



The Path to a 1-Million Tonne Demonstration of Carbon Sequestration from a Biofuel Source: The Illinois Basin - Decatur Project

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Midwest Geological Sequestration Consortium

Illinois State Geological Survey

University of Illinois

November 16, 2011



**ILLINOIS STATE
GEOLOGICAL SURVEY**
PRAIRIE RESEARCH INSTITUTE

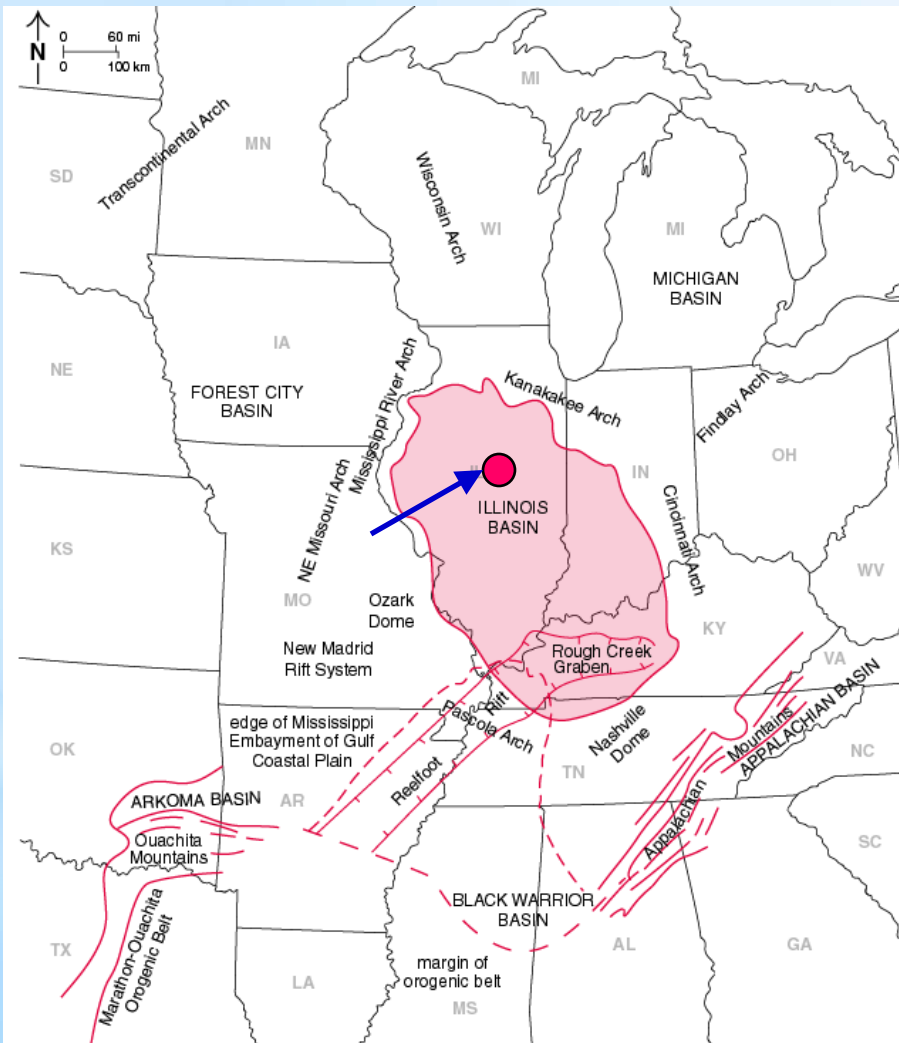


Acknowledgments

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- The [Midwest Geological Sequestration Consortium \(MGSC\)](#) is a collaboration led by the geological surveys of Illinois, Indiana, and Kentucky
- Landmark Graphics software via University Donation Program and Petrel software via Schlumberger Carbon Services



Illinois Basin - Decatur Project Scope

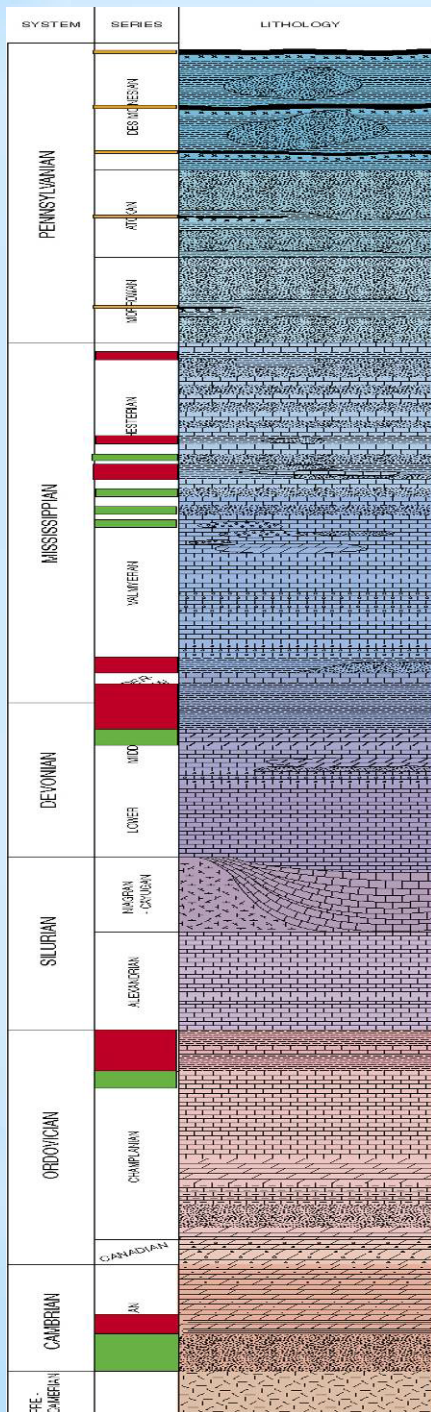


- A collaboration of the Midwest Geological Sequestration Consortium, the Archer Daniels Midland Company (ADM), Schlumberger Carbon Services, and other subcontractors to inject 1 million metric tons of anthropogenic carbon dioxide at a depth of 7,000 +/- ft (2,000 +/- m) to test **geological carbon sequestration in a saline reservoir** at a site in Decatur, Illinois

Key Points to Remember about the IBDP

- IBDP is the first demonstration-scale (1 million tonne) US project to use carbon dioxide (CO₂) from a man-made source within the DOE Regional Carbon Sequestration Partnership (RCSP) program
- IBDP is a fully integrated demonstration, from a compression-dehydration facility and a pipeline to delivery of supercritical CO₂ to a three-well injection and observation system on an intensely monitored site
- IBDP is the product of four years of effort, from date of funding to CO₂ in the reservoir, including site characterization, permitting, 17,900 ft of drilling, reservoir geology, engineering, and geophysics, risk assessment, outreach, and baseline monitoring

Illinois Basin Stratigraphic Column



Pennsylvanian coal seams

Mississippian sandstone and carbonate oil reservoirs

New Albany Shale

back-up seals

Maquoketa Shale

St. Peter Sandstone

Eau Claire Shale

seal

Mt. Simon Sandstone

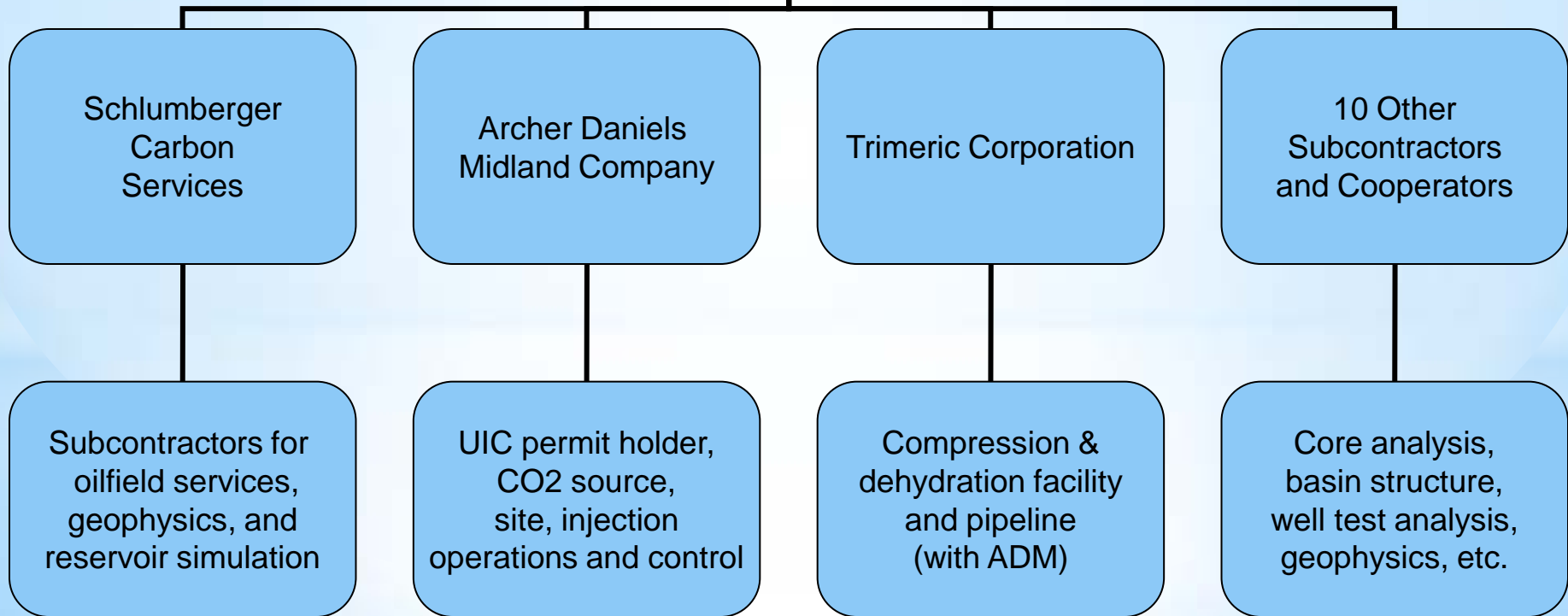
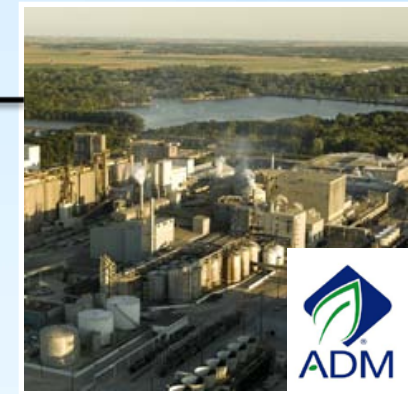
reservoir

Illinois Basin - Decatur Project

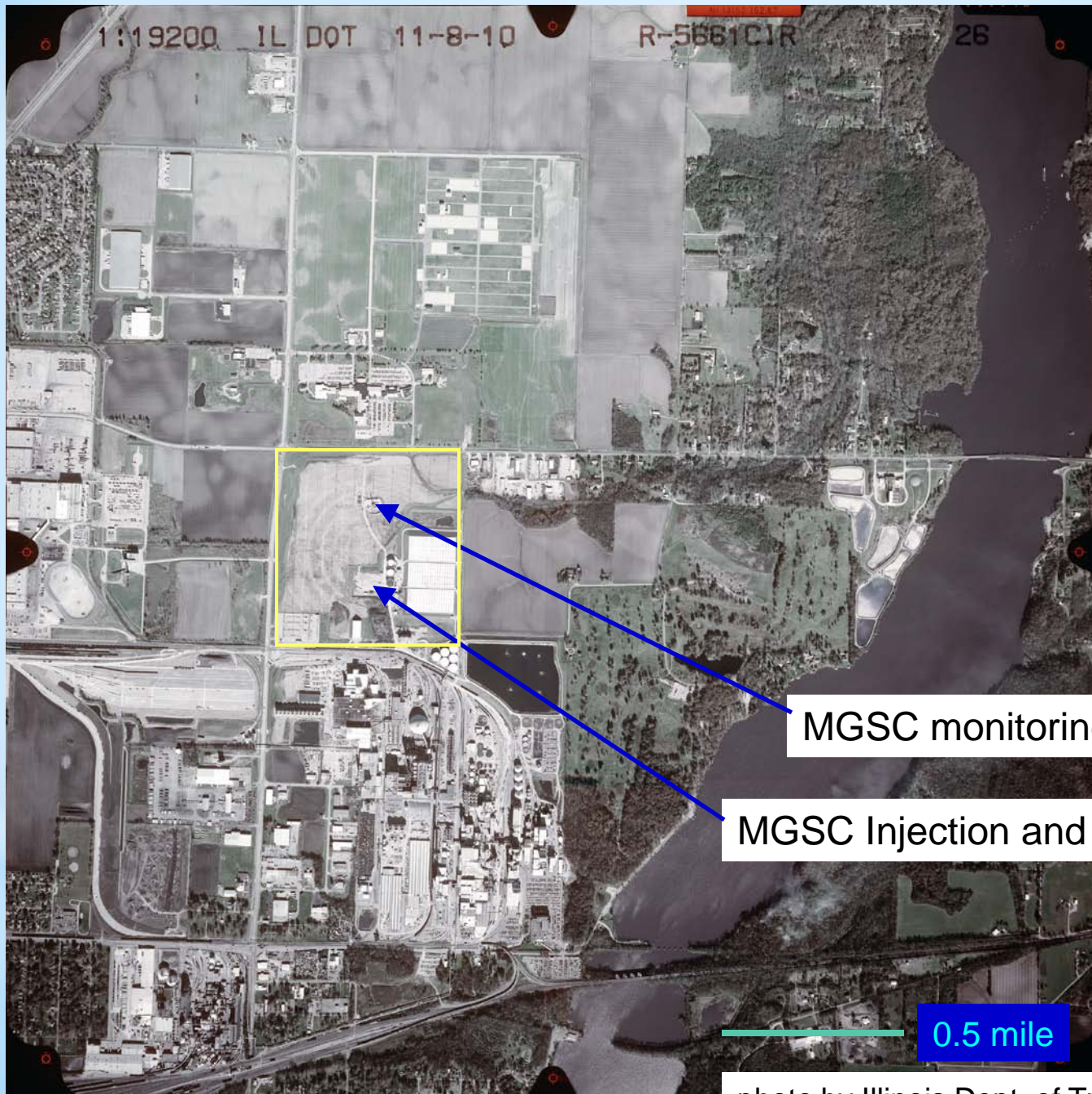
Major Project Elements

- UIC permitting: January 2008-ongoing
 - Application, hearing, minor modification, major modification
- Injection well drilled: February-May 2009
- Geophone well drilled: September-November 2009
- Baseline 3D seismic survey completed: January 2010
- Compression/dehy/pipeline facility: design, procure, construct, test: February 2009-October 2011
- Monitoring well drilled, completed: September-November 2010, March-June 2011
- Authorization to inject: November 2, 2011
- Initiated operational testing: November 4, 2011

Illinois Basin-Decatur Project Organization



**MGSC
Illinois
Basin-
Decatur
Project
(IBDP) Site**



MGSC monitoring well

MGSC Injection and geophone wells

0.5 mile

Illinois Basin- Decatur Project Site

(on ADM industrial site)

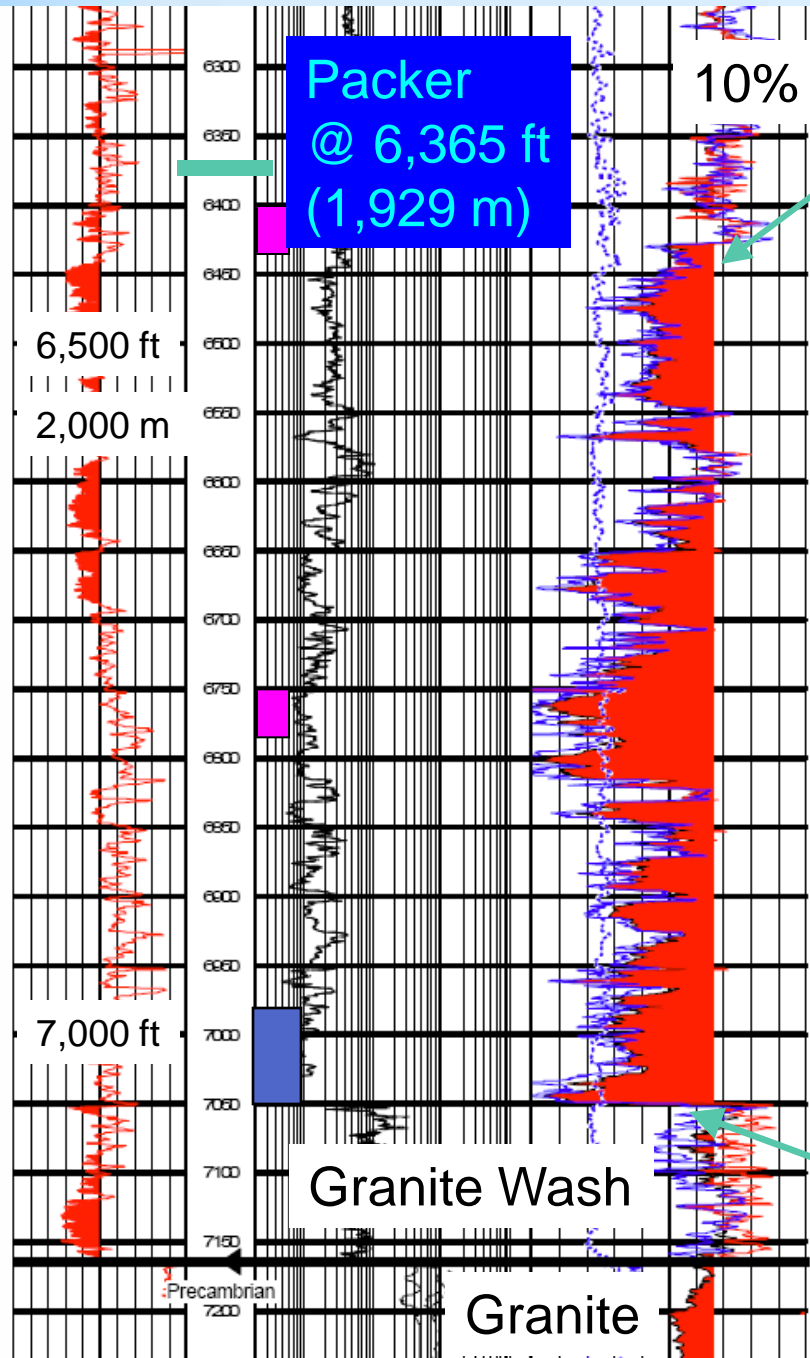
- **A** Dehydration/
compression facility
location
- **B** Pipeline route
- **C** Injection well site
- **D** Verification/
monitoring well site
- **E** Geophone well



**Injection Well Drilled to
7,230 ft (2,190 m)**

Completed May 4, 2009





Packer
@ 6,365 ft
(1,929 m)

10% Porosity Cutoff

Mt. Simon Core 6,404 – 6,433 feet

Injection Well Completion

Mt. Simon Core 6,751 – 6,780 feet

Perforations: 6,985 -7,015; 7,025 - 7,050
55 ft (16.7 m) open interval

Base of Mount Simon

Granite Wash

Granite

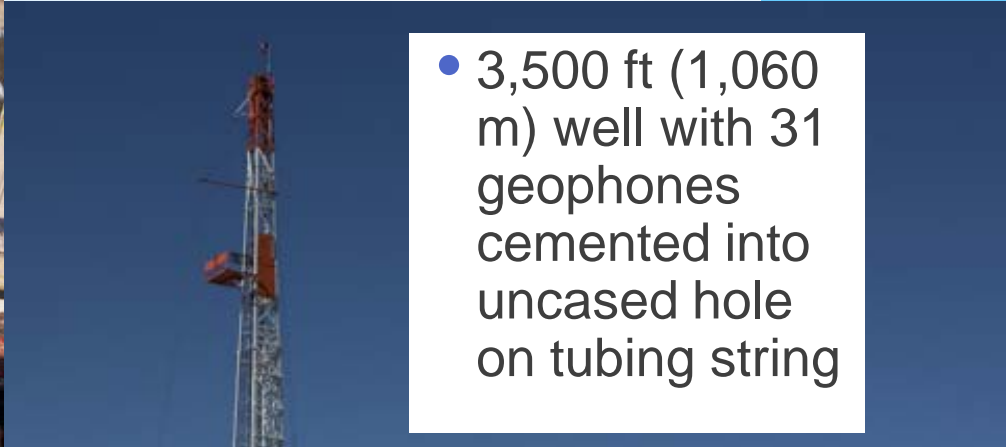
TD=7236

Geophone Well Completed November 2009

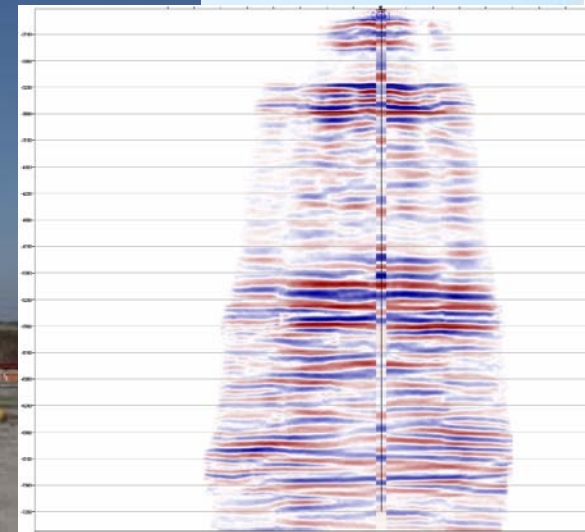
Geophone in special carrier strapped to 3.5 inch (8.9 cm) tubing



- 3,500 ft (1,060 m) well with 31 geophones cemented into uncased hole on tubing string



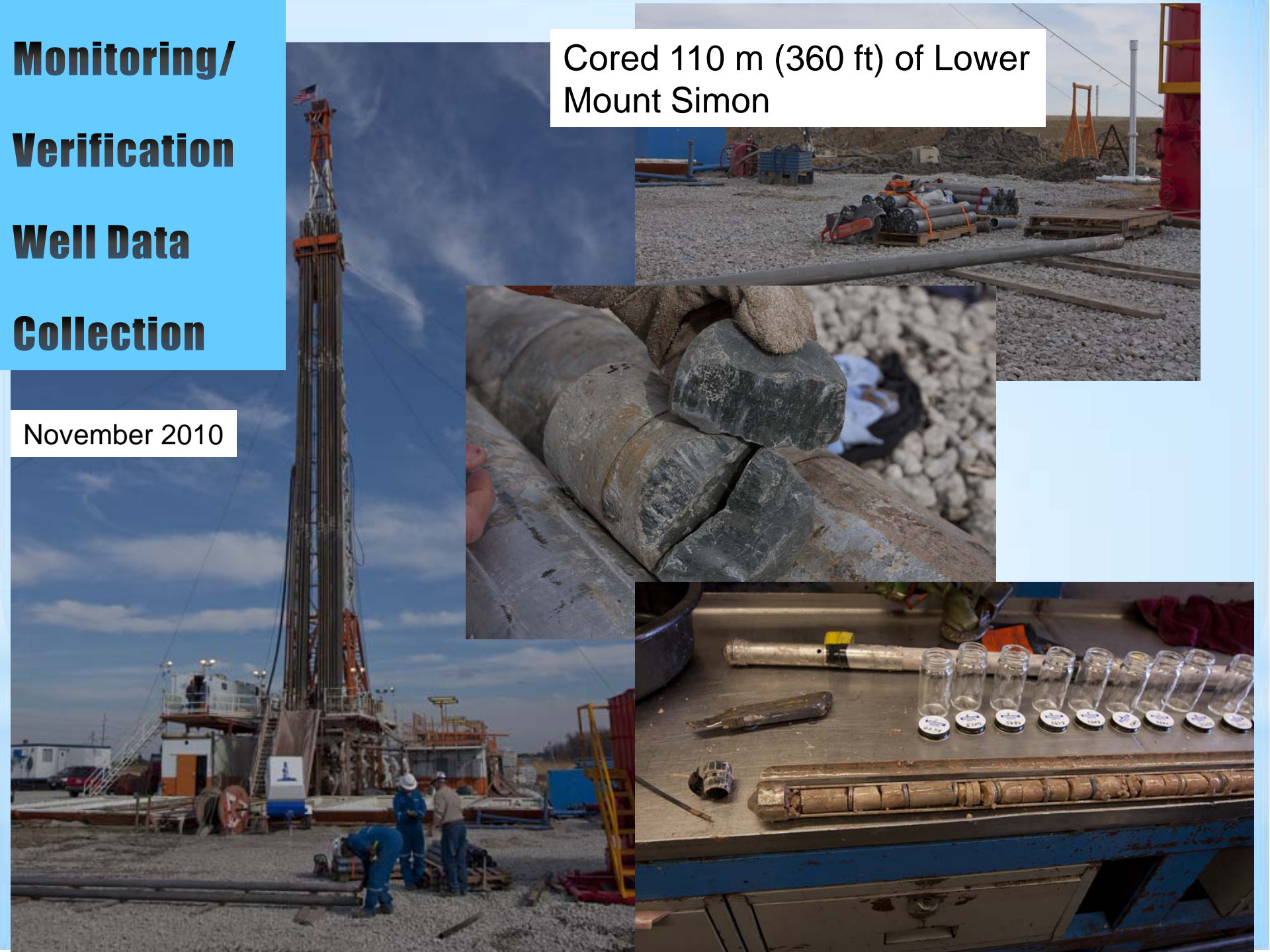
Injection Well



**Monitoring/
Verification
Well Data
Collection**

Cored 110 m (360 ft) of Lower
Mount Simon

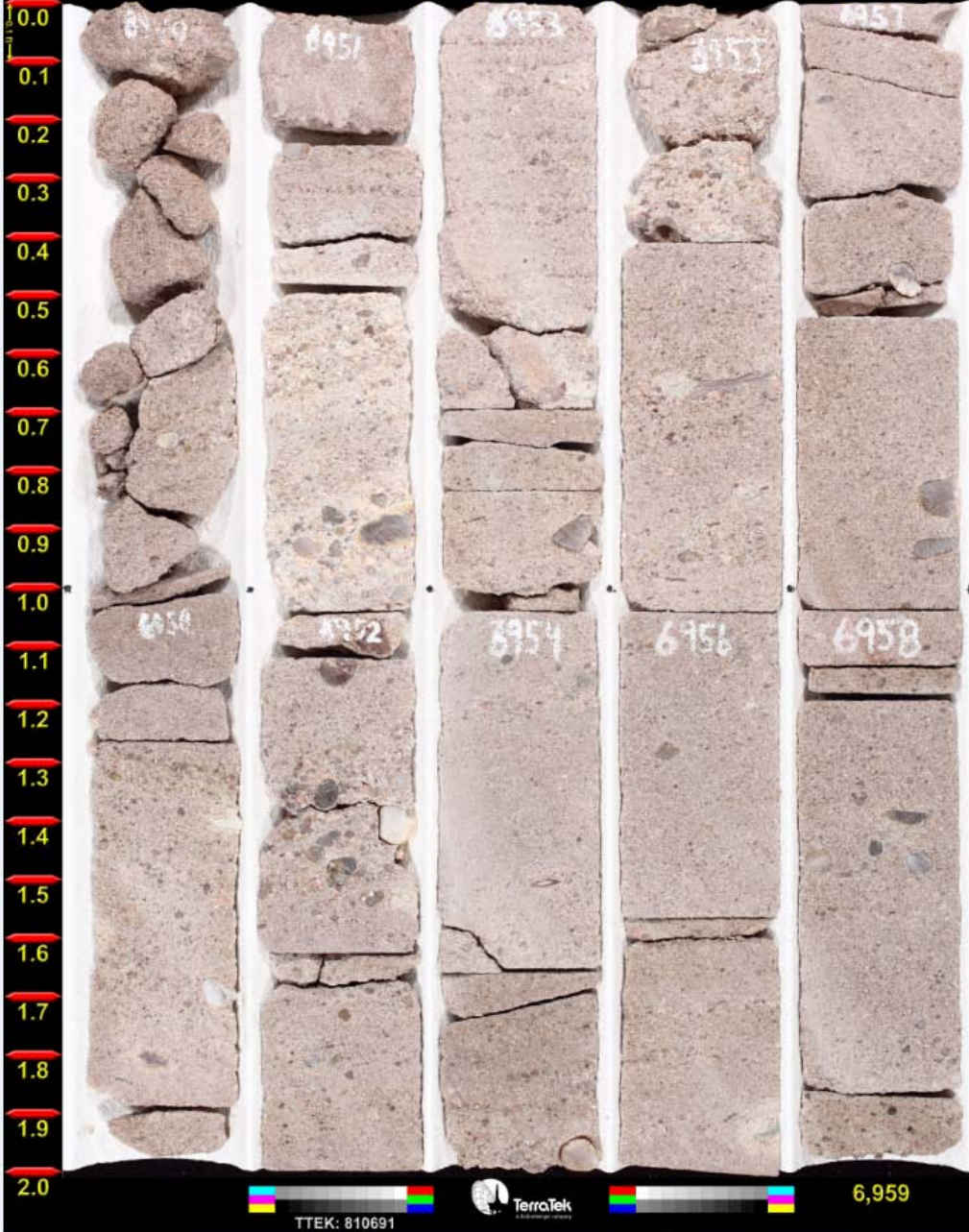
November 2010



SLB Carbon Services
ADM Verification Well 1

6,949

Core 14



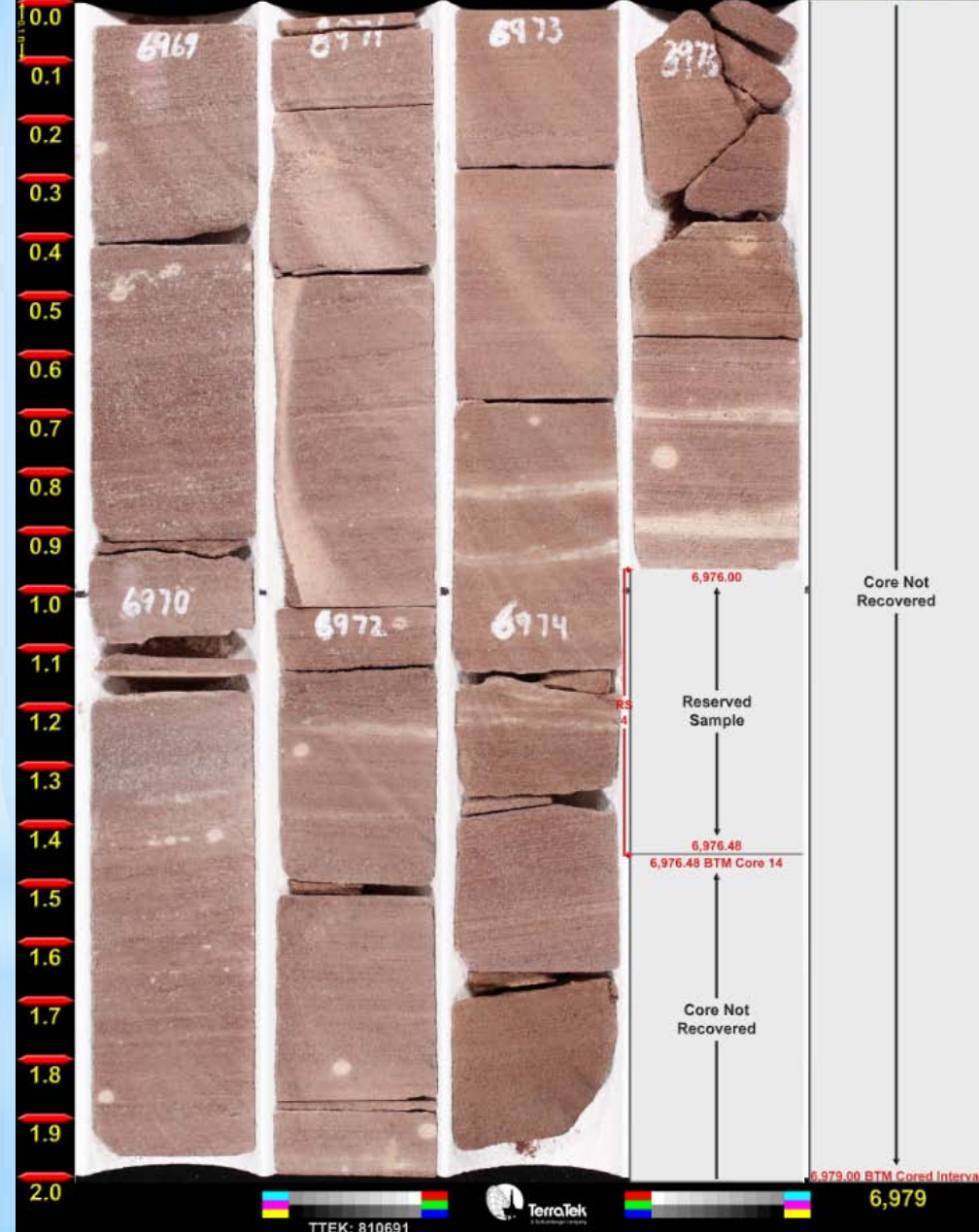
Core Equivalent to Upper Perforated Interval



Porosity = 17%
Perm = 193 md

6,969

Core 14



Core Equivalent to Lower Perforated Interval



Porosity = 22%
Perm = 144 md

January 2010



Injection Wellhead Installed and Pipeline Constructed

February 2011

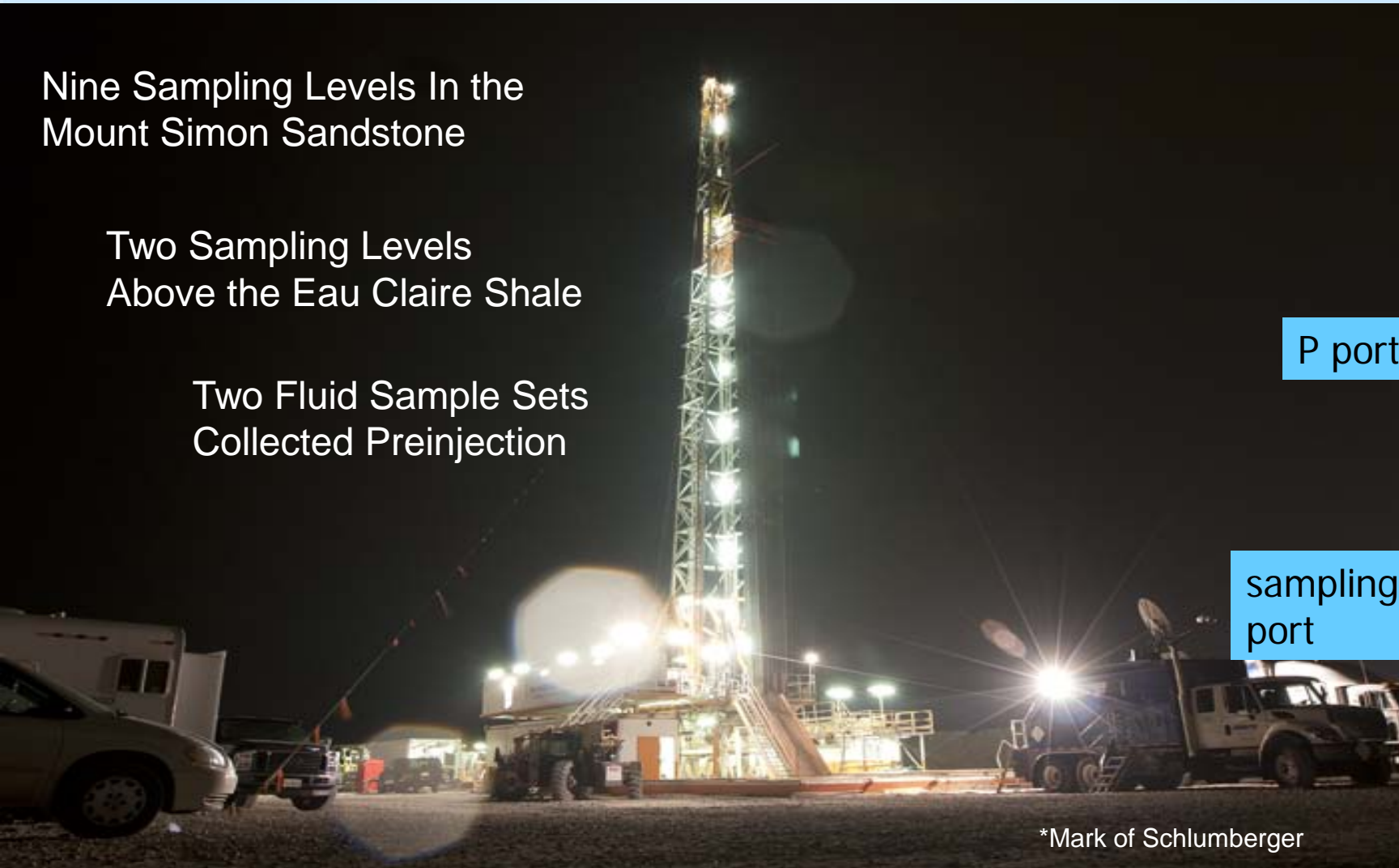


Schlumberger Westbay* System First-in-the-World Deployment at 7,000 ft+ for Eleven Sampling Levels

Nine Sampling Levels In the
Mount Simon Sandstone

Two Sampling Levels
Above the Eau Claire Shale

Two Fluid Sample Sets
Collected Preinjection



P port

sampling port



*Mark of Schlumberger

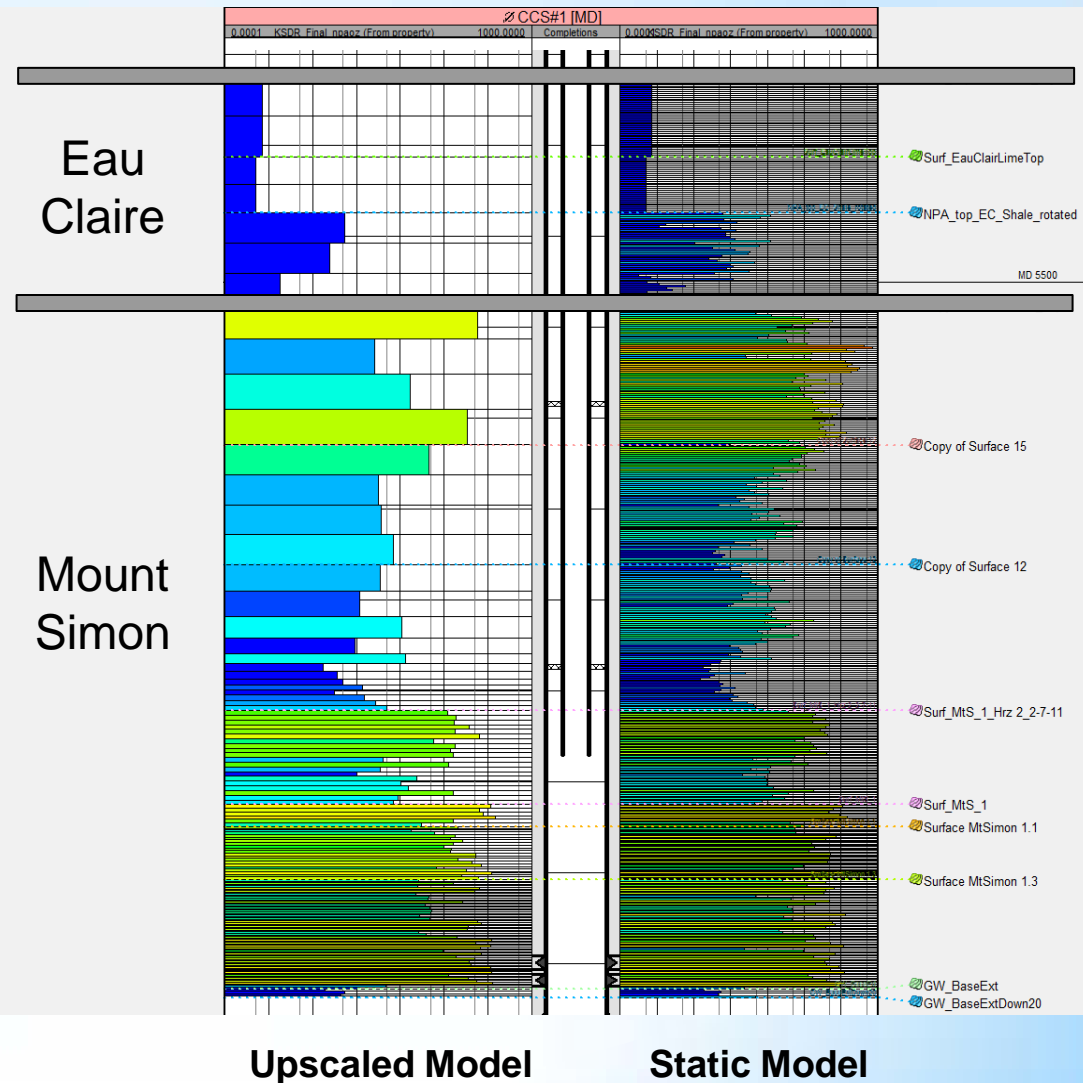
Westbay Installation and Sampling



IBDP Model development

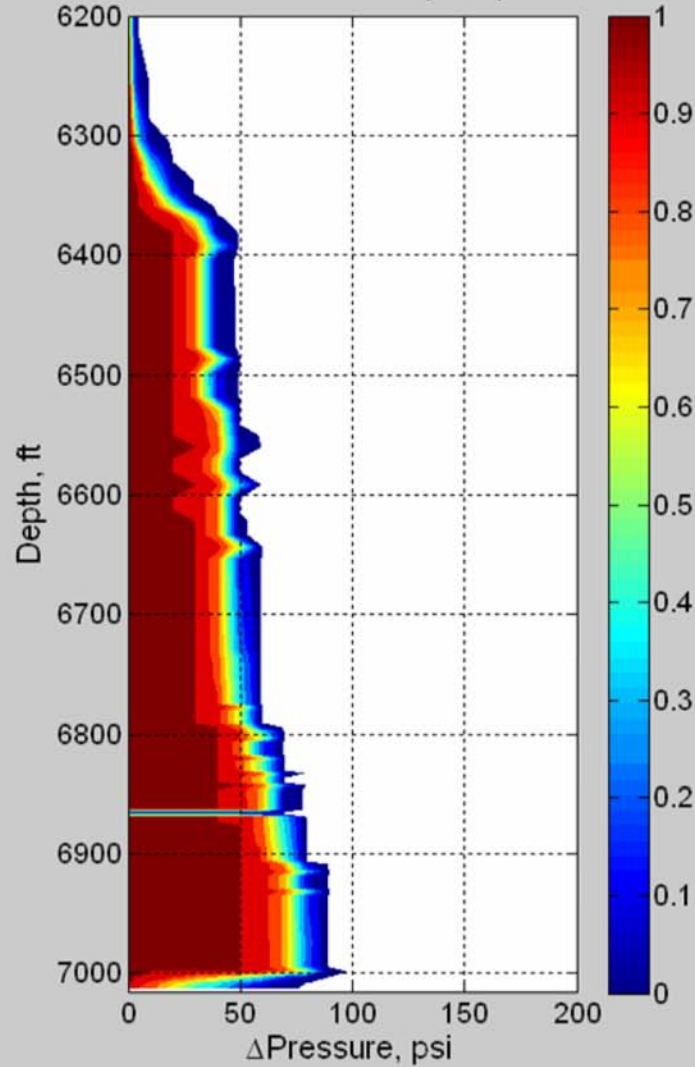
Upscaling to Build Model

- Reservoir Model:
 - 20 × 20 mile
 - 143 × 143 × 148
~ 3 million Cells
 - 50ft to 1500ft lateral cells

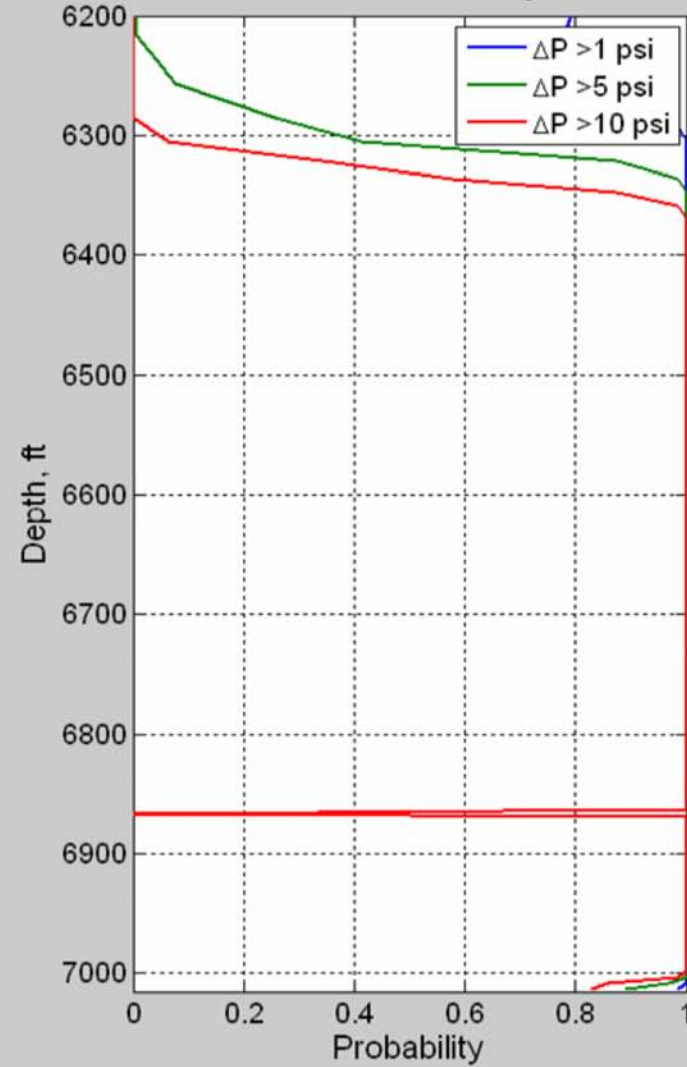


Verification Well at One Month

Verification Well 1: Probability Map at 1 months

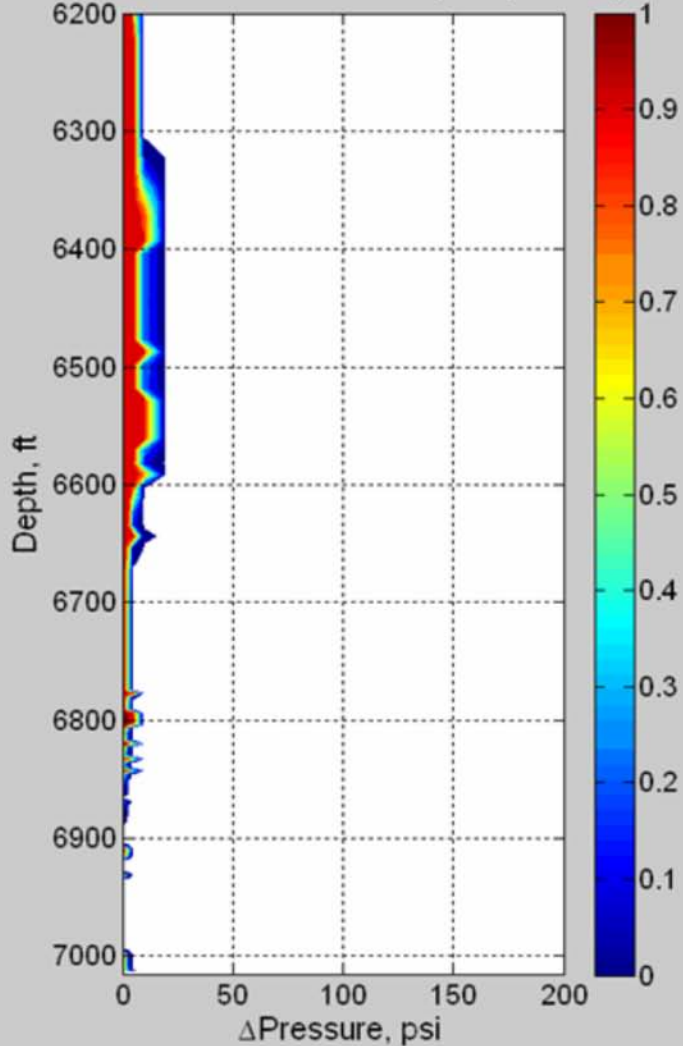


Measurement Screening Chart

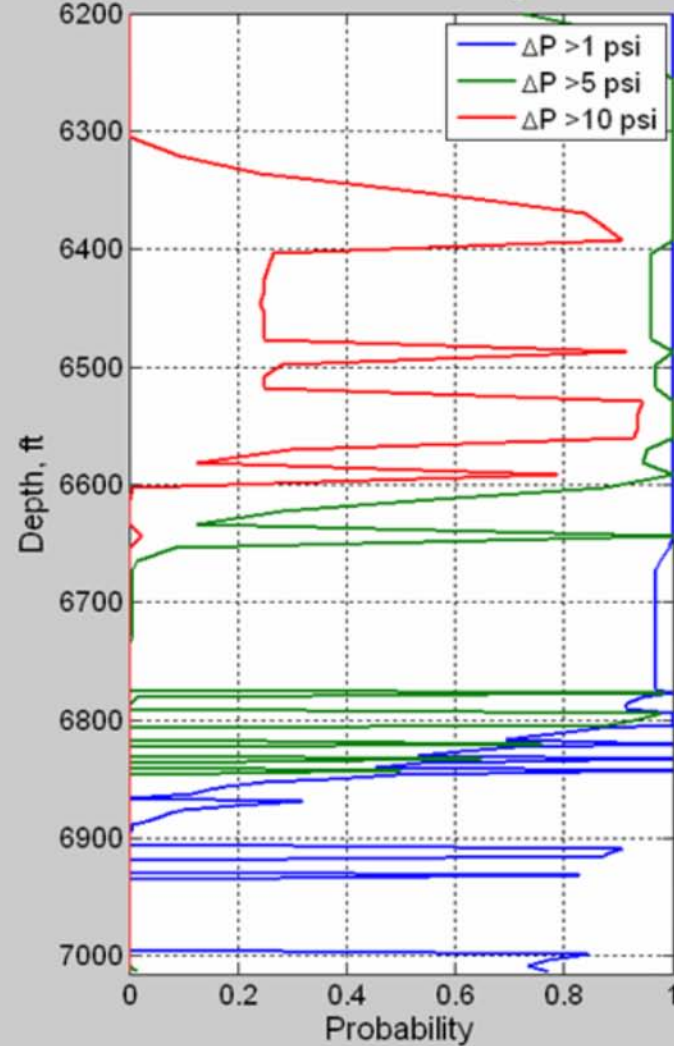


Verification Well at 10 Years

Verification Well 1: Probability Map at 10 yrs



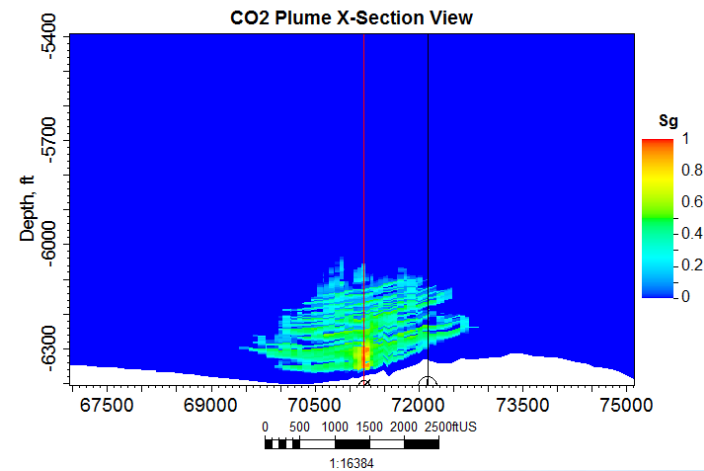
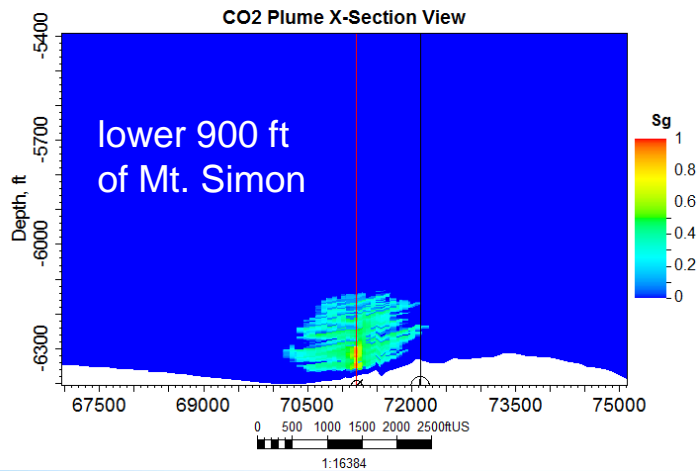
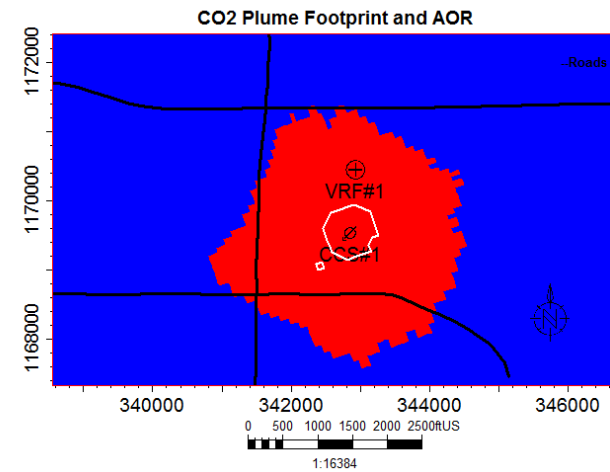
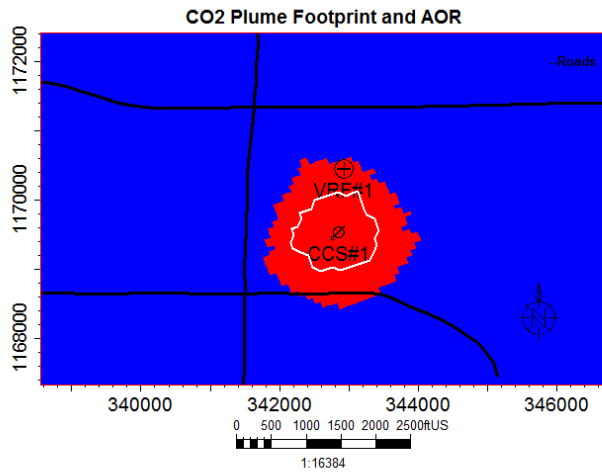
Measurement Screening Chart



IBDP - CO₂ Plume & Pressure Pulse Evolution

1 Year

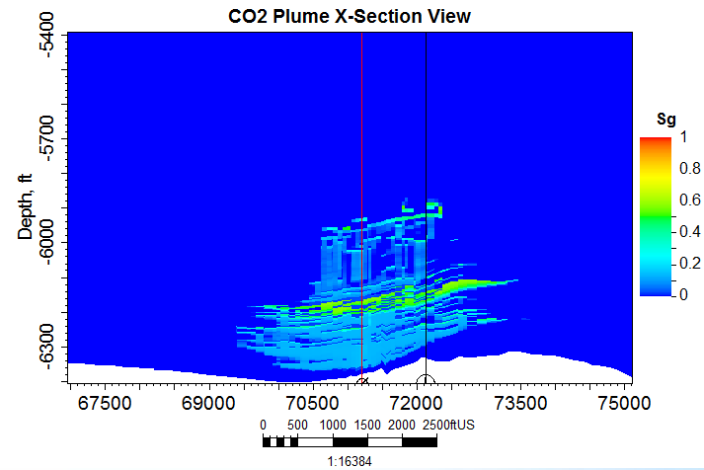
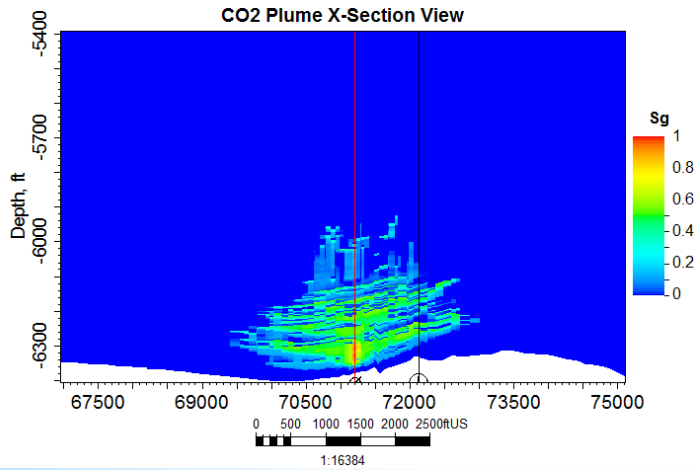
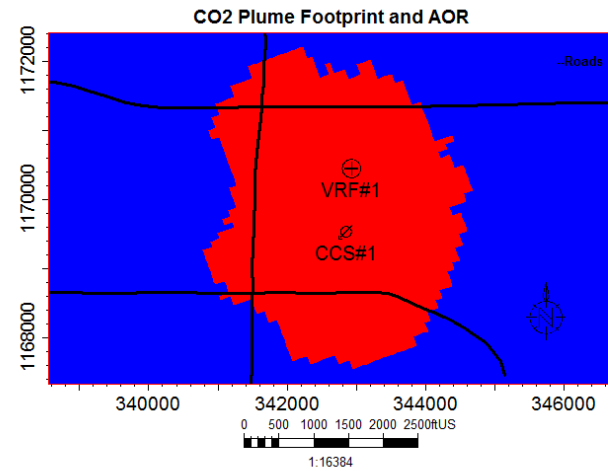
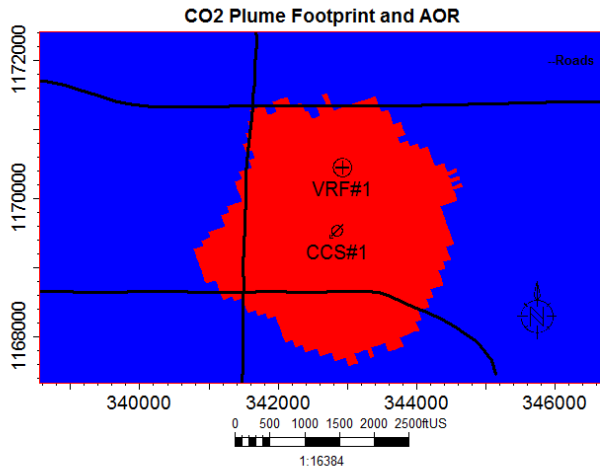
3 Years



IBDP - CO₂ Plume & Pressure Pulse Evolution

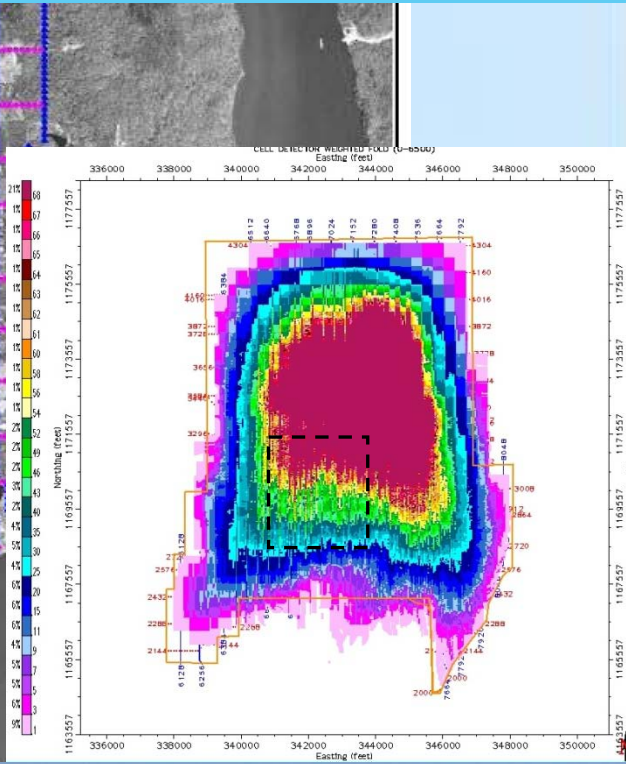
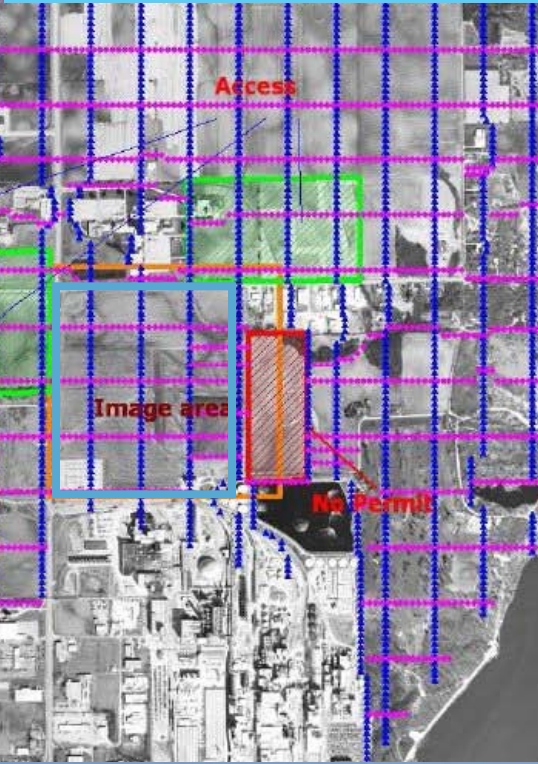
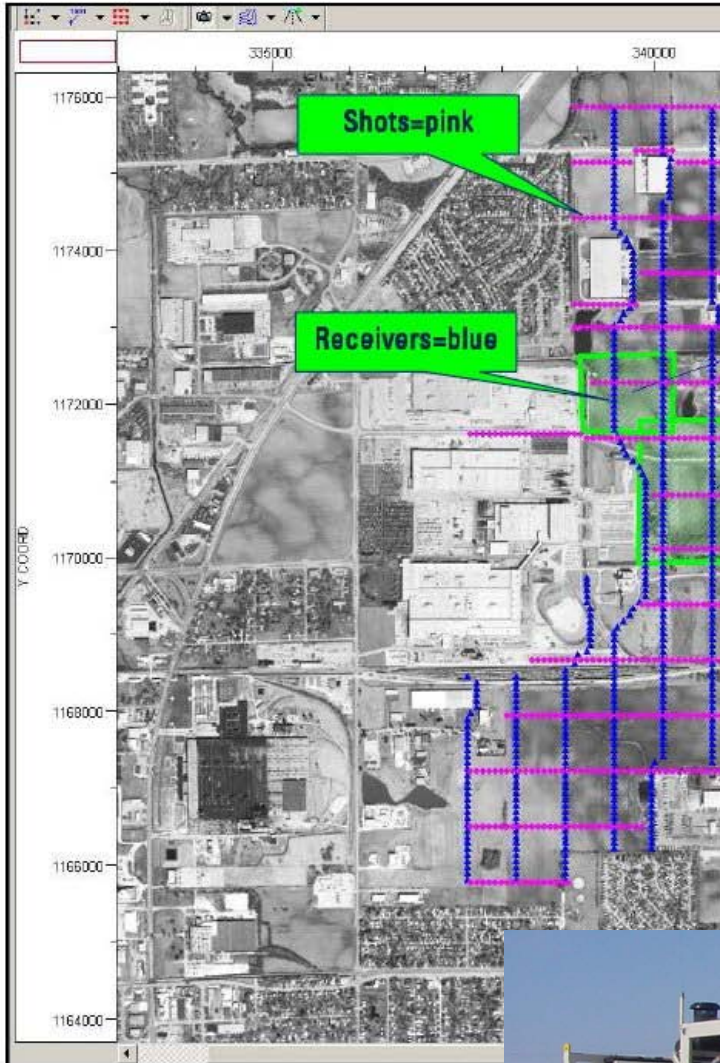
10 Years

50 Years

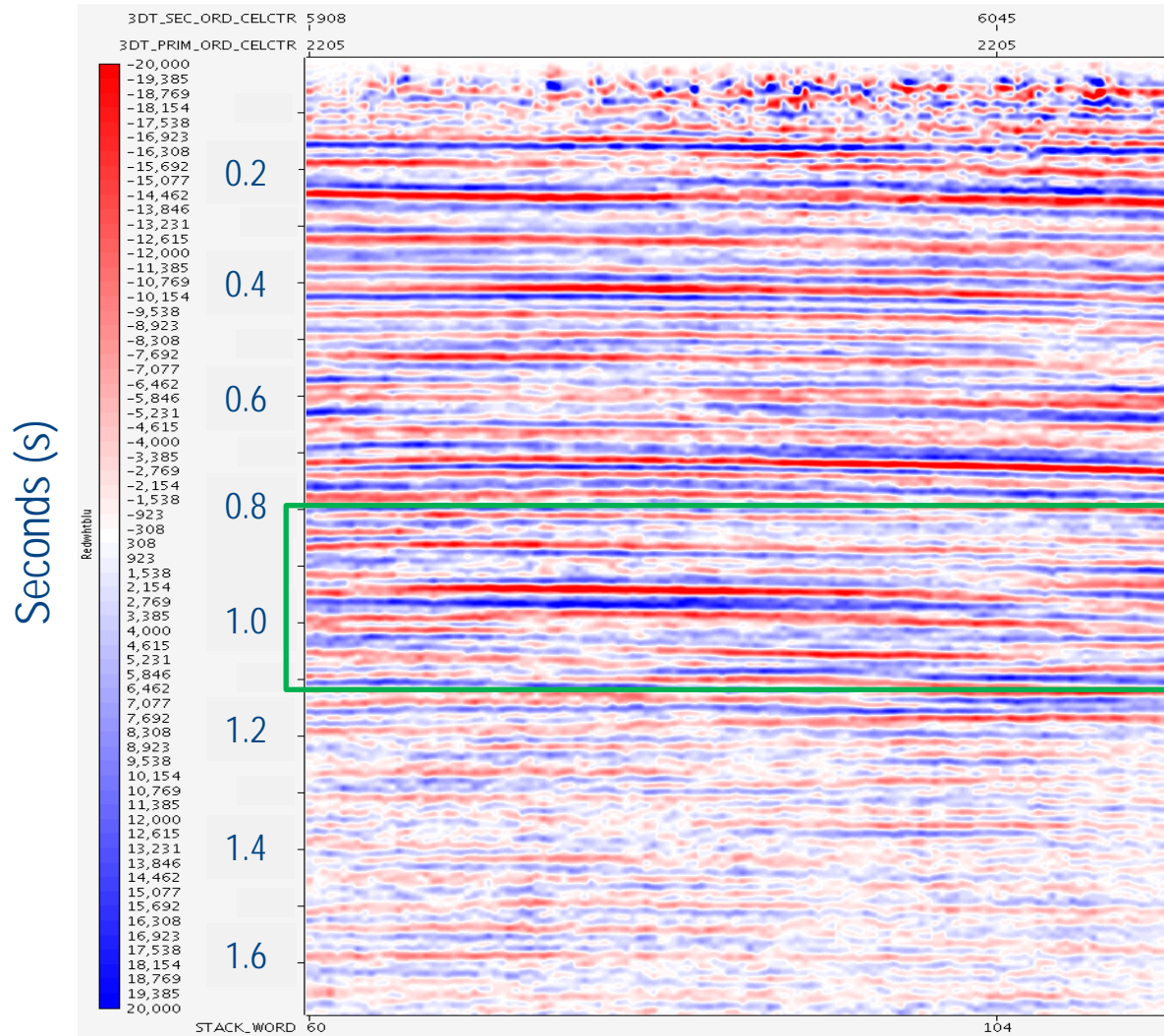


Baseline 3D Geophysical Survey

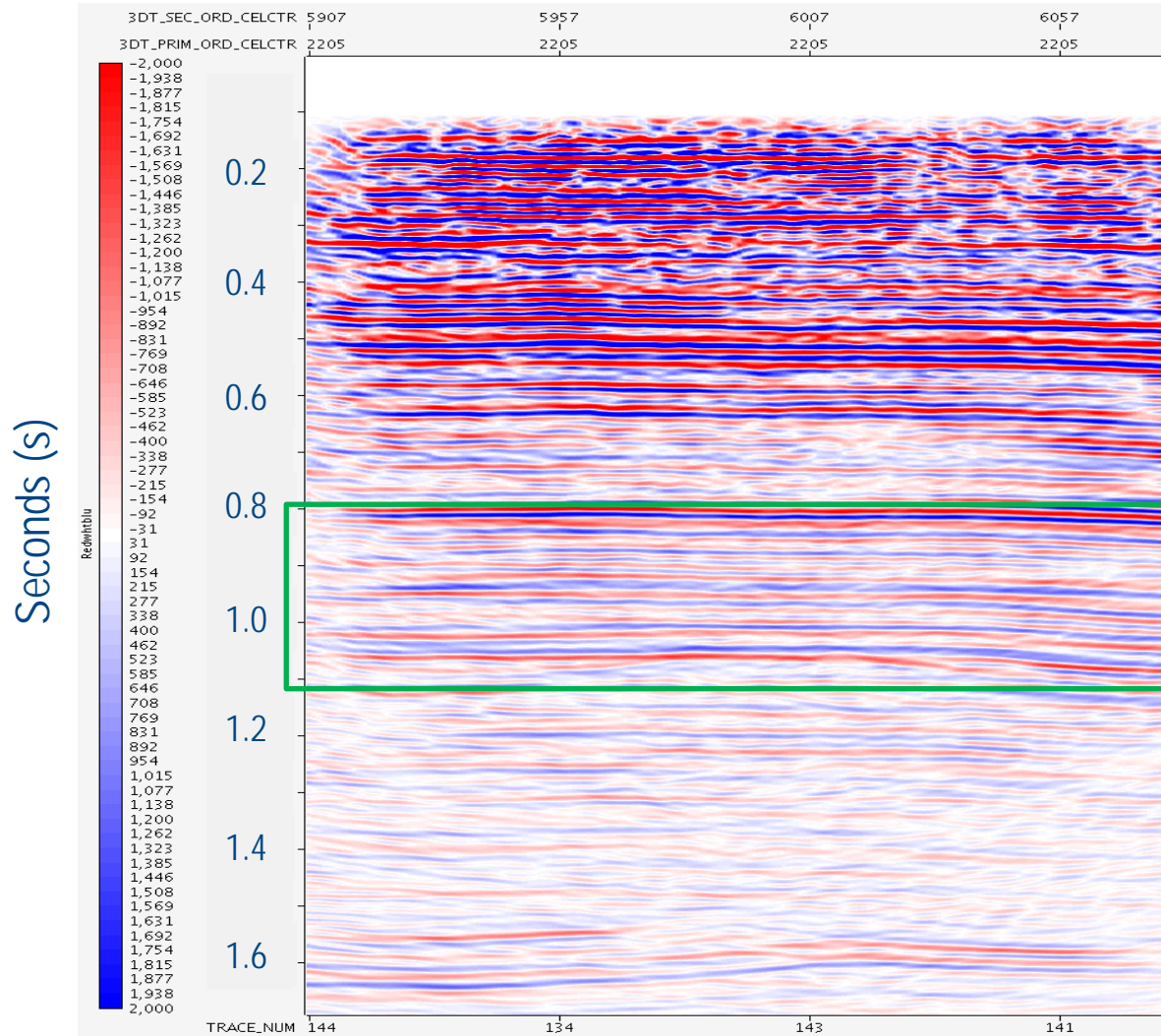
Completed January 2010



Data Comparisons: Legacy 2D Line 17



Data Comparisons: Q-Land 3D Crossline

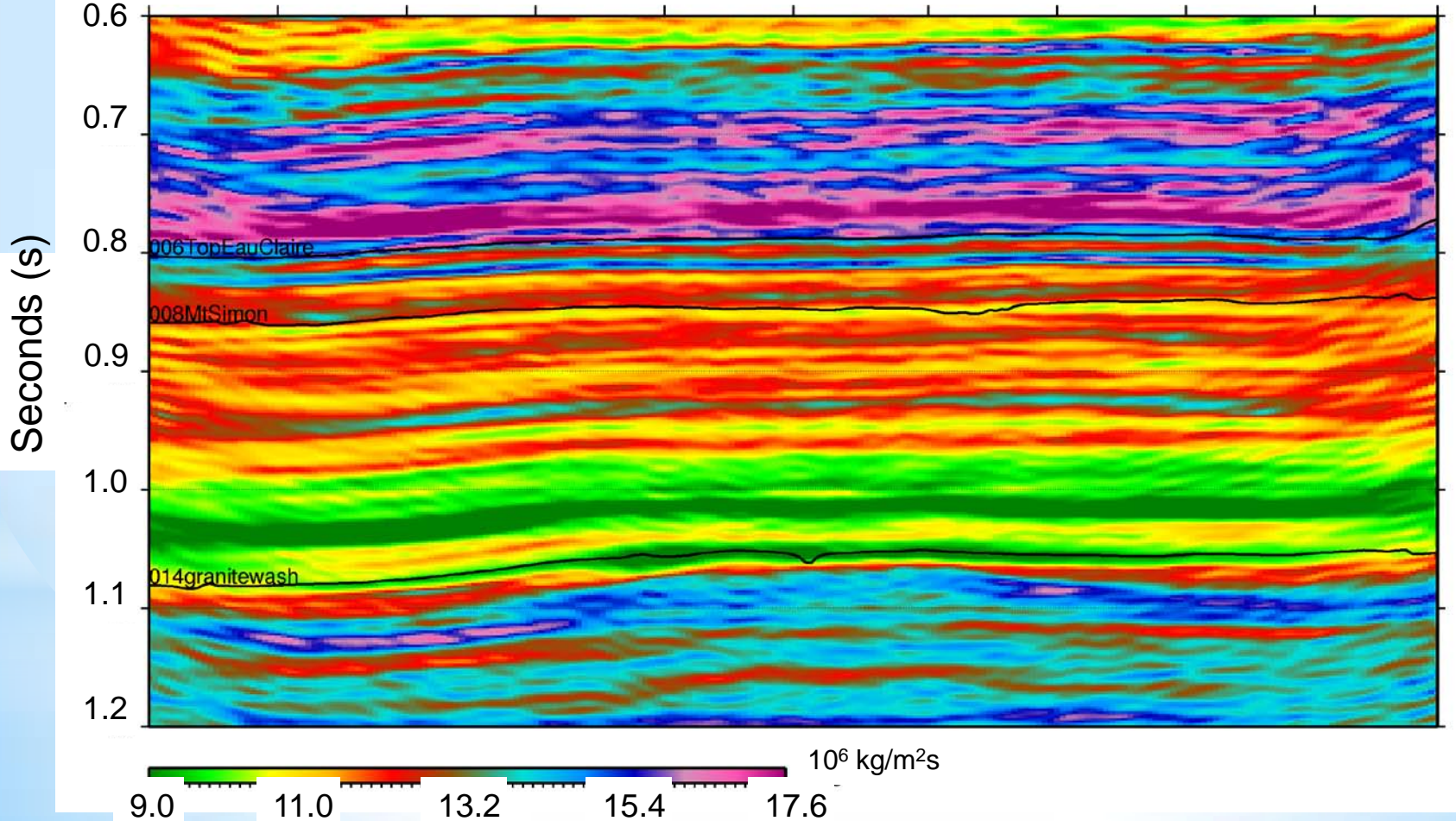


Inversion Analysis: 3D X-line 2203

Acoustic Impedance

3D.run01_9deg_abs_RATT0.0015_M4.r2zp.acoustic impedance.X-line.2203

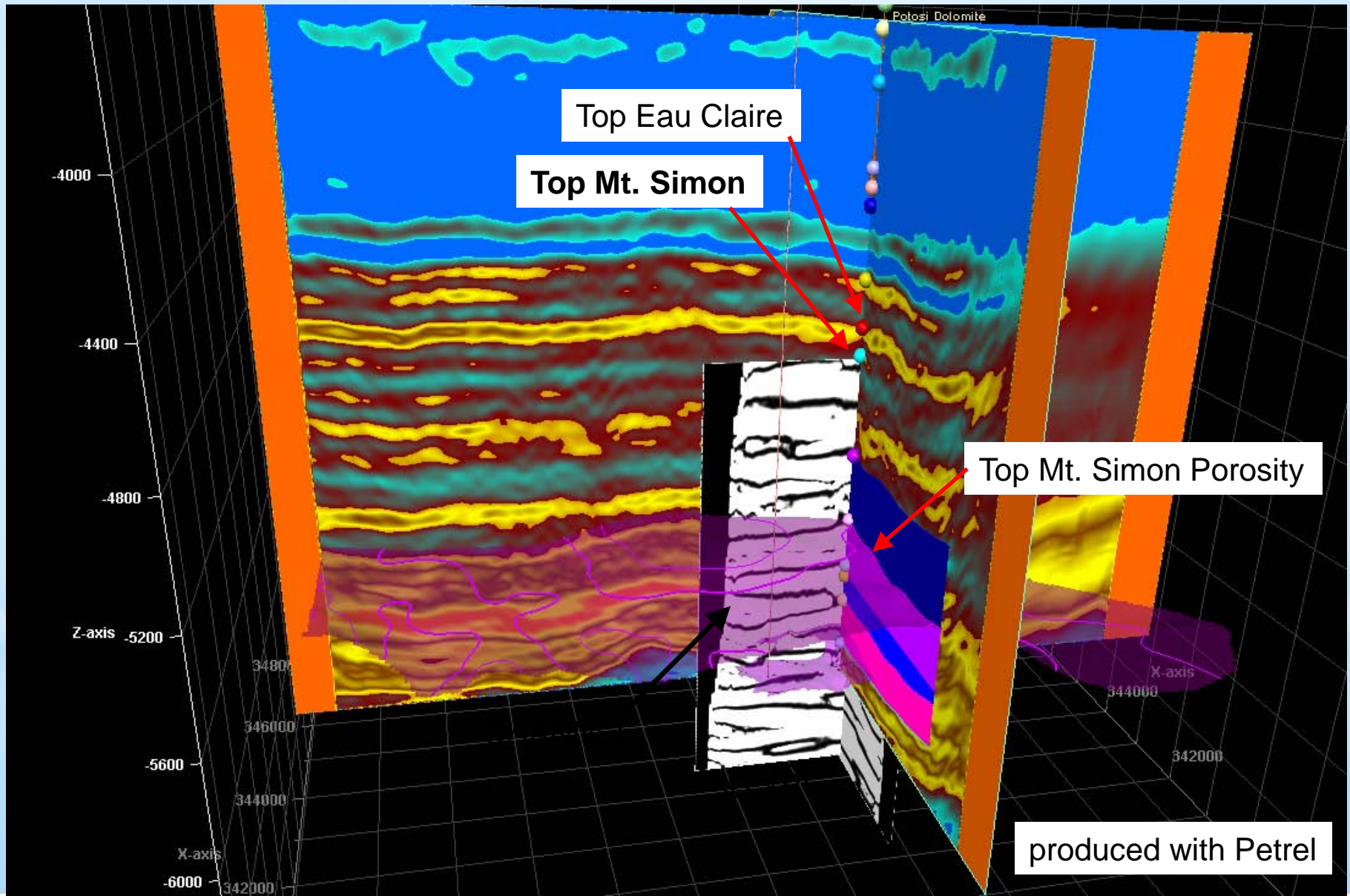
In-line 6110 6089 6068 6047 6026 6005 5983 5962 5941 5920 5900
X "---- 2203 2203 2203 2203 2203 2203 2203 2203 2203 2203



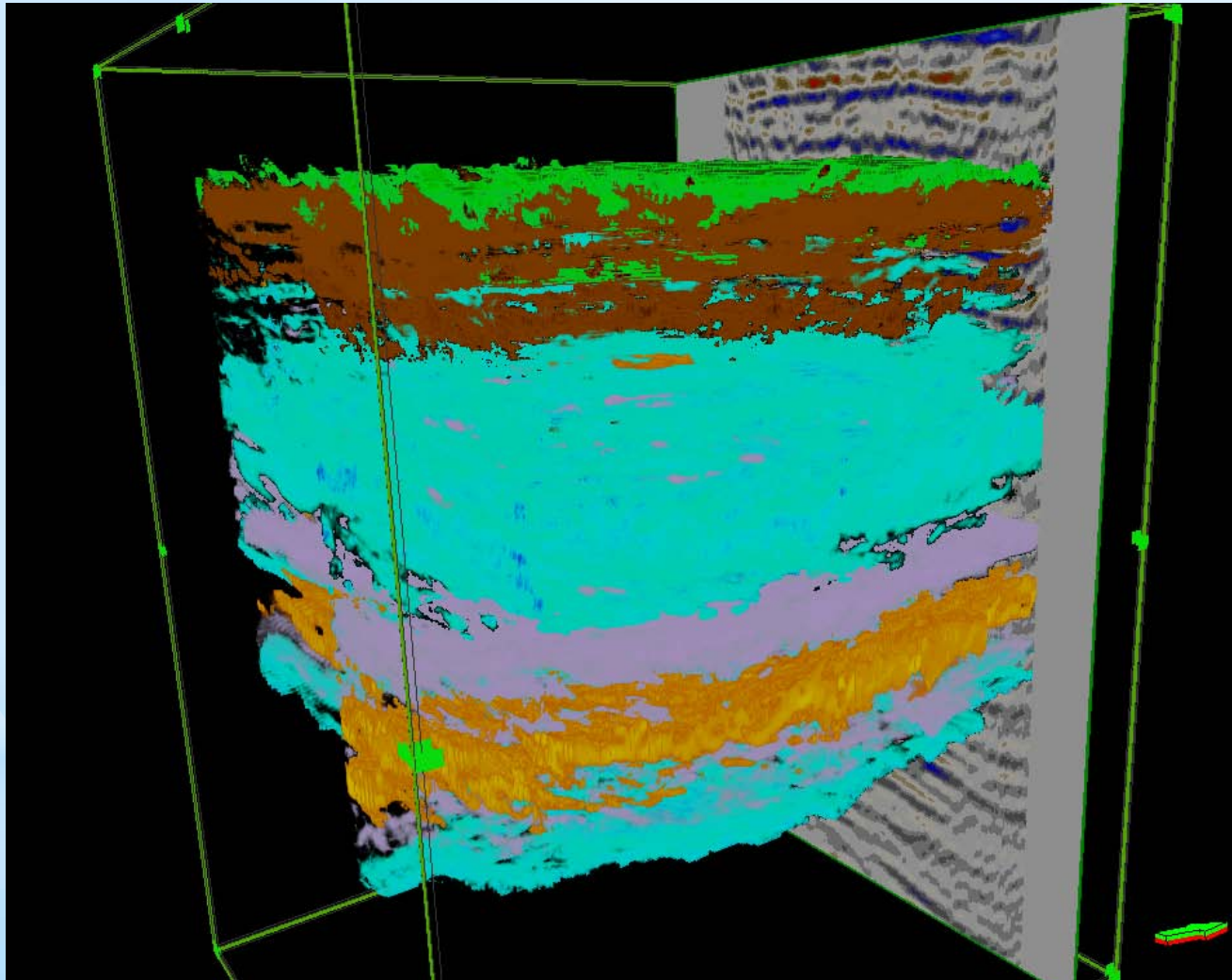
(Interpretation by H. Leetaru)

Courtesy of Schlumberger Carbon Services

Acoustic Impedance Model



Inversion Analysis: Lithology Distribution



- Limestone
- >20% sandstone
- Shale
- 10 - 20% sandstone
- <10% sandstone

Enviromental Monitoring

Soil flux



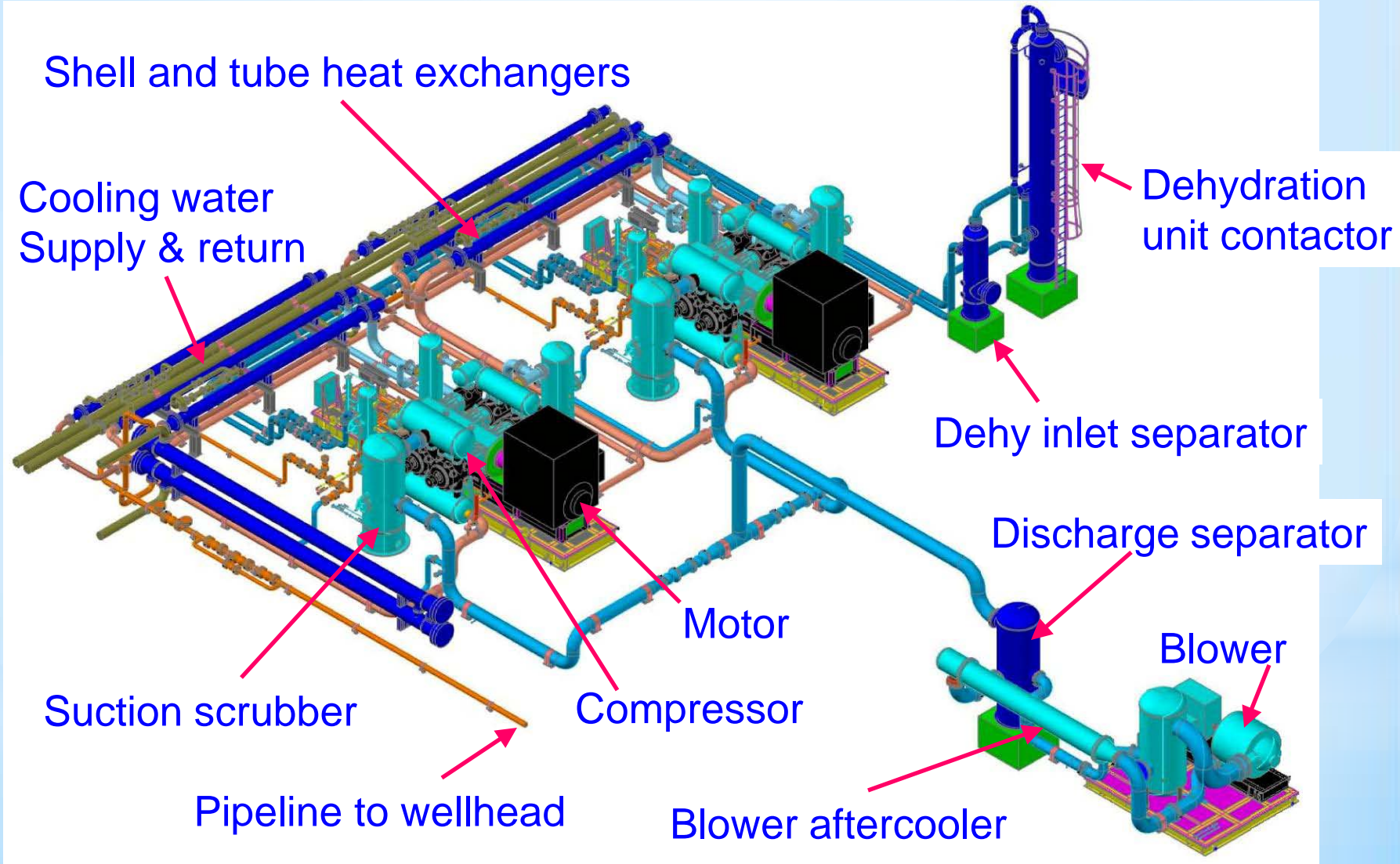
Satellite interferometry



Groundwater



Dual 550 TPD Reciprocating Compressors with Dehydration



Feed Blower, Glycol Regenerator, and High-Pressure Pump



Compressor Installation



December 2010

Compressor, Motor, Heat Exchangers

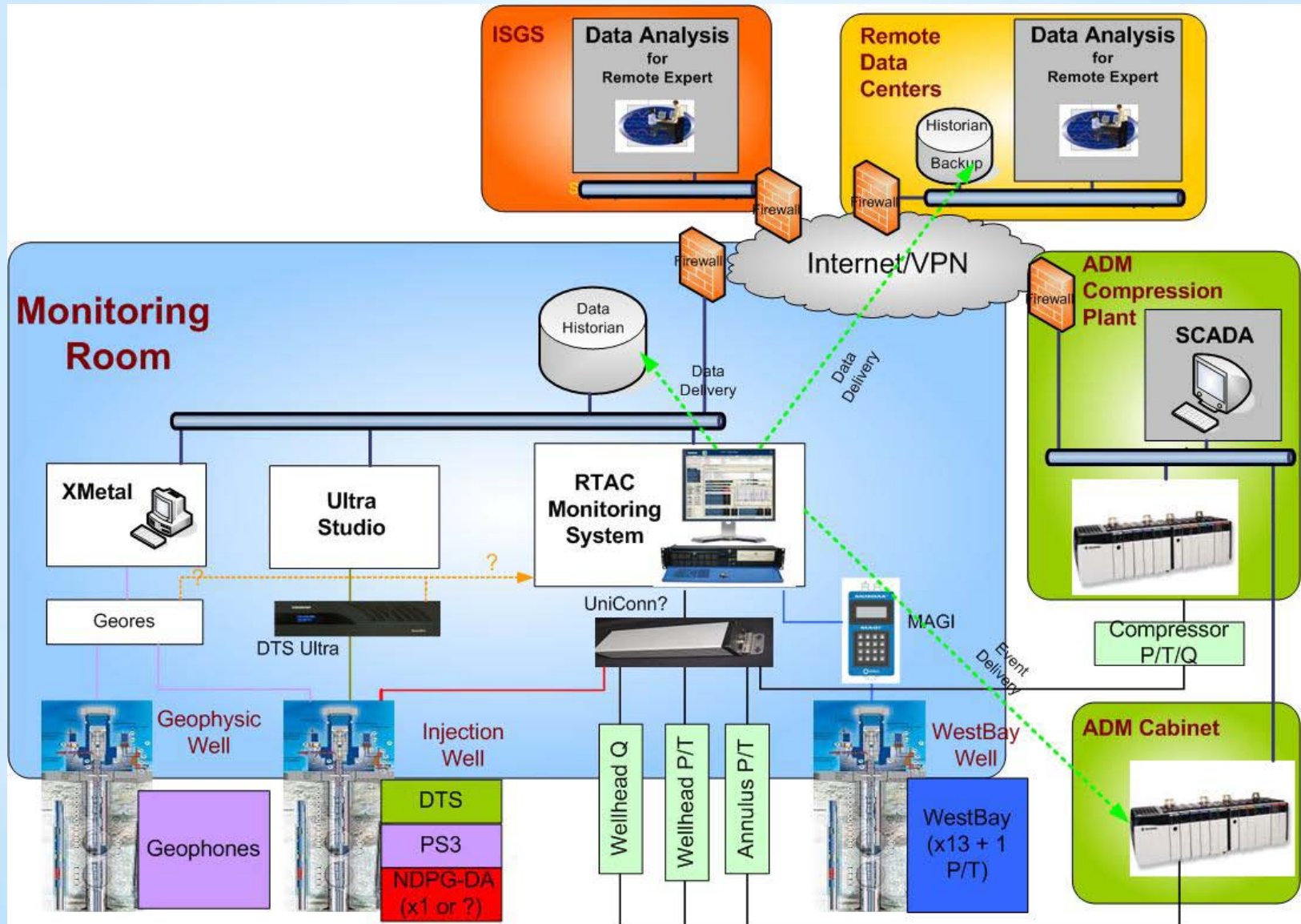


October 2011

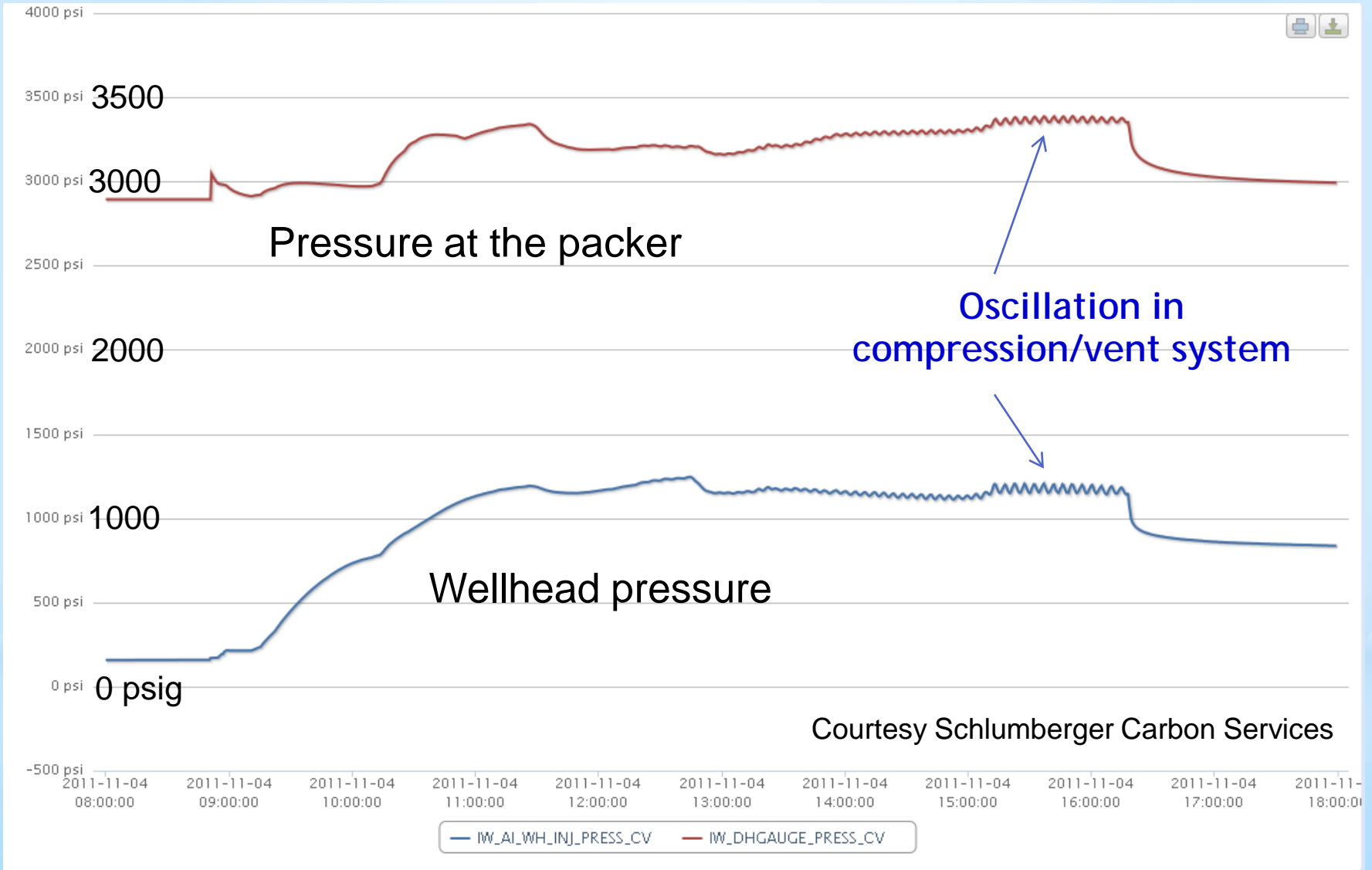


Data Collection System

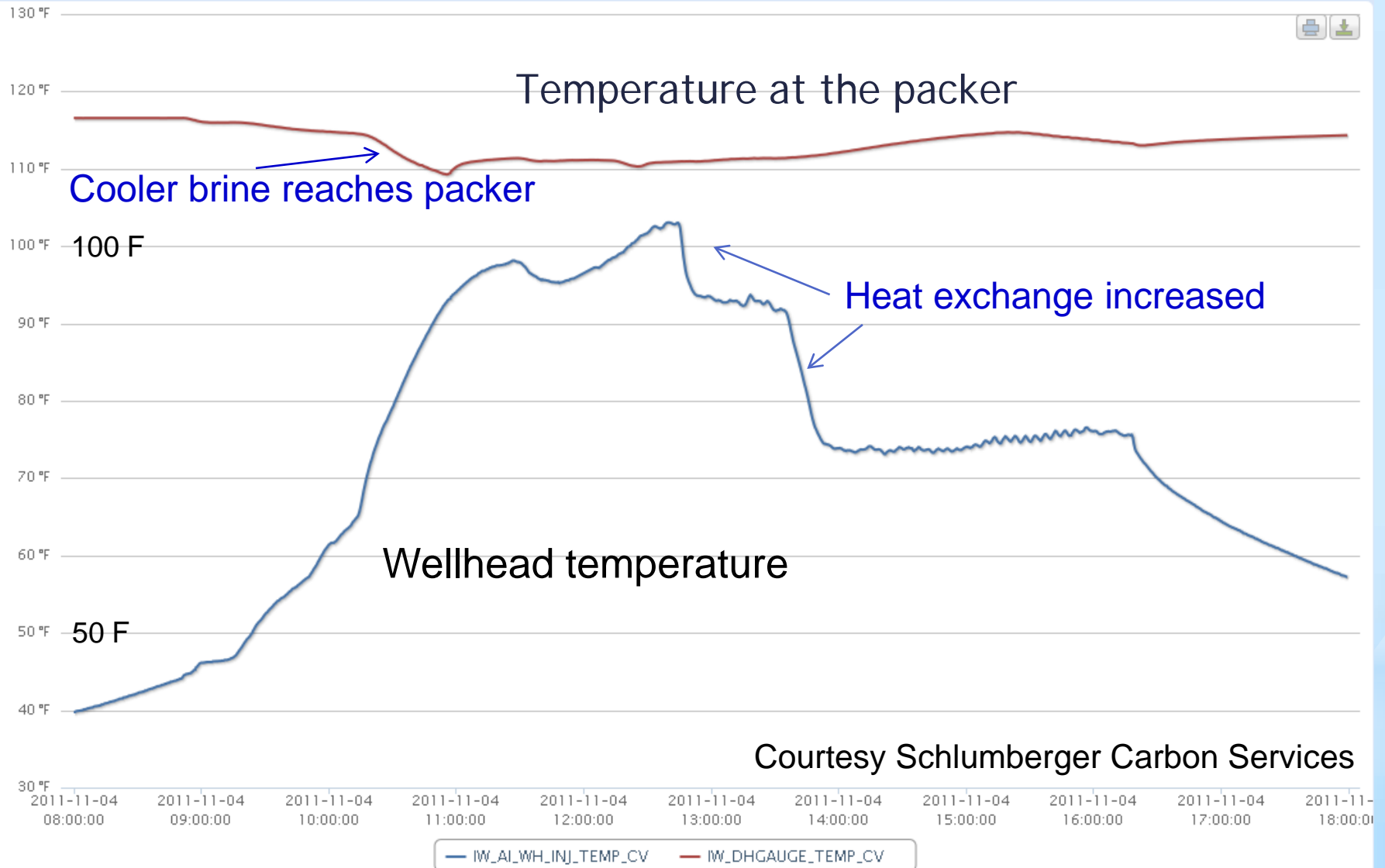
Courtesy Schlumberger Carbon Services



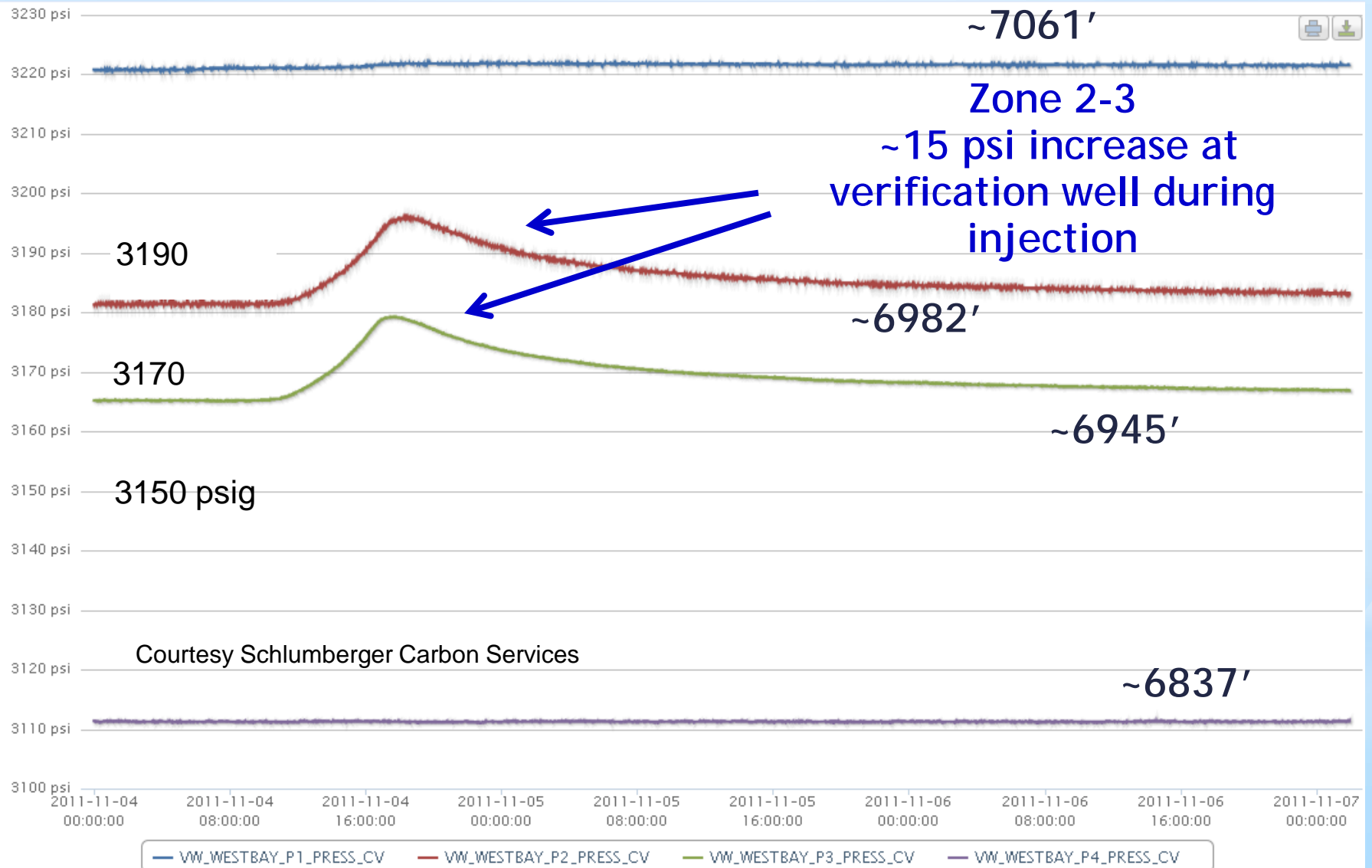
Surface & Downhole Pressure at Startup



Surface & Downhole Temperature at Startup



Westbay Pressure Data November 4-6, 2011





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