“Integration of the recently drilled basement test at Cutter Field, Stevens County, Kansas into the evaluation of regional CO2 storage potential”

W. Lynn Watney and Jason Rush
Joint PIs, DE-FE0002056
Kansas Geological Survey

Dana Wreath
Berexco, LLC

KU
Kansas Geological Survey
The University of Kansas

KSCO2

BEREXCO

NETL
Outline

• Background of Project DE-FE0002056 (Characterization of CO2 Storage Capacity in Southern Kansas)
  – Type wells
  – Regional characterization
  – Wellington Field

• Selection of site for southwestern Kansas calibration site
  – Satisfy statement of work and budget with industry participants bidding on the project
    • Sites with geology suited for evaluating carbon management
      – CO2-EOR potential in oil field
      – Geology is representative of the Arbuckle in the region
  – Site is western anchor for the regional carbon management characterization
    • Calibrate capacity and evaluate efficacy/risks of commercial scale CO2 injection into the Arbuckle
    • Utilization of CO2-EOR in the shallower oil fields
      – Fund the infrastructure
      – Revitalize the oil fields

• Geology of Cutter Field and Vicinity

• Core and logging in Berexco Cutter KGS #1
  – Drilling prognosis
  – Drilling statistics
  – Georeport and oil shows
  – Core recovery and first look
  – Core-log integration
  – Comparison with Wellington KGS #1-32

• Future studies

• Key findings, significance
Work is partially supported by the U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL) under Grant Number DE-FE0002056.

The development of a digital well log standard LAS in the 1990's, digital acquisition by all Kansas logging companies in late 2000's, and accommodation and use of digital logs in surface mapping software has encouraged increasing use of digital well logs. This has been accompanied by the new technology driven developments in the oil and gas industry driven by price and importantly, ideas on where remaining petroleum resides, conventional and unconventional. The ideas are founded upon the currency of reliable stratigraphic formation tops to frame the subsurface analyses. Reference stratigraphic type well logs that are digital and linked with peer reviewed stratigraphic datums will serve as a starting point that will aid in further advancing our Geoscience for future. The existing Kansas Type Logs published in 1960s by the Kansas Geological Society have served the community extremely well, created by a committee of volunteers. A new digital version of the type logs, the Bob Slamal Digital Type Logs Project, builds on this heritage and is dedicated to an untiring stratigrapher and subsurface geologist who exemplified the enthusiasm of an oil finder and a scientist seeking answers to important stratigraphic problems up to the day he lost his life in a tragic car accident on a snowy Saturday morning on the way to the society library.

The Bob Slamal Digital Type Logs Project is first and foremost, an effort of an expert community of geologists who are dedicating their time and knowledge to establish a consistent, detailed subsurface stratigraphic framework across Kansas. No one geologist has detailed knowledge and extensive experience across the entire state. This is why we seek the assistance of Society members in the correlation of the stratigraphic framework, in a members area of expertise. To contribute to the project all you need is the desire to help and a computer with an internet connection. The online application is easy to use and contains "workflow" assistance and extensive help files.

The project is a joint effort between the Kansas Geological Society and the Kansas Geological Survey utilizing membership of the Society and the programming talents of John Victorine, of the Kansas Geological Survey, who has developed the online Java application to manage and display the digital logs and stratigraphic data. John Doveton has been instrumental in advancing knowledge and use of digital well logs from the efforts in the 1990's to develop a "Kansas Virtual Geology" and a more recently "Stratigraphic GIS", to make the Kansas subsurface visible through imaging of digital logs, facilitating ties between surface exposures and the subsurface.

Society member Paul Gerlach has worked with Larry Nicholson and Tom Hansen to development the initial "seed" correlations under DOE-NETL Contract DE-FE0002056, where digital type logs have been defined, digitized, and correlated to support mapping and petrophysical analysis in the evaluation of carbon storage potential of southern Kansas. Paul is managing this effort to deliver a compiled CD set of type wells for the Society and inclusion of logs among other type wells that will be accessible on the DOE-supported interactive oil and gas project mapper soon available through the Kansas Geological Survey.

This version of the Bob Slamal Digital Type Logs Project is constructed to facilitate future updates anticipating that new research and stratigraphic concepts will continue to evolve as science and technology advance. The collective stratigraphic information will enable elevation of informal stratigraphy to formal status following protocol established by the Kansas Geological Survey Stratigraphic Nomenclature Committee.

Lynn Watney, DOE project Joint PI with Jason Rush, Kansas Geological Survey, 14 December 2012
Bob Slamal Digital Type Logs Project Applet

Introduction | Is Java JRE on your PC? | Applet Security Warning | Applet | Help | Copyright & Disclaimer |

Work is partially supported by the U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL) under Grant Number DE-FE0002058.

Step 1: Login to Enable Image Map:
Enter your Email Address and then Select Login Button:

Login  Clear

Step 2: Choose Button to Display Wells by County or by Area:
Display Wells in County Map  Display Wells in Area Map

Step 3: Click on Map Below to Plot Wells on a Township-Range-Section (TRS) Grid County Map or Area Map:

Areas of Log Committee
ID Description
1  North West Kansas
2  South West Kansas
3  Northern CKU
4  Southern CKU and saddle area to east
5  South-Central Kansas
6  Southeast Kansas
7  Eastern Salina Basin
8  Northeast Kansas

Author: John R. Victorine  jvictor@ku.edu

The URL for this page is http://www.kgs.ku.edu/PRS/Ozark/TYPE_LOG/applet.html
DOE-CO2 digital type wells are “seeded” with regional tops from “near surface” to Pre-Cambrian to serve as basis part of the Kansas Type Log Project.
Interactive map to compare control well with well to be classified

Seward County

-- Precambrian arkose in SW portion of county
Structural features and of the Paleozoic aquifer systems of the mid-continent

Elev. (ft)

Cimmaron Arch
Sierra Grande Uplift
Las Animas Arch

Wichita, Amarillo Uplifts

Pratt Anticline
CKU

Nemaha Uplift

Precambrian structure, 18x vertical exag.

North

IHS (2009); KGS data; Adler and others (1971), modified after Bayley and Muehlberger (1968)

D. Higley, USGS, 2012
Arbuckle Isopach Map

KGS Cutter #1
Wellington KGS #1-32 & #1-28

KGS Website
Web-based Interactive DOE-CO2 Project Mapper
Overlay of Oil and gas field outlines and
Top Arbuckle Group in study area of southern Kansas

http://maps.kgs.ku.edu/co2/?pass=project
Lower Ordovician Arbuckle Group

Western Interior Plains Aquifer & Ozark Plateau Aquifer System

Proposed injection zone

Mississippian — dolomite/ker (CO2-EOR)

Pennsylvanian shales
Tight lower Mississippian Argillaceous dolosiltstone

Simpson Group
Arbuckle Group
aquiclude

Top core: 3550 ft

5158 ft - granite

Cored well, Berexco Wellington KGS #1-32 at Wellington Field, Sumner County
### CO₂ injection zones in Arbuckle and Mississippian Wellington Field KGS #1-28 --- Synthetic seismogram and seismic impedance

<table>
<thead>
<tr>
<th>Depth Equivalent</th>
<th>Precambrian granite – bottom of core = 5174 ft</th>
</tr>
</thead>
</table>

#### Stratigraphic Units
- **Top Mississippian**: 3658 ft.
- **Top Arbuckle**: 4164 ft
- **Top Cherokee Gp.**: Secondary caprock
- **“Pierson Fm.”**: Chapman Sh.
- **Simpson Group**: Primary caprock interval
- **Jefferson City Cotter**: Baffle/barrier – Tight, dense – High impedance
- **Roubidoux Fm.**: CO₂ injection zone
- **Gasconade Dol.**: CO₂-EOR pilot
- **Gunter Ss.**: Pay

#### Seismic Parameters
- **Reflection Coefficient**: Synthetic
- **Synthetic Impedance**: 100 Hz
- **Sonic**: Impedance Sonic Neutron-Density Microresistivity

[http://www.kgs.ku.edu/software/SS/]
Arbitrary seismic impedance profile – Wellington Field

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

Impedance = \( \rho \times \varnothing \)

Top Mississippian

Top Arbuckle

Top Precambrian

Top Kansas City Ls.

Thick Lansing Group Shales

Top Oread

Lower Pierson

Baffle or potential barrier to vertical flow (high impedance)

Low impedance injection interval
• 400 ft of tighter rock
• Widespread high seismic impedance
Zonal fracturing in Arbuckle, KGS #1-32

*Spectral acoustic log, core, microresistivity imaging*

Scheffer, 2012; Lorenz and Cooper, 2011
Arbuckle Hydrostratigraphy at Wellington Field

obtained from DST and perf & swab test

Zonation Evidence in Arbuckle and Mississippian Formation Brines

Scheffer (2012)
Lower and upper Arbuckle are not in hydraulic communication.

- Lower Arbuckle injection interval: Waters distinct from upper Arbuckle and Miss.
  - Lower intervals are also geochemically homogeneous.

- Upper Arbuckle: distinct

Oxygen & Hydrogen isotopes of brines from DST and perf & swabbing.

Scheffer, 2012
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
230 ft gross thickness interval of primary caprock in KGS #1-28 (injection well) — illustrated by nuclear magnetic resonance log

- **Permeability**
- **Porosity**
- **T2 (pore size)**

**Caprock evidence:**
- Micro-nano darcy perm
- Quiet fracture wise
- Organic matter 1%
Flow units in the lower Arbuckle injection zone, ~4900-5160 ft

KGS #1-32
- Porosity%
- Ø

KGS #1-28
- Porosity%
- Ø

Wells 3500 ft apart

Connected vugs → Solution fracture

Nonconnected vugs

Interparticle/matrix

Flow unit boundaries

Step rate test perforations

Utilize whole core analysis, NMR, spectral sonic, and resistivity logs

Doveton and Fazelalavi, 2012
Selection of site for southwestern Kansas calibration site
**Technical Status**

Evaluate CO₂ sequestration potential in Arbuckle Group saline aquifer and CO₂-EOR in four fields in southwestern Kansas

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**Southwest Kansas CO₂ Consortium (Western Annex)**

Seismic blocks are color coded by operator (~120 mi² of 3D seismic)

Chester/Morrow Sandstone (IVF) & Deep saline Arbuckle aquifer

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KU Kansas Geological Survey
The University of Kansas
Industry Partners
Southwest Kansas CO₂ Consortium

- IHR
- Improved Hydrocarbon Recovery LLC
- CIMAREX
- Hedke-Saenger Geoscience, Ltd
- Sunflower Energy LLC
- GloriOil
- Anadarko Petroleum Corporation
- BEREXCO
- Dawson-Markwell Exploration Co.

Industry and Electrical Power Sources of CO₂

- Conestoga Energy Partners, LLC
- Sunflower Electric Power Corporation
- Abengoa Bioenergy: The Global Ethanol Company

+drilling and seismic contractors TBN
Successful bid to drill well by Berexco

**Previous discussion:**

Completed review of geology and seismic data at proposed drill sites using following criteria to evaluate the sites --

- 1) provide a useful location in the incised valley fill sandstones for operator,
- 2) avoid fault zones around drill site or within the 10 mi² around the well so faults are at minimum outside of the multicomponent seismic survey, and
- 3) ideally, we'd have a drill site with a high potential for porous section of lower Arbuckle and shaly or tight layers above the porous interval.

To reduce AFE costs, reduce core from 2100 ft to 1200 ft

Met the project budget.
Basement Test Well Selection Made by Watney

- Accepted quote from Berexco for well with 1180 ft of core
- Well location
  - Cutter Field, Stevens County
  - Section 1-T31S–R35W
  - Spud date by early August 2012
- 10 mi² multicomponent survey
  - design likely to include incised valley to east of proposed well location; acquisition as soon as possible to use initial p-wave data to assist in selecting location of new well

<table>
<thead>
<tr>
<th>Depth Interval</th>
<th>Footage</th>
<th>Formation</th>
<th>Core storage</th>
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<tbody>
<tr>
<td>5210-5290</td>
<td>80</td>
<td>Morrow</td>
<td>Alum Bbl</td>
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<tr>
<td>5400-5600</td>
<td>200</td>
<td>Chester</td>
<td>Boxes</td>
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<tr>
<td>6400-6800</td>
<td>400</td>
<td>Kinderhook/Viola/Upper Arb</td>
<td>Alum Bbl</td>
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<td>6900-7200</td>
<td>300</td>
<td>Arbuckle</td>
<td>Boxes</td>
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<tr>
<td>7350-7550</td>
<td>200</td>
<td>Lower Arb</td>
<td>Alum Bbl</td>
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</table>
Cutter Field drill site, SW Kansas
Top Mississippian (contours), surface lineaments (red lines), Lower Permian top Ft. Riley Ls. dip gradient (gray shading)

Outline Cutter Field & Location of basement test: Berexco Cutter KGS #1 @3250 ft 8-20-12
Top Mississippian (contours), surface lineaments (red lines), Lower Permian top Ft. Riley Ls. dip gradient (gray shading)
New Seismic Acquisition & Vintage Data at Cutter Field

Outline of Chester incised valley

New seismic
Reprocessed Kansas Magnetics -- Tilt Angle, Total Magnetic 2-10 mi + Total Magnetic Reduced to Pole (910m)
Modeling Carbon Dioxide Sequestration Potential in Kansas

Cutter Field

Tilt Angle, Total Magnetic 2-10 mi + Total Magnetic Reduced to Pole (910m)

Midcontinent Rift System

Wellington Field

1.1 Ga
Oblique view between Cutter drillsite (left) and Satanta, KS (right) with Cimarron River valley between (looking north)
Cutter KGS #1
S/2 SE 1/2 NE, Sec. 1-313-35W
Stevens County, Kansas
API Number: 15-188-22781

<table>
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<th>Elevation: 2926' GL, 2939' KB</th>
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<tbody>
<tr>
<td>2440' from North line of Section</td>
</tr>
<tr>
<td>1320' from East line of Section</td>
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<tr>
<td>Regular Section — —</td>
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<tr>
<td>Irregular Section — —</td>
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</table>

Primary Objective: Core Morrow, Chester and Arbuckle

**DAILY REPORTS FROM CONTRACTOR**

**Weekdays:**
FAX reports NO LATER THAN 9:00 a.m., to the BEREXCO offices in Wichita.

**Weekends/Holidays:**
Call Ed Crawford at 316-215-1345.

**SURFACE CASING**
Size: 5 5/8" Depth: Est. 1,750'
Surface cement: Basic 420 804 2727

**DRILLING TIME**
One foot drilling time over the following interval(s): 3500' to TD

**SAMPLES**
One set of washed, clean, dried and bagged cuttings should be caught and saved as follows:
1' intervals: 0' - 3500' 3500' - TD
Additional 2' samples may be caught per the geologist's instructions.

**DRILL STEM TESTING**
Probable zones: Arbuckle
Possible zones: Upper Morrow, Chester
Tester: Tri-State 800, 820, 804, Colby

**CORING:**
David's Coring (305) 808 3123

**GAS DETECTOR:**
Yes.

**LOGGING:**
Halliburton
(505) 634 8129
e-mail: TIF, PDF, LAS to lwatney@kgs.ku.edu,
Gwraith@Berexco.com, rikoudeles@berexco.com

**Mission Accomplished**
Wireline Logging

- Halliburton has provided excellent service at Wellington and an equivalent log suite is requested as listed below.
- SERVICE CENTER: Liberal, Kansas
- SERVICE COORDINATOR: Steven White
- SERVICE MANAGER: Scott Carr
- TOOL NAME (HALLIBURTON)

<table>
<thead>
<tr>
<th>NAME</th>
<th>ABBREVIATED</th>
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<tr>
<td>Gamma Ray</td>
<td>(GTET-I)</td>
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<td>Array Compensated True Resistivity</td>
<td>(ACRT-I)</td>
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<td>Dual Spaced Neutron</td>
<td>(DSNT-I)</td>
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<td>Microlog</td>
<td>(ML)</td>
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<td>(WSTT-I)</td>
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<td>Elemental Analysis Tool</td>
<td>(GEM)</td>
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<td>Comp. Spectral Natural Gamma</td>
<td>(CSNG-I)</td>
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<td>Magnetic Resonance Imaging Log</td>
<td>(MRIL)</td>
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<td>Extended Reach Micro Imaging Tool</td>
<td>(XRMI)</td>
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Weatherford Labs, Houston
describe & ID sampling on 1042 ft of core, Nov. 11-13, 2012

<table>
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<tr>
<th>sample</th>
<th>Core Plug (Saugata)</th>
<th>Whole core or Core Plug (Eugene)</th>
<th>Whole Core Section</th>
<th>Core Section 3a</th>
<th>Extraction and HC saturations</th>
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<td>Possibly run saturation on plug</td>
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November 12-13, 2012
Cutter Core
With Lynn and Eugene
Core Sections and Core Plugs
Between KG-1 and KG-2
Between Cutter Core KG-1 (15-189-22781)
Sample for Total Organic Carbon Analysis

Sample for Total Organic Carbon Analysis
UV Fluorescence Shows in Cutter KGS #1

- 5401-5403 light show
- 5420-5424 light show
- 5476-5480 mid show
- 5530-5532 heavy show
- 5533-5543 heavy show
- 5557-5562 light show
- 5592-5596 light show
- 5600-5619 heavy show
- 5611-5636 heavy show
- 5638-5642 light show
- 5664-5668 light show
- 6515-6725 light show
- 6515-6518 light show
- 6524-6526 light show
- 6690-6697 light show
- 6708-6711 light show
- 6741-6753 light show
- 6907-6909 very light show
- 6915-6921 very light irregular show
- 6928-6932 light show
- 6937-6940 light show
- 6953-6959 light show
- 6967-6971 light show
- 6975-6977 light show
- 6978-6982 light show
- 7090-7095 light show
- 7099-7101 light show
- 7112-7106 light show
- 7158-7160 light show
- 7222-7224 light show
- 7381-7388 light show
- 7420-7420 light show
- 7402-7412 light show
- 7550-7589 light show
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<th>LUNG TW</th>
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<td>0.001-0.0005</td>
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<td>0.0005-0.0002</td>
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<td>WASHOUT</td>
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</table>

**Legend:**
- **GAMMA RAY, SP:** Color-coded gamma ray data.
- **PERMEABILITY:** Values indicating permeability.
- **LUNG TW:** Time values for lung tissue.
- **BULK VALUE:** Bulk value data.

**Diagram:**
- Arrows indicate T1 and T2 relaxation times.
MRIL log and Main pay of Field
-- Upper Morrow Sandstone

Long T1 > oil threshold
Base Gasconade Dolomite, Gunter Sandstone, granite wash, Precambrian granite

MRIL log

Gunter Ss. core 2’ high
Granite wash?
Precambrian Granite

7550-7589 UV fluorescence, light show
#2 – Kent’s DST #1, 7522-7735 213' of anchor
Low GR, porosity 7-10%, microlog separation
Gunter Sandstone, 7579 ft
(core depth 2 ft high to logs)
Gunter Sandstone
(core depth 2 ft high to logs)
Gunter Sandstone, 7532 ft
(core depth 2 ft high to logs)
Gunter Sandstone, 7530-50 ft
Northeast dip

Top of sand
Gunter Sandstone-Granite contact, 7590-7610 ft
SE dip, lower sandstone on weathered granite
Weathered and Fresh Precambrian Granite

Partial & open fractures

Weathered granite

Fresh granite
Gunter Ss.

Top Gasconade Dolomite (7040 ft) -- 2 high porosity zones

7112-7106 light show

MRIL log to follow

Core cored

Primary Rock Lithology

Secondary Rock Lithology

Fusilius

Bivalvia

Clams, oysters, etc.

Shells, clams, etc.

Other fossils

Permian Type

- Arthropods
- Insects
- Reptiles
- Mammals
- Vagaries
- Trilobites
- Dinosaurs
- Birds
- Plants

Clay, Claystone

Shale

Silts, Siltstone

Sand, Sandstone

Gravel

Biosurt

Limestone, Breccia

Dolomitic Breccia

Chert

Limestone, Mudstone

Wackestone

Pakstone

Greenschist

Dolomitic Dolomite

Dolomite

Dolomitic Mudstone

Dolomitic Pakstone

Dolomitic Greenschist

Greenschist

7112-7106 light show

MRIL log to follow
Lower Gasconade Dolomite
(7280-7500 ft)

- Large pores
- 7402-7412 light show
- 7450
- Larger pores
Lower Gasconade Dolomite, 7420-50 ft
Lower Gasconade, 7433 ft
(core depth 3 ft high to log)

Gray-brown, packstone with quartz sandstone, cm sized vugs that are interconnected cut across core, saddle dolomite, very porous breccia
Lower Gasconade, 7427 ft
(core depth 3 ft high to log)

dolomitic packstone-grainstone, medium to coarse grained vugs, occ. diagonal fractures
Lower Gasconade to Gunter Ss.

Lynn DST #3 (now perf and swab)
Kent’s DST #2 7416-7457 31’ interval

Lynn DST #2
Kent’s DST #1

Gunter Ss.
Lower Gasconade, 7337-38 ft
(core depth 3 ft high to log)

Dolopackstone to dolograinstone, brown fine vugs & molds of pelloids, fine to medium grained

upper contact of Ø in next image log
Lower Gasconade Dolomite, 7330-50 ft
Change in dip at tight/porous contact

Sharp contact

Vugs noted in previous photo
Upper Gasconade Dolomite
-- UV fluorescence, light oil show

Base Gasconade 7532 ft.
Top Gasconade (below shaly interval) 7040 ft

Core Photo and MRIL

Lynn DST #3
Kent’s DST #2 7416-7457

Lower Arbuckle Gasconade to Gunter Ss.
Upper Gasconade, 7100 ft
(core 2 ft high to log)

- Packstone with flat pebble conglomerate,
- Horizontal disruptive bedding lenticular chert,
- Pinpoint vugs,
- Poor porosity.

UV florescence interval (light show)
Upper Gasconade Dolomite, 7100-7120 ft
Interbedded tight and porous

Change in dip at sharp bed boundary
Gasconade to basement

Preliminary hydrocarbon analysis using BVW and apparent "M"
Contact between Jeff-City Cotter and Gasconade Dolomite, 7020-7040 ft
Lower Jefferson City-Cotter Fm.
More hydrocarbons shows and oil indications on MRIL

Exceeds T1 oil threshold

Lower Jefferson
City-Cotter Fm.
core 3’ high

Top Gasconade

6907-6909 very light show
6915-6921 very light irregular show
6928-6932 light show
6937-6940 light show
6953-6959 light show
6967-6971 light show
6975-6977 light show
6978-6982 light show
UV shows
Lower
Jefferson City-
Cotter Fm.

Top
Gasconade
Lower Jefferson City-Cotter Fm, 6932 ft (core 3 ft high to log)

Dolopackstone, light brown, autoclastic breccia, stromatolitic, pebble conglomerate, fair porosity
Lower Jefferson City-Cotter Fm, 6932 ft
(core 3 ft high to log)

UV florescence interval
Lower Jefferson City-Cotter Fm, 6908-09 ft
(core 3 ft high to log)

Dolomite packstone to dolomite boundstone, light brown, stromatolite, mm-cm sized vugs, poor to fair porosity

UV fluorescence interval
Lower Jefferson City-Cotter Dolomite
UV Fluorescence Show in Stromatolite

--- More light oil shows

Oil show while drilling – dark brown oil spots, fair odor

6690-6a697 light show
6708-6711 light show
6741-6753 light show
Viola

Arbuckle (Jefferson City-Cotter Dol.)

cored

6690-6a697 light show
6708-6711 light show

6744-6753 light show
Simpson Group

6708-6711 light show

6741-6753 light show
CUTTER KGS #1 - Simpson to Gasconade

Porosity vs. Resistivity

Porous, clean
HC saturation

Simpson to Gasconade
Depth: 6650 - 7050
X: a 1
m: 2
n: 2

6690-6697 light show
6708-6711 light show
6741-6753 light show

6650 6700 6750 6800 6850 6900 6950 7000 7050

0.01 1.00 100.00

0 45 90

6600 - 6688
6688 - 6776
6776 - 6864
6864 - 6952
6952 - 7128

GR .api

RWA

RT
Lower Osage, Northview Shale, Compton Ls., Chattanooga Shale, and upper Viola Ls.
Lower Ste. Genevieve Ls. and upper St. Louis Ls.

Oil show by MRIL

Top Ste. Genevieve Ls.

Top St. Louis Ls.

5600-5611 heavy show
5611-5636 heavy show
5638-5642 light show
5664-5668 light show
Lower Morrow to upper Chester

MRIL not indicate oil

- Core 1 ft low
- Core 1’ high
- Core = log depth
- Top Ste. Genevieve Ls.

- 5401-5403 light show
- 5420-5424 light show
- 5476-5480 mid show
- 5530-5532 heavy show
- 5533-5543 heavy show
- 5557-5562 light show
- 5592-5596 light show
CUTTER KGS #1 - Chester

Gr. SW = 20%

Gr. SW = 40%

Gr. SW = 60%

Gr. SW = 80%

Gr. SW = 100%

BVW = 0.02

BVW = 0.04

BVW = 0.06

BVW = 0.08

0.010

0.100

1.000

1 10 100 1000 10000

Resistivity Ohm.m

Porosity

Chester

Depth: 5476 - 5665

X:

Y:

a:

m:

n:

RW: 0.04

5460 - 5502

5502 - 5544

5544 - 5586

5586 - 5628

5628 - 5670

5656 - 5656

Top Chester Sandstone

Shaly?

Tight?
Upper Morrow Sandstone
-- Pay zone for Cutter Field

core 10' low

High T1 over oil threshold
Near constant porosity

Decreasing resistivity with depth = in transition

Nice clean sandstone reservoir
Future Studies
Key Findings, Significance

• **Core analysis;** core-log correlation
• **Perf and Swab;** fluid sampling and pressure buildup; pressure monitoring in nearby wells
• **Interpret 3D seismic** and integrate in reservoir model of Upper Morrow Sandstone
• **Simulation** CO2-EOR (U. Morrow) and CO2 sequestration (Arb.)
• **Arbuckle is complex stack of meter-scale peritidal cycles,** porous and non-porous
• **Oil shows need to be validated** – hot wire, UV, core analysis/saturations, oil typing
• **Potentially significant implications for petroleum system**
Acknowledgements

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