

Paleotopographic Control on the Variability of Woodford Shale strata Across the Southern Cherokee Platform Area of Central Oklahoma: a Mechanism for Increased Preservation-Potential of Organic Content*

Brenton J. McCullough¹ and Roger M. Slatt²

Search and Discovery Article #51125 (2015)**

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¹Devon Energy, Oklahoma City, OK (brent.mccullough@dvn.com)

²School of Geology and Geophysics, University of Oklahoma, Norman, OK (rslatt@ou.edu)

Abstract

The Woodford Shale on the southern Cherokee Platform of central Oklahoma was deposited mainly within two linear trends (Trend 1 and Trend 2) that correspond to eroded and missing sections in the underlying Hunton Group. These trends have been interpreted as incised valleys that were carved out of the underlying Hunton Group by erosional processes that occurred prior to the deposition of the Woodford Shale. The Woodford Shale preferentially filled the incised valleys as they represent the maximum accommodation that was available in the study area at the time of deposition. Identification, correlation and mapping of 12 well-log facies (RGRPs) from 137 wells reveals that Trend 2 began to backfill during regional transgression prior to the onset of backfilling of Trend 1. As a result, the well-log facies are not necessarily correlative between the two trends in either time or space. Total organic carbon content (TOC) models, estimated from Δ Log R log calculations, suggest that the linear trends contain separate organic rich RGRPs. This observation implies that the hydrocarbons present in the terminal extents of each trend were sourced by separate organic-rich strata. Therefore, paleotopographic limitations on deposition are thought to be a potential mechanism for the development of localized bottom-water anoxia and, by extension, the preservation of organic matter.

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- Mankin, C.J., 1987, Correlation of Stratigraphic Units in North America Texas-Oklahoma Tectonic Region Correlation Chart, *in* O.E. Childs, G. Steele, and A. Salvador, (Project Directors), Correlation of Stratigraphic Units of North America (COSUNA) Project: American Association of Petroleum Geologists, Tulsa, Oklahoma, 1 sheet.
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Passey, Q.R., S. Creany, J.B. Kulla, F.J. Moretti, and J.D. Stroud, 1990, A practical Model for Organic Richness from Porosity and Resistivity Logs: American Association of Petroleum Geologists Bulletin, v. 74, p 1777-1794.

Passey, Q.R., K.M. Bohacs, W.L. Esch, R. Klimentidis, and S. Sinha, 2010, From Oil Prone Source Rock to Gas Producing Shale Reservoir:, International Oil and Gas Conference Exhibition, Beijing, China, Society of Petroleum Engineering 131350, 29 p.

Paleotopographic control on the variability of Woodford Shale strata across the southern Cherokee Platform area of central Oklahoma: a mechanism for increased preservation-potential of organic content

Brenton J. McCullough¹ and Roger M. Slatt²

Devon Energy Corporation¹

University of Oklahoma: ConocoPhillips School of Geology and Geophysics²

AAPG Southwest Section Meeting

April 11-14, 2015

Wichita Falls, TX

AAPG Woodford Shale Forum

May 12, 2015

Oklahoma City, OK

AAPG Woodford Shale Forum

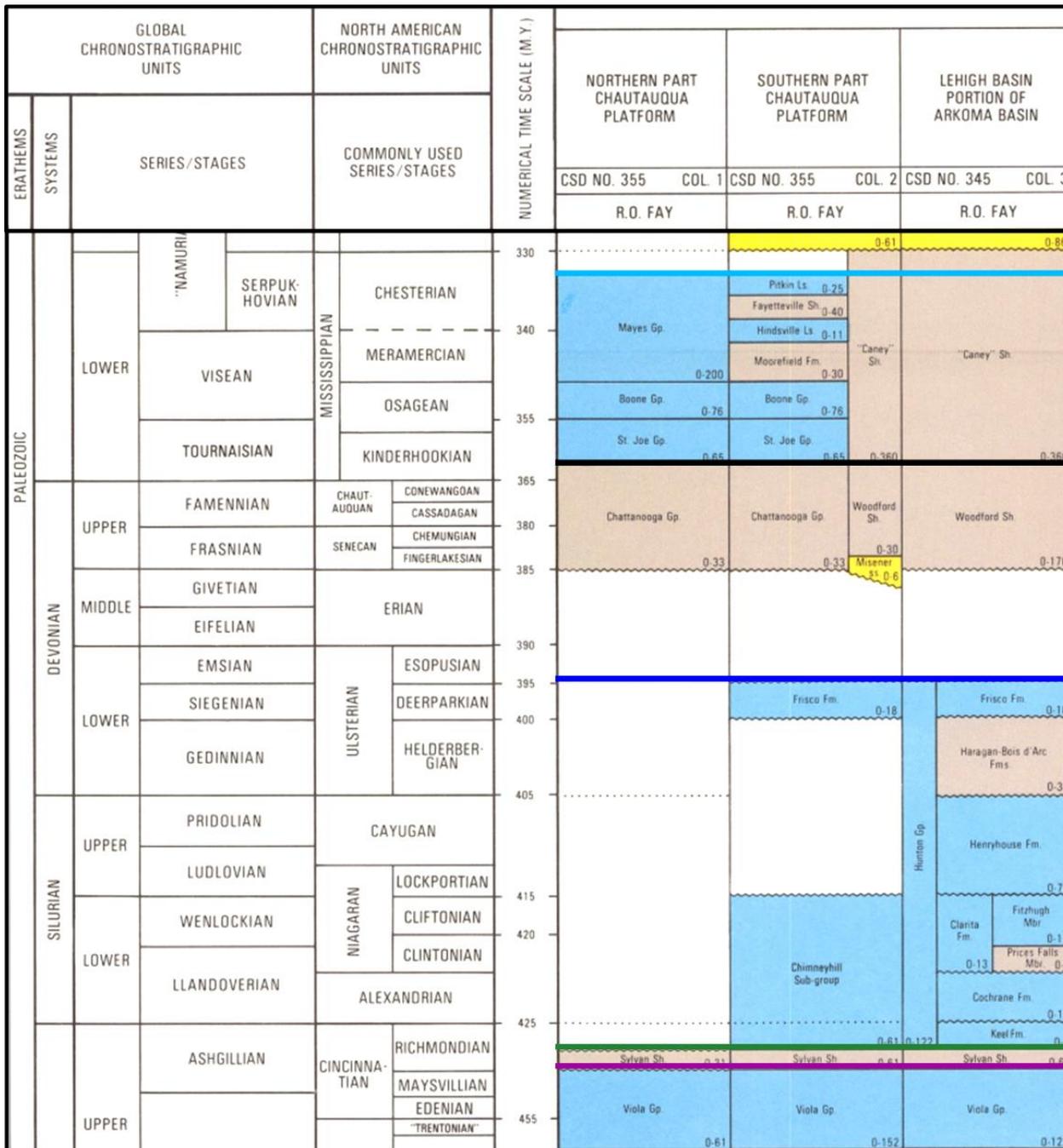
May 12, 2015

Oklahoma City OK

Outline:

- 1. Background**
- 2. Observations**
- 3. Interpretation and Hypothesis**
- 4. Conclusion**
- 5. References**

1. Stratigraphy:



Mayes Group/
Caney Shale

Woodford Shale

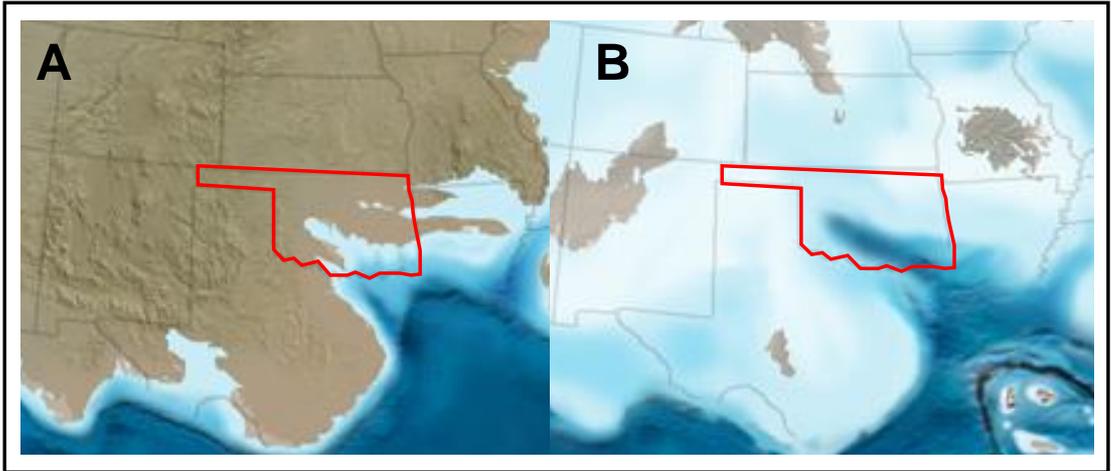
Erosional
Unconformity

Hunton Group

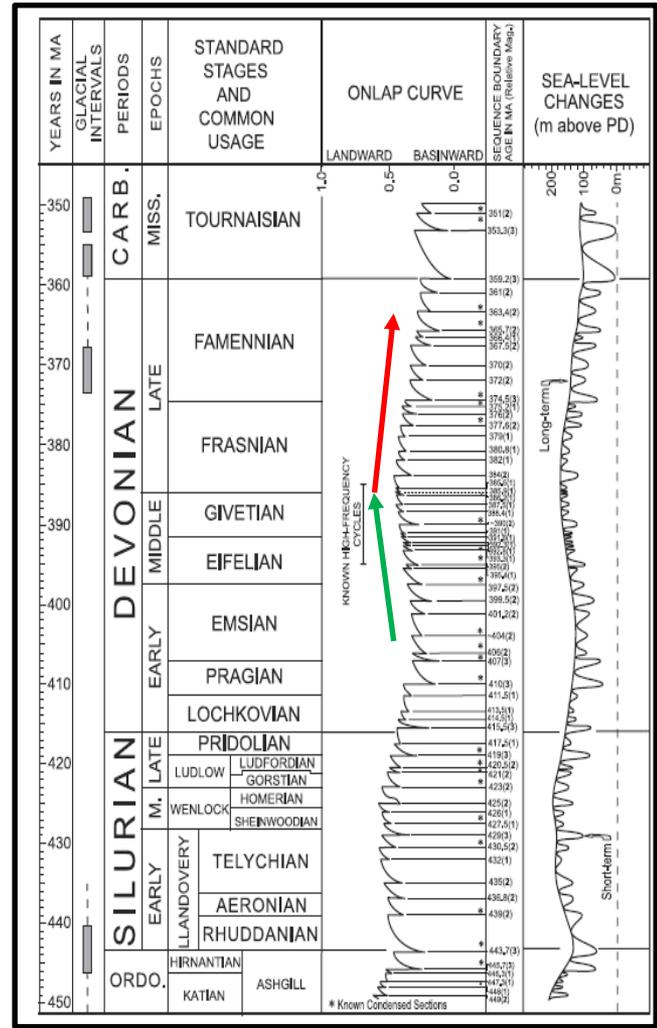
Sylvan Shale
Viola Group

(Modified from Mankin et al., 1987)

1. Paleogeography:

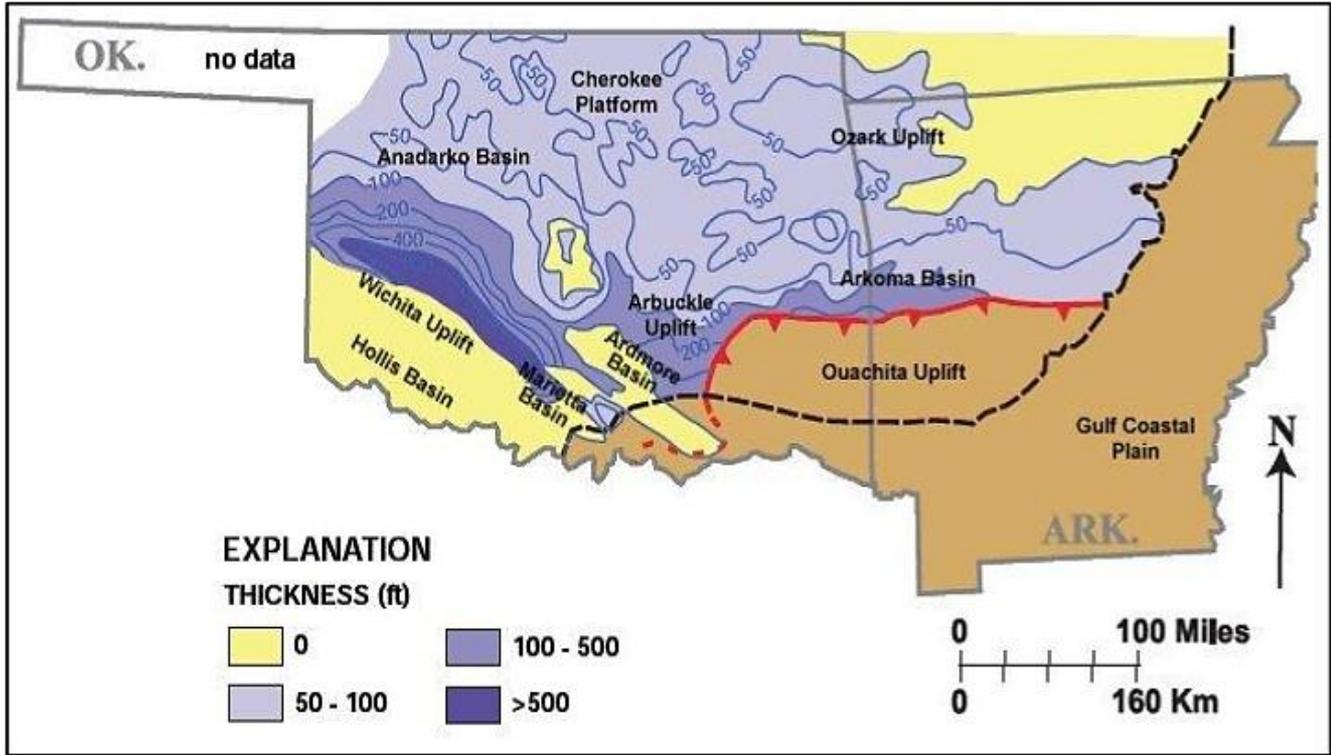


A.) Onset of the Devonian B.) Onset of the Mississippian
 Large scale transgression initiated at some point during the Devonian.
 (Modified from Blakey, 2012)



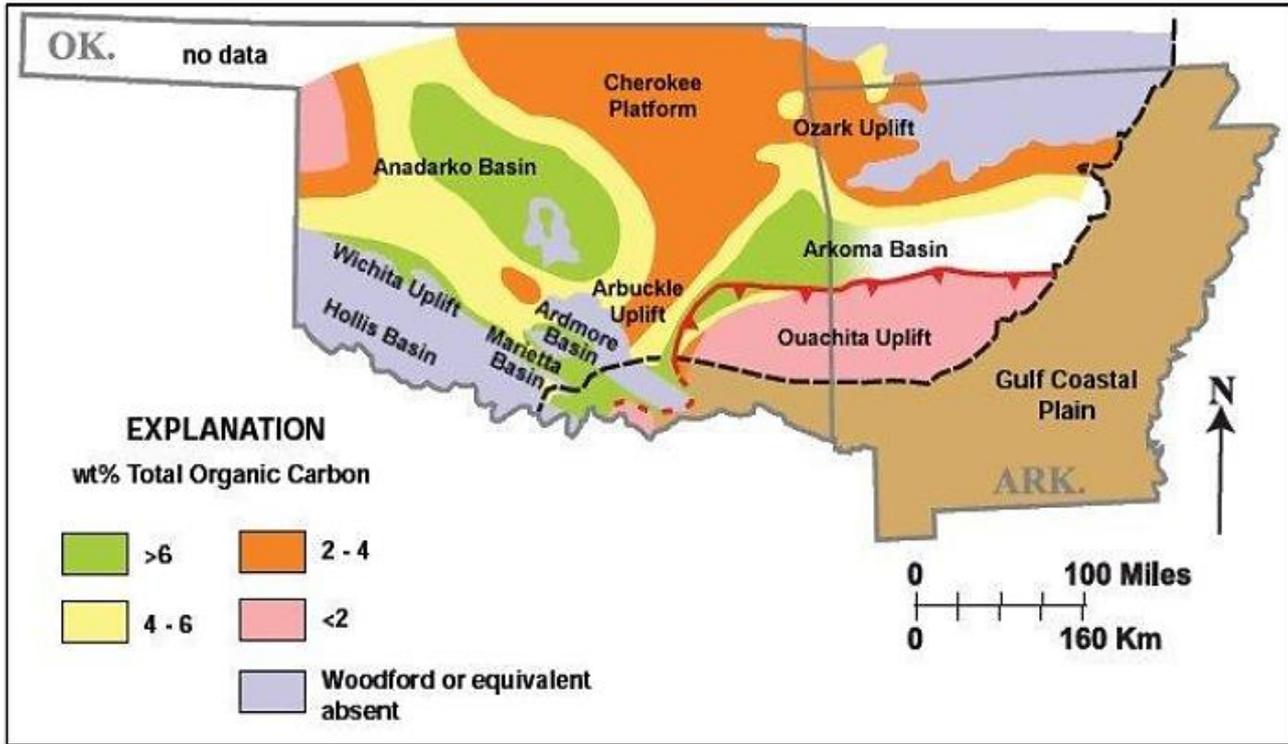
(Haq and Schutter, 2008)

1. Regional Thickness Distribution:



(Comer, 2008 in Miceli, 2010)

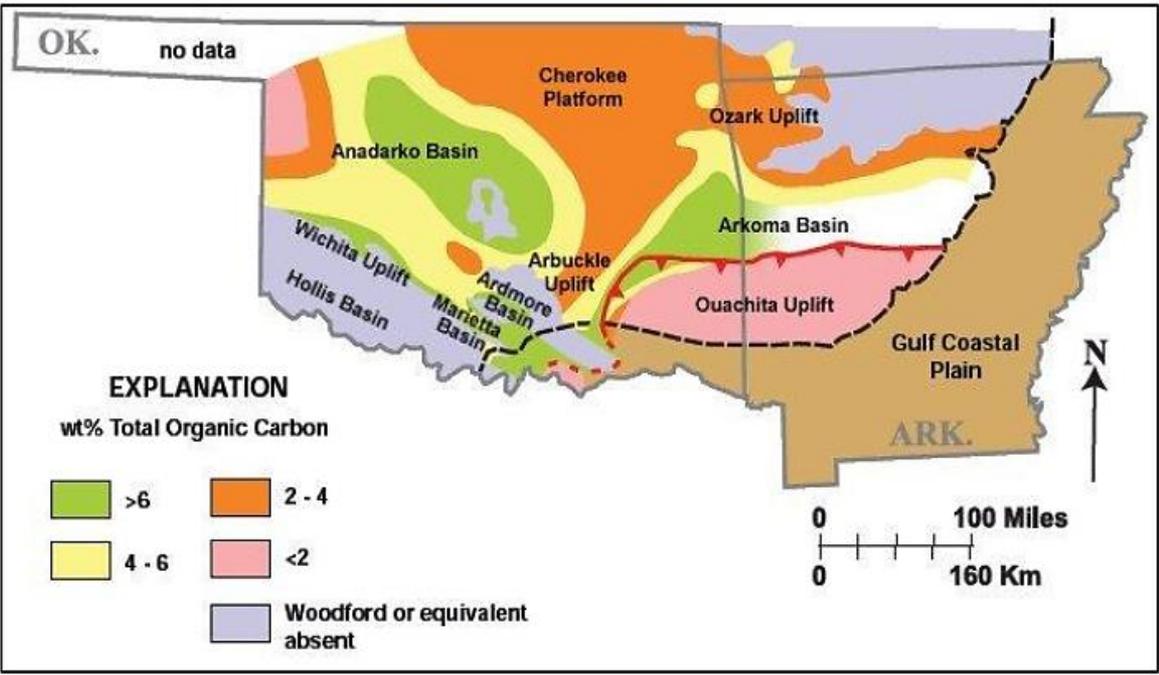
1. Regional TOC Distribution:



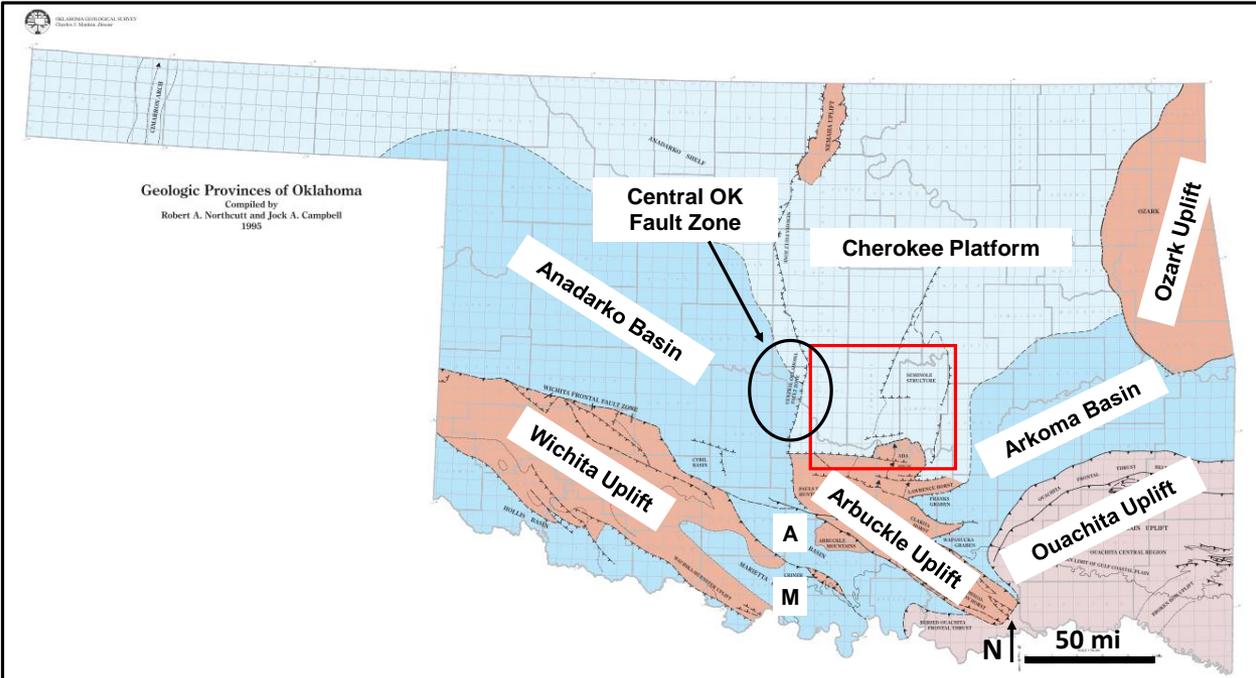
(Comer, 2008 in Miceli, 2010)

1. Regional TOC Distribution:

Relationship between the relative organic-richness of a Devonian shale and Carboniferous Tectonostratigraphic patterns?



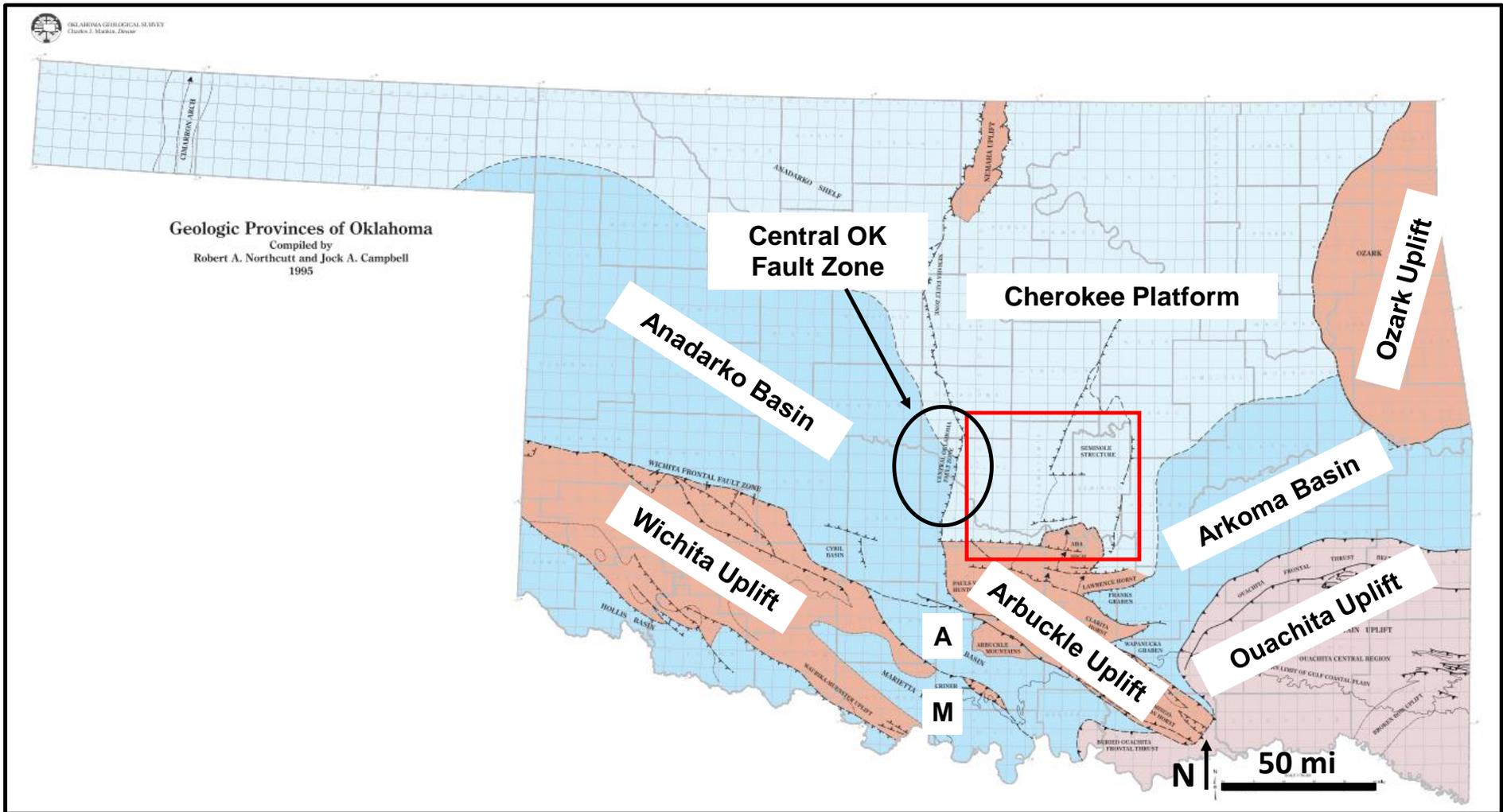
(Modified from Northcutt and Campbell, 1995)



(Comer, 2008 in Miceli, 2010)

1. Tectonostratigraphic Provinces:

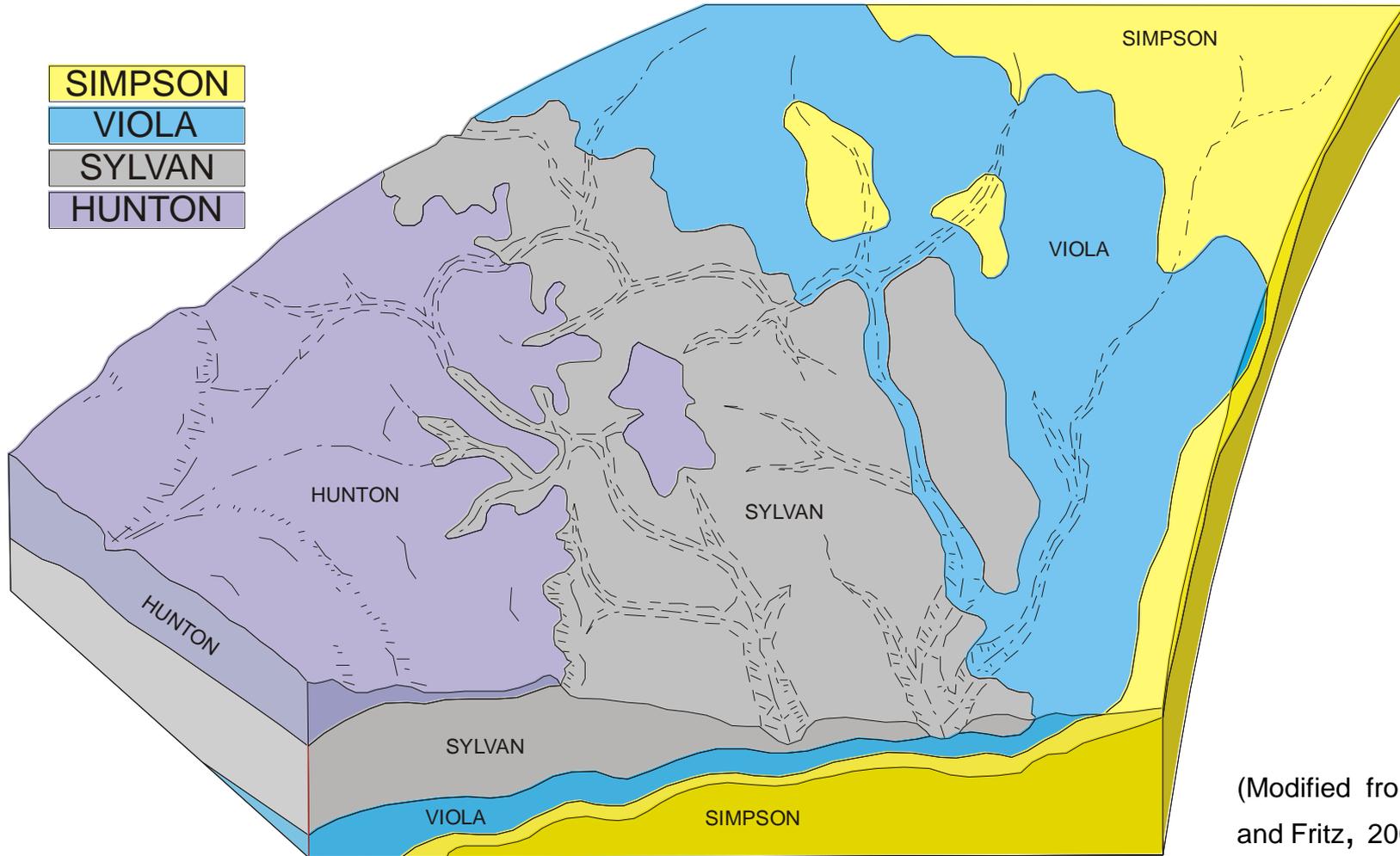
Study location contains Pottawatomie and Seminole counties.



(Modified from Northcutt and Campbell, 1995)

1. Woodford Shale Subcrop:

Unconformity surface subject to erosional incision prior to Woodford Shale deposition.

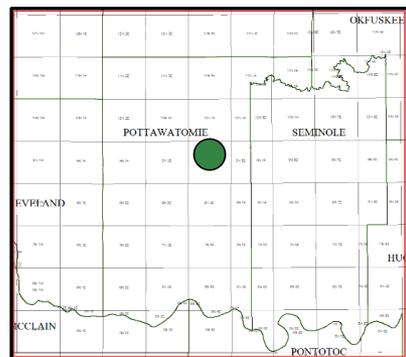
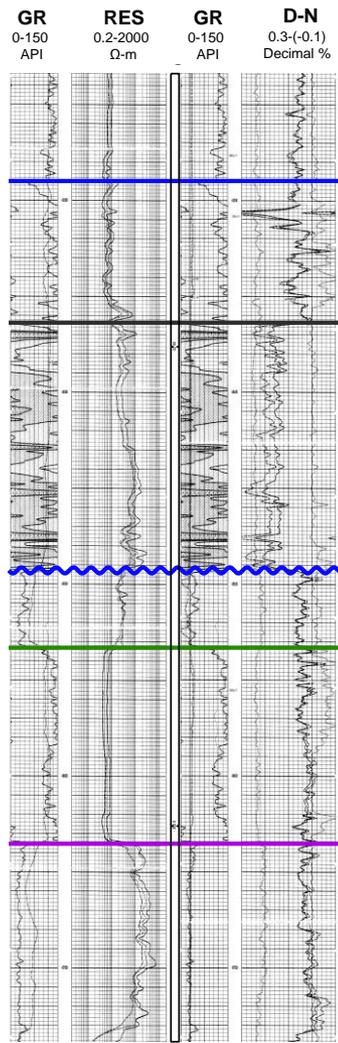


(Modified from Kuykendall and Fritz, 2001)

2. A Type Log:



Type Log Formation Tops:



Unconformity Surface

Unconformity Surface

Mayes Group

Woodford Shale

Hunton Group

Sylvan Shale

Viola Group

N
6 mi.

Operator: **Sharber Billy Jack OP**
 Lease Name: **Jones**
 Lease Number: **1-9A**
 UWI/API: **35125237970000**
 Field: **Tecumseh Northeast**
 Formation at TD: **1st Wilcox**
 Produced Formation: **Hunton**

100 ft
20 m

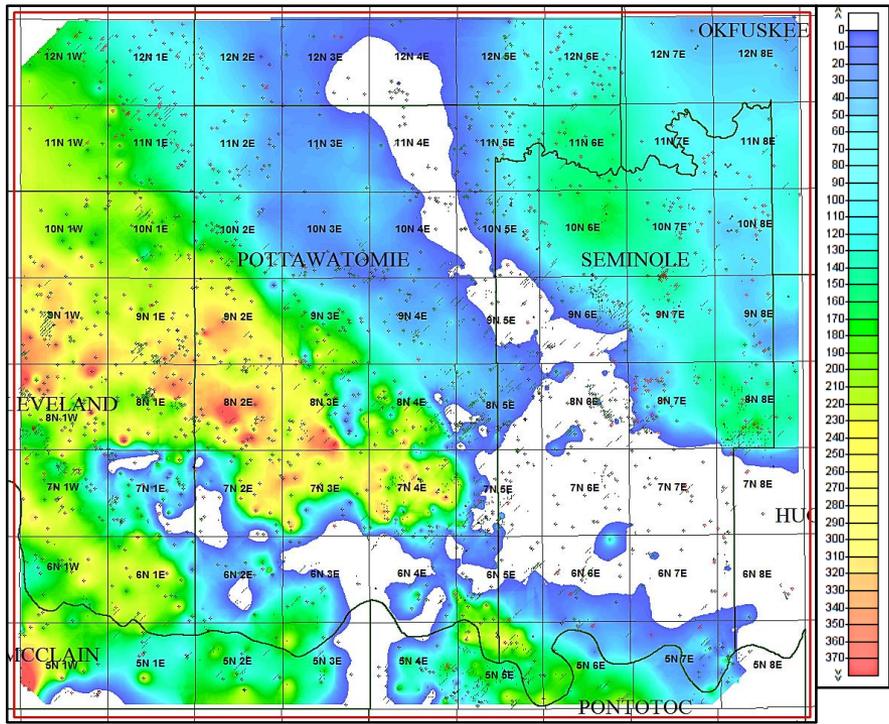
T9N R4E S9
POTTAWATOMIE

(in McCullough, 2014)

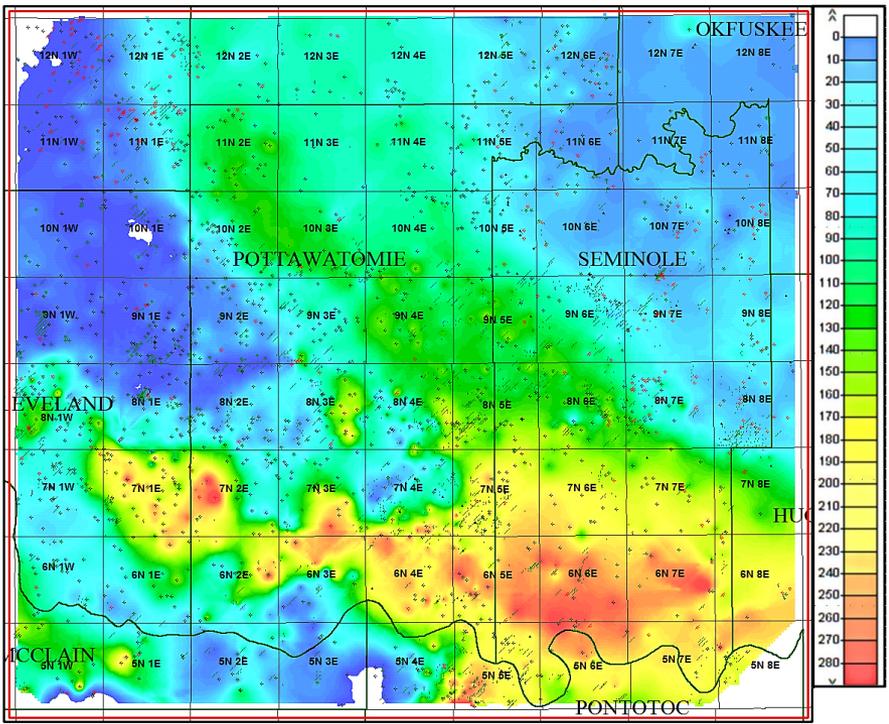
2. Paleotopographic Relationship:

First described by Amsden (1975).

Hunton Group Isopach Map



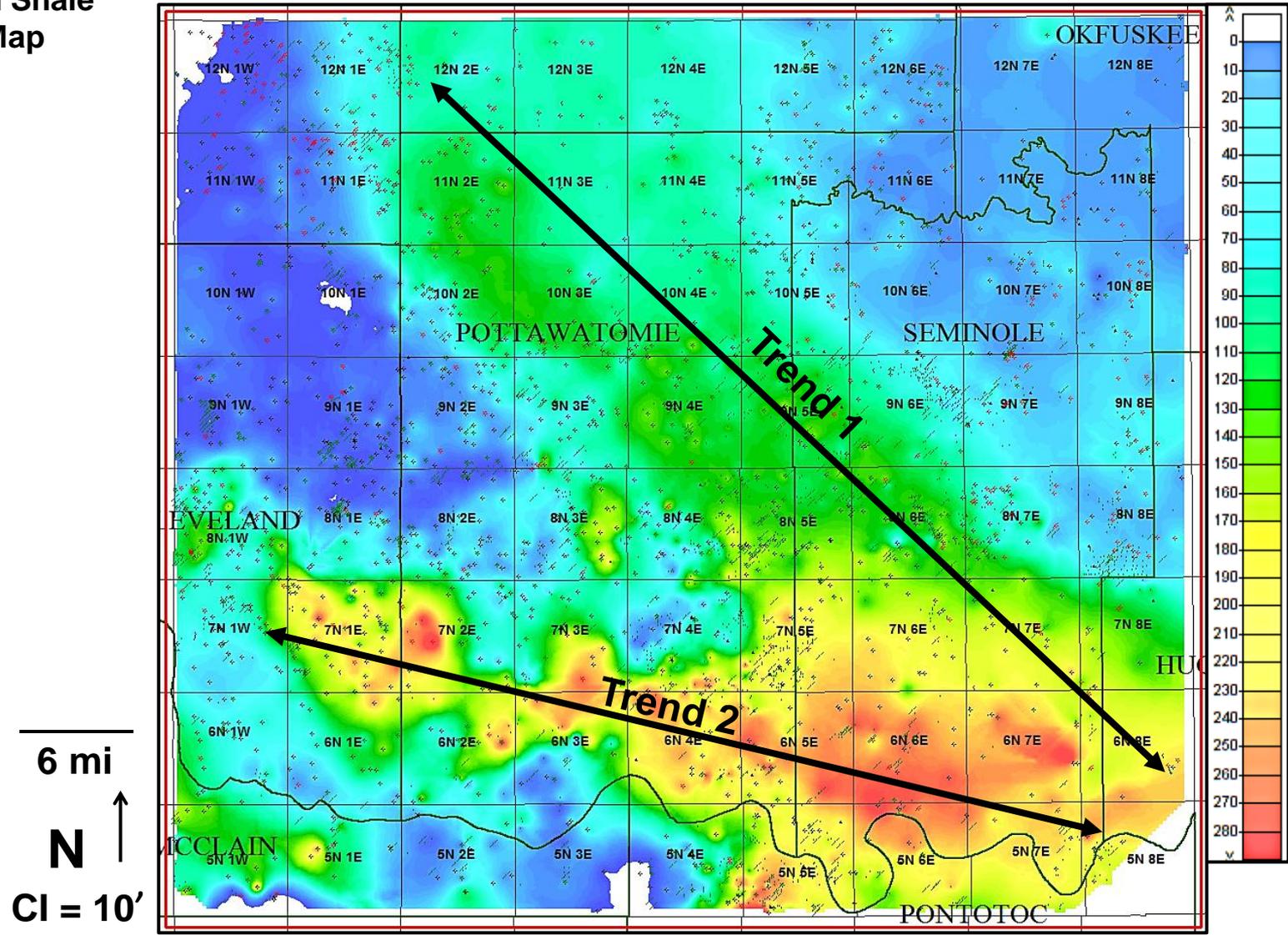
Woodford Shale Isopach Map



(in McCullough, 2014)

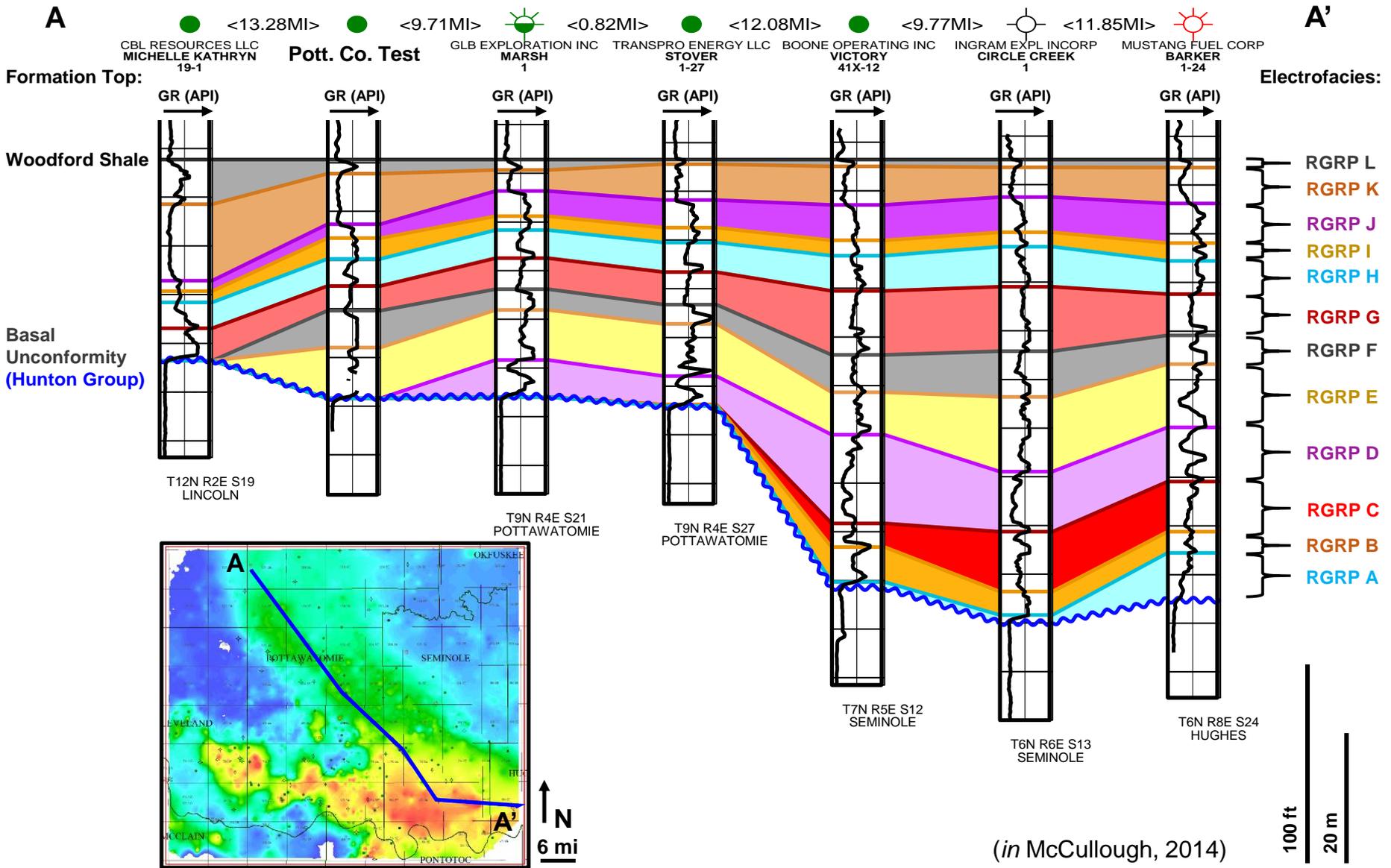
2. Paleotopographic Relationship:

Woodford Shale Isopach Map

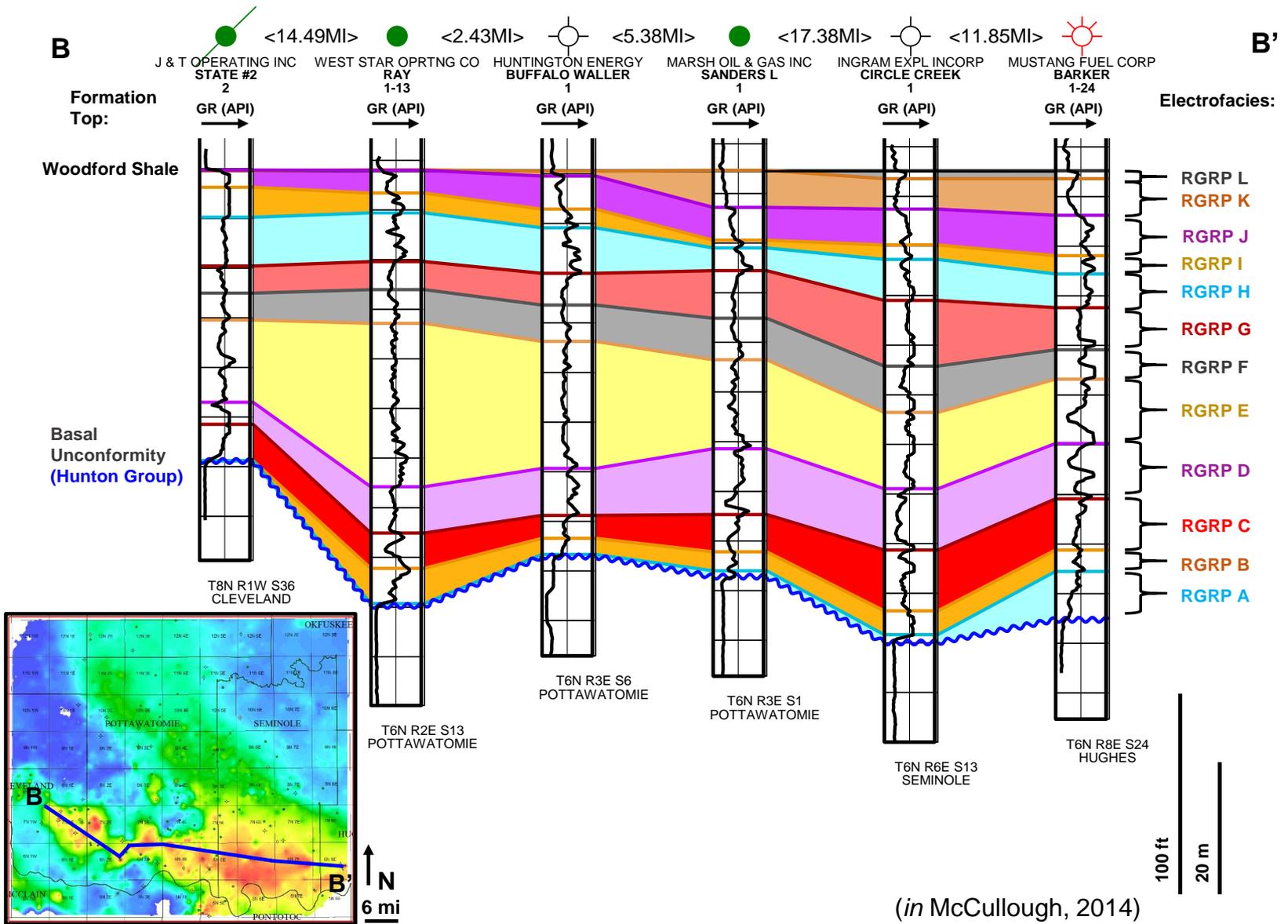


(in McCullough, 2014)

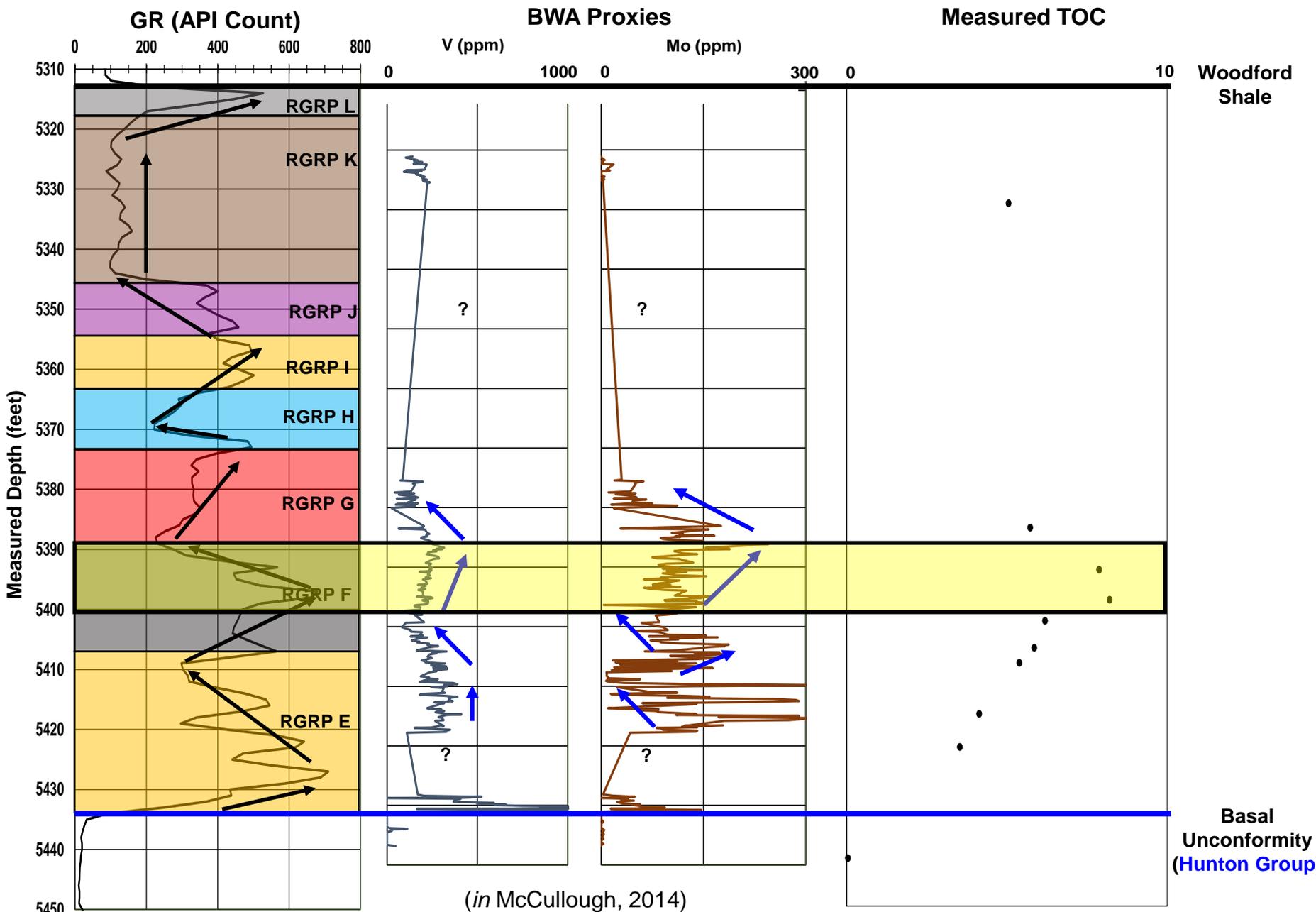
2. Paleotopographic Relationship: Trend 1 Axis



2. Paleotopographic Relationship: Trend 2 Axis

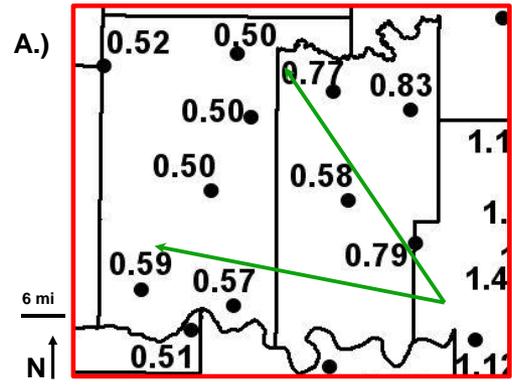
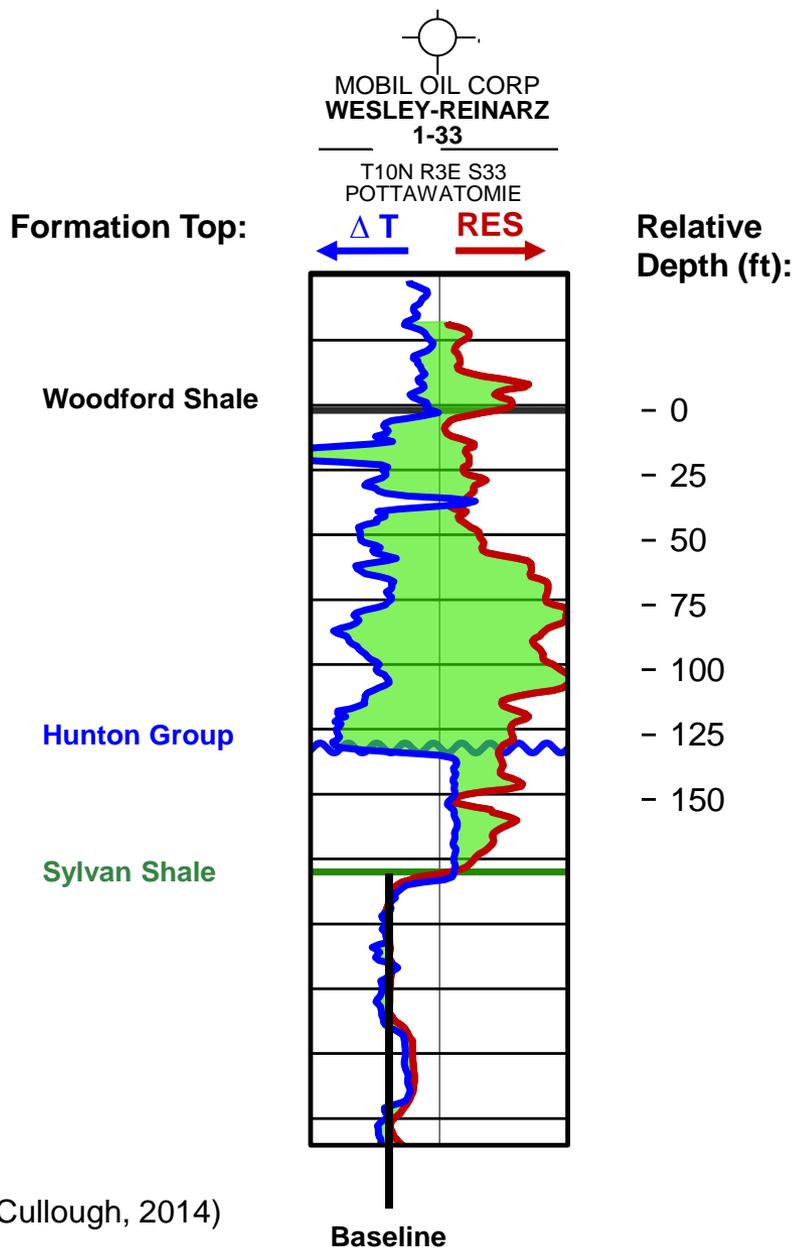


2. Core Analyses from Trend 1: Chemostratigraphy and TOC

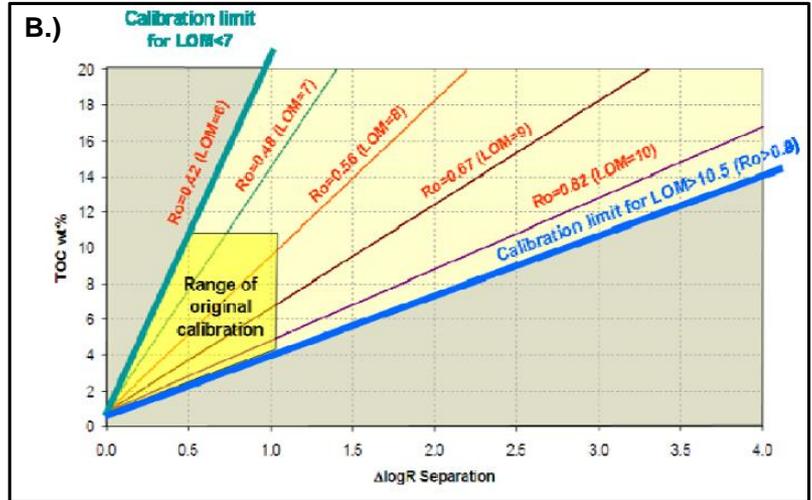


(in McCullough, 2014)

2. Modeled TOC: "Passey Method" $\Delta \text{Log R}$ Petrophysical Proxy



A.) Modified from Cardott (2011).
B.) Modified from Passey et al. (2010).



$$\Delta \text{Log } R_P = \text{Log}_{10} \left(\frac{Res}{Res_{baseline}} \right) - 2.5(P_B - P_{Bbaseline})$$

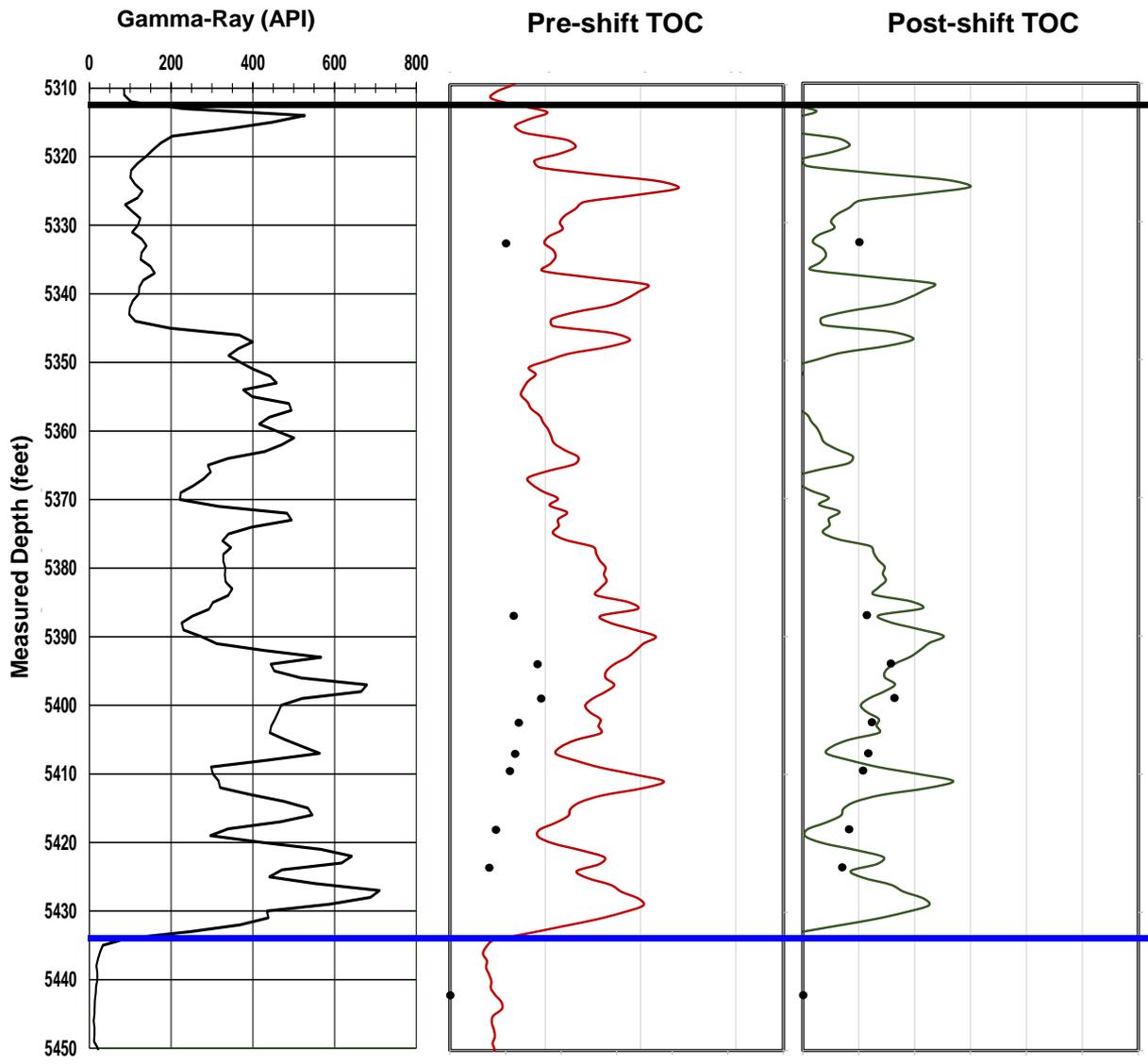
$$\Delta \text{Log } R_S = \text{Log}_{10} \left(\frac{Res}{Res_{baseline}} \right) + 0.2(\Delta t - \Delta t_{baseline})$$

$$TOC = (\Delta \text{Log } R) * 10^{2.297 - (0.1688 * LOM)}$$

(Modified from Passey et al., 1990)

(in McCullough, 2014)

2. Modeled TOC: "Passey Method" Petrophysical Proxy



Formation Top:

Woodford Shale

$$\Delta \text{Log } R_p = \text{Log}_{10} \left(\frac{Res}{Res_{baseline}} \right) - 2.5(P_B - P_{Bbaseline})$$

$$\Delta \text{Log } R_s = \text{Log}_{10} \left(\frac{Res}{Res_{baseline}} \right) + 0.2(\Delta t - \Delta t_{baseline})$$

$$TOC = (\Delta \text{Log } R) * 10^{2.297 - (0.1688 * LOM)}$$

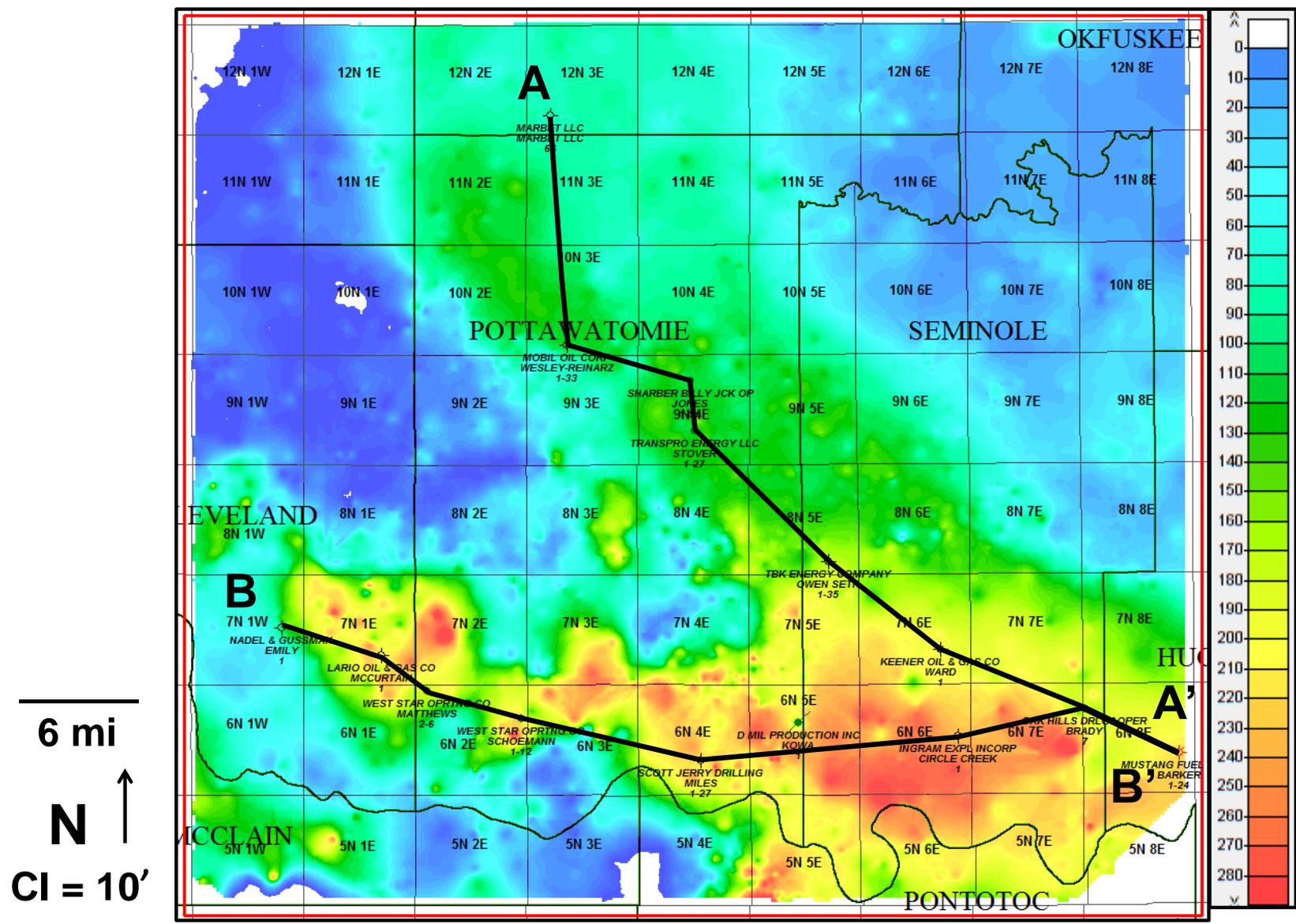
$$TOC = \left((\Delta \text{Log } R) * 10^{2.297 - (0.1688 * LOM)} \right) - 9.$$

(Modified from Passey et al., 1990)

Hunton Group

(in McCullough, 2014)

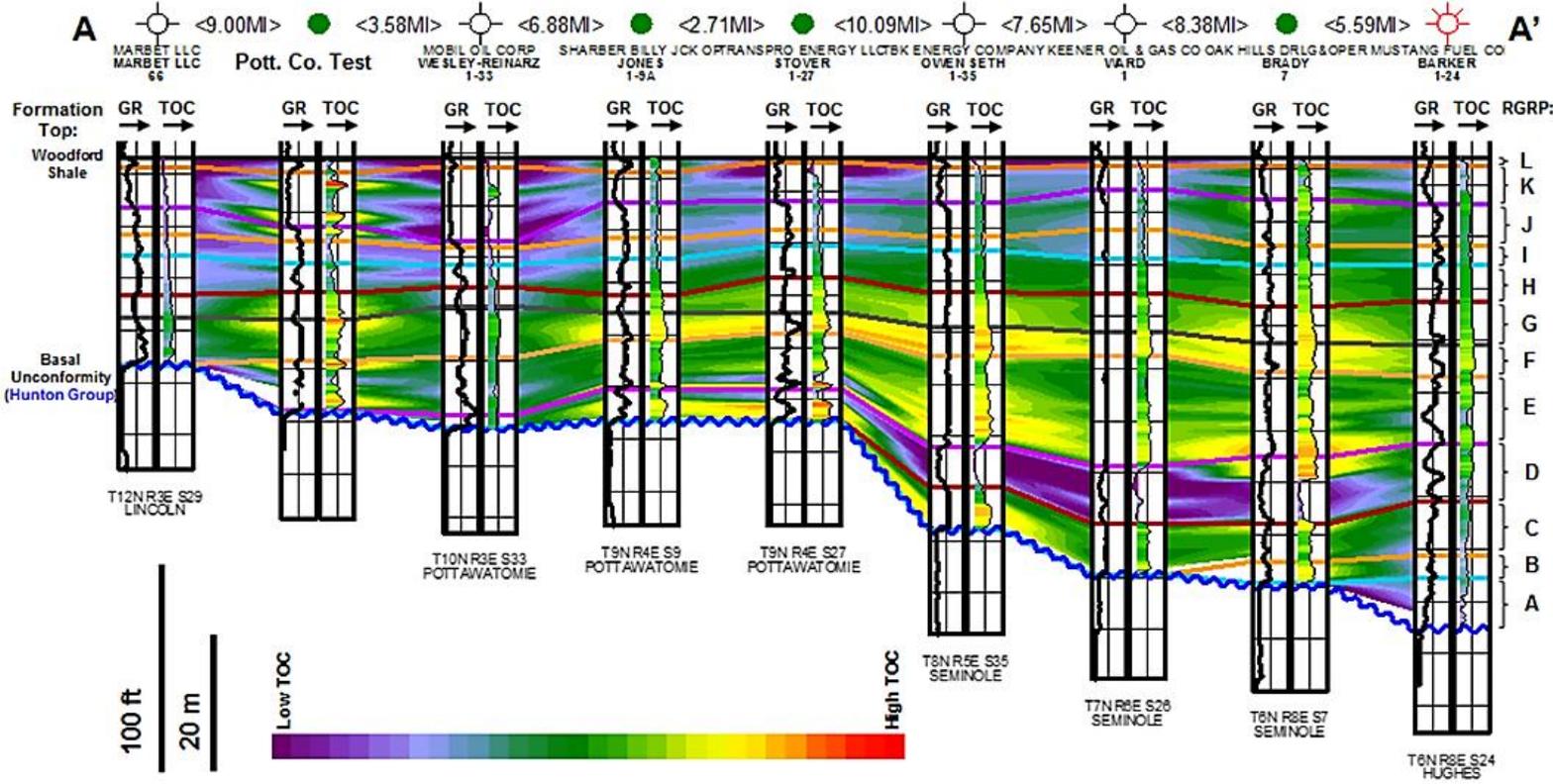
2. Modeled TOC: "Passey Method" Petrophysical Proxy



(in McCullough, 2014)

Modeled TOC: Trend 1 Axis (Depositional Dip)

Electrofacies F-G show highest degree of lateral continuity.

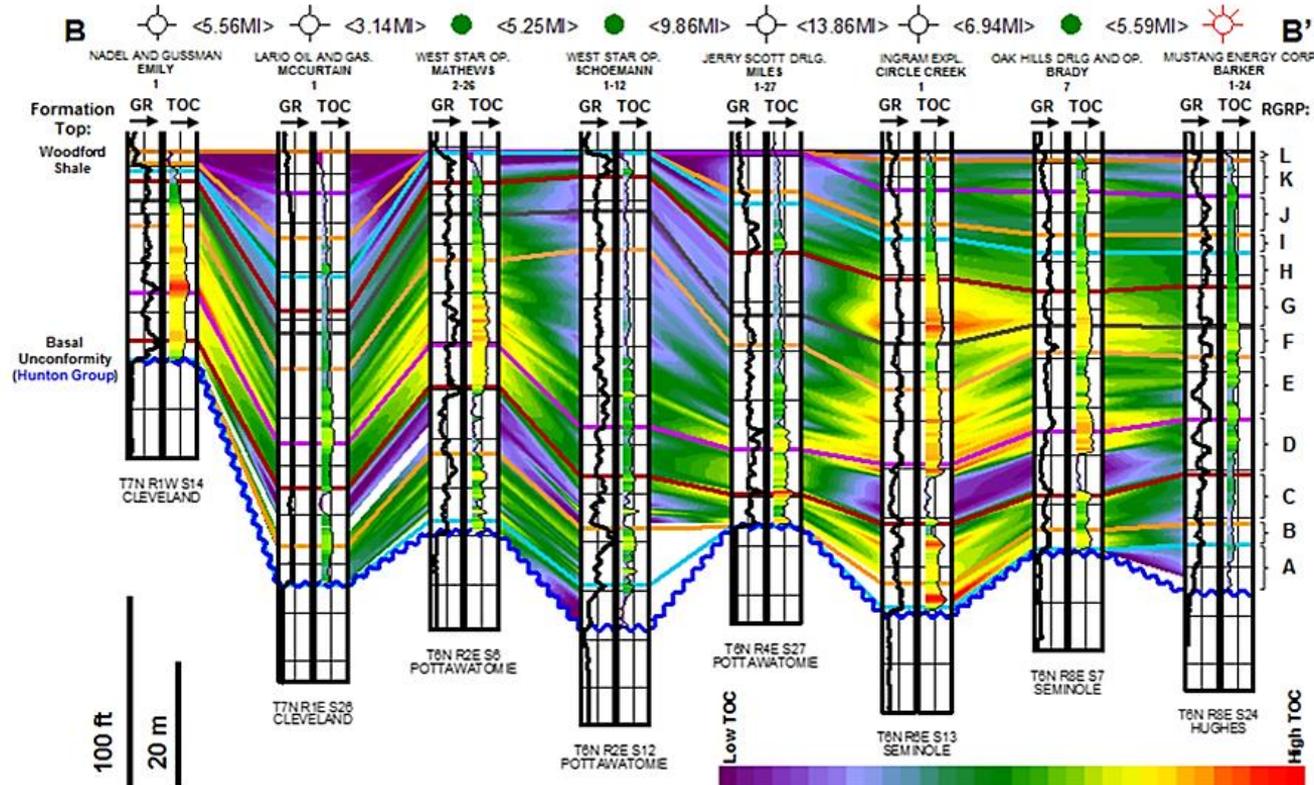


(in McCullough, 2014)

2. Modeled TOC: Trend 2 Axis

Electrofacies D-E show highest degree of lateral continuity.

Stratigraphic variations are function of variable preservation due to paleo-structural highs and overlying erosional unconformity; top of Woodford is not an appropriate datum.



(in McCullough, 2014)

3. Initial learnings:

The terminal extents of Trend 1 and Trend 2 appear to display differential preservation of separate organic rich strata (F/G vs. D/E)

Implication:

The terminal extents of either trend contain separate organic rich strata, therefore the strata that have the highest potential to act as “source beds”.

Further Question:

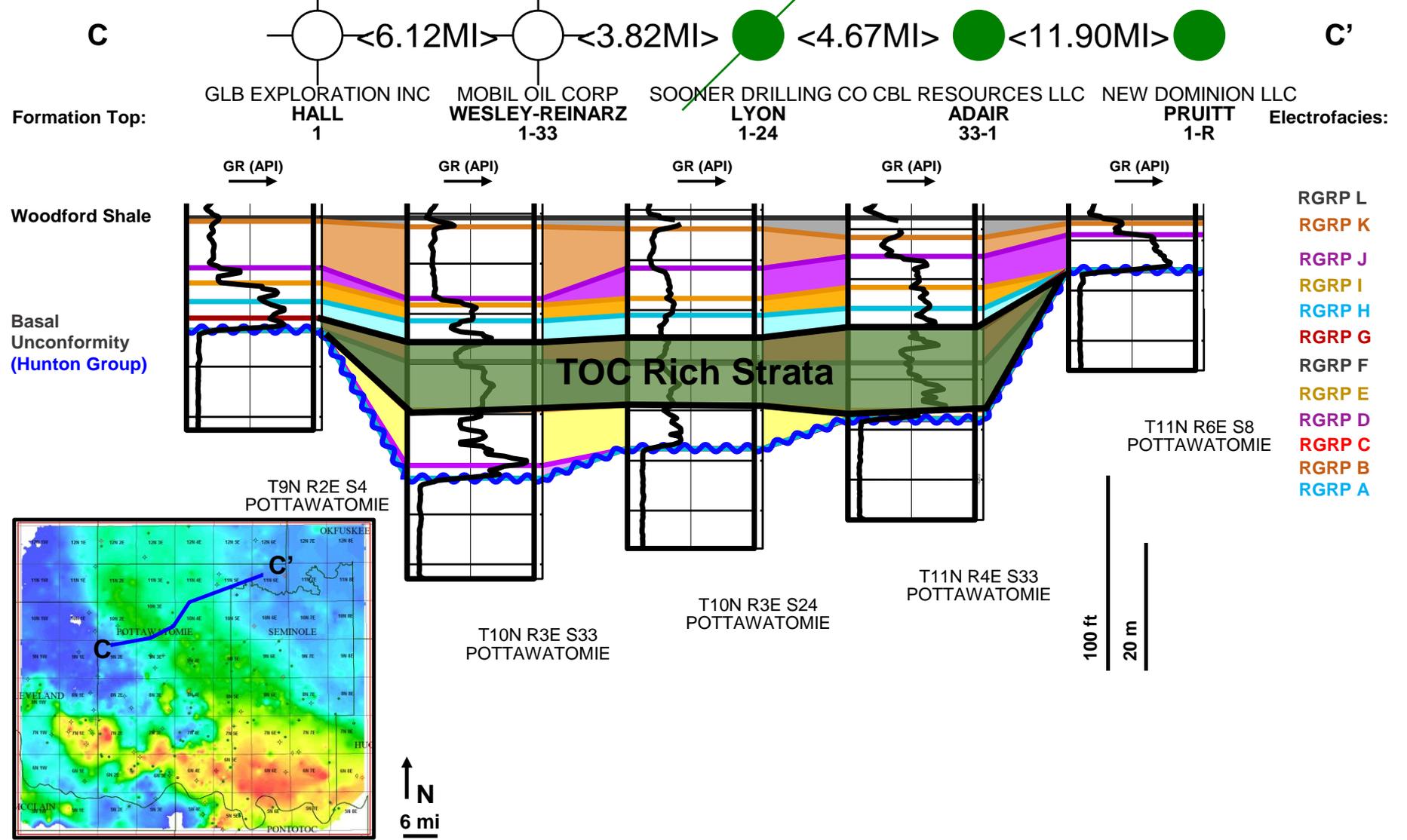
Why are organic-rich strata preserved depositionally updip? Specifically why do they occur depositionally updip in Trend 1.

3. Trend 1 Summary:

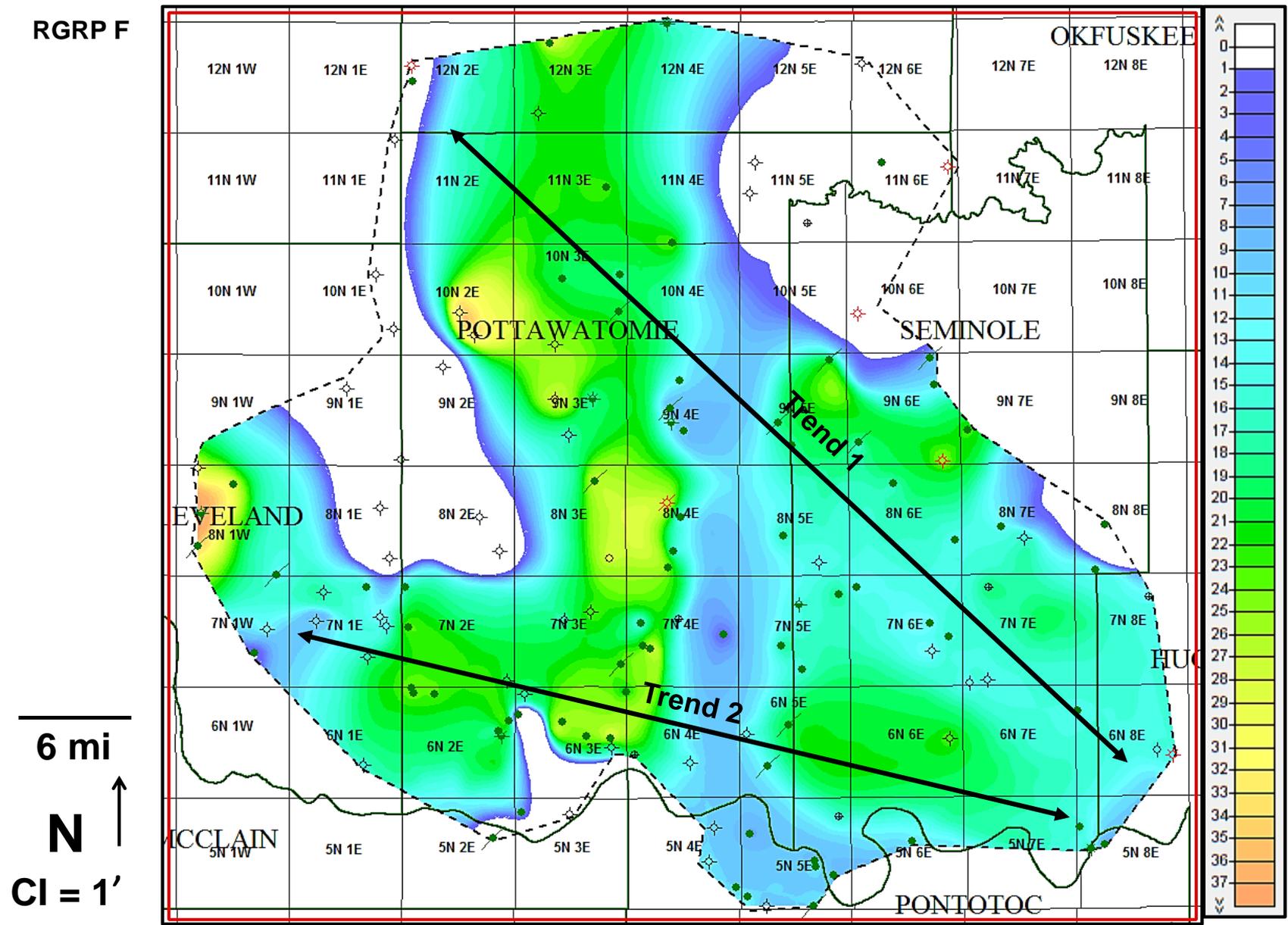
- Stratigraphy shows onlapping of lower-most Woodford units in a landward direction.
- Modeled TOC shows highest lateral continuity updip at the interface of electrofacies F and G.
- Measured TOC values from core samples are highest in electrofacies F
- Chemostratigraphic proxies for BWA indicate increasing Mo and V content in electrofacies F; suggesting conditions conducive to the sequestration of both at the time of deposition (bottom water anoxia).

3. Modeled TOC: Trend 1 Depositional Strike

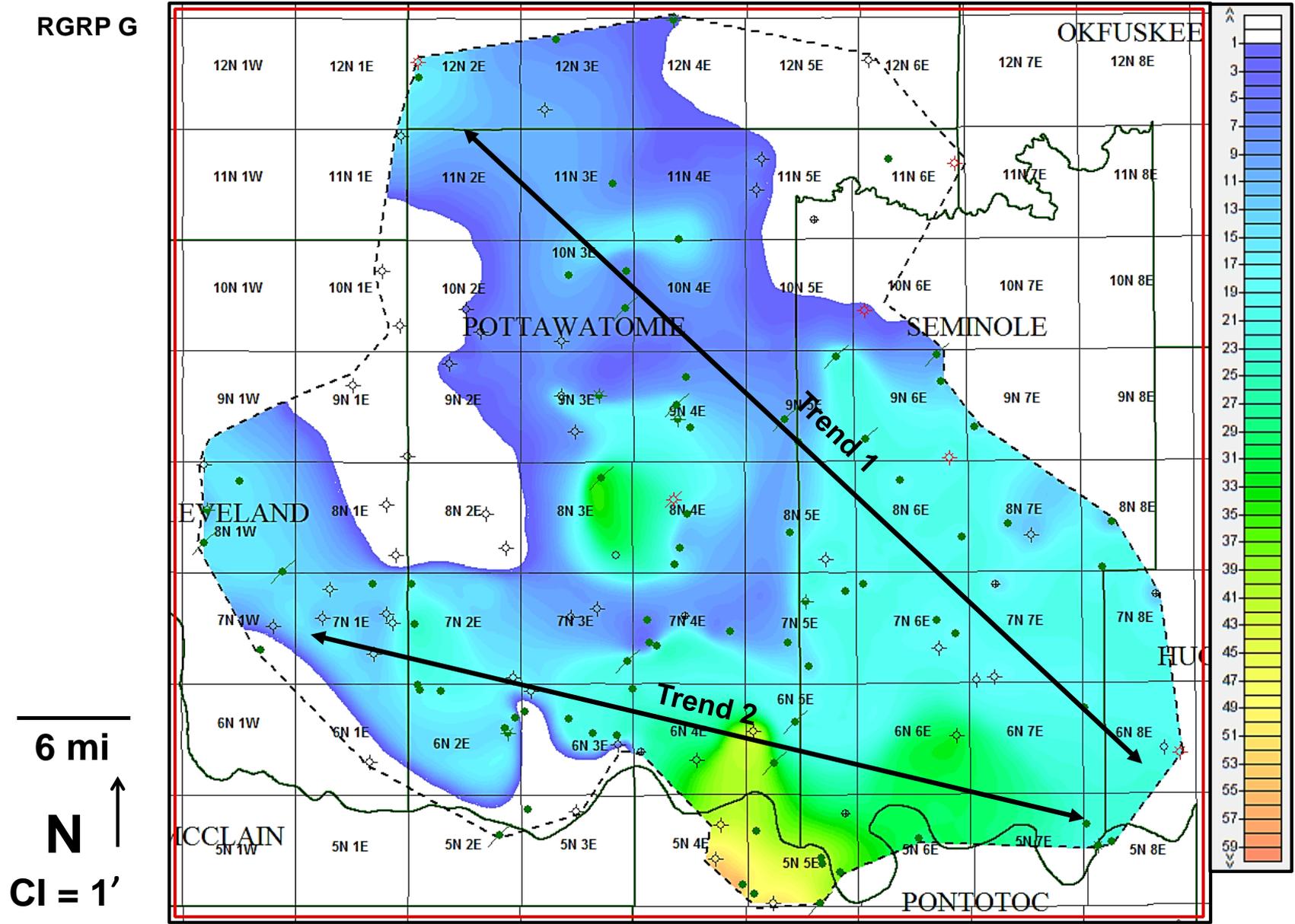
Electrofacies F-G show highest degree of lateral continuity, spatially limited to deeper part of paleo-topographic setting



3. Electrofacies F Distribution: Limited by underlying paleotopography

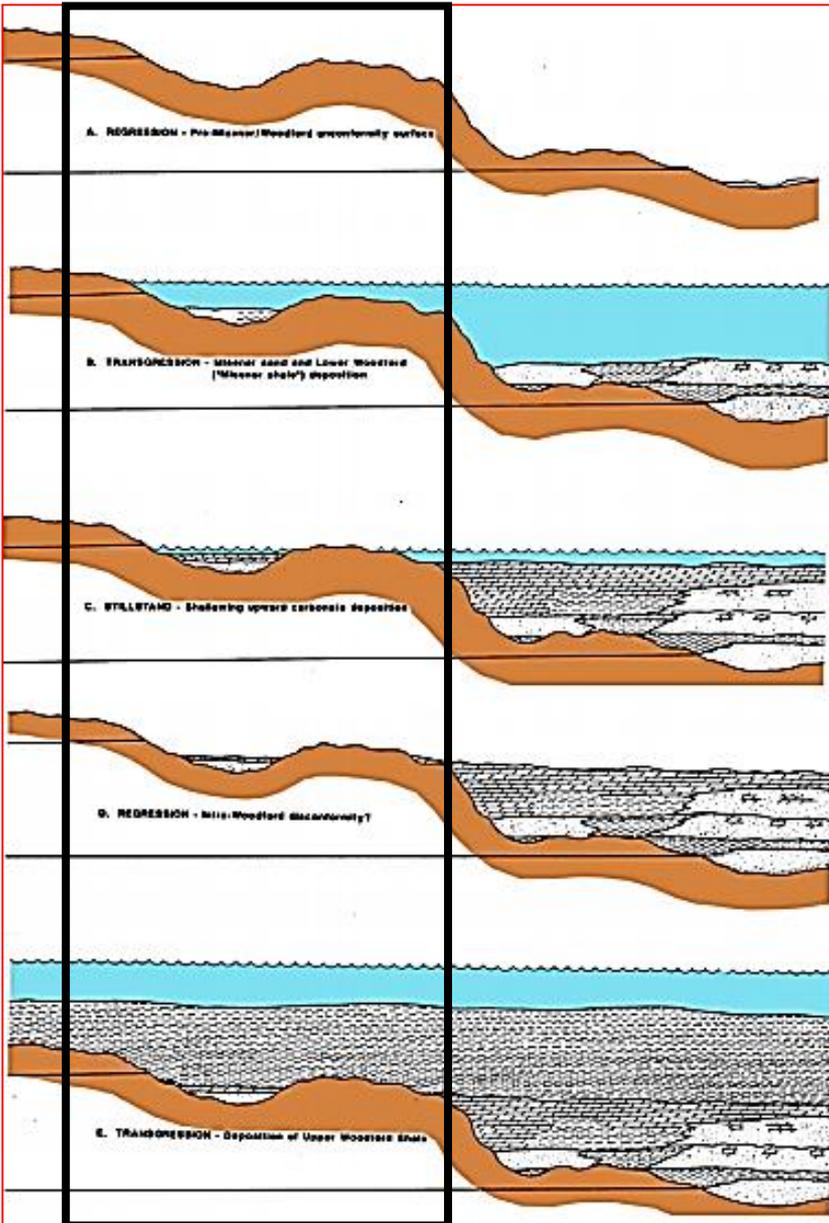


3. Electofacies G Distribution: Also limited by underlying paleotopography



4. Mechanism: (Hypothetical)

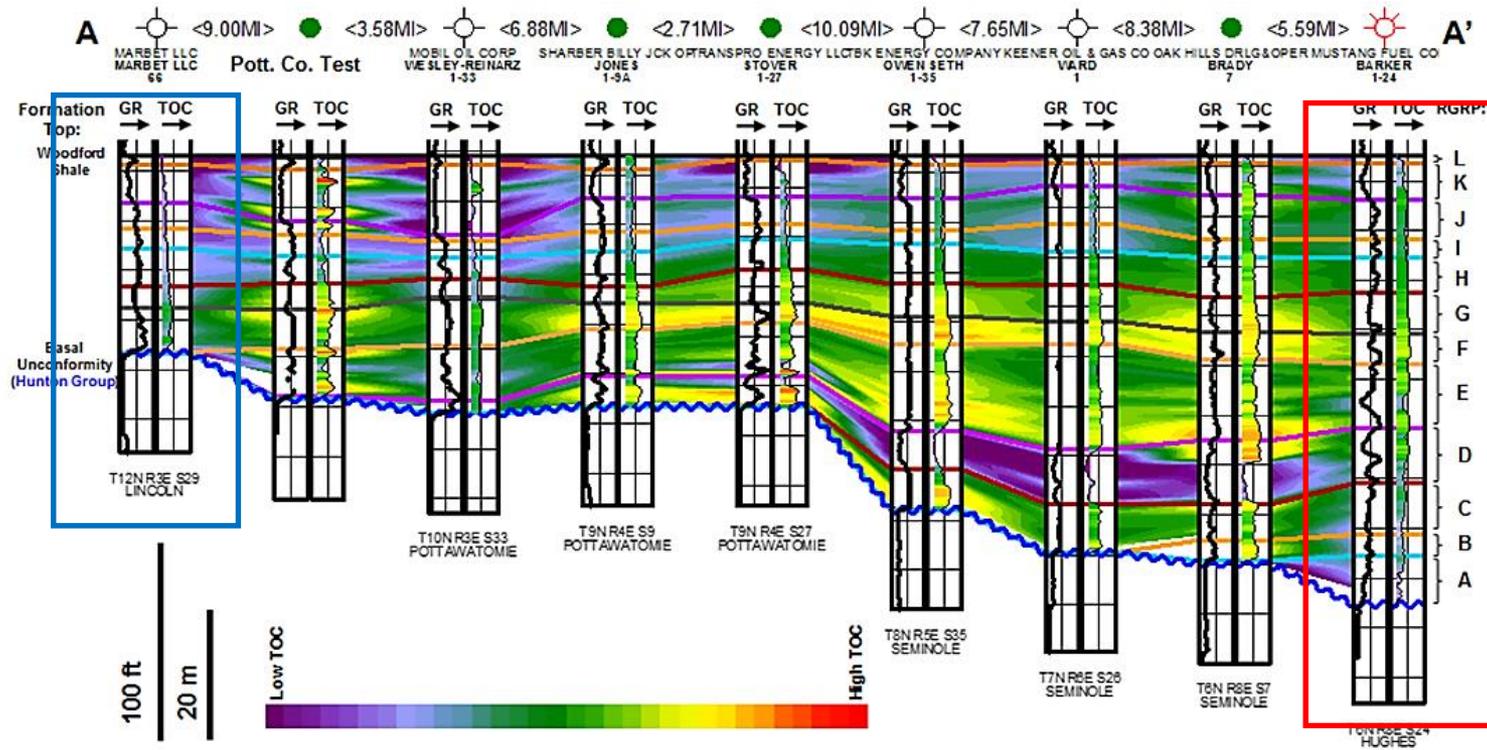
- Isolated paleo-topographic setting (Incised Valley) may allow for the development of localized restriction resulting in localized bottom water anoxia (XRF) which allows for enhanced preservation potential of organic matter (TOC).
- Similar to silled basin.



(Kuykendall and Fritz, 2001)

5. Conclusion: Where is the "fridge"? What kind of "fridge"?

(in McCullough, 2014)



Thanks and Acknowledgements:

AAPG, Devon Energy, Roger Slatt, IHS

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