An Evaluation of the Carbon Sequestration Potential of the Cambro-Ordovician Strata of the Illinois and Michigan Basins

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NETL, Pittsburgh

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- SeisRes 2020, Houston: VSP acquisition and processing
- Sandia Technologies, Houston: engineering and wellsite supervision

Budget and Project Period

- Total budget of $12.8 million
- Including
  - $ 9.8 million from US Department of Energy
  - $ 3 million in cost share
    - 23% cost share
- Project ends in 09/30/2013

Objective

- Characterize new areas for sequestration in southern Illinois, southern Indiana, western Kentucky, and Michigan

Why do the study?

- Mt. Simon has limited sequestration potential in southern Illinois and western Kentucky
- Limited studies have been conducted on the potential of the carbonate Knox Supergroup, St. Peter Sandstone, and the Maquoketa Shale.

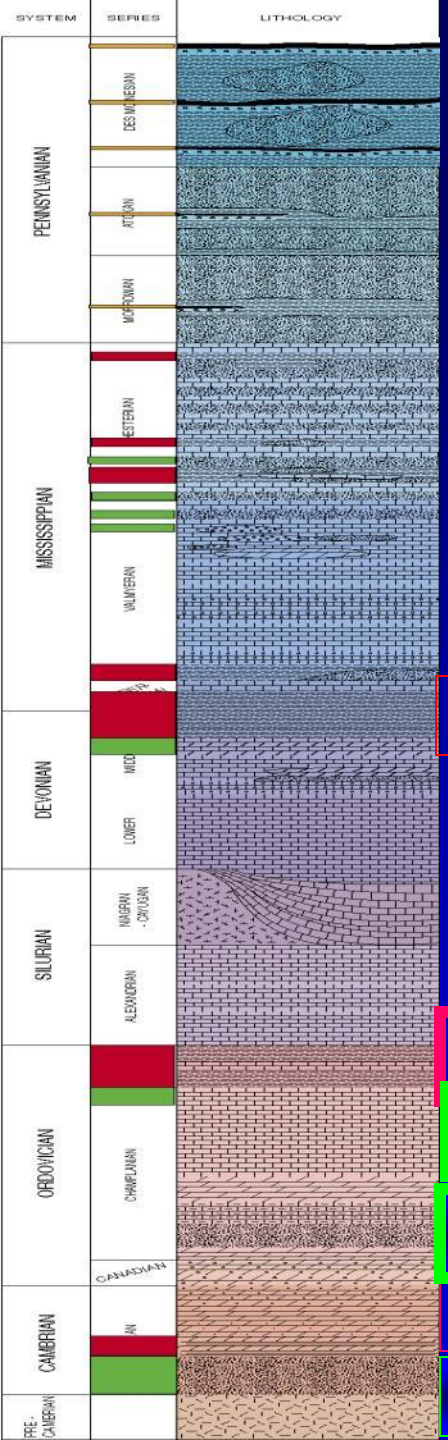
Why the Knox and St. Peter?

- Knox is regionally widespread at supercritical CO_2 depths, yet shallower than the Mount Simon
- Evidence for significant porosity in the Knox, although in thinner, more complex reservoir units
- St. Peter Sandstone has significant thickness and porosity in both the Michigan and Illinois Basins; but has not been adequately characterized

Background

What are our sequestration targets?

Illinois Basin Stratigraphic Column
Showing
Seals and Sinks



New Albany (Seal)

Maquoketa (Seal)

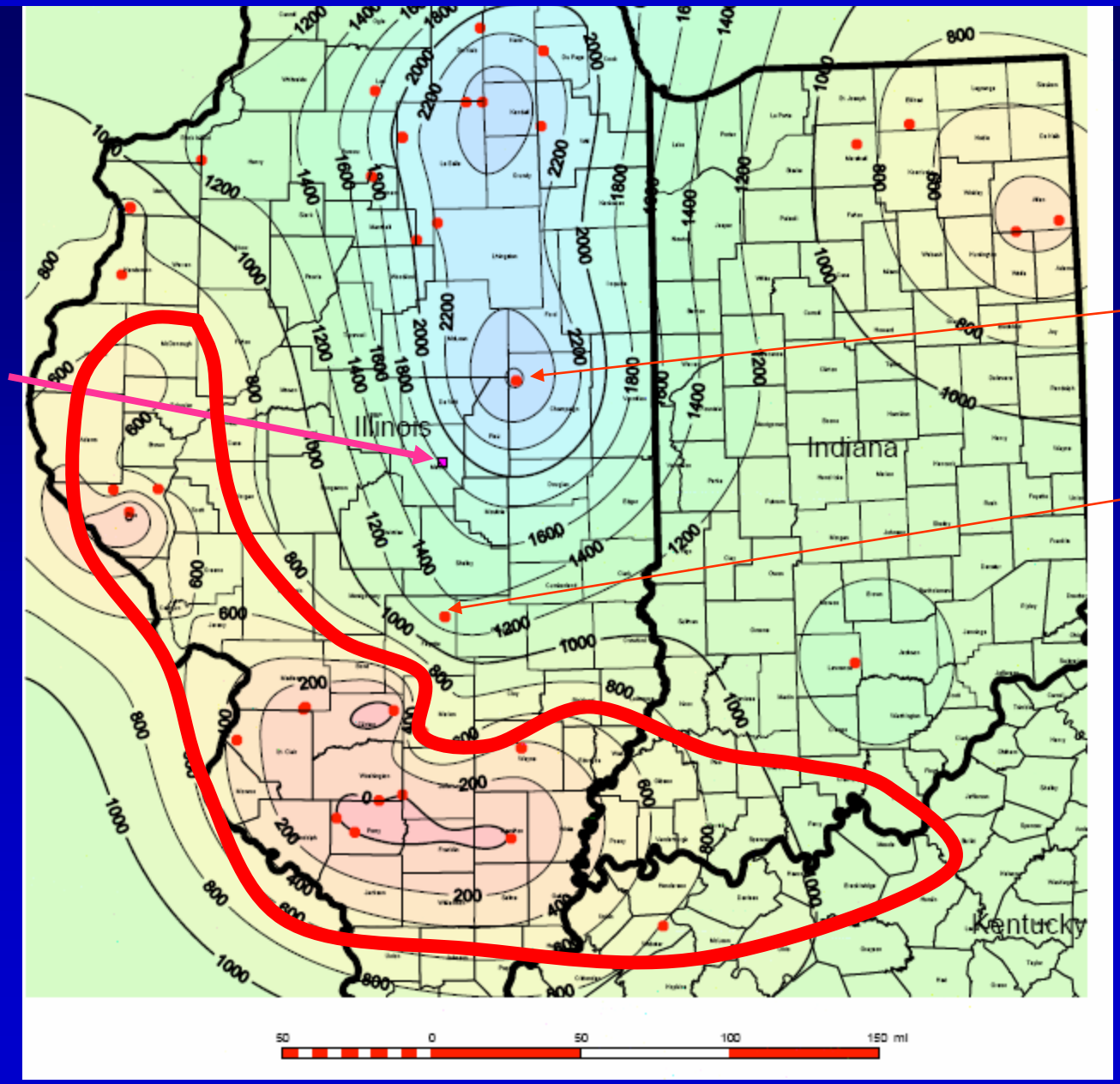
St Peter (Sink)

Knox (Sink)

Eau Claire (Seal)

Mt. Simon (Sink)

Thickness of the Mt. Simon Sandstone

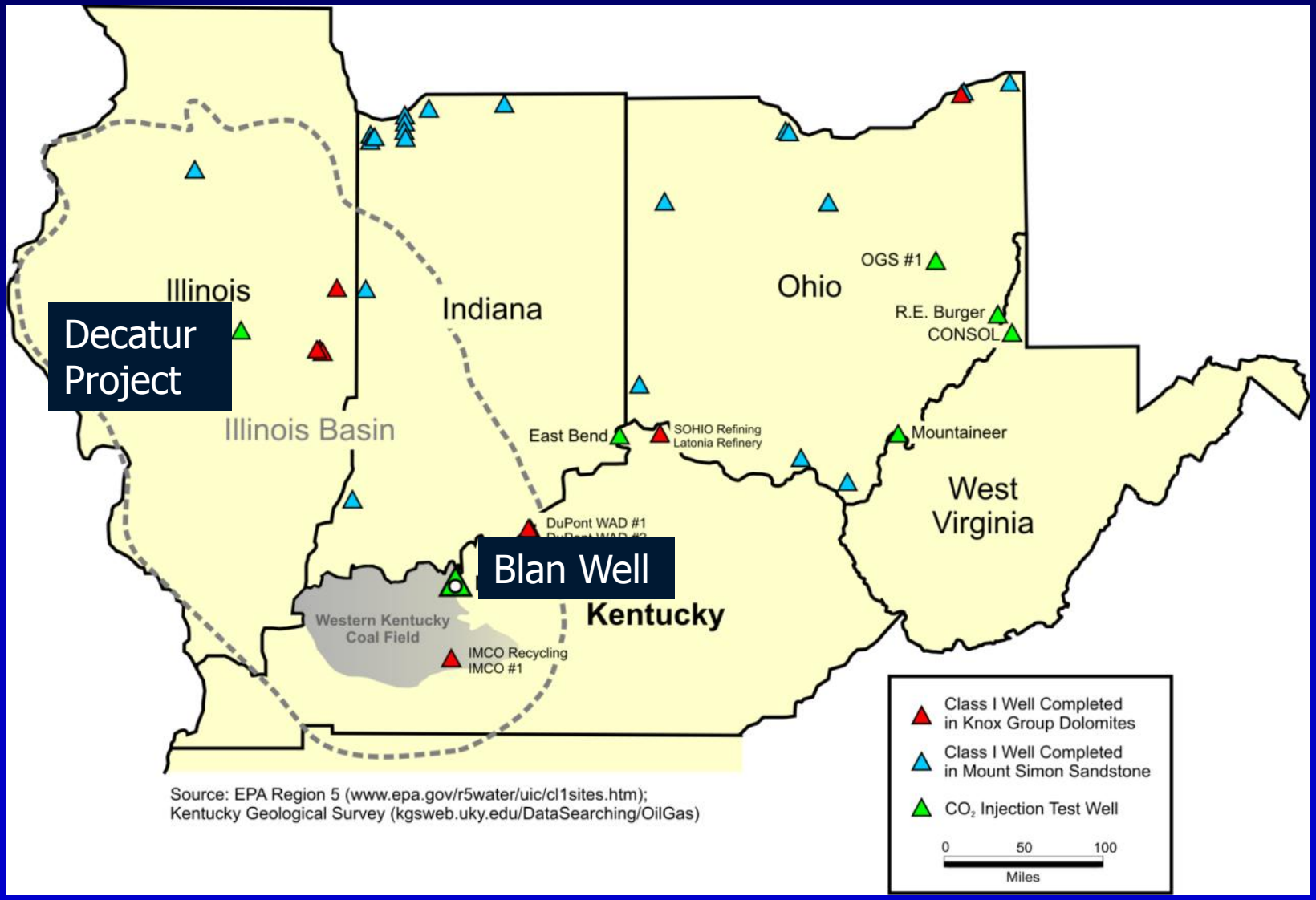


Hinton #7 penetrated 2600 feet of Mt. Simon

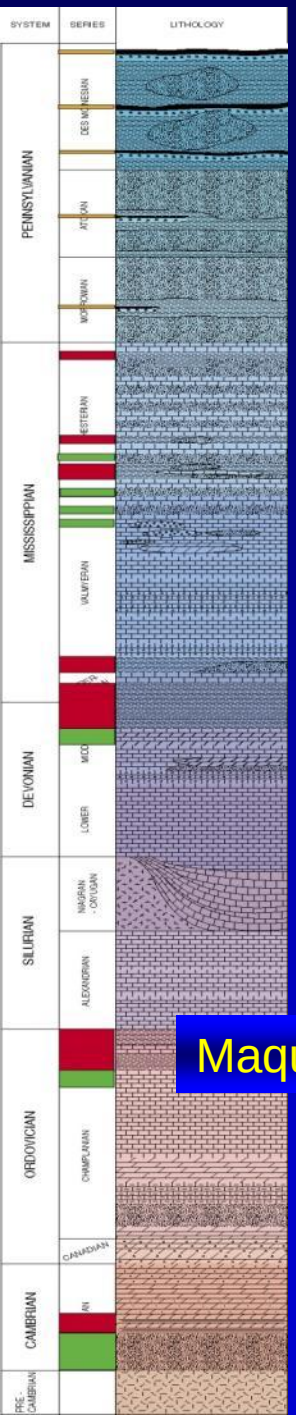
Wells with Precambrian granite

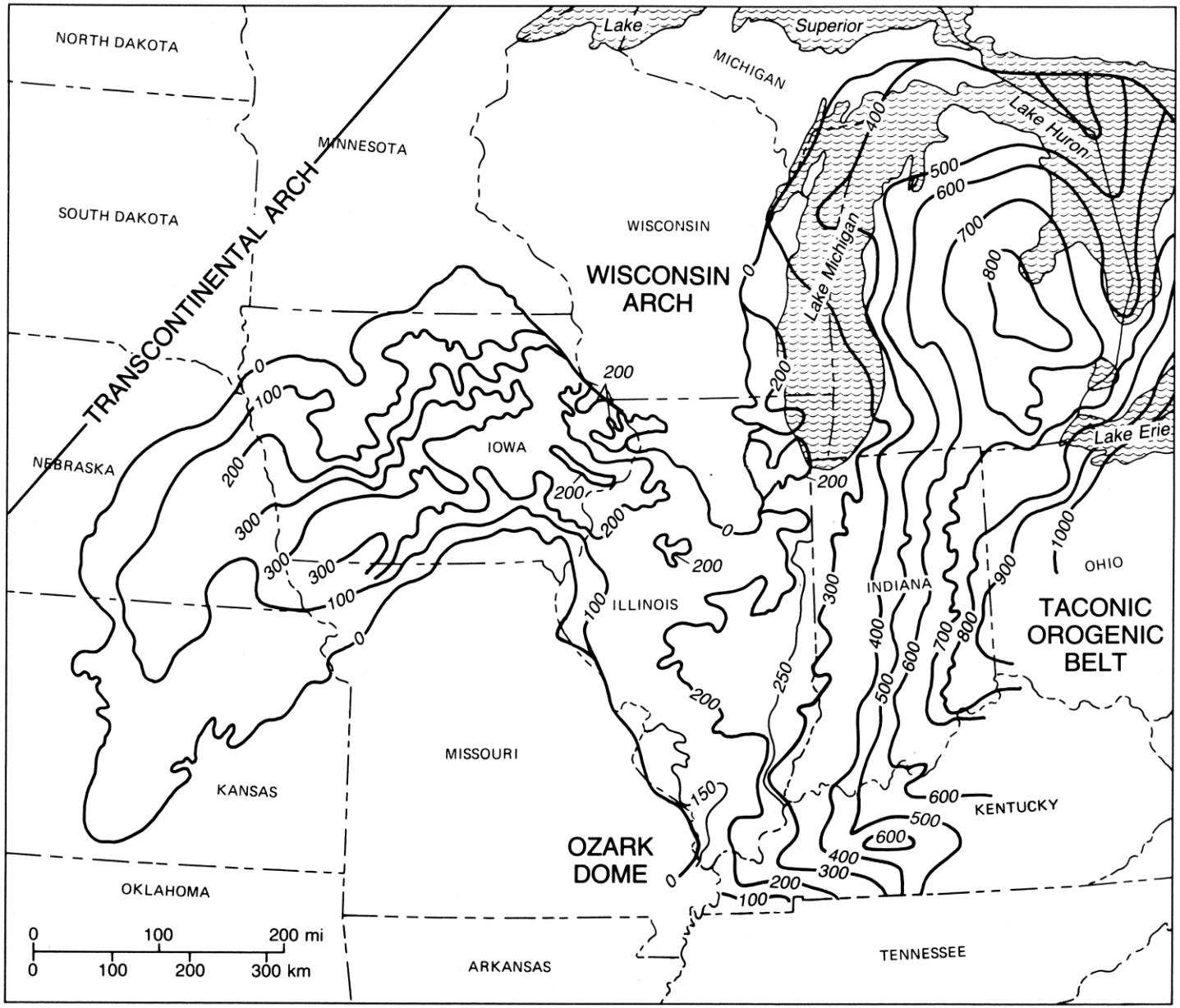
Mt. Simon may be too thin within the red outline

Waste Injection Wells Use the Knox



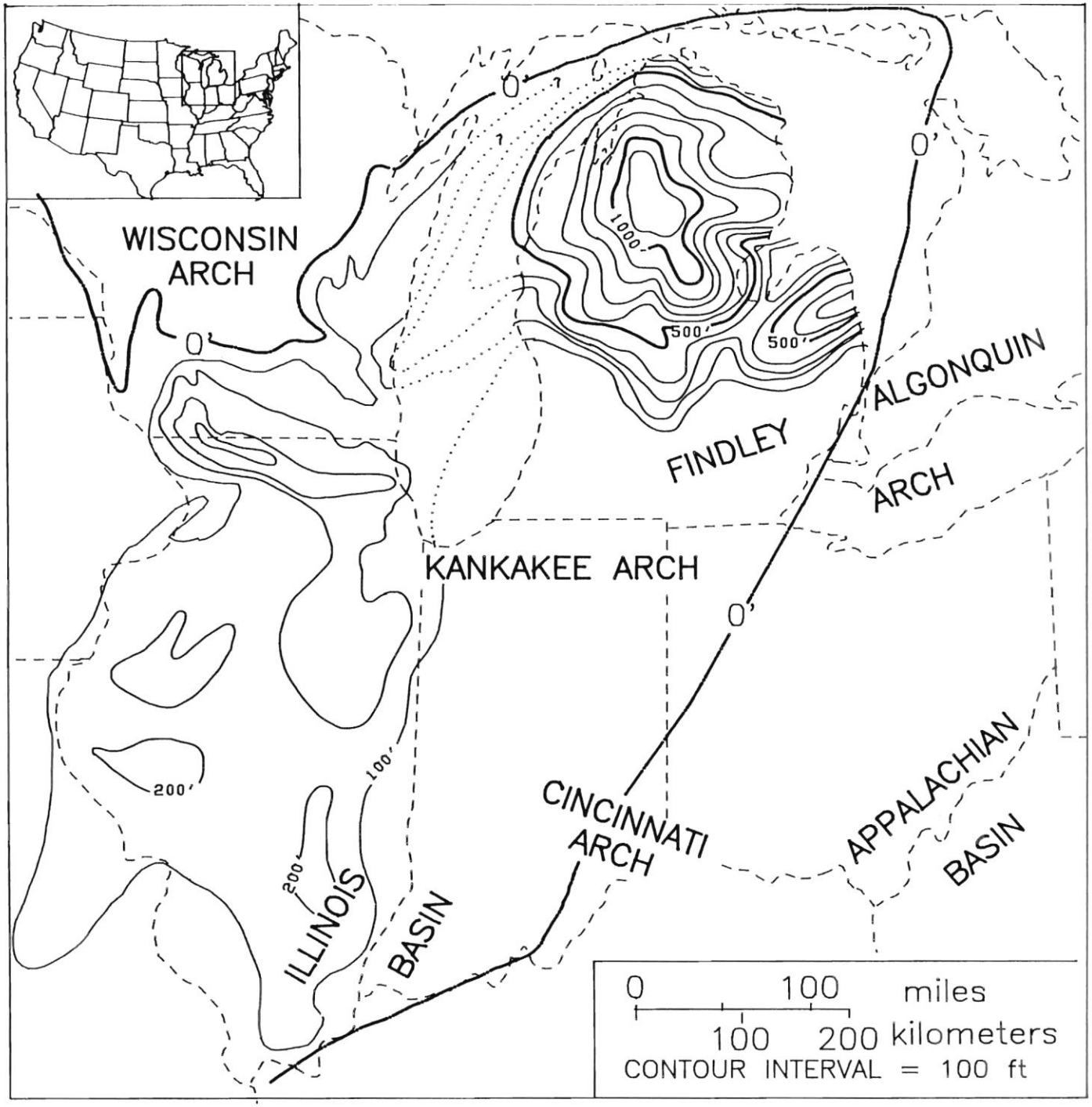
Thickness of Maquoketa



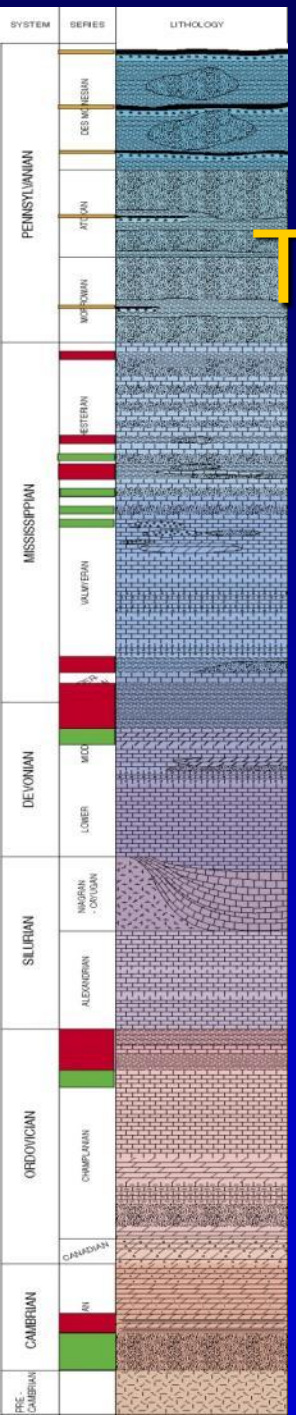


Regional St. Peter Sandstone Thickness

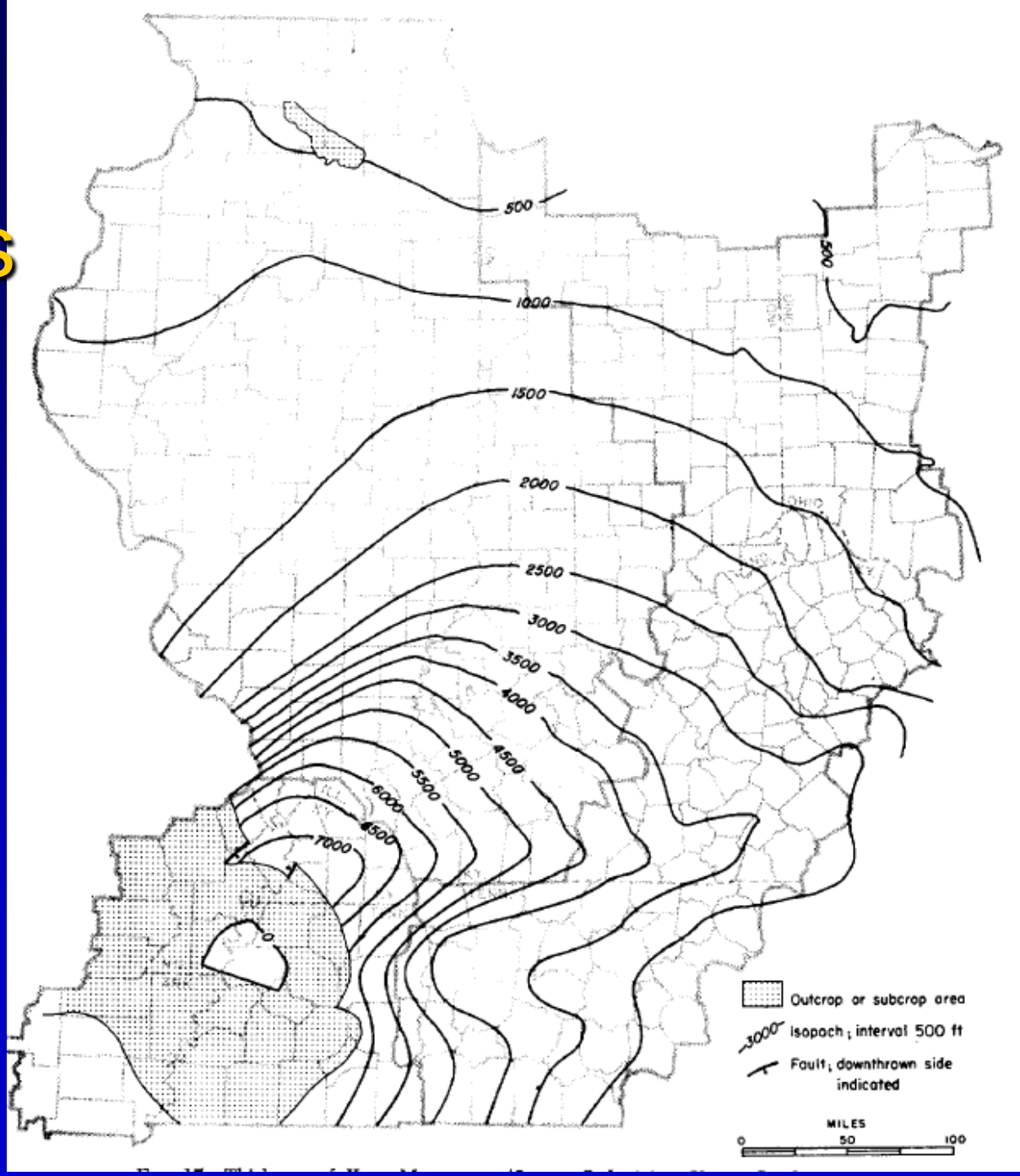
Natural Gas Storage Fields in St. Peter illustrate storage capacity



Knox Thickness

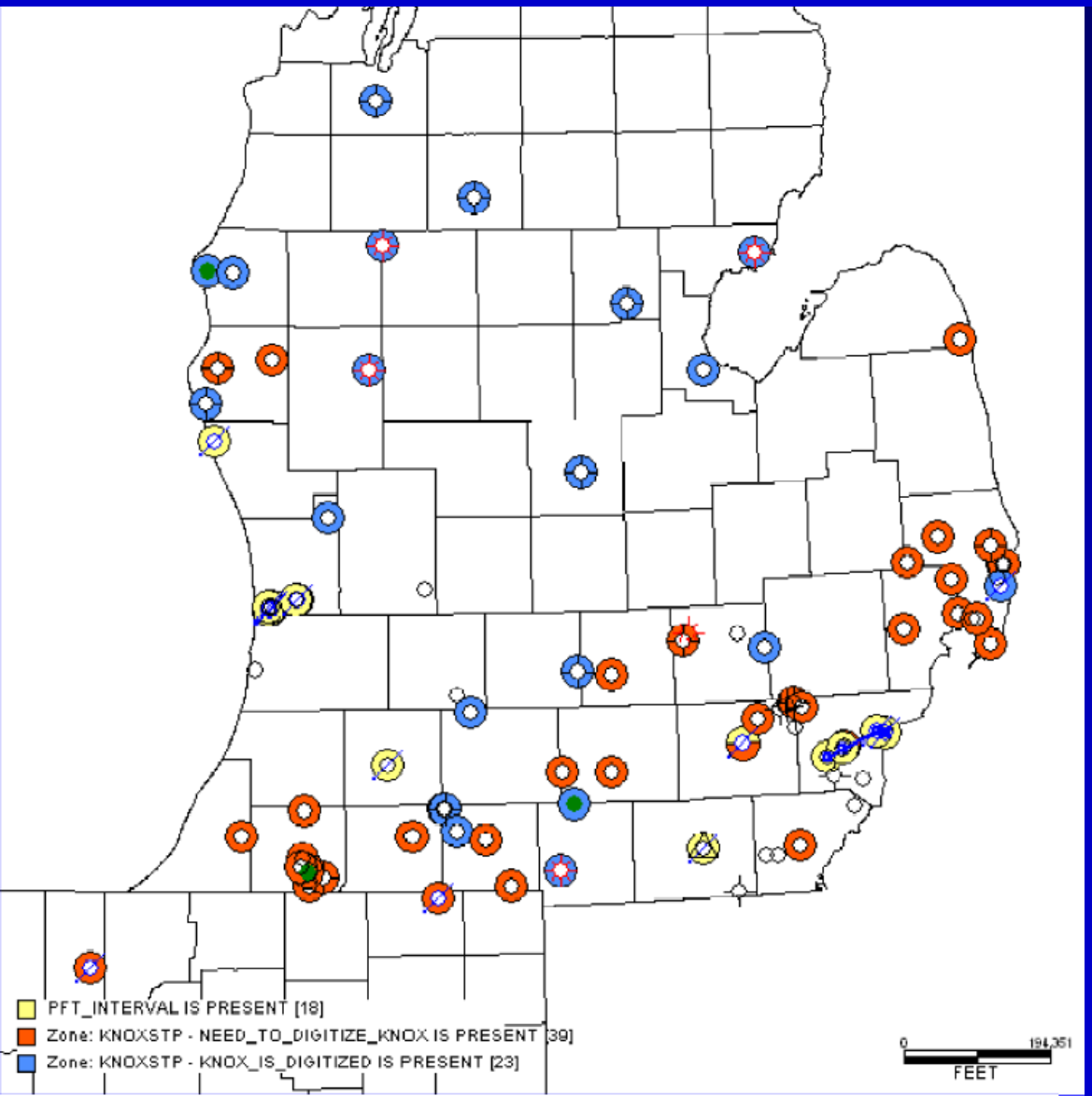


Knox



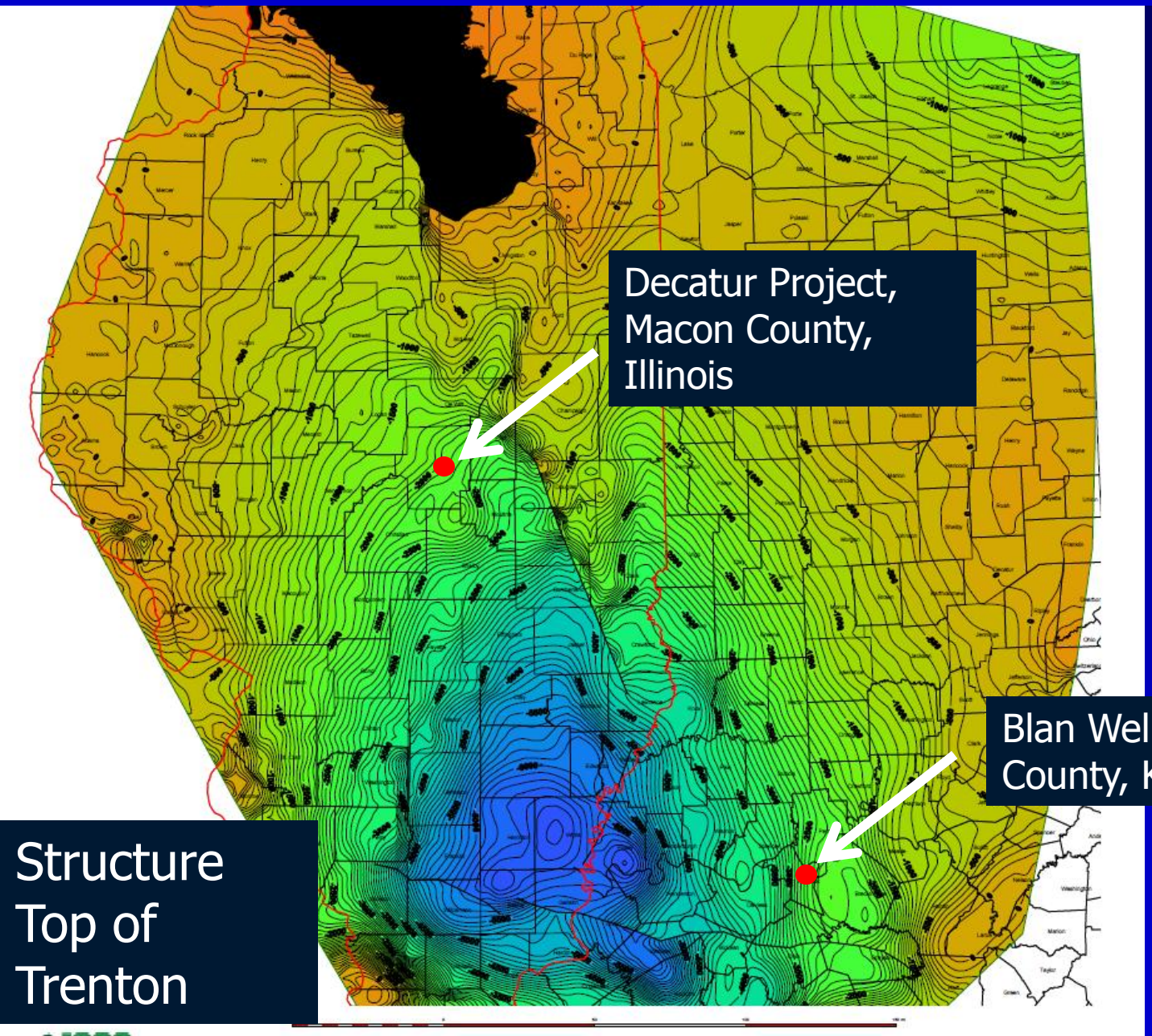
Ongoing Work

Task 2.0 – Compile Available Base data and Assess Data Needs



Task is almost complete: Final maps and databases need to be finalized

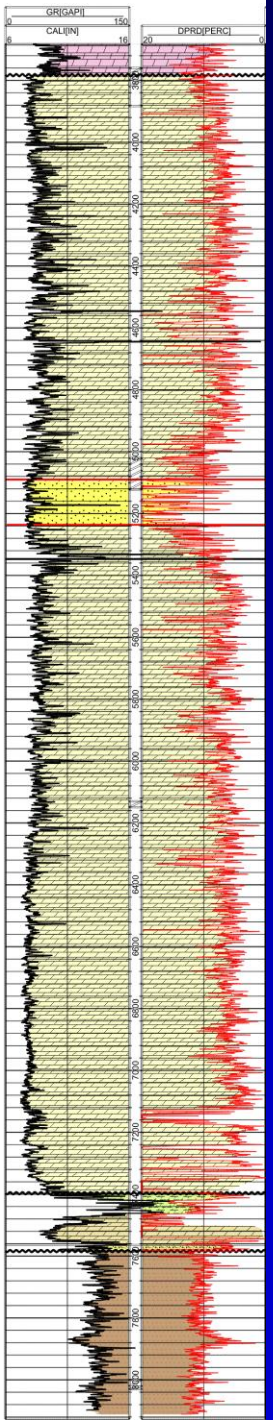
Task 3.0 Site Characterization



Blan Well Characterization

Knox CO_2 Injection Test and Monitoring

- KGS #1 Blan well drilled in 2009 to 8,126 ft
- Very good initial open-hole Knox injection tests with brine and CO_2, but had problems with packers and zone isolation
- New open-hole tests designed to isolate Gunter sandstone zone
- Time-lapse VSP used to try and image CO2 plume in Gunter



St. Peter Sandstone (6” thick)

Upper Knox dolostones

Gunter Sandstone

Deep stratigraphic units, KGS #1 Blan well, Hancock Co.

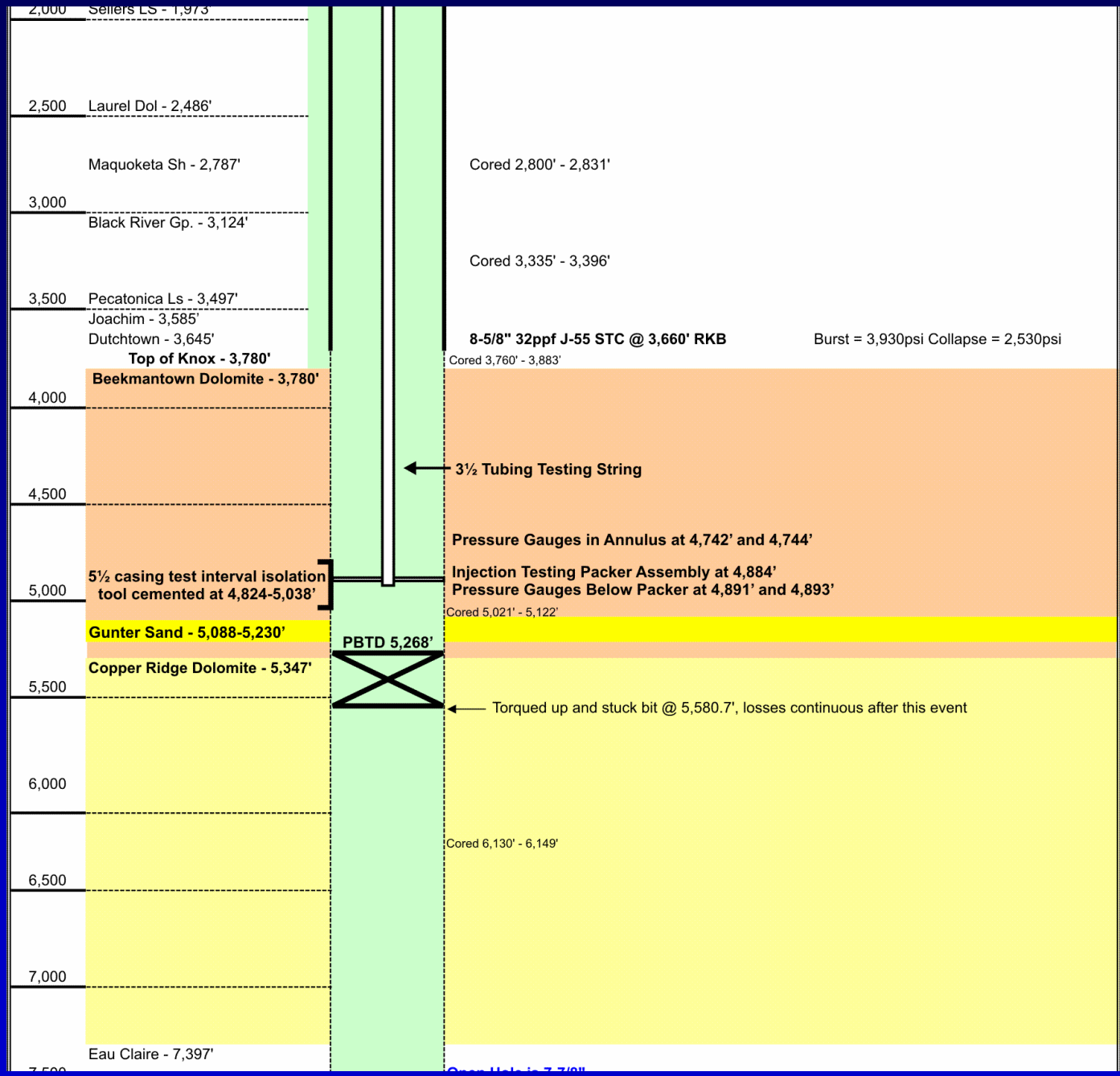
Lower Knox dolostones

Eau Claire Fm. (Mt. Simon Sandstone absent)

Precambrian Middle Run Formation (red sandstone/siltstone)

Well design to isolate open hole Gunter zone

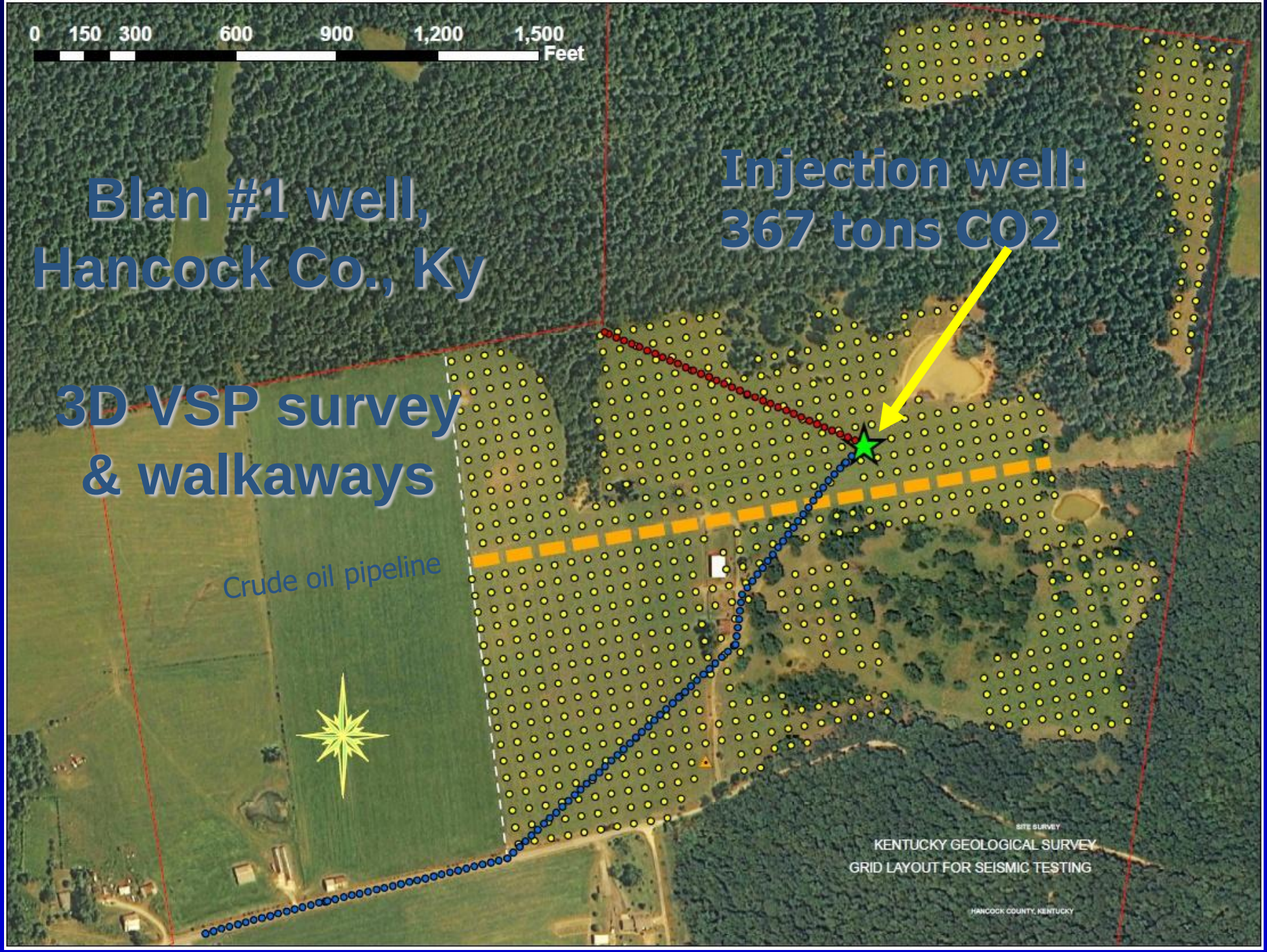
128 ft ≥ 7.5% Φ



CO_2 injection test Knox sandstone, Sept. 20-21, 2010

Open-hole interval 5,038 – 5,268 ft

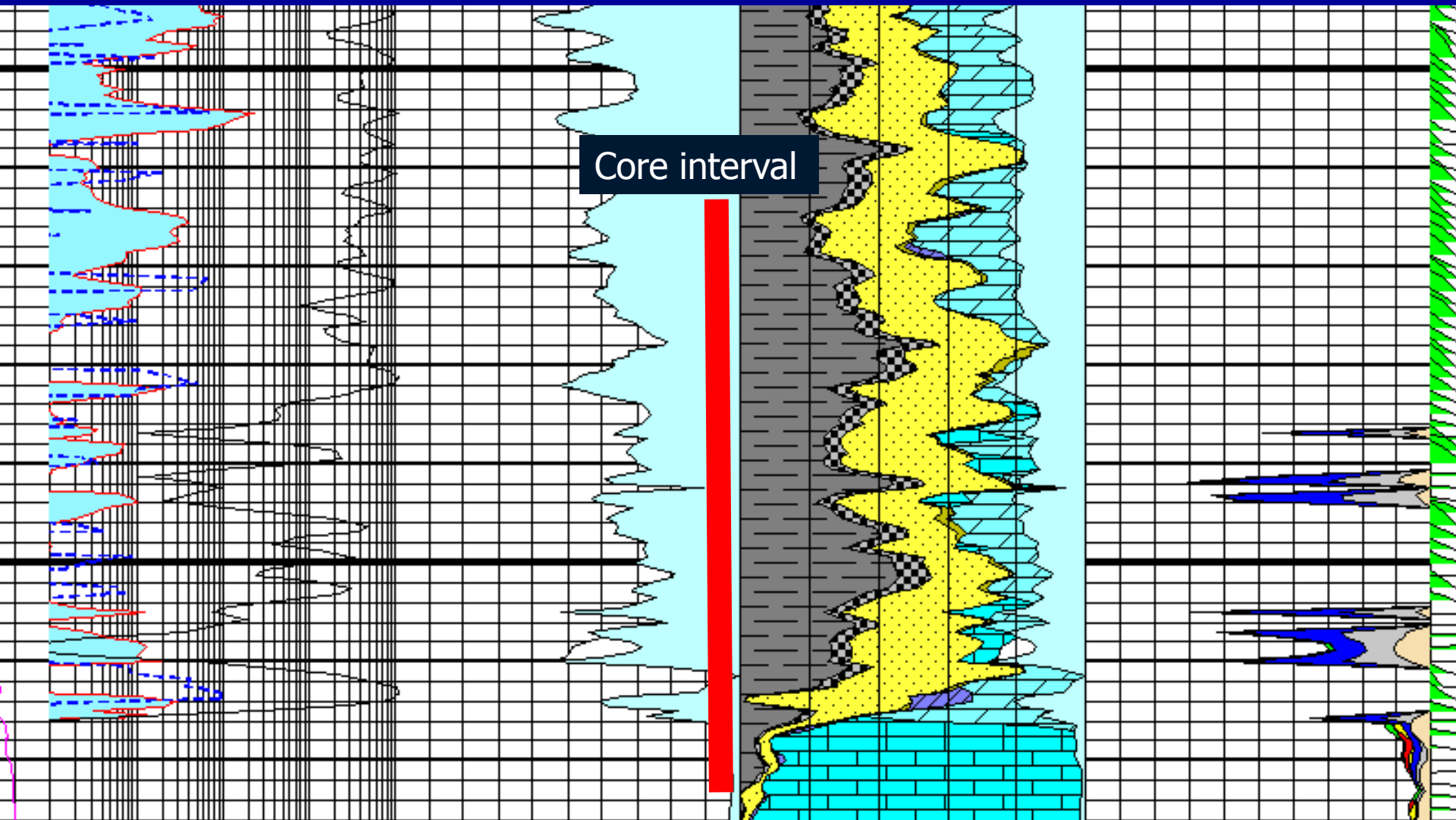
367 tons CO_2
3 bbl per minute
1,000 psi wellhead
2,538 psi final bottom hole pressure


0 150 300 600 900 1,200 1,500
Feet
Blan #1 well,
Hancock Co., Ky
Injection well:
367 tons CO2
3D VSP survey
& walkaways
Crude oil pipeline
SITE SURVEY
KENTUCKY GEOLOGICAL SURVEY
GRID LAYOUT FOR SEISMIC TESTING
HANCOCK COUNTY, KENTUCKY

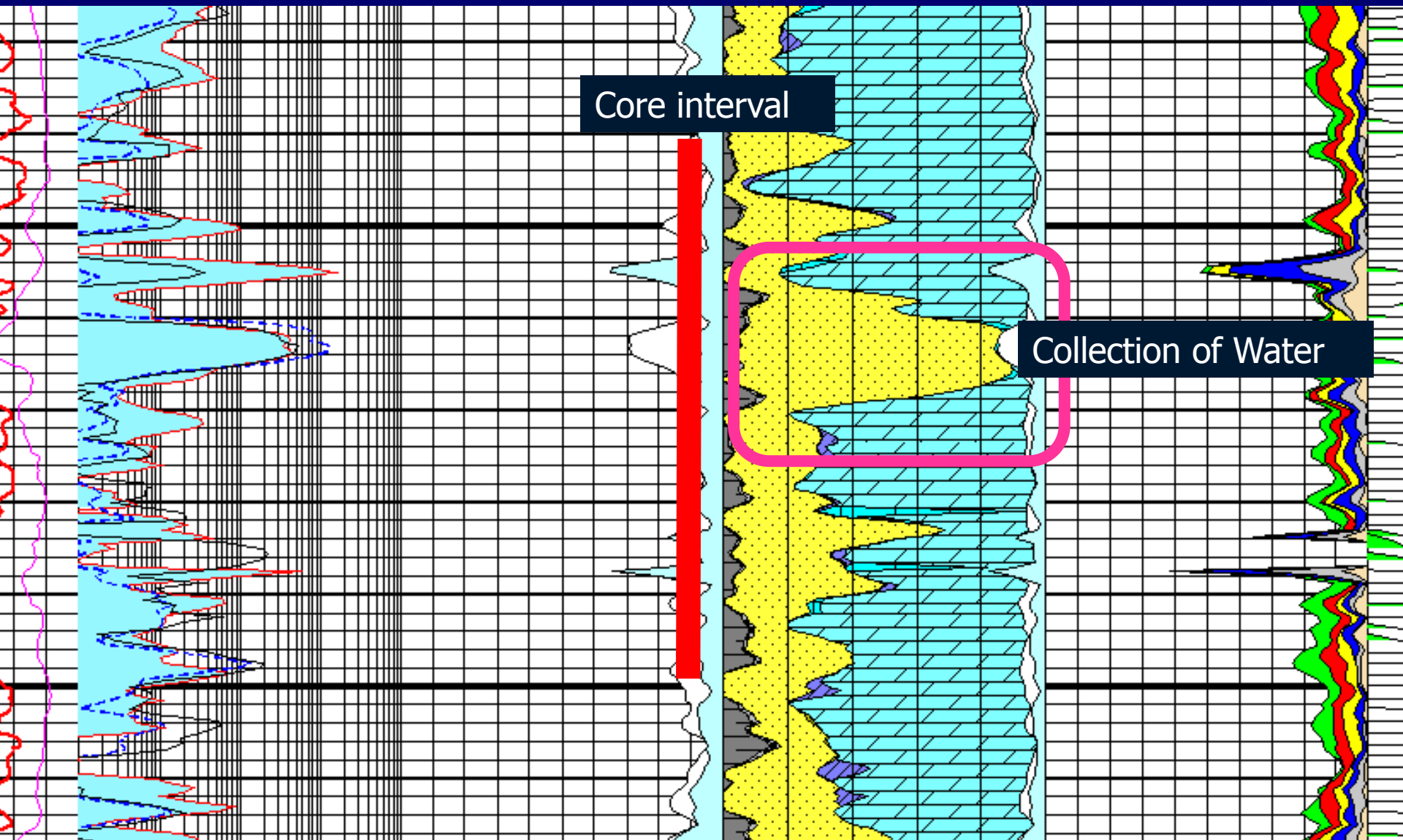
Open house for Blan Well is being planned for end of October at a community center in Hancock County

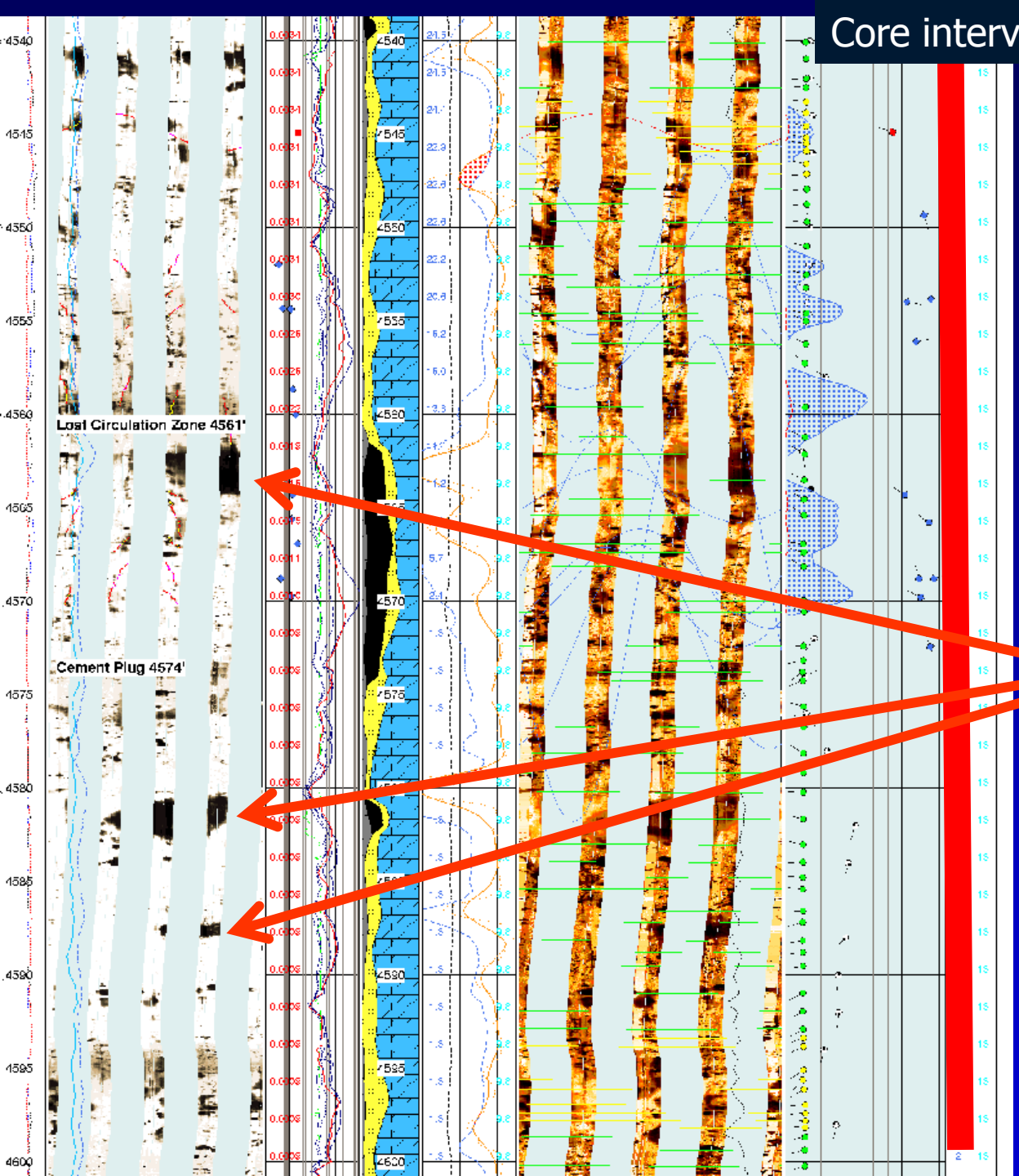
Decatur Project Characterization

Core interval (2765-2825) Maquoketa Shale



Core interval (4240-4300)
Gunter Sandstone and Eminence Formation



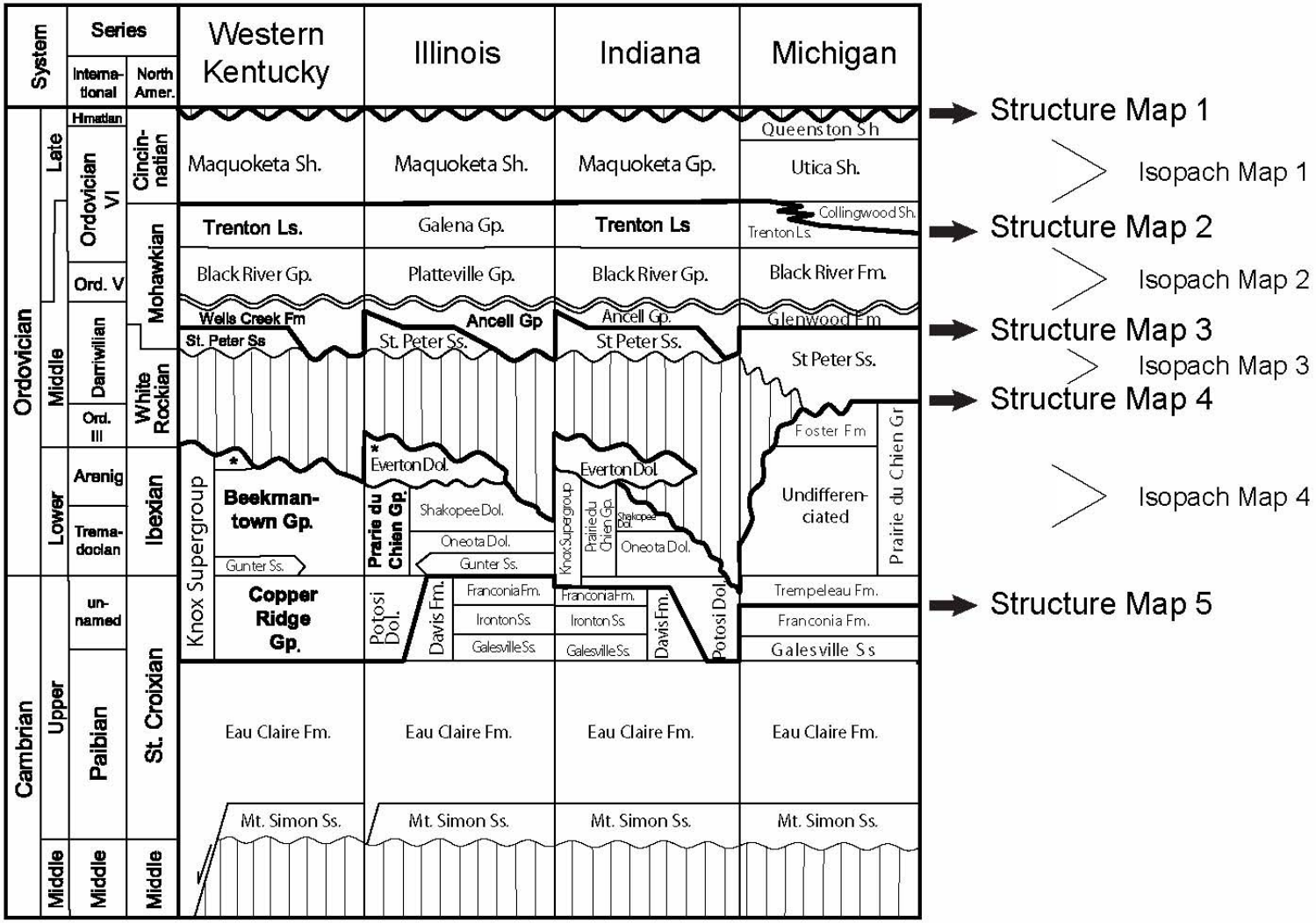


FMI Log
Core interval
(4540-4600)
Potosi lost circulation zone

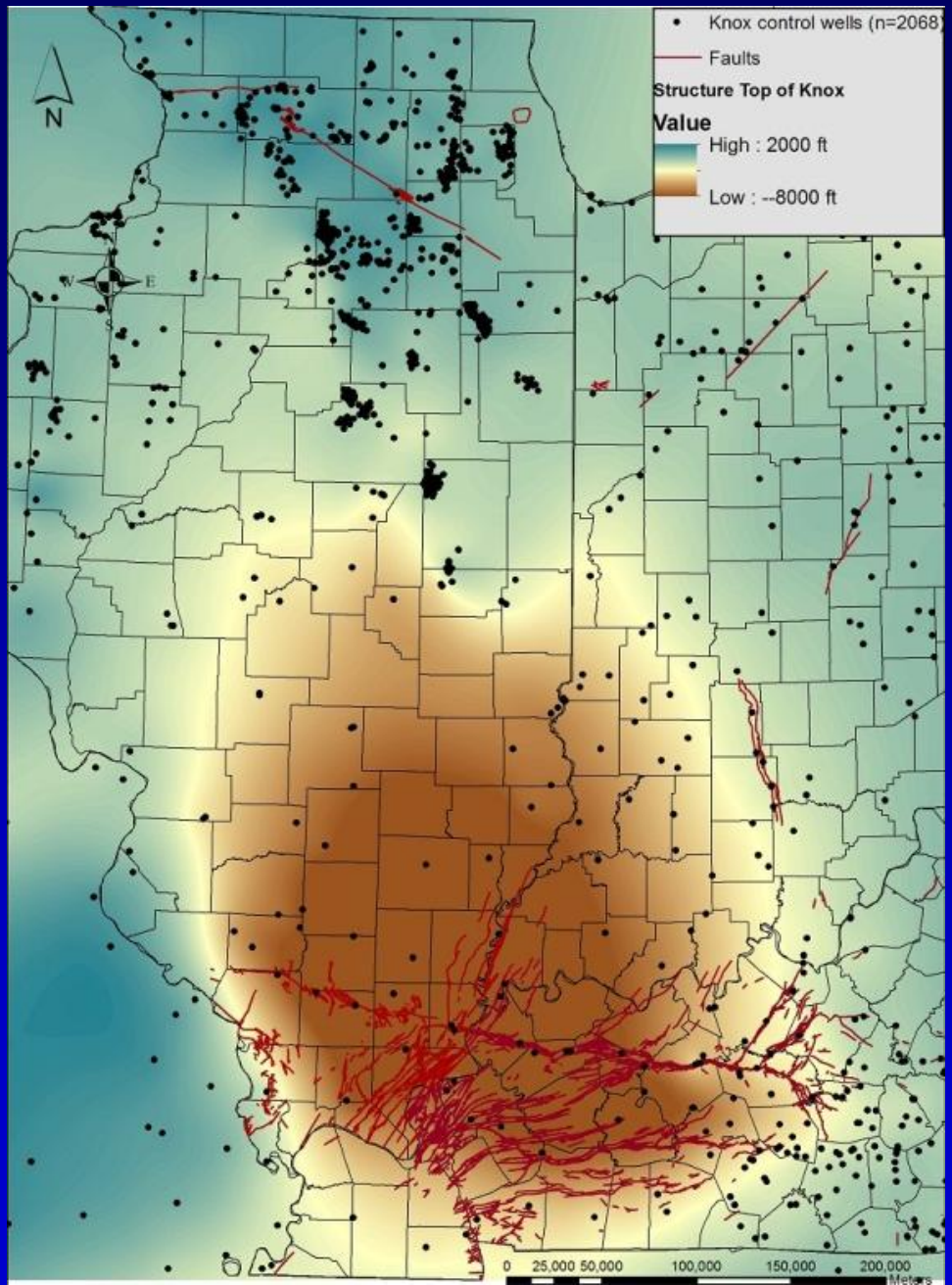
Solution cavities

Task 4.0 Regional Significance

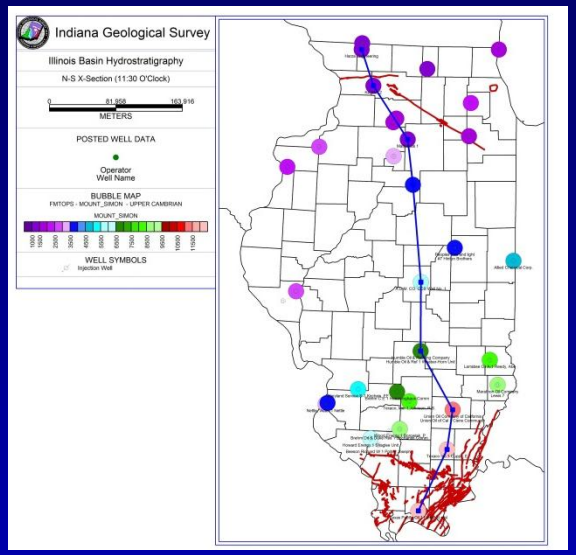
Correlated stratigraphic column for C-O project and structure and isopach maps under development

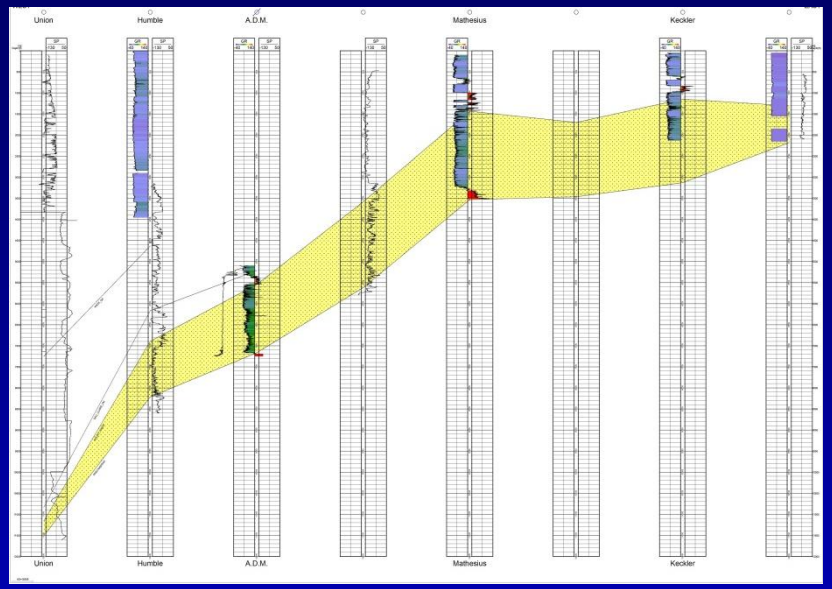


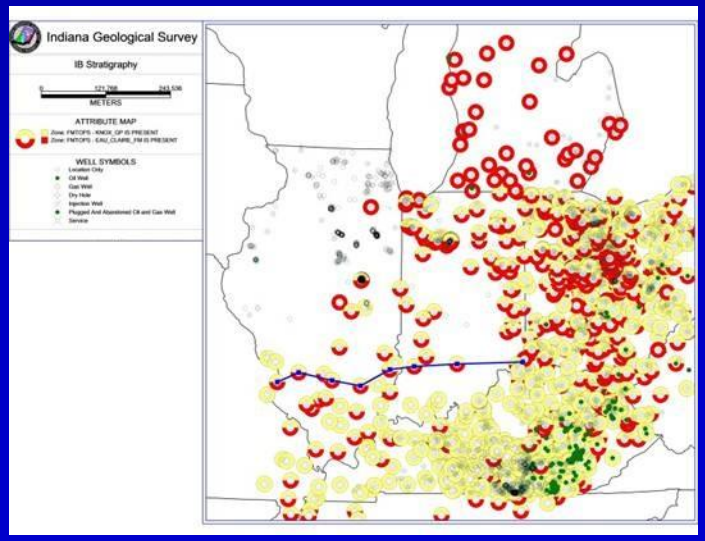
Example of new maps under development

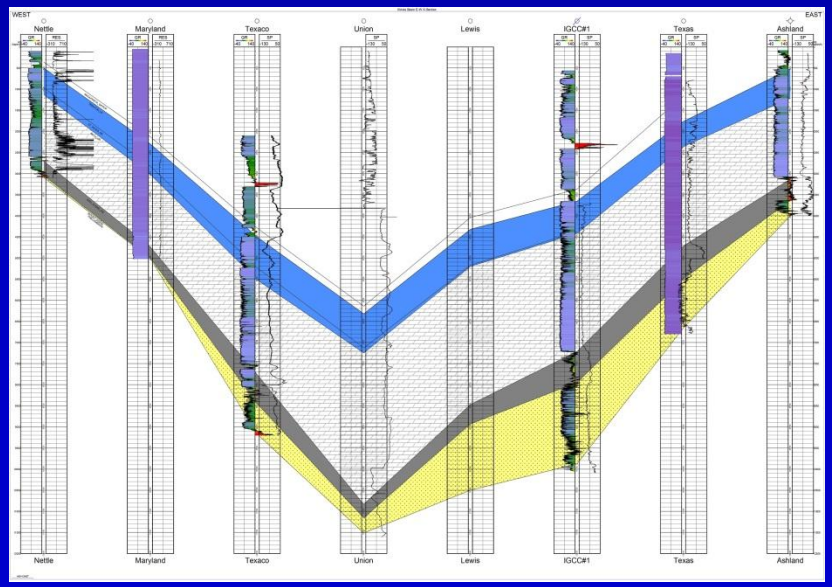


Examples of cross-sections under development









Acquisition of 120 miles of 2D Seismic reflection data

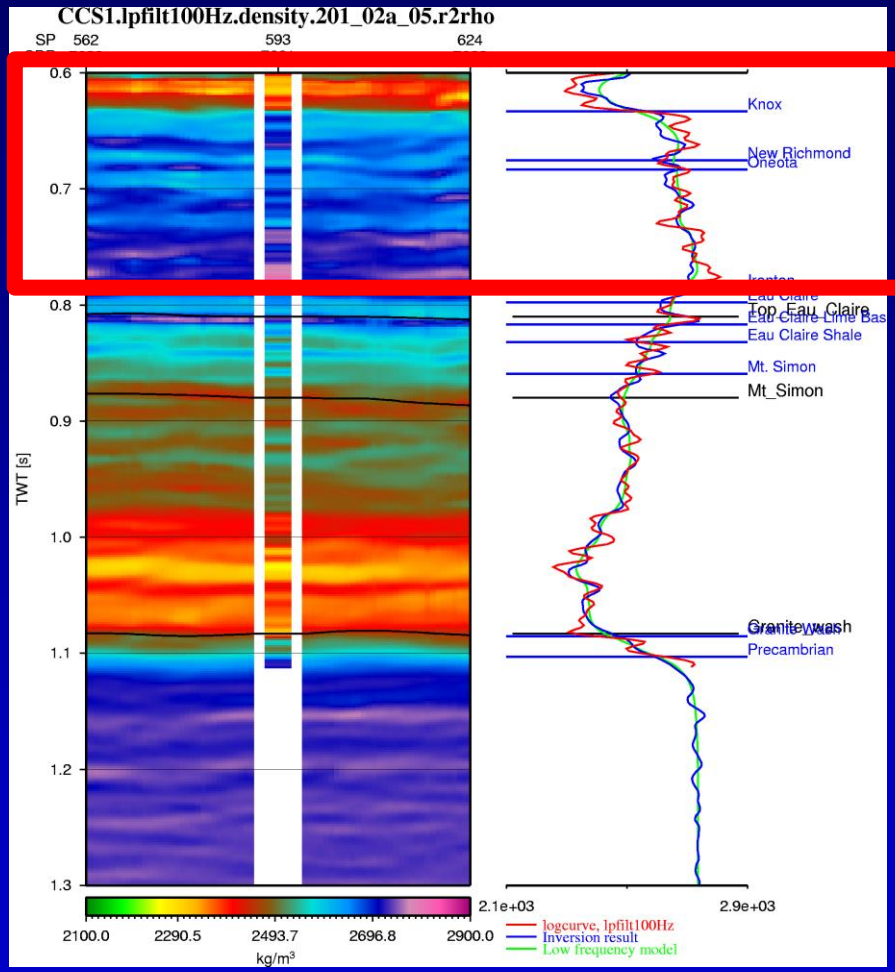
Seismic line

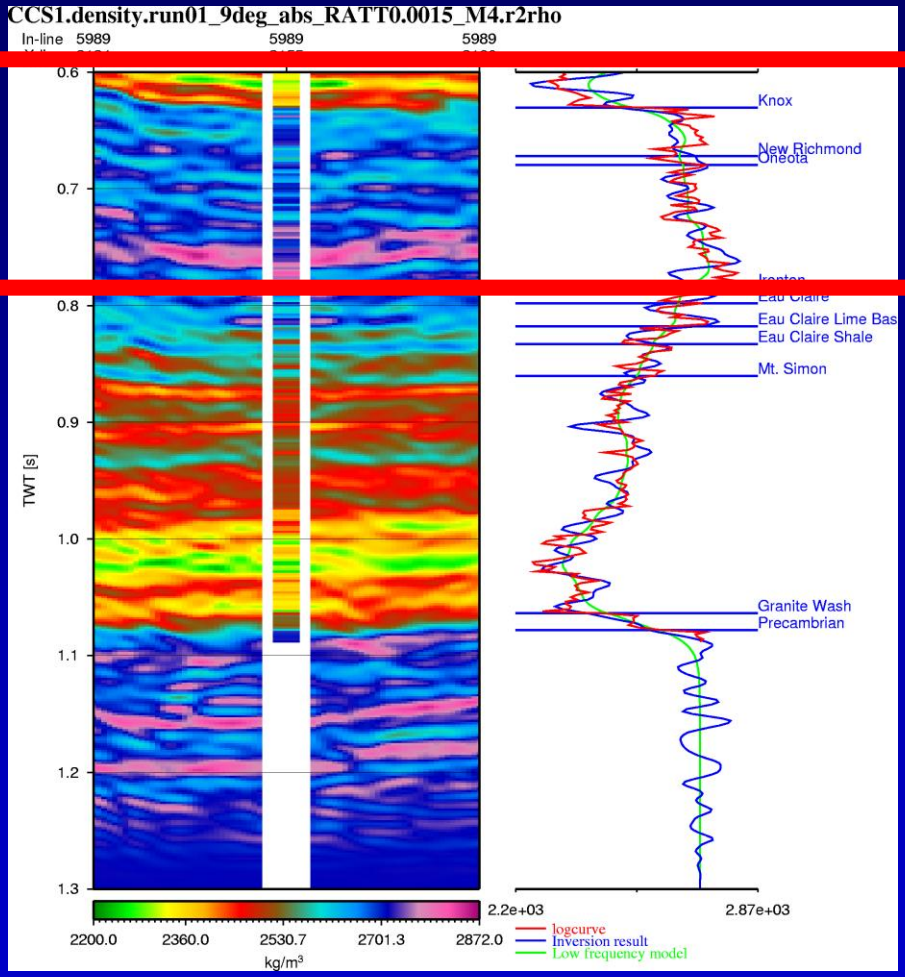
Decatur Project

We are currently evaluating the best path and plan to begin acquisition in December, 2010

Task 5.0 – Capacity Estimates
Task 6.0 – Injectivity of the Formation
Task 7.0 – Stratigraphic Containment

Comparison of previous 2D inversion and 3D Density

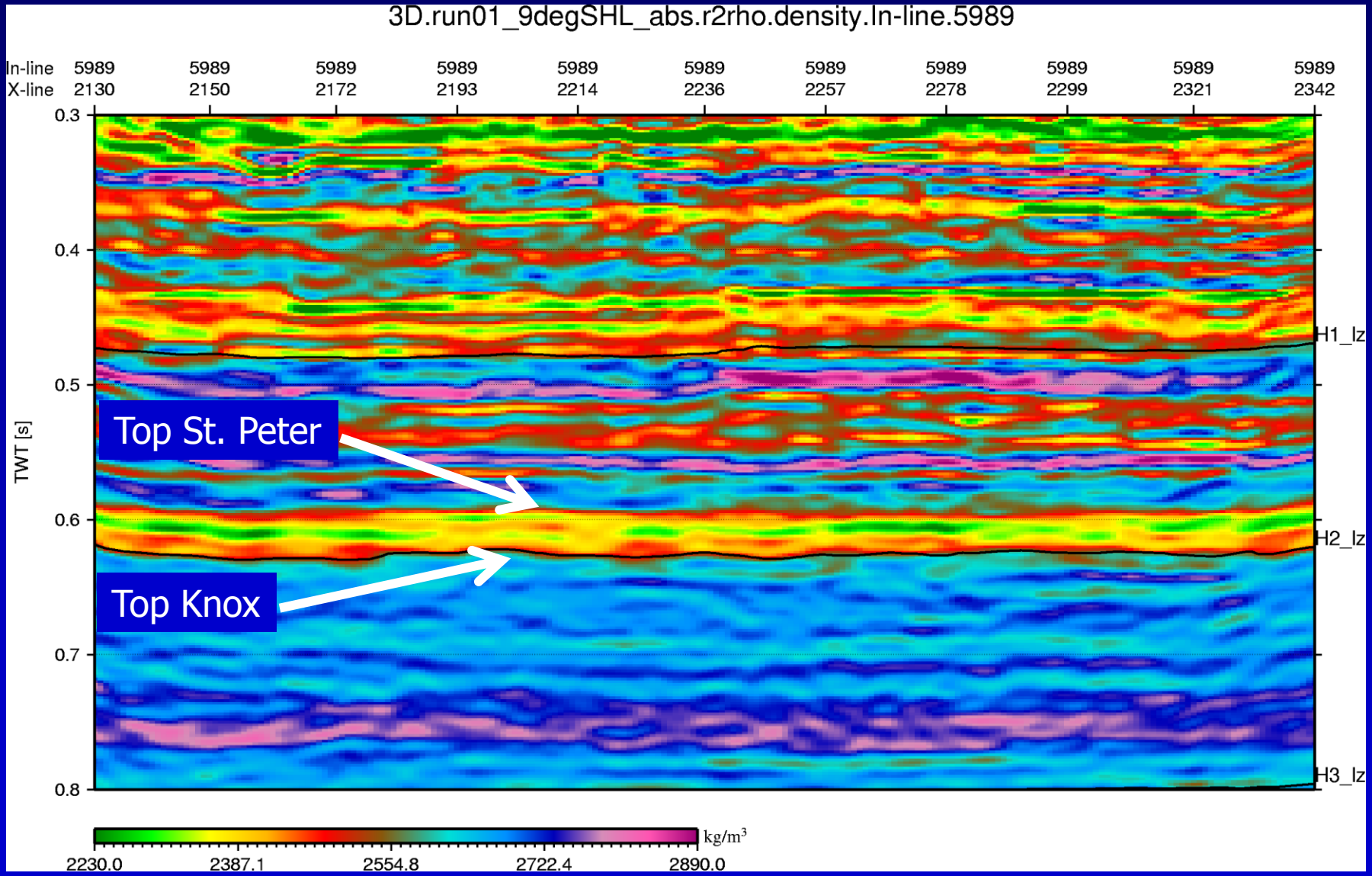




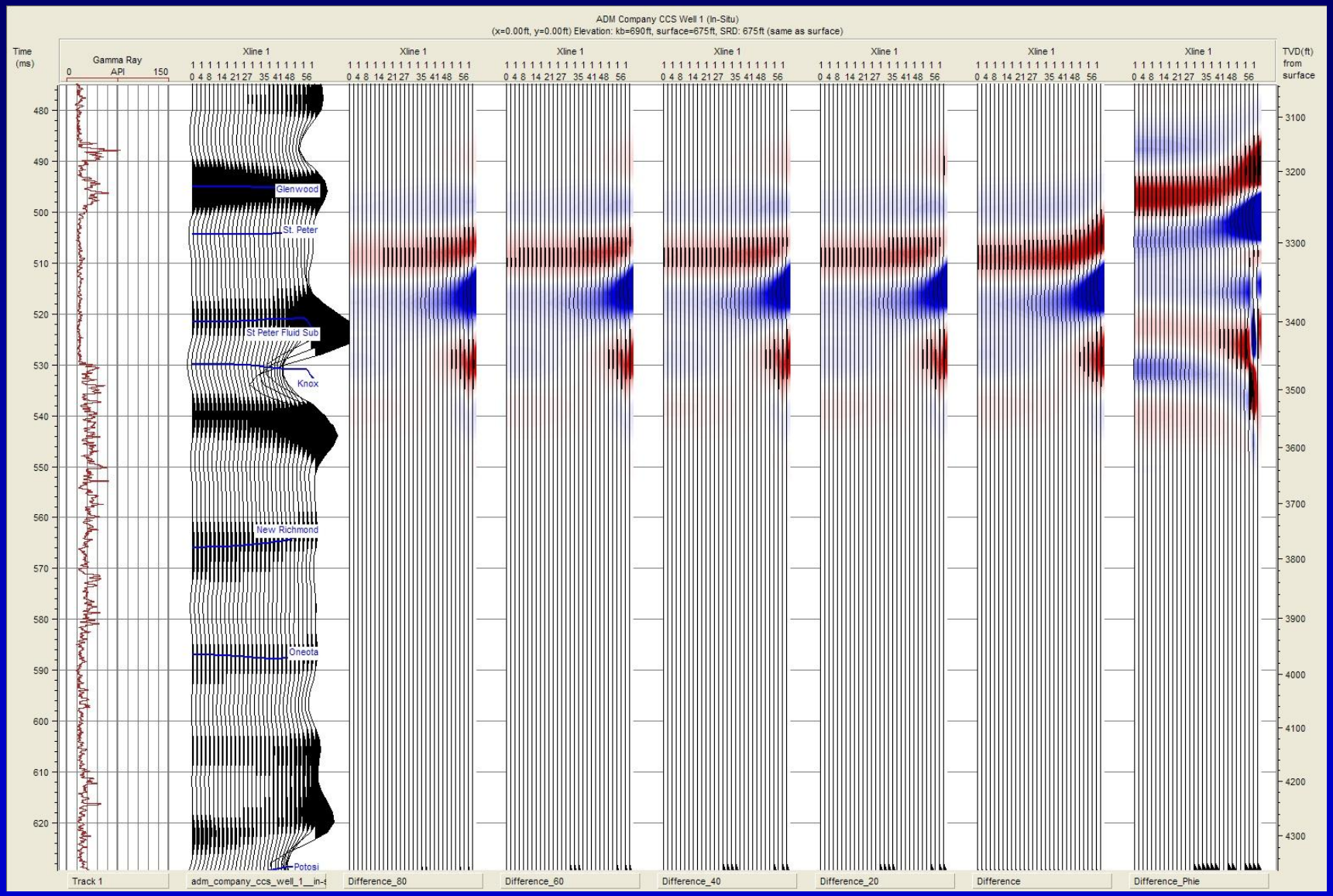
2D line 201

3D

Seismic Inversion: Density



Can we see the CO_2 in the St. Peter



Evaluating Capacity, Injectivity, and Stratigraphic Containment of St Peter and Knox

- Geomechanical properties of the rock
- Using the seismic inversion data as input into a reservoir simulator to evaluate the capacity of the formations to accept CO_2
- Use regional porosity logs to get capacity values
- Natural gas storage projects as analogs

Task 9.0 Mineralization Containment

Outcrop Analogs to Develop Subsurface Depositional Models

Conduct interaction studies to mimic the geochemical reactions between a CO_2-rich brine and the Maquoketa and Knox

Pressurized to 1,430 psi (9.86 Mpa) with CO_2 and heated simultaneously to 38° C to correspond to the temperature-pressure regime at a depth of 3,475 feet (1,059 m)

Ultimate Goal

- Define fairways where the Knox and the St. Peter reservoirs would be good sequestration targets