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## NEW TECHNOLOGIES

IN THE

## MID-CONTINENT

# CALL FOR PAPERS

DEADLINE IS MARCH 1, 2013

AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS

## MID-CONTINENT SECTION MEETING

## WICHITA - OCTOBER 12-15 2013

[WWW.AAPGMCS.ORG](http://WWW.AAPGMCS.ORG)

LOOK FORWARD TO A SPECIAL MISSISSIPPIAN SYMPOSIUM DISCUSSING  
THE LATEST EXPLORATION PLAYS OF KANSAS AND OKLAHOMA



HOSTED BY:  
KANSAS GEOLOGICAL SOCIETY  
212 NORTH MARKET STREET, SUITE 100  
WICHITA, KANSAS 67202  
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ORAL PRESENTATIONS

CONTACT: W. LYNN WATNEY  
[lwatney@kgs.ku.edu](mailto:lwatney@kgs.ku.edu)  
785-864-2184

GENERAL POSTER SESSION

CONTACT: ERNIE MORRISON  
[EMorrison@MullDrilling.com](mailto:EMorrison@MullDrilling.com)  
316-264-6366

# ***“Evaluating CO<sub>2</sub> Utilization and Storage in Kansas”***

**Update on DOE-funded projects**

- a) Characterization of CO<sub>2</sub> sequestration capacity southern Kansas (DE-FE0002056)***
- b) Small scale field test at Wellington Field, Sumner County (DE-FE0006821)***
- c) Arbuckle modeling with horizontal drilling (DE-FE0004566)***

**W. Lynn Watney**

**Jason Rush, Joint PI**

**Kansas Geological Survey**

**Lawrence, KS 66047**



**TULSA GEOLOGICAL SOCIETY, INC.**  
**TULSA, OK.**

**} EST. 1920**

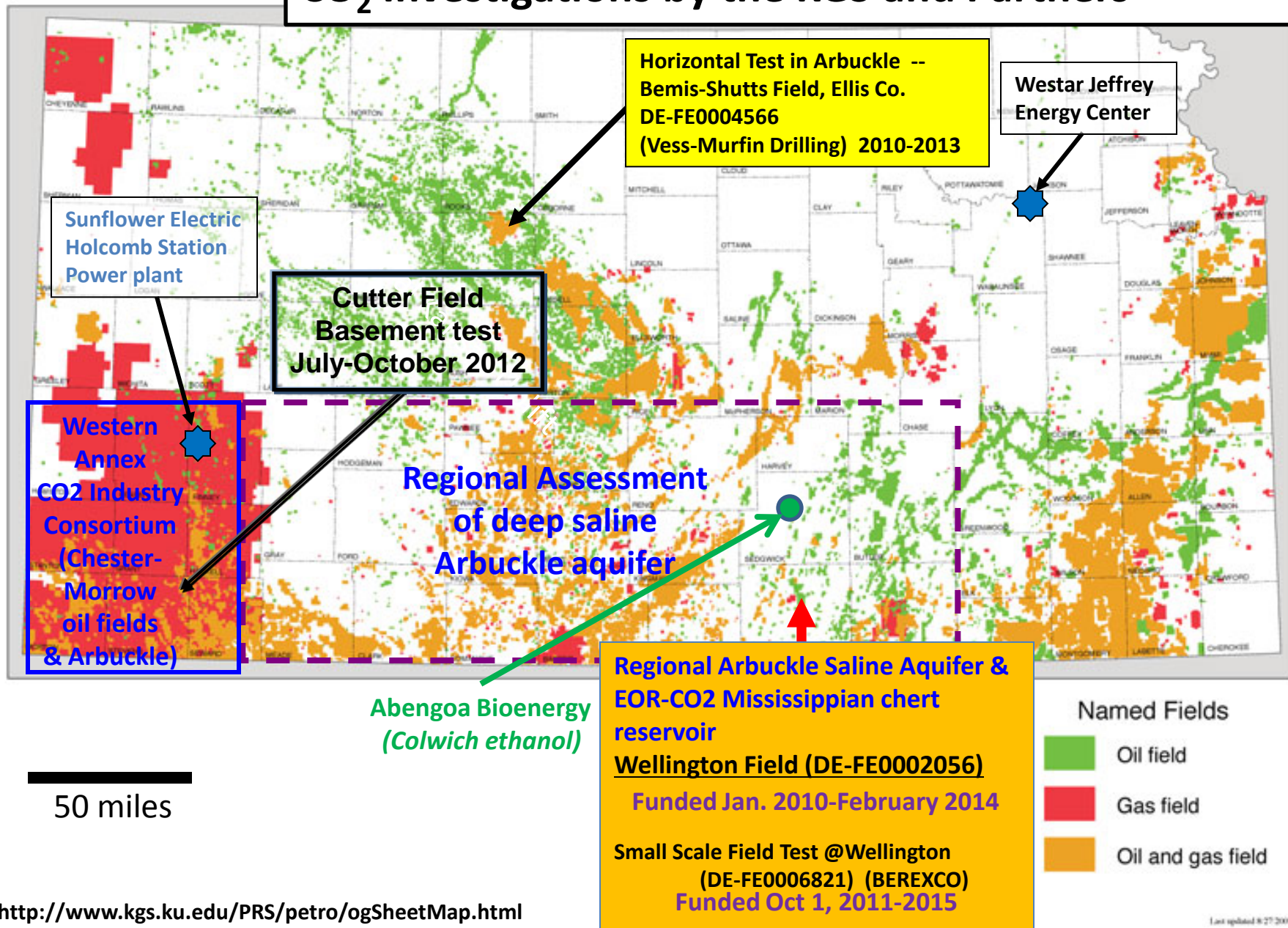
# Outline

- **Locations of studies, schedule, fundamental principles**
- **Accomplishments**
  - Regional geology & estimate of CO<sub>2</sub> storage capacity in the Arbuckle saline formation in southern Kansas
  - Source-sink network for CO<sub>2</sub> utilization and storage
  - Calibration sites for CO<sub>2</sub>-EOR and Arbuckle saline formation
    - Wellington Field, Sumner County (2 new wells, seismic)
    - Cutter Field, Stevens County (1 new well, seismic)
    - Pleasant Prairie South, Eubank North, and Shuck fields
      - Make CO<sub>2</sub>-EOR ready
- **Small scale field test at Wellington Field**
  - Assessment of CO<sub>2</sub> injection zone, caprocks, and isolation from USDW (*Mississippian CO<sub>2</sub>-EOR & Arbuckle saline aquifer*)
  - CO<sub>2</sub> plume management through simulation and MVA
  - 70,000 metric tons CO<sub>2</sub> from nearby ethanol plant
- Spin-off research on the Mississippian Lime Play & lower Paleozoic hydrocarbon system
- **Summary**





# Oil and Gas Map of Kansas & Areas of DOE-Funded CO<sub>2</sub> Investigations by the KGS and Partners







Partners  
FE0002056



DEPARTMENT OF  
GEOLOGY

KANSAS STATE UNIVERSITY

KU THE UNIVERSITY OF  
KANSAS

Department of Geology



**fairfield**nodal



Devilbiss Coring Service  
Basic Energy Services

Wellington  
Field  
Operator



**BEREXCO**

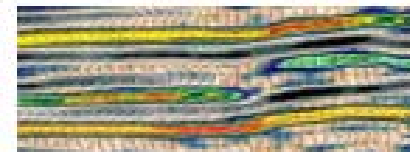
**ne** noble  
energy



**HALLIBURTON**

**HEDKE-SAENGER GEOSCIENCE, LTD**

*Bittersweet Energy Inc.*



**Petrotek**



**LOGDIGI**  
A LEADING CONSULTING COMPANY

# Southwest Kansas CO<sub>2</sub>-EOR Initiative

Industry Partners (modeling 4 Chester/Morrowan oil fields to make CO<sub>2</sub> ready)



HEDKE-SAENGER GEOSCIENCE, LTD



Dawson-Markwell Exploration Co.



## Industrial and Electrical Power Sources of CO<sub>2</sub>



SUNFLOWER ELECTRIC POWER CORPORATION

A Touchstone Energy Cooperative

... energy done right

Abengoa Bioenergy : The Global Ethanol Company



# Organizational Chart

W. Lynn Watney & Jason Rush, Joint Pls

Kansas Geological Survey

Kansas Center for Research (KUCR) – contracting, financial assurance, compliance

## UNIVERSITY OF KANSAS

### Kansas Geological Survey

#### Co-Principal Investigators

Kerry D. Newell, Co-PI -- structure and diagenesis  
Jason Rush, Co-PI -- Petrel geomodeling and data integration  
Richard Miller, Co-PI -- seismic interpretation, shearwave analysis  
John Doveton, Co-PI -- log petrophysics and core-log modeling  
Jianghai Xia, Co-PI -- gravity-magnetics modeling & interpretation  
Marios Sophocleous, Co-PI -- aquifer modeling & well testing

#### Key Personnel

John Victorine -- Java web app development  
David Laflen -- manage core & curation  
Mike Killion -- modify ESRI map service for project  
Database Manager (TBD) -- manage and integrate data

### KU Department of Geology

Evan Franseen, Co-PI -- stratigraphy and diagenesis of OPAS  
Robert Goldstein, Co-PI -- diagenesis, fluid inclusion  
Grad Research Asst 2 years  
David Fowle, Co-PI -- reactive pathways, microbial catalysis  
Jennifer Roberts, Co-PI -- reactive pathways, microbial catalysis  
Geology Technician (TBD) - fluid/rock handling  
Grad Research Asst - 1 year

## Services

LOGDIGI, LLC, Katy, TX - wireline log digitizing  
Petrographics, Montrose, CO - thin section preparation  
KOGER, Dallas, TX - remote sensing data and analysis

## SUBCONTRACTS

### Kansas State University - Seismic and Geochemical Services

PI- Saugata Datta -- reactive pathways and reaction constants  
PI- Abdelmoneam Raef -- seismic analysis and modeling  
GRA 1- Datta- aqueous geochemistry  
GRA 2- Raef - seismic analysis and modeling

### Bittersweet Energy, Inc., Wichita, KS

Tom Hansen. Principal. Wichita. Geological Supervision - regional data. hydrogeology of Arbuckle  
Paul Gerlach, Charter Consulting, regional mapping and analysis  
Larry Nicholson, Great Plains Consulting  
Student Consultant -- regional data acquisition  
Ken Cooper, Petrotek Engineering, Littleton, CO- engineer, well injection, hydrogeology  
John Lorenz, FractureStudies, Edgewood, NM -- structural analysis

### CMG - Simulation Services, Calgary, Alberta

simulation software and Greenhouse Gas Simulation Consultancy

### Weatherford Laboratories, Houston, TX

core analyses

### Berexco, Beredco Drilling -- Wichita, KS

access to Wellington Field; drilling, coring, completion and testing; participation in modeling and simulation  
Key Berexco staff

Dana Wreath - manager, reservoir and production engineer  
Randy Koudele - reservoir engineer  
Bill Lamb - reservoir engineer

### Halliburton, Liberal, KS -- wireline logging services

Hedke-Saenger Geoscience, LTD., Wichita, KS - geophysical acquisition design, seismic interpretation

Susan E. Nissen, McLouth, KS -- Geophysical Consultant - volumetric curvature

Lockhart Geophysical, Denver, CO -- 2D shear wave acquisition, gravity & mag acquis. & interpret

Fairfield Industries, Inc., Denver, CO -- 2D, 3D multicomponent processing

Paragon Geophysical Services, Wichita, KS -- 3D seismic acquisition

Echo Geophysical, Denver, CO -- 3D processing

Converging Point - QC seismic acquisition

Noble Energy, Houston, TX; Denver, CO -- collaborating company, fields adjoining Wellington

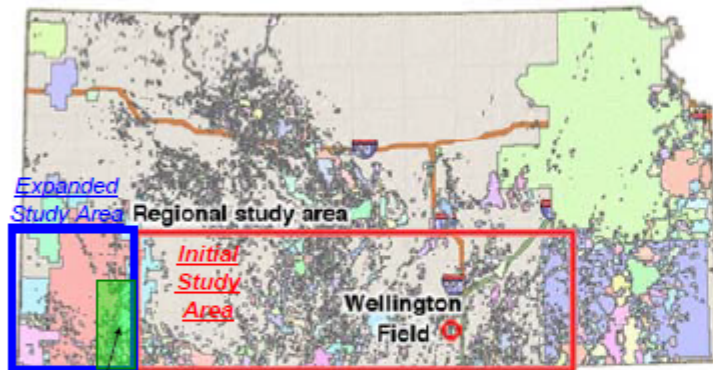


# Organizational chart (continued)

## Southwest Kansas CO2 EOR Initiative

### Chester and Morrow Reservoirs

*Western Annex to Regional CO2 Sequestration Project (DE-FE0002056) run by the Kansas Geological Survey*



CO2 EOR Study

#### Six Industry partners:

- Anadarko Petroleum Corp.
- Berexco LLC
- Cimarex Energy Company
- Glori Oil Limited
- Elm III, LLC
- Merit Energy Company

#### Support by:

Sunflower Electric Power Corp.

#### The SW Kansas part of project

- CO2 EOR technical feasibility study – Chester IVF and Morrow
- Part of larger KGS-industry CCS and EOR study
- Will not inject CO2 – paper study only
- Get fields in study “CO2-ready”

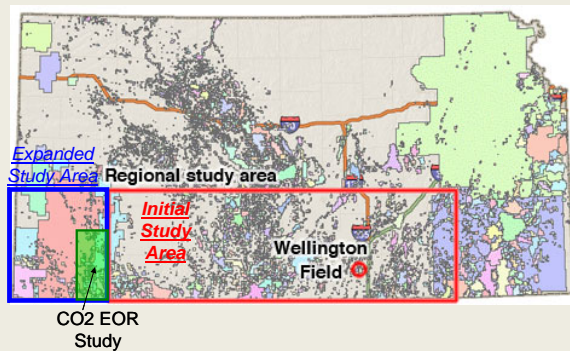
#### Technical Team:

	Project Role	Company
Martin Dubois	Team Lead, geo-model	IHR LLC
John Youle	Core and depo-models	Sunflower Energy
Ray Sorenson	Data sleuth and advisor	Consultant
Eugene Williams	Reservoir engineering	Williams Petroleum
Dennis Hedke	Geophysicist	Hedke & Saenger
Peter Senior	Reservoir modeling	MS student, KU
Susan Nissen	Geophysicist	Consultant
Lynn Watney	Project PI	KGS
Jason Rush	Project PI	KGS
John Doveton	Log Petrophysics	KGS
Tom Hansen	Subcontract mngr., aquifer	Bittersweet Energy
Paul Gerlach	Regional stratigraphy, data	Charter Consulting
Larry Nicholson	Regional stratigraphy, data	Consultant

# Southwest Kansas CO<sub>2</sub>-EOR Initiative

Evaluate CO<sub>2</sub> sequestration potential in Arbuckle Group saline aquifer and  
CO<sub>2</sub>-EOR in four fields in southwestern Kansas

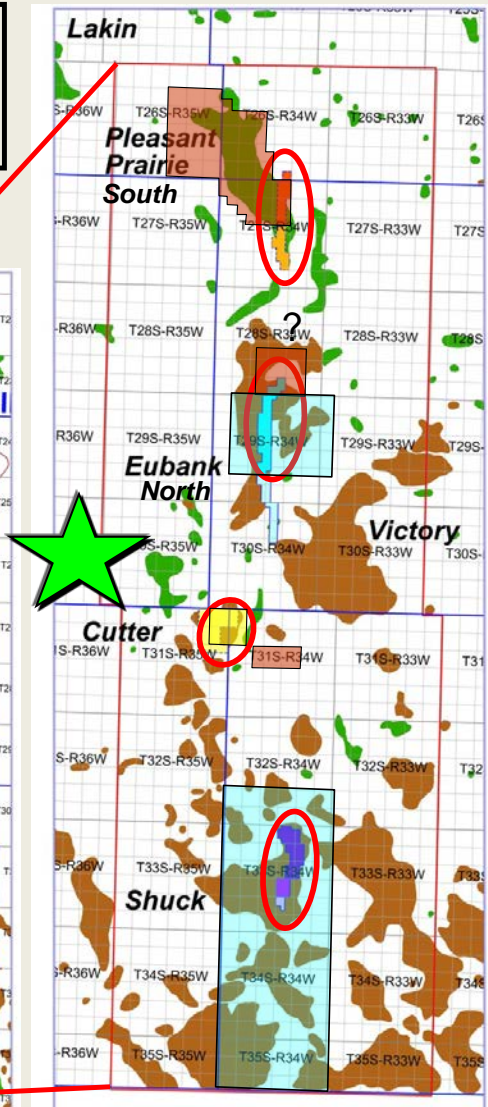
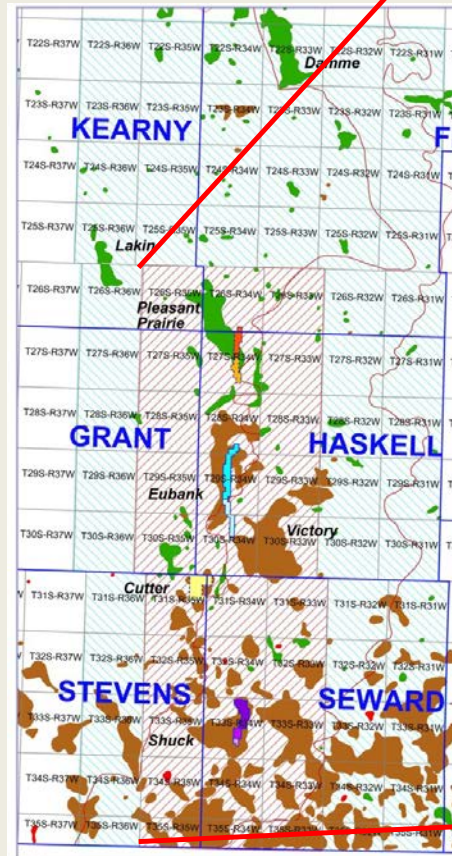
## Southwest Kansas CO<sub>2</sub> Consortium (Western Annex)



**Chester/Morrow  
Sandstone (IVF) &**

**Deep saline Arbuckle  
aquifer**

Seismic blocks are color  
coded by operator  
(~120 mi<sup>2</sup> of 3D seismic)





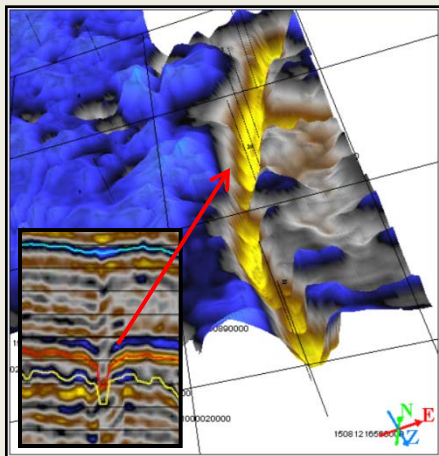
# Southwest Kansas CO<sub>2</sub>-EOR Initiative

Integrated Multi-Discipline Project for CO<sub>2</sub>-EOR Evaluation

## Static Model

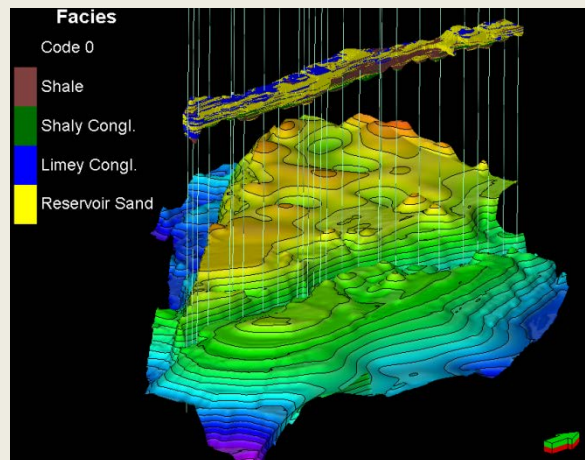
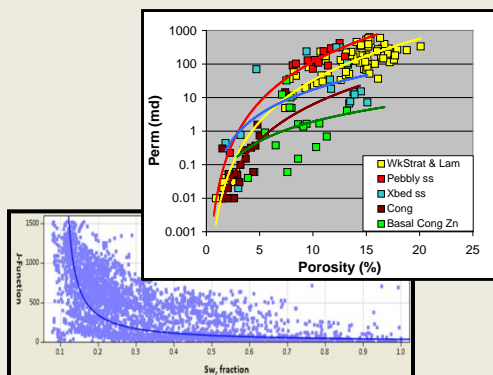
### Geophysics:

structure, attributes, faults



### Petrophysics:

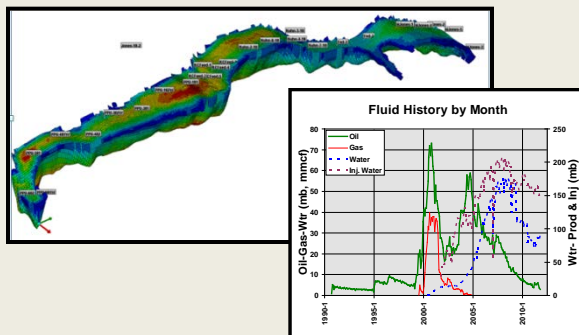
Core K-Phi, corrected porosity, free water level, J-function



### Engineering:

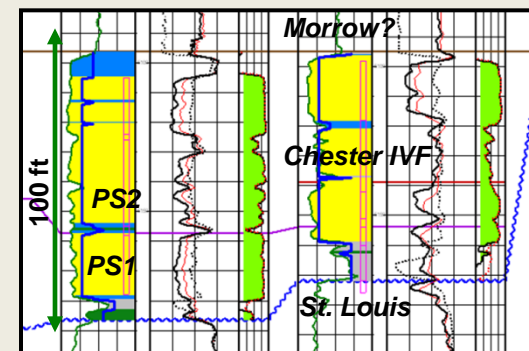
PVT and fluid analysis, recurrent histories, dynamic modeling

## Dynamic Model



### Geology:

Formation tops, sequence stratigraphy, core lithofacies, lithofacies prediction (NNet)





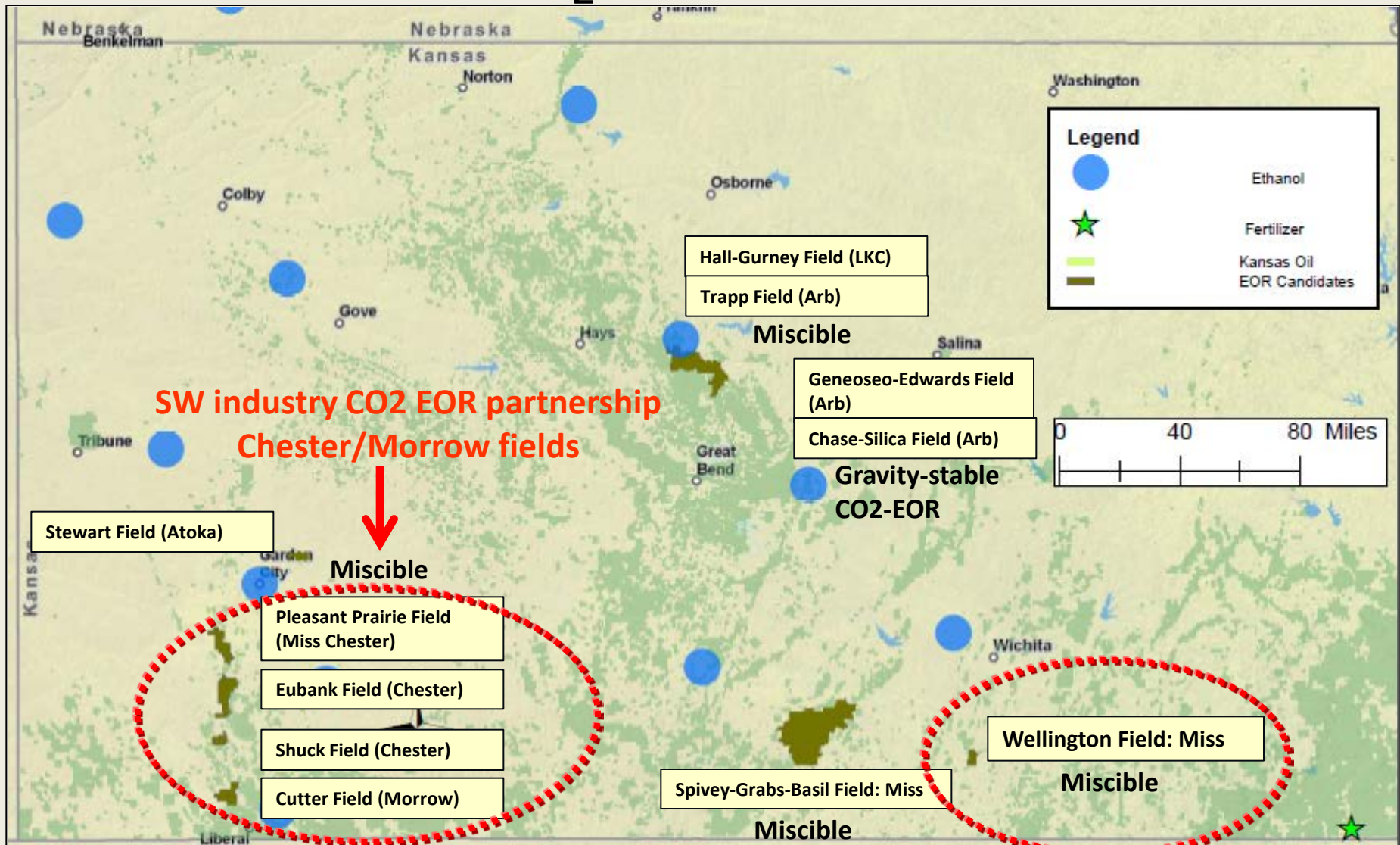
# Source-Sink Network for CCUS

*(Carbon Capture, Utilization, and Storage)*

- **Infrastructure for capture and use of CO<sub>2</sub> in Kansas**
  - **1<sup>st</sup> Step** – Capture from Kansas ethanol plants and use in CO<sub>2</sub>-EOR
  - **2<sup>nd</sup> Step** - Capture from other Kansas point sources and connect pipelines to other regional supplies; use for
    - 1) CO<sub>2</sub>-EOR and
    - 2) saline formation sequestration/disposal



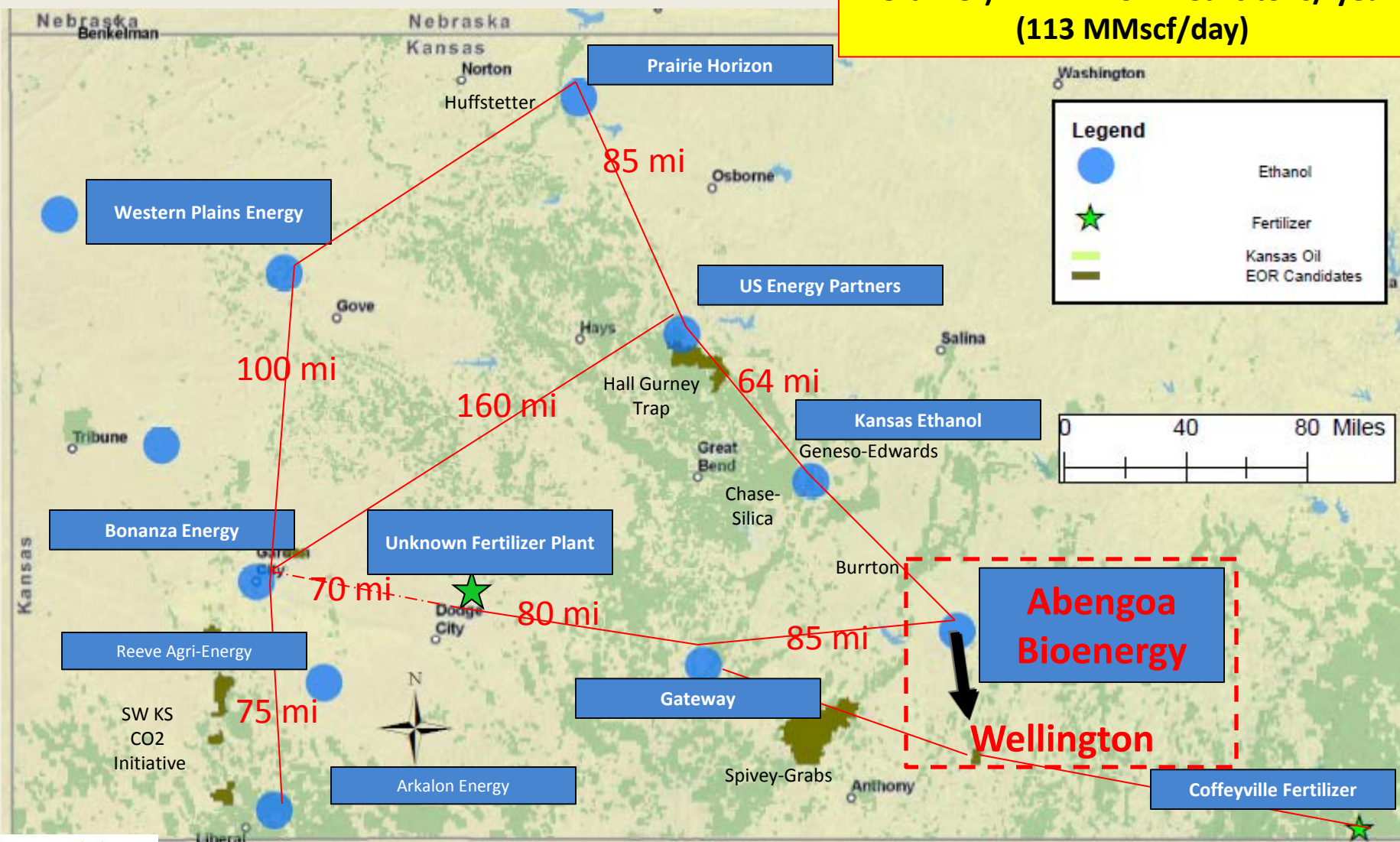
# Ethanol Plants and Selected Oil Fields for CO<sub>2</sub>-EOR in Kansas



KGS in collaboration with Midwest Governor's Association  
& Clinton Foundation Climate Initiative

# Ethanol CO<sub>2</sub> Pipeline Concept – Step 1

Total annual CO<sub>2</sub> emissions (ethanol + fertilizer): 2.2 million metric tons/ year (113 MMscf/day)



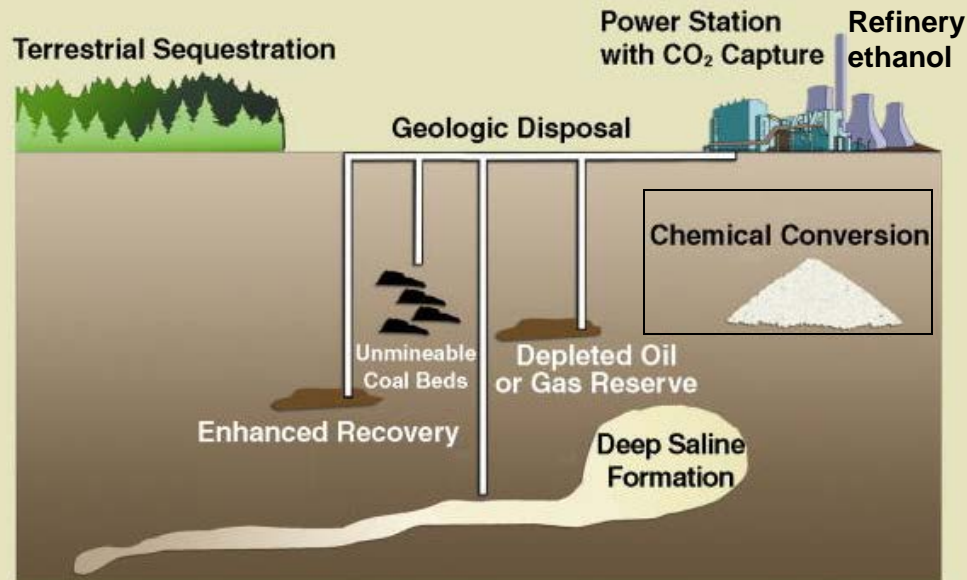
KGS in collaboration with Midwest Governor's Association  
& Clinton Foundation Climate Initiative





# Preeminence of Deep Saline Aquifer Sequestration of CO<sub>2</sub>

## Carbon Sequestration Options



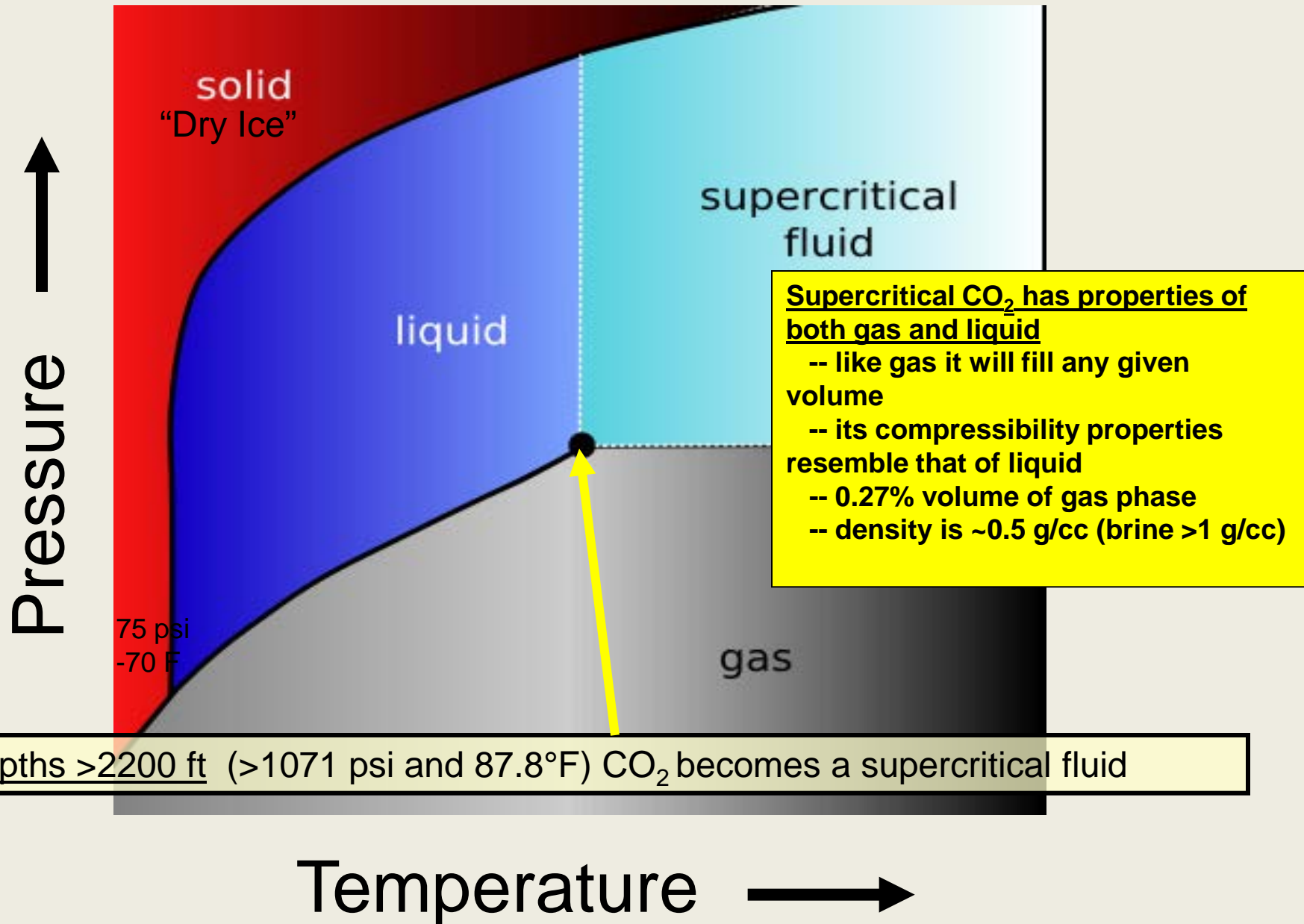
**Industry participation in infrastructure development possible if CO<sub>2</sub>-EOR is viable**

Global annual CO<sub>2</sub> emissions  $\approx 8 * 10^9$  tons  
Earth Policy Institute

>400 yrs  
Current  
Global  
emissions

Formation Type	10 <sup>9</sup> Metric Tons	%
Saline Aquifers	3,297 – 12,618	91.8 – 97.5
Unmineable Coal Seams	157 – 178	4.4 – 1.4
Mature Oil & Gas Reservoirs	138	3.8 – 1.1
Total Capacity	3,592 – 12,934	100.0

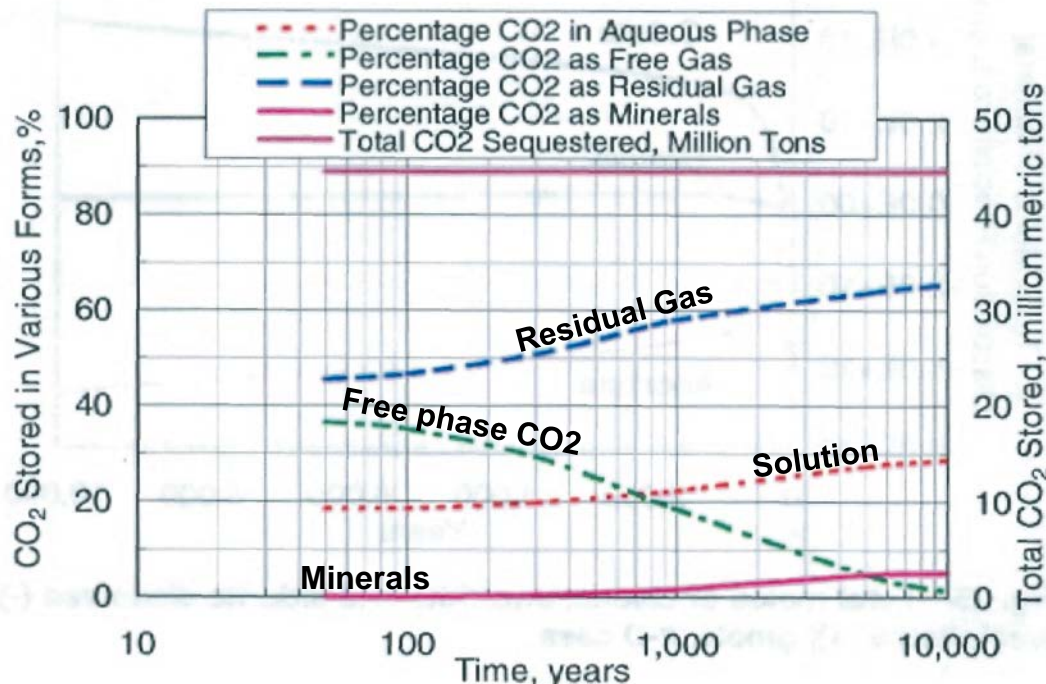
# Supercritical CO<sub>2</sub>



# Fate and Entrapment of CO<sub>2</sub> in Saline Aquifers

## Injected CO<sub>2</sub> entrapped in 4 different ways

- some dissolves in brine
- some gets locked as residual gas (saturation)
- some trapped as minerals
- Remaining CO<sub>2</sub> – resides as free phase
  - Sub- or super-critical as per *in situ* conditions (depth/pressure and temperature)



*Ozah, 2005 – In situ CO<sub>2</sub> distribution after 50 years of injection*

## CO<sub>2</sub> Entrapment Audit:

### 1. Residual gas

- Start 45% to End 65%

### 2. Solution

- Start 18% to End 28%

### 3. Minerals

- Start negligible to End 5%

### 4. Free Phase

- Start 37% to End 2%



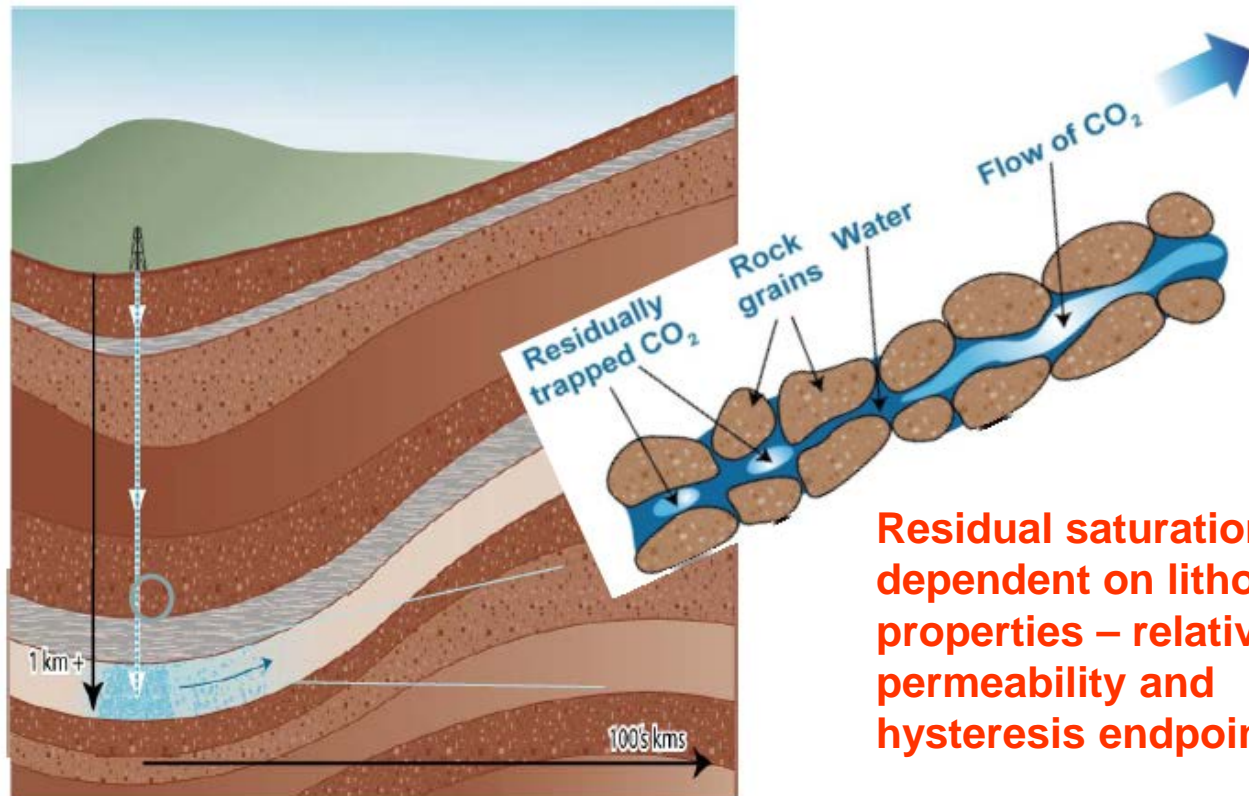
# CO<sub>2</sub> Entrapment as Residual Gas



IEA Greenhouse Gas R&D Programme



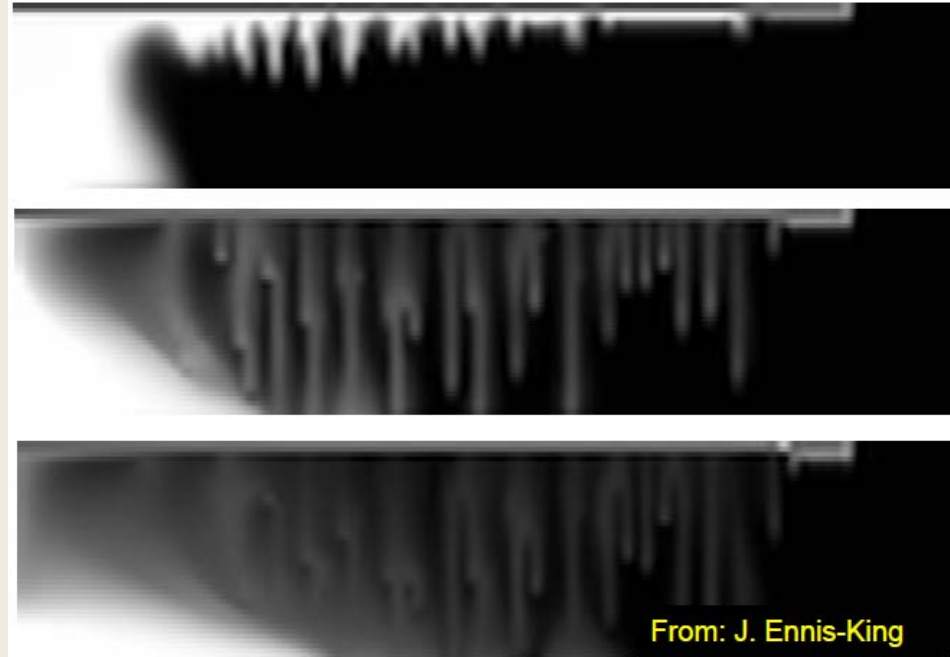
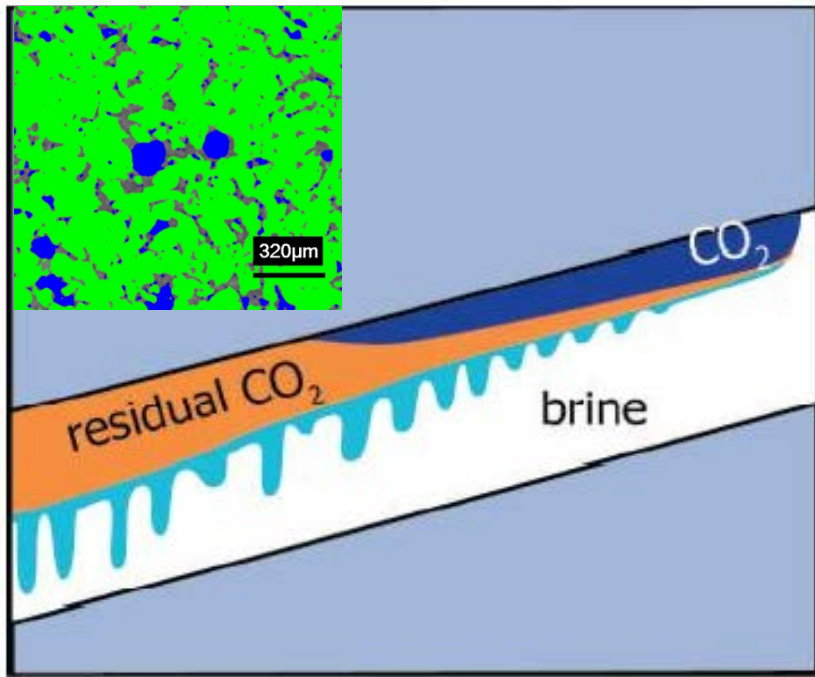
## Residual Trapping



**Residual saturation  
dependent on lithofacies  
properties – relative  
permeability and  
hysteresis endpoints**

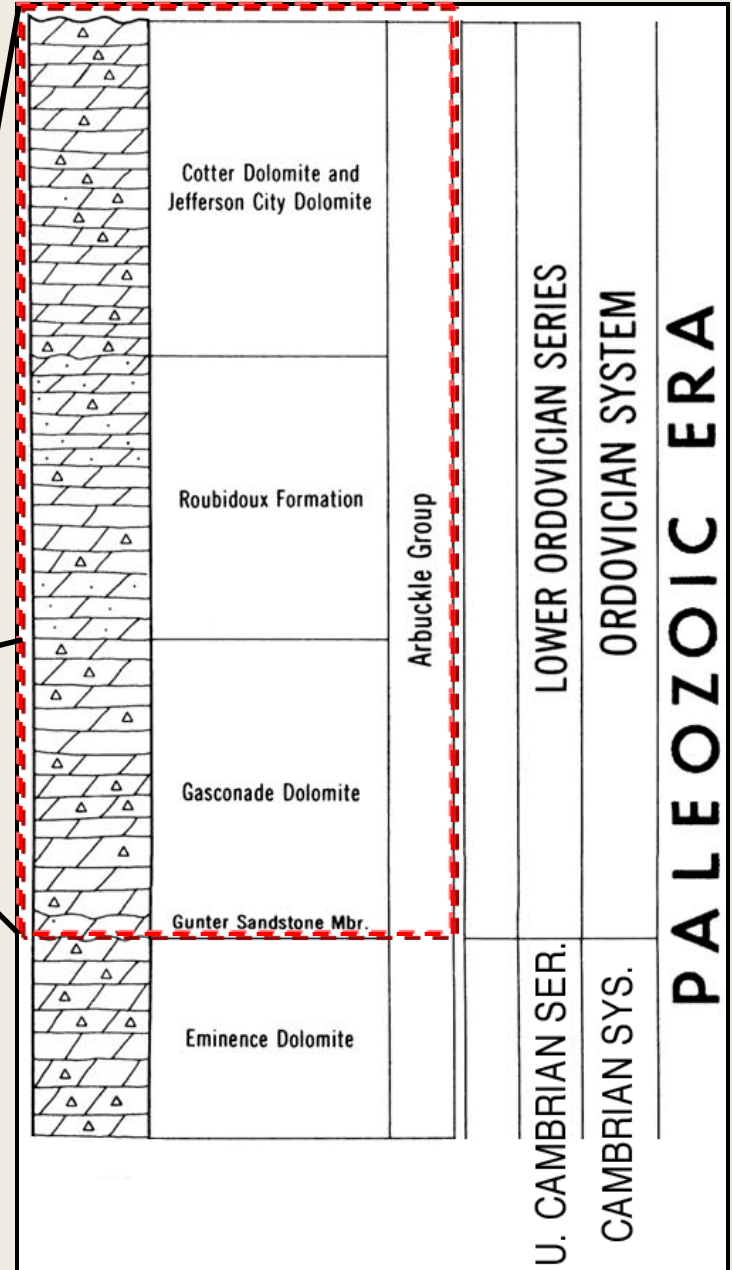
# Dissolution of CO<sub>2</sub> in Brine

## Convection Cycle Increases Entrapment



-- Convection included in simulators

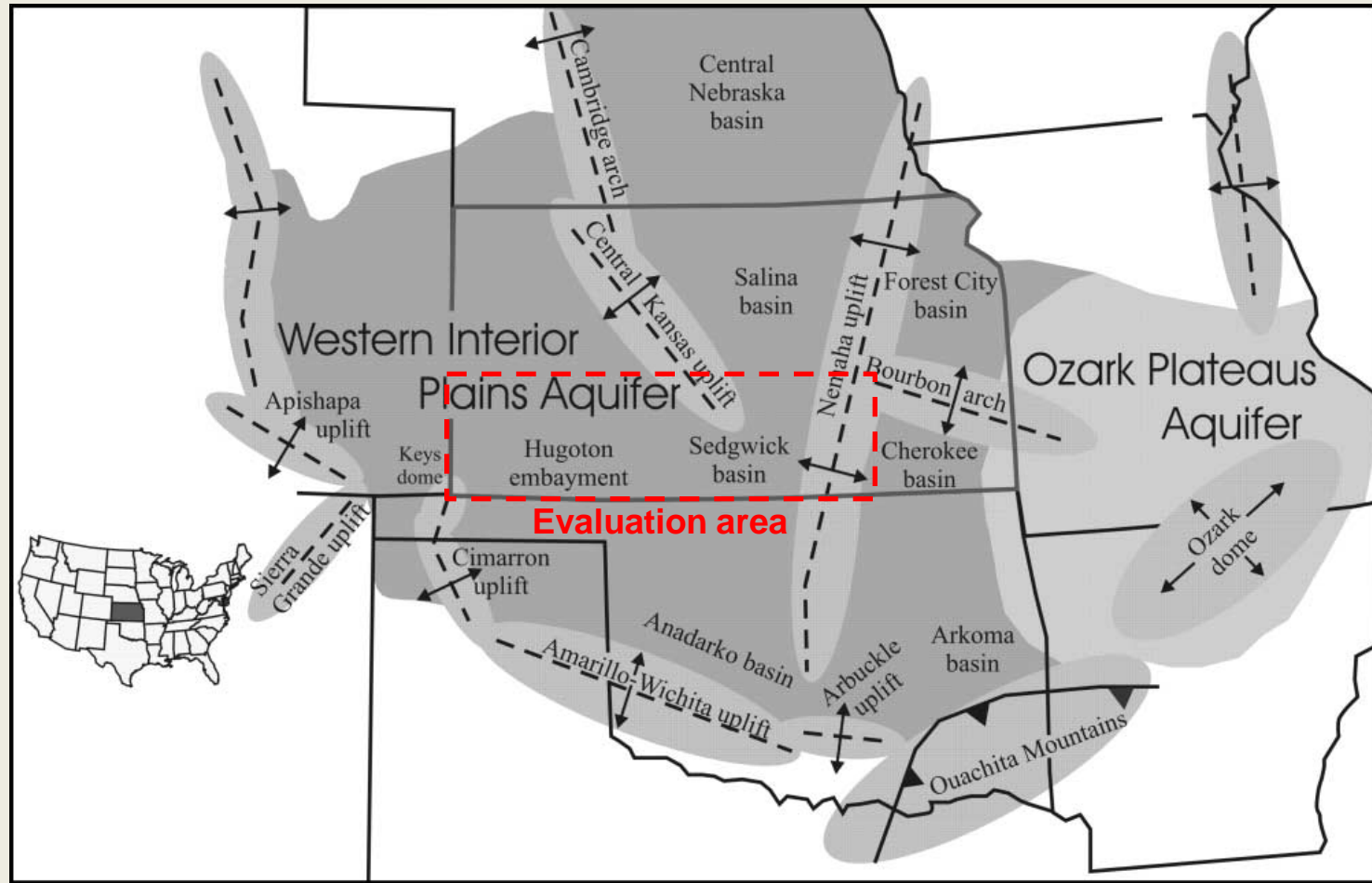
## Lower Ordovician Arbuckle Group



<http://www.kgs.ku.edu/stratigraphic/PROFILE/>



# Structural features and Paleozoic aquifer systems of the mid-continent

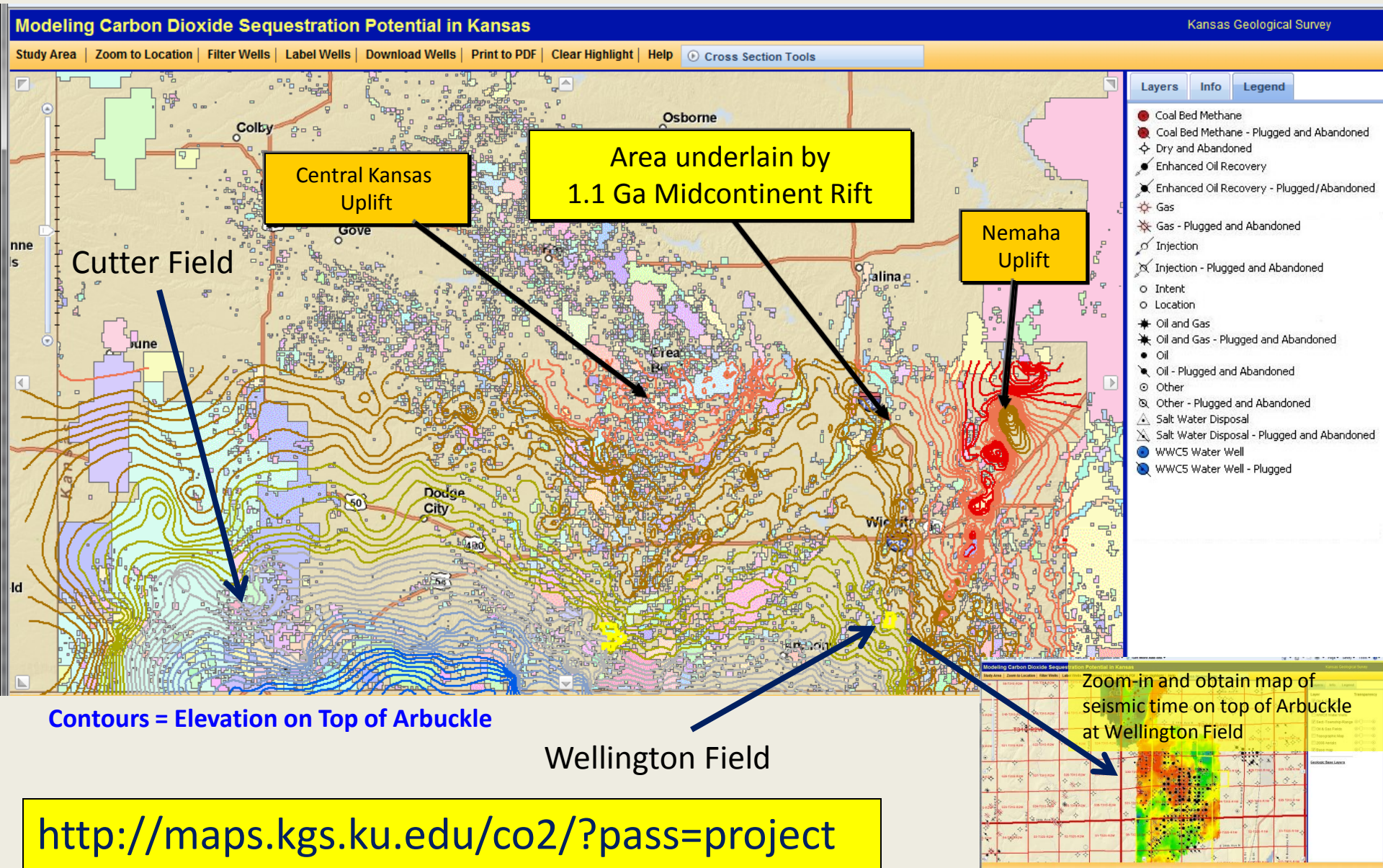


modified from Merriam, 1963; from Jorgensen et al. (1993).

Carr et al., AAPG Bulletin, v. 89, no. 12 (December 2005), pp. 1607–1627

# Web-based Interactive DOE-CO2 Project Mapper

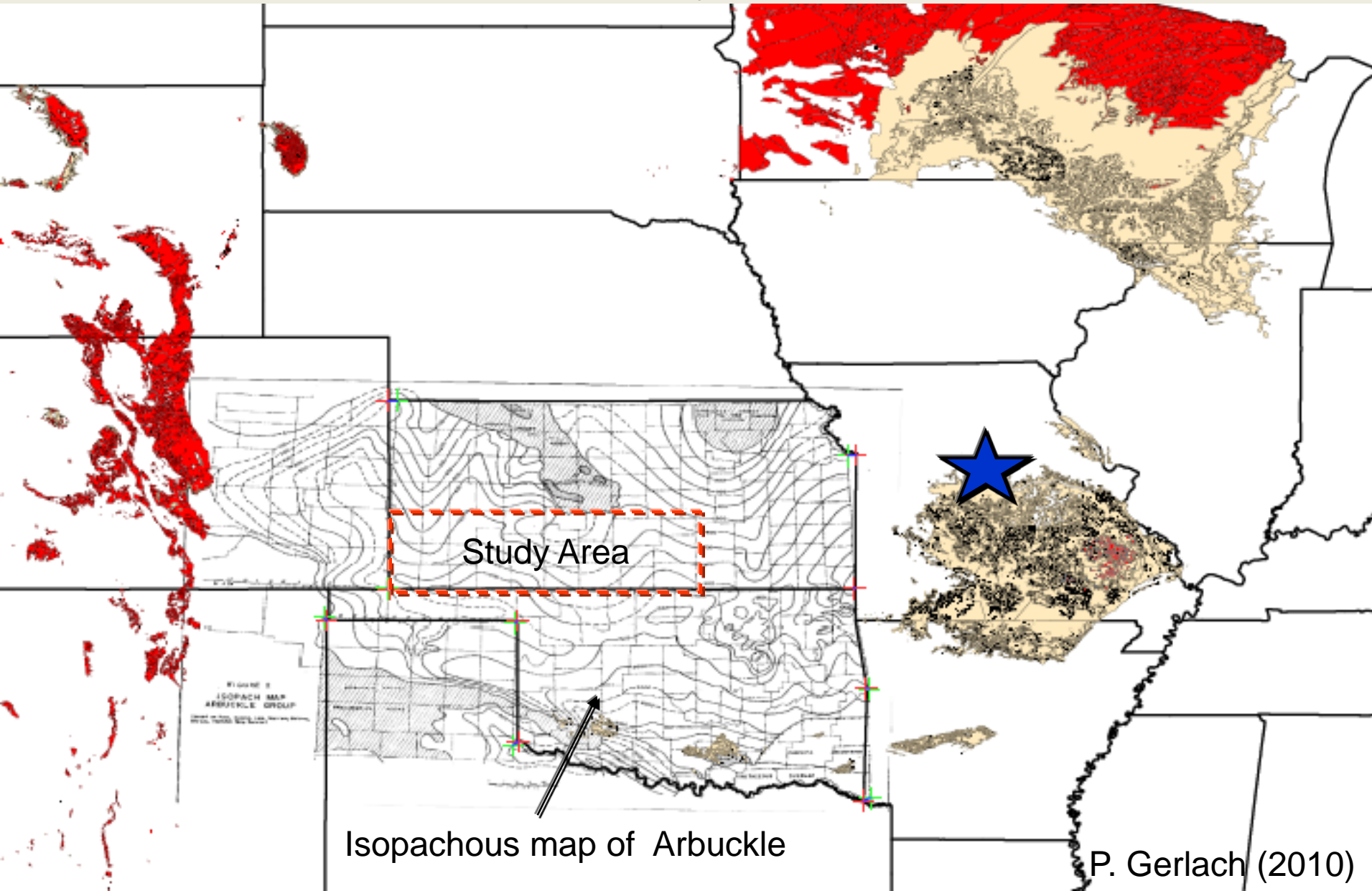
Overlay of Oil and gas field outlines and  
Top Arbuckle Group in study area of southern Kansas





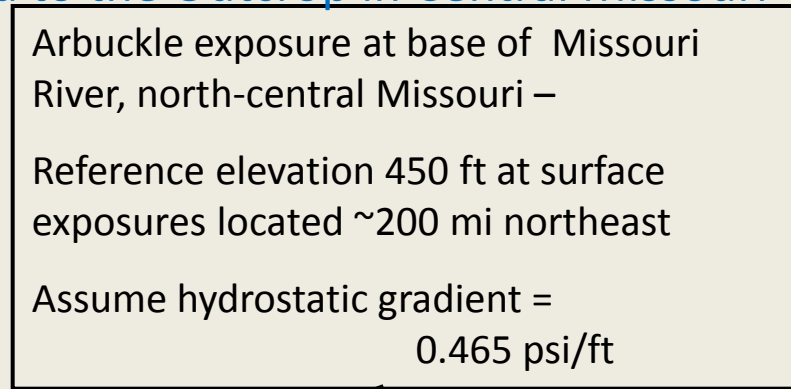
# Outcrops of Arbuckle Strata and Isopachous Map of Arbuckle

lowest elevation of surface exposures on west flank of Ozark Uplift along Missouri River at Jefferson City, Missouri (~450 ft)





## Arbuckle Saline Aquifer Is Inferred to be Connected to the Outcrop in Central Missouri



KE FI HG PN ED RN SG BU KM SV SW ME CA CM BA HI SU CL

KGS Cutter #1

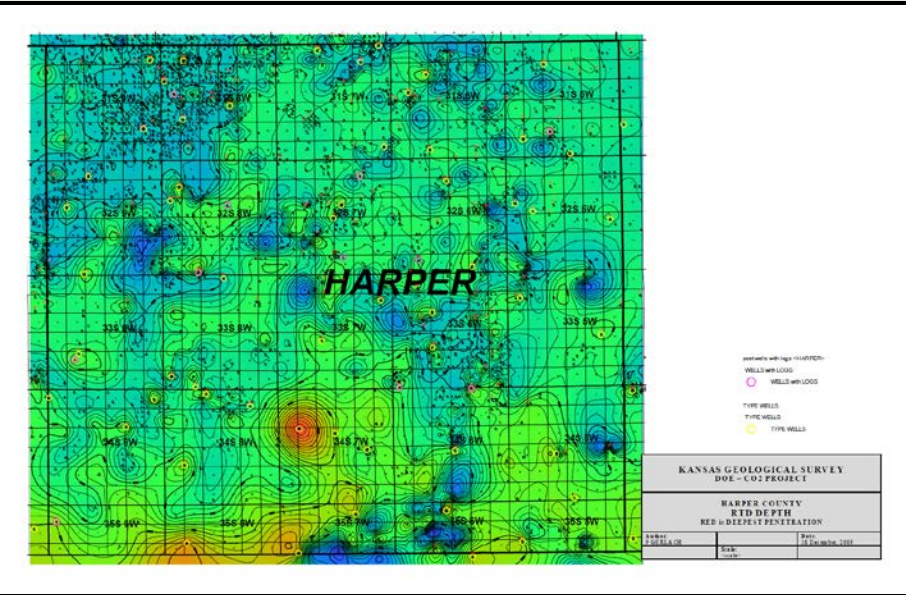
Wellington KGS #1-32 & #1-28

Sumner Co.

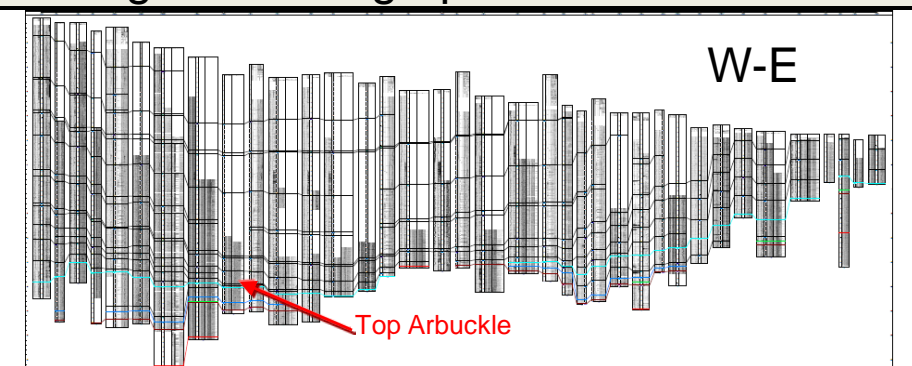
50 mi

Bittersweet team 2010

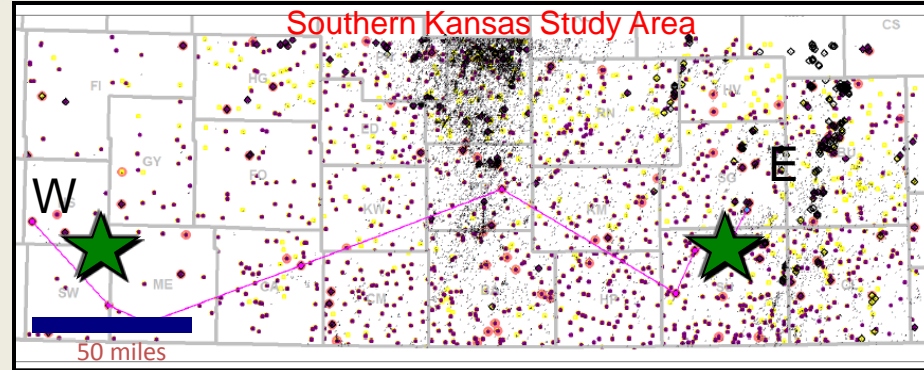
# Selection and Correlation of Digital Type Wells for DOE-CO2 project



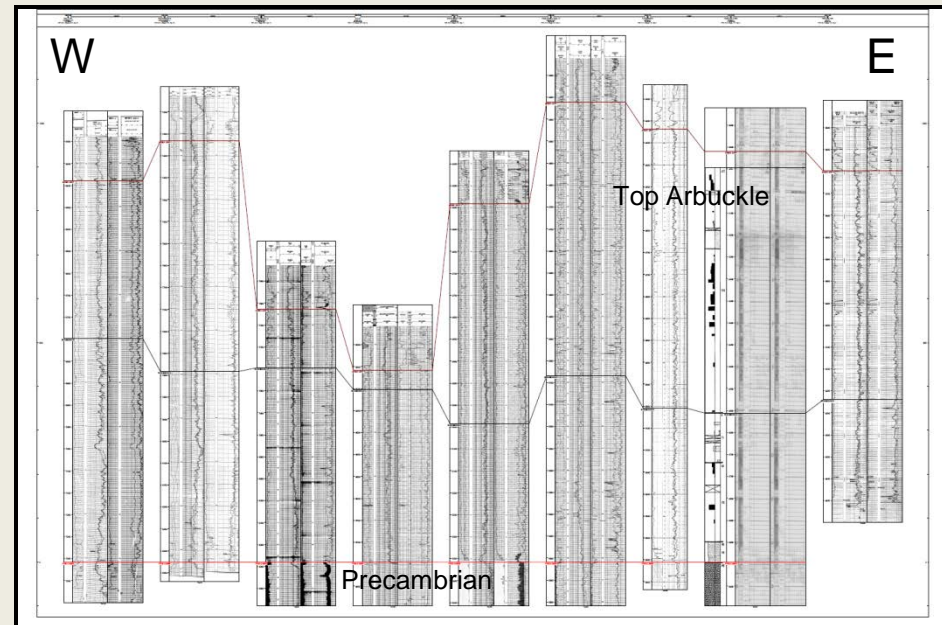
Regional stratigraphic correlation



Bittersweet team (Gerlach, Nicholson, Hansen)

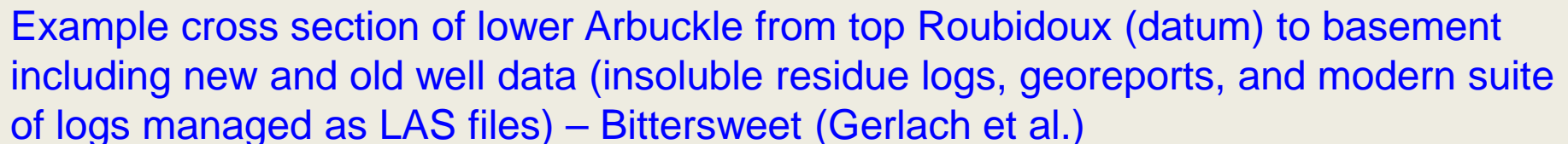


Internal Arbuckle correlations of hydrostratigraphic units and petrophysical properties with digital (LAS) logs



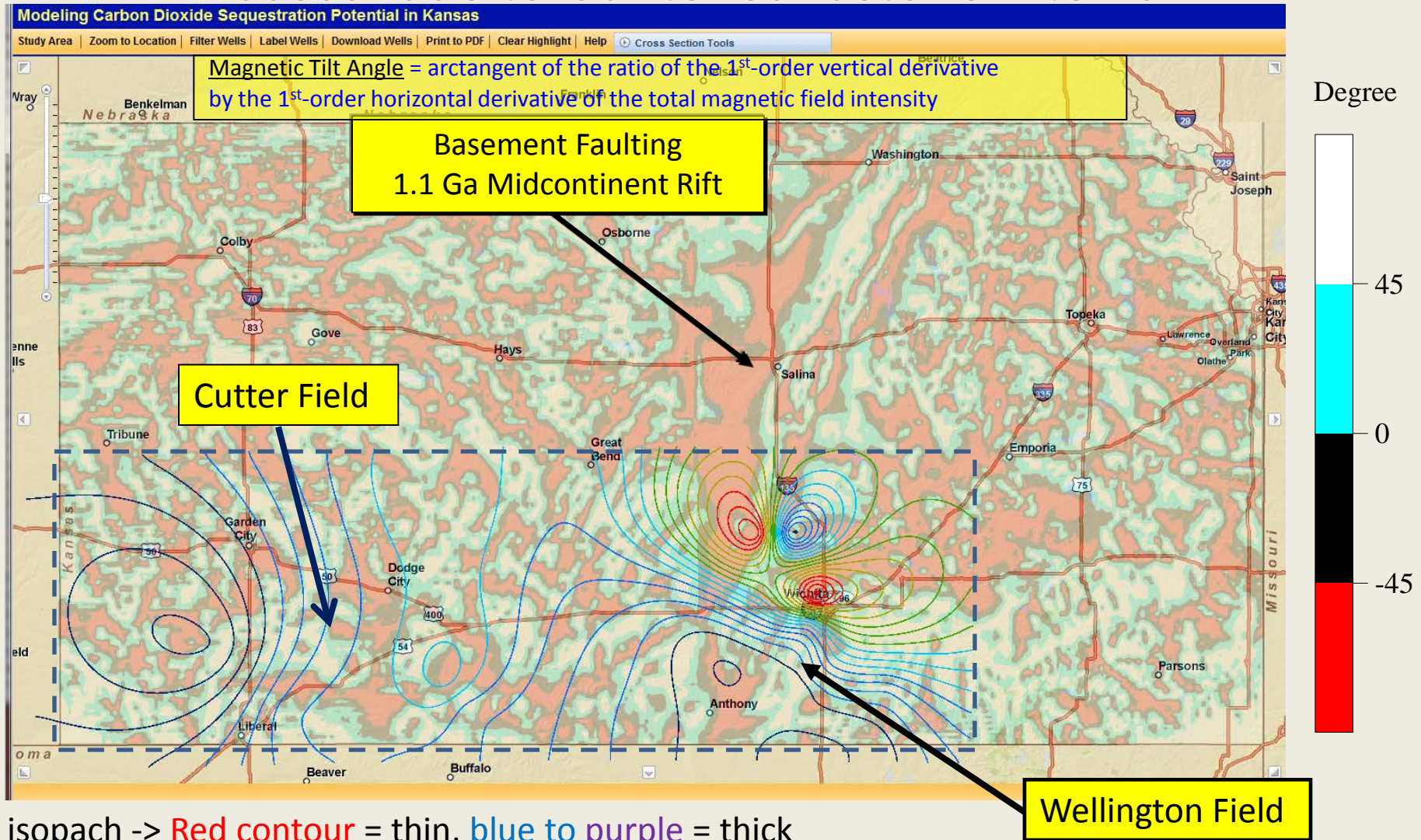


## Internal Arbuckle Stratigraphy





# Tilt angle map of the total magnetic field intensity in Kansas overlay with isopachous contours of Gasconade to Gunter Sandstone interval

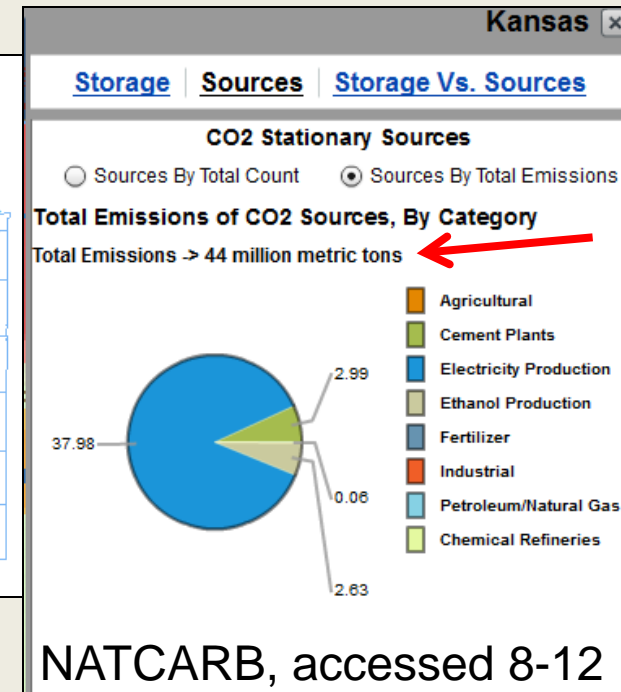
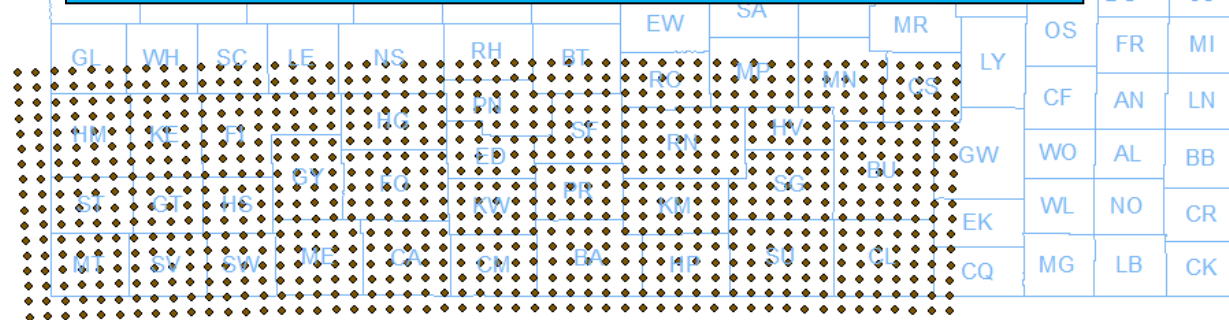


# Initial CO<sub>2</sub> Storage Capacity Estimate

*Deep Arbuckle Saline Formation (reported April 2011 for NATCARB)*

$$G_{CO_2} = A_t h_g \varnothing_{tot} \rho E_{saline}$$

**9-75 billion metric tons in Arbuckle only**  
(200+ years for all KS stationary CO<sub>2</sub> emissions)



**Metric tons CO<sub>2</sub>**  
**per Grid Cell**  
**10 km<sup>2</sup>**  
**(3.8 mi<sup>2</sup>)**

Each grid cell is 10K (+/-)

P10	Total All Cells
8,781,380,535	
22,214,247	High Cell
10,287,863	Median Cell
10,554,544	Mean Cell

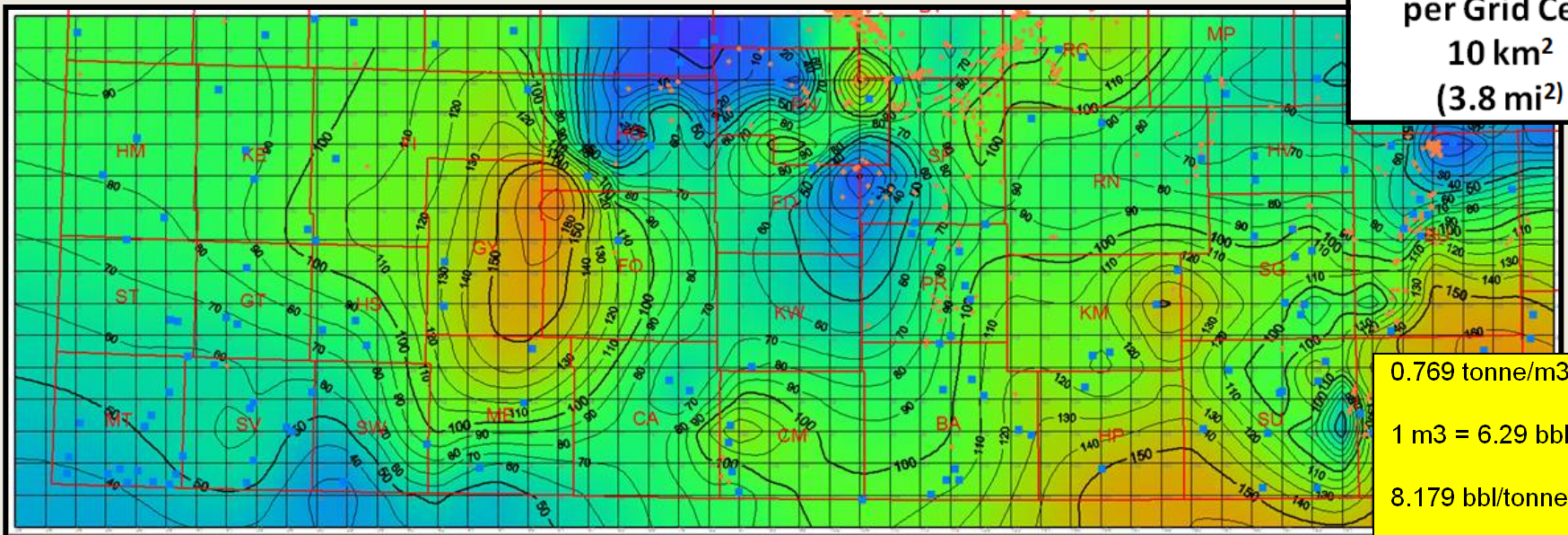
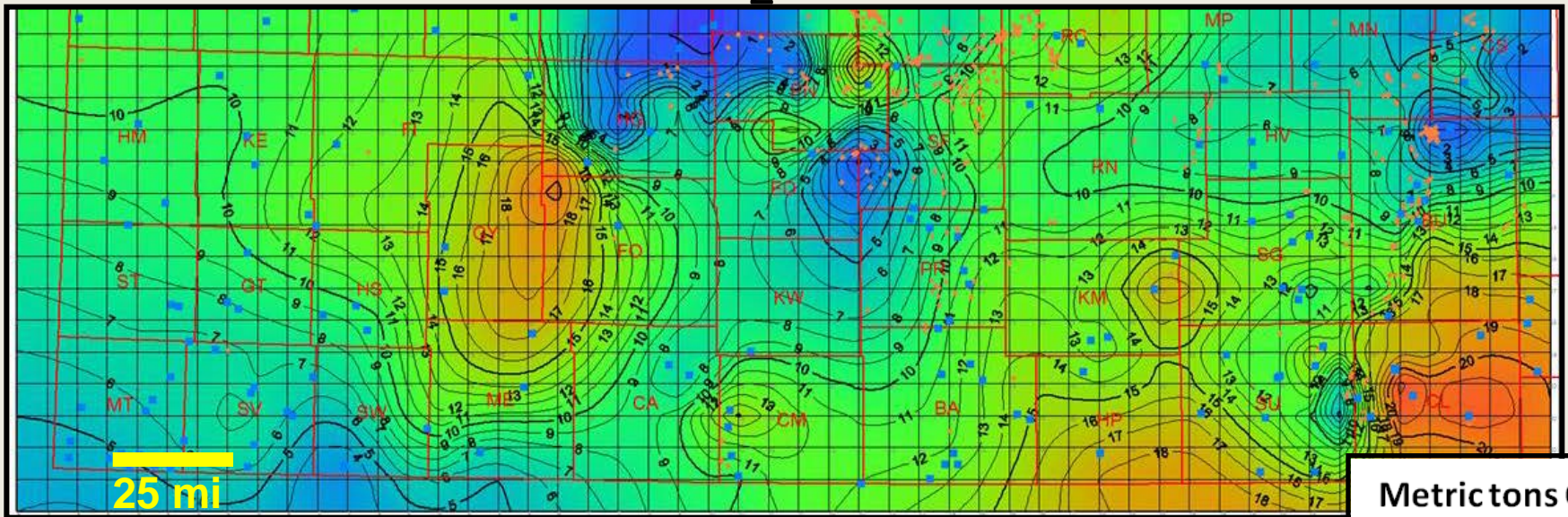
P90	Total All Cells
75,464,988,970	
190,903,682	High Cell
88,411,323	Median Cell
90,703,112	Mean Cell

**Gerlach and Bittersweet team, 2012**





# P10 (top) and P90 (bottom) Storage Volume CO<sub>2</sub> (million metric tons)



Metric tons CO<sub>2</sub>  
per Grid Cell  
10 km<sup>2</sup>  
(3.8 mi<sup>2</sup>)

0.769 tonne/m<sup>3</sup>

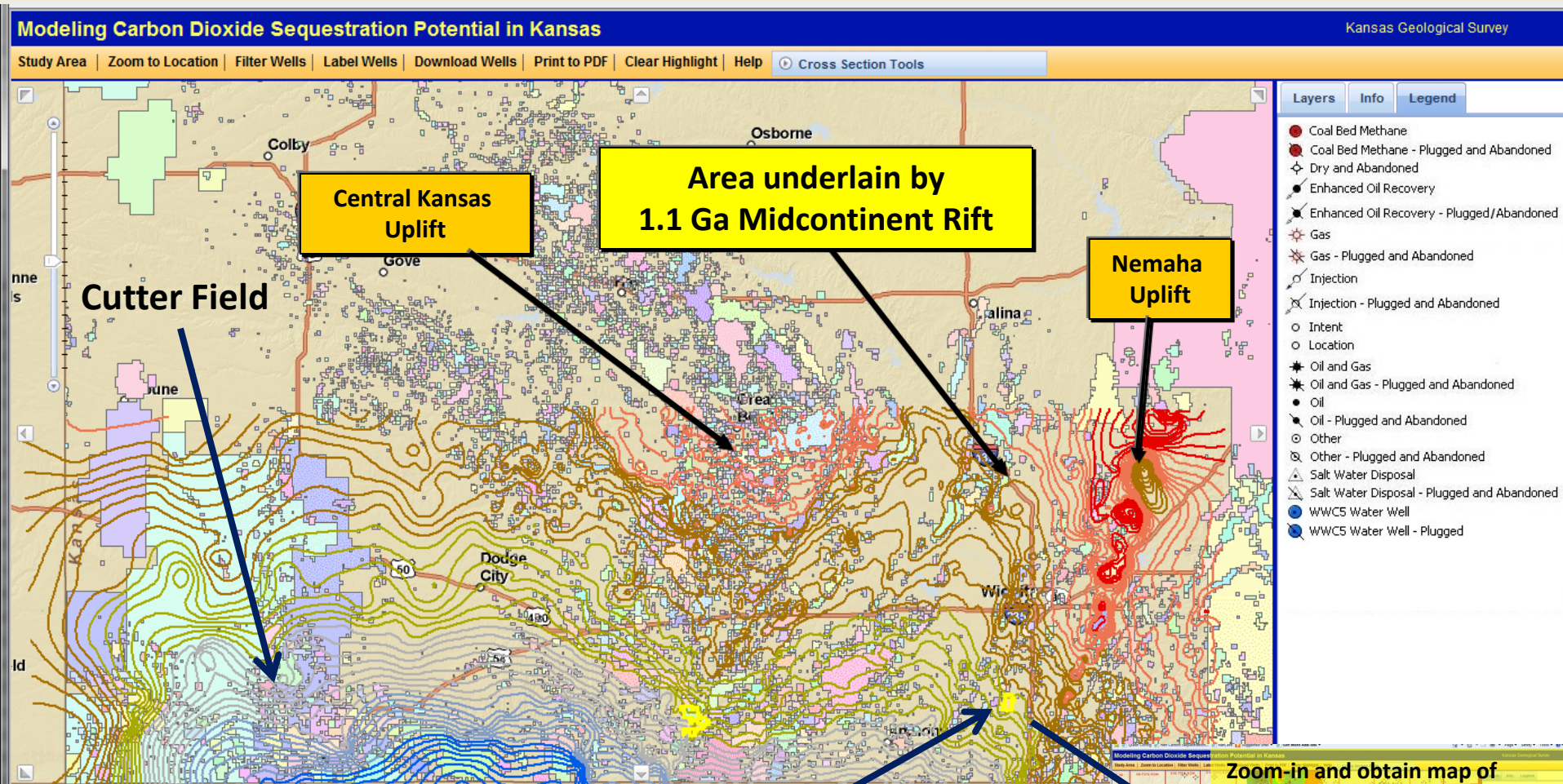
1 m<sup>3</sup> = 6.29 bbls

8.179 bbl/tonne CO<sub>2</sub>



# Web-based Interactive DOE-CO2 Project Mapper

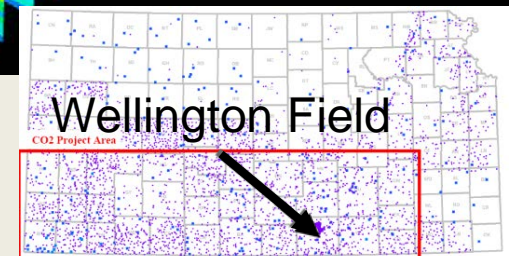
Overlay of Oil and gas field outlines and  
Top Arbuckle Group in study area of southern Kansas



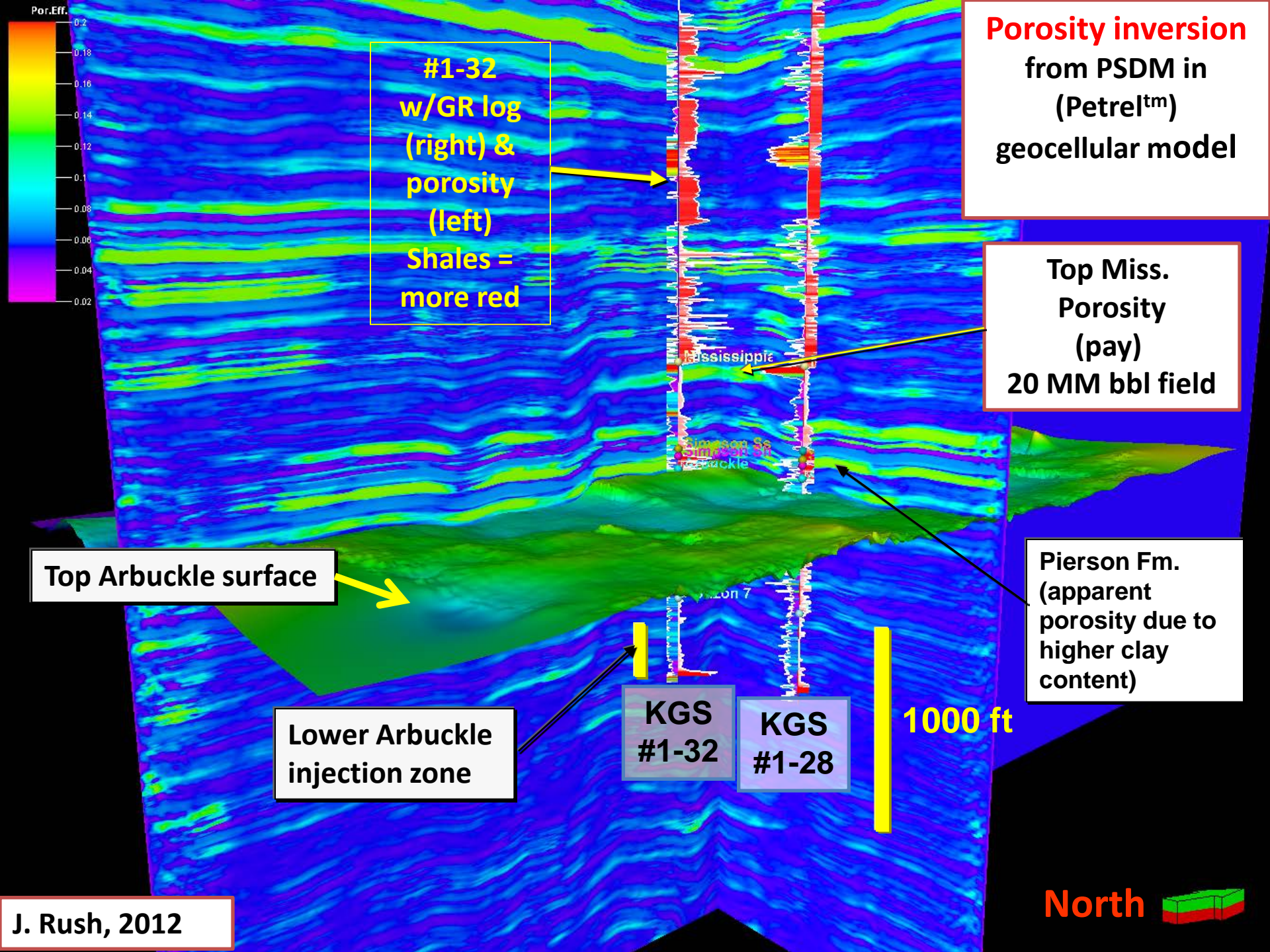
Contours = Elevation on Top of Arbuckle

<http://maps.kgs.ku.edu/co2/?pass=project>

# Mississippian siliceous dolomite reservoir & Arbuckle aquifer saline aquifer



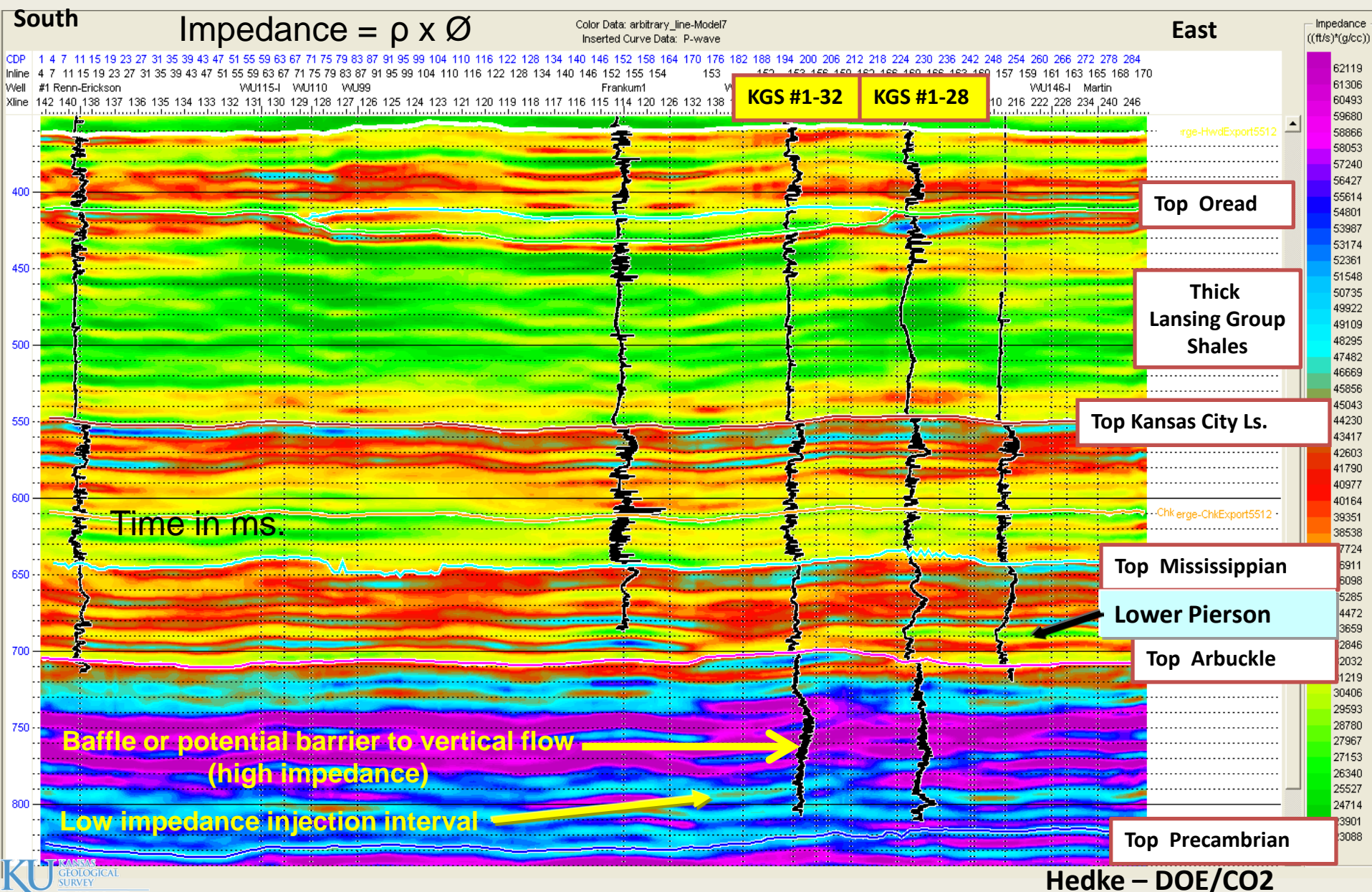






# Arbitrary seismic impedance profile – Wellington Field

distinct caprock, mid-Arbuckle tight, lower Arbuckle injection zone



## Wellington Field KGS #1-28 --- Synthetic seismogram and seismic impedance

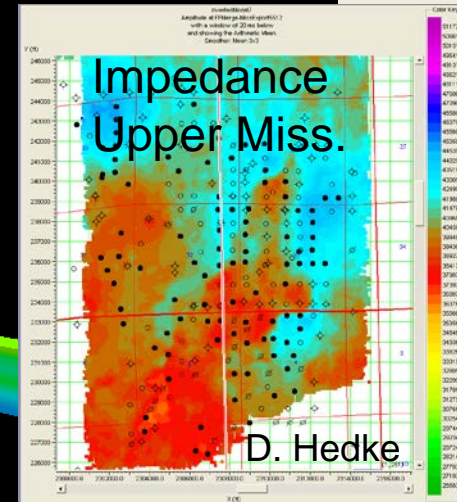
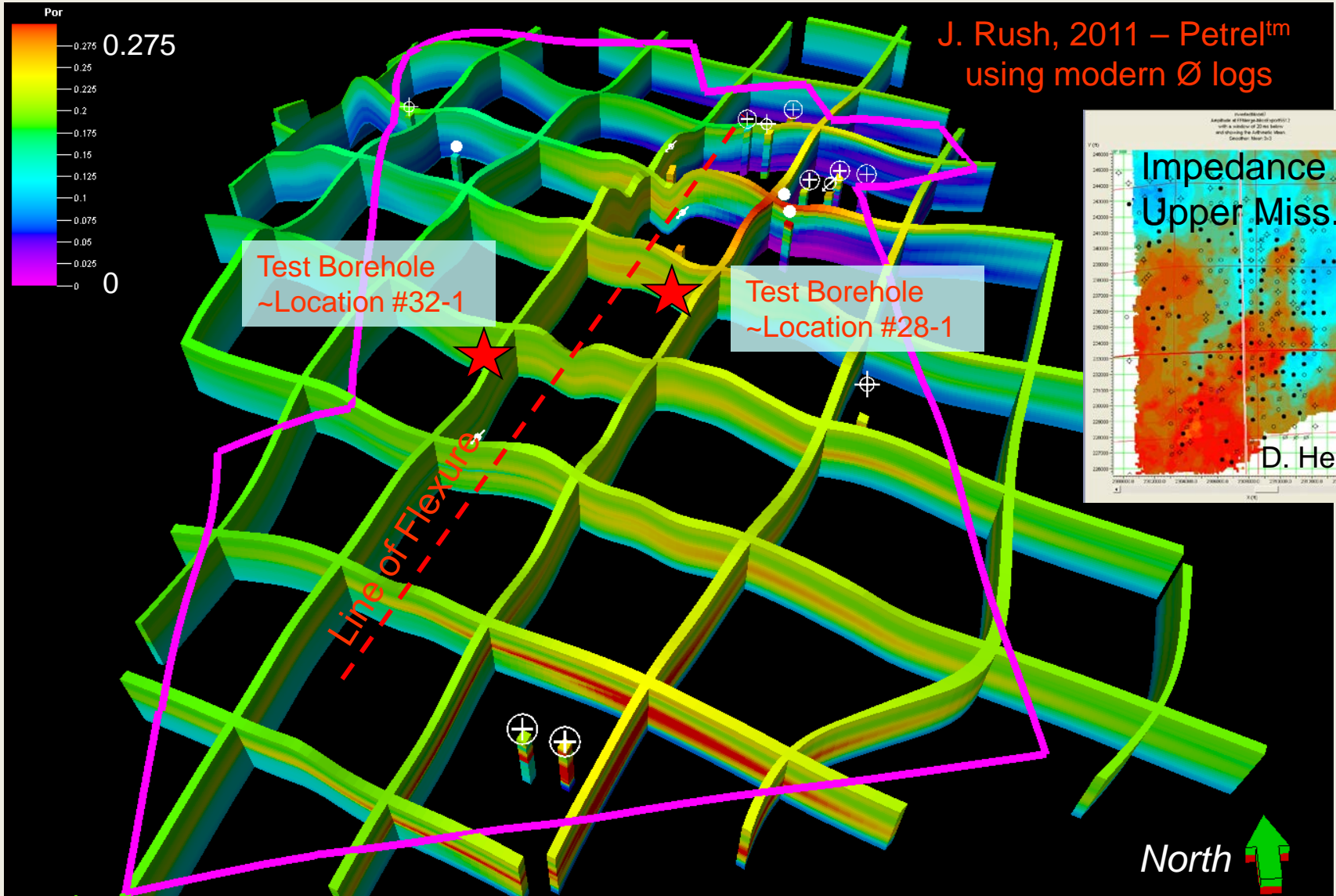


# Wellington Field – 30,000 metric ton CO<sub>2</sub> pilot for EOR

## Porosity Fence Diagram

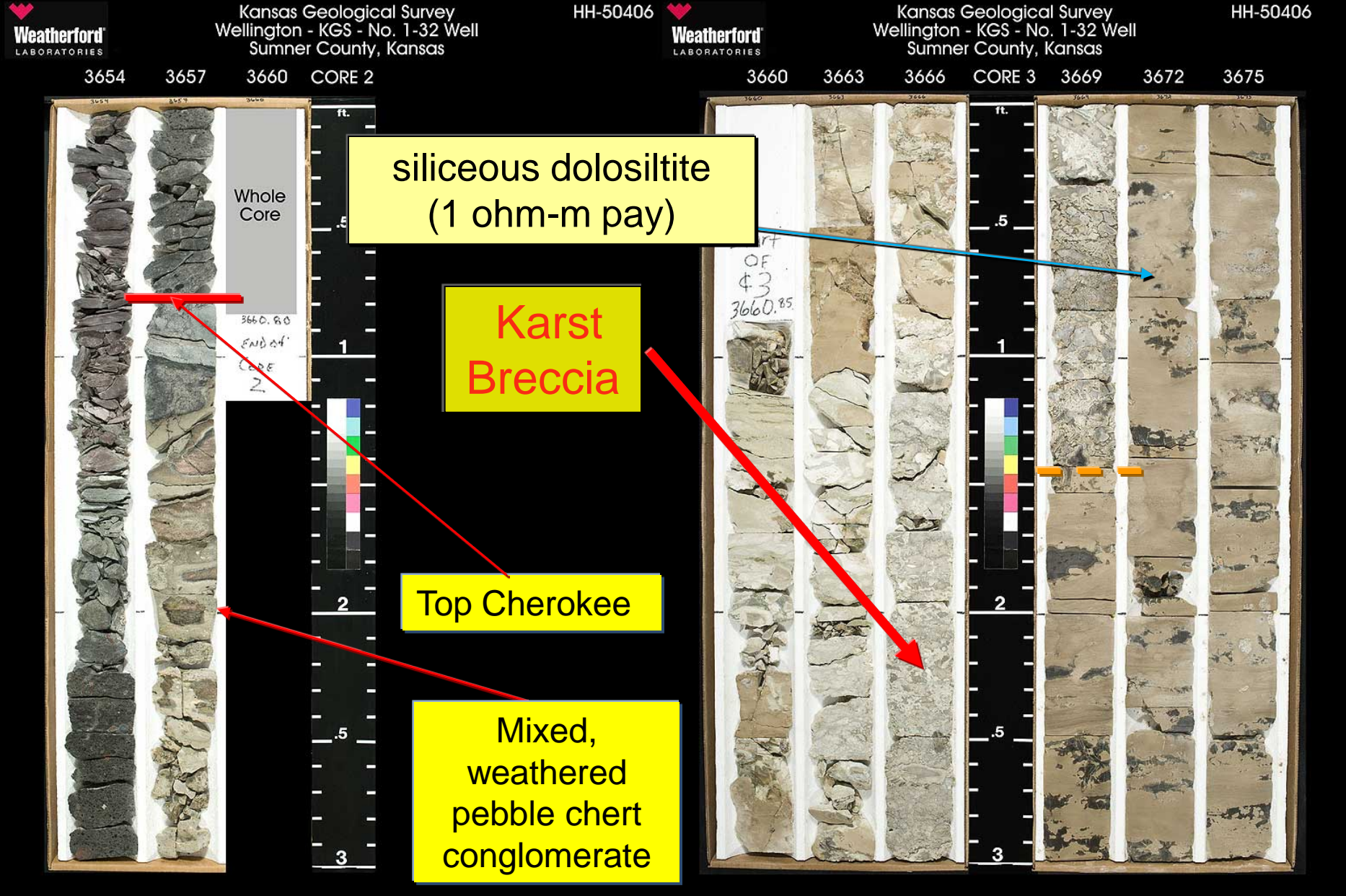
Pay zone at top of the Mississippian

Porosity



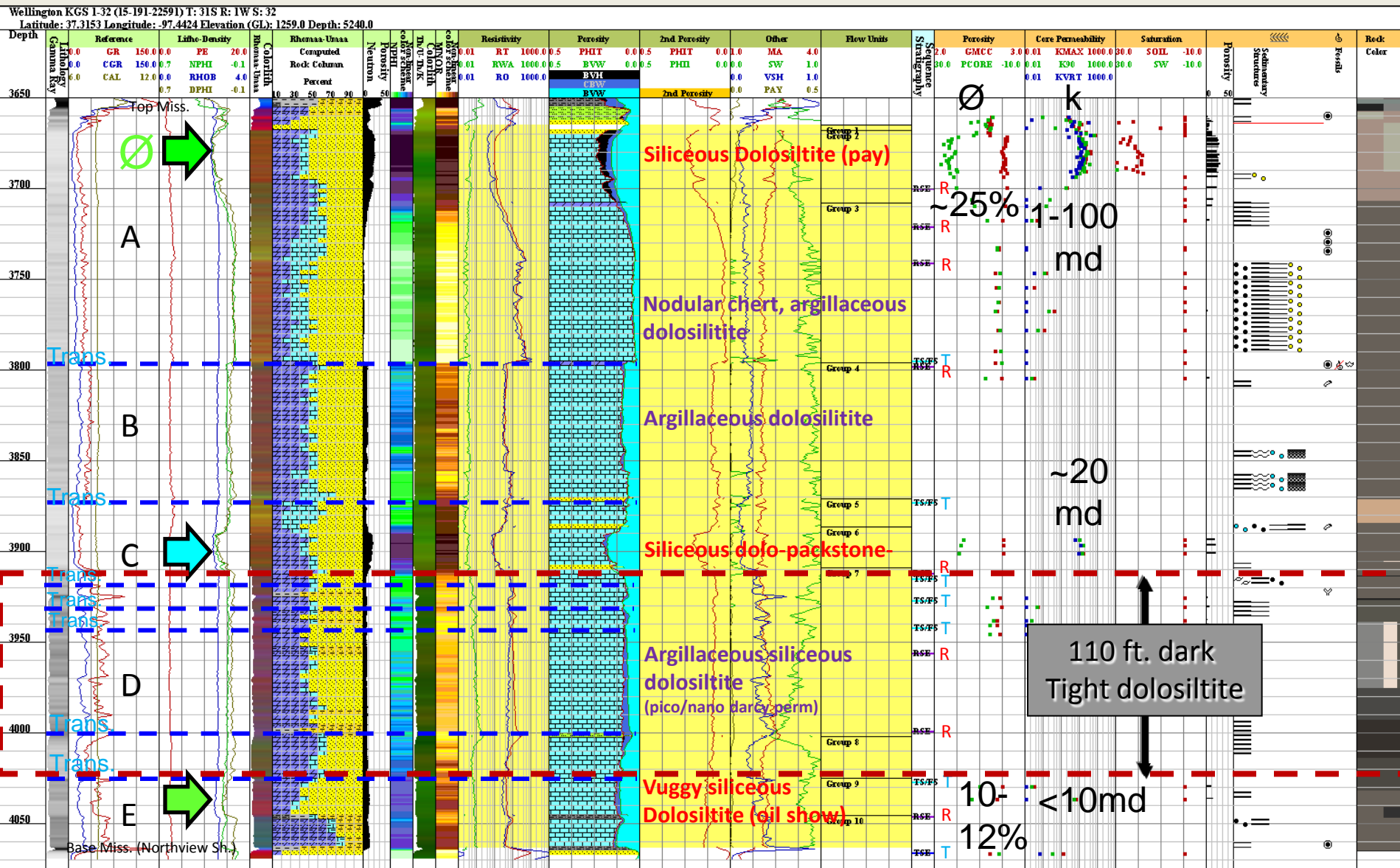


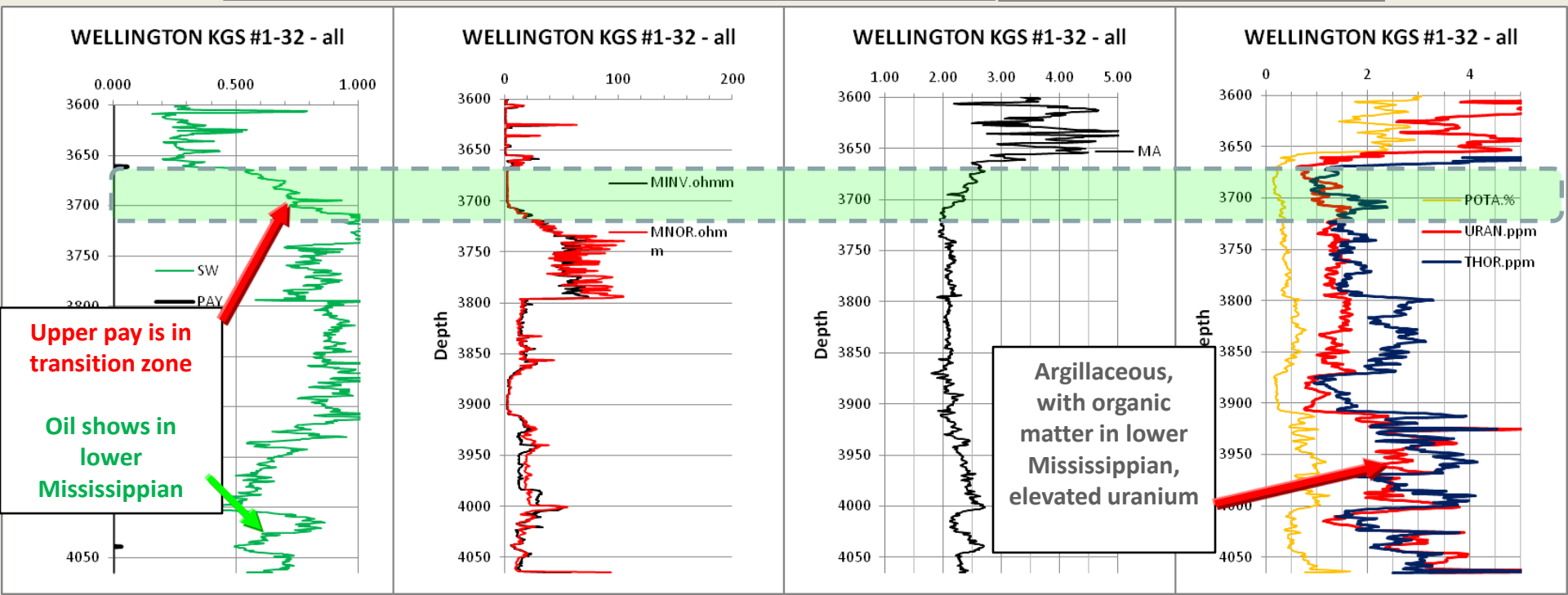
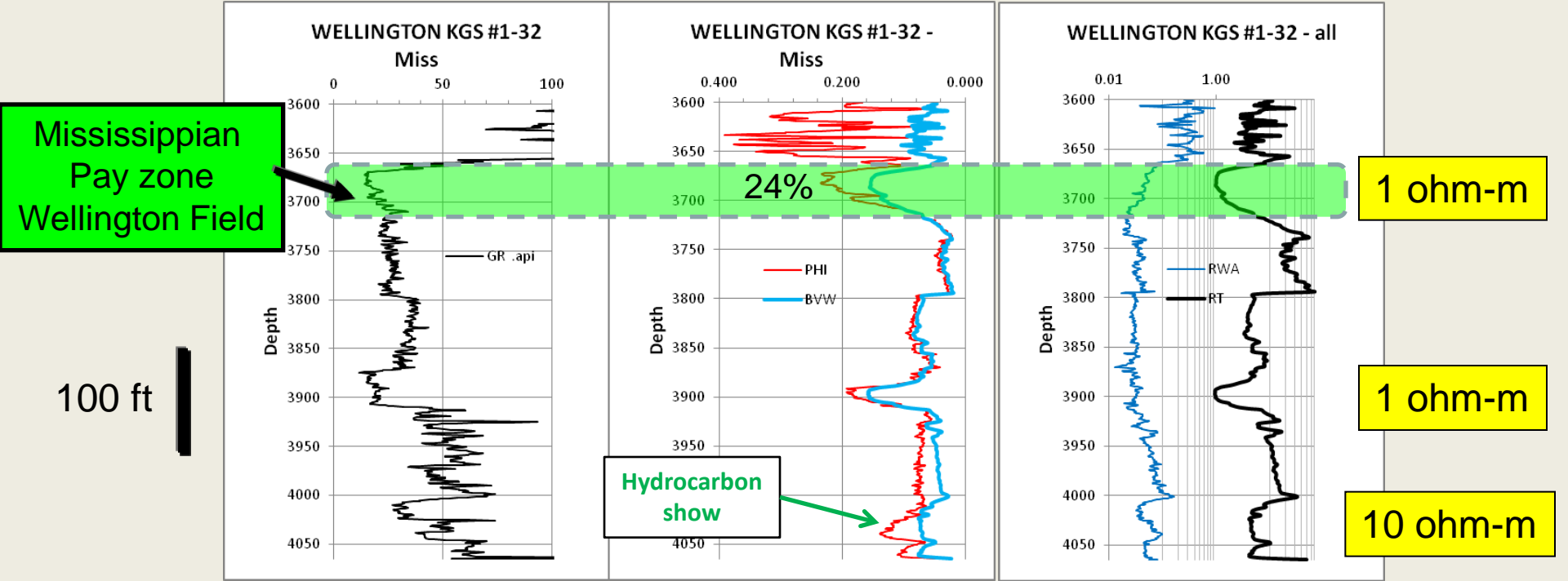
# Mississippian Pay Zone in Berexco Wellington KGS #1-32



# Cored Well, Berexco Wellington KGS #1-32

## Top Mississippian to Kinderhook Shale (410 ft)



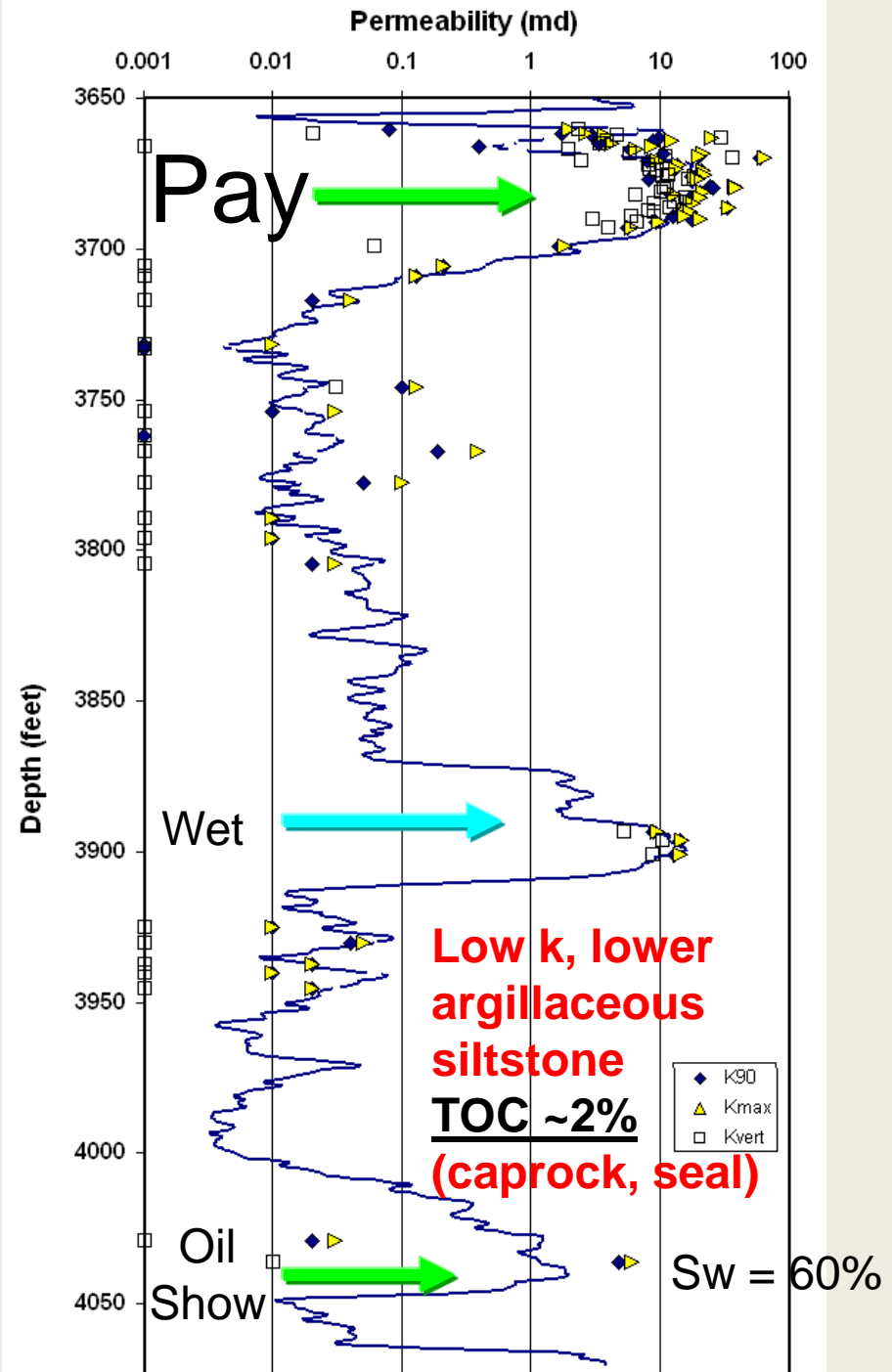




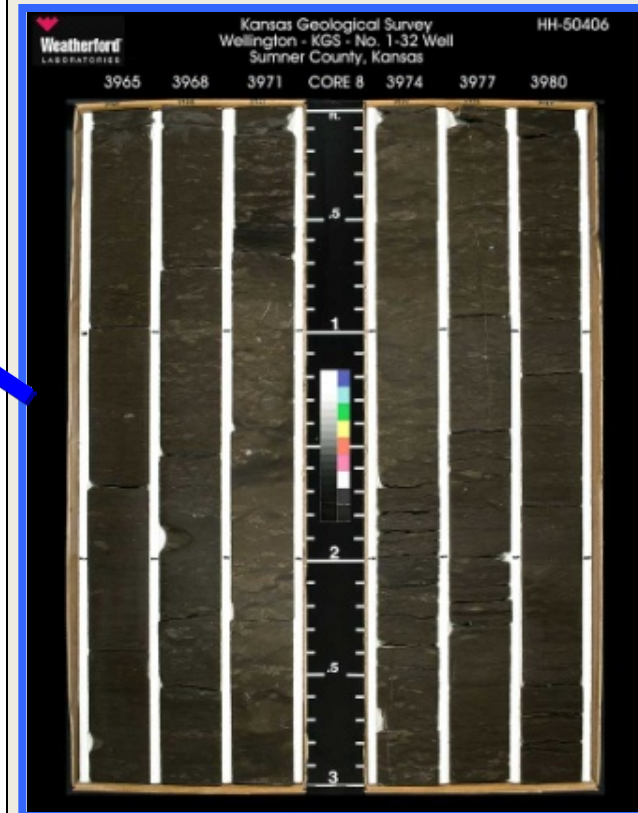
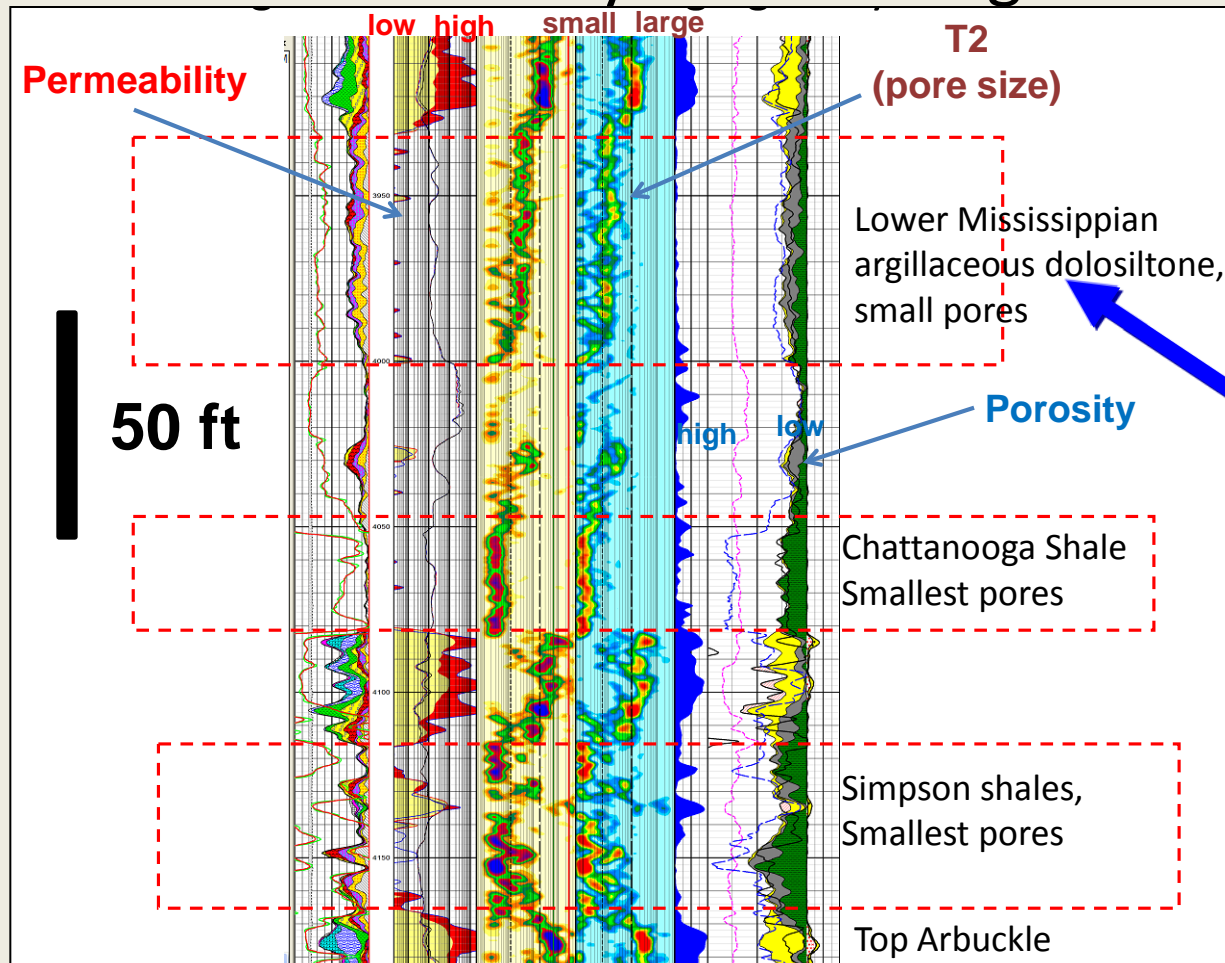
# Permeability profile entire Mississippian

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

Doveton & Fazelalavi, July 2012



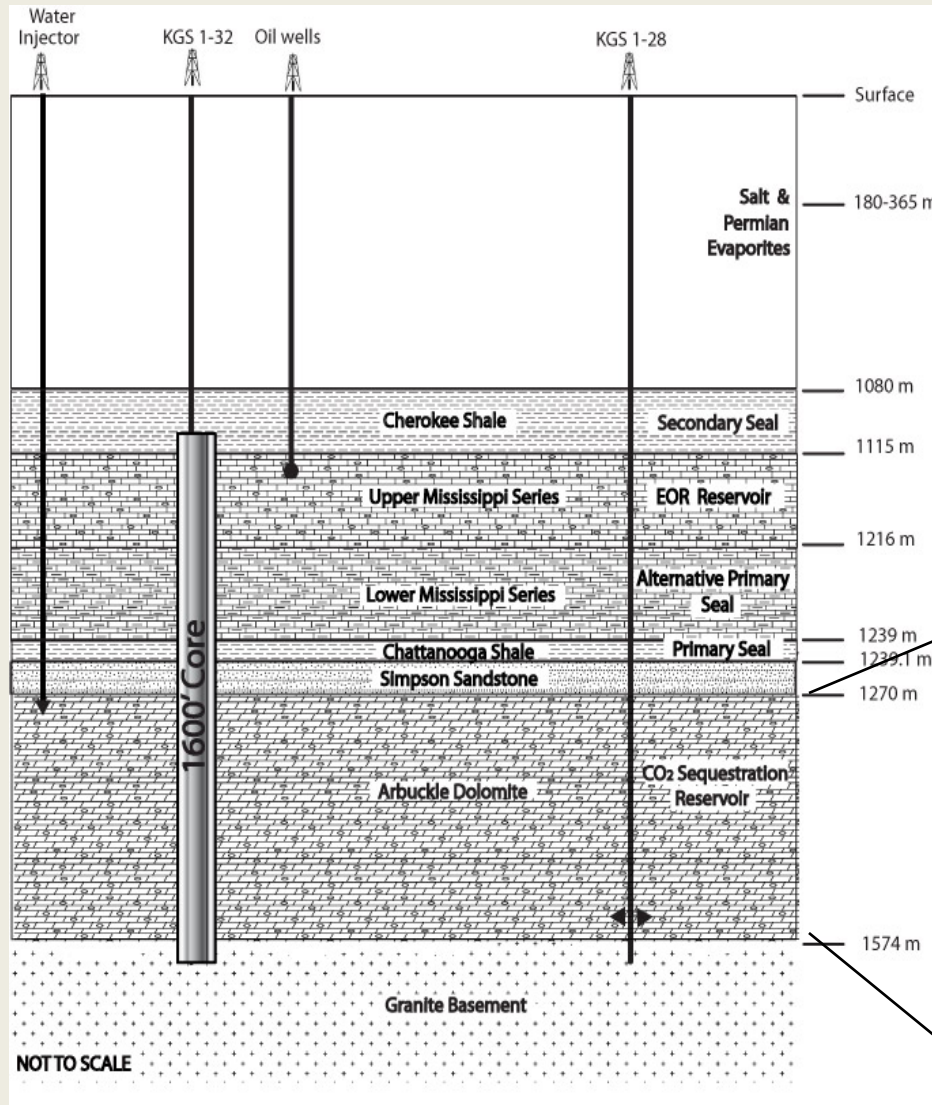
# 230 ft Gross Thickness of Primary Caprock above Arbuckle in KGS #1-28 (injection well) – illustrated by nuclear magnetic resonance log



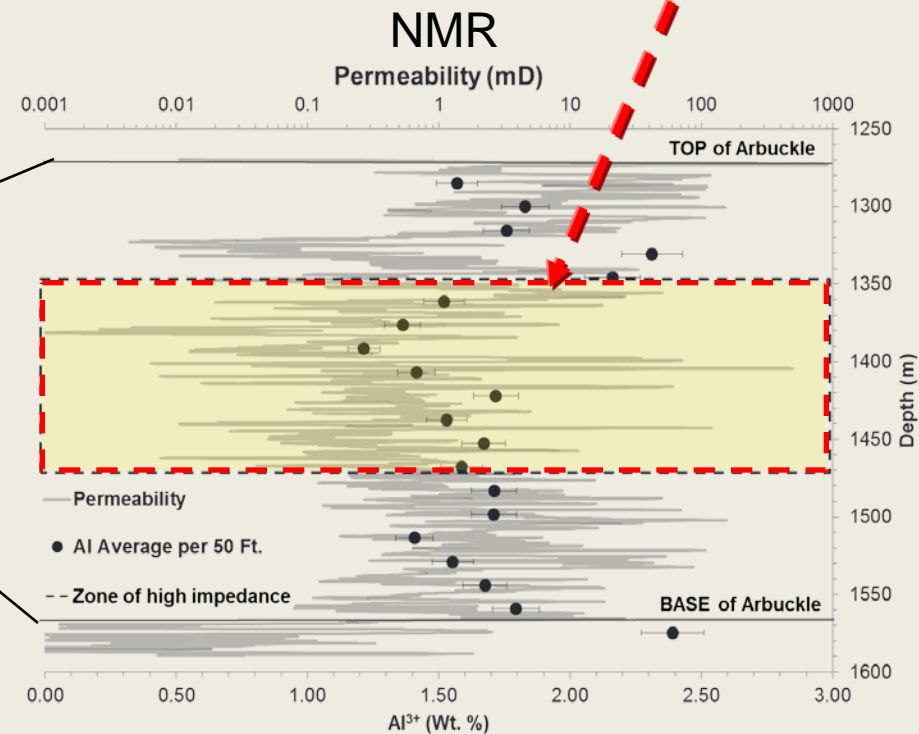
Caprock evidence:

- Micro-nano darcy perm
- Quiet fracture wise
- Organic matter 1%

# Mid-Arbuckle Flow Barrier KGS #1-32



- 400 ft of tighter rock
- Widespread high seismic impedance

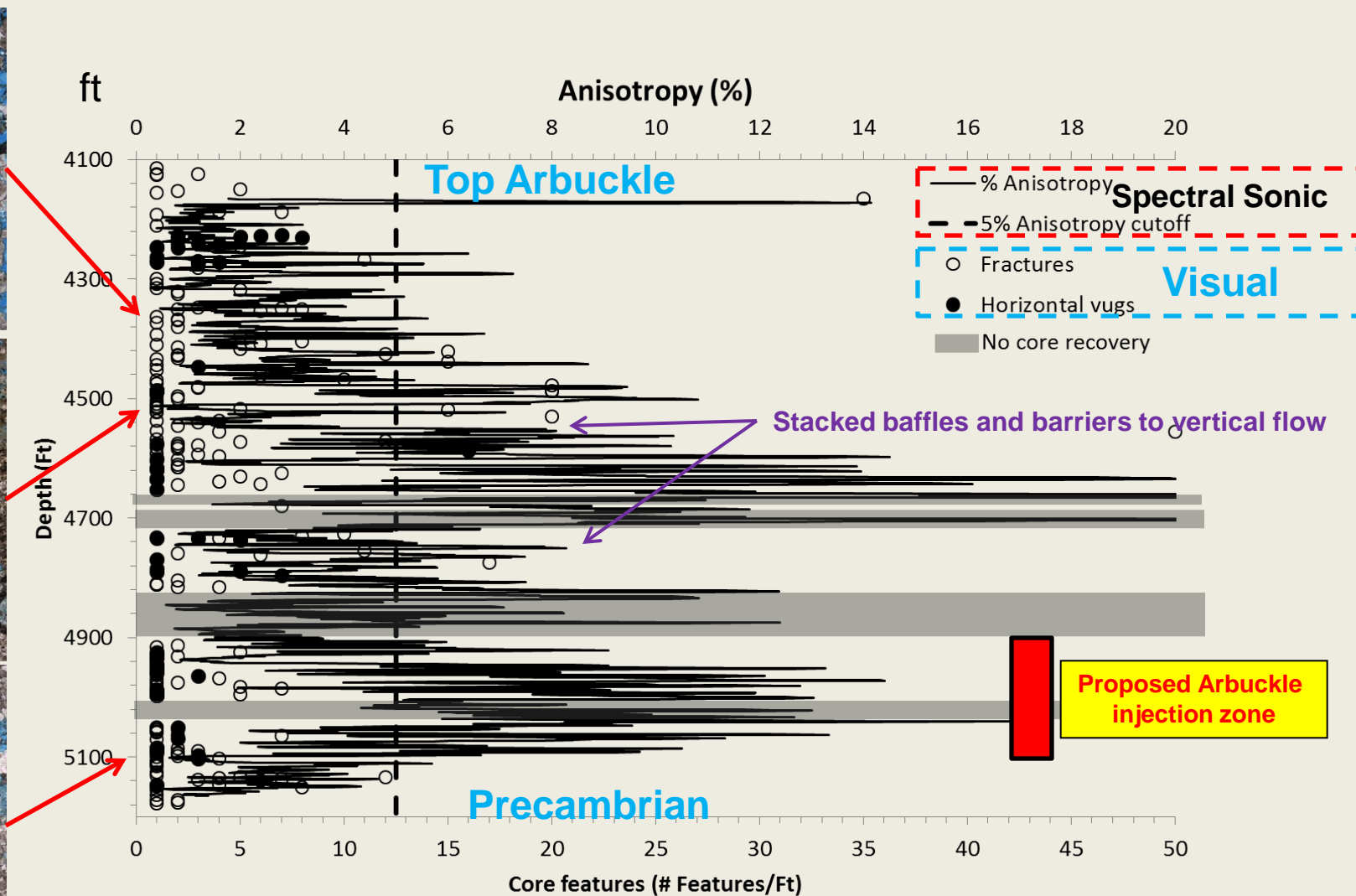


Scheffer, 2012



# Zonal Fracturing in Arbuckle, KGS #1-32

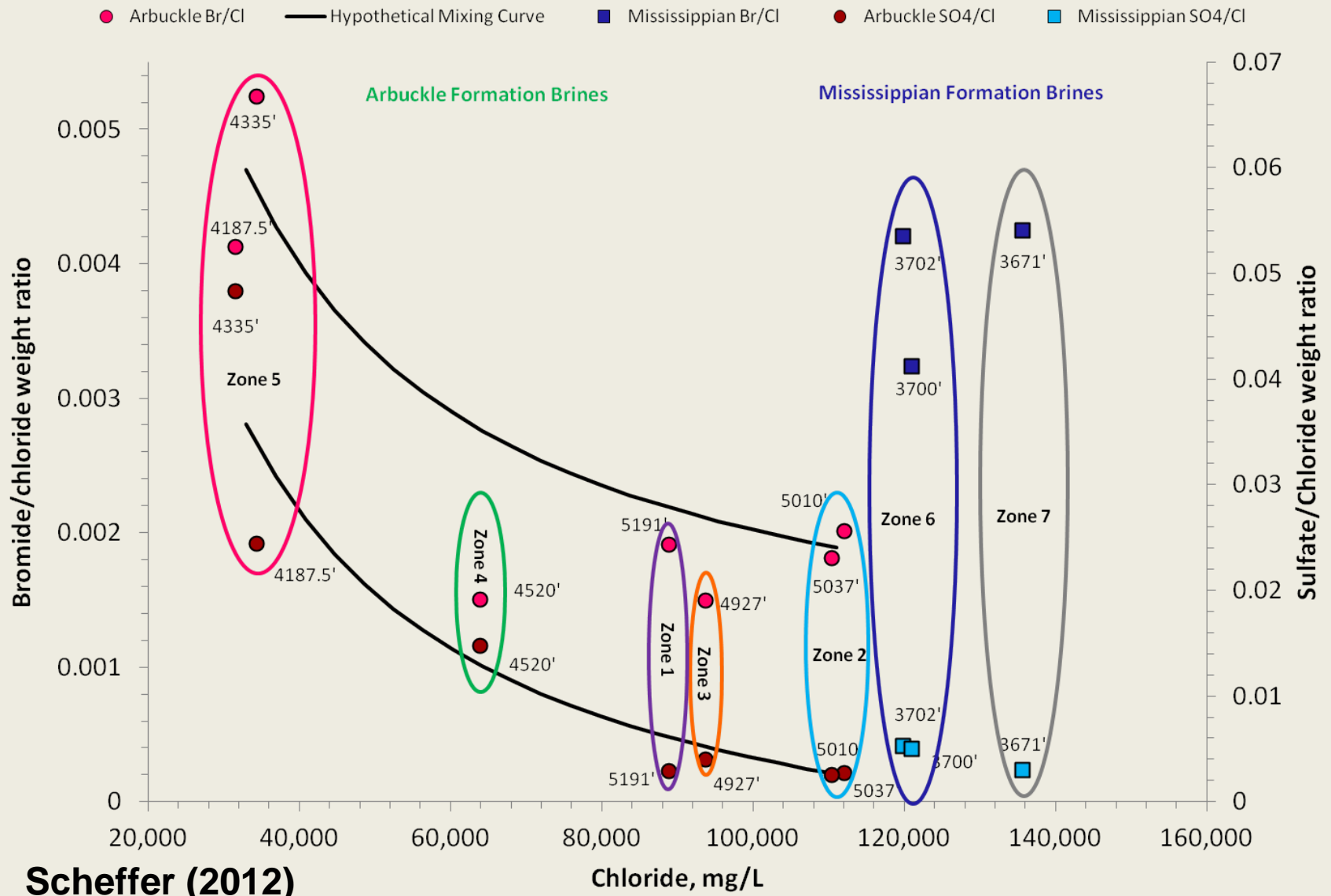
*Spectral acoustic log, core, microresistivity imaging*



# Arbuckle Hydrostratigraphy at Wellington Field

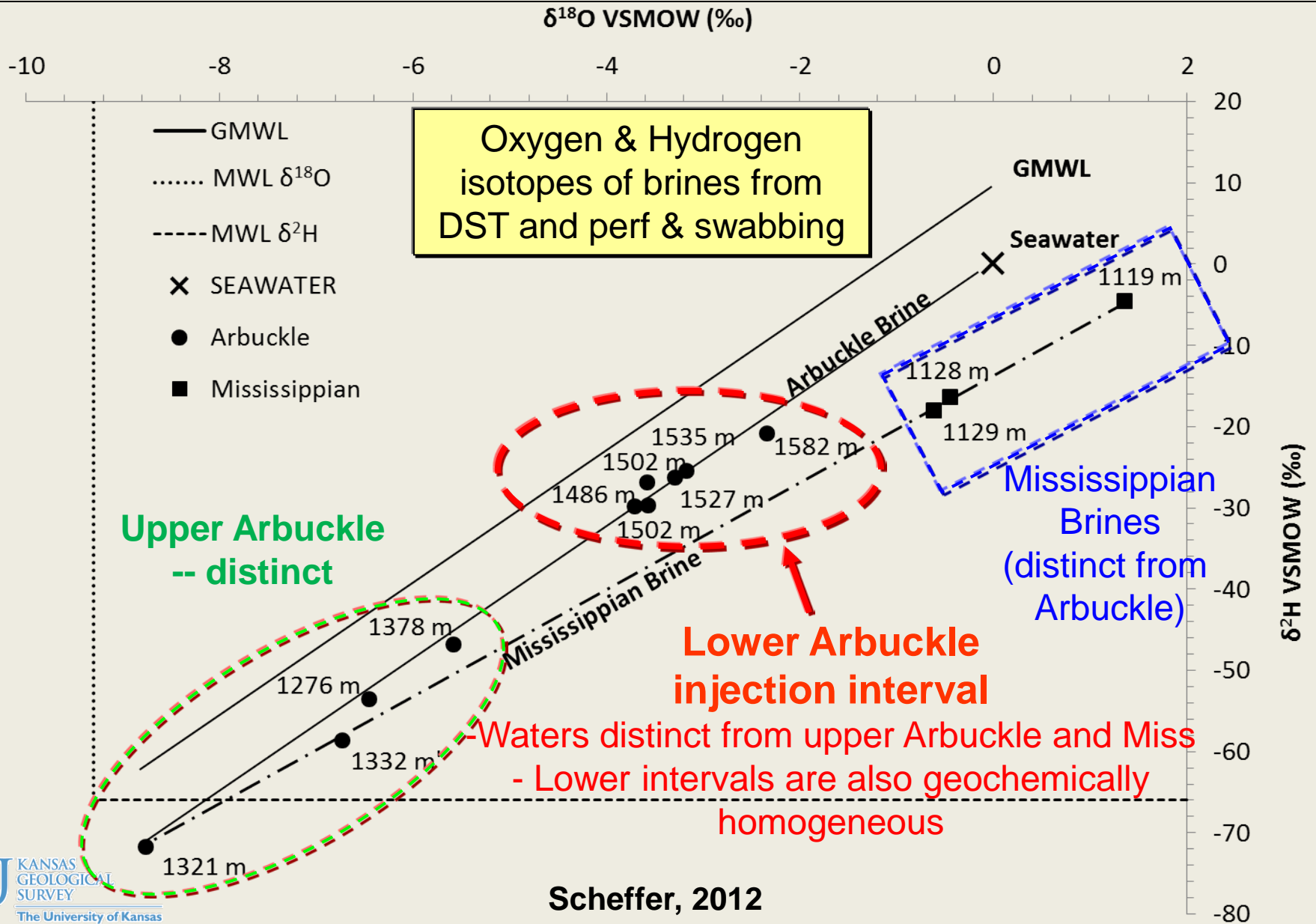
## *obtained from DST and perf & swab test*

### Zonation Evidence in Arbuckle and Mississippian Formation Brines





# Lower and Upper Arbuckle are Not in Hydraulic Communication



# Selected Core from Lower Arbuckle

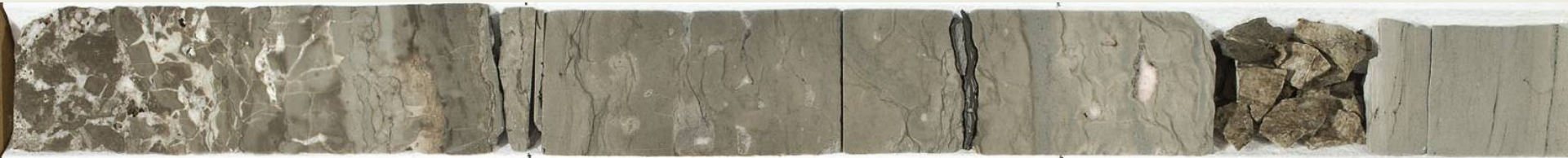
5089-92 ft

Proposed Injection Interval



5080-83

Vug and interparticle Ø



Crackle breccia w/ Ø

5053-56

Fracture Ø



4995-97.7 ft

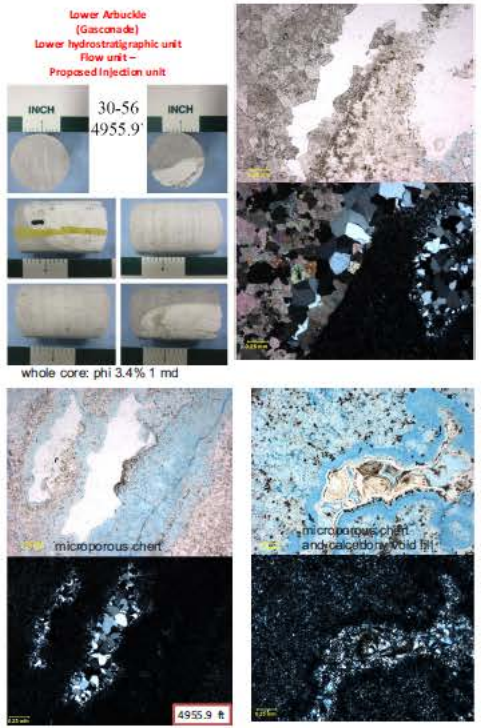
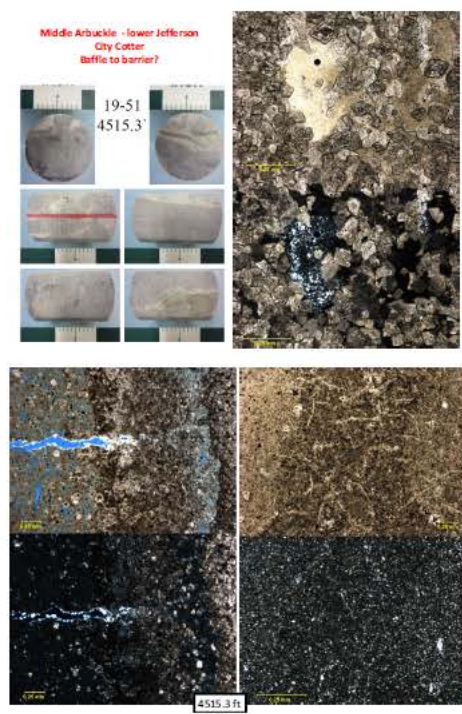


Vugs and interparticle Ø

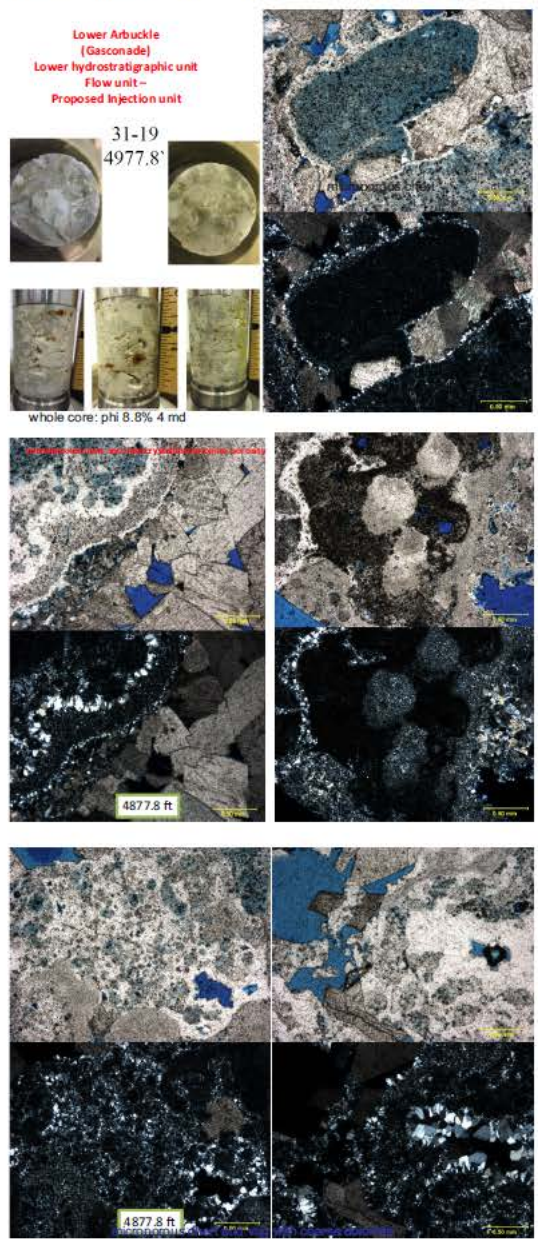
Fine interparticle Ø



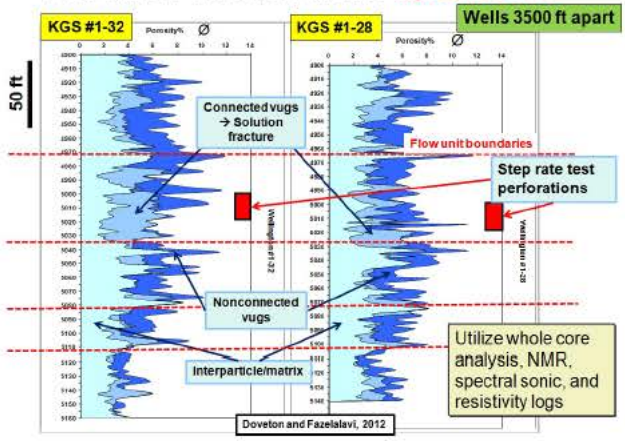
Thin Sections – Baffle Zone (Mid Arb.)



Lower Arbuckle Injection Zone



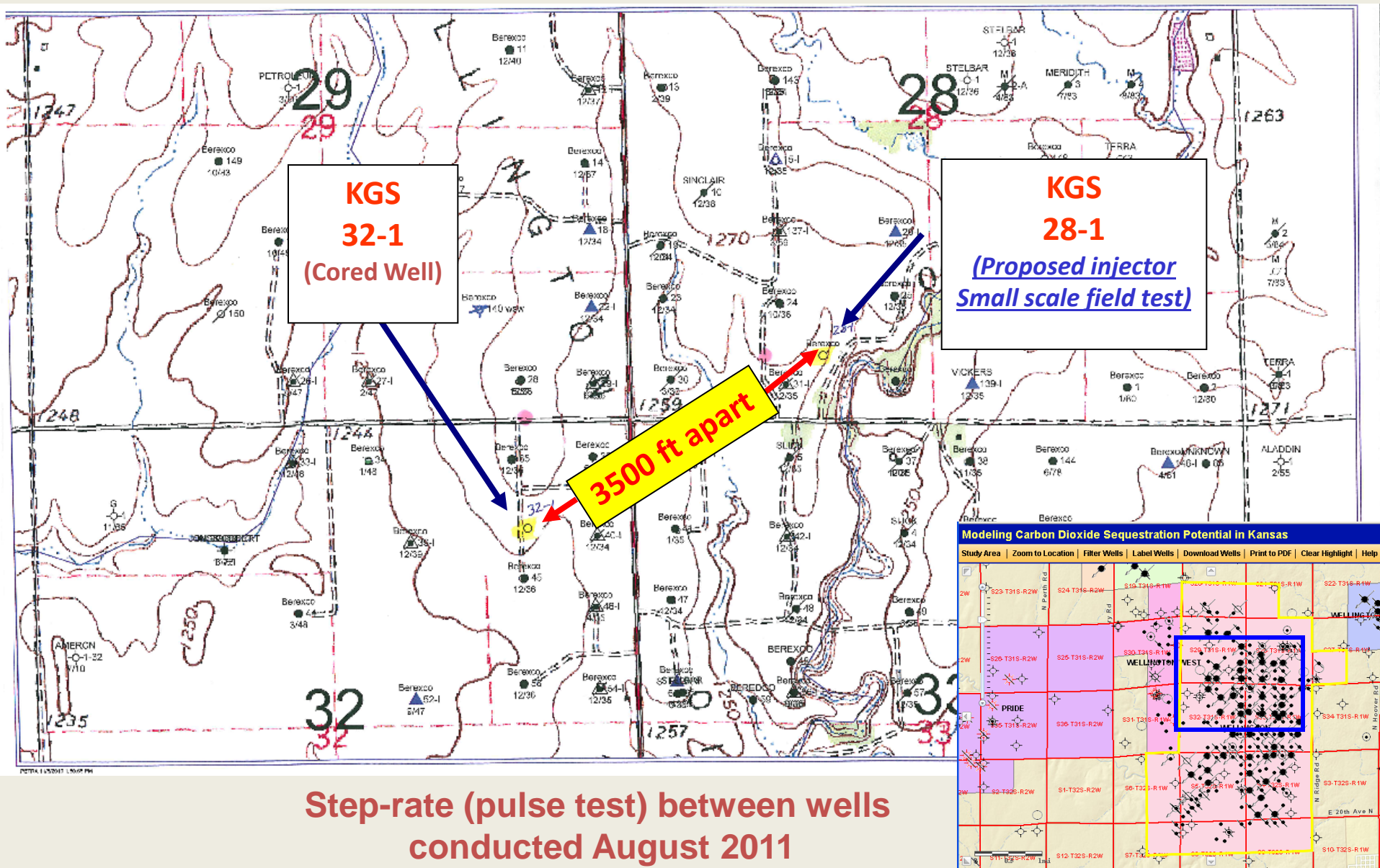
Flow units in the lower Arbuckle injection zone



Pairs of photomicrographs  
Plane light and crossed nichols



# Surface Location of Basement Test (#1-32 & 31-28) Drilled in Wellington Field During Jan-Feb 2011

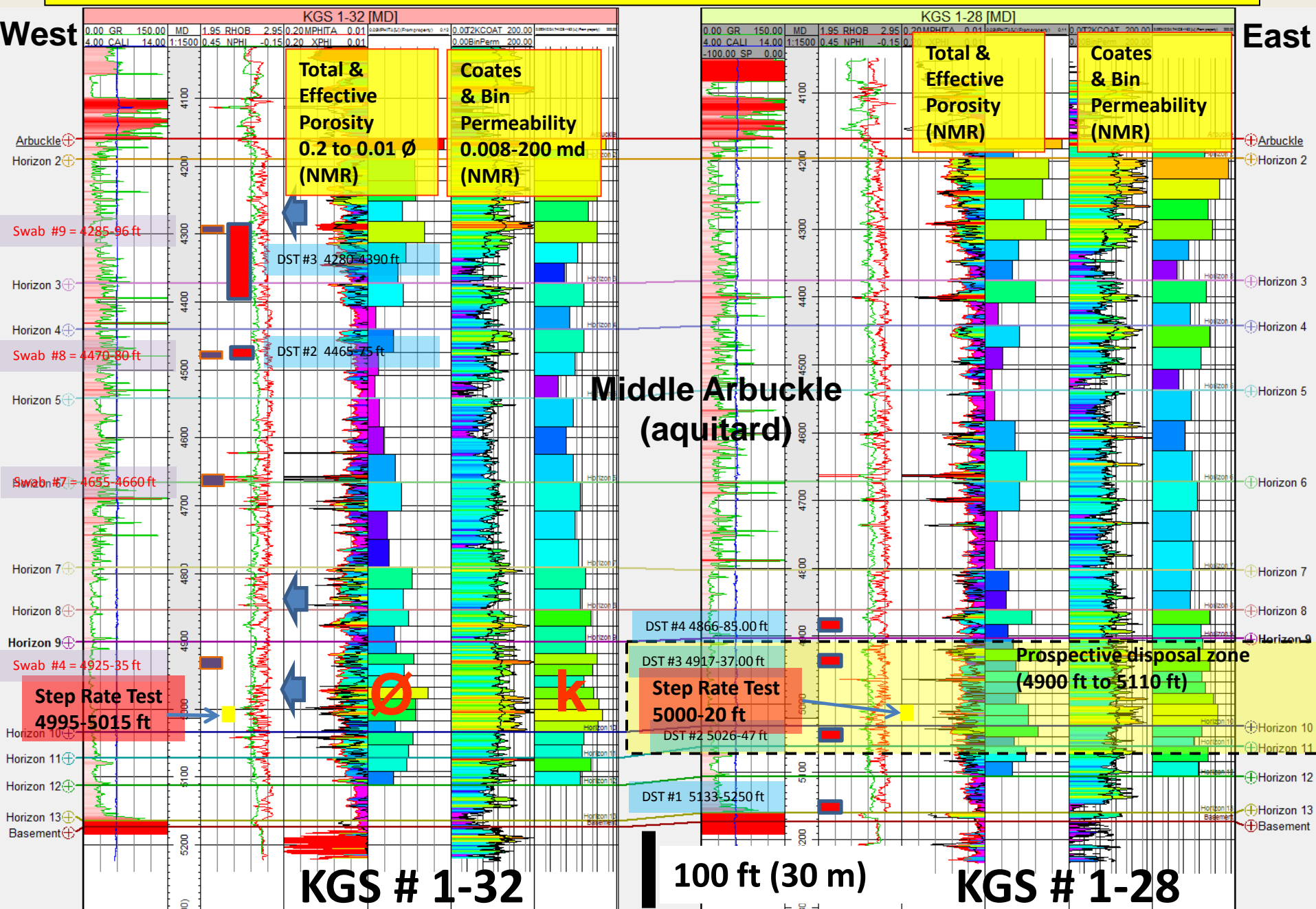




# Cross section showing 20 ft interval of step rate test and proposed swab intervals in the Arbuckle

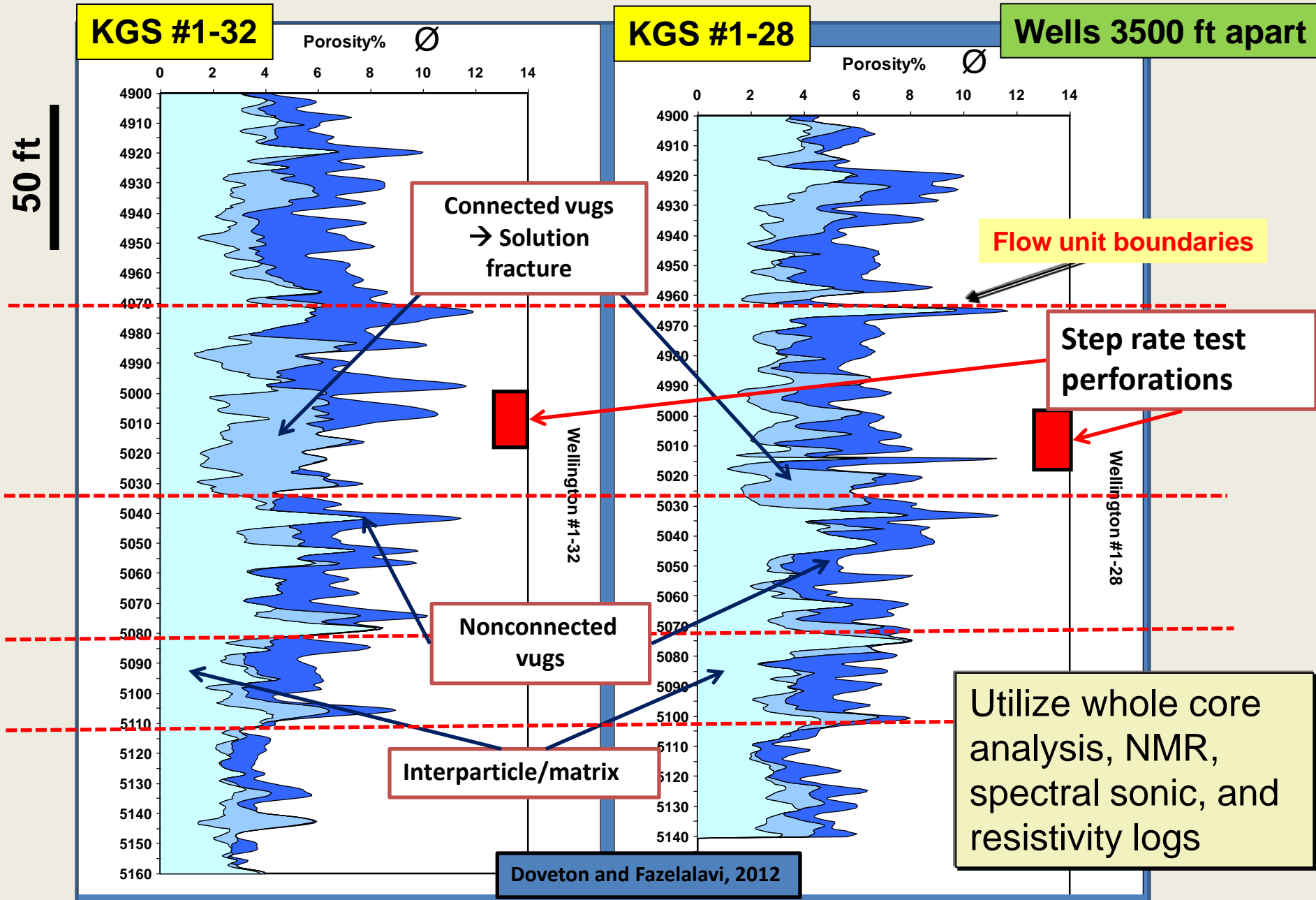
West

East



# Flow Units in the **Lower Arbuckle Injection Zone**, ~4900-5160 ft

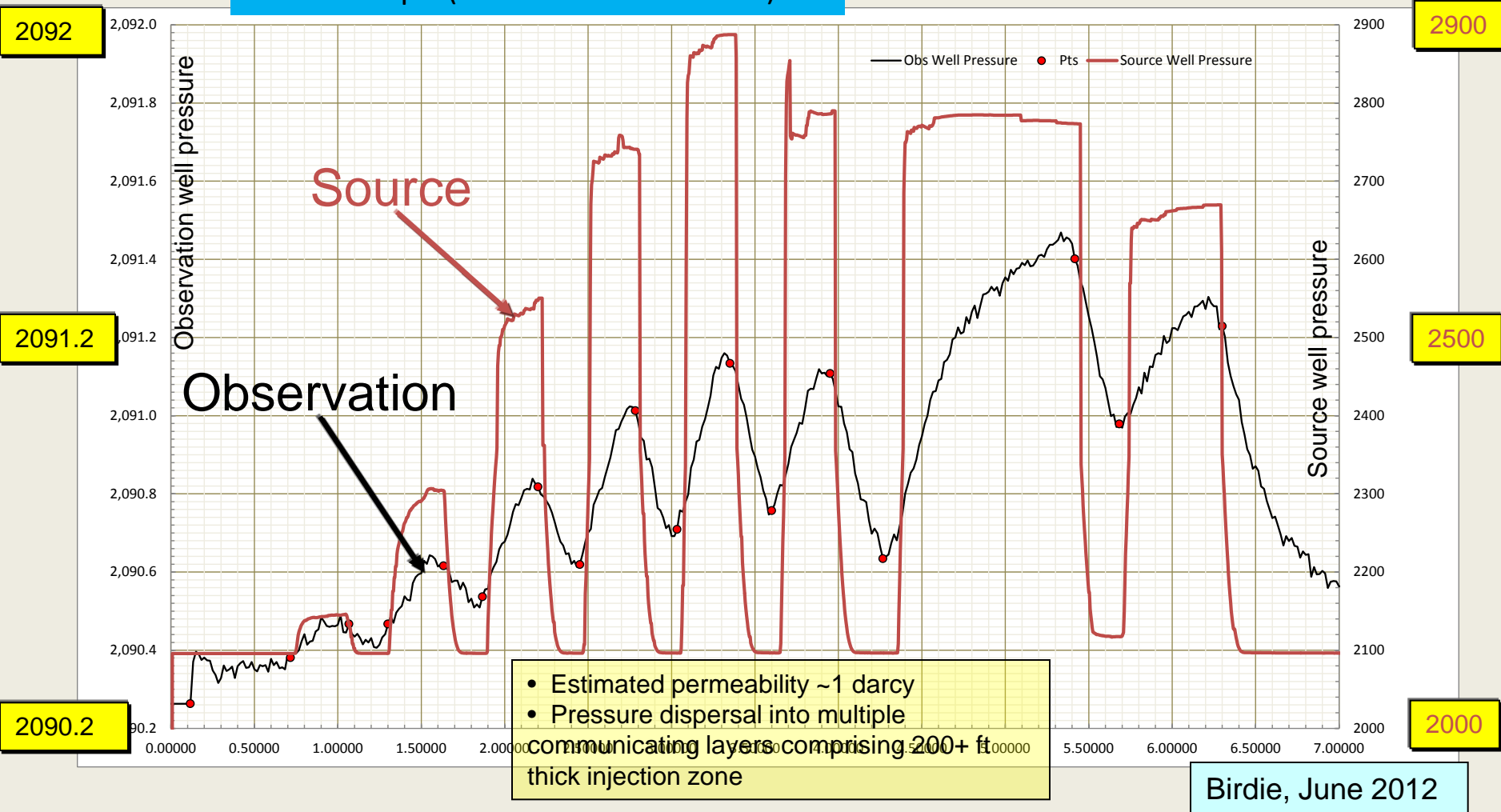
## Gasconade Dolomite to Gunter Sandstone



# Step-Rate Test Pressure-Time Plot

Source Well (#1-32) and Observation Well (#1-28) Pressures in 20 ft Perforated Zone in Lower Arbuckle Injection Interval

Est. fracture pressure =  $0.7 \text{ psi/ft} \times 5000 \text{ ft}$   
= 3500 psi (to create new fracture)





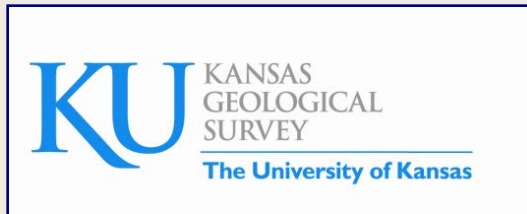
# **SMALL SCALE FIELD TEST DEMONSTRATING CO<sub>2</sub> SEQUESTRATION IN ARBUCKLE SALINE AQUIFER AND BY CO<sub>2</sub>-EOR AT WELLINGTON FIELD, SUMNER COUNTY, KANSAS**

Project Number DE-FE0006821

W. Lynn Watney, Jason Rush, Joint Pls  
Kansas Geological Survey  
Lawrence, KS

# Project Team

## DOE-NETL Contract #FE0006821



L. Watney (Joint PI), J. Rush (Joint PI), J. Doveton,  
E. Holubnyak, M. Fazelalavi, R. Miller, D. Newell



T. Birdie



Brian Dressel, P.M.



Tom Daley, Barry Freifeld



Dana Wreath, Adam Beren



KANSAS STATE  
UNIVERSITY

Saugata Datta



Chris Standlee, Danny Allison, Tim Frazer

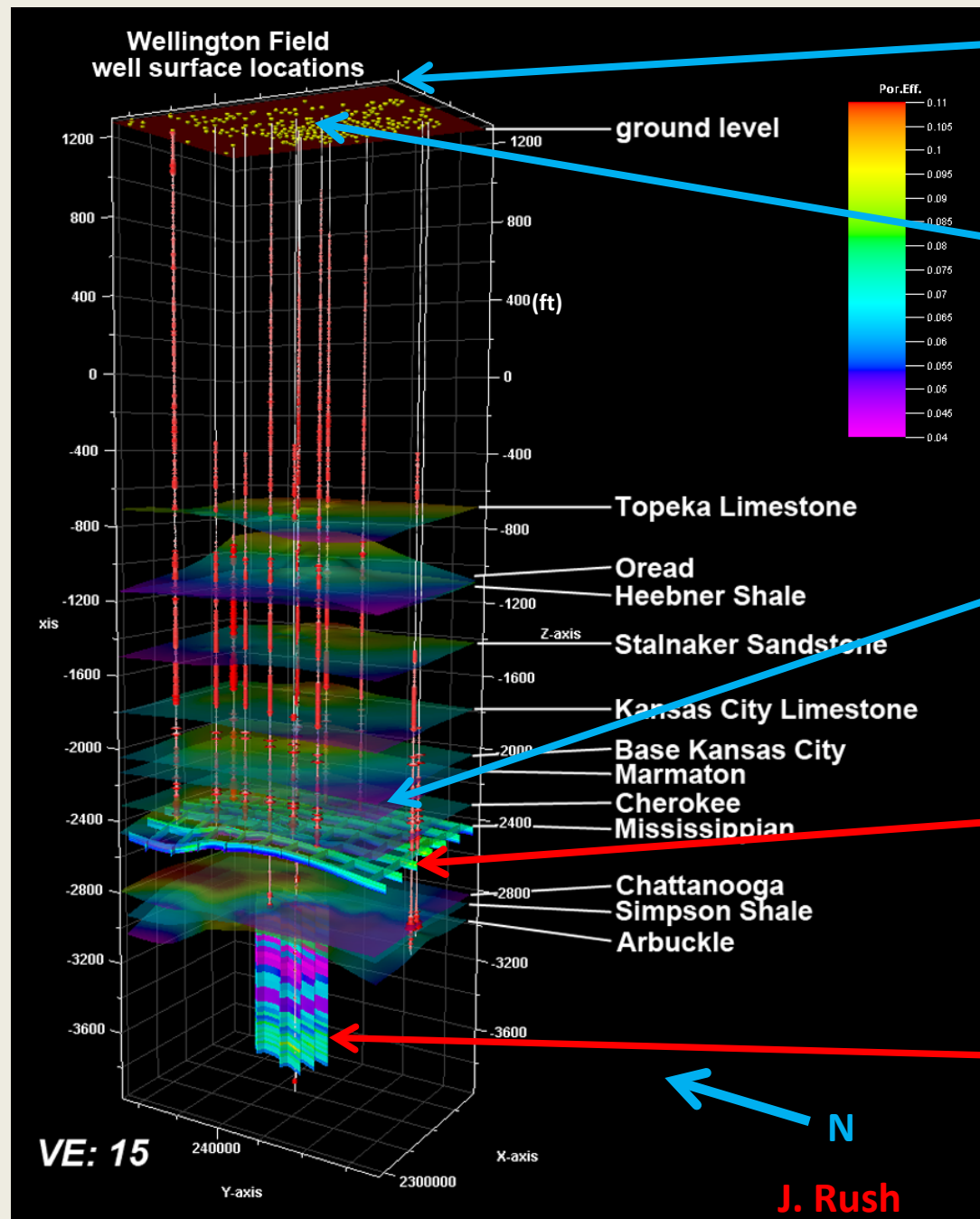


Mike Taylor, Ross Black, George Tsoflias



Dan Collins, David Freeman

# Finalize static & dynamic model for Class VI



- InSAR CGPS surface deformation/IRIS seismometers
- Measure soil gas flux and chemistry through series of shallow probes.

- Monitor for tracers, CO<sub>2</sub>, inorganics and organics in 12 shallow freshwater wells (in two nests of 6 wells)
- Monitor two deeper wells ~600 ft deep below shallow evaporite cap rock

- Measure for tracers and CO<sub>2</sub> casing head gas and fluid samples from Mississippian wells (if positive, run 2D seismic) *(Underpressured oil reservoir should trap any vertically migrating CO<sub>2</sub>)*

**Inject 30,000 tonnes of CO<sub>2</sub> into Mississippian oil reservoir to demonstrate CO<sub>2</sub>-EOR and 99% assurance of storage with MVA**

**Pending Class VI permit and DOE funding -- Inject 40,000 tonnes of CO<sub>2</sub> with SF<sub>6</sub> and krypton tracers into lower Arbuckle saline aquifer and seismically image and sample in situ CO<sub>2</sub> plume development to verify geomodel and simulations**



# Boreholes Penetrating the Arbuckle Saline Aquifer in Wellington Field

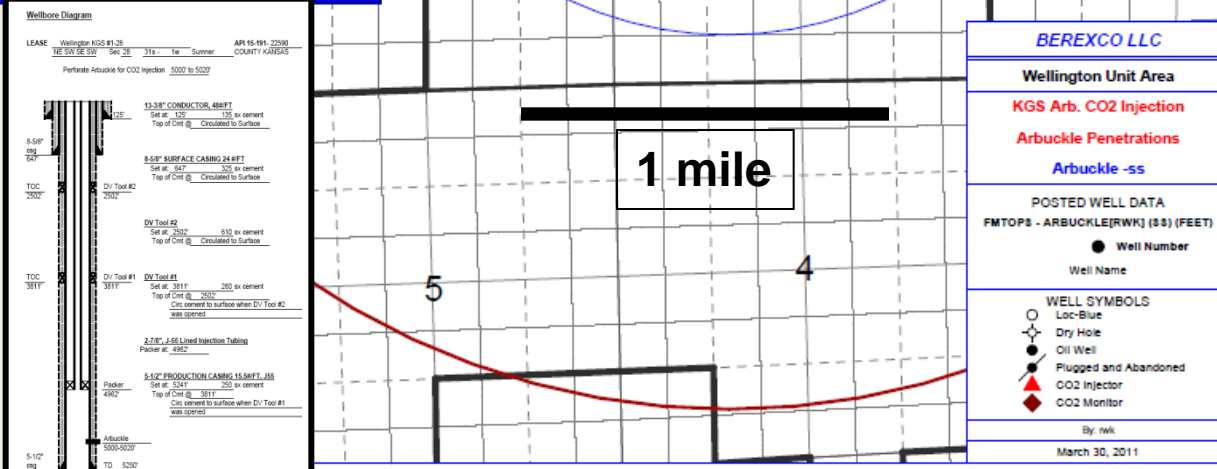
- Proposed monitoring borehole (#2-28) within 600 ft of the existing #1-28 CO<sub>2</sub> injector into Arbuckle

- Yellow dot – modeled maximum size of CO<sub>2</sub> plume, ~600 ft radius

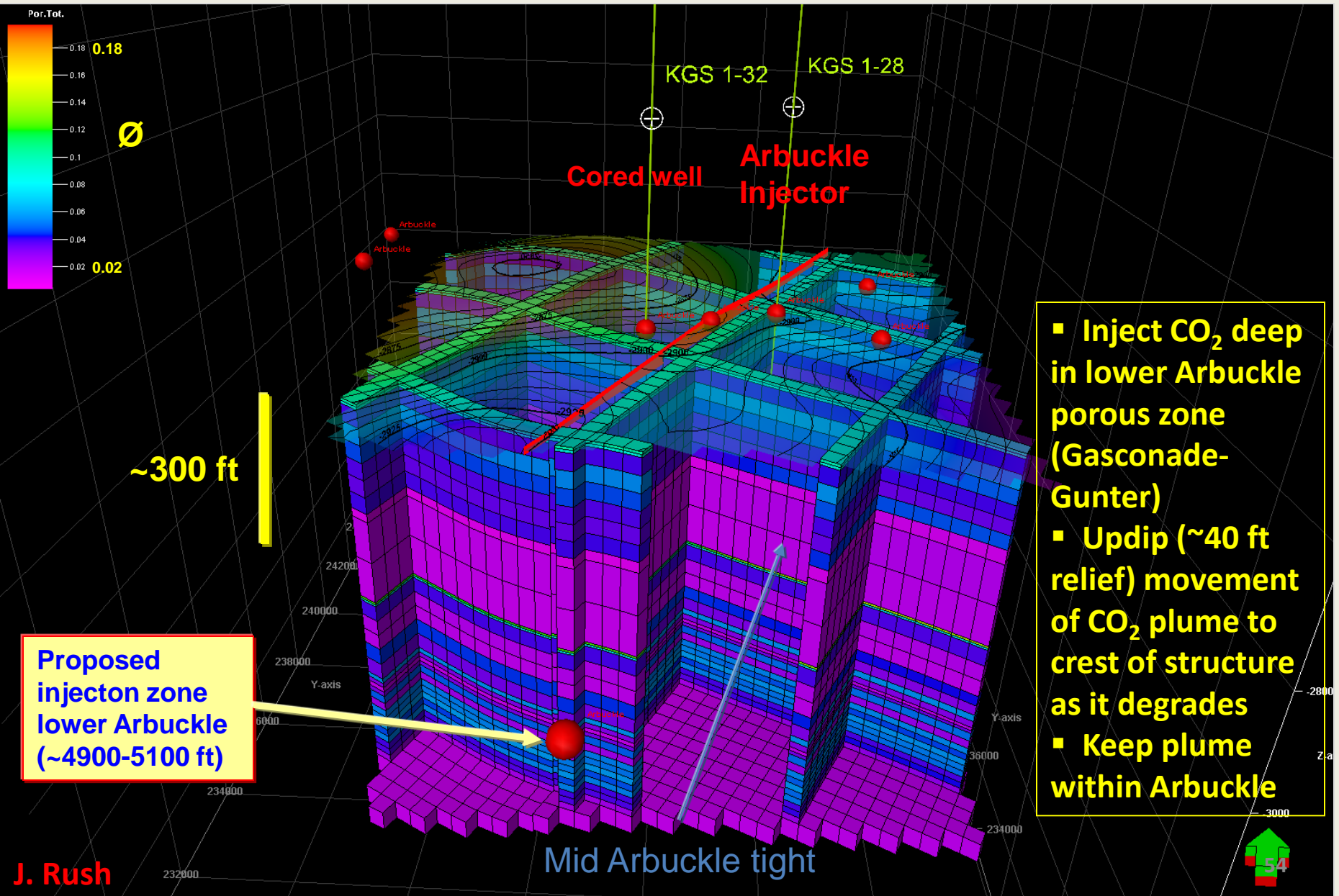
- Orange circle – extent of pressure field, 1800 radius, 125 psi max.

## Berexco, LLC has:

- Purchased pore space
- Insured activity
- #1-28 well completion in compliance with EPA specs
- Disposal fee of CO<sub>2</sub> as part of cost share

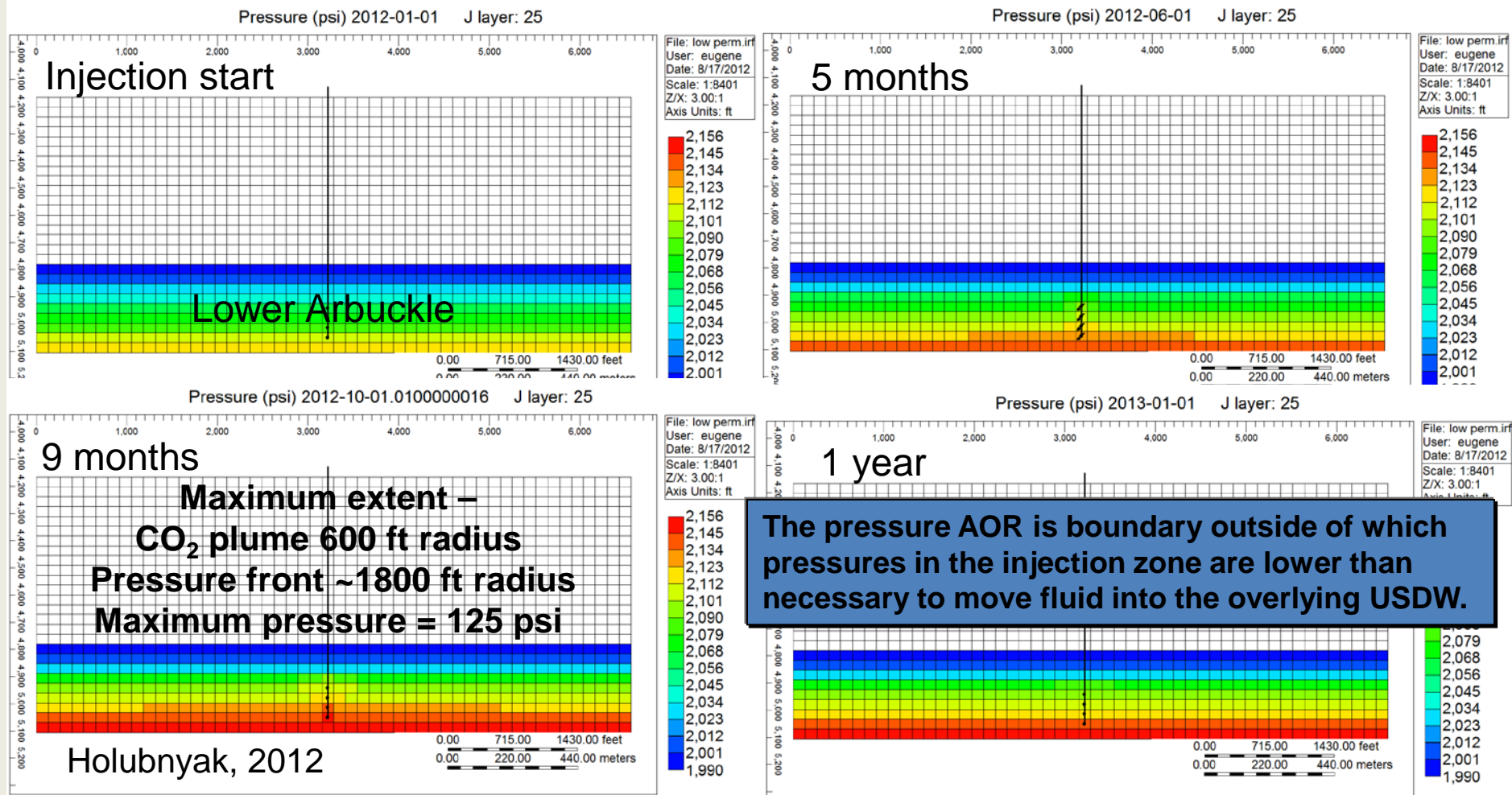


# Petrel<sup>tm</sup> geomodel of Arbuckle (porosity & structure)



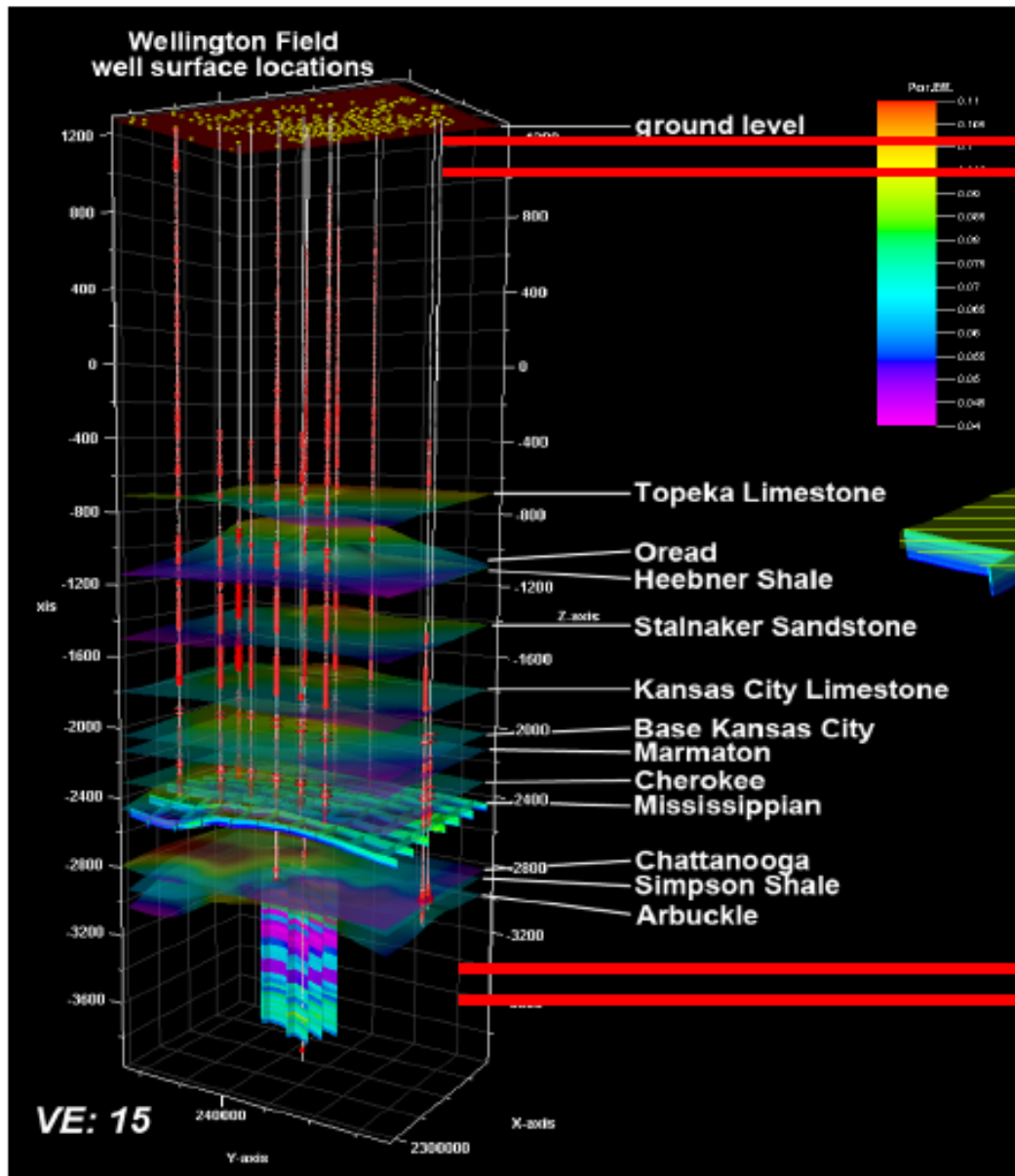
# Simulated Pressure Profile around KGS #1-28

9 Months, 40 kt CO<sub>2</sub> injection scenario into lower Arbuckle  
– Low permeability case, (100-500 md), dual  $\emptyset$   
Elevated pressure limited to lower Arbuckle injection zone





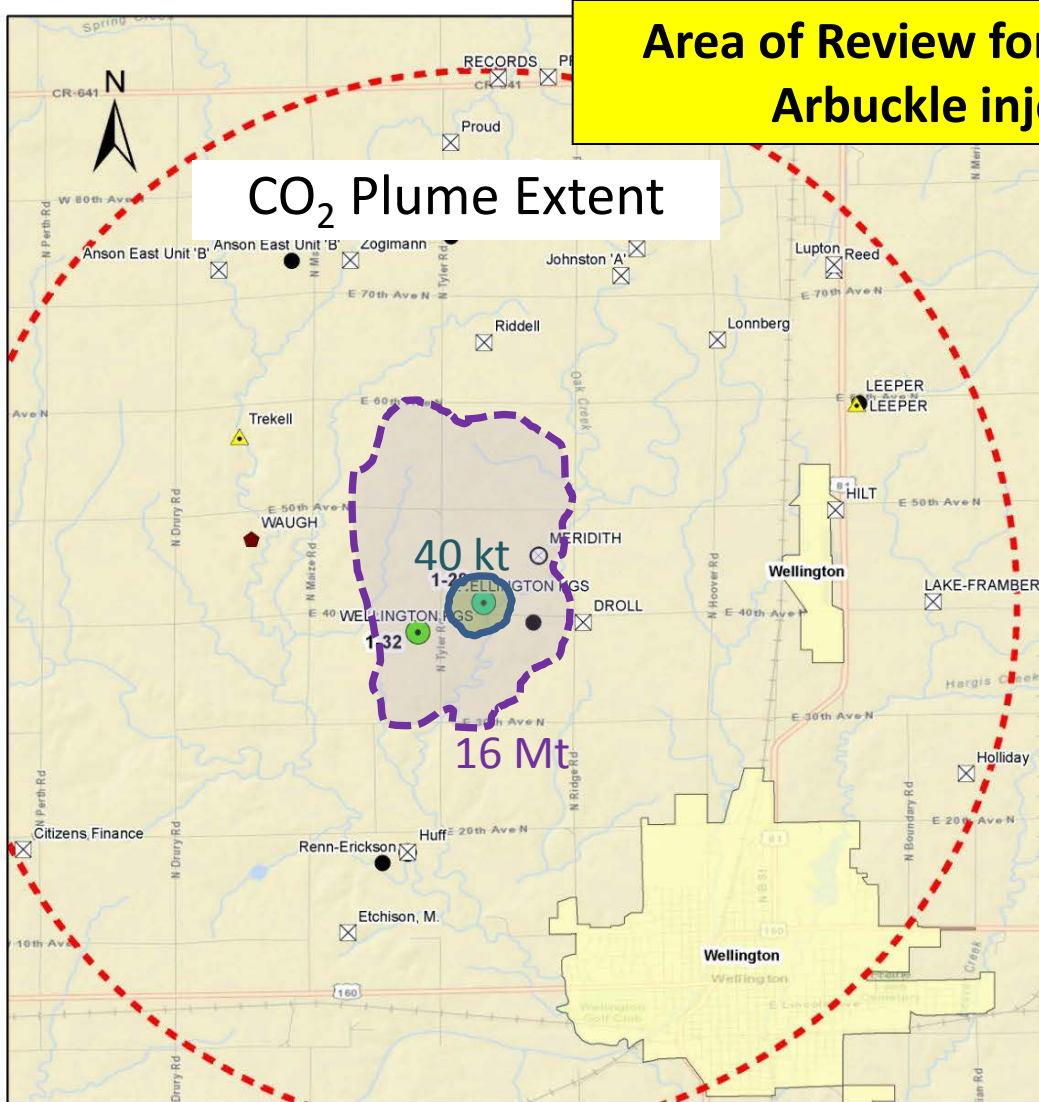
# Head Difference Between Arbuckle and USDW



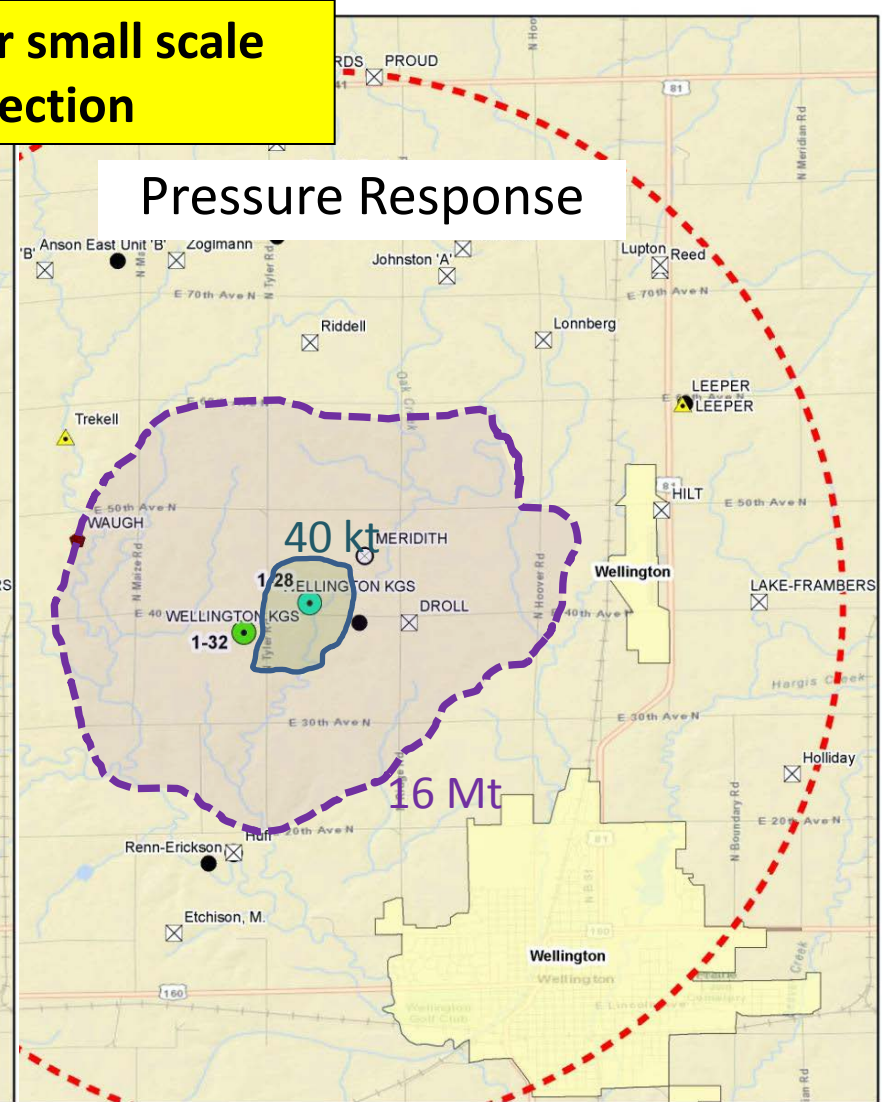
- No natural connection between USDW and underlying Paleozoic strata
- Potentiometric surface of Arbuckle ~500 ft below USDW
- Maximum injection pressure = 125 psi within 1<sup>st</sup> month of injection
- Pressure front 1800 ft radius from injector
- Pressure well below parting or fracture pressure of caprock
- Regional study has established that Arbuckle is an open system

# Area of Review for small scale Arbuckle injection

## CO<sub>2</sub> Plume Extent



## Pressure Response



### Legend

- Arbuckle Wells**
- <all other values>
  - KGS 1-32
  - KGS 1-28
  - 5 Mile Radius
- STATUS**
- ⊗ D&A
  - OIL
  - OIL-P&A
  - ◆ OTHER
  - ▲ SWD

Dynamic Simulation of CO<sub>2</sub>  
Injection in Saline Aquifer,  
Arbuckle Fm. in Wellington Field

Yevhen Holubnyak, KGS

# Presentation Summary

- **Locations of studies, schedule, fundamentals**
- **Accomplishments**
  - Regional geology & estimate of CO<sub>2</sub> storage capacity in the Arbuckle saline formation in southern Kansas
  - Source-sink network for CO<sub>2</sub> utilization and storage
  - Calibration sites for CO<sub>2</sub>-EOR and Arbuckle saline formation
    - Wellington Field, Sumner County (2 new wells, seismic)
    - Cutter Field, Stevens County (1 new well, seismic)
    - Pleasant Prairie South, Eubank North, and Shuck fields
- **Small scale field test at Wellington Field**
  - Assessment of CO<sub>2</sub> injection zone, caprocks, and isolation from USDW
  - CO<sub>2</sub> plume management through simulation and MVA
  - 70,000 metric tons CO<sub>2</sub> from nearby ethanol plant
- Spin-off research on the Mississippian Lime Play & lower Paleozoic hydrocarbon system
- **Summary**





# Acknowledgements & Disclaimer

## Acknowledgements

- *The work supported by the U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL) under Grant DE-FE0002056 and DE-FE0006821, W.L. Watney and Jason Rush, Joint PIs. Project is managed and administered by the Kansas Geological Survey/KUCR at the University of Kansas and funded by DOE/NETL and cost-sharing partners.*

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