Vitrinite Reflectance and Organic Petrology, Koorkah-1,T/18P Bass Basin

OR-0289

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Attention: Steven C. Bane
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REPORT F 6358/86

YOUR REFERENCE:	Letter received 11 December 1985
TITLE:	Vitrinite reflectance and organic petrology, Koorkah-1, T-18-P, Bass Basin
MATERIAL:	17 cuttings samples, 4 sidewall cores
LOCALITY:	KOORKAH-1
DATE RECEIVED:	11 December 1985 to 19 March 1986
WORK REQUIRED:	Vitrinite reflectance and descriptions of dispersed organic matter

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CONTENTS

1. INTRODUCTION

Seventeen cuttings samples from Koorkah-1 were received for vitrinite reflectance determinations and descriptions of dispersed organic matter over the period 11-24 December 1985. Results of these samples were reported by phone on a daily basis as work was completed.

Four sidewall core samples were received on 19 March 1986 for the same analyses. This report is a formal presentation of both sets of data on Koorkah-1.

2. ANALYTICAL PROCEDURE

Representative portions of each sample (crushed to -14+35 BSS mesh) were obtained with a sample splitter and then mounted in cold setting Glasscraft resin using a 2.5 cm diameter mould. Each 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 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 23±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.

3. RESULTS

Vitrinite reflectance determinations are summarised in Table 1. Figure 1 is a plot of vitrinite reflectance versus depth. Histogram plots of this data are presented in Appendix 1. Descriptions of the dispersed organic matter in these samples are presented in Tables 2-4. These descriptions are illustrated by a series of plates in Appendix 2.

4. DISCUSSION

4.1 Maturity

The vitrinite reflectance data (Table 1, Figure 1) indicates that the sedimentary section penetrated by Koorkah-1 is sufficiently mature for the generation of light oil from resinite-rich dispersed organic matter (DOM) below approximately 1950 metres depth (threshold VR = 0.45%; Snowdon and Powell, 1982).

Significant gas generation from woody-herbaceous DOM (vitrinite, and to a lesser extent, inertinite) commences at VR = 0.6 (Monier *et al.*, 1983). On this basis, sediments below 2800 metres depth in Koorkah-1 should be sufficiently mature to generate significant quantities of gas.

Oil generation from terrestrial organic matter rich in exinites other than resinite commences at VR ≈ 0.7% (Connan and Cassou, 1980). The top of this oil generation window occurs at approximately 2950 metres depth in Koorkah-1.

Narrow intervals of mature and overmature sediments occur above and below the sill (2095-2129 metres depth). These intervals are similar in thickness to the sill.

4.2 Organic Richness

Organic richness is generally poor in the samples examined from Koorkah-1 (Table 3), with DOM contents generally less than 1%. Organic richness is fair in the following intervals:

1996 -2005 m
2465.5-2555 m

In these samples DOM contents range up to 1-2%.

The low organic richness is in this well in comparison to other Bass Basin wells studied is largely due to the absence of the thick coaly sequences which are prolific in other parts of the basin. However, this effect is coupled with the lower organic richness of the shale and siltstone sediments in the Koorkah-1 location.

4.3 Organic Matter Type and Source Quality

Exinite contents are significantly lower in Koorkah-1 than other parts of the Bass Basin. The estimated proportions of exinite in the dispersed organic matter included in the shales, siltstones and coals, ranges from <<5% to 10% (Table 2). Only one sample contained cuttings with a greater proportion of exinite and in this case the exinite was bitumen (sandstone 1906-1915 metres depth).

Vitrinite contents are similar in this well to the shales and siltstones in wells previously examined. However, the vitrinite contents are low in the intervals 2465.5-2617 metres depth and 2905-3013 metres depth indicating a slightly more oxidising environment of deposition.

Free oil occurs in most samples below 2400 metres although this oil becomes significantly more abundant below 3050 metres depth. This oil is thought to have migrated into these sediments rather than to have been generated in situ.

Exsudatinite is present in the coals from 2806-2815 metres depth.

Bitumen is present in a large proportion of the samples below 1700 metres depth. This bitumen is likely to be a contaminant from the drilling mud (Gilsonite) in many of these samples. However, in the sidewall core sample from 3062 metres depth the bitumen occurs as small spheres (up to 0.05 mm diameter) in the silty shale and is unlikely to be a contaminant.

5. CONCLUSIONS

The vitrinite reflectance data indicates that the:

1. sediments from Koorkah-1 are sufficiently mature for the generation of:

   - light napthenic oil from resinite-rich organic matter below 1950 metres depth.

   - significant quantities of gas from vitrinite (and to a lesser extent inertinite) rich organic matter below 2800 metres depth.

   - oil from exinite-rich organic matter below 2950 metres depth.

2. Organic richness of the sediments from Koorkah-1 is generally poor although sediments with fair organic richness occur in the intervals:

   1996-2005 m
   2465-2555 m

   This low organic richness is uncharacteristic of Bass Basin wells previously examined and stems from a lack of thick coaly sequences and a lower organic content in the siltstones and shales of Koorkah-1.

3. Source potential for the generation of liquid hydrocarbons is generally poor (exinite contents <<5-10%; DOM contents <0.5-2%). Source potential for gas generation is also fairly poor with few mature sediments having vitrinite contents greater than 20% (DOM content of mature sediments range from 0.5-1%).

   The uncharacteristic low organic richness and poor source quality in the Koorkah-1 location may be linked with a lower sedimentation rate in this location (Ibach, 1982).

4. Free oil is present in most samples below 2400 metres depth although this oil becomes significantly more abundant below 3050 metres depth. The majority of this oil is thought to have migrated into this sequence rather than to have been generated in situ.

5. Exsudatinite is present in the thin coaly intervals between 2806-2815 metres depth.

6. Bitumen is present in a large proportion of the samples below 1700 metres depth. In most of these cases this bitumen is likely to be gilsonite from the drilling mud. However, the bitumen in the sidewall core from 3062 metres occurs as small spheres in the silty shale and is unlikely to have been introduced from the drilling mud.

6. REFERENCES

MONIER, F., POWELL, T.G. and SNOWDON, L.R., 1983. Qualitative and quantitative aspects of gas generation during maturation of sedimentary organic matter. Examples from Canadian Frontier basins. In : Bjoroy, M. *et al.*, (eds), *Advances in Organic Chemistry* 1981, Wiley, pp. 487-495.

SNOWDON, L.R., and POWELL, T.G., 1982. Immature oil and condensate-modification of hydrocarbon generation model for terrestrial organic matter. *Bull. Am. Assoc. Petrol. Geol.*, 66, pp. 775-778.

IBACH, L.E.J., 1982. Relationship between sedimentation rate and total organic carbon content in ancient marine sediments. *AAPG Bull.*, V66 No. 2, pp. 170-188.

TABLE 1: SUMMARY OF VITRINITE REFLECTANCE MEASUREMENTS, KOORKAH-1

Depth (m)	Mean Maximum Reflectance (%)	Standard Deviation	Range	Number of Determinations
1520-1530	0.39	0.08	0.32-0.52	28
1590-1600	0.41	0.03	0.36-0.44	7
1708-1717	0.42	0.03	0.38-0.46	15
1807-1816	0.43	0.08	0.37-0.54	19
1906-1915	0.43	0.05	0.36-0.49	7
1996-2005	0.51	0.04	0.47-0.59	15
2086-2095	-	-	-	-
2203-2212	0.58	0.05	0.50-0.71	16
2302-2311	0.53	0.04	0.46-0.66	27
2401-2410	0.49	0.03	0.42-0.54	18
2465.5+	0.55* (0.51)	0.06	0.44-0.65	23
2500-2509	-	-	-	-
2555+	-	-	-	-
2608-2617	0.59	0.03	0.53-0.63	8
2707-2716	0.56	0.03	0.52-0.62	8
2806-2815	0.65	0.04	0.55-0.75	24
2905-2914	0.64	0.01	0.63-0.65	2
3004-3013	0.69	0.07	0.53-0.76	10
3062+	0.85	0.06	0.74-0.98	36
3103-3112	0.87	0.07	0.77-1.00	21
3126+	0.85	0.06	0.69-0.85	31

*influenced by reworked vitrinite.

( )preferred value.

+SWC

TABLE 2: PERCENTAGE OF VITRINITE, INERTINITE AND EXINITE IN DISPERSED ORGANIC MATTER, KOORKAH-1

Depth (m)		Percentage of		
		Vitrinite	Inertinite	Exinite
1520-1530	Si,Sh	60	30	10
1590-1600	Ca	50	40	10
1708-1717	Si	25	70	5
1807-1816	Si	60	30	10
1906-1915	Si,Sh,Ca	10	80	10
	Sa	10	-	90
1996-2005	Sh,Si	60	30	10
2086-2095	Sa,Si	<5	90	<<5
2203-2212	Sa,Ca	10	85	<5
	Sh,Si	70	20	10
2302-2311	Sh	15	75	10
2401-2410	Si,Sh	15	75	10
2465.5+	Si	<5	85	10
2500-2509	Sh	-	90	10
2555.5+	Sh	-	90	10
2608-2617	Si,Sh	<5	85	10
2707-2716	Sa,Si	15	75	10
2806-2815	Sh,Sa	20	75	5
	C	95	-	5
2905-2914	Sa,Si	5	90	5
3004-3013	Sa,Si,Sh	5	95	<5
3062+	Sh	60	30	10
3103-3112	Sh	10	85	5
3126+	Sh	30	60	10

Key

Sh Shale
Si Siltstone
C Coal
Cs Carbonaceous Shale
Ca Carbonate
Sa Sandstone
+SWC

TABLE 3: ORGANIC MATTER TYPE AND ABUNDANCE, KOORKAH-1

Depth (m)	Exinite Macerals	Estimated Volume of DOM	Exinites
1520-1530	spo,lipto,cut,phyto	≈0.5	Ra
1590-1600	phyto,lipto	≈0.5	Ra-Vr
1708-1717	bmite,phyto,spo	0.5-1	Vr
1807-1816	res,cut,spo,sub	0.5-1	Ra
1906-1915	bmen,spo,cut	0.5-1	Ra
1996-2005	spo,lipto,cut,res,bmite	1-2	Ra
2086-2095	bmen	0.5-1	Tr
2203-2212	spo,cut,lama,res,tela	<0.5	Ra
2302-2311	phyto,lipto,spo,cut,thuc	0.5-1	Ra
2401-2410	lipto,lama,spo,res,cut,phyto,bmen, thuc,?oil	0.5-1	Ra
2465.5+	spo,lama,cut,?tela,res,?oil	≈1	Ra-Vr
2500-2509	lama,lipto,phyto,tela,spo,?oil	≈1	Ra
2555+	lama,tela,?oil,spo	≈1	Ra
2608-2617	lipto,lama,spo,cut,phyto,tela,bmen, ?oil	0.5-1	Ra
2707-2716	lama,lipto,bmen,?oil	≈0.5	Ra-Vr
2806-2815	lama,lipto,spo,exs,cut,tela	≈0.5	Vr
2905-2914	lama,lipto,spo,cut,?phyto,bmen	≈0.5	Vr
3004-3013	lama,lipto,spo,cut,?phyto,bmen	<0.5	Vr
3062+	?oil,spo,cut,sub,bmen	≈0.5	Ra-Vr
3103-3112	oil,spo,bmen,cut,bmite	0.5-1	Ra
3162+	spo,bmen,?oil,lama	0.5-1	Ra-Vr

+SWC

TABLE 4: EXINITE MACERAL ABUNDANCE AND FLUORESCENCE CHARACTERISTICS

Depth (m)	Exinite Macerals	Lithology/Comments
1520-1530	spo(Ra;mY-dO),lipto(Vr;mO),?phyto(Tr;mY)	chiefly sandy siltstone, ≈5% shale, ≈5% carbonate; some sporinite appears to be oxidised.
1590-1600	phyto(Ra-Vr;iY),lipto(Vr;iY)	carbonate.
1708-1717	bmite(Vr-Tr;dO),phyto(Vr;mY),spo(Tr;mO)	siltstone.
1807-1816	res(Ra;iG-mO),cut(Ra;mO),spo(Ra;mO),sub(Vr;dO)	50-60% sandstone, 40-50% siltstone.
1906-1915	bmen(Ra;dO-dB),spo(Vr;mY-mO),cut(Vr;mO)	chiefly siltstone and shale, ≈30% sandstone, ≈20% carbonate. Bitumen is interstitial to quartz in the sandstone.
1996-2005	spo(Ra;mY-mO),lipto(Ra;mO-dO),cut(Vr;mO),res(Vr;iY),bmite(Vr;dO)	shale and siltstone.
2086-2095	bmen(Tr;dB)	chiefly sandstone, 10-15% siltstone. DOM is over-mature.
2203-2212	spo(Ra;mY-mO),cut(Ra;mY-mO),lama(Vr;mO),res(Tr;mY),tela(Tr;mY-mO)	chiefly sandstone, 10-20% siltstone and shale, ≈5% intrusives (?cavings).
2302-2311	phyto(Ra;iY),lipto(Ra;mY-mO),spo(Vr;mY-mO),cut(Vr;mO),thuc(Tr;dO)	chiefly shale with silty bands ≈5% carbonate, <5% sandstone. Thucholite is evidence of oil migration.
2401-2410	lipto(Ra;mY-mO),lama(Ra;mO),spo(Vr;mO),res(Vr;iY-mO),cut(Vr;dO),phyto(Vr;mY);bmen(Vr;dO),thuc(Tr;dO),?oil(Tr;iY-iO)	chiefly siltstone and shale, <5% carbonate. ?Oil and bmen occur in sandier siltstones.
2465.5	spo(Ra-Vr;mO),lama(Ra-Vr; mY-mO),cut(Vr;mO),?tela(Vr;iO),res(Vr-Tr;iY-mO),?oil(Tr;iY)	silty shale, telaginite as appears to be biodegraded and may be Botryococcus-related.
2500-2509	lama(Ra;mO),lipto(Ra;mY-mO),phyto(Vr;iY),tela(Vr;iY),spo(Vr;dO),?oil(Tr;iY-iO)	shale; ?oil as above. Sporinite is oxidised.

.../cont.

TABLE 4: (Continued)

Depth (m)	Exinite Macerals	Lithology/Comments
2555	lama(Ra;mD),tela(Vr;iD-mD),?oil(Vr-Tr;iG-iY),spo(Tr;mY-mD)	siltstone; telalginite appears to be biodegraded and may be Botryococcus-related.
2608-2617	lipto(Ra;mY-mD),lama(Ra;mD),spo(Vr;mY),cut(Vr;mD),phyto(Tr;iY),tela(Tr;iY-iD),bmen(Tr;dD),?oil(Tr;iG-iY)	siltstone and shale.
2707-2716	lama(Ra-Vr;mD),lipto(Vr-Tr;mD),bmen(Tr;dD),?oil(Tr;iG-iY)	chiefly silty sandstone, 5-10% siltstone. Oil and bitumen occur in the sandstones.
2806-2815	lama(Vr;mD),lipto(Vr;mY-mD),spo(Vr-Tr;mY-mD),exs(Vr-Tr;iG-iY),cut(Tr;mY-mD),tela(Tr;mY-mD)	chiefly fine-grained sandstone, ≈5% shale, <5% coal; exsudatinite occurs in the coals.
2905-2914	lama(Vr;mD),lipto(Vr;mD),spo(Tr;mD),cut(Tr;mD),phyto(Tr;iY)bmen(Tr;dB)	chiefly fine-grained sandstone, ≈5 carbonate-rich siltstone.
3004-3013	bmite(Vr;dD-dB),lipto(Vr;mD),?oil(Vr-Tr;iG)	chiefly sandstone, ≈5% siltstone and shale; oil occurs in both sandstone and siltstone cuttings
3062	?oil(Ra-Vr;iY),spo(Ra-Vr;mD-NoFl),cut(Tr;dD),sub(Tr;NoFl),bmen(Tr;dD-dB)	silty shale with coal fragments (up to 0.1 mm). Exinite consists largely of ?oil. Some sporinite and cutinite are oxidised.
3103-3112	oil(Ra;iY),spo(Vr;mD-dD),bmen(Vr;dD),cut(Vr;mD-dD),bmite(Vr;dB-NoFl)	shale with silty bands and lenses; oil and bitumen generally occurs in the silty bands.
3126	spo(Ra-Vr;dD),bmen(Ra-Vr;dD-dB),?oil(Vr;iY),lama(Tr;mD-dD)	shale with siltstone bands; oil and bitumen are more common in the siltstone bands. Bitumen occurs as spheres (up to 0.05 mm diameter).

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	i	Intense
Y	Yellow	m	Moderate
O	Orange	d	Dull
B	Brown		

FIGURE 1

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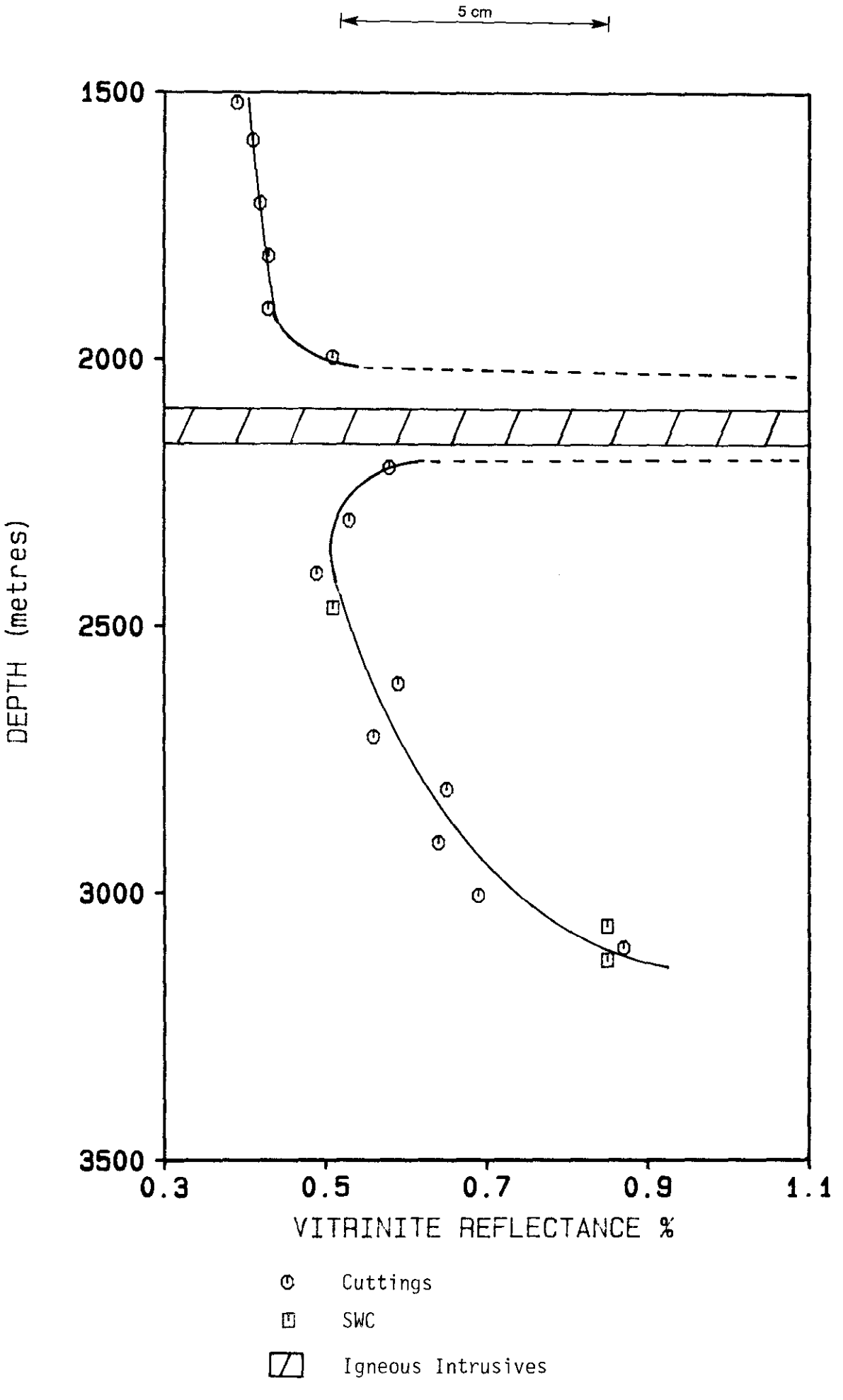
VITRINITE REFLECTANCE Vs. DEPTH PLOT, KOORKAH-1



APPENDIX 1

Histograms of Vitrinite Reflectance Determinations

KOORKAH #1

1520-1530 M

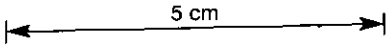
SORTED LIST

.32 .34 .36 .38 .38 .38 .38 .4 .4 .4
.4 .4 .4 .4 .4 .42 .42 .42 .42 .42
.42 .42 .42 .44 .44 .48 .52 .52
Number of values= 28

MEAN OF VALUES .411
STD DEVIATION .043

HISTOGRAM OF RESULTS
Values are reflectance multiplied by 100

32 - 34 |
35 - 37 |
38 - 40 |
41 - 43 |
44 - 46 |
47 - 49 |
50 - 52 |



KOORKAH #1

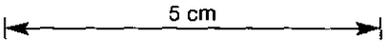
1590-1600 M

SORTED LIST
.36 .38 .42 .42 .44 .44
Number of values= 6

MEAN OF VALUES .41
STD DEVIATION .03

HISTOGRAM OF RESULTS
Values are reflectance multiplied by 100

36 - 38 |
39 - 41 |
42 - 44 |



KOORKAH #1

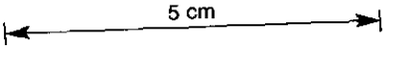
1708-1717 M

SORTED LIST
.38 .38 .38 .4 .4 .42 .42 .44 .44 .46
.46 .48 .48 .52 .52
Number of values= 15

MEAN OF VALUES .439
STD DEVIATION .046

HISTOGRAM OF RESULTS
Values are reflectance multiplied by 100

38 - 40 | ▒▒▒▒
41 - 43 | ▒▒
44 - 46 | ▒▒▒▒
47 - 49 | ▒▒
50 - 52 | ▒▒



KOORKAH #1

1807-1816 M

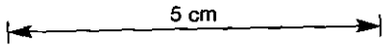
SORTED LIST

.37 .37 .38 .39 .39 .39 .41 .41 .42 .42
.43 .46 .49 .49 .5 .5 .52 .52 .54
Number of values= 19

MEAN OF VALUES .442
STD DEVIATION .056

HISTOGRAM OF RESULTS
Values are reflectance multiplied by 100

37 - 39 |
40 - 42 |
43 - 45 |
46 - 48 |
49 - 51 |
52 - 54 |



281020

KOORKAH #1

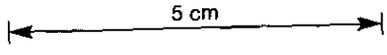
1906-1915 M

SORTED LIST
.36 .39 .4 .43 .47 .49 .49
Number of values= 7

MEAN OF VALUES .433
STD DEVIATION .048

HISTOGRAM OF RESULTS
Values are reflectance multiplied by 100

36 - 38 | ▒
39 - 41 | ▒▒
42 - 44 | ▒
45 - 47 | ▒
48 - 50 | ▒▒



281021

KOORKAH #1

1996-2005 M

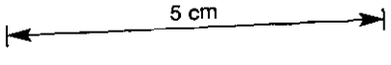
SORTED LIST

.47 .47 .47 .49 .49 .49 .51 .51 .51 .52
.53 .53 .54 .58 .59
Number of values= 15

MEAN OF VALUES .513
STD DEVIATION .035

HISTOGRAM OF RESULTS
Values are reflectance multiplied by 100

47 - 49 |
50 - 52 |
53 - 55 |
56 - 58 |
59 - 61 |



KOORKAH #1

2203-2212 M

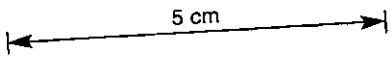
SORTED LIST

.5 .54 .54 .55 .55 .56 .57 .57 .58 .59
.6 .6 .61 .61 .63 .71
Number of values= 16

MEAN OF VALUES .582
STD DEVIATION .046

HISTOGRAM OF RESULTS
Values are reflectance multiplied by 100

50 - 52	▒
53 - 55	▒▒▒▒
56 - 58	▒▒▒▒
59 - 61	▒▒▒▒▒
62 - 64	▒
65 - 67	
68 - 70	
71 - 73	▒



KOORKAH #1

2302-2311 M

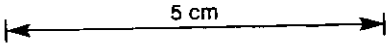
SORTED LIST

.46 .47 .49 .49 .5 .5 .5 .5 .51 .51
.51 .52 .52 .52 .52 .52 .53 .53 .53 .54
.55 .55 .56 .57 .57 .59 .67
Number of values= 27

MEAN OF VALUES .527
STD DEVIATION .041

HISTOGRAM OF RESULTS
Values are reflectance multiplied by 100

46 - 48 | ▓▓
49 - 51 | ▓▓▓▓▓▓▓▓▓▓
52 - 54 | ▓▓▓▓▓▓▓▓▓▓
55 - 57 | ▓▓▓▓▓
58 - 60 | ▓
61 - 63 |
64 - 66 |
67 - 69 | ▓



KOORKAH #1

2401-2410 M

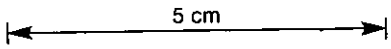
SORTED LIST

.42 .45 .45 .46 .47 .47 .48 .49 .49 .5
.5 .5 .51 .51 .52 .52 .53 .54
Number of values= 18

MEAN OF VALUES .489
STD DEVIATION .031

HISTOGRAM OF RESULTS
Values are reflectance multiplied by 100

42 - 44	▒
45 - 47	▒▒▒▒▒
48 - 50	▒▒▒▒▒▒
51 - 53	▒▒▒▒▒
54 - 56	▒



KOORKAH #1

2465.5 M

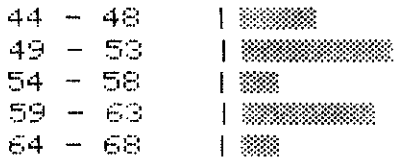
SORTED LIST

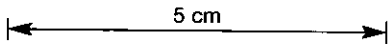
.44	.47	.48	.48	.49	.5	.5	.51	.53	.53
.53	.53	.56	.56	.59	.59	.59	.6	.6	.61
.63	.64	.65							

Number of values= 23

MEAN OF VALUES .548
STD DEVIATION .058

HISTOGRAM OF RESULTS
Values are reflectance multiplied by 100





KOORKAH #1

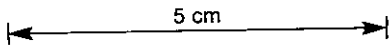
2608-2617 M

SORTED LIST
.53 .54 .56 .59 .59 .61 .62 .63
Number of values= 8

MEAN OF VALUES .584
STD DEVIATION .035

HISTOGRAM OF RESULTS
Values are reflectance multiplied by 100

53 - 55 | ▒▒
56 - 58 | ▒
59 - 61 | ▒▒▒
62 - 64 | ▒▒



KOORKAH #1

2707-2716 M

SORTED LIST

.52 .53 .55 .55 .56 .56 .57 .62

Number of values= 8

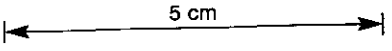
MEAN OF VALUES .558

STD DEVIATION .028

HISTOGRAM OF RESULTS

Values are reflectance multiplied by 100

```
52 - 54    | ▒▒
55 - 57    | ▒▒▒▒▒
58 - 60    |
61 - 63    | ▒
```



KOORKAH #1

2806-2815 M

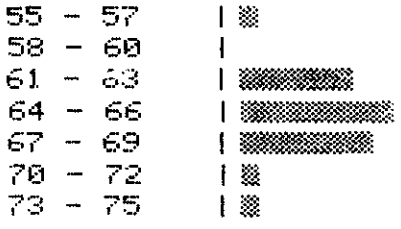
SORTED LIST

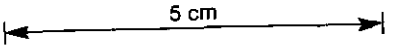
.55	.61	.61	.62	.62	.63	.63	.64	.65	.65
.65	.65	.65	.66	.66	.67	.67	.67	.67	.68
.68	.69	.71	.75						

Number of values= 24

MEAN OF VALUES .653
STD DEVIATION .038

HISTOGRAM OF RESULTS
Values are reflectance multiplied by 100





KOORKAH #1

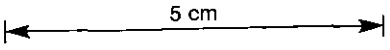
2905-2914 M

SORTED LIST
.63 .65
Number of values= 2

MEAN OF VALUES .64
STD DEVIATION .01

HISTOGRAM OF RESULTS
Values are reflectance multiplied by 100

63 - 65 |▒▒



KOORKAH #1

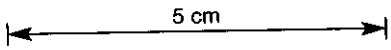
3004-3013 M

SORTED LIST
.53 .63 .69 .69 .69 .7 .74 .75 .76
Number of values= 9

MEAN OF VALUES .687
STD DEVIATION .067

HISTOGRAM OF RESULTS
Values are reflectance multiplied by 100

```
53 - 55    | ▒
56 - 58    |
59 - 61    |
62 - 64    | ▒
65 - 67    |
68 - 70    | ▒▒▒▒
71 - 73    |
74 - 76    | ▒▒▒
```



KOORKAH #1

3062 M ;SWC

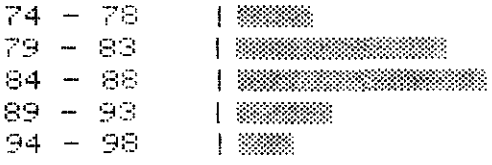
SORTED LIST

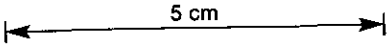
.74	.74	.75	.77	.79	.8	.8	.81	.81	.82
.82	.82	.82	.83	.83	.84	.84	.84	.84	.85
.86	.86	.86	.87	.87	.87	.87	.87	.89	.89
.89	.9	.9	.96	.96	.98				

Number of values= 36

MEAN OF VALUES .846
STD DEVIATION .055

HISTOGRAM OF RESULTS
Values are reflectance multiplied by 100





KOORKAH #1

3103-3112 M

SORTED LIST

.77	.79	.79	.8	.81	.81	.83	.84	.84	.85
.85	.85	.86	.89	.91	.93	.93	.96	.97	.99

1

Number of values= 21

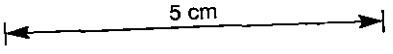
MEAN OF VALUES .87

STD DEVIATION .068

HISTOGRAM OF RESULTS

Values are reflectance multiplied by 100

77 - 79	▒▒
80 - 82	▒▒
83 - 85	▒▒▒▒
86 - 88	▒
89 - 91	▒
92 - 94	▒
95 - 97	▒
98 - 100	▒



KOORKAH #1

3126 M ;SWC

SORTED LIST

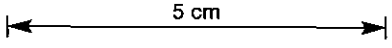
.69 .76 .77 .78 .78 .78 .79 .79 .8 .81
.81 .82 .83 .84 .84 .85 .86 .87 .88 .88
.89 .89 .89 .89 .9 .9 .91 .92 .93 .95
.95

Number of values= 31

MEAN OF VALUES .847
STD DEVIATION .062

HISTOGRAM OF RESULTS
Values are reflectance multiplied by 100

69 - 73 |
74 - 78 |
79 - 83 |
84 - 88 |
89 - 93 |
94 - 98 |



APPENDIX 2

Plates

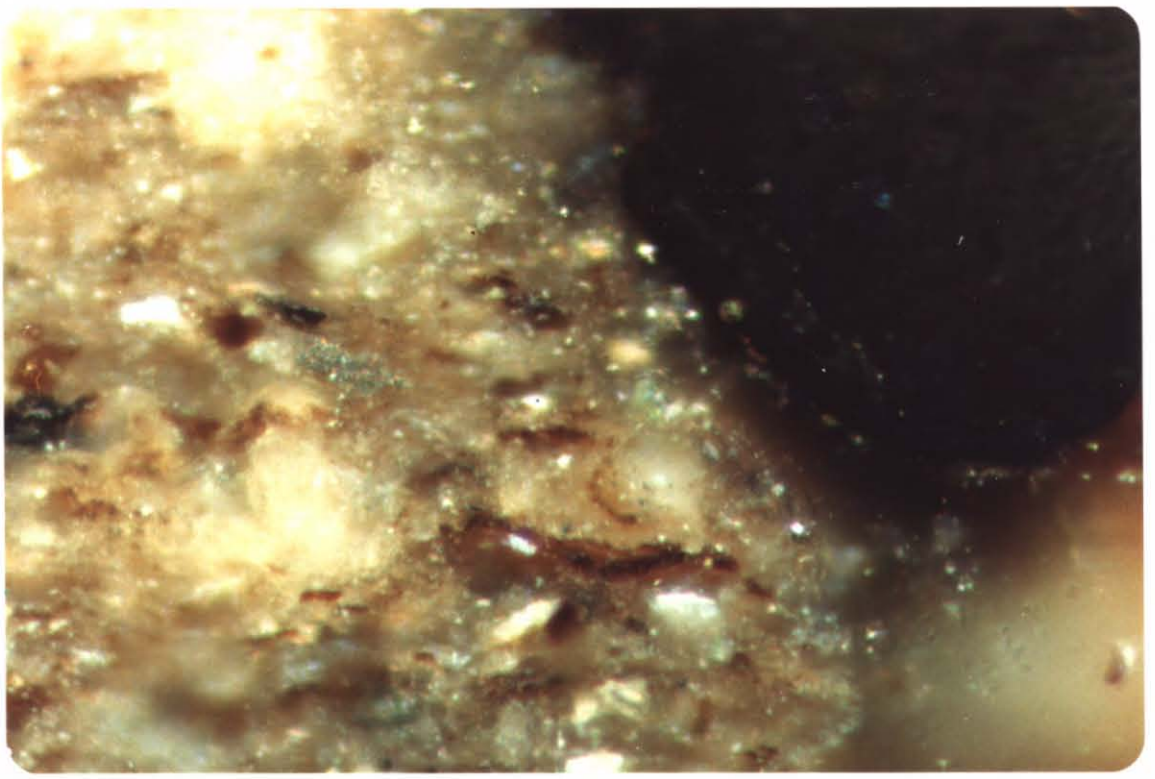


PLATE 1: 1906-1915 m Reflected Light
Bitumen (top right) occurs adjacent to a siltstone fragment (left) containing inertinite (light grey/white) and oxidised exinite (brown).
Field Dimensions 0.26 x 0.18 mm

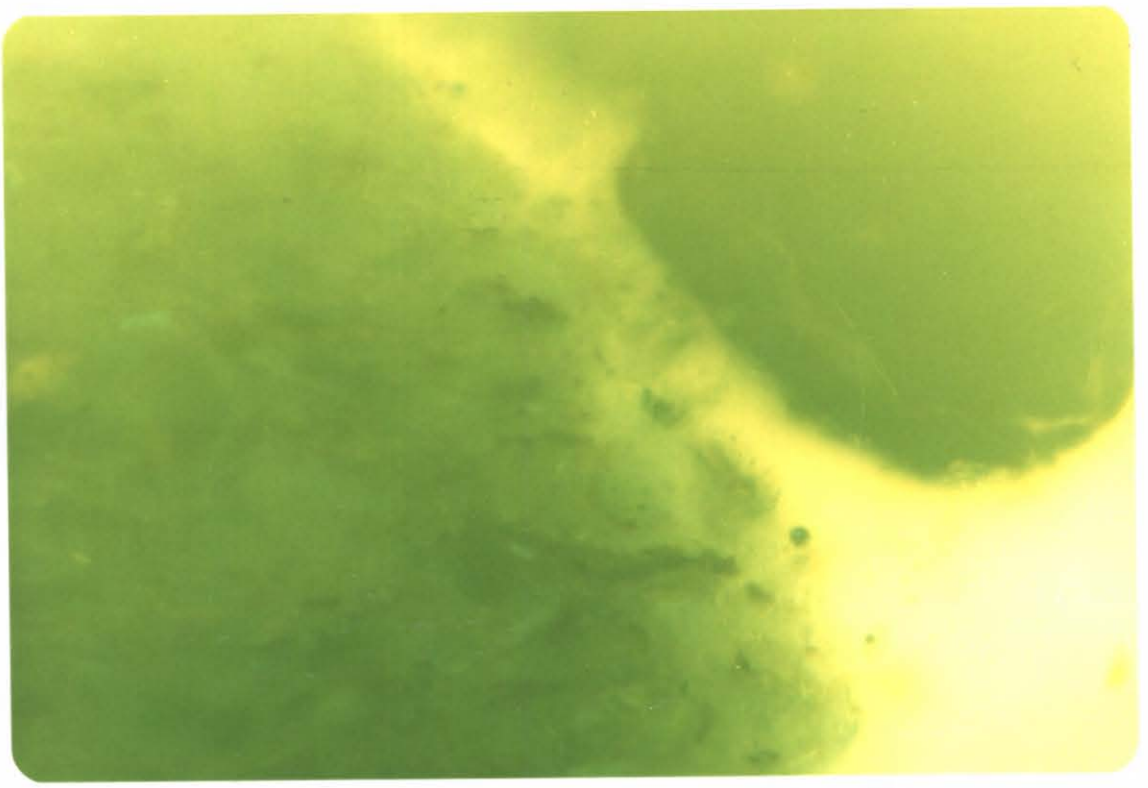


PLATE 2: 1906-1915 m Fluorescence Mode
The bitumen and exinite have a dull brown fluorescence. This fluorescence colour is duller than expected at this maturity and is therefore indicative of oxidation.

5 cm

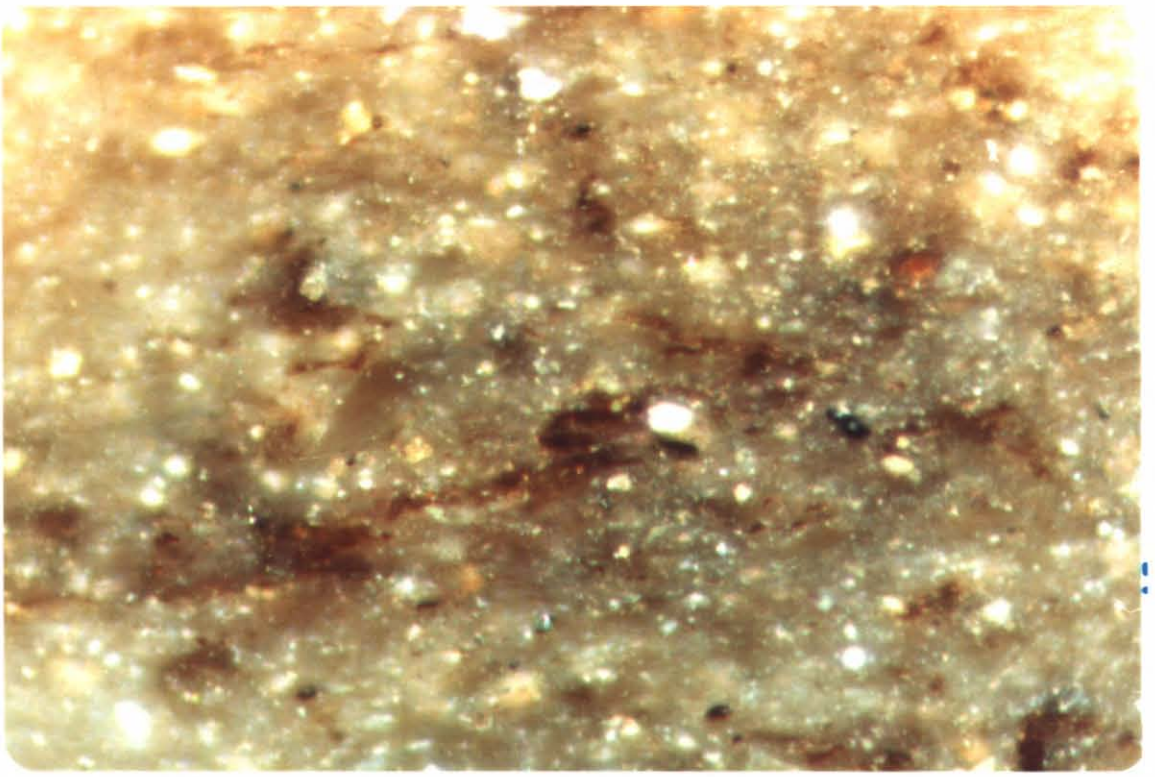


PLATE 3: 1996-2005 m Reflected Light
Exinite (brown) in this shale is largely liptodetrinite (fragmented exinite) and occurs here with inertinite (light grey-white).
Field Dimensions 0.26 x 0.18 mm

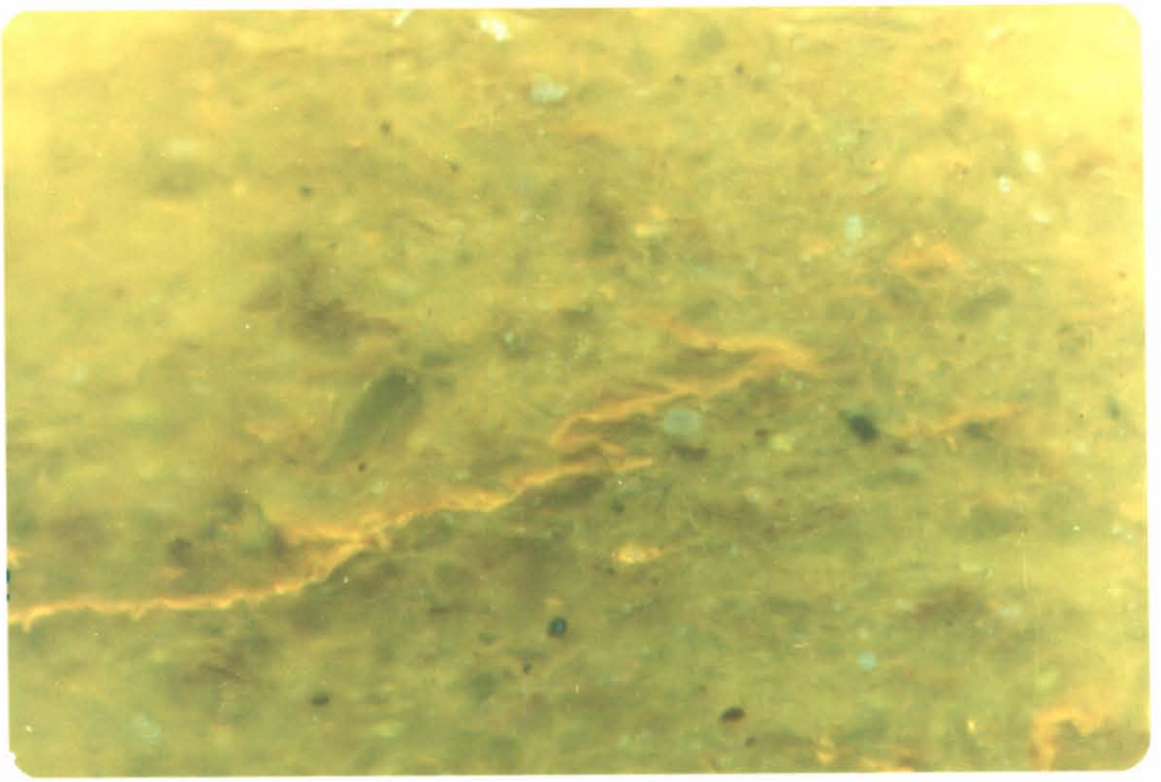


PLATE 4: 1996-2005 m Fluorescence Mode
Cutinite (lower left to centre) is more easily distinguished in fluorescence mode and has a moderate yellow to moderate orange fluorescence.

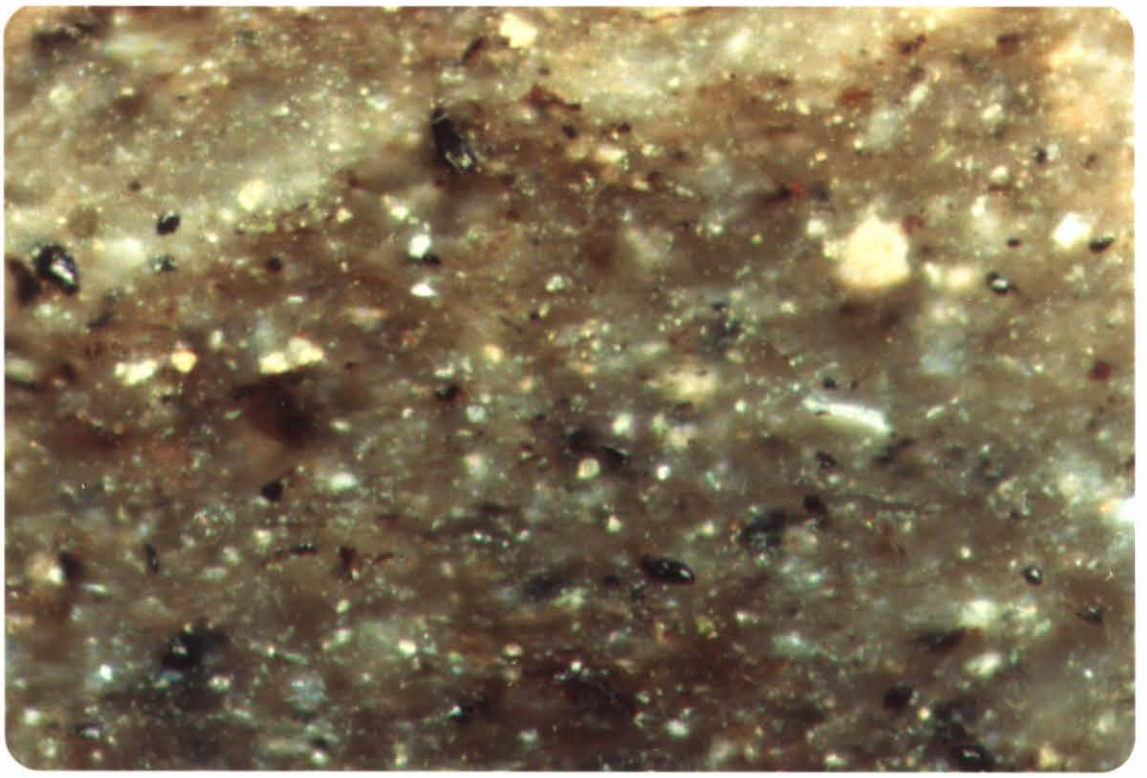


PLATE 5: 2806-2815 m Reflected Light
The majority of the organic matter in this shale fragment is inertinite (white). Exinite (brown) and vitrinite (grey) are less common.
Field Dimensions 0.26 x 0.18 mm

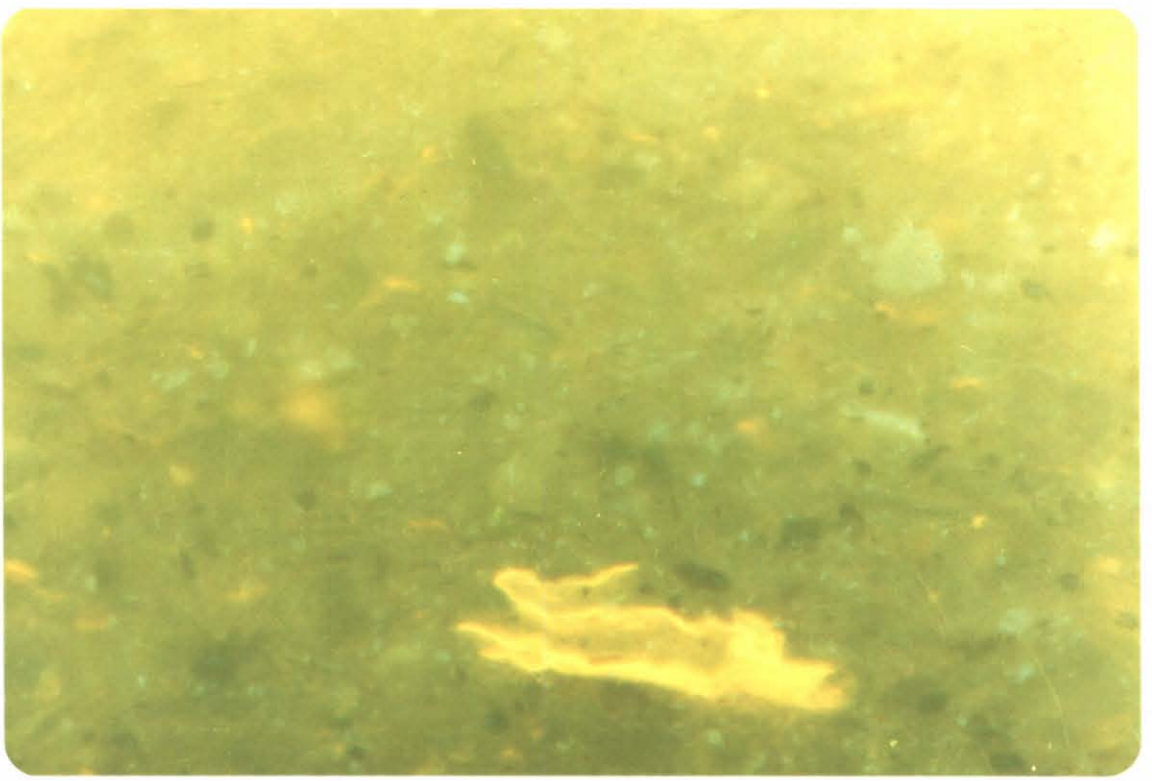


PLATE 6: 2806-2815 m Fluorescence Mode
The exinite macerals present are lamalginite (centre bottom) and liptodetrinite (dispersed).

5 cm

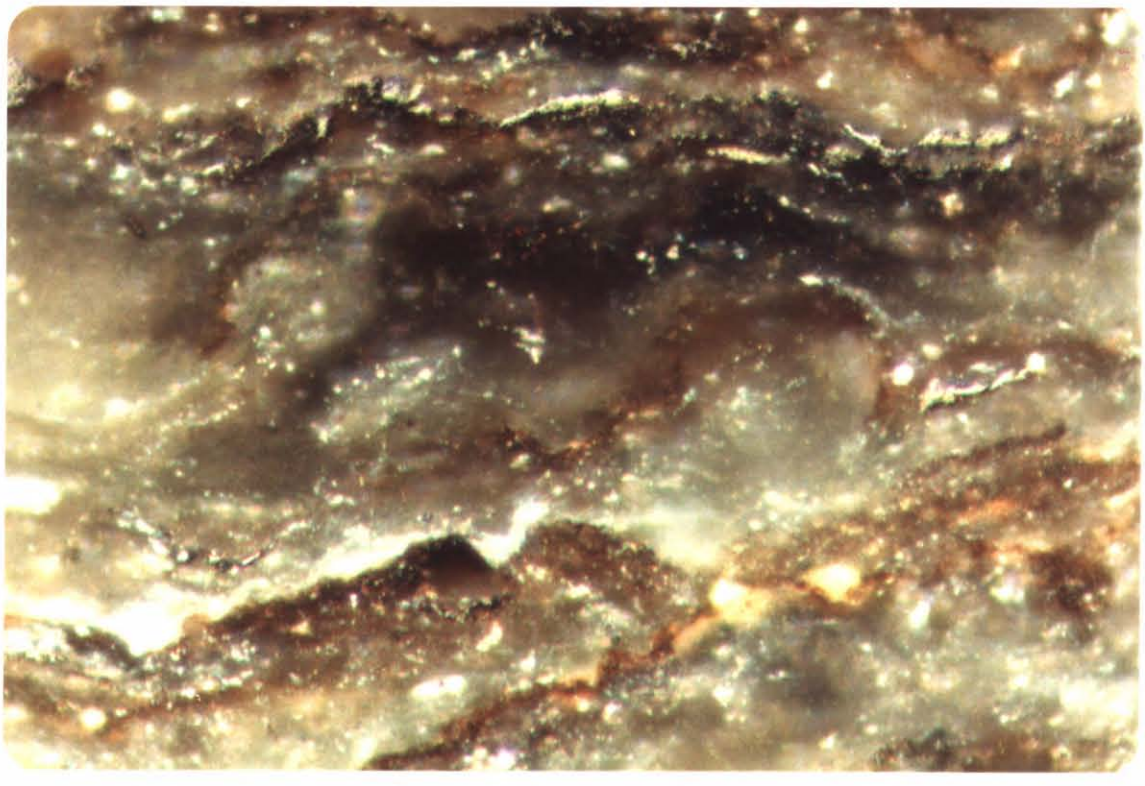


PLATE 7: 3103-3112 m Reflected Light
Oil appears to have migrated through the silty band (centre) in this inertinite (white) rich shale.
Field Dimensions 0.26 x 0.18 mm

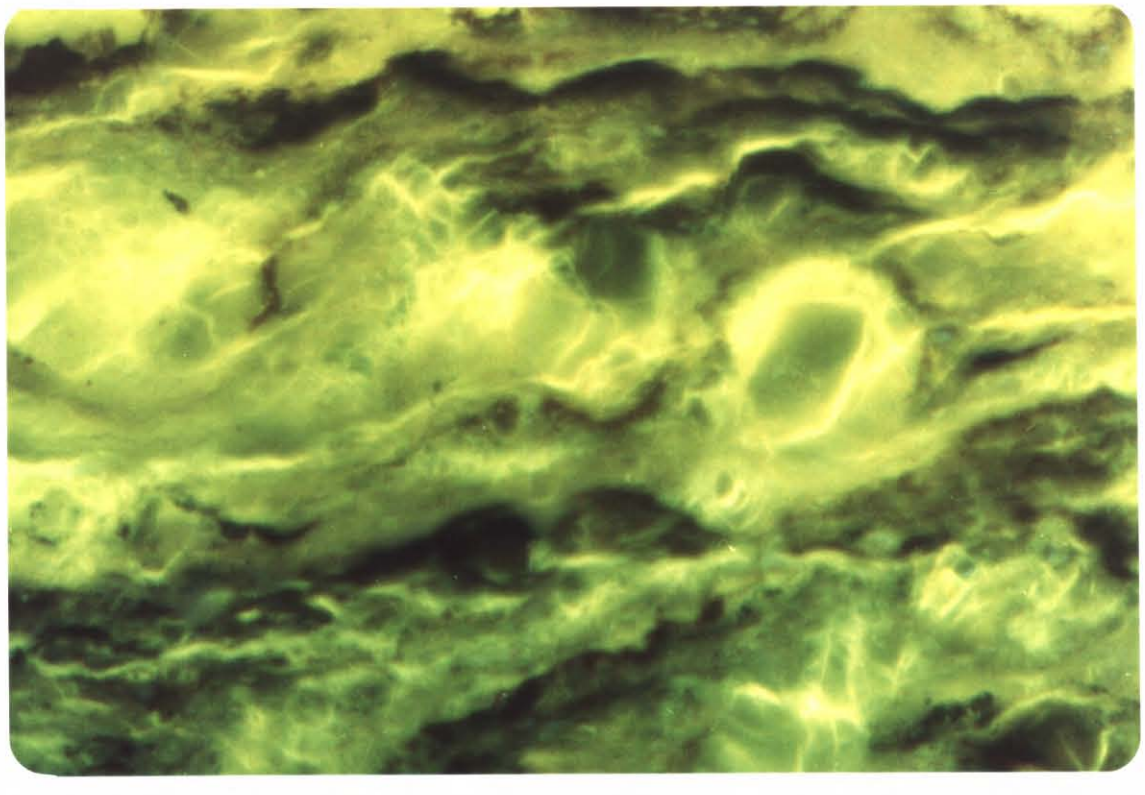


PLATE 8: 3103-3112 m Fluorescence Mode
The intense fluorescence of this oil is quite distinctive.

5 cm

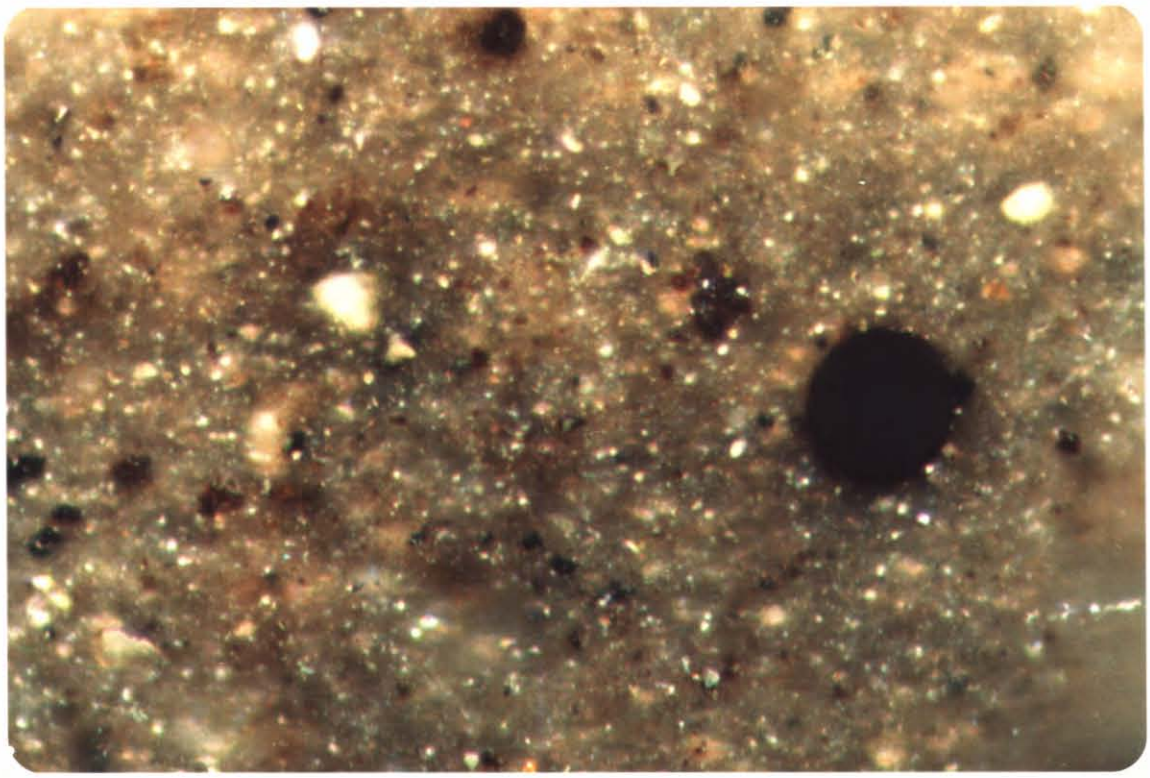


PLATE 9: 3126 m Reflected Light
The small spheres of bitumen (black; centre right and top centre) in this inertinite-rich shale are not likely to be contaminants from the drilling mud.
Field Dimensions 0.26 x 0.18 mm

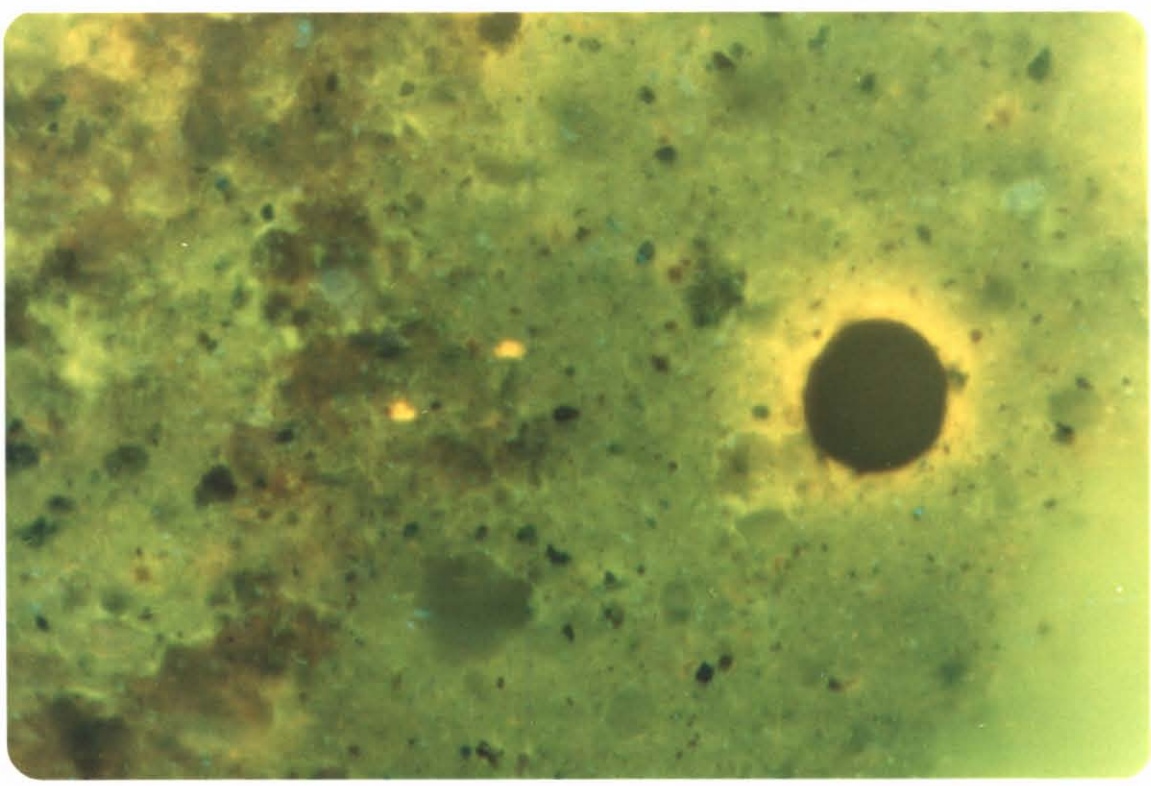


PLATE 10: 3126 m Fluorescence Mode
The spheres of bitumen are commonly surrounded by a halo of oil (centre right).

5 cm