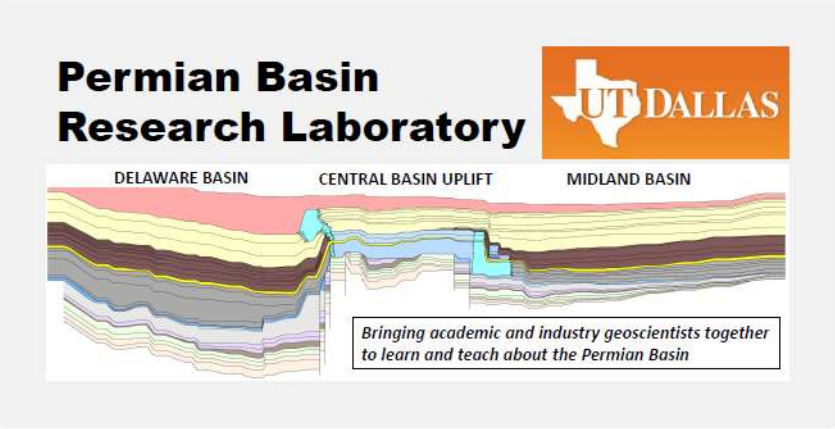
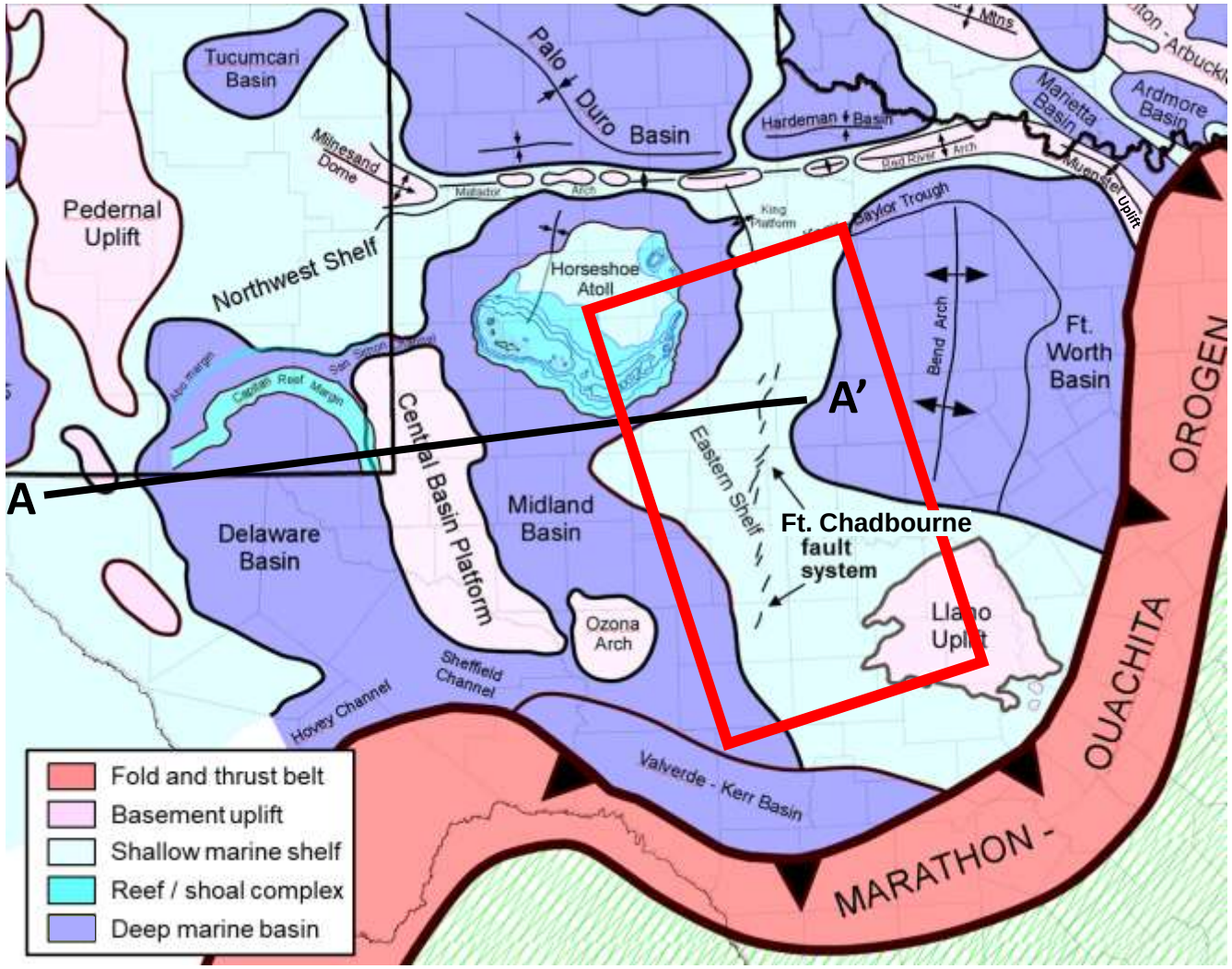
The Eastern Shelf of the Midland Basin: The Next Big Playground For Exploration?

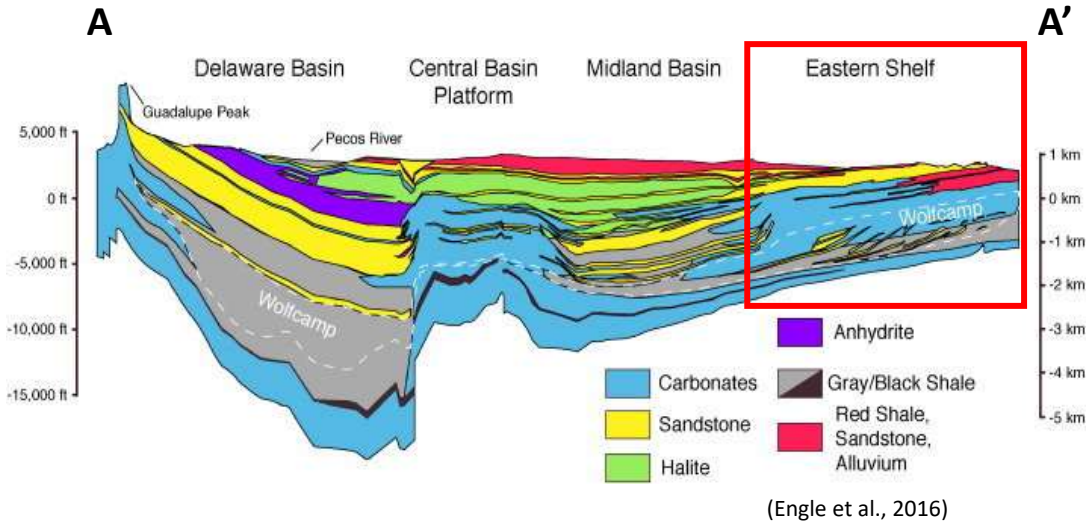


Lowell Waite
Department of Geosciences
Permian Basin Research Lab
University of Texas at Dallas

SIPES Dallas Energy Forum
November 9, 2022

Greater Permian Basin of west TX and SE New Mexico: Paleogeographic elements



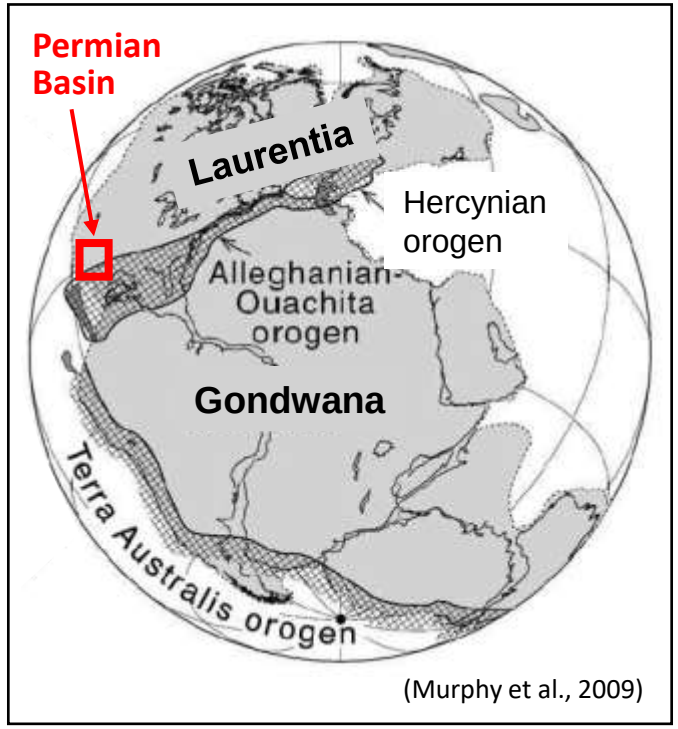


(Engle et al., 2016)

- Eastern Shelf one of several high-standing Permo-Pennsylvanian shelves surrounding deeper Delaware and Midland basins
- Eastern Shelf dips westward ~ 1.3 degrees
- General stratigraphy: thin Pre-Penn (mostly L. Ord. Ellenburger dolomite and U. Camb. Ss) unconformably overlain by thick Pennsylvanian to lower Permian carbonate and clastic units (~ 4000 – 8000 ft. MD)
- Note location of Ft. Chadbourne fault system: chain of small basement-involved structural blocks; upthrown to east

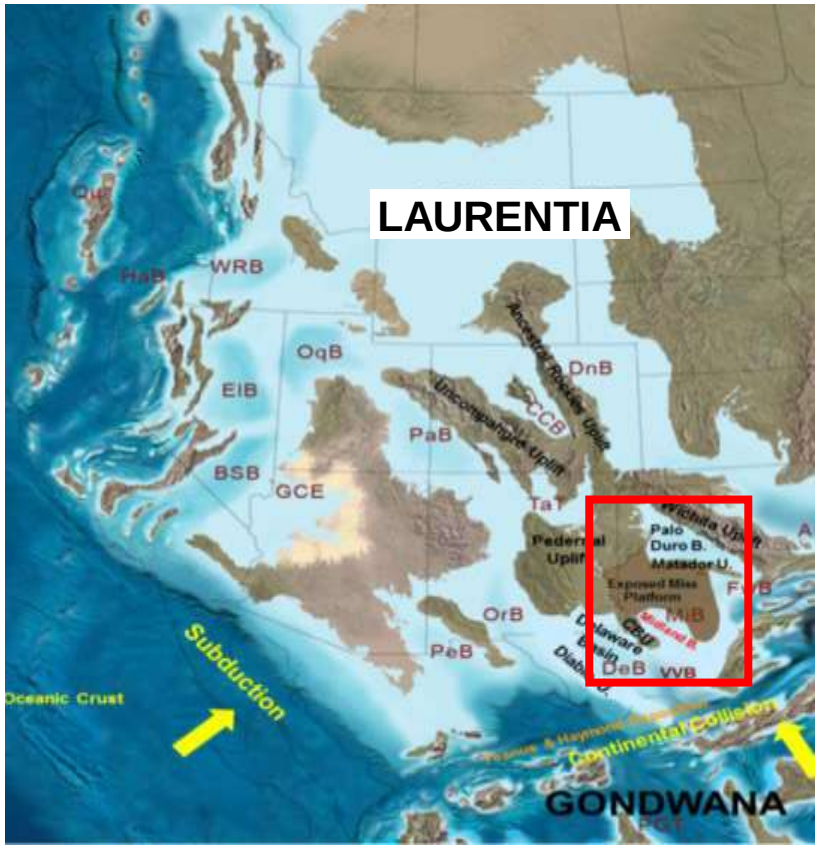
Pennsylvanian – Early Permian Themes

- SW Laurentian region during assembly of Pangea; active margin phase: Hercynian orogeny & rise of Ancestral Rockies (Tobosa Basin becomes Permian Basin)
- Climate: Icehouse phase throughout Penn. – Early Permian, transitioning to greenhouse; Permian Basin in low-latitudes (tropics); humid w/ monsoonal precipitation
- Sea level: long-term rise and expansion of Penn. seaway; short-term: **Penn cyclothems** (high frequency, high amplitude glacioeustatic cycles)
- Dominance of phylloid algae as main reef builders (aragonite skeletons; limestones susceptible to early leaching)

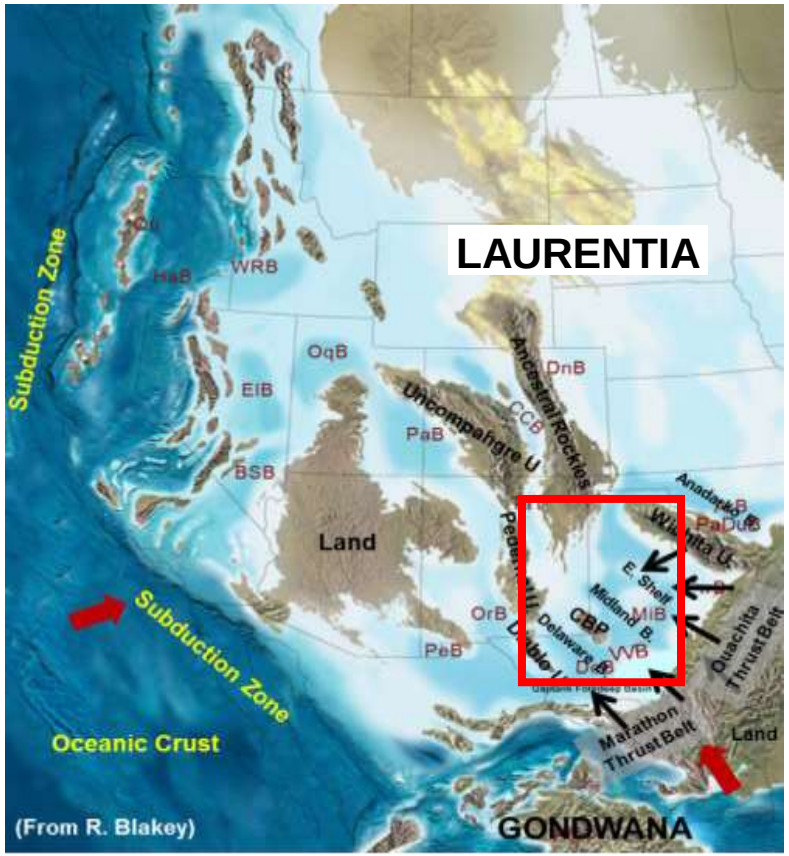


(Murphy et al., 2009)

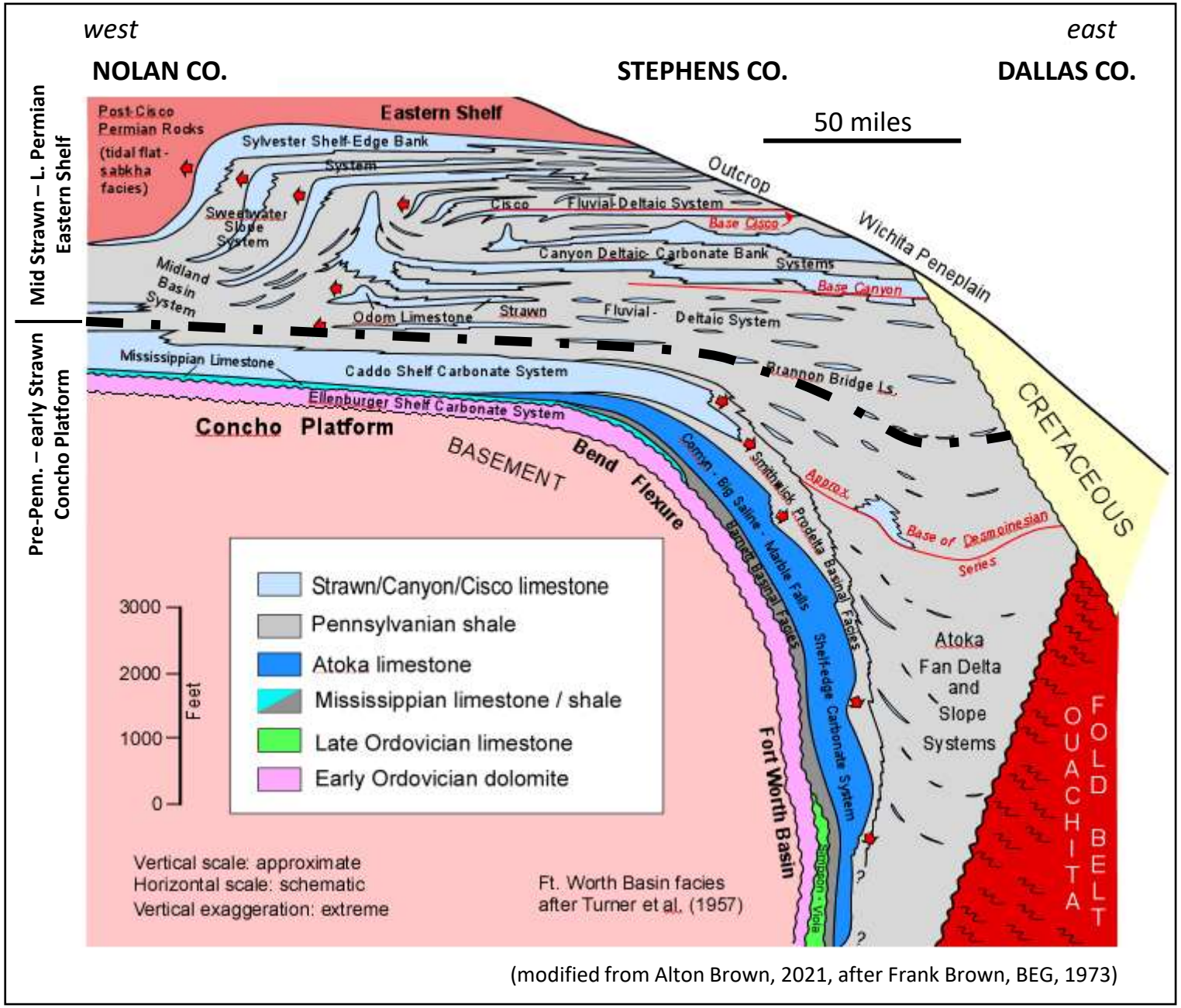
Early Penn. (Atokan)



Late Penn. (Missourian)



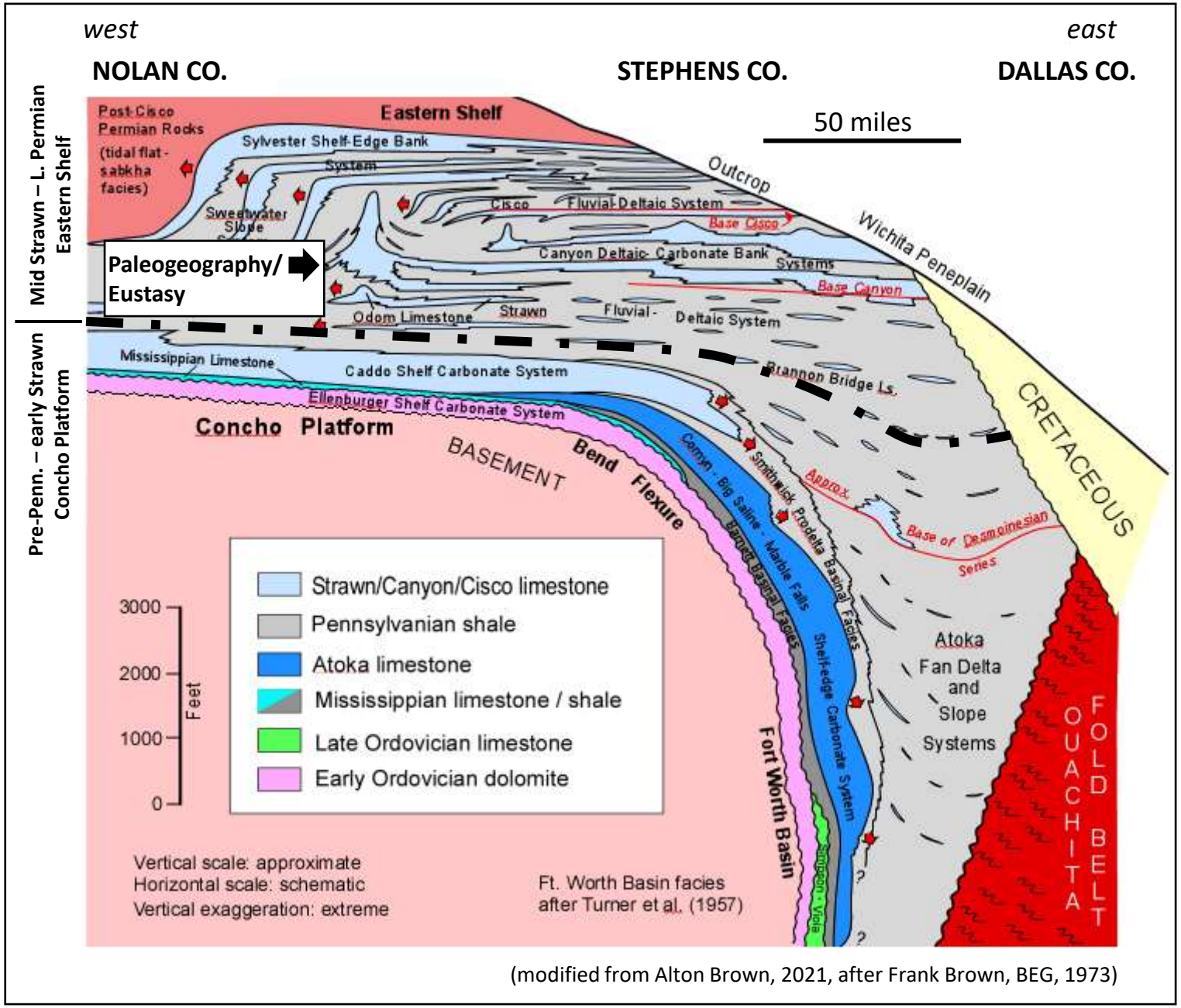
Eastern Shelf Depositional Systems



(modified from Alton Brown, 2021, after Frank Brown, BEG, 1973)

- Prior to middle Strawn time (pre-Odom; thick dashed line), the Eastern Shelf was a shallow-water carbonate platform (Concho Platform) constituting the eastward dipping, western margin of the actively subsiding Ft. Worth Basin
- Following the rapid filling of the Ft. Worth Basin by Early Penn. Atoka and early Strawn clastics, deposition shifted to westward-dipping sedimentary systems defining the Eastern Shelf of the subsiding Midland Basin
- Penn – L. Perm sediments represent a thick assemblage of numerous alternating cyclothem deposits (lowstand clastics, highstand carbonates)

General Stratigraphy of the Eastern Shelf



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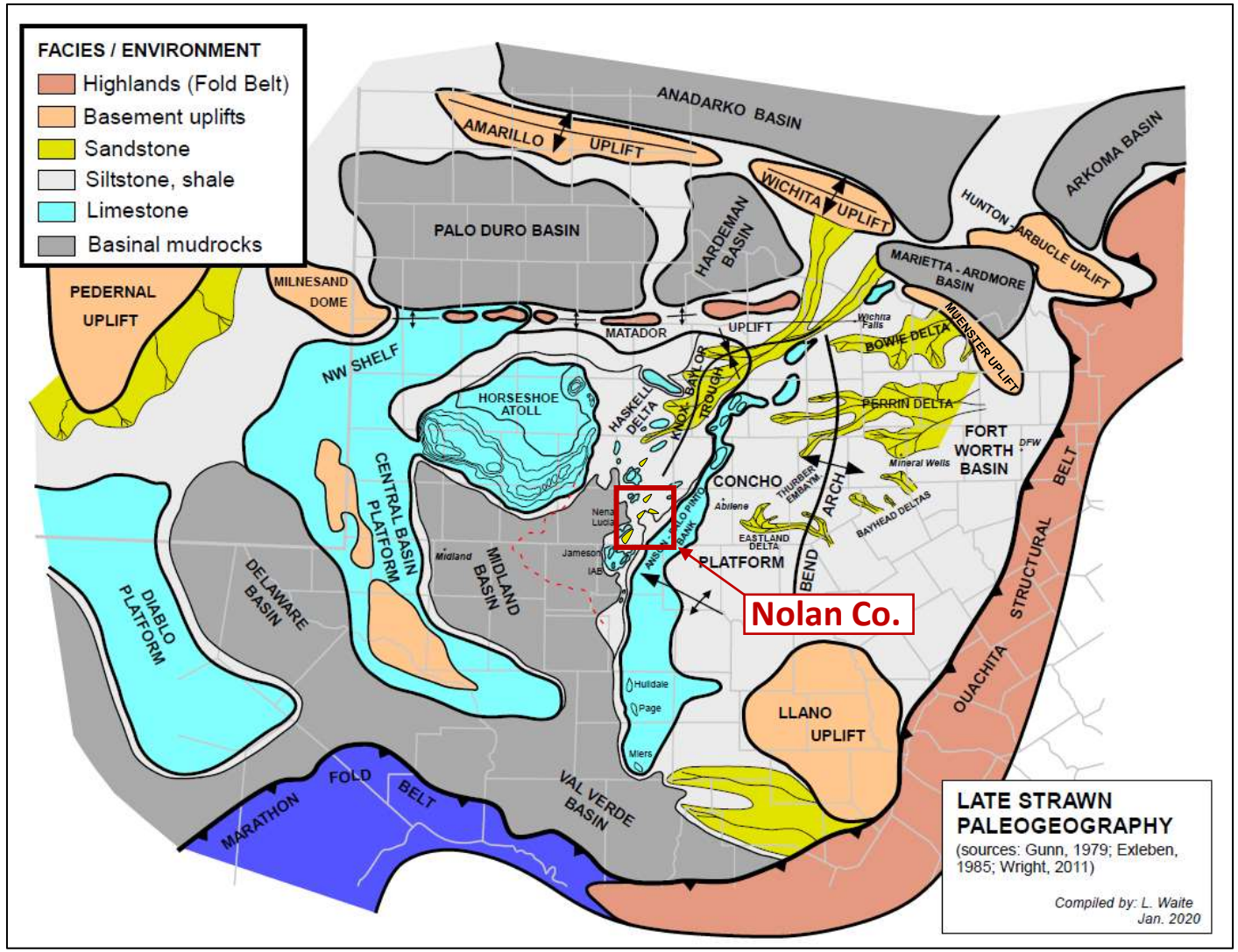
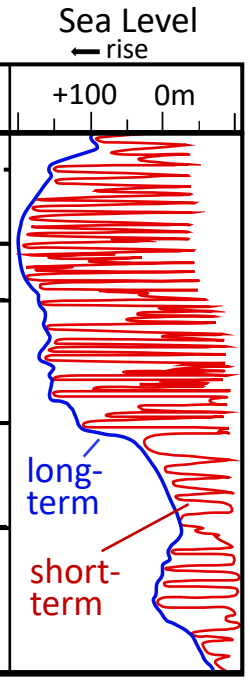
Late Desmoinesian - Missourian (Upper Strawn - Canyon) Paleogeography



Pennsylvanian Eustasy

(after Wright, 2020)

Regional Stage	Group
Virgilian	Bursam / Cisco
Missourian	Canyon
Demoinesian	Strawn
Atokan	Atoka
Morrowan	Morrow



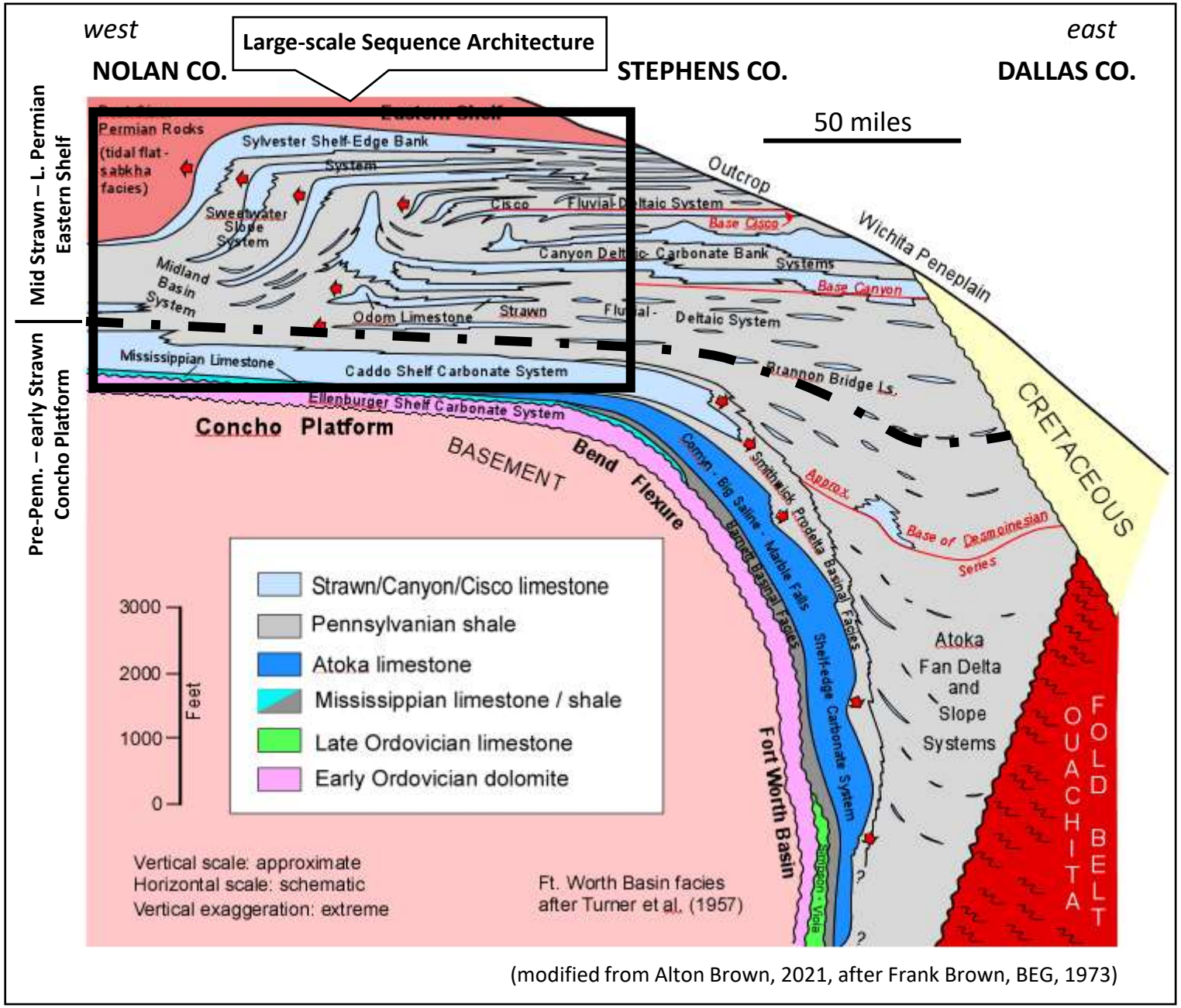
Long-term sea-level (tectonic control)

- Prolonged transgression drowns the underlying L. Strawn Concho Platform; organic-rich black shales (Wolfcamp D / Cline) deposited in rapidly subsiding “starved” basins

Short-term sea-level (glacioeustacy)

- During glacial maxima (S.L. lowstands), tectonically-active Ancestral Rockies uplifts and Ouachita Fold Belt shed voluminous amounts of clastics (channel/delta/slope systems) across Eastern Shelf
- During glacial minima (highstands), massive shallow-water carbonate deposition occurs along outboard shelf margins, including a series of large, isolated carbonate mounds/reefs

Eastern Shelf Depositional Systems



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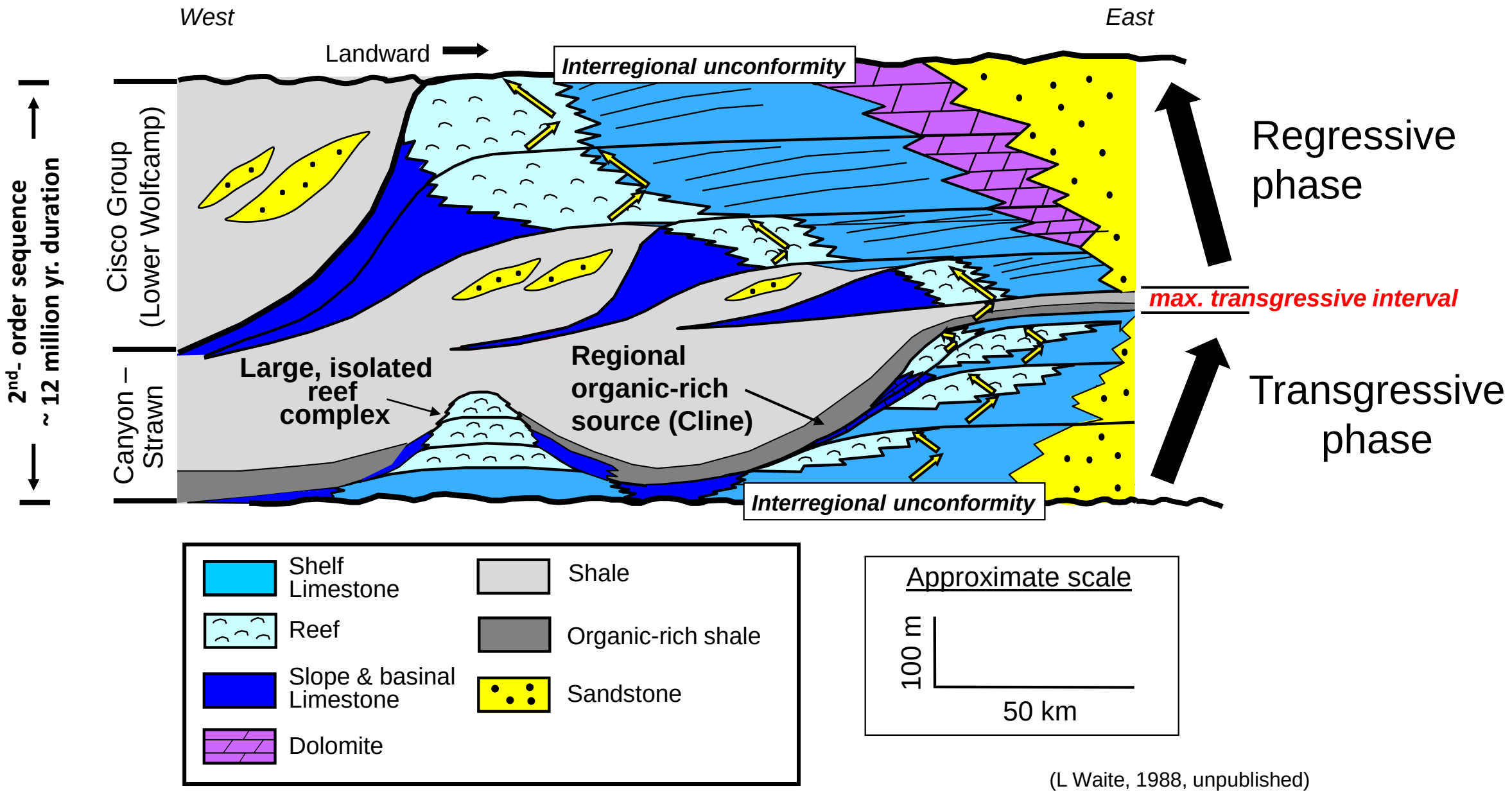
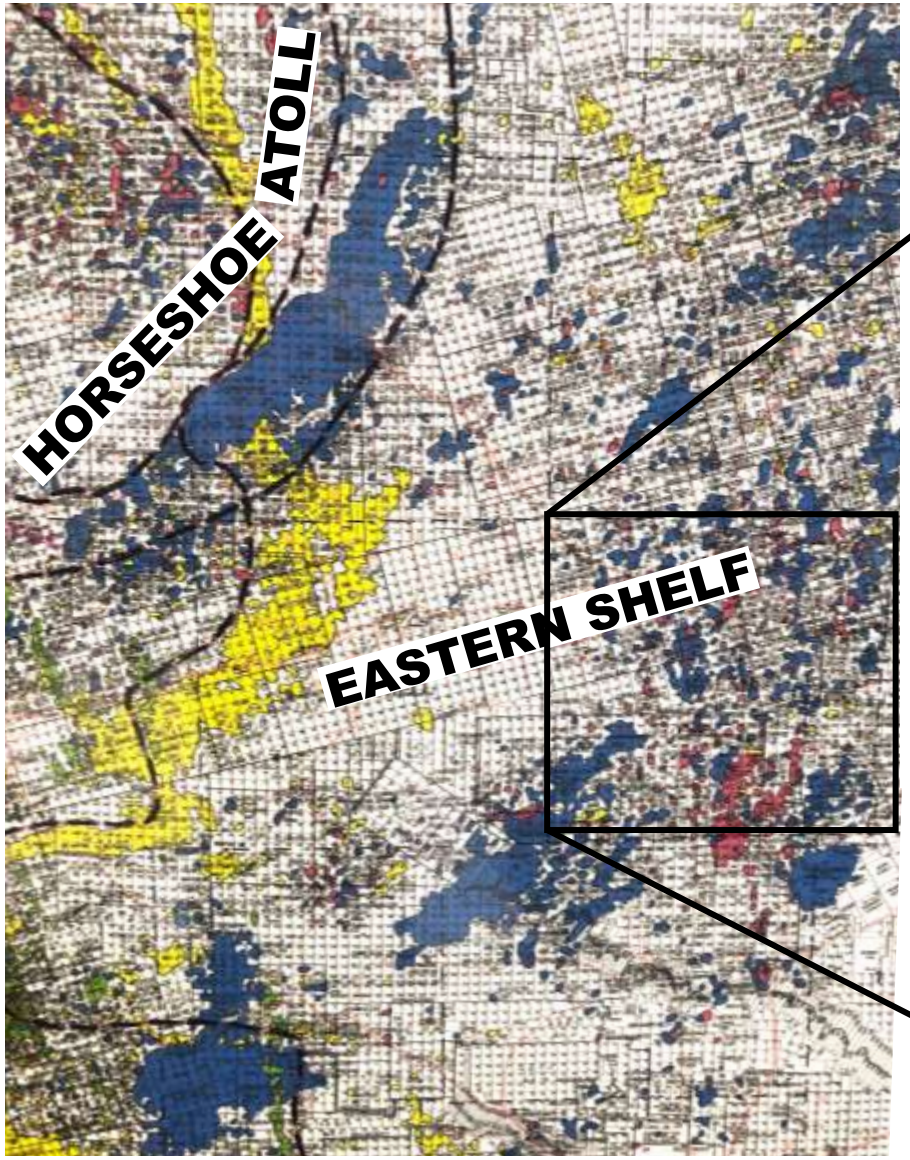
Schematic stratigraphic architecture, Penn. – lower Permian, Eastern Shelf



(L Waite, 1988, unpublished)

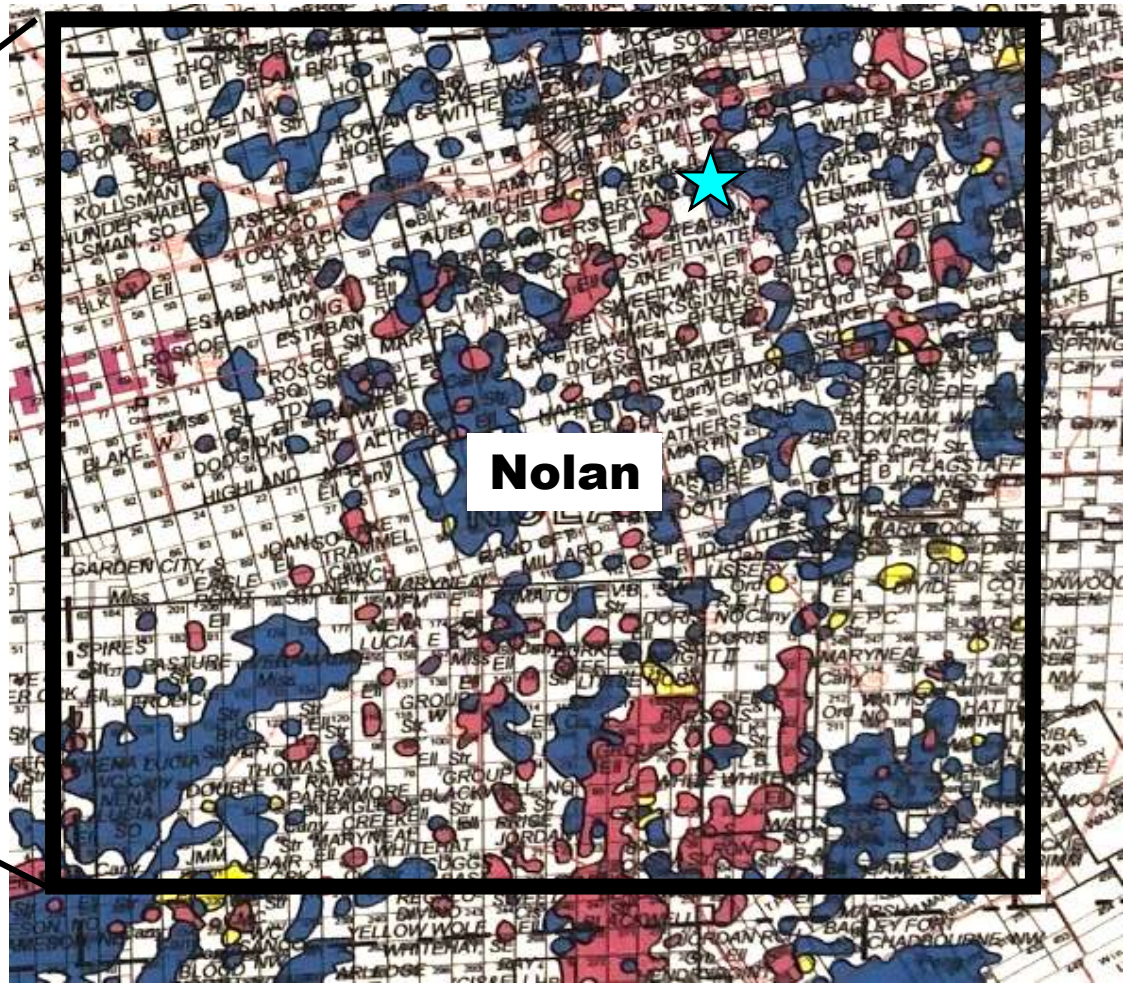
- **Goal of study: better understanding of producing trends along western margin of Eastern Shelf**

- **Question: what is remaining potential ? (via field growth, exploration, horizontal drilling, etc.)**
- Starting point: Nolan County
  - Centrally-located; previously worked (late 1980s)
  - Two small Caddo core samples provided by UTD alum Jerry Bergthold ★



30 miles

(Midland Map Co.)



10 miles

Age of reservoir

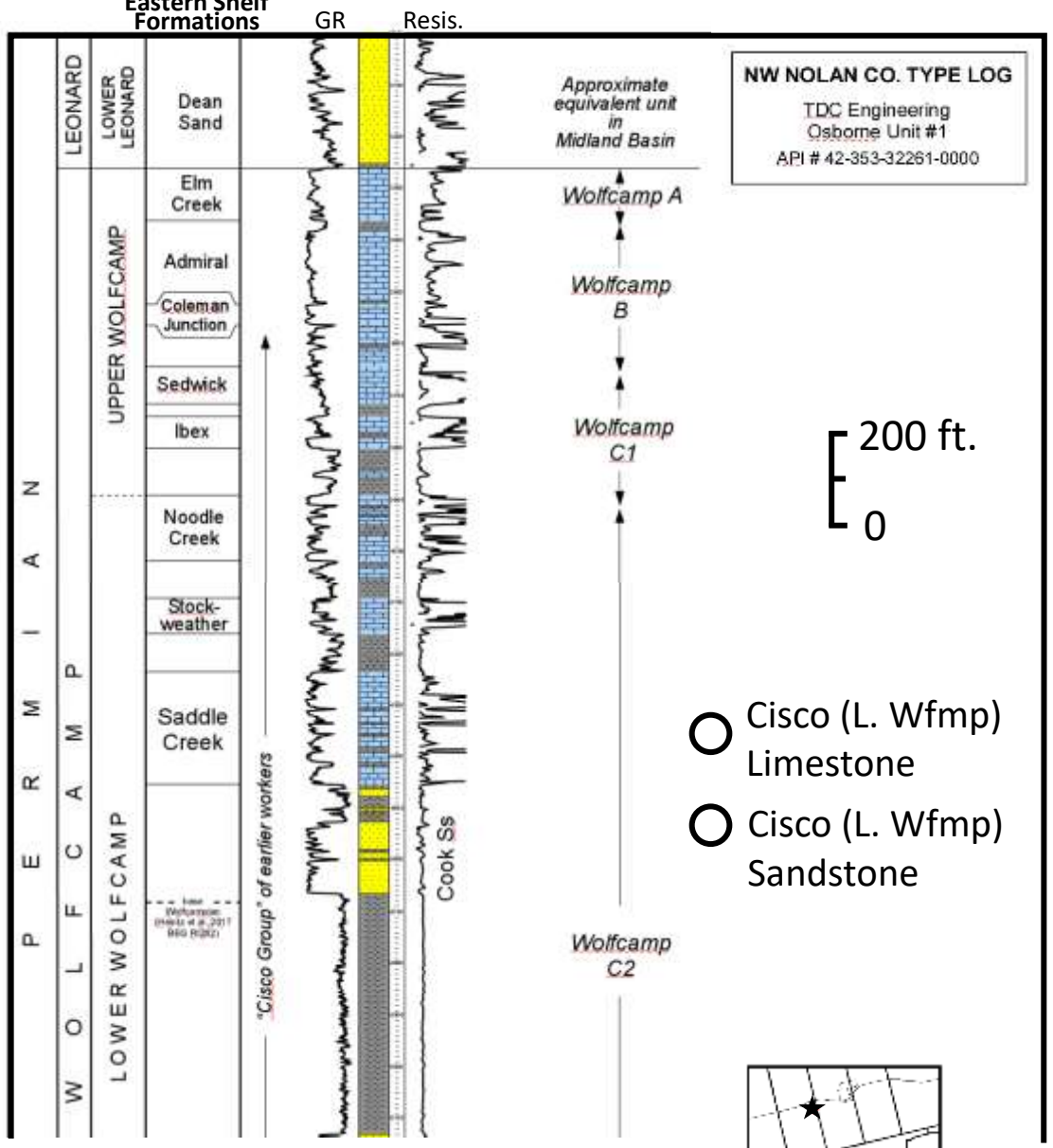
- Permian
- Penn.
- L. Ord. (Ellen-burger)

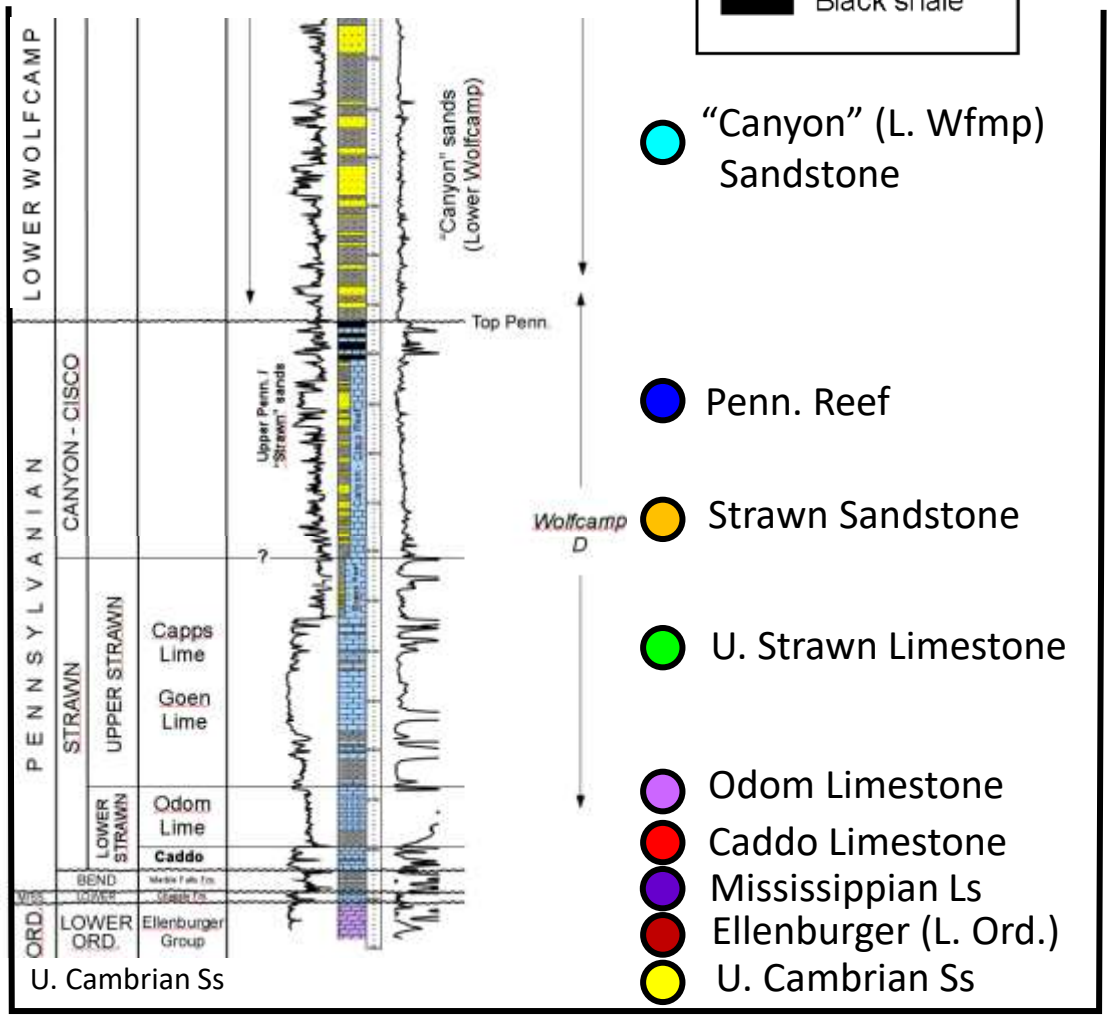
Analysis of Nolan Co. producing trends: Method

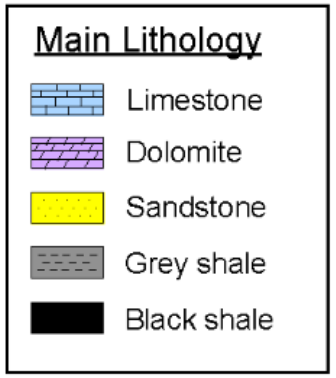
- Export Nolan County wells from Enverus database including producing zone (n = 5123)
- Utilizing Petra, check perforated zones for each well; amend Enverus producing zones ($n_{ammended}$ = 4926)
    - 3.8 % of wells in eliminated mainly due to non-reported perfs
    - Some wells eliminated due to missing API#
- Identify & map a number of high-resolution producing zones (11 total; color-coded by zone)
- Analyze drilling and producing statistics (part 2 of presentation by Yuxiang [Shawn] Zhang)

Note: Individual checking of perf zone(s) in all wells is a very time-consuming, but critical step in the identification and assignment of correct, high-resolution producing zones

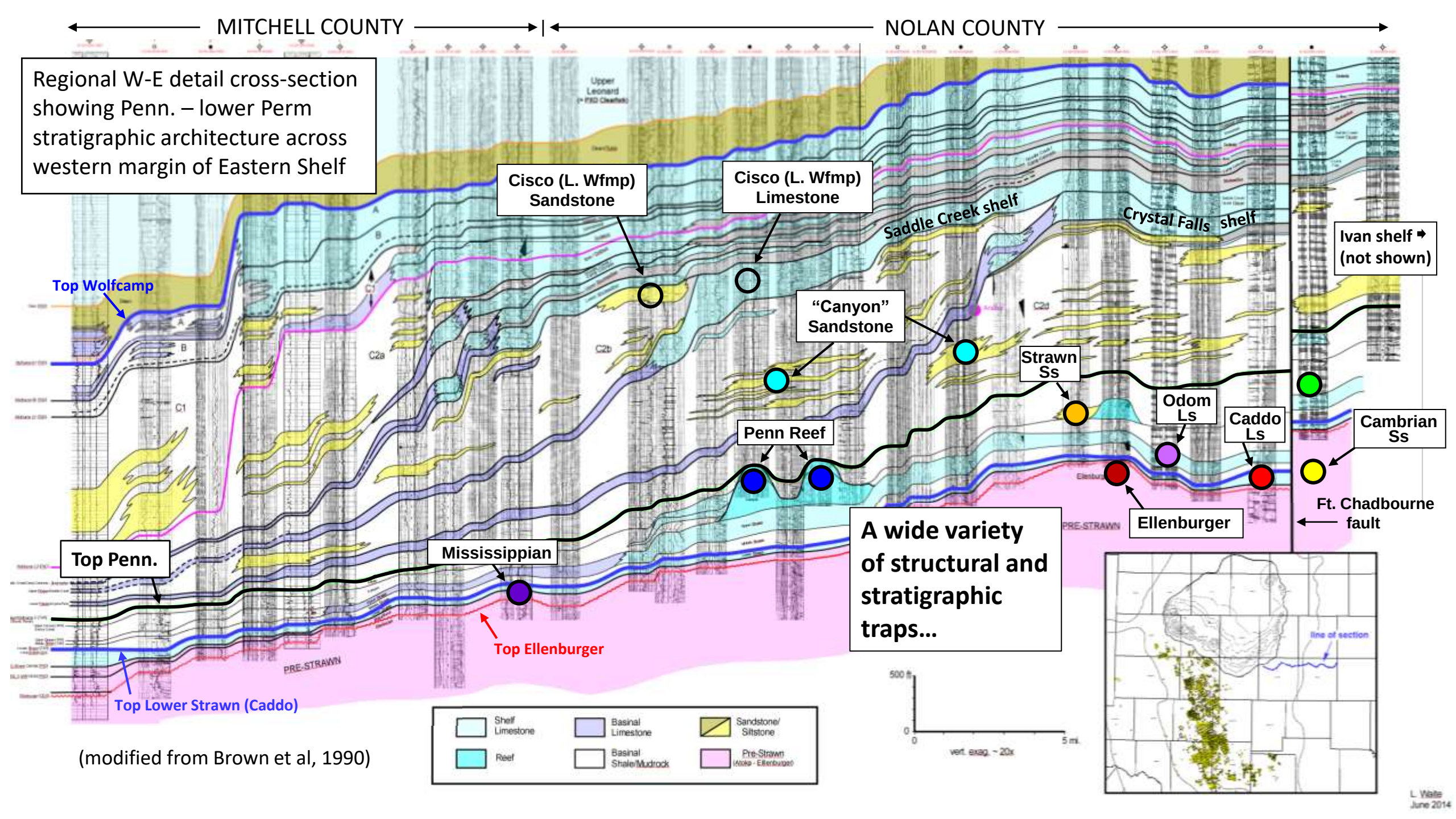
NW Nolan Co. type log showing strat. position of high-resolution producing zones (11)



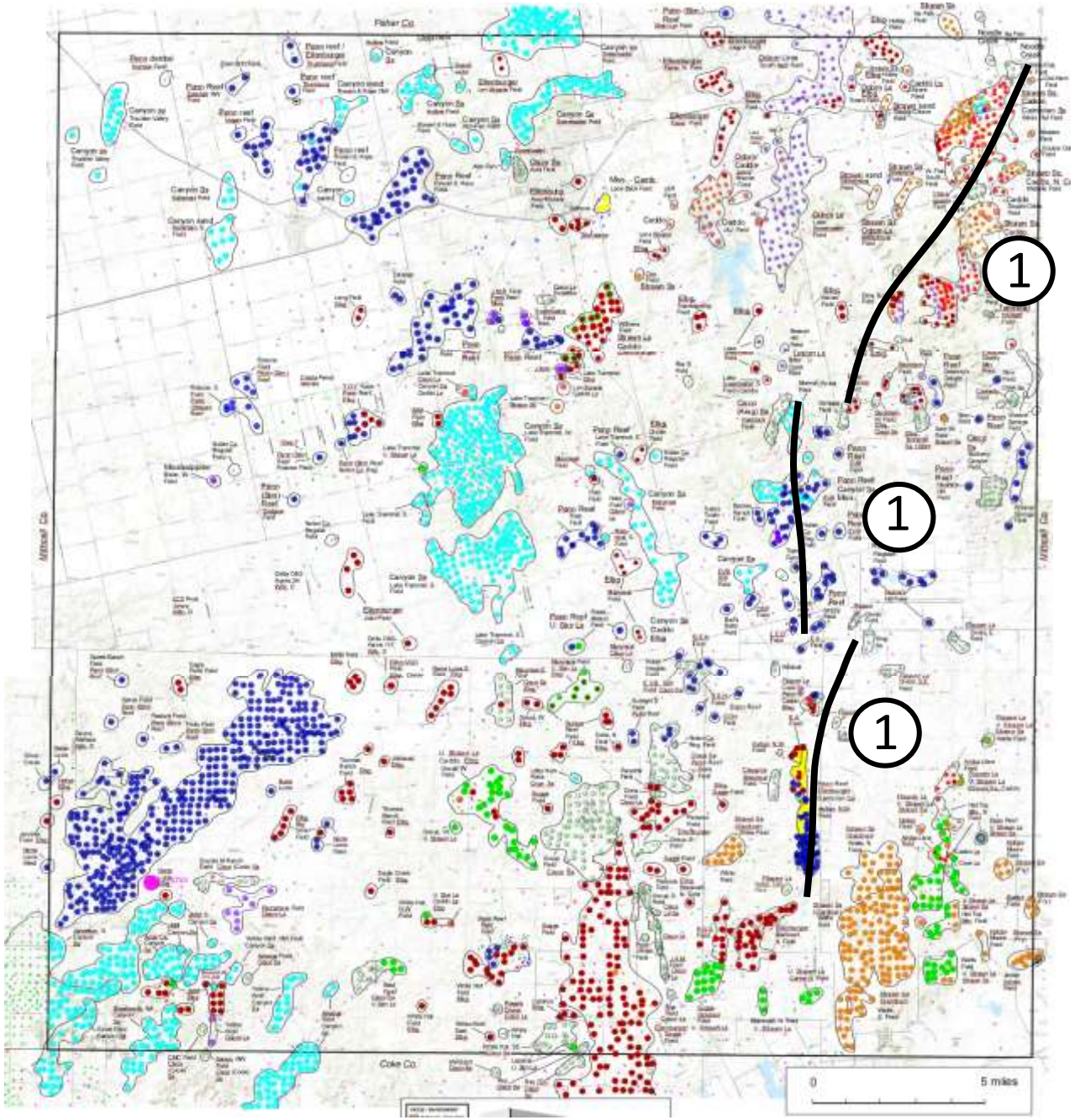




L. Waite, UTD Permian Basin Research Lab
March, 2022


MITCHELL COUNTY
NOLAN COUNTY
Regional W-E detail cross-section showing Penn. – lower Perm stratigraphic architecture across western margin of Eastern Shelf
Upper Leonard
Cisco (L. Wfmp) Sandstone
Cisco (L. Wfmp) Limestone
Saddle Creek shelf
Crystal Falls shelf
Ivan shelf ➡ (not shown)
Top Wolfcamp
"Canyon" Sandstone
Strawn Ss
Odom Ls
Caddo Ls
Cambrian Ss
Penn Reef
Ft. Chadbourne fault
Ellenburger
Top Penn.
Mississippian
Top Ellenburger
PRE-STRAWN
Top Lower Strawn (Caddo)
A wide variety of structural and stratigraphic traps…
line of section
500 ft
0
0
5 mi
vert. exag. ~ 20x
Shelf Limestone
Basinal Limestone
Sandstone/ Siltstone
Reef
Basinal Shale/Mudrock
Pre-Strawn
(modified from Brown et al, 1990)
L. Waite
June 2014

NOLAN COUNTY
PRODUCING TRENDS
MAP



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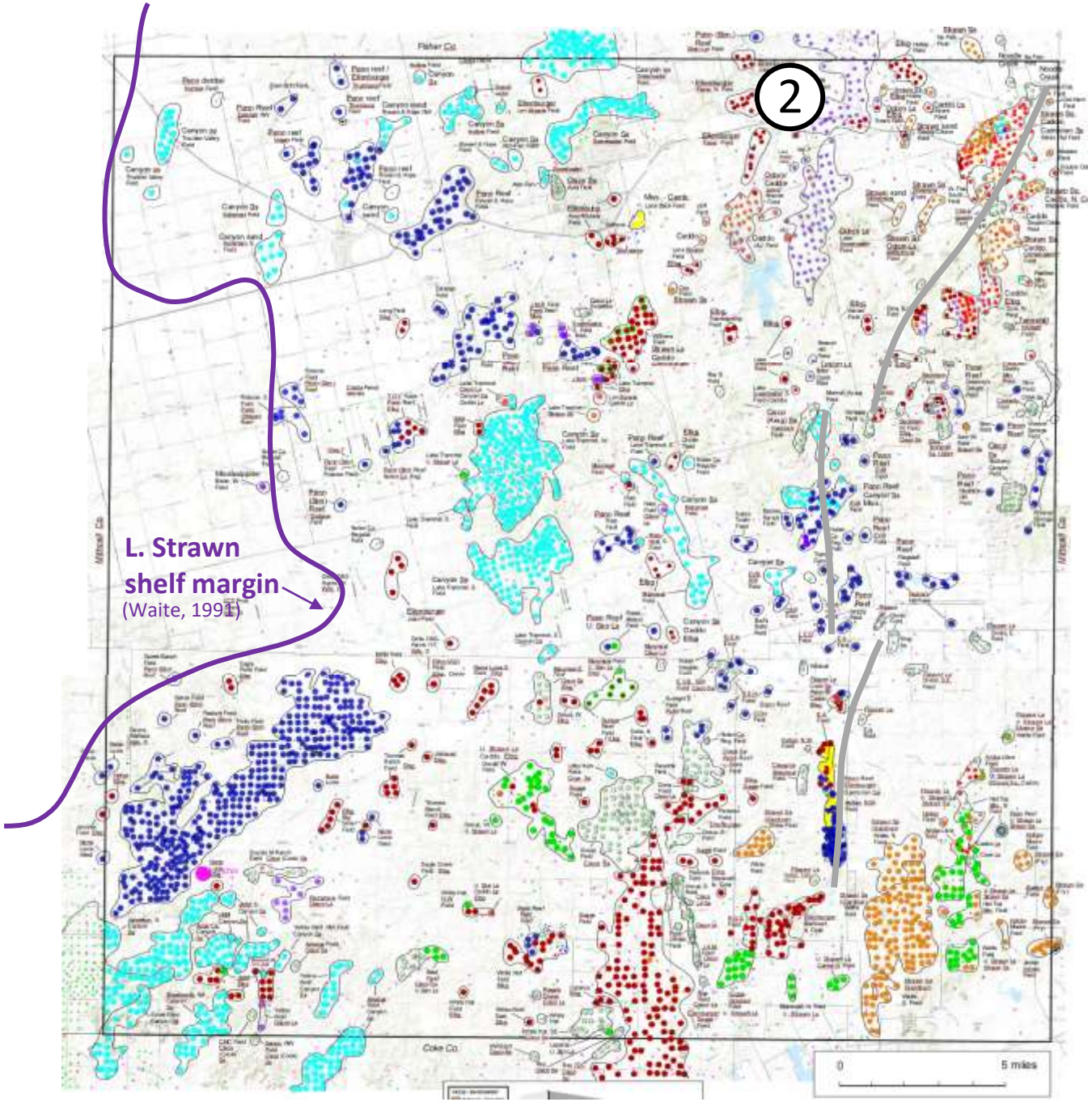
- Canyon Ss
- Penn Reef
- U. Strawn Ls
- Strawn Ss
- Odom Ls
- Caddo Ls
- Mississippian
- Ellenburger
- Camb. Ss

Nolan County Producing Trends

(1) Ft. Chadbourne structural and combination traps; multiple zones (Cambrian Ss, Elbg., Caddo Ls, Strawn Ss., U. Strawn Ls, Penn Reef. Canyon Ss) (faults from Ewing, Tectonic Map of TX)



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2. Odom low-relief, mid-shelf carbonate buildups inboard of shelf margin; also, Caddo grainstones

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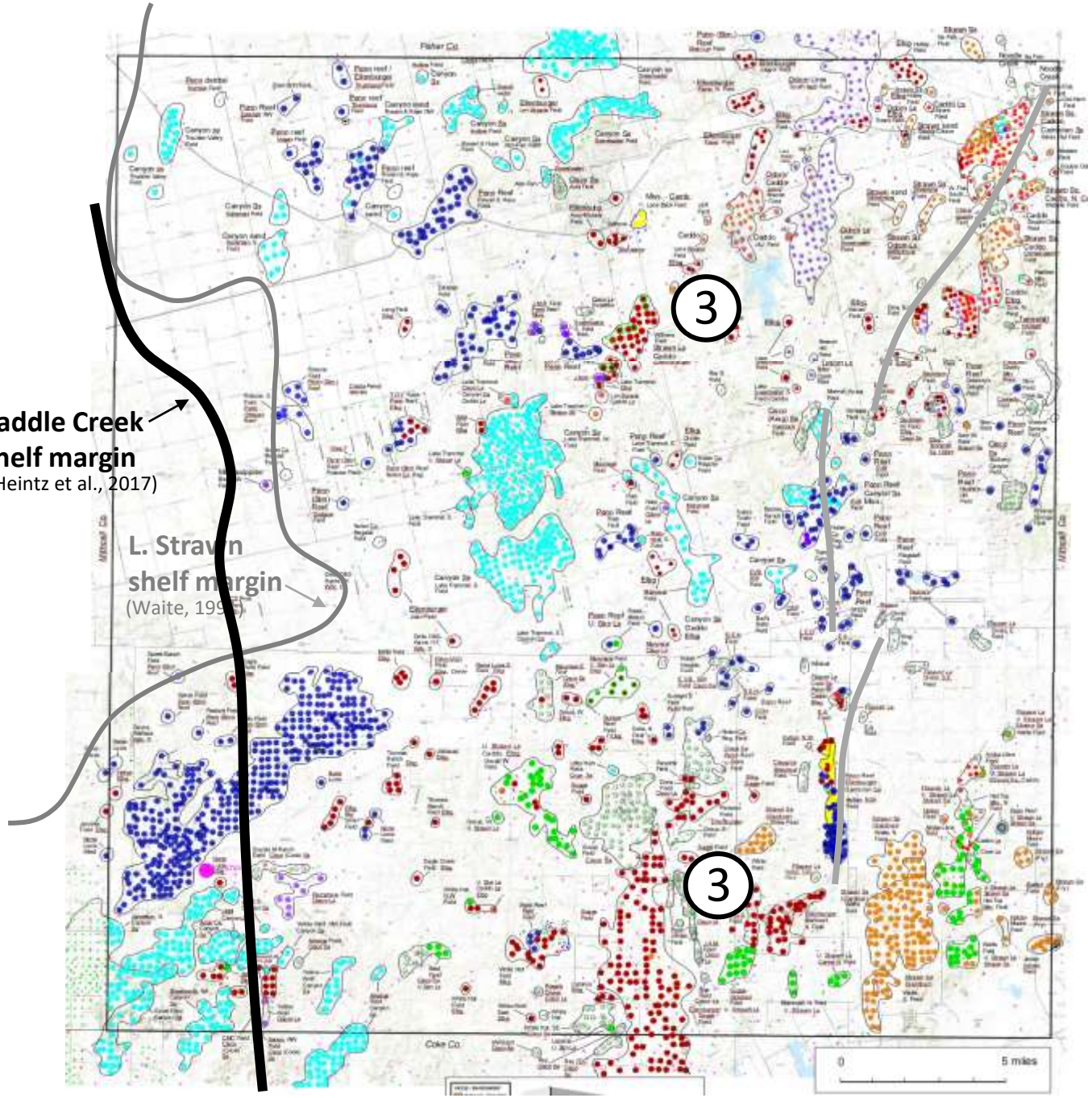

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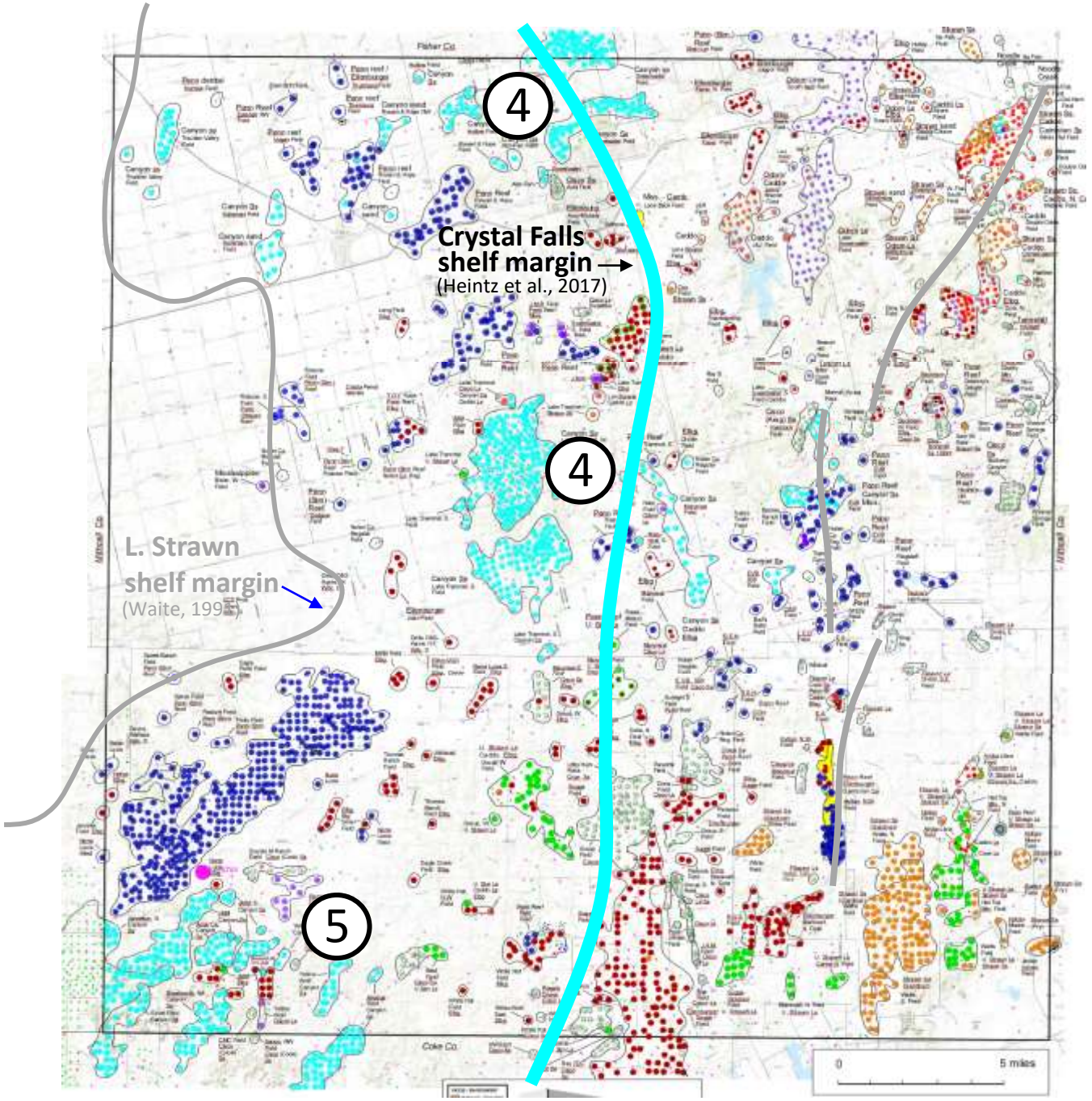

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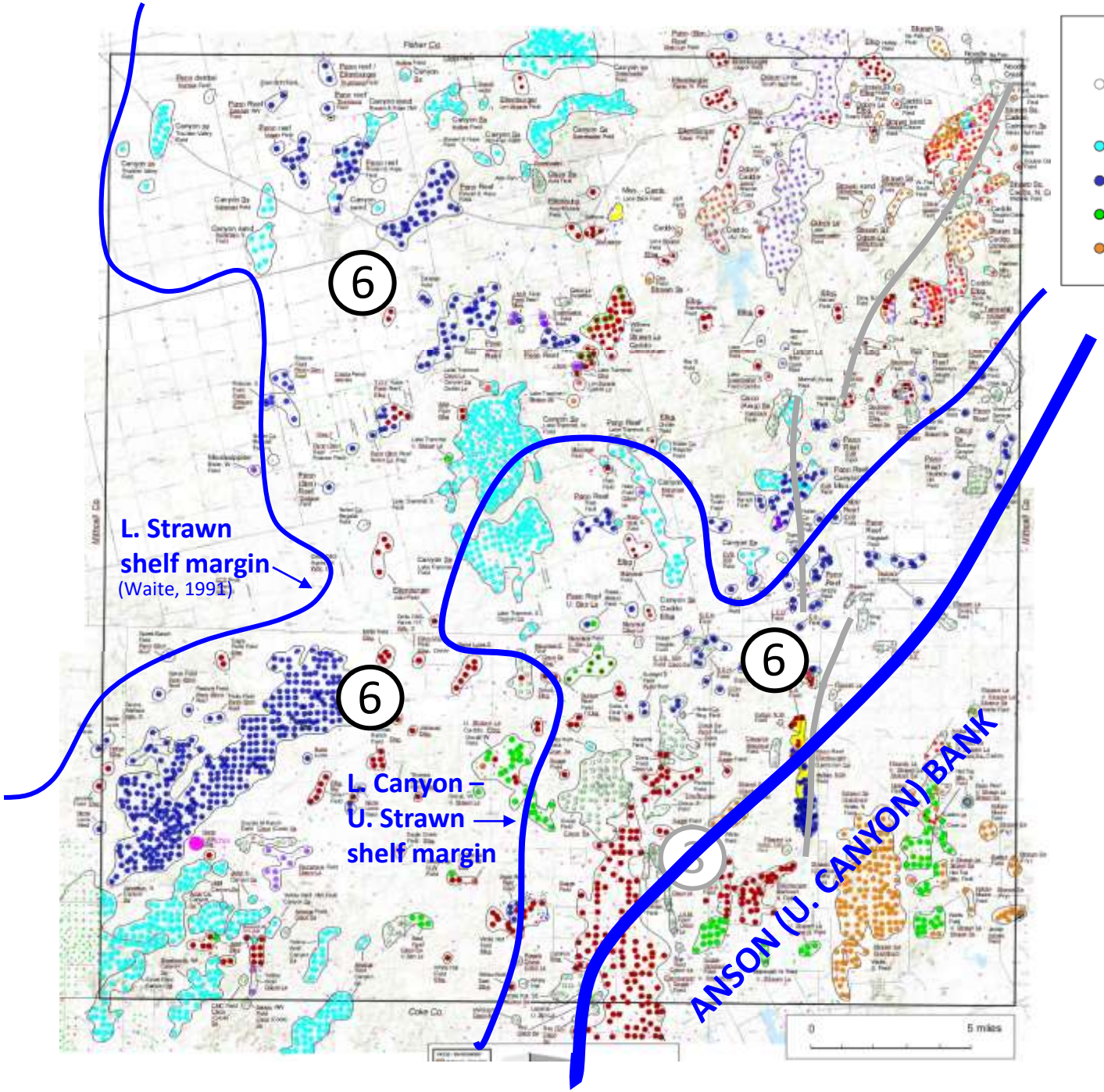

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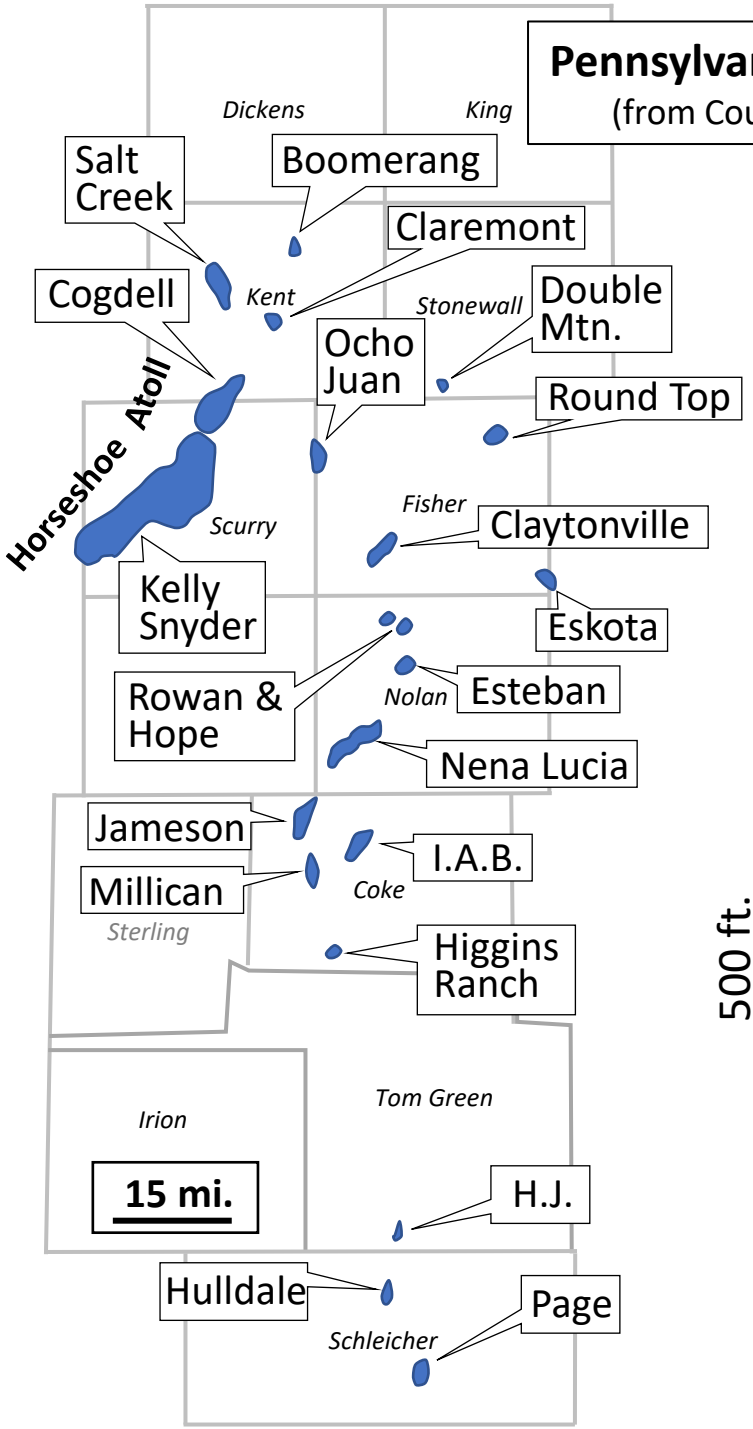
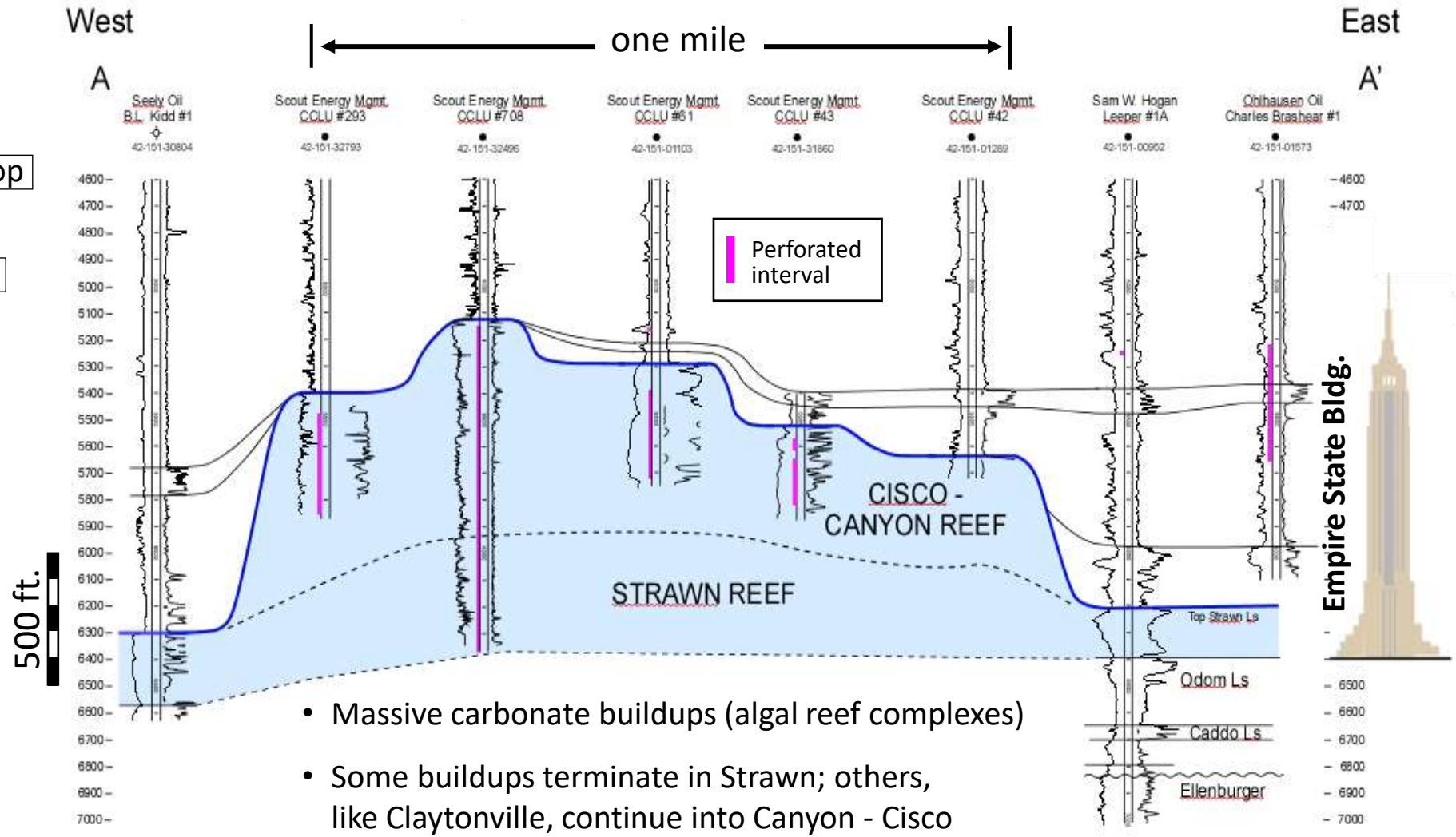
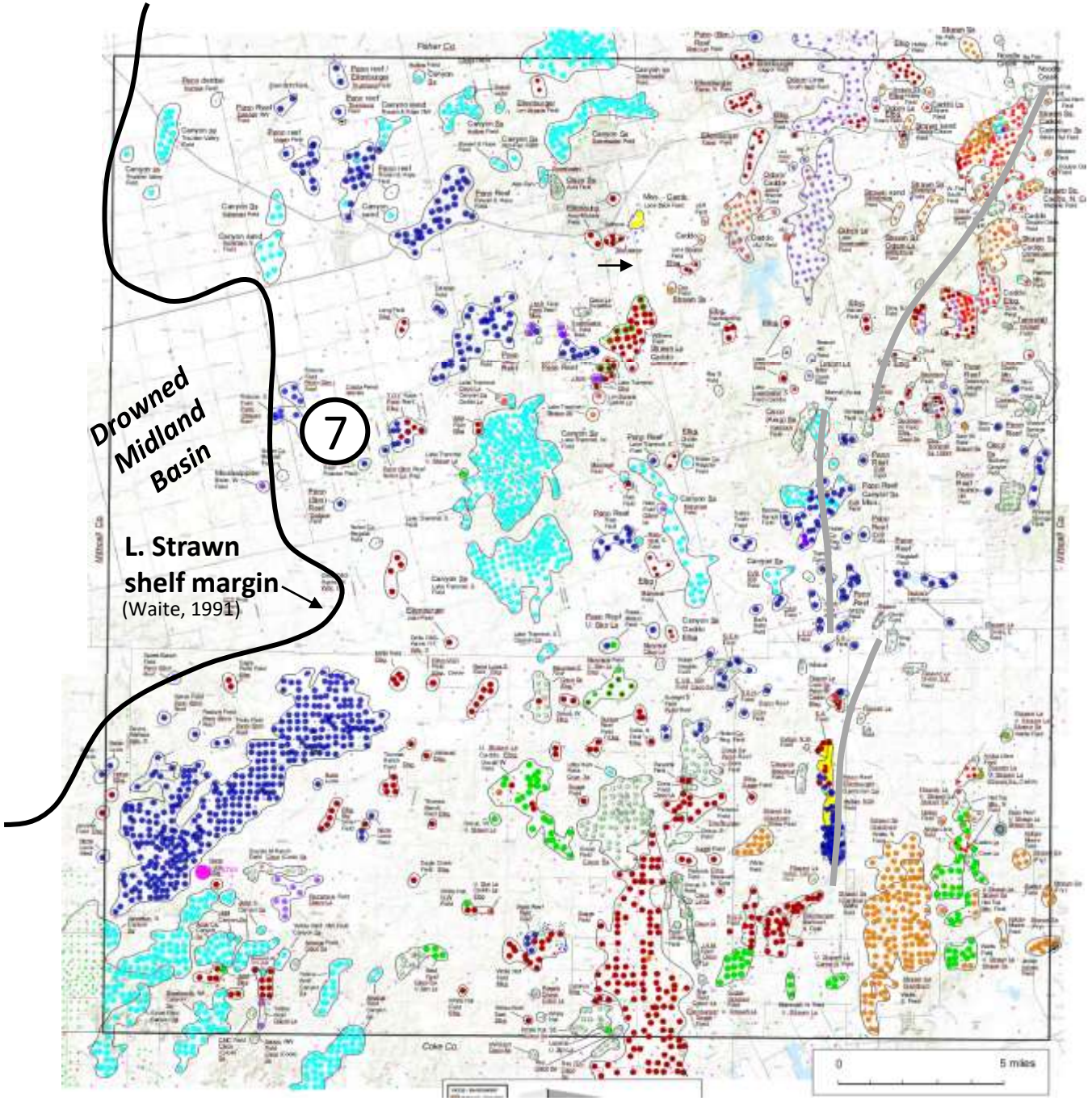
Pennsylvanian Reef Trend
(from Counselman, 1960)



Claytonville Reef, Fisher County



- Massive carbonate buildups (algal reef complexes)
- Some buildups terminate in Strawn; others, like Claytonville, continue into Canyon - Cisco
- Important conventional oil reservoirs Claytonville: ~ 67 MMBO
  Kelly Snyder: 1300 MMBO



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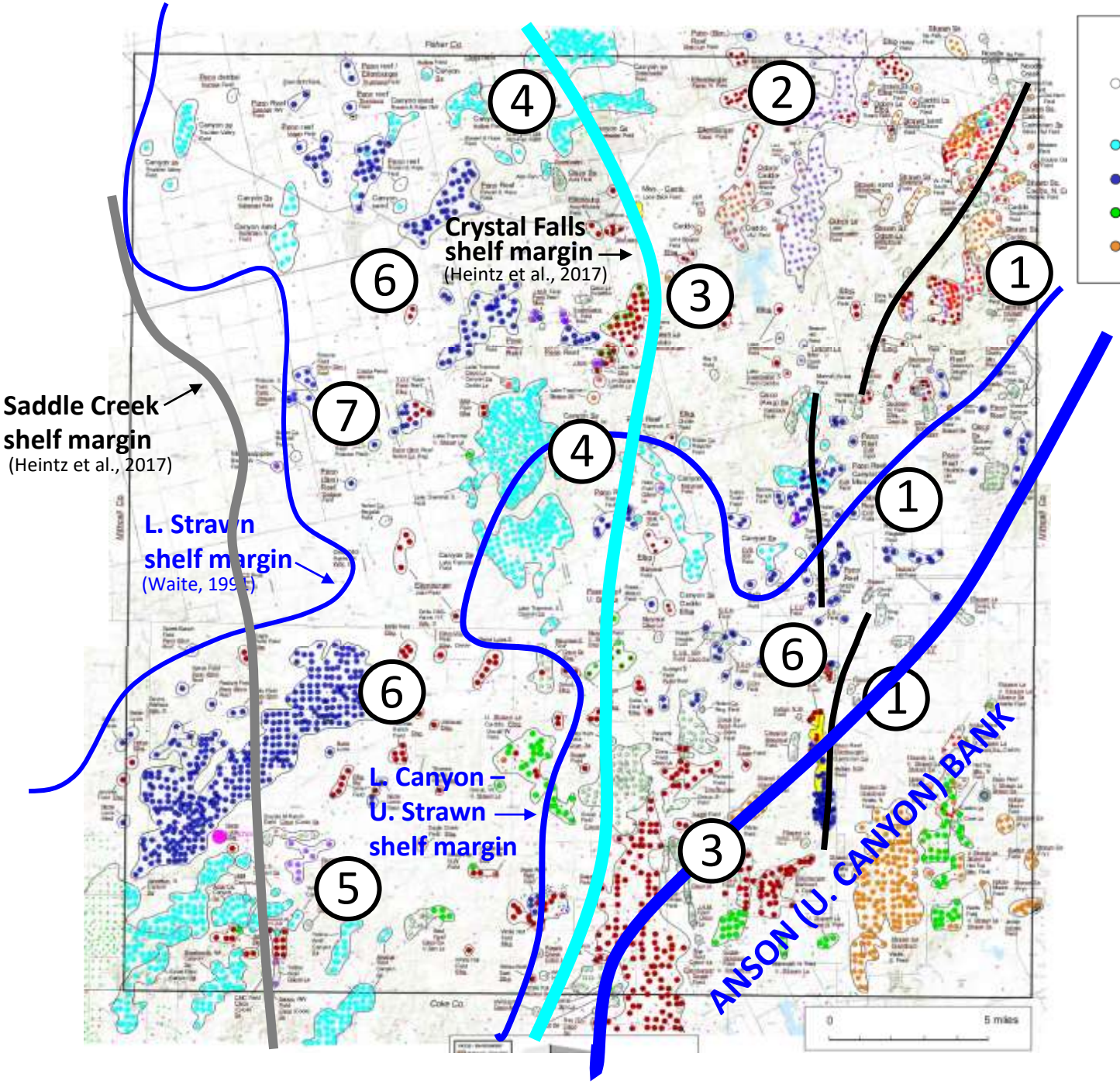

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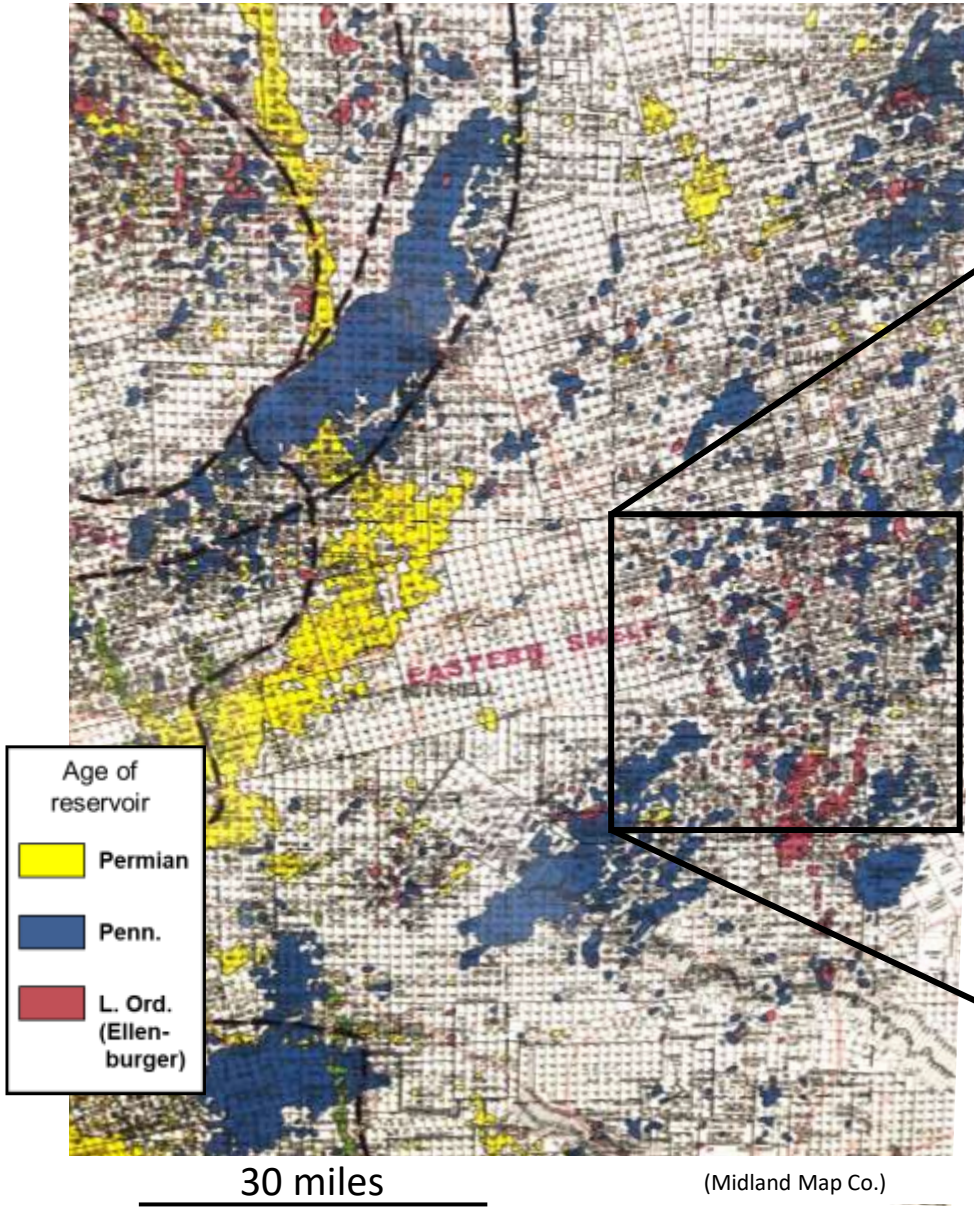

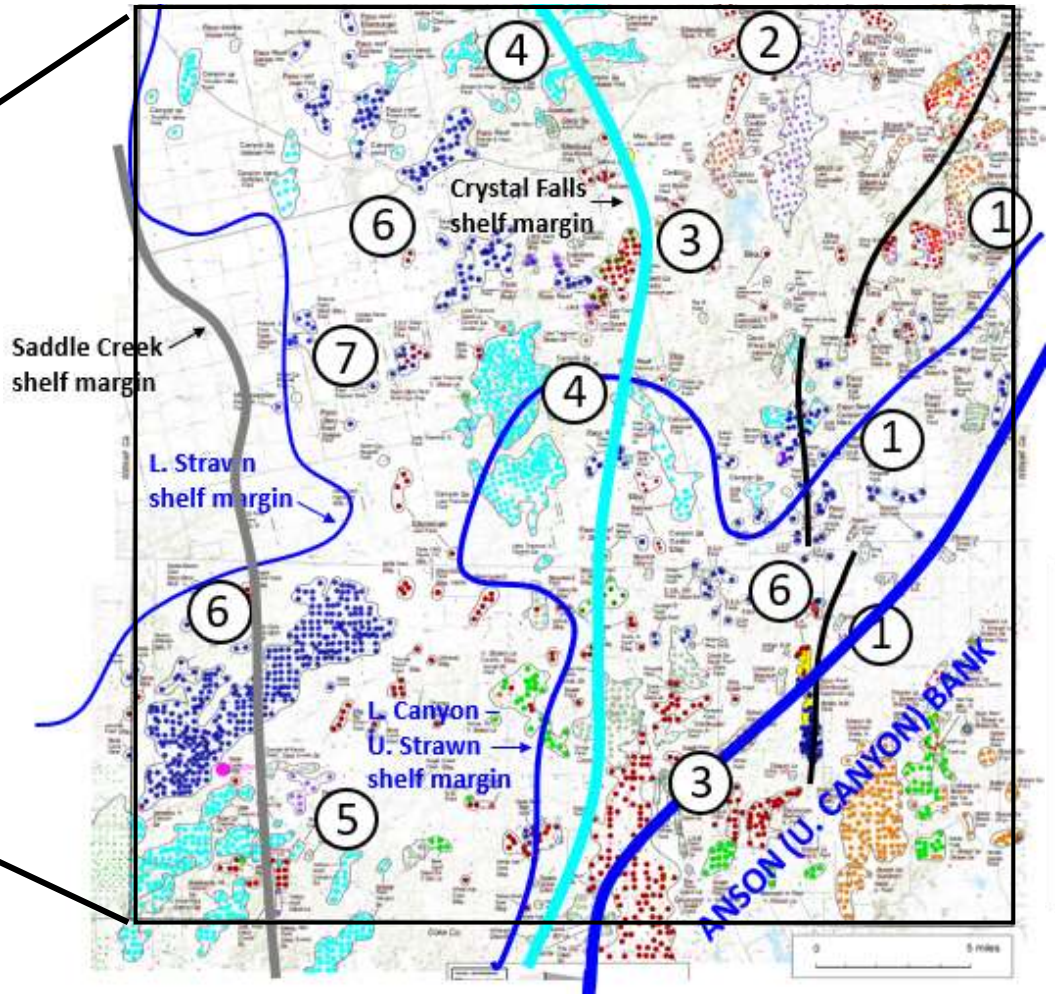

PART II

"Analysis of Producing Zones, Nolan County, Eastern Shelf, Permian Basin"

Dr. Yuxiang (Shawn) Zhang
Research Associate, UTD PBRL
Core Geologic