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COMPARATIVE SOURCE ROCK POTENTIAL OF COAL/SHALE PAIRS, PELICAN-5, T-22-P, BASS BASIN

R216/86

Amoco Australia Petroleum Company

F3/786/0-F6482/86 October 1986

OR-357 ✓

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CONTENTS

TABLES

FIGURES

FIGURES (continued)

APPENDICES

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F 3/786/0
F 6482/86

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REPORT F 6482/86

YOUR REFERENCE: LPO 1281

TITLE: Comparative source rock potential of coal/shale pairs, Pelican-5, T-22-P, Bass Basin

MATERIAL: Sidewall core (4 samples). Cuttings (2 samples).

LOCALITY: PELICAN-5

IDENTIFICATION: As in Table 1 of report

DATE RECEIVED: 23 June 1986

WORK REQUIRED: Hand pick cuttings. Total organic carbon and Rock-Eval pyrolysis. Organic petrology. Kerogen isolation, elemental analysis (C, H, N, S, O, ash) and pyrolysis-GC. Interpretation.

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1. INTRODUCTION

The vitrinite reflectance versus depth profile for Pelican-5 indicates that the oil window (VR = 0.7-1.35%) spans the interval 2775-3975 metres depth (McKirdy *et al.*, 1986). Within this interval sediments are presently mature for hydrocarbon generation from terrestrial organic matter as follows:

	VR %	Product
Eocene	0.70-0.85	oil and gas (initial generation)
Paleocene	0.85-1.15	oil and gas (peak generation)
Cretaceous	1.15-1.35	gas-condensate

Rock-Eval data on Eocene and Paleocene cuttings confirm the presence of ostensibly oil and gas-prone Type II-III kerogen (HI >200) to a depth of 3500 metres. Although now post-mature for oil generation, Cretaceous shales display organic petrological evidence of having been prolific sources of liquid hydrocarbons at an earlier stage of their burial history (McKirdy *et al.*, 1986).

Immature paraffinic condensate (MPI-derived source VR = 0.69%) was recovered from an Eocene reservoir during RFT 3 (2788 m) and DST 6 (2786-2790 m, 400 bbls/day). This condensate appears to be *in situ* (i.e. generated from within the Eocene). The only other reported liquids were "trace oil" associated with a minor gas flow (DST 4, 3143-3162.5 m) from the top of the Paleocene.

In order to rigorously evaluate and compare the hydrocarbon-source potential of mature Eocene, Paleocene and Cretaceous sediments in Pelican-5, three coal/shale pairs (Table 1) were selected for detailed examination by

1) organic petrology
2) Rock-Eval pyrolysis
3) kerogen isolation, elemental analysis (C, H, N, O, S, ash) and pyrolysis-GC.

Much of the coal recorded in cuttings from below 3700 metres depth in Pelican-5 probably is cavings. Efforts to obtain *bona fide* Cretaceous coal for analysis were unsuccessful. Hand-picked cuttings from 3951-3964 metres depth, upon examination by reflected-light optical microscopy, proved to be largely carbonaceous shale (Table 1).

2. ANALYTICAL PROCEDURE

Details of the analytical methods are given in Appendix 1.

3. RESULTS

Analytical data are summarised and presented herein as follows:

	Table	Figure	Appendix
Vitrinite reflectance	1	-	-
Organic petrology	2-4	-	2
Rock-Eval pyrolysis	5	1	-
Kerogen elemental composition	6	2	-
Kerogen pyrolysis-GC	7,8	3-10	3

4. DISCUSSION

4.1 Maturity

The maturity of the coal/shale samples increases with depth in the Eastern View Coal Measures:

	VR %	Tmax °C
Eocene	0.57-0.60	428-429
Paleocene	0.85-0.88	447
Cretaceous	1.20-1.35	465-476

There is reasonable agreement between the two listed maturity parameters, except for the Eocene samples (Fig. 1). Here Rock-Eval Tmax values and kerogen H/C and O/C atomic ratios (Table 6, Fig. 2) both indicate *immaturity* (VR $\leqslant$0.5%). Consequently, the original source potential of the Eocene coal/shale pair has not been significantly reduced by generation and expulsion of hydrocarbons.

Even in the case of the Eocene coal, where thermally labile resinite and suberinite together comprise approximately 25% of the total kerogen (Table 4) less than 5% of their initial oil source potential has been realised. The main oil generation range for these particular exinites is VR = 0.5-0.8% (Cook, 1986).

When comparing their hydrocarbon source potential with that of the Eocene coal/shale pair, due allowance must be made for the more advanced maturity of the Paleocene and Cretaceous samples. The following correction factors have been applied in this study:

		Oil Generation Index*
Eocene	- shale	0
	- coal	0
Paleocene	- shale	22
	- coal	30
Cretaceous	- shale	97
	shale + coal	100

*See Table 8 for explanation

4.2 Hydrocarbon Source Potential

Eocene

Notwithstanding their similar whole-rock hydrogen index values, these coal and shale Type II-III kerogens have different elemental (Fig. 2) and maceral compositions, thus:

	HI	H/C	O/C	V	I	E
	mgS_2/g TOC	atomic			%	
coal	339	1.00	0.15	70	-	30
shale	344	0.92	0.19	85	<<5	10

This qualitative difference in kerogen composition is further evident in their pyrolysis-GC traces (Figs. 3, 4). The *coal* has the highest proportion of aliphatic C_{11+} compounds in its pyrolysate (42% : Fig. 8) and the lowest "gas/oil ratio" (C_1-C_4/C_{5+} = 0.44 : Table 8), and is clearly *oil-prone*. By comparison, the *shale* kerogen is somewhat more aromatic in composition and *gas-condensate* is its likely maturation product (Figs. 9, 10). Oil-source potential appears to be directly related to exinite content.

Quantitatively, the potential yields of liquid hydrocarbons (C_{11}-C_{31} : Table 8) from these two Eocene kerogens are as follows:

	C_{11+} Yield		Source Rating
	mg/g TOC	kg/t rock	
coal	141	97	excellent
shale	88	41	excellent

Paleocene

The identical kerogen H/C atomic ratios of this particular coal/shale pair are reflected in neither Rock-Eval hydrogen index nor organic petrological data:

	HI	H/C	O/C	V	I	E
	mgS_2/g TOC	atomic			%	
coal	318	1.00	[0.21]	75	5	20
shale	108	1.00	[0.16]	80	15	<5

Moreover, for reasons that are not clear, both samples plot as immature on a van Krevelen diagram (Fig. 2); the quoted O/C ratios appear to be anomalously high.

In these two kerogens (unlike the Eocene samples), exinite content correlates closely with hydrogen index, but exerts little influence on the character of the pyrograms (Figs. 5, 6). At their present maturation level (VR = 0.85-0.90%), the coal and shale kerogens have nearly identical pyrolysates and are essentially *gas-prone* (Table 7; Figs, 9, 10).

Prior to entering the oil-generation window, however, the coal may have had appreciable liquids-generating potential, as indicated by the following data (Table 8):

	C_{11+} Yield mg/g TOC	kg/t rock	Source Rating
coal	84	45	excellent
shale	23	23	poor

Cretaceous

As already mentioned, sampling difficulties have prevented comparison of representative shale and coal kerogens from the basal part of the Eastern View Coal Measures.

The pyrolysates of both Cretaceous kerogens (Figs. 7, 8) are predominantly aromatic in composition and indicative of residual *gas-prone* Type III organic matter (Figs. 9, 10). Again, elemental composition (Table 6) is anomalous for post-mature kerogen (VR = 1.20-1.35% : Fig. 2).

The presence of micrinitised bituminite (up to 90% of dispersed organic matter) in some Cretaceous shales (Table 2; Appendix 2, Plate 11) implies that the original oil source potential of their kerogen was considerable. However, on the basis of the analytical data presented herein, this potential is very difficult to quantify (Table 8).

5. CONCLUSIONS

1. Exinite-rich Eocene coals are excellent potential source rocks for oil in the Eastern View Coal Measures at Pelican-5.

2. Eocene shales and Paleocene coals are also potential sources of liquid hydrocarbons in the form of gas-condensate.

3. Comparative *ultimate* yields of C_{11+} hydrocarbons for selected samples of these source rocks are as follows:

		mg/g TOC	kg/t rock
Eocene	coal	141	97
	shale	88	41
Paleocene	coal	84	45

4. Whether or not these source rocks have actually generated and expelled significant quantities of liquid hydrocarbons in the Pelican-5 well section is a function of their present maturity. *Effective* source rocks are likely to occur only in the basal Eocene (below 2775 metres depth) and the Paleocene (McKirdy *et al.*, 1986).

5. The advanced maturity of Cretaceous shales in Pelican-5 precludes quantitative estimation of their original oil-source potential. In the case of bituminite-rich shales, this potential was considerable, although they are now post-oil generative and contain only residual dry gas-prone Type III kerogen.

6. REFERENCES

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WATSON, B.L., 1986. Vitrinite reflectance and organic petrology, Pelican-5, T-22-P, Bass Basin. *AMDEL Report F6365/86 for Amoco Australia Petroleum Company* (unpubl.).

TABLE 1: SAMPLES SELECTED FOR DETAILED SOURCE-ROCK EVALUATION, PELICAN-5

Depth m	Age	Sample Type	Lithology	Vr* %
2298.5	Eocene	SWC	Coal	0.57
2451.0	Eocene	SWC	Shale	0.60
3139.0	Paleocene	SWC	Shale	0.85
3204-13	Paleocene	Cuttings	Coal	0.88
3778.1	Cretaceous	SWC	Shale	1.20
3951-64	Cretaceous	Cuttings	Shale (95%) Coal (5%)	1.35

*Estimated from vitrinite reflectance *versus* depth profile of Pelican-5 (Watson, 1986).

TABLE 2: MACERAL GROUP PROPORTIONS IN SEDIMENTARY ORGANIC MATTER, PELICAN-5

Depth	Lithology	Percentage of		
m		Vitrinite	Inertinite	Exinite
2298.5	coal[1]	70	-	30
2451.0	shale[1]	85	<<5	10
3139.0	shale[1]	80	15	<5
3204-13	coal[2]	75	5	20
3778.1	shale[1]	75	20	<5
3951-64	shale[2]	-	10	90*
	coal[2]	90	<5	5

1. Demineralised (kerogen concentrate)
2. Intact cuttings

*Micrinitised bituminite

TABLE 3: ORGANIC MATTER TYPE AND ABUNDANCE, PELICAN-5

Depth m	Lithology	Relative Maceral Group Abundance	Estimated Volume of Exinites	Exinite Macerals
2298.5	Coal[1]	V>E	Ma	res,sub,spo,cut, exs
2451.0	Shale[1]	V>>E>I	Co-Ab	spo,res,cut,bmite
3139.0	Shale[1]	V>I>E	Ra	spo,cut,res,exs
3204-13	Coal[2]	V>E>I	Ma	spo,res,lama,cut
3778.1	Shale[1]	V>I>E	Ra	spo,res,bmite,exs
3951-64	Shale[2]	E>>I	Ma	bmite
	Coal[2]	V>E>I	Sp	res,spo,cut

1. Demineralised (kerogen concentrate)
2. Intact cuttings

TABLE 4: EXINITE MACERAL ABUNDANCE AND FLUORESCENCE CHARACTERISTICS PELICAN-5

Depth (m)	Exinite Macerals	Lithology/Comments
2298.5*	res(Ab;mO-dB),sub(Ab;mO-dB),spo (Ab;mY-mO),cut(Ab;mO),exs(Vr;iY)	Demineralised coal; exsudatinite is generally associated with the resinite and suberinite.
2451.0	spo(Ca-Ab;mY-mO),res(Co;mO-dB), cut(Sp;mO),bmite(Ra;dB)	Demineralised shale.
3139.0	spo(Ra;mO),cut(Ra;mO),res(Ra;dO-dB),exs(Tr;mO)	Demineralised shale; exsudatinite is associated with resinite.
3204-13	spo(Ma;mO-dO),res(Ab;mO-dB),lama (Co;dO),cut(Sp;dO)	Coal.
3778.1	spo(Ra;dO),res(Ra;no fl),bmite (Ra;dO-dB),exs(Tr;mO)	Demineralised shale; exsudatinite as above.
3951-64	shale-bmite(Ma;no fl);coal-spo (Ra;no fl),res(Ra;no fl),lipto (Ra;no fl)	Mostly shale; coal (≤55%) is probably cavings.

*Note: Although each within the same concentration range (2-15%), resinite and suberinite are much more abundant than sporinite and cutinite in this sample.

KEY TO DISPERSED ORGANIC MATTER DESCRIPTIONS

MACERAL GROUPS

V	Vitrinite
I	Inertinite
E	Exinite

EXINITE MACERALS

spo	Sporinite
cut	Cutinite
res	Resinite
sub	Suberinite
lipto	Liptodetrinite
fluor	Fluorinite
exs	Exsudatinite
phyto	Phytoplankton
tela	Telalginite
lama	Lamalginite
bmite	Bituminite
bmen	Bitumen
thuc	Thucholite

ABUNDANCE (by vol.)

Ma	Major	>15%
Ab	Abundant	2-15%
Co	Common	1-2%
Sp	Sparse	0.5-1%
Ra	Rare	0.1-0.5%
Vr	Very Rare	≈0.1%
Tr	Trace	<0.1%

FLUORESCENCE COLOUR AND INTENSITY

G	Green
Y	Yellow
O	Orange
B	Brown

i	Intense
m	Moderate
d	Dull

TABLE 5: TOC AND ROCK-EVAL PYROLYSIS DATA ON SELECTED COALS AND SHALES, PELICAN-5

Depth (m)	Tmax	S_1	S_2	S_3	S_1+S_2	PI	S_2/S_3	PC	TOC	HI	OI
2298.5	429	12.04	233.06	2.24	245.10	0.05	104.04	20.42	68.8	339	3
2451.0	428	1.02	16.18	0.44	17.20	0.06	36.77	1.43	4.70	344	9
3139.0	447	0.30	1.08	1.59	1.38	0.22	0.67	0.11	1.00	108	159
3204-13	447	19.75	172.65	4.33	192.40	0.10	39.87	16.03	54.2	318	8
3778.1	465	0.62	2.03	1.70	2.65	0.23	1.19	0.22	2.10	97	81
3951-64	476	2.25	16.12	2.34	18.37	0.12	6.88	1.53	13.2	122	18

KEY TO ROCK-EVAL PYROLYSIS DATA SHEET

	PARAMETER	SPECIFICITY
T max	position of S_2 peak in temperature program (^oC)	Maturity/Kerogen type
S_1	kg hydrocarbons (extractable)/tonne rock	Kerogen type/Maturity/Migrated oil
S_2	kg hydrocarbons (kerogen pyrolysate)/tonne rock	Kerogen type/Maturity
S_3	kg CO_2 (organic)/tonne rock	Kerogen type/Maturity *
$S_1 + S_2$	Potential Yield	Organic richness/Kerogen type
PI	Production Index ($S_1/S_1 + S_2$)	Maturity/Migrated Oil
PC	Pyrolysable Carbon (wt. percent)	Organic richness/Kerogen type/Maturity
TOC	Total Organic Carbon (wt. percent)	Organic richness
HI	Hydrogen Index (mg h'c (S_2)/g TOC)	Kerogen type/Maturity
OI	Oxygen Index (mg CO_2(S_3)/g TOC)	Kerogen type/Maturity *

*Also subject to interference by CO_2 from decomposition of carbonate minerals.

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TABLE 6: KEROGEN ELEMENTAL COMPOSITION, PELICAN-5

Depth m	Age	Lithology*	C	H	N wt %	O	S	Ash	H/C atomic	O/C
2298.5	Eocene	C	75.21	6.30	1.03	14.06	1.8	0.3	1.00	0.15
2451.0	Eocene	S	64.34	4.97	1.03	16.03	1.3	15.5	0.92	0.19
3139.0	Paleocene	S	72.04	6.07	1.43	14.9	1.5	4.1	1.00	0.16
3204-13	Paleocene	C	71.77	6.04	1.50	20.0	0.9	0.4	1.00	0.21
3778.1	Cretaceous	S	74.12	5.11	1.06	nd	nd	nd	0.82	nd
3951-64	Cretaceous	S+C	71.52	4.97	0.77	20.1	0.7	2.0	0.83	0.21

*Prior to demineralisation : C = coal, S = shale

nd = not determined

TABLE 7: KEROGEN PYROLYSIS-GC DATA, PELICAN-5

Depth m	Age	Lithology*	C_1-C_4 %	C_5-C_{10} %	C_{11+} %	C_1-C_4 / C_{5+}	Tol / $n-C_{7:1}$	m,p-Xyl / $n-C_{8:1}$
2298.5	Eocene	C	30.5	27.8	41.7	0.44	1.1	0.79
2451.0	Eocene	S	46.6	27.9	25.5	0.87	2.0	1.7
3139.0	Paleocene	S	61.4	21.7	16.9	1.59	3.8	3.4
3204-13	Paleocene	C	59.7	21.9	18.4	1.48	3.6	4.1
3778.1	Cretaceous	S	64.7	20.5	14.8	1.83	4.6	4.5
3951-64	Cretaceous	S+C	76.5	12.6	10.9	3.24	23.4	26.7

*Prior to demineralisation : C = coal, S = shale

$\%C_1-C_4$, C_5-C_{10} and C_{11+} = percentage of all compounds in the nominated number ranges

TABLE 8: COMPARATIVE OIL-SOURCE POTENTIAL BASED ON KEROGEN PYROLYSIS-GC FOR SELECTED COALS AND SHALES, PELICAN-5

Depth m	Age	Lithology*	OGI[1] %	$C_{11}-C_{31}$ Yield Present[2] mg/g TOC	$C_{11}-C_{31}$ Yield Present[2] kg/t rock	$C_{11}-C_{31}$ Yield Original[3] mg/g TOC	$C_{11}-C_{31}$ Yield Original[3] kg/t rock
2298.5	Eocene	C	0	141	97	141	97
2451.0	Eocene	S	0	88	41	88	41
3139.0	Paleocene	S	22	18	18	23	23
3204-13	Paleocene	C	30	59	32	84	45
3778.1	Cretaceous	S	97	14	30	?	?
3951-64	Cretaceous	S+C	100	13	18	?	?

*Prior to demineralisation : C = coal, S = shale

1. Oil generation index = estimated percentage of original oil-generating potential of kerogen already converted to hydrocarbons

2. Calculated from pyrolysis-GC data (Appendix 2)

3. Measured $C_{11}-C_{31}$ abundance (all compounds) $\times \frac{100}{100-OGI}$

FIGURE 1

Client : AMOCO
Well name : PELICAN-5

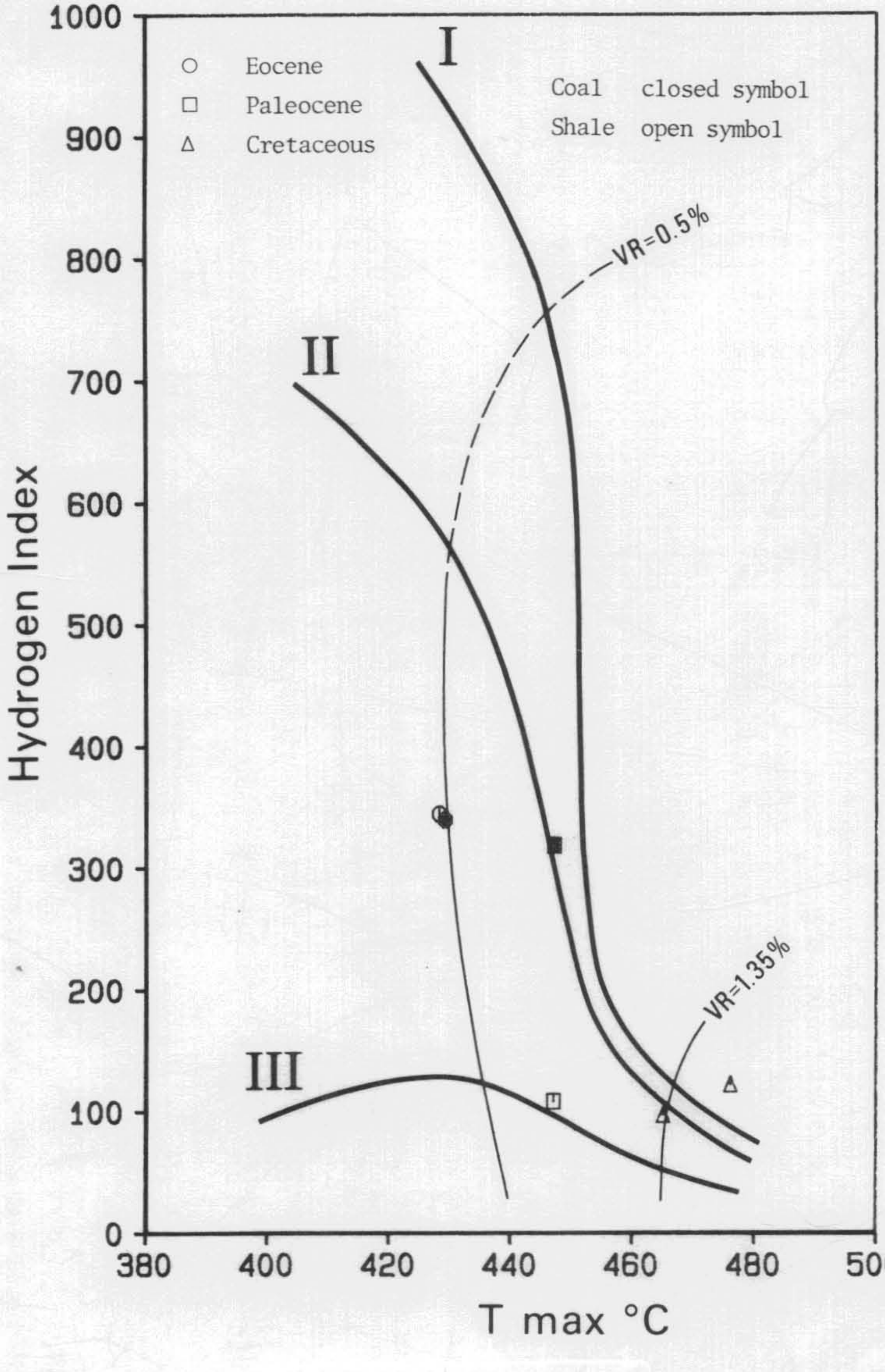
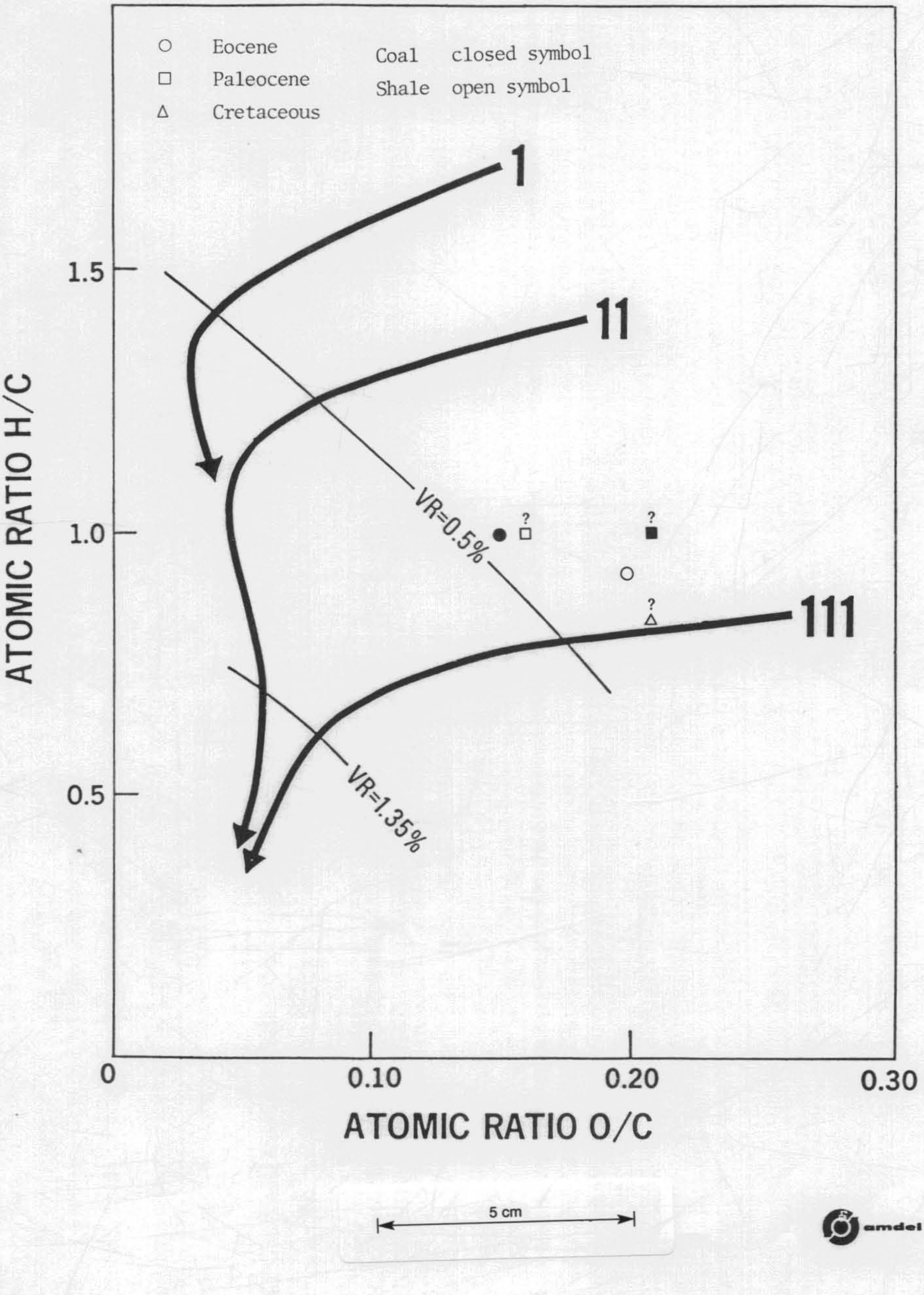


FIGURE 2

KEROGEN ELEMENTAL
COMPOSITION, PELICAN-5



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FIGURES 3-8

PYROLYSIS-GC TRACES OF KEROGENS FROM EASTERN VIEW COAL MEASURES, PELICAN-5

Key : A = aromatic hydrocarbon; numbers refer to carbon numbers of *n*-alkene/*n*-alkane doublets

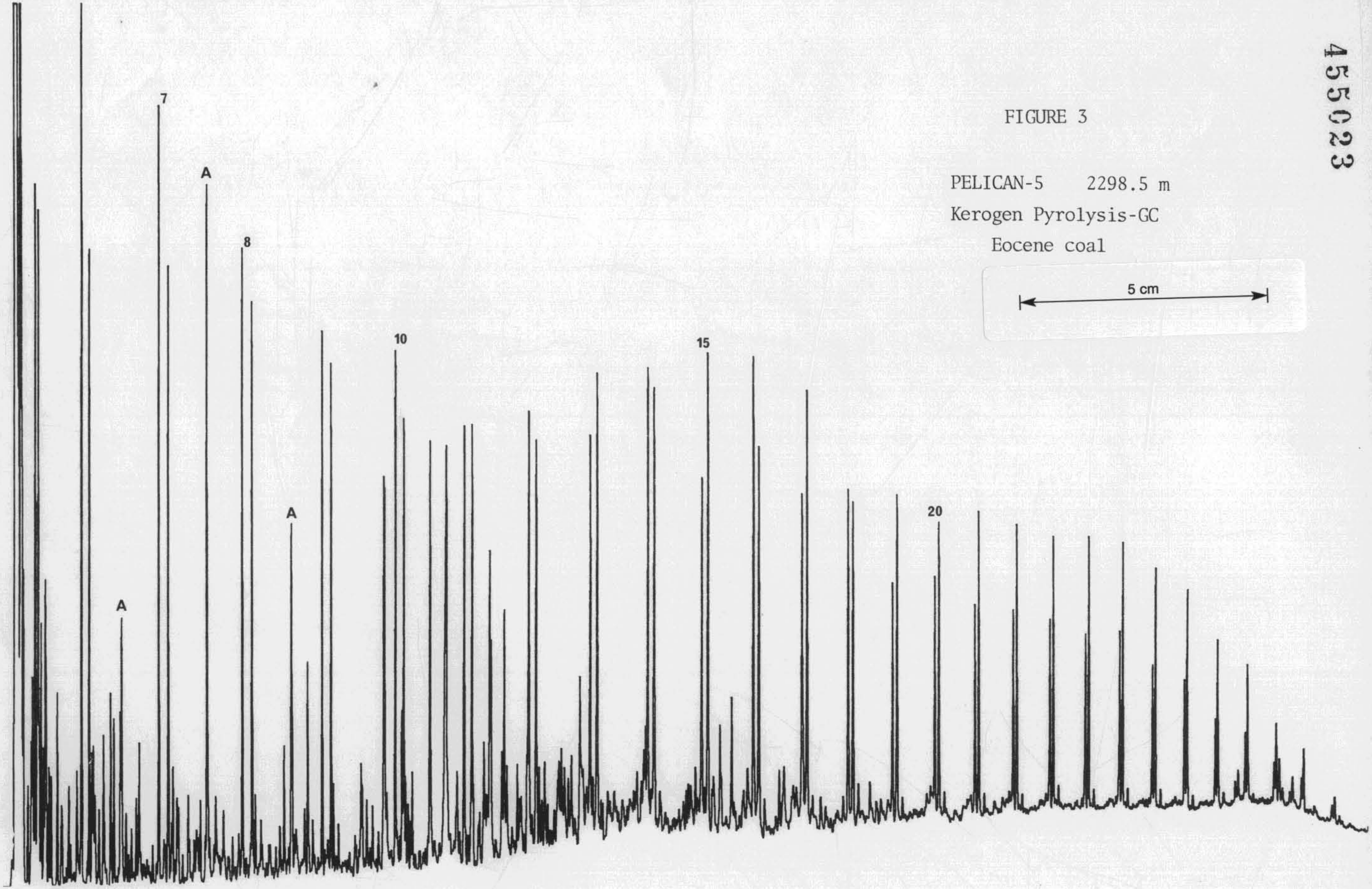

FIGURE 3

PELICAN-5 2298.5 m
Kerogen Pyrolysis-GC
Eocene coal

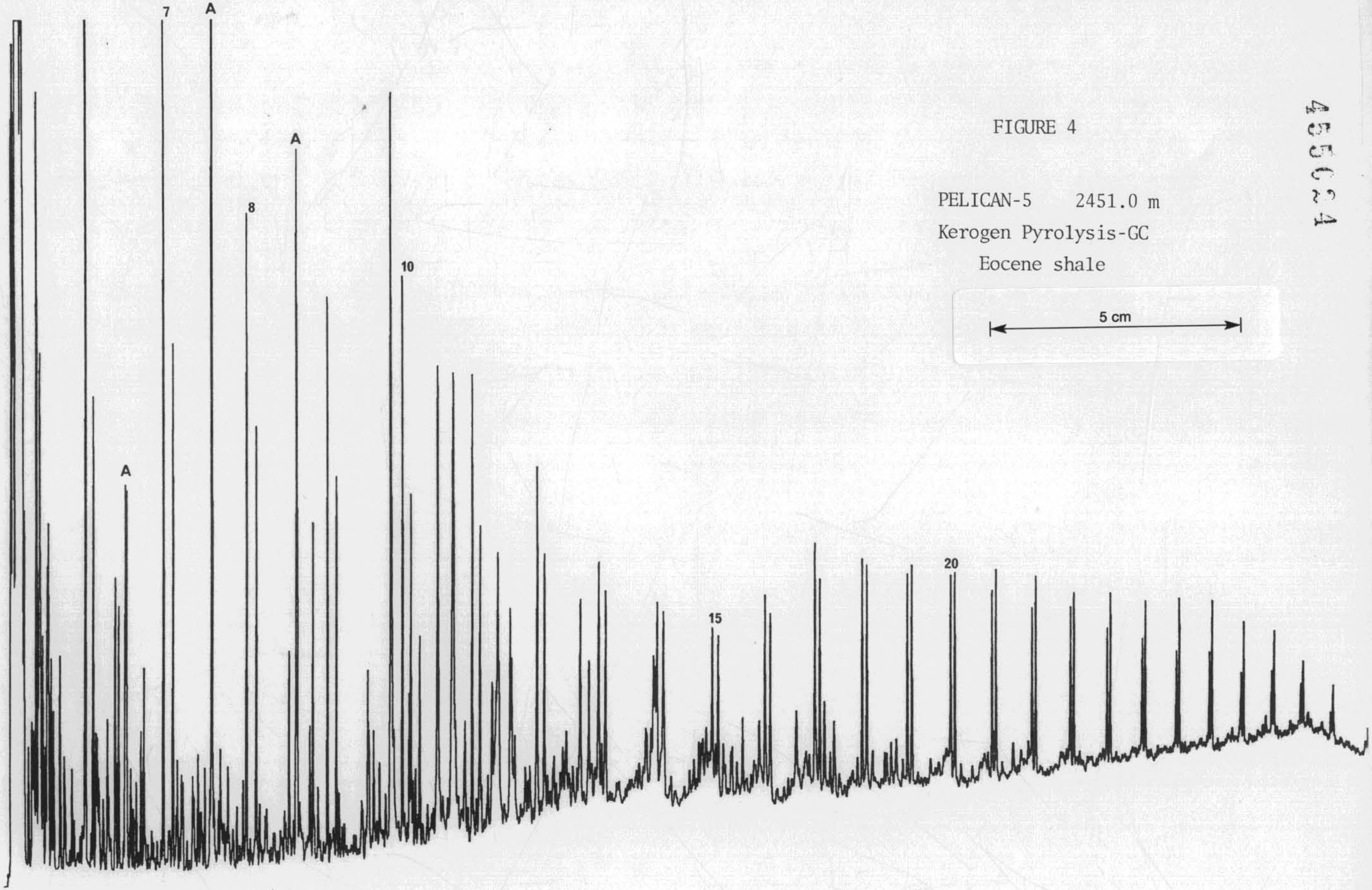

FIGURE 4

PELICAN-5 2451.0 m

Kerogen Pyrolysis-GC

Eocene shale

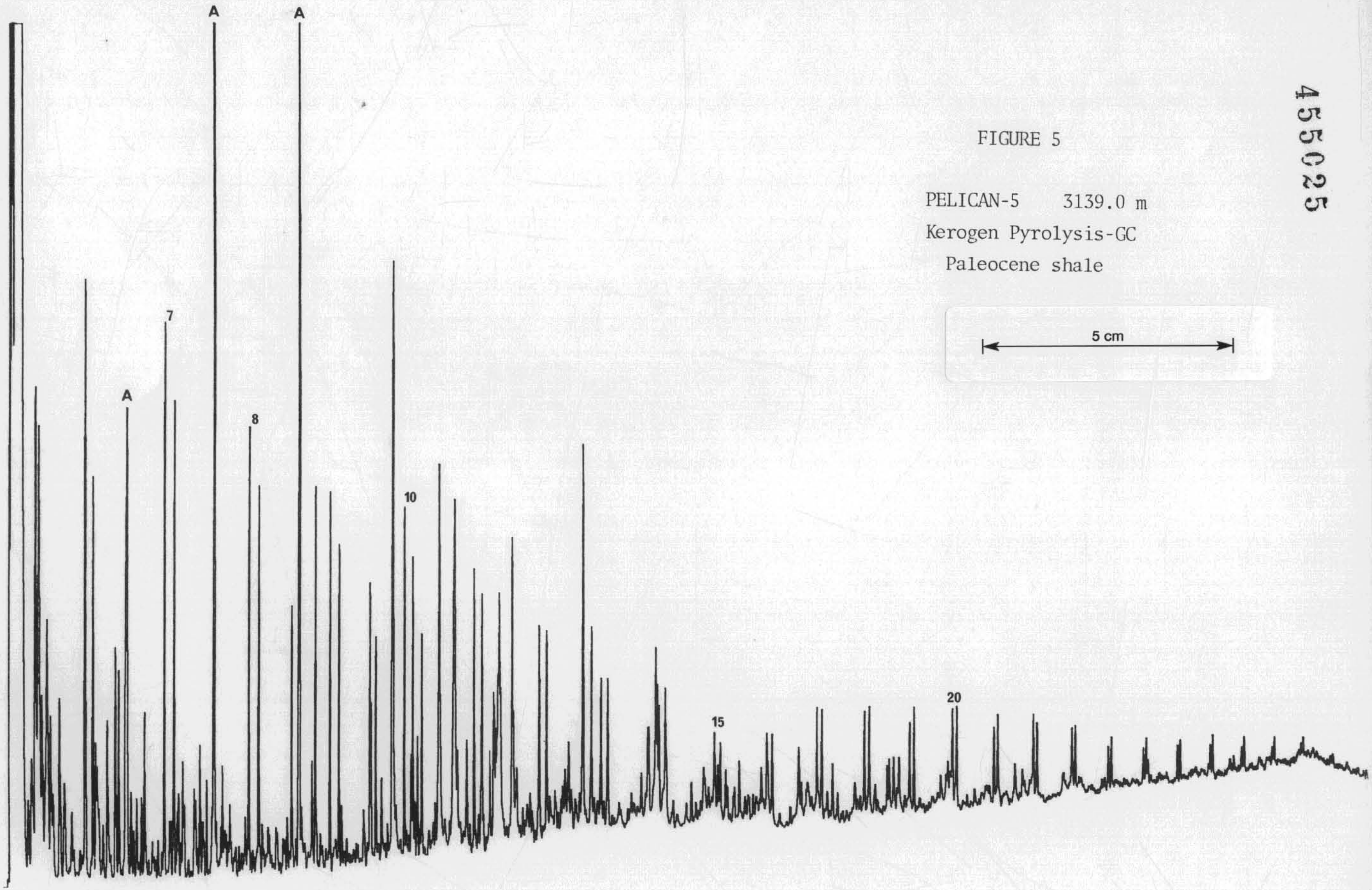

FIGURE 5

PELICAN-5 3139.0 m

Kerogen Pyrolysis-GC

Paleocene shale

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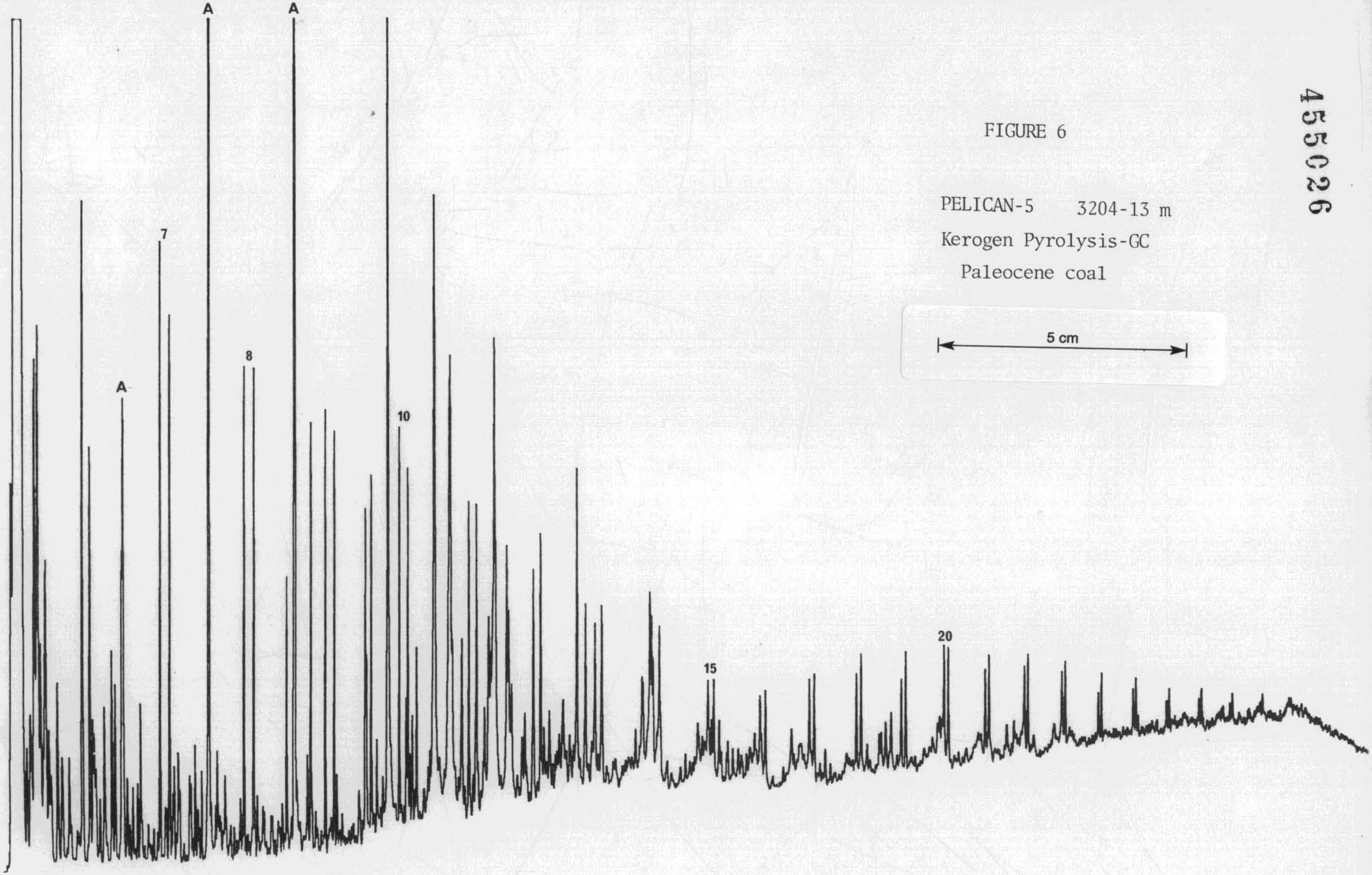

FIGURE 6

PELICAN-5 3204-13 m

Kerogen Pyrolysis-GC

Paleocene coal

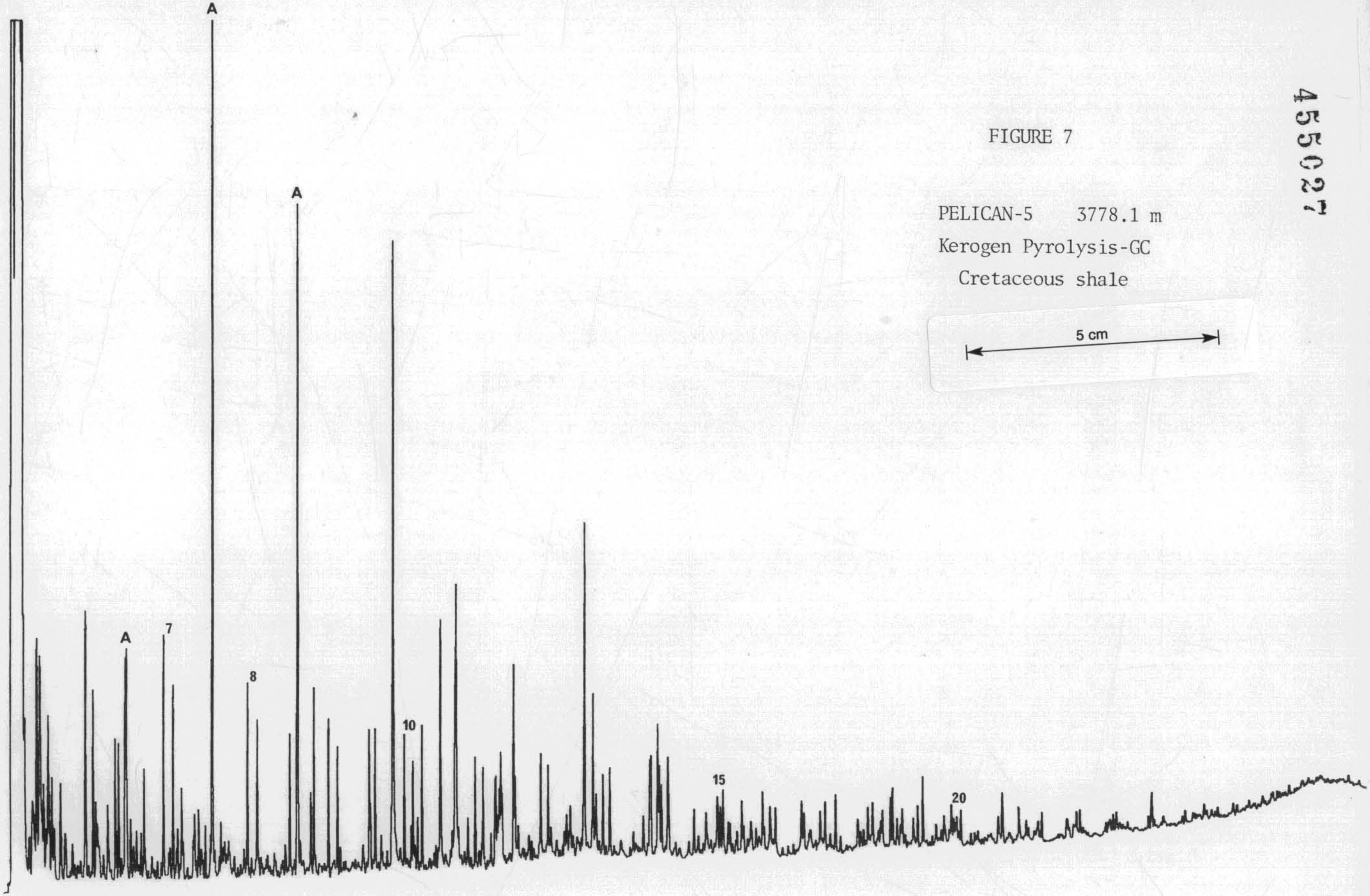

FIGURE 7

PELICAN-5 3778.1 m

Kerogen Pyrolysis-GC

Cretaceous shale

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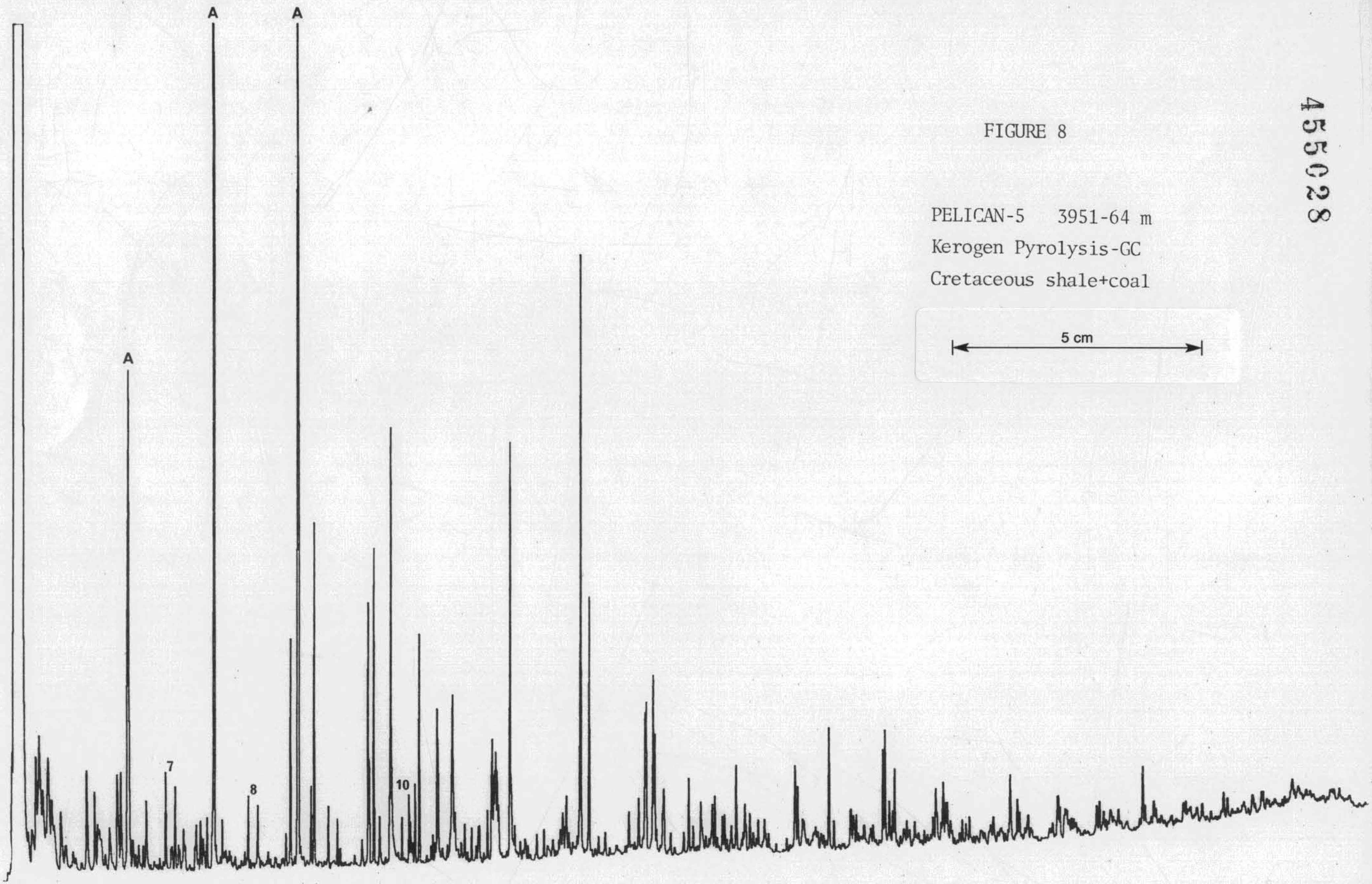

FIGURE 8

PELICAN-5 3951-64 m
Kerogen Pyrolysis-GC
Cretaceous shale+coal

5 cm

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FIGURE 9

HYDROCARBON SOURCE POTENTIAL BASED ON KEROGEN PYROLYSIS-GC, PELICAN-5

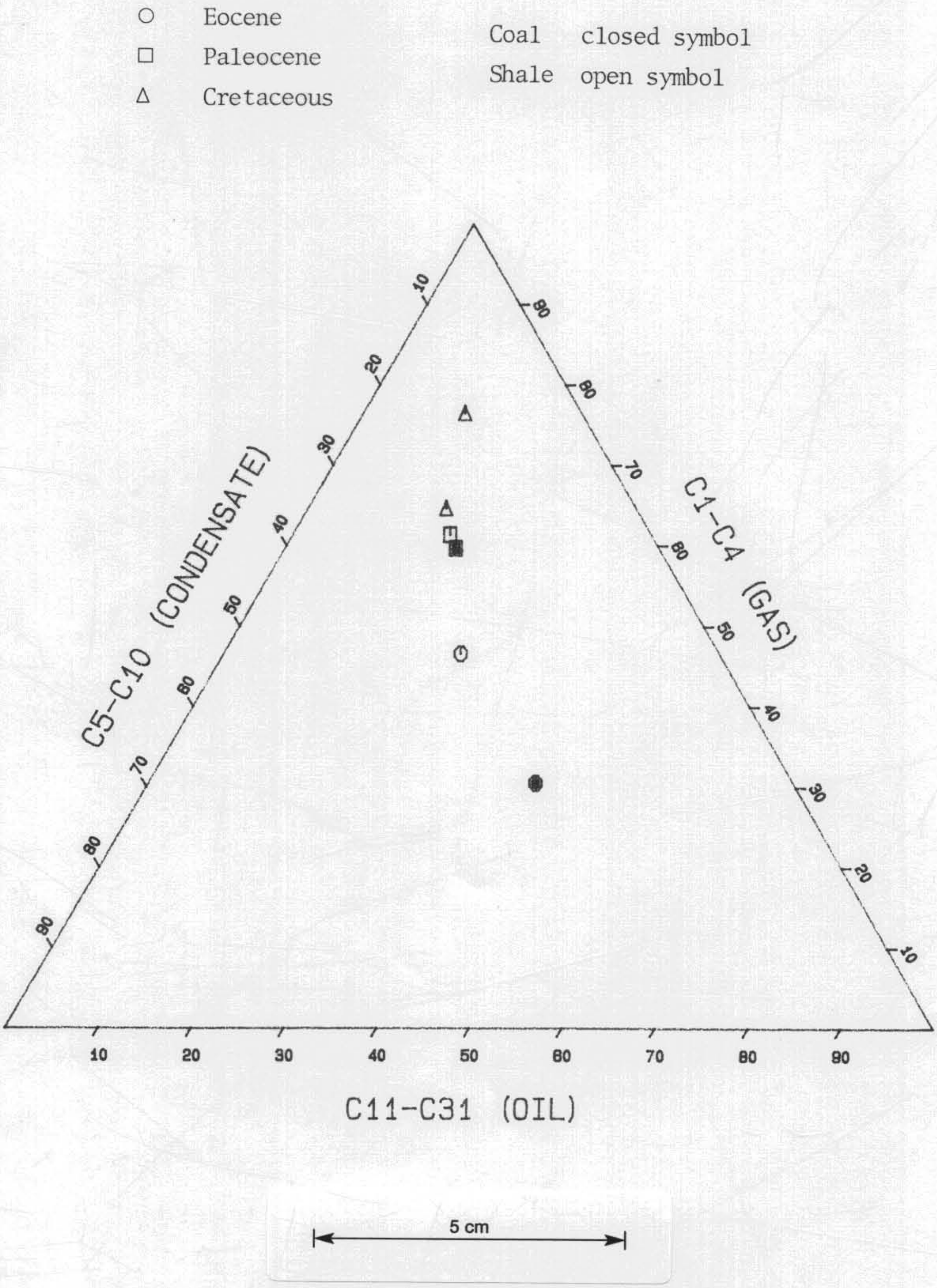
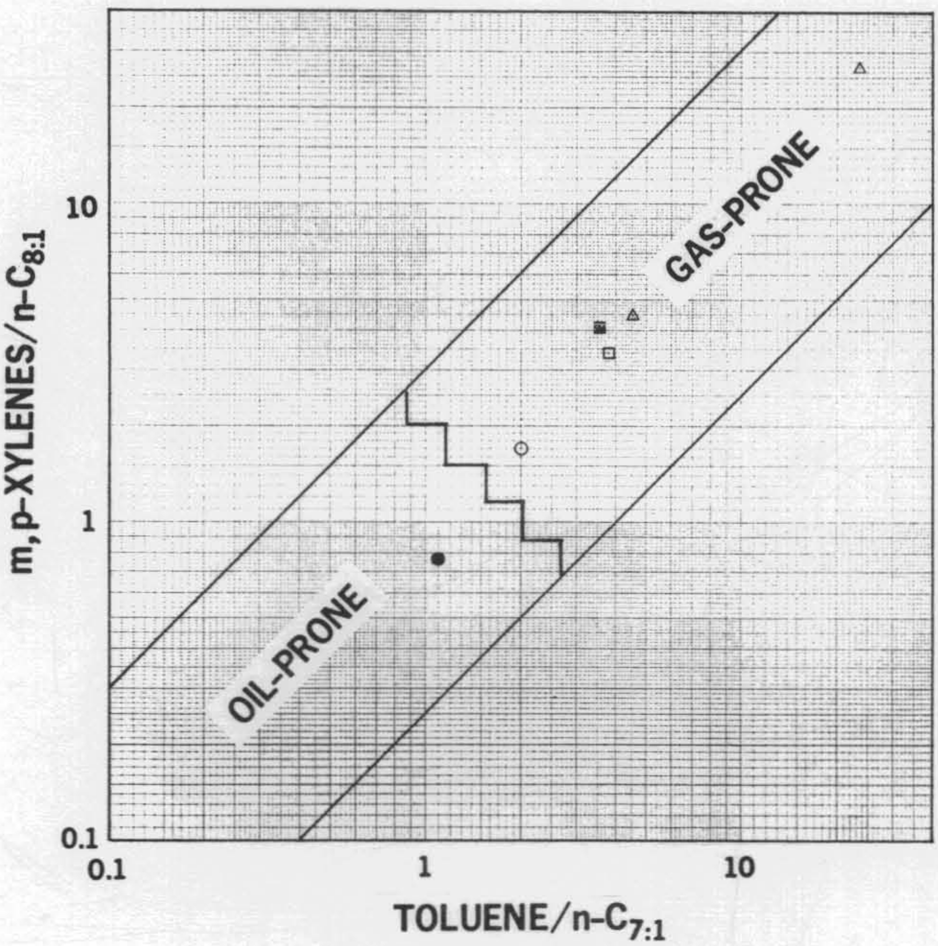


FIGURE 10

SOURCE QUALITY BASED ON
KEROGEN PYROLYSIS-GC,
PELICAN-5



○ Eocene
□ Paleocene
△ Cretaceous

Coal closed symbol
Shale open symbol

5 cm

APPENDIX 1

ANALYTICAL METHODS

1. SAMPLE PREPARATION

Cuttings were washed in water to remove mud and lost circulation material and then air-dried at 60° prior to hand-picking for coal or shale. Clean dry cuttings and sidewall cores (scraped free of mud cake) were ground in a Siebtechnik mill for 20-30 secs. Aliquots of intact cuttings were set aside for organic petrology.

2. TOTAL ORGANIC CARBON (TOC)

Total organic carbon was determined by digestion of a known weight (≈0.2 g) of powdered rock in 50% HCl to remove carbonates, followed by combustion in oxygen in the induction furnace of a Leco IR-12 Carbon Determinator and measurement of the resultant CO_2 by infra-red detection.

3. ROCK-EVAL PYROLYSIS

A 100 mg portion of powdered rock was analysed by the Rock-Eval pyrolysis technique (Girdel IFP-Fina Mark 2 instrument; operating mode, Cycle 1).

4. KEROGEN ISOLATION AND PYROLYSIS-GC

Solvent-extracted rock powder was forwarded to Laola Pty Limited, Perth, for kerogen isolation by a standard palynological acid digestion technique.

Kerogen concentrates were then submitted to the Petroleum Geochemistry Group, Western Australian Institute of Technology for analysis by pyrolysis-GC using a Chemical Data Systems Pyroprobe 120 in the subambient mode.

5. ORGANIC PETROLOGY

A representative portion of the kerogen concentrate (SWC samples), or intact cuttings (crushed to -14+35 BSS mesh), was mounted in cold setting Astic resin using a 2.5 cm diameter mould. The block was ground flat using diamond impregnated laps and carborundum paper. The surface was then polished with aluminium oxide and finally magnesium oxide.

Reflectance measurements on vitrinite phytoclasts (not part of this study) were made with a Leitz MPV1.1 microphotometer fitted to a Leitz Ortholux microscope and calibrated against synthetic standards. All measurements were taken using oil immersion (n = 1.518) and incident monochromatic light (wavelength 546 nm) at a temperature of 24±1°C. Fluorescence observations were made on the same microscope utilising a 3 mm BG3 excitation filter, a TK400 dichroic mirror and a K510 suppression filter.

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APPENDIX 2

PHOTOMICROGRAPHS OF KEROGEN CONCENTRATES (SWC SAMPLES) AND DISPERSED ORGANIC MATTER (INTACT CUTTINGS), PELICAN-5

5 cm

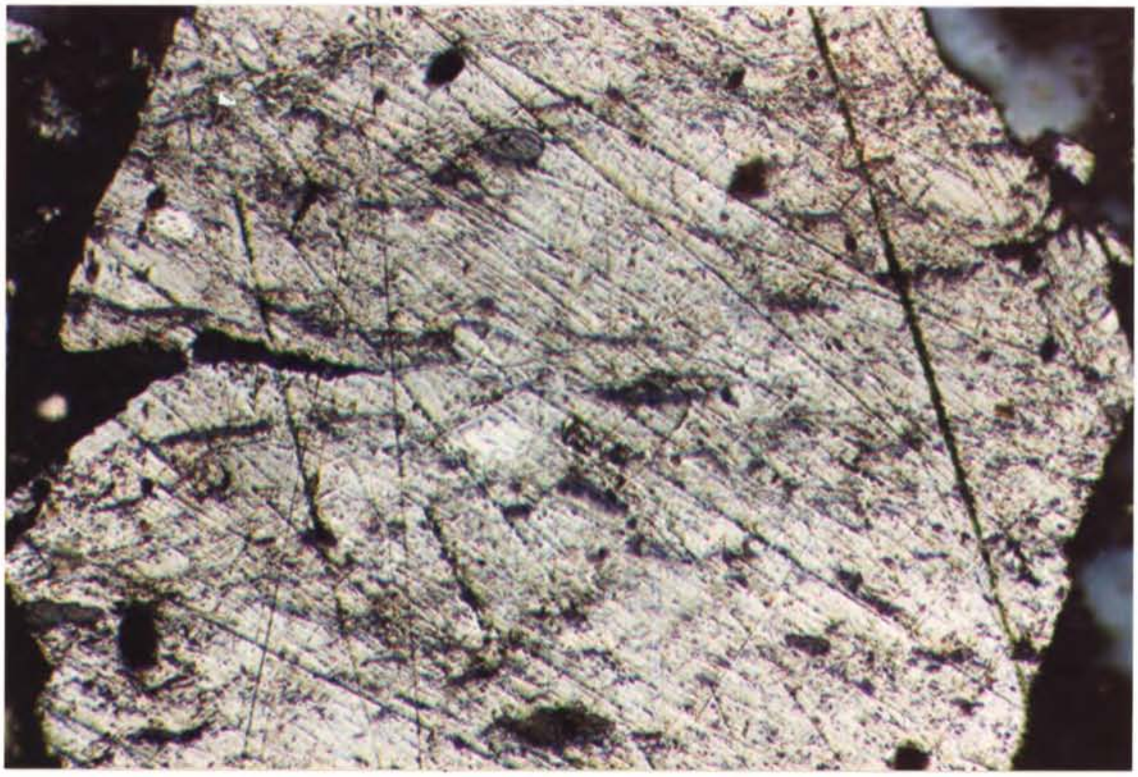

PLATE 1: 2298.5 m, Eocene coal — Reflected Light

A fairly typical fragment of this coal consisting of vitrinite (grey) and exinite (dark grey).

Field Dimensions 0.43 x 0.29 mm

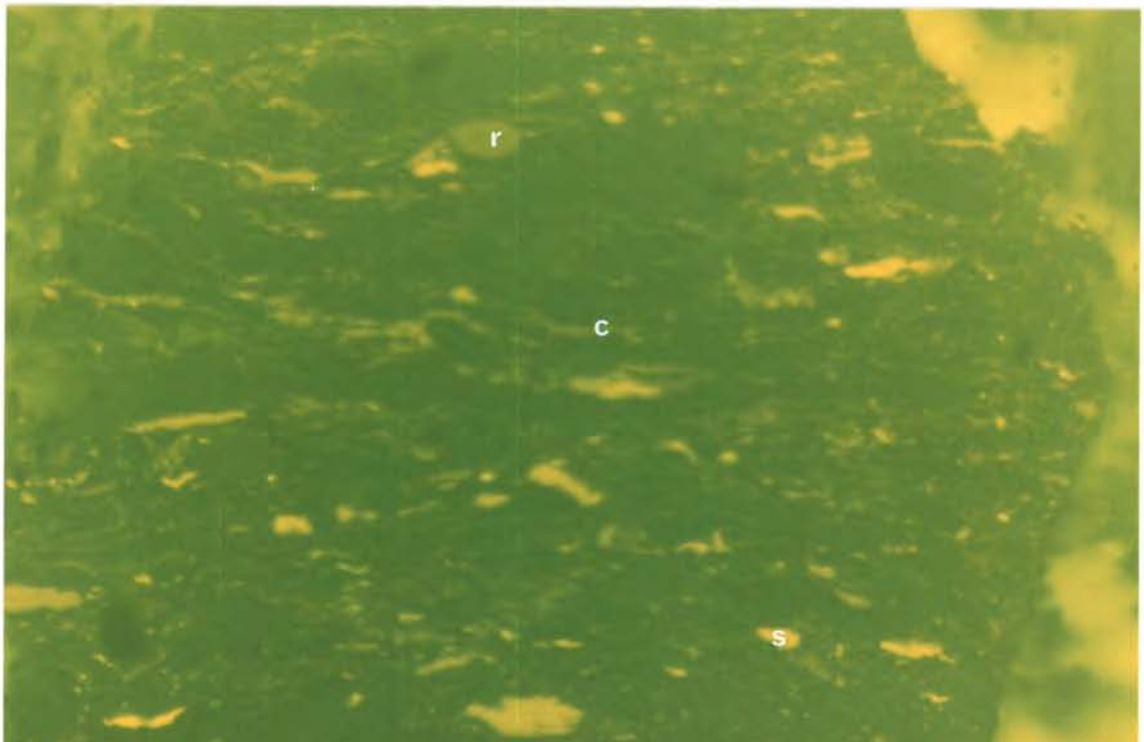

PLATE 2: Same f.o.v. as above. — Fluorescence Mode

The exinite macerals are resinite (r), sporinite (s), cutinite (c) and liptodetrinite (finely fragmented; dispersed).

5 cm

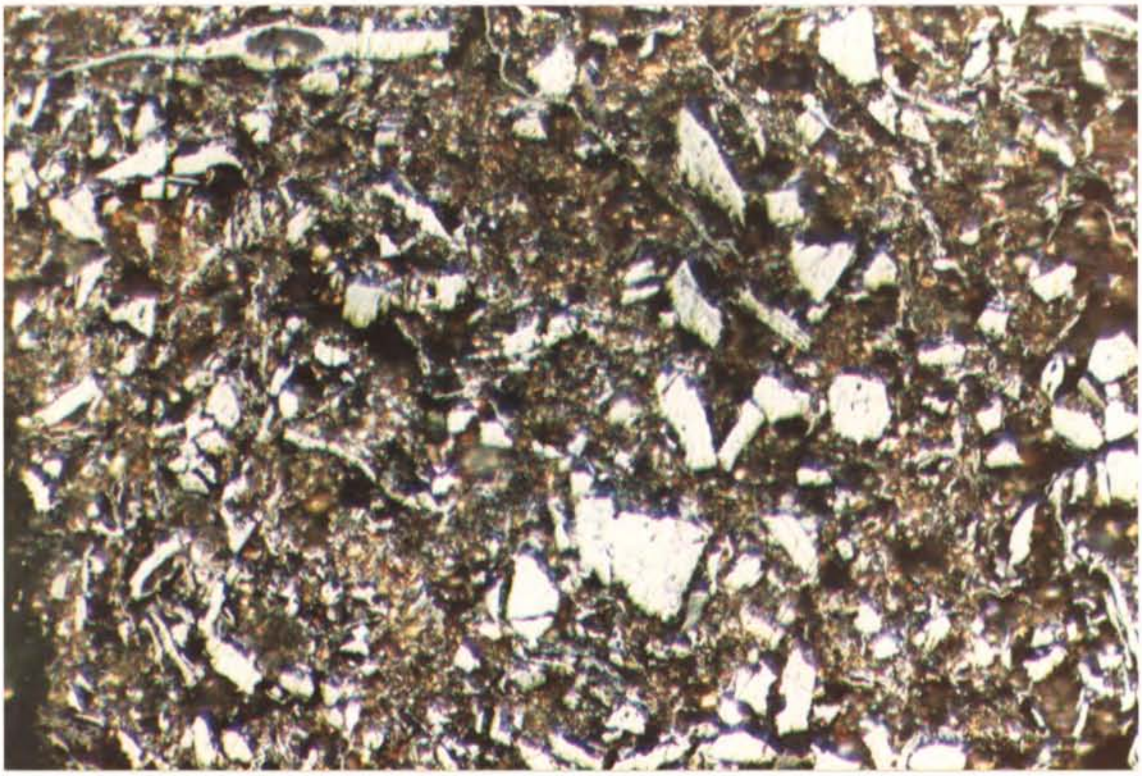

PLATE 3: 2451 m, Eocene shale Reflected Light
Kerogen concentrate consisting largely of vitrinite (grey) and exinite (dark grey).
Field Dimensions 0.43 x 0.29 mm

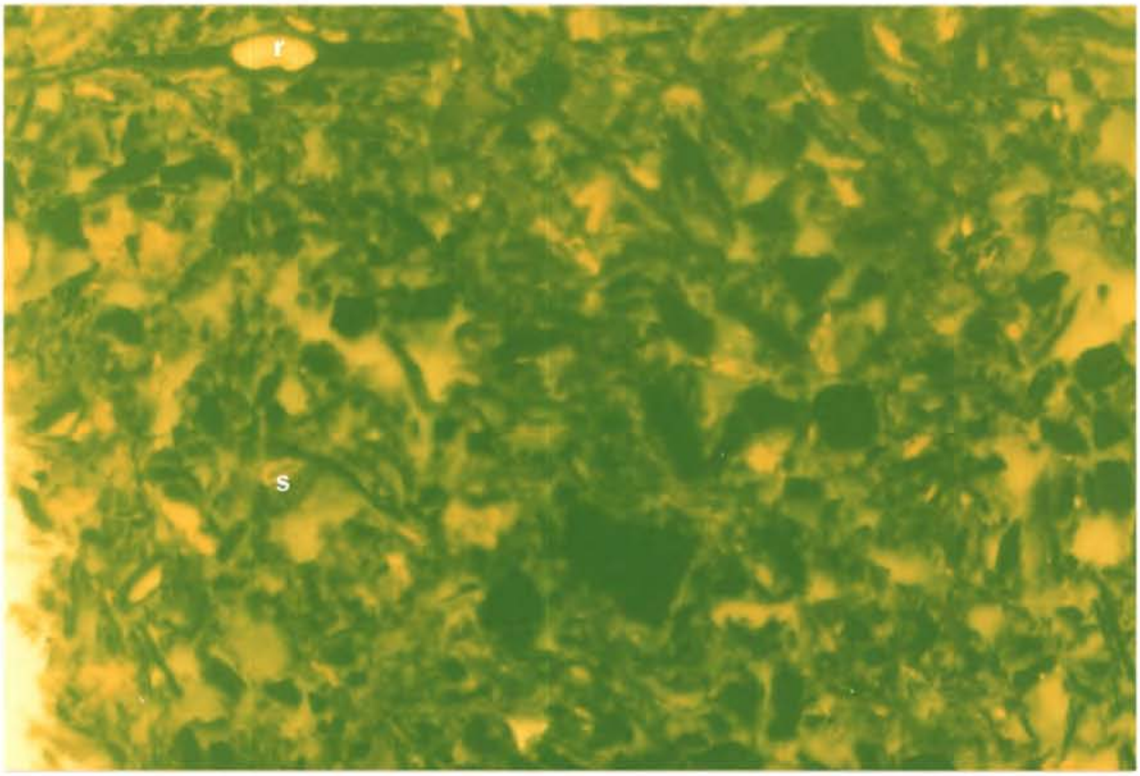

PLATE 4: Same f.o.v. as above. Fluorescence Mode
The exinite macerals in this plate are resinite (r), sporinite (s) and liptodetrinite (dispersed).

5 cm

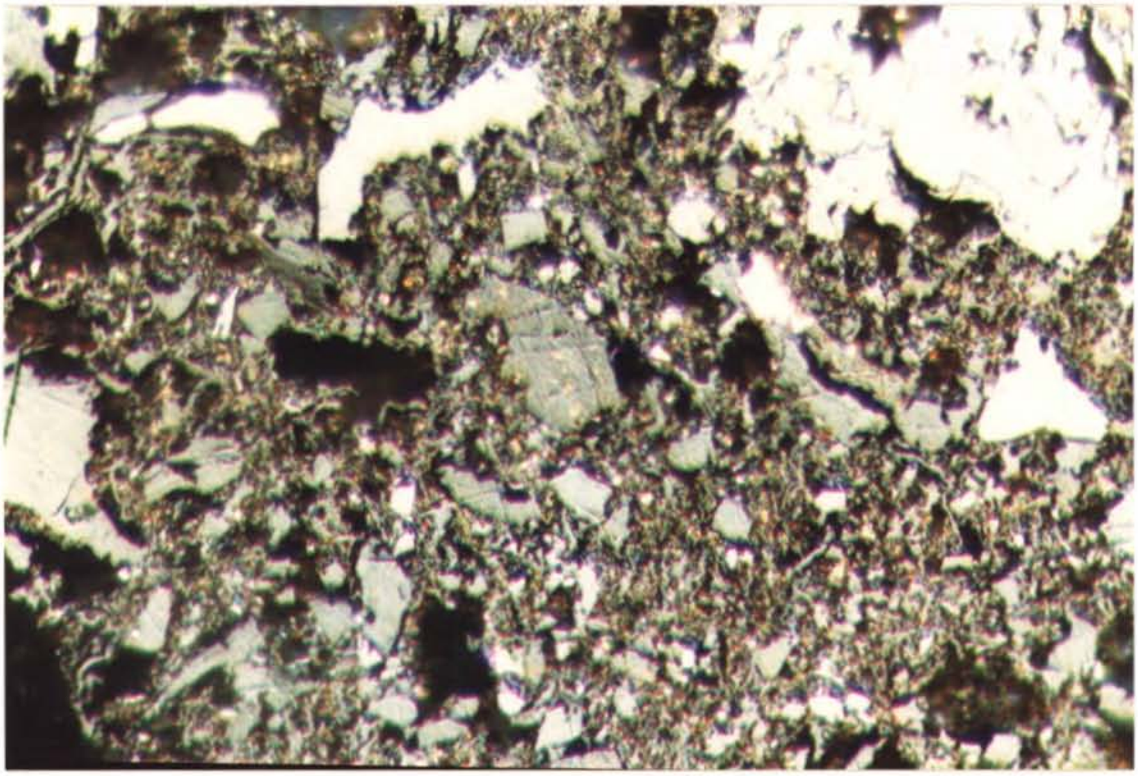

PLATE 5: 3139 m, Paleocene shale Reflected Light
This kerogen consists of inertinite (white), vitrinite (grey) and exinite (dark grey; centre and centre left).
Field Dimensions 0.26 x 0.18 mm

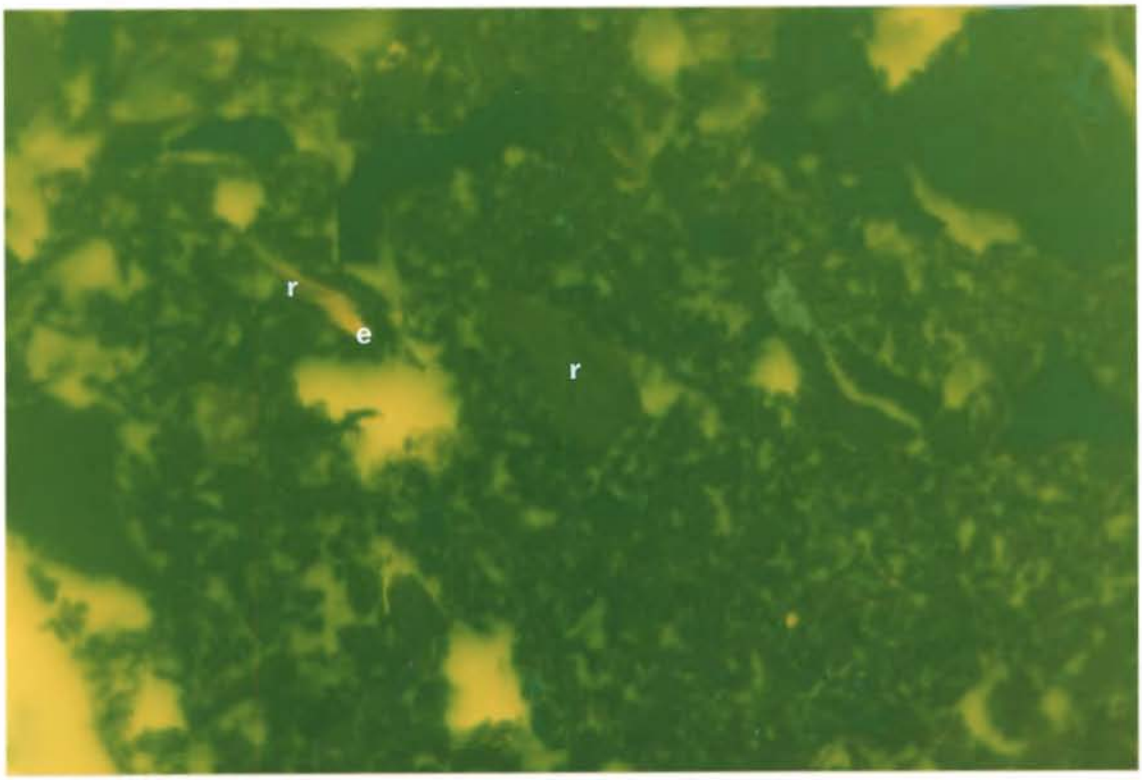

PLATE 6: Same f.o.v. as above. Fluorescence Mode
The exinite in this plate is resinite (r) and associated exsudatinite (e).

5 cm

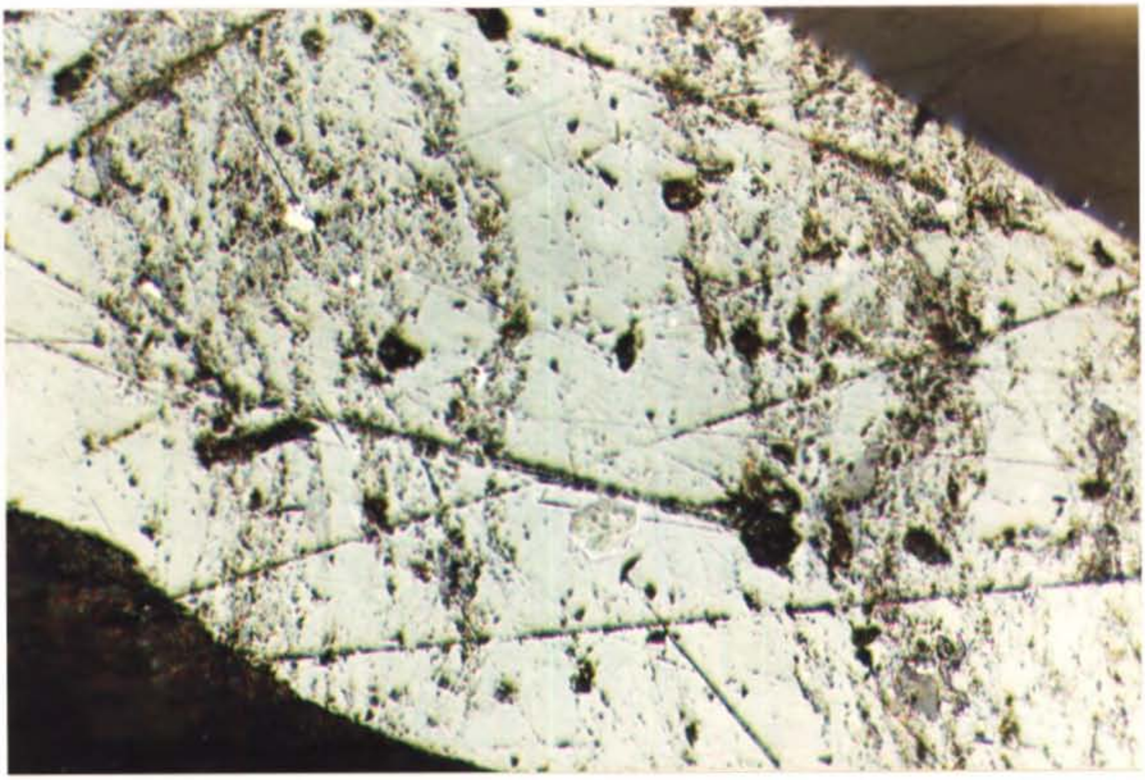

PLATE 7: 3204-13 m, Paleocene coal Reflected Light
This coal comprises mostly vitrinite (grey) and exinite (dark grey). Inertinite (white) is a minor component.
Field Dimensions 0.43 x 0.29 mm

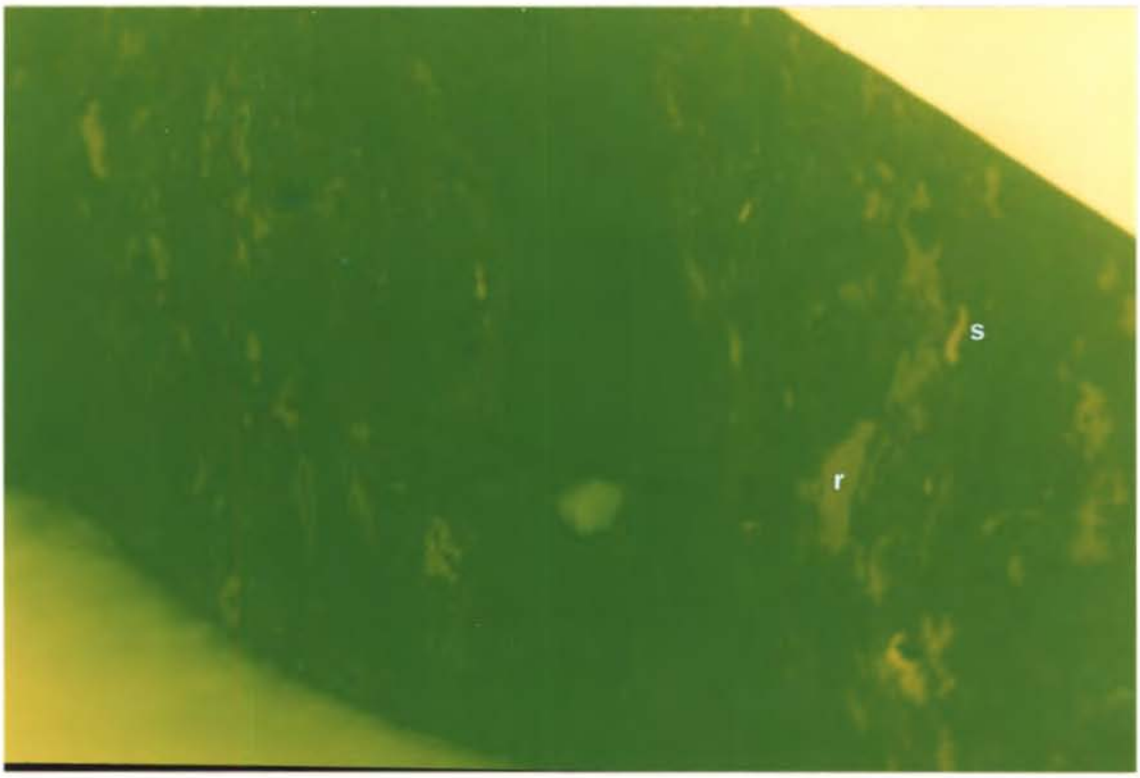

PLATE 8: Same f.o.v. as above. Fluorescence Mode
Resinite (r), sporinite (s) and liptodetrinite (dispersed) are the exinites in this field.

5 cm

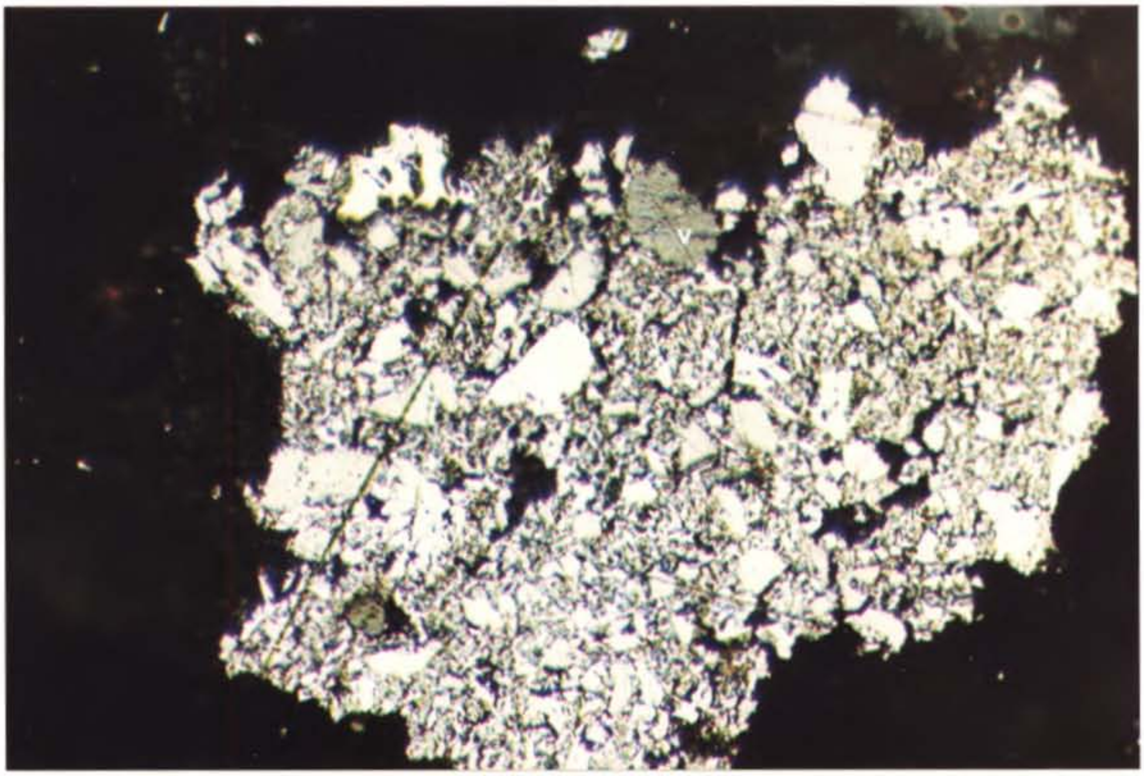

PLATE 9: 3778.1 m, Cretaceous shale Reflected Light
Inertinite (white) is much more abundant in this kerogen. Vitrinite (v) and exinite (dark grey) are the other macerals.

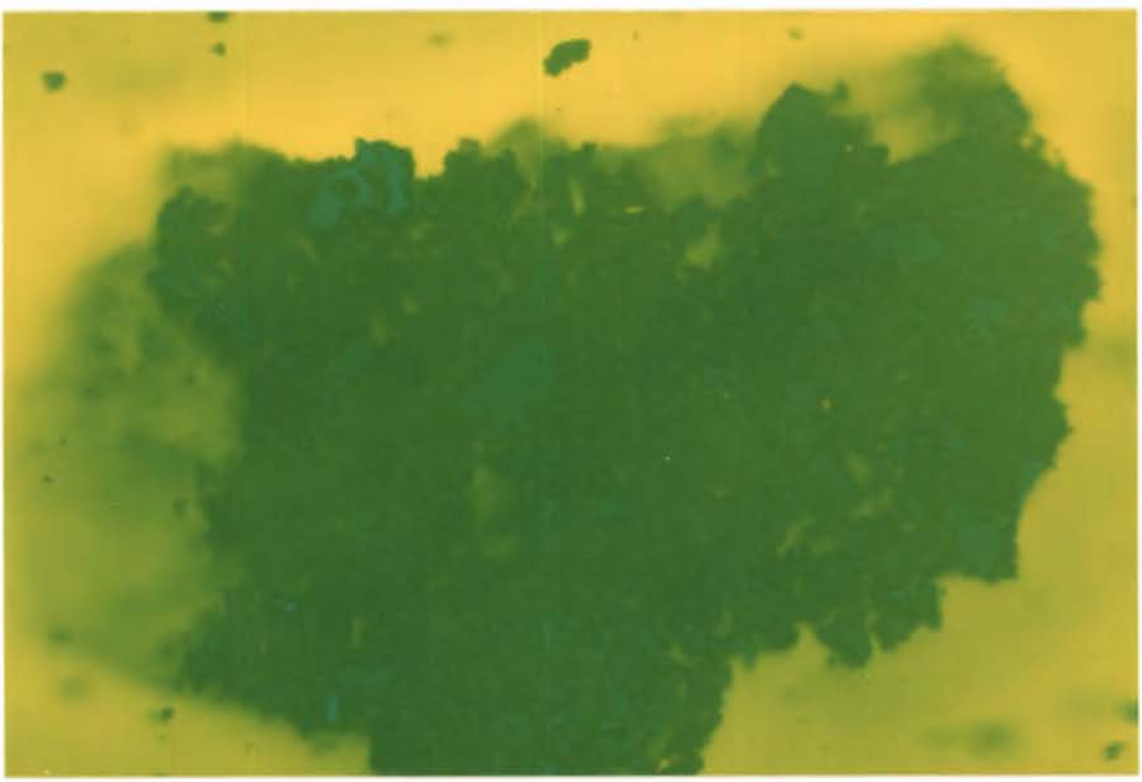

PLATE 10: Same f.o.v. as above. Fluorescence Mode
The primary exinite (sporinite) in this kerogen has a very subdued fluorescence. Minor exsudatinite associated with it (top centre) has a more intense fluorescence.

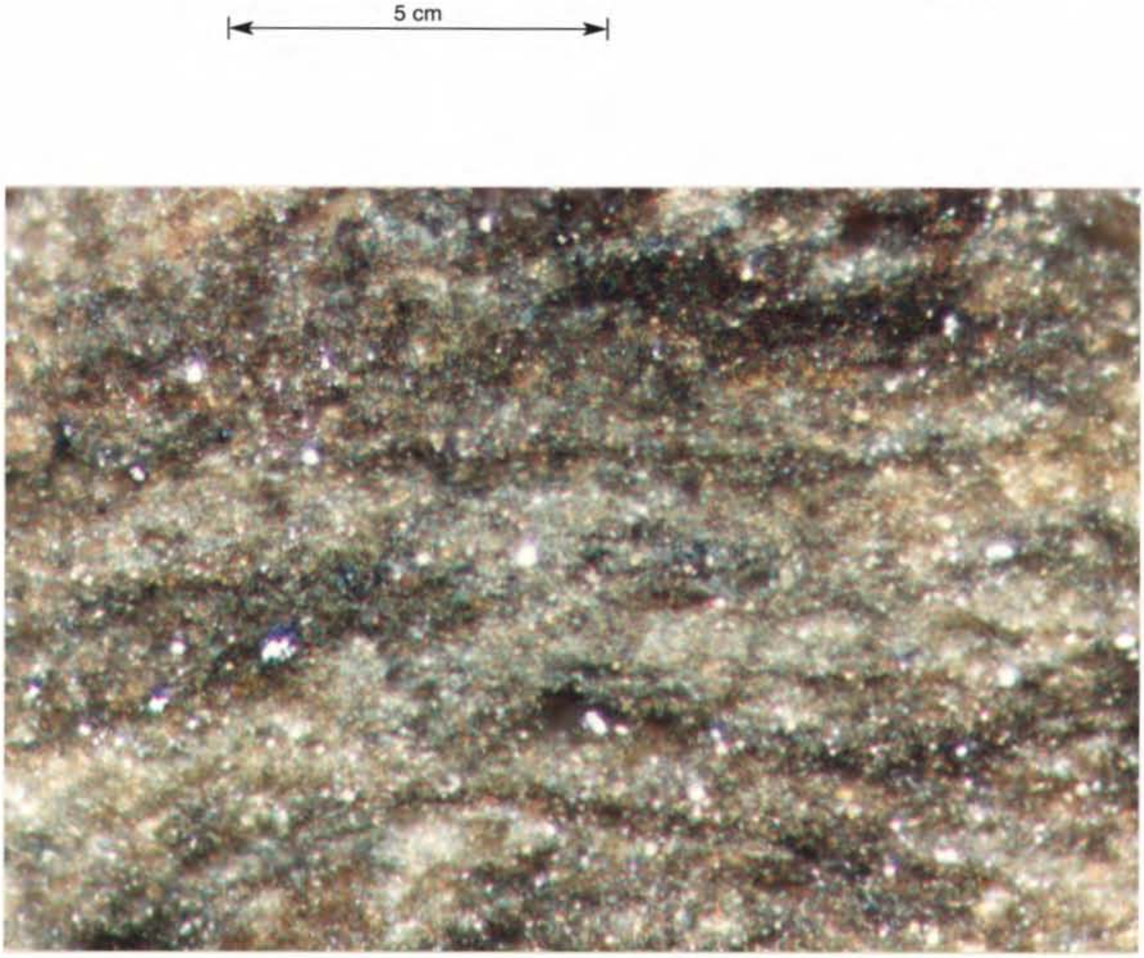

PLATE 11: 3951-60 m, Cretaceous shale Reflected Light
Organic matter in this shale consists of extensively micrinitised bituminite (diffuse bands with speckled appearance) and minor detrital inertinite (white). It has no fluorescence.

APPENDIX 3

KEROGEN PYROLYSIS-GC DATA, PELICAN-5

SUMMARY OF DATA FROM PYROLYSIS GAS CHROMATOGRAPHY

Well name: Pelican #5 Date: 07/10/86

Sample:2298.5m

Parameter	A	B	C	D
	----------	-Value*	----------	
C1-C4 abundance (all compounds)	30.52	71.130	1.034	
C5-C10 abundance (all compounds)	27.80	64.791	0.942	
C11-C31 abundance (all compounds)	41.68	97.139	1.412	
C5-C31 abundance (all compounds)	69.48	161.930	2.354	
C5-C10 abundance (alkenes + alkanes)				
C11-C31 abundance (alkenes + alkanes)				
C5-C31 abundance (alkenes + alkanes)				
C5-C31 alkene abundance				
C5-C31 alkane abundance				
C5-C10 alkane/alkene				
C11-C31 alkane/alkene				
C5-C31 alkane/alkene				
C1-C4 abundance/S2				0.305
C5-C31 abundance/S2				0.695
(C1-C4)/C5+ abundance				0.439
PI x PC x TOC				70.245
R Index				0.786
toluene/heptene				1.146

*

A = % of S2
B = mg/g Rock
C = (mg/g Rock)/TOC
D = no units
R Index = m+p-xylene/oct-1-ene
PI = Production Index
PC = Pyrolysable carbon
S2 = Rock-Eval S2 value
TOC = Total Organic Carbon
nd = no data

SUMMARY OF DATA FROM PYROLYSIS GAS CHROMATOGRAPHY

Well name: Pelican #5 | Date: 07/10/86

Sample: 2451.0m

Parameter	A	B	C	D
C1-C4 abundance (all compounds)	46.56	7.533	1.603	
C5-C10 abundance (all compounds)	27.87	4.509	0.959	
C11-C31 abundance (all compounds)	25.57	4.137	0.880	
C5-C31 abundance (all compounds)	53.44	8.647	1.840	
C5-C10 abundance (alkenes + alkanes)				
C11-C31 abundance (alkenes + alkanes)				
C5-C31 abundance (alkenes + alkanes)				
C5-C31 alkene abundance				
C5-C31 alkane abundance				
C5-C10 alkane/alkene				
C11-C31 alkane/alkene				
C5-C31 alkane/alkene				
C1-C4 abundance/S2				0.466
C5-C31 abundance/S2				0.534
(C1-C4)/C5+ abundance				0.871
PI x PC x TOC				0.403
R Index				1.684
toluene/heptene				2.006

(Column headings A–D fall under "-Value-*".)

*
A = % of S2
B = mg/g Rock
C = (mg/g Rock)/TOC
D = no units
R Index = m+p-xylene/oct-1-ene
PI = Production Index
PC = Pyrolysable carbon
S2 = Rock-Eval S2 value
TOC = Total Organic Carbon
nd = no data

SUMMARY OF DATA FROM PYROLYSIS GAS CHROMATOGRAPHY

Well name: Pelican #5 Date: 07/10/86

Sample:3139.0m

Parameter	Value* A	B	C	D
C1-C4 abundance (all compounds)	61.37	0.663	0.663	
C5-C10 abundance (all compounds)	21.76	0.235	0.235	
C11-C31 abundance (all compounds)	16.87	0.182	0.182	
C5-C31 abundance (all compounds)	38.63	0.417	0.417	
C5-C10 abundance (alkenes + alkanes)				
C11-C31 abundance (alkenes + alkanes)				
C5-C31 abundance (alkenes + alkanes)				
C5-C31 alkene abundance				
C5-C31 alkane abundance				
C5-C10 alkane/alkene				
C11-C31 alkane/alkene				
C5-C31 alkane/alkene				
C1-C4 abundance/S2				0.614
C5-C31 abundance/S2				0.386
(C1-C4)/C5+ abundance				1.589
PI x PC x TOC				0.024
R Index				3.447
toluene/heptene				3.788

*
A = % of S2
B = mg/g Rock
C = (mg/g Rock)/TOC
D = no units
R Index = m+p-xylene/oct-1-ene
PI = Production Index
PC = Pyrolysable carbon
S2 = Rock-Eval S2 value
TOC = Total Organic Carbon
nd = no data

SUMMARY OF DATA FROM PYROLYSIS GAS CHROMATOGRAPHY

Well name: Pelican #5 Date: 07/10/86

Sample:3204-13m

Parameter	A	B	C	D
	-Value*			
C1-C4 abundance (all compounds)	59.69	103.055	1.901	
C5-C10 abundance (all compounds)	21.90	37.810	0.698	
C11-C31 abundance (all compounds)	18.41	31.785	0.586	
C5-C31 abundance (all compounds)	40.31	69.595	1.284	
C5-C10 abundance (alkenes + alkanes)				
C11-C31 abundance (alkenes + alkanes)				
C5-C31 abundance (alkenes + alkanes)				
C5-C31 alkene abundance				
C5-C31 alkane abundance				
C5-C10 alkane/alkene				
C11-C31 alkane/alkene				
C5-C31 alkane/alkene				
C1-C4 abundance/S2				0.597
C5-C31 abundance/S2				0.403
(C1-C4)/C5+ abundance				1.481
PI x PC x TOC				86.883
R Index				4.101
toluene/heptene				3.609

*

A = % of S2
B = mg/g Rock
C = (mg/g Rock)/TOC
D = no units
R Index = m+p-xylene/oct-1-ene
PI = Production Index
PC = Pyrolysable carbon
S2 = Rock-Eval S2 value
TOC = Total Organic Carbon
nd = no data

SUMMARY OF DATA FROM PYROLYSIS GAS CHROMATOGRAPHY

Well name: Pelican #5 Date: 07/10/86

Sample:3778.1m

Parameter	Value* A	B	C	D
C1-C4 abundance (all compounds)	64.71	1.314	0.626	
C5-C10 abundance (all compounds)	20.46	0.415	0.198	
C11-C31 abundance (all compounds)	14.84	0.301	0.143	
C5-C31 abundance (all compounds)	35.30	0.717	0.341	
C5-C10 abundance (alkenes + alkanes)				
C11-C31 abundance (alkenes + alkanes)				
C5-C31 abundance (alkenes + alkanes)				
C5-C31 alkene abundance				
C5-C31 alkane abundance				
C5-C10 alkane/alkene				
C11-C31 alkane/alkene				
C5-C31 alkane/alkene				
C1-C4 abundance/S2				0.647
C5-C31 abundance/S2				0.353
(C1-C4)/C5+ abundance				1.833
PI x PC x TOC				0.106
R Index				4.492
toluene/heptene				4.621

*

A = % of S2
B = mg/g Rock
C = (mg/g Rock)/TOC
D = no units
R Index = m+p-xylene/oct-1-ene
PI = Production Index
PC = Pyrolysable carbon
S2 = Rock-Eval S2 value
TOC = Total Organic Carbon
nd = no data

SUMMARY OF DATA FROM PYROLYSIS GAS CHROMATOGRAPHY

Well name: Pelican #5 Date: 07/10/86

Sample:3951-3964m

Parameter	Value* A	Value* B	Value* C	Value* D
C1-C4 abundance (all compounds)	76.44	12.322	0.933	
C5-C10 abundance (all compounds)	12.63	2.036	0.154	
C11-C31 abundance (all compounds)	10.93	1.762	0.133	
C5-C31 abundance (all compounds)	23.56	3.798	0.288	
C5-C10 abundance (alkenes + alkanes)				
C11-C31 abundance (alkenes + alkanes)				
C5-C31 abundance (alkenes + alkanes)				
C5-C31 alkene abundance				
C5-C31 alkane abundance				
C5-C10 alkane/alkene				
C11-C31 alkane/alkene				
C5-C31 alkane/alkene				
C1-C4 abundance/S2				0.764
C5-C31 abundance/S2				0.236
(C1-C4)/C5+ abundance				3.244
PI x PC x TOC				2.424
R Index				26.664
toluene/heptene				23.458

*

A = % of S2
B = mg/g Rock
C = (mg/g Rock)/TOC
D = no units
R Index = m+p-xylene/oct-1-ene
PI = Production Index
PC = Pyrolysable carbon
S2 = Rock-Eval S2 value
TOC = Total Organic Carbon
nd = no data