SECARB Anthropogenic Test Update

12th Annual SECARB Stakeholders Briefing

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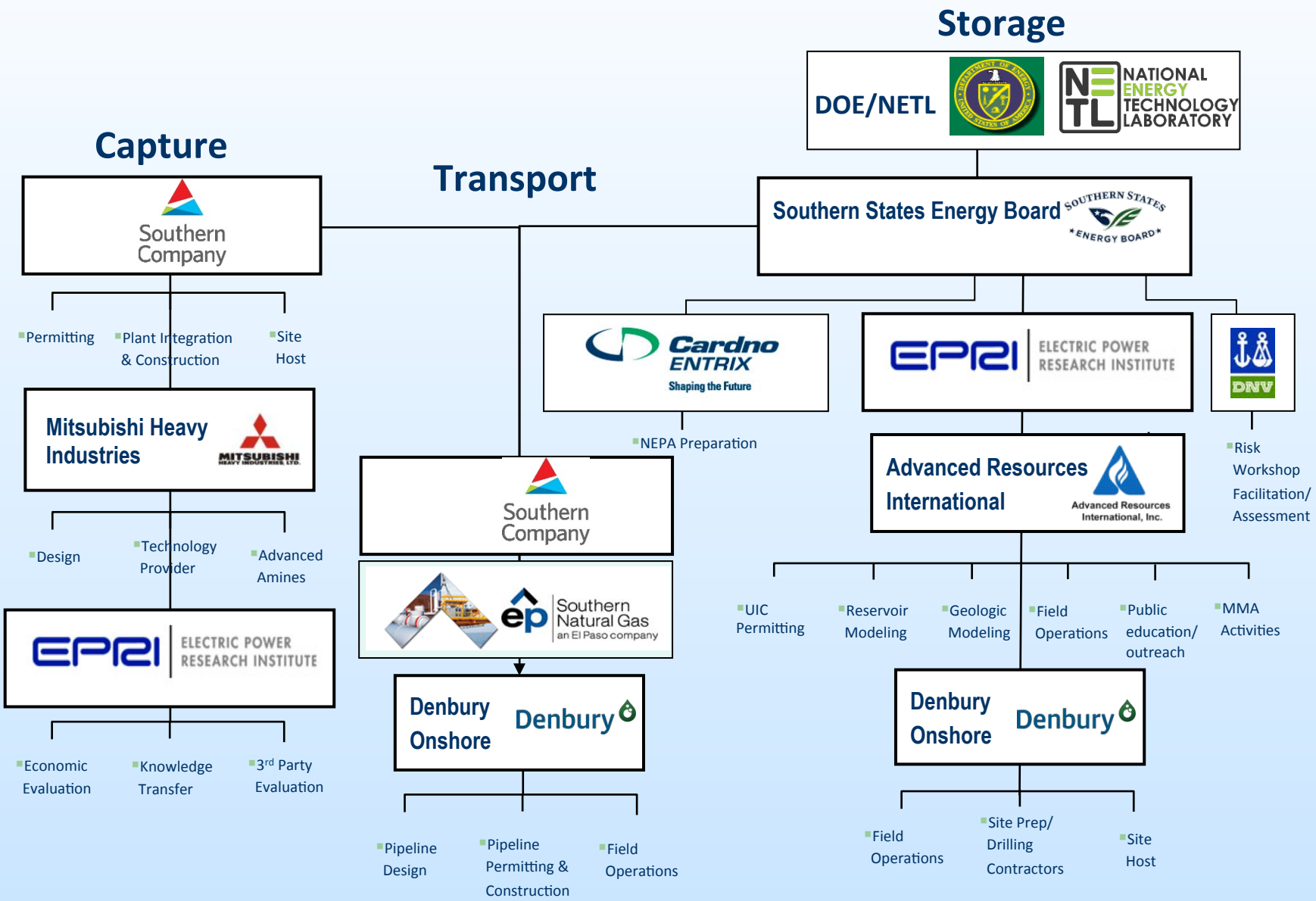
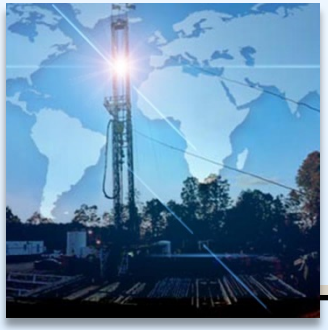
Organizational Chart



Presentation Outline

1. Project Introduction
2. Status
3. 2016-17 Monitoring Results
4. Project Closeout



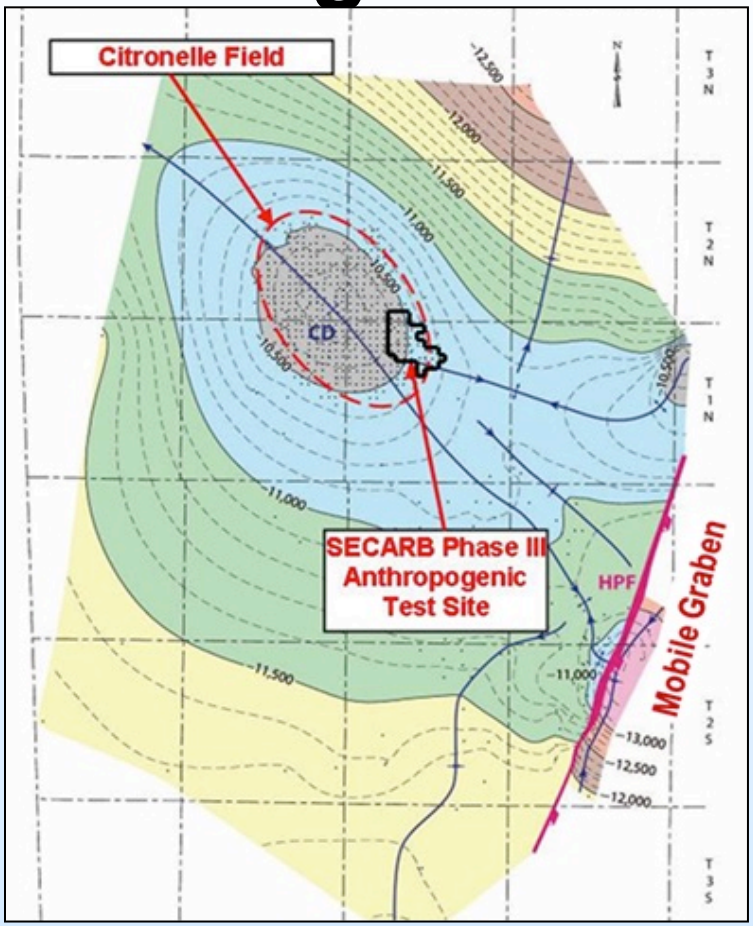
SECARB Anthropogenic Test Introduction

Project Goals and Objectives

Baseline 1 year	Injection 2 years	Post 3 years
APR 2011 to AUG 2012	SEP 2012 to SEP 2014	SEP 2014 to SEP 2017

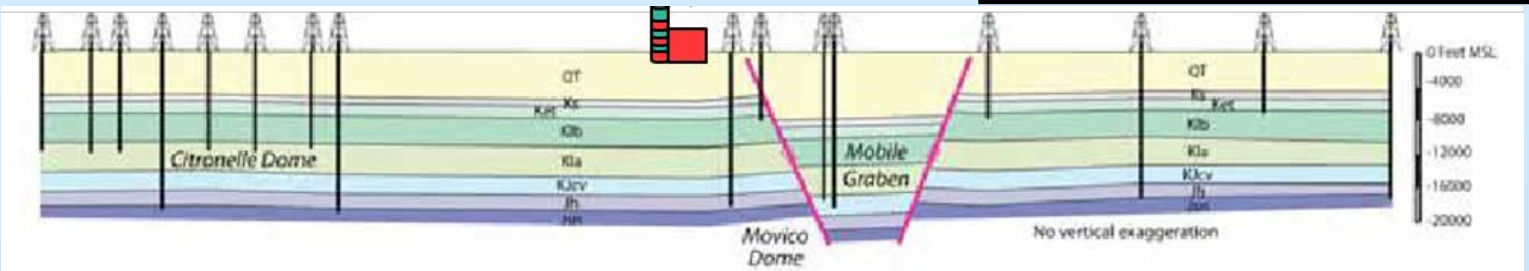
1. Support the United States' largest (*at the time*) prototype CO_2 capture and transportation demonstration, with injection, monitoring and storage activities;
2. Test the CO_2 flow, trapping and storage mechanisms of the Paluxy;
3. Demonstrate how a saline reservoir's architecture can be used to maximize CO_2 storage and minimize the areal extent of the CO_2 plume;
4. Test the adaptation of commercially available oil field tools and techniques for monitoring CO_2 storage;
5. Test experimental CO_2 monitoring activities, where such technologies hold promise for future commercialization;
6. Begin to understand the coordination required to successfully integrate all four components (capture, transport, injection and monitoring) of the project; and
7. Document the permitting process for all aspects of a CCS project.

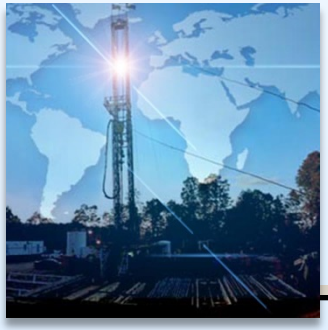
Storage Site: The Citronelle Oilfield



Structure map and cross section by GSA

System	Series	Stratigraphic Unit	Major Sub Units	Potential Reservoirs and Confining Zones
Tertiary	Plio-Pliocene		Citronelle Formation	Freshwater Aquifer
	Miocene	Undifferentiated		Freshwater Aquifer
	Oligocene		Chickasawhay Fm.	Base of USDW
		Vicksburg Group	Bucatunna Clay	Local Confining Unit
	Eocene	Jackson Group		Minor Saline Reservoir
		Claiborne Group	Talahatta Fm.	Saline Reservoir
		Wilcox Group	Hatchetigbee Sand Bashi Marl Salt Mountain LS	Saline Reservoir
	Paleocene			
		Midway Group	Porters Creek Clay	Confining Unit
Cretaceous	Upper	Selma Group		Confining Unit
		Eutaw Formation		Minor Saline Reservoir
		Tuscaloosa Group	Upper Tusc.	Minor Saline Reservoir
			Mid. Tusc. Marine Shale	Confining Unit
			Lower Tusc. Pilot Sand Massive sand	Saline Reservoir
	Lower	Washita-Fredericksburg	Dantzler sand Basal Shale	Saline Reservoir Primary Confining Unit
		Paluxy Formation	'Upper' 'Middle' 'Lower'	Injection Zone
		Mooringsport Formation		Confining Unit
		Ferry Lake Anhydrite		Confining Unit
		Donovan Sand	Rodessa Fm. Upper' 'Middle' 'Lower'	Oil Reservoir Minor Saline Reservoir Oil Reservoir



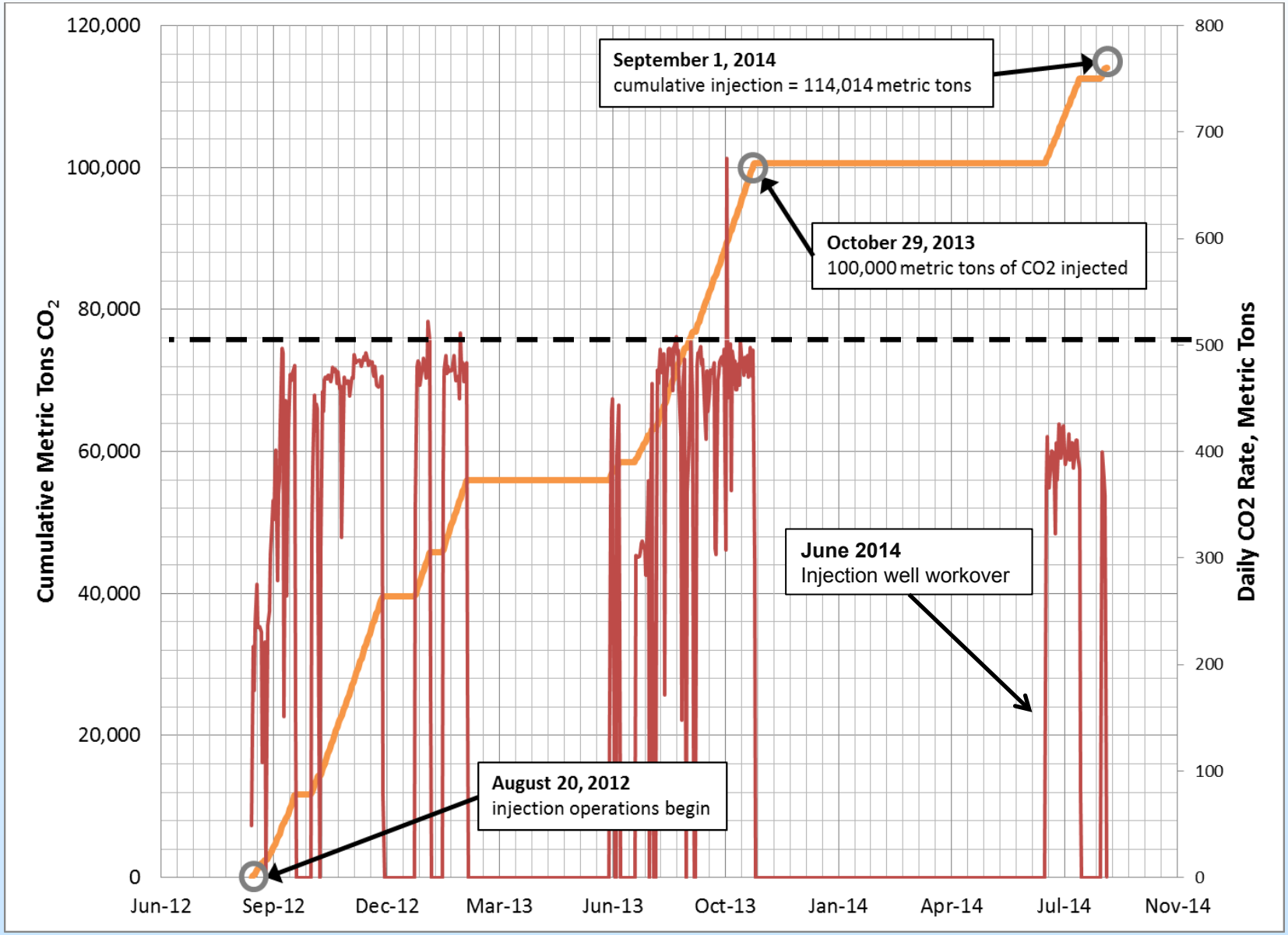


Project Status

Storage Project Status

- Injection commenced on August 20, 2012; ended September 1, 2014
- 114,104 metric tons of CO_2 injection
- Entered the three year Post-Injection Site Care Period on September 1, 2014
- Workover of the D-9-8#2 monitoring well resulted in a failed fishing operation and subsequent plugging and abandonment
- Post-injection time-lapse VSP acquired in January 2017
- Testing and monitoring results indicate containment

CO_2 Injection History



2016 D-9-8#2 Workover: The Plan

The purpose for the workover was to prepare the D-9-8#2 monitoring well for a post-injection time-lapse cross well seismic survey (receiver well). To do so the monitoring tool string had to be removed.

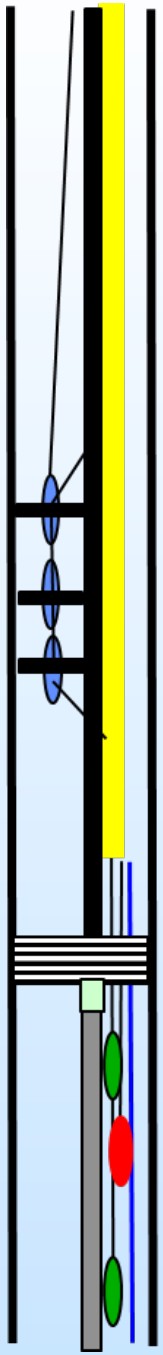
The scope of the workover included:

- Pulling the monitoring tool (MBM) assembly, tubing and packer
- Spool the MBM and geophone cables
- Set a bridge plug above the perforations
- Re-purpose the tubing, if salvageable

The pull was originally planned to take ***four*** days

The D-9-8#2 Modular Borehole Monitoring System*

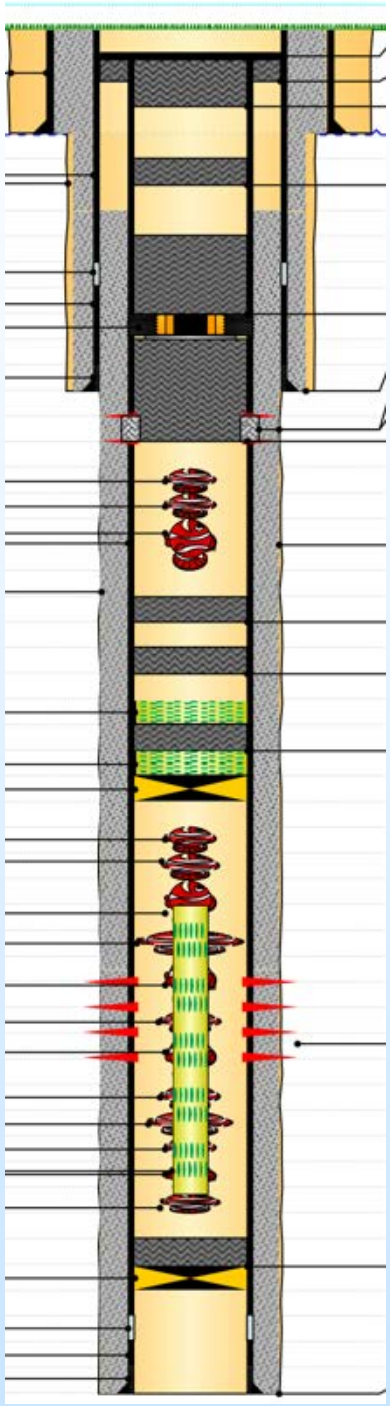
Deployment of the Modular Borehole Monitoring (MBM) Conventional geophone array (left) and yellow flat pack containing the fiber optic based DAS array (right)



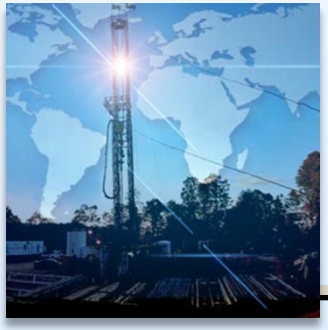
* The MBM was designed by LBNL under support from the CCP

2016 D-9-8#2 Workover Outcome

- Tubing packer could not be released
- After a series of tubing cuts above the packer, 218 joints and several geophones were retrieved
- 246 feet of flatpack was retrieved, some showing swelling
- ***After 16 days*** the workover was suspended with the packer, >2,700 ft of tubing, 16 or 17 geophones and most of the flat pack and TEC cable remaining in the hole
- A pull plug and abandonment operation was implemented which included a total of 8 cement plugs
- Crosswell seismic acquisition eliminated; short array VSP substituted



MBM Pull Photographs



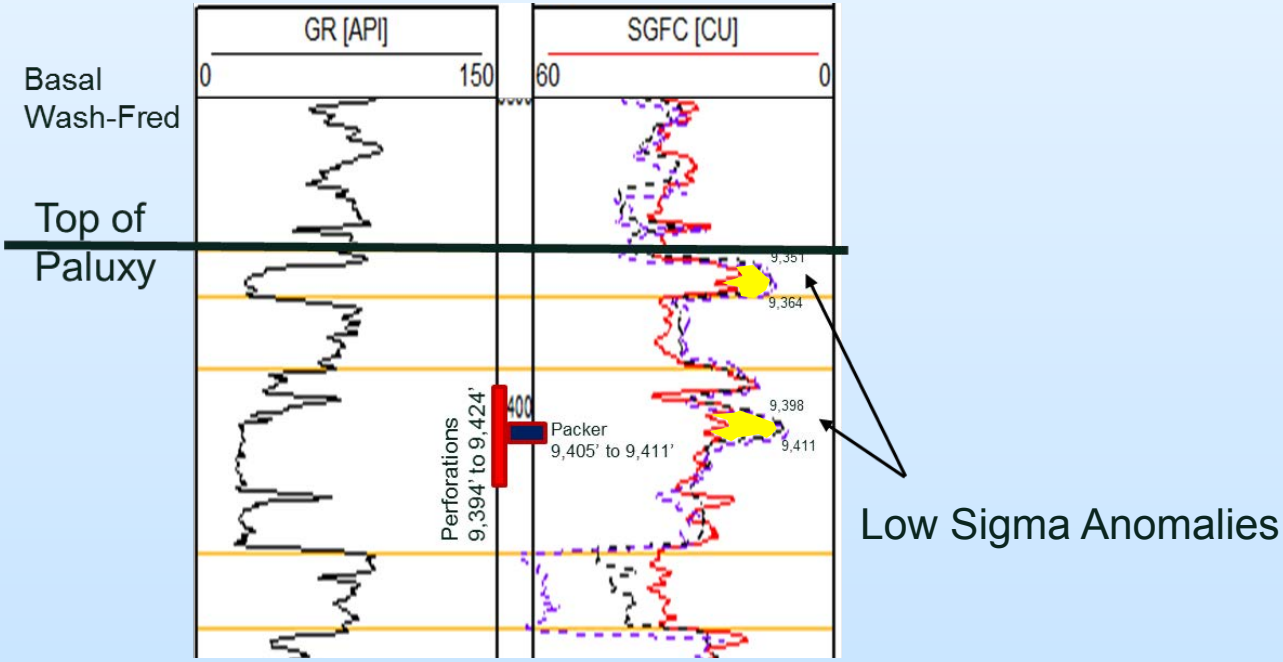
2016 Monitoring Results

Shallow Monitoring

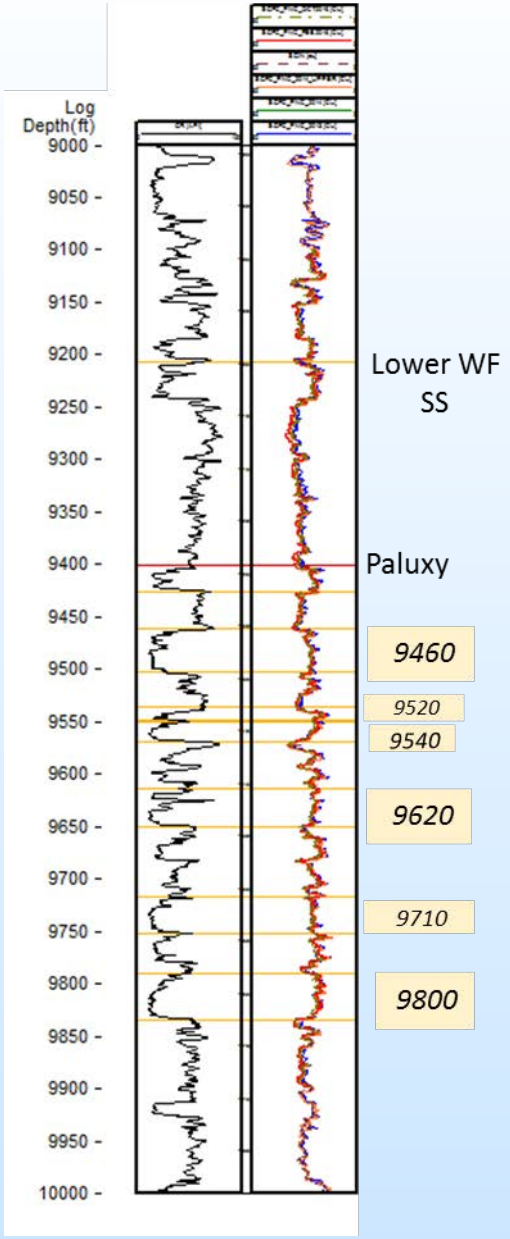
- Soil CO_2 flux continues to show seasonal variability.
- PFT monitoring at injection wellsite and surrounding oilfield well sites continue to result in non-detects
- Quarterly groundwater monitoring results indicate non-endangerment of USDWs (*stay tuned for Mike's presentation*)

Deep Monitoring

- Late 2015 cased hole saturation logs (PNC) identified CO_2 breakthrough at the D-9-8#2 well
- 2016 PNC log of the D-9-9#2 shows no evidence of CO_2 breakthrough

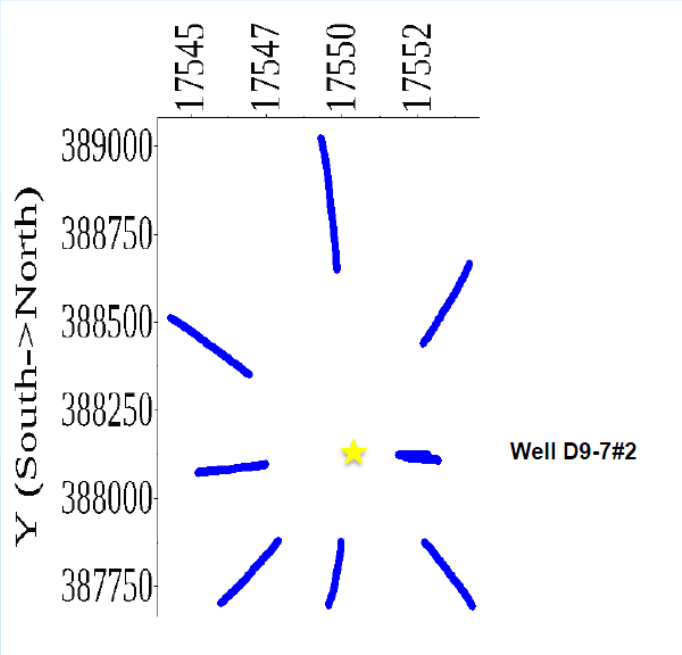


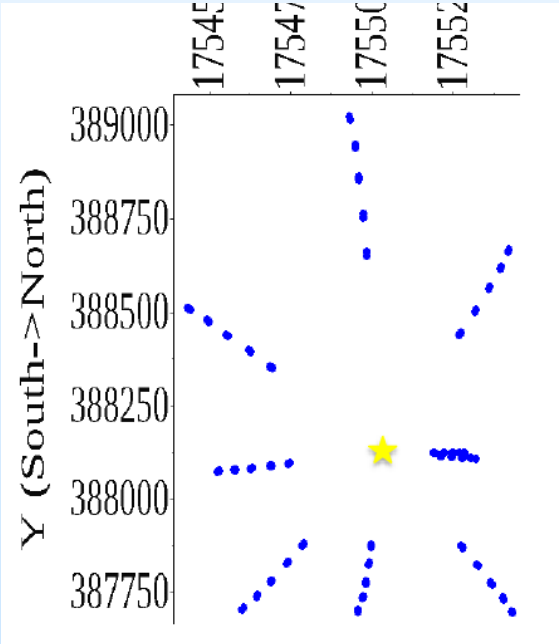
D-9-9#2 Time-Lapse PNC



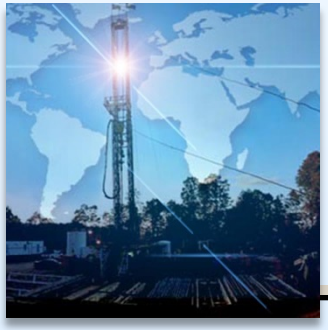
2017 Repeat VSP

- In January 2017 a post-injection VSP was acquired with geophones deployed in the D-9-7#2 injection well.
- Due to the requirement for full pressure control in a perforated well, only a two level string could be run (50 ft spacing). The pre-injection survey utilized an 80-level string (25 ft spacing)
- The short array was moved up and down the well to maximize the acquisition aperture





2012 80-level VSP coverage of reservoir illumination (left) versus 2017 post-injection 2-level repeat (right)



Closure

Project Closure Plans

- Complete post-injection monitoring
  - VSP time-lapse processing
  - Continue quarterly groundwater sampling
- Demonstration of CO_2 containment within the injection zone and non-endangerment of USDWs using modeling and monitoring results
  - Close out UIC permit
- Temporary or permanent abandonment of remaining project wells and transfer of test site to oilfield operator