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VITRINITE REFLECTANCE DETERMINATIONS AND ORGANIC PETROLOGY, TILANA-1, T-14-P, BASS BASIN

Amoco Australia Petroleum Company

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OR-326

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28 November 1985

F 3/786/0
F 6321

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REPORT F 6321 - Part 1

YOUR REFERENCE: LPO No. 0524

TITLE: Vitrinite reflectance determinations and organic petrology, Tilana-1, T-14-P, Bass Basin

MATERIAL: Cuttings and 1 sidewall core

LOCALITY: TILANA-1

DATE RECEIVED: 24 September 1985

WORK REQUIRED: Vitrinite reflectance determinations and organic petrology

Investigation and Report by: Brian Watson

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1. INTRODUCTION

Cuttings samples from Tilana-1 were received over a four week period (24 September to 23 October 1985). Vitrinite reflectance and organic petrology results were summarised and reported by telex on an urgent basis (24 hour turnaround time) so that the maturity, source richness and source quality of the sedimentary section, could be assessed as the drilling progressed.

This report is a formal presentation of this data and includes the results of the petrology performed on sidewall core samples received after the completion of Tilana-1.

2. ANALYTICAL PROCEDURE

Representative portions of each sidewall core (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 a diamond impregnated laps and carborundum paper. The surface was then polished with aluminium oxide and finally magnesium oxide.

Reflectance measurements on vitrinite phytoclasts, 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 at 23±1°C. Fluorescence obserbations were made on the same microscope utilising a 3 mm BG3 excitation filter, a TK400 dichroic mirror and a K510 suppression filter.

3. RESULTS

The vitrinite reflectance data is presented in Table 1. Histogram plots of these data are included in Appendix 1. Figure 1 is a plot of vitrinite reflectance verses depth and includes the locations of the major flows and intrusions.

Descriptions of the dispersed organic matter are summarised and presented in table form (Tables 2-4). Key features of 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 sampled portion of the sedimentary section penetrated by Tilana-1 (1540-3870 metres depth interval) is mature for the generation of light oil from resinite-rich DOM (threshold VR = 0.45%; Snowdon and Powell, 1982). The hydrocarbon generating potential from this type of organic matter should be exhausted at a maturity level of VR = 0.8% (Mukhopadhyay and Gormly, 1984). This level of maturity is reached at approximately 2900 metres depth in Tilana-1.

Significant gas generation from woody-herbaceous organic matter (vitrinite and to a lesser extent inertinite) commences at VR = 0.6% (Monnier *et al.*, 1983). On this basis, the sediments below 2300 metres depth in Tilana-1 are the most likely sources of significant quantities of gas.

Oil generation from terrestrial organic matter rich in exinites other than resinite, suberinite and bituminite occurs within the vitrinite reflectance range VR = 0.7-1.2% (Connan and Cassou, 1980). The top of this oil generation window occurs at approximately 2650 metres depth in Tilana-1, although narrow intervals of sediments with maturities in this range occur near the intrusives and volcanics.

Overmature sediments occur in the following intervals:

1750-2020 m
2260-2300 m
3800-TD

The assymetrical variation of maturity around the sill (2020-2259 metres depth) may possibly be due to the passage of super-heated steam through permeable reservoir rocks above the sill. Alternatively there may be another intrusion in the interval 1800-2000 metres depth, nearby, but laterally displaced from the Tilana-1 location.

The depth interval of overmature sediments immediately below the sill in Tilana-1 is quite similar to the intervals of overmature sediments around the sill in Yolla-1 suggesting that the heat flows from these two sills may be similar.

4.2 Organic Richness

Organic richness ranges from poor to excellent in the samples studied with DOM contents on a whole sample basis, ranging from <0.1% to >40%. Samples with good to excellent organic richness (DOM contents >5%) generally contain coals. The organic content of the shales and siltstones in the Easternview Formation at the Tilana-1 location generally lie in the range 0.5-2%. However, organic richness is significantly higher in some shales.

Dispersed organic matter is generally very rare or absent from the sandstones in this sequence. The organic matter in these units generally consists of a mixture of inertinite and oil.

4.3 Kerogen type and Source Quality

The Easternview Formation coals are rich in vitrinite (60-90%) and exinite (5-30%, generally 15-25%). Inertinite contents are low and lie in the range <5-15%. Coals in the sample from 3597-3600 metres depth were possibly deposited in the Cretaceous and contain significantly more inertinite (35%) and less vitrinite (50%) than coals from the Easternview Formation.

Sporinite, resinite, cutinite and suberinite are the most abundant exinite macerals in the coals and carbonaceous shales from Tilana-1. The ?Cretaceous coals (3597-3600 metres depth) are slightly richer in cutinite than the Easternview Formation coals.

Dispersed organic matter in the shales and siltstone from Tilana-1 is similar to that of the coals although generally more inertinite-rich. Lamalginite and bituminite are commonly major components of the exinite in these sediments along with sporinite, resinite and cutinite.

Free oil and exsudatinite are present in the following samples as indicated:

Depth (metres)	
2385-2394	E
2493-2502	E
2592-2601	E
2700-2709	E
2799-2808	O
2997-3006	O
3147-3156	O
3237-3246	O
3435-3444	O
3597-3600	O

E = exsudatinite
O = free oil

Intervals with the best source quality as indicated by the organic petrology are listed over:

Depth (m)		% of DOM Exinite	% of DOM Vitrinite	Major Exinite Macerals
1640-1650		60	10	Bituminite
2385-2394		25	65	Sporinite, resinite, suberinite
2493-2502	coal	25	70	Suberinite, sporinite, resinite
	siltst.	55	5	Lamalginite, liptodetrinite
2592-2601	coal	25	65	Sporinite, resinite
	siltst.	35	60	Lamalginite, telalginite
2700-2709	coal	25	60	Sporinite, resinite
	shl.	25	5	Sporinite, lamalginite
2799-2808	shl+siltst.	35	15	Sporinite, lamalginite
3237-3246	coal+shl.	25	70	Sporinite, resinite

5. CONCLUSIONS

1. Sediments from several intervals in Tilana-1 have good source potential, and sufficient maturity, for the generation of both liquid and gaseous hydrocarbons. Intervals with the best source potential are listed below:

Depth (m)	Type of hydrocarbons likely to have been generated
1640-1650	1
2385-2394	1 & 2
2493-2502	1 & 2
2592-2601	1 & 2
2700-2709	1, 2 & 3
3237-3246	1, 2 & 3

1 = light naphthenic oil.
2 = gas/condensate
3 = oil

2. The vitrinite reflectance data indicates that the sedimentary section is sufficiently mature for the generation of:

   - light naphthenic oil and condensate from resinite-rich DOM in the interval 1540-2900 metres depth (VR = 0.45-0.8%).

   - gas from the woody-herbaceous DOM (vitrinite) below 2300 metres depth (VR threshold = 0.6%)

   - oil from DOM rich in exinites other than resinite, bituminite and suberinite in the interval 2650-3800 metres depth (VR = 0.7-1.4%).

3. The presence of exsudatinite indicates that hydrocarbons have been generated from sediments in the following intervals:

   2385-2394 m
   2493-2502 m
   2592-2601 m
   2700-2709 m

4. Free oil is present in the following samples:

   2799-2808 m
   2997-3006 m
   3147-3156 m
   3237-3246 m
   3435-3444 m
   3597-3600 m

5. ?Cretaceous coals are richer in inertinite than the Easternview Formation coals and slightly richer in cutinite.

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

Depth (m)	Mean Maximum Reflectance (%)	Standard Deviation	Range	Number of Determinations
1540-1550	0.57	0.04	0.51-0.62	9
1640-1650	0.60	0.06	0.50-0.71	16
1736-1746	3.45	0.27	2.92-3.90	32
1836-1845	3.84	0.45	3.26-4.52	19
1944-1953	4.93	0.52	4.14-5.72	18
2043-2052	-	-	-	-
2286-2295	3.55	0.27	2.96-4.04	19
2395-2394	0.73	0.08	0.61-1.01	31
2493-2502	0.65	0.08	0.54-0.84	31
2592-2601	0.69	0.08	0.55-0.84	35
2700-2709	0.74	0.06	0.57-0.85	36
2799-2808	0.62*	0.05	0.48-0.73	29
2997-3006	0.83	0.08	0.70-1.11	28
3147-3156	0.83 *(0.92)	0.09	0.66-0.96	8
3237-3246	0.92	0.06	0.80-1.02	31
3291-3300	0.94	0.07	0.80-1.09	32
3390-3399	0.91*	0.02	0.89-0.92	2
3435-3444	0.87*	0.06	0.74-0.94	7
3597-3600	1.16	0.08	0.97-1.31	31
3870	1.59	0.19	1.30-1.92	24

*influenced by caved cuttings.

()preferred value.

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

Depth (m)		Percentage of		
		Vitrinite	Inertinite	Exinite
1540-1550	Sst.+Siltst.	5	85	10
1640-1650	Shale	10	30	60
1736-1746	Carb Shl+Coal	80	5	15
1836-1845	Shl+Coal	90	5	5
1944-1953	Carb Shl+Coal	85	5	10
2043-2052	Shale	-	100*	-
2286-2295	Shale+Coal	70	20	10
2385-2394	Coal+Siltst.	65	10	25
2493-2502	Coal	70	5	25
	Siltstone	5	40	55
2592-2601	Coal	65	10	25
	Shale+Siltst.	60	5	35
	Carbonate	<5	75	20
2700-2709	Coal	60	15	25
	Shale	5	70	25
2799-2808	Sandstone	<5	90	5
	Shale+Siltst.†	15	50	35
	Coal†	75	5	20
2997-3006	Shale+Siltst.	10	75	15
	Coal	80	<5	15
3147-3156	Siltstone†	<5	85	10
3237-3246	Coal+Carb Shl	70	<5	25
	Siltstone	25	60	15
3291-3300	Coal+Carb. Shl	70	<5	25
	Siltstone	35	45	20
3390-3399	Coal†	65	5	30
	Shale+Siltst.†	30	60	10
3435-3444	Siltstone†	5	90	5
3597-3600	Coal	50	35	15
	Siltstone	5	80	15
3870	Siltstone	15	75	10

*Graphite.

†Probably cavings.

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

Depth (m)	Estimated Volume of DOM (%)	Exinites	Exinite Macerals
1540-1550	0.5-1	Ra	bmite,spo,cut
1640-1650	5-15	Ab	bmite,lipto,spo,cut
1736-1746	10-20	Ra	spo,res,cut
1836-1845	1-2	-	-
1944-1953	∿5	Ra	spo,res,cut
2043-2052	<0.1*	-	-
2286-2295	5-10	Ra-Sp	spo,lipto,cut
2385-2394	>40	Ab	spo,res,sub,exs,cut,lipto,bmite
2493-2502	5-10	Co	lipto,lama,sub,spo,res,cut,?phyto, exs,thuc
2592-2601	5-10	Sp-Co	lama,spo,res,cut,tela,lipto, ?phyto,sub,exs,bmite
2700-2709	>40	Ab	spo,res,cut,lama,sub,exs,lipto, ?phyto,tela
2799-2808	3-5†	Ra	spo,res,lama,cut,tela,bmite, phyto,oil
2977-3006	1-3	Ra	spo,oil,phyto,lama,cut,res,tela, sub,bmen
3147-3156	<0.5†	Vr	lipto,?oil,spo,cut
3237-3246	15-25	Co	spo,res,bmite,cut,sub,oil
3291-3300	15-25	Co	res,spo,bmite,lipto,cut
3390-3399	0.5-1†	Tr	spo,cut,res,lama,sub
3435-3444	<0.5†	Tr	spo,?oil
3597-3600	20-30	Sp	spo,cut,res,?oil
3870	1-2	Ra	lama,lipto

*Graphite.

†Cavings.

TABLE 4: EXINITE MACERAL ABUNDANCE AND FLUORESCENCE CHARACTERISTICS, TILANA-1

Depth (m)	Exinite Macerals	Lithology/Comments
1540-1550	bmite(Ra;d0),spo(Vr;mY-m0),cut (Tr;m0)	chiefly silty sandstone, 10-20% siltstone. Caved coals of lower and higher maturity.
1640-1650	bmite(Ab;d0-dB),lipto(Ra;mY-m0), spo(Ra-Vr;m0-d0),cut(Vr;m0)	shale with silty bands.
1736-1746	spo(Ra;NoFl),res(Vr;NoFl),cut (Vr;NoFl)	chiefly silty sandstone and siltstone, ∿20% coal (anthracite), ∿10% carbonaceous shale. The lack of exinite fluorescence is a function of overmaturity.
1836-1845	spo(Ra;NoFl),res(Vr;NoFl)	chiefly sandstone, 5-10% shale, <5% coal (anthracite) and coke. Exinite fluorescence as above.
1944-1953	spo(Ra;NoFl),res(Ra;NoFl),cut (Vr;NoFl)	chiefly sandstone, ∿5% carbonaceous shale, ∿5% coal (anthracite); exinite fluorescence as above.
2043-2052	-	chiefly igneous rocks, ∿1% shale.
2286-2295	spo(Ra;NoFl),lipto(Ra;NoFl),cut (Ra;NoFl)	chiefly shale, 5-10% coal (anthracite) and coke, ∿5% carbonate; exinite fluorescence as above.
2385-2394	spo(Ab;m0-d0),res(Ab;d0-dB),sub (Co-Ab;d0-dB),exs(Sp-Co;mY-dB), cut(Sp;m0-d0),lipto(Ra;m0-dB), bmite(Vr;d0)	chiefly coal, ∿20% sandstone, 5-10% siltstone with DOM rich bands; the variation of fluorescence colours of exsudatinite (primary oil) indicate the possibility more than one phase of oil generation.
2493-2502	lipto(Co;m0),lama(Sp;mY-d0),spo (Sp;mY-m0),res(Sp;m0-dB),cut(Ra; mY-m0),?phyto(Tr;m0),exs(Tr;m0), thuc(Tr;m0-d0)	chiefly siltstone, 5-10% coal, ∿5% carbonate; thucholite is evidence of oil migration. Exsudatinite is primary oil (i.e. formed in situ).
2592-2601	lama(Ra-Sp,mY-d0),spo(Ra-Sp; m0-d0),res(Ra;m0-dB),cut(Ra;m0-d0),tela(Ra;iY-m0),lipto(Ra; m0-d0),phyto(Ra-Vr;mY),sub(Vr; NoFl),exs(Tr;iYG),bmite(Tr;d0)	chiefly shale and siltstone, 10-20% carbonate, 5-10% coal; some coals contain up to 30% exinite (mostly sporinite and resinite).
2700-2709	spo(Ab;m0-d0),res(Ab;m0-dB),cut (Co;m0-d0),lama(Ra;m0),sub(Vr; d0),exs(Vr;iY-iG,d0-dB),lipto (Vr;m0-d0),?phyto(Vr-Tr;mY), tela(Tr;iY)	chiefly coal, 10-20% siltstone; resinite and suberinite are extensively micrinitised and have dull fluorescence, indicating that oil generation from these macerals is nearly complete.
2799-2808	spo(Ra;m0-d0),res(Ra;m0-NoFl), lama(Ra;mY-m0),cut(Vr;m0-d0), tela(Vr;m0),bmite(Vr;d0),phyto (Tr;m0),oil(Tr;iYG)	chiefly sandstone, 5-10% siltstone and shale, <5% coal; resinite as above. Oil occurs as small accumulations (<0.03 mm) in the siltstone cuttings.

.../2

TABLE 4: (Continued)

Depth (m)	Exinite Macerals	Lithology/Comments
2997-3006	spo(Ra;m0-d0),oil(Ra-Vr;iG-i0),phyto (Vr;m0),lama(Vr;m0),cut(Vr-Tr;m0-d0),res(Vr-Tr;m0-d0),tela(Tr;m0),sub (Tr;d0),bmen(Tr;d0)	chiefly sandstone, 10-15% siltstone, <5% coal; oil and bitumen occur interstitial to quartz grains in the sandstone and siltstone cuttings.
3147-3156	lipto(Vr;m0-d0),?oil(Vr;iYG),spo (Vr;m0),cut(Vr;m0)	chiefly sandstone, 10-15% siltstone; oil as above.
3237-3246	spo(Co;m0-d0),res(Sp-Co;d0-NoFl), bmite(Sp;d0),cut(Ra;m0-d0),sub(Vr; d0-dB),?oil(Tr;iG,m0)	chiefly sandstone, 15-20% coal, 10-15% siltstone, ∿10% carbonaceous shale; resinite and suberinite as above. Oil as above.
3291-3300	res(Co;dB-NoFl),spo(Co;d0),bmite(Co; dB-NoFl),lipto(Sp;d0-dB),cut(Ra;d0)	chiefly carbonaceous shale, 20-30% sandstone, 10-20% coal, 10-15% siltstone; fluorescence colours of resinite and bituminite indicate oil generation from these macerals is nearly complete.
3390-3399	spo(Tr;m0),cut(Tr;m0),res(Tr;m0),lama (Tr;m0),sub(Tr;d0)	chiefly volcanics, <5% siltstone and shale, <1% coal.
3435-3444	spo(Tr;d0),?oil(Tr;iY)	chiefly sandstone, ∿10% volcanics, <5% siltstone; ?oil as above.
3537-3600	spo(Sp;NoFl),cut(Sp;NoFl),res(Sp; NoFl), ?oil(Tr;iY)	chiefly sandstone, 20-30% coal, 10-20% siltstone; oil as above. Exinite fluorescence colours indicate that this sample is over-mature.
3870	lama(Ra;NoFl),lipto(Ra;NoFl)	Siltstone; exinite as above.

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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.)

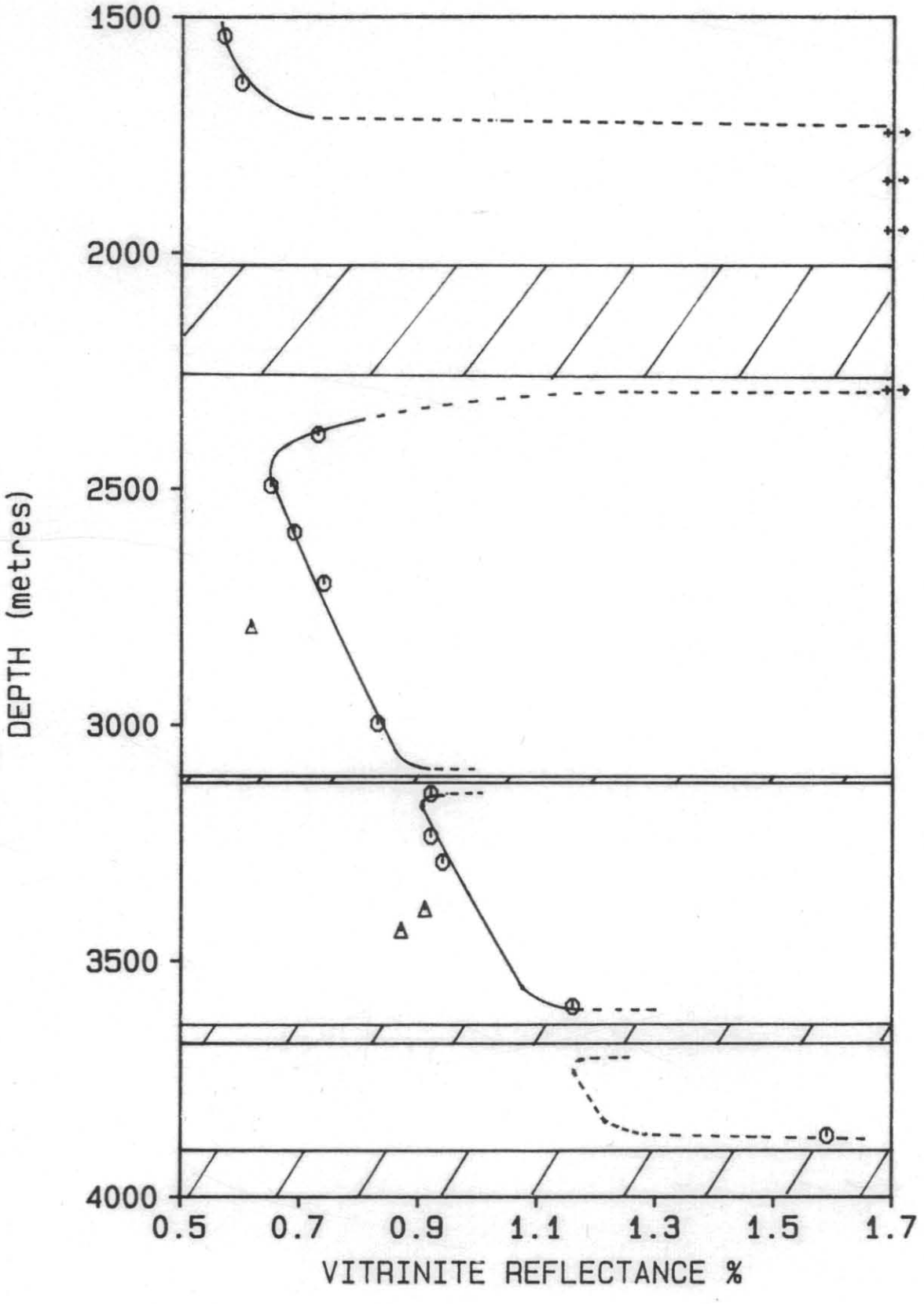
Ma	Major	>15%
Ab	Abundant	2-15%
Co	Common	1-2%
Sp	Sparse	0.5-1%
Ra	Rare	0.1-0.5%
Vr	Very Rare	∿0.1%
Tr	Trace	<0.1%

FLUORESCENCE COLOUR AND INTENSITY

G	Green	i	Intense
Y	Yellow	m	Moderate
O	Orange	d	Dull
B	Brown		
NoFl	No Visible Fluorescence		

323015 FIGURE 1

VITRINITE REFLECTANCE Vs. DEPTH PLOT, TILANA-1

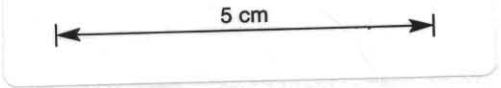


APPENDIX 1

HISTOGRAMS OF VITRINITE REFLECTANCE MEASUREMENTS

323017

TILANA #1



1540-1550 M

SORTED LIST
.51 .52 .53 .56 .57 .58 .6 .6 .62
Number of values= 9

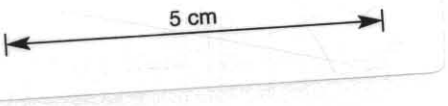
MEAN OF VALUES .566
STD DEVIATION .037

HISTOGRAM OF RESULTS
Values are reflectance multiplied by 100

51 - 55 | ▒▒▒
56 - 60 | ▒▒▒▒▒
61 - 65 | ▒

323018

TILANA #1



1640-1650 M

SORTED LIST
.5 .53 .53 .55 .57 .57 .58 .58 .58 .6
.61 .61 .66 .69 .7 .71
Number of values= 16

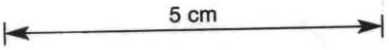
MEAN OF VALUES .598
STD DEVIATION .061

HISTOGRAM OF RESULTS
Values are reflectance multiplied by 100

50 - 54 |
55 - 59 |
60 - 64 |
65 - 69 |
70 - 74 |

323019

TILANA #1



1736-1746 M

SORTED LIST

2.92 3 3.02 3.04 3.1 3.14 3.16 3.2 3.34 3.34
3.36 3.36 3.42 3.42 3.46 3.46 3.46 3.48 3.5 3.52
3.56 3.6 3.6 3.62 3.68 3.68 3.7 3.74 3.86 3.9
3.9 3.9

Number of values= 32

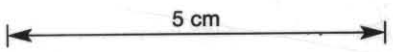
MEAN OF VALUES 3.451
STD DEVIATION .272

HISTOGRAM OF RESULTS
Values are reflectance multiplied by 100

292 - 296 | ▒
297 - 301 | ▒
302 - 306 | ▒▒▒
307 - 311 | ▒
312 - 316 | ▒▒▒
317 - 321 | ▒
322 - 326 |
327 - 331 | ▒▒▒
332 - 336 | ▒▒▒▒▒▒▒▒
337 - 341 | ▒
342 - 346 | ▒▒▒▒▒▒▒▒
347 - 351 | ▒▒▒▒▒▒
352 - 356 | ▒▒▒▒
357 - 361 | ▒▒▒▒▒▒
362 - 366 | ▒▒▒
367 - 371 | ▒▒▒▒▒▒▒
372 - 376 | ▒
377 - 381 | ▒
382 - 386 | ▒
387 - 391 | ▒▒▒▒

323020

TILANIA #1



1836-1845 M

SORTED LIST

3.26	3.28	3.3	3.34	3.4	3.44	3.58	3.6	3.64	3.66
3.8	3.98	4.24	4.26	4.36	4.36	4.42	4.48	4.52	

Number of values= 19

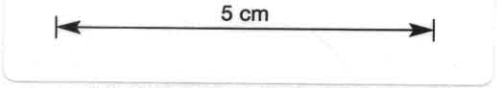
MEAN OF VALUES 3.838
STD DEVIATION .45

HISTOGRAM OF RESULTS
Values are reflectance multiplied by 100

326 - 330	1	▒▒▒
331 - 335	1	▒
336 - 340	1	▒
341 - 345	1	▒
346 - 350	1	
351 - 355	1	
356 - 360	1	▒▒
361 - 365	1	▒
366 - 370	1	▒
371 - 375	1	
376 - 380	1	▒
381 - 385	1	
386 - 390	1	
391 - 395	1	
396 - 400	1	▒
401 - 405	1	
406 - 410	1	
411 - 415	1	
416 - 420	1	
421 - 425	1	▒
426 - 430	1	▒
431 - 435	1	
436 - 440	1	▒▒
441 - 445	1	▒
446 - 450	1	▒
451 - 455	1	▒

323021

TILANA #1



1944-1953 M

SORTED LIST

4.14 4.18 4.28 4.32 4.34 4.68 4.74 4.8 4.88 5.02
5.08 5.16 5.38 5.44 5.5 5.56 5.6 5.72
Number of values= 18

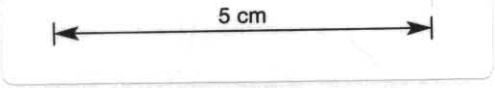
MEAN OF VALUES 4.934
STD DEVIATION .516

HISTOGRAM OF RESULTS
Values are reflectance multiplied by 100

```
414 - 418  |▒▒▒
419 - 423  |
424 - 428  |▒
429 - 433  |▒
434 - 438  |▒
439 - 443  |
444 - 448  |
449 - 453  |
454 - 458  |
459 - 463  |
464 - 468  |▒
469 - 473  |
474 - 478  |▒
479 - 483  |▒
484 - 488  |▒
489 - 493  |
494 - 498  |
499 - 503  |▒
504 - 508  |▒
509 - 513  |
514 - 518  |▒
519 - 523  |
524 - 528  |
529 - 533  |
534 - 538  |▒
539 - 543  |
544 - 548  |▒
549 - 553  |▒
554 - 558  |▒
559 - 563  |▒
564 - 568  |
569 - 573  |▒
```

323022

TILANA #1



2285-2295 M

SORTED LIST

2.96 3.28 3.3 3.32 3.34 3.38 3.46 3.48 3.5 3.52
3.58 3.6 3.62 3.7 3.7 3.8 3.92 4.02 4.04
Number of values= 19

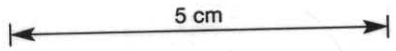
MEAN OF VALUES 3.554
STD DEVIATION .265

HISTOGRAM OF RESULTS
Values are reflectance multiplied by 100

```
296 - 300  | ▒
301 - 305  |
306 - 310  |
311 - 315  |
316 - 320  |
321 - 325  |
326 - 330  | ▒▒
331 - 335  | ▒▒
336 - 340  | ▒
341 - 345  |
346 - 350  | ▒▒▒
351 - 355  | ▒
356 - 360  | ▒▒
361 - 365  | ▒
366 - 370  | ▒▒
371 - 375  |
376 - 380  | ▒
381 - 385  |
386 - 390  |
391 - 395  | ▒
396 - 400  |
401 - 405  | ▒▒
```

323023

TILANA #1



2385-2394 M

SORTED LIST

.61 .65 .66 .66 .66 .67 .68 .68 .69 .7
.7 .7 .7 .71 .71 .71 .71 .71 .71 .72
.72 .72 .73 .73 .74 .75 .75 .81 .83 .94
1.01

Number of values= 31

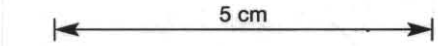
MEAN OF VALUES .725
STD DEVIATION .078

HISTOGRAM OF RESULTS
Values are reflectance multiplied by 100

61 - 65	▒▒
66 - 70	▒▒▒▒▒▒▒▒▒▒▒▒
71 - 75	▒▒▒▒▒▒▒▒▒▒▒▒▒▒▒▒▒▒▒▒
76 - 80	
81 - 85	▒▒
86 - 90	
91 - 95	▒
96 - 100	
101 - 105	▒

323024

TILANA #1



2493-2502 M

SORTED LIST

.54 .57 .57 .57 .57 .57 .57 .58 .58 .59
.59 .6 .6 .6 .62 .62 .63 .64 .66 .67
.68 .68 .69 .7 .72 .72 .75 .77 .78 .8
.84

Number of values= 31

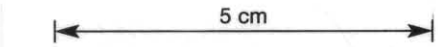
MEAN OF VALUES .647
STD DEVIATION .079

HISTOGRAM OF RESULTS
Values are reflectance multiplied by 100

54 - 56	▒
57 - 59	▒▒▒▒▒▒▒▒▒▒▒▒▒▒
60 - 62	▒▒▒▒▒▒▒
63 - 65	▒▒▒
66 - 68	▒▒▒▒▒
69 - 71	▒▒▒
72 - 74	▒▒▒
75 - 77	▒▒▒
78 - 80	▒▒▒
81 - 83	
84 - 86	▒

323025

TILANA #1



2592-2601 M

SORTED LIST

.55	.57	.58	.58	.59	.62	.63	.63	.63	.63
.64	.64	.65	.65	.66	.67	.67	.67	.68	.68
.68	.69	.71	.73	.73	.77	.78	.78	.78	.79
.79	.79	.82	.83	.84					

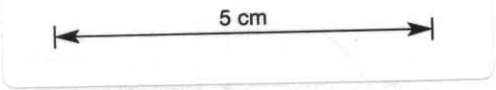
Number of values= 35

MEAN OF VALUES .689
STD DEVIATION .08

HISTOGRAM OF RESULTS
Values are reflectance multiplied by 100

323026

TILANA #1



2700-2707 M

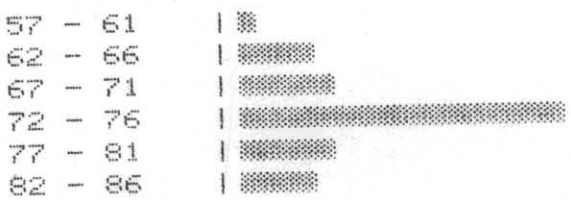
SORTED LIST

.57	.65	.65	.65	.66	.67	.67	.68	.71	.71
.72	.72	.73	.74	.74	.74	.74	.74	.75	.75
.75	.75	.75	.75	.75	.75	.76	.78	.78	.79
.8	.8	.82	.82	.83	.85				

Number of values= 36

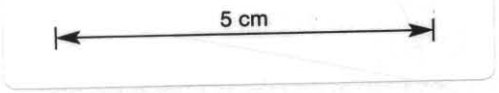
MEAN OF VALUES .737
STD DEVIATION .058

HISTOGRAM OF RESULTS
Values are reflectance multiplied by 100



323027

TILANA #1



2799-2808 M

SORTED LIST

.48 .54 .55 .56 .56 .57 .57 .58 .58 .59
.6 .6 .62 .62 .62 .63 .64 .64 .64 .65
.65 .66 .66 .67 .67 .67 .67 .69 .73

Number of values= 29

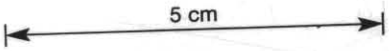
MEAN OF VALUES .618
STD DEVIATION .053

HISTOGRAM OF RESULTS
Values are reflectance multiplied by 100

48 - 52 | ▒
53 - 57 | ▒▒▒▒▒
58 - 62 | ▒▒▒▒▒▒▒
63 - 67 | ▒▒▒▒▒▒▒▒▒▒▒▒
68 - 72 | ▒
73 - 77 | ▒

323028

TILANA #1



2997-3006 M

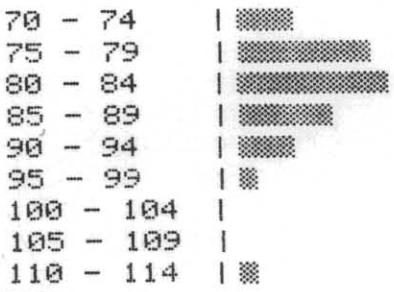
SORTED LIST

.7	.71	.71	.77	.77	.77	.78	.78	.78	.79
.8	.81	.81	.81	.83	.83	.83	.84	.85	.85
.87	.88	.89	.9	.91	.91	.97	1.11		

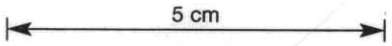
Number of values= 28

MEAN OF VALUES .831
STD DEVIATION .083

HISTOGRAM OF RESULTS
Values are reflectance multiplied by 100



TILANA #1



3147-3155 M

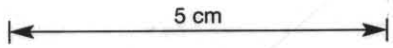
SORTED LIST
.66 .8 .8 .82 .82 .87 .92 .96
Number of values= 8

MEAN OF VALUES .831
STD DEVIATION .085

HISTOGRAM OF RESULTS
Values are reflectance multiplied by 100

66 - 70 | ▓
71 - 75 |
76 - 80 | ▓▓
81 - 85 | ▓▓
86 - 90 | ▓
91 - 95 | ▓
96 - 100 | ▓

TILANA #1



3237-3246 M

SORTED LIST

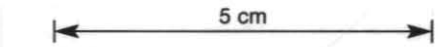
.8 .8 .82 .86 .87 .89 .89 .89 .9 .9
.91 .91 .91 .91 .92 .92 .93 .93 .94 .94
.95 .95 .96 .97 .97 .97 .97 .98 1.02 1.02
1.02
Number of values= 31

MEAN OF VALUES .923
STD DEVIATION .056

HISTOGRAM OF RESULTS
Values are reflectance multiplied by 100

80 - 84 | ▒▒▒
85 - 89 | ▒▒▒▒▒
90 - 94 | ▒▒▒▒▒▒▒▒▒▒▒▒▒▒▒
95 - 99 | ▒▒▒▒▒▒▒▒▒
100 - 104 | ▒▒▒

TILANA #1



3291-3300 M

SORTED LIST

.8 .8 .8 .83 .86 .88 .89 .9 .91 .91
.91 .92 .93 .94 .94 .95 .95 .95 .96 .96
.97 .97 .98 .98 .99 1 1.01 1.01 1.02 1.03
1.05 1.09

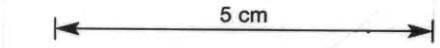
Number of values= 32

MEAN OF VALUES .94
STD DEVIATION .071

HISTOGRAM OF RESULTS
Values are reflectance multiplied by 100

80 - 84 |
85 - 89 |
90 - 94 |
95 - 99 |
100 - 104 |
105 - 109 |

TILANA #1



3390-3399 M

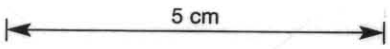
SORTED LIST
.89 .92
Number of values= 2

MEAN OF VALUES .905
STD DEVIATION .015

HISTOGRAM OF RESULTS
Values are reflectance multiplied by 100

89 - 93 |▒▒

TILANA #1



3435-3444 M

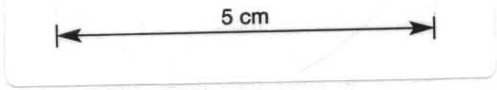
SORTED LIST
.74 .84 .85 .89 .91 .91 .94
Number of values= 7

MEAN OF VALUES .869
STD DEVIATION .062

HISTOGRAM OF RESULTS
Values are reflectance multiplied by 100

```
74 - 78    | ▒
79 - 83    |
84 - 88    | ▒▒
89 - 93    | ▒▒▒
94 - 98    | ▒
```

TILANA #1



3597-3600 M

SORTED LIST

.97 1 1.06 1.08 1.09 1.09 1.1 1.12 1.12 1.13
1.13 1.15 1.15 1.16 1.16 1.16 1.17 1.17 1.18 1.18
1.18 1.21 1.22 1.22 1.23 1.24 1.25 1.27 1.27 1.28
1.31

Number of values= 31

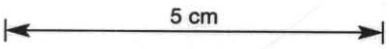
MEAN OF VALUES 1.163
STD DEVIATION .078

HISTOGRAM OF RESULTS
Values are reflectance multiplied by 100

97 - 101 | ▒▒
102 - 106 | ▒
107 - 111 | ▒▒▒▒
112 - 116 | ▒▒▒▒▒▒▒▒▒▒
117 - 121 | ▒▒▒▒▒▒
122 - 126 | ▒▒▒▒▒
127 - 131 | ▒▒▒▒

323035

TILANA #1



3870 M

SORTED LIST

1.3 1.32 1.33 1.41 1.41 1.42 1.44 1.46 1.51 1.51
1.54 1.54 1.55 1.57 1.6 1.69 1.71 1.73 1.76 1.81
1.84 1.87 1.9 1.92

Number of values= 24

MEAN OF VALUES 1.589
STD DEVIATION .188

HISTOGRAM OF RESULTS
Values are reflectance multiplied by 100

130 - 134 | ▒▒▒
135 - 139 |
140 - 144 | ▒▒▒▒
145 - 149 | ▒
150 - 154 | ▒▒▒▒
155 - 159 | ▒▒
160 - 164 | ▒
165 - 169 | ▒
170 - 174 | ▒▒
175 - 179 | ▒
180 - 184 | ▒▒
185 - 189 | ▒
190 - 194 | ▒▒

APPENDIX 2

PLATES

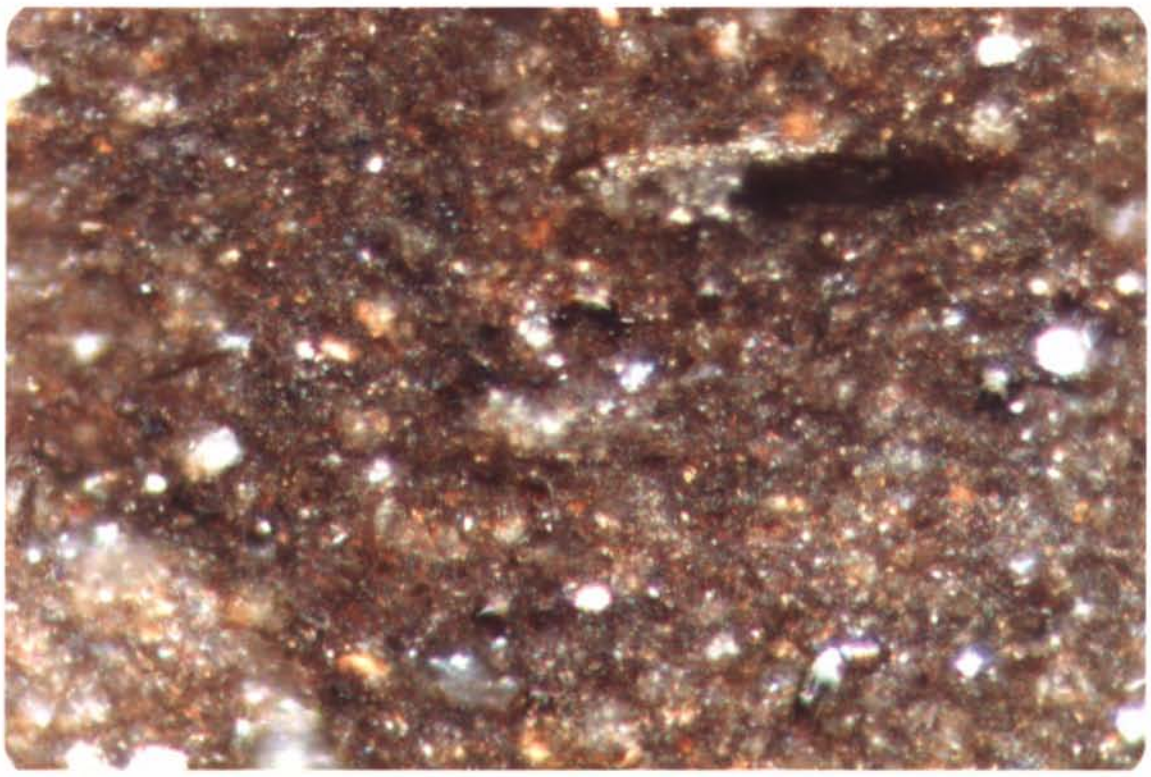


PLATE 1: 1640-1650 m Reflected Light
This plate shows bituminite (brown) and inertinite (white) occurring in a DOM rich shale fragment
Field Dimensions 0.26 mm x 0.18 mm

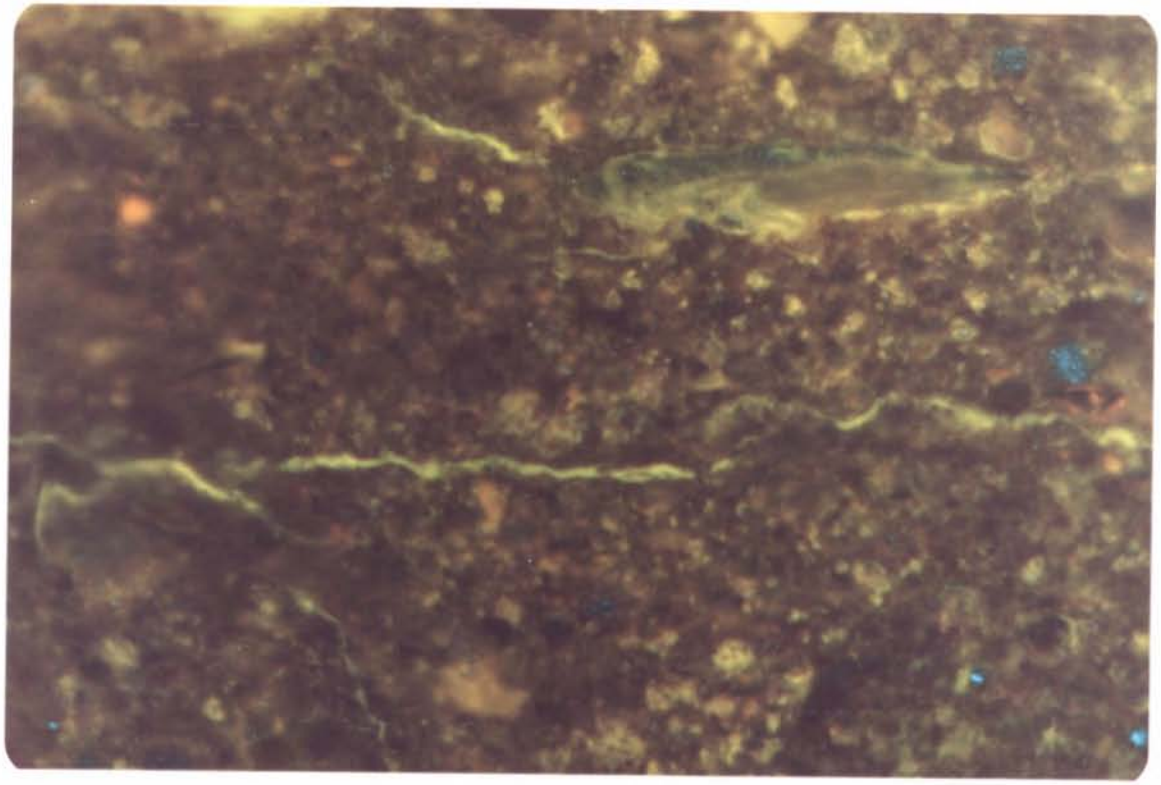


PLATE 2: 1640-1650 m Fluorescence Mode
In this field the bituminite has a dull brown fluorescence. Some liptodetrinite (moderate orange) is present towards the upper left of the plate.

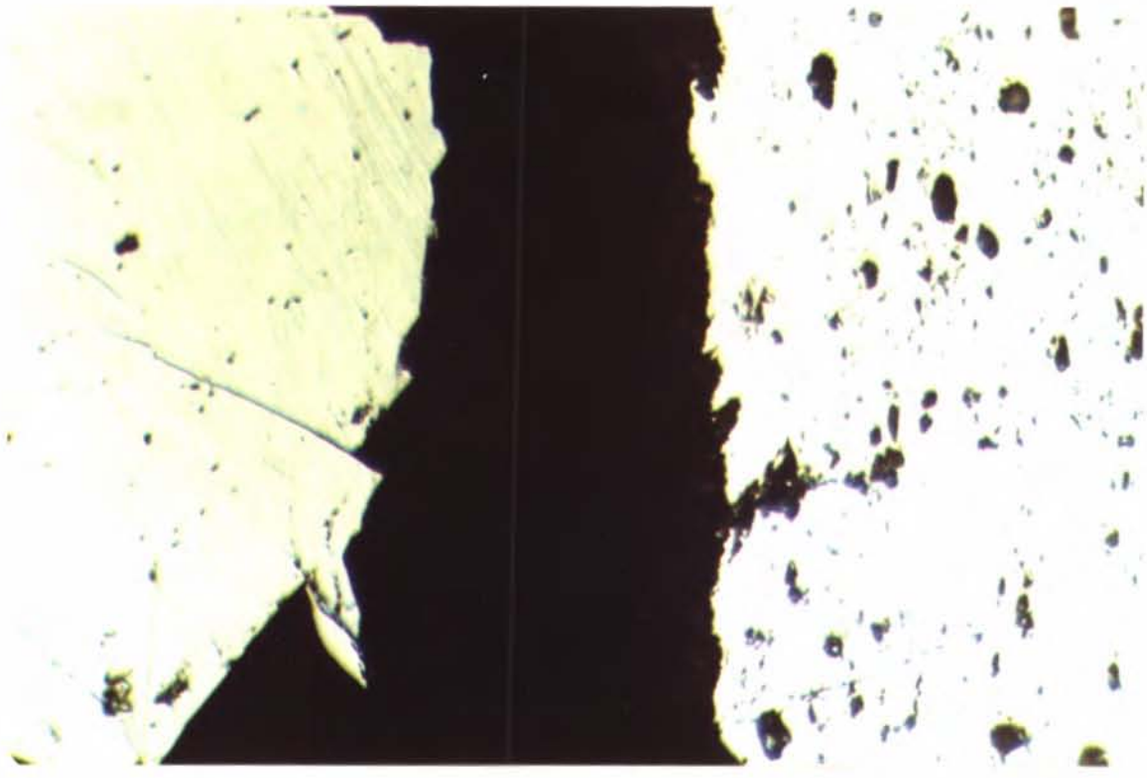


PLATE 3: 2286-2295 m Reflected Light

This plate shows a coal fragment (anthracite - left) and a fragment of naturally formed coke (right). These fragments have no fluorescence.

Field Dimensions 0.43 mm x 0.29 mm

PLATE 4: 2385-2394 m Reflected Light
This coal fragment consists largely of resinite (dark grey) and vitrinite light grey.
Field Dimensions 0.43 mm x 0.29 mm

PLATE 5: 2385-2394 m Fluorescence Mode
The resinite bands have a dull orange to dull brown fluorescence at this maturity. Some small sporinite fragments (moderate orange) are also present.

PLATE 6: 2443-2502 m Reflected Light
The dark grey band (left of centre) in this coal fragment is exsudatinite.
Field Dimensions 0.26 mm x 0.18 mm

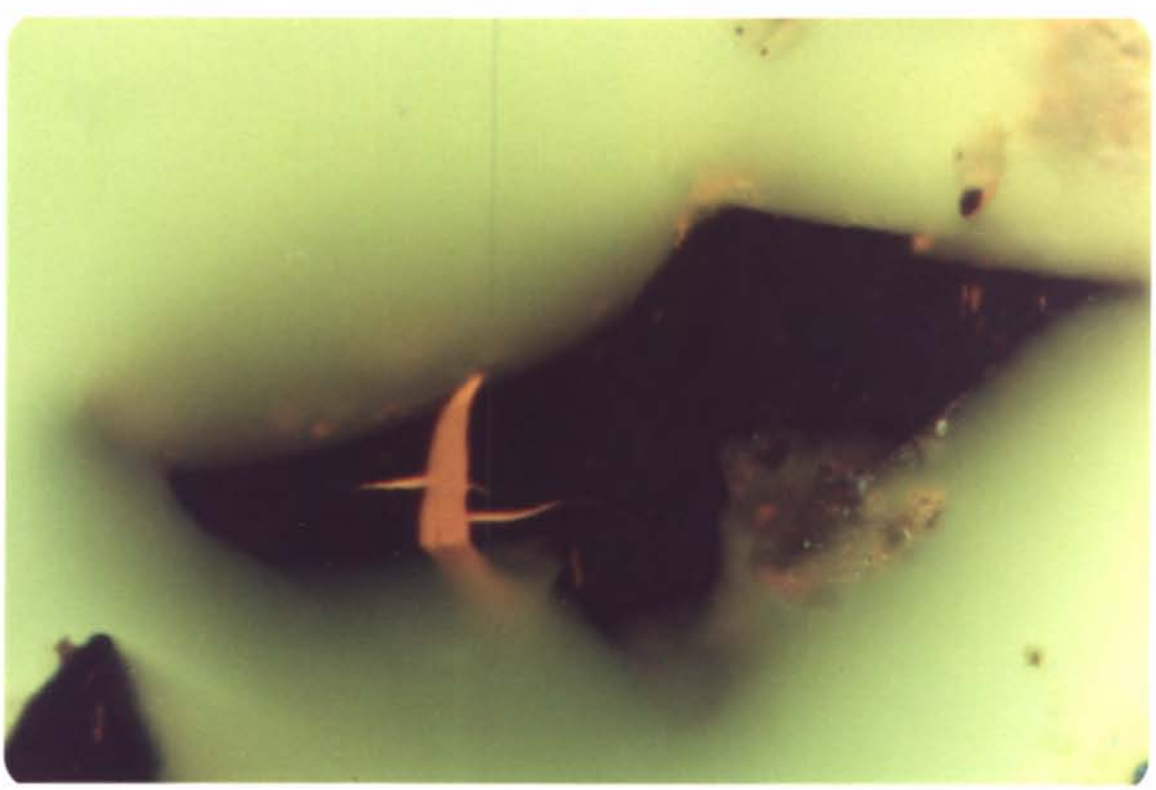


PLATE 7: 2493-2502 m Fluorescence Mode
In fluorescence mode the exsudatinite is clearly distinguished in this coal fragment.

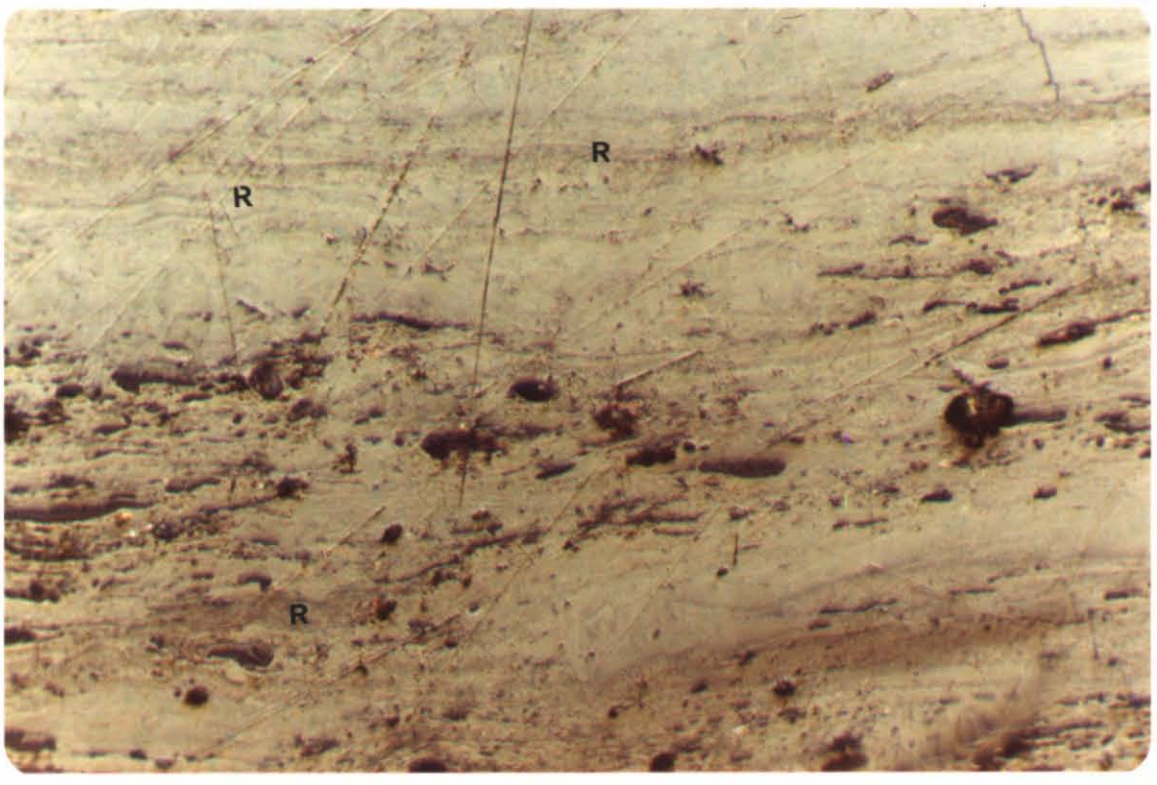


PLATE 8: 2700-2709 m Reflected Light
Resinite (R) in this coal is micrinitised (specular appearance) and has very dull or no fluorescence indicating that the oil generation potential of this maceral has been exhausted.
Field Dimensions 0.43 mm x 0.29 mm

PLATE 9: 2700-2709 m Fluorescence Mode
Sporinite (moderate orange) and liptodetrinite (dull orange) have the potential for further oil generation.

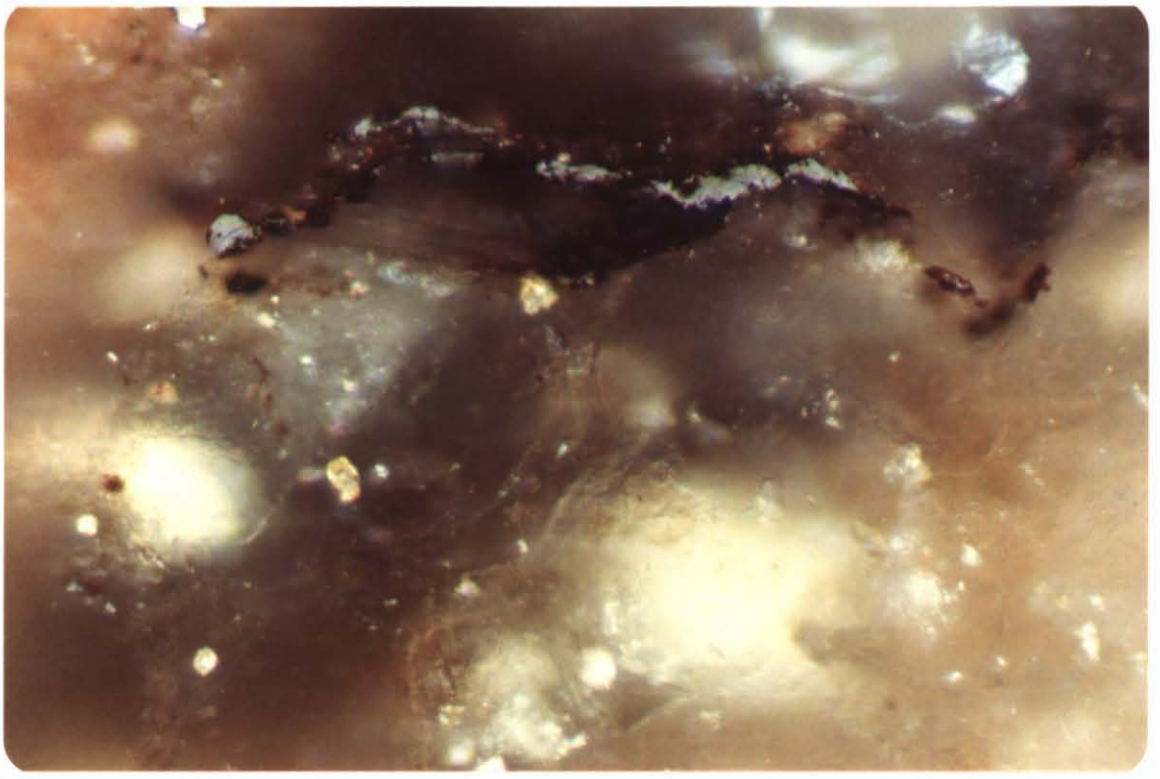


PLATE 10: 2997-3006 m Reflected Light
This plate shows inertinite (grey) in a sandstone.
Field Dimensions 0.43 mm x 0.29 mm

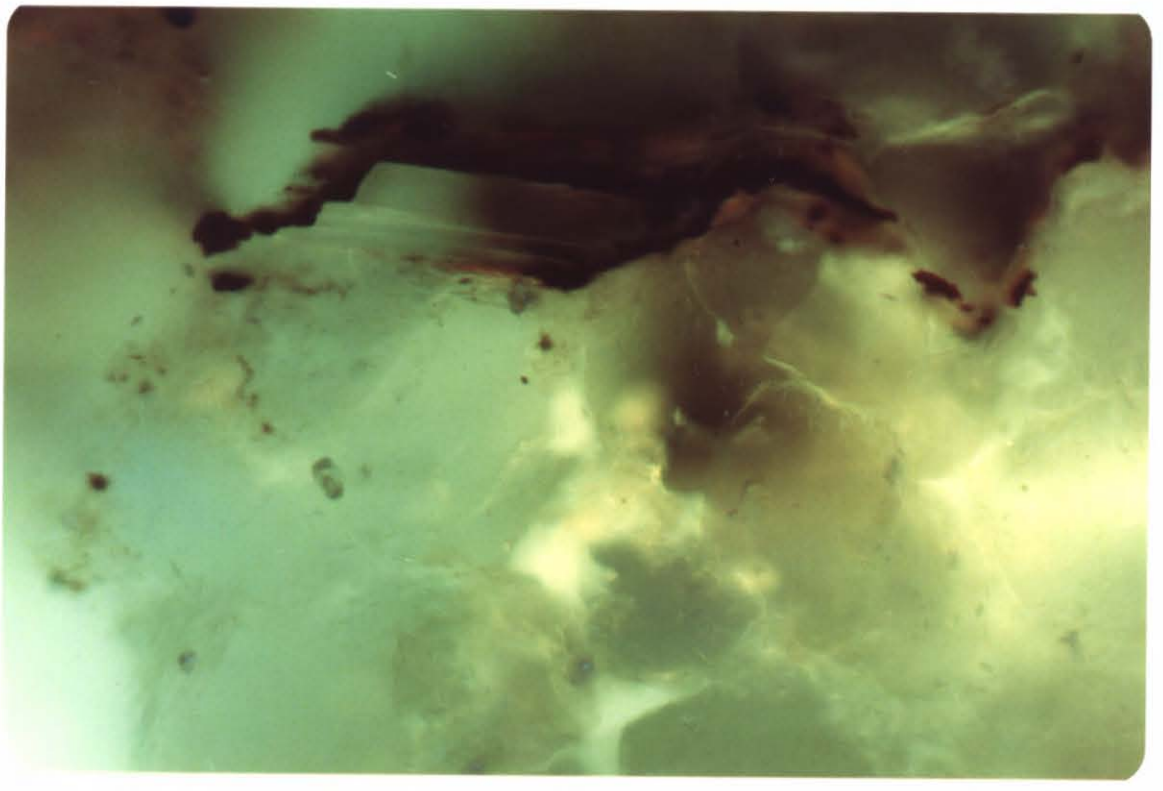


PLATE 11: 2947-3006 m Fluorescence Mode
In fluorescence mode oil (intense yellow and intense green fluorescence; centre and centre right) can be distinguished intersitial to the quartz grains.

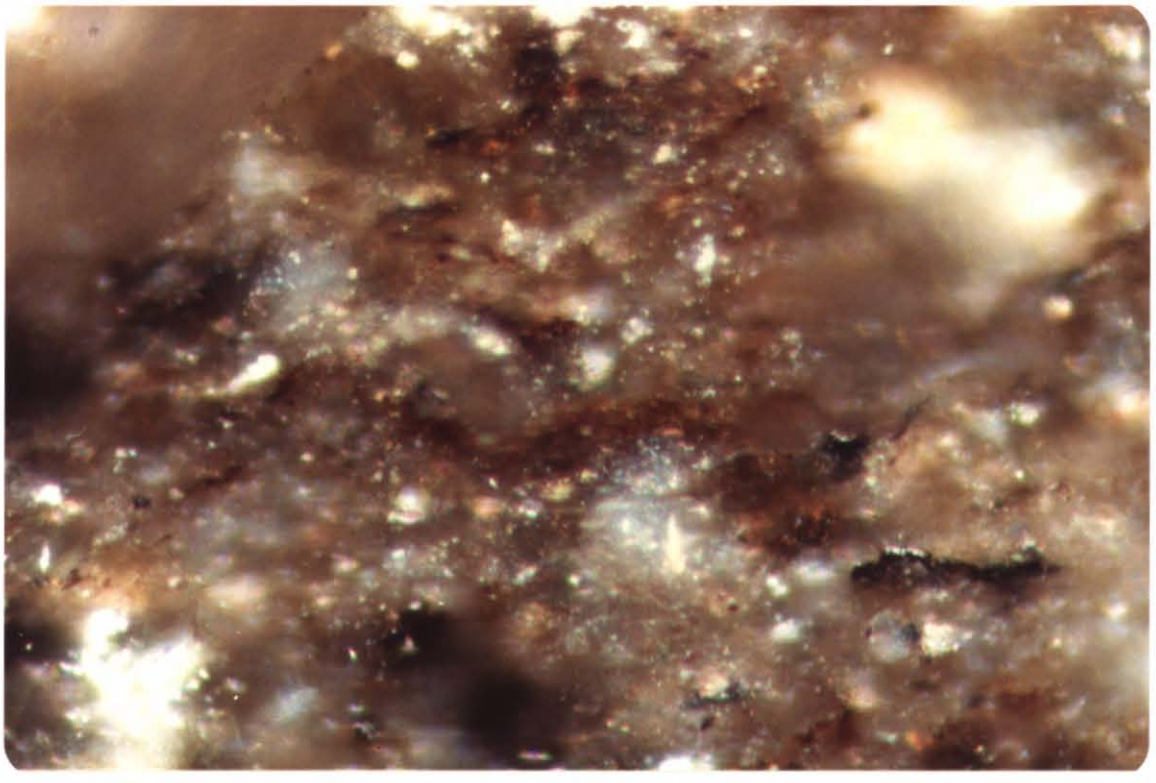


PLATE 12: 3870 m Reflected Light
This siltstone contains lamalginite (brown; slightly micrinitised) and inertinite (white).
Field Dimensions 0.26 mm x 0.18 mm

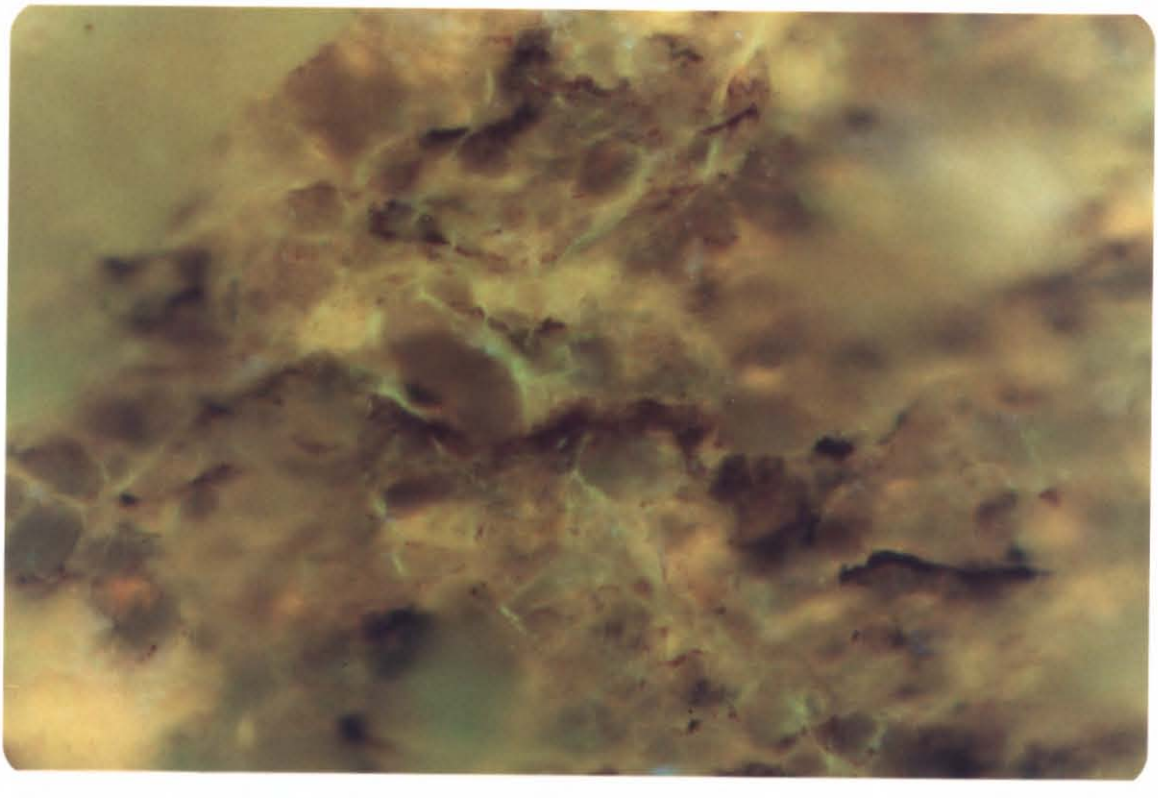


PLATE 13: 3870 m Fluorescence Mode
The lamalginite has a dull brown fluorescence in this field.