

**Petroleum Geochemistry, Cormorant-1.**

**Analabs, Esso Exploration and Production Australia  
Incorporated,  
Petrecon Australia Proprietary Limited**

**OR-0334C**

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PETROLEUM GEOCHEMISTRY - CORMORANT-11. Introduction

This report consists of a series of letters between K.C. Morrison of Petrecon Australia Ltd. and replies in the form of reports from P. Tybor of Analabs, Perth.

A sample of oil from Cormorant-1 was collected from the Department of Mines and later analysed. The sample had been stored in an unsealed container for approximately 15 years and so had probably deteriorated to some extent.

341004



PETRECON AUSTRALIA PTY. LTD.

Petroleum Exploration Consultants

190 Macquarie Street  
Hobart 7000 Australia  
Ph 002 312122  
Telex AAS7229

3rd July, 1985.

Mr. P. Tyber,  
Analabs,  
55 Murray Road,  
WELSHPOOL .. W.A. .. 6106.

Dear Paul,

Following our phone conversation yesterday, I am forwarding a sample of crude oil which we would like to have analysed, using methods you judge to be appropriate to answer the following questions.

- 1/. Is the oil biodegraded?
- 2/. Is the oil immature?
- 3/. What is the explanation for the unusually low API gravity value of this oil?

As mentioned on the phone the oil has not been stored in a sealed condition so it is likely that the more mobile compounds have escaped.

. Yours sincerely,

KEN C. MORRISON.

Enc.

**ANALABS**

A Division of Macdonald Hamilton &amp; Co. Pty. Ltd.

ANALYTICAL CHEMISTS

PERTH:  
52 MURRAY ROAD,  
WELSHPOOL, WESTERN AUSTRALIA, 6106  
TELEPHONE (09) 458 7999  
TELEX: ANALAB AA 92560  
P.O. BOX 210, BENTLEY, W.A. 6102

PT/fmh

12th July, 1985.

Mr. K. C. Morrison  
Petroleum Australia Pty. Ltd.  
192 Macquarie Street  
HOBART TAS 7000

Dear Mr Morrison,

Please find enclosed the results of the C1-C31 whole oil gas chromatography and liquid chromatography analyses performed on the oil sample from the Bass Basin. GC-MS analysis is currently underway and will be forwarded to you upon completion.

Based on the data obtained from the above analyses, this oil is characterised as a naphtheno-aromatic crude oil which has undergone bacterial attack. However, there is a normal alkane component which may represent a secondary oil input into the reservoir.

The general absence of normal alkanes (numbered equidistant peaks) on the C1-C31 gc trace indicates that bacteria have attacked this oil. In bacterially attacked oils the straight chain hydrocarbons (normal alkanes) are preferentially removed first, followed by the cycloalkanes (naphthenes) then the aromatics. Since the naphthenes are still present, it appears that the bacteria have not severely altered this crude. Apparently during biodegradation, conditions changed to such a degree that the environment became too hostile for bacteria. Consequently, the naphthenes were not degraded.

The presence of the normal alkanes between nC16 and nC25 is very unusual in a biodegraded oil. Had these compounds been present in the oil during biodegradation, then they too would have been depleted. This leads us to believe that they probably entered the reservoir sometime after the reservoir was removed from the influence of bacteria.

The unusually low API gravity of the oil is due to two factors. Firstly, the naphtheno-aromatic nature of the crude is probably largely responsible for its low gravity. Naphthenes and aromatic hydrocarbons have ring structures which tend to pack together very tightly, thereby giving high densities and low gravities to crude oils rich in these compounds. On the other hand, normal alkanes are straight chain compounds which do not pack together

well. As a result paraffinic crudes usually have high gravities. Secondly, the low amounts of light molecular weight hydrocarbons (C1-C10) in this oil may also be why this oil has a low API gravity.

Until the GC-MS data is available we cannot comment on the maturity of this crude. Since the biomarkers used to determine maturity are C27 through C32 compounds, the data obtained from this analysis will be representative mainly of the degraded oil, and not of the secondary oil input. This is because the second unaltered oil appears to be comprised mainly of C15 to C25 compounds.

Should you have any queries concerning these analysis please do not hesitate to contact me.

Yours faithfully,

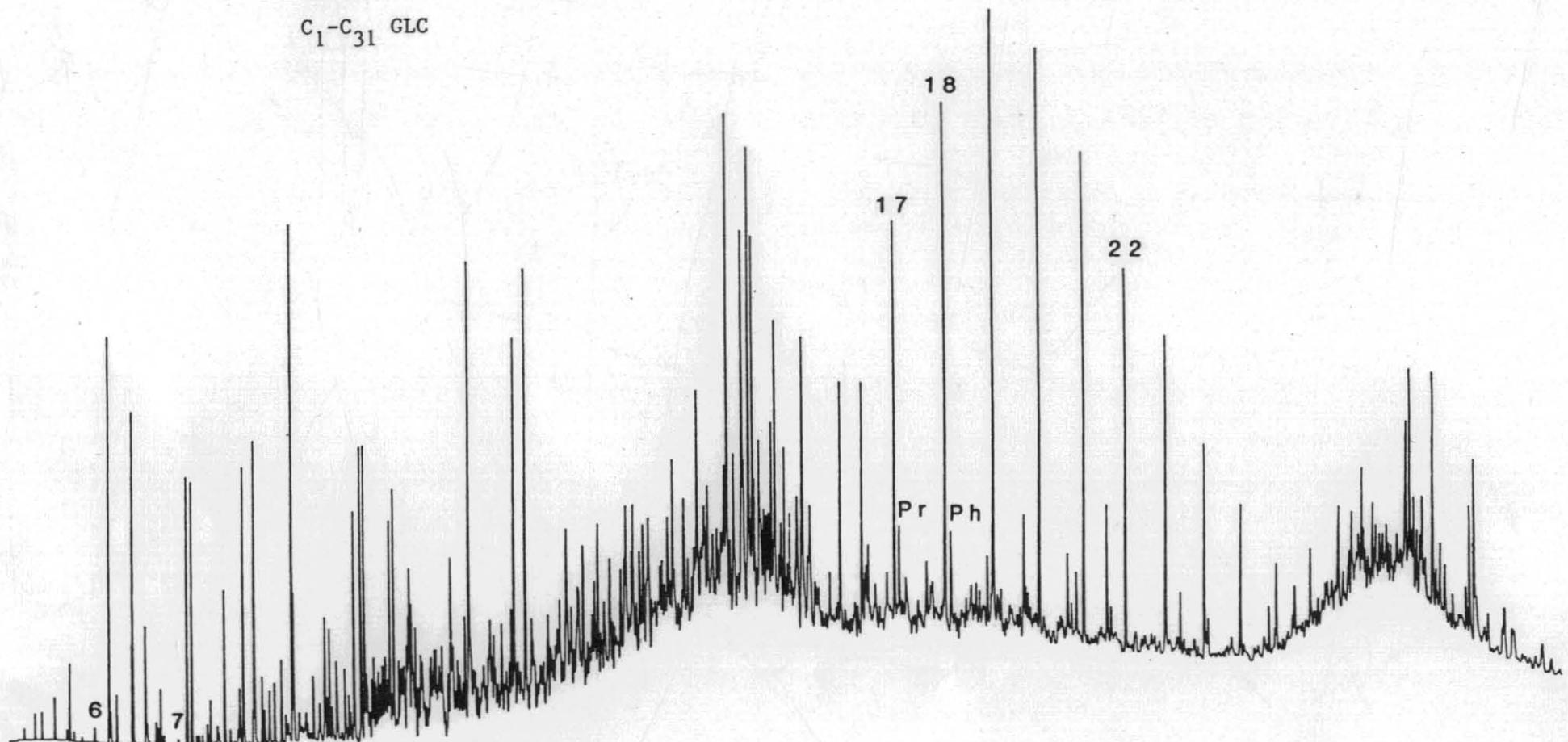


PAUL TYBOR  
Manager - Operations

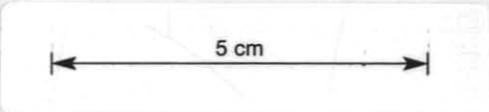
OIL SAMPLE FROM BASS BASIN

Whole Oil

C<sub>1</sub>-C<sub>31</sub> GLC



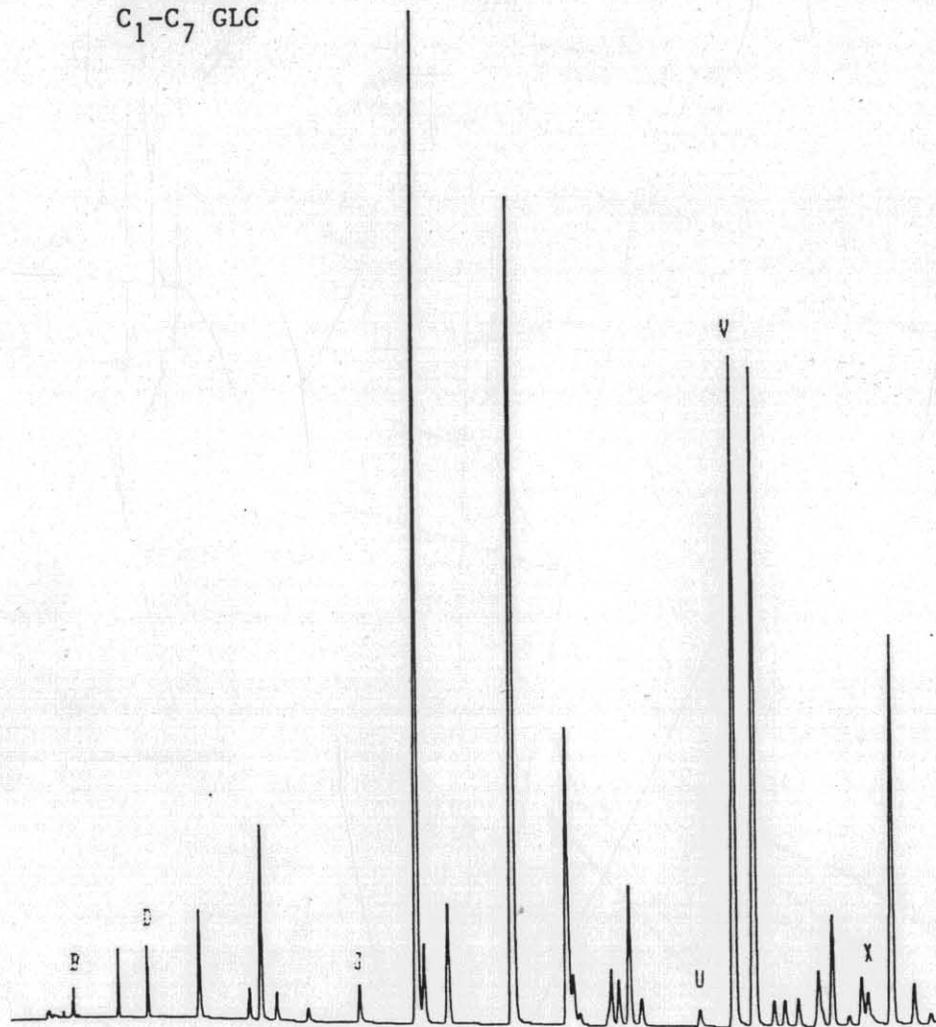
341007



OIL SAMPLE FROM BASS BASIN

Whole Oil

C<sub>1</sub>-C<sub>7</sub> GLC



C4-7 COMPOUNDS

- A isobutane
- B n-butane
- C isopentane
- D n-pentane
- E 2,2-dimethylbutane
- F cyclopentane
- G 2,3-dimethylbutane
- H 2-methylpentane
- I 3-methylpentane
- J n-hexane
- K methylcyclopentane
- L 2,4-dimethylpentane
- M benzene
- N cyclohexane
- O 1,1-dimethylcyclopentane
- P 2-methylhexane
- Q 3-methylhexane
- R 1 cis-3-dimethylcyclopentane
- S 1 trans-3-dimethylcyclopentane
- T 1 trans-2-dimethylcyclopentane
- U n-heptane
- V methylcyclohexane
- W 1 cis-2-dimethylcyclopentane
- X toluene

5 cm

TABLE 1

## SUMMARY OF WHOLE OIL ANALYSIS

Date: 1985

Company: PETRECON AUST. PTY. LTD. Sample: BASS BASIN OIL

## PHYSICAL PROPERTY DATA

API Gravity	%Sulphur (w/w)	Viscosity (25°C)	Viscosity (60°C)	Pour Pt (°C)
nd	nd	nd	nd	nd

## COMPOSITION BY CARBON NUMBER

## COMPOSITION OF C4-C7 FRACTION

Carbon Number	Rel. Wt %	Compound	Rel. Wt %
1 - 3	nd	A isobutane	0.11
4	0.01	B n-butane	0.47
5	0.04	C isopentane	1.06
6	0.75	D n-pentane	1.12
7	0.86	E 2,2-dimethylbutane	1.71
8	2.52	F cyclopentane	0.52
9	5.08	G 2,3-dimethylbutane	3.39
10	4.71	H 2-methylpentane	0.52
11	6.03	I 3-methylpentane	0.26
12	7.39	J n-hexane	0.65
13	8.75	K methylcyclopentane	16.90
14	11.29	L 2,4-dimethylpentane	2.75
15	7.84	M benzene	nd
16	5.63	N cyclohexane	21.65
17	5.15	O 1,1-dimethylcyclopentane	6.99
18	4.34	P 2-methylhexane	1.24
19	4.46	Q 3-methylhexane	1.42
20	3.17	R 1 cis-3-dimethylcyclopentane	1.06
21	2.47	S 1 trans-3-dimethylcyclopentane	3.36
22	1.38	T 1 trans-2-dimethylcyclopentane	0.68
23	1.09	U n-heptane	0.47
24	0.53	V methylcyclohexane	16.63
25	0.51	W 1 cis-2-dimethylcyclopentane	16.27
26	1.03	X toluene	0.75
27	2.01		
28	3.56		
29	3.47		
30	4.17		
31	1.75		

## CALCULATED DATA - C4-C7 FRACTION

## CALCULATED DATA - C12+ FRACTION

Pristane/Phytane	1.13
Pristane/n-C17	0.62
Phytane/n-C18	0.52
TMTD/Pristane	nd
(C21+C22) / (C28+C29)	1.57

Paraffin Index I	0.52
Paraffin Index II	0.88
N/K (Maturity)	1.28
C/D (Maturity)	0.95
J/K (Maturity)	0.04
I/M (Water washing)	nd
I/J (Biodegradation)	0.40

nd = no data

TMTD = Trimethyltridecane

is = Insufficient sample

Paraffin Index I = (P+Q)/(R+S+T)

Paraffin Index II = %U in all compounds N-V

bdl = Below detection limit

TABLE 1-1

## SUMMARY OF WHOLE OIL ANALYSIS

Date: 1985

Company: PETRECON AUST. PTY. LTD. Sample: BASS BASIN OIL

## PHYSICAL PROPERTY DATA

API Gravity	%Sulphur (w/w)	Viscosity (25°C)	Viscosity (60°C)	Pour Pt (°C)
nd	nd	nd	nd	nd

## COMPOSITION BY CARBON NUMBER

Carbon Number	Rel. Wt %
1 - 3	nd
4	0.01
5	0.06
6	0.95
7	1.10
8	3.16
9	6.44
10	6.34
11	8.10
12	9.97
13	12.31
14	14.23
15	10.72
16	6.95
17	5.09
18	3.92
19	3.13
20	2.21
21	1.27
22	0.61
23	0.59
24	0.26
25	0.25
26	nd
27	nd
28	0.52
29	nd
30	1.24
31	0.56

## COMPOSITION OF C4-C7 FRACTION

Compound	Rel. Wt %
A isobutane	0.07
B n-butane	0.28
C isopentane	0.71
D n-pentane	1.49
E 2,2-dimethylbutane	1.70
F cyclopentane	0.43
G 2,3-dimethylbutane	3.26
H 2-methylpentane	0.43
I 3-methylpentane	0.21
J n-hexane	0.57
K methylcyclopentane	16.91
L 2,4-dimethylpentane	2.78
M benzene	nd
N cyclohexane	21.83
O 1,1-dimethylcyclopentane	7.02
P 2-methylhexane	1.17
Q 3-methylhexane	1.48
R 1 cis-3-dimethylcyclopentane	1.09
S 1 trans-3-dimethylcyclopentane	3.34
T 1 trans-2-dimethylcyclopentane	0.68
U n-heptane	0.10
V methylcyclohexane	16.82
W 1 cis-2-dimethylcyclopentane	16.38
X toluene	1.24

## CALCULATED DATA - C4-C7 FRACTION

## CALCULATED DATA - C12+ FRACTION

Pristane/Phytane	nd
Pristane/n-C17	nd
Phytane/n-C18	nd
TMTD/Pristane	nd
(C21+C22)/(C28+C29)	nd

Paraffin Index I	0.52
Paraffin Index II	0.19
N/K (Maturity)	1.29
C/D (Maturity)	0.48
J/K (Maturity)	0.03
I/M (Water washing)	nd
I/J (Biodegradation)	0.38

nd = no data  
TMTD = Trimethyltridecane  
is = Insufficient sample

Paraffin Index I = (P+Q)/(R+S+T)  
Paraffin Index II = %U in all compounds N-V  
bdl = Below detection limit

TABLE 2

## Summary of Physical Property and Sulphur Data

Date of Job: JULY 1985

Sample	API Gravity	%Sulphur (w/w)	Viscosity( 25°C)	Viscosity( 60°C)
BASS BASIN OIL	nd	nd	nd	nd

TABLE 2a

## Summary of Liquid Chromatography(Compositional Data)

Date of Job: JULY 1985

Sample	-----Hydrocarbons-----			-----Nonhydrocarbons-----			SAT	ASPH	HC
	%SAT.	%AROM.	%HC's	%NSO's	%ASPH.	%Non HC's	AROM	NSO	Non HC
BASS BASIN OIL	64.7	22.1	86.8	13.2	nd	13.2	2.93	nd	6.6

na = not applicable    nd = no data

**ANALABS**

A Division of Macdonald Hamilton & Co. Pty. Ltd.  
ANALYTICAL CHEMISTS

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PT/fmh

16th July, 1985.

Mr. K. C. Morrison  
Petrecon Australia Pty. Ltd.  
192 Macquarie Street  
HOBART TAS 7000

Dear Ken,

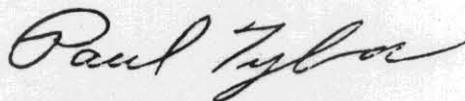
Please find enclosed the repeated C1-C31 whole oil data obtained from the Bass Basin oil sample.

The first analysis of this sample indicated the oil was biodegraded, but at the sametime contained a significant amount of nC16 through nC25 normal alkanes. This was an unusual combination and suggested that a second oil input was present. We have since rerun the sample and found that these normal alkanes represented a wax contamination, and are not indigenous to the oil. Consequently, this crude is characterised as a biodegraded oil without any unaltered normal alkane fraction present. This oil has a low gravity due to the reasons given in our letter of the 12th July 1985 (high napthenic and aromatic content, low concentrations of low molecular weight compounds). We do not know when this sample was biodegraded, however since it was sampled some time ago, the alteration could have occurred since sampling from the reservoir.

GC-MS analysis is underway and the results will be forwarded to you as soon as they beccme available.

If you have any queries concerning these results please do not hesitate to contact us.

Yours sincerely,

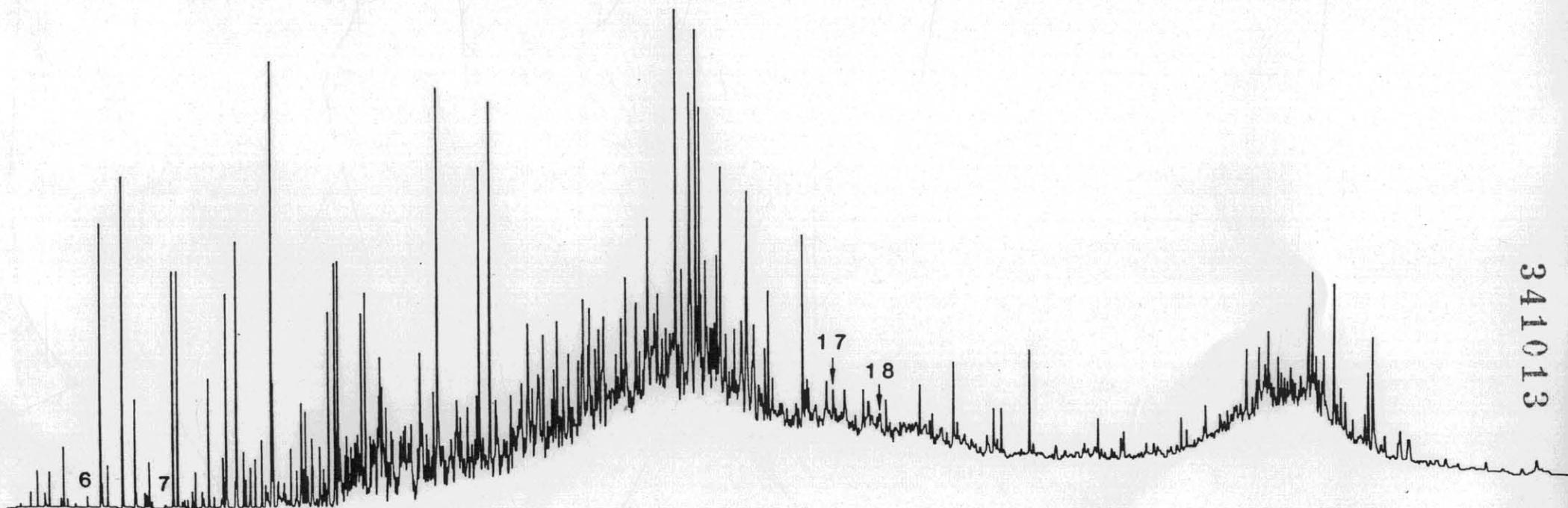


PAUL TYBOR  
Manager - Operations  
encs:

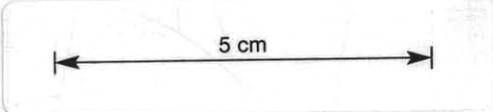
OIL SAMPLE FROM BASS BASIN

Whole Oil

C<sub>1</sub>-C<sub>31</sub> GLC



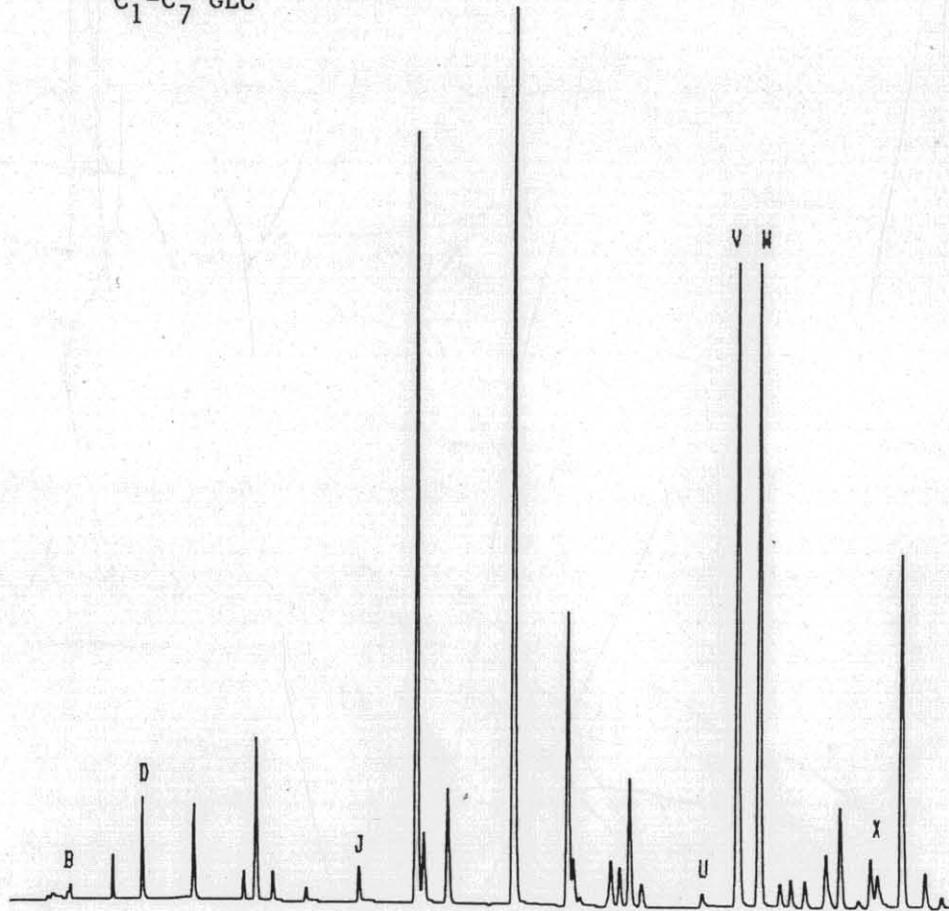
341013



OIL SAMPLE FROM BASS BASIN  
 Whole Oil  
 C<sub>1</sub>-C<sub>7</sub> GLC

C4-7 COMPOUNDS  
 -----

- A isobutane
- B n-butane
- C isopentane
- D n-pentane
- E 2,2-dimethylbutane
- F cyclopentane
- G 2,3-dimethylbutane
- H 2-methylpentane
- I 3-methylpentane
- J n-hexane
- K methylcyclopentane
- L 2,4-dimethylpentane
- M benzene
- N cyclohexane
- O 1,1-dimethylcyclopentane
- P 2-methylhexane
- Q 3-methylhexane
- R 1 cis-3-dimethylcyclopentane
- S 1 trans-3-dimethylcyclopentane
- T 1 trans-2-dimethylcyclopentane
- U n-heptane
- V methylcyclohexane
- W 1 cis-2-dimethylcyclopentane
- X toluene



5 cm

341014

**ANALABS**

A Division of Macdonald Hamilton & Co. Pty. Ltd.  
ANALYTICAL CHEMISTS

• PERTH:  
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P.O. BOX 210, BENTLEY, W.A. 6102

PT/fmh

5th August, 1985.

Mr. K. C. Morrison  
Petrecon Australia Pty. Ltd.  
192 Macquarie Street  
HOBART TAS 7000

Dear Ken,

Please find enclosed the results of the gas chromatography-mass spectrometry analysis performed on the Bass Basin oil sample.

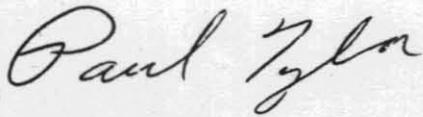
These data indicate the oil is marginally mature, to at best, moderately mature, and originated from dominantly terrestrial organic matter. The low maturity of this hydrocarbon is based on the low amounts of C<sub>29</sub> S to C<sub>29</sub> R steranes (Figure 1-1, 217 ion). In mature hydrocarbons these compounds are usually in equal proportions. Also the moderately high amount of C<sub>30</sub> moretane in relation to the C<sub>30</sub> hopane (Figure 1-5; 191 ion) is another indication of this oil being of low maturity. Moretanes convert to hopanes with increasing maturity.

The terrestrial source for this hydrocarbon is evidenced by the high amount of C<sub>29</sub> steranes and diasteranes in relation to the corresponding C<sub>27</sub> compounds (Figure 1-1, 217 and 259 ion). In oils sourced from aquatic organic matter, these compounds are usually in equal proportions. Other indications of a high land plant source for this hydrocarbon include the presence of the C<sub>19</sub> and C<sub>20</sub> isopimeranes (Figure 1-9; 123 ion) and phyllocladanes (Figure 1-10, 123 ion). These compounds are derived from high land plant source material.

This oil is believed to be moderately biodegraded, as opposed to severely degraded due to the absence of demethylated hopanes (Figure 1-5, 177 ion). In severely degraded crudes the hopanes are degraded by the removal of a methyl group, resulting in demethylated hopanes. Since these compounds are not present, we can assume that biodegradation has not advanced to the alteration of the hopanes. However, the alkyl cyclohexanes have been removed indicating that the oil is moderately altered.

Should you have any queries concerning these results or if we may be of further assistance, please do not hesitate to contact us.

Yours sincerely,

A handwritten signature in cursive script that reads "Paul Tybor".

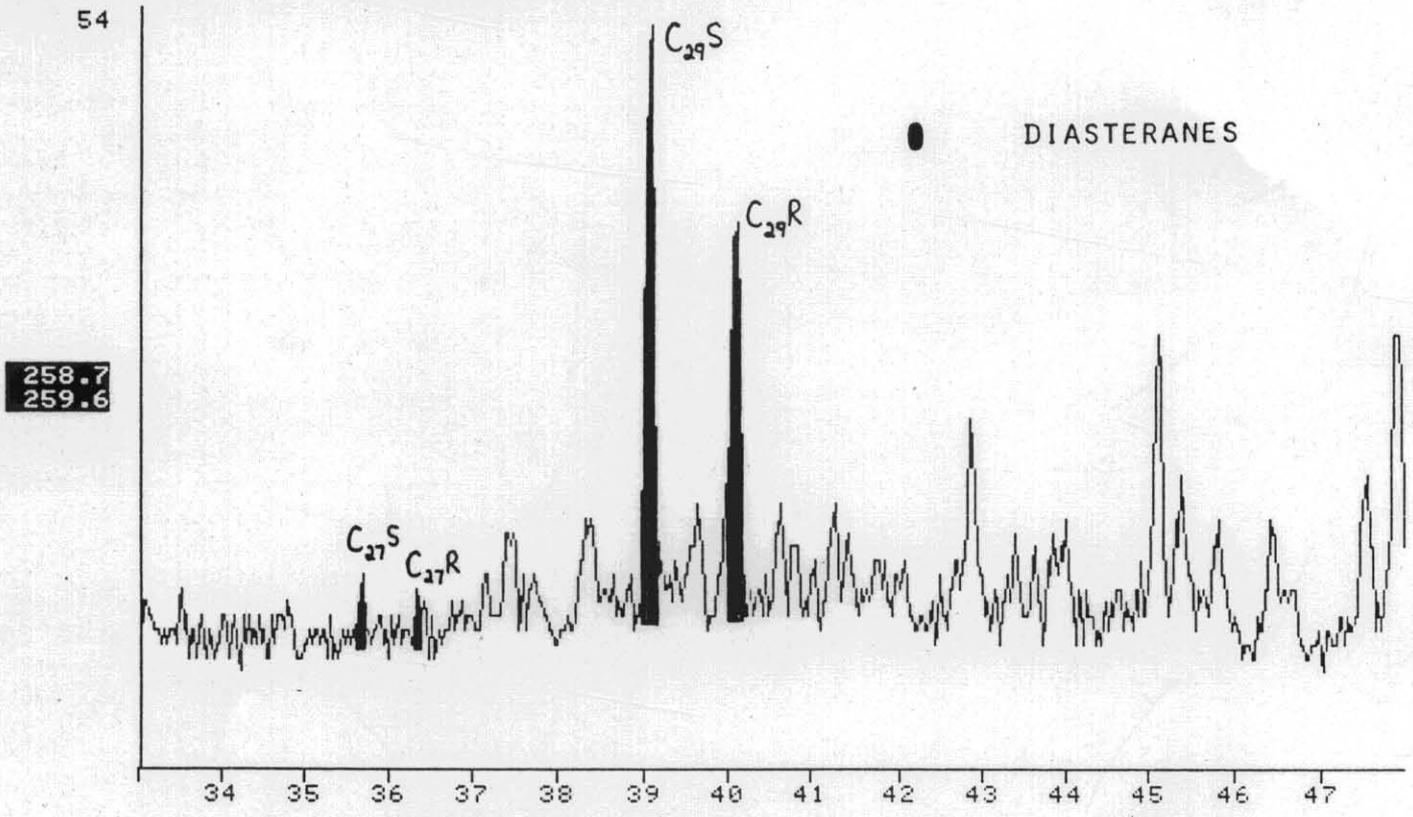
PAUL TYBOR  
Manager - Operations

FIGURE 1-1

341017

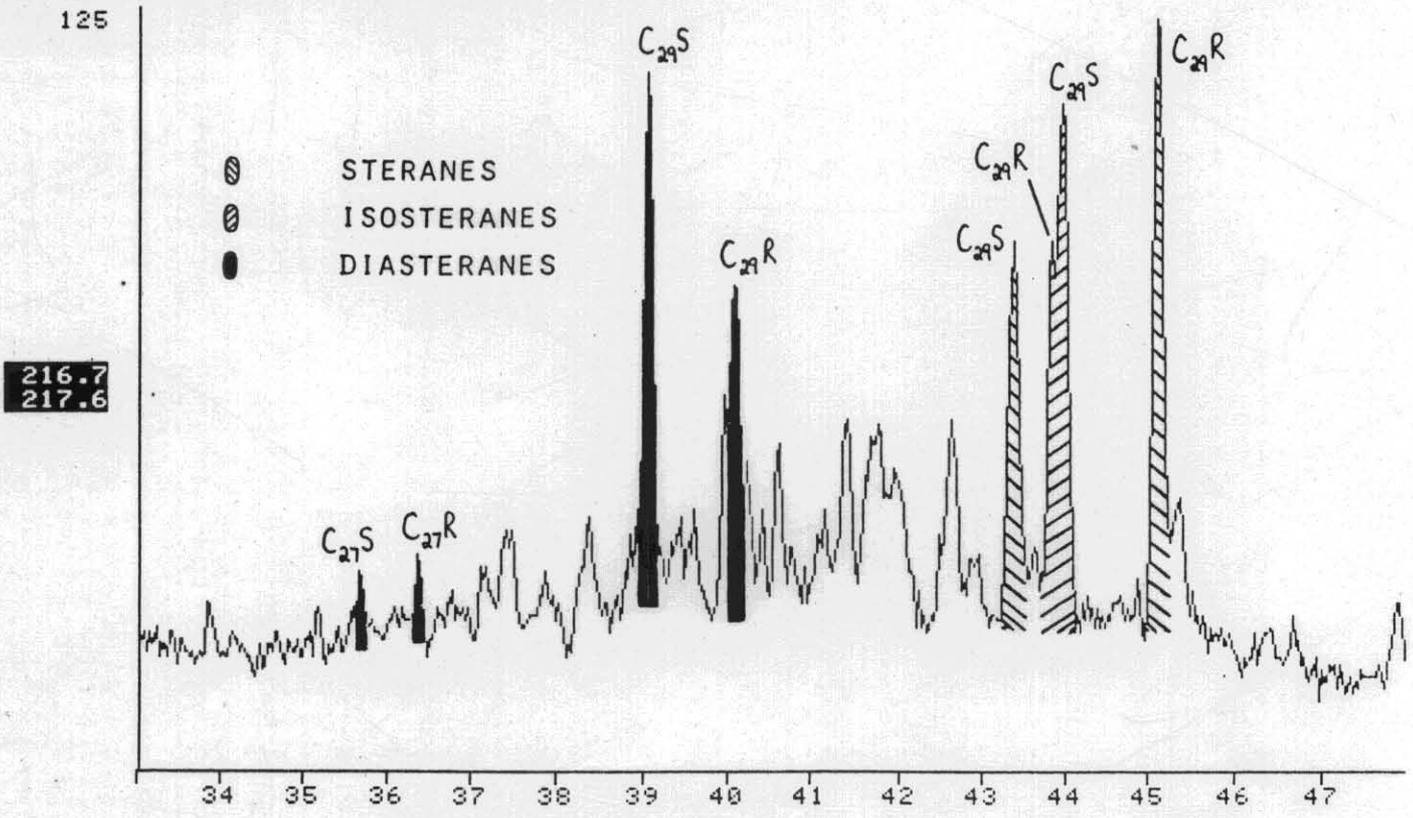
NAME BASS BASIN OIL, BRANCHED CYCLIC FRAGMENTOGRAM.  
MISC 24-7-85, GH/GW. 0.2ul/180ul. COL#43.

FRN 5774



NAME BASS BASIN OIL, BRANCHED CYCLIC FRAGMENTOGRAM.  
MISC 24-7-85, GH/GW. 0.2ul/180ul. COL#43.

FRN 5774

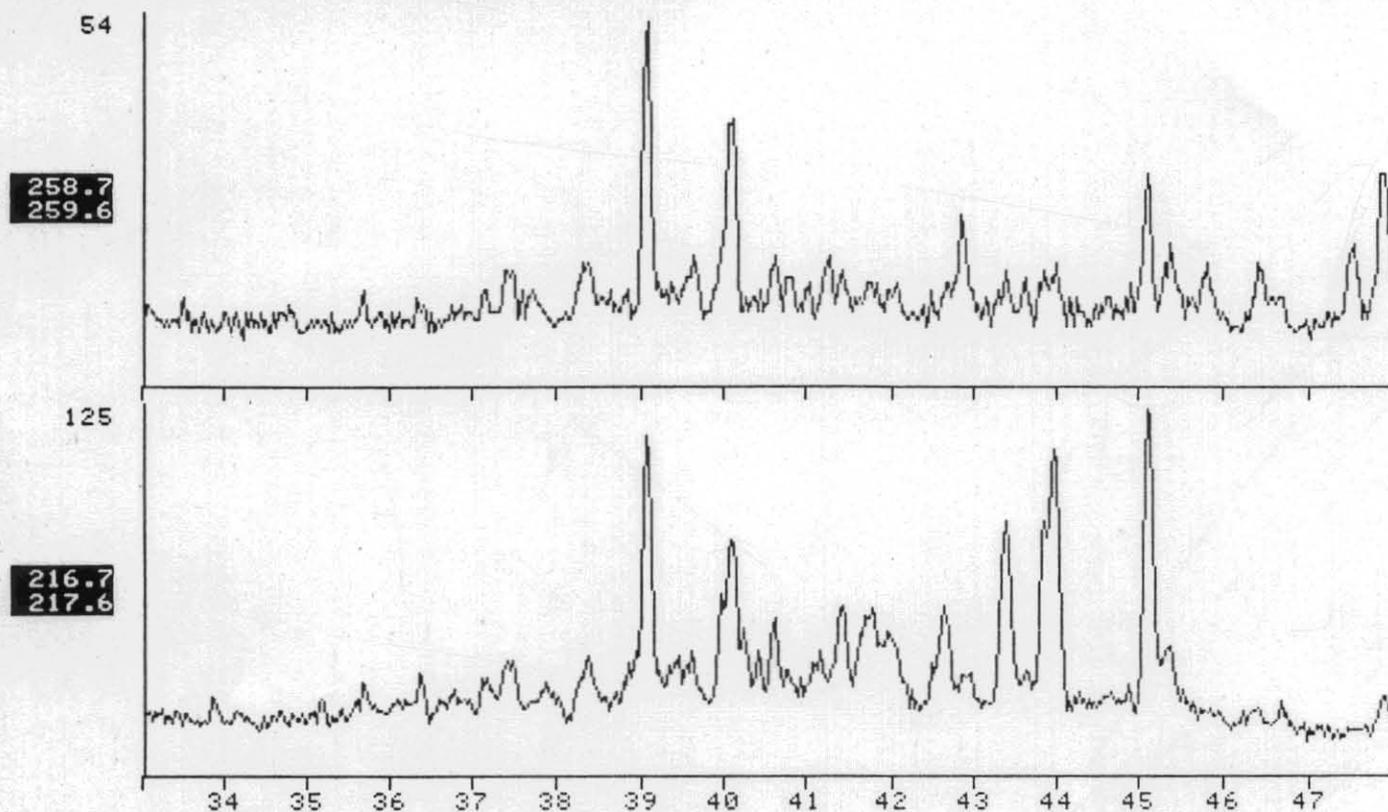


5 cm

FIGURE 1-2

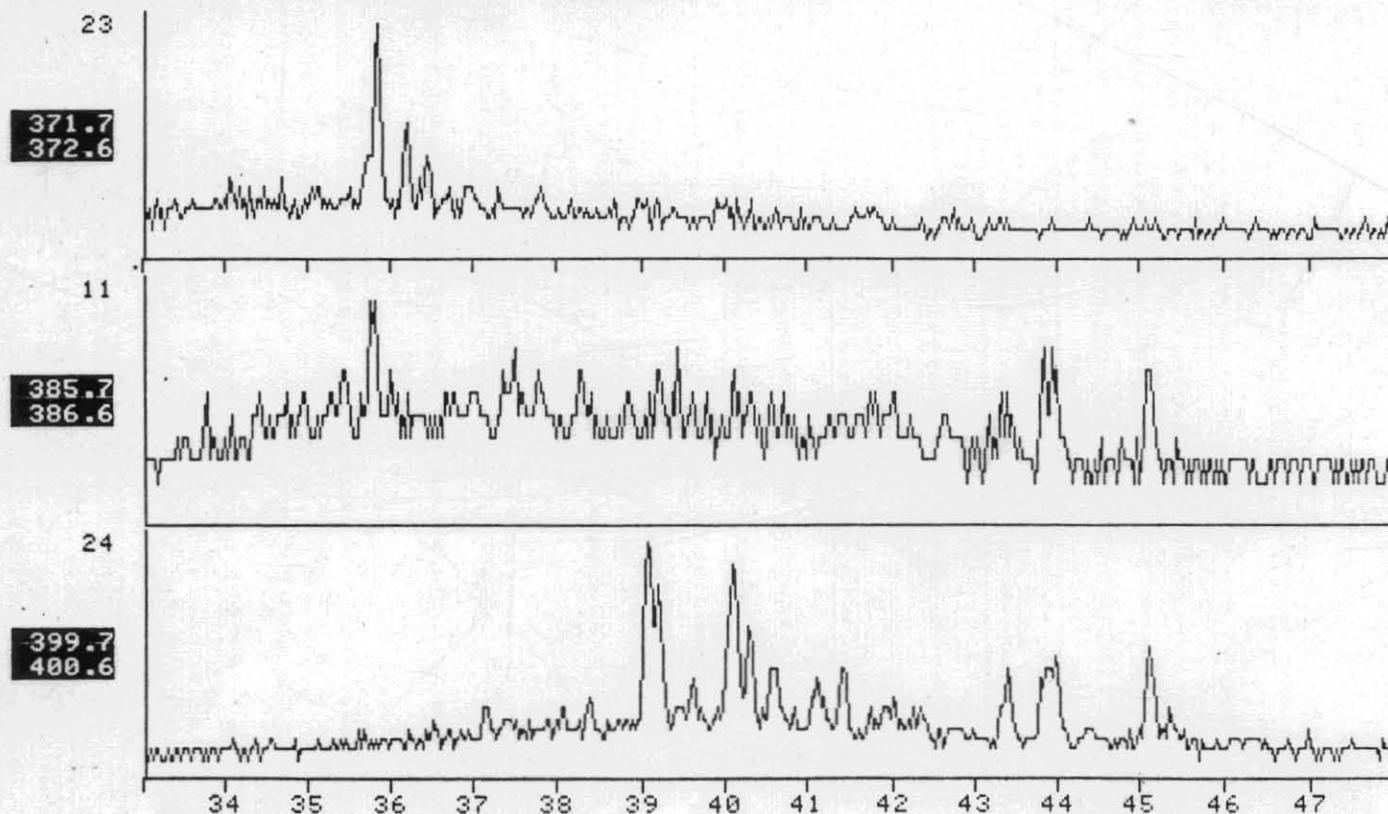
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 MISC 24-7-85, GH/GW. 0.2ul/180ul. COL#43.

FRN 5774



NAME BASS BASIN OIL, BRANCHED CYCLIC FRAGMENTOGRAM.  
 MISC 24-7-85, GH/GW. 0.2ul/180ul. COL#43.

FRN 5774

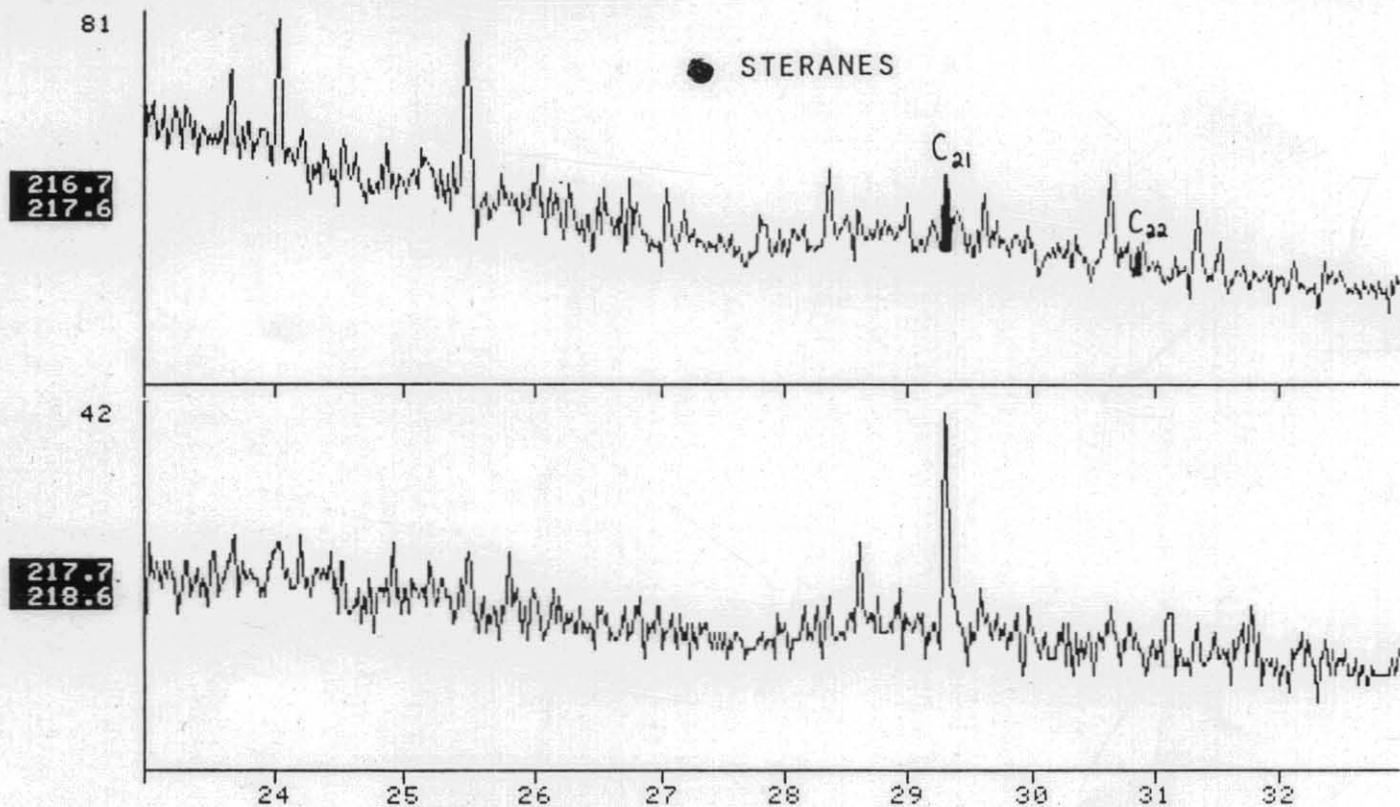


5 cm

FIGURE 1-3

NAME BASS BASIN OIL, BRANCHED CYCLIC FRAGMENTOGRAM.  
MISC 24-7-85, GH/GW. 0.2ul/180ul. COL#43.

FRN 5774



NAME BASS BASIN OIL, BRANCHED CYCLIC FRAGMENTOGRAM.  
MISC 24-7-85, GH/GW. 0.2ul/180ul. COL#43.

FRN 5774

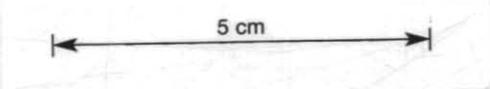
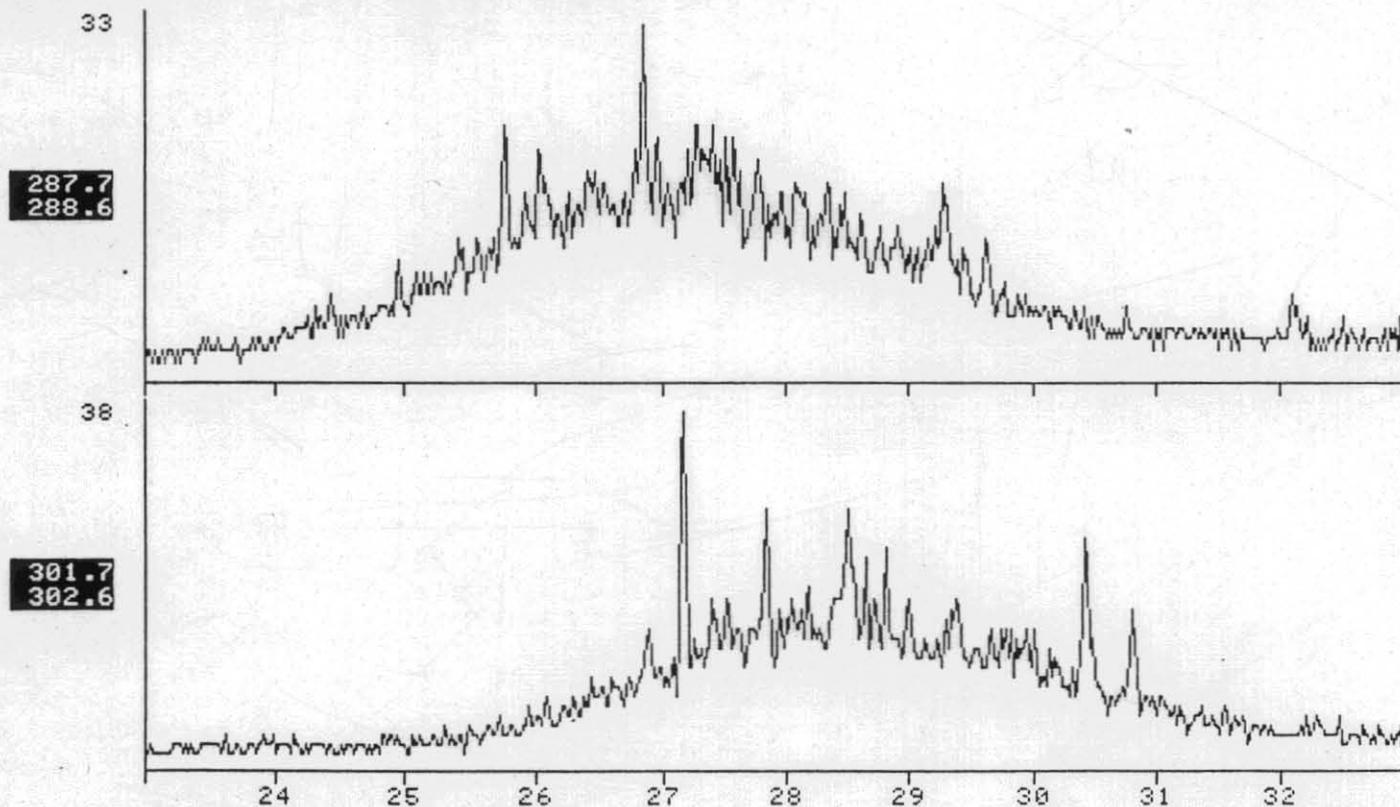
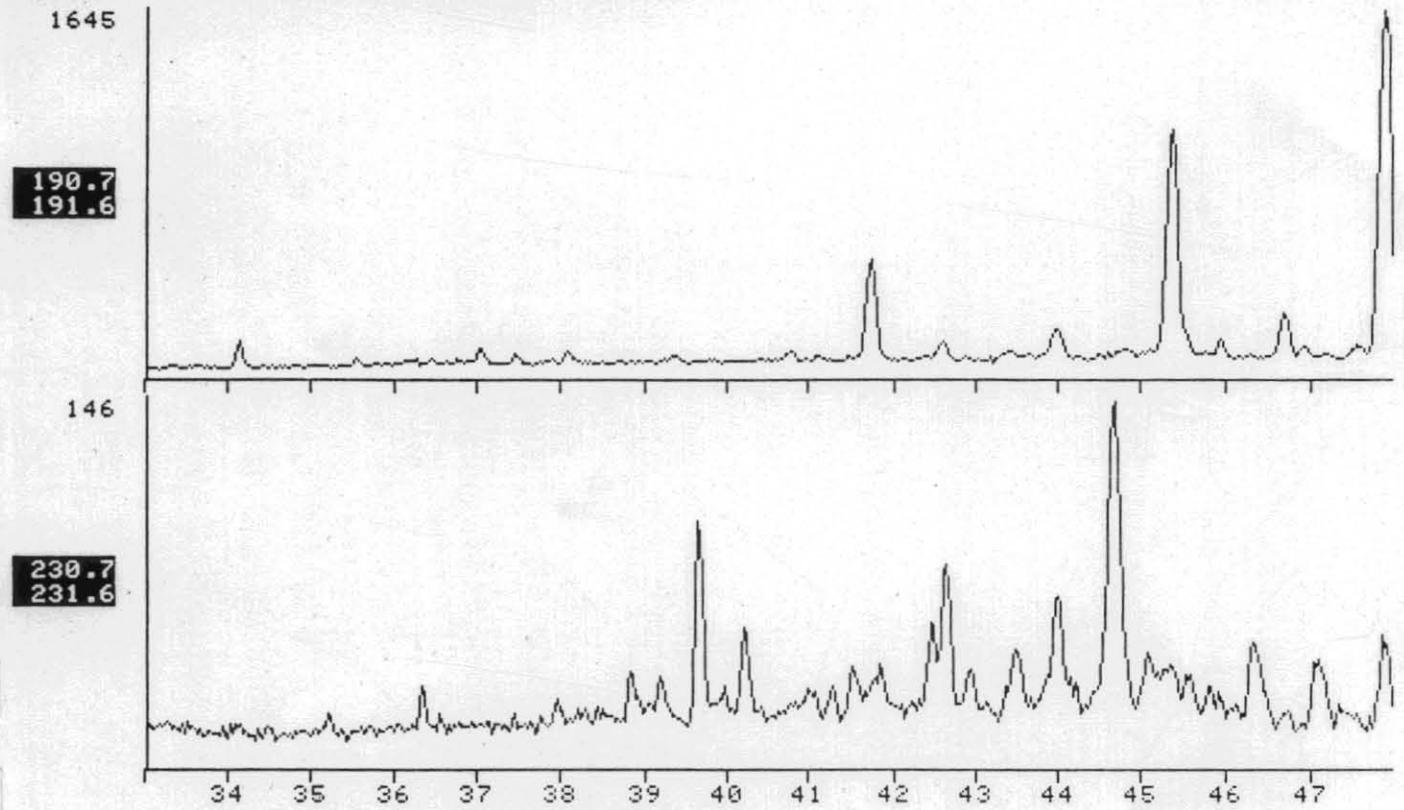


FIGURE 1-4

341020

NAME BASS BASIN OIL, BRANCHED CYCLIC FRAGMENTOGRAM.  
MISC 24-7-85, GH/GW. 0.2ul/180ul. COL#43.

FRN 5774



NAME BASS BASIN OIL, BRANCHED CYCLIC FRAGMENTOGRAM.  
MISC 24-7-85, GH/GW. 0.2ul/180ul. COL#43.

FRN 5774

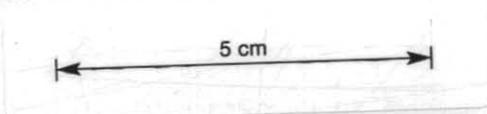
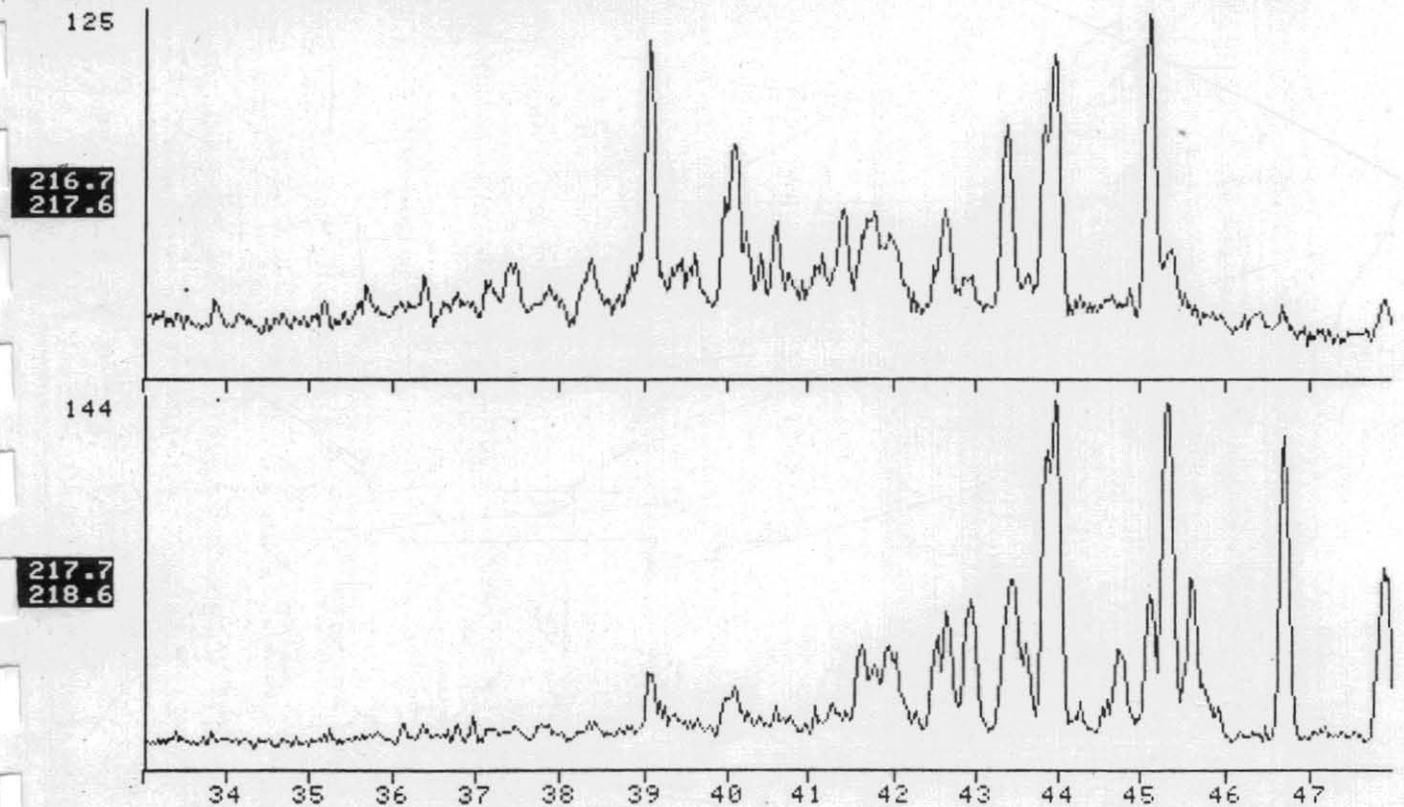
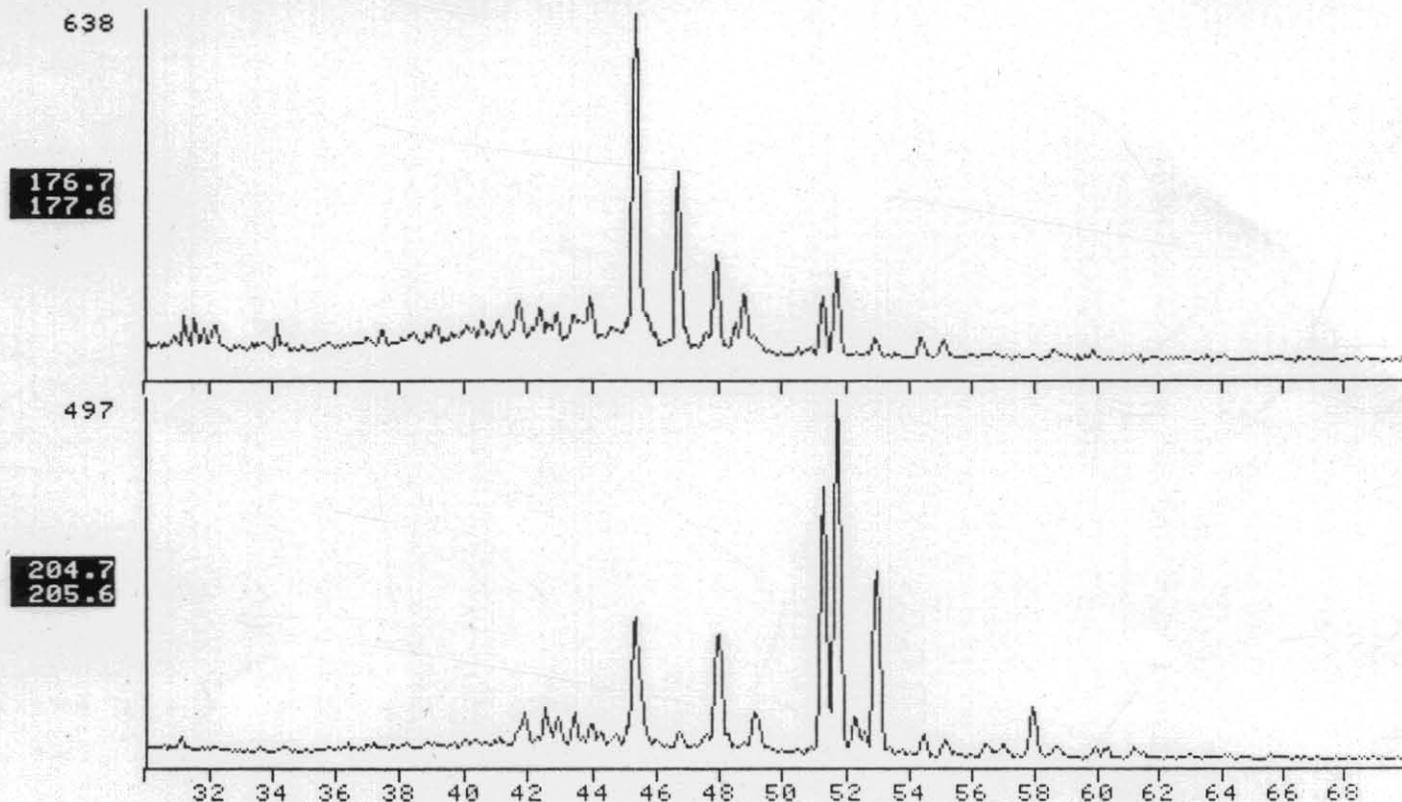


FIGURE 1-5

341021

NAME BASS BASIN OIL, BRANCHED CYCLIC FRAGMENTOGRAM.  
MISC 24-7-85, GH/GW. 0.2ul/180ul. COL#43.

FRN 5774



NAME BASS BASIN OIL, BRANCHED CYCLIC FRAGMENTOGRAM.  
MISC 24-7-85, GH/GW. 0.2ul/180ul. COL#43.

FRN 5774

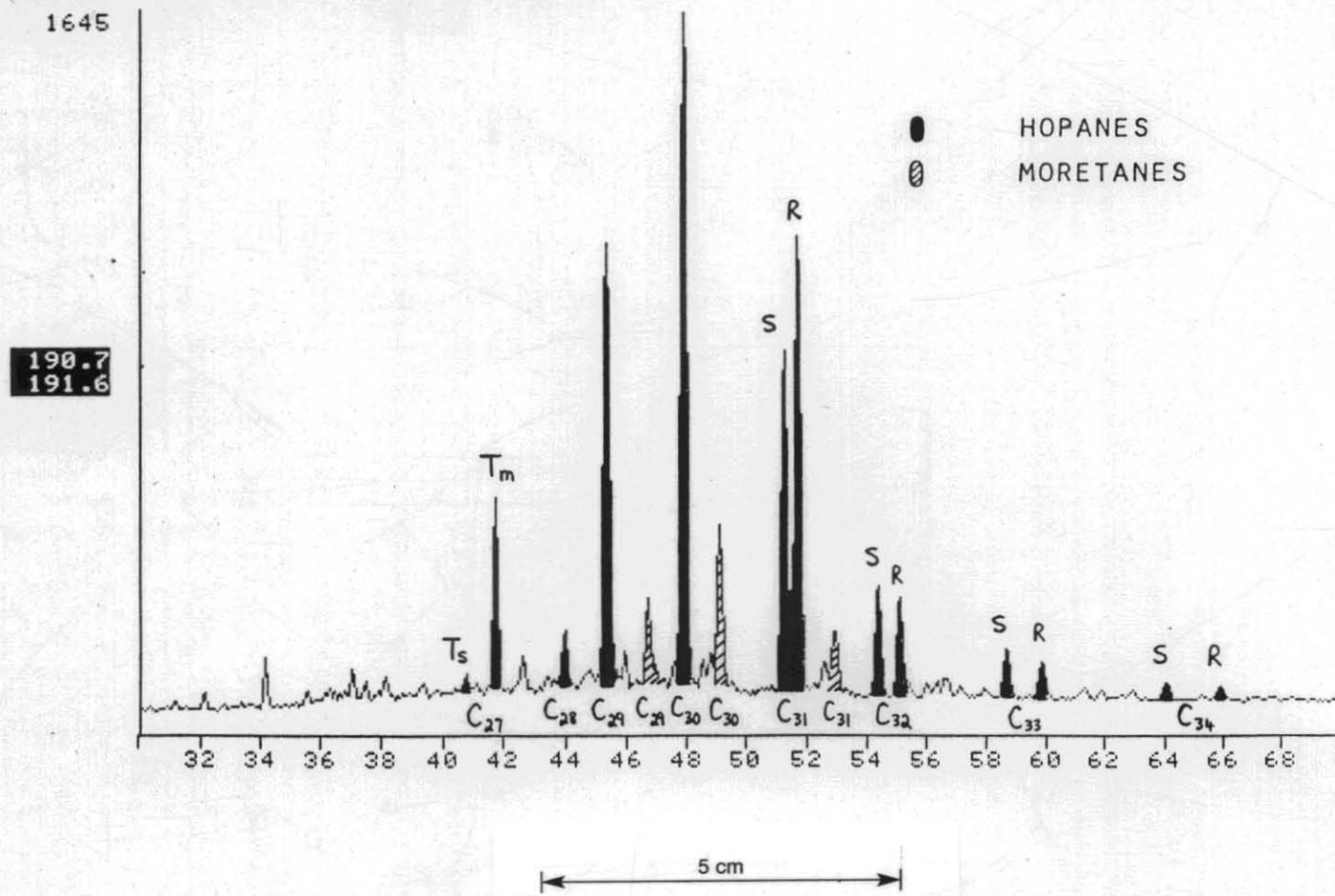
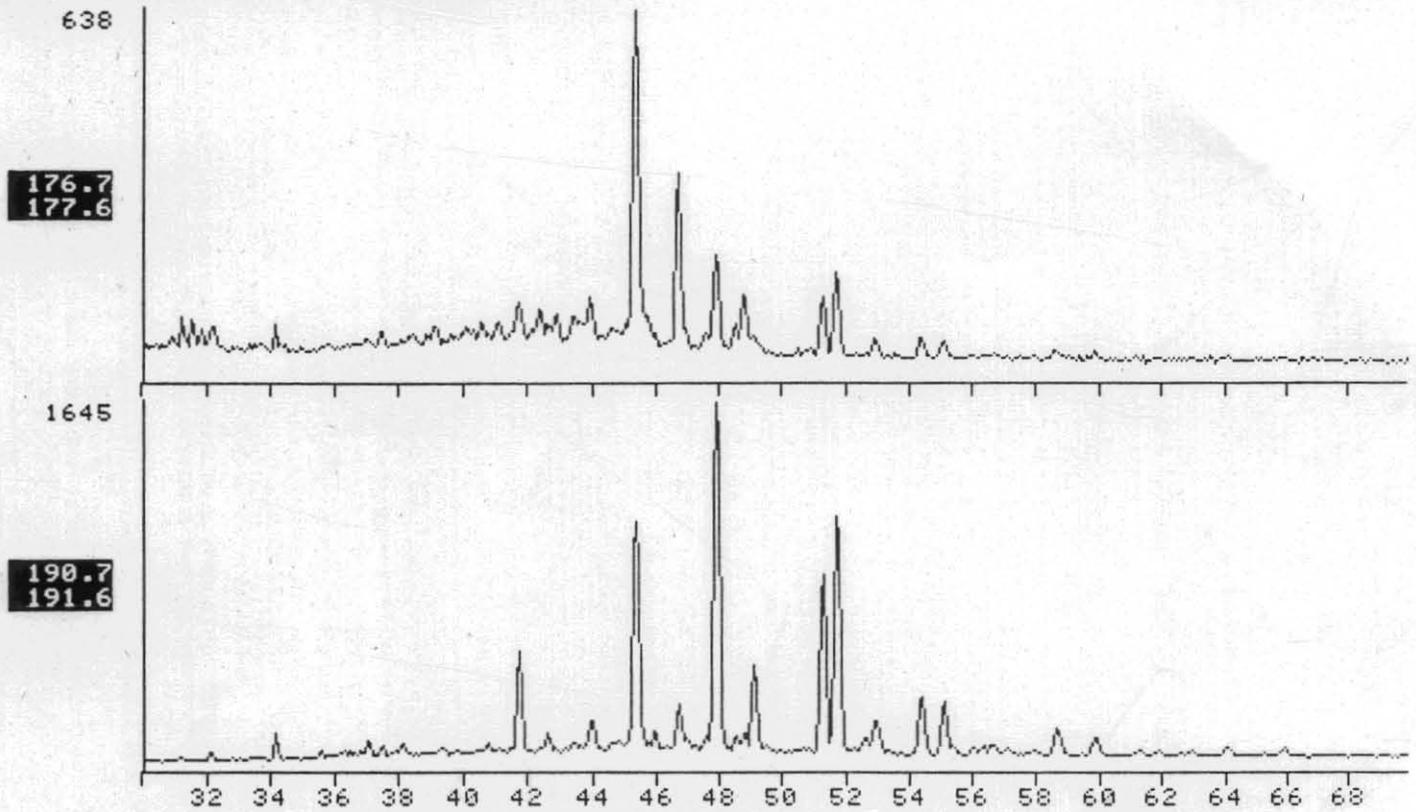


FIGURE 1-6

NAME BASS BASIN OIL, BRANCHED CYCLIC FRAGMENTOGRAM.  
MISC 24-7-85, GH/GW. 0.2ul/180ul. COL#43.

FRN 5774



NAME BASS BASIN OIL, BRANCHED CYCLIC FRAGMENTOGRAM.  
MISC 24-7-85, GH/GW. 0.2ul/180ul. COL#43.

FRN 5774

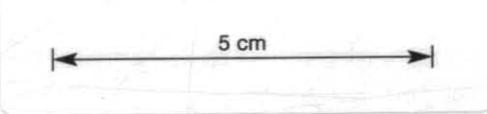
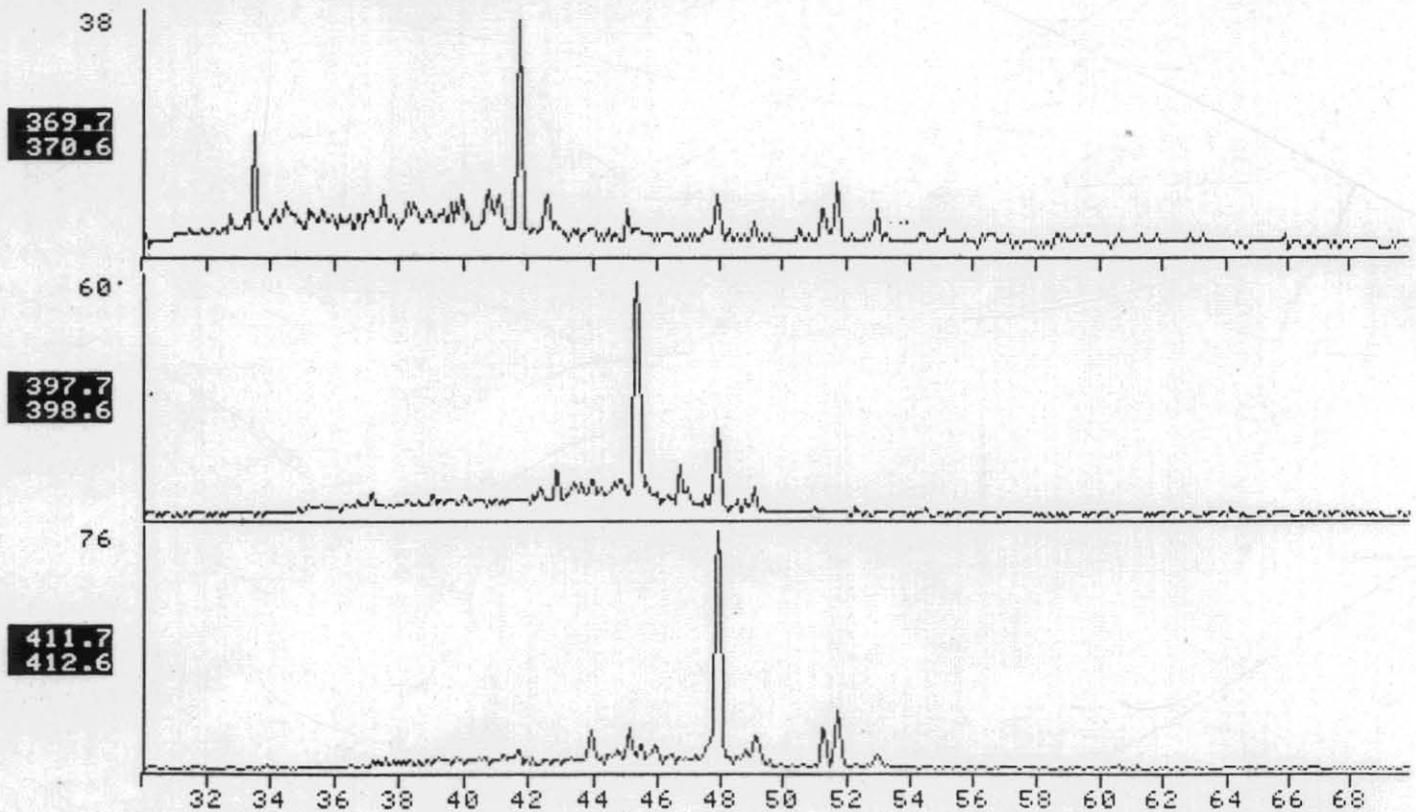
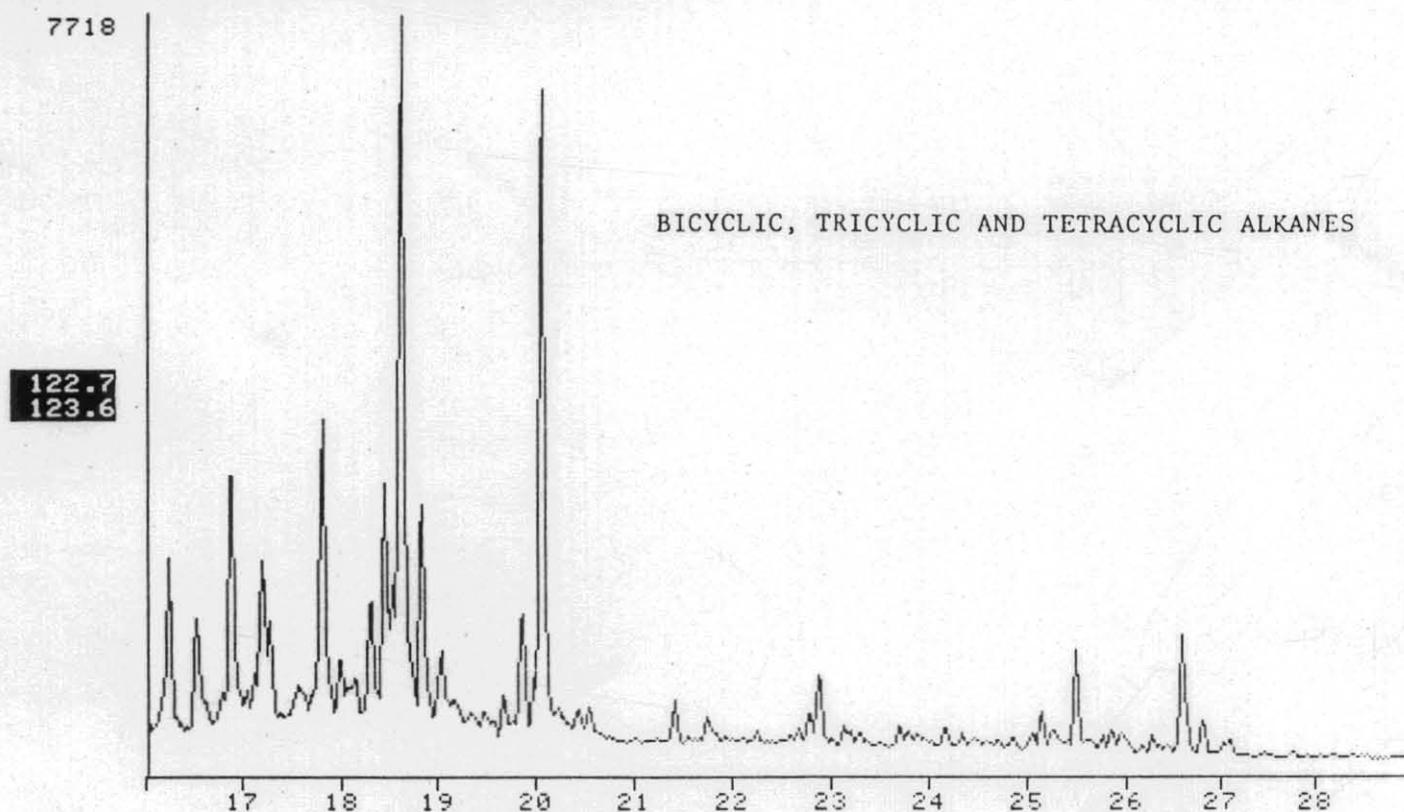


FIGURE 1-7

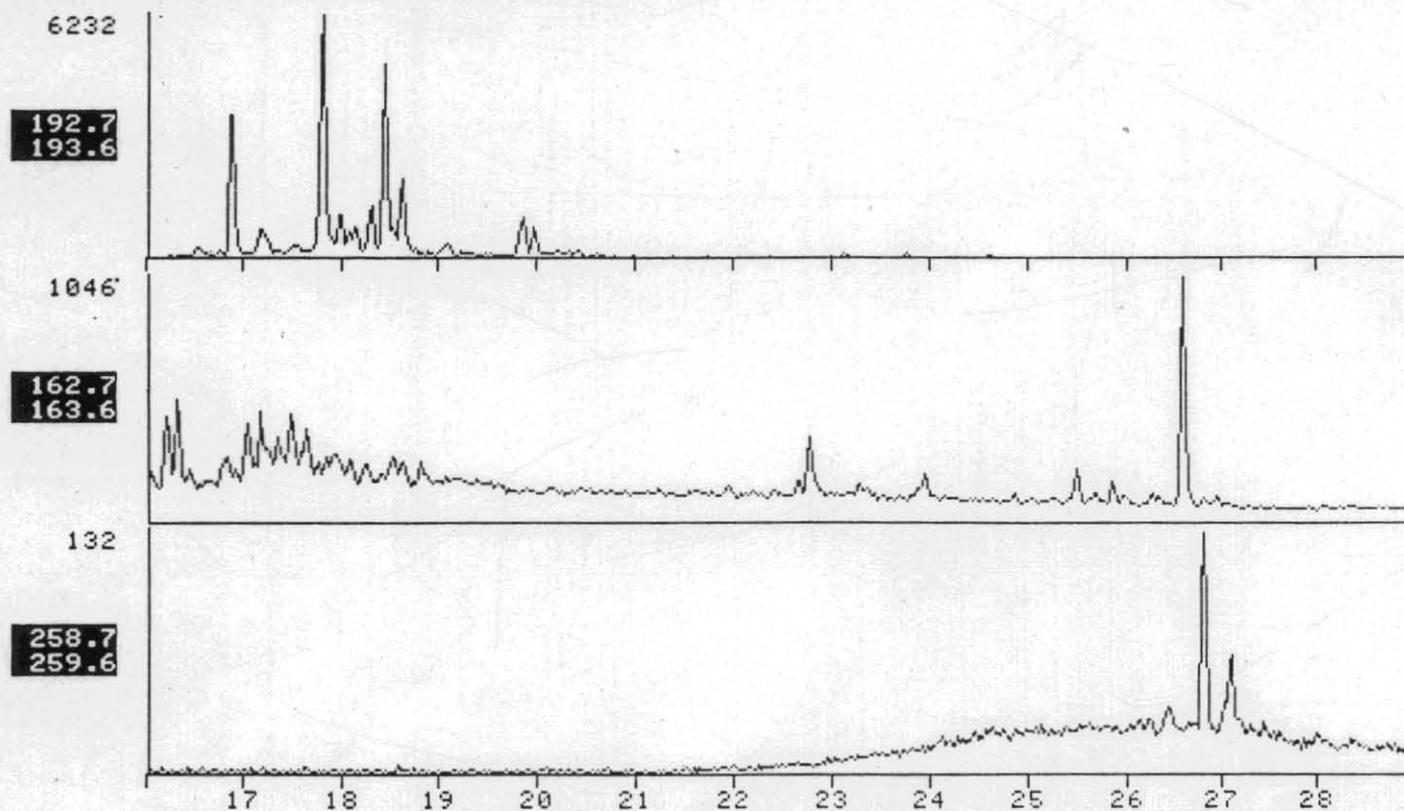
NAME BASS BASIN OIL, BRANCHED CYCLIC FRAGMENTOGRAM.  
MISC 24-7-85, GH/GW. 0.2ul/180ul. COL#43.

FRN 5774



NAME BASS BASIN OIL, BRANCHED CYCLIC FRAGMENTOGRAM.  
MISC 24-7-85, GH/GW. 0.2ul/180ul. COL#43.

FRN 5774

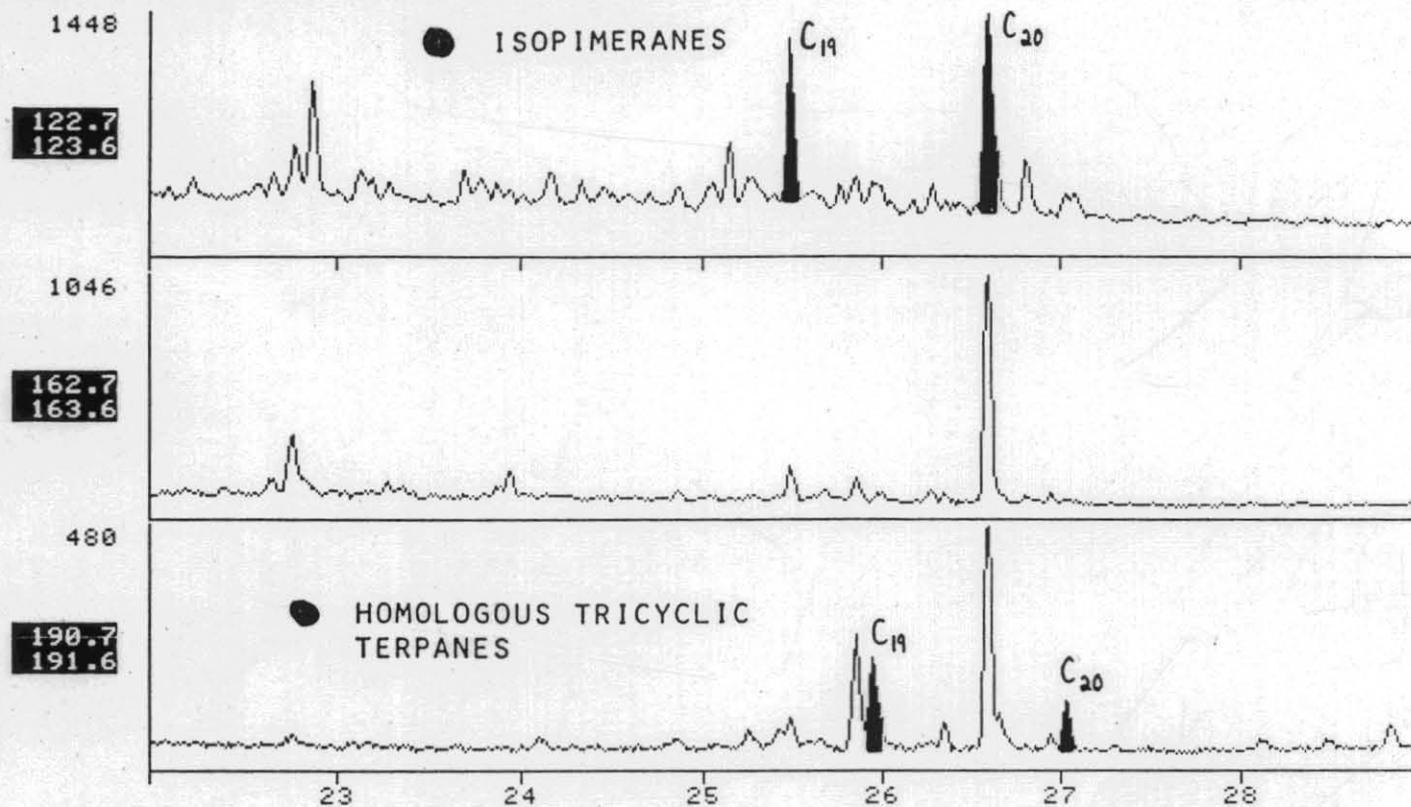


5 cm

FIGURE 1-9

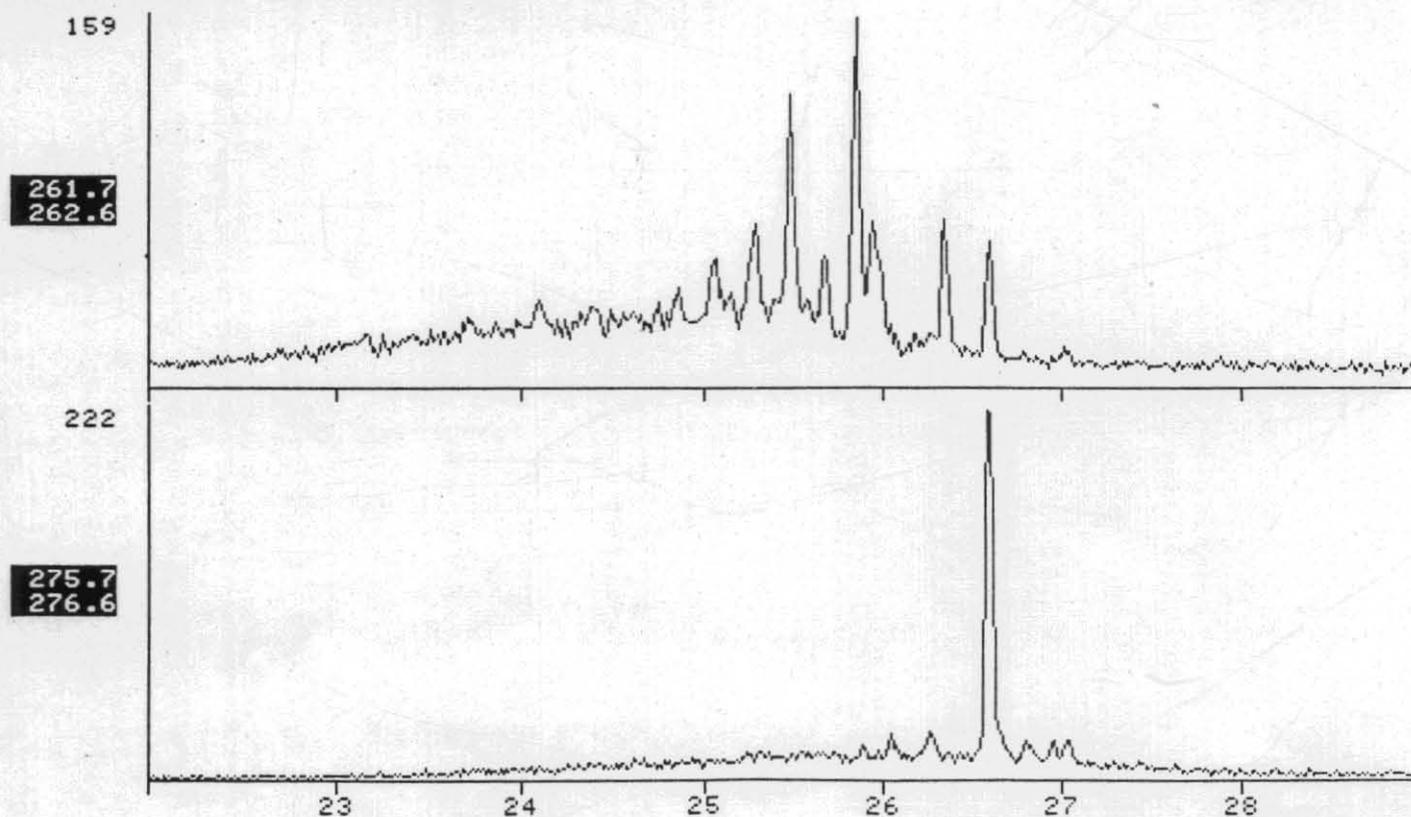
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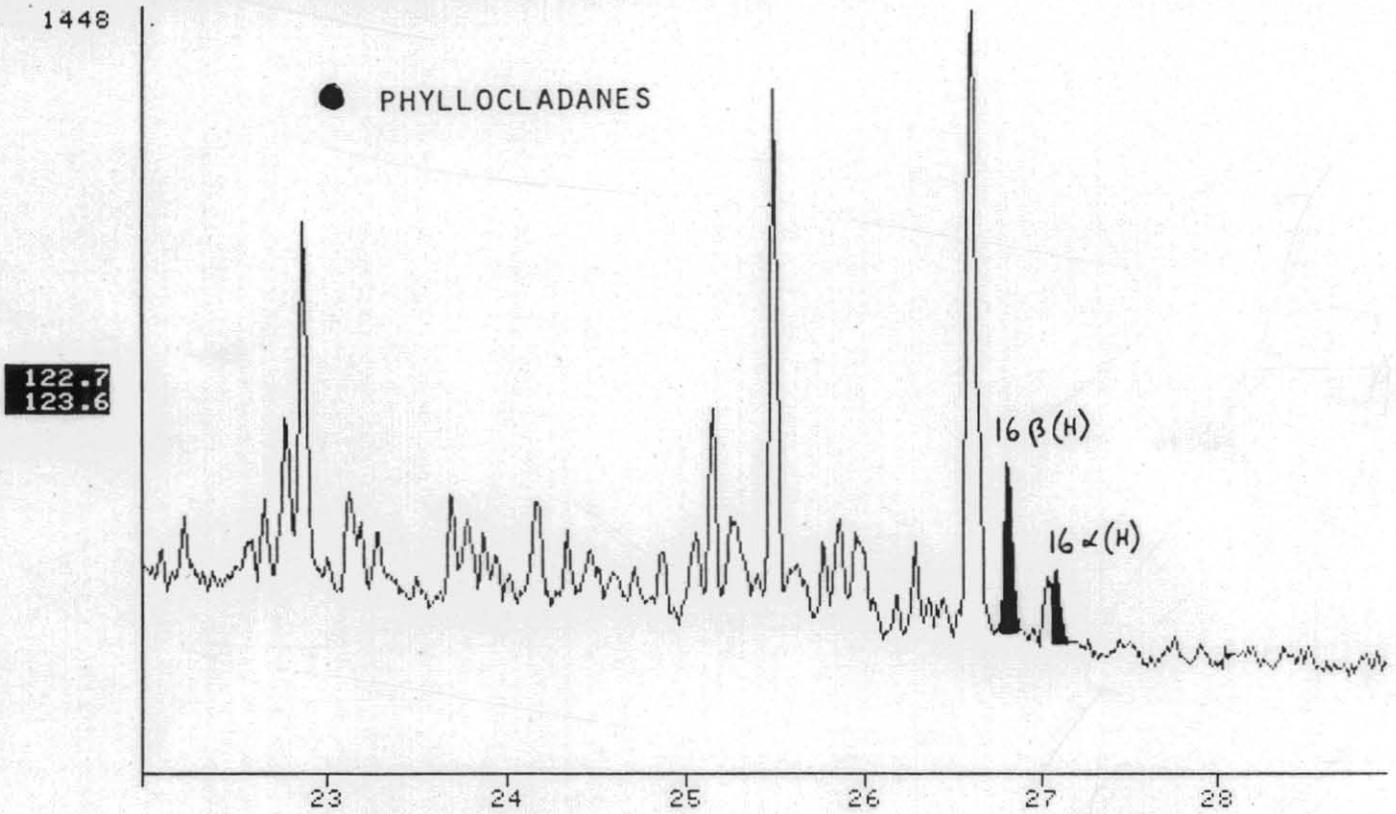
FRN 5774



5 cm

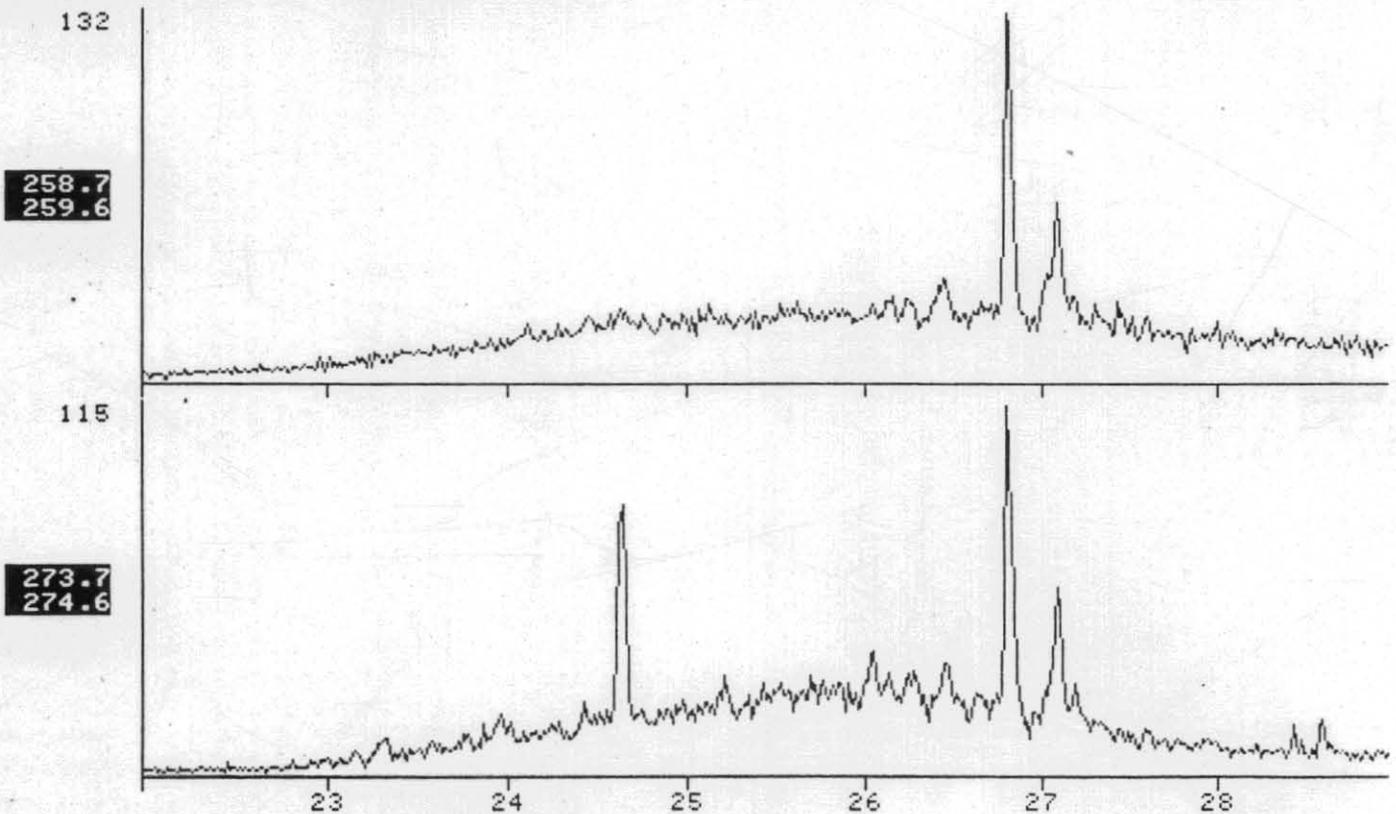
NAME BASS BASIN OIL, BRANCHED CYCLIC FRAGMENTOGRAM.  
MISC 24-7-85, GH/GW. 0.2ul/180ul. COL#43.

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MISC 24-7-85, GH/GW. 0.2ul/180ul. COL#43.

FRN 5774



5 cm

FIGURE 1-11

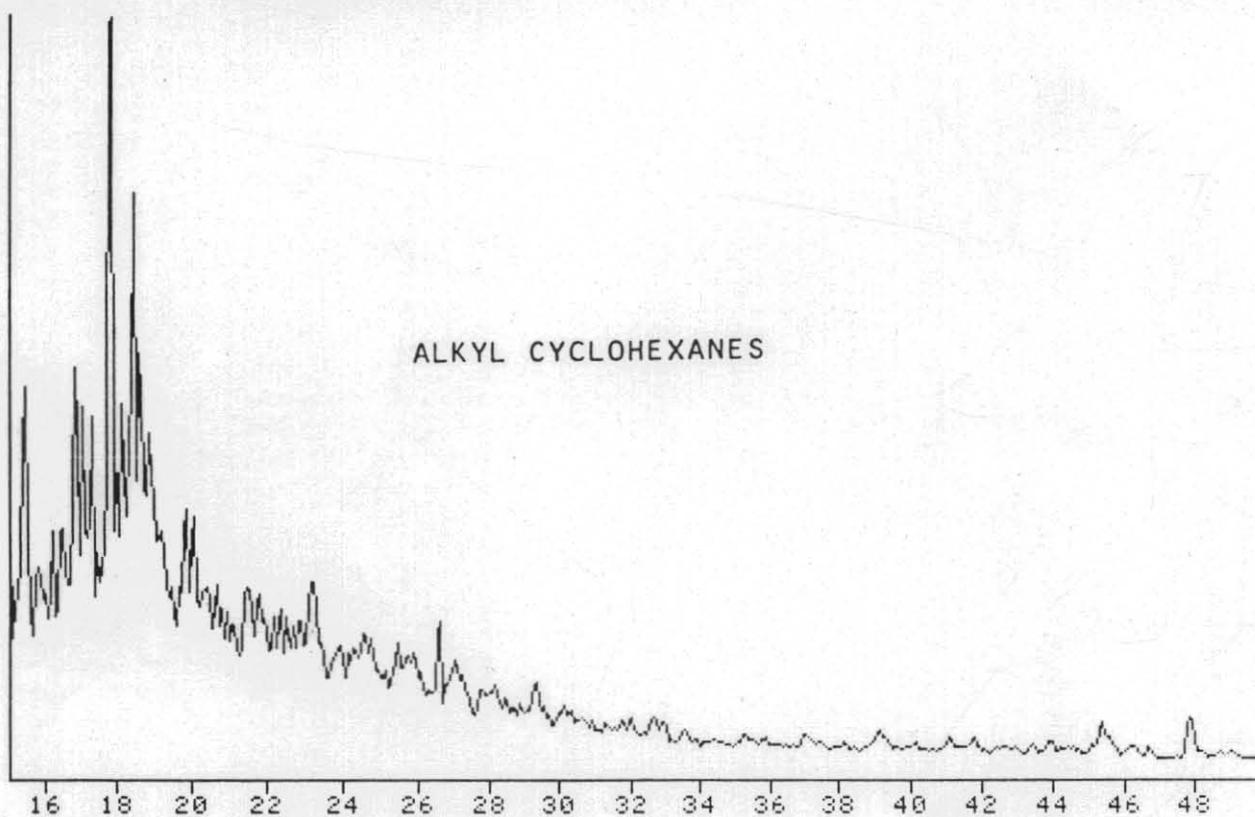
NAME BASS BASIN OIL, BRANCHED CYCLIC FRAGMENTOGRAM.  
MISC 24-7-85, GH/GW. 0.2ul/180ul. COL#43.

FRN 5774

5746

82.7  
83.6

ALKYL CYCLOHEXANES



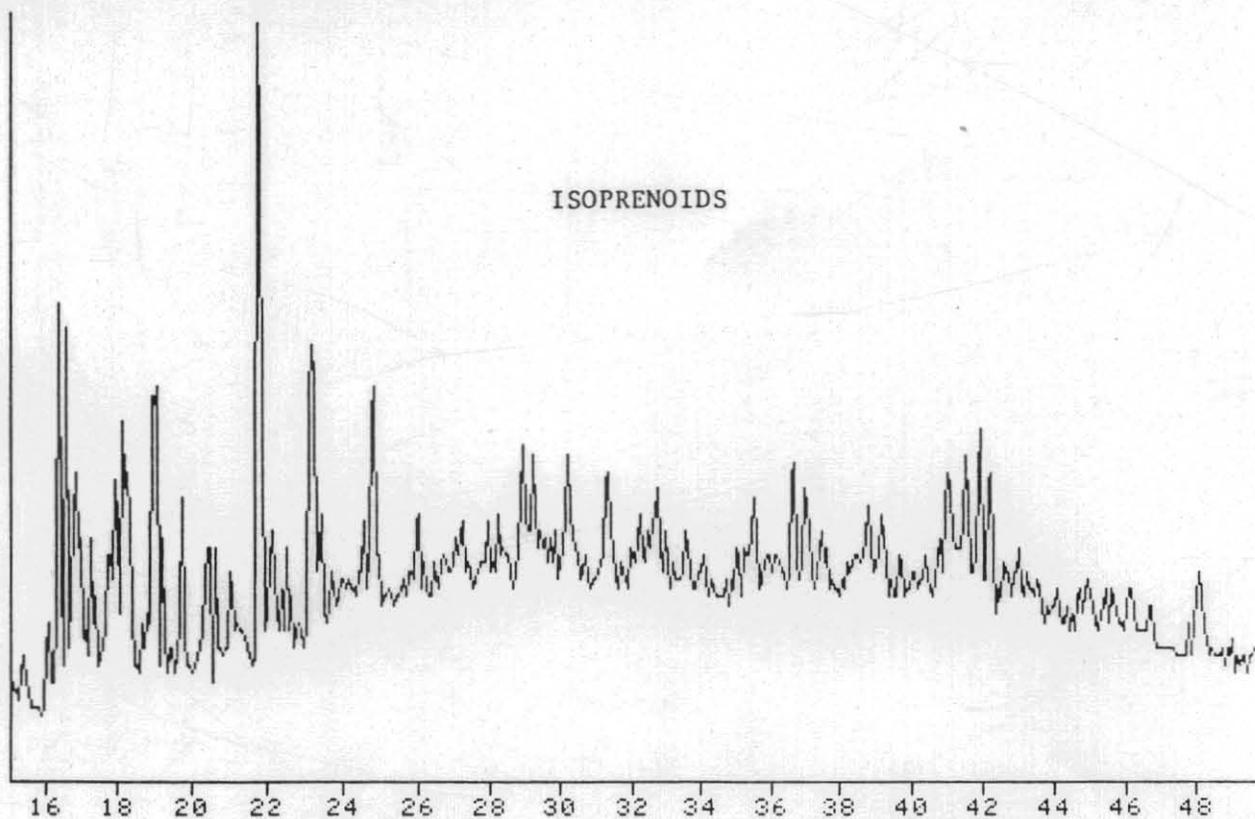
NAME BASS BASIN OIL, BRANCHED CYCLIC FRAGMENTOGRAM.  
MISC 24-7-85, GH/GW. 0.2ul/180ul. COL#43.

FRN 5774

91

182.7  
183.6

ISOPRENOIDS



5 cm