DOE F 4600.2
(03/11)
All Other Editions Are Obsolete

U.S. Department of Energy
FEDERAL ASSISTANCE REPORTING CHECKLIST AND INSTRUCTIONS FOR RD&D PROJECTS

1. Identification Number: **DE-FE0006821**	2. Program/Project Title: **Small Scale Field Test Demonstration CO2 Sequestration**
3. Recipient: **University of Kansas Center for Research, Inc.**	

4. Reporting Requirements:	Frequency	Addressees
A. MANAGEMENT REPORTING		
☒ Research Performance Progress Report (RPPR)	Q	FITS@NETL.DOE.GOV
☒ Special Status Report	A	FITS@NETL.DOE.GOV
B. SCIENTIFIC/TECHNICAL REPORTING		
(Reports/Products must be submitted with appropriate DOE F 241. The 241 forms are available at www.osti.gov/elink)		
Report/Product — Form		
☒ Final Scientific/Technical Report — DOE F 241.3	FG	http://www.osti.gov/elink-2413
☒ Conference papers/proceedings* — DOE F 241.3	A	http://www.osti.gov/elink-2413
☐ Software/Manual — DOE F 241.4		
☐ Other (see special instructions) — DOE F 241.3		
** Scientific and technical conferences only*		
C. FINANCIAL REPORTING		
☒ SF-425 Federal Financial Report	Q, FG	FITS@NETL.DOE.GOV
D. CLOSEOUT REPORTING		
☒ Patent Certification	FC	FITS@NETL.DOE.GOV
☒ SF-428 & 428B Final Property Report	FC	FITS@NETL.DOE.GOV
☐ Other		
E. OTHER REPORTING		
☒ Annual Indirect Cost Proposal	O	See block 5 below for instructions.
☐ Audit of For-Profit Recipients		
☒ SF-428 Tangible Personal Property Report Forms Family	A	FITS@NETL.DOE.GOV
☒ Other – see block 5 below	A	FITS@NETL.DOE.GOV

FREQUENCY CODES AND DUE DATES:

A - Within 5 calendar days after events or as specified.
FG- Final; 90 calendar days after the project period ends.
FC- Final; End of Effort.
Y - Yearly; 90 calendar days after the end of the reporting period.
S - Semiannually; within 30 calendar days after end of project year and project half-year.
Q - Quarterly; within 30 days after end of the reporting period.
Y180 – Yearly; 180 days after the end of the recipient's fiscal year
O - Other; See instructions for further details.

5. Special Instructions:

Annual Indirect Cost Proposal – If DOE is the Cognizant Federal Agency, then the proposal should be sent to FITS@NETL.DOE.GOV . Otherwise, it should be sent to the Cognizant Federal Agency.

Other – The Recipient shall provide all deliverables as contained in Section D of Attachment 2 Statement of Project Objectives.

QUARTERLY PROGRESS REPORT
To
DOE-NETL
Brian Dressel, Program Manager
Award Number: DE-FE0006821

SMALL SCALE FIELD TEST DEMONSTRATING CO_2 SEQUESTRATION IN ARBUCKLE SALINE AQUIFER AND BY CO_2-EOR AT WELLINGTON FIELD, SUMNER COUNTY, KANSAS

Project Director/Principal Investigator:
W. Lynn Watney
Senior Scientific Fellow
Kansas Geological Survey

Ph: 785-864-2184, Fax: 785-864-5317
lwatney@kgs.ku.edu

Joint Principal Investigator:
Jason Rush

Prepared by Lynn Watney

Date of Report: August 11, 2015
DUNS Number: 076248616

Recipient: University of Kansas Center for Research &
Kansas Geological Survey
1930 Constant Avenue
Lawrence, KS 66047

Project/Grant Period: 10/1/2011 through 9/30/2016

Fifteenth Quarterly Report

Period Covered by the Report: April 1, 2015 through June 30, 2015

Signature of Submitting Official:

Willard Lynn Watney
Digitally signed by Willard Lynn Watney
DN: cn=Willard Lynn Watney, o=University of Kansas, ou=Kansas Geological Survey, email=lwatney@kgs.ku.edu, c=US
Date: 2015.08.11 16:50:24 -05'00'

EXECUTIVE SUMMARY

Project Objectives

The objectives of this project are to understand the processes that occur when a maximum of 70,000 metric tonnes of CO_2 are injected into two different formations to evaluate the response in different lithofacies and depositional environments. The evaluation will be accomplished through the use of both *in situ* and indirect MVA (monitoring, verification, and accounting) technologies. The project will optimize for carbon storage accounting for 99% of the CO_2 using lab and field testing and comprehensive characterization and modeling techniques.

CO_2 will be injected under supercritical conditions to demonstrate state-of-the-art MVA tools and techniques to monitor and visualize the injected CO_2 plume and to refine geomodels developed using nearly continuous core, exhaustive wireline logs, and well tests and a multi-component 3D seismic survey. Reservoir simulation studies will map the injected CO_2 plume and estimate tonnage of CO_2 stored in solution, as residual gas, and by mineralization and integrate MVA results and reservoir models shall be used to evaluate CO_2 leakage. A rapid-response mitigation plan will be developed to minimize CO_2 leakage and provide comprehensive risk management strategy. A documentation of best practice methodologies for MVA and application for closure of the carbon storage test will complete the project. The CO_2 shall be supplied from a reliable facility and have an adequate delivery and quality of CO_2.

Scope of Work

Budget Period 1 includes updating reservoirs models at Wellington Field and filing Class II and Class VI injection permit application. Static 3D geocellular models of the Mississippian and Arbuckle shall integrate petrophysical information from core, wireline logs, and well tests with spatial and attribute information from their respective 3D seismic volumes. Dynamic models (composition simulations) of these reservoirs shall incorporate this information with laboratory data obtained from rock and fluid analyses to predict the properties of the CO_2 plume through time. The results will be used as the basis to establish the MVA and as a basis to compare with actual CO_2 injection. The small scale field test shall evaluate the accuracy of the models as a means to refine them in order to improve the predictions of the behavior and fate of CO_2 and optimizing carbon storage.

Budget Period 2 includes completing a Class II underground injection control permit; drilling and equipping a new borehole into the Mississippian reservoir for use in the first phase of CO_2 injection; establishing MVA infrastructure and acquiring baseline data; establishing source of CO_2 and transportation to the injection site; building injection facilities in the oil field; and injecting CO_2 into the Mississippian-age spiculitic cherty dolomitic open marine carbonate reservoir as part of the small scale carbon storage project.

In Budget Period 3, contingent on securing a Class VI injection permit, the drilling and completion of an observation well will be done to monitor injection of CO_2 under supercritical conditions into the Lower Ordovician Arbuckle shallow (peritidal) marine dolomitic reservoir. Monitoring during pre-injection, during injection, and post injection will be accomplished with MVA tools and techniques to visualize CO_2 plume movement and will be used to reconcile simulation results. Necessary documentation will be submitted for closure of the small scale carbon storage project.

Project Goals

The proposed small scale injection will advance the science and practice of carbon sequestration in the Midcontinent by refining characterization and modeling, evaluating best practices for MVA tailored to the geologic setting, optimize methods for remediation and risk management, and provide technical information and training to enable additional projects and facilitate discussions on issues of liability and risk management for operators, regulators, and policy makers.

The data gathered as part of this research effort and pilot study will be shared with the Southwest Sequestration Partnership (SWP) and integrated into the National Carbon Sequestration Database and Geographic Information System (NATCARB) and the 6th Edition of the Carbon Sequestration Atlas of the United States and Canada.

Project Deliverables by Task

1.5	Well Drilling and Installation Plan (Can be Appendix to PMP or Quarterly Report)
1.6	MVA Plan (Can be Appendix to PMP or Quarterly Report)
1.7	Public Outreach Plan (Can be Appendix to PMP)
1.8	Arbuckle Injection Permit Application Review go/no go Memo
1.9	Mississippian Injection Permit Application Review go/no go Memo
1.10	Site Development, Operations, and Closure Plan (Can be Appendix to PMP)
2.0	Suitable geology for Injection Arbuckle go/no go Memo
3.0	Suitable geology for Injection Mississippian go/no go Memo
11.2	Capture and Compression Design and Cost Evaluation go/no go Memo
19	Updated Site Characterization/Conceptual Models (Can be Appendix to Quarterly Report)
21	Commercialization Plan (Can be Appendix to Quarterly Report).
30	Best Practices Plan (Can be Appendix to Quarterly or Final Report)

ACCOMPLISHMENTS

1. The review of the Class VI application has made significant progress, and is nearing the final stages to be approved by EPA.

EPA has undergone numerous revisions of the Class VI permit application, and we are nearing the final round of responses to fulfill the requirements due by federal regulations. The KGS has been in close and frequent communication with EPA throughout the review process, and both parties have openly discussed the limited schedule that is imposed on the project for a December 2016 deadline. EPA has agreed to cooperate with us to the best of their ability to ensure we receive approval of the Class VI permit by the necessary date.

2. Freshwater monitoring boreholes have been sampled and indicate no presence of a USDW at the Wellington site.

The wells have been sampled according to QASP requirements established by EPA for the evaluating the USDW above the Arbuckle injection in the AOR established by simulation of injection of 40,000 tonnes of CO_2. EPA has requested that wells drilled late 2014 and early

2015 be re-purged and resampled to confirm that the wells exceed 10,000 TDS (no USDW at the site) and to sample two nearby domestic wells that are used for non-human consumption.

3. CO2 suppliers have been secured.

Linde and Praxair are suppliers for the CO2 for the Mississippian CO2-EOR and the Arbuckle saline aquifer small-scale injection. The CO2 market is favorable and suppliers have adequate CO2 available from several fertilizer plants. CO_2 supply and pumping/storage equipment availability reflects a shift in the CO_2 market to the buyer side that will benefit the project.

4. Performed workovers and obtained baseline sampling on surrounding Mississippian Boreholes for production and MVA during CO2-EOR.

Wells to be affected by and monitored during the CO2-EOR to evaluate the performance were checked, reconditioned as needed, and pressure tested. This work was completed during the spring and early summer 2015. Equipping and sampling of Mississippian monitoring wells was accomplished in the summer of 2015. Baseline analyses including prior brine analyses have now online and accessible as lists of wells, their analyses, and standard plots and maps of brine chemistry

Java web tools have been developed in 2015 to maintain the geochemical data obtained from fluid sampling of the monitoring wells. Baseline sampling of and existing recent brine analyses from the Mississippian has been compiled so that they can be analyzed temporally and spatially. Brine data obtained for KGS #2-32 during initial completion is illustrated with Java apps in following sections. Displays include database entry screens, lists of brine analyses, standard Piper and bar charts, and mapping of constituents in order to compare temporally and spatially between wells.

5. MVA components in place to monitor the Mississippian CO2-EOR injection, and revisited design and updated costs to fabricate U-Tube and CASSM for Arbuckle monitoring.

The design plans for the U-Tube and CASSM have been re-established to update costs pending actual fabrication that will occur during BP3 after receipt of the Class VI permit. Other MVA activities have been designed and are implemented for monitoring of the Mississippian CO2-EOR including installation and operation of infrastructure for data acquisition for 1) cGPS and InSAR to detect ground motion resulting from pressure changes when CO2 is injected, 2) an 18-seismometer array to monitor small (micro) seismic events down to -1 magnitude, 3) protocol and implementation of baseline fluid sampling in Mississippian monitoring wells near the sites of the CO2-EOR and the Arbuckle injection.

6. Conducted pulse test at KGS 2-32 Mississippian well

A variable rate pulse test was conducted on 5/12/15 between the closest four wells surrounding the injection well #2-32 and #2-32. Importantly, the test results established that there is communication between the KGS #2-32 and well immediately east, even though the two locations are believed to reside in separate progradational wedges of the spiculitic dolomite reservoir. Also, it was determined that the dominant flow is matrix not fracture.

7. Installed three new broadband seismometers near injection borehole

Seismometer Array – We are operating, archiving data, and interpreting baseline information obtained from fifteen Mark Products L-22 3-component seismometers with IRIS Ref-Tek R-130 Data Acquisition Systems (DAS) obtained from loan of NSF's IRIS program. Three new broadband, high sensitivity Nanometrics Trillium Compact Posthole seismometers purchased by KGS were installed and are now operational. The new Nanometrics systems have been configured for continuous data collection into an onboard recoding medium (SD card) at maximum sensitivity of 2 volts peak to peak with a sampling rate of 250 Hz, necessary to detect and analyze small microseismic events (**Figure 1**). An optimized methodology was developed to process the large data stream and to adjust the recording by processing earthquake data (signal/coda) from the region and comparing to other interpretations. It is confirmed that the seismometers array records a highly resolved, high frequency spectra.

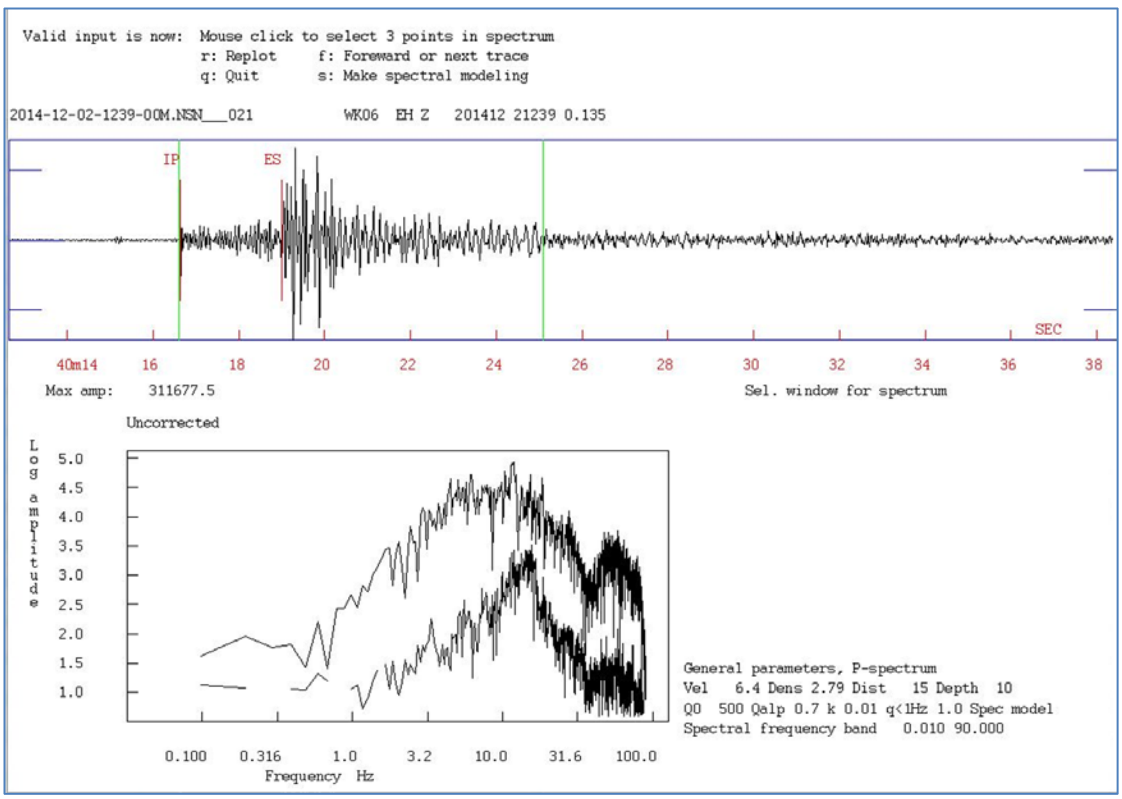


Figure 1. A record of waveforms (coda) of a 3.0 earthquake located ~15 miles west of Wellington to illustrate signal over the noise and preservation of the high frequency range (>10 Hz) which is usually attenuated significantly or absent in most recordings of earthquakes.

8. Establish Protocols for InSAR data collection

The InSAR data collection is underway following standard protocols. The satellite antenna has been set to record radar images over Wellington Field (**Figure 2**). The images are processed to generate interferograms and scenes are compared to establish persistent point scatterers as described later.

Motion of the scatterers provides the means to detect surface motion between scenes obtained roughly every 20 days.

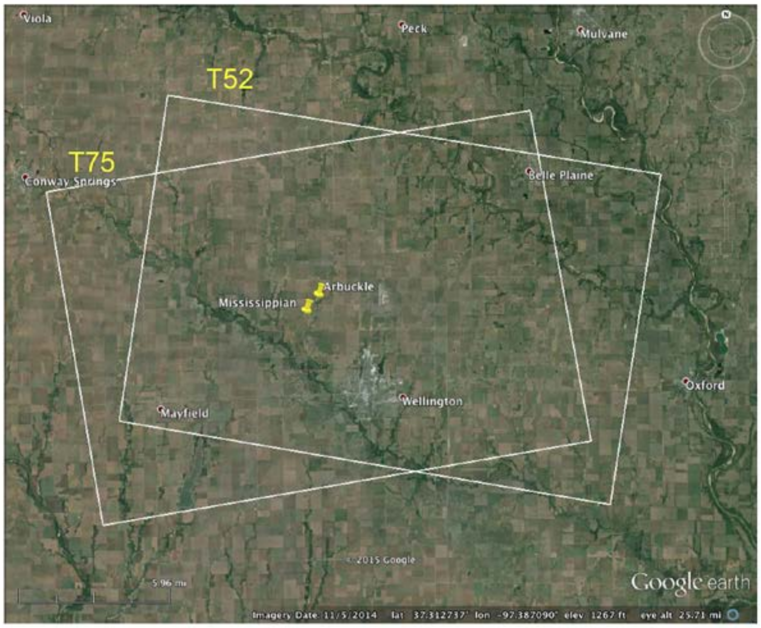


Figure 2. Footprints of a single ascending and descending pair of radarsat acquisitions obtained on an approximate 20-day interval.

Milestone Status Report

Task	Budget Period	Number	Milestone Description
Task 2.	1	1	Site Characterization of Arbuckle Saline Aquifer System - Wellington Field
Task 3.	1	2	Site characterization of Mississippian Reservoir for CO2 EOR - Wellington Field
Task 10.	2	3	Pre-injection MVA - establish background (baseline) readings
Task 13.	2	4	Retrofit Arbuckle Injection Well (#1-28) for MVA Tool Installation
Task 18.	3-yr1	5	Compare Simulation Results with MVA Data and Analysis and Submit Update of Site Characterization, Modeling, and Monitoring Plan
Task 22.	3-yr1	6	Recondition Mississippian Boreholes Around Mississippian CO2-EOR injector
Task 27.	3-yr2	7	Evaluate CO2 Sequestration Potential of CO2-EOR Pilot
Task 28.	3-yr2	8	Evaluate Potential of Incremental Oil Recovery and CO2 Sequestration by CO2-EOR - Wellington field

Project Schedule

Task 2 – Site Characterization of Arbuckle Saline Aquifer System - Wellington Field

Activities with this task were focused on addressing Requests for Additional Information (RAI) from EPA related to their review of the Wellington Class VI application. Activities are addressed as a timeline.

April 15-16, 2015

We received comments EPA on Table 3 of the RAI and the QASP and the team met with EPA to discuss .injection well monitoring (e.g., MIT's, injectate sampling, continuous monitoring of pressure/temperature/rate/volume) and discuss a schedule that EPA wishes to follow for the review of the Wellington Class VI permit. Above Confining Zone (ACZ), groundwater sampling, and Plume and Pressure Front monitoring were to be addressed in a later call in early May.

April 20

Meeting with EPA focused on financial assurance and PISC. It was conveyed by the team that our analyses to date from the shallow water wells installed that a fresh, usable shallow aquifer is not present in our AOR. A number of items were resolved during the meeting. Other items were addressed later with additional detail regarding questions related to modeling of the AoR.

The Wellington Shale is an aquiclude based on our drilling of shale in the AOR. The shale, beginning at a depth of 10 to 15 ft below the surface contains gypsum crystals. The uppermost argillaceous silt and sand above the Wellington Shale contains brine, apparently derived from a mixing of rainwater and groundwater. The lack of prospects for viable groundwater in the Wellington Shale due to low yield is also deemed in too close a proximity to the underlying 200 ft thick Hutchinson halite bed to be remediated. Moreover, unless a well is leaking from beneath, the Wellington Shale is acting as an aquiclude and protects the halite from meteoric infiltration and dissolution as occurs closer to the land surface east of Wellington Field.

We conveyed that local seismicity is being discussed with state regulators on at least a weekly basis. Action was taken by state regulators on March 17th to reduce brine injection in three areas southwest of Wellington Field. The basis is that the KGS assessment of seismicity along lineaments and what is believed to be likely do to unsafe levels of high volume brine injection wells in a 3 mile radius of the seismically defined lineaments.

April 29

Response to comments (51 questions) from EPA on QASP (Quality Assurance Surveillance Plan) submitted this week to EPA.

Second iteration of responses to EPA's RAI Tables 1 (AoR and Corrective Action, 28 questions) and Table 3 (Testing and Monitoring, 20 questions) submitted to EPA.

EPA has requested a conference call during the week of May 11th to discuss "Above Confining Zone and Plume/Pressure Front tracking monitoring". It would be highly beneficial for us to discuss the availability of acoustic fiber optic cable for use at Wellington Field to obtain a pseudo 3D VSP.

May 11th was deemed to be an important meeting so invitations to all members of the team who have technologies related to the Class VI injection into the Arbuckle were invited to address the readiness and capabilities –

- In situ CASSM, U-Tube, and crosswell seismic
- Surface based InSAR & cGPS, seismometers, 2D high resolution seismic to image any CO2 migrated into overlying Mississippian, repeat 3D seismic to close the project
- New InSAR scenes and cGPS records will be shared
- Seismometers are recording operational microseismicity and sensitivity has been estimated at magnitudes down to -1.

Clarifications and update of the well completion report on the third shallow water well, SW #3, was submitted to EPA this week. Results --

- The 50 ft well confirms TDS of surface water is well above 10,000 ppm as noted in Figure 1 and also previously observed in the 200-ft and 100-ft well SW #1 and SW#2 (**Figure 3**).
- The surface bedrock, Wellington Shale, is a shale aquitard lying beneath unconsolidated surficial silt and clay at ~20 ft.
- Shale contains gypsum beginning at 20 ft and brine includes Ca and SO4 in a predominately NaCl brine suggesting source of ions is from dissolution of gypsum and halite inherent to bedrock in the are
- Cuttings description and logging of KGS #2-32 in March confirms base of Wellington Shale at 260 ft overlying halite of Hutchinson Salt
- Aquiclude and shallow depth of halite precludes need for any mitigation of the shallow ground water.

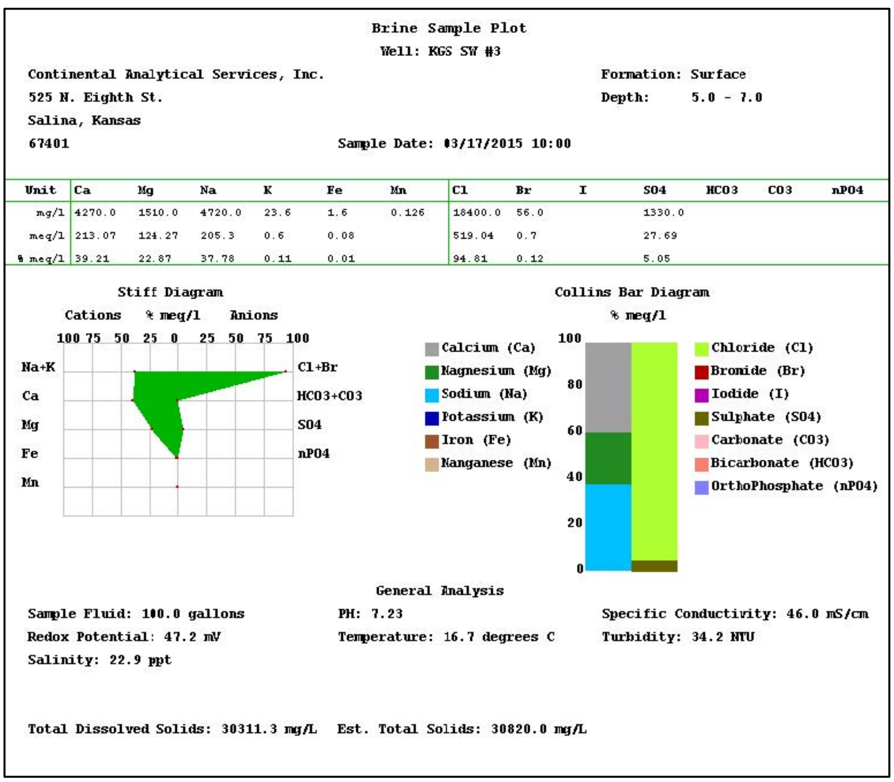


Figure 3. Java app prototype to display water/brine analyses stored in Oracle database for in tracking chemical changes in scientific monitoring and for EPA compliance. Example of brine from SW #3.

- KGS team also met with state regulators overseeing Class I wells including at ~20,000 barrels of hazardous waste within 30 miles of Wellington. This compares to roughly 500 bbls equivalent CO_2 per day to be injected in the Arbuckle.

April 30

Discussions with EPA have taken on a more productive and deliberate path in the last month with EPA offering a schedule. We have been very clear about of time constraints. The EPA schedule was endorsed by DOE Headquarters as discussions continued on responses to RAI's.

Our next conference call with EPA is tentatively set for **May 15th** when the topic will be **Above Confining Zone and Plume/Pressure Front tracking monitoring**. With DOE approval, we will introduce highlights of **DE-FE-OO12700** (R. Trautz, Distribute Fiber Optics) to EPA at this meeting as an additional means to monitor the CO_2 plume in the Arbuckle. Pseudo VSP monitoring with the acoustic fiber would significantly improve our ability to monitor the CO_2 plume, detect any leakage, and close the project

May 7

EPA received our responses to Tables 1, 3, and the QASP document.

We are updating our report of the evaluation of the surface waters in the AOR after receiving comments from EPA. The revision will be submitted to EPA this week as we prepare for a conference call with EPA on May 15th

Discuss with EPA the potential for using the 100-ft and 200-ft shallow wells as observation wells.

Finalized plans for location and acquisition of high resolution 2D seismic by R. Miller, KGS include: 1)further characterization of the confining zone above the Arbuckle, 2) heterogeneity in the Mississippian reservoir, 3) use vibroseis seismic source to obtain interval velocity by high resolution recording from seismometers in an effort to refine hypocenters of potential microseismic activity associated with movement of CO_2 along fractures during the Mississippian CO_2-EOR, 4) use of baseline to model the seismic response of CO_2 plume in the Mississippian reservoir that would be later tested by repeating the seismic line over the Mississippian injection well.

Work continues on establishing baseline for Mississippian water use with both the Mississippian and Arbuckle injections.

- Incorporating data obtained by Berexco related to previous well maintenance
- Incorporating analyses of Mississippian brine from DE-FE0002056 activities
- New sampling starting soon to provide a longer term (6+ mo.) baseline for the Arbuckle injection.

Mississippian injection well, KGS #2-32, was successfully completed last week. Mississippian was perforated 3663-3706 ft. acidized and a brine injectivity test was conducted indicating #150 psi surface pressure and 4 barrels per minute (5760 bbls per day). This is roughly 10x that rate that CO_2 would be injected so well has more than adequate injectivity.

Mississippian at KGS #2-32 is at residual oil saturation, estimated by Mina to be between 23 and 30% based on NMR log.

A 5-well interference test will commence on Monday of next week designed to:

Test communication between KGS #2-32 and surrounding wells and evaluate the effects of a small fault east of #2-32

Provide important geomechanical parameters via leakoff test in steps E-G of the pulse test schedule. Pulse test is designed and will be analyzed by Mina.

Pressure sampling rate is 1 second and duration of the recording will extend until the next day.

May 8

Berexco reviewed equipment and schedules for CO2. We still have some work to do on negotiating price. Plans have been reviewed to reduce costs that should translate into a better deal on CO2. More efficient field operations will translate into buying more CO2.

May 12

A pulse test was conducted between the closest four wells surrounding the injection well #2-32 and #2-32 (**Figure 4**). Importantly, the test results established that there is communication between the KGS #2-32 and well immediately east, even though the two locations are believed to reside in separate progradational wedges of the spiculitic dolomite reservoir.

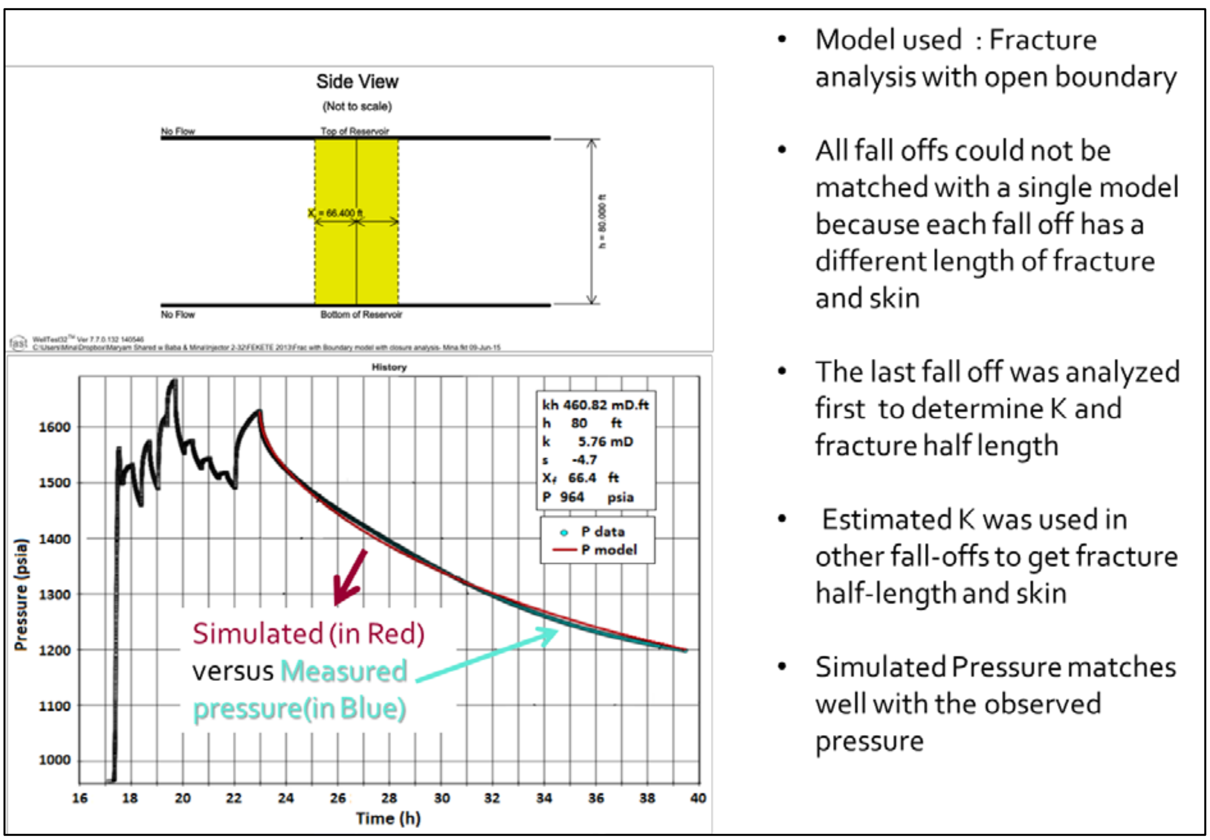


Figure 4. Pulse test simulation compared to actual data.

Effective permeability from the pulse test was 5.8 mD which will be equivalent to 17.8 mD in absolute permeability. Average log calculated absolute permeability for the equivalent interval of the pulse test and DST test is 19 mD. The two absolute permeabilities from the pulse test and logs are in agreements but permeability from DST is unreliable. The comparison of permeability obtained from whole-core and computed from well logs using the Fazelalavi method (*patent pending from this study*) is illustrated in **Figure 5**.

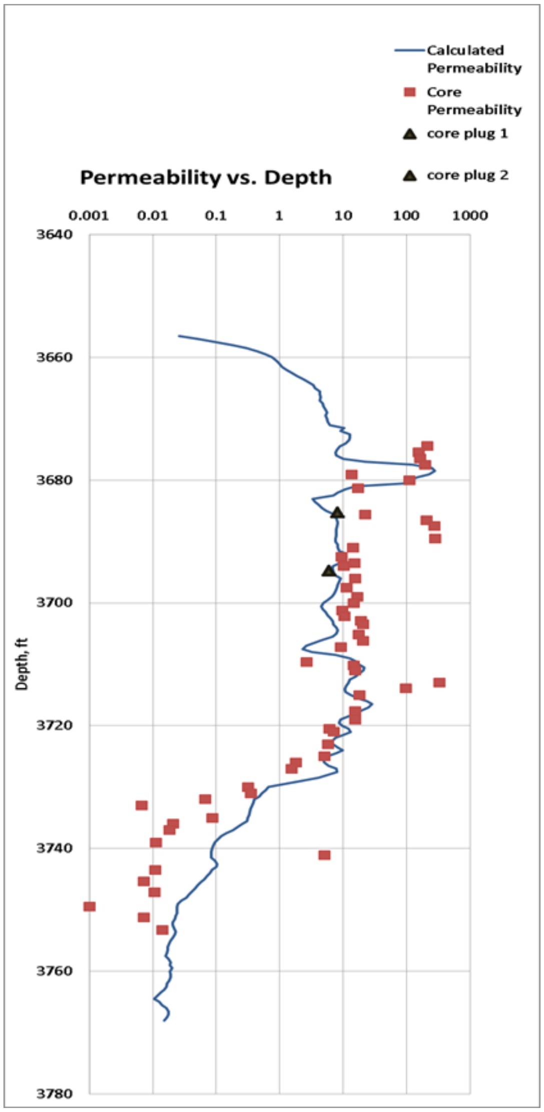
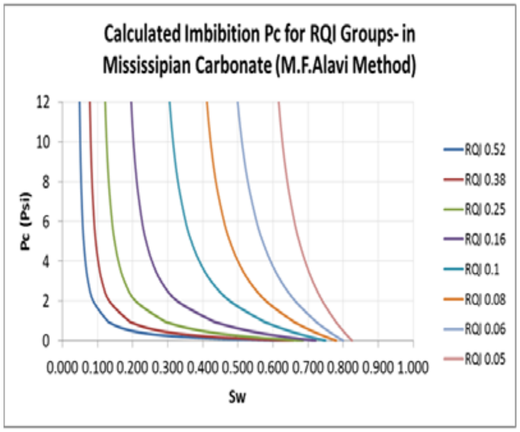


Figure 5. Comparison of calculated and measured permeability from logs and whole core from KGS #2-32 reveal a close match confirming again the accuracy of the log-derived permeability method in the primary reservoir interval with permeability over 0.1 md.

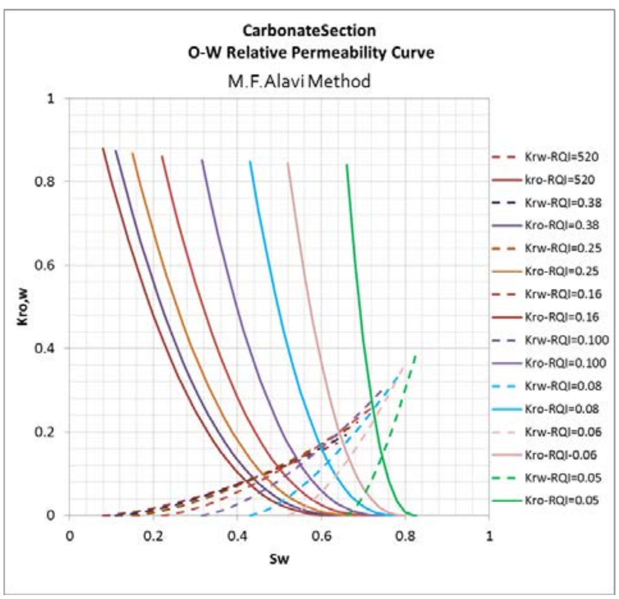
Additional log-based estimates of capillary pressure and relative permeability have confirmed accuracy and reliability when compared with corresponding core analyses from KGS #2-32 (**Figures 6 and7**).



- 8 Pc curves were calculated for 8 RQI ranges
- In this Technique, endpoints of Pc curves are related to RQI
- It was shown that endpoints of Pc curves (Sor and Swir) have stronger relations with RQI than K, ϕ or FZI

RT	From	To	Avg RQI
1	0.450	0.590	0.520
2	0.315	0.450	0.380
3	0.205	0.315	0.250
4	0.130	0.205	0.160
5	0.090	0.130	0.100
6	0.070	0.090	0.080
7	0.055	0.070	0.060
8	0.045	0.055	0.050

Figure 6. Log-derived computed capillary pressure curves for eight rock type (RQI, reservoir quality index).



- 8 Relative permeability curves for brine and oil were calculated for each RQI range
- Endpoints of relative permeability curves are related to RQI
- These endpoints have a stronger relationship with RQI than K , ϕ or FZI (Flow Zone Indicator)
- Corey exponents used for oil and water are 2.5 and 1.5

Figure 7. Log-derived relative permeability curves were calibrated with core derived data and show close correspondence.

RAI Table 5 sent to the KGS on 5-11-15 in preparation for prepare for May 15 meeting. We have been compiling specific information and responses to questions that have been addressed in the tables in order to expedite the review of the Testing and Monitoring and PISC Plan development. All relevant parties have been asked to participate in the meeting to ensure that we are able to offer sufficient detail in each area of expertise.

May 15

EPA meeting discussed responses to RAI Table 5.

1. Plume Monitoring

- Question: Validation of AoR modeling predictions with U-tube sampling results

General Response: Barry Freifeld, LBNL, described his validation methods in conjunction with other monitoring data. He went into detail about the specific benefits and limitations of each, and explained how those observations would relate to our other monitoring techniques.

- Questions: Seismic Surveys

  - Methodology
  - Comparison of results with model predictions,
  - Coverage of plume migration with seismic monitoring, and
  - Adequacy of well-based plume monitoring methods to detect leakage.

General Responses: G. Tsoflias, KU Geology, provided detail regarding the microseismic monitoring and 3D seismic evaluation used to refine his analysis. He explained his experience in 3D seismic surveys and how refining the acquisition would increase the ability to detect and monitor the CO2 plume in the formation. R. Miller described the procedures for the 3D and 2D seismic survey and coverage including details on how the 2D seismic surveys would clearly resolve gaseous CO2 at depth including Arbuckle and explained that these same methodologies should easily be able to detect migration into shallower intervals.

R. Trautz gave an overview of his funded Fiber Optic proposal and what the deployment could mean for our project – emphasizing tentatively scheduled for Wellington and experimental nature needing validation.

The EPA appreciated the helpful clarification and now understood the 2D seismic as more of an above confining zone monitoring technique. B. Freifeld, LBNL described downhole monitoring techniques and detection capability of the plume or potential CO2 leakage.

- Questions: CASSM and Cross-well Tomography

  - Baseline monitoring schedule
  - Design and placement of downhole sensors
  - Comparison of results with AoR modeling predictions

General Responses: B. Freifeld, LBNL, responded with specific designs tailored to Wellington and frequency of sampling events.

2. Pressure-Front Monitoring

- Questions: InSAR and GPS

  - Thresholds of observed pressure increases requiring further investigation
  - Existing observations of baseline data

General Response: M. Taylor, KU Geology, presented images of collected InSAR data and analysis of baseline cGPS to date. He will continue to process radar scenes, but their use for pressure monitoring yet is indeterminate. An interferometery comparison of two scenes from Wellington was presented. Detection of ground motion below 1 mm is questionable even though scene resolution is very good. Discussion addressed the experimental nature of this methodology.

- Questions: Passive Seismic Monitoring

  - Additional details on resolution and detection capability of seismometer array

General Response: Rick Miller will explain the ability to identify x,y,z coordinates of microseismic events, and clarify that the detection capability of the network far exceeds EPA reporting requirements for M2.5+ earthquakes. Details on John Victorine's processing tools will also be introduced as a means to identify the location and depth of observed earthquakes.

A large portion of the discussion centered on quantifying deviations in field observations from the predictive models that would trigger further investigation to characterize leakage.

- There was some confusion on the level of detail that the EPA required for each of the technologies, and it was argued that defining a specific threshold would be extremely difficult with the level of uncertainty surrounding the planned injection.

- To resolve this issue, the team prepared an ***Operational Plan for Safe and Effective Injection*** that was submitted to EPA as part of the response to the RAI Table 5 questions as part of the Class VI application and specifically, the section on ***Emergency and Remedial Response Plan***

3. Groundwater/Geochemical Monitoring Above the Confining Zone

- Questions:

  - Shallow Water Well locations
  - Above Confining Zone Pressure Monitoring

General Responses: D. Wreath, Berexco, clarified operating conditions in the field including waterflooding causing normal fluctuations in pressure in the well annulus of wells completed in the Mississippian oil reservoir making it extremely difficult to accurately identify leakage based on pressure monitoring alone. As a precaution, the annulus of the Mississippian monitoring wells will be checked daily for escaping gas. In the unlikely event that gas is observed during the Arbuckle test, samples will be collected and tested to detect the presence of any escaped CO_2.

May 18th

Establish communication with Sumner County Economic Development Commission www.gosumner.com. Set general plans to meet with Sumner County Commissioners and Wellington City Council in late August, early Sept. before meeting with the public regarding progress related to CO_2-EOR pilot injection and saline aquifer pilot test. Will update and share the *Wellington Field Fact Sheet* and the *FAQ document.*

May 21

The ***Operational Plan for Safe and Effective Injection*** outlines a workflow that uses the most reliable and most responsive monitoring methods to detect anomalies during injection that may trigger some kind of corrective action. Preset thresholds of injection pressure, temperature, injection profile monitoring, chemical composition, and passive seismic monitoring will provide the primary means prevent leakage of CO_2 accompanied by our 2nd tier monitor to evaluate the progress of the plume.

The passive seismic monitoring described in the ***Operational Plan for Safe and Effective Injection*** parallels the approach taken by ADM for their Class VI permit at Decatur, Ill using known performance of the seismometer array installed and operating at Wellington.

The ***Operational Plan for Safe and Effective Injection*** also incorporates methodologies from Kansas' Induced Seismicity Task Force to evaluate brine injection and take action to mitigate recent seismicity associated with high rate, pressure, and volume brine injection in Class II wells located southwest of Wellington Field.

We plan to share a draft of the plan early next week.

May 22

Interval review of the geomechanical analysis of the Arbuckle injection – "*Supplement to Section 6 of Wellington Class VI Permit Application*"

May 26

In the ongoing discussions with EPA regarding seismicity comparison made of commercial brine and hazard waste disposal with Wellington, important to note the relative differences between the injection rates in the Arbuckle at Wellington vs. nearby Class I wells (~18 mi north of Wellington) (**Figure 8**). At the CO_2 site, we will be injecting about 25,000 tons which equates to about 6 million gallons (MG) of fluid. By contrast, at the OxyChem site north of Wellington, they have been injecting about 700 million gallons per year (nearly 100 times more every year). Additionally, the injection per well at the OxyChem site is as high as 175 MG/yr. All this injection at OxyChem has occurred without any major earthquakes.

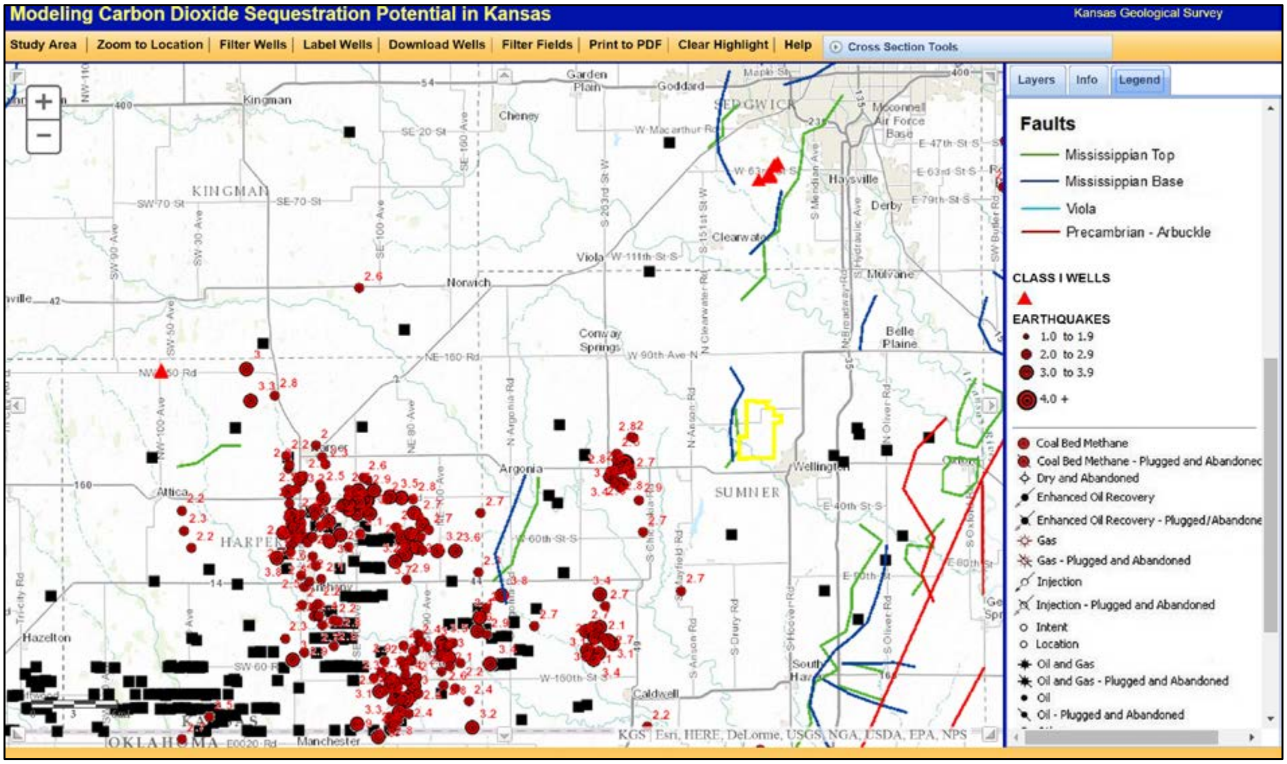


Figure 8. Location map of Class 1 wells near Wichita north of Wellington on base map with oil fields (colored squares). Map also shows inferred faults and recent (since 2011) earthquakes located west and southwest of Wellington Field.

May 29

RAI Table #6 was received by KGS on 5-19-15 and RAI Table #5 was submitted to EPA today.

The latest version of the ***Operational Plan for Safe and Effective Injection (OPSEI)*** outlines a *"…workflow for deploying day-to-day operation of the Arbuckle CO_2 injection. The workflow integrates system operation, testing and monitoring, and emergency and remedial response that are necessary for prudent operation to satisfy both DOE and EPA criteria for success, namely, to understand the behavior, fate, and storage of CO_2; and to conduct the test safely, meeting or exceeding GS permit requirements. Moreover, the workflow is focused in early detection of multiple changes in data types to validate that changes are occurring in the behavior CO_2 injection that warrants better understanding, analysis, and action. The operational plan incorporates and cross references information already part of the GS Permit as described in Sections 8, 10, and 13, and provides more details of operating activities that will ensure success.*

This document also defines our operation strategy toward successfully conducting the research for DOE to satisfy the SOPO and PMP requirements and to ensure safety first for EPA. ***OPSEI*** stems from the conference call with EPA held on 5-15-15. Conveying the operational plan to EPA at this time is critical to completing the Class VI review by providing a strategy that will minimize risks and emphasize safety of the pilot test.

OPSEI provides a bridge between well, monitoring, and response items initially submitted to EPA for the Geosequestration (GS) Class VI Permit Application, namely,

- *Section 8* -- *System Design, Construction, and Operation*
- *Section 10* -- *Proposed Testing and Monitoring Plan*
- *Section 13* -- *Proposed Emergency and Remedial Response*
-

The ISSTF incorporates the Seismic Action Plan and it will be very important for the state regulators to be fully cognizant of the activities related to CO2 injection into the Arbuckle at Wellington Field. We look at the injection as a key element in understanding the behavior of fluid injection in the Arbuckle with minimal risk for seismicity due to rates, volume, and pressures of the CO_2 injection. Moreover, we are utilizing work done by the KGS to share with the Kansas' Induced Seismicity Task Force who are building regional static and dynamic models of larger scale brine disposal in the south-central Kansas that includes the Wellington area. These results are allowing us to compare sizes of injection between Wellington and nearby UIC Class I and II disposal wells. All of this is important information to convey to the public in terms of relaying the focus and coordination between federal and state agencies to better understanding on what are safe injection parameters to ensure public safety in the future, an objective of the induced seismicity task force.

June 5

The updated grid file requested in Table 1 RAI was uploaded to the GS Data Tool, along with the original rescue file to verify that errors in cell values were due to conversion issues between the requested file formats.

Well completion reports for SW #1 and #2 have been completed and are under review by S. Datta and when submitted to EPA will serve as information to determine the presence of a USDW at the Wellington site.

Task 3 – Site characterization of Mississippian Reservoir - Wellington Field

May during month –Excessive rain has pushed back deploying the 2D seismic. At this point, our plan is to wait until the wheat has been harvested mid-June. This will also avoid paying damages to landowners. However, now that the new seismometers have been installed, it will be a good opportunity to calibrate them with the various tests that occurred around the Mississippian injection.

May 4

- **Completion of Mississippian injection well and discussion of variable rate pulse test test**

May 11

Request the 3D velocity volume from Fairfield-Nodal of Wellington to use in computing hypocenter location of microseismicity.

May 11-12

Conduct variable rate pulse test on Wellington KGS #2-32

May 19

KGS received capillary injection pressure analyses on Wellington #2-32 Mississippian reservoir samples (**Figure 5**).

MERCURY INJECTION DATA SUMMARY

Company:	Berexco LLC
Well:	Wellington KGS #2-32
Field:	Wellington
Formation:	Upper Mississippian
Location:	Sumner County, Kansas
File:	HOU-150357

Sample: 1m	un-	Host Plug	
Depth, feet 3685.20	stressed	n/a	n/a
Klinkenberg Permeability, md:	N/A	-	-
Permeability to Air, md:	N/A	-	-
Swanson Permeability, md:	9.41	-	-
Porosity, fraction:	0.237	-	-
maximum Sb/Pc, fraction:	0.109		
R35, microns:	1.26		
R50 (median pore throat radius):	0.991		

Injection Pressure, psia	Mercury Saturation, fraction	Pseudo-Wetting Saturation, fraction	Pore Throat Radius, microns	J Values	Conversion to other Laboratory Fluid Systems, psia G-W	G-O	O-W	Estimated Height Above Free Water, feet G-W	O-W
0.770	0.000	1.000	140	0.00283	0.149	0.0497	0.0862	0.311	0.619
1.10	0.000	1.000	97.9	0.00404	0.213	0.0711	0.123	0.445	0.884
1.39	0.000	1.000	77.5	0.00511	0.269	0.0898	0.156	0.562	1.12
1.66	0.000	1.000	64.9	0.00610	0.322	0.107	0.186	0.671	1.33
2.05	0.000	1.000	52.6	0.00753	0.397	0.132	0.229	0.828	1.65
2.50	0.000	1.000	43.1	0.00919	0.484	0.161	0.280	1.01	2.01
3.01	0.000	1.000	35.8	0.0111	0.583	0.194	0.337	1.22	2.42
3.55	0.000	1.000	30.4	0.0130	0.688	0.229	0.397	1.43	2.85
4.16	0.000	1.000	25.9	0.0153	0.806	0.269	0.465	1.68	3.34
4.80	0.000	1.000	22.4	0.0176	0.930	0.310	0.537	1.94	3.86
5.50	0.000	1.000	19.6	0.0202	1.07	0.355	0.615	2.22	4.42
6.25	0.000	1.000	17.2	0.0230	1.21	0.404	0.699	2.53	5.02
7.04	0.000	1.000	15.3	0.0259	1.36	0.455	0.788	2.85	5.66
7.90	0.000	1.000	13.6	0.0290	1.53	0.510	0.884	3.19	6.35
8.80	0.000	1.000	12.2	0.0323	1.71	0.568	0.985	3.56	7.07
9.74	0.000	1.000	11.1	0.0358	1.89	0.629	1.09	3.94	7.83
10.8	0.000	1.000	9.99	0.0396	2.09	0.696	1.21	4.36	8.68
11.9	0.000	1.000	9.06	0.0437	2.30	0.768	1.33	4.81	9.56
13.4	0.000	1.000	8.05	0.0492	2.59	0.864	1.50	5.42	10.8
15.3	0.000	1.000	7.07	0.0560	2.96	0.985	1.71	6.18	12.3
17.6	0.000	1.000	6.14	0.0645	3.40	1.13	1.96	7.11	14.1
20.4	0.000	1.000	5.28	0.0750	3.96	1.32	2.28	8.24	16.4
23.6	0.000	1.000	4.57	0.0867	4.57	1.52	2.64	9.54	19.0
26.8	0.000	1.000	4.02	0.0985	5.20	1.73	3.00	10.8	21.5

Sample: 1m

Median Pore Throat, µm	Pore Radius Throat, µm	System	Approximate Threshold Data, Entry Pressure, psia Lab	Resv	Height, ft
0.991	2.86	A-Hg	37.7	-	n/a
		G-W	7.3	5.1	15
		O-W	4.2	2.6	30
		A-Hg	260	(kPa)	

Pressure, psia	Increm. Hg sat'n fraction	Cumulative Kf
0.530	0.0000	0.00E+00
0.770	0.0000	0.00E+00
1.10	0.0000	0.00E+00
1.39	0.0000	0.00E+00
1.66	0.0000	0.00E+00
2.05	0.0000	0.00E+00
2.50	0.0000	0.00E+00
3.01	0.0000	0.00E+00
3.55	0.0000	0.00E+00
4.16	0.0000	0.00E+00
4.80	0.0000	0.00E+00
5.50	0.0000	0.00E+00
6.25	0.0000	0.00E+00
7.04	0.0000	0.00E+00
7.90	0.0000	0.00E+00
8.80	0.0000	0.00E+00
9.74	0.0000	0.00E+00
10.8	0.0000	0.00E+00
11.9	0.0000	0.00E+00
13.4	0.0000	0.00E+00
15.3	0.0000	0.00E+00
17.6	0.0000	0.00E+00
20.4	0.0000	0.00E+00
23.6	0.0000	0.00E+00
26.8	0.0000	0.00E+00

Pore Throat Radius, µm	Hg Sat'n, fraction cumulative	frequency
<0.0025	0.000	0.000
0.0050	0.004	0.003
0.0075	0.009	0.006
0.010	0.016	0.007
0.025	0.058	0.042
0.050	0.085	0.027
0.075	0.103	0.018
0.10	0.121	0.018
0.25	0.198	0.077
0.50	0.296	0.098
0.75	0.390	0.095
1.0	0.504	0.113
2.5	0.999	0.495
5.0	1.000	0.001
7.5	1.000	0.000
10	1.000	0.000
25	1.000	0.000
50	1.000	0.000
75	1.000	0.000
100	1.000	0.000
>100	1.000	0.000

Conversion Parameters

	air/water	air/oil	oil/water
Laboratory Theta -->	0.0	0.0	30.0
Laboratory IFT -->	72.0	24.0	48.0
Reservoir Theta -->	0.0	0.0	30.0
Reservoir IFT	50.0	0.0	30.0
Laboratory TcosTheta --	72.0	24.0	41.6
Reservoir TcosTheta -->	50.0	0.0	26.0
A-Hg Contact Angle:	140		
A-Hg IFT:	485		
A-Hg TcosTheta:	371.5		
Density Gradients, psi/foot		(typical)	
Water:	0.433	0.433	
Oil:	0.346	0.346	
Gas:	0.100	0.100	

Sample Parameters	
Weight, g	7.697
PVol, cc	0.847
GVol, cc	2.727
BVol, cc	3.574
GDens, gm/cc	2.822
Bdens, gm/cc	2.154

R35 Line	
0.001	0.35
100	0.35
Micro boundary	
0.5	0
0.5	1
Macro boundary	
2.5	0
2.5	1

Gas-Water Pc Test Pc	I-F Sw
0	
25	
50	
100	
200	
300	
450	
650	
900	
1200	

Total Surface Area m^2/g

Qv value is from:

estimated	CoCw	NMR	CEC	BJ adsb H2O

Qv Correction

1	Salinity, g/L
0.00	Qv, e/L
1.000	A = phi(eff)/phi(tot)
-	Qv, e/L for ~good match
-	Qv from companion

Thomeer and Swanson Parameters

PS1 (large pore system) G Factor	Pd	BV(inf)	PS2 (fine pore system) G Factor	Pd	BV(inf)	PS3 (fine pore system) G Factor	Pd	BV(inf)	BV TOTAL
									0.00

Thomeer K, md: #DIV/0! Swanson K md: 9.41

Swanson Point is at max Bv corr/Pc = 0.1091 Pc= 102 Bv= 11.167

Figure 5. Capillary pressure data for a sample from core analysis done by Core Lab on the Mississippian of KGS #2-32.

May 26

Mina Falzelalavi provided pressure-temp plots on interference test in KGS #2-32 and initial assessment. It appears that the response in the nearby wells may have been impacted by nearby production/injection to the east and northwest. Jenn Raney and Mina obtained operational information on these wells from Berexco so she can perform further analysis. They will work with Eugene to see how he handles these wells in his simulation.

Based in these preliminary findings of the inference test, Eugene indicates pre-pressurization will take considerably less than 20 days. We will make sure that the simulation most closely reflects the conditions of the field.

Task 7. Pre-injection MVA - Establish Background (Baseline) Readings

Seismometer array – R. Miller compiled baseline reports for seismicity around Wellington. We plan to present these to EPA to demonstrate the variation in what has been observed and what is expected during the injection. Rick is also establishing a case for using the passive seismic data more strongly to support the pressure front monitoring of the plumes (in lieu of exclusively using the InSAR as the primary technology). Recent communication from G. Tsoflias, expresses his reservations on pressure front detection until we have a real test. He is the primary collaborator whose team will carry out the microseismic event detection. He states,

> "*…microseismic will image the pressure front only if the pressure front induces fracturing of the formation on the order of -1.0 or greater magnitude earthquake event. Until we establish what the likelihood is for the pressure front to cause such events as it diffuses away from the injection borehole, unless it re-activates existing fault(s) and fractures. The seismometer network at the surface is likely to detect induced seismicity at times of rapid pressure regime change, most likely near the injection borehole and in regions where existing fault(s) and fractures get re-activated. Moreover, previous discussions of using microseismic to monitor the pressure front were in reference to a borehole seismic installation. That work was proposed for a KU internal funding initiative by Mike Taylor but it was not funded. In my opinion a fair statement is that we will use the seismometer network to monitor for seismicity induced by the pressure front. But we should not commit to a pressure front map derived from microseismic until we have had the chance to look at some data from the Mississippian injection…*"

Berexco reserved two Mississippian wells into which the borehole seismic could be installed at optimal locations on the edge of the modeled pressure front.

High Res 2D Seismic Lines Targeting Mississippian Reservoir -- Acquisition of the baseline high-resolution 2D seismic survey was set to begin on May 14th, but wet ground has prevented deployment to the date of filing this report. Lines will connect our key wells and evaluate inferred small fault that some seismic interpretations indicate affect the Mississippian reservoir

(**Figure 6**). Specific objectives set this this 2D survey include: 1) further characterization of the confining zone above the Arbuckle, 2) further resolve heterogeneity in the Mississippian reservoir, 3) use of seismic source to obtain velocity volume to location of hypocenters of microseismic activity anticipated with the Mississippian injection, 4) use of baseline to model the seismic response of CO_2 plume in the Mississippian that would be later tested by repeating the seismic line over the Mississippian injection well.

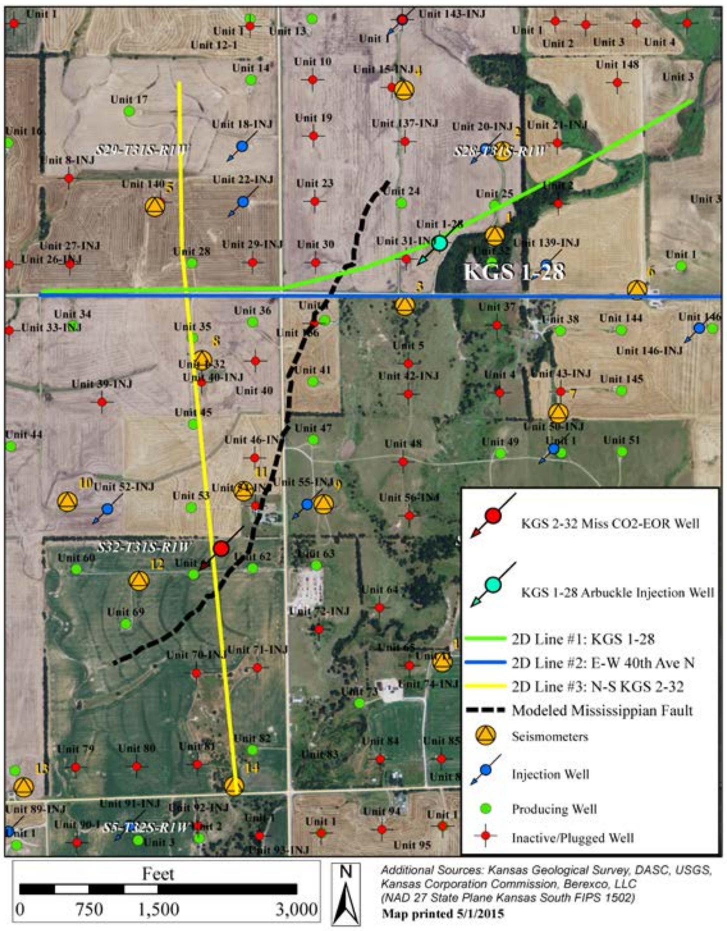


Figure 6. Index map of the high resolution 2-D surveys.

cGPS-InSAR is operational. Question now on whether persistent scatterers in the SAR images are sufficient to detect ground motion from either a Mississippian or Arbuckle injection. Accordingly, we relegating the use of InSAR to detect the CO2 pressure front to be uncertain at this point until sufficient background are obtained and the method tested during repressurization and injection in the Mississippian.

The latest SAR images are encouraging based on what M. Taylor shared earlier, but at this point levels of detection; any kind of calibration to pressure is only speculative. The April 2015 SAR image was compared to the 2014 aerial photos of the drill sites, KGS #1-32 and

#2-32. The SAR image shows strong point scatterers at the wellsite and other nearby wells **(see Figures 7-13)**.

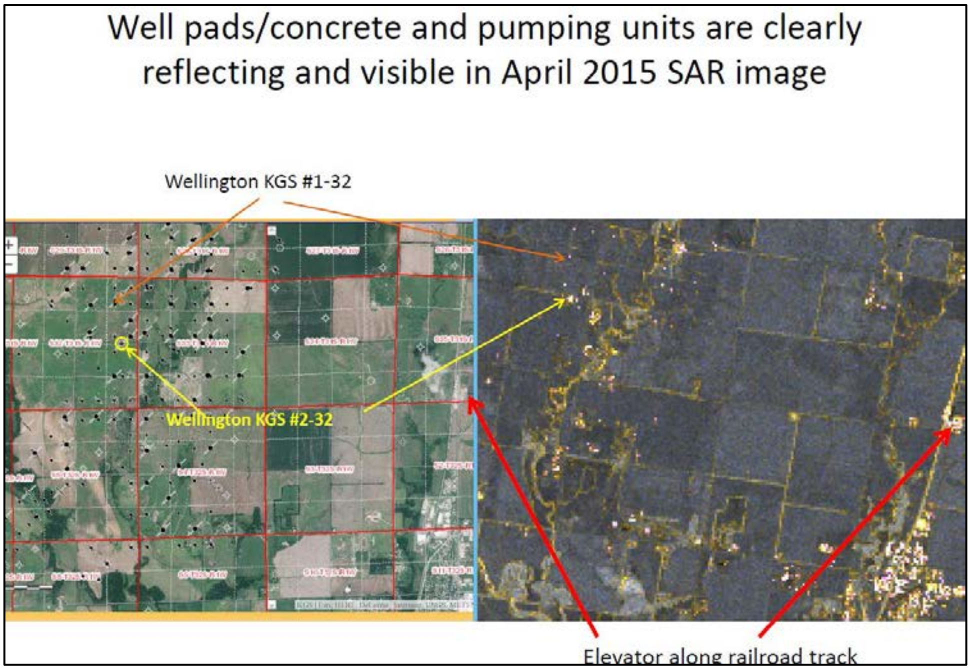


Figure 7. Aerial view from 2014 compared to SAR image with KGS #1-32 and #2-32 shown.

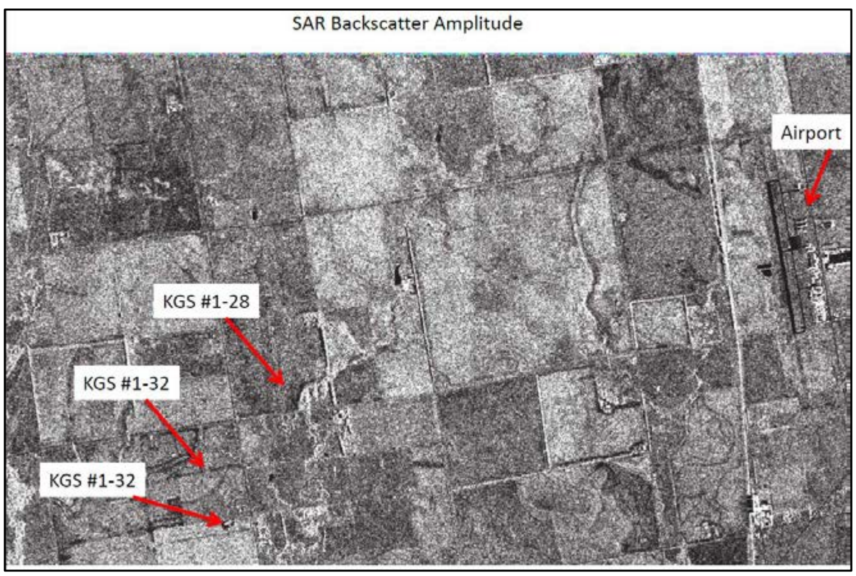


Figure 8. Unprocessed SAR from Wellington Field area (acquired April 2015)

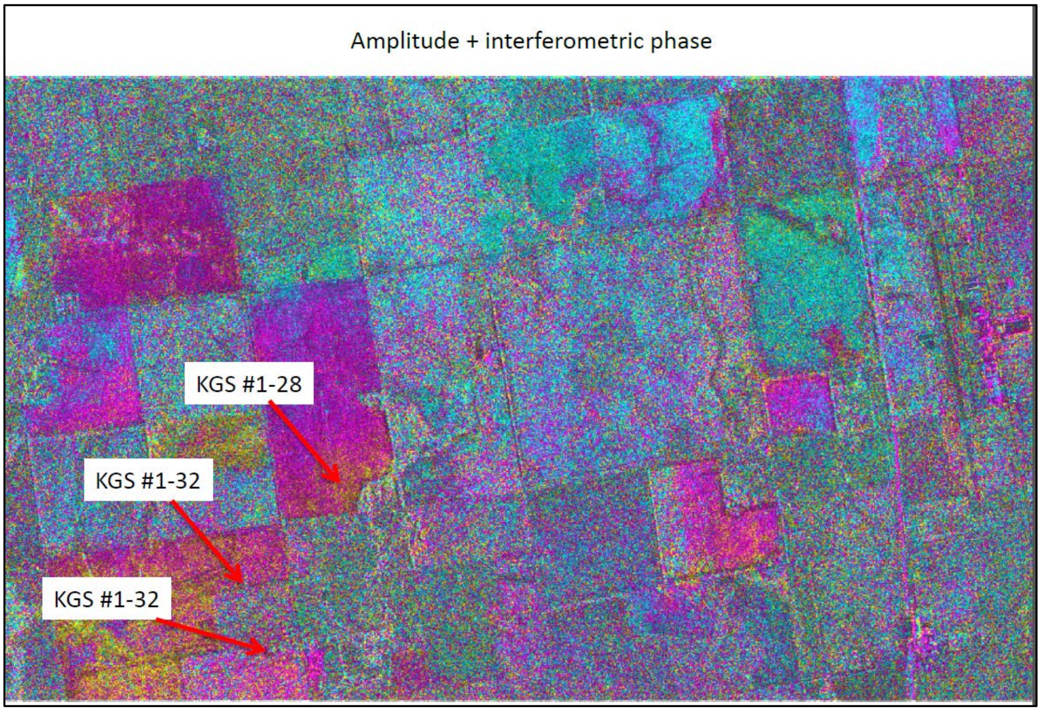


Figure 9. Processed SAR acquired April 2015.

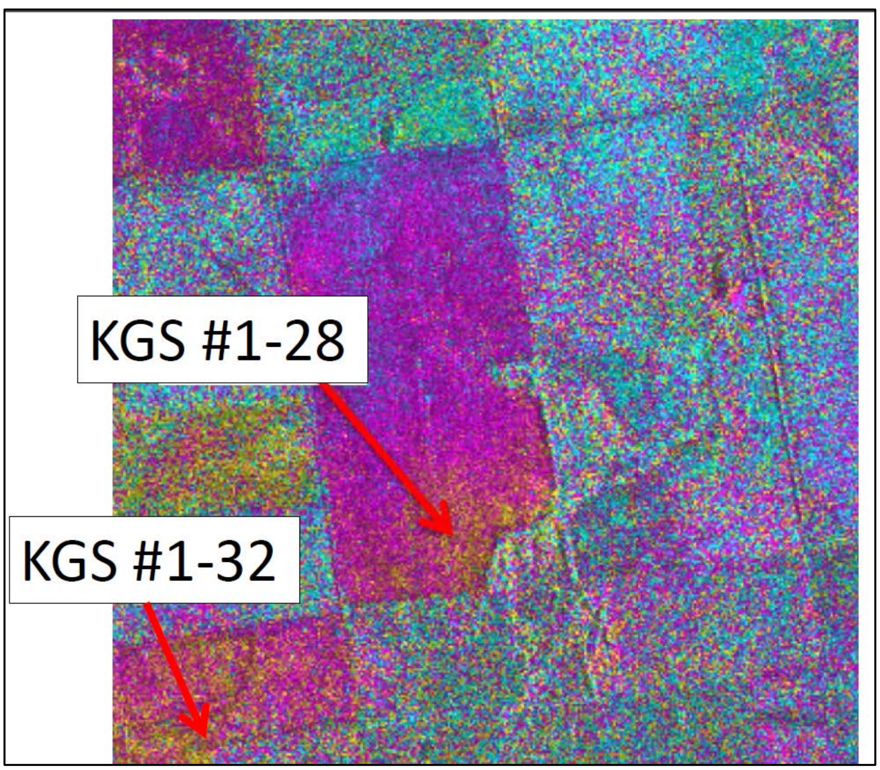


Figure 10. Close-up of SAR from April 2015.

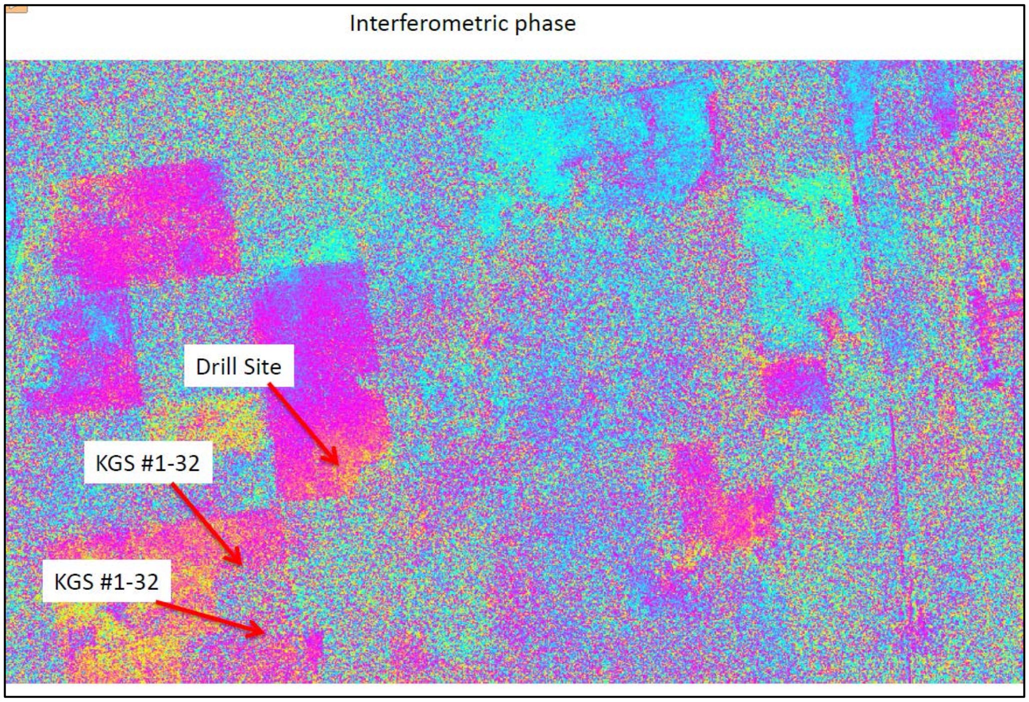


Figure 11. Processed SAR from 2015.

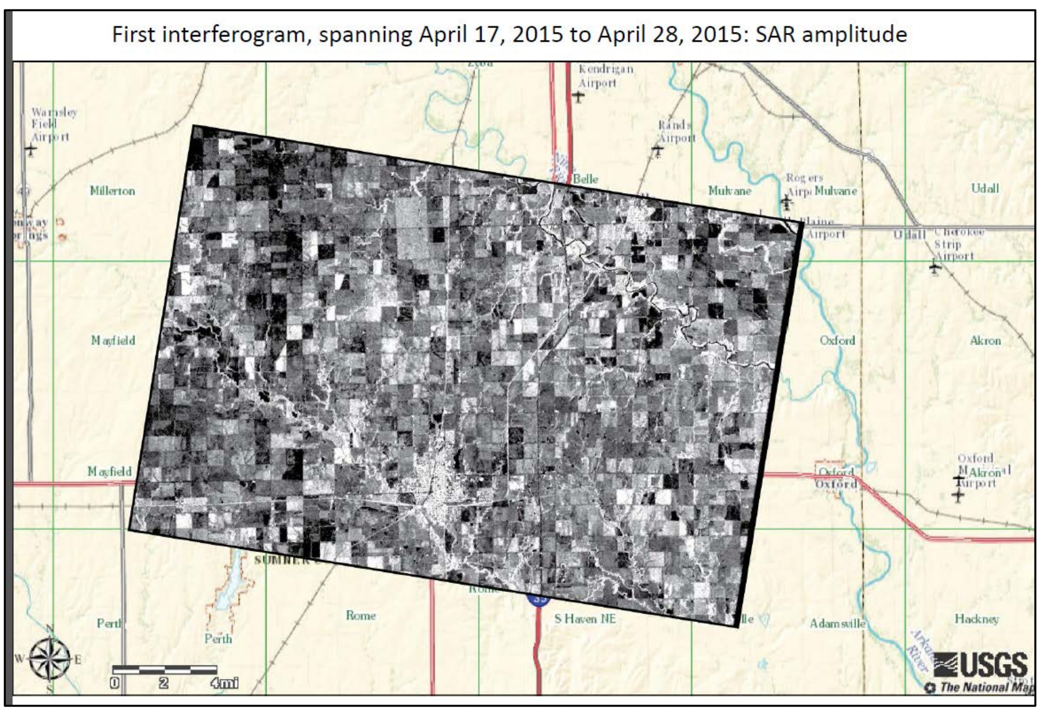


Figure 12. Reference map of area covered by SAR scene, April 2015.

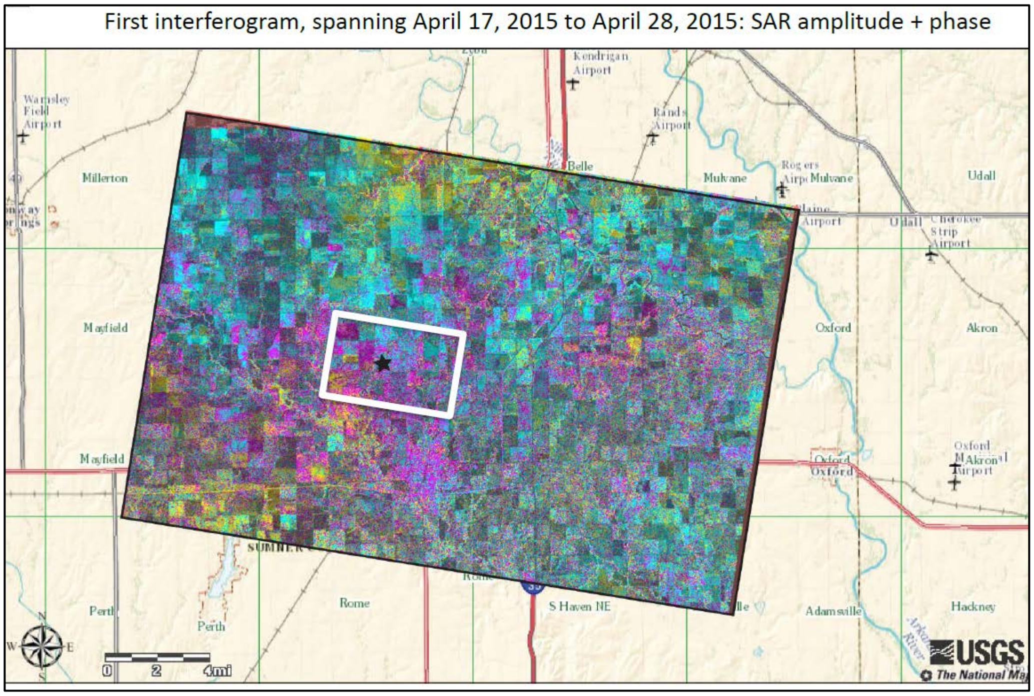


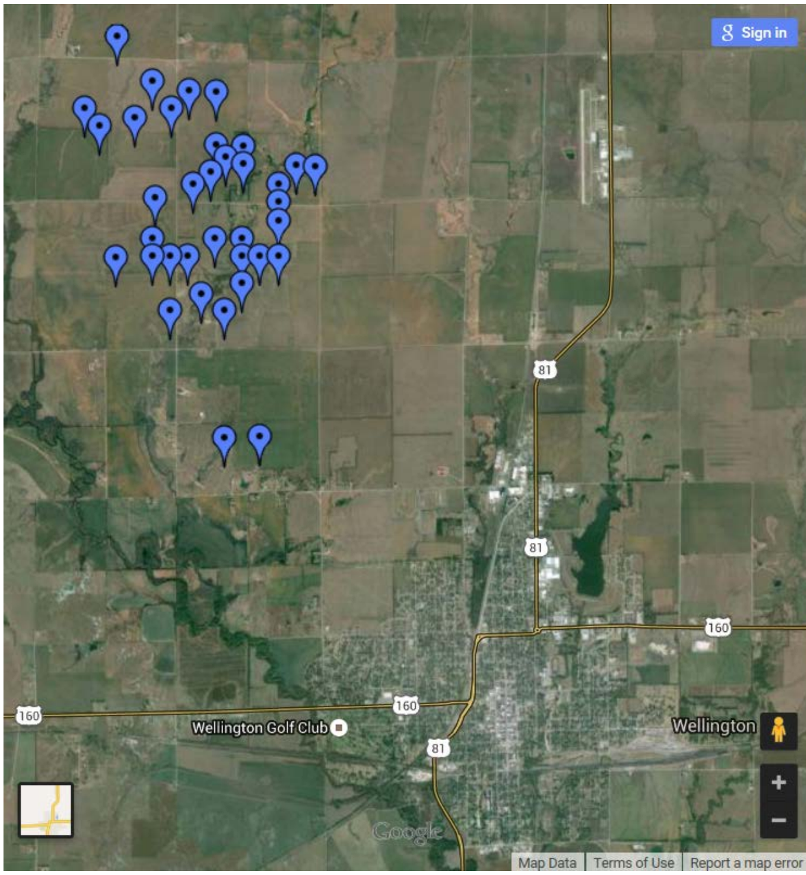
Figure 13. Interferogram for SAR.

Subtask 7.4 Head Gas & Water Sampling from Surrounding Mississippian Wells

S. Datta, C. Reese, and B. Campbell began sampling the Mississippian wells this quarter to obtain baseline fluid analyses. Standardized reporting for the analyses established reside on a KGS Oracle database. The brine and other baseline analysis of fluids from the Mississippian and accessed, processed, and results of analyses displayed using Java software (**Figures 14-18**).

The new approach for the GIS display used KML files created using ORACLE stored procedure. The web page is at **http://www.kgs.ku.edu/PRS/Ozark/Software/google-maps/brine_data_by_wells.html.** The markers and the well information are displayed in the upper right hand corner with a link to a Brine Data Summary Web Page for a specific well. The Brine Data Summary Web Page by Well Header KID will show all brine samples for that well.

A brine analysis lab is being set up in Wellington to expedite analysis of Mississippian wells to accelerate establishment of the baseline before CO2 injection begins. Details of the wells to be sampled and the sampling protocol have been established.



WELLINGTON KGS 1-32
15-191-22591
Longitude:
-97.442414
Latitude: 37.315444
Elevation (GL): 1259

Figure 14. Google map based access to the brine data is being examined as a means to quickly share results with the team and permit comparison of other MVA data such as microseismic and InSAR during the Mississippian CO2 injection.

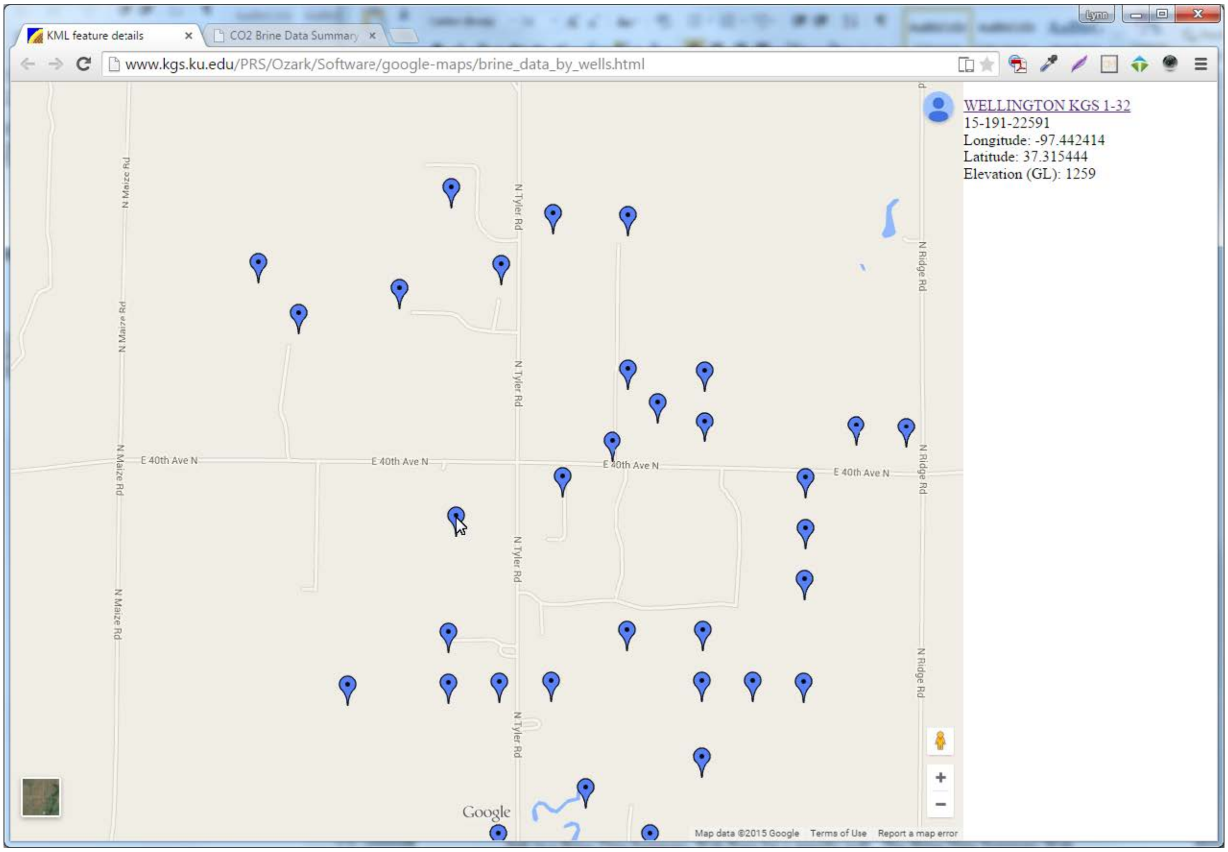
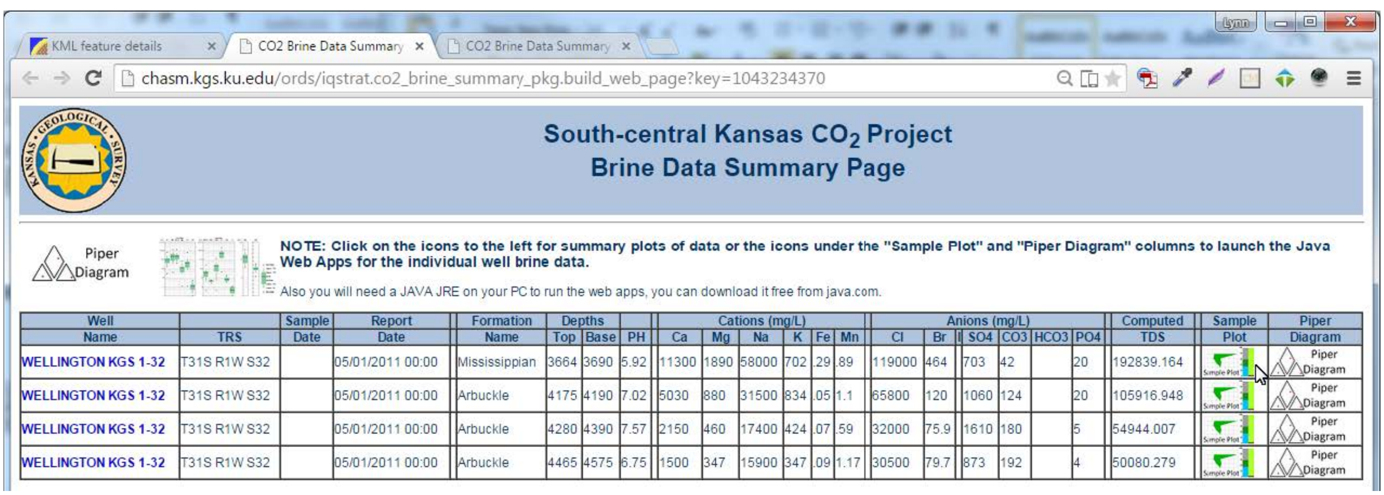


Figure 15. Well KGS #1-32 water samples were selected in this interactive map as noted in the upper right corner of the map.


KML feature details | CO2 Brine Data Summary | CO2 Brine Data Summary

chasm.kgs.ku.edu/ords/iqstrat.co2_brine_summary_pkg.build_web_page?key=1043234370

South-central Kansas CO_2 Project
Brine Data Summary Page

Piper Diagram

NOTE: Click on the icons to the left for summary plots of data or the icons under the "Sample Plot" and "Piper Diagram" columns to launch the Java Web Apps for the individual well brine data.

Also you will need a JAVA JRE on your PC to run the web apps, you can download it free from java.com.

Well Name	TRS	Sample Date	Report Date	Formation Name	Depths Top	Depths Base	PH	Cations (mg/L) Ca	Mg	Na	K	Fe	Mn	Anions (mg/L) Cl	Br	I	SO4	CO3	HCO3	PO4	Computed TDS	Sample Plot	Piper Diagram
WELLINGTON KGS 1-32	T31S R1W S32		05/01/2011 00:00	Mississippian	3664	3690	5.92	11300	1890	58000	702	.29	.89	119000	464		703	42		20	192839.164	Sample Plot	Piper Diagram
WELLINGTON KGS 1-32	T31S R1W S32		05/01/2011 00:00	Arbuckle	4175	4190	7.02	5030	880	31500	834	.05	1.1	65800	120		1060	124		20	105916.948	Sample Plot	Piper Diagram
WELLINGTON KGS 1-32	T31S R1W S32		05/01/2011 00:00	Arbuckle	4280	4390	7.57	2150	460	17400	424	.07	.59	32000	75.9		1610	180		5	54944.007	Sample Plot	Piper Diagram
WELLINGTON KGS 1-32	T31S R1W S32		05/01/2011 00:00	Arbuckle	4465	4575	6.75	1500	347	15900	347	.09	1.17	30500	79.7		873	192		4	50080.279	Sample Plot	Piper Diagram

Figure 16. Click on KGS 1-32 well samples in Figure 15 and obtain the list of samples available. Idea is to permit comparison of brine data both temporally and spatially.

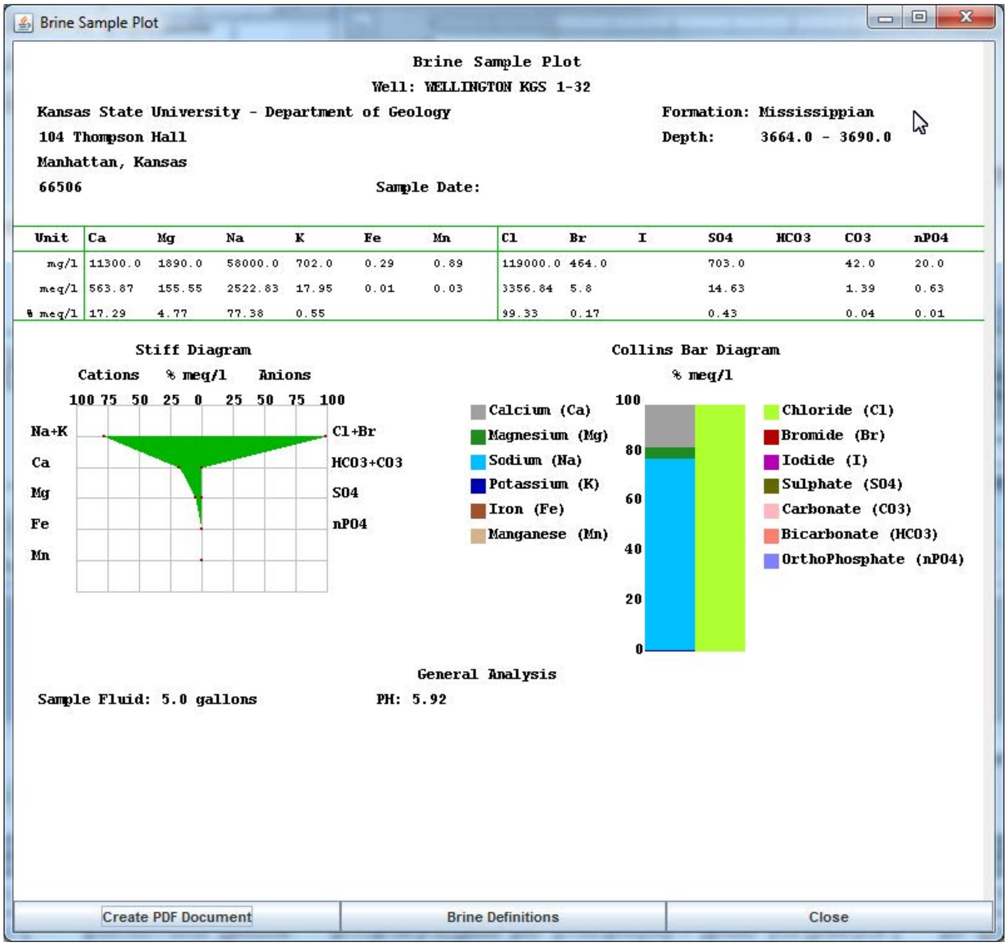


Figure 17. Brine sample plot of Mississippian analysis at KGS #1-32.

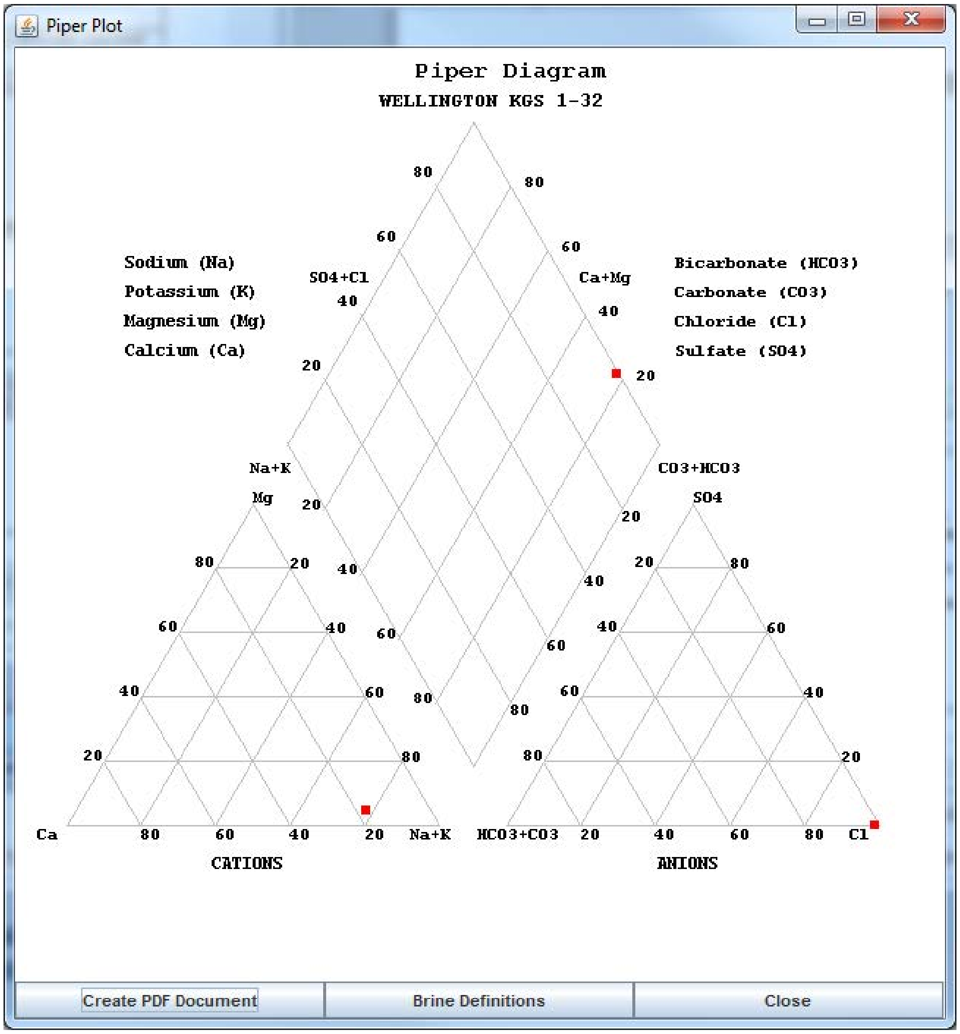


Figure 18. Piper diagram of Mississippian analysis at KGS #1-32.

Project schedule for pre- and post-Arbuckle injection at Wellington Field.

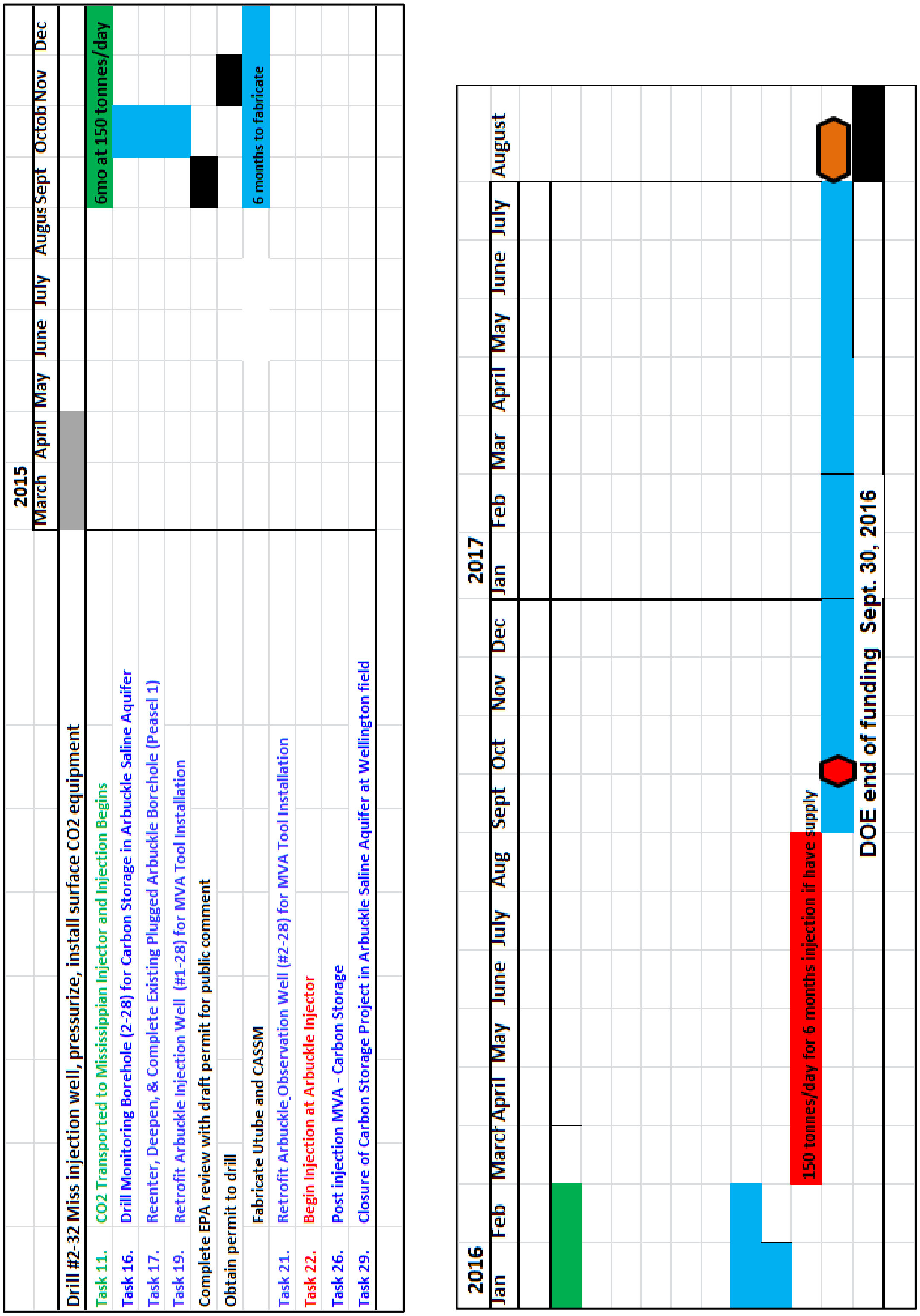


Figure 19. Revised Gantt chart.

Activities of Lawrence Berkeley National Lab

No work has been completed or funds expended during this quarter by LBNL.

Key Findings

1. Review by EPA and responses to RAI's for Class VI application have reached the final stages currently focused on 1) resolution of grid transformation of the simulation that will confirm the AOR and 2) the final field testing and analyses of the water and the local geohydrology to the presence of a USDW in the AOR.
2. The Mississippian CO2-EOR activities including completion and testing of the CO2 injection well, KGS #2-32, and establishing the baseline MVA measurements are complete as of the time this report is submitted.
3. Addressed safe CO2 injection with an operational plan that outlines use of monitoring activities and thresholds to detect anomalies, operate safely, acquire necessary data, and complete the injection successfully to evaluate the MVA technologies.

Plans for Fourth Quarter 2015

1. Complete preparations for CO2 injection to the Mississippian.
2. Inject CO2 into the Mississippian.
3. Continue to respond to EPA's review of the Class VI permit application.

PRODUCTS

Publications, conference papers, and presentations

L. Watney, April 14, 2015, *A Maturing Mississippian Lime Play in the Midcontinent – A Perspective on What We Know and Need to Know*, KU Interdisciplinary Carbonate Consortium.

L. Watney, May 5, 2015, *CO2-EOR in the Wellington Field, Sumner County, South Central Kansas -- Southwest Kansas CO2-EOR Initiative CO2 utilization in oil fields and storage in Arbuckle saline aquifer in southern: Kansas, Implementing CO2 Utilization and Storage (CCUS) in Kansas*, KU TORP Improved Oil Recovery Conference, Wichita.

L. Watney, June 18 2015, invited presentation to Kansas Society of Professional Engineers, "Local Earthquake Activity, Wichita.

PARTICIPANTS & OTHER COLLABORATING ORGANIZATIONS

Organizational Structure
Small Scale Field Test - Wellington Field (FE0006821)

University of Kansas Center For Research

Kansas Geological Survey

Name	Project Job Title	Primary Responsibility
W. Lynn Watney	Project Leader, Joint PI	*Geology, information synthesis, point of contact*
Jason Rush	Joint PI	*Geology, static modeling, data integration, synthesis*
Tiraz Birdie	Consulting Engineer	*Engineer, data synthesis, Class VI application*
Yevhen 'Eugene' Holubnyak	Petroleum Engineer	*Reservoir Engineer, dynamic modeling, synthesis*
John Doveton	Co-Principal Investigator	*Log petrophysics, geostatistics*
Kerry D. Newell	Co-Principal Investigator	*Fluid geochemistry*
Richard Miller	Geophysicist	*2D Seismic acquisition, interpretation, monitoring wells*
Fatemeh 'Mina' FazelAlavi	Engineering Assistant	*Log data analysis, modeling*
John Victorine	Software Programmer	*Database management, web tool design*
Jennifer Raney	Project Coordinator	*Project management, communications, data handling*

KU Department of Geology

Name	Project Job Title	Primary Responsibility
Mike Taylor	Co-Principal Investigator	CGPS, InSAR surveys, microseismic data integration
Drew Schwab	Graduate Research Student	InSAR surveys, seismic

Subcontracts

Kansas State University

Name	Project Job Title	Primary Responsibility
Saugata Datta	Co - Principal Investigator	*Aqueous Geochemistry, tracer analysis*
Austin Krehel	Graduate Research Assistant	*Sampling, aqueous geochemistry*

Lawrence Berkeley National Laboratory

Name	Project Job Title	Primary Responsibility
Tom Daley	Co - Principal Investigator	*Geophysicist, crosshole and CASSM data*
Barry Freifeld	Co - Principal Investigator	*Mechanical Engineer, U-Tube Sampler*

Berexco, Beredco Drilling -- *Wichita, KS*

Wellington Field access; drilling, completion and testing; monitoring and sampling, daily field operation

Name	Primary Responsibility
Dana Wreath - VP	*Manager, engineer*
Evan Mayhew	*Operations manager, well design*
Brett Blazer	*Engineer, field operations*
Jason Bruns	*Canaan Well Services - contact*
Beredco Drilling Team	*Drilling and completion activities*

CO_2 Suppliers

Praxair Services, Inc.

Pete Wilt	*Commercial Business Director*
Justin Anderson	*Oil & Gas Representative*
Mark Weise	*Oil & Gas Representative*

Linde, LLC

Earl Lawson	*Vice President*
Neeraj Saxena	*Clean Energy Services*
Chris White	*Business Development Engineer*
Kevin Watts	*EOR Director*

Figure 20. Organizational Chart.

IMPACT

Discussions with EPA around the Class VI application have established a means to effectively manage injection in an area what has been affected by induced seismicity.

CHANGES/PROBLEMS

No significant change or problems.

BUDGETARY INFORMATION

Cost Status Report

See figure on the following page for the cost status for quarters 1-15.

COST PLAN/STATUS	BP1 Starts: 10/1/11						
Baseline Reporting Quarter	10/1/11-12/31/11 Q1	1/1/12-3/31/12 Q2	4/1/12-6/30/12 Q3	7/1/12-9/30/12 Q4	10/1 /12- 12/31/12 Q5	1/1/13 - 3/31/13 Q6	4/1/13 - 6/30/13 Q7
Baseline Cost Plan (from SF-424A)	(from 424A, Sec. D)						
Federal Share	$326.84	$17,208.52	$17,282.92	$31,693.50	$23,000.00	$23,000.00	$23,000.00
Non-Federal Share	$365,421.00	$365,421.00	$365,421.00	$365,421.00	$0.00	$0.00	$0.00
Total Planned (Federal and Non-Federal)	$365,747.84	$382,629.52	$382,703.92	$397,114.50	$23,000.00	$23,000.00	$23,000.00
Cumulative Baseline Cost	$365,747.84	$748,377.36	$1,131,081.28	$1,528,195.78	$1,551,195.78	$1,574,195.78	$1,597,195.78
Actual Incurred Costs							
Federal Share	$326.84	$17,208.52	$17,282.92	$31,693.50	$31,572.56	$25,465.07	$13,078.68
Non-Federal Share	$0.00	$6,475.85	$43,028.94	$9,058.04	$15,226.34	$0.00	$0.00
Total Incurred Costs-Quarterly (Federal and Non-Federal)	$326.84	$17,208.52	$60,311.86	$40,751.54	$46,798.90	$25,465.07	$13,078.68
Cumulative Incurred Costs	$326.84	$17,535.36	$77,847.22	$118,598.76	$165,397.66	$190,862.73	$203,941.41
Variance							
Federal Share	$0.00	$0.00	$0.00	$0.00	-$8,572.56	-$2,465.07	$9,921.32
Non-Federal Share	$365,421.00	$358,945.15	$322,392.06	$356,362.96	-$15,226.34	$0.00	$0.00
Total Variance-Quarterly Federal and Non-Federal)	$365,421.00	$358,945.15	$322,392.06	$356,362.96	-$23,798.90	-$2,465.07	$9,921.32
Cumulative Variance	**$365,421.00**	**$724,366.15**	**$1,046,758.21**	**$1,403,121.17**	**$1,379,322.27**	**$1,376,857.20**	**$1,386,778.52**

			BP1 Ends 8/31/14		BP2 Starts 9/1/14	Ends 8/31/15		
Baseline Reporting Quarter	7/1/13-9/30/13 Q8	10/1/13 - 12/31/13 Q9	1/1/14 - 3/31/14 Q10	4/1/14 - 6/30/14 Q11	7/1/14 - 9/30/14 Q12	10/1/14 - 12/31/14 Q13	1/1/15 - 3/31/15 Q14	4/1/15 - 6/30/15 Q15
Baseline Cost Plan (from SF-424A)								
Federal Share	$23,000.00	$1,997,070.75	$1,997,070.75	$1,997,070.75	$1,997,070.75	$325,087.75	$325,087.75	$325,087.75
Non-Federal Share	$0.00	$258,982.75	$258,982.75	$258,982.75	$258,982.75	$184,656.00	$184,656.00	$184,656.00
Total Planned (Federal and Non-Federal)	$23,000.00	$2,256,053.50	$2,256,053.50	$2,256,053.50	$2,256,053.50	$509,743.75	$509,743.75	$509,743.75
Cumulative Baseline Cost	$1,620,195.78	$3,876,249.28	$6,132,302.78	$8,388,356.28	$10,644,409.78	$11,154,153.53	$11,663,897.28	$12,173,641.03
Actual Incurred Costs								
Federal Share	$52,993.14	$23,181.46	$12,053.49	$9,400.96	$0.00	$50,936.04	$74,137.93	$435,392.38
Non-Federal Share	$0.00	$0.00	$0.00	$90,624.59	$0.00	$33,953.80	$1,409,519.41	$0.00
Total Incurred Costs-Quarterly (Federal and Non-Federal)	$52,993.14	$23,181.46	$12,053.49	$100,025.55	$0.00	$84,889.84	$1,483,657.34	$435,392.38
Cumulative Incurred Costs	$256,934.55	$280,116.01	$292,169.50	$392,195.05	$392,195.05	$477,084.89	$1,960,742.23	$2,396,134.61
Variance								
Federal Share	-$29,993.14	$1,973,889.29	$1,985,017.26	$1,987,669.79	$1,997,070.75	$274,151.71	$250,949.82	-$110,304.63
Non-Federal Share	$0.00	$258,982.75	$258,982.75	$168,358.16	$258,982.75	$150,702.20	-$1,224,863.41	$184,656.00
Total Variance-Quarterly Federal and Non-Federal)	-$29,993.14	$2,232,872.04	$2,244,000.01	$2,156,027.95	$2,256,053.50	$424,853.91	-$973,913.59	$74,351.37
Cumulative Variance	**$1,356,785.38**	**$3,589,657.42**	**$5,833,657.43**	**$7,989,685.38**	**$10,245,738.88**	**$10,670,592.79**	**$9,696,679.20**	**$9,771,030.57**