Stratigraphy of Lower Hinton: A Record of Transgressive-Regressive Episodes Preserved in the Ancient Coastal Plain and Estuaries of the Upper Mississippian Appalachian Basin, WV, USA*

Tyson M. Smith[1] and Louis R. Bartek[2]

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Abstract

In southern West Virginia, the Hinton Formation is a lithologic record of coastal plain (in outcrop) to estuarine marginal marine (in the subsurface) environments that were intermittently inundated by marine sedimentation during the late Chesterian. The ancient coastal plain on which these sediments were deposited existed along the northeastern shore of the Appalachian basin where an extensive record of Late Paleozoic sedimentation was preserved by foreland basin subsidence.

Cyclothems, a characteristic feature of Pennsylvanian Appalachian basin stratigraphy, are attributed to glacioeustatic fluctuation during the late Paleozoic, and have been the subject of much research. Despite geologic evidence that supports the presence of continental ice sheets during the late Mississippian, comparatively little work has been done until recent with regard to the identification of similar cycles in Chesterian stratigraphy. This study provides evidence for the presence of high frequency, transgressive-regressive cycles during the late Mississippian, in many ways similar to Pennsylvanian cyclothems. The eight transgressive-regressive episodes recorded in the coastal plain to marginal marine stratigraphy occurred over a roughly 2.5 million-year span. These time constraints allow the eight transgressive-regressive episodes to be classified as fourth order. The character of these episodes appears to be modulated by a third order lowstand and transgression. Sedimentation in these ancient environments was controlled by multiple allogenic forcing mechanisms, the interaction of which shaped the architectural motif of the geologic record that is present today. This study analyzes that record and documents how multiple controls on relative sea level, which operate on different timescales, influence sedimentation within coastal plain to marginal marine environments.

Selected References

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Stratigraphy of the Lower Hinton:

A Record of Transgressive-Regressive Episodes preserved in the Ancient Coastal Plain and Estuaries of the Upper Mississippian Appalachian Basin, WV, USA

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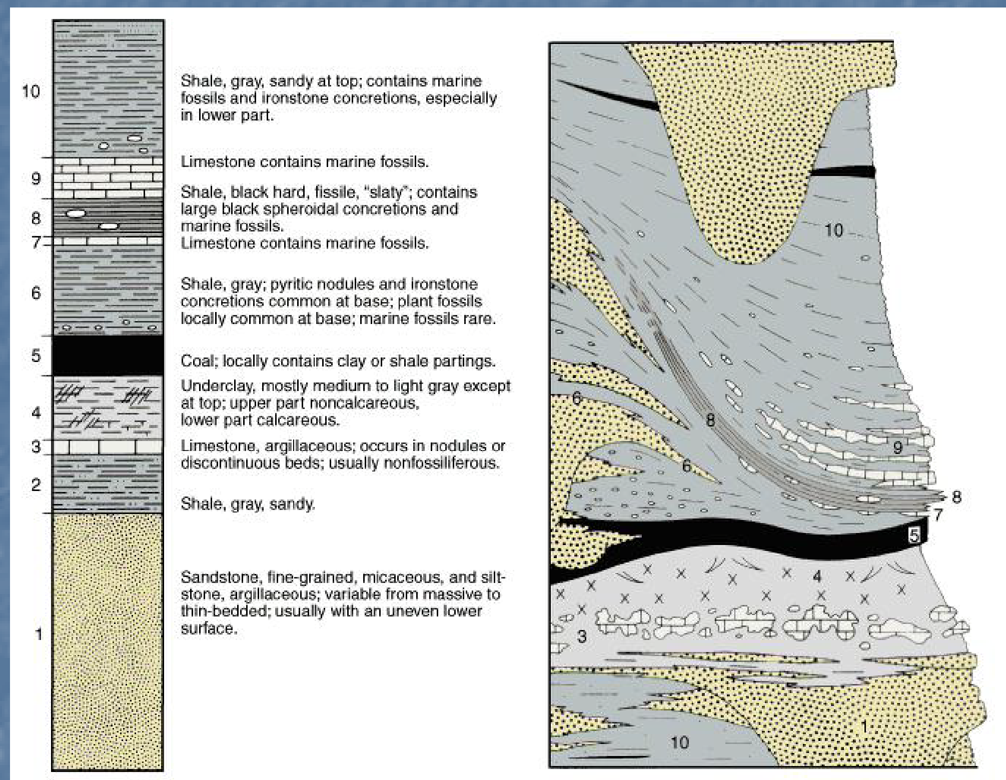
Louis R. Bartek

Motivation

Pennsylvanian cyclothem:



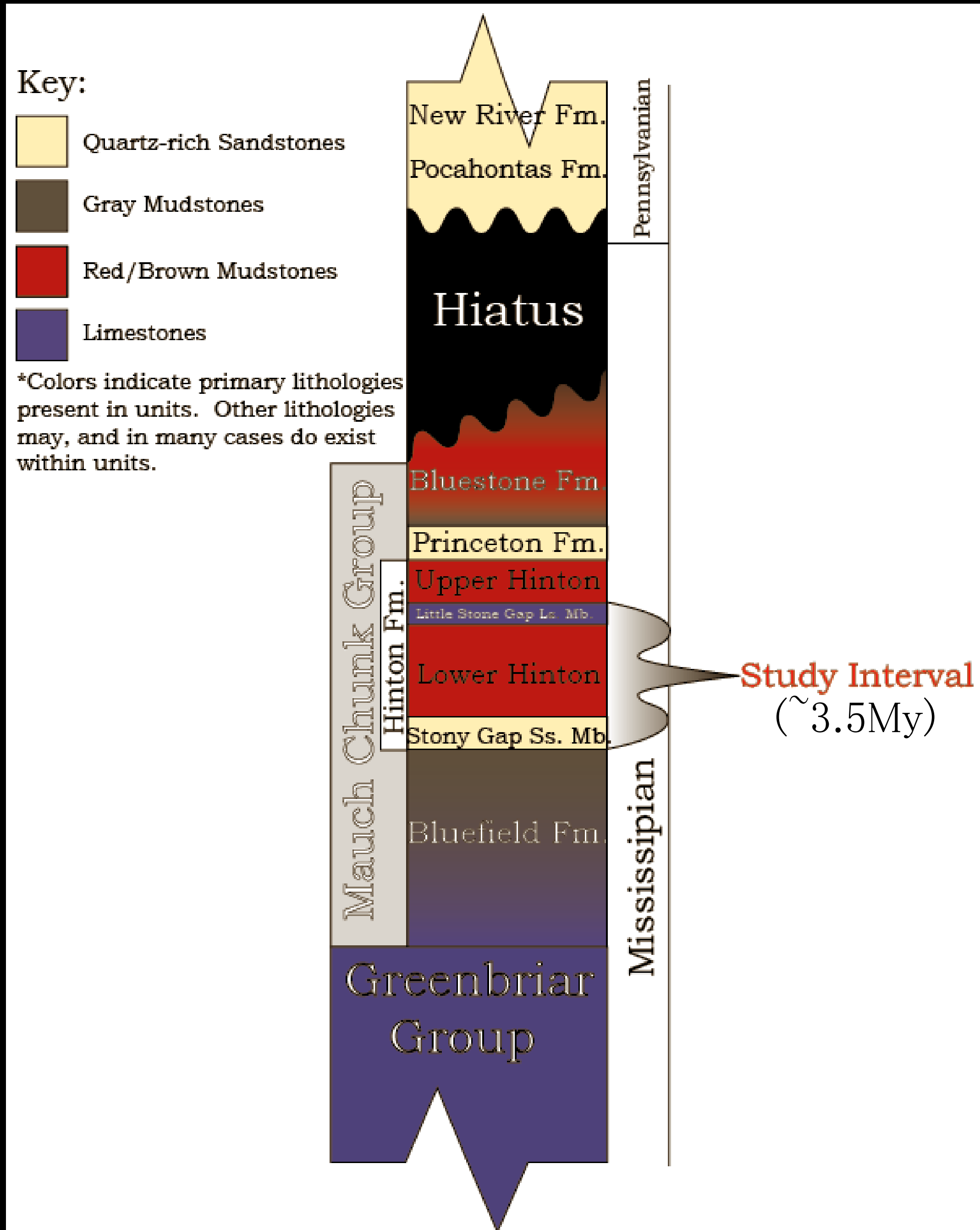
(William & Payne, 1942) (Baird & Shabica, 1980)

Do Mississippian transgressive/regressive events exist?

Outline

- Geologic Background
- Data & Facies Associations
- Depositional Model & Cross-Sections
- Discussion & Conclusions

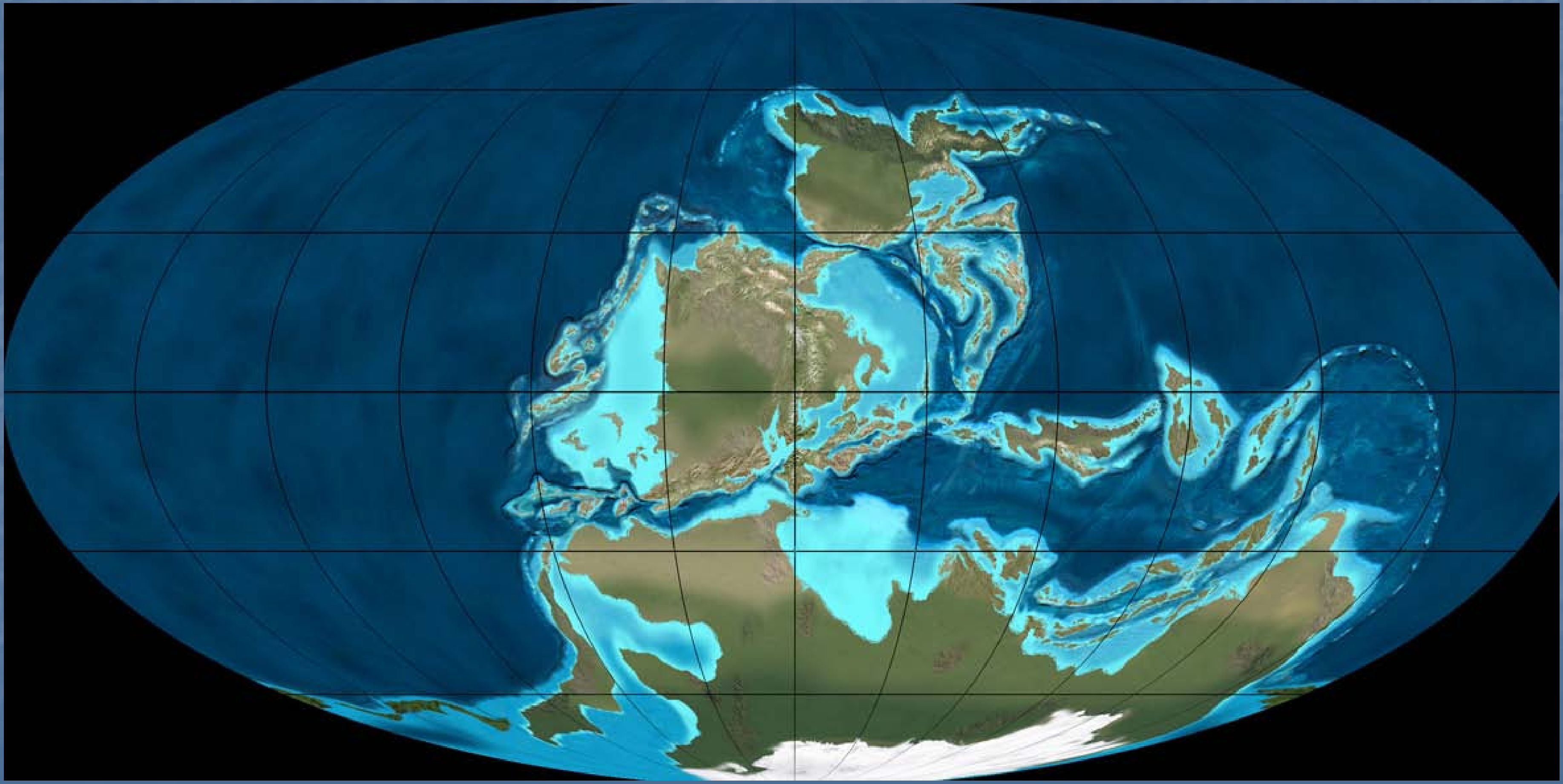
Mississippian Stratigraphy



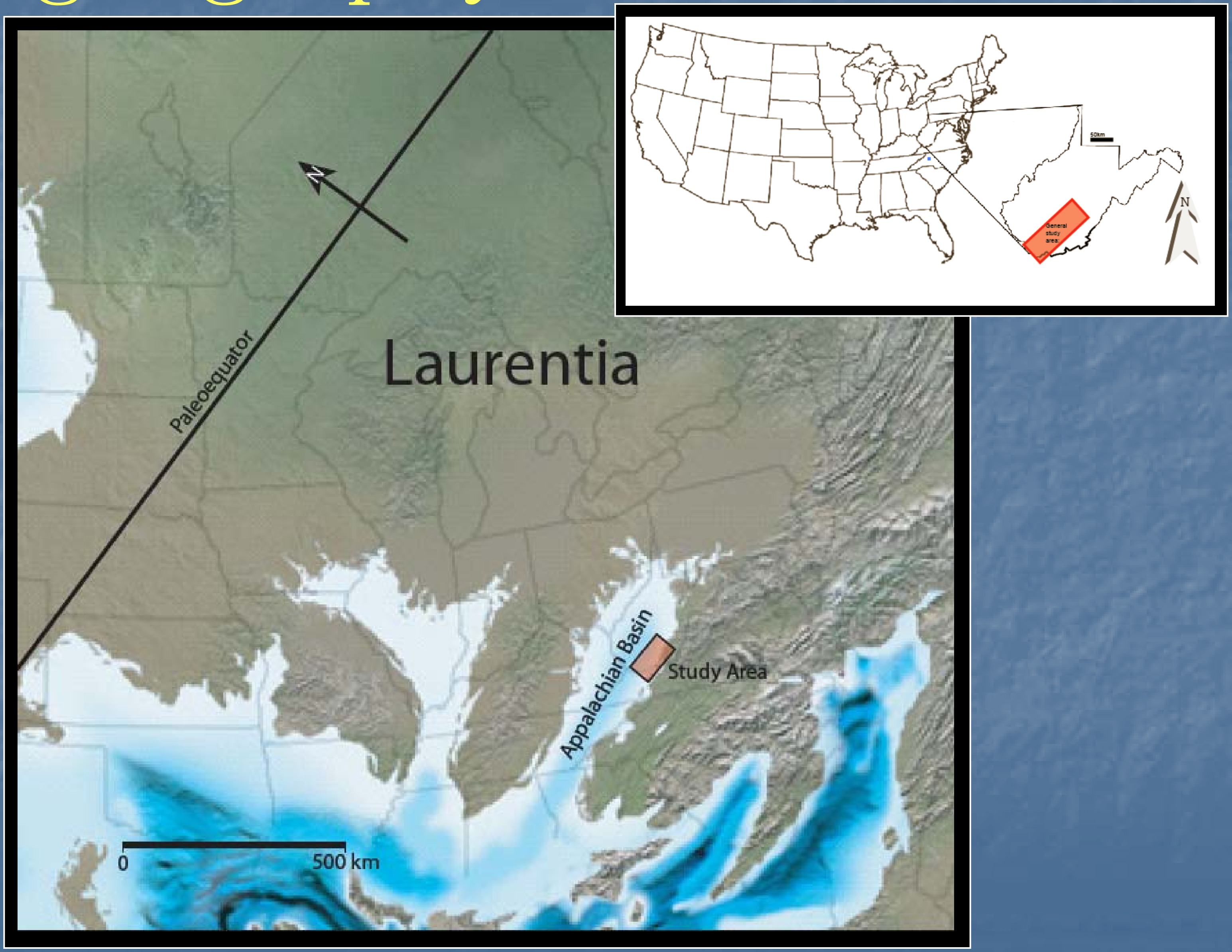
Study Interval:

328.5 My to 325 My

Paleogeography ~340 Ma

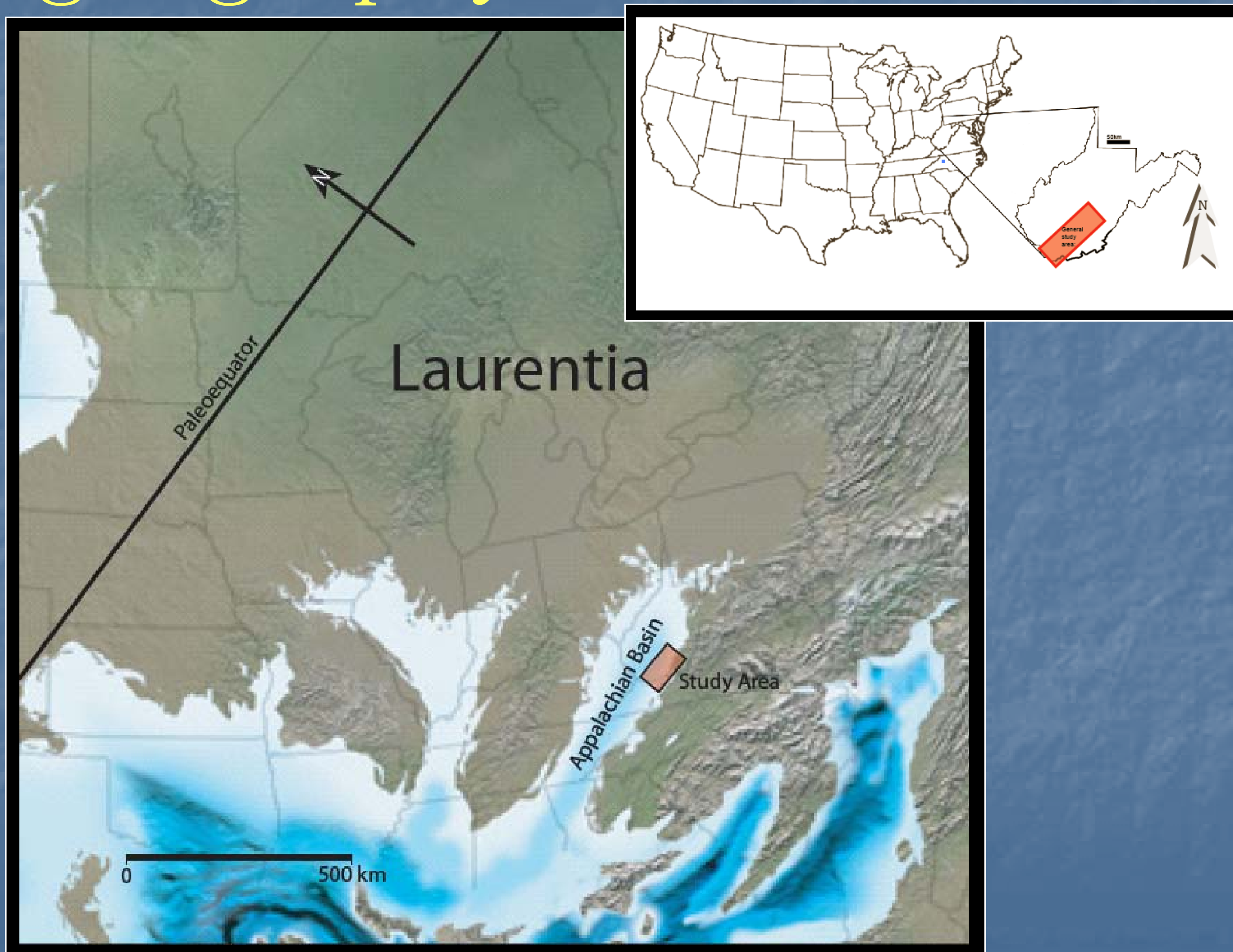


Paleogeography ~325 Ma



(Blakey, 2009)

Paleogeography ~325 Ma



(Blakey, 2009)

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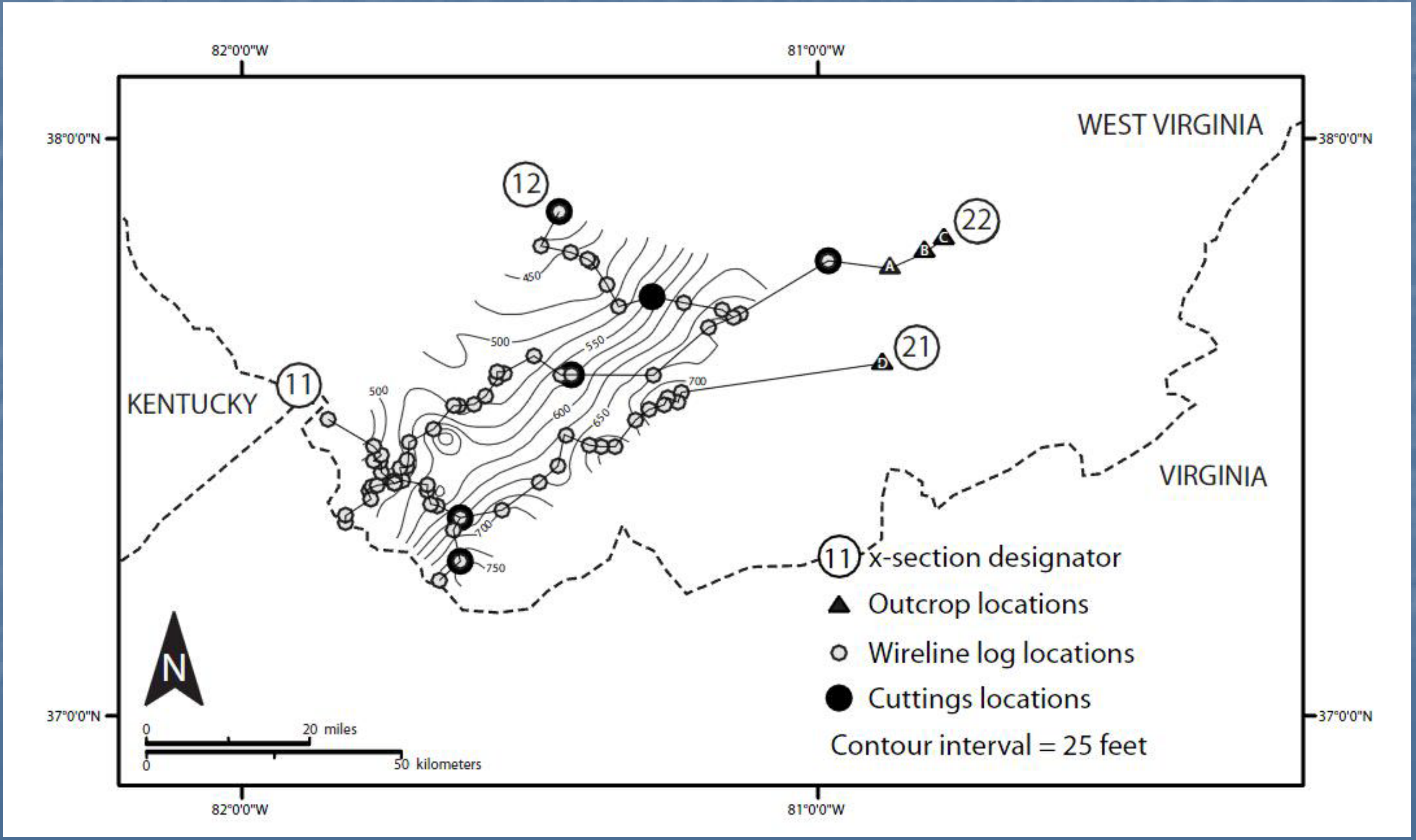
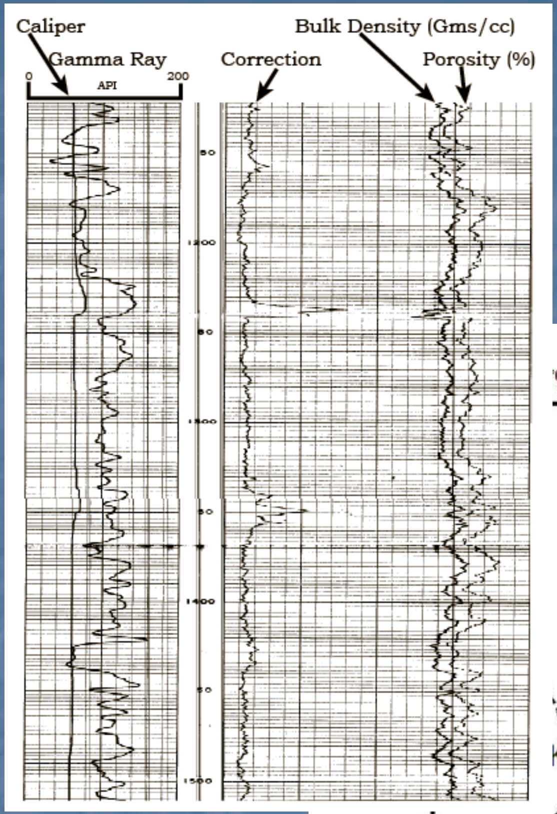
Data



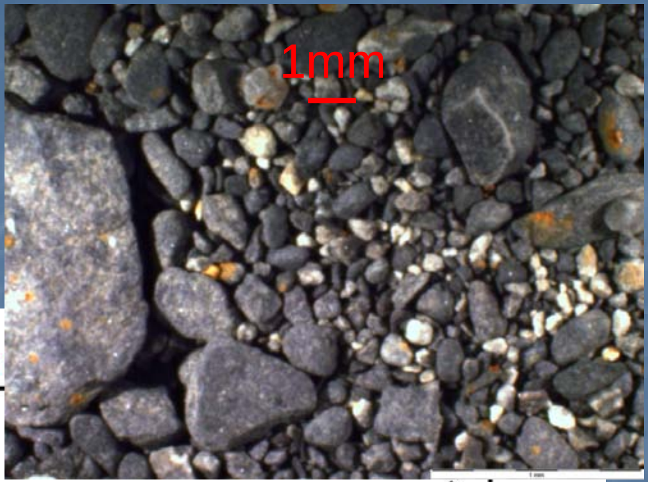
82°0'0"W
81°0'0"W
38°0'0"N
37°0'0"N
WEST VIRGINIA
KENTUCKY
VIRGINIA
12
22
21
11
A
B
C
D
450
500
550
600
650
700
750
11 x-section designator
Outcrop locations
Wireline log locations
Cuttings locations
Contour interval = 25 feet
N
0 20 miles
0 50 kilometers

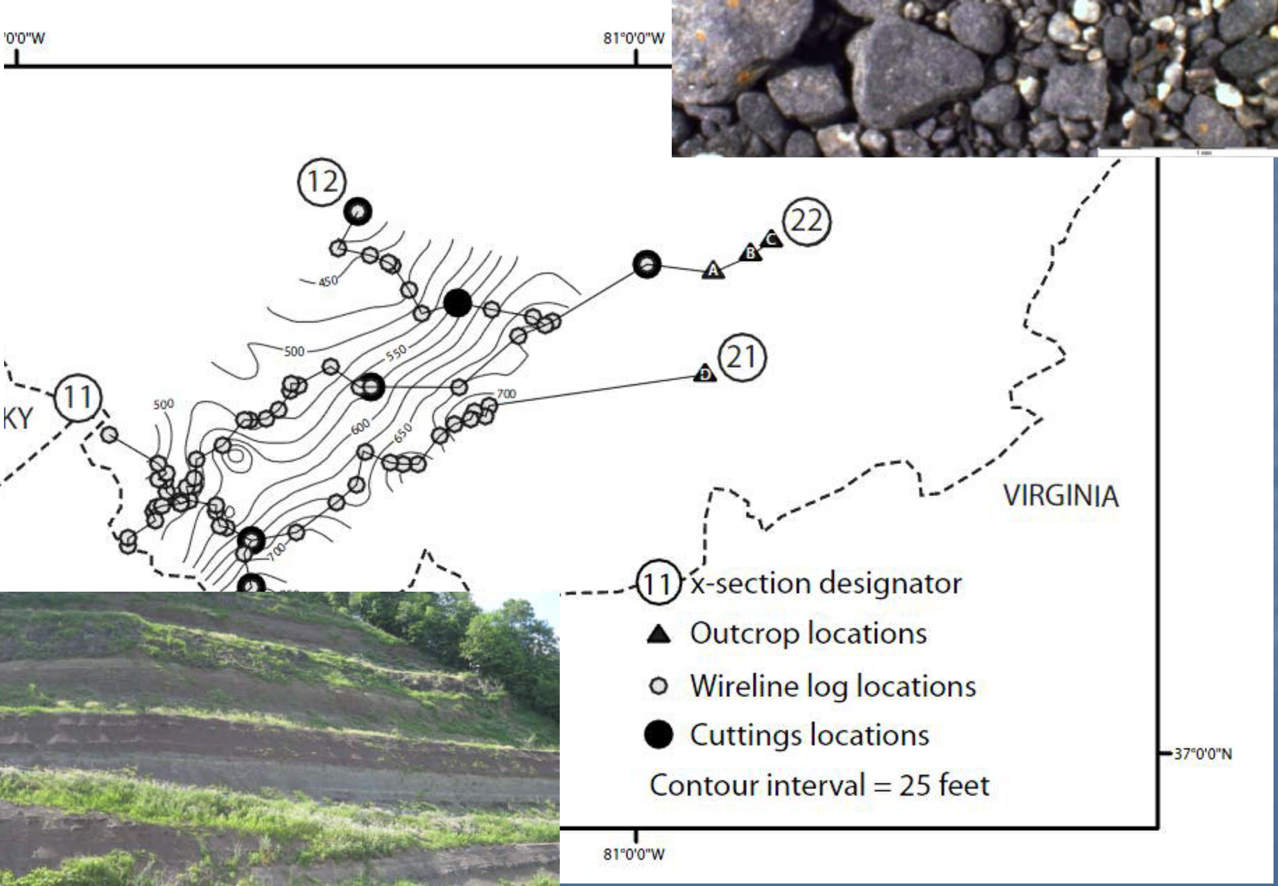
Data

Wire line logs



Cuttings





Outcrop

Facies Association 1– Coastal Plain

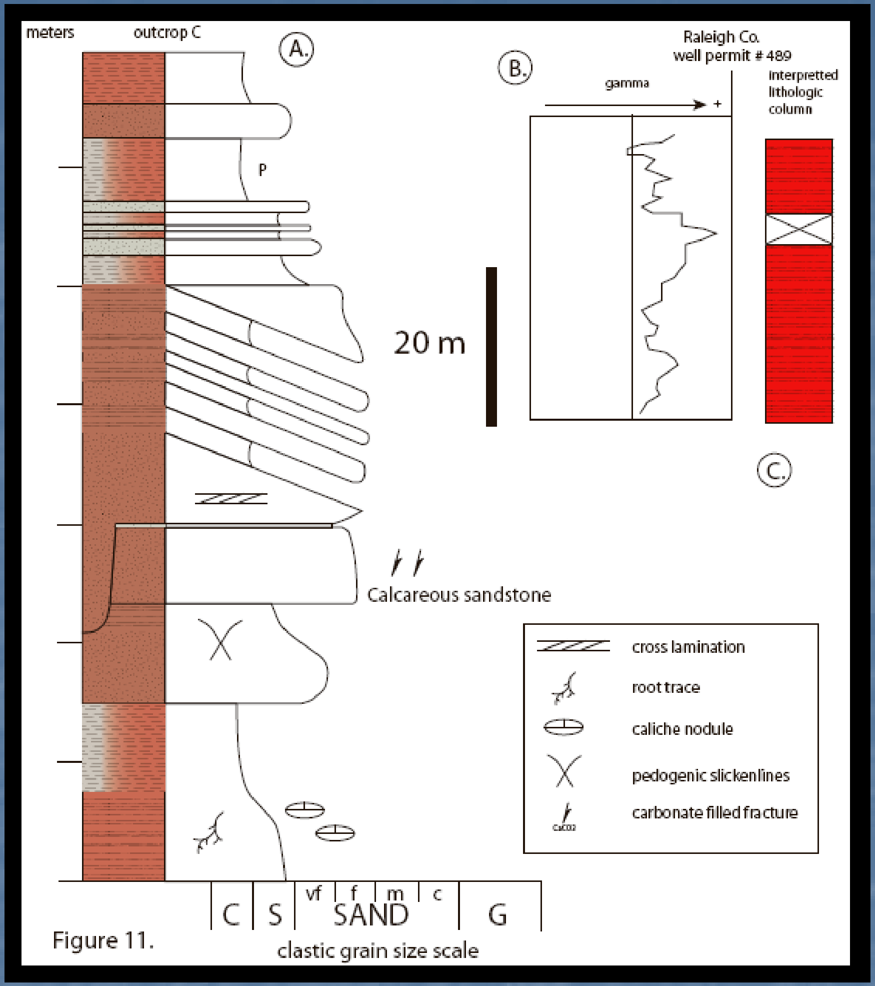
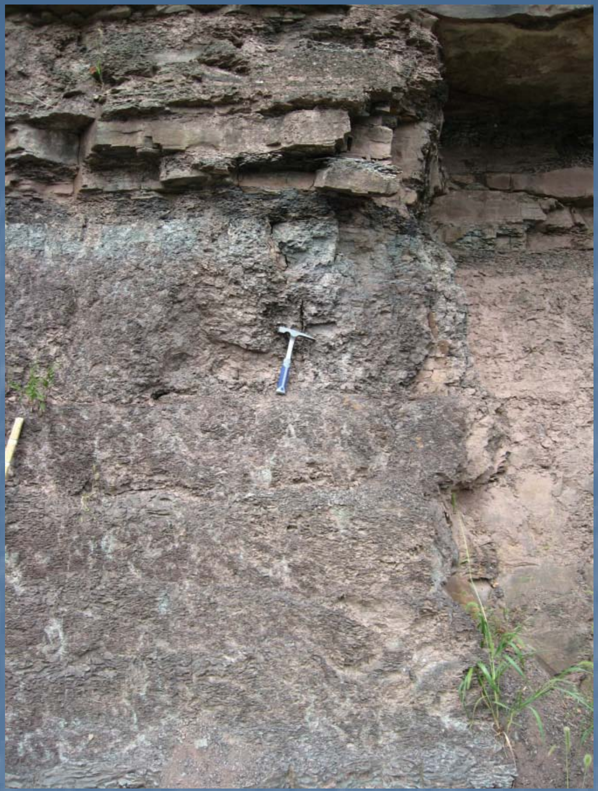
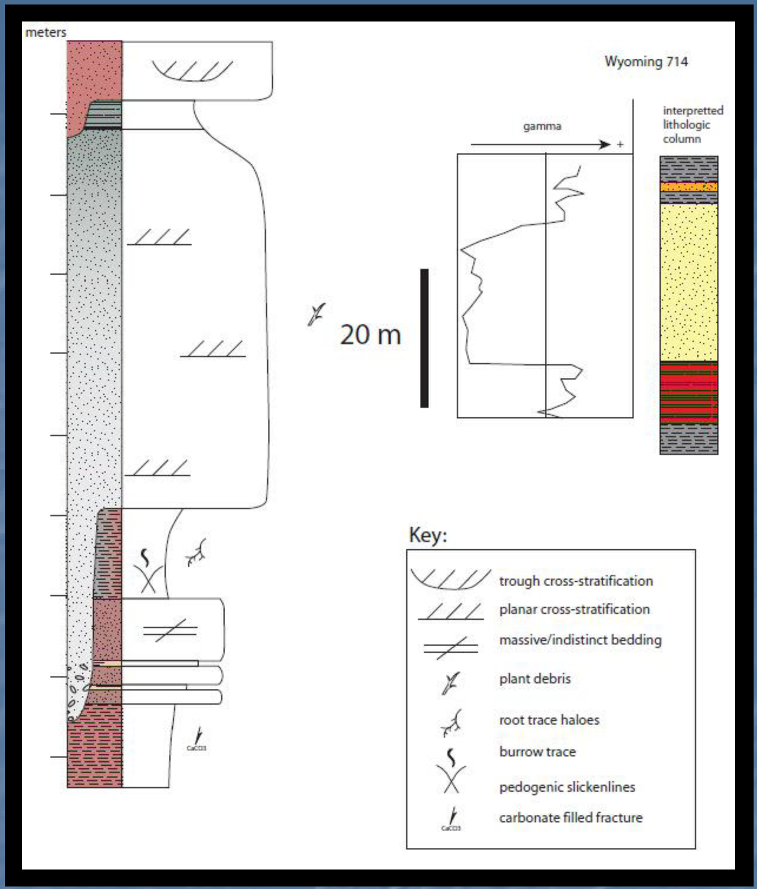


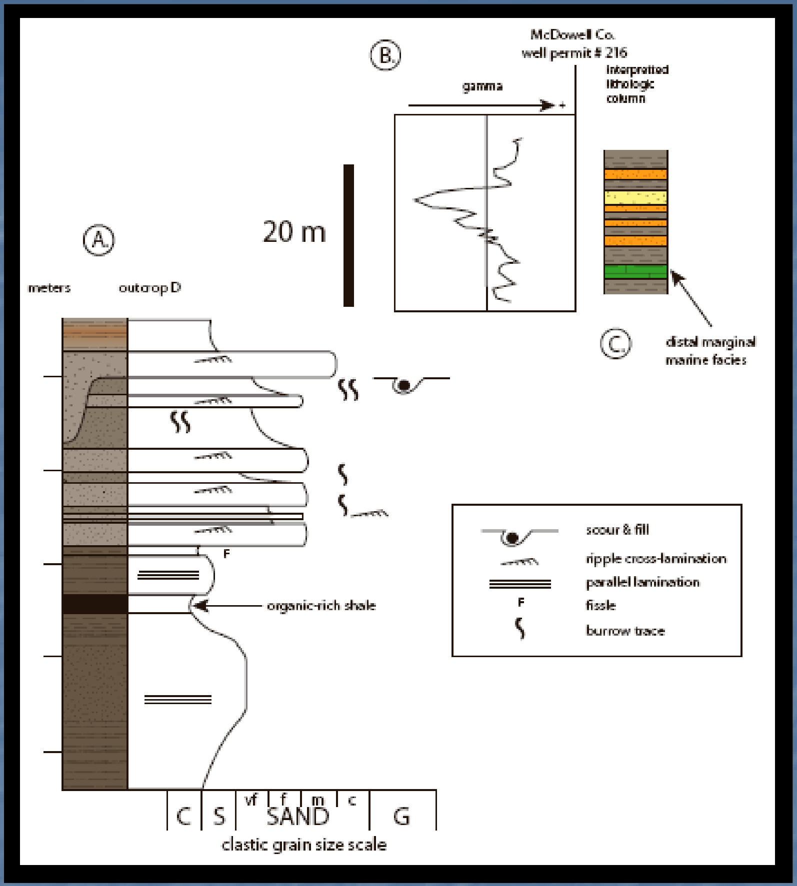
Figure 11.



Facies Association 2–High Energy Fluvio/Estuarine

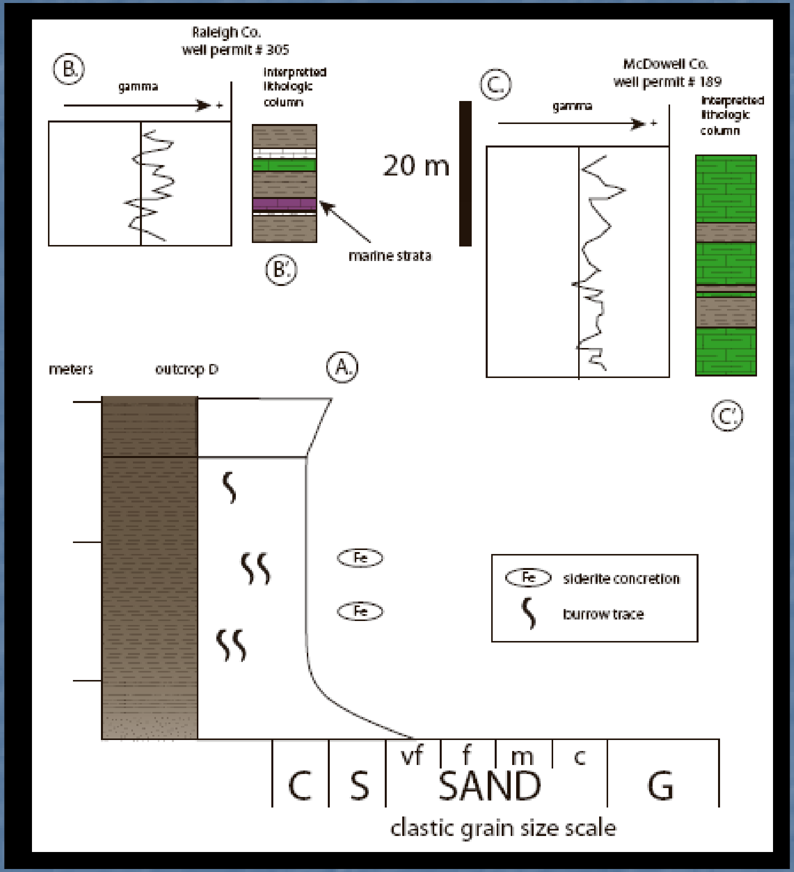


Facies Association 3– Proximal Marginal Marine

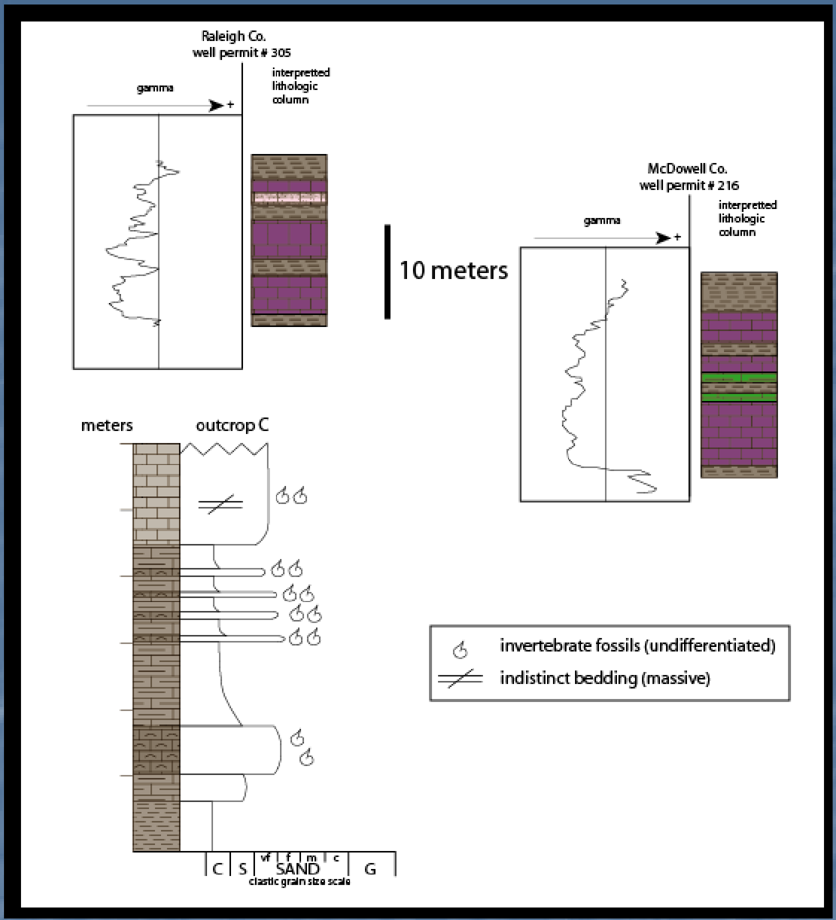


Facies Association 4–

Mixed Clastic/Carbonate Distal Marginal Marine



Facies Association 5- Carbonate Dominated Marine



Outline

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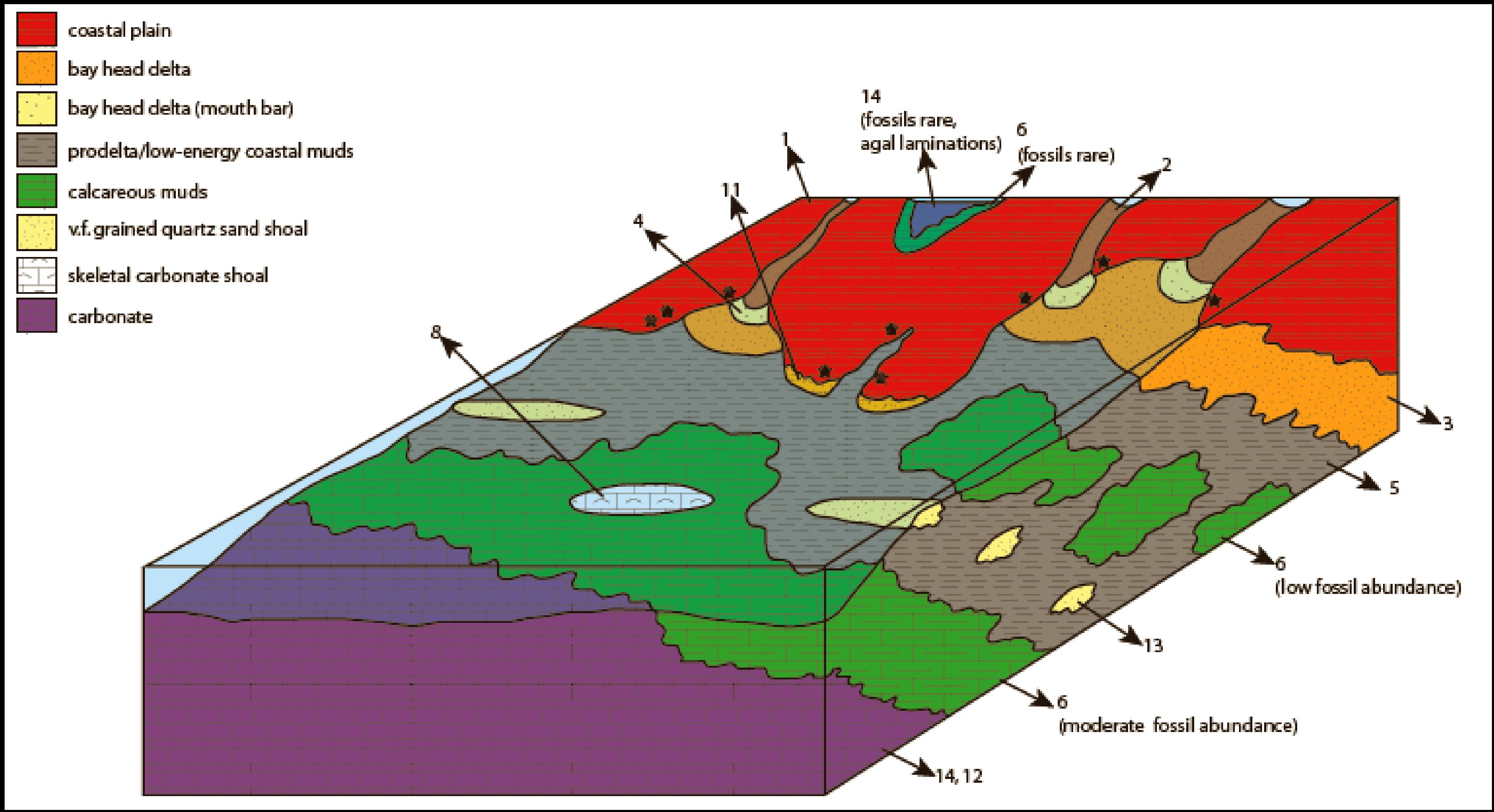
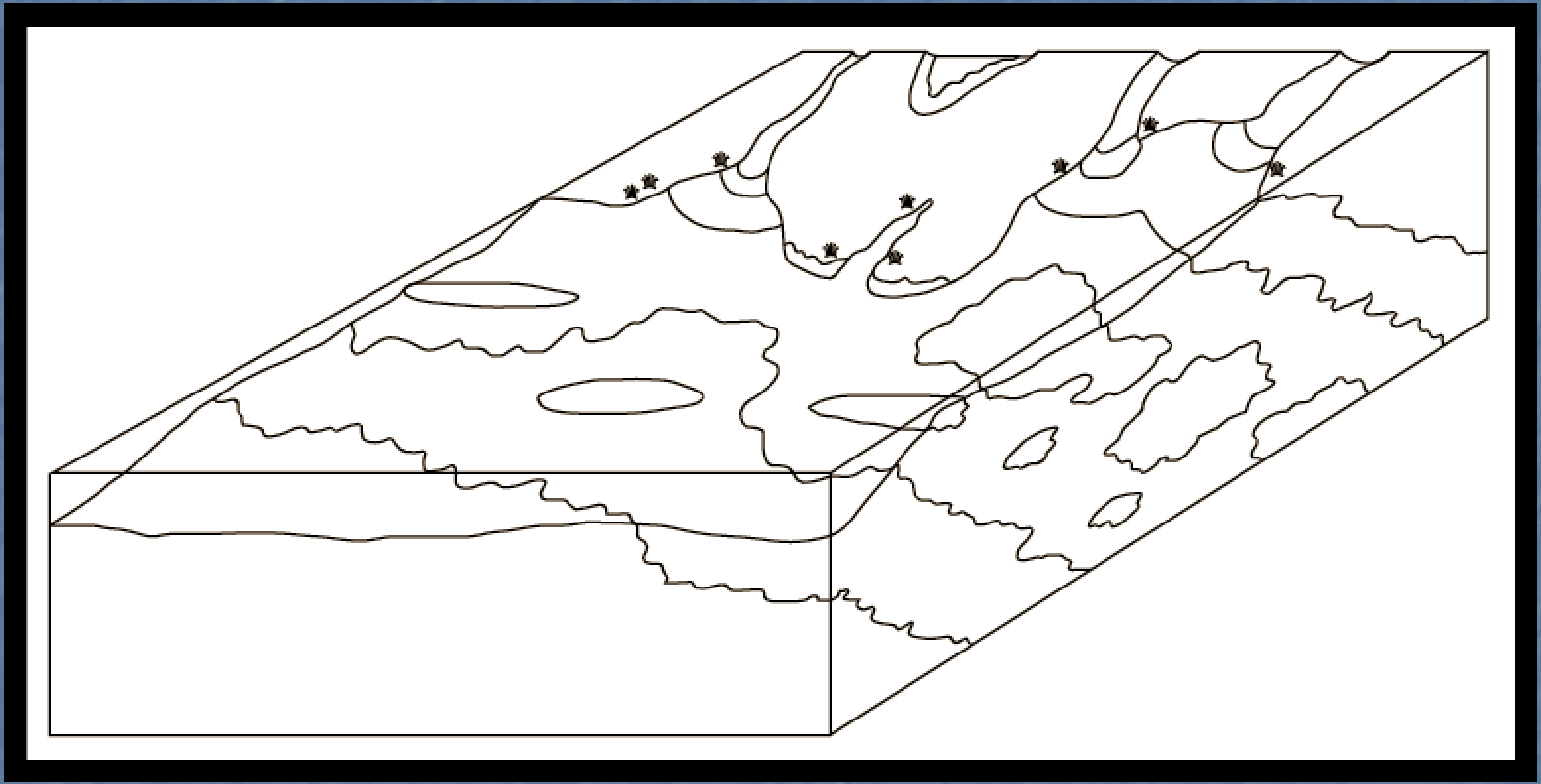
Depositional Model



Facies Model



Facies Model

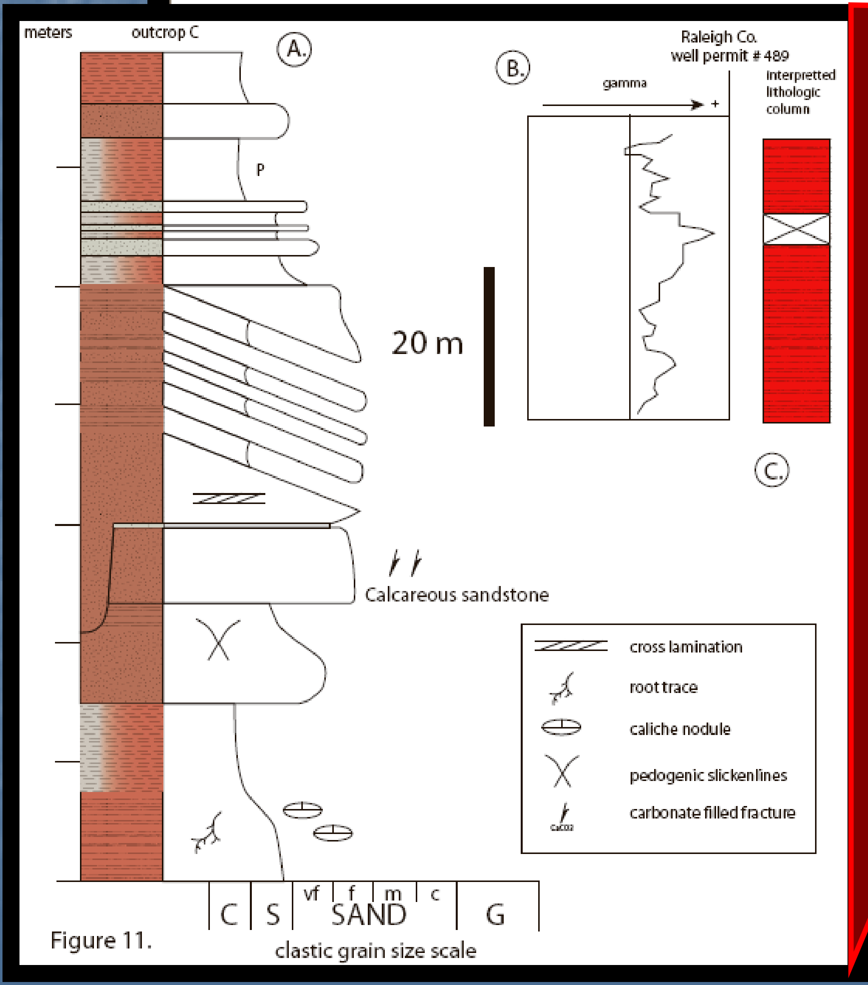
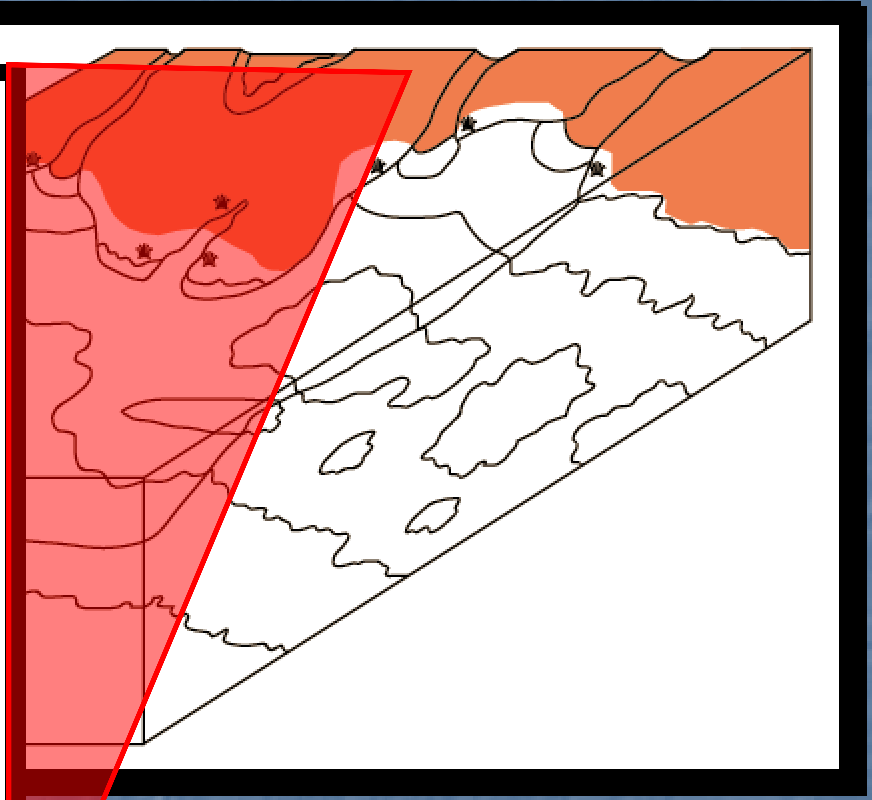
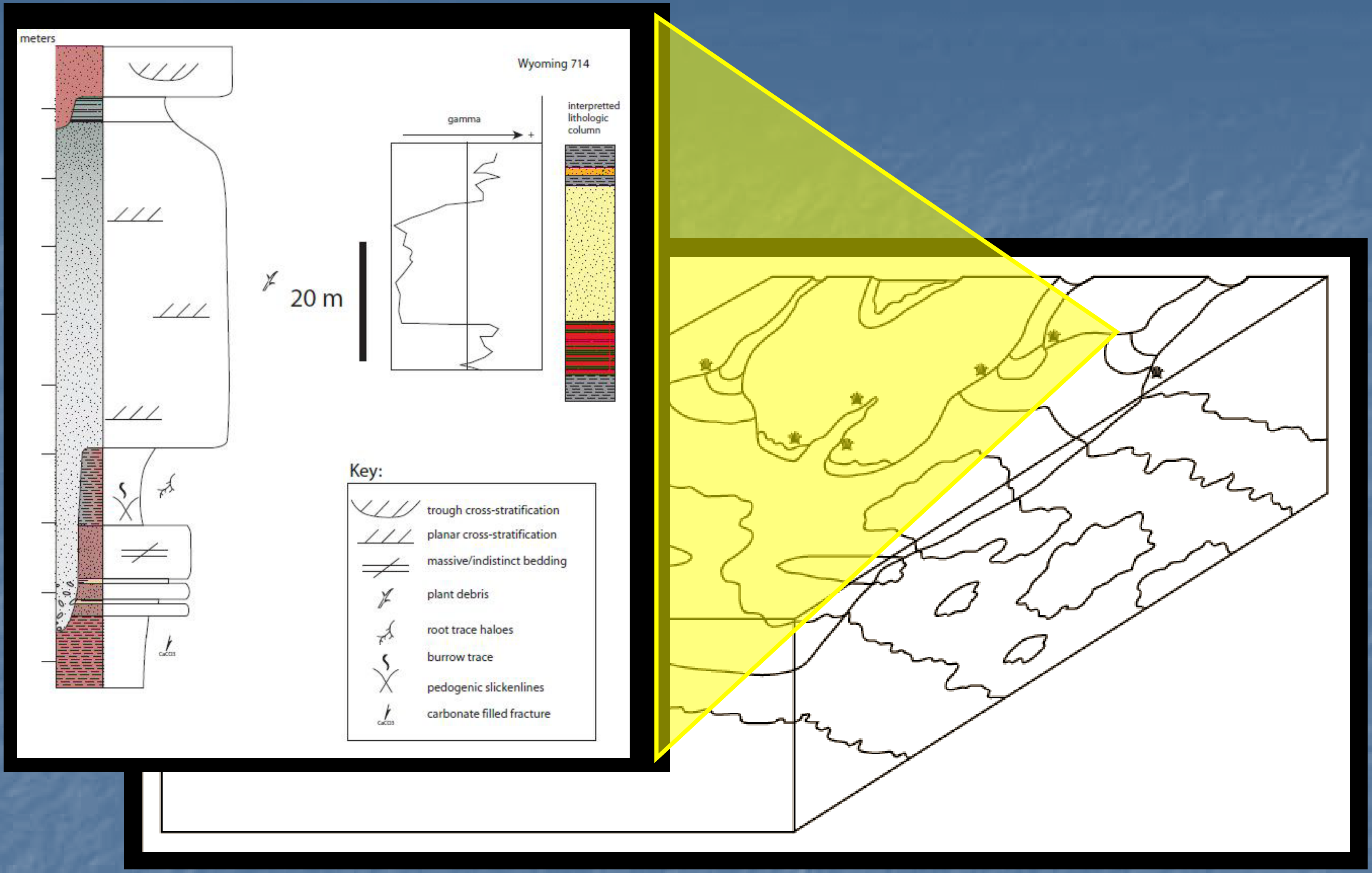
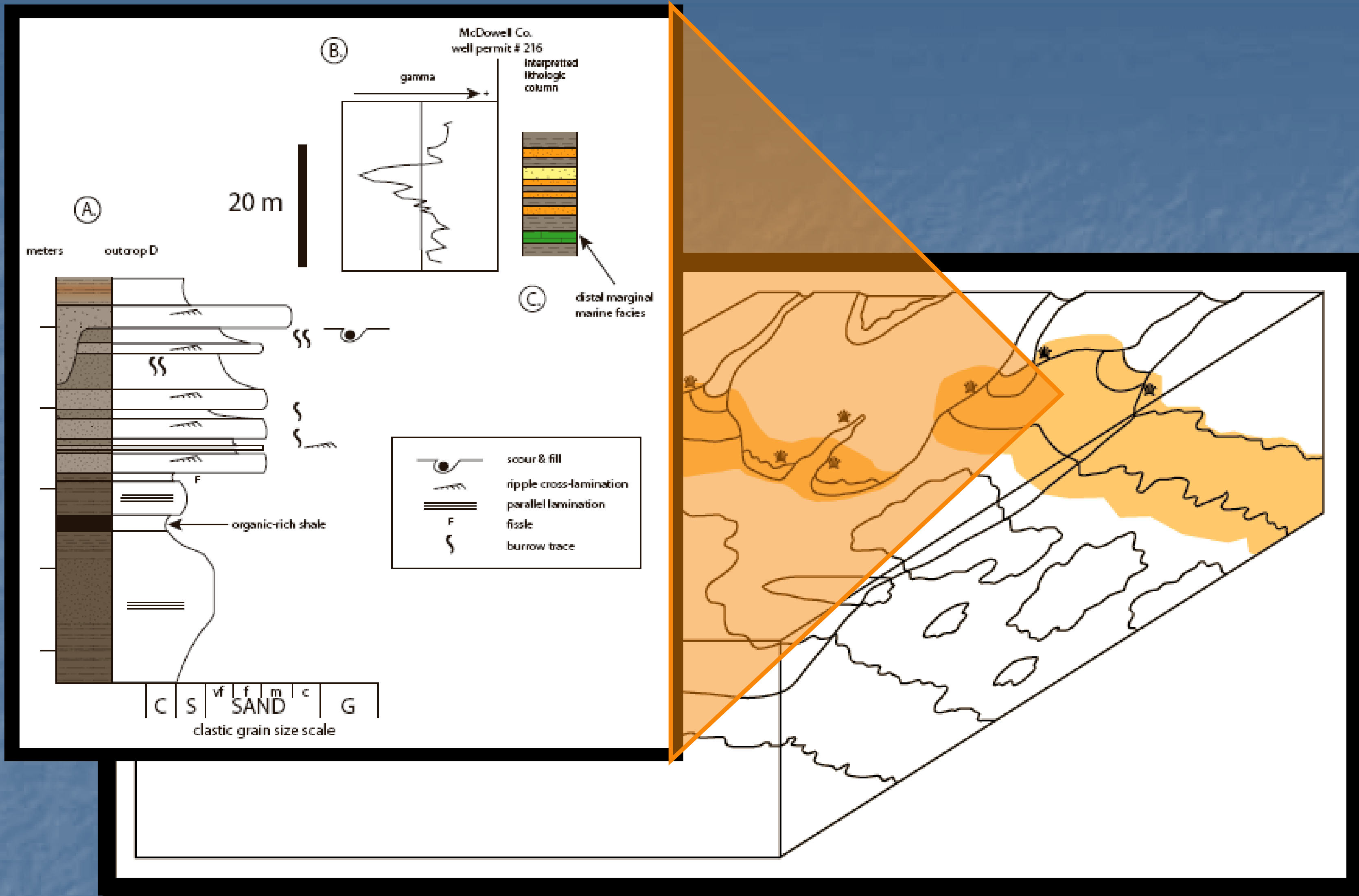


Figure 11.





meters
Wyoming 714
gamma
interpretted lithologic column
20 m
Key:
trough cross-stratification
planar cross-stratification
massive/indistinct bedding
plant debris
root trace haloes
burrow trace
pedogenic slickenlines
carbonate filled fracture



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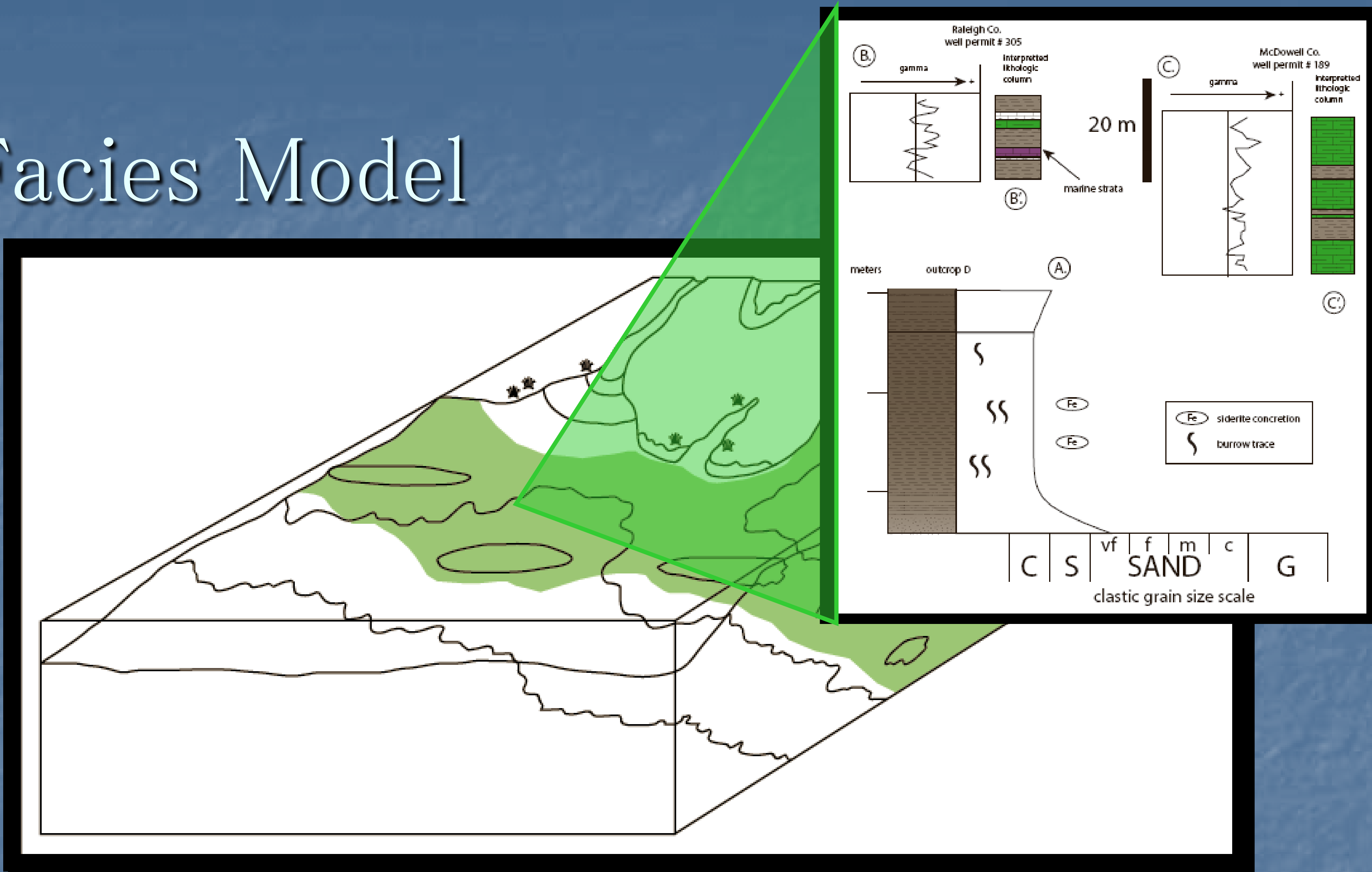
well permit # 216
(B.)
gamma
interpretted lithologic column
20 m
(A.)
meters
outcrop D
(C.)
distal marginal marine facies
organic-rich shale
F
scour & fill
ripple cross-lamination
parallel lamination
fissle
burrow trace
C S vf f m c SAND G
clastic grain size scale

Facies Model



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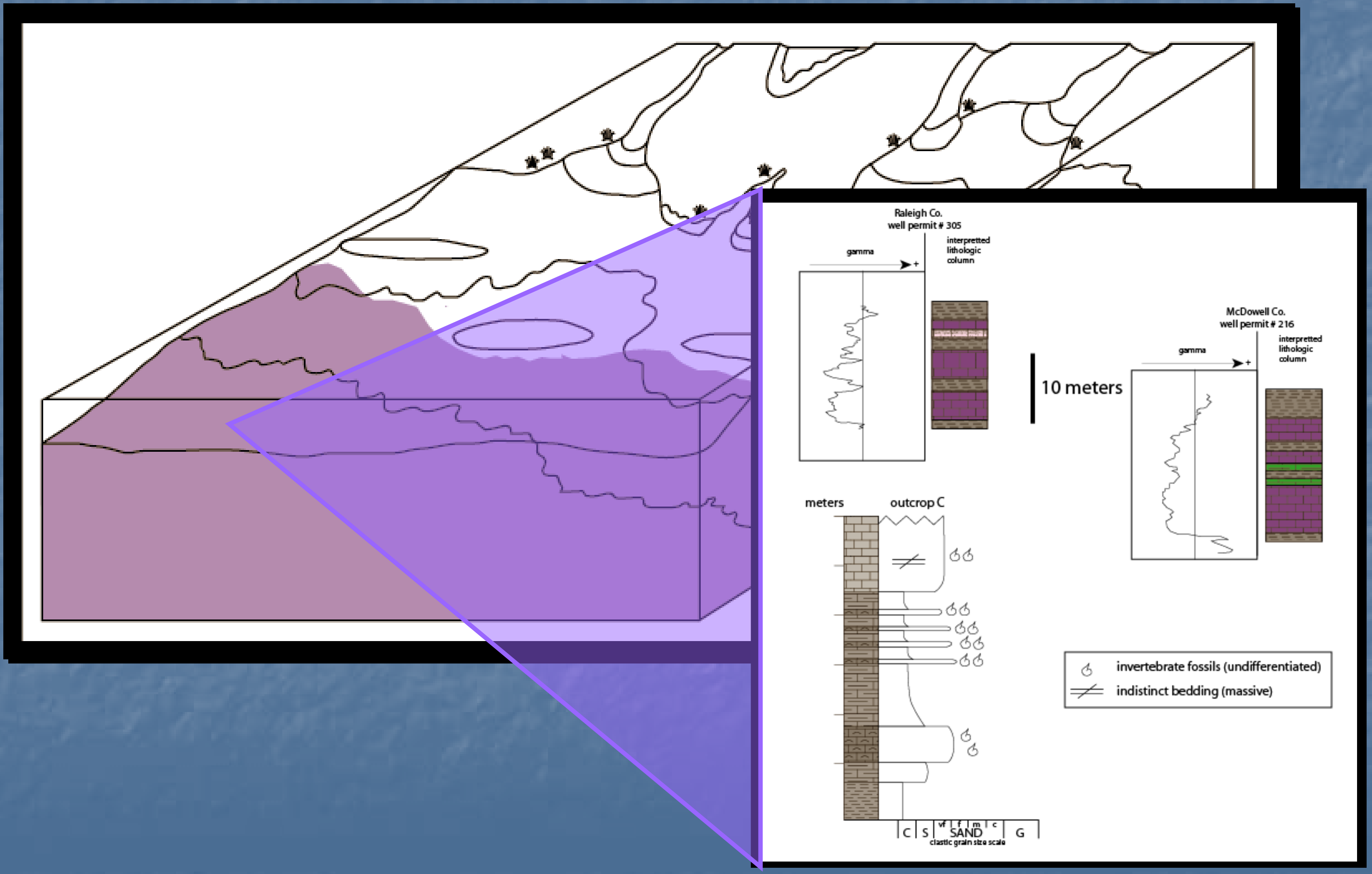

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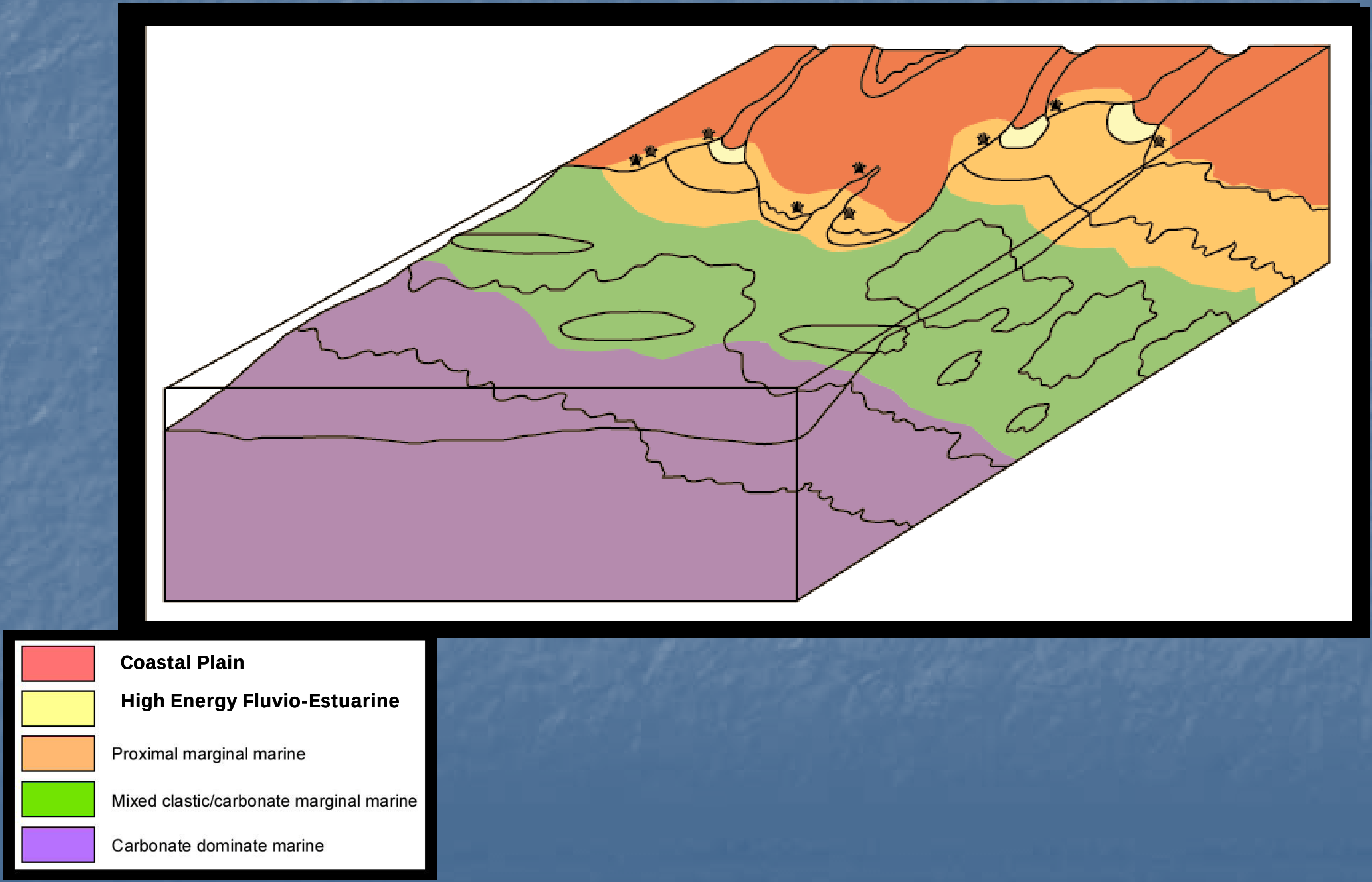
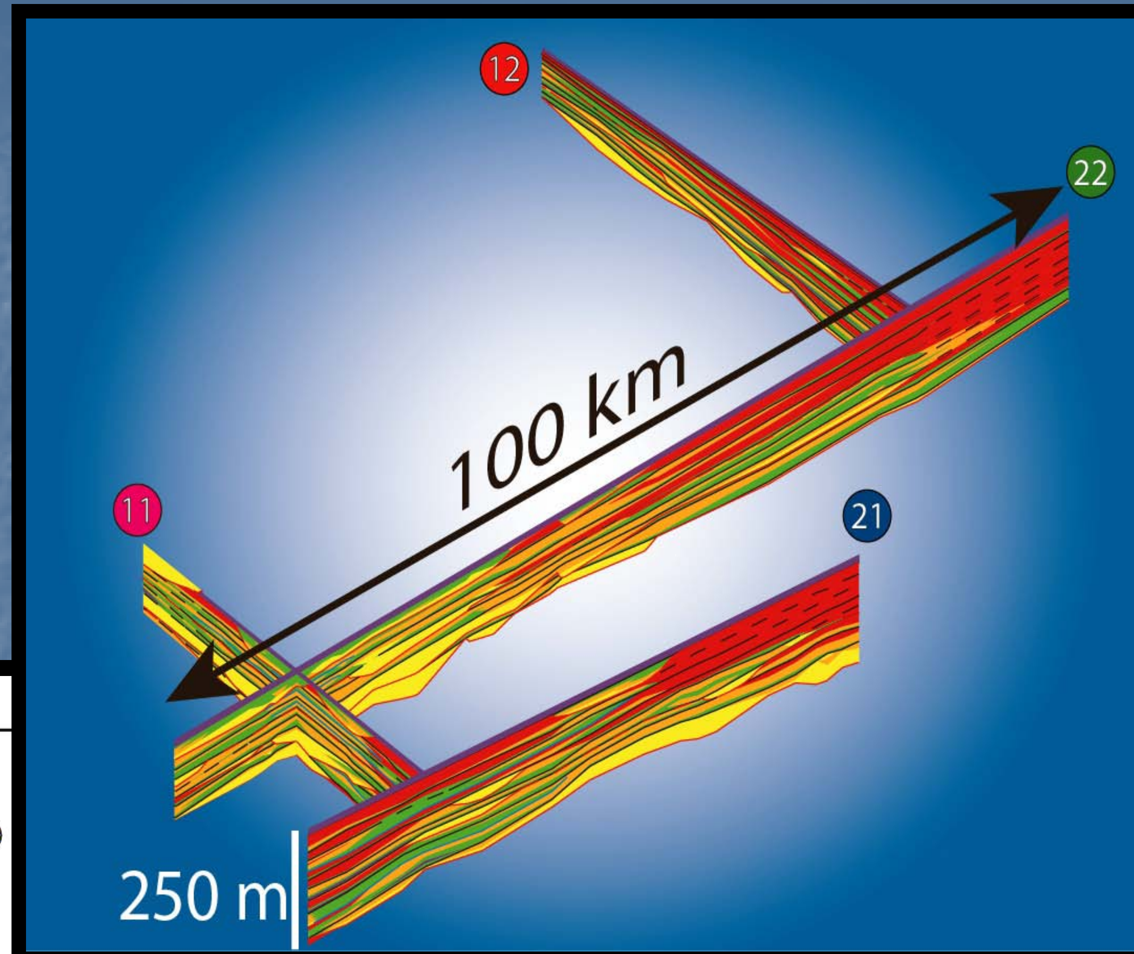
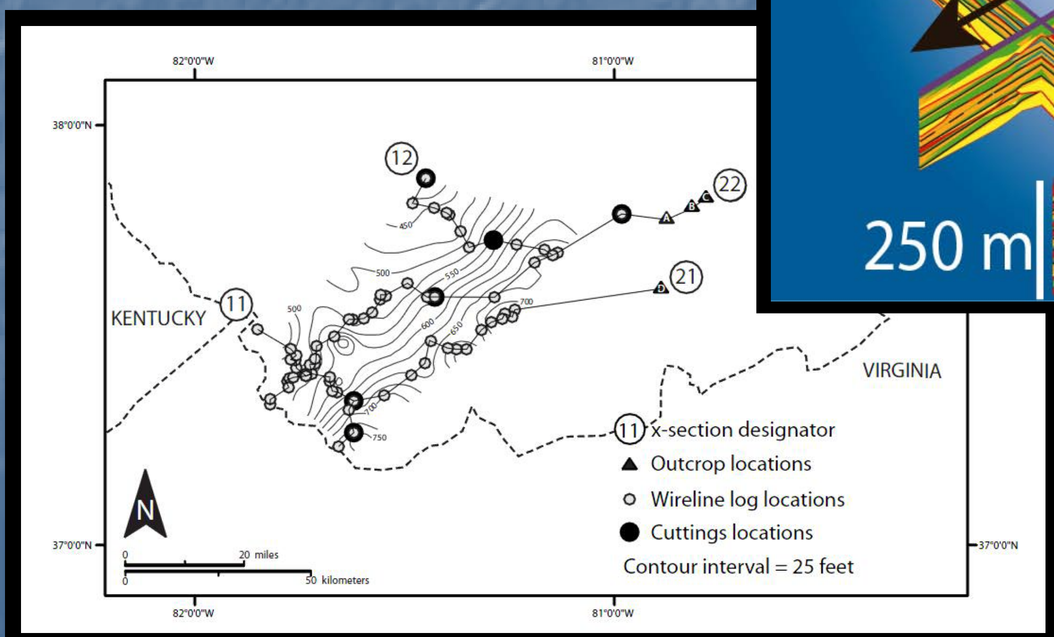
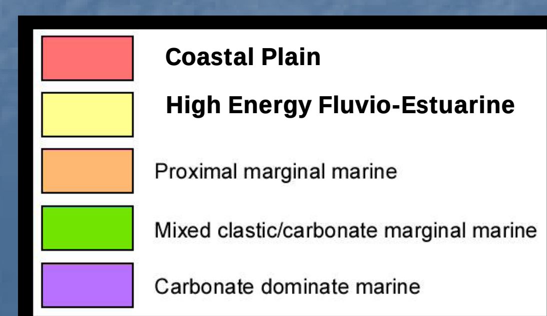


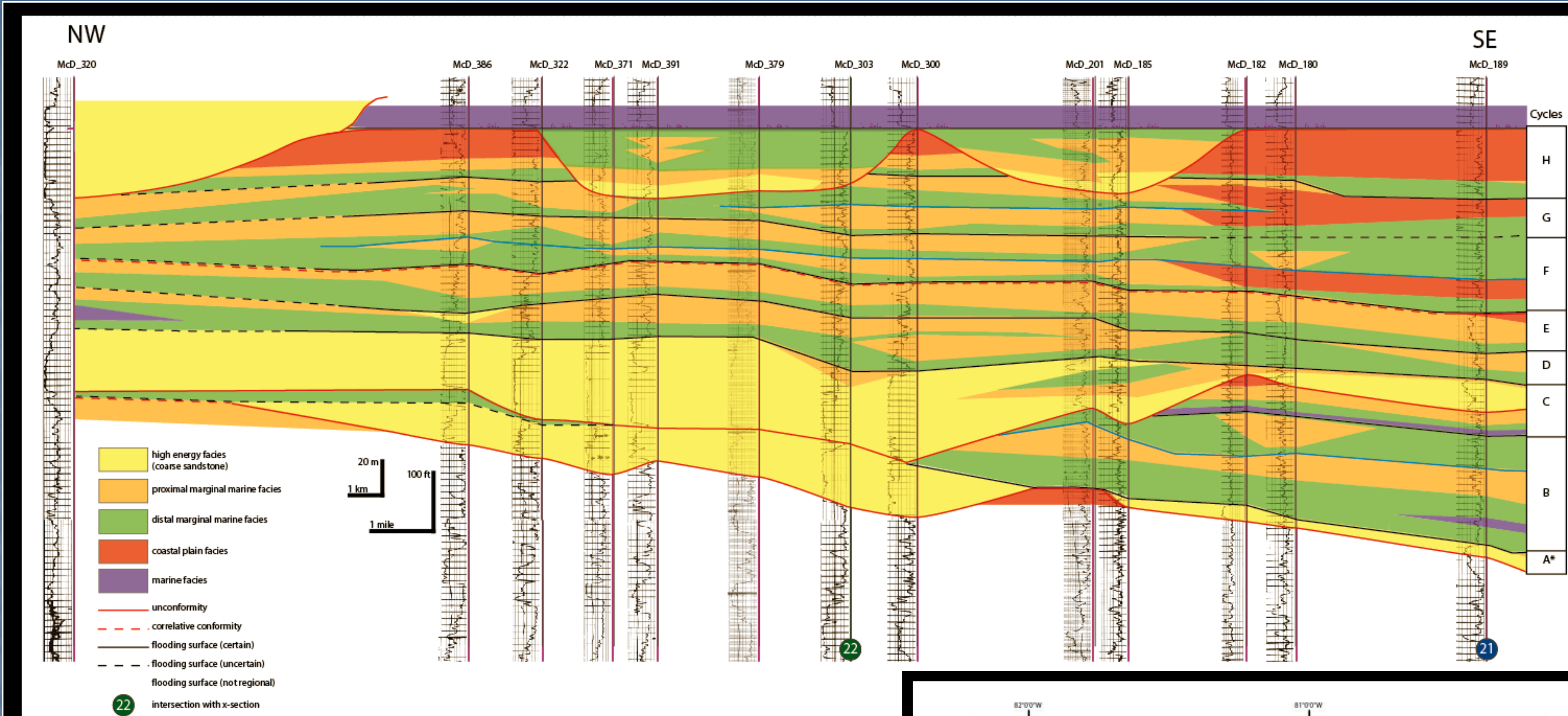
Regional Correlations







X-Section Line 11



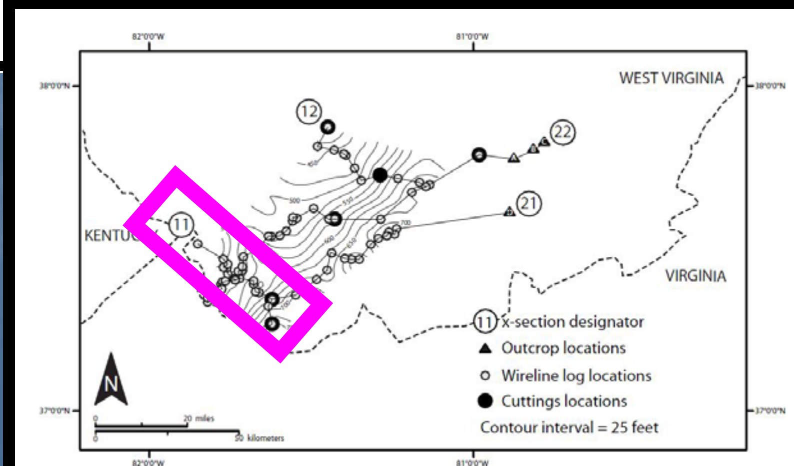
Coastal Plain

High Energy Fluvio-Estuarine

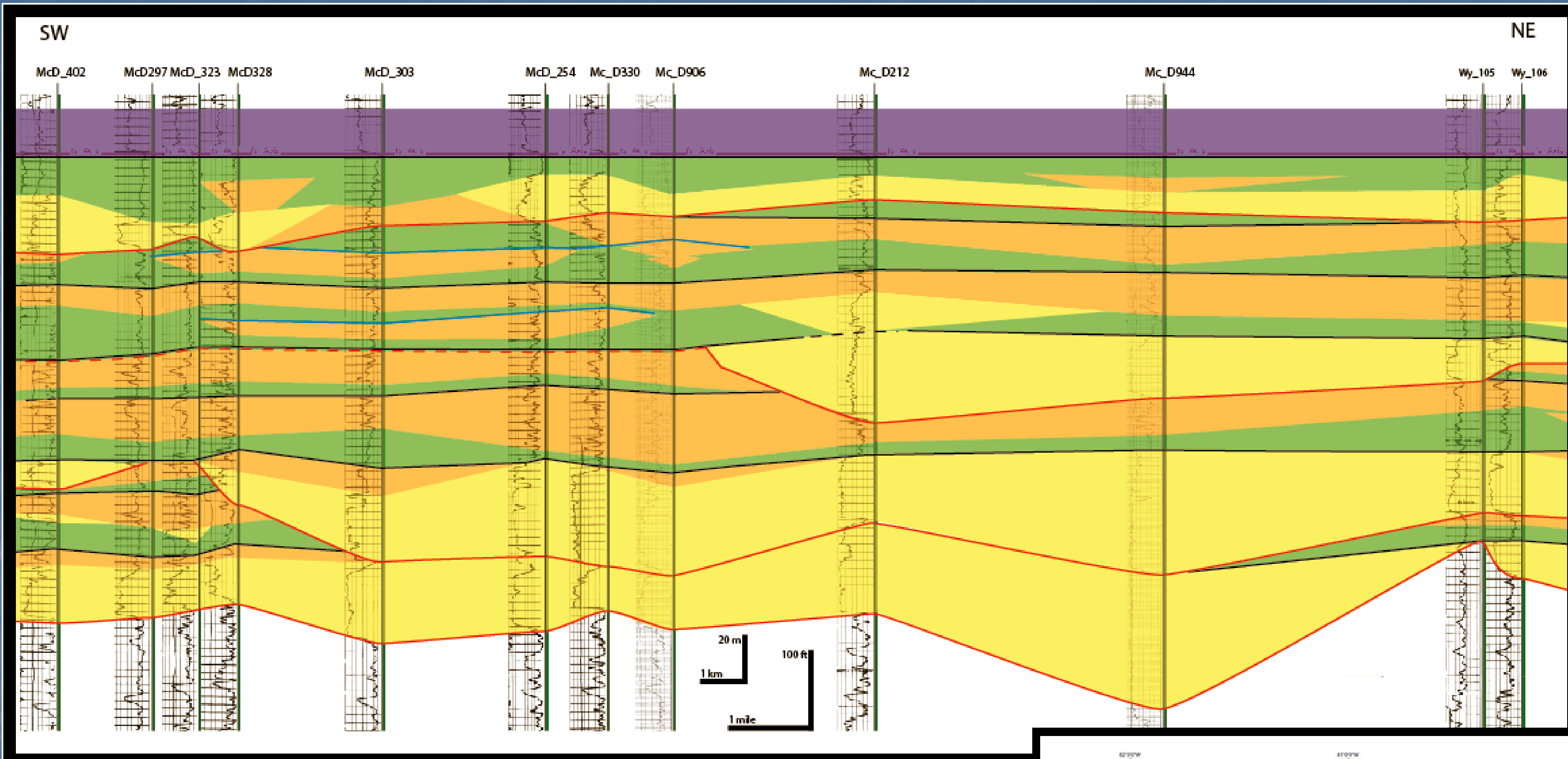
Proximal marginal marine

Mixed clastic/carbonate marginal marine

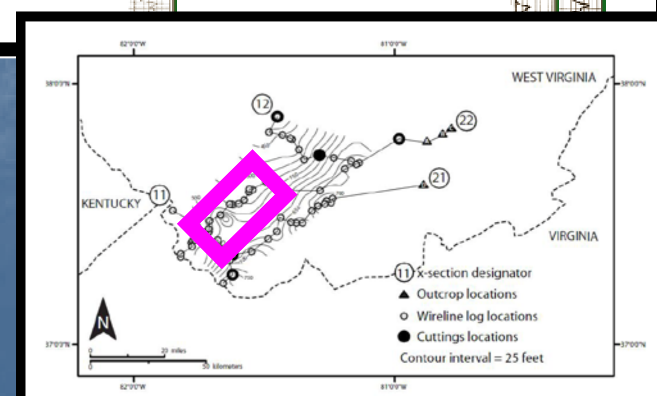
Carbonate dominate marine



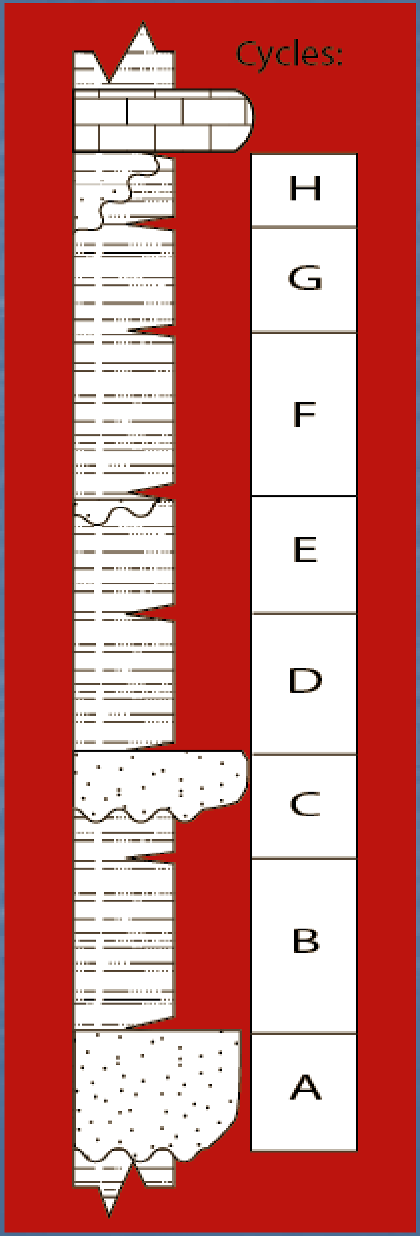
X-Section Line 22



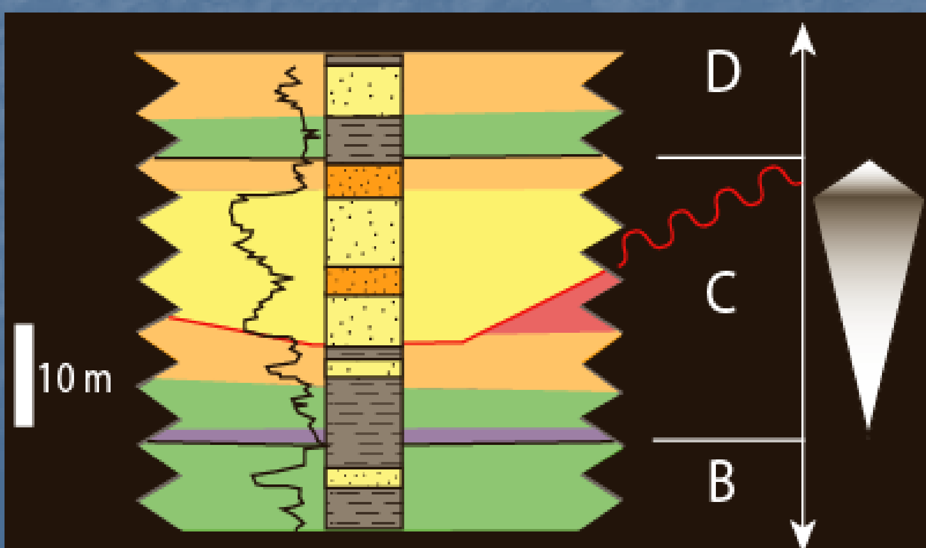
- Coastal Plain
- High Energy Fluvio-Estuarine
- Proximal marginal marine
- Mixed clastic/carbonate marginal marine
- Carbonate dominate marine

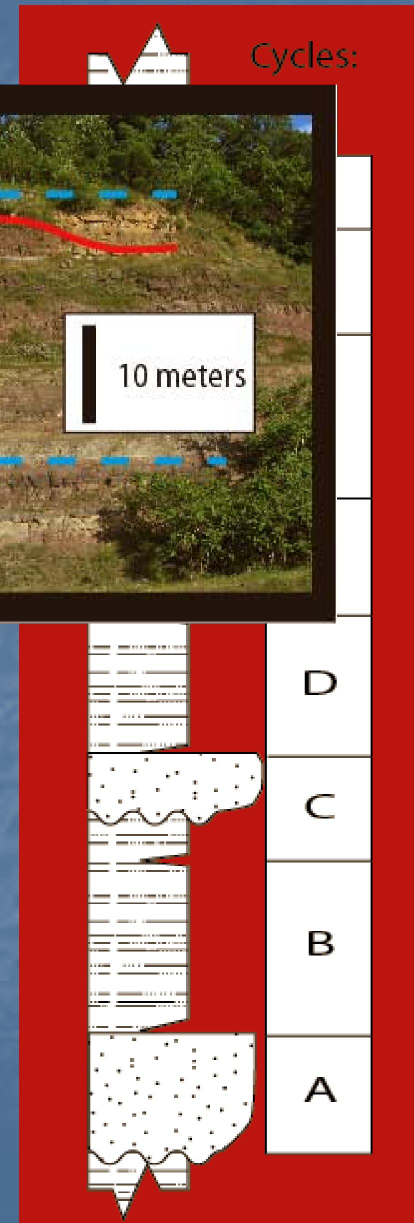


Late Mississippian T-R Cycles



Late Mississippian T-R Cycles





Outline

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What could possibly have caused these cycles?

- Tectonics

  Timescales of 100,000 years within foreland basin settings most commonly reflect surface processes (Paola, 1992, Blum and Tornqvist, 2000).

- Climate

  Paleosols exhibited no significant change in character.

- Eustasy

  Glacioeustasy as a potential 4^{th} order mechanism

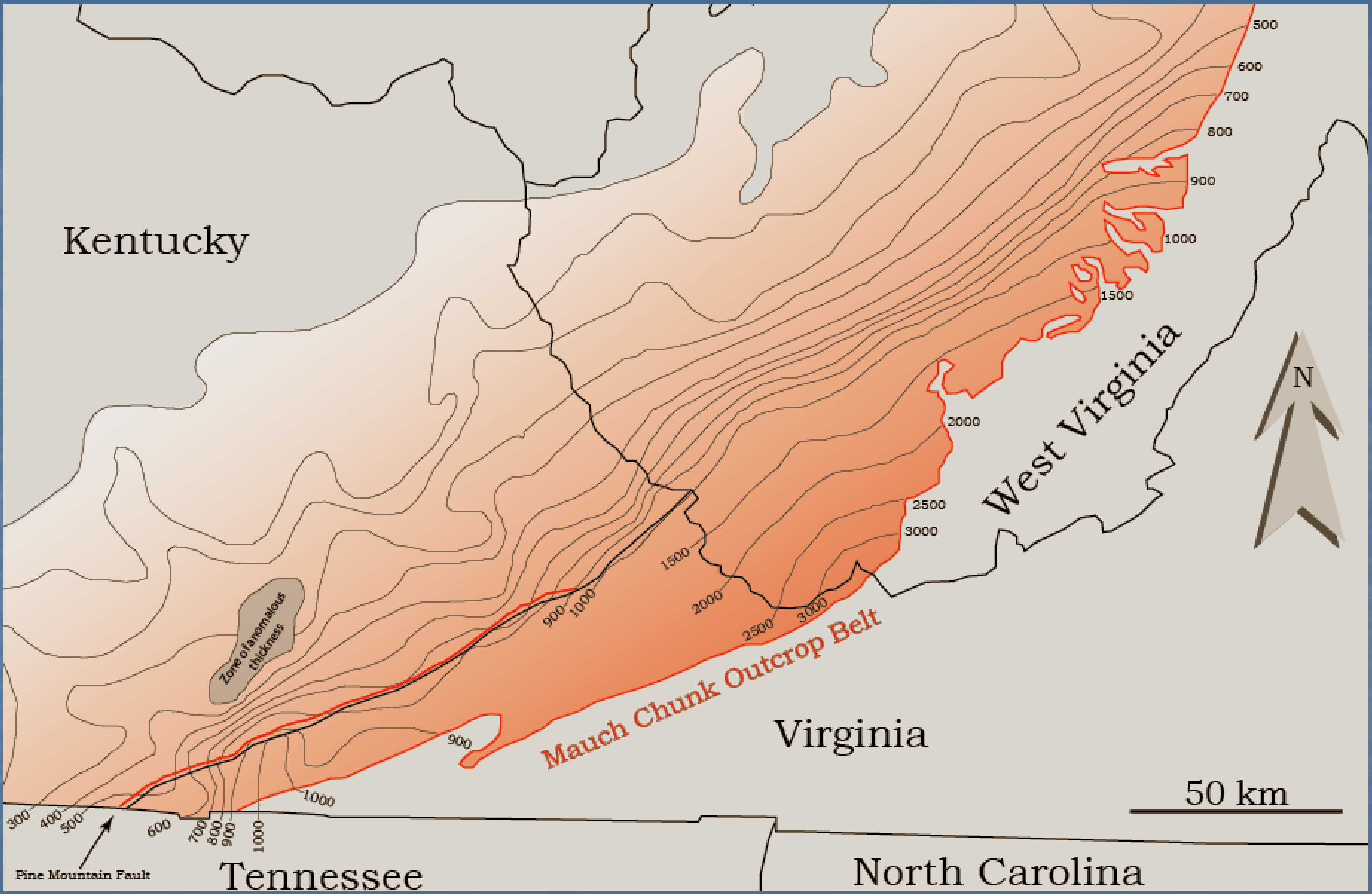
Conclusions

- High frequency, transgressive-regressive cycles (4th order) exist with in the lower Hinton.
- In basins that lack high quality suites of wire-line logs and have limited outcrop exposure, borehole cuttings can be applied with these data to generate a high resolution sequence stratigraphic framework and depositional model.

Thank you

Acknowledgements: Louis R. Bartek, Brian Coffey, Brian Horn, Steve Meyers, Kevin Stewart, Jack Beuthin, Mitch Blake, UNC graduate students, WVGES, Martin Fund, and BHP Billiton.

EXTRAS


Kentucky
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North Carolina
Mauch Chunk Outcrop Belt
Zone of anomalous thickness
Pine Mountain Fault
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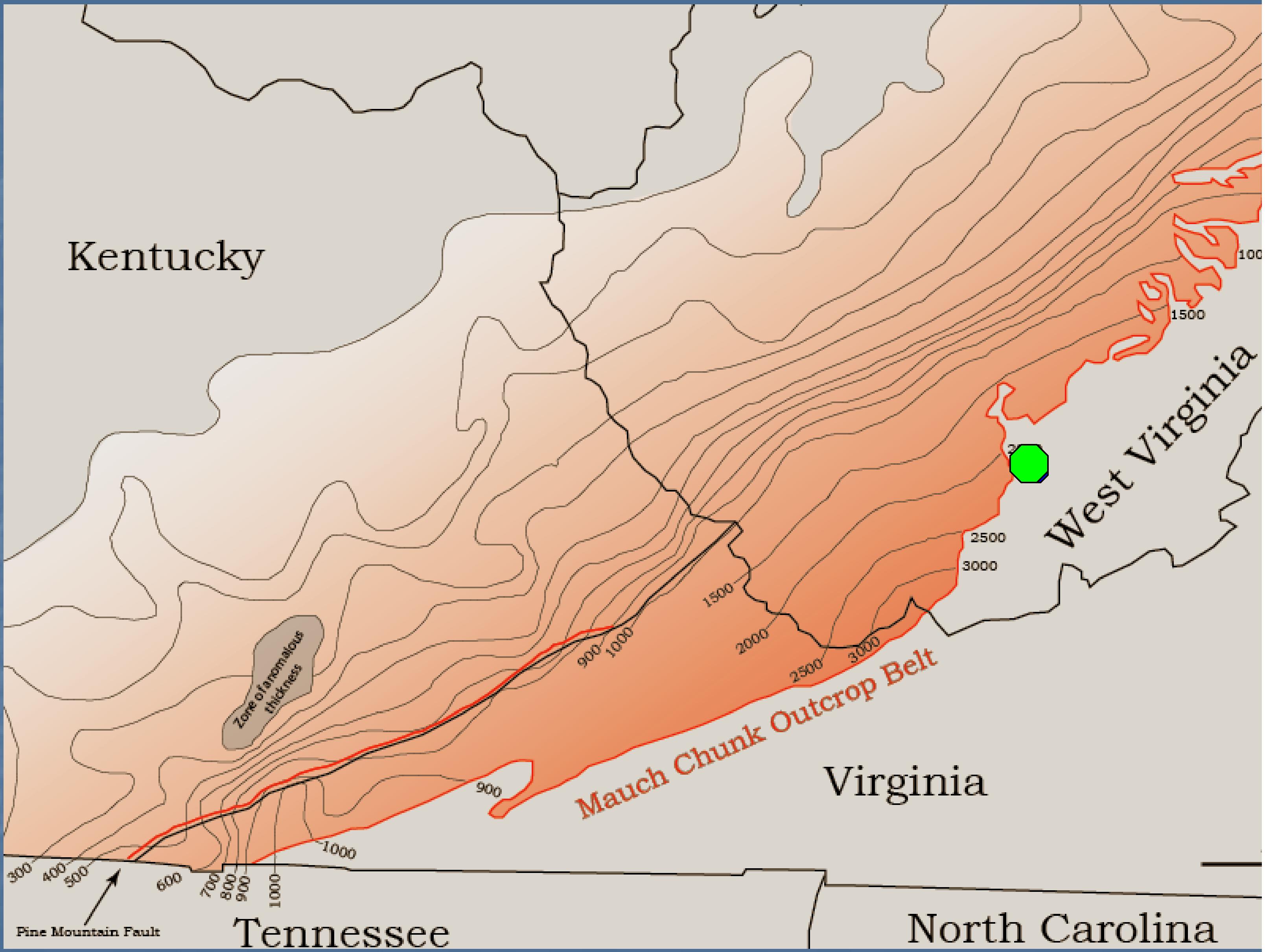
Kentucky
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Zone of anomalous thickness
Pine Mountain Fault
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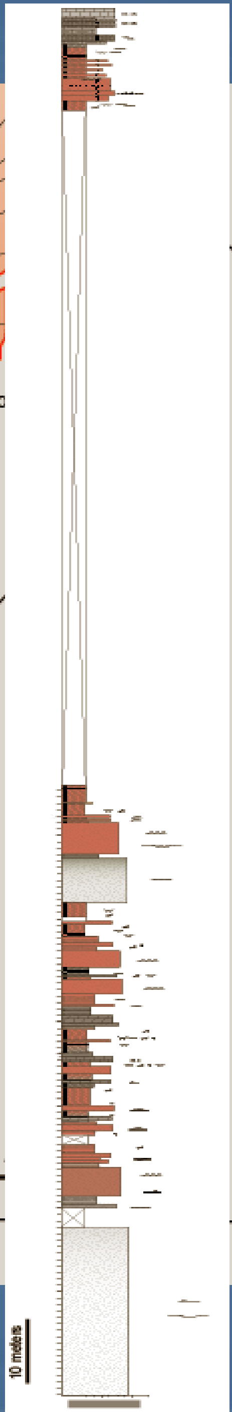
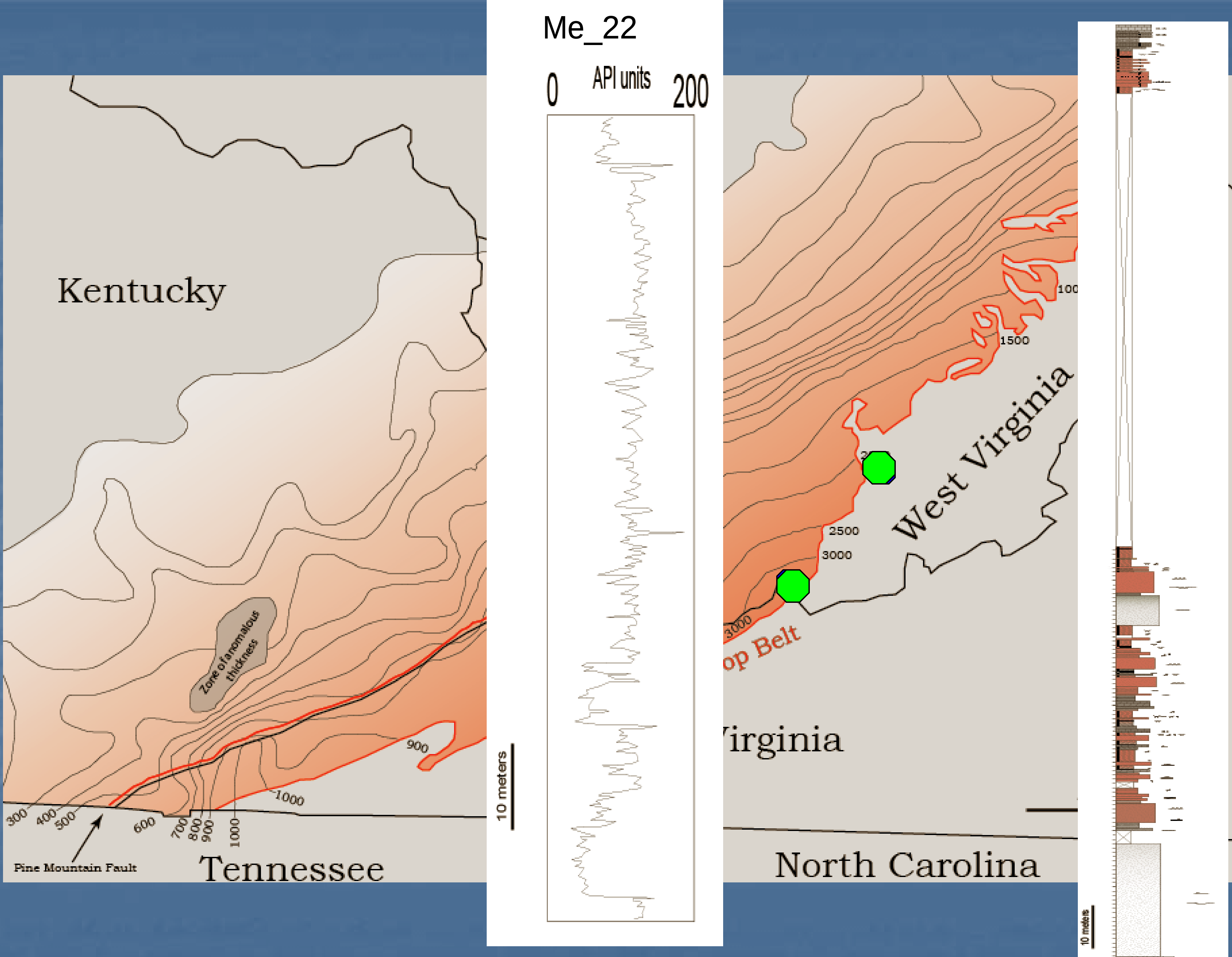

10 meters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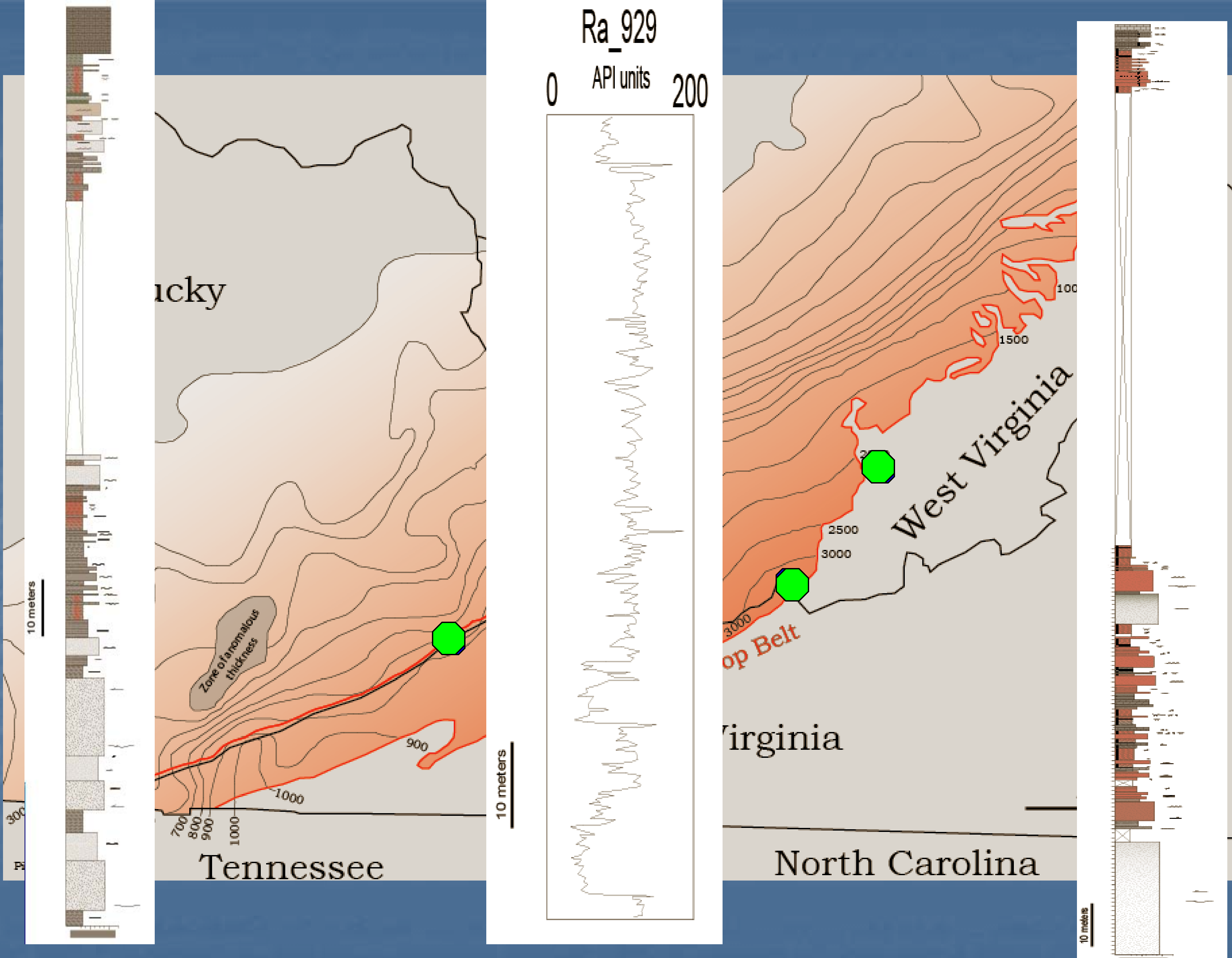
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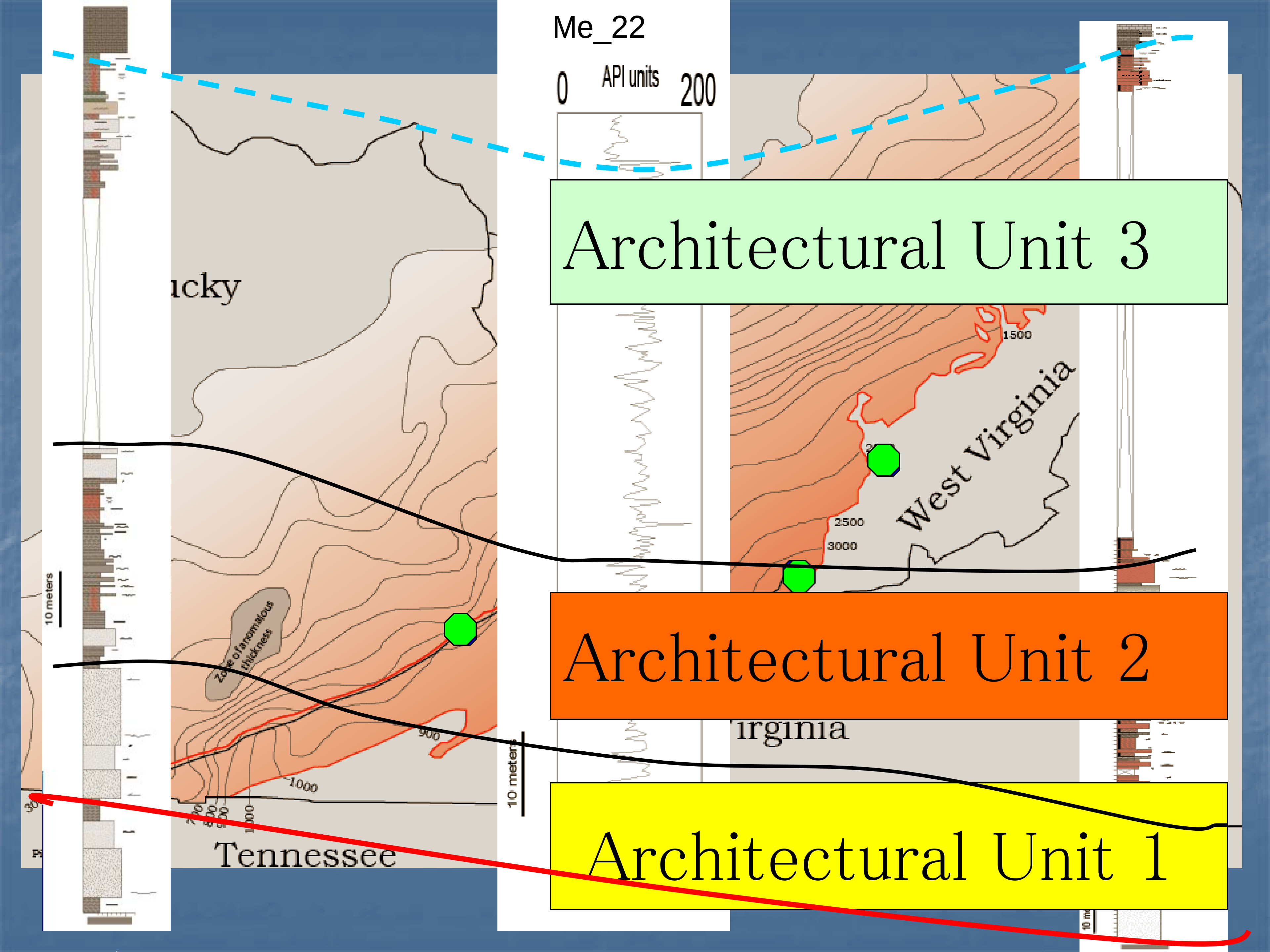
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Tennessee
Zone of anomalous thickness
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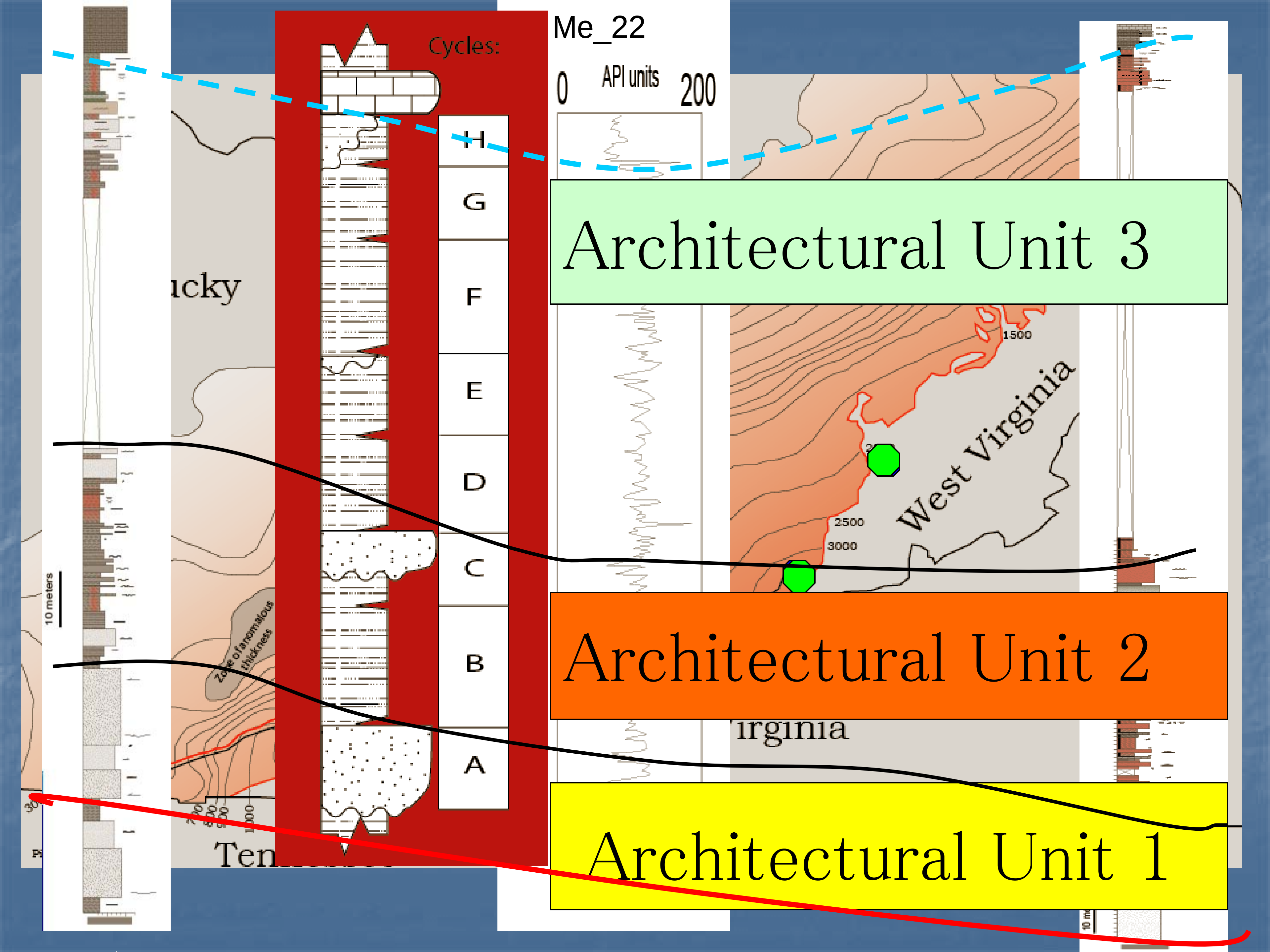

Cycles:
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Me_22
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West Virginia
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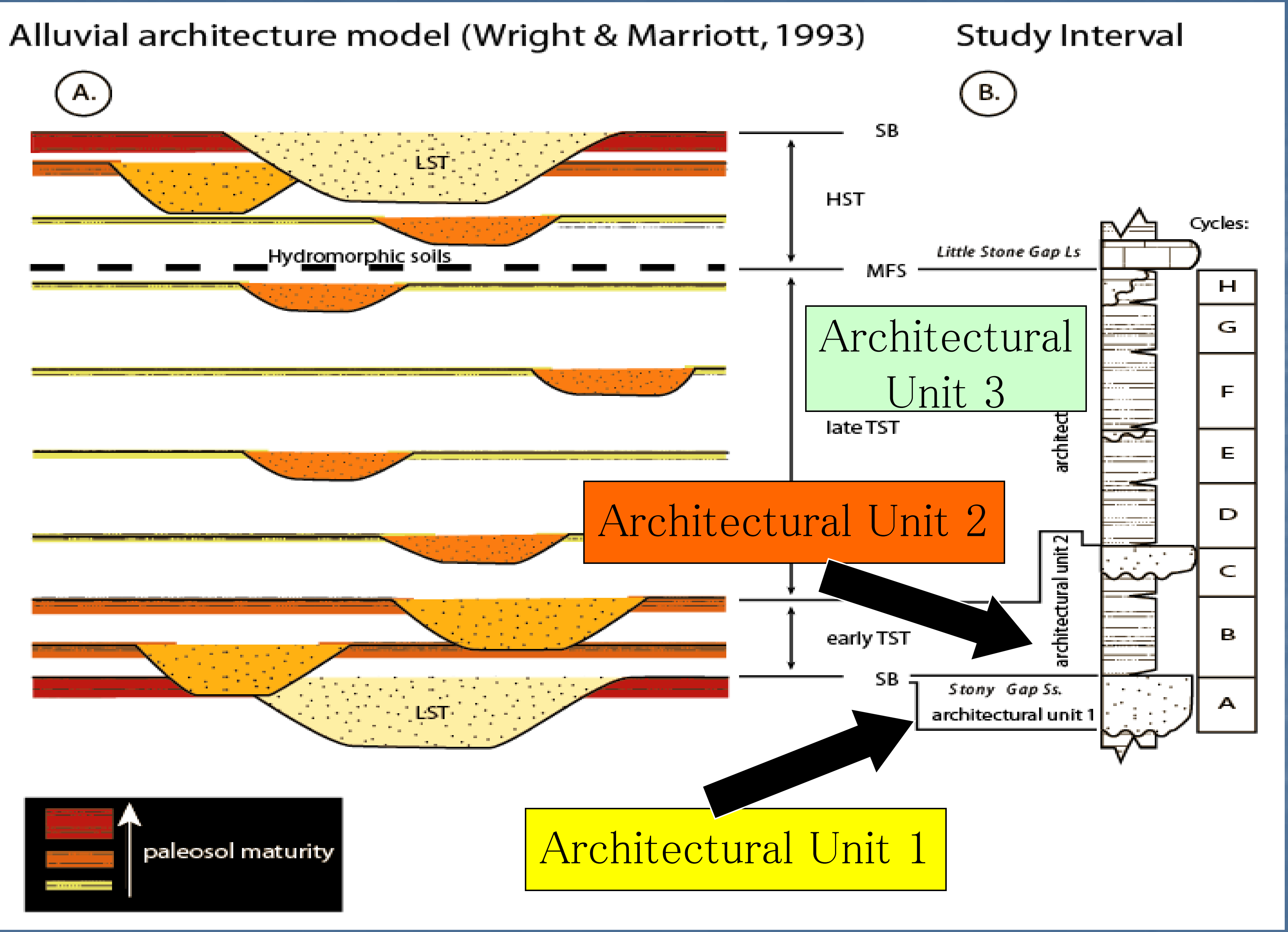
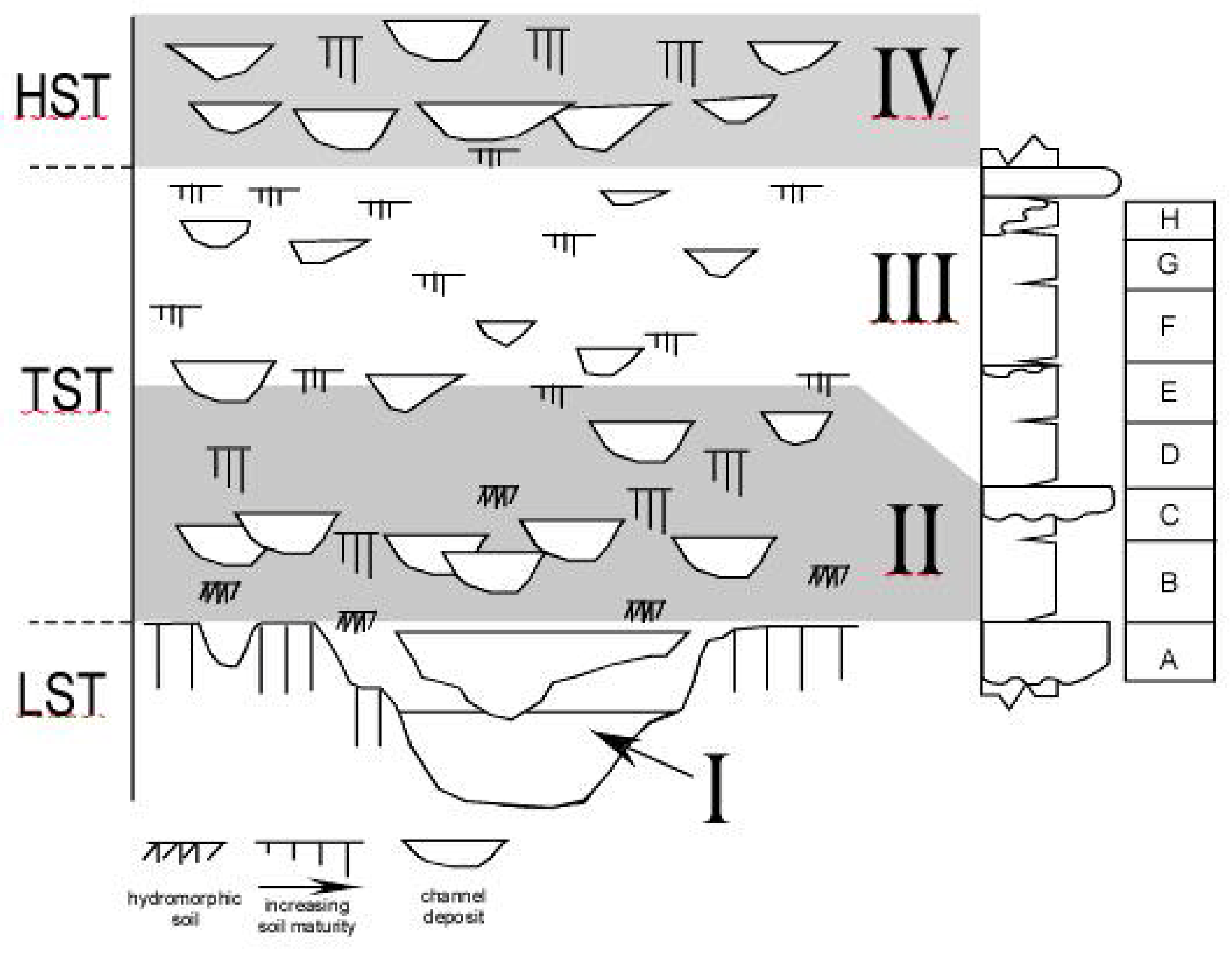
10 meters
Zone of aromatous thickness



Model modified from Cateanu' s (2006) adaptation of Wright and Marriott (1993).


HST
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A
hydromorphic soil
increasing soil maturity
channel deposit

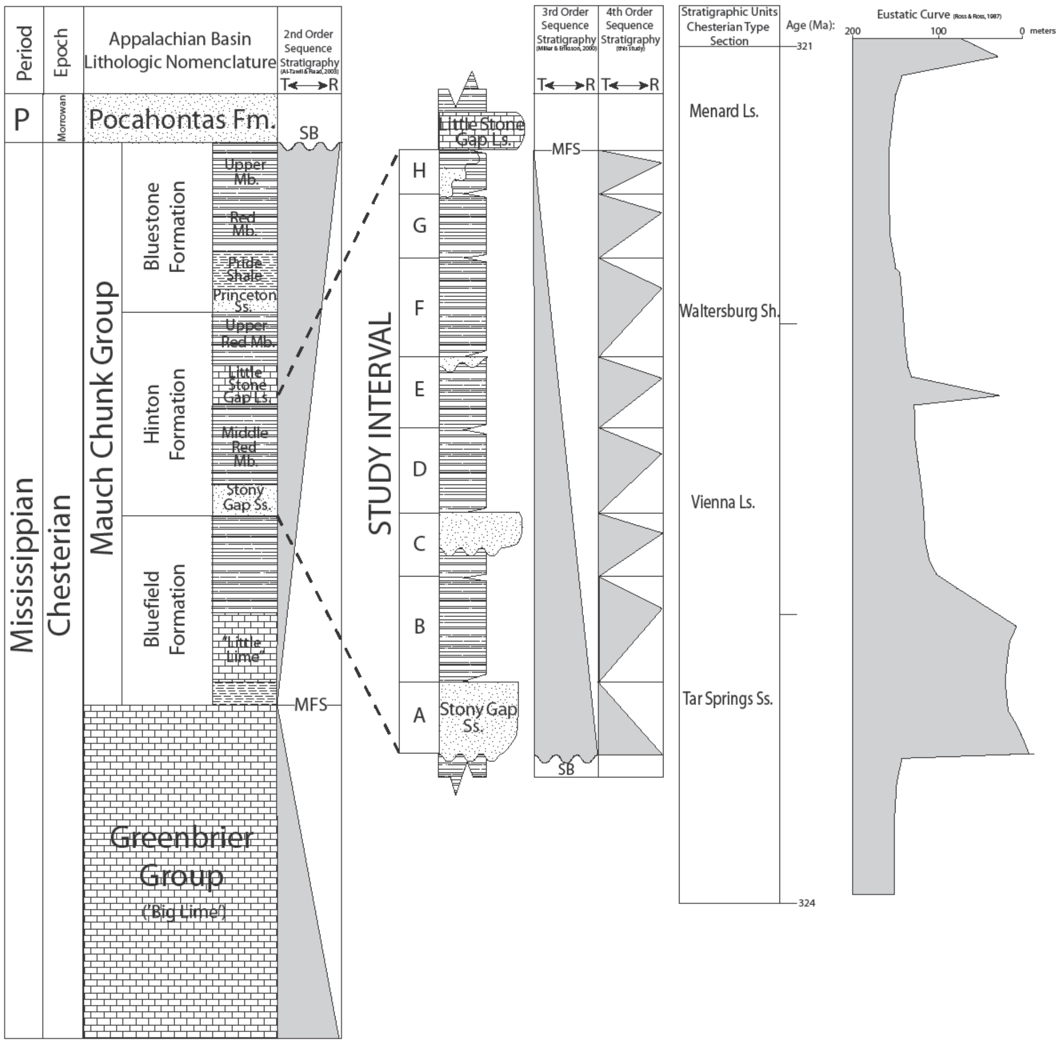
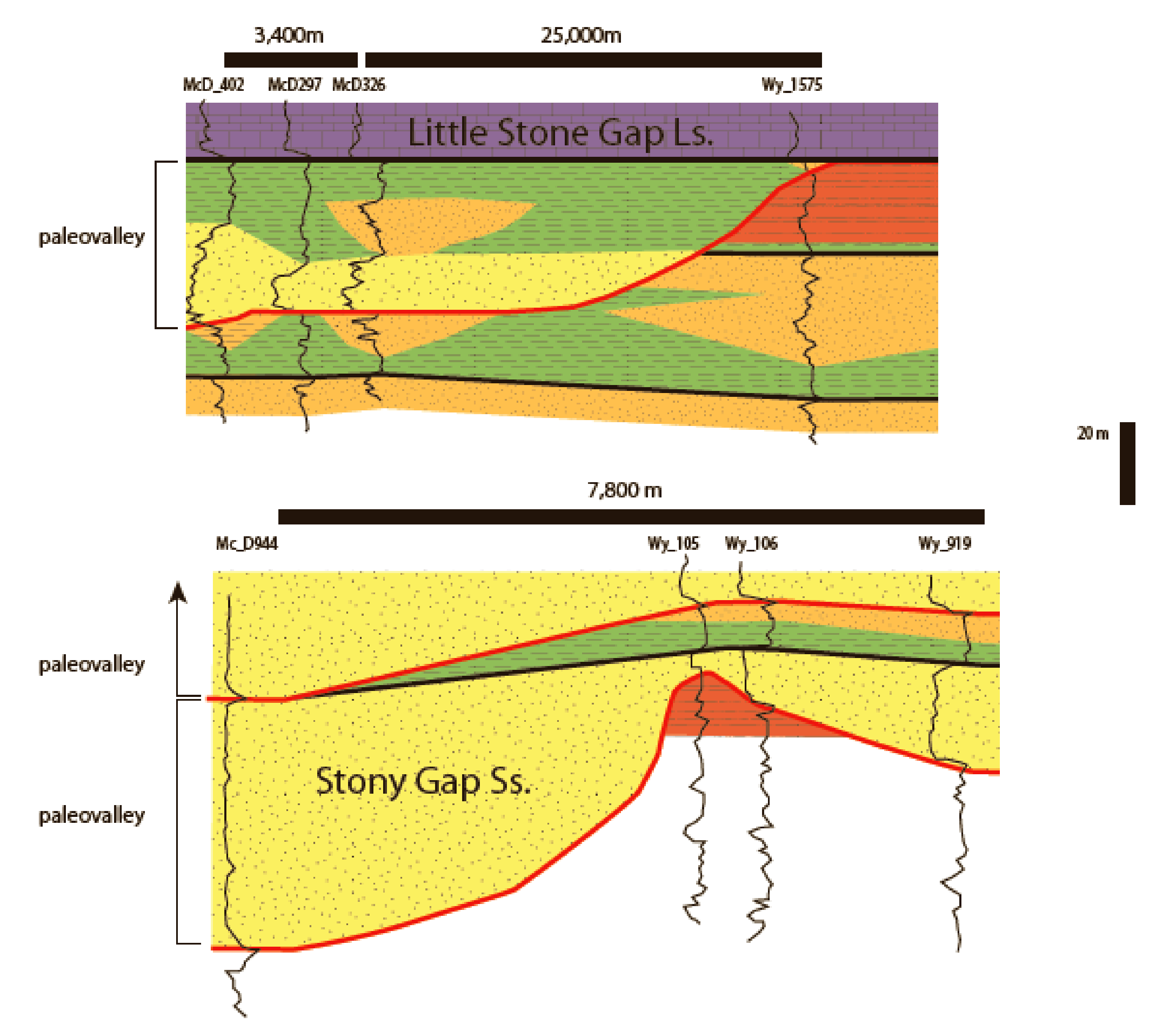


Figure 3.

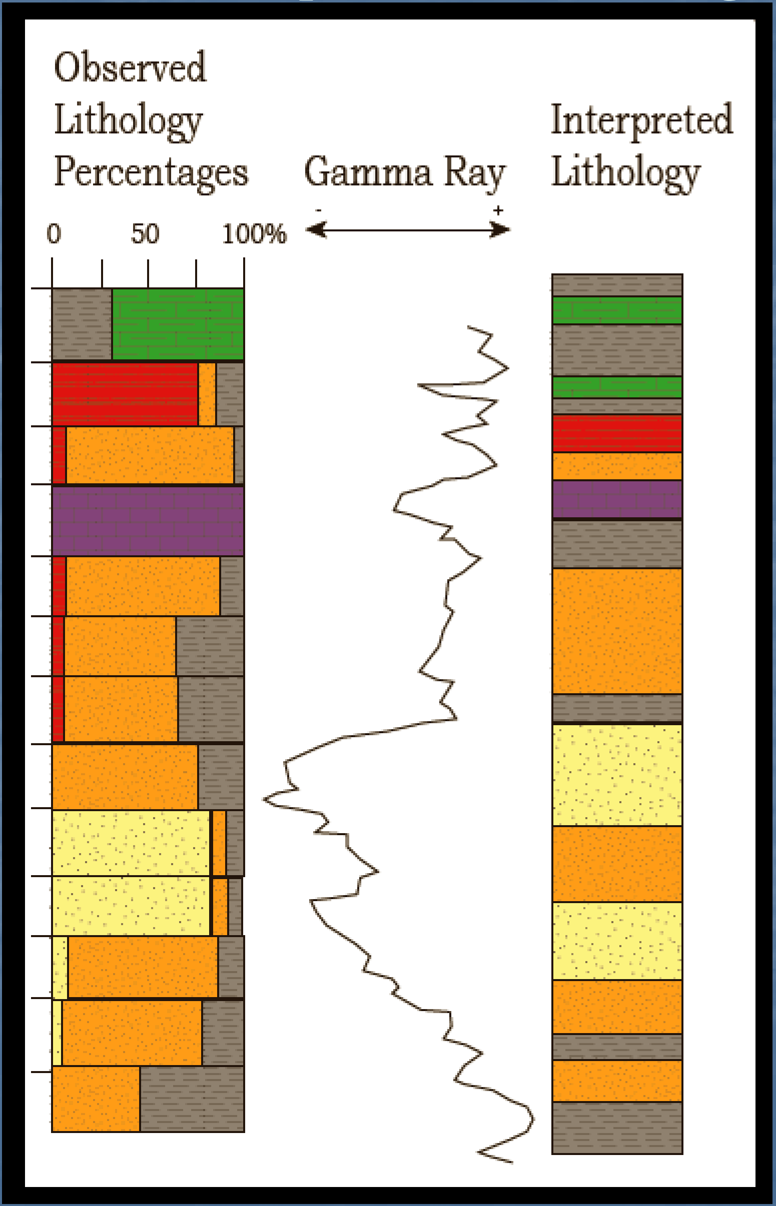
Schematic of Mississippian lithostratigraphy, sequence stratigragraphy, and sea level curve gathered from information documented in other publications (Al-Tawil & Read, 2003, Maynard & Eriksson, 2006, Miller & Eriksson, 2000, Kahmann & Driese, 2008, Ross & Ross, 1987) and data generated in this study.

Paleovalley Comparison



Cuttings:

Observed → Interpreted lithologic column



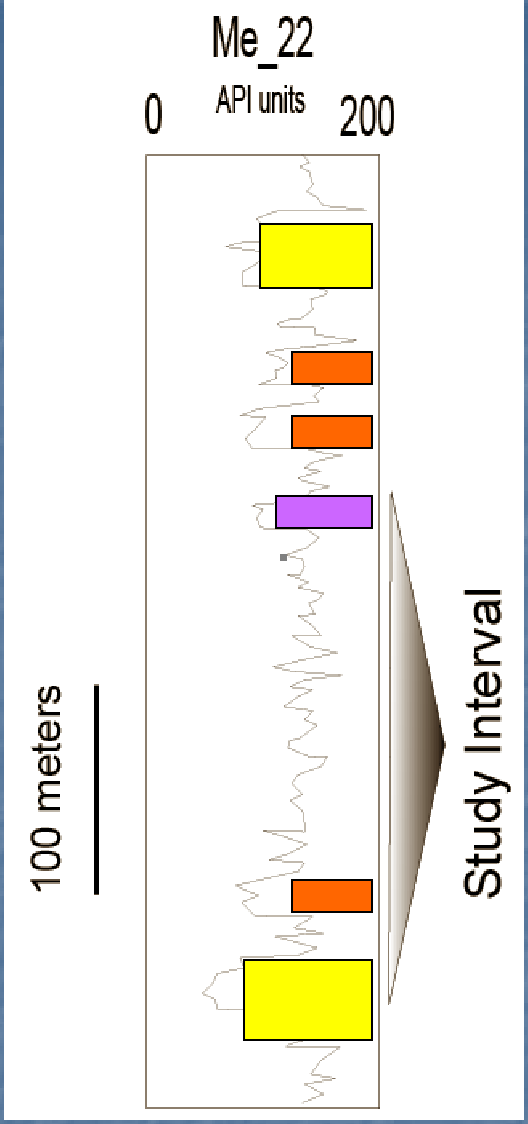
Stratigraphic Architecture

- The structure, character, and style of a sedimentary succession

Early Jurassic Limestones in Great Britain

Pennsylvanian siliciclastics in KY

Paleosols of the lower Hinton


Me_22
API units
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100 meters
Study Interval