Chronostratigraphic and Sedimentological Interpretation of the Barnett Shale (Mississippian) of the Llano Uplift and Fort Worth Basin, Texas*

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Abstract

The base of the Barnett Shale in outcrop and in subsurface of the Fort Worth Basin is lower Chesterian (upper Visean of global usage) in age based upon the co-occurrence of *Gnathodus texanus*, *Cavusgnathus unicornis*, and *Lochriea commutata*. The basal Barnett Shale rests unconformably upon the Chappel Limestone that is middle Osagean in age (*anchorali-latus* Zone). The intra-Mississippian unconformity separating the Barnett Shale from the underlying Chappel Limestone is highly significant and represents a hiatus that comprises the upper Osagean, Meramecian and basal Chesterian stages. On outcrop, this is denoted by a red paleosol developed on the underlying Chappel Limestone. In the Fort Worth Basin (FWB) locally massive pyrite layer marks the disconformity. The significance of this regional unconformity is paramount for the understanding of the tectonic evolution and basin-filling pattern of the FWB. Currently published sedimentological models of the Barnett Shale suggest a deep basinal interpretation for the unit. However, we interpret the Barnett Shale of the FWB as a cyclical, dysoxic to anoxic shelfal, but not basinal mudrock. This mudrock contains pelagic taxa (conodonts, radiolarians, ammonoids) along with episodic occurrences of opportunistic benthic biota (bivalves, brachiopods). Much of the Barnett Shale consists of dark, organic-rich, mudrock that is barren of benthic taxa. The highly restricted and toxic nature of the Barnett Shale is consistent with geochemical evidence recently presented by Rowe and others (2008). The upper part of the lower Barnett Shale of the northernmost FWB laterally grades into Mississippian-aged platform carbonates that comprise bioturbated packstones, encrinites, and carbonate mounds capped by oolitic grainstones. A high density of closely spaced samples reveals that these shallow-water carbonates contain only a very rare occurrence of a single species of conodont (*Cavusgnathus unicornis*). This species gives a Chesterian age as the youngest possible date for the top of the lower Barnett Shale.

Selected References

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William S. Elliott, Jr. – *University of Southern Indiana*

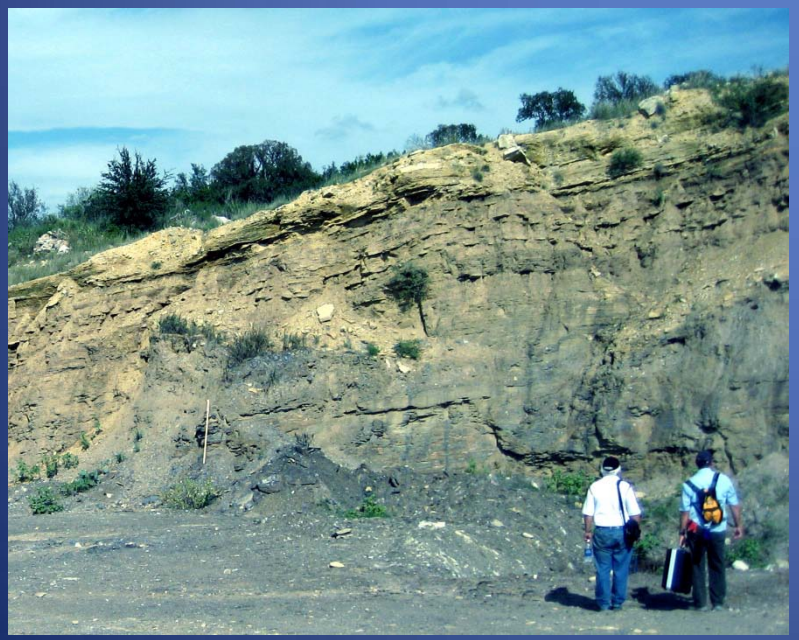
Acknowledgement

Motivating questions

Age of the Barnett?

Nature of the basal contact?

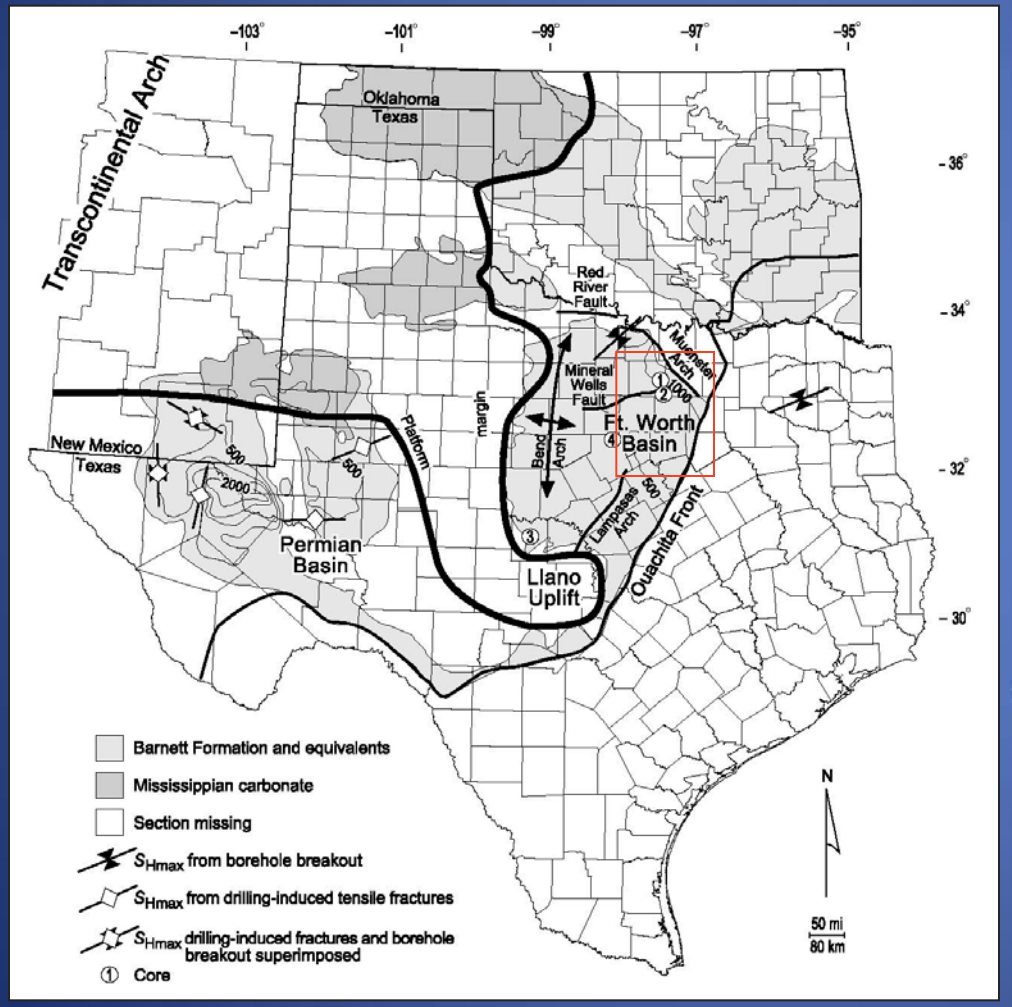
Depositional setting?



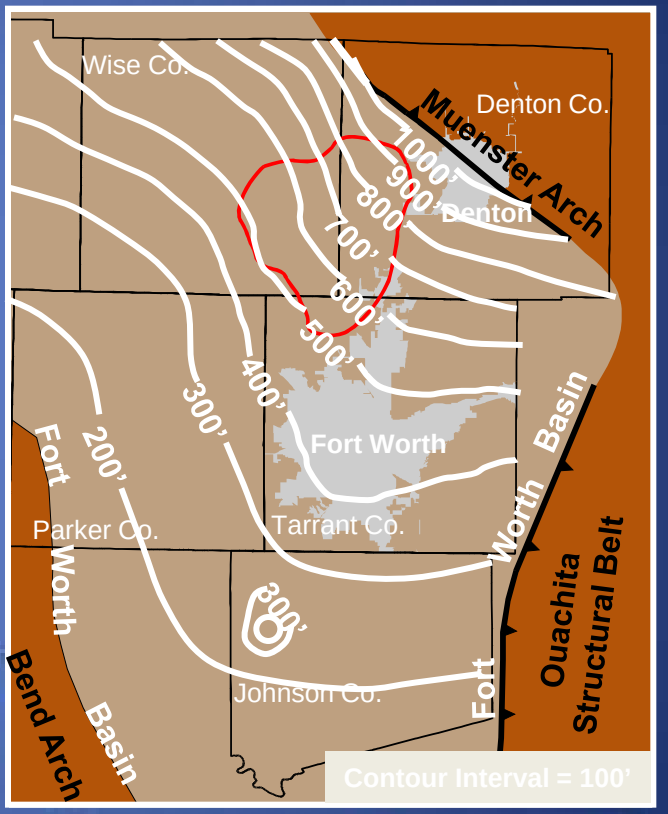
Main Take-aways

- Conodonts support a upper Meramecian-Chesterian age for the Barnett throughout the Fort Worth Basin (FWB)
- An intra-Mississippian, subaerial unconformity exists between the Barnett and the subjacent Chappel Lime
- The Barnett conodont fauna indicates restricted/nearshore marine conditions in northern FWB
- Chesterian platform carbonates filled accommodation in the structurally deepest part of the FWB.

Regional setting



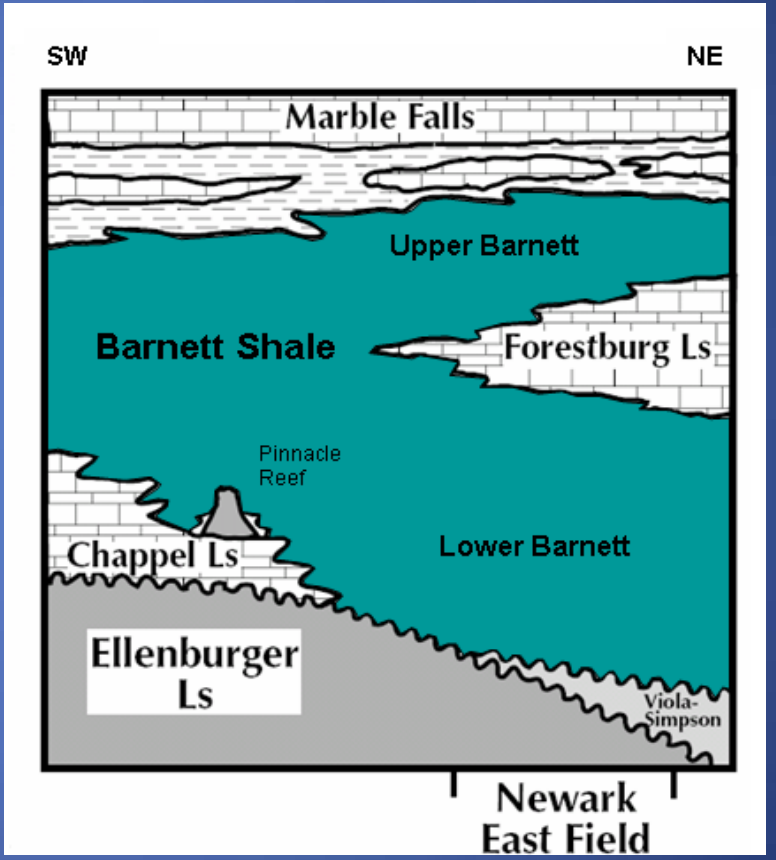
From Gale et al (2007)



Generalized isopach map of the Barnett Shale and equivalent strata in the northern FWB (ft)

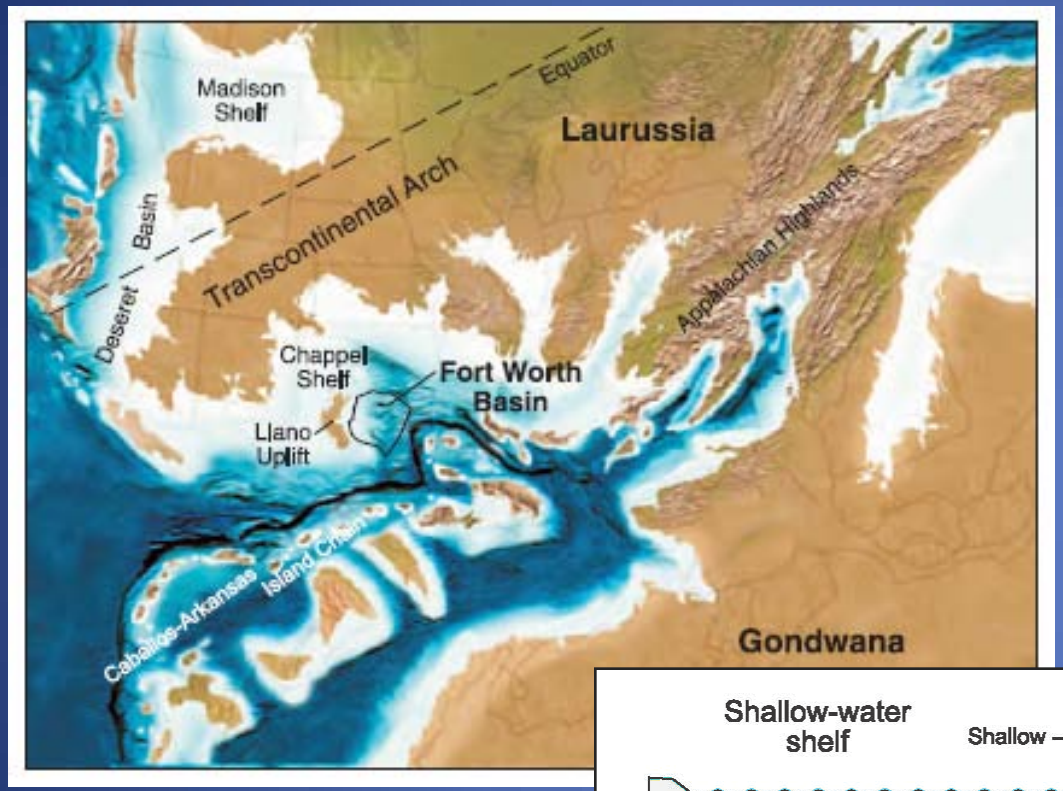
Barnett stratigraphy

SYSTEM AND SERIES		STAGE	GROUP or FORMATION
CRETACEOUS	LOWER	COMANCHEAN	
PERMIAN		OCHOAN - GUADALUPIAN	
		LEONARDIAN	
		WOLFCAMPIAN	CISCO GROUP
PENNSYLVANIAN		VIRGILIAN	
		MISSOURIAN	CANYON GROUP
		DESMOINESIAN	STRAWN GROUP
		ATOKAN	BEND GROUP
		MORROWAN	MARBLE FALLS LIMESTONE
MISSISSIPIAN		CHESTERIAN-MERAMECIAN	**BARNETT SHALE**
		OSAGEAN	CHAPPEL LIMESTONE
ORDOVICIAN	U		VIOLA LIMESTONE
	M		SIMPSON GROUP
	L		ELLENBURGER GROUP
CAMB	UPPER		WILBERNS - RILEY - HICKORY FORMATIONS
PRE-CAMB		GRANITE - DIORITE - METASEDIMENTS	



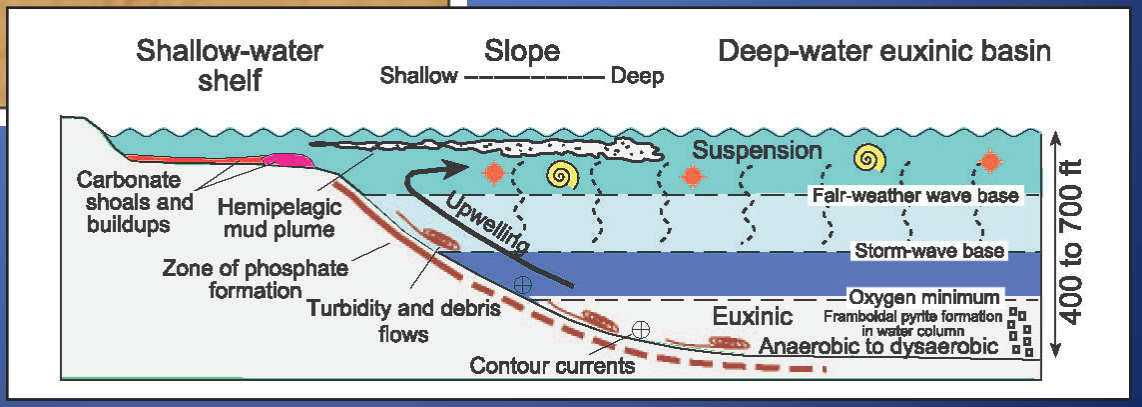
Both diagrams modified from Montgomery et al (2005)

Deep water depositional model

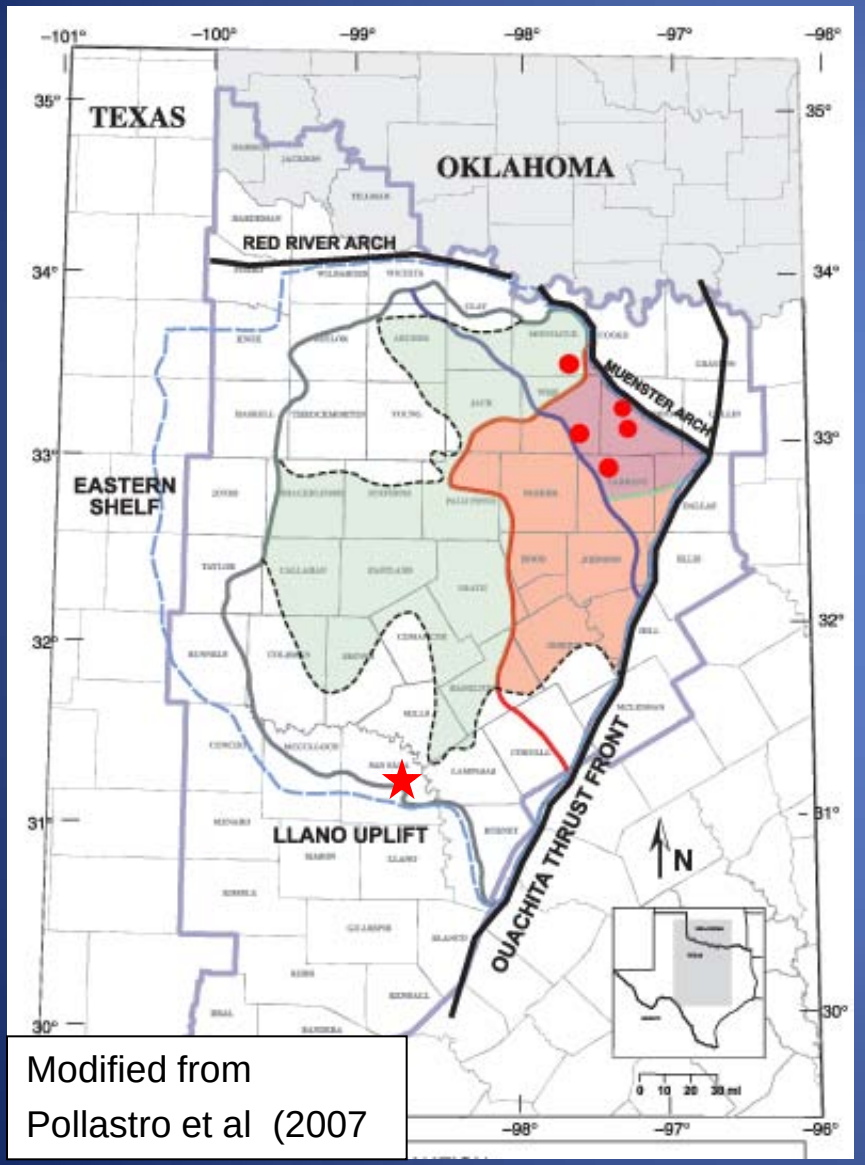


Modified from Blakey (2005)

From Loucks & Ruppel (2007)



Data localities



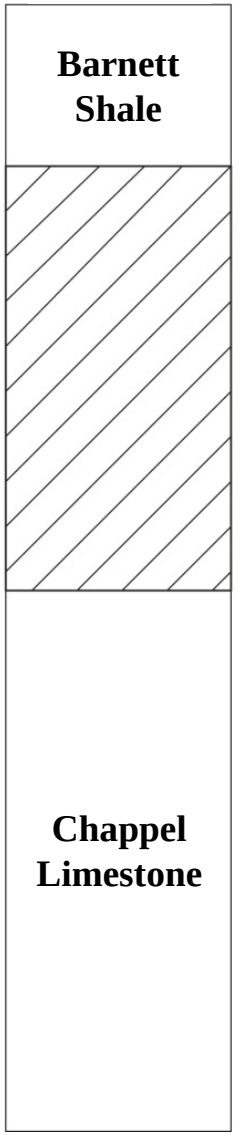
Modified from Pollastro et al (2007

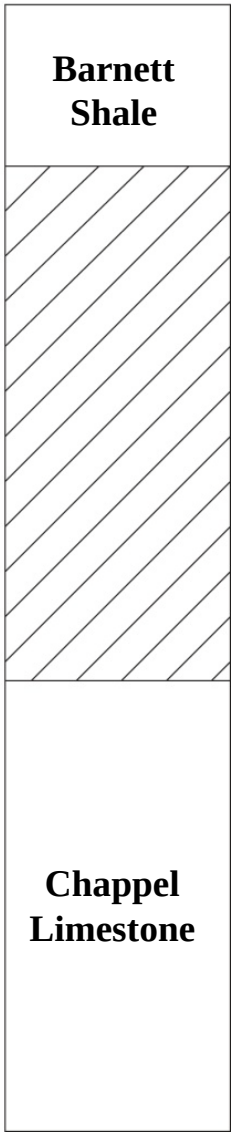
- 5 cores from northern FWB basin
  - -Montague County (1)
  - -Denton County (2)
  - -Wise County (1)
  - -Tarrant County (1)

- Roadcut and quarry exposures near San Saba, Texas (including type Chappel Limestone)

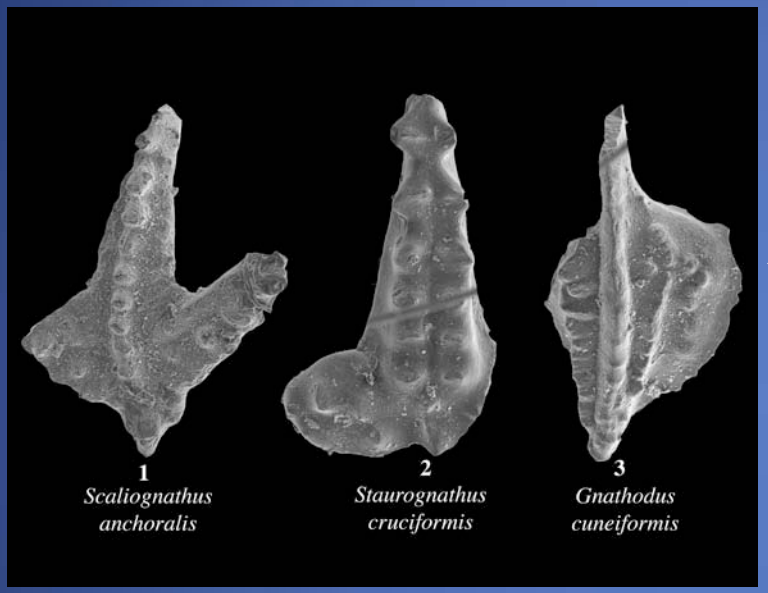
Conodont Biostratigraphy

Global Stages	North American Provincial Stages	Conodont Zonation	
Visean Stage	Chesterian Stage	*bilineatus-texanus-commutatus* Zone	*
	Meramecian Stage	*texanus-Cavusgnathus-* Zone	
		linguiformis-varians-homopunctatus Zone	
	Osagean Stage	*linguiformis-varians* Zone	
		linguiformis Zone	
		bulbosus Zone	
Tournaisian Stage		*mehli* Zone	
		distortus lanei Zone	
		latus-anchoralis Zone	
		upper multistriatus-cuneiformis Zone	
		lower multistriatus Zone	*
		communis carina- upper *punctatus* Zone	
	Kinderhookian Stage	*obsoleta-punctatus* Zone	
		cooperi-delicatus Zone	*
		crenulata-lobata Zone	



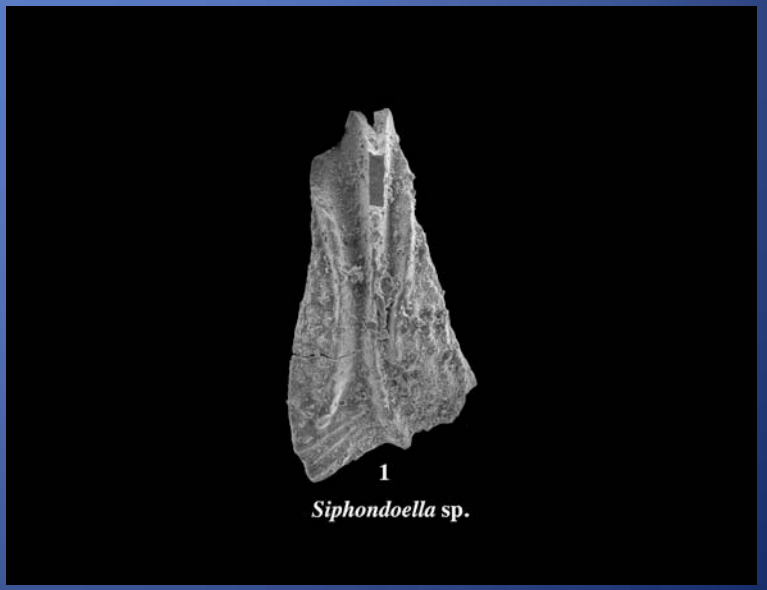


Chappel Lime – Northern FWB (Kinderhookian-lower Osagean)

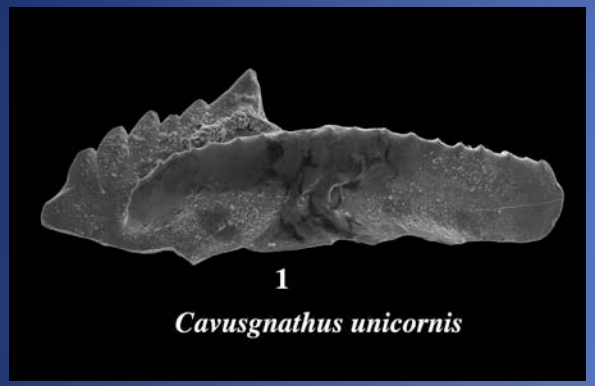


multistriatus Zone (lower Osagean)

cooperi-delicatus Zone (upper Kinderhookian)

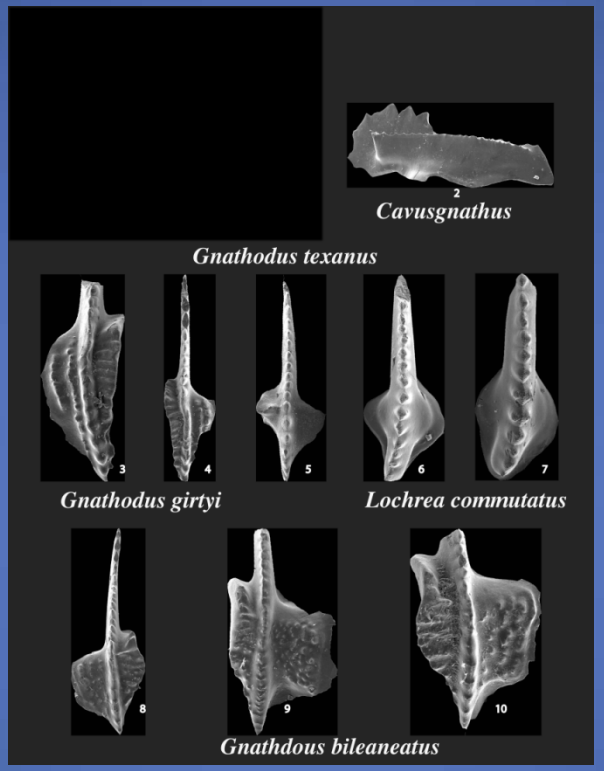


Barnett conodonts (Chesterian)



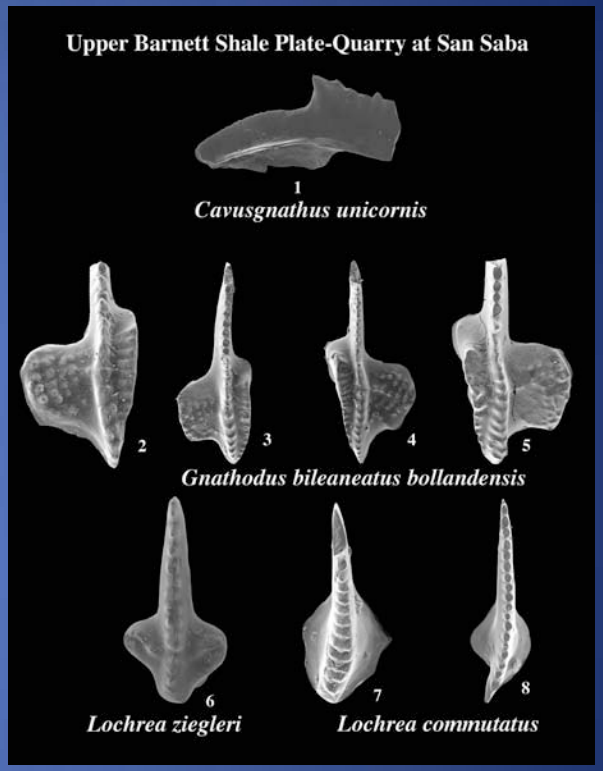
Northern FWB, lower Barnett carbonate facies

Cavusgnathus records a nearshore,stressed environment



San Saba, "lower" Barnett

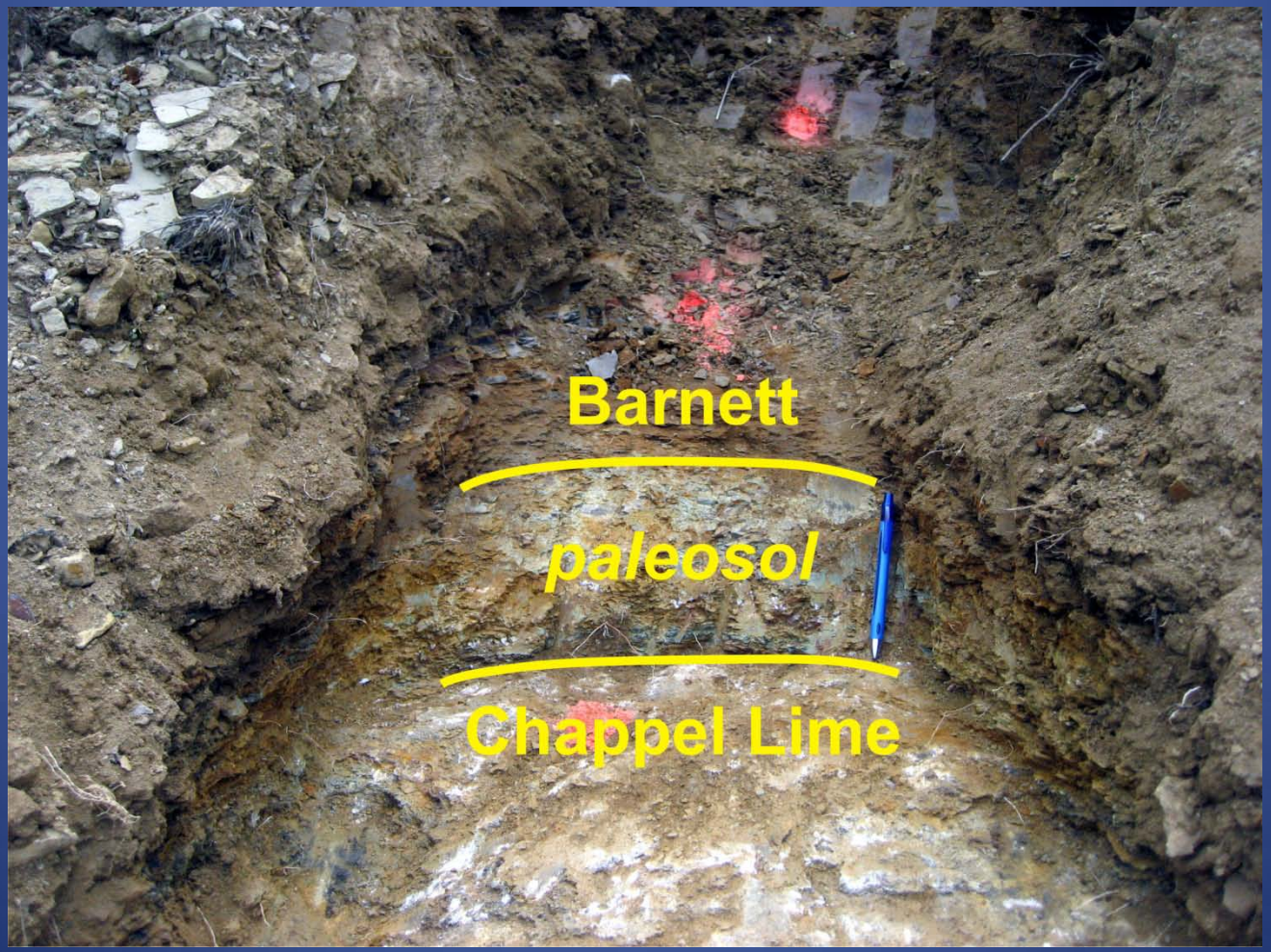
Visean (classic Chesterian) fauna



San Saba, "upper" Barnett

Serpukhovian (upper Chesterian) fauna

Evidence for subaerial exposure of the Chappel Lime, San Saba outcrop



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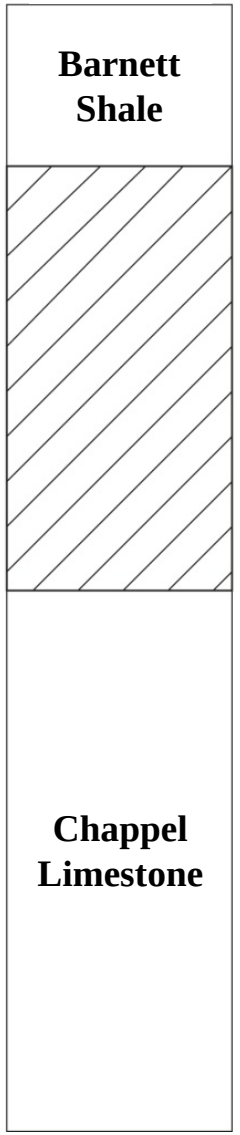
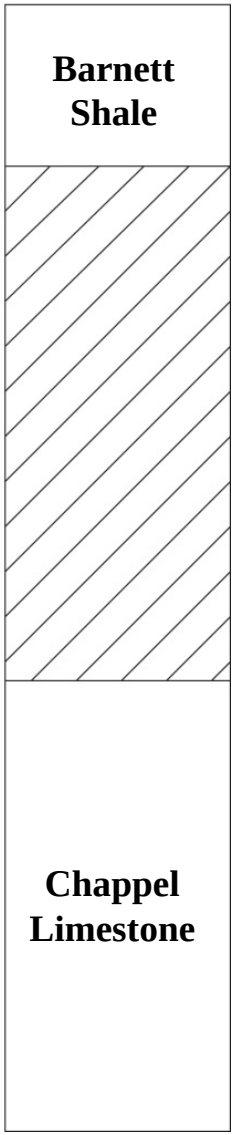
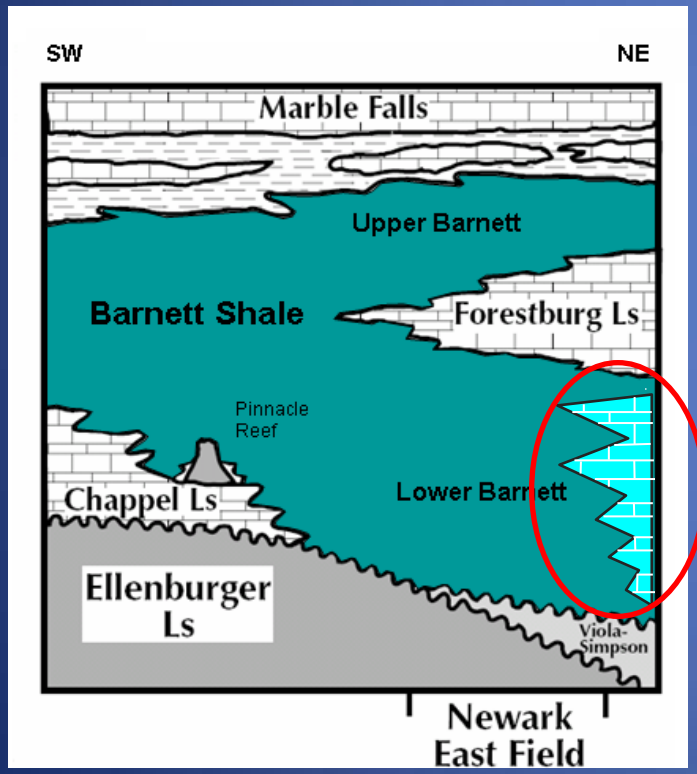
		crenulata-lobata Zone

regional subaerial unconformity

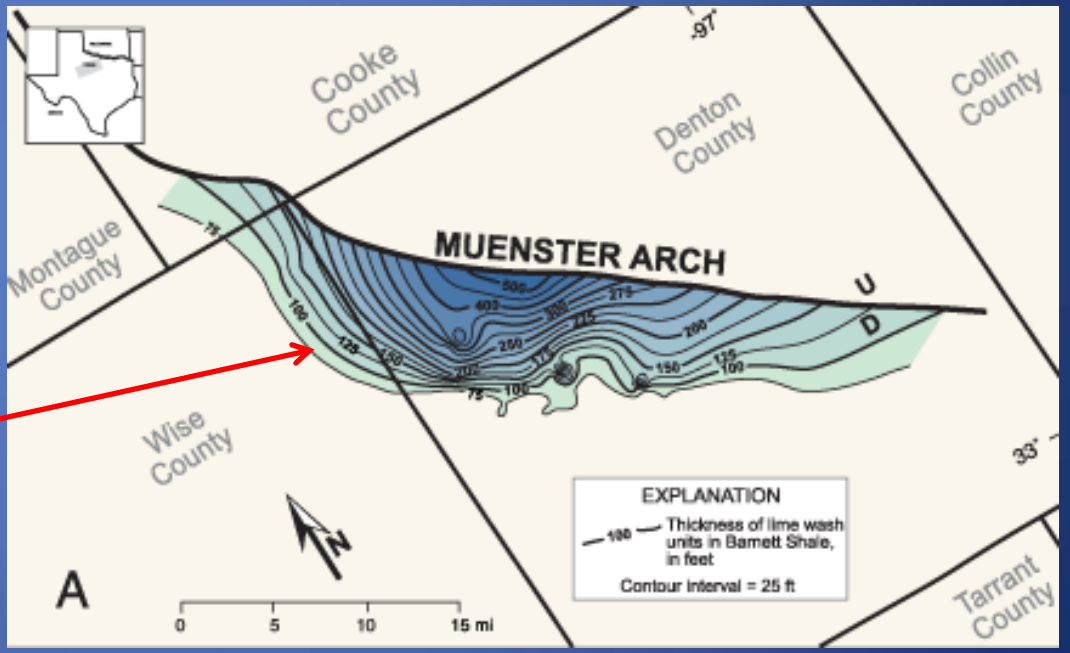




Barnett-equivalent platform carbonates, northern FWB ("lime wash")



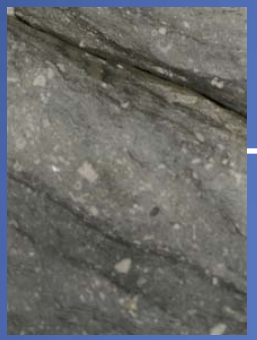
Modified from Montgomery et al (2005)



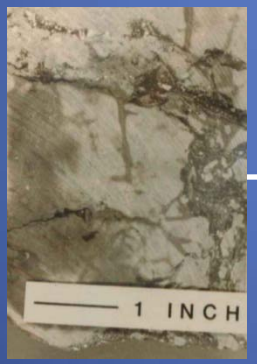
From Pollastro et al (2007)

Carbonate ramp succession in northern FWB (Montague County)

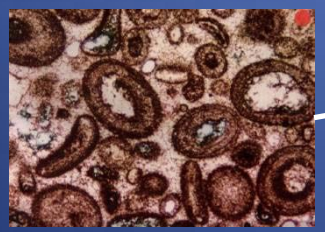
crinoidal flank beds (core slab)

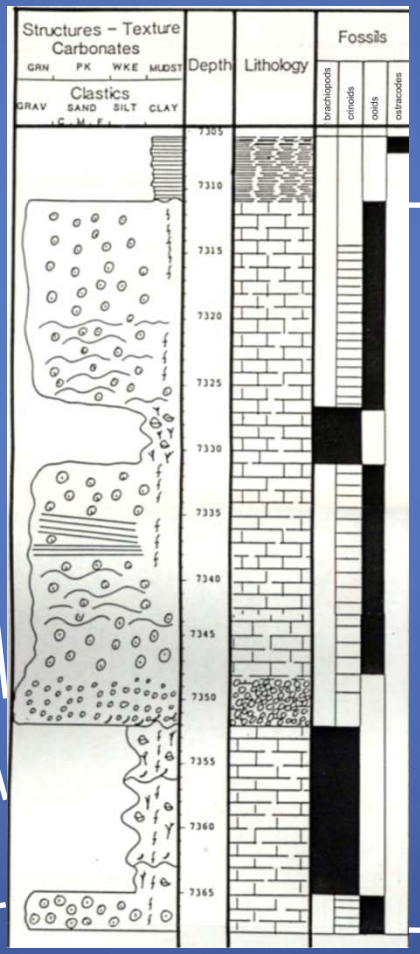


mud build-up (core slab)



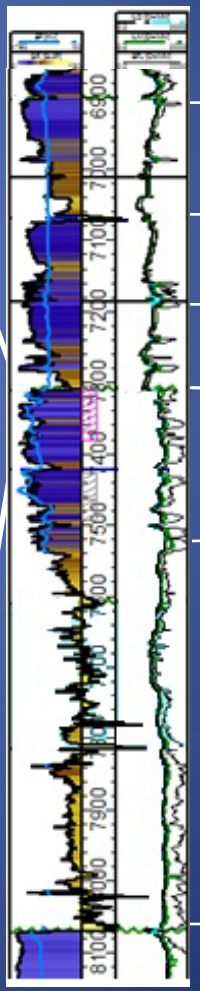
oolitic shoal (thin section); *Cavusgnathus* bearing





From Vessel and Davies (1982)

10 ft



Marble Falls

upper Barnett

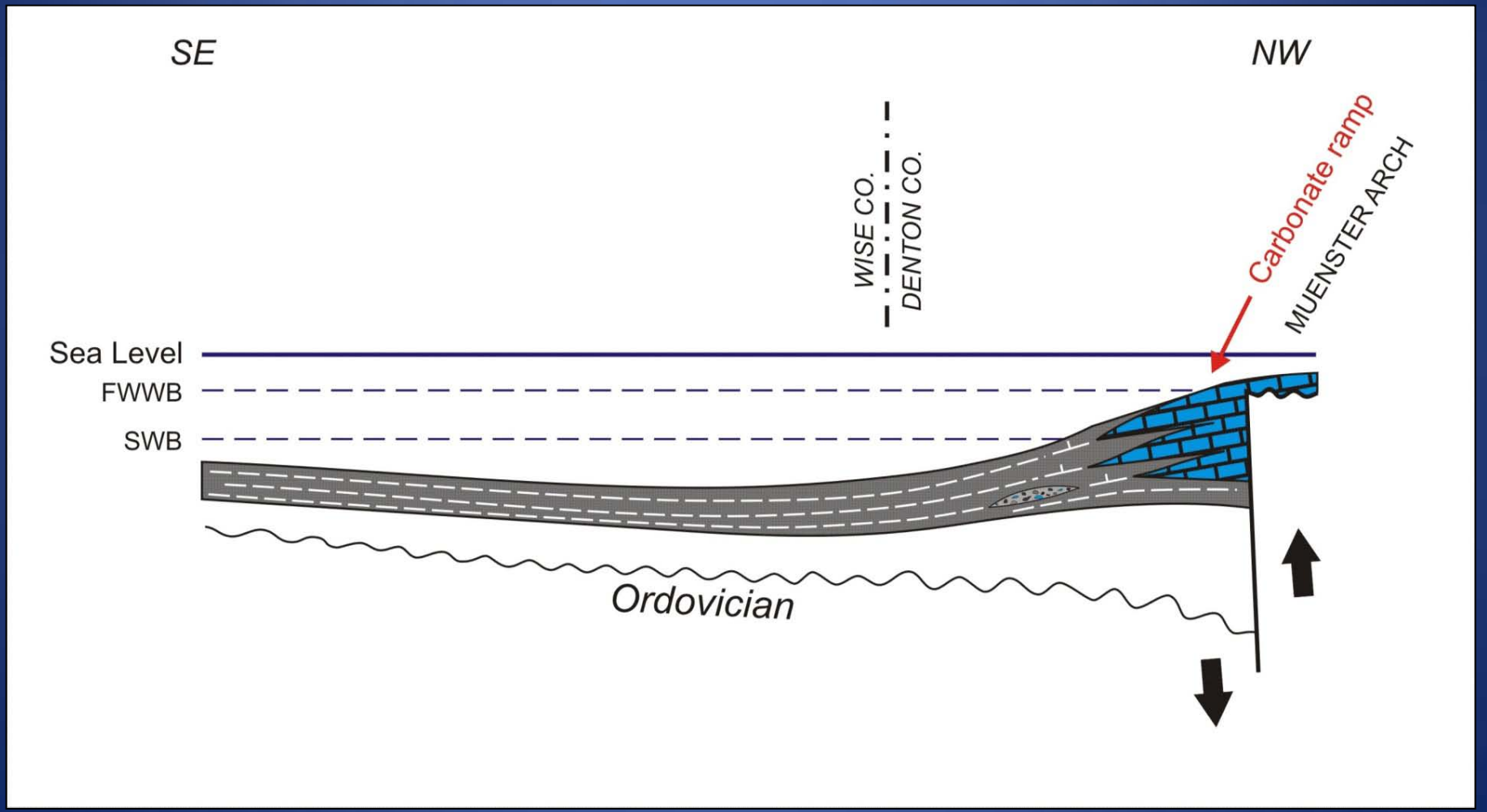
Forestburg

"lime wash"

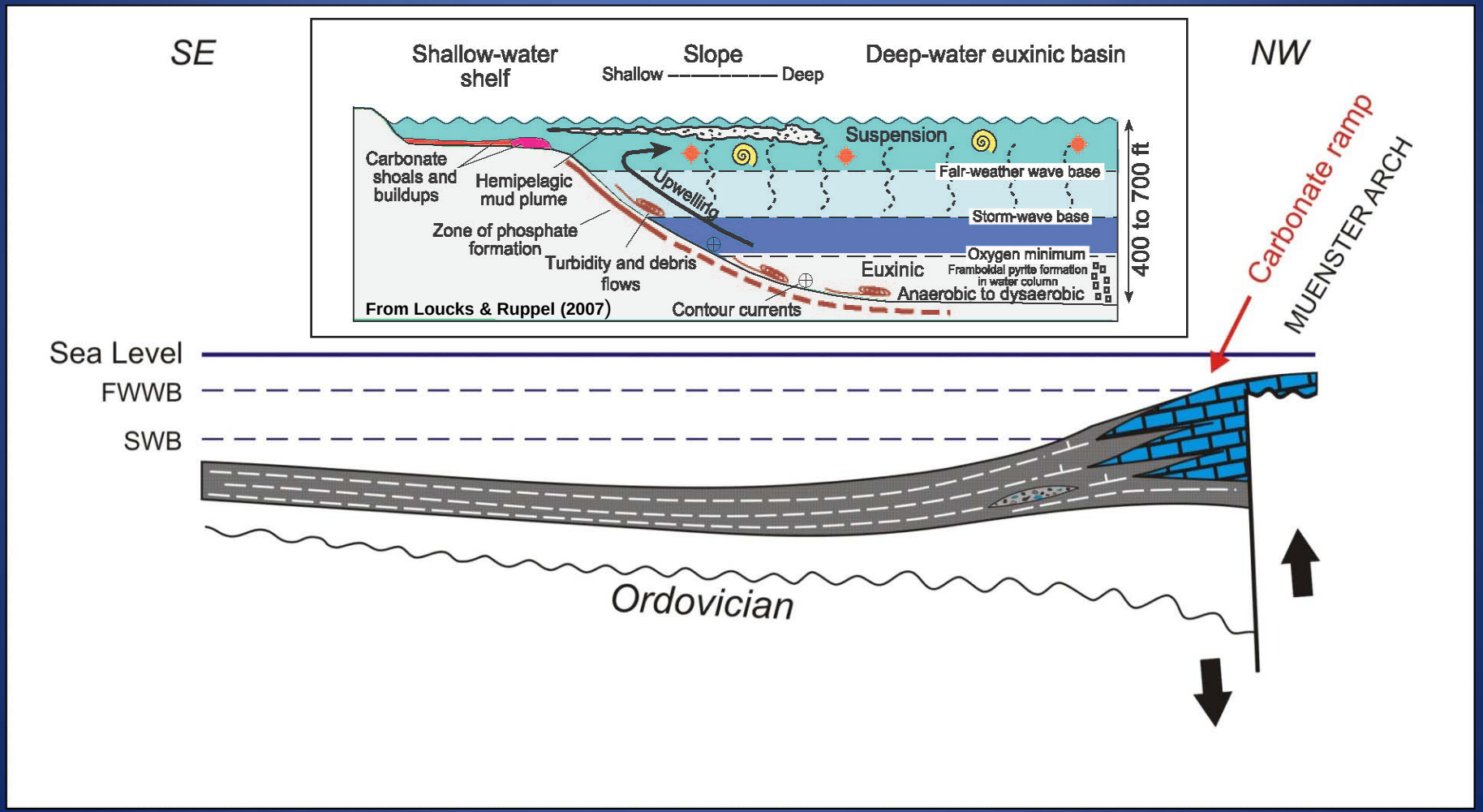
lower Barnett

Ordovician

Generalized carbonate ramp model ("shallow water") for northern FWB



Generalized carbonate ramp model ("shallow water") for northern FWB



Recap

- A major intra-Mississippian subaerial unconformity exists between Barnett (Chesterian) and Chappel Lime (Kinderhookian-Osagean)

- Shallow-water, ramp carbonates filled accommodation in the structurally deepest part of the FWB, not deep-water pelagites nor “lime wash” fan-delta facies

- Nearshore conodonts and sub-Barnett unconformity are consistent with a shallow-water, restricted marine interpretation of the Barnett; a deep-water, open marine interpretation is difficult to reconcile with these data

Thank you.
Questions/comments?