1987/13. Petroleum geochemistry of crudes from Yolla-1 and Pelican-5, Bass Basin

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Abstract

Liquid hydrocarbons from the Yolla-1 and Pelican-5 exploration wells have been subjected to liquid chromatography, C1-C31 whole oil chromatography, and capillary gas chromatography/mass spectrometry in order to characterise and determine maturity, and also to determine information about their source.

Samples from Yolla are low maturity paraffinic crudes, whose source material was in part marine, and deposited in an oxidising depositional environment.

A sample from Pelican is more mature, and although genetically related to the Yolla crudes, probably originated in a more continental environment.

INTRODUCTION

Yolla-1 and Pelican-5 were drilled by Amoco Australia Petroleum Company during the period 1985-86.

Drill stem tests carried out over hydrocarbon-bearing intervals in the Yolla well were the first such tests performed on wells drilled in Tasmanian waters. DST-1 (2809-2814, 2818-2824.5 m) and DST-2B (1813-1833 m) produced significant flows.

Six intervals were perforated in the Pelican-5 well, but only two had hydrocarbon flows in any quantity; DST-4 (3142-3163 m) and DST-6 (2786-2790 m).

Samples of the liquids recovered from three of the tests (Yolla DST-1 and DST-2; Pelican DST-4) were forwarded to Analabs, Perth, for geochemical analysis. The results and interpretation are the subject of this report.

LIQUID CHROMATOGRAPHY

The crude oil is separated into saturate, aromatic, and NSO (asphaltenes plus resins) fractions by medium pressure liquid chromatography. Results are shown as Table 1. The three samples are very paraffinic and contain only minor amounts of aromatics.

WHOLE OIL CHROMATOGRAPHY

Whole oil capillary gas chromatography (C1-C31 GLC) and C4-C7 detailed gasoline range gas chromatography (C1-C7 GLC) were carried out on each of the samples and the results are shown as Figures 1-6 and tabulated as Table 2.

The high pristane/phytane ratios indicate that the organic matter was dominantly of terrestrial origin and deposited in a relatively oxidising depositional environment (Powell and McKirdy, 1975; Tissot and Welte, 1984). The pristane -n C17 ratio for the Pelican sample (2.4) indicates a peat-swamp depositional environment (Lijmbach, 1976).

(C21 + C22)/(C28 + C29) ratios are high (›3.5) for the Yolla samples, indicating that marine matter contributed to the source material. The ratio from Pelican is much lower.

The two Yolla samples are similar regarding their C1-C31 and C4-C7 fingerprints (fig. 1-4). The deeper sample (fig. 1) contains a higher amount of light molecular weight compounds, indicating a higher maturity level than obtained for the DST-2 sample. This is possibly due to the proximity to a 100 m+ intrusive dolerite body encountered below 2580 m.

GAS CHROMATOGRAPHY/MASS SPECTROMETRY

Gas chromatography/mass spectrometry (GC/MS) enables investigation of compounds with characteristic structures ('biological markers'), even though these may account for only very small percentages of the total crude. These studies help in understanding geochemical processes, grouping oil into families, establishing the past thermal history, and reconstruction of the depositional environment (Seifert and Moldowan, 1981).

GC/MS was carried out on the Yolla DST-2 and the Pelican samples. The results of the Yolla sample are shown as Figures 7-15 and the Pelican sample as Figures 16-24. Selected parameters are shown in tabular form as Tables 5 and 6.

Maturity is indicated by several parameters including the 18α(H) - hopane/17α(H) - hopane ratio. The ratio increases exponentially with increasing maturity from about 0.2 at the onset of oil generation to approximately 1.0 at peak oil generation (Tissot and Welte, 1984). The sample from Yolla is seen to be of low maturity (Table 5.1) whereas the Pelican sample is mature (Table 6.1). A further maturity indicator, the C29 20/20R ααα sterane ratio (Table 5.5) indicates a higher maturity for the Yolla sample. The Pelican sample did not contain sufficient steranes to determine reliable sterane ratios.

C27/C29 ratios can be used as an indicator of source type. High ratios (›1) indicate algal matter; aquatic organic matter has a ratio of approximate unity; low ratios (‹1) are indicative of higher plants (Tissot and Welte, 1984). Limited information is only available for Yolla, and indicates that higher plants contributed to the source. Mass fragmentograms from both Yolla and Pelican show diterpanes of higher plant origin including beyerane, isoprimerane, phyllocladane and kaurane, although these compounds occur in greater abundance in the Pelican sample (fig. 15, 24).

SUMMARY

The similarity of source material from both Yolla and Pelican suggests a genetic relationship between them. The organic matter is derived predominantly from higher land plants, but marine sources produced a significant component, particularly at Yolla.

Differences in maturity level between the two Yolla samples and also to the Pelican sample are due to different igneous and burial histories. Differences could also be due to different migration histories.

REFERENCES

LIJMBACH, G. W. M. 1976. On the origin of petroleum. *Proc. 9th World Petroleum Conference* 2:357-369.

POWELL, T. G.;McKIRDY, D. M. 1975. Geological factors controlling crude oil composition in Australia and New Guinea. *Bull. Amer. Assoc. Petr. Geol.* 59:1176.

SEIFERT, W. K.;MOLDOWAN, J. M. 1981. Paleoreconstruction by biological markers. *Geochim. Cosmochim. Acta* 45:783-794.

TISSOT, B. P.;WELTE, D. H. 1984. *Petroleum formation and occurrence.* Springer-Verlag (2nd Edition).

[23 February 1987]

TABLE 1

Summary of Liquid Chromatography(Compositional Data)

Date of Job: OCTOBER 1986

	-----Hydrocarbons------			-----Nonhydrocarbons------			SAT	ASPH	HC
Sample	%SAT.	%AROM.	%HC's	%NSO's	%ASPH.	%Non HC's	AROM	NSO	Non HC
YOLLA 1, DST 2 1833m	89.7	7.3	97.0	3.0	nd	3.0	12.32	nd	32.4
YOLLA 1, DST 1 2809m	85.1	12.6	97.7	2.3	nd	2.3	6.73	nd	42.8
PELICAN 5, DST 4 3142m	86.6	9.8	96.4	3.6	nd	3.6	8.86	nd	26.5

FIGURE 1

YOLLA 1, DST 2, 1833m

Whole Oil

C_1-C_{31} GLC

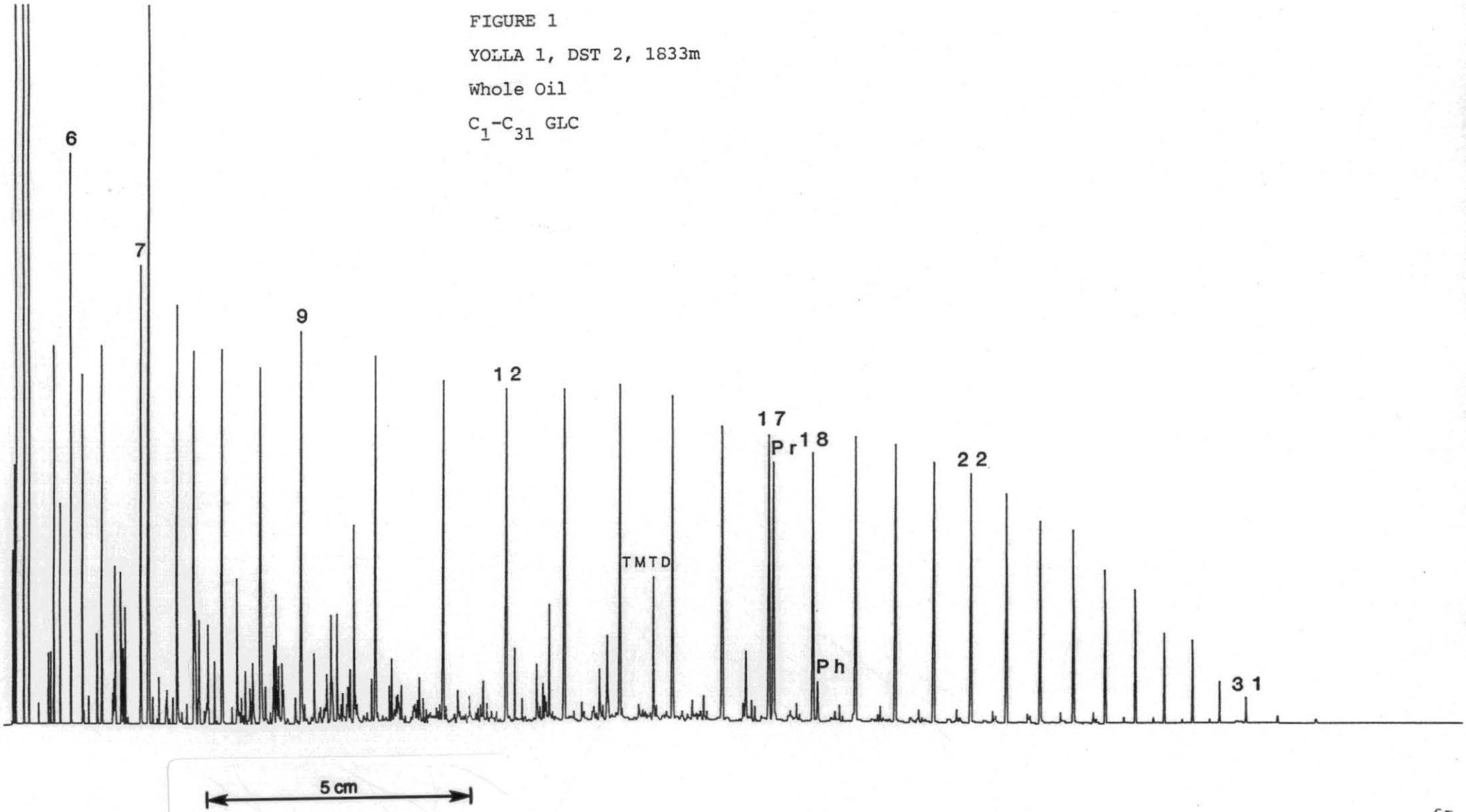
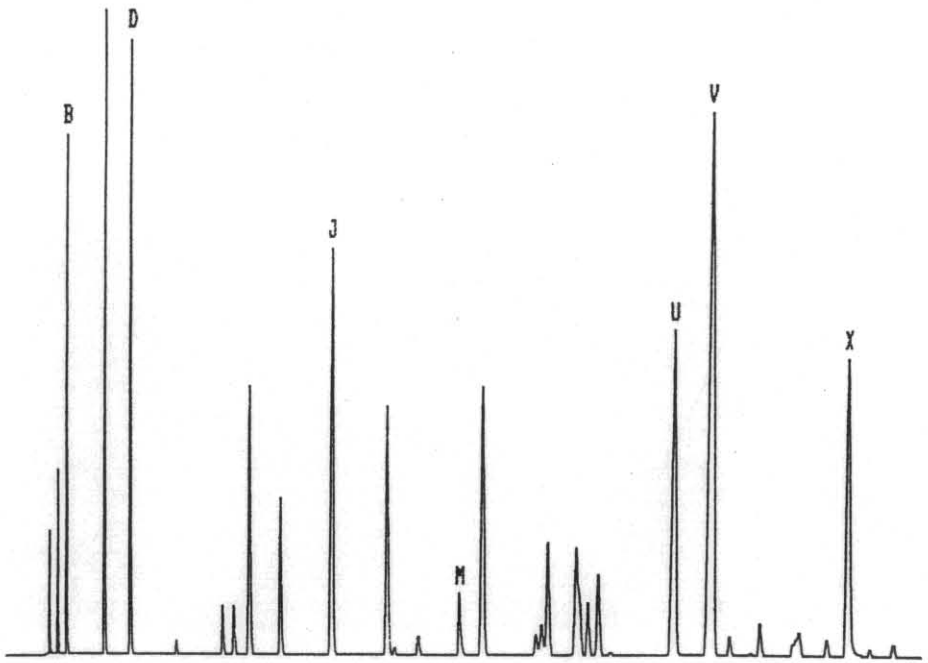


FIGURE 2

YOLLA 1, DST 2, 1833m

Whole Oil

C_1-C_7 GLC



5 cm

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

FIGURE 3

YOLLA 1, DST 1, 2809m

Whole Oil

C_1-C_{31} GLC

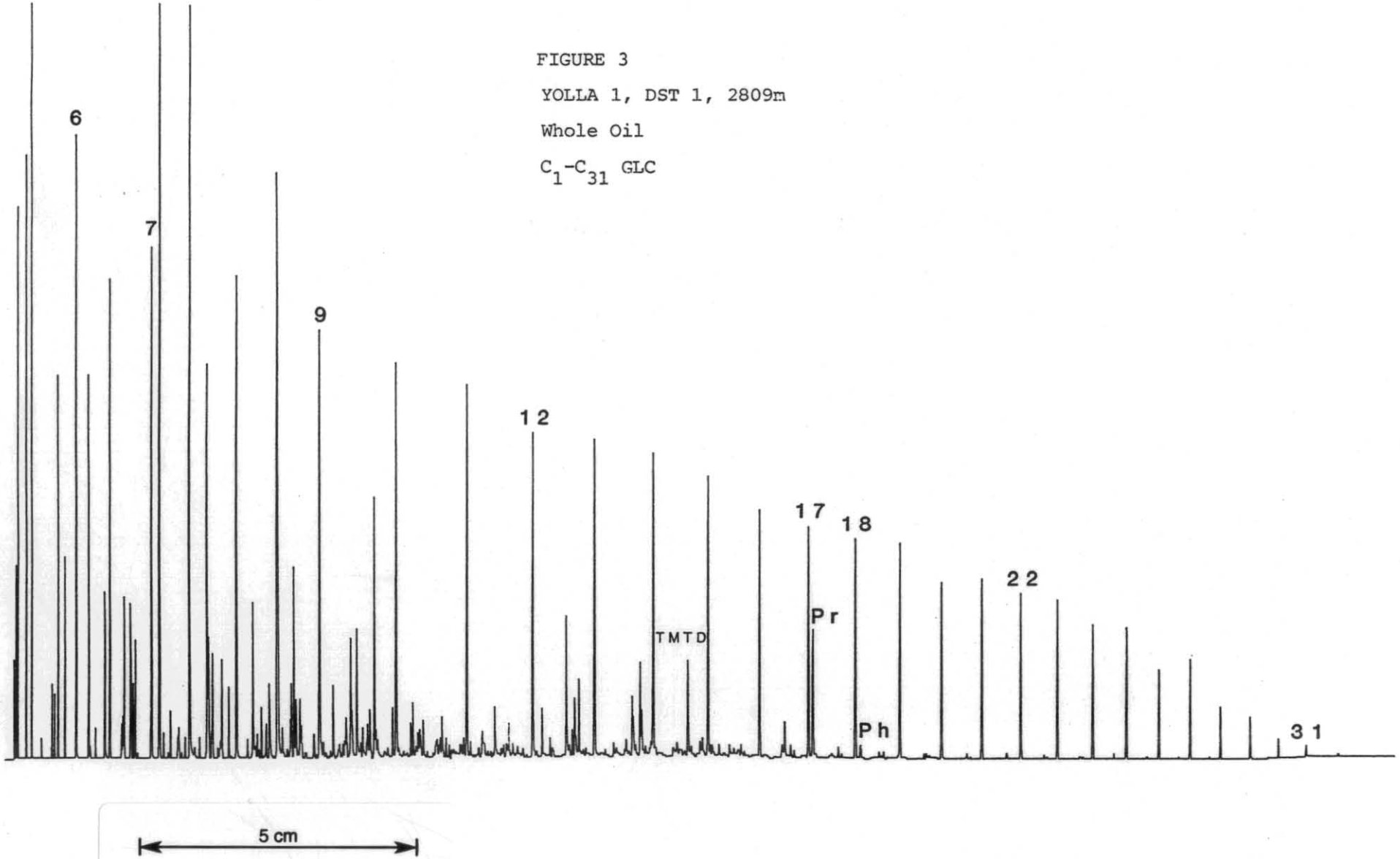
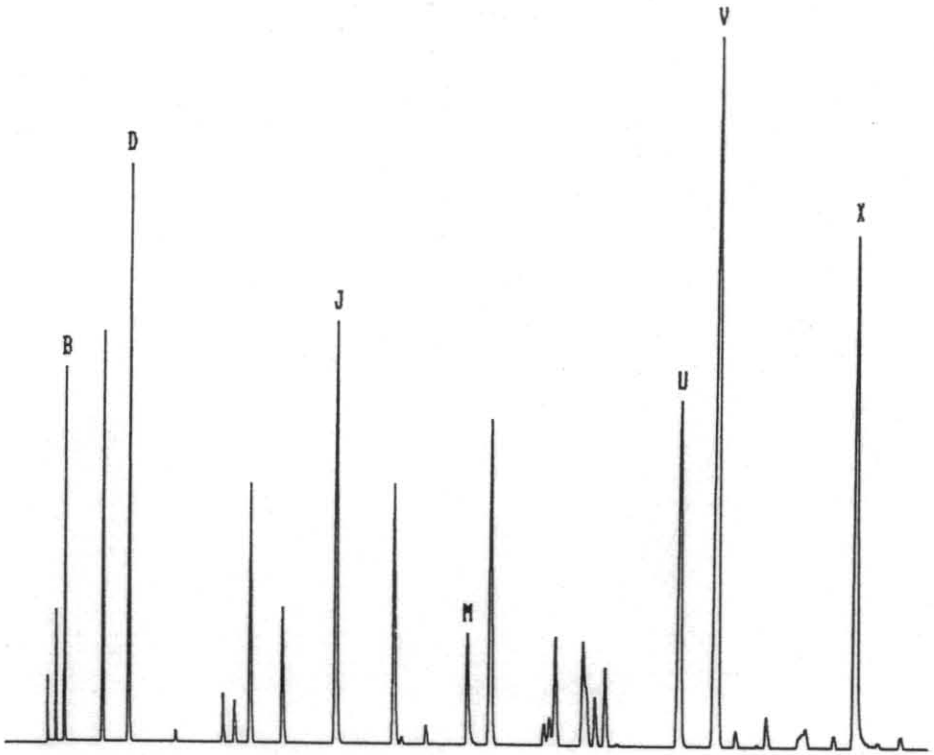


FIGURE 4

YOLLA 1, DST 1, 2809m

Whole Oil

C_1-C_7 GLC



5 cm

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

TABLE 2

SUMMARY OF WHOLE OIL ANALYSIS Date: 1986

Company: TASMANIAN MINES DEPT. Sample: YOLLA 1, DST 2, 1833m

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	0.18
4	1.12
5	2.78
6	6.38
7	11.09
8	8.07
9	7.46
10	6.78
11	5.21
12	4.78
13	5.29
14	5.45
15	4.91
16	3.50
17	6.17
18	2.86
19	3.01
20	2.47
21	2.17
22	2.03
23	1.78
24	1.50
25	1.30
26	1.03
27	0.93
28	0.62
29	0.57
30	0.27
31	0.29

COMPOSITION OF C4-C7 FRACTION

	Compound	Rel. Wt %
A	isobutane	1.43
B	n-butane	3.81
C	isopentane	5.39
D	n-pentane	6.80
E	2,2-dimethylbutane	0.23
F	cyclopentane	0.80
G	2,3-dimethylbutane	0.85
H	2-methylpentane	4.65
I	3-methylpentane	2.61
J	n-hexane	8.51
K	methylcyclopentane	5.01
L	2,4-dimethylpentane	0.48
M	benzene	1.47
N	cyclohexane	6.53
O	1,1-dimethylcyclopentane	0.80
P	2-methylhexane	2.71
Q	3-methylhexane	3.94
R	1 cis-3-dimethylcyclopentane	1.27
S	1 trans-3-dimethylcyclopentane	2.05
T	1 trans-2-dimethylcyclopentane	0.16
U	n-heptane	9.75
V	methylcyclohexane	20.99
W	1 cis-2-dimethylcyclopentane	0.56
X	toluene	9.19

CALCULATED DATA - C12+ FRACTION

Pristane/Phytane	8.18
Pristane/n-C17	1.38
Phytane/n-C18	0.18
TMTD/Pristane	0.31
(C21+C22)/(C28+C29)	3.58

CALCULATED DATA - C4-C7 FRACTION

Paraffin Index I	1.91
Paraffin Index II	20.23
N/K (Maturity)	1.30
C/D (Maturity)	0.79
J/K (Maturity)	1.70
I/M (Water washing)	1.78
I/J (Biodegradation)	0.31

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 3

SUMMARY OF WHOLE OIL ANALYSIS

Date: 1986

Company: TASMANIAN MINES DEPT. Sample: YOLLA 1, DST 1, 2809m

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	0.12
4	1.06
5	3.07
6	8.41
7	12.81
8	10.01
9	13.84
10	8.67
11	5.62
12	4.43
13	5.35
14	5.31
15	4.02
16	2.42
17	3.23
18	1.74
19	1.50
20	1.39
21	1.19
22	1.13
23	1.03
24	0.93
25	0.79
26	0.62
27	0.52
28	0.31
29	0.25
30	0.12
31	0.09

COMPOSITION OF C4-C7 FRACTION

	Compound	Rel. Wt %
A	isobutane	0.99
B	n-butane	3.21
C	isopentane	4.74
D	n-pentane	6.50
E	2,2-dimethylbutane	0.24
F	cyclopentane	0.87
G	2,3-dimethylbutane	0.83
H	2-methylpentane	4.46
I	3-methylpentane	2.56
J	n-hexane	9.00
K	methylcyclopentane	5.39
L	2,4-dimethylpentane	0.50
M	benzene	3.00
N	cyclohexane	7.67
O	1,1-dimethylcyclopentane	0.77
P	2-methylhexane	2.83
Q	3-methylhexane	4.01
R	1 cis-3-dimethylcyclopentane	1.31
S	1 trans-3-dimethylcyclopentane	2.06
T	1 trans-2-dimethylcyclopentane	0.17
U	n-heptane	10.46
V	methylcyclohexane	11.27
W	1 cis-2-dimethylcyclopentane	0.51
X	toluene	16.64

CALCULATED DATA - C12+ FRACTION

Pristane/Phytane	6.92
Pristane/n-C17	0.72
Phytane/n-C18	0.11
TMTD/Pristane	0.62
(C21+C22)/(C28+C29)	3.99

CALCULATED DATA - C4-C7 FRACTION

Paraffin Index I	1.93
Paraffin Index II	25.81
N/K (Maturity)	1.42
C/D (Maturity)	0.73
J/K (Maturity)	1.67
I/M (Water washing)	0.85
I/J (Biodegradation)	0.28

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

FIGURE 5

PELICAN 5, DST 4, 3142m

Whole Oil

C_1-C_{31} GLC

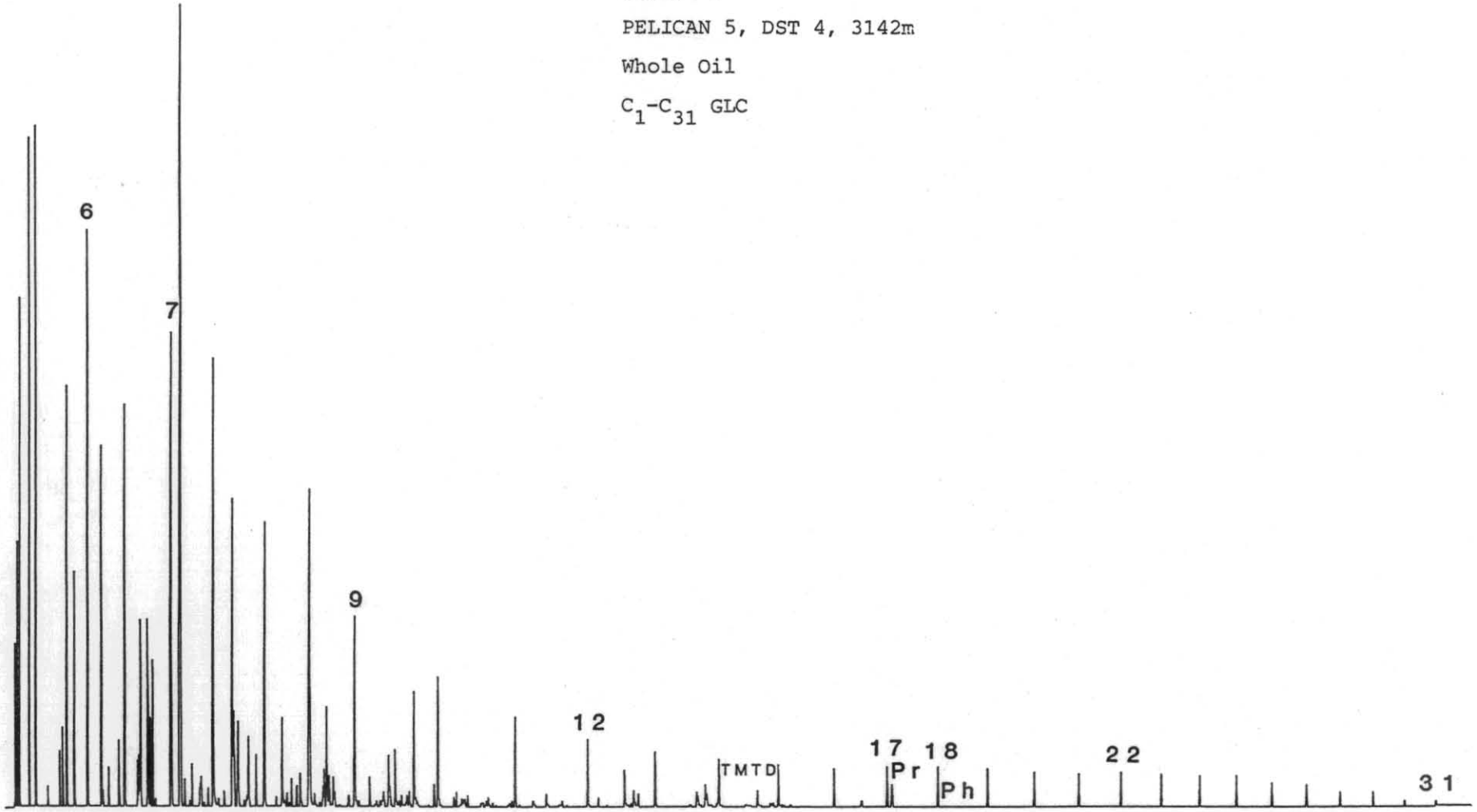
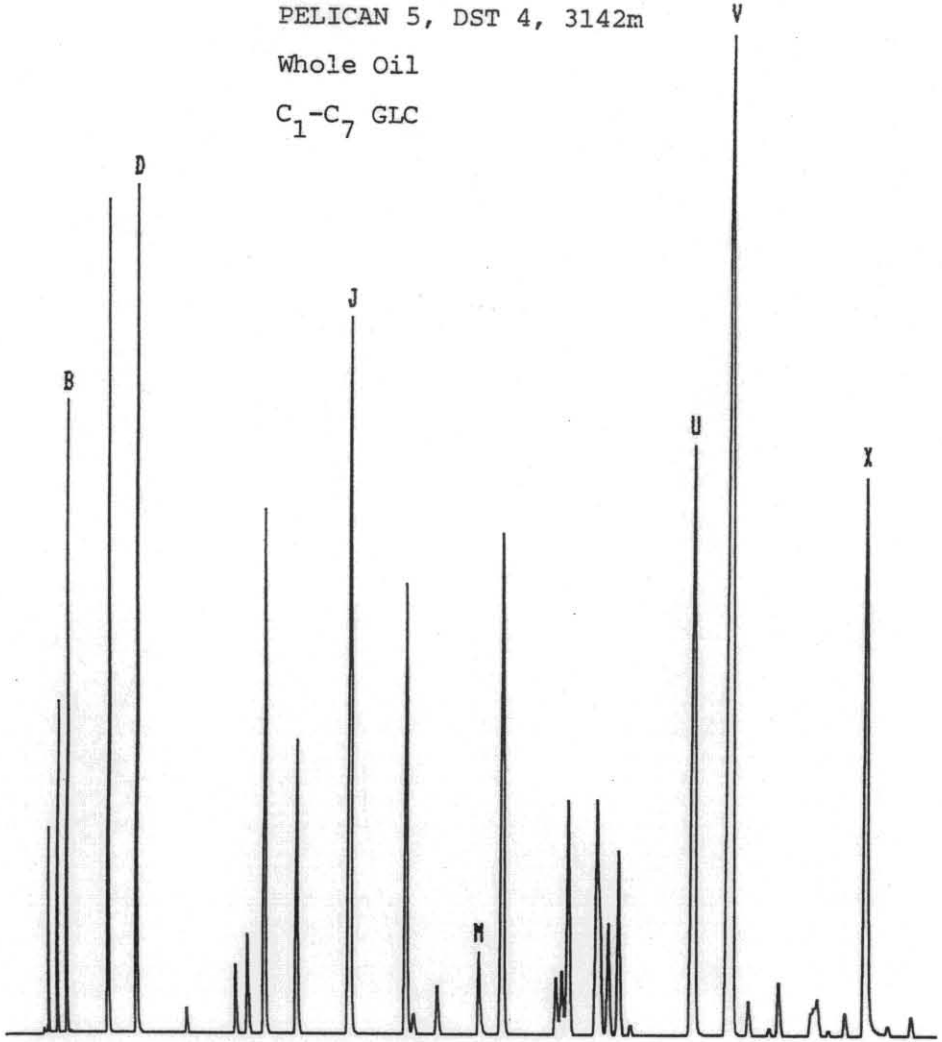


FIGURE 6

PELICAN 5, DST 4, 3142m

Whole Oil

C_1-C_7 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

TABLE 4

SUMMARY OF WHOLE OIL ANALYSIS

Date: 1986

Company: TASMANIAN MINES DEPT.

Sample: PELICAN 5, DST 4, 3142m

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	0.41
4	1.98
5	5.23
6	15.16
7	26.96
8	16.95
9	12.13
10	5.73
11	2.65
12	1.53
13	2.03
14	1.90
15	1.31
16	0.61
17	1.08
18	0.57
19	0.51
20	0.48
21	0.39
22	0.38
23	0.37
24	0.33
25	0.33
26	0.28
27	0.24
28	0.17
29	0.14
30	0.08
31	0.07

COMPOSITION OF C4-C7 FRACTION

	Compound	Rel. Wt %
A	isobutane	1.32
B	n-butane	2.70
C	isopentane	4.66
D	n-pentane	5.29
E	2,2-dimethylbutane	0.26
F	cyclopentane	0.65
G	2,3-dimethylbutane	1.00
H	2-methylpentane	5.00
I	3-methylpentane	2.93
J	n-hexane	8.80
K	methylcyclopentane	4.94
L	2,4-dimethylpentane	0.63
M	benzene	1.07
N	cyclohexane	6.73
O	1,1-dimethylcyclopentane	0.85
P	2-methylhexane	3.25
Q	3-methylhexane	4.51
R	1 cis-3-dimethylcyclopentane	1.44
S	1 trans-3-dimethylcyclopentane	2.23
T	1 trans-2-dimethylcyclopentane	0.19
U	n-heptane	9.84
V	methylcyclohexane	21.48
W	1 cis-2-dimethylcyclopentane	0.54
X	toluene	9.70

CALCULATED DATA - C12+ FRACTION

Pristane/Phytane	6.12
Pristane/n-C17	0.88
Phytane/n-C18	0.15
TMTD/Pristane	0.61
(C21+C22)/(C28+C29)	2.40

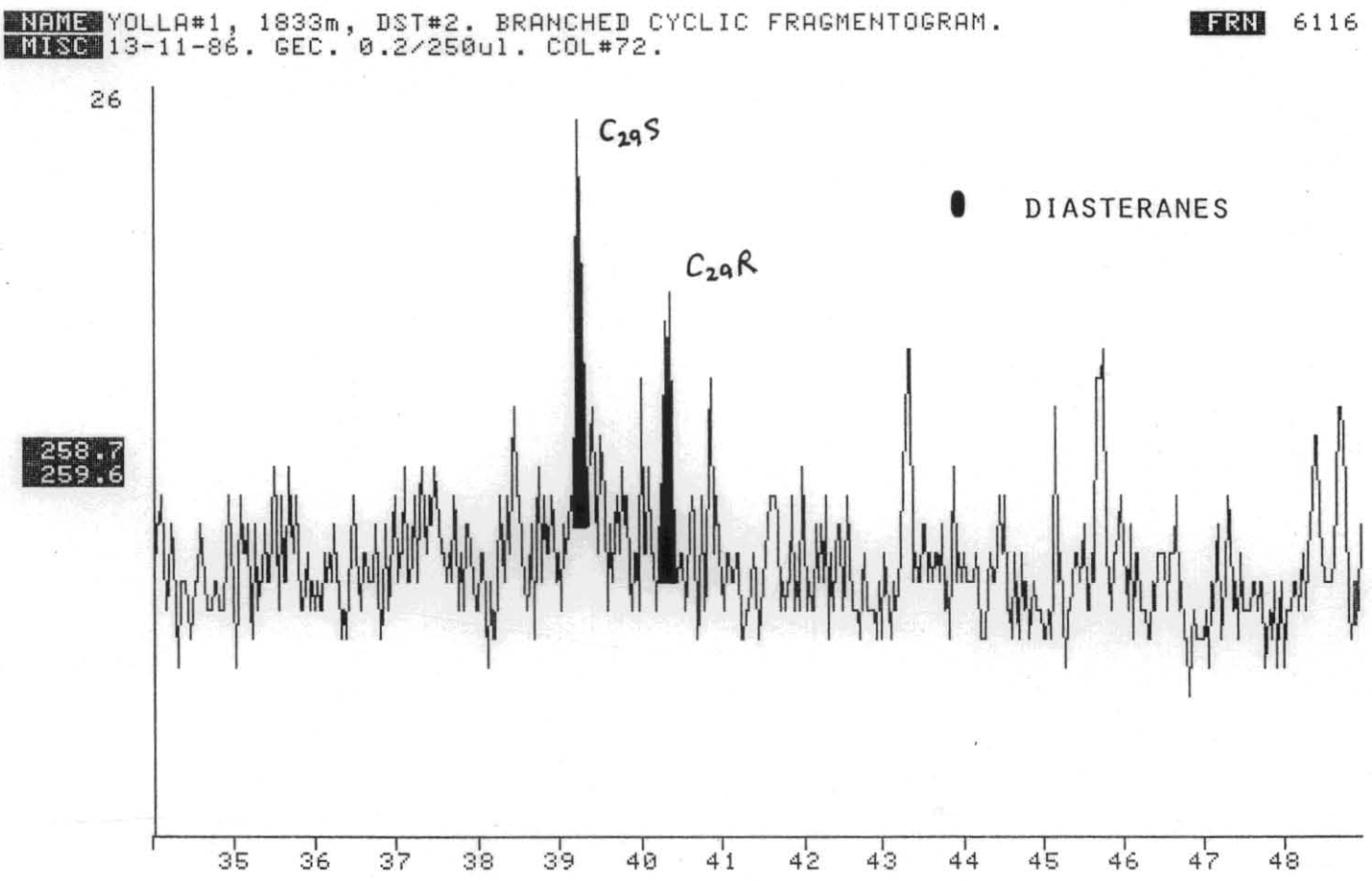
CALCULATED DATA - C4-C7 FRACTION

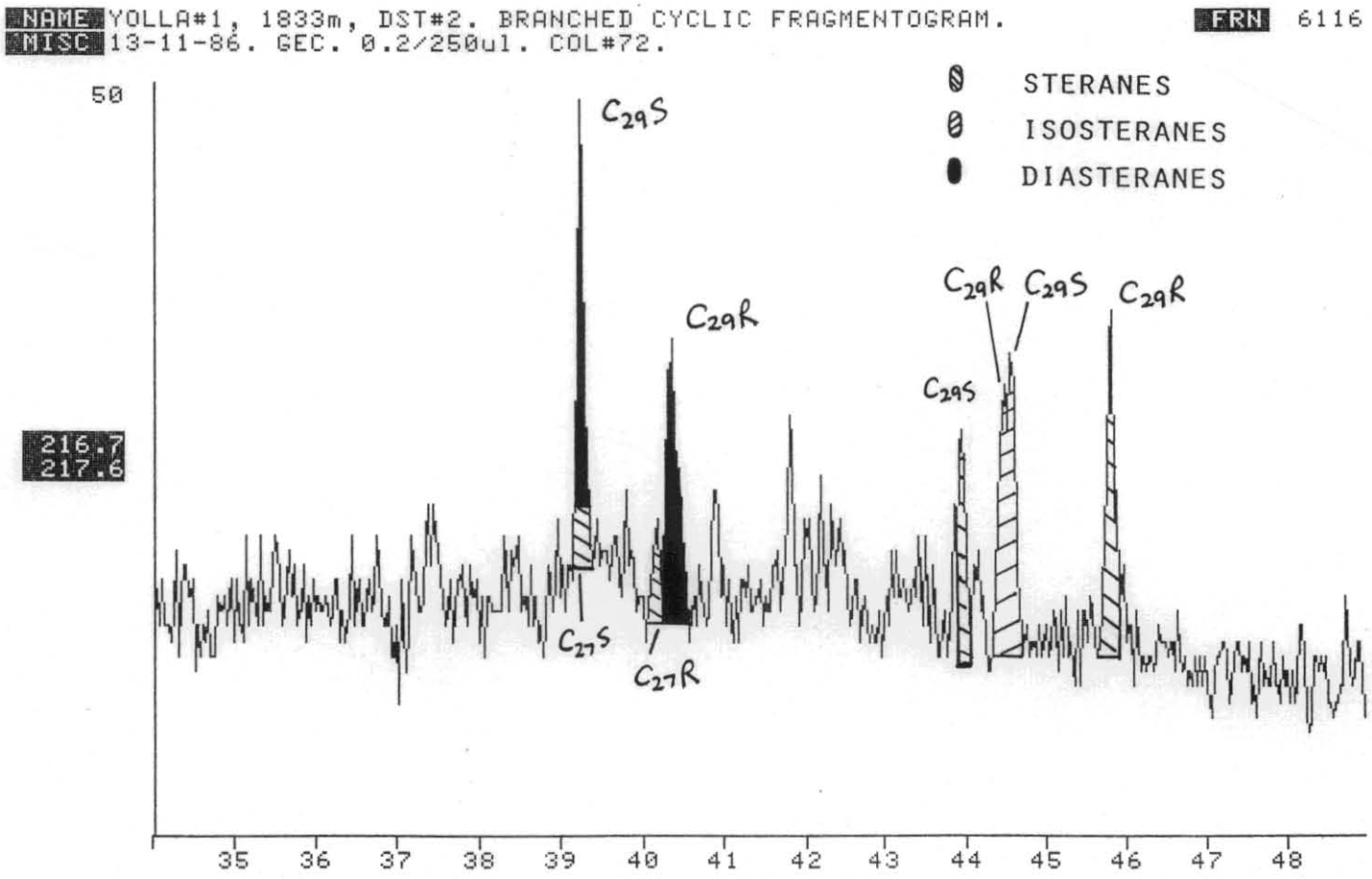
Paraffin Index I	2.02
Paraffin Index II	19.47
N/K (Maturity)	1.36
C/D (Maturity)	0.88
J/K (Maturity)	1.78
I/M (Water washing)	2.74
I/J (Biodegradation)	0.33

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

FIGURE 7


NAME YOLLA#1, 1833m, DST#2. BRANCHED CYCLIC FRAGMENTOGRAM.
FRN 6116
MISC 13-11-86. GEC. 0.2/250ul. COL#72.
26
C29S
C29R
DIASTERANES
258.7
259.6
35 36 37 38 39 40 41 42 43 44 45 46 47 48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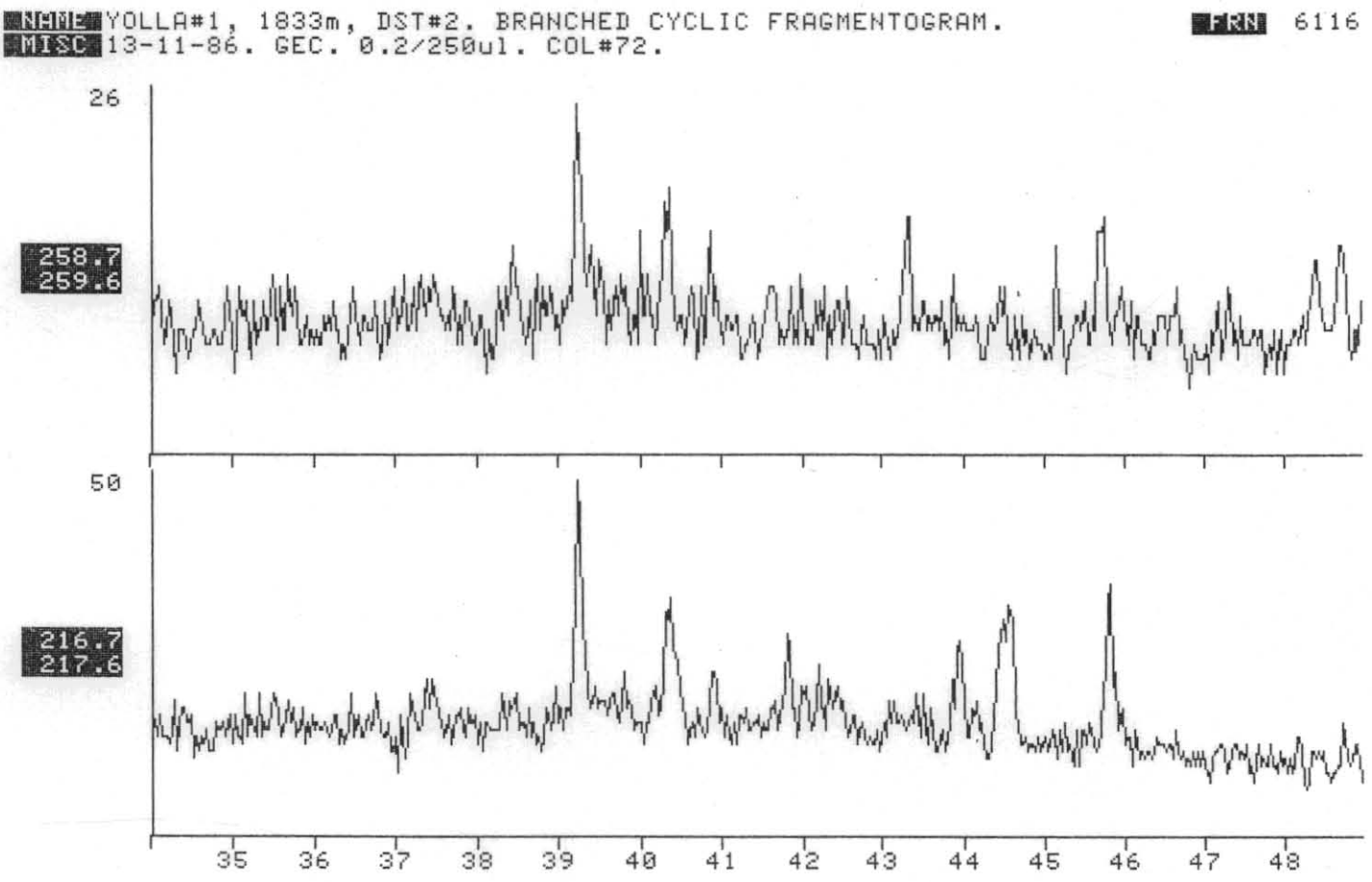
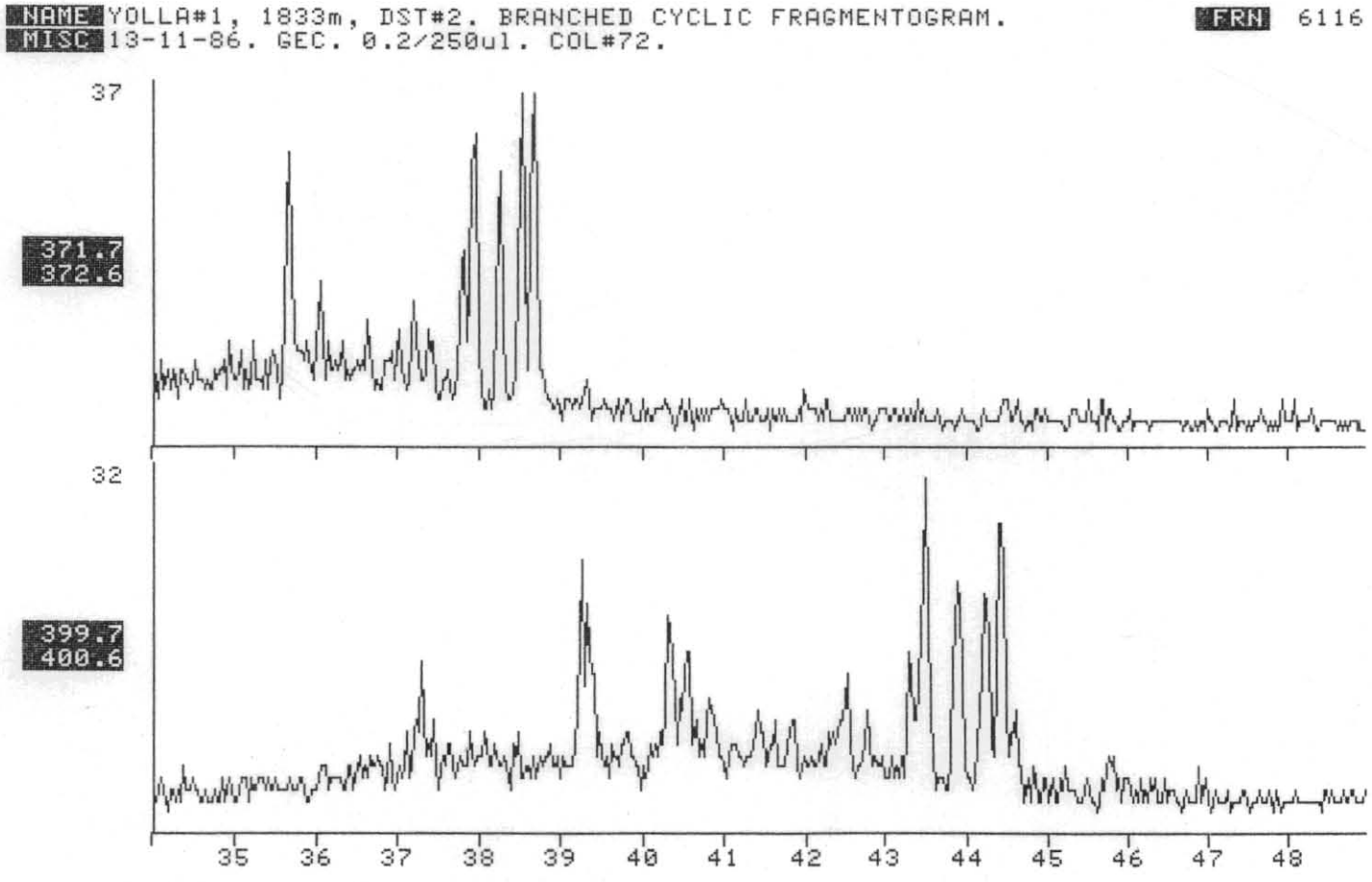
FRN 6116
MISC 13-11-86. GEC. 0.2/250ul. COL#72.
50
STERANES
ISOSTERANES
DIASTERANES
C29S
C29R
C29R C29S C29R
C29S
C27S
C27R
216.7
217.6
35 36 37 38 39 40 41 42 43 44 45 46 47 48

5 cm

FIGURE 8



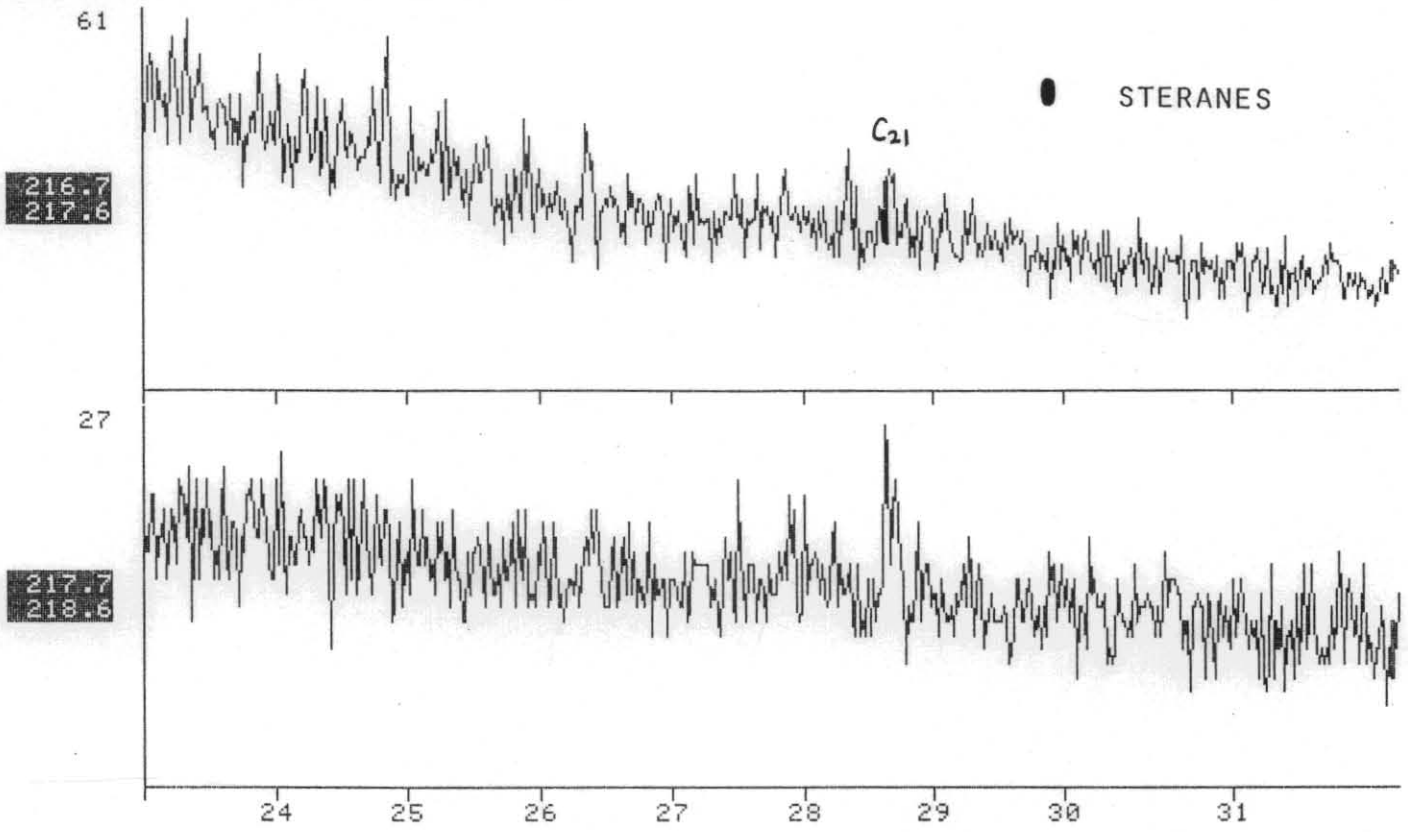


13-15

5 cm

FIGURE 9

NAME YOLLA#1, 1833m, DST#2. BRANCHED CYCLIC FRAGMENTOGRAM. FRN 6116
MISC 13-11-86. GEC. 0.2/250ul. COL#72.



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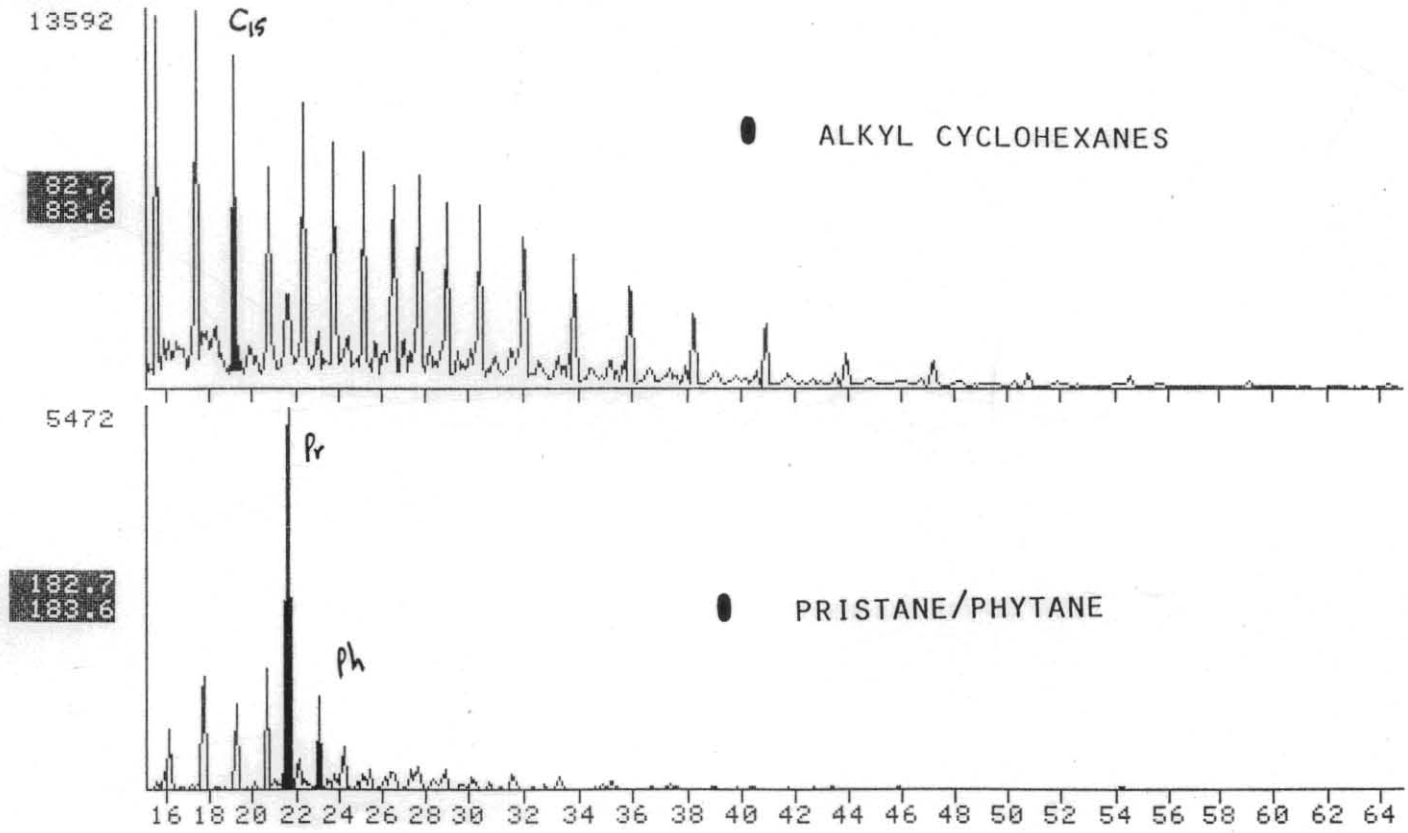
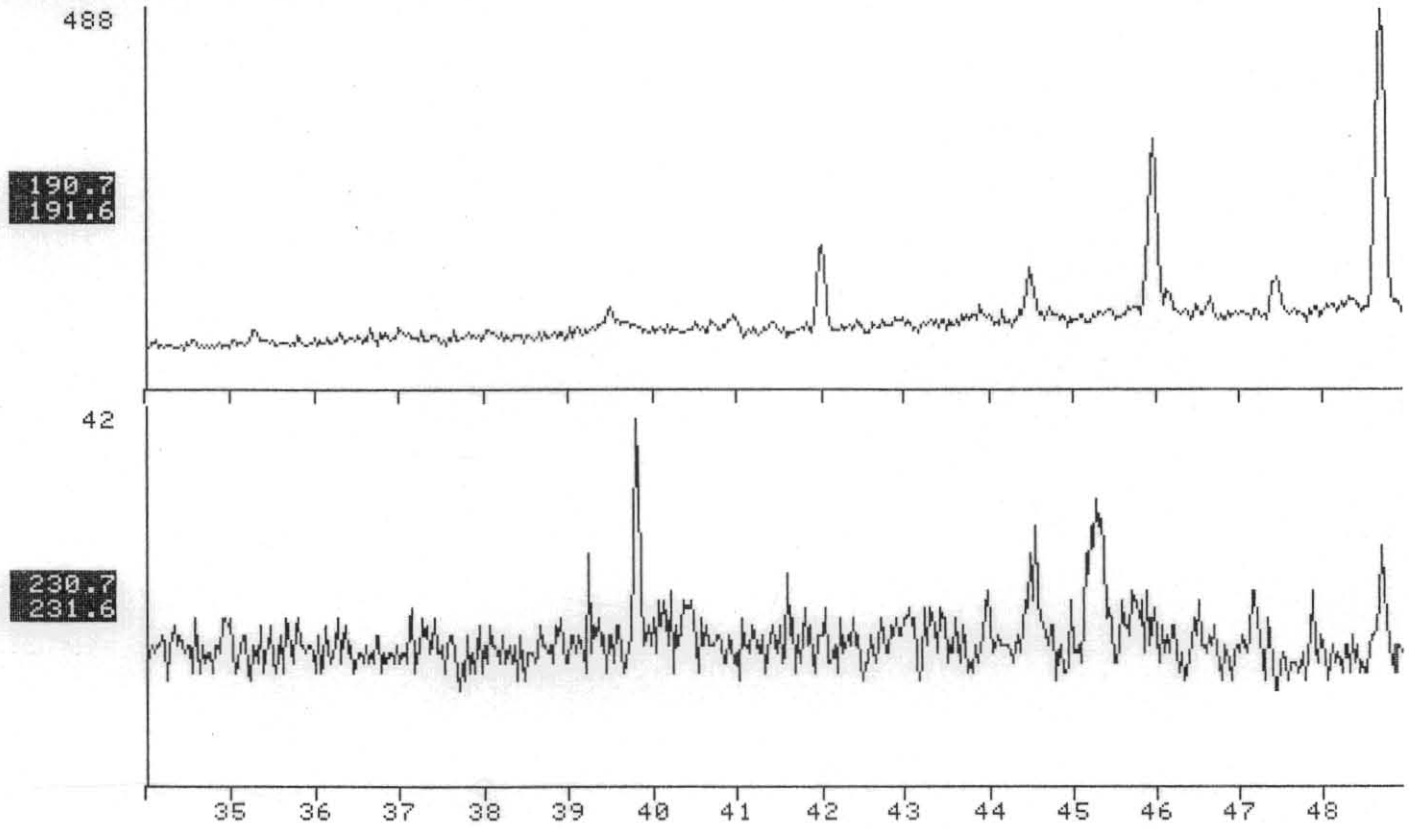
MISC 13-11-86. GEC. 0.2/250ul. COL#72.



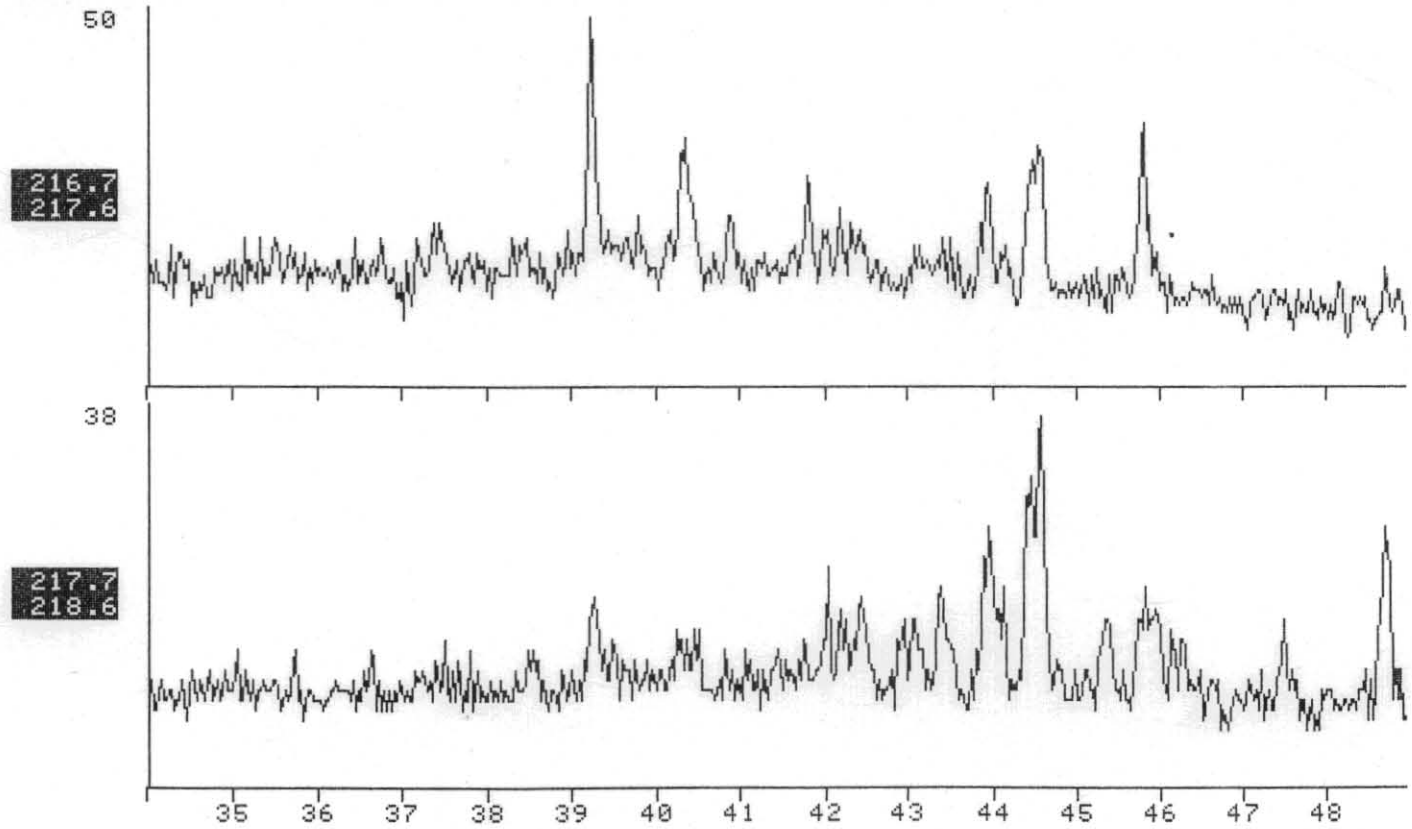
5 cm

FIGURE 10

NAME YOLLA#1, 1833m, DST#2. BRANCHED CYCLIC FRAGMENTOGRAM. FRN 6116
MISC 13-11-86. GEC. 0.2/250ul. COL#72.



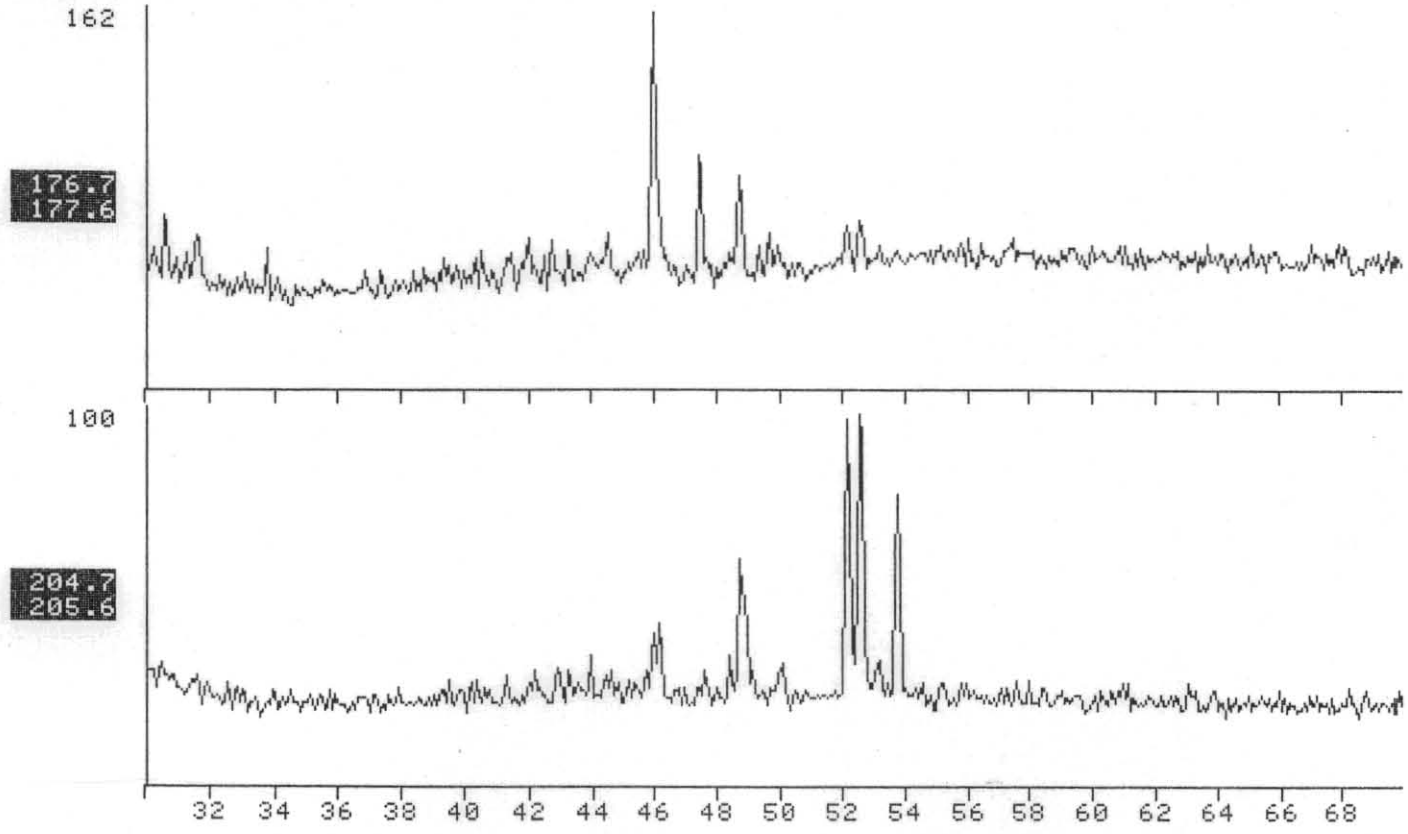
NAME YOLLA#1, 1833m, DST#2. BRANCHED CYCLIC FRAGMENTOGRAM. FRN 6116
MISC 13-11-86. GEC. 0.2/250ul. COL#72.



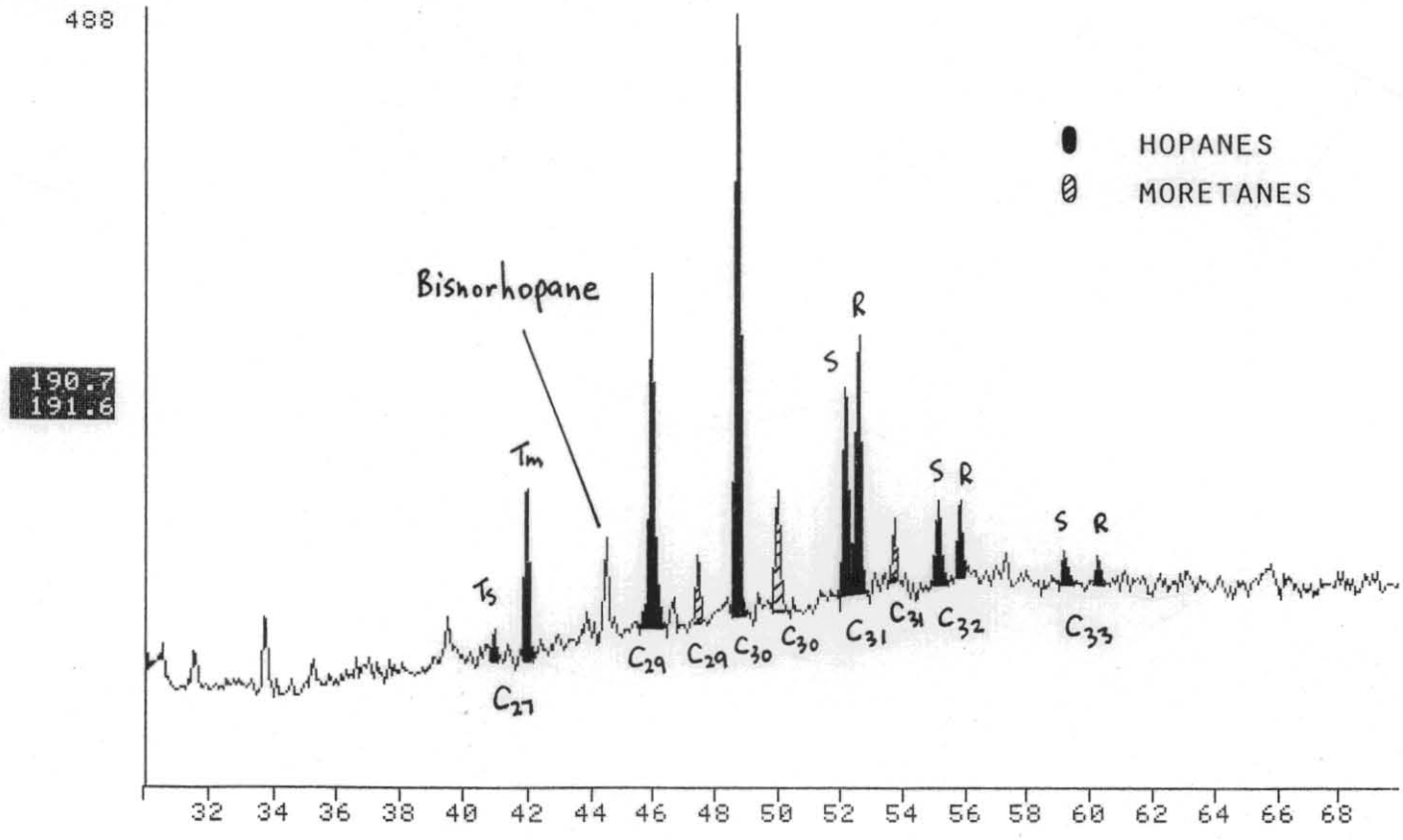
5 cm

FIGURE 11

NAME YOLLA#1, 1833m, DST#2. BRANCHED CYCLIC FRAGMENTOGRAM. FRN 6116
MISC 13-11-86. GEC. 0.2/250ul. COL#72.

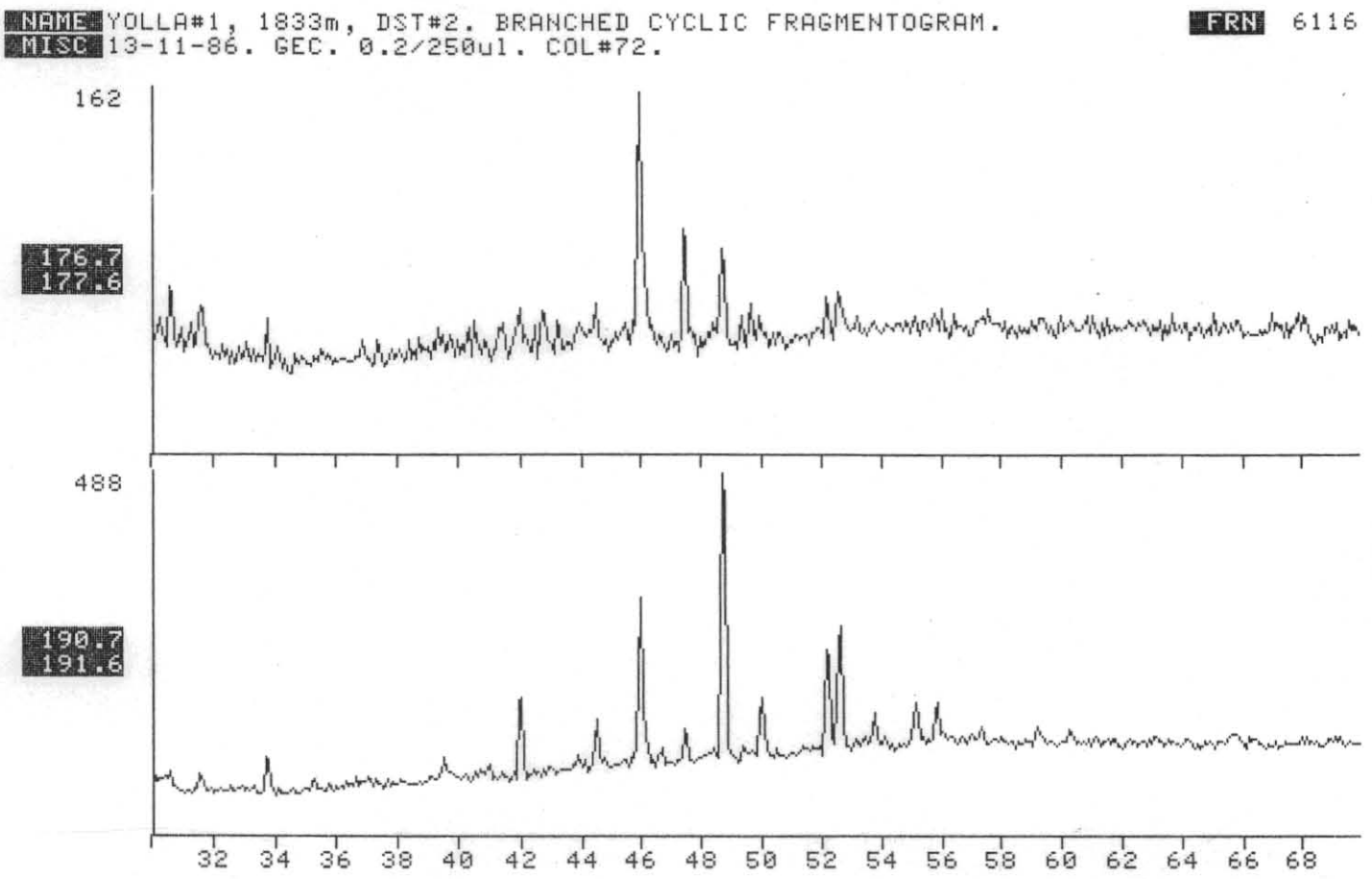


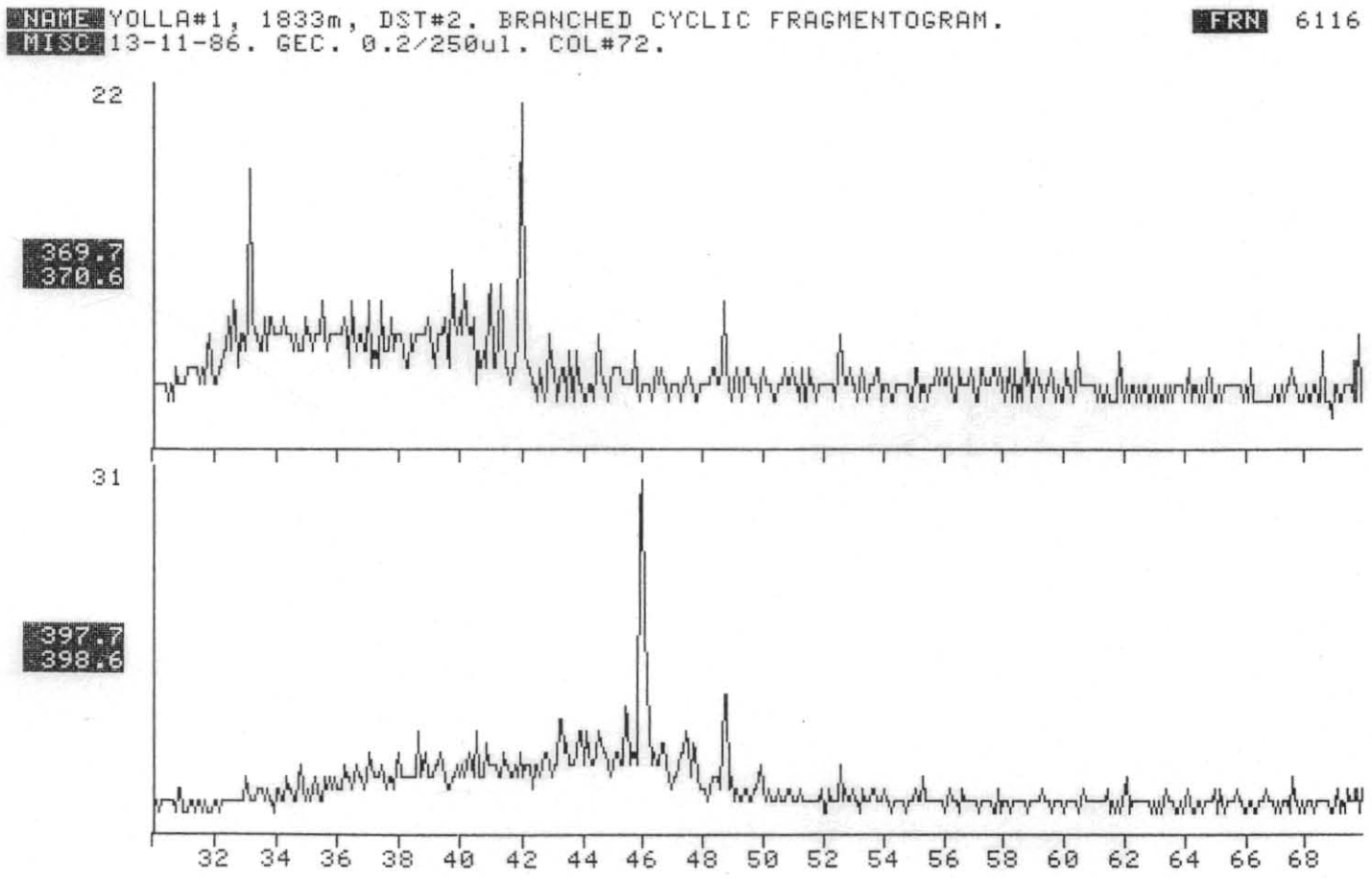
NAME YOLLA#1, 1833m, DST#2. BRANCHED CYCLIC FRAGMENTOGRAM. FRN 6116
MISC 13-11-86. GEC. 0.2/250ul. COL#72.



5 cm

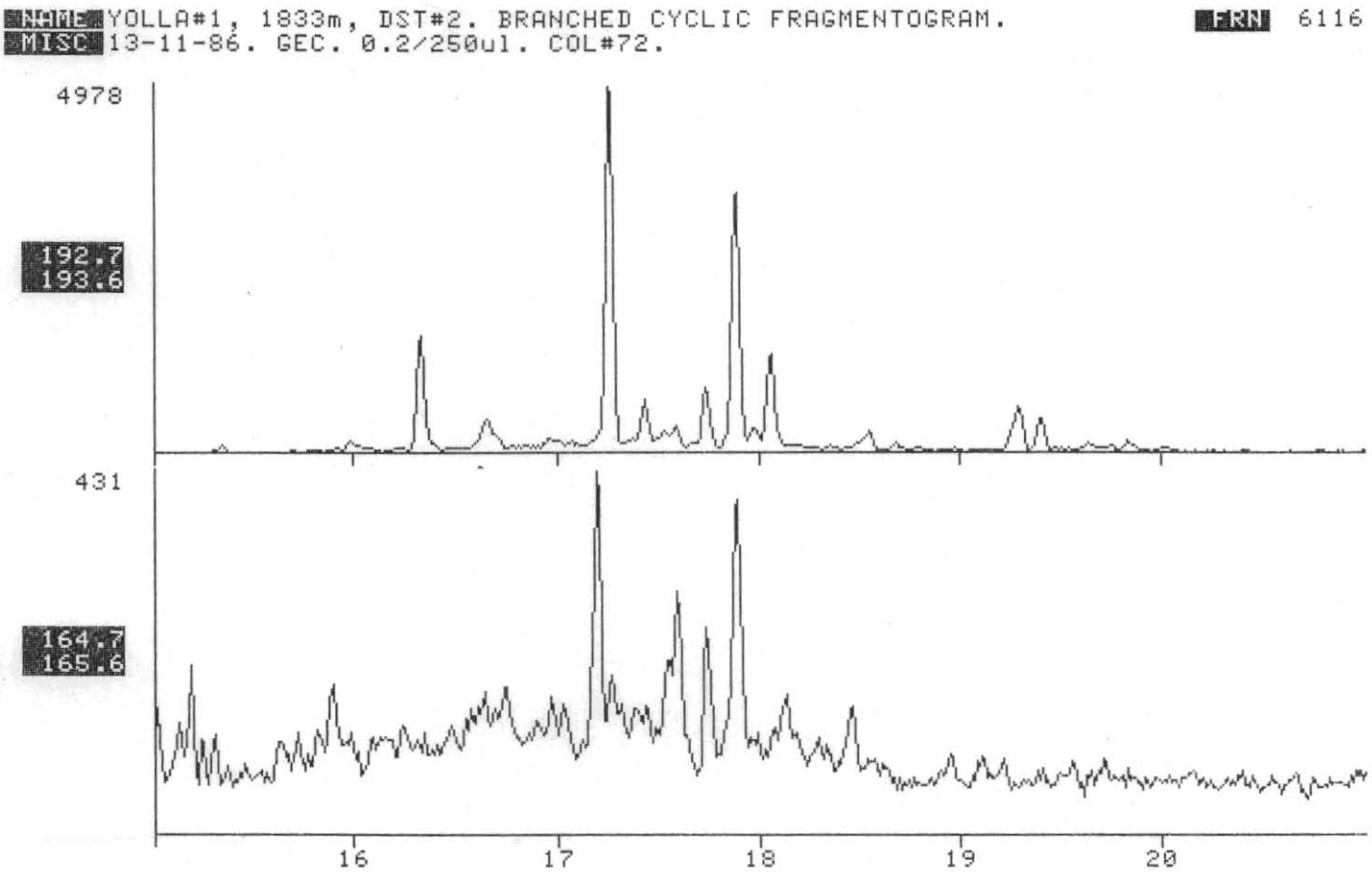
FIGURE 12





5 cm

FIGURE 13


NAME YOLLA#1, 1833m, DST#2. BRANCHED CYCLIC FRAGMENTOGRAM.
FRN 6116
MISC 13-11-86. GEC. 0.2/250ul. COL#72.
4978
192.7
193.6
431
164.7
165.6
16
17
18
19
20

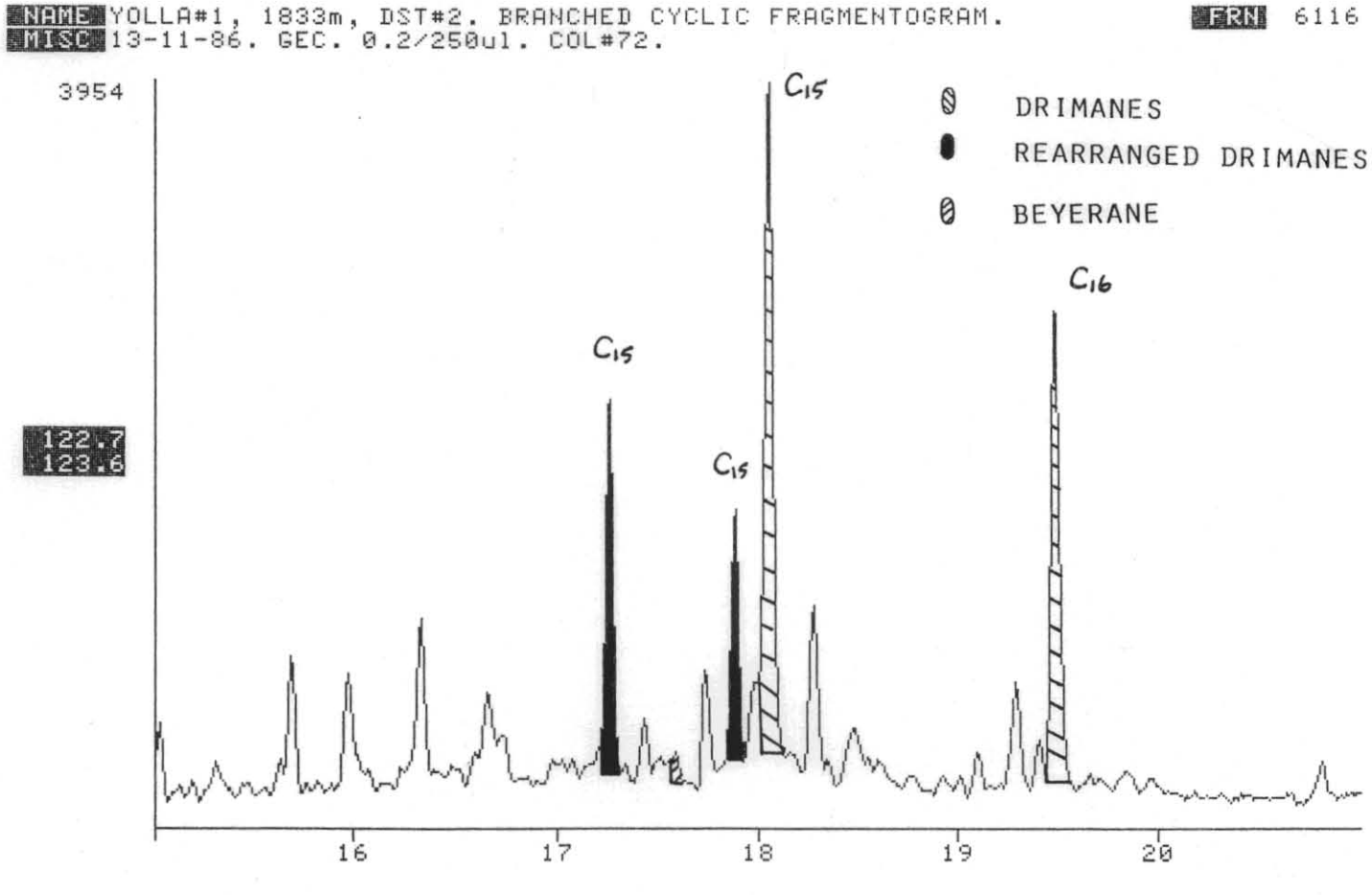
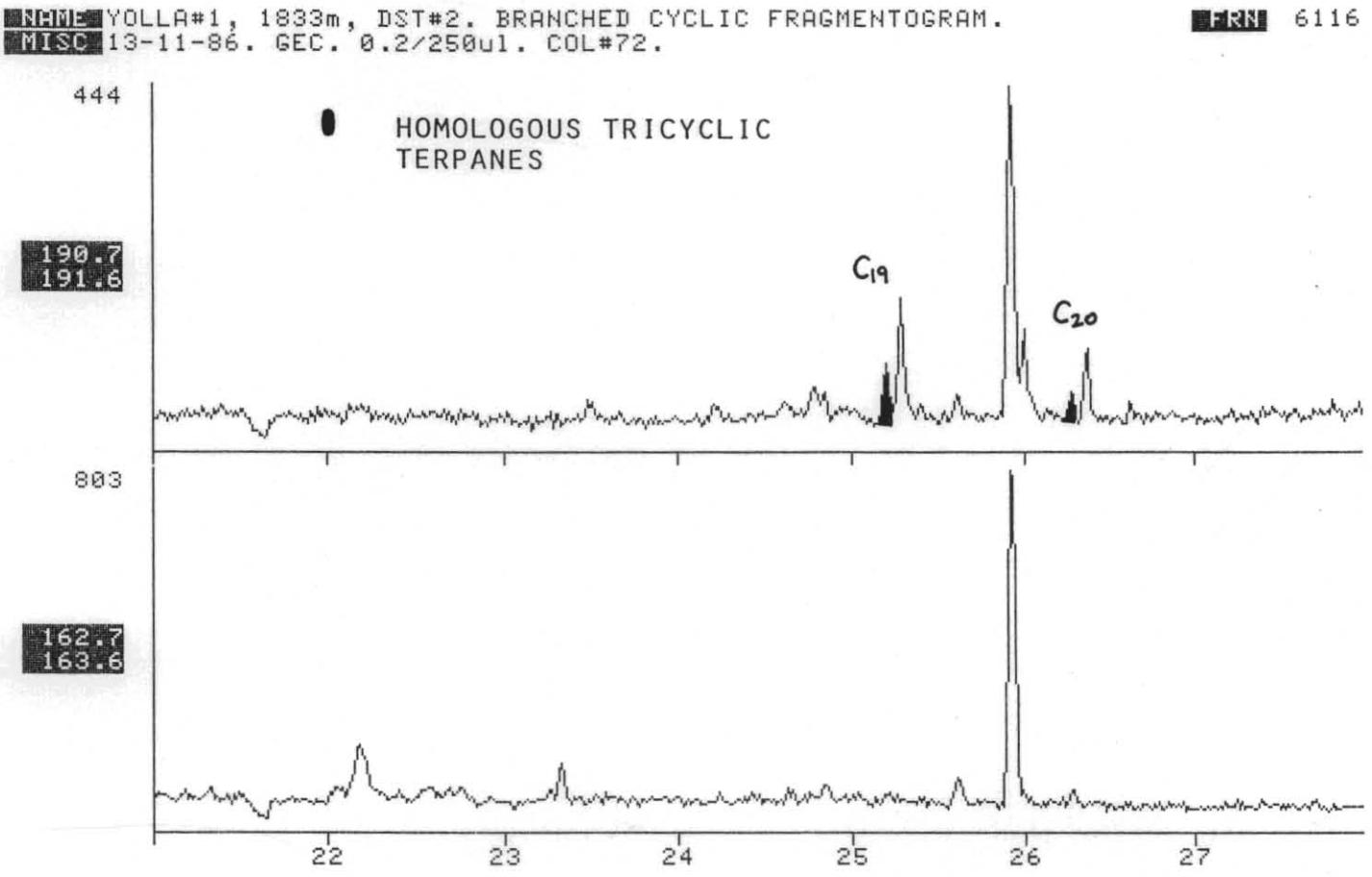
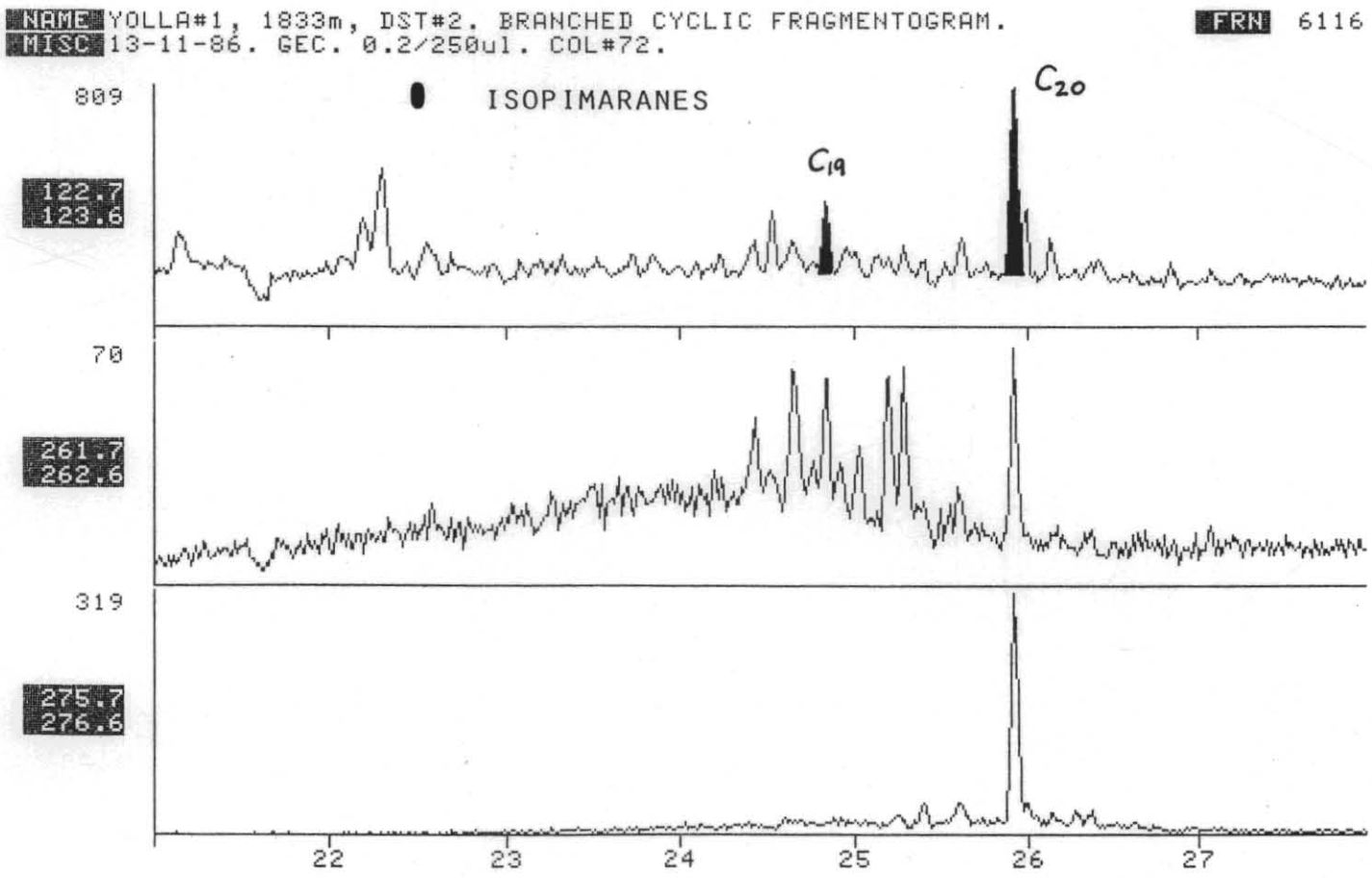

NAME YOLLA#1, 1833m, DST#2. BRANCHED CYCLIC FRAGMENTOGRAM.
FRN 6116
MISC 13-11-86. GEC. 0.2/250ul. COL#72.
3954
122.7
123.6
C15
C15
C15
C16
DRIMANES
REARRANGED DRIMANES
BEYERANE
16
17
18
19
20
5 cm

FIGURE 14

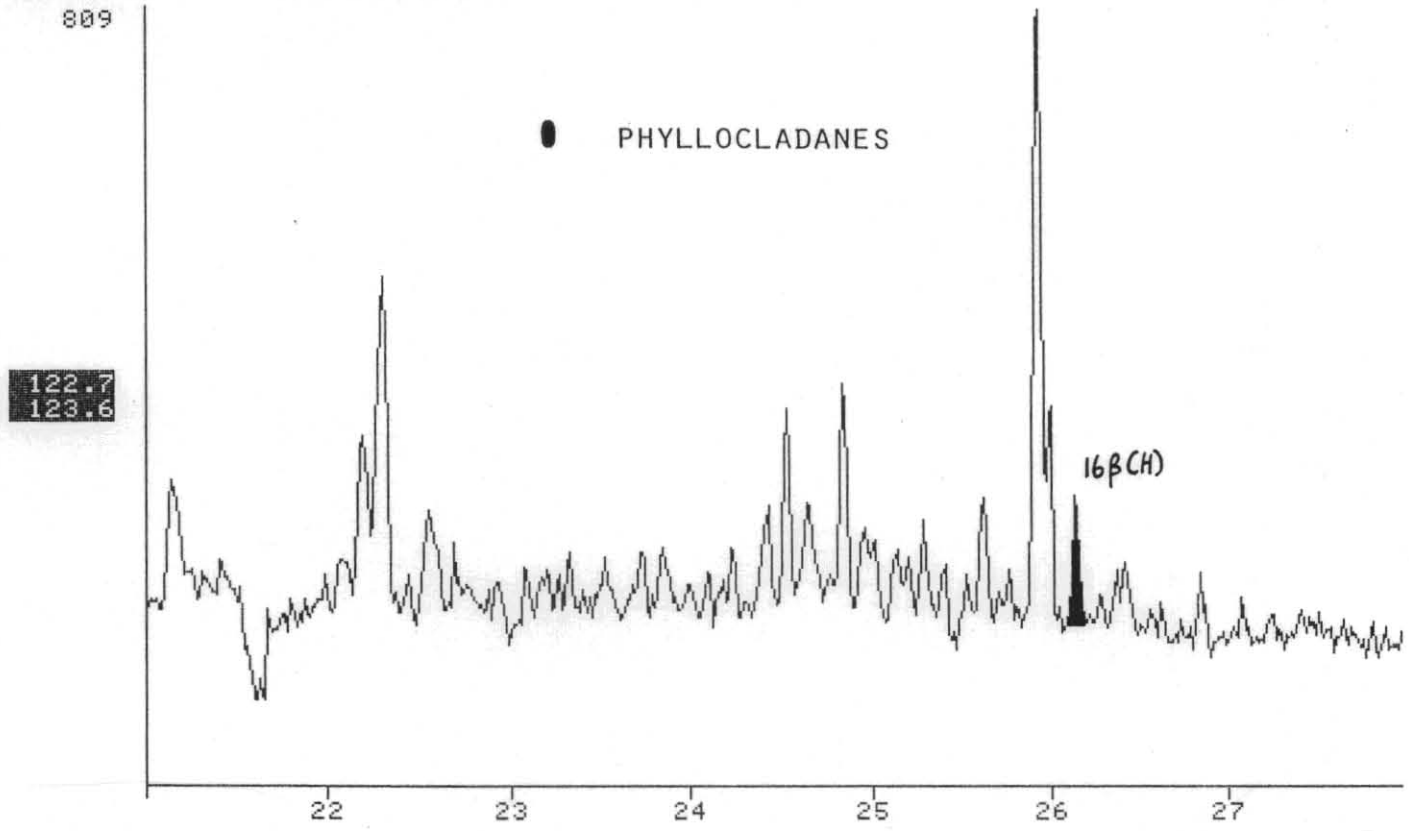




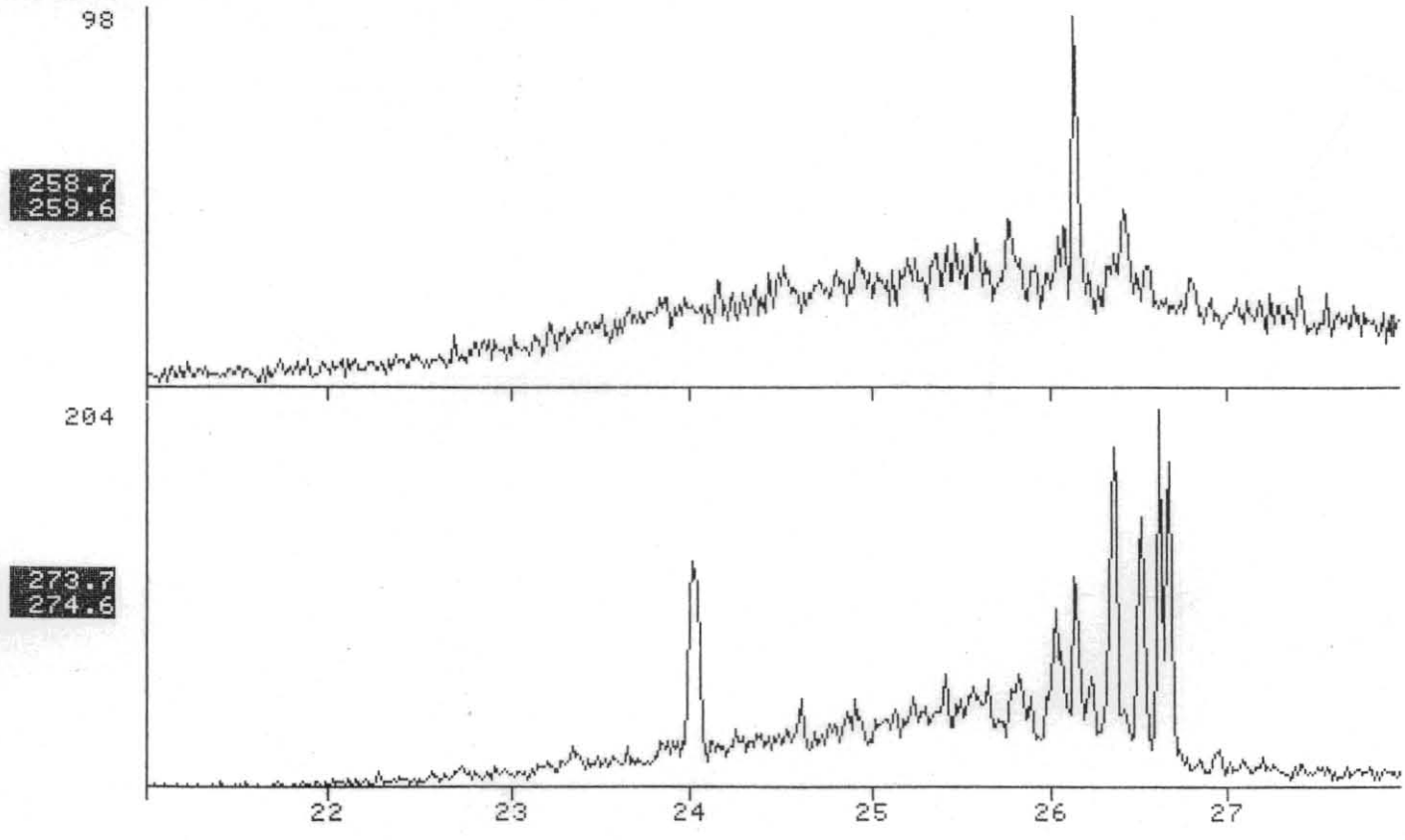
5 cm

FIGURE 15

NAME YOLLA#1, 1833m, DST#2. BRANCHED CYCLIC FRAGMENTOGRAM. FRN 6116
MISC 13-11-86. GEC. 0.2/250ul. COL#72.



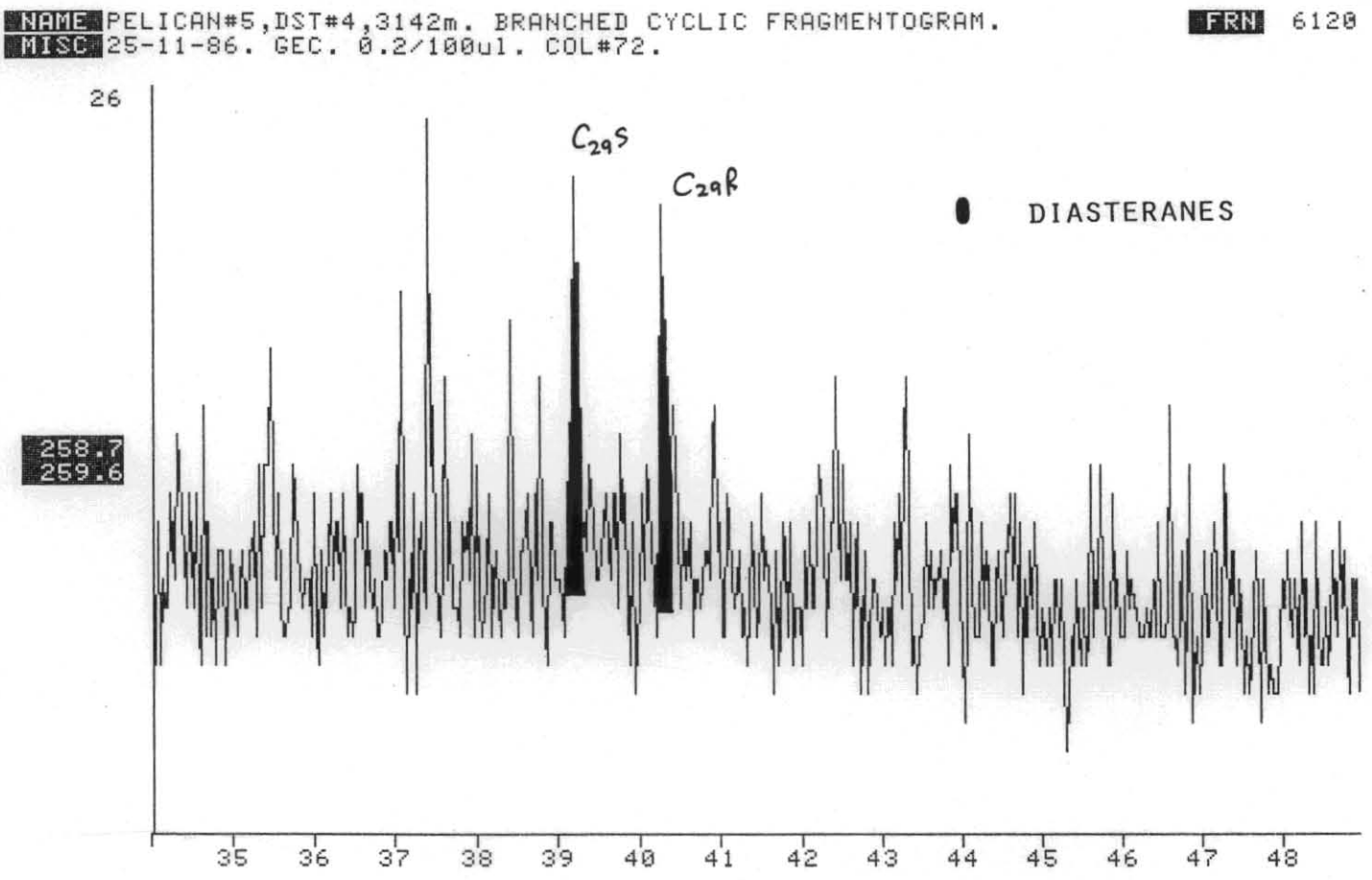
NAME YOLLA#1, 1833m, DST#2. BRANCHED CYCLIC FRAGMENTOGRAM. FRN 6116
MISC 13-11-86. GEC. 0.2/250ul. COL#72.

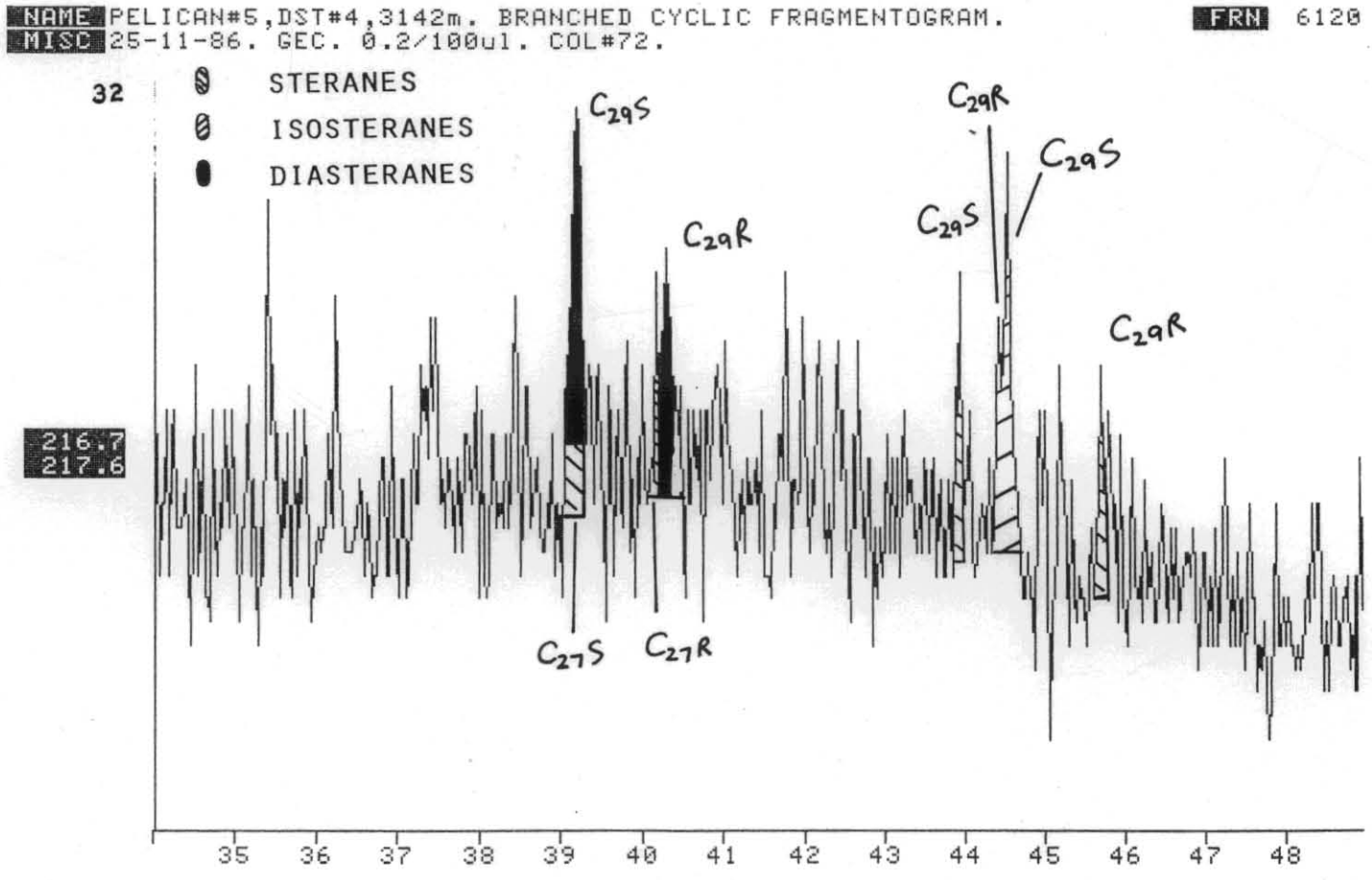


13-22

5 cm

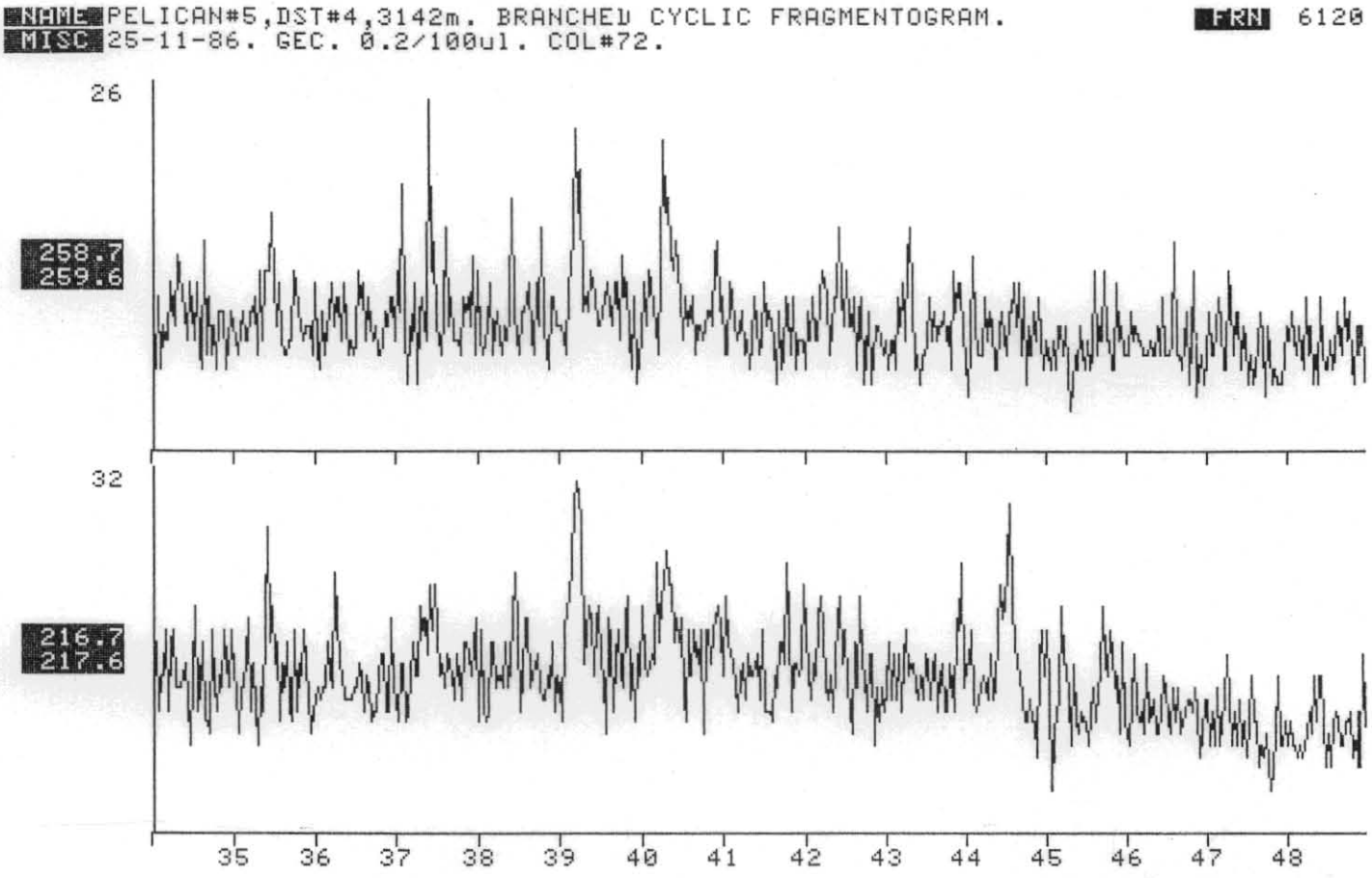
FIGURE 16

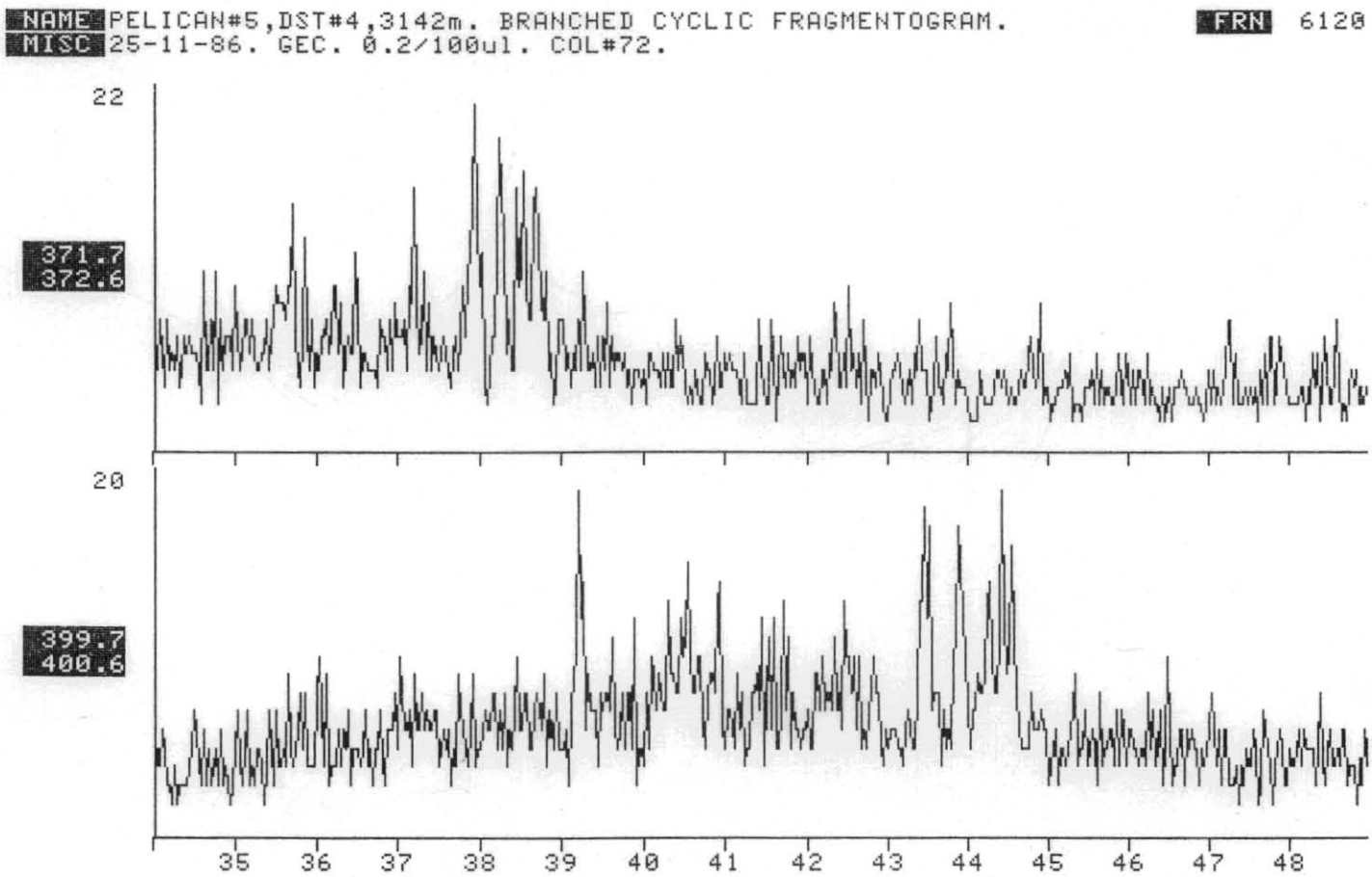




5 cm

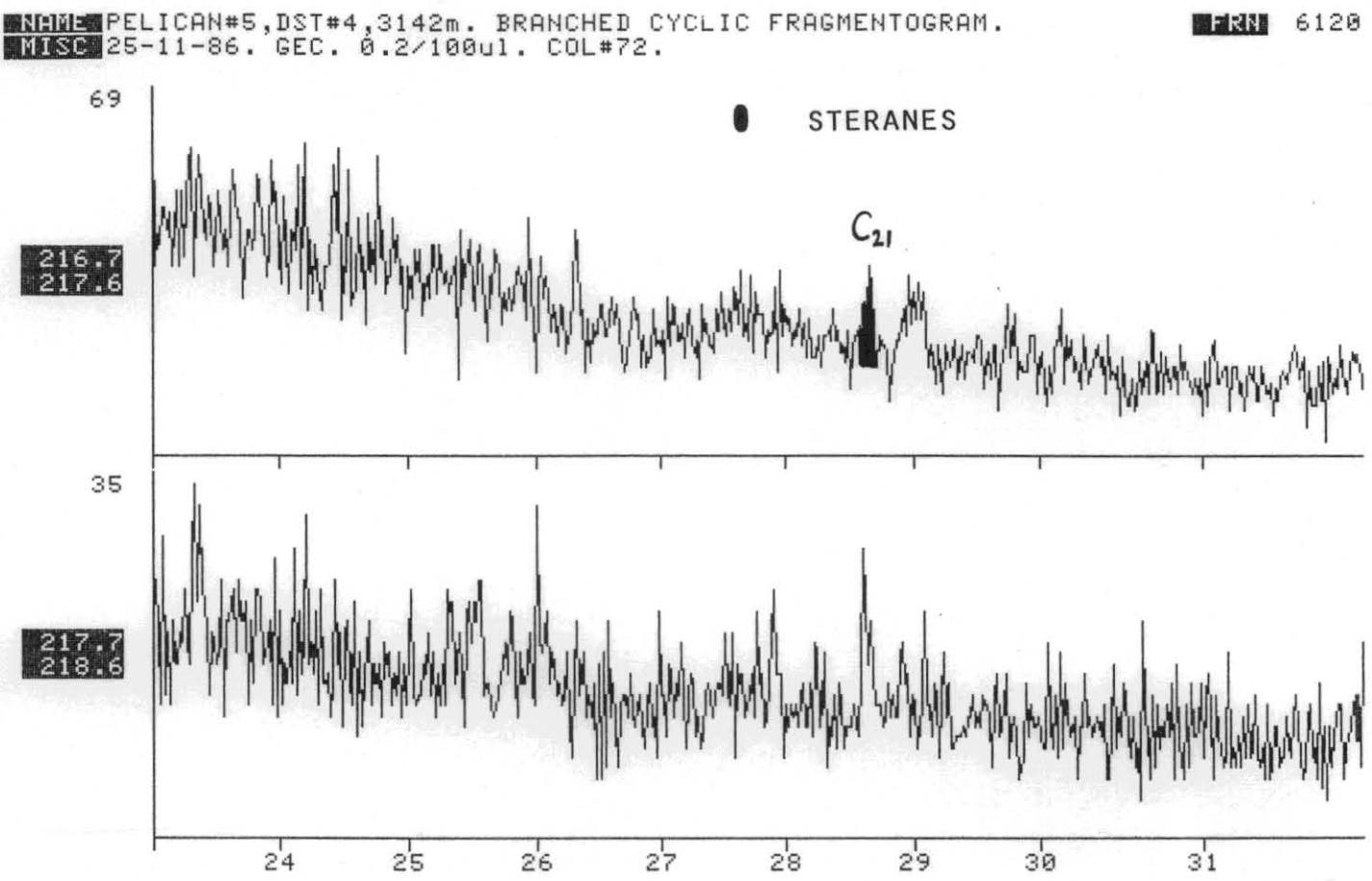
FIGURE 17

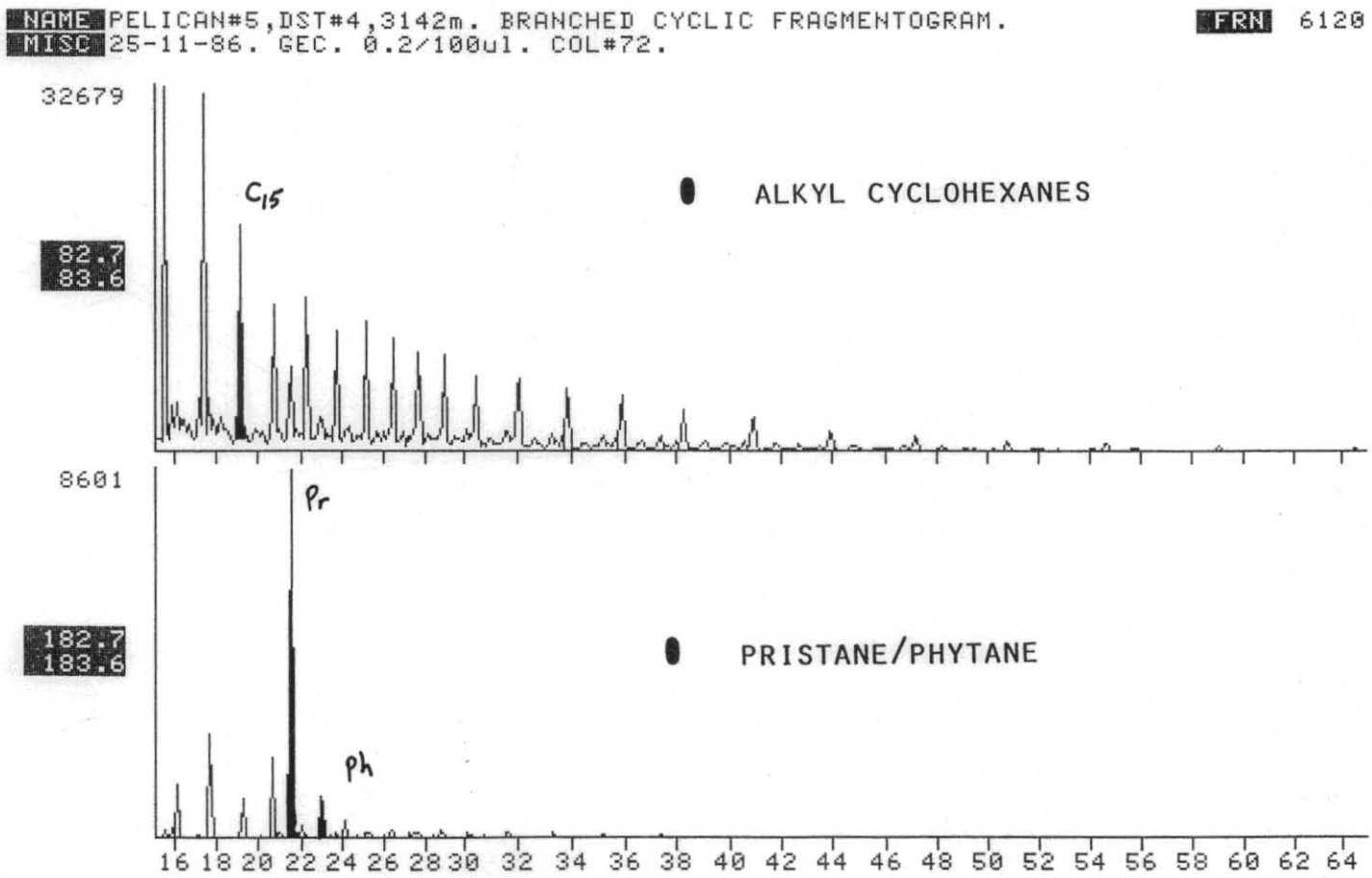




5 cm

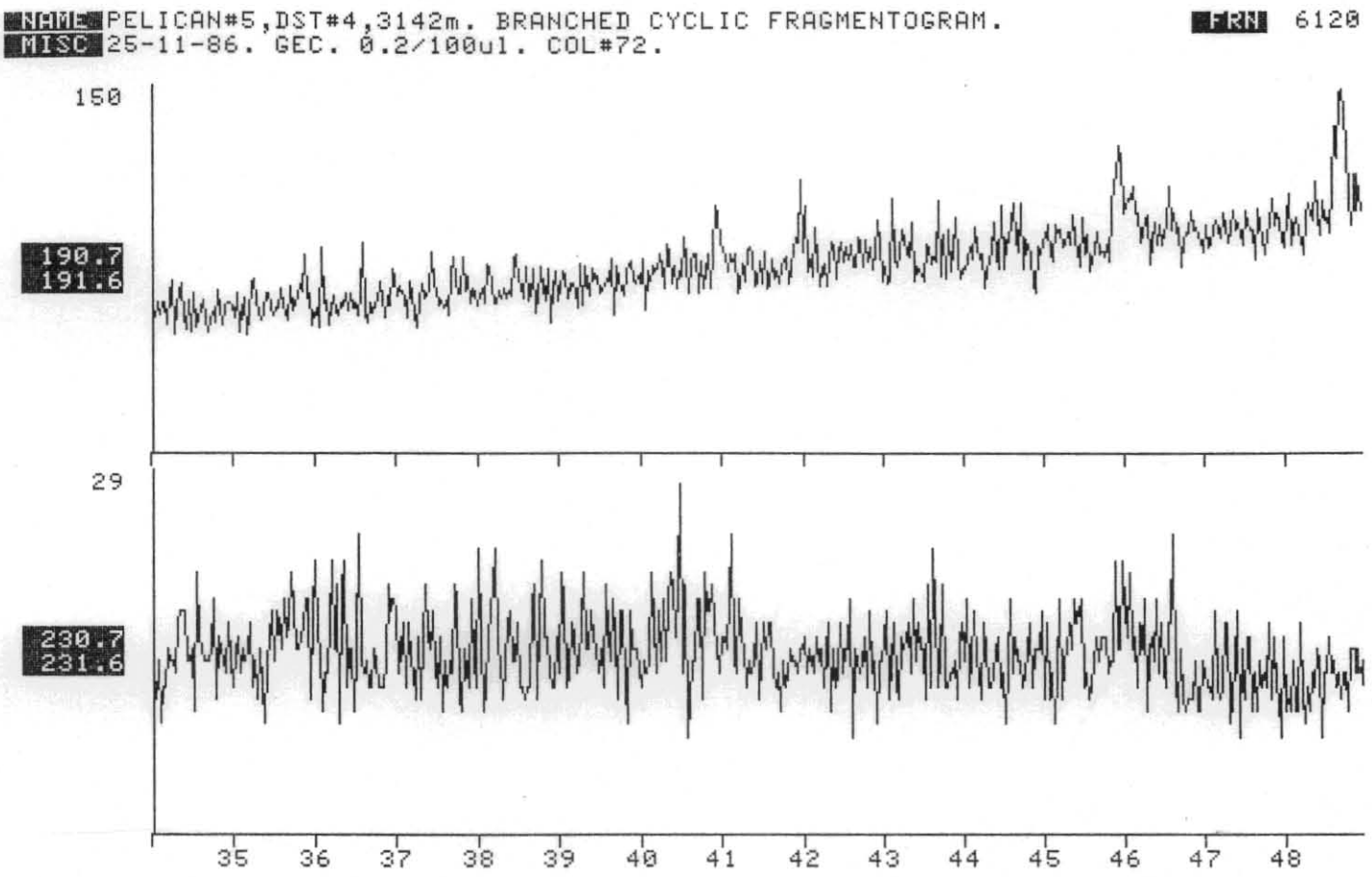
FIGURE 18

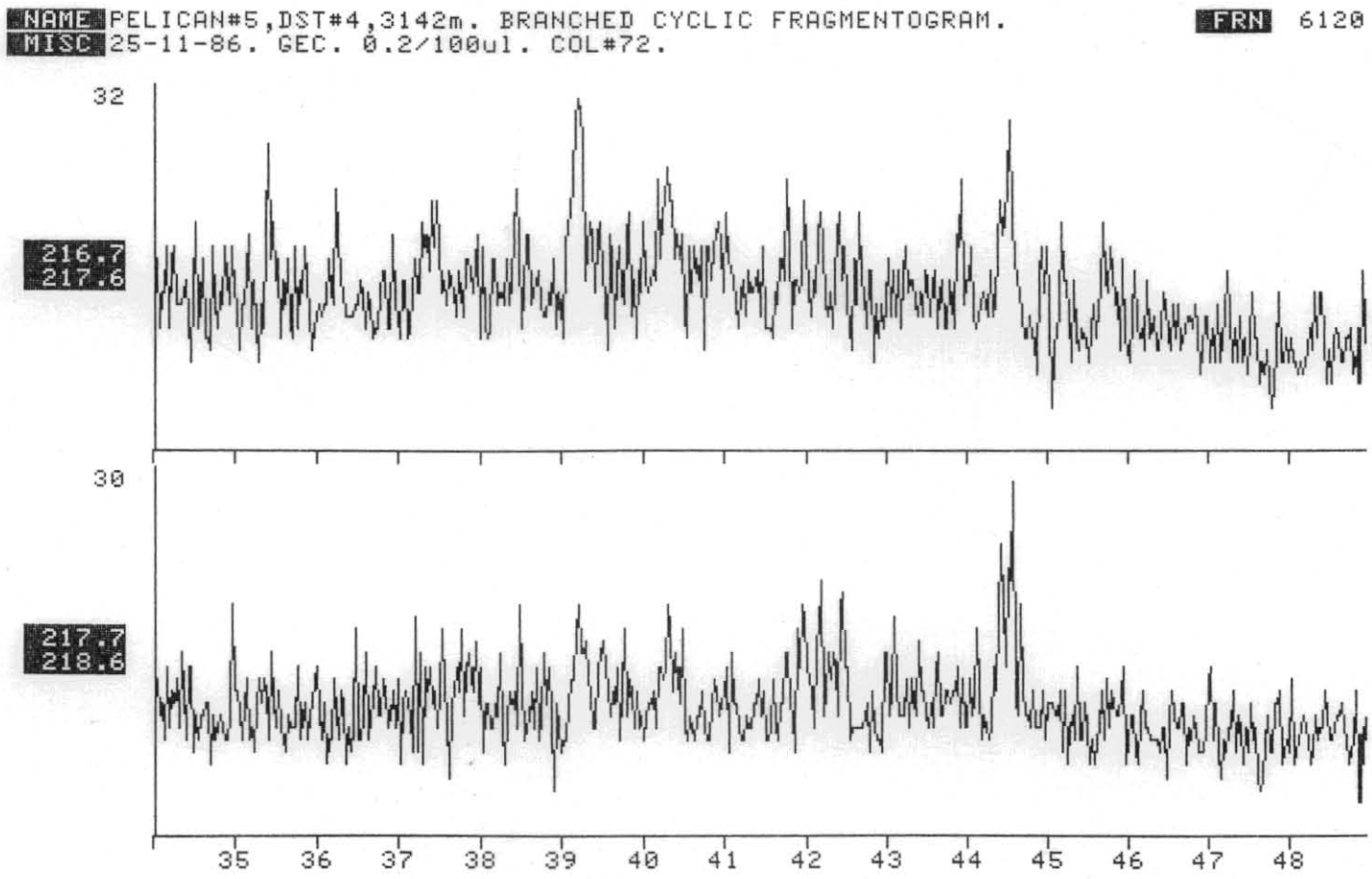




5 cm

FIGURE 19

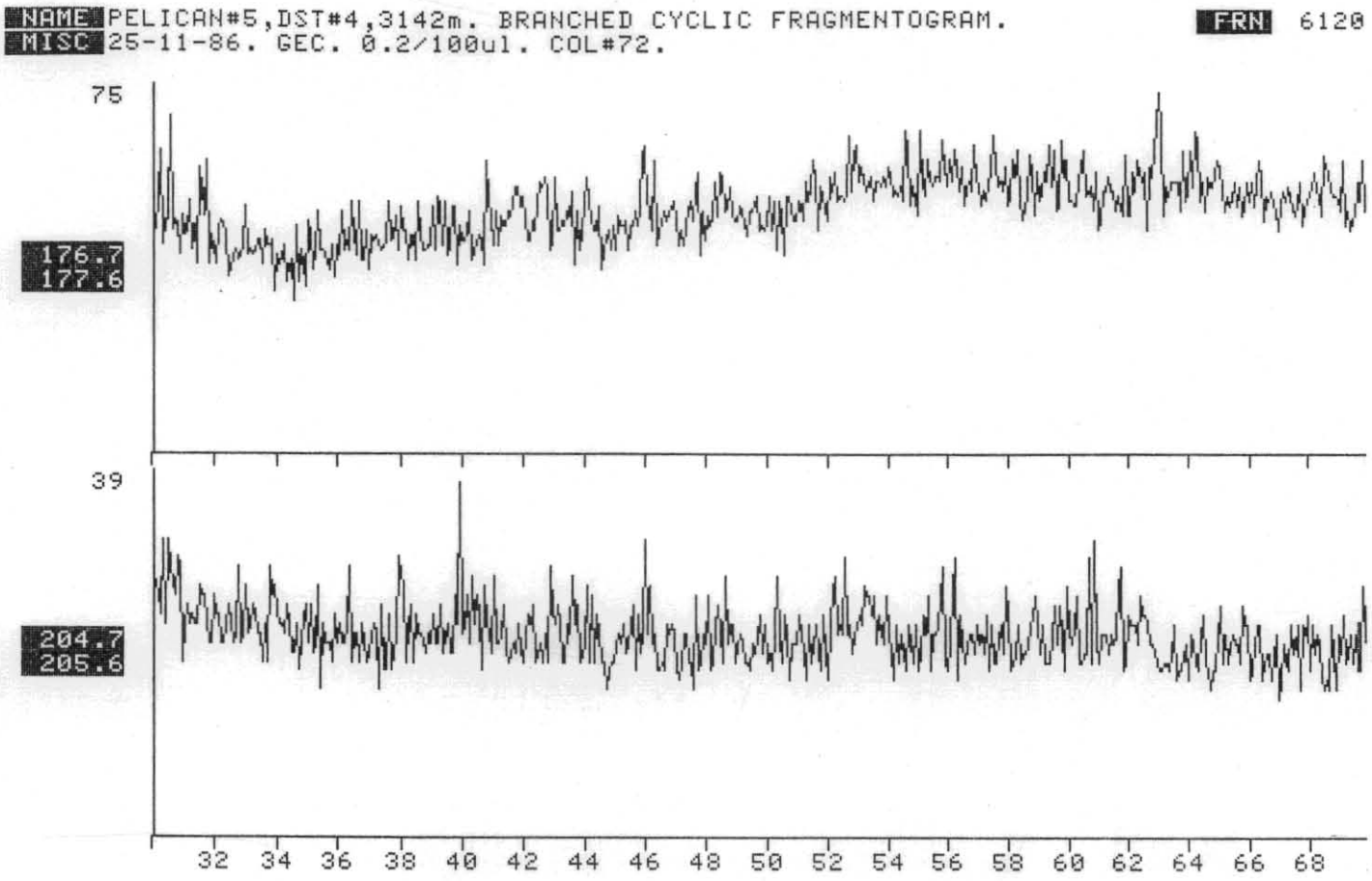


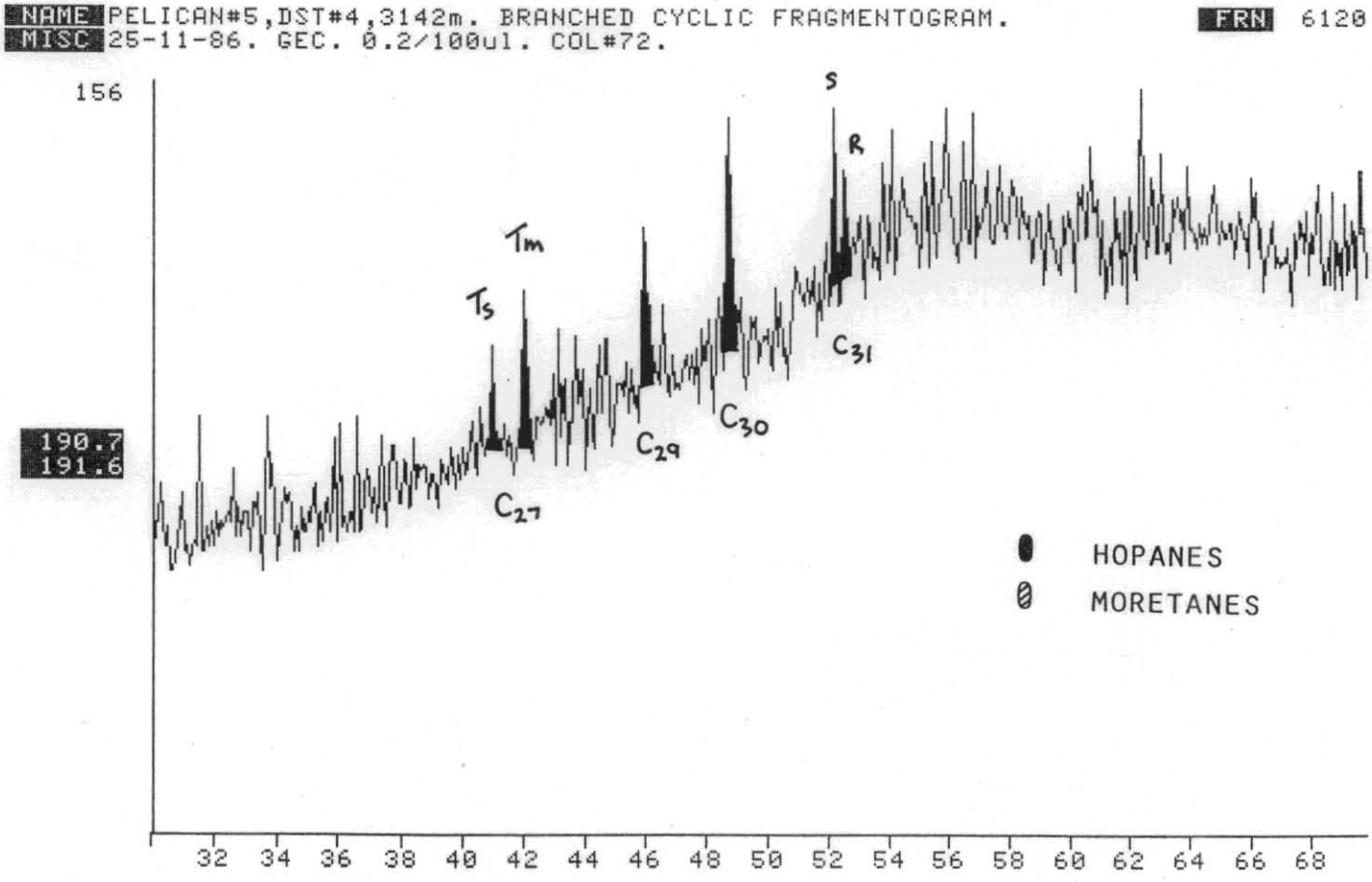


13-26

5 cm

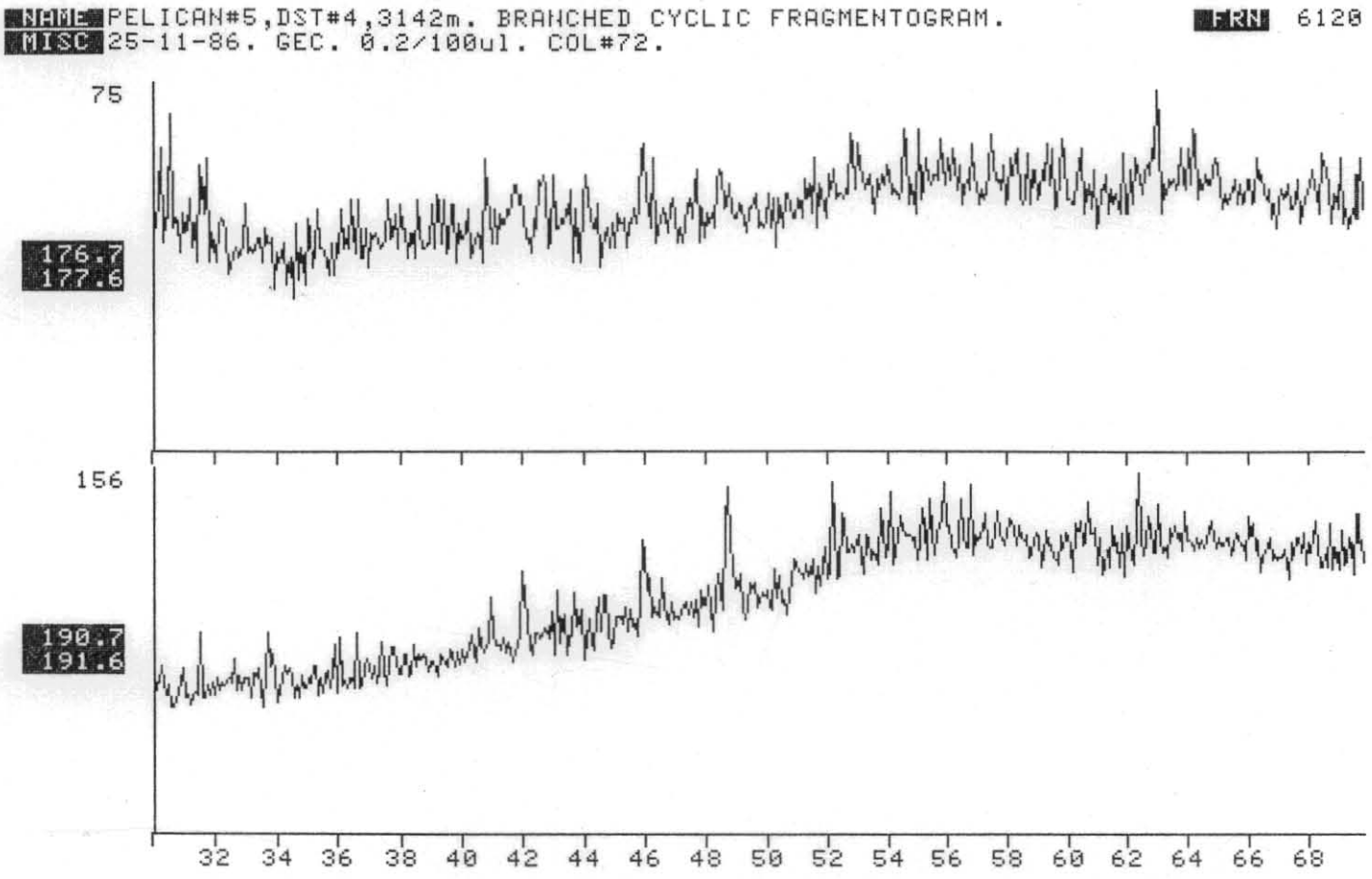
FIGURE 20

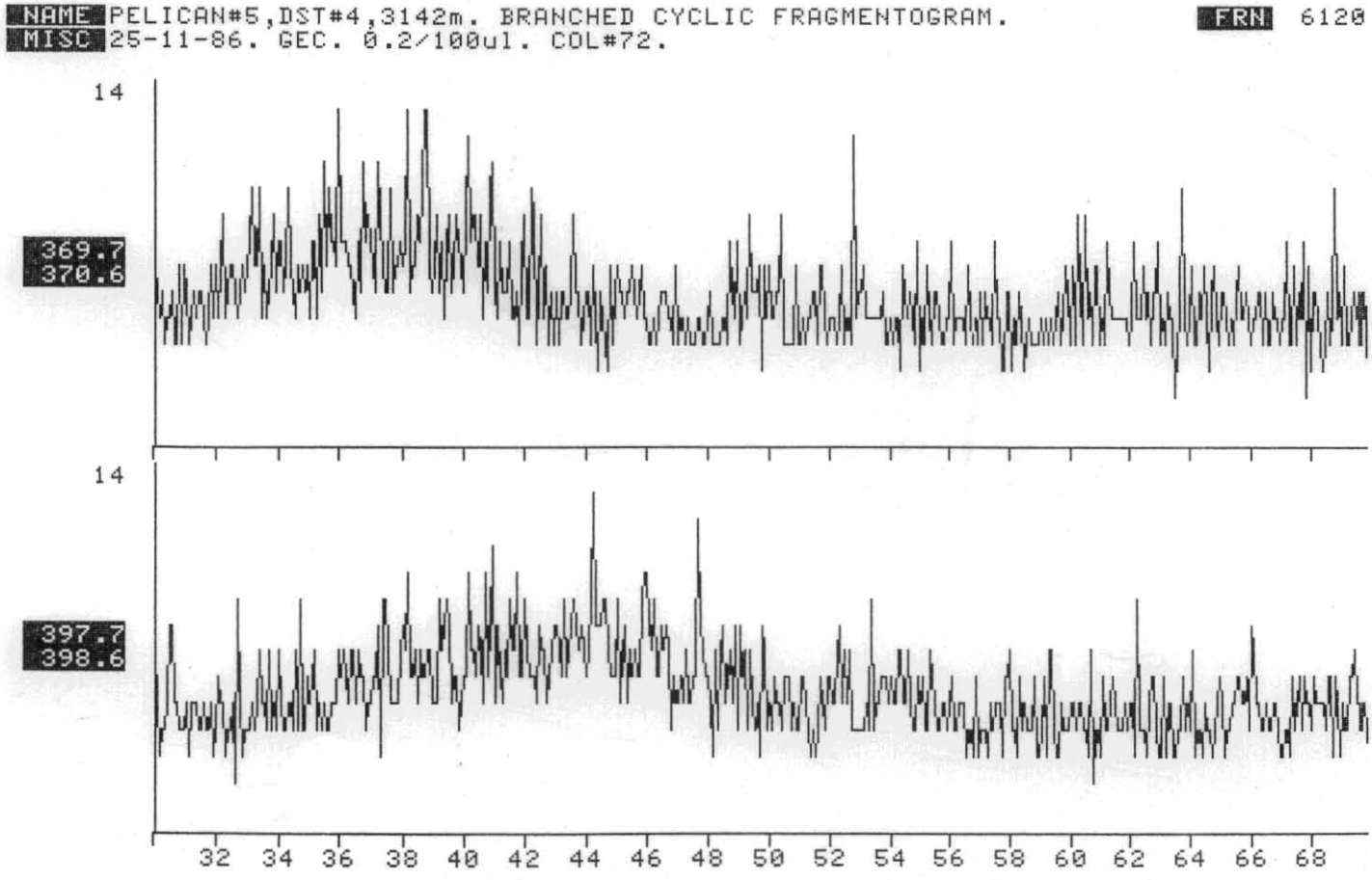




5 cm

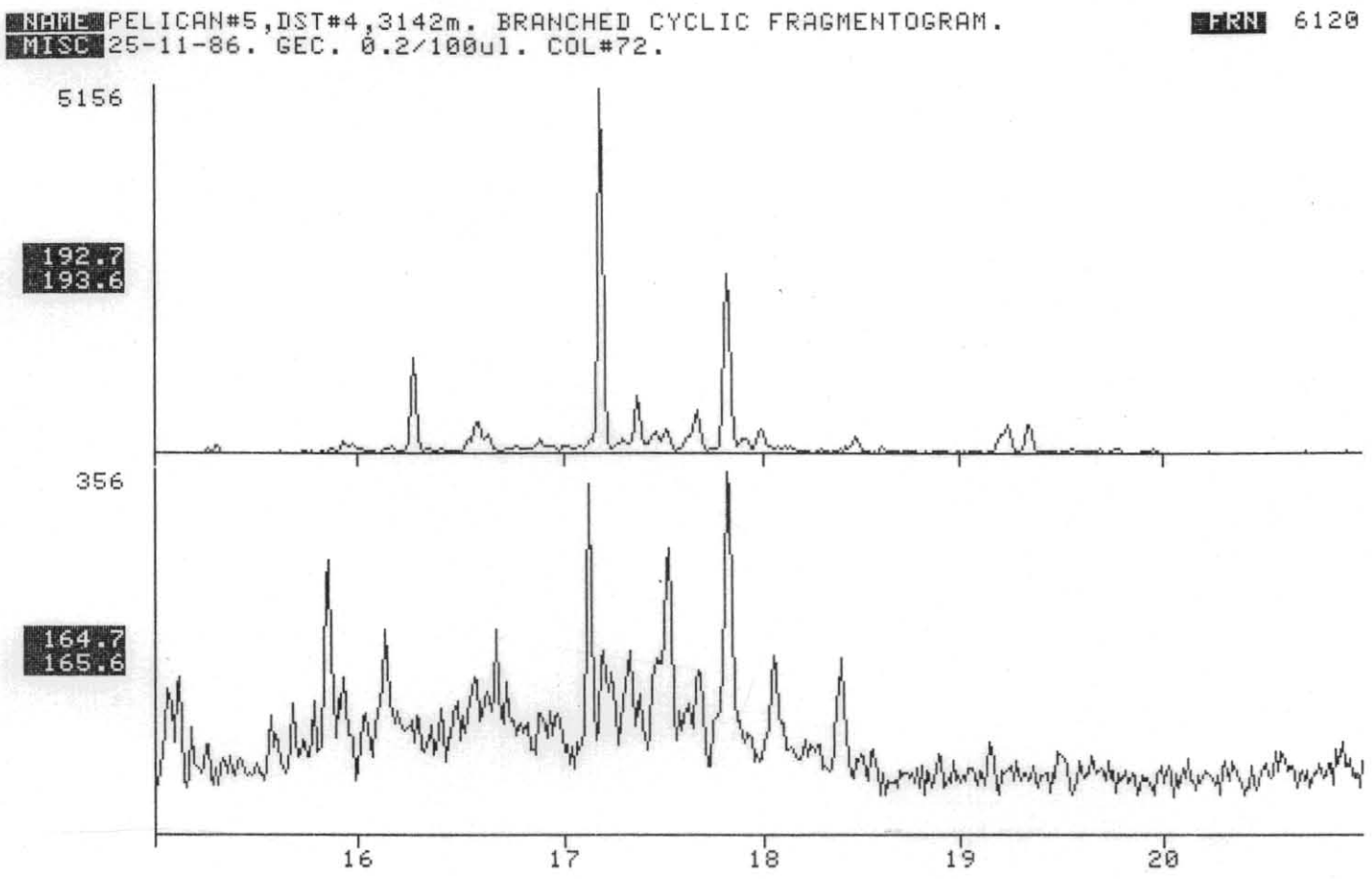
FIGURE 21

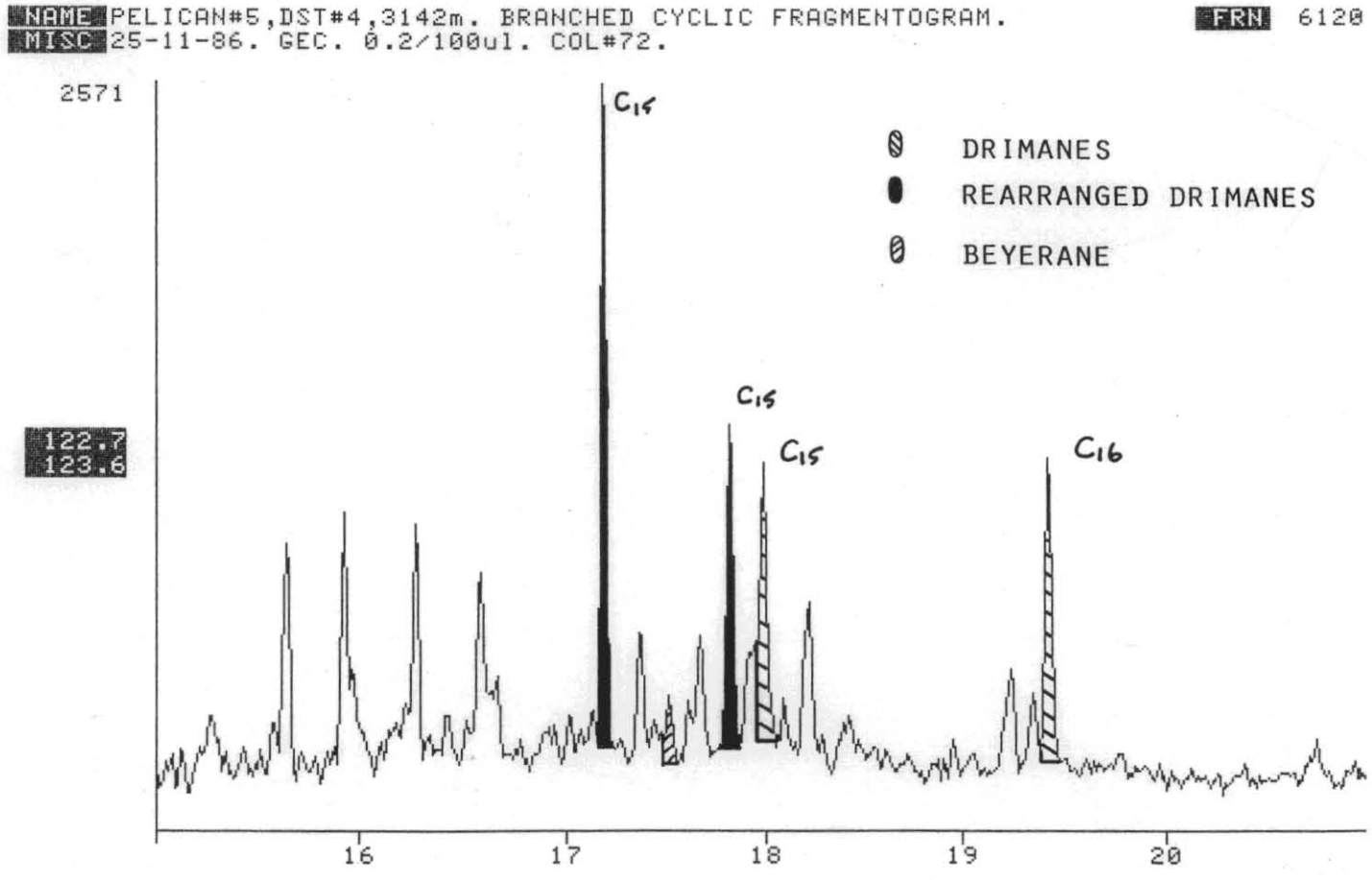




5 cm

FIGURE 22

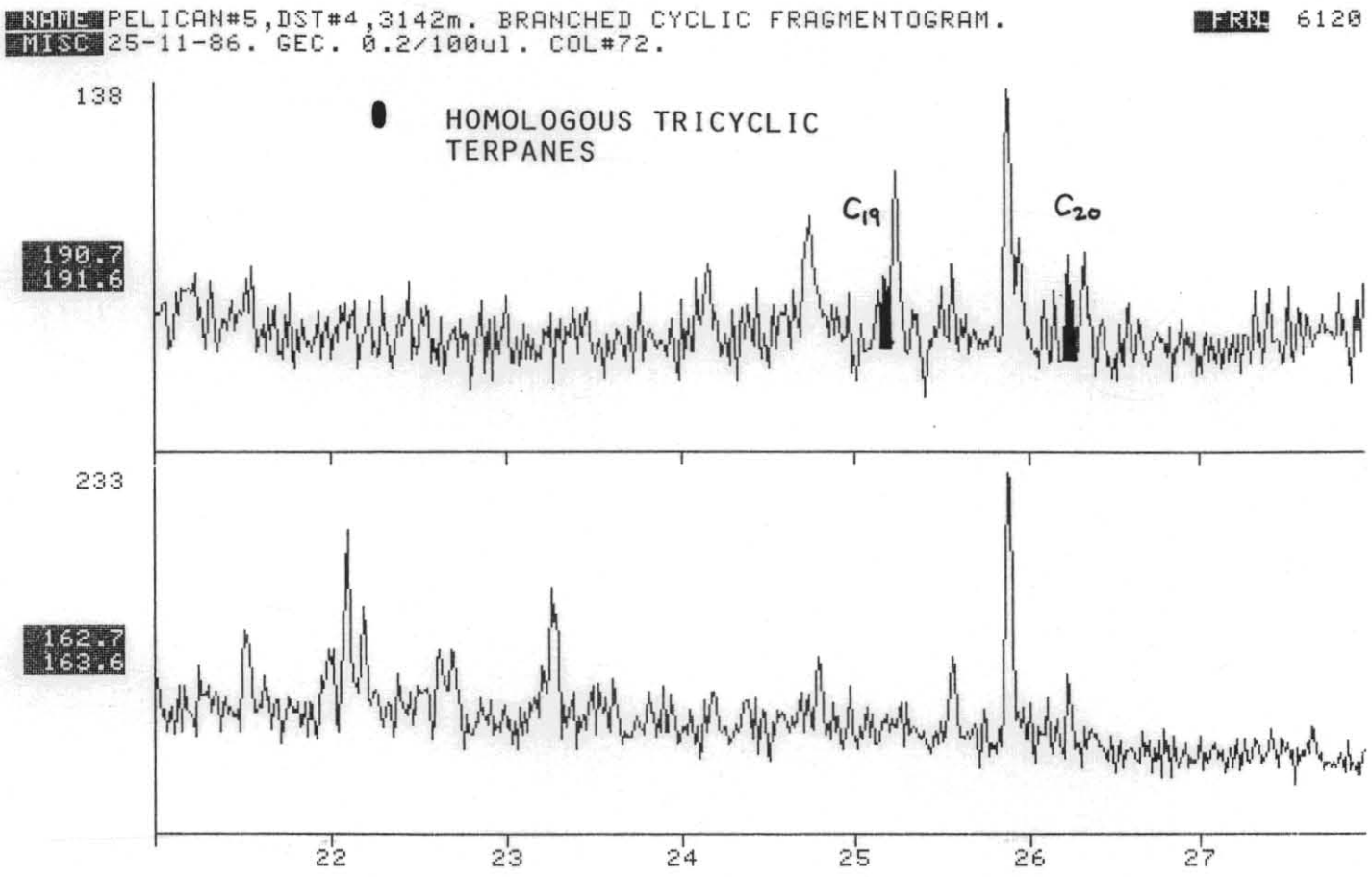


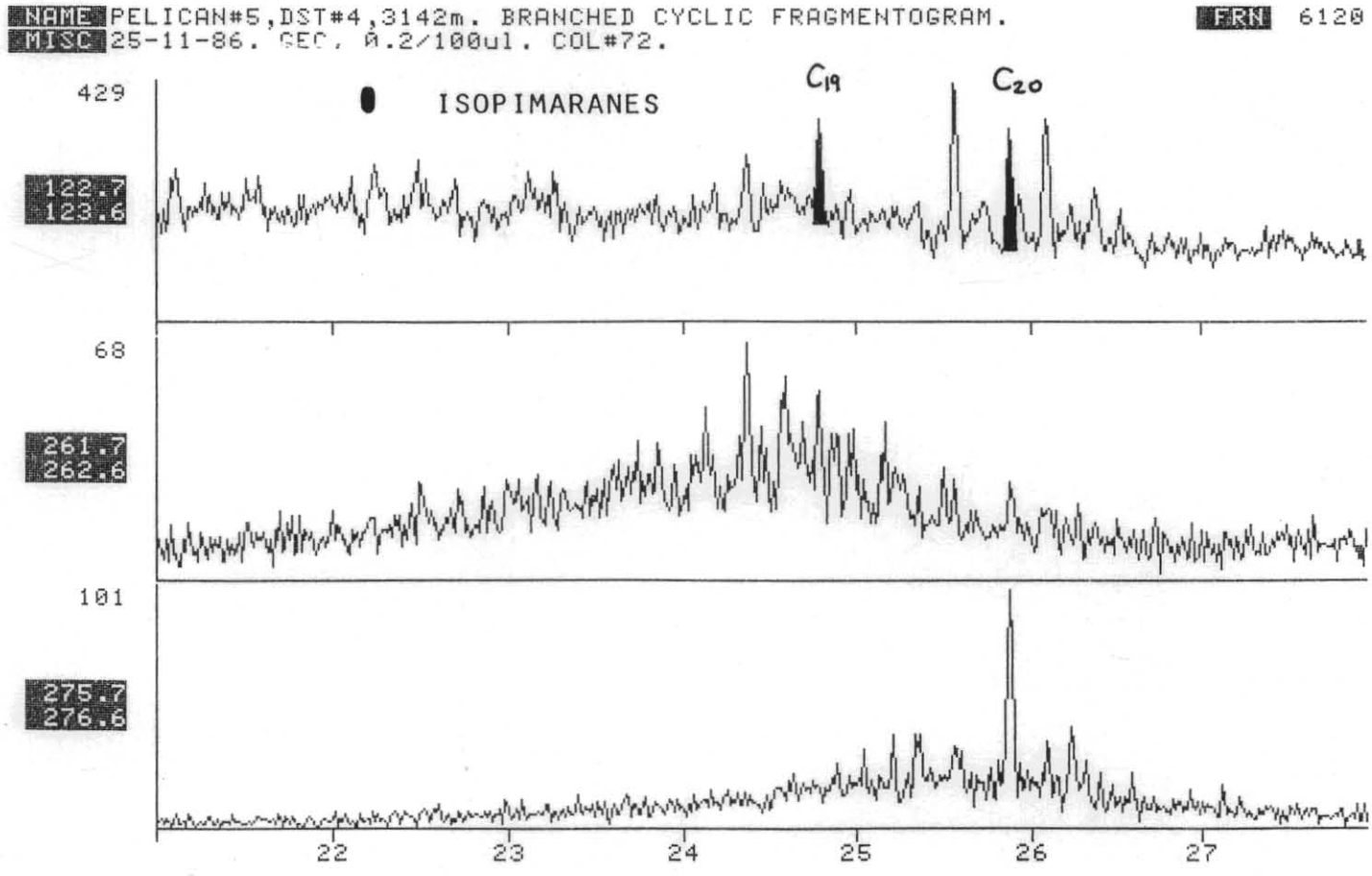


13-29

5 cm

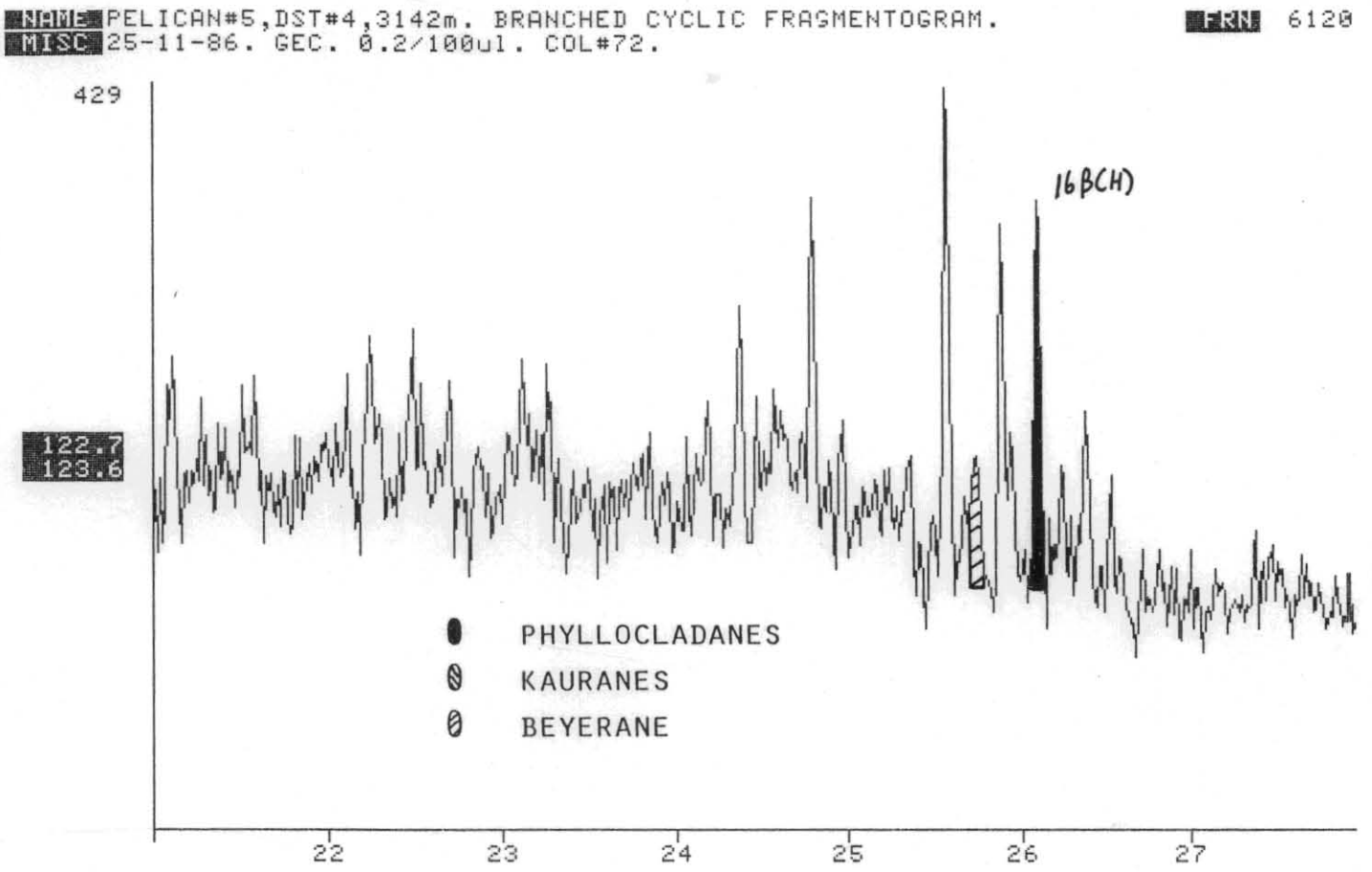
FIGURE 23

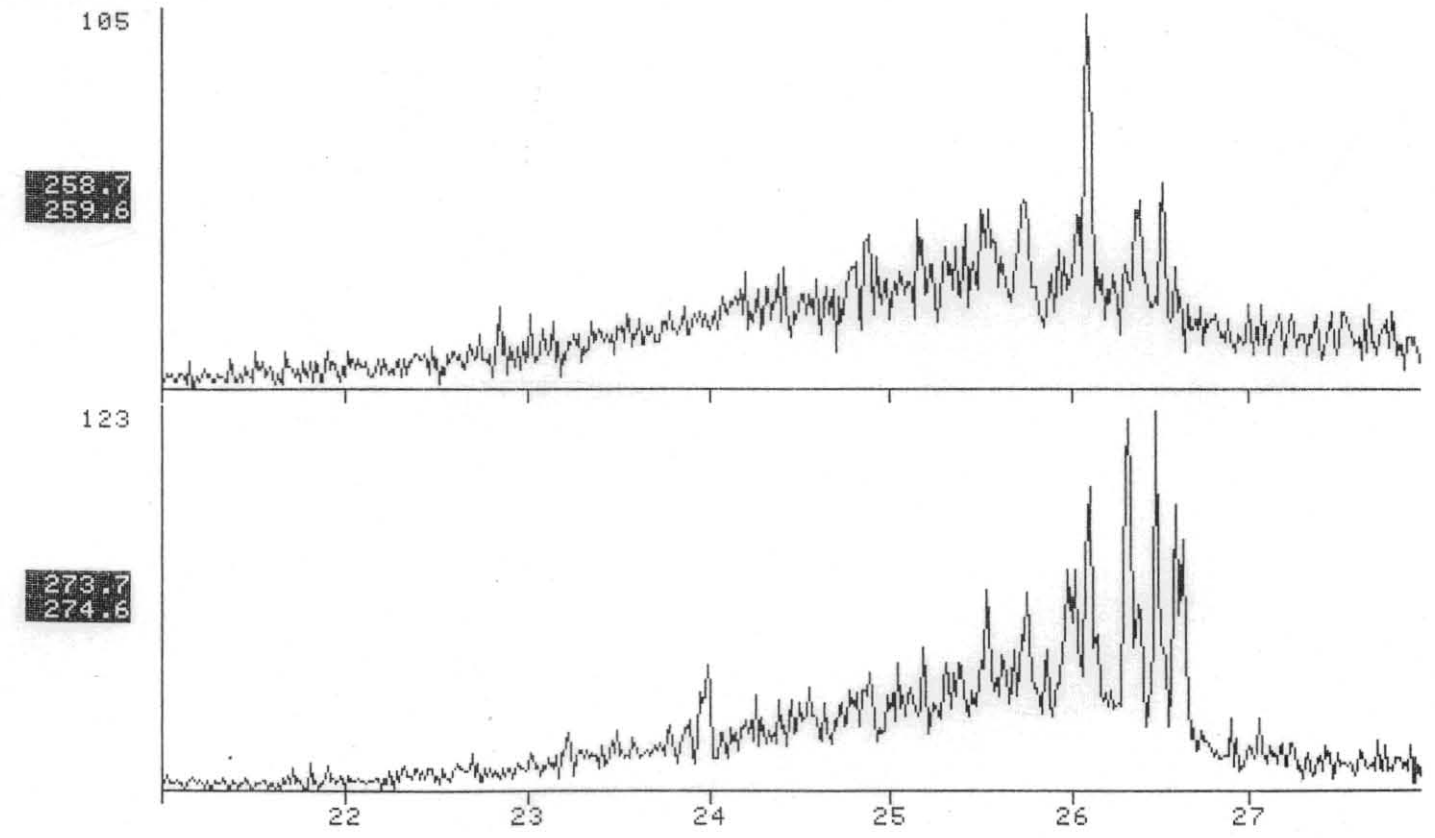




5 cm

FIGURE 24





5 cm

TABLE 5

SELECTED PARAMETERS FROM GC/MS ANALYSIS

Sample: YOLLA 1, 1833m, DST 2

	Parameter	Ion(s)	Value
1.	18α(H)-hopane/17α(H)-hopane (Ts/Tm)	191	0.16
2.	C_{30} hopane/C_{30} moretane	191	5.28
3.	C_{31} 22S hopane/C_{31} 22R hopane	191	0.87
4.	C_{32} 22S hopane/C_{32} 22R hopane	191	1.10
5.	C_{29} 20S ααα sterane/C_{29} 20R ααα sterane	217	0.56
6.	$\frac{C_{29}\ \alpha\beta\beta\ \text{steranes}}{C_{29}\ \alpha\alpha\alpha\ \text{steranes} + C_{29}\ \alpha\beta\beta\ \text{steranes}}$	217	0.56
7.	C_{27}/C_{29} diasteranes	259	n.d.
8.	C_{27}/C_{29} steranes	217	0.29
9.	18α(H)-oleanane/C_{30} hopane	191	n.d.
10.	$\frac{C_{29}\ \text{diasteranes}}{C_{29}\ \alpha\alpha\alpha\ \text{steranes} + C_{29}\ \alpha\beta\beta\ \text{steranes}}$	217	0.91
11.	$\frac{C_{30}\ (\text{hopane} + \text{moretane})}{C_{29}\ (\text{steranes} + \text{diasteranes})}$	191/217	3.61
12.	C_{15} drimane/C_{16} homodrimane	123	1.50
13.	Rearranged drimanes/normal drimanes	123	0.51
14.	C_{15} alkyl cyclohexane/C_{30} hopane	83/191	10.10
15.	C_{15} alkyl cyclohexane/C_{16} homodrimane	83/123	4.36

n.d. = not detectable

TABLE 6

SELECTED PARAMETERS FROM GC/MS ANALYSIS

Sample: PELICAN 5, 3142m, DST 4

	Parameter	Ion(s)	Value
1.	18α(H)-hopane/17α(H)-hopane (Ts/Tm)	191	0.68
2.	C_{30} hopane/C_{30} moretane	191	> 15.00
3.	C_{31} 22S hopane/C_{31} 22R hopane	191	1.50
4.	C_{32} 22S hopane/C_{32} 22R hopane	191	n.d.
5.	C_{29} 20S ααα sterane/C_{29} 20R ααα sterane	217	n.d.
6.	$\frac{C_{29}\ \alpha\beta\beta\ \text{steranes}}{C_{29}\ \alpha\alpha\alpha\ \text{steranes} + C_{29}\ \alpha\beta\beta\ \text{steranes}}$	217	n.d.
7.	C_{27}/C_{29} diasteranes	259	n.d.
8.	C_{27}/C_{29} steranes	217	n.d.
9.	18α(H)-oleanane/C_{30} hopane	191	n.d.
10.	$\frac{C_{29}\ \text{diasteranes}}{C_{29}\ \alpha\alpha\alpha\ \text{steranes} + C_{29}\ \alpha\beta\beta\ \text{steranes}}$	217	n.d.
11.	$\frac{C_{30}\ (\text{hopane} + \text{moretane})}{C_{29}\ (\text{steranes} + \text{diasteranes})}$	191/217	n.d.
12.	C_{15} drimane/C_{16} homodrimane	123	1.08
13.	Rearranged drimanes/normal drimanes	123	1.40
14.	C_{15} alkyl cyclohexane/C_{30} hopane	83/191	116.00
15.	C_{15} alkyl cyclohexane/C_{16} homodrimane	83/123	18.40

n.d. = not detectable