Fluid Migration and Accumulation within the Mississippian: Why 2% Oil Cut Here, 15% Oil Cut One Mile Away*

W. Lynn Watney[1]

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*Adapted from oral presentation given at Mississippian Lime Play Forum, Oklahoma City, Oklahoma, February 20, 2014

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Abstract

Water cut is a big factor in gauging the success of horizontal drilling in the Mississippi Lime Play (MLP). The contributing factors are related in part to the spectrum of producing lithofacies and reservoir quality encountered that varies laterally and vertically, sometimes dramatically. As the extent of the play has increased, so have the types of reservoirs including conventional tripolite, spiculite, and dolomite reservoirs that may or may not be affected by Pennsylvanian karst. Conventional reservoirs are typically in transition when sufficient oil column is not present to lead to irreducible water saturation, inherently leading to variable water cuts based on height about free water and types of pores that are present.

Unconventional reservoir such as tight, dark organic-bearing dolomitic and silty lithofacies of the “Cowley” are often interbedded the spicultic and dolomitic conventional reservoirs. These rocks with sufficient oil prone organic matter and thermal maturity can locally be-come self-sourced reservoirs and possibly charge adjoining conventional reservoirs. Coupled with a thick thermally mature Woodford or Chattanooga Shale and fracturing, a hydrocarbon sweet spot is likely.

The structural history during and after the Mississippian with the development of the Arkoma and Anadarko basins and surrounding uplifts led to early thermal maturity of the Woodford Shale that goes back as far to the early Pennsylvanian. Evidence notable wrench faulting peaked in Atokan and Morrowan time in the Anadarko Basin extending well into Kansas. This dynamic setting lead to reactivation of basement weaknesses with both compressional strike-slip and transtensional faults that appear to closely tied to hydrocarbon migration fairways in the northern Midcontinent.

Fluid Migration and Accumulation within the Mississippian: Why 2% oil cut here, 15% oil cut one mile away

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KU KANSAS GEOLOGICAL SURVEY The University of Kansas

NETL

KSCO2

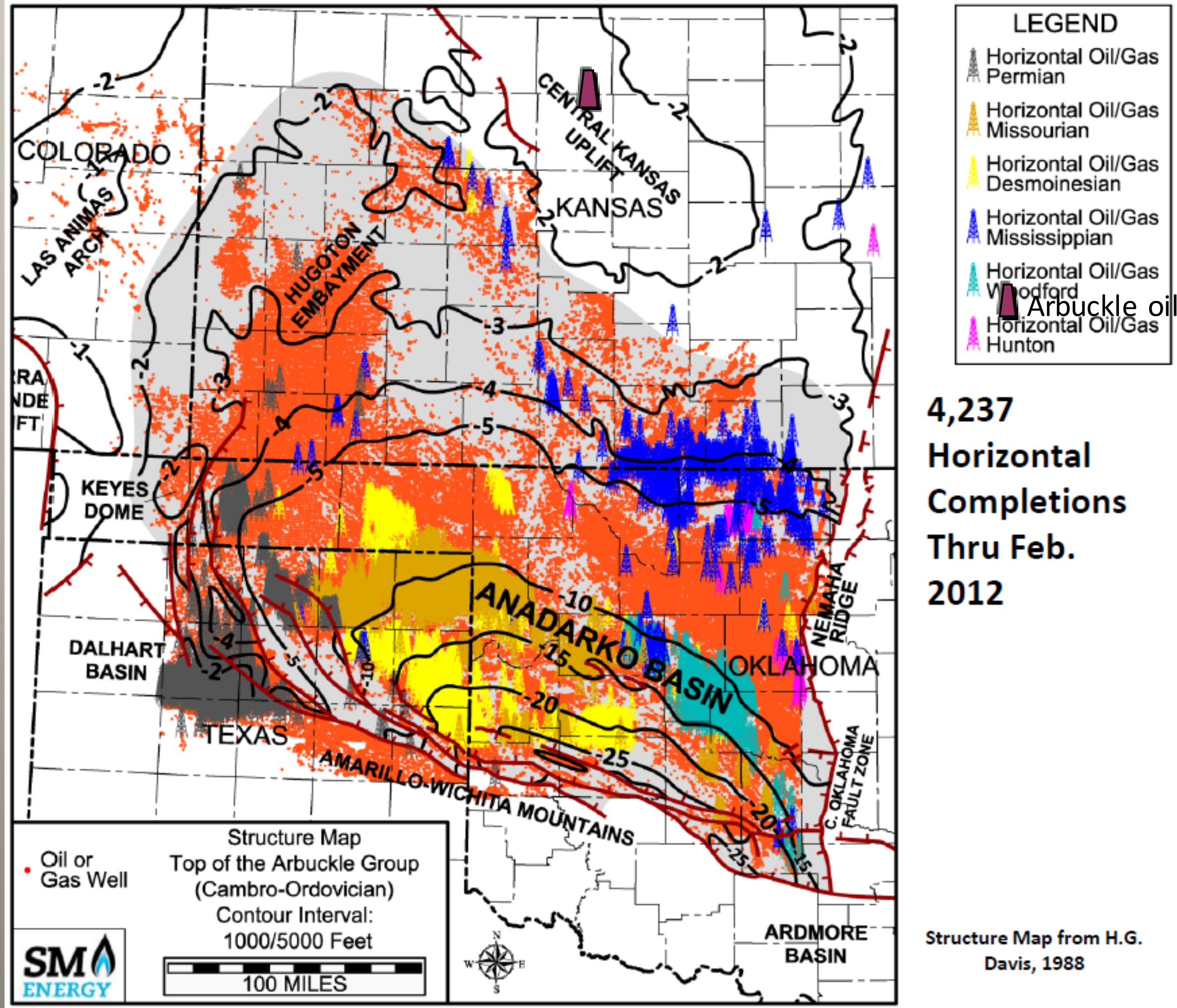
Kansas Interdisciplinary Carbonates Consortium

Outline

- Mississippi Lime Play - definition
- Structural history of Arkoma and Anadarko Basin
- Source rocks
- Hydrocarbon migration
- Spectrum of lithofacies and quality reservoir rock
- Conventional reservoir
- Unconventional reservoir lithofacies
- Why variations in water cut?
- Conclusions

Mississippi Lime Play - Definition

Regional Structural Features-Horizontal Wells

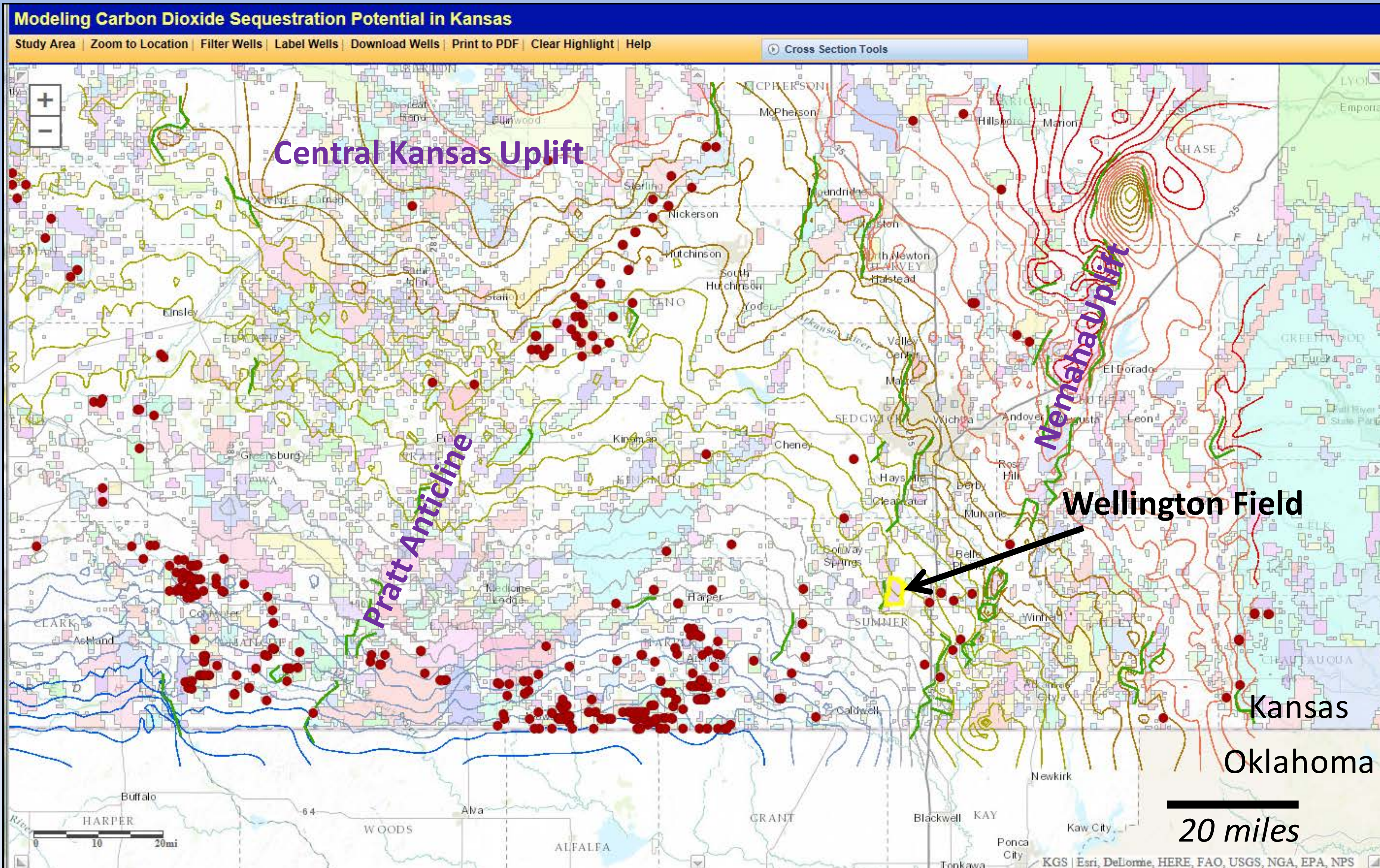


4,237 Horizontal Completions Thru Feb. 2012

Structure Map from H.G. Davis, 1988

John Mitchell, retired
SM Energy Co.
Tulsa, Oklahoma
March 2012

MLP in southern Kansas



Horizontal wells drilled since January 2011

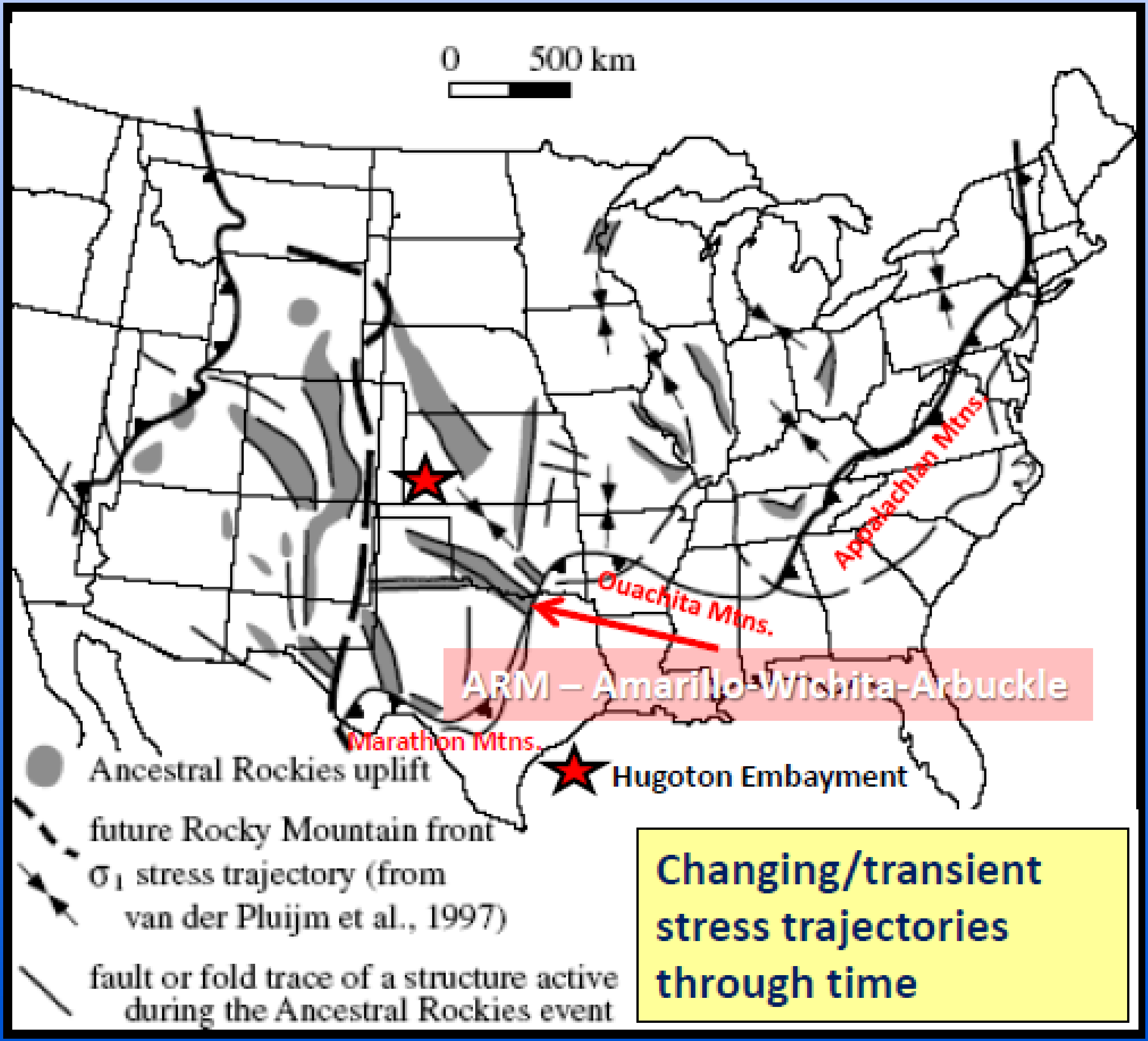
Mississippian structure (450 ft C.I.) and notable faults

Structural history of Arkoma and Anadarko Basin

- Concurrent and post Mississippian structural setting
- Reactivation of basement weaknesses
- Major wrench fault systems and directed stress into craton
- Affecting maturation of organic matter, migration routes of oil migration, and contributed to trapping of hydrocarbon
- Inherited fractures contribute to well performance

Structures - Ancestral Rockies

Early Chesterian - Late Leonardian deformation

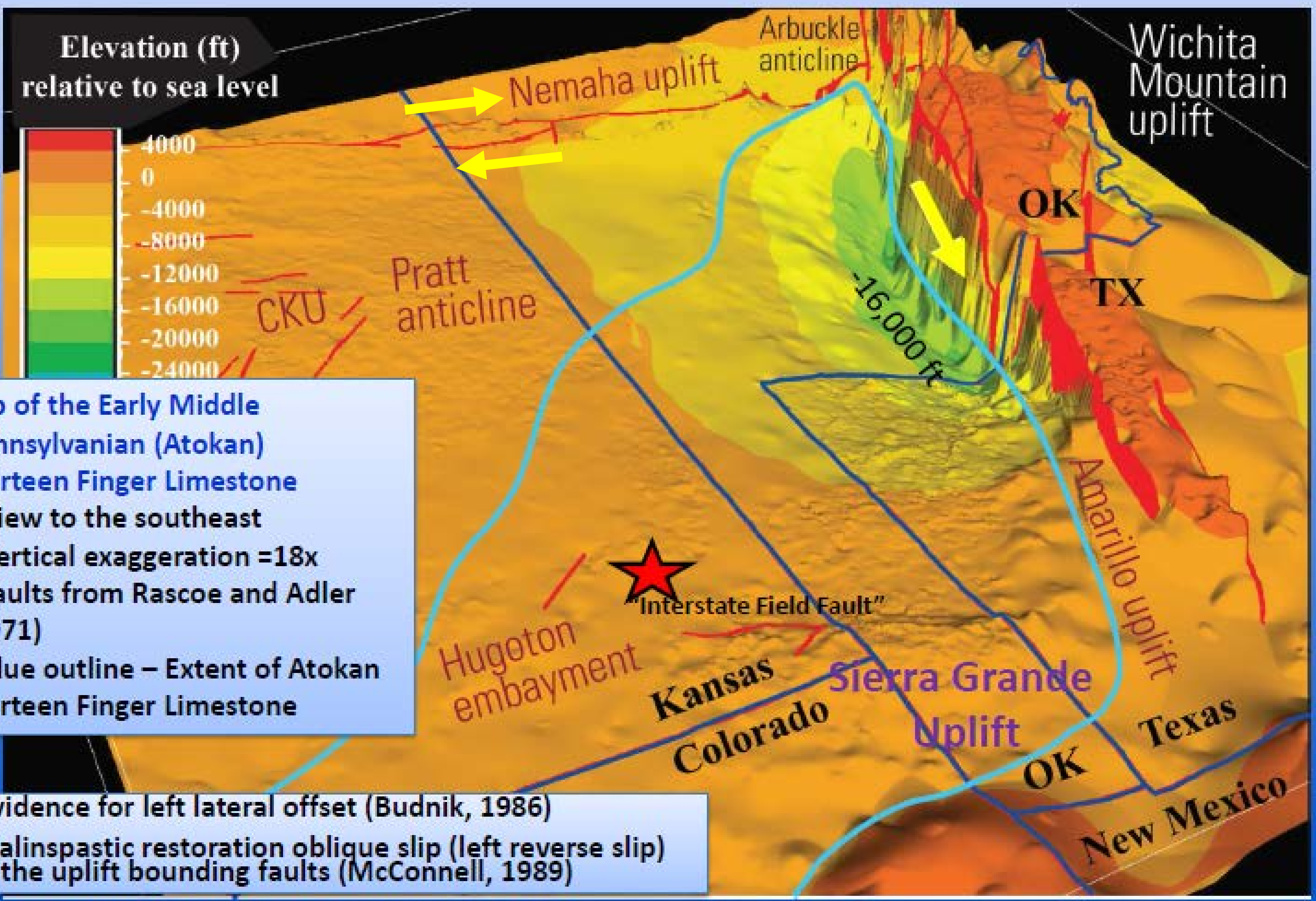


Changing/transient stress trajectories through time

Intraplate fault reactivation is mainly dependent on orientation of (weak) fault zones relative to plate margin… deformation in interior can be represented by simple rheological models (van der Pluijm et al., 1997)

Marshak, Karlstrom, and Timmons (2000)
Ages from Dickinson and Lawton (2003)

Peak Late Paleozoic Tectonism during Morrowan and Atokan



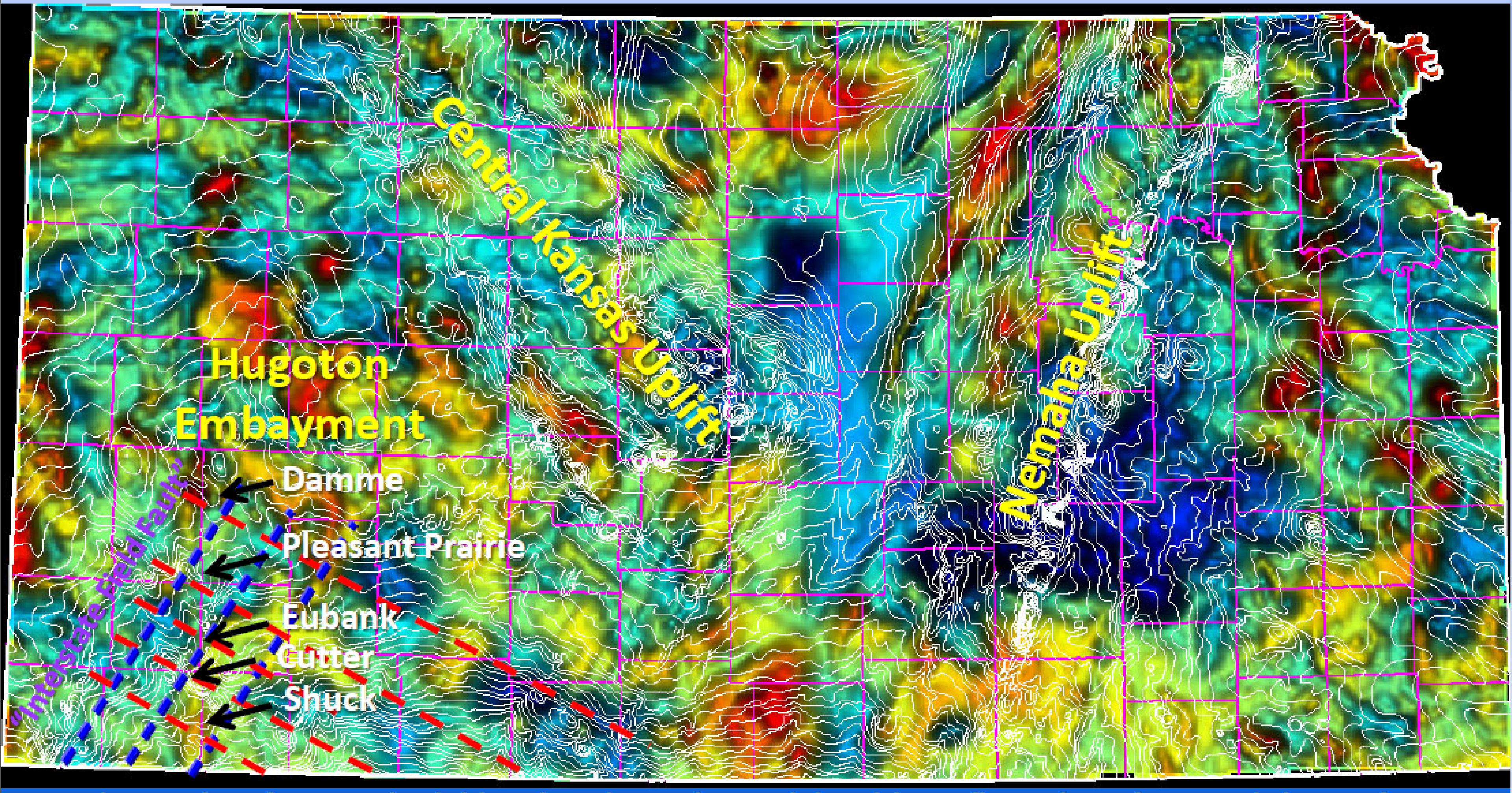
Top of the Early Middle Pennsylvanian (Atokan) Thirteen Finger Limestone

- View to the southeast
- Vertical exaggeration =18x
- Faults from Rascoe and Adler (1971)
- Blue outline – Extent of Atokan Thirteen Finger Limestone

- Evidence for left lateral offset (Budnik, 1986)
- Palinspastic restoration oblique slip (left reverse slip) on the uplift bounding faults (McConnell, 1989)

(Higley, 2011)

Proterozoic correlations –
Magnetic Field and Phanerozoic Structures



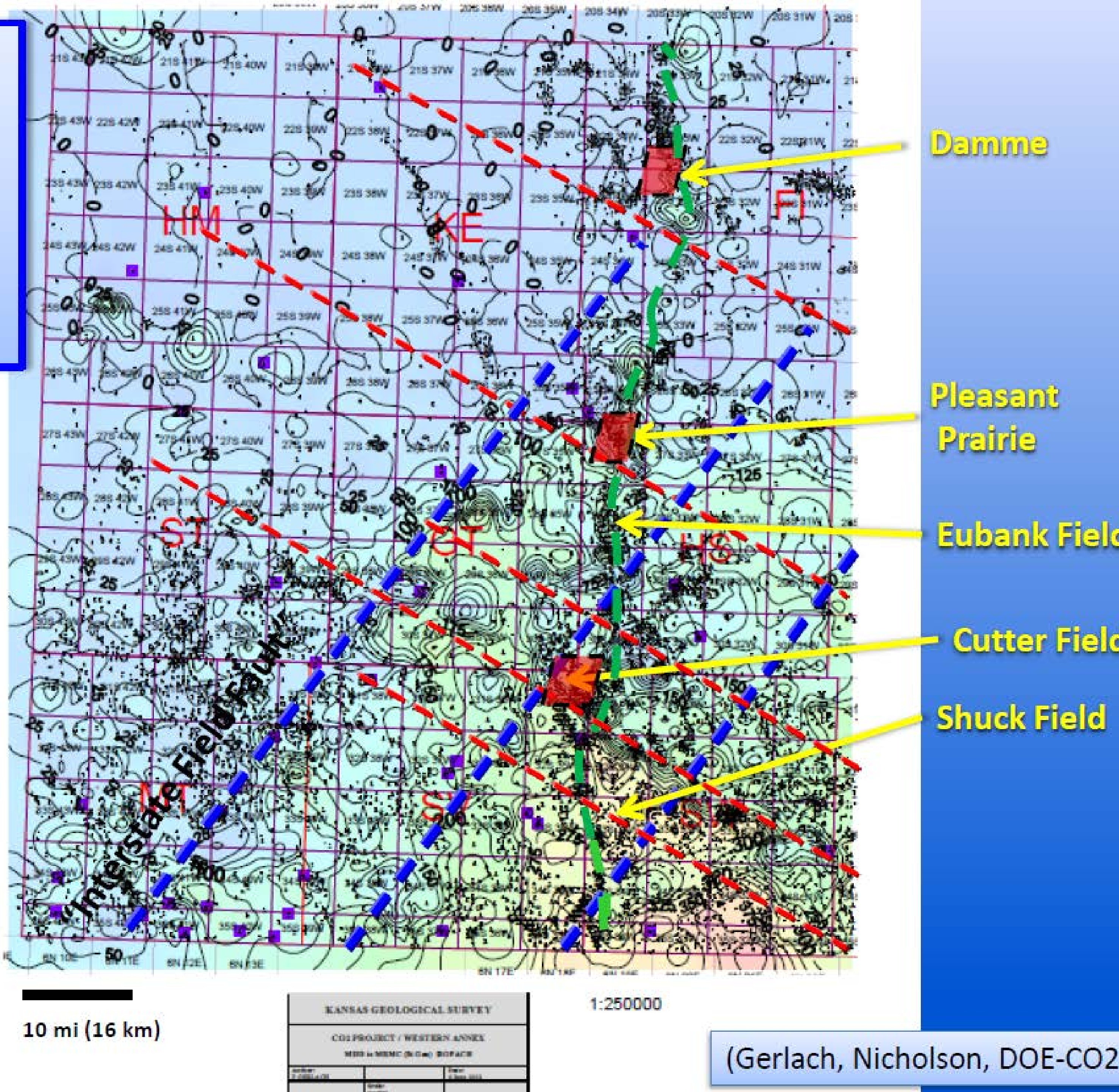
Total Intensity of Magnetic Field Reduced to Pole overlain with configuration of Precambrian surface

- Correspondence of Phanerozoic structures to magnetic anomalies
- Local and subregional changes in strike and dip appear to closely correlate to magnetic map
- Major influence on lithofacies distribution and sequence characteristics

(Cole, 1976; Kruger, 1999)

Chester Isopach delimiting *incised valley system*

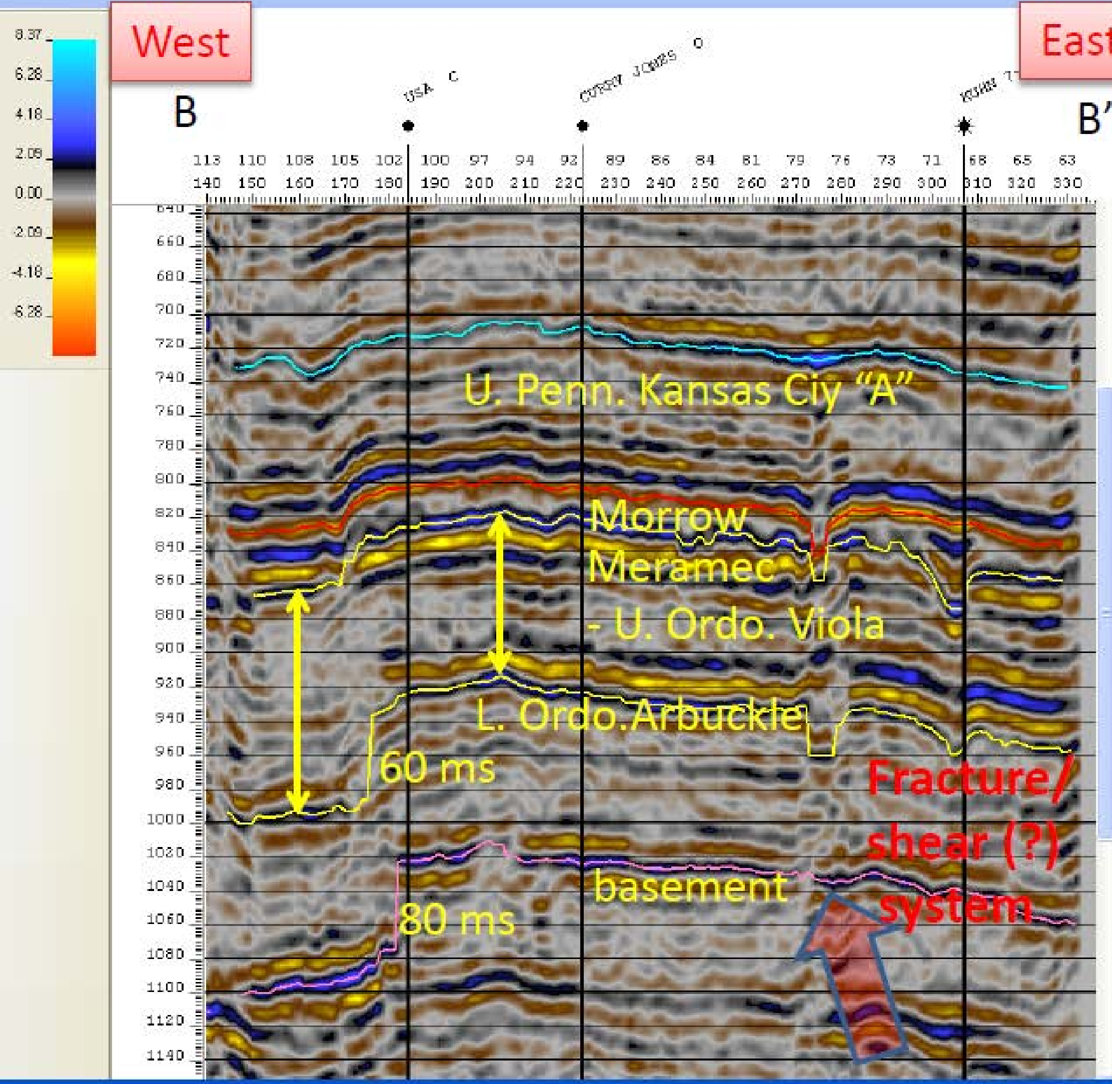
(~100 miles long)



(Gerlach, Nicholson, DOE-CO2)

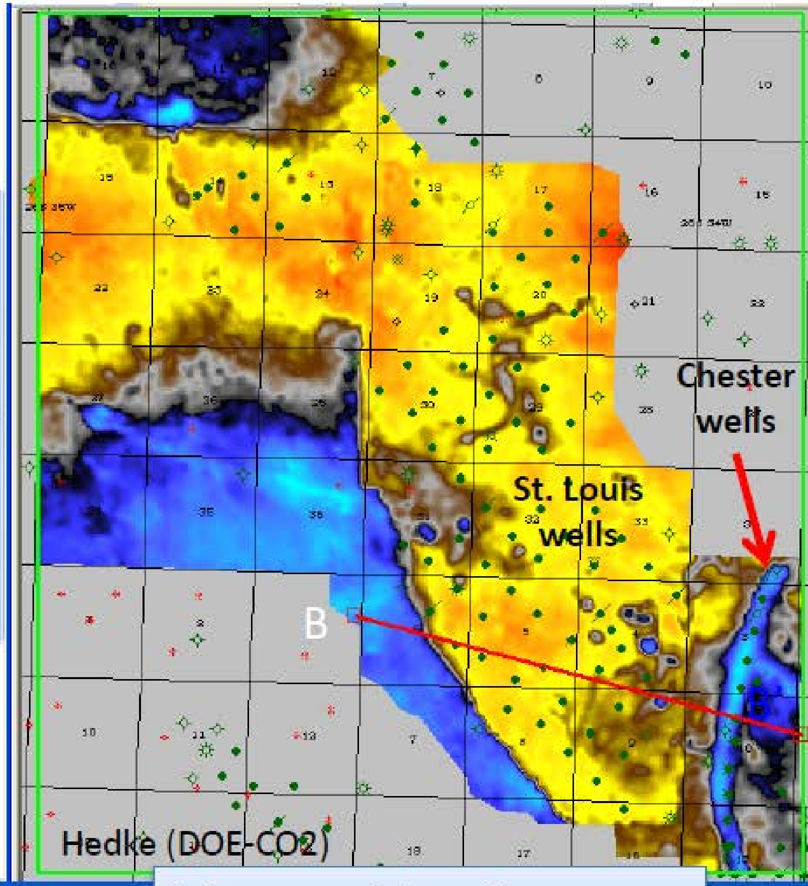
Mississippian-U. Orodovician Expansion

Chester incised valley & fracture set



Arbitrary Time Profile B-B', W – E

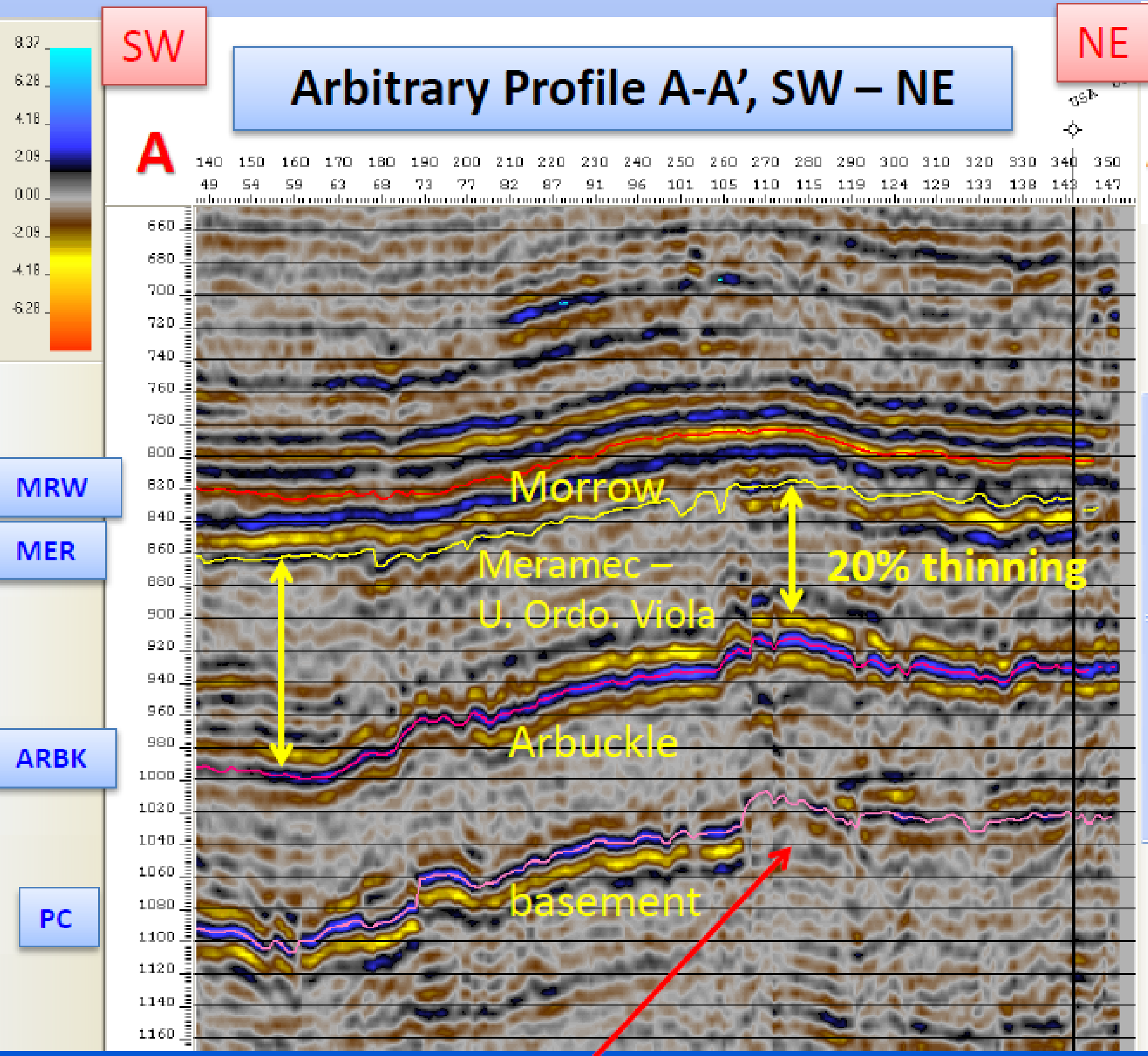
Disrupted beds within the St. Louis interval that are suggestive of karst collapse.

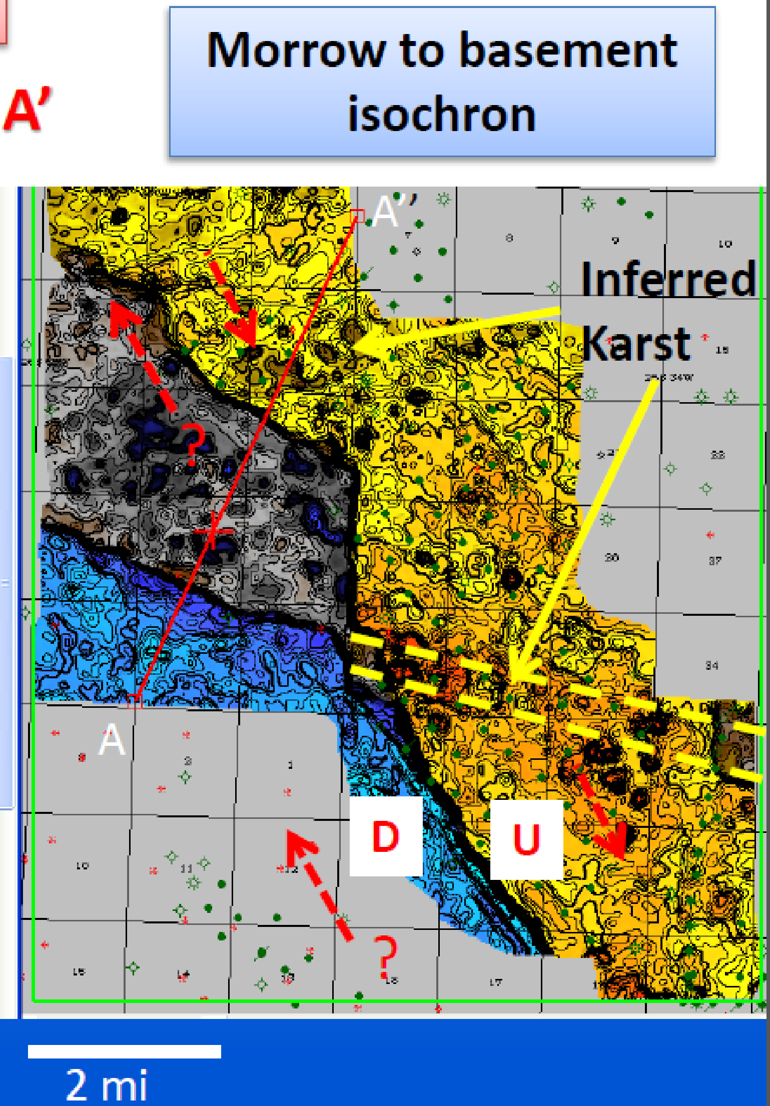


Meramec Time Structure
Pleasant Prairie Field

Pleasant Prairie structural block

Fault orientation-right lateral component along restraining bend



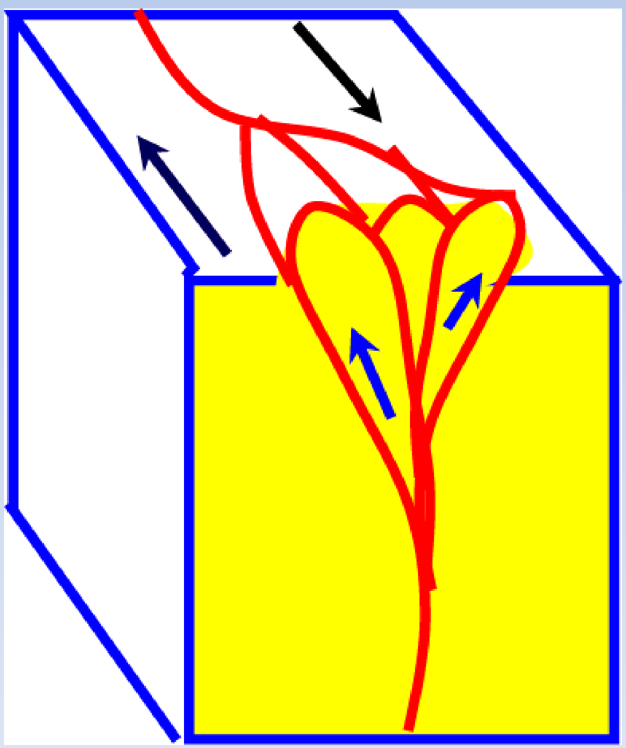


Flower structure
Right lateral fault?

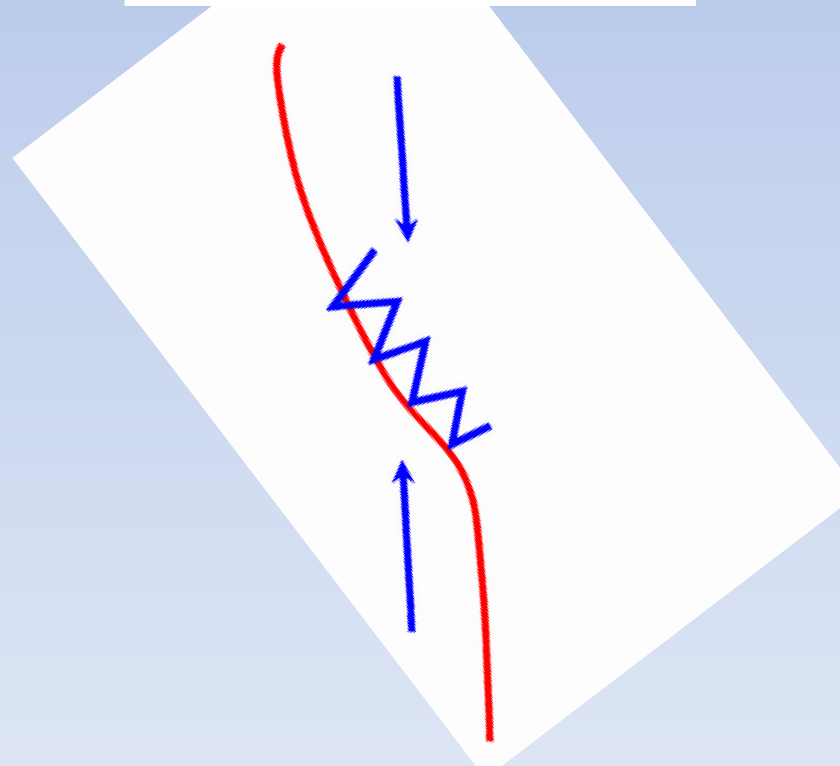
Hedke (DOE-CO2)

Strike-Slip Faults – flower structures & restraining bends

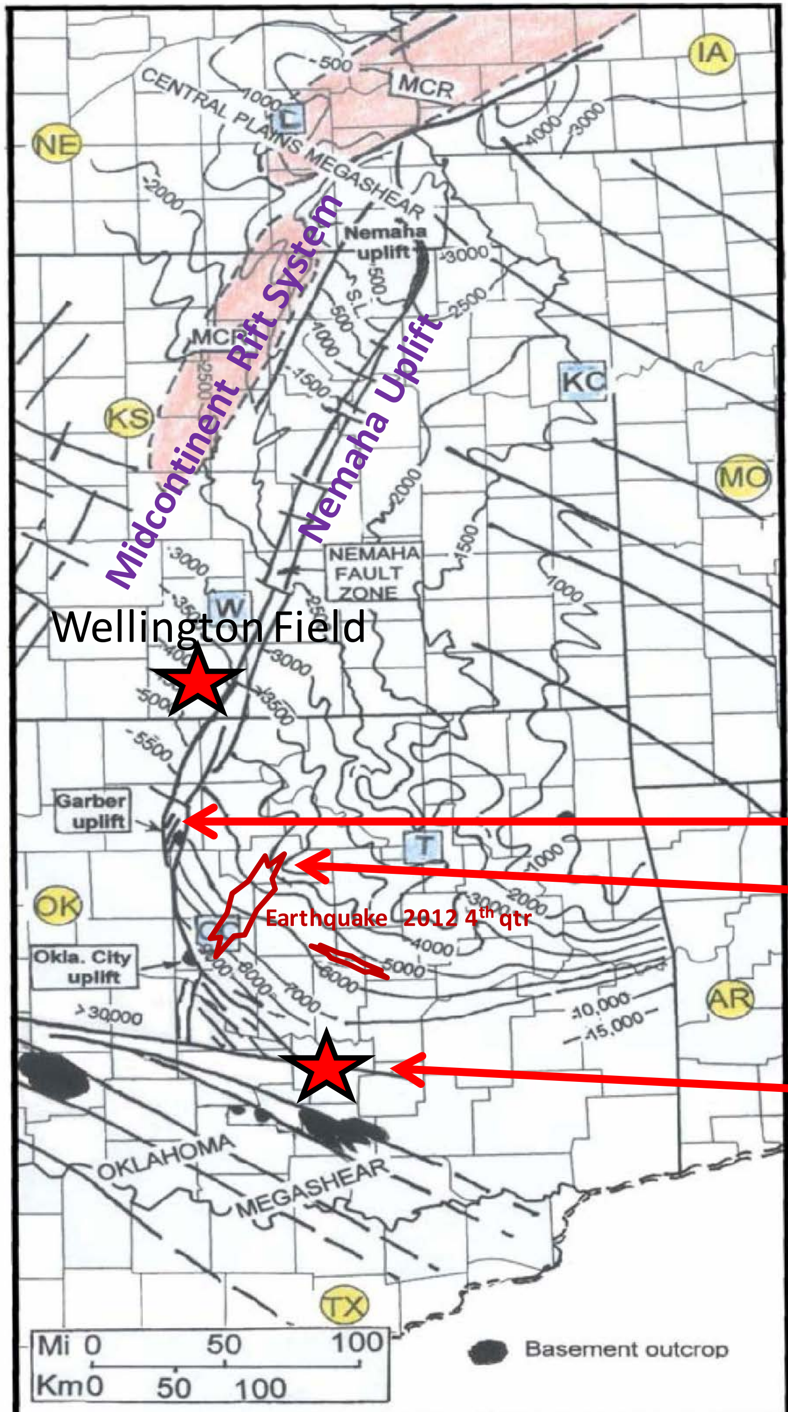
Flower Structures
Positive (Palm Tree) → Transpression
Right lateral



Restraining Bends-
transpressional zones
occurring at fault bends
Push Up Ridges



Modified from http://www4.uwsp.edu/geo/faculty/hefferan/geol320/strikeslip.html



Structural contour map, on top Precambrian surface

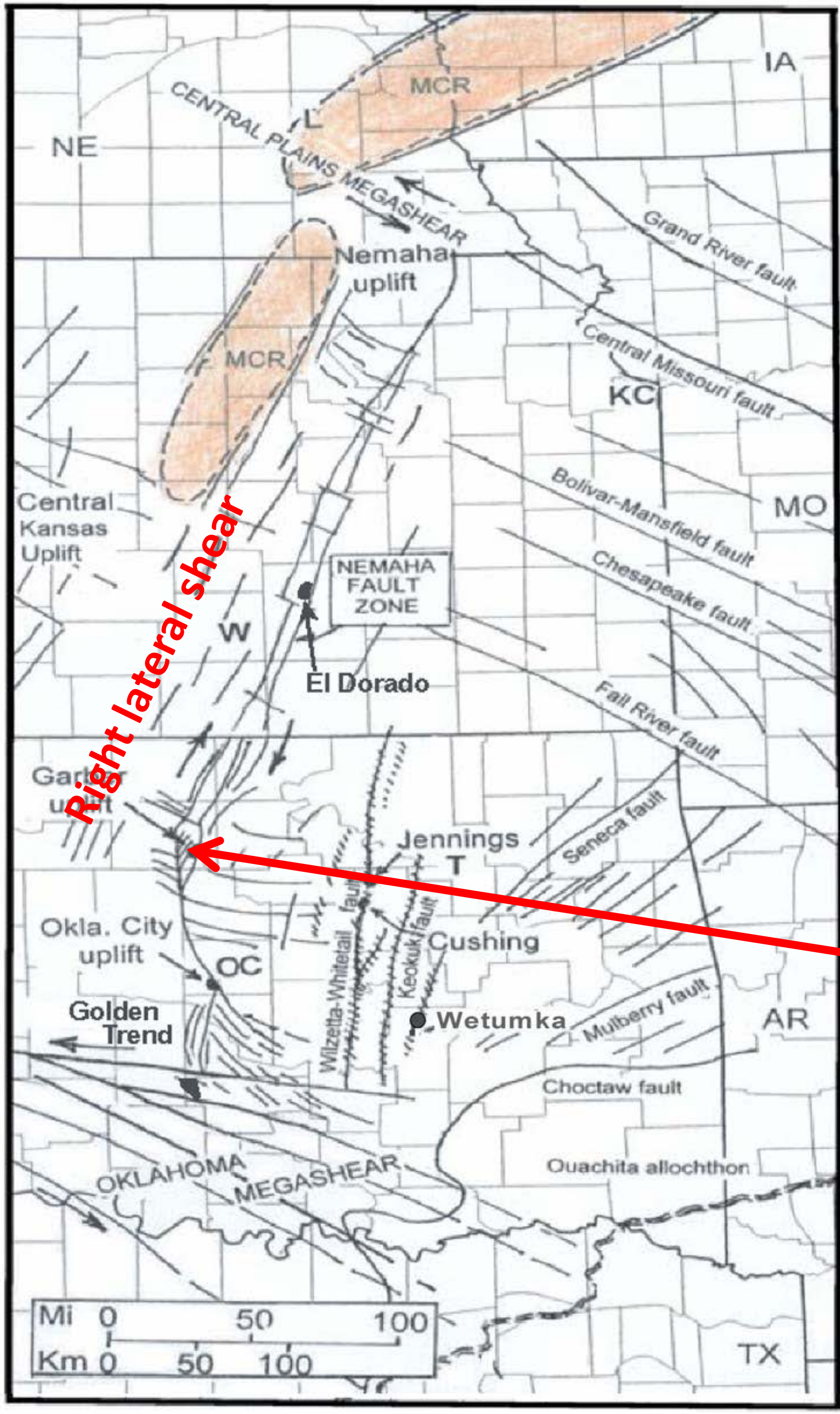
- Contours in Kansas and Nebraska modified from Burchett et al. (1981)
- Nemaha fault trace in Kansas adapted from Berendsen and Blair (1992).

Garber Uplift – restraining bend along Nemaha U.

Cluster of current earthquakes near Edmund OK

KGS-OGS Current #1, Pontotoc County, OK

http://www.searchanddiscovery.com/documents/2003/**mcbee**/images/mcbee.pdf



Generalized fault framework of the area encompassing the Nemaha zone

- En echelon, northwest-southeast surface faults east of the Nemaha zone in Oklahoma form north - to north-northeast- trends (Miser, 1954).
- The Nemaha zone originated by strike-slip movements – **right lateral**
- Trace of the Nemaha fault adapted from Berendsen and Blair (1992).

Garber Uplift – restraining bend along Nemaha U.

http://www.searchanddiscovery.com/documents/2003/**mcbee**/images/mcbee.pdf

Major NE-trending faults on the top of Mississippian overlying and on the flanks of the Nemaha Uplift

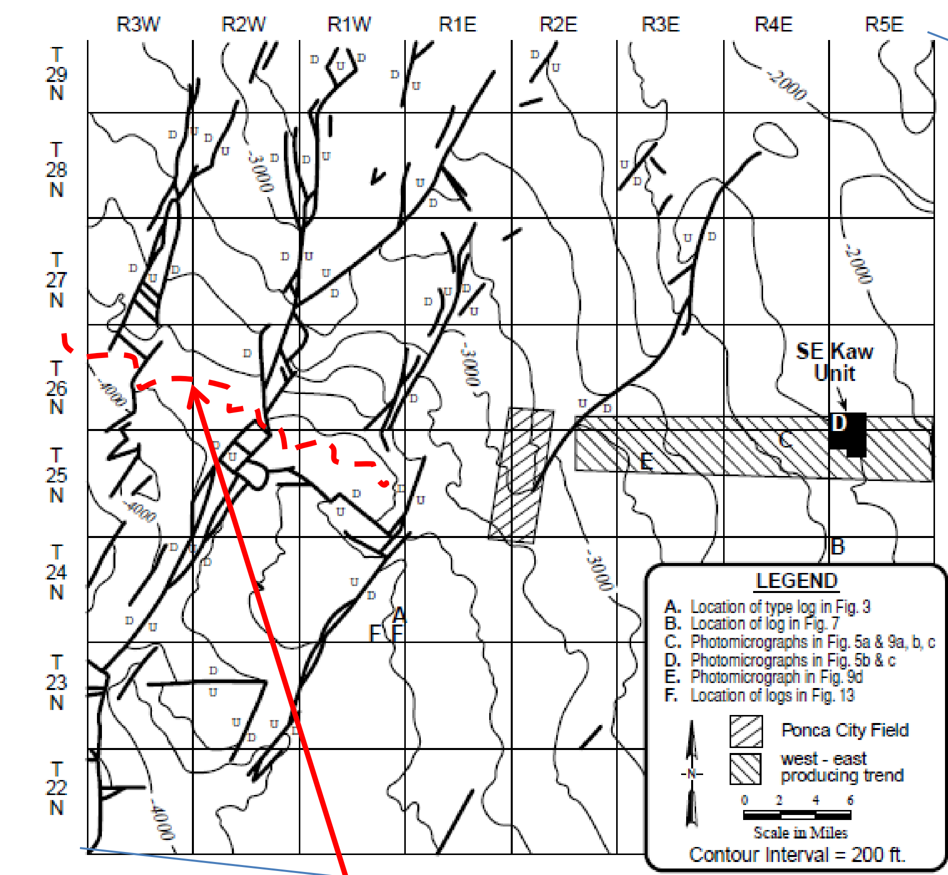
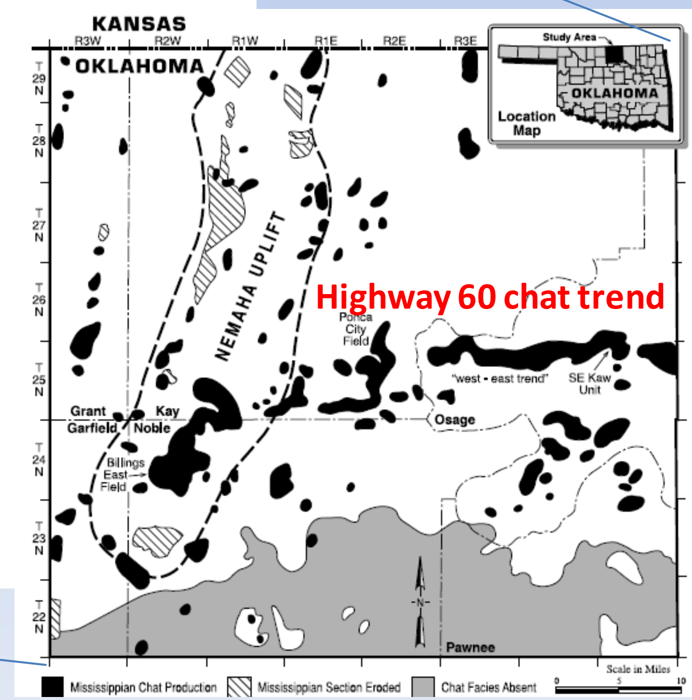


Figure 8. Regional structure map of the study area contoured on top of the Mississippian and showing major faulting and regional dip to the southwest. Two major productive areas and the locations of wells mentioned in this article are indicated.

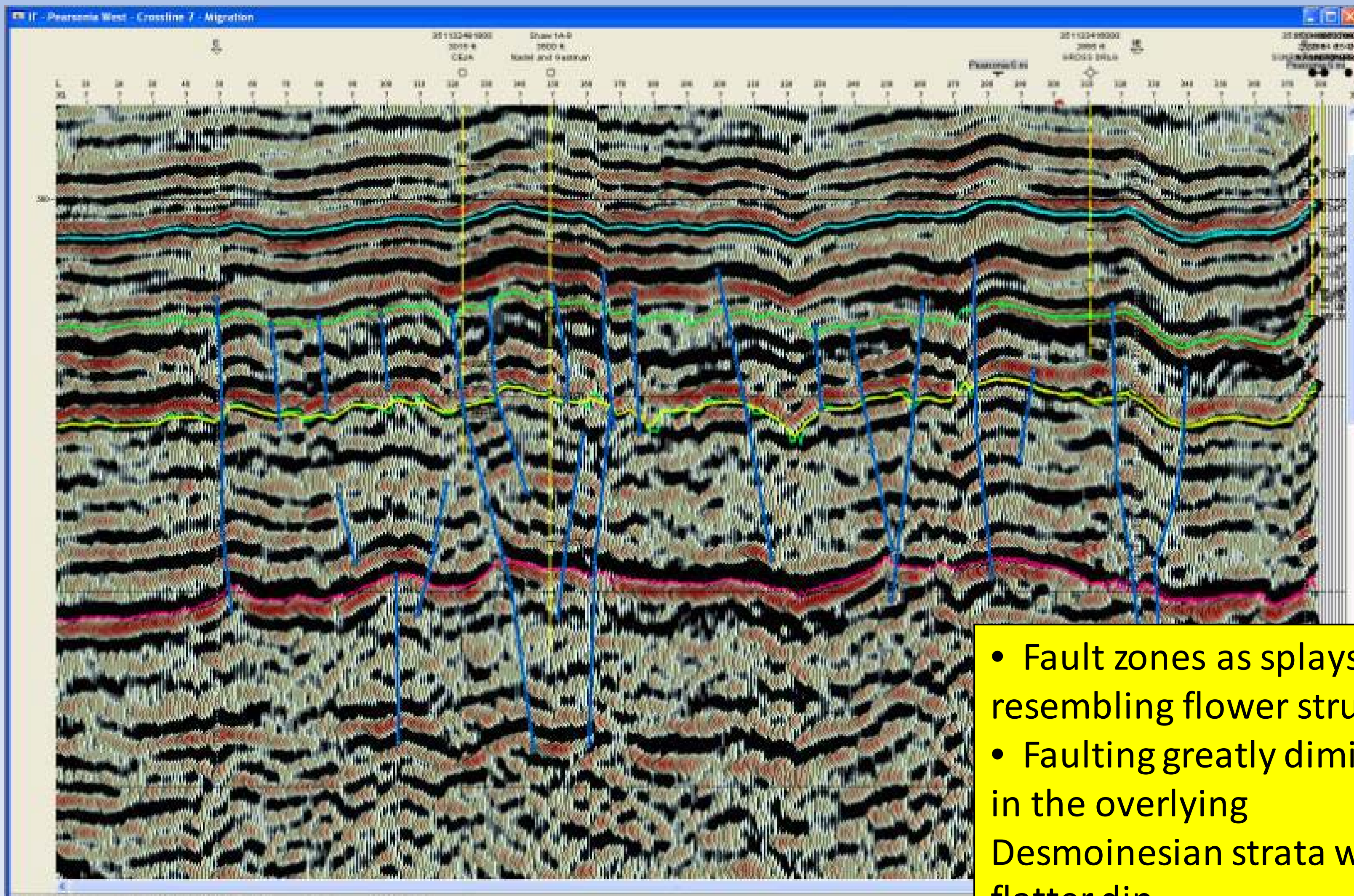


Suzanne Rogers, AAPG Bulletin, v. 85, no. 1 (January 2001), pp. 115–129

Seismic Section HW 60 Trend

Ron Snyder and colleagues at Ceja Corporation,

AAPG Mississippi Lime Forum, Jan. 31, 2013, Oklahoma City

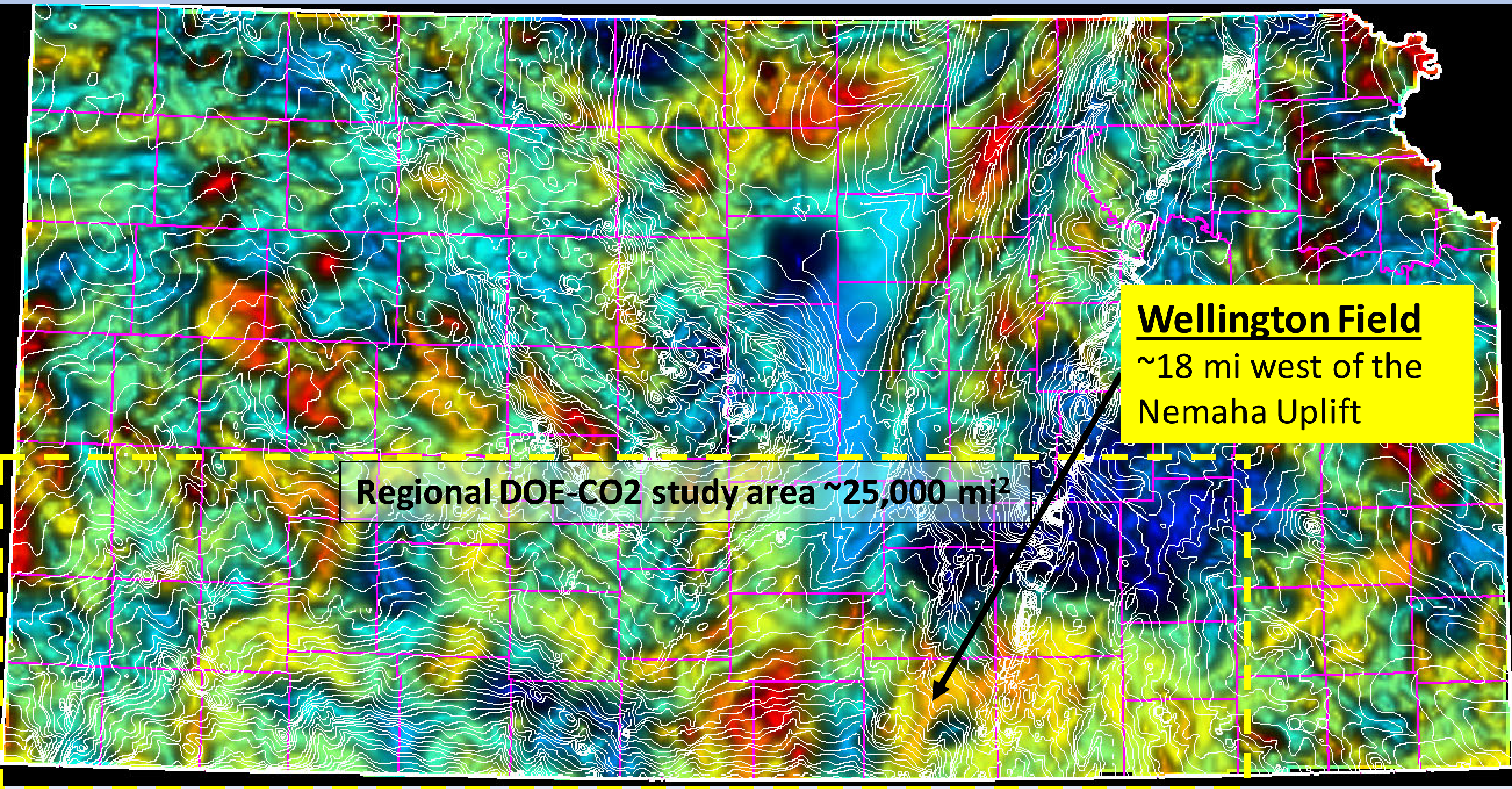


- Fault zones as splays and resembling flower structures
- Faulting greatly diminished in the overlying Desmoinesian strata with flatter dip

Phanerozoic structures are largely derived by reactivation of basement weaknesses

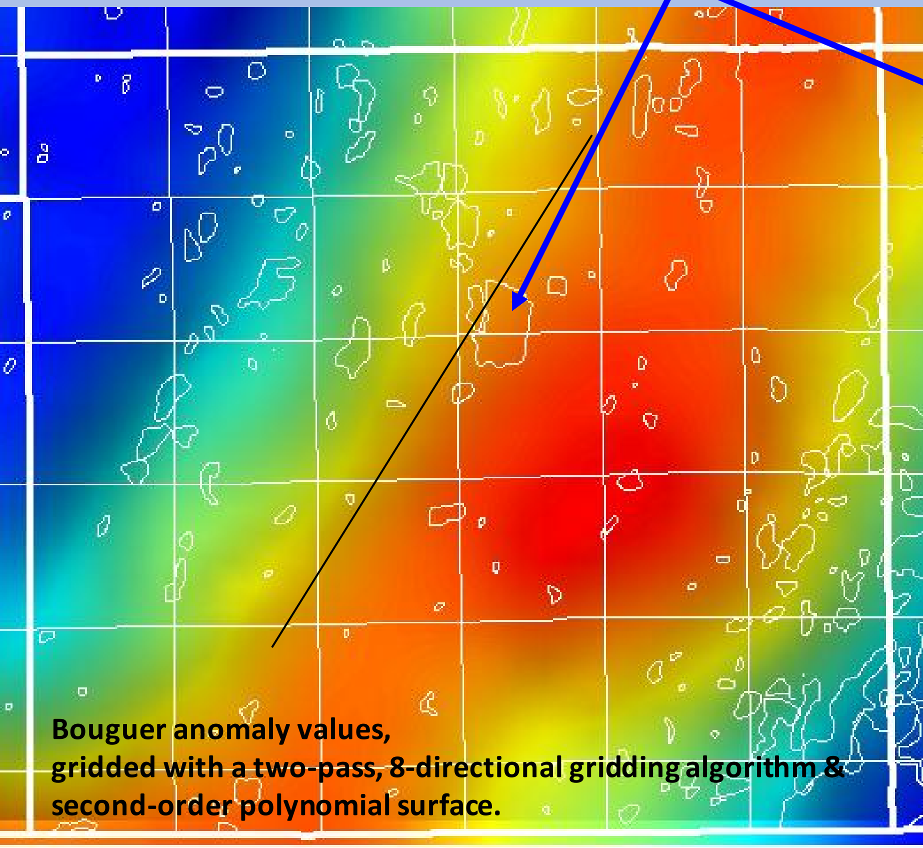
-- MLP developed on southern ryolite granite Proterozoic terrane cross-cut by the Midcontinent Rift System

Magnetic – reduced to pole, overlain with *configuration of Precambrian surface* (Cole, 1976; Kruger, 1999)



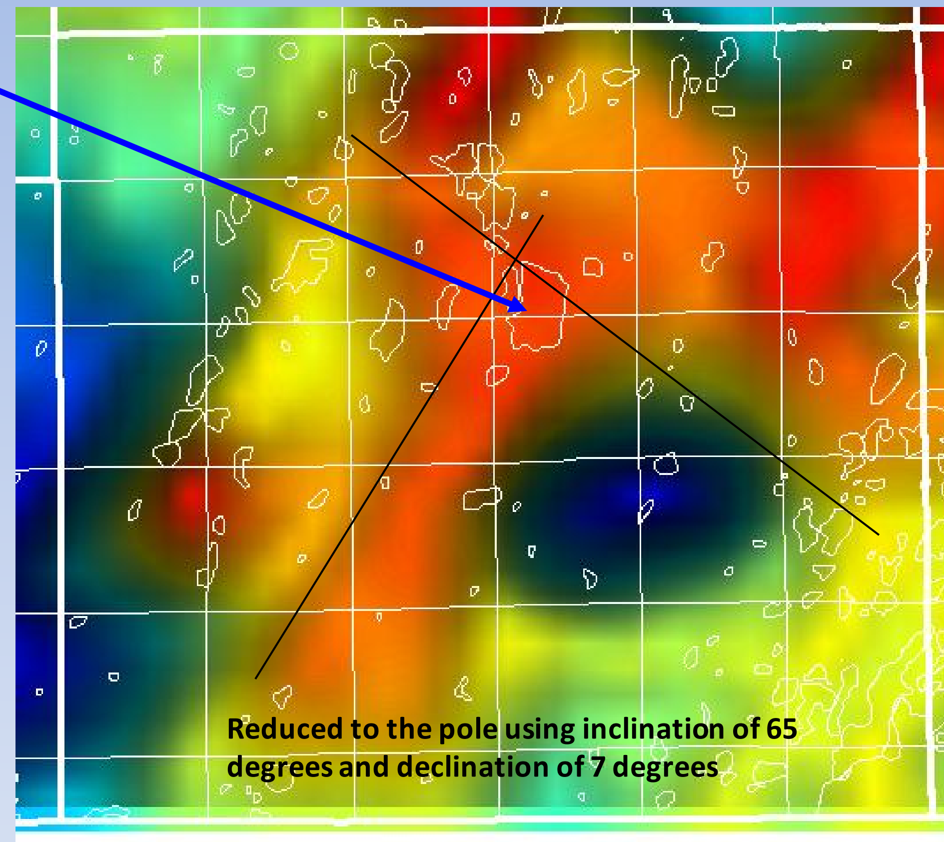
Potential Fields in Sumner County, KS

Wellington Field



Sumner County Kansas
Gravity with oil and gas fields

6 mi.

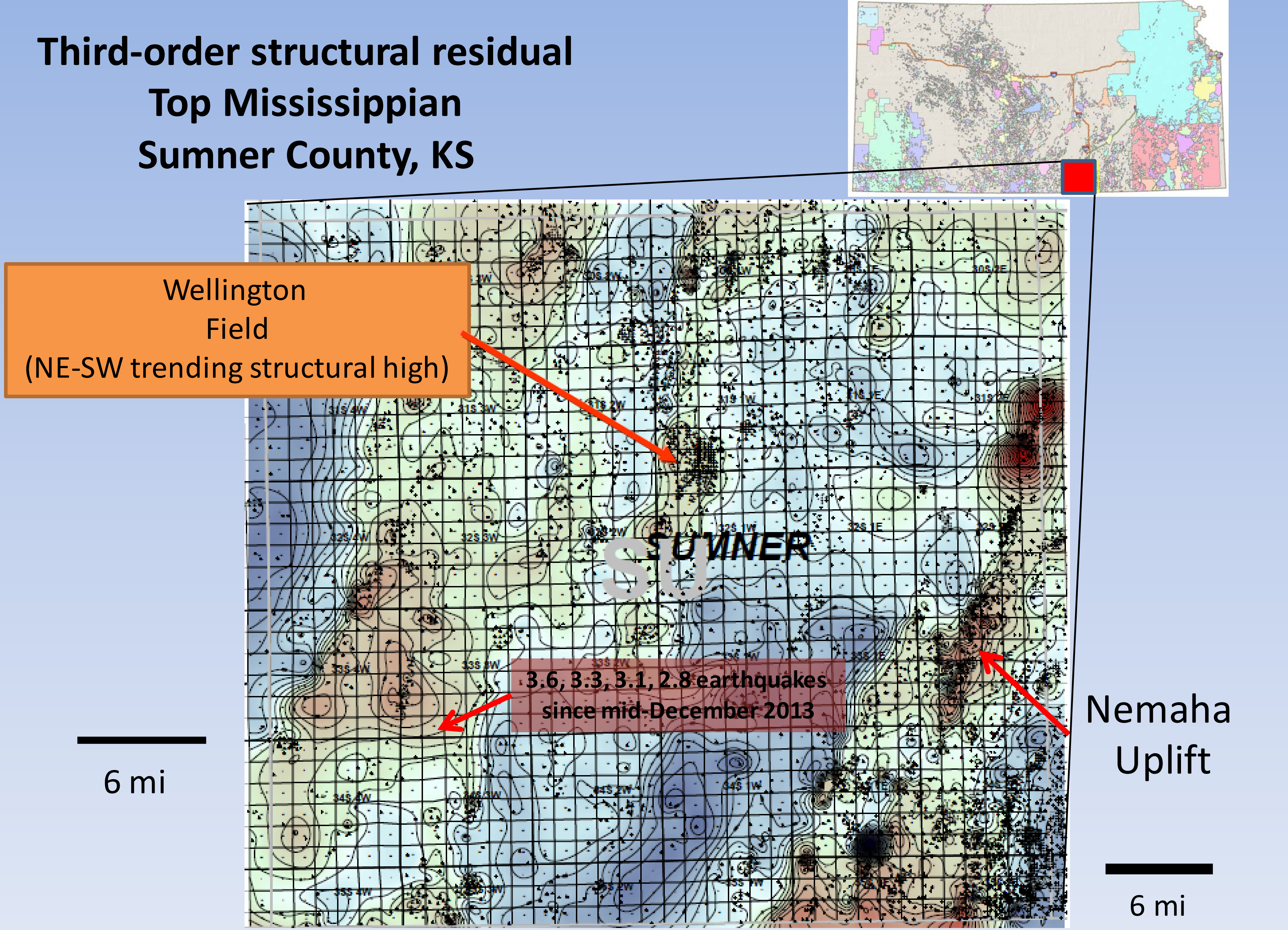


Sumner County Kansas
Magnetics with oil and gas fields

http://www.kgs.ku.edu/PRS/PotenFld/County/rs/sumnerMagOg.html

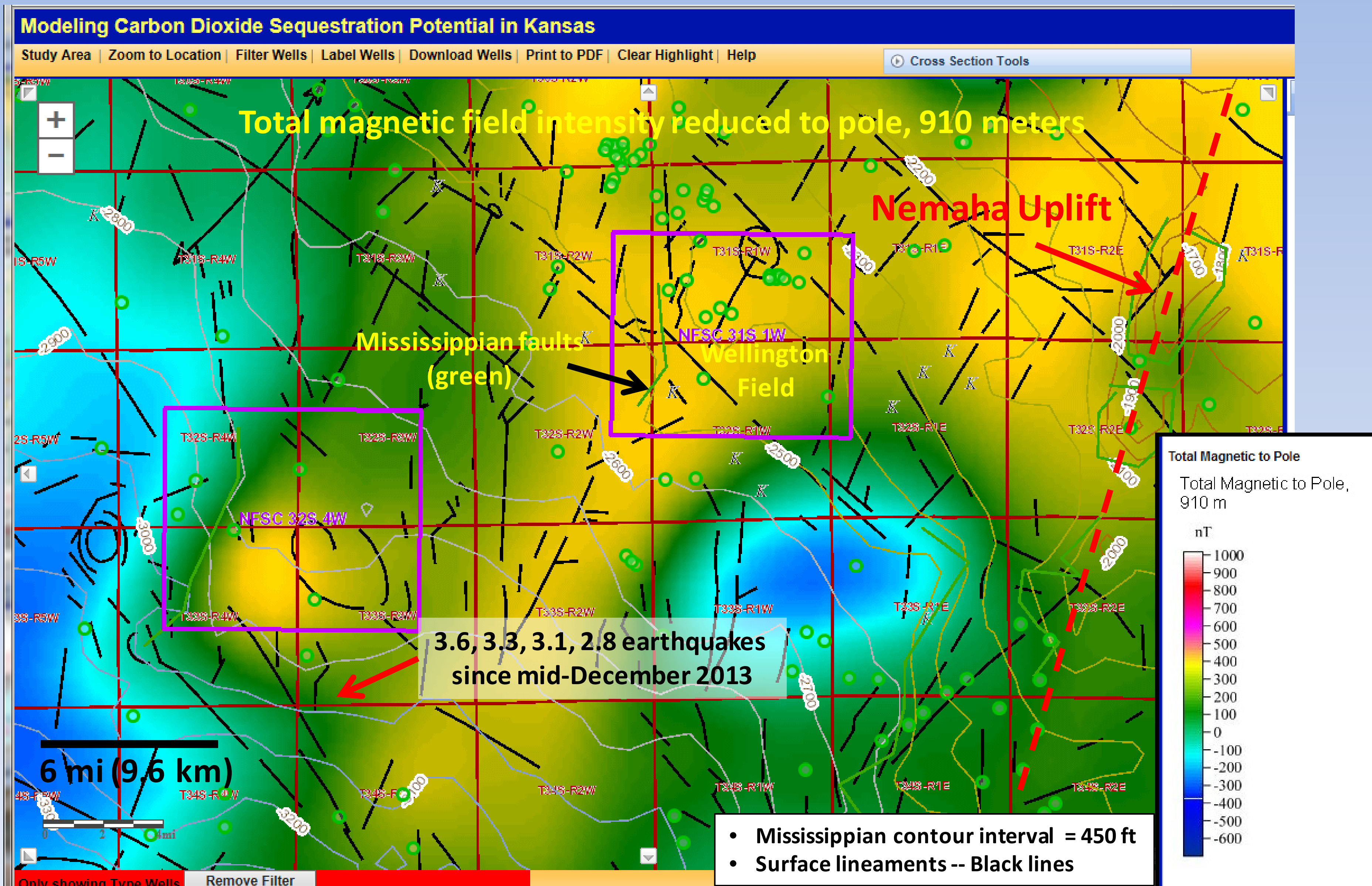
http://www.kgs.ku.edu/PRS/PotenFld/County/rs/sumnerGravOg.html

Third-order structural residual
Top Mississippian
Sumner County, KS



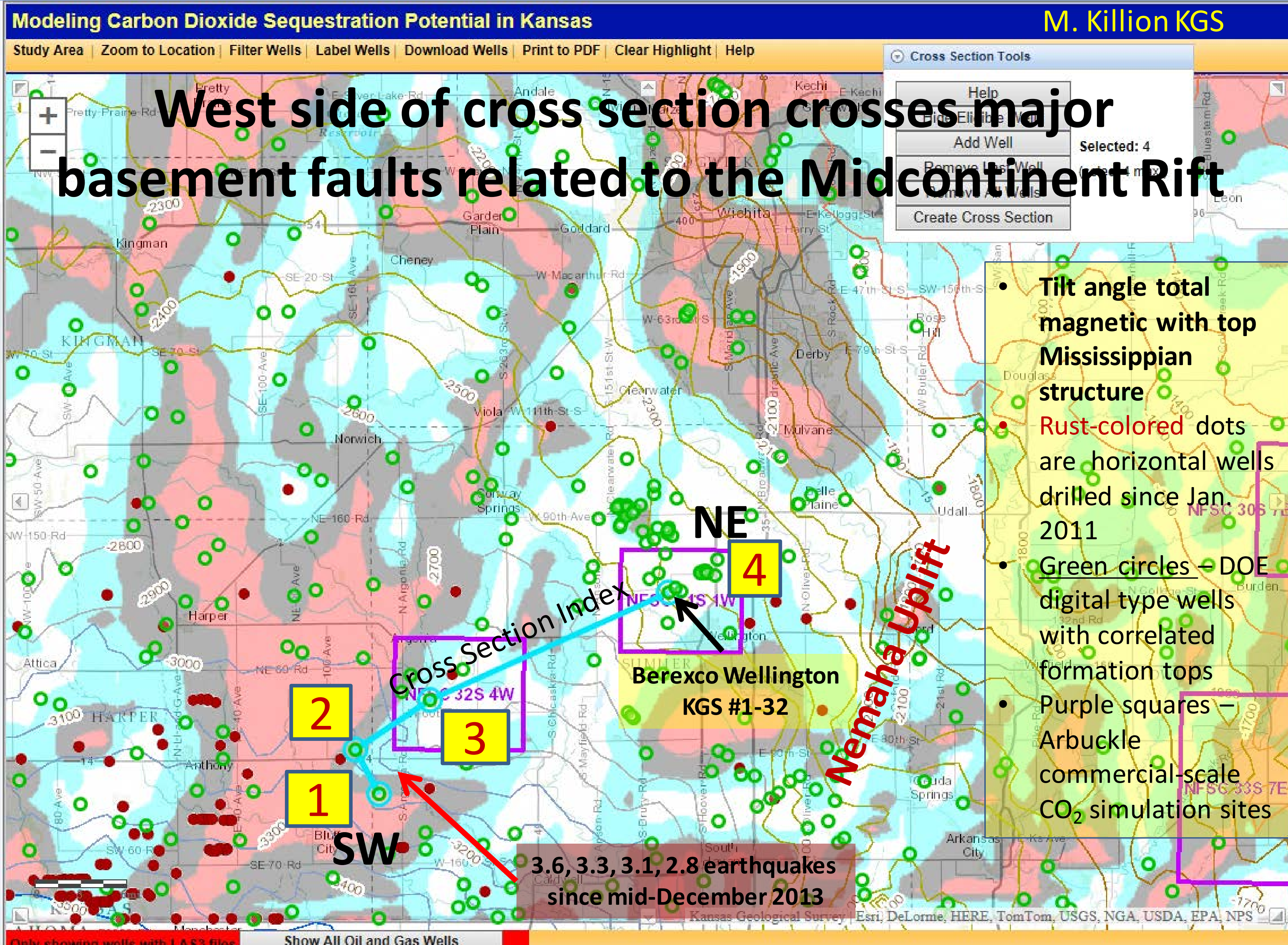
P. Gerlach, DOE-CO2

Sumner County
Magnetic field anomalies delineate discontinuities/faults in the basement

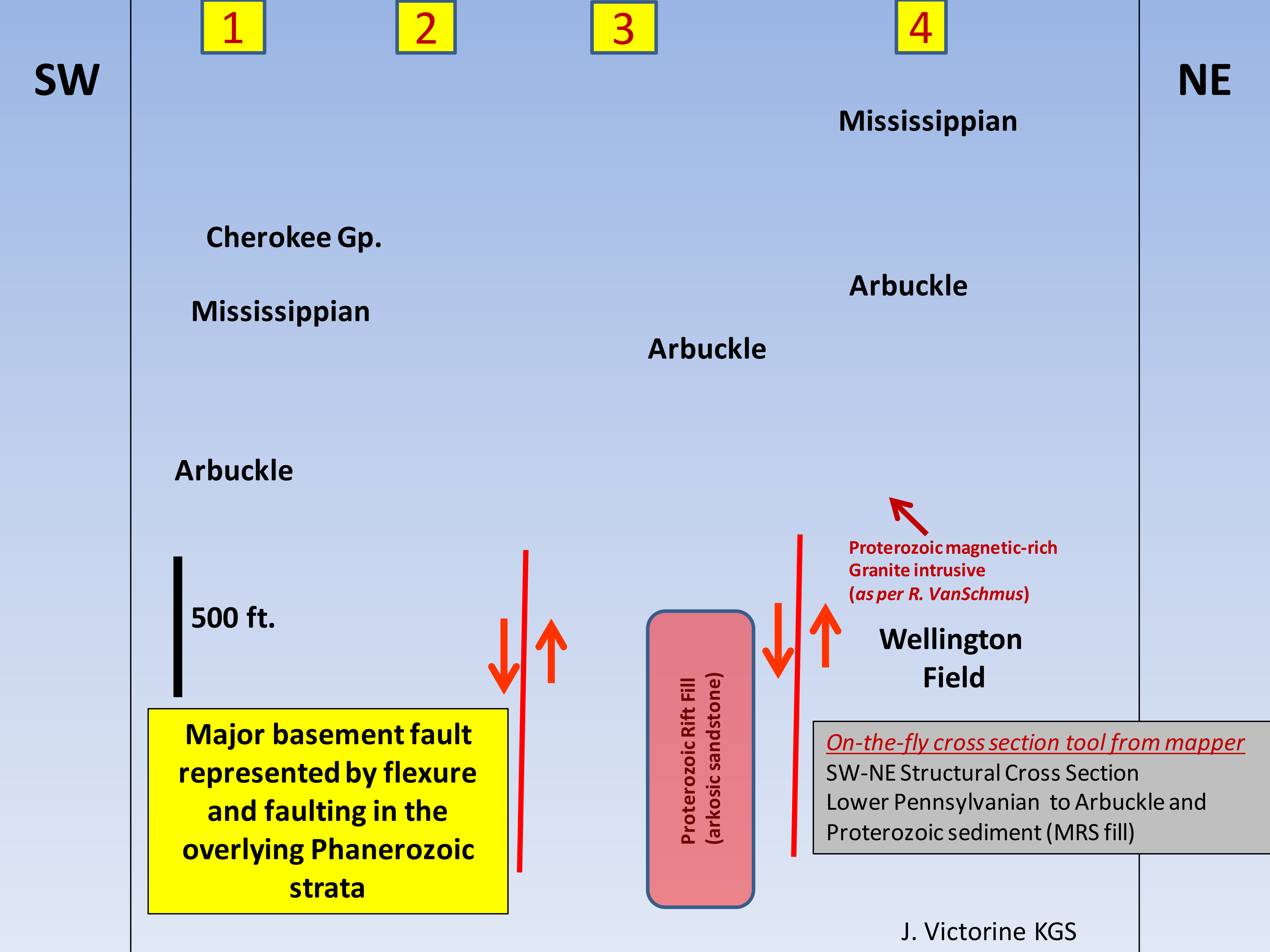


West side of cross section crosses major basement faults related to the Midcontinent Rift

M. Killion KGS



- Tilt angle total magnetic with top Mississippian structure
- Rust-colored dots are horizontal wells drilled since Jan. 2011
- Green circles – DOE digital type wells with correlated formation tops
- Purple squares – Arbuckle commercial-scale CO_2 simulation sites



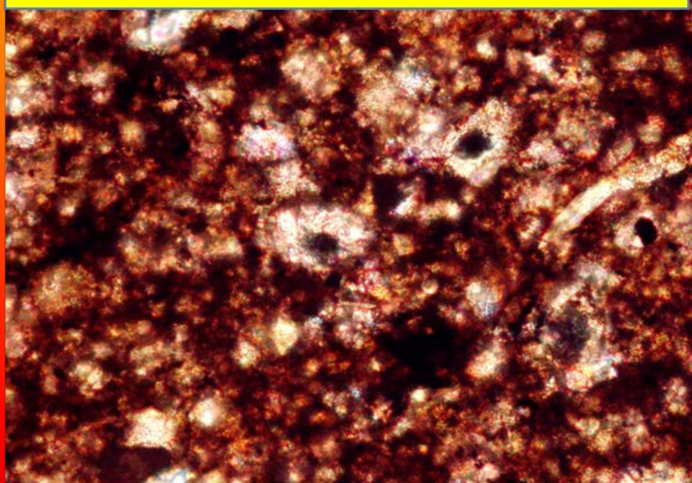
SW
NE
1
2
3
4
Mississippian
Cherokee Gp.
Mississippian
Arbuckle
Arbuckle
Arbuckle
500 ft.
Proterozoic magnetic-rich
Granite intrusive
(*as per R. VanSchmus*)
Wellington
Field
Proterozoic Rift Fill
(arkosic sandstone)
Major basement fault represented by flexure and faulting in the overlying Phanerozoic strata
On-the-fly cross section tool from mapper
SW-NE Structural Cross Section
Lower Pennsylvanian to Arbuckle and
Proterozoic sediment (MRS fill)
J. Victorine KGS

Source rocks

– Organic richness, maturity, timeframe of generation

"Cowley facies is likely a source rock"

4003.7 ft dark cored dolomite (x-nic)



100 µm

Pierson Ls. Member (Cowley facies) is *organic-bearing and thermally mature* and probably local source rock for MLP

Weatherford Laboratories

TOTAL ORGANIC CARBON

Received 2-13-13

Client ID	Well Name	State	County	Top depth (ft)	Formation	Sample Type	Prep	TOC, wt. %	Verified	Lab Id	Comments
	Berexco LLC Wellington KGS No. 1-32			3605.40		Core	NOPR	0.10		3402822662	Penn sh
	Berexco LLC Wellington KGS No. 1-32			3738.25		Core	NOPR	0.39		3402822664	MSSP
	Berexco LLC Wellington KGS No. 1-32			3754.00		Core	NOPR	0.19		3402822666	MSSP
	Berexco LLC Wellington KGS No. 1-32			3784.50		Core	NOPR	1.87	TOC	3402822668	MSSP
	Berexco LLC Wellington KGS No. 1-32			3937.25		Core	NOPR	0.94		3402822670	MSSP
	Berexco LLC Wellington KGS No. 1-32			3968.75		Core	NOPR	1.28		3402822672	MSSP
	Berexco LLC Wellington KGS No. 1-32			3982.00		Core	NOPR	0.60	TOC	3402822674	MSSP
	Berexco LLC Wellington KGS No. 1-32			4024.00		Core	NOPR	0.21		3402822676	MSSP
	Berexco LLC Wellington KGS No. 1-32			4048.50		Core	NOPR	1.11		3402822678	MSSP
	Berexco LLC Wellington KGS No. 1-32			4059.75		Core	NOPR	0.69		3402822680	MSSP
	Berexco LLC Wellington KGS No. 1-32			4065.50		Core	NOPR	1.59	TOC	3402822682	M-D Chat Sh

OPERATOR AND WELL NAME

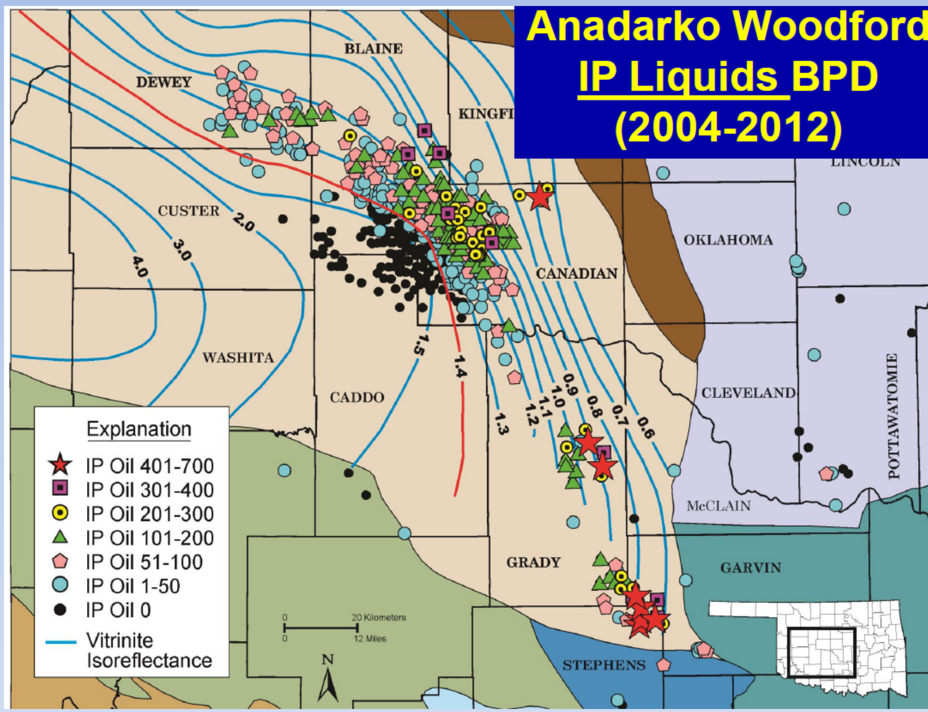
SEC	T	R	SPOT	SAMPLE INTERVAL	SUBSURF.	AGE	FORM	LITH	TOC	S1	S2	S3	HI	OI	TMAX	PI	S1+S2
32	31S	01W	SW NE NE		3784.50	Missp		ls	1.87	0.71	8.06	0.93	432	50	442	0.08	8.77
32	31S	01W	SW NE NE		3937.25	Missp		ls	0.94	0.77	3.28	0.43	350	46	439	0.19	4.05
32	31S	01W	SW NE NE		3968.75	Missp		ls	1.28	0.49	2.14	0.54	168	42	441	0.19	2.63
32	31S	01W	SW NE NE		3982.00	Missp		ls	0.60	0.66	1.92	0.58	321	97	440	0.26	2.58
32	31S	01W	SW NE NE		4024.00	Missp		ls	0.21								
32	31S	01W	SW NE NE		4048.50	Missp		ls	1.11	0.79	4.02	0.41	361	37	437	0.16	4.81
32	31S	01W	SW NE NE		4059.75	Missp		ls	0.69								
32	31S	01W	SW NE NE		4065.50	Dev	CHAT	sh	1.59	0.91	7.75	0.27	487	17	440	0.11	8.66
32	31S	01W	SW NE NE		4099.60	OrdM	SMPS	sh	0.17								

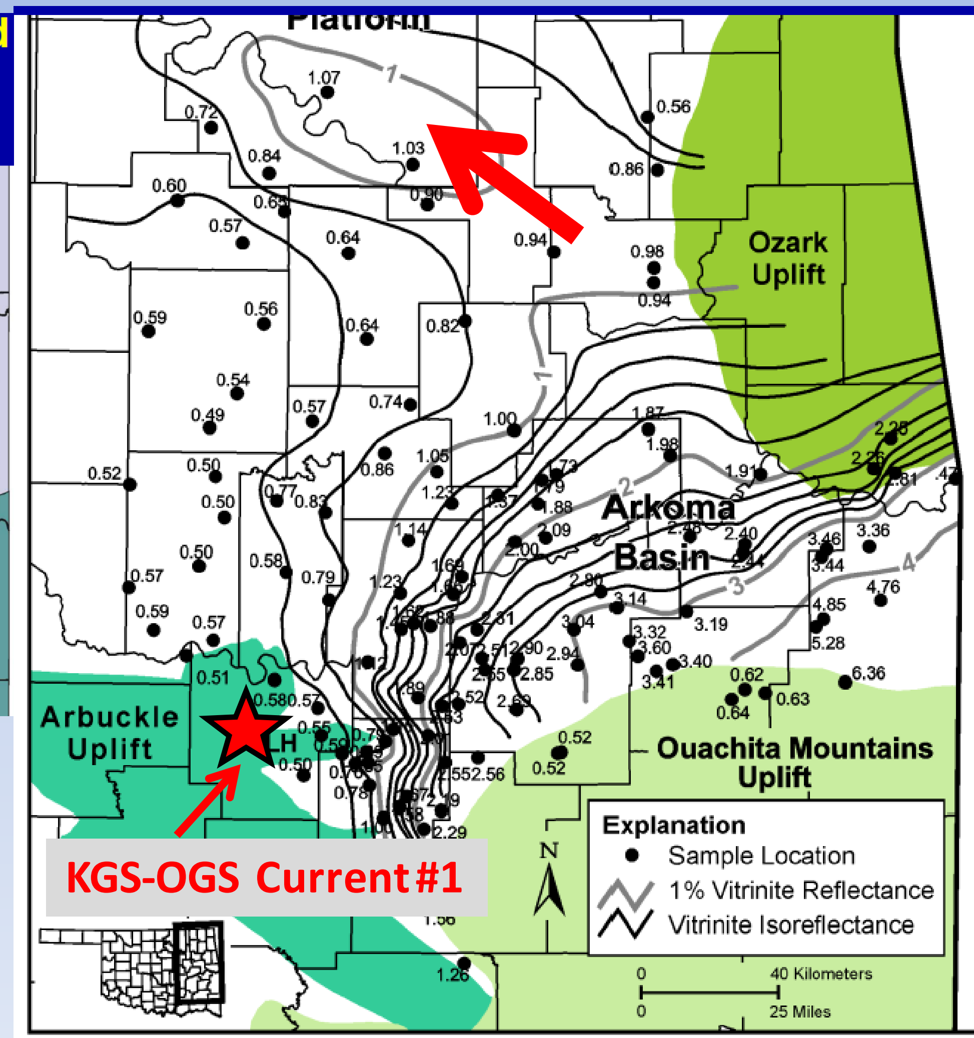
Compilation of Hydrocarbon Source-Rock Analyses for Wells in East-Central and Northeastern Kansas, and adjacent areas in Missouri and Nebraska by K. David Newell (Kansas Geological Survey, University of Kansas, Lawrence, KS 66046-3736), August, 2013

Hydrocarbon migration

- Proximity of source rocks, timing and mechanism of HC migration

Elevated thermal maturation in NE Oklahoma and along the NE edge of the Anadarko Basin



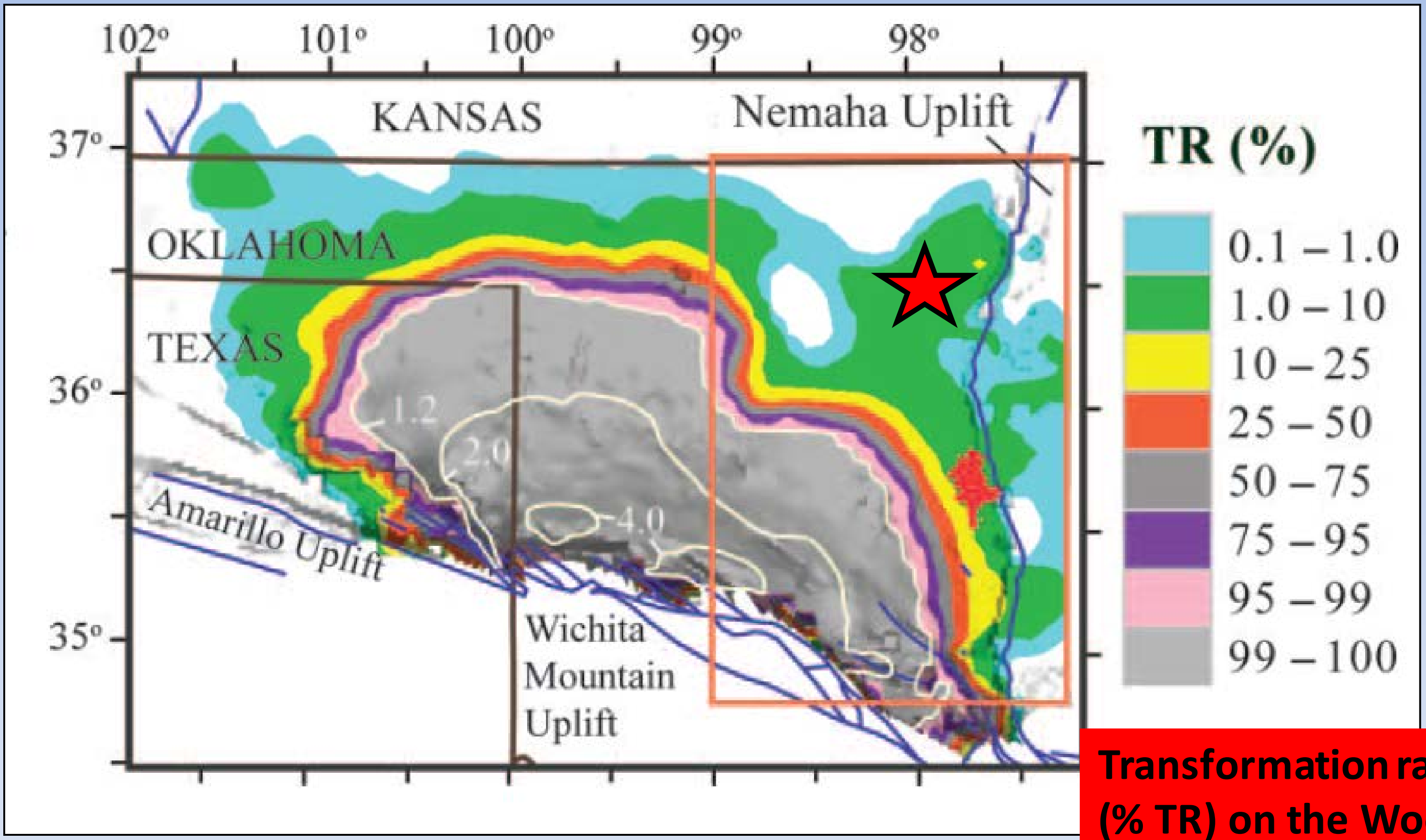


Vitrinite isoreflectance map of Woodford Shale

- Left – Anadarko Basin
- Right --- Arkoma Basin

(from B. Cardott, 2012)

Elevated thermal maturation along NW flank of Anadarko Basin



Transformation ratios (% TR) on the Woodford Shale layer from the four-dimensional petroleum system model

S.B. Gaswirth and D.K. Higley, 2013, AAPG Bulletin, v. 97, no. 7 (July 2013), pp. 1163–1179

Burial history curves for the Lone Star 1 Bertha Rogers (A) and Chesapeake 1-24 West Edmond SWD (B) wells in Anadarko Basin

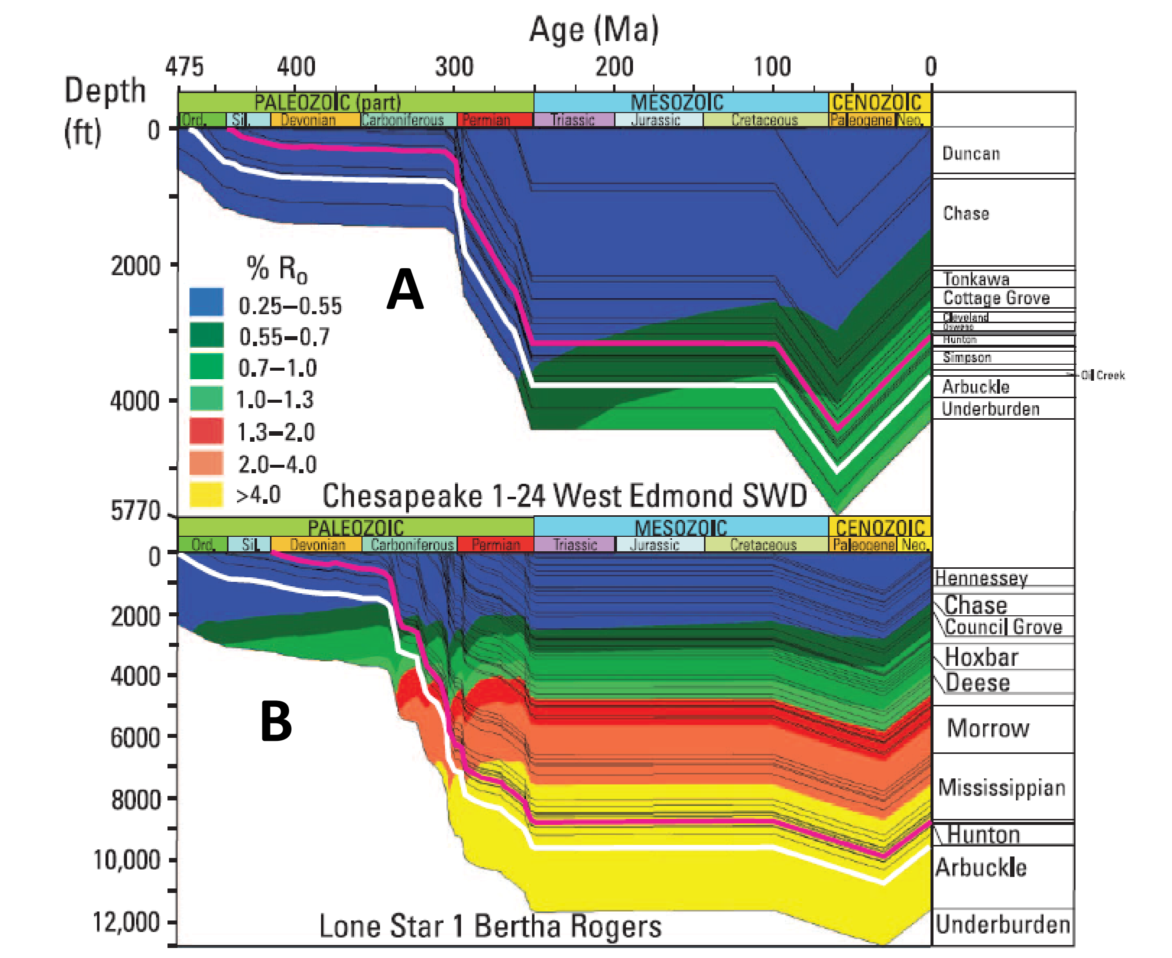
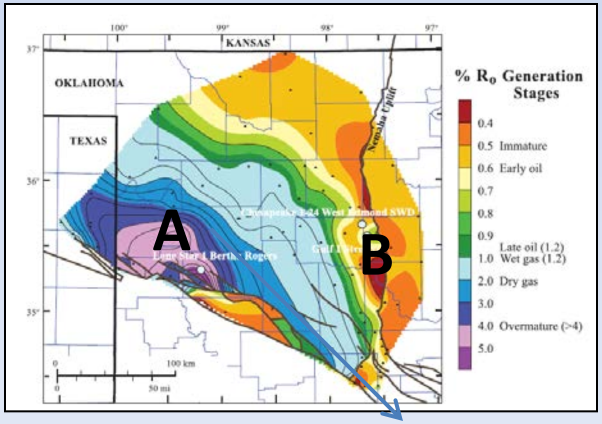


Figure 9. Burial history curves for the Lone Star 1 Bertha Rogers and Chesapeake 1-24 West Edmond SWD wells (Figure 8). Modeled vitrinite reflectance (R_o) through time includes heat flow of 70 mW/m^2 to 260 Ma, followed by 40 mW/m^2 for Lone Star 1 Bertha Rogers and 50 mW/m^2 for Chesapeake 1-24 West Edmond SWD. White and pink lines follow the upper part of the Arbuckle Group and Woodford Shale, respectively. Ord. = Ordovician; Sil. = Silurian; Neo. = Neogene.

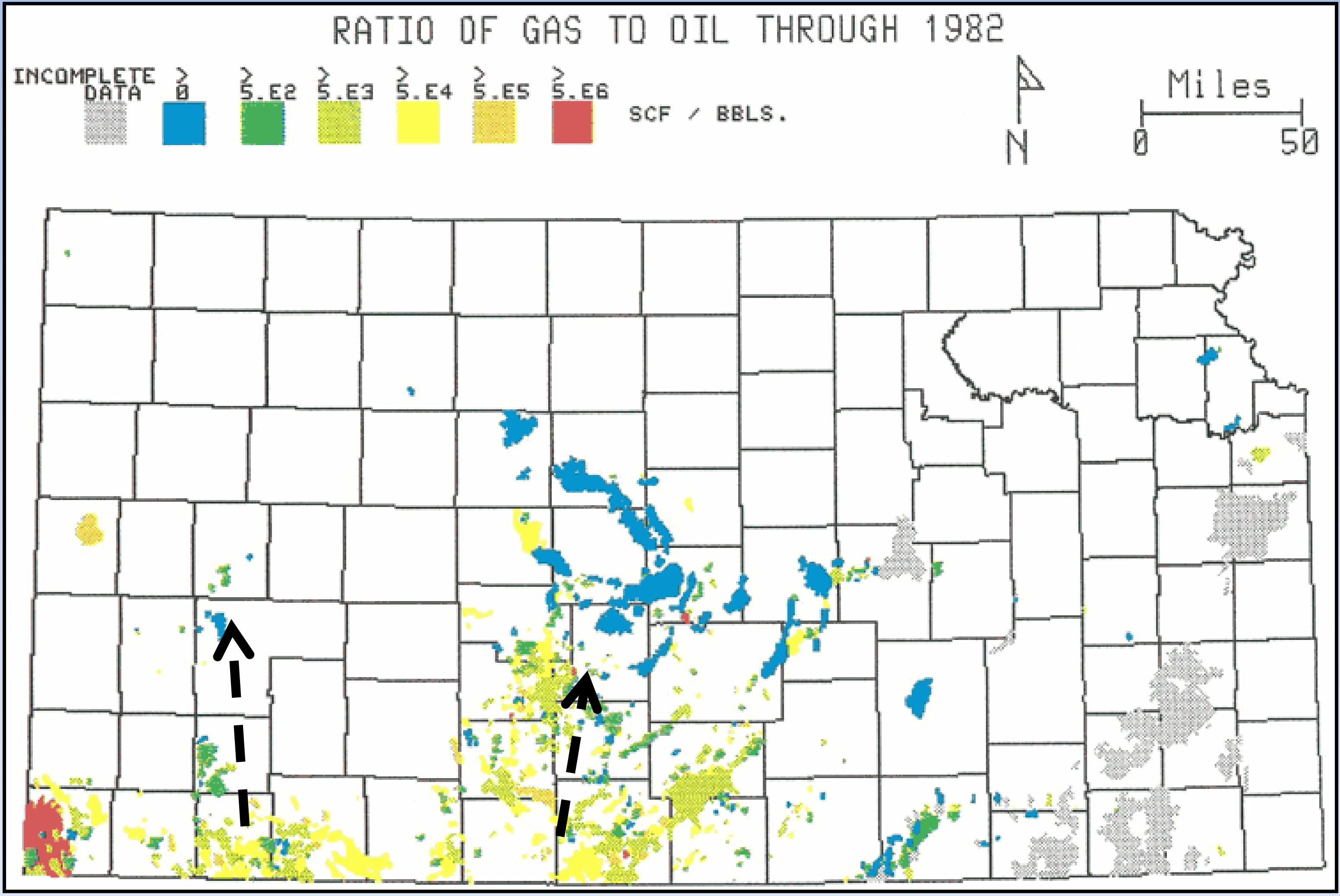
- Generation from the Simpson Group Oil Creek Formation layer source rocks (light green) started about **340 Ma**.
- Woodford Shale oil generation about **335 Ma**
- Thirteen Finger limestone (blue) about **300 Ma**.

%Ro Generation Stages Anadarko Basin



S.B. Gaswirth and D.K. Higley, 2013, AAPG Bulletin, v. 97, no. 7 (July 2013), pp. 1163–1179

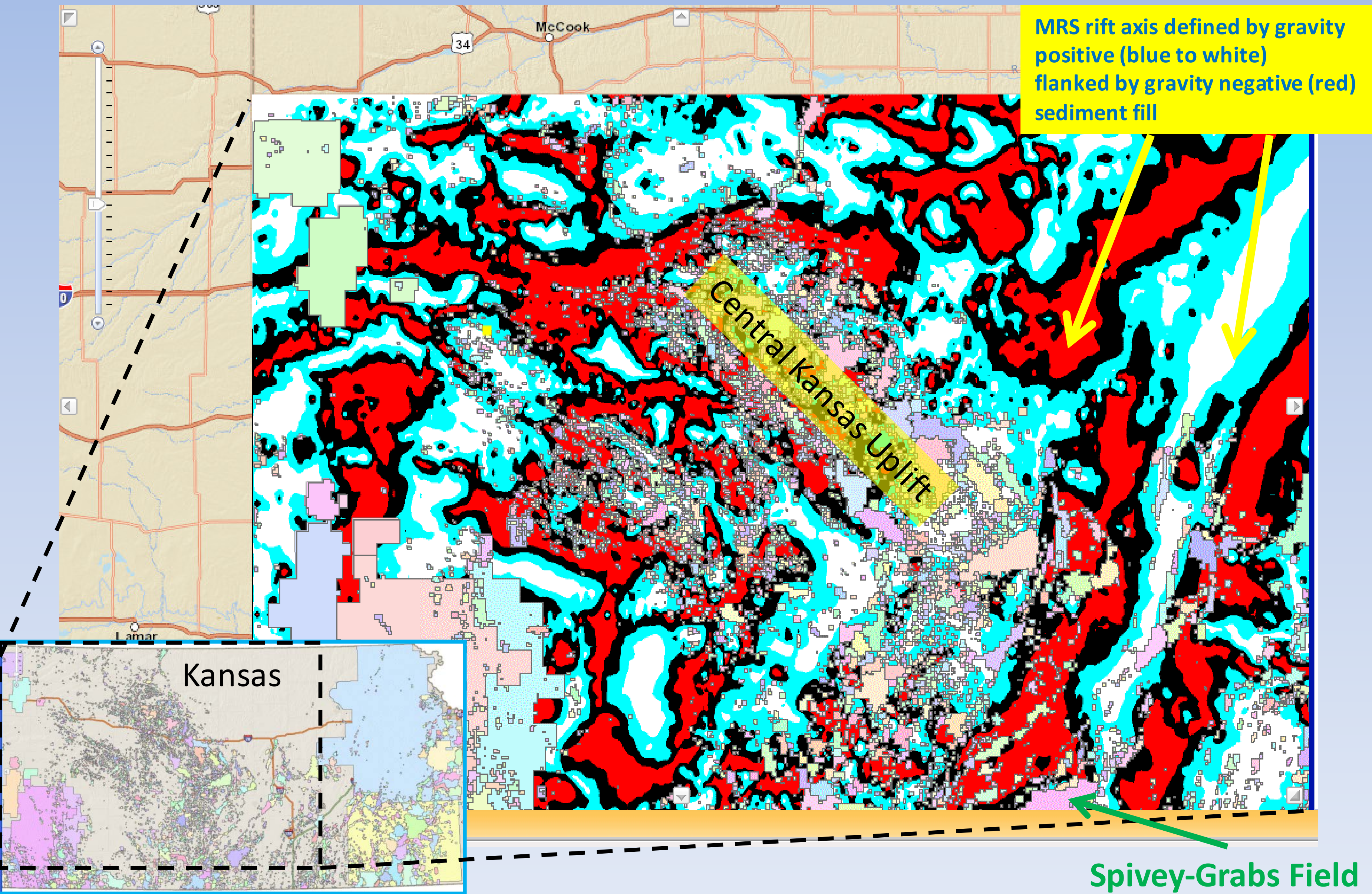
Higher gas-oil ratio in south-central and southwest Kansas
-- early oil migration followed by methane



Newell et al (1989)

Tilt Angle Bouguer gravity 2-5 mile filter
with oil fields overlay western 2/3rd of Kansas

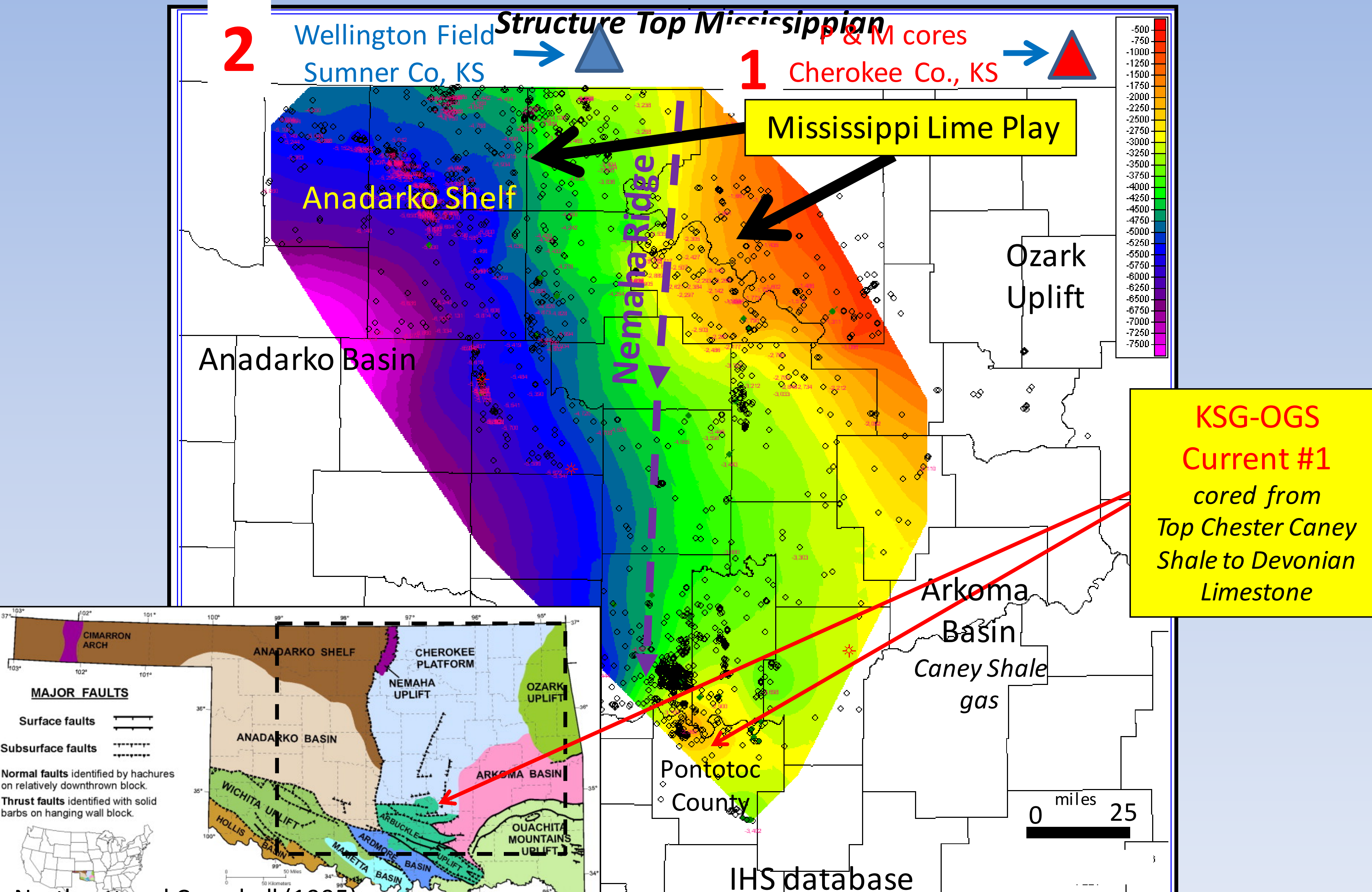
Strong delineation of inferred basement structure and distribution of oil fields influence of basement derived fractures and faults



Spectrum of lithofacies and quality reservoir rock

- **Conventional reservoir** – deposition, diagenesis, and structural setting, hydrocarbon accumulation controlled by <u>capillary pressure (matrix), hydrocarbon column, relative permeability, fractures dictate water cut</u>
  - Weathered chert breccia, tripolilitic chert, porous dolosparite, spiculite
- **Unconventional reservoir lithofacies –**
  - Argillaceous dolomitic cherty argillaceous siltstones.
  - Tight rocks tight rocks interbedded with porous nodular chert and spiculite
  - Organic bearing and local source rock

Eastern Oklahoma
Basinal lithofacies in western Arkoma Basin and ramp & carbonate platform on Ozark and NE Anadarko Shelf



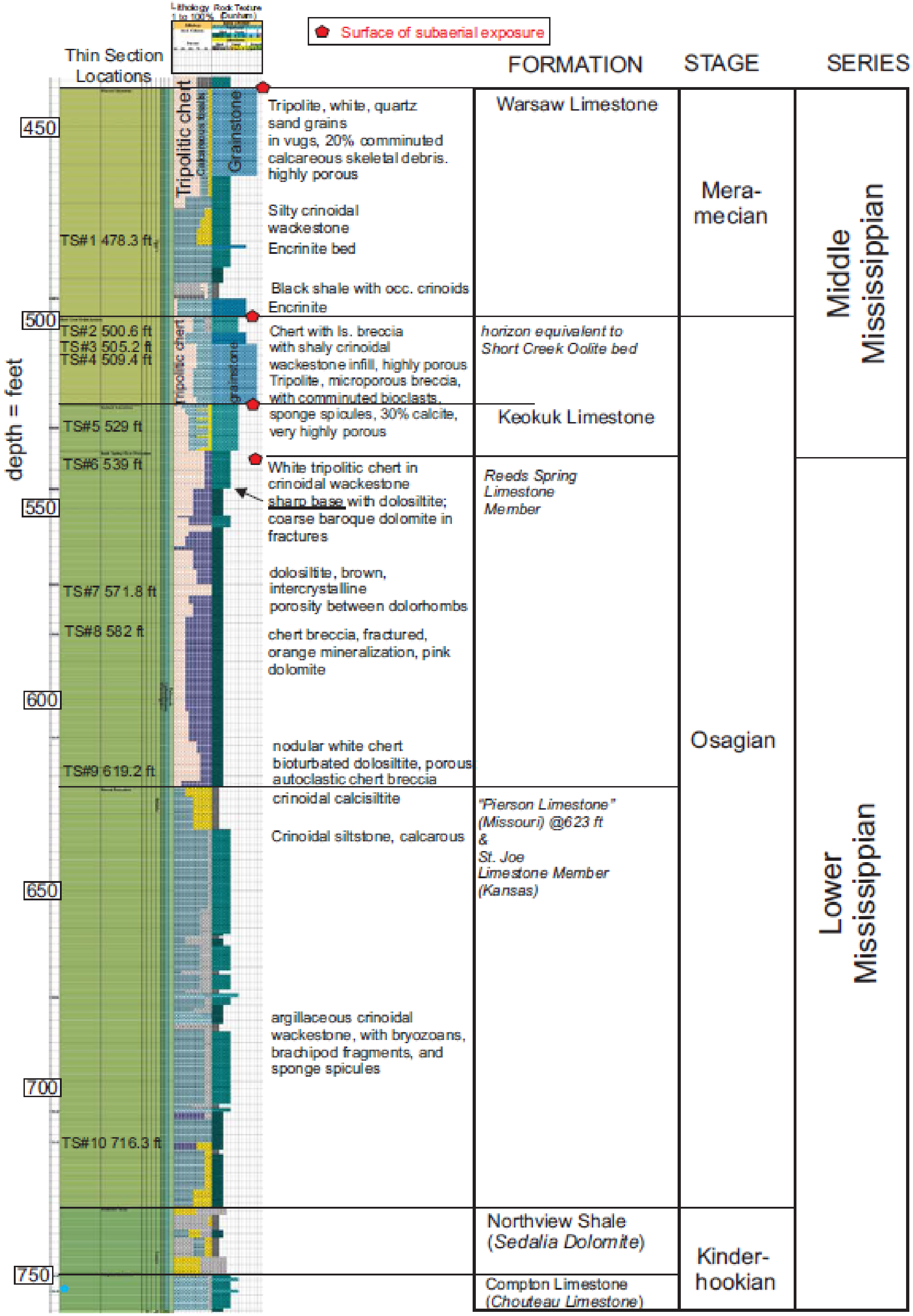
Northcutt and Campbell (1995)

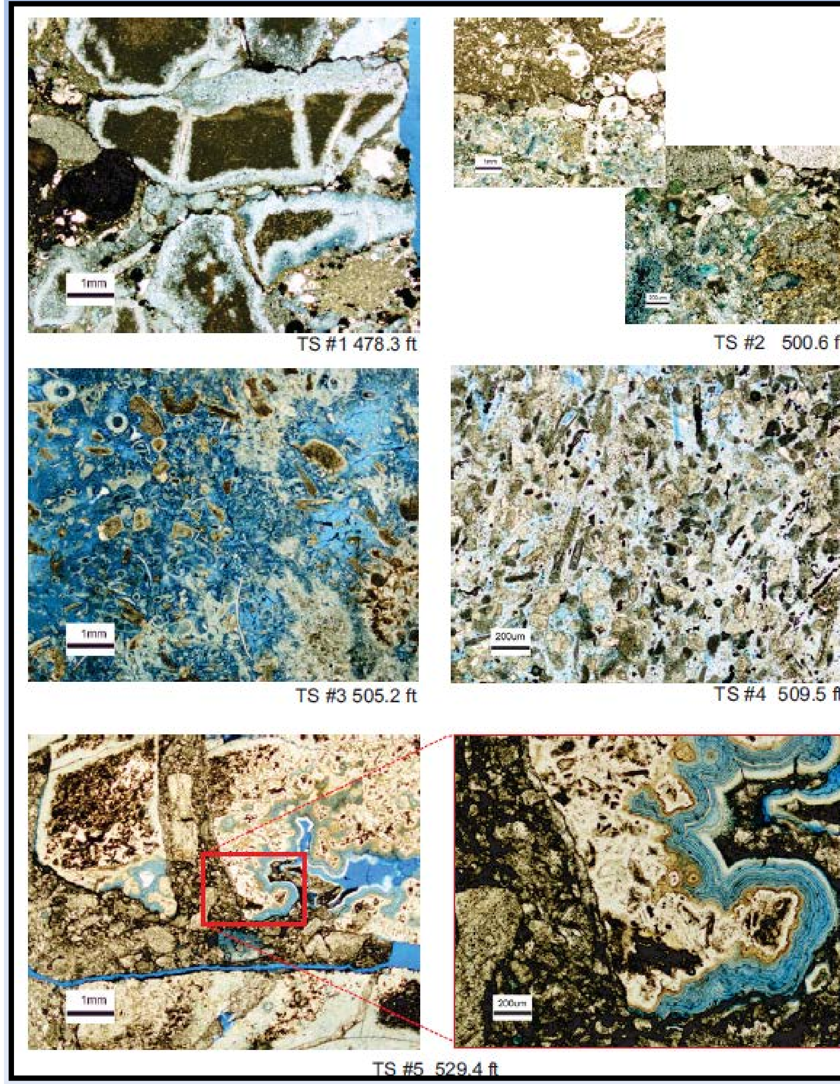
Pittsburgh and Midway Coal Co. #12 Test Hole, Cherokee County Southeast Kansas

Pennsylvanian to the top of Arbuckle

-- Western flank of Ozark Uplift near Tri-State Pb-Zn Mining District

1

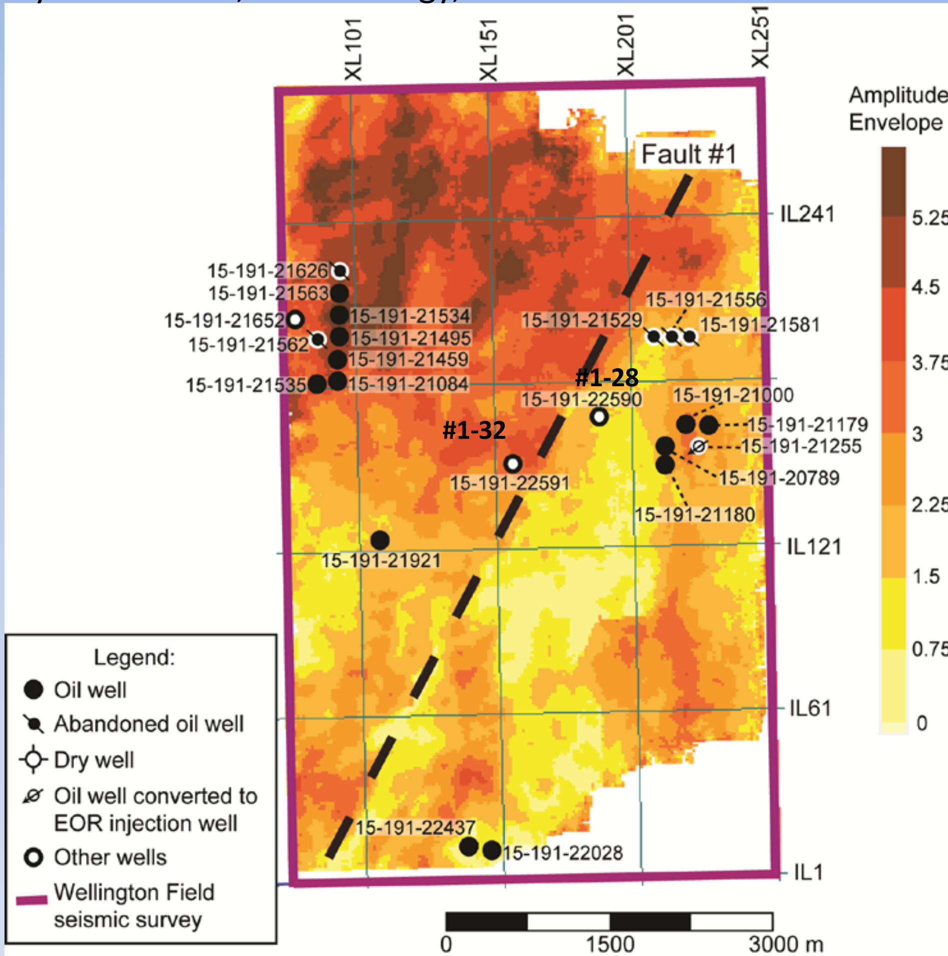


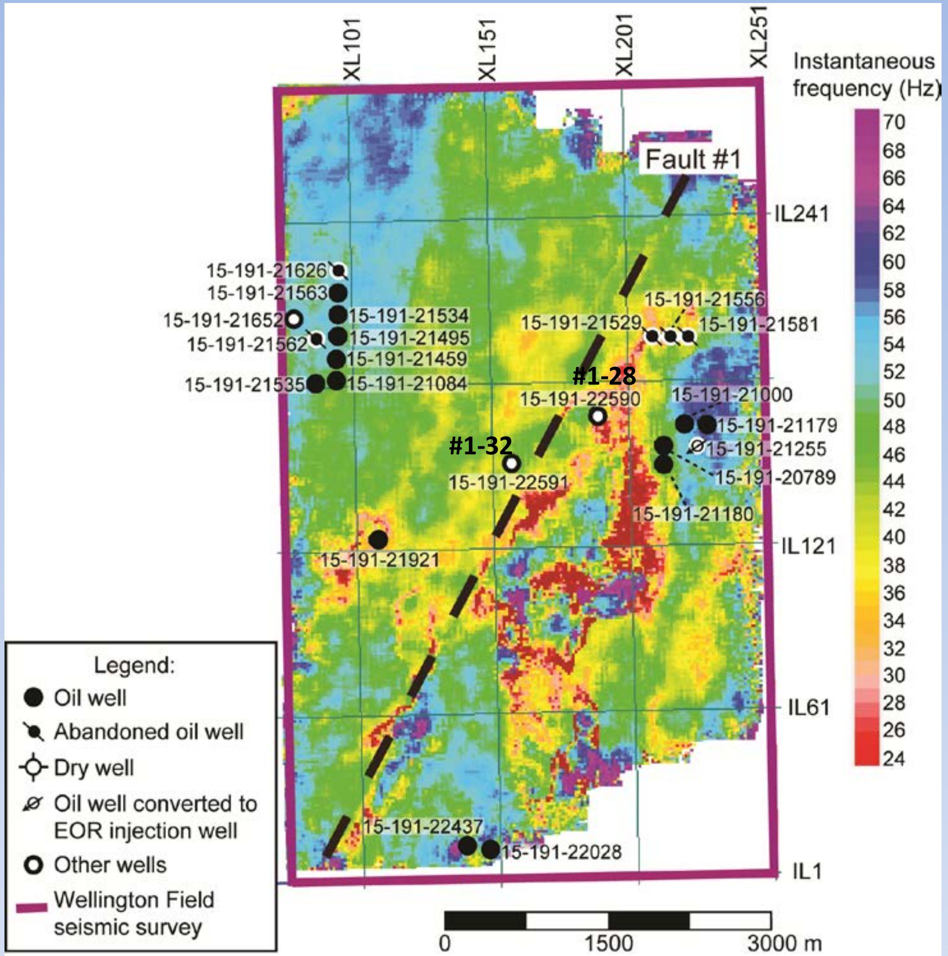


2

Upper cherty intercrystalline dolomite reservoir (main pay) Wellington Field, Sumner County, KS

Ayrat Sirazhiev, M.S. Geology, 2012



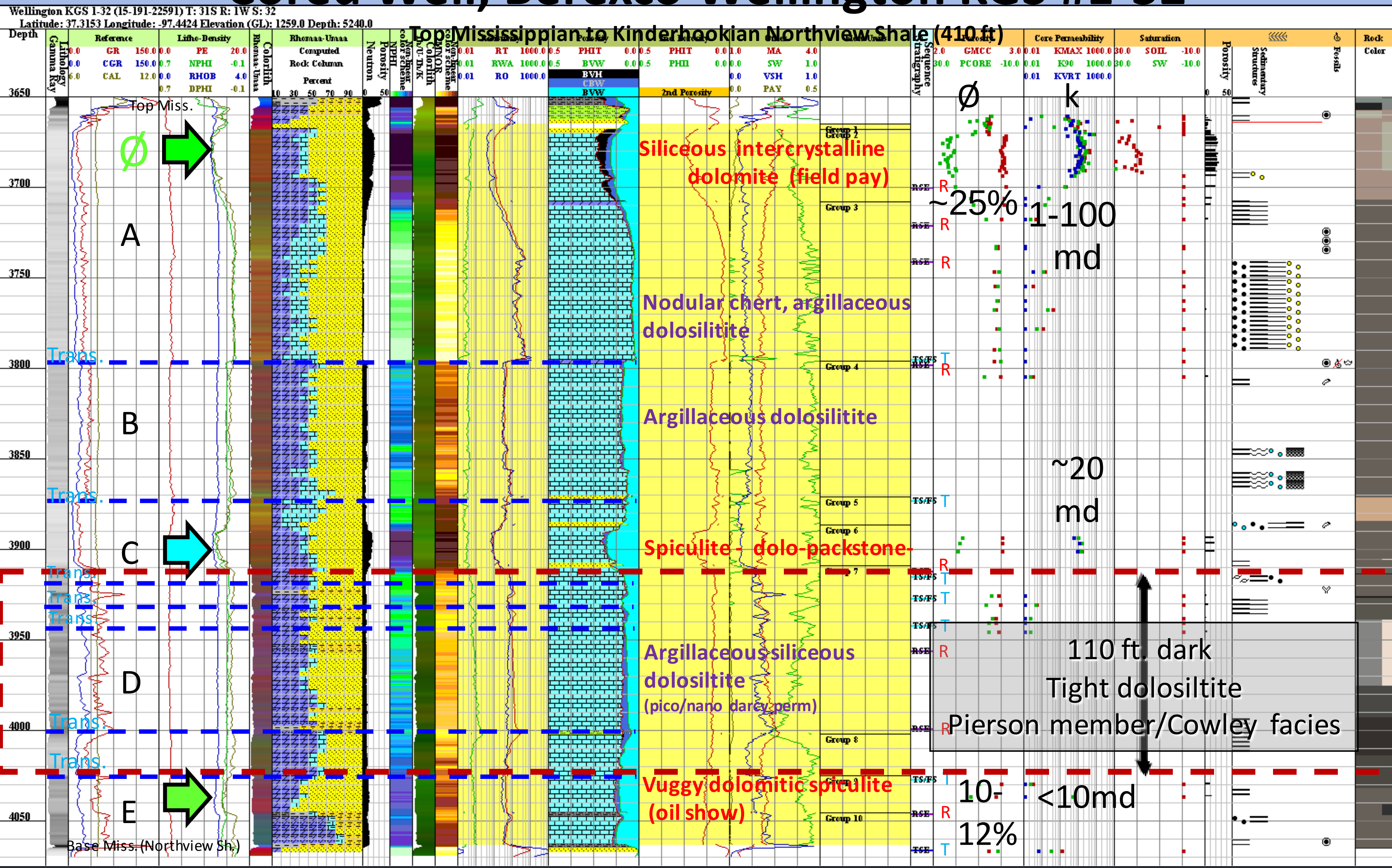


Amplitude envelope map of the Mississippian reflection

Instantaneous frequency map of the Mississippian reflection

Can we relate real data seismic amplitude and frequency to reservoir thickness as it has been suggested by the modeling?

Mississippian oil reservoir (top)
Cored Well, Berexco Wellington KGS #1-32

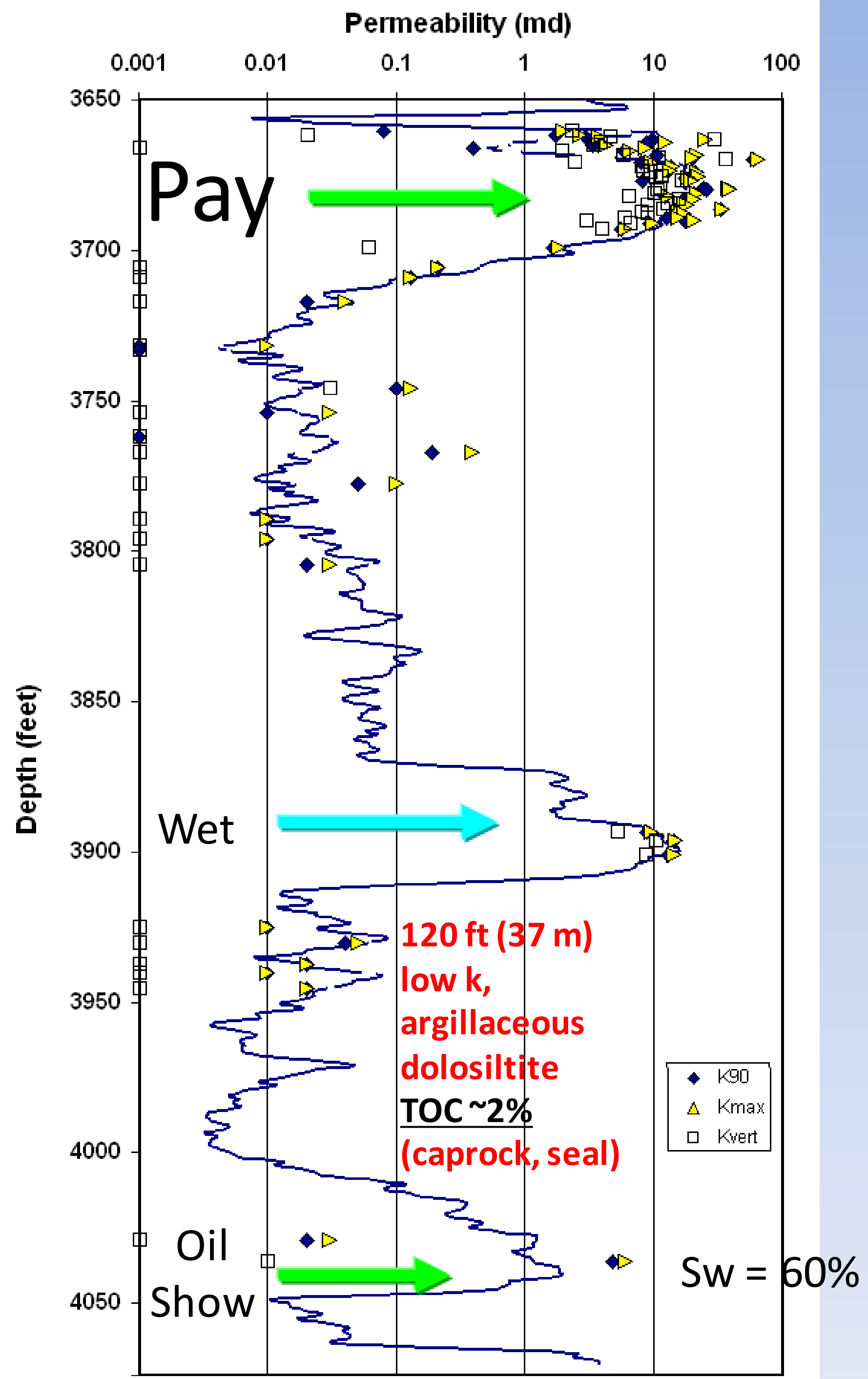


Freeware:http://www.kgs.ku.edu/stratigraphic/PROFILE/

Permeability profile

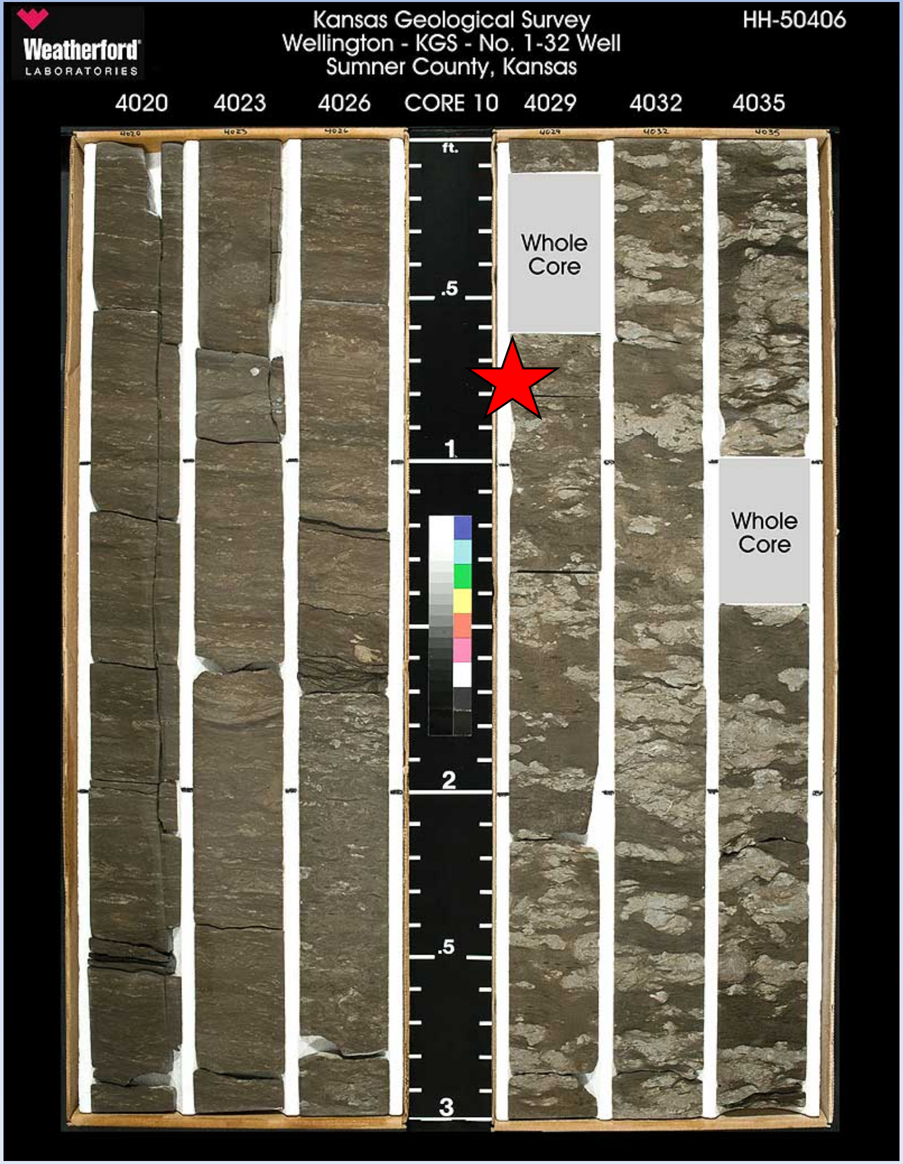
entire Mississippian

KGS #1-32 Wellington : Estimation of permeability based on *magnetic resonance imaging (MRIL^{tm})* using porosity and T2 center-of-gravity versus core Kmax, K90, and Kvert core permeabilities

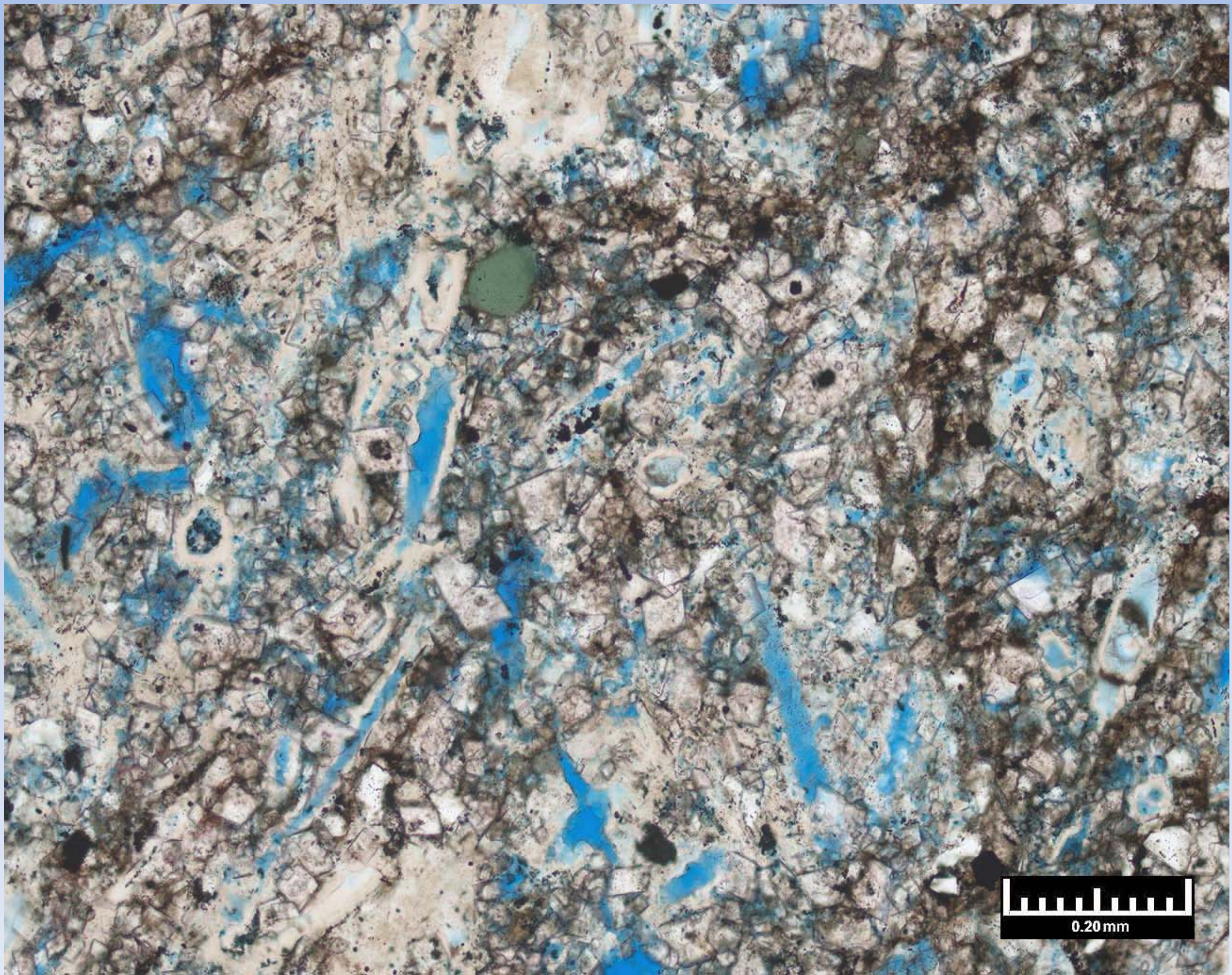


Doveton & Fazelalavi, July 2012

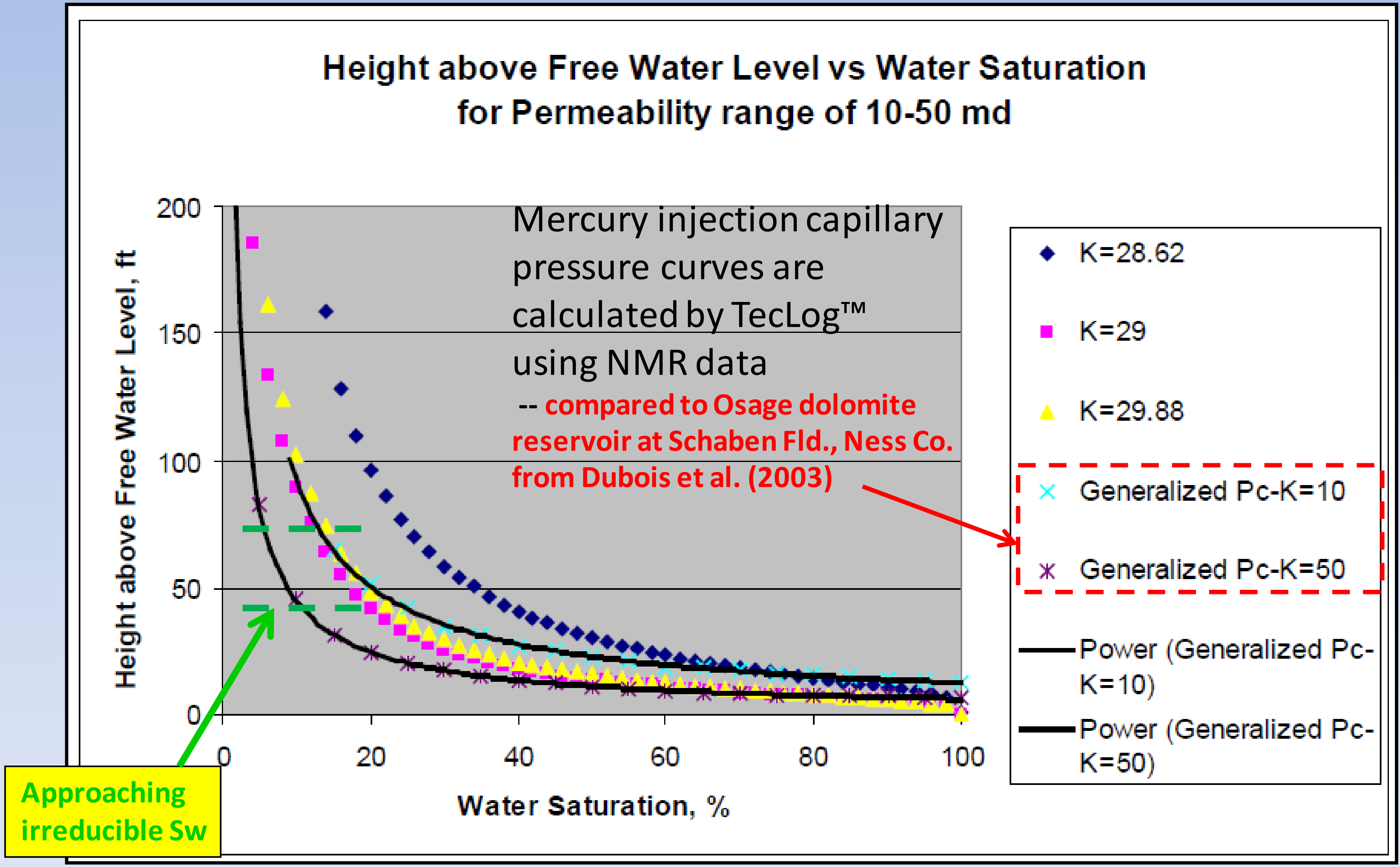
Bottom porosity in dolomitic spiculite in lower Cowley facies with oil show near base of Mississippian
KGS Wellington #1-32



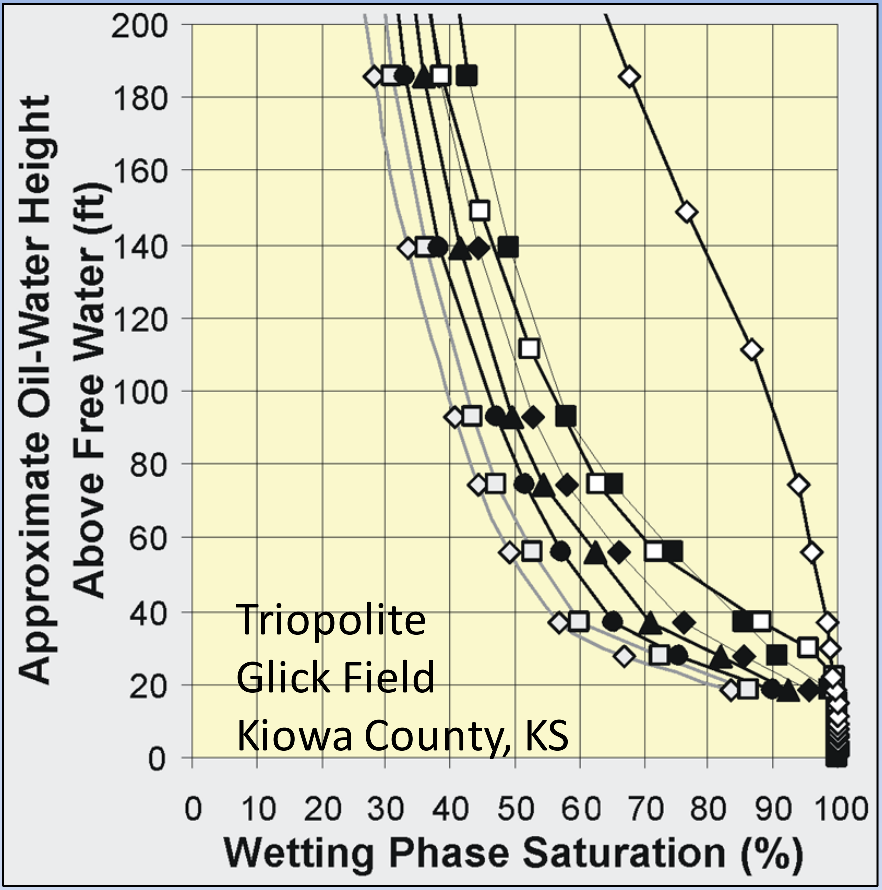
Wellington 4029.73 ft (Cowley facies)
deep-water, porous and permeable dolospiculite (oil bearing)

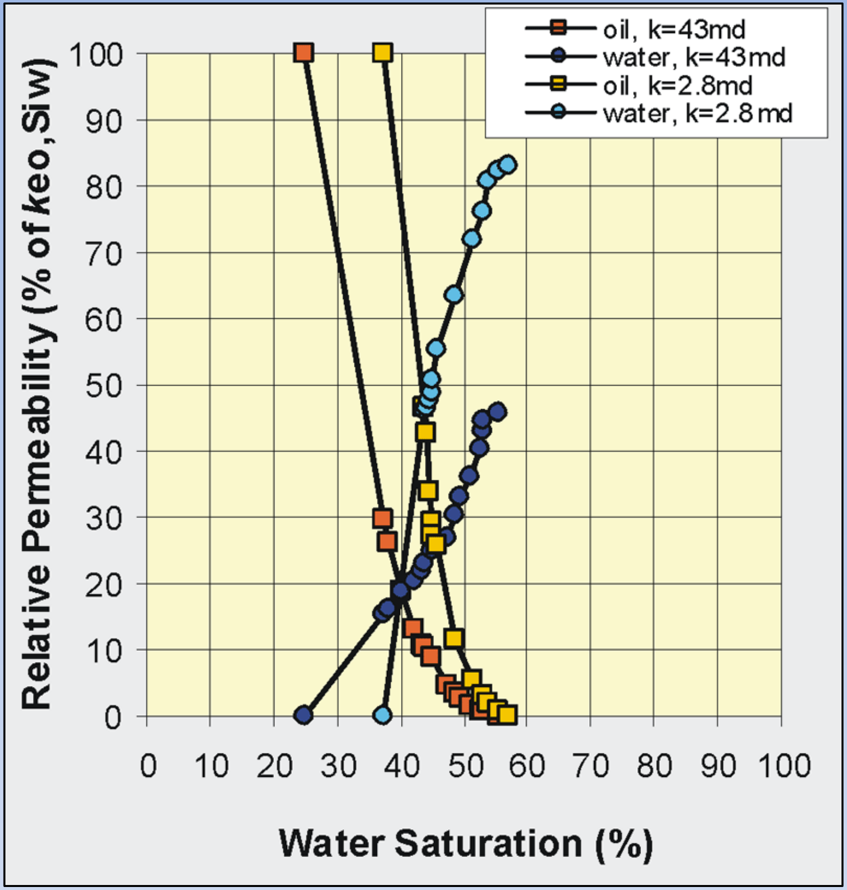


Oil column in typical conventional reservoirs requires ~75 ft to approach irreducible water saturation and zero water cut based on capillary pressure curves for common Mississippian reservoirs in MLP



Fazelalavi



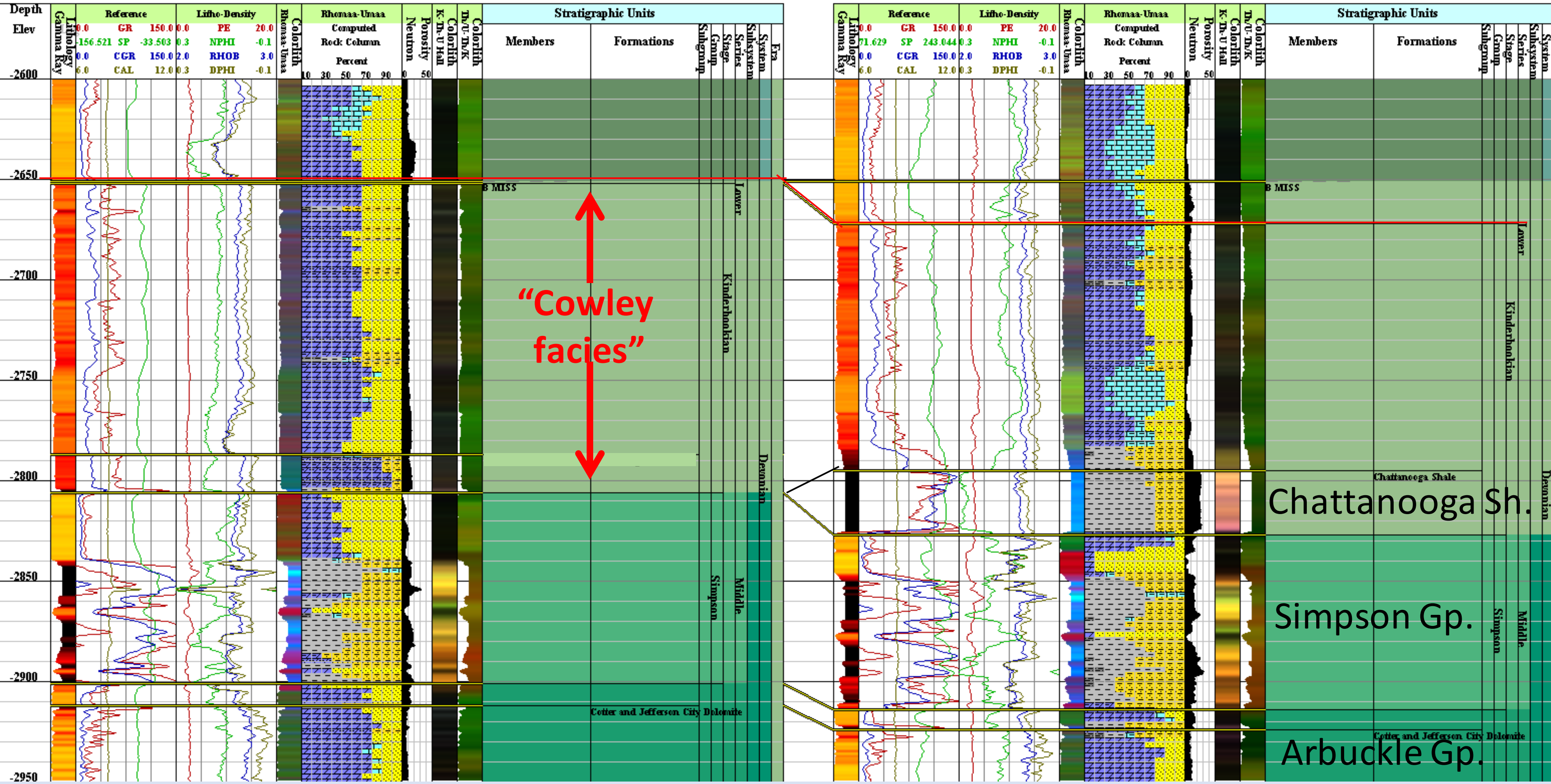


"High bound water saturations in the tripolitic chert have led to difficulty in estimating reserves and determining producible zones. This problem in water saturations is further complicated by difficulty in establishing free water level. While some fields exhibit apparent structural closure greater than 200 feet, the presence of nearly isolated blocks of production within these fields surrounded by nonproductive areas may indicate that there is not a continuous hydrocarbon column and that free water level is independently established for each block". -- Watney, Guy, Byrnes (2001)

"Cowley facies"

Berexco Wellington KGS #1-32 (left) & #1-28 (right)

(3000 ft northeast of #1-32)



50 ft

Cross Section Java Appet – J. Victorine, KGS, DOE-CO2

Correlations – regional team (Bittersweet), DOE-CO2

Pierson Ls. Member (Cowley facies) is *organic-bearing and thermally mature* and probably local source rock for MLP

Weatherford LABORATORIES

TOTAL ORGANIC CARBON

Received 2-13-13

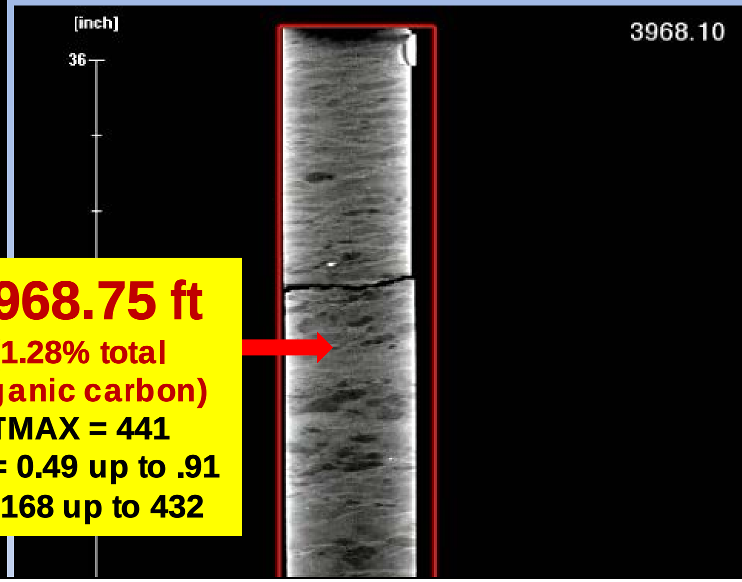
Client ID	Well Name	State	County	Top depth (ft)	Formation	Sample Type	Prep	TOC, wt. %	Verified	Lab Id	Comments
	Berexco LLC Wellington KGS No. 1-32			3605.40		Core	NOPR	0.10		3402822662	Penn sh
	Berexco LLC Wellington KGS No. 1-32			3738.25		Core	NOPR	0.39		3402822664	MSSP
	Berexco LLC Wellington KGS No. 1-32			3754.00		Core	NOPR	0.19		3402822666	MSSP
	Berexco LLC Wellington KGS No. 1-32			3784.50		Core	NOPR	1.87	TOC	3402822668	MSSP
	Berexco LLC Wellington KGS No. 1-32			3937.25		Core	NOPR	0.94		3402822670	MSSP
	Berexco LLC Wellington KGS No. 1-32			3968.75		Core	NOPR	1.28		3402822672	MSSP
	Berexco LLC Wellington KGS No. 1-32			3982.00		Core	NOPR	0.60	TOC	3402822674	MSSP
	Berexco LLC Wellington KGS No. 1-32			4024.00		Core	NOPR	0.21		3402822676	MSSP
	Berexco LLC Wellington KGS No. 1-32			4048.50		Core	NOPR	1.11		3402822678	MSSP
	Berexco LLC Wellington KGS No. 1-32			4059.75		Core	NOPR	0.69		3402822680	MSSP
	Berexco LLC Wellington KGS No. 1-32			4065.50		Core	NOPR	1.59	TOC	3402822682	M-D Chat Sh

OPERATOR AND WELL NAME

SEC	T	R	SPOT			SAMPLE INTERVAL	SUBSURF.	AGE	FORM	LITH	TOC	S1	S2	S3	HI	OI	TMAX	PI	S1+S2
32	31S	01W	SW	NE	NE		3784.50	Mssp		ls	1.87	0.71	8.06	0.93	432	50	442	0.08	8.77
32	31S	01W	SW	NE	NE		3937.25	Mssp		ls	0.94	0.77	3.28	0.43	350	46	439	0.19	4.05
32	31S	01W	SW	NE	NE		3968.75	Mssp		ls	1.28	0.49	2.14	0.54	168	42	441	0.19	2.63
32	31S	01W	SW	NE	NE		3982.00	Mssp		ls	0.60	0.66	1.92	0.58	321	97	440	0.26	2.58
32	31S	01W	SW	NE	NE		4024.00	Mssp		ls	0.21								
32	31S	01W	SW	NE	NE		4048.50	Mssp		ls	1.11	0.79	4.02	0.41	361	37	437	0.16	4.81
32	31S	01W	SW	NE	NE		4059.75	Mssp		ls	0.69								
32	31S	01W	SW	NE	NE		4065.50	Dev	CHAT	sh	1.59	0.91	7.75	0.27	487	17	440	0.11	8.66
32	31S	01W	SW	NE	NE		4099.60	OrdM	SMPS	sh	0.17								

Compilation of Hydrocarbon Source-Rock Analyses for Wells in East-Central and Northeastern Kansas, and adjacent areas in Missouri and Nebraska
by K. David Newell (Kansas Geological Survey, University of Kansas, Lawrence, KS, 66046-3736), August, 2013

Helical CT scan of 3968.1 to 3971.1 ft



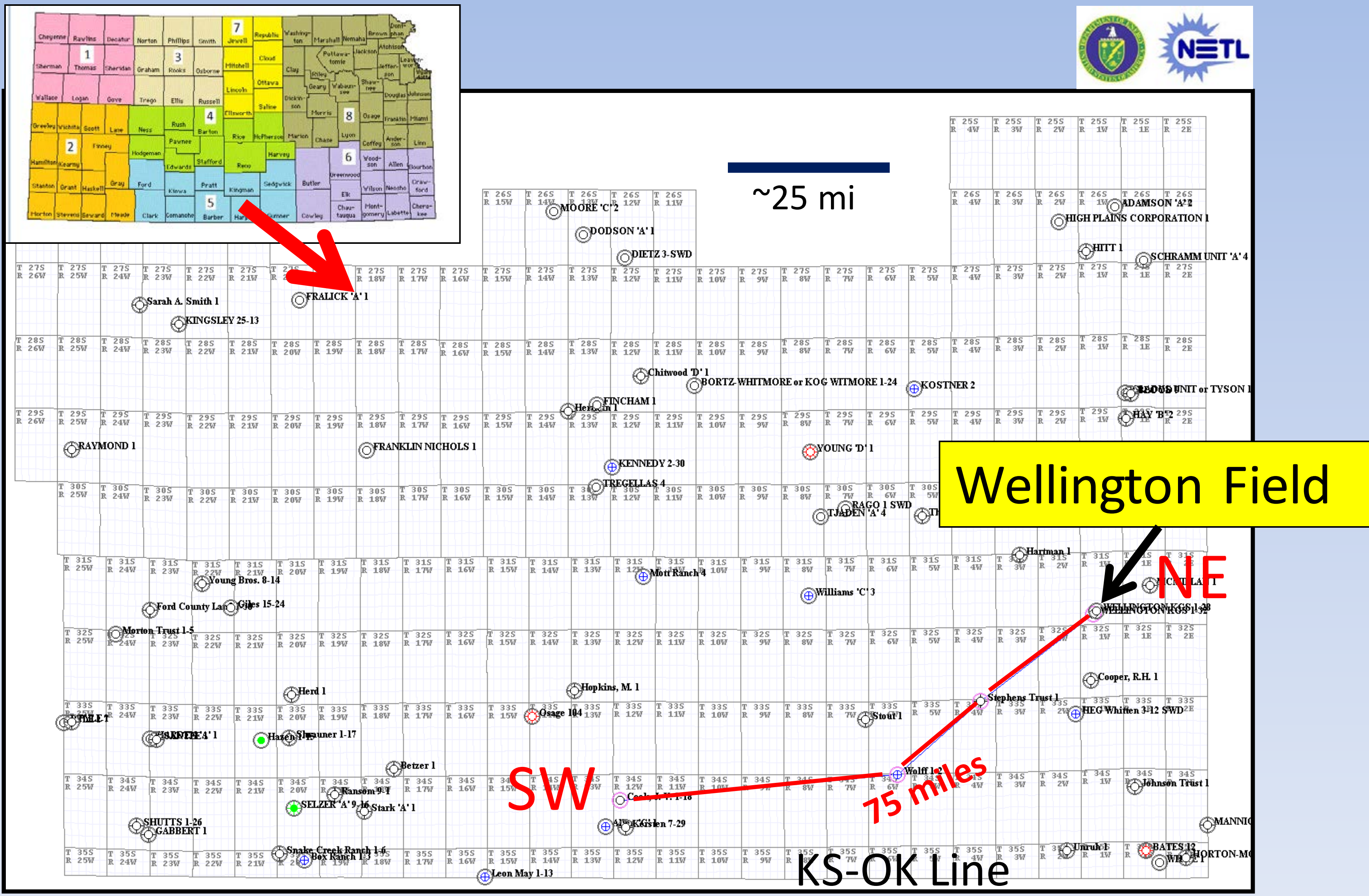
3968.75 ft
(1.28% total organic carbon)
TMAX = 441
S1 = 0.49 up to .91
HI 168 up to 432

Local HC maturation in Woodford Shale and "Cowley facies"

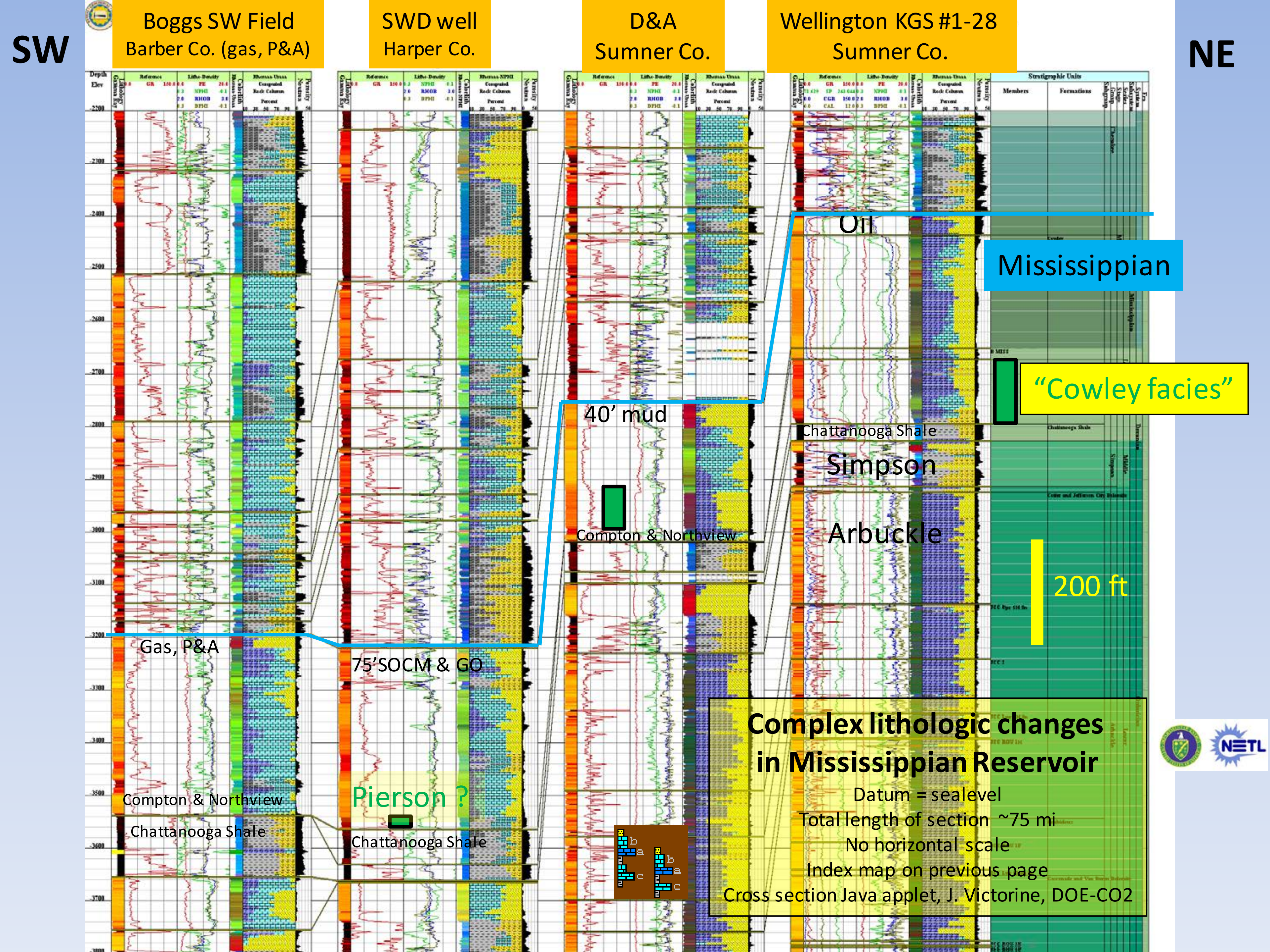
- Potential for charging along fractures
- Displace water
- Increasing oil cut
- Locally, continuous HC column???

Prototype index map of type logs & Index for SW to NE Cross Section in south-central Kansas

Type wells = deep wells with digitized modern logging suites



J. Victorine, KGS



SW
NE
Boggs SW Field
Barber Co. (gas, P&A)
SWD well
Harper Co.
D&A
Sumner Co.
Wellington KGS #1-28
Sumner Co.
Oil
Mississippian
"Cowley facies"
40' mud
Compton & Northview
Chattanooga Shale
Simpson
Arbuckle
200 ft
Gas, P&A
75'SOCM & GO
Pierson ?
Compton & Northview
Chattanooga Shale
Chattanooga Shale
Complex lithologic changes in Mississippian Reservoir
Datum = sealevel
Total length of section ~75 mi
No horizontal scale
Index map on previous page
Cross section Java applet, J. Victorine, DOE-CO2

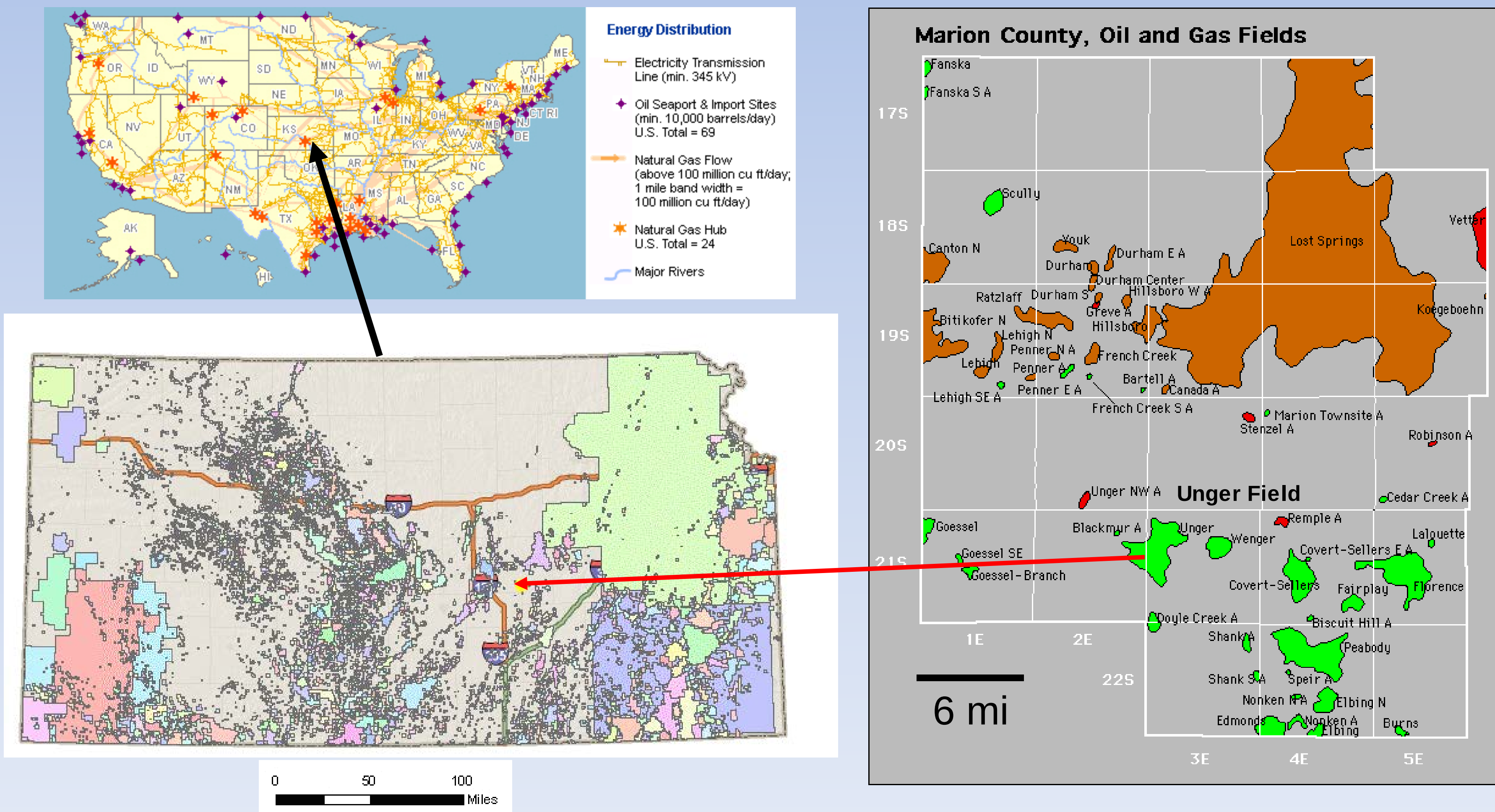
UNGER FIELD HORIZONTAL FRACTURE SETS WITH WATER

Horizontal Well
American Energies Corporation
Slocombe-Rood #1-19
Unger Field
Marion County, Kansas

RPSEA
Research Partnership to Secure Energy for America

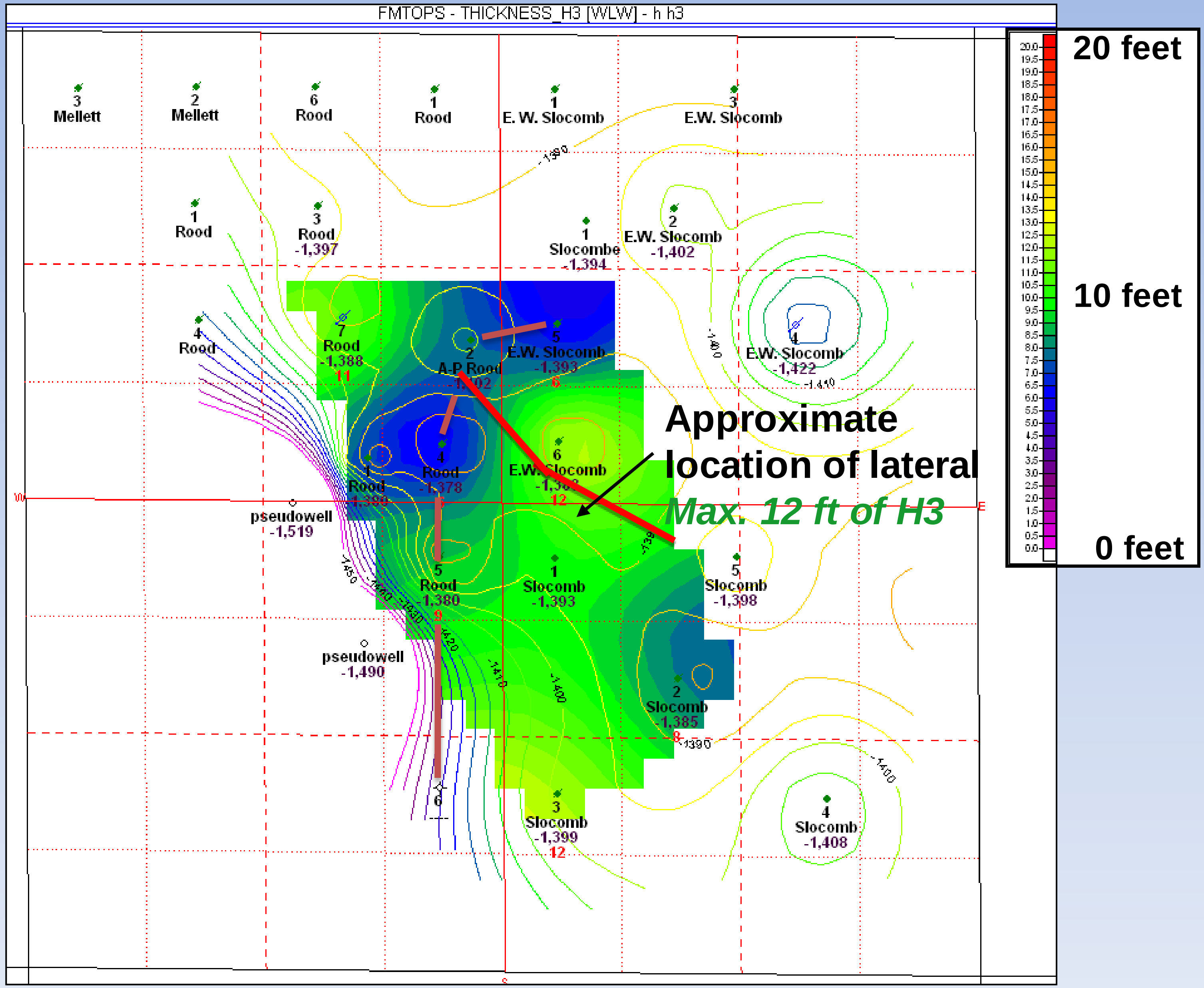
Small Producer Project #07123-04

NETL

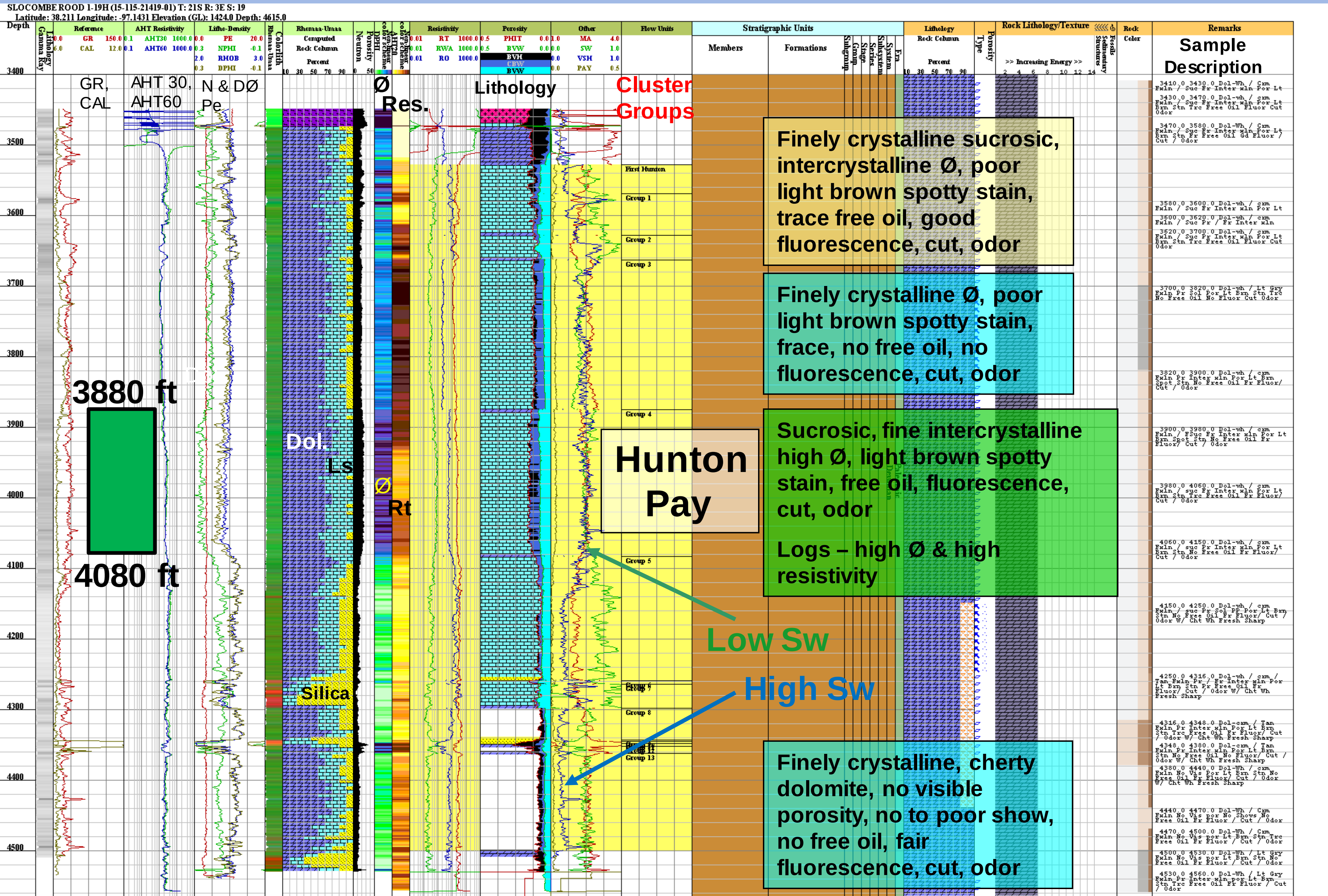


Thickness of uppermost H3 layer (color fill) with structure top of pay zone (contours)

NW-SE trending horizontal well - east flank of NW-SE trending structure



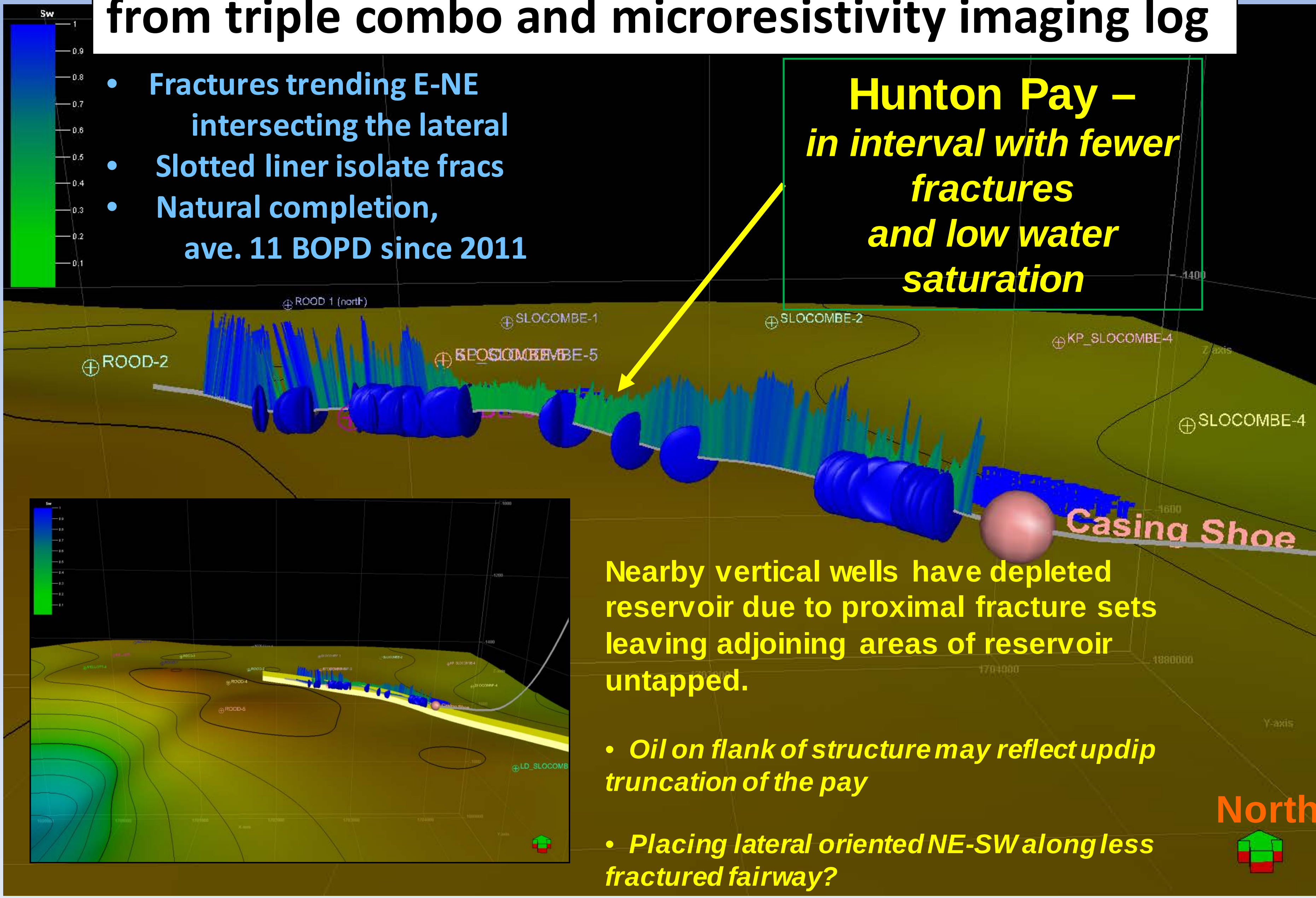
Horizontal well, nearly depleted water-drive Hunton Gp. oil field with untapped oil -- *Drill-pipe conveyed triple-combo log and cuttings*



Water Saturation and Conductive (Open) Fractures from triple combo and microresistivity imaging log

- Fractures trending E-NE intersecting the lateral
- Slotted liner isolate fracs
- Natural completion, ave. 11 BOPD since 2011

Hunton Pay –
in interval with fewer fractures and low water saturation



Nearby vertical wells have depleted reservoir due to proximal fracture sets leaving adjoining areas of reservoir untapped.

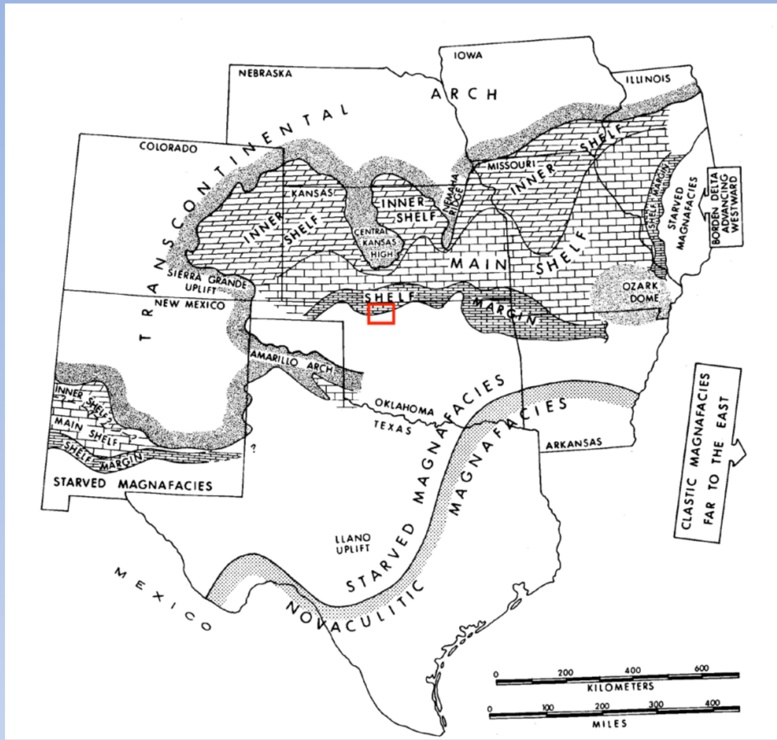
- ***Oil on flank of structure may reflect updip truncation of the pay***
- ***Placing lateral oriented NE-SW along less fractured fairway?***

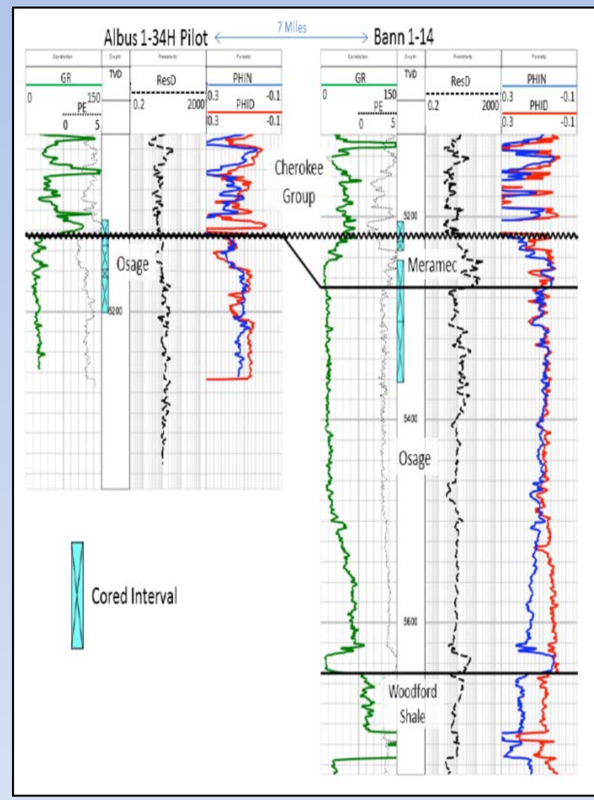
Core to Characterization and Modeling of the Mississippian, North Alva Area, Woods and Alfalfa Counties, Oklahoma

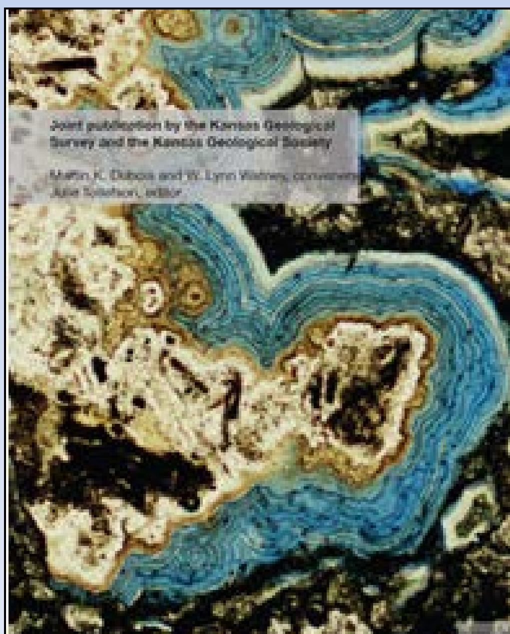
Dan Costello[1], Martin Dubois[2], and Ryan Dayton[1]

1 Chesapeake Energy Corporation

2 Improved Hydrocarbon Recovery, LLC



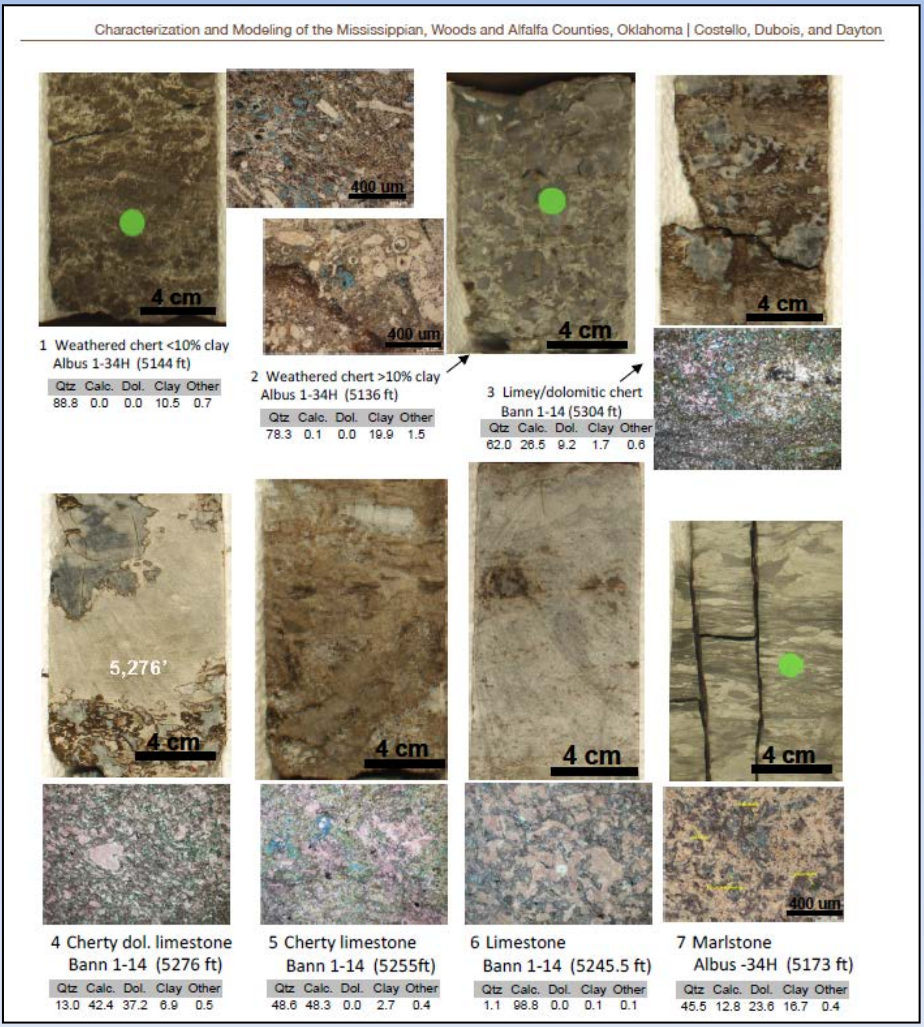


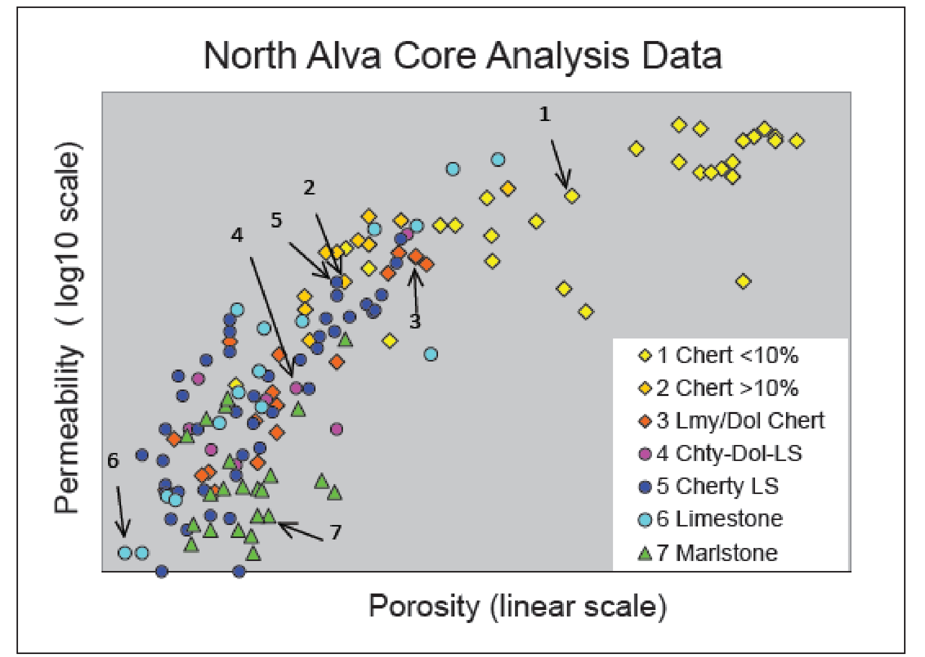


Joint publication by the Kansas Geological Survey and the Kansas Geological Society

Martin K. Dubois and W. Lynn Watney, conveners
Julie Tollefson, editor

Reservoir lithofacies and phi-k relationships





Core to Characterization and Modeling of the Mississippian, North Alva Area, Woods and Alfalfa Counties, Oklahoma

Dan Costello1, Martin Dubois2, and Ryan Dayton1

1 Chesapeake Energy Corporation

2 Improved Hydrocarbon Recovery, LLC

Factors in water cut?

South North

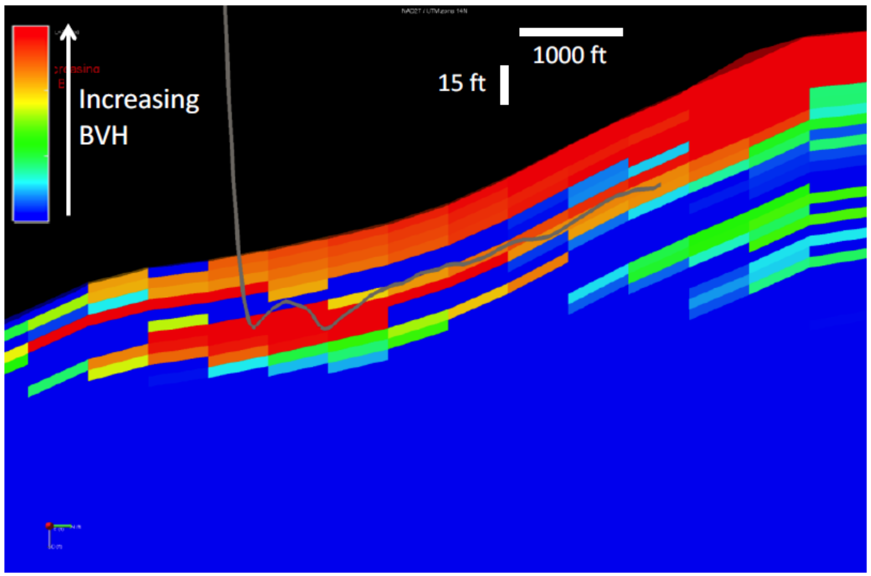


Figure 11—Example view of horizontal wellbore planned using geocellular model. Grid is displaying modeled distribution of bulk volume hydrocarbon (BVH). Vertical exaggeration 30x.

~135 ft oil column

- Prograding and downlapping Osage and Meramec strata along ramp
- Variable pore types along the lateral
- Not simple oil:water contact
- ~135 ft of oil column
- Reservoir pressure, drive?
- Locally charged with thermally mature, underlying Woodford Shale or "Cowley facies"?
- Fractures? Water or oil?
- How was well completed?

Core to Characterization and Modeling of the Mississippian, North Alva Area, Woods and Alfalfa Counties, Oklahoma

Dan Costello[1], Martin Dubois[2], and Ryan Dayton[1]
[1]*Chesapeake Energy Corporation*
[2]*Improved Hydrocarbon Recovery, LLC*

Conclusions

- Mississippi Lime Play - definition
- Structural history of Arkoma and Anadarko Basin
- Source rocks
- Hydrocarbon migration
- Spectrum of lithofacies and quality reservoir rock
- Conventional reservoir
- Unconventional reservoir lithofacies
- Why variations in water cut?
- Conclusions