Devonian Shale Plays of the Black Warrior Basin and Appalachian Thrust Belt in Alabama*

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Abstract

The Black Warrior basin and Appalachian thrust belt of Alabama are frontier areas for shale gas production, and diverse opportunities for development exist in Devonian strata. The Chattanooga Shale is being developed along the southeast margin of the Black Warrior basin. Unnamed pre-Chattanooga shale, by comparison, is prospective in the interior of the Appalachian thrust belt. Integrated geological analysis indicates that the characteristics of each area differ markedly, and these characteristics should be taken into account during exploration and development.

The Chattanooga Shale is an organic-rich, cratonic shelf facies in the Black Warrior basin. Development in the northeastern part of the basin is focused along the hinges of fault-related folds with geometry ranging from detachment folds to breakthrough fault-propagation folds. The crestal regions of these folds are major zones of meteoric recharge, and significant quantities of water are produced from the Chattanooga in this region. Reservoirs are about 2500 feet deep and are characterized by low temperature, low pressure, and maturity near the base of the thermogenic gas window. Isotherms indicate that a large part of the adsorbed gas fraction can be recovered as reservoir pressure is reduced by dewatering.

Farther south, where the Chattanooga is deeper than 5000 feet, the shale is being explored in a depocenter along the southeastern margin of the Black Warrior basin. Extensional faults are abundant in the depocenter, and the best opportunities for development are in coherent structural panels between the faults. Pre-Chattanooga black shale in the interior of the Appalachian thrust belt is preserved within large-scale ramp-flat structures. Here, thick black shale units that are interbedded with limestone and siltstone were deposited on a slope near the edge of the Laurussian craton. All wells penetrating this shale section have encountered major gas shows. Thermal maturity is near the top of the thermogenic gas window, and geochemical data indicate that the preserved organic matter is highly gas-prone. Gas capacity in the shale correlates strongly with TOC content. Devonian shale reservoirs in the Black Warrior depocenter and the interior of the thrust belt are warm, deep reservoirs that are sheltered from meteoric recharge. Elevated pressure gradients in the shale are attributed to hydrocarbon overpressure that formed during thermogenesis and may contribute to gas mobility.

References

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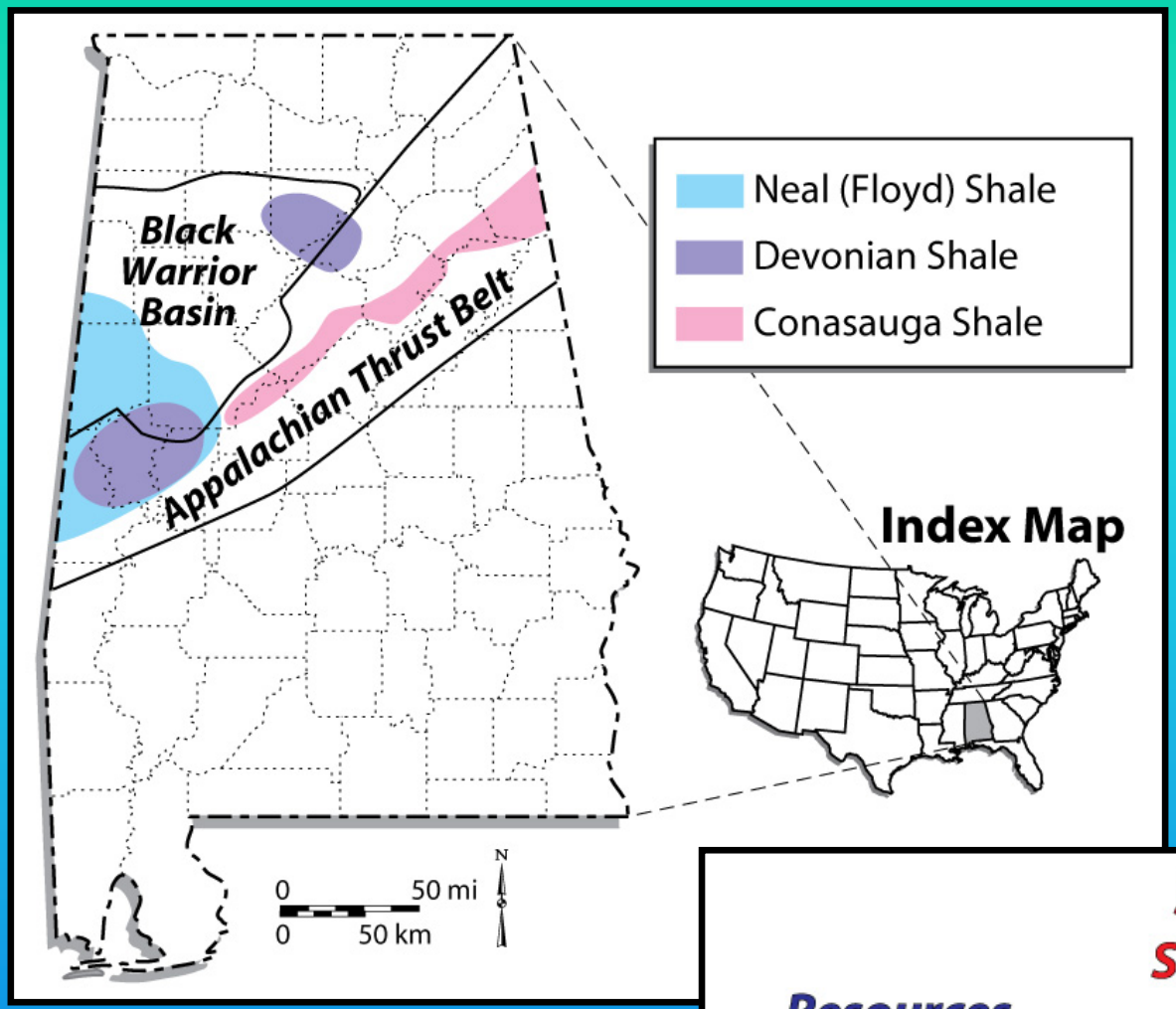
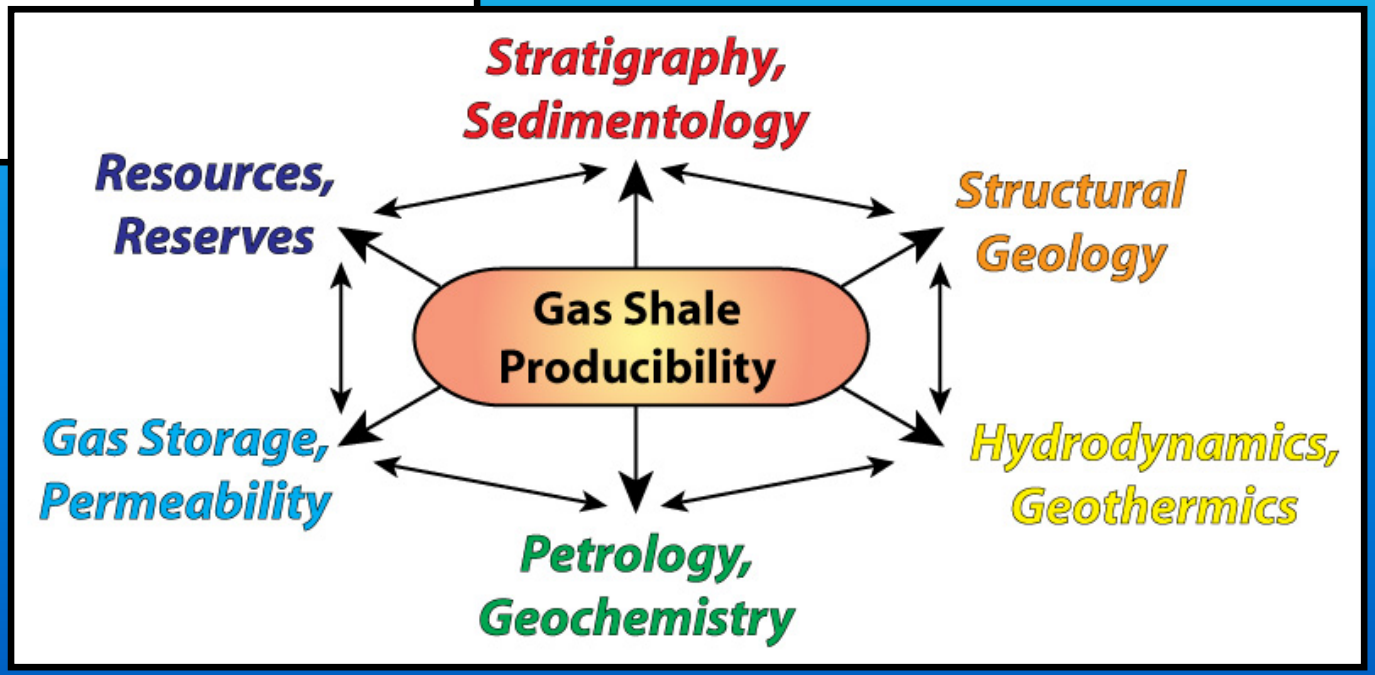
Geological Survey of Alabama

PLAY CONCEPTS





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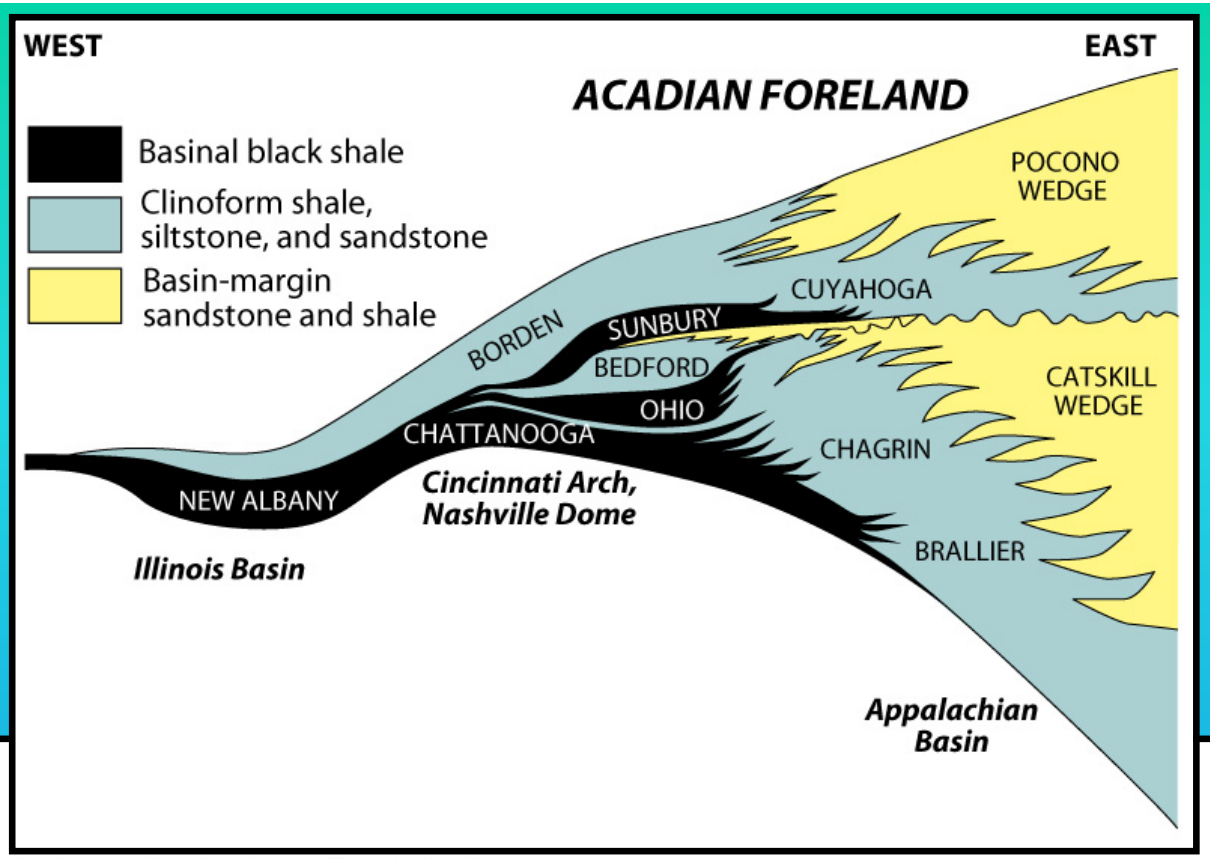
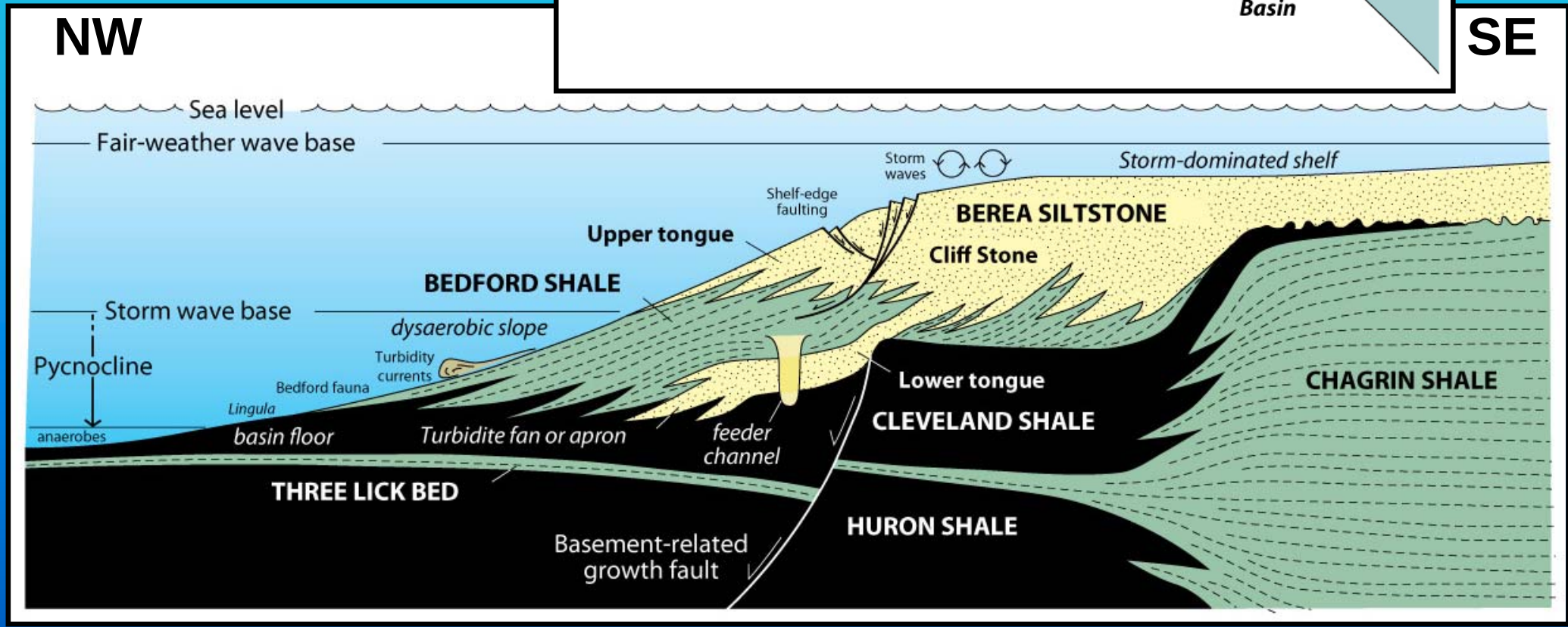
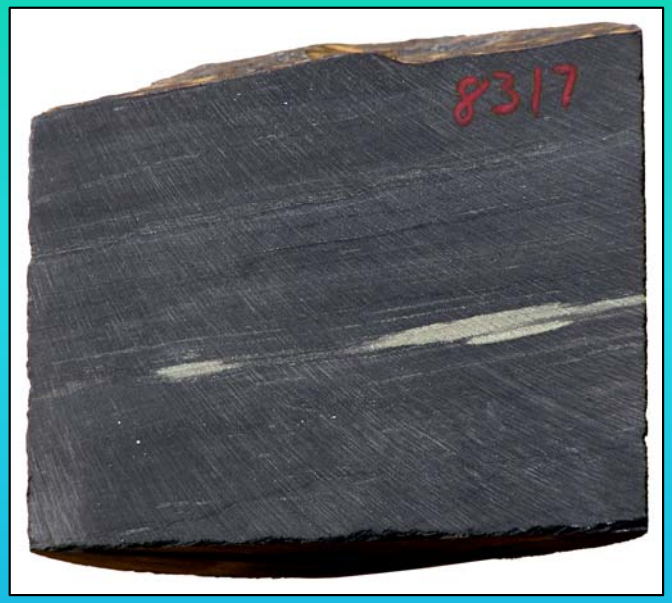
DEVONIAN EUXINIC BASIN

Pashin and Ettensohn (1995)



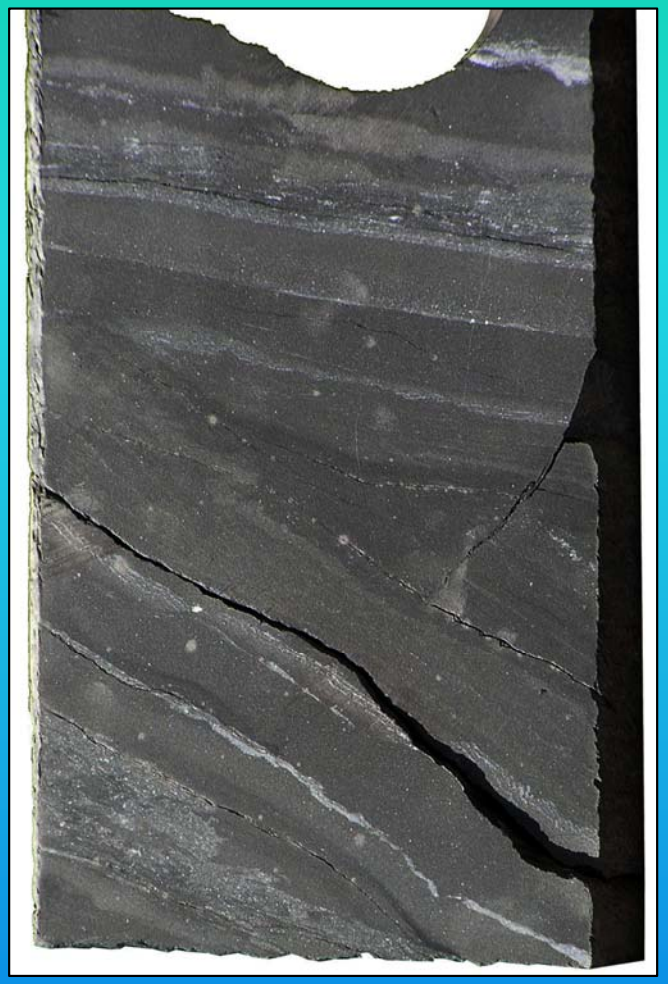


Laminae



Distal mudflows

Onlapped tilt block

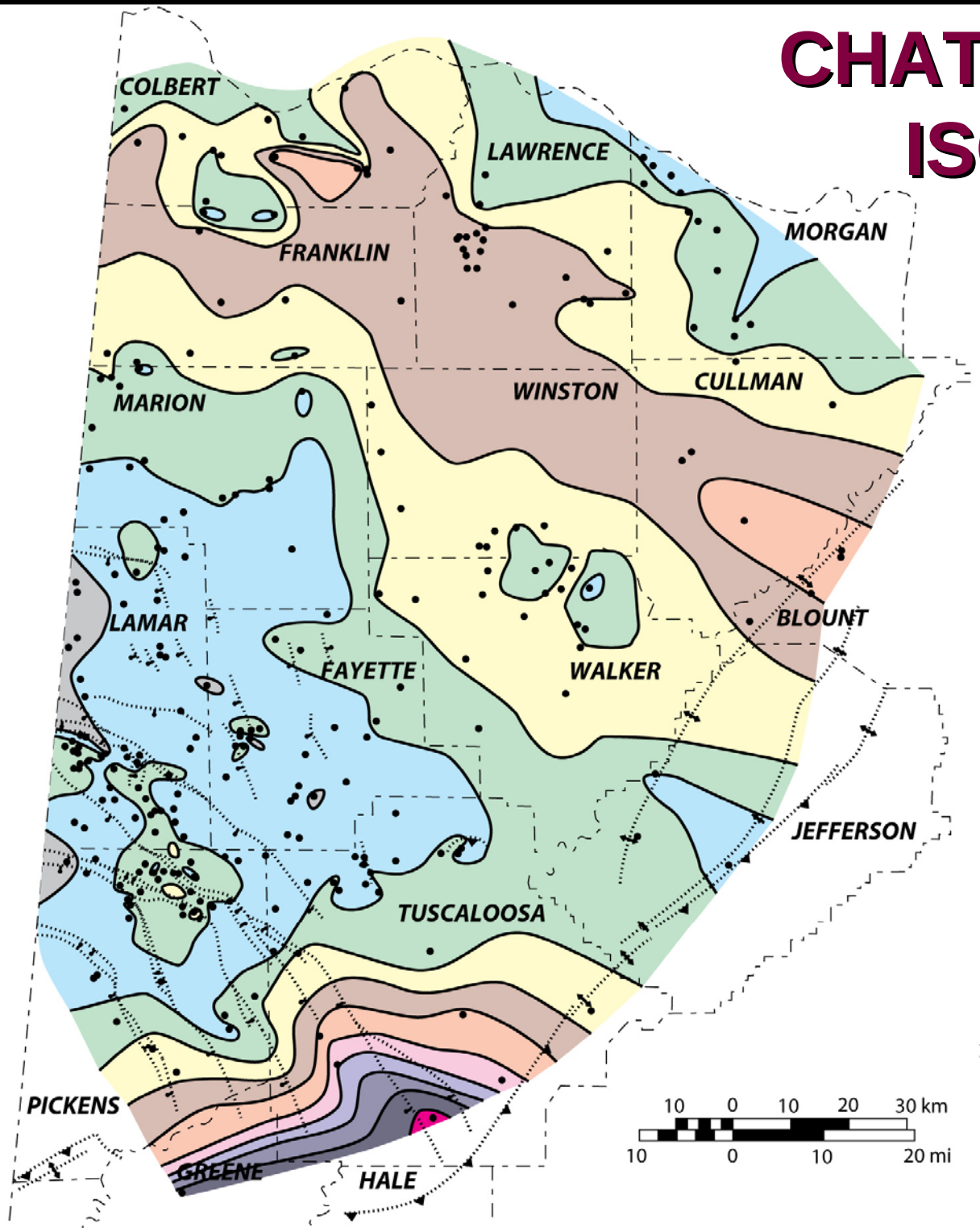


Burrows

Overturned folds

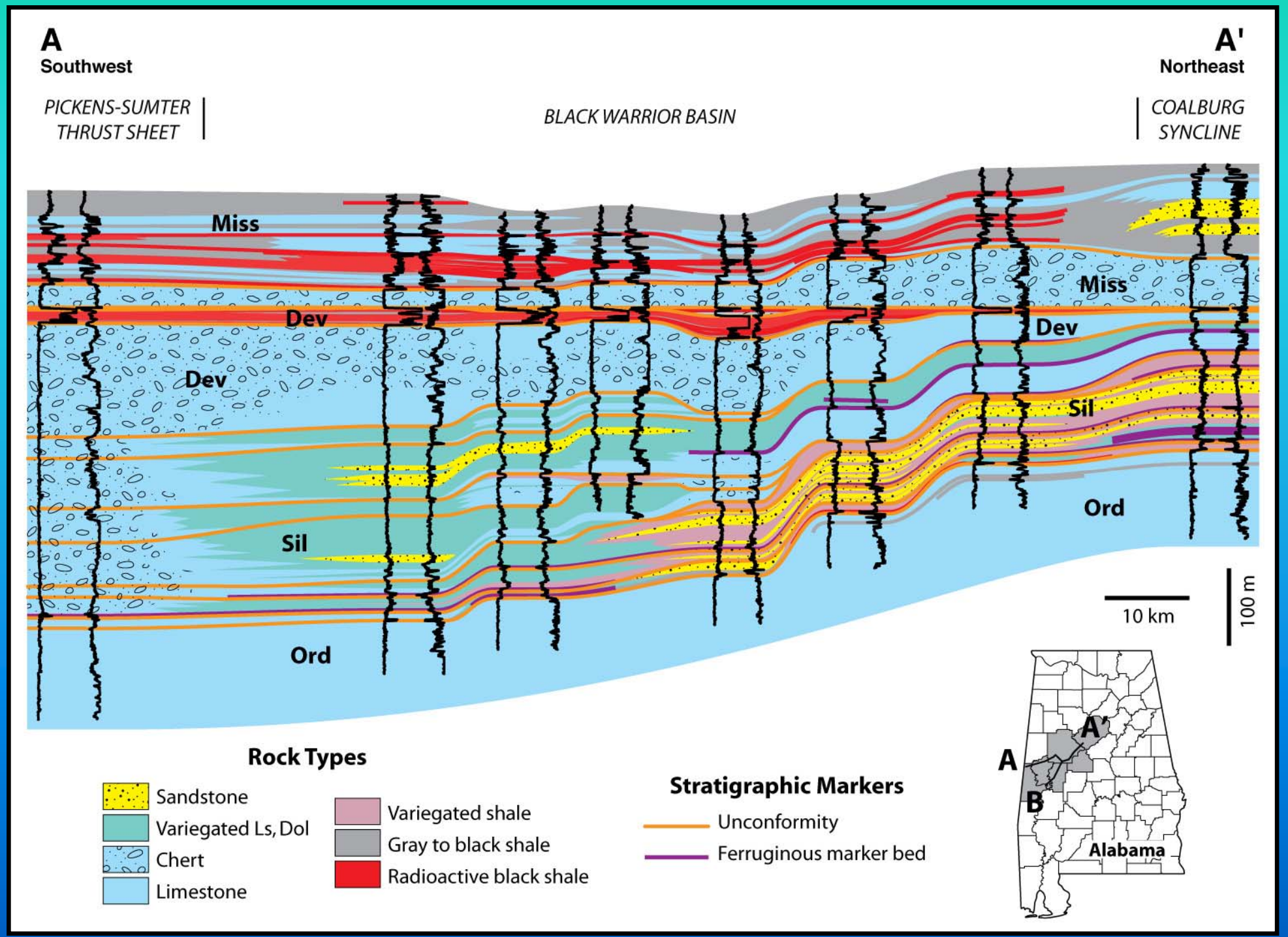
Core width = 4 in

CHATTANOOGA ISOPACH

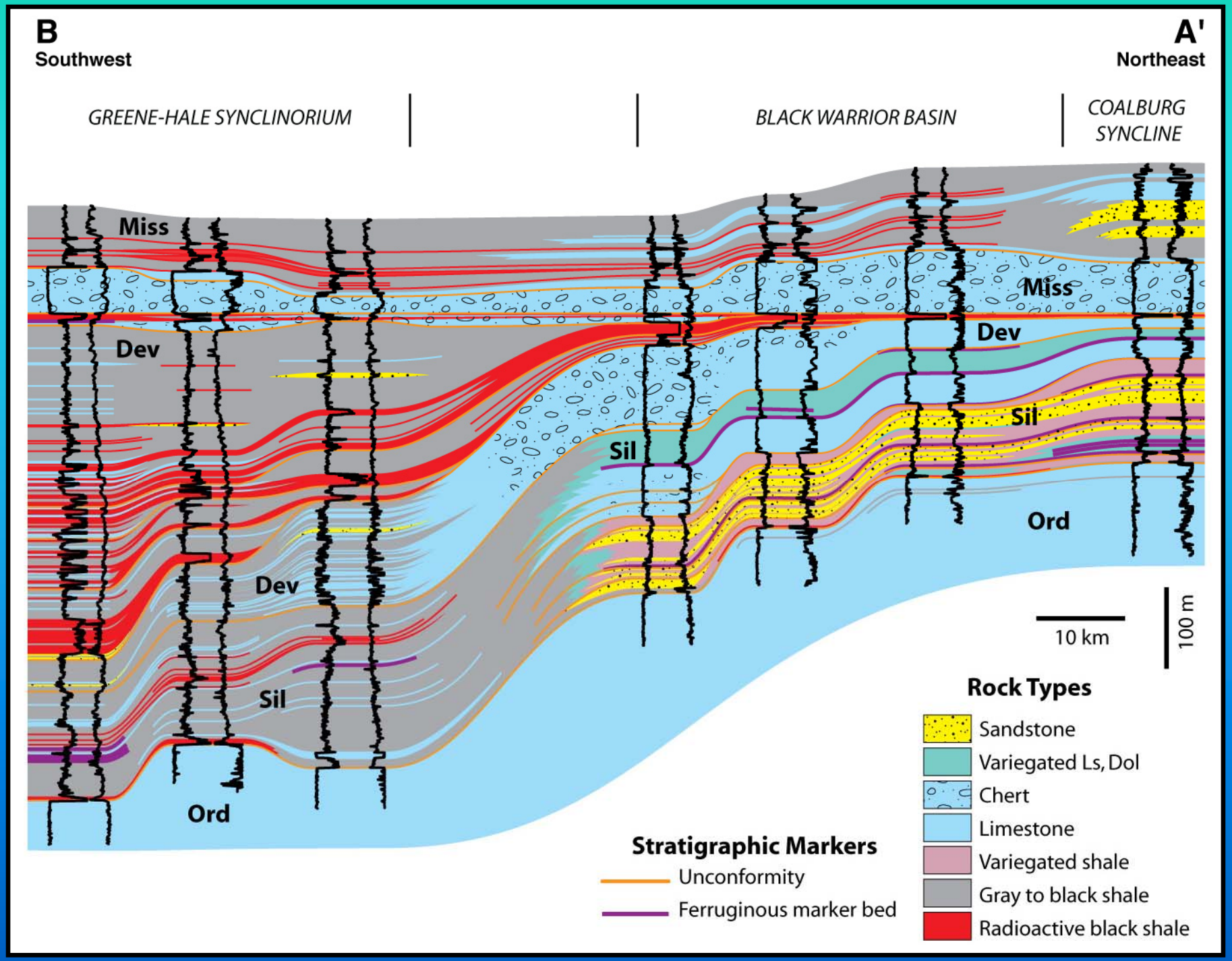


Pashin (2008)

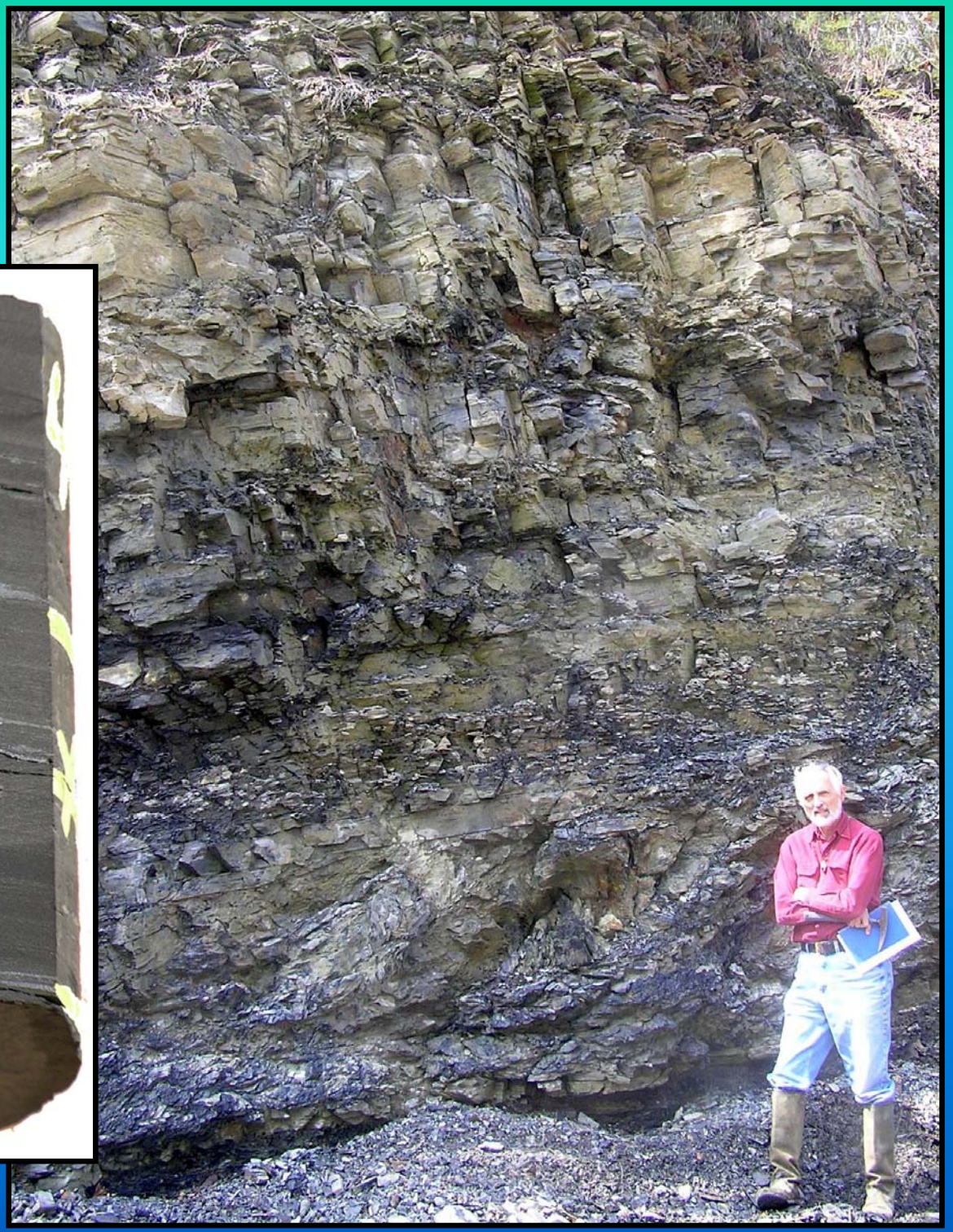
DEVONIAN-MISSISSIPPIAN SHALE



SILURIAN-MISSISSIPPIAN SHALE



FOLDS AND JOINTS



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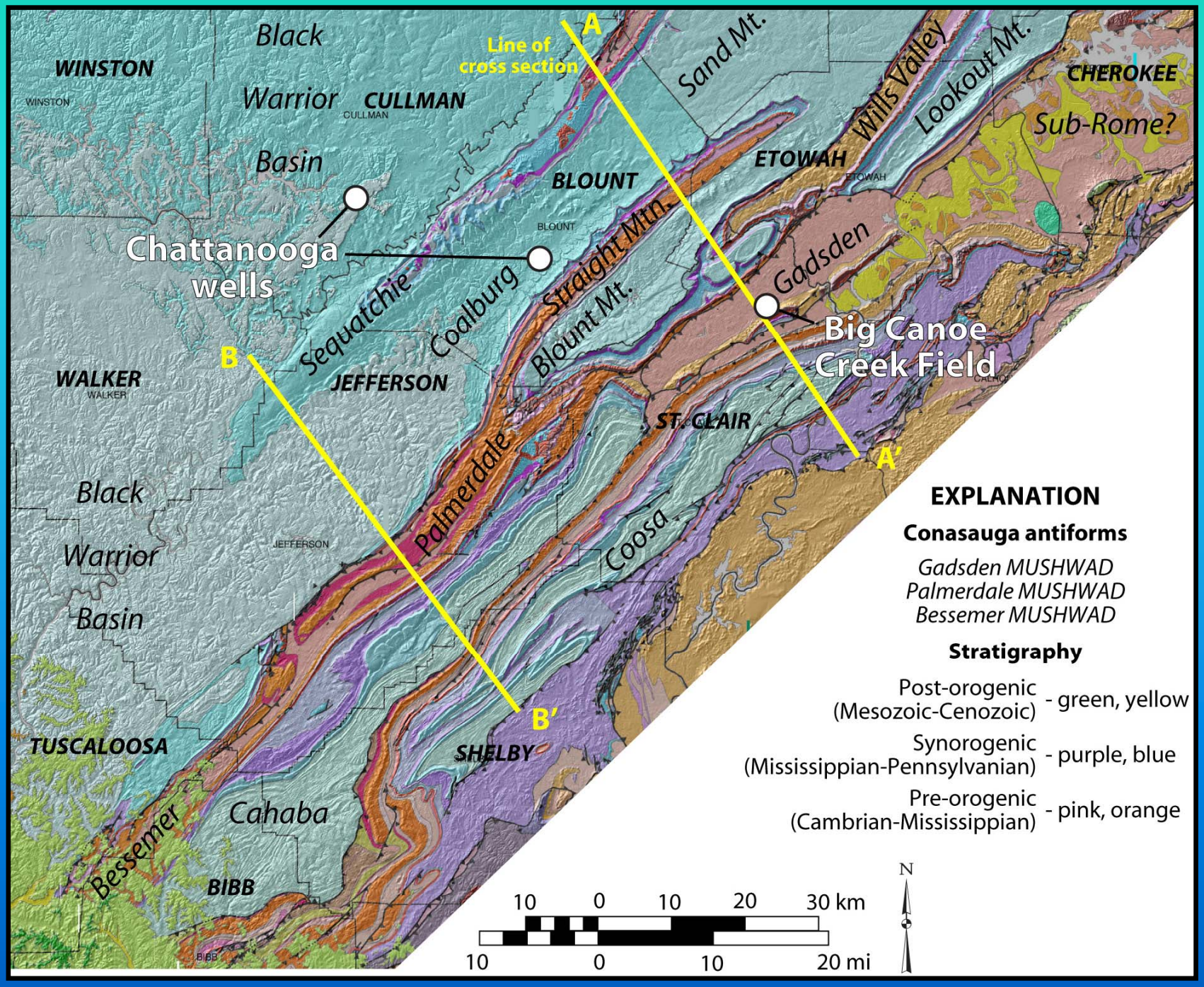

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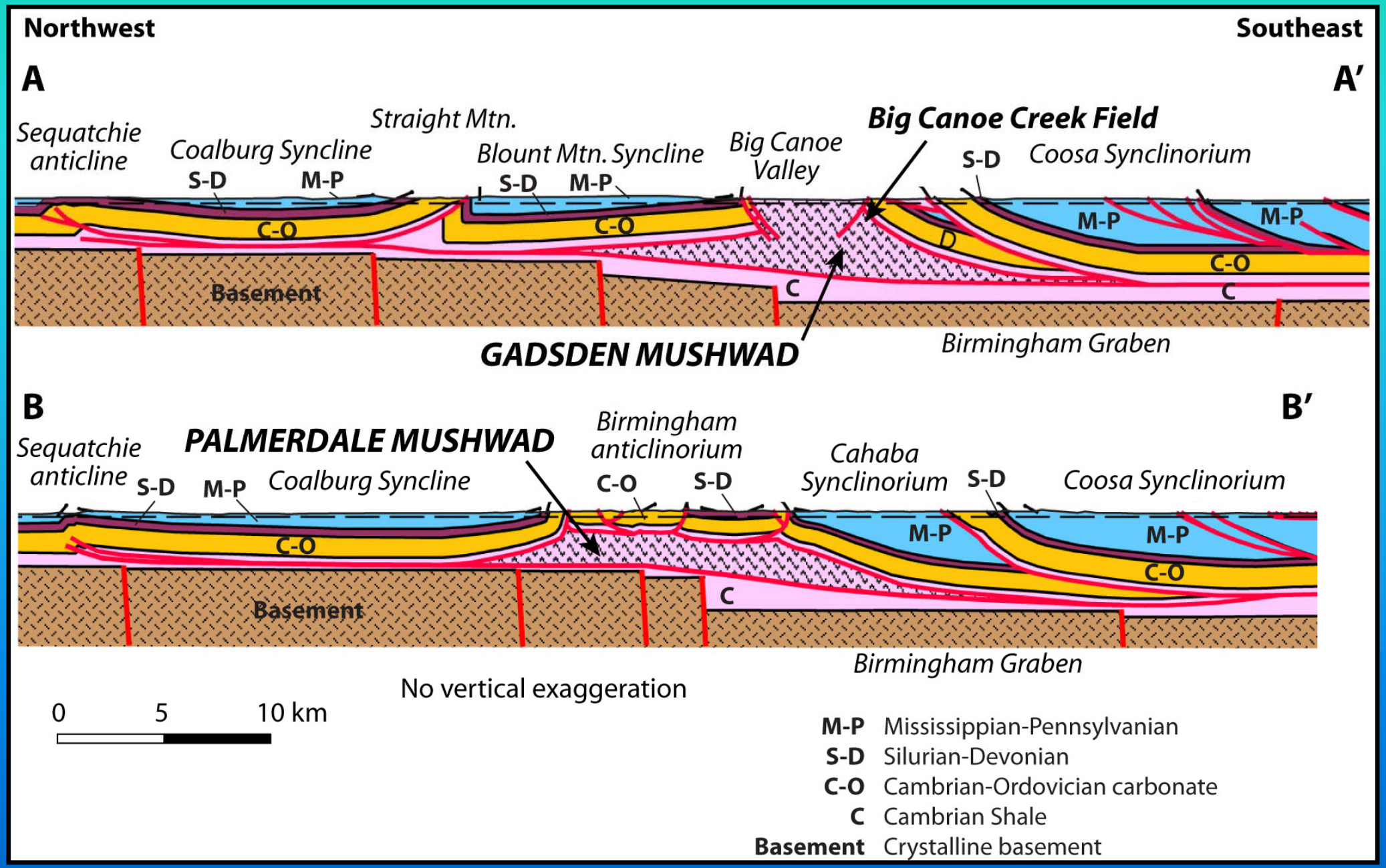
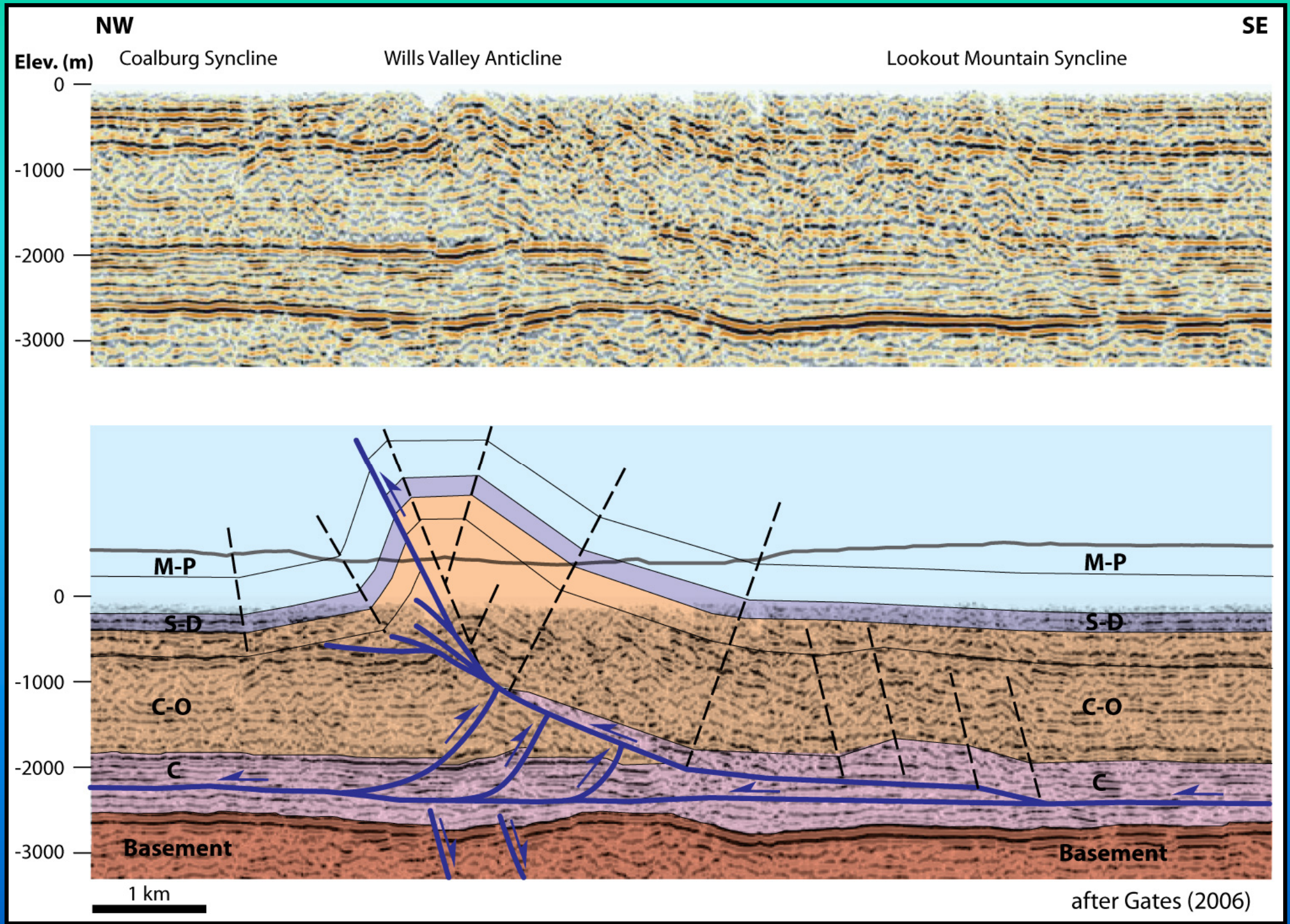
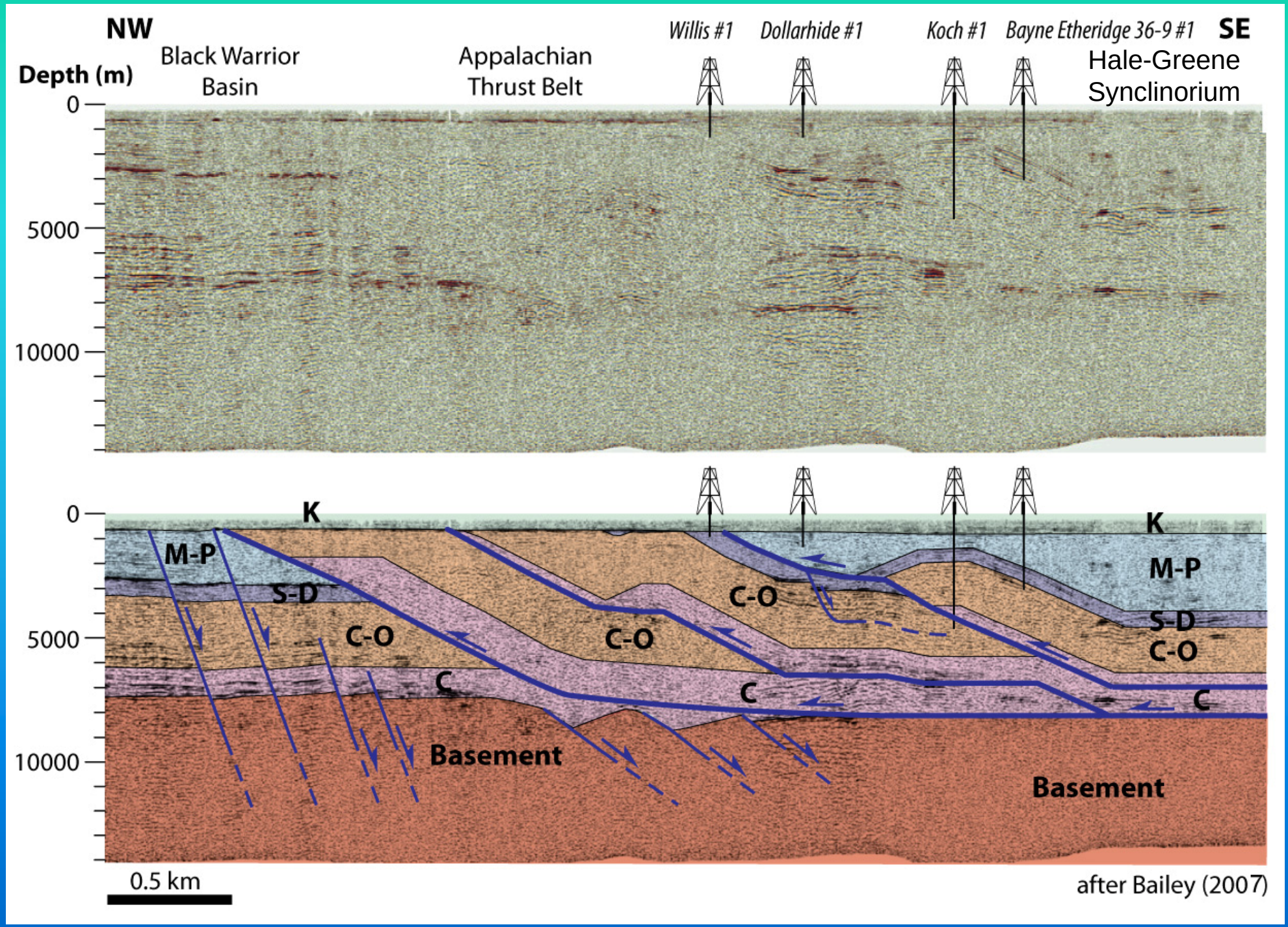
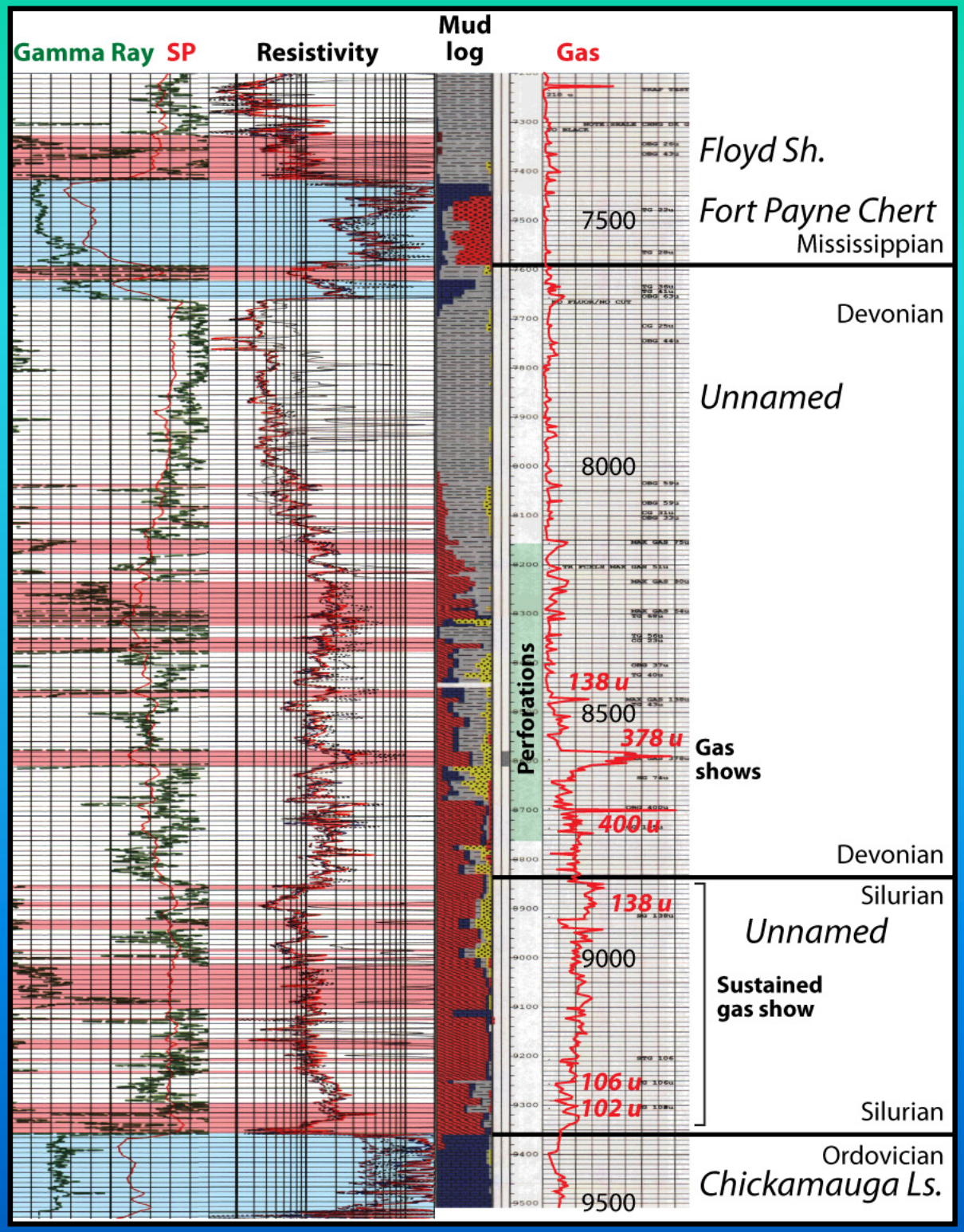


Thomas and Bayona (2005)


NW
SE
Elev. (m)
Coalburg Syncline
Wills Valley Anticline
Lookout Mountain Syncline
0
-1000
-2000
-3000
M-P
S-D
C-O
C
Basement
1 km
after Gates (2006)


NW
SE
Depth (m)
Black Warrior Basin
Appalachian Thrust Belt
Hale-Greene Synclinorium
Willis #1
Dollarhide #1
Koch #1
Bayne Etheridge 36-9 #1
0
5000
10000
K
M-P
S-D
C-O
C
Basement
0.5 km
after Bailey (2007)



DEVONIAN GAS SHOWS

BAYNE-ETHERIDGE 36-9 #1 WELL

GREENE COUNTY, AL

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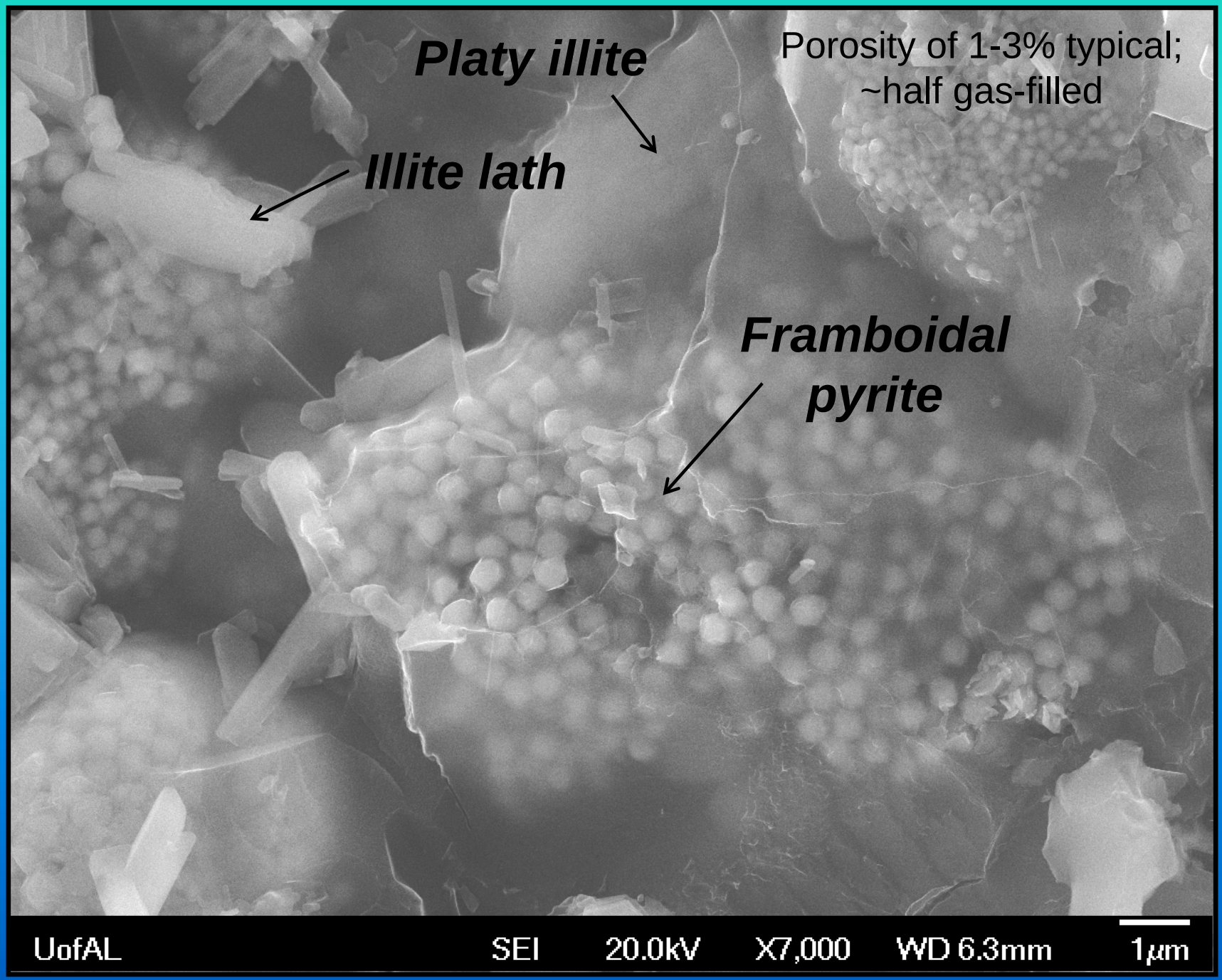
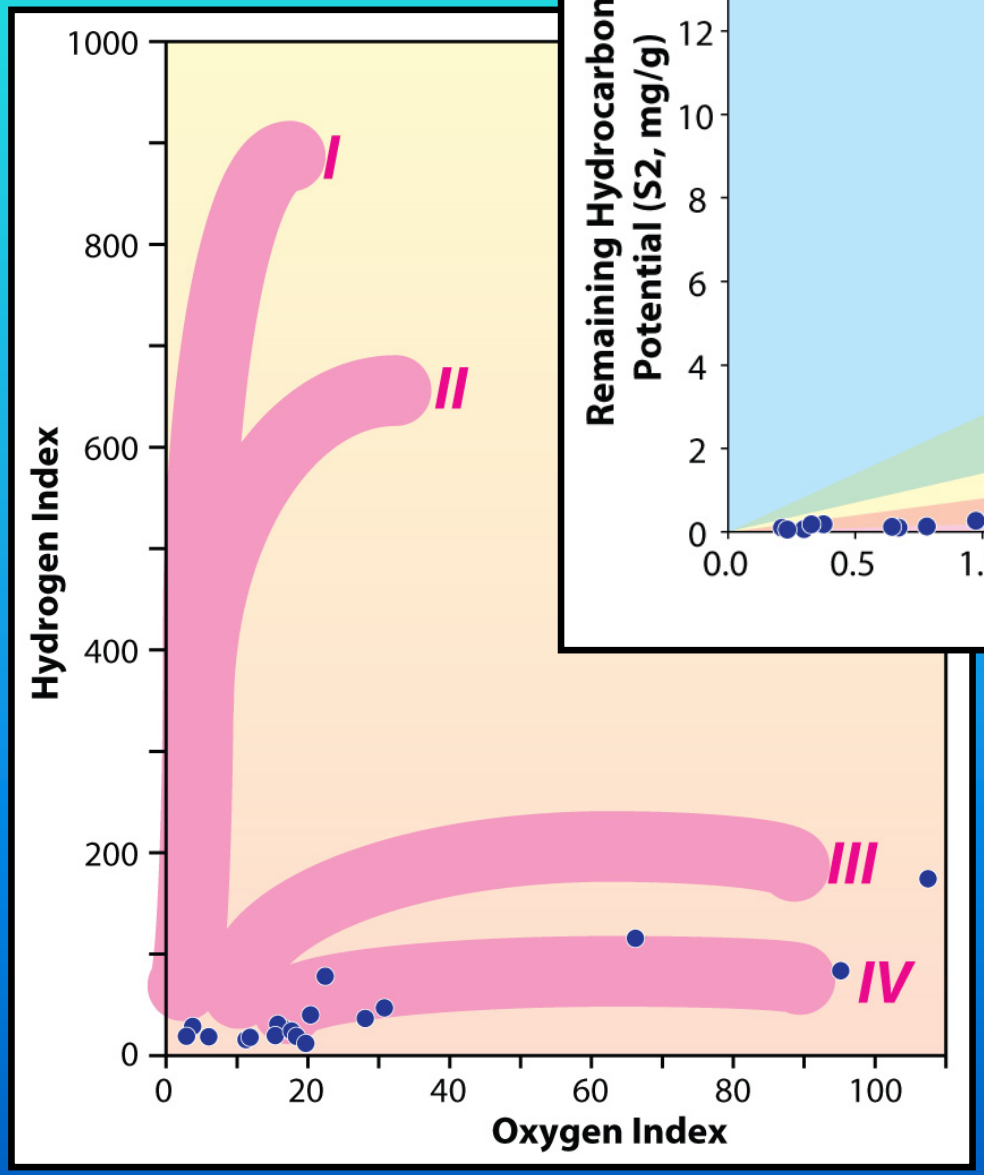
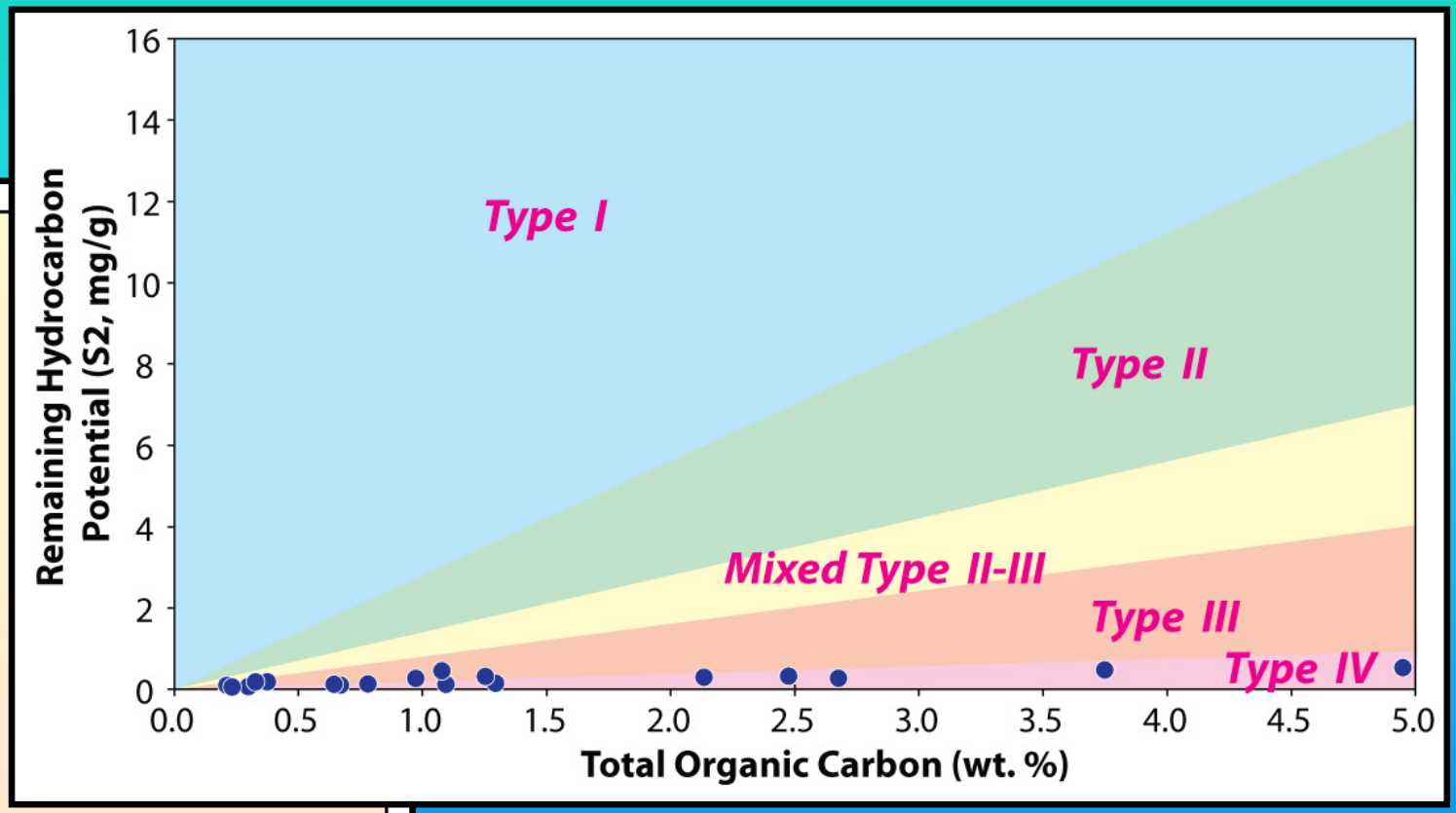
PETROLOGY, DEVONIAN SHALE



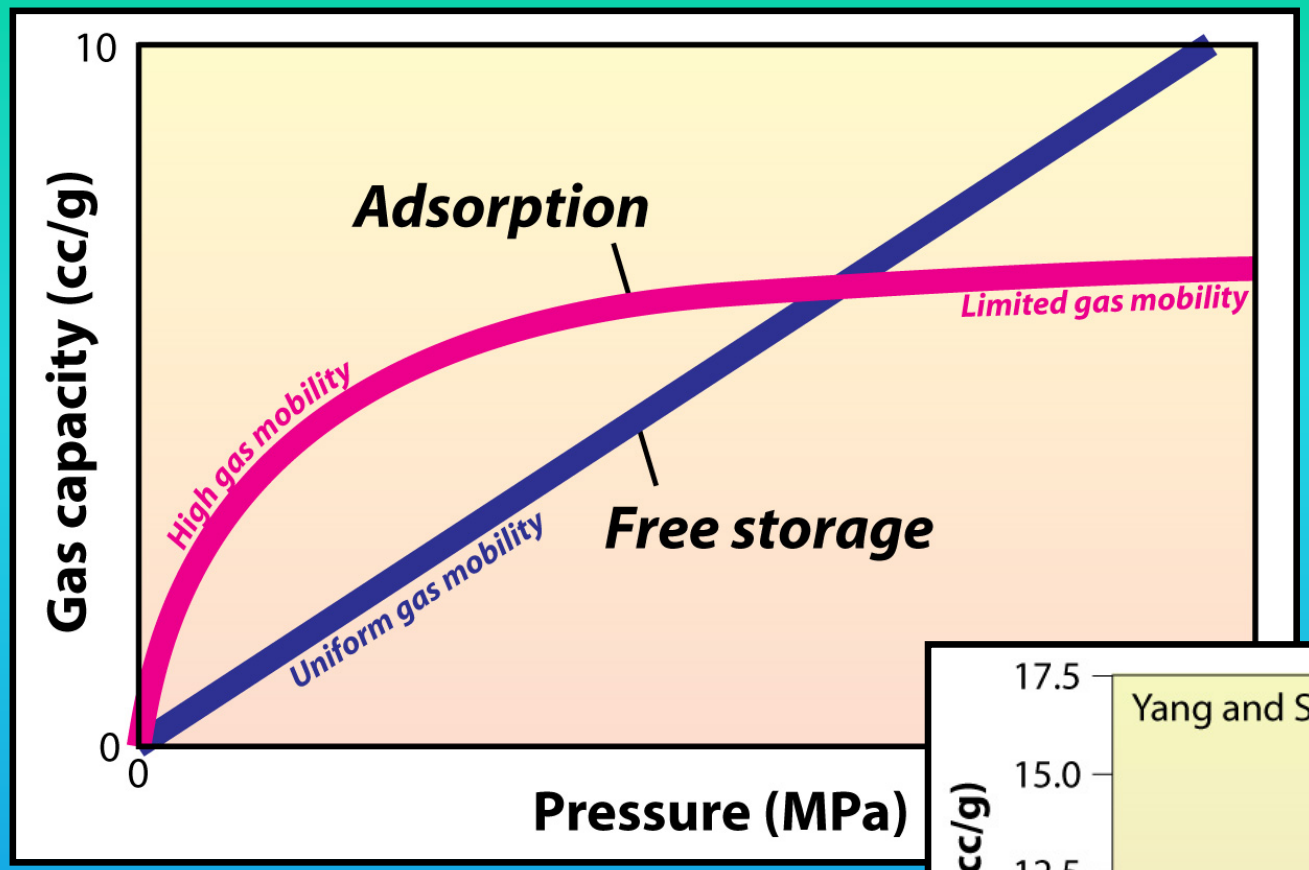
KEROGEN ANALYSIS



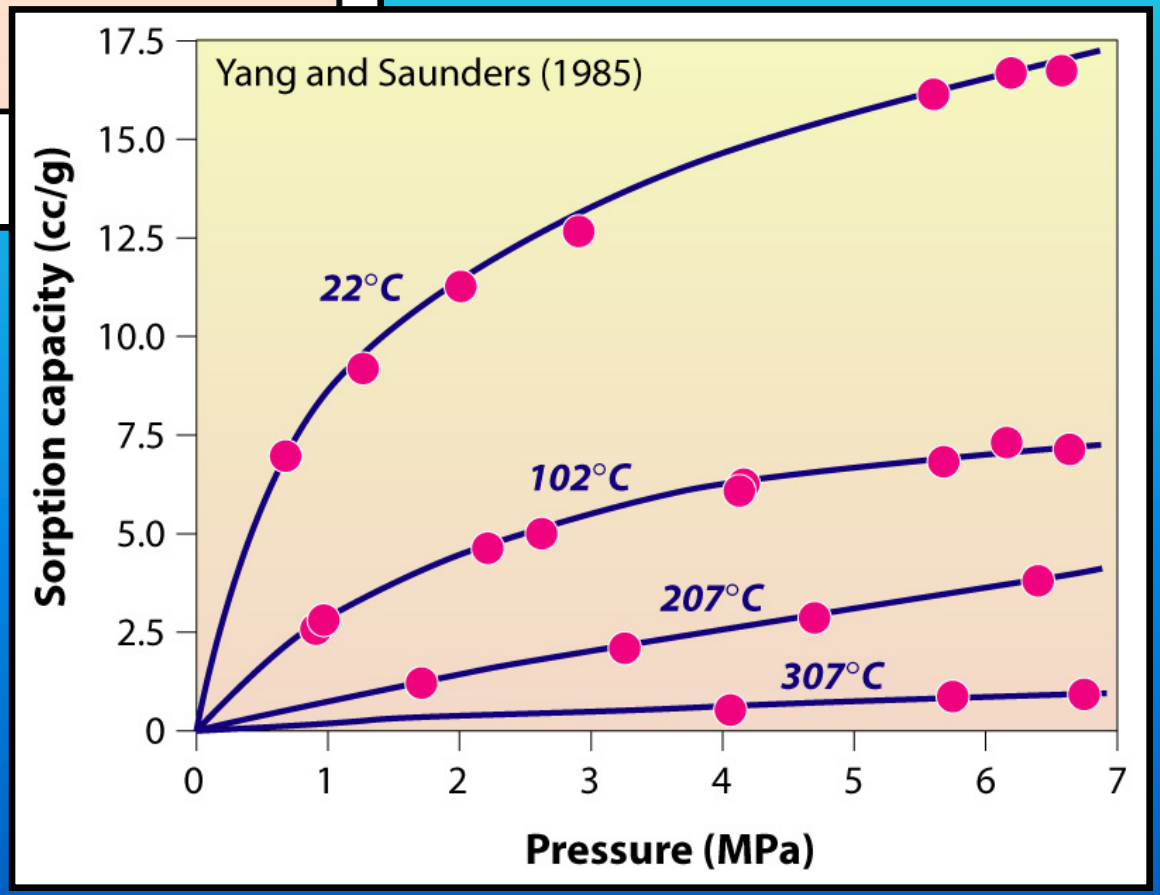


Greene-Hale synclinorium

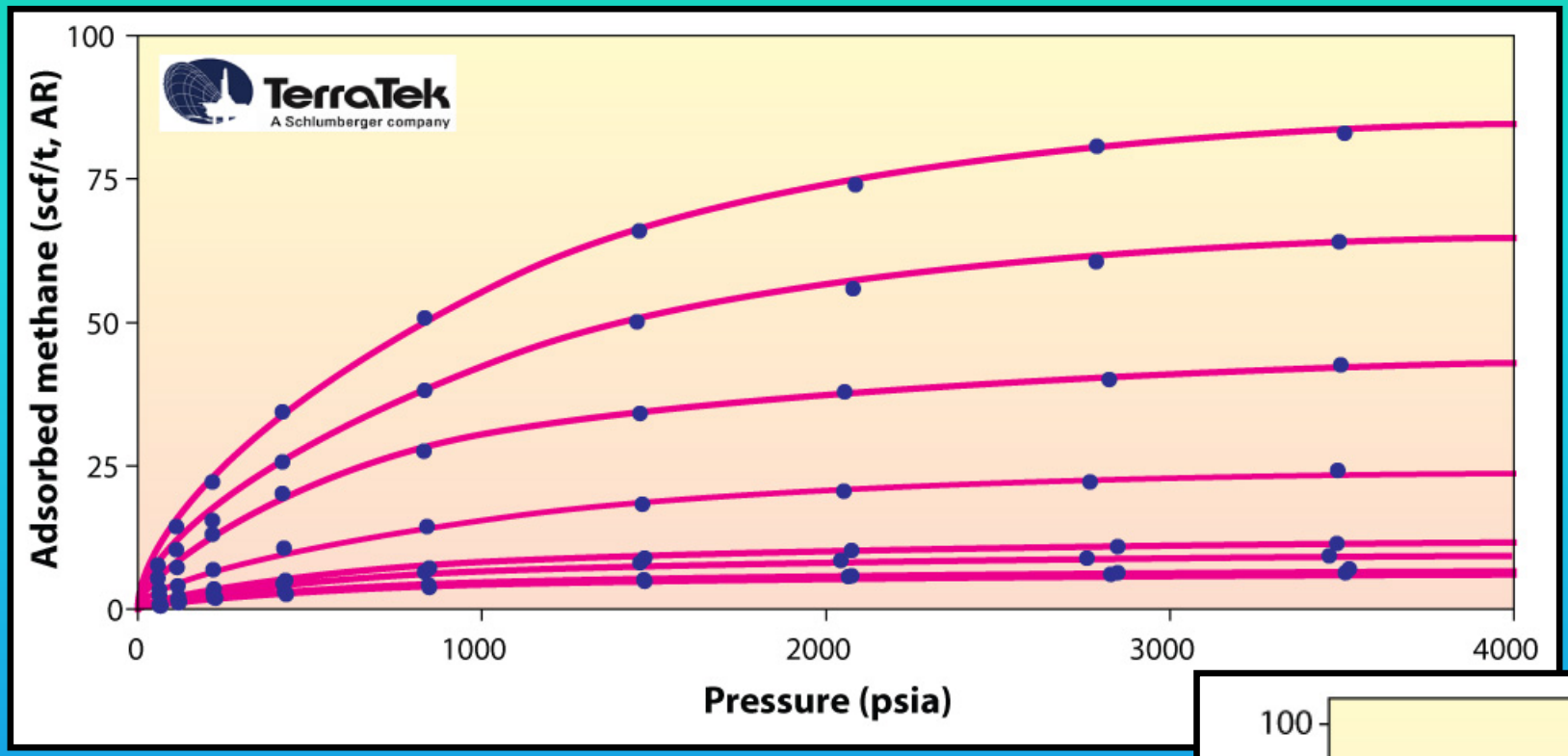
GAS STORAGE



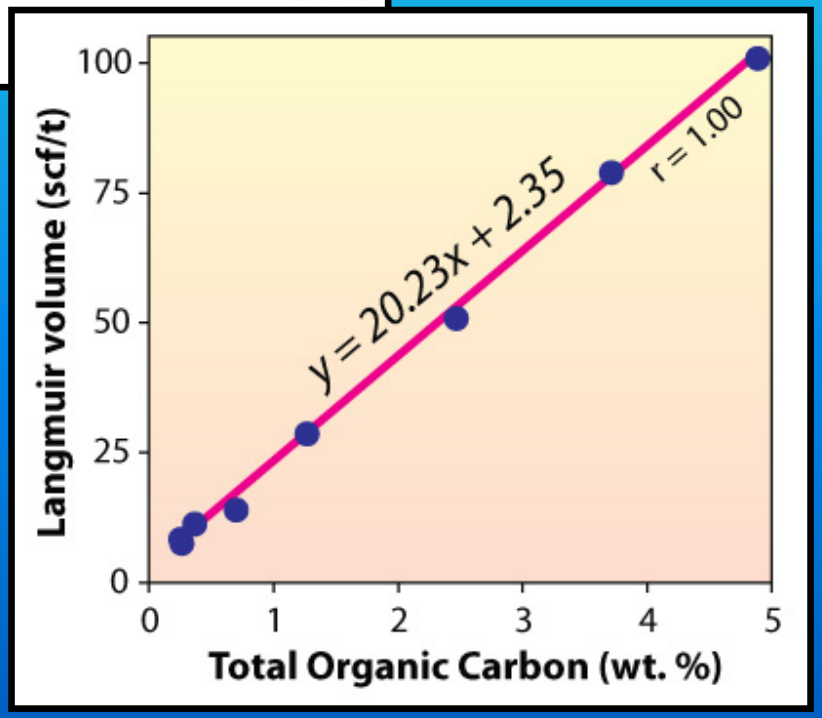
CH_4 SORPTION AND TEMPERATURE



ADSORPTION ISOTHERMS



Devonian shale
Bayne Etheridge 36-9 #1



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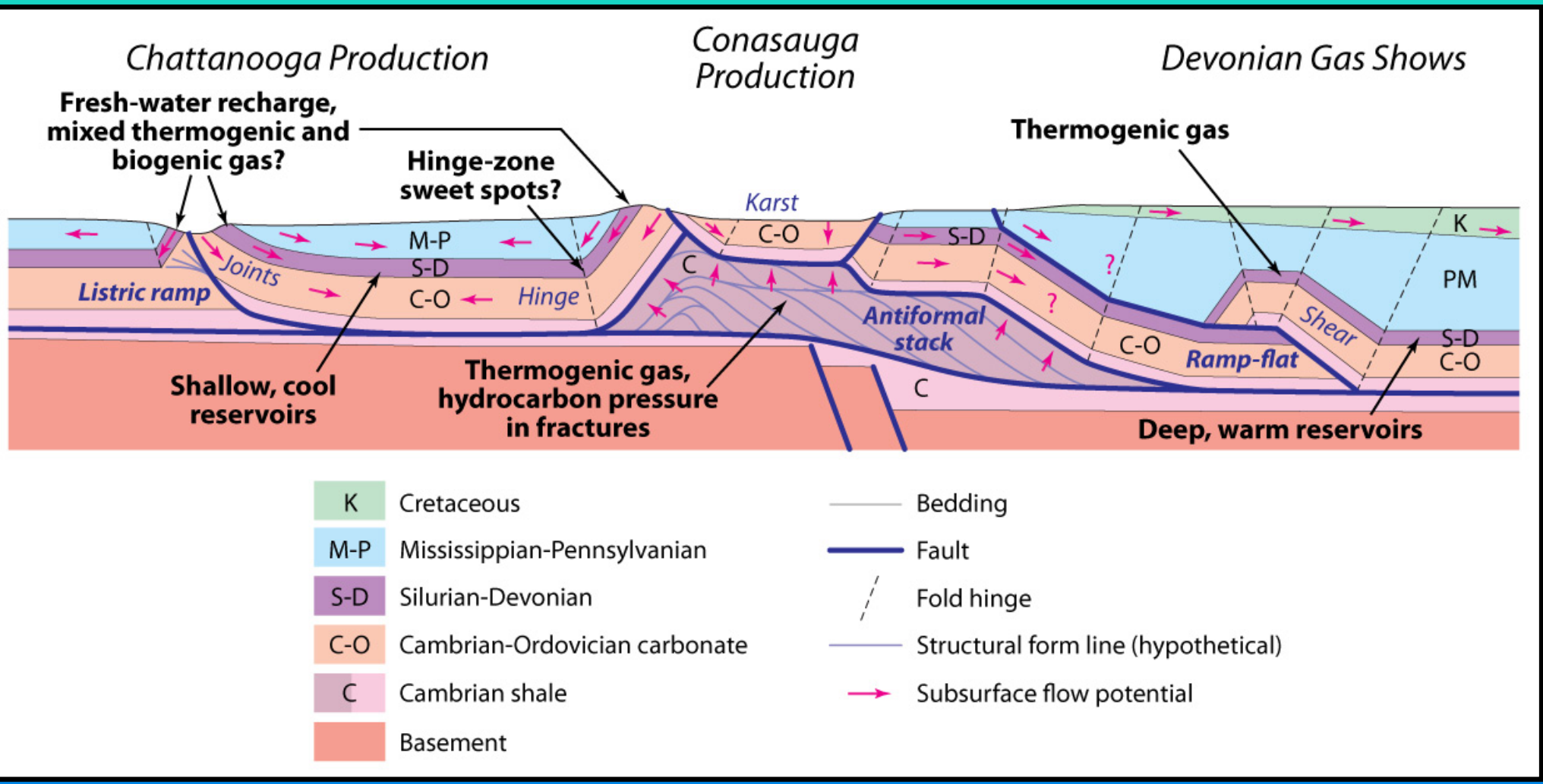
HYDRODYNAMICS, GEOTHERMICS



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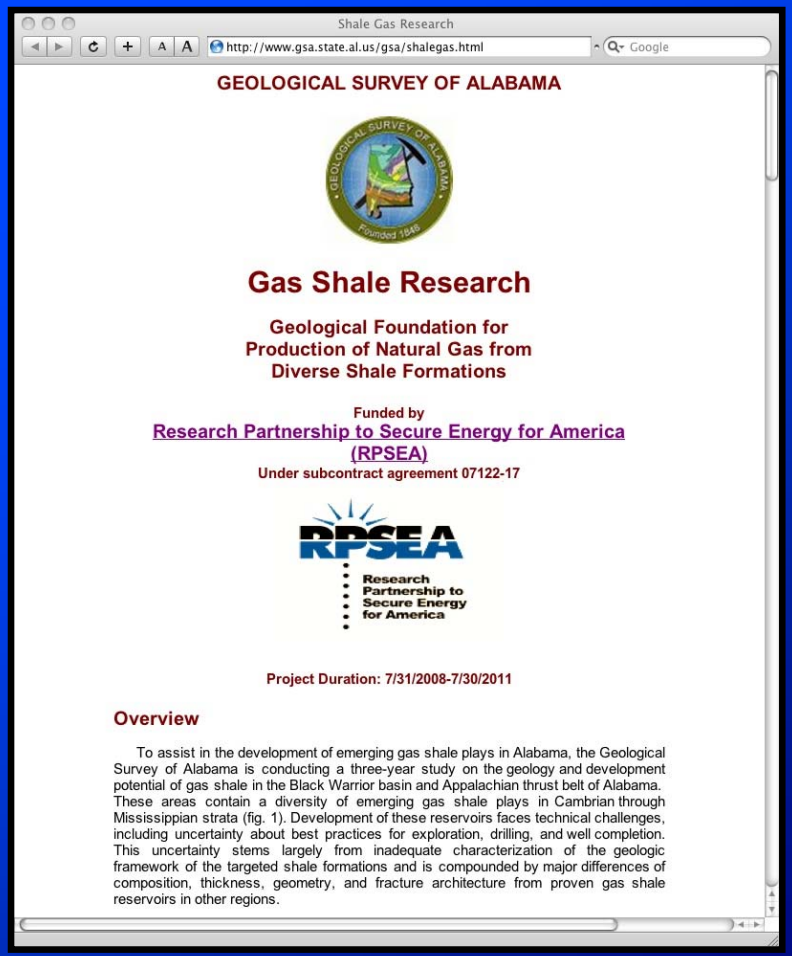
WORK CONTINUES

- Stratigraphy, sedimentation and structure
- Basin hydrodynamics and geothermics
- Petrology and gas storage
- Resources and reserves
- Technology Transfer



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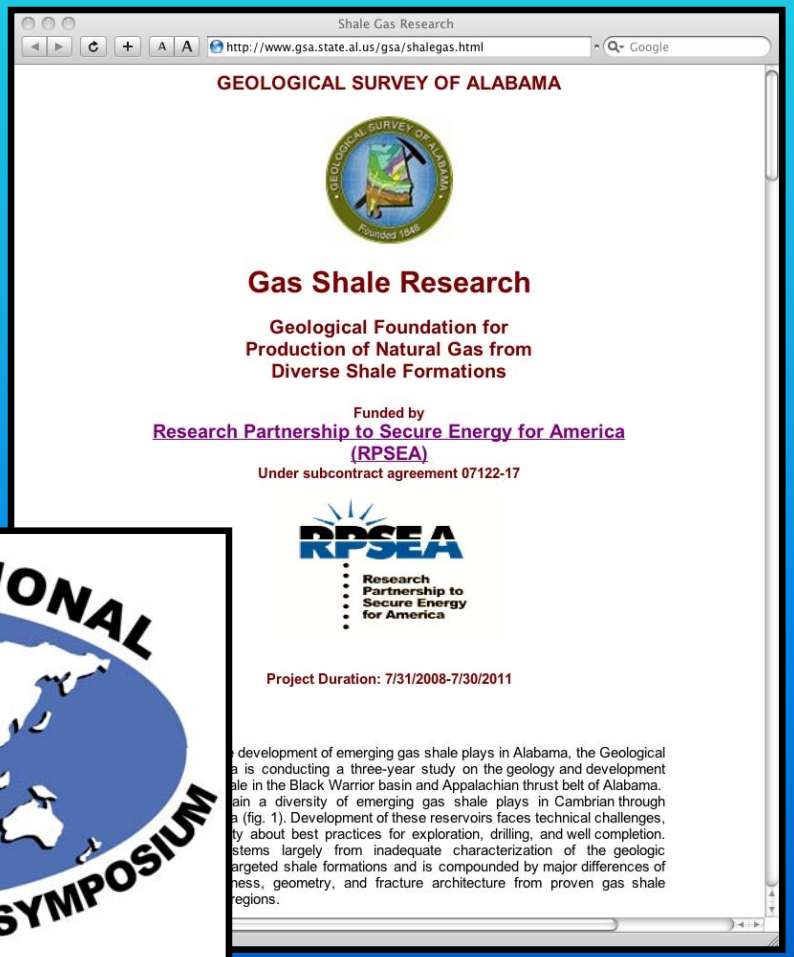

AAPG 2010 Field Trip

1926 SEPM Society for Sedimentary Geology

AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS — EMD — 1977 — ENERGY MINERALS DIVISION

2010 INTERNATIONAL COALBED & SHALE GAS SYMPOSIUM