The Illinois Basin – Decatur Project: Updates and Recent Experiences

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ILLINOIS STATE GEOLOGICAL SURVEY
PRAIRIE RESEARCH INSTITUTE

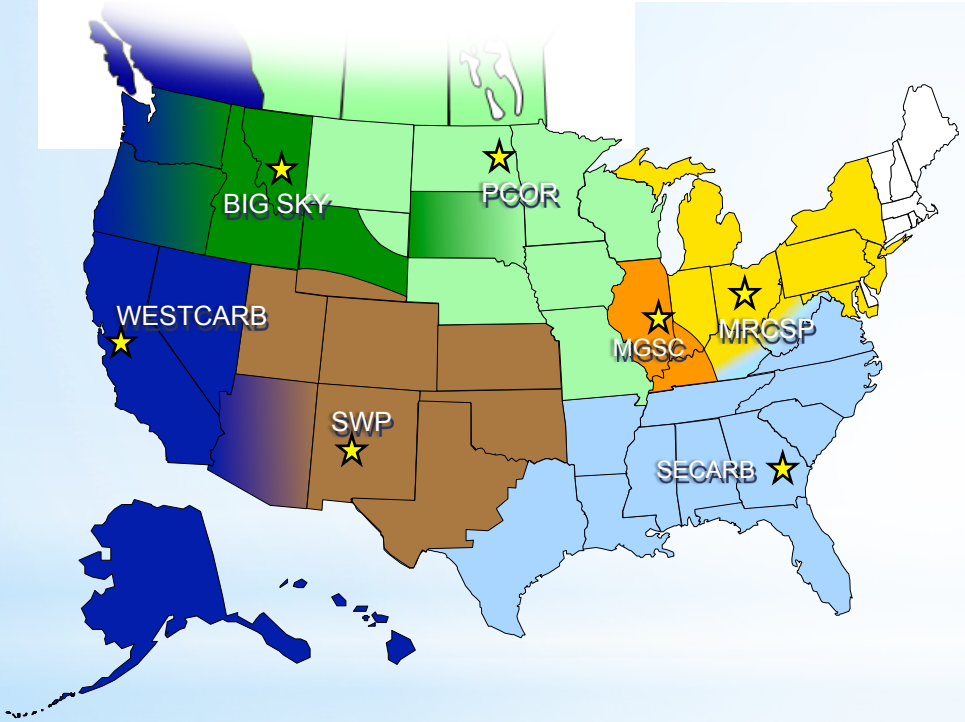
Outline

- Brief IBDP overview
- MVA program scope
- Updates on:
  - Reservoir sampling experiences
  - 3D seismic data interpretation

Regional Carbon Sequestration Partnerships: Developing the Infrastructure for Wide Scale Deployment

Seven Regional Partnerships

400+ distinct organizations, 43 states, 4 Canadian Provinces



- Engage regional, state, and local governments
- Determine regional sequestration benefits
- Baseline region for sources and sinks
- Establish monitoring and verification protocols
- Address regulatory, environmental, and outreach issues
- Validate sequestration technology and infrastructure

Characterization Phase (2003-2005)

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

Validation Phase (2005-2011+)

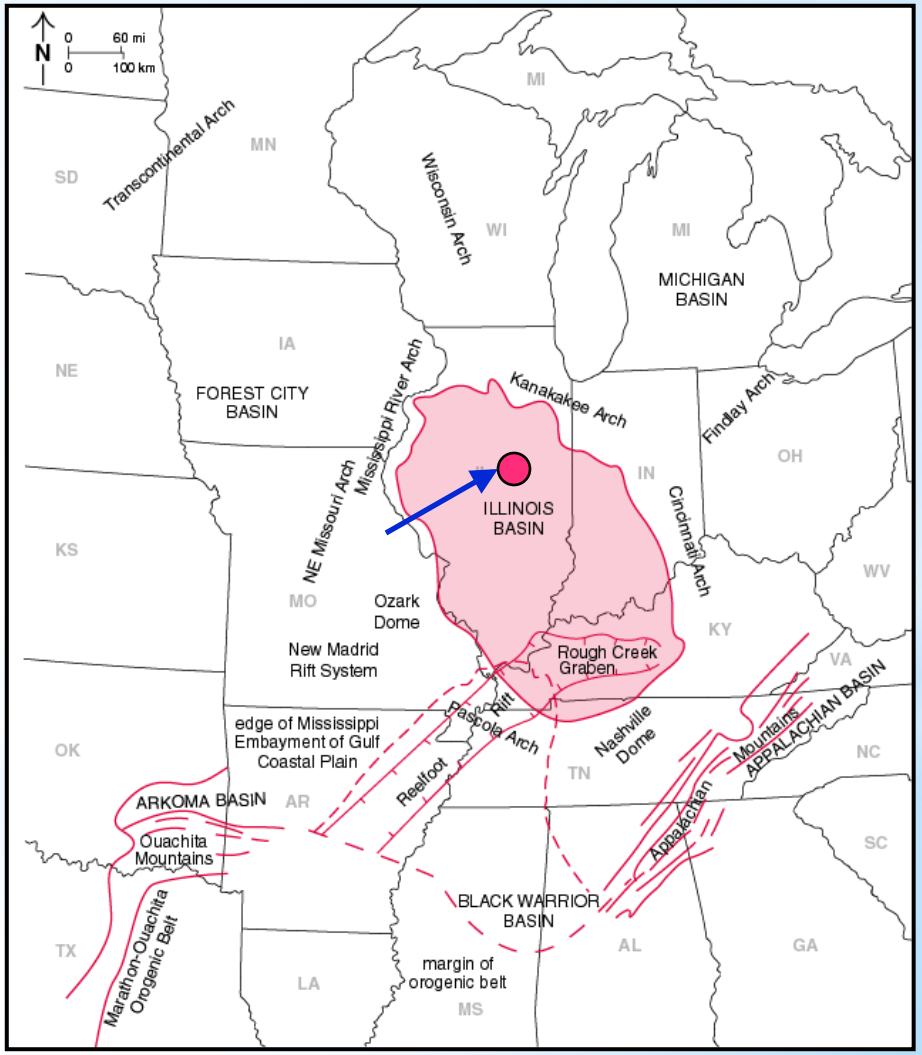
19 injection tests in saline formations, depleted oil, unmineable coal seams, and basalt

Development Phase (2008-2018+)

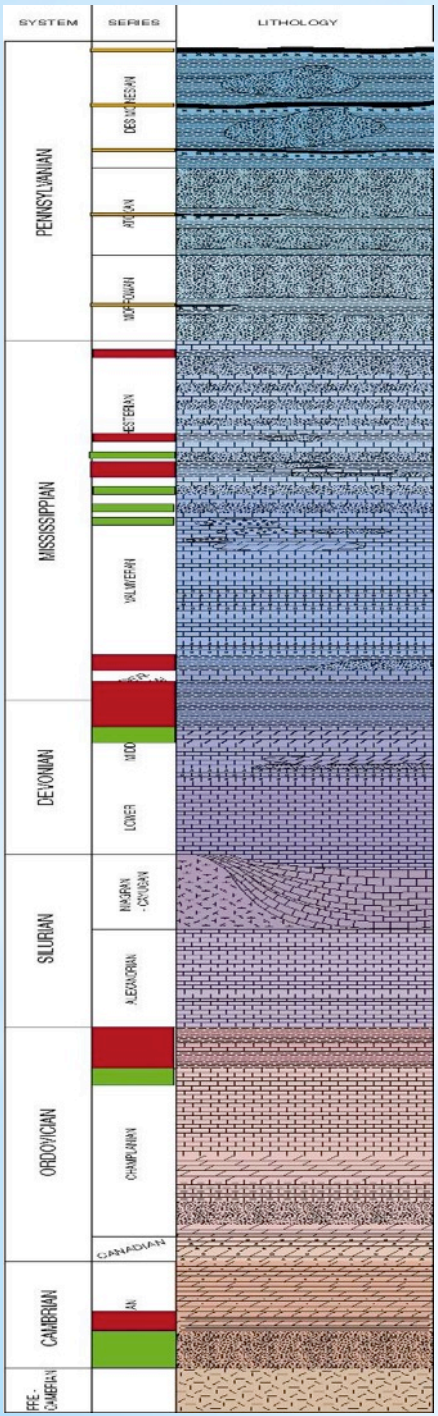
Large scale injections	Commercial scale understanding	Regulatory, liability, ownership issues

Illinois Basin - Decatur Project (IBDP)

- IBDP is a collaboration of the MGSC, the Archer Daniels Midland Company (ADM), Schlumberger Carbon Services, and may other partners.
- A demonstration of carbon sequestration in a saline reservoir at a site in Decatur, Illinois USA
- Will inject 1 million tonnes of anthropogenic carbon dioxide at a depth of 2,100 m (7,000 ft) over 3 years
- 7 years of monitoring planned;
  - 2 years pre-injection,
  - 3 years during injection, and
  - 2 years post-injection



Illinois Basin Strata



Pennsylvanian coal seams

Mississippian sandstone and carbonate oil reservoirs

New Albany Shale (seal)

Maquoketa Shale (seal)

Saint Peter Sandstone

Eau Claire Shale (seal)

Mount Simon Sandstone (reservoir)

Mount Simon Sandstone:

- Regionally most significant sequestration resource in the Midwestern US
- 11 to 151 Gtonnes capacity (US DOE Atlas, 3rd edition)
- 500 m (1650 ft) thick at IBDP site

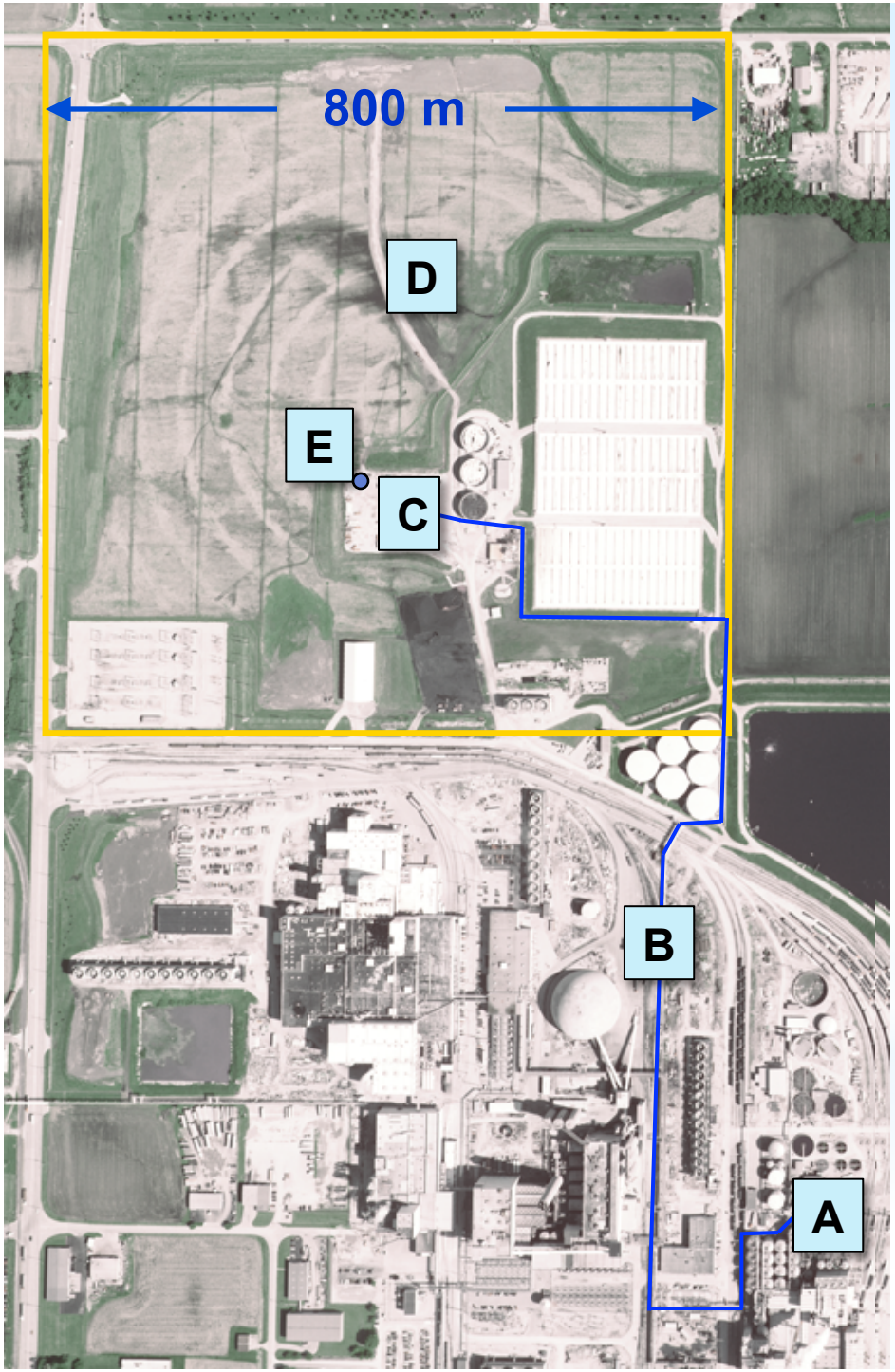
Illinois Basin - Decatur Project

Major Activities and Milestones

- UIC permitting: 2008 (January) - ongoing
  - Application, hearing, minor and major modifications
- Drilled injection well (CCS#1): 2009 (February – May)
- Drilled geophone well (GM#1): 2009 (September – November)
- Baseline 3D seismic survey: 2010 (January)
- Compression/dehydration/pipeline facility: 2009 – 2011
  Designed, constructed, and tested
- Drilled verification well (VW#1): 2010 (September – November)
  Completed VW#1 2011 (March – June)
- **Authorization to inject: 2 November 2011**
- **Fully operational (1000 tonnes/d): 17 November 2011**

Fully operational: 17 November 2011

- IBDP is the first CCS project in the US with CO_2 source from a biofuel facility
- Cumulative injection on 16 June 2012: 184,000 tonnes
- Injection through 2014
- Monitoring through 2016



Illinois Basin-Decatur Project Key Features

A. Dehydration - Compression Facility

B. Pipeline route

C. Injection well

D. Verification well

E. Geophone well

IBDP Environmental Monitoring Framework

Near Surface

Atmos.

- Eddy covariance
- Meteorological conditions
- Ambient CO_2 for HHS
- Tunable diode laser for CO_2

Soil/vadose zone

- CIR aerial imagery
- InSAR and GPS
- Soil gases
- Soil CO_2 flux
- Tunable diode laser for CO_2

Shallow groundwater

- Geophysical surveys
- Geochemical sampling
- P/T monitoring

Deep Subsurface

Above seal

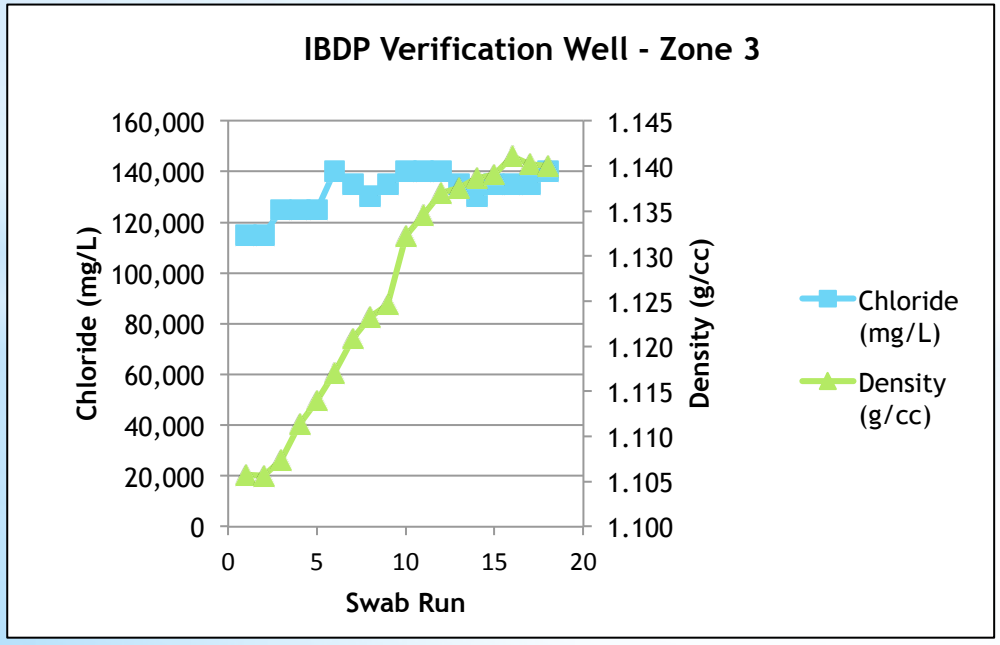
- Geophysical surveys
- Geochemical sampling
- P/T monitoring

Injection zone

- Geophysical surveys
- Geochemical sampling
- P/T monitoring

May 2011 – Verification Well

- Produced 290 m^3 (76,000 gallons, 1,800 barrels) over 18 days from 10 perforated zones by swabbing
- Field samples (n = 232) were tested for density, chloride, potassium, pH, Eh, electrical conductivity, etc.
- After **density** and chloride stabilized, representative formation samples (n = 24) were collected for later analysis of ~40 constituents

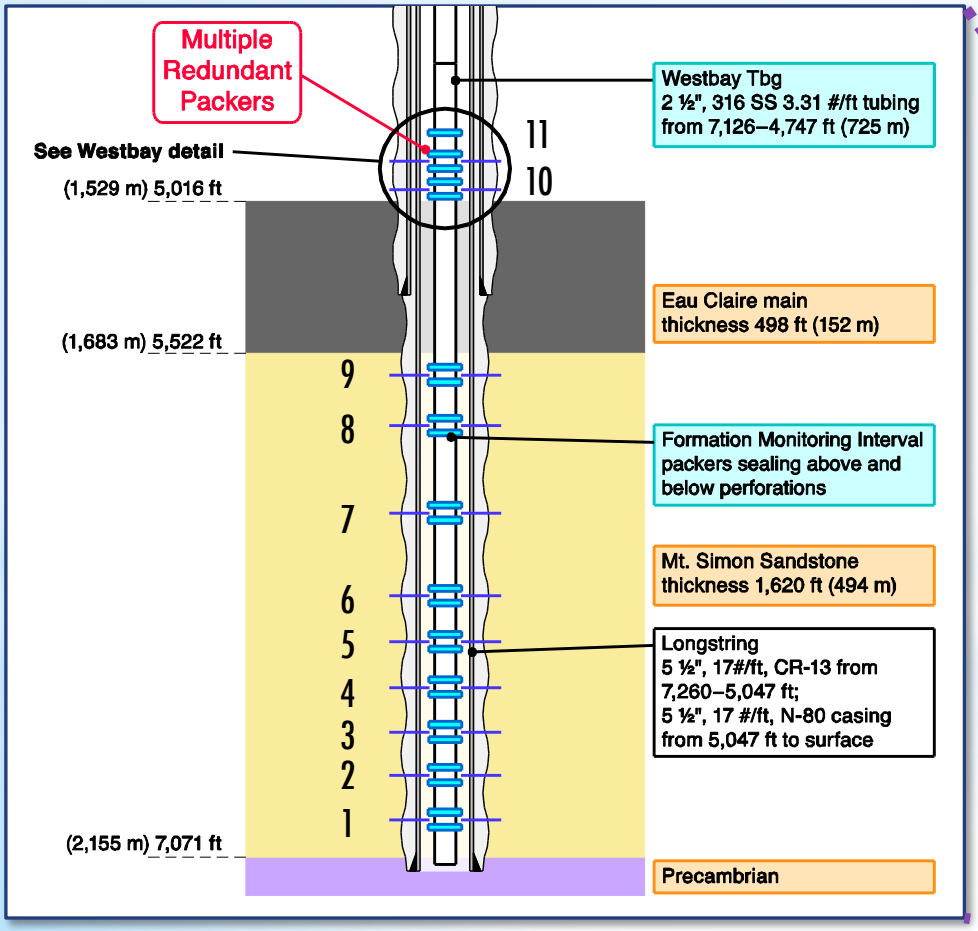


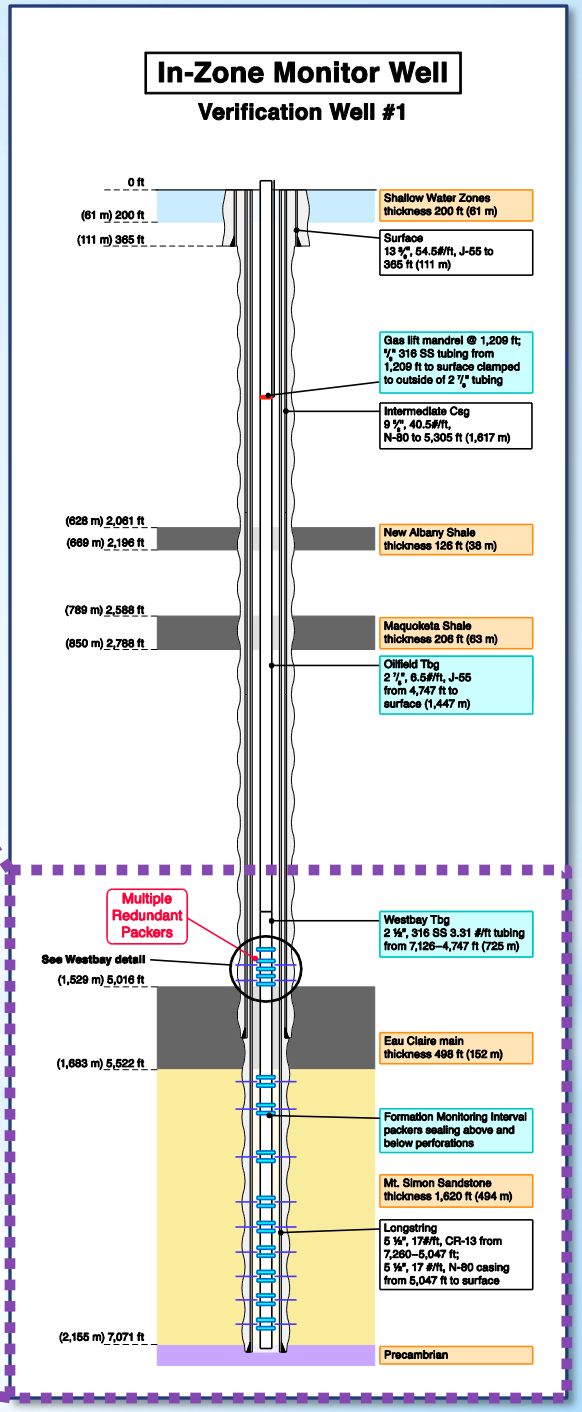
Deepest Westbay Installation in the World (2,100 m, 7000 ft)

Nine zones in the
Mount Simon Sandstone

Two zones above the
Eau Claire Shale
(primary seal)

Verification Well Schematic

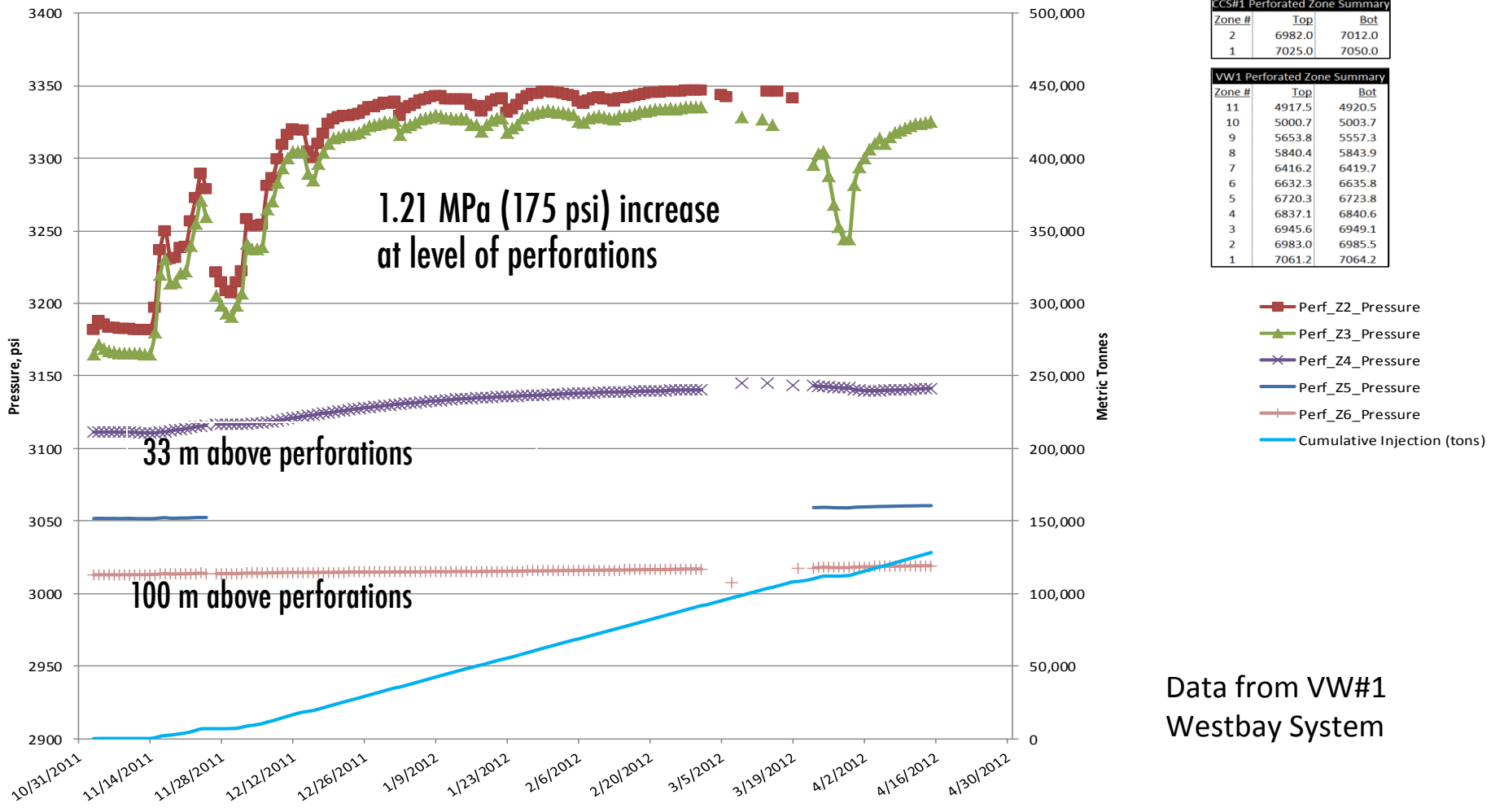




Pressure Response 300 m from Injector

Illinois Basin Decatur Project
Pressure data as observed in Verification Well #1 (VW1)
VW1 is 1000 ft from Injection Well CCS#1

Plotted pressure data is based on averages for each day.



CCS#1 Perforated Zone Summary		
Zone #	Top	Bot
2	6982.0	7012.0
1	7025.0	7050.0

VW1 Perforated Zone Summary		
Zone #	Top	Bot
11	4917.5	4920.5
10	5000.7	5003.7
9	5653.8	5557.3
8	5840.4	5843.9
7	6416.2	6419.7
6	6632.3	6635.8
5	6720.3	6723.8
4	6837.1	6840.6
3	6945.6	6949.1
2	6983.0	6985.5
1	7061.2	7064.2

Data from VW#1
Westbay System

First Westbay Sampling (June 2011)

- Purged 34 m^3 (9,000 gal, 214 bbl) over 18 days
- Selected integrity tests for
  - **Density**
  - **Bromide**
  - Chloride
  - Ammonia
- Samples from 8 of 10 zones met acceptance criteria e.g.,

$[Br_{WB}]/[Br_{swab}] > 90\ \%$

Fluid Type	Chloride (ppt)	Bromide (ppm)	Ammonia (ppm)
Formation brine	37 to 144	200 to 880	4 to 7
Synthetic brine	100	30	--
Synthetic brine with corrosion inhibitor	120	30	70

Sample Integrity

- Example = TDS values (in ppt)
- Mostly consistent between sampling events, except in Zones 10 and 11
- Largest volumes purged from
  - Z10 (16 m^3 ; 4,200 gal)
  - Z11 (24 m^3 ; 6,300 gal)

Zone	Swab	WB1	WB2
11	63	131	81
10	68	155	89
9	149	151	151
8	162	165	163
7	201	197	198
6	202	200	203
5	201	205	207
4	207	197	185
3	206	207	204
2	207	197	203

ppt = parts per thousand

Water Quality Comparison

Constituent	Shallow Groundwater	Ironton-Galesville	Mt. Simon (injection formation)
Conductivity (mS/cm)	**1.5**	**80**	**170**
TDS (mg/L)	**1,000**	**65,600**	**190,000**
Cl^- (mg/L)	**170**	**36,900**	**120,000**
Br^- (mg/L)	**1**	**180**	**680**
Alkalinity (mg/L)	**380**	**130**	**80**
Na^+ (mg/L)	**140**	**17,200**	**50,000**
Ca^{2+} (mg/L)	**100**	**5,200**	**19,000**
K^+ (mg/L)	**1**	**520**	**1,700**
Mg^{2+} (mg/L)	**50**	**950**	**1,800**
pH (units)	**7.2**	**6.9**	**5.9**

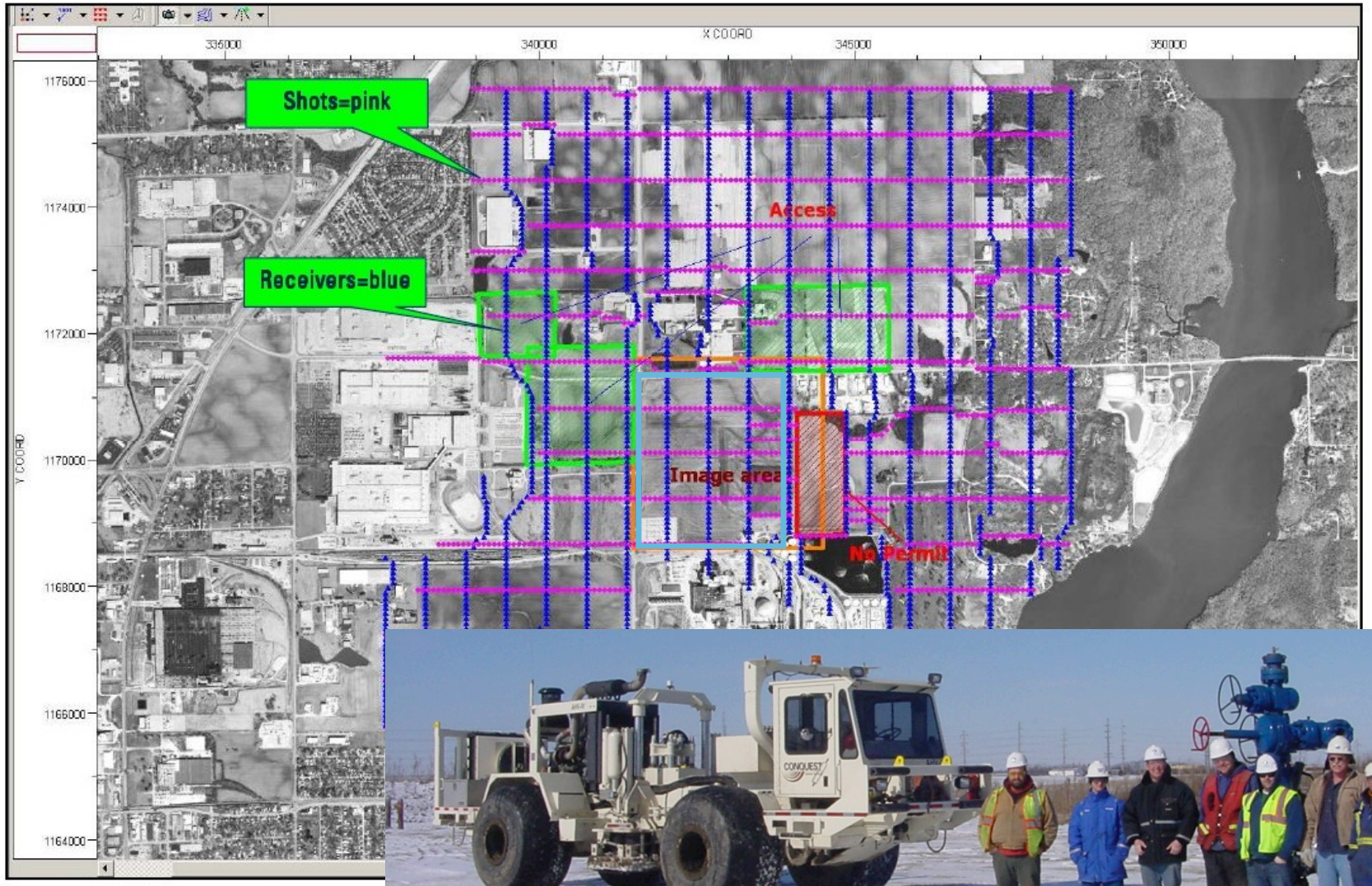
- Shallow groundwater (16 well average)
- Ironton-Galesville (2 zone average; swab only)
- Mount Simon (9 zone average)

IBDP Deep Fluid Sampling

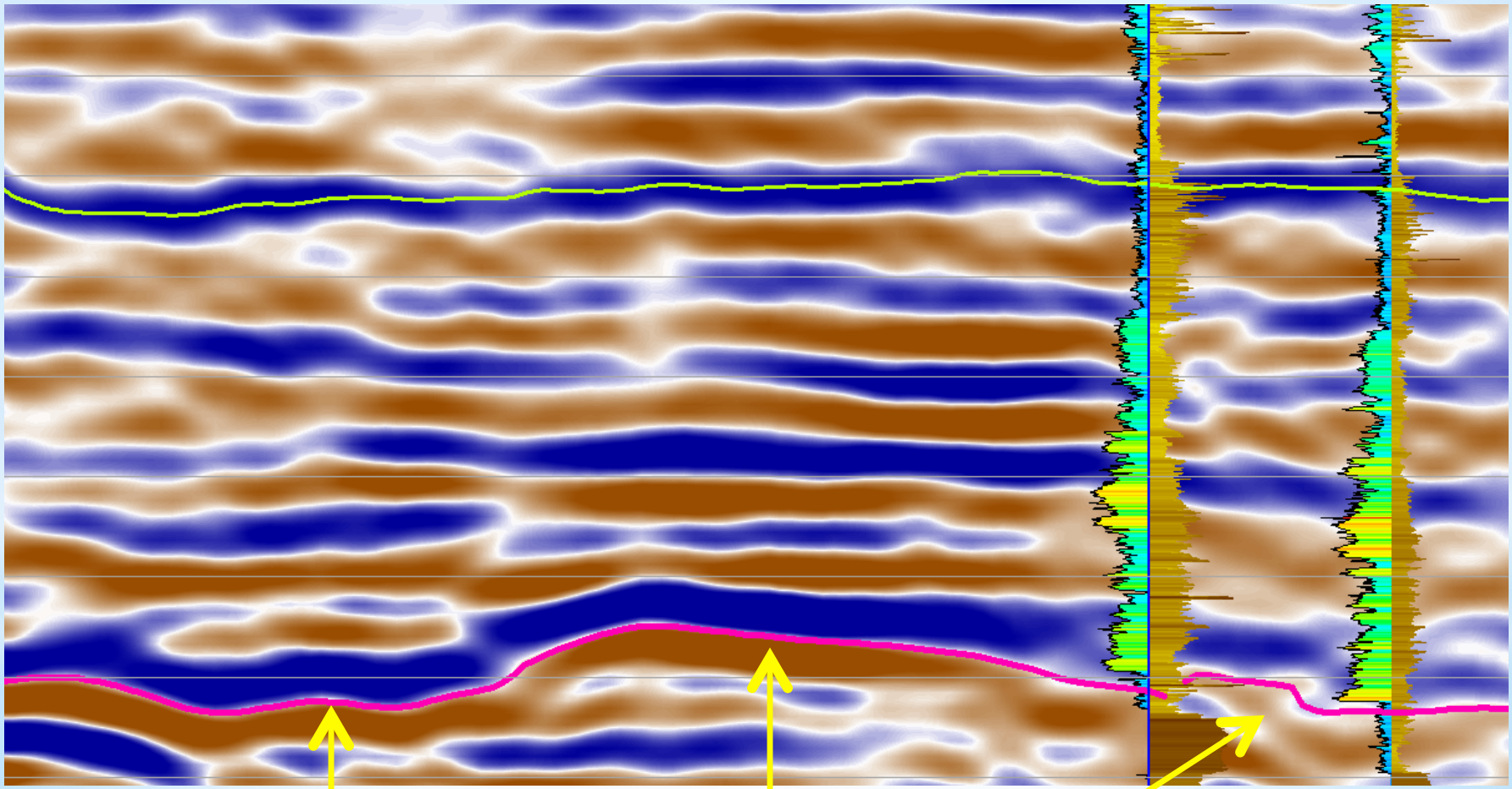
- **Outcomes**
  - Developed detailed sampling procedures for IBDP Westbay system
  - Developed pre-injection data set to characterize deep brines
  - Validated/adjusted geochemical modeling inputs

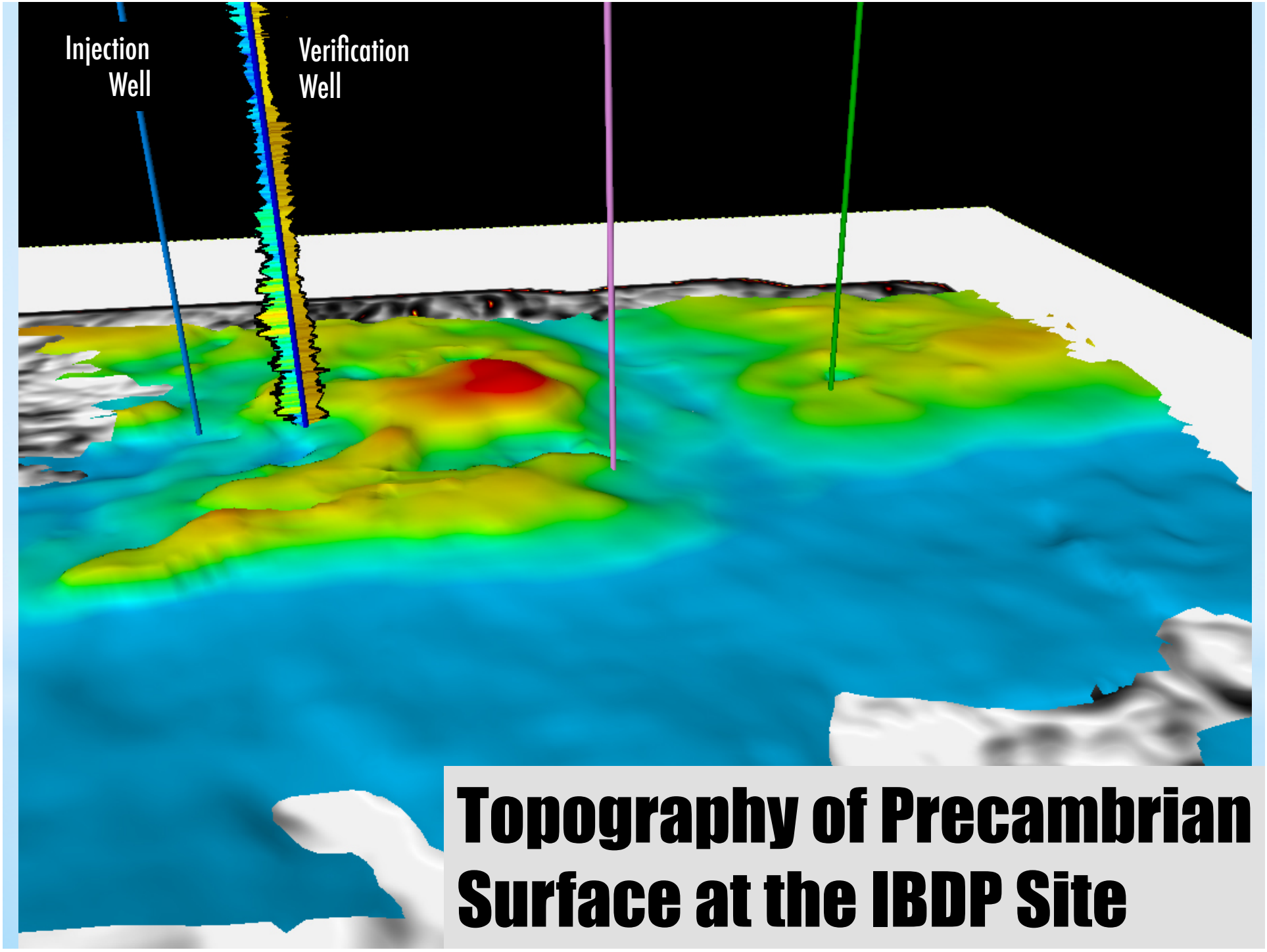
- **Lessons Learned**
  - Minimize non-native fluid movement into sampling zones from cross-zone flow, well circulation, and completion fluids
  - Select field/lab tests and purge adequate volumes to ensure sample integrity

Baseline 3D Geophysical Survey Completed January 2010



Topography Influences CO_2 Movement





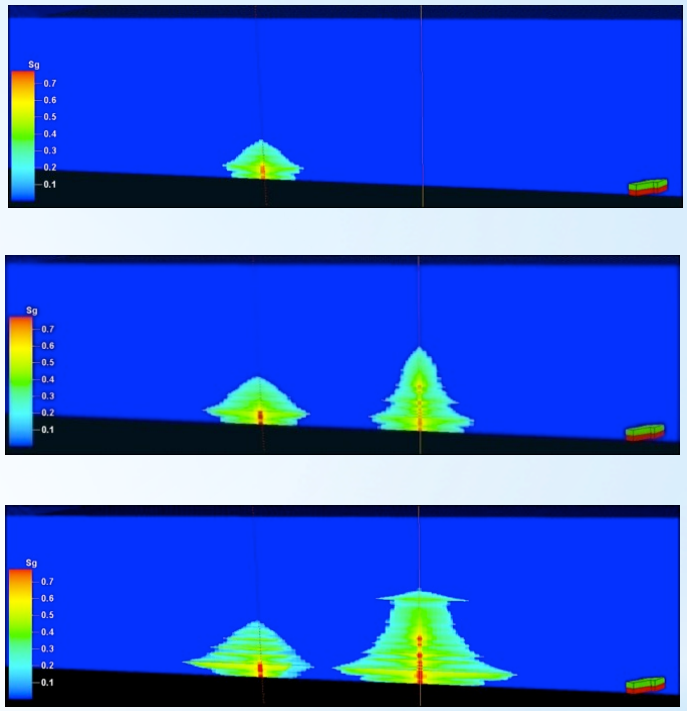
Topography of Precambrian Surface at the IBDP Site

Testing Injections at Scale

- A second project in Decatur, the Illinois Industrial CCS (IL-ICCS) project is underway (2010-2015) using rates and injected masses greater than IBDP with some overlap in injection operations.

- IL-ICCS will test CCS injections on a scale similar a commercial coal-fired power plant to assess pressure distribution, plume interaction, and reservoir and seal performance.

- Commercial scale operations of one million tonnes per year will be achieved.



IBDP and ICCS Plume Development

Key Points

- For early implementation stages of field projects, it is very important to integrate new field data into models quickly and communicate changes in model predictions (e.g., rates of CO_2 migration) across the team so project activities can adapt as needed.

- IBDP is a fully integrated CCS demonstration with a compression-dehydration facility, 1,950 m (6,400 ft) pipeline delivering supercritical CO_2 to the injection well, and a comprehensive MVA program involving ~20 different monitoring methods/technologies.

- IBDP is the product of more than four years of effort from many people. Efforts include: site characterization, permitting, 5,500 m (17,900 ft) of drilling, reservoir modeling, engineering, geophysics, risk assessment, outreach, and baseline monitoring.

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Midwest Geological
Sequestration Consortium
www.sequestration.org

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2012
MIDWEST CARBON SEQUESTRATION
SCIENCE CONFERENCE

The Midwest Geological Sequestration Consortium (MGSC), one of the US Department of Energy Regional Carbon Sequestration Partnerships, the Sequestration Training and Education Program (STEP), and Schlumberger Carbon Services are hosting a knowledge sharing event at the Illinois Basin-Decatur Project (IBDP).

SAVE THE DATE!

September 17 – 19, 2012
Champaign, IL USA

This 2–day event features:
A full day of presentations on the IBDP 1-million tonne saline reservoir injection demonstration, including geology, geophysics, environmental monitoring, outreach/education, and compression/infrastructure. An optional visit to the Project site at the Archer Daniels Midland Company in Decatur, Illinois will be offered.

A STEP developed educational opportunity will be available to all attending.

Networking opportunities including an opening mixer, conference reception and dinner, and meeting lunches.

MGSC

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