

Upper Viséan (Meramecian-Chesterian) Conodont Biostratigraphy of the SW Ozarks of NW Oklahoma, SW Missouri, and NW Arkansas

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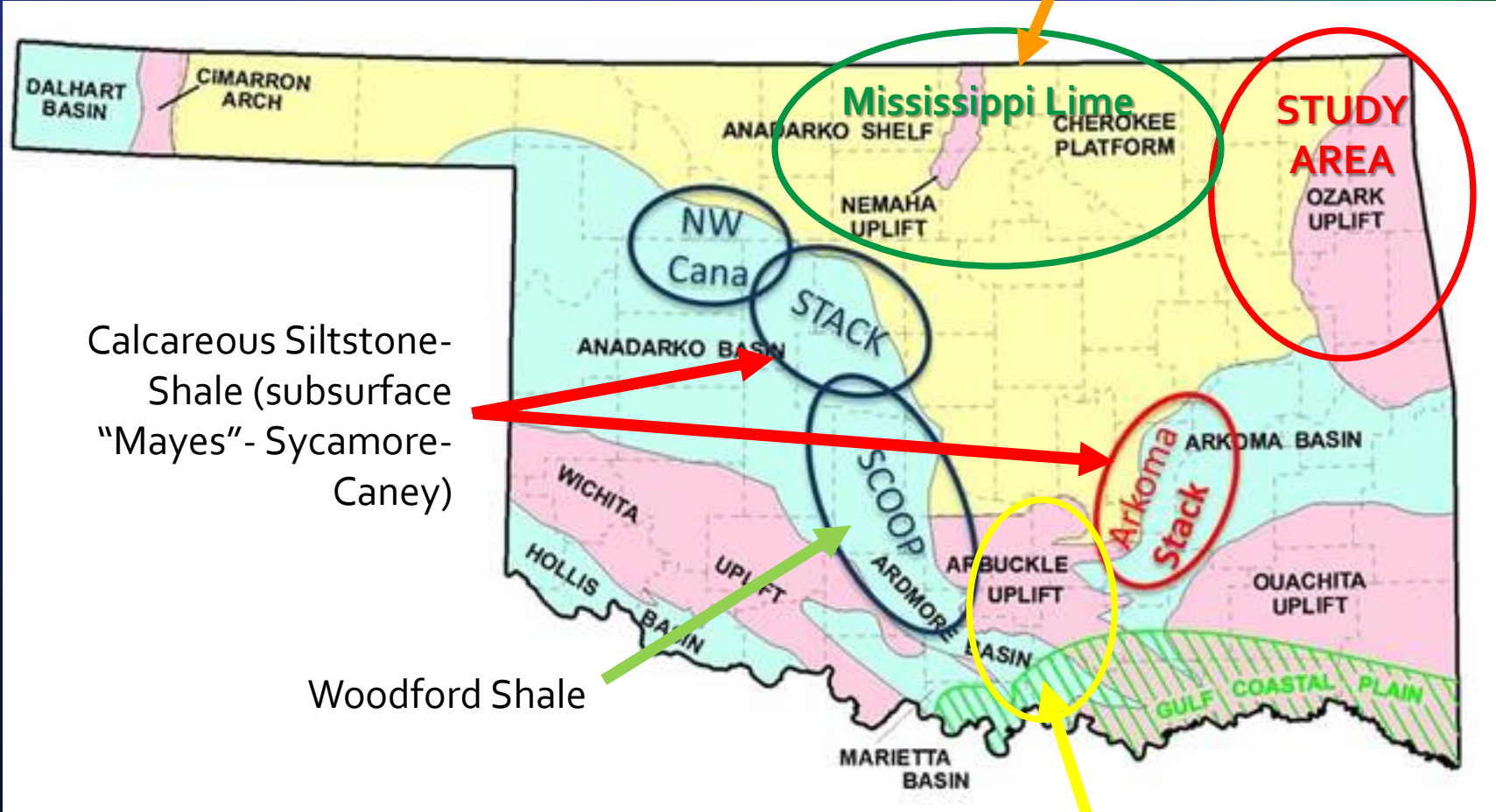
Purpose

- Relative time-constrained evaluation of Meramecian and early to middle Chesterian (pre-Fayetteville) strata and conodont taxa within the outcrop area
- User-friendly provincial biostratigraphic template for surface and subsurface correlations and interpretations



Oklahoma Mississippian Plays

Historically thought to be exclusively Kinderhookian & Osagean (lower Boone Group)



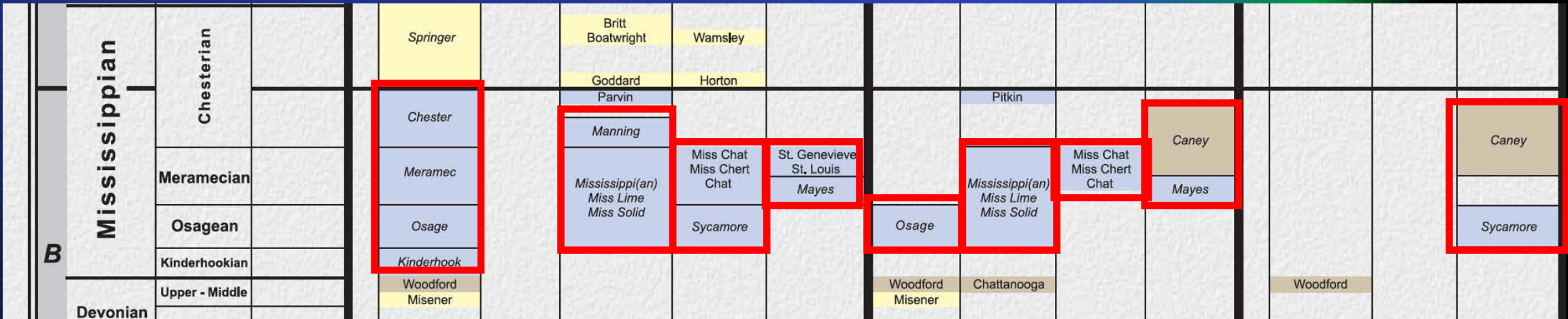
Fayetteville Shale
& Moorefield Shale
of Arkansas

Problematic Subsurface and Industry Stratigraphy

Greater Anadarko Basin & Shelf

Cherokee Platform

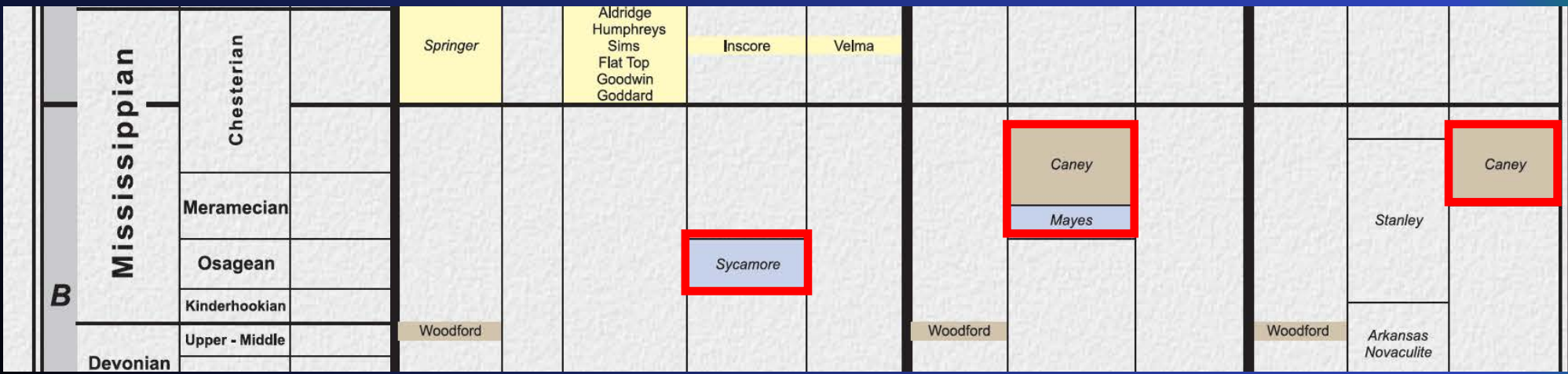
Wichita Uplift/Hollis-Marietta Basin



Ardmore Basin

Greater Arbuckle Uplift (Outcrop)

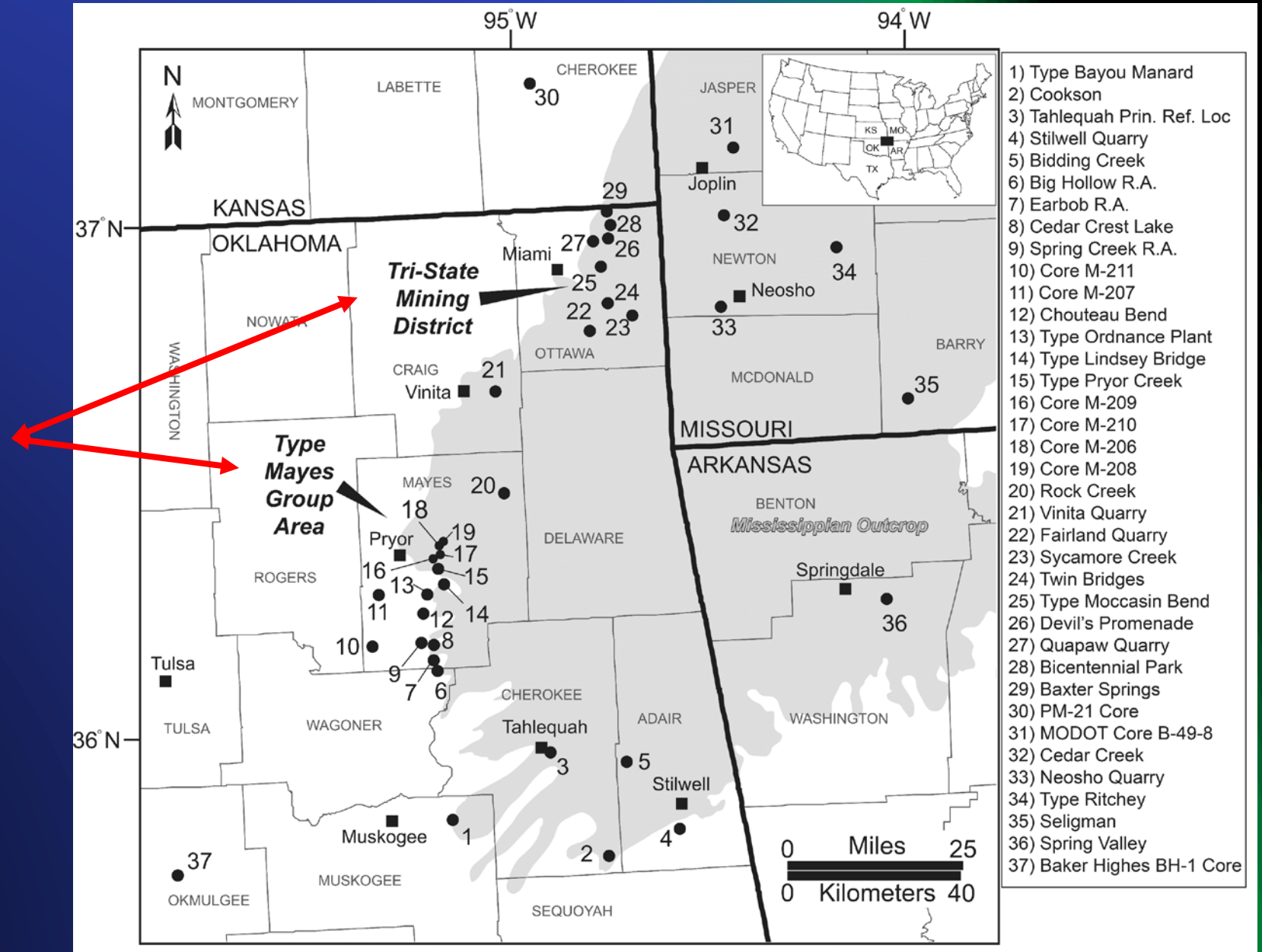
Arkoma Basin & Ouachita Uplift



From Boyd
(2008)
Oklahoma
Geological
Survey
SP 2008-1

Study Area

- Western edge of the Mississippian outcrop belt
- Two distinct “lithostratigraphic districts” within the study area



Revised Outcrop Lithostratigraphy

Tri-State Mining District (Oklahoma portion)				Northeastern Oklahoma (including type Mayes Group area)			
McKnight & Fischer (1970)		THIS STUDY		Snider (1915)	Huffman (1958)	THIS STUDY	
Fayetteville Shale		Fayetteville Shale		Fayetteville Shale	Fayetteville Shale	Fayetteville Shale	
Hindsville Formation		Mayes Group	Hindsville Formation	Mayes formation	Mayes Group	Hindsville Formation	
Quapaw Limestone			Quapaw Limestone			Moorefield Fm.	Ordnance Plant Member
Boone Formation	Moccasin Bend Member	Moccasin Bend Formation	Lindsey Bridge Member				Lindsey Bridge Member
	Baxter Springs Member	Ritchey Formation	Bayou Manard Member				Bayou Manard Member
	Joplin Member	Bentonville Formation	Tahlequah Member				Tahlequah Limestone
	Grand Falls Chert Member	Reeds Spring Formation	Keokuk				
	Reeds Spring Member		Reeds Spring				
			Boone Group	Bentonville Formation	Boone Group	Bentonville Formation	
		Reeds Spring Formation		Reeds Spring Formation			

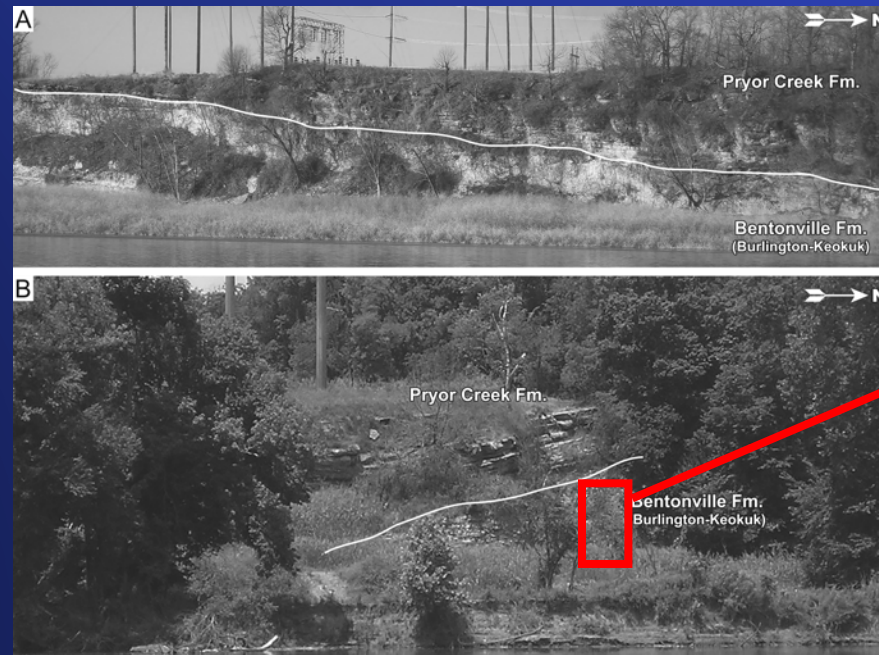
- Osagean Boone Group nomenclature based on Mazzullo et al. (2013)
- Pryor Creek Formation (new name; Godwin et al., 2018)
- Revised Boundaries and contacts

SUB-MAYES UNCONFORMITY

1. Most significant surface in the study area – major sequence-bounding unconformity – ***Significant shift in depositional style***
2. Mayes Group **overlies** strata ranging in age from Ordovician through Mississippian
3. Paleotopographic erosional relief mixed with pre-depositional and possibly syndepositional structural elements

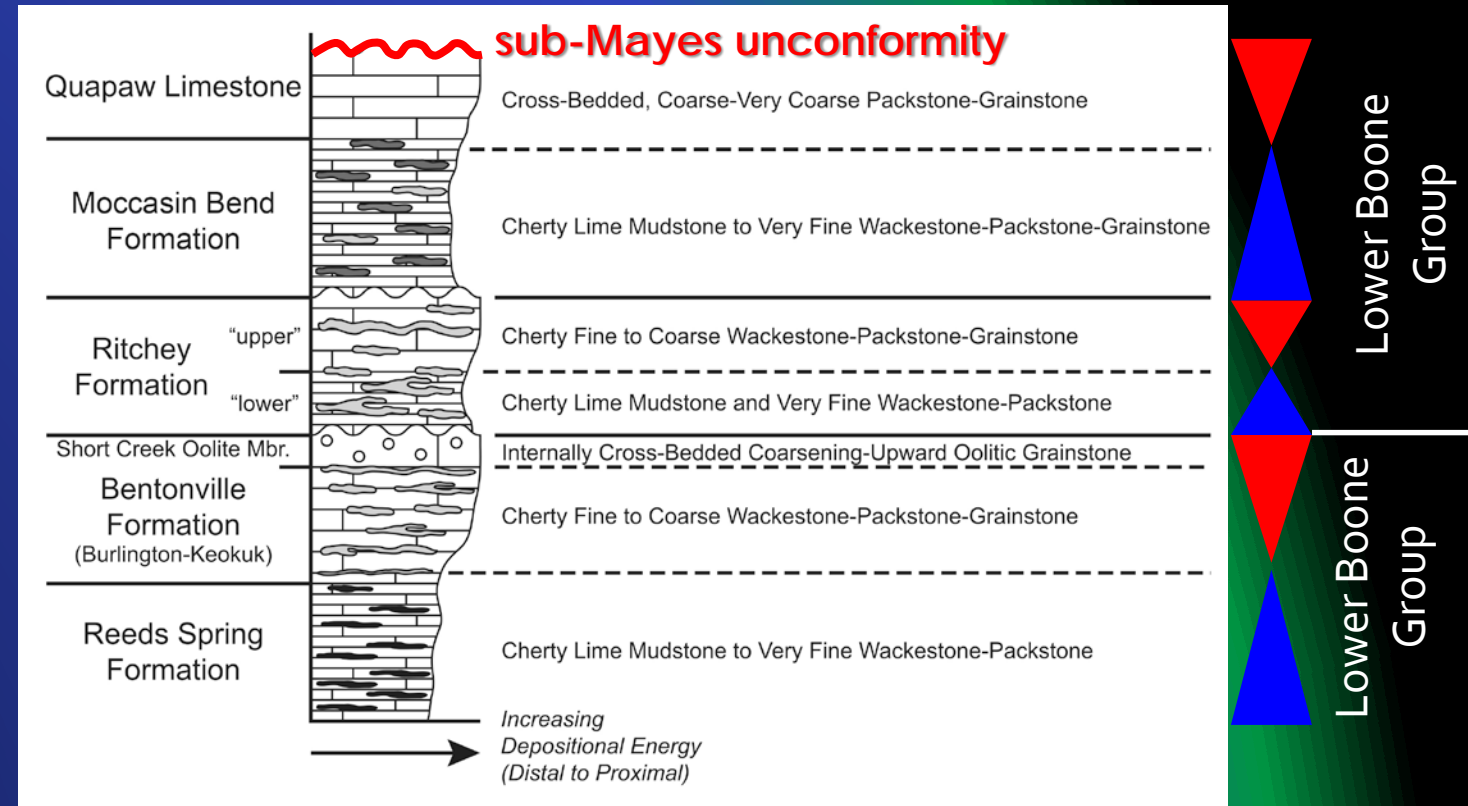


Location #15 (Mayes County)



Location #13 (Mayes County)

- Upper (Meramecian) Boone Group strata represent a continuation of lower (Kinderhookian-Osagean) Boone Group deposition
- Multiple unconformities and anomalous stratigraphic relationships within Boone Group
- Lithologic similarities between not only between lower and upper Boone Group strata, but also between certain parts of the Mayes Group and Boone Group



- Averaged (sub)meter-scale sampling intervals
 - Also sampled above and below important boundaries and lithologic changes
- Process samples of at least 2 kg
- More than 14,000 identifiable P₁ elements (+ more than 30,000 non-P₁ elements and unidentifiable fragments)
- Resulting in designation of 4 informal provincial biozones and 3 subzones

FAIRLAND QUARRY REFERENCE SECTION
Ottawa County, Oklahoma
W SW NW 11-26N-R23E

The diagram illustrates a geological cross-section of the Fairland Quarry Reference Section. The section is divided into two main groups: the Mayes Group (top) and the Boone Group (bottom). The Mayes Group includes the Hindsville Formation, and the Boone Group includes the Ritchey Formation, Short Creek Oolite Member, and Bentonville Formation. The section shows various stratigraphic units with different colors and patterns, representing different rock types. Fossil locations are marked with red dots and labeled with FQ numbers (FQ-1 to FQ-35). A red arrow points to the boundary between the Mayes and Boone groups. A scale bar at the bottom right indicates distances in feet (0 to 10) and meters (0 to 3).

Mayes Group

Hindsville Formation

Boone Group

Ritchey Formation

Short Creek Oolite Member

Bentonville Formation

SCALE

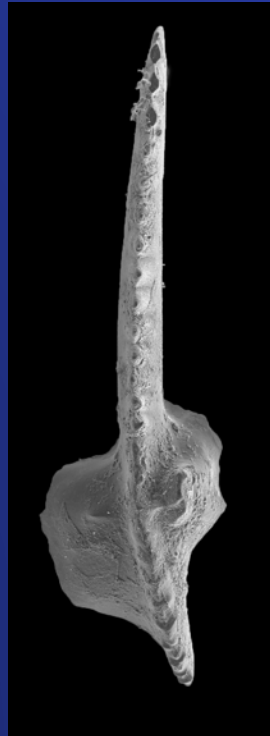
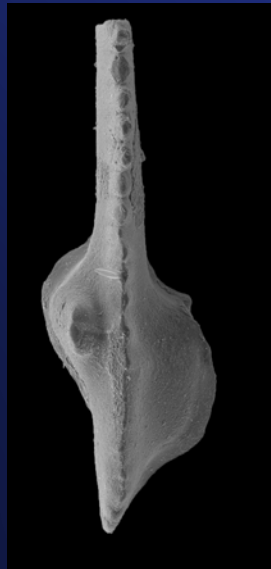
Feet

Meters

FQ-35
FQ-34
FQ-33
FQ-32
FQ-31
FQ-30
FQ-29
FQ-28
FQ-27
FQ-26
FQ-25
FQ-24
FQ-23
FQ-22
FQ-21
FQ-20
FQ-19
FQ-18
FQ-17
FQ-16
FQ-15
FQ-14
FQ-13
FQ-12
FQ-11
FQ-10
FQ-9
FQ-8
FQ-7
FQ-6
FQ-5
FQ-4
FQ-3
FQ-2
FQ-1

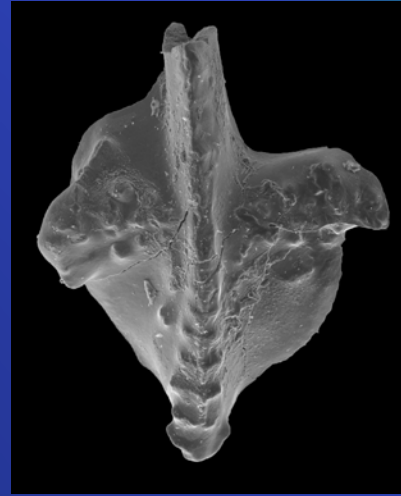
Gnathodus texanus

- Long-ranging form species spanning the entire study interval
- Representing possible new species, subspecies, and morphotypes



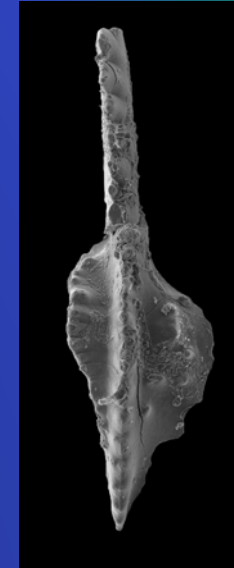
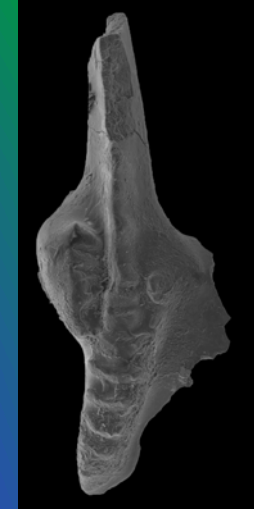
Biozone 1 Fauna

- Ritchey Fm. in the Tri-State area & Tahlequah Lmst. to the southwest
- Warsaw-Salem? equivalent
- First and only occurrence of:
 - *Gnathodus* n. sp. 15 aff. *punctatus*
 - *Gnathodus* sp. A
- Top marked by last occurrence of *Gnathodus pseudosemiglaber*
- Increased or common occurrence of *Taphrognathus*
- First occurrence of *Lochriea homopunctatus* (Tahlequah Limestone)

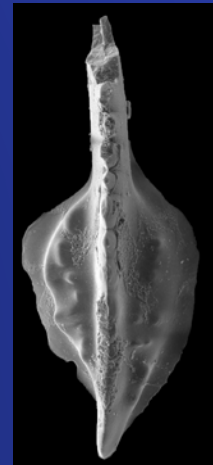


Gnathodus n.
sp. 15 aff.
punctatus

Gnathodus
pseudosemiglaber



Gnathodus sp. A



Lochriea
homopunctatus



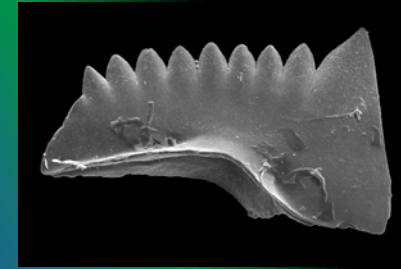
Taphrognathus
varians

Biozone 2 Fauna

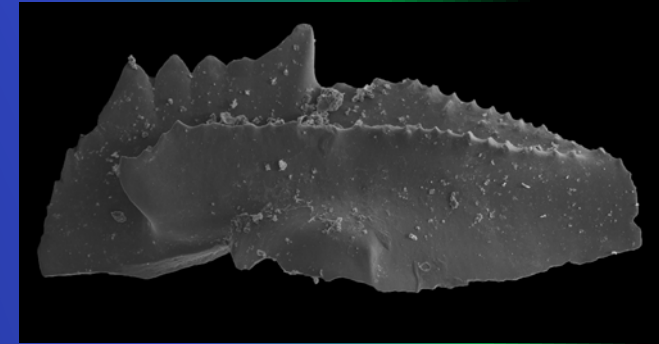
- Moccasin Bend Fm. & Quapaw Lmst. Of the Tri-State area, not present to the SW
- Lower St. Louis-equivalent
- First occurrence of *Hindeodus cristula*
- First occurrence of species of *Cavusgnathus*
- Top marked by last occurrence of *Taphrognathus*
- Co-occurrence of *Cavusgnathus* & *Taphrognathus*
- Continuing taxa: *G. texanus*, *L. homopunctatus*, and *Taphrognathus*



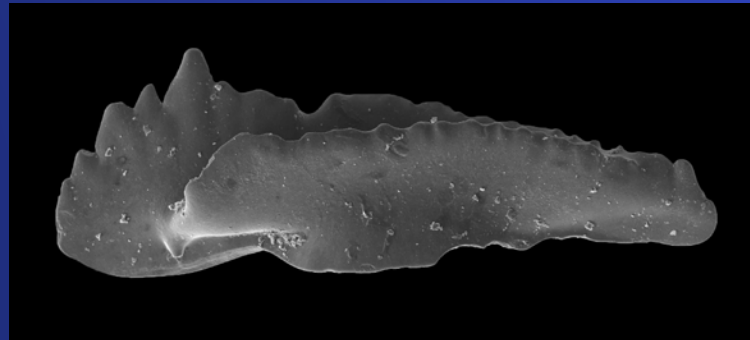
*Taphrognathus
varians*



Hindeodus cristula



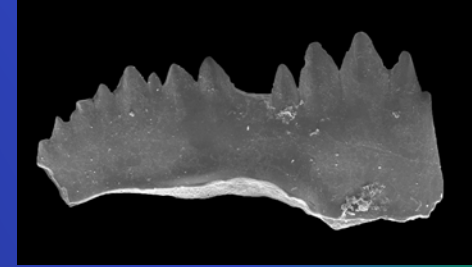
Cavusgnathus unicornis



Cavusgnathus charactus

Biozone 3 Fauna

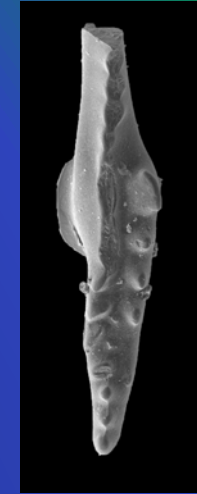
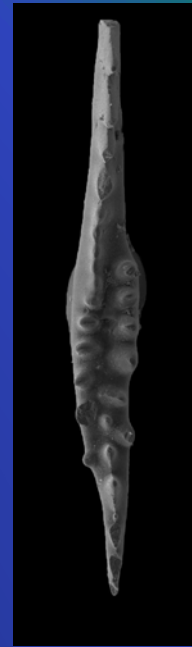
- Bayou Manard Member of the Pryor Creek Formation (Mayes Group) – NOT PRESENT IN THE TRI-STATE AREA
- Upper St. Louis-equivalent
- Occurrence of *Cavusgnathus* WITHOUT *Taphrognathus*
- First occurrence of *Hindeodontoides spiculus*
- Continuing taxa: *G. texanus*, *L. homopunctatus*, *H. cristula*, and species of *Cavusgnathus*



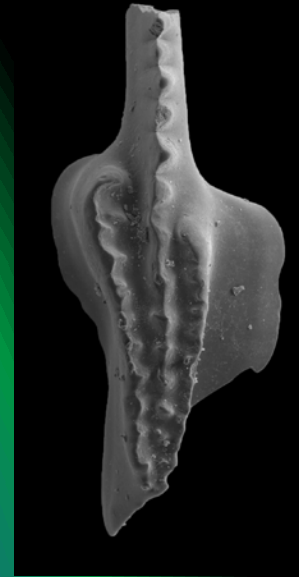
Hindeodontoides spiculus

Biozone 4 Fauna

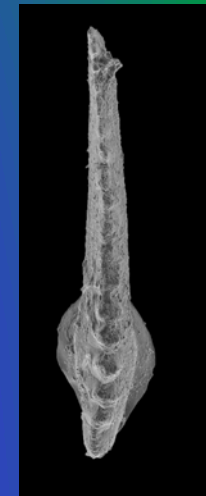
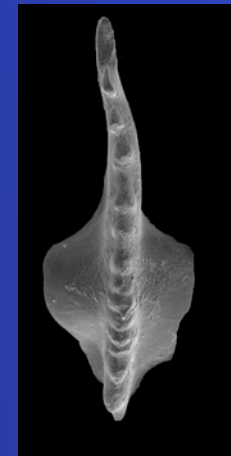
- Major faunal shift
- Definitive Chesterian fauna (Maples and Waters, 1987)
- First occurrences of:
 - *Gnathodus girtyi girtyi*
 - *Rhachistognathus* sp. B aff. *R. muricatus*
 - *Lochreia commutata*
 - *Gnathodus bilineatus* (Biozones 4M and 4U)
- Continuing taxa: *H. cristula*, *Hd. spiculus*, *L. homopunctatus*, and species of *Cavusgnathus*



Rhachistognathus sp.
B cf. *R. muricatus*



Gnathodus girtyi girtyi

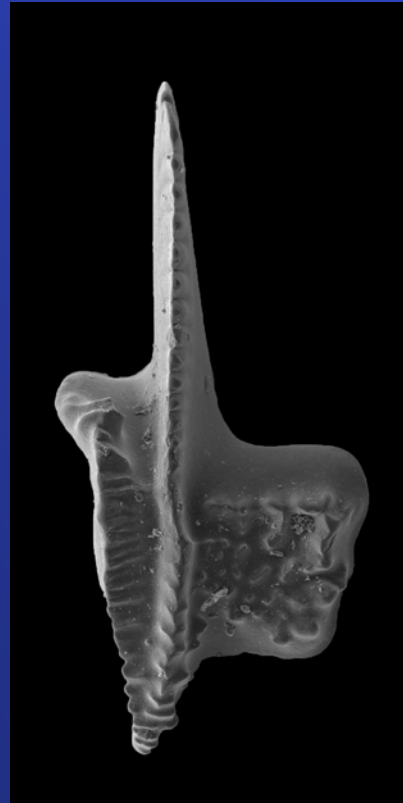


Lochreia commutata

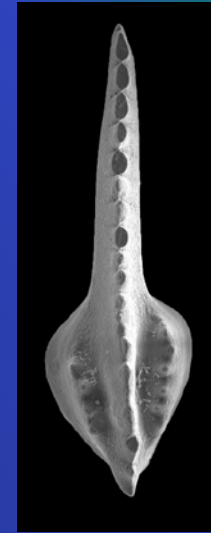
Biozone 4 Subzones

- Biozone 4L – absence of *Gnathodus bilineatus*
- Biozone 4M – First occurrence of *G. bilineatus* morphotype 1 and occurrences of possible new species: *Lochriea* sp. A and *Lochriea* sp. B
- Biozone 4U – First occurrence of *G. bilineatus* morphotype 2, *Vogelgnathus campbelli*, and significant decrease in *L. homopunctatus*

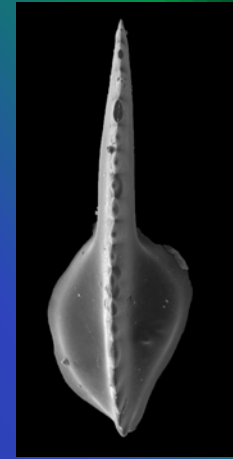
Biozone 4M



G. Bilineatus
morphotype 1

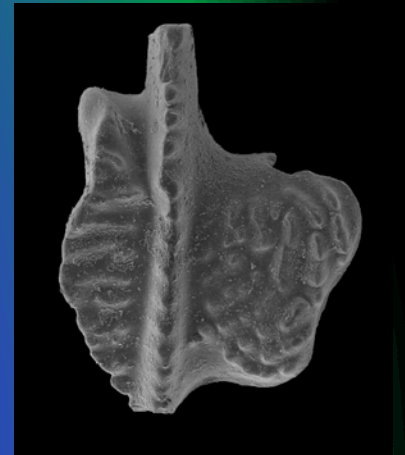
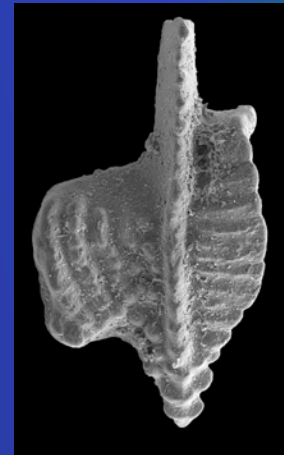


Lochriea
sp. B



Lochriea
sp. A

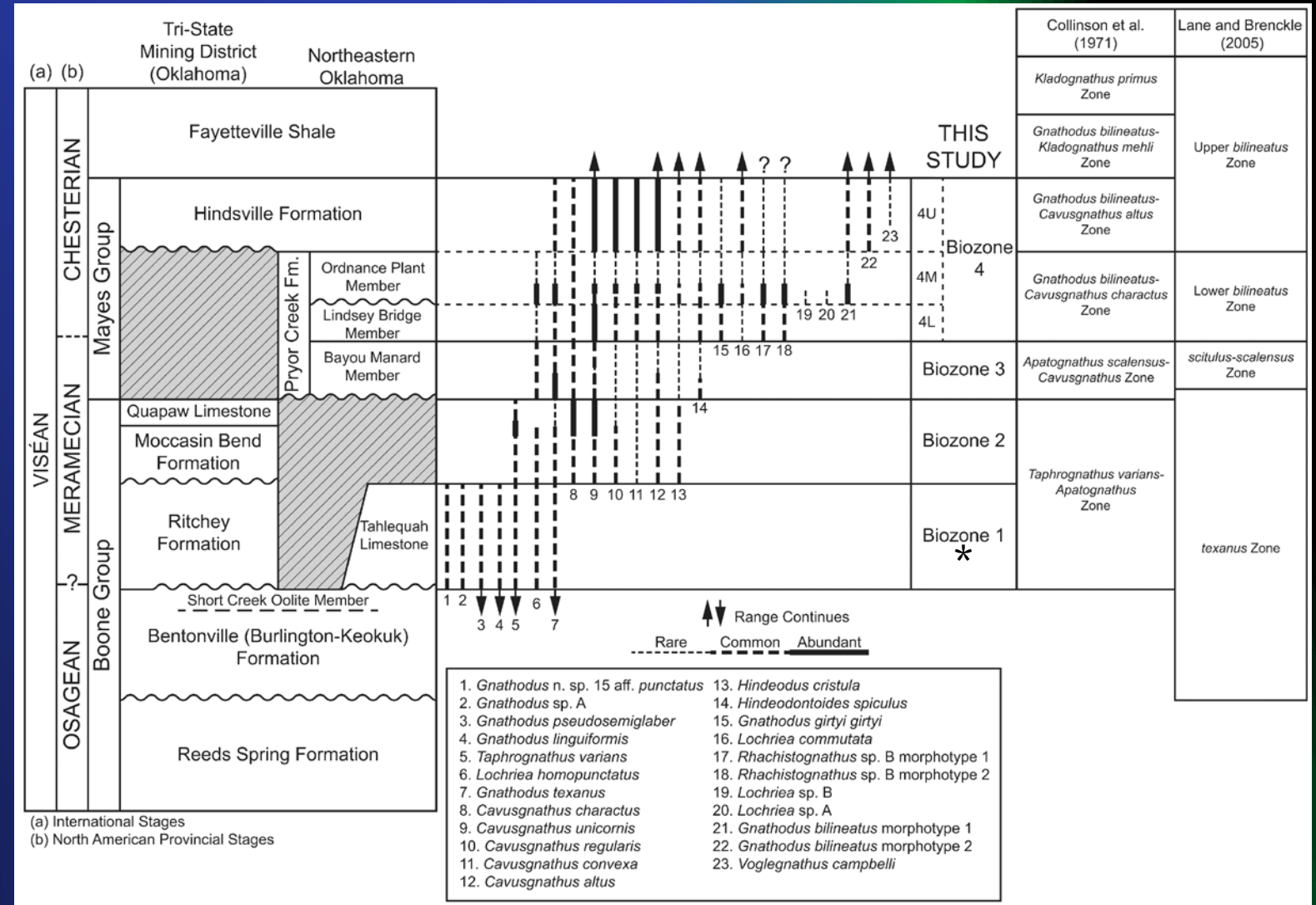
Biozone 4U



G. Bilineatus
morphotype 2

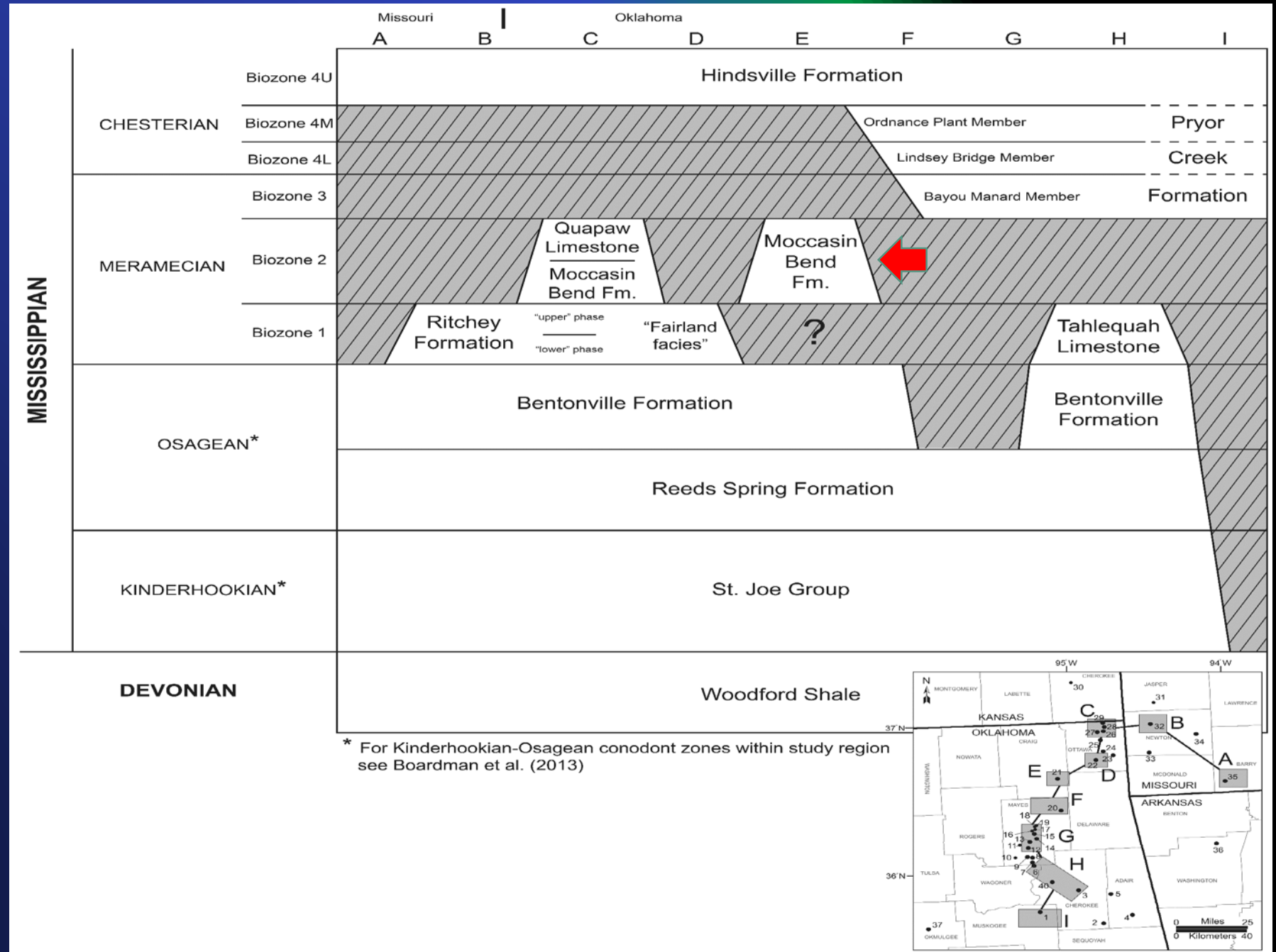
Provincial Biozones

- 4 biozones and 3 subzones
- Based on assemblages and FOs and LOs
- User-friendly provincial biozones for local and regional correlations
- Compares favorably with previous zonations, but nominal species are not as important



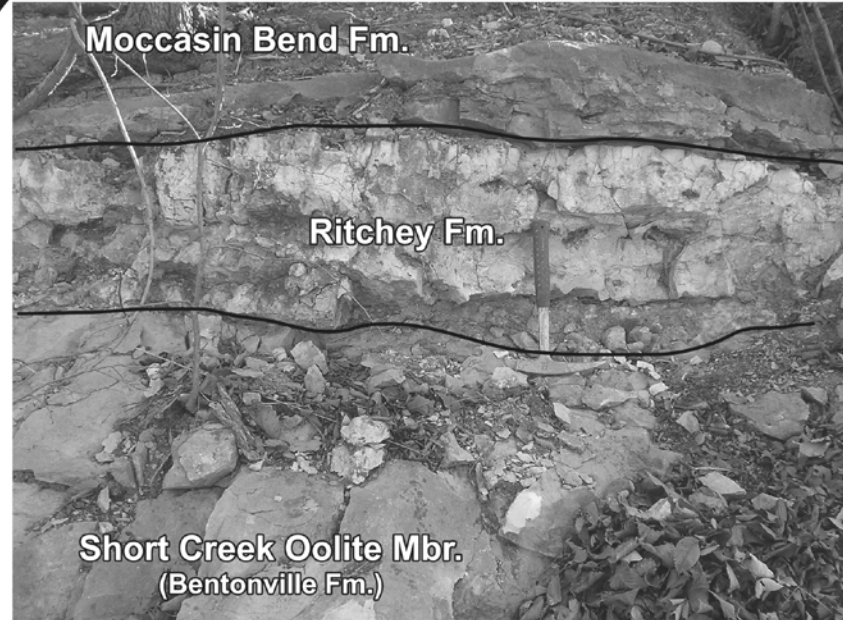
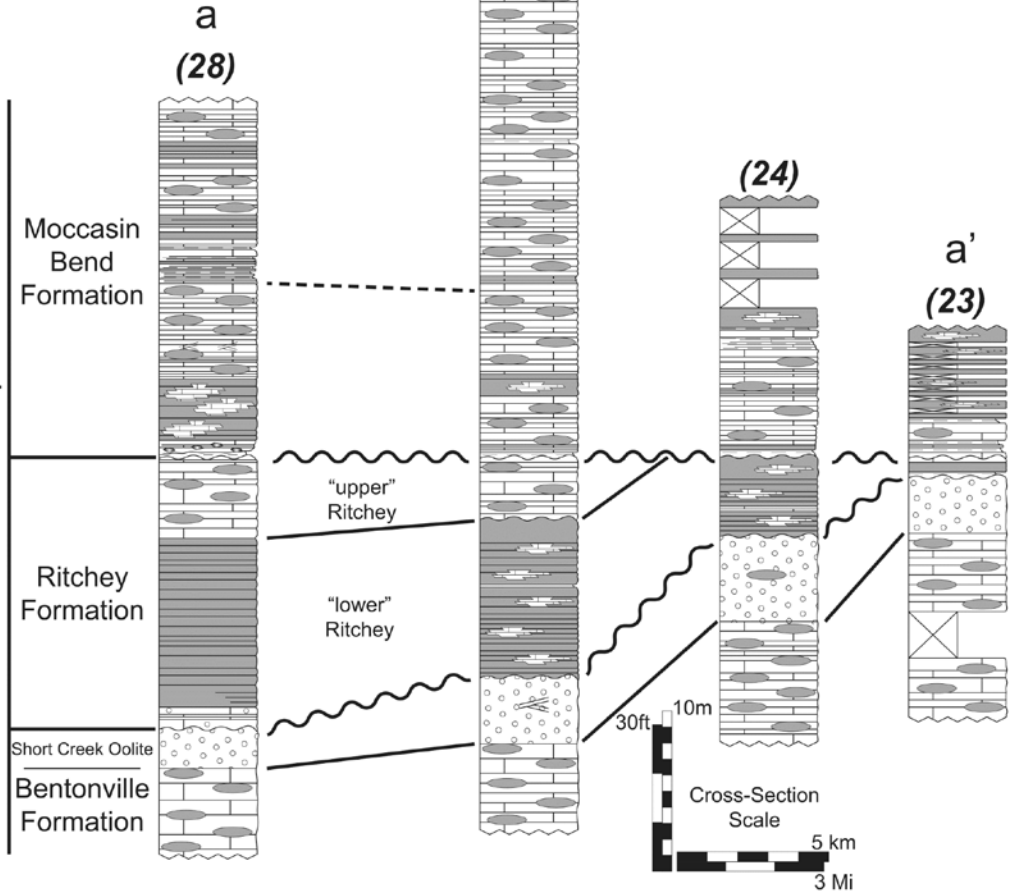
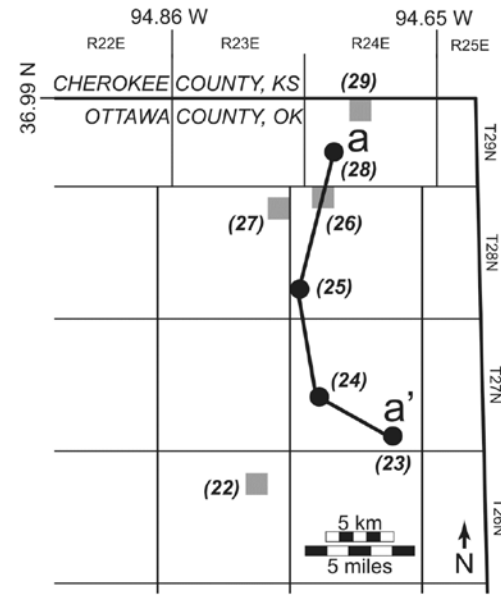
*Biozone 1 = Upper *texanus*-*G. n. sp. 15 aff. punctatus* Zone of Boardman et al. (2013)

Simplified Regional Stratigraphic Relationships



NORTH

SOUTH



Biozone 2 (Moccasin Bend)

Chert (no processing)
suspect Biozone 1 (Ritchey)

Barren (Short Creek)

Middle *texanus-*
pseudosemiglaber Zone

Pan Am Barnes Unit D #2 (Major Co., OK; 23-T22N-R16W)												
Sample No.	Depth (from page 166 of File 2296))	Taxa	Older Forms	<i>G. texanus</i>	<i>G. pseudosemiglaber</i>	<i>L. homopunctatus</i>	<i>Taphrognathus</i>	Transition Form	<i>H. cristata</i>	<i>G. bilineatus</i>	Godwin Biozones	Interp From Amoco File
45	7921.7-7922	<i>Hindeodus cristata</i>						X	X		Biozone 4 (Chesterian)	St. Genevieve-L. Chester
100		<i>Convognathus</i>						X				
139		<i>Convognathus</i> (worm)						X				
170		<i>Convognathus</i>						X				
196		<i>Convognathus</i> , <i>G. bilineatus</i> fragments, <i>Hindeodus</i> or <i>Hindeodontoides</i> fragment						X	X			
209		<i>Convognathus</i> , <i>G. texanus</i>		X				X				
212		<i>Convognathus</i> , <i>G. texanus</i>		X				X			Biozone 3 (Bayou Mansard-equivalent?) (upper St. Louis)	317-350 Barren
275	8207.6-8208.2	<i>Gnathodus bilineatus</i> (morphotype I have not encountered in Ozarks outcrop area)							X			
306	8236-8236.5	<i>Convognathus</i>						X				
308		<i>Convognathus</i> , <i>H. cristata</i>						X	X			
313	8241.6-8242	<i>Convognathus unkarrii</i>						X				
315		<i>Convognathus</i>						X				
316		<i>Convognathus</i>						X				
317-350?		Barren										
341		<i>Convognathus</i>						X				
351	8271.8	<i>Convognathus</i>						X				
366		<i>Convognathus</i>						X				
370		<i>Convognathus</i>						X				
378		<i>Convognathus</i>						X				
395		<i>Convognathus</i>						X				
417		<i>Convognathus</i>						X				
437		<i>Convognathus</i>						X				
446		<i>Convognathus</i>						X				
472	8345.1-8345.6	<i>Convognathus</i> , <i>L. homopunctatus</i>			X			X				
497	8424-8424.4	<i>Convognathus</i> , <i>Taphrognathus</i>				X		X				
515		<i>Taphro-Cav Transition form?</i>						X				
575		<i>Convognathus</i> , <i>Apotognathus</i>						X				
592	8528.3-8528.8	<i>Convognathus</i> , <i>Taphrognathus</i>					X	X				
600		<i>G. typicus</i> or <i>G. texanus</i> ?		X								
610		<i>Convognathus</i> , <i>G. texanus</i>		X				X				
623		<i>Convognathus</i>						X				
632		<i>Hindeodus cristata</i>							X			
637		<i>Convognathus</i> , <i>Taphrognathus</i> , <i>G. texanus</i>		X	X		X					
640		<i>Taphrognathus</i> (abundant), <i>G. texanus</i>		X	X							
648		<i>Convognathus</i> , <i>Taphrognathus</i> , <i>G. texanus</i>		X	X		X					
659		<i>Convognathus</i> , <i>Taphrognathus</i> , <i>G. texanus</i> , <i>G. pseudosemiglaber</i> ??		X	X	X	X					
672		<i>Taphrognathus</i>					X					
678		<i>Convognathus</i> , <i>Taphrognathus</i>					X	X				
684	8680.1-8680.9	<i>Taphrognathus</i> , <i>G. texanus</i> , possible <i>Convognathus</i>		X	X		X					
687	8698.1-698.7	<i>Taphrognathus</i>					X					
688-706		Barren										
707	8741.3	<i>Taphrognathus</i> , <i>G. texanus</i>		X	X							
711		<i>Taphrognathus</i>					X					
711		<i>Taphrognathus</i> , <i>G. texanus</i> , <i>G. pseudosemiglaber</i>		X	X	X						
716		<i>Gnathodus texanus</i> , maybe <i>G. bulbosus</i> ?		X								
719		<i>Taphrognathus</i> , <i>G. texanus</i>		X	X							
725		<i>Taphrognathus</i> , <i>G. texanus</i>		X	X							
728		<i>Gnathodus texanus</i> , maybe <i>G. bulbosus</i> ?		X	X							
728		<i>Taphrognathus</i> , <i>G. texanus</i>		X	X							
736		<i>Taphrognathus</i> , <i>G. texanus</i>		X	X							
742		<i>Taphrognathus</i> , <i>G. texanus</i>		X	X							
746		<i>Taphrognathus</i> , <i>G. texanus</i>		X	X							
751		<i>Taphrognathus</i> , <i>G. texanus</i>		X	X							
755		<i>Taphrognathus</i> , <i>G. texanus</i>		X	X							
760	8858.5-8859.5	<i>Taphrognathus</i>					X					
761 to 831											Barren	Barren
832	9035?	Two specimens, dark in color, Kinderhookian forms		X							Unconformity Zone?	Chouteau
832		Older forms, varying color, <i>Siphonodella</i> , <i>G. typicus</i> ? <i>G. delicatus</i> ?		X								
833											Barren	Barren
834												
835												
836	9039.5											
837												
838	9050											Henrietal
839												
840												
841	9064											
842												U. Devonian
843												
844												
845												Hunton
846												

Biozone 4

CHESTERIAN

Biozone 3

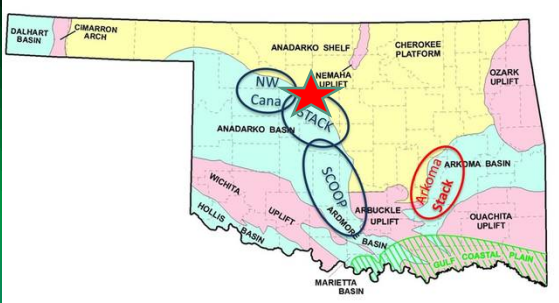
MERAMECIAN

Biozone 2

MERAMECIAN-(OSAGEAN?)

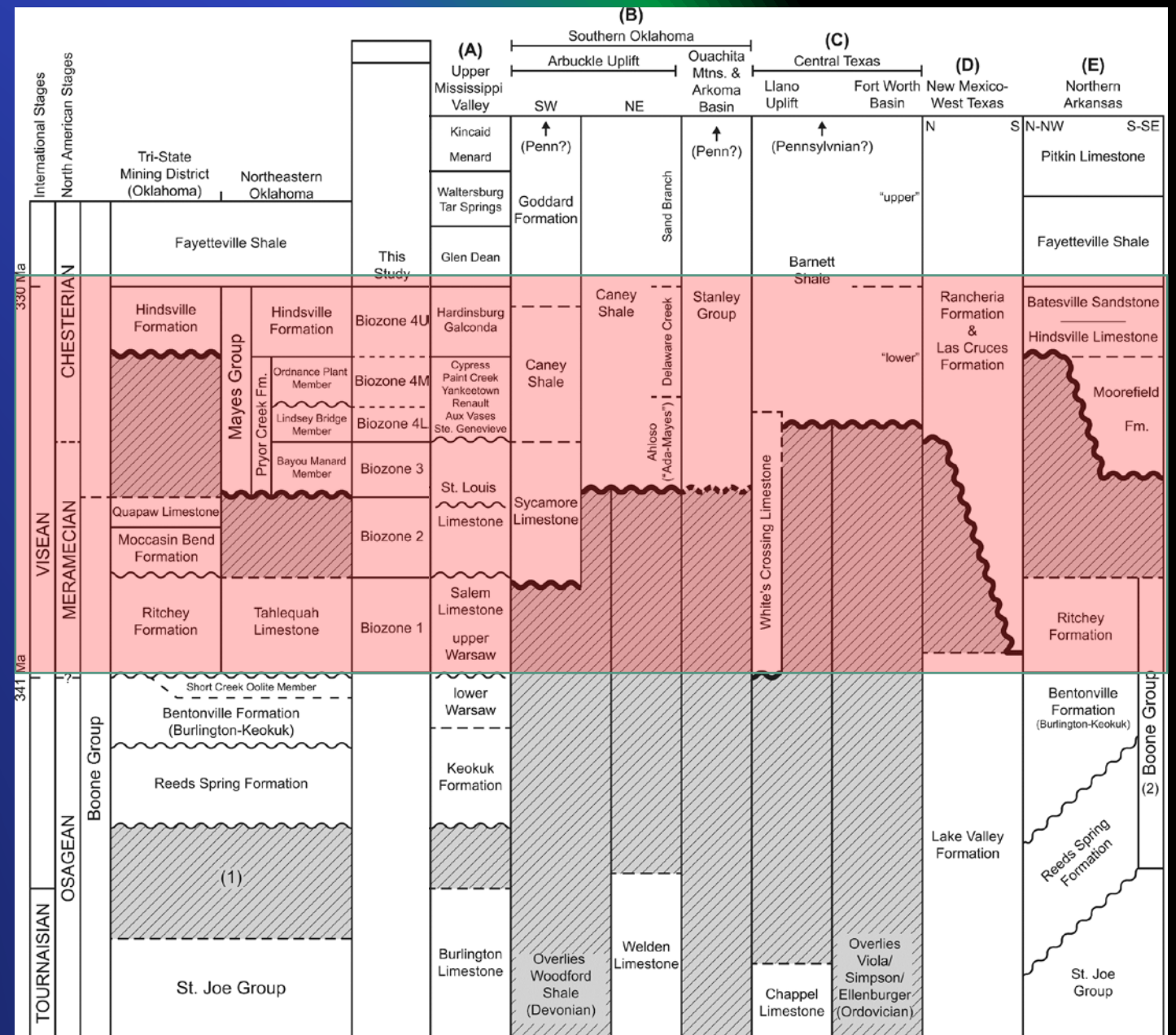
Biozone 1

KINDERHOOKIAN-OSAGEAN
DEVONIAN
ORDOVICIAN



Inter-Regional Correlations

- Correlation of Mayes Group with post-unconformity strata
- Common absence of upper Boone Group strata, as well as lower Boone Group



Correlative Stratigraphy compiled from (A) Collinson et al. (1970) (Hass (1950); Elias (1956), Straka (1972), Lane and Straka (1974), Ormiston and Lane (1976), Haywa-Branch (1988), Haywa-Branch and Barrick (1990), Schwartzapfel (1990), White (1996); (C) Roundy (1926), Hass (1953, 1959), Grayson and Merrill (1991), Montgomery et al. (2005); Singh (2007); (D) Lane (1974), Bachtel and Dorobek (1995); (E) Gordon (1944) (77), Sutherland and Manger (1979), Handford (1995), Mazzullo et al. (2013), Boardman et al. (2013). Absolute geologic time from Menning et al. (2006). (1) Missing conodont zones based upon samples reported at the 3, p. 119 and Mazzullo et al. (2013, p. 418) (2) Diachronous lithostratigraphic units of Boone Group recognize

What About Facies Controls?

- Conodonts are susceptible to facies controls, and there are examples in this study
- Moccasin Bend-Quapaw Shallowing-Upward Succession
 - More offshore taxa occur in Moccasin Bend, whereas only nearshore taxa are typically represented in Quapaw
 - BUT, zone-defining taxa are present in both
- Ritchey Shallowing-Upward Succession
 - “upper” and “lower” Ritchey are depositionally different, but share important taxa
- Ritchey-Tahlequah Offshore Transition?
 - Greater abundance and diversity in the Tahlequah, including *L. homopunctatus*, but share zone-defining taxa
- Mayes Group – cyclicity in the Hindsville Fm; less clear in the Pryor Creek Fm.

Discussion/Summary:

- These are some of the closest outcropping rocks to the subsurface
- Evidence in the subsurface for less Kinderhookian and Osagean, more Meramecian and Chesterian
- Subsurface age-identification may be informally defined based on the recovery of a few taxa, which may influence drilling and placement of horizontal wellbores
- Where do we go from here:
 - Continued work with operators
 - Core & drill-cuttings(?)
 - Continued field work (need minions or someone with minions)
 - Reworking the Sycamore, Caney (and Welden), Stanley Group in Oklahoma and Moorefield Fm. in Arkansas

Extra Stuff

