REPORT TITLE/ TITTEL

Supplement to oil/oil correlation, well 6407/1-3

CLIENT/ OPPDRAGSGIVER

Statoil

RESPONSIBLE SCIENTIST/ PROSJEKTANSVARLIG

P.B. Hall

AUTHORS/ FORFATTERE

P.B. Hall, L. Schou, G. van Graas, K. Lind and I.K. Almås

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SUMMARY/ SAMMENDRAG

A comparison of data of four samples from well 6307/1-3 indicates that the oil samples (B-922 and B-2317) and condensate (B-2318) probably originate from the same source rock (or source rocks with similar characteristics) but of different maturity (higher maturity for the condensate). The oil in mud sample B-122 appears to be derived from a different source rock. This conclusion is based mainly on difference in $\delta^{13}C$ and slight variations in hydrocarbon ratios such as pristane/-phytane.

KEY WORDS/ STIKKORD

Correlation	GC-MS
Haltenbanken	

125/f/ah/1

CONTENTS

1. INTRODUCTION

The objective of this report is as a supplement to two previous reports on analysis and correlation of oil/condensate samples from well 6407/1-3 (P.B. Hall, 1983 and L. Schou et al., 1984).

This report presents C_2-C_8 GC data of 3 condensates/oils. These data and API gravity could not be acquired for the oil in mud sample (B-122) since mostly water was left of this sample. In addition to the GC results, $\delta^{13}C$ isotope and GC-MS data of the oil in mud sample are presented.

A correction should be made to the previous report (L. Schou et al., 1984), B-922 is not an oil sample obtained from the mud as indicated in this report. It was in fact a sample of oil from an RFT (recovered from 3692m on 2/12/83). Hence the full list of oil samples analysed is as follows:

B-122	Oil removed from surface of mud sample taken at casing shoe (2000-2500m).
B-922	RFT oil collected 2/12/83.
B-2317	DST (no. 1?) oil.
B-2318	DST no. 2 condensate.

2. EXPERIMENTAL

Only the procedure for the GC analysis of C_2-C_8 hydrocarbons is given here, for the other experimental procedures we refer to the previous reports.

2.1 GC analysis of C_2-C_8 hydrocarbons

The analysis was performed on a HP5880 GC, fitted with a 50mx0.2mm fused silica OV-101 column. Helium (1ml/min.) was used as carrier gas. Split injection of 0.2-0.5µl whole oils (split ratio 1:60) was applied.

The temperature program was 30^{o}C to 110^{o}C at 4^{o}C/min. and at 8^{o}C/min. further to 180^{o}C.

Identification of compounds is based on retention of standard compounds and on comparison with literature data. The quantitation as weight % of total sample was performed by comparison with a standard sample containing n-pentane, n-hexane, n-heptane, n-octane, benzene, toluene, m-xylene, o-xylene and p-cymene.

3. RESULTS AND DISCUSSION

GC data of C_2-C_8 hydrocarbons are presented here together with data from aromatic hydrocarbon traces, δC13 isotopes and GC-MS mass fragmentograms of the oil in mud sample with tabulation of GC-MS molecular parameters for all four samples. For the rest of the data we refer to the two previous reports.

3.1 GC of C_2-C_8 hydrocarbons and whole oils

Comparison C_2-C_8 hydrocarbons of three of the samples (B-922, B-2317, B-2318) indicates that they are similar, and probably originated from a similar type of source rock. Sample B-2318 is lighter than the other two, and possibly of slightly higher maturity.

A comparison by whole oil gas chromaotgraphy of the hydrocarbons in the mud (B-122) with these three samples does not reveal any great differences. The whole oil GC and the gross composition show that the relative abundance of n-alkanes versus cyclic and aromatic hydrocarbons to be slightly higher in sample B-122. From the GC's of the hydrocarbon fractions this sample B-122 was seen to be most similar to the lightest of the three other samples, B-2318.

3.2 Aromatic hydrocarbons

The MPI 1 value for oil B-122 is almost the same as the oil samples (RFT sample B-922 and the other from a DST B-2317) and lower than the condensate.

IKU no.	Sample type	MPI*
B-122	Oil in mud	0.59
B-922 RFT	Oil	0.65
B-2317 DST (1?)	Oil	0.61
B-2318 DST 2	Condensate	0.94

$$*MPI = \frac{1.5\ (2\text{-MP} + 3\text{-MP})}{P + 1\text{-MP} + 9\text{-MP}}$$

This suggests that the oil in mud sample has come from a source of similar maturity to the oil samples (B-922 and B-2317) and lower than that for the condensate (B-2318).

3.3 Carbon Isotopes

The $\delta^{13}C$ isotope values of the saturate and aromatic fractions of the sample B-122 are heavier by between 1-2 per mil than the oils and condensate samples (B-922/B-2317 and B-2318 respectively).

$\delta^{13}C$ isotope data for oil/condensate

IKU no.	Sample type	SAT	ARO	Whole oil
B-122	Oil from mud	-28.6	-27.6	No sample available for analysis
B-922	Oil from RFT	-30.4	-29.1	-29.2
B-2317	Oil from DST	-30.1	-29.1	-29.4
B-2318	Condensate from DST	-30.5	-28.9	-29.2

This might indicate that the mud oil (B-122) comes from a different source than the other samples.

3.4 GC-MS

Similar conclusions could be drawn from the GC-MS data to that made above. There were noticeable differences in B-122 compared with the other samples particularly in the %C_{29}20S steranes (ratio 6), Tm/Ts (ratio 2) and Q/E (tricyclic terpane/$C_{30}\alpha\beta$hopane-ratio 1).

4. CONCLUSION

Only small variations were seen between the four samples that were compared except in isotope data. Two of them, B-122 and B-2318, contain slightly higher relative abundance of the lower molecular weight compounds than the other two. Samples of the oil (B-922 and B-2317) and the condensate (B-2318) may have originated from the same or very similar source rocks, but probably at different stages of maturity. The oil mud sample B-122, although only slightly different in GC-MS data (table 3), has a higher pristane/phytane ratio and the $\delta^{13}C$ isotope is significantly different suggesting that there may be a different source for B-122 than for the other samples.

5. REFERENCES

HALL, P.B., 1983: Investigation of hydrocarbons in mud samples from 6407/1-3. IKU report 05.0208.

SCHOU, L., LEITH, T.L., HUSTAD, E., BAKKEN, O., HAUGEN, G. and VINGE, T., 1984: Oil/oil correlations, well 6407/1-3. IKU report 05.1707/1/84.

Table 1. Identified C_2-C_8 hydrocarbons expressed as area % of total C_2-C_8 compounds. Identifications are based on retention time or on coelution with standard compounds (*).

Compound no.	Identification	B-922	B-2317	B-2318
1	* propane	4.6		
2	i-butane	1.9		
3	* n-butane	5.9	1.4	
4	i-pentane	3.6	2.0	1.3
5	* n-pentane	5.6	3.6	3.0
6	2,3-dime-butane + cyclopentane	1.2	1.0	1.0
7	2-me-pentane	2.8	2.6	3.1
8	3-me-pentane	1.8	1.7	2.1
9	* n-hexane	5.1	5.2	6.7
10	me-cyclopentane	3.5	4.0	3.9
11	* benzene	3.5	4.0	3.3
12	cycohexane	5.4	6.2	6.0
13	2-me-hexane	1.5	1.8	2.4
14	2,3-dime-pentane	0.6	0.7	0.9
15	3-me-hexane	2.0	2.4	3.0
16	1,3-cis-dime-cyclopentane	0.8	0.9	1.0
17	1,3-trans-dime-cyclopentane	0.9	1.1	1.2
18	2,2,4-trime-pentane	1.5	1.8	1.9
19	* n-heptane	5.4	6.6	8.3
20	me-cyclohexane	8.3	10.5	10.0
21	2,4-dime-hexane	1.1	1.4	1.4
22	* toluene	7.3	9.4	7.7
23	2-me-heptane	2.3	2.9	3.4
24	4-me-heptane	0.7	0.9	1.0
25	3-me-heptane	1.2	1.6	1.8
26	1,3-cis-dime-cyclohexane	1.7	2.2	2.0
27	1,1-dime-cyclohexane	0.7	0.9	0.9
28	* n-octane	6.4	8.5	8.8
29	et-benzene	2.3	3.2	2.4
30	* m/p-xylene	4.5	6.3	4.5
31	* o-xylene	2.1	2.8	1.8

Table 2. Identified C_2-C_8 hydrocarbons as wgt % of total sample.

Compound no.	Identification	B-922	B-2317	B-2318
1	propane	1.5		
2	i-butane	0.6		
3	n-butane	1.9	0.4	
4	i-pentane	1.2	0.5	0.3
5	n-pentane	1.8	0.9	0.8
6	2,3-dime-butane + cyclopentane	0.4	0.3	0.3
7	2-me-pentane	0.7	0.5	0.7
8	3-me-pentane	0.4	0.3	0.5
9	n-hexane	1.3	1.0	1.5
10	me-cyclopentane	0.9	0.8	0.8
11	benzene	0.8	0.7	0.7
12	cyclohexane	1.3	1.2	1.3
13	2-me-hexane	0.3	0.3	0.5
14	2,3-dime-pentane	0.1	0.1	0.2
15	3-me-hexane	0.4	0.4	0.6
16	1,3-cis-dime-cyclopentane	0.2	0.2	0.2
17	1,3-trans-dime-cyclopentane	0.2	0.2	0.2
18	2,2,4-trime-pentane	0.3	0.3	0.3
19	n-heptane	1.2	1.1	1.6
20	me-cyclohexane	1.8	1.8	1.9
21	2,4-dime hexane	0.2	0.2	0.2
22	toluene	1.5	1.6	1.4
23	2-me-heptane	0.4	0.4	0.6
24	4-me-heptane	0.1	0.1	0.2
25	3-me-heptane	0.2	0.2	0.3
26	1,3-cis-dime-cyclohexane	0.3	0.3	0.3
27	1,1-dime-cyclohexane	0.1	0.1	0.1
28	n-octane	1.2	1.3	1.5
29	et-benzene	0.5	0.5	0.4
30	m/p-xylene	0.9	1.0	0.8
31	o-xylene	0.4	0.5	0.3

Table 3. Molecular ratios calculated from peak heights in terpane (m/z 191) and sterane (m/z 217) mass chromatograms.

	m/z 191				m/z 217		
IKU no.	Q/E[1)]	Tm/Ts[2)]	αβ/αβ+βα[3)]	%22S[4)]	%ββ[5)]	%20S[6)]	a/a+j[7)]
B-922	0.17	0.6	0.96	62	80	63	0.88
B-2317	0.17	0.5	0.94	60	78	60	0.85
B-2318	0.28	0.5	0.94	62	78	58	0.88
B-122	0.11	0.8	0.89	56	71	45	0.88

1) Relative abundance of tricyclic terpanes (Q/E in m/z 191).

2) B/A in m/z 191.

3) E/E+F in m/z 191.

4) % distribution between first and second eluting isomers of doublet J (m/z 191).

5) 2(r+s)/(q+t+2(r+s)) in m/z 217.

6) q/q+t in m/z 217.

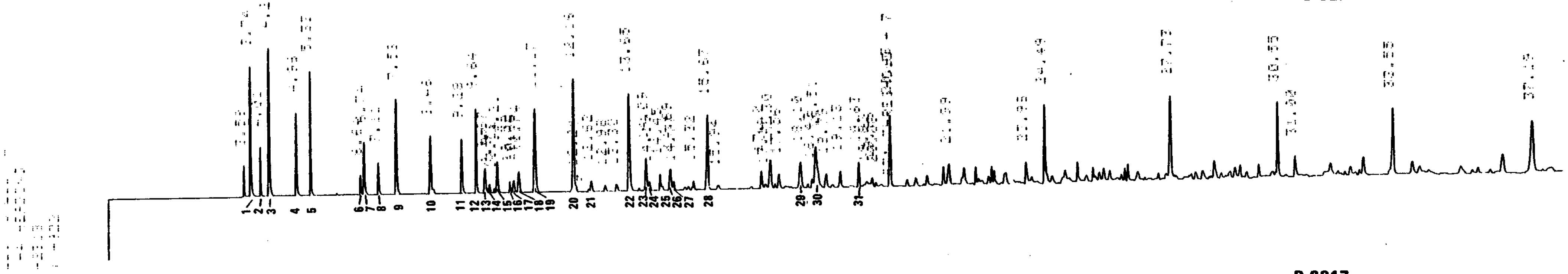
7) Relative abundance of C_{27} rearranged steranes (a/a+j in m/z 217)

GC of C_2-C_8 hydrocarbons

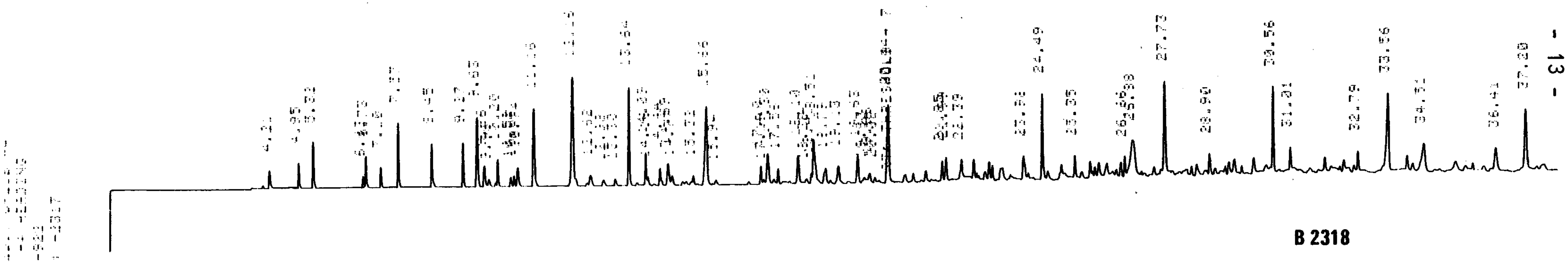
For key to numbers in the trace of sample B-922, see Table 1.

C_2 – C_8 HC's

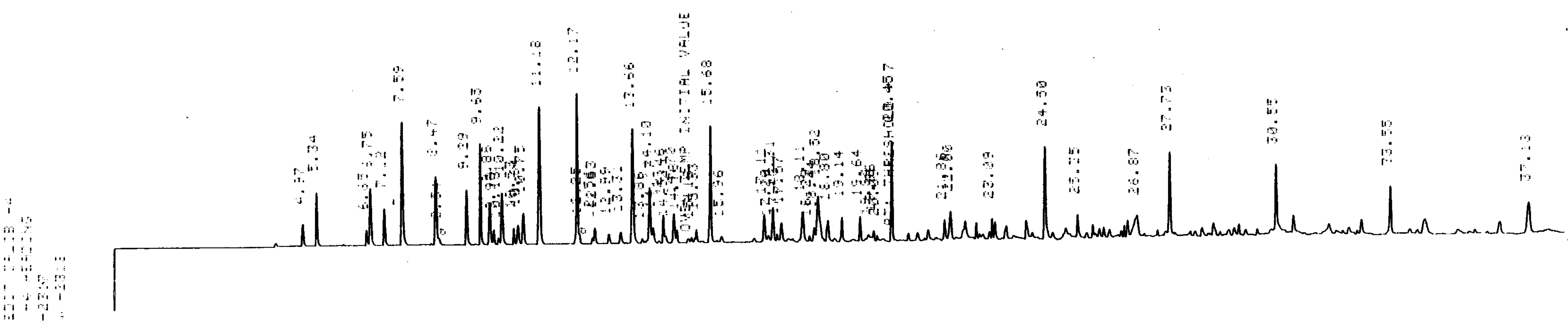
B 922



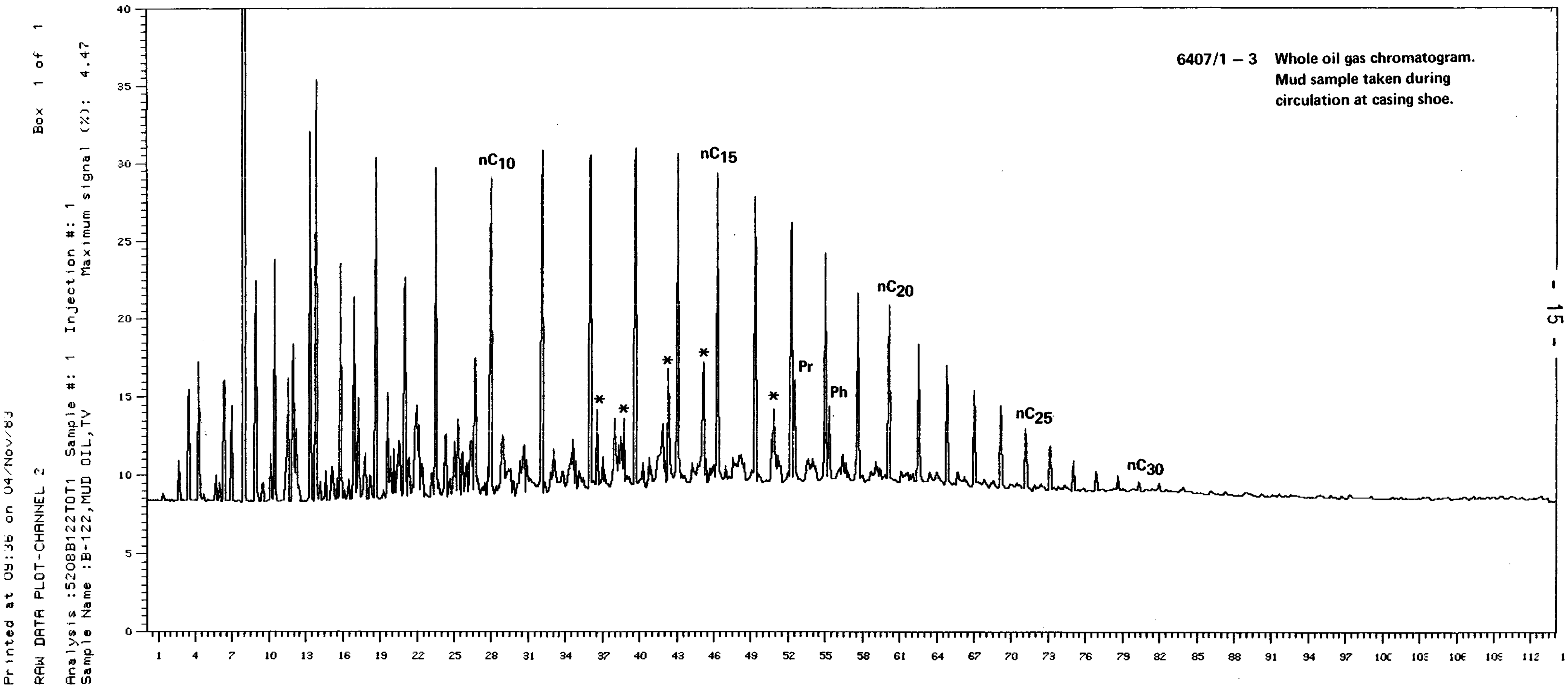
B 2317



B 2318



Gas chromatograms and mass
fragmentograms of oil in mud sample
(B-122)



6407/1 – 3 Whole oil gas chromatogram. Mud sample taken during circulation at casing shoe.

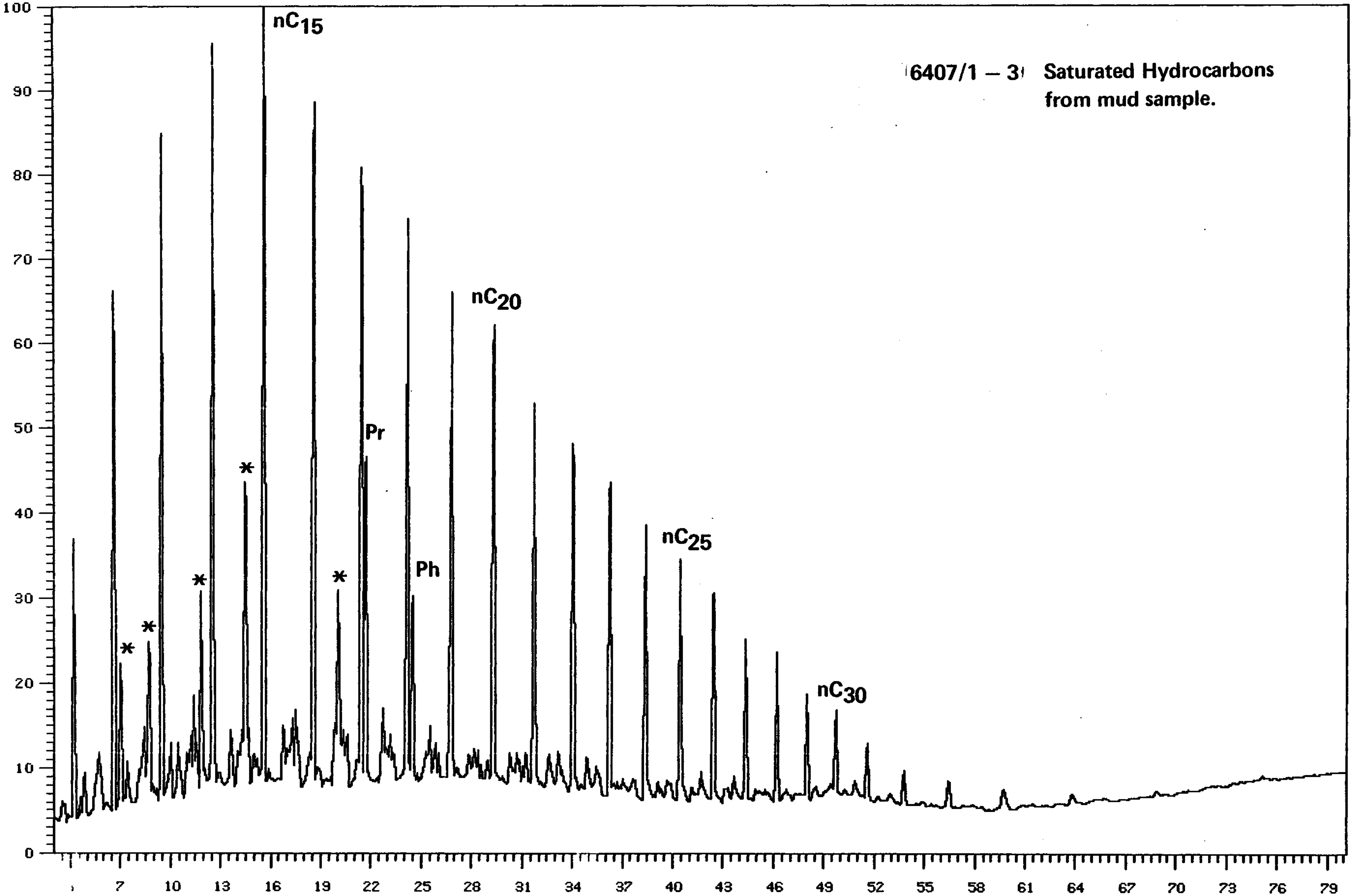
Printed at 14:29 on 15/Nov/83

RAW DATA PLOT-CHANNEL 1

Box 1 of 1

Analysis :BI22SAT Sample #: 1 Injection #: 1

Sample Name :BI22 SAT TB Maximum signal (%): 6.70



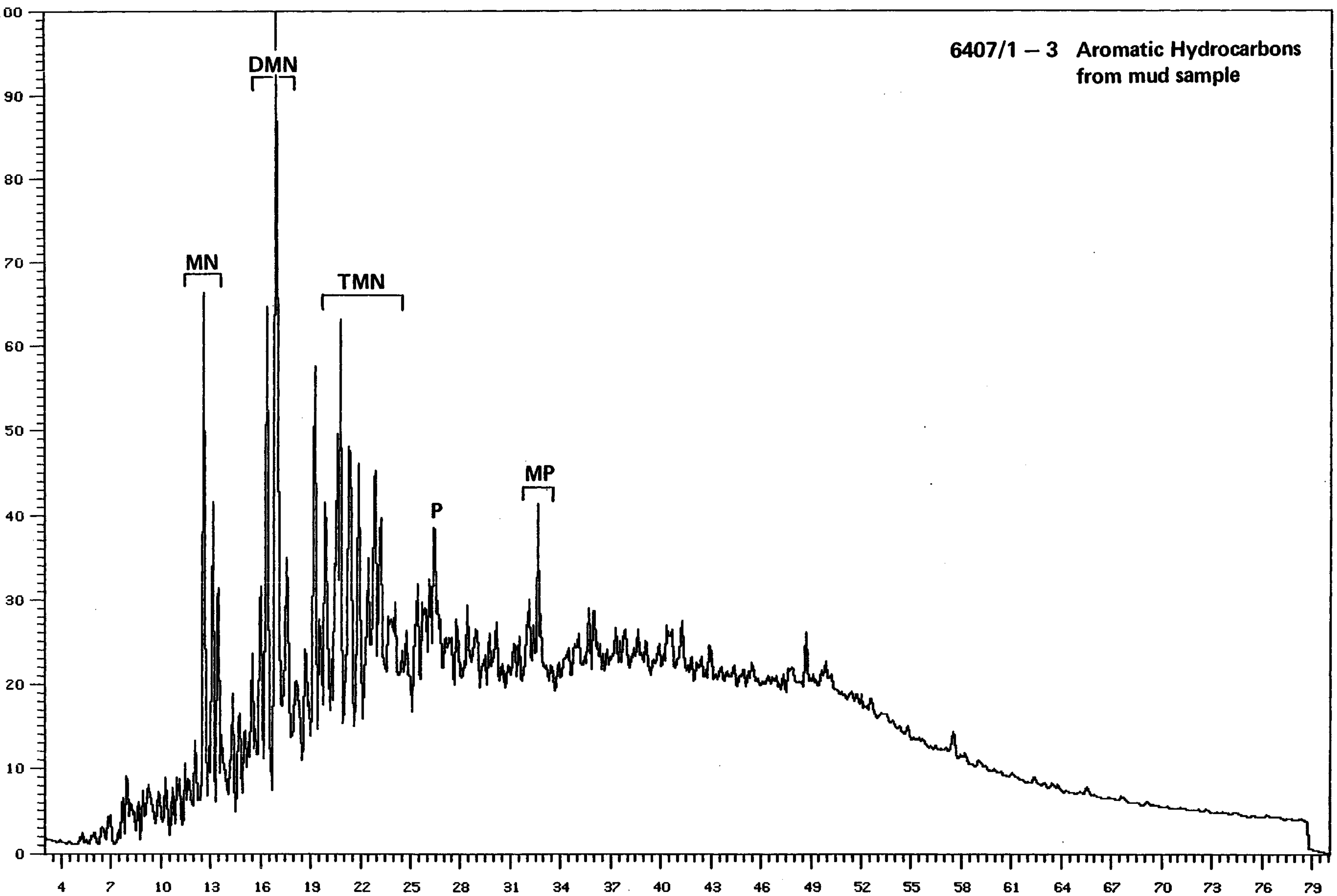
Printed at 11:01 on 15/Nov/83

RAW DATA PLOT-CHANNEL 4

Analysis :BI22ARO Sample #: 1 Injection #: 1

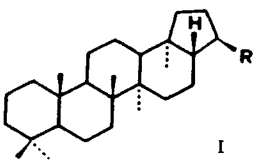
Sample Name :BI22 ARO TB Maximum signal (%): 31.20

Box 1 of 1



Mass chromatograms representing terpanes (m/z 191)

A	T_s, 18α(H)-trisnorneohopane	$C_{27}H_{46}$	(III)
B	T_m, 17α(H)-trisnorhopane	$C_{27}H_{46}$	(I,R=H)
C	17α(H)-norhopane	$C_{29}H_{50}$	(I,R=C_2H_5)
D	17β(H)-normoretane	$C_{29}H_{50}$	(II,R=C_2H_5)
E	17α(H)-hopane	$C_{30}H_{52}$	(I,R=C_3H_7)
F	17β(H)-moretane	$C_{30}H_{52}$	(II,R=C_3H_7)
G	17α(H)-homohopane (22S)	$C_{31}H_{54}$	(I,R=C_4H_9)
H	17α(H)-homohopane (22R)	$C_{31}H_{54}$	(I,R=C_4H_9)
	+ unknown triterpane (gammacerane?)		
I	17β(H)-homomoretane	$C_{31}H_{54}$	(II,R=C_4H_9)
J	17α(H)-bishomohopane (22S,22R)	$C_{32}H_{56}$	(I,R=C_5H_{11})
K	17α(H)-trishomohopane (22S,22R)	$C_{33}H_{58}$	(I,R=C_6H_{13})
L	17α(H)-tetrakishomohopane (22S,22R)	$C_{34}H_{60}$	(I,R,=C_7H_{15})
M	17α(H)-pentakishomohopane (22S,22R)	$C_{35}H_{62}$	(I,R=C_8H_{17})
Z	bisnorhopane	$C_{28}H_{48}$	
X	unknown triterpane	$C_{30}H_{52}$	
P	tricyclic terpane	$C_{23}H_{42}$	(IV,R=C_4H_9)
Q	tricyclic terpane	$C_{24}H_{44}$	(IV,R=C_5H_{11})
R	tricyclic terpane (17R,17S)	$C_{25}H_{46}$	(IV,R=C_6H_{13})
S	tetracyclic terpane	$C_{24}H_{42}$	(V)
T	tricyclic terpane (17R,17S)	$C_{26}H_{48}$	(IV,R=C_7H_{15})



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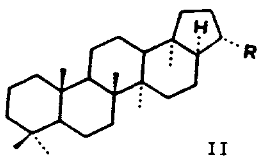

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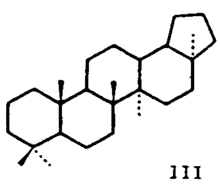

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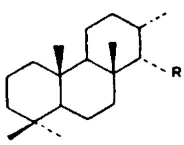

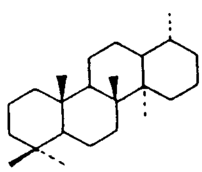

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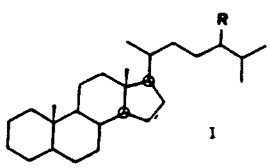
Mass chromatograms representing steranes (m/z 217 and 218)

a	13β(H),17α(H)-diasterane (20S)	$C_{27}H_{48}$	(III,R=H)
b	13β(H),17α(H)-diasterane (20R)	$C_{27}H_{48}$	(III,R=H)
c	13α(H),17β(H)-diasterane (20S)	$C_{27}H_{48}$	(IV,R=H)
d	13α(H),17β(H)-diasterane (20R)	$C_{27}H_{48}$	(IV,R=H)
e	13β(H),17α(H)-diasterane (20S)	$C_{28}H_{50}$	(III,R=CH_3)
f	13β(H),17α(H)-diasterane (20R)	$C_{28}H_{50}$	(III,R=CH_3)
g	13α(H),17β(H)-diasterane (20S)	$C_{28}H_{50}$	(IV,R=CH_3)
	+ 14α(H),17α(H)-sterane (20S)	$C_{27}H_{48}$	(I,R=H)
h	13β(H),17α(H)-diasterane (20S)	$C_{29}H_{52}$	(III,R=C_2H_5)
	+ 14α(H),17α(H)-sterane (20R)	$C_{27}H_{48}$	(II,R=H)
i	14β(H),17β(H)-sterane (20S)	$C_{27}H_{48}$	(II,R=H)
	+ 13α(H),17β(H)-diasterane (20R)	$C_{28}H_{50}$	(IV,R=CH_3)
j	14α(H),17α(H)-sterane (20R)	$C_{27}H_{48}$	(I,R=H)
k	13β(H),17α(H)-diasterane (20R)	$C_{29}H_{52}$	(III,R=C_2H_5)
l	13α(H),17β(H)-diasterane (20S)	$C_{29}H_{52}$	(III,R=C_2H_5)
m	14α(H),17α(H)-sterane (20S)	$C_{28}H_{50}$	(I,R=CH_3)
n	13α(H),17β(H)-diasterane (20R)	$C_{29}H_{52}$	(III,R=C_2H_5)
	+ 14β (H),17β (H)-sterane (20R)	$C_{28}H_{50}$	(II,R=CH_3)
o	14β(H),17β(H)-sterane (20S)	$C_{28}H_{50}$	(II,R=CH_3)
p	14α(H),17α(H)-sterane (20R)	$C_{28}H_{50}$	(I,R=CH_3)
q	14α(H),17α(H)-sterane (20S)	$C_{29}H_{52}$	(I,R=C_2H_5)
r	14β(H),17β(H)-sterane (20R)	$C_{29}H_{52}$	(II,R=C_2H_5)
	+ unknown sterane		
s	14β(H),17β(H)-sterane (20S)	$C_{29}H_{52}$	(II,R=C_2H_5)
t	14α(H),17β(H)-sterane (20R)	$C_{29}H_{52}$	(I,R=C_2H_5)
u	5α(H)-sterane	$C_{21}H_{36}$	(V,R=C_2H_5)
v	5α(H)-sterane	$C_{22}H_{38}$	(IV,R=C_3H_7)



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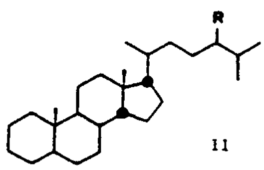

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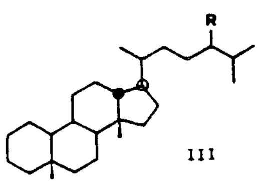

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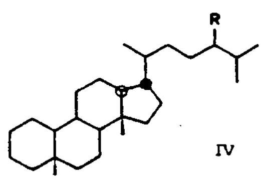

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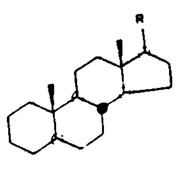

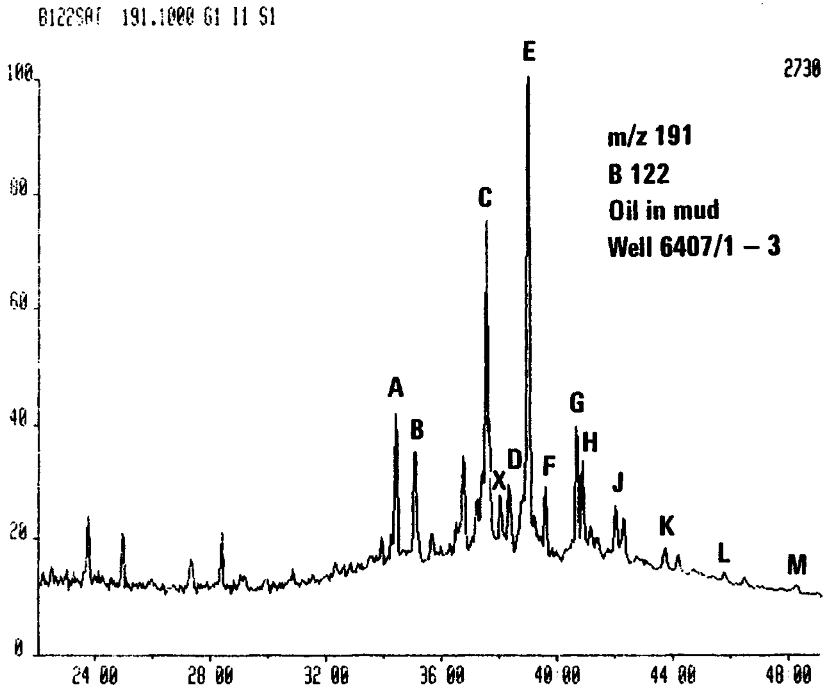
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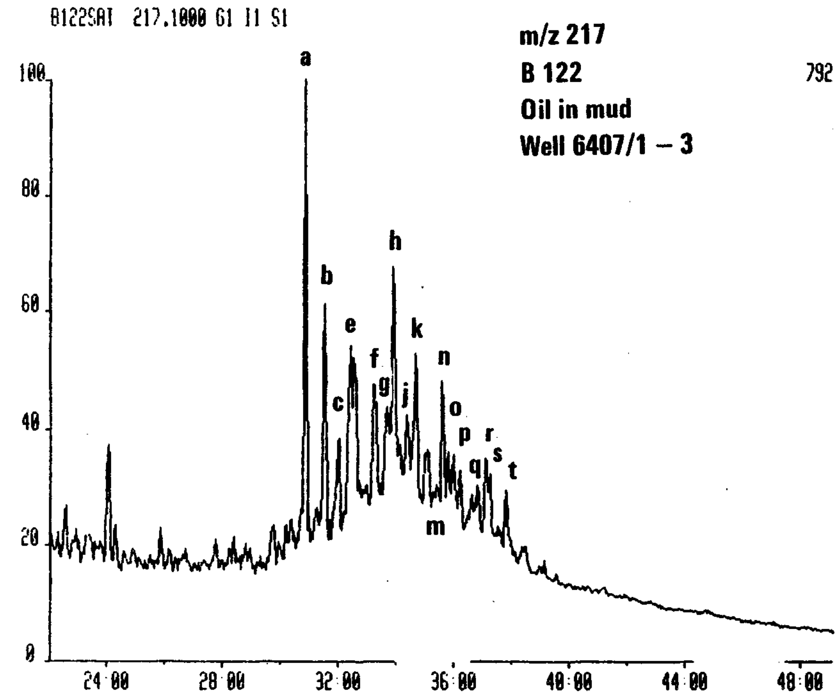
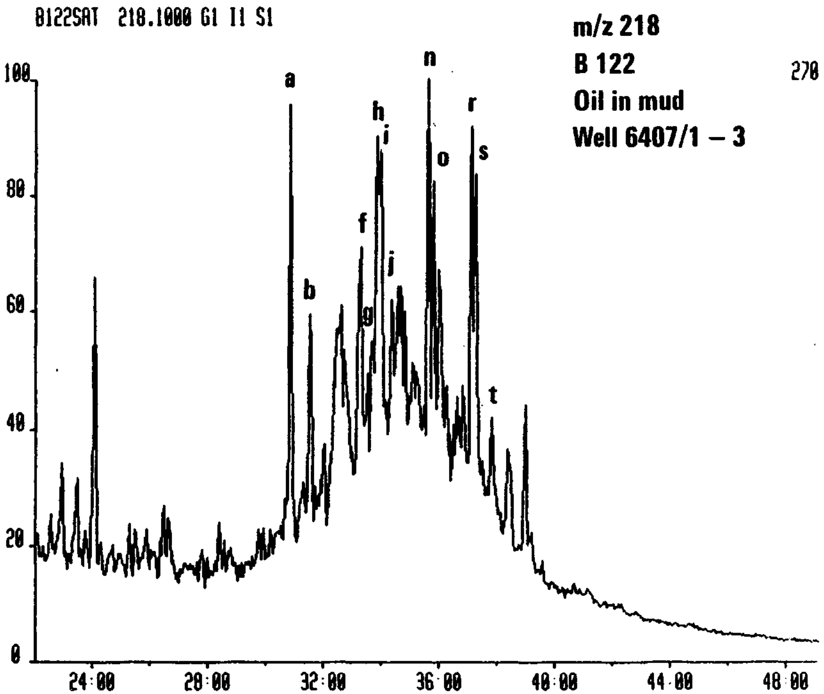
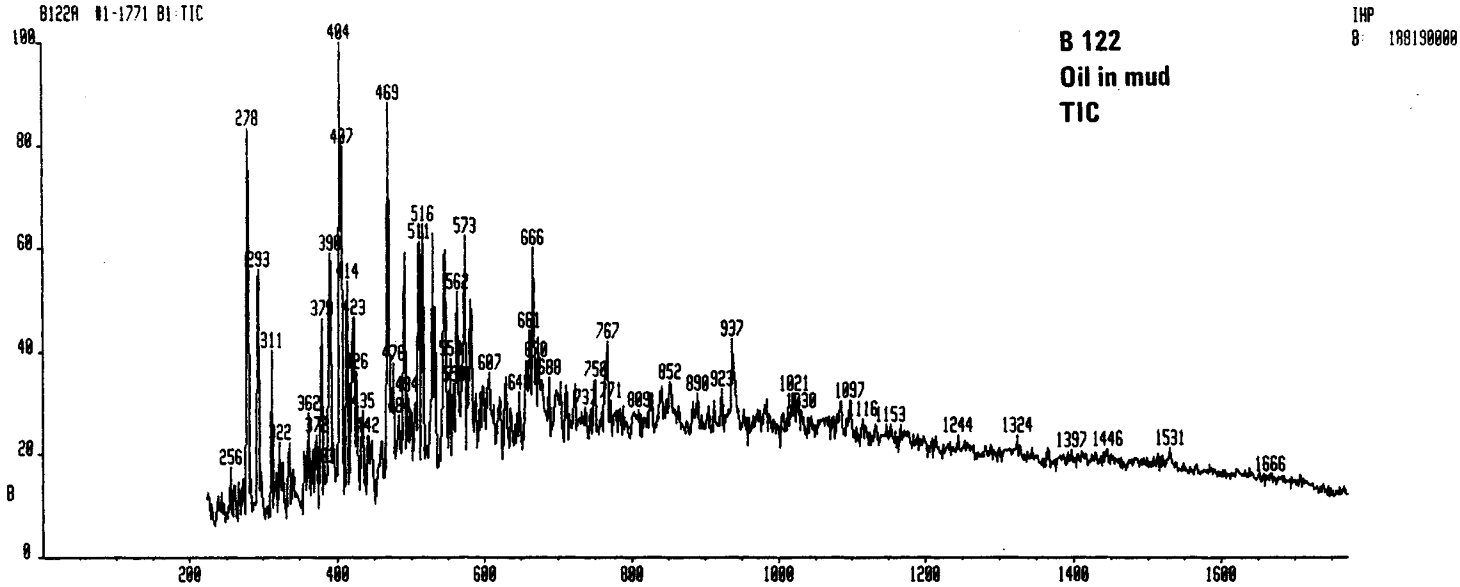
2730
m/z 191
B 122
Oil in mud
Well 6407/1 – 3
A
B
C
D
E
F
G
H
J
K
L
M
X
100
80
60
40
20
0
24 00
28 00
32 00
36 00
40 00
44 00
48 00

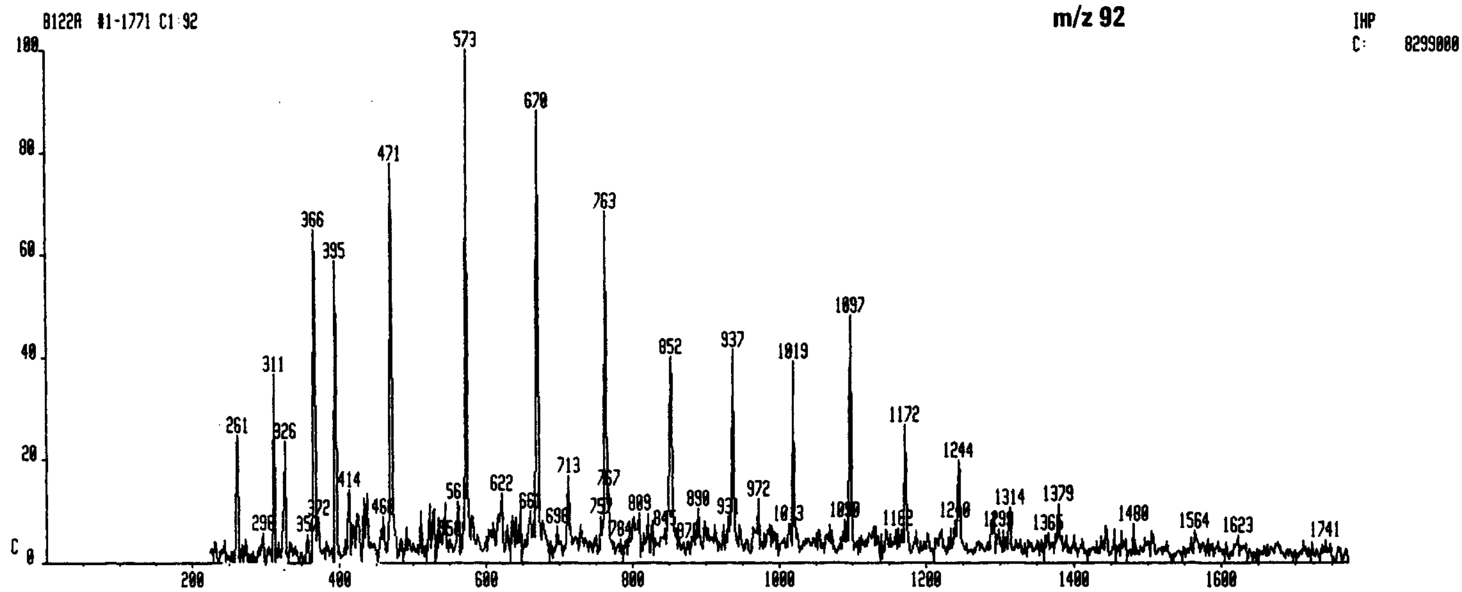

B122SAT 217.1000 G1 I1 S1
792
m/z 217
B 122
Oil in mud
Well 6407/1 – 3
a
b
c
e
f
g
h
j
k
m
n
o
p
q
r
s
t
100
80
60
40
20
0
24:00
28:00
32:00
36:00
40:00
44:00
48:00

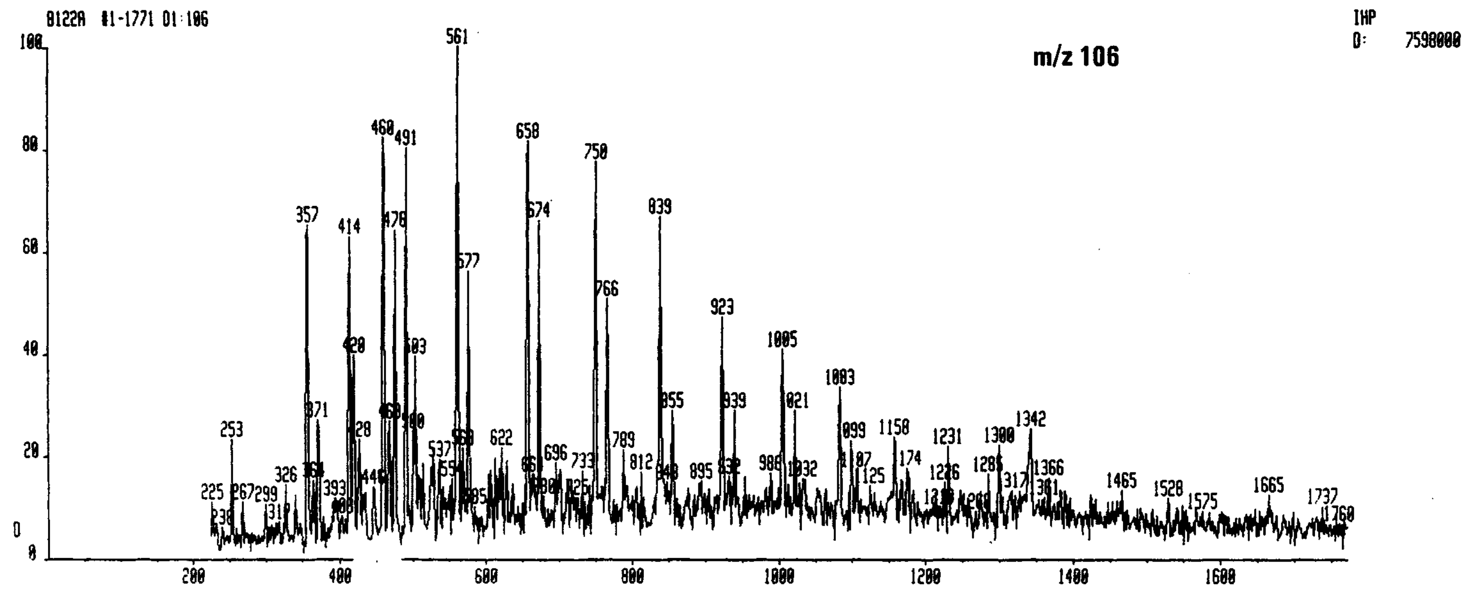

B122SAT 218.1000 G1 I1 S1
270
m/z 218
B 122
Oil in mud
Well 6407/1 – 3
a
b
f
g
h
i
j
n
o
r
s
t
100
80
60
40
20
0
24:00
28:00
32:00
36:00
40:00
44:00
48:00

Mass chromatograms of aromatic hydrocarbons

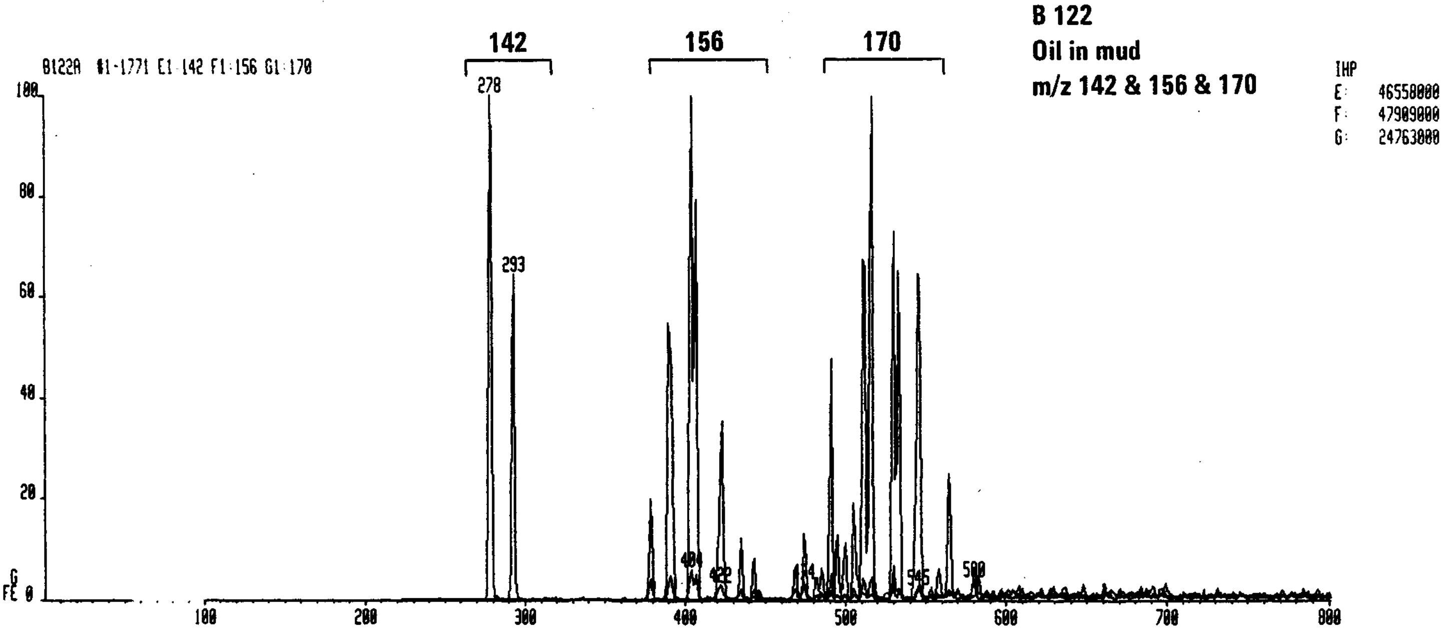
TIC	- total ion chromatograms
m/z 92,106	- alkylated benzenes
m/z 142,156,170	- alkylated naphthalenes
m/z 178,192,206	- alkylated phenanthrenes
m/z 184,198,212	- alkylated dibenzothiophenes (DBT)
m/z 231	- triaromatic steranes
m/z 253	- monoaromatic steranes


B122A #1-1771 B1:TIC
IHP
B: 188190000
B 122
Oil in mud
TIC

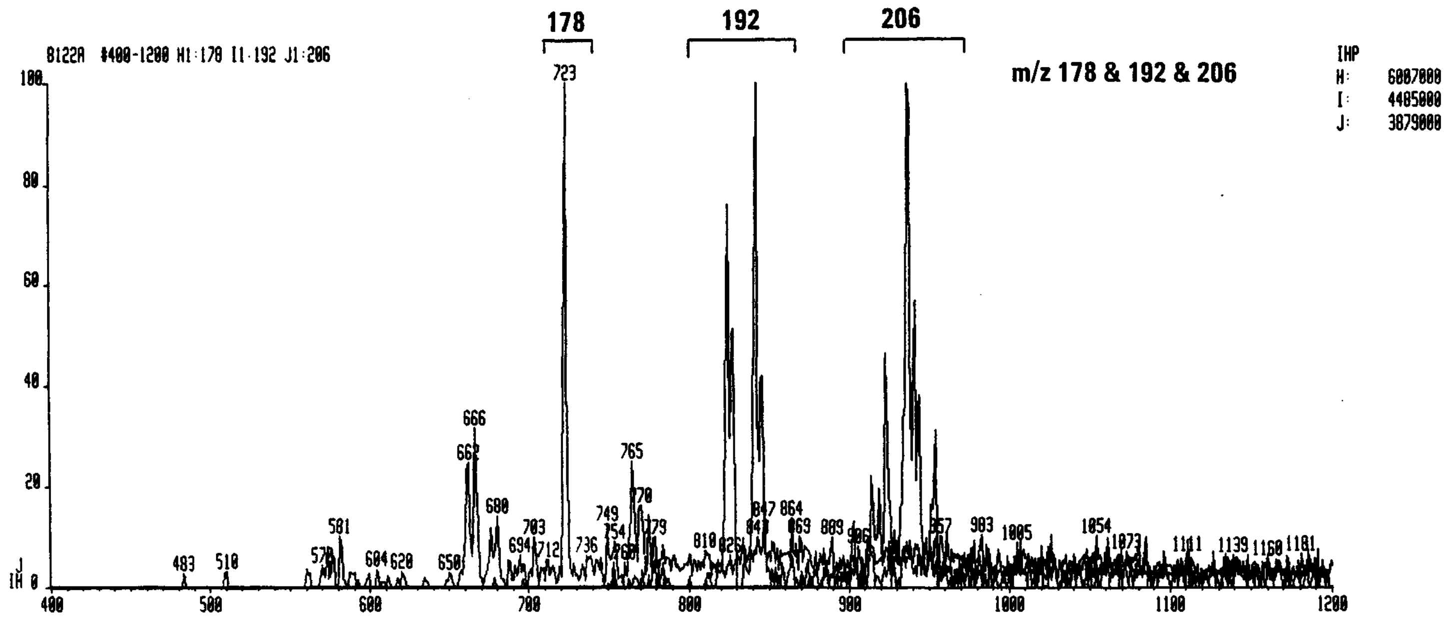

B122A #1-1771 C1:92
m/z 92
IHP
C: 8299000

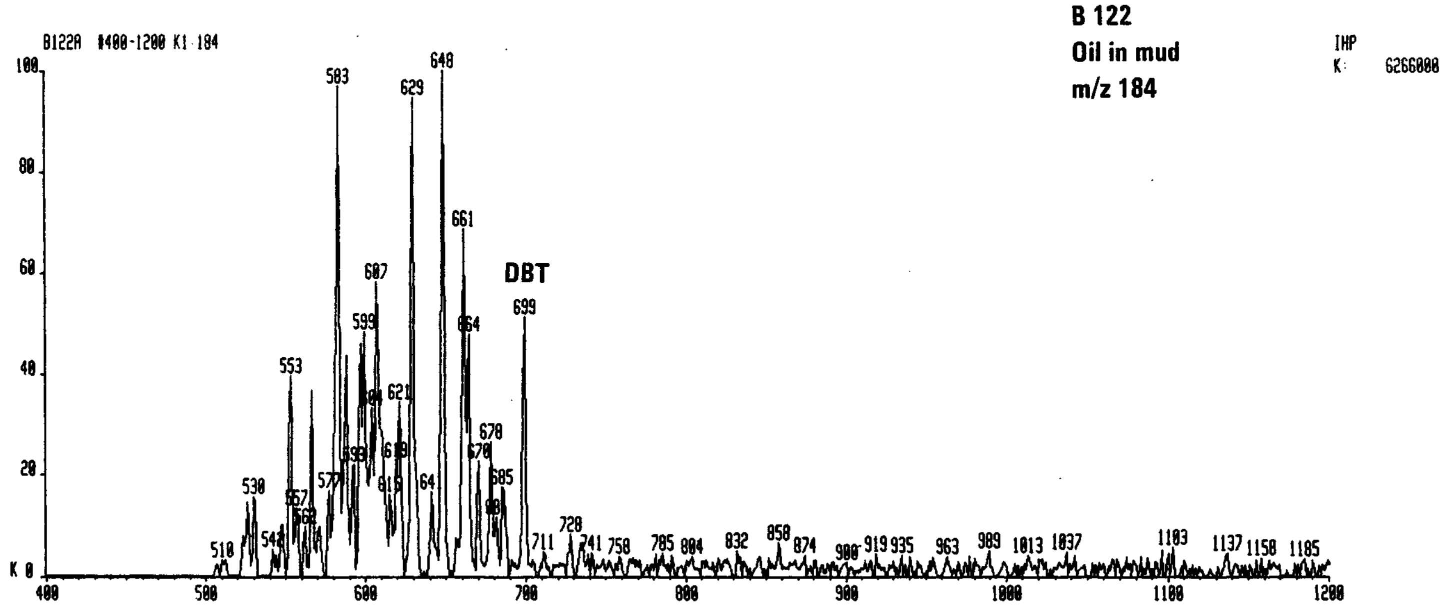

B122A #1-1771 D1:106
m/z 106
IHP
D: 7598000

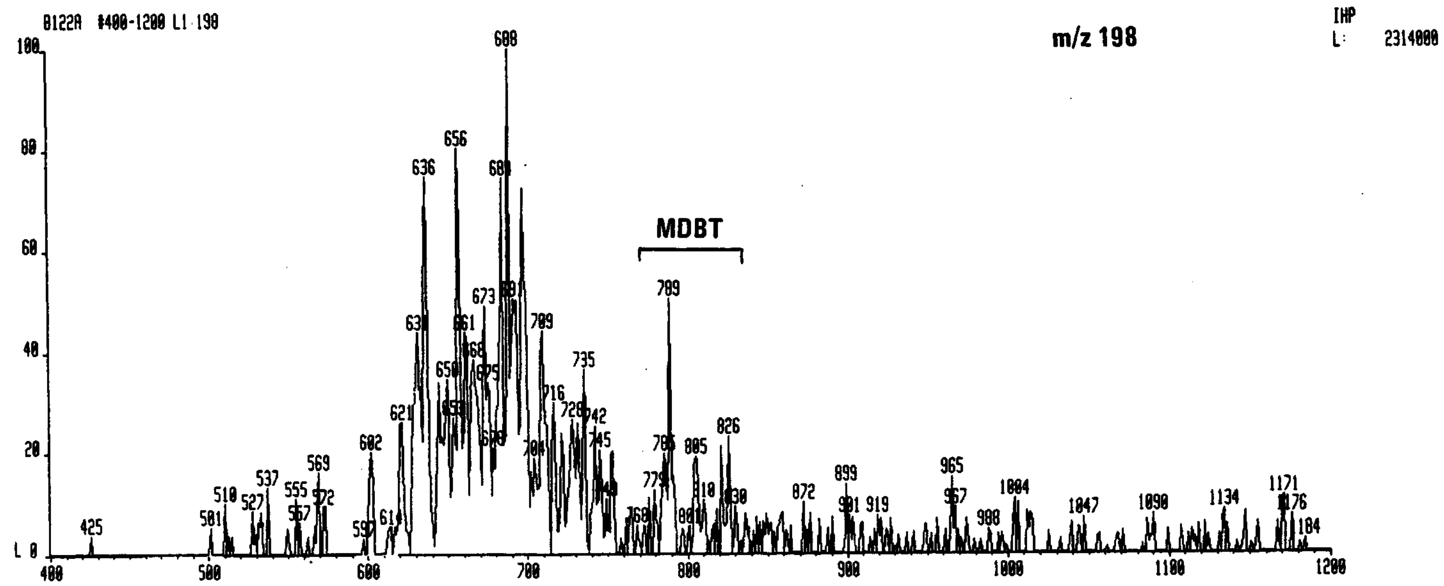
B 122
Oil in mud
m/z 142 & 156 & 170

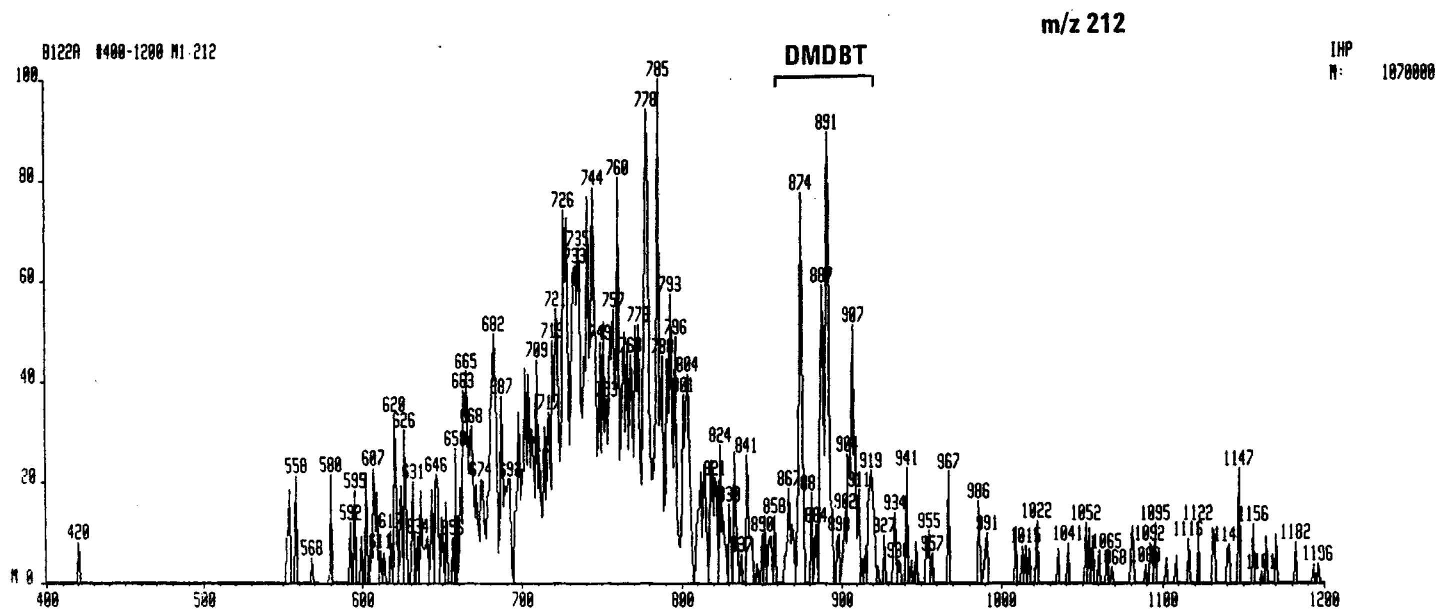


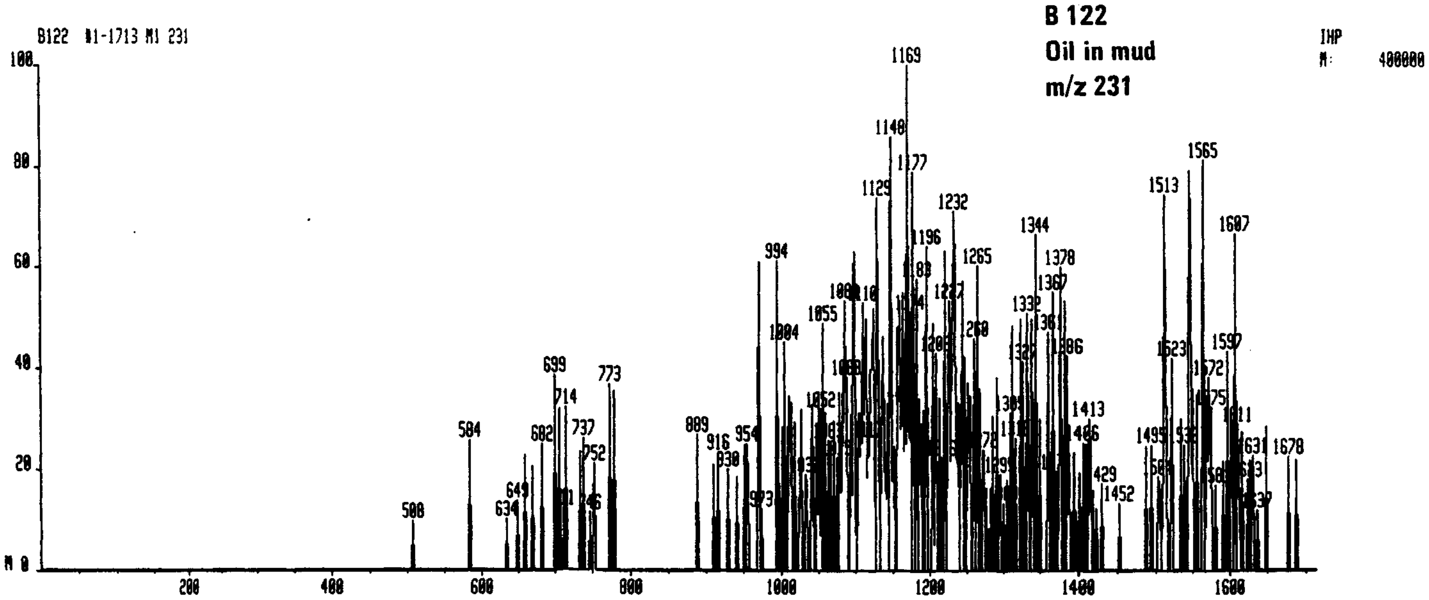
m/z 178 & 192 & 206

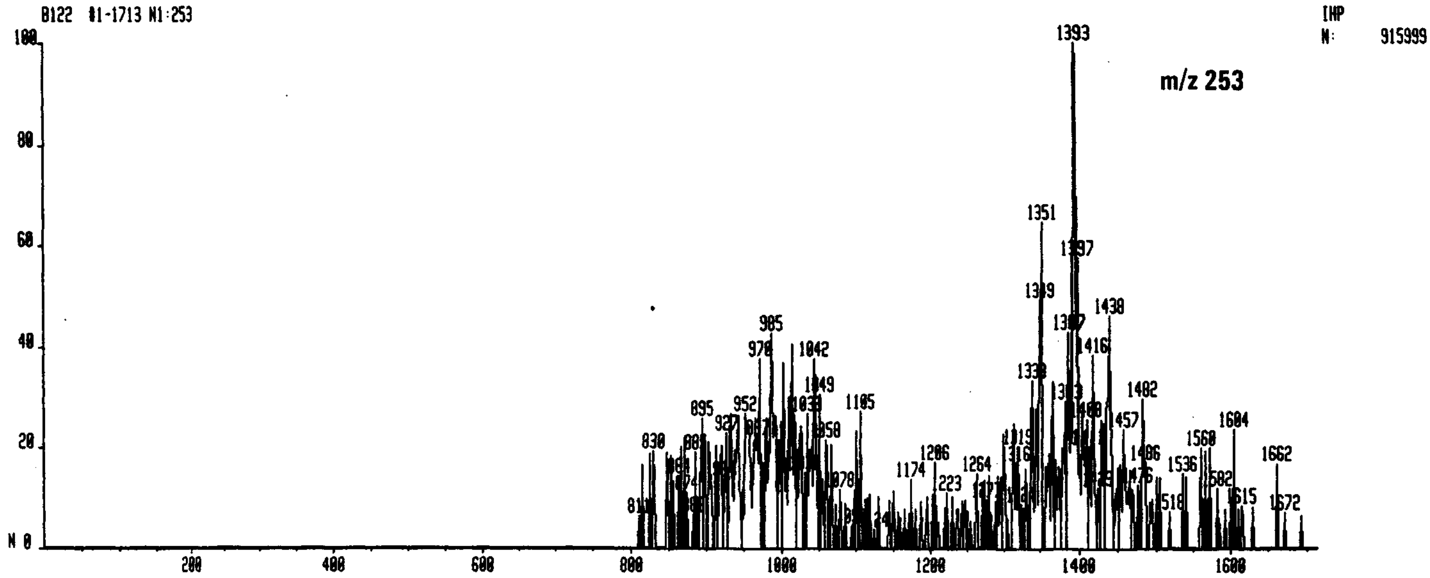



B122A #400-1200 K1 184
B 122
Oil in mud
m/z 184
IHP
K: 6266000
DBT
100
80
60
40
20
K 0
400
500
600
700
800
900
1000
1100
1200


B122A #400-1200 L1 198
m/z 198
IHP
L: 2314000
MDBT
100
80
60
40
20
L 0
400
500
600
700
800
900
1000
1100
1200


B122A #400-1200 M1 212
m/z 212
DMDBT
IHP
M: 1070000
100
80
60
40
20
M 0
400
500
600
700
800
900
1000
1100
1200


B122 #1-1713 MI 231
B 122
Oil in mud
m/z 231
IHP
M: 400000


B122 #1-1713 MI:253
m/z 253
IHP
M: 915999