

Facies architecture, sequence stratigraphy and depositional history of the Ordovician Bromide Formation

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*Stratigraphy is the triumph of
terminology over common sense-*
P.D. Krynine

Facies architecture and sequence stratigraphy of the Ordovician Bromide Formation (Oklahoma): a new perspective on a mixed carbonate-siliciclastic ramp

Jesse R. Carlucci · Stephen R. Westrop ·
Carlton E. Brett · Roger Burkhalter

**I-35N, new reference section
for the Bromide Formation**





The Traditional View

- Transgressive-Regressive cycle
- Evolution from ramp to rimmed platform with shelf edge carbonate buildups.
- While peritidal carbonates were deposited on the shelf, the aulacogen was a major depocenter, accumulating thick deposits of limestone-shale rhythmites.

What are the goals?

- Update correlations based on lithofacies analysis and bounding surfaces to better understand depositional history.
- Apply sequence stratigraphic techniques to interpret sea level change at a variety of hierarchical scales.
- Understand the sedimentology and facies cyclicity of a petroleum-producing formation.
- Integrate with invertebrate paleontology.

The Bromide Formation

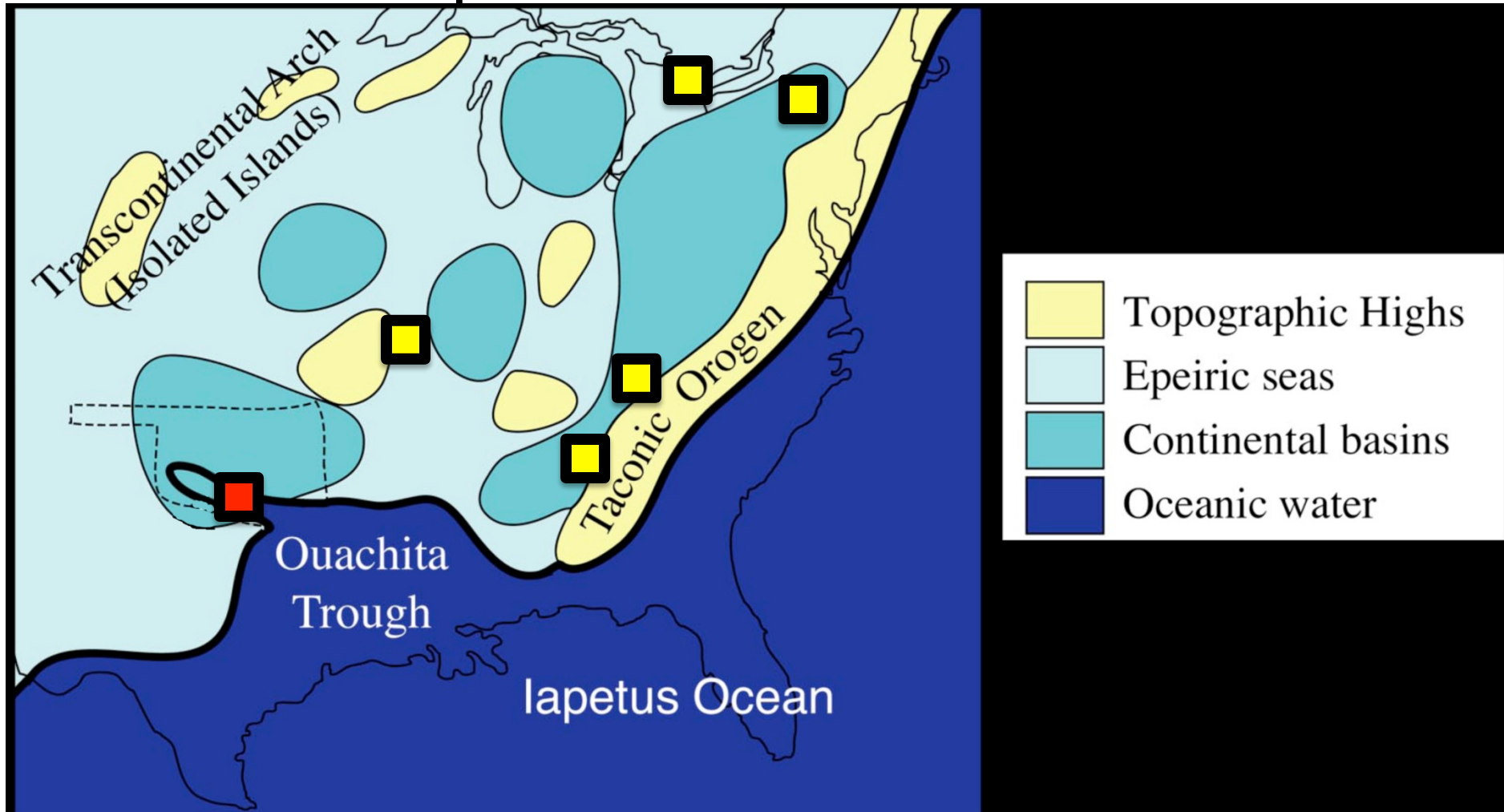
Upper Ordovician			
Dariw.	Sandbian	Katian	
Whiterockian	Mohawkian		
Chazyan	Turinian	GSSP	Chat
Simpson Group		Viola Gp	
C. sweeti	B. gerdæ	P. undatus	
Tulip Creek Fm.	Bromide Formation	Viola Springs Fm.	
		Corbin Ranch	
		Pooleville	
		Mtn. Lake	
		Pontotoc	

REGRESSIVE

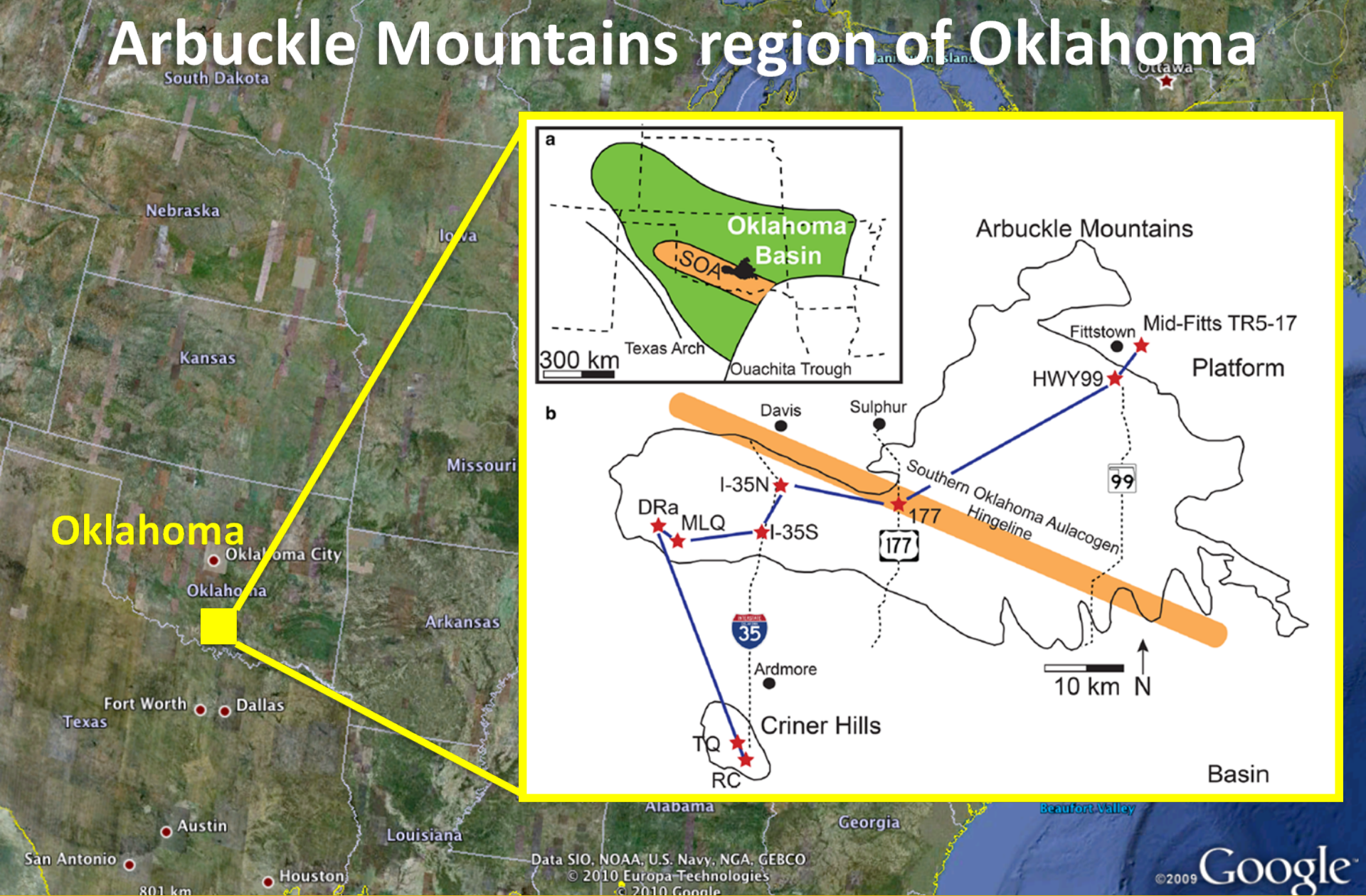
TRANSGRESSIVE



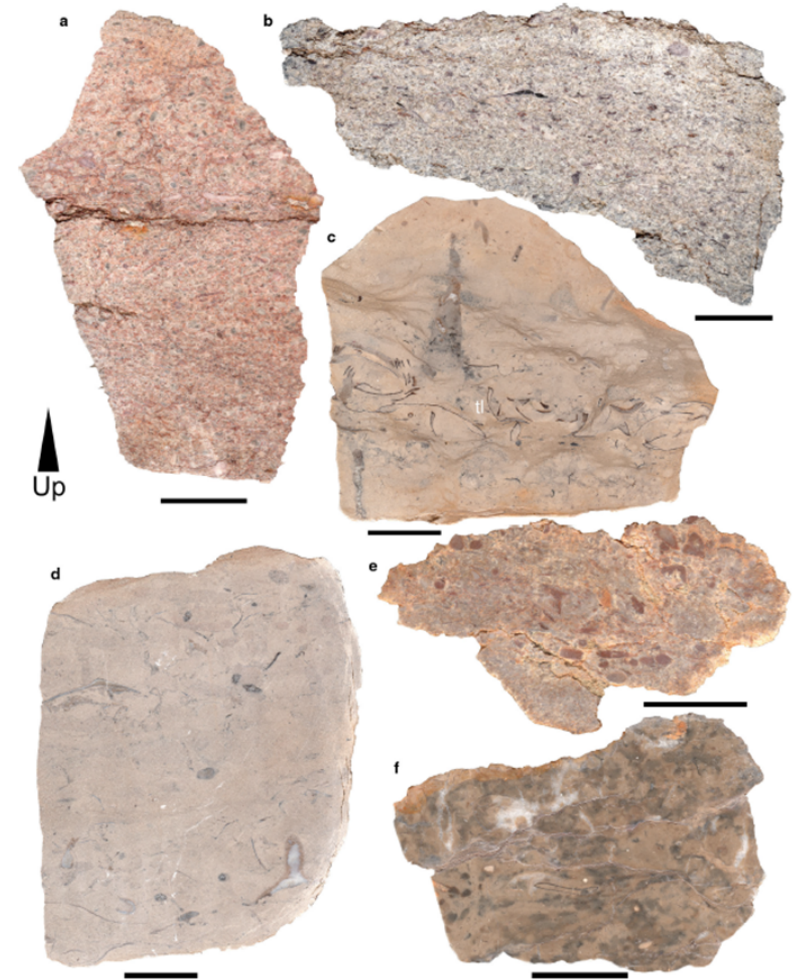
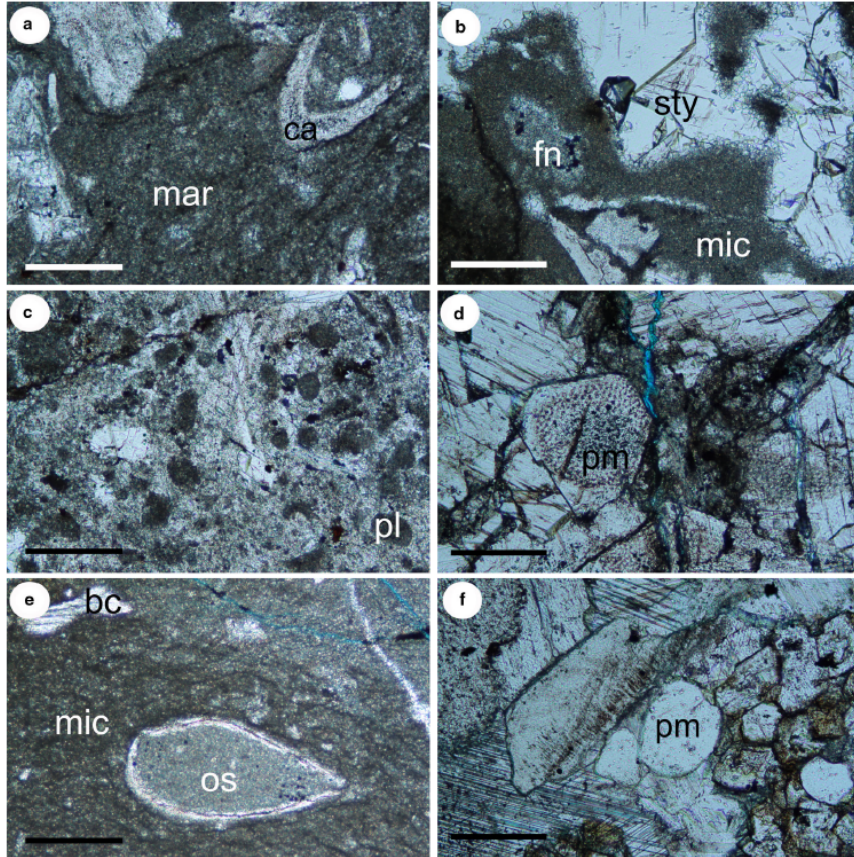
Comparison of Mohawkian Depositional Sequences across Laurentia

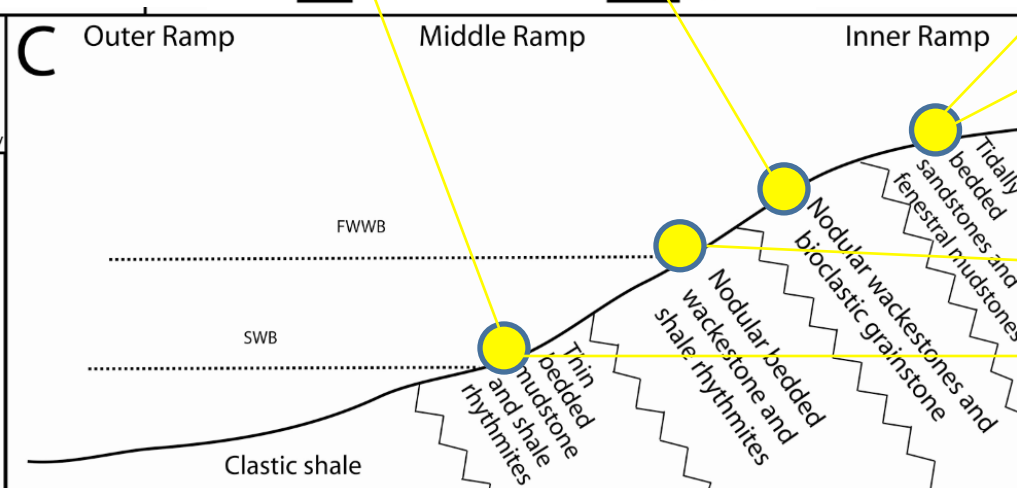
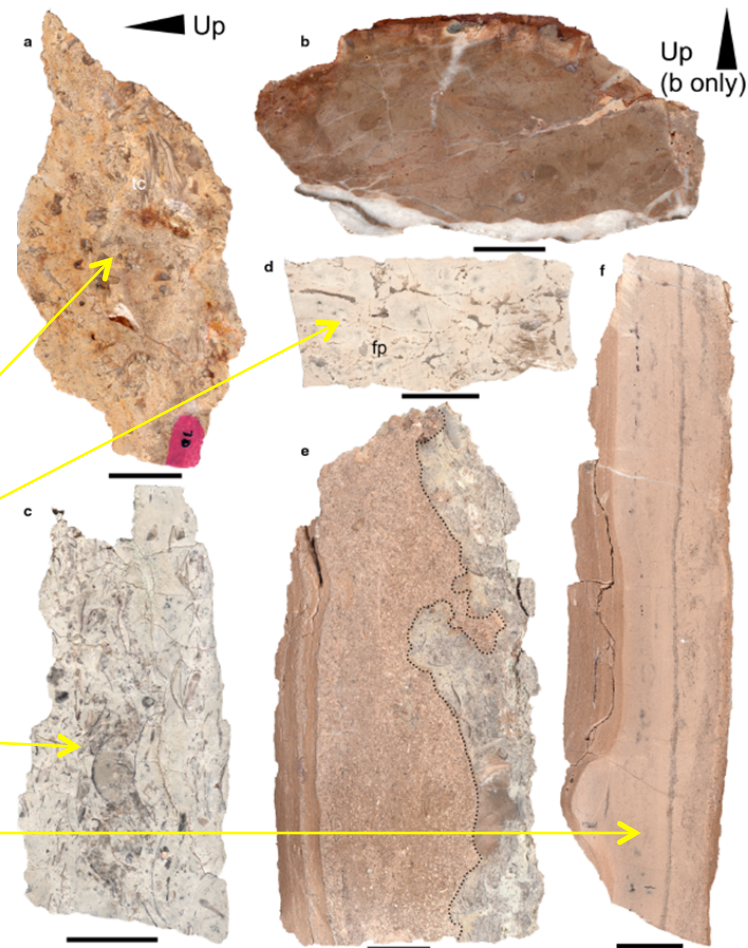
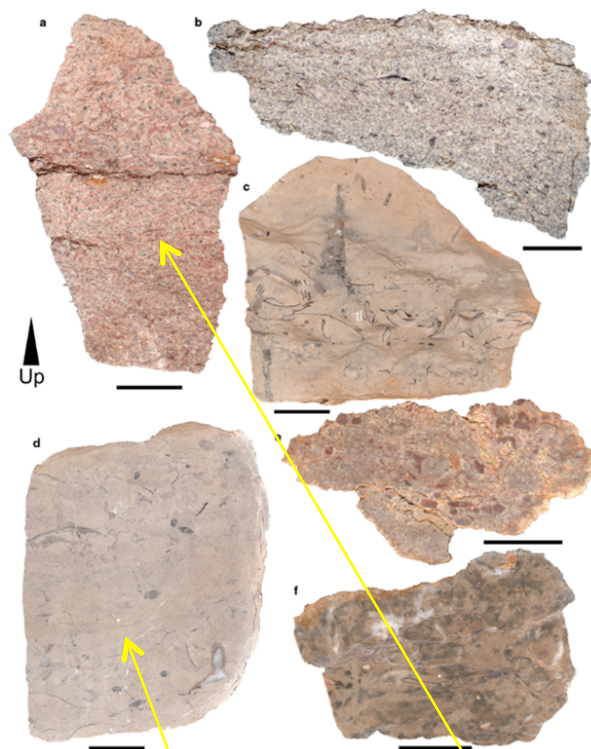


Arbuckle Mountains region of Oklahoma



Placing Facies (15) in a depositional model





MIDWESTERN
STATE UNIVERSITY

Wave-rippled calcisiltite and grainstone lithofacies

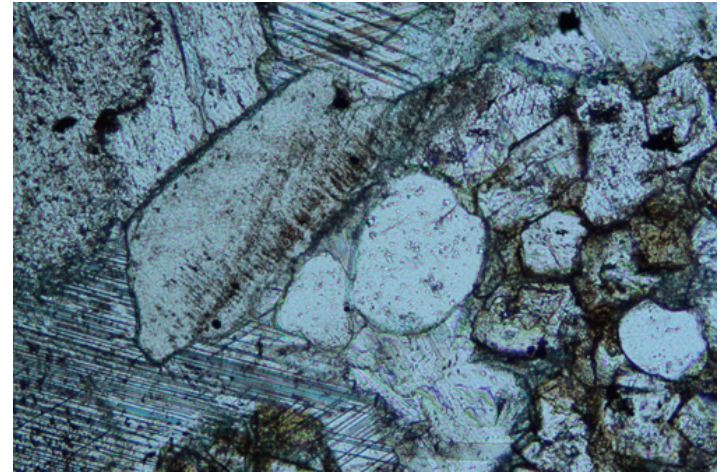


One of the shallowest facies of the Mt. Lake.

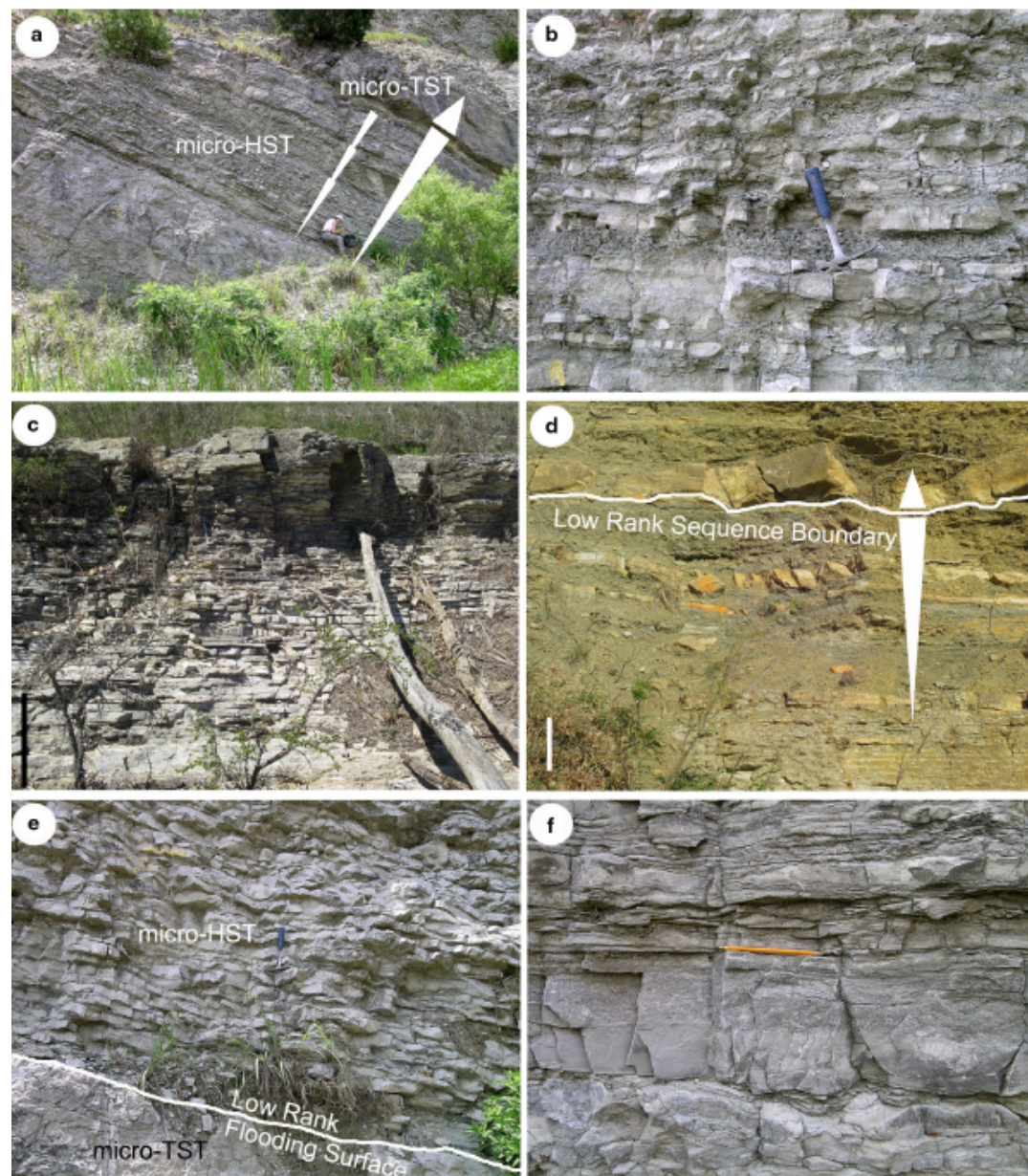
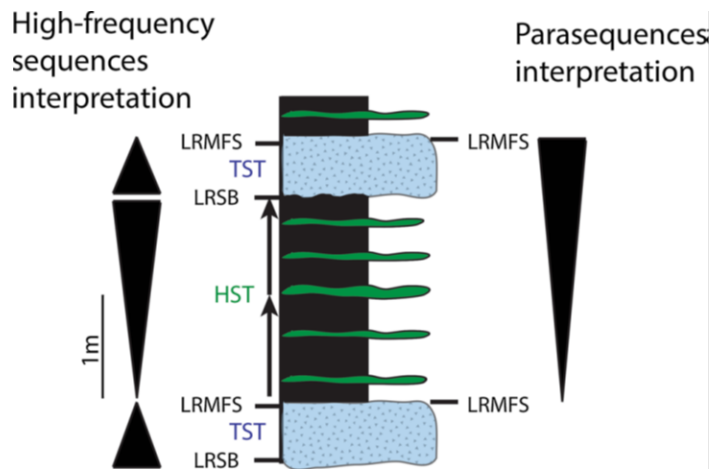
Overlies surfaces of forced regression.

Abruptly overlies outer ramp rhythmites.

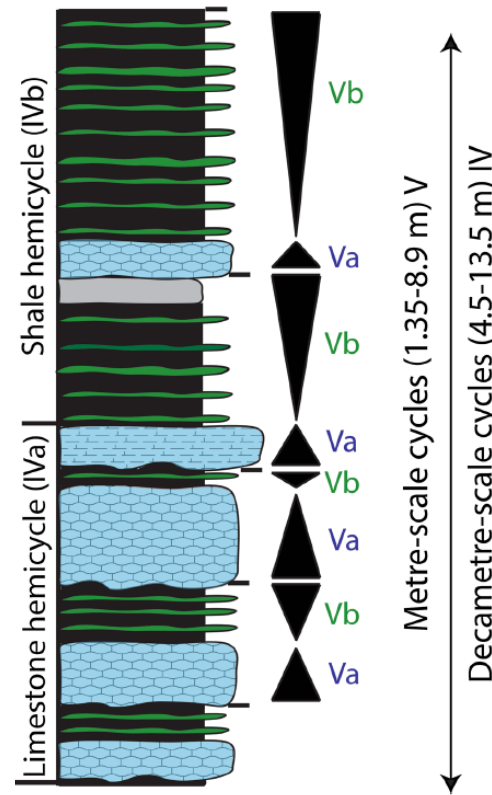
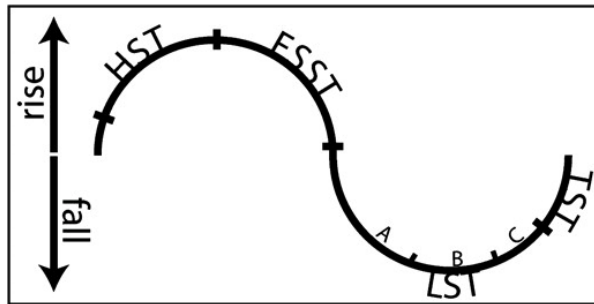
High energy detached shoreface deposits



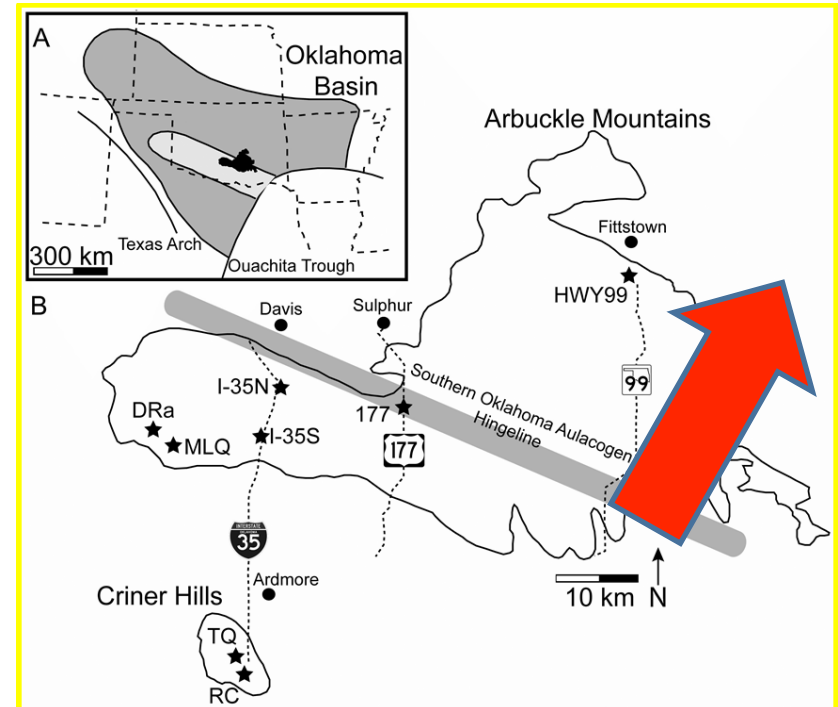
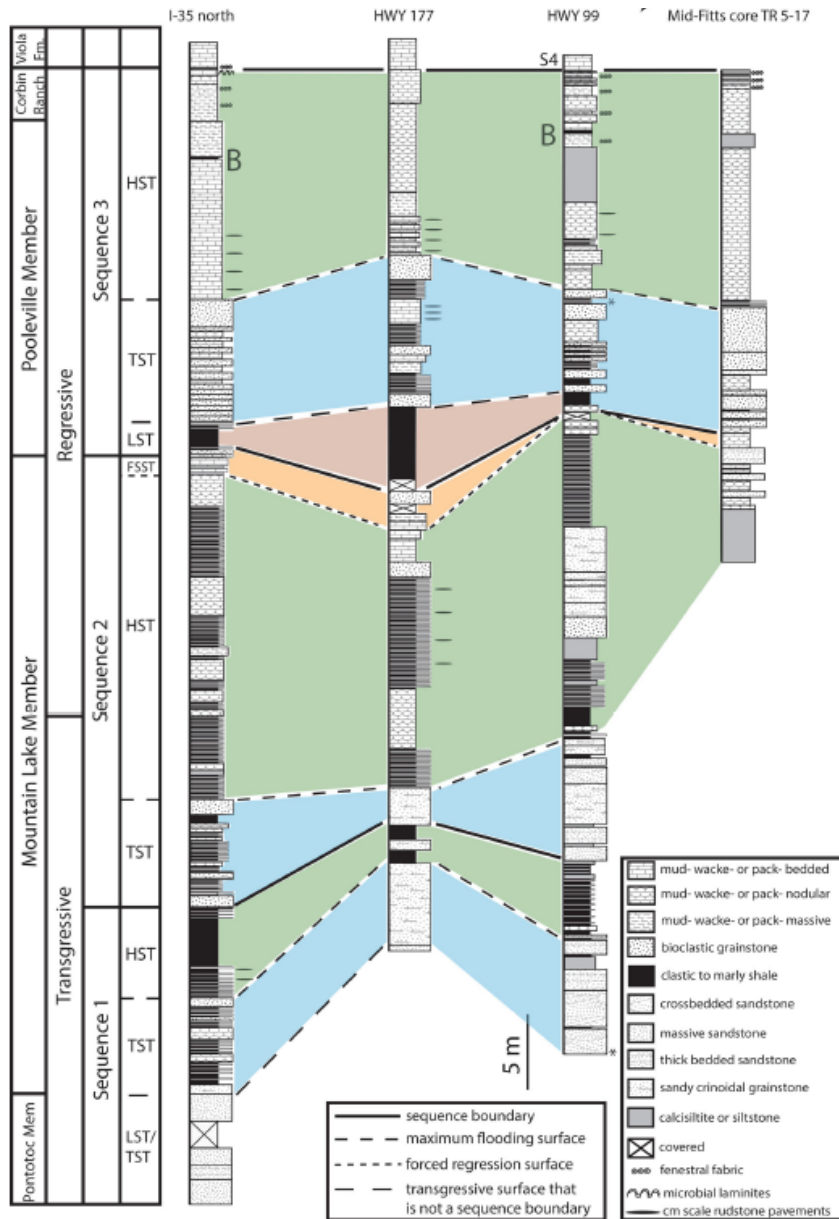
Meter Scale Cycle Hierarchy



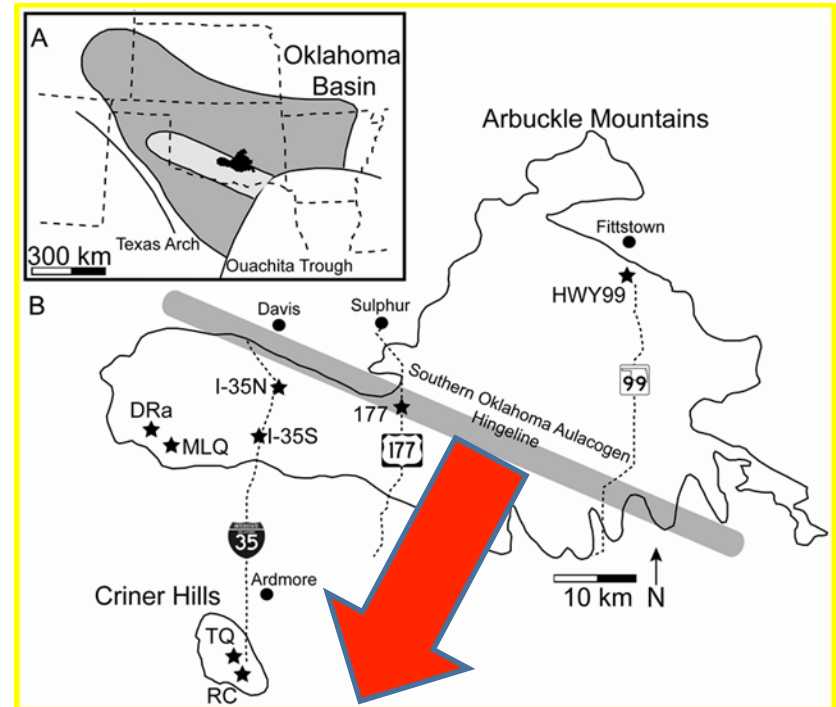
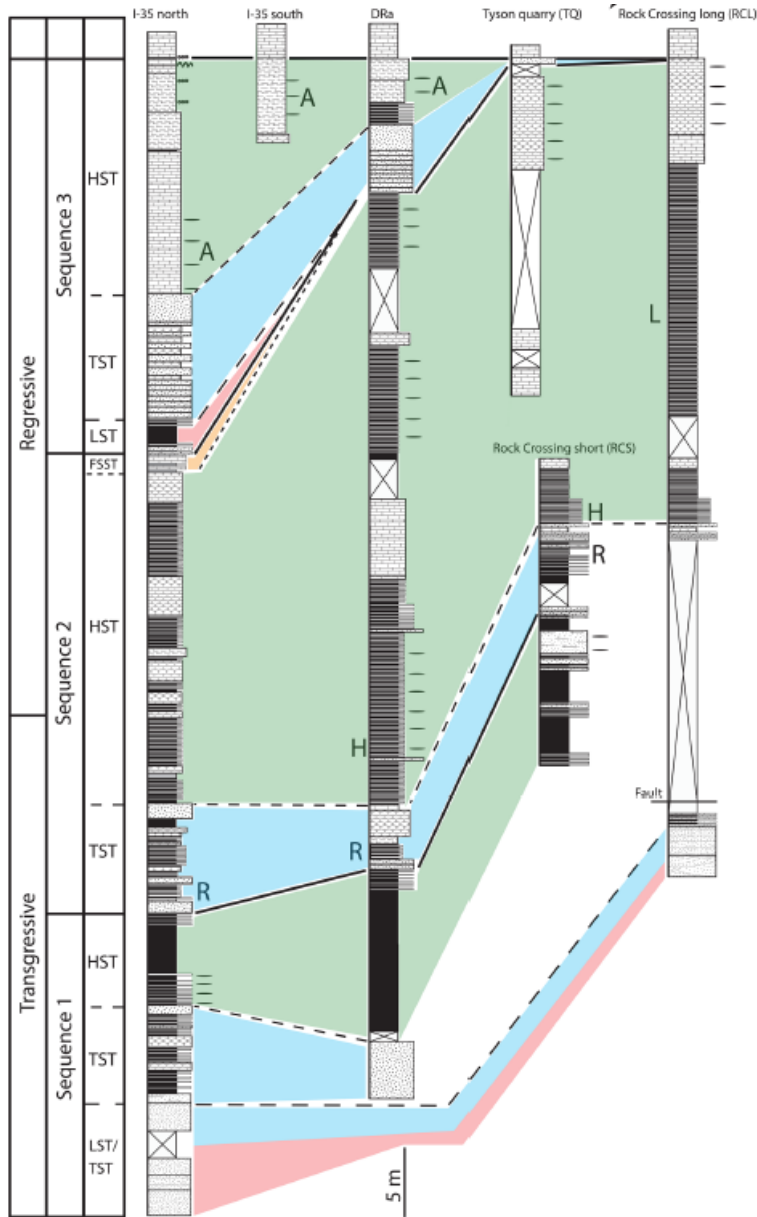
Directional trend of meter-scale cycles: net progradation, aggradation, retrogradation etc.



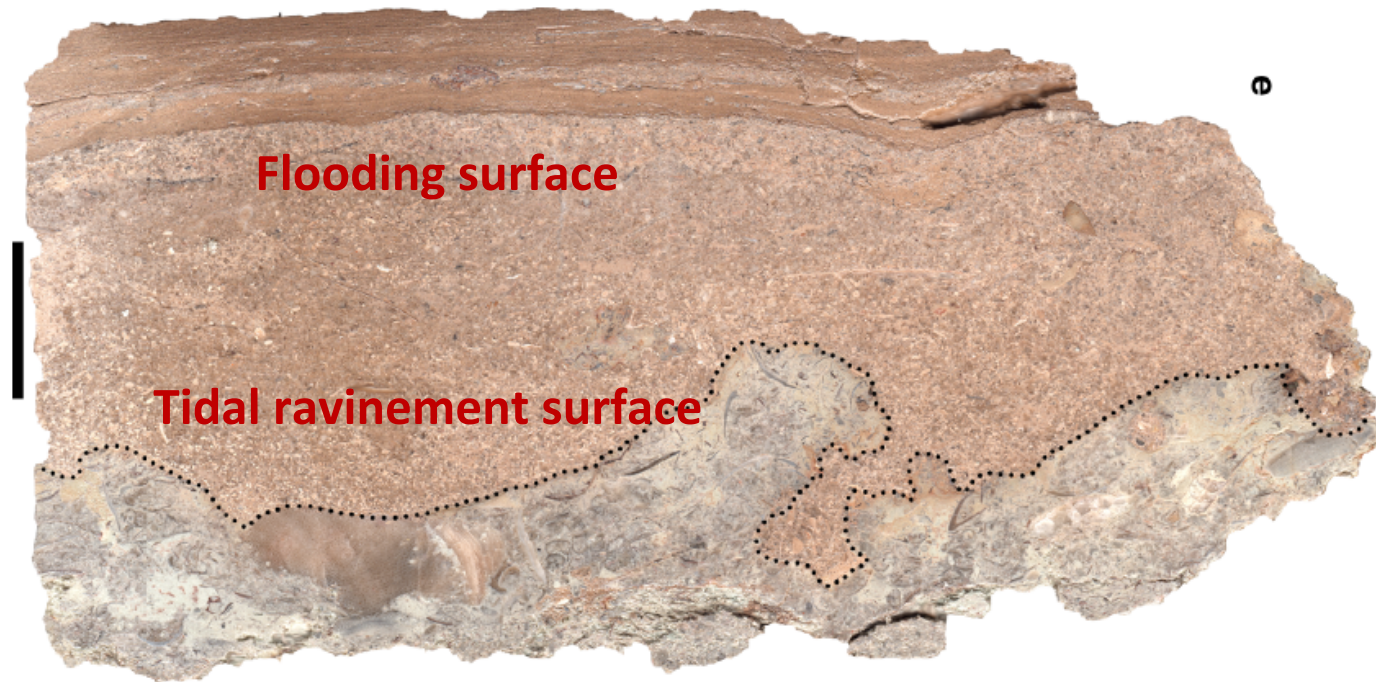
Depositional Sequence Hierarchy

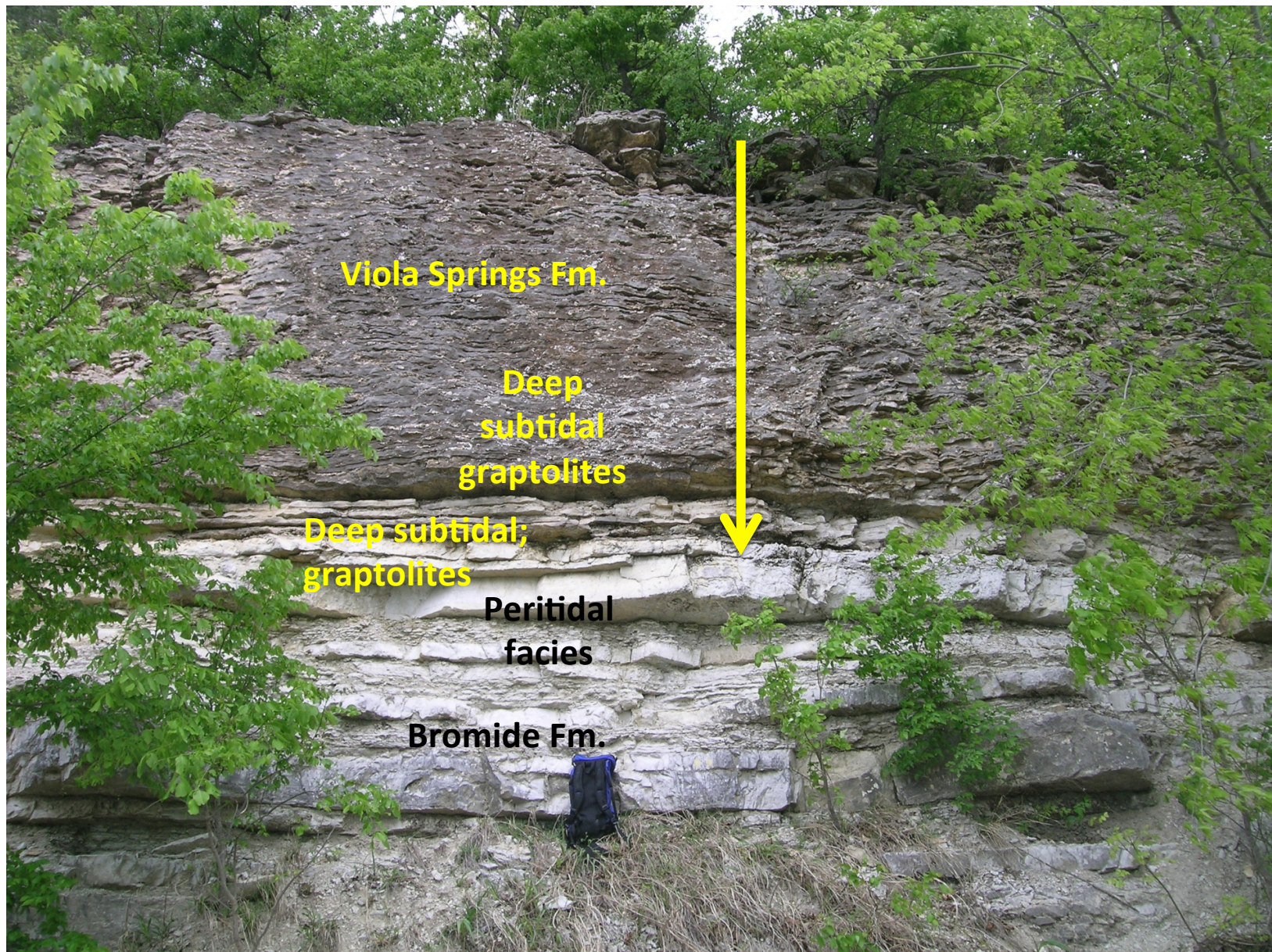


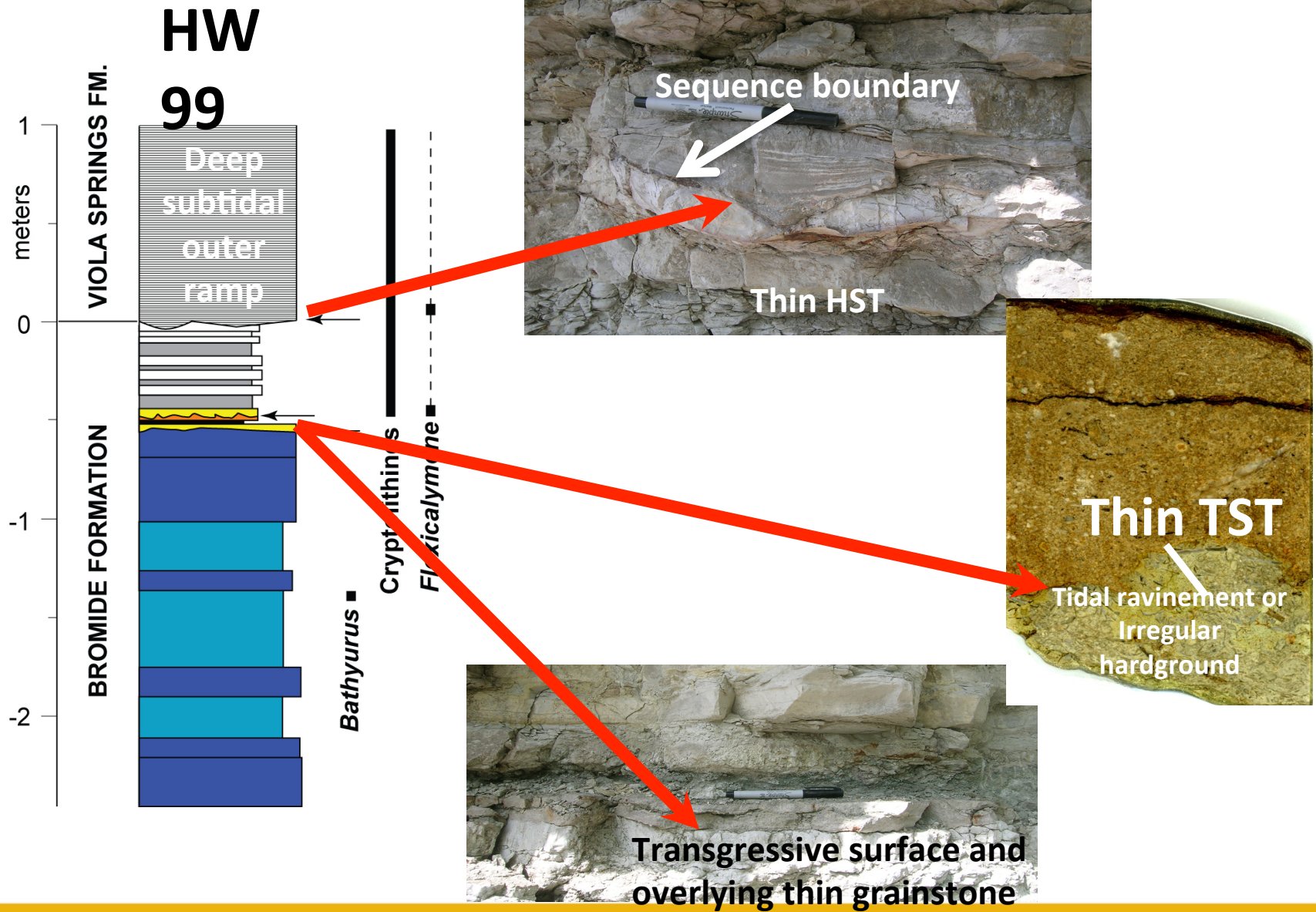
Depositional Sequence Hierarchy



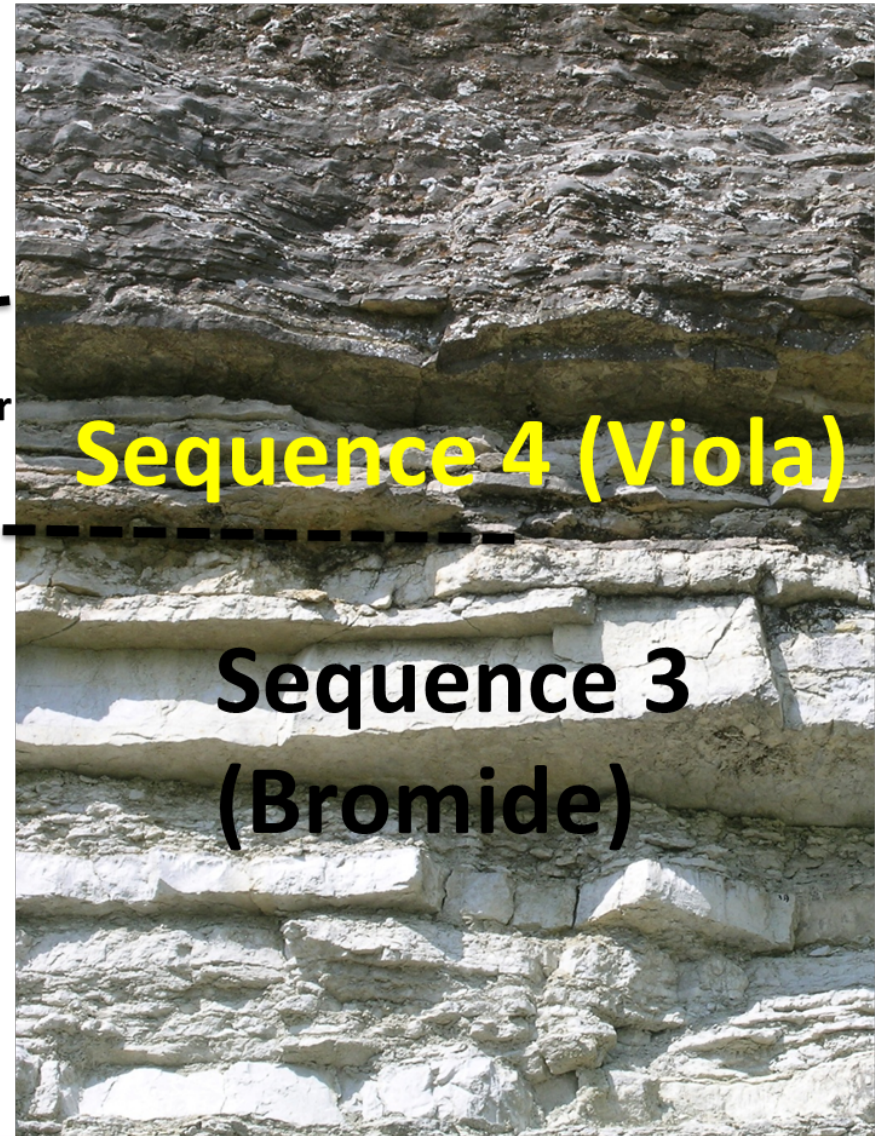
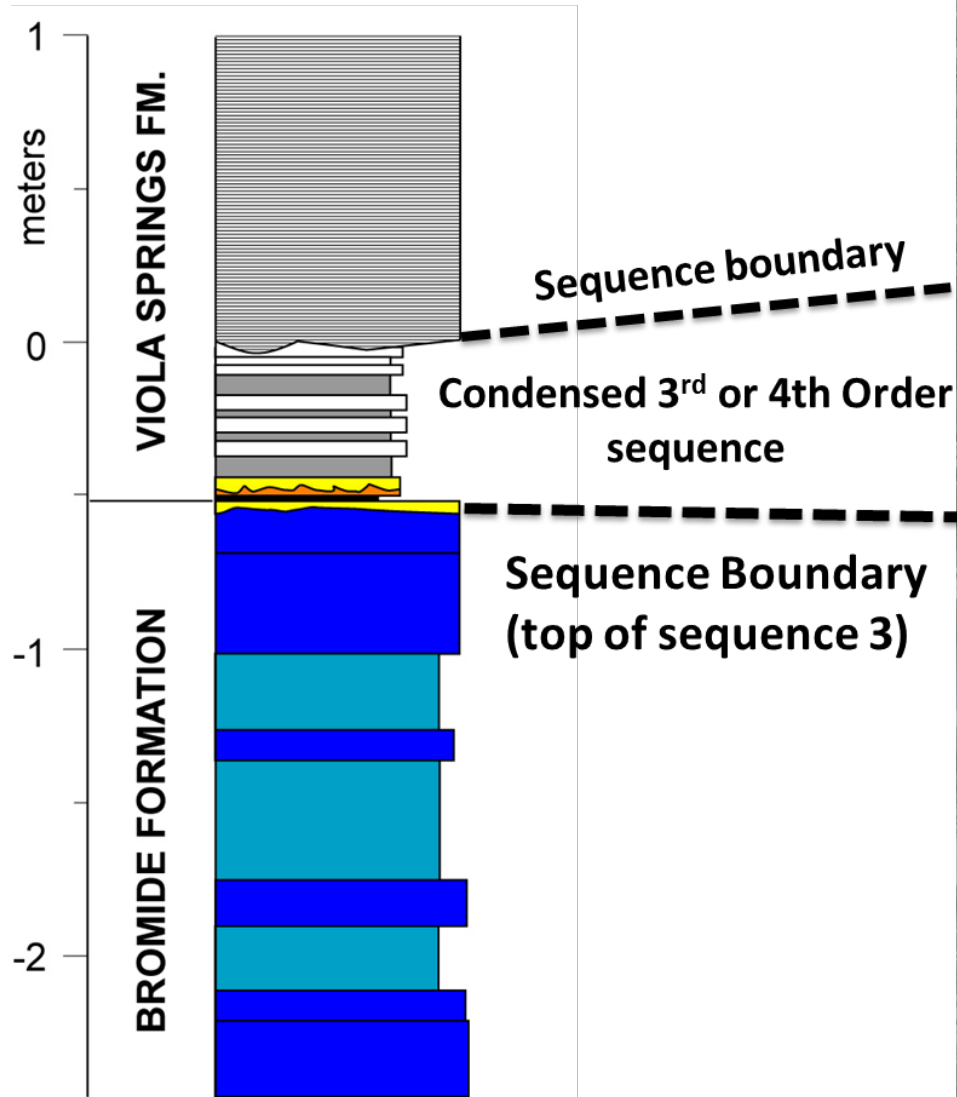
Transgressive, wave dominated coastline



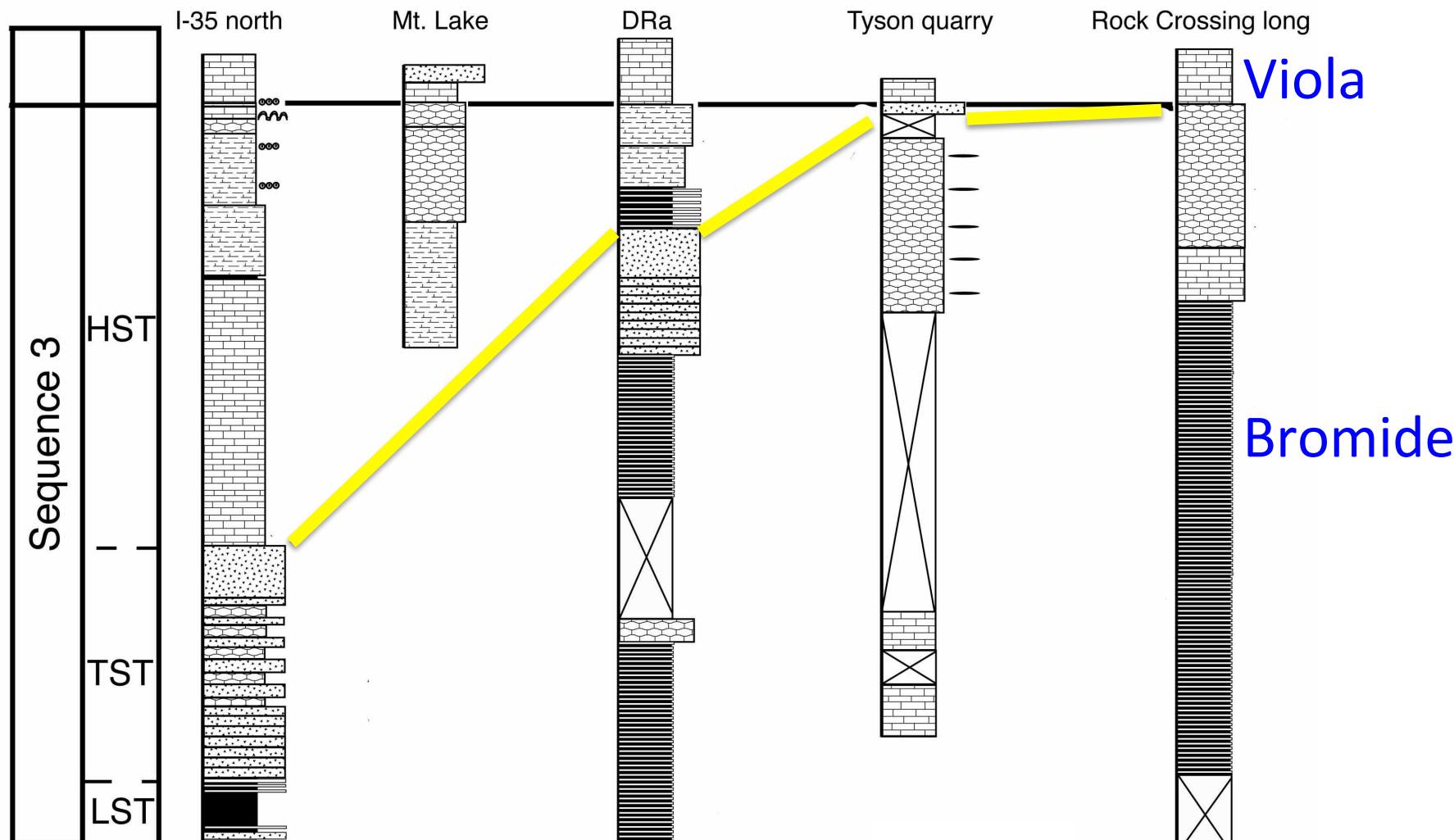




Interpretation



Downramp



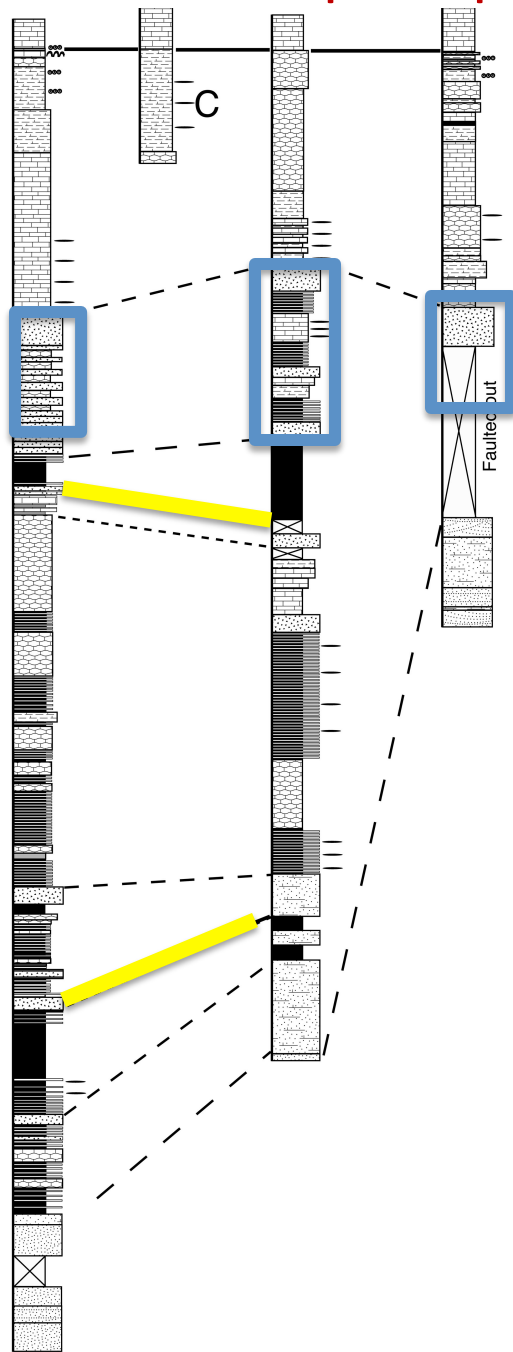
Sequence 3 is progressively cut-out downramp; Late Mohawkian equivalent is missing from the deepest portion of the basin.

Shelf edge buildup?

- The condensed grainstones that are progressively cut-out downramp were previously interpreted as a buildup that was only present near the hinge-line of the aulacogen.
 - We prefer an interpretation that describes them as a transgressive mosaic.
 - Extensive authigenic mineral crusts
 - Still present in aulacogen
 - No relief, gradational between localities

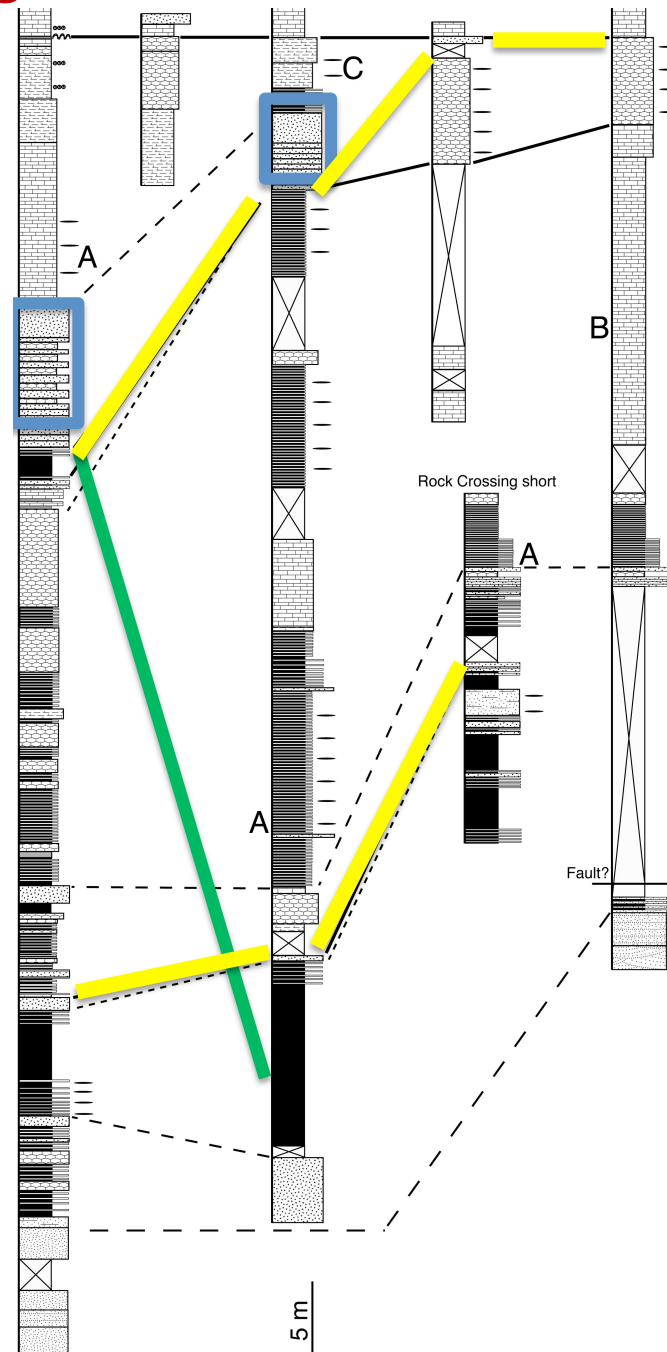
Hingeline → Upramp

Sequence 1 Sequence 2 Sequence 3



Hingeline → Downramp

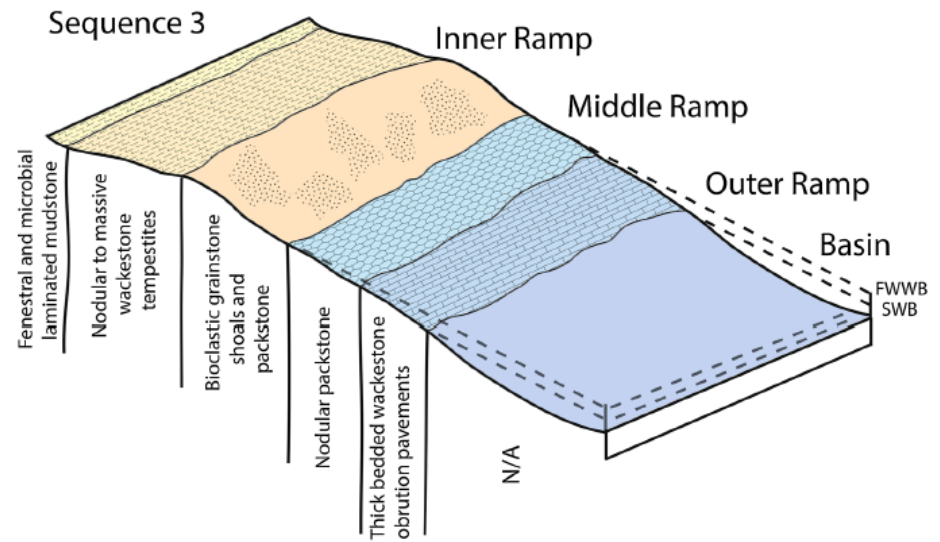
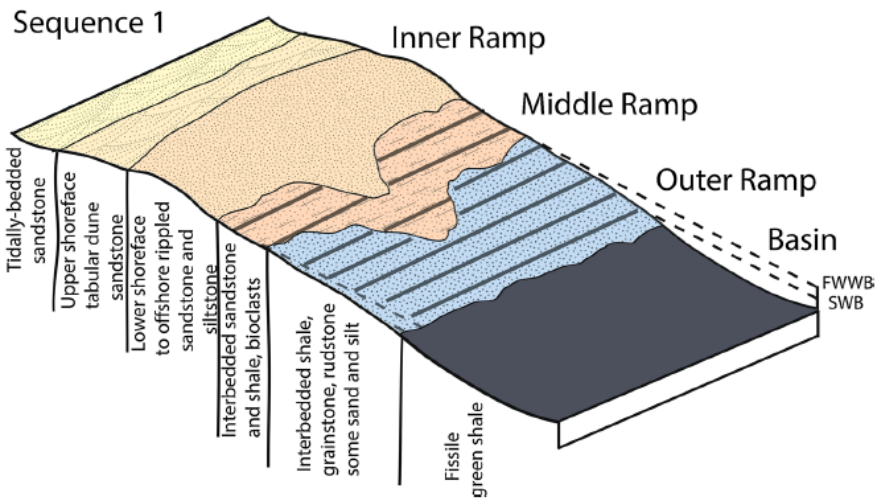
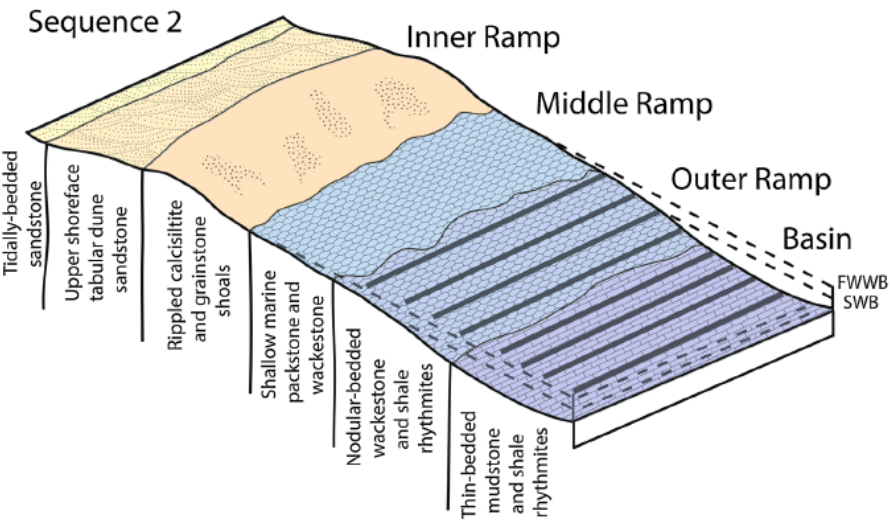
Sequence 1 Sequence 2 Sequence 3



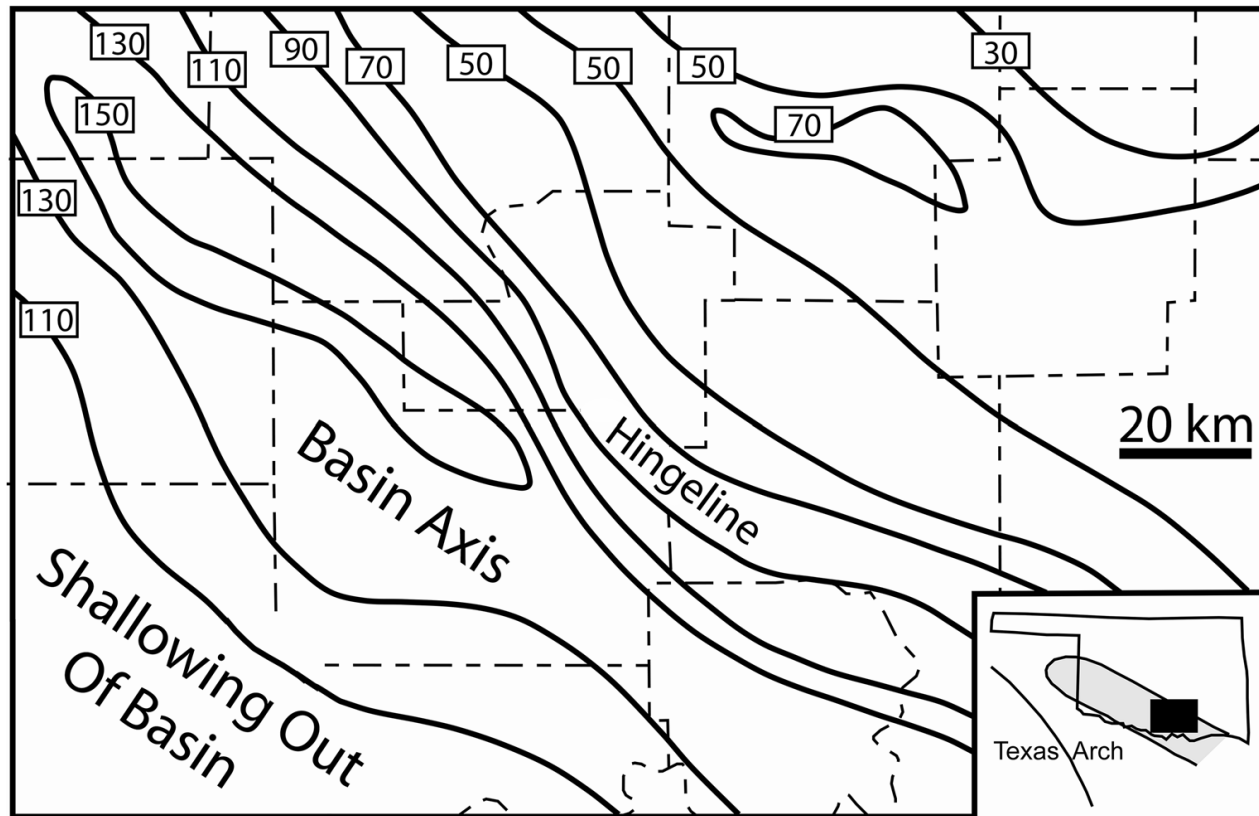
Our Interpretation

- The mixed siliclastic-carbonate succession (sequence 2, Mt. Lake) expanded downramp into the aulacogen, rather than the fully carbonate succession (sequence 3, Pooleville)
- It is not just downramp facies change because all the same facies are in the same order, but its cut-out in the aulacogen.

Updated Depositional Model

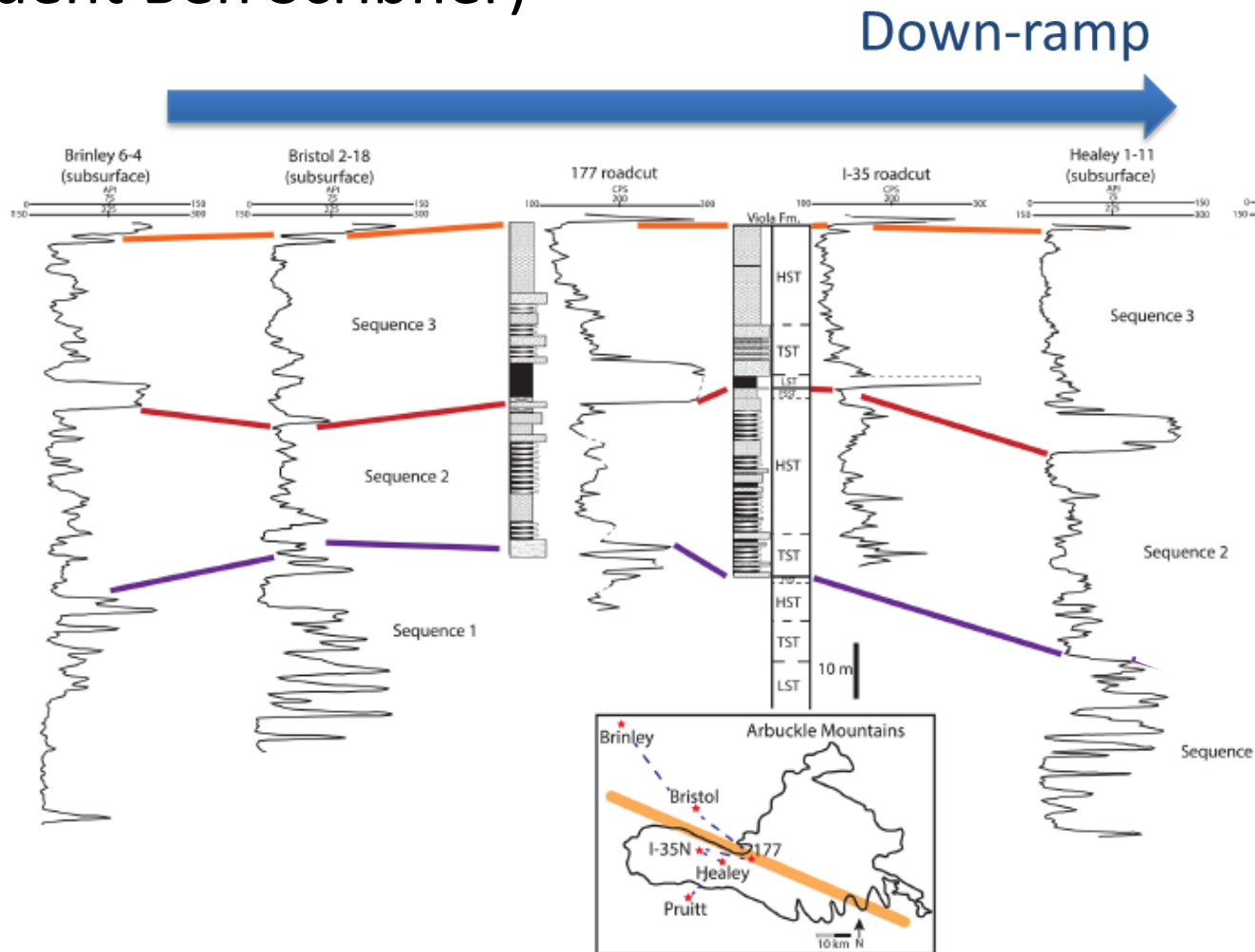


Criner Hills Region of Oklahoma is on the southern ramp, shallowing towards the Texas Arch



Longman 1982,
modified by
Carlucci et
al 2014

Correlation into the subsurface (work is ongoing by M.S. student Ben Scribner)

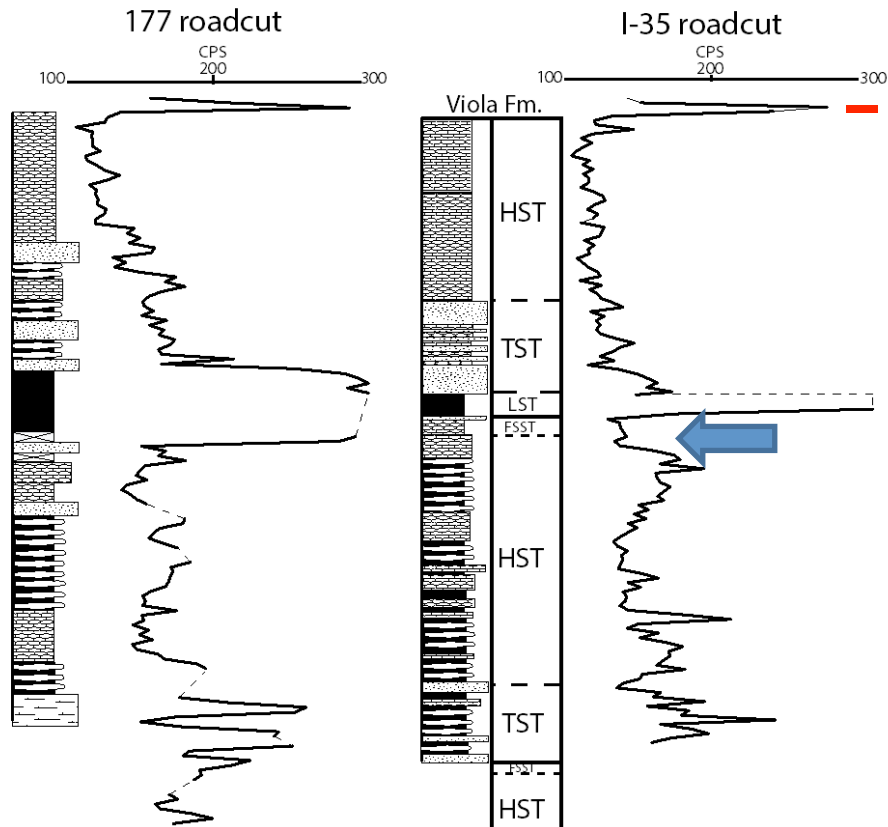


SOA Hingeline



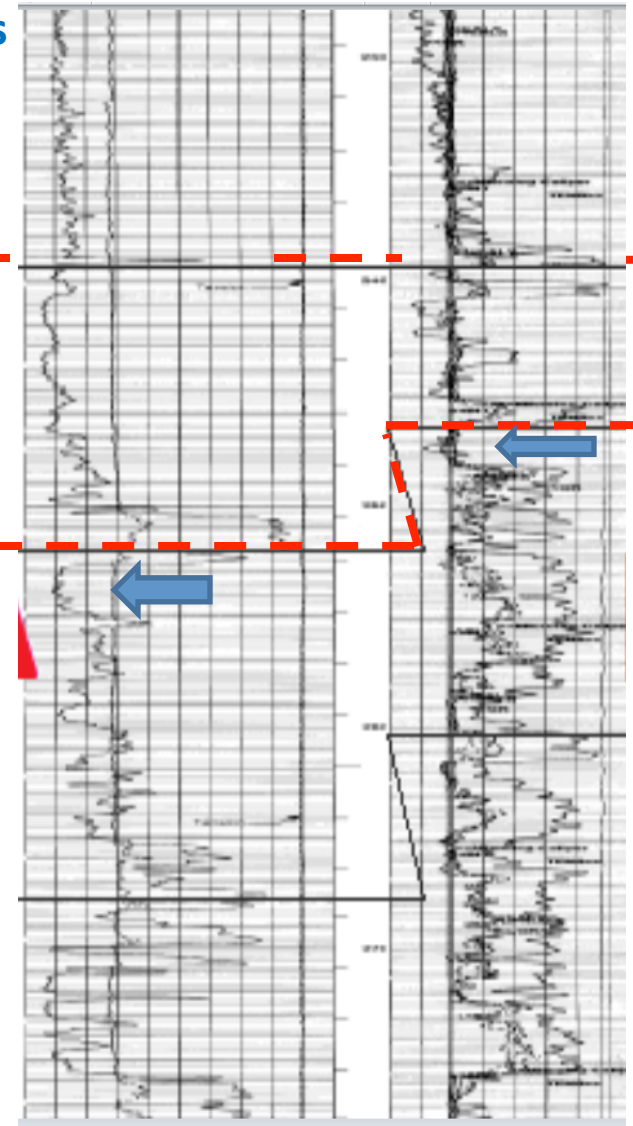
Criner Hills

Outcrop Gamma Ray



Viola

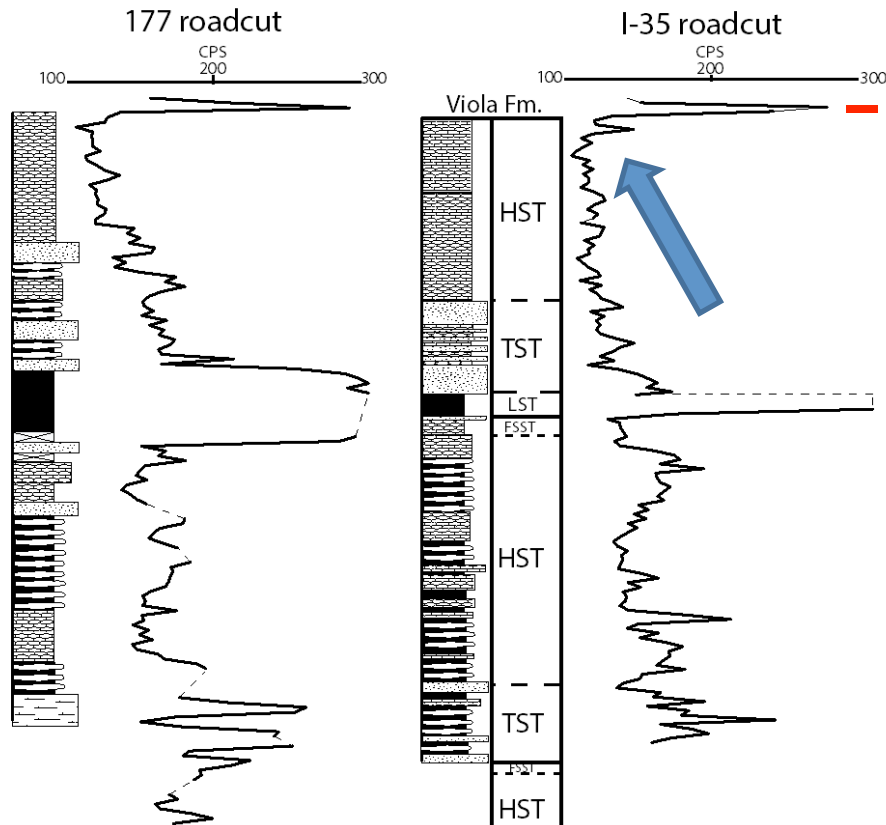
Bromide



Rippled grainstone of
Falling Stage
Sequence 2 in
outcrop and
subsurface

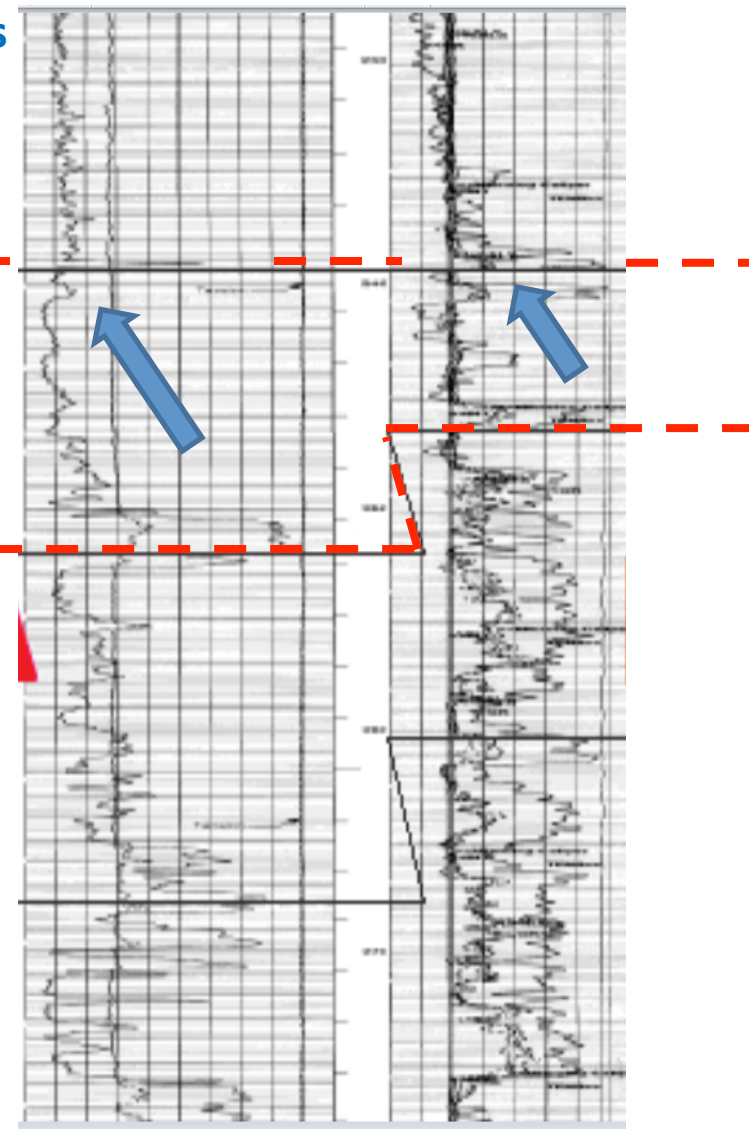


Outcrop Gamma Ray



Viola

Bromide



Bromide/Viola contact is always accompanied by a rapid “hot” jump in outcrop, above the upper Pooleville/Corbin Ranch.

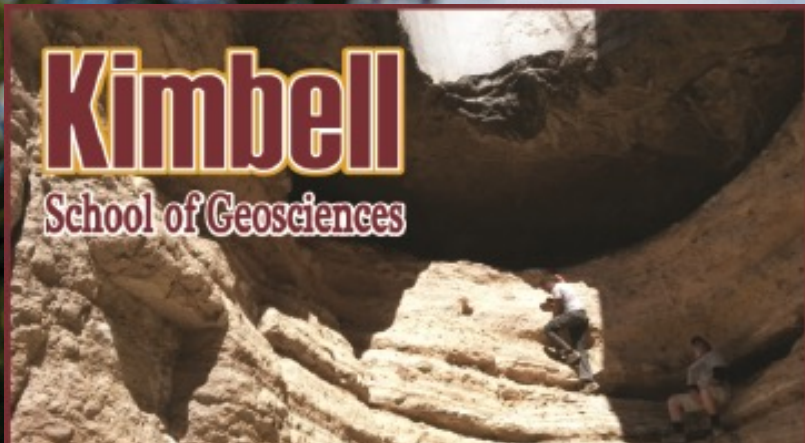
The Pooleville is a shallowing upward HST between the Viola “hot” jump and the “hot” jump of the illitic-chloritic shale at the base of Sequence 3.

Modern View (accounting for sequence stratigraphic boundaries)

- Multiple levels of cyclicity within three 3rd order depositional sequences.
- Each successive sequence becomes more carbonate-dominated and less siliciclastic-dominated.
- Sequence 2 expanded downramp, so the aulacogen either wasn't an active depozone during sequence 3, or it was, but the deposits were subaqueously removed.
 - *Viola unconformity cuts down into the aulacogen from the southern part of the ramp*
 - *Far field tectonics from the Taconic Orogeny?*
 - *Dissolution from internal waves below the pycnocline?*

Modern View (accounting for sequence stratigraphic boundaries)

- The lack of a buildup, and gradational transitions between facies suggested the Bromide was a ramp rather than a rimmed platform.
- Criner Hills Region is not near the center of the aulacogen, but actually on a southern ramp towards the Texas Arch.
- These interpretations are also supported by biostratigraphy (thousands of trilobite individuals) and by carbon isotope chemostratigraphy.



Collaborators:

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