

# **ANALYTICAL REPORT**

## **SOURCE ROCK ORGANIC MATTER REFLECTANCE AND TYPING**

### **VARIOUS SAMPLES**

### **PREPARED FOR DMRS - GEOLOGICAL SURVEY AND RESOURCE STRATEGY DIVISION**

**JUNE 2021**



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## SOURCE ROCK ORGANIC MATTER REFLECTANCE AND TYPING

### INTRODUCTION

Samples were received (see table below) to be evaluated for the reflectance of organic matter (vitrinite where possible) as well as an assessment of the types of organic matter present. If HAWK pyrolysis was also requested, the equivalent sample number is also indicated. HAWK data are reported separately.

ERC Sample No.		Company Reference	Sample Type	Other information
Vr	HAWK			
E4160	HWA4160	GSWA # 237702	Drill powder	Pioneer Resources Bogadi BORC-06
E4161	HWA4161	GSWA # 235024	cuttings	Wooramel Seismic Line 3 SP314
E4162	HWA4162	GSWA # 222041	outcrop	Coolkilya Pool Outcrop - Measured section 140m from base
E4163	HWA4163	GSWA # 222039	outcrop	Coolkilya Pool Outcrop - Measured section 172m from base
E4164	HWA4164	GSWA # 222047	outcrop	Coolkilya Pool Outcrop - Measured section 34m from base
E4165	HWA4165	GSWA # 222031	outcrop	Outcrop Minilya River
E4166	HWA4166	GSWA # ?	core	GBH4
E4167	HWA4167	GSWA # 219286	core	GBH4

### METHODS

Sample preparation methods may vary slightly depending upon whether core/ outcrop or cuttings were received.

With core and outcrop samples, a flat face perpendicular to bedding is prepared by grinding. This is placed in a 30 mm diameter mould along with several randomly oriented grains. The whole is mounted in epoxy resin.

With cuttings, the samples are passed through a 2 mm sieve and where necessary are gently cracked in a mortar and pestle. This is then mounted in epoxy resin.

The epoxy resin mounted samples are polished using a variety of wet and dry papers, diamond polishing compounds and colloidal silica. The polished samples are dried in a desiccator for a minimum of 12 hours prior to analysis.

Analysis is made using a Leica MP4500P system with Hilgers DISKUS software. A mechanical stage is used to traverse the sample in a regular pattern. Mean maximum reflectance in oil of the organic matter is determined by rotating the microscope stage. Reflectance is determined of a 2  $\mu\text{m}^2$  area at 546nm using a total magnification of 500X.

A visual estimation of organic matter types and abundances was also made using comparison charts under both reflected and blue light excitation. The categories used are:

Descriptor	%
Absent	0
Rare	<0.1
Sparse	$0.1 < x < 0.5$
Common	$0.5 < x < 2.0$
Abundant	$2.0 < x < 10.0$
Major	$10.0 < x < 40.0$
Dominant	>40.0

The samples are also examined in blue light fluorescence using a Royal Blue LED as the excitation source.

## RESULTS

Results are tabulated as follows. Low resolution images are provided in an appendix for reference purposes. High quality images are provided in a separate image file.

### Data presentation

Individual sample results are reported in the following format:

ERC No. Client No.	Depth (ft / m)	$R_{Vmax}^{*1}$	Range <sup>*2</sup>	SD <sup>*3</sup>	N <sup>*4</sup>
x1234	3106	0.79	0.64 - 0.91	0.145	25
	$R_I^{*5}$				
	Alginite <sup>*5</sup>				
	Bitumen <sup>*5</sup>				

\*1 Mean of all the maximum reflectance readings obtained.

\*2 Lowest Rmax and highest Rmax of the population considered to represent the first generation vitrinite population.

\*3 Standard Deviation

\*4 Number of fields measured (Number of measurements = 2N because 2 maximum values are recorded for each field)

\*5 Reflectance of multiple vitrinite populations or of other organic matter types.  $R_I$  = Inertinite mean maximum reflectance etc; subscripts may be expanded as necessary.

HAWK data, where requested, are reported separately in spread sheet format.

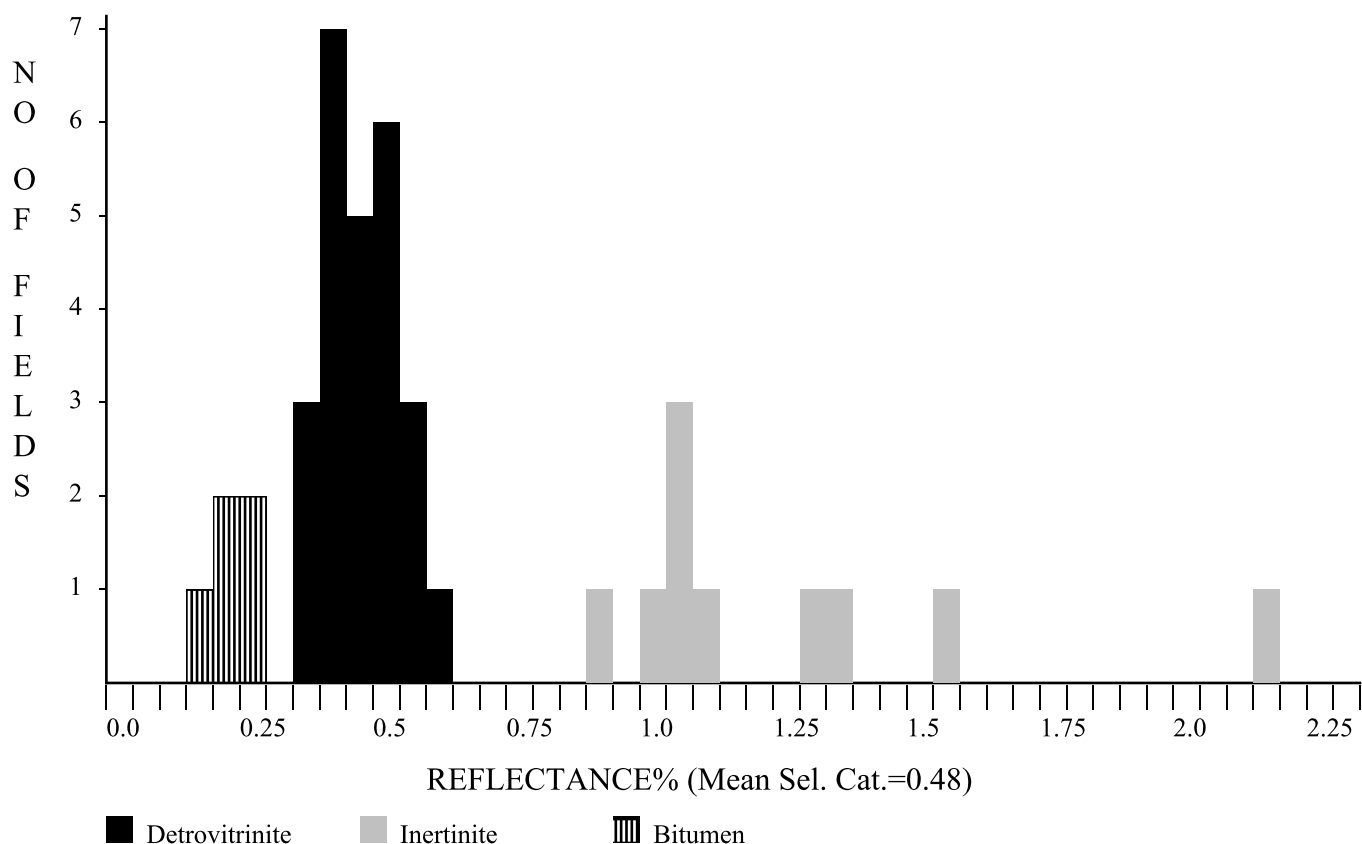
Note that if samples are retained by ERC, they will be held for at least 12 months after reporting but may be discarded after that date.

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA						
	Depth (m)	$\overline{R}_{\text{vmax}}$	Range	SD	N	Sample description including liptinite fluorescence, maceral abundances, mineral fluorescence Pioneer Resources Bogadi BORC-06 GSWA#237702
E4160	6	0.48	0.36-0.60	0.066	25	Sparse sporinite and rare liptodetrinite orange to dull orange,
237702	$\overline{R}_{\text{I}}$	1.27	0.91-2.16	0.350	10	rare cutinite dull orange. (Silty claystone>siltstone. Dom
Ctgs	Bitumen	0.23	0.18-0.28	0.037	5	abundant, I>L>V. Inertinite abundant, liptinite sparse, vitrinite rare to sparse. Rare dull orange fluorescing bitumen in claystone. Mineral fluorescence weak orange. Iron oxides sparse. Pyrite sparse.)

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA						
	Depth (m)	$\overline{R}_{vmax}$	Range	SD	N	Sample description including liptinite fluorescence, maceral abundances, mineral fluorescence Coolkilya Pool Outcrops, Measured Section 140m From Base <b>GSWA#222041</b>
E4162	140m From	0.54	0.44-0.71	0.070	25	Common sporinite and rare liptodetrinite orange to dull orange, sparse cutinite dull orange, rare to sparse <i>Botryococcus</i> -related telalginite bright yellow. (Silty claystone and claystone. Dom abundant, I>L>V. Inertinite abundant, liptinite common, vitrinite sparse. Mineral fluorescence weak orange. Iron oxides common. Pyrite common.) Coolkilya Pool Outcrops, Measured Section 172m From Base <b>GSWA#222039</b>
222041 O/C	$\overline{R}_I$	1.45	1.01-2.24	0.311	10	
E4163	172m From	0.51	0.40-0.63	0.061	25	Common sporinite and sparse liptodetrinite orange to dull orange, sparse cutinite dull orange, rare <i>Botryococcus</i> -related telalginite bright yellow. (Silty claystone and claystone. Dom abundant, I>L>V. Inertinite abundant, liptinite common, vitrinite sparse. Mineral fluorescence weak to moderate orange. Iron oxides abundant. Pyrite common.) Coolkilya Pool Outcrops, Measured Section 34m From Base <b>GSWA#222047</b>
222039 O/C	$\overline{R}_I$	1.21	0.98-1.69	0.185	10	
E4164	34m From B	0.57	0.40-0.71	0.074	25	Sparse sporinite and rare liptodetrinite orange to dull orange, rare cutinite orange to dull orange. (Silty claystone and claystone. Dom abundant, I>L>V. Inertinite abundant, liptinite sparse, vitrinite rare to sparse. . Mineral fluorescence weak orange. Iron oxides abundant. Pyrite sparse.)
222047 O/C	$\overline{R}_I$	1.22	1.01-1.87	0.241	10	

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA						
	Depth (m)	$\overline{R}_{vmax}$	Range	SD	N	Sample description including liptinite fluorescence, maceral abundances, mineral fluorescence <b>Outcrop, Minilya River</b> <b>GSWA#222031</b>
E4165	-	0.72	0.58-0.83	0.068	25	Abundant sporinite and sparse liptodetrinite orange to dull orange, rare cutinite dull orange. (Claystone. Dom abundant, I>L>V. Inertinite and liptinite common, vitrinite rare. Mineral fluorescence weak dull orange. Iron oxides sparse. Pyrite sparse.)
222031 O/C	$\overline{R}_I$	1.51	1.08-1.90	0.256	10	
GEOLOGICAL SURVEY OF WESTERN AUSTRALIA						
	Depth (m)	$\overline{R}_{vmax}$	Range	SD	N	Sample description including liptinite fluorescence, maceral abundances, mineral fluorescence <b>GBH4</b> <b>GSWA# ?</b>
E4166	442.7	0.78	0.66-0.90	0.063	25	Abundant sporinite and sparse liptodetrinite orange to dull orange, common cutinite dull orange, rare <i>Botryococcus</i> -related telalginite bright orange, rare resinite orange. (Argillaceous siltstone and siltstone. Dom major, I>L>V. Inertinite abundant to major, liptinite abundant, vitrinite sparse. Well preserved tetrad spores present. Mineral fluorescence weak to moderate orange. Iron oxides abundant. Pyrite sparse.)
? Ctgs	$\overline{R}_I$	1.54	1.12-2.31	0.395	10	
GEOLOGICAL SURVEY OF WESTERN AUSTRALIA						
	Depth (m)	$\overline{R}_{vmax}$	Range	SD	N	Sample description including liptinite fluorescence, maceral abundances, mineral fluorescence <b>GSWA# 219286</b>
E4167	201.4	0.72	0.60-0.87	0.065	25	Common sporinite and sparse liptodetrinite orange to dull orange, rare cutinite dull orange, rare <i>Botryococcus</i> -related telalginite bright orange. (Silty claystone. Dom abundant, I>L>V. Inertinite abundant, liptinite common, vitrinite rare. Mineral fluorescence weak orange. Iron oxides abundant. Pyrite sparse.)
#219286 Ctgs	$\overline{R}_I$	1.58	1.36-2.29	0.295	10	

GSWA #237702, Pioneer Resources Bogadi BORC-06, 6m, Ctgs(E4160)

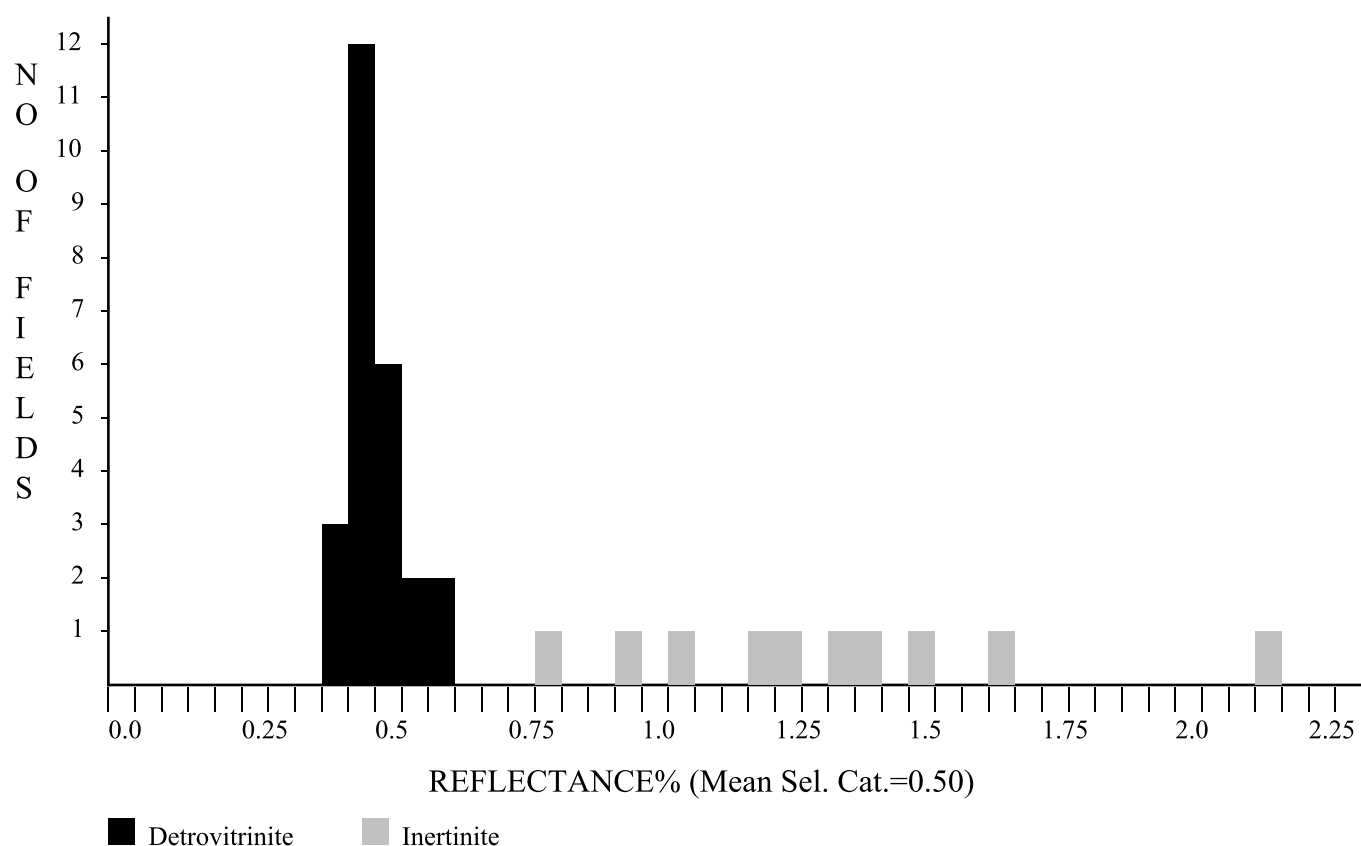


Maceral Category	N	Mean	Standard Deviation
Detrovitrinite	25	0.48	0.066
Inertinite	10	1.27	0.350
Bitumen	5	0.23	0.037
<b>Total</b>	<b>40</b>	<b>0.64</b>	<b>0.412</b>

Selected categories: Detrovitrinite:

No. of Readings: 25  
Mean of Selected Categories: 0.48  
Standard Deviation of Selected categories: 0.066

GSWA #235024, Woorame Seismic Line 3, SP314, 245-440ft, Ctgs(E4161)

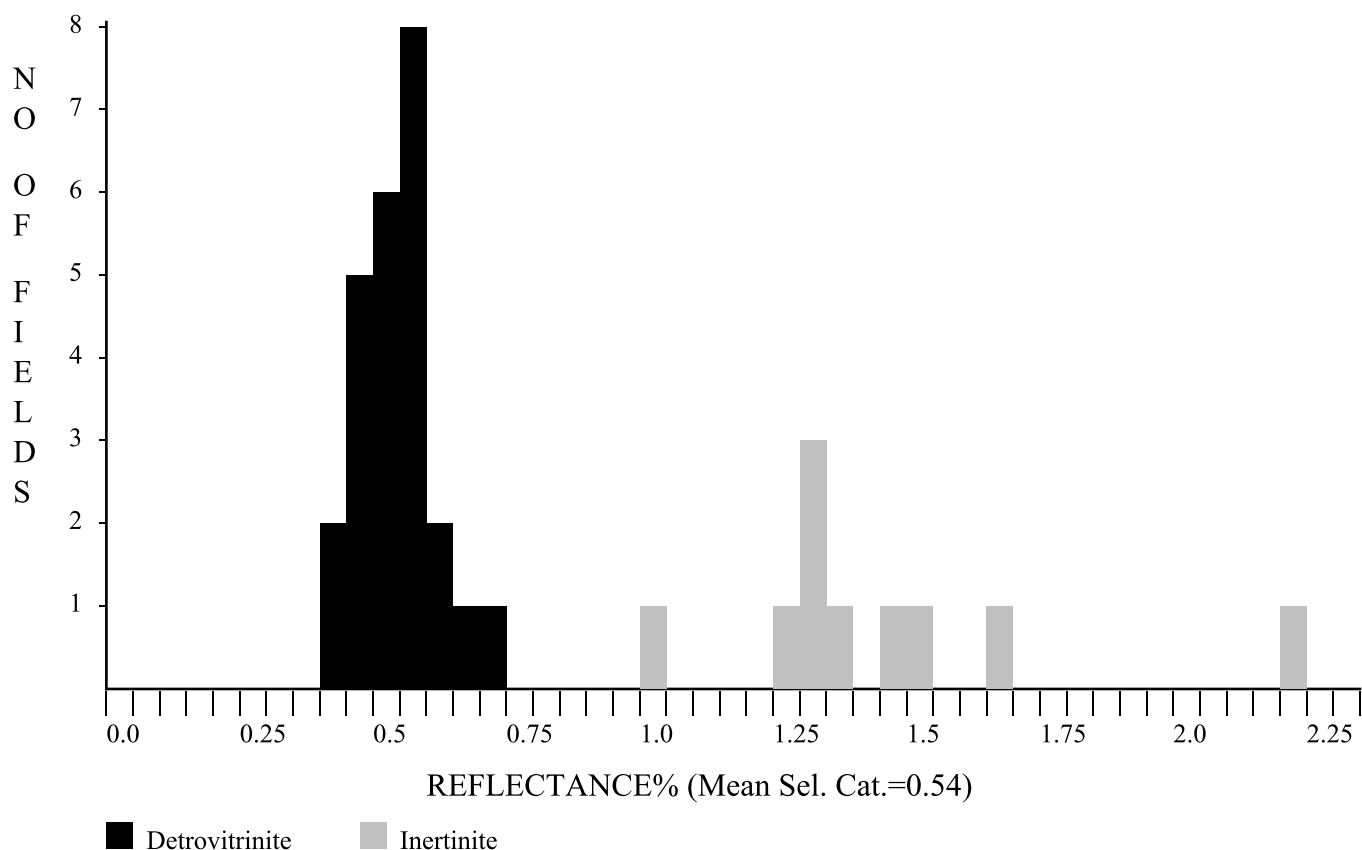


Maceral Category	N	Mean	Standard Deviation
Detrovitrinite	25	0.50	0.054
Inertinite	10	1.35	0.364
<b>Total</b>	<b>35</b>	<b>0.74</b>	<b>0.434</b>

Selected categories: Detrovitrinite:

No. of Readings:	25
Mean of Selected Categories:	0.50
Standard Deviation of Selected categories:	0.054

GSWA #222041, Coolkilya Pool Outcrops, Measured Section 140m from Base, OC(E4162)



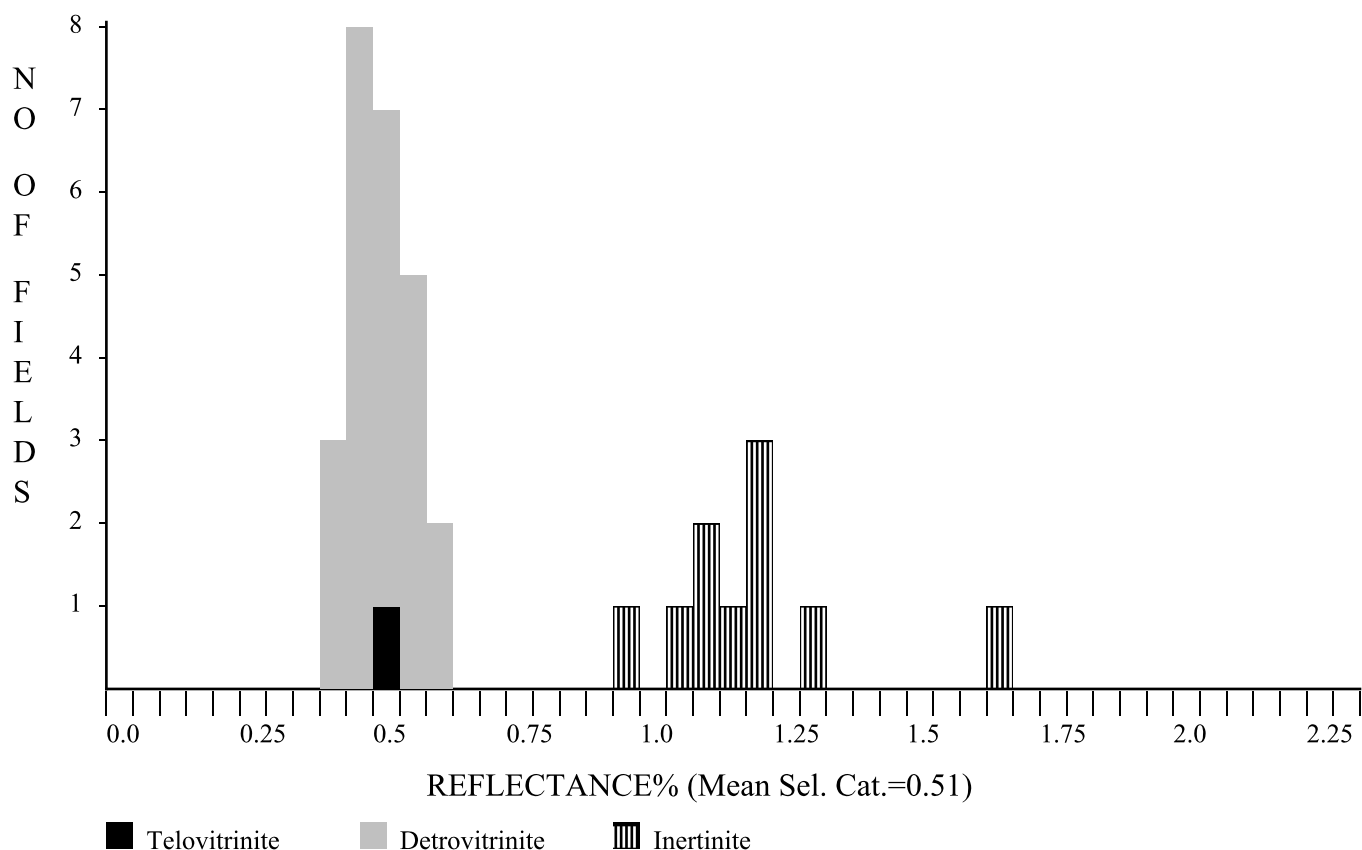
Maceral Category	N	Mean	Standard Deviation
Detrovitrinite	25	0.54	0.070
Inertinite	10	1.45	0.311
<b>Total</b>	<b>35</b>	<b>0.80</b>	<b>0.447</b>

Selected categories: Detrovitrinite:

No. of Readings:	25
Mean of Selected Categories:	0.54
Standard Deviation of Selected categories:	0.070



GSWA #222039 Coolkilya Pool Outcrops, Measured Section 172m from Base, OC(E4163)

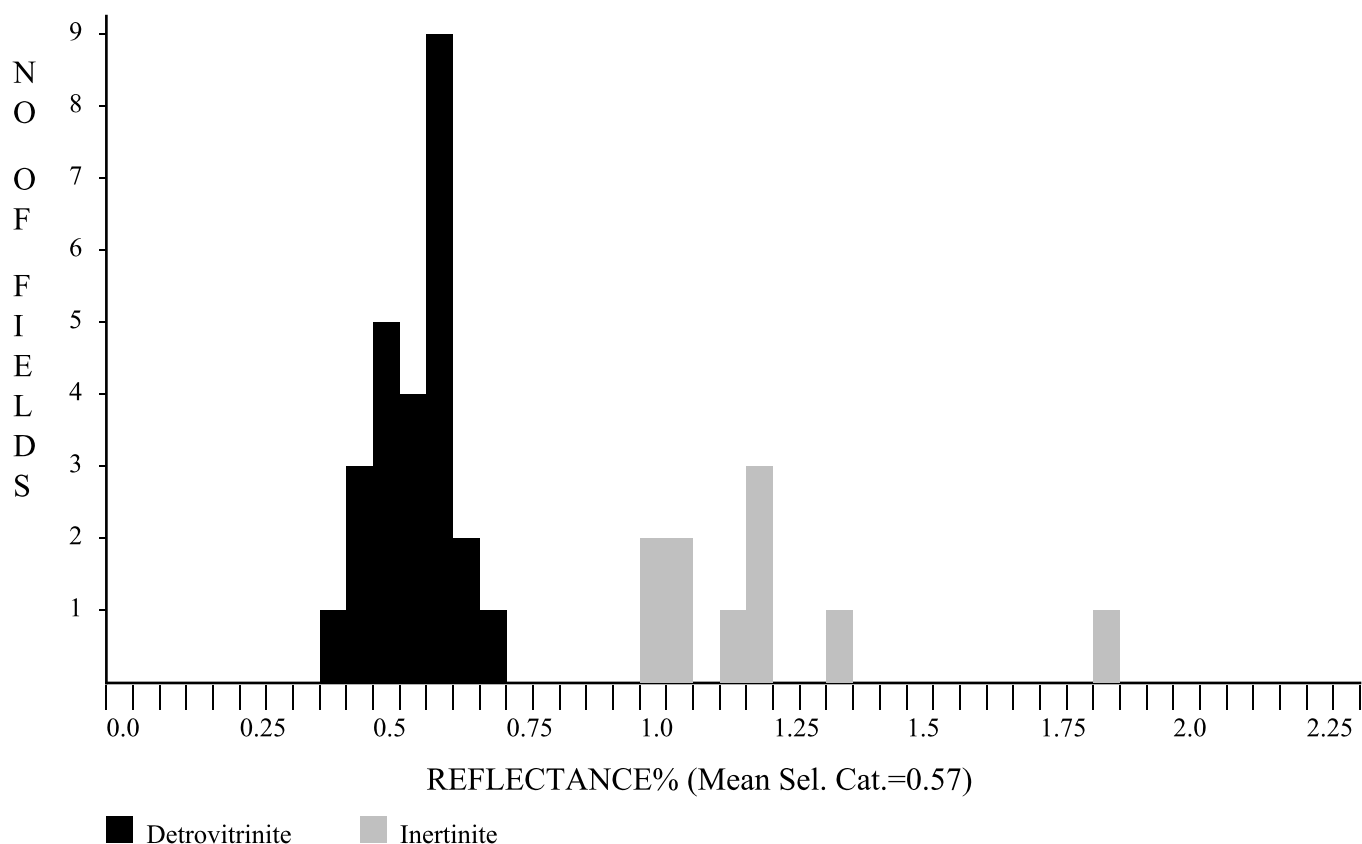


Maceral Category	N	Mean	Standard Deviation
Telovitrinite	1	0.51	0.000
Detrovitrinite	24	0.51	0.062
Inertinite	10	1.21	0.185
<b>Total</b>	<b>35</b>	<b>0.71</b>	<b>0.336</b>

Selected categories: Telovitrinite, Detrovitrinite:

No. of Readings: 25  
Mean of Selected Categories: 0.51  
Standard Deviation of Selected categories: 0.061

GSWA #222047 Coolkilya Pool Outcrops, Measured Section 34m from Base, OC(E4164)

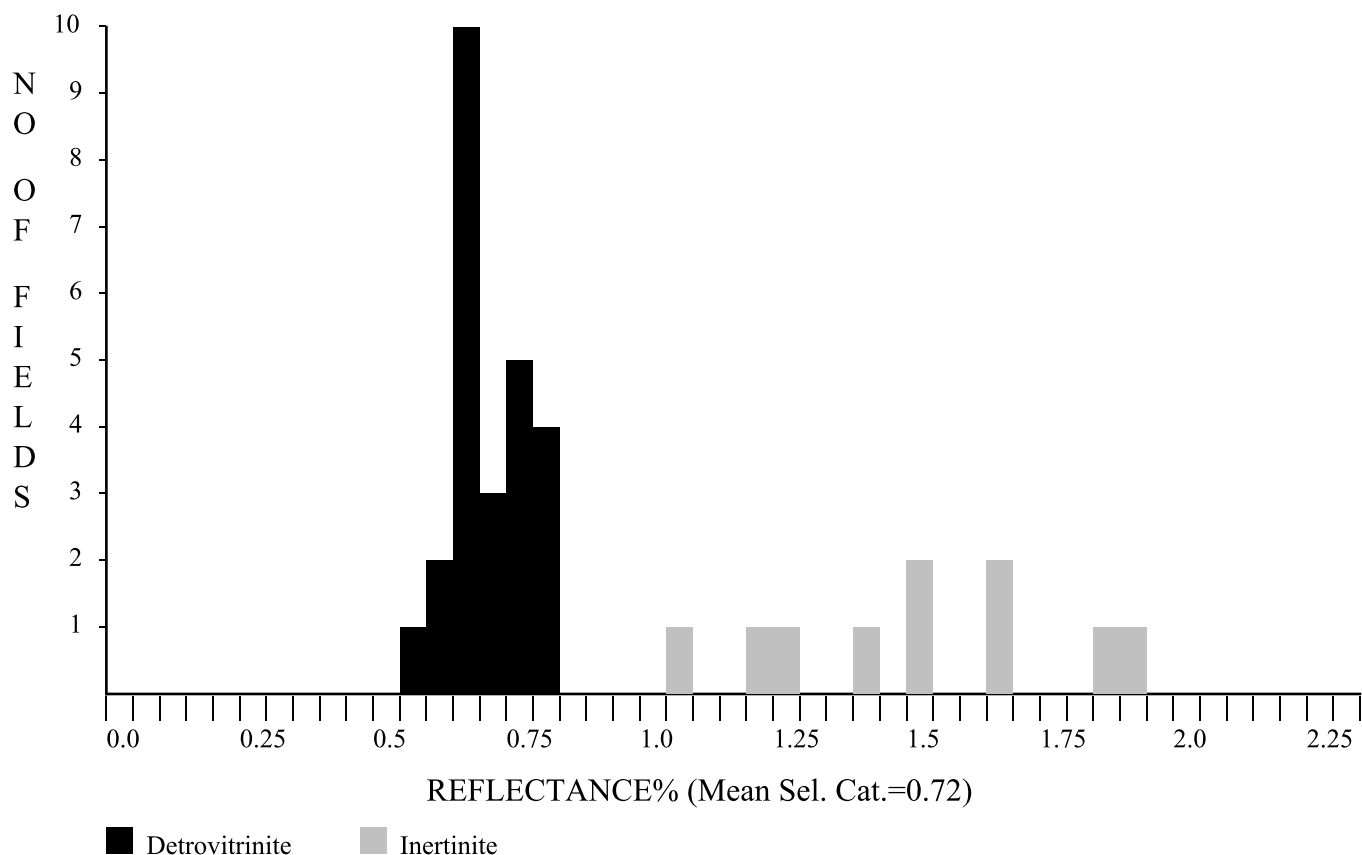


Maceral Category	N	Mean	Standard Deviation
Detrovitrinite	25	0.57	0.074
Inertinite	10	1.22	0.241
<b>Total</b>	<b>35</b>	<b>0.76</b>	<b>0.326</b>

Selected categories: Detrovitrinite:

No. of Readings:	25
Mean of Selected Categories:	0.57
Standard Deviation of Selected categories:	0.074

GSWA #222031, Outcrop, Minilya River, OC(E4165)

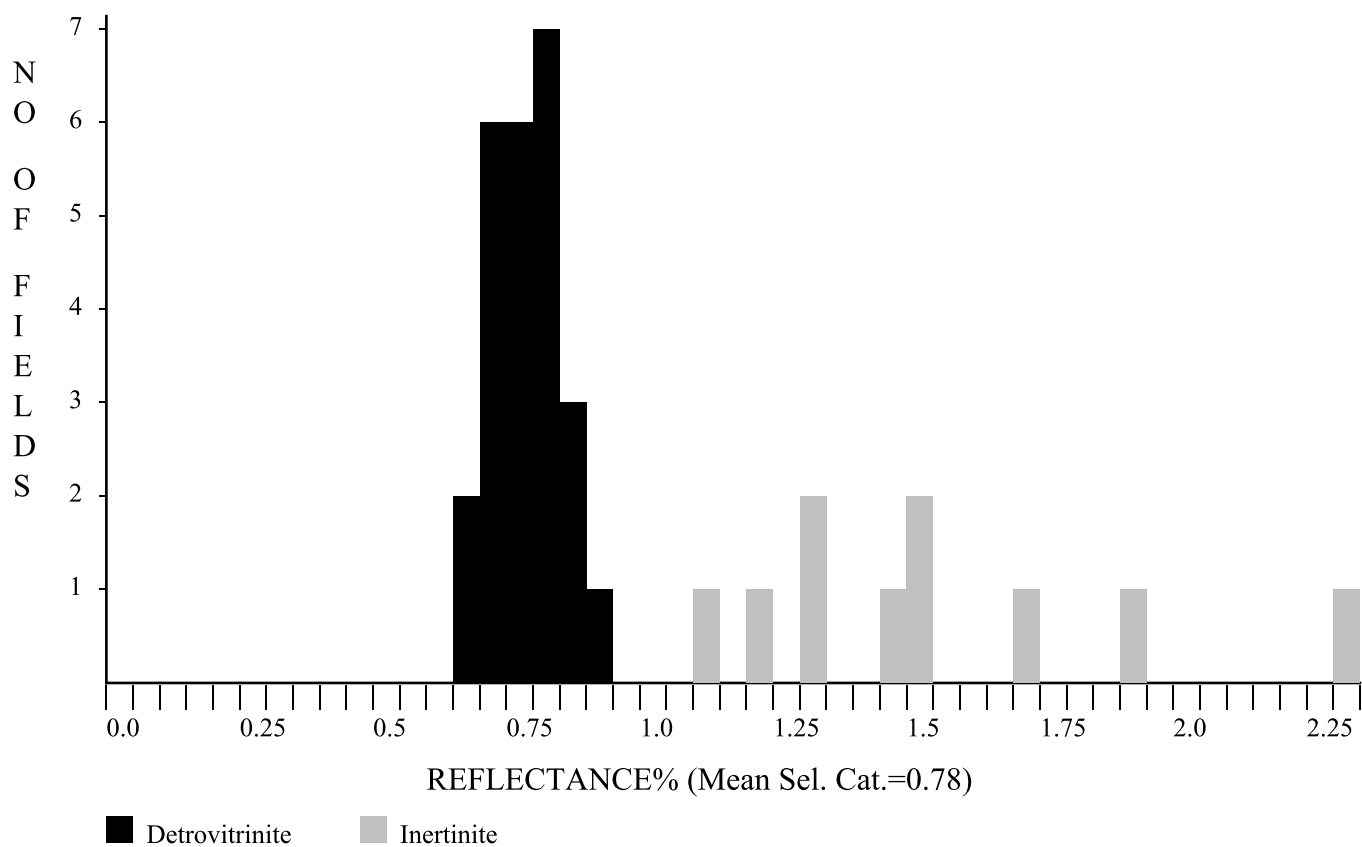


Maceral Category	N	Mean	Standard Deviation
Detrovitrinite	25	0.72	0.068
Inertinite	10	1.51	0.256
<b>Total</b>	<b>35</b>	<b>0.94</b>	<b>0.388</b>

Selected categories: Detrovitrinite:

No. of Readings: 25  
Mean of Selected Categories: 0.72  
Standard Deviation of Selected categories: 0.068

GSWA #?, GBH4, 442.7m, Core(E4166)

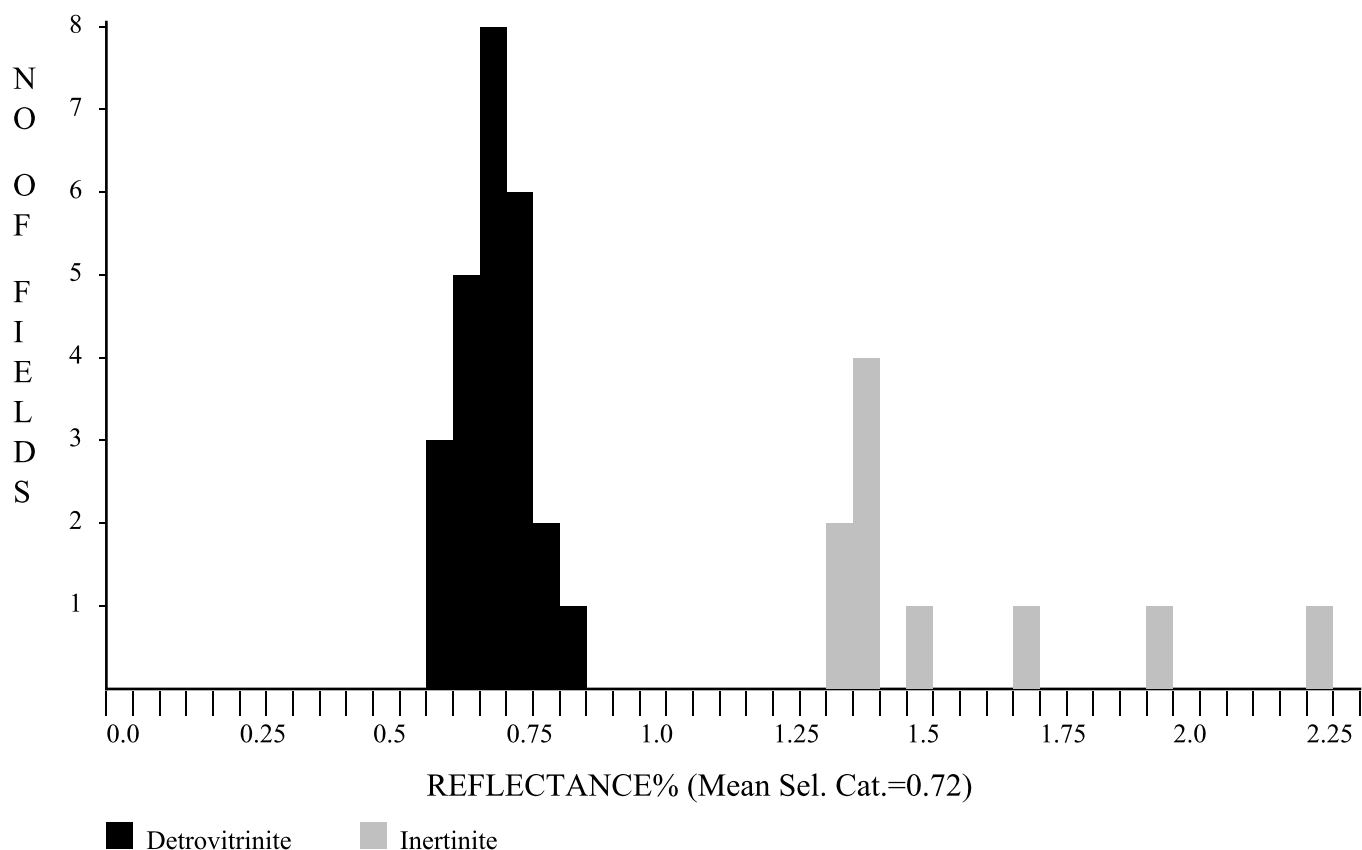


Maceral Category	N	Mean	Standard Deviation
Detrovitrinite	25	0.78	0.063
Inertinite	10	1.54	0.335
Total	35	1.00	0.388

Selected categories: Detrovitrinite:

No. of Readings:	25
Mean of Selected Categories:	0.78
Standard Deviation of Selected categories:	0.063

GSWA #219286, GBH4, 201.4m, Core(E4167)



Maceral Category	N	Mean	Standard Deviation
Detrovitrinite	25	0.72	0.065
Inertinite	10	1.58	0.295
<b>Total</b>	<b>35</b>	<b>0.97</b>	<b>0.424</b>

Selected categories: Detrovitrinite:

No. of Readings: 25  
Mean of Selected Categories: 0.72  
Standard Deviation of Selected categories: 0.065

Dr Peter Crosdale (MAIG)  
Director, ERC  
4<sup>th</sup> June, 2021

## **APPENDIX - PLATES**

High quality images are provided in a separate image file. Images provided in this report are for reference purposes only.

E4160A Detrovitrinite in claystone,  $R_{v\max} = 0.49\%$ , reflected white light, X50  
 E4160B Same as E4160A, in fluorescence mode  
 E4160C Semifusinite in silty claystone,  $R_l = 1.14\%$ , reflected white light, X50  
 E4160D Same as E4160C, in fluorescence mode  
 E4160E Sporinite in silty claystone, reflected white light, X50  
 E4160F Same as E4160E, in fluorescence mode

E4160G Bitumen in silty claystone,  $R_{\text{Bit}} = 0.22\%$ , reflected white light, X50  
 E4160H Same as E4160G, in fluorescence mode

E4161A Detrovitrinite in silty claystone,  $R_{v\max} = 0.53\%$ , reflected white light, X50  
 E4161B Same as E4161A, in fluorescence mode  
 E4161C Semifusinite in silty claystone,  $R_l = 1.52\%$ , reflected white light, X50  
 E4161D Same as E4161C, in fluorescence mode  
 E4161E Abundant sporinite in silty claystone, reflected white light, X50  
 E4161F Same as E4161E, in fluorescence mode

E4162A Detrovitrinite in silty claystone,  $R_{v\max} = 0.71\%$ , reflected white light, X50  
 E4162B Same as E4162A, in fluorescence mode  
 E4162C Abundant sporinite in silty claystone, reflected white light, X50  
 E4162D Same as E4162C, in fluorescence mode  
 E4162E Botryococcus-related telalginite in silty claystone, reflected white light, X50  
 E4162F Same as E4162E, in fluorescence mode

E4163A Detrovitrinite in silty claystone,  $R_{v\max} = 0.57\%$ , reflected white light, X50  
 E4163B Same as E4163A, in fluorescence mode  
 E4163C Cutinite in silty claystone, reflected white light, X50  
 E4163D Same as E4163C, in fluorescence mode

E4164A Detrovitrinite in silty claystone,  $R_{v\max} = 0.57\%$ , reflected white light, X50  
 E4164B Same as E4164A, in fluorescence mode  
 E4164C Semifusinite in silty claystone,  $R_l = 1.15\%$ , reflected white light, X50  
 E4164D Same as E4164C, in fluorescence mode  
 E4164E Sporinite in silty claystone, reflected white light, X50  
 E4164F Same as E4164E, in fluorescence mode

E4164G Cutinite in silty claystone, reflected white light, X50  
 E4164H Same as E4164G, in fluorescence mode

E4165A Detrovitrinite in claystone,  $R_{v\max} = 0.0.66\%$ , reflected white light, X50  
 E4165B Same as E4165A, in fluorescence mode  
 E4165C Semifusinite in claystone,  $R_l = 1.21\%$ , reflected white light, X50  
 E4165D Same as E4165C, in fluorescence mode  
 E4165E Abundant sporinite in claystone, reflected white light, X50  
 E4165F Same as E4165E, in fluorescence mode



E4166A Detrovitrinite in argillaceous siltstone,  $R_{v\max} = 0.76\%$ , reflected white light, X50

E4166B Same as E4166A, in fluorescence mode

E4166C Semifusinite in argillaceous siltstone,  $R_1 = 1.51\%$ , reflected white light, X50

E4166D Same as E4166C, in fluorescence mode

E4166E Abundant sporinite in argillaceous siltstone, reflected white light, X50

E4166F Same as E4166E, in fluorescence mode

E4166G Well preserved tetrad spore in argillaceous siltstone, reflected white light, X50

E4166H Same as E4166G, in fluorescence mode

E4166I Botryococcus-related telalginite in argillaceous siltstone, reflected white light, X50

E4166J Same as E4166I, in fluorescence mode

E4167A Detrovitrinite in silty claystone,  $R_{v\max} = 0.75\%$ , reflected white light, X50

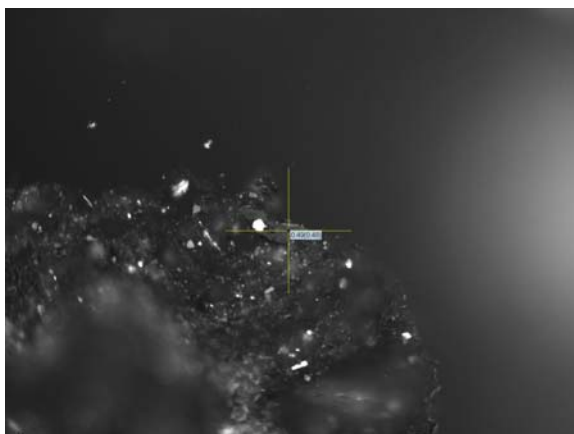
E4167B Same as E4167A, in fluorescence mode

E4167C Common sporinite in silty claystone, reflected white light, X50

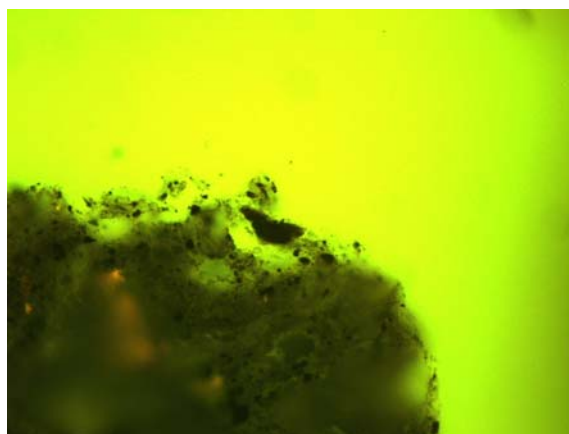
E4167D Same as E4167C, in fluorescence mode

E4167E Botryococcus-related telalginite in silty claystone, reflected white light, X50

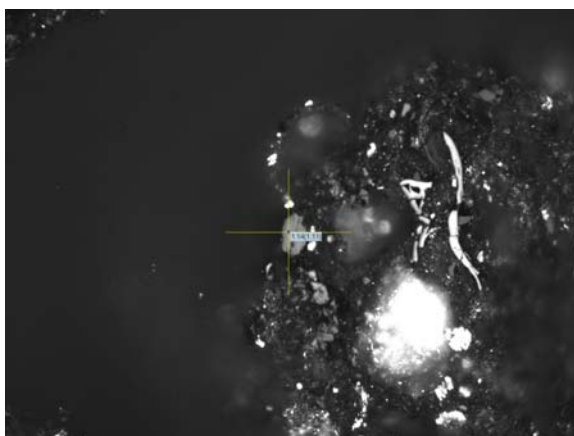
E4167F Same as E4167E, in fluorescence mode



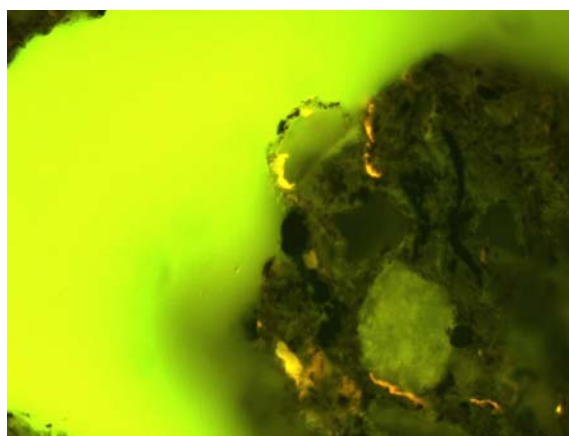
E4160A Detrovitrinite in claystone,  $R_{v\max} = 0.49\%$ , reflected white light, X50



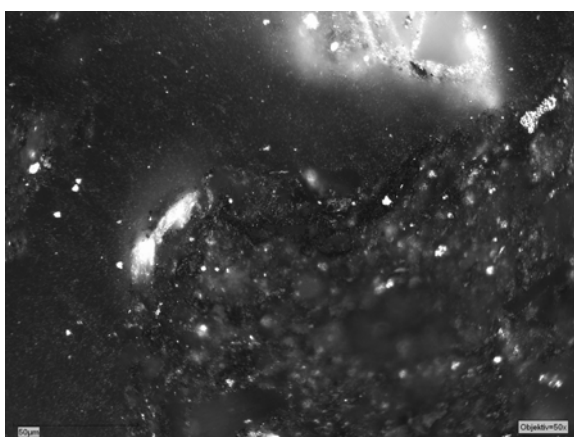
E4160B Same as E4160A, in fluorescence mode



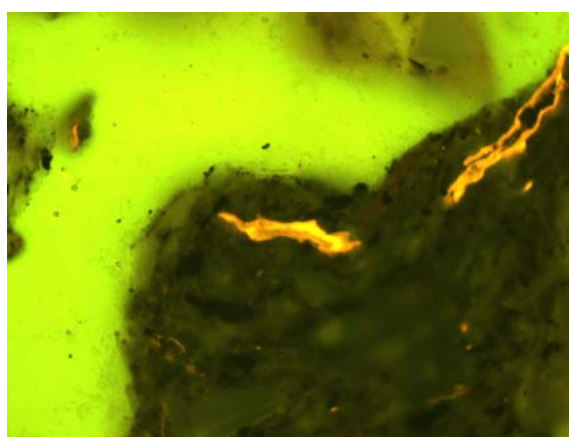
E4160C Semifusinite in silty claystone,  $R_t = 1.14\%$ , reflected white light, X50



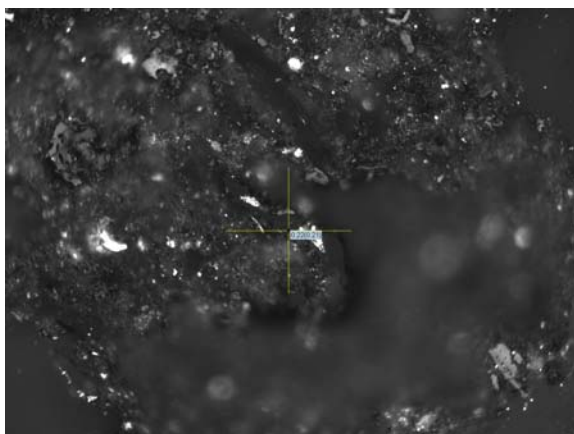
E4160D Same as E4160C, in fluorescence mode



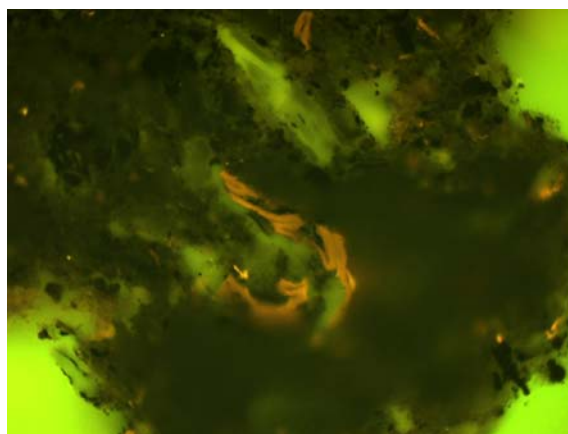
E4160E Sporinite in silty claystone, reflected white light, X50



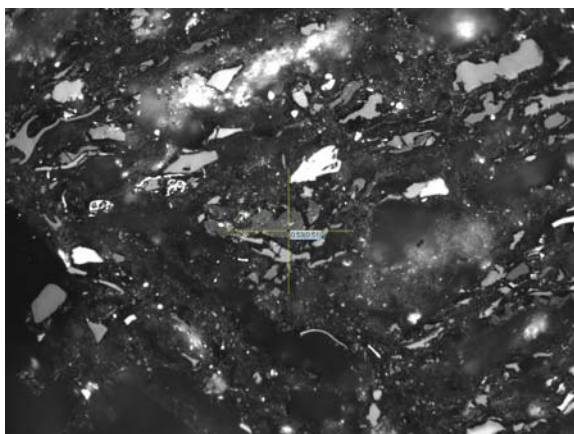
E4160F Same as E4160E, in fluorescence mode



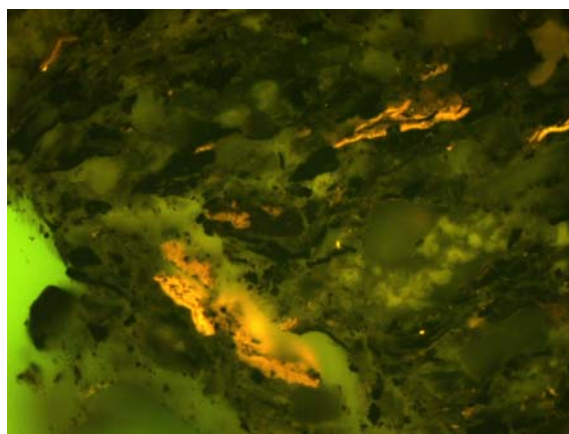
E4160G Bitumen in silty claystone,  $R_{\text{Bit}} = 0.22\%$ , reflected white light, X50



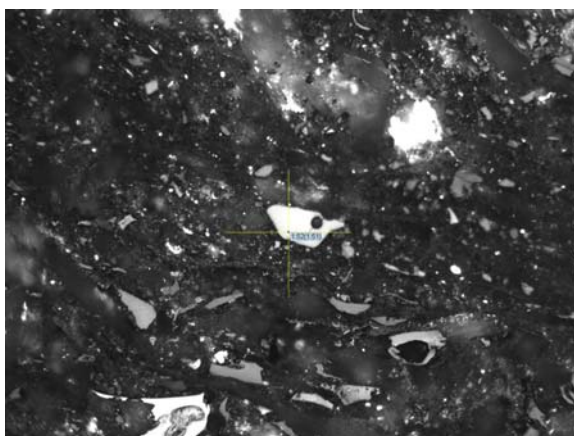
E4160H Same as E4160G, in fluorescence mode



E4161A Detrovitrinite in silty claystone,  $R_v$   
 $\text{max} = 0.53\%$ , reflected white light, X50



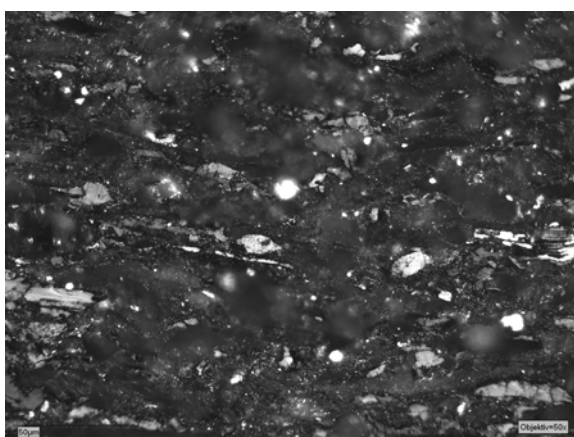
E4161B Same as E4161A, in fluorescence  
mode



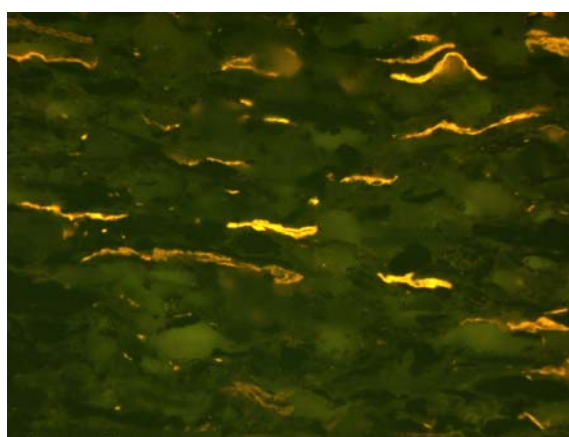
E4161C Semifusinite in silty claystone,  $R_1$   
 $= 1.52\%$ , reflected white light, X50



E4161D Same as E4161C, in fluorescence  
mode

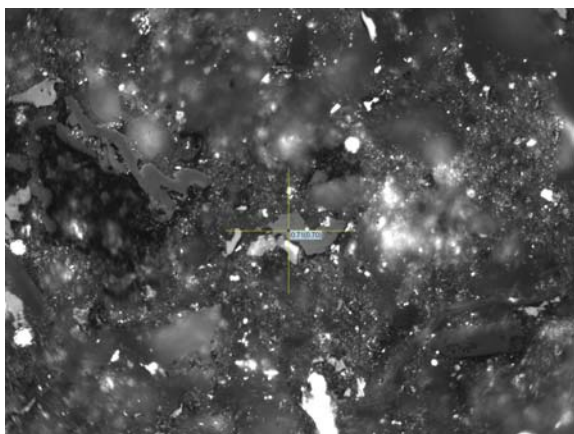


E4161E Abundant sporinite in silty  
claystone, reflected white light, X50

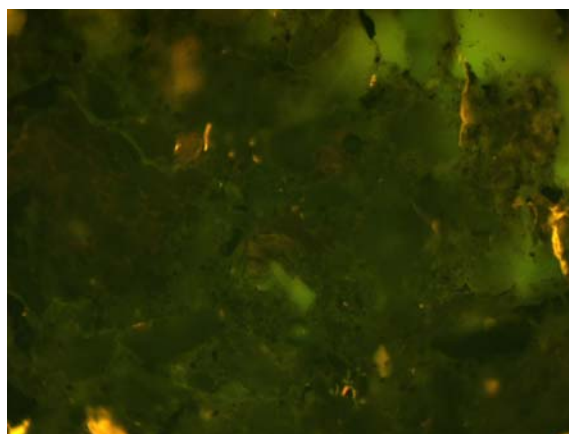


E4161F Same as E4161E, in fluorescence  
mode

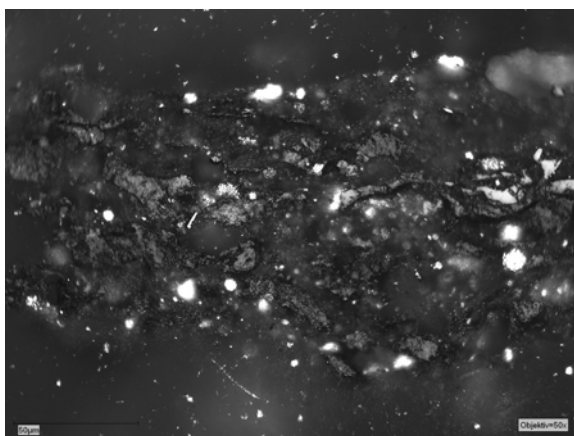




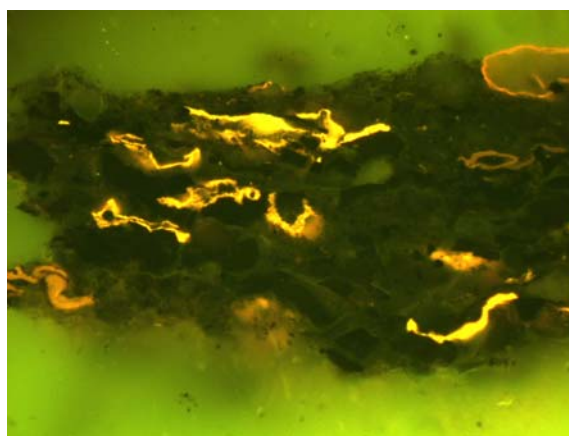
E4162A Detrovitrinite in silty claystone,  
 $R_{v \max} = 0.71\%$ , reflected white light, X50



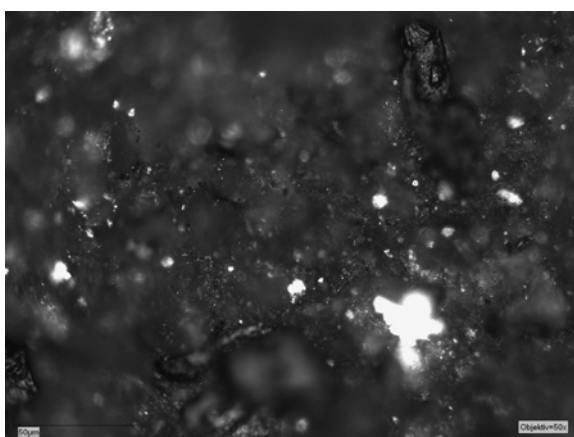
E4162B Same as E4162A, in fluorescence mode



E4162C Abundant sporinite in silty claystone, reflected white light, X50



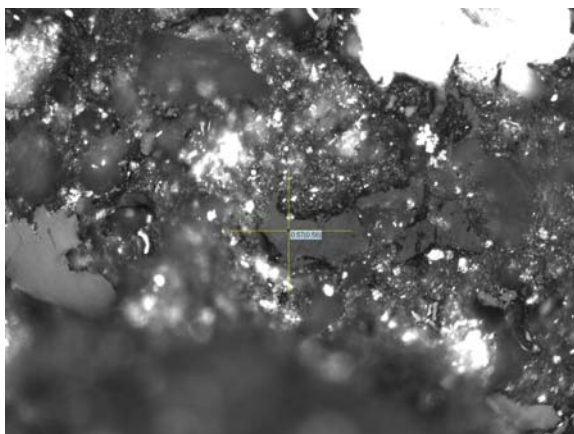
E4162D Same as E4162C, in fluorescence mode



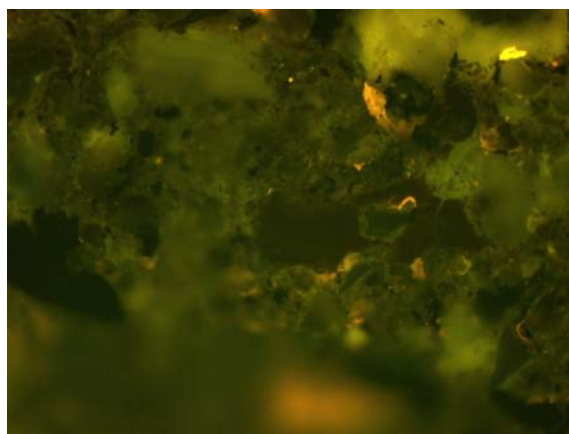
E4162E Botryococcus-related telalginite in silty claystone, reflected white light, X50



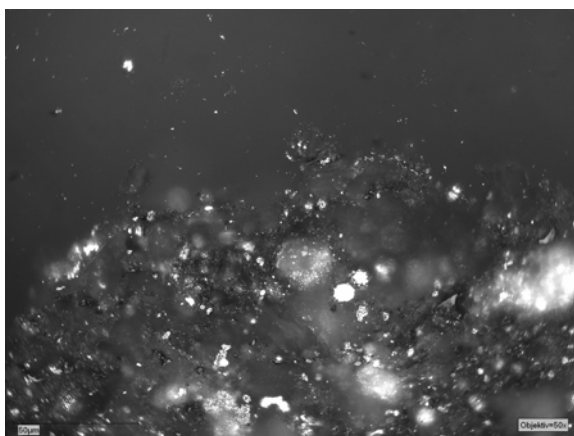
E4162F Same as E4162E, in fluorescence mode



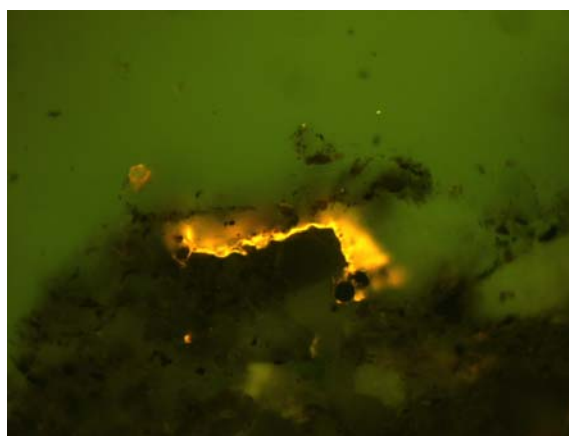
E4163A Detrovitrinite in silty claystone,  
 $R_{v \max} = 0.57\%$ , reflected white light, X50



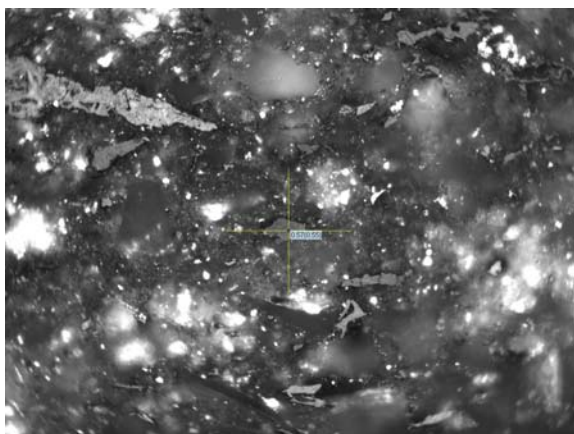
E4163B Same as E4163A, in fluorescence  
mode



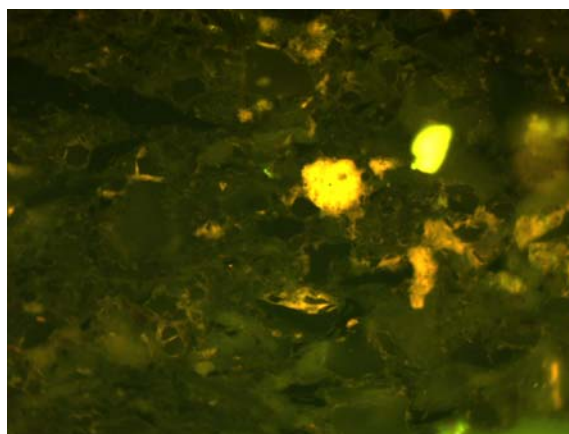
E4163C Cutinite in silty claystone,  
reflected white light, X50



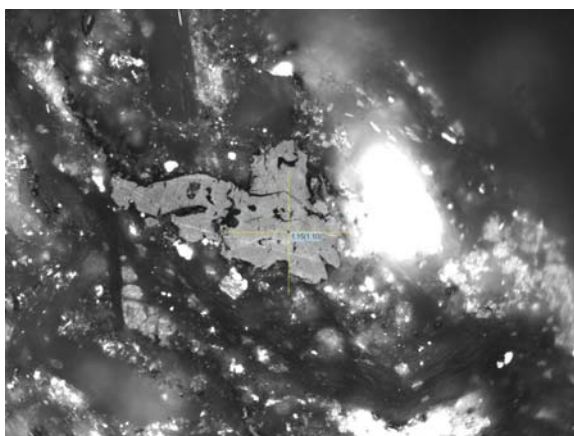
E4163D Same as E4163C, in fluorescence  
mode



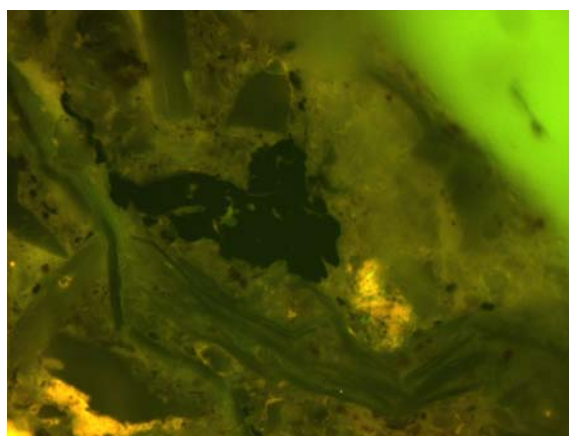
E4164A Detrovitrinite in silty claystone,  
 $R_{v\max} = 0.57\%$ , reflected white light, X50



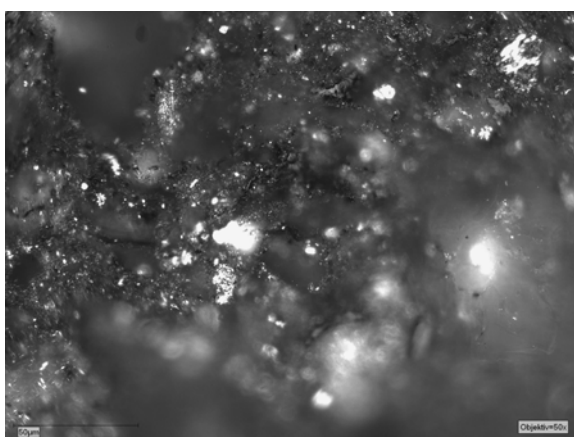
E4164B Same as E4164A, in fluorescence mode



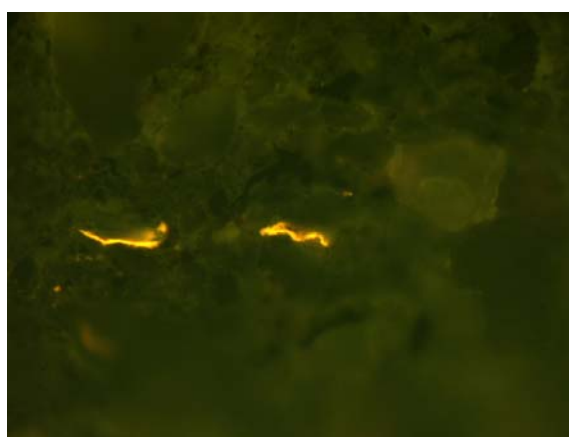
E4164C Semifusinite in silty claystone,  
 $R_1 = 1.15\%$ , reflected white light, X50



E4164D Same as E4164C, in fluorescence mode

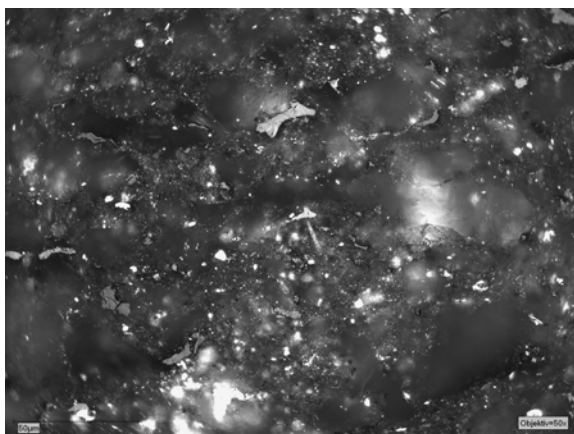


E4164E Sporinite in silty claystone,  
reflected white light, X50

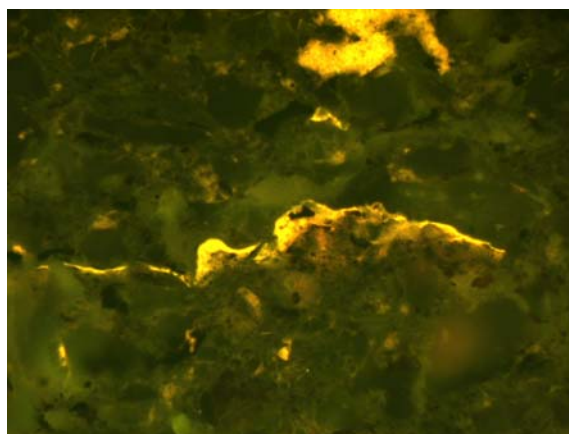


E4164F Same as E4164E, in fluorescence mode



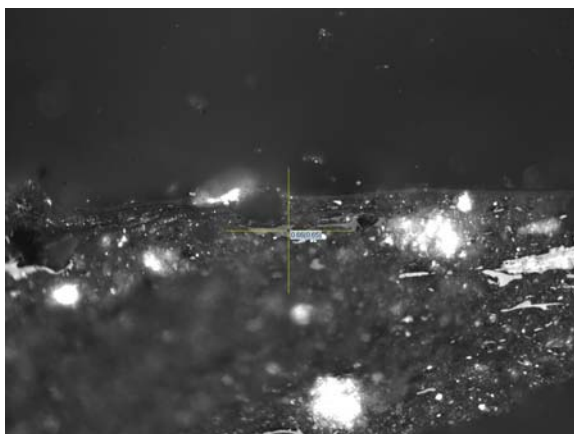


E4164G Cutinite in silty claystone,  
reflected white light, X50

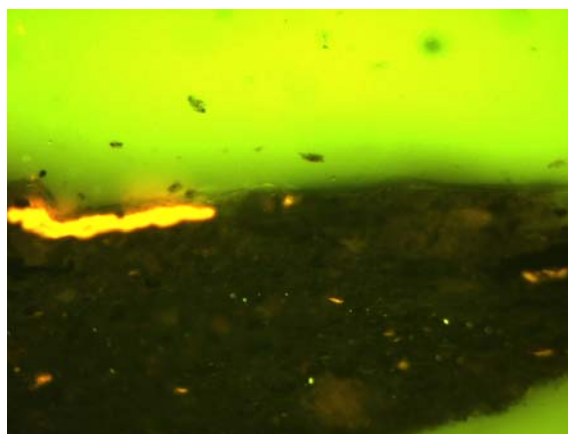


E4164H Same as E4164G, in fluorescence  
mode

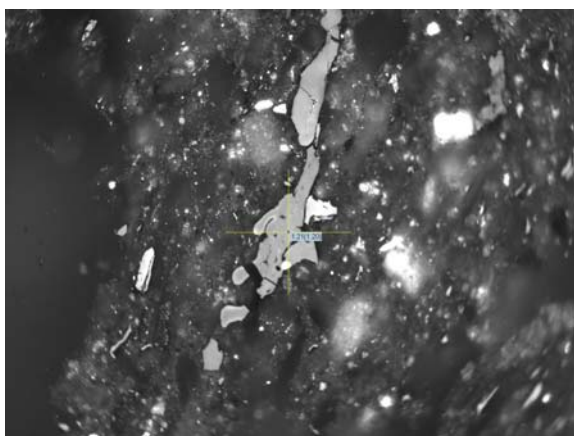




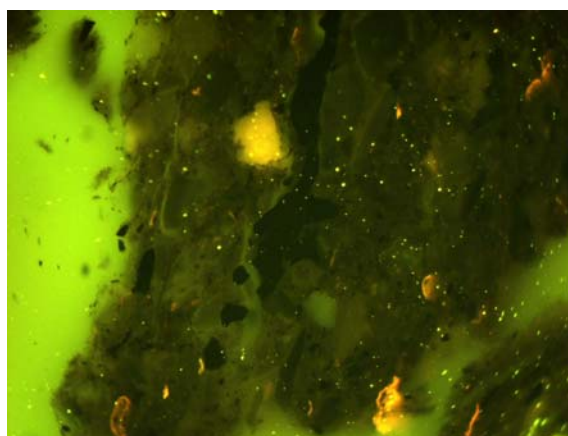
E4165A Detrovitrinite in claystone,  $R_{v\max} = 0.066\%$ , reflected white light, X50



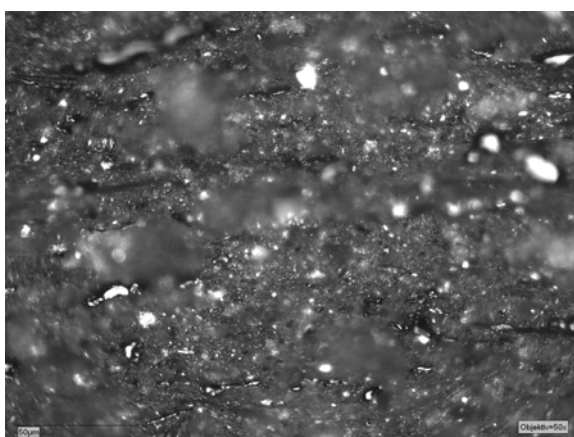
E4165B Same as E4165A, in fluorescence mode



E4165C Semifusinite in claystone,  $R_t = 1.21\%$ , reflected white light, X50



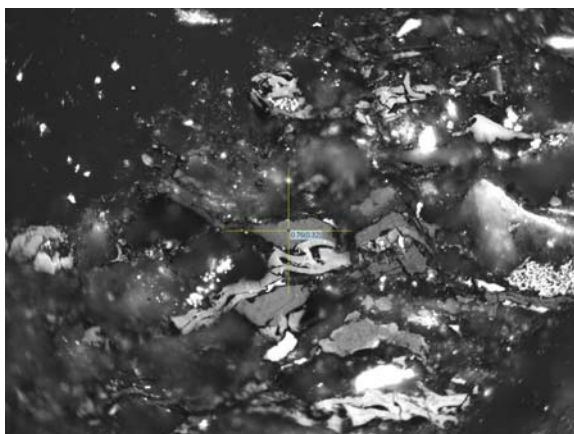
E4165D Same as E4165C, in fluorescence mode



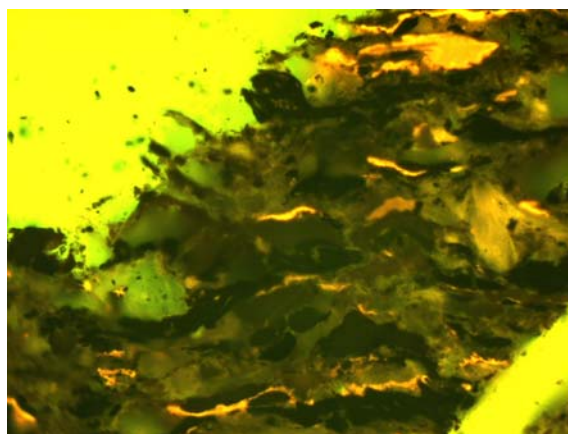
E4165E Abundant sporinite in claystone, reflected white light, X50



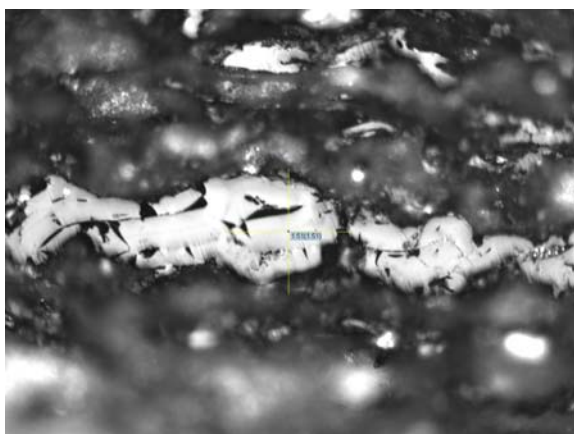
E4165F Same as E4165E, in fluorescence mode



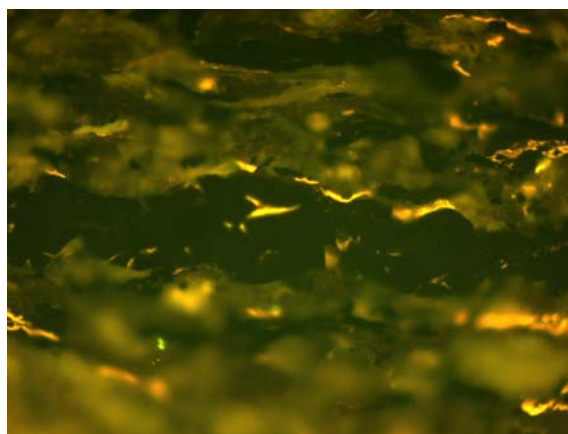
E4166A Detrovitrinite in argillaceous siltstone,  $R_v \text{ max} = 0.76\%$ , reflected white light, X50



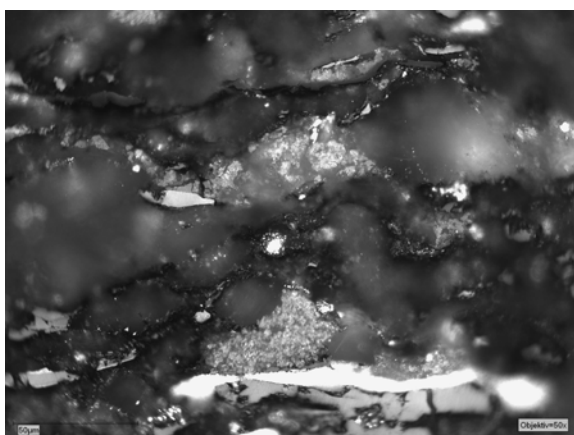
E4166B Same as E4166A, in fluorescence mode



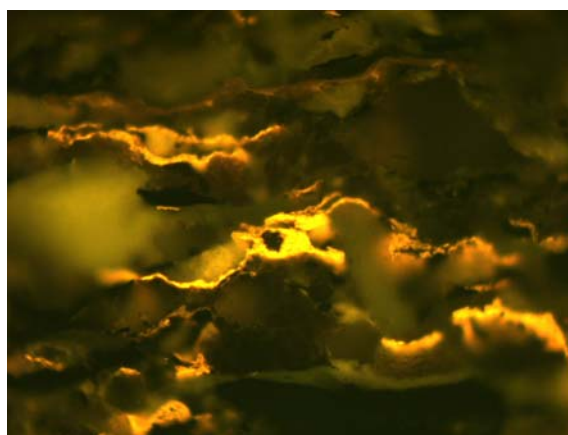
E4166C Semifusinite in argillaceous siltstone,  $RI = 1.51\%$ , reflected white light, X50



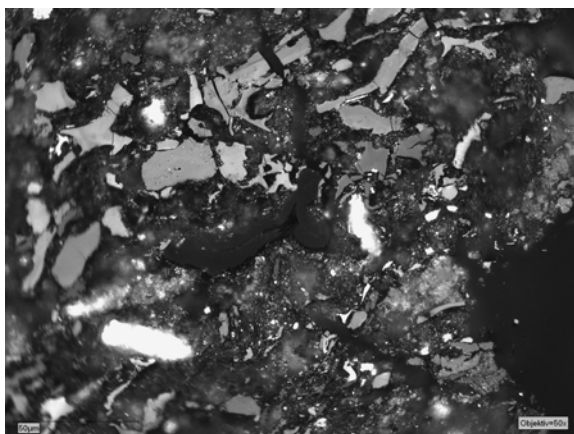
E4166D Same as E4166C, in fluorescence mode



E4166E Abundant sporinite in argillaceous siltstone, reflected white light, X50



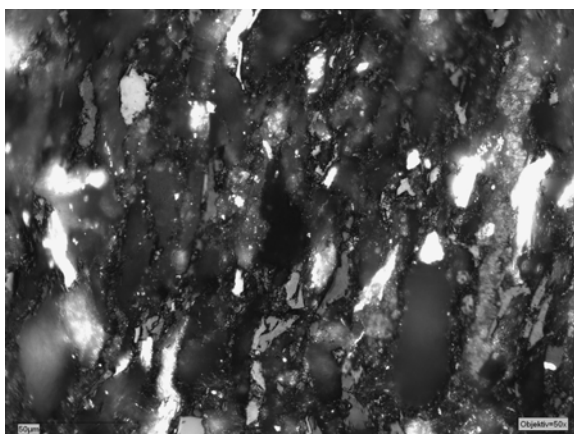
E4166F Same as E4166E, in fluorescence mode



E4166G Well preserved tetrad spore in argillaceous siltstone, reflected white light, X50



E4166H Same as E4166G, in fluorescence mode

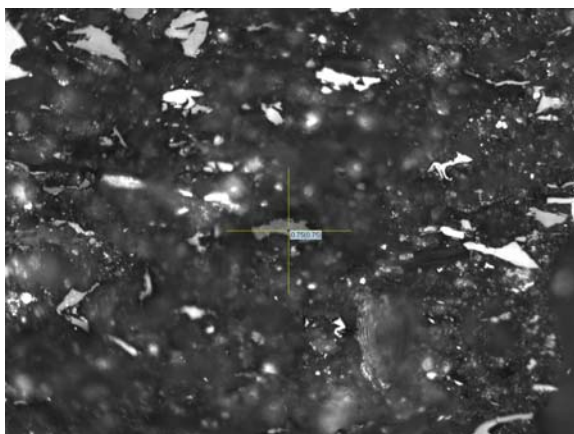


E4166I Botryococcus-related telalginite in argillaceous siltstone, reflected white light, X50

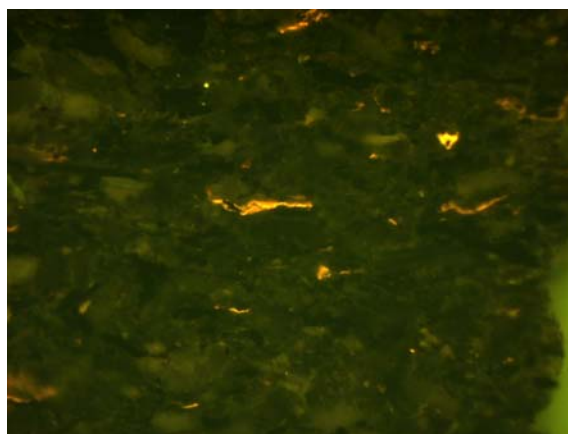


E4166J Same as E4166I, in fluorescence mode

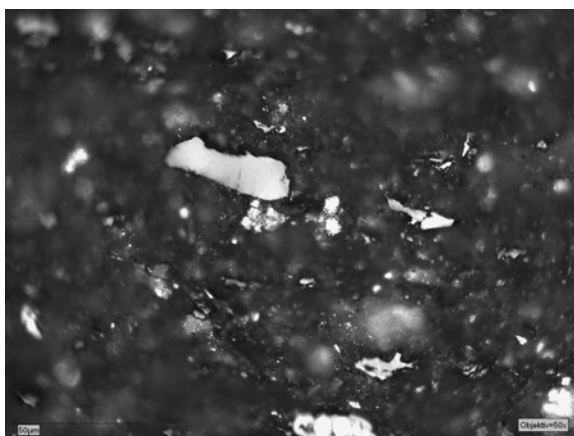




E4167A Detrovitrinite in silty claystone, Rv max = 0.75%, reflected white light, X50



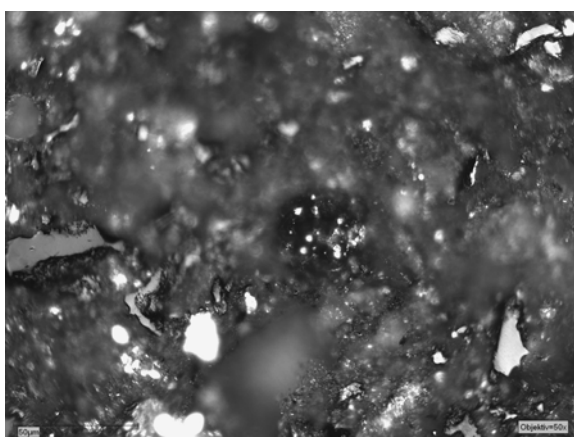
E4167B Same as E4167A, in fluorescence mode



E4167C Common sporinite in silty claystone, reflected white light, X50



E4167D Same as E4167C, in fluorescence mode



E4167E Botryococcus-related telalginite in silty claystone, reflected white light, X50



E4167F Same as E4167E, in fluorescence mode