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REPORT TITLE/ TITTEL
ANALYSIS OF CORE SAMPLES FROM 34/10-16. CORRELATION OF OILS, OILS SHOWS AND COAL SAMPLES FROM 34/10-16 AND 34/10-17.

CLIENT/ OPPDRAGSGIVER
Statoil

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SUMMARY/ SAMMENDRAG

The report includes extraction, GC and GC-MS data for 4 sandstone cores from 34/10-16. These data together with data from 34/10-17 are used in an attempt to correlate oils, oil shows and coal samples. The oil shows in the sandstones at 3180-3356m in 34/10-16 were seen to be fairly similar to the oils and shows in 34/10-17. The coal from 34/10-17 can not have sourced the hydrocarbons present in the oil shows.

KEY WORDS/ STIKKORD

Oil show	Correlation
GC-MS	Cores

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CONTENTS

EXPERIMENTAL

Extractable Organic Matter

Approximately 50gm of powdered rock was extracted by a ultrasonic probe for 3 minutes using dichloromethane (DCM) as solvent. The DCM used was of organic geochemical grade and blank analyses showed the occurrence of negligible amounts of contaminating hydrocarbons.

Activated copper fillings were used to remove any free sulphur from the samples.

After extraction the solvent was removed on a Buchi Rotavapor and the amount of extractable organic matter (EOM) was determined.

Chromatographic Separation

The extractable organic matter (EOM) was separated into saturated fraction, aromatic fraction and non hydrocarbon fraction using a MPLC system with hexane as eluant (Radke et al., Anal. Chem., 1980). The various fractions were evaporated on a Buchi Rotavapor and transferred to glass vials and dried in stream of nitrogen.

Gas Chromatographic Analysis

The saturated hydrocarbon fractions were each diluted with n-hexane and analysed on a HP 5730A gas chromatograph, fitted with a 25m OV-101 fused silica capillary column. Hydrogen (0.7ml/min) was used as carrier gas. The aromatic fractions were after dilution with n-hexane, analysed on a Carlo Erba Fractovap Series 2150 GC fitted with a 20mm SE-54 fused silica column.

Injections on both systems were performed in the split mode (1:20). The temperature program applied was $80^{o}C$ (2 min) to $260^{o}C$ at $4^{o}C/min$.

The data processing for all the GC analyses was performed on a VG Multichrom System.

Gas chromatography - mass spectrometry (GC-MS)

GC-MS analyses were performed on a VG Micromass 70-70H GC-MS-DS system.
The Varian Series 3700 GC was fitted with a fused silica OV-1 capillary
column (30m x 0.3mm i.d.). Helium ($0.7kg/cm^2$) was used as carrier gas
and the injections were performed in split mode (1:15). The GC oven was
programmed from 70^oC to 280^oC at 4^oC/min. after an initial isothermal
period of 2 minutes.

The saturated hydrocarbons were analysed in multiple ion mode (MID) at
a scan cycle time of approximately 2 secs. The mass spectrometer opera-
ted at 70eV electron energy and an ion source temperature of 200^oC. Data
acquisition was done by a GC data system.

Peak identification was performed applying knowledge of elution patterns
in certain mass chromatograms. Calculation of peak ratios was done from
peak height in the appropriate mass chromatograms.

CORRELATION OF OIL SHOWS AND OILS WITH COAL SAMPLES FROM WELL 34/10-16 AND 34/10-17

Table A summarises all GC-MS data obtained on samples from the two wells. Since no claystone samples have been analysed by GC-MS, a correlation can only be performed with the coals. The data suggest there are two types of oils, one light oil/condensate type, represented by the two shallowest oil samples, and one paraffinic type represented by the sample at 2889m in well 34/10-17. This is seen both from the API gravity and 'the gas chromatograms of the saturated hydrocarbons. The variations in the biomarker ratios are only minor, the most pronounced difference being seen in the molecular weight distribution of C_{27} to C_{29} steranes and of rearranged to regular C_{27} steranes.

A similar trend as for the oils, is seen for the oil shows in the sandstones in both wells. The deepest samples contain more of the high molecular weight components than do the shallower samples. Only small variations are seen in the biomarker ratios, the most pronounced difference being seen in the C_{27} hopanes (B/A). The increased values of B/A for the 34/10-16 samples could be due to lower maturity, or it might reflect a different source for these samples. The bisnorhopane (Z) is found in highest abundance in the two deepest samples in 34/10-16. This compound is also tentatively identified in reduced abundance in the other samples, a fact that may reflect slightly different migration processes. From the sterane mass chromatograms the 4 samples in 34/10-17 seem to be most similar to the shallow 34/10-16 samples and the two light oils. The two deepest samples in 34/10-16 contains more of the C_{29} steranes relative to the C_{27} analogs, than do the other samples.

Since no claystone samples from these two wells have been analysed by GC-MS, only the coal samples can be used in the correlation. Of the 5 samples ana- lysed, only one, at 2800m in 34/10-17, shows chromatograms typical of coal. The chromatograms suggest that the other 4 samples have been "contaminated" by migrated hydrocarbons, probably of the same type as the oil shows. The one representative coal sample is definitely different to the oils shows and oils in both sterane and terpane distributions, and can thus not be the source.

To conclude it might be said that there are two types of oils in 34/10-17, one light oil/condensate type and one heavier paraffinic type. The oils could have been generated from the same source rock, and different maturity and migration processes are responsible for the variations, or two different
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types of source rocks may have generated the oils. Only minor variations were seen in the oil shows, suggesting they originate from one main source rock. The source rock for the shows could be the same as for the oils.

Of the analysed samples only one coal was found to be representative of a possible source rock. the biomarker distribution of this coal was different to oils, thus implying no correlation.

To be able to perform further source rock/oil correlation in these two wells, we would suggest that a few claystone samples from the sections with the best source rock potential be analysed.

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Table A: Summary of GC-MS data of wells 34/10-16 and 34/10-17

34/10-16			TRI/E	B/A	Z/E	X/E	αβ/αβ+βα	%22S	%20S	%ββ	a+b/h+k	h+k/q+r+s+t
A-8250	sst.	3180.35-.42m	0.11	1.1	-	0.11	0.87	61.9	42.7	70.8	0.8	1.3
A-8251	sst.	3240.13-.19m	0.07	1.9	-	0.16	0.83	66.7	47.6	69.3	0.6	1.0
A-8252	sst.	3325.42-.49m	0.63	2.2	0.16	0.14	0.83	60.7	48.8	66.4	0.5	0.6
A-8253	sst.	3355.93-.3356m	0.03	1.8	0.09	0.10	0.88	63.6	49.3	71.8	0.6	0.6

34/10-17												
A-8254	sst.	2685.6-.69m	0.11	0.9	0.05	0.11	0.92	56.3	43.7	77.9	1.1	0.9
A-8263	cond.	2687.5m	0.28	0.7	-	0.17	0.92	56.5	47.6	75.0	1.3	1.6
A-8264	oil	2697m	0.14	0.6	0.07	0.23	0.86	54.8	40.6	73.2	1.2	1.3
A-8255	coal	2717.50m	0.03	2.3	-	0.12	0.75	54.2	26.7	58.3	0.8	0.5
A-8256	coal	2752.95m	0.05	1.7	0.05	0.14	0.84	56.1	33.3	70.3	1.0	1.2
A-8257	sst.	2774.50-.56m	0.23	0.7	0.05	0.14	0.89	58.8	49.1	70.7	1.3	1.3
A-8258	coal	2800.00m	-	23.8	-	0.13	0.64	52.9	29.0	58.7	0.1	0.7
A-8259	sst.	2837.64-.70m	0.14	0.8	0.04	0.19	0.88	57.7	49.2	74.9	1.1	1.2
A-8260	coal	2861.35m	0.08	1.7	0.08	0.14	0.86	61.9	41.6	68.6	1.2	1.0
A-8265	oil	2889m	0.06	0.6	0.05	0.14	0.90	62.5	50.0	75.7	0.9	0.8
A-8261	coal	2904.25m	0.06	0.8	0.10	0.17	0.85	62.3	46.2	69.1	1.1	0.7
A-8262	sst.	2922.93-2933m	0.11	0.4	0.07	0.18	0.91	58.3	43.5	75.2	1.2	1.3

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T A B L E : 1.1

CONCENTRATION OF EOM AND CHROMATOGRAPHIC FRACTIONS

Well 34/10-16

IKU-No	DEPTH (m)	Rock Extr. (g)	EOM (mg)	Sat. (mg)	Aro. (mg)	HC (mg)	Non HC (mg)	TOC (%)
A 8250	3180.35 -.42	98.6	153.9	34.9	12.8	47.7	106.2	0.10
A 8251	3240.13 -.18	98.4	159.9	56.0	10.7	66.7	93.2	0.12
A 8252	3325.42 -.49	88.0	95.2	31.4	7.6	39.0	56.2	0.16
A 8253	3355.93 -6.00	91.4	974.9	352.3	91.4	443.7	531.2	0.79

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T A B L E : 1.2

WEIGHT OF EOM AND CHROMATOGRAPHIC FRACTIONS

(Weight ppm OF rock)

Well 34/10-16

IKU-No	DEPTH (m)	EOM	Sat.	Aro.	HC	Non HC
A 8250	3180.35 -.42	1561	354	130	484	1077
A 8251	3240.13 -.18	1625	569	109	678	947
A 8252	3325.42 -.49	1082	357	86	443	639
A 8253	3355.93 -6.00	10666	3854	1000	4854	5812

DATE : 4 - 10 - 83.

IKU

T A B L E : 1.3

CONCENTRATION OF EOM AND CHROMATOGRAPHIC FRACTIONS

(mg/g TOC)

Well 34/10-16

IKU-No	DEPTH (m)	EOM	Sat.	Aro.	HC	Non HC
A 8250	3180.35 -.42	1560.9	354.0	129.8	483.8	1077.1
A 8251	3240.13 -.18	1354.2	474.3	90.6	564.9	789.3
A 8252	3325.42 -.49	676.1	223.0	54.0	277.0	399.1
A 8253	3355.93 -6.00	1350.2	487.9	126.6	614.5	735.7

DATE :   4 - 10 - 83.

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T A B L E : 1.4

COMPOSITION IN % OF MATERIAL EXTRACTED FROM THE ROCK

Well 34/10-16

IKU-No	DEPTH (m)	Sat --- EOM	Aro --- EOM	HC --- EOM	SAT --- Aro	Non HC ------ EOM	HC ------ Non HC
A 8250	3180.35 -.42	22.7	8.3	31.0	272.7	69.0	44.9
A 8251	3240.13 -.18	35.0	6.7	41.7	523.4	58.3	71.6
A 8252	3325.42 -.49	33.0	8.0	41.0	413.2	59.0	69.4
A 8253	3355.93 -6.00	36.1	9.4	45.5	385.4	54.5	83.5

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Table 1.5: Weights of NSO and asphaltene fractions
Well 34/10-16

IKU No.	Depth	NSO (mg)	Asphalthenes (mg)
A-8250	3180.35-.42	3.2	0.4
A-8251	3240.13-.19	3.2	0.2
A-8252	3325.42-.49	4.6	0.6
A-8253	3355.93-3356.00	37.9	3.4

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T A B L E 2

TABULATION OF DATAS FROM THE GASCHROMATOGRAMS
Well 34/10-16

IKU No.	DEPTH (m)	PRISTANE / n-C17	PRISTANE / PHYTANE	CPI
A 8250	3180.35 -.42	0.5	1.9	1.1
A 8251	3240.13 -.18	0.6	3.0	1.1
A 8252	3325.42 -.49	0.6	2.5	1.1
A 8253	3355.93 -6.00	0.5	2.0	1.0

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Well 34/10-16

FIGURE 1

GC of saturated hydrocarbons

Pr - pristane
Ph - phytane
C_{15}-C_{30} normal alkanes
S - squalane (internal standard)

Box 1 of 1

Saturated hydrocarbons
A - 8250
34/10 – 16
Core, Sst.
3180.35 – 42m

C15
C20
C25
C30
Pr
Ph
S

Box 1 of 1

Saturated hydrocarbons
A - 8251
34/10 – 16
Core, Sst.
3240.13 – 19m

C15
C20
C25
C30
Pr
Ph
S

Box 1 of 1

Saturated hydrocarbons
A - 8252
34/10 – 16
Core, Sst.
3325.42 – 49m

C15
C20
C25
C30
Pr
Ph
S

Box 1 of 1

Saturated hydrocarbons
A - 8253
34/10 – 16
Core, Sst.
3355.93 – 3356.0m

C15
C20
C25
C30
Pr
Ph
S
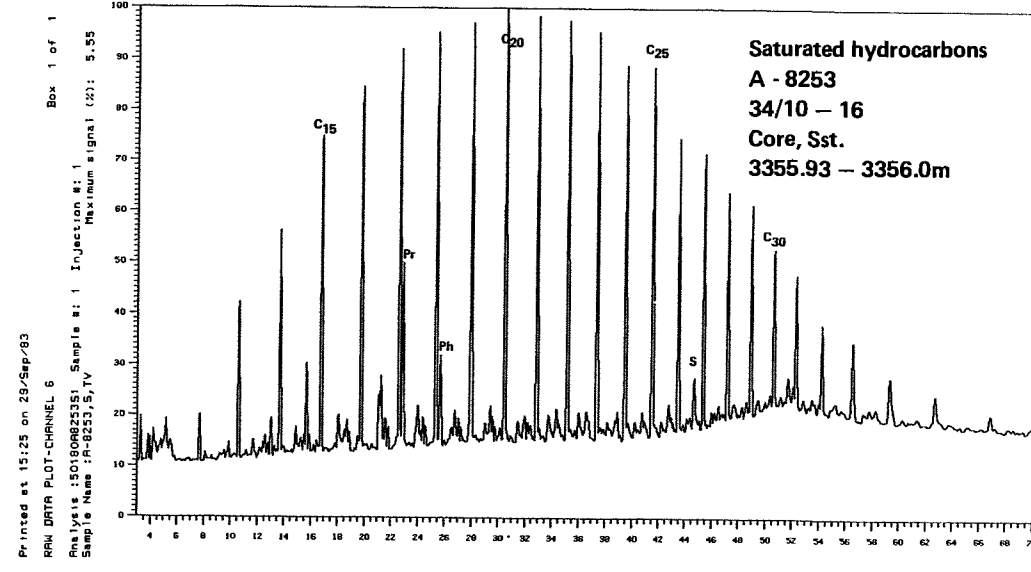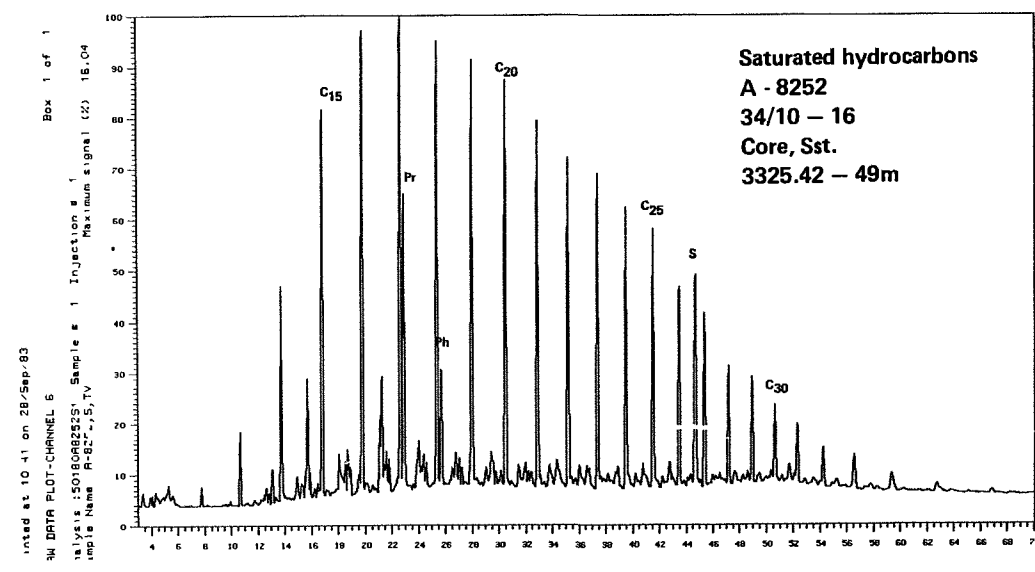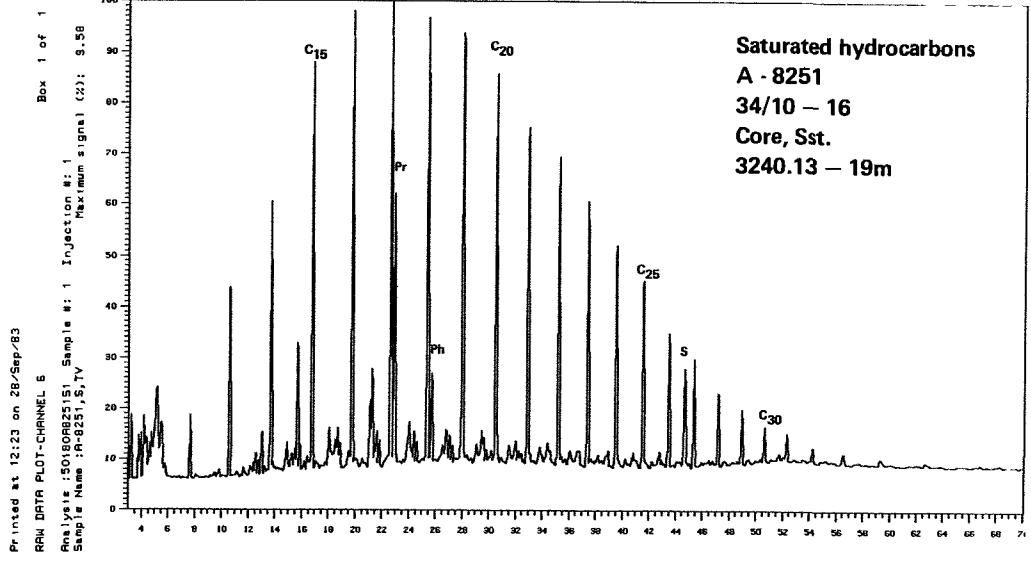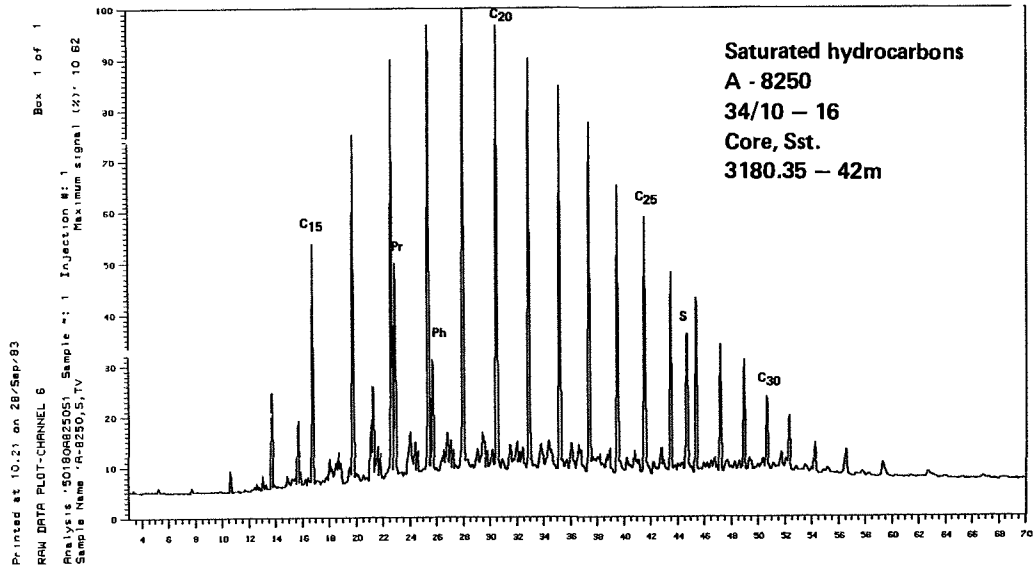
Well 34/10-16

FIGURE 2
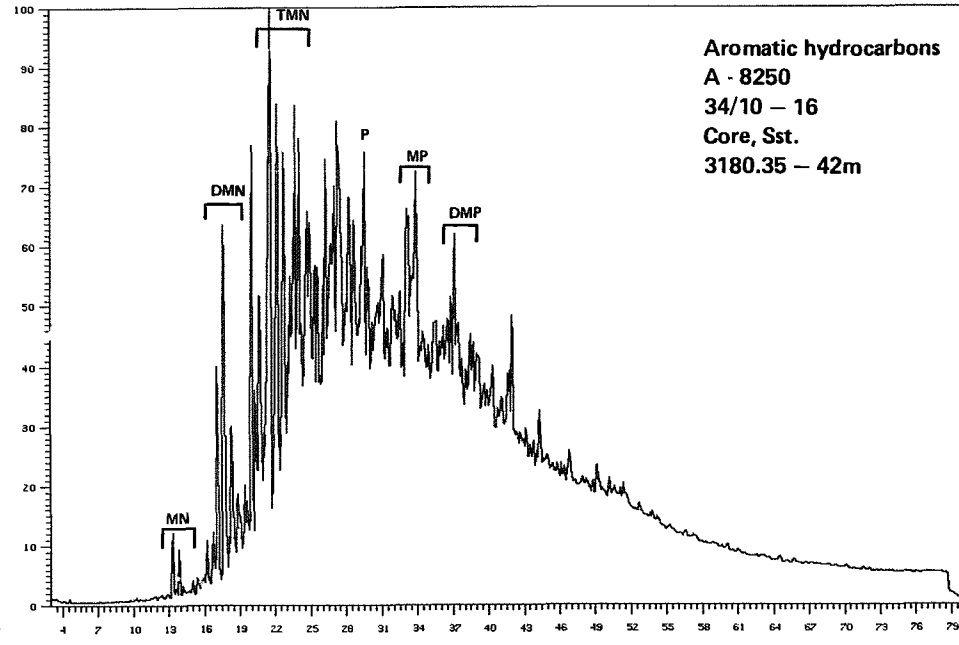
GC of aromatic hydrocarbons

N   - naphthalene
MN - C_1-naphthalenes
DMN - C_2-naphthalenes
TMN - C_3-naphthalenes
P   - phenanthrene
MP - C_1-phenanthrenes
DMP - C_2-phenanthrenes
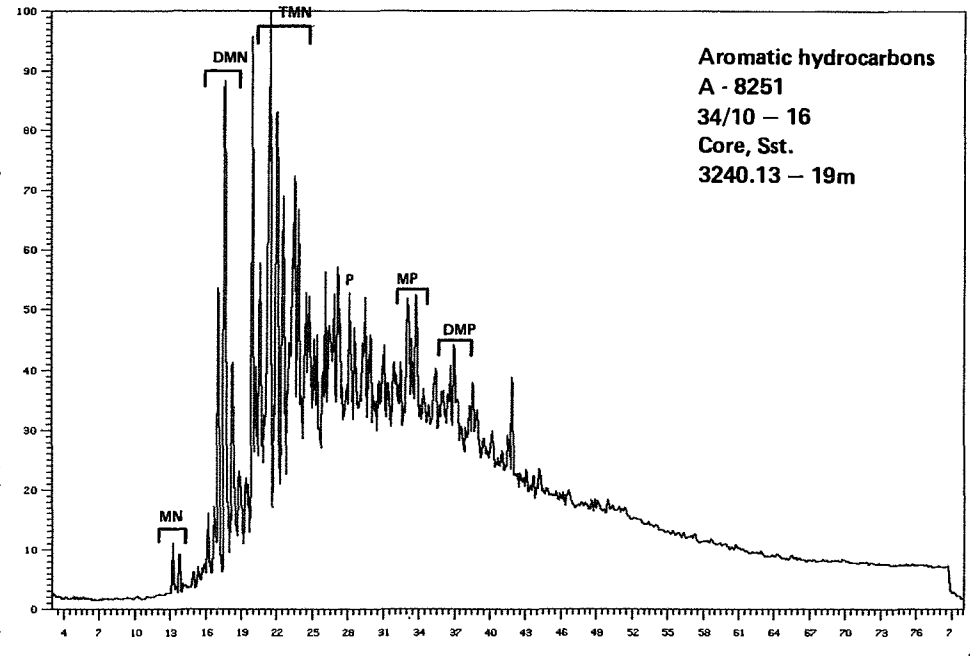
Well 34/10-16
Figure 3.

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) + unknown triterpane (gammacerane?)	$C_{31}H_{54}$	(I,R=C_4H_9)
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})

m/z 191
A - 8250
34/10 — 16
Core, sst
3180.35 — 3180.42m

m/z 191
A - 8251
34/10 — 16
Core, sst
3240.13 — 3240.19m

m/z 191
A - 8252
34/10 — 16
Core, sst
3325.42 — 3325.49m

m/z 191
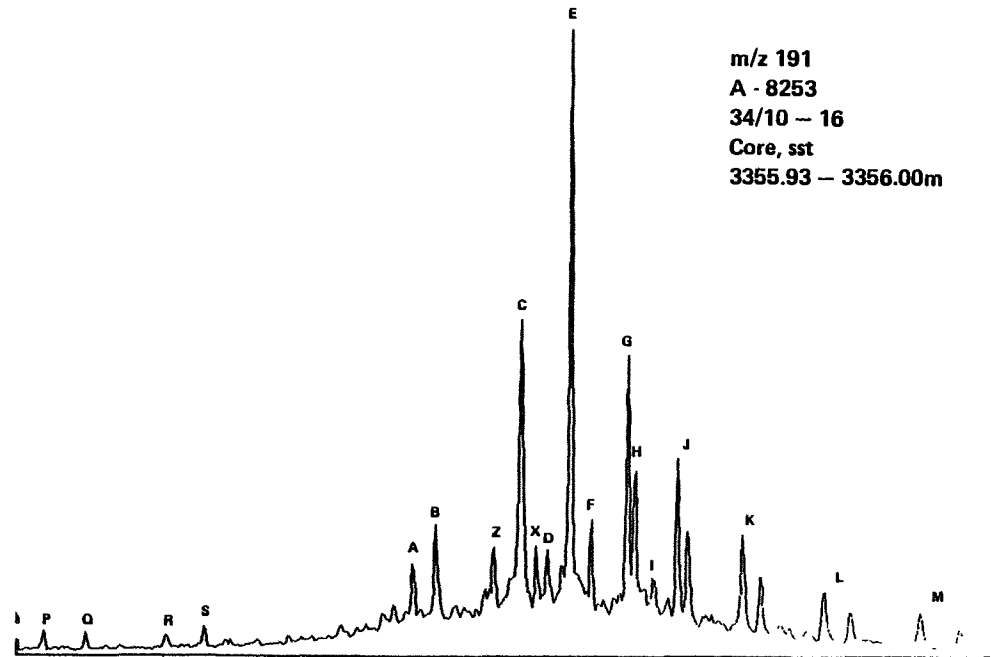A - 8253
34/10 — 16
Core, sst
3355.93 — 3356.00m
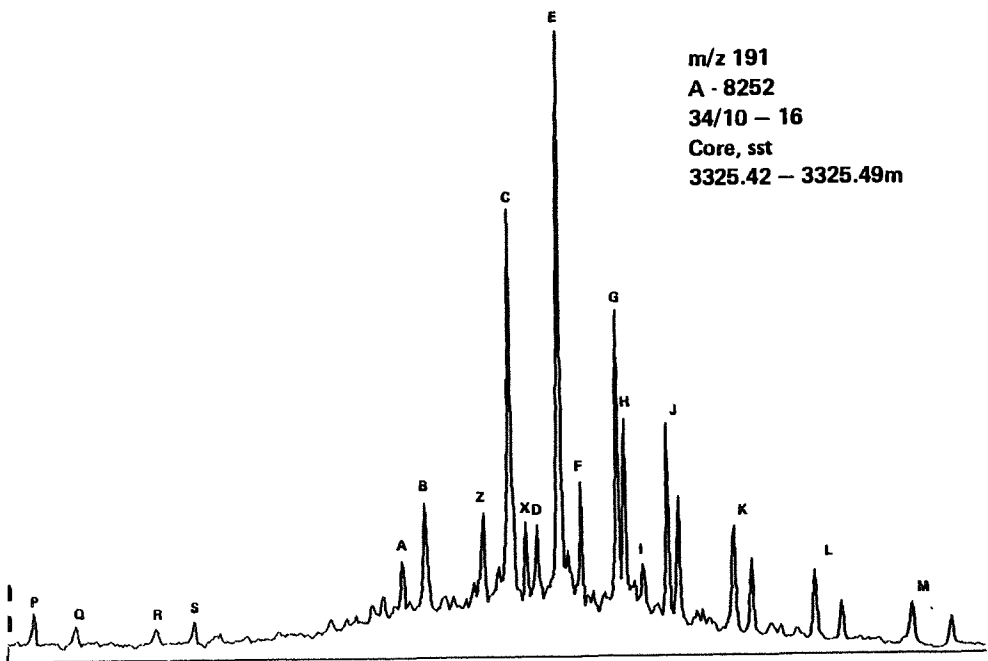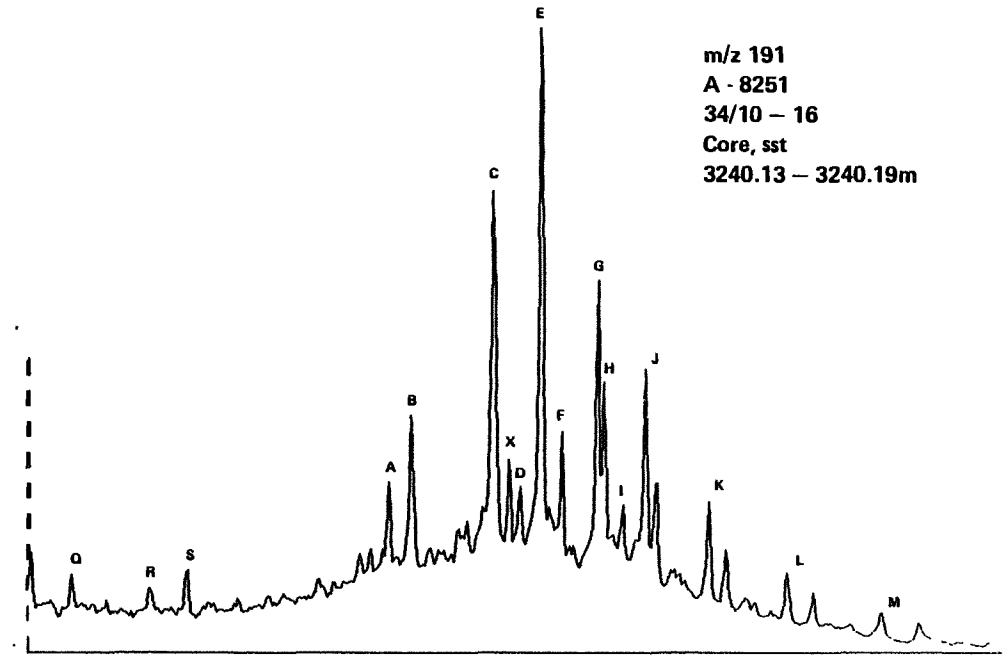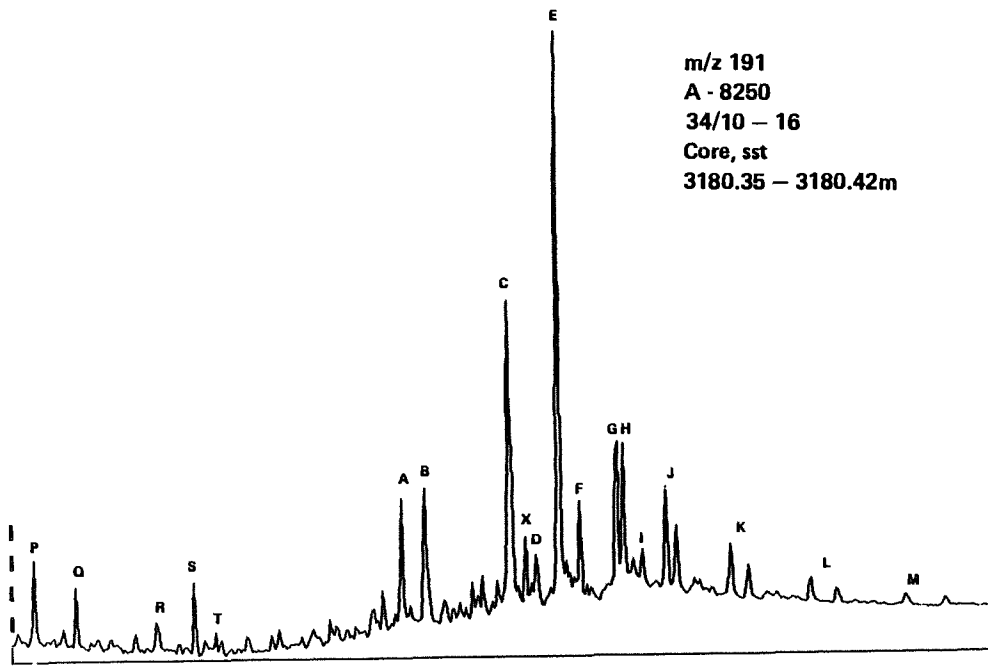
Well 34/10-16

Figure 4.

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$_2$H$_5$)
	+ 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$_2$H$_5$)
l	13α(H),17β(H)-diasterane (20S)	$C_{29}H_{52}$	(III,R=C$_2$H$_5$)
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$_2$H$_5$)
	+ 14β (H),17β (H)-steane (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)-steane (20R)	$C_{28}H_{50}$	(I,R=CH$_3$)
q	14α(H),17α(H)-sterane (20S)	$C_{29}H_{52}$	(I,R=C$_2$H$_5$)
r	14β(H),17β(H)-sterane (20R)	$C_{29}H_{52}$	(II,R=C$_2$H$_5$)
	+ unknown sterane		
s	14β(H),17β(H)-sterane (20S)	$C_{29}H_{52}$	(II,R=C$_2$H$_5$)
t	14α(H),17β(H)-sterane (20R)	$C_{29}H_{52}$	(I,R=C$_2$H$_5$)
u	5α(H)-sterane	$C_{21}H_{36}$	(V,R=C$_2$H$_5$)
v	5α(H)-sterane	$C_{22}H_{38}$	(IV,R=C$_3$H$_7$)

m/z 217
A - 8250
34/10 — 16
Core, sst
3180.35 — 3180.42m

m/z 217
A - 8251
34/10 — 16
Core, sst
3240.13 — 3240.19m

m/z 217
A - 8252
34/10 — 16
Core, sst
3325.42 — 3325.49m

m/z 217
A - 8253
34/10 — 16
Core, sst
3355.93 — 3356.00m

m/z 218
A - 8250
34/10 — 16
Core, sst
3180.35 — 3180.42m

m/z 218
A - 8251
34/10 — 16
Core, sst
3240.13 — 3240.19m

m/z 218
A - 8252
34/10 — 16
Core, sst
3325.42 — 3325.49m

m/z 218
A - 8253
34/10 — 16
Core, sst
3355.93 — 3356.00m