Illinois Basin - MVA Programs at Mumford Hills and Sugar Creek EOR Sites

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Overview

- Monitoring, Verification and Accounting (MVA) Goals
- MVA Efforts
  - Mumford Hills
  - Sugar Creek
- Preliminary Observations at Sugar Creek

Primary MVA Contributors

- Kentucky Geological Survey
  - Glynn Beck, Kathy Takacs, Marty Parris
- Illinois State Geological Survey
  - MVA Coodinator: Ivan Krapac
  - Field sampling: Abbas Iranmanesh, Bracken Wimmer
  - Data Acquisition and Management: Steve Sargent, Mike Dodd, Mark Hart, Damon Garner
  - GIS and Graphics: Chris Korose, Don Luman, Daniel Byers
  - Geochemical Modeling: William Roy, Peter Berger

Selected MVA Goals at EOR sites

- Establish baseline conditions to assess impacts of CO_2 injection
- Demonstrate that project methods adequately protect human health and the environment
- Estimate CO_2 mass sequestered

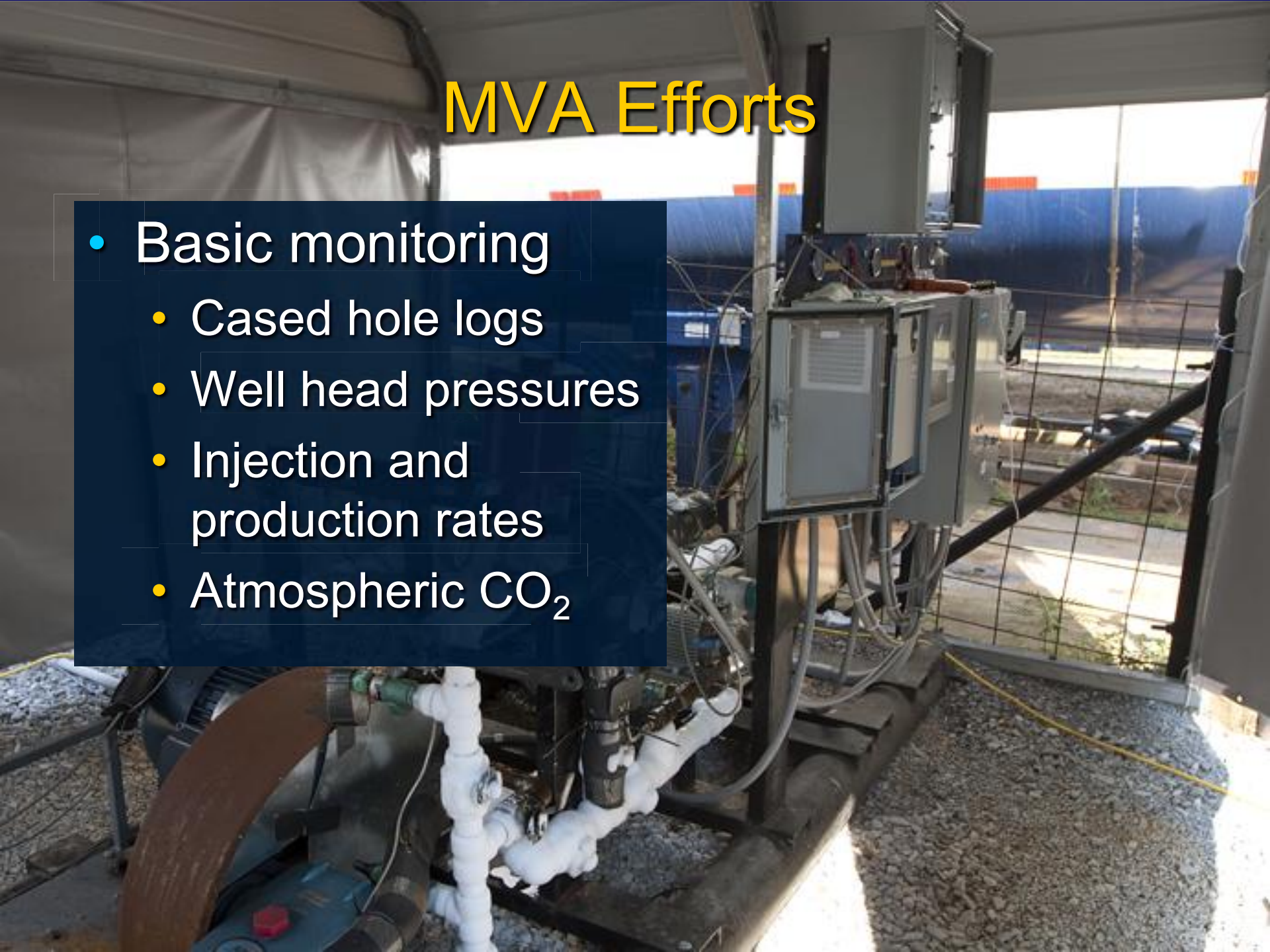
MVA Efforts

- Mumford Hills (EOR II) and Sugar Creek (EOR III) efforts are very similar
- Both sites use elements of ‘basic’ and ‘enhanced’ monitoring packages (Benson et al., 2004)

Benson, S.M., Gasperikova, E., and Hoversten, G.M. 2004. Overview of monitoring techniques and protocols for GS projects, IEA Greenhouse Gas R&D Program Report

MVA Efforts

- Basic monitoring
  - Cased hole logs
  - Well head pressures
  - Injection and production rates
  - Atmospheric CO_2



MVA Efforts

- Enhanced monitoring
  - Produced brine and gas quality
  - Annular pressure (SC only)
  - Shallow groundwater quality in residential and monitoring wells
  - Reservoir modeling
  - Groundwater flow modeling
  - Geochemical modeling
  - CO_2 flux monitoring

Brine Sampling

Gas Sampling

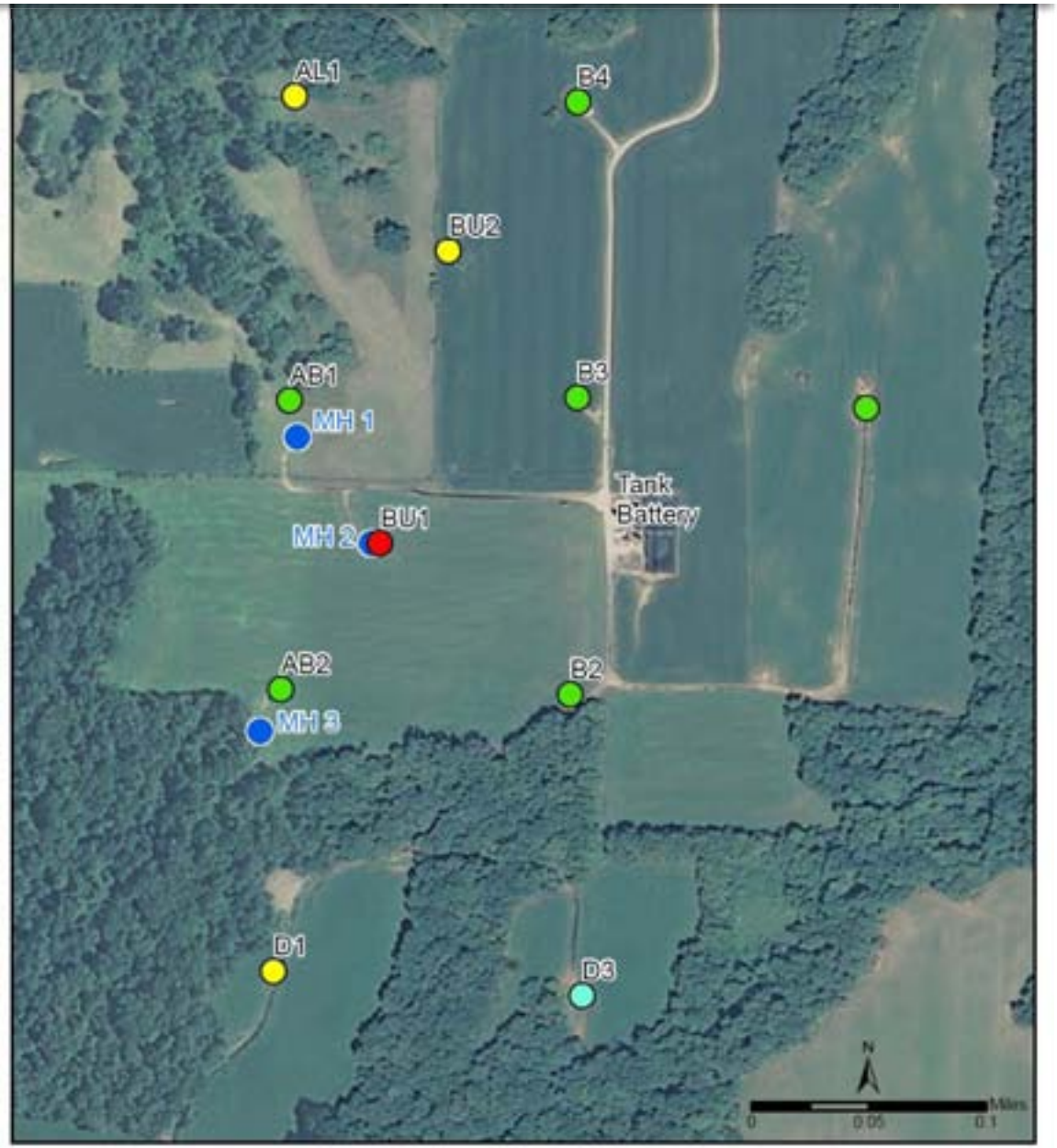
Chemical and Physical Analyses

- Liquid samples
  - Field: temperature, pH, ORP, EC, DO
  - Lab: anions, cations (major and trace), TDS, TOC, alkalinity, dissolved CO_2, and isotopes ($\delta^{13}C$, $\delta^{14}C$ of DIC, δD and $\delta^{18}O$ of H_20)
- Gas samples
  - Field: % CO_2
  - Lab: total composition (C1-C6) and isotopes ($\delta^{13}C$ of CH_4 and CO_2, δD of CH_4)

Mumford Hills, Posey Co., Indiana

Legend

- CO_2 injection well
- Active oil well
- Temp. aband. oil well
- Water supply well
- GW monitoring well



Mumford Hills Site, Posey Co., IN

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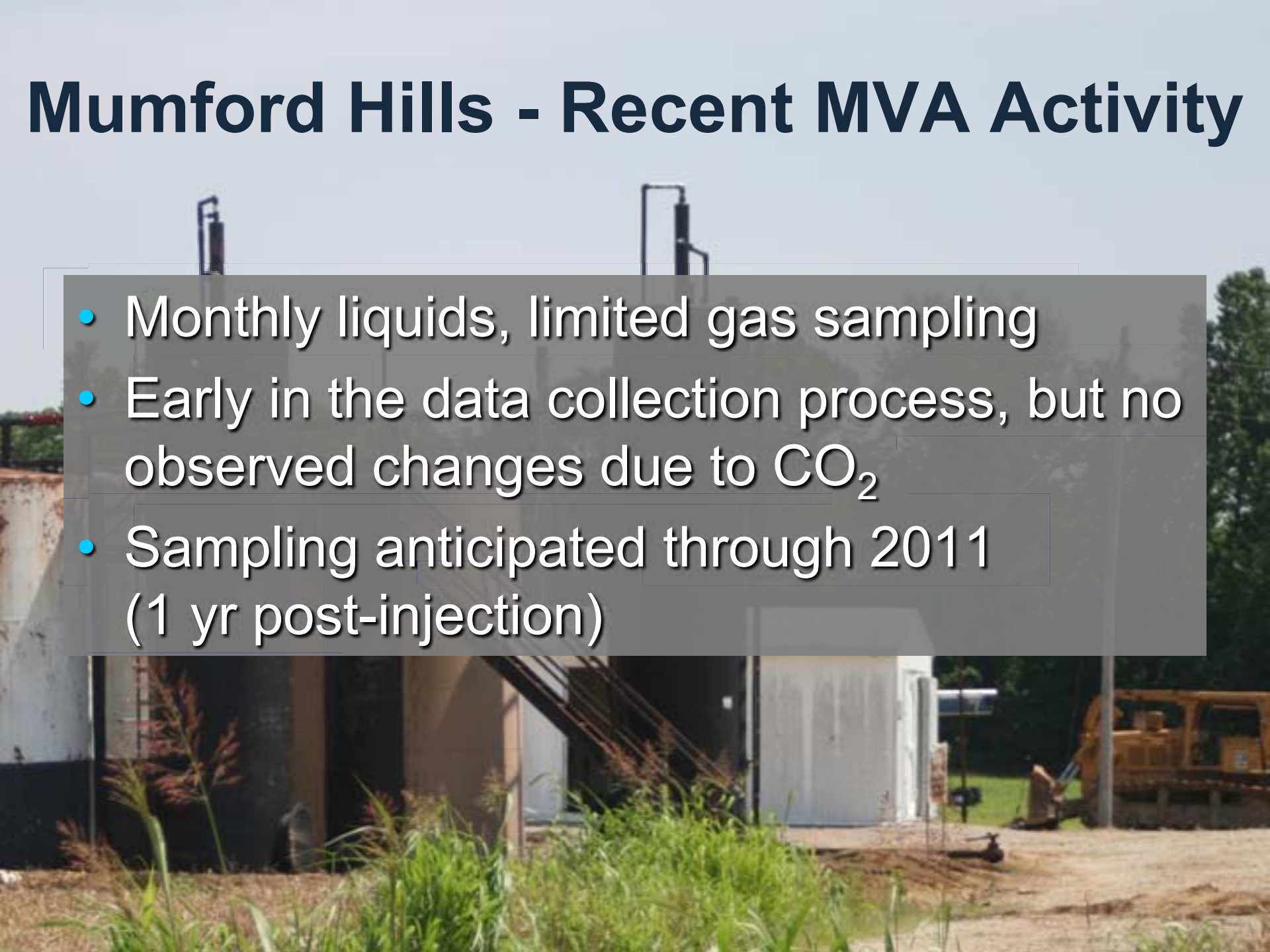
Mumford Hills - Recent MVA Activity

- Shallow groundwater flow model built
- Shallow groundwater monitoring wells installed, developed and instrumented near CO_2 injection and 2 production wells

Mumford Hills - Recent MVA Activity

- Geochemical sampling began 8/11/09
- Injection began 9/3/09
- 5 sampling rounds to date (2 pre-injection)

Mumford Hills - Recent MVA Activity

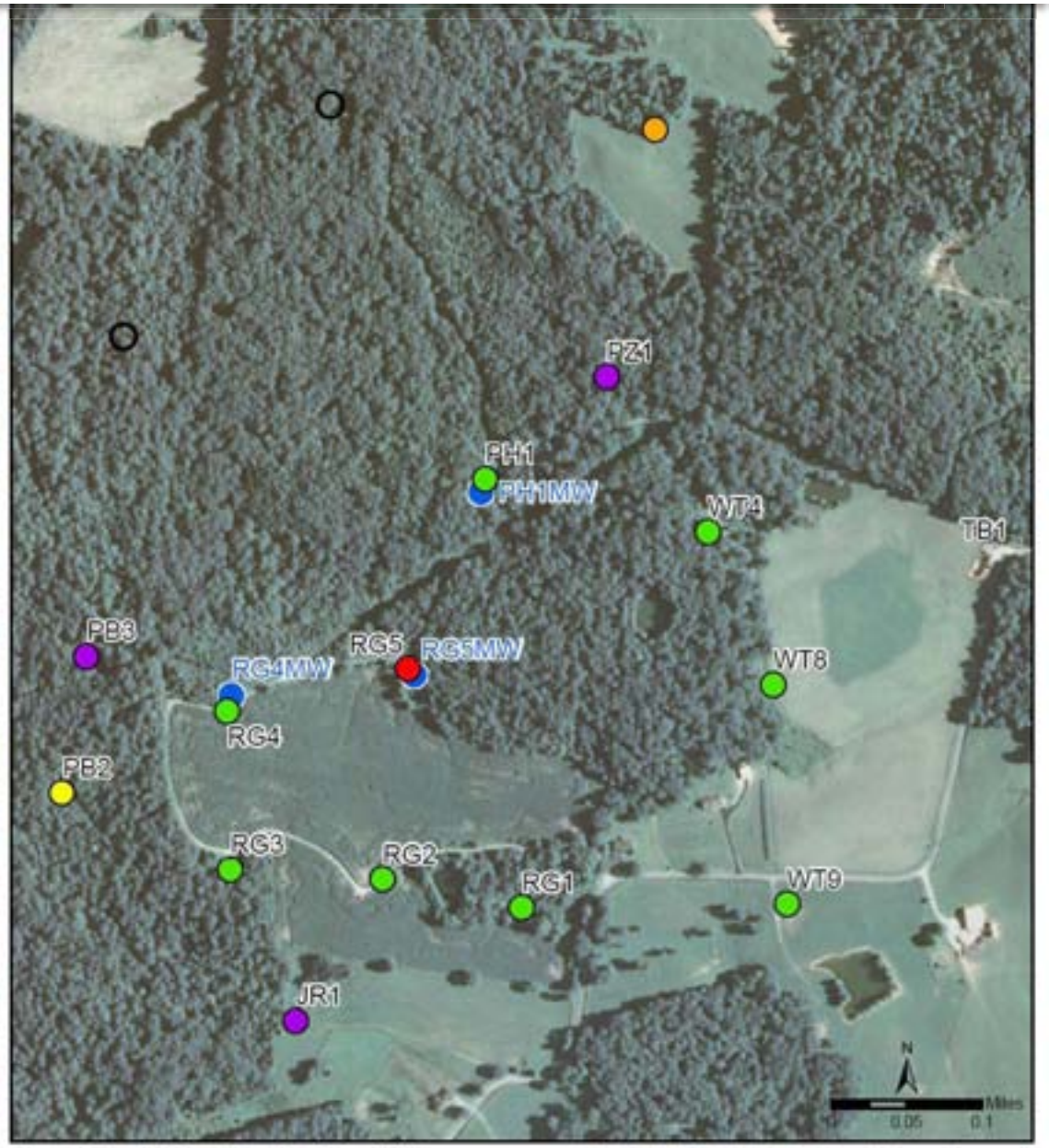


- Monthly liquids, limited gas sampling
- Early in the data collection process, but no observed changes due to CO_2
- Sampling anticipated through 2011 (1 yr post-injection)

Sugar Creek, Hopkins Co., Kentucky

Legend

- CO_2 injection well
- Active oil well
- Temp. aband. oil well
- Water injection well
- Dry or unknown
- Reservoir monitoring well
- GW monitoring well



Sugar Creek Site, Hopkins Co., KY

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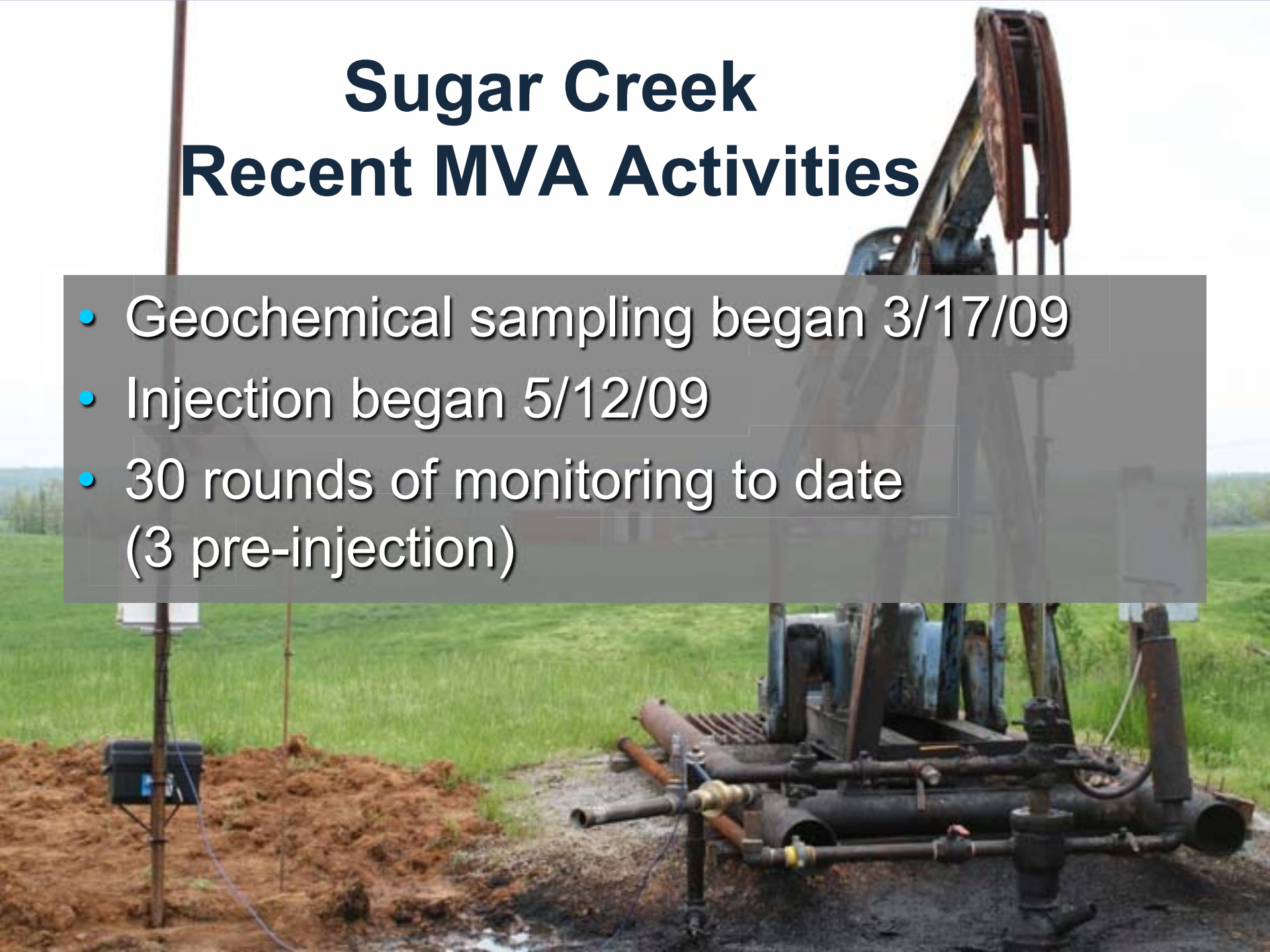
Sugar Creek
Recent MVA Activities

- Shallow groundwater flow model built
- Shallow groundwater monitoring wells installed, developed and instrumented near CO_2 injection and 2 production wells

Sugar Creek
Recent MVA Activities

- Geochemical sampling began 3/17/09
- Injection began 5/12/09
- 30 rounds of monitoring to date (3 pre-injection)



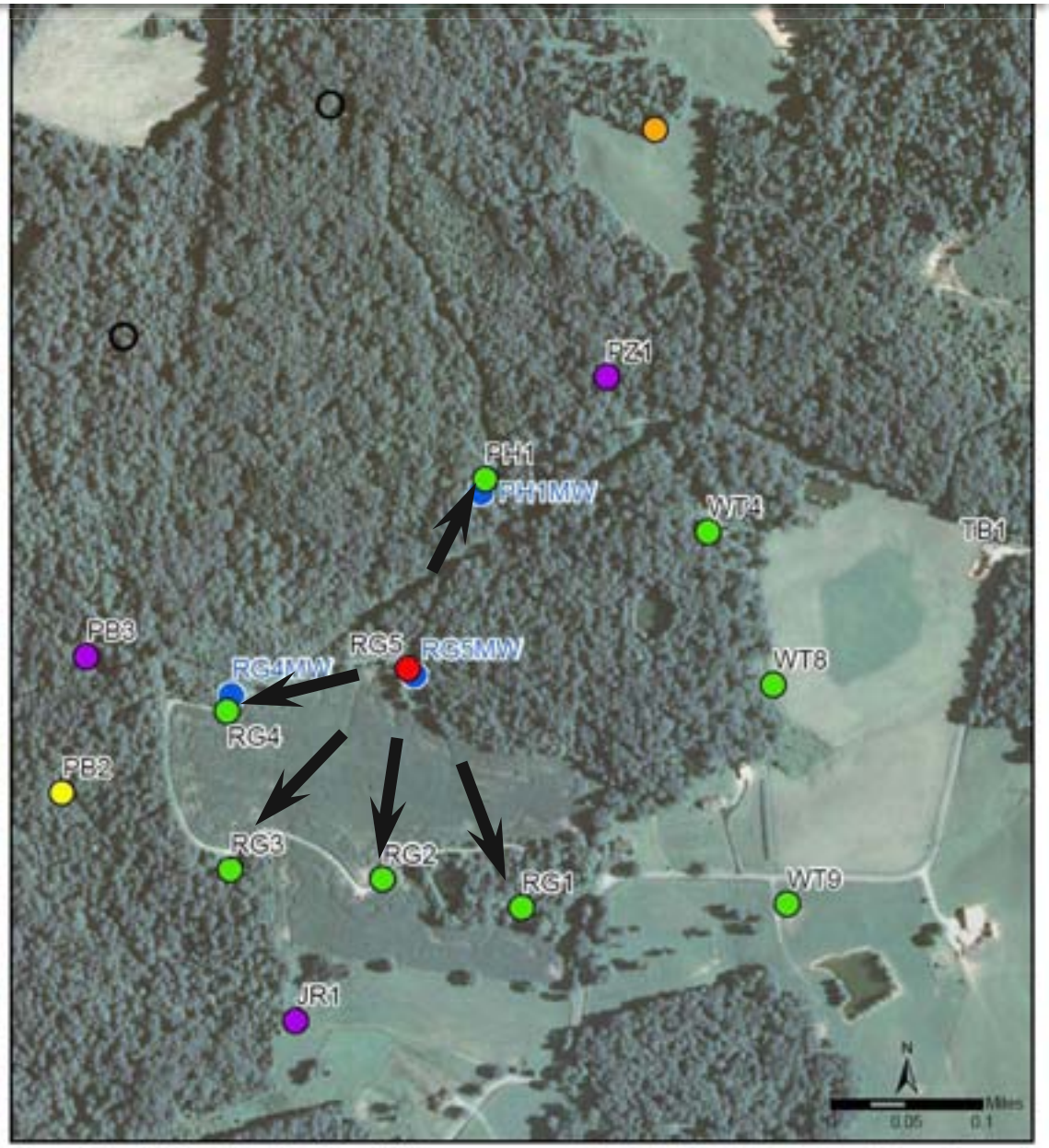
Sugar Creek
Recent MVA Activities

- Weekly annular CO_2 gas readings, monthly gas and brine sampling, quarterly shallow groundwater sampling
- Observed geochemical and pressure responses at 5 of 8 production wells
- Sampling anticipated through 2011 (1 yr post injection)

Sugar Creek, Hopkins Co., Kentucky

Legend

- CO_2 injection well
- Active oil well
- Temp. aband. oil well
- Water injection well
- Dry or unknown
- Reservoir monitoring well
- GW monitoring well



Sugar Creek Site, Hopkins Co., KY

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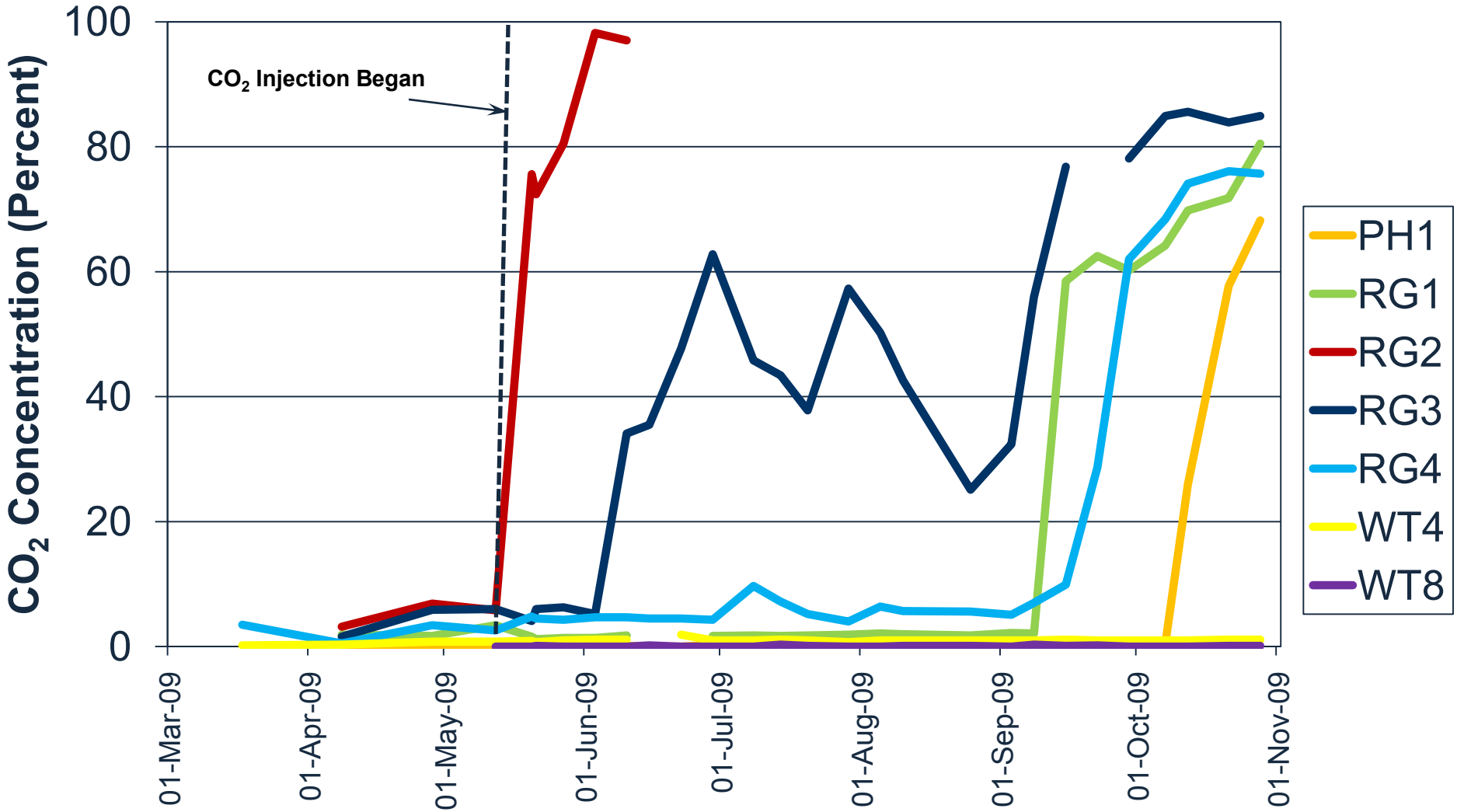
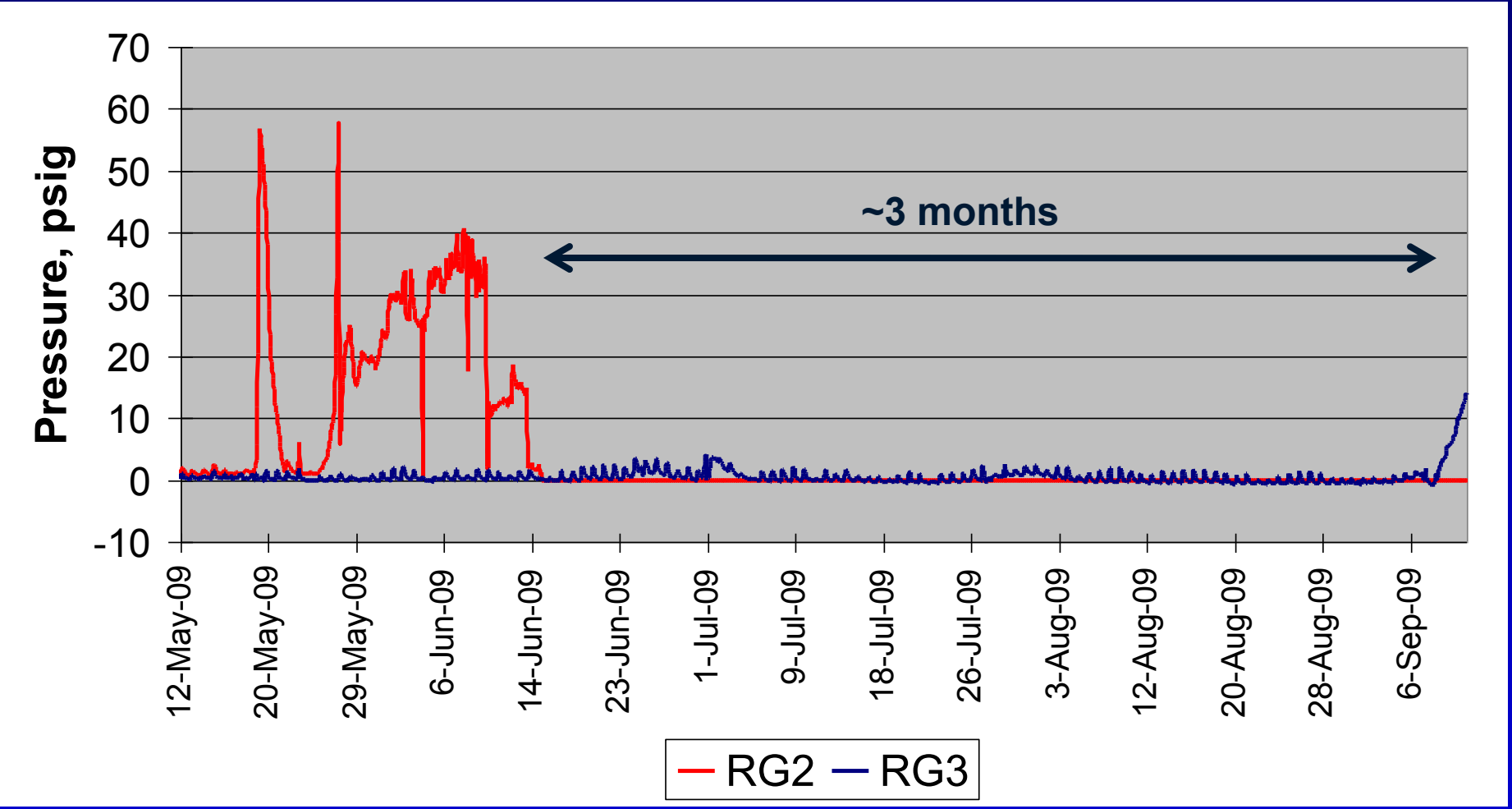
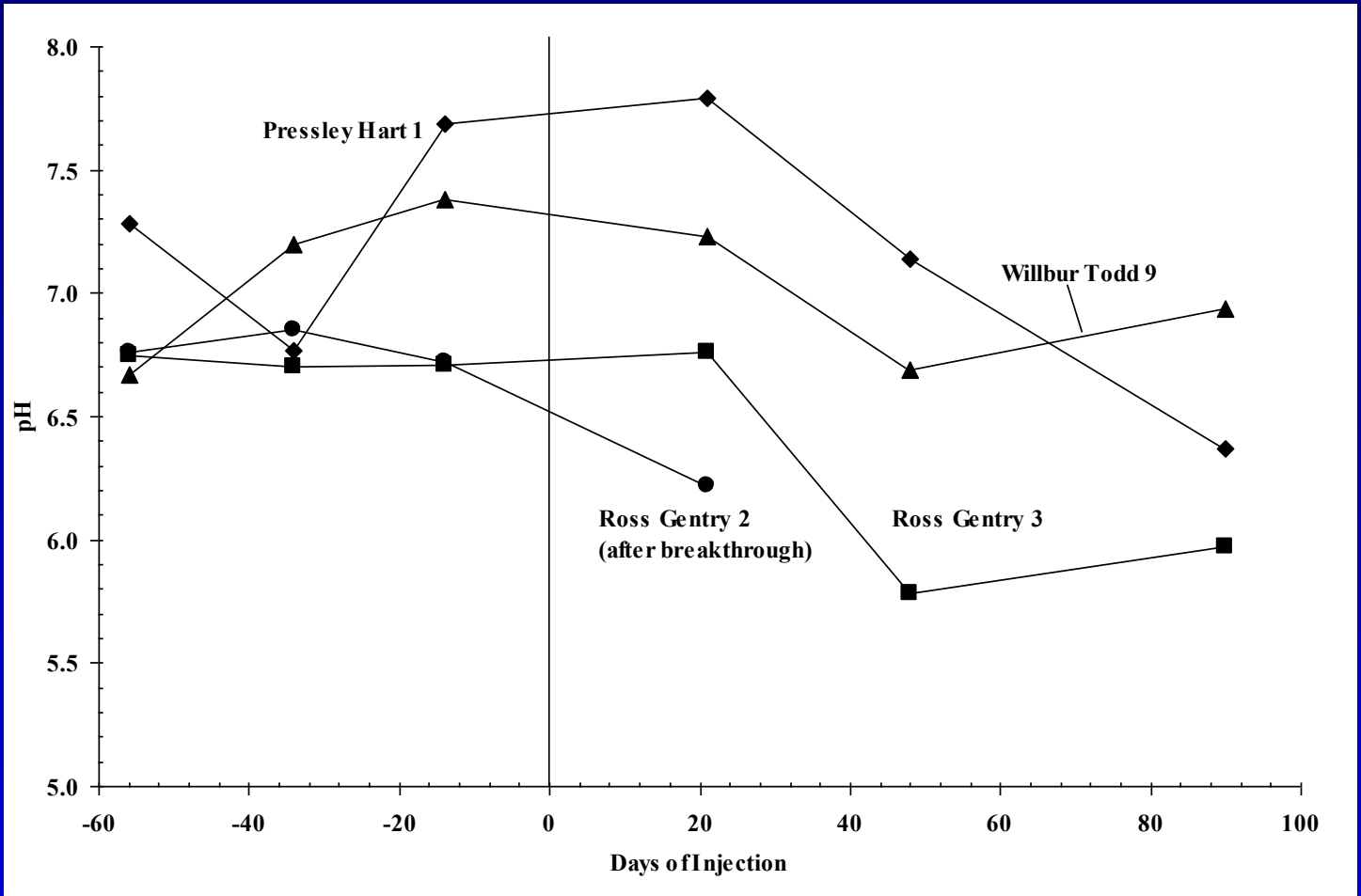
Annular CO_2 Gas in Oil Wells Sugar Creek



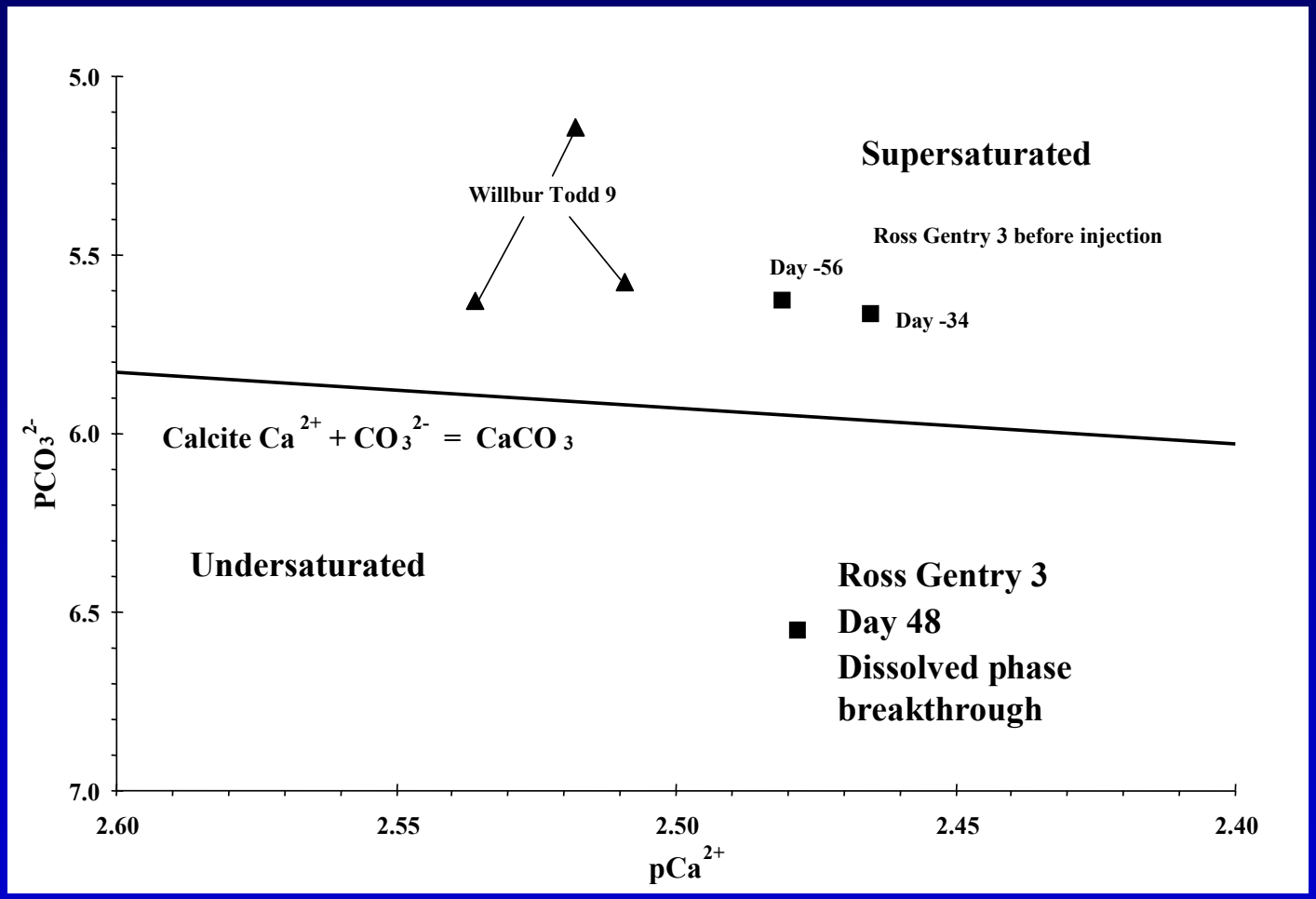
Annular Pressure in RG2 and RG3 - Sugar Creek



Change in Brine pH - Sugar Creek



Calcite Equilibria at Sugar Creek



Preliminary Observations

- CO_2 responses observed
  - increase in annular CO_2 concentration **with** increase in casing pressure
  - Increase in annular CO_2 concentration **before** increase in casing pressure
- Possible scenarios? (dissolved vs. free phase, edge of plume, etc.)
- 2% of injected CO_2 produced, ~½ at RG2

Sugar Creek Transfer Line Release

Release Details

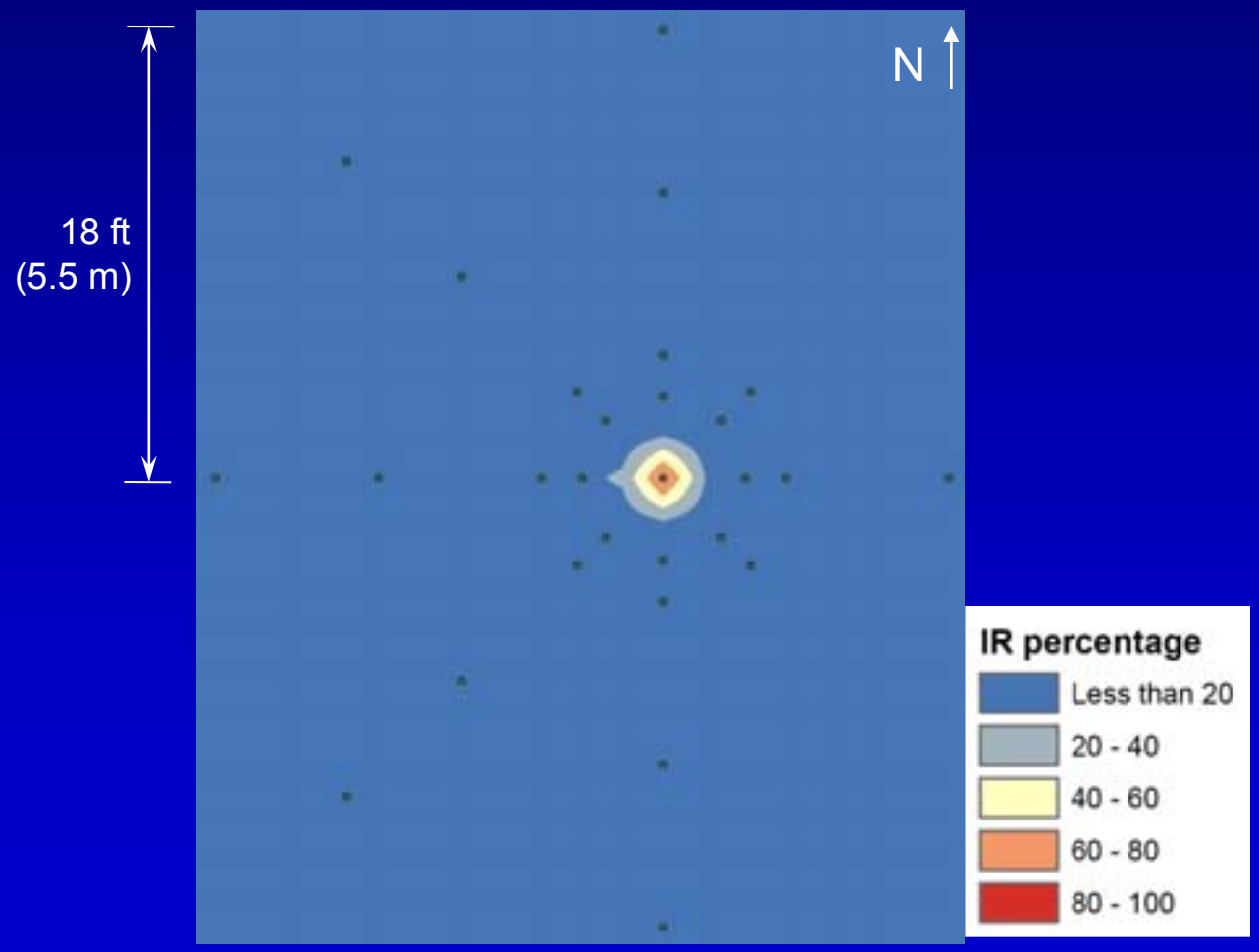
- ~100 feet from CO_2 injector well
- Opportunity to test monitoring methods
- Monitored July 6 to July 8, 2009
- CO_2 injection restarted on July 7
- Caused by bad seal in CO_2 transfer line (~3 ft underground)

Methods

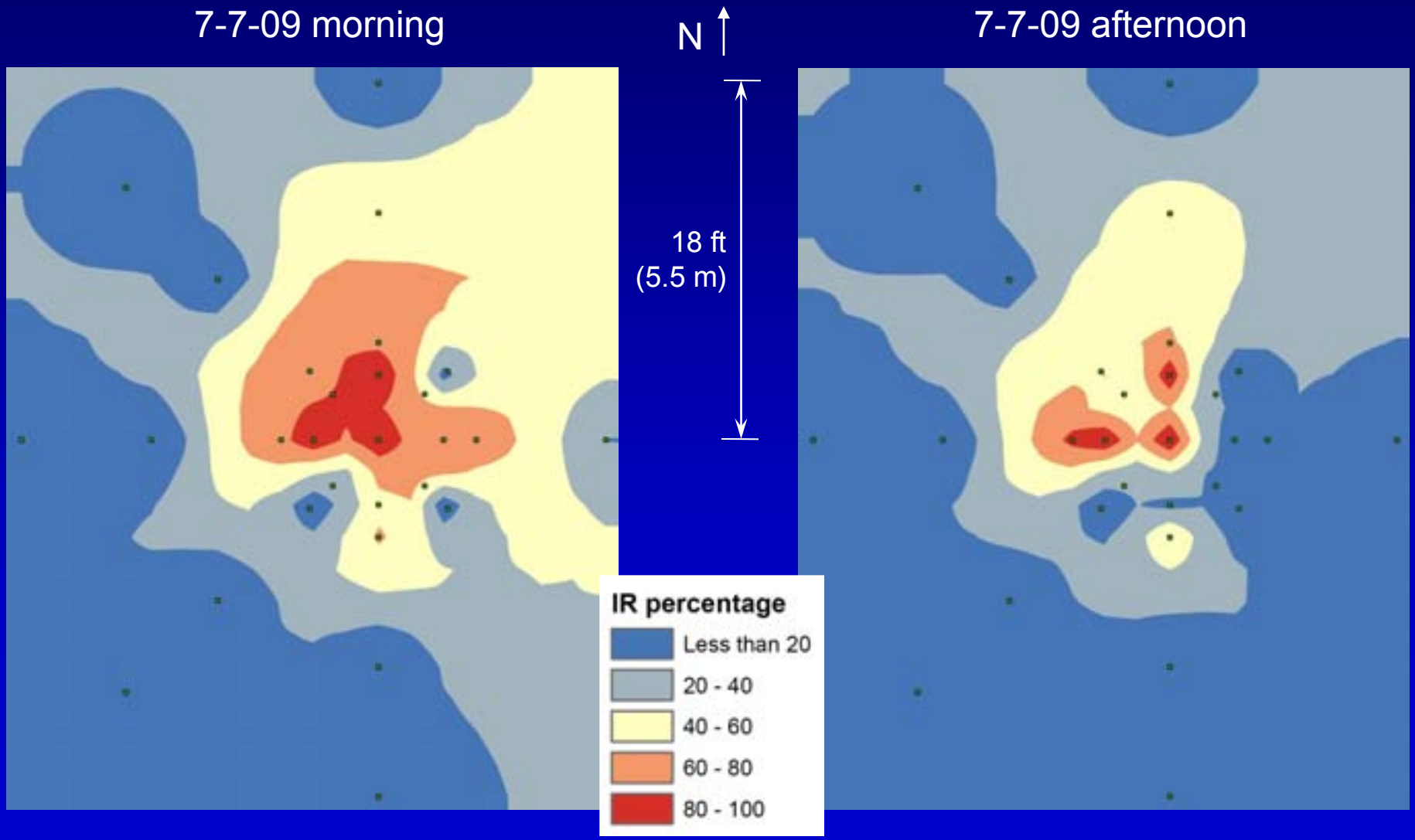
- Multiple monitoring methods tested (Field infrared gas analyzer, accumulation chamber, vadose zone with field IRGA)
- Measured CO_2 concentration at several levels above land surface with field IRGA
- 26 grid points (~ 1 hr to measure all)

CO_2 Percentage (Field IR)

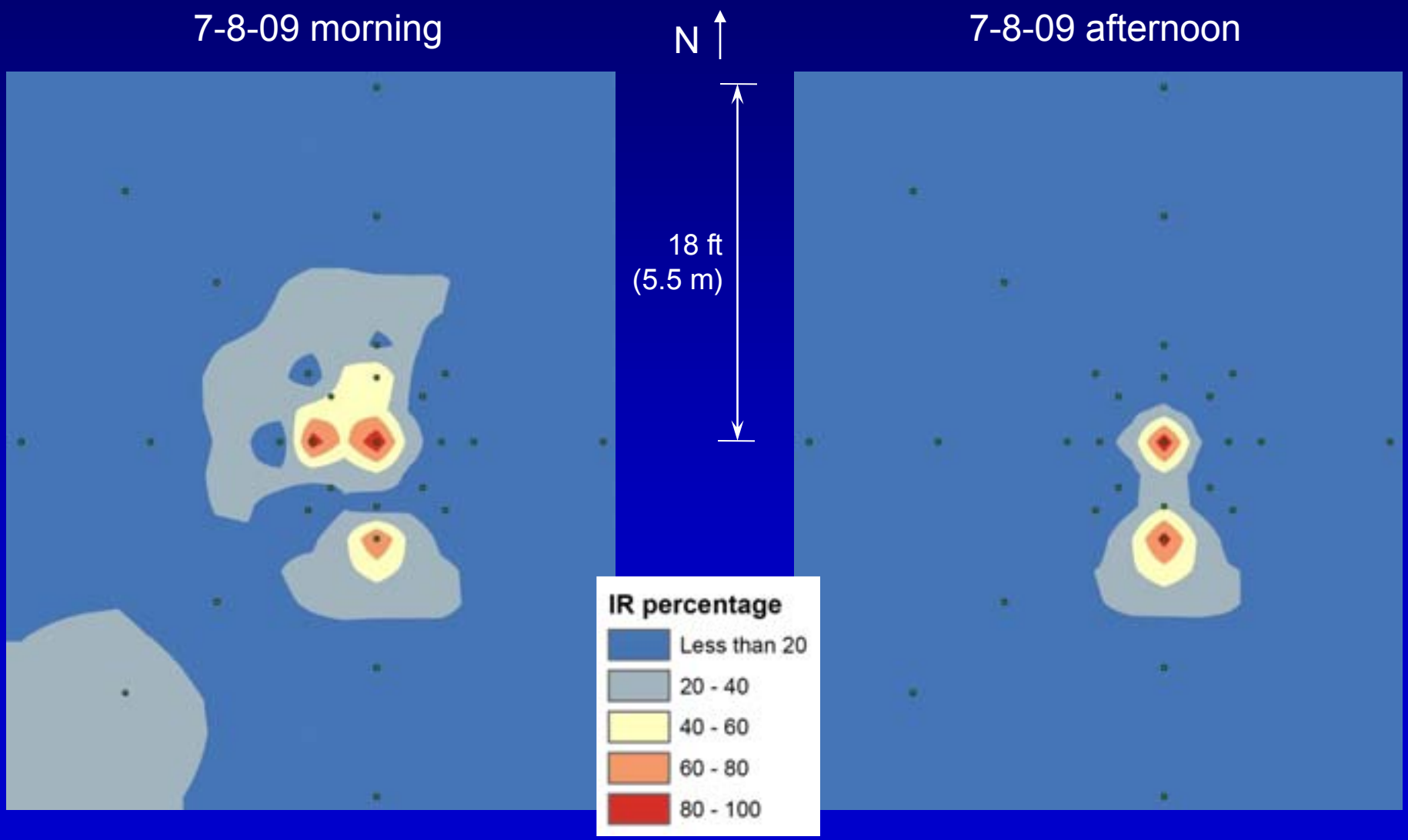
7-6-09 (initial condition)



CO_2 Percentage (Field IR)



CO_2 Percentage (Field IR)



Monitoring Experiences

- Multiple monitoring methods tested
- All methods detected elevated CO_2 levels/fluxes
- Elevated CO_2 concentrations generally not observed > 2.5 cm above ground

Monitoring Experiences

- Ground disturbances altered the test grid
- Challenging to characterize rapid CO_2 movement with a single field instrument
- Significant practical monitoring experience was gained

Acknowledgements

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