High-resolution Reservoir characterization of the Lewis Shale in the Wamsutter field Wyoming

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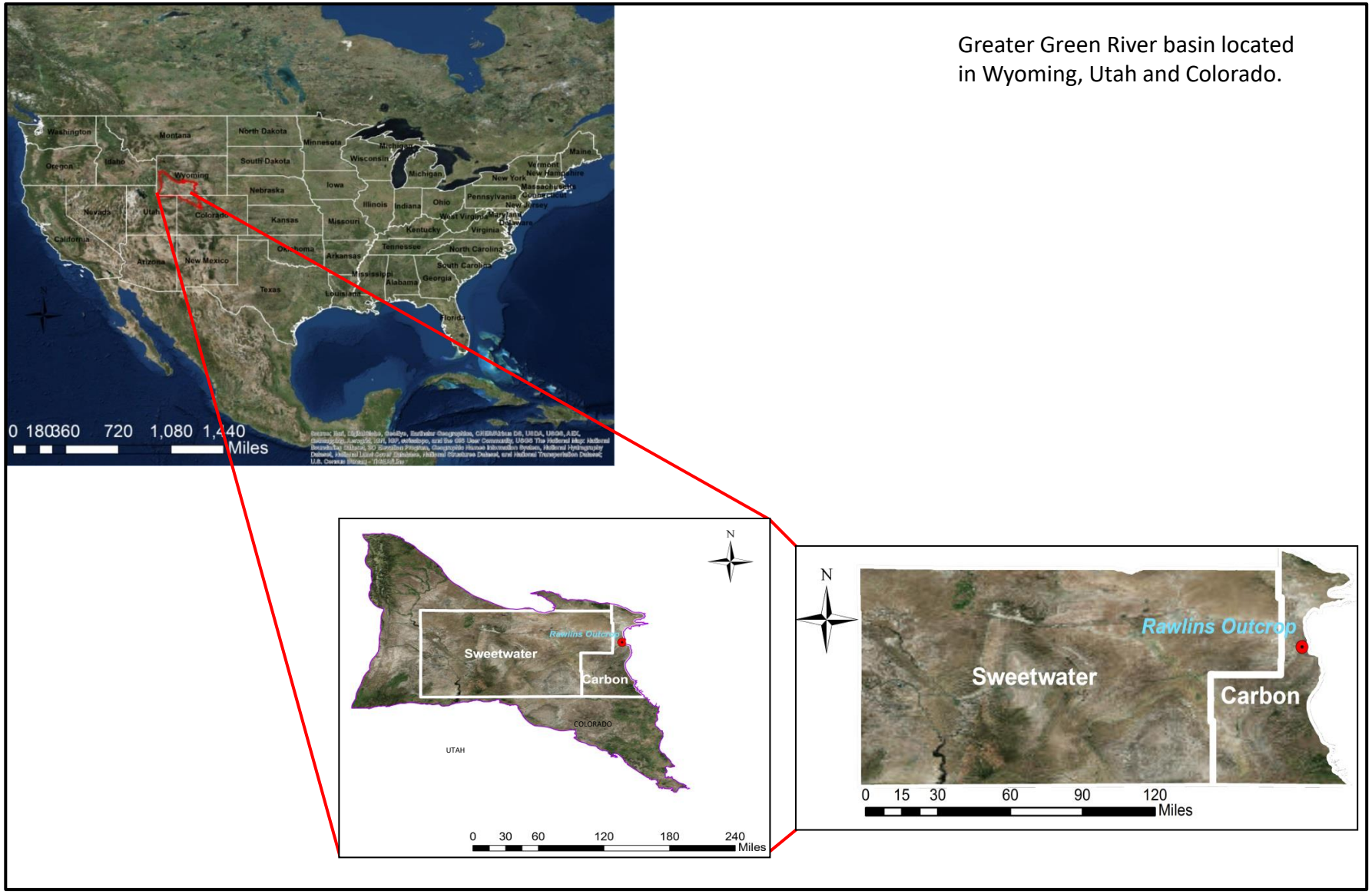
Outline

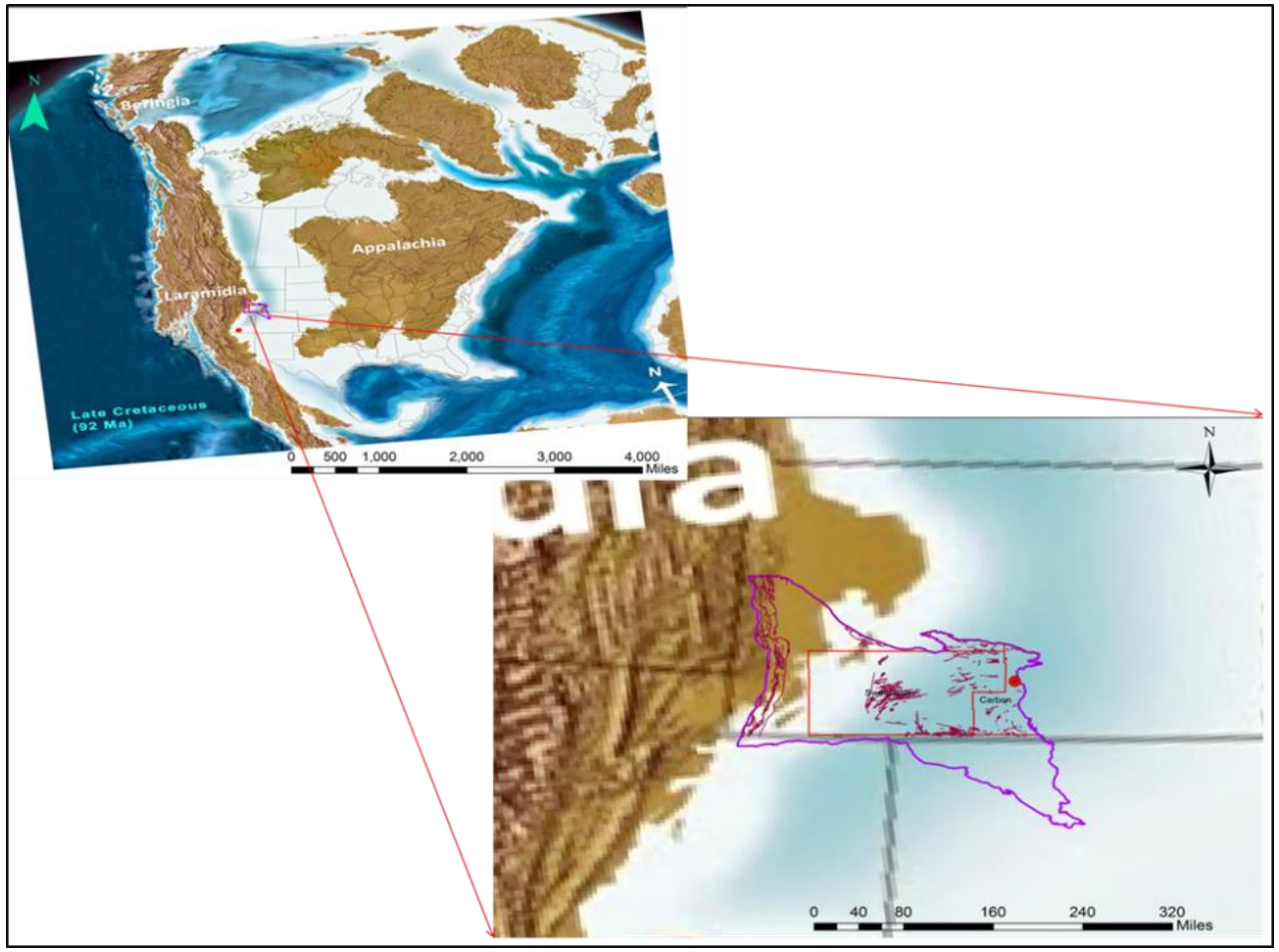
- Introduction
- Objectives
- Core facies and thin section analyses
- XRF and XRD profiles
- Correlations
- Conclusions

Introduction

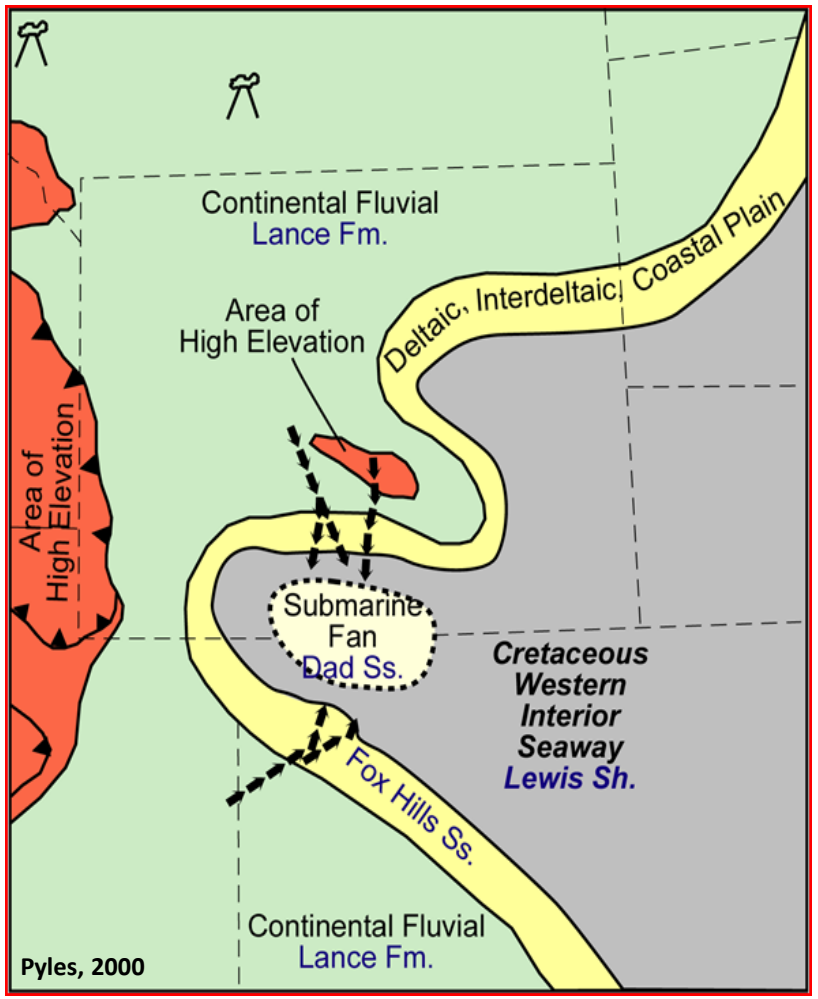


Greater Green River basin located in Wyoming, Utah and Colorado.

Introduction



Paleomap from Colorado Plateau Geosystems



Introduction

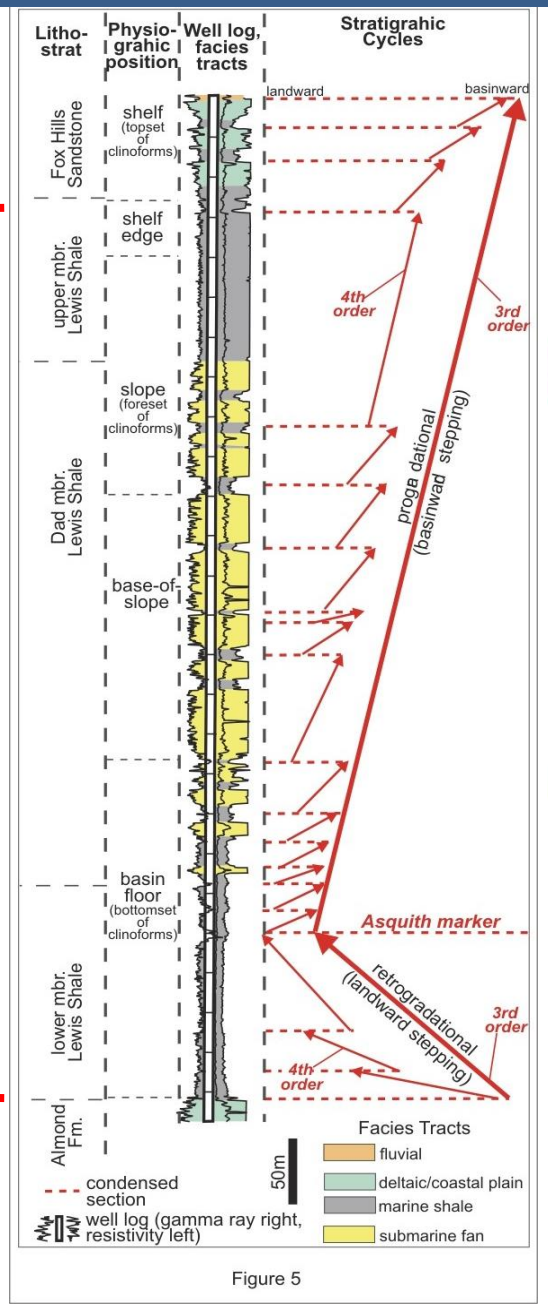
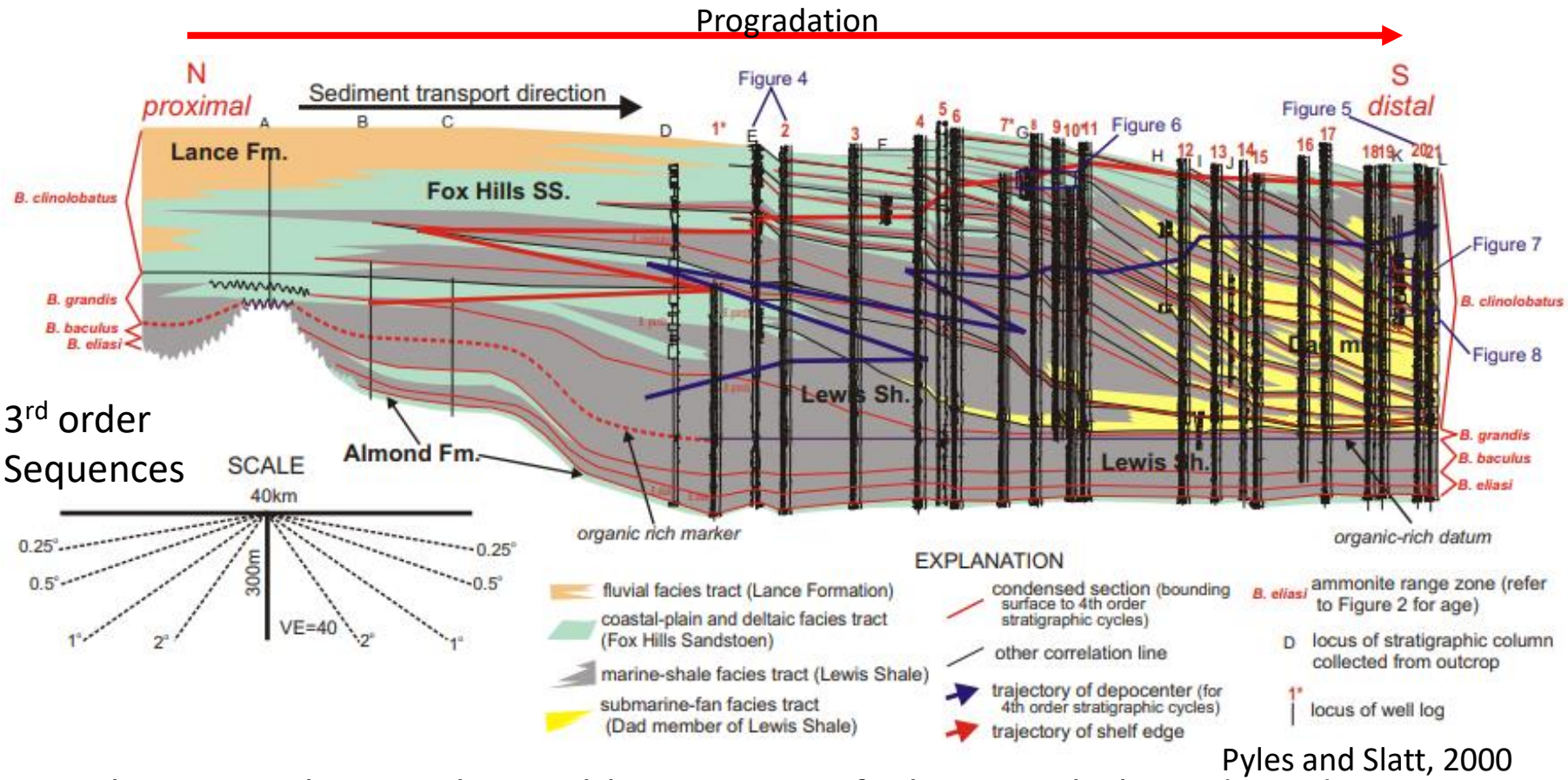


Figure 5

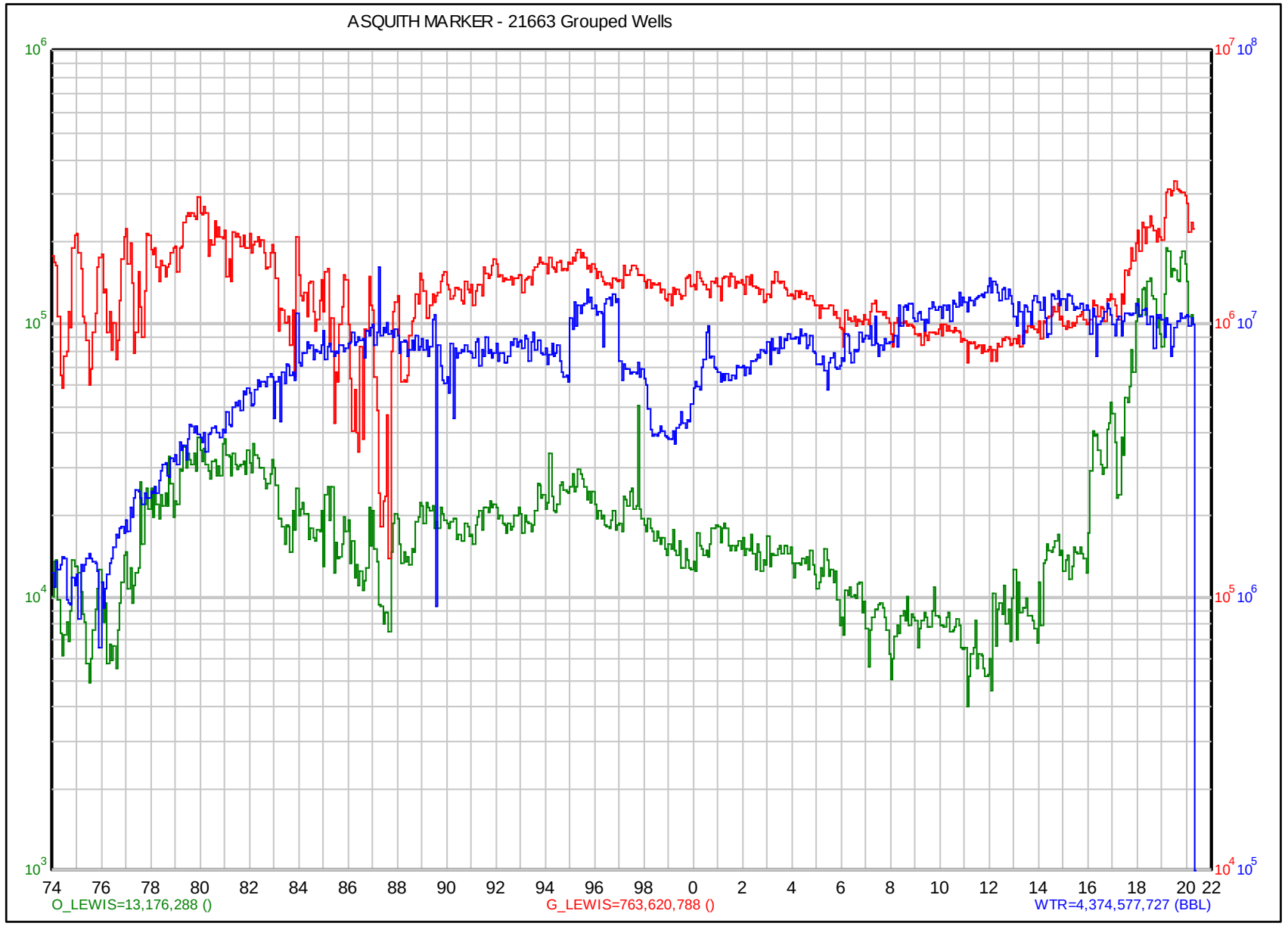
Sequence Stratigraphy



Pyles and Slatt, 2000

- Three members with variable amounts of Siltstone Shale and sandstone.
- Two third order sequences.
- Retrogradational sequence capped by the Asquith Marker.
- Progradational sequence capped by the Fox Hills Sandstone.

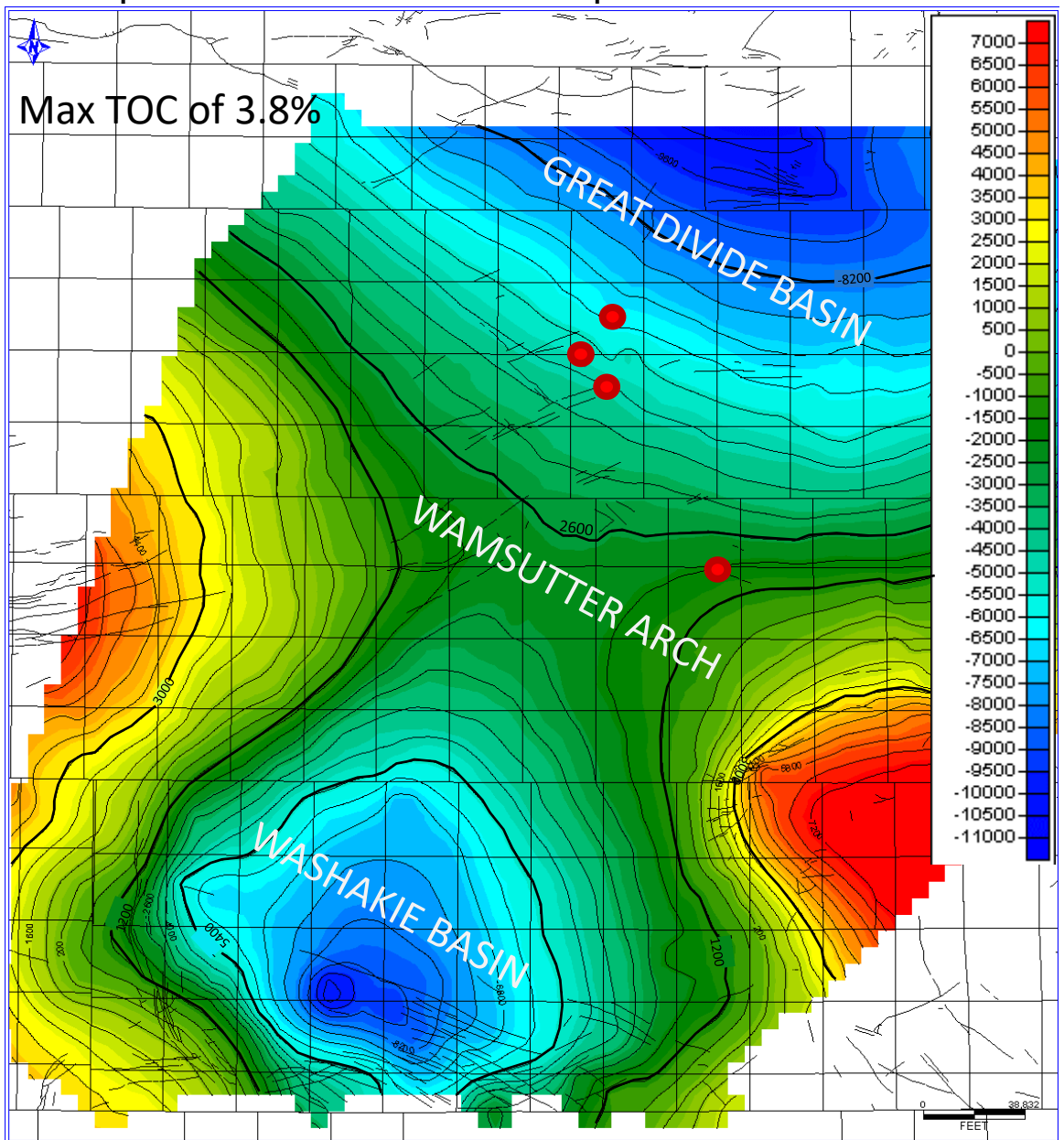
Production in the area



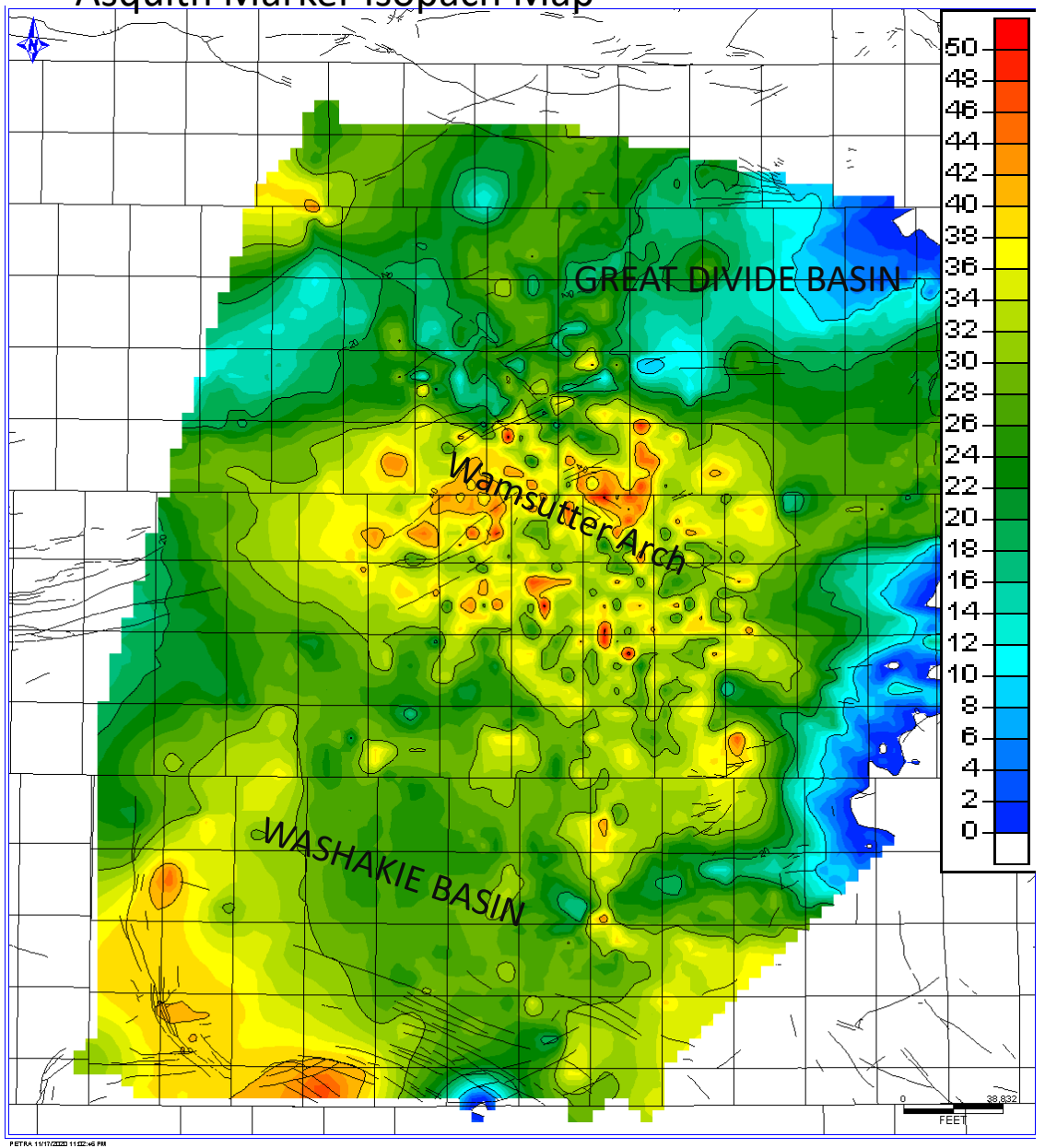
- It is mainly gas producer with some potential for liquid hydrocarbons.
- Between 600 and 675 BCFG with some minor amounts of oil have been produced since 1974.

Source of Hydrocarbons

Asquith Marker Structural Map



Asquith Marker Isopach Map



Objectives

- Define main characteristics of some of the intervals and evaluate reservoir quality.
- Based on the different observations, which intervals seem to be better for development.

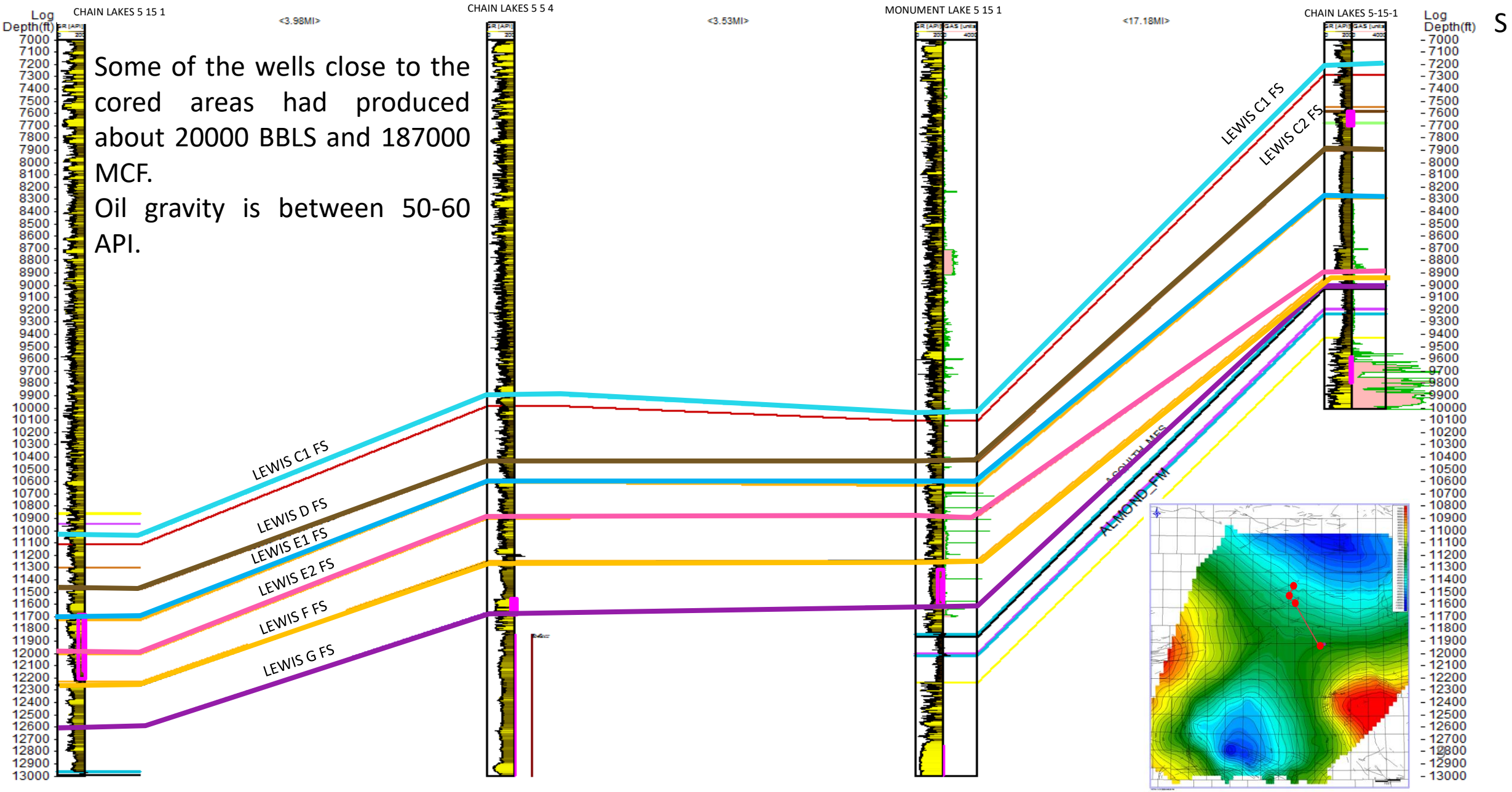
Core Distribution

N

S

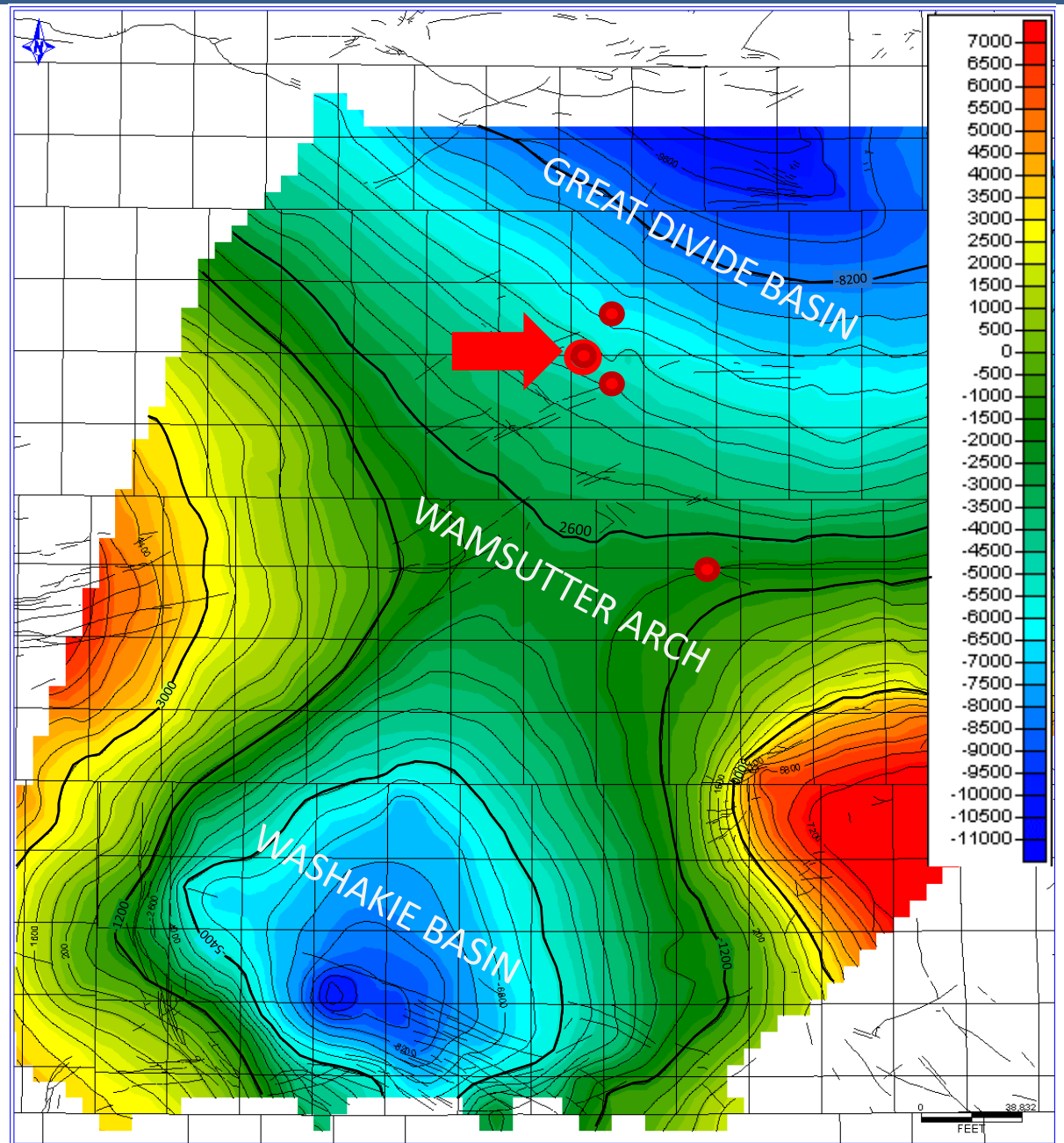
Some of the wells close to the cored areas had produced about 20000 BBLS and 187000 MCF.

Oil gravity is between 50-60 API.

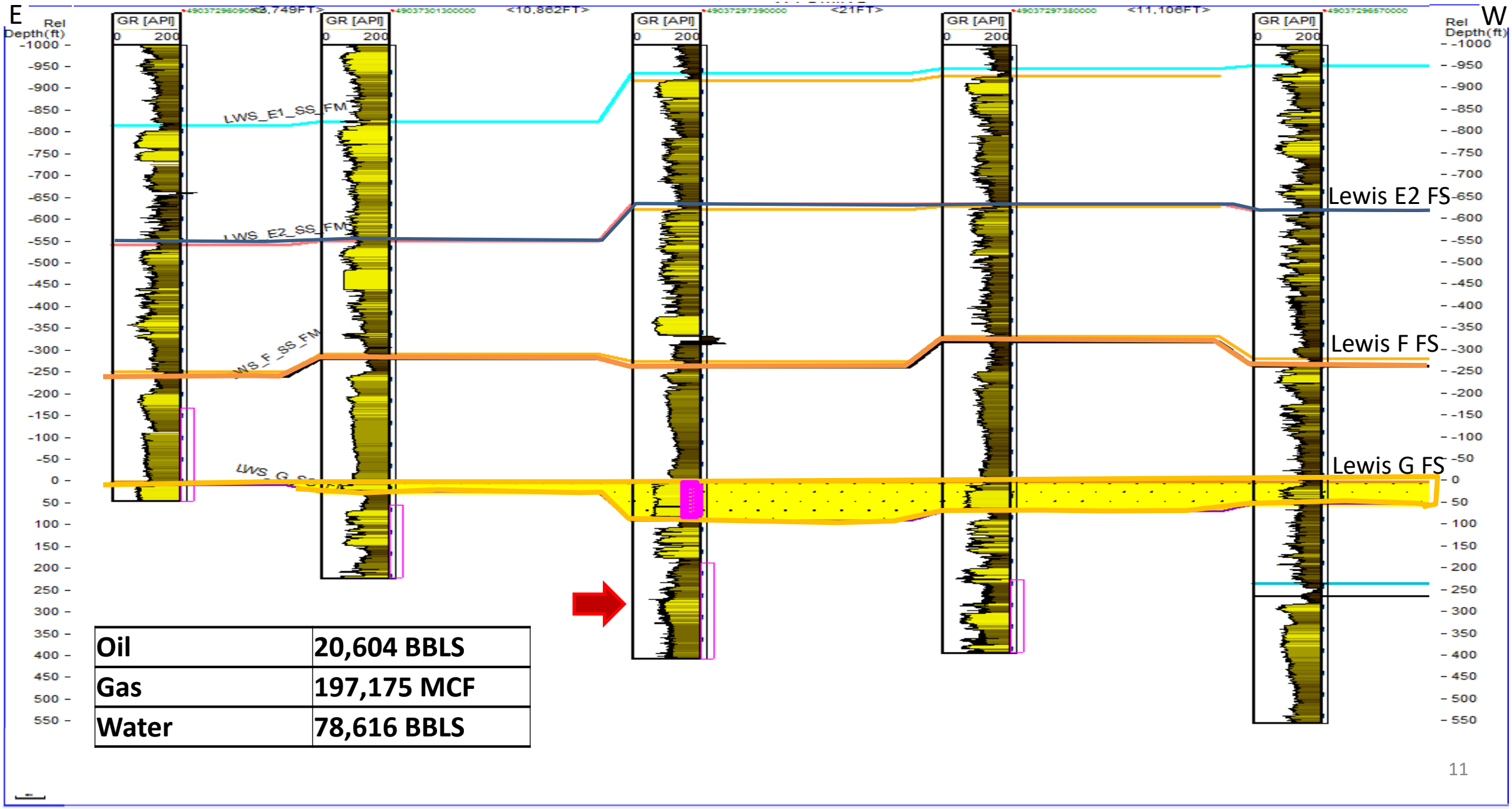


Chain Lakes 5 5 4

Asquith Marker Structural Map

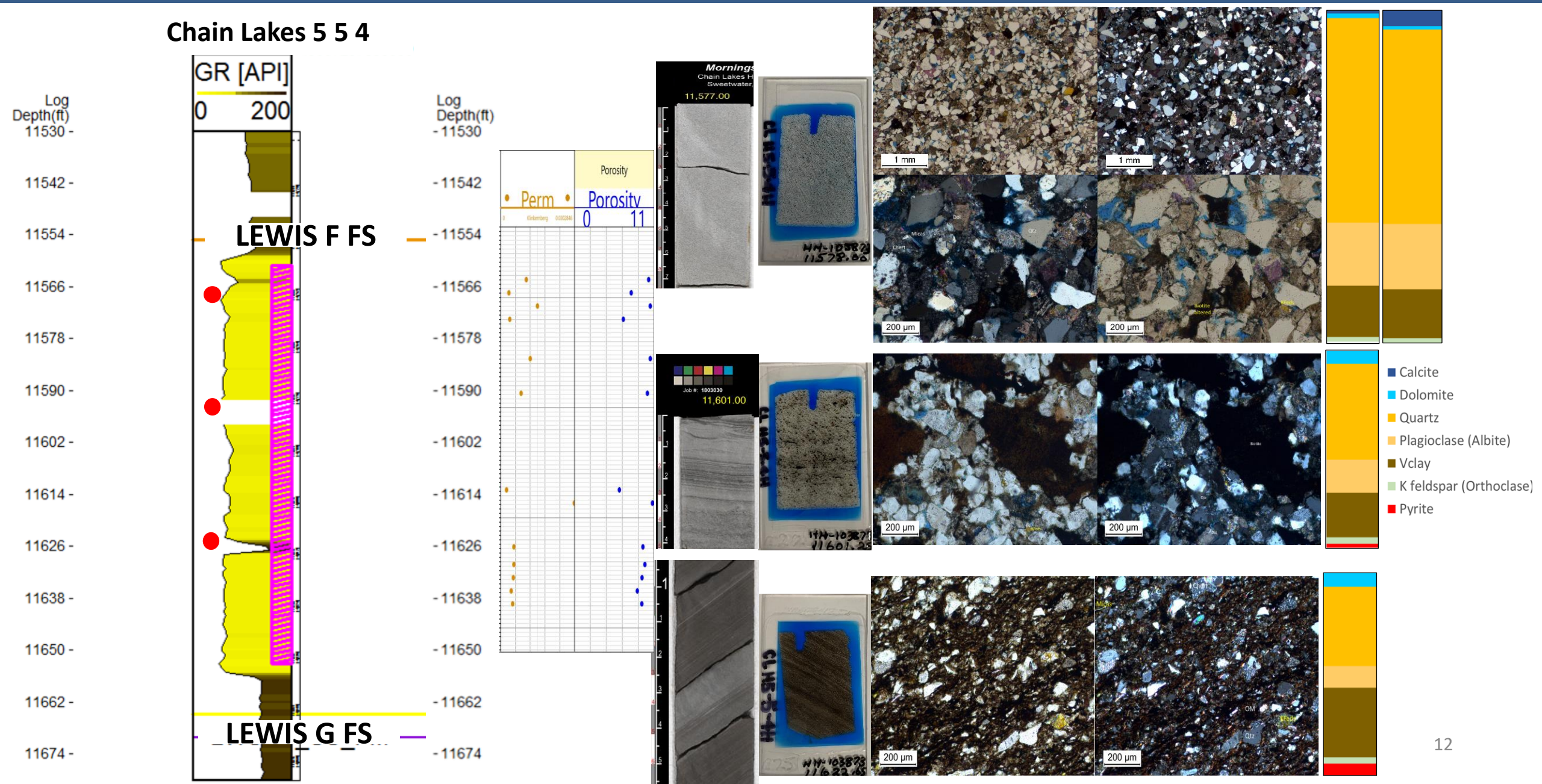


Correlation Chain Lakes 5 5 4 area



Oil	**20,604 BBLS**
Gas	**197,175 MCF**
Water	**78,616 BBLS**

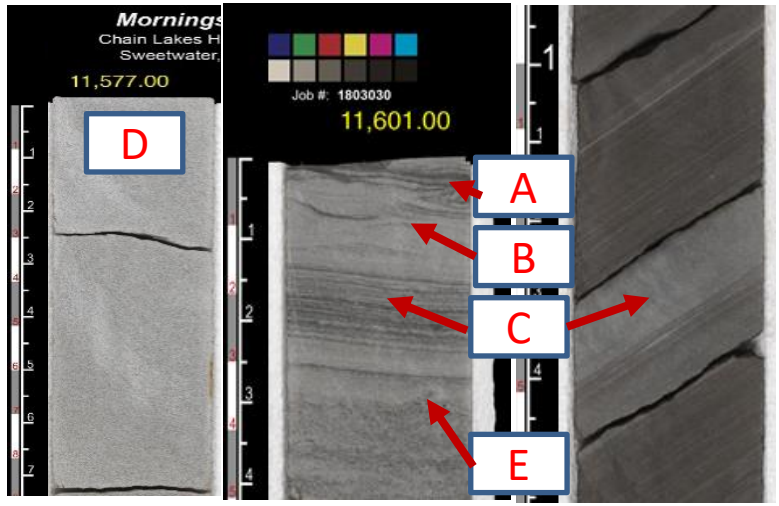
Chain Lakes 5 5 4

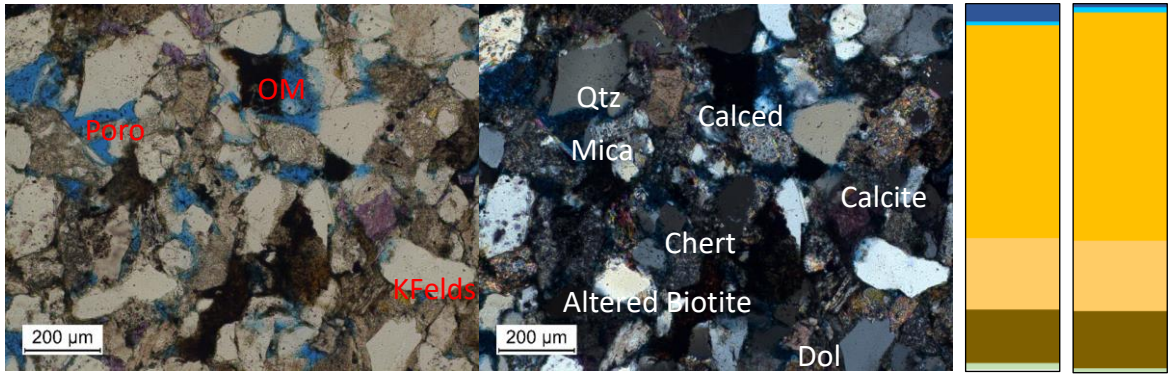


Core facies Chain Lakes 5-5-4

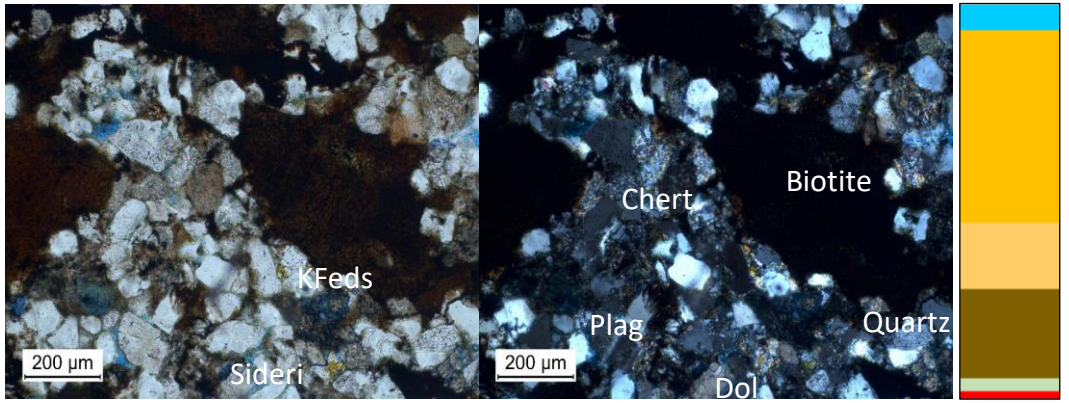
Sedimentary Structures

- Convoluted beds A
- Ripples B
- Finely Laminations C
- Cryptobioturbation D
- Flame up Structures E

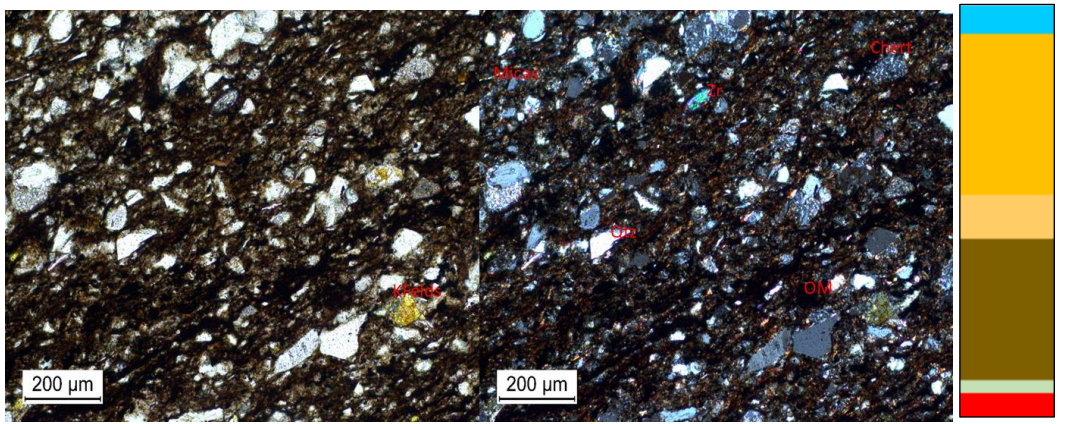




"Massive" Sandstone (Cryptobioturbated)

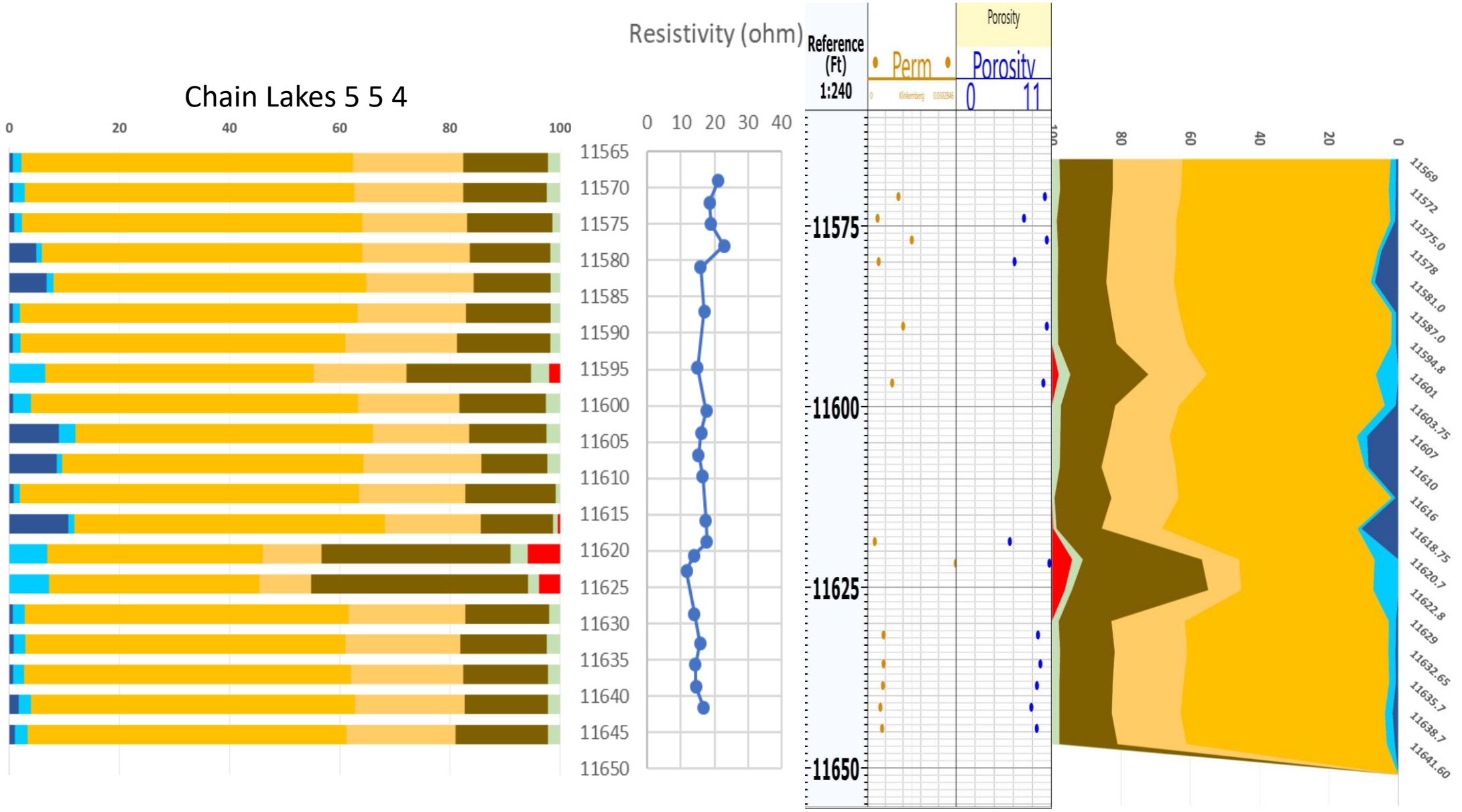


Finely laminated bioturbated silty fine sandstone



Finely laminated bioturbated sandy siltstone

Core facies Chain Lakes 5 5 4

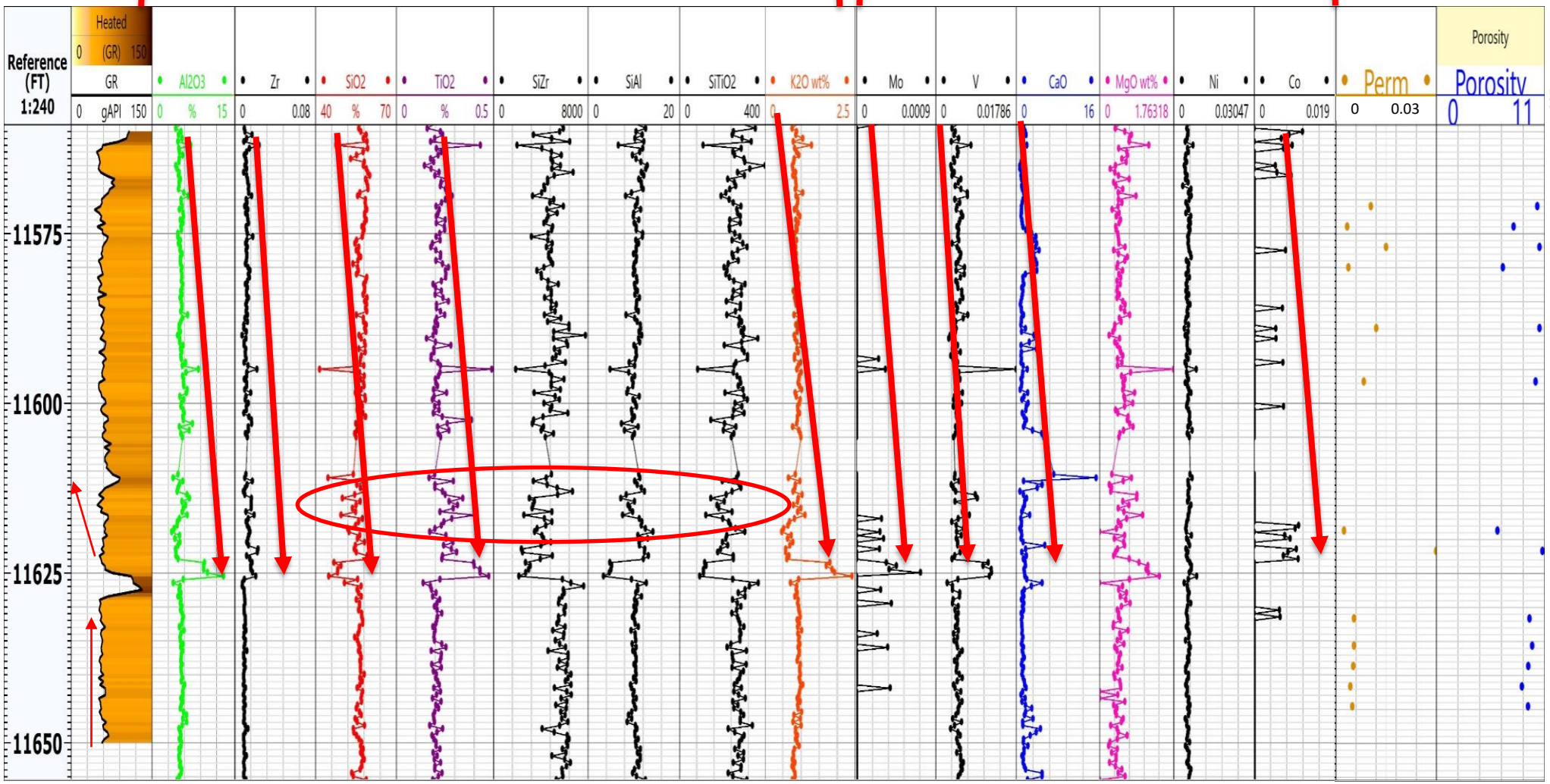


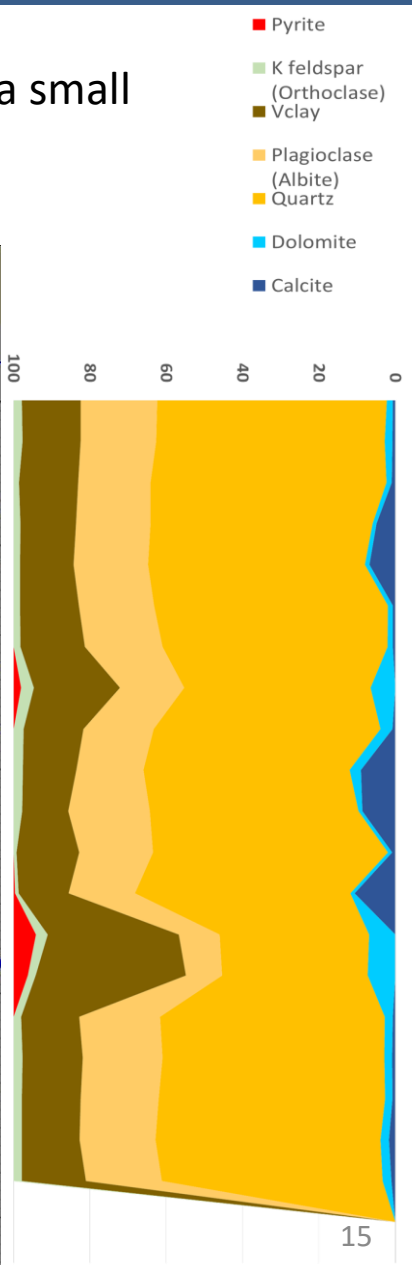
XRF Chain Lakes 5 5 4

- Al, Ti and Zr seem to be increasing indicating a detrital input and a prograding sedimentation.
- Increase in V and Mo seem to coincide with the shale break in the core and increase in Al indicating a small possible anoxic event.

Detrital proxies

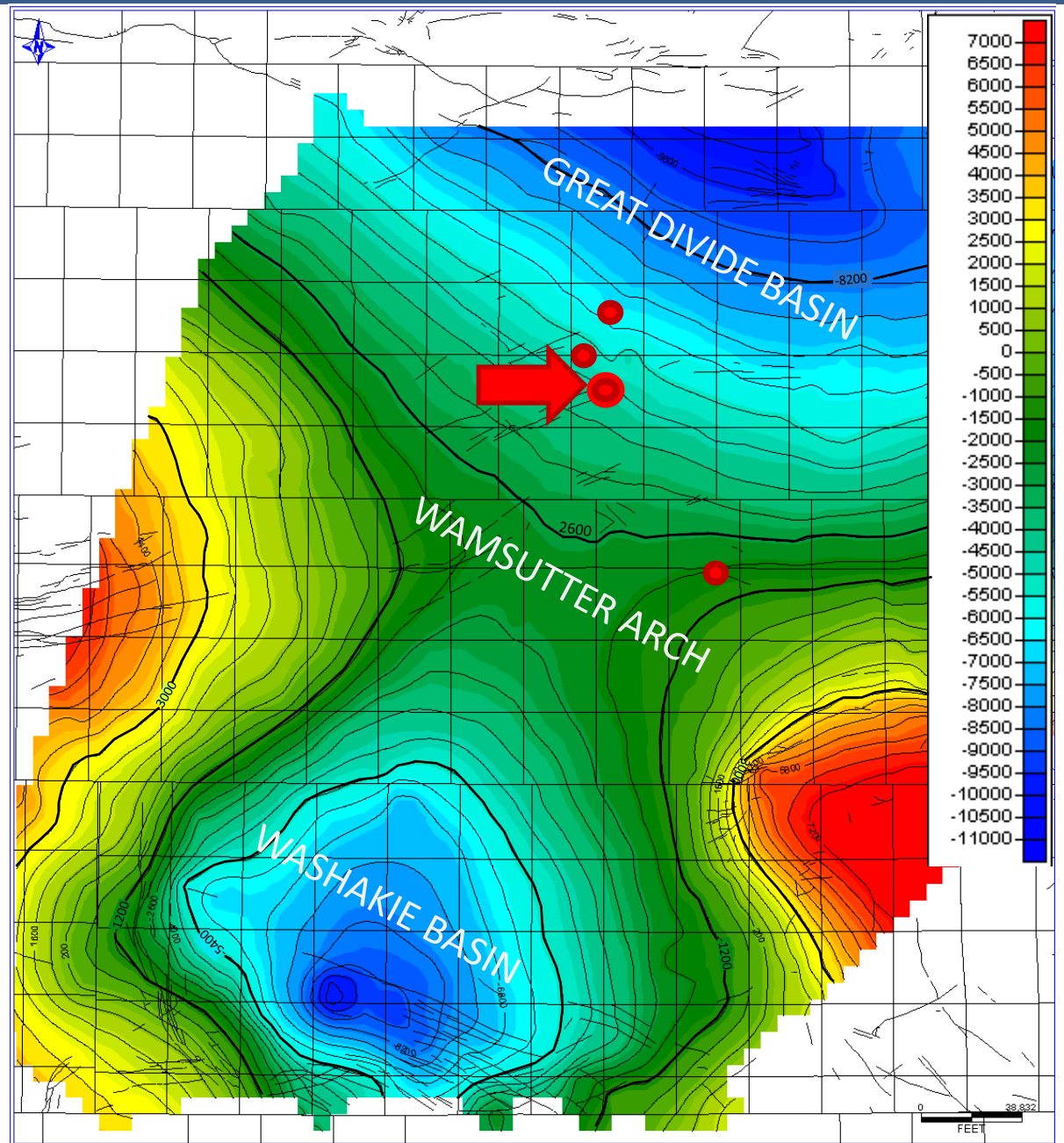
Marine anoxic proxies



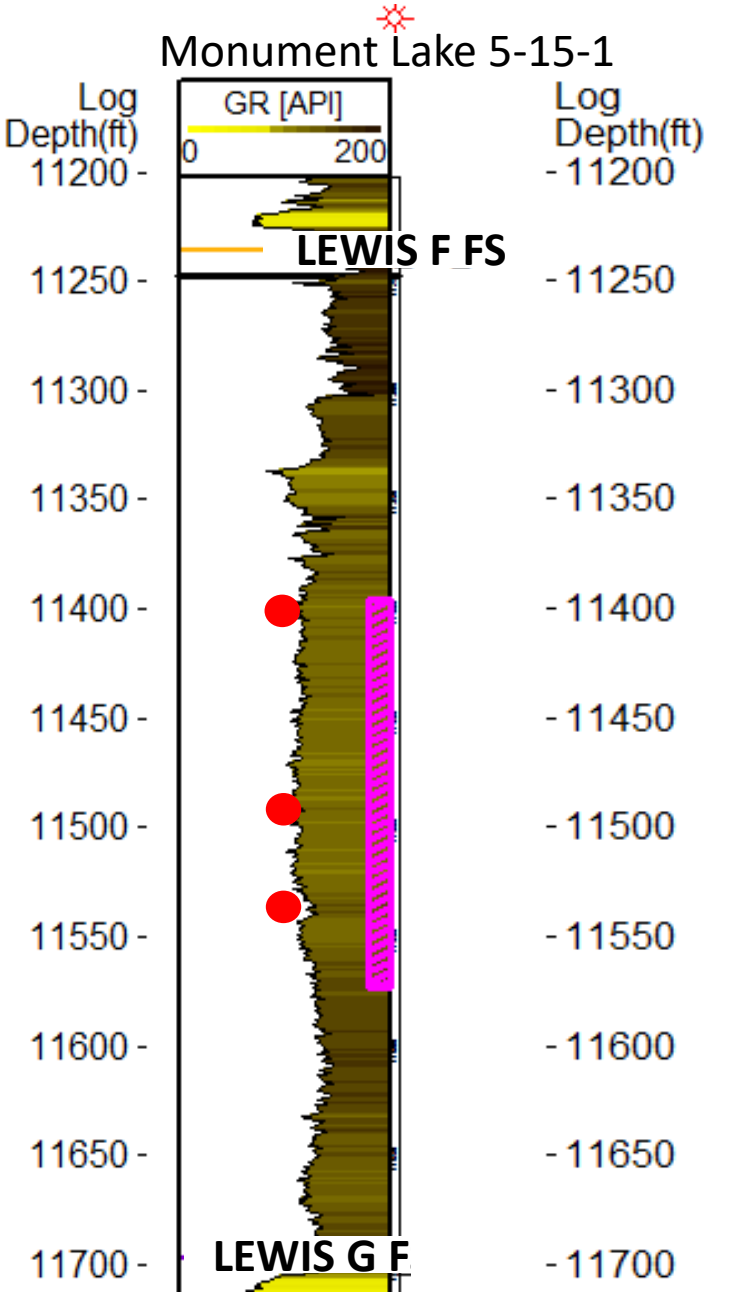


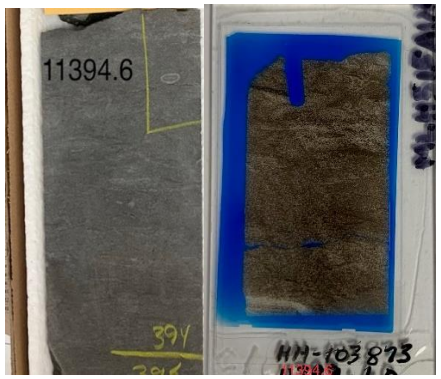
Monument Lakes 5 15 1

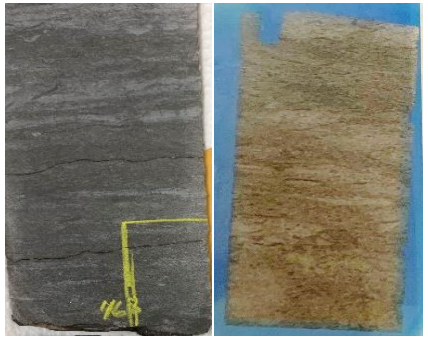
Asquith Marker Structural Map

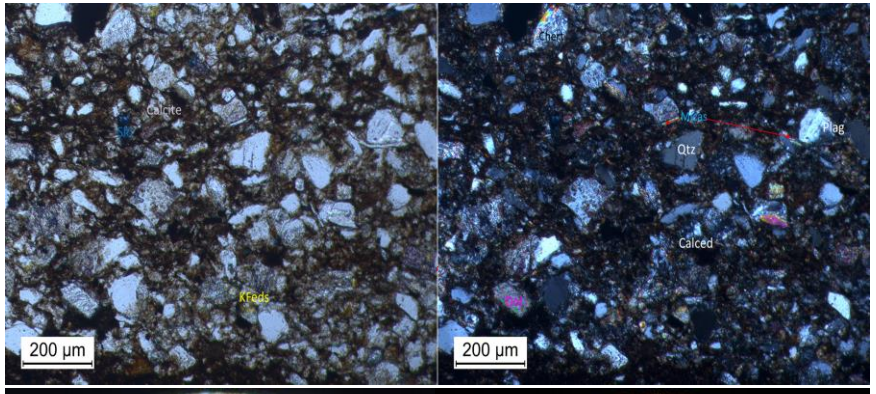


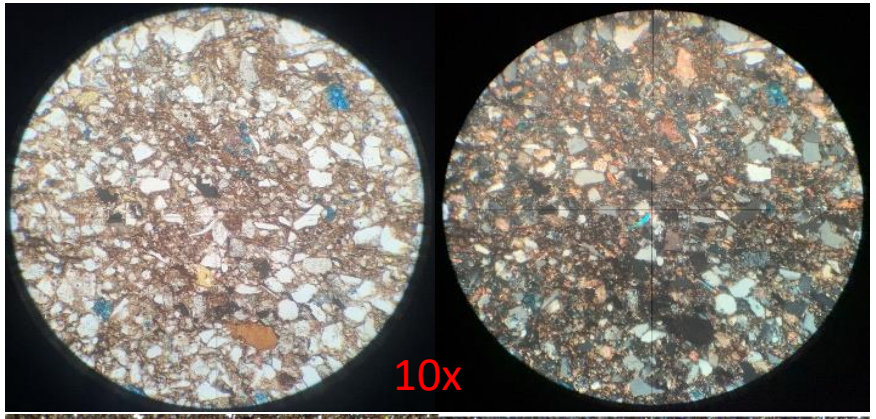
Monument Lakes 5 15 1

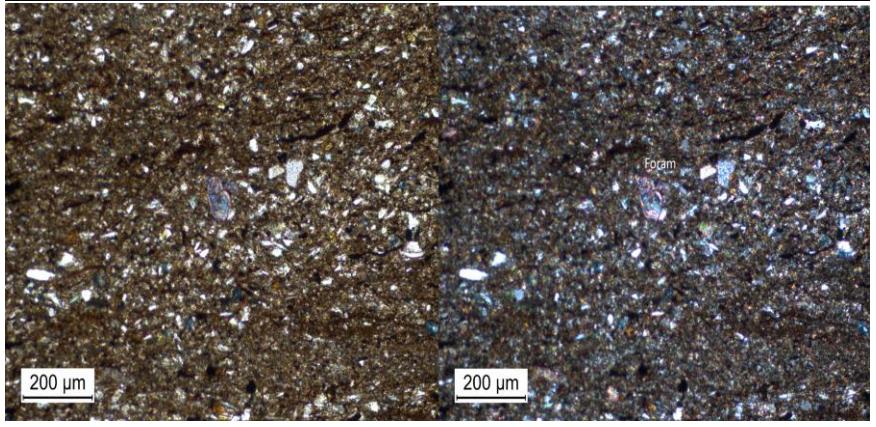


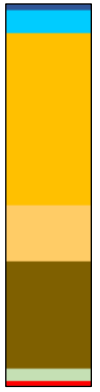


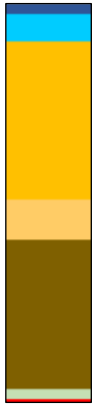


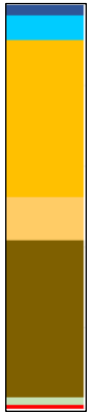








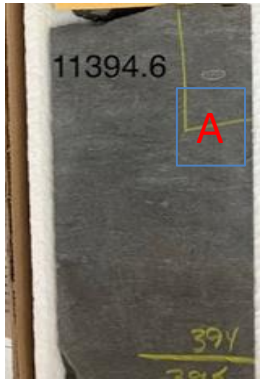


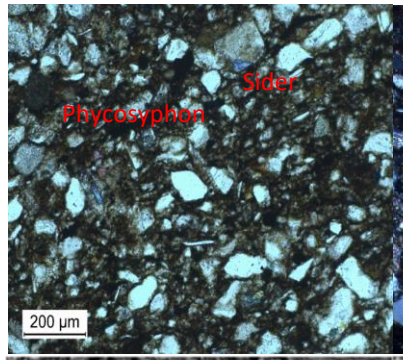


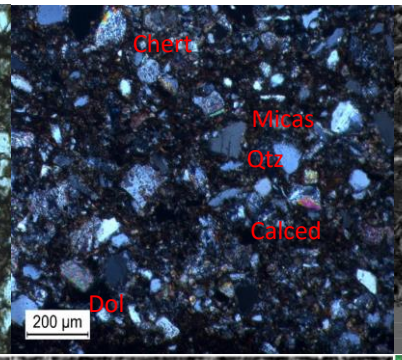
- Calcite
- Dolomite
- Quartz
- Plagioclase (Albite)
- Vclay
- K feldspar (Orthoclase)
- Pyrite

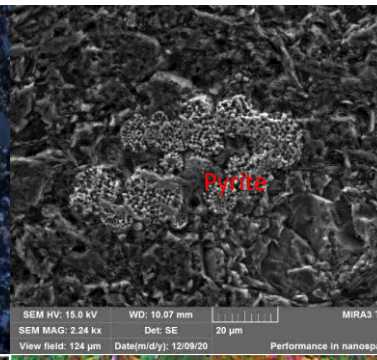
Core facies Monument Lakes 5 15 1

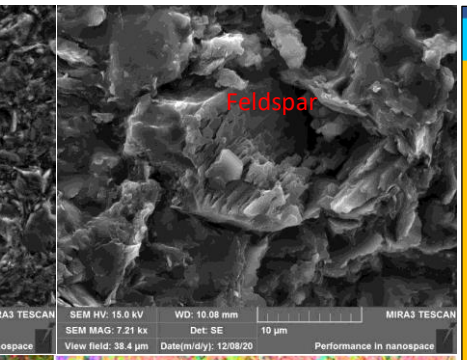
- Sedimentary Structures:
- None easily visible due to high bioturbation.
- Phycosyphon and Schaubcylindricnus present. A
- TOC: 0.75%

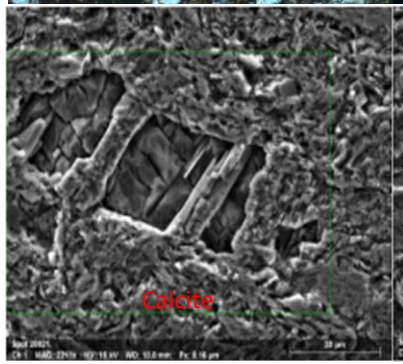


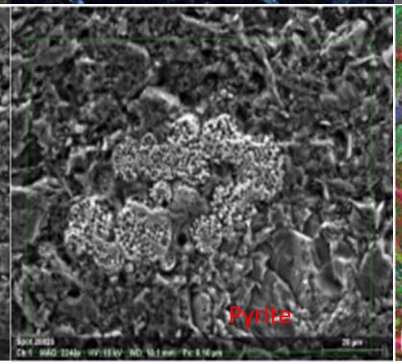


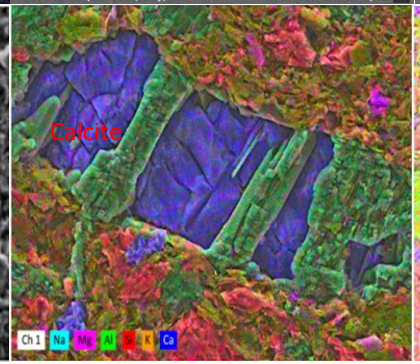


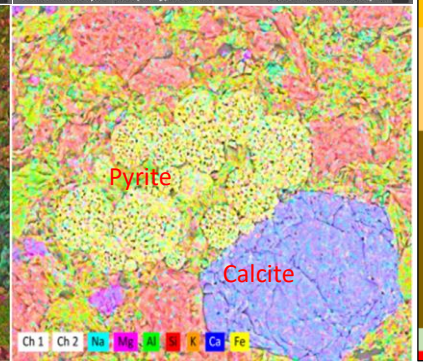


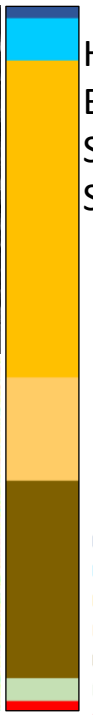








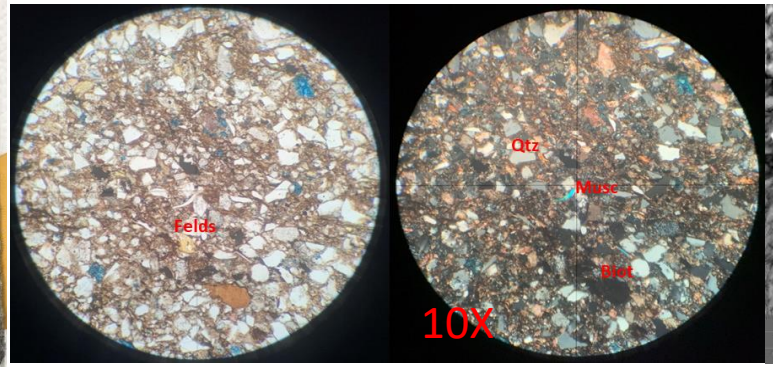


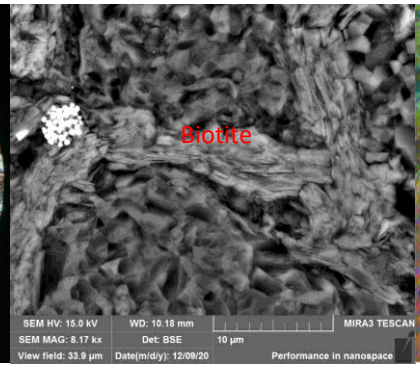


Heavily Bioturbated Sandy Siltstone

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

- Sedimentary Structures:
- Some lamination is present but it is usually disturbed.
- Phycosyphon and Schaubcylindricnus present.
- TOC: 0.72%





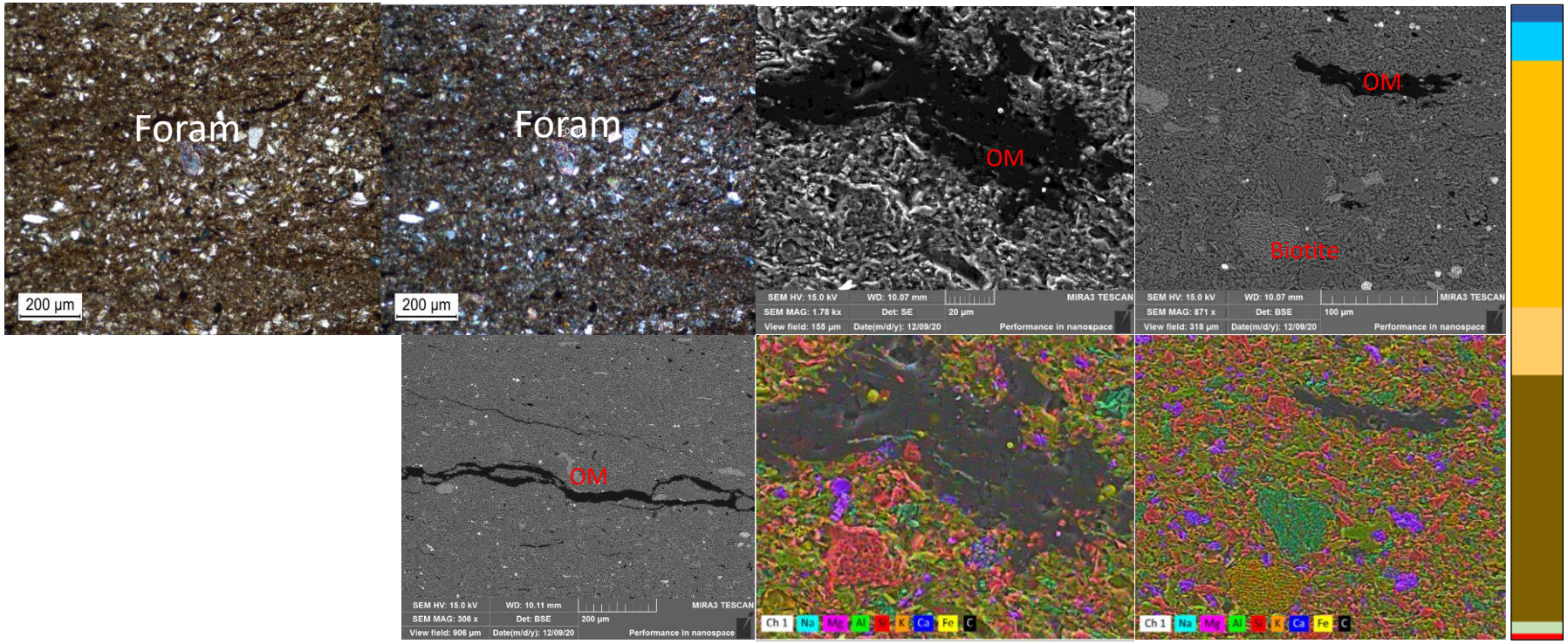
Bioturbated Sandy Siltstone

Core facies Monument Lakes 5 15 1

Sedimentary Structures:

- Finely laminations
- Smaller Phycosyphon and less frequent
- TOC:1.09%

Slightly Bioturbated Sandy Siltstone

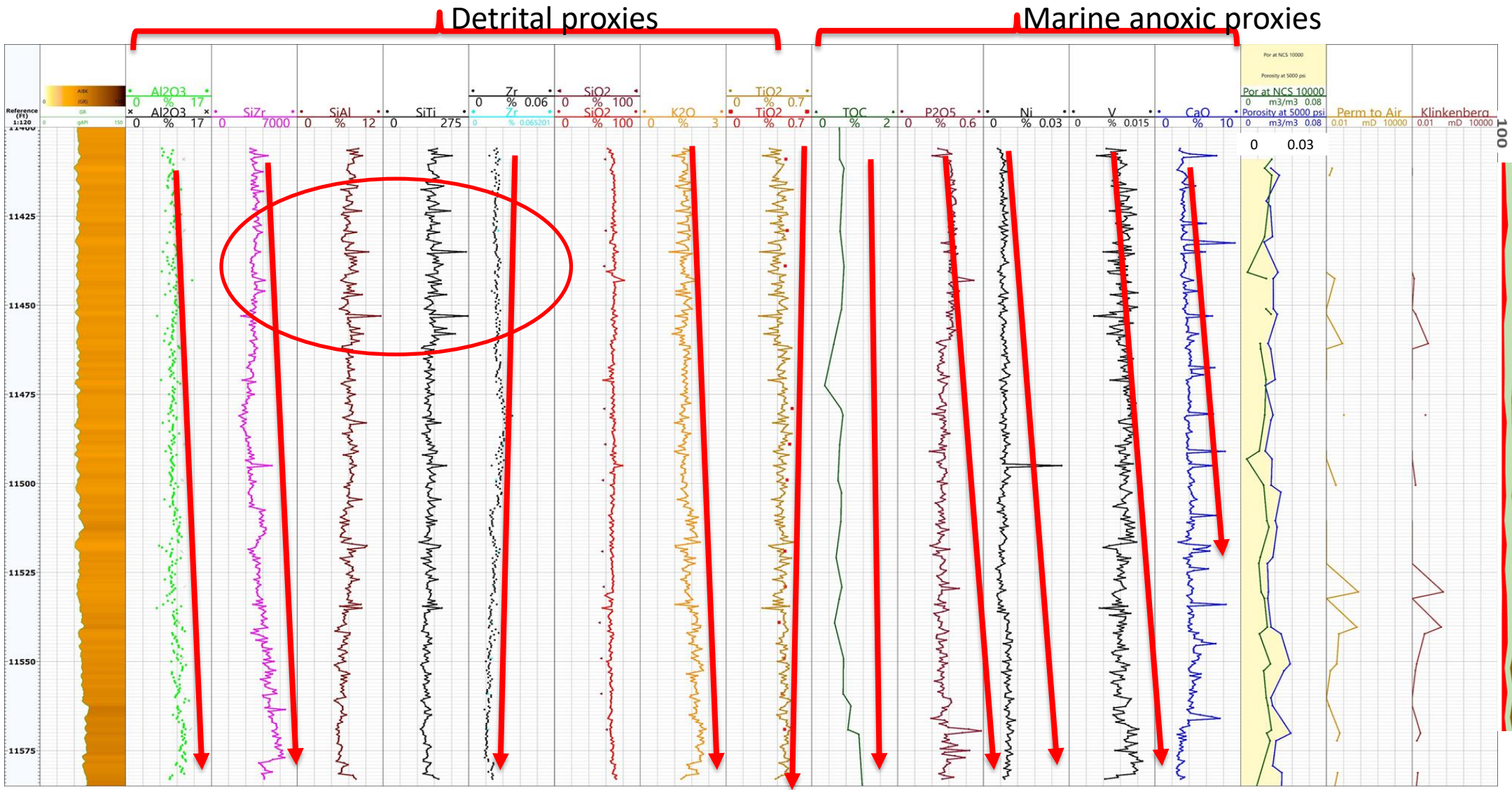


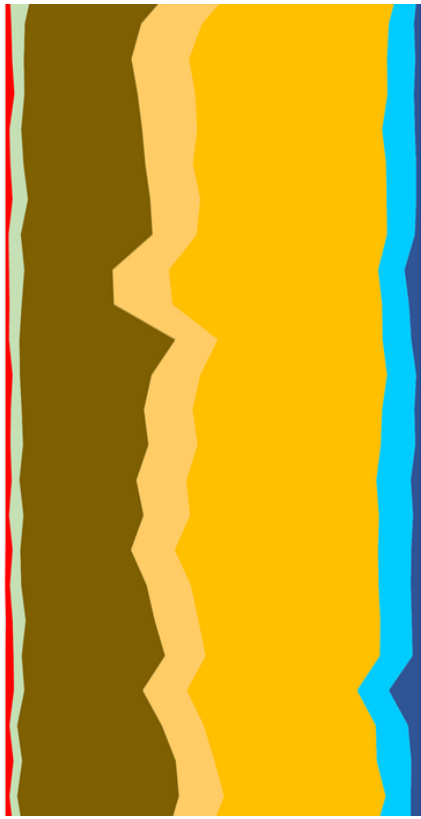
Vitrinite Reflectance:

- Measured on three samples. Macerals were not present and the measurements were performed on Bitumen. Places it on the wet gas window which coincides with the Oil gravity of 50-60 from the surrounding wells.
- According to the lab these solid bitumen particles seem to formed after migrated hydrocarbons cracked into gas and condensate

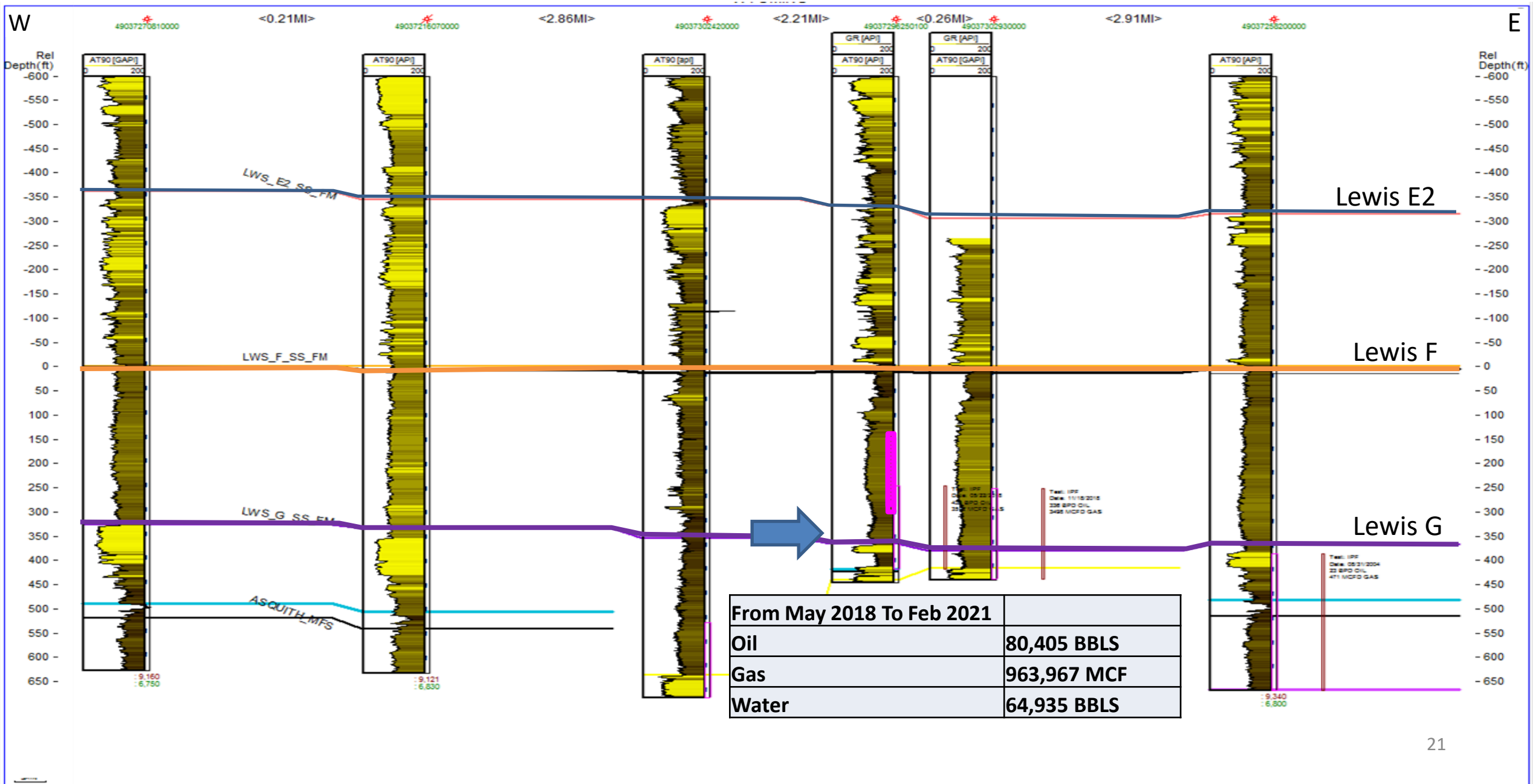
XRF Monument Lakes 5 15 1

Decrease in Ti, Zr and Si/Al with constant increasing of Al and K signals suggests retrogradation.
Porosity increases towards the bottom of the core but permeability decreases.





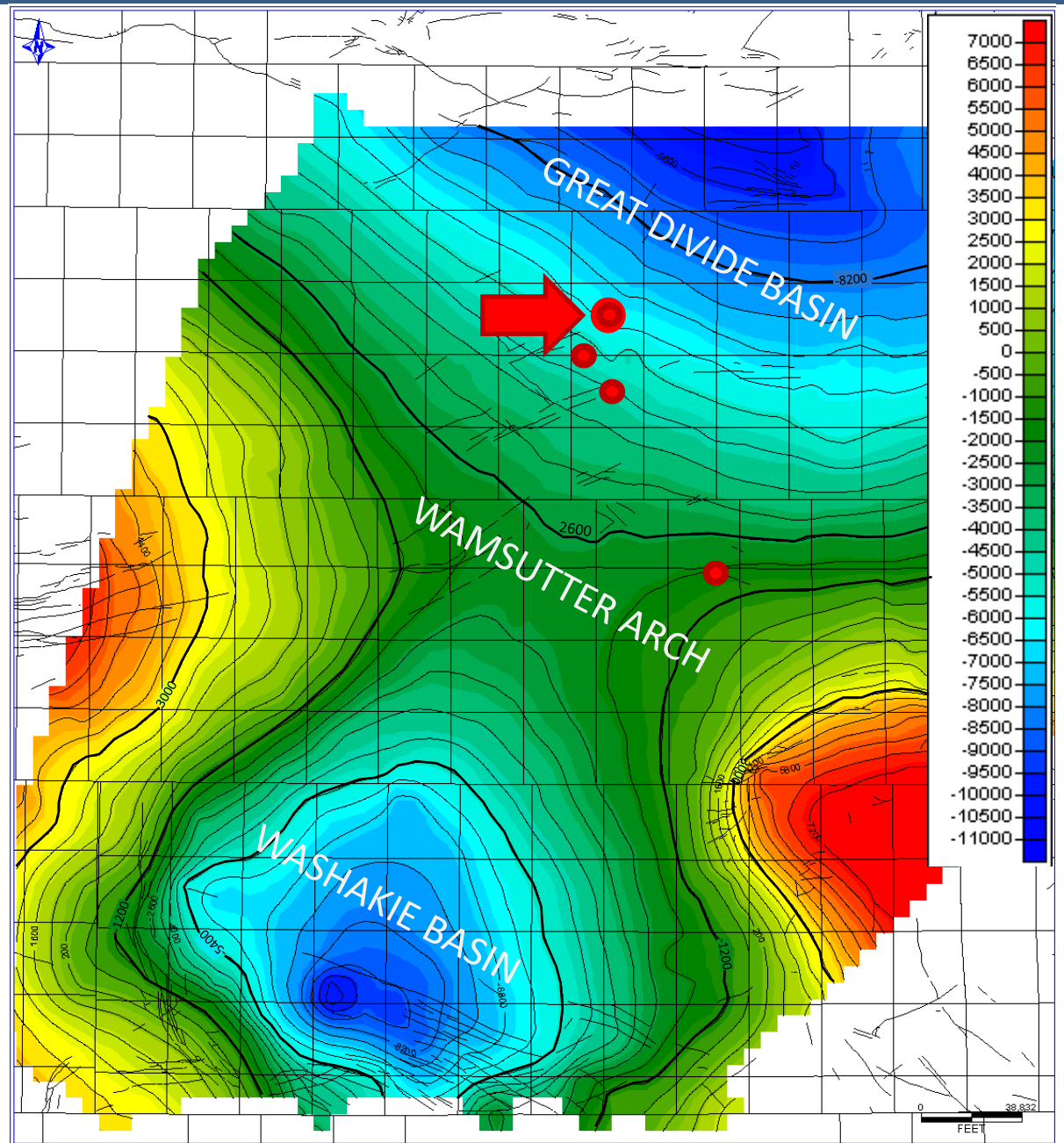
Monument Lakes 5 15 1



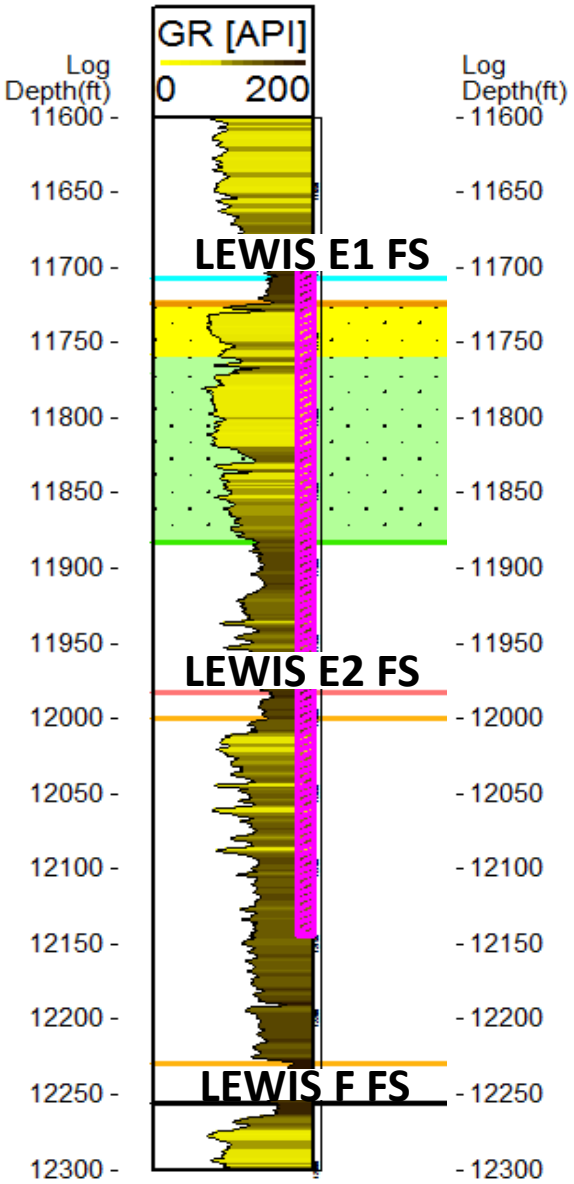
From May 2018 To Feb 2021	
Oil	80,405 BBLS
Gas	963,967 MCF
Water	64,935 BBLS

Chain Lakes 5 15 1

Asquith Marker Structural Map



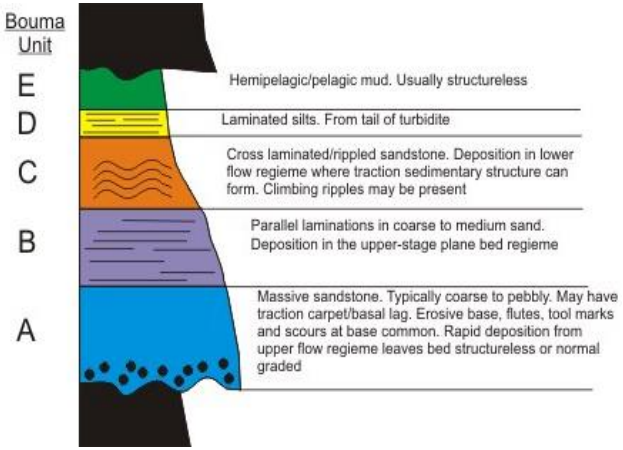
Core facies Chain Lakes 5 15 1

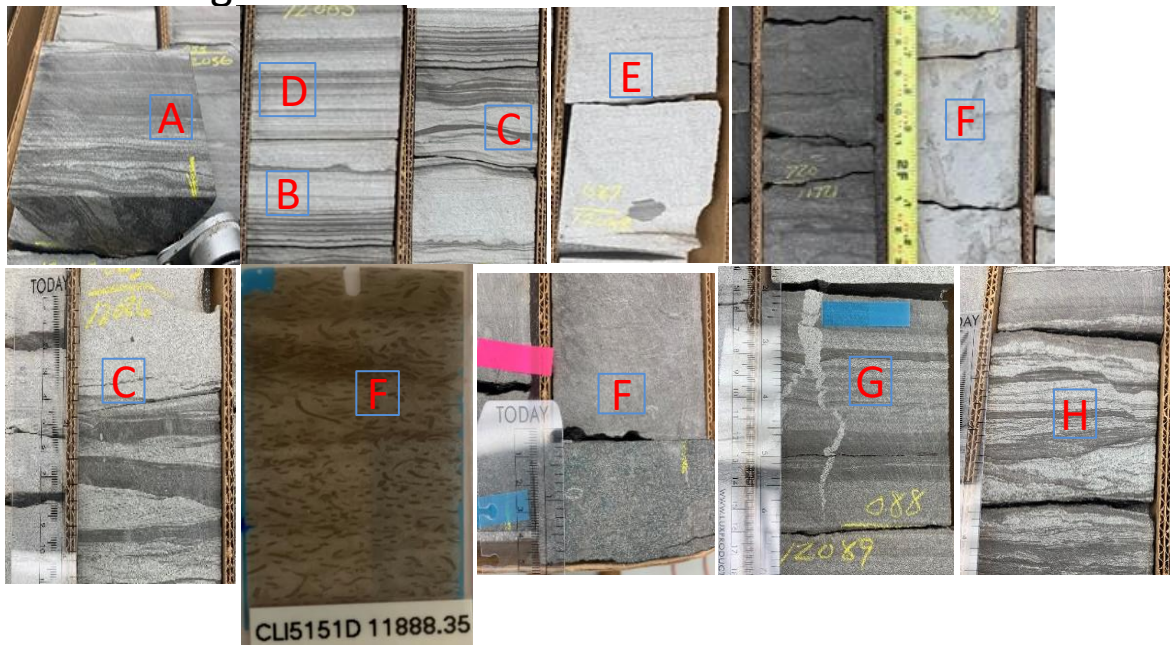


Sedimentary Structures:

- Convoluted beds A
- Flame up Structures B
- Climbing up ripples C
- Planar lamination D
- "Massive" beds E
- Ophiomorpha, Schaubcylindricnus, Phycosyphon F
- Injectites G
- Shear Zones H
- Leaves and shell fragments are abundant

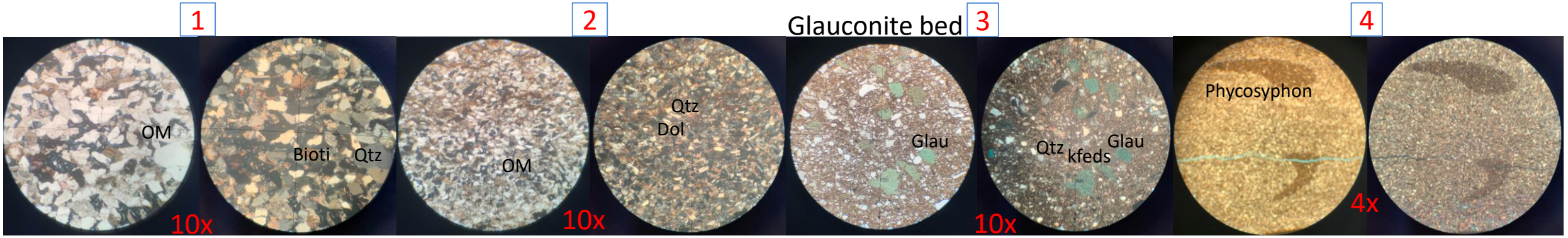
- Core varies from sandstones to siltstones to shales and exhibits several incomplete Bouma sequences at different scales



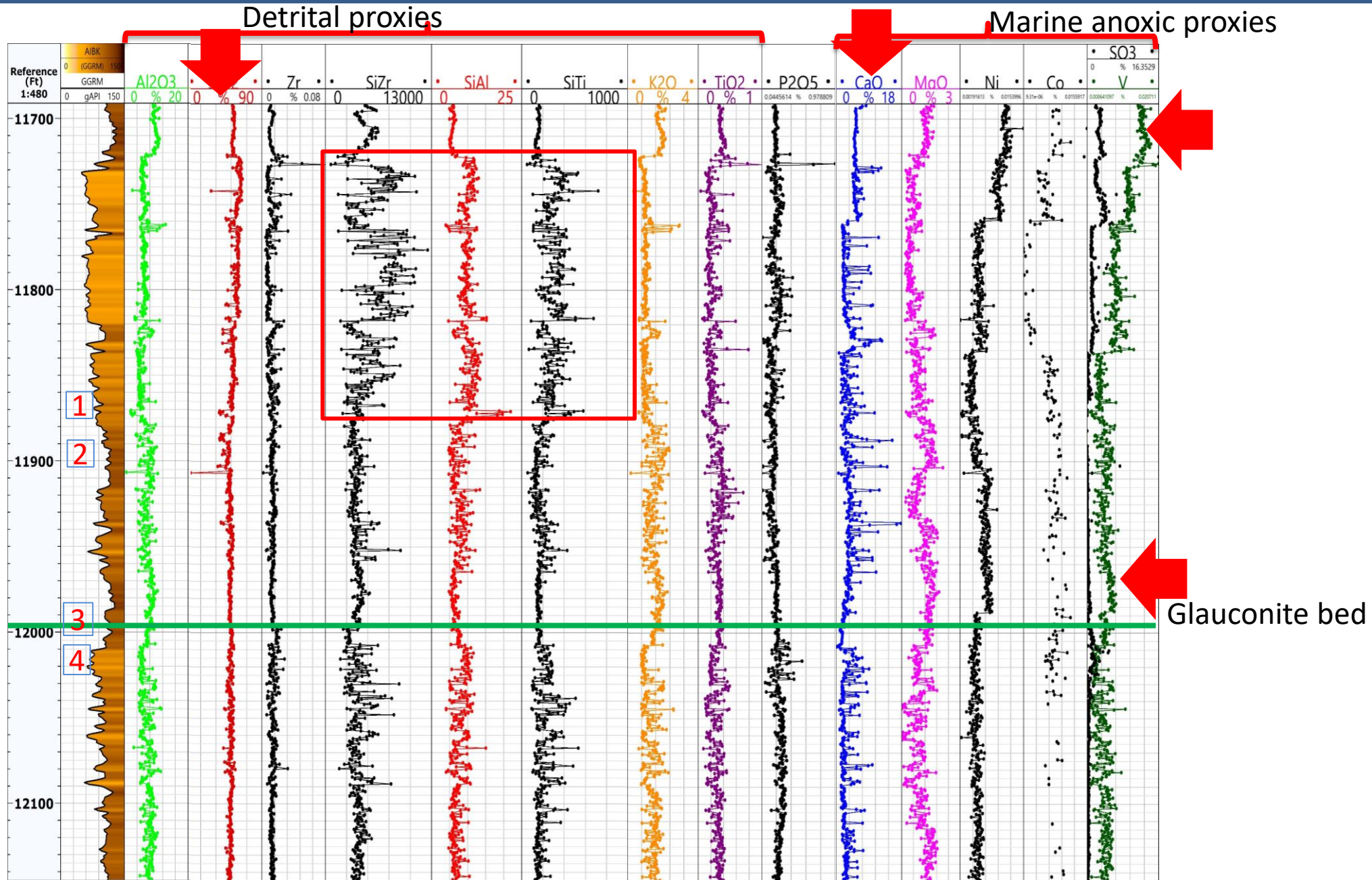


Chain Lakes 5 15 1

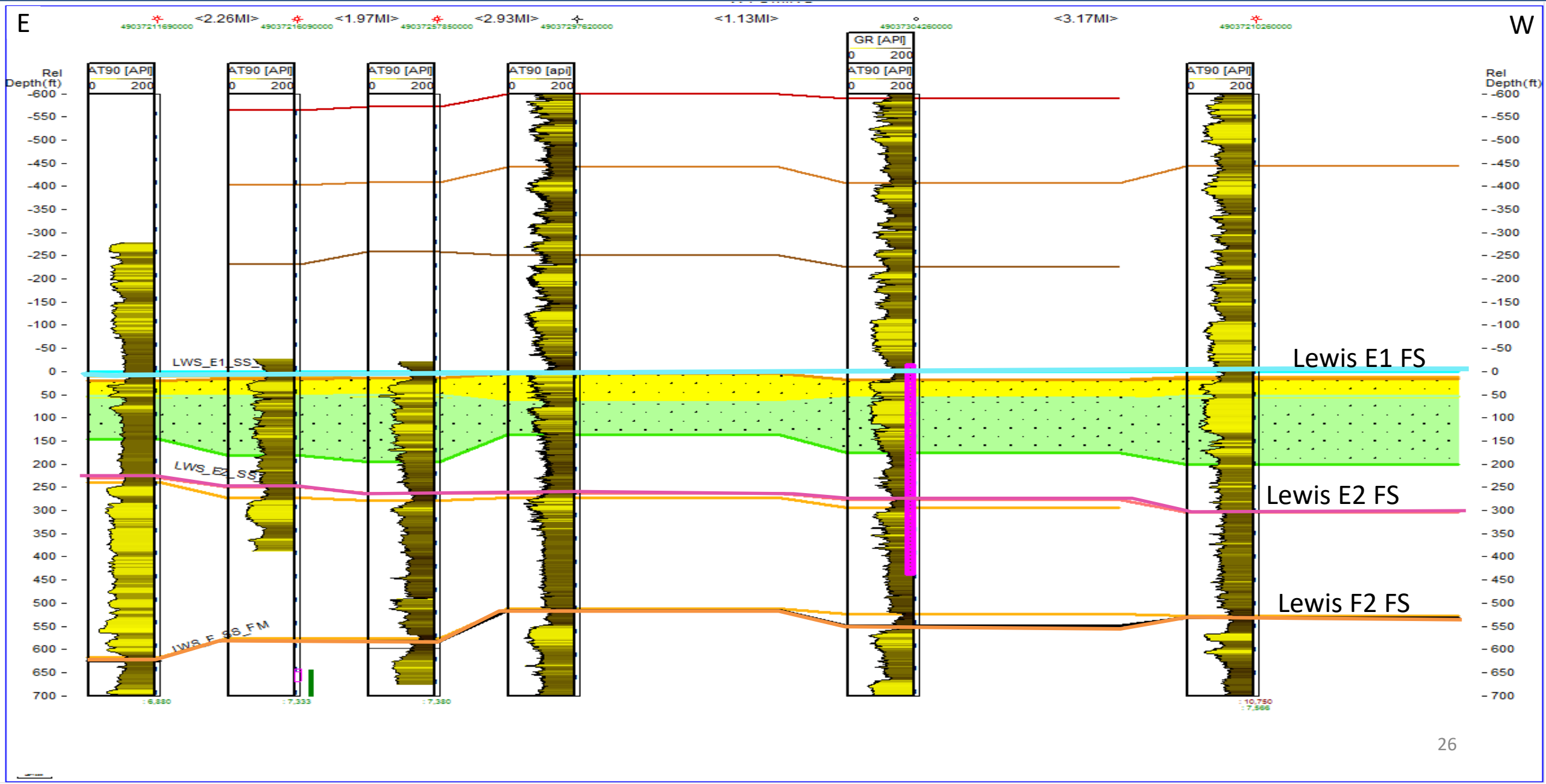
- Facies range from “Massive” sandstone, Finely laminated Coarse sandstone, Silty Sandstone, Sandy Siltstone, Siltstones and shale. All with different grades of Bioturbation.
- Compositionally similar to the other cores.
- High quartz content.
- Abundance of micas, Pyrite, Organic matter, Dolomite and Chlorite.
- Microcrystalline quartz present in all the samples.
- Calcite cement and Dolomite as grain and replacement.
- Organic matter is highly abundant and seems to be filling pore space.
- There seems to be a correlation between the size of the Phycosyphons and grain size.



XRF Chain Lakes 5 15 1

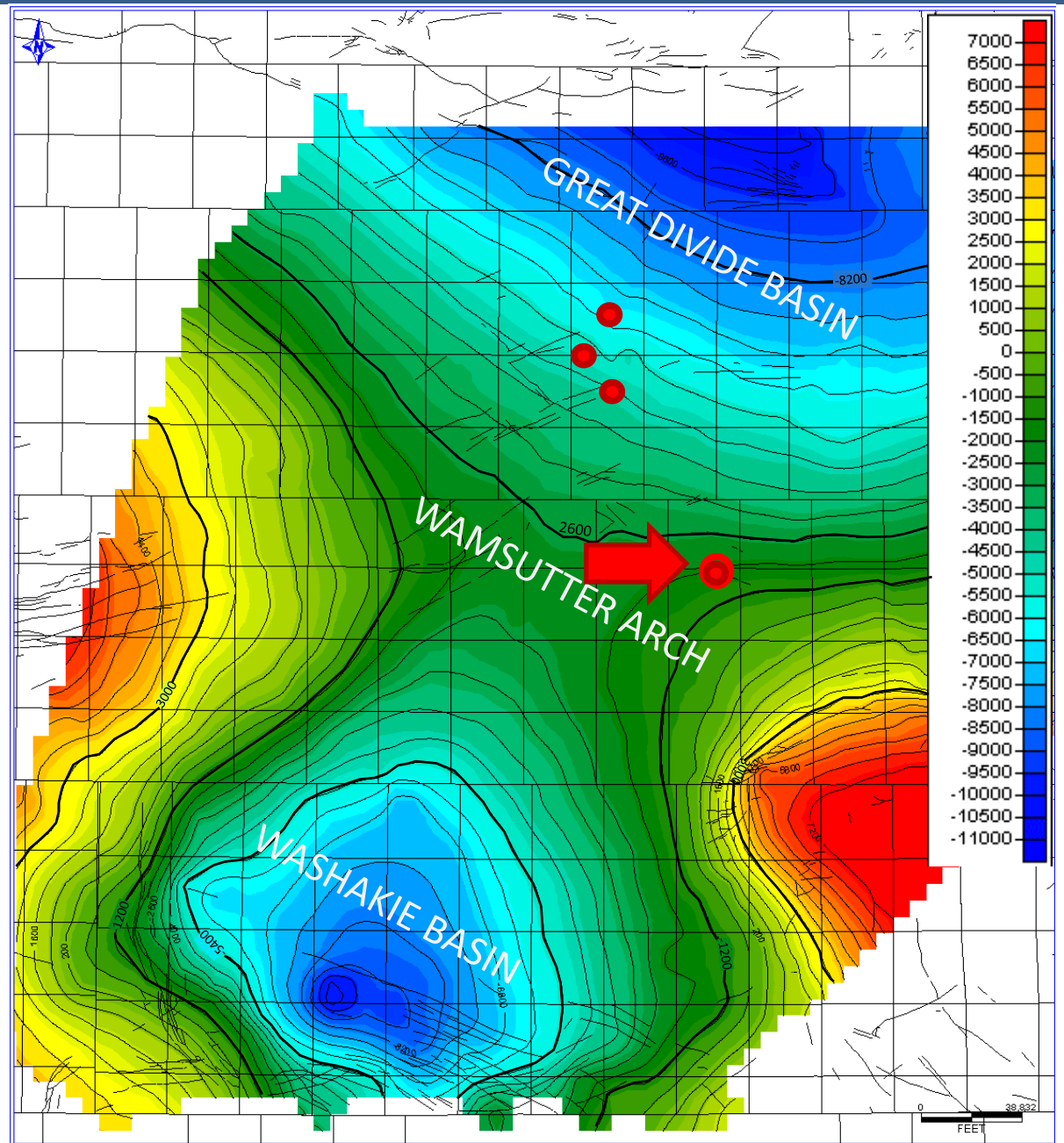


Chain Lakes 5 15 1



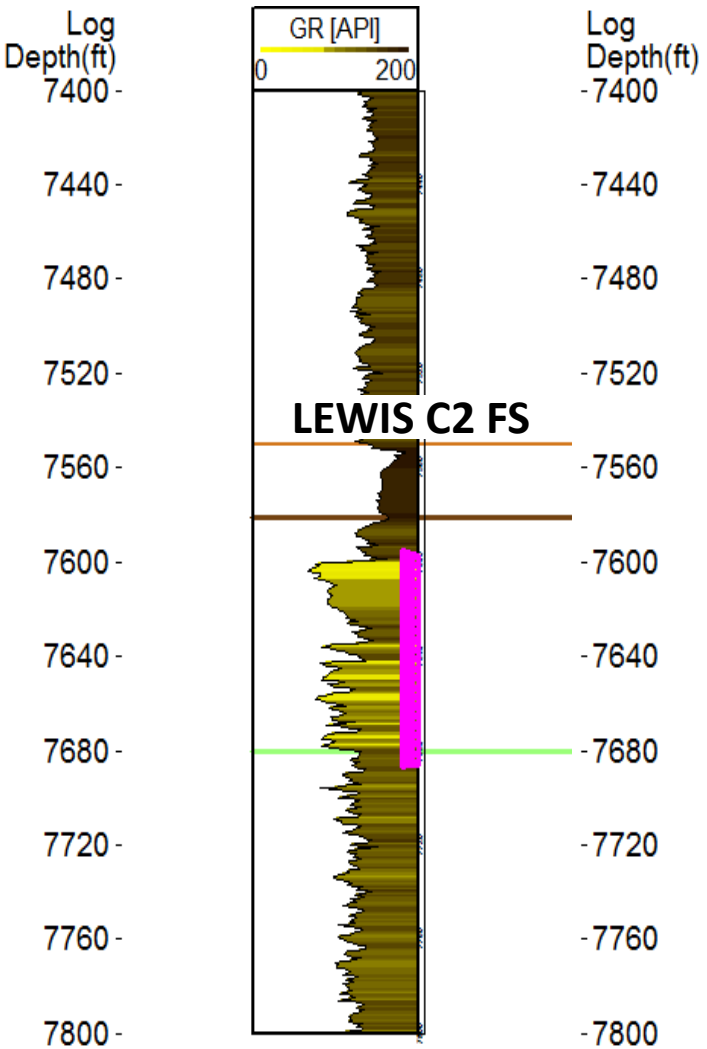
Echo Springs area

Asquith Marker Structural Map



Echo Springs core

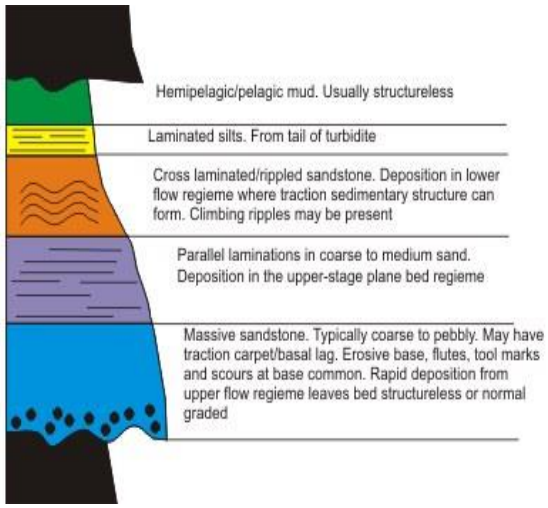
Echo Springs Core

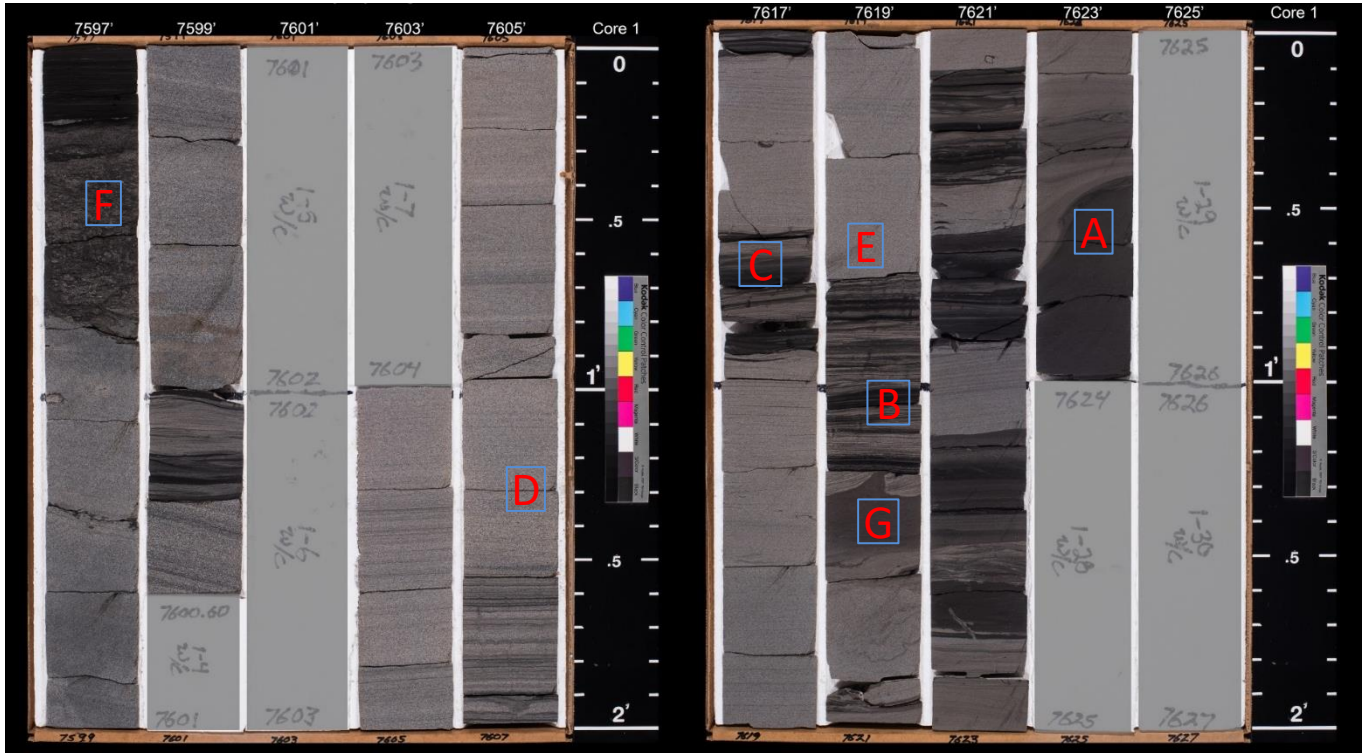


Sedimentary Structures:

- Convoluted beds A
- Flame up Structures B
- Climbing up ripples C
- Planar lamination D
- "Massive" beds E
- Ophiomorpha, Schaubcylindricnus, Phycosyphon F
- Soft sediment deformation G

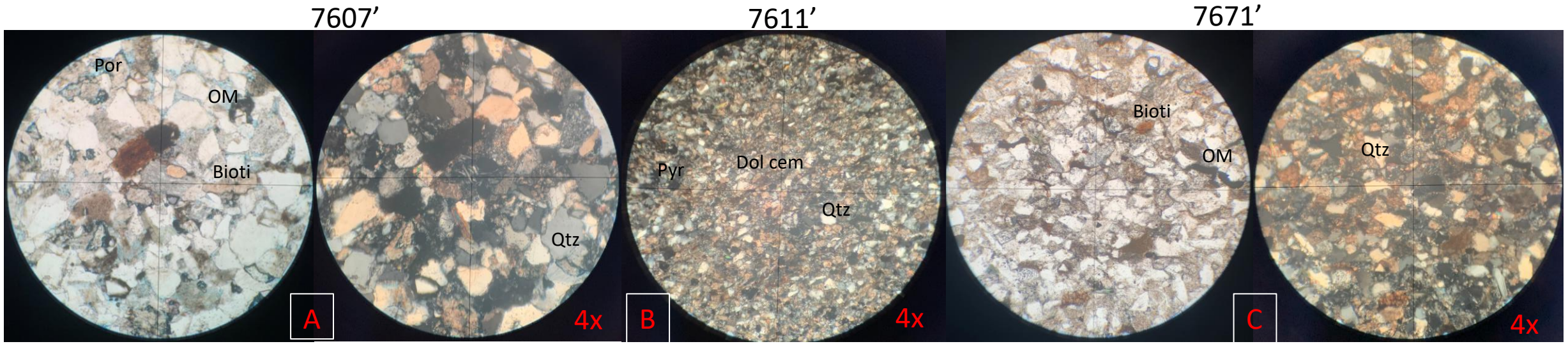
- Core varies from sandstones to siltstones to shales and exhibits several incomplete Bouma sequences at different scales





Echo Springs core

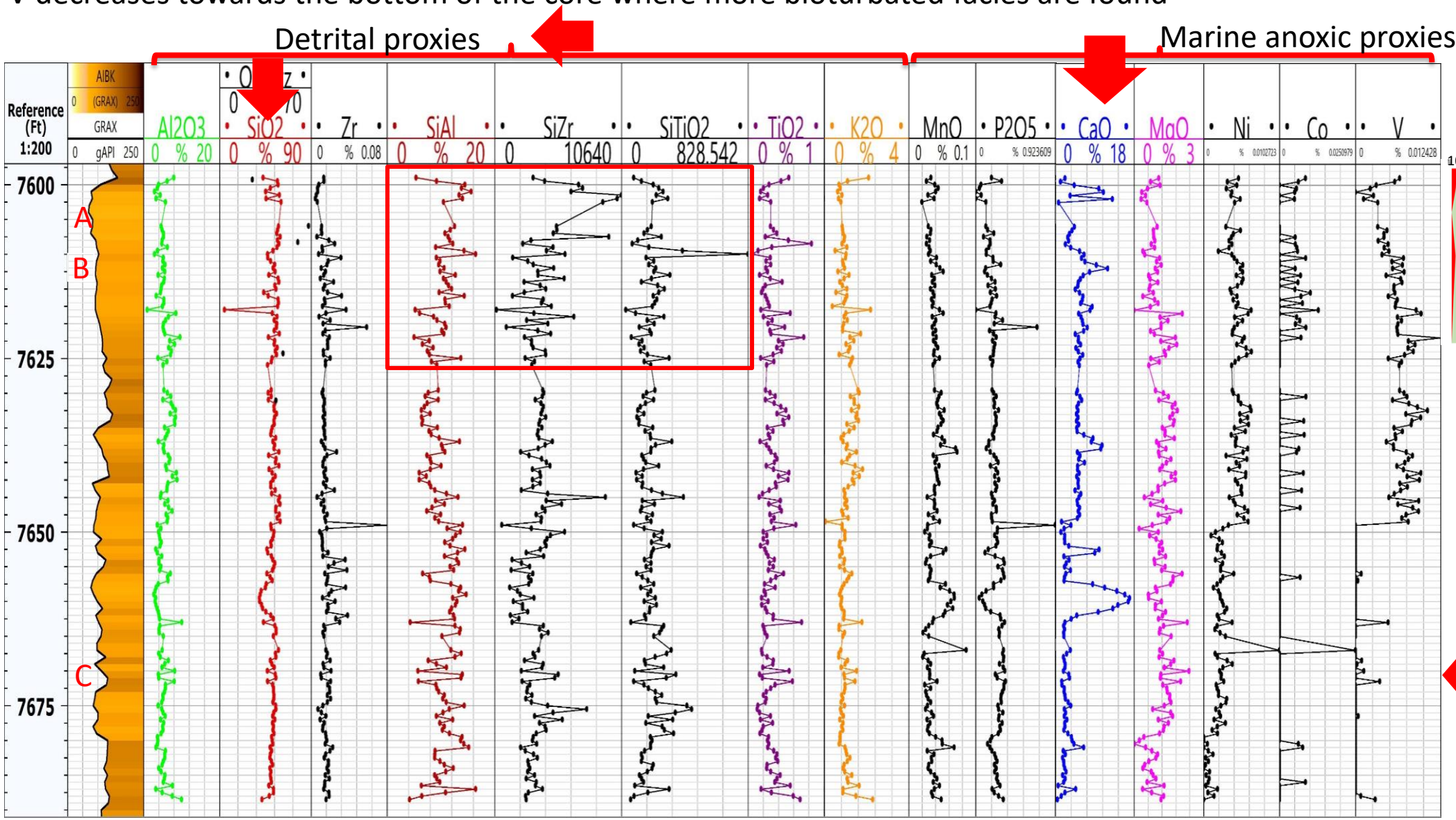
- Facies range from “Massive” sandstone, Finely laminated Coarse sandstone, Silty Sandstone, Sandy Siltstone, Siltstones and shale. All with different grades of Bioturbation.
- Compositionally similar to the other cores.
- High quartz content.
- Abundance of micas, Pyrite, Organic matter, Dolomite and Chlorite.
- Microcrystalline quartz present in all the samples.
- Calcite cement and Dolomite.
- Organic matter is highly abundant and seems to be filling pore space.

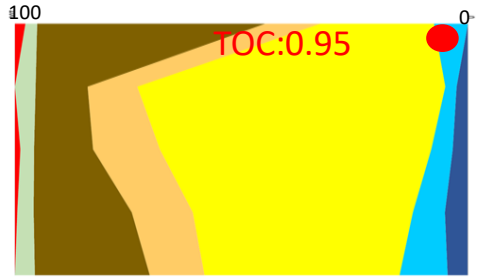


XRF Echo Springs area

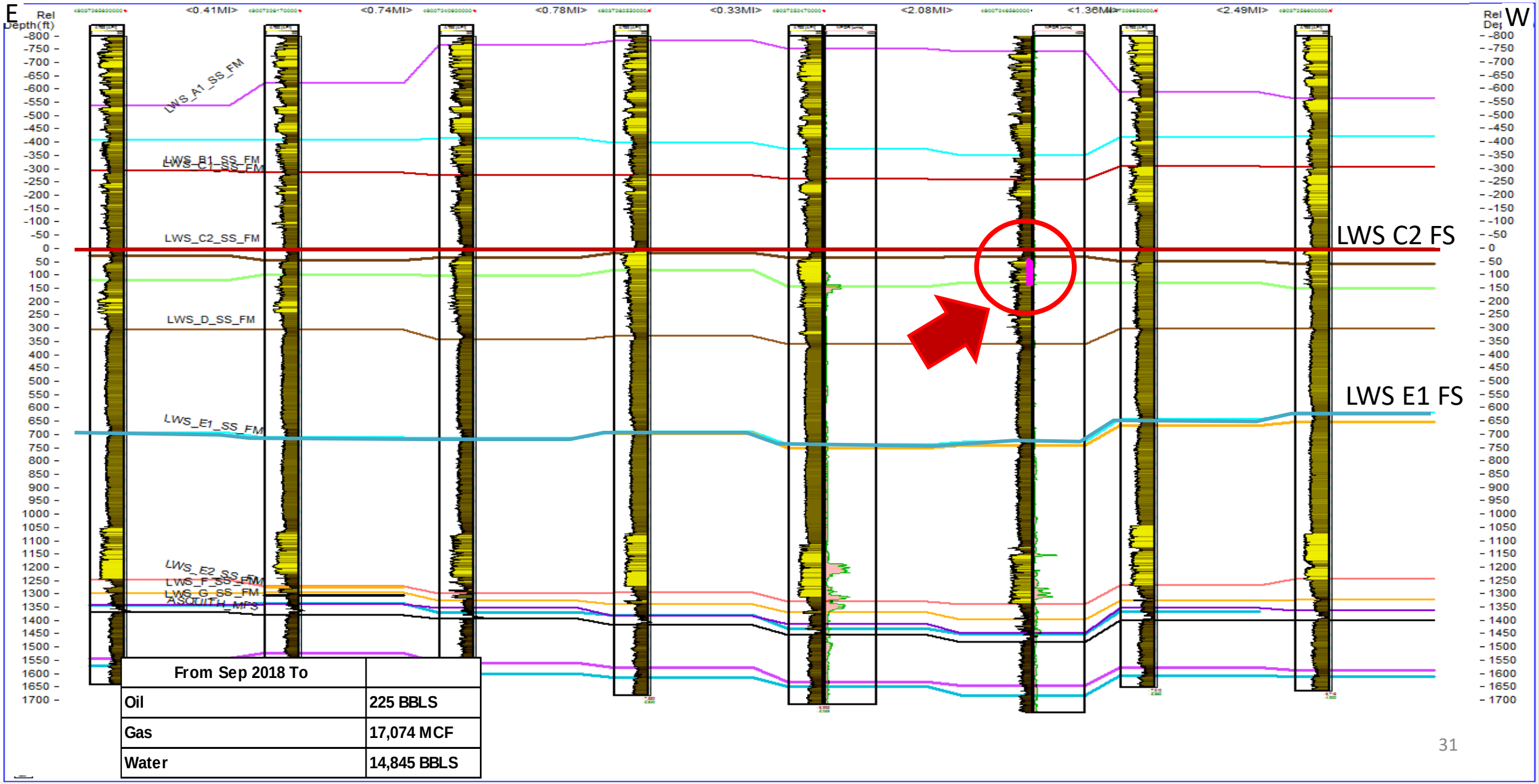
There seems to be some biogenic quartz.

V decreases towards the bottom of the core where more bioturbated facies are found



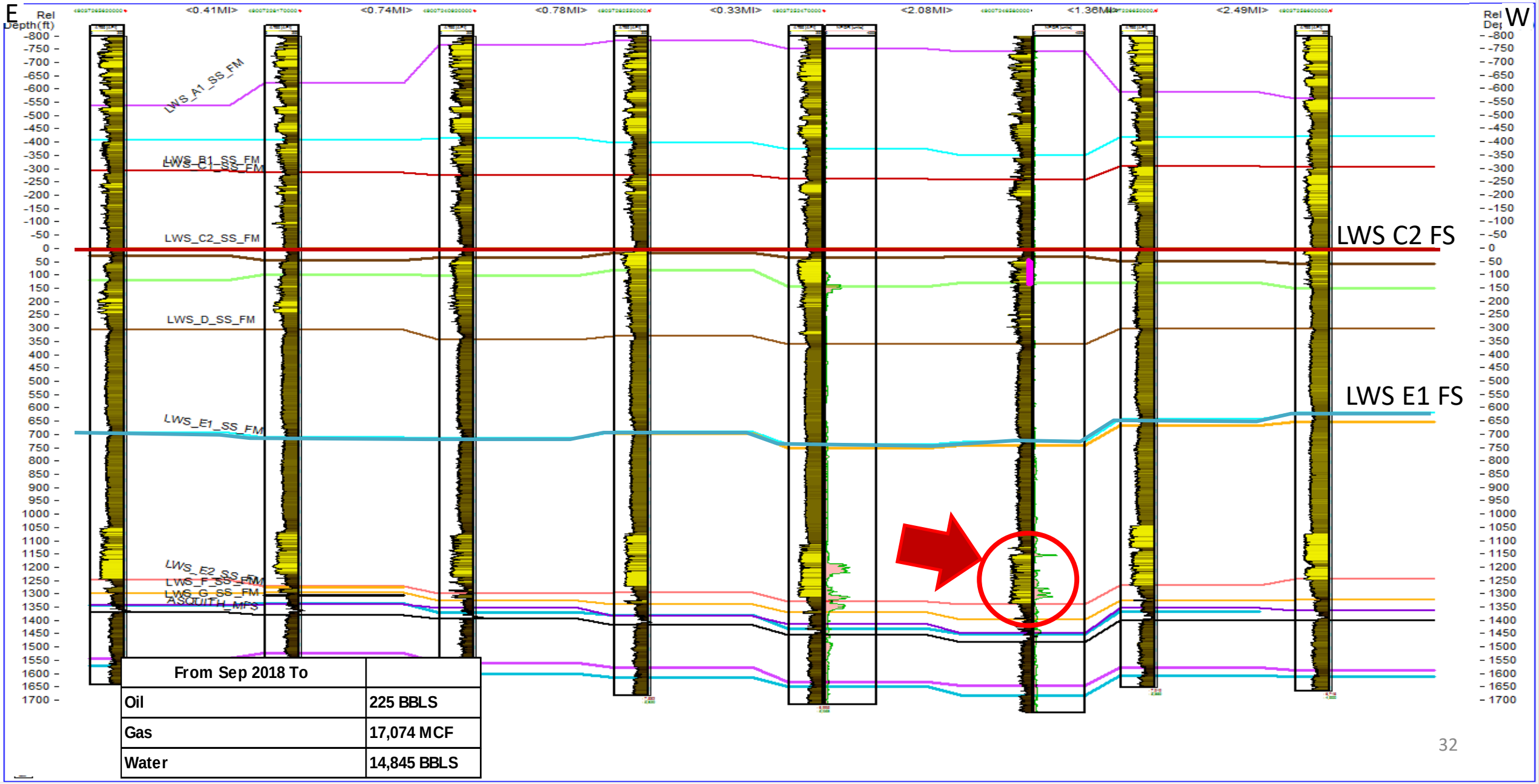


Correlation Echo Springs area



From Sep 2018 To	
Oil	225 BBLS
Gas	17,074 MCF
Water	14,845 BBLS

Correlation Echo Springs area



From Sep 2018 To	
Oil	225 BBLS
Gas	17,074 MCF
Water	14,845 BBLS

Conclusions

So Far

- Compositionally all the cores are very similar indicating the source of sediment didn't change drastically during the deposition of the Lewis Shale.
- High quartz and calcite content make these reservoirs ideal candidates for hydraulic fracturing. And areas with higher Ca content seem to have better permeability.
- Clay content could decrease permeability and increase bound water.
- Resistivity seems to be affected by both clay content and Pyrite content.
- Thickness of the intervals and lateral variability are correlated with the depositional environment and very important to keep in mind during the drilling of a well.
- All intervals seems to be restricted to Shelf Slope.
- Siltstones intervals seem to be good candidates for horizontal wells due to its continuity and high brittleness but could run into some problems with the formation water.

Next up

- Production data analysis for cored areas
- Petrophysical model
- Porosity maps
- Mineralogical model

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Spring 2021

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