

New Interpretations for the Deposition of Mississippian Limestones in the Mid-Continent: A Reflection of Sequence Stratigraphy and Associated Migration of Facies Belts*

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Abstract

Detailed outcrop analysis of Mississippian-age strata in southwestern Missouri was completed in an effort to clarify the depositional environment and associated complex facies mosaics. This study includes analyses of facies vertically and horizontally to identify geometries and vertical stacking patterns on what is interpreted as the third-, fourth-, and fifth-order scales. A hierarchy of sequence stratigraphic packages are discernible in the Lower to Middle Mississippian in the Tri-State region and have been identified by a combination of exposure horizons and vertical stacking patterns. A model derived from a sequence stratigraphic approach includes modified paleo-depositional maps that better illustrate the complex facies mosaics associated with Milankovitch-scale sea level change. The construction of a high resolution sequence stratigraphic architecture at the Jane outcrop near Jane, MO provides a datum for a more accurate interpretation of how Mississippian lithofacies fit into the sequence stratigraphic framework. This outcrop-based data was applied to the regional depositional model of Mississippian-age strata in the Mid-Continent to produce accurate paleo-depositional maps, leading to a better understanding of overall shifts in depositional facies. Determining how Mississippian lithofacies fit into the regional sequence stratigraphic framework will increase the accuracy of paleo-depositional maps used for modeling changes in facies mosaics.

References Cited

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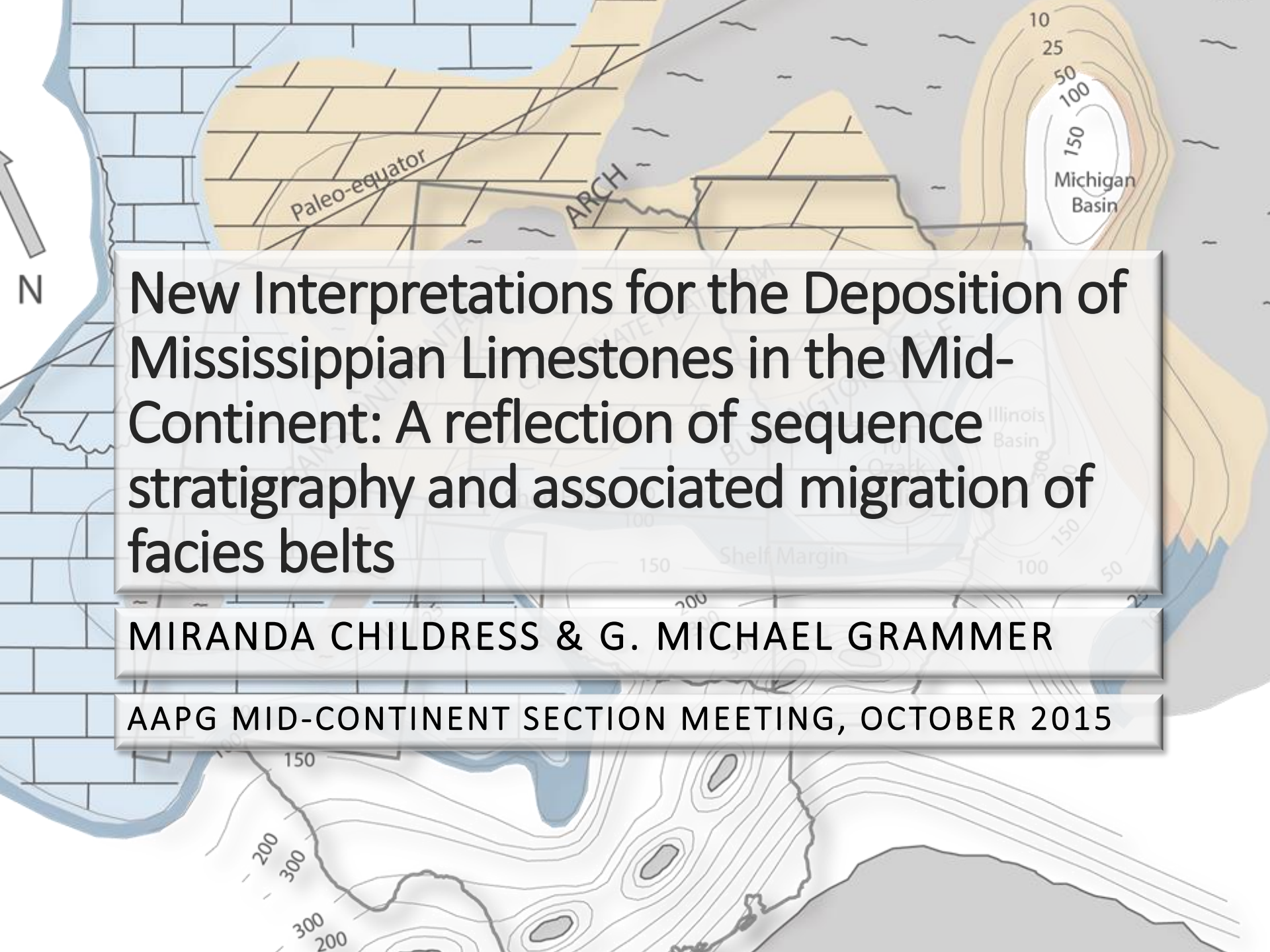
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Mazzullo, S.J., D.R. Boardman, B.W. Wilhite, C. Godwin, and B.T. Morris, 2013, Revisions of Outcrop Lithostratigraphic Nomenclature in the Lower to Middle Mississippian Subsystem (Kinderhookian to Basal Meramecian Series) Along the Shelf-Edge in Southwest Missouri, Northwest Arkansas, and Northeast Oklahoma: Shale Shaker, v. 63, p. 414-454.



The background is a geological map of the Mid-Continent region. It features a paleo-equator line, an arch, and various basins including the Michigan Basin, Illinois Basin, and Ozark. Contour lines are labeled with values such as 10, 25, 50, 100, 150, 200, and 300. A north arrow is visible on the left side.

New Interpretations for the Deposition of Mississippian Limestones in the Mid-Continent: A reflection of sequence stratigraphy and associated migration of facies belts

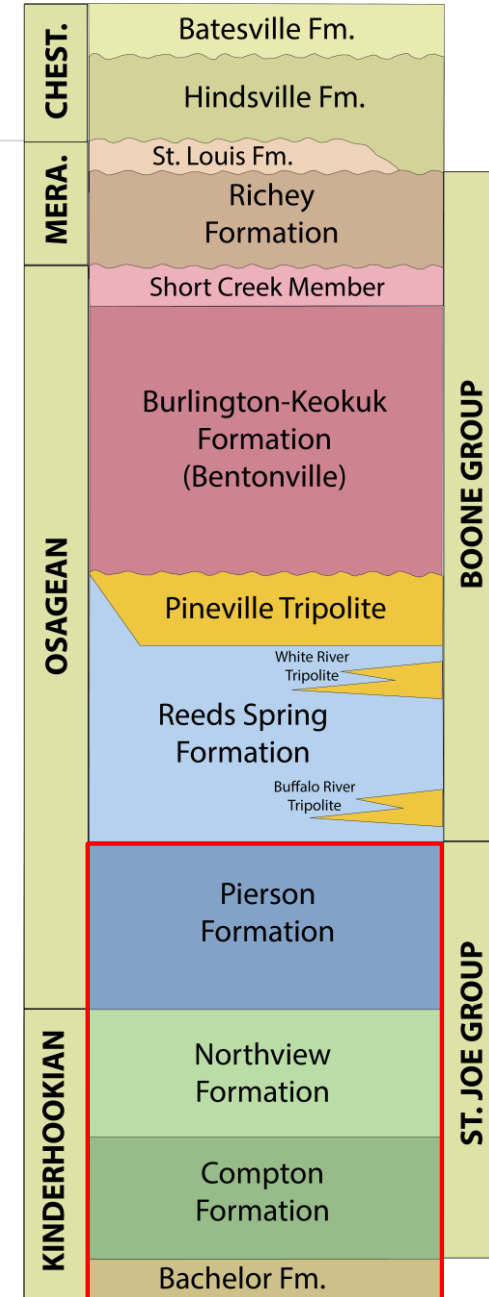
MIRANDA CHILDRESS & G. MICHAEL GRAMMER

AAPG MID-CONTINENT SECTION MEETING, OCTOBER 2015



Outline

- Problems/Questions
- Background
- Stratigraphic Architecture
- Depositional Environment
- Sequence Stratigraphic Architecture
- Modified paleo-depositional maps
- Conceptual Model
- Conclusions



(Modified from Mazzullo et al., 2013)



Problems

1. Significant heterogeneities in facies and reservoir quality exist in the Mid-Continent formations of the Mississippian, resulting in compartmentalized reservoir systems.
2. The Mississippian-age strata in this area has been interpreted by some to be deposited in a shelf margin environment.
3. Complex and dynamic shifts in facies complicate the lithology-based nomenclature used throughout the Mid-Continent.

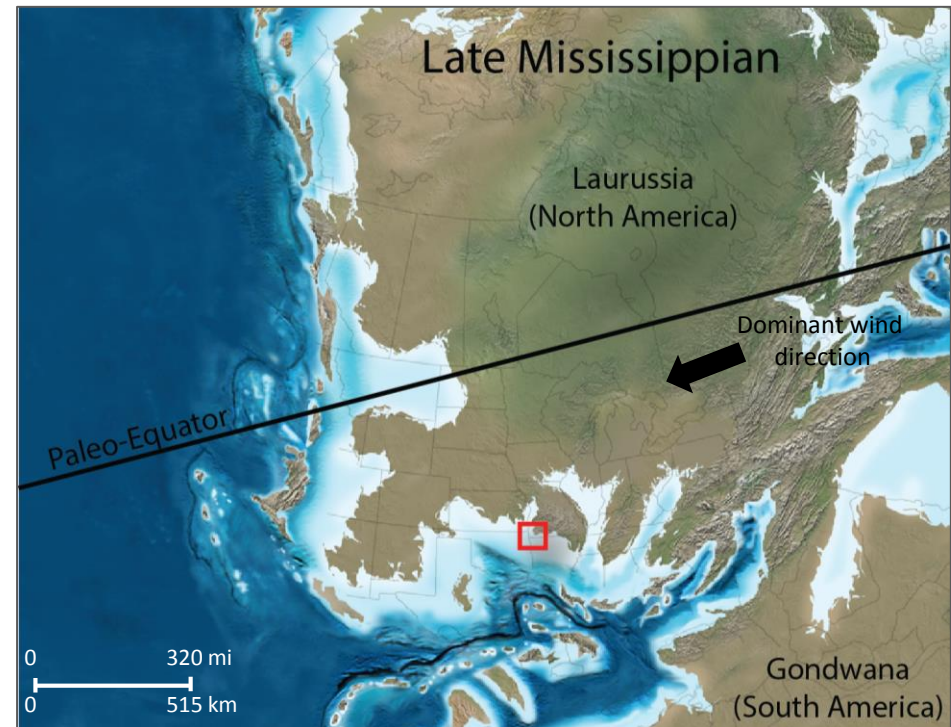
Questions

1. Are HFS and HFC discernible in the Lower to Middle Mississippian in the tri-state region?
2. Can a regional model be developed to capture the dynamic nature of the system?
3. How do sea level variations effect the distribution of facies belts within the system?

Background: Mississippian Paleogeography

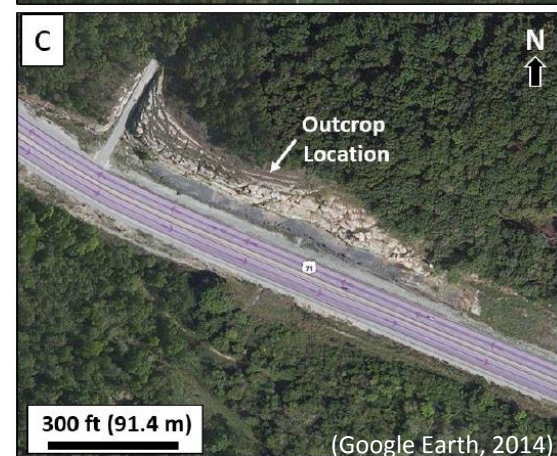
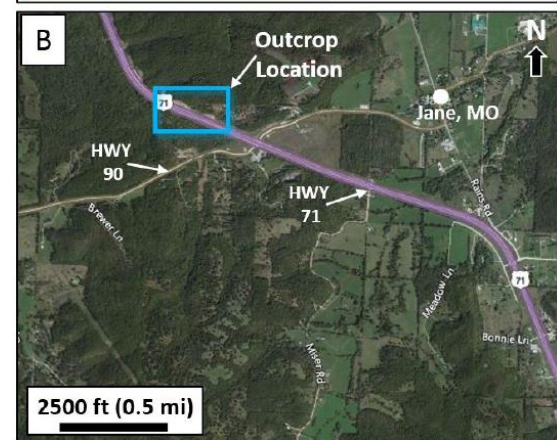
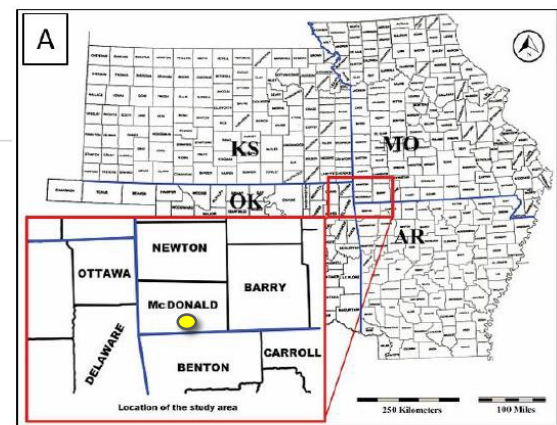


(Blakey, 2013)



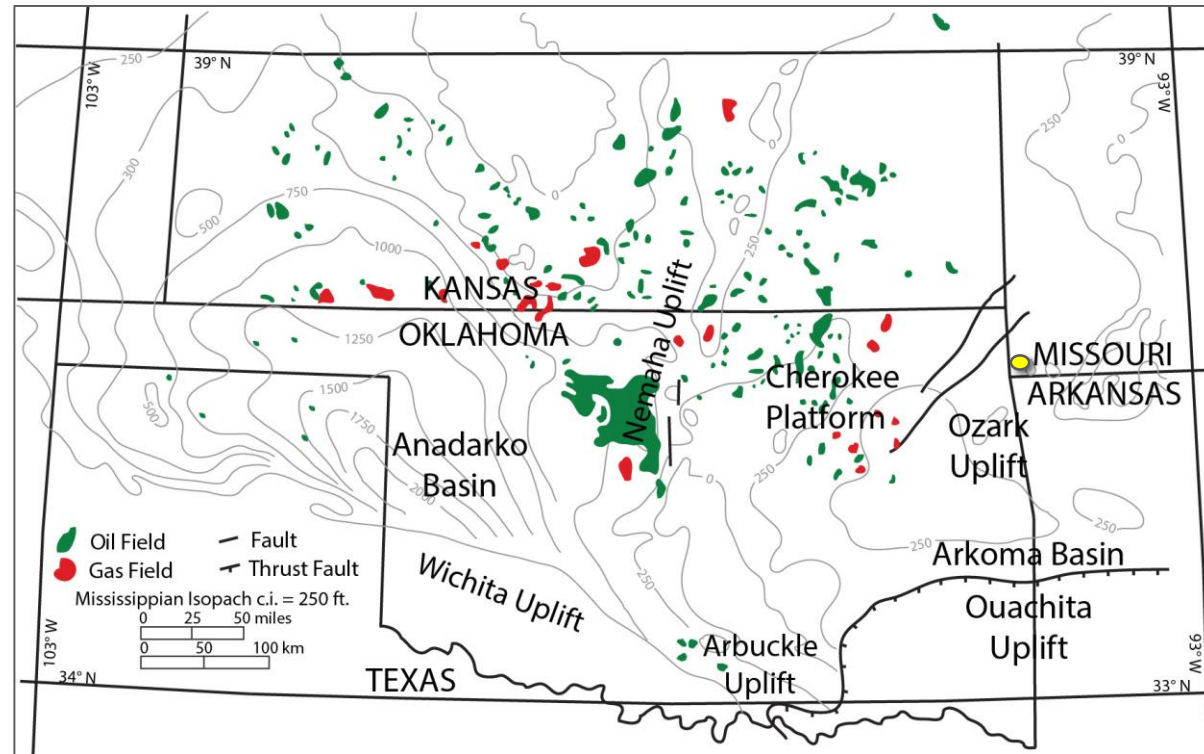
(Blakey, 2013)

Background: Geographical Extent



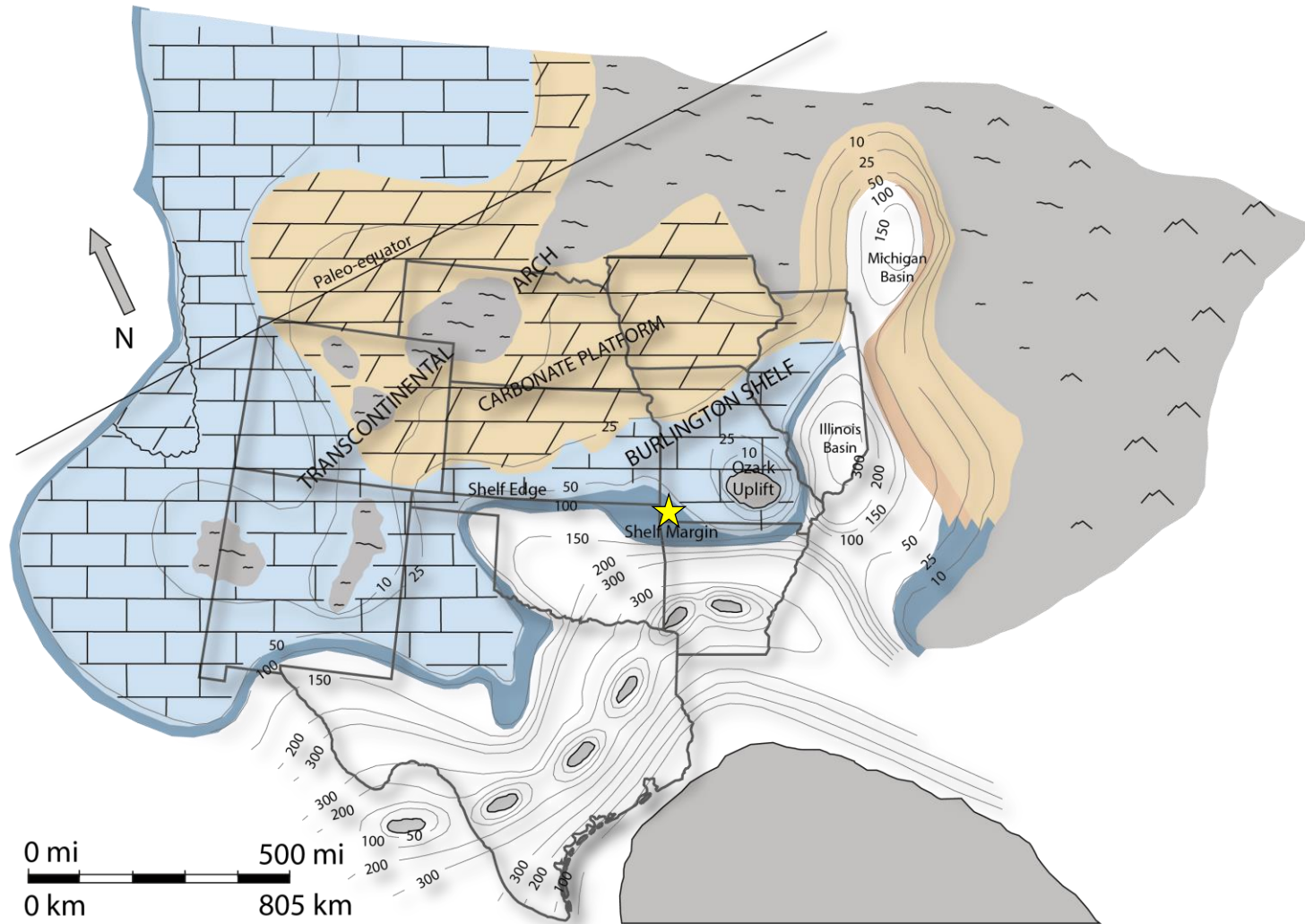
(Google Earth, 2014)

(Modified from Harris, 1987)





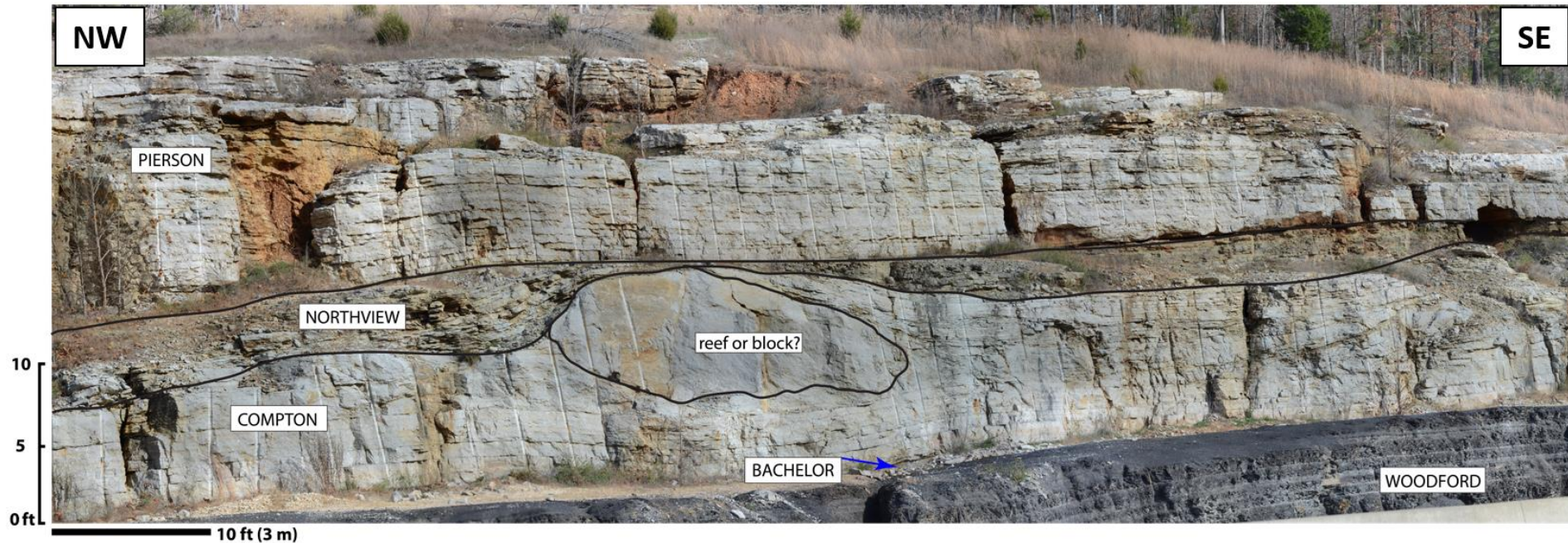
Background: Current Paleo-Depositional Map



(Modified from Gutschick and Sandberg, 1983)



Background: Stratigraphy



Pierson: similar to Compton, increase in grainstones, 15-18 ft (4.5-5.5 m) thick

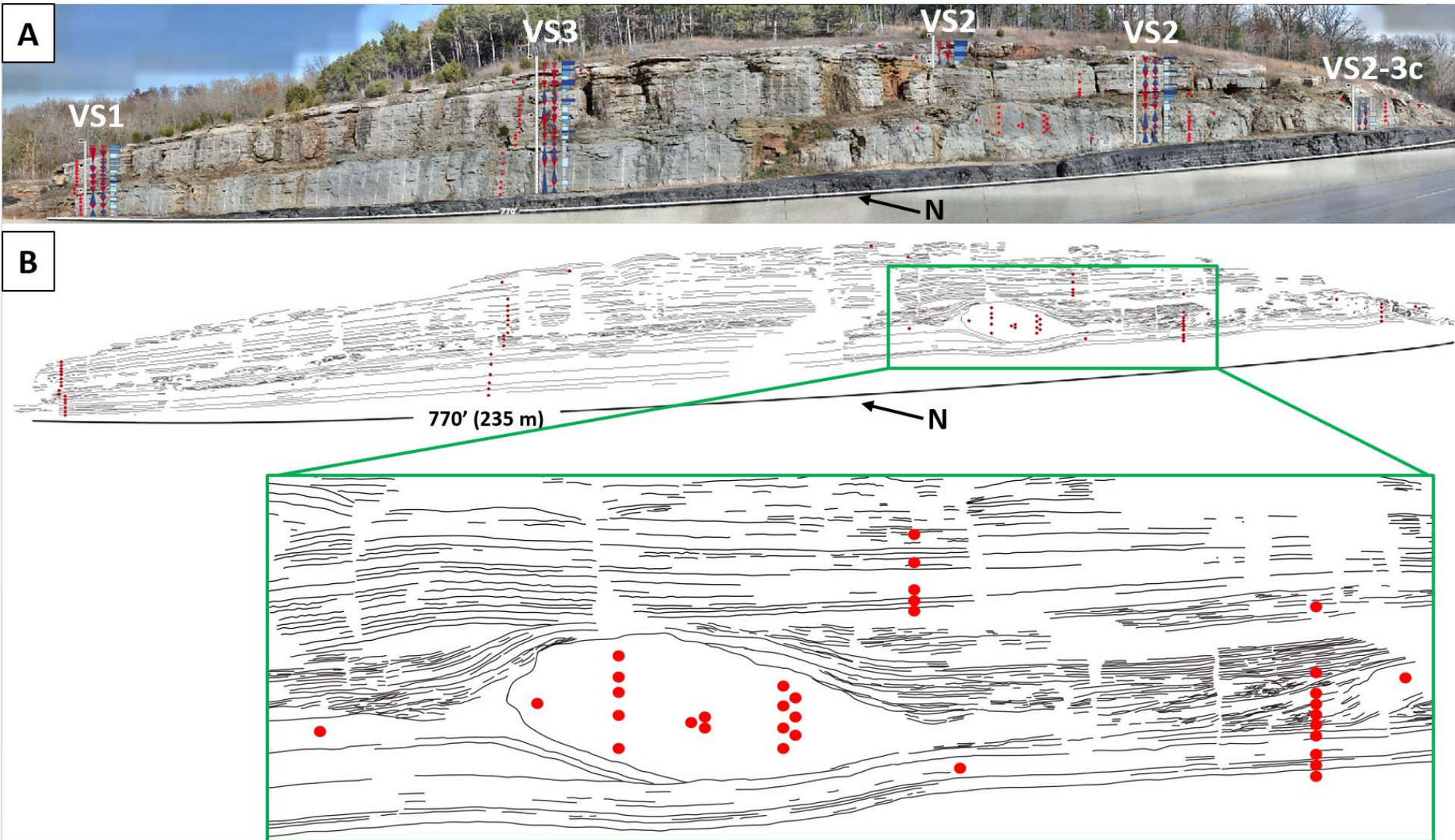
Northview: crinoidal wackestones, packstones, grainstones, 2-5 ft (0.6-1.5 m) thick, contains flaser bedding, ripples, clay drapes, and subaerial exposure surfaces

Compton: light gray crinoidal-bryozoan wackestones and packstones, 10-12 ft (3-3.6 m) thick

Bachelor: gray-green calcareous shale, 1-3 inches (2.5-7.6 cm) thick, often absent



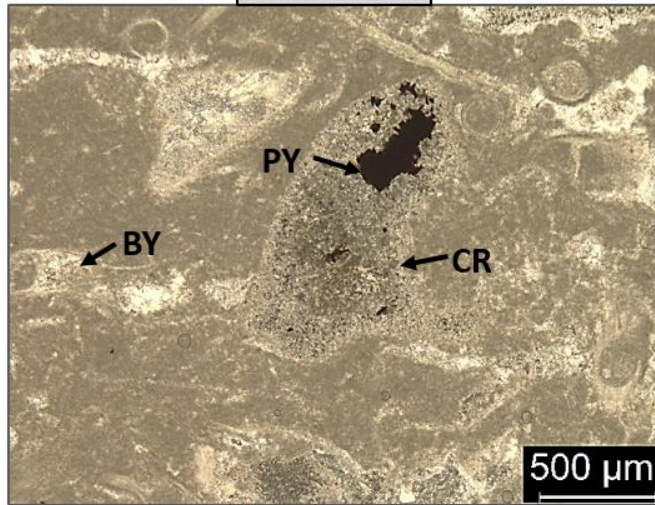
Stratigraphic Architecture



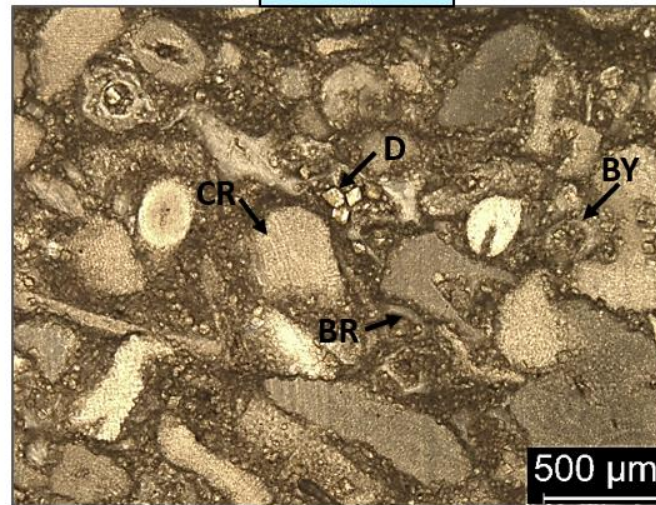


Facies and Idealized Stacking Patterns

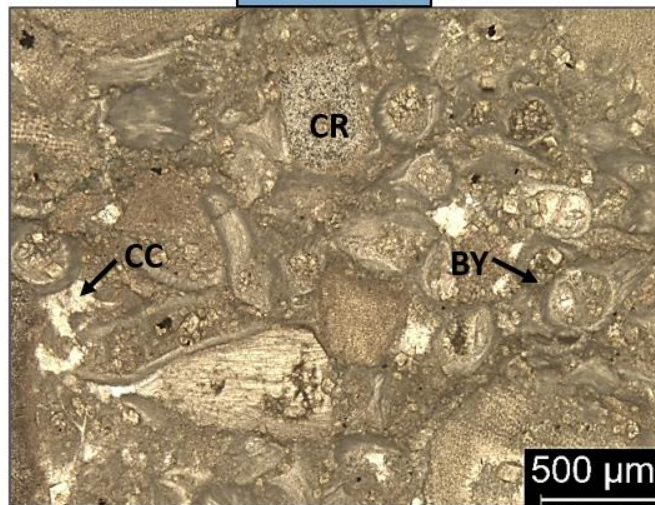
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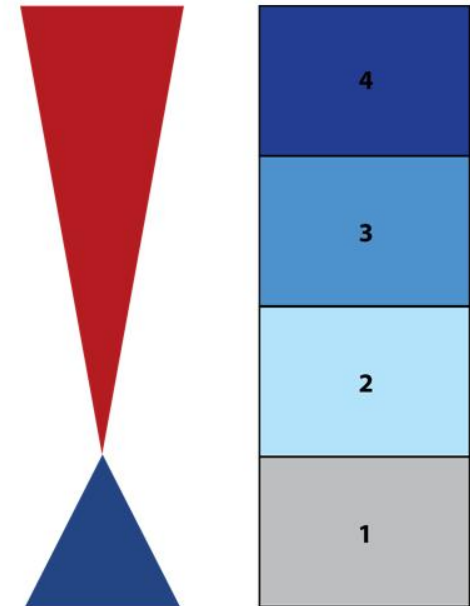
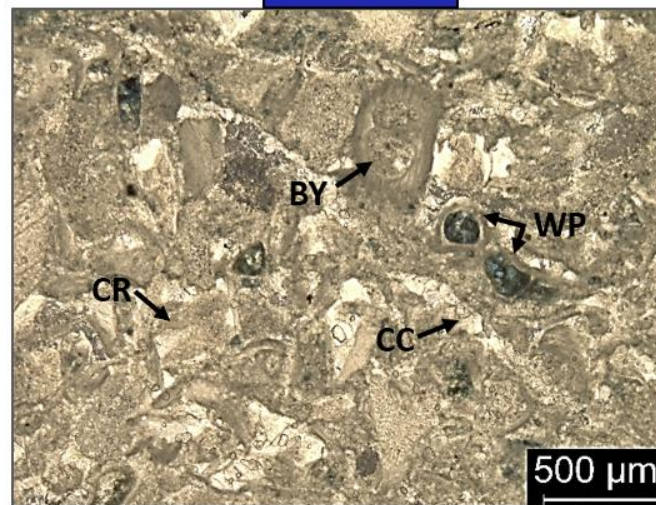
Facies 2



Facies 3

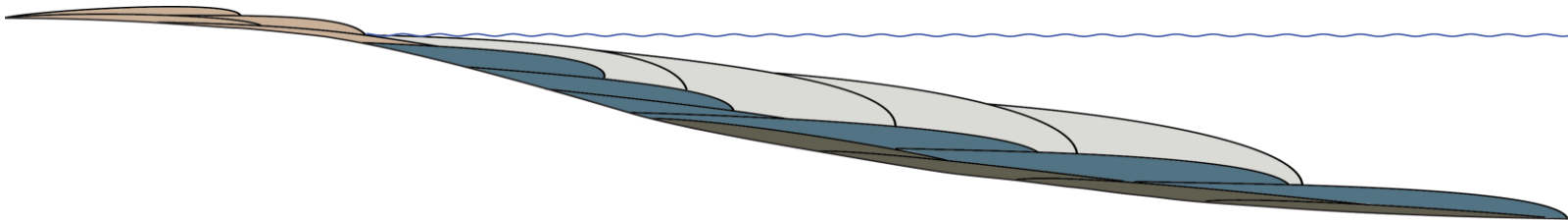
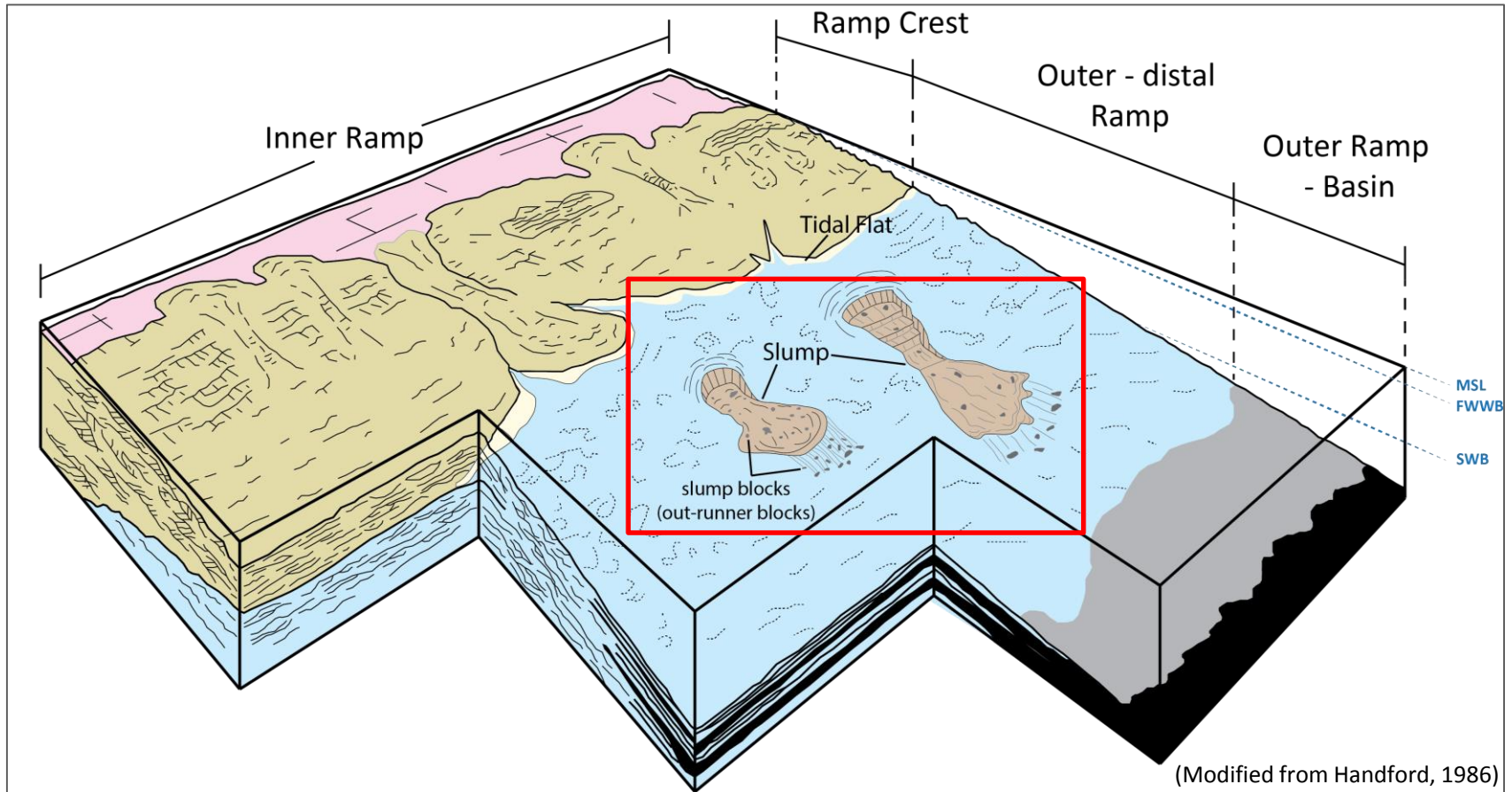


Facies 4



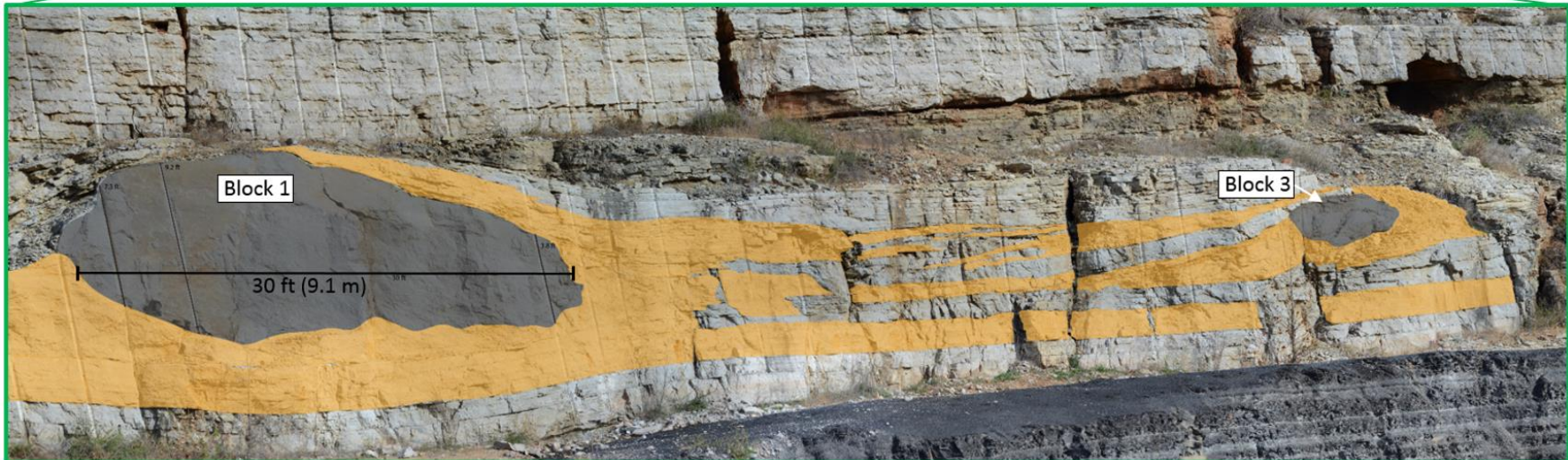
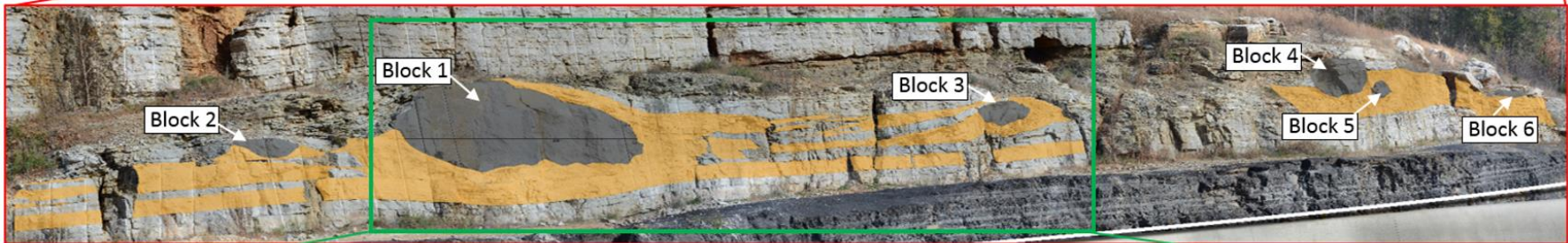
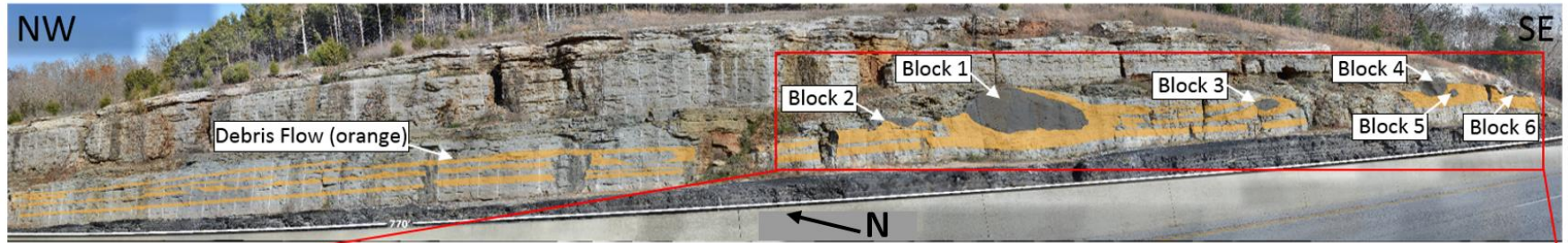


Depositional Environment





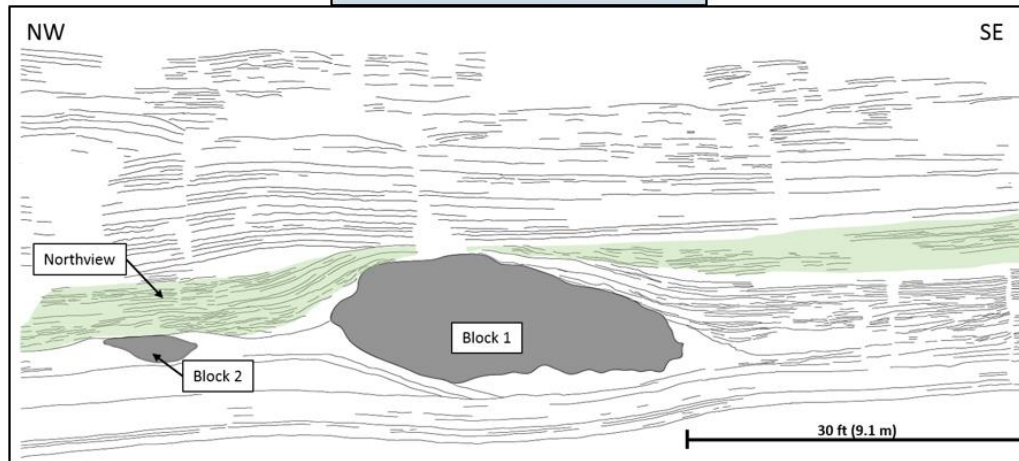
Compton Blocks



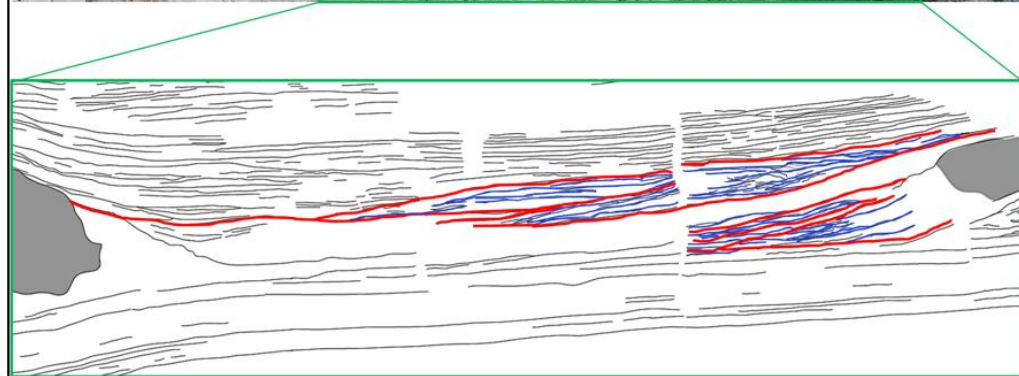


Compton Outrunner Blocks

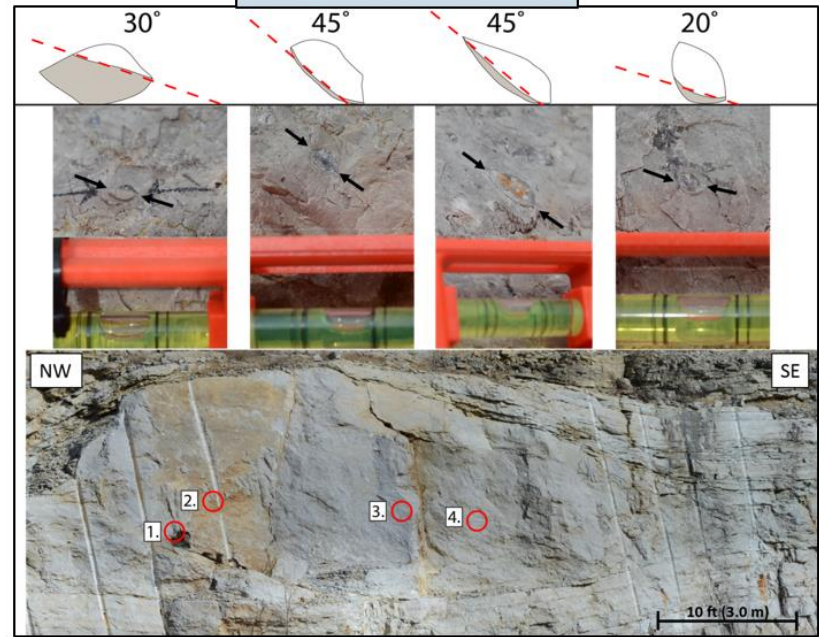
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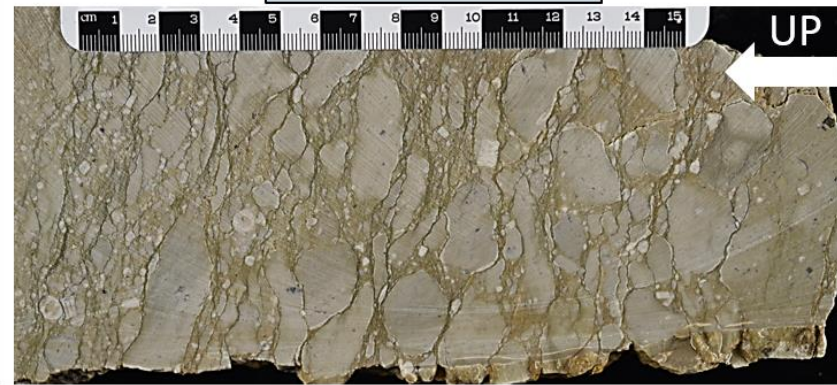
Truncated Beds



Geopetal Structures

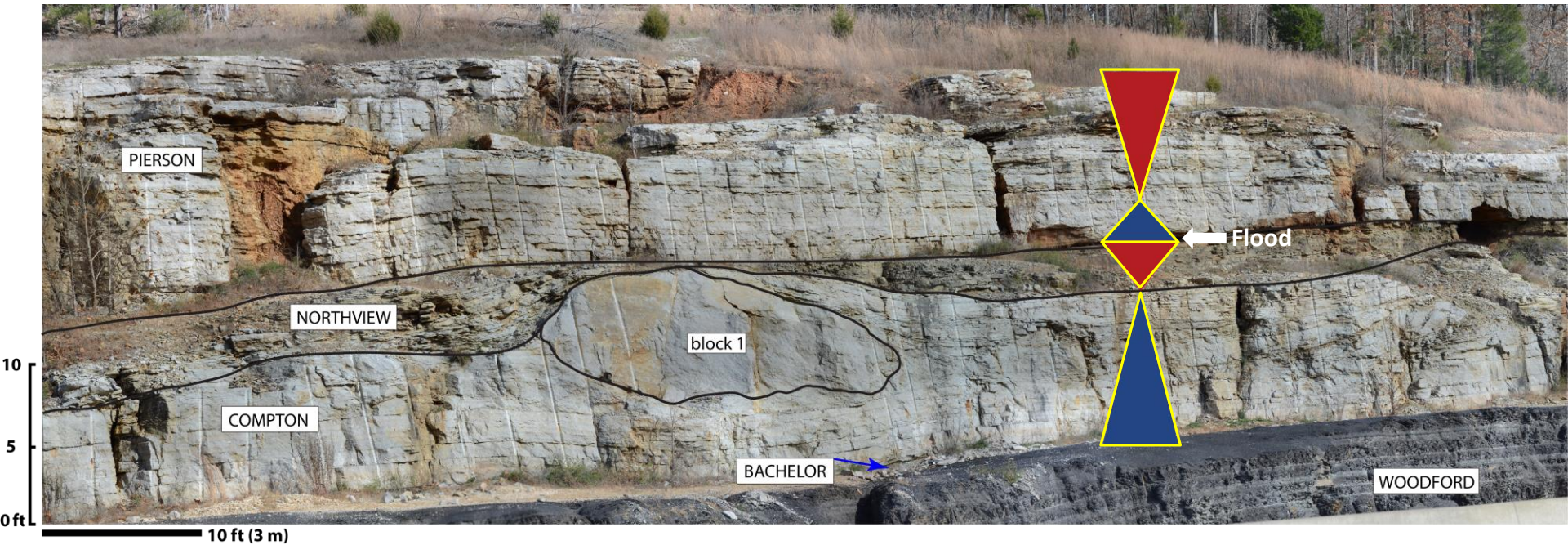


Debris Flow Sample





Sequence Stratigraphy



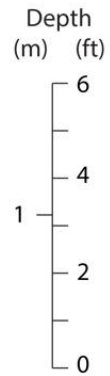
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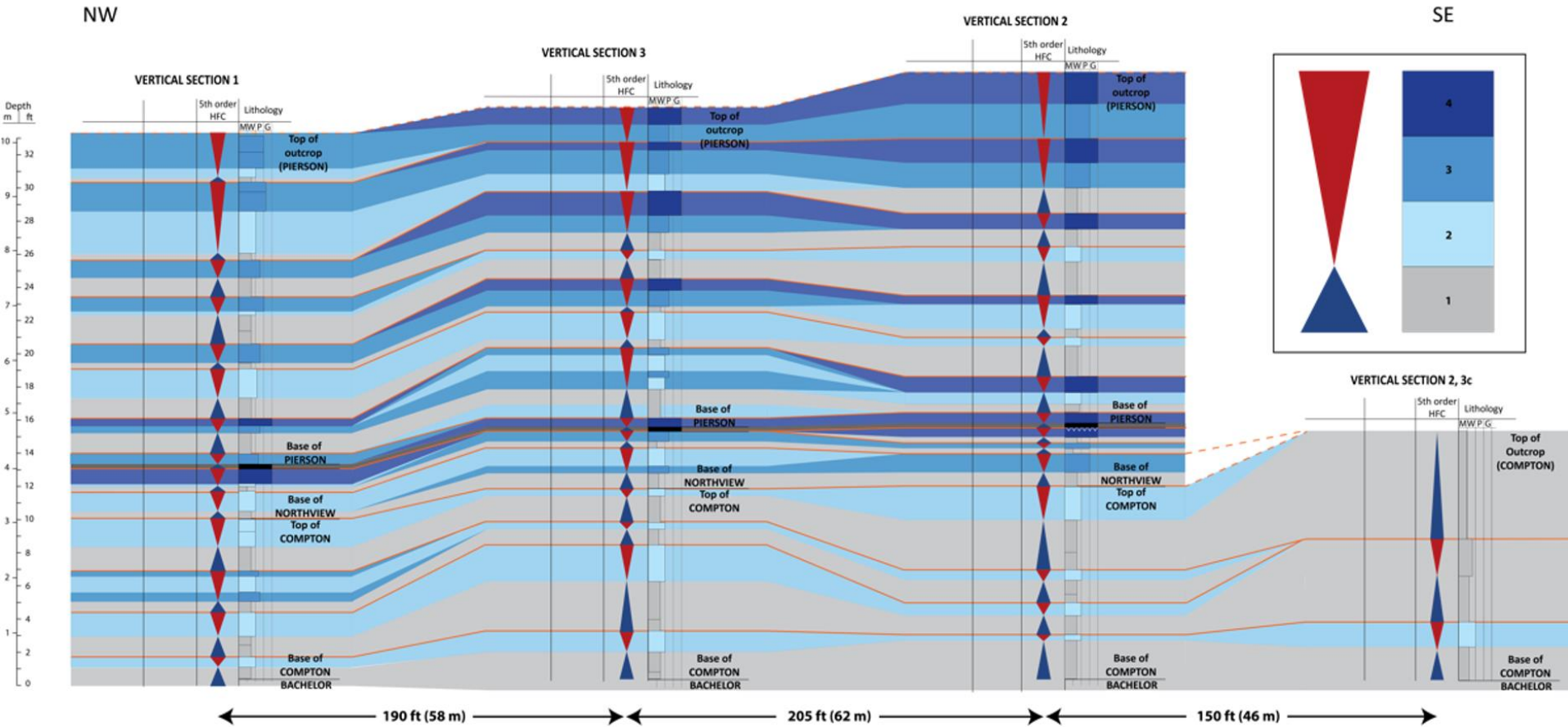
Bachelor: gray-green calcareous shale, 1-3 inches (2.5-7.6 cm) thick, often absent

A cartoon illustration of a character with a large black hat, a white face, and a prominent black mustache. The character has orange eyes and is looking slightly to the side. The style is simple and graphic, with bold black outlines.



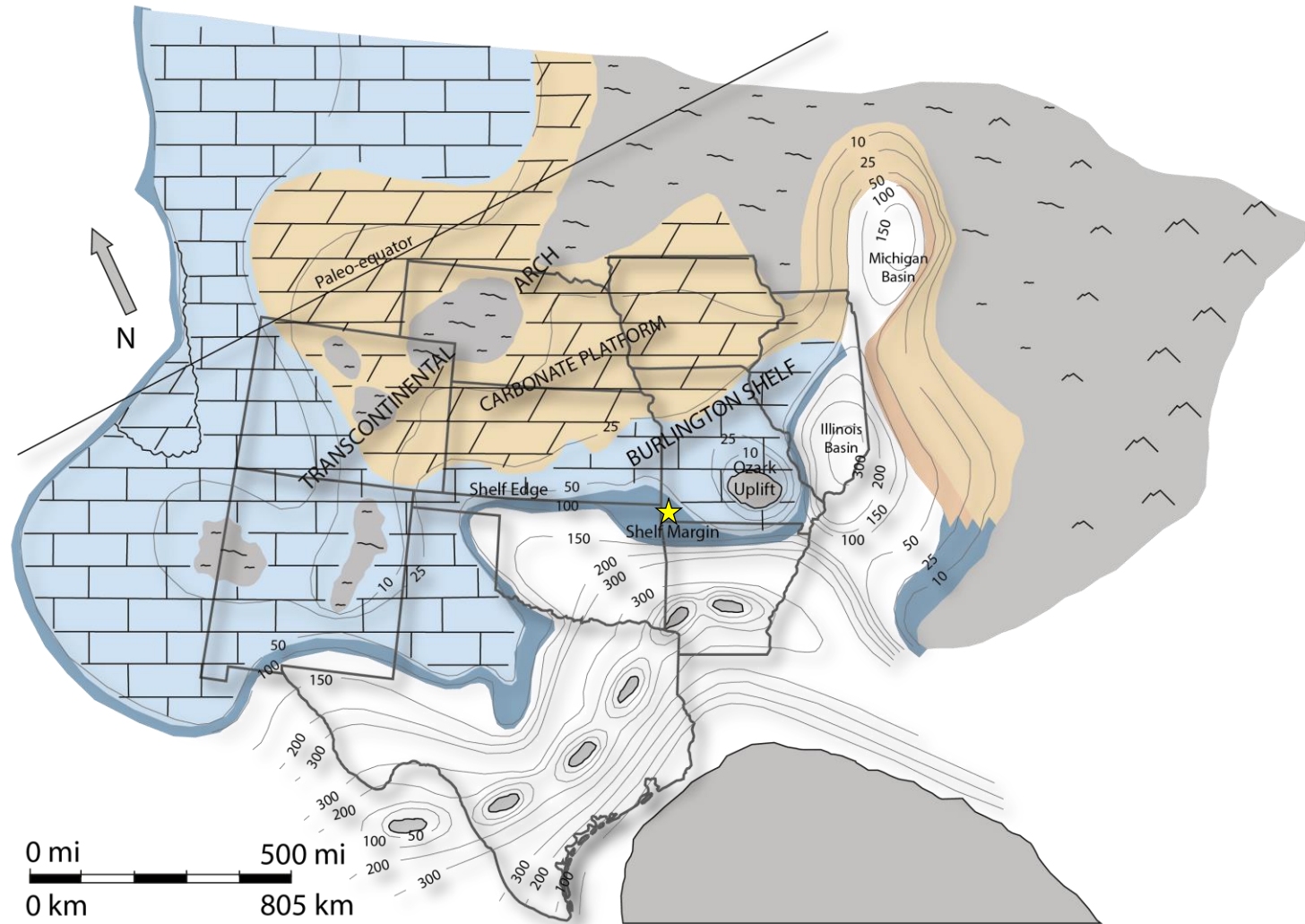


Sequence Stratigraphic Architecture





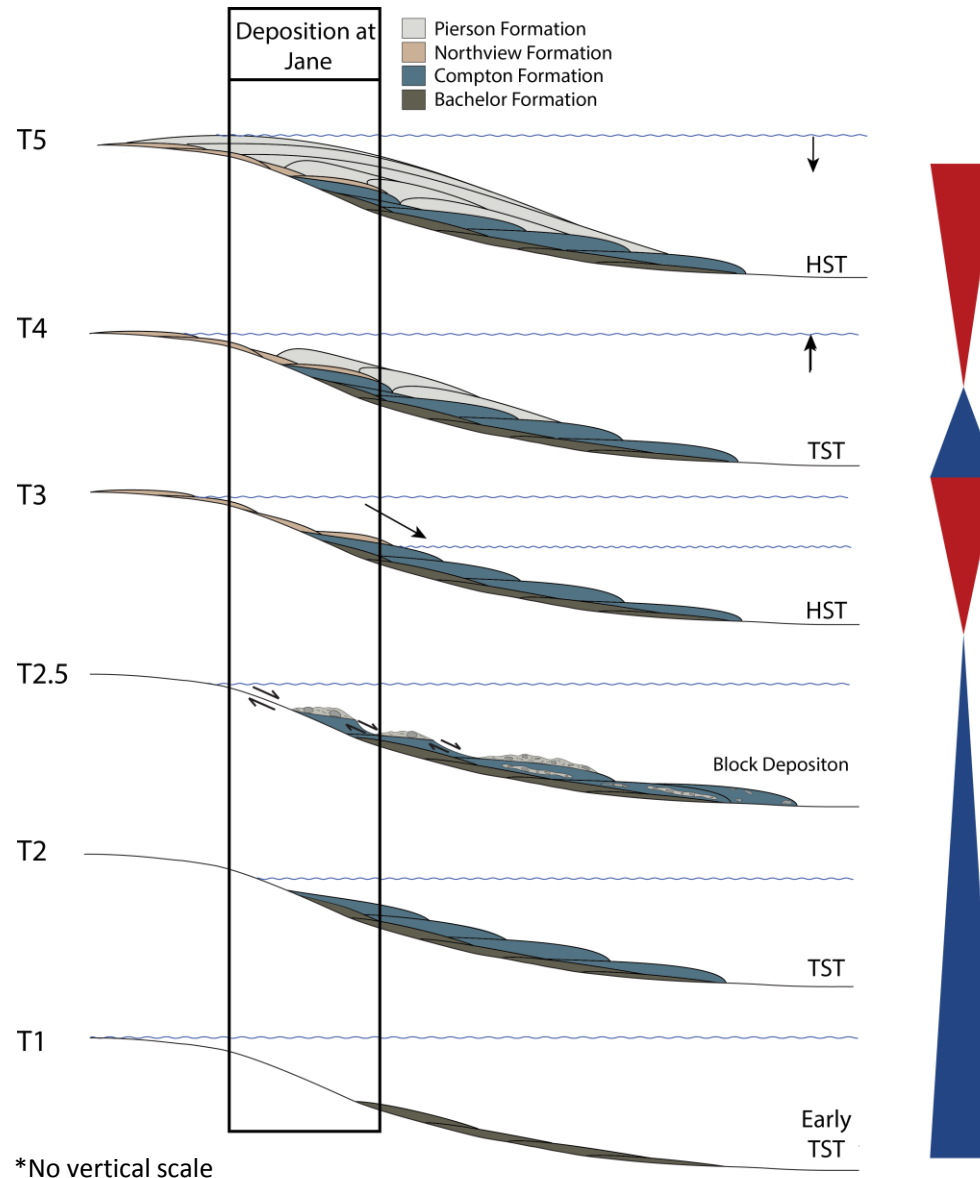
Current Paleo-Depositional Map



(Modified from Gutschick and Sandberg, 1983)

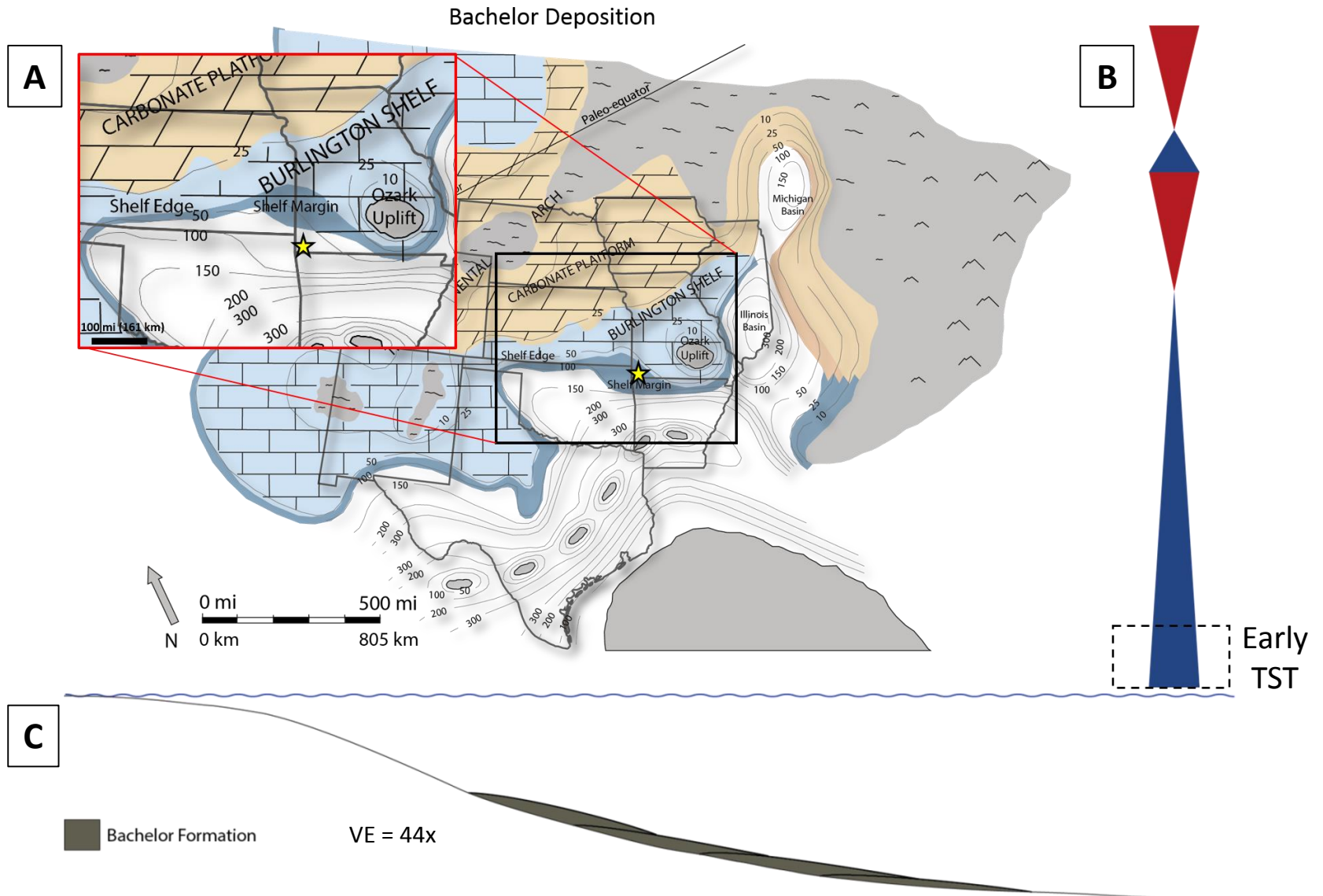


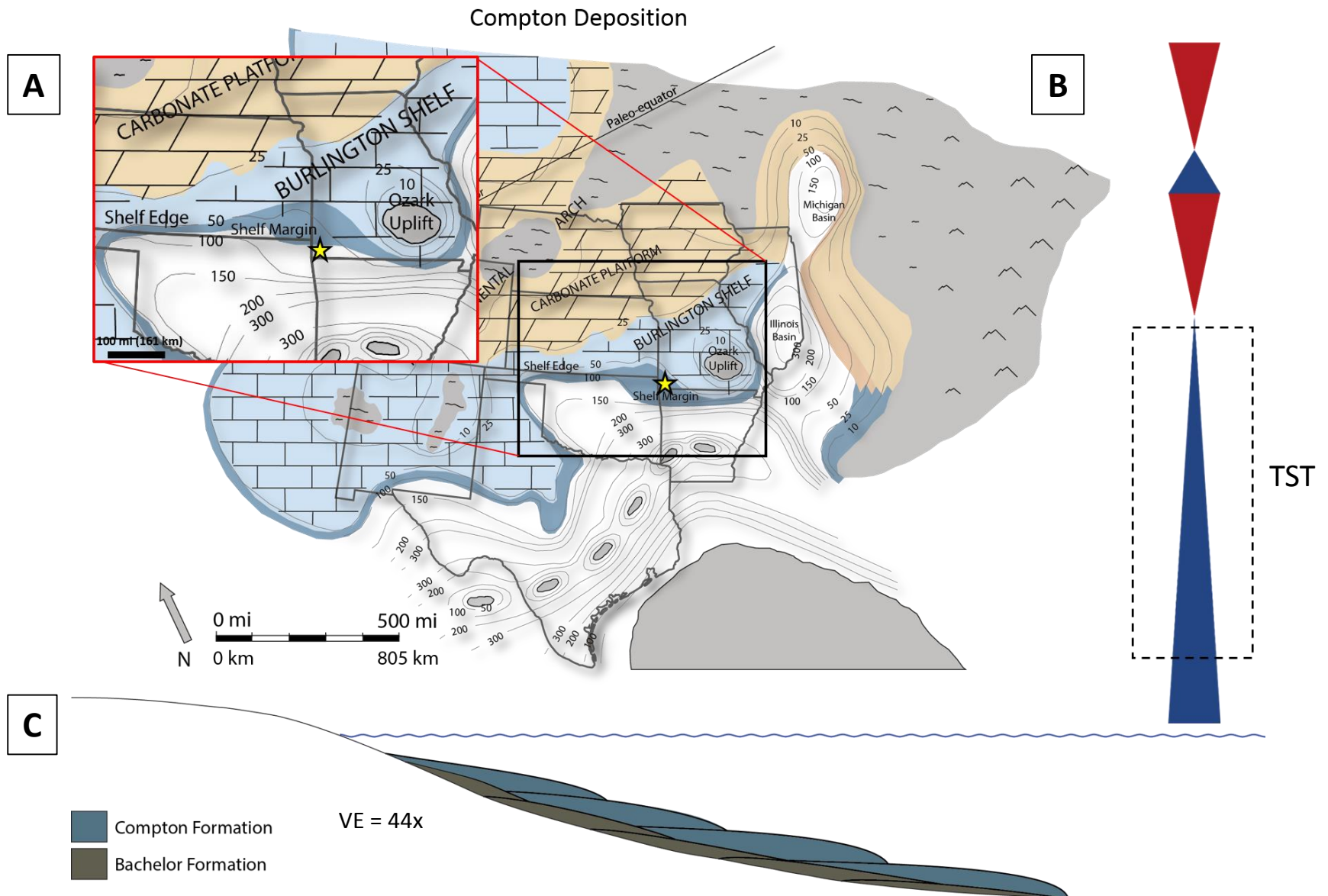
Distally Steepened Ramp Cross-Sections





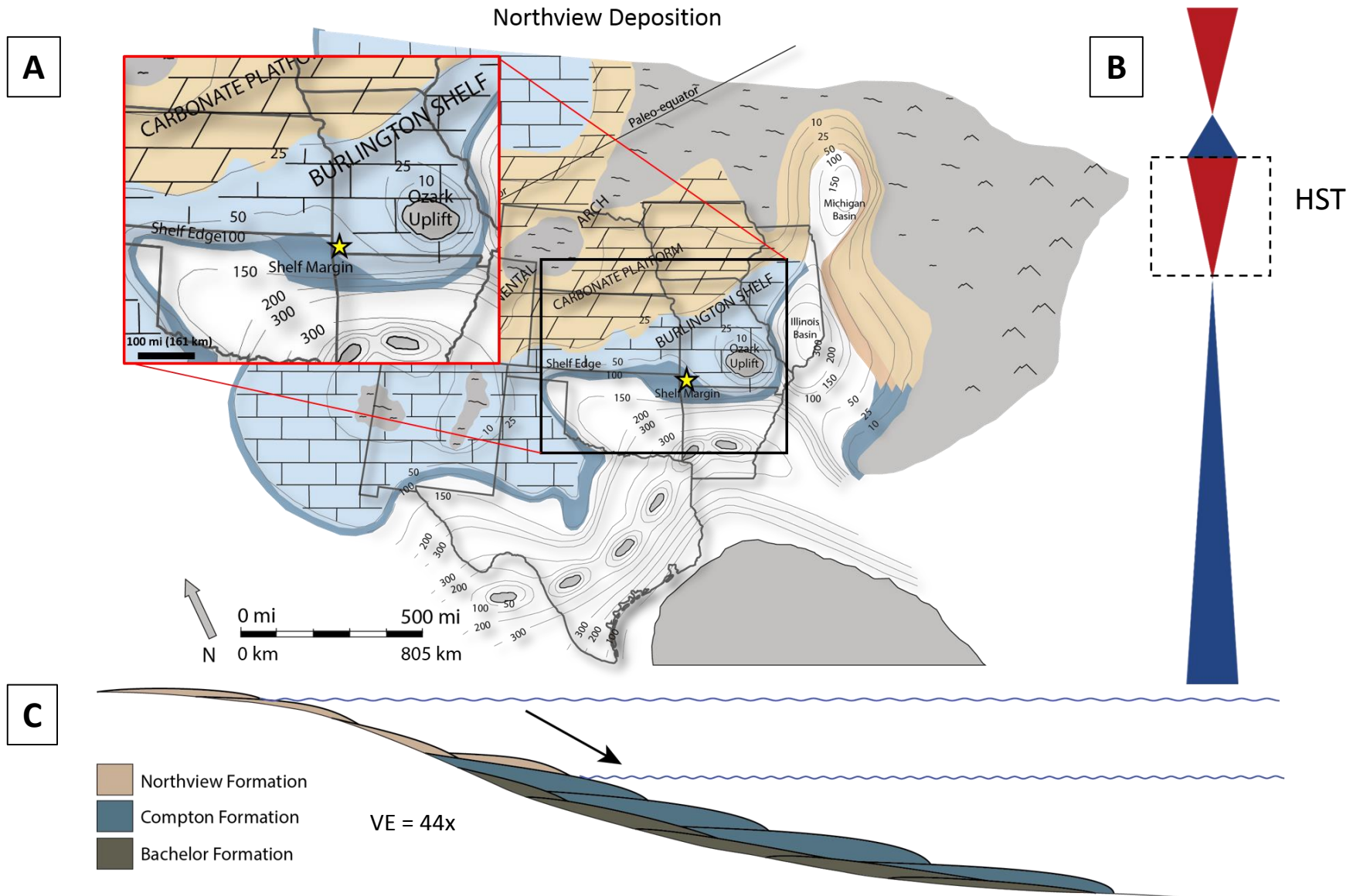
Modified Paleo-Depositional Maps





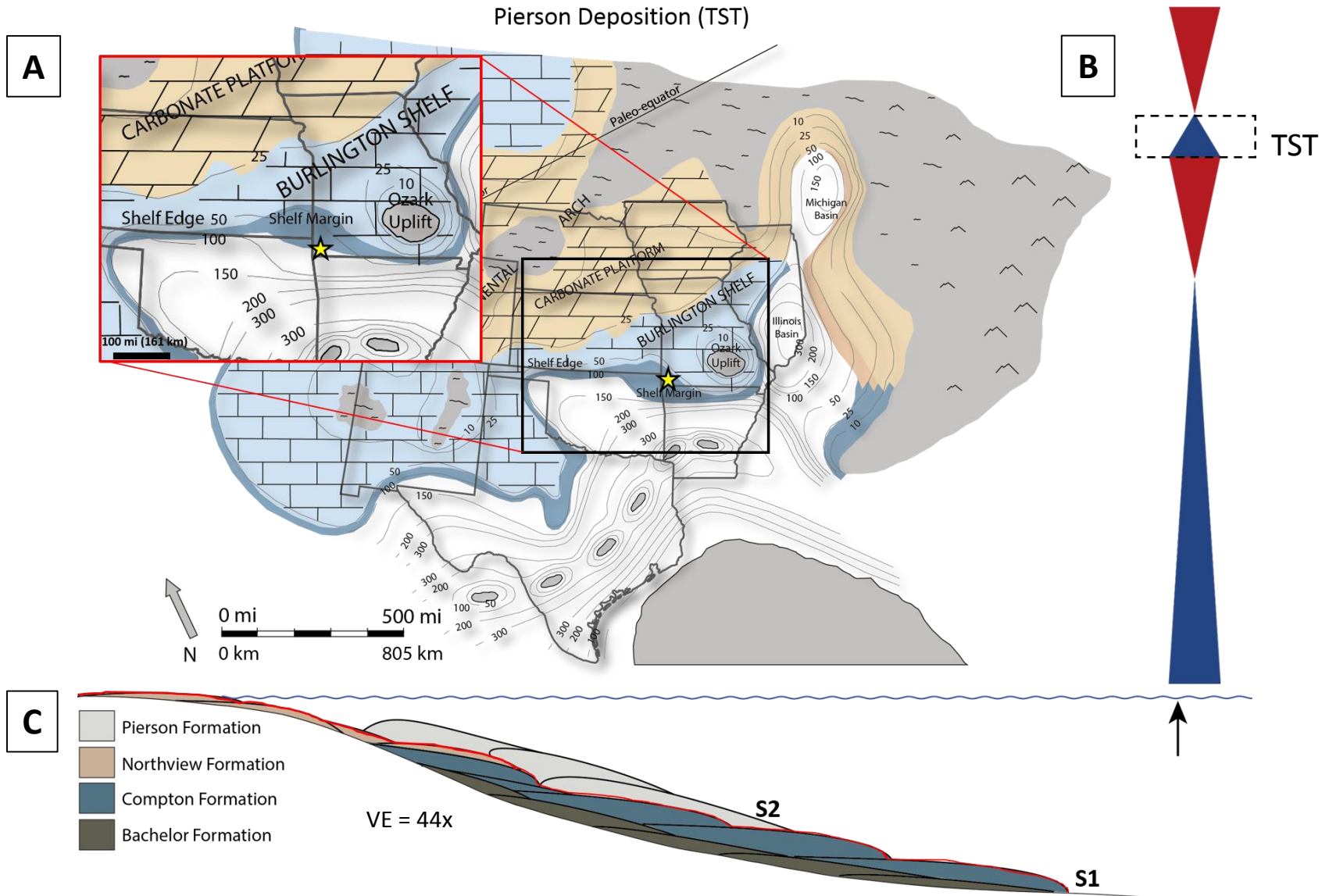


Modified Paleo-Depositional Maps



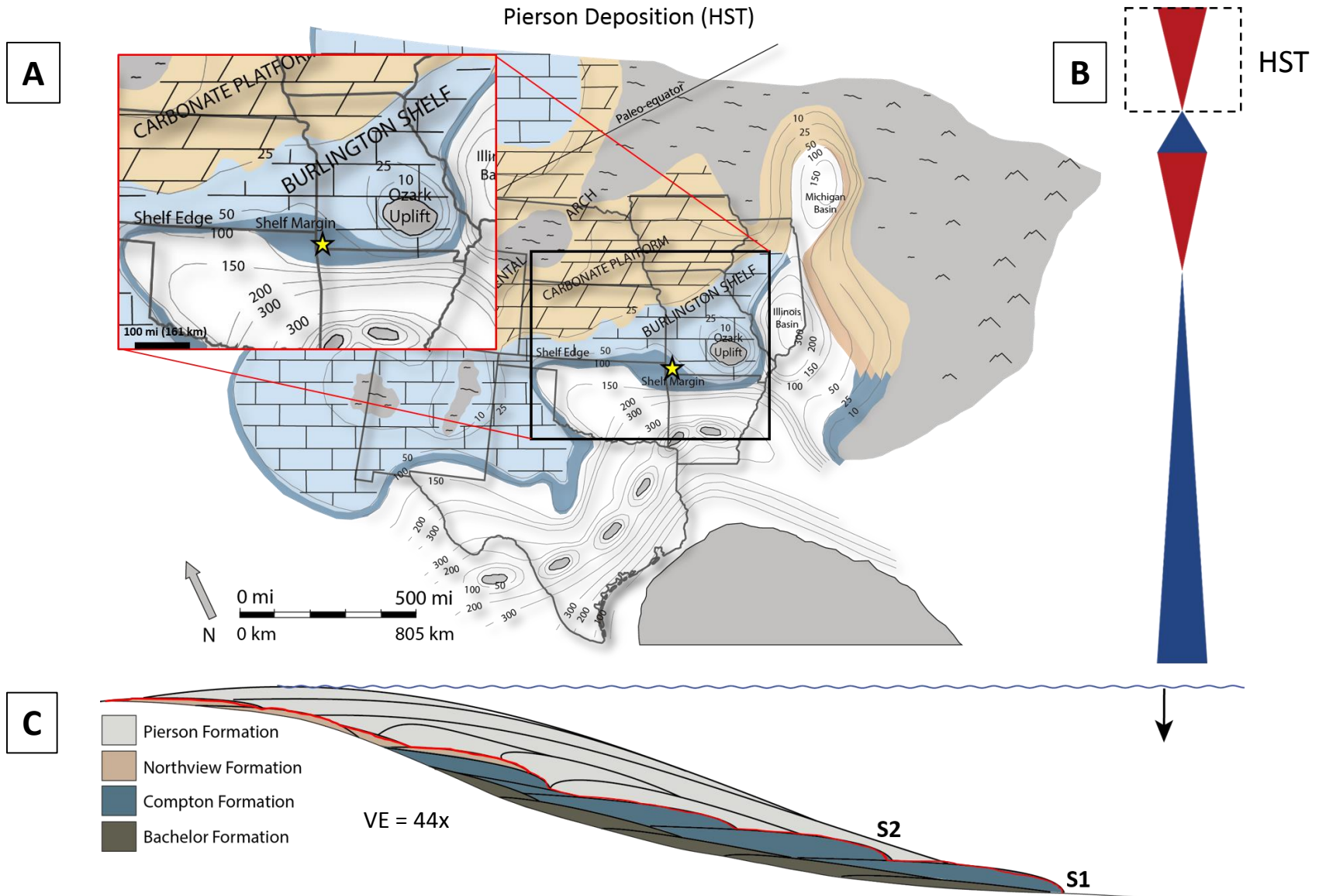


Modified Paleo-Depositional Maps



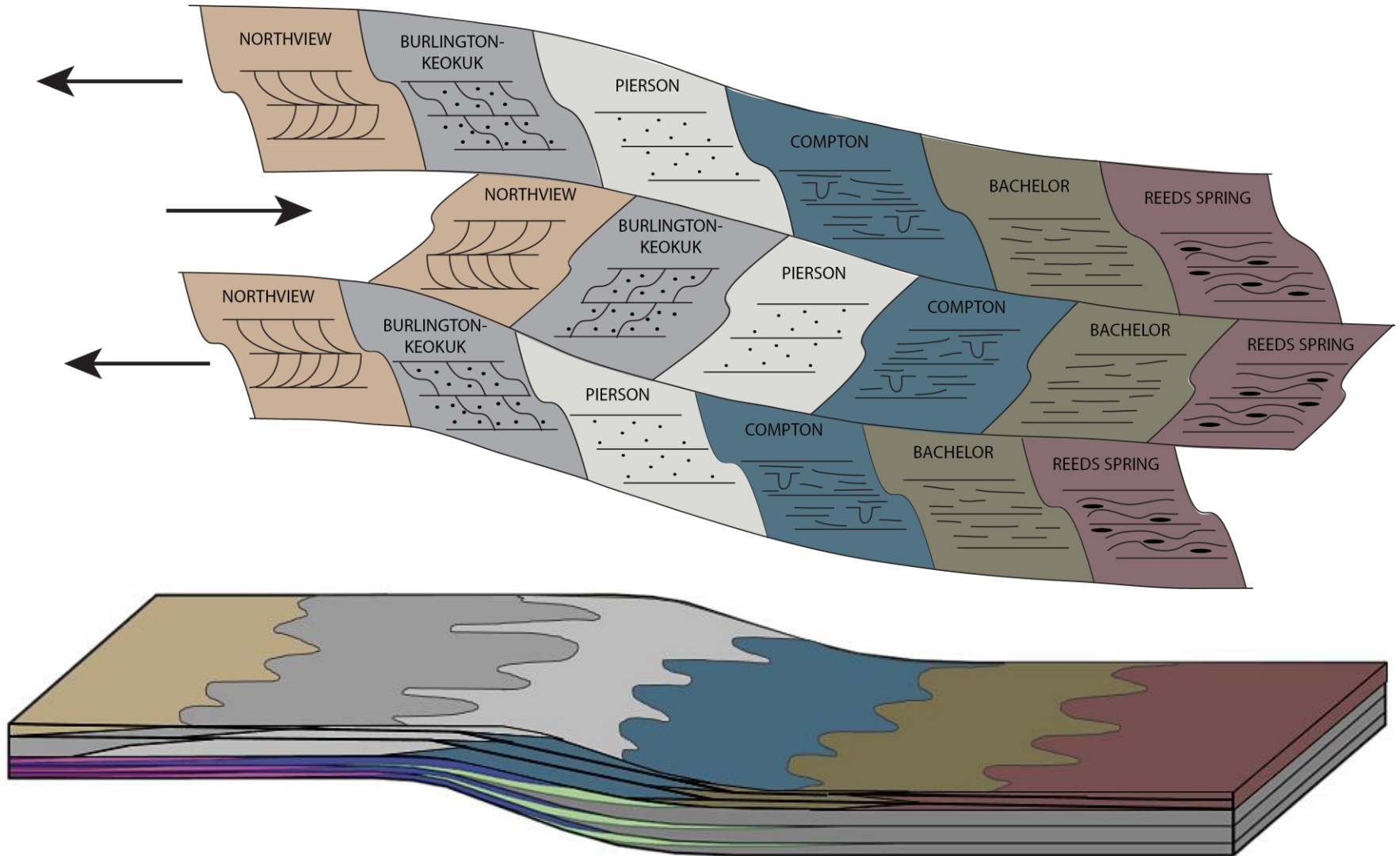


Modified Paleo-Depositional Maps





Mississippian Deposition: A Dynamic System



(Modified from Harris et al., 2011)

Conclusions



1. A hierarchy of cyclicity is discernible in the Lower to Middle Mississippian.
2. Use of the distally steepened ramp model more accurately captures the facies distribution and stacking patterns.
3. The Compton “mud mounds” are not truly *in situ* reefs, but are outrunner blocks set within a debris flow.
4. Sequence stratigraphic approach + complexity of shifting facies belts = modified time series of paleo-depositional maps.
5. When using Mississippian lithologic nomenclature, integration of facies mosaics shifting through time can **increase the predictability of potential reservoir units** in the system.

Thank You



Questions?