

Shenandoah S-1

Organic Petrology Analysis

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Stasiuk Petrography Ltd

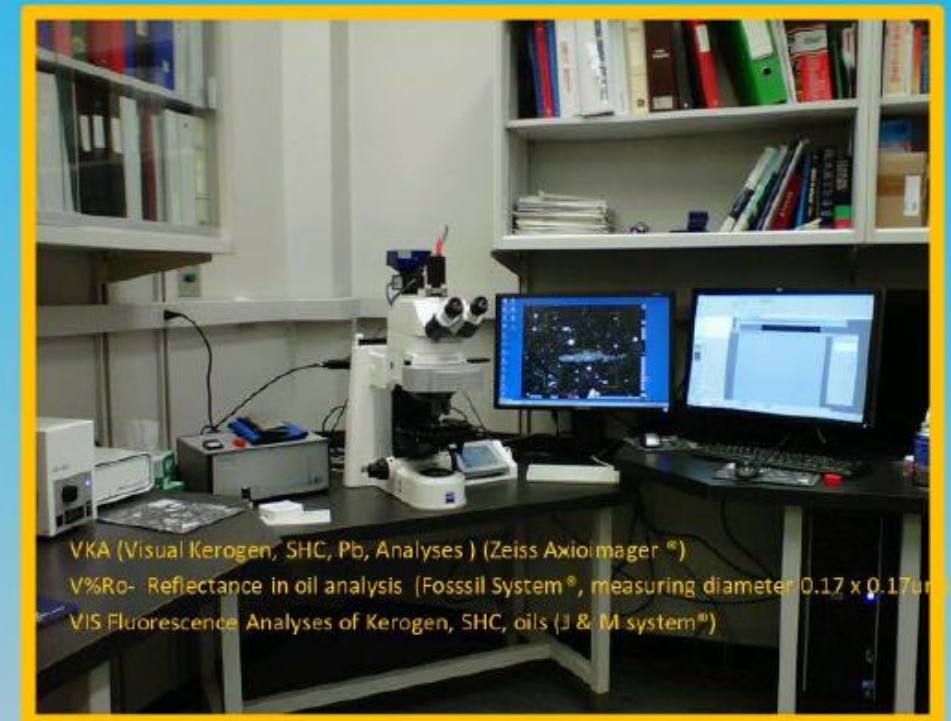
March 20, 2024

Whole rock samples prepared & analysed with optical microscope up to $\sim 1200\times$ mag

Sample preparation for microscopy: Critical!



Reflected white light & Fluorescence microscopy:



Organic matter classification

Total Organic Matter in a rock comprises:

Kerogen (derived from biological organic matter)

+

Secondary thermal maturation products like oils/petroleum
& **Pyrobitumens**



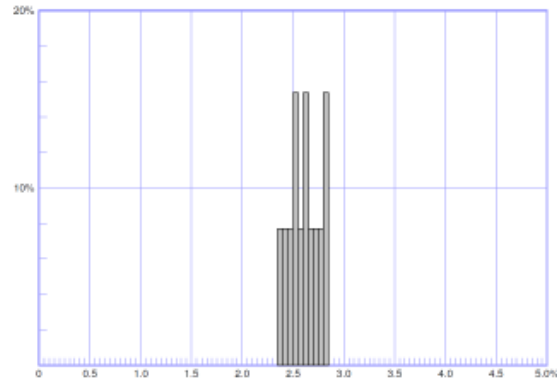
Kerogen	Primary Macerals	Particulate Organic Matter	Vitrinite	Telovitrinite	Telinite		
				Detrovitrinite	Collotelinite		
					Vitrodetrinite		
			Gelovitrinite	Collodetrinite			
				Corpogelinite			
			Liptinite	Alginite	Telalginitite		
				Sporinite	Lamalginitite		
					Microsporinite		
					Macrosporinite		
					Tenuisporinite		
					Crassisporinite		
				Other	Liptodetrinite		
					Cutinite		
					Suberinite		
			Resinite				
			Exsudatinitite				
			Inertinite	Semifusinitite			
				Funginitite (Sclerotinitite)			
				Fusinitite			
				Macrinitite			
				Inertodetrinitite			
				Micrinitite			
				Cenospheres			
				Graphite Recycled			
				Intertinitite Recycled			
				Zooclasts	Graptolite	Telagraptolite	
					Foram Linings	Collograptolite	
			Scoledont				
			Structureless Organic Matter (SOM)	Amorphinite	Fluoramorphinit e (Fluorescing)	Load Bearing	Dense Layers
							Lenses
	Hebamorphinitite (Non-Fluorescing)	Diffuse / Intergranular					
		Load Bearing			Dense Layers		
	Isotropic	Fluorescing			Lenses		
				Diffuse / Intergranular			
		Non-Fluorescing		Low Reflecting			
				Medium Reflecting			
	Bitumen (Petroleum Products)	Secondary Macerals	Pyrobitumen	Anisotropic (Mosaic microtextures)	High Reflecting		
					Low Reflecting		
Medium Reflecting							
High Reflecting							
Very Fine Grained							
Fine Grained							
Anisotropic (Mosaic microtextures)				Medium Grained			
				Coarse Grained			
				Coarse Grained Flow			
				Domain Flow			
	Large Domain						

Velkerri Formation, Shenandoah S-1 and Tanumbirini-1, Thermal Maturity Assessment – Summary
 Medium %Ro, non mosaic, low bireflectance PB mean used for calculating V%Ro using Jacobs 1987
 equation, where $\%V\text{Ro} = (\text{B}\% \text{Ro} * 0.618) + 0.40$

Well	Formation	Top Depth	Base Depth	Depth Units	SHC or Solid Bitumen Isotropic medium reflecting %Ro	Rn	std dev	Vitrinite %Ro Calculated from SHC using Jacobs eqn
Shenandoah S1	Velkerri	2700	2710m		2.94	32	0.36	2.22
Shenandoah S1	Velkerri	3020	3030m		3.44	20	0.31	2.53
Shenandoah S1	Velkerri	3040	3050m		4.11	20	0.47	2.94
Shenandoah S1	Velkerri	3080	3090m		3.69	34	0.51	2.68
Shenandoah S1	Velkerri	3120	3130m		3.75	30	0.48	2.72

Shenandoah S-1, Velkerri Formation, Medium-reflecting, non mosaic, solid bitumen-PB %RoR population reflectance histograms; mean used for calculating V%Ro using Jacobs 1987 equation, where %VRo = $(B\%Ro * 0.618) + 0.40$

Sample : Shenandoah_S_1_2700m_2710m_a



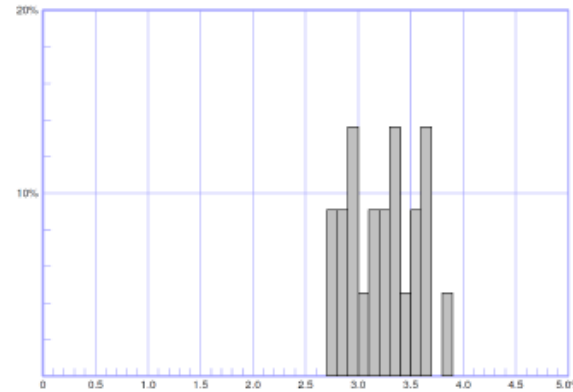
Measure count = 13
 Reflectance Rr = 2.609 %
 s = 0.143 %

Date 2/15/2024 02:42 PM
 lds
 Operator Printed 2/20/2024

2.35 - 2.40 % R	7.7 %	2.60 - 2.65 % R	15.4 %
2.40 - 2.45 % R	7.7 %	2.6	
2.45 - 2.50 % R	7.7 %	2.7	
2.50 - 2.55 % R	15.4 %	2.7	
2.55 - 2.60 % R	7.7 %	2.8	

F:\2025\70 D\1.804284

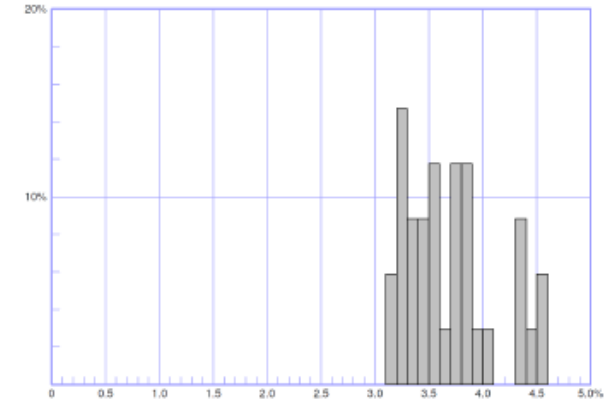
Sample : Shenandoah_S_1_3020m_3030m



Measure count = 22
 Reflectance Rr = 3.241 %
 s = 0.311 %

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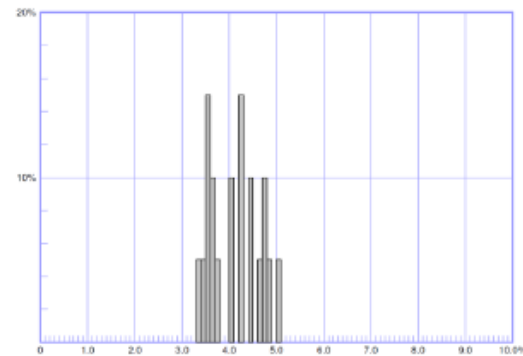
Sample : Shenandoah_S_1_3040m_3050m



Measure count = 34
 Reflectance Rr = 3.695 %
 s = 0.111 %

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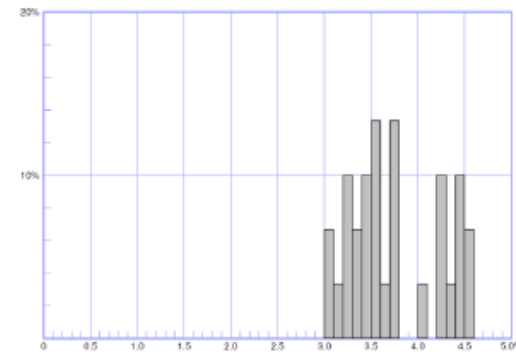
Sample : Shenandoah_S_1_3080m_3090m



Measure count = 20
 Reflectance Rr = 4.117 %
 s = 0.509 %

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 Operator Printed 2/20/2024

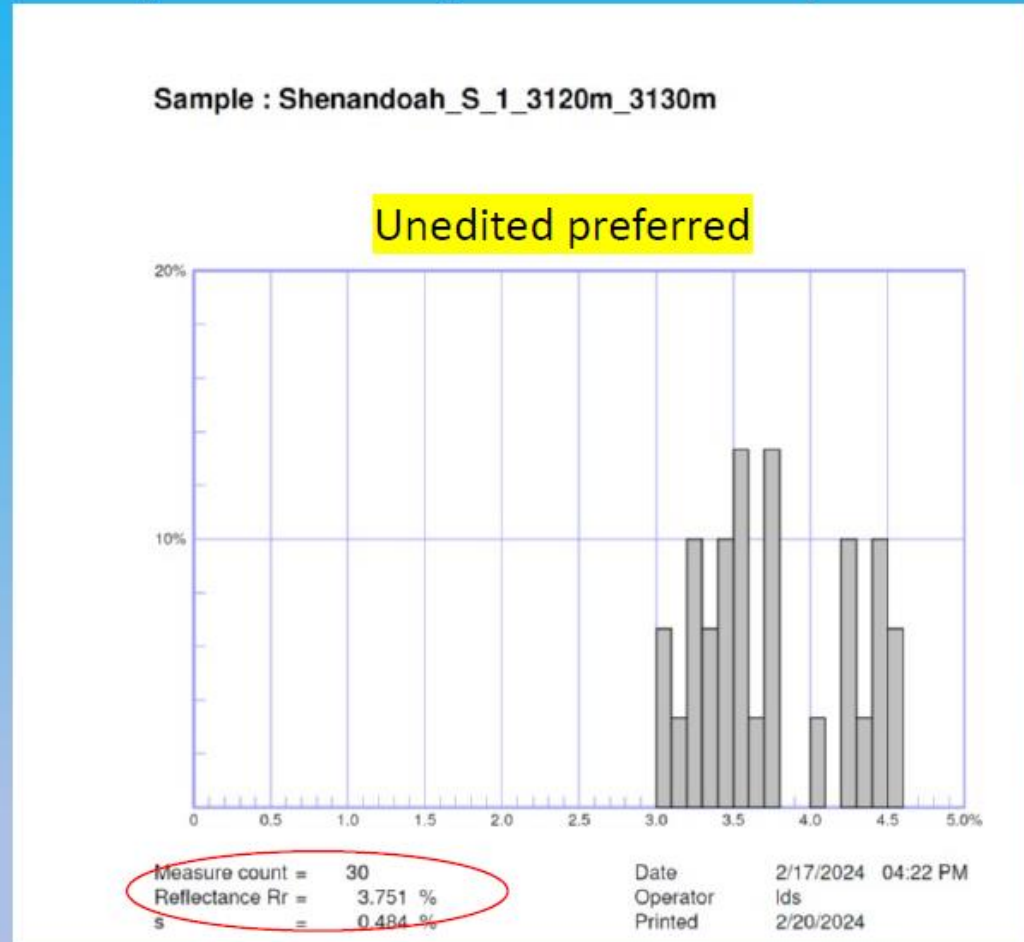
Sample : Shenandoah_S_1_3120m_3130m



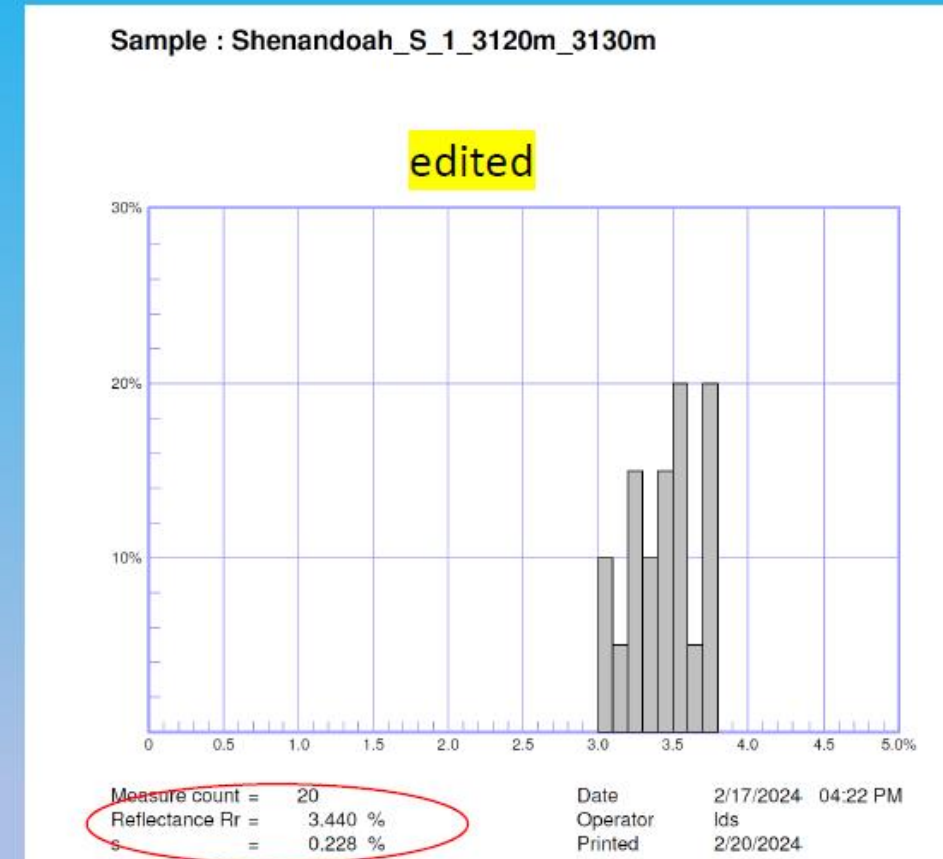
Measure count = 30
 Reflectance Rr = 3.751 %
 s = 0.484 %

Date 2/17/2024 04:22 PM
 lds
 Operator Printed 2/20/2024

Example of unedited histogram of medium %Ro non mosaic PB showing 2 distinct population representing the %Romax and bireflectance of PB (i.e. ~ biaxial 'indicatrix'). Edited histogram has removed %Romax measurements. Note resulting difference in mean %Ro (shown as Reflectance Rr =) and minimal effect of V%Rocalculated, well within margin of error assigned to method. I prefer to use all measurements.

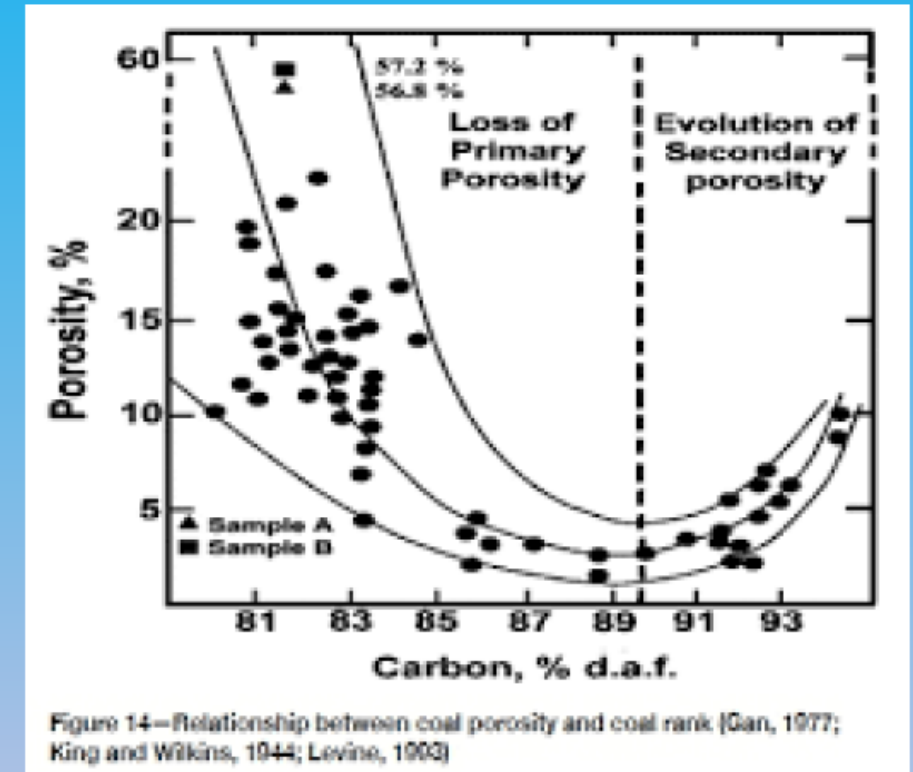
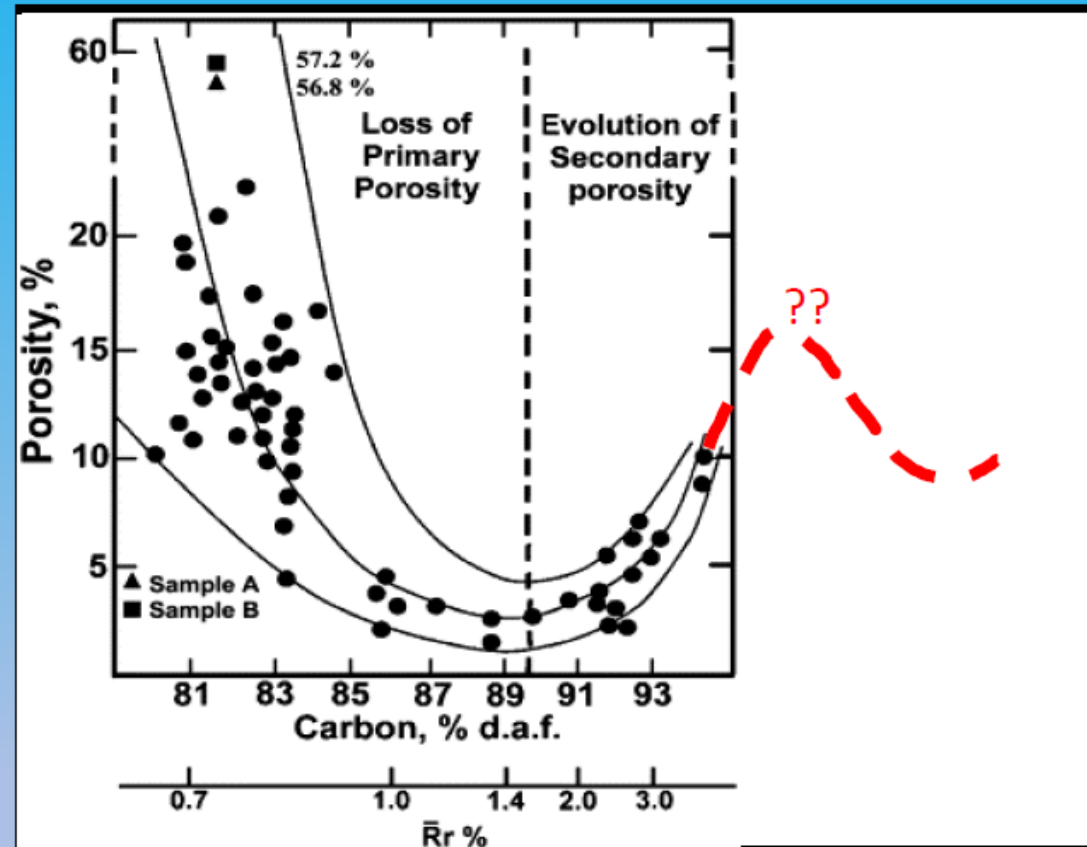


V%Rocalc = 2.71



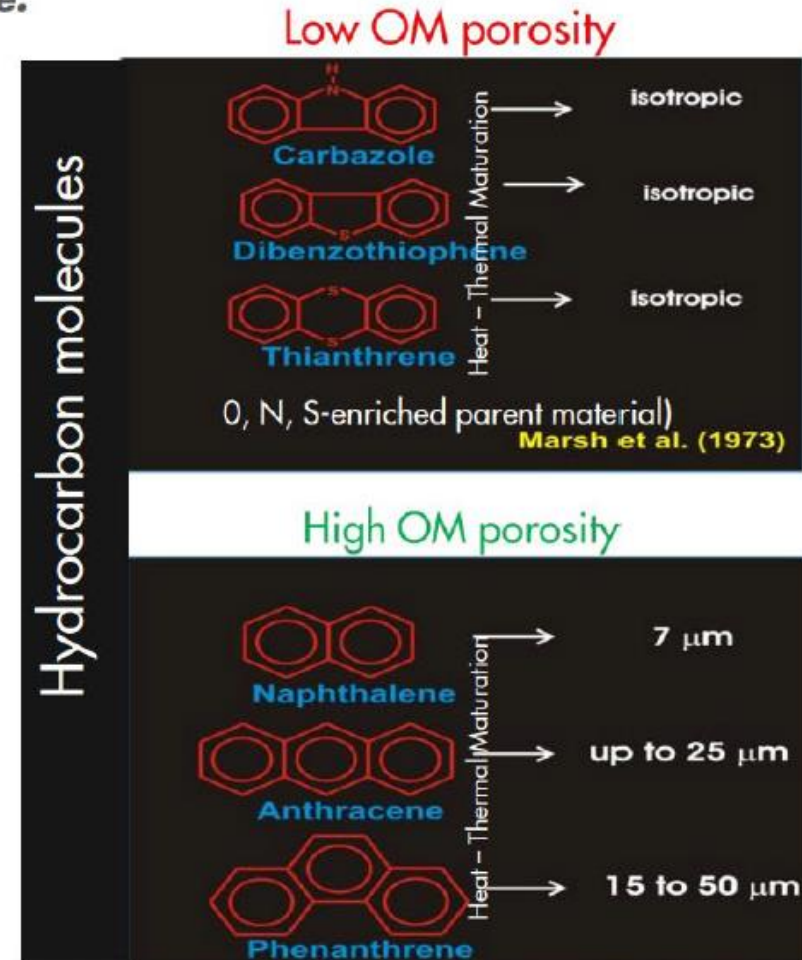
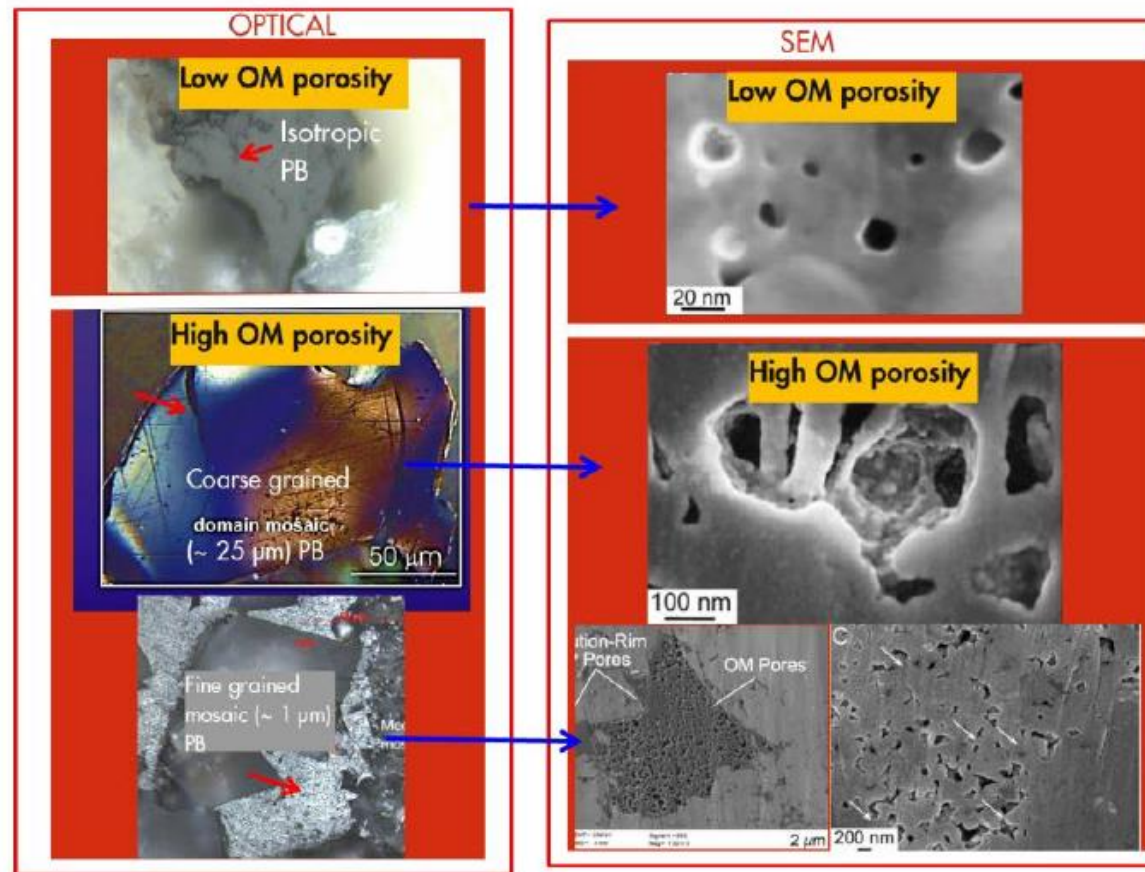
V%Rocalc = 2.52

Coal rank/thermal maturity versus porosity (from coal studies)



Relationship between coal porosity and coal rank; porosity decreases with increasing rank, and then increases with the development of secondary porosity at high levels of thermal maturity. Proprietary studies indicate a decrease in porosity at meta anthracite to and then possibly increase in porosity at very high maturity levels (i.e. $> 8\% \bar{R}oV\bar{R}o$).

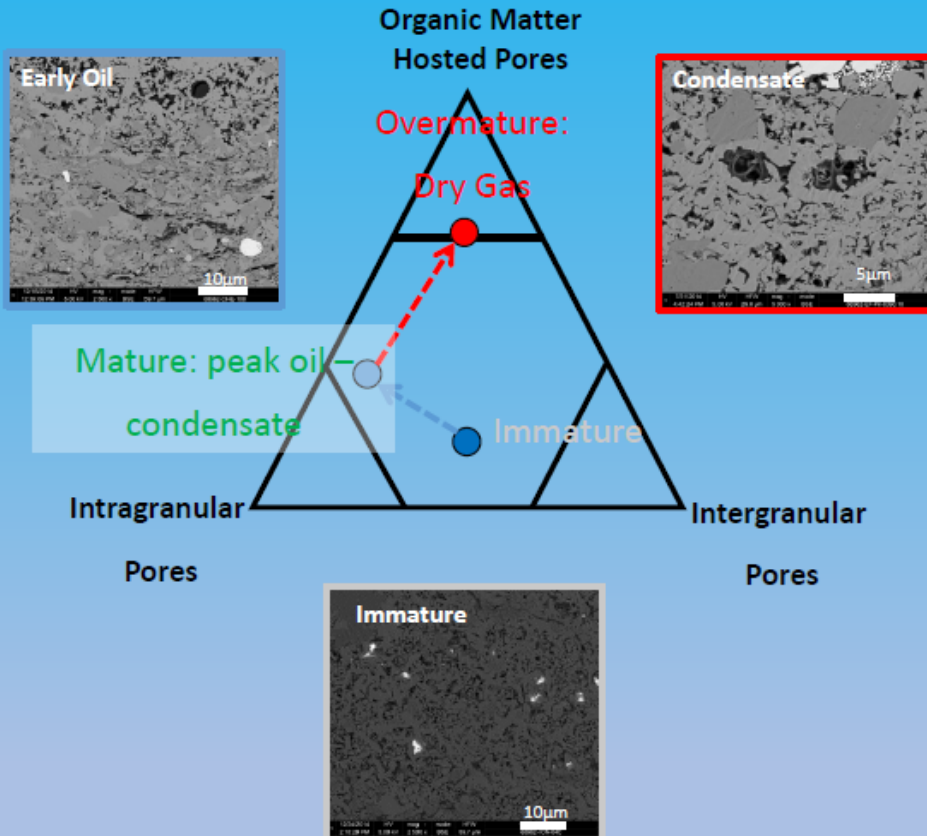
Pyrobitumens at optical microscope and EM scale. OM porosity is inferred at the Optical scale based on PB type. Porosity is High for PB's with mosaic optical microtextures and low for Isotropic PB. Organic matter composition - pyrobitumen is abundant in gas shales & classified into isotropic forms and Anisotropic mosaic forms. Precursor hydrocarbons - control Pb Type.



All kerogen and secondary products like bitumens, Solid hydrocarbons, and pyrobitumens can be classified into those with isotropic, non-coke optical character and those with anisotropic, coke optical microtextures character. This is determined by examining the samples at ~ 1250-2500x in polarized, reflected light using an analyser

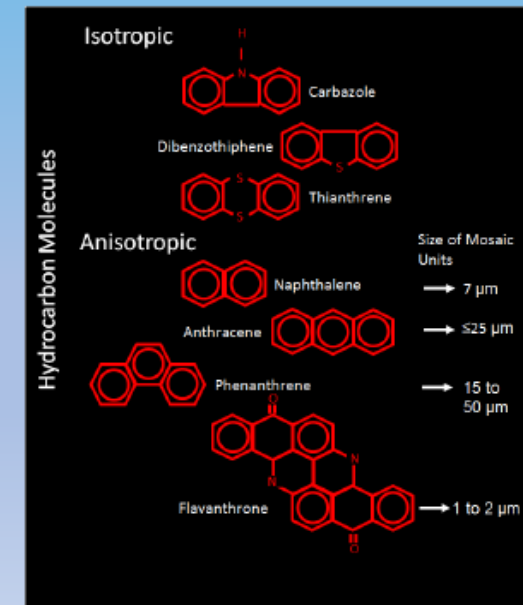
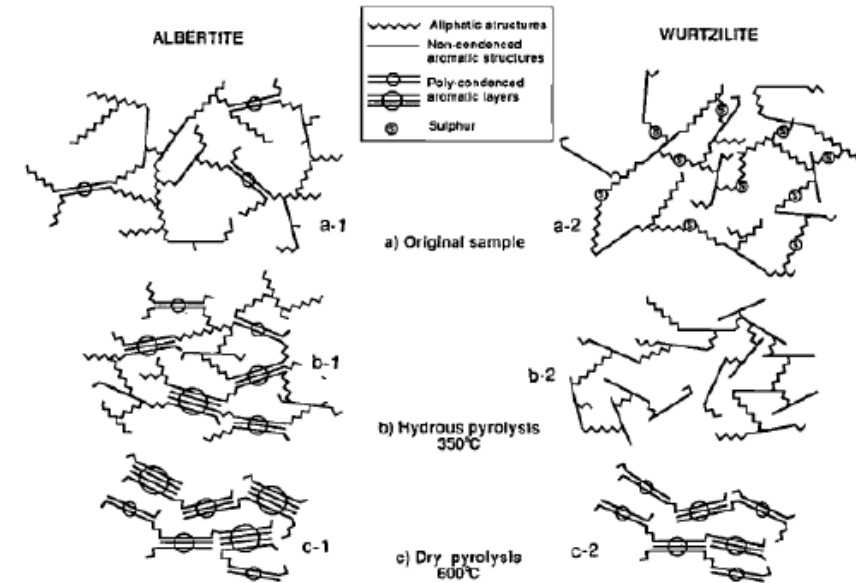
PORE SYSTEMS

Pore system modification with thermal maturity in the EF Formation

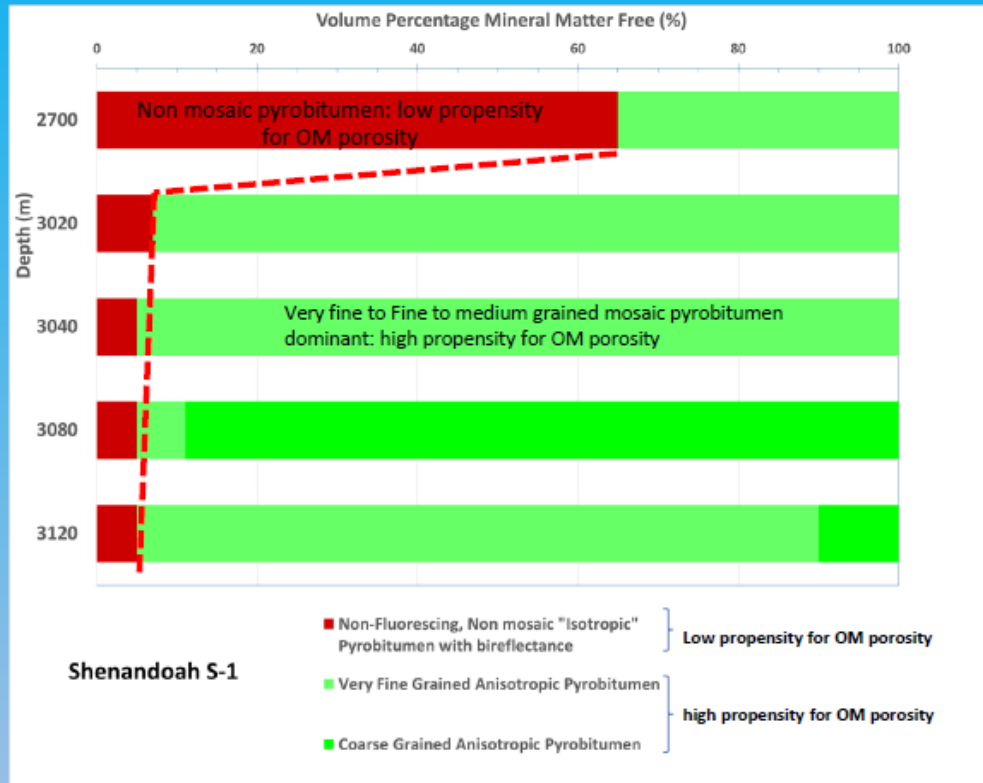


Pore types evolve with maturity in the EF formation. Intergranular pores are present between grains and constituents of the matrix which is made of smectite, calcite and moderate amounts of clay particles. Intragranular pores are present within thin crystals (pyrite framboids, kaolinite cement, etc.) associated with organic matter are called organic matter hosted pores. They are significant contributors to pore systems within the thermally mature, organic matter-rich mudrocks and are oil wet. Porosity within organic matter is termed intrinsic porosity..

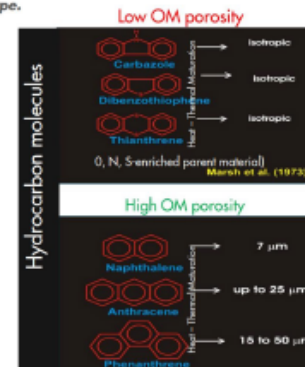
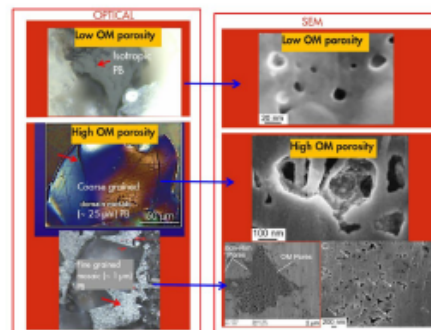
THERMAL EVOLUTION OF SULPHUR-POOR ALBERTITE AND SULPHUR-RICH WURTZILITE: BULK STRUCTURAL MODEL



Maceral Analysis Summary (estimate based on 23-30 fields of view): Optical Microscopy of Organic Matter:

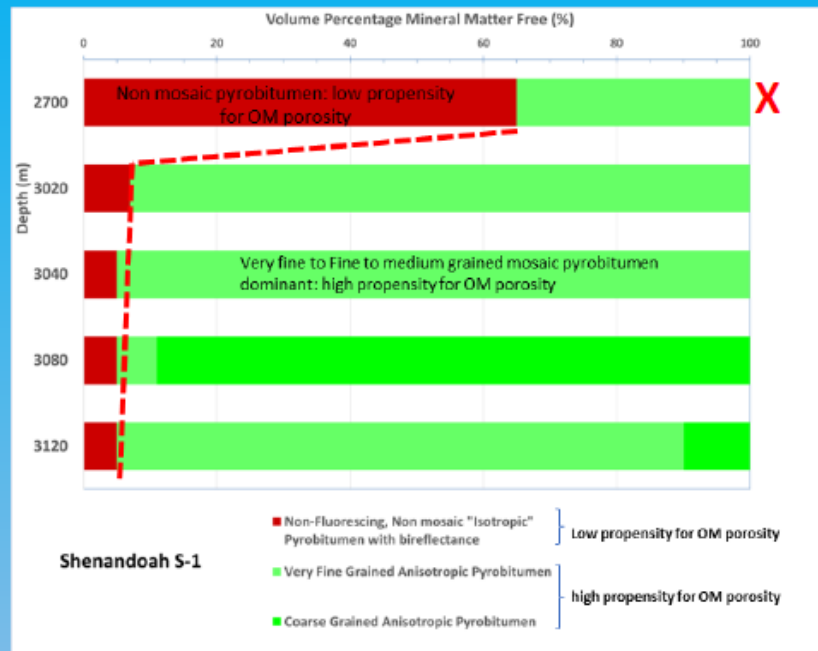


Pyrobitumens at optical microscope and EM scale. OM porosity is inferred at the Optical scale based on PB-type. Porosity is High for PB's with mosaic optical microtextures and low for Isotropic PB. Organic matter composition - pyrobitumen is abundant in gas shales & classified into isotropic forms and Anisotropic mosaic forms. Precursor hydrocarbons - control Pb Type.



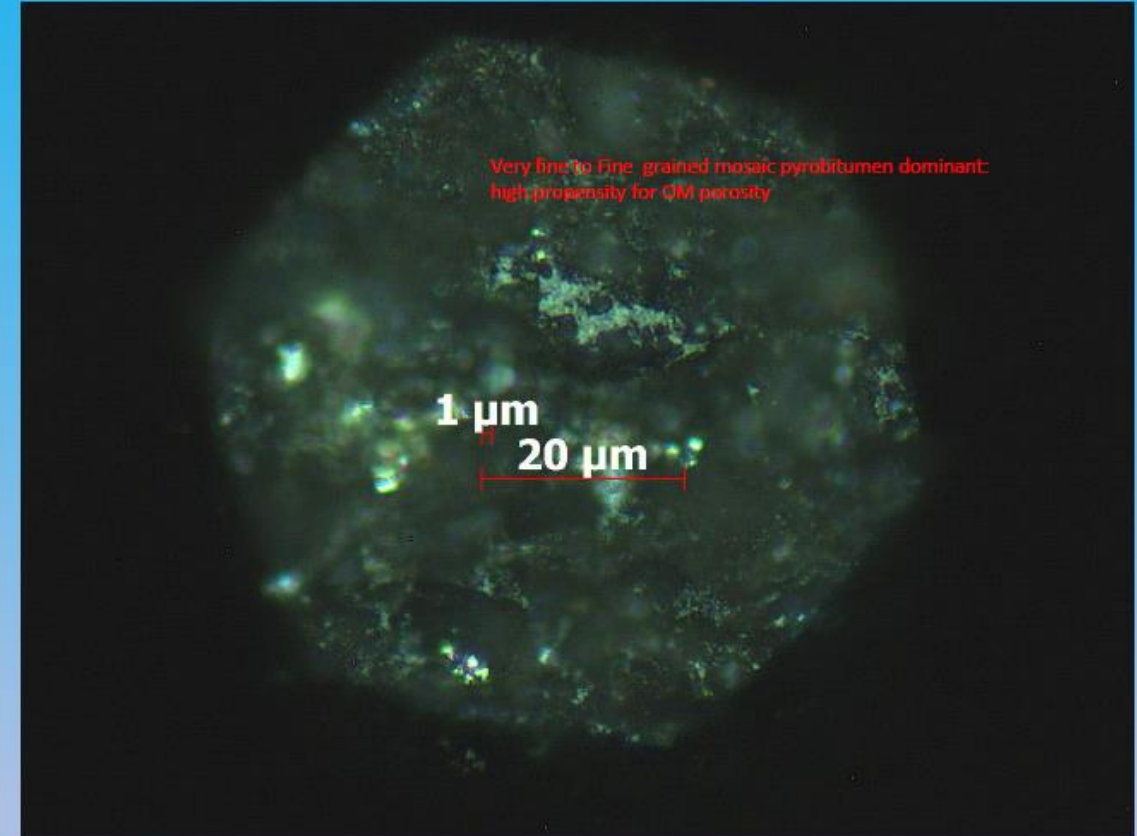
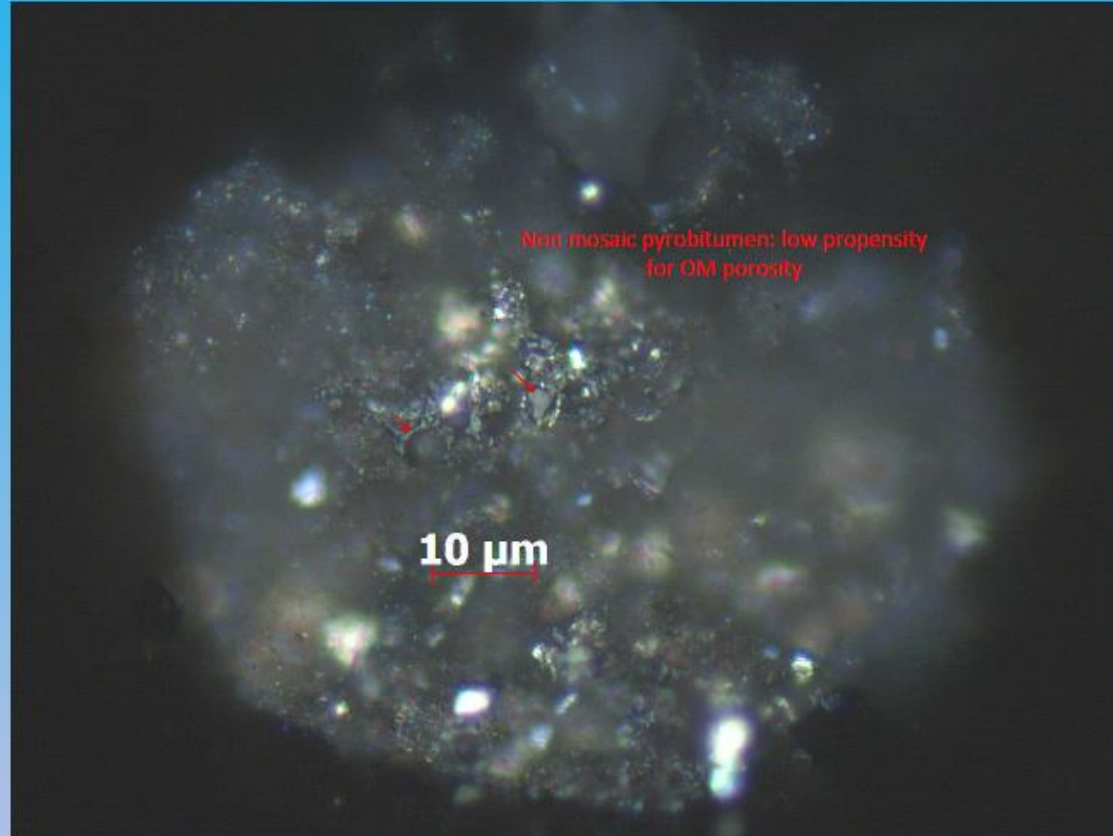
All hydrocarbon secondary products like bitumens, solid hydrocarbons, and pyrobitumens can be classified into those with isotropic, non-optical character and those with anisotropic, optical microtexture character. This is determined by examining the samples at ~ 1250-2200x in polarized, reflected light using an analyzer.

Assessment of original source rock potential and possible kerogen type precursor

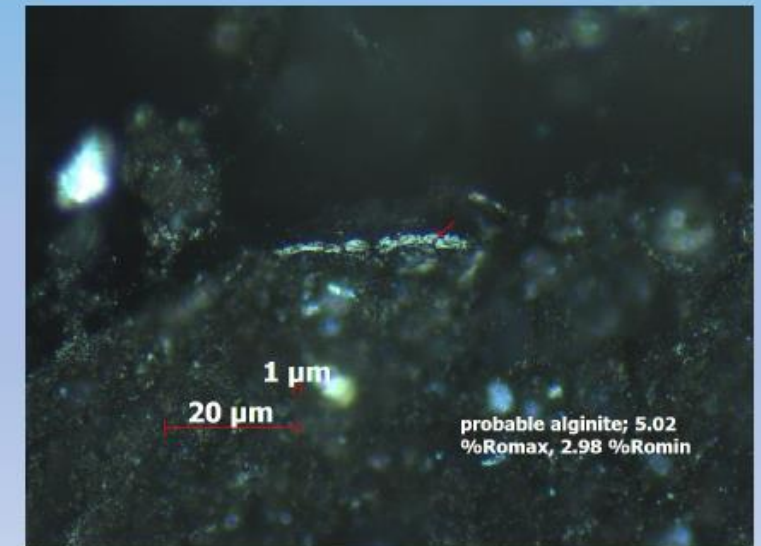
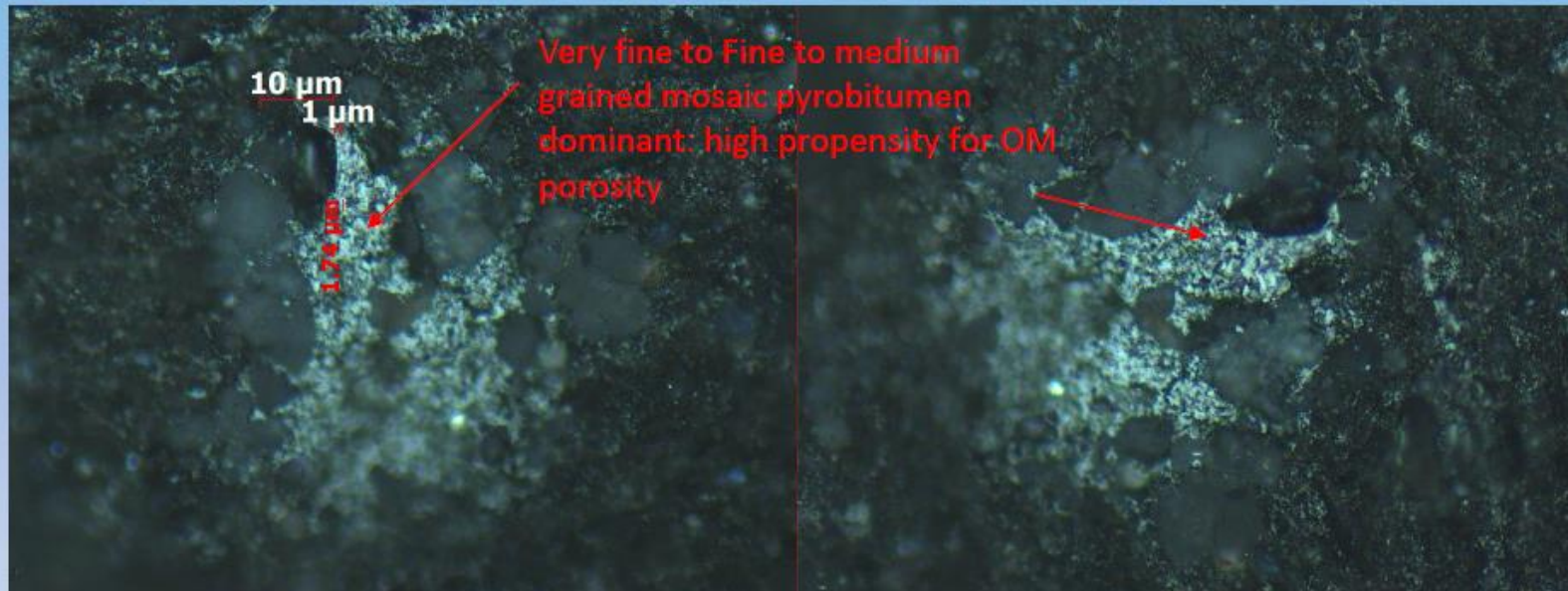
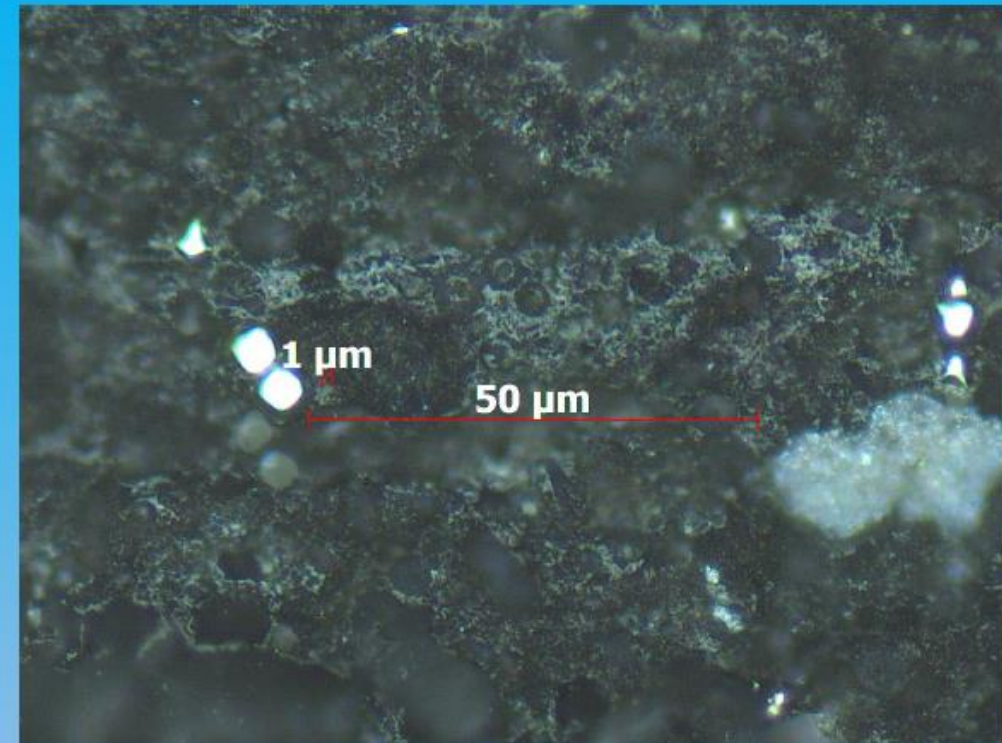
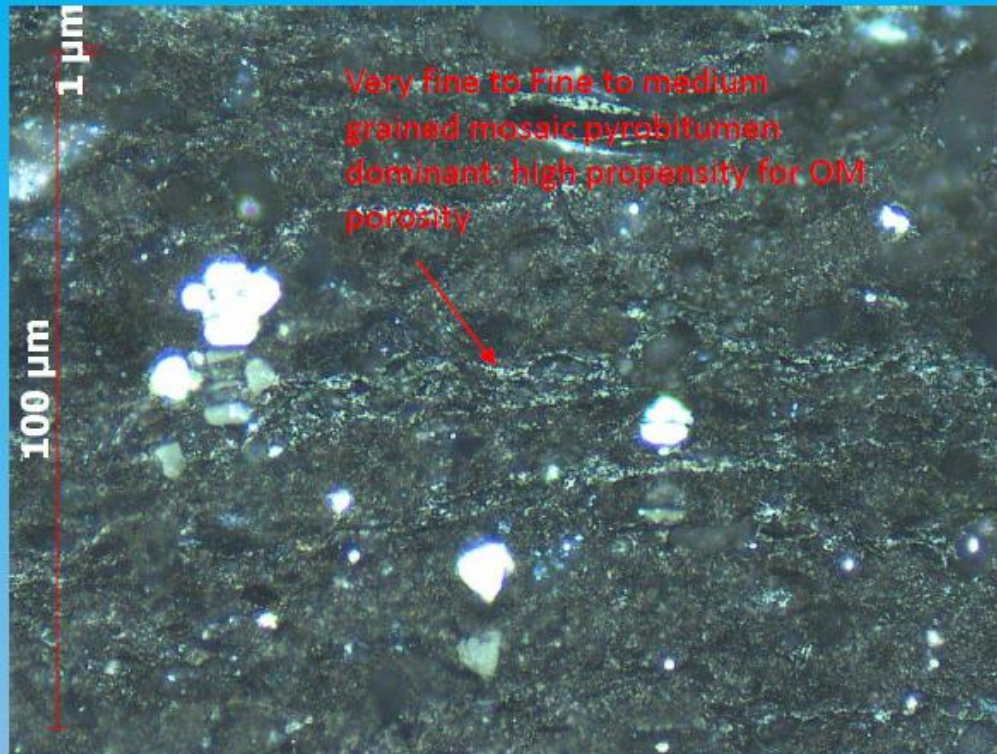


Well	Formation	Top Depth	Base Depth	Depth Units	SR and Kerogen Type Assessment	OM (micro)-network
Shenandoah S1	Velkerri	2700	2710	m	poor to fair (?), Type II ?	predom discontinuous X
Shenandoah S1	Velkerri	3020	3030	m	excellent; Type I	continuous/connected
Shenandoah S1	Velkerri	3040	3050	m	excellent; Type I	continuous/connected
Shenandoah S1	Velkerri	3080	3090	m	good to v good ; Type I to I/II	discontinuous to continuous
Shenandoah S1	Velkerri	3120	3130	m	moderate ?, Type I/II	ultra thin OM, continuous (?)

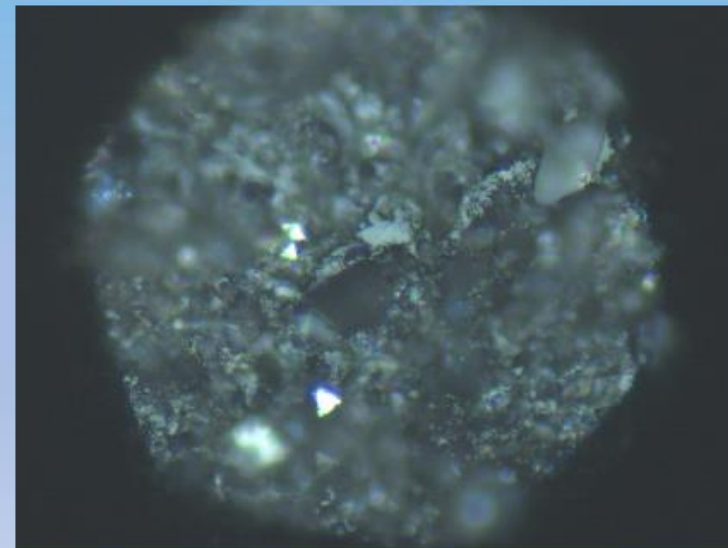
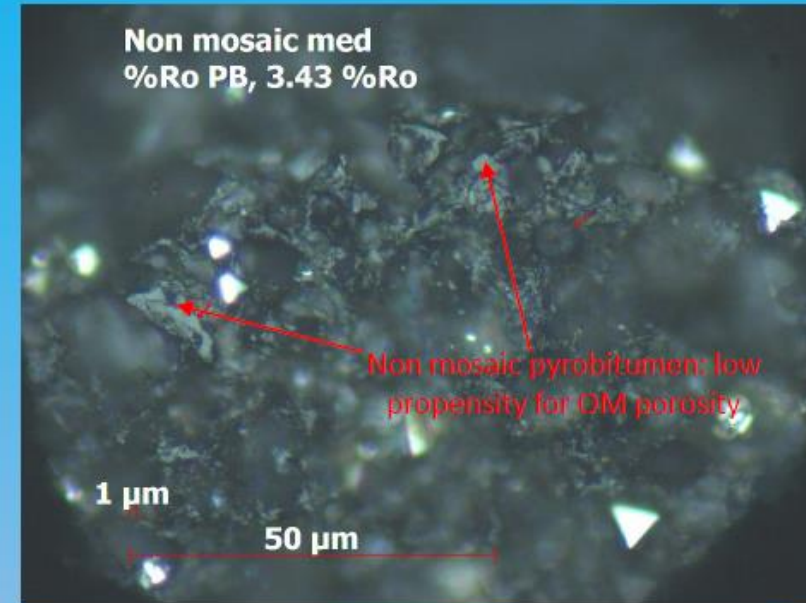
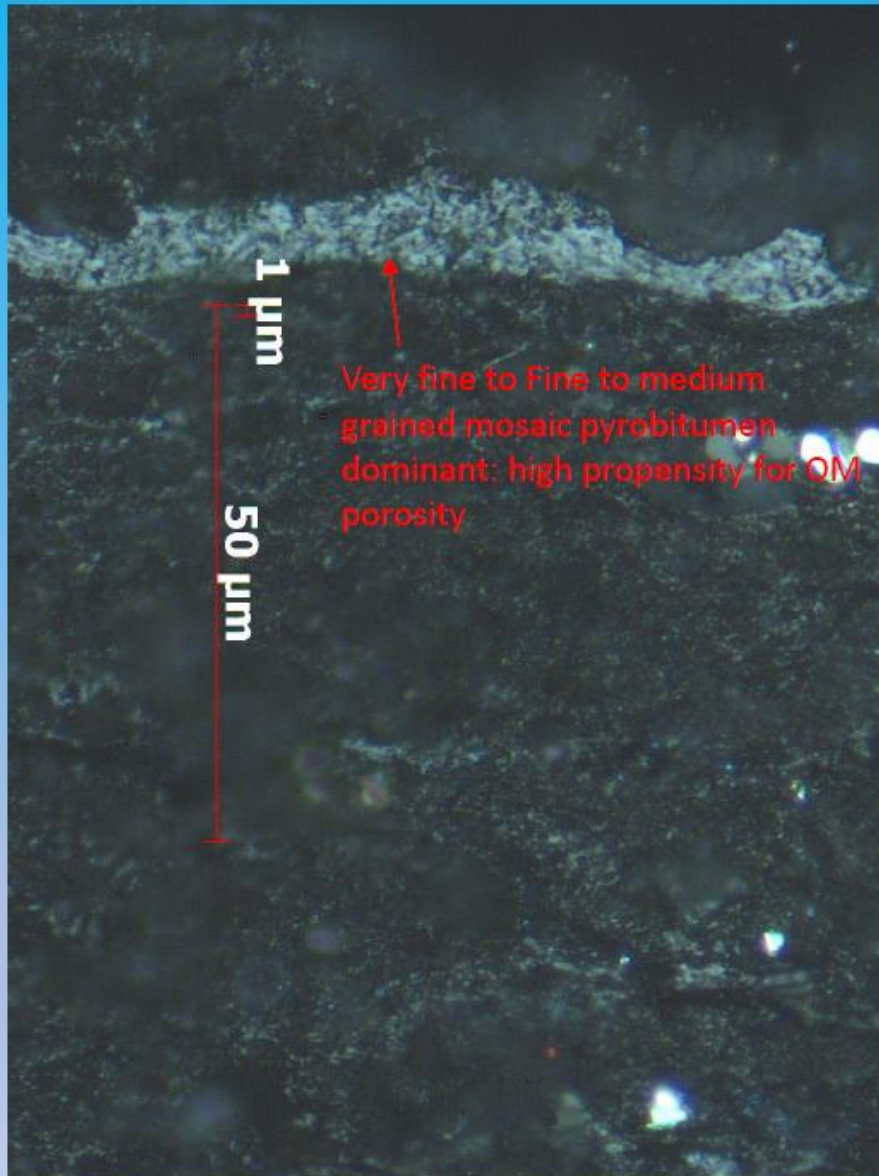
Shenandoah S-1, 2700-2710m Maceral Images Summary



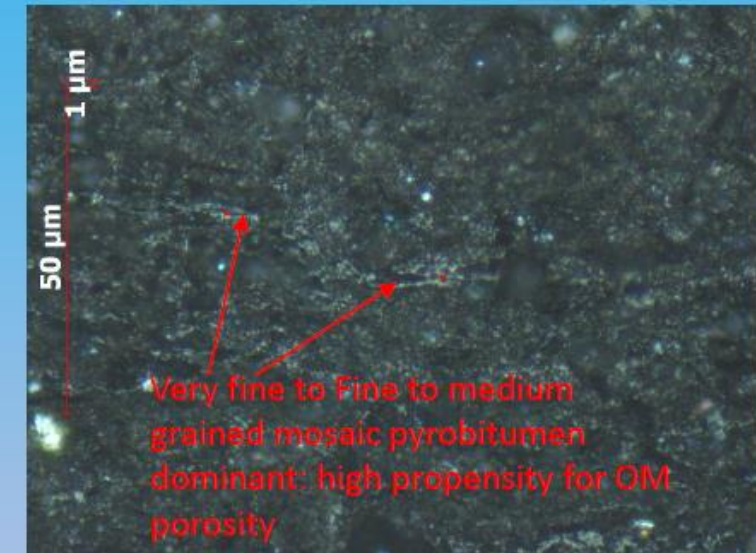
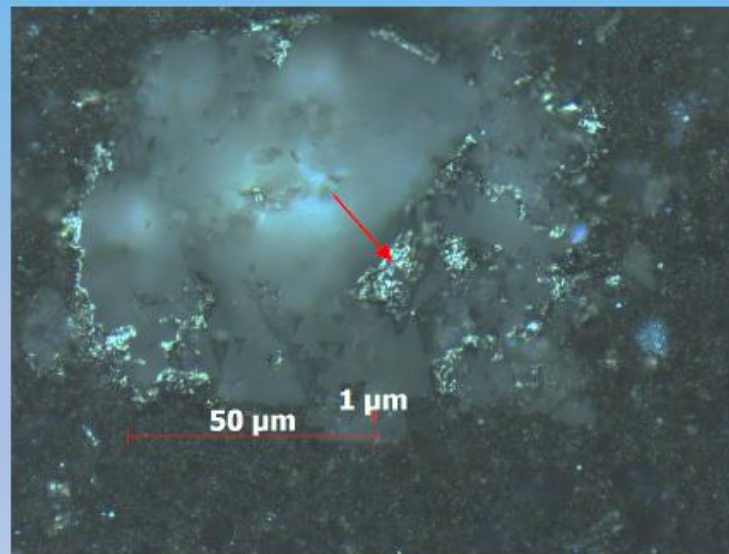
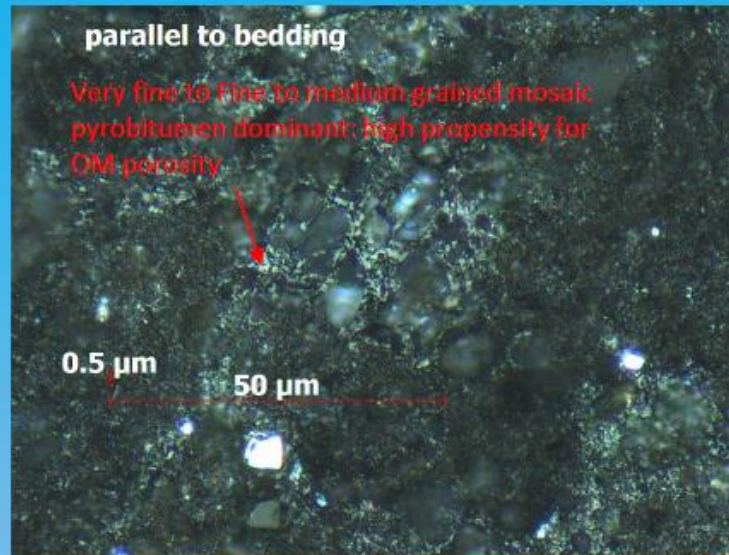
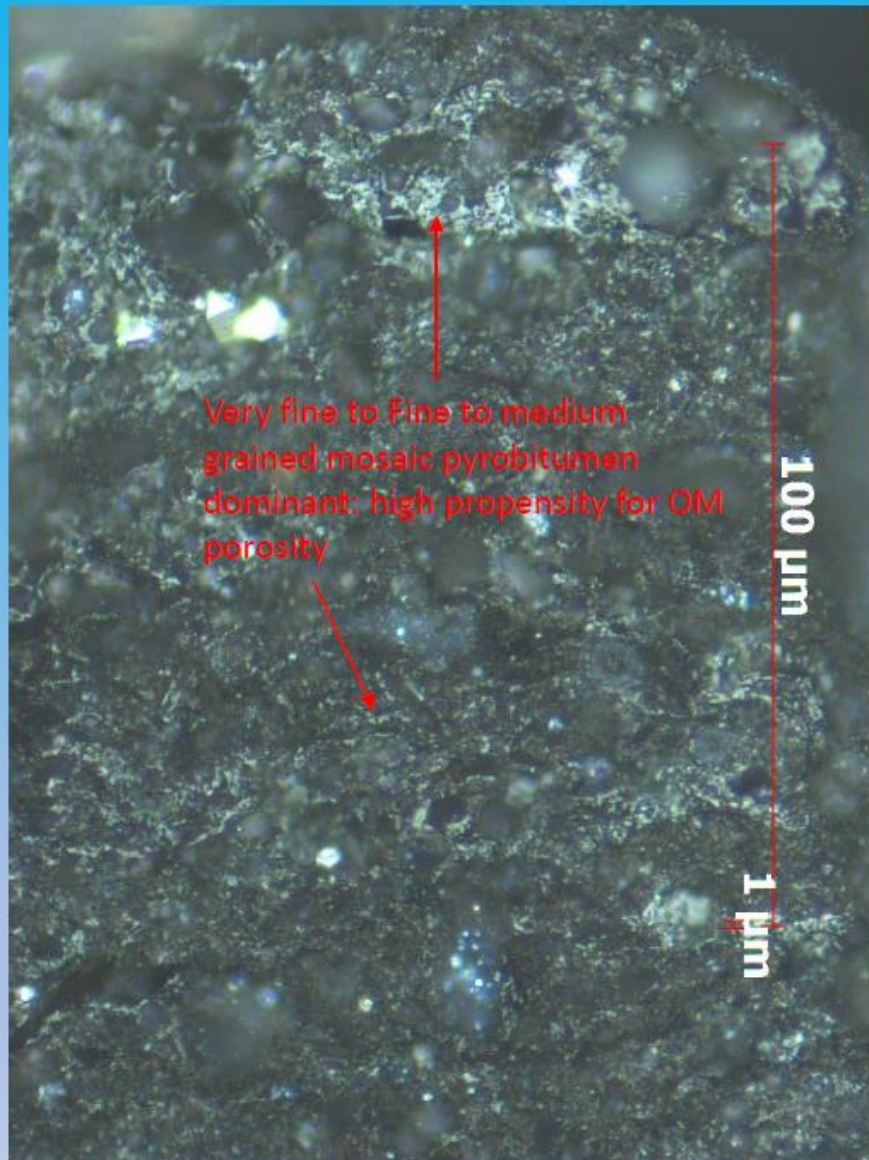
Shenandoah S-1, 3020-3030m Maceral Images Summary



Shenandoah S-1, 3040-3050m Maceral Images Summary



Shenandoah S-1, 3080-3090m Maceral Images Summary



Shenandoah S-1, 3120-3130m Maceral Images Summary

