ANALYTICAL REPORT

SOURCE ROCK
ORGANIC MATTER REFLECTANCE
AND TYPING

HARVEY 3A

PREPARED FOR
GSWA

JULY 2015

Energy Resources
Consulting Pty Ltd

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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			
E1398		219131	Core	789.60 m
E1399		219130	Core	841.10 m
E1400		219127	Core	967.90 m
E1401		219124	Core	1193.10 m
E1402		219116	Core	1434.10 m
E1403		219115	Core	1540.15 m

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 though 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 μm^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 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.

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
HARVEY 3A

ERC# Type	Depth (m)	$\overline{R}_{vmax}$	Range	SD	N	Sample description including liptinite fluorescence, maceral abundances, mineral fluorescence
E1398 219131 Core	789.6 $\overline{R}_I$	0.29 1.25	0.21-0.35 -	0.034 -	25 1	Fluorescing liptinite absent. (Coarse sandstone with coal. Coal dominant, V, vitrite. Coal comprises about 35% of the sample and consists exclusively of vitrinite. Dom common, V>I. Vitrinite common, inertinite rare, liptinite absent. Most coal grains are highly fractured and weathered. Measurements were only made from un-weathered zones in coal grains. Organic matter in some coals has been completely replaced by pyrite. Mineral fluorescence none. Iron oxides rare. Pyrite abundant.)
E1399 219130 Core	841.66 $\overline{R}_I$	0.21 -	0.16-0.28 -	0.030 -	25 -	Fluorescing liptinite absent. (Coal with thin bands of sandstone. Coal dominant, V, vitrite. Coal comprises about 70% of the sample and consists exclusively of vitrite. Coal is made up of telenite bands with lenticular bodies of phlobaphinite. Weak yellow fluorescence from telenites under blue light excitation. Layers of translucent unaltered cellulose common among telenites bands. These layers appear reddish in reflected white light and bright orange under blue light excitation. Pyrite sparse)
E1400 219127 Core	967.9 $\overline{R}_I$	0.34 -	0.28-0.44 -	0.038 -	25 -	Fluorescing liptinite absent. (Coal. Coal dominant, V, vitrite. Sample comprises exclusively of coal and consists of vitrite. Desiccation cracks are abundant in some coal grains. Mineral fluorescence bright orange. Pyrite sparse)
E1401 219124 Core	1193.1 $\overline{R}_I$	0.36 1.29	0.28-0.52 0.89-1.90	0.058 0.313	25 10	Rare cutinite and liptodetrinite bright yellow, rare sporinite orange. (Coarse sandstone with traces of coal. Coal sparse, I>V, inertinite>vitrite. Dom abundant, I>V>L. Inertinite abundant, vitrinite common, liptinite rare. Rare coalified leaf tissues. Weak orange fluorescence from most vitrinite. Mineral fluorescence none. Iron oxides rare. Pyrite rare)
E1402 21916 Core	1434.1 $\overline{R}_I$	0.34 -	0.19-0.54 -	0.094 -	25 -	Fluorescing liptinite absent. (Sandstone with coal. Coal Dominant, V, vitrite. Coal comprises about 60% of the sample and consists exclusively of vitrite. Dom sparse, V. Vitrinite sparse, inertinite and liptinite absent. Organic matter in the sample is highly weathered and measured reflectance may not represent true maturity level. Desiccation cracks are abundant in some coal grains. Mineral fluorescence none. Pyrite sparse)
E1403 219115 Core	1540.15 $\overline{R}_I$	0.49 1.21	0.36-0.60 0.80-1.79	0.056 0.300	25 10	Rare cutinite and liptodetrinite bright yellow, rare resinite yellow. (Coarse sandstone with coal. Coal dominant, V>I>L, vitrite>clarite>vitrinertite(v). Coal comprises about 40% of the sample and approximate maceral composition on mineral free basis: vitrinite 95%; inertinite 3%; liptinite 2%. Dom common, V>I>L. Vitrinite and inertinite sparse, liptinite rare. Weak orange fluorescence from most vitrinite. Mineral fluorescence none. Iron oxides rare. Pyrite sparse)

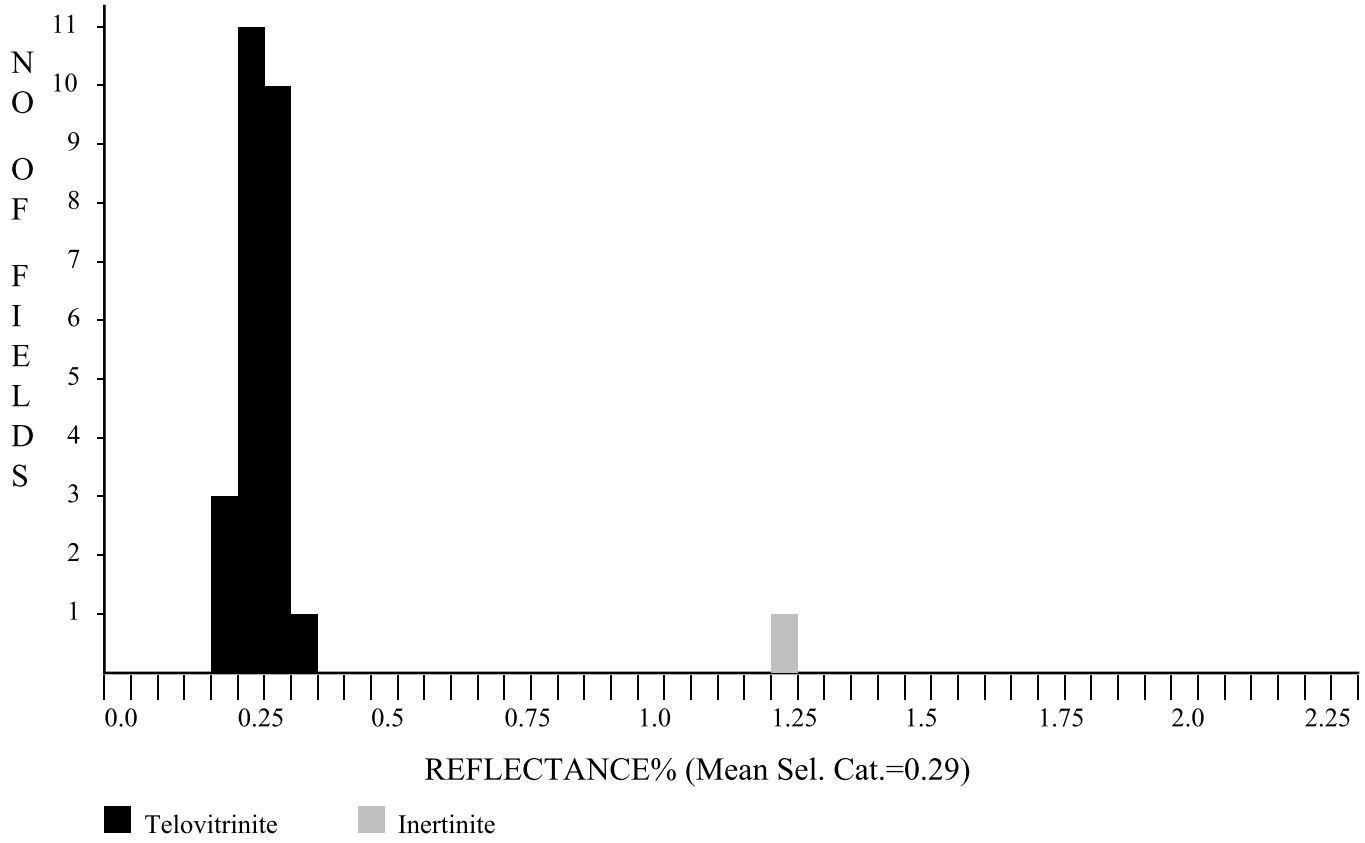
Plates

E1398A Coal vitrite, Rv max = 0.31%, reflected white light, X50
E1398B Same as E1398A, in fluorescence mode
E1398C Fractured and highly weathered coal, reflected white light, X50
E1398D Same as E1398C, in fluorescence mode
E1398E Total replacement of organic matter in coal by pyrite, reflected white light, X50
E1399A Coal (phlobaphinite) in telenite, Rv max = 0.20%, reflected white light, X50
E1399B Same as E1399A, in fluorescence mode
E1399C Telenite with unaltered cellulose, reflected white light, X50
E1399D Same as E1399C, in fluorescence mode
E1400A Coal vitrite, Rv max = 0.35%, reflected white light, X50
E1400B Same as E1400A, in fluorescence mode
E1400C Abundant desiccation cracks in coal , reflected white light, X50
E1401A Telovitrinite and inertinite in sandstone, Rv max = 0.33%, reflected white light, X50
E1401B Same as E1401A, in fluorescence mode
E1401C Coalified leaf tissue in sandstone, reflected white light, X50
E1401D Same as E1401C, in fluorescence mode
E1402A Highly weathered vitrinite coal, Rv max = 0.38%, reflected white light, X50
E1402B Same as E1402A, in fluorescence mode
E1402C Unweathered vitrinite coal, Rv max = 0.48%, reflected white light, X50
E1402D Same as E1402C, in fluorescence mode
E1403A Coal vitrite, Rv max = 0.51%, reflected white light, X50
E1403B Same as E1403A, in fluorescence mode
E1403C Detrovitrinite in sandstone, Rv max = 0.44%, reflected white light, X50
E1403D Same as E1403C, in fluorescence mode
E1403E Resinite in clarite coal, reflected white light, X50
E1403F Same as E1403E, in fluorescence mode
E1403G Cutinite in clarite coal, reflected white light, X50
E1403H Same as E1403G, in fluorescence mode

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GSWA, Harvey 3A, 219131, 789.6m, Core(E1398)



Maceral Category	N	Mean	Standard Deviation
Telovitrinite	25	0.29	0.034
Inertinite	1	1.25	0.000
Total	26	0.32	0.188

Selected categories: Telovitrinite:

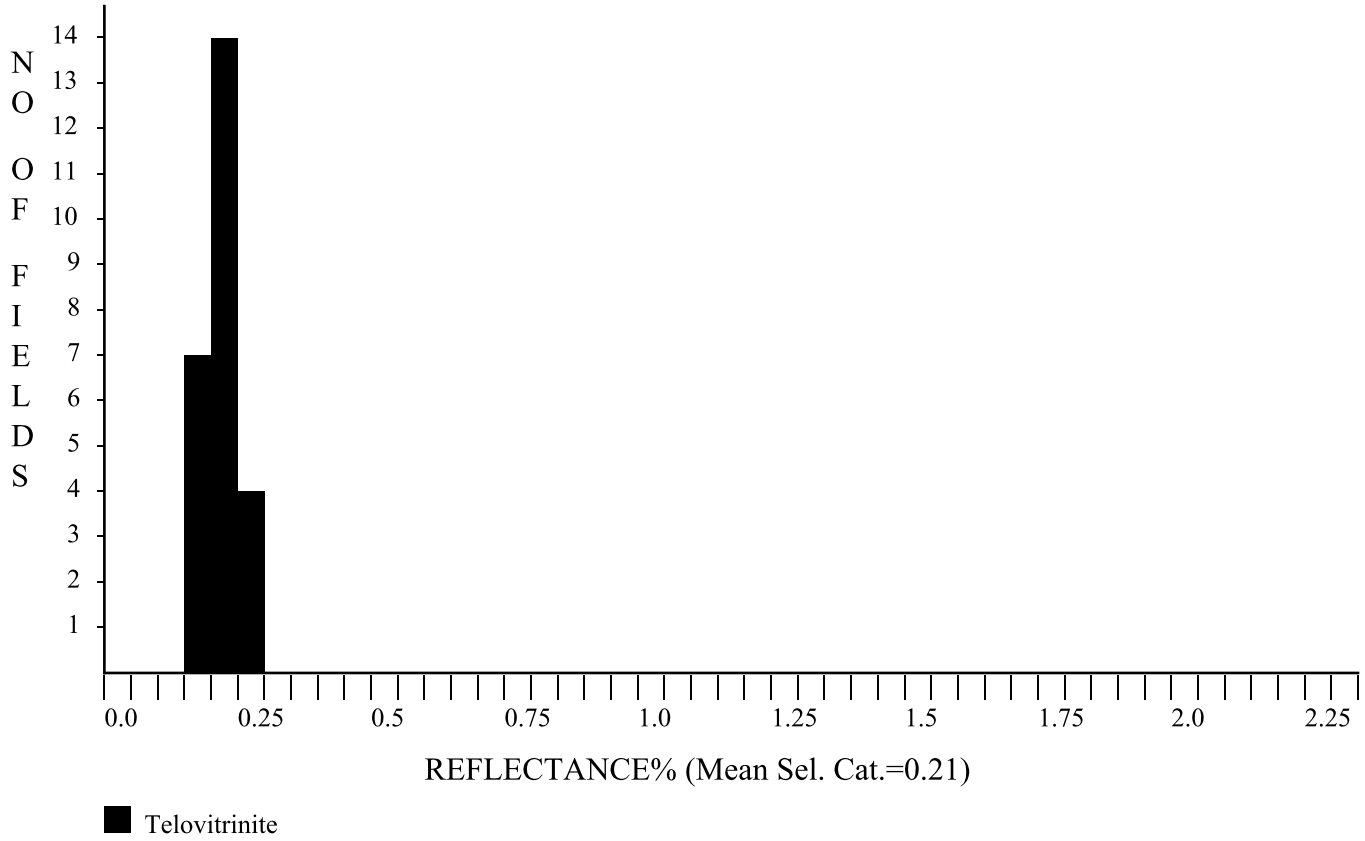
No. of Readings:	25
Mean of Selected Categories:	0.29
Standard Deviation of Selected categories:	0.034

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GSWA, Harvey 3A, 219130, 841.1m, Core(E1399)



Maceral Category	N	Mean	Standard Deviation
Telovitrinite	25	0.21	0.030
Total	25	0.21	0.030

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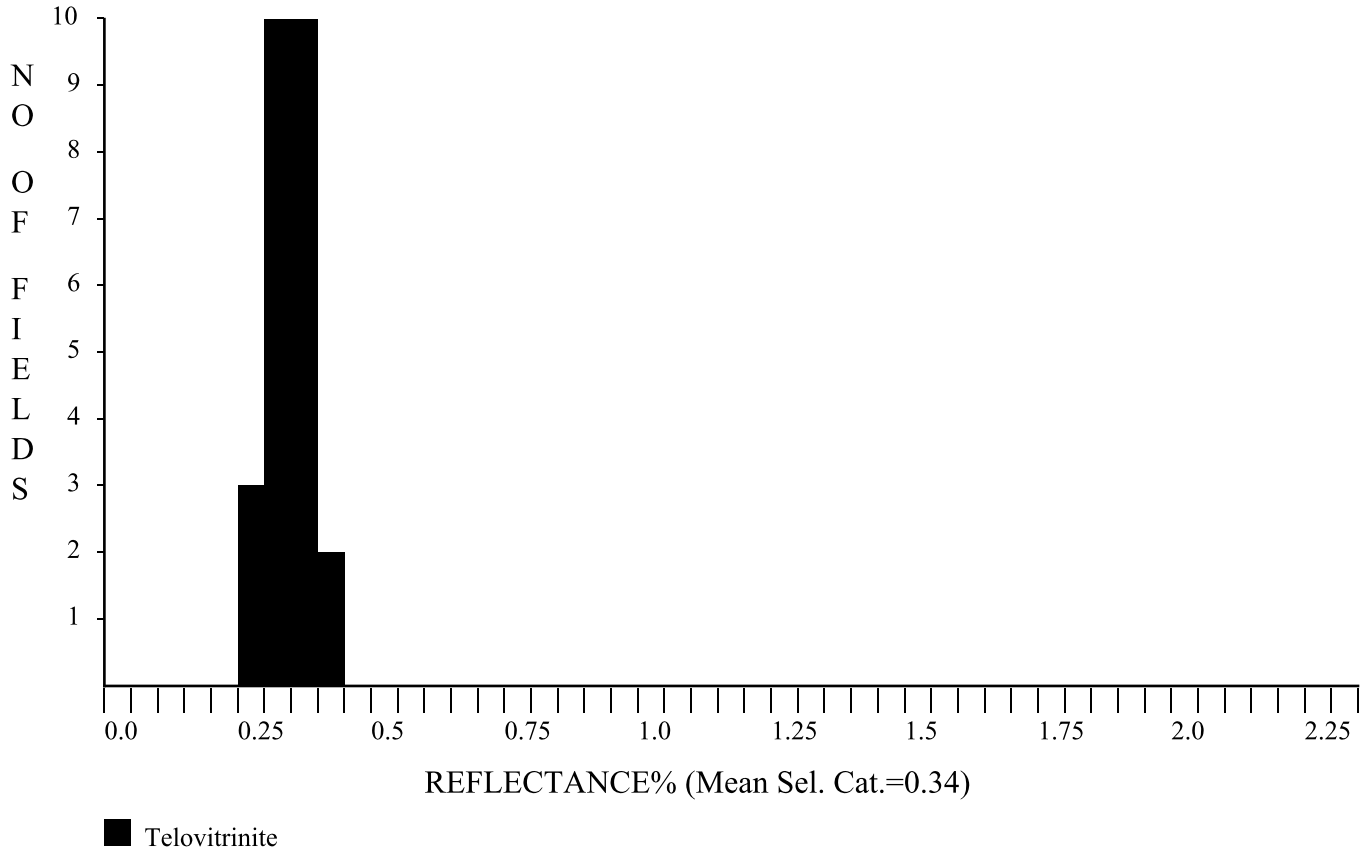
No. of Readings:	25
Mean of Selected Categories:	0.21
Standard Deviation of Selected categories:	0.030

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GSWA, Harvey 3A, 219127, 967.9m, Core(E1400)



Maceral Category	N	Mean	Standard Deviation
Telovitrinite	25	0.34	0.038
Total	25	0.34	0.038

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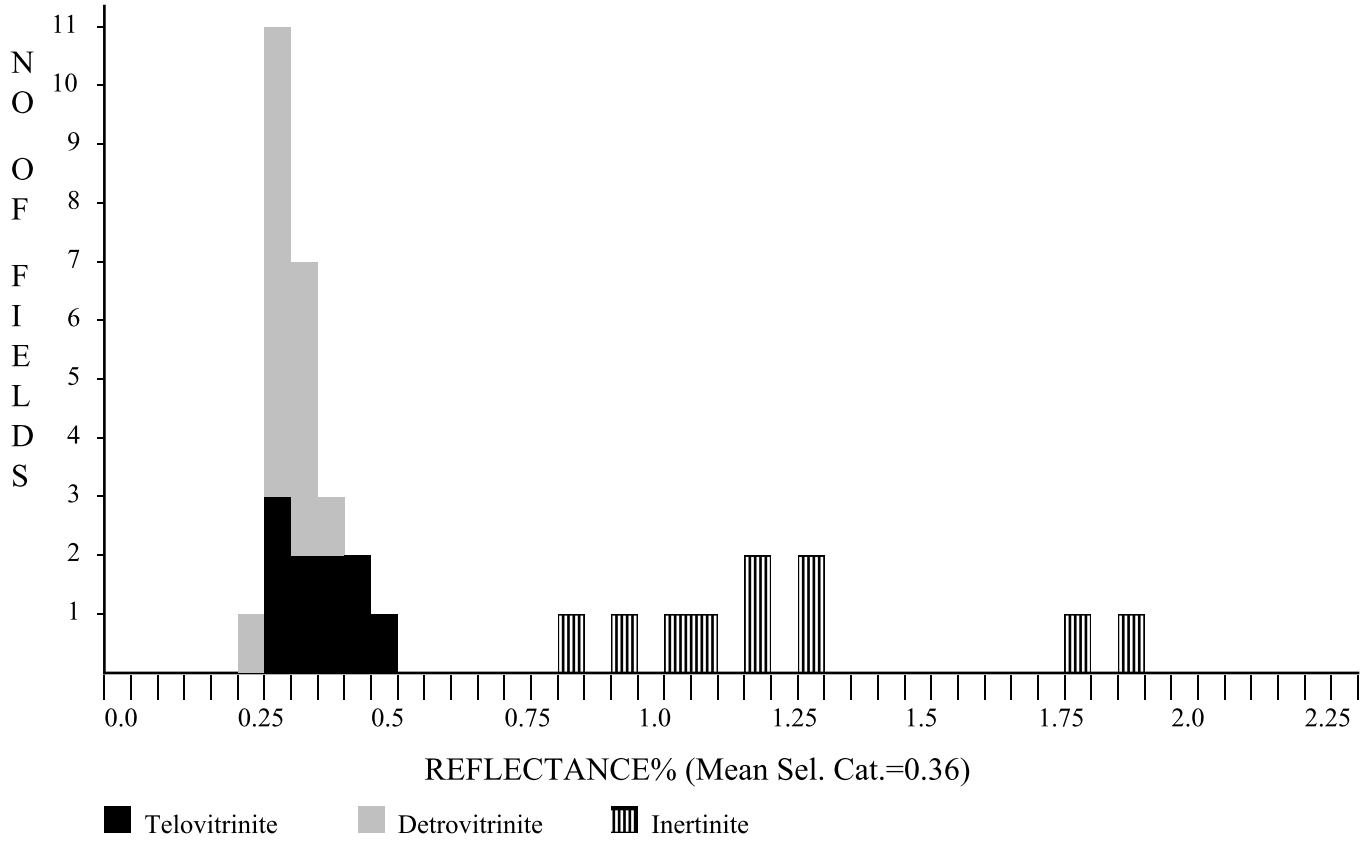
No. of Readings:	25
Mean of Selected Categories:	0.34
Standard Deviation of Selected categories:	0.038

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GSWA, Harvey 3A, 219124, 1193.1m, Core(E1401)



Maceral Category	N	Mean	Standard Deviation
Telovitrinite	10	0.40	0.066
Detrovitrinite	15	0.34	0.035
Inertinite	10	1.29	0.313
Total	35	0.63	0.454

Selected categories: Telovitrinite,Detrovitrinite:

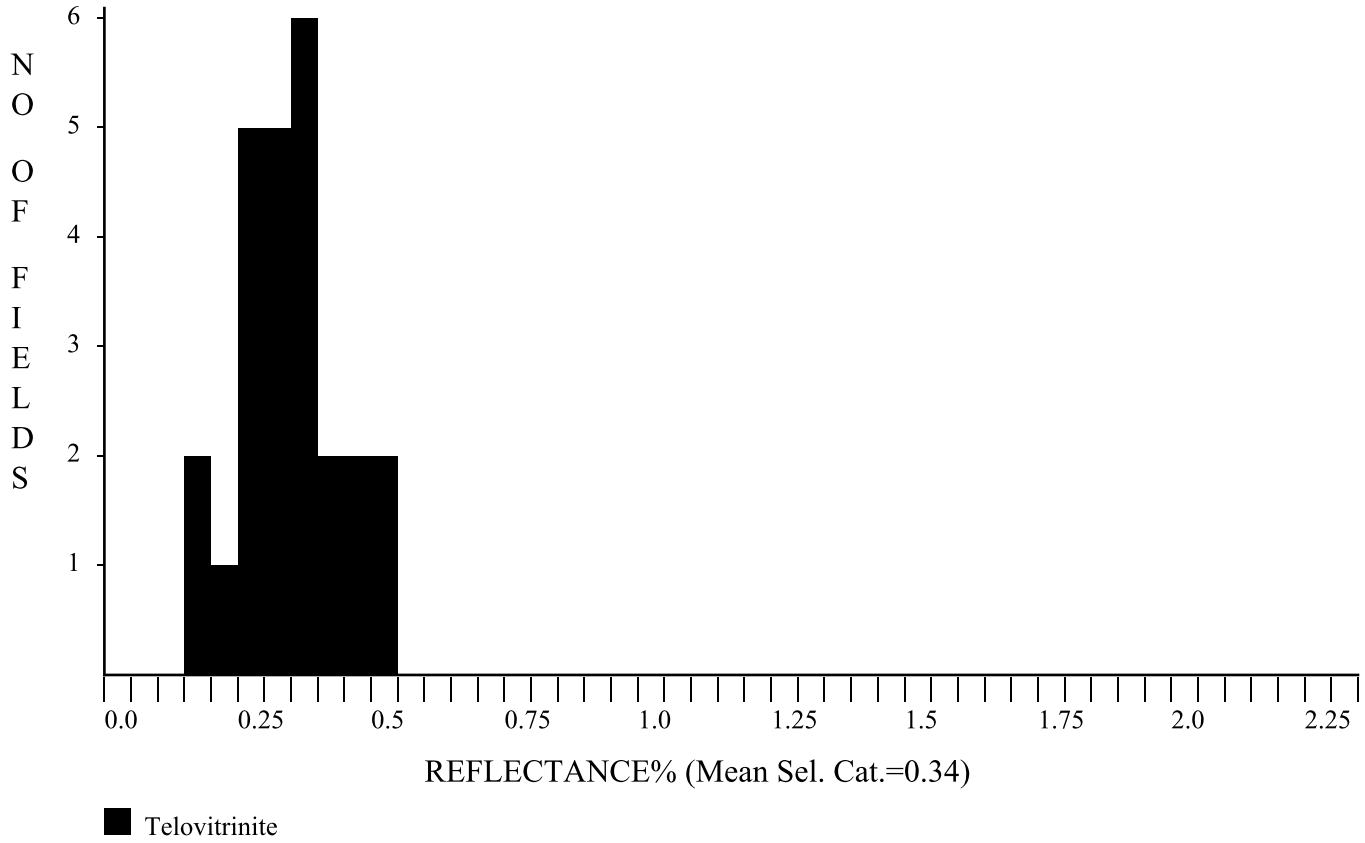
No. of Readings:	25
Mean of Selected Categories:	0.36
Standard Deviation of Selected categories:	0.058

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GSWA, Harvey 3A, 219116, 1434.1m, Core(E1402)



Maceral Category	N	Mean	Standard Deviation
Telovitrinite	25	0.34	0.094
Total	25	0.34	0.094

Selected categories: Telovitrinite:

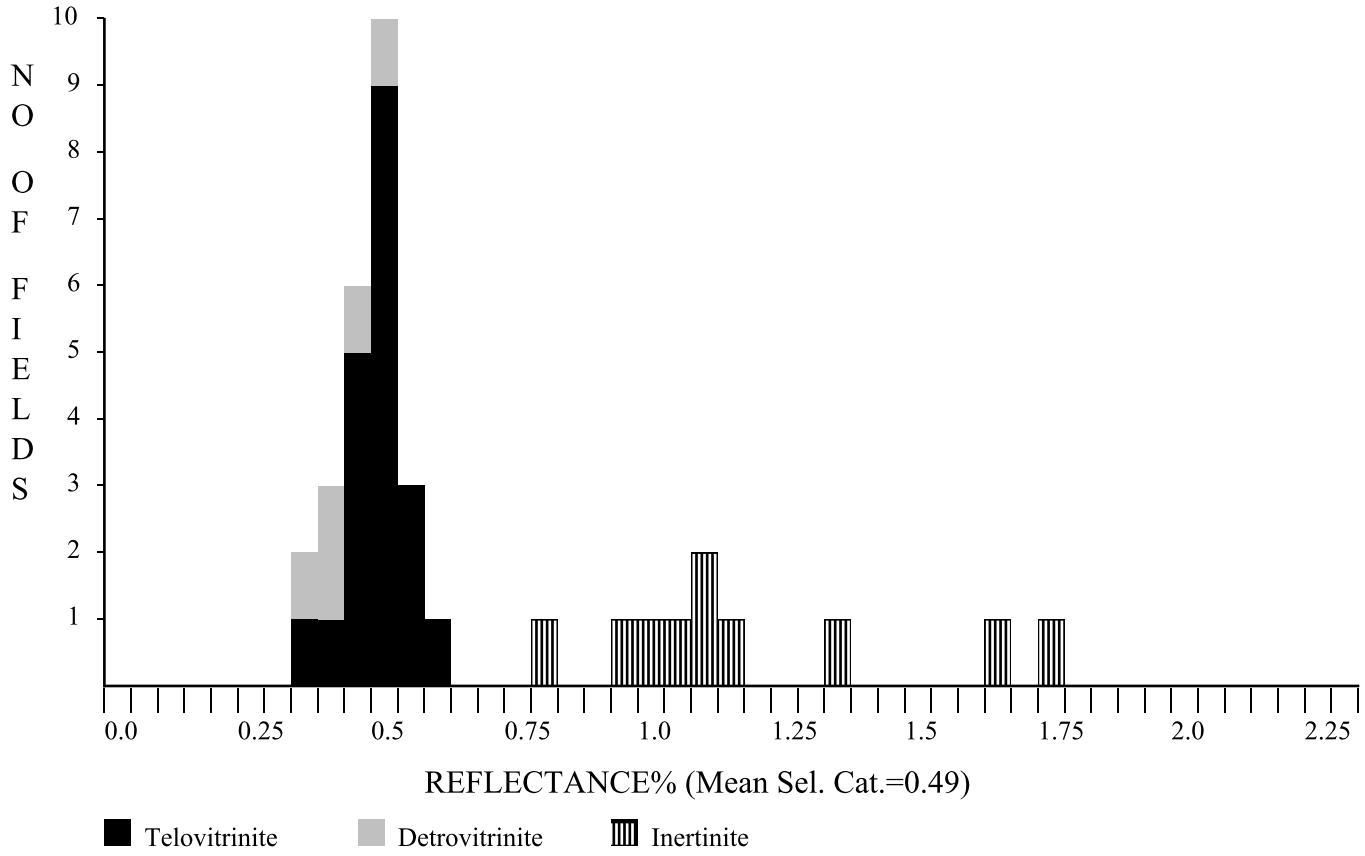
No. of Readings:	25
Mean of Selected Categories:	0.34
Standard Deviation of Selected categories:	0.094

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GSWA, Harvey 3A, 219115, 1540.15m, Core(E1403)



Maceral Category	N	Mean	Standard Deviation
Telovitrinite	20	0.50	0.054
Detrovitrinite	5	0.45	0.040
Inertinite	10	1.21	0.300
Total	35	0.70	0.366

Selected categories: Telovitrinite,Detrovitrinite:

No. of Readings:	25
Mean of Selected Categories:	0.49
Standard Deviation of Selected categories:	0.056

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Dr Peter Crosdale (MAIG)
Director, ERC
21st July, 2015

APPENDIX - PLATES

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

E1398A Coal vitrite, Rv max = 0.31%, reflected white light, X50
E1398B Same as E1398A, in fluorescence mode
E1398C Fractured and highly weathered coal, reflected white light, X50
E1398D Same as E1398C, in fluorescence mode
E1398E Total replacement of organic matter in coal by pyrite, reflected white light, X50

E1399A Coal (phlobaphinite) in telenite, Rv max = 0.20%, reflected white light, X50
E1399B Same as E1399A, in fluorescence mode
E1399C Telinite with unaltered cellulose, reflected white light, X50
E1399D Same as E1399C, in fluorescence mode

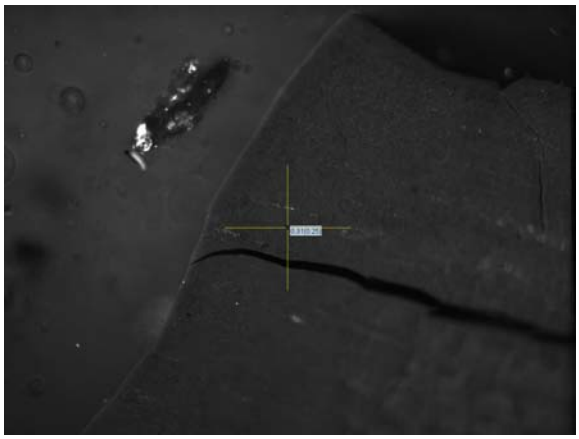
E1400A Coal vitrite, Rv max = 0.35%, reflected white light, X50
E1400B Same as E1400A, in fluorescence mode
E1400CAbundant desiccation cracks in coal , reflected white light, X50

E1401A Telovitrinite and inertinite in sandstone, Rv max = 0.33%, reflected white light, X50
E1401B Same as E1401A, in fluorescence mode
E1401C Coalified leaf tissue in sandstone, reflected white light, X50
E1401D Same as E1401C, in fluorescence mode

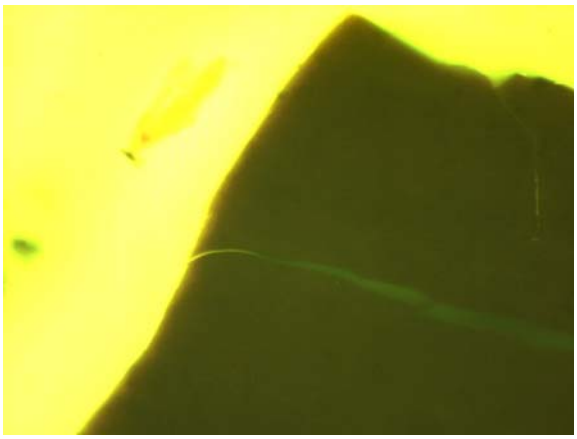
E1402A Highly weathered vitrinite coal, Rv max = 0.38%, reflected white light, X50
E1402B Same as E1402A, in fluorescence mode
E1402C Unweathered vitrinite coal, Rv max = 0.48%, reflected white light, X50
E1402D Same as E1402C, in fluorescence mode

E1403A Coal vitrite, Rv max = 0.51%, reflected white light, X50
E1403B Same as E1403A, in fluorescence mode
E1403C Detrovitrinite in sandstone, Rv max = 0.44%, reflected white light, X50
E1403D Same as E1403C, in fluorescence mode
E1403E Resinite in clarite coal, reflected white light, X50
E1403F Same as E1403E, in fluorescence mode

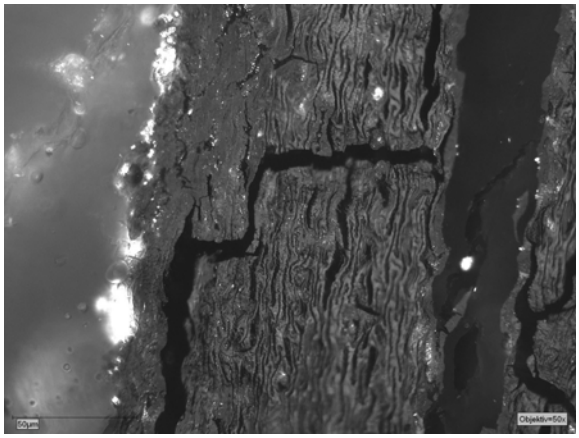
E1403G Cutinite in clarite coal, reflected white light, X50
E1403H Same as E1403G, in fluorescence mode



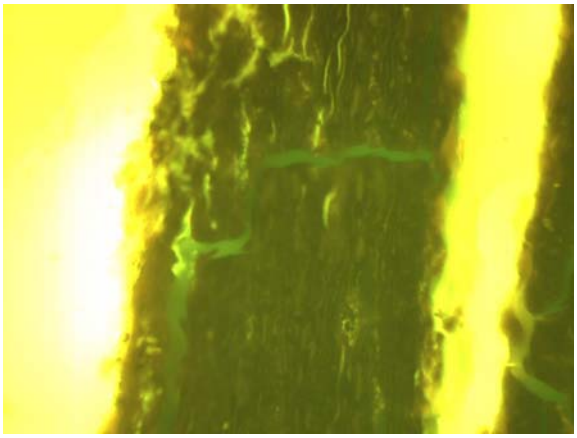
E1398A Coal vitrite, Rv max = 0.31%, reflected white light, X50



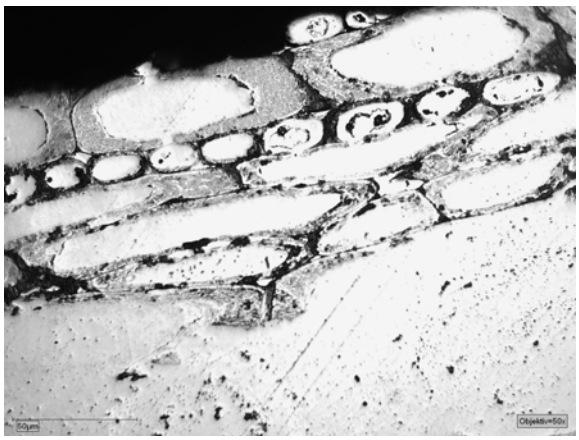
E1398B Same as E1398A, in fluorescence mode



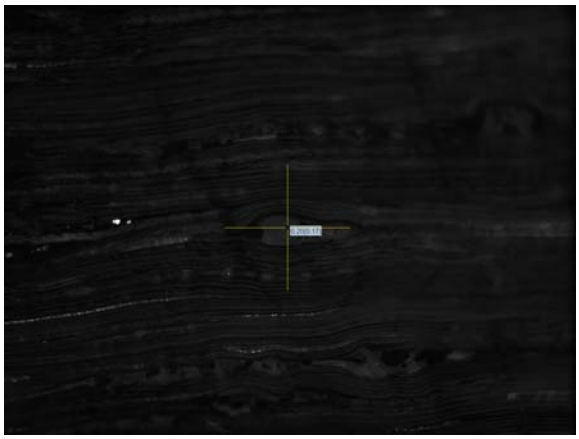
E1398C Fractured and highly weathered coal, reflected white light, X50



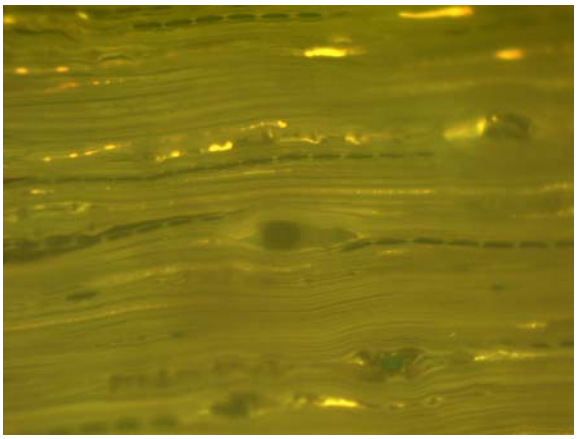
E1398D Same as E1398C, in fluorescence mode



E1398E Total replacement of organic matter in coal by pyrite, reflected white light, X50



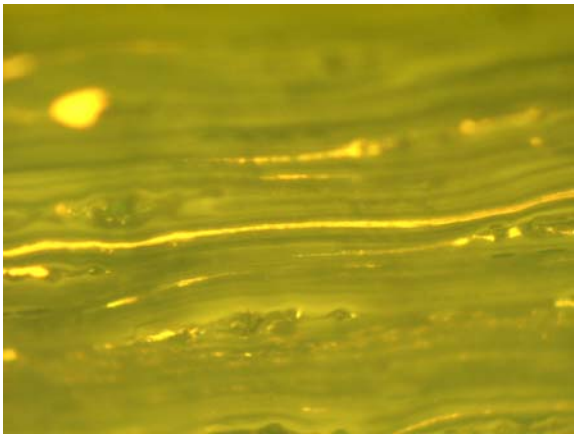
E1399A Coal (phlobaphinite) in telenite, Rv max = 0.20%, reflected white light, X50



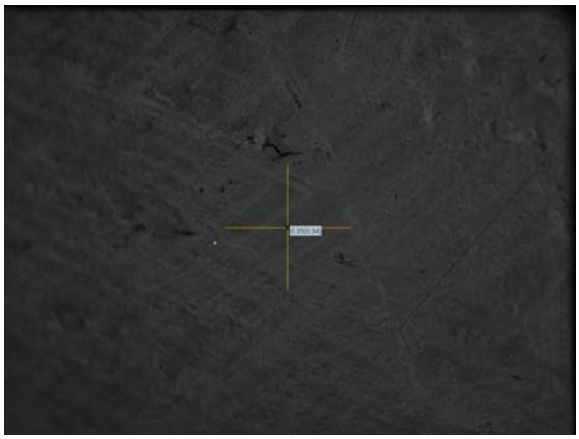
E1399B Same as E1399A, in fluorescence mode



E1399C Telinite with unaltered cellulose, reflected white light, X50



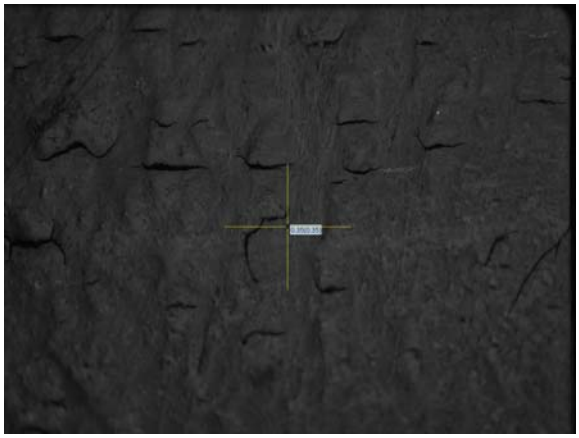
E1399D Same as E1399C, in fluorescence mode



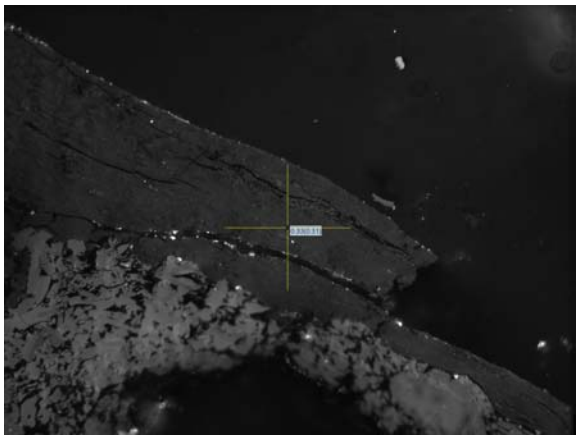
E1400A Coal vitrite, Rv max = 0.35%, reflected white light, X50



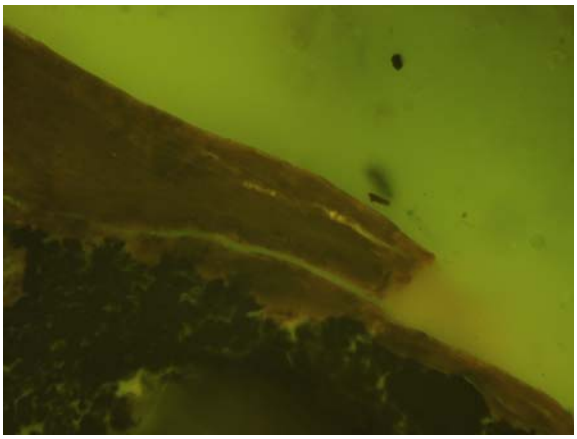
E1400B Same as E1400A, in fluorescence mode



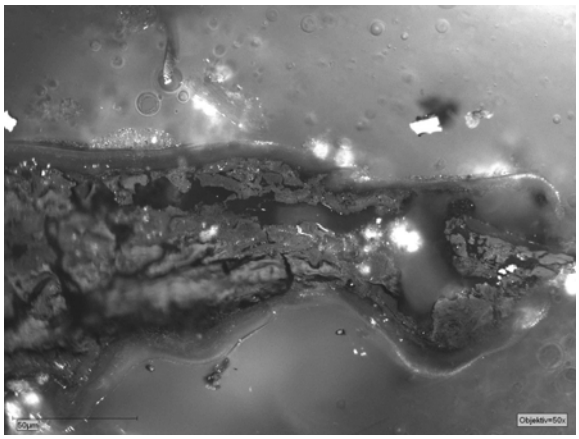
E1400CAbundant desiccation cracks in coal, reflected white light, X50



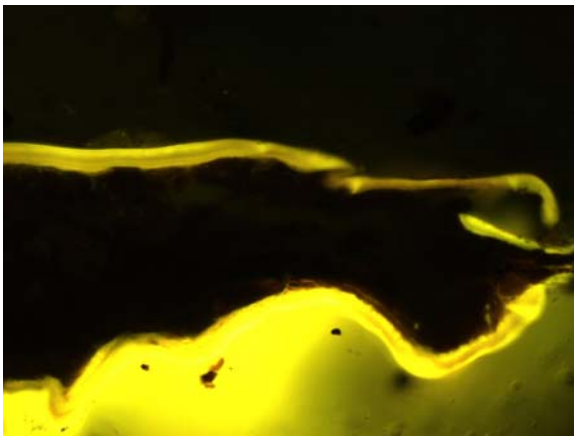
E1401A Telovitrinite and inertinite in sandstone, Rv max = 0.33%, reflected white light, X50



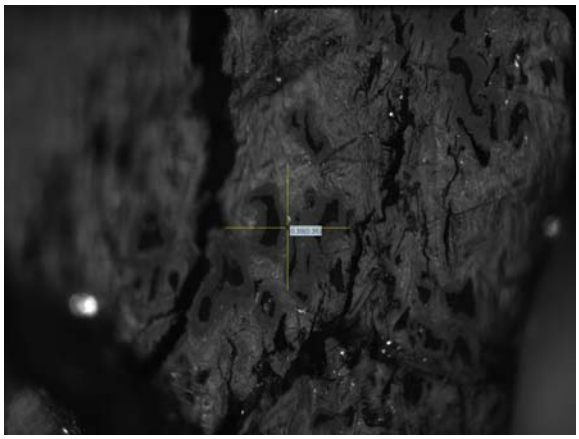
E1401B Same as E1401A, in fluorescence mode



E1401C Coalified leaf tissue in sandstone, reflected white light, X50



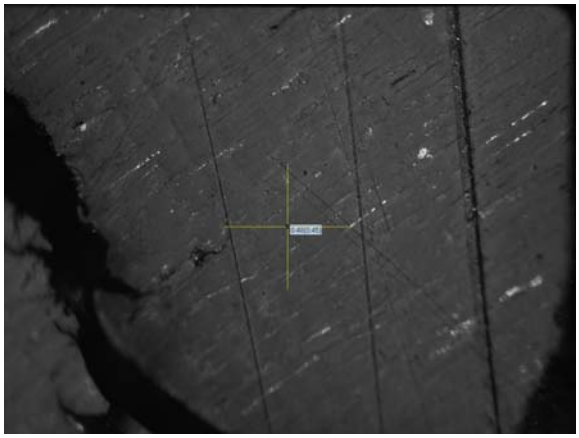
E1401D Same as E1401C, in fluorescence mode



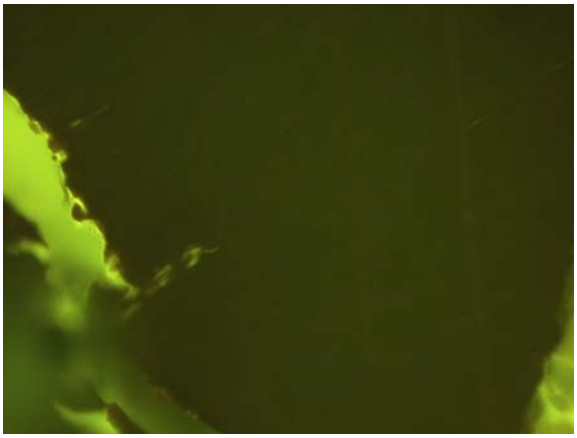
E1402A Highly weathered vitrinite coal, Rv max = 0.38%, reflected white light, X50



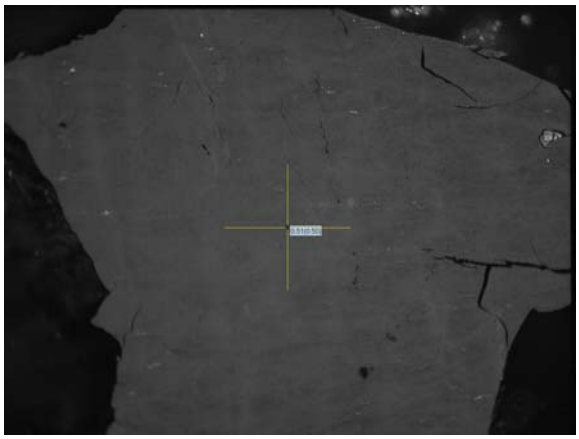
E1402B Same as E1402A, in fluorescence mode



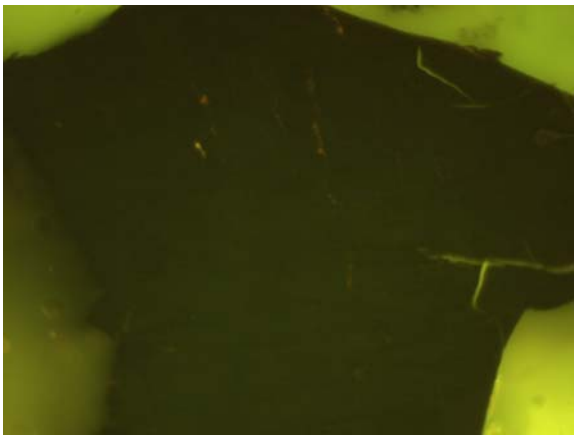
E1402C Unweathered vitrinite coal, Rv max = 0.48%, reflected white light, X50



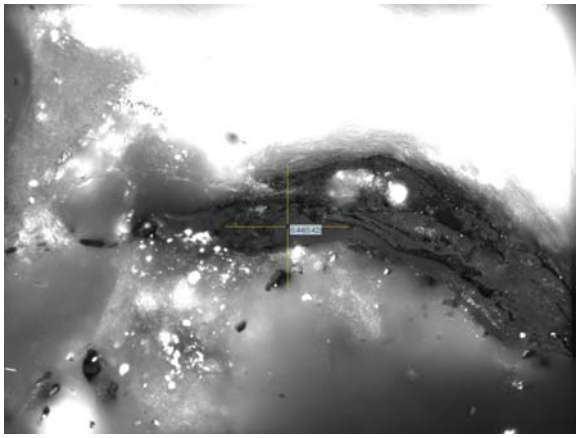
E1402D Same as E1402C, in fluorescence mode



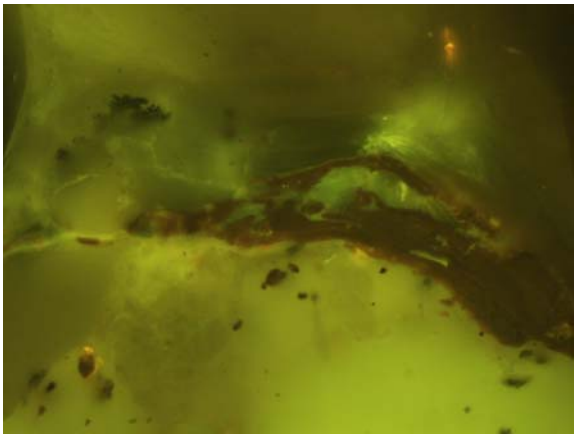
E1403A Coal vitrite, Rv max = 0.51%, reflected white light, X50



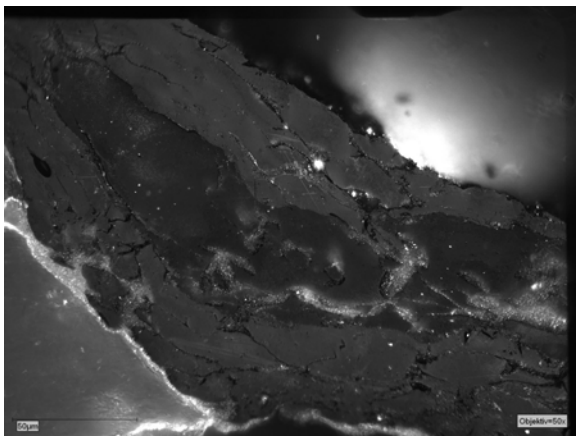
E1403B Same as E1403A, in fluorescence mode



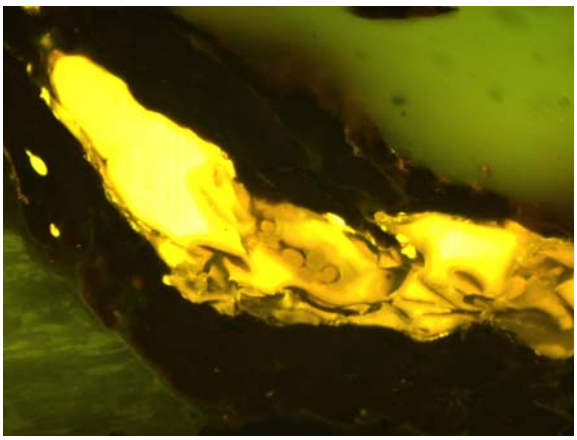
E1403C Detrovitrinite in sandstone, Rv max = 0.44%, reflected white light, X50



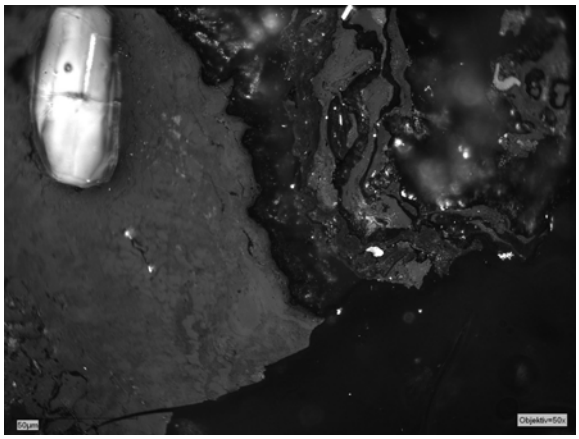
E1403D Same as E1403C, in fluorescence mode



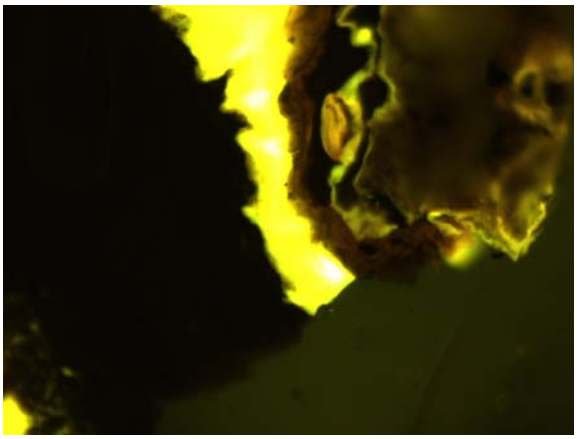
E1403E Resinite in clarite coal, reflected white light, X50



E1403F Same as E1403E, in fluorescence mode



E1403G Cutinite in clarite coal, reflected white light, X50



E1403H Same as E1403G, in fluorescence mode