Palynology and Carbon Isotopes of Paleocene-Eocene Outcrops, Bastrop Area, Central Texas: Continuing Investigation of the PETM in the U.S. Gulf Coast*

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Search and Discovery Article #51561 (2019)**
Posted April 29, 2019

*Adapted from oral presentation given at 2018 AAPG Annual Convention & Exhibition, Salt Lake City, Utah, May 20-23, 2018
 DOI:10.1306/51561Demchuk2019

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Abstract

Re-evaluation of Wilcox/Carrizo outcrops in Central Texas, using sedimentology, ichnology and palynology, has provided new insights into up-dip to down-dip relationships with shelf-edge deltas and deepwater deposits.

Lower Wilcox formations remain poorly known. Macrofossils indicate marine conditions during deposition of the Solomon Creek and Caldwell Knob. The Hooper has marine trace fossils and tidal sedimentary structures in its lower part, with carbonaceous siltstones and lignites in the upper part marking a shift to predominantly non-marine conditions. In the overlying Simsboro, basal rip-up clasts indicate an erosional lower contact, with tidal sedimentary structures and rare glauconite above. In the upper Wilcox, older literature emphasizes non-marine deposition for the Calvert Bluff, but along the outcrop belt the upper part of the Calvert Bluff consists of tidal flats, inclined tidal heterolithics, and tidal channels. *Ophiomorpha* can be locally abundant. A transgressive lag forms the base of the succeeding Sabinetown; it consists of several siltstone-dominated parasequences. A bioturbated siltstone erosionally overlying the Sabinetown yields common to abundant *A. homomorphum*, a dinocyst influx marking the PETM (Paleocene-Eocene Thermal Maximum). A basal Carrizo *Glossifungites* surface, siltstone rip-ups draped on sigmoidal cross-beds, robust *Ophiomorpha*, and tidal heterolithics indicate marine deposition.

Overall, the Wilcox/Carrizo is mainly nearshore, shallow marine, with widespread evidence of mesotidal influence. Both the Simsboro and Carrizo are likely the products of tidal deltas. These were not fluvial channel complexes and not conduits for sediment bypass to reservoir sandstones in shelf edge deltas and deepwater turbidites. Various stratigraphic breaks point to the fragmentary nature of this up-dip succession, which probably represents only parts of late highstand and transgressive systems tracts. Although the duration of most breaks remains to be

resolved, the time gap at the base of the Carrizo is estimated at over four million years. The thin Simsboro, Sabinetown and Carrizo marine progradational units probably do not extend far basinward, and are not coeval with, nor sediment sources for, paralic shelf edge deltaic deposits and deepwater turbidites. The only continuous link between the outcrop belt and offshore deepwater turbidites is the PETM, which provides a biostratigraphically constrained surface between the lower Wilcox below and upper Wilcox above.

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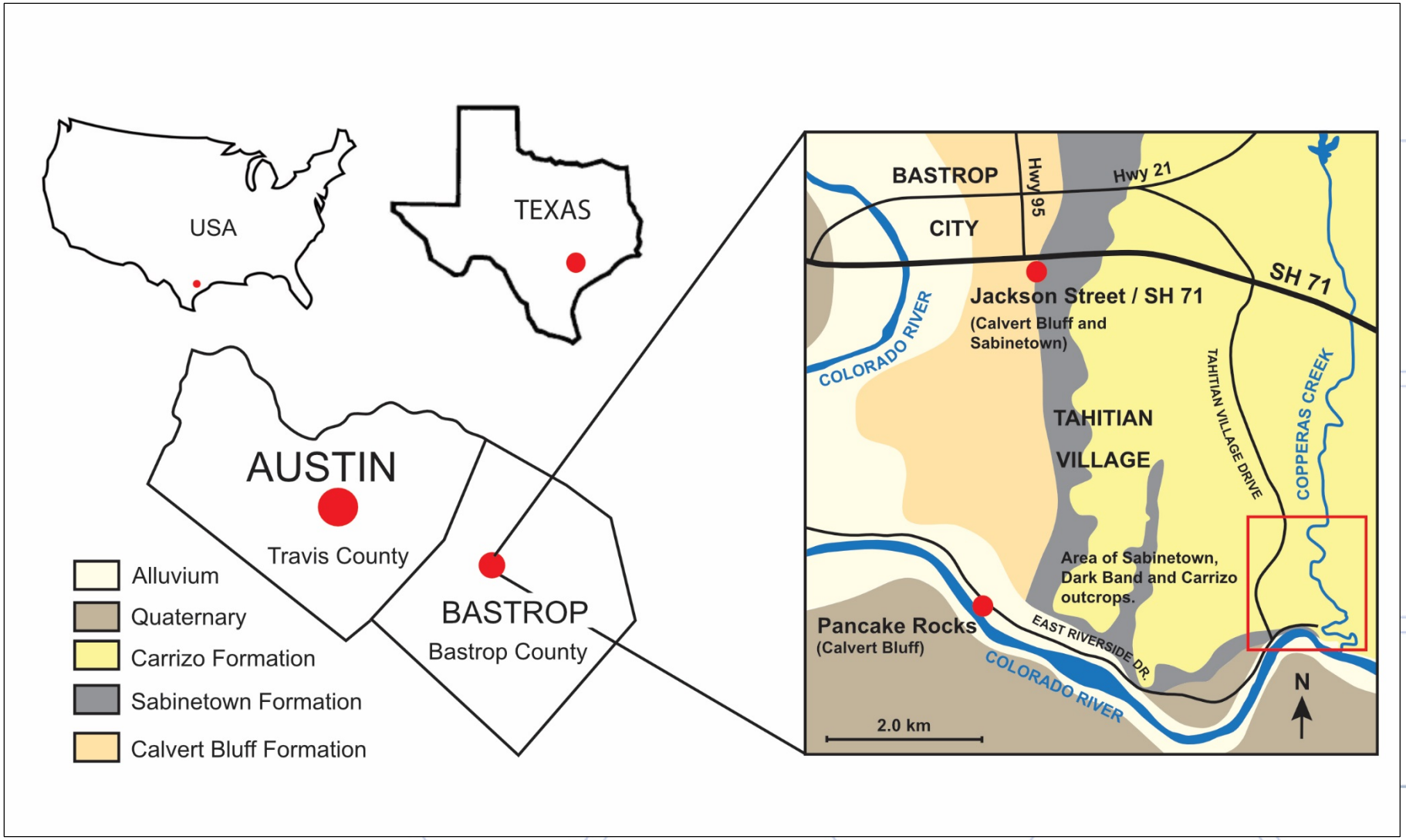
August 2018

Wilcox sediment by-pass

Location: Bastrop County, Central Texas



Revised environmental interpretations for part of the Wilcox Group in Bastrop County

Stage	Local Stage	Group	Formation	'Standard' Interpretation	Revised Interpretation
Ypresian (pars)	Claibornian (pars)	Claiborne Group (pars)	Weches		
			Queen City	fluvial channel	?tidal delta
			Reklaw	marine transgression	
			Carrizo	fluvial channel	tidal delta
Danian-Thanetian	Sabinian	Wilcox Group	Sabinetown	?delta front	tidal delta front
			Calvert Bluff	fluvio-deltaic, swamps	mesotidal coastline
			Simsboro	fluvial channel	tidal delta
			Hooper	?marine	marine & tidal flats
	Midwayan	Midway Group	Caldwell Knob	shallow marine	
			Solomon Creek	shallow marine	
			Wills Point	shallow marine	
			Kincaid		

Wilcox sediment by-pass

Fluvial (Mississippi) delta interpretation of Wilcox Group

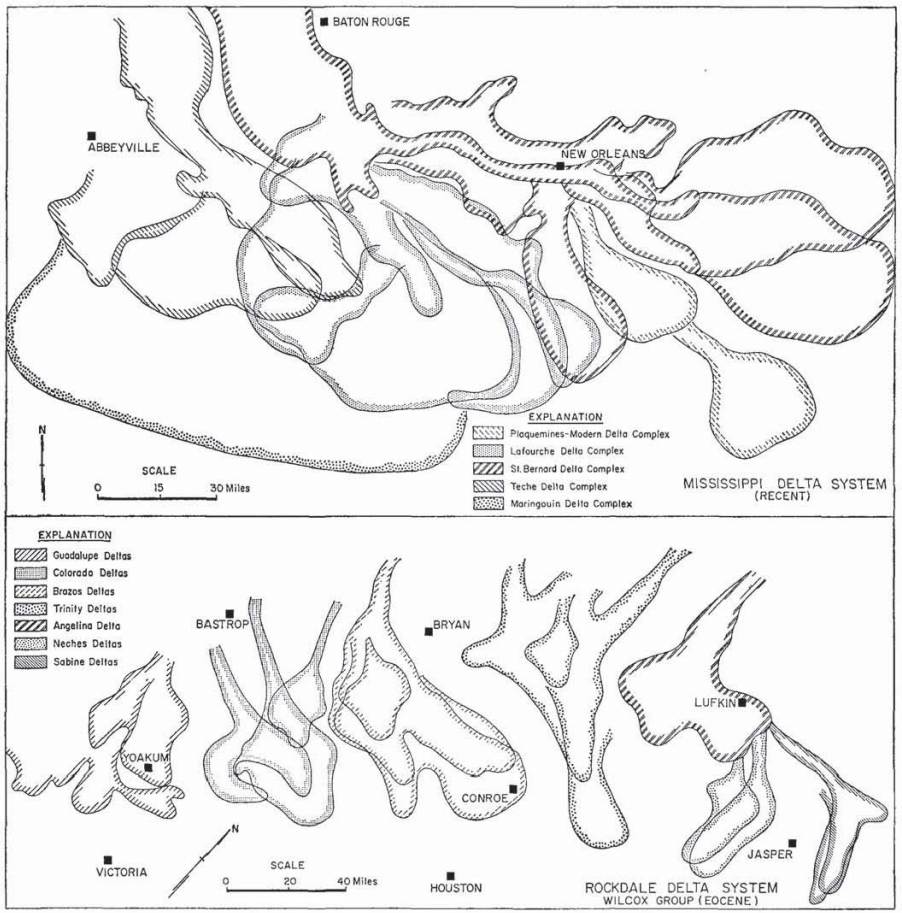


Figure 6. Comparison of size, distribution, and arrangement of principal delta lobes of the Mississippi Delta System (Recent, southeastern Louisiana) (modified from Frazier, 1967) and Rockdale Delta System, Wilcox Group (Eocene, Texas)

Fisher & McGowan, 1967

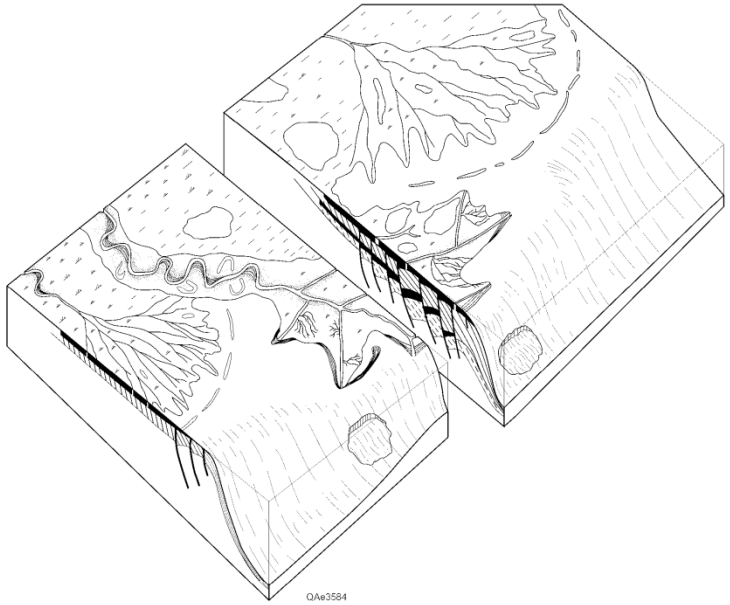
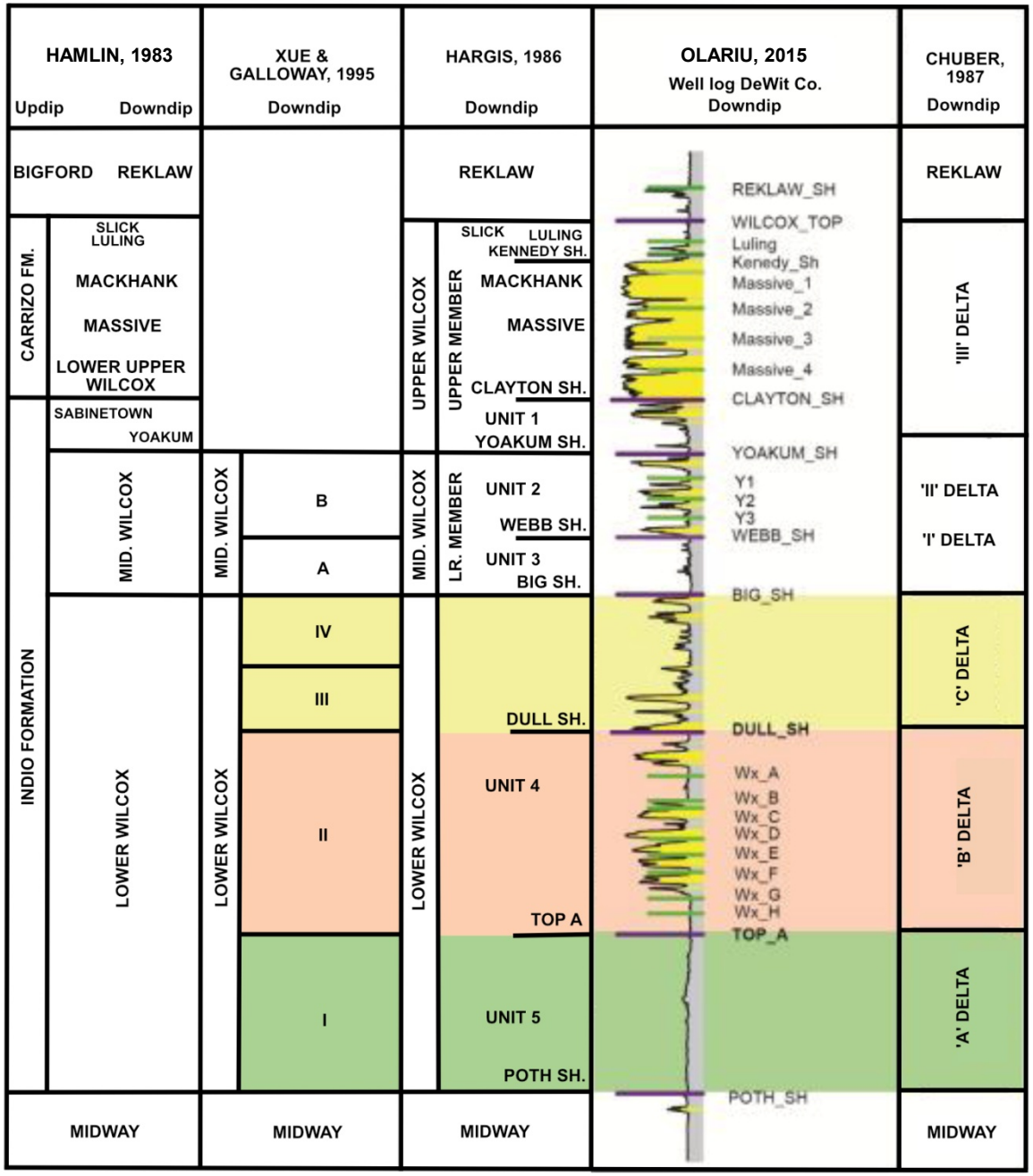


Figure 4. Schematic diagram showing principal deltaic morphologies in the Upper Wilcox Group in south-central Texas. Modified from Edwards (1981).

Ambrose & Clift, 2015

Wilcox sediment by-pass



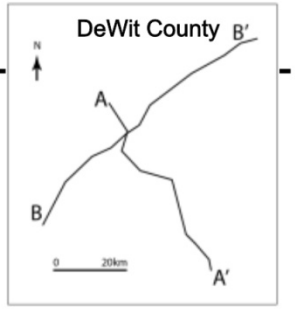
Wilcox sediment by-pass

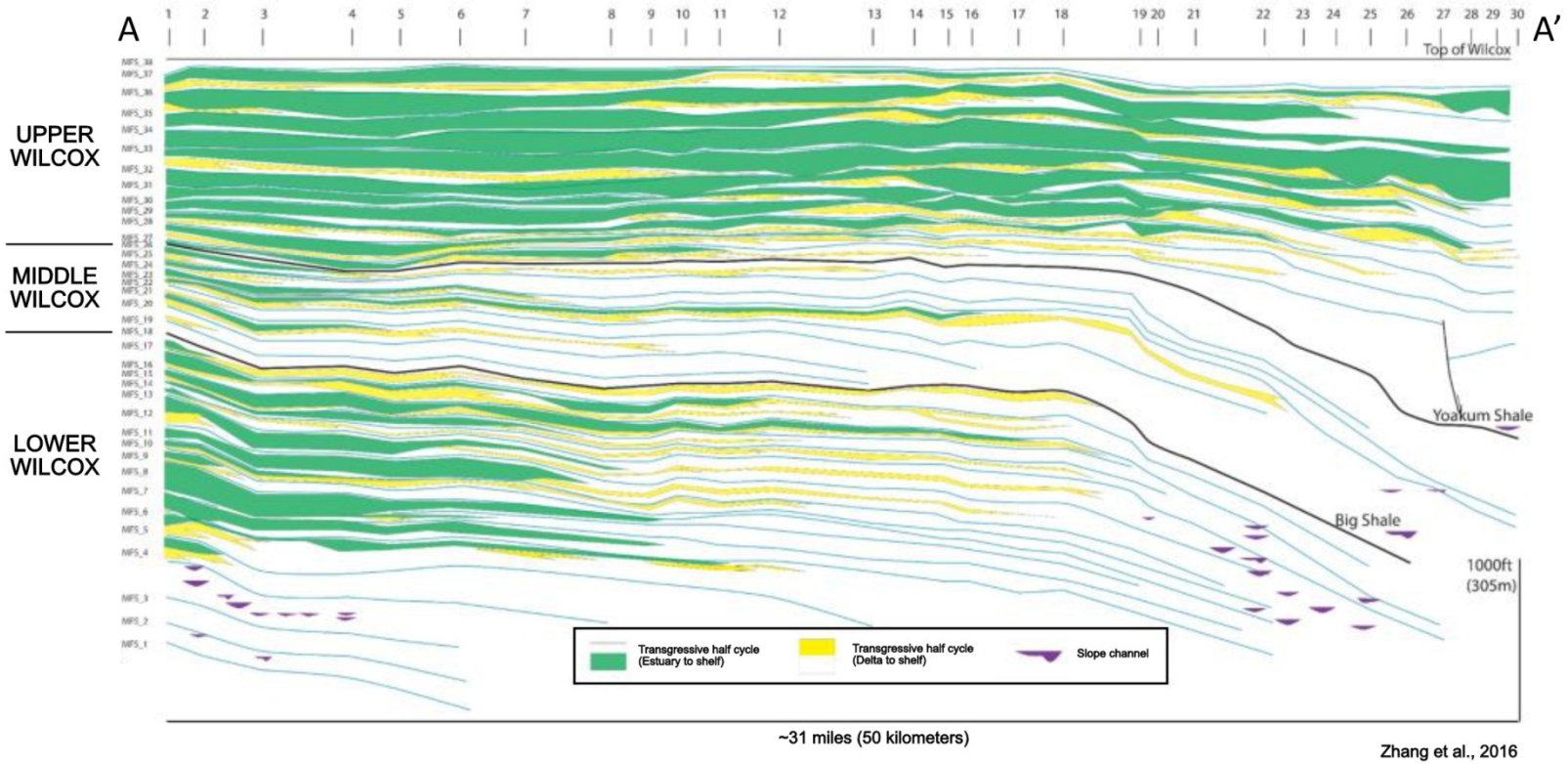
Wilcox Group is divided into 37 4th-order sequences (~200-300 ky).
Each sequence is divided into one regressive half-cycle and one transgressive half-cycle.

Interpreted as continuous deposition through Wilcox Group.
Shoreface and tidal deposits forming shelf-edge deltas.

What happens to cycles in the up-dip direction? - thin to coastal plain and omission surfaces.

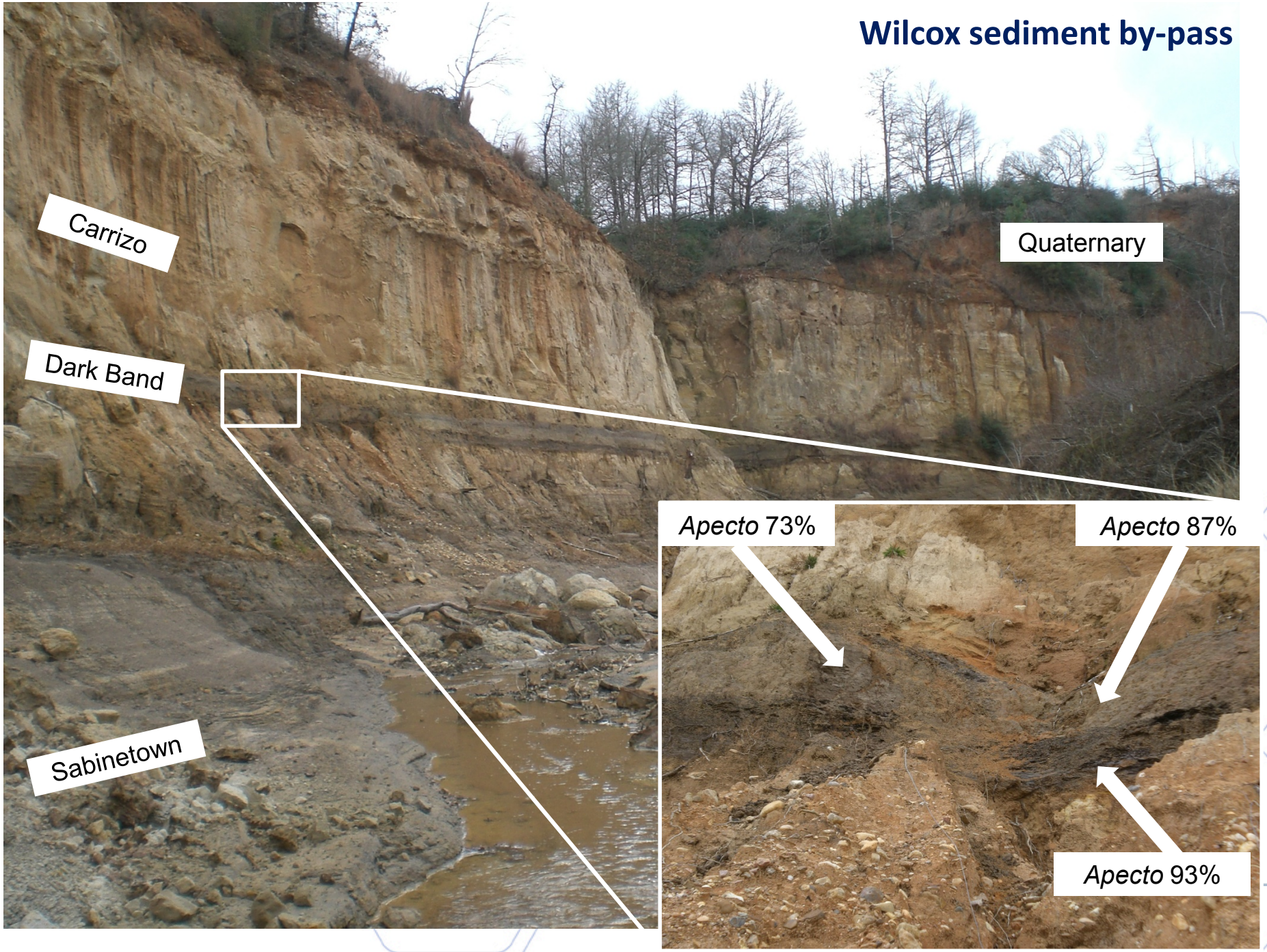
What if each cycle is only ~20-30 ky? - most time is missing and there must be significant time gaps.



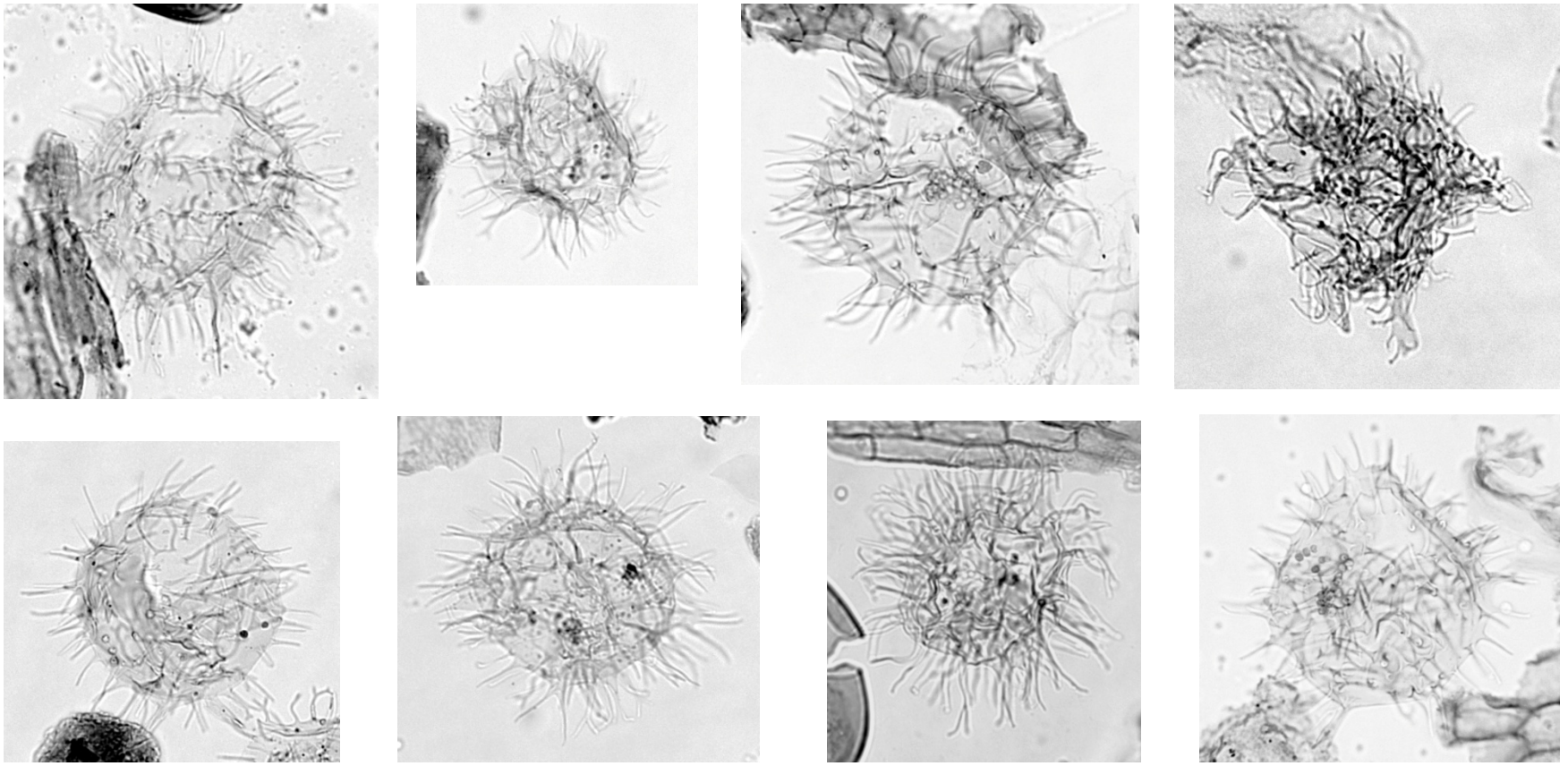


Zhang et al., 2016

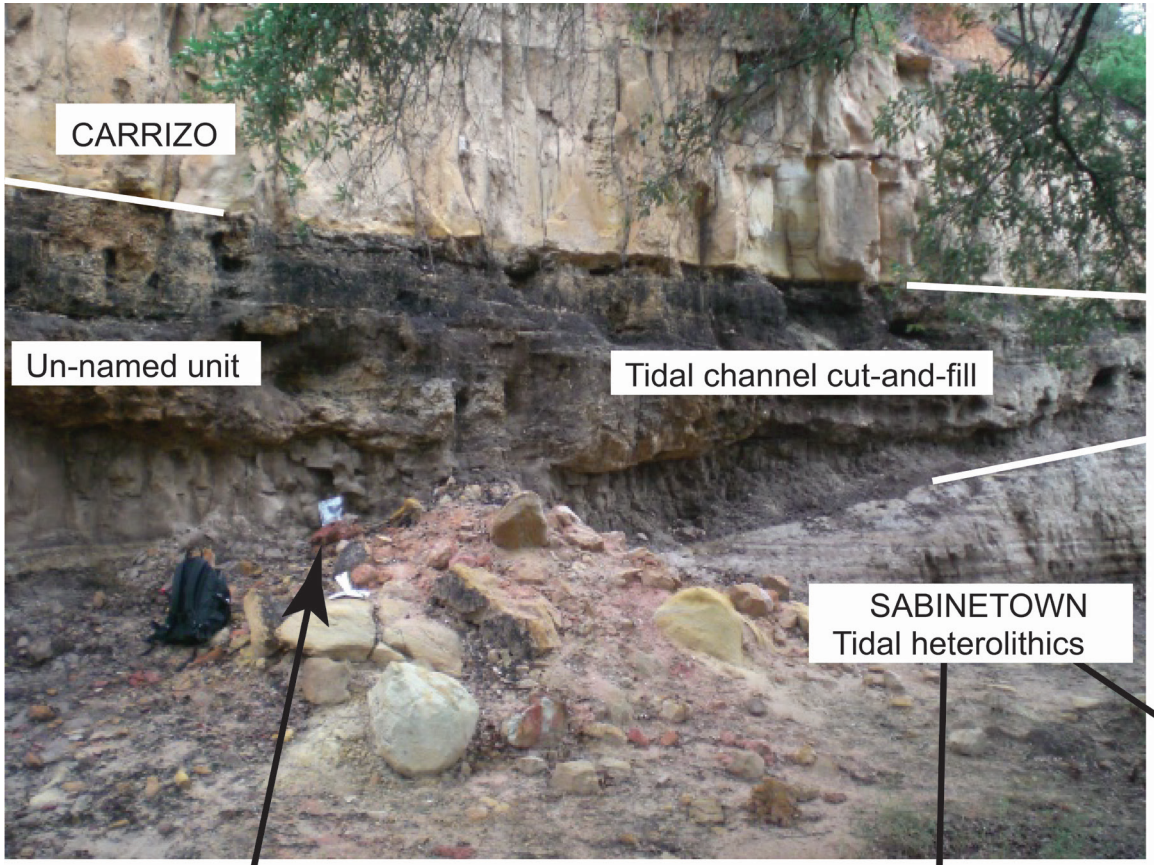
Wilcox sediment by-pass



Wilcox sediment by-pass

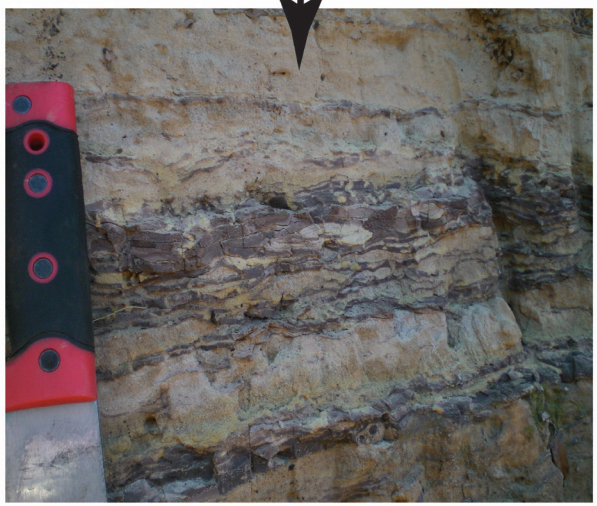


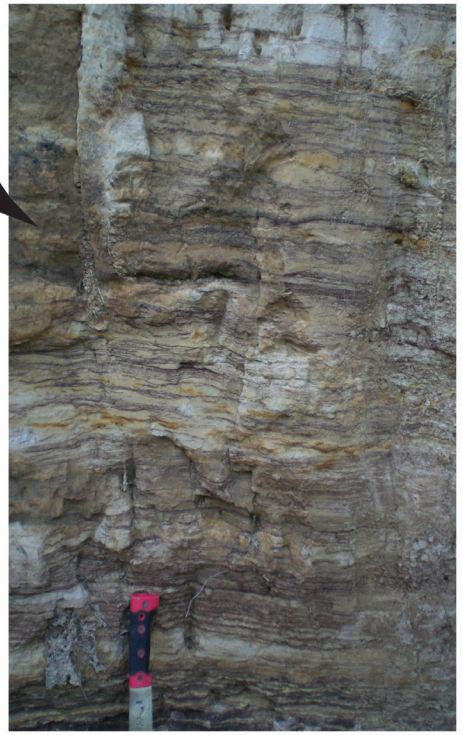
Marine dinocyst *Apectodinium homomorphum*
– acme is worldwide marker for PETM



Glossifungites / woodground at base of Carrizo Fm.

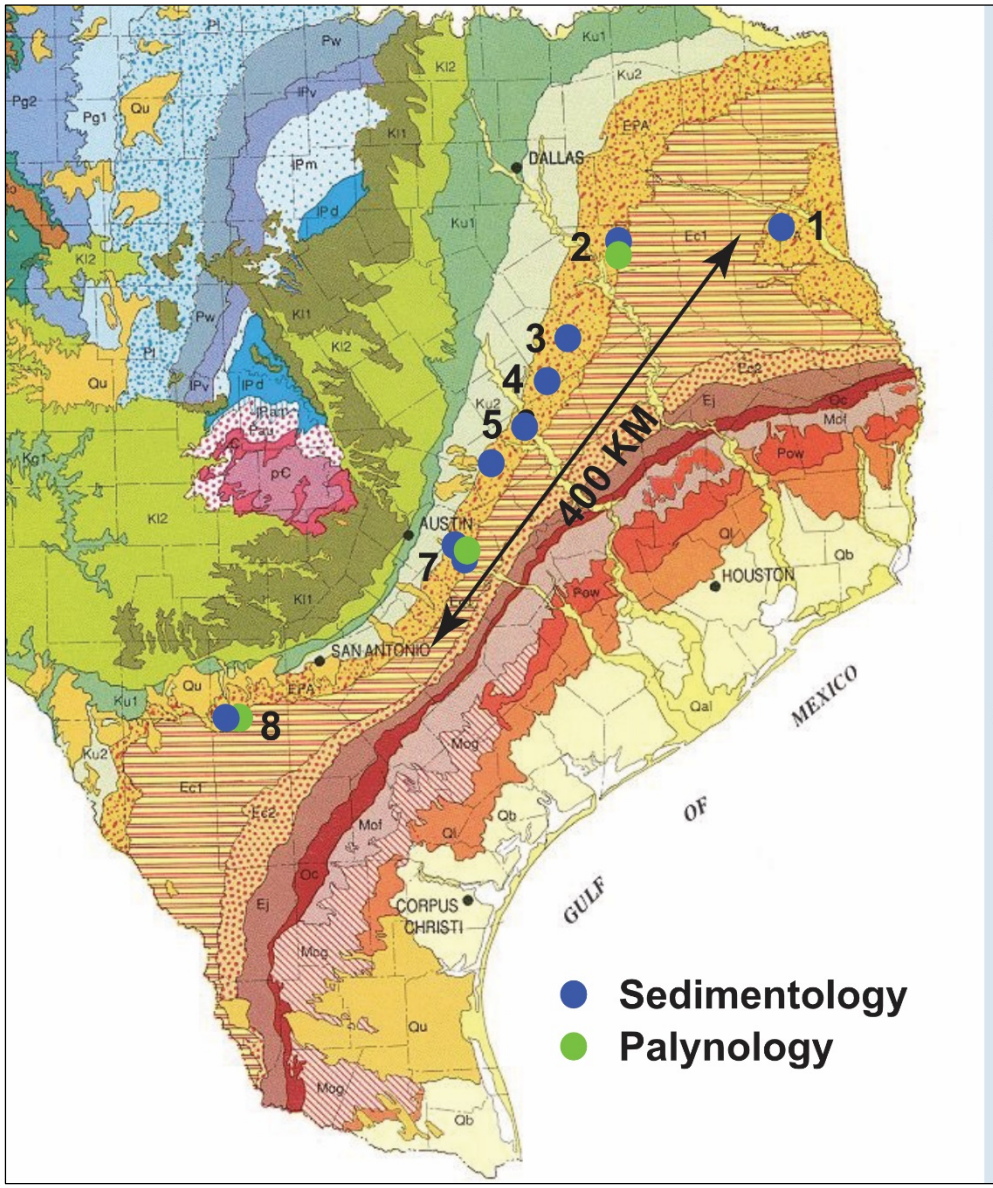
Rare microplankton; *A. homomorphum*, freshwater algae.





Pine Forest Golf Course outcrop. Marine sedimentary structures.

Marine / tidal influence, Wilcox Group outcrop belt

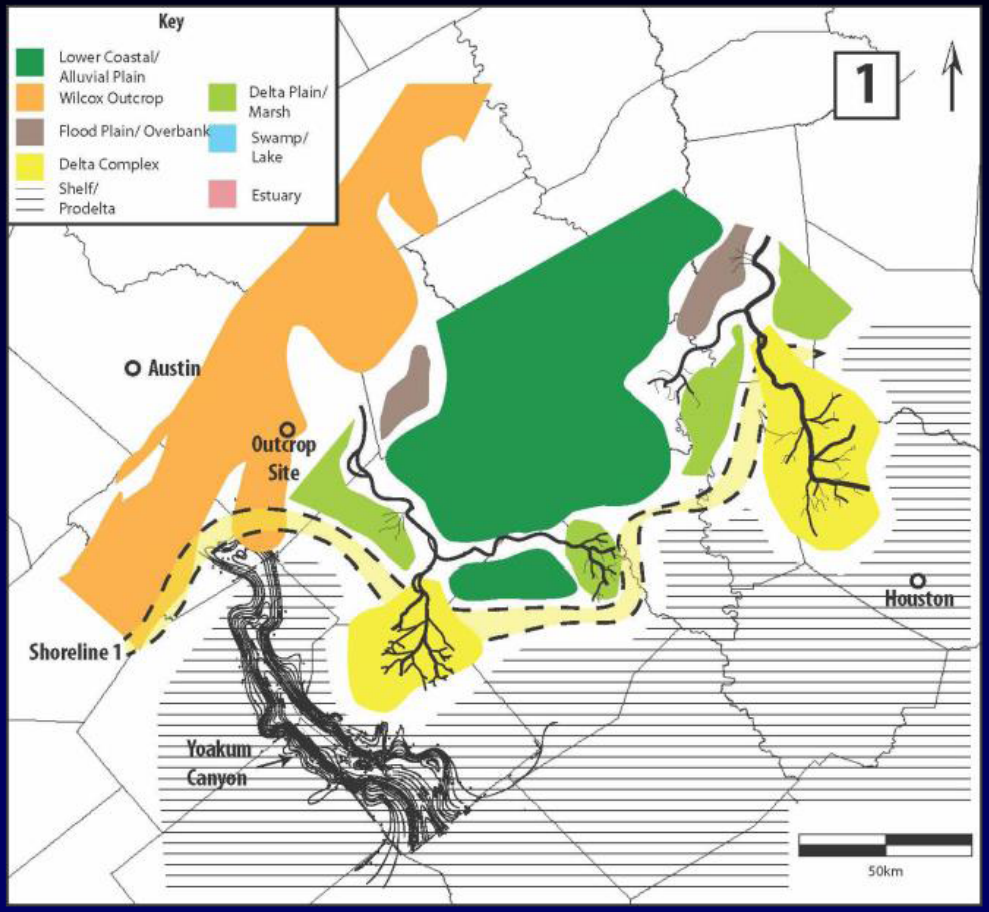


MARINE INFLUENCE IN WILCOX GROUP

1. Galloway, 2002 (CB)
2. Breyer, 1989 (CB); Klein, 2000 (CB); O'Keefe, 2005 (CB); Sturdy, 2006 (CB)
3. Bammel, 1979 (Simsboro)
4. Kosse sand-pit (Simsboro)
5. Boenig,1970; Yancey & Davidoff 1991 (Carrizo)
6. Warme & Stanton, 1971 (Hooper)
7. Denison et al., 2017 (Hooper, Simsboro, CB, Sabinetown, Carrizo)
8. Breyer, 1987 (CB); Breyer & McCabe, 1986 (CB); Nichols, 1970 (CB)

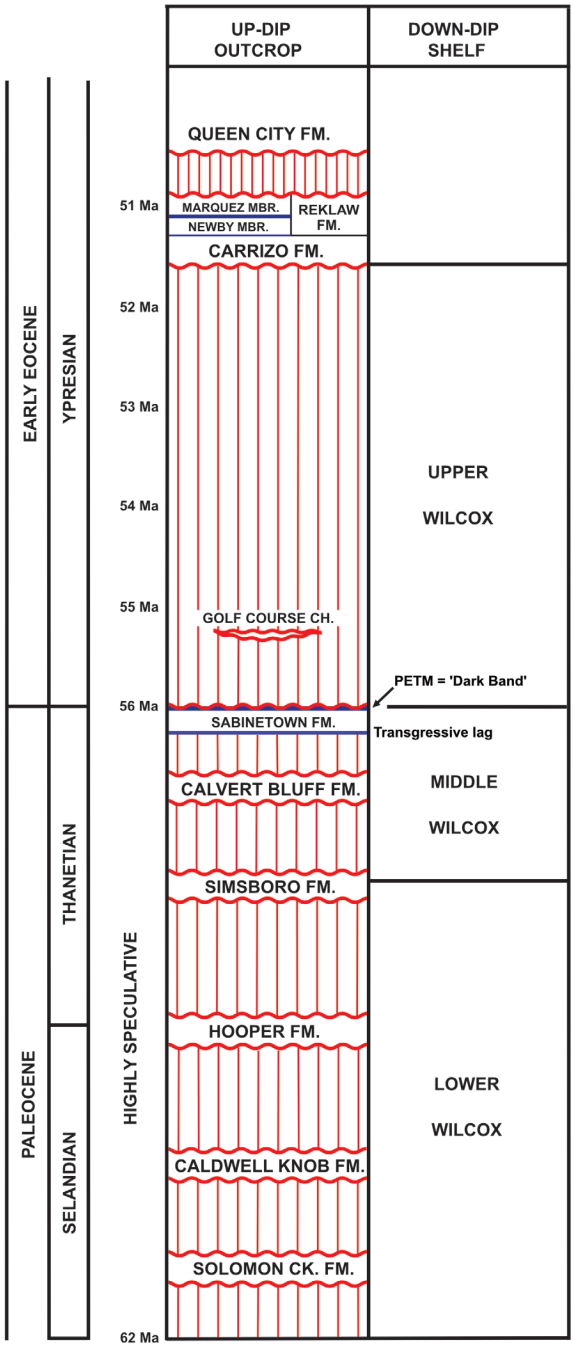
Wilcox sediment by-pass

Upper Wilcox Paleogeography, SE Texas



Modified from Conwell (2015)

Wilcox sediment by-pass



Initial stratigraphic observations:

1. Most of the examined outcrop succession is shallow, nearshore marine with clear evidence of tidal influences.

2. Surfaces (erosional and *Glossifungites*) suggest significant time gaps.

Interpretations:

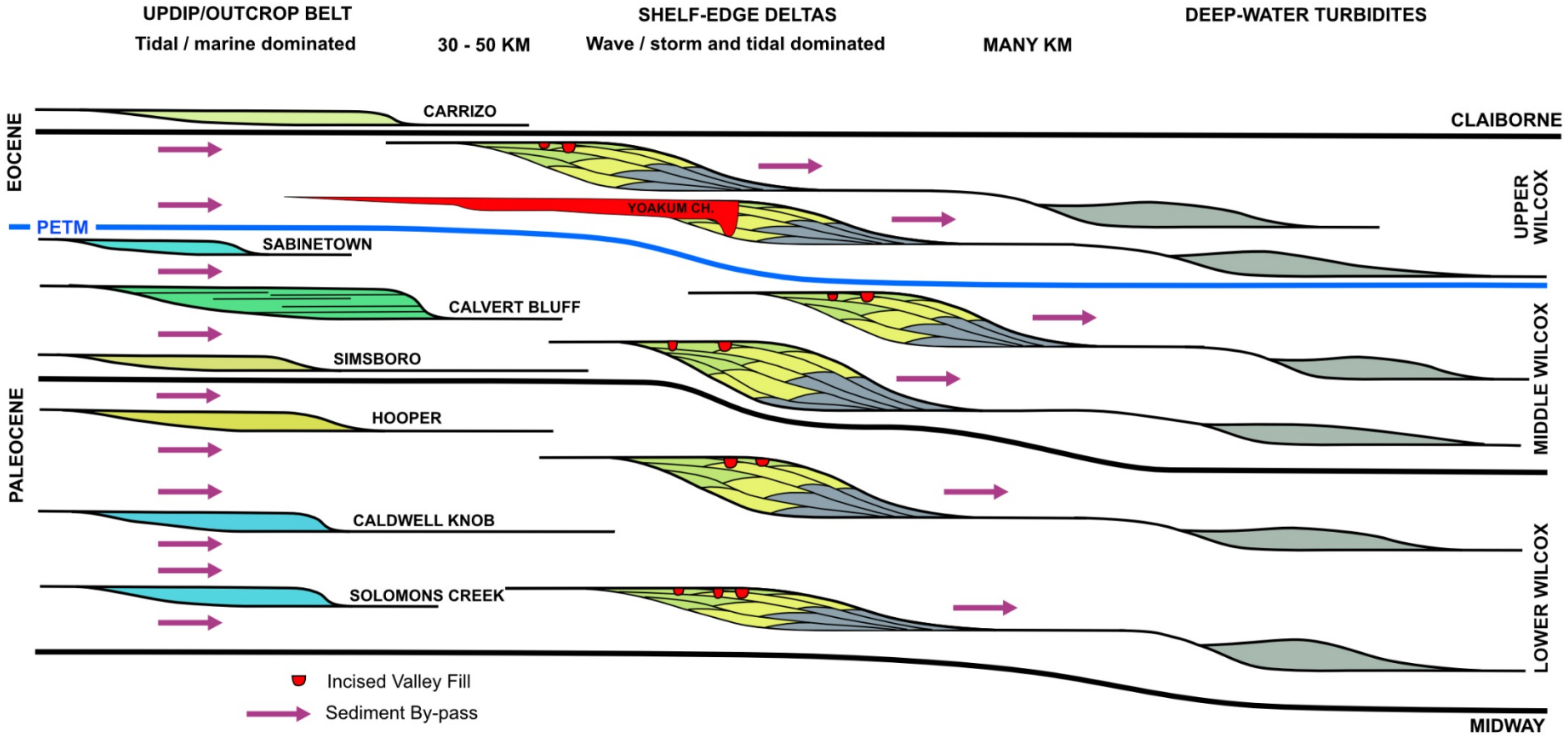
1. Paleocene/Eocene shelf was mesotidal: tidal range was amplified across a broad, shallow shelf with no need for estuaries or structural embayments.

2. The Wilcox coastline was some distance to the northwest of the current outcrop belt (Balcones fault zone as the ultimate coastline?).

3. Stratigraphic units in these up-dip outcrops represent only fragments of the total time. Most time is represented at omission surfaces.

4. Marine up-dip deposits cannot be coeval with shelf-edge deltas.

Wilcox sediment by-pass



SUMMARY AND CONCLUSIONS

- Sedimentology and biostratigraphy demonstrate that up-dip outcrops of the Wilcox Group and Carrizo Formation are more consistently marine and tidally-dominated than previously thought.

- Simsboro and Carrizo sandstones do not represent the fluvial fill of channel systems that fed sediment basinward, but more likely represent progradational tidal deltas deposited at latest highstand. These sandstones are not coeval with shelf edge deltas and deepwater sandstones.

- The Dark Band represents maximum landward transgression driven by ocean thermal expansion during the PETM climatic optimum. The PETM provides a correlative link from the outcrop to the deepwater GOM, but has yet to be documented in the shelf-edge deltas.

- The Calvert Bluff, Sabinetown and Carrizo up-dip succession represents only fragments of the available time. By analogy, all up-dip Wilcox formations are interpreted as representing a small duration of the available time.

- During most of Wilcox time, the coastline was several 10's of kilometers basinward of the outcrop belt. Shelf edge deltas accumulated in wave/storm and tidal settings. During the time represented by stratigraphic breaks in the outcrop belt, sediment translated across the low gradient coastal plain to feed the shelf edge deltas and deepwater turbidites.

- Provenance studies need to take this temporal dislocation into account.