High Resolution reservoir Characterization of the Lewis Shale. Greater Green River Basin

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- Objectives
- Core facies and thin section analyses
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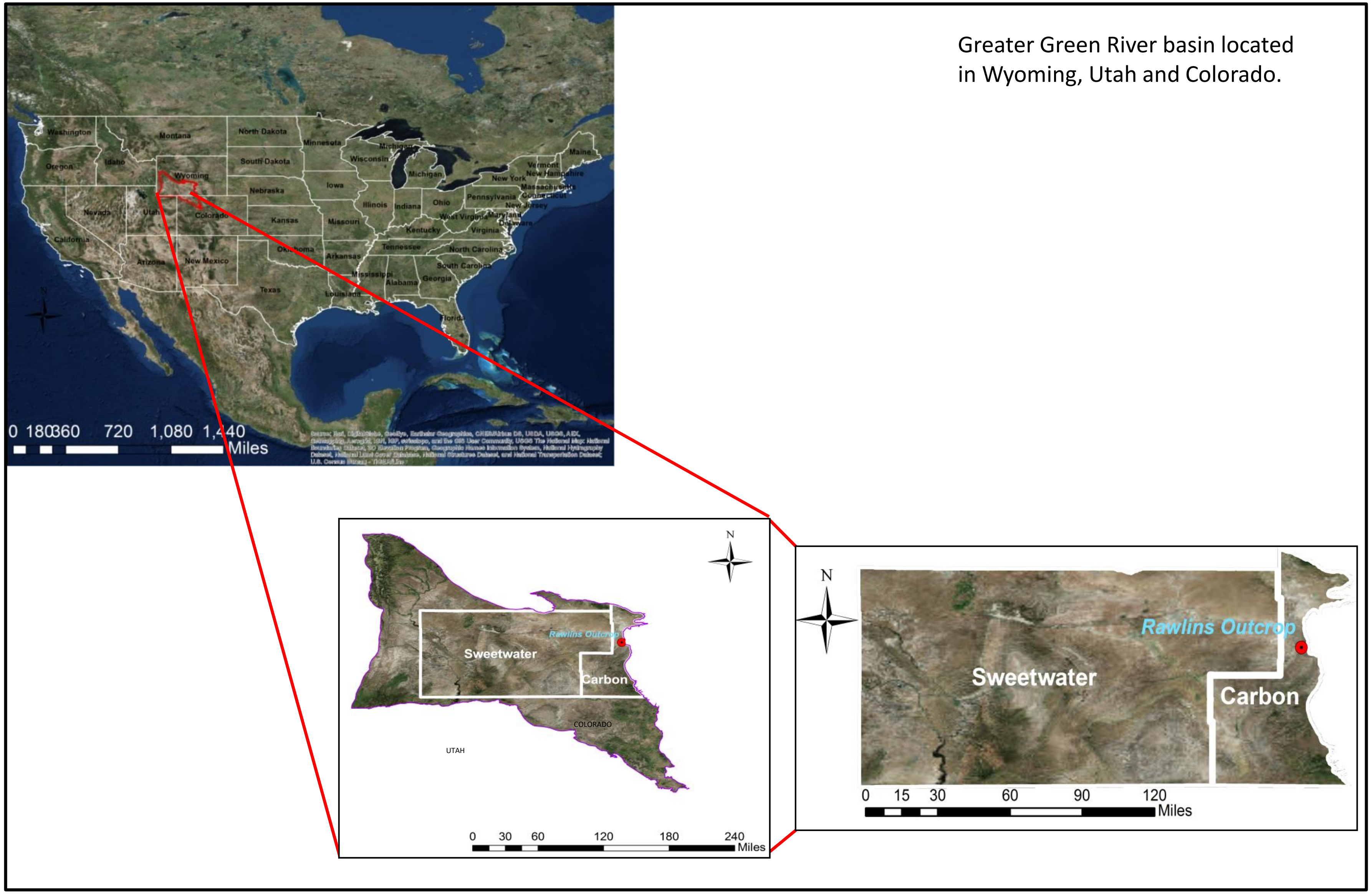
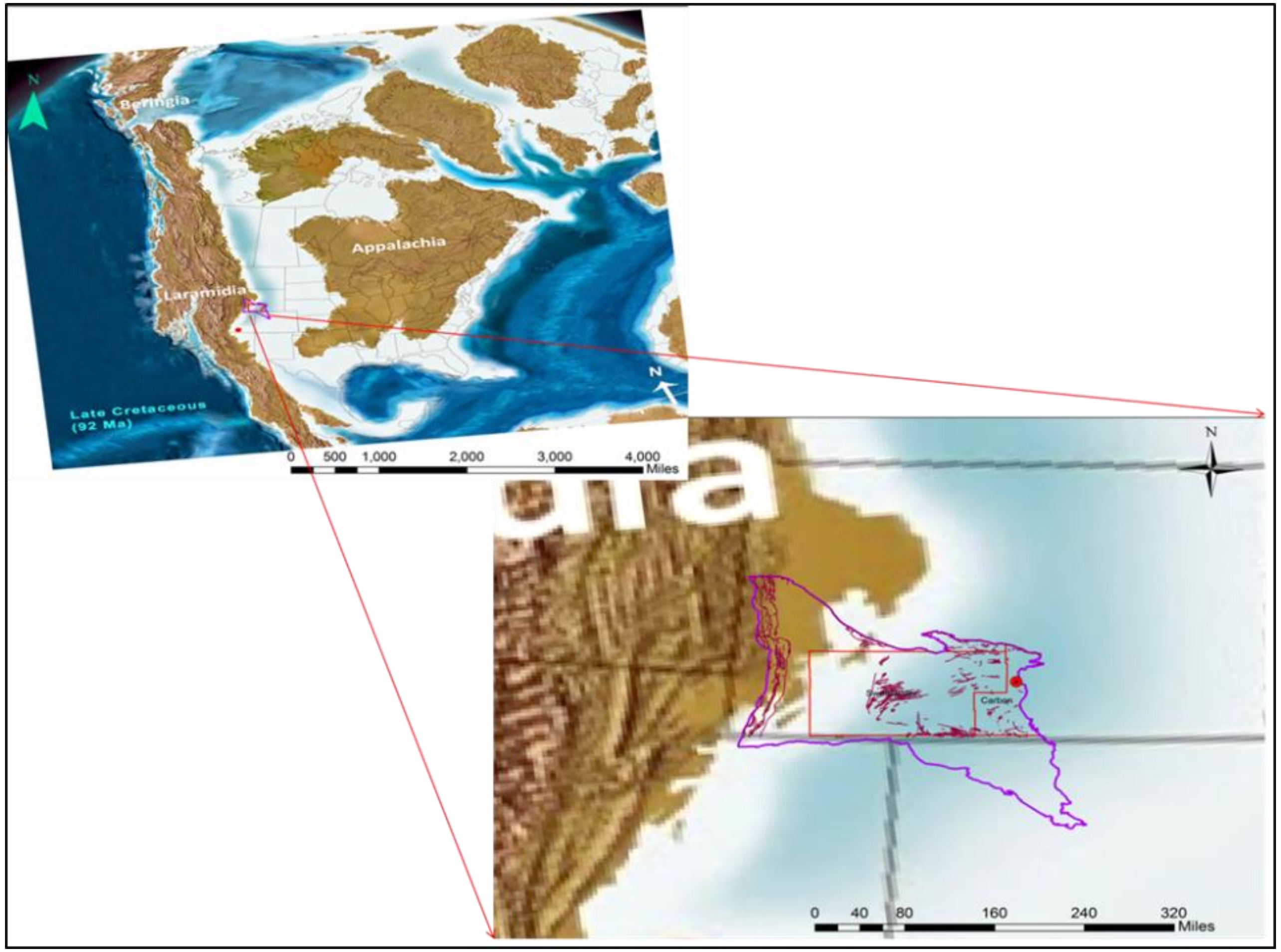
Introduction

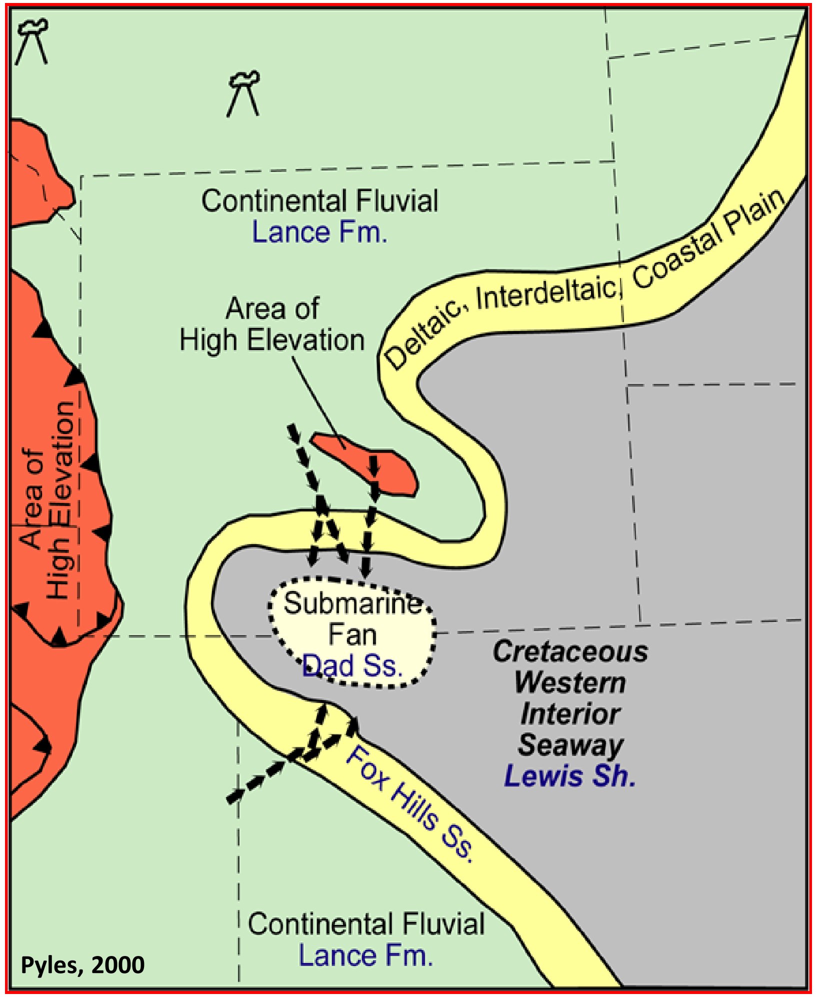
Greater Green River basin located in Wyoming, Utah and Colorado.



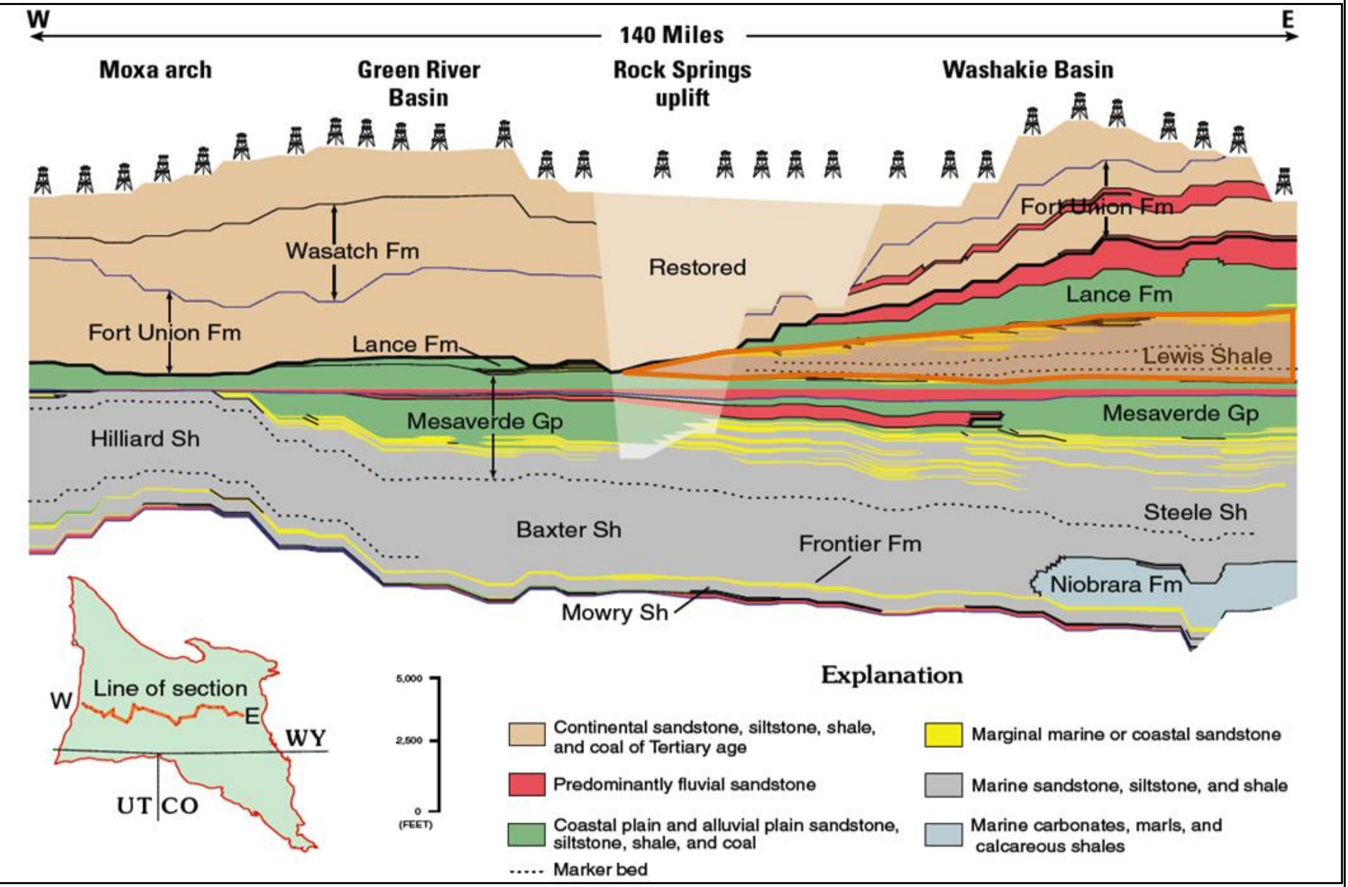
introduction



Paleomap from Colorado Plateau Geosystems

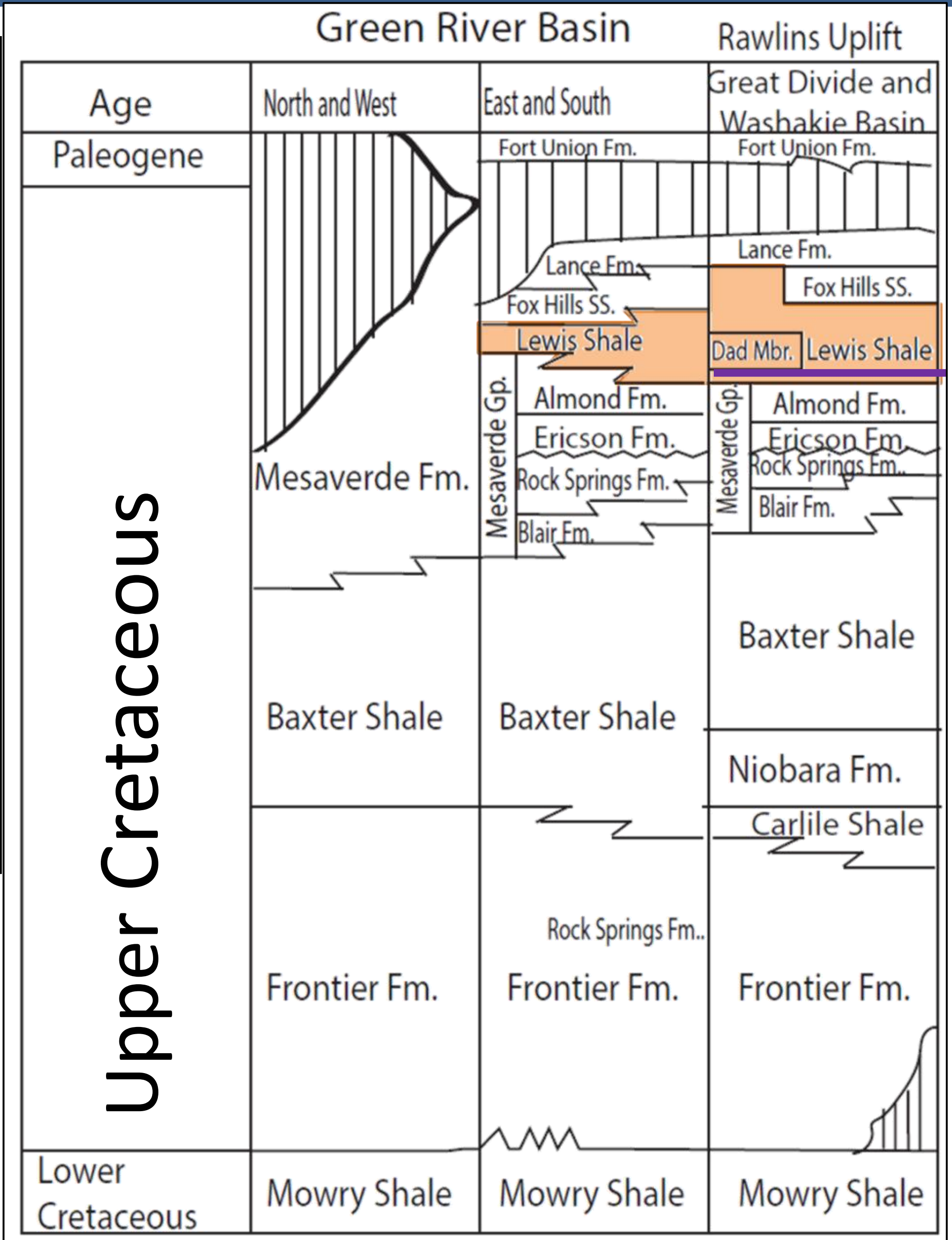


Introduction

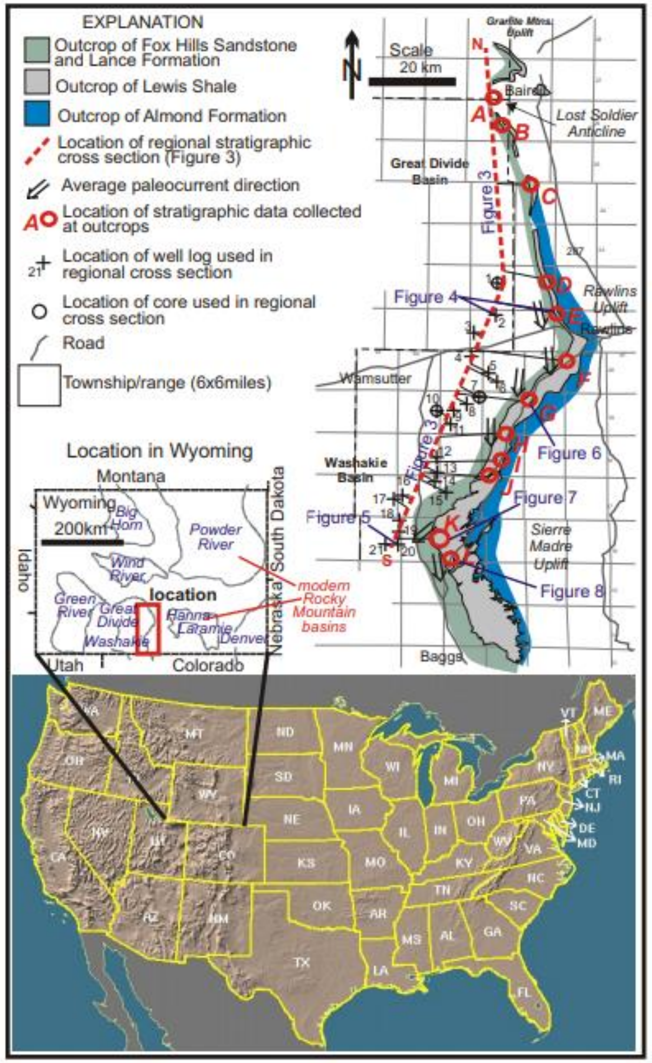


USGS, 2005

- It is mainly gas producer is some potential for liquid hydrocarbons.
- Between 600 and 675 BCFG with some minor amounts of oil have been produced since 1974.



Pyles (2000)



Pyles and Slatt, 2000

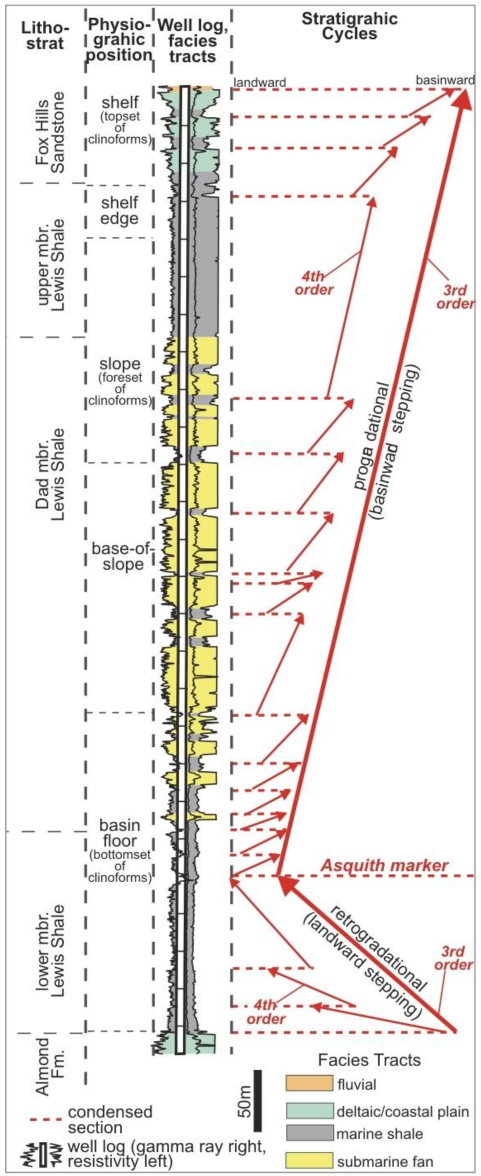
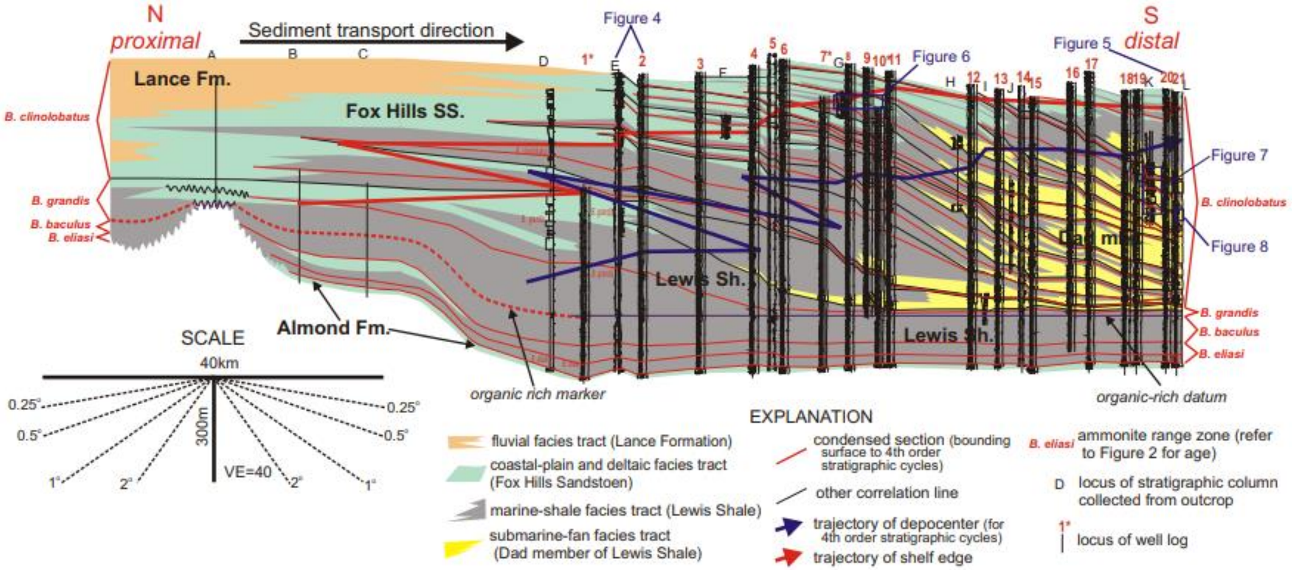


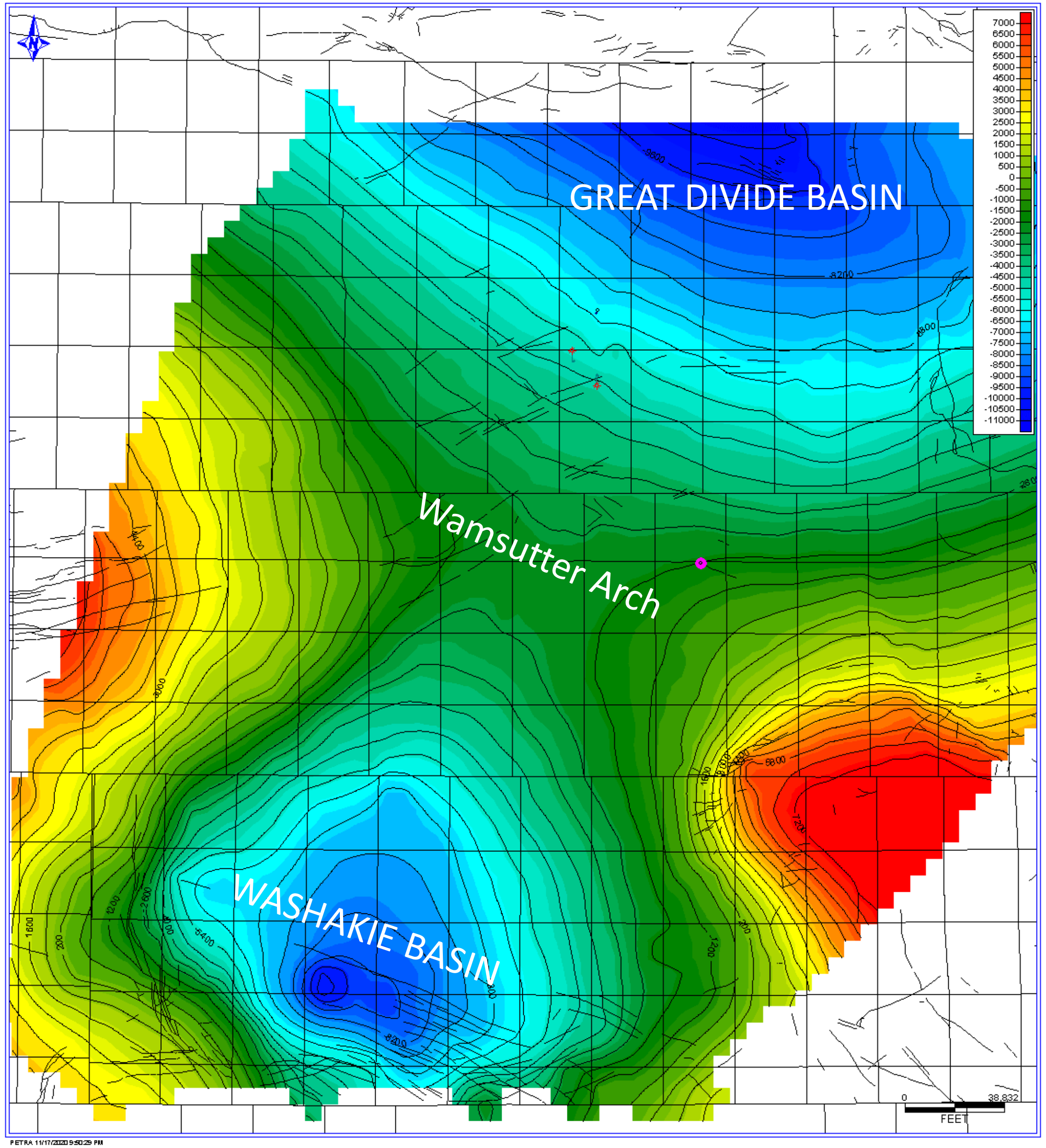
Figure 5

3rd order Sequence

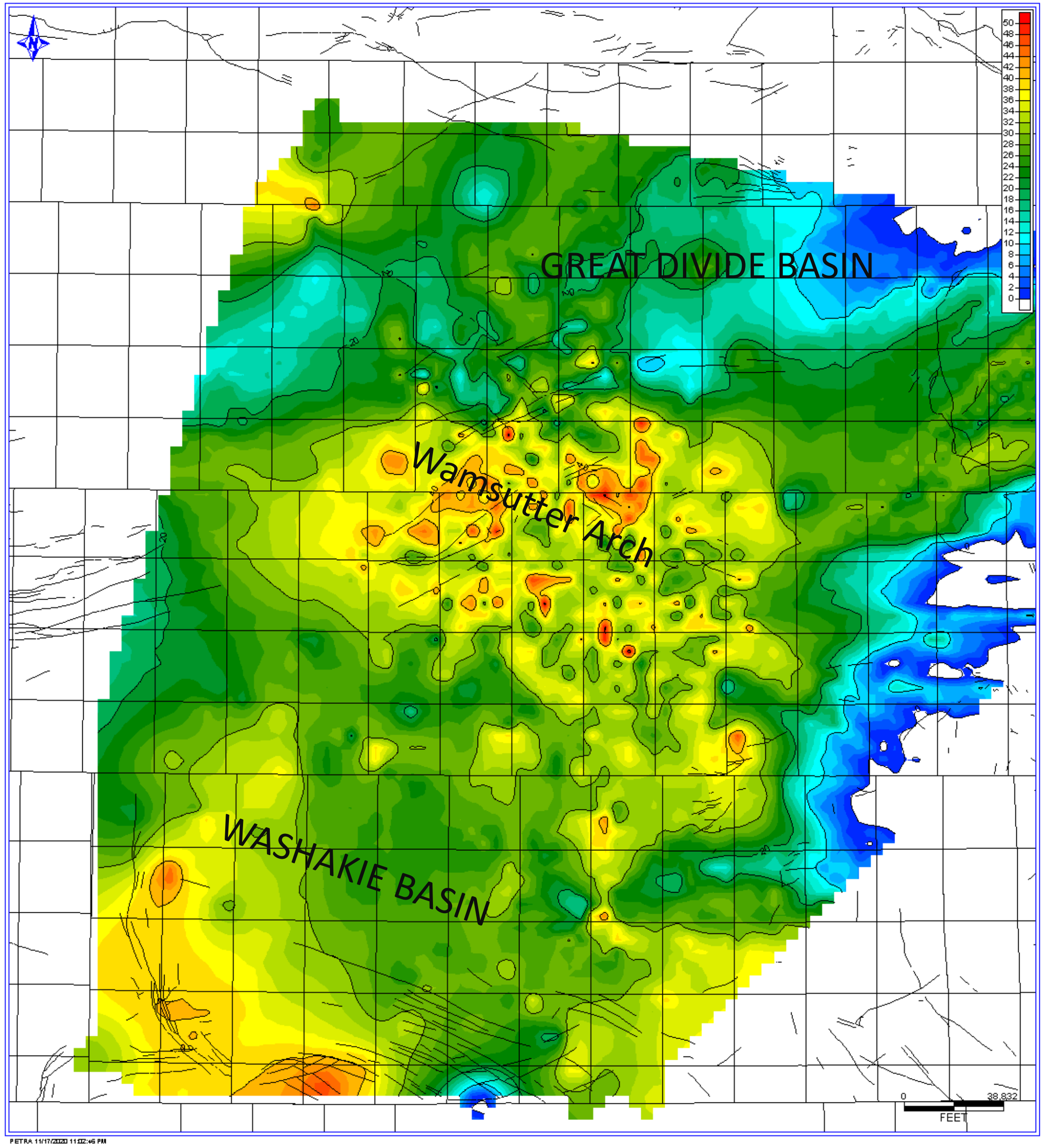


Source of hydrocarbons

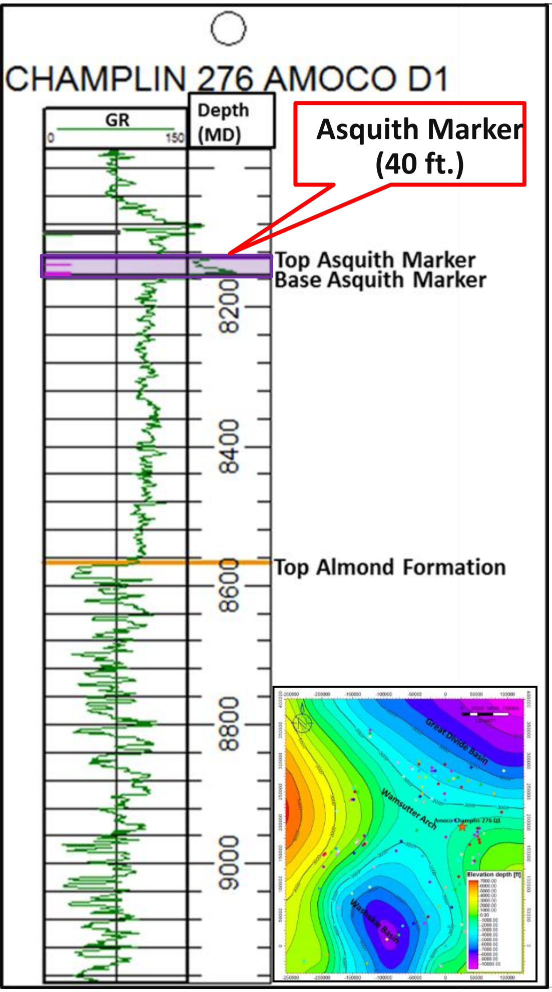
Asquith Marker Structural Map



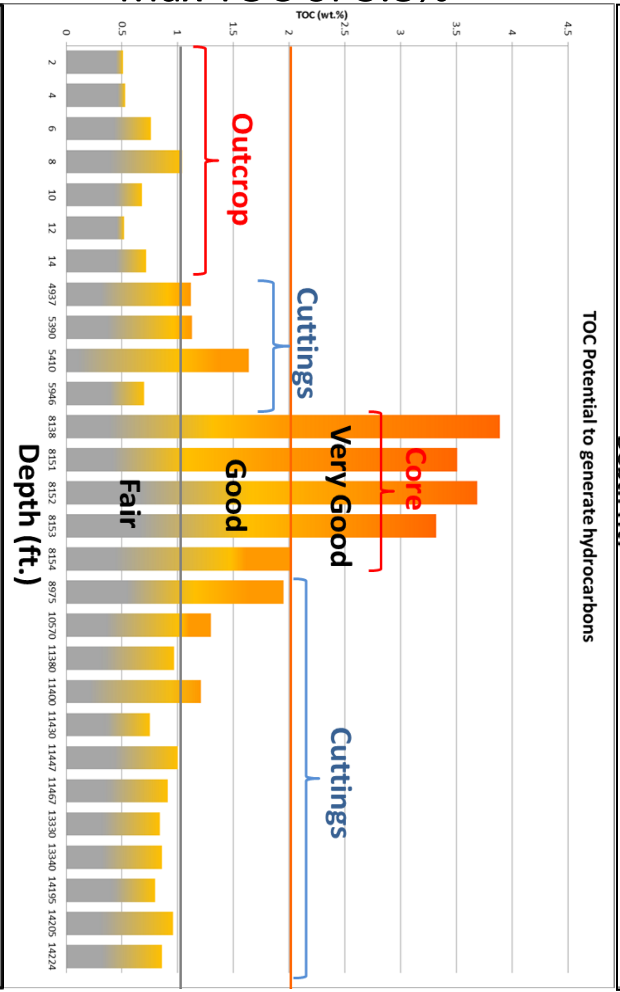
Asquith Marker Isopach Map

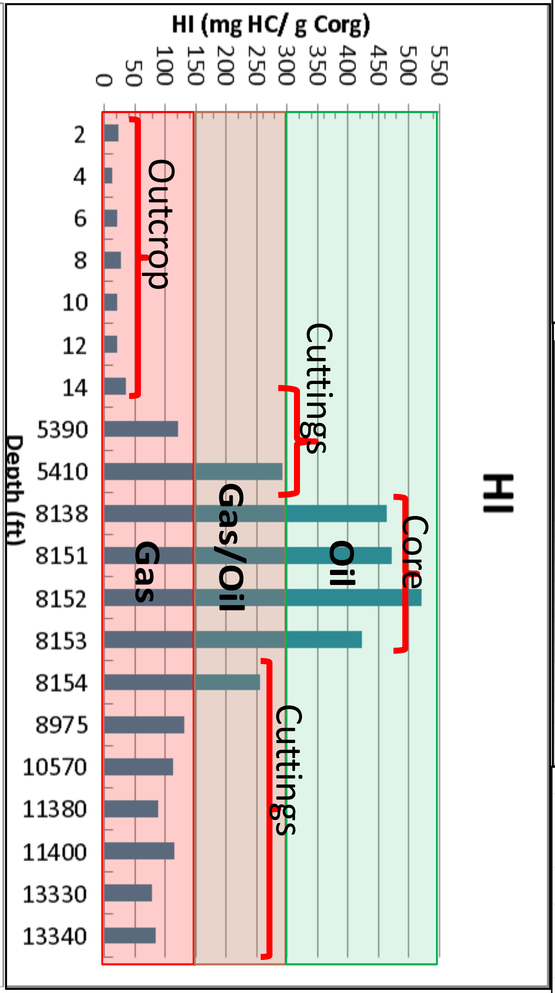


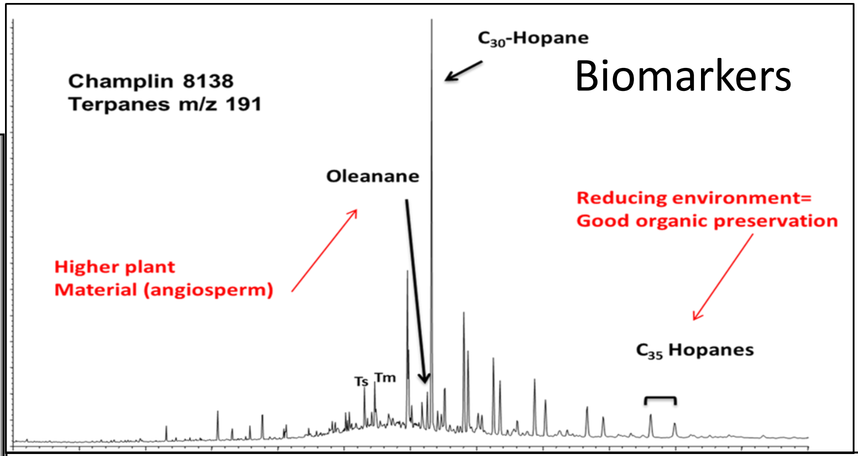
Source of hydrocarbons

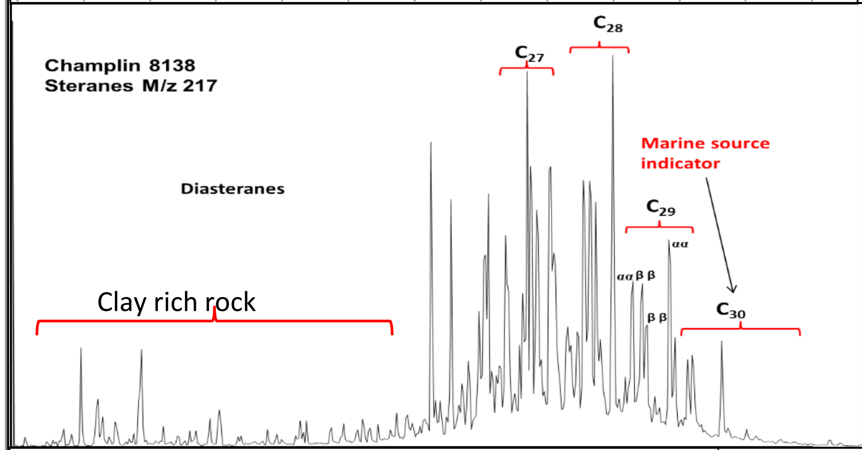


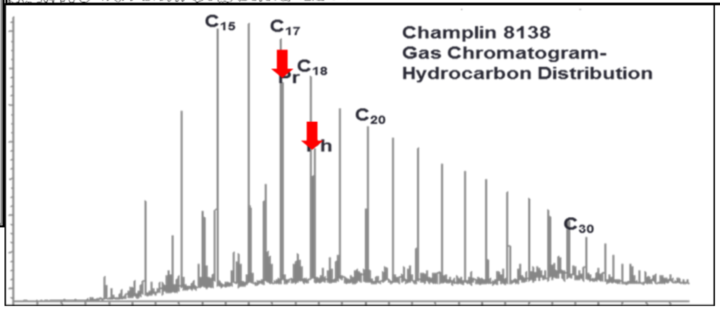
Max TOC of 3.8%



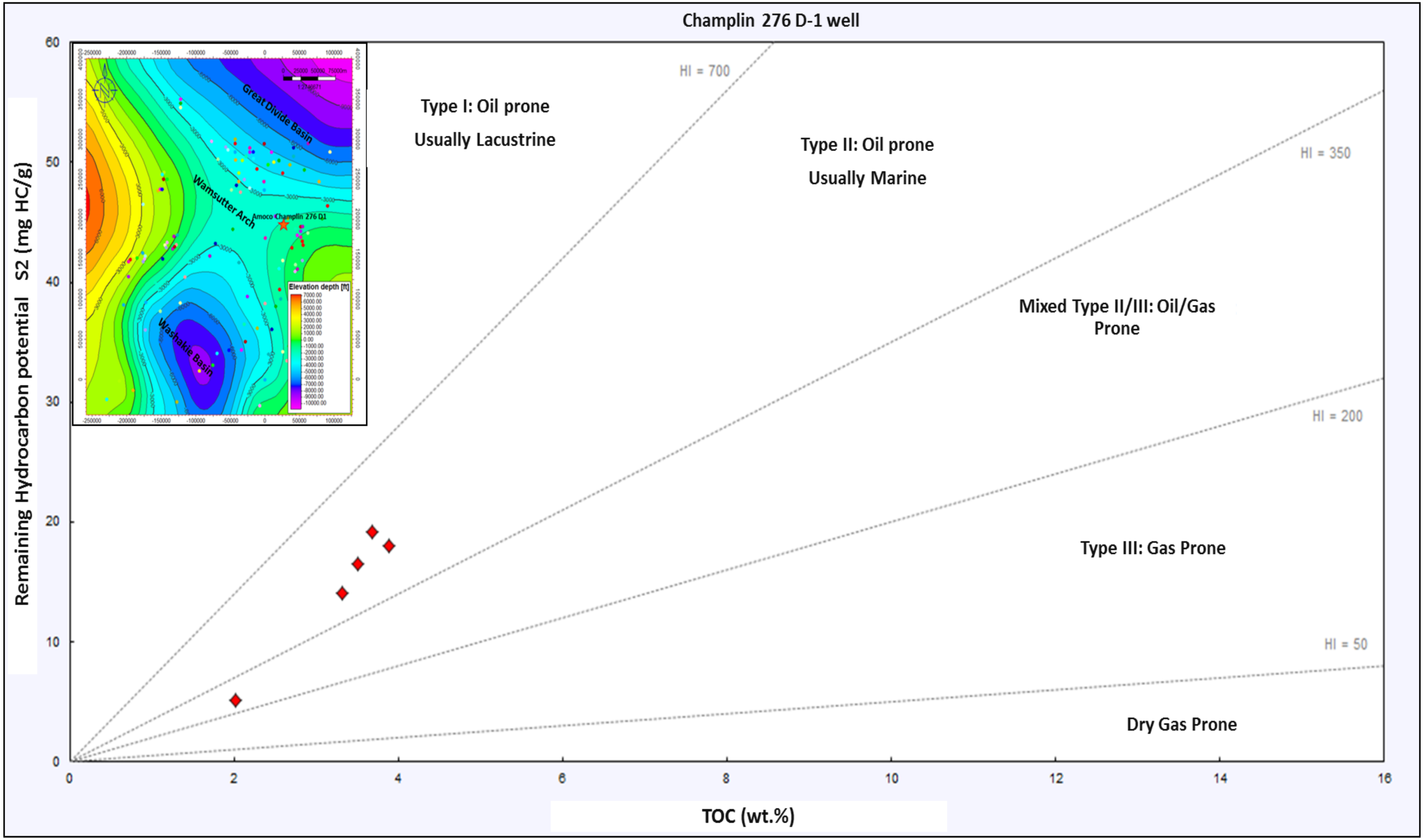








Kerogen Type



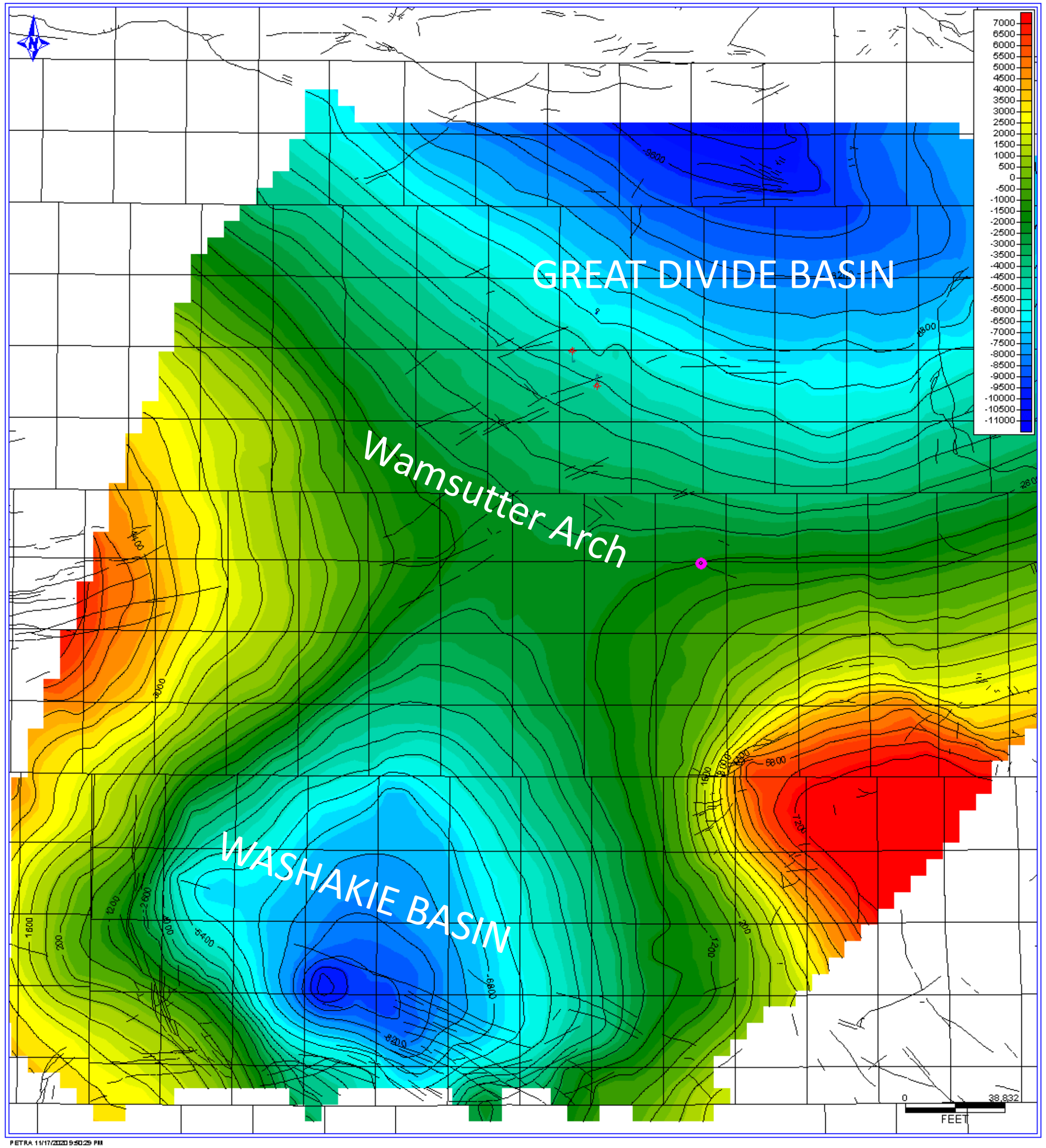
Objectives

- Perform a high-resolution reservoir characterization of the Lewis Shale in the Sweetwater and Carbon County.
- Define depositional environments of the cores obtained within the basin.
- Evaluate the internal characteristics of the different reservoirs and determine reservoir quality.

Data Available

- Four cores located on the northern part of the basin. Close to the town of Wamsutter. One located close to the Wamsutter arch
- Analyses include:
  - Log Data
  - XRD
  - XRF
  - TOC
  - Rock-Eval data
  - Vitrinite Reflectance
  - Porosity and Permeability data

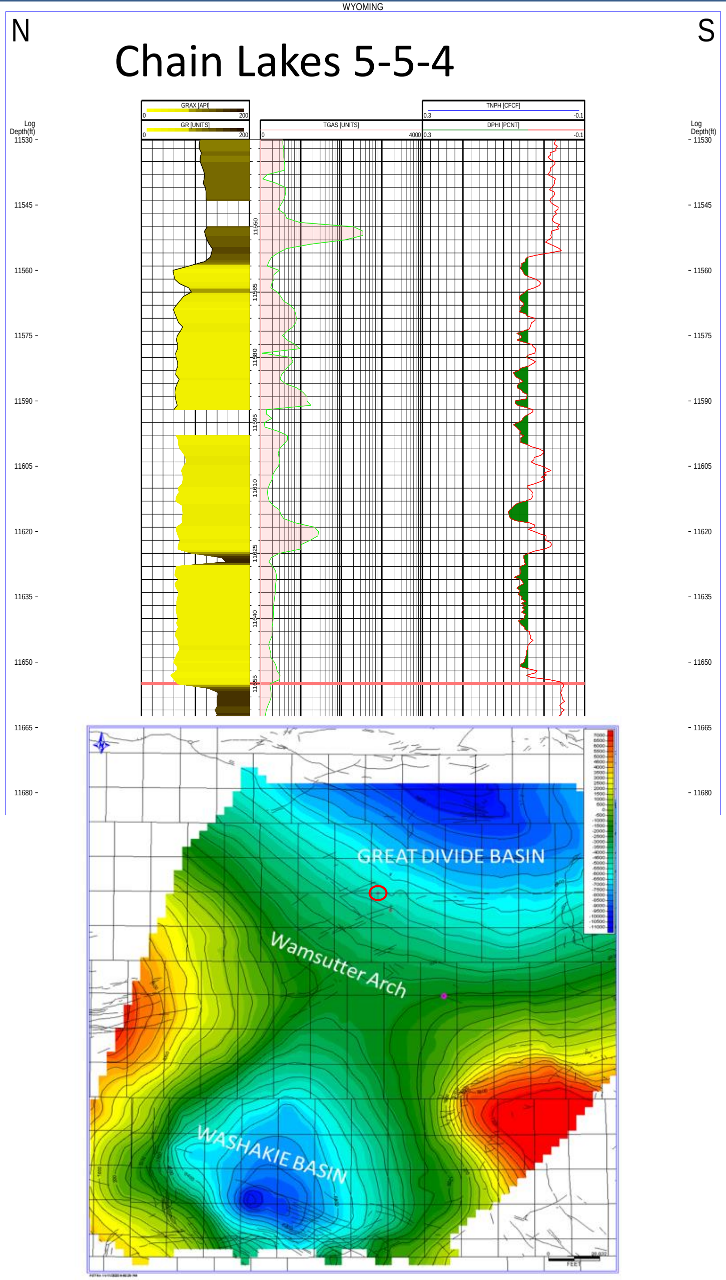
Cores Location

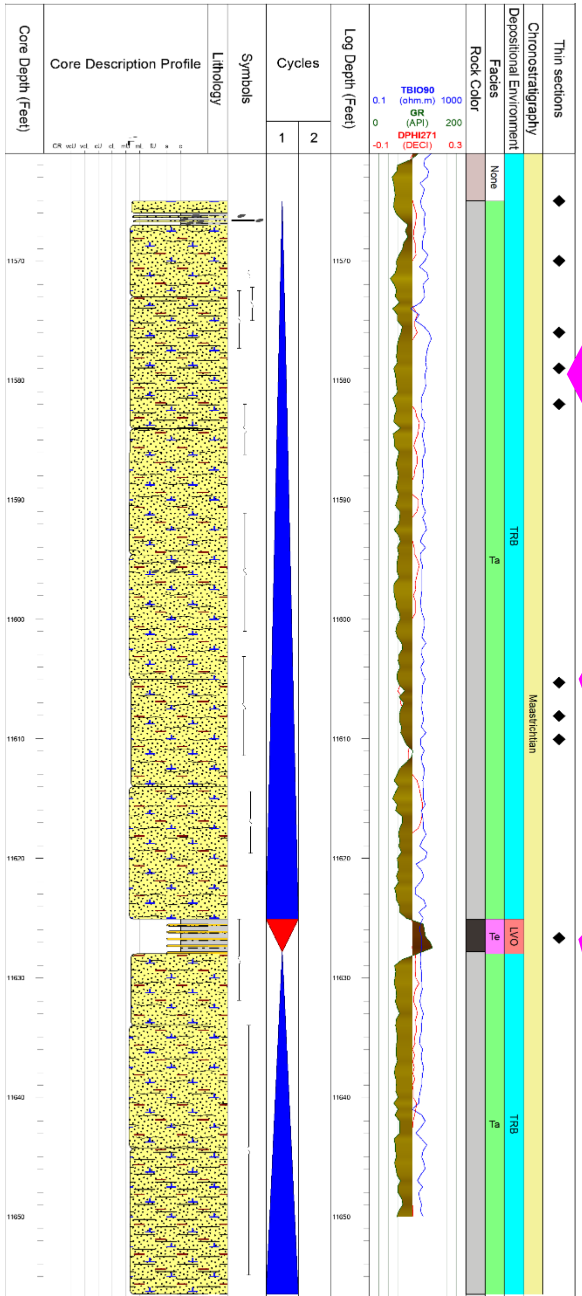


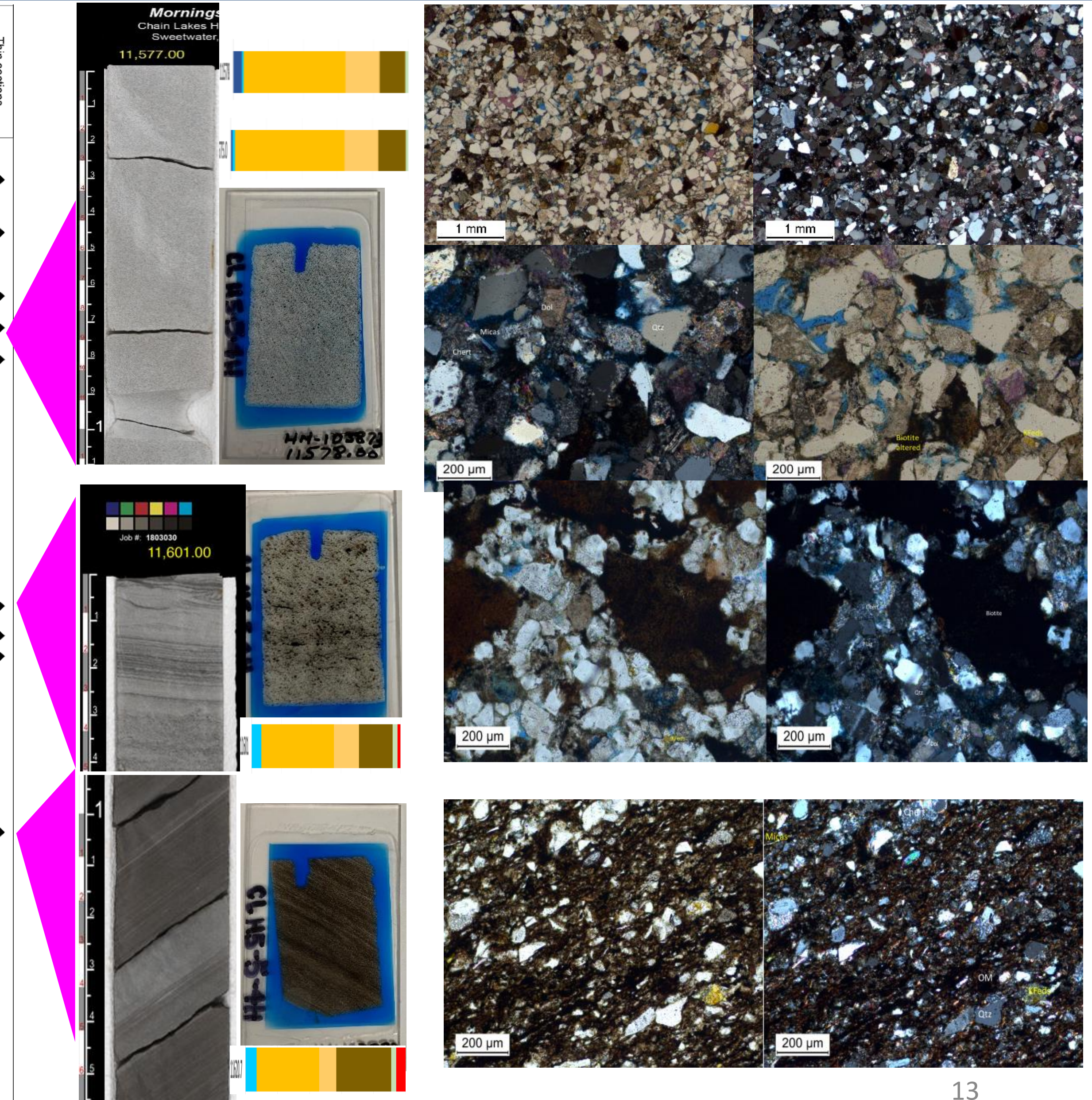
Some of the wells close to the cored areas had produced about 20000 BBLS and 187000 MCF

Oil gravity is between 50-60 API

Chain Lakes 5-5-4



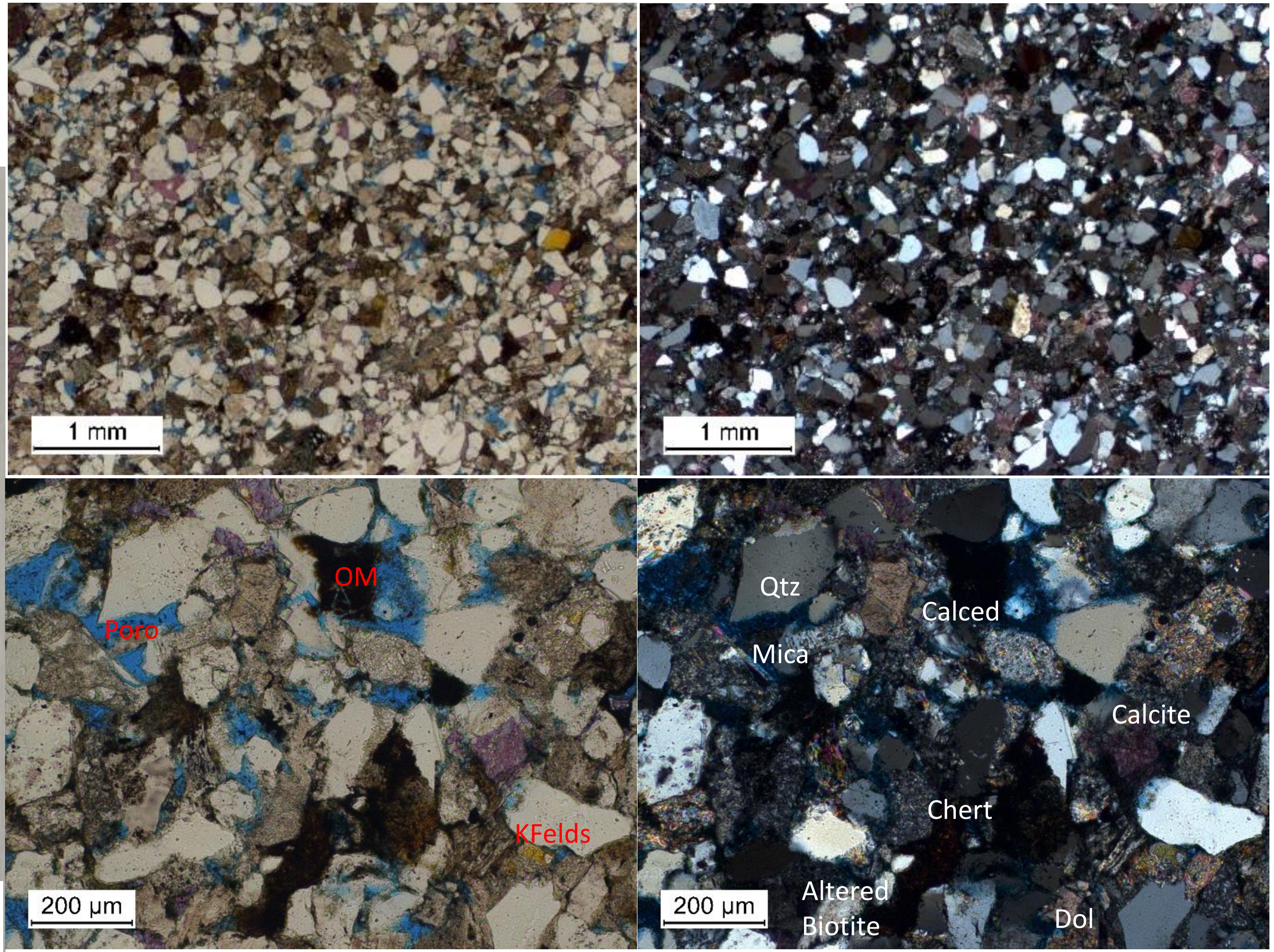




Depositional Environment: Channel Fill

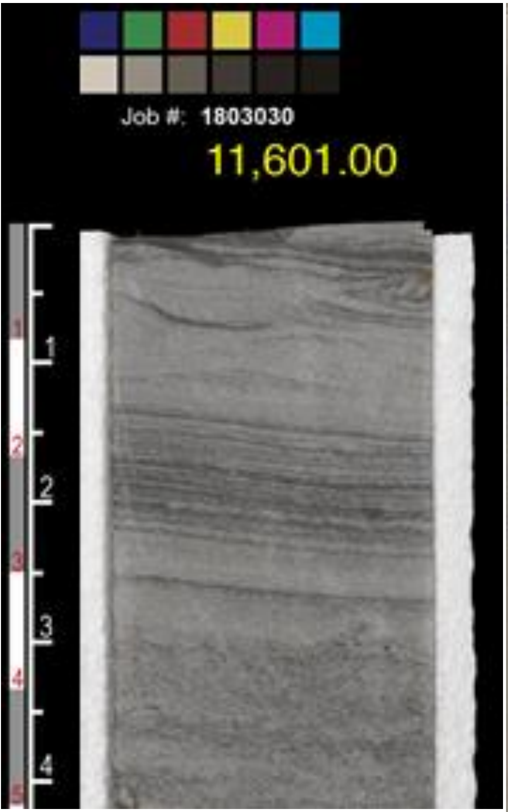
Core facies

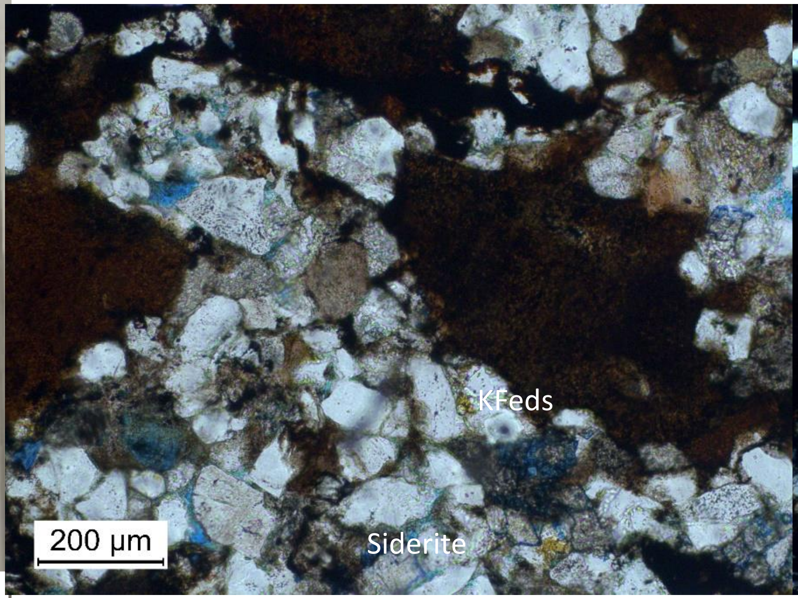
"Massive" Sandstone (Cryptobioturbated)

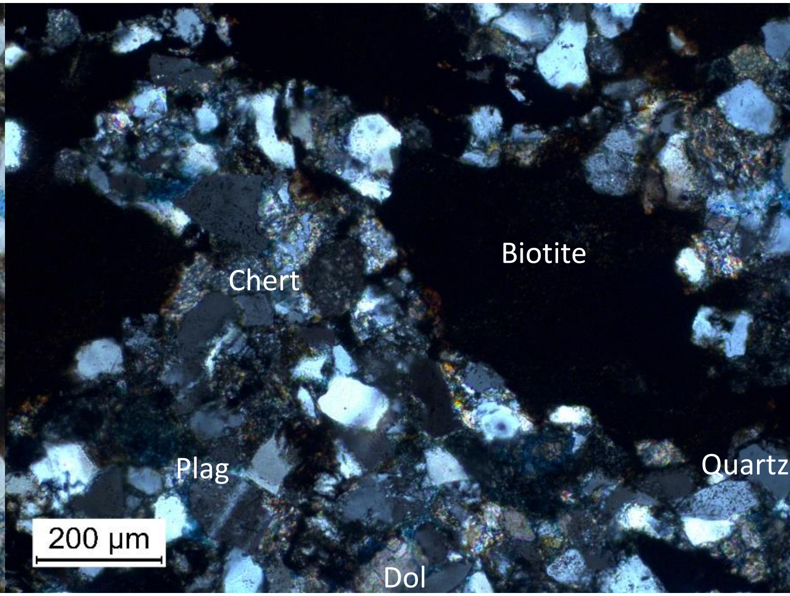


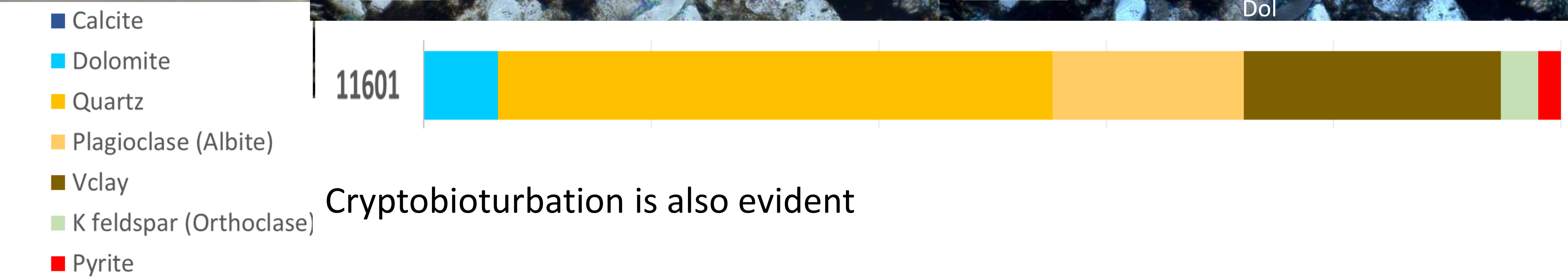
Core facies

Finely laminated bioturbated silty fine sandstone







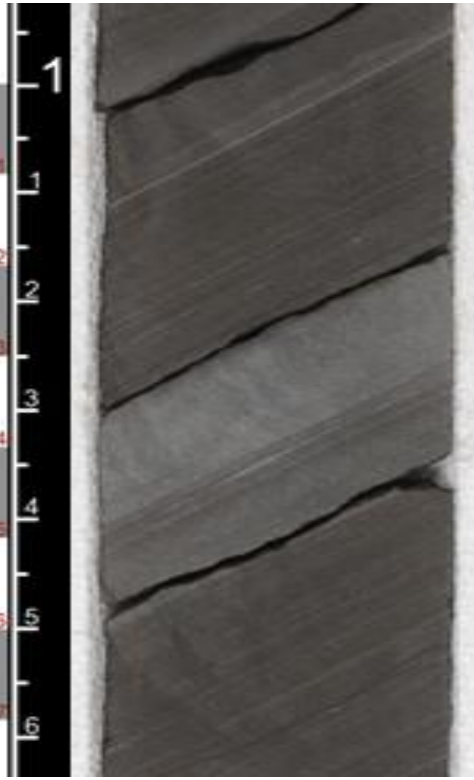


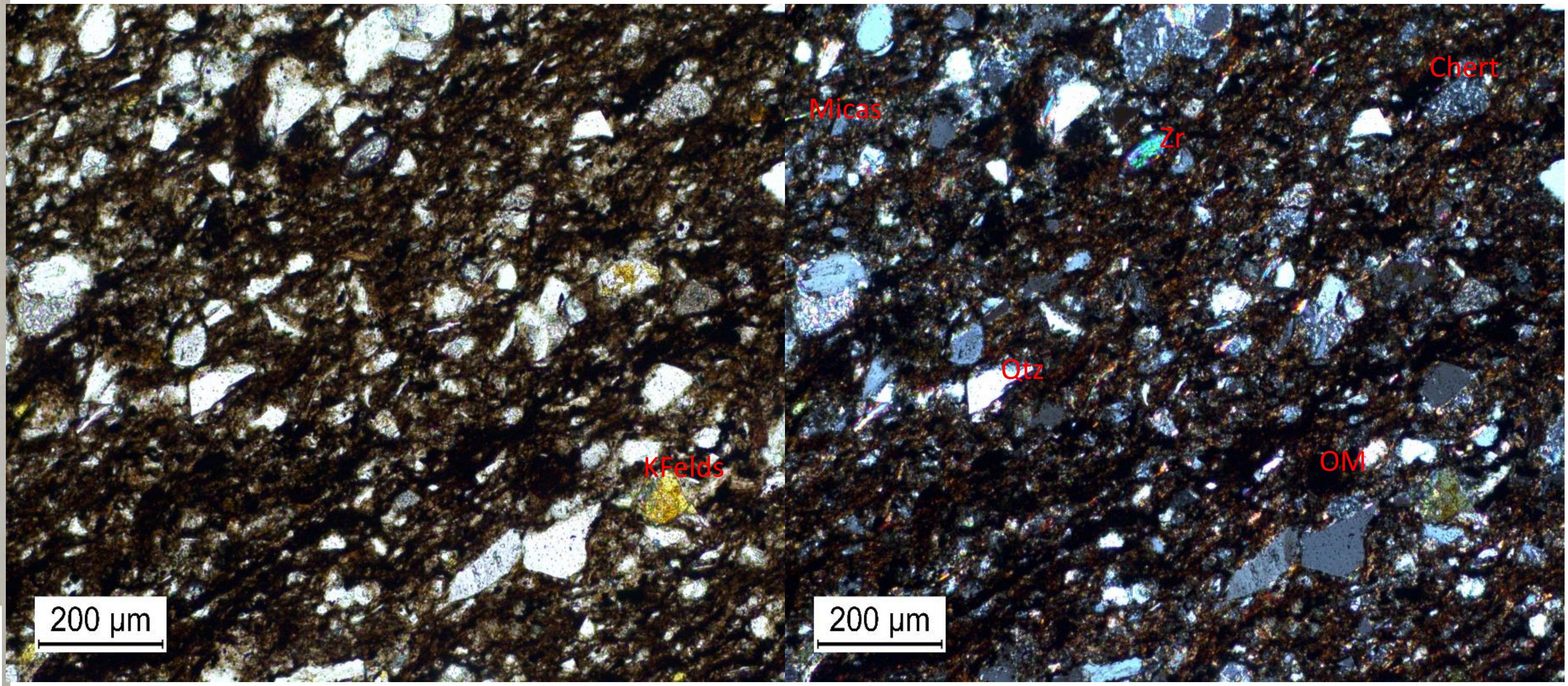
Cryptobioturbation is also evident

Depositional Environment: Channel Fill

Core facies

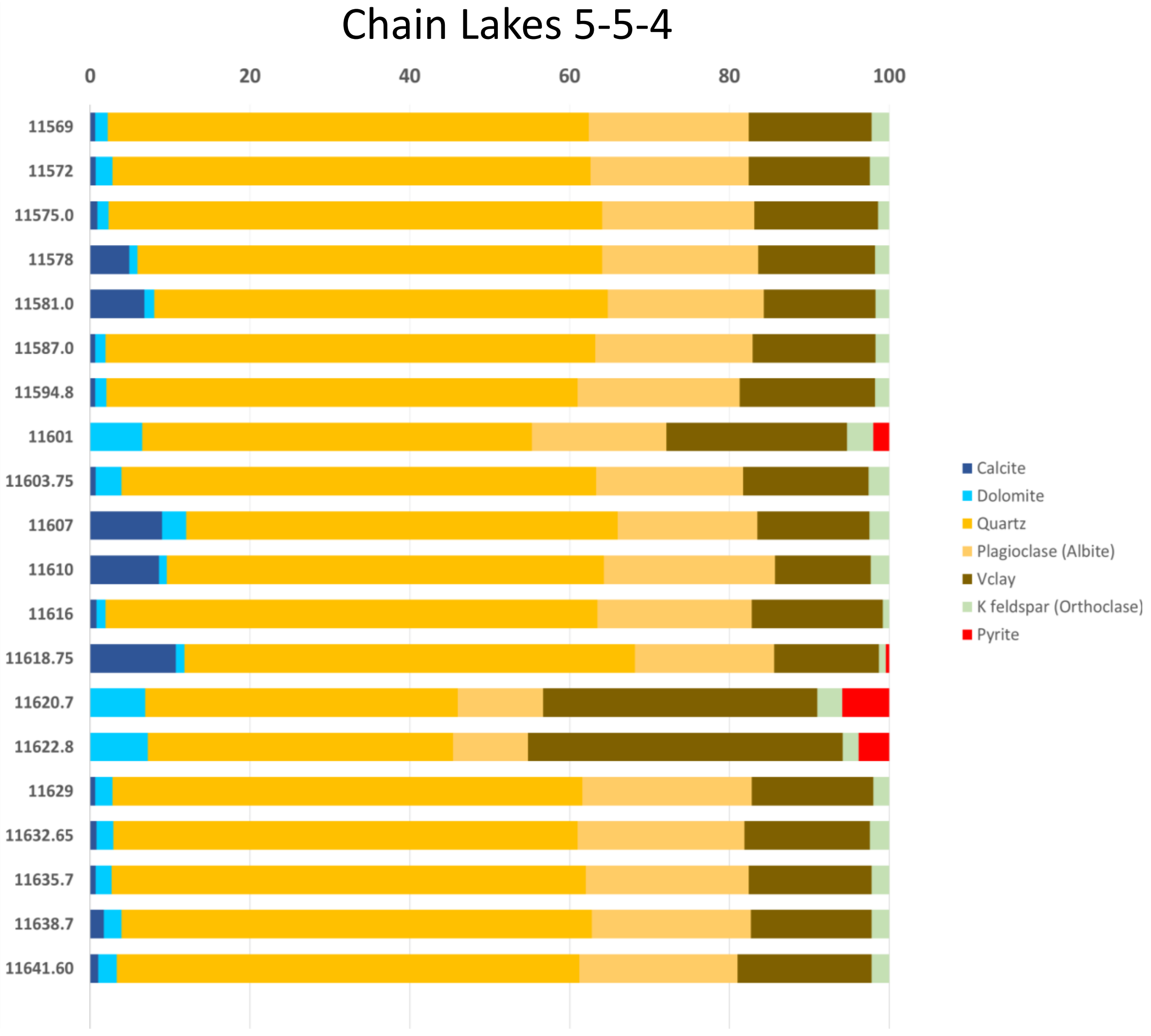
Finely laminated bioturbated sandy siltstone



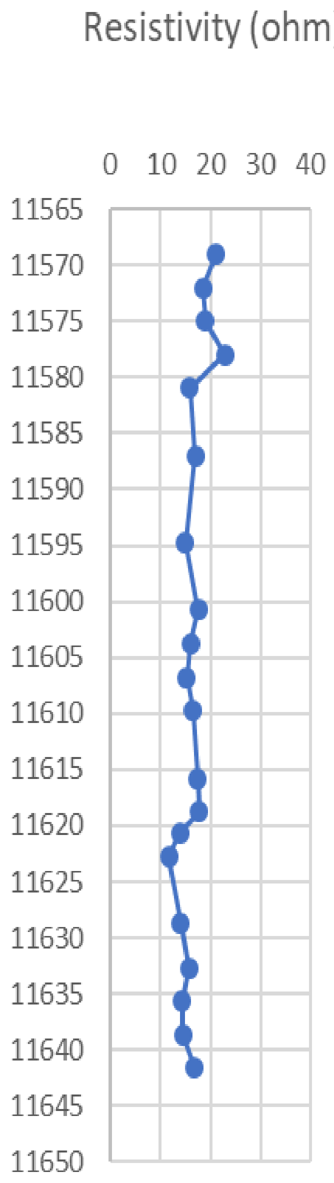


Depositional Environment: Channel Fill

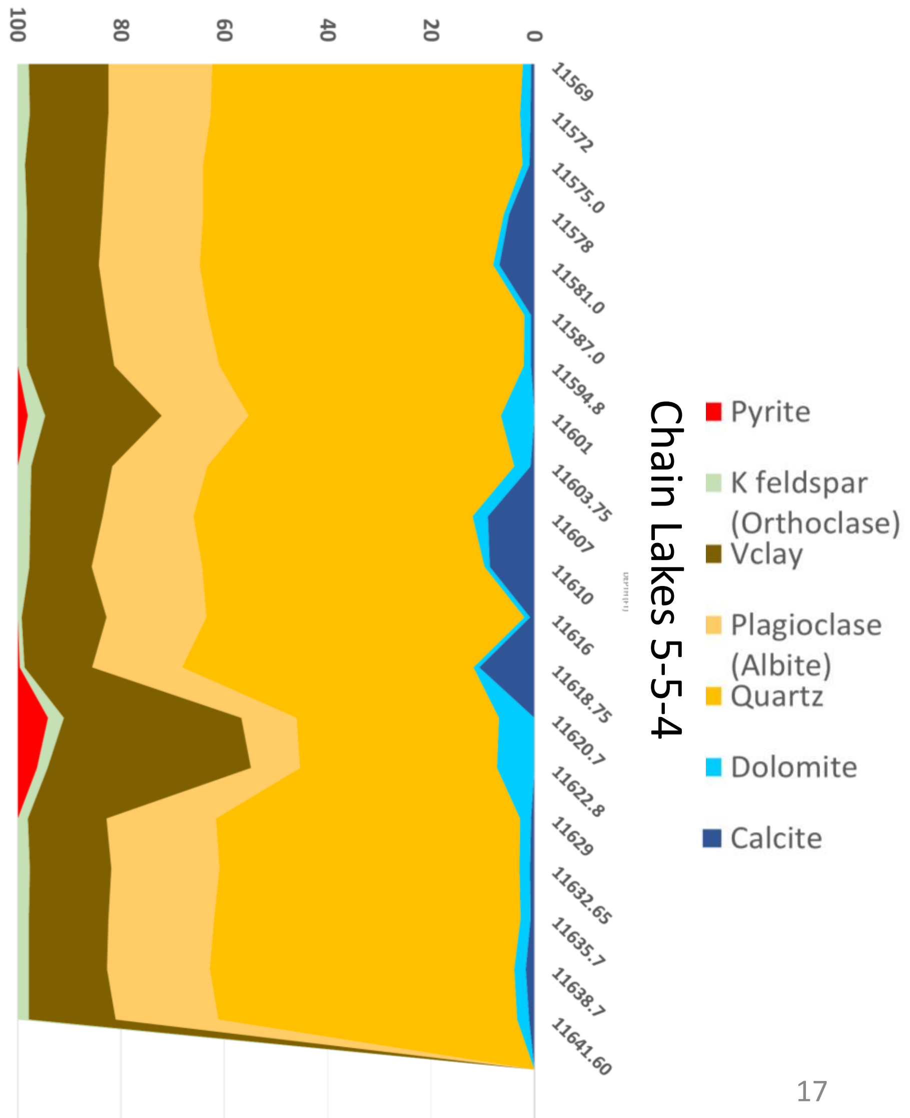
Core facies



Chain Lakes 5-5-4
0
20
40
60
80
100
11569
11572
11575.0
11578
11581.0
11587.0
11594.8
11601
11603.75
11607
11610
11616
11618.75
11620.7
11622.8
11629
11632.65
11635.7
11638.7
11641.60
Calcite
Dolomite
Quartz
Plagioclase (Albite)
Vclay
K feldspar (Orthoclase)
Pyrite

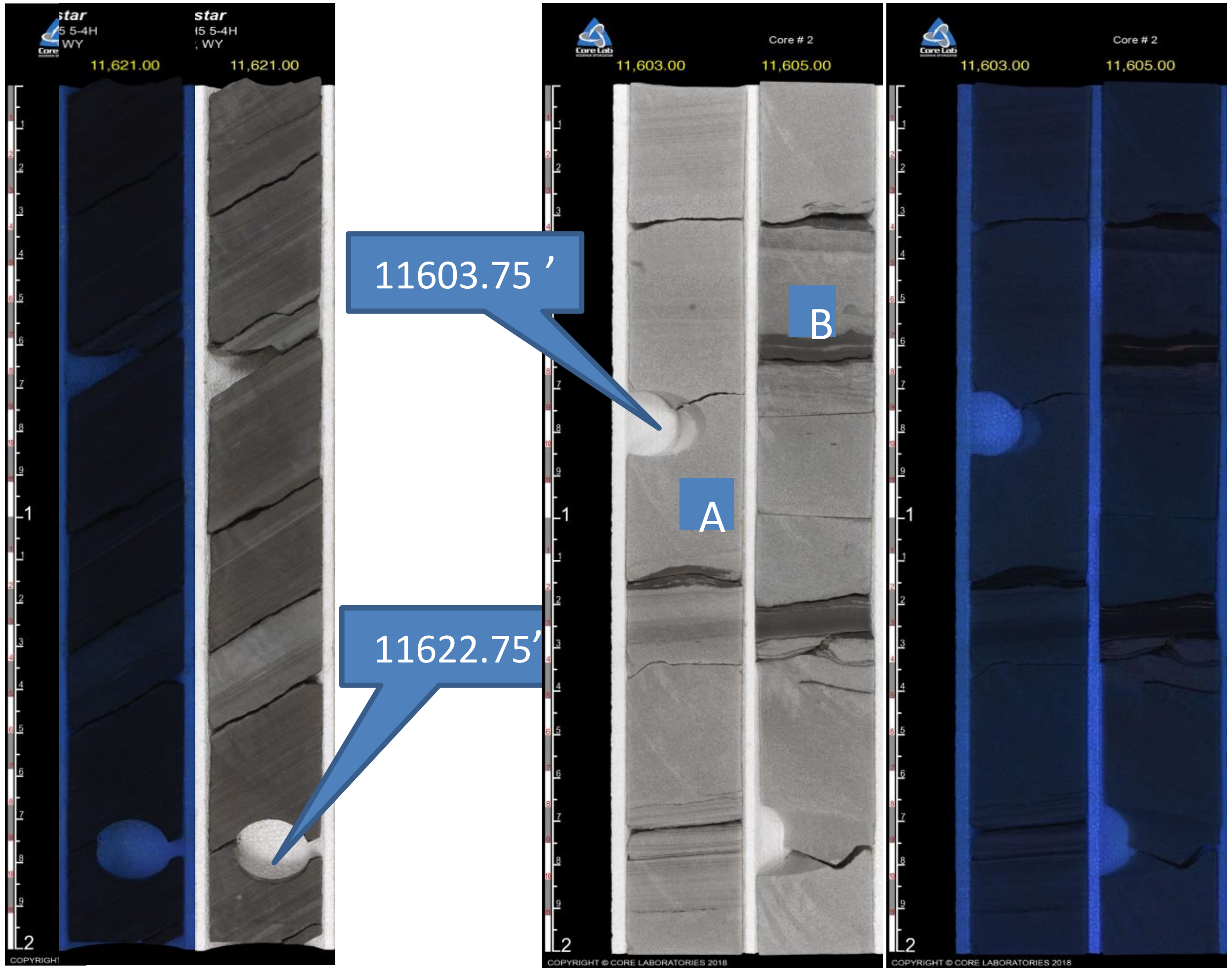


Resistivity (ohm)
0 10 20 30 40
11565
11570
11575
11580
11585
11590
11595
11600
11605
11610
11615
11620
11625
11630
11635
11640
11645
11650



Chain Lakes 5-5-4
100
80
60
40
20
0
Pyrite
K feldspar (Orthoclase)
Vclay
Plagioclase (Albite)
Quartz
Dolomite
Calcite

Depositional Environment



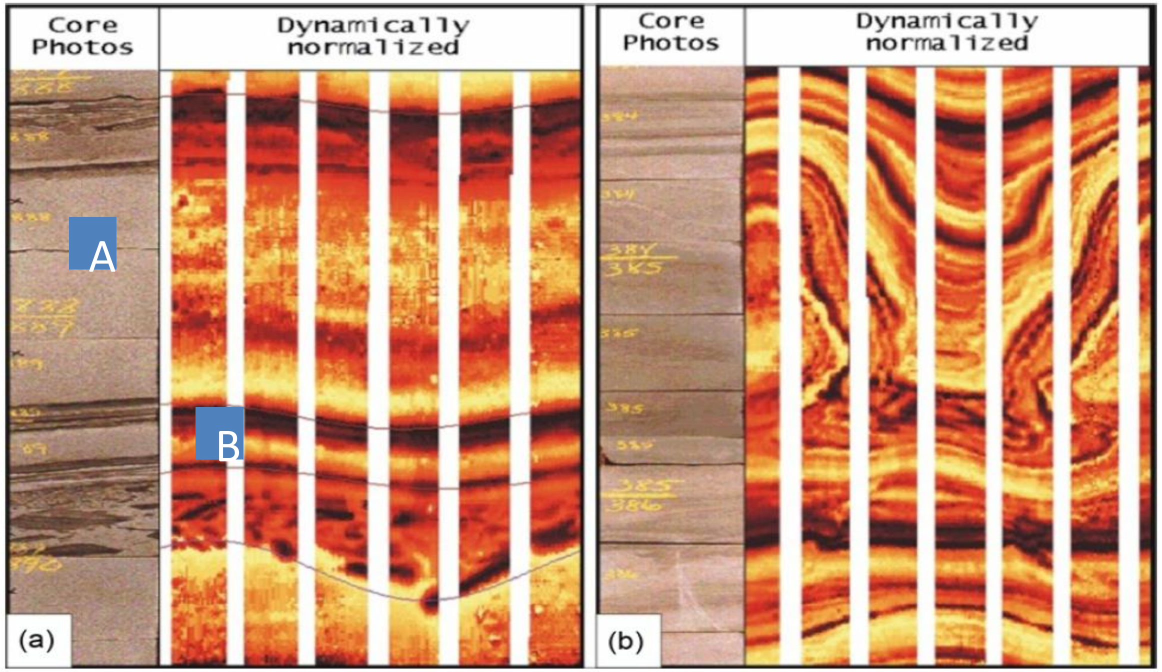


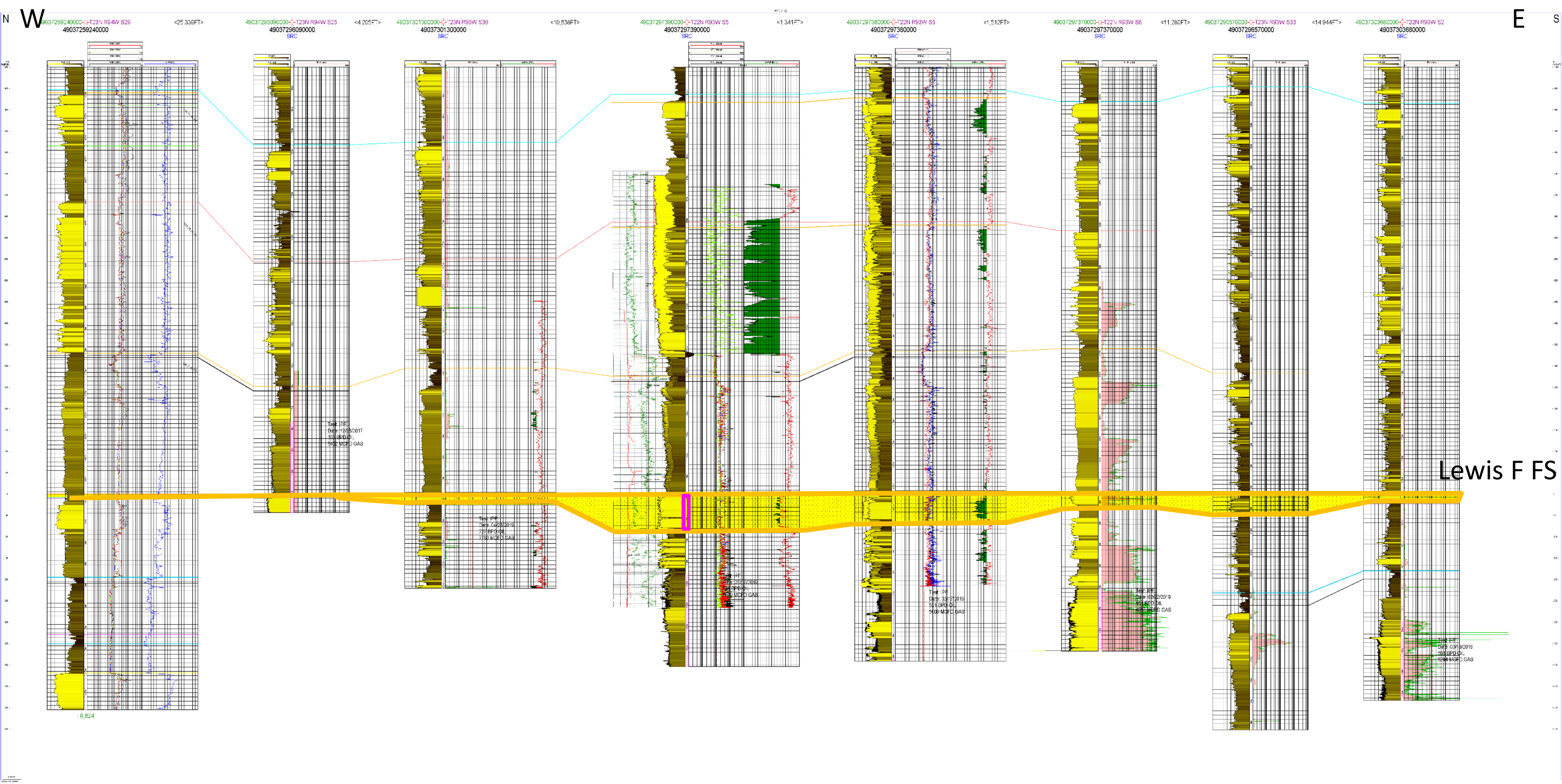
FIGURE 4.74 (a) Borehole-image log illustrating an erosional surface lined with shale clasts, as calibrated to a core in the same interval. (b) Borehole-image log illustrating a contorted (slumped) bedset; the slumped beds are more easily recognized on the borehole-image log than in the core! This example is from the Cretaceous Lewis Shale, Wyoming. *Images and photographs provided by S. Goolsby.*

Channel or Slump deposit

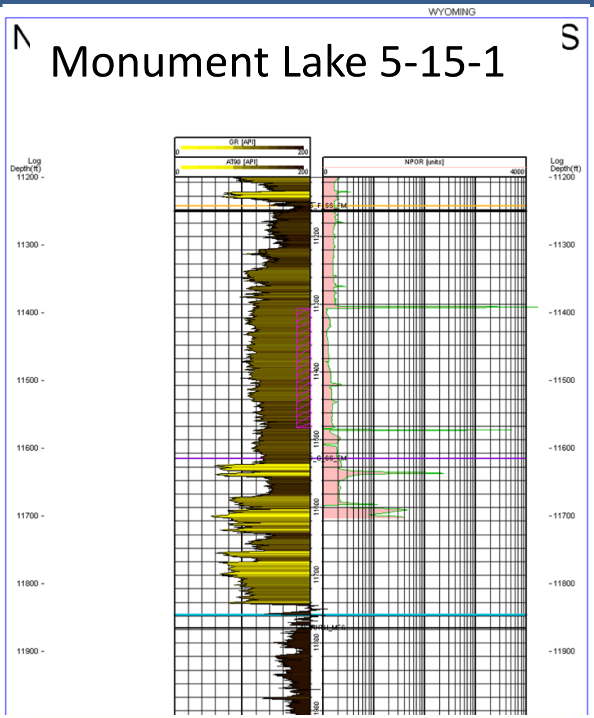
Example

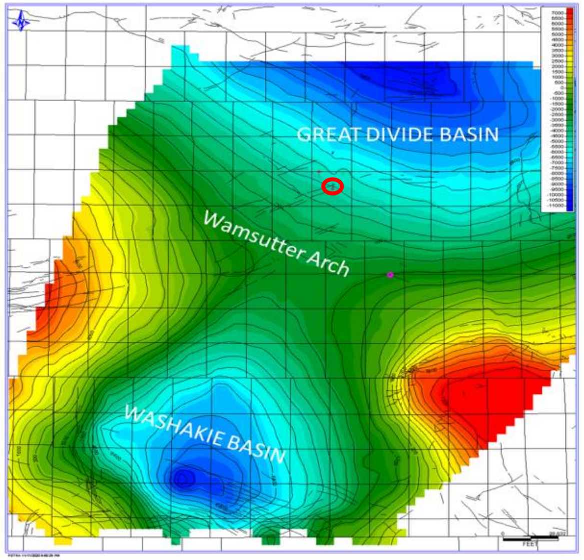
Depositional Environment: Channel fill

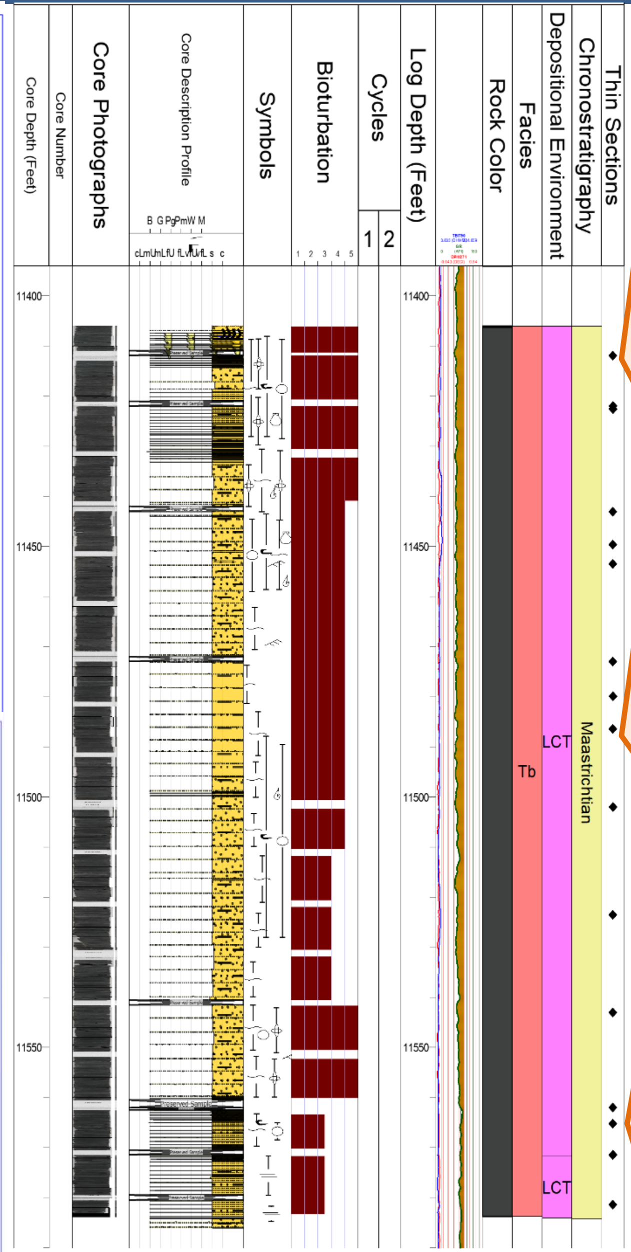
Correlation Chain Lakes-5-4-4 Area

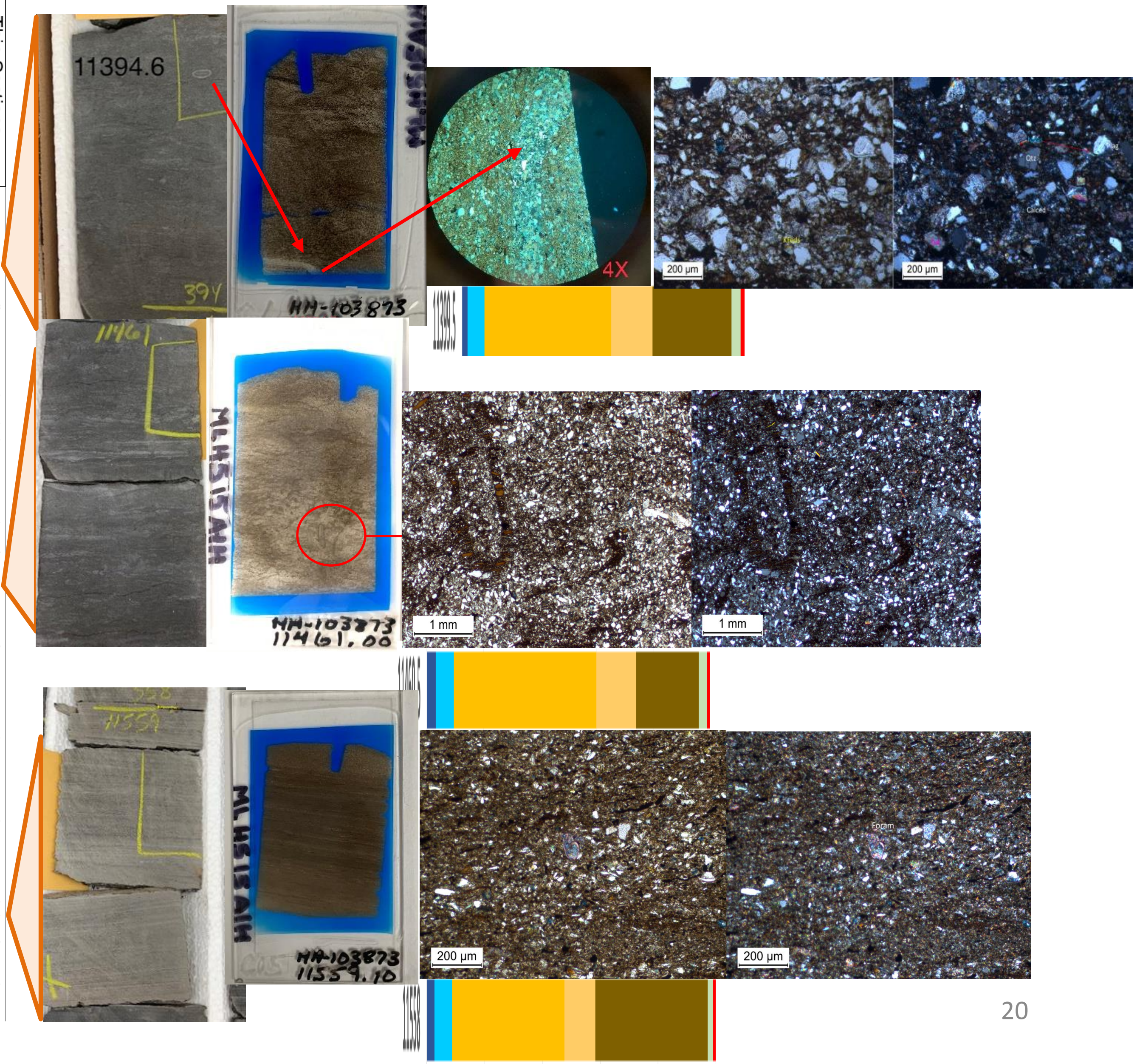


Monument Lake 5-15-1



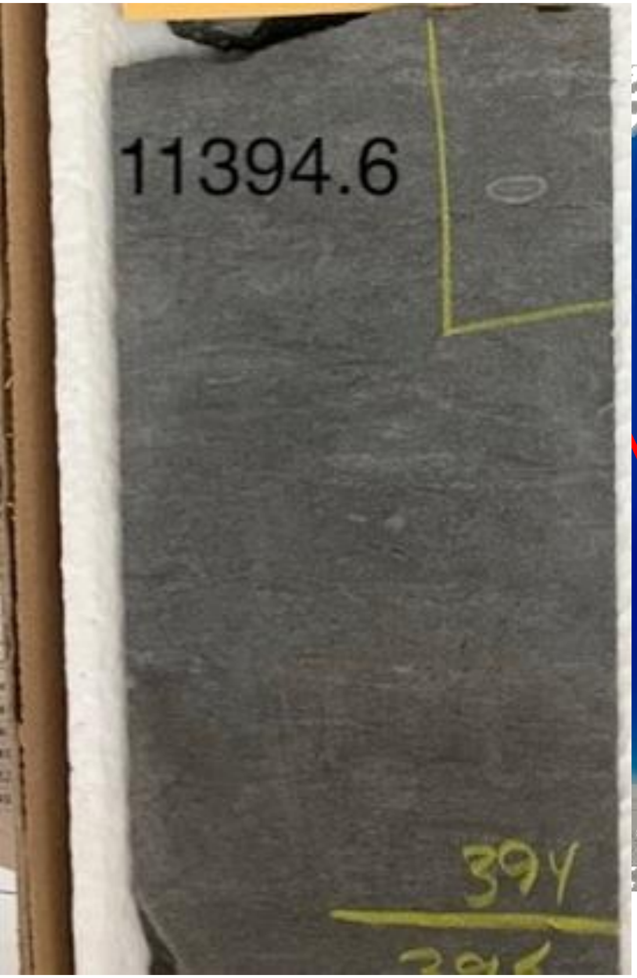


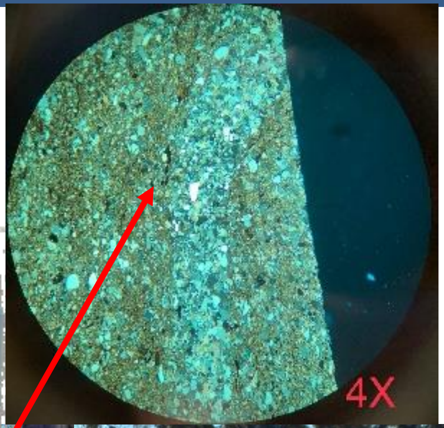


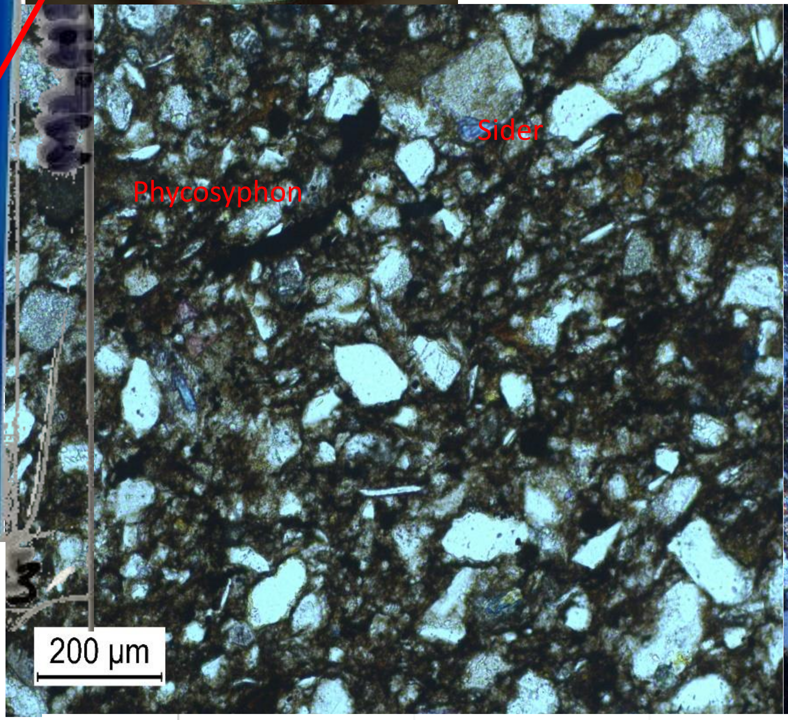


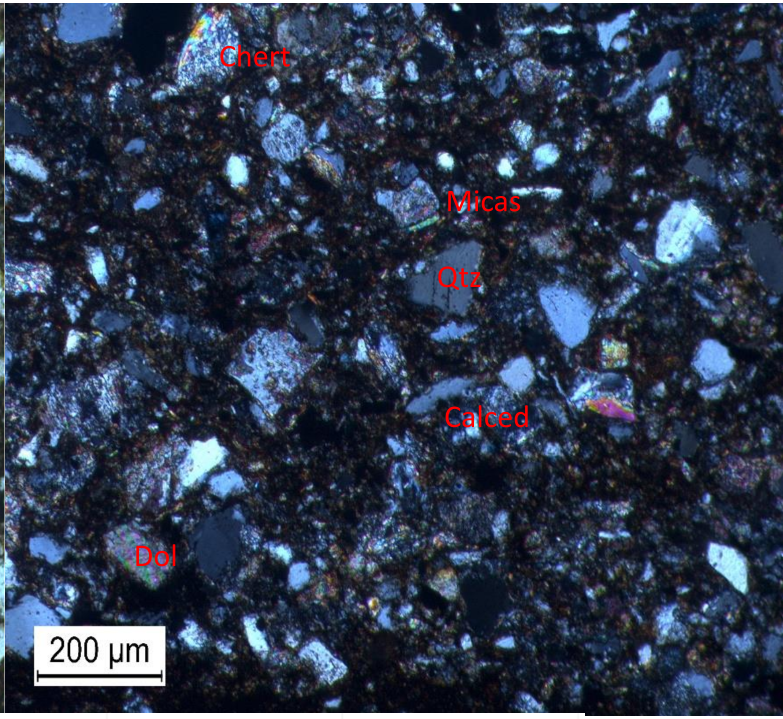
Core facies

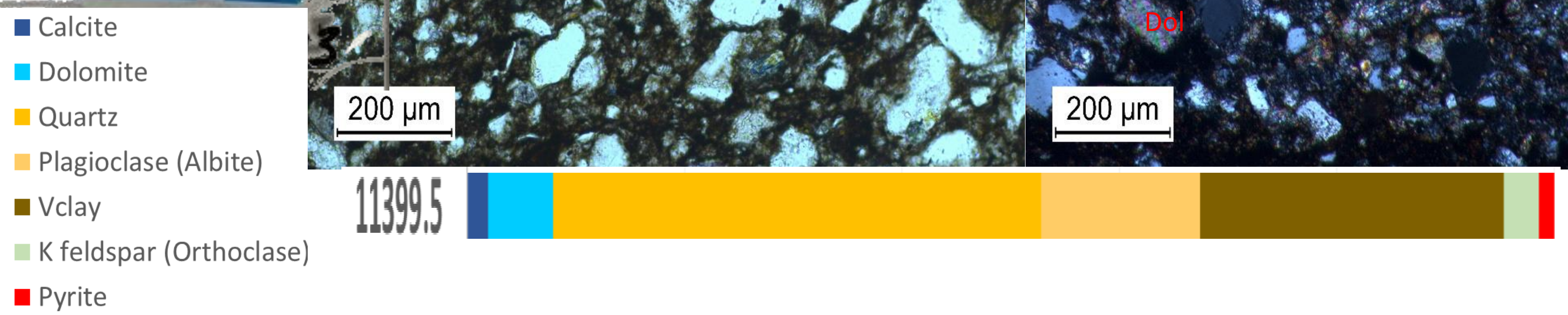
Heavily Bioturbated Sandy Siltstone





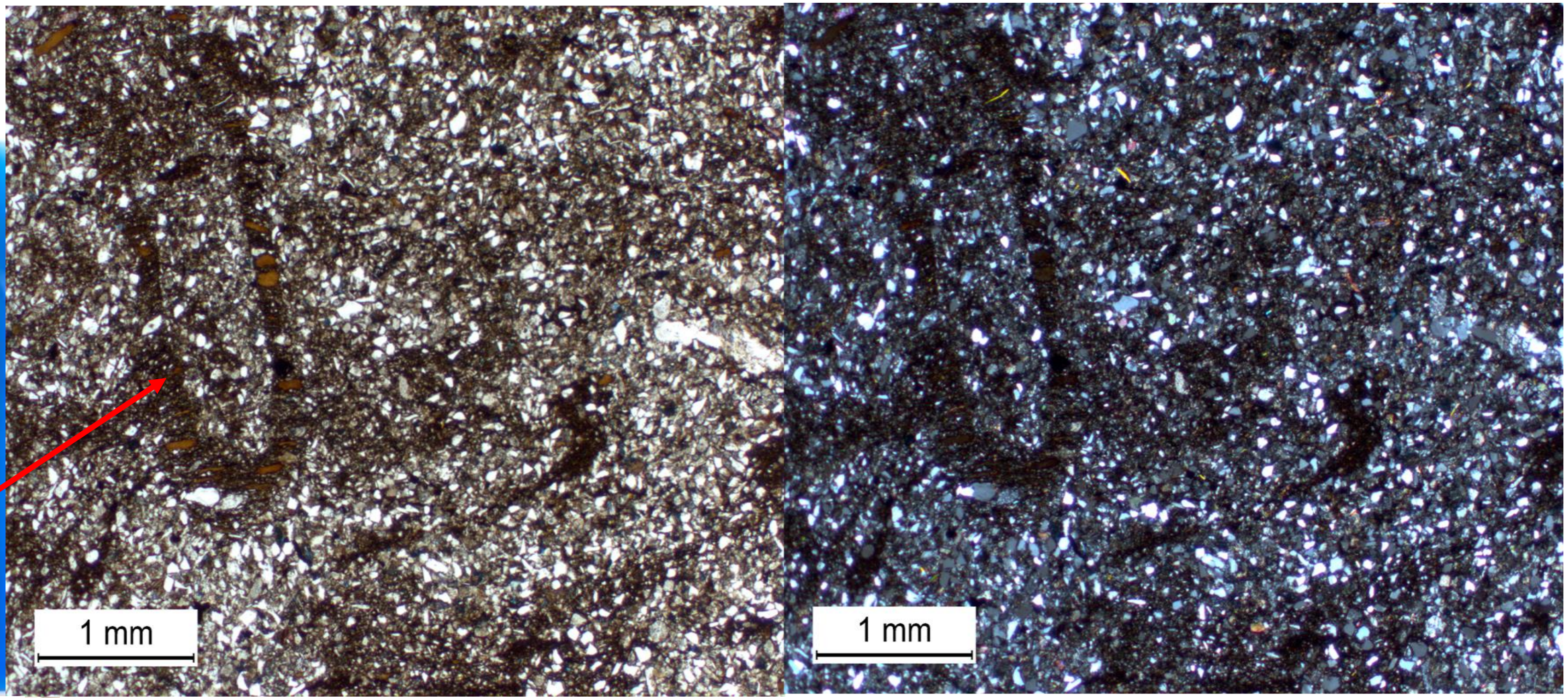




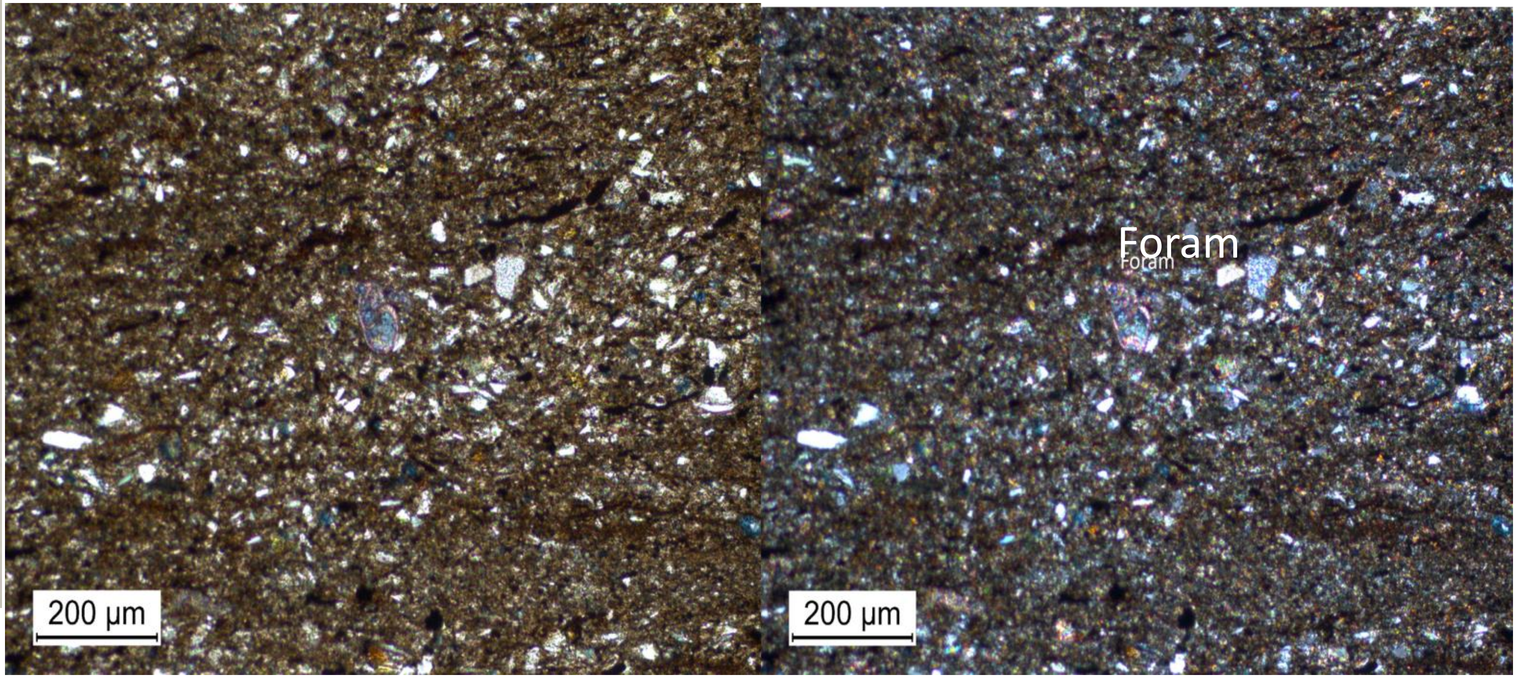


Core facies

Bioturbated Sandy Siltstone



Slightly Bioturbated Sandy Siltstone



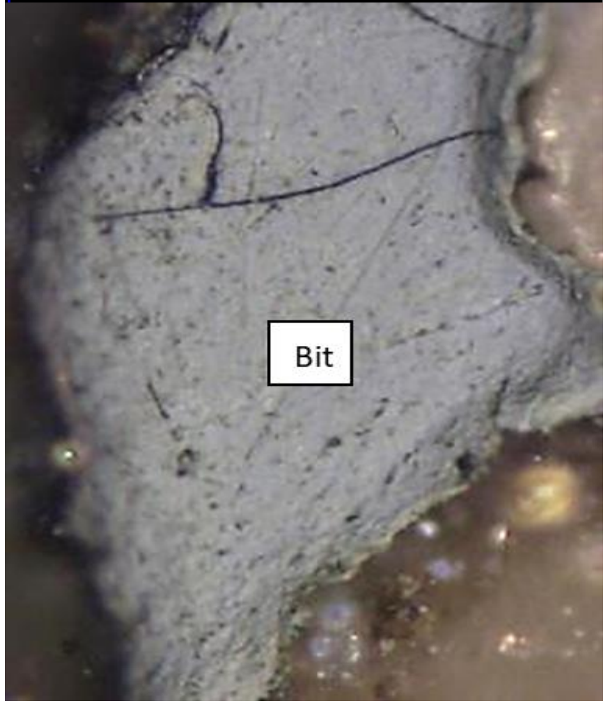
- Calcite
- Dolomite
- Quartz
- Plagioclase (Albite)
- Vclay
- K feldspar (Orthoclase)
- Pyrite

Source Rock

Wet gas window

DEPTH	FORMATION	TOC	Tmax	HI	S1	S2
11399.5	Lewis	0.75				
11401.5	Lewis	0.72517	463	85.49719	0.21	0.62
11430.5	Lewis	0.83				
11439	Lewis	0.69214	461	98.24602	0.23	0.68
11448.75	Lewis	0.51301	465	95.51471	0.17	0.49
11460.5	Lewis	0.3				
11468.8	Lewis	0.72568	461	78.54702	0.18	0.57
11490.45	Lewis	0.69				
11498.5	Lewis	0.67821	464	78.14689	0.17	0.53
11508.75	Lewis	0.56604	459	44.16649	0.09	0.25
11508.75	Lewis	0.57				
11520.3	Lewis	0.64				
11550.4	Lewis	0.91				
11558.4	Lewis	1.0964	468	95.76797	0.38	1.05

Depth (ft):	11401.50
Min Value	1.03
Max Value	1.37
Mean Value	1.25
# of Measurements	17
Strd Deviation	0.10



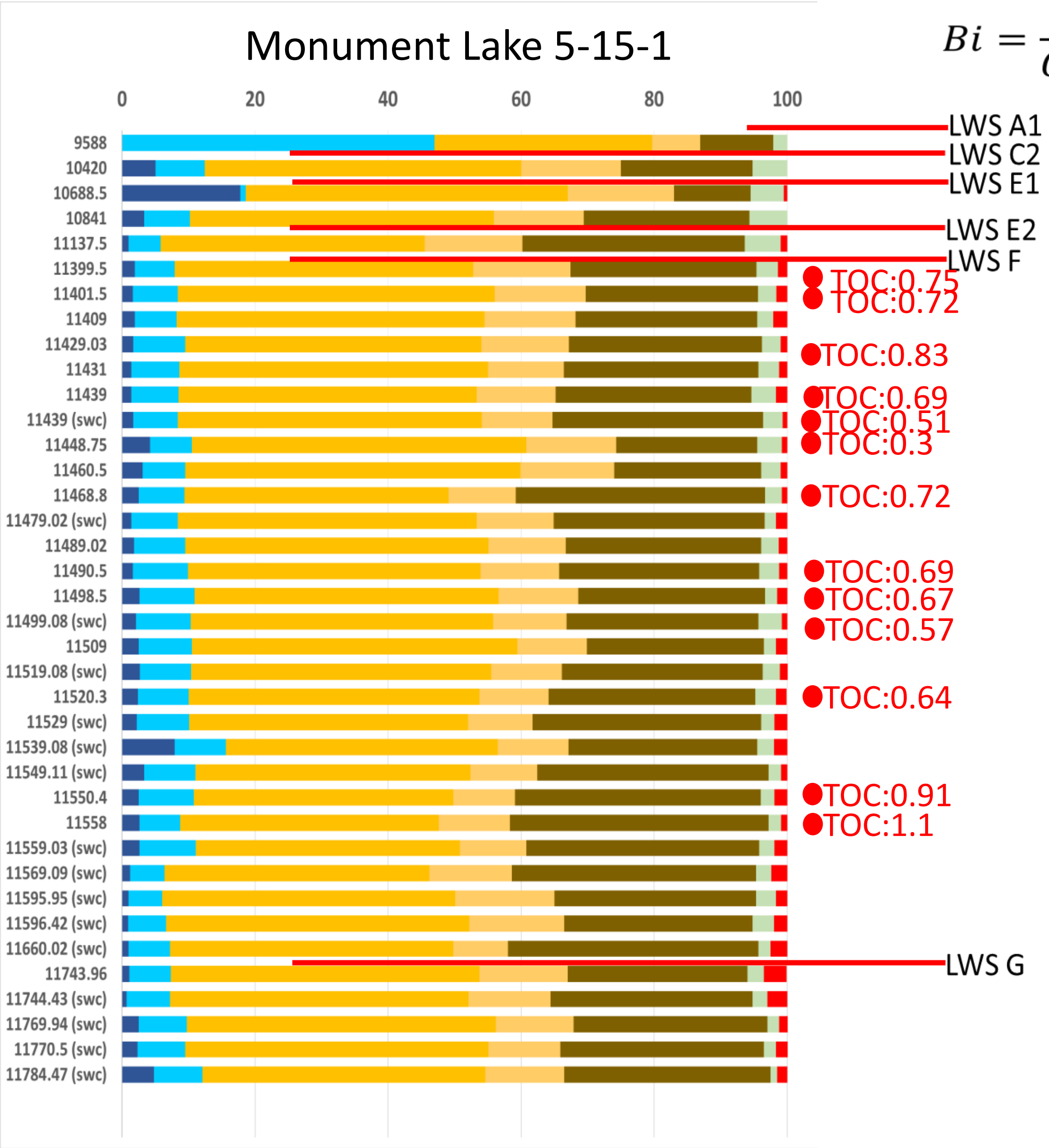
The above values were measured on bitumen. The VRo-eq is estimated to be 1.17% using the Jacob formula (Rvit = Rbit x 0.618 + 0.4).

Solid bitumen can be Allochthonous or Autochthonous. It forms when liquid hydrocarbons are present and crack onto gas and condensate with increasing depth and temperature.

Defining if it is formed in situ can be based on thin section and SEM analyses and how it fills cavities.

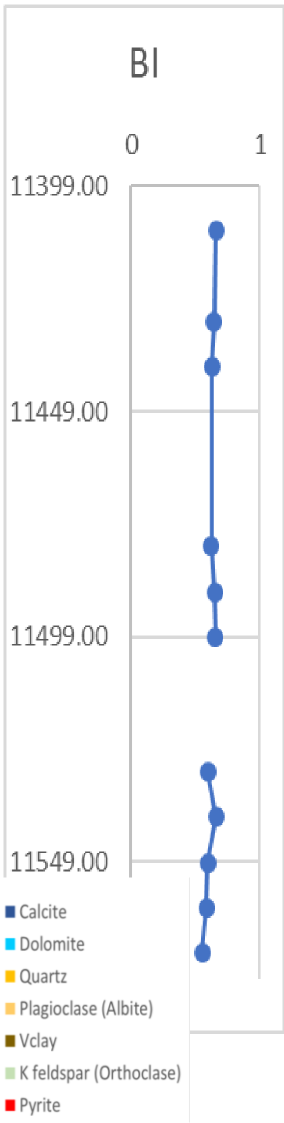
According to the lab these solid bitumen particles seem to formed after migrated hydrocarbons cracked into gas and condensate

Core facies

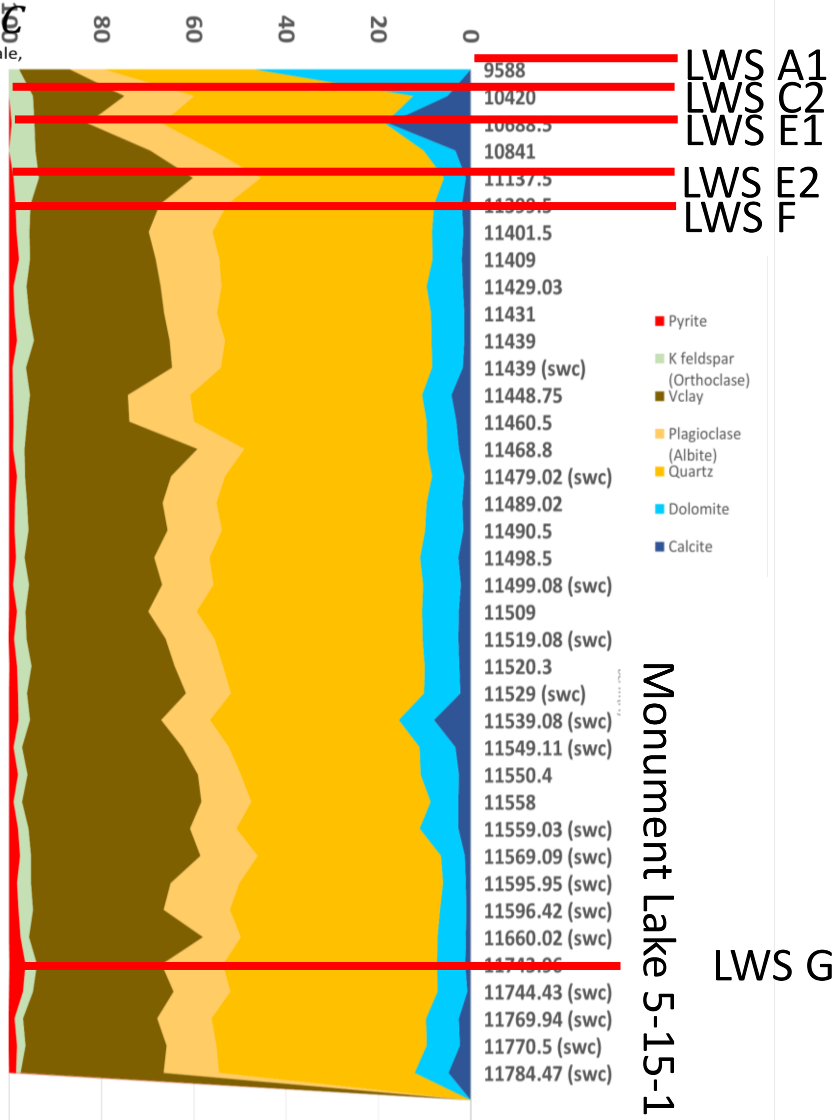


$$Bi = \frac{(Dol + Qz + Ca)}{Qz + Dol + Ca + Cly + TOC}$$

Modified after Wang & Gale, 2009

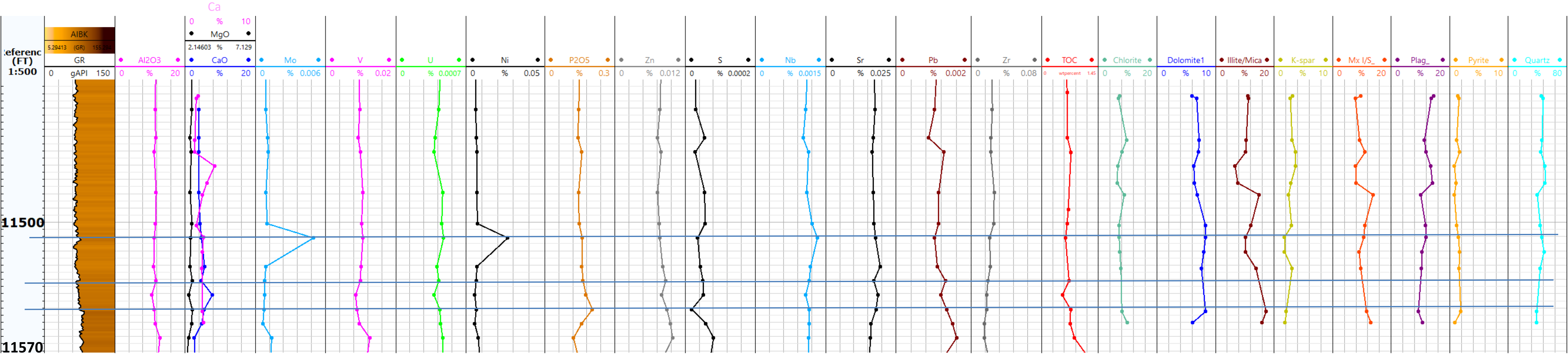


BI
0.7506568
0.6887629
0.5733873
0.6610067
0.6454698
0.6250722
0.6220822
0.6470934
0.6540851
0.5970149
0.6613602
0.5958608
0.5870796
0.5517077
0.6386102
0.5645618
0.6536823
0.6226844
0.6324569



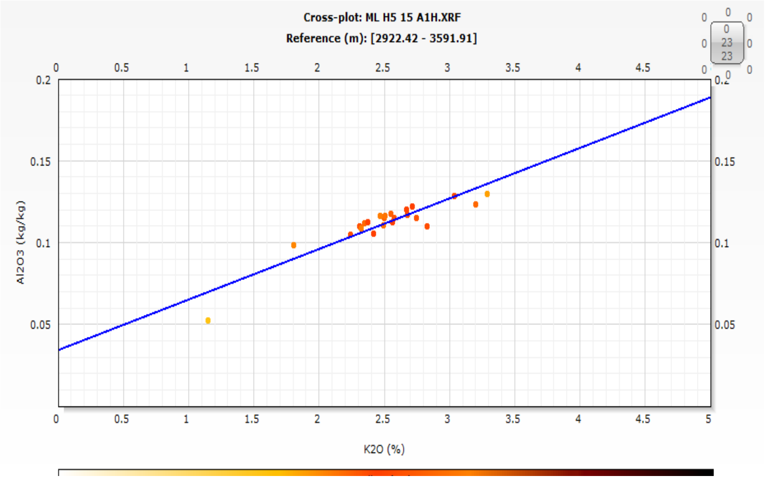
XRF Marine proxies

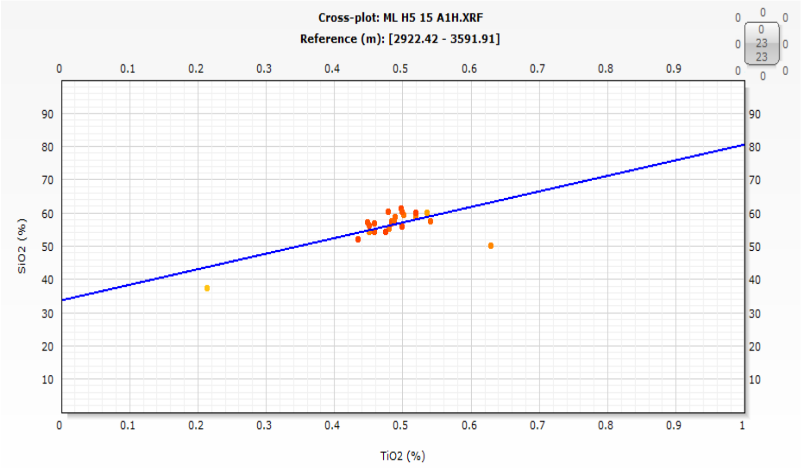
Low resolution XRF analyses

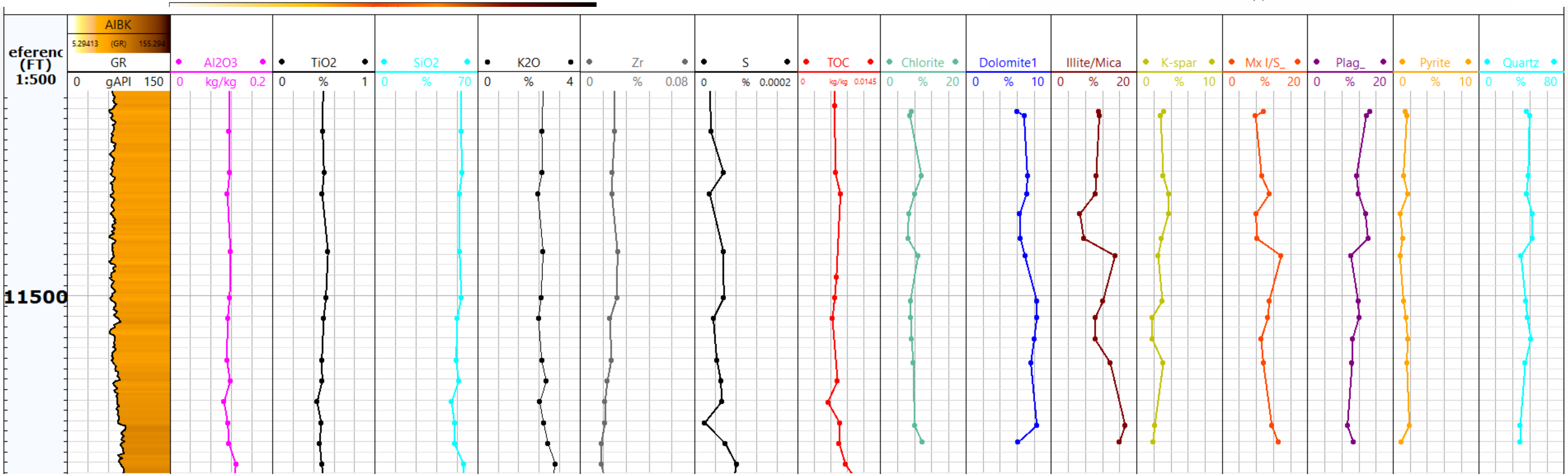


It seems there is a small event of euxinia shown by the increase of Mo and Ni, but in general it is very difficult to identify clear changes. Mix of anoxic environments and continental input

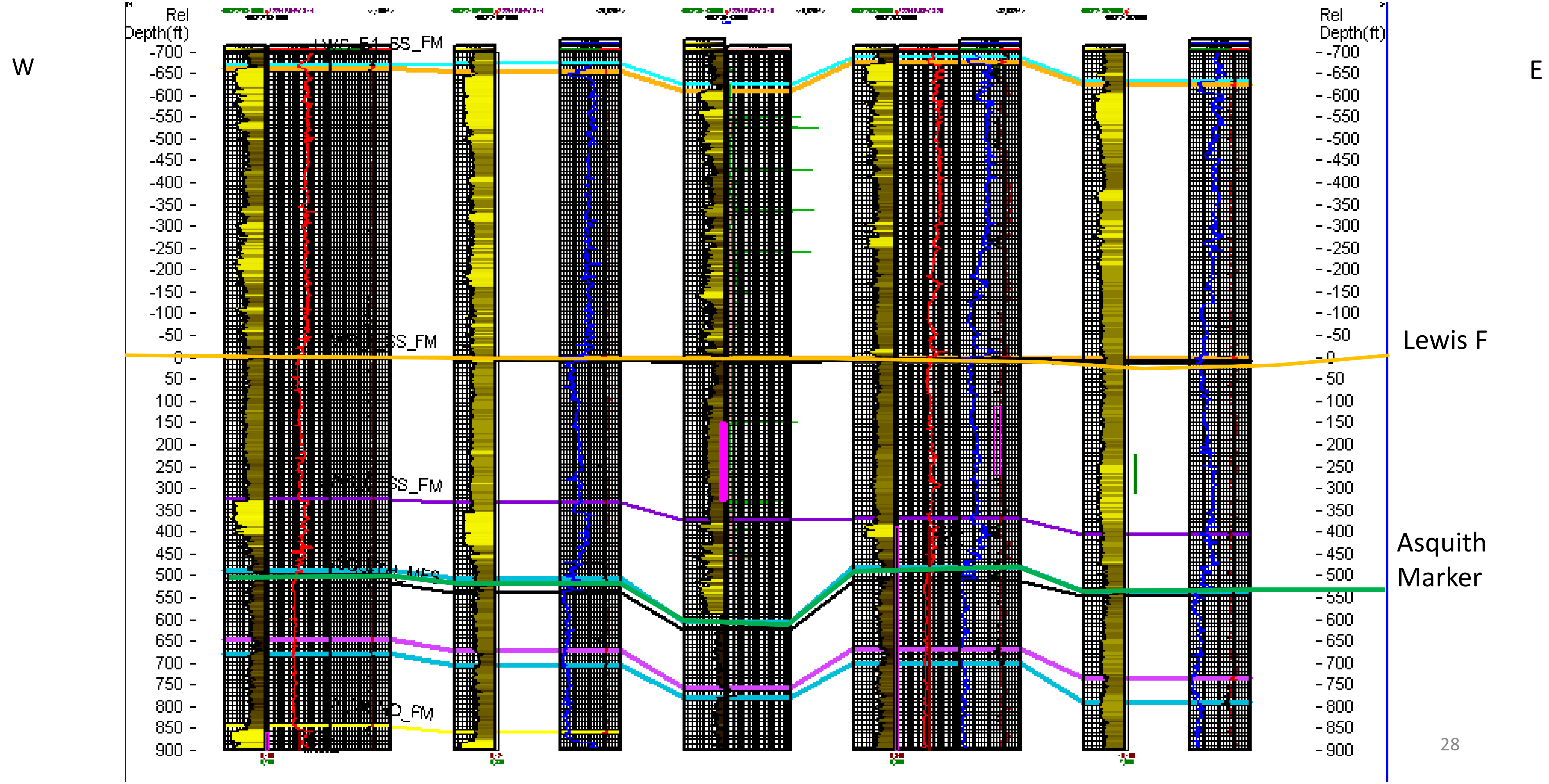
Detrital Source



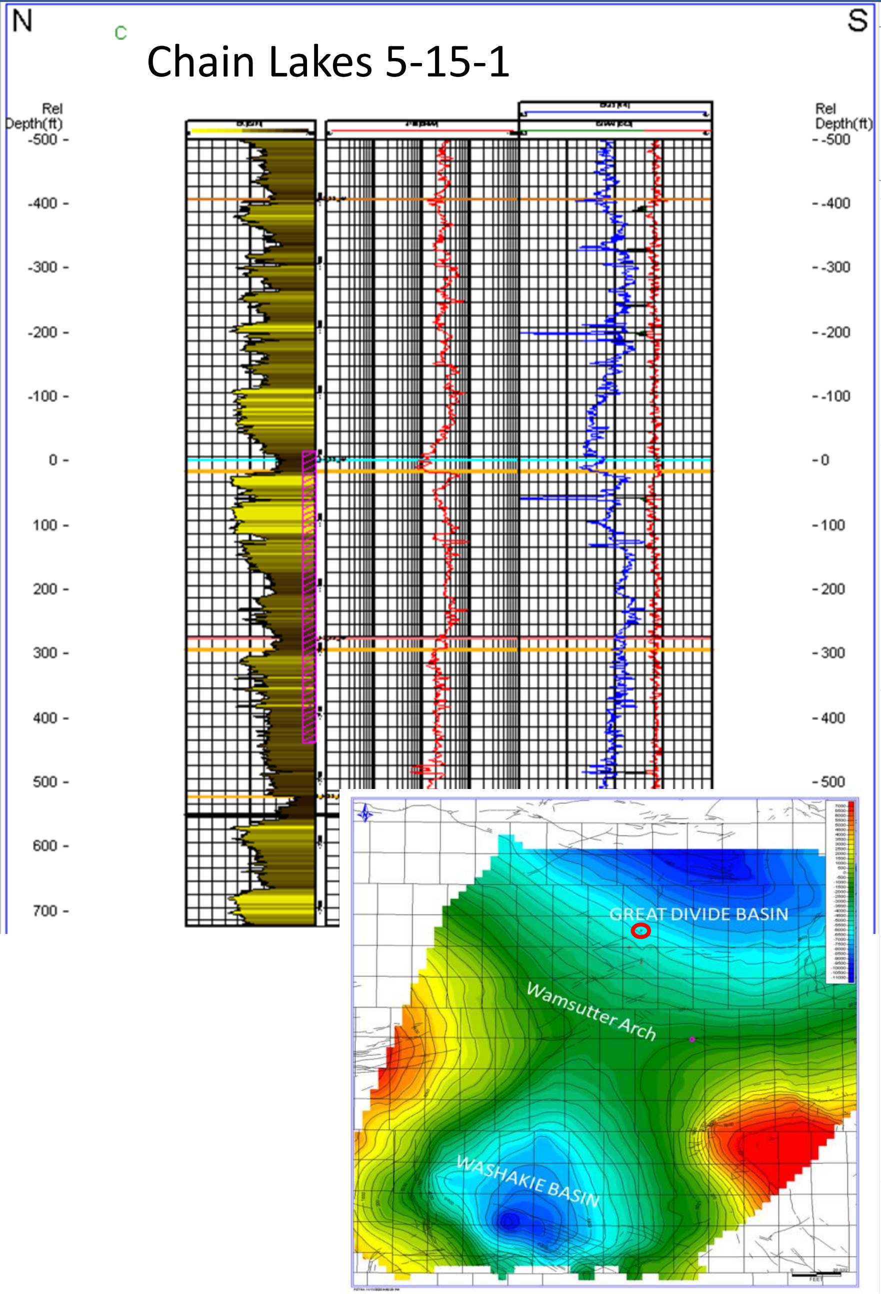


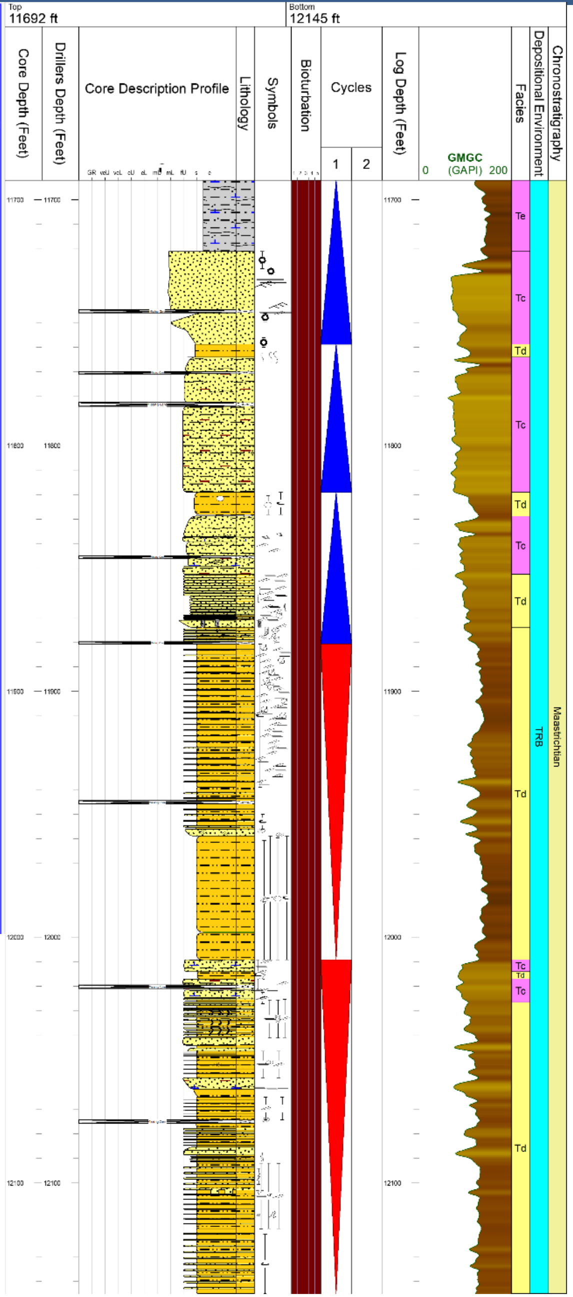


Correlation ML area

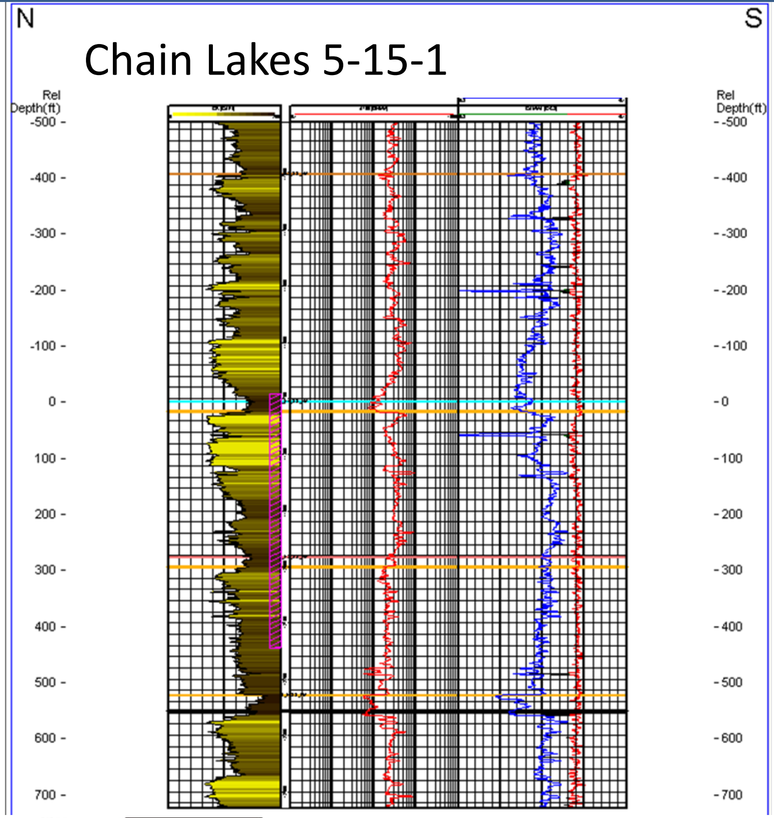


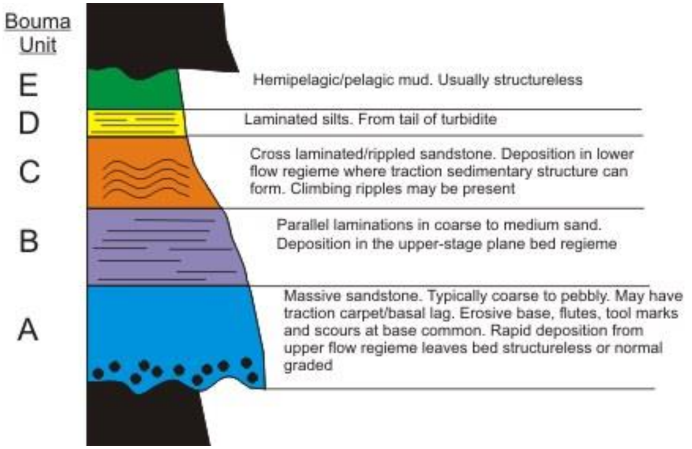
Chain Lakes 5-15-1





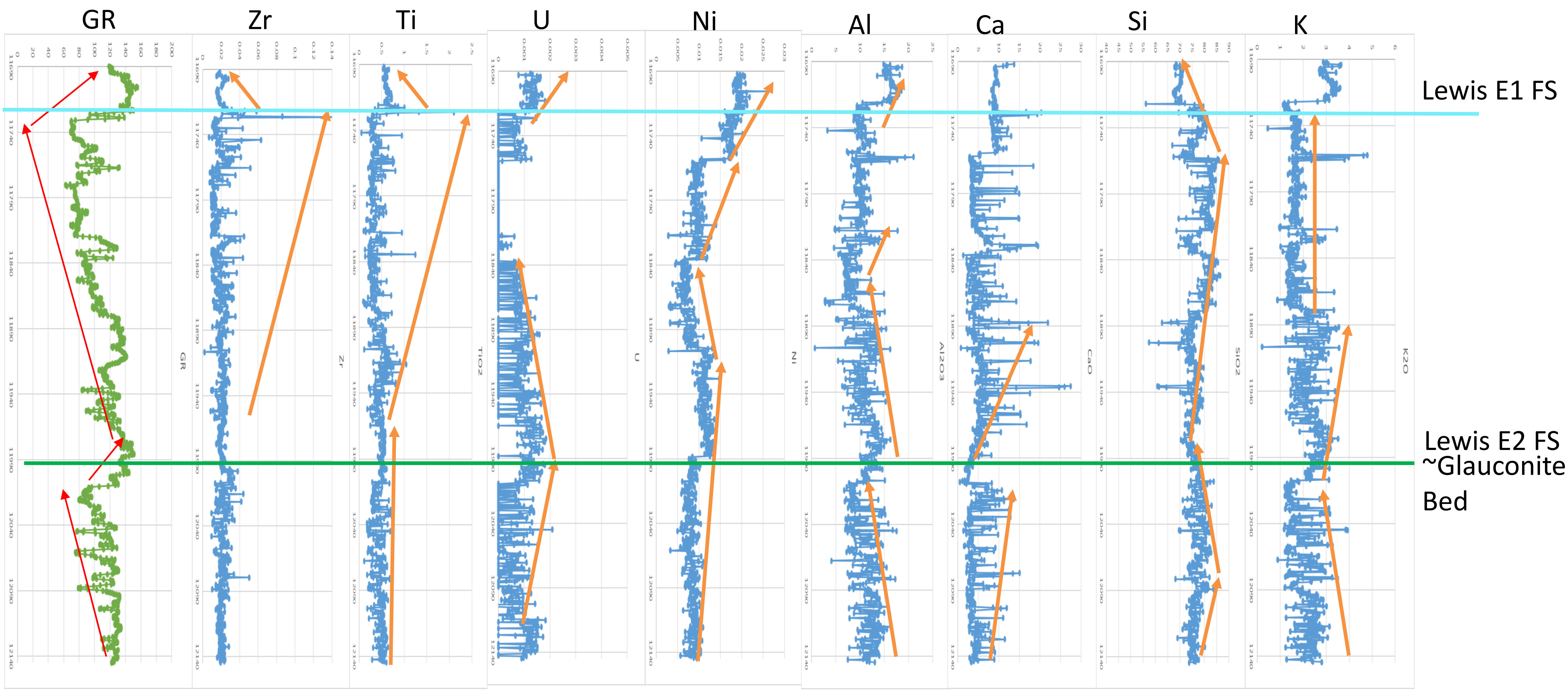
Core facies



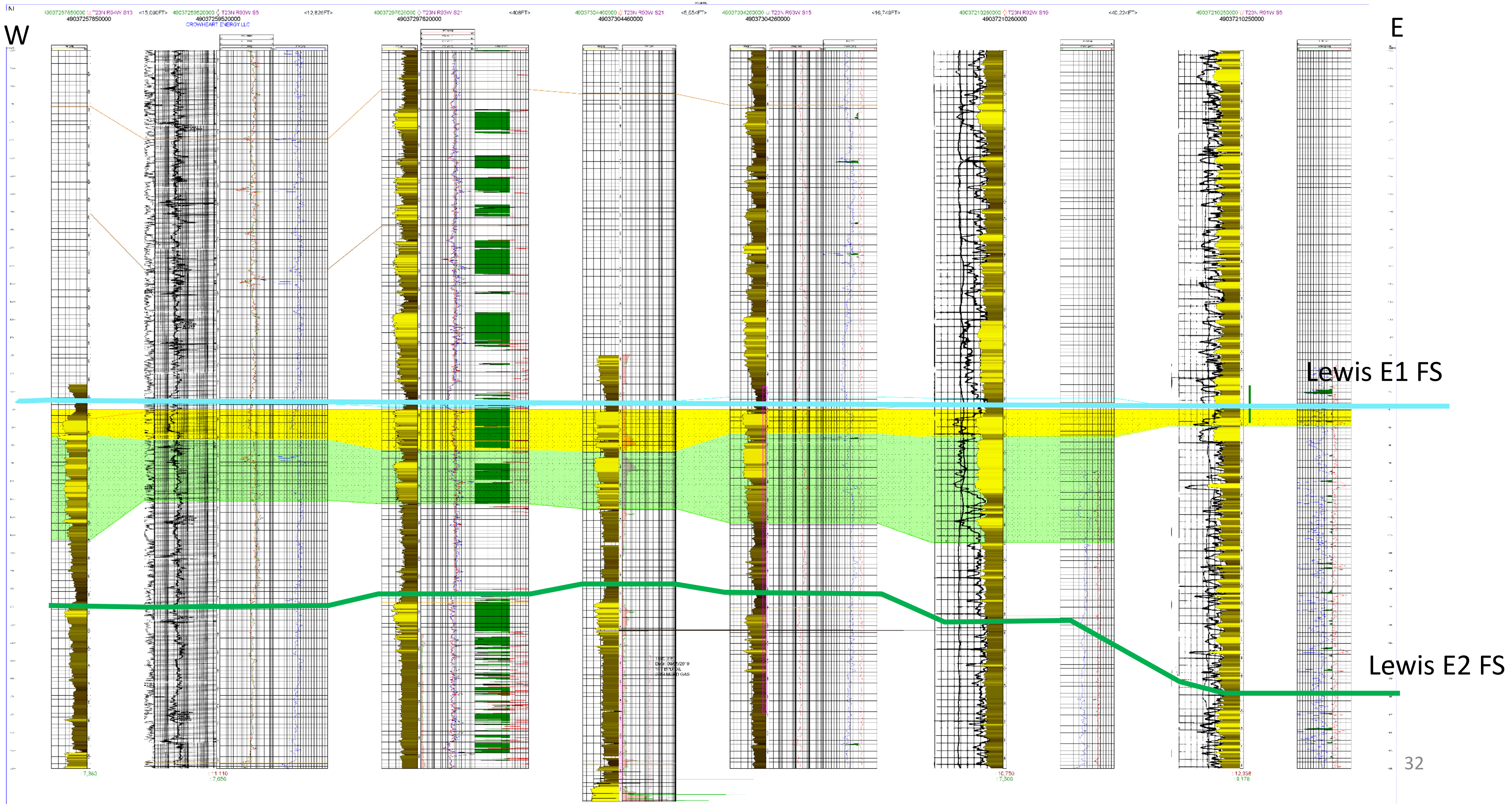


Depositional Environment:
Sheet sands, channel fill, flood plain?

XRF data

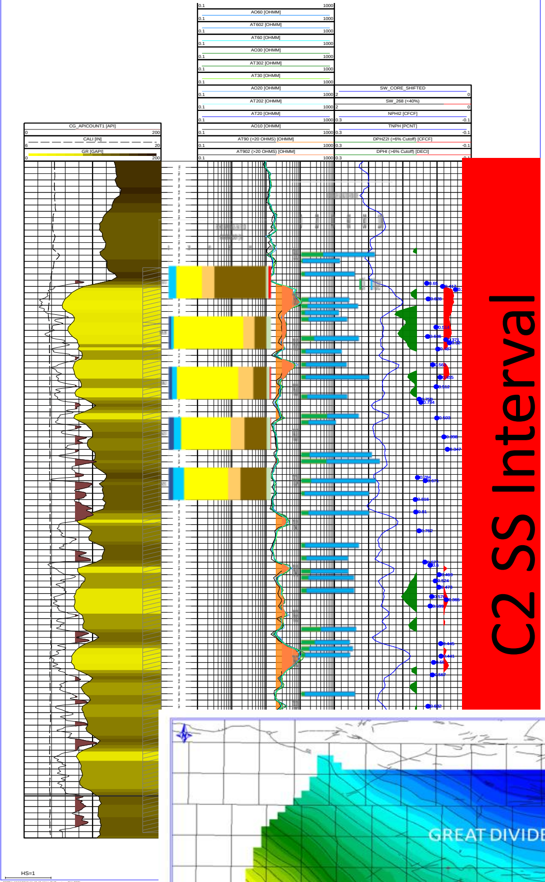


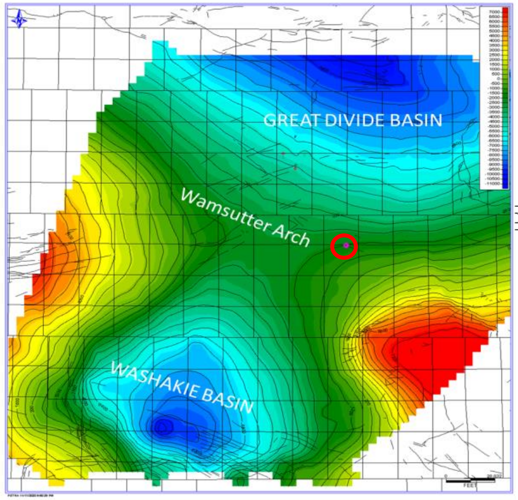
Interval Correlation

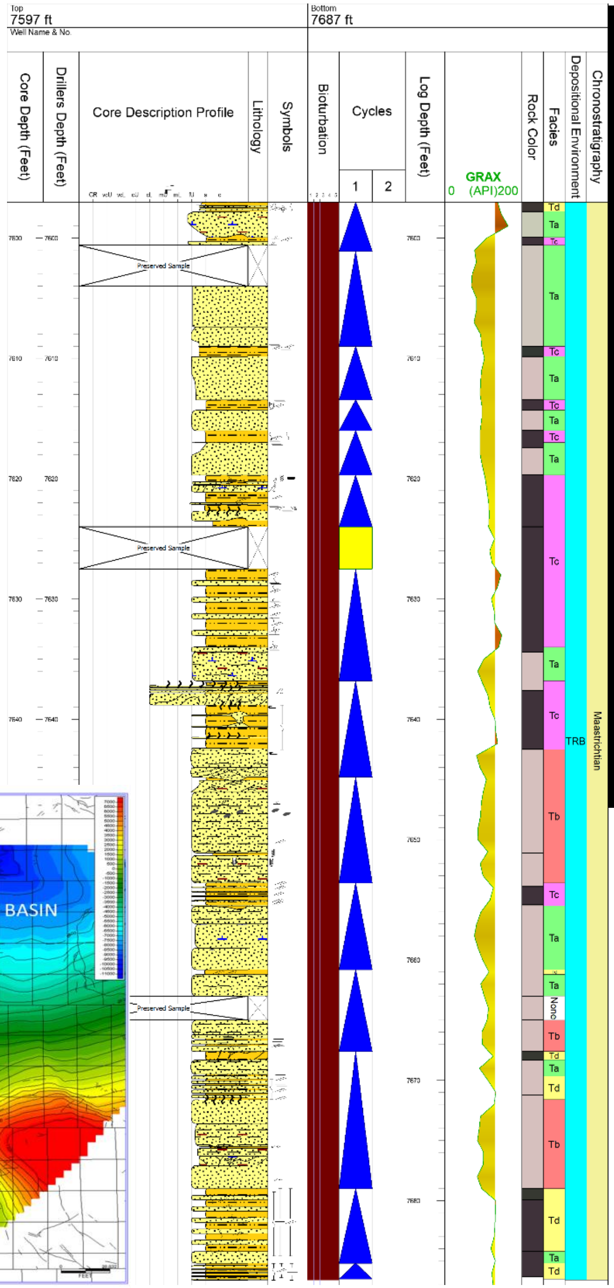


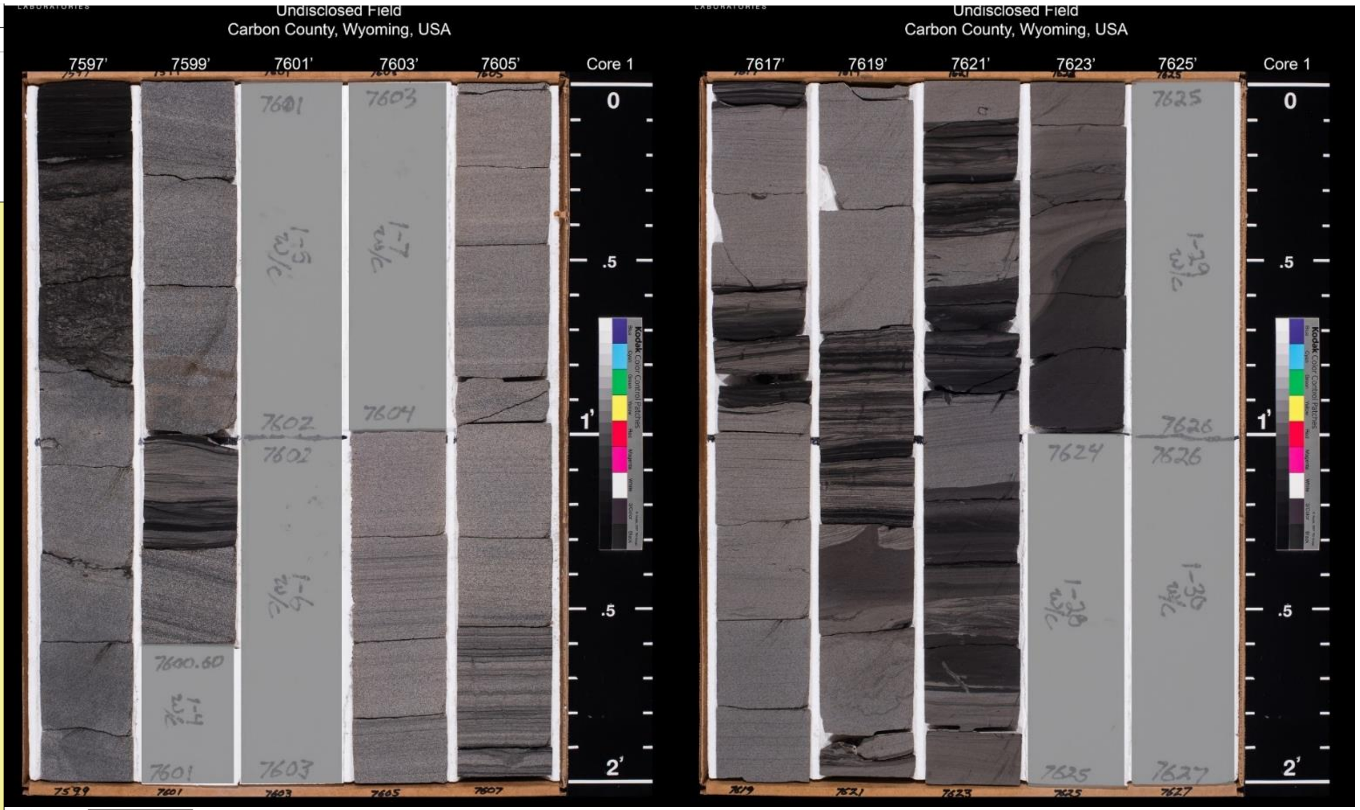
Echo Springs

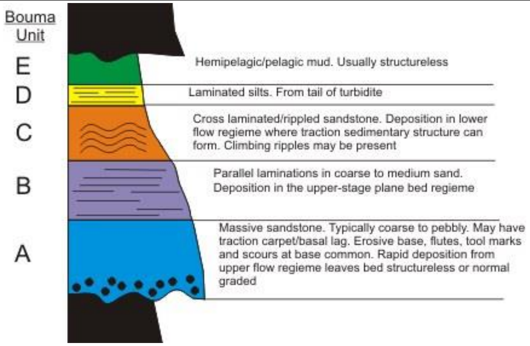
Echo Springs Core





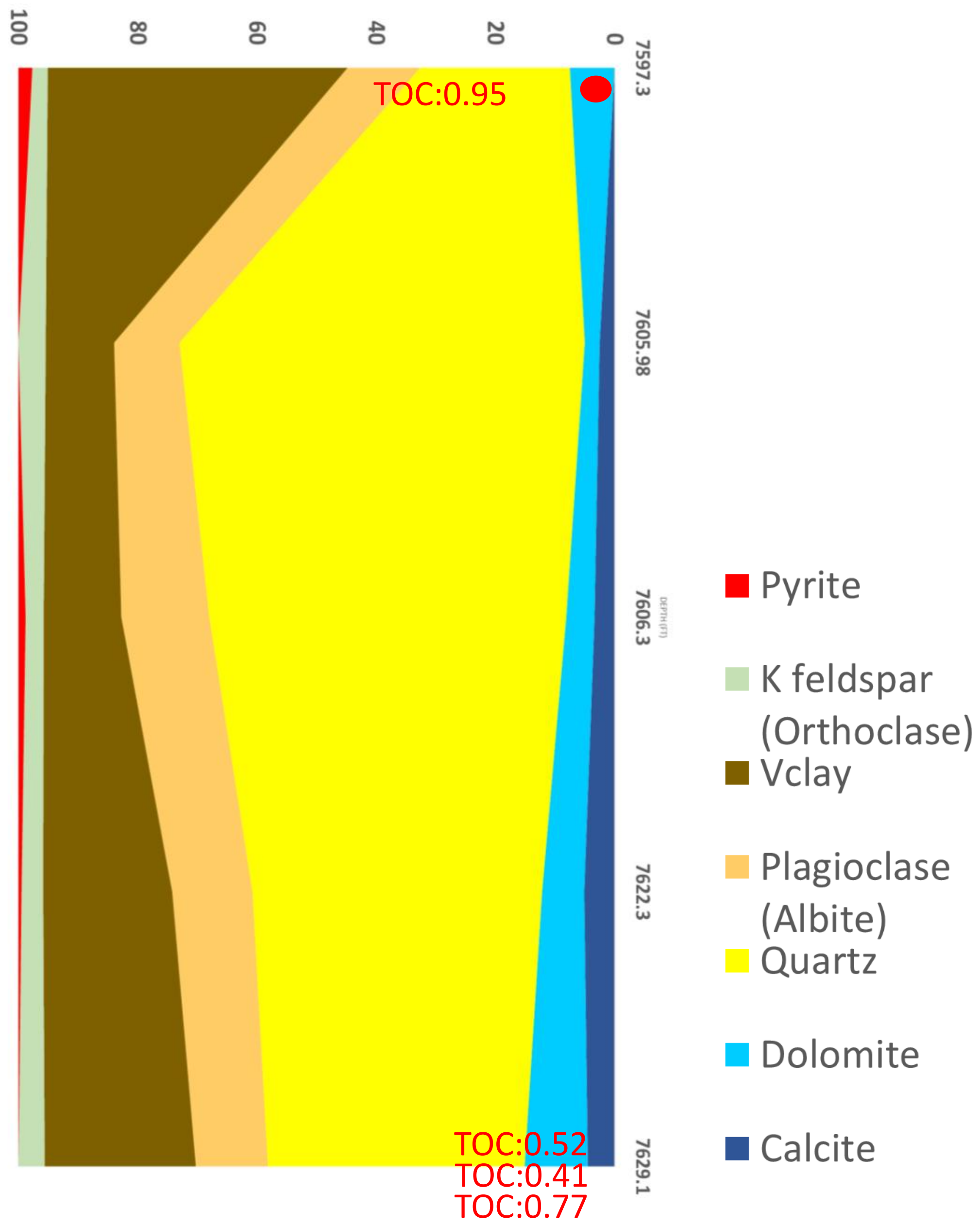




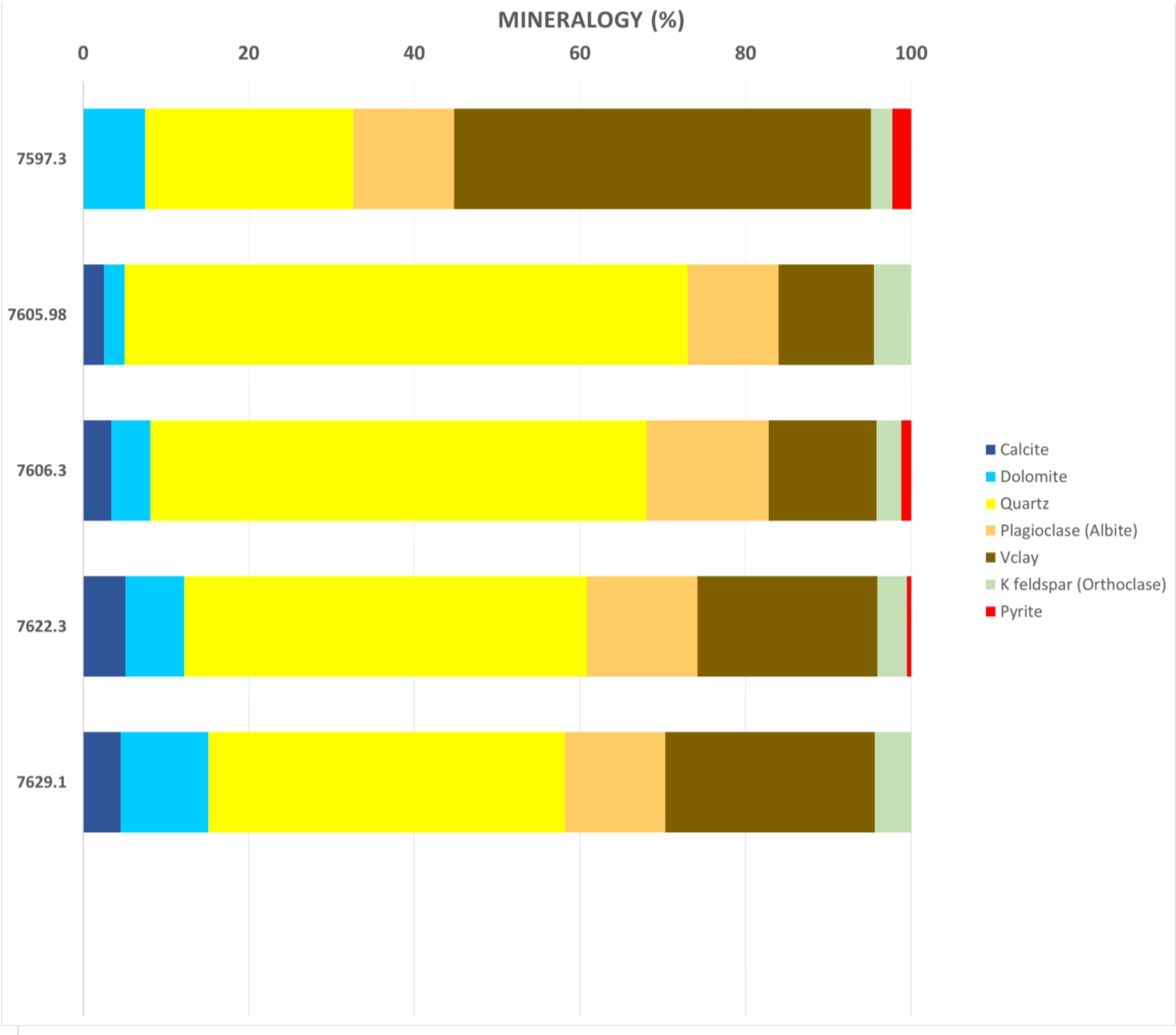


Depositional Environment: High density Turbidites?

Mineralogy

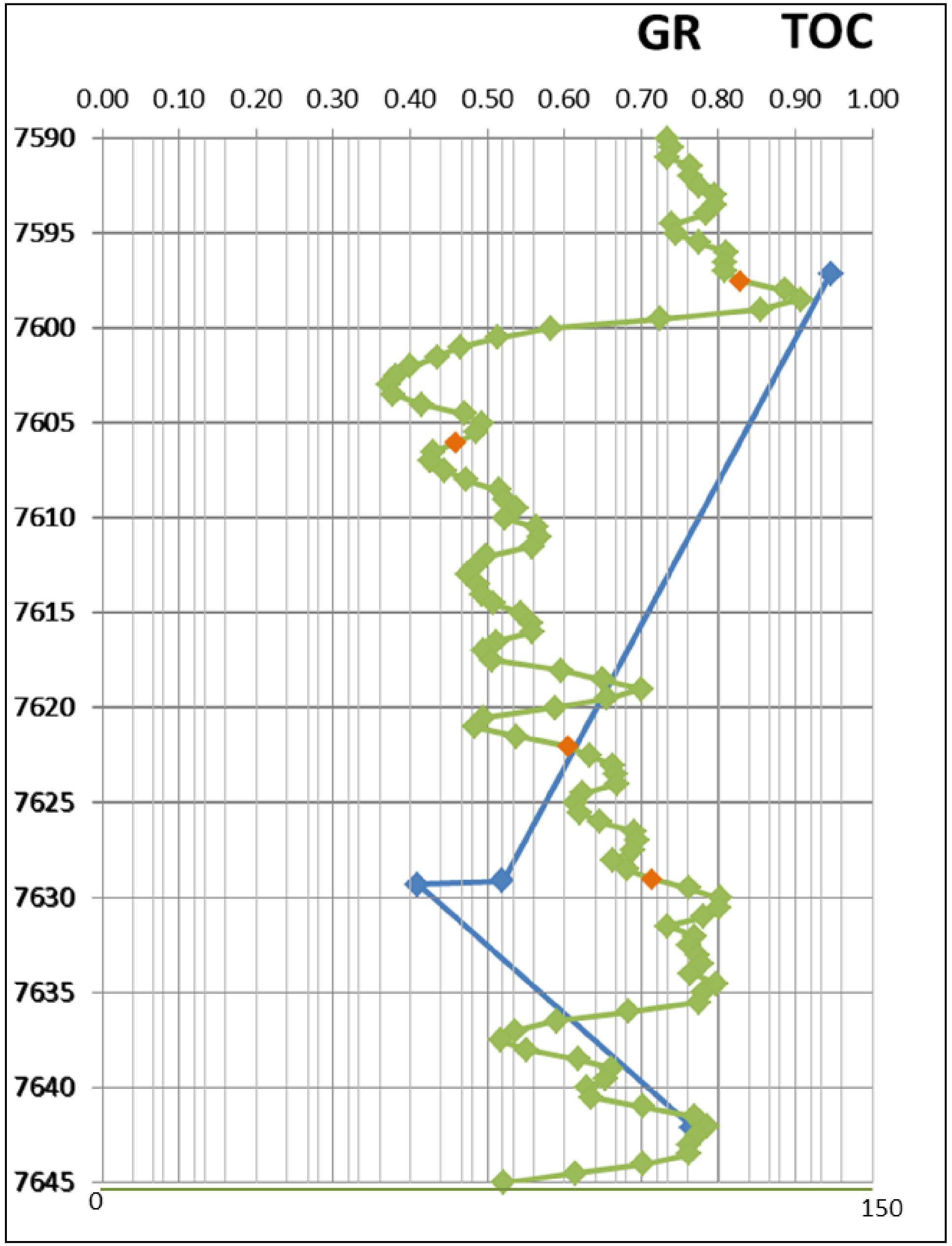


100
80
60
40
20
0
7597.3
7605.98
7606.3
7622.3
7629.1
TOC:0.95
TOC:0.52
TOC:0.41
TOC:0.77
Pyrite
K feldspar (Orthoclase)
Vclay
Plagioclase (Albite)
Quartz
Dolomite
Calcite



MINERALOGY (%)
0
20
40
60
80
100
7597.3
7605.98
7606.3
7622.3
7629.1
Calcite
Dolomite
Quartz
Plagioclase (Albite)
Vclay
K feldspar (Orthoclase)
Pyrite

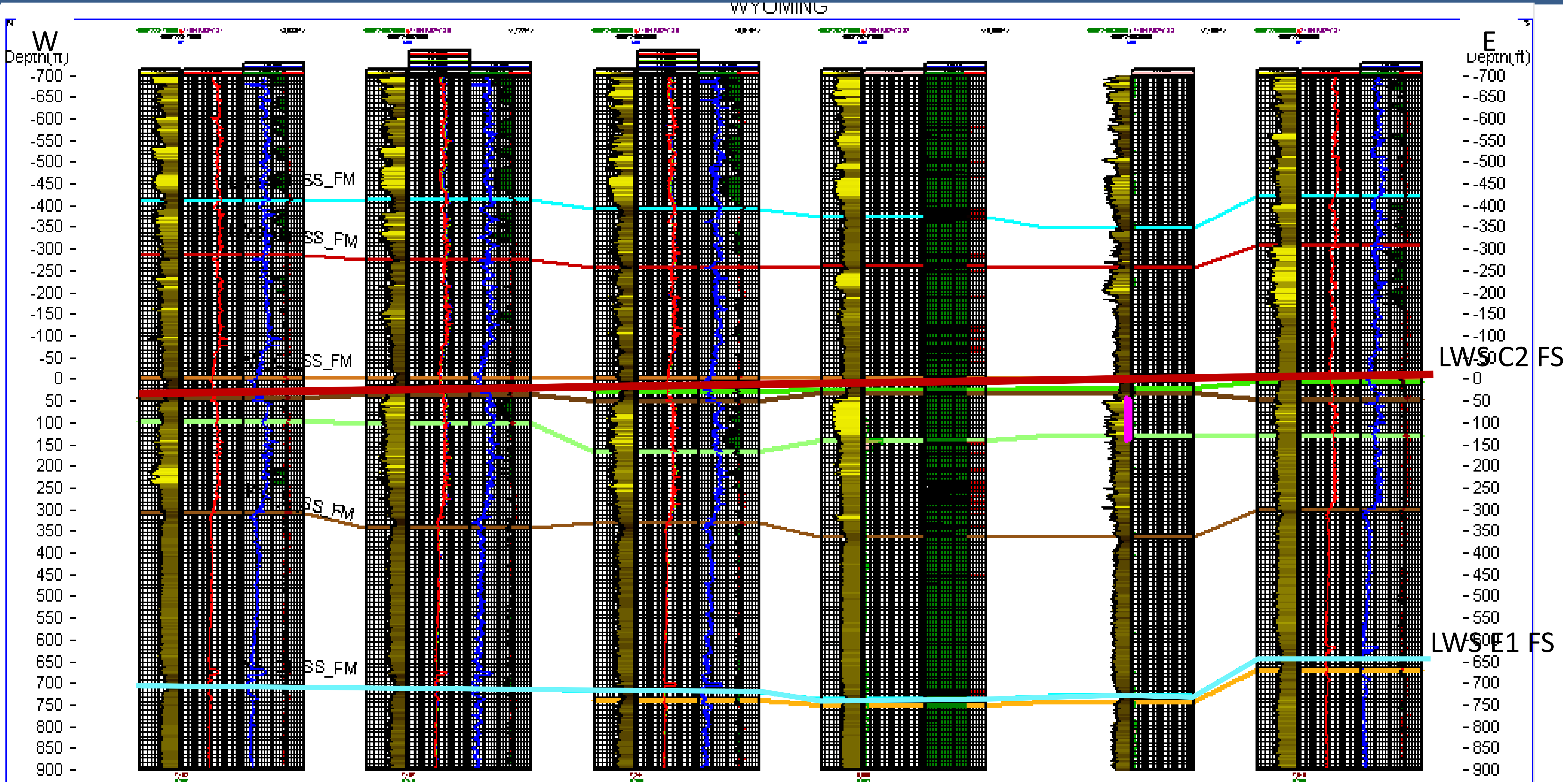
TOC data



Tmax data and low TOC showed low potential for hydrocarbon generation

Formation	Depth	TOC	
Lewis C2 SS	7597.15	0.95	Shale
Lewis C2 SS	7629.15	0.52	Base of upper sand transition to shale
Lewis C2 SS	7629.35	**0.41**	Twined for corelab
Lewis C2 SS	7642.15	0.77	Top of second transitioning into sand

Correlation core area



Future Work

- Maps of the individual intervals
- XRF data from the remaining wells
- Map the shelf edge to help identify depositional environment
- Further analyze elemental composition and build mineralogical models
- Analyze thin sections and perform SEM analyses on silty intervals
- Petrophysical model of each of the intervals

Conclusions

- The core descriptions and analyses available show the complexity and heterogeneity of these reservoirs
- Some natural migration pathways such as injectites and burrows were identified
- High quartz content will facilitate hydraulic fracturing
- Although these intervals have some organic matter, the presence of burrows and sedimentary structures such as ripples evidence an oxygenated environment where very low preservation of organic matter took place. Thus, these intervals are not source of hydrocarbons

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