Influence of Provenance and Sediment Supply on Sandstone Composition and Depositional Styles: Pennsylvanian Upper Morrowan and Cherokee, Oklahoma:
Why Are These Sandstones so Different?*

Jim Puckette[1]

Search and Discovery Article #51223 (2016)**
Posted February 29, 2016

*Adapted from oral presentation given at AAPG Mid-Continent Section Meeting, Tulsa, Oklahoma, October 4-6, 2015, Tulsa, OK

[1]Oklahoma State University, Stillwater, OK (jim.puckette@okstate.edu)

Abstract

Pennsylvanian (Cherokee) fluvio-deltaic complexes prograded southward toward the Arkoma and Anadarko basins and contain channel-fill, delta-fringe and delta-plain deposits. During lowstand, sediment was transported across the exposed shelf and deposited on the basin slope or floor, or redistributed as shallow-marine bars. In contrast, upper Morrowan sandstones form linear trends interpreted as valley fills and contain evidence of increased marine influence toward the top. It is proposed that drainage-basin size and paleoclimate influenced sediment supply. Cherokee fluvio-deltaic complexes were well supplied with sand derived from an extensive drainage basin with shield areas that provided a distinct metamorphic detrital compositional signature. In contrast, upper Morrow valleys were undersupplied with sand. Lowstand deposits are thin clay-clast-rich channel-lag conglomerates. The incomplete filling of valleys with sand reflects a smaller drainage basin predominantly on sedimentary rocks that weathered mostly to mud, but provided chert as an important detrital grain. Sand transported across the shelf was diluted with mud in the Morrowan sea. During transgression, sand was trapped in the valleys, but the limited volume was insufficient to fill valleys and estuarine and marine deposits dominate the upper portions of valley fills. Wetter climate and the Wichita-Arbuckle orogenic belt possibly heightened seasonal storm intensity, facilitating Cherokee sediment transport.

References Cited

Al-Shaieb, Z., J. Shelton, J. Puckette, and D. Boardman, 1995, Sandstone and carbonate reservoirs of the Mid-continent, Syllabus for Short Course, OCGS-OSU Core Workshop: Oklahoma City Geological Society, 194 p.

Astarita, A.M., 1975, Depositional trends and environments of "Cherokee" sandstones, east-central Payne County, Oklahoma: unpublished M.S. thesis, Oklahoma State University, 50 p.

Anderson, C.J., 1992, Distribution of submarine fan facies of the upper Red Fork interval in the Anadarko Basin, western Oklahoma: unpublished M.S. thesis, Oklahoma State University, 275 p.

Blakey, R., 2014, North American Paleogeographic Maps: CP Geosystems, Early Pennsylvanian (315 Ma) and Late Pennsylvanian (300Ma). Website accessed February 11, 2016, https://www2.nau.edu/rcb7/nam.html; https://www2.nau.edu/rcb7/namPP315.jpg; https://www2.nau.edu/rcb7/namPP300.jpg.

Chandler, C.E., 1977, Subsurface stratigraphic analysis of selected sandstones of the "Cherokee" Group, southern Noble County, Oklahoma: Shale Shaker, v. 28/3, p. 56 [part 1]; v. 28/4, p. 72-83 [part 2].

Clement, W.A., 1994, East Clinton Field, *in* S. Takken and E.P. Kerr, editors, Oil and Gas Fields of Oklahoma, Volume 2: Oklahoma City Geological Society, 181 p.

Cockrell, D.R., 1985, Stratigraphy, distribution and structural geology of Lower and Middle Pennsylvanian sandstones in adjacent portions of Okfuskee and Seminole counties, Oklahoma: unpublished M.S. thesis, Oklahoma State University, 55 p.

Cole J.G., 1968, Stratigraphic study of the Cherokee and Marmaton sequences, Pennsylvanian (Desmoinesian) east flank of the Nemaha Ridge, north-central Oklahoma: unpublished Ph.D. dissertation, University of Oklahoma, 90 p.

Folk, R.L., 1974, Petrology of sedimentary rocks: Austin Texas, Hemphill's Book Store, 170 p.

Gerken, L.D., 1992, Morrowan sandstones in south-central Texas County, Oklahoma: unpublished M.S. thesis, Oklahoma State University, 414 p.

Habicht, J.K.A, 1979, Paleoclimate, Paleomagnetism, and Continental Drift: AAPG Studies in Geology 9, 29 p.

Harrison, J.C., 1990, "Upper" Morrow Purdy sandstones in parts of Texas and Cimarron Counties, Oklahoma: unpublished M.S. thesis, Oklahoma State University, 95 p.

Lojeck, C.A., 1984, Petrology, diagenesis and depositional environment of the Skinner Sandstone, Desmoinesian, northeastern Oklahoma platform: unpublished M.S. thesis, Oklahoma State University, 158 p.

Masera Corporation, 1994, Red Fork Sandstone of Oklahoma.

Munson, T.W., 1989, Depositional, diagenetic and production history of the upper Morrowan Buckhaultz sandstone, Farnsworth Field, Ochiltree County, Texas: Oklahoma City Geological Society Shale Shaker Digest, vol. XXXX-XXXXIV, p. 2-20.

Phillips, T.L., R.A. Peppers, and W.A. DiMichele, 1985, Stratigraphic and interregional changes in Pennsylvanian coal-swamp vegetation: environmental inferences: International Journal of Coal Geology, p. 43-110.

Puckette, J., 1990, Depositional setting, facies, and petrology of Cabaniss (Upper "Cherokee") Group in Beckham, Dewey, Custer, Ellis, Roger Mills, and Washita Counties, Oklahoma: unpublished M.S. thesis, Oklahoma State University, 144 p.

Puckette, J., A. Abdalla, Z. Al-Shaieb, and A. Rice, 1996, The upper Morrow reservoirs: Complex fluvio-deltaic depositional systems, *in* K.S. Johnson and J. A. Campbell, editors, Fluvial-dominated deltaic reservoirs in the southern Midcontinent, Oklahoma Geological Survey Circular 98, p. 47-84.

Pulling, D.M., 1979, Subsurface stratigraphic and structural analysis, Cherokee Group, Pottawatomie County, Oklahoma: Shale Shaker, v. 29/6, p. 124-137 [part 1]; v. 29/7, p. 148-158 [part 2].

Rascoe, B., Jr., and F.J. Adler, 1983, Permo-Carboniferous hydrocarbon accumulations, Mid-Continent U.S.A.: AAPG Bull., v. 67, p. 979-1001.

Ross, C.A., and J.R.P. Ross, 1987, Biostratigraphic zonation of Late Paleozoic depositional sequences: Cushman Foundation Foraminiferal Research, Special Publications, no. 24, p. 151-168.

Shipley, R.D., 1977, Local depositional trends of “Cherokee” sandstones, Payne County, Oklahoma: Shale Shaker v. 28/2, p. 24-35 [part 1]; v. 28/3, p. 48-55 [part 2].

Shulman, C., 1966, Stratigraphic analysis of the “Cherokee” Group in adjacent portions of Lincoln, Logan and Oklahoma counties, Oklahoma: Shale Shaker, v. 16/6, p. 126-140.

Siemers, W.A., 2003, Distribution and reservoir properties of Lower Skinner valley fill sandstones, Payne County, Oklahoma: unpublished M.S. thesis, Oklahoma State University, 111 p.

Swanson, D.C., 1979, Deltaic deposits in the Pennsylvanian Upper Morrow formation of the Anadarko Basin, *in* Pennsylvanian Sandstones of the Midcontinent: Tulsa Geological Society Special Publication 1, p. 115-168.

Valderrama, R., 1976, The Skinner sandstone zone of central Oklahoma: Shale Shaker, v. 26/5, p. 86-98 [part 1]; v. 26/6, p. 106-114 [part 2].

Verish, N.P., 1979, Reservoir trends, depositional environments and petroleum geology of “Cherokee” sandstones in T11-13N, R4-5E, central Oklahoma: Shale Shaker, v. 29/9, p. 209 [part 1]; v.29/10, p. 224-237 [part 2].

Influence of Provenance and Sediment Supply on Sandstone Composition and Depositional Styles: Pennsylvanian Upper Morrowan and Cherokee, Oklahoma

Why are these sandstones so different?

Jim Puckette
Boone Pickens School of Geology
Oklahoma State University

Acknowledgements

Boone Pickens School of Geology, Oklahoma State University

American Association of Petroleum Geologists

Chuck Anderson

Adam DeVries

Many graduate students who completed theses on Cherokee and Morrowan sandstones

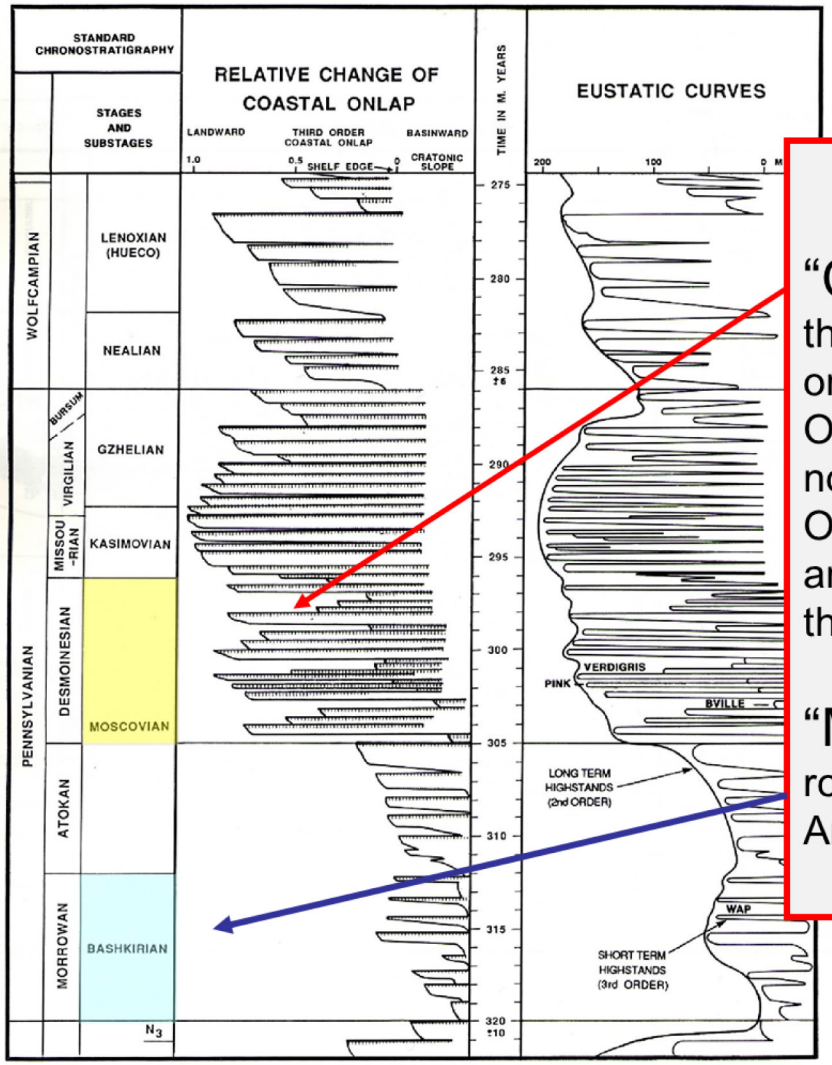
John Shelton, Gary Stewart, Rick Fritz and Masera Corporation

Objectives

Examine the depositional style and composition of Morrowan and Desmoinesian sediment dispersal systems

Consider factors that influence depositional style and composition to determine if there is a fundamental difference between the Morrowan and Desmoinesian dispersal systems

Stratigraphy



Cyclic chart (coastal onlap and eustacy) for the Pennsylvanian (Ross and Ross, 1987).

"Cherokee" – Operational term for the Desmoinesian Cherokee Group on Oklahoma Platform, northeastern Oklahoma. "Cherokee" operational nomenclature extended to western Oklahoma and includes Prue, Skinner and Red Fork sandstone intervals in the Anadarko Basin

"Morrow" – Operational term for rocks of Morrowan Series (North America), Pennsylvanian

Data used in this study

Observations based on examination of over 50 cores, thousands of wireline logs from oil and gas wells and key outcrops

"Cherokee" depositional style: distribution of sand bodies, geometry and sandstone/shale ratios

"Cherokee" composition: detrital grains identified using thin-section petrography

Upper Morrow depositional style: distribution of sand bodies, geometry and sandstone shale/ratios

Composition: detrital grains

Desmoinesian “Cherokee”central and western Oklahoma

Prue

Upper Skinner

Lower Skinner

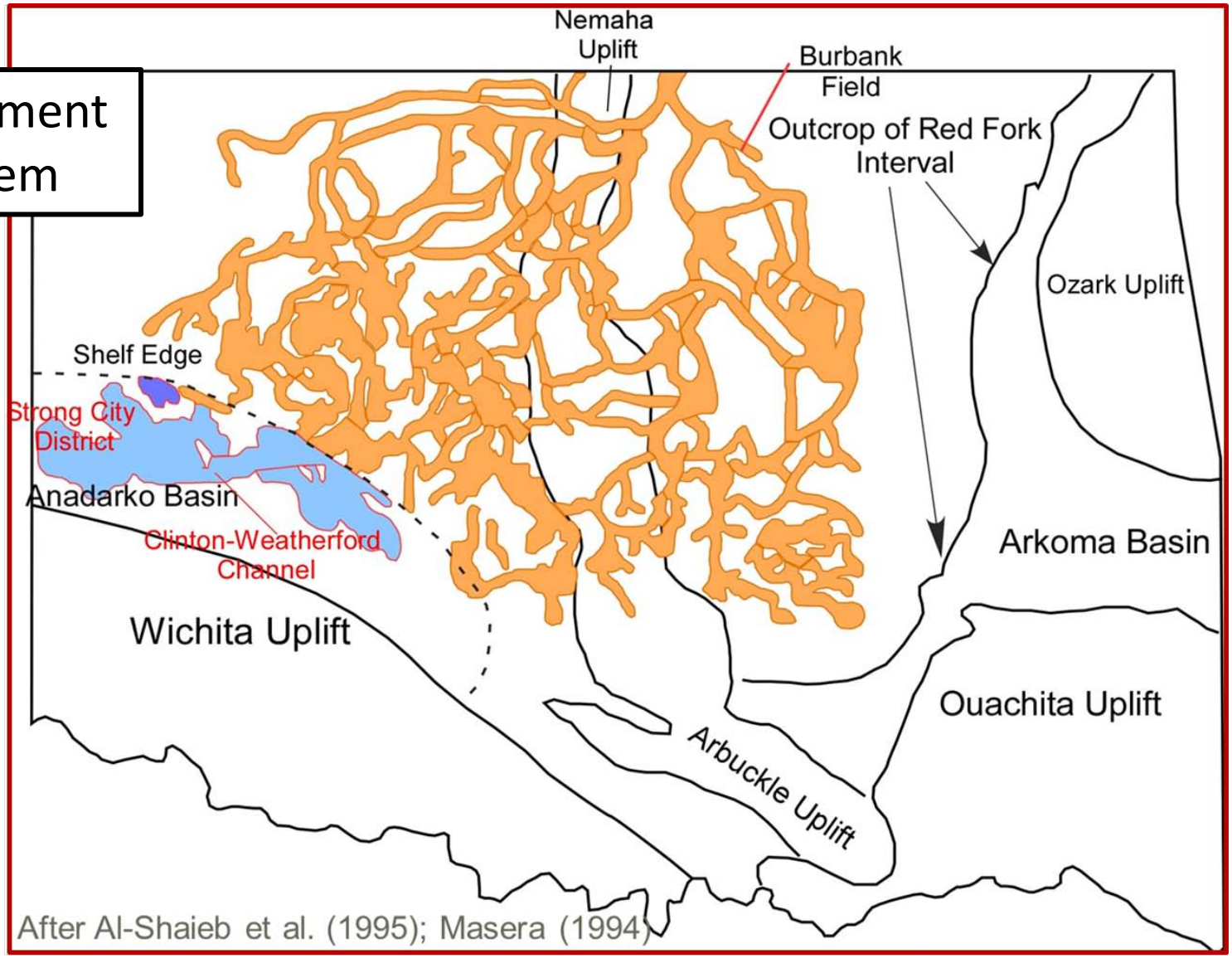
Red Fork

Bartlesville

Fluvio-deltaic complexes with channel, delta-plain and delta-fringe environments,
as well as shallow-marine bars, slope channels and submarine fans

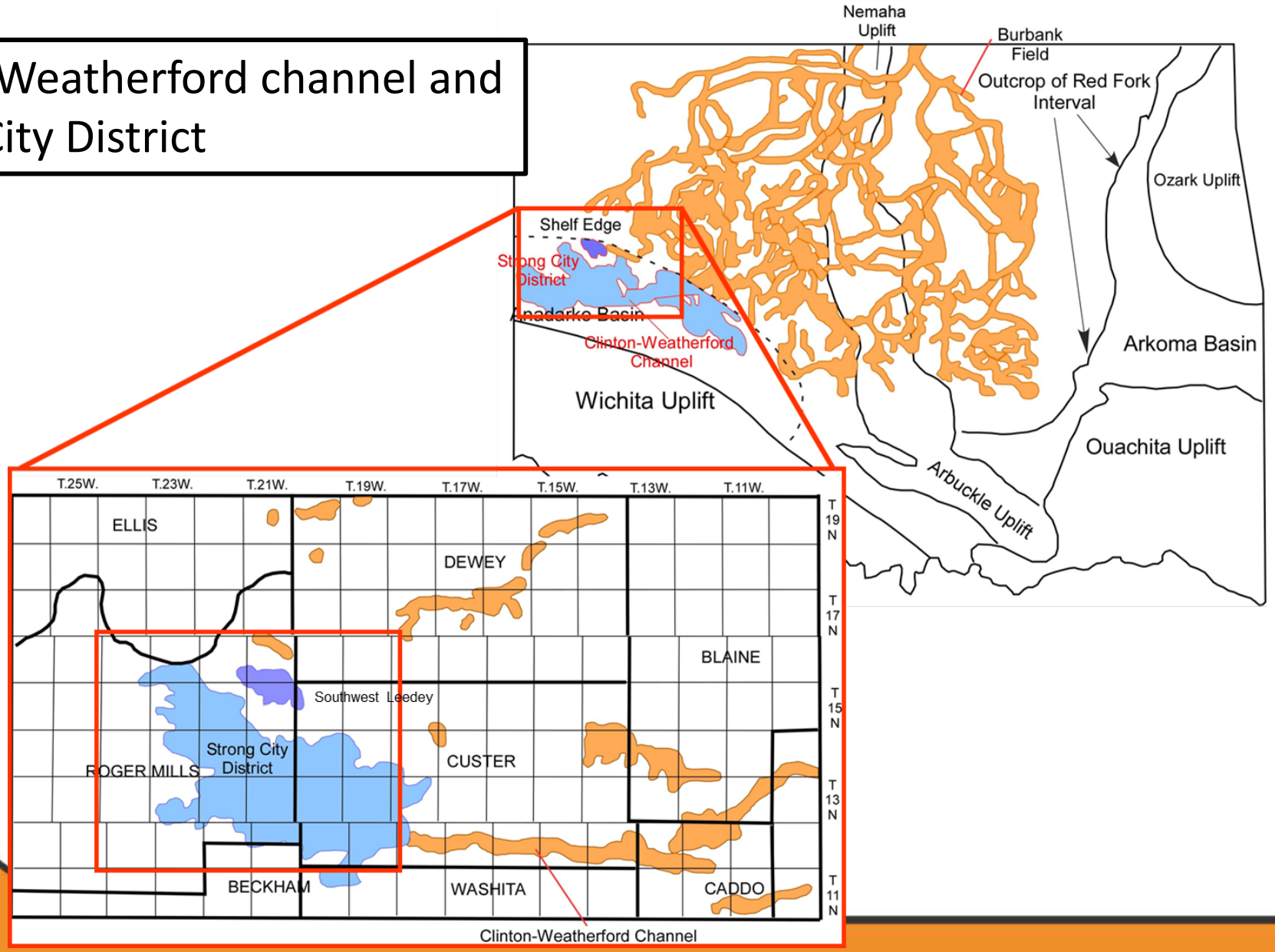
Cherokee: Red Fork sand dispersal system

Red Fork sediment dispersal system

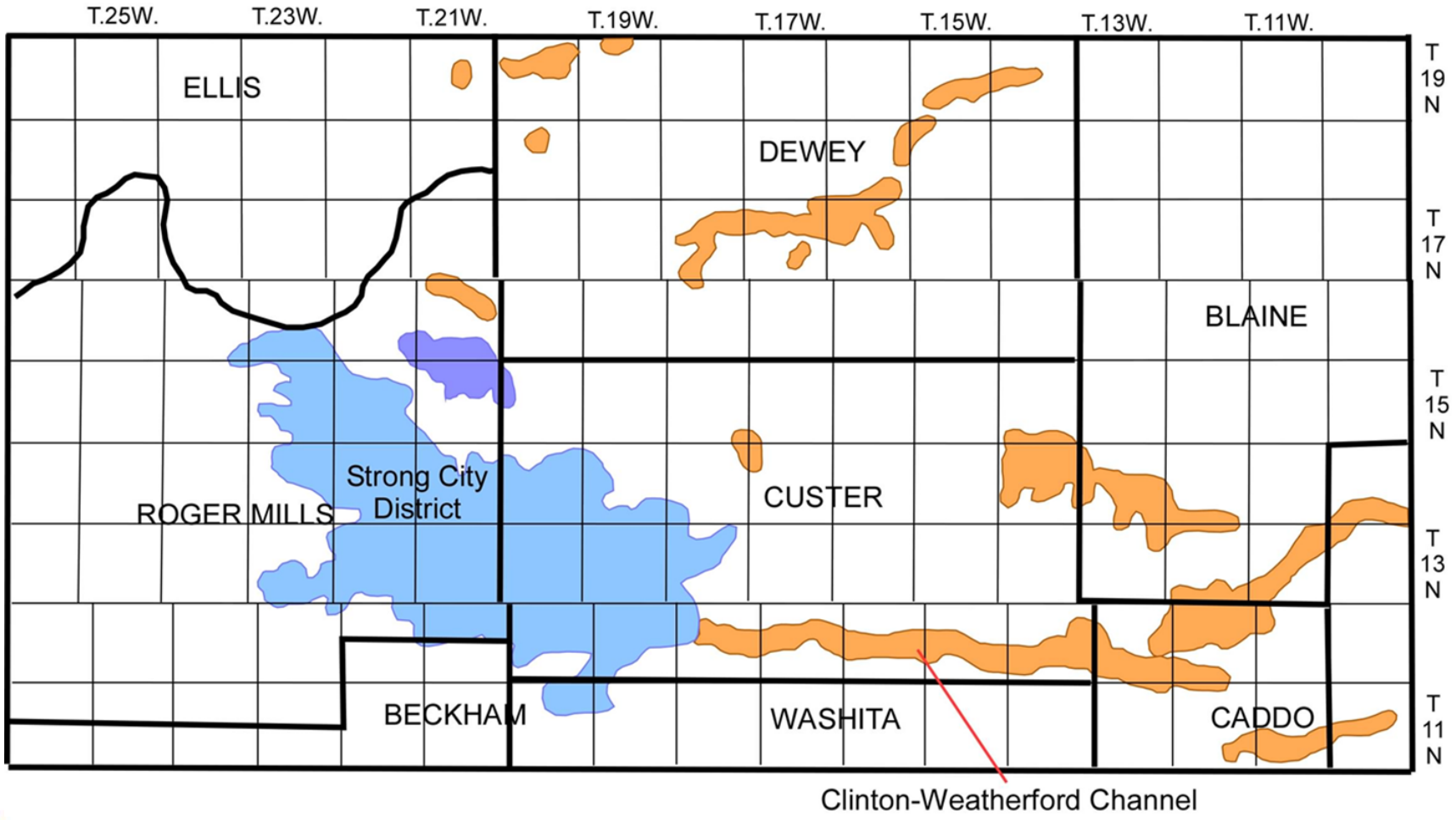


Cherokee: Red Fork sandstone lowstand incision and deposition of basin floor fan

Clinton-Weatherford channel and Strong City District

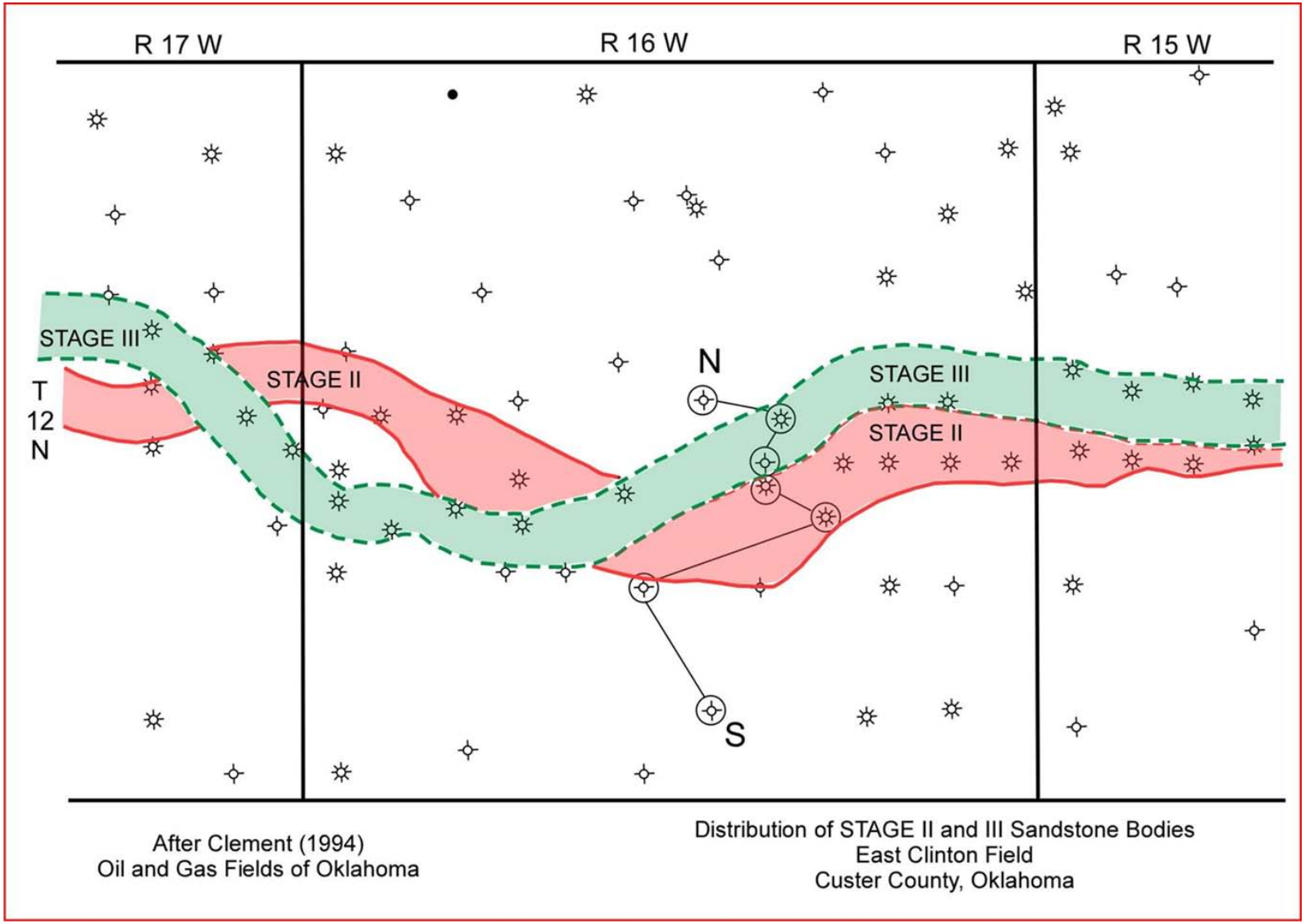


Cherokee: Red Fork sandstone lowstand incision and deposition of basin floor fan

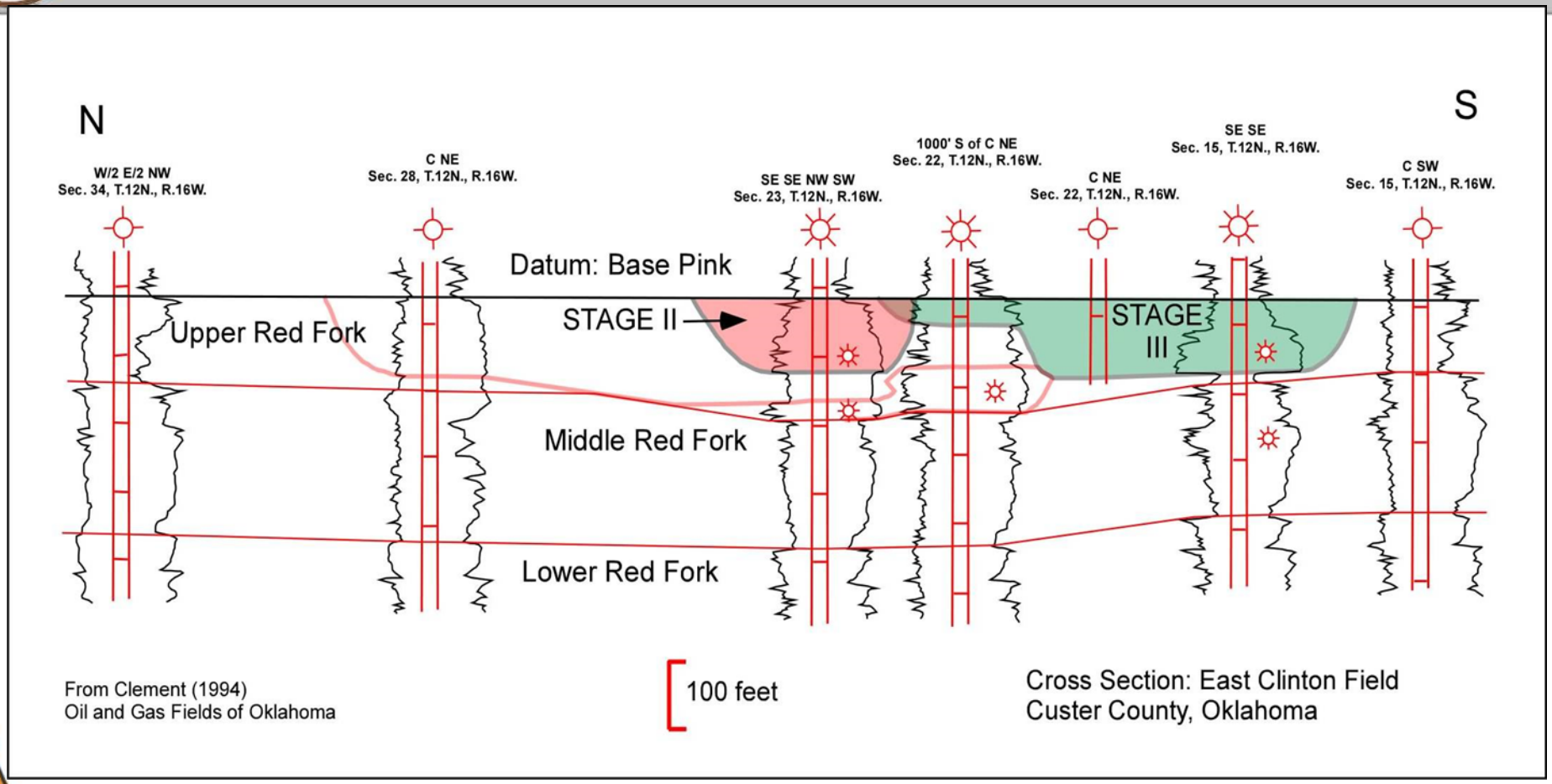


East Clinton Field: lack of accommodation forces incision and sediment dispersal to the west

Cherokee: Red Fork sandstone in East Clinton Field



Cherokee: Red Fork sandstone in East Clinton Field

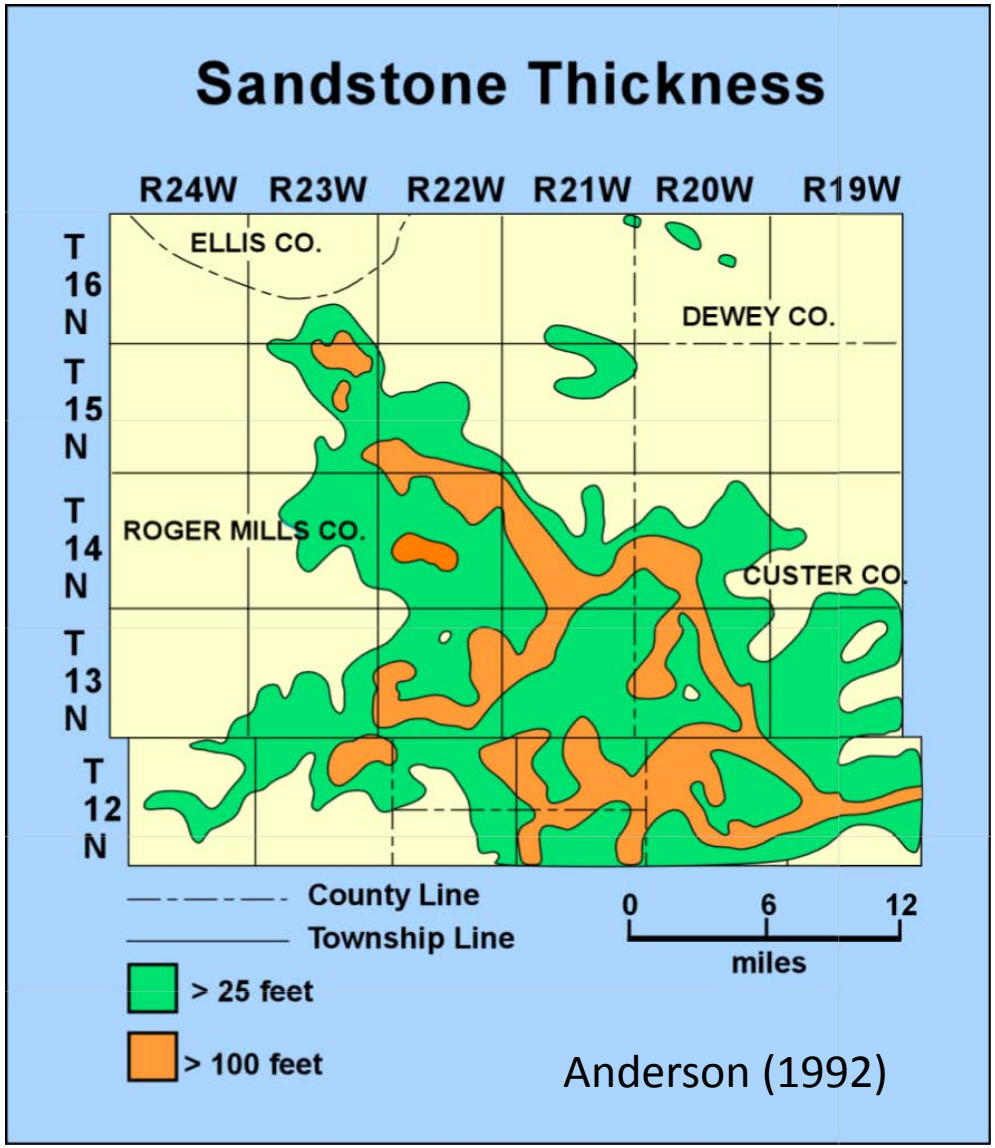


Heterogeneity of fill in the East Clinton valley

Cherokee: Red Fork sandstone in Strong City District

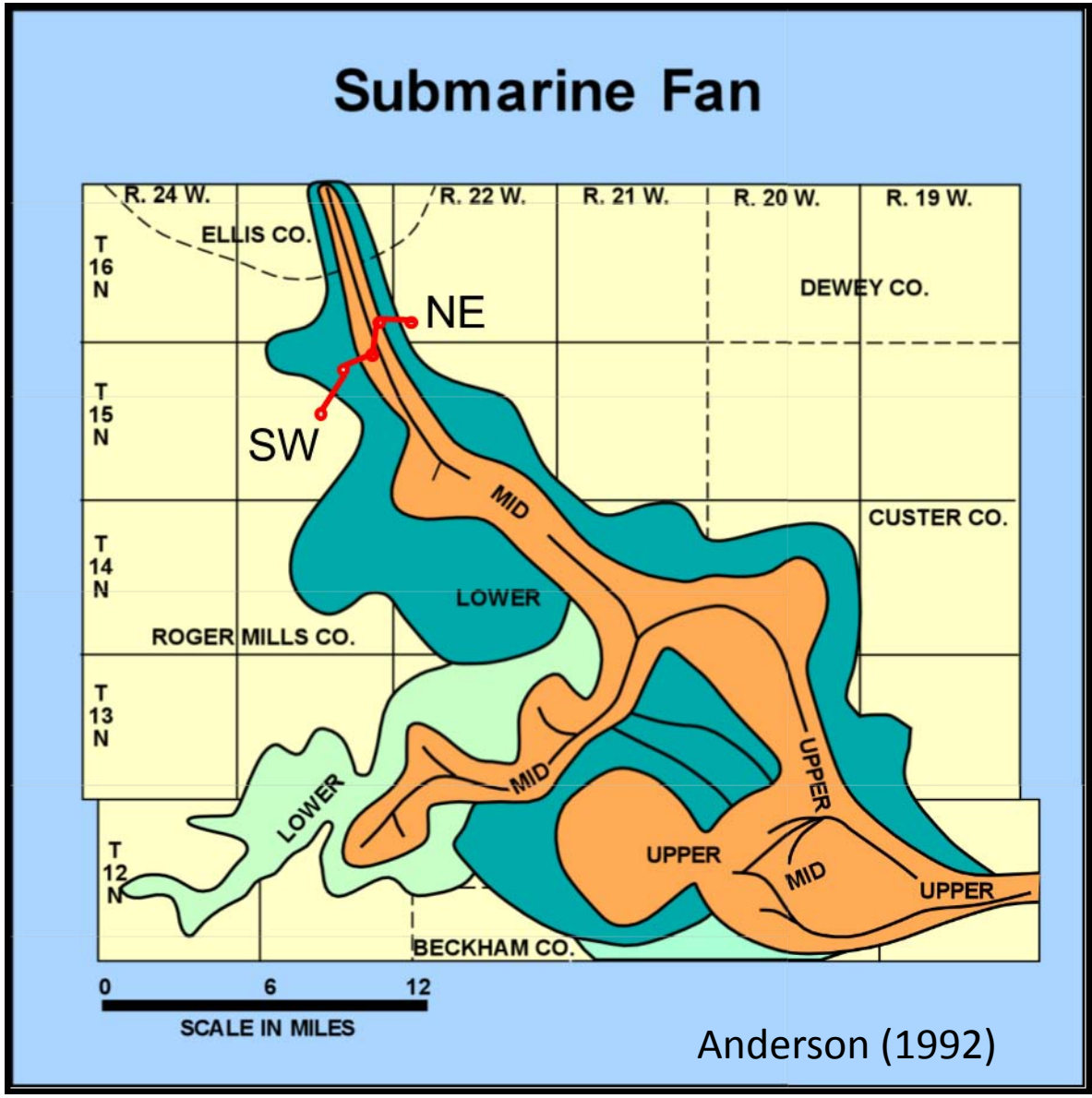
West- to northwest-trending sandstone bodies with decreasing sandstone content distal to "feeder channel" in T.12 N., R. 19 W.

Upper Red Fork sandstone thickness



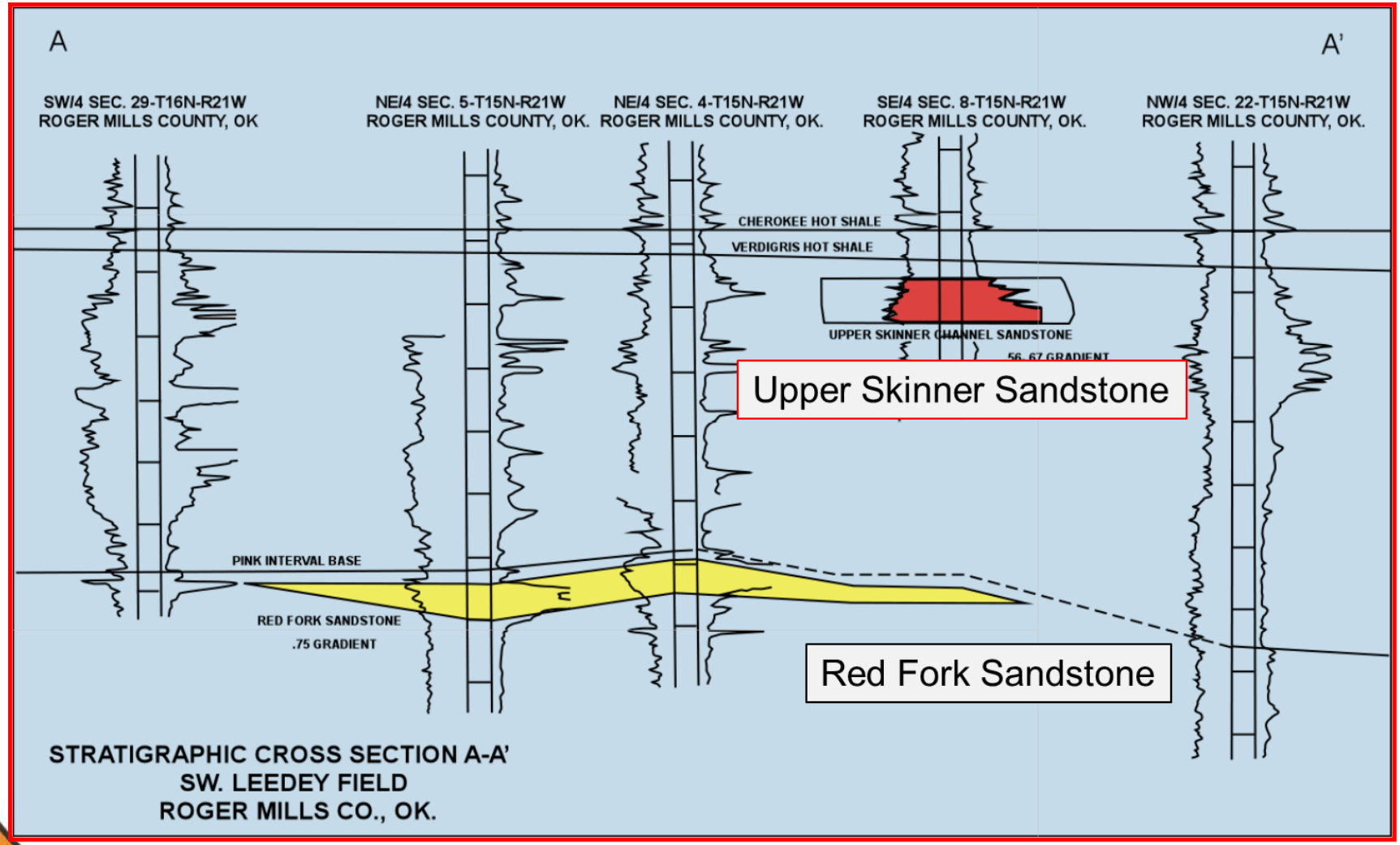
Cherokee: Red Fork sandstone in Strong City District

Interpretation of generalized Submarine-fan morphology from Anderson (1992)



Anderson (1992)

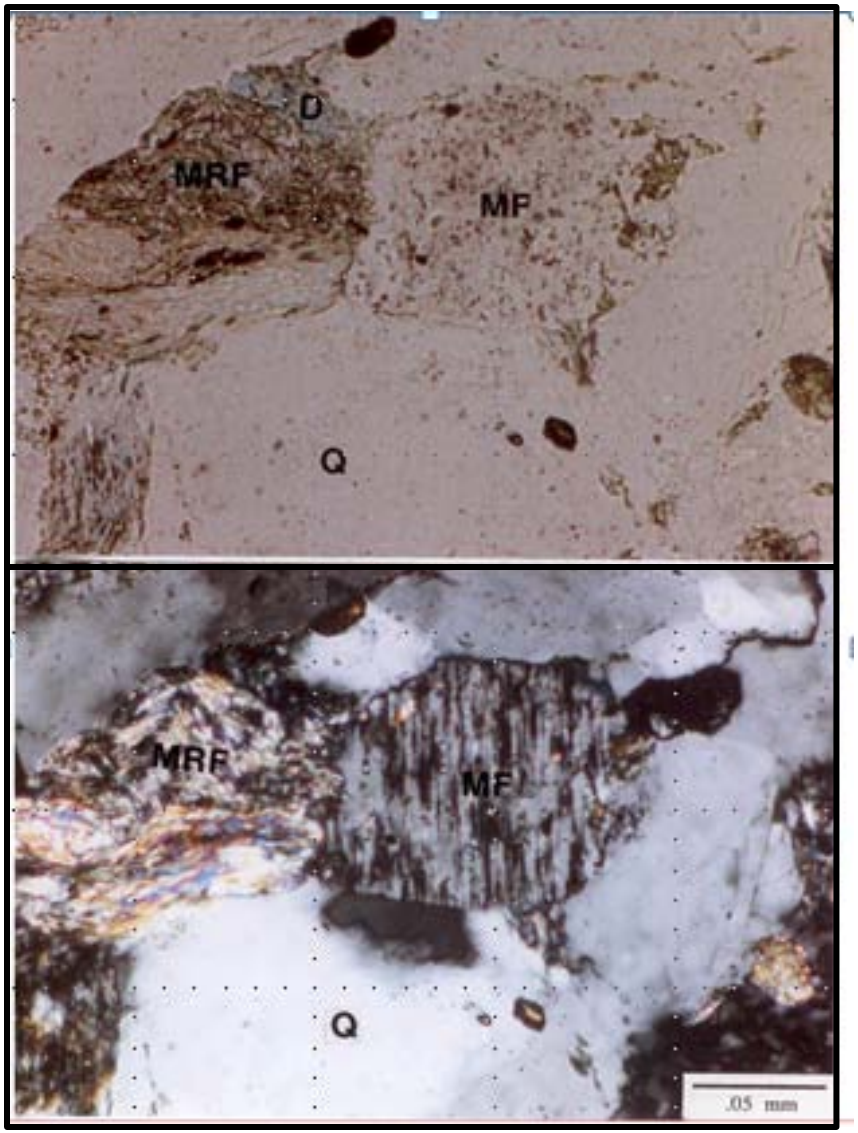
Cherokee: Red Fork shallow-marine bar, SW Leedey Field



Provenance and composition: northerly source and southerly source

Primary: northern source with metamorphic rock fragments (MRF)

Secondary: southerly source with granitic rock fragments microperthite (MP) and granophyre



Cherokee: Red Fork sandstone characteristics

Large fluvial-deltaic complex that is incised by lowstand valleys

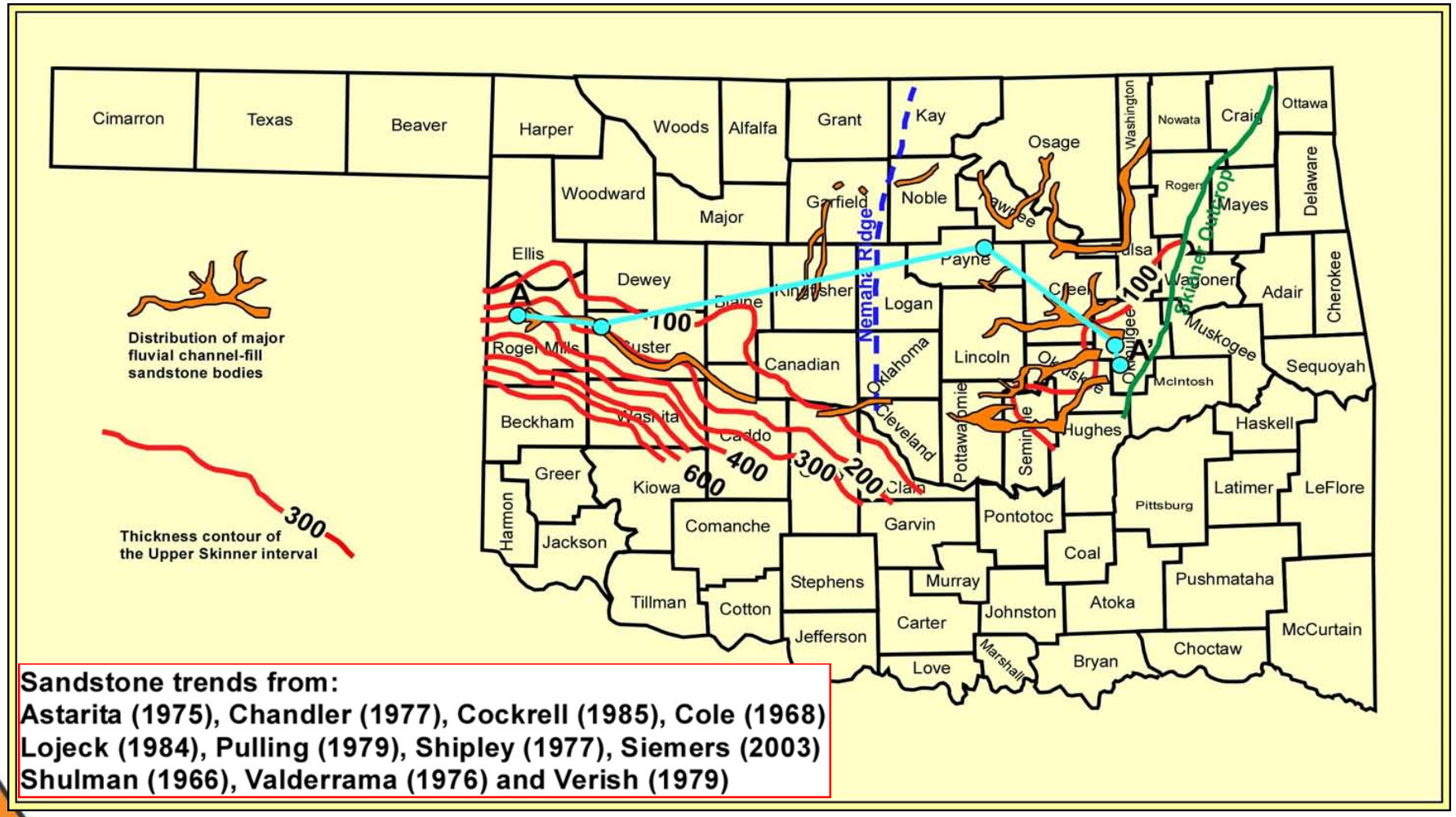
Lowstand valleys transported sediment across the shelf and provided sand for lowstand fans

Marine processes reworked and redistributed sand in delta-margin and shallow-marine settings

Abundant sand is evident in channel fills and fan complex

Detrital composition includes metamorphic rock fragments

Generalized distribution of the upper Skinner sediment dispersal system



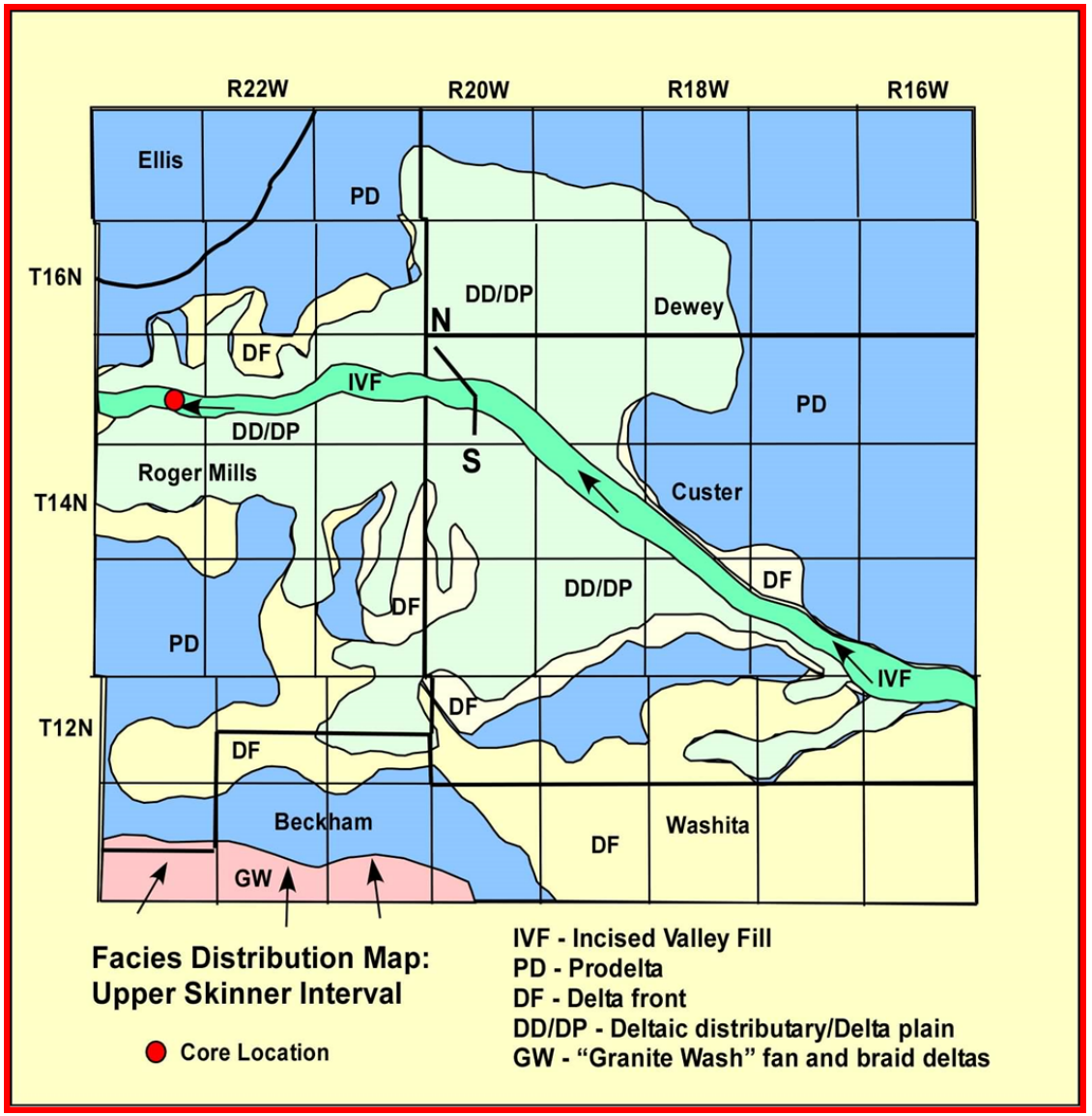
Sandstone trends from:
Astarita (1975), Chandler (1977), Cockrell (1985), Cole (1968)
Lojeck (1984), Pulling (1979), Shipley (1977), Siemers (2003)
Shulman (1966), Valderrama (1976) and Verish (1979)

Increased thickness of the upper Skinner interval in the Anadarko Basin reflects basin subsidence and available accommodation.

Upper Skinner depositional facies

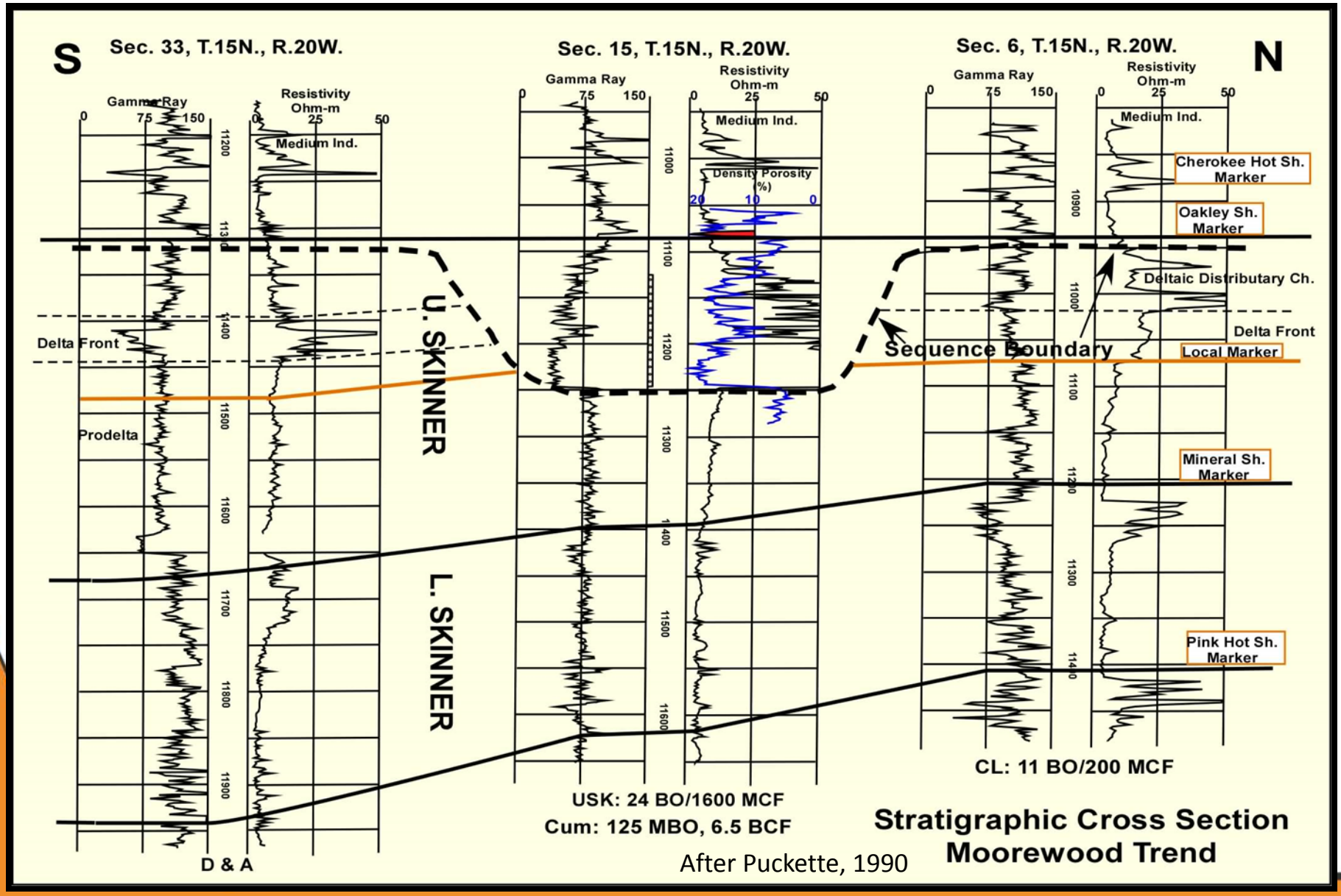
Distribution of interpreted depositional facies for the upper Skinner sandstone in the western part of the Anadarko Basin

Fluvio-deltaic complex incised by valley. Lowstand delta at valley terminus



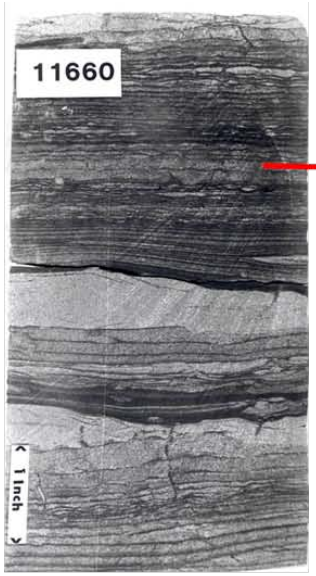
After Puckette, 1990

Valley geometry: upper Skinner sandstone

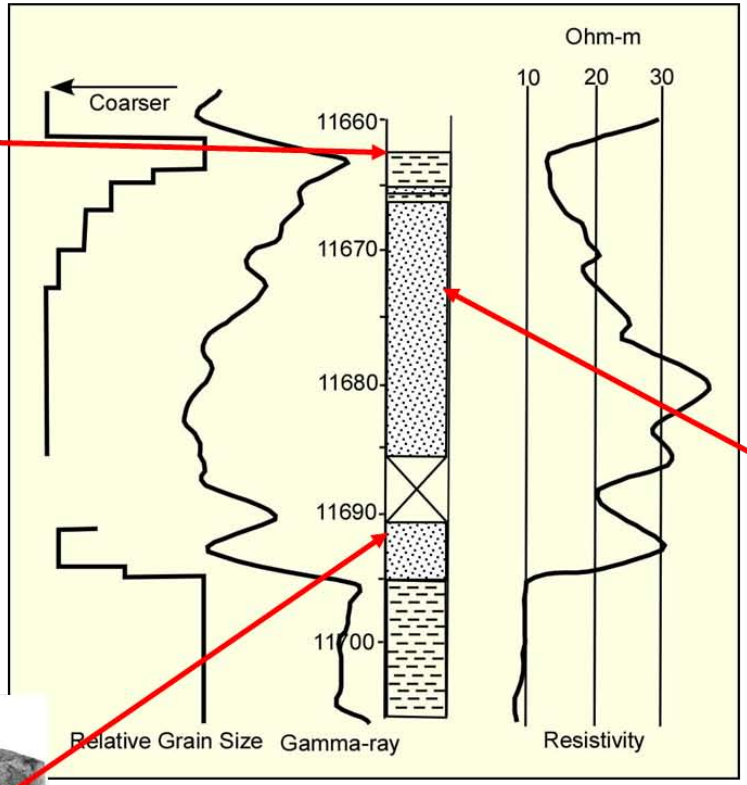


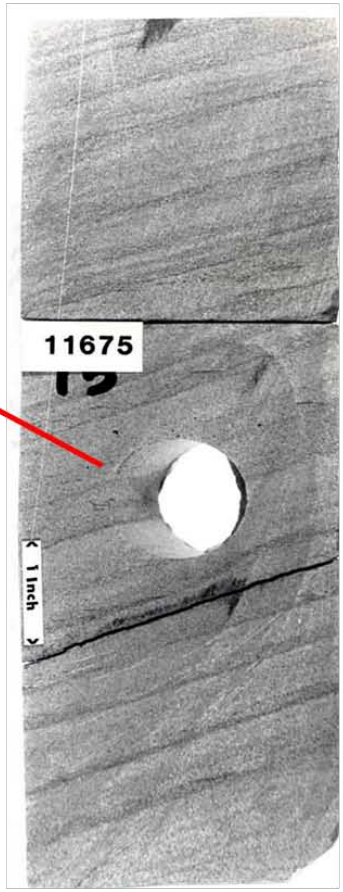
After Puckette, 1990

Sedimentary features: upper Skinner valley filling sandstone

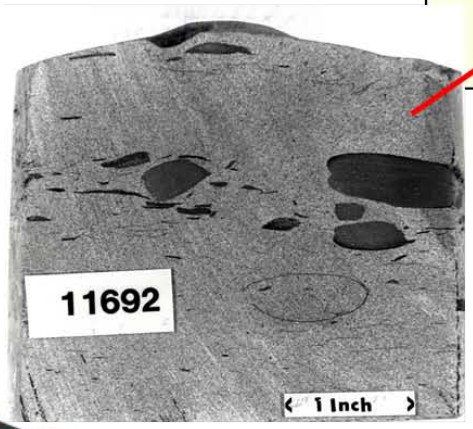


Tidal-laminae





Tabular cross beds

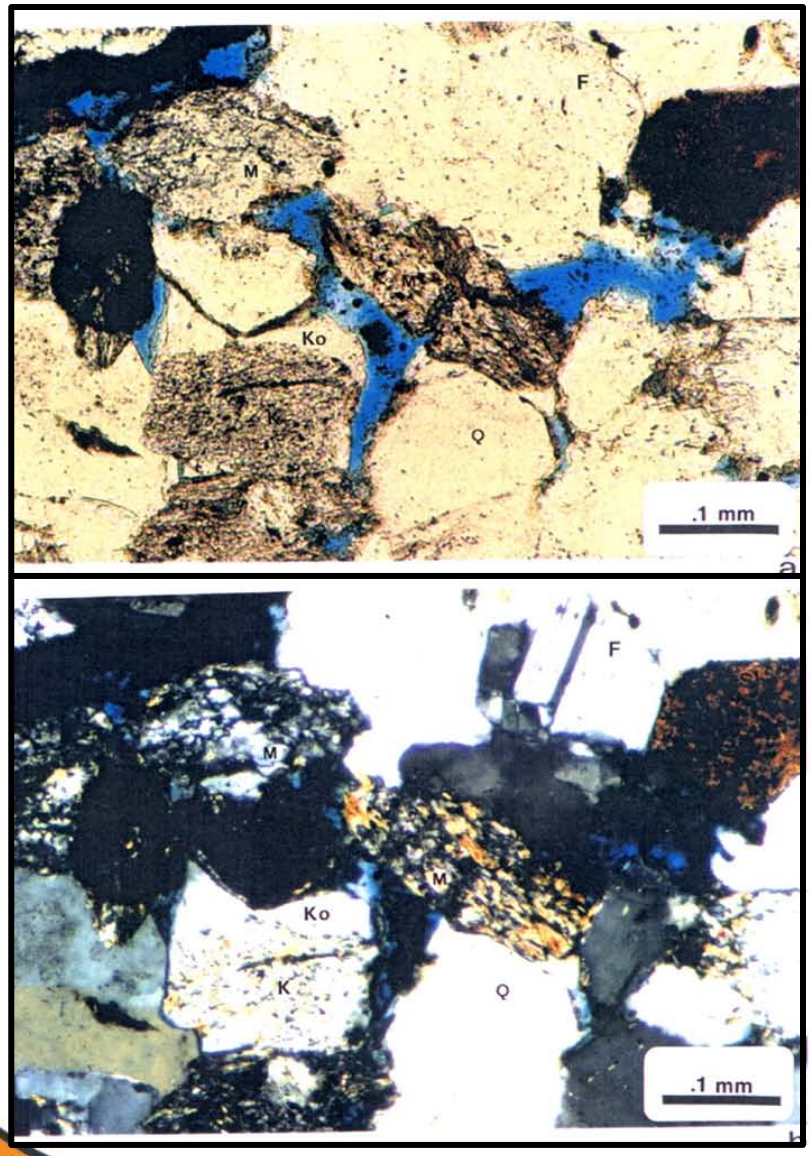


Clay-clast conglomerate

Sedimentary Features

After Puckette, 1990

Detrital composition: upper Skinner sandstone



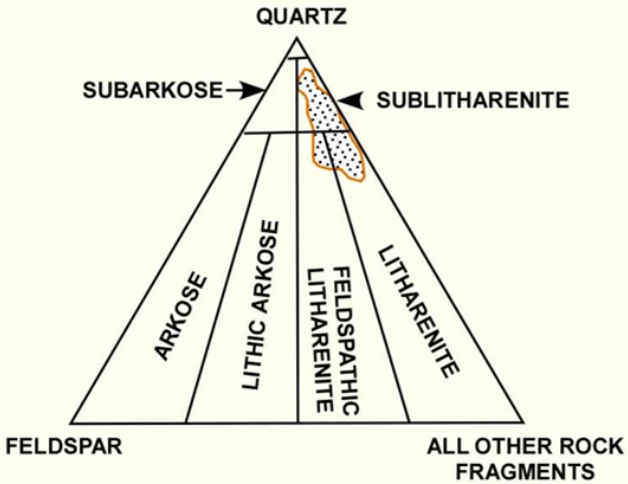
Upper Skinner Sandstone
Moorewood Trend

Photomicrographs of the Upper Skinner Sandstone showing metamorphic rock fragments common to Cherokee sandstones, which have the same provenance. Top is PPL, bottom CPL.

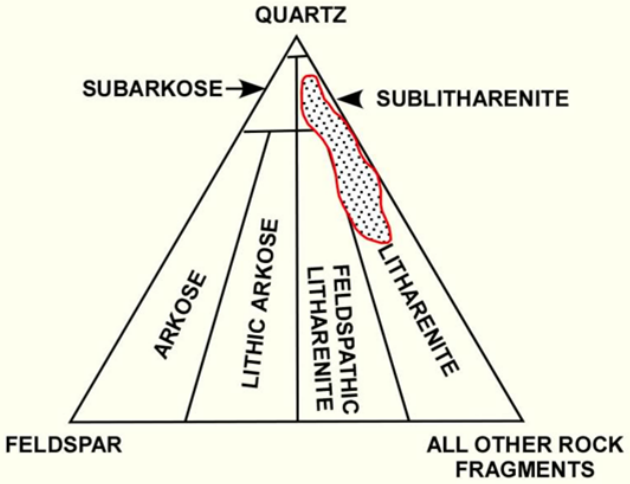
Q – monocrystalline quartz
F – plagioclase feldspar
K – potassium feldspar
M – metamorphic rock fragments

Puckette, 1990

Composition of Cherokee sandstones: Red Fork and Skinner sandstones are similar



UPPER and LOWER SKINNER SANDSTONE



RED FORK SANDSTONE

General composition of Red Fork and Skinner sandstones.
Plotted on a quartz-rock fragments-feldspar diagram of Folk (1974).

Cherokee: Skinner sandstone characteristics

Fluvial-deltaic complexes that are incised by lowstand valleys

Channel fill is dominated by fluvial sands

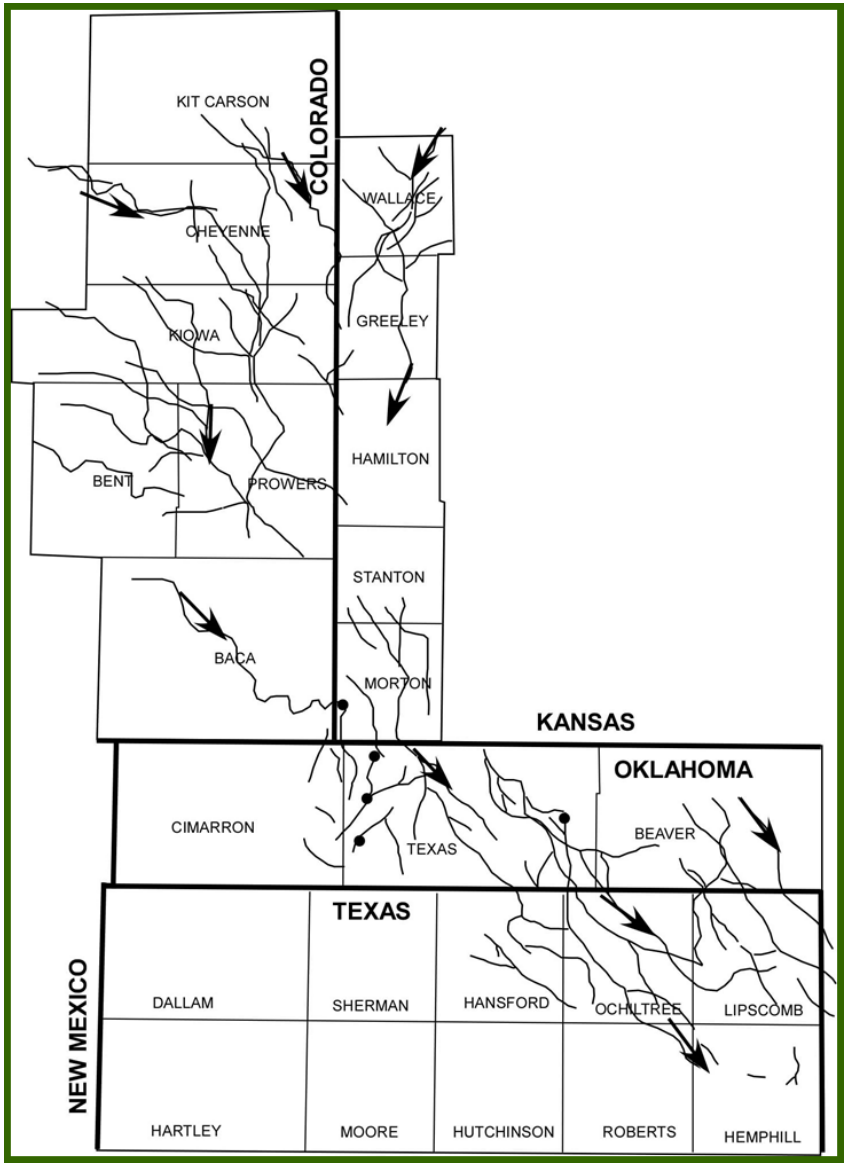
Marine influence (if present) is limited to top of channel fills

Sand was relatively abundant and redistributed by coastal processes (delta-fringe environments common)

Detrital framework grains include metamorphic rock fragments

Southerly flowing, Upper Morrow sediment dispersal system

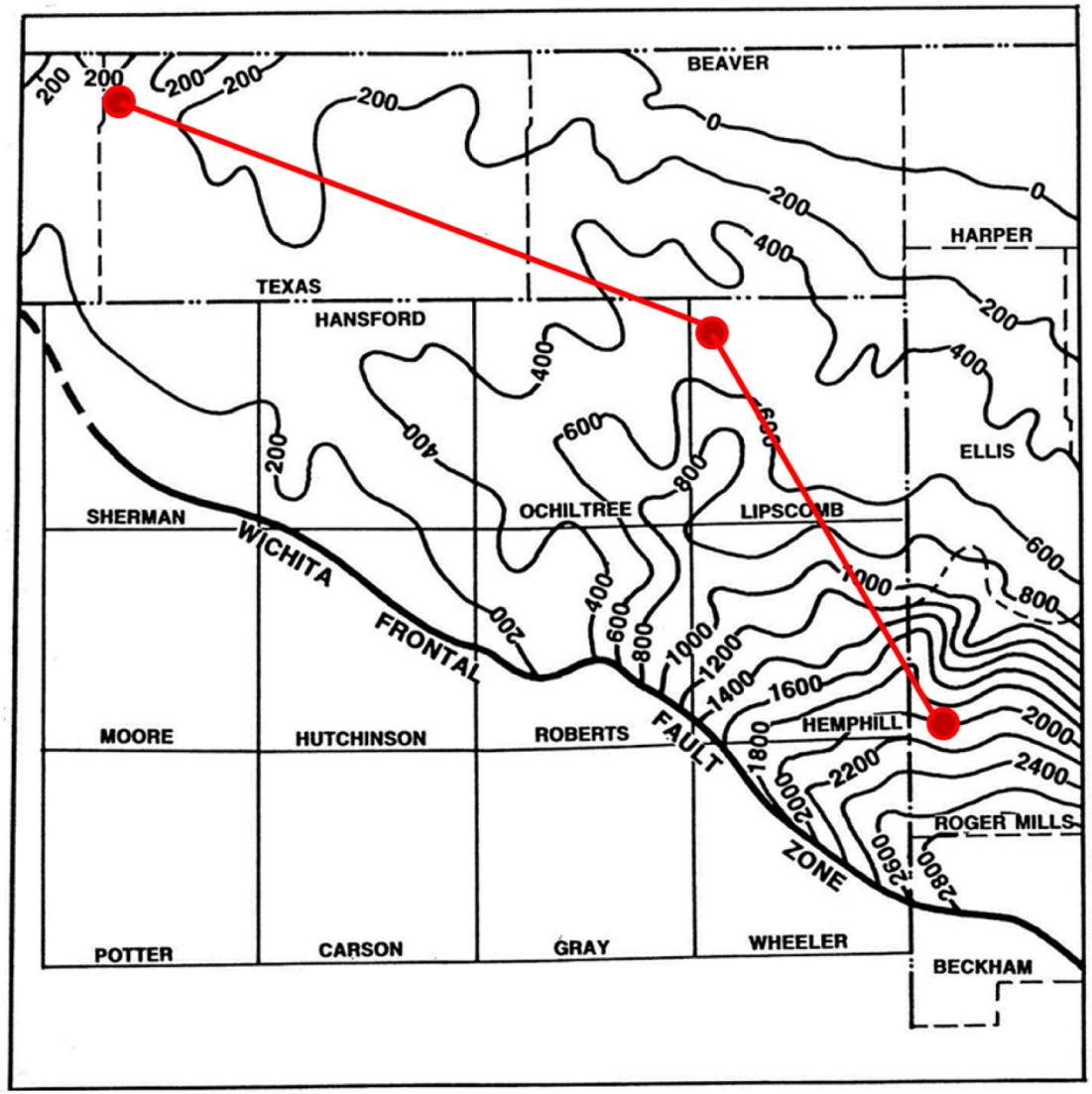
Upper Morrow channel-fill sandstone bodies form linear trends



Puckette et al., 1996

Thickness of the Upper Morrow interval: western Oklahoma, Texas Panhandle and Oklahoma Panhandle

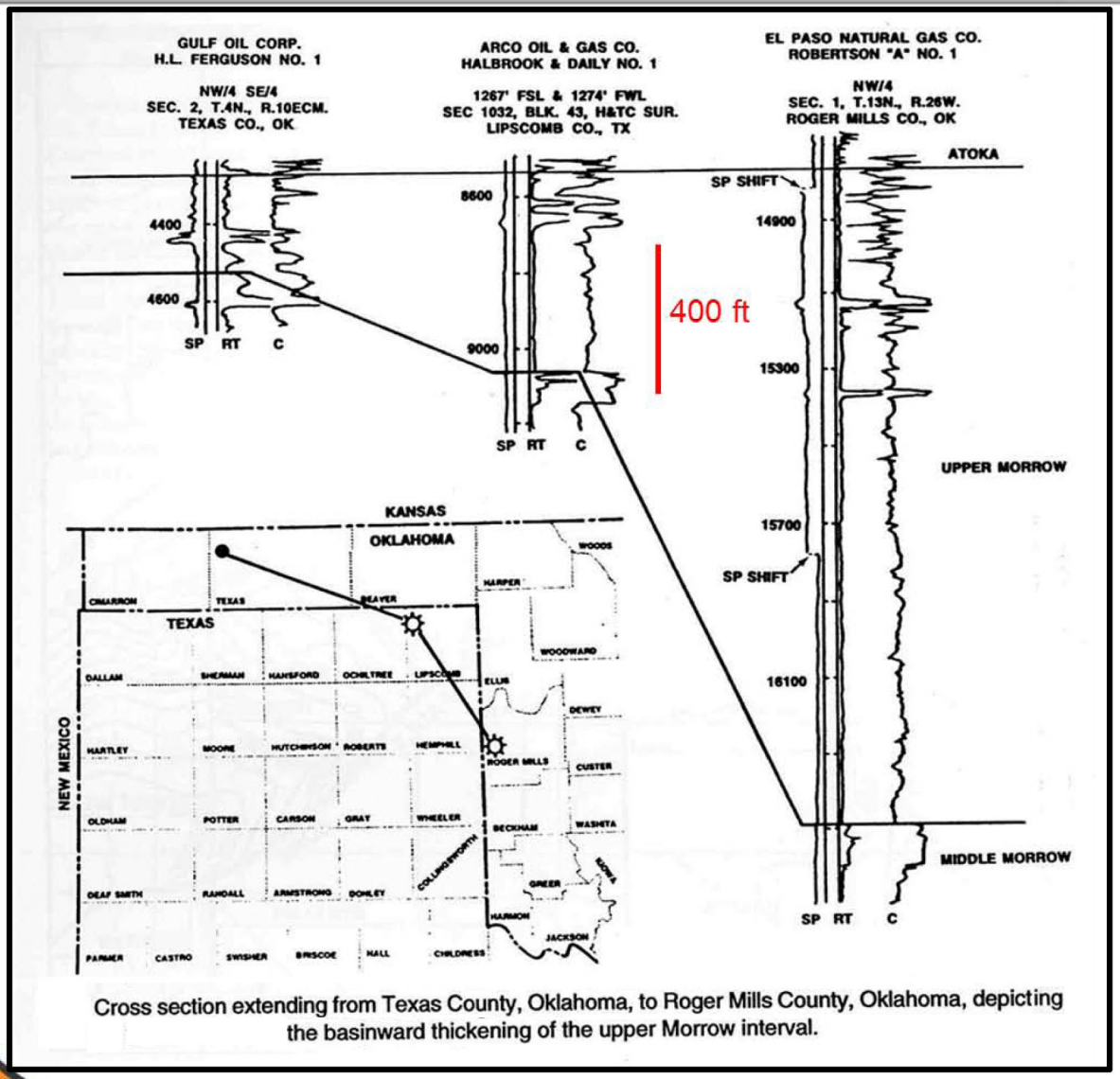
Red line is cross section shown in following slide



Thickness map of the upper Morrow interval in western Oklahoma and the Texas and Oklahoma Panhandles.

Puckette et al., 1996

Isolated Upper Morrow sandstone bodies within thick mudrock (shale) interval

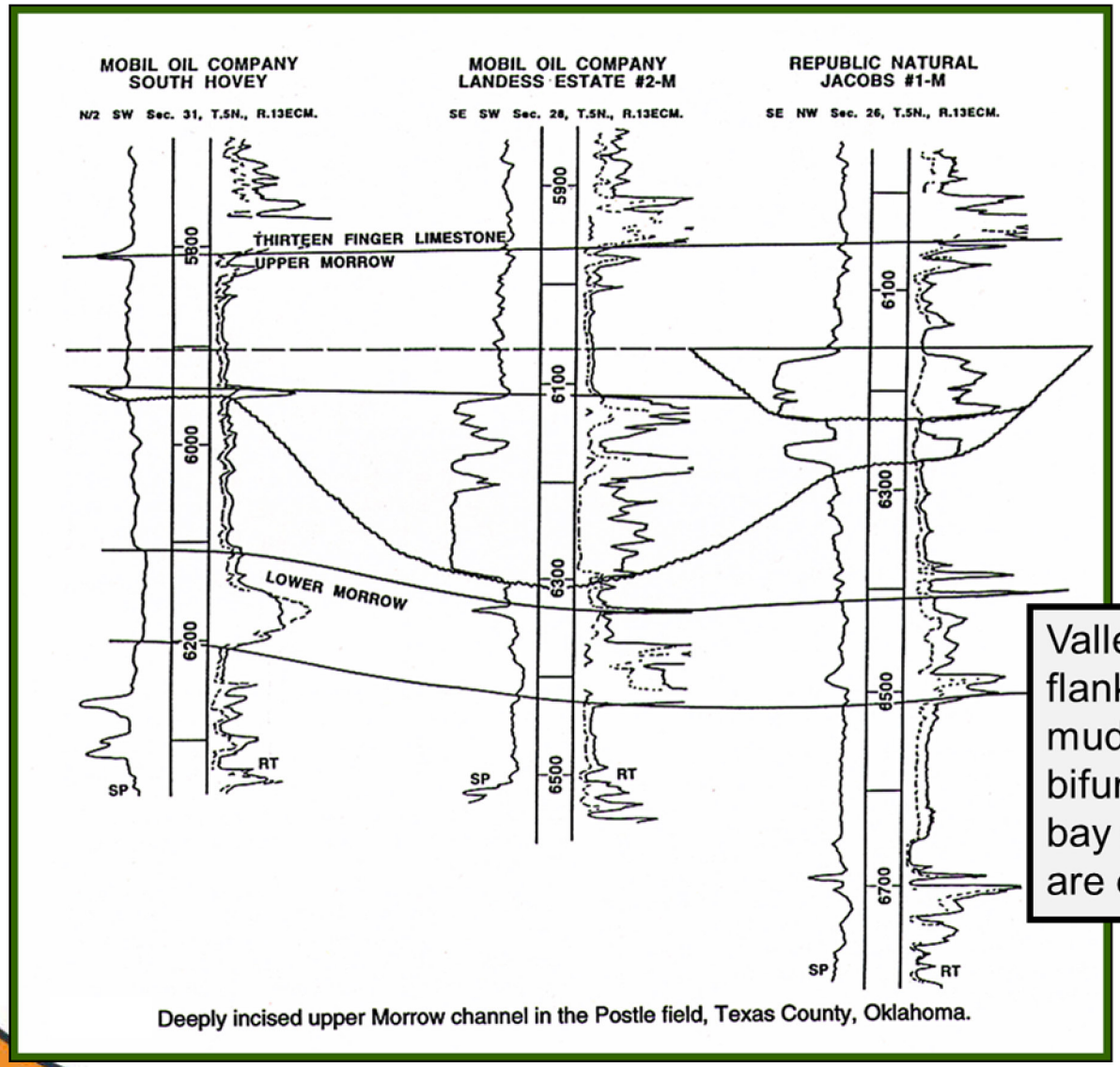


Cross section extending from Texas County, Oklahoma, to Roger Mills County, Oklahoma, depicting the basinward thickening of the upper Morrow interval.

Isolated sandstone bodies (<50 total feet) within thick (1500 feet) Upper Morrow interval

Puckette et al., 1996

Upper Morrow: valley fill geometry in Postle Field



Deeply incised upper Morrow channel in the Postle field, Texas County, Oklahoma.

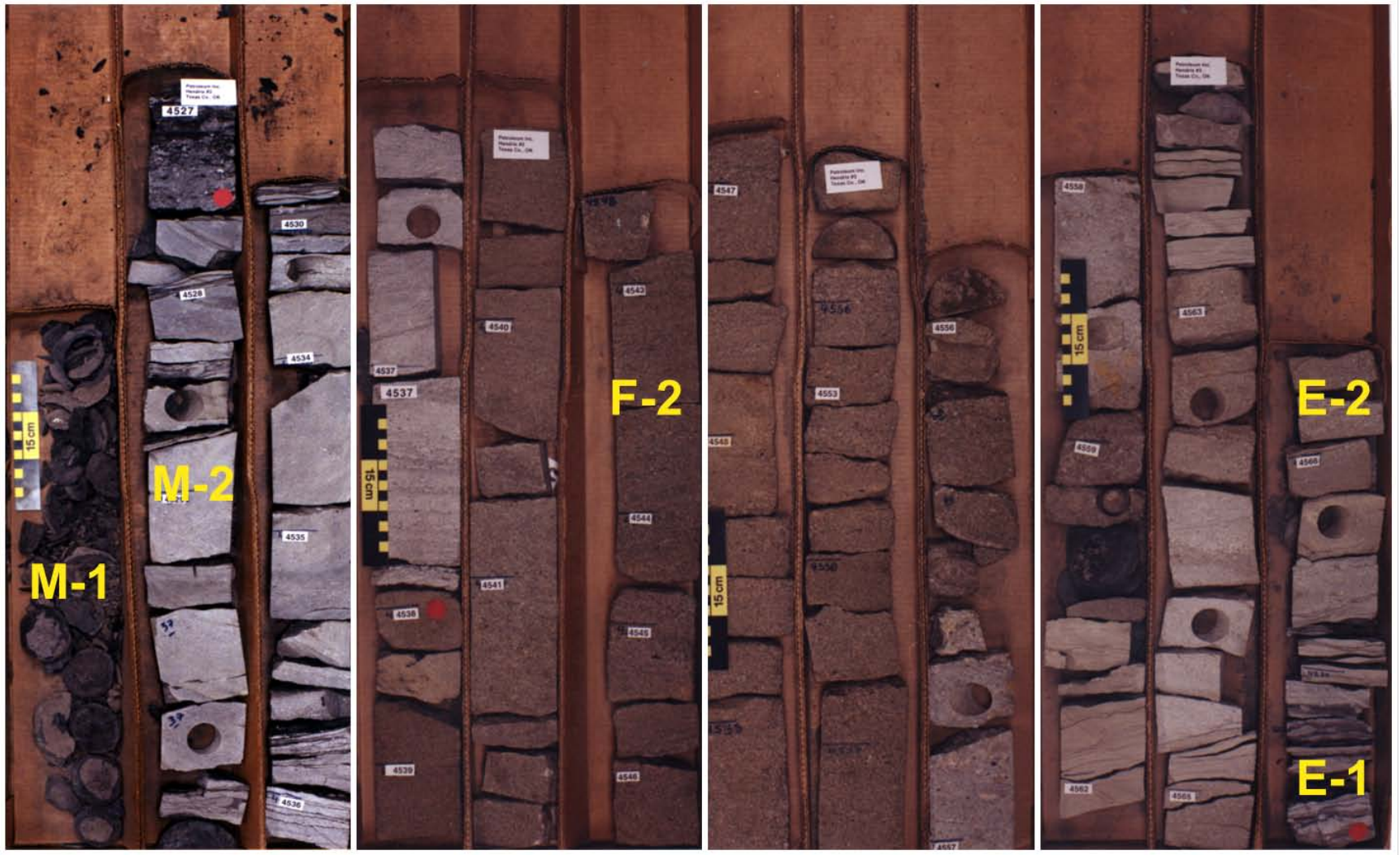
Upper Morrow

Incised valley Postle Field, Texas, Co., OK

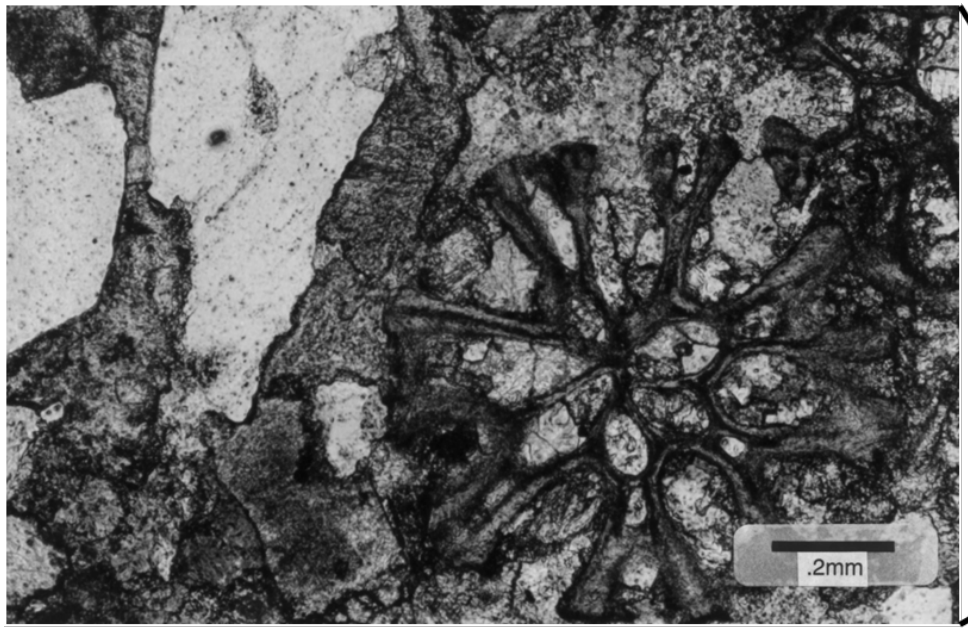
Valley fill deposits are flanked by marine mudstones. No overbank, bifurcating distributary, bay or delta fringe deposits are evident

Puckette et al., 1996

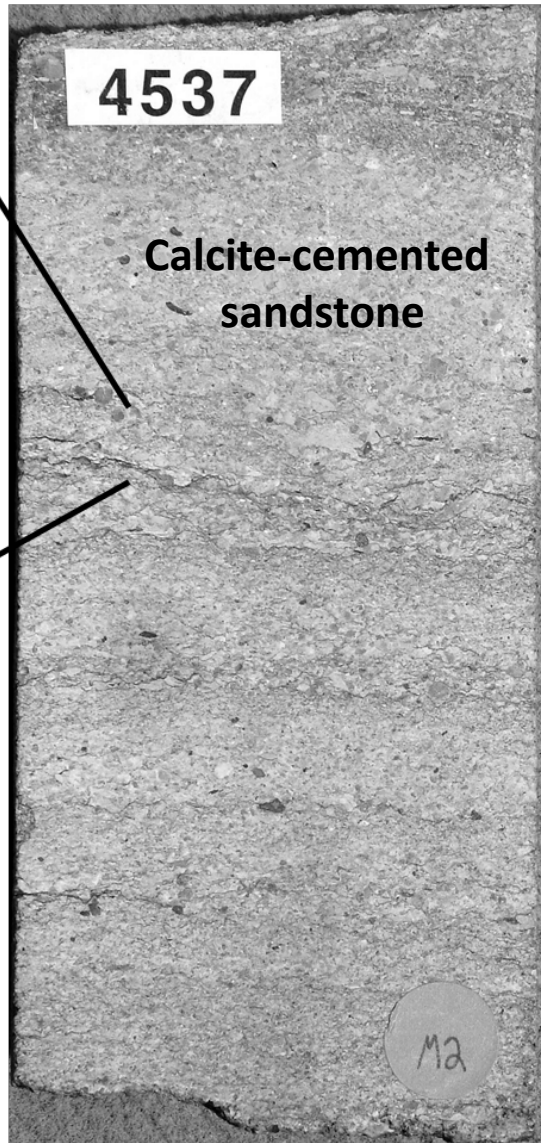
Upper Morrow depositional facies: Petroleum Inc. Hendricks #3, T.6N., R.10E.C.M., Texas Co., OK



Marine influenced Upper Morrow deposition



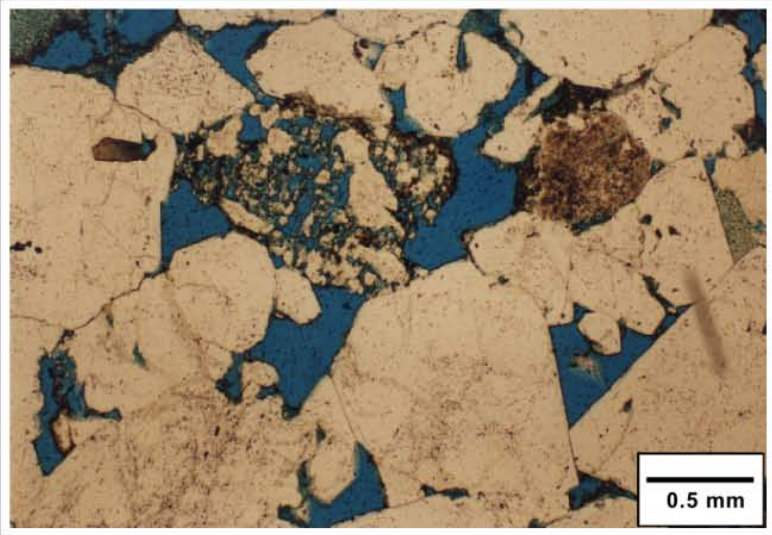
Bryozoan fossil fragment



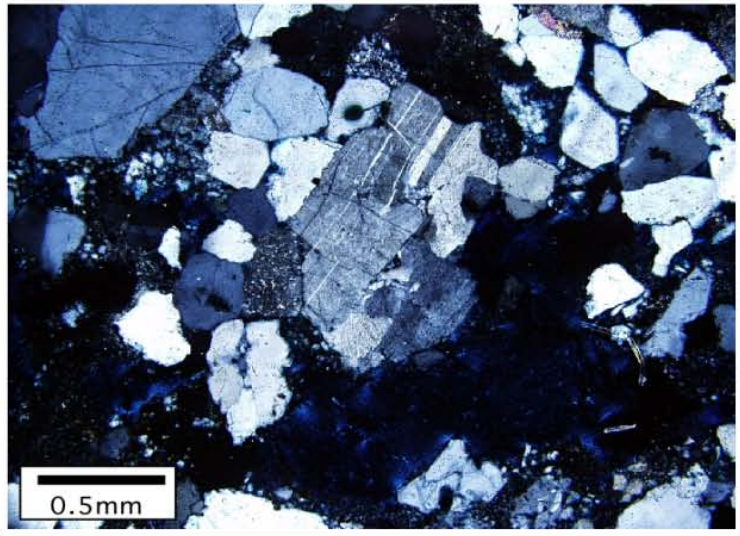
Marine indicators in the Upper Morrow valley fill

Puckette et al., 1996

Upper Morrow: detrital constituents/composition



Primary and secondary porosity

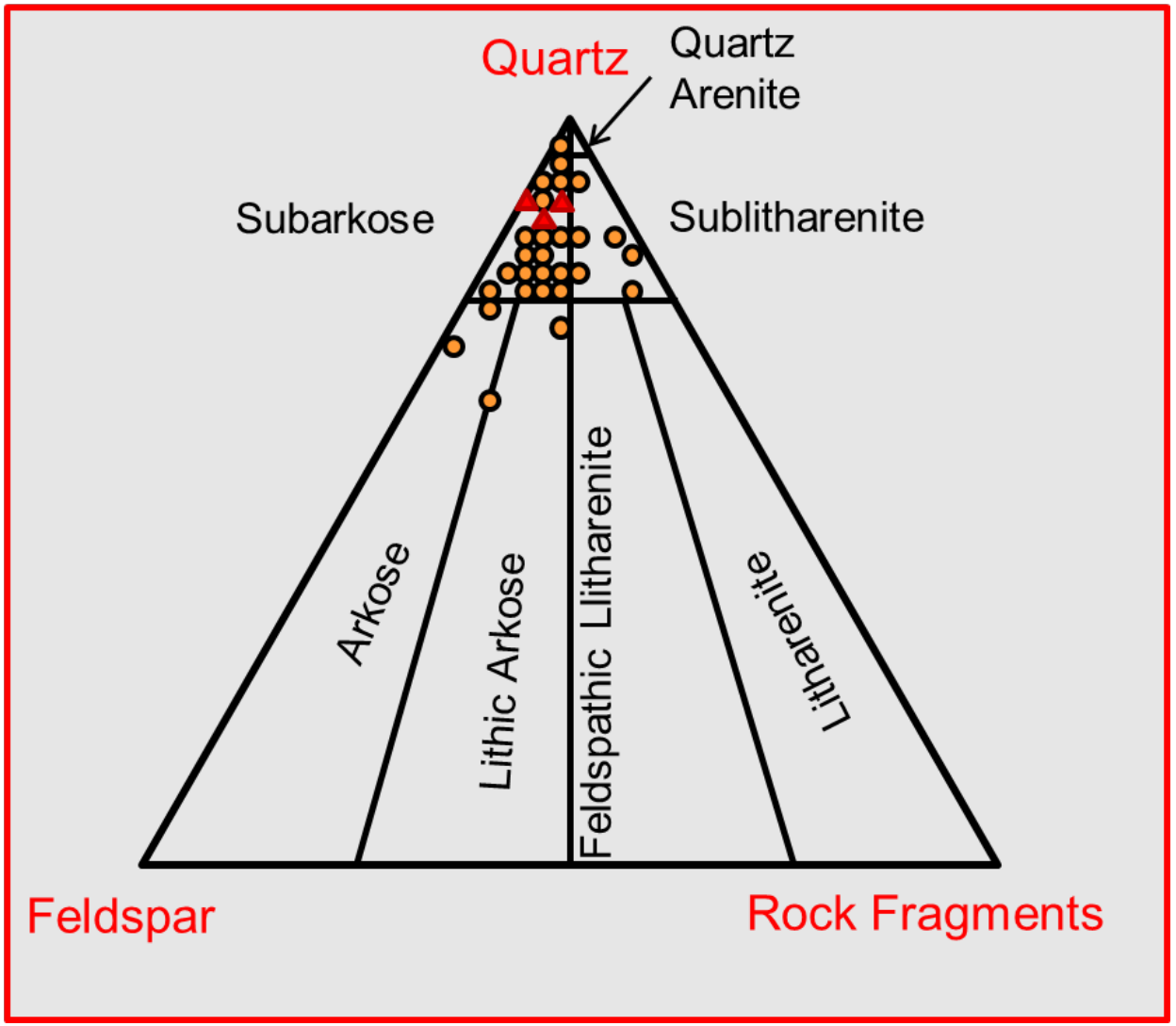


Plagioclase feldspar and quartz

Chert: sedimentary rock fragment

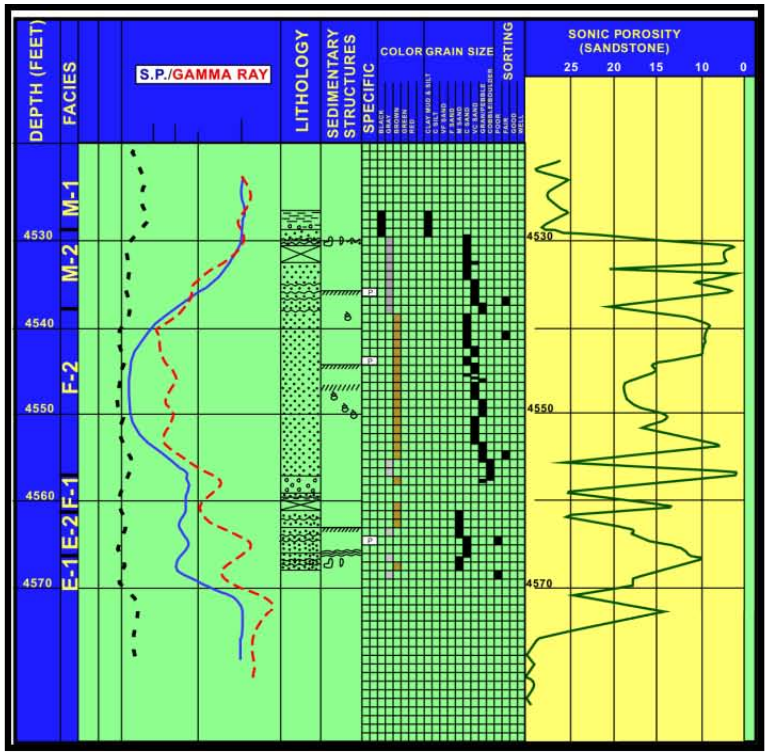
Granophyre: igneous rock fragment

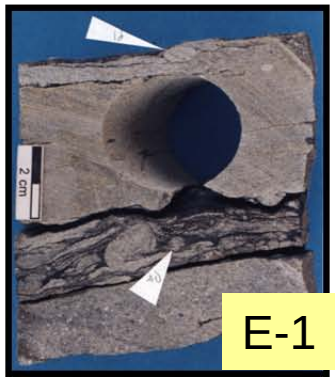
Classification of Upper Morrow sandstones

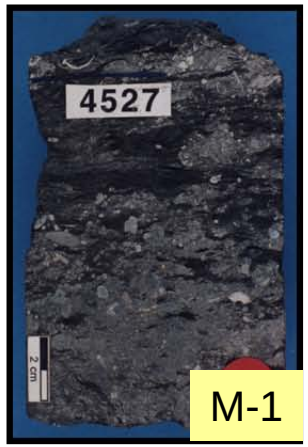


(After Gerken, 1992, Harrison, 1990, and Munson, 1989)

Upper Morrow depositional facies







Facies-dependent reservoir quality

	Lithofacies	Sedimentary Structures Depositional Facies	Generalized Reservoir Quality
Fluvial	F-1	Matrix-supported paraconglomerate *High current-energy stream*	Poor: cement and pseudomatrix
	F-2	Coarse-grained sandstone & Conglomerate w/ stacked, Fining-upward sequences *High energy braided stream, mid-lower channel fill*	Fair to Good: abundant primary and enlarged secondary porosity
	F-3	Rippled & low angle cross-bedded Fine to coarse grained sandstone *Meandering stream, upper channel fill*	Fair to Good: porosity reduction by cementation and pore-filling kaolinite
	F-4	Fine-grained sandstone, Shale and coaly intervals *Channel abandonment*	Poor to fair: intergranular space filled with clay- and silt-rich matrix
Estuarine	E-1	Burrowed shale and fine-grained sandstone *Mid-estuarine, low energy environment*	Poor: low porosity and permeability are result of cement and pseudomatrix
	E-2	Burrowed fn-gr. sandstone & Coarse-grained sandstone *Upper-estuarine, fluvial and tidal processes*	Fair: primary and enlarged intergranular porosities are common
Marine	M-1	Fossiliferous shale/claystone *Low-energy, restricted offshore shelf setting*	
	M-2	Fossiliferous sandstone *High-energy shallow marine setting*	Poor: extensive calcite cement

Observations: Upper Morrow

- Fluvial channel system (southerly flowing)
- Delta-fringe deposits are not evident
- Valleys contain evidence of estuarine and marine sediments
- Sand appears to be confined to channels (No delta-plain or interdistributary deposits)
- Detrital composition Includes chert, microcline and granitic rock fragments (No schistose metamorphics)

Comparative sand supply and types of deposits

- Cherokee: Oversupplied with sand-sized sediment, lower mudrock to sandstone ratio
- Cherokee: Extensive multistoried channel-filling (fluvial) sandstone units, sandy delta-fringe and delta-plain deposits; sandy marine deposits including shelf bars, slope-channel fills and basin-floor fans

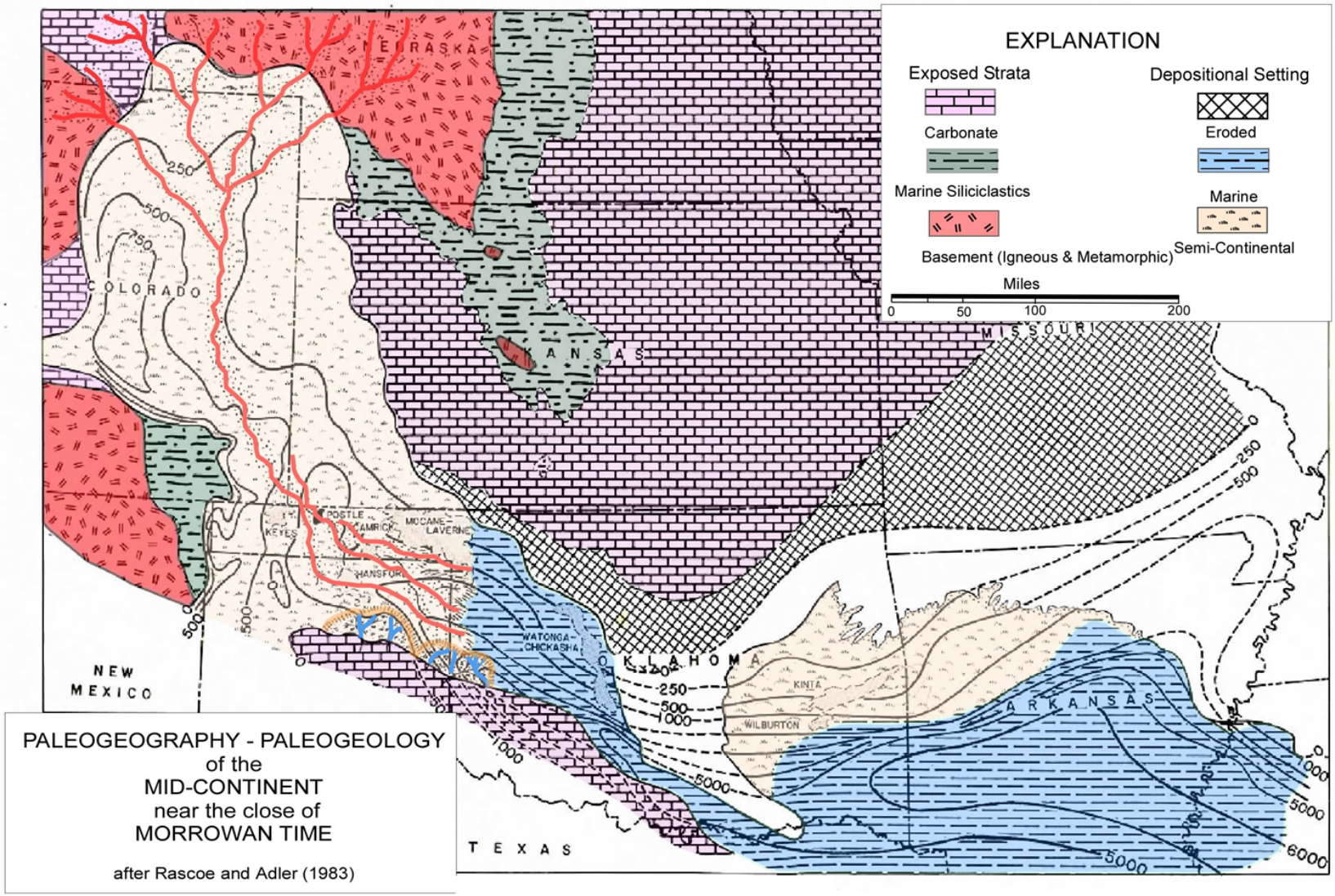
- Upper Morrow: Undersupplied with sand, higher mudrock to sandstone ratio
- Upper Morrow: Rare delta-fringe or plain deposits; sandy marine deposits limited to channel boundaries. Channel fill is heterogeneous and contains fluvial, estuarine, and marine deposits.

Comparative Composition: Upper Morrow and Cherokee

- Cherokee: Metamorphic rock fragments important detrital framework grains
- Metamorphic rock fragments and feldspars critical to genesis of secondary porosity in sandstones

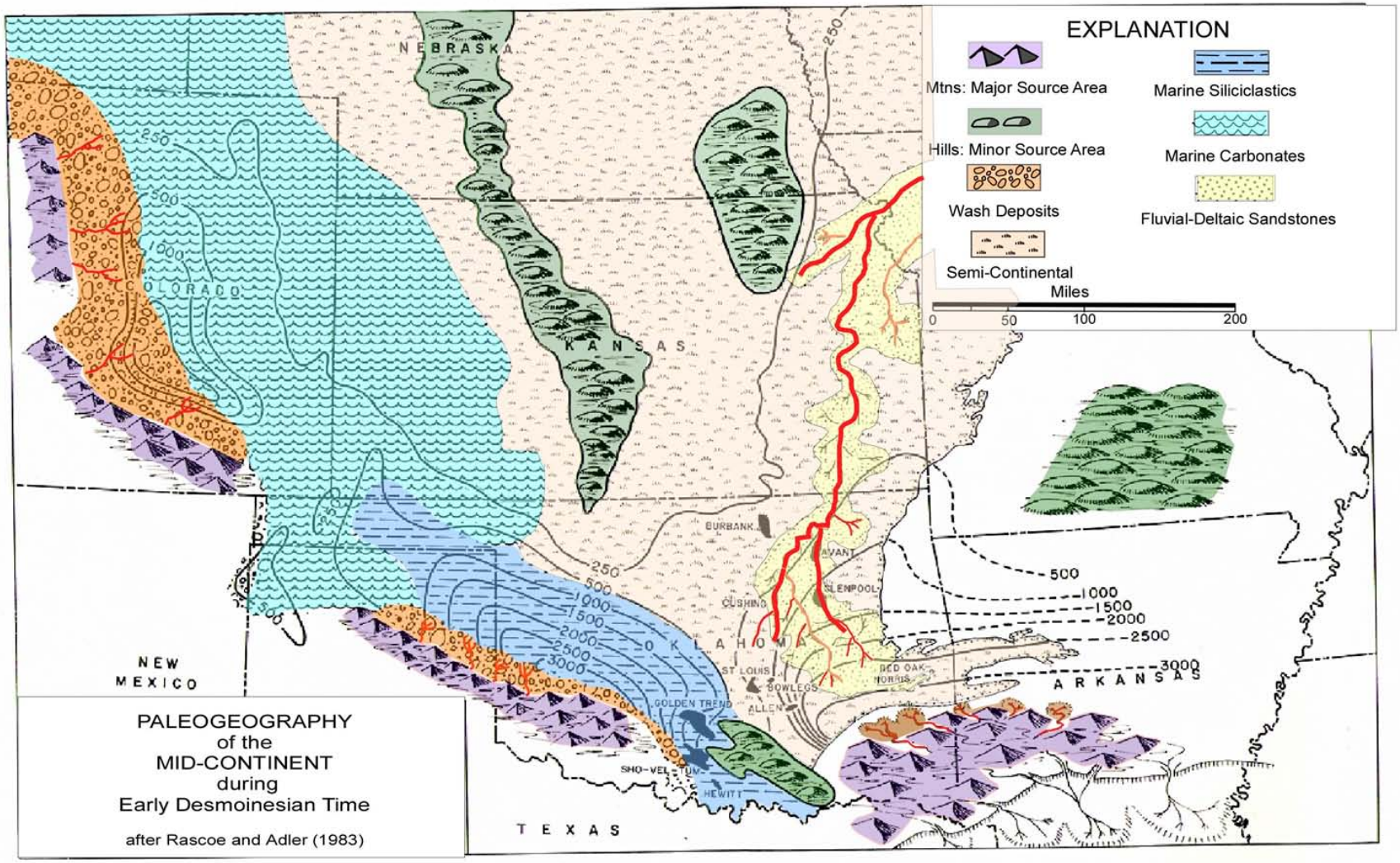
- Upper Morrow: granitic-rock fragments important detrital-framework grains; chert more abundant.
- Dissolution of granitic-rock fragments and chert contributes to secondary porosity

Upper Morrowan Paleogeography



After Rascoe and Adler (1983)

Early Desmoinesian Paleogeography – Bartlesville Sand



After Rascoe and Adler (1983)

Drainage Basin Attributes

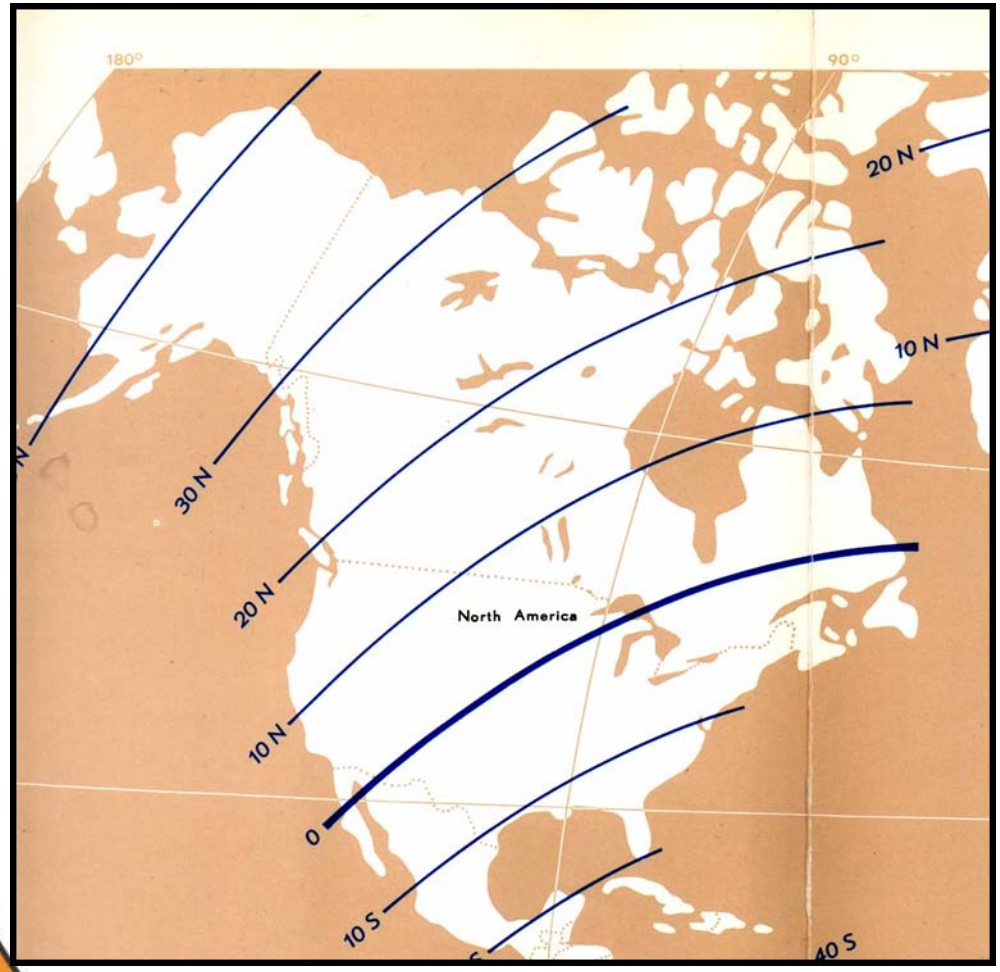
Morrow

Size: 128,700 km^2 (80,000 mi^2) (Swanson, 1979)
Geology: Mostly sedimentary rocks: mudrocks and carbonates that weather to mud or soluble matter. Limited basement compared to Cherokee

Cherokee

Size: > 300,000 km^2 (187,500 mi^2)
Geology: Basement of Canadian Shield, Northern Appalachian Shield, and Southern Appalachians?

Climate: Paleolatitudes during Carboniferous

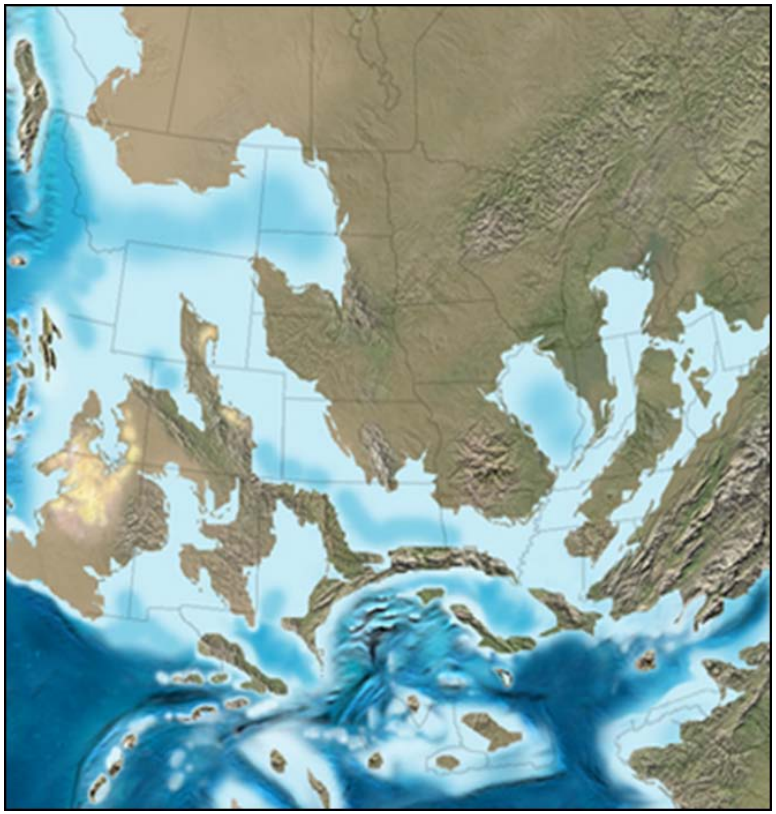


Orogenic belts that formed after the Morrow were prominent during Cherokee deposition and could have intensified monsoon effects, creating wet/dry cycles with larger precipitation events.

Desmoinesian (Cherokee) was wetter than Morrowan (Phillips et al., 1985).

Equatorial Climate: Floral evidence suggests tropical conditions (Habicht, 1979)

Topography during the Pennsylvanian



Early Pennsylvanian

Late Pennsylvanian

Maps from R. Blakey – *cpgeosystems.com*

Summary and Interpretation

- **Cherokee** dispersal systems were **well supplied** with **sand-derived from shield rocks** in **larger drainage basin**. **Common source** for all Cherokee sandstones.
- **Lowstand** deposits are **submarine fans** (RF) and **lowstand deltas** (SK).
- **Transgressive** deposits are **dominantly fluvial**, marine influence is limited.
- **Morrow** dispersal system was comparatively **undersupplied with sand** derived primarily from **smaller drainage basin** with basement rocks of the **Ancestral Rockies, Cambridge Arch, & Central KS Uplift**. Mud and **chert** came from weathered **sedimentary rocks.**
- **Lowstand** deposits are primarily **channel-lag conglomerates** and **sand** was transported into Morrow sea and **diluted by mud**.
- **Transgressions captured sand** in **valleys**: valleys flooded, generating **fluvial, estuarine** and **marine** deposits.
- Climatic favors **accelerated weathering in Cherokee,** and monsoon pattern could have provided seasonal discharge to carry larger sediment volumes.

References

Al-Shaieb, Z., J. Shelton, J. Puckette, and D. Boardman, 1995, Sandstone and carbonate reservoirs of the Mid-continent, Syllabus for Short Course, OCGS-OSU Core Workshop: Oklahoma City Geological Society, 194 p.

Astarita, A.M., 1975, Depositional trends and environments of "Cherokee" sandstones, east-central Payne County, Oklahoma: unpublished M.S. thesis, Oklahoma State University, 50 p.

Anderson, C.J., 1992, Distribution of submarine fan facies of the upper Red Fork interval in the Anadarko Basin, western Oklahoma: unpublished M.S. thesis, Oklahoma State University, 275 p.

Chandler, C.E., 1977, Subsurface stratigraphic analysis of selected sandstones of the "Cherokee" Group, southern Noble County, Oklahoma: Shale Shaker, v. 28, no. 3, p. 56 [part 1]; v. 28, no. 4, p. 72-83 [part 2].

Clement, W.A., 1994, East Clinton Field, *in* Takken, S., and Kerr, E.P. (eds), Oil and Gas Fields of Oklahoma, Volume 2: Oklahoma City Geological Society, 181 p.

Cockrell, D.R., 1985, Stratigraphy, distribution and structural geology of Lower and Middle Pennsylvanian sandstones in adjacent portions of Okfuskee and Seminole counties, Oklahoma: unpublished M.S. thesis, Oklahoma State University, 55 p.

Cole J. G., 1968, Stratigraphic study of the Cherokee and Marmaton sequences, Pennsylvanian (Desmoinesian) east flank of the Nemaha Ridge, north-central Oklahoma: unpublished Ph.D. dissertation, University of Oklahoma, 90 p.

References

Folk, R.L., 1974, Petrology of sedimentary rocks: Austin Texas, Hemphill's Book Store, 170 p.

Gerken, L.D., 1992, Morrowan sandstones in south-central Texas County, Oklahoma: unpublished M.S. thesis, Oklahoma State University, 414 p.

Habicht, J.K.A, 1979, Paleoclimate, Paleomagnetism and Continental Drift: AAPG Studies in Geology 9, 29 p.

Harrison, J.C., 1990, "Upper" Morrow Purdy sandstones in parts of Texas and Cimarron Counties, Oklahoma: unpublished M.S. thesis, Oklahoma State University, 95 p.

Lojeck, C.A., 1984, Petrology, diagenesis and depositional environment of the Skinner Sandstone, Desmoinesian, northeastern Oklahoma platform: unpublished M.S. thesis, Oklahoma State University, 158 p.

Munson, T. W., 1989, Depositional, diagenetic and production history of the upper Morrowan Buckhaultz sandstone, Farnsworth Field, Ochiltree County, Texas: Oklahoma City Geological Society Shale Shaker Digest, vol. XXXX-XXXXIV, p. 2-20.

Phillips, T. L., R.A. Peppers & W.A. DiMichele, 1985, Stratigraphic and interregional changes in Pennsylvanian coal-swamp vegetation: environmental inferences: International Journal of Coal Geology, P. 43-110.

References

Puckette, J., 1990, Depositional setting, facies, and petrology of Cabaniss (Upper "Cherokee") Group in Beckham, Dewey, Custer, Ellis, Roger Mills, and Washita Counties, Oklahoma: unpublished M.S. thesis, Oklahoma State University, 144p.

Puckette, J., A. Abdalla, Z. Al-Shaieb, and A. Rice, 1996, The upper Morrow reservoirs: Complex fluvio-deltaic depositional systems, *in* K. S. Johnson and J. A. Campbell (eds.), Fluvial-dominated deltaic reservoirs in the southern Midcontinent, Oklahoma Geological Survey Circular 98, p. 47-84.

Pulling, D. M., 1979, Subsurface stratigraphic and structural analysis, Cherokee Group, Pottawatomie County, Oklahoma: Shale Shaker, v. 29, no. 6, p. 124-137 [part 1]; v. 29, no. 7, p. 148-158 [part 2].

Rascoe, B. Jr., and F. J. Adler, Permo-Carboniferous hydrocarbon accumulations, Mid-Continent U.S.A. AAPG Bull., v. 67, p. 979-1001, 1983

Ross, C.A., and J.R.P. Ross, 1987, Biostratigraphic zonation of Late Paleozoic depositional sequences: Cushman Foundation Foram. Research, Spec. Publ. no. 24, p. 151-168.

Shipley, R. D., 1977, Local depositional trends of “Cherokee” sandstones, Payne County, Oklahoma: Shale Shaker v. 28, no. 2, p. 24-35 [part 1]; v. 28, no. 3, p. 48-55 [part 2].

Shulman, C., 1966, Stratigraphic analysis of the “Cherokee” Group in adjacent portions of Lincoln, Logan and Oklahoma counties, Oklahoma: Shale Shaker, v. 16, no. 6, p. 126-140.

References

Siemers, W.A., 2003, Distribution and reservoir properties of Lower Skinner valley fill sandstones, Payne County, Oklahoma: unpublished M.S. thesis, Oklahoma State University, 111 p.

Valderrama, R., 1976, The Skinner sandstone zone of central Oklahoma: Shale Shaker, v. 26, no. 5, p. 86-98 [part 1]; v. 26, no. 6, p. 106-114 [part 2].

Verish, N.P., 1979, Reservoir trends, depositional environments and petroleum geology of "Cherokee" sandstones in T11-13N, R4-5E, central Oklahoma: Shale Shaker, v. 29, no. 9, p. 209 [part 1]; v.29, no. 10, p. 224-237 [part 2].