Lower Mississippian Sequence Stratigraphy and Depositional Dynamics: Further Insights from the Outcrops, Northwestern Arkansas and Southwestern Missouri

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OSAGEAN PALEOGEOGRAPHY – modified from LANE, 1982

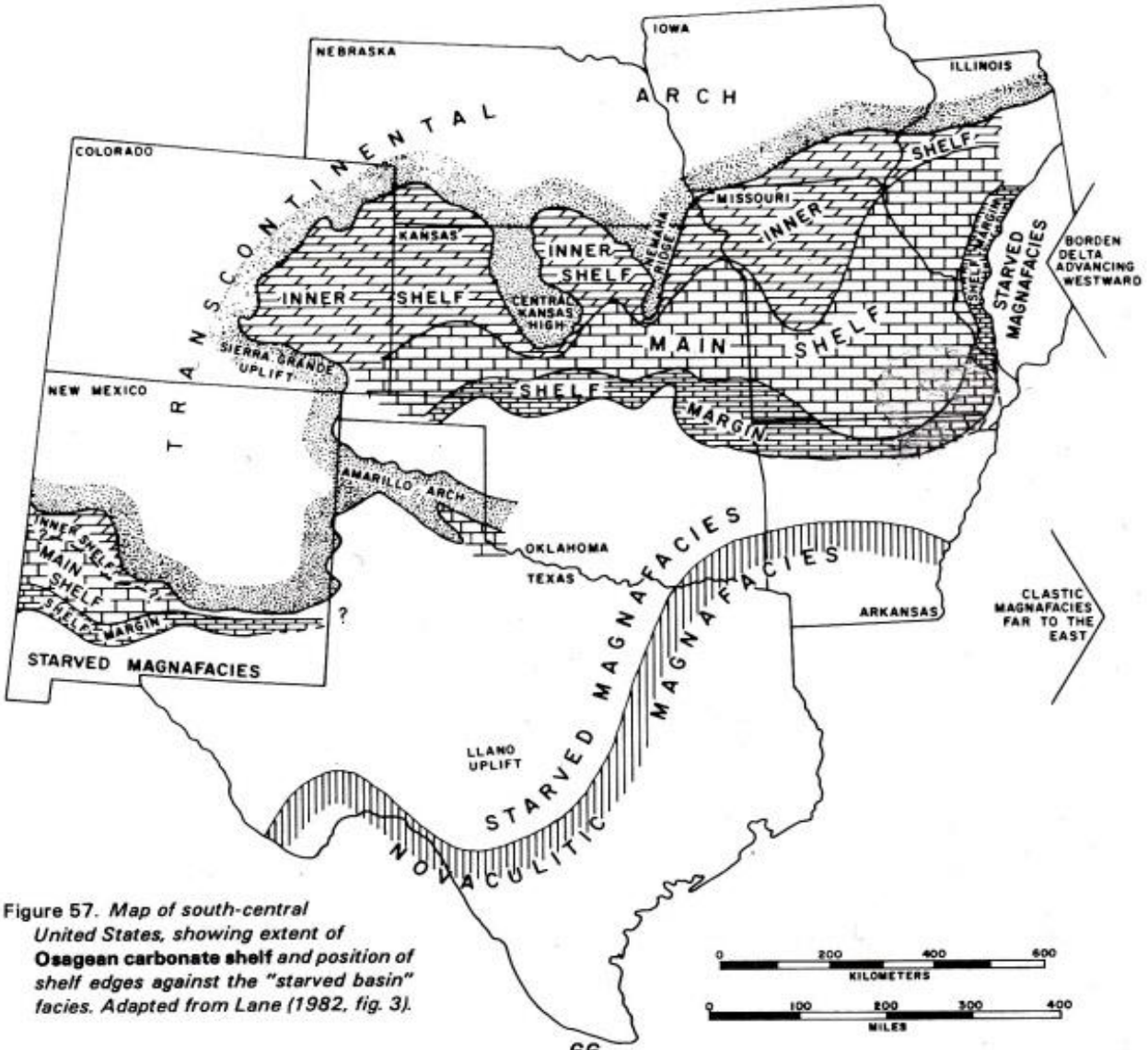


Figure 57. *Map of south-central United States, showing extent of* **Osagean carbonate shelf** *and position of shelf edges against the "starved basin" facies. Adapted from Lane (1982, fig. 3).*

LOWER MISSISSIPPIAN LITHOSTRATIGRAPHY

- THREE UNITS REFLECTING EUSTATIC CYCLICITY
- BASAL CHERT-FREE INTERVAL – BACHELOR, COMPTON, NORTHVIEW, PIERSON = ST. JOE
- MEDIAL CHERT-BEARING INTERVAL – REEDS SPRING, ELSEY =LOWER BOONE
- UPPER CHERT-BEARING INTERVAL – BURLINGTON/KEOKUK = UPPER BOONE

MISSISSIPPIAN LITHOSTRATIGRAPHY – SOUTHWESTERN MISSOURI – THOMPSON, 1986

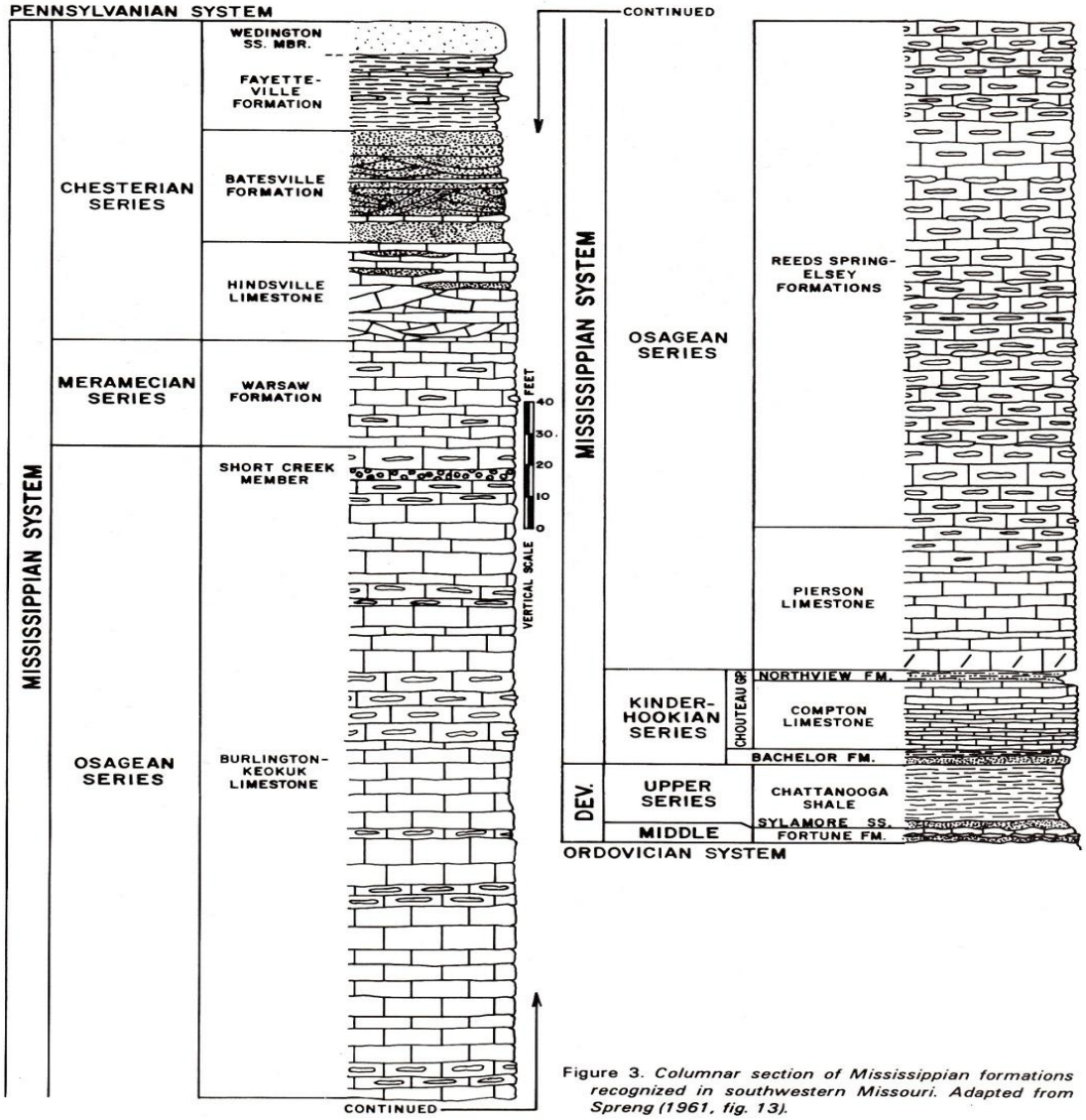
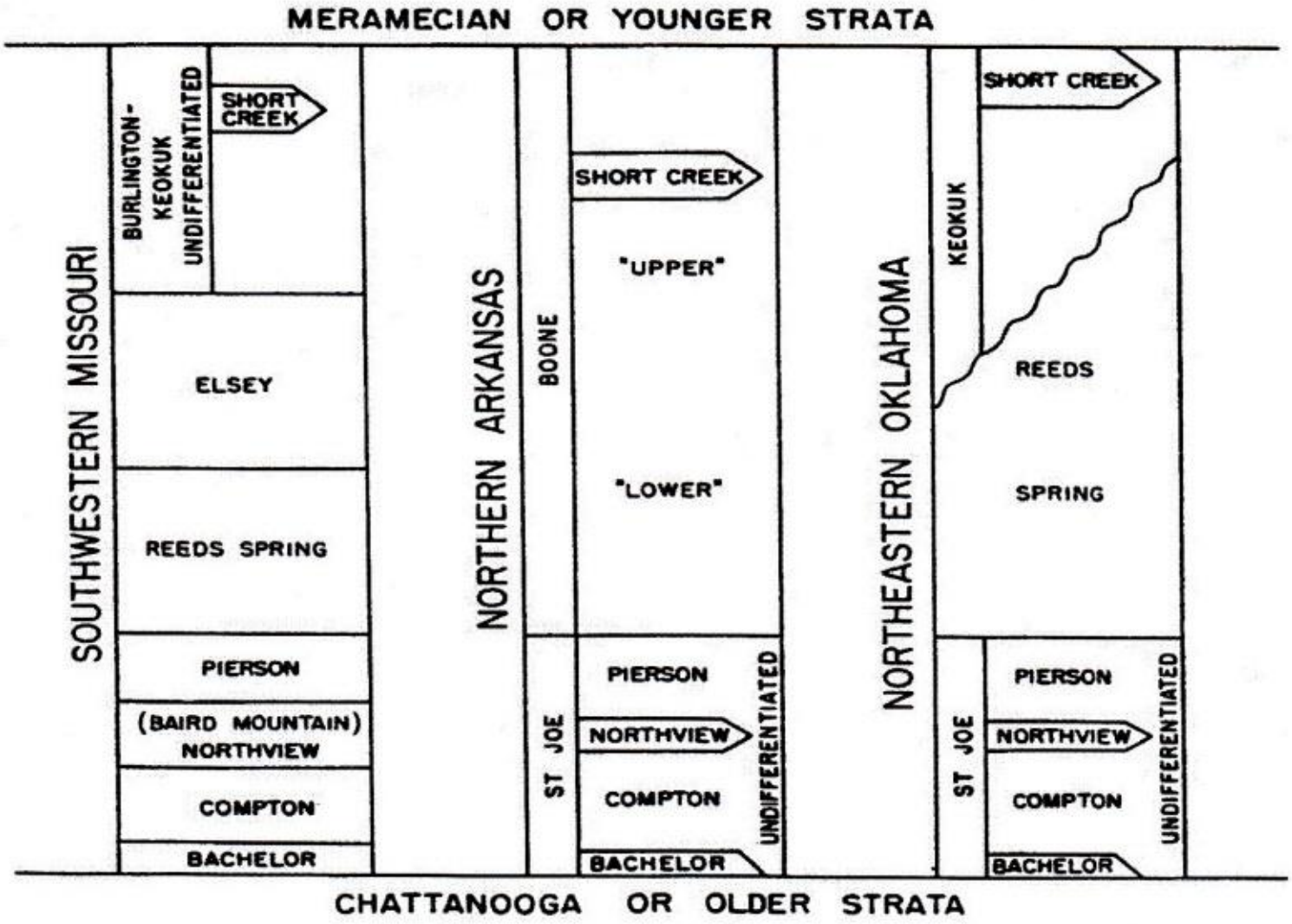
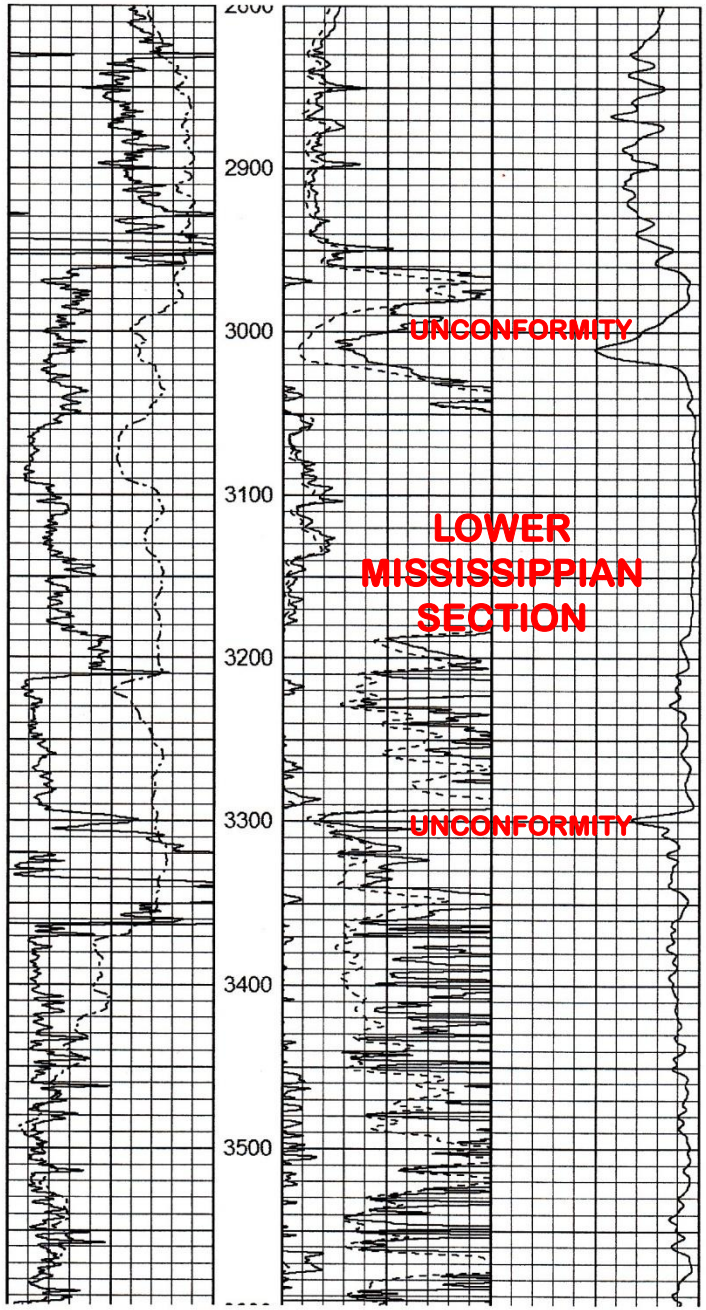


Figure 3. *Columnar section of Mississippian formations recognized in southwestern Missouri. Adapted from Spreng (1961, fig. 13).*

LOWER MISSISSIPPIAN LITHOSTRATIGRAPHY, SOUTHERN MIDCONTINENT - MANGER AND OTHERS, 1988





PENNSYLVANIAN SECTION

MISSISSIPPI CHAT ?

UPPER CHERT-BEARING CRINOIDAL LIMESTONE – HIGHSTAND/REGRESSION

LOWER CHERT-BEARING CRINOIDAL LIMESTONE – MAXIMUM FLOODING INTERVAL

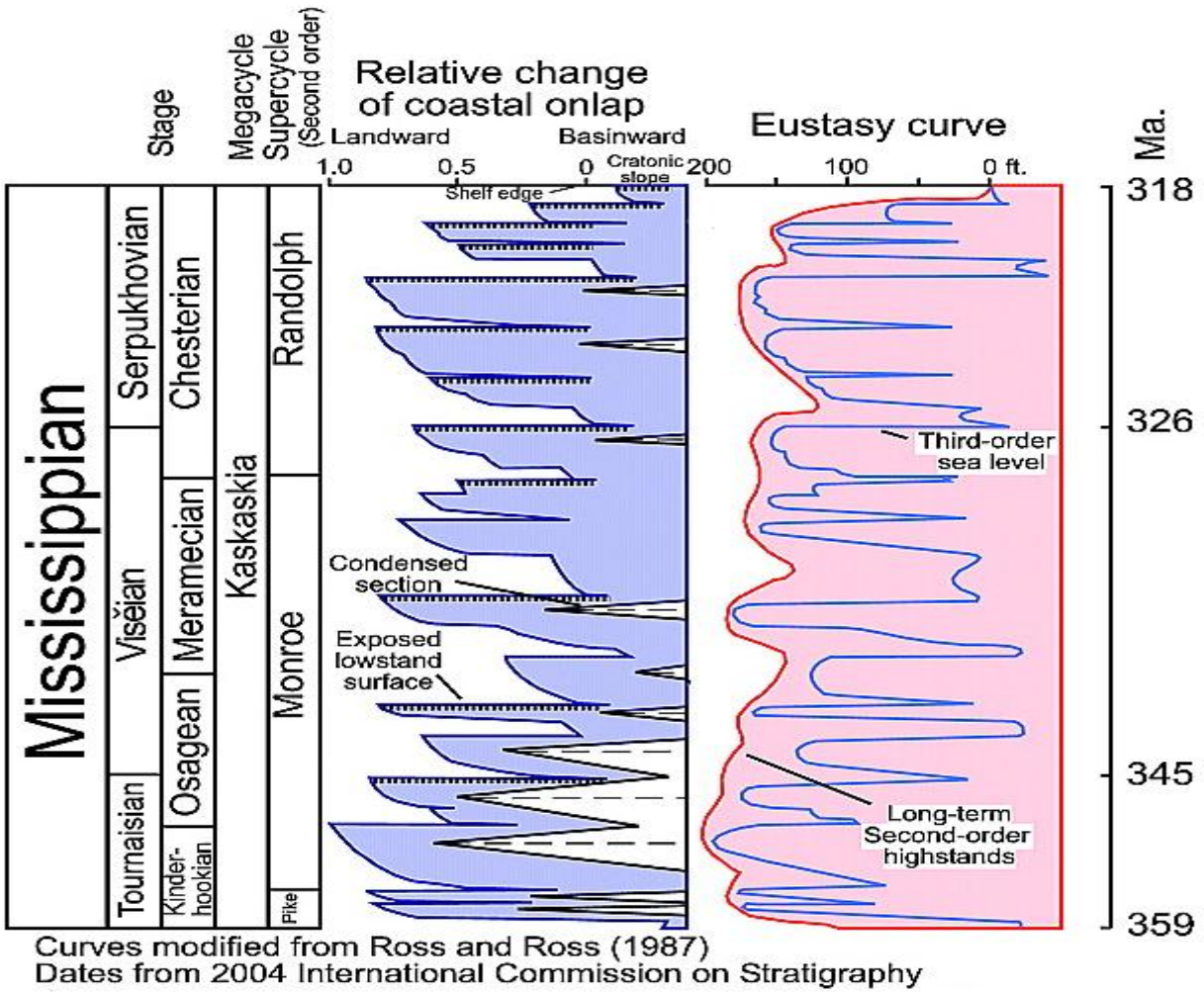
CHERT-FREE DOLOMITIC LIMESTONE - TRANSGRESSIVE SYSTEMS TRACT

WOODFORD

ARBUCKLE

LAWCO - OLSEN #2 WELL
OSAGE CO., OK

Record of Sea-level Eustacy and Coastal Onlap for the Mississippian Period



Loucks and Ruppel, 2007

SEQUENCE STRATIGRAPHIC HISTORY

- LOWER MISSISSIPPIAN IS SINGLE, UNCONFORMITY- BOUNDED, THIRD-ORDER CYCLE WITH SIGNATURE OF HIGHER ORDER CYCLES

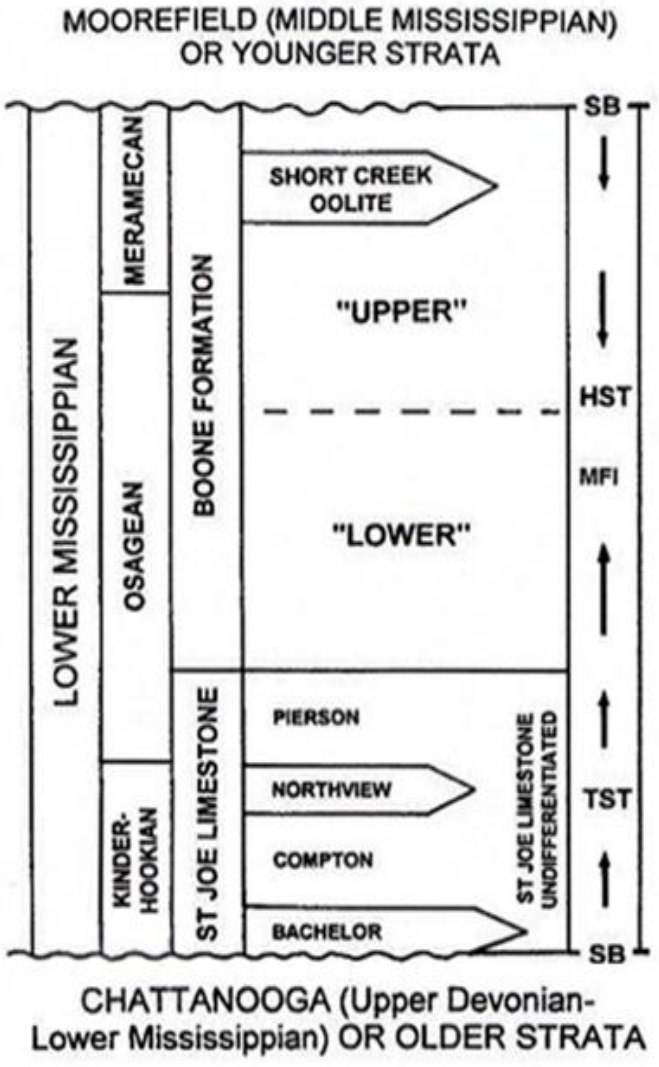
- UNCONFORMITIES AT BASE OF BACHELOR, BASE OF ST. JOE, OR WITHIN CHATTANOOGA AND AT TOP OF KEOKUK OR UPPER BOONE

- TRANSGRESSION - BASAL CHERT-FREE INTERVAL BACHELOR TO PIERSON - ST. JOE

- MAXIMUM FLOODING INTERVAL – CHERT-BEARING - REEDS SPRING – LOWER BOONE

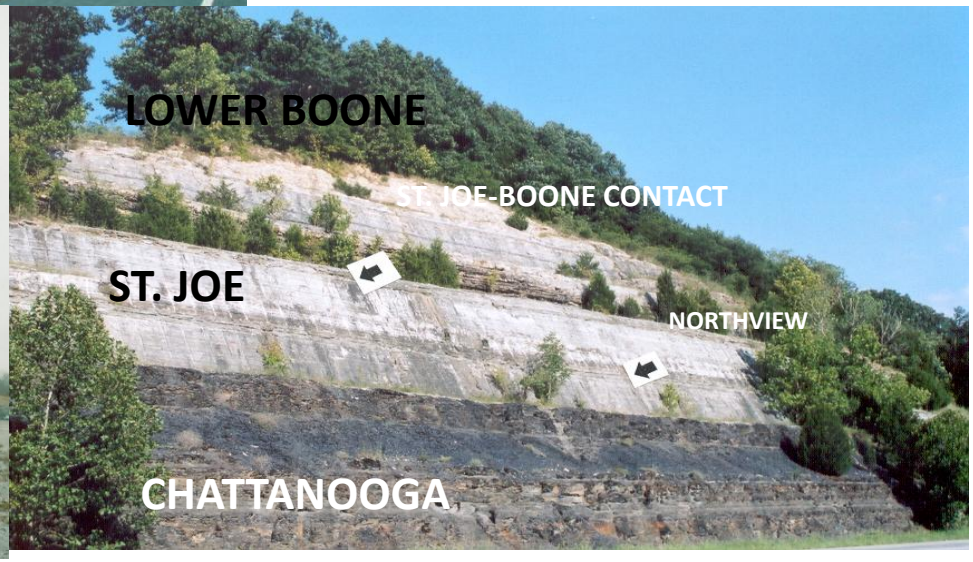
- HIGHSTAND AND REGRESSION – CHERT-BEARING BURLINGTON/ KEOKUK (SHORT CREEK) – UPPER BOONE

MISSISSIPPIAN LITHOSTRATIGRAPHY – NORTHWESTERN ARKANSAS - Manger and Shelby, 2000



LOWER MISSISSIPPIAN OUTCROP, NORTHWESTERN ARKANSAS AND SOUTHWESTERN MISSOURI

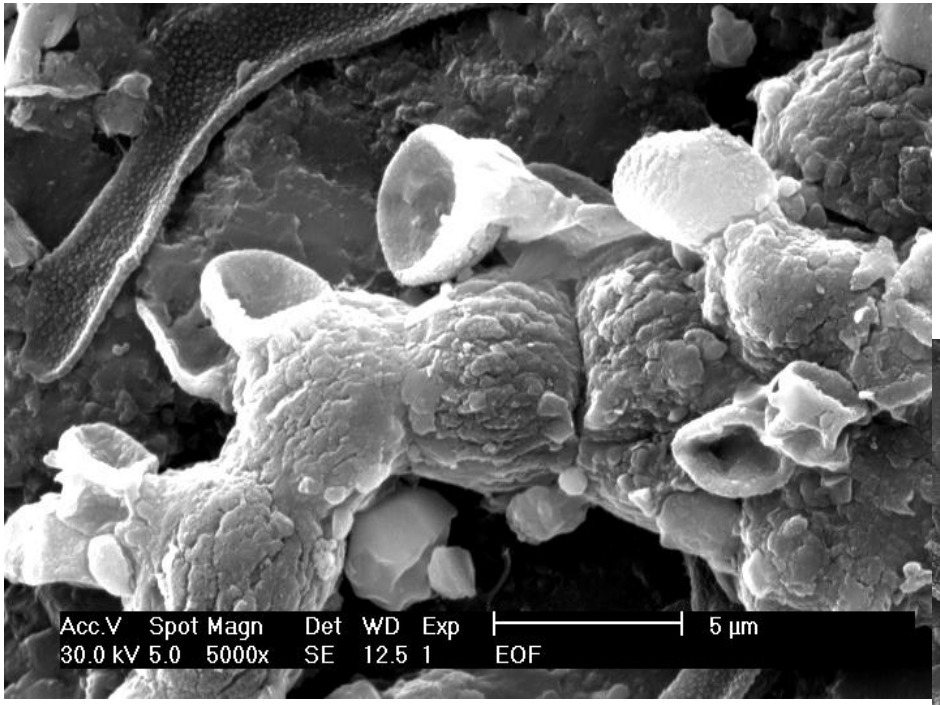
TRANSGRESSION TO MAXIMUM FLOODING INTERVAL = ST JOE AND LOWER BOONE



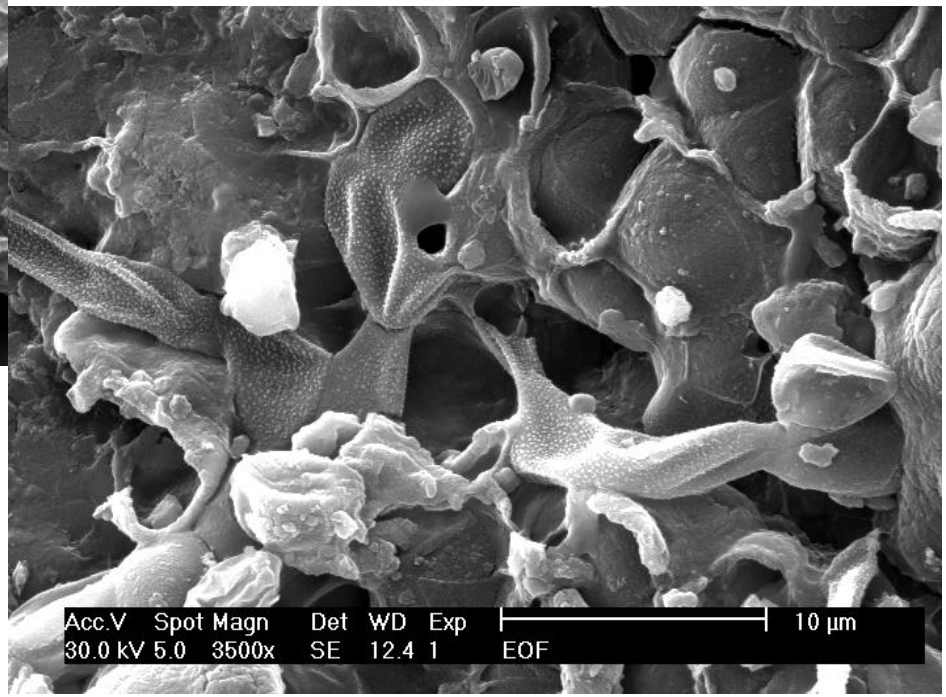
PENECONTEMPORANEOUS CHERT – LOWER BOONE – MAXIMUM FLOODING INTERVAL

Opal – A ➞ Opal – CT ➞ Chalcedony ➞ Quartz
Shrinkage fractures from de-watering
Fractured chert – reservoir?

SEM IMAGES – PENECONTEMPORANEOUS CHERT

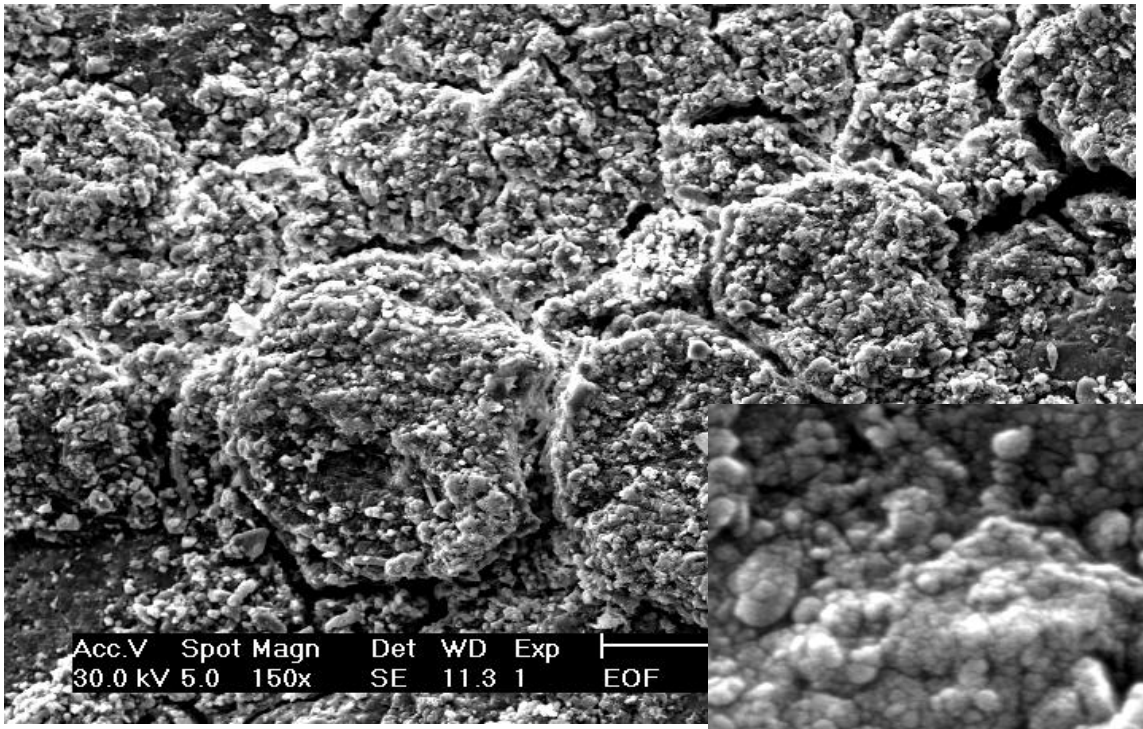


HIGH ORGANIC CONTENT

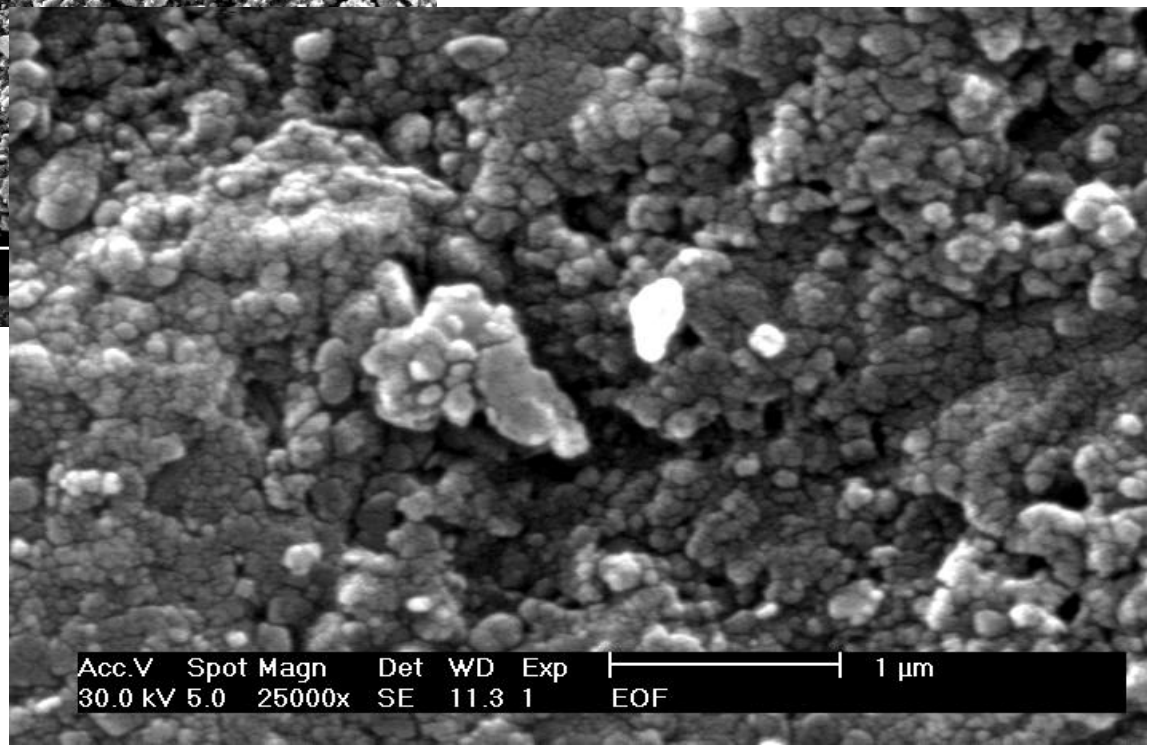


LOWER BOONE – BELLA VISTA ROADCUT, ARKANSAS

SEM IMAGES – PENECONTEMPORANEOUS CHERT



LOW MAGNIFICATION – CRUDE CRYSTALLITES



MICROBOTRYOIDAL TEXTURE - SILICA LEPISPHERES ?

LOWER BOONE – BELLA VISTA ROADCUT, ARKANSAS

BURLINGTON/UPPER BOONE – HIGHSTAND/REGRESSIVE SEQUENCE

▲UPPER BOONE HIGHSTAND SEQUENCE – CRINOIDAL PACKSTONES AND LATER DIAGENETIC CHERT

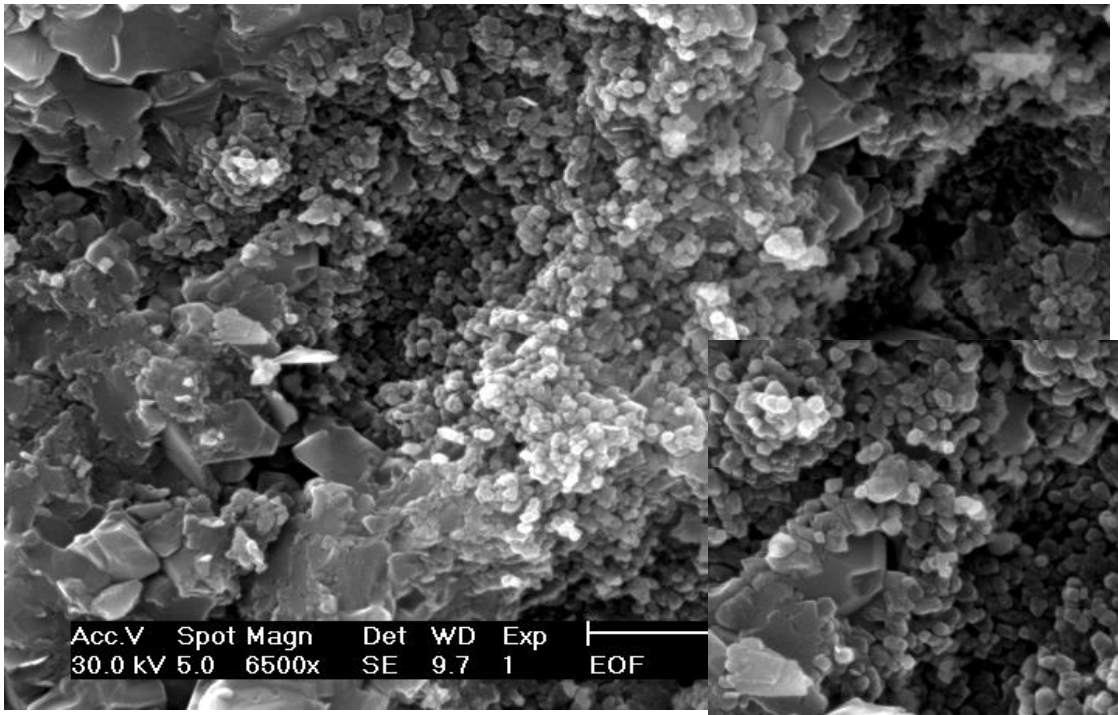
LATER DIAGENETIC CHERT – POTENTIAL TRIPOLITIZATION – PRINCIPAL RESERVOIR INTERVAL▼

UPPER BOONE MISSISSIPPIAN OUTCROP, NORTHWESTERN ARKANSAS

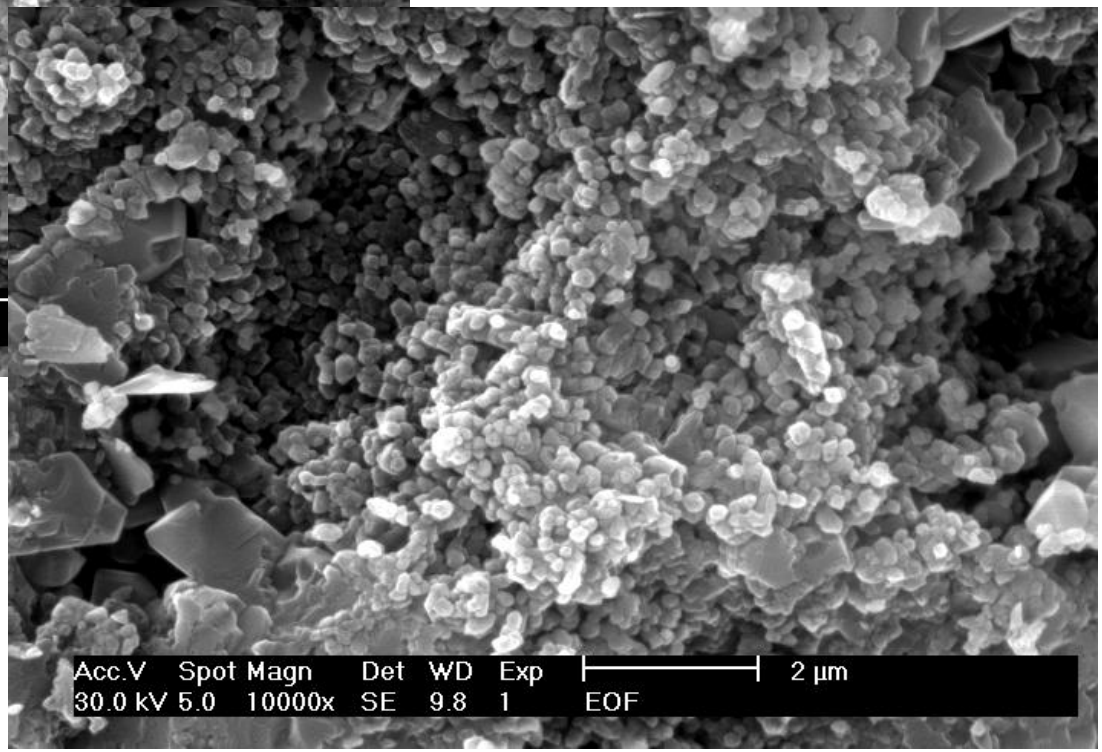
▲REGRESSIVE CARBONATES WITH LATER DIAGENETIC CHERT REPLACEMENT ALONG BEDDING PLANES

DEPOSITION WITHIN EFFECTIVE WAVE BASE ▼

SEM IMAGES – LATER DIAGENETIC CHERT



UPPER BOONE – BELLA VISTA, ARKANSAS



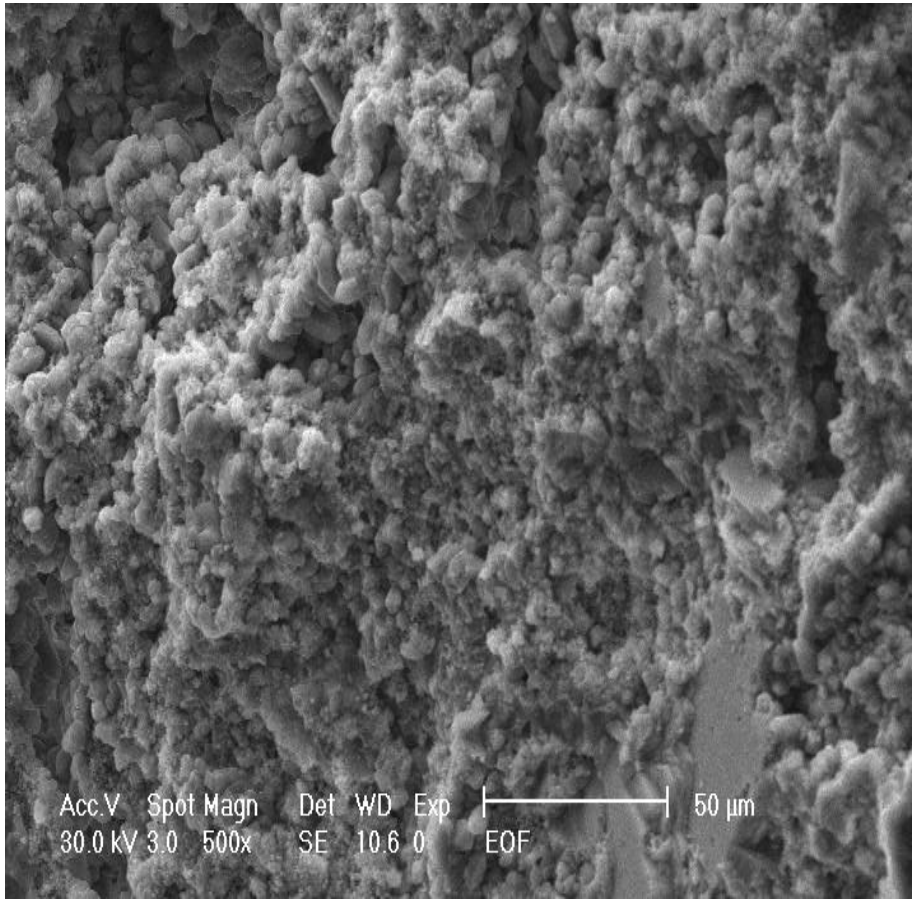
SILICA LEPISPHERES?

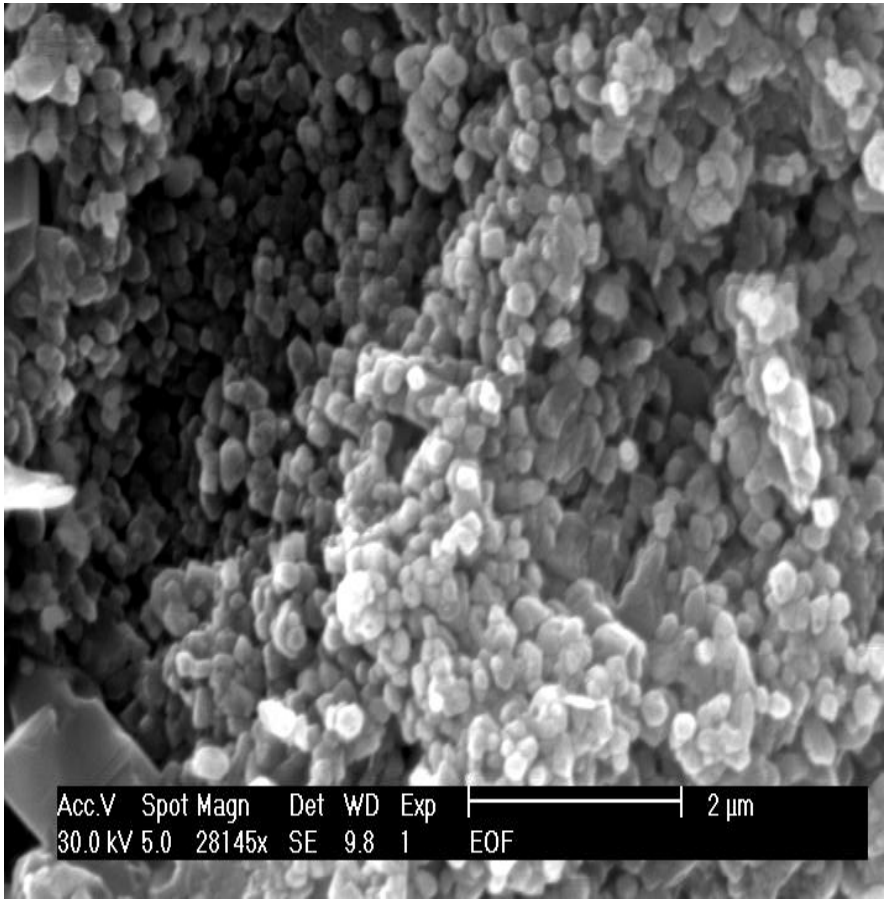
TRIPOLIC CHERT RESERVOIR – HIGHSTAND/REGRESSION – UPPER BOONE

LIGHT = TRIPOLITIC CHERT / DARK = LIMESTONE

TRIPOLITIC CHERT DEVELOPS ONLY IN CALCAREOUS INTERVALS

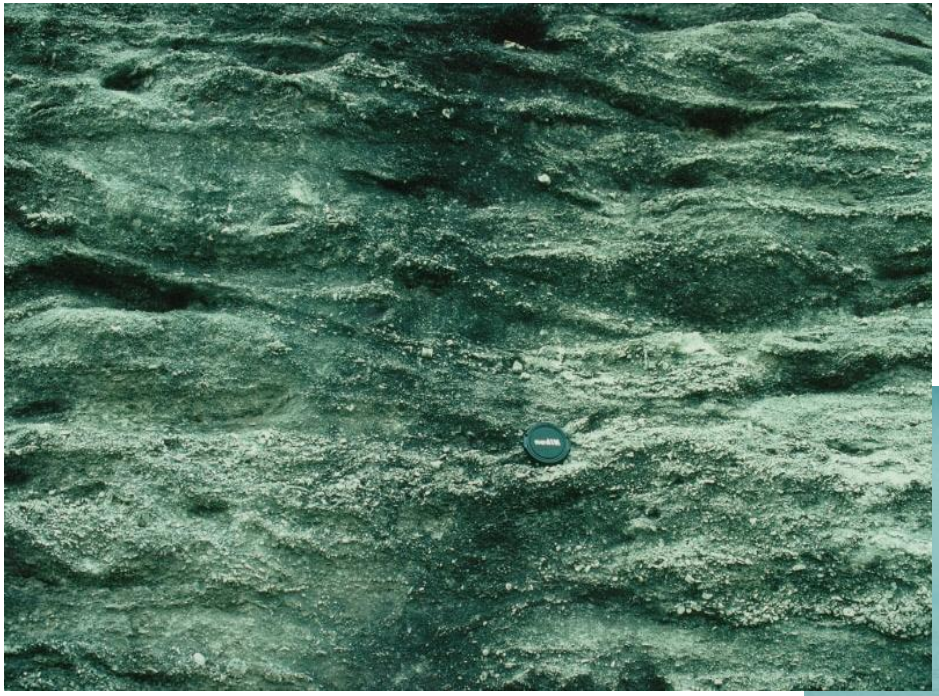
SEM - TRIPOLITIC CHERT





PINEVILLE, MISSOURI – U.S. HIGHWAY 71 ROADCUTS

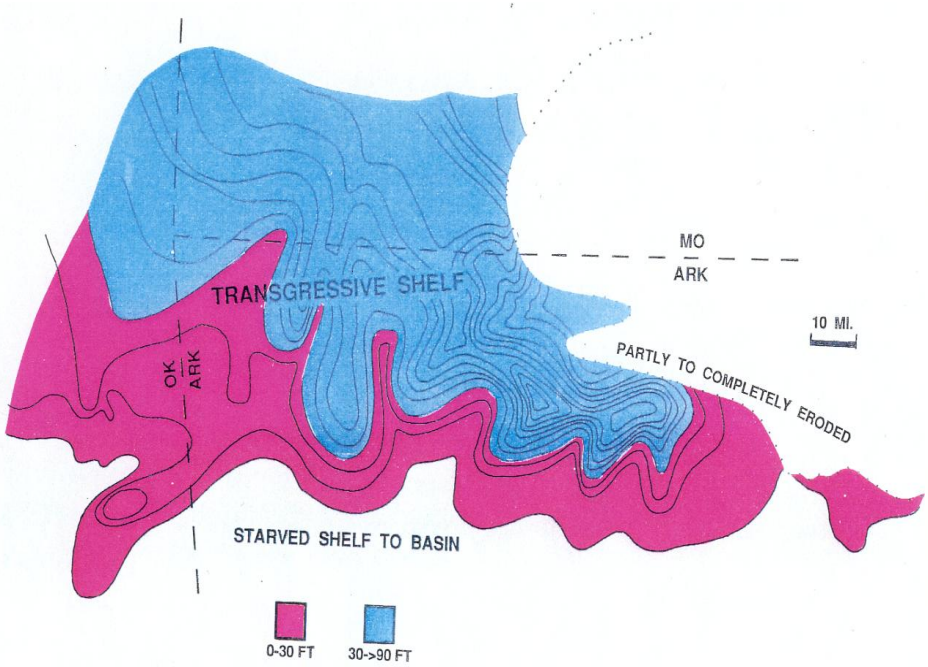
KEOKUK – REGRESSIVE SEQUENCE



Return to Effective Wave Base

Mobile Skeletal Sand of Crinozoan Detritus – NOTE LACK OF CHERT

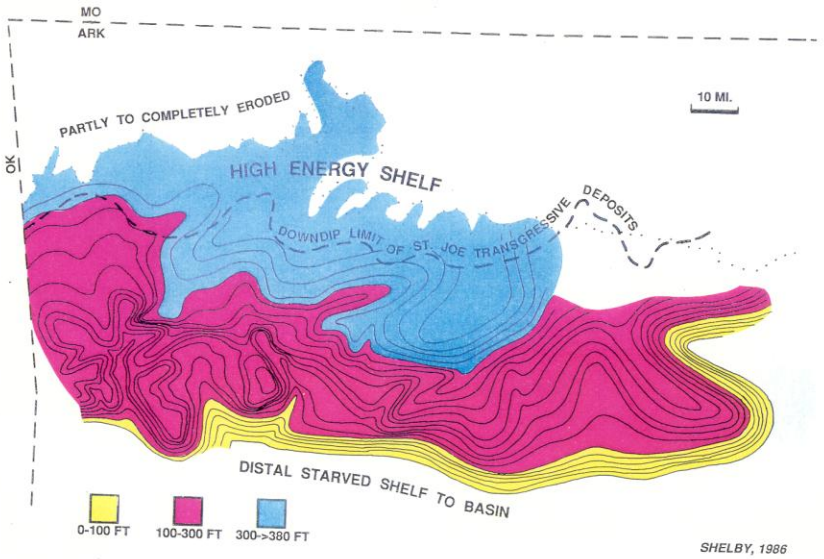
LOBATE SEDIMENT MOVEMEMNT - LOWER MISSISSIPPIAN ISOPACHOUS MAPS – ST JOE AND BOONE



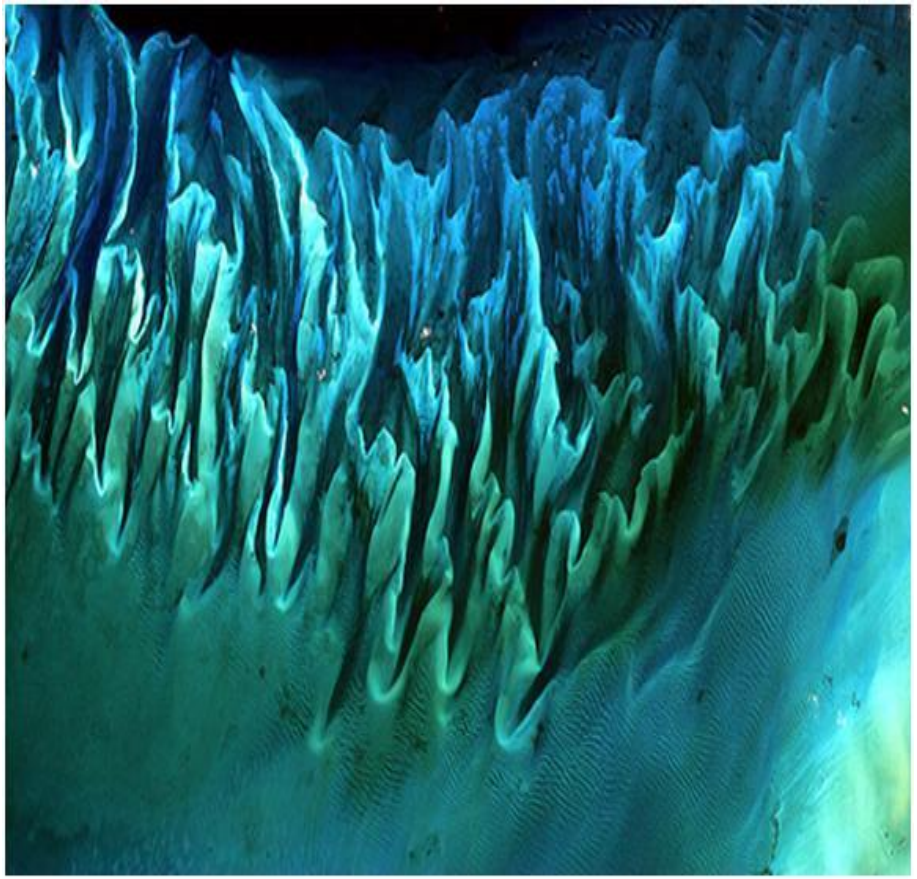
Terry, 1980

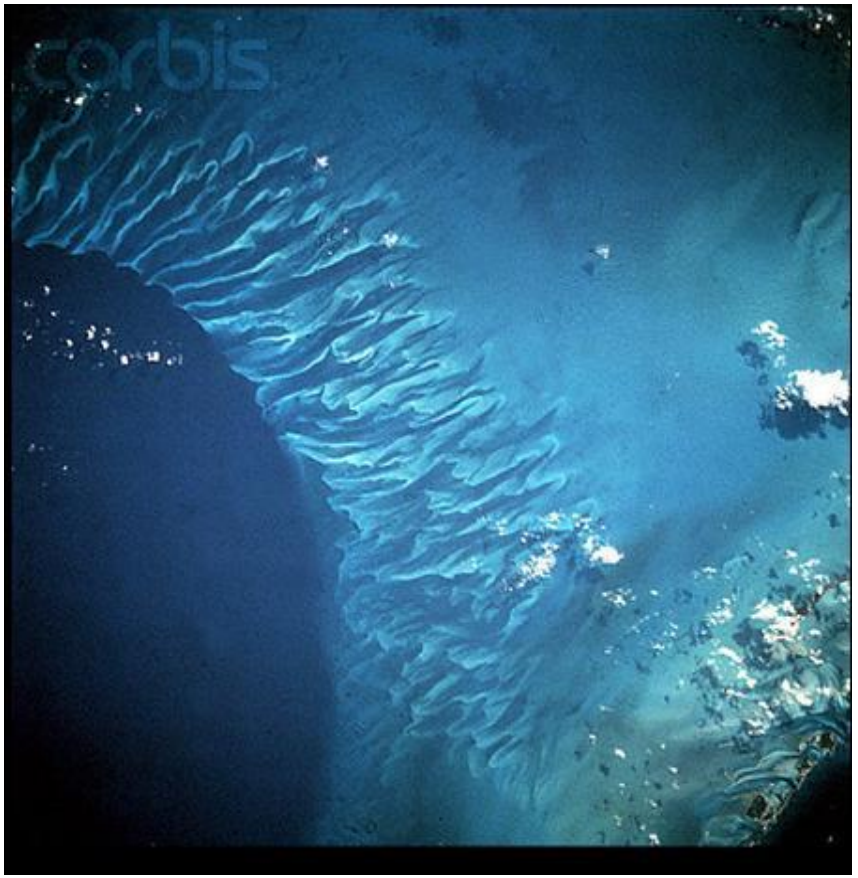
▲ ST JOE – MIDDLE KINDERHOOKIAN to LOWER OSAGEAN

BOONE – UPPER OSAGEAN to MERAMECAN? ▼



MODERN ANALOGUE - SEDIMENT MOVEMENT AT SOUTHEASTERN END OF TONGUE OF THE OCEAN, BAHAMAS





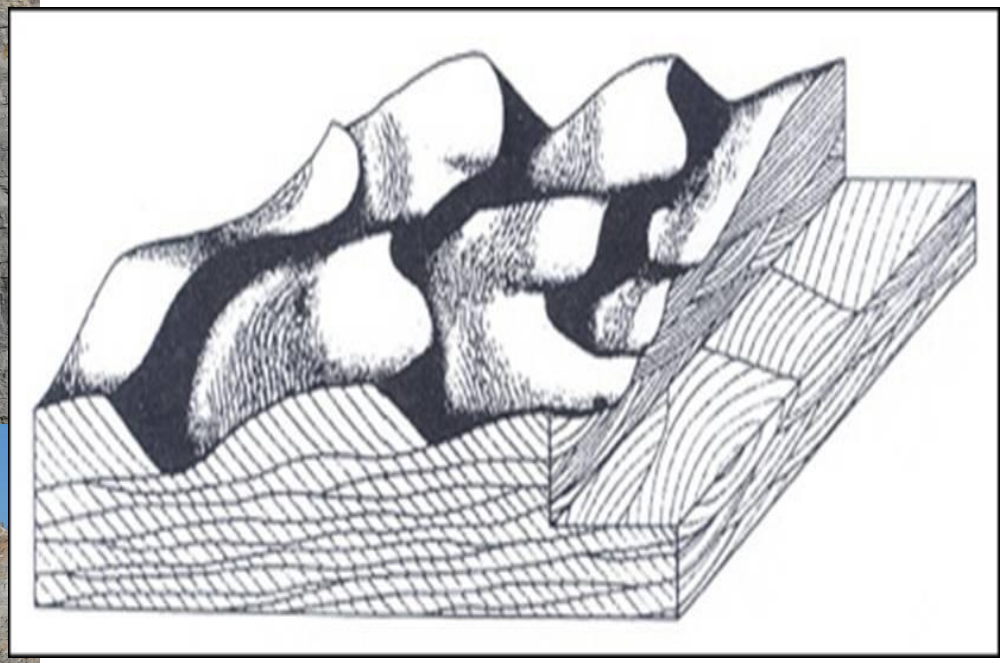
This sediment is mostly clean carbonate sand

MODRN ANALOGUE - SEDIMENT MOVEMENT, SOUTH CAT CAY, BAHAMA PLATFORM

Figure 6.9. The oolitic sands on the3 tide dominated shoal east of Cat Cay, Little Bahama Bank are shaped into enechelon shoals. Lobate spillovers show the direction of dominant transport.

This sediment is clean oolite

HIGH WALL EXPOSURES, VALLEY SPRING QUARRY, NORTHERN ARKANSAS

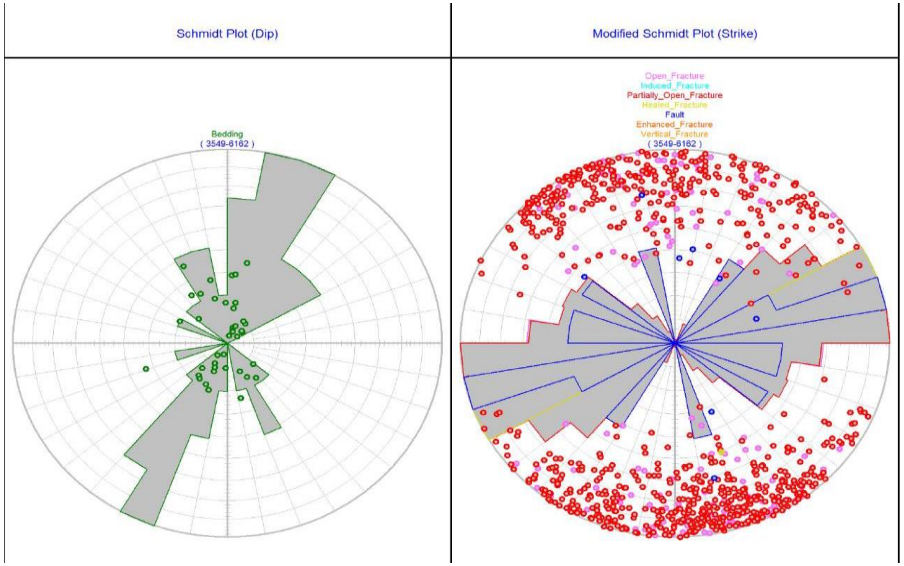


BLOCK DIAGRAM OF FESTOON BEDDING

HIGH WALL EXPOSURES, VALLEY SPRING QUARRY, NORTHERN ARKANSAS

HIGH WALL EXPOSURES, VALLEY SPRING QUARRY, NORTHERN ARKANSAS

SCHMIDT PLOTS – BEDDING AND FRACTURES



▲ Gray 2-13H, Osage County, OK

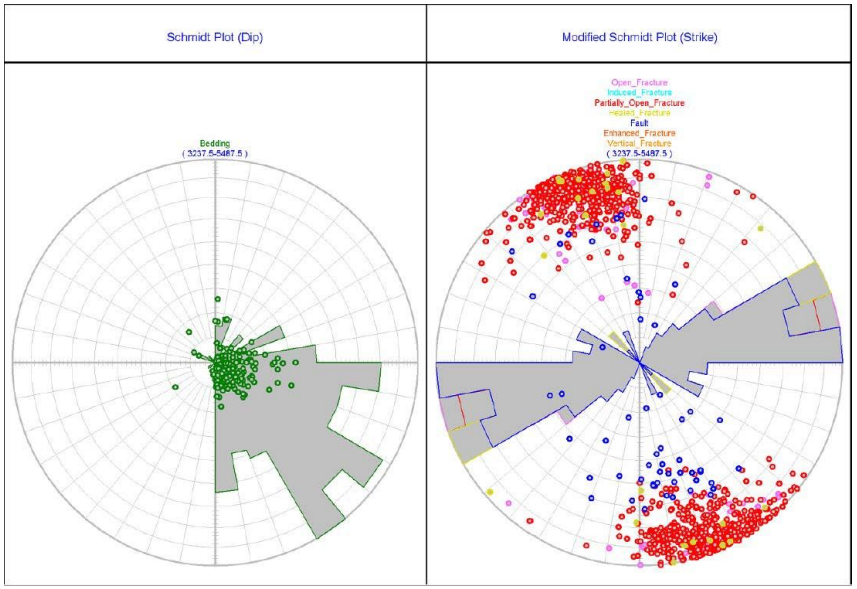
TWO MAIN POPULATIONS OF BEDDING PLANE DIPS – NE AND SW, WITH MINOR NW AND SE ORIENTATION

MANY FRACTURES SCATTERED WITH ESSENTIALLY E-W ORIENTATION

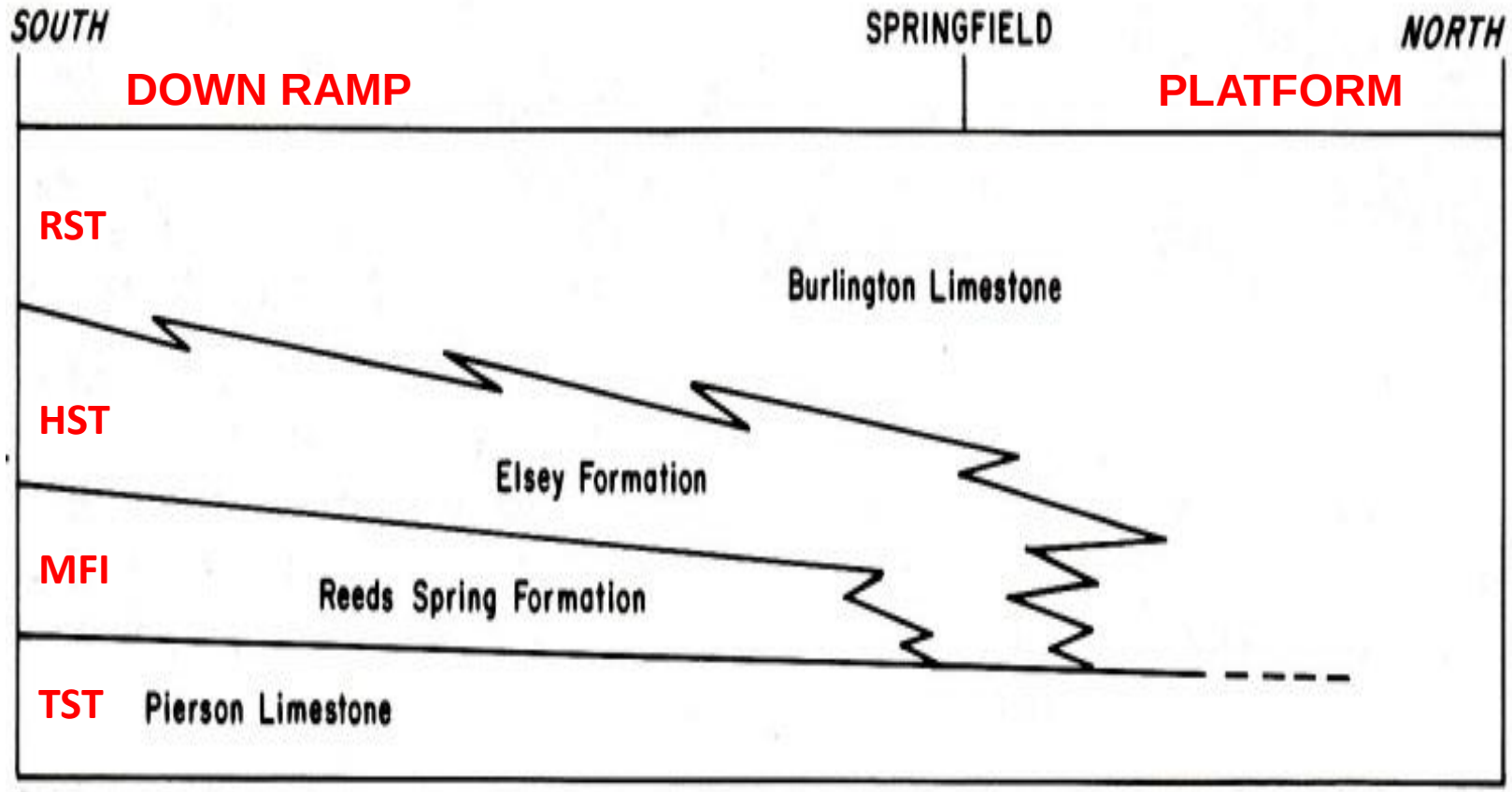
Olson 4 -14H, Osage County, OK▼

VIRTUALLY ALL BEDDING PLANE DIPS TO SE, BUT SCATTERED WITHIN 90º

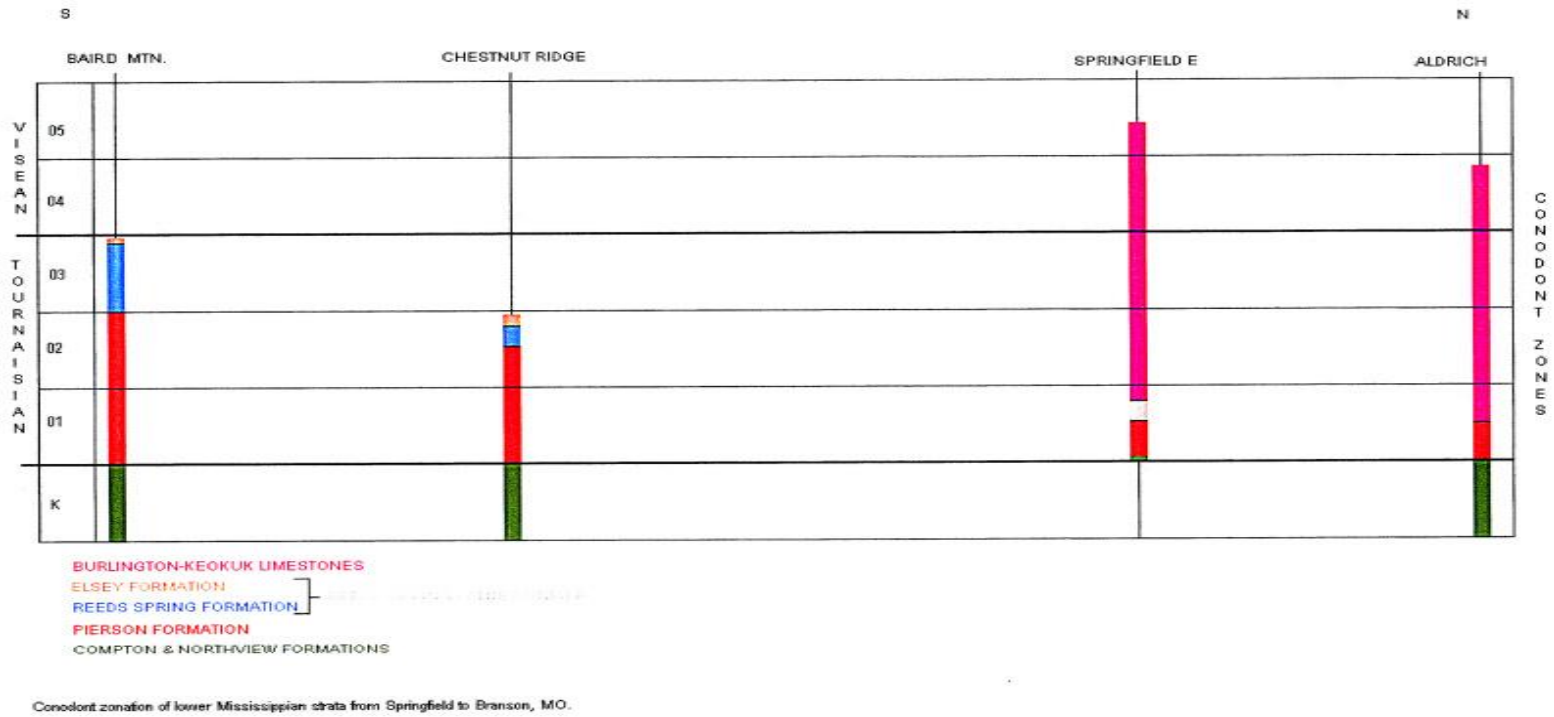
FEWER, MORE CONCENTRATED FRACTURES WITH ESSENTIALLY E-W ORIENTATION



NORTH-SOUTH FACIES RELATIONSHIPS – OZARK RAMP

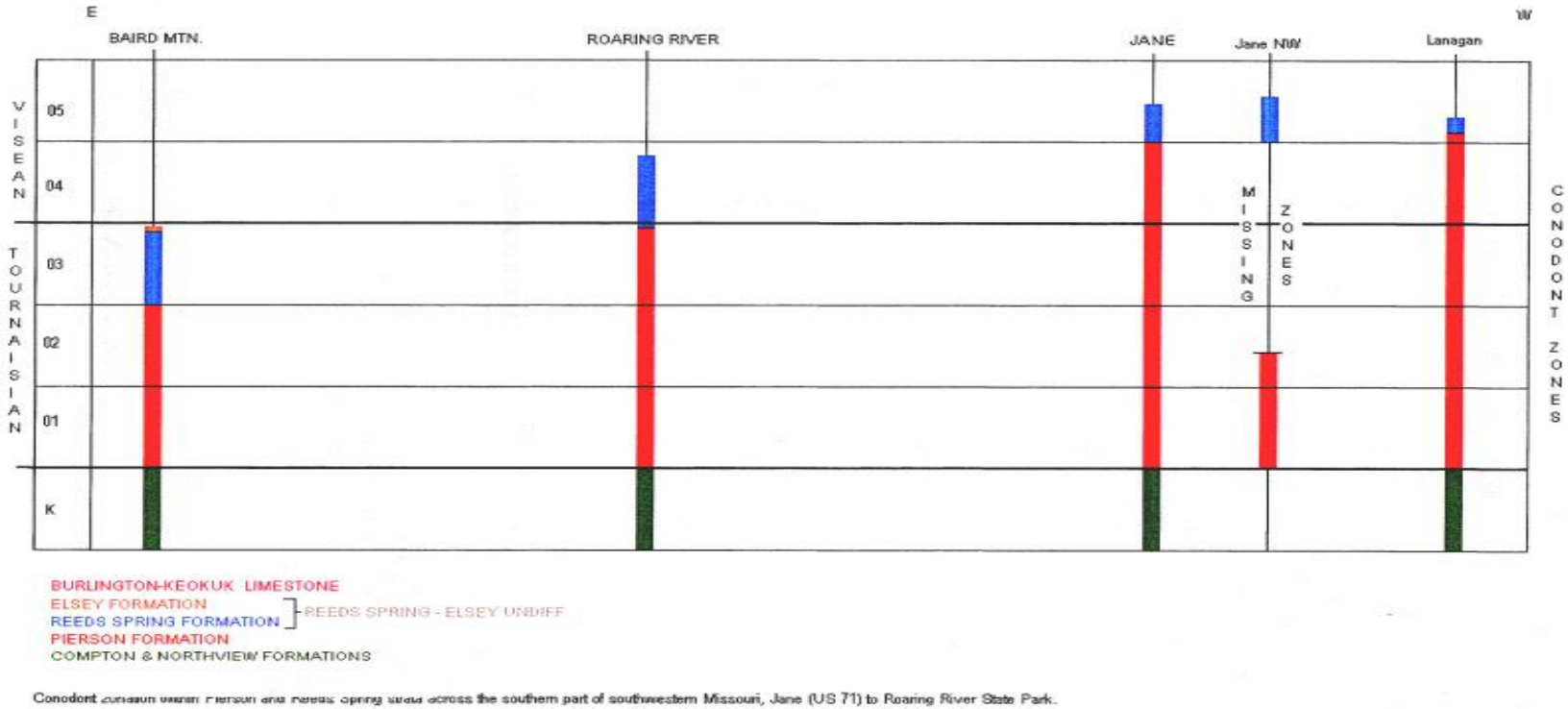


Thompson, 1986



Conodont zonation of lower Mississippian strata from Springfield to Branson, MO.

N-S Correlation of the Compton through Burlington-Keokuk Interval in Southwestern Missouri (Thompson, 2012, personal communication, unpublished figure)



Conodont zonation within Pierson and Reeds Spring strata across the southern part of southwestern Missouri, Jane (US 71) to Roaring River State Park.

E-W Correlation of the Compton through Burlington-Keokuk Interval in Southwestern Missouri (Thompson, 2012, personal communication, unpublished figure)

OBSERVATIONS ON RESERVOIR INTERVAL – MISSISSIPPI LIME PLAY

- RESERVOIR INTERVALS SEEM TO BE DEVELOPED IN BOTH THE LOWER AND UPPER CHERT-BEARING INTERVALS, BUT NOT CONSISTENTLY IN ALL WELLS

- UNDERSTANDING OF TRIPOLITIC CHERT DEVELOPMENT SUGGESTS THOSE INTERVALS ARE CONFINED TO THE UPPER PORTION OF THE LOWER MISSISSIPPIAN SECTION

- CHERT-BEARING INTERVALS EXHIBIT SIGNIFICANT FRACTURES, BUT SOME ARE CONDUITS FOR GROUNDWATER

- TRANSPORTATION DOWN-RAMP BY LOBATE MOVEMENT CONFOUNDS SUBSURFACE CORRELATION OF RESERVOIR INTERVALS

- MAJOR FRACTURE SYSTEMS NEED TO BE AVOIDED; MAPPING OF GROUNDWATER PRODUCTION MAY PROVIDE INSIGHTS TO RESERVOIR DISTRIBUTION

- HIGHER PRESSURE FRACKING WITH LESS PROPPANT MAY PRODUCE HIGHER HYDROCARBON PRODUCTION