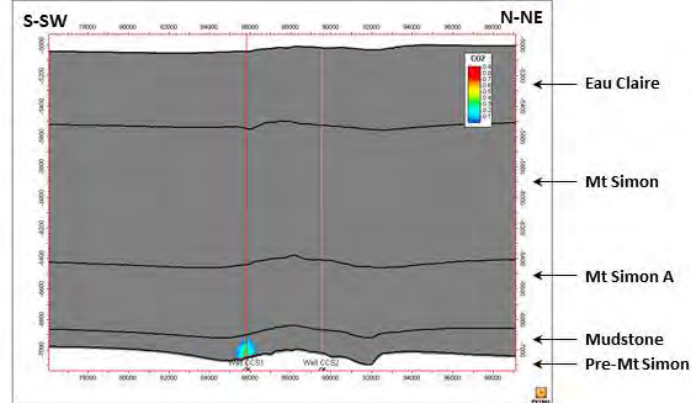
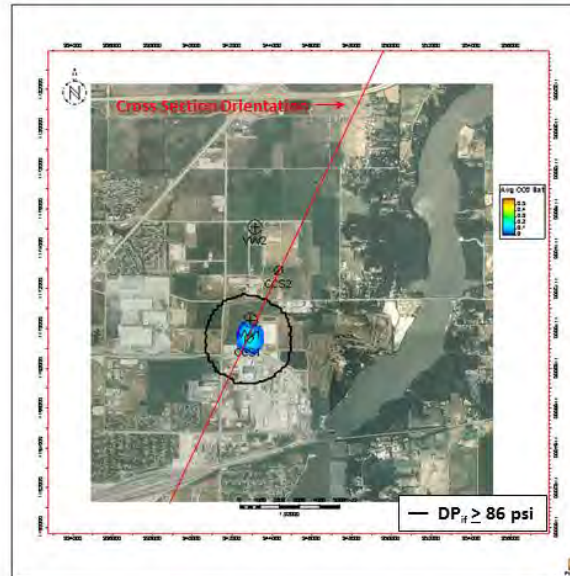


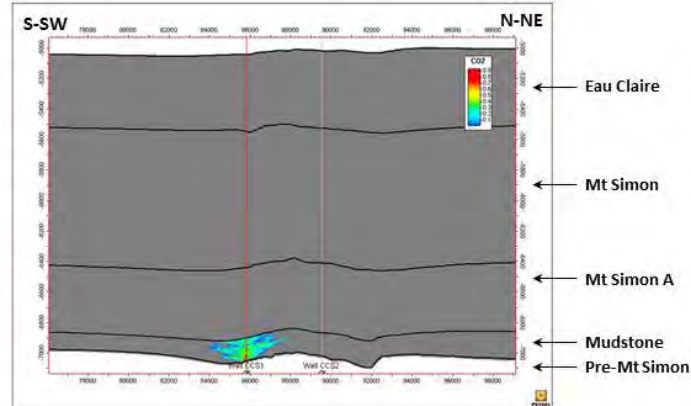
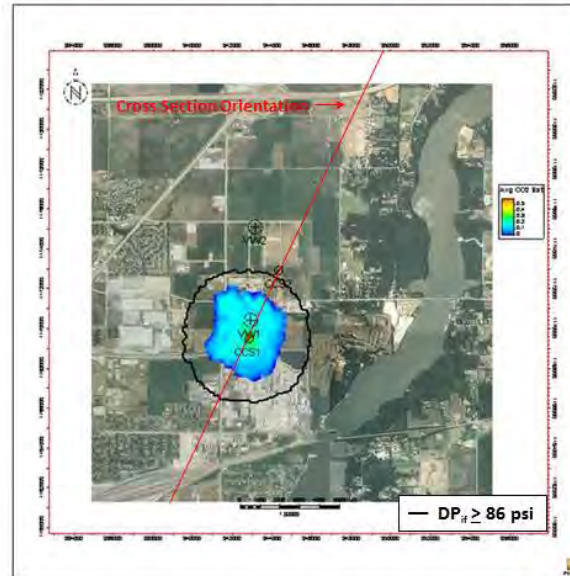
Geophysical Modeling

**Extent of Plume & Saturation Cross Section
January 1, 2012 [DP_{if} ≥ 86 psi, SCO₂ ≥ 1.0%]**



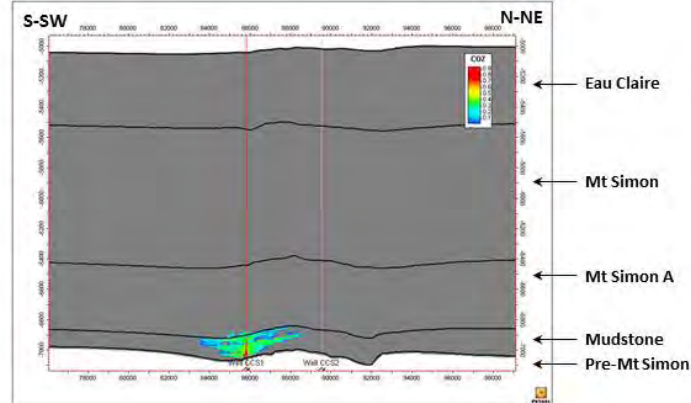
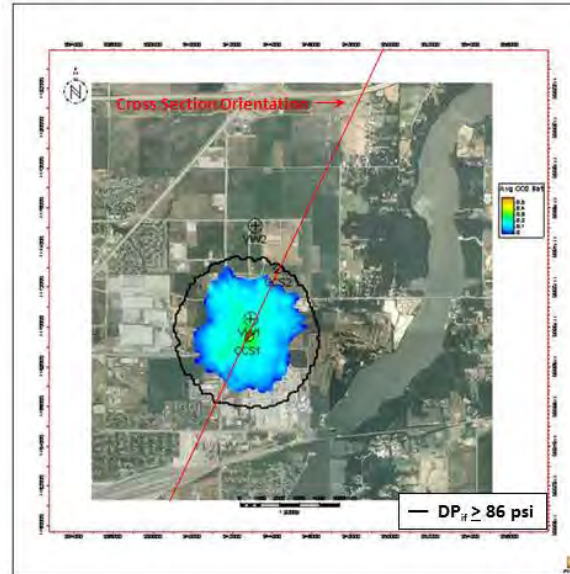
Geophysical Modeling

**Extent of Plume & Saturation Cross Section
January 1, 2013 [DP_{if} ≥ 86 psi, SCO₂ ≥ 1.0%]**



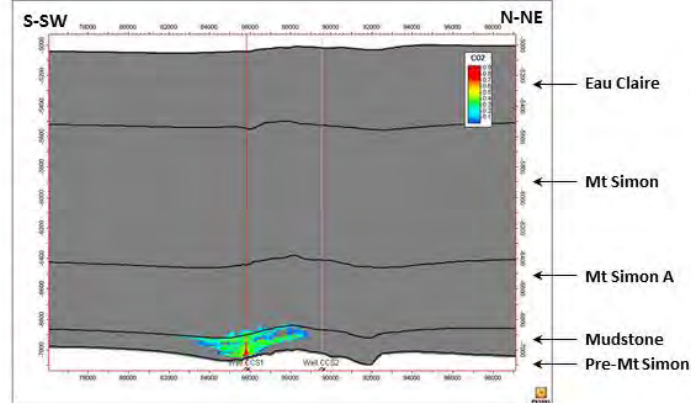
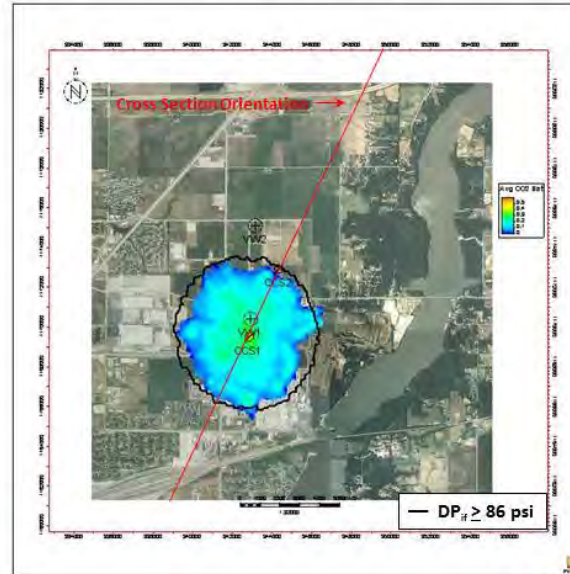
Geophysical Modeling

**Extent of Plume & Saturation Cross Section
January 1, 2014 [DP_{if} ≥ 86 psi, SCO₂ ≥ 1.0%]**



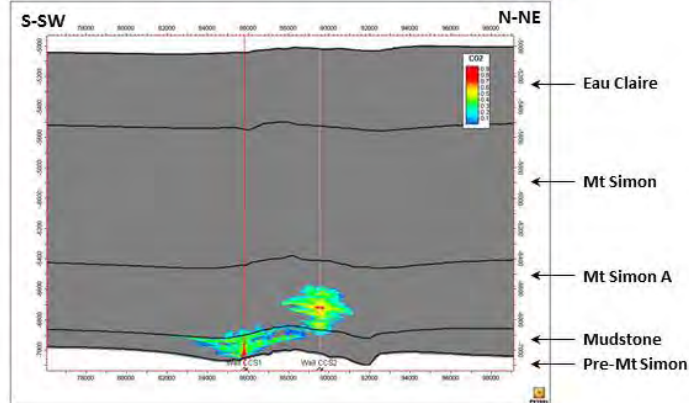
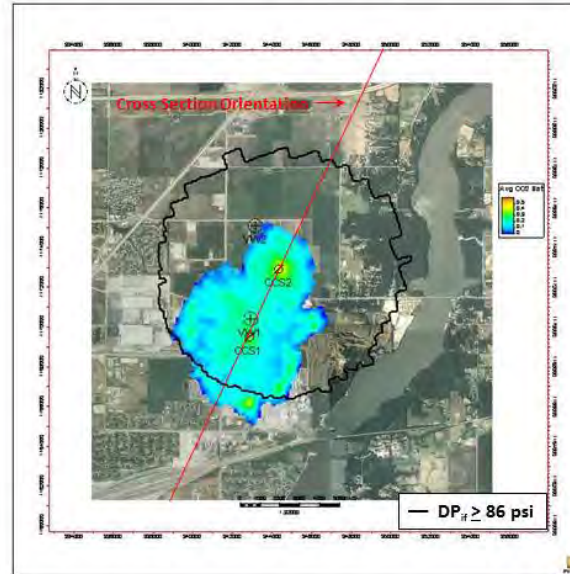
Geophysical Modeling

**Extent of Plume & Saturation Cross Section
January 1, 2015 [DP_{if} ≥ 86 psi, SCO₂ ≥ 1.0%]**



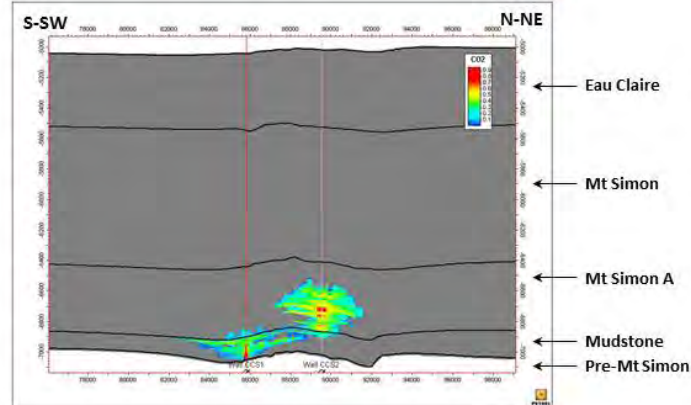
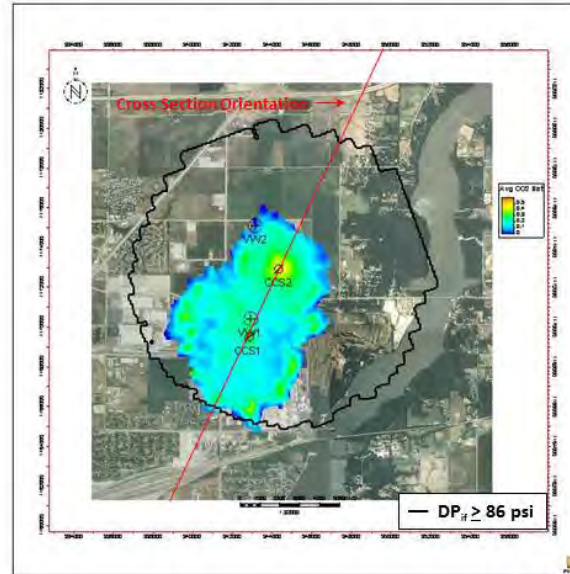
Geophysical Modeling

**Extent of Plume & Saturation Cross Section
January 1, 2016 [DP_{if} ≥ 86 psi, SCO₂ ≥ 1.0%]**



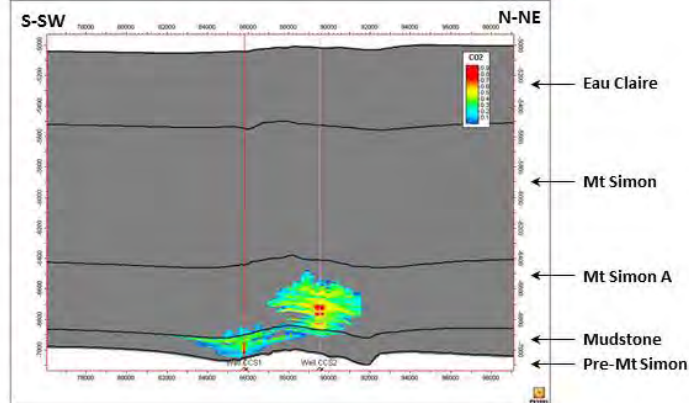
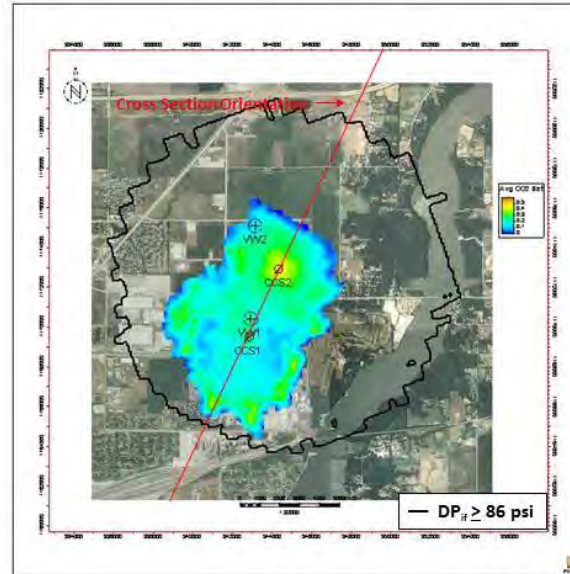
Geophysical Modeling

**Extent of Plume & Saturation Cross Section
January 1, 2017 [DP_{if} ≥ 86 psi, SCO₂ ≥ 1.0%]**



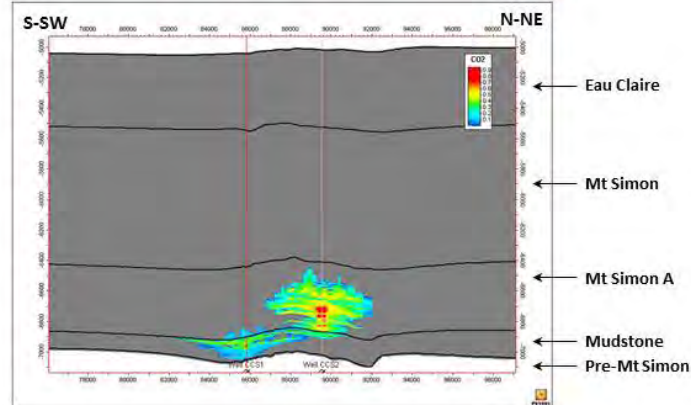
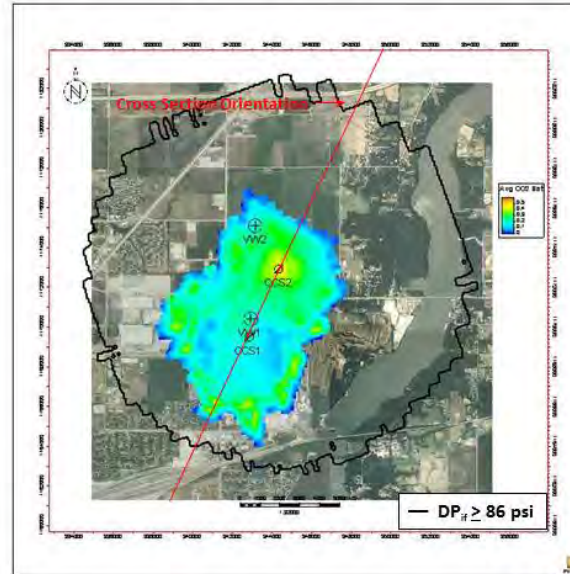
Geophysical Modeling

**Extent of Plume & Saturation Cross Section
January 1, 2018 [DP_{if} ≥ 86 psi, SCO₂ ≥ 1.0%]**



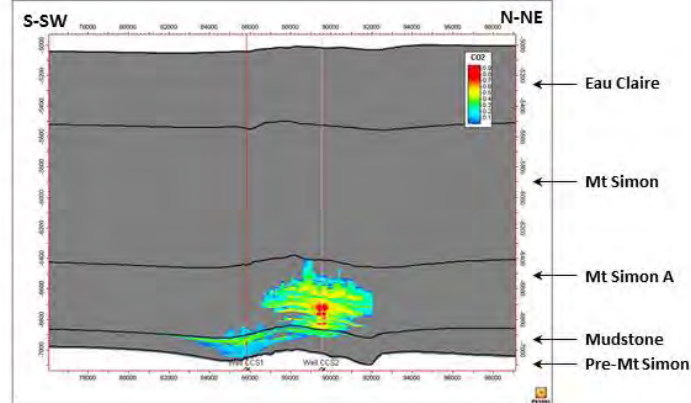
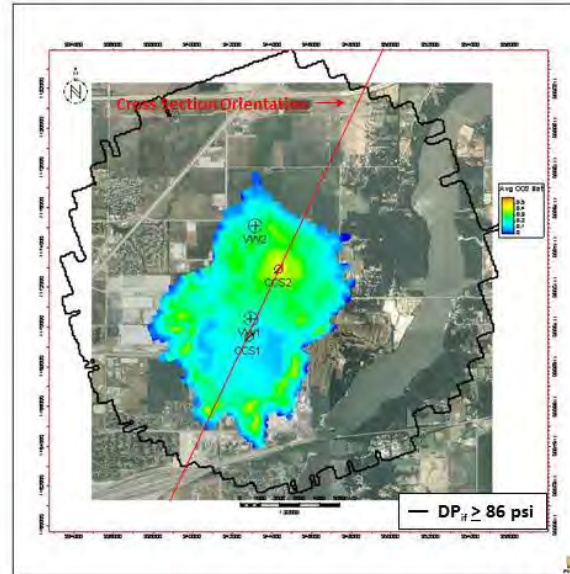
Geophysical Modeling

**Extent of Plume & Saturation Cross Section
January 1, 2019 [DP_{if} ≥ 86 psi, SCO₂ ≥ 1.0%]**



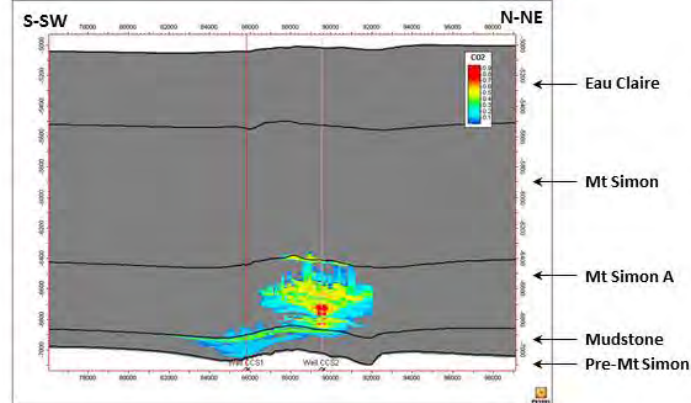
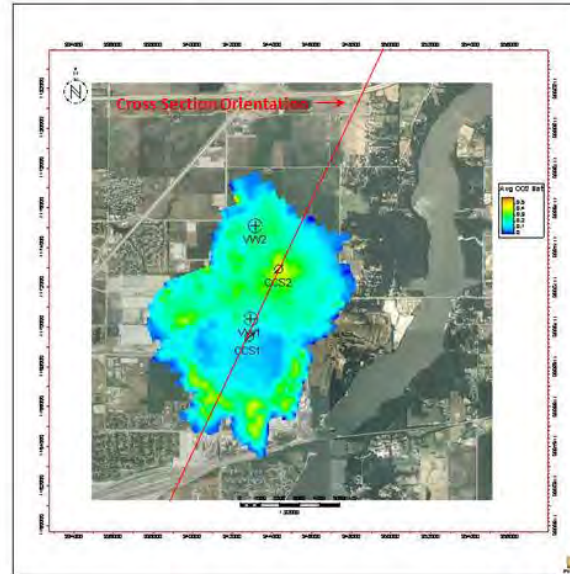
Geophysical Modeling

**Extent of Plume & Saturation Cross Section
January 1, 2020 [DP_{if} ≥ 86 psi, SCO₂ ≥ 1.0%]**



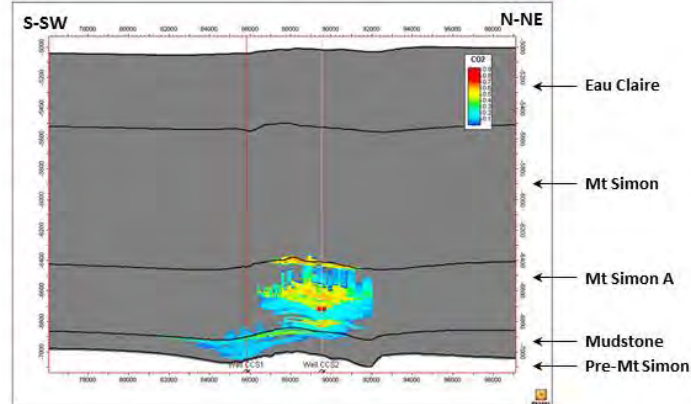
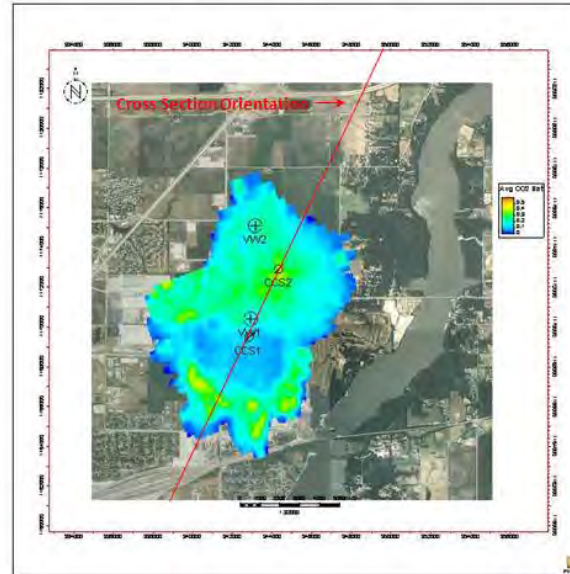
Geophysical Modeling

Extent of Plume & Saturation Cross Section January 1, 2025 [$\text{SCO}_2 \geq 1.0\%$]



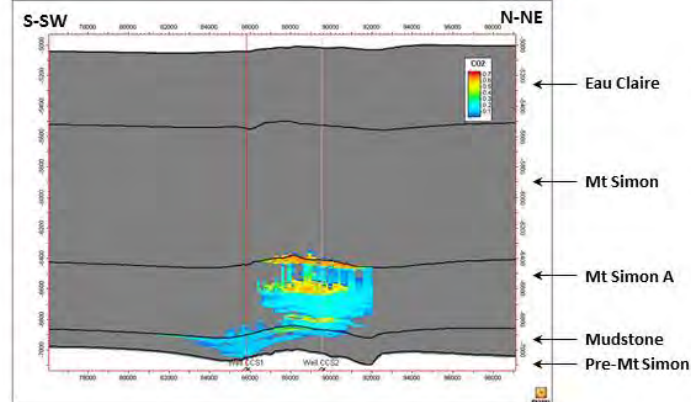
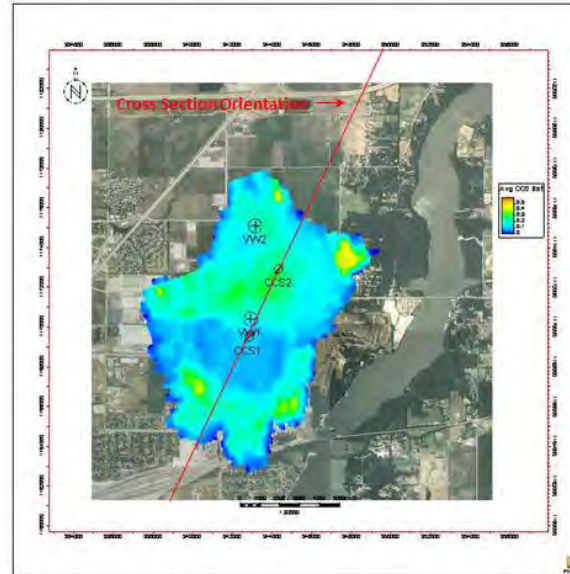
Geophysical Modeling

Extent of Plume & Saturation Cross Section January 1, 2030 [$\text{SCO}_2 \geq 1.0\%$]



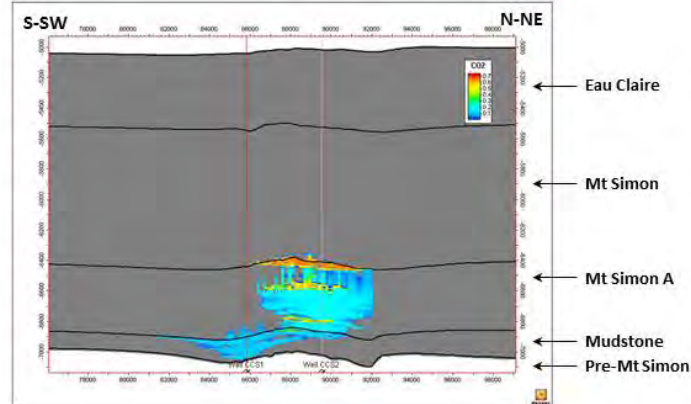
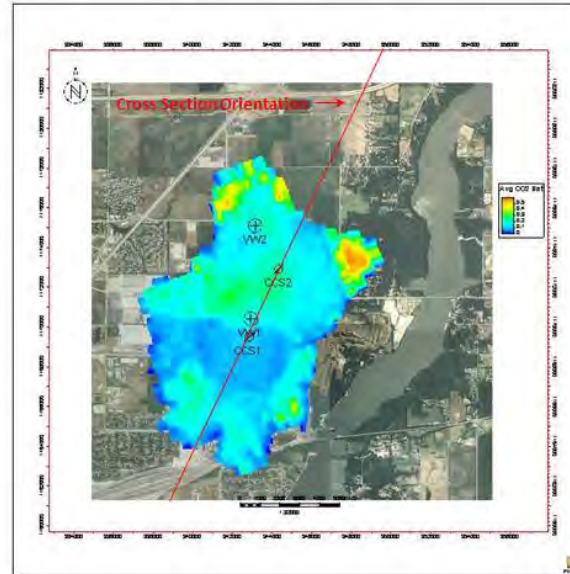
Geophysical Modeling

Extent of Plume & Saturation Cross Section January 1, 2040 [$\text{SCO}_2 \geq 1.0\%$]



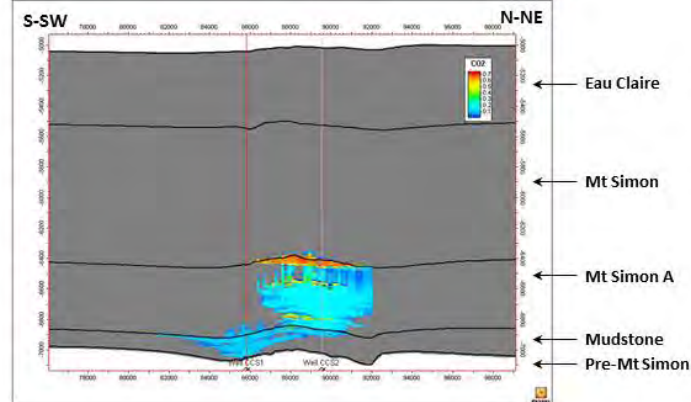
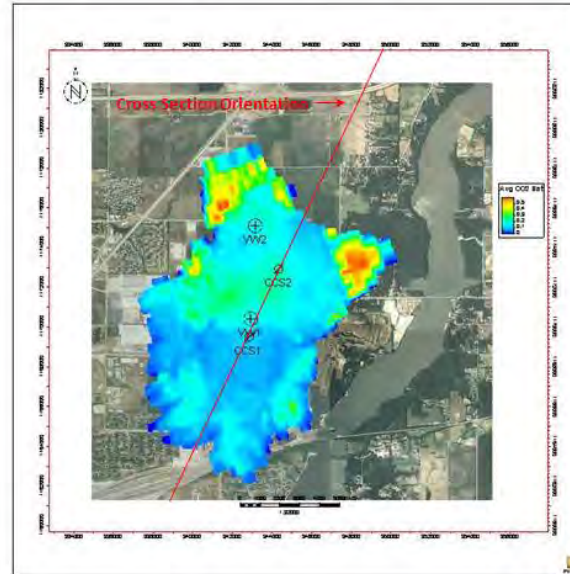
Geophysical Modeling

Extent of Plume & Saturation Cross Section January 1, 2050 [$\text{SCO}_2 \geq 1.0\%$]



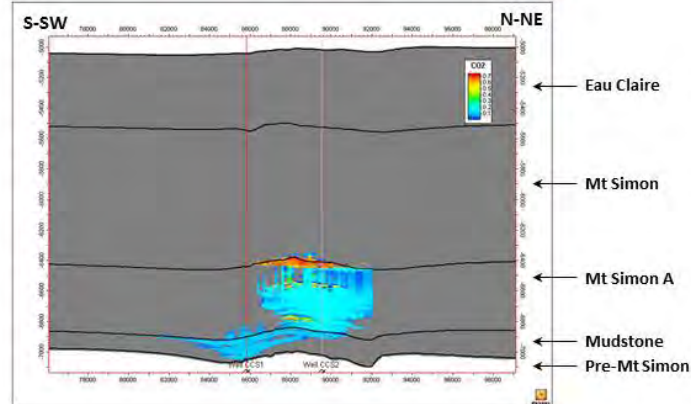
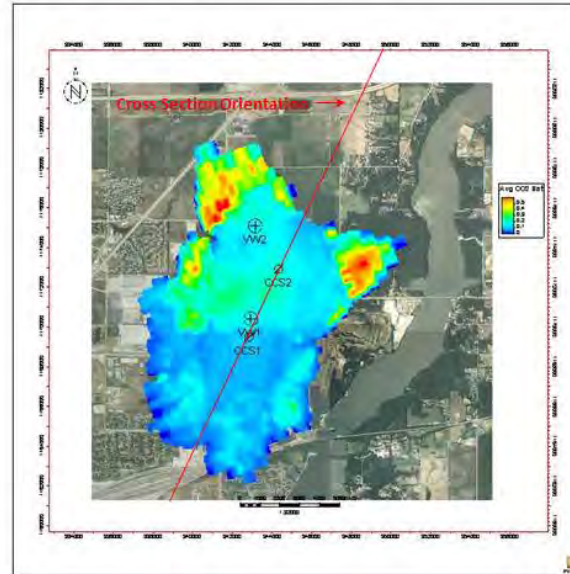
Geophysical Modeling

Extent of Plume & Saturation Cross Section January 1, 2060 [$\text{SCO}_2 \geq 1.0\%$]



Geophysical Modeling

Extent of Plume & Saturation Cross Section January 1, 2070 [$\text{SCO}_2 \geq 1.0\%$]



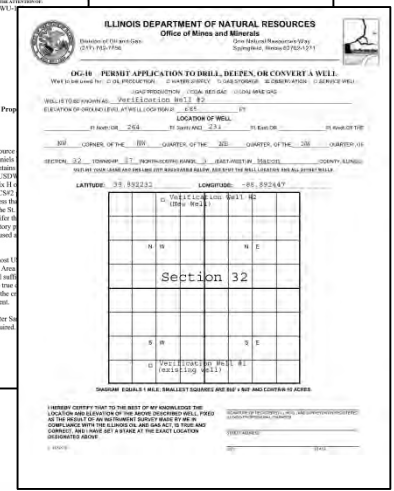
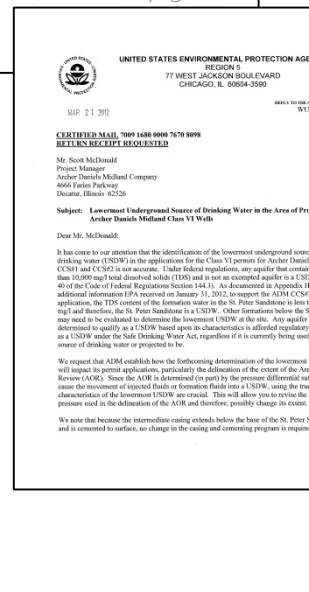
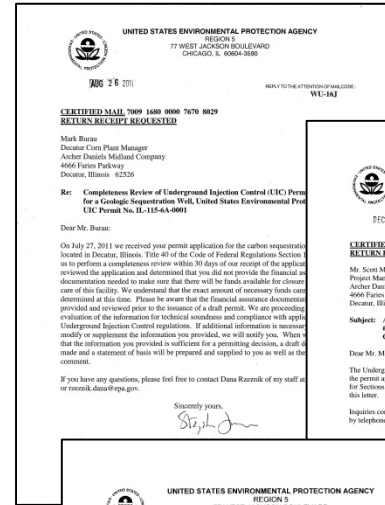


Site Permitting

USEPA: UIC Class VI Permit

1st UIC Class VI Permit Application Reviewed by the USEPA

- UIC Class VI permit application submitted on July 25, 2011.
- US EPA Region V issued a draft permit on April 15, 2014.
- Public hearing conducted on May 21, 2014.
- Public Comment Period concluded May 31, 2014.
- Final permit issued September 23, 2014.





Environmental Monitoring (MVA) *Conceptual Framework*

Near Surface

Deep Subsurface

Soil and Vadose Zone

Ground Water

Above Seal

Injection Zone

Aerial Imagery

Soil CO₂ Flux

Geochemical Sampling
P/T Monitoring

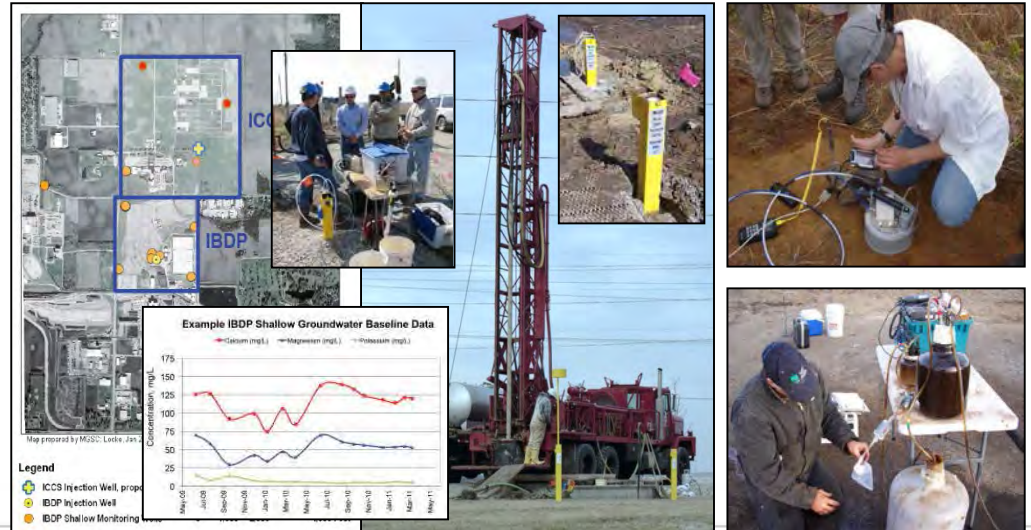
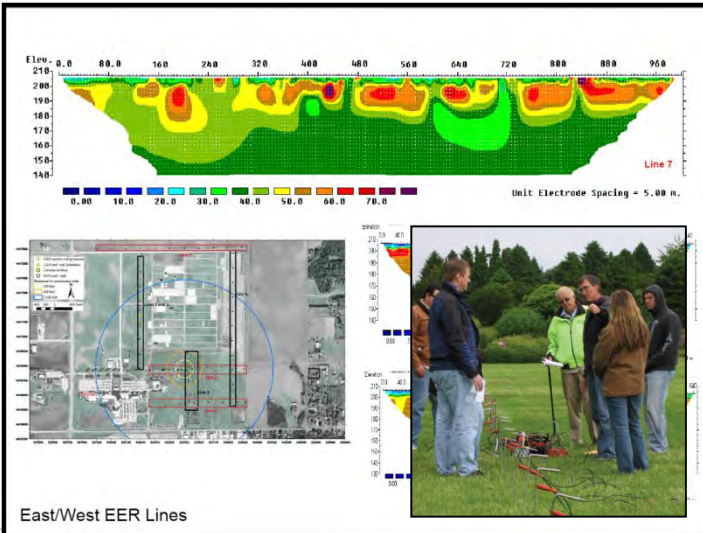
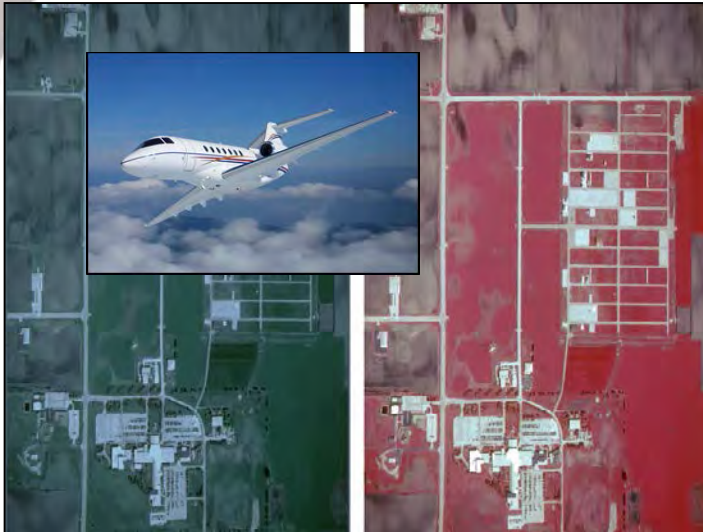
Geophysical Surveys
Seismic Monitoring
P Monitoring

Geophysical Surveys
Geochemical sampling
P/T Monitoring



Environmental Monitoring *Near Surface Monitoring*

- Near infrared aerial imagery will be used to evaluate plant stress
- Soil resistivity characterized shallow depths for identification of optimum GWM locations
- GWM for baseline conditions and operational surveillance
- Surface soil CO₂ flux monitoring



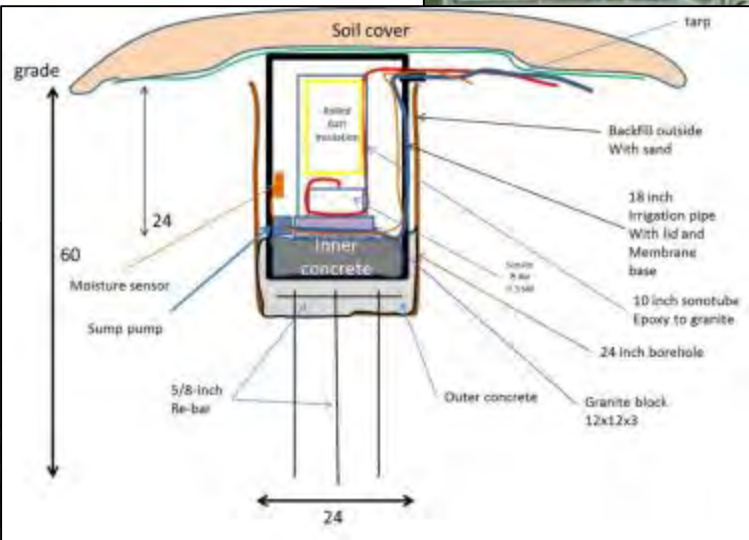
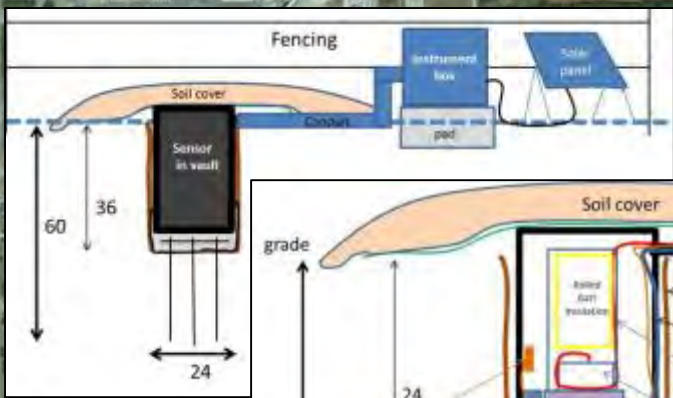
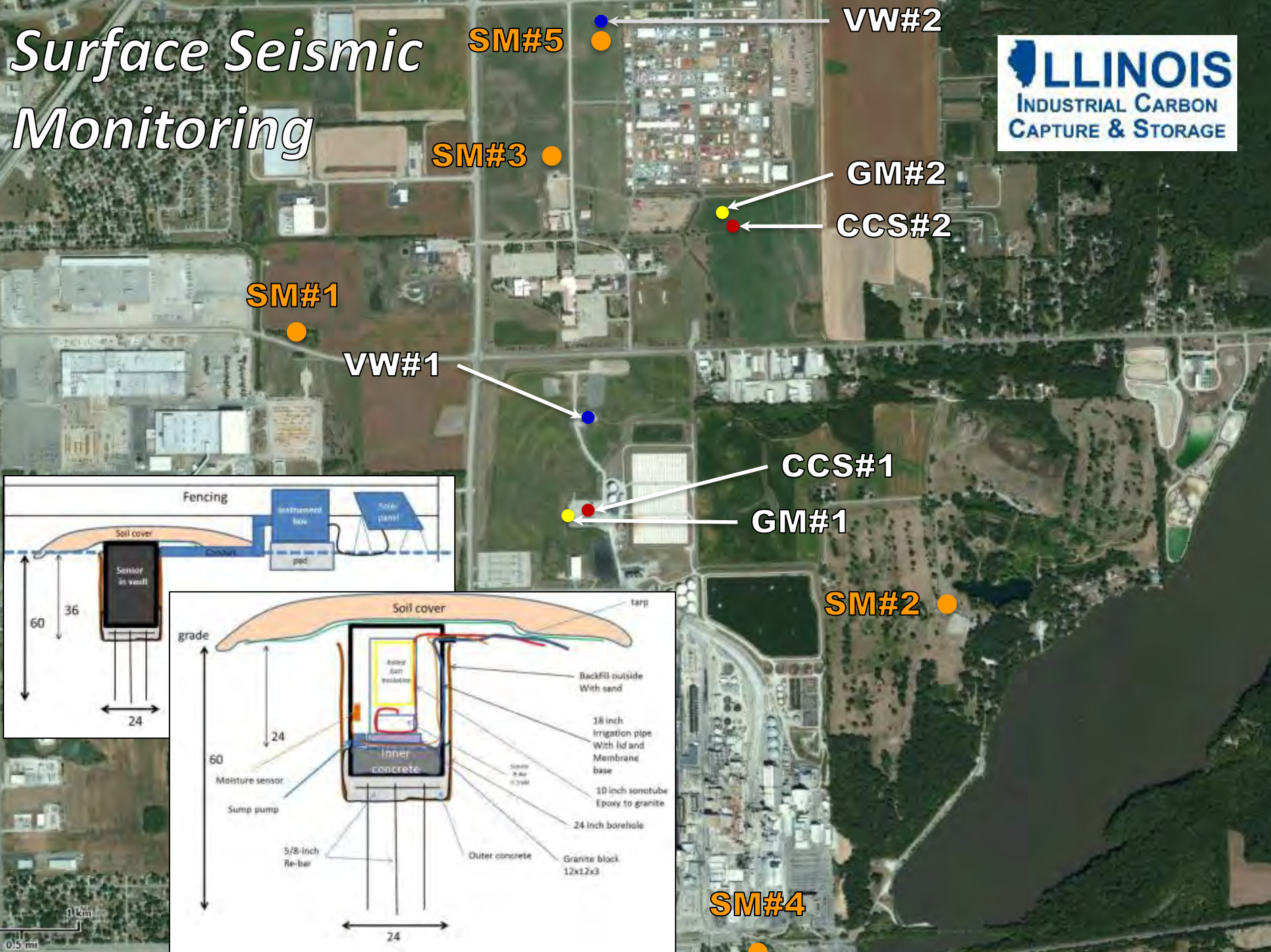
Environmental Monitoring

Deep Subsurface Monitoring



- CCS#2 T/P monitoring
- Distributed Temp Sensor
- VM#2 Westbay system
- Multi-level sampling ports reservoir fluid collection and T/P monitoring
- GM#2 has 31 sensor array
- Pressure sensor to monitor above the seal
- Allow offset or walkaway Vertical Seismic Profile (VSP)
- Well logging (RST)

Surface Seismic Monitoring

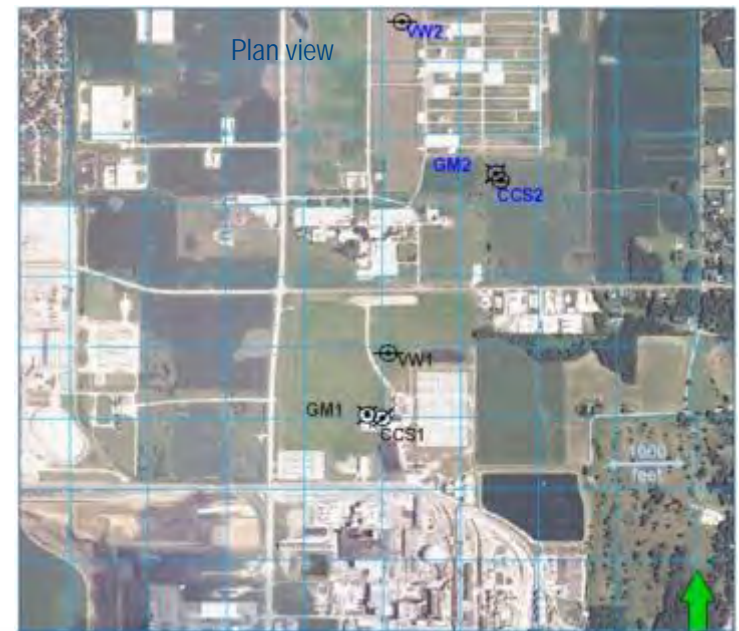
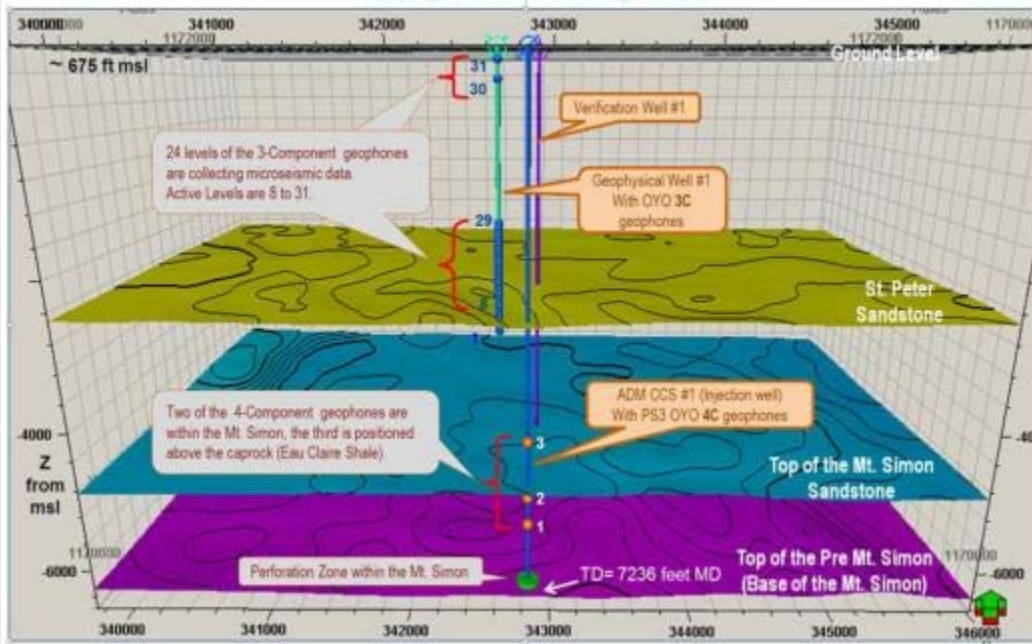


0.5 mi



Deep Seismic Monitoring

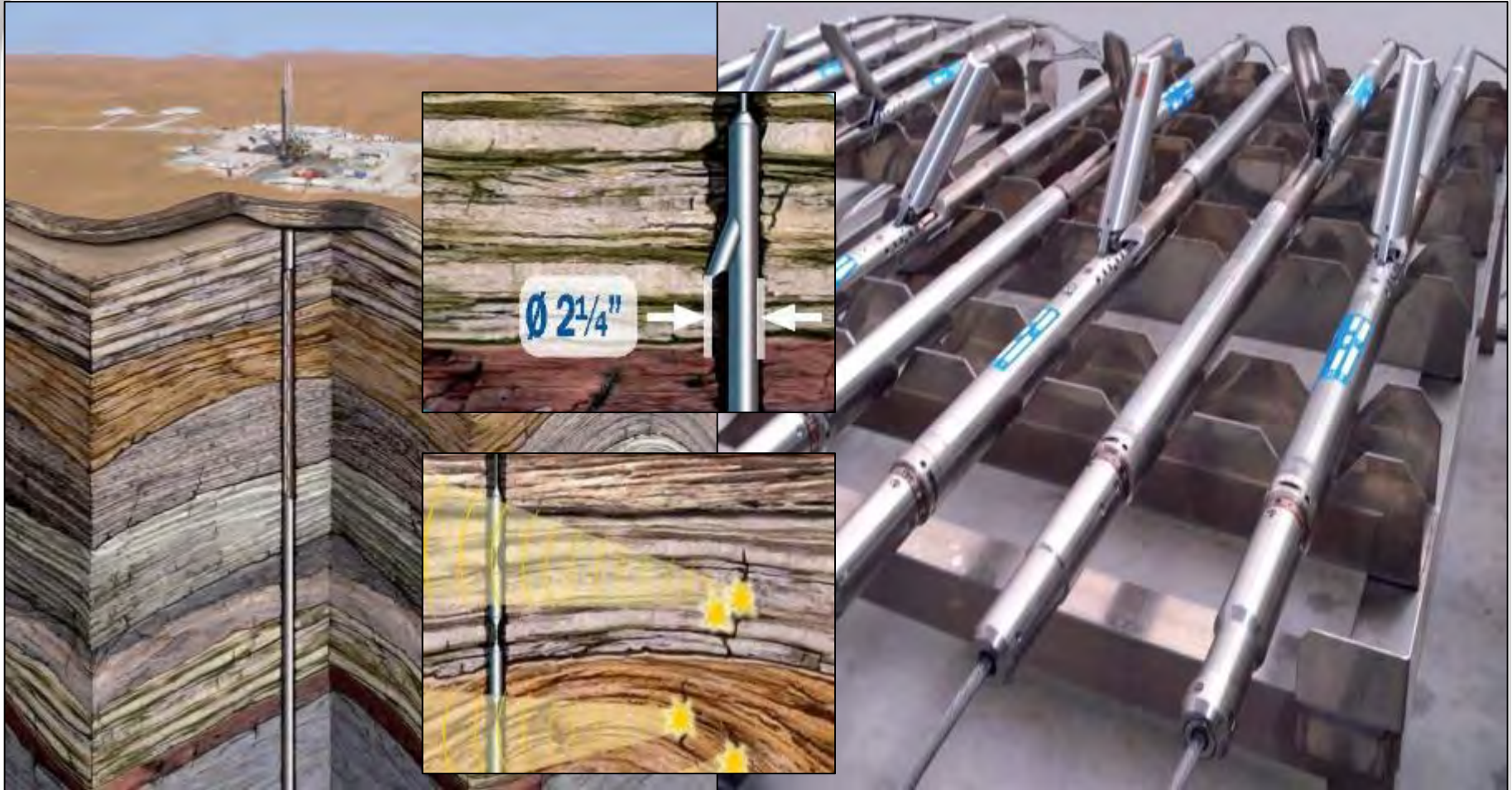
- 3 Geophones in CCS1
- 24 Active Geophones in GM1
- Monitoring Started May 2010
- Geoware LTD is processing data
- SCS analyzing results
- Processing of pre-injection data



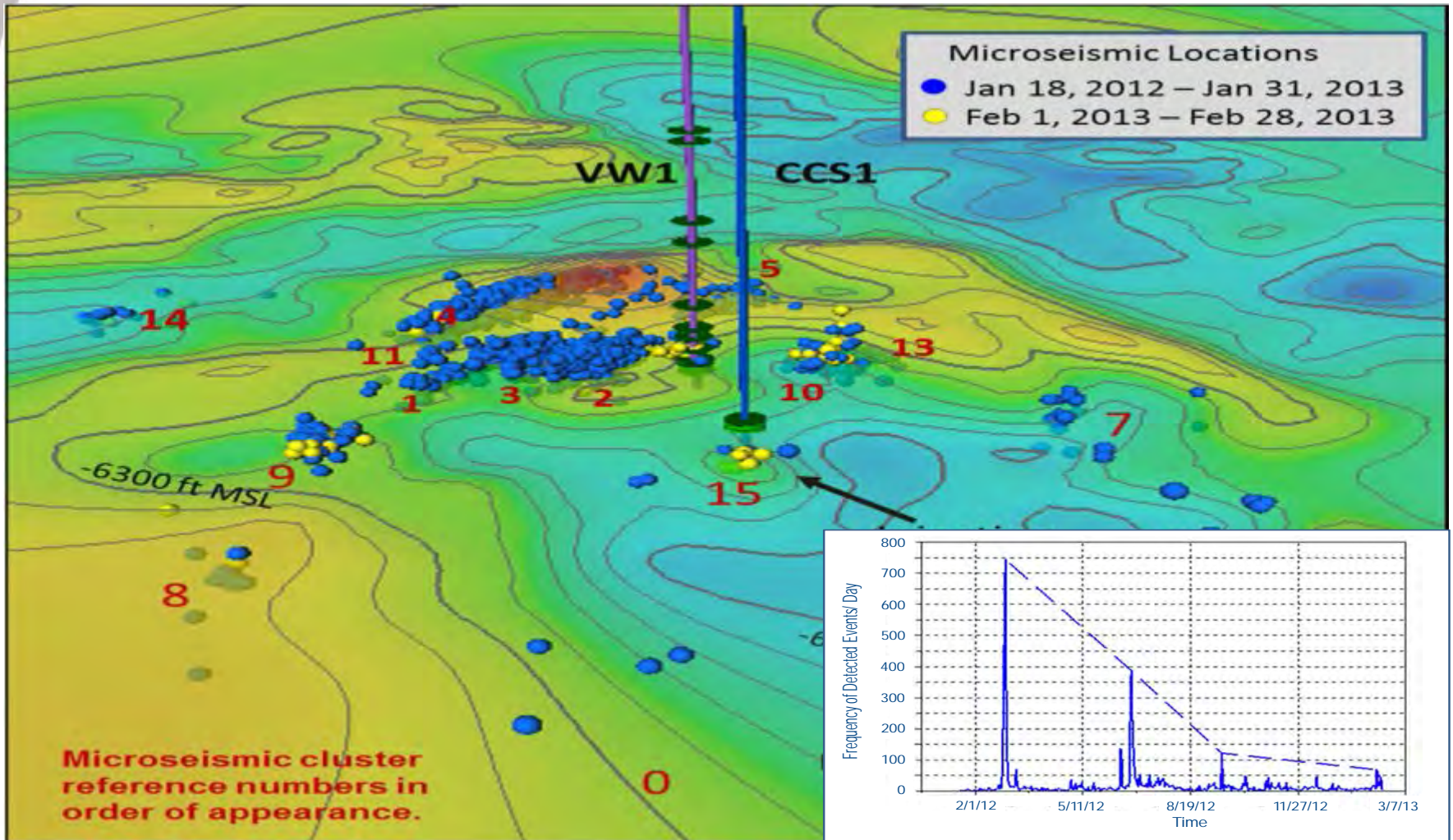


Deep Seismic Monitoring

"Slim Wave" Retrievable Geophones



Seismic Monitoring Data





CO₂ Based Chemicals

• Carbonates

- Glycerol Carbonate
- Propylene Carbonate
- Dimethyl Carbonate

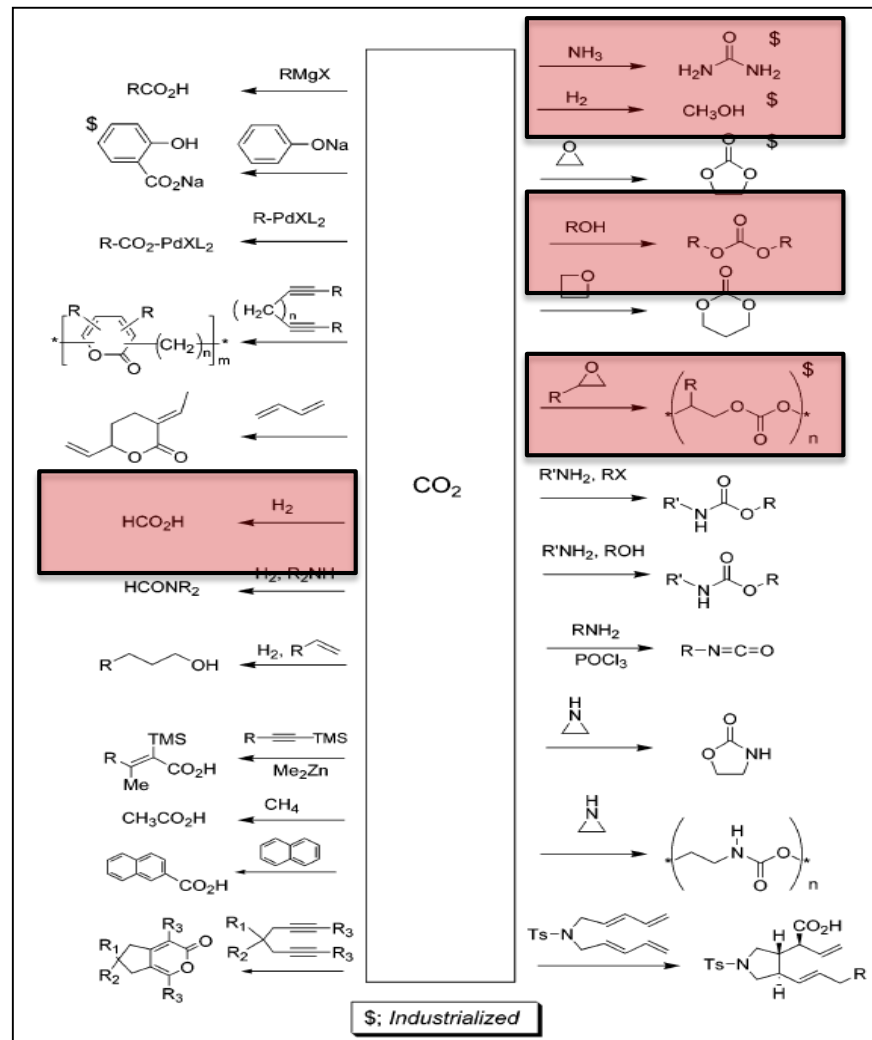
• Fertilizers

• Alcohols

• Fuels

• Acids

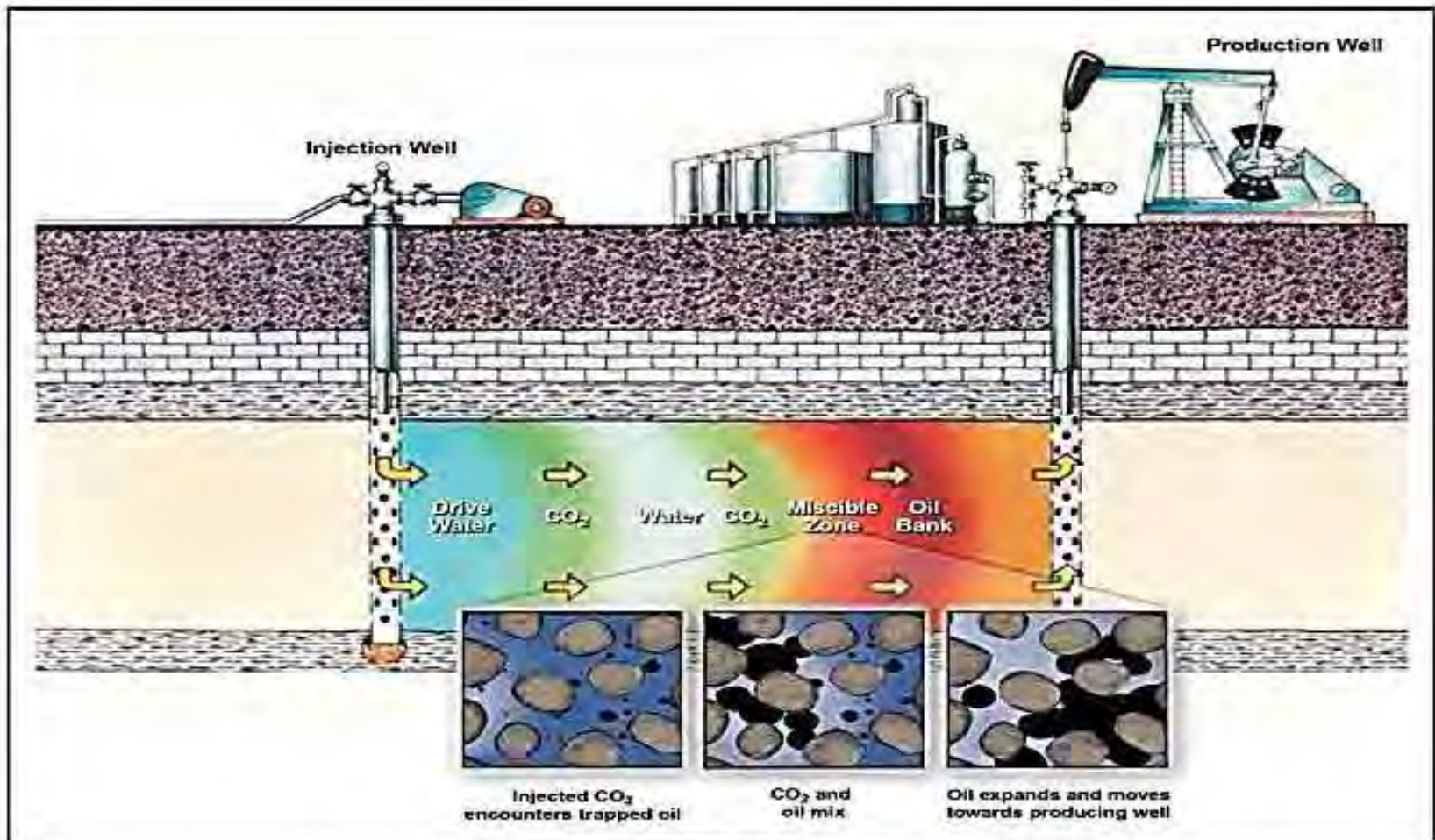
• Others



Transformation of Carbon Dioxide, Sakakura, Choi, & Yasuda, 2007

Enhanced Oil Production

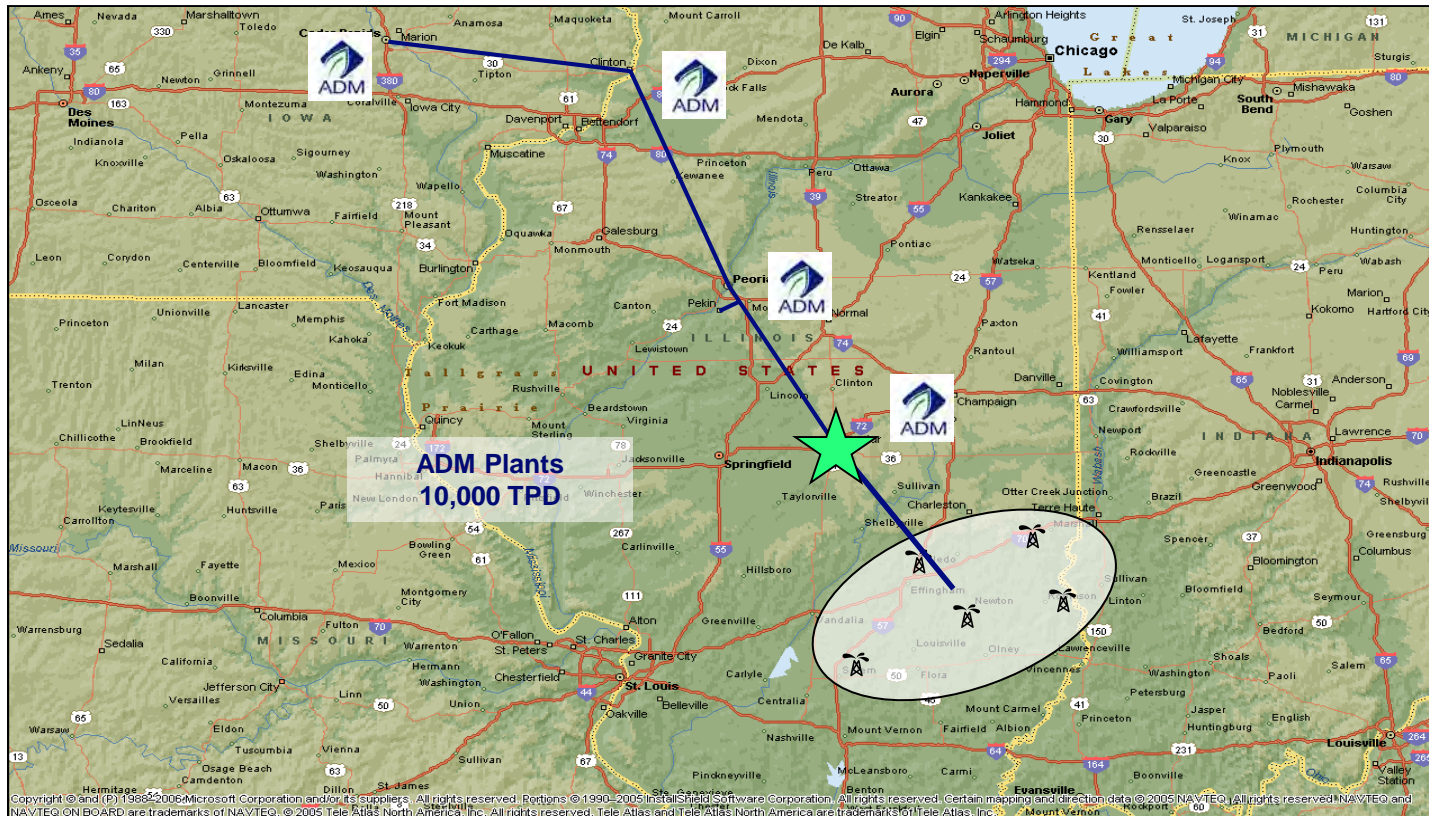
<http://www.youtube.com/watch?v=azLVjYij5U4>



Cross-section illustrating how carbon dioxide and water can be used to flush residual oil from a subsurface rock formation between wells



Illinois Basin Potential



- Illinois Basin - Oil Producing Region
- Est. Recoverable Oil = 700 million bbls⁽¹⁾
- Est. CO₂ Requirements = 150 million tons

(1) BASIN ORIENTED STRATEGIES FOR CO₂ ENHANCED OIL RECOVERY: ILLINOIS AND MICHIGAN BASIN OF ILLINOIS, INDIANA, KENTUCKY AND MICHIGAN; Advanced Resources International, February 2006



Future Commercial Potential

- **Direct Application**
 - EOR
 - CO₂ Liquids
- **Product Development**
 - CO₂ Based Chemicals
- **Process Development**
 - SC Extraction
 - Solvent Applications
- **Carbon Management**
 - Storage
 - Trading & Risk Management





Environmental and Cost Benefits

GHG Reduction & Fuel LCA



- Reduction in site's CO₂ emissions.
- Process has a GHG reduction efficiency of 94% based on using Midwest electricity grid average.
- Reduction of the carbon footprint of fuel ethanol.
- The operational expense is significantly lower than other forms of CO₂ capture.
- 15 billion gallons annually, represents about 40 million metric tons of CO₂.



Thank You!



Industrial Carbon Capture and Storage Project:

- U.S. Department of Energy Award No. DE-FE-0001547
- Administered by the DOE's Office of Fossil Energy
- Managed by the National Energy Technology Laboratory
- DOE cost share from American Recovery and Reinvestment Act of 2009

Cost Share Agreements:

- Archer Daniels Midland Company
- University of Illinois through the Illinois State Geological Survey
- Schlumberger Carbon Services
- Richland Community College

Project Team Members Contacts:

- Dr. Sai Gollakota (NETL-DOE) Sai.Gollakota@NETL.DOE.GOV
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- John Medler, (Schlumberger Carbon Services) jmedler@slb.com
- Dr. Douglas Brauer (RCC) dbrauer@richland.edu

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