Illinois Industrial Carbon Capture & Storage Project

Eliminating CO_2 Emissions from the Production of Bio Fuels - A 'Green' Carbon Process

CIBO Technical Focus Group

June 5, 2018

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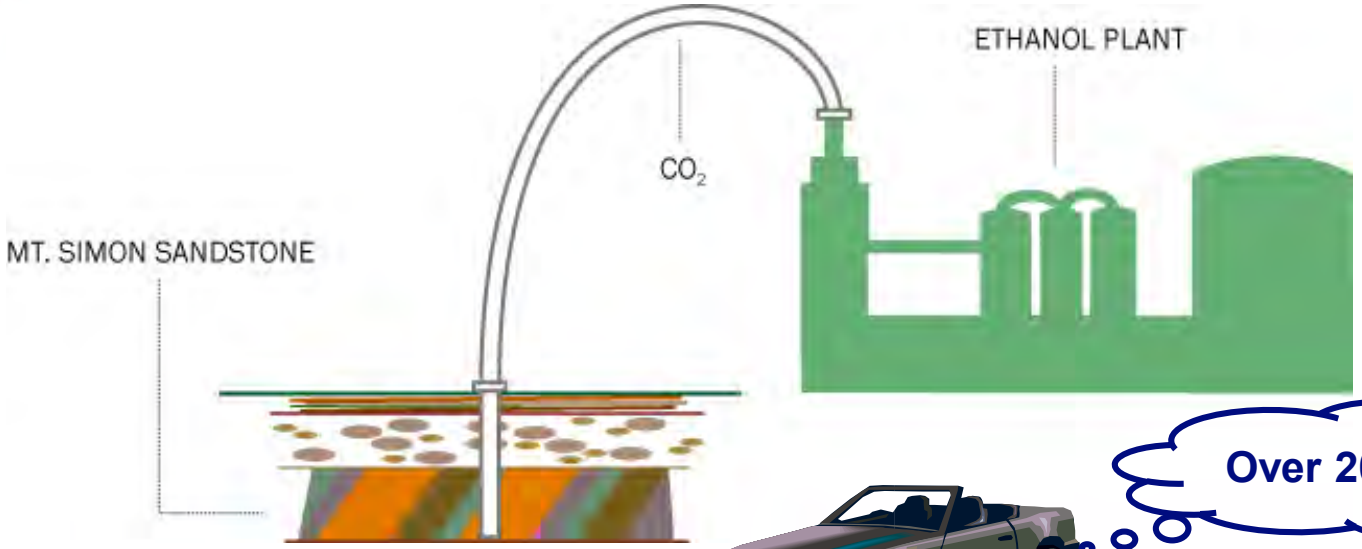
ILLINOIS INDUSTRIAL CARBON CAPTURE & STORAGE

U.S. Initiative on Climate Change

- The DOE has established the Carbon Capture Utilization & Storage (CCUS) Program focusing on developing technologies with significant potential to reduce GHG emissions.
- Part of this program is dedicated to advancing technologies that capture, store, and/or beneficially reuse CO_2.
- Geologic sequestration of CO_2 in saline reservoirs have been identified as a potential pathway to reduce GHG that would otherwise reside in the atmosphere.

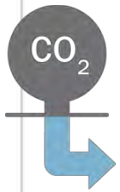
Climate of Innovation in Illinois

Investigating Geologic Carbon Sequestration's Potential as an Environmental Solution



Over 200,000 Cars/yr

Emission Facts, EPA420-F-00-013, April 2000



Decatur is host to three CCS projects

1. A demonstration project to capture one million tons of CO_2 over a three year period.
2. An industrial scale project to capture one million tons of CO_2 per year.
3. Advanced monitoring project using fiber optic technology.

Geologic Storage of CO_2

ADM Decatur Facility

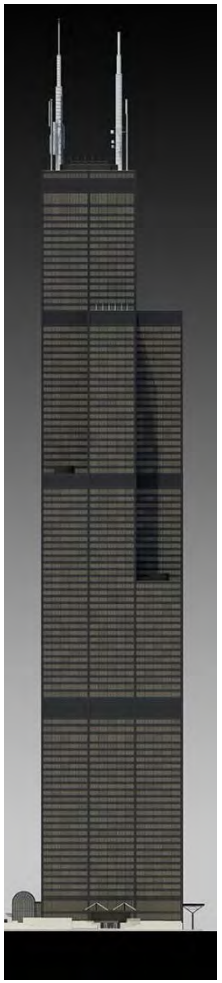
6,000 ft underground there is a porous formation known as the Mt Simon.

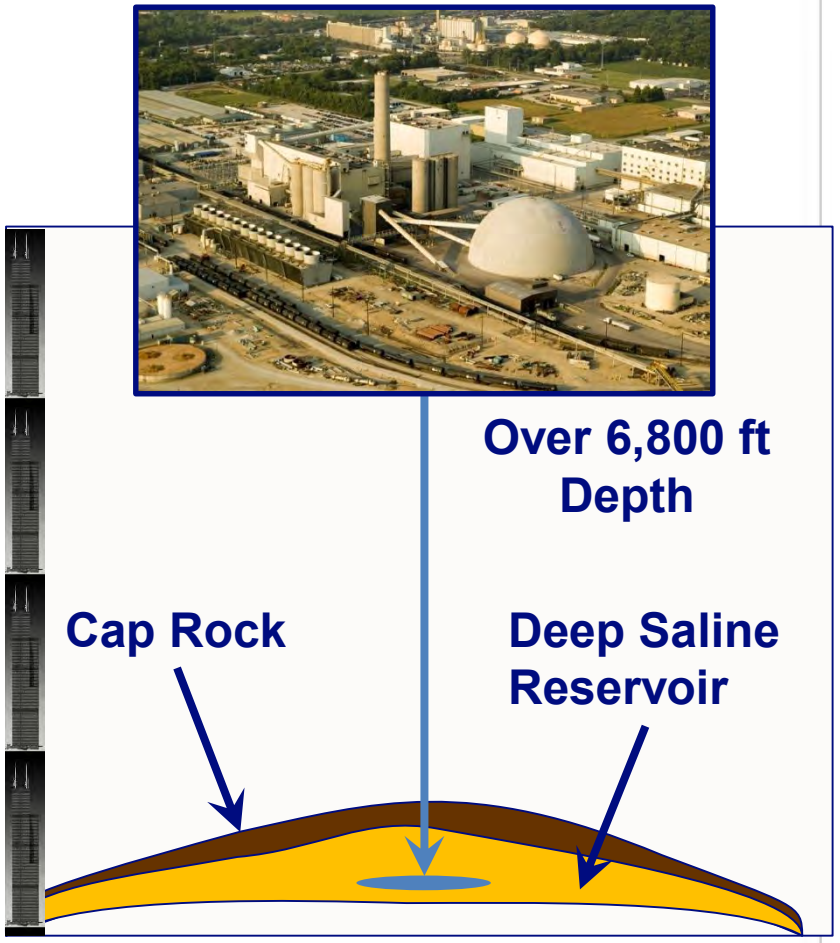
Above the Mt Simon is a shale formation know as the Eau Claire.

Compress CO_2 to a fluid like state.

Inject CO_2 into the deep subsurface.

Deep enough to stack 4 Willis Towers on end.





Illinois Basin Decatur Project (IBDP)

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Program Objective

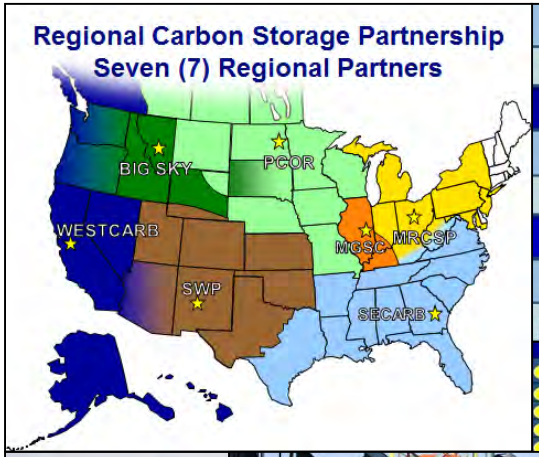
Large scale geologic test to inject 1.0 million tons of CO_2 over a three year period (1,000 MT/day).

Project Team Members

Knowledge Base

- Site Geological Characterization
- Risk Assessment & Reservoir Modeling
- Engineering Design & MVA

Nov 2014-Completed goal of injecting and storing 1,000,000 tons of CO_2.



Characterization Phase (2003-2005)

Search of potential storage locations and CO_2 sources | Found potential for 100's of years of storage

Validation Phase (2005-2010)

20 injection tests in saline formations, depleted oil, unmineable coal seams, and basalt

Development Phase (2008-2017+)

9 large scale injections (over 1 million tons each) | Commercial scale understanding | Regulatory, liability, ownership issues

	Partnership	Geologic Province	Type
1	Big Sky	Triassic Nugget Sandstone / Moxa Arch	Saline
2	MGSC	Deep Mt. Simon Sandstone	Saline
3	MRCSP	St. Peter Sandstone	Saline
4	PCOR	Bell Creek Field	Oil Bearing
5		Devonian Age Carbonate Rock	Saline

Illinois Industrial CCS Project (IL-ICCS)

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Program Objectives

- Target & Demonstrate Advanced CCS Technologies at Industrial Scale Facilities
- Inject and Store One Million Tons of CO_2 Annually (3,000 tons/day)

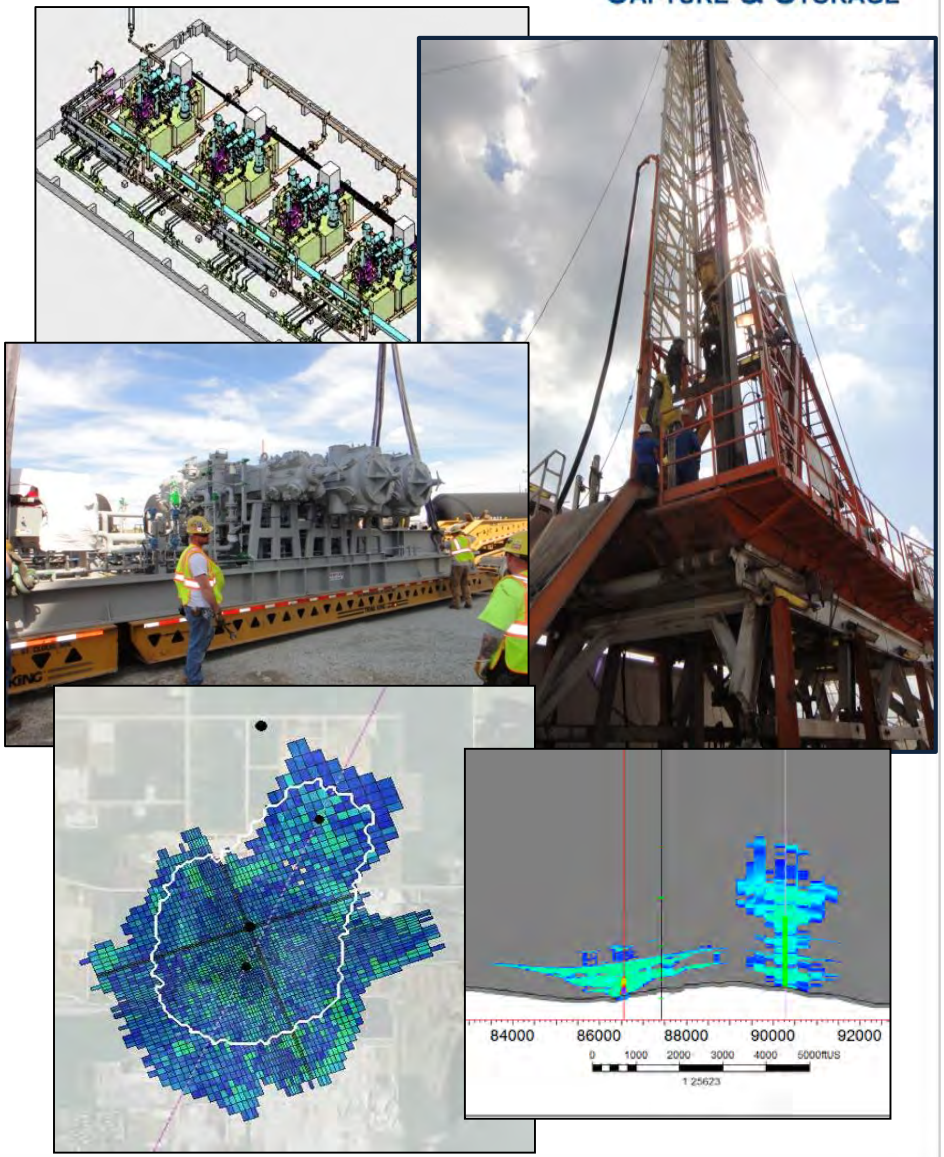
Project Team Members

ADM · Schlumberger Carbon Services · Richland Community College · NETL

Knowledge Base

- Site Geological Characterization
- Risk Assessment & Reservoir Modeling
- Engineering Design & MVA
- Education and Public Outreach

Study the interaction between the CO_2 plumes from two injection wells within the same formation.



Intelligent Monitoring System (IMS)

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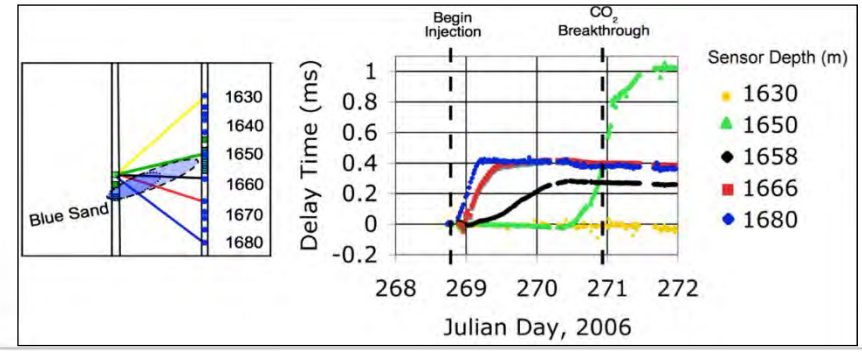
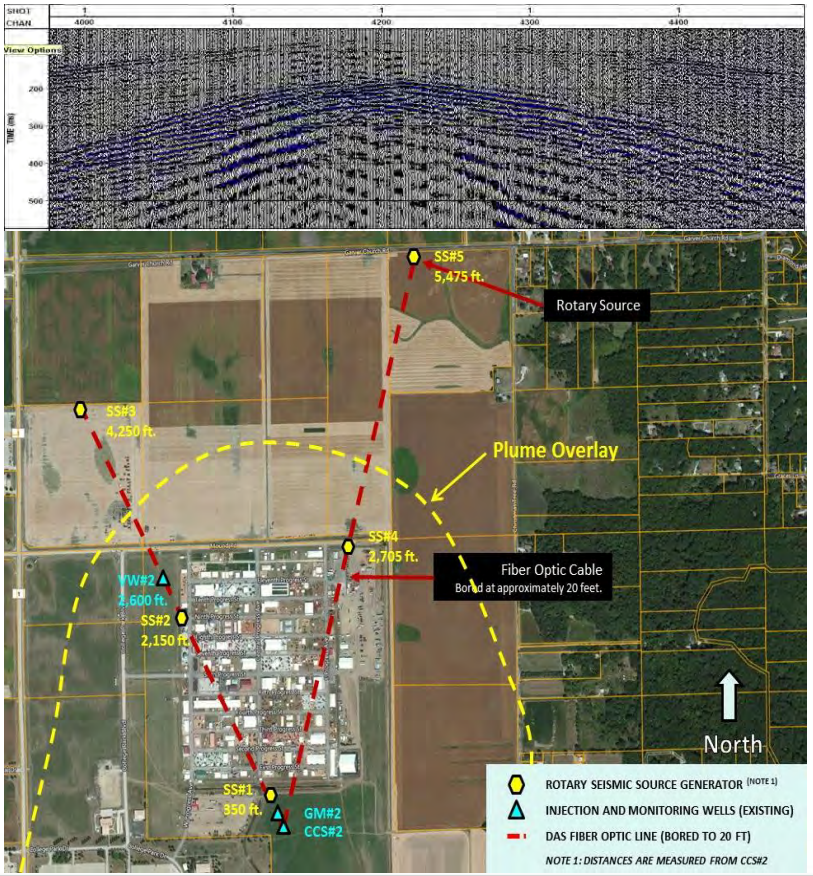
Program Objectives

- Develop and validate software tools that advance CCS-specific IMS by enabling access, integration and analysis of real-time surface and subsurface data for decision-making and automation of process
- Demonstrate integration of system components to validate feasibility of real-world application to CCS.

Project Team Members

ADM, Berkeley Lab, Silixa, NETL, USGS science for a changing world, Richland Community College, Schlumberger Carbon Services, Illinois





CarbonSAFE Nebraska Project

Program Objectives

- This project is a pre-feasibility study of an integrated CO_2 storage hub in the mid-continent region of the United States, with the ultimate objective of storing anthropogenic CO_2.

- **Project Team Members**

Battelle

ADM

NETL

EERC
Energy & Environmental Research Center®
Putting Research into Practice

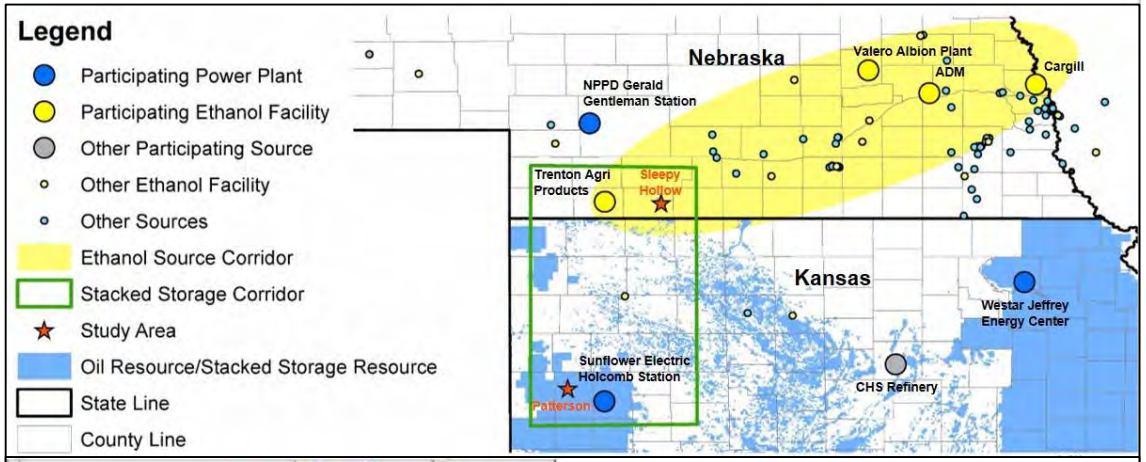
KU
KANSAS GEOLOGICAL SURVEY
The University of Kansas

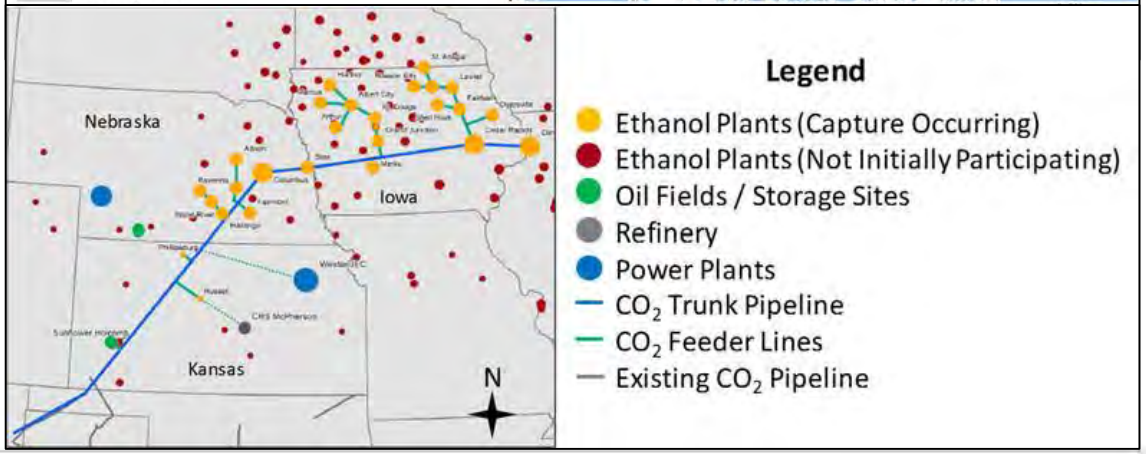
Los Alamos
NATIONAL LABORATORY
EST. 1943

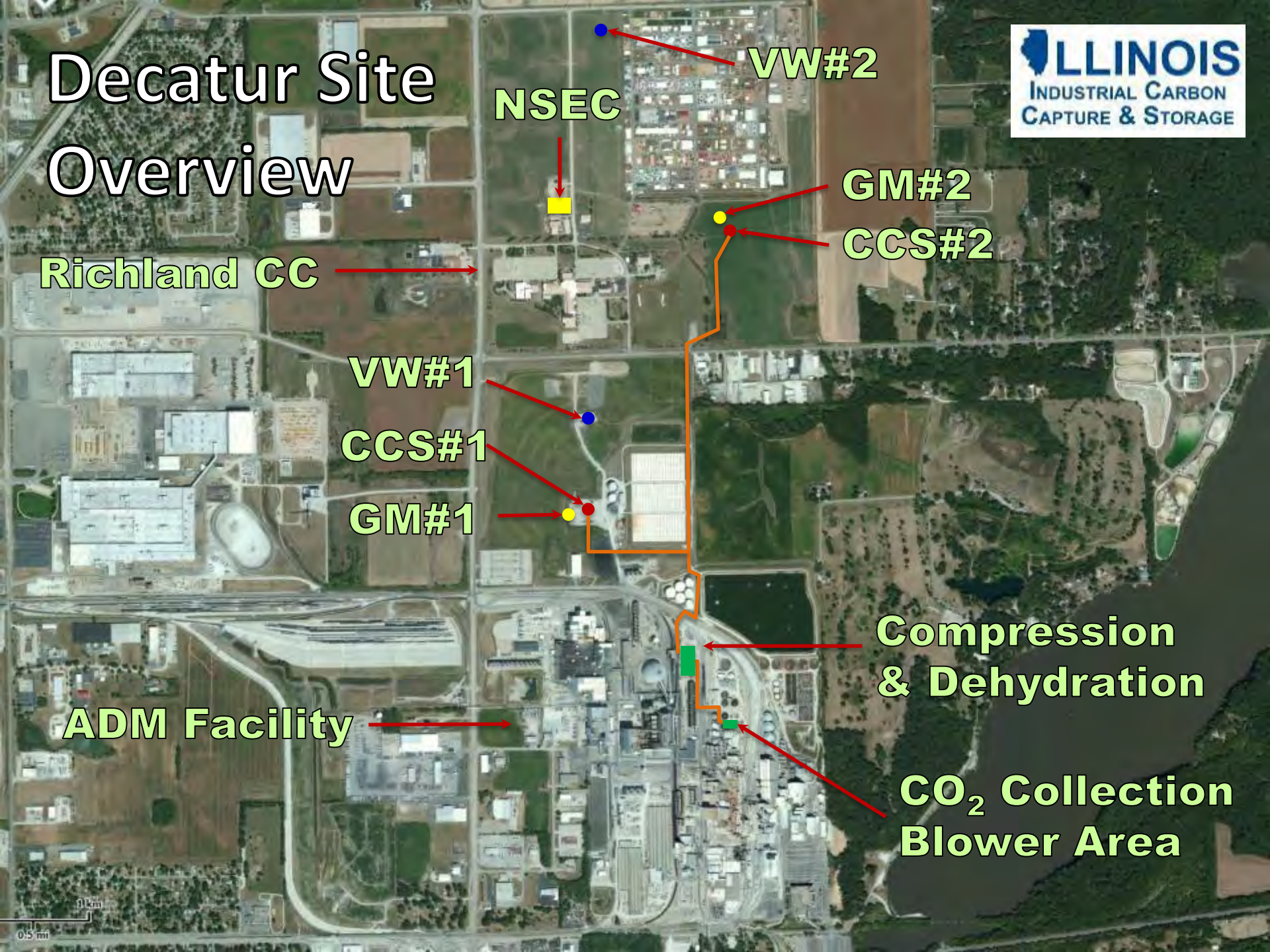
Schlumberger

Advanced Resources International, Inc.

BEREXCO






Decatur Site Overview
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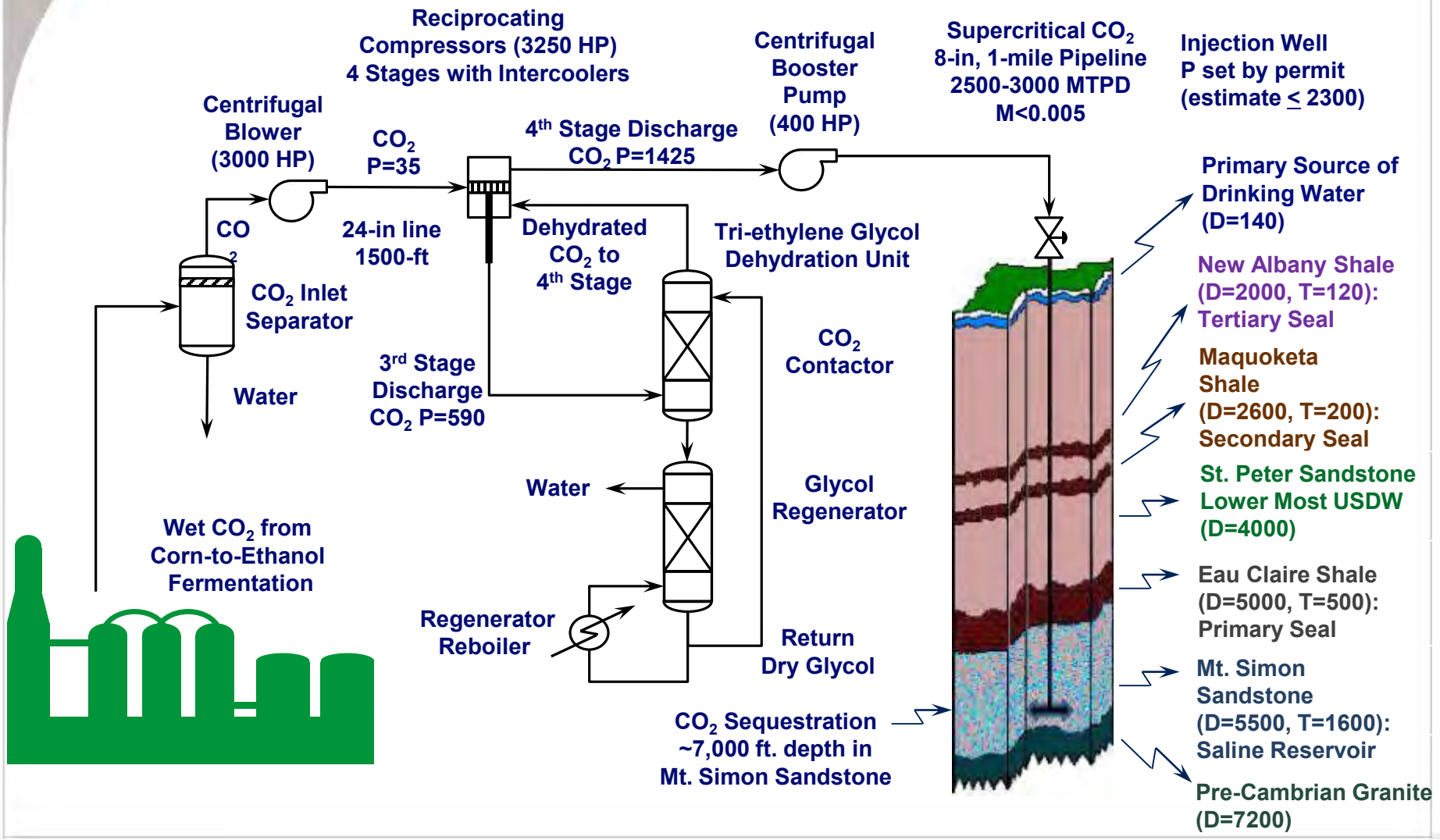
VW#2
NSEC
GM#2
CCS#2
Richland CC
VW#1
CCS#1
GM#1
Compression & Dehydration
ADM Facility
CO_2 Collection Blower Area

Project Process Flow Diagram



CO_2 Collection Facility

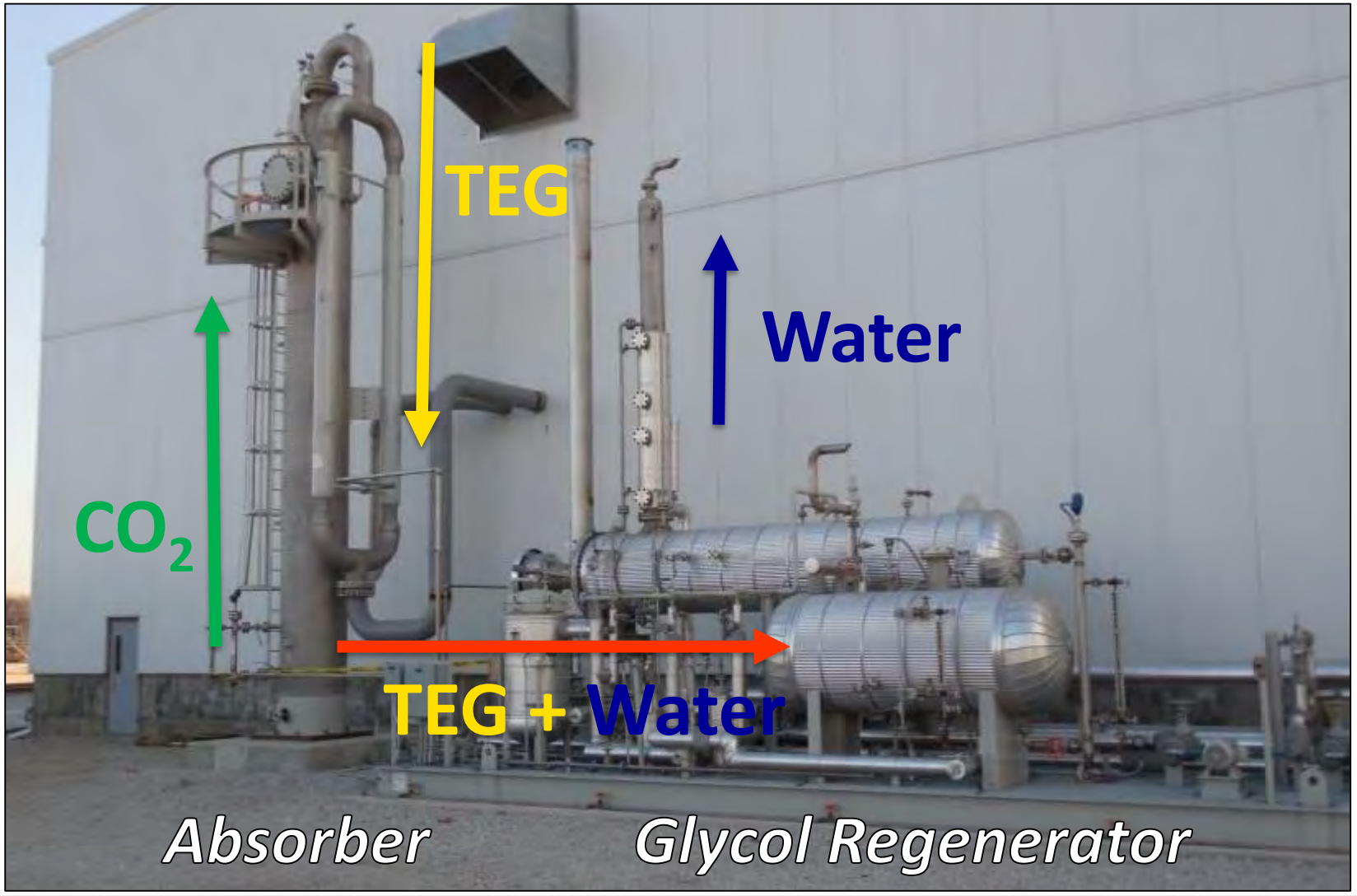
1750 hp Centrifugal Compressor

Main Compression Building

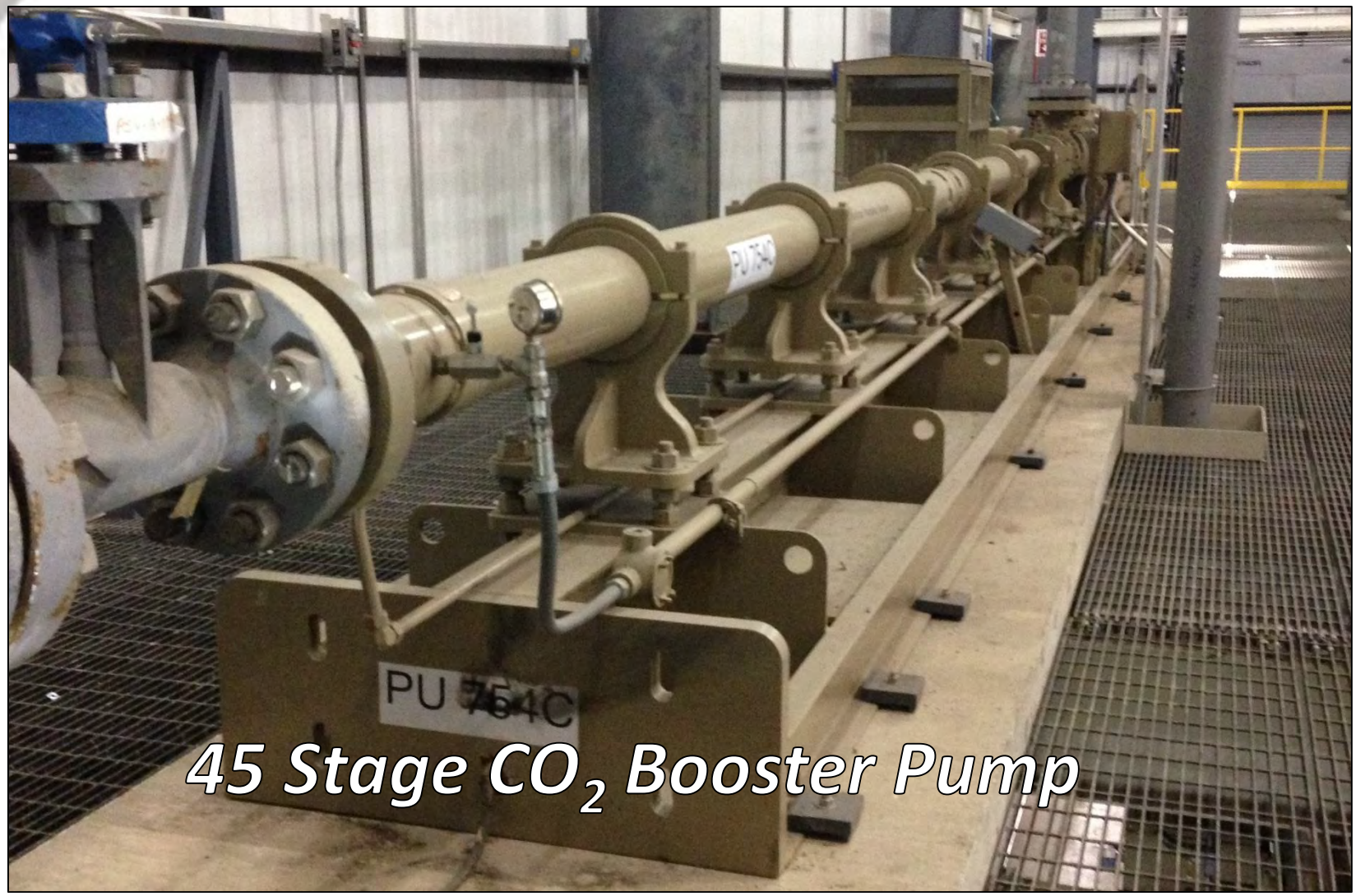
Main Compression Building

Main Compression Building

CO_2 Dehydration Unit



Main Compression Building



45 Stage CO_2 Booster Pump

IBDP Injection Well

Site Selection
Regional Geologic Characterization

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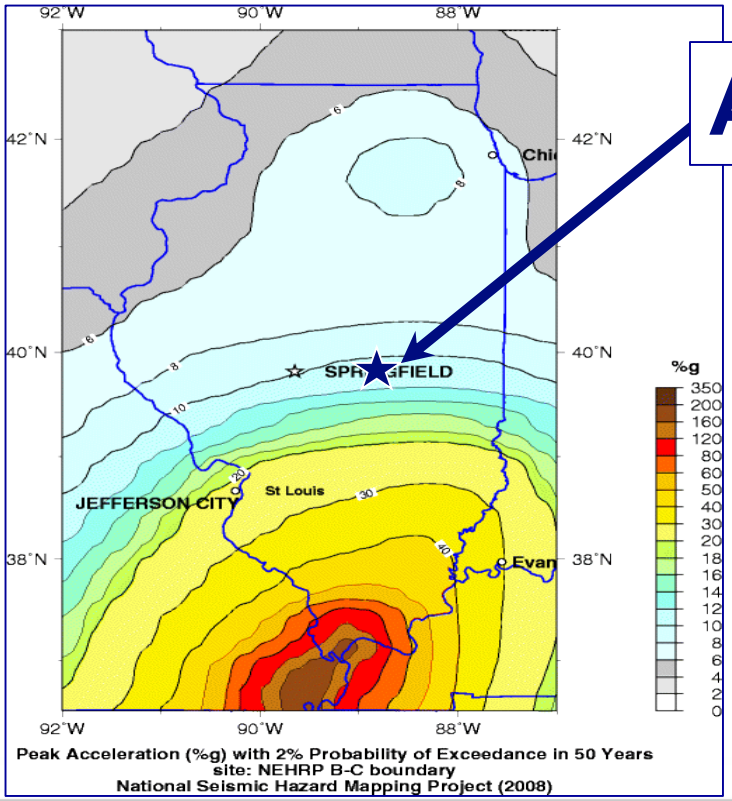
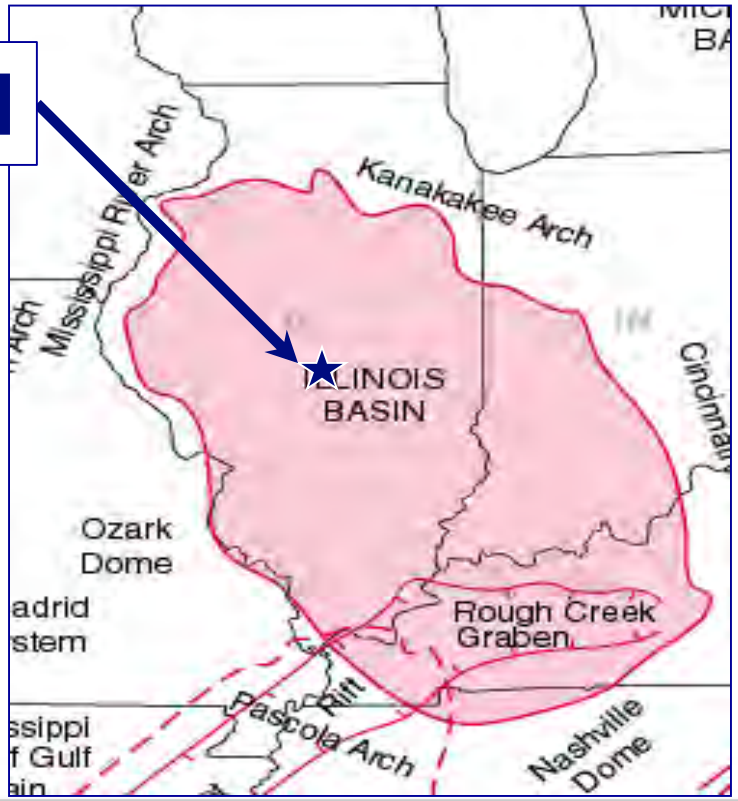
- Cratonic basin
- 60,000 square mile area
- Structurally complex to the south with faulting and seismicity

- ADM Decatur facility is located near the center of this geologic formation
- Estimated CO_2 storage capacity between 27 to 109 billion metric tons

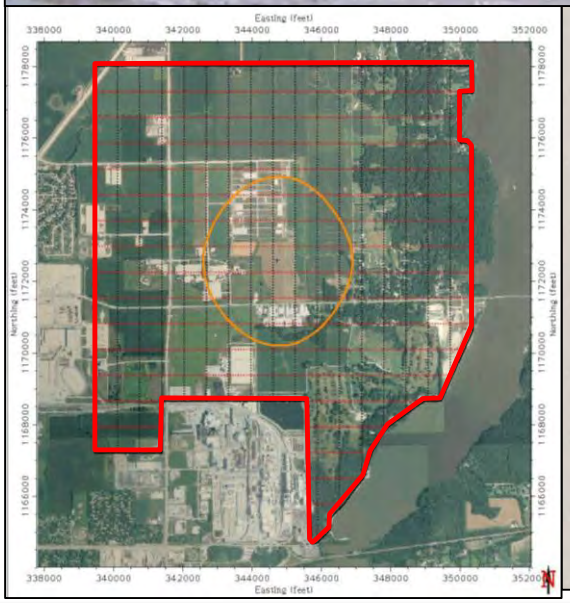


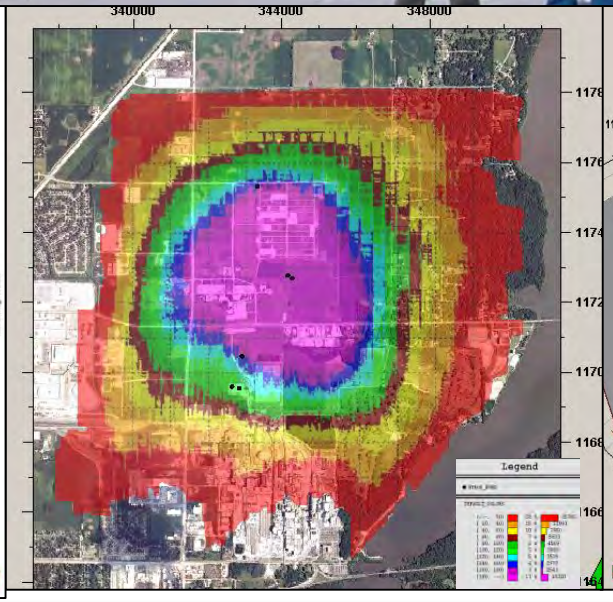
ADM

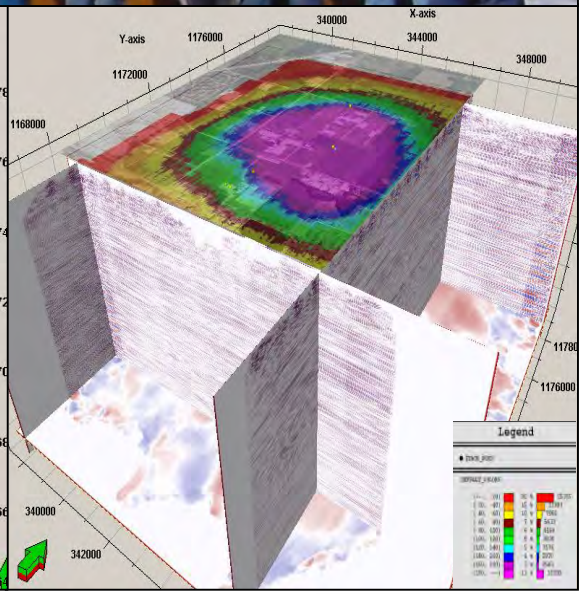


Site Characterization

Seismic Acquisition



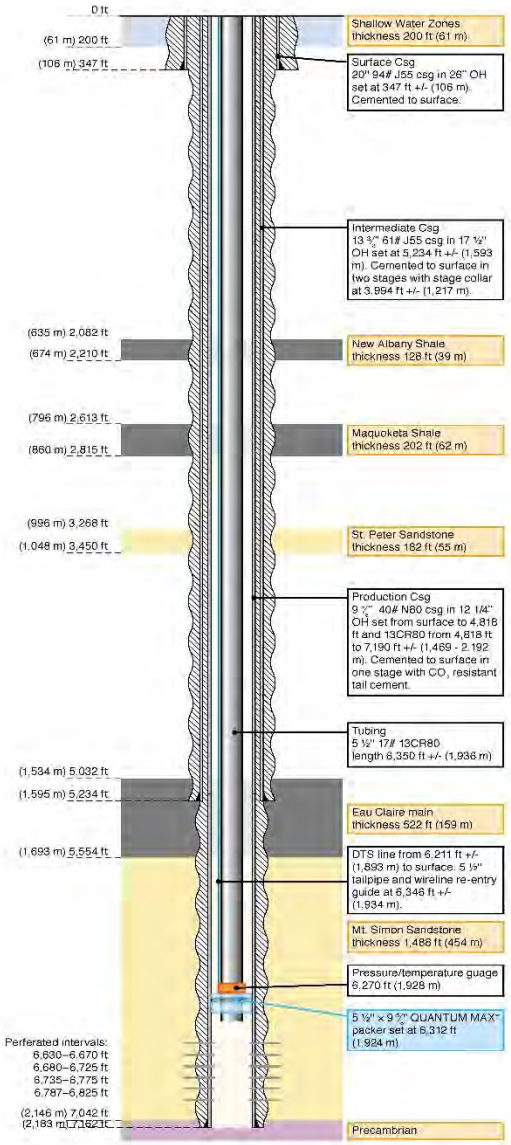




Illinois Industrial Carbon Capture & Storage Project Major Well Schematics

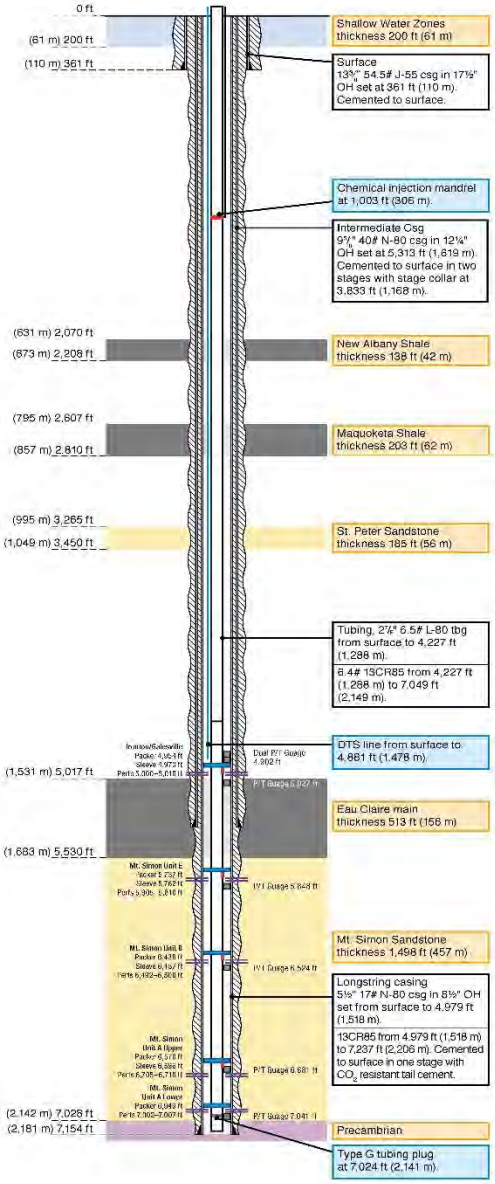
Injection Well

CCS2



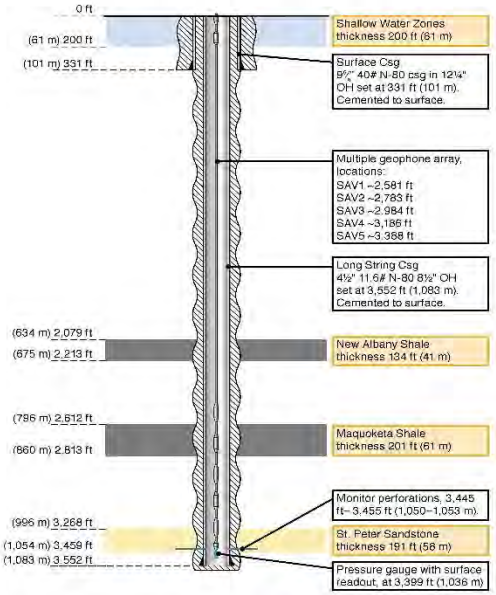
Verification Well

VW2



Geophysical Monitoring Well

GM2



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Test Well Construction

Coring and Well Logging

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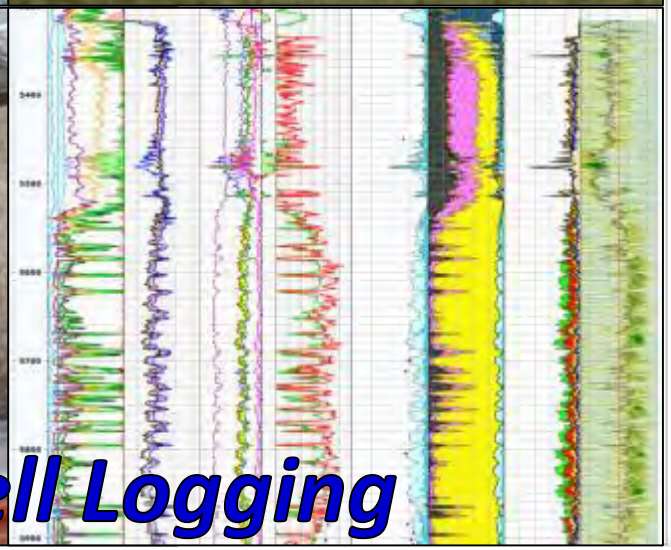
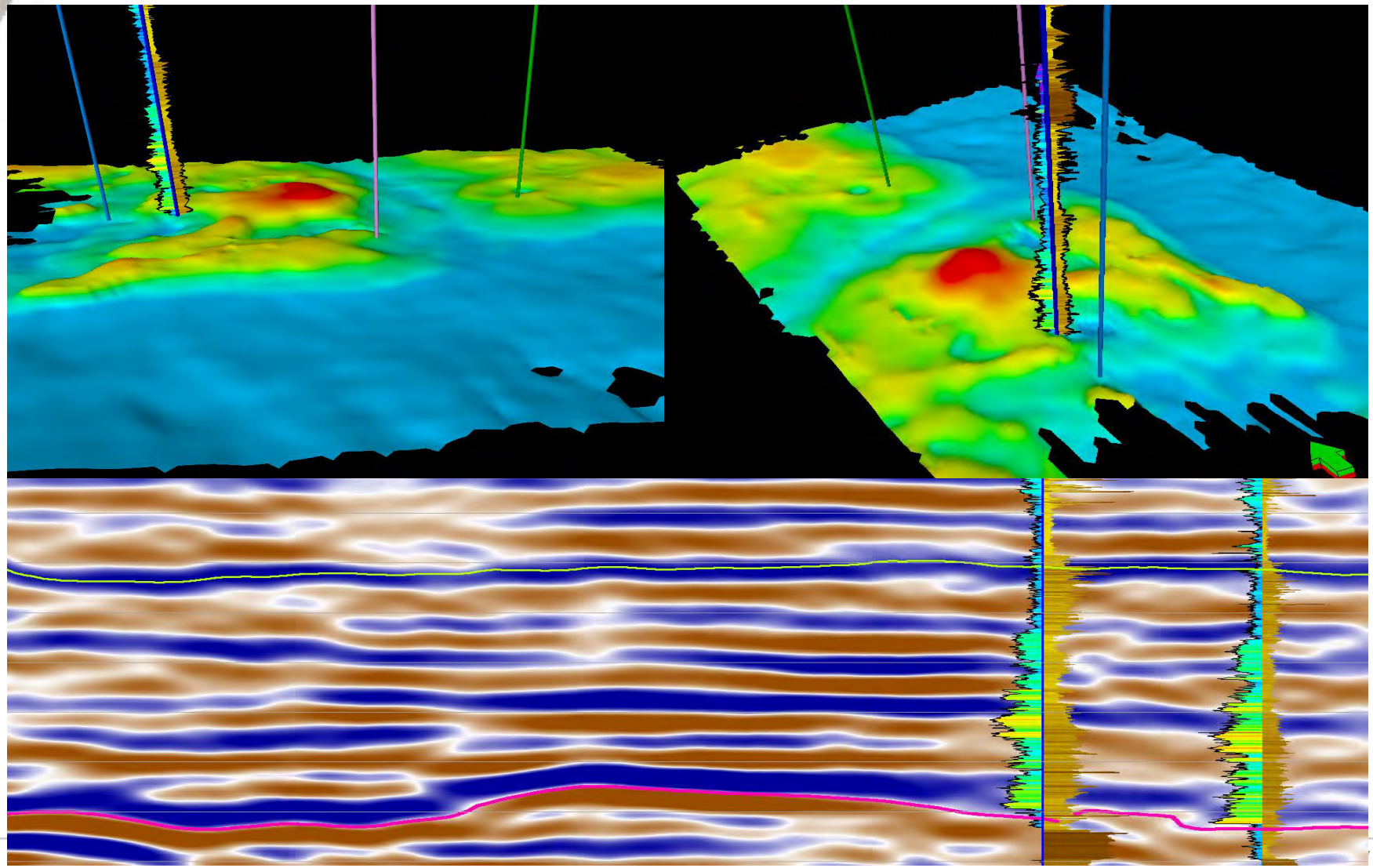


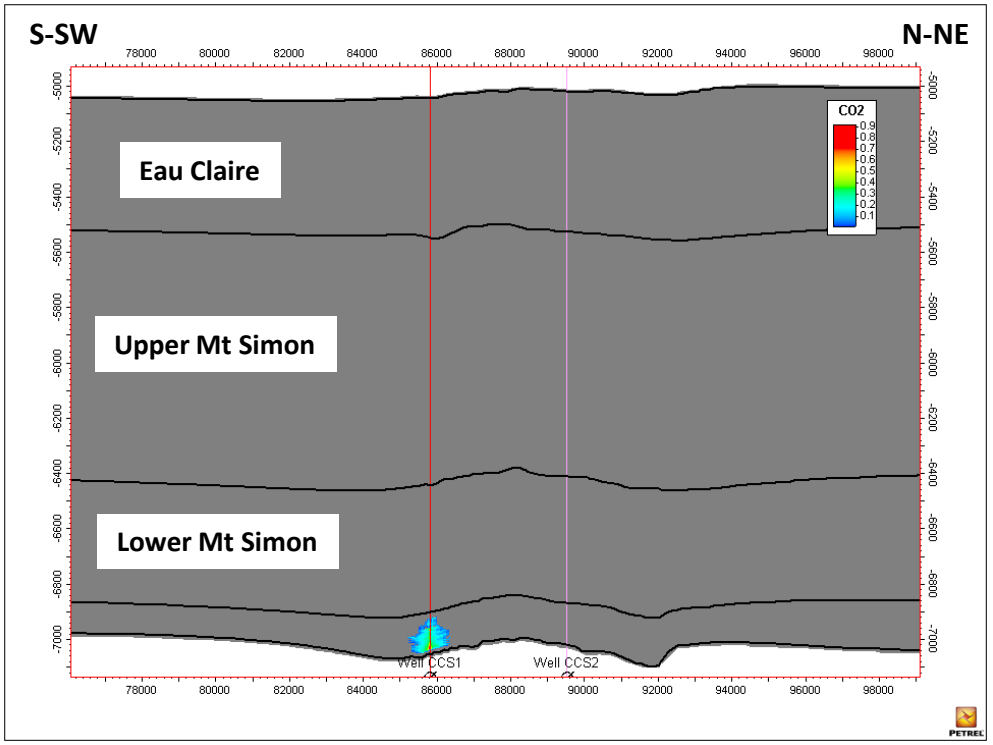
Core Samples and Well Logging

Geophysical Model Development



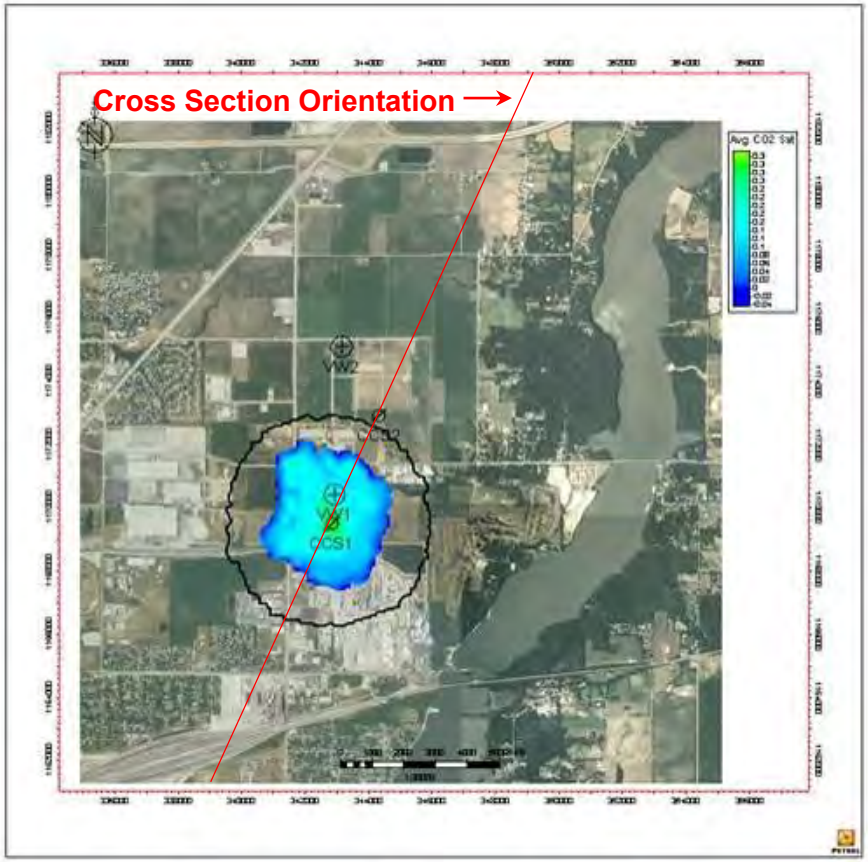
Geophysical Modeling

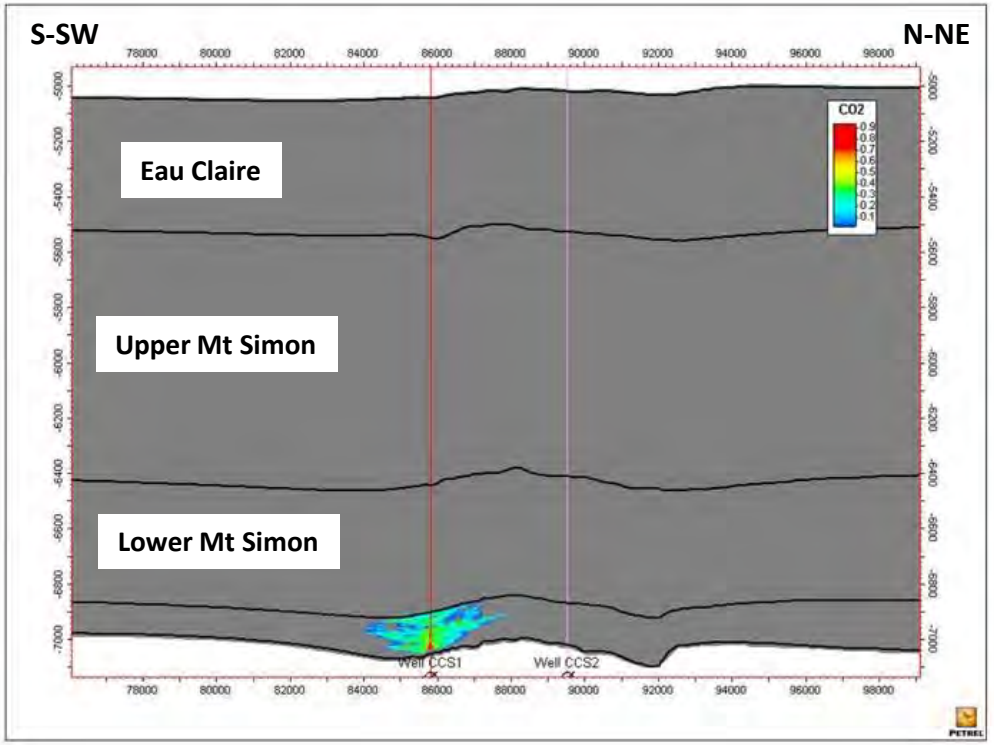
CO_2 Plume Position - 2012



Geophysical Modeling

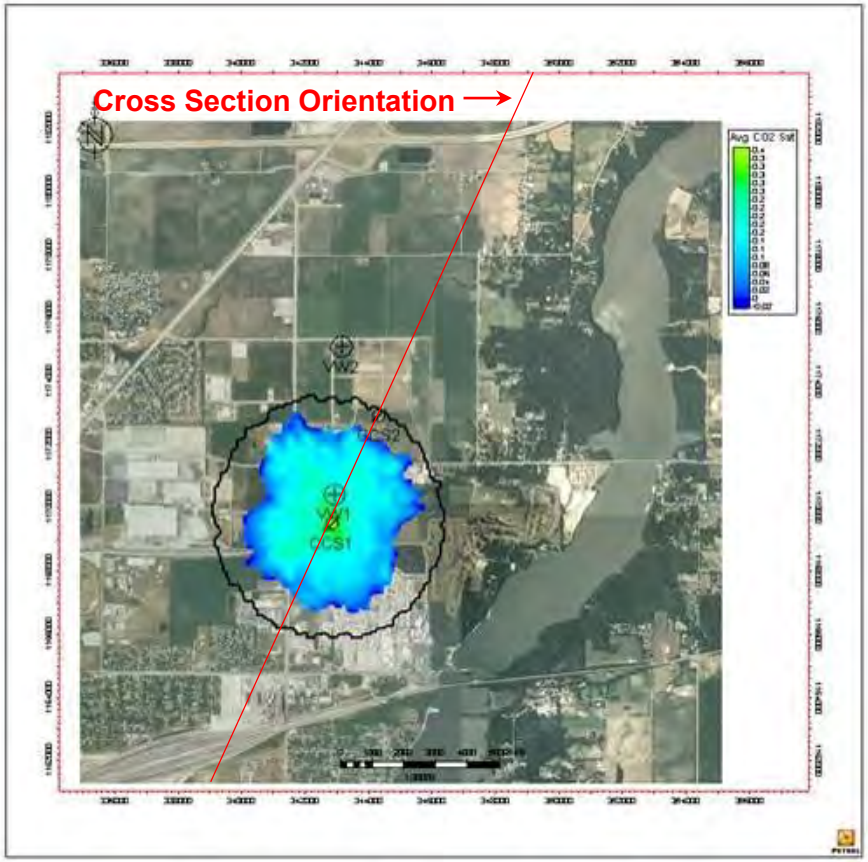
CO_2 Plume Position - 2013

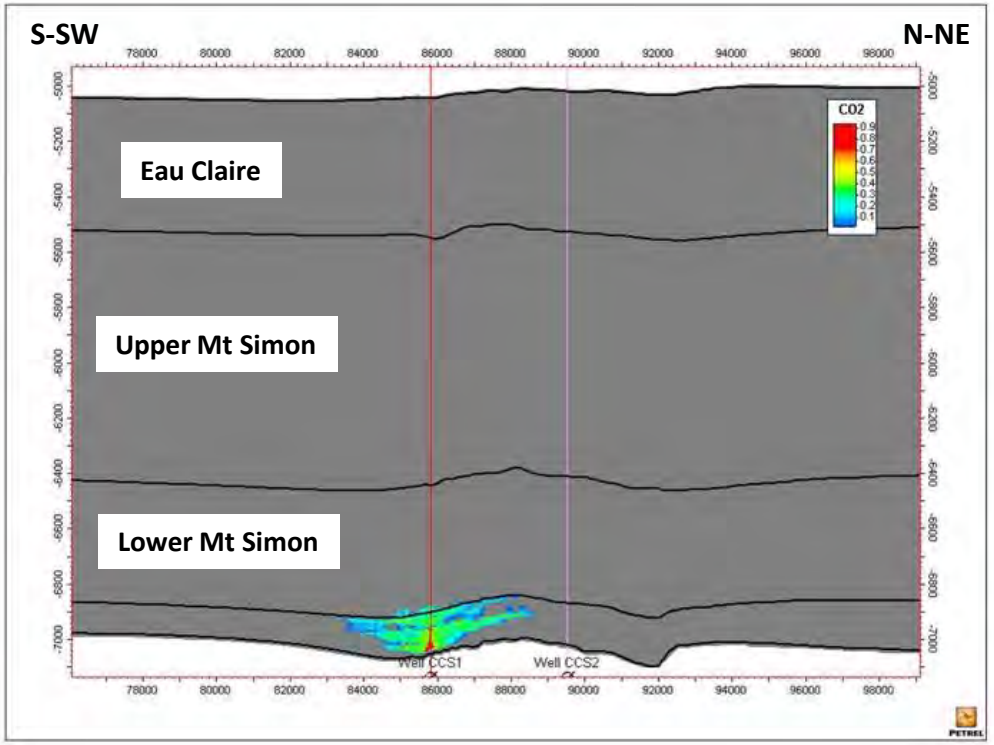




Geophysical Modeling

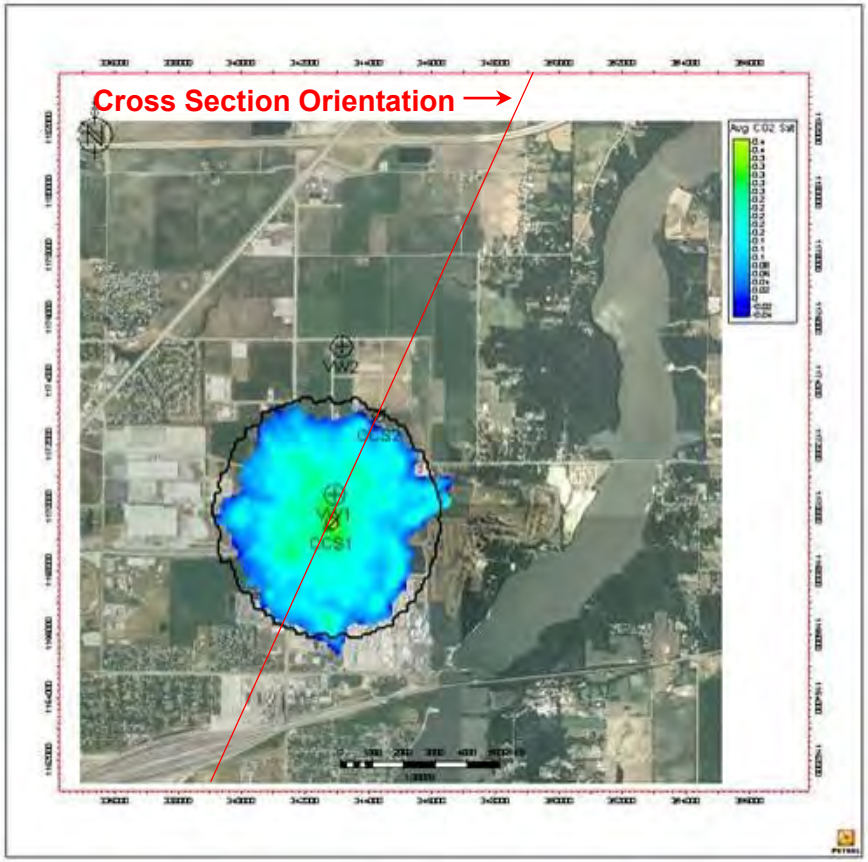
CO_2 Plume Position - 2014

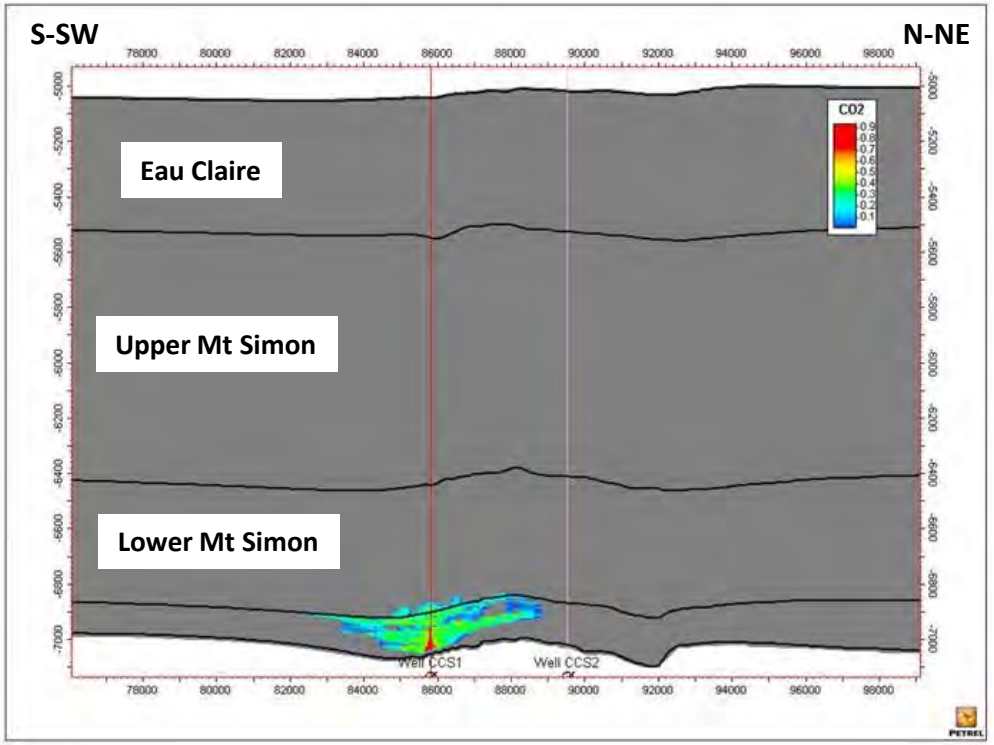




Geophysical Modeling

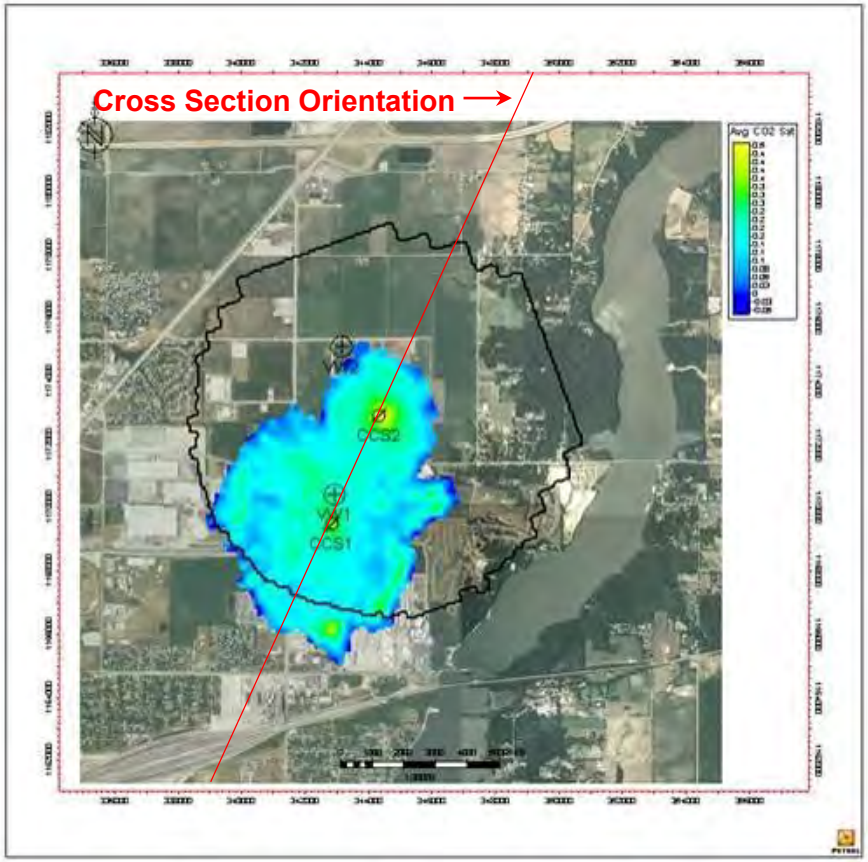
CO_2 Plume Position - 2015

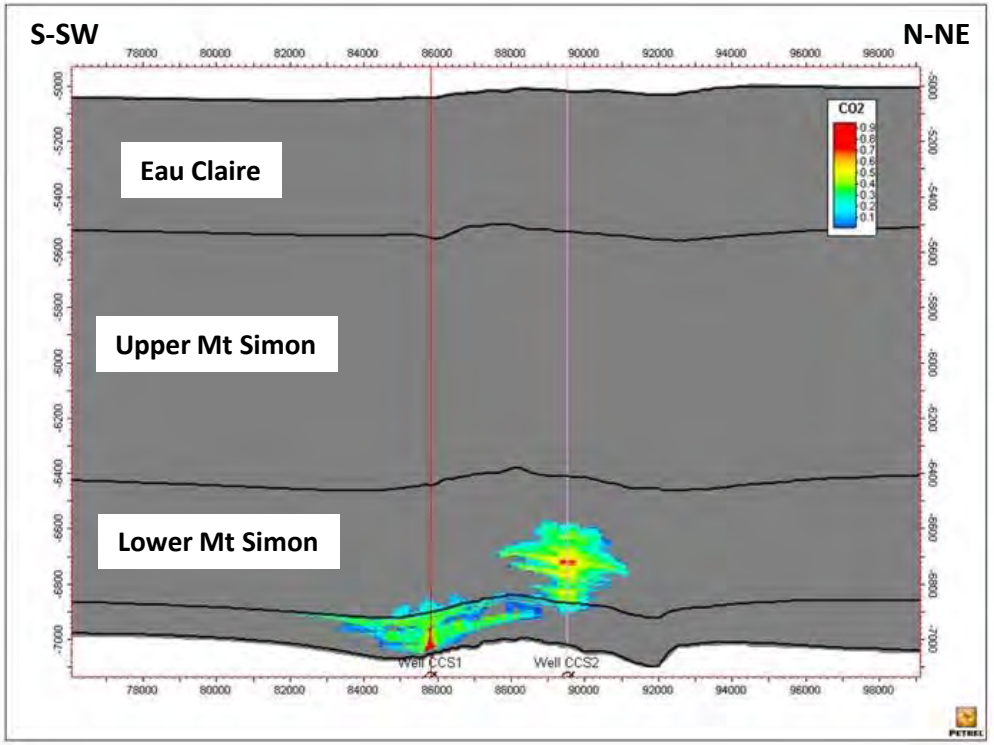




Geophysical Modeling

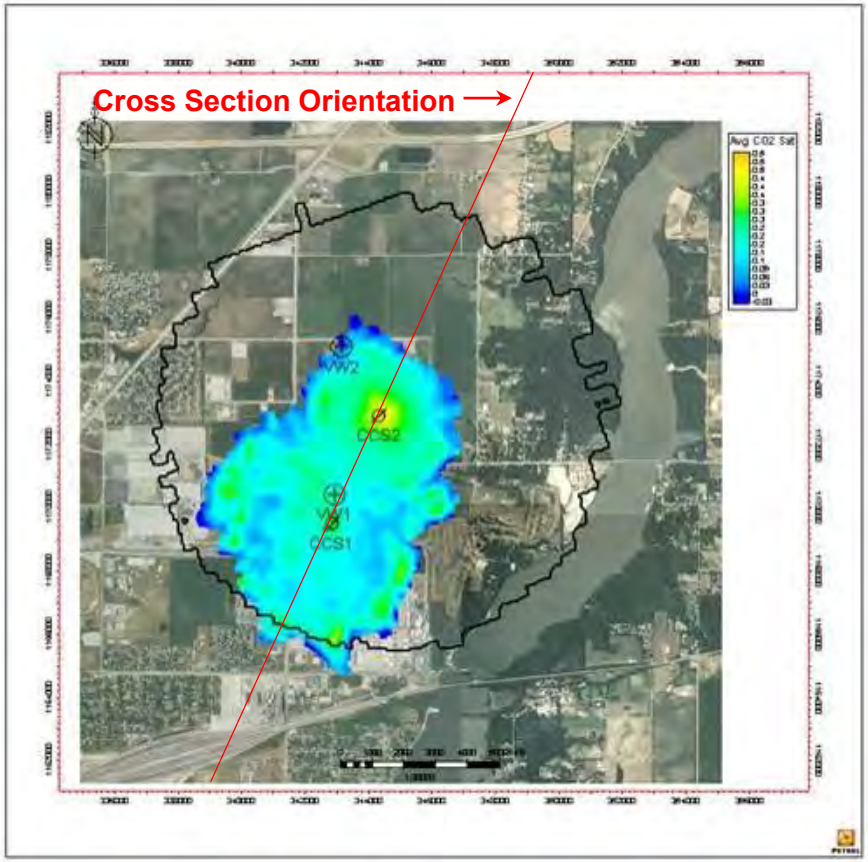
CO_2 Plume Position - 2018

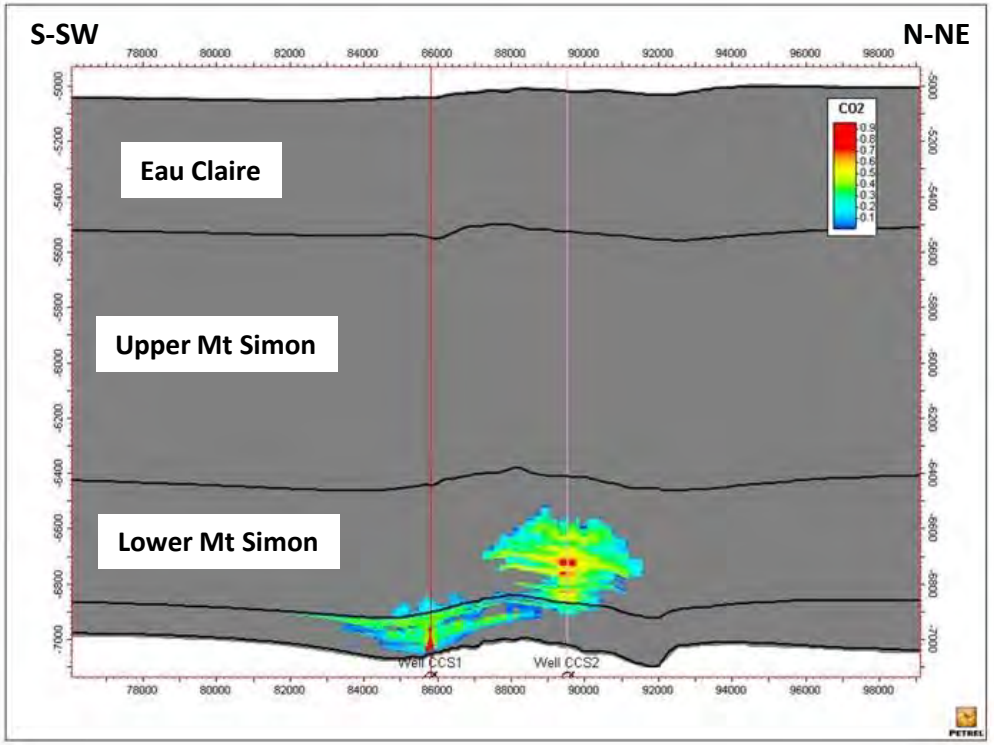




Geophysical Modeling

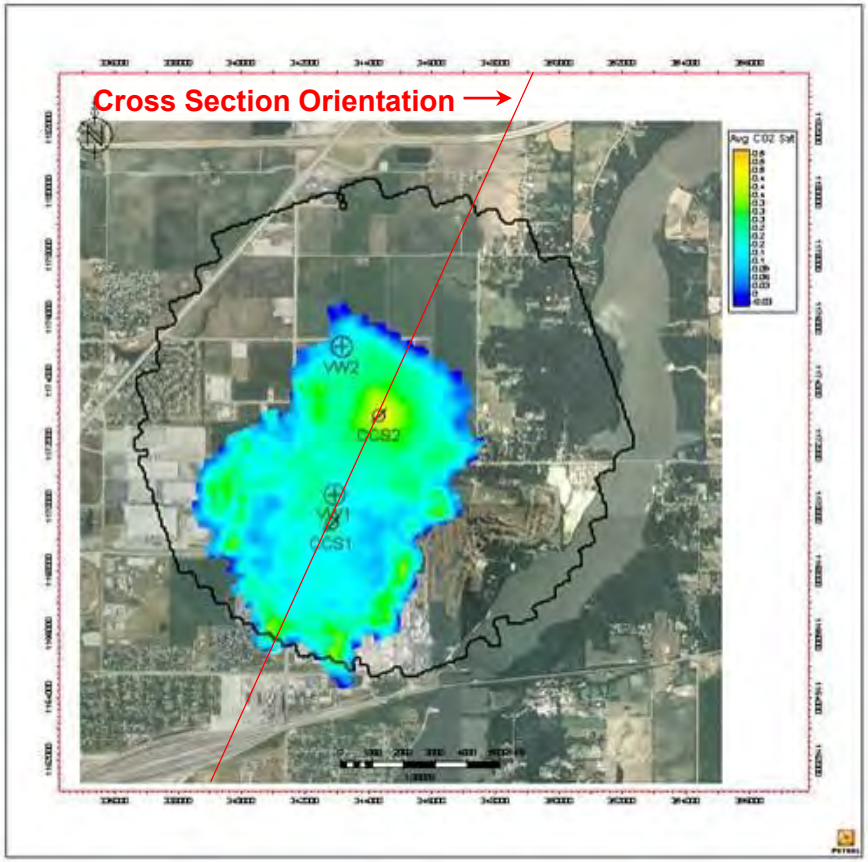
CO_2 Plume Position - 2019

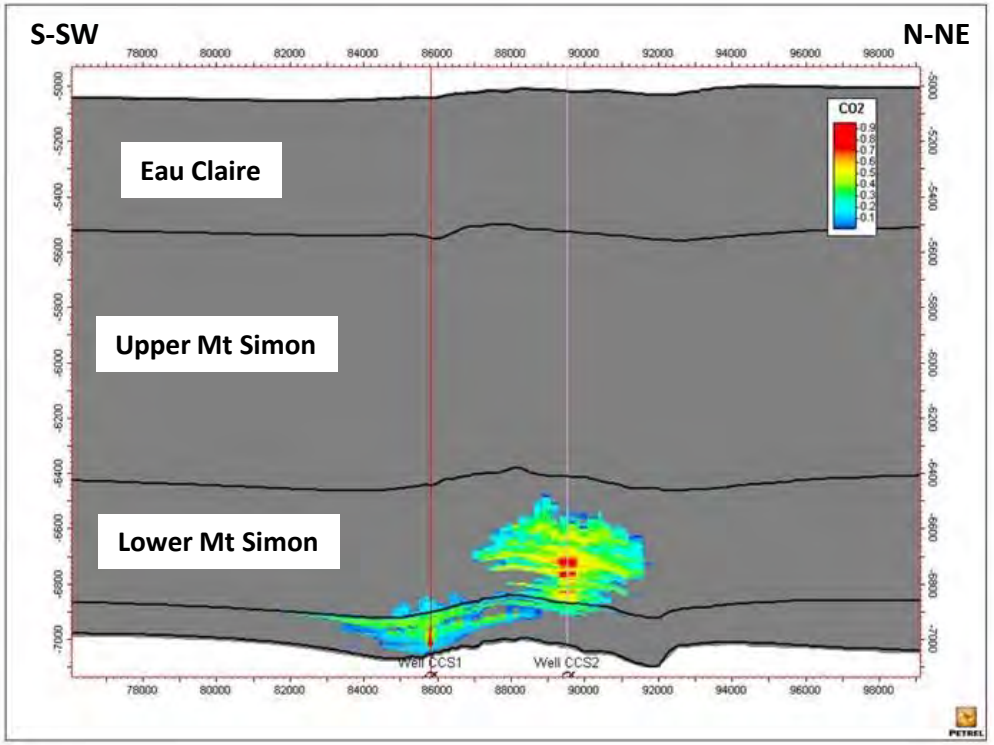




Geophysical Modeling

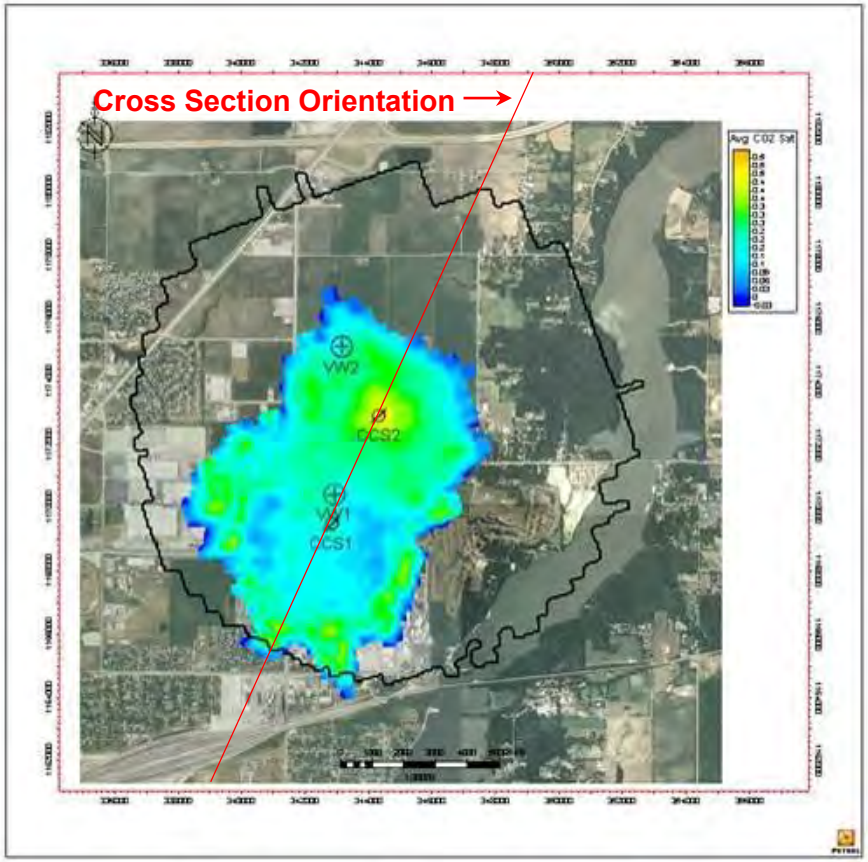
CO_2 Plume Position - 2020

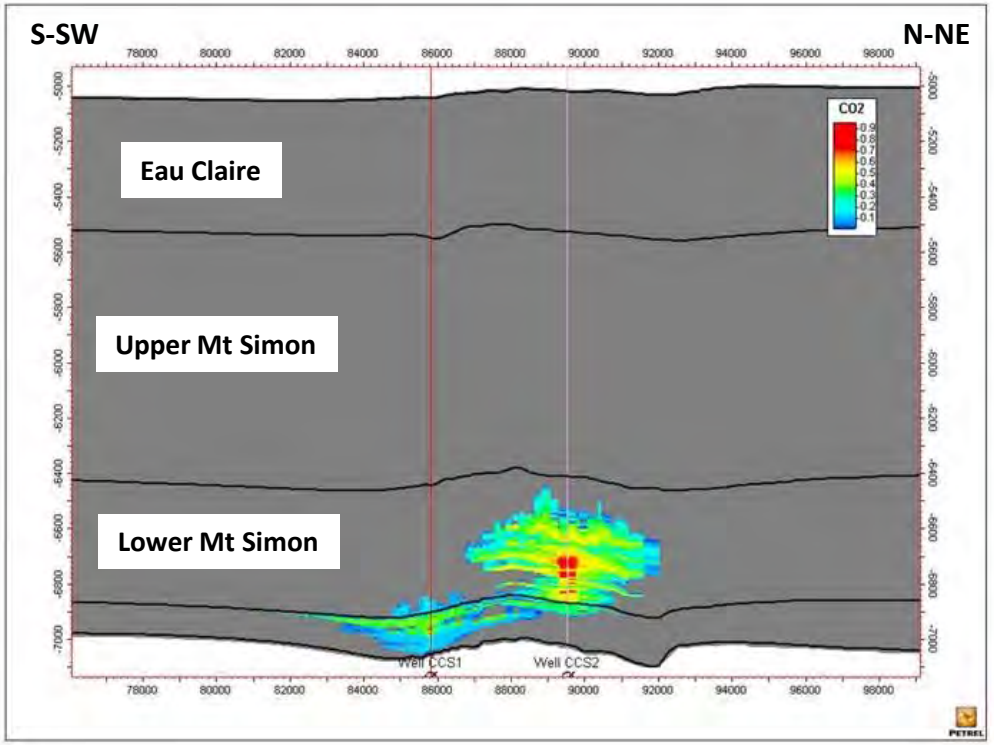




Geophysical Modeling

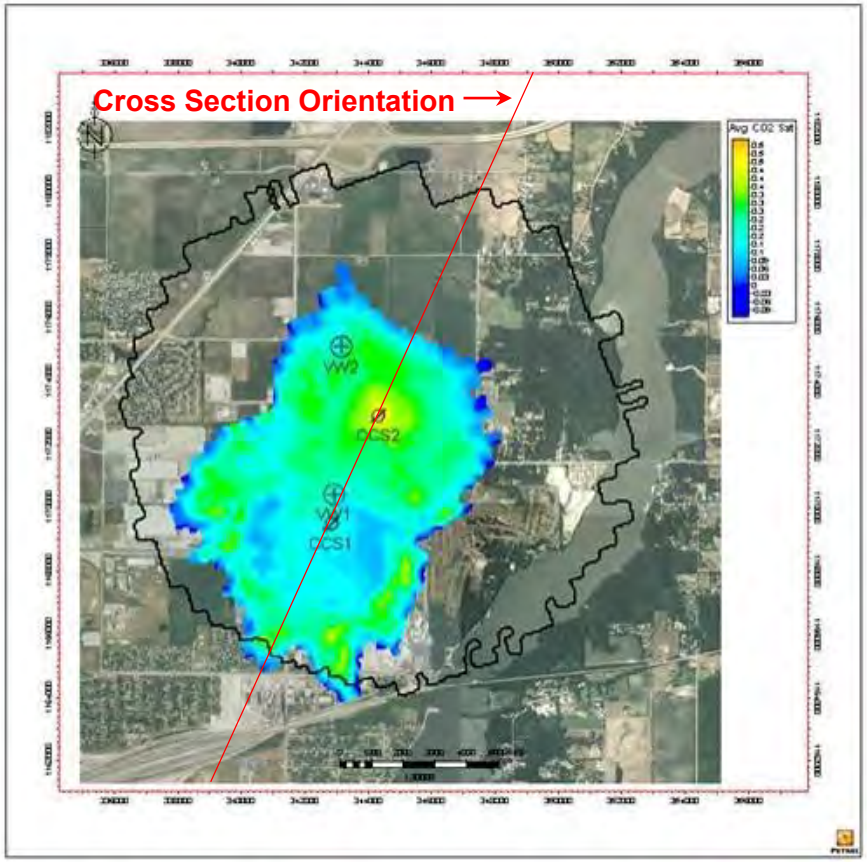
CO_2 Plume Position - 2021

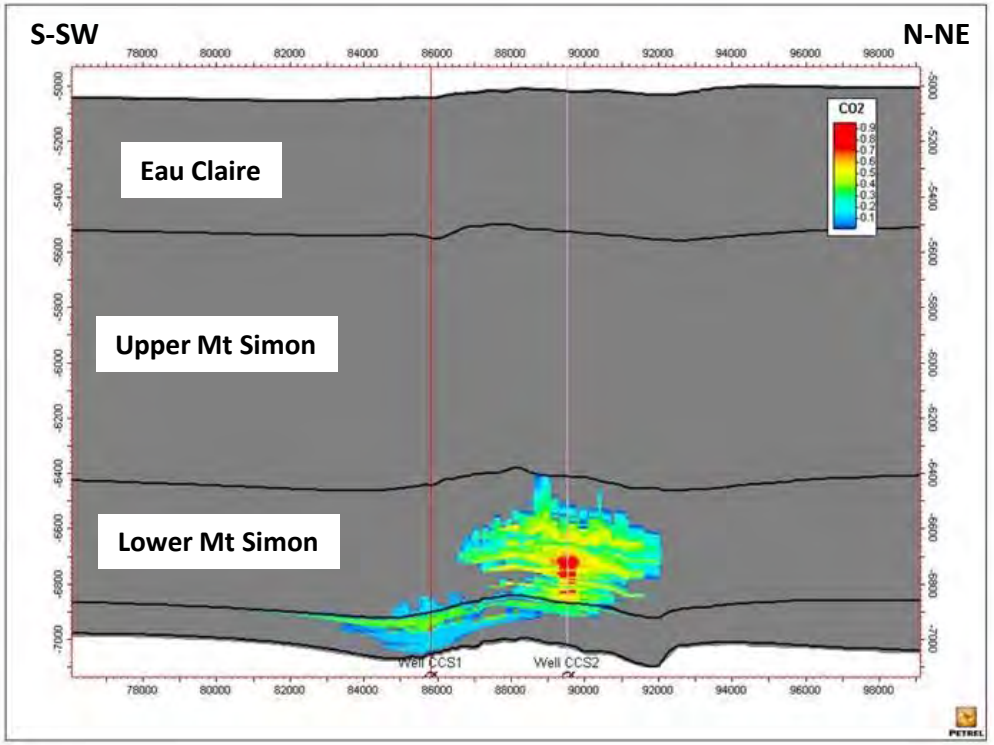




Geophysical Modeling

CO_2 Plume Position - 2022





Environmental Monitoring (MVA)
Conceptual Framework

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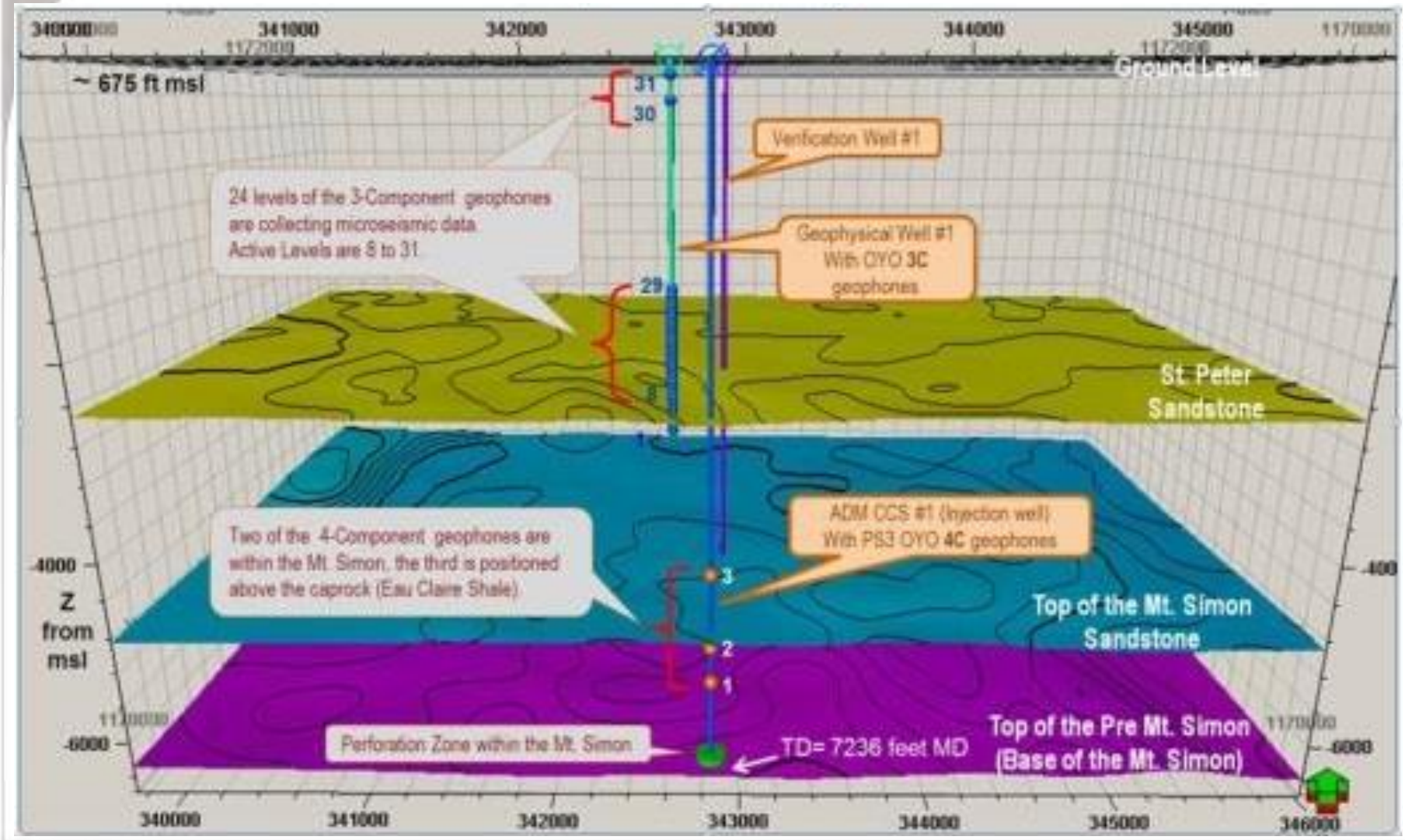
Near Surface		Deep Subsurface		
Soil and Vadose Zone		Ground Water	Above Seal	Injection Zone
Aerial Imagery	Soil CO_2 Flux	Geochemical Sampling P/T Monitoring	Geophysical Surveys Seismic Monitoring P Monitoring	Geophysical Surveys Geochemical sampling P/T Monitoring

VW#2 Monitoring Well

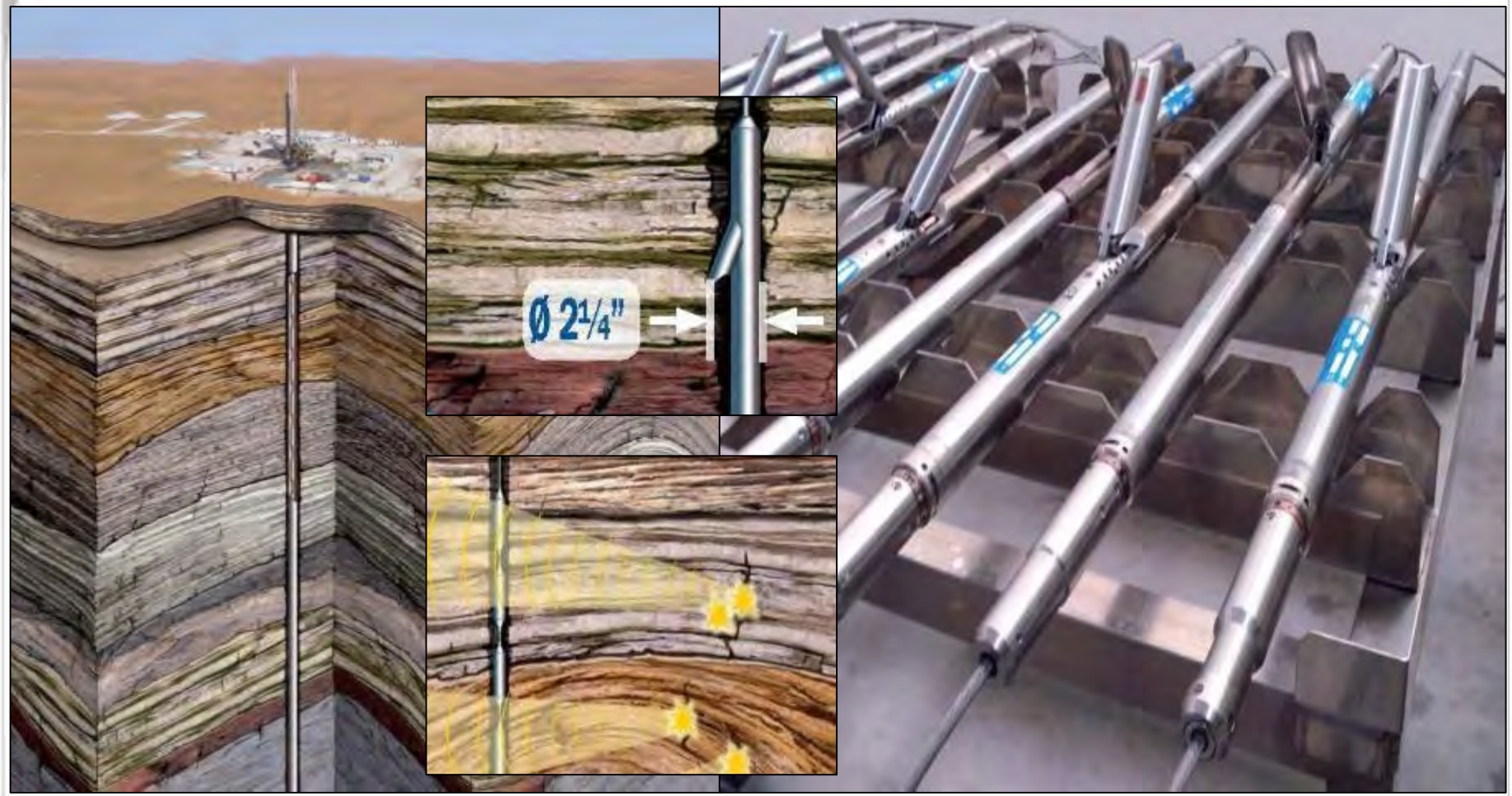
VW#2 Monitoring Well

Deep Seismic Monitoring

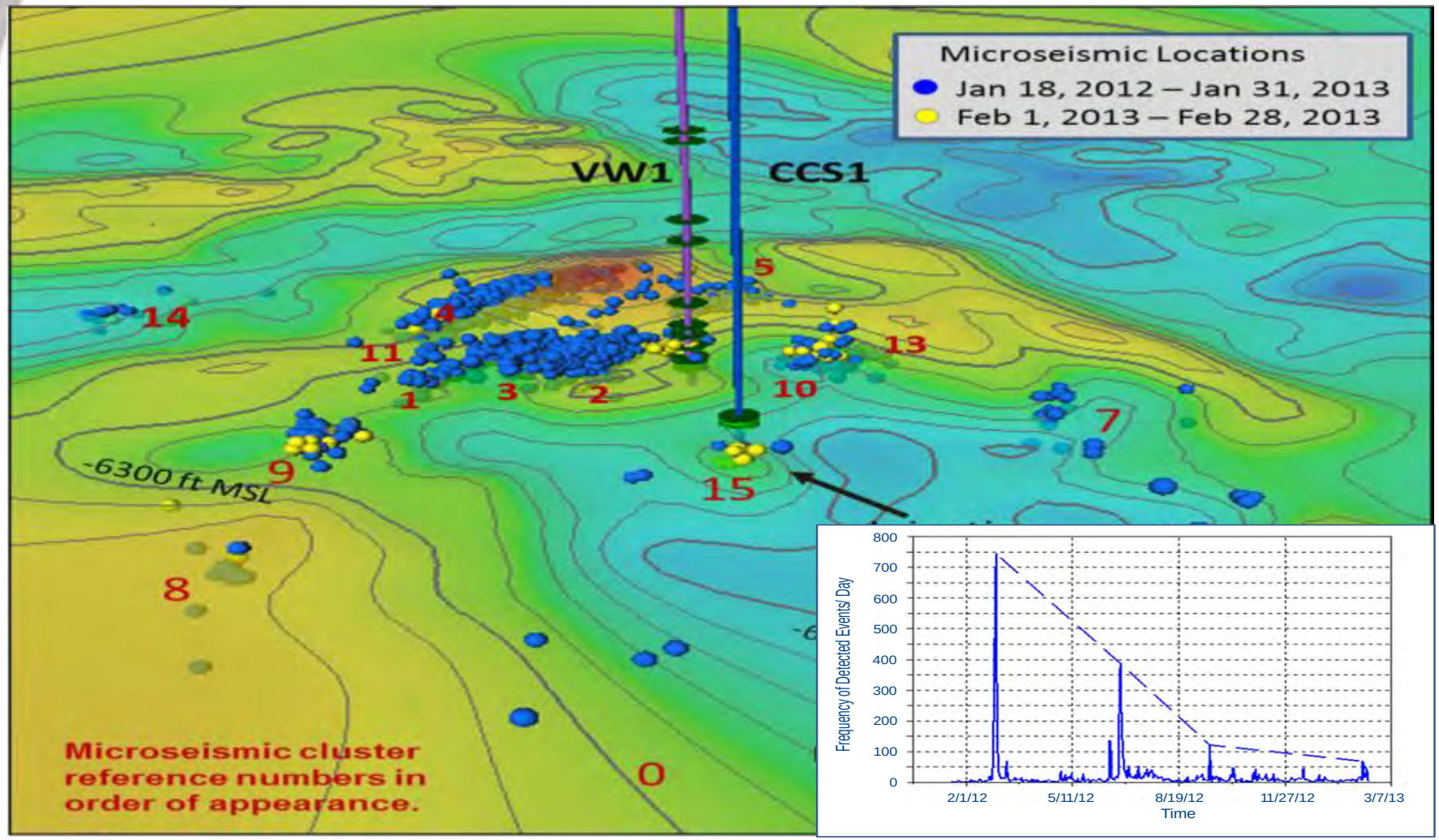


Deep Seismic Monitoring

"Slim Wave" Retrievable Geophones



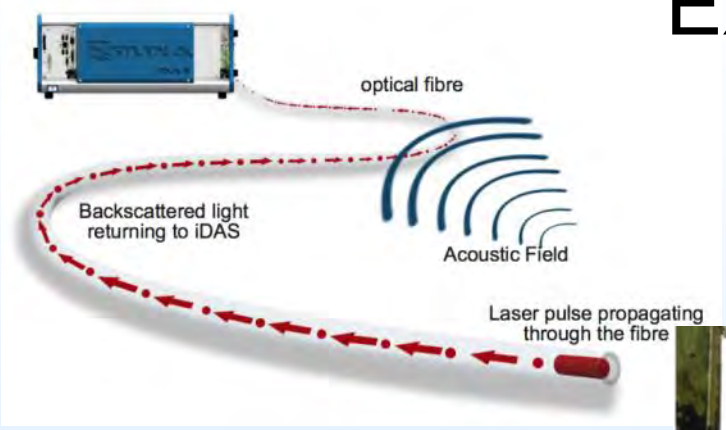
Seismic Monitoring Data

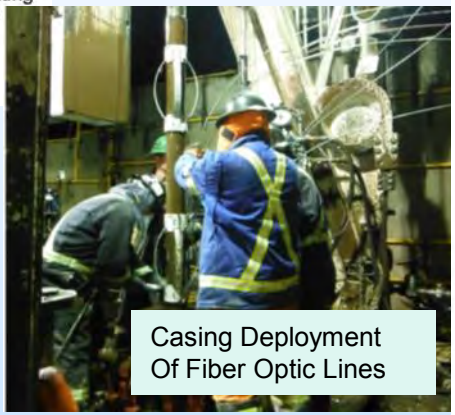


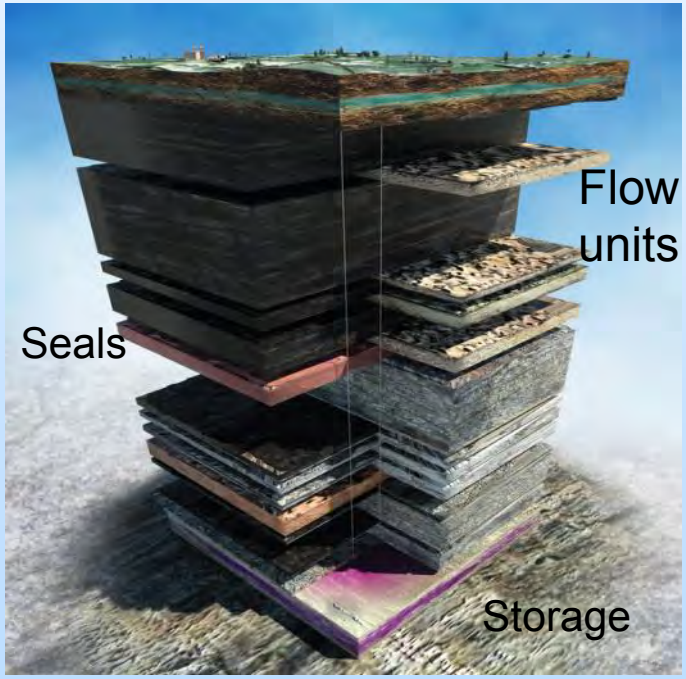
Distributed Acoustic Sensing (DAS)

Example from PTRC Aquistore

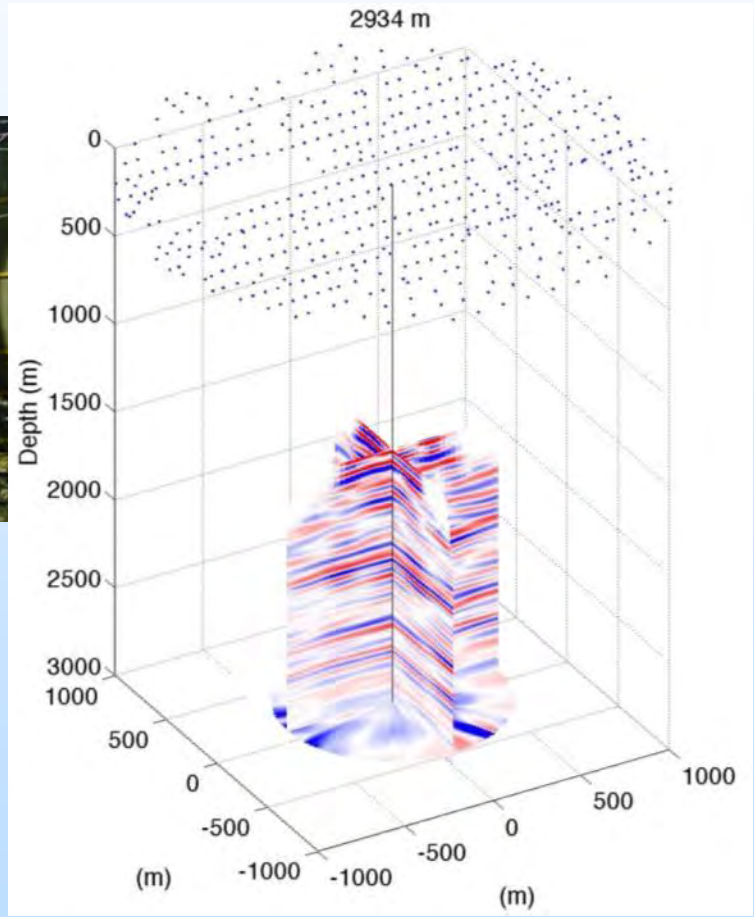
DAS Baseline 3D-VSP




Casing Deployment Of Fiber Optic Lines



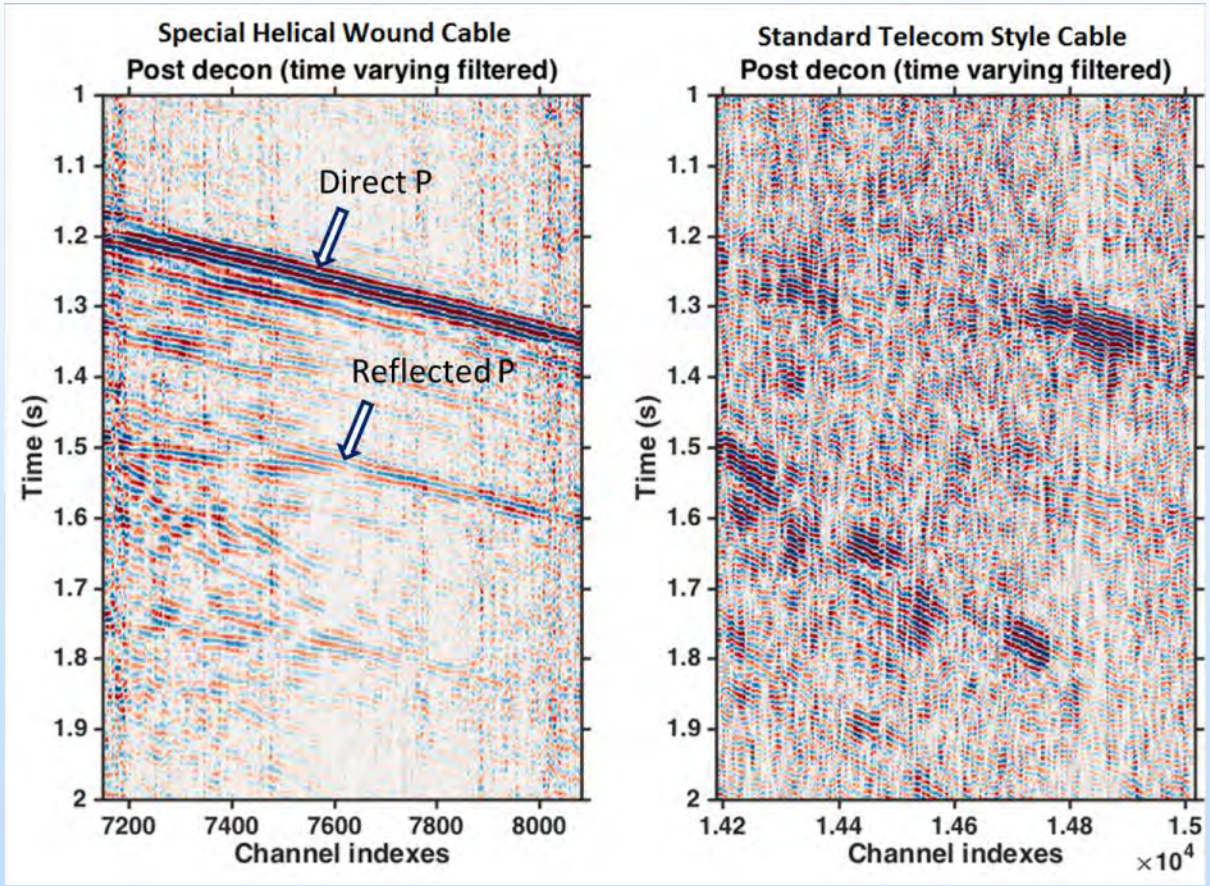
DAS VSP is becoming accepted technology.



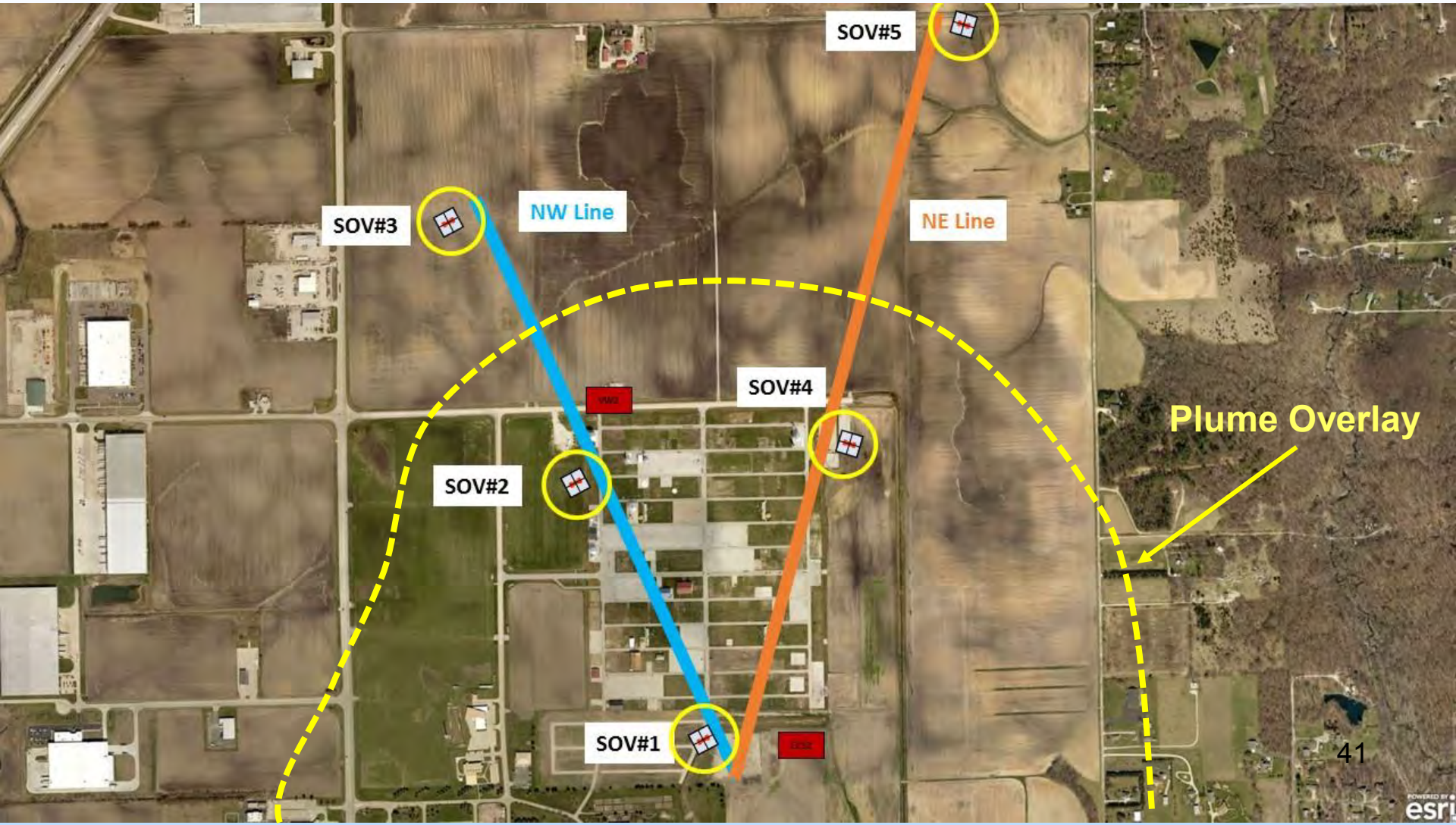
Technologies Developed under DOE Core R&D are incorporated into the IMS

Rotary Orbital Source

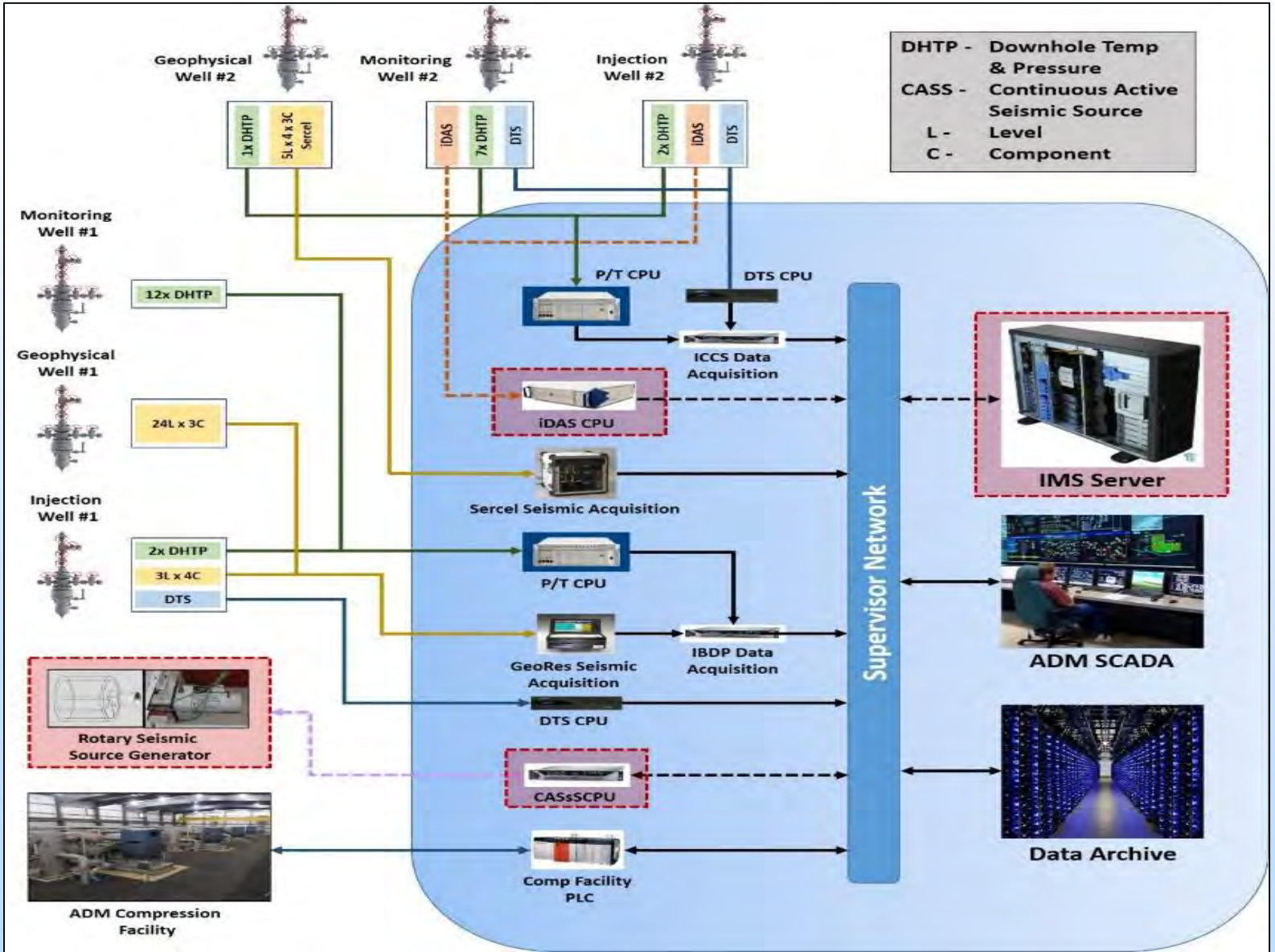
Broadside Sensitive Cable



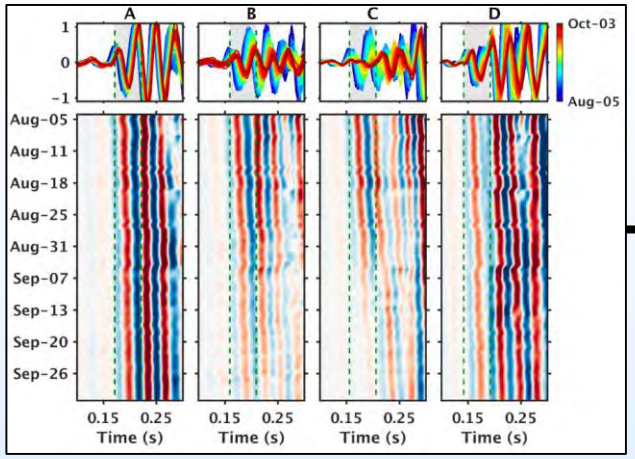
IMS Equipment Layout

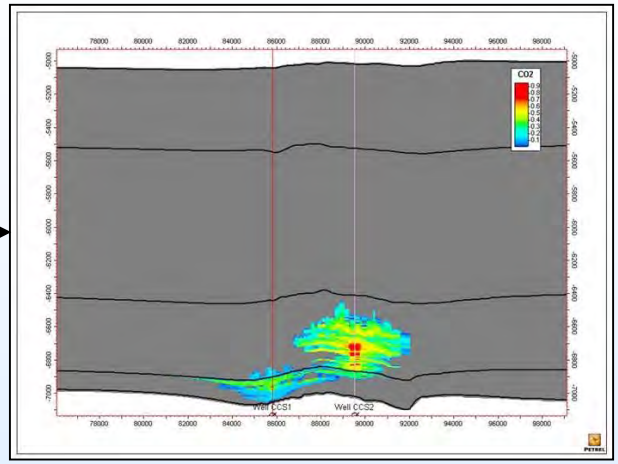


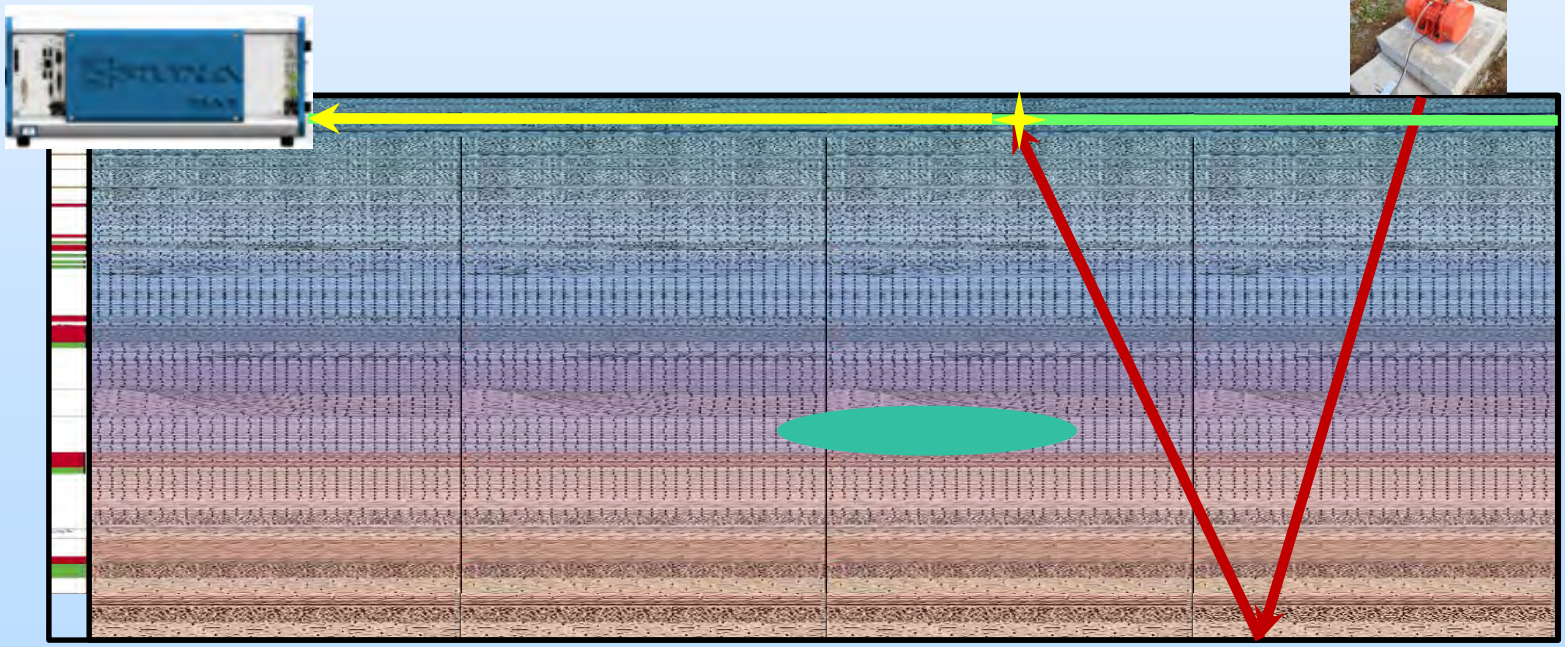
IMS Data Acquisition Architecture



IMS Operation & Results

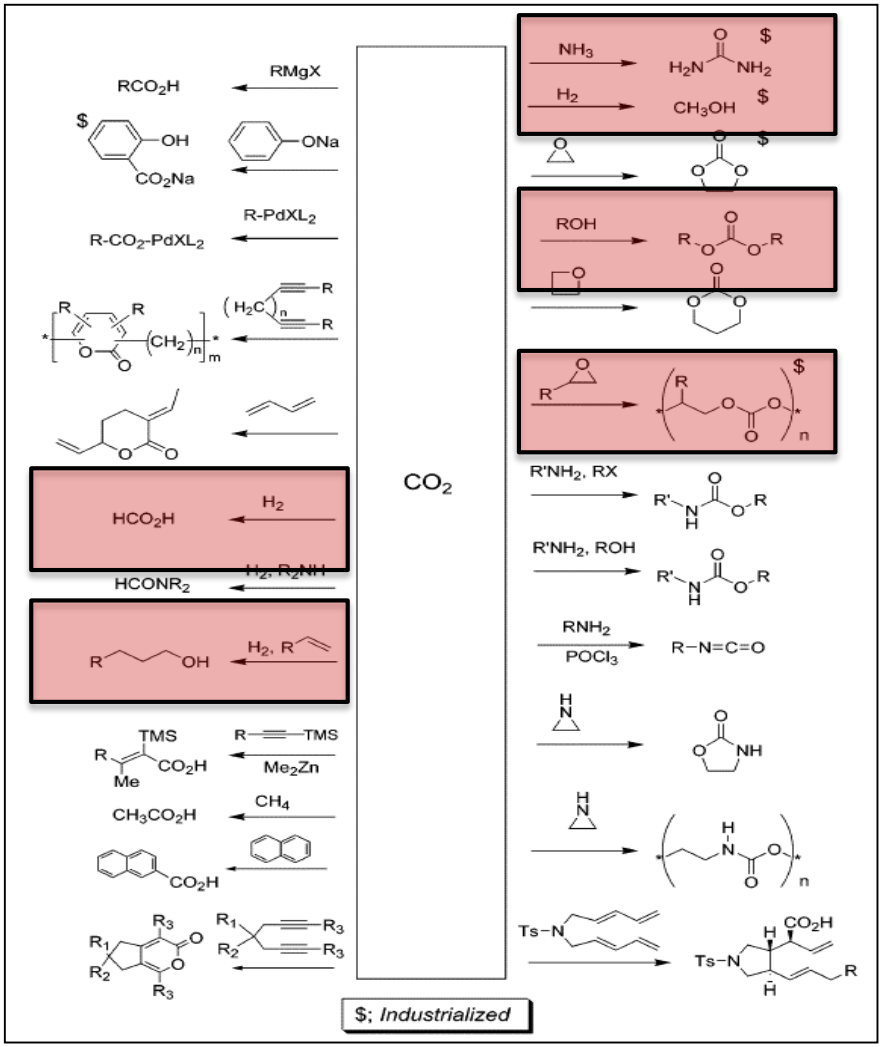






Commercial Drivers- CO_2 Based Chemicals

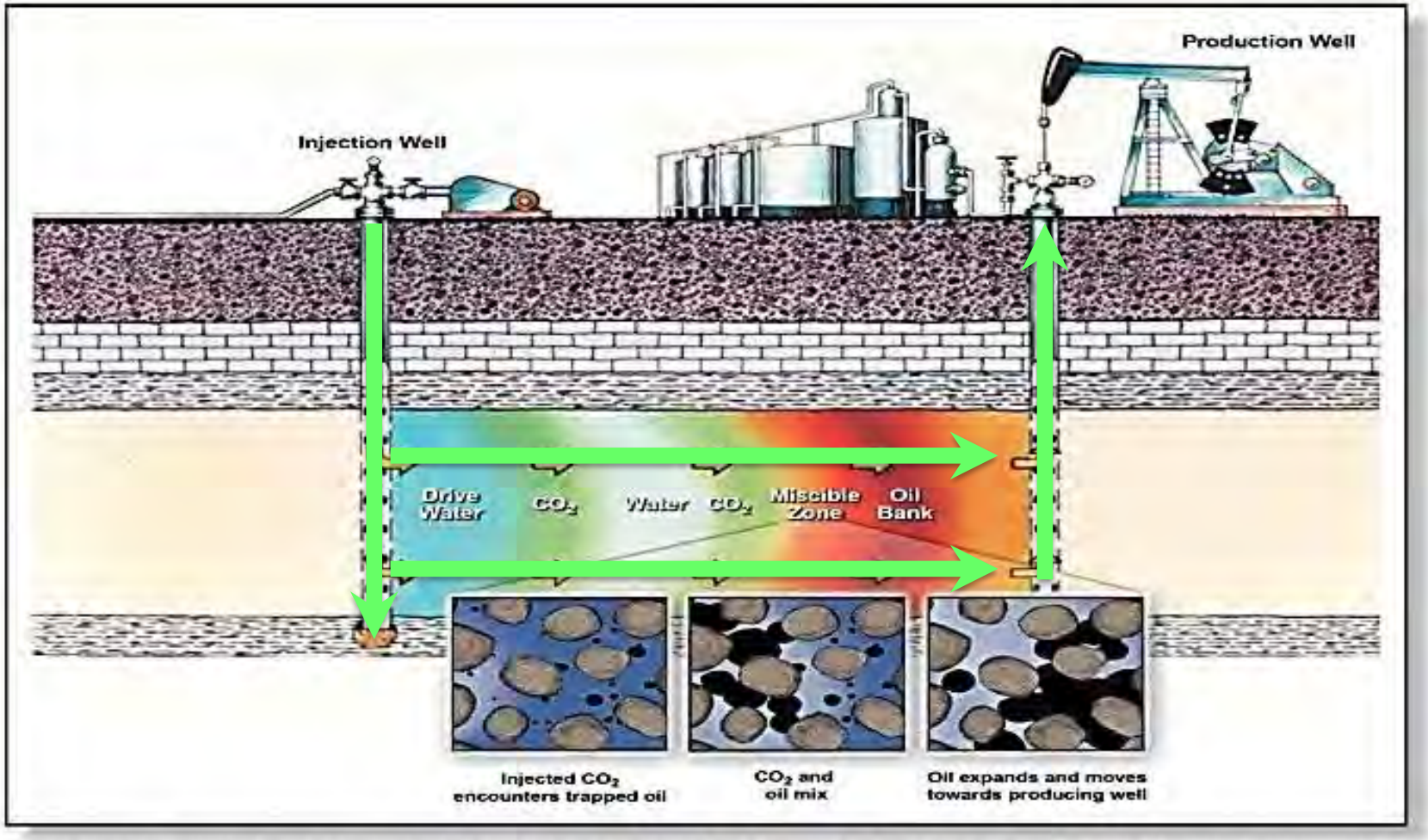
- **Carbonates**
  - Glycerol Carbonate
  - Propylene Carbonate
  - Dimethyl Carbonate
- **Fertilizers**
- **Alcohols**
- **Fuels**
- **Acids**
- **Polymers**
- **Cement**



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

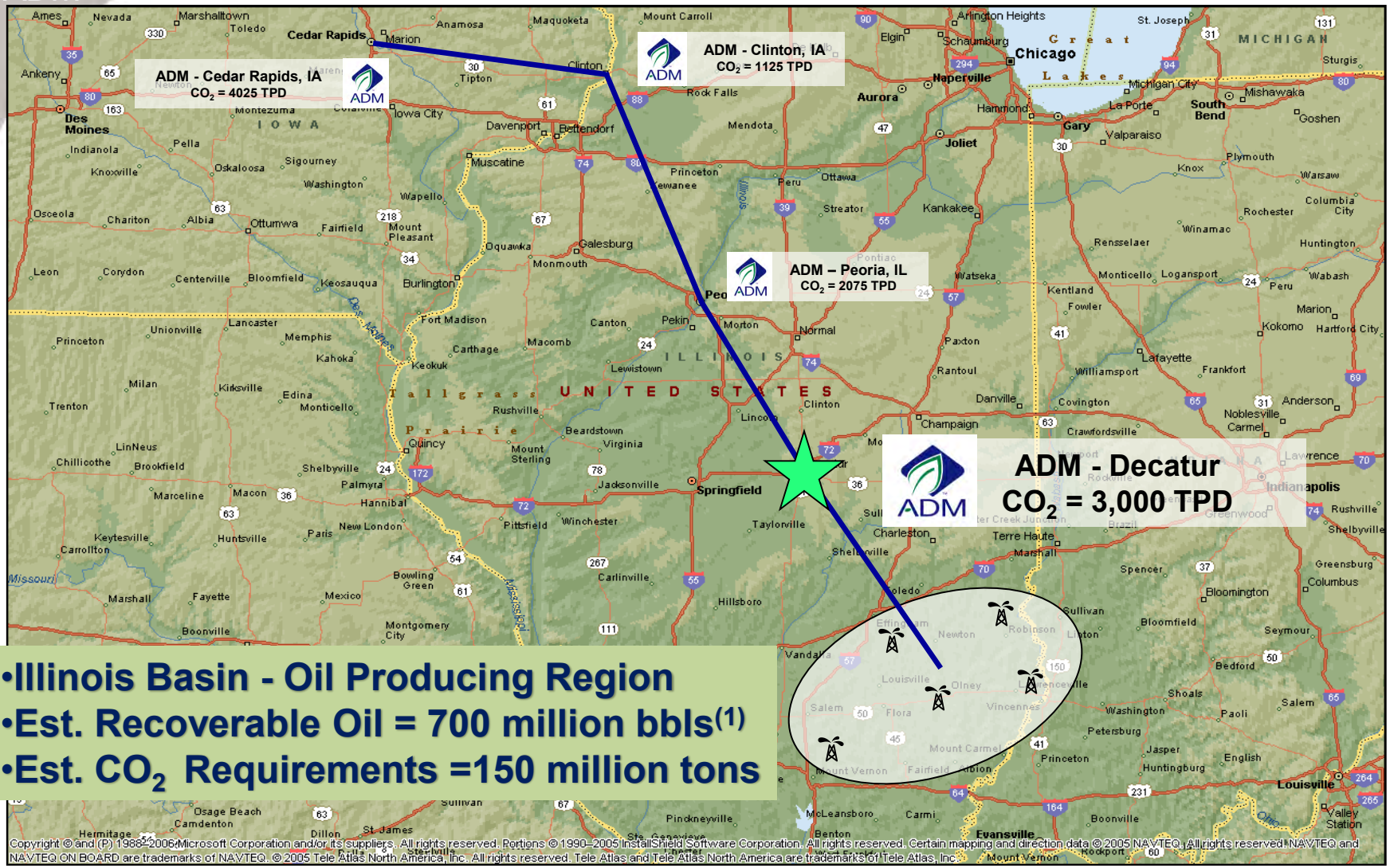
Commercial Drivers- *Enhance Oil Recovery*

https://www.youtube.com/watch?v=NMBhX1IxajU



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

Future Commercial Potential



- Illinois Basin - Oil Producing Region
- Est. Recoverable Oil = 700 million bbls(1)
- Est. CO_2 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

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

Cost Share Agreements:

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

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