

Southwest Regional Partnership on Carbon Sequestration

Aneth Project Overview

DE- FC26-05NT42591

James Rutledge

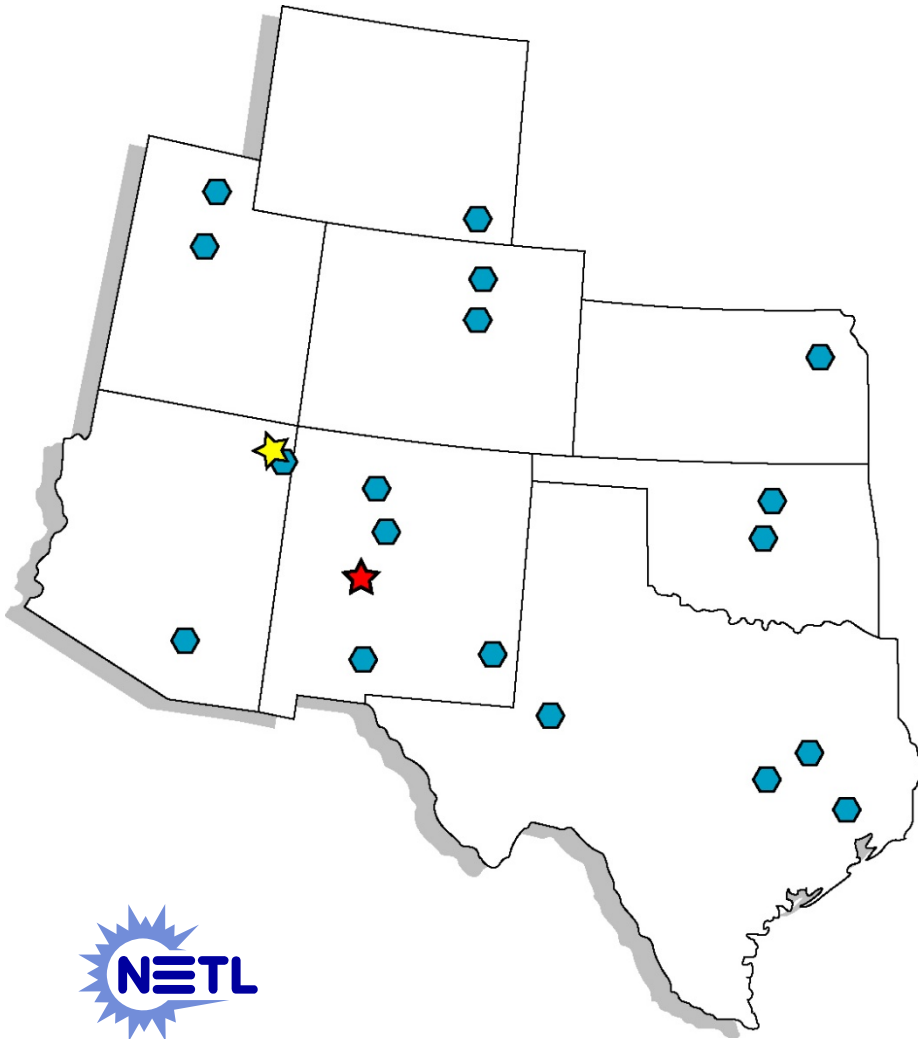
Lianjie Huang

Julianna Fessenden

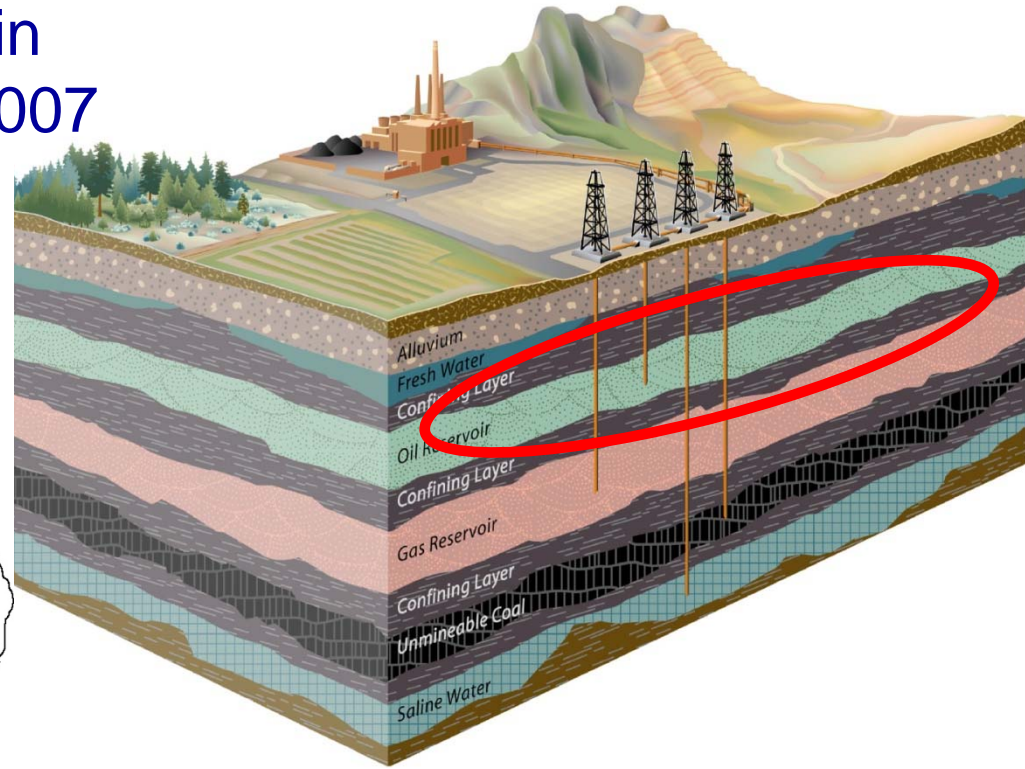
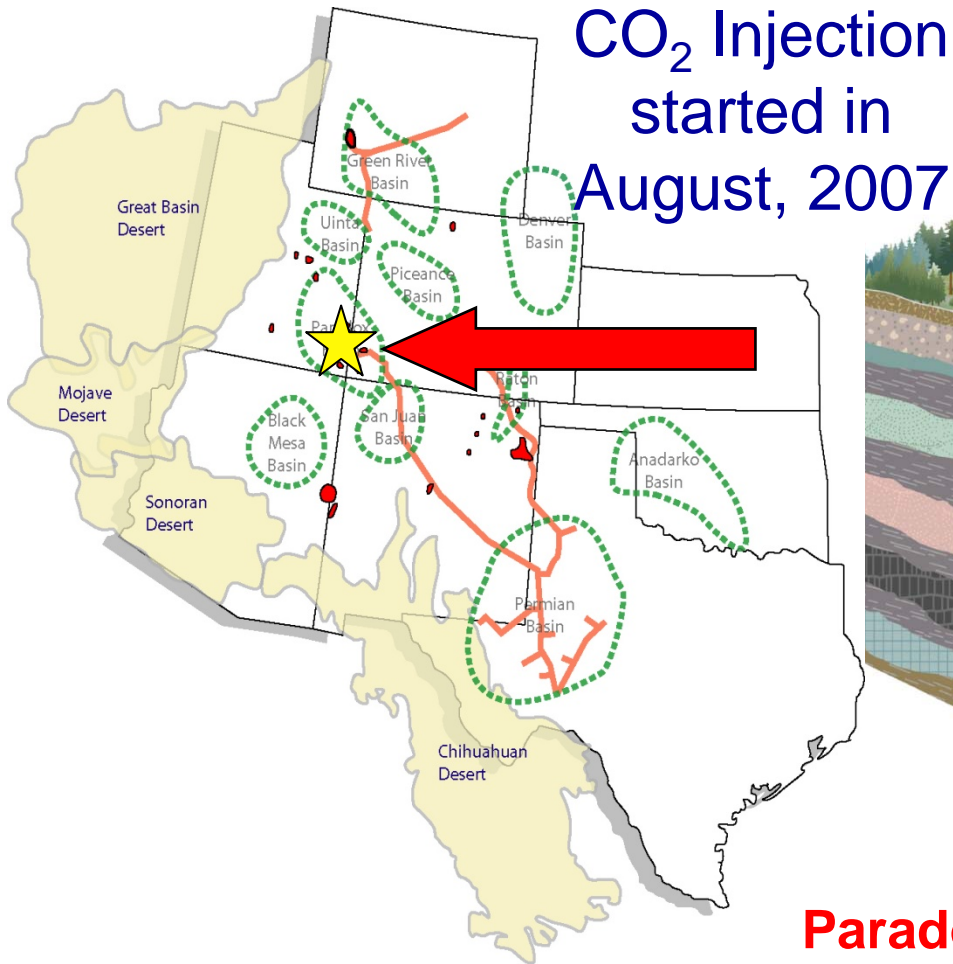
Los Alamos National Laboratory

October 6-8, 2008

Pittsburgh, Pennsylvania

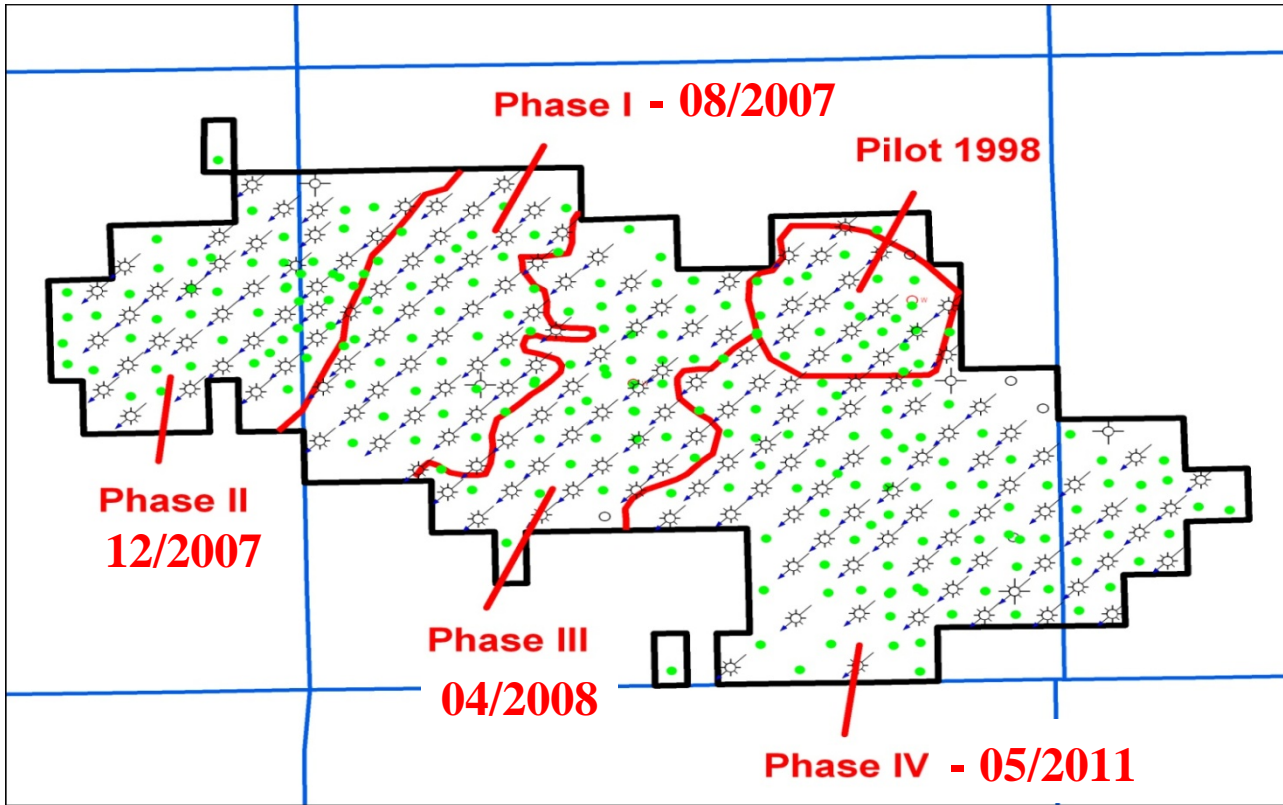


Southwest Phase II – Aneth Project



**Paradox Basin, Utah: 150,000 tons/year
Enhanced oil recovery with sequestration**

Aneth Unit Injection Schedule

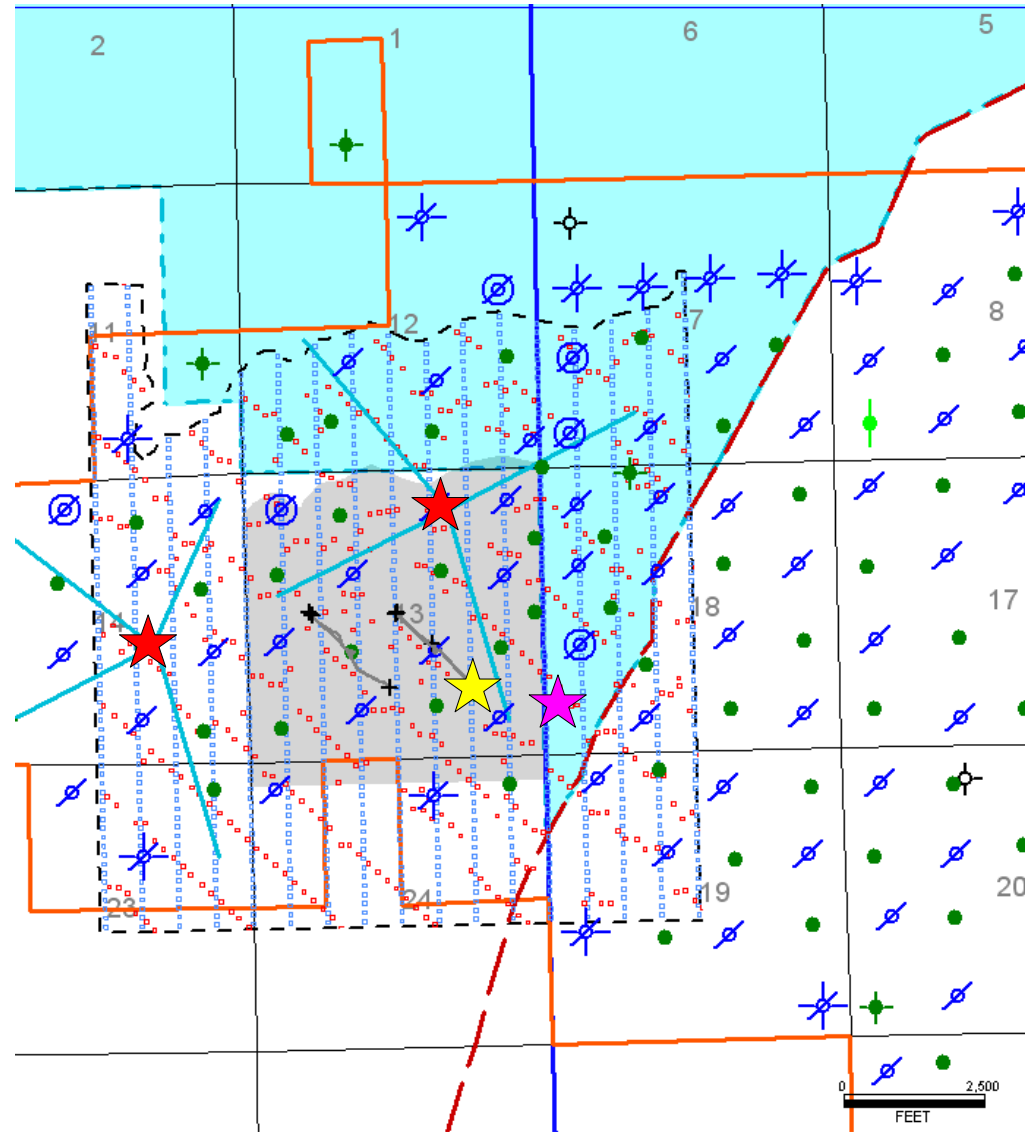


- Well type**
- Oil Well
 - Water injection well
 - Dry hole
 - ^w Water source well
 - Well type not available
- Phase Boundaries
- Aneth Unit
- Township



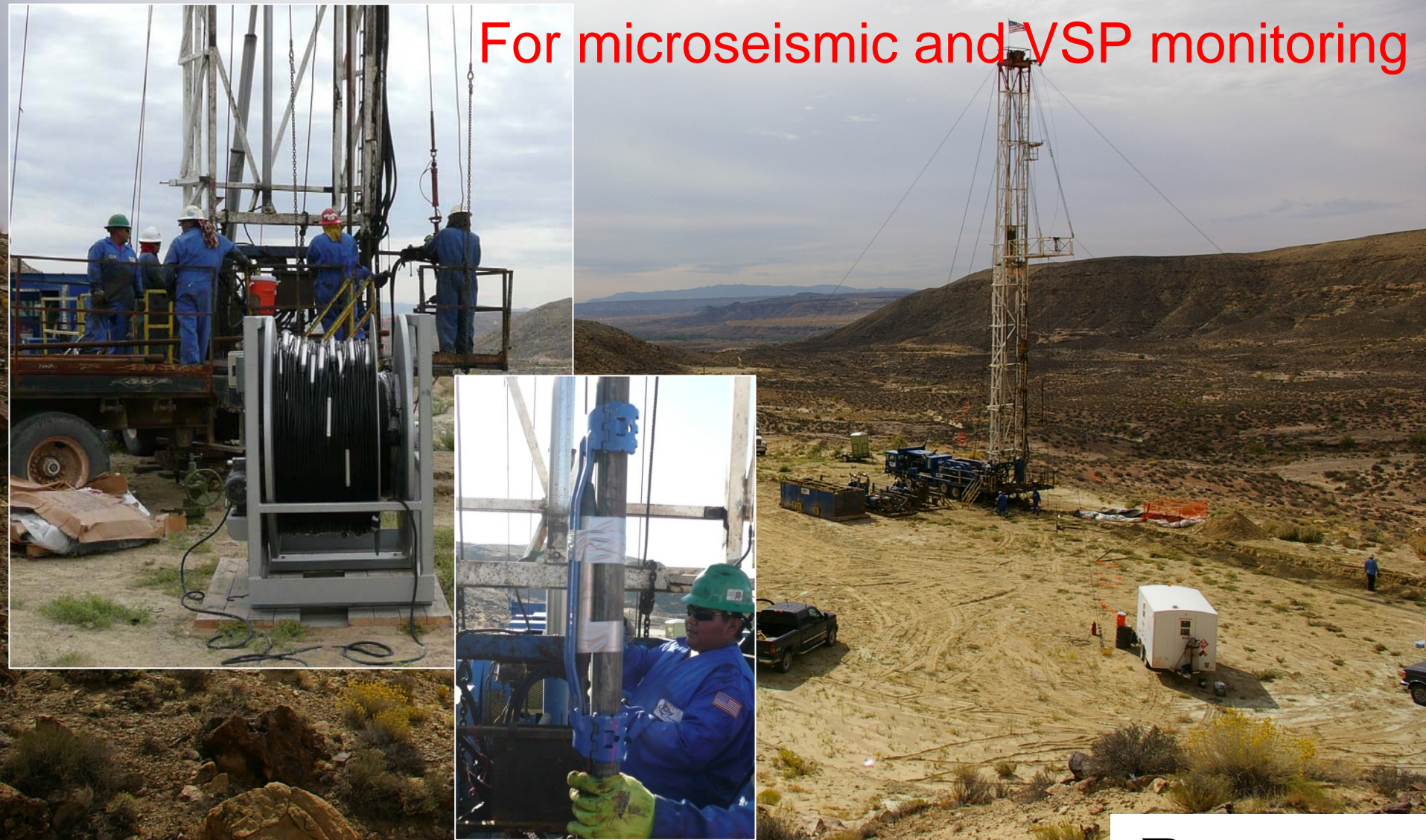
Sections 13 and 14 – Demonstration Study Area

- 3D seismic over entire Unit
- CO₂ soil flux measurements
- ★ Downhole geophone array deployment
 - Time-lapse VSP
 - Microseismic monitoring
- ★ SWD wells - one completed
- ★ Core well E-418
 - Includes Gothic and Desert Creek
- Tracer Test
- Produced water sampling
- UGS compiled all log data and mapped surface fractures
- UU-EGI subsurface modeling and simulation

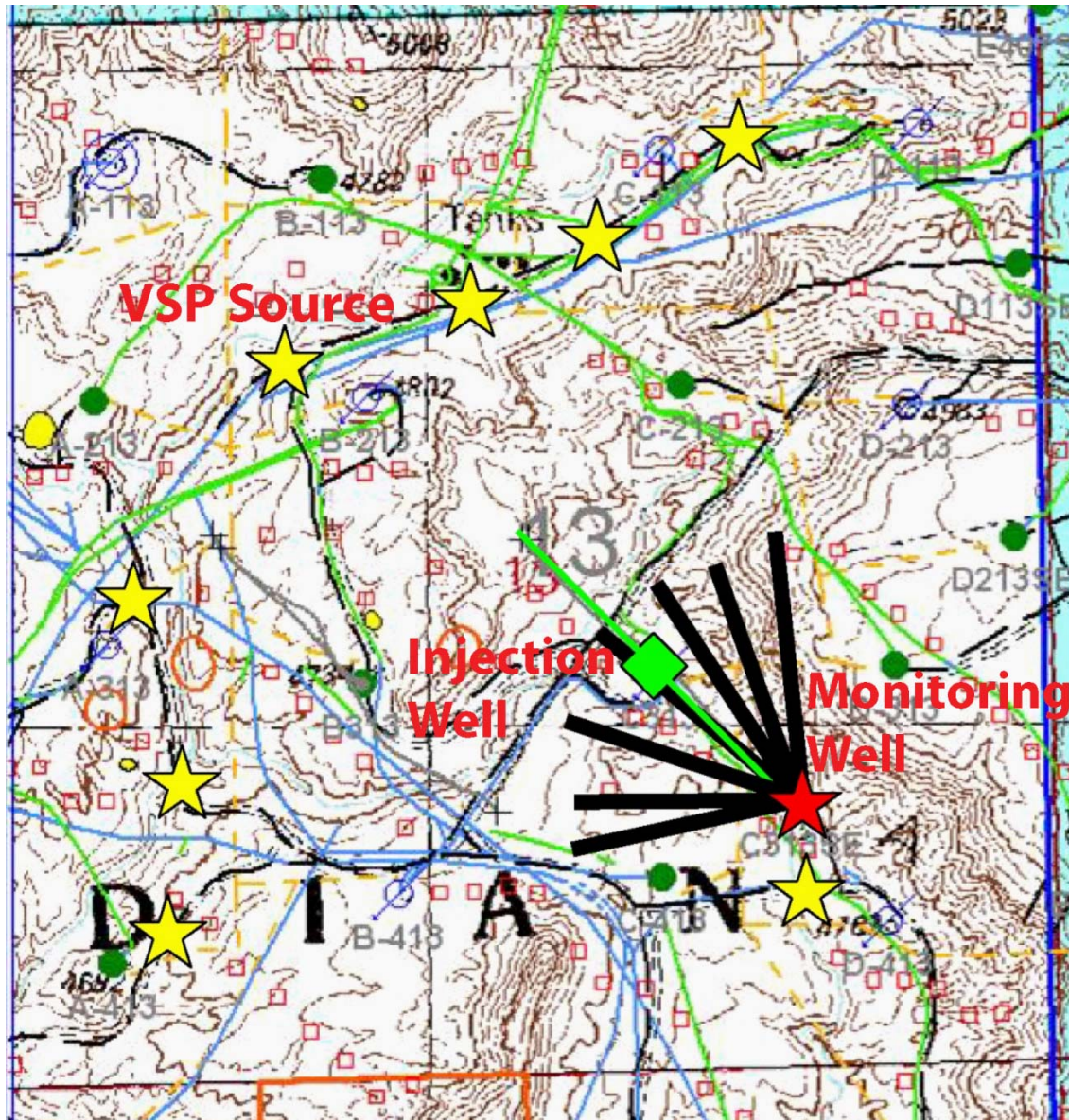


Geophone cable deployment – October, 2007

For microseismic and VSP monitoring



Time-Lapse VSP Monitoring



Seven Offset VSP
Vibraseis source

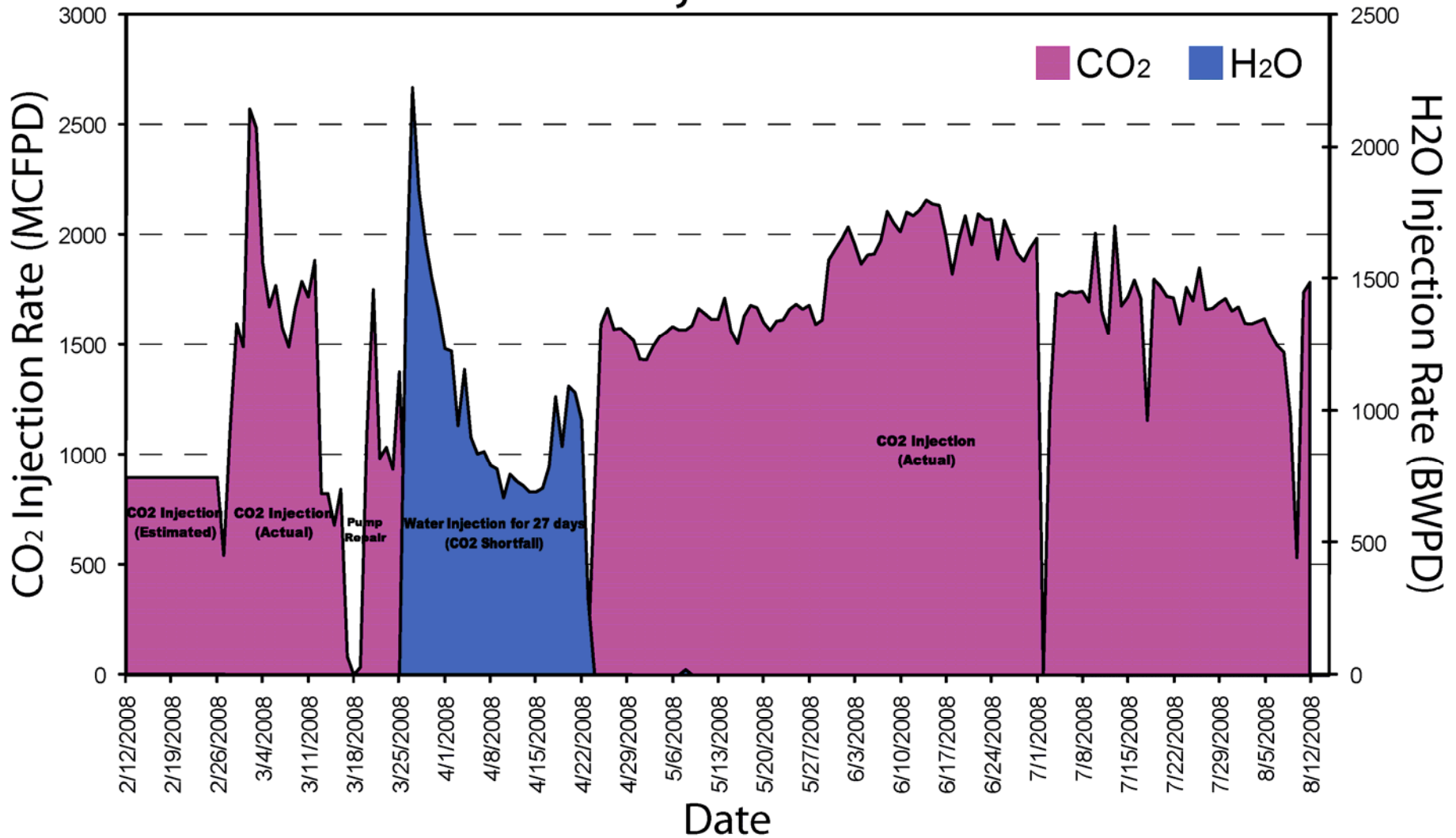
Baseline VSP:
Oct. 21, 2007

Repeat VSP:
July 8, 2008

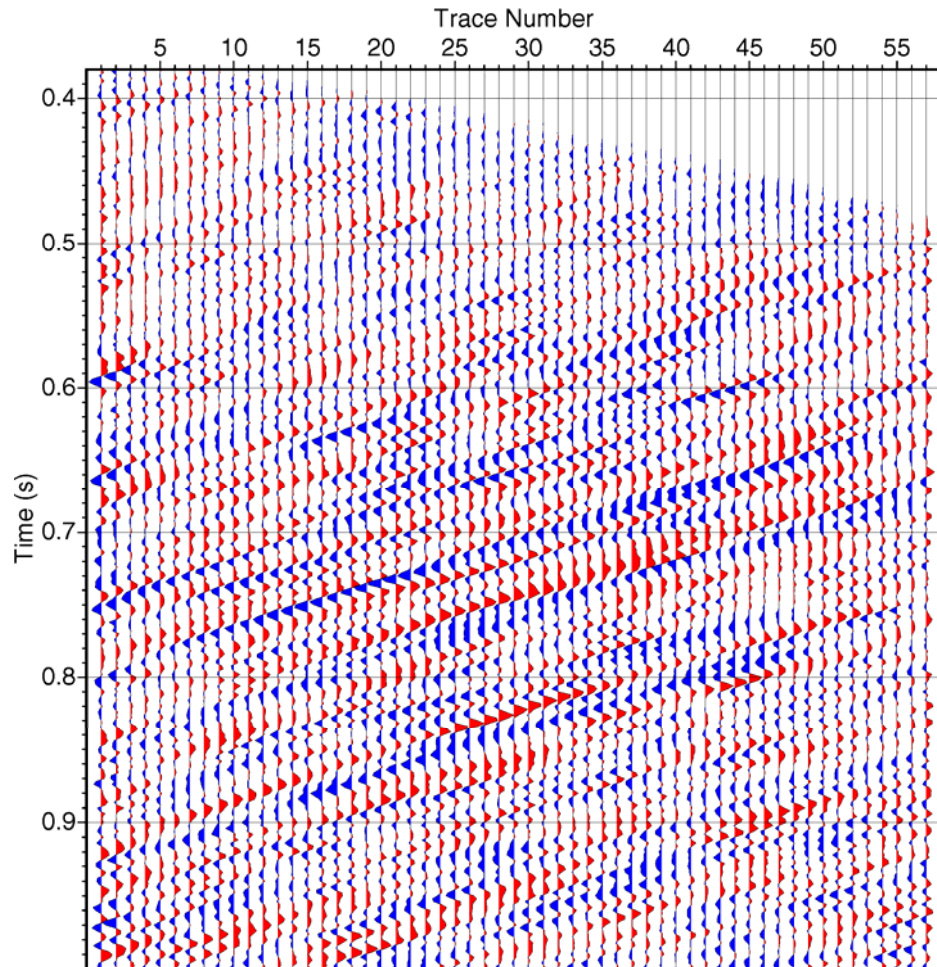
CO₂ injected:
181,000 MCF
(~10,500 tons)

CO₂ and Water Injection Rates

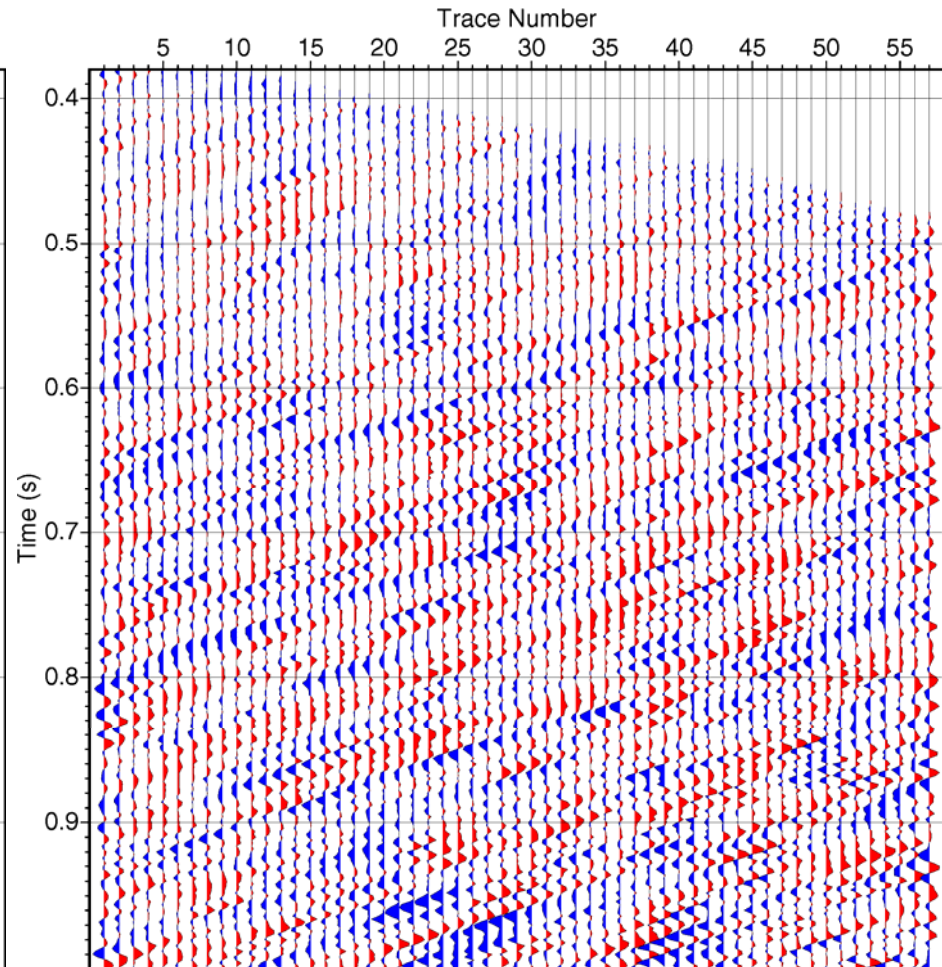
C-313 Injection Rates



Upgoing Waves for Offset 2

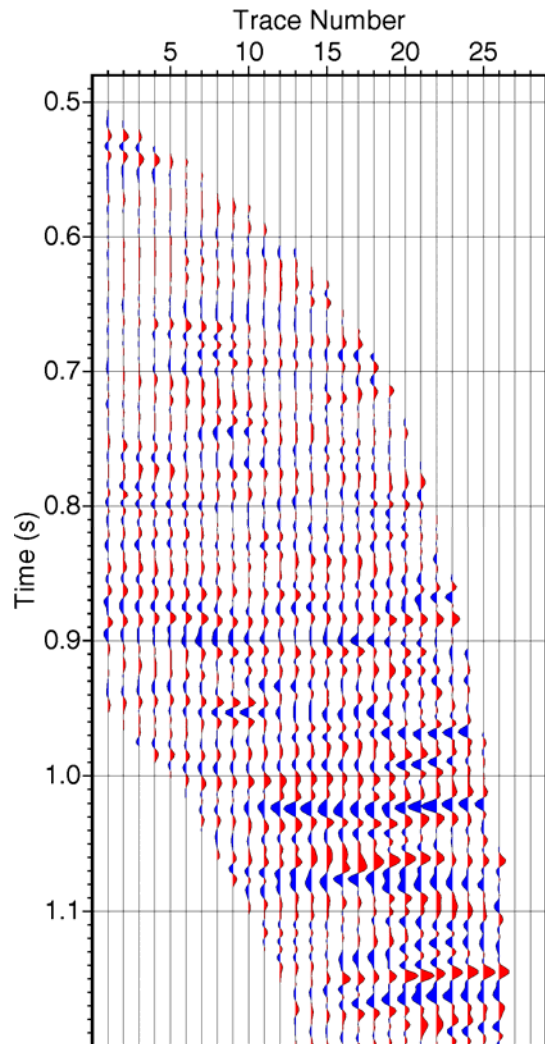


Pre-injection

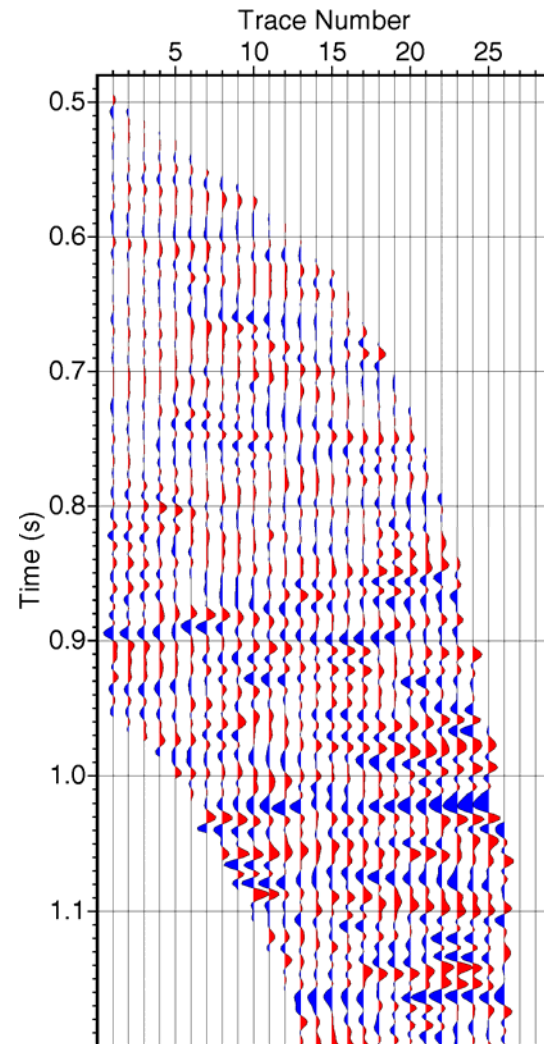


Post-injection

VSP-CDP Mapping for Offset 2

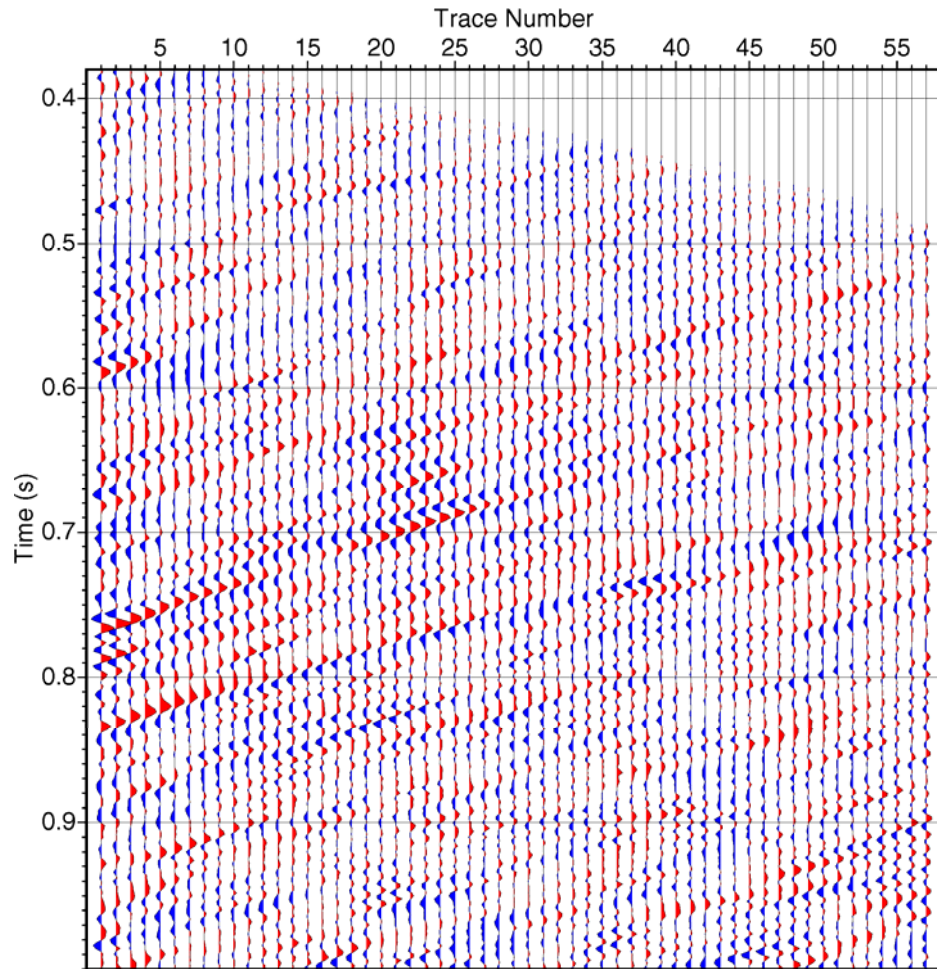


Pre-injection

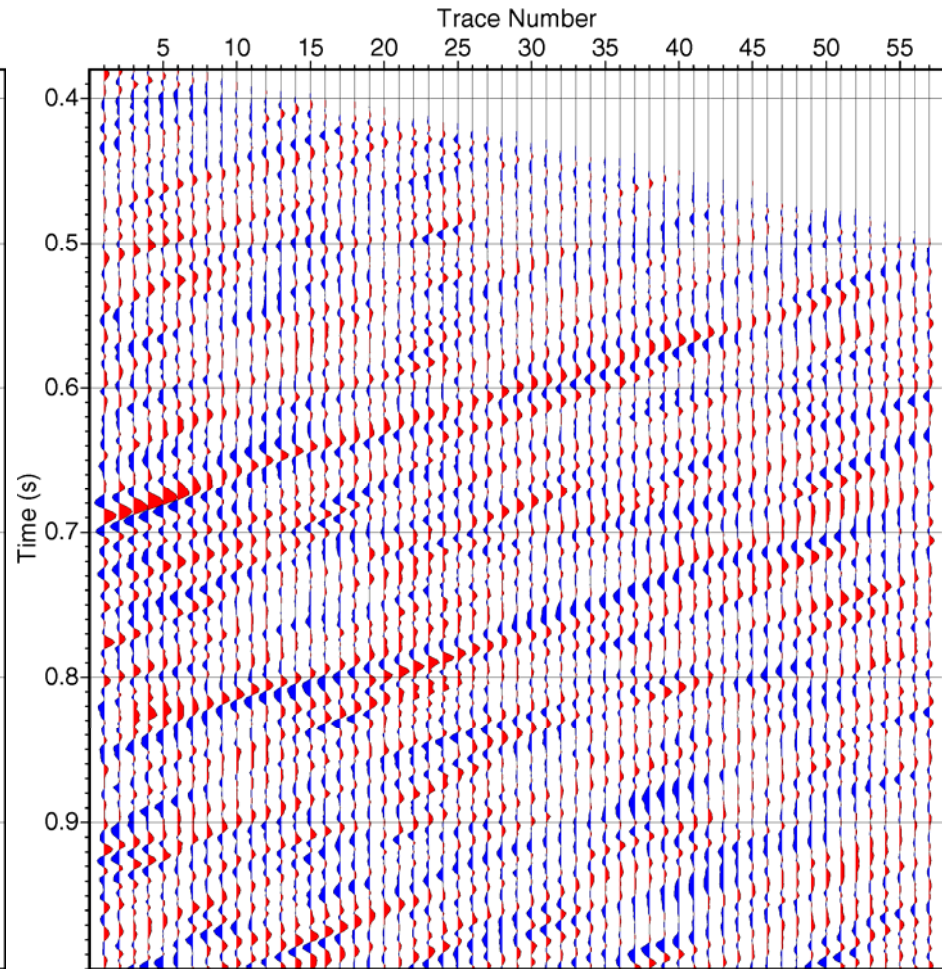


Post-injection

Upgoing Waves for Offset 5

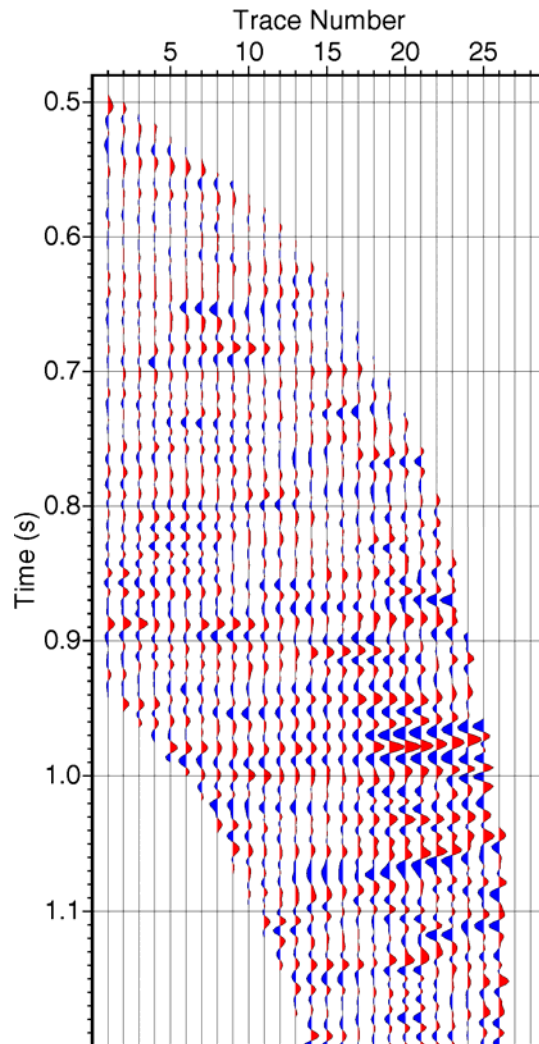


Pre-injection

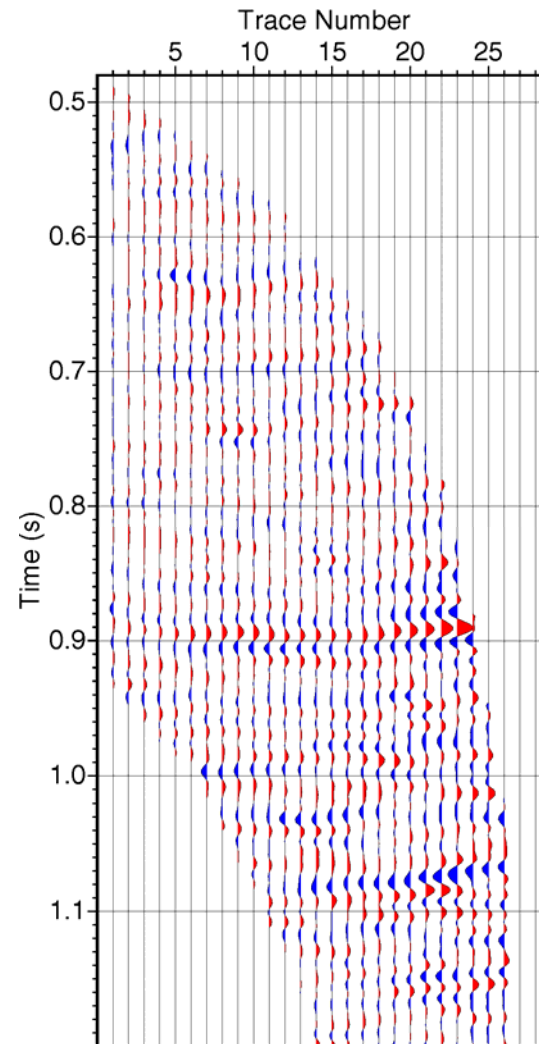


Post-injection

VSP-CDP Mapping for Offset 5

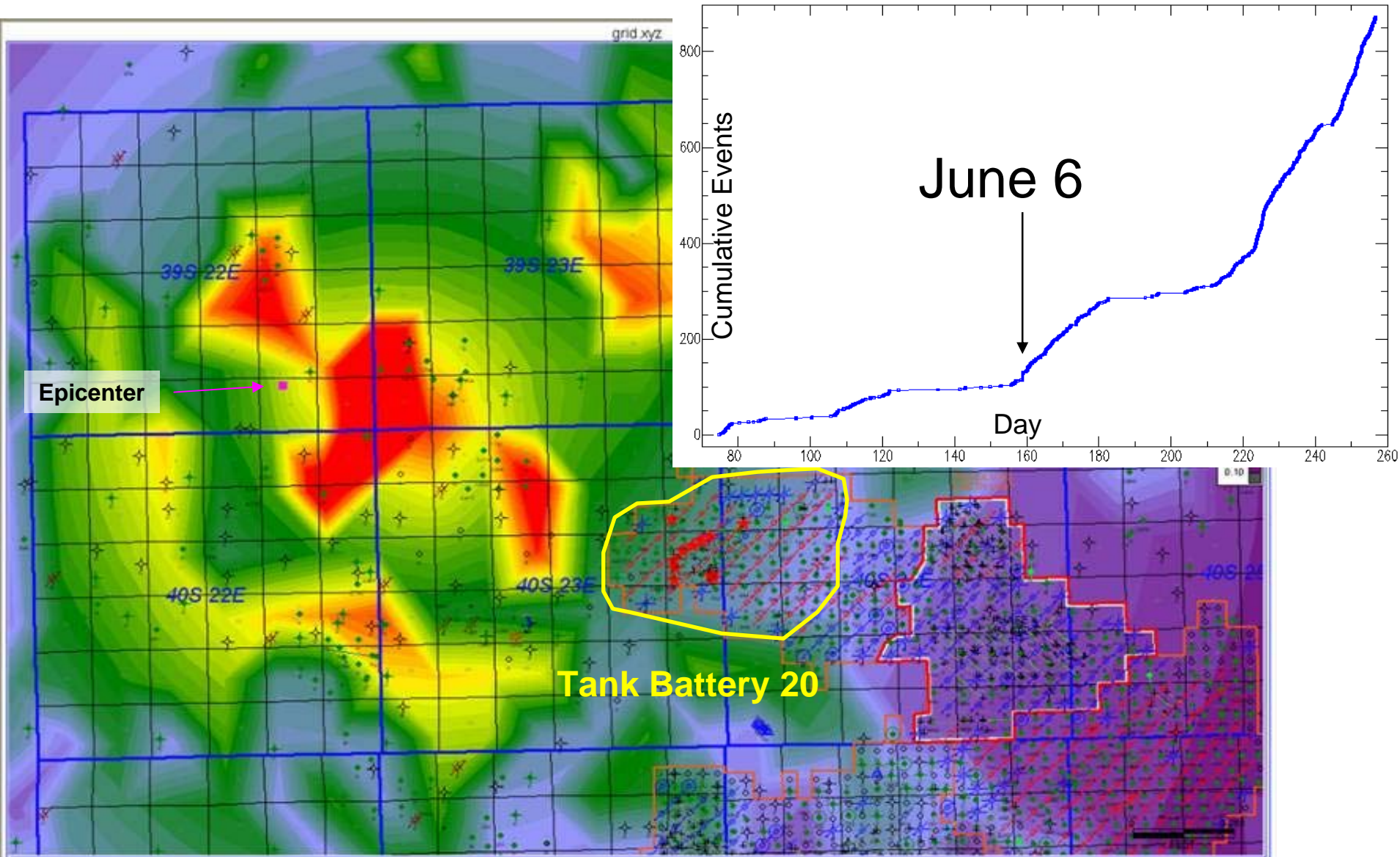


Pre-injection



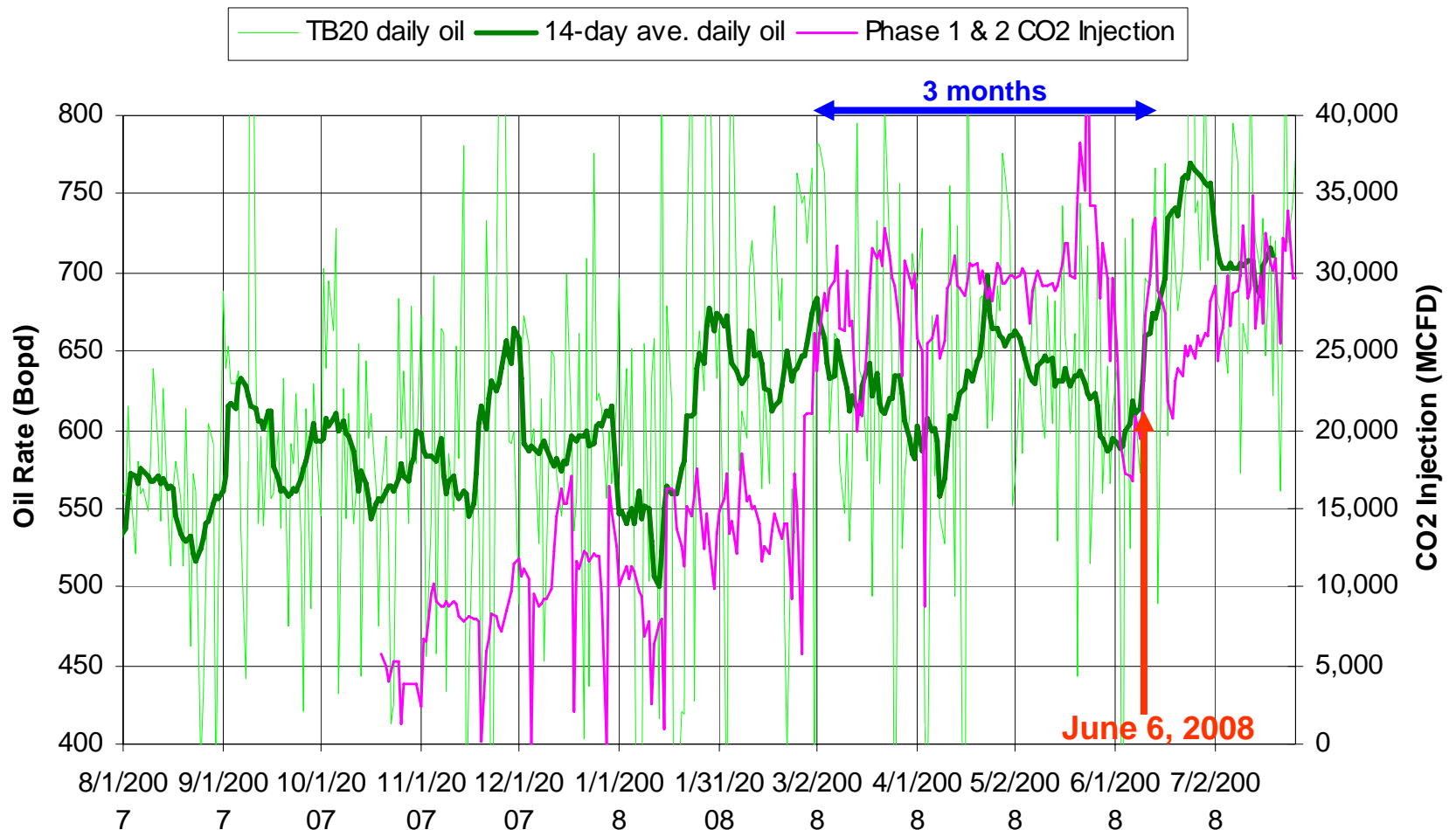
Post-injection

Shake Intensity – Bluff Earthquake June 6, 2008

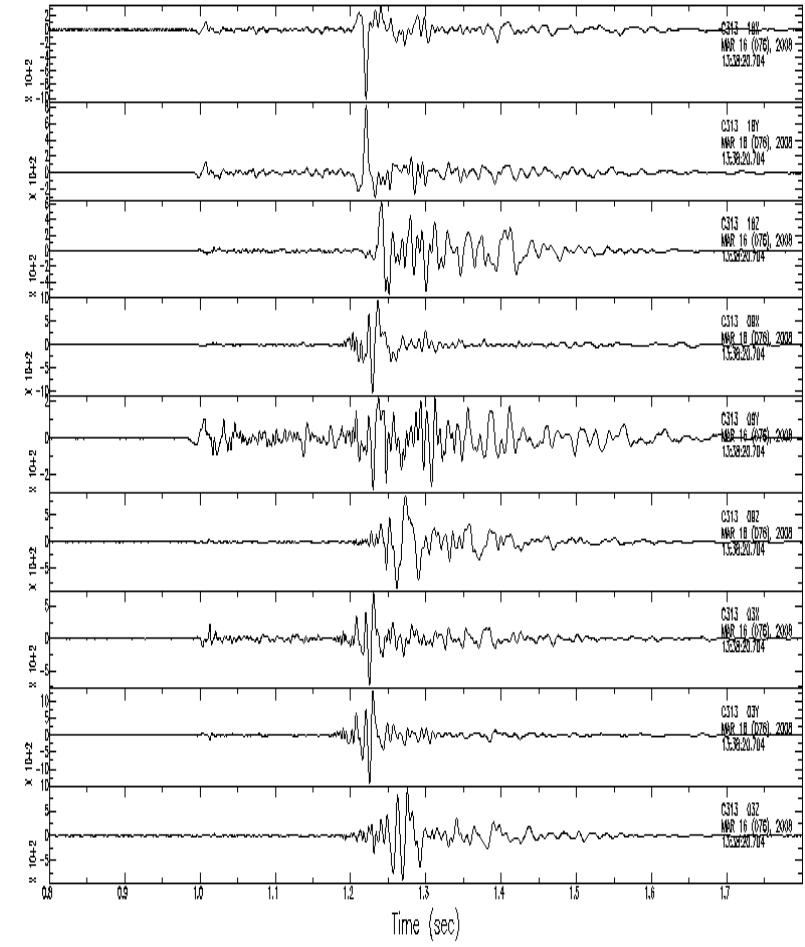
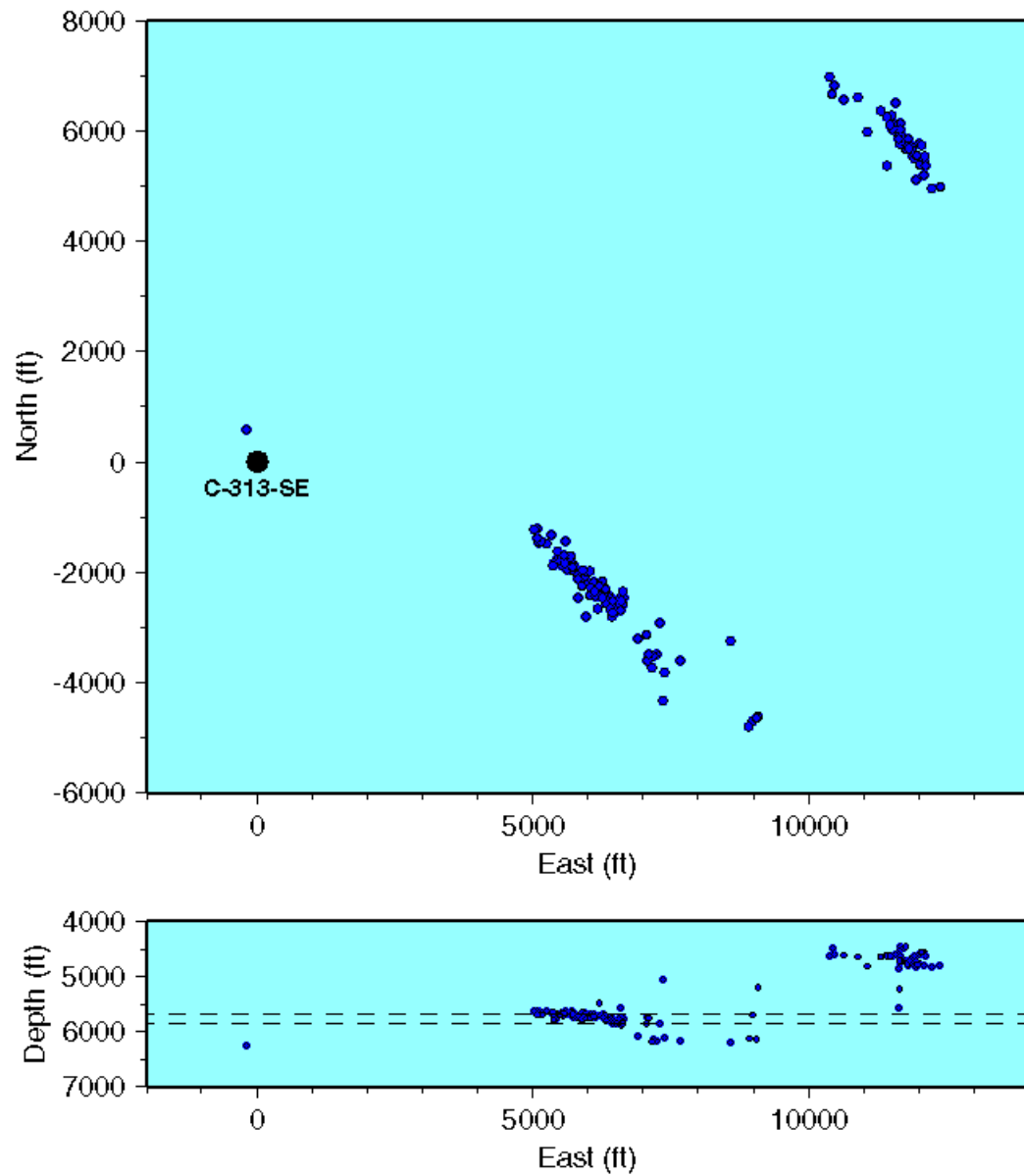


Oil Production – Tank Battery 20

Aneth TB-20 Oil Production History
through 7/28/08



Aneth Microseismicity April 25 to August 18, 2008



Self Potential Monitoring System

Institute of Advanced Industrial Science and Technology, Japan



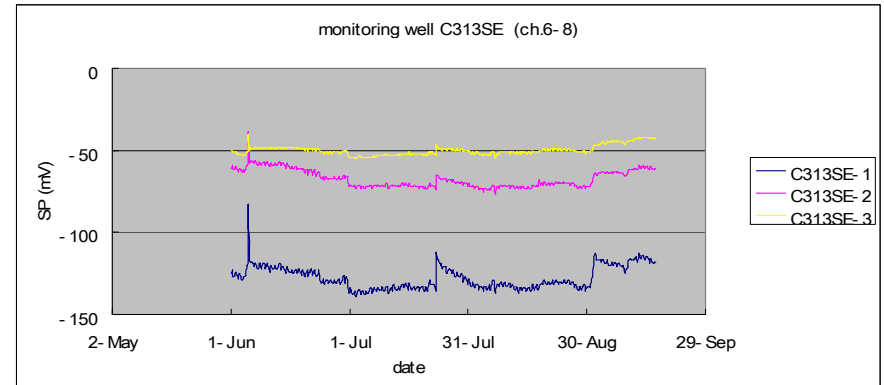
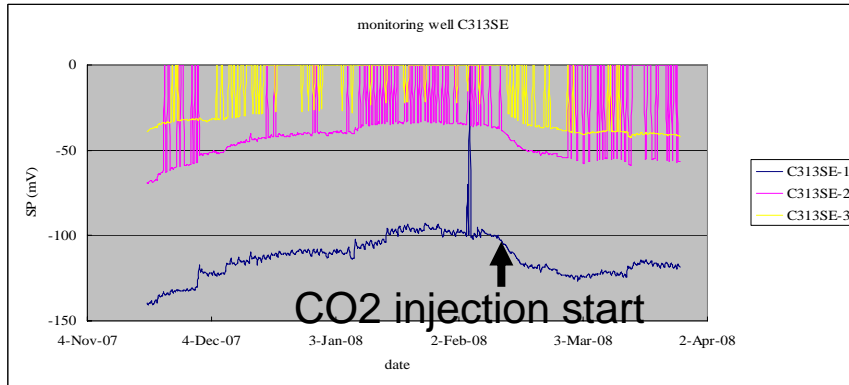
Installation of Ag-AgCl electrode



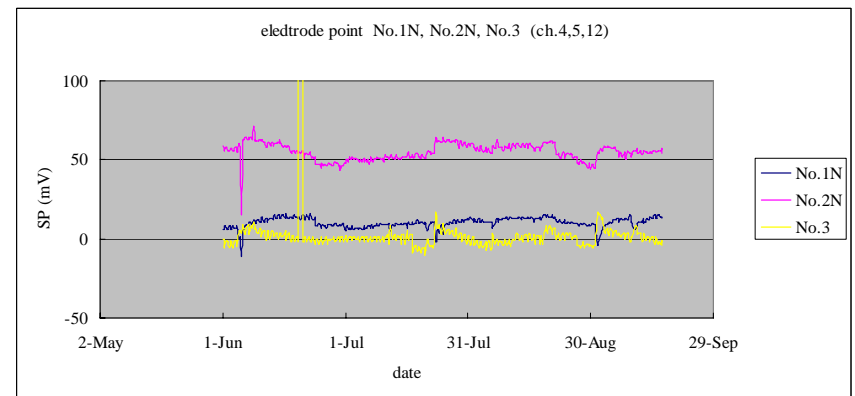
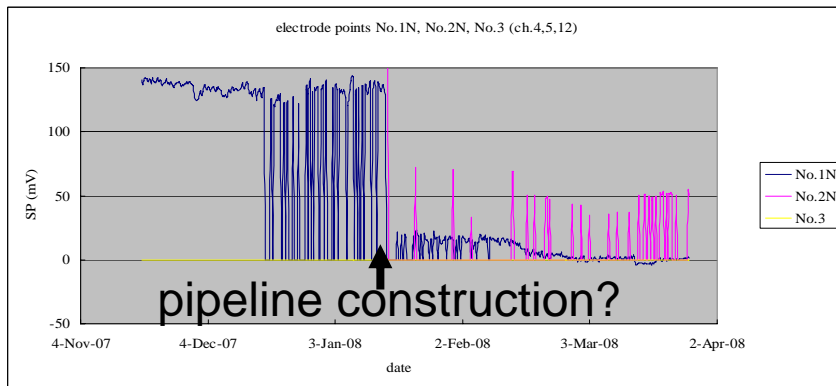
Three electrodes near C313SE

SP Monitoring : Example of Data

Electrodes around C313SE



Electrodes between wells



Nov., 2007 – Apr., 2008



May – Sep., 2008

maintenance to optimize data acquisition

Reservoir Seal Assessment – Gothic Shale

Geomechanical properties:

- Continuous strength profiling
- Multistage compression testing
- Multi-stress path testing

Petrological description:

- SEM, XRD, XRF, TOC
- Thin sections

Petrophysical properties:

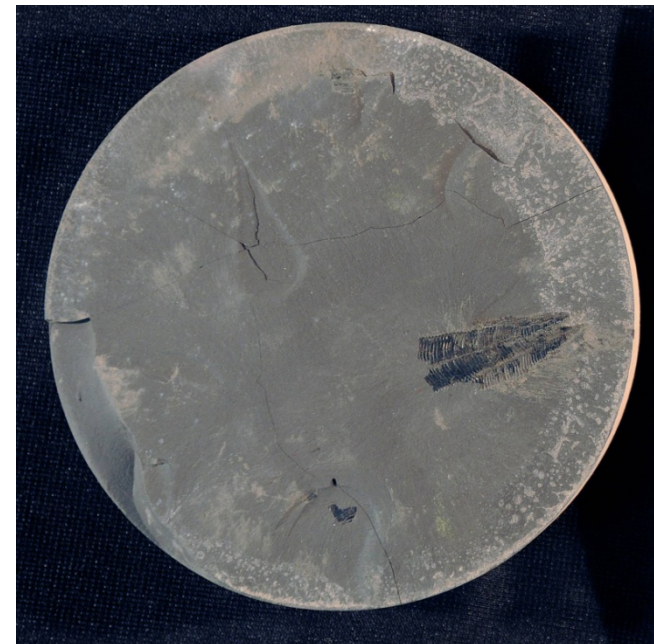
- Tight rock analysis method
- Permeability, porosity

Fracture analysis:

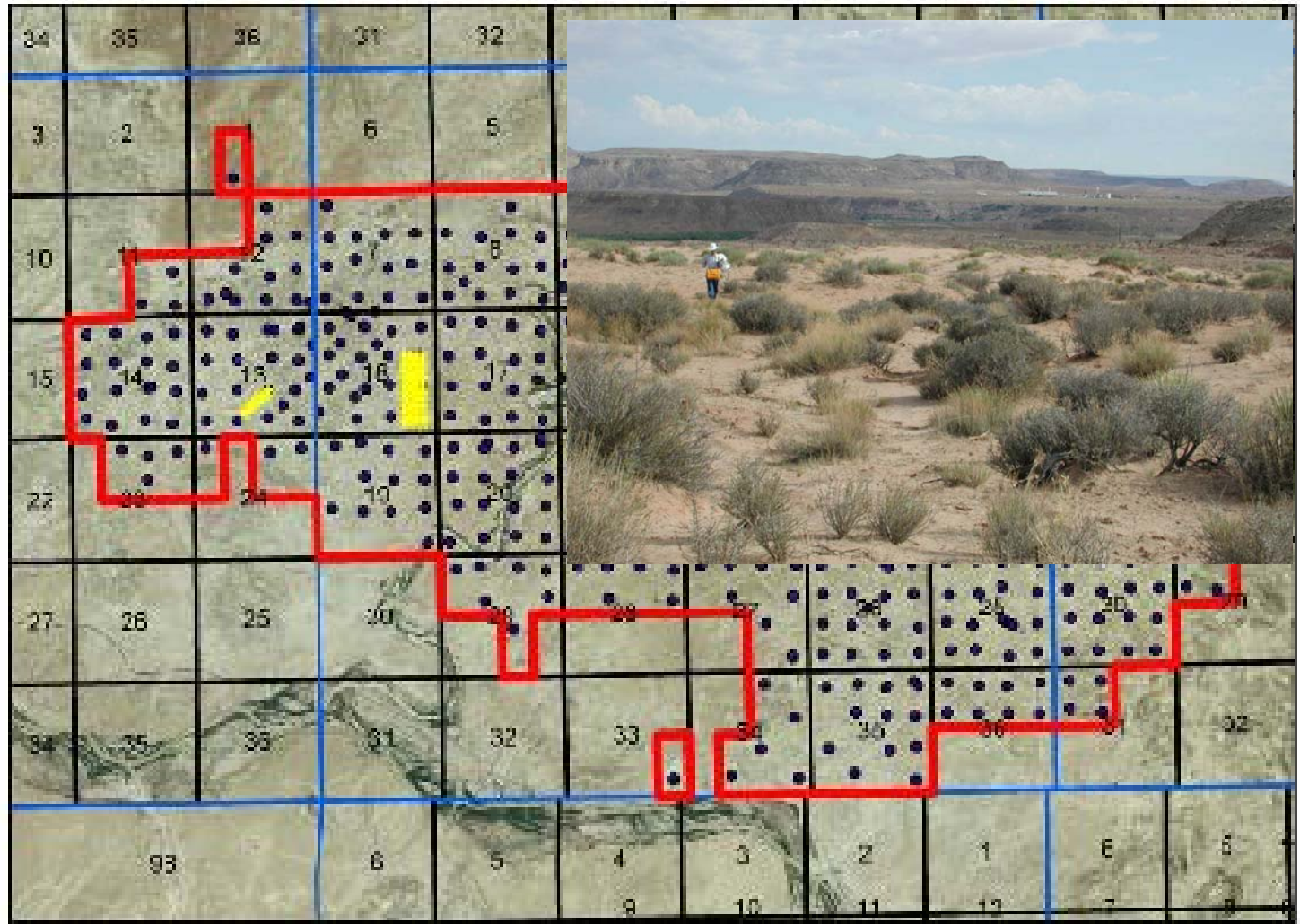
- Fracture type, orientation, dip, mineral fill, assessment of failure potential of natural fractures

Tests using CO₂:

- CO₂ adsorption isotherm
- Gas breakthrough pressure



Surface CO2 Flux (2006-2008):



● CO2 Flux Measurement Locations

● Oil Wells

□ Aneth Unit

0 0.5 1 2 Miles

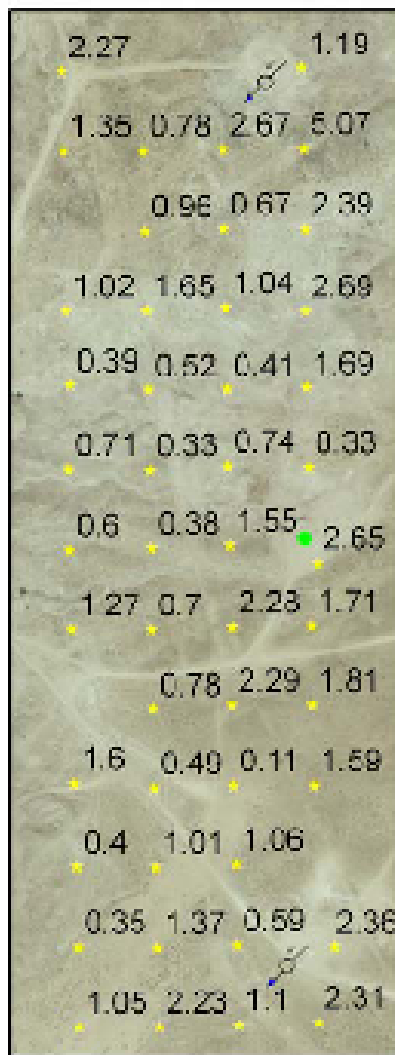


Flux Measurements in Phase I Area

July 2006



August 2007



May 2008



● Flux Measurement Locations

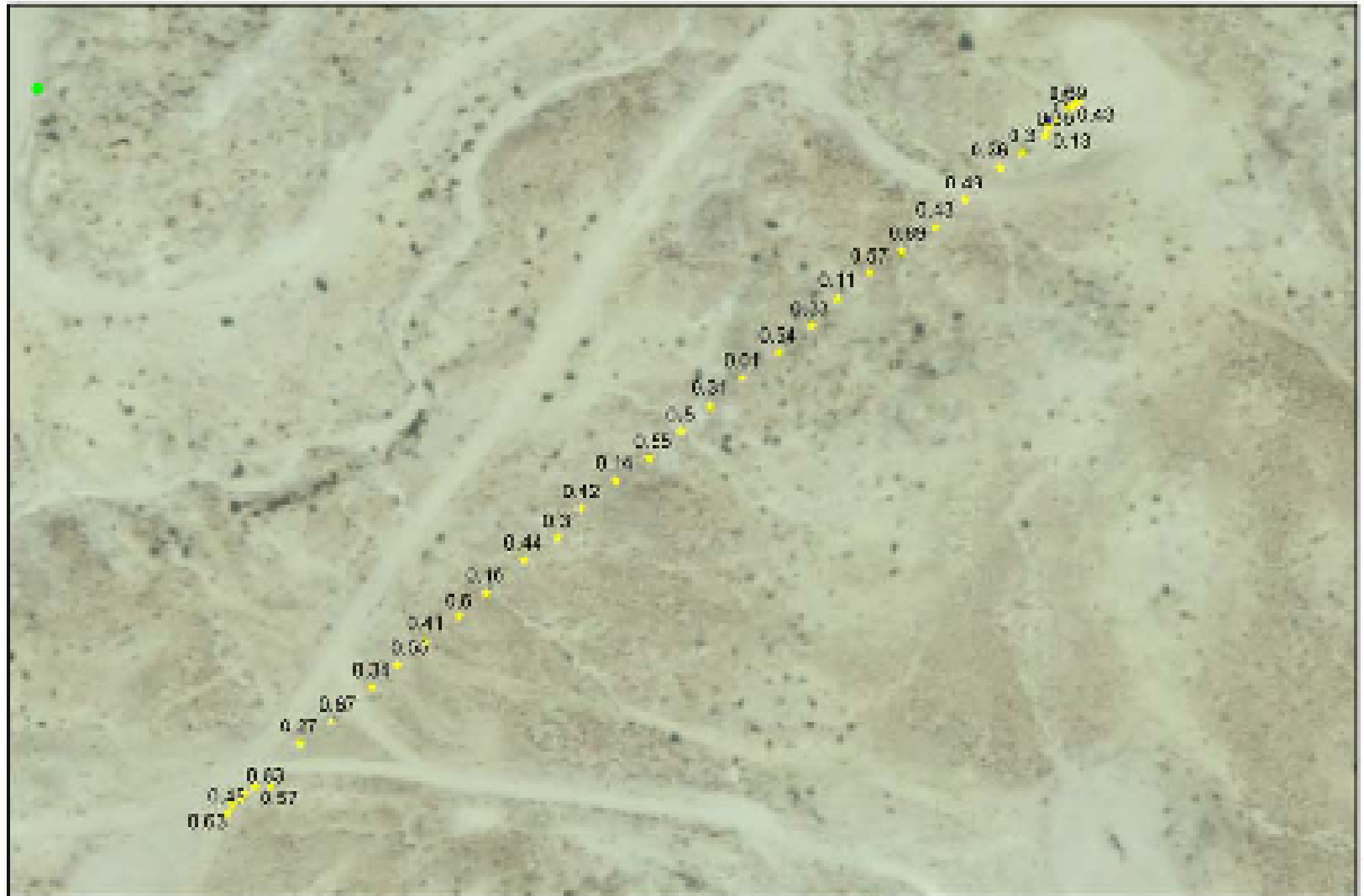
● Production Wells

0 75 150 300 Meters



Aneth Unit - Flux Measurements in Phase II Area

May 2008



● Flux Measurement Locations

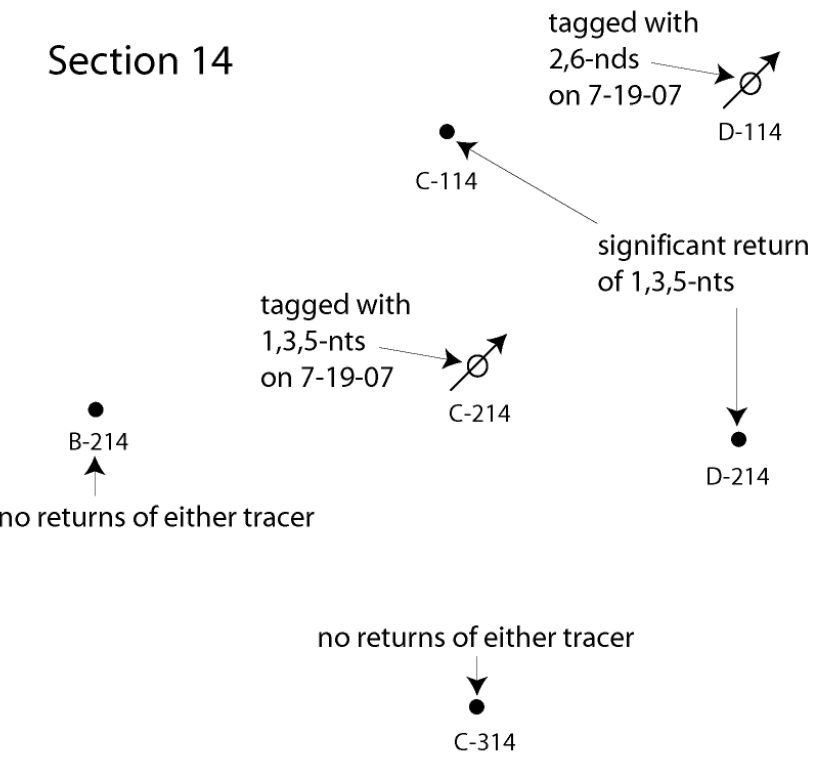
Water Flood Tracer Testing

- Tracers injected on July 19, 2007
 - 100 kg of 1,3,5-naphthalene disulfonate into well C-214
 - 100 kg of 2,6-naphthalene disulfonate into well D-114
- Intermittent sampling and analysis over subsequent 14 months
- Large data gaps after 11/21/2007

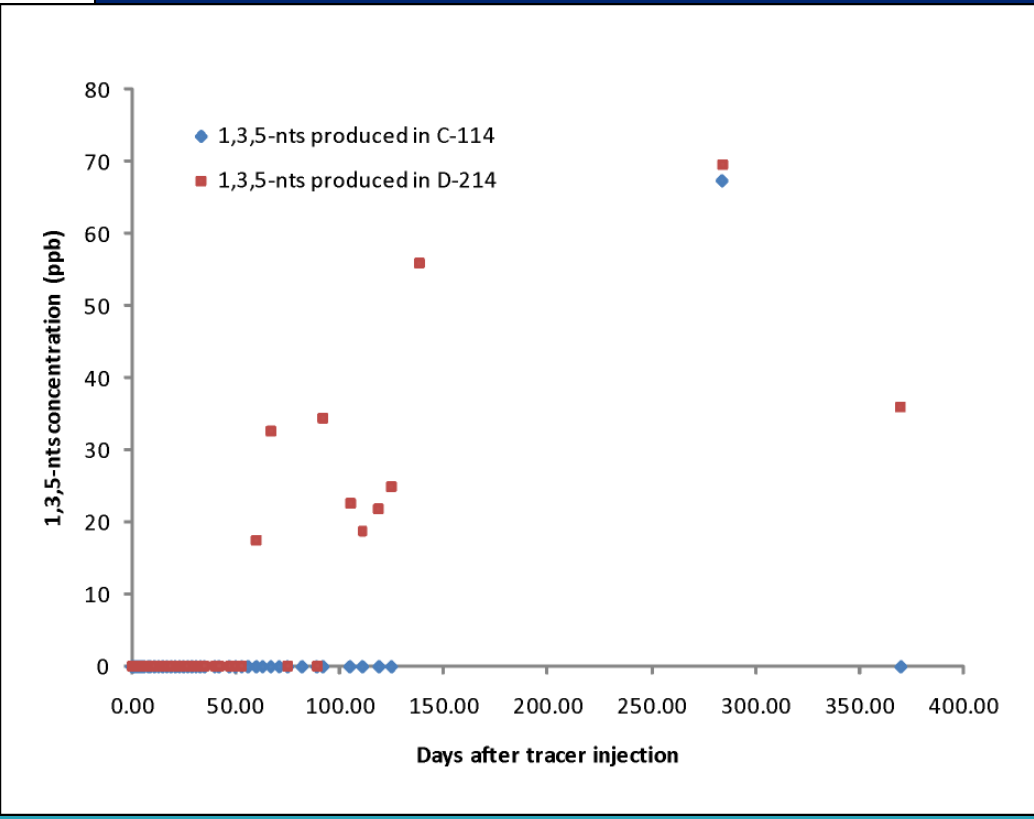


Injection and sampling wells

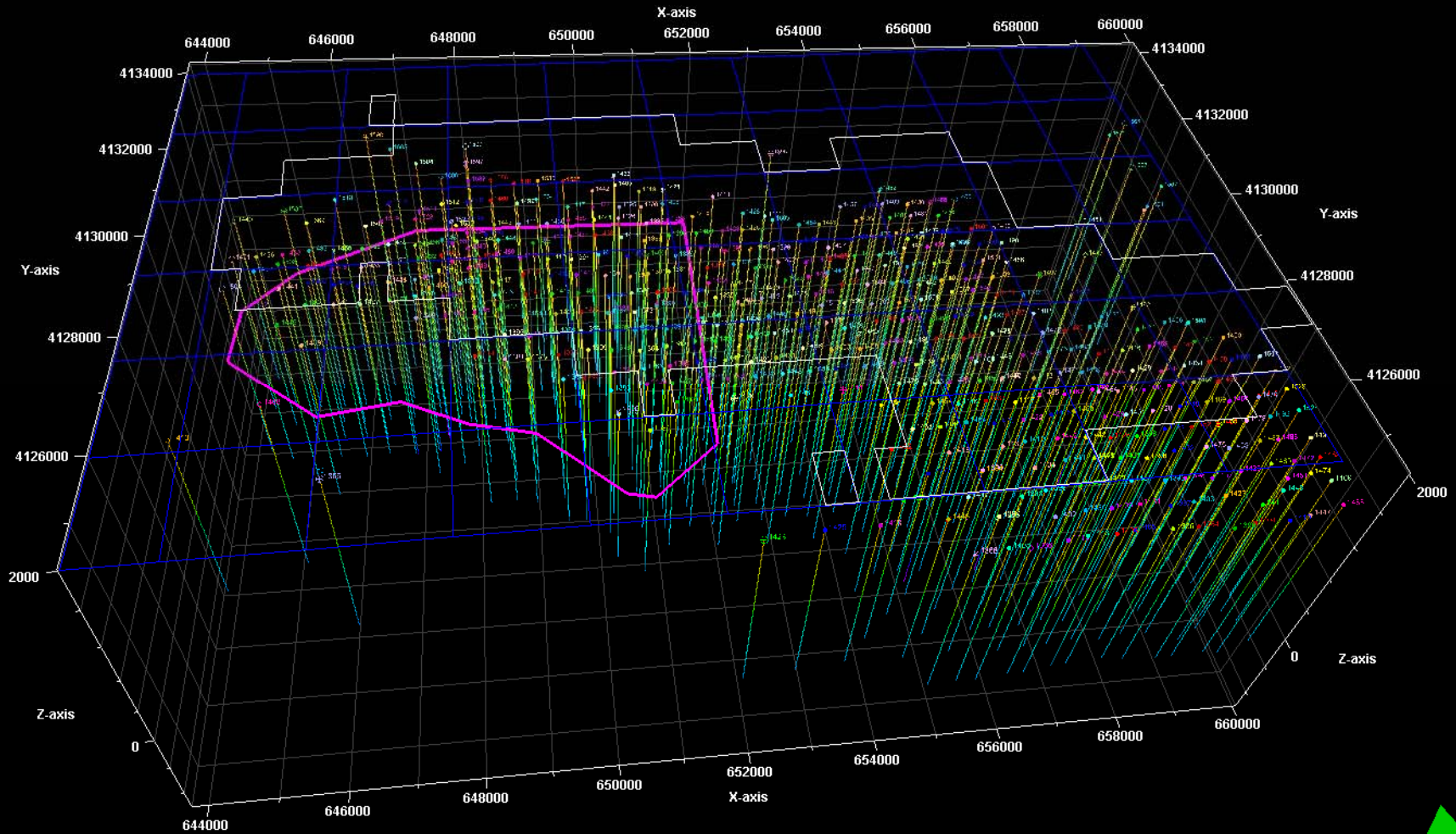
Section 14



Return Curves

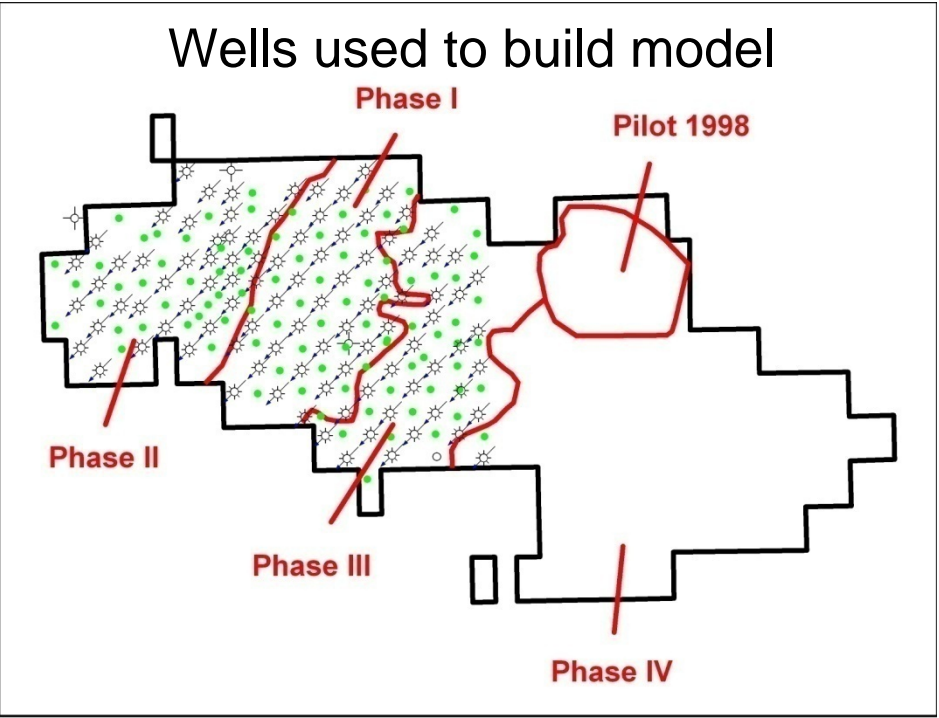
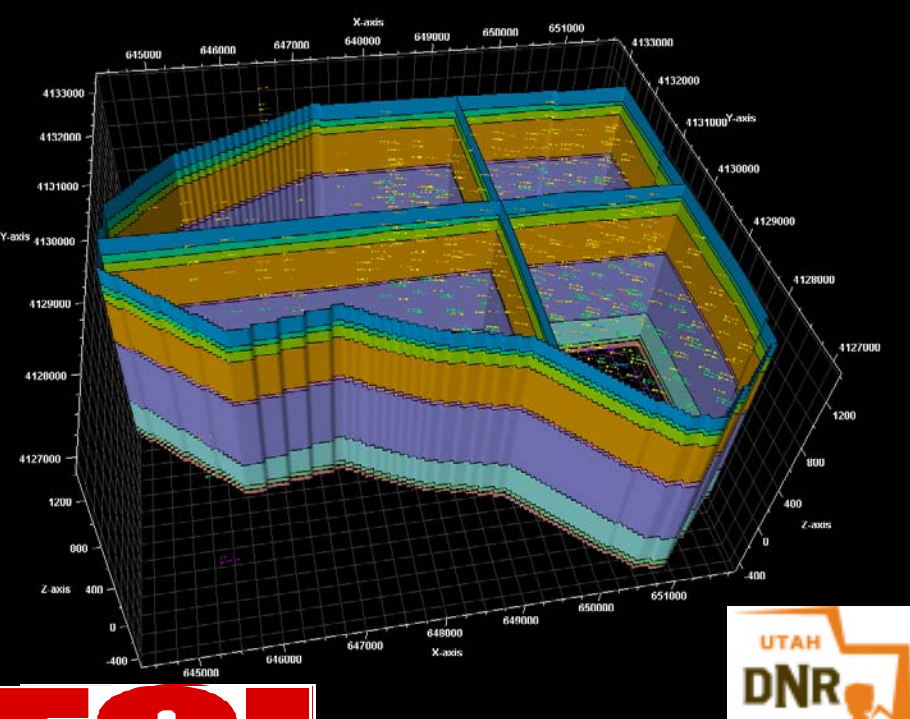
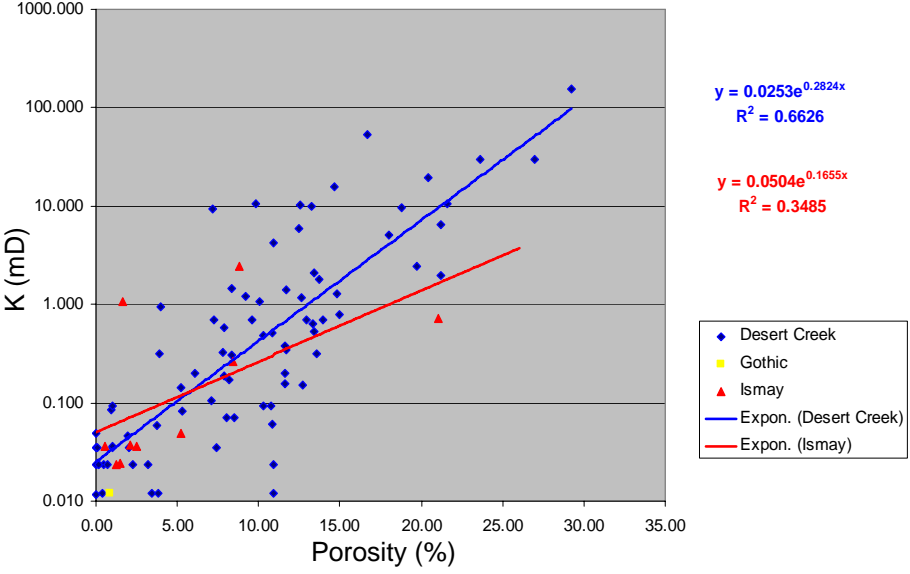


Wells of Aneth Units with Formation Picks



Geologic Model

- Frame work built
- Porosity logs digitized
- Porosity / Permeability relation derived from core-plug measurements
- Production / injection data compiled



● Oil Well ✧ Dry Hole — Phase Boundaries
 ✧ Water Inj ○ Unknown □ Aneth Unit

0 0.5 1 2 Miles



Acknowledgements

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- We express our gratitude also to our many institutional and industry partners, who have contributed to this project:

- New Mexico Tech
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- Baker Atlas
- Schlumberger
- AIST – Japan
- VCable, LLC
- DAQ Systems
- Terra Tek
- Cambridge Geosciences
- Sandia National Labs
- Los Alamos National Laboratory