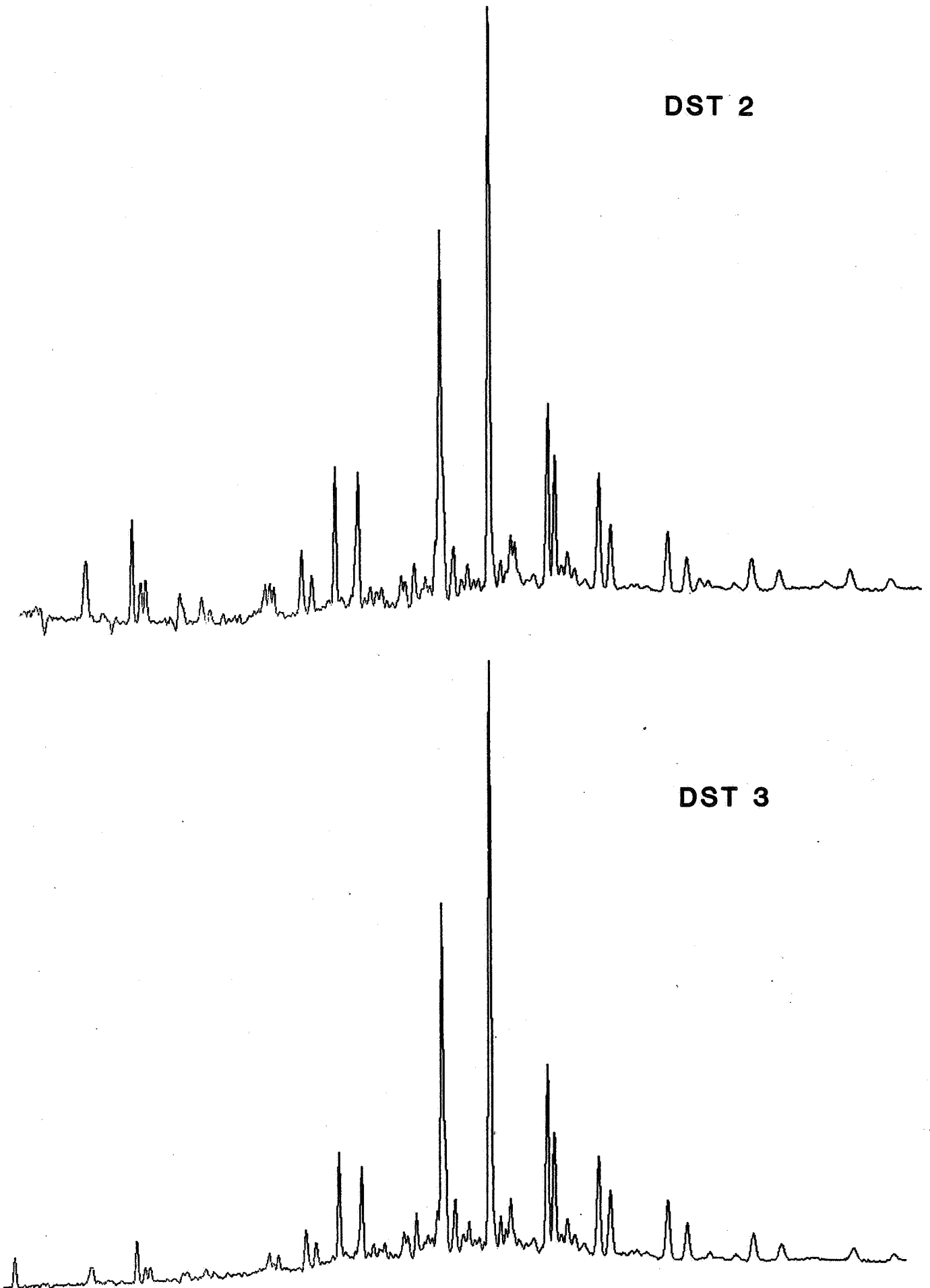
TRITERPANES m/z 191



TRITERPANES m/z 191

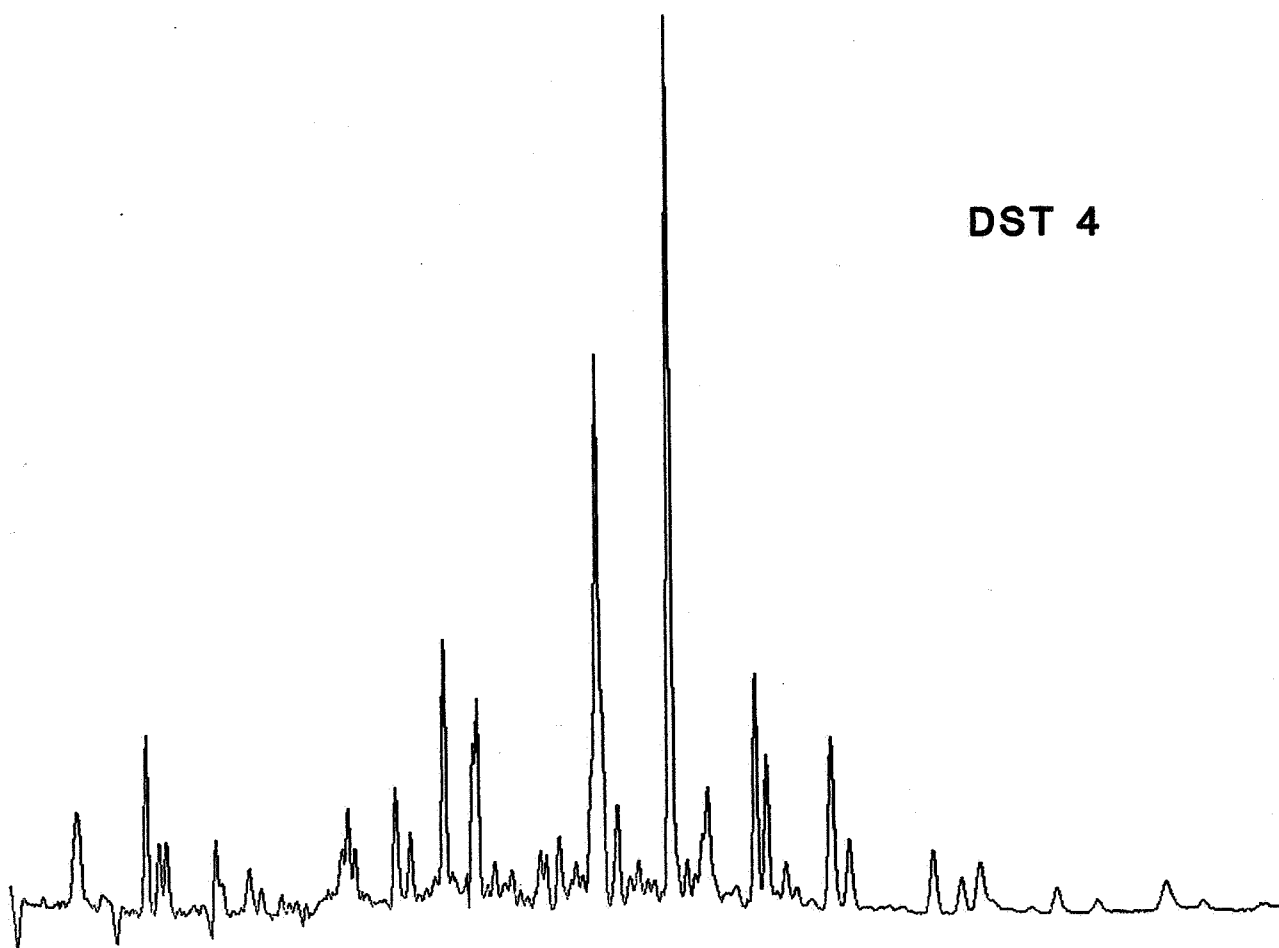
DST 2

DST 3



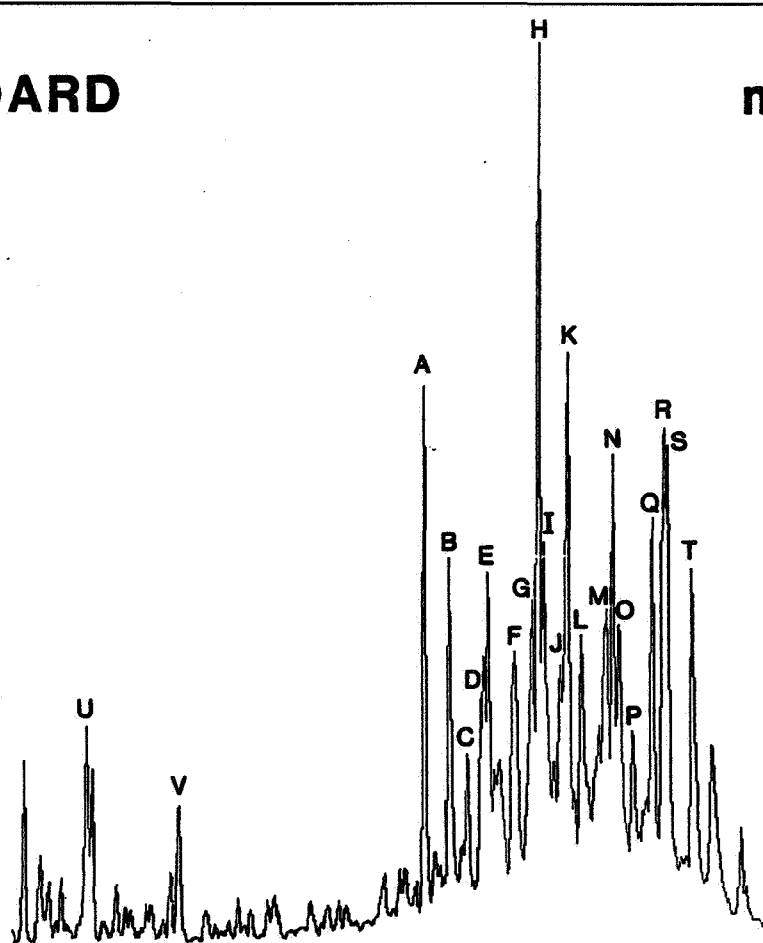
TRITERPANES m/z 191

DST 4



STANDARD

m/z 217

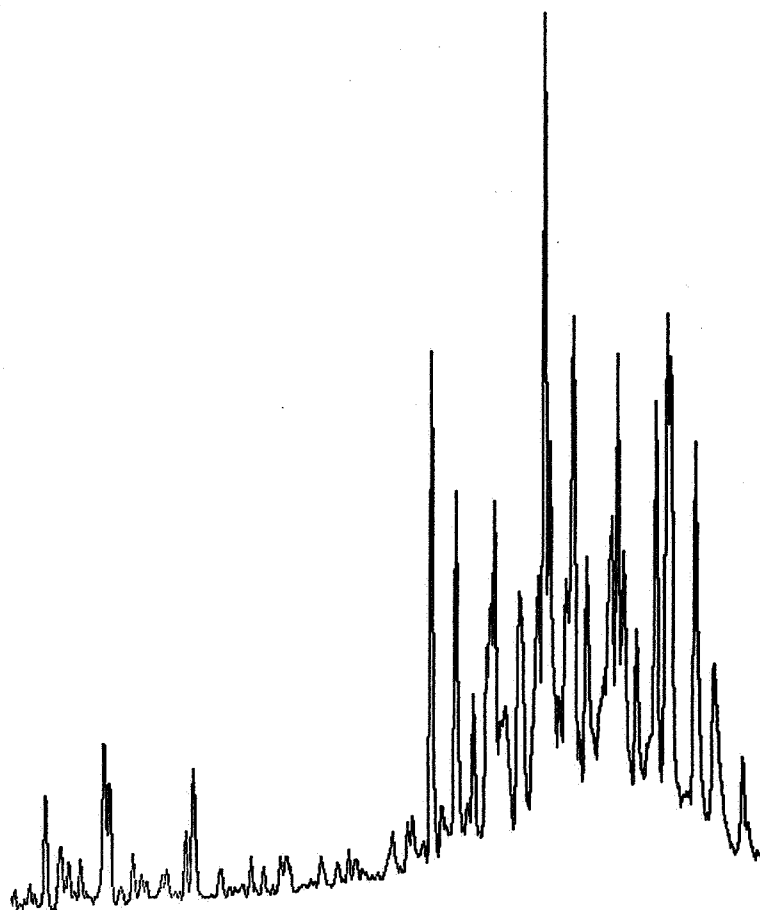


STERANE IDENTIFICATION

(M/Z 217 FRAGMENTOGRAM)

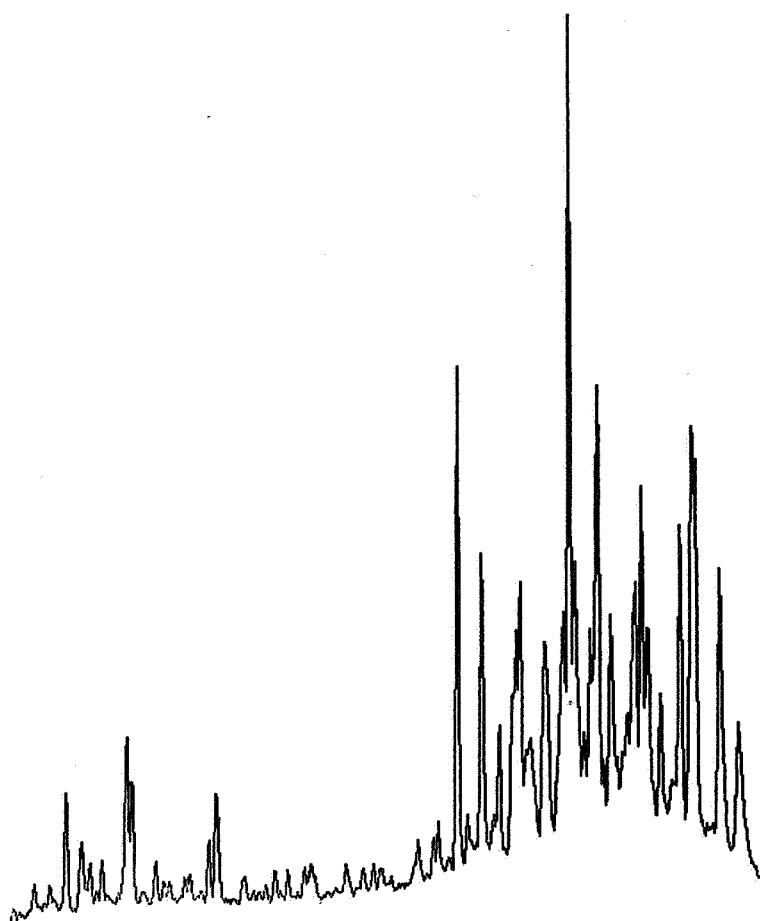
COMPOUND	(M/Z 217 FRAGMENTOGRAM)	ELEMENTAL COMPOSITION
A	13 β ,17 α -diacholestane (20S)	C ₂₇ H ₄₈
B	13 β ,17 α -diacholestane (20R)	C ₂₇ H ₄₈
C	13 α ,17 β -diacholestane (20S)	C ₂₇ H ₄₈
D	13 α ,17 β -diacholestane (20R)	C ₂₇ H ₄₈
E	24-methyl-13 β ,17 α -diacholestane (20S)	C ₂₈ H ₅₀
F	24-methyl-13 β ,17 α -diacholestane (20R)	C ₂₈ H ₅₀
G	24-methyl-13 α ,17 β -diacholestane (20S)	C ₂₈ H ₅₀
+	14 α ,17 α -cholestane (20S)	C ₂₇ H ₄₈
H	24-ethyl-13 β ,17 α -diacholestane (20S)	C ₂₉ H ₅₂
+	14 β ,17 β -cholestane (20R)	C ₂₇ H ₄₈
I	14 β ,17 β -cholestane (20S)	C ₂₇ H ₄₈
+	24-methyl-13 α ,17 β -diacholestane (20R)	C ₂₈ H ₅₀
J	14 α ,17 α -cholestane (20R)	C ₂₇ H ₄₈
K	24-ethyl-13 β ,17 α -diacholestane (20R)	C ₂₉ H ₅₂
L	24-ethyl-14 α ,17 β -diacholestane (20S)	C ₂₉ H ₅₂
M	24-methyl-13 α ,17 α -cholestane (20S)	C ₂₈ H ₅₀
N	24-ethyl-13 α ,17 β -diacholestane (20R)	C ₂₉ H ₅₂
+	24-methyl-14 β ,17 β -cholestane (20R)	C ₂₈ H ₅₀
O	24-methyl-14 β ,17 β -cholestane (20S)	C ₂₈ H ₅₀
P	24-methyl-14 α ,17 α -cholestane (20R)	C ₂₈ H ₅₀
Q	24-ethyl-14 α ,17 α -cholestane (20S)	C ₂₉ H ₅₂
R	24-ethyl-14 β ,17 β -cholestane (20R)	C ₂₉ H ₅₂
+	UNKNOWN STERANE	
S	24-ethyl-14 β ,17 β -cholestane (20S)	C ₂₉ H ₅₂
T	24-ethyl-14 α ,17 α -cholestane (20R)	C ₂₉ H ₅₂
U	5 α (H)-pregnane	C ₂₁ H ₃₆
V	5 α (H)-bisanorcholane	C ₂₂ H ₃₈

STERANES m/z 217



2429.5m

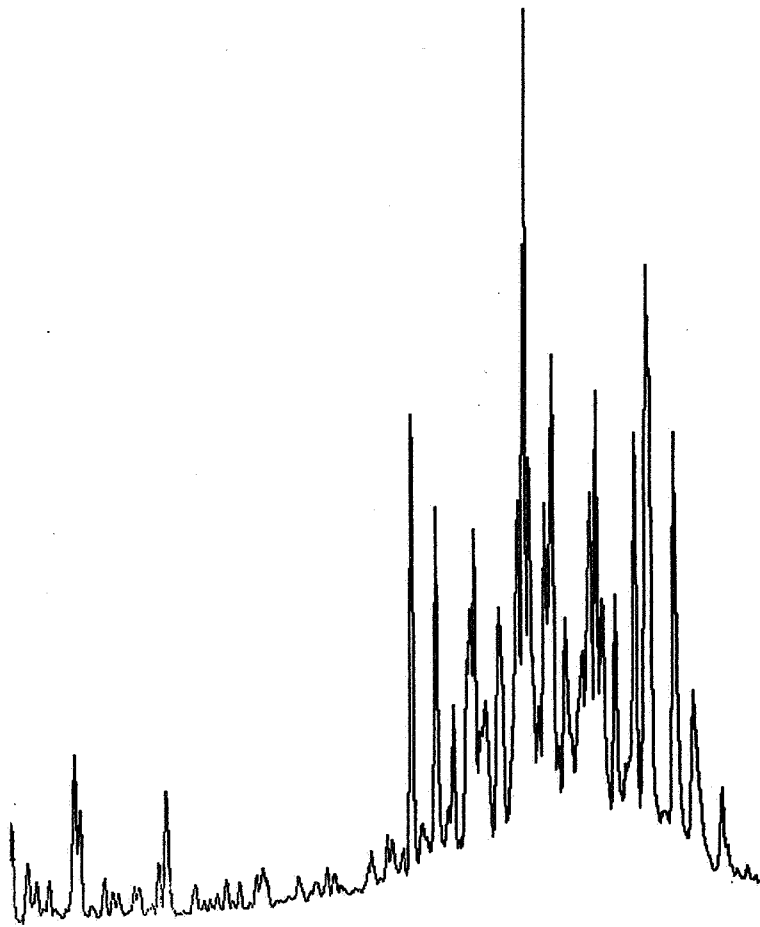
S.W.C.



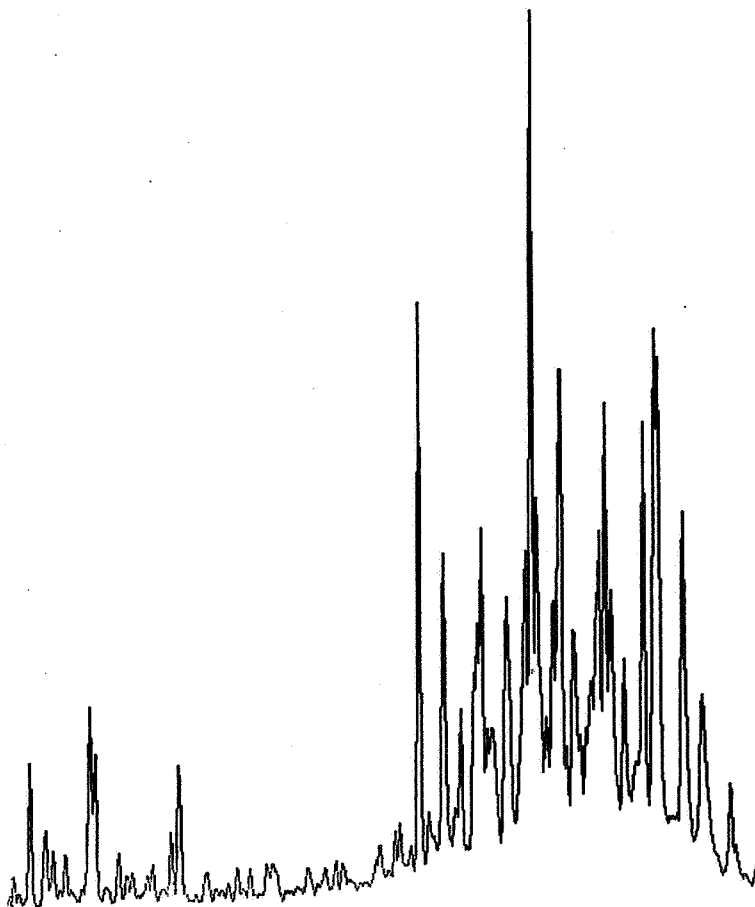
2443m

S.W.C.

STERANES m/z 217



2468.5m
S.W.C.

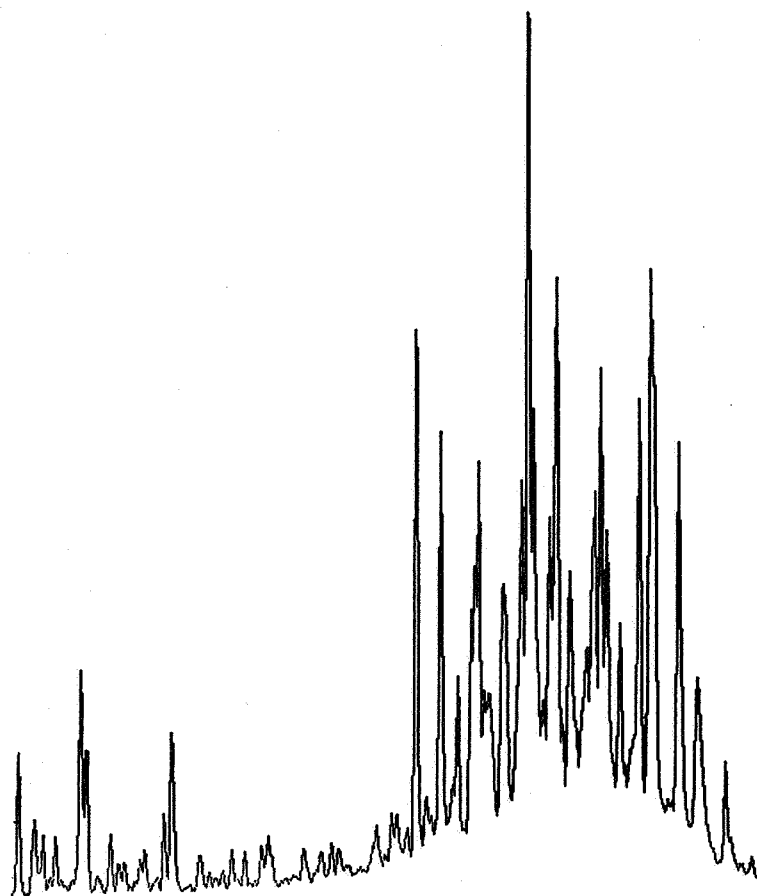


2474m
S.W.C.

STERANES m/z 217

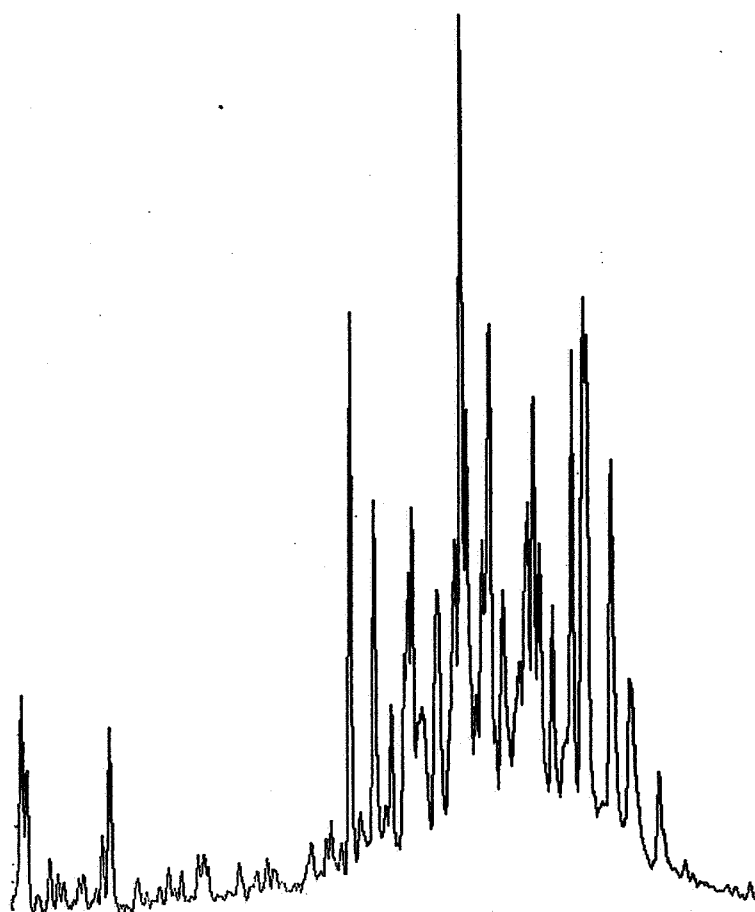
2480m

S.W.C.

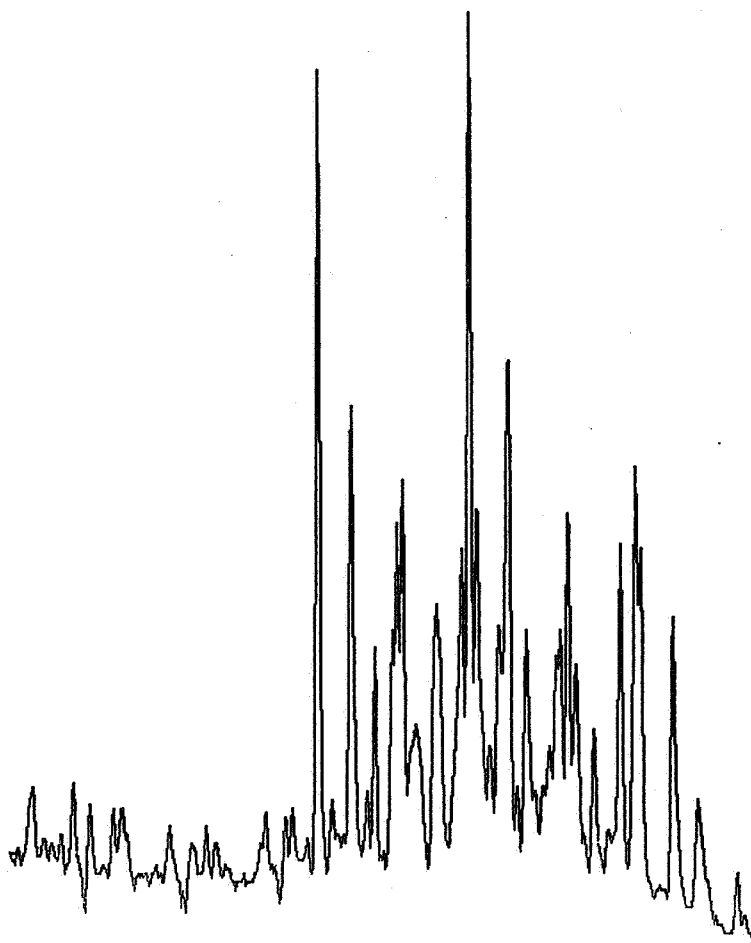


2485m

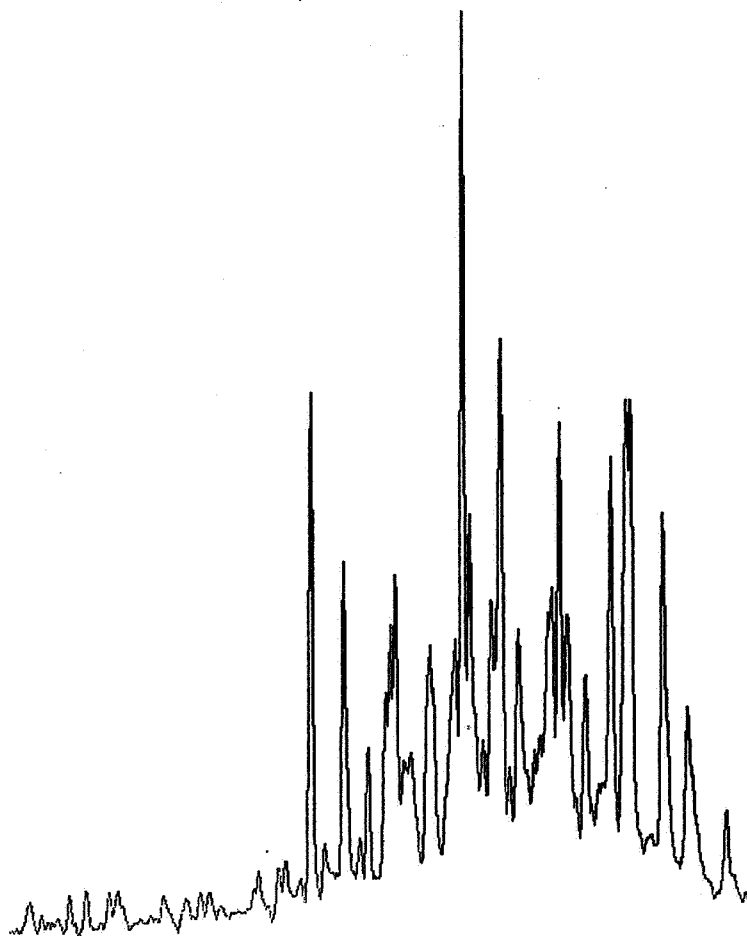
S.W.C.



STERANES m/z 217

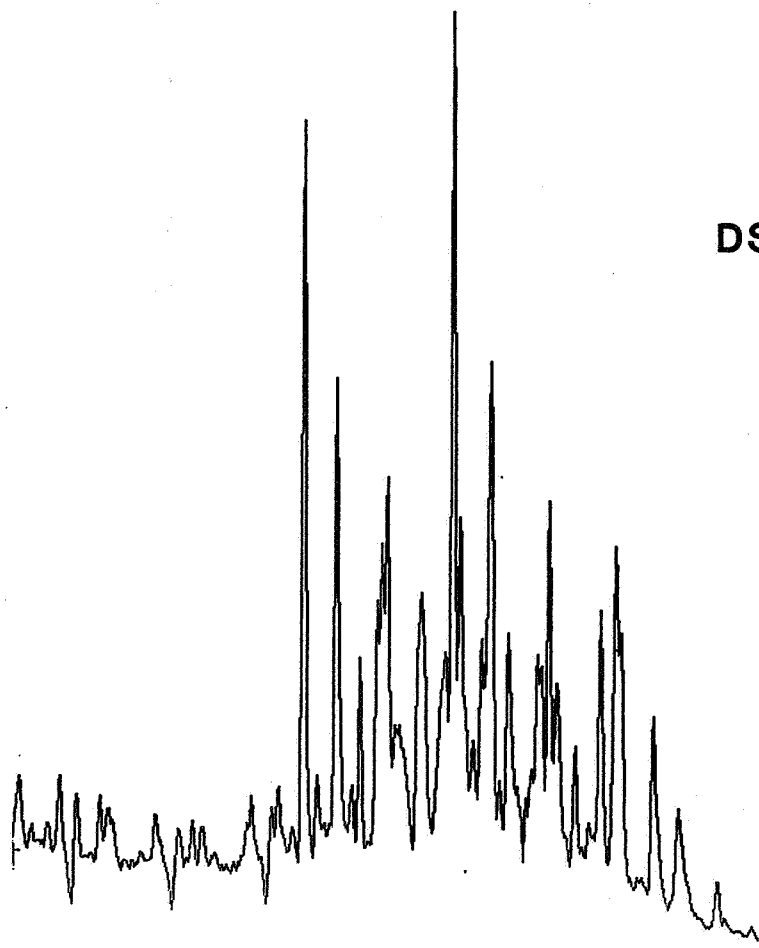


DST 2



DST 3

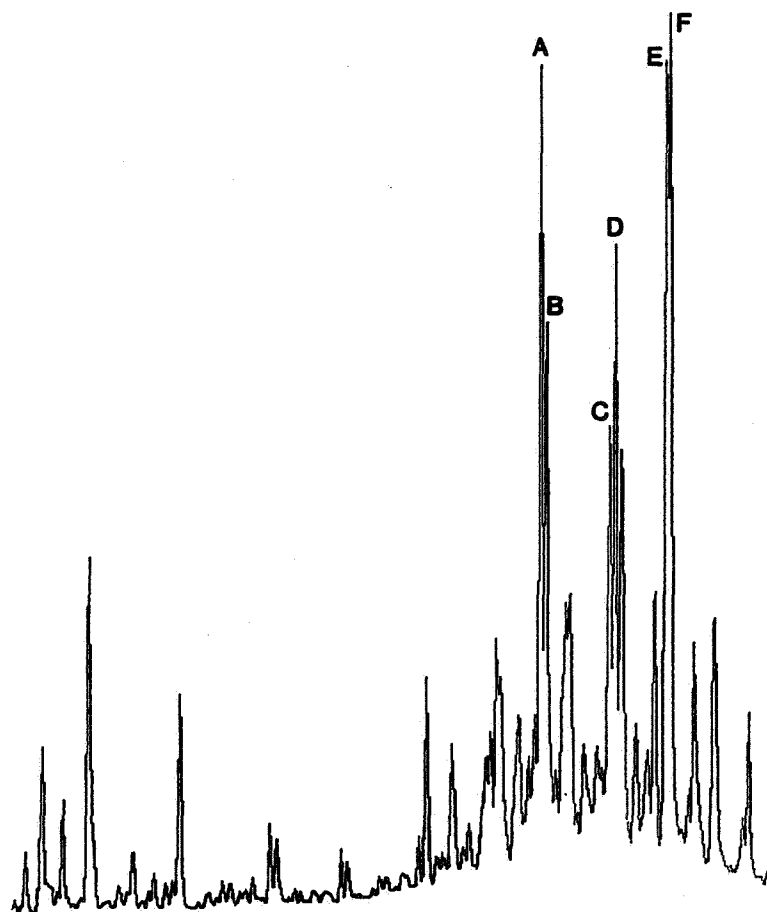
STERANES. m/z 217



DST 4

STANDARD

m/z 218

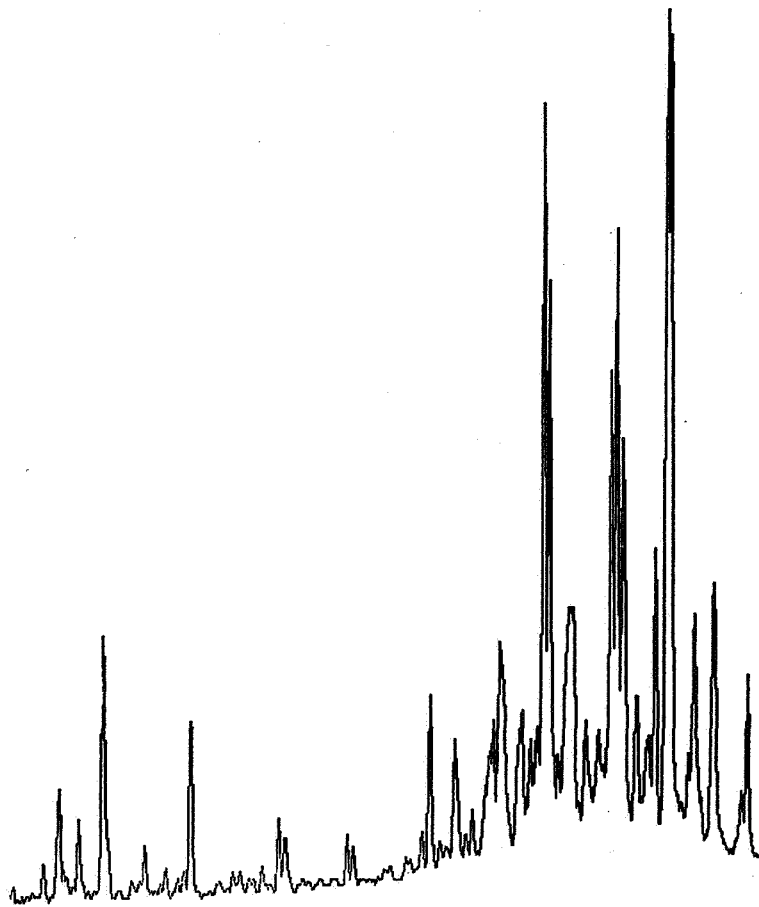


STERANE IDENTIFICATION

(M/Z 218 FRAGMENTOGRAM)

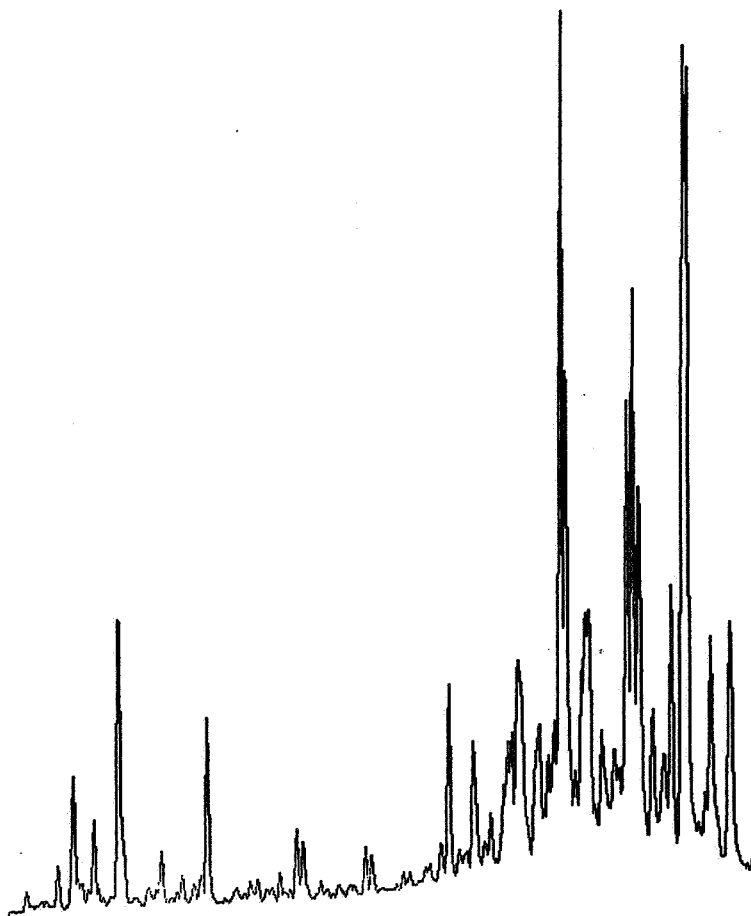
<u>COMPOUND</u>	<u>ELEMENTAL COMPOUND</u>
A 14 β ,17 β -cholestane (20R)	C ₂₇ H ₄₈
B 14 β ,17 β -cholestane (20S)	C ₂₇ H ₄₈
C 24-methyl-14 β ,17 β -cholestane (20R)	C ₂₈ H ₅₀
D 24-methyl-14 β ,17 β -cholestane (20S)	C ₂₈ H ₅₀
E 24-ethyl-14 β ,17 β -cholestane (20R)	C ₂₉ H ₅₂
F 24-ethyl-14 β ,17 β -cholestane (20S)	C ₂₉ H ₅₂

STERANES m/z 218



2429.5m

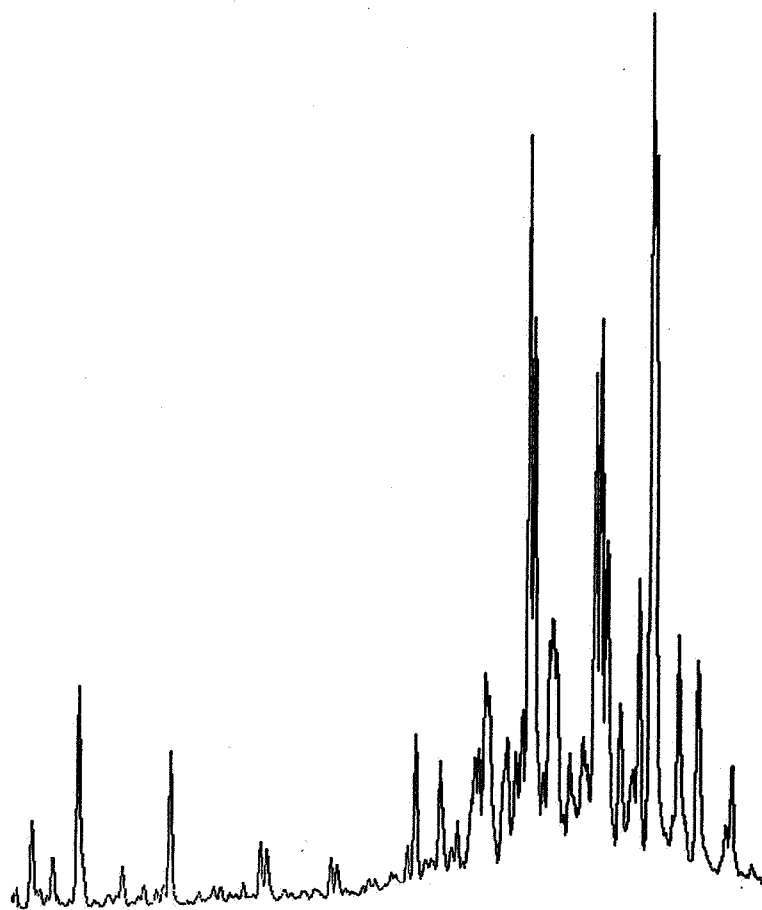
S.W.C.



2443m

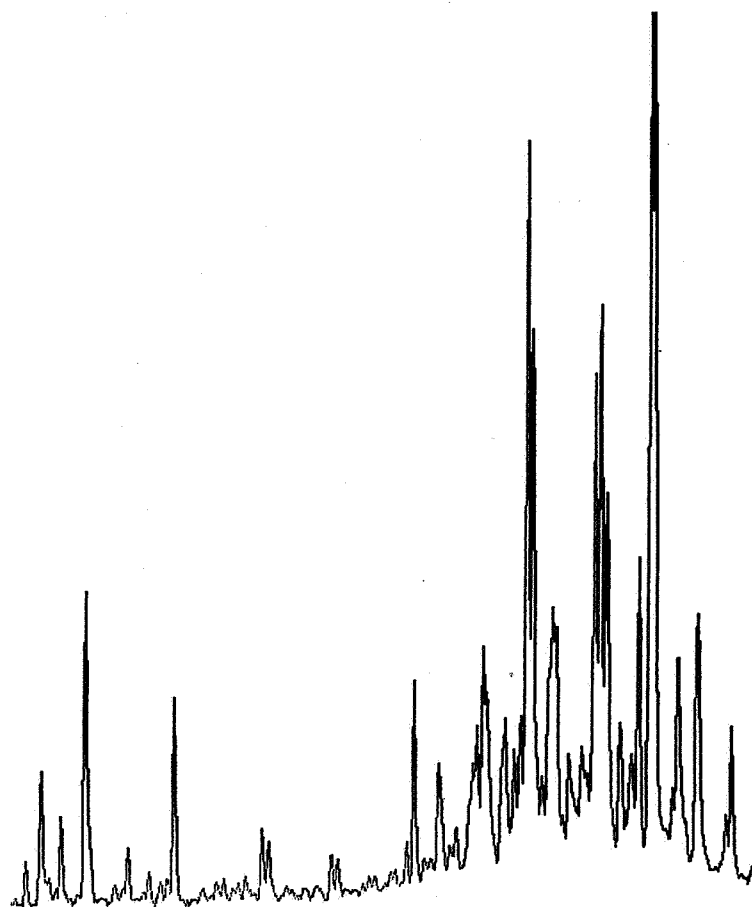
S.W.C.

STERANES m/z 218



2468.5m

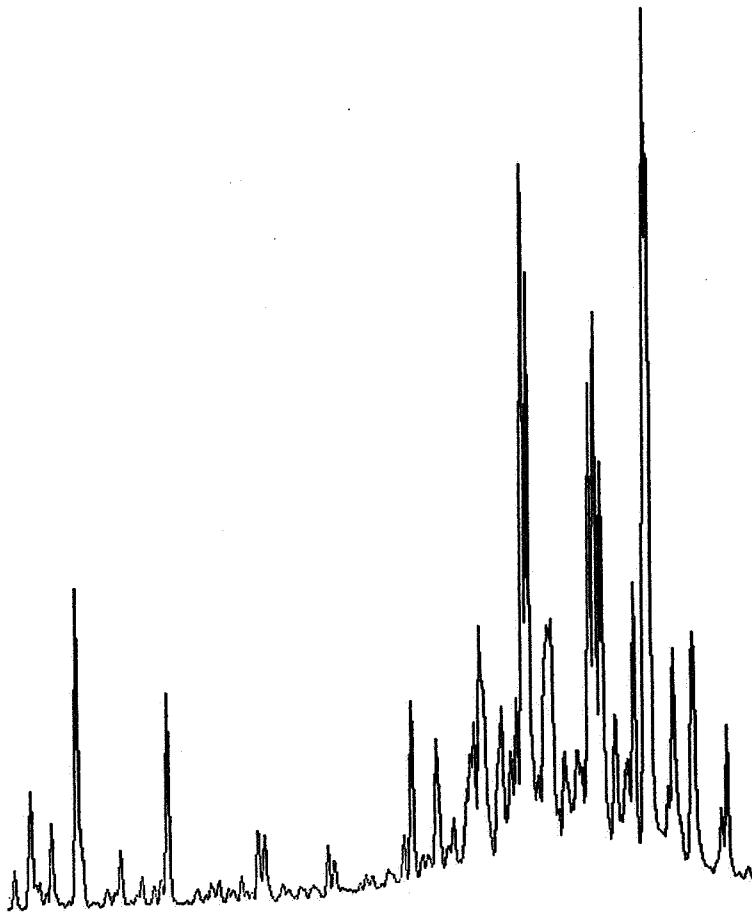
S.W.C.



2474m

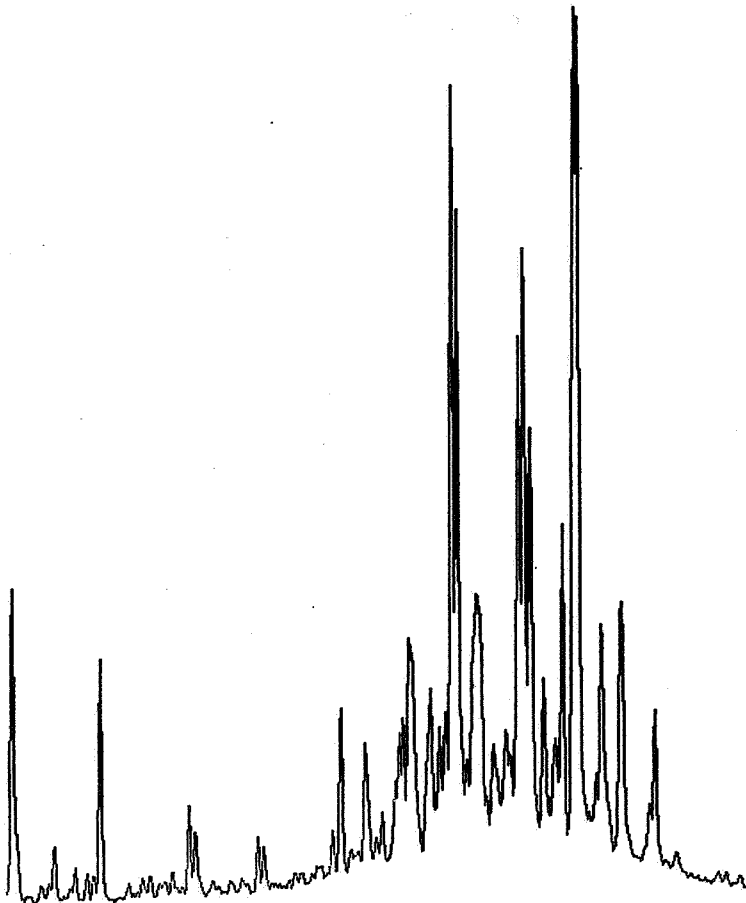
S.W.C.

STERANES m/z 218



2480m

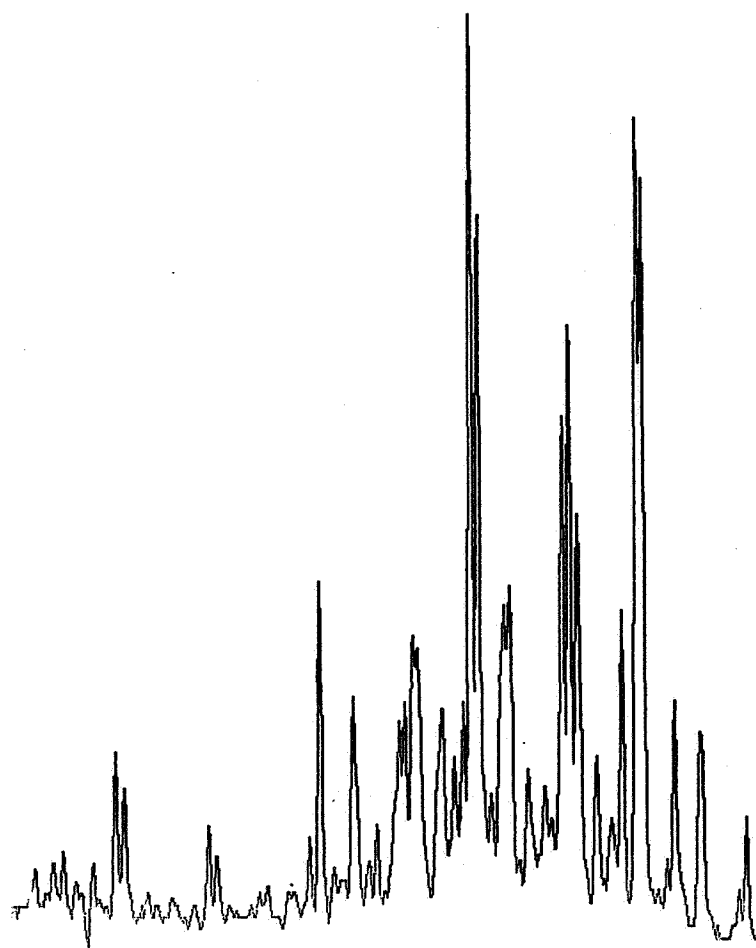
S.W.C.



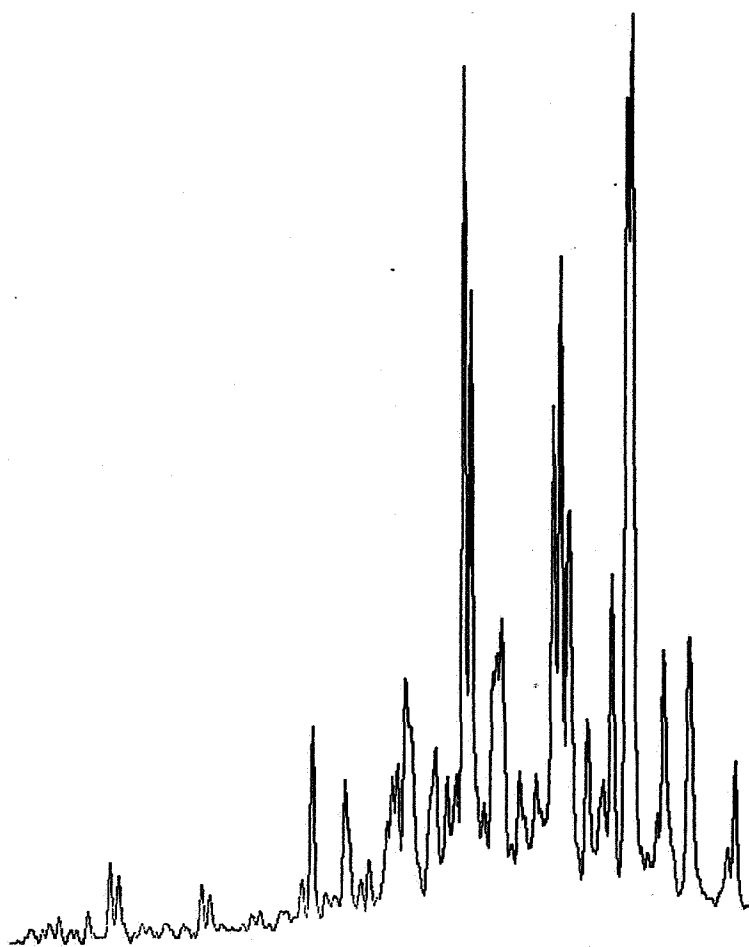
2485m

S.W.C.

STERANES m/z 218

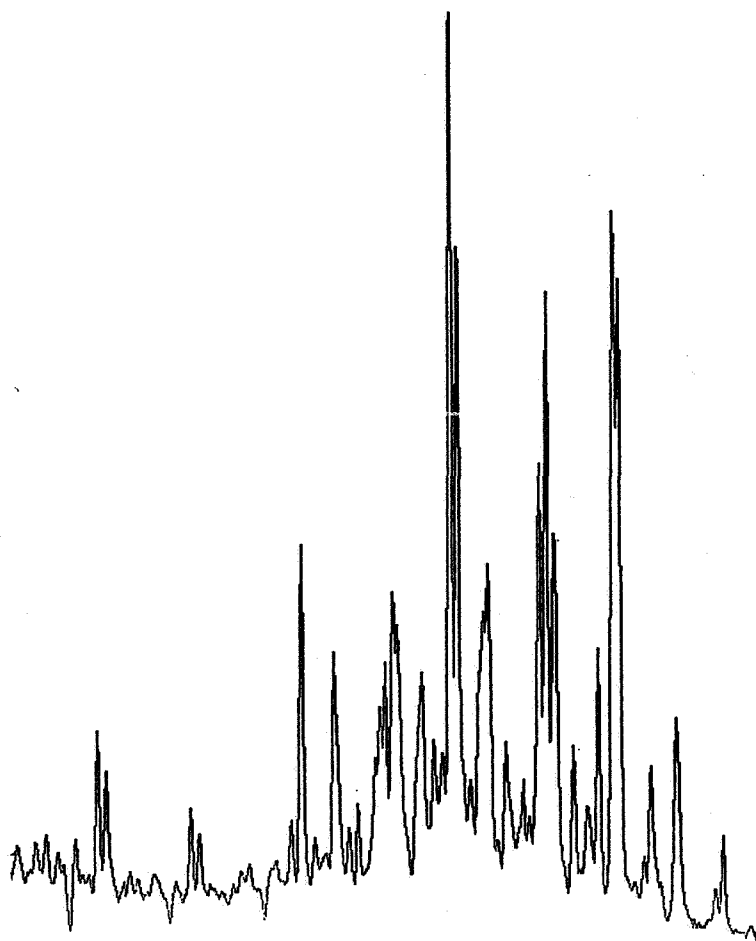


DST 2



DST 3

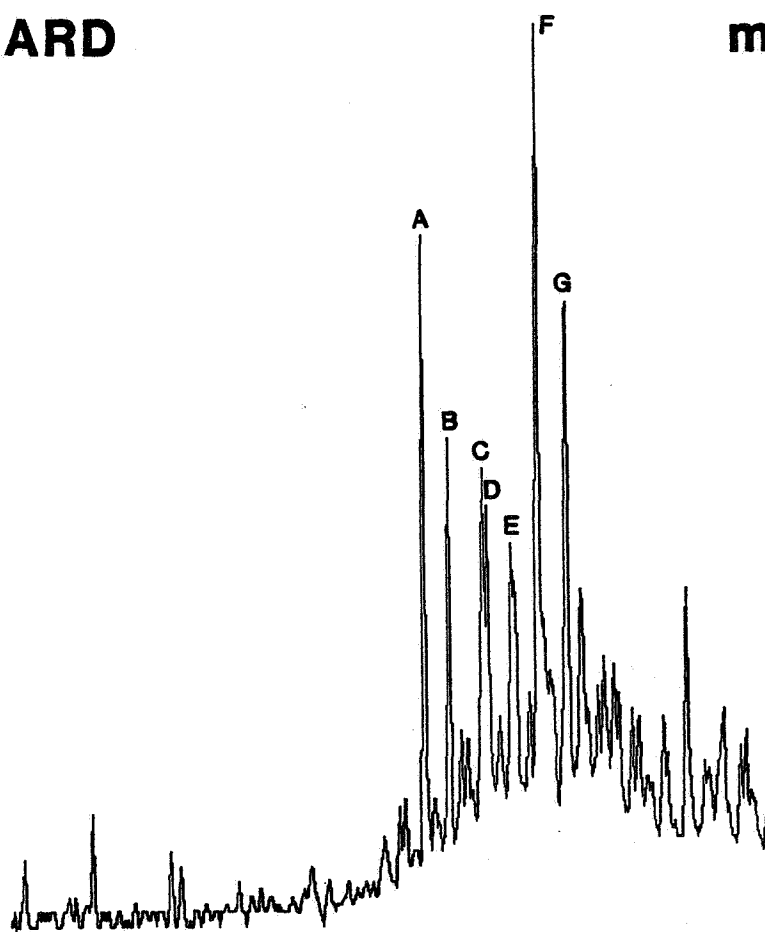
STERANES m/z 218



DST 4

STANDARD

m/z 259

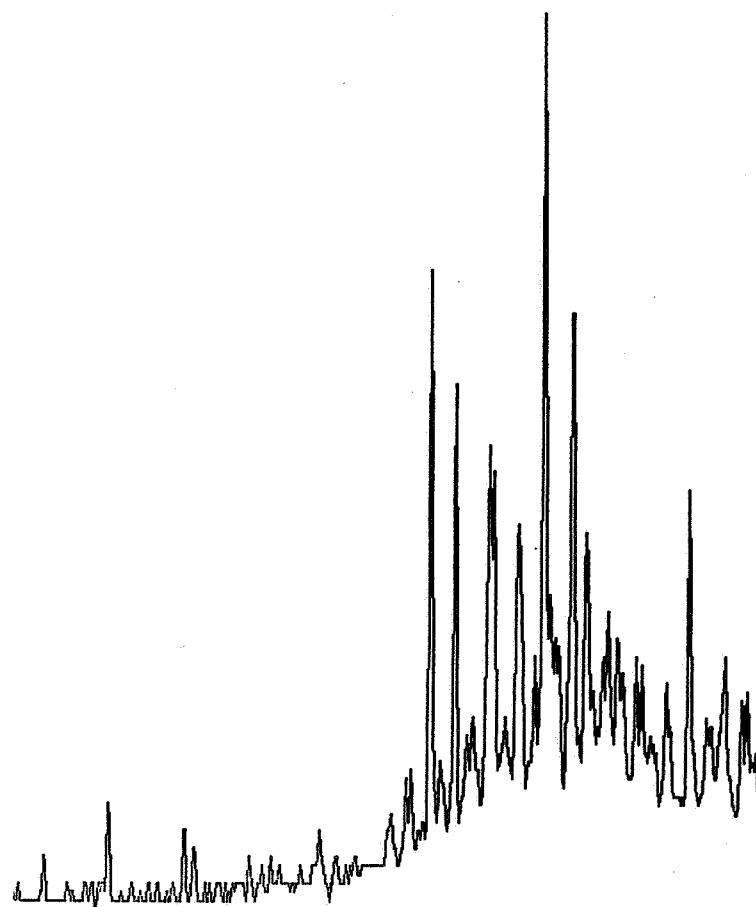


STERANE IDENTIFICATION

(M/Z 259 FRAGMENTOGRAM)

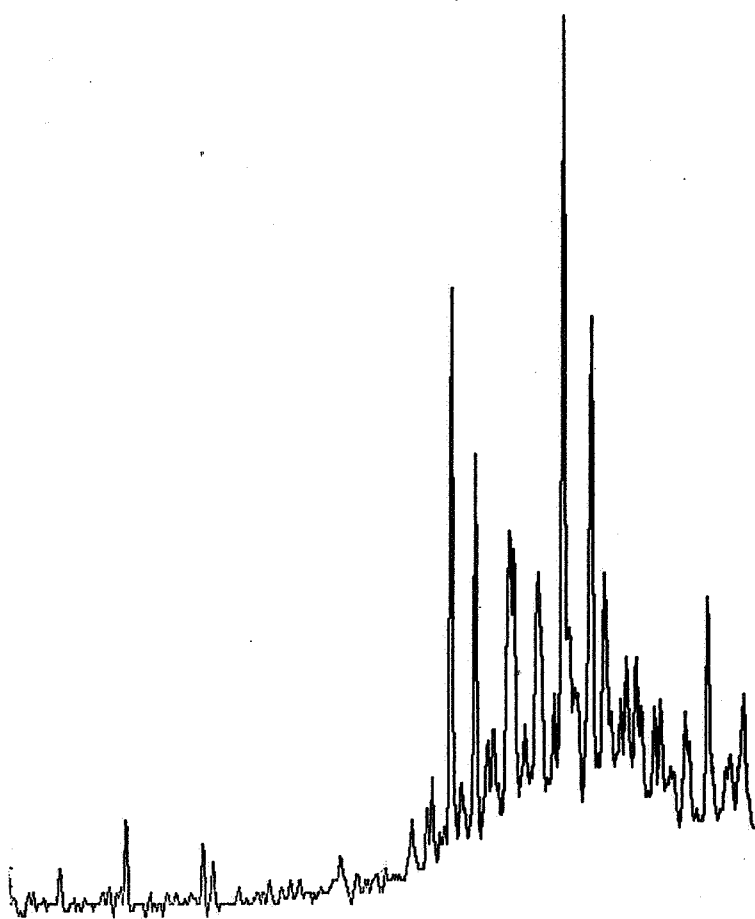
<u>COMPOUND</u>	<u>ELEMENTAL COMPOSITION</u>
A 13 β ,17 α -diacholestane (20S)	C ₂₇ H ₄₈
B 13 β ,17 α -diacholestane (20R)	C ₂₇ H ₄₈
C 13 α ,17 β -diacholestane (20R)	C ₂₇ H ₄₈
D 24,-methyl-13 β ,17 α -diacholestane (20S)	C ₂₈ H ₅₀
E 24,-methyl-13 β ,17 α -diacholestane (20R)	C ₂₈ H ₅₀
F 24,-ethyl-13 β ,17 α -diacholestane (20S)	C ₂₉ H ₅₂
G 24,-ethyl-13 β ,17 α -diacholestane (20R)	C ₂₉ H ₅₂

REARRANGED STERANES m/z 259



2429.5m

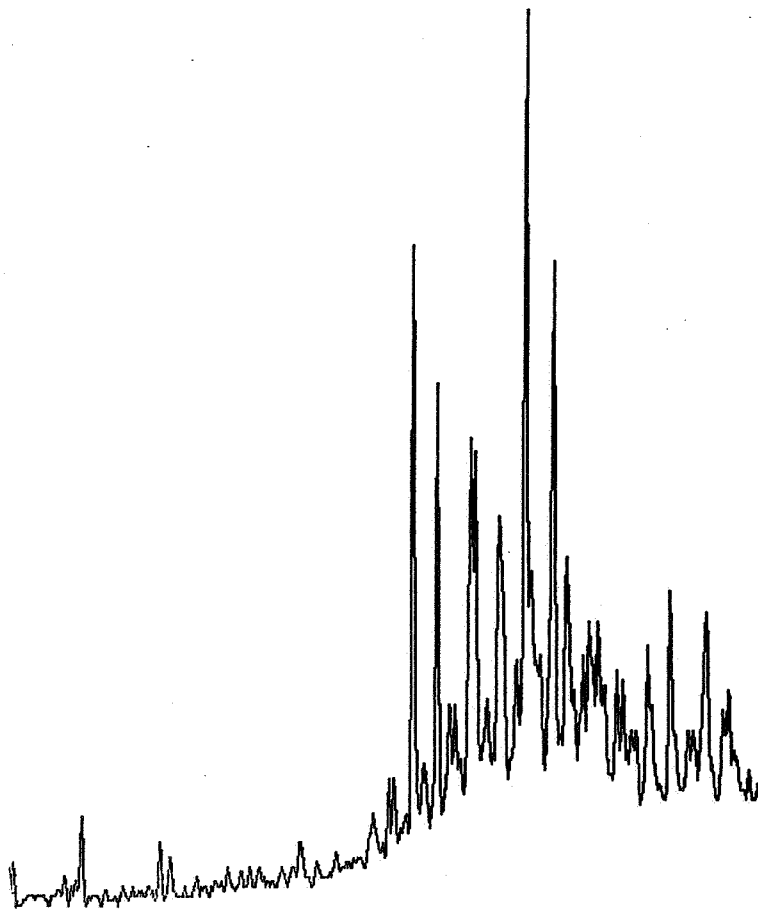
S.W.C.



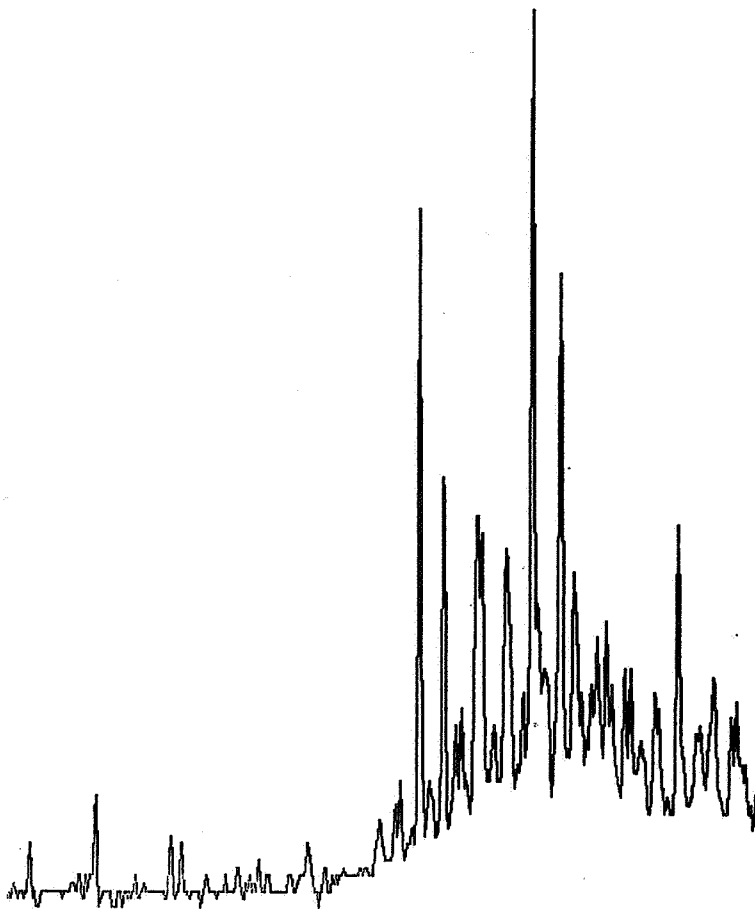
2443m

S.W.C.

REARRANGED STERANES m/z 259

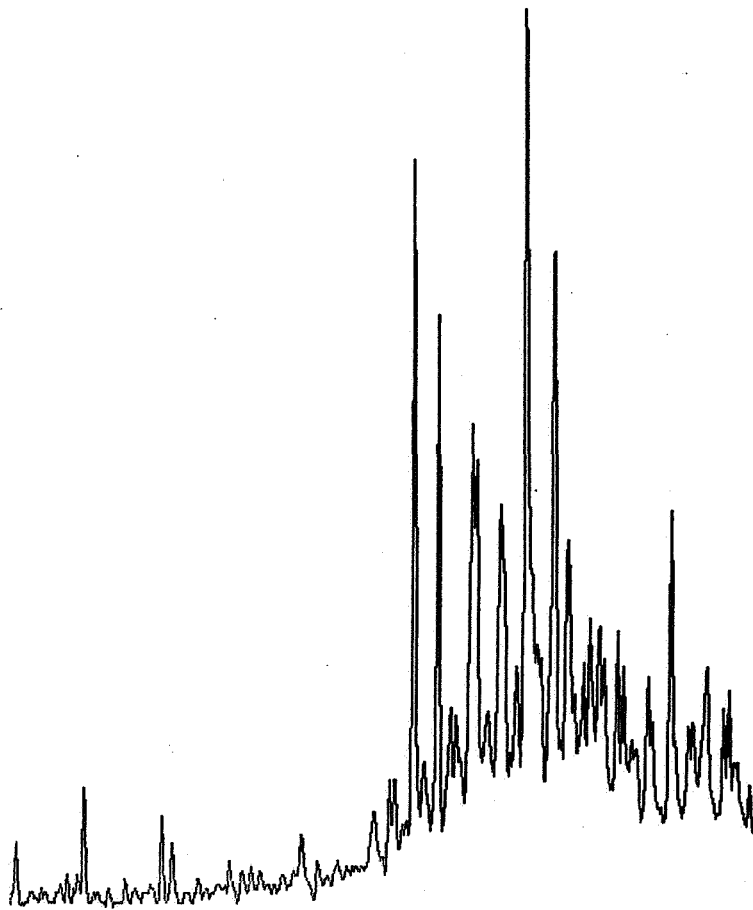


2468.5m
S.W.C.



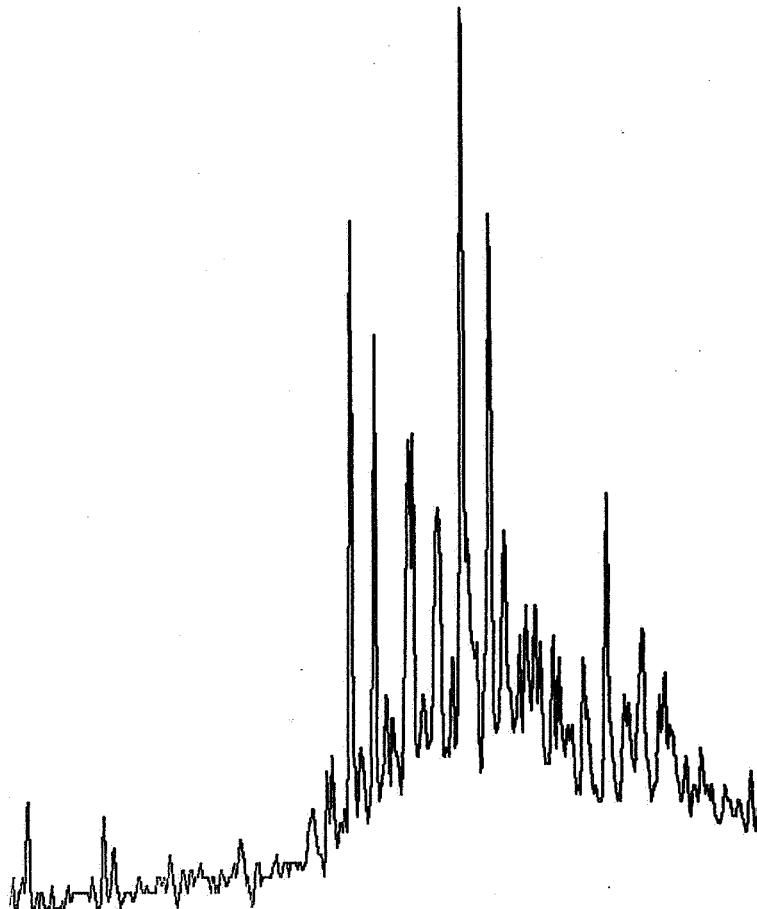
2474m
S.W.C.

REARRANGED STERANES m/z 259



2480m

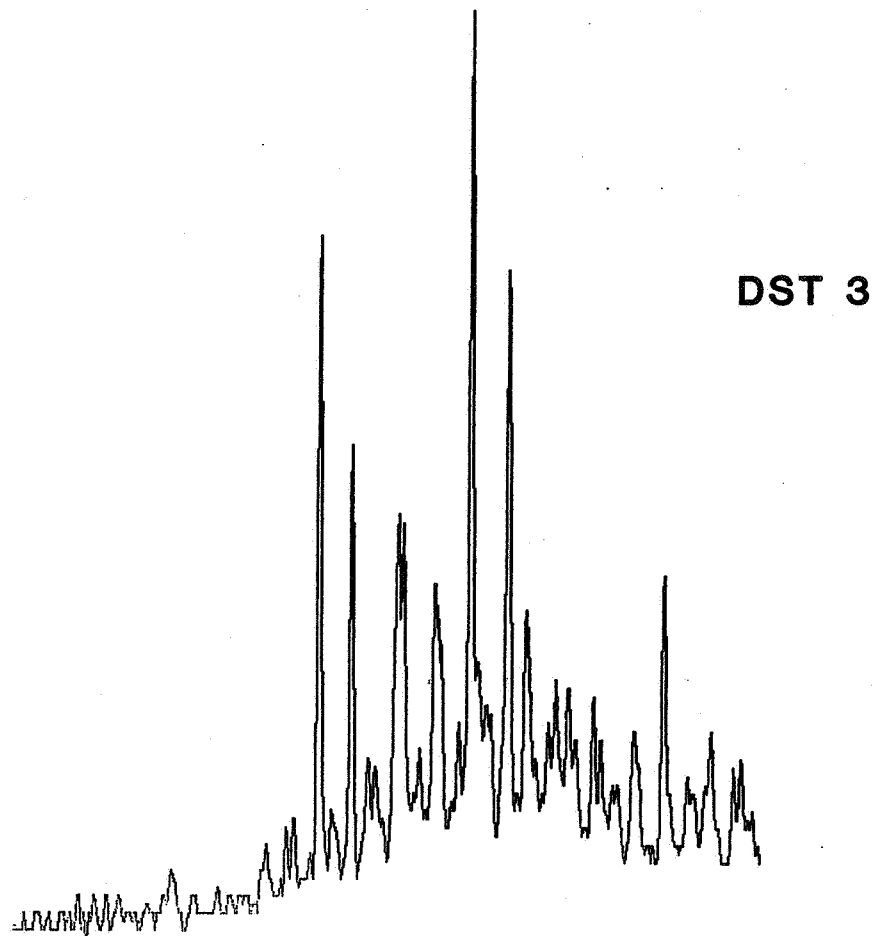
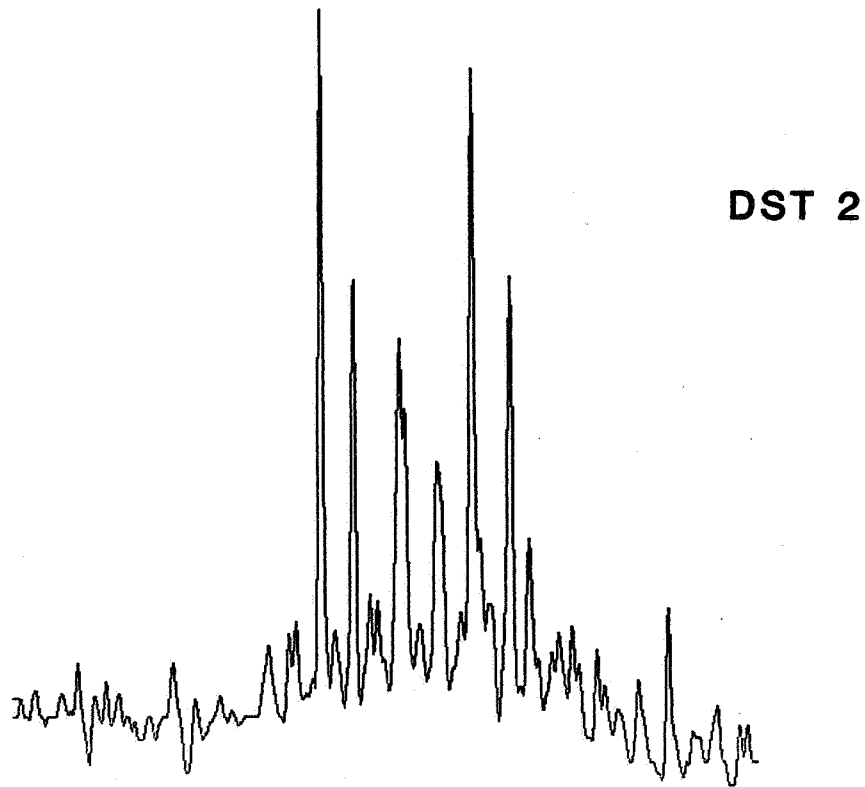
S.W.C.



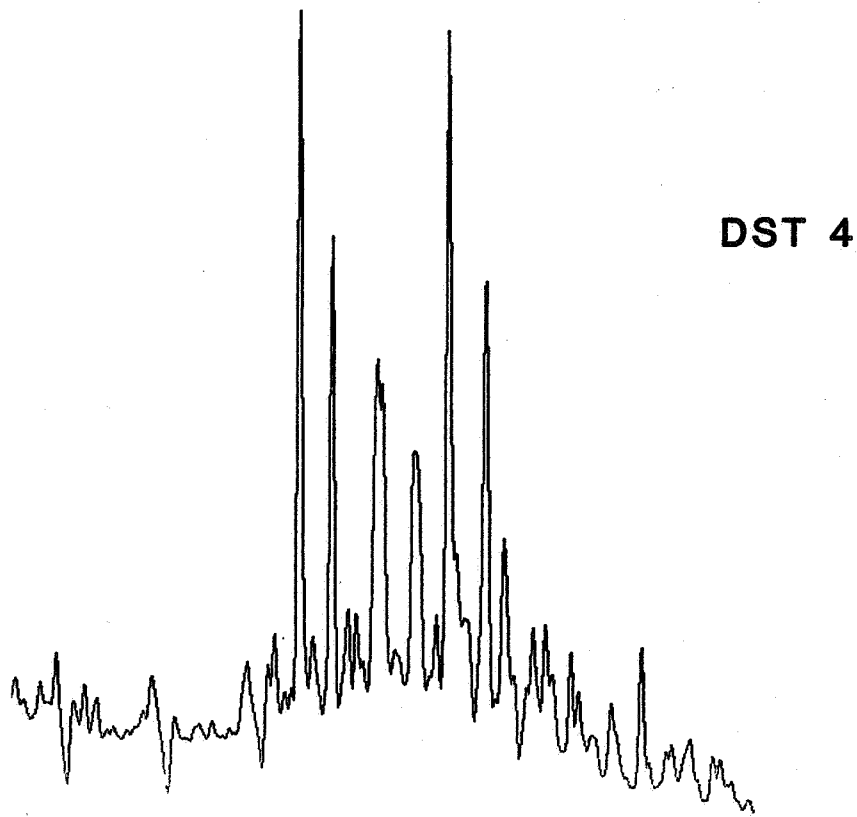
2485m

S.W.C.

REARRANGED STERANES m/z 259



REARRANGED STERANES m/z 259

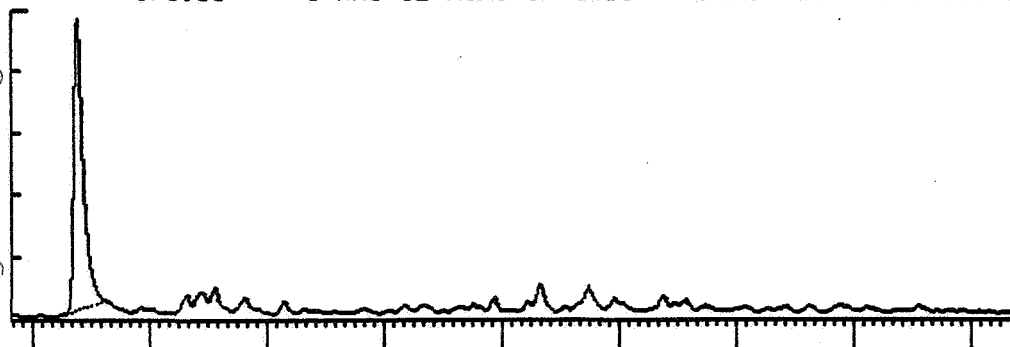


AROMATIC MASS FRAGMENTOGRAMS PHENANTHRENE SERIES

SIR REPORT. FILE - STD. .SD RUN - 1

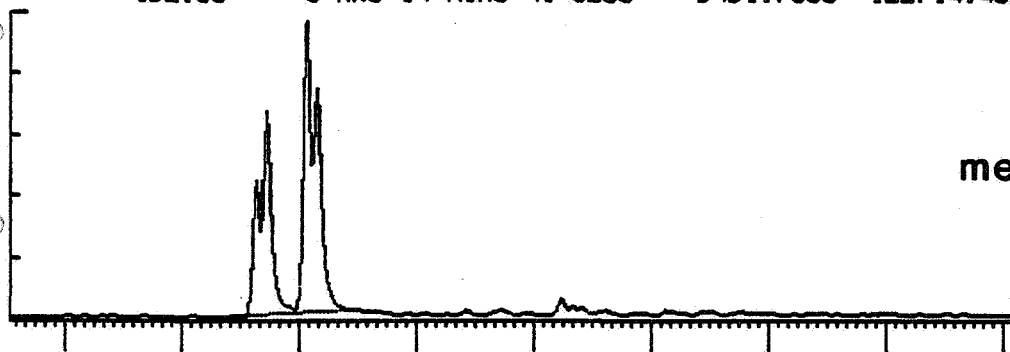
UNCALIBRATED.
MASS

RETENTION TIME	HEIGHT	AREA	CONC. (H)	CONC. (A)
178.00 0 HRS 12 MINS 17 SECS	9885.1530	52863.6900	0.0000	0.0000



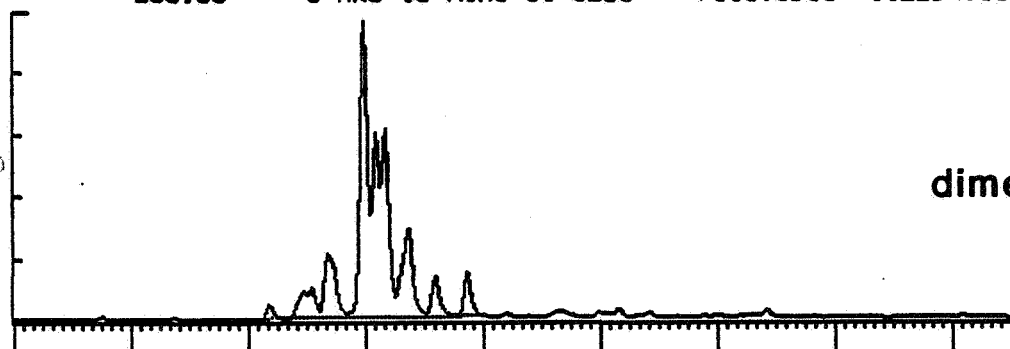
phenanthrene

192.00 0 HRS 14 MINS 41 SECS	9491.7360	122714.4000	0.0000	0.0000
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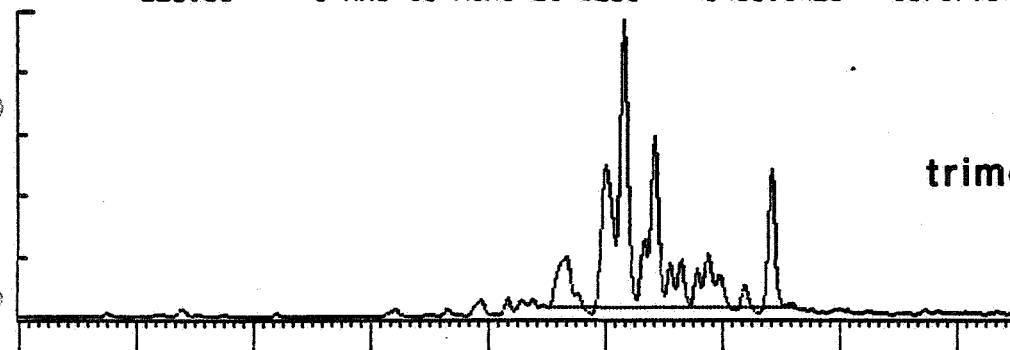
methyl phenanthrenes

206.00 0 HRS 16 MINS 31 SECS	7513.8950	112294.6000	0.0000	0.0000
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dimethyl phenanthrenes

220.00 0 HRS 18 MINS 21 SECS	3435.1420	68787.8400	0.0000	0.0000
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trimethyl phenanthrenes

0 HRS 13 MINS 59 SECS

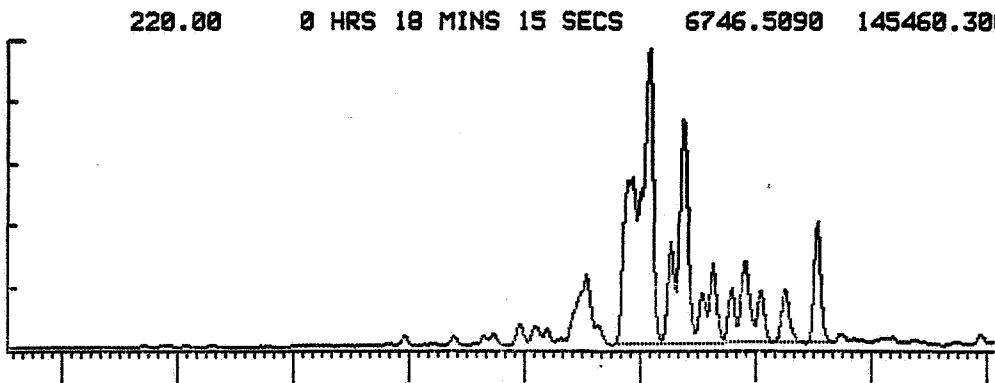
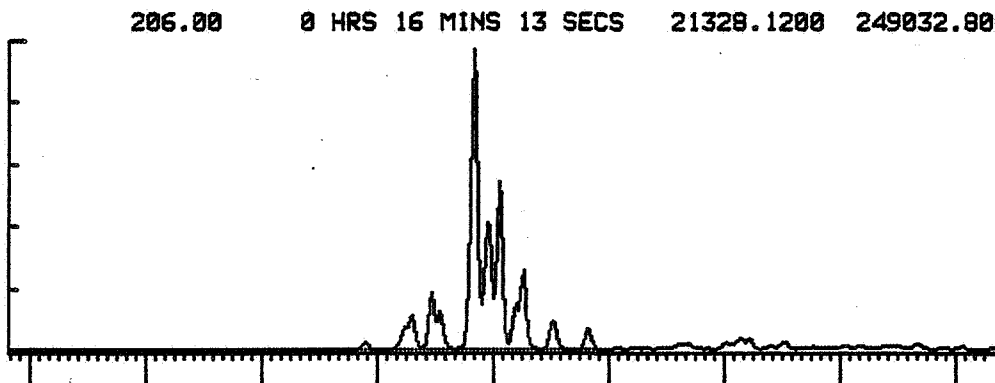
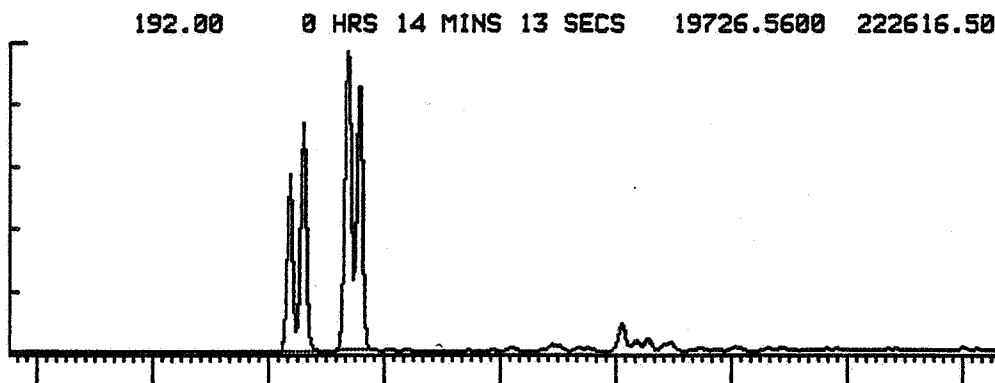
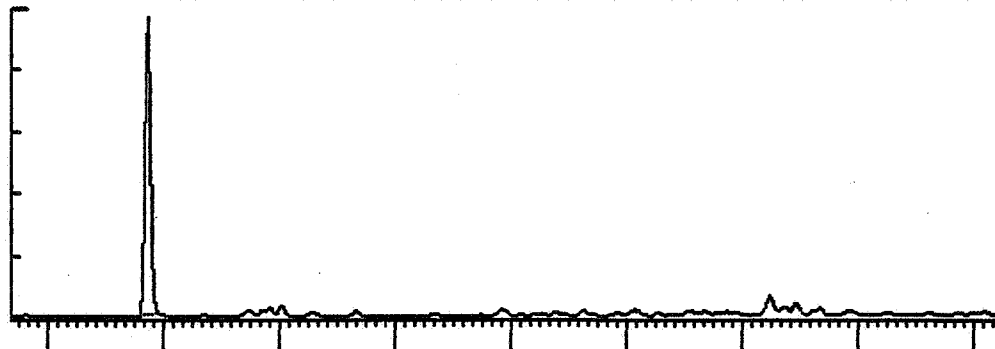
0 HRS 22 MINS 10 SECS

PHENANTHRENE SERIES

SIR REPORT. FILE - 975001 .SD RUN - 1

UNCALIBRATED.
MASS

RETENTION TIME	HEIGHT	AREA	CONC. (H)	CONC. (A)
178.00 0 HRS 11 MINS 40 SECS	25789.0500	82889.8900	0.0000	0.0000
192.00 0 HRS 14 MINS 13 SECS	19726.5600	222616.5000	0.0000	0.0000
206.00 0 HRS 16 MINS 13 SECS	21328.1200	249032.8000	0.0000	0.0000
220.00 0 HRS 18 MINS 15 SECS	6746.5890	145460.3000	0.0000	0.0000

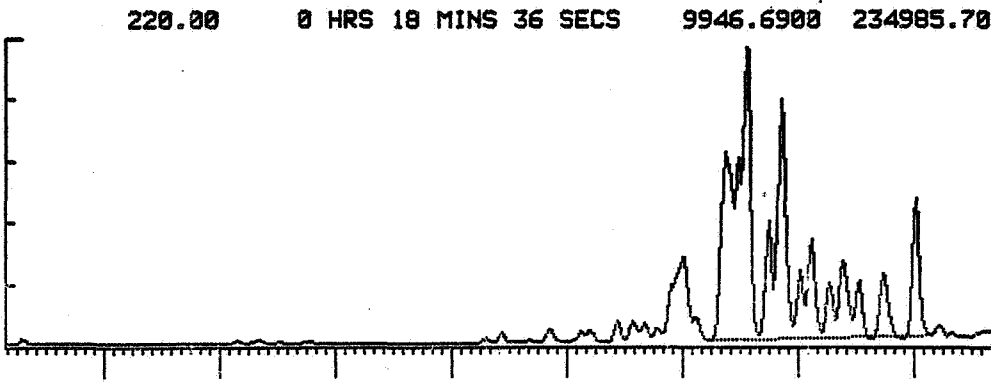
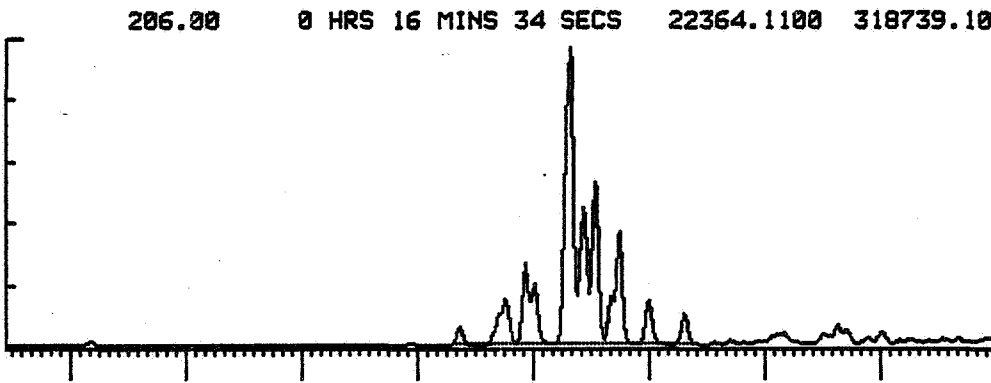
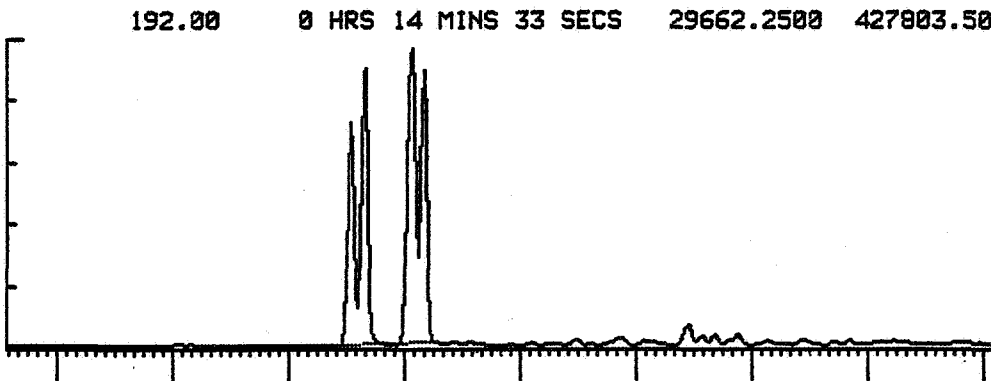
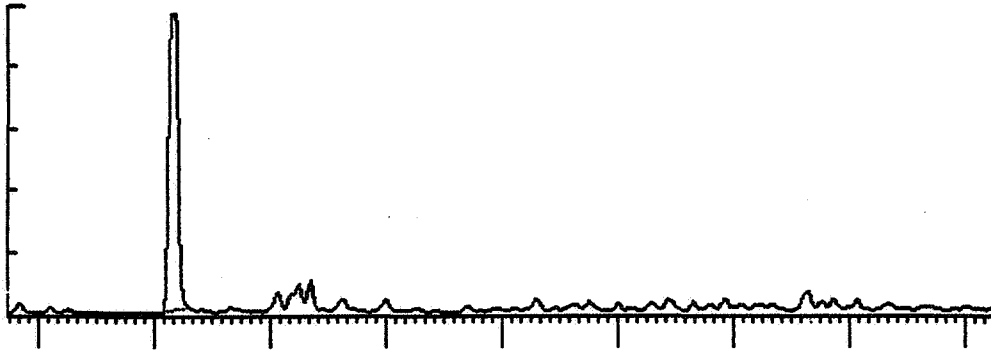


PHENANTHRENE SERIES

SIR REPORT. FILE - 973002 .SD RUN - 1

UNCALIBRATED.
MASS

RETENTION TIME	HEIGHT	AREA	CONC. (H)	CONC. (A)
178.00 0 HRS 11 MINS 56 SECS	31515.6200	172559.7000	0.0000	0.0000
192.00 0 HRS 14 MINS 33 SECS	29662.2500	427803.5000	0.0000	0.0000
206.00 0 HRS 16 MINS 34 SECS	22364.1100	318739.1000	0.0000	0.0000
220.00 0 HRS 18 MINS 36 SECS	9946.6900	234985.7000	0.0000	0.0000

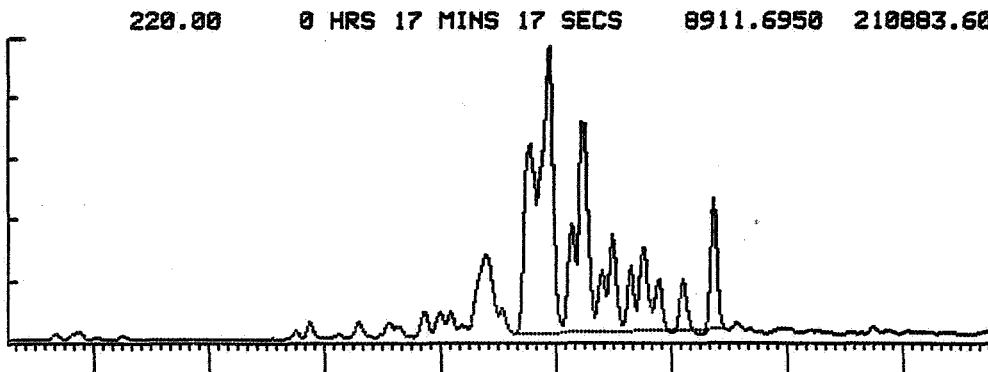
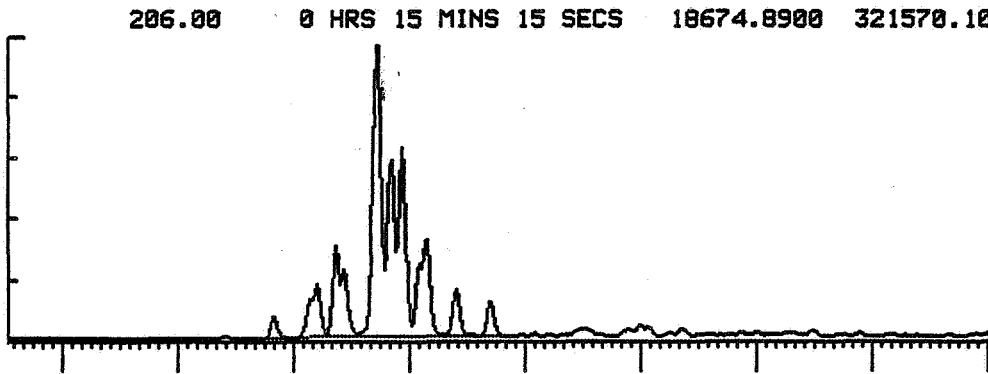
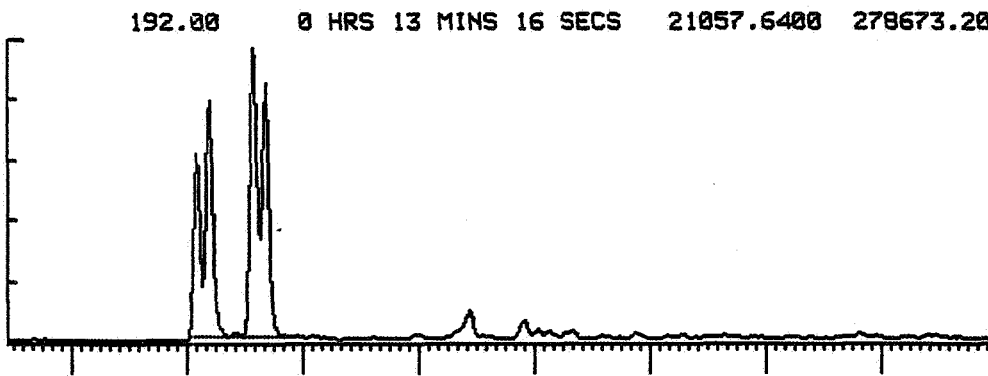
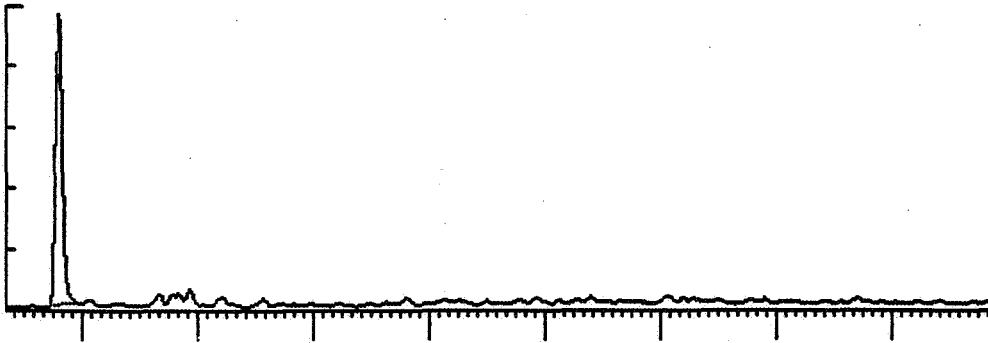


PHENANTHRENE SERIES

SIR REPORT. FILE - 975003 .SD RUN - 1

UNCALIBRATED.

MASS	RETENTION TIME	HEIGHT	AREA	CONC. (H)	CONC. (A)
178.00	0 HRS 10 MINS 45 SECS	28816.9500	112991.0000	0.0000	0.0000
192.00	0 HRS 13 MINS 16 SECS	21057.6400	278673.2000	0.0000	0.0000
206.00	0 HRS 15 MINS 15 SECS	18674.8900	321570.1000	0.0000	0.0000
220.00	0 HRS 17 MINS 17 SECS	8911.6950	210803.6000	0.0000	0.0000

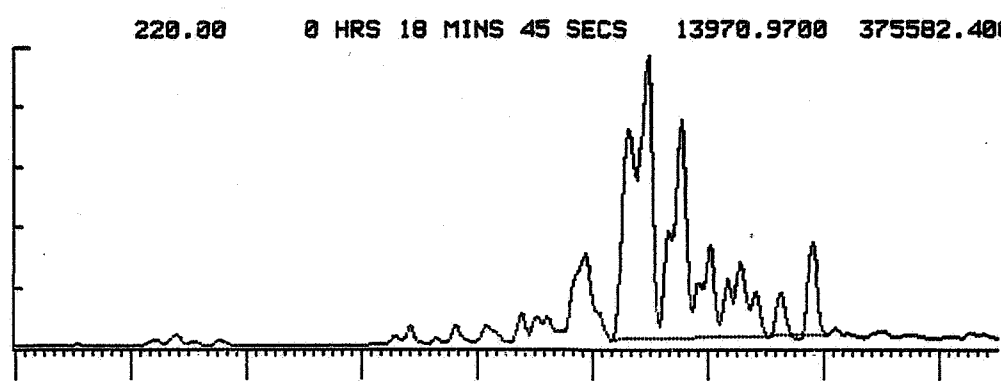
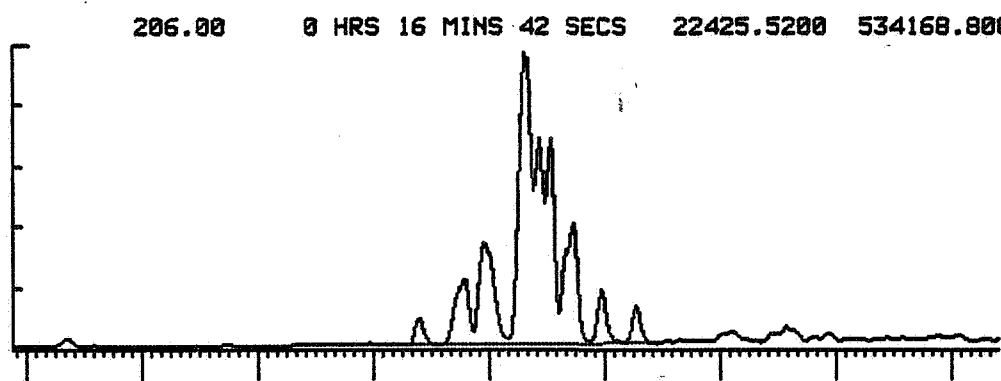
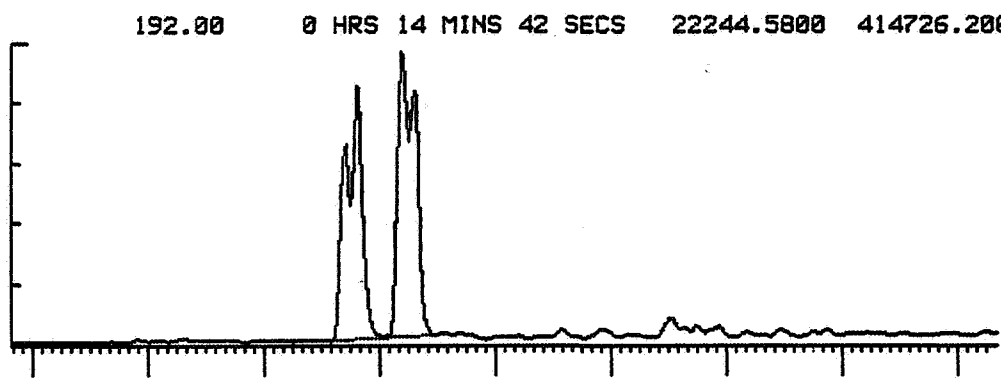
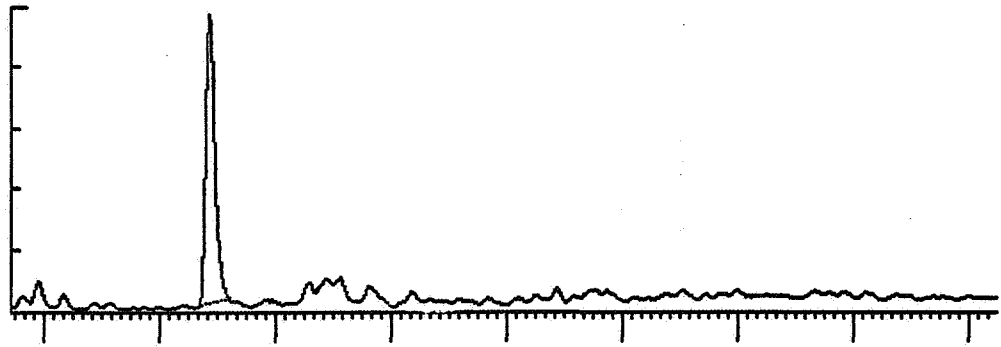


PHENANTHRENE SERIES

SIR REPORT. FILE - 975005 .SD RUN - 1

UNCALIBRATED.
MASS

RETENTION TIME	HEIGHT	AREA	CONC. (H)	CONC. (A)
178.00	26541.6500	140549.7000	0.0000	0.0000
192.00	22244.5800	414726.2000	0.0000	0.0000
206.00	22425.5200	534168.8000	0.0000	0.0000
220.00	13970.9700	375582.4000	0.0000	0.0000



0 HRS 13 MINS 59 SECS

2474m S.W.C.

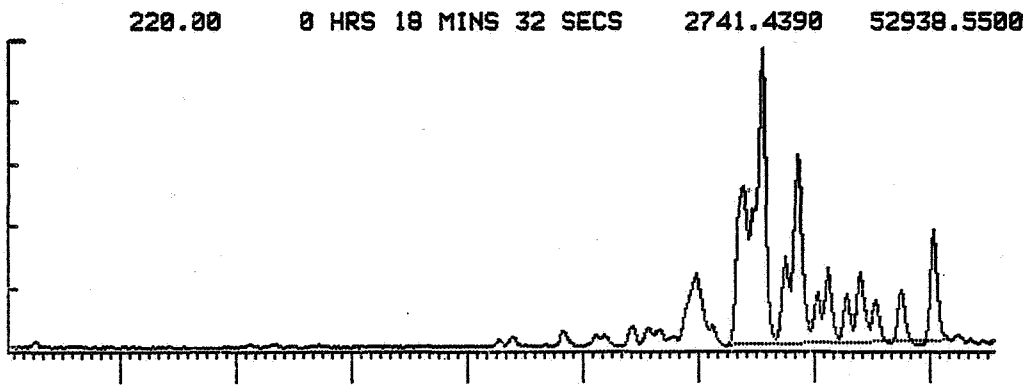
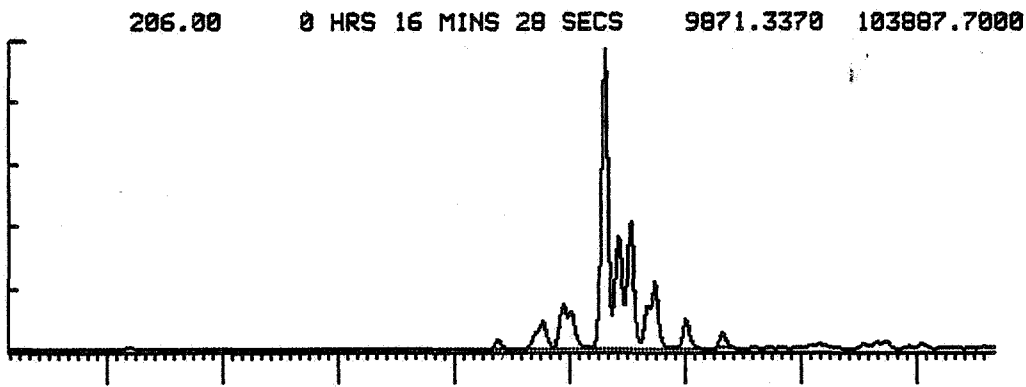
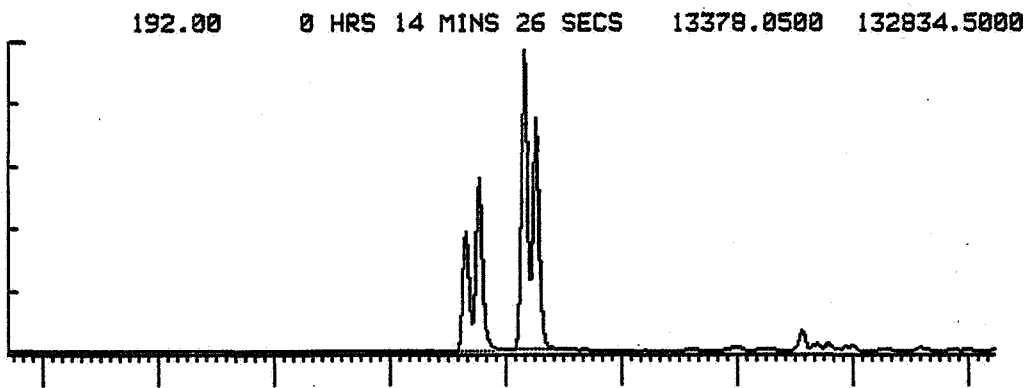
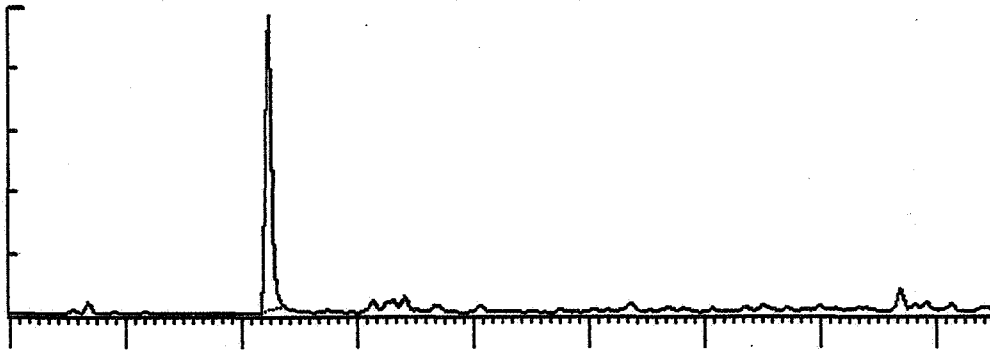
0 HRS 22 MINS 10 SECS

PHENANTHRENE SERIES

SIR REPORT. FILE - 975006 .SD RUN - 1

UNCALIBRATED.
MASS

RETENTION TIME	HEIGHT	AREA	CONC. (H)	CONC. (A)
178.00	12537.2500	44729.9100	0.0000	0.0000
192.00	13378.0500	132834.5000	0.0000	0.0000
206.00	9871.3370	103887.7000	0.0000	0.0000
220.00	2741.4390	52938.5500	0.0000	0.0000

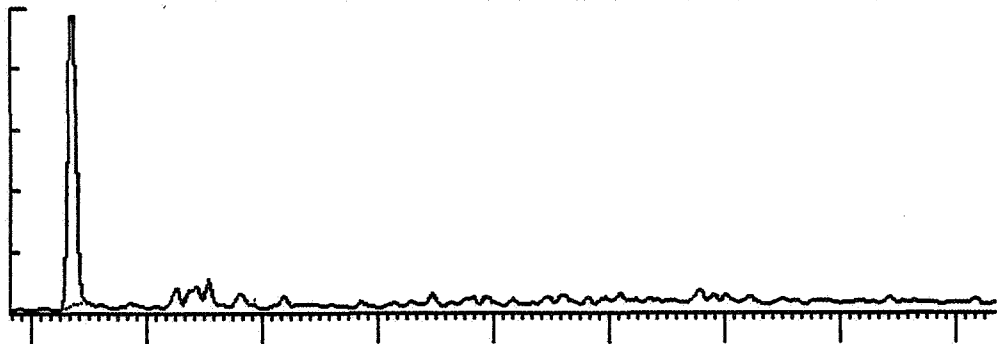


PHENANTHRENE SERIES

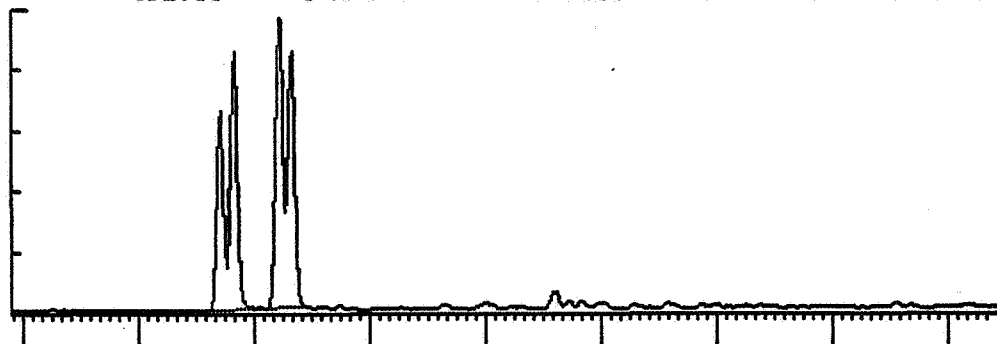
SIR REPORT. FILE - 975007 .SD RUN - 1

UNCALIBRATED.

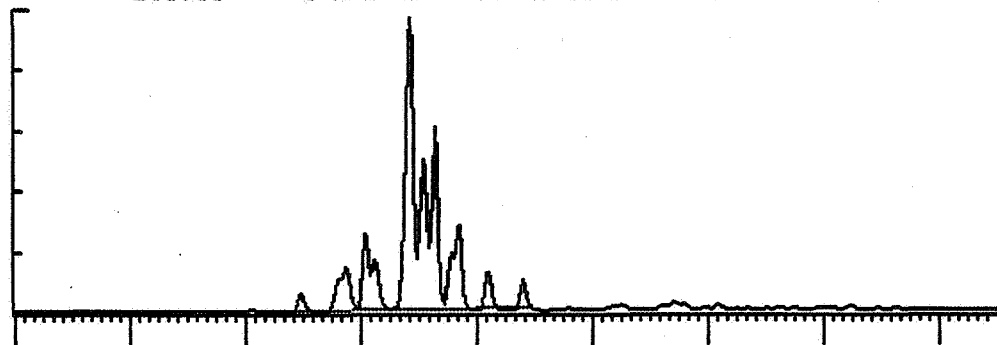
MASS	RETENTION TIME	HEIGHT	AREA	CONC. (H)	CONC. (A)
178.00	0 HRS 12 MINS 15 SECS	31170.6500	153419.7000	0.0000	0.0000



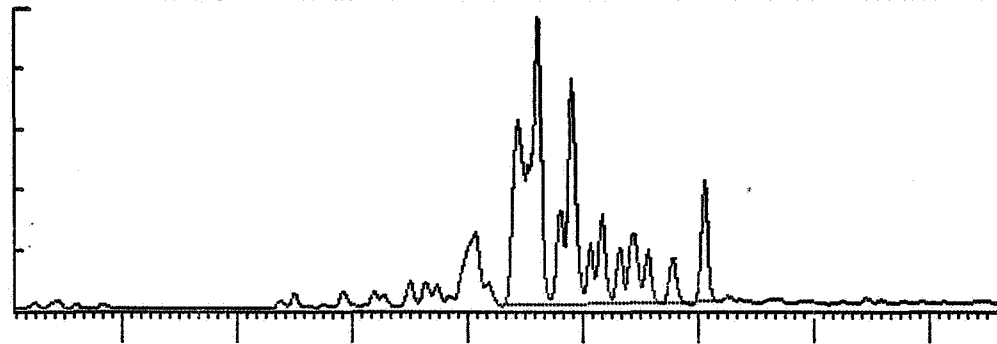
192.00	0 HRS 14 MINS 53 SECS	30900.7400	440648.3000	0.0000	0.0000
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206.00	0 HRS 16 MINS 56 SECS	29401.3100	417716.6000	0.0000	0.0000
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220.00	0 HRS 18 MINS 59 SECS	10297.9700	220283.0000	0.0000	0.0000
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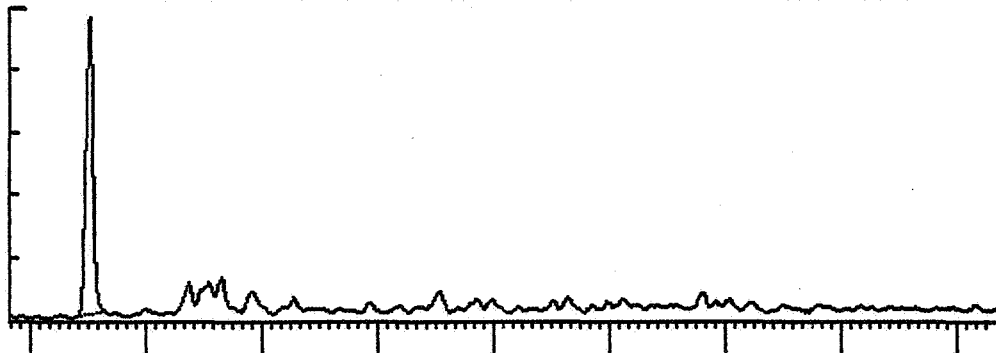


PHENANTHRENE SERIES

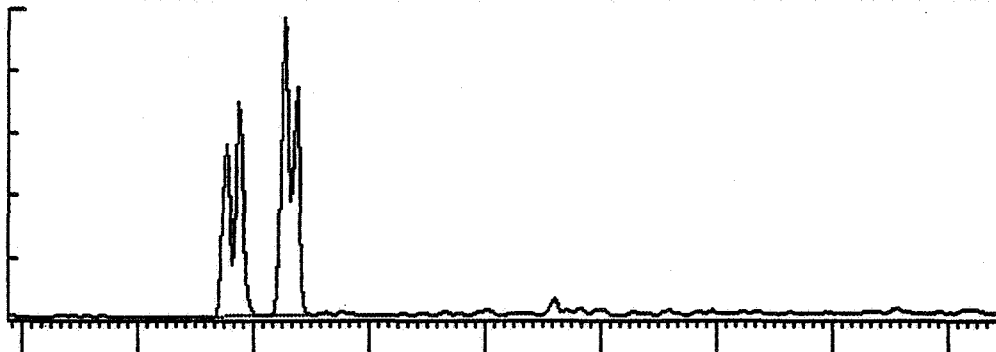
SIR REPORT. FILE - 975009 .SD RUN - 1

UNCALIBRATED.

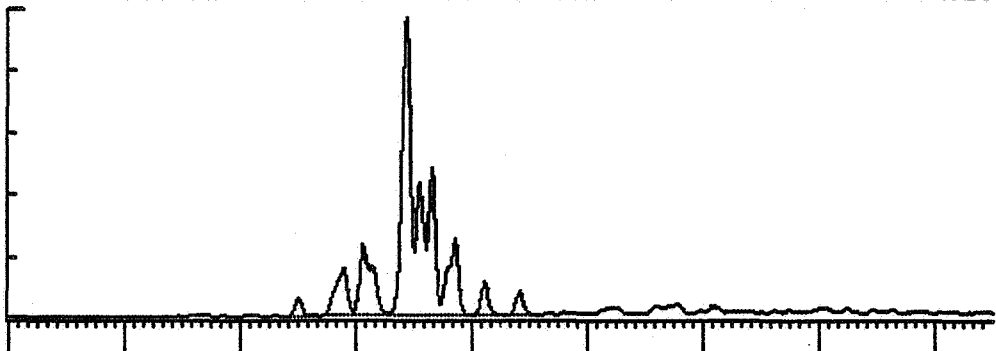
MASS	RETENTION TIME	HEIGHT	AREA	CONC. (H)	CONC. (A)
178.00	0 HRS 12 MINS 24 SECS	24085.9300	100987.3000	0.0000	0.0000



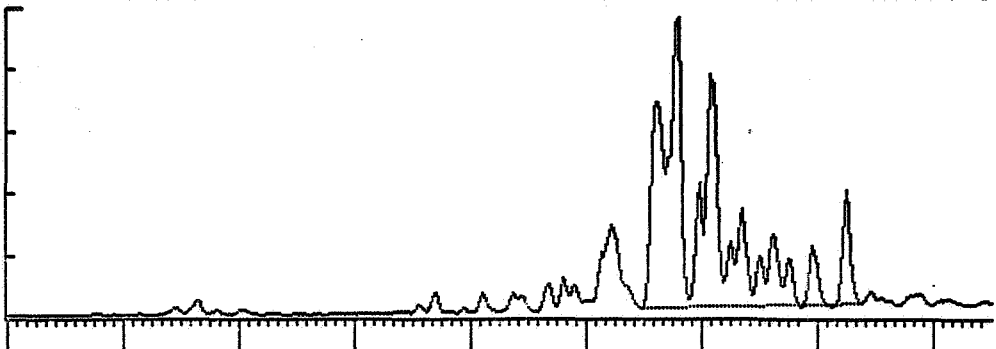
192.00	0 HRS 14 MINS 54 SECS	22871.8600	292774.2000	0.0000	0.0000
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206.00	0 HRS 16 MINS 55 SECS	13704.5900	196912.2000	0.0000	0.0000
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220.00	0 HRS 18 MINS 56 SECS	4283.7360	110256.4000	0.0000	0.0000
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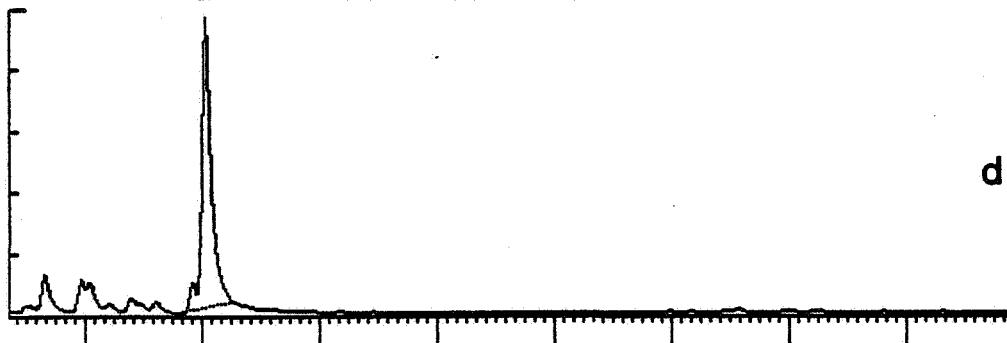
AROMATIC MASS FRAGMENTOGRAMS

DIBENZOTHIOPHENE SERIES

SIR REPORT. FILE - STD. .SD RUN - 1

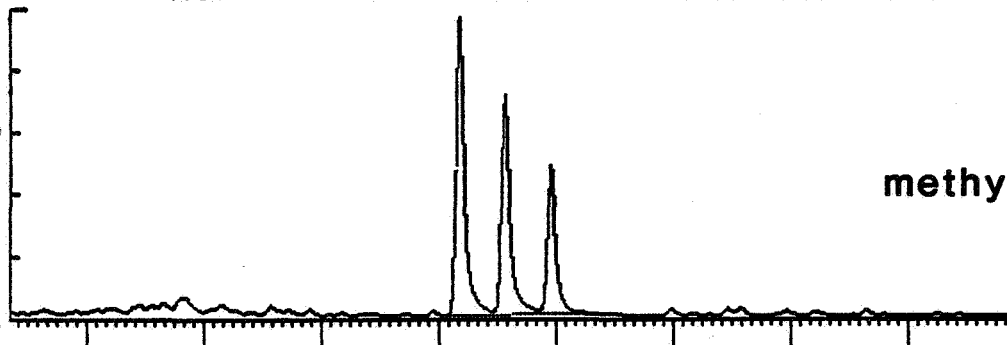
UNCALIBRATED.

MASS	RETENTION TIME	HEIGHT	AREA	CONC. (H)	CONC. (A)
184.00	0 HRS 11 MINS 47 SECS	26003.8900	144753.9000	0.0000	0.0000



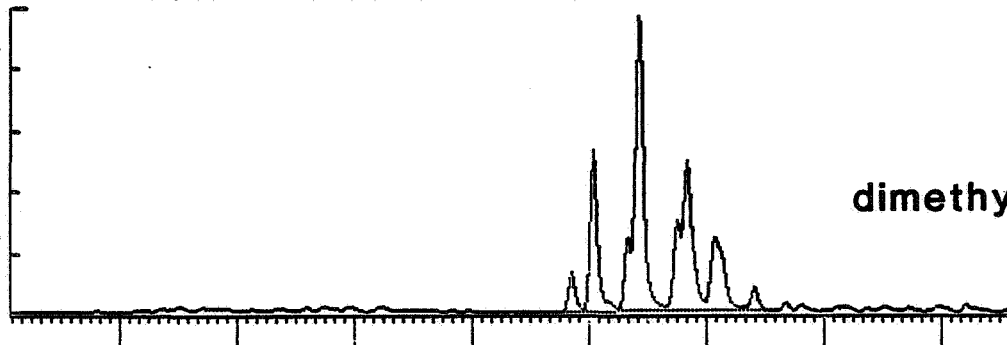
dibenzothiophene

198.00	0 HRS 13 MINS 36 SECS	16854.6700	187694.7000	0.0000	0.0000
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methyl dibenzothiophenes

212.00	0 HRS 15 MINS 36 SECS	14042.6900	208491.3000	0.0000	0.0000
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dimethyl dibenzothiophenes

0 HRS 11 MINS 4 SECS

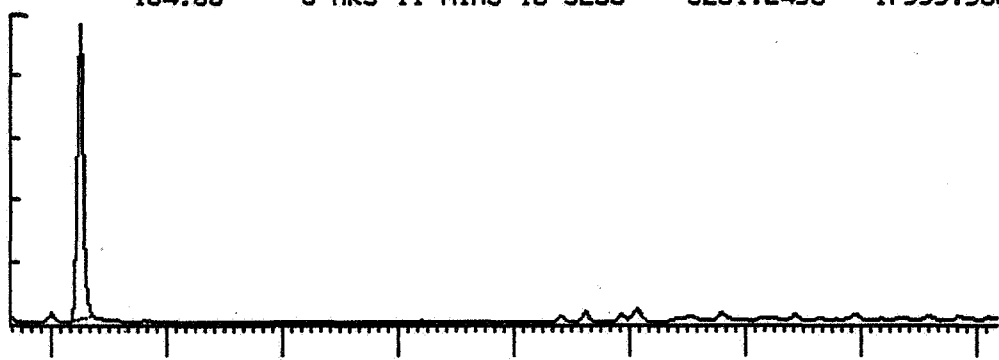
0 HRS 19 MINS 16 SECS

FIGURE 9a AROMATIC MASS FRAGMENTOGRAMS WELL 7121/4-1
 DIBENZOTHIOPHENE SERIES

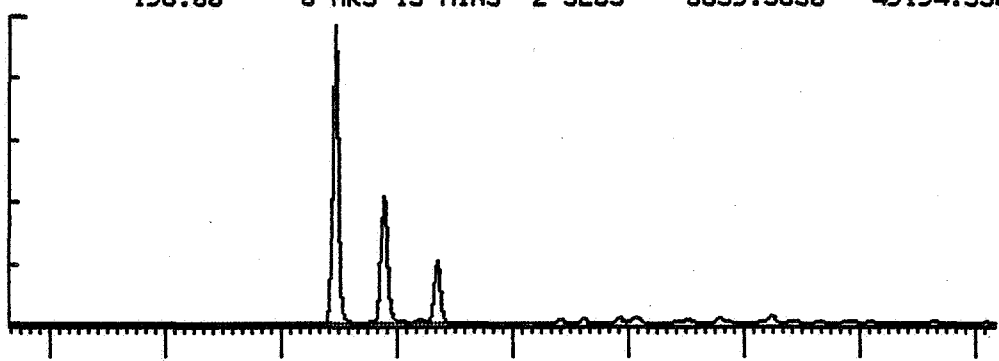
SIR REPORT. FILE - 975001 .SD RUN - 1

UNCALIBRATED.

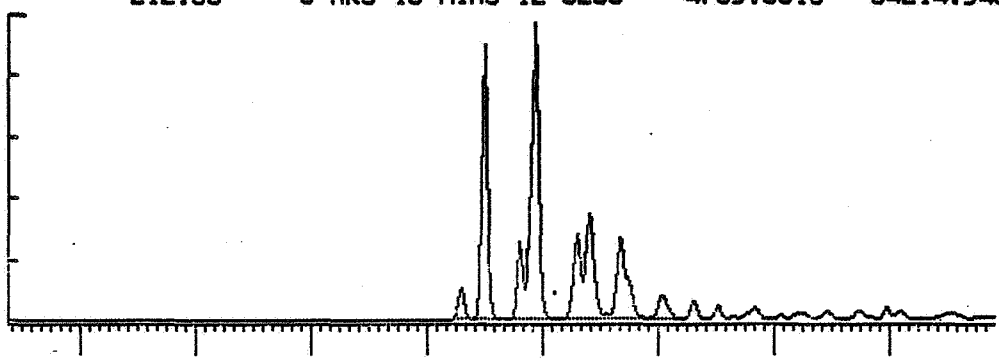
MASS	RETENTION TIME	HEIGHT	AREA	CONC. (H)	CONC. (A)
184.00	0 HRS 11 MINS 10 SECS	5281.2490	17999.9800	0.0000	0.0000



198.00	0 HRS 13 MINS 2 SECS	8639.3930	49194.5300	0.0000	0.0000
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212.00	0 HRS 15 MINS 12 SECS	4789.0610	64214.9400	0.0000	0.0000
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0 HRS 11 MINS 22 SECS

0 HRS 19 MINS 34 SECS

2429.5m

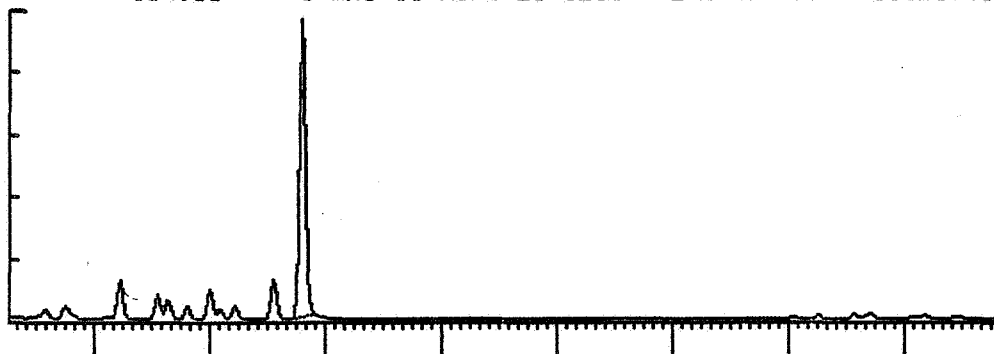
S.W.C.

FIGURE 9b AROMATIC MASS FRAGMENTOGRAMS WELL 7121/4-1
DIBENZOTHIOPHENE SERIES

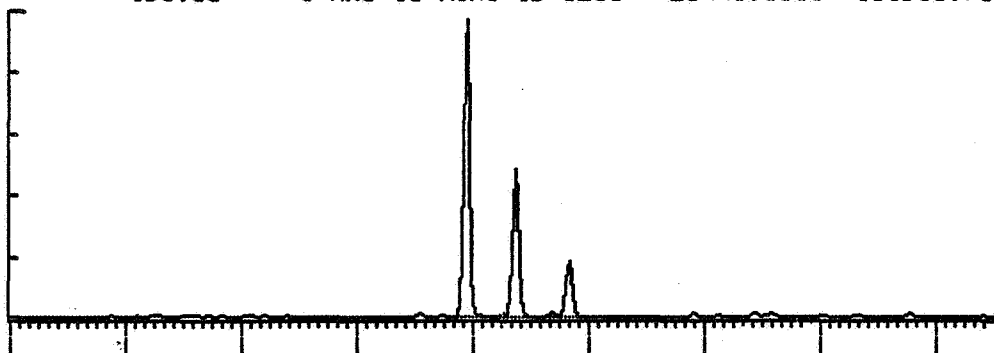
SIR REPORT. FILE - 973002 .SD RUN - 1

UNCALIBRATED.

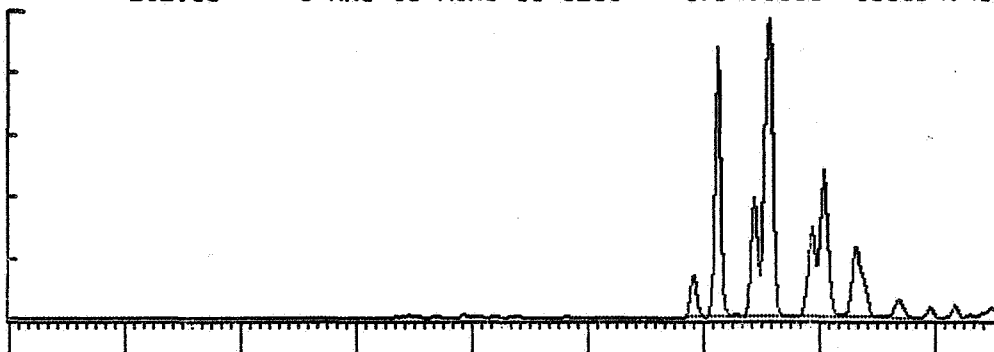
MASS	RETENTION TIME	HEIGHT	AREA	CONC. (H)	CONC. (A)
184.00	0 HRS 11 MINS 23 SECS	24070.9400	83621.1300	0.0000	0.0000
198.00	0 HRS 13 MINS 19 SECS	25440.1600	151900.7000	0.0000	0.0000
212.00	0 HRS 15 MINS 33 SECS	8794.8030	133394.4000	0.0000	0.0000



198.00	0 HRS 13 MINS 19 SECS	25440.1600	151900.7000	0.0000	0.0000
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212.00	0 HRS 15 MINS 33 SECS	8794.8030	133394.4000	0.0000	0.0000
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0 HRS 9 MINS 59 SECS

0 HRS 18 MINS 10 SECS

2443m

S.W.C.

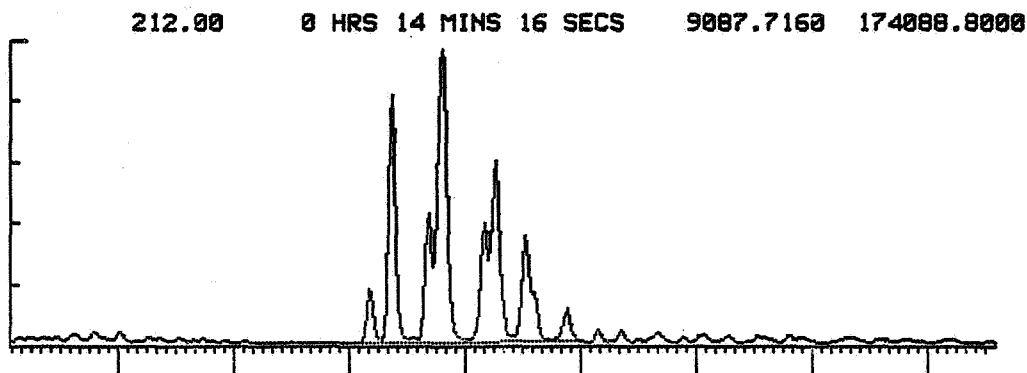
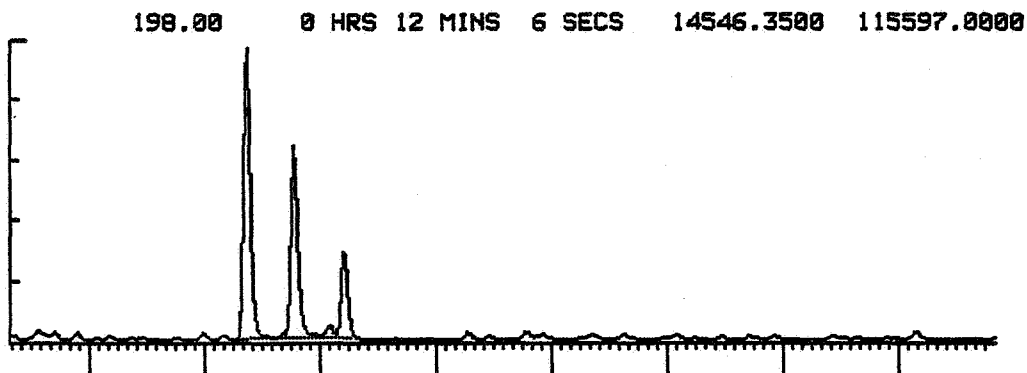
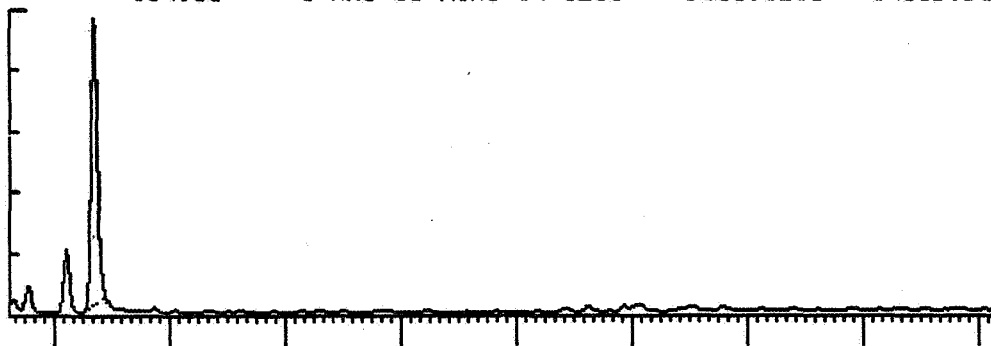
AROMATIC MASS FRAGMENTOGRAMS WELL 7121/4-1

DIBENZOTHIOPHENE SERIES

SIR REPORT. FILE - 975003 .SD RUN - 1

UNCALIBRATED.

MASS	RETENTION TIME	HEIGHT	AREA	CONC. (H)	CONC. (A)
184.00	0 HRS 10 MINS 14 SECS	9503.1230	34589.9500	0.0000	0.0000
198.00	0 HRS 12 MINS 6 SECS	14546.3500	115597.0000	0.0000	0.0000
212.00	0 HRS 14 MINS 16 SECS	9087.7160	174088.8000	0.0000	0.0000



0 HRS 11 MINS 4 SECS

0 HRS 19 MINS 16 SECS

2468.5m

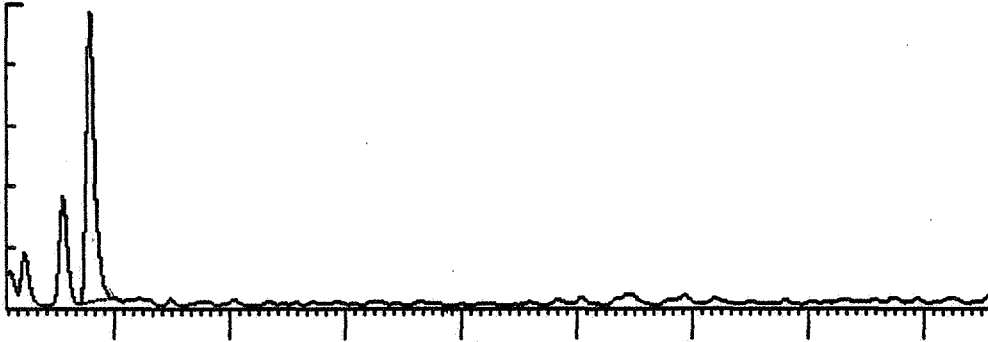
S.W.C.

FIGURE 9d AROMATIC MASS FRAGMENTOGRAMS WELL 7121/4-1
 DIBENZOTHIOPHENE SERIES

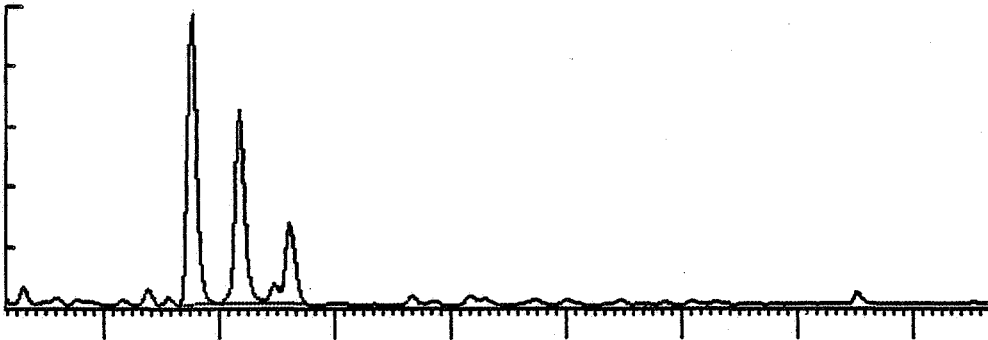
SIR REPORT. FILE - 975005 .SD RUN - 1

UNCALIBRATED.

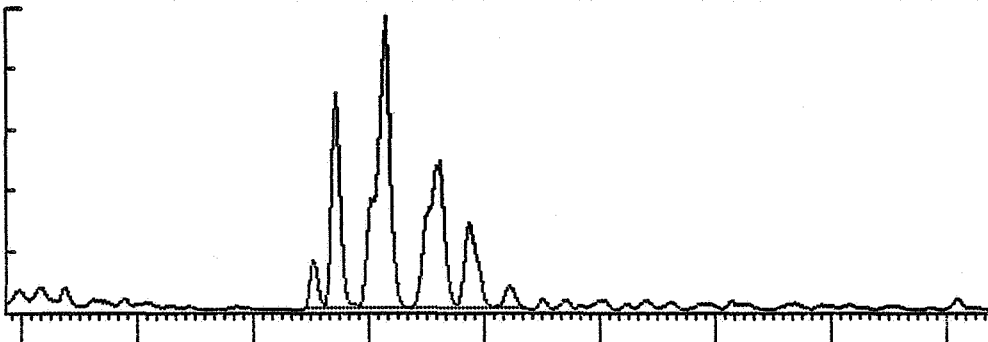
MASS	RETENTION TIME	HEIGHT	AREA	CONC. (H)	CONC. (A)
184.00	0 HRS 11 MINS 40 SECS	10433.3500	51014.9000	0.0000	0.0000



198.00	0 HRS 13 MINS 32 SECS	17552.3900	193401.6000	0.0000	0.0000
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212.00	0 HRS 15 MINS 42 SECS	14546.8700	294667.1000	0.0000	0.0000
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0 HRS 12 MINS 52 SECS

0 HRS 21 MINS 3 SECS

2474m

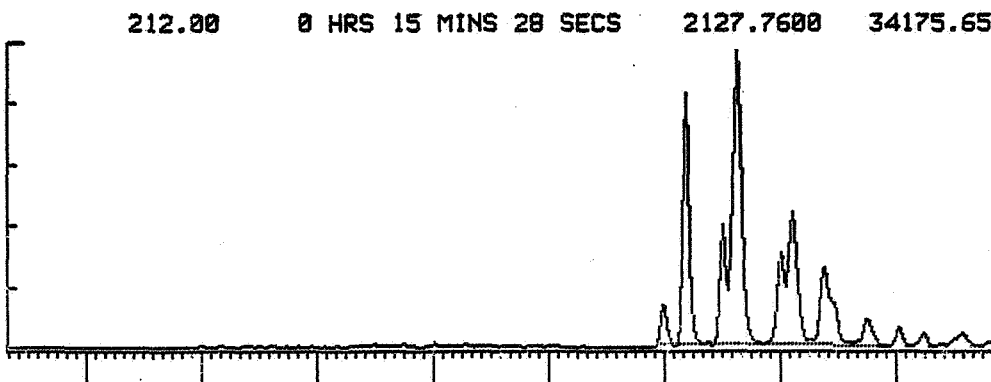
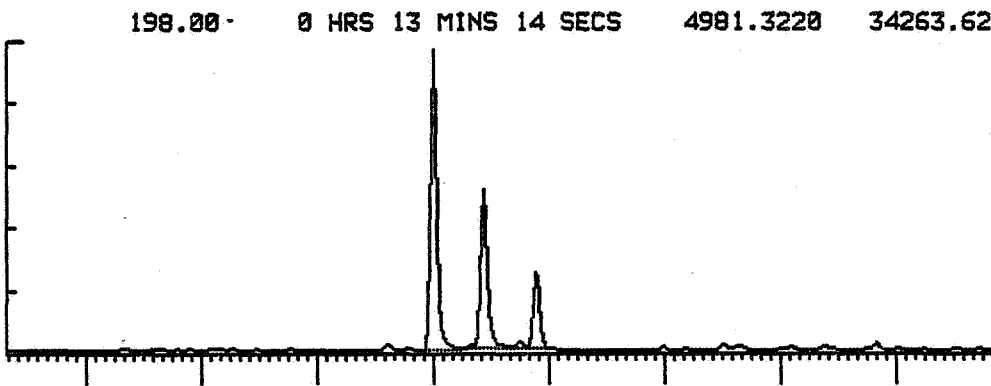
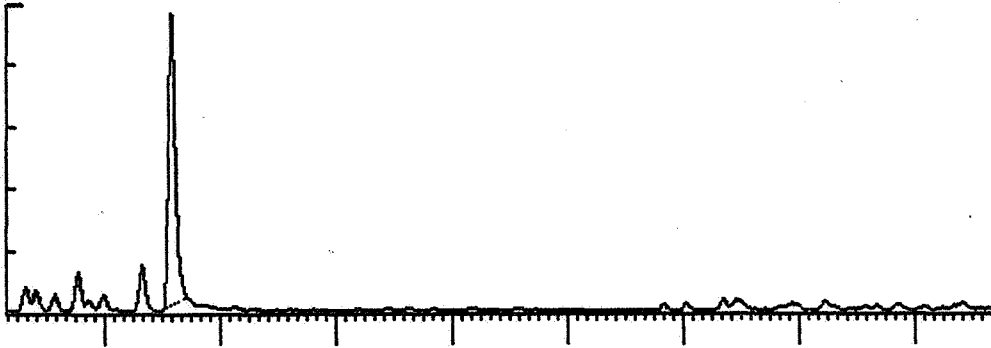
S.W.C.

DIBENZOTHIOPHENE SERIES

SIR REPORT. FILE - 975006 .SD RUN - 1

UNCALIBRATED.

MASS	RETENTION TIME	HEIGHT	AREA	CONC. (H)	CONC. (A)
184.00	0 HRS 11 MINS 20 SECS	2861.9770	11508.7200	0.0000	0.0000
198.00	0 HRS 13 MINS 14 SECS	4981.3220	34263.6200	0.0000	0.0000
212.00	0 HRS 15 MINS 28 SECS	2127.7600	34175.6500	0.0000	0.0000



0 HRS 10 MINS 18 SECS

0 HRS 18 MINS 30 SECS

2480m

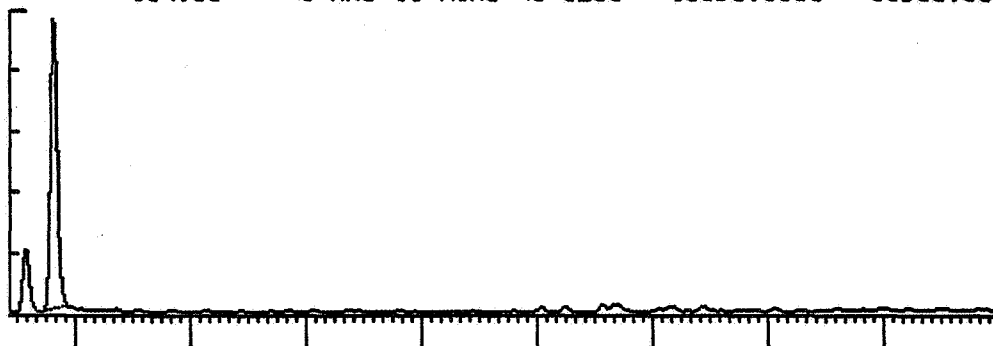
S.W.C.

DIBENZOTHIOPHENE SERIES

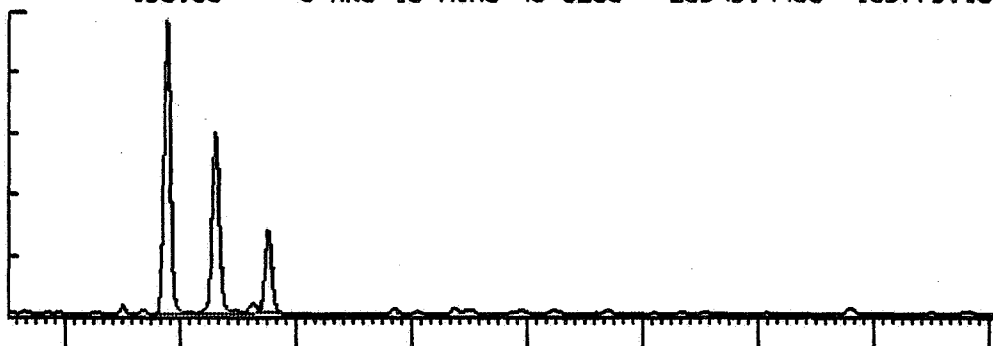
SIR REPORT. FILE - 975007 .SD RUN - 1

UNCALIBRATED.

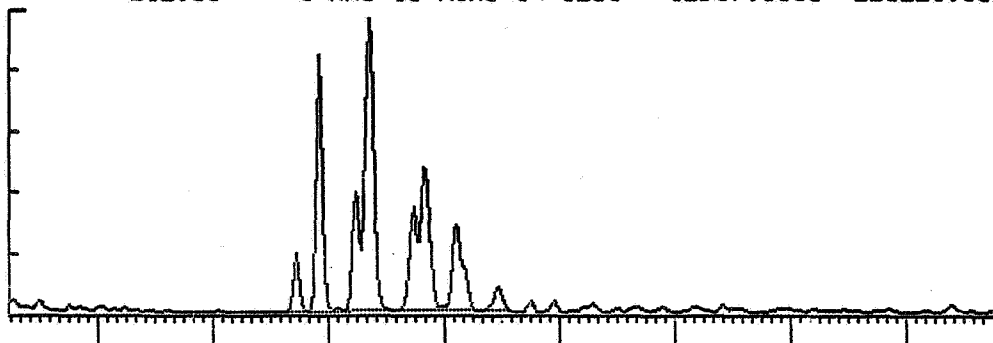
MASS	RETENTION TIME	HEIGHT	AREA	CONC. (H)	CONC. (A)
184.00	0 HRS 11 MINS 43 SECS	16895.8300	66903.6300	0.0000	0.0000



198.00	0 HRS 13 MINS 40 SECS	23949.4400	189779.1000	0.0000	0.0000
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212.00	0 HRS 15 MINS 54 SECS	12957.3300	220221.0000	0.0000	0.0000
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0 HRS 13 MINS 14 SECS

0 HRS 21 MINS 25 SECS

2485m

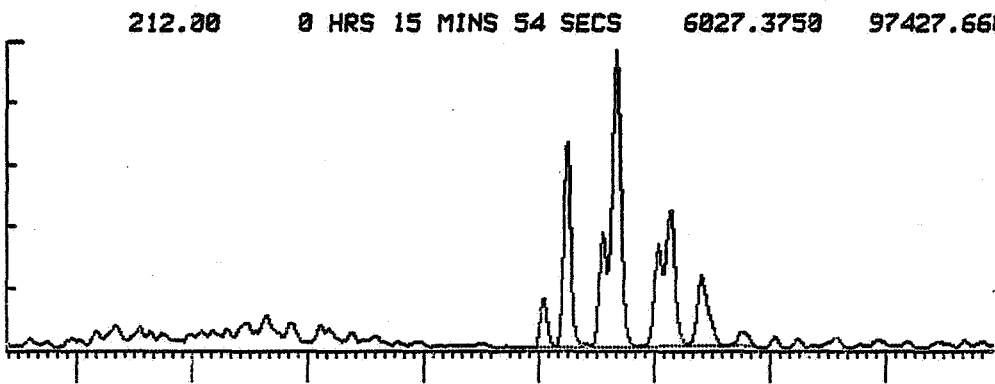
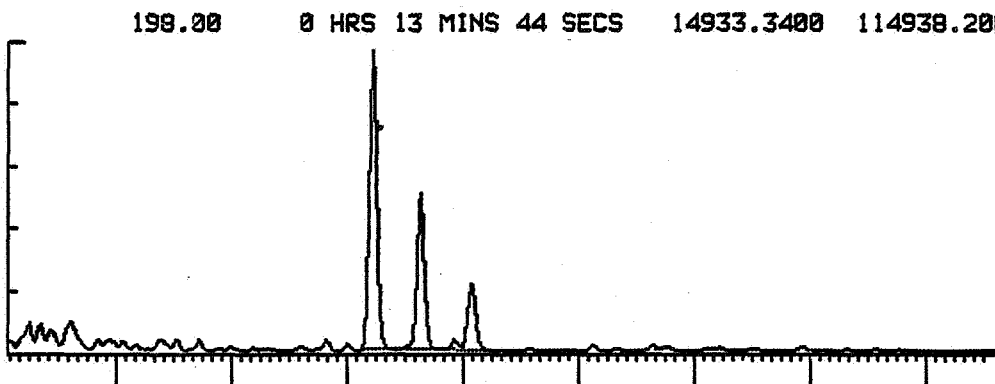
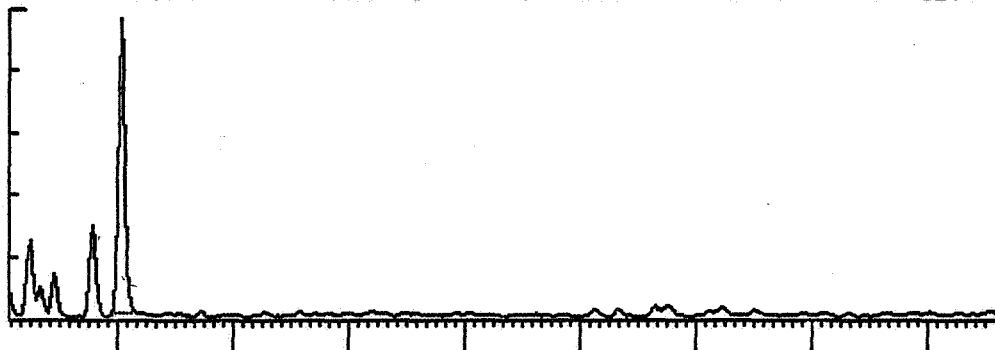
S.W.C.

DIBENZOTHIOPHENE SERIES

SIR REPORT. FILE - 975009 .SD RUN - 1

UNCALIBRATED.
MASS

RETENTION TIME	HEIGHT	AREA	CONC. (H)	CONC. (A)
184.00 0 HRS 11 MINS 53 SECS	9772.1320	36022.4400	0.0000	0.0000
198.00 0 HRS 13 MINS 44 SECS	14933.3400	114938.2000	0.0000	0.0000
212.00 0 HRS 15 MINS 54 SECS	6027.3750	97427.6600	0.0000	0.0000



0 HRS 11 MINS 24 SECS

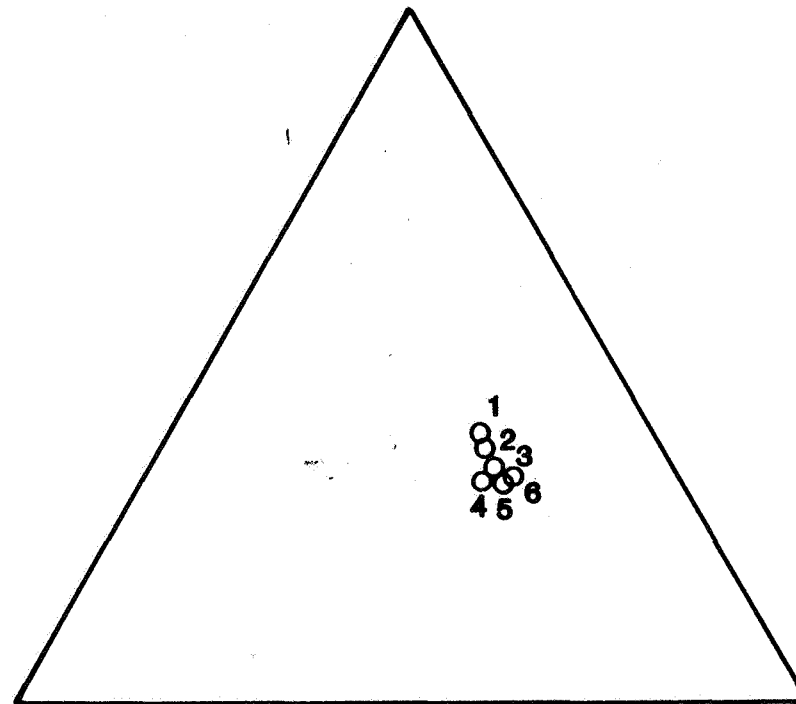
0 HRS 19 MINS 36 SECS

DST 3

FIGURE 10

**TERTIARY DIAGRAM SHOWING RELATIVE
ABUNDANCE OF C₂₇, C₂₈ and C₂₉
5 α (H), 14 β (H), 17 β (H) STERANES**

WELL 7121/4-1



- 1 O DST 4
- 2 O DST 2
- 3 O (2470, 2480, 2485) SWC & DST 3
- 4 O 2468.5 SWC
- 5 O 2443 SWC
- 6 O 2474 SWC

FIGURE 11

STABLE CARBON ISOTOPE RATIOS
(‰, PDB)

WELL 7121/4-1

