Illinois Storage Corridor: Updates

DE-FE0031892

U.S. Department of Energy
National Energy Technology Laboratory
2023 FECM/NETL Carbon Management Research Project Review Meeting
August 27th – September 1st, 2023

Roland Okwen
Illinois State Geological Survey
University of Illinois

Tuesday, August 29, 2023

ILLINOIS
Illinois State Geological Survey
PRAIRIE RESEARCH INSTITUTE

Presentation Outline

- Project objective and overview
- Prairie State Generating Company (PSGC) site updates
- One Earth Energy (OEE) site updates
- UIC Class VI permit status
- Future tasks
- Key accomplishments to date
- Announcement
- Acknowledgment

Project Objective

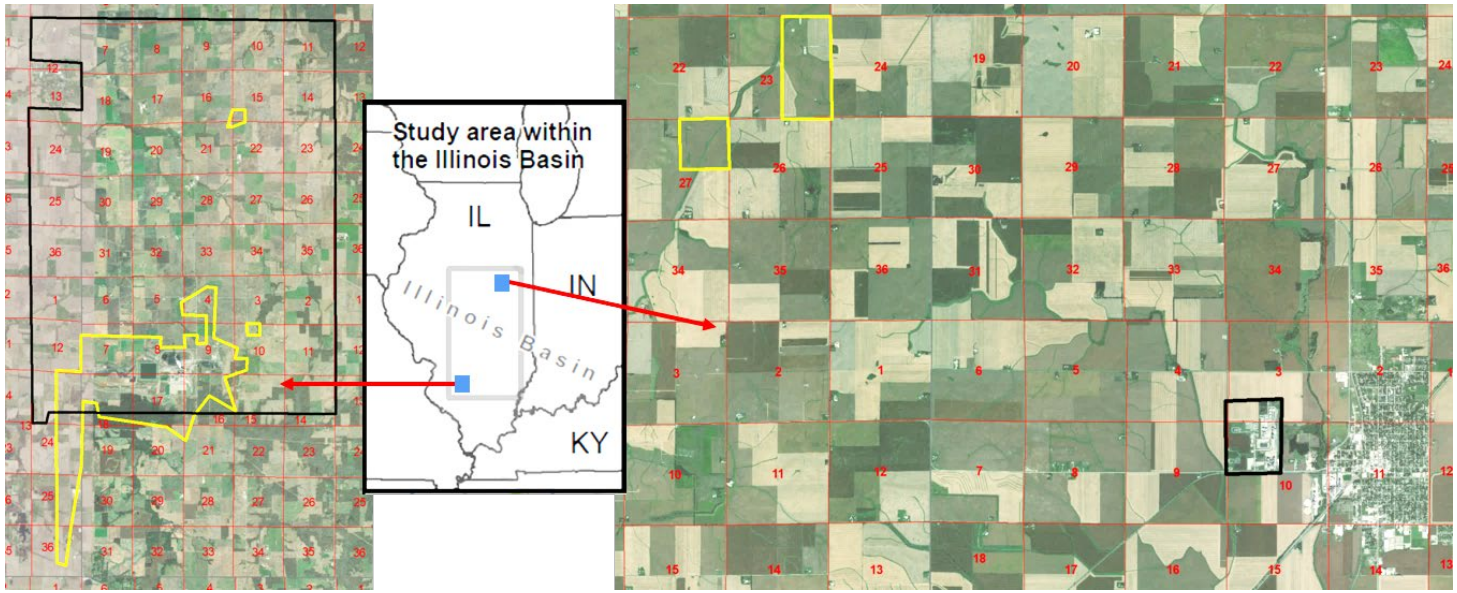
Accelerate commercial deployment of carbon capture utilization and storage (CCUS) within a region with proven geologic storage performance and with numerous industrial carbon sources.

Goals:

- Characterize two individual sites with committed industrial CO_2 sources for commercial-scale CO_2 storage
- Prepare Underground Injection Control (UIC) Class VI permits for construction at each site.

Project Sites

- Prairie State Generating Company site : Washington County, IL
- One Earth Energy site: Ford County, IL



Prairie State

One Earth Energy

Storage Complexes

SYSTEM	GROUP	FORMATION	Storage Elements
Ordovician	Maquoketa	Brainard	Seal
		Ft. Atkinson	
		Scales	
	Galena	Kimmswick	
		Decorah	
	Platteville		
	Ancell	Joachim	
		St. Peter	Reservoir
	Knox	Shakopee	Reservoir/ Seal
		New Richmond	
		Oneota	
		Gunter	
Cambrian		Eminence	
		Potosi	Reservoir
		Franconia	
		Ironton-Galesville	
		Eau Claire	Seal
	Potsdam	Mt. Simon	Reservoir
Precambrian			

St. Peter-Knox Storage Complex

Mt. Simon Storage Complex

Cambro-Ordovician Storage Complex

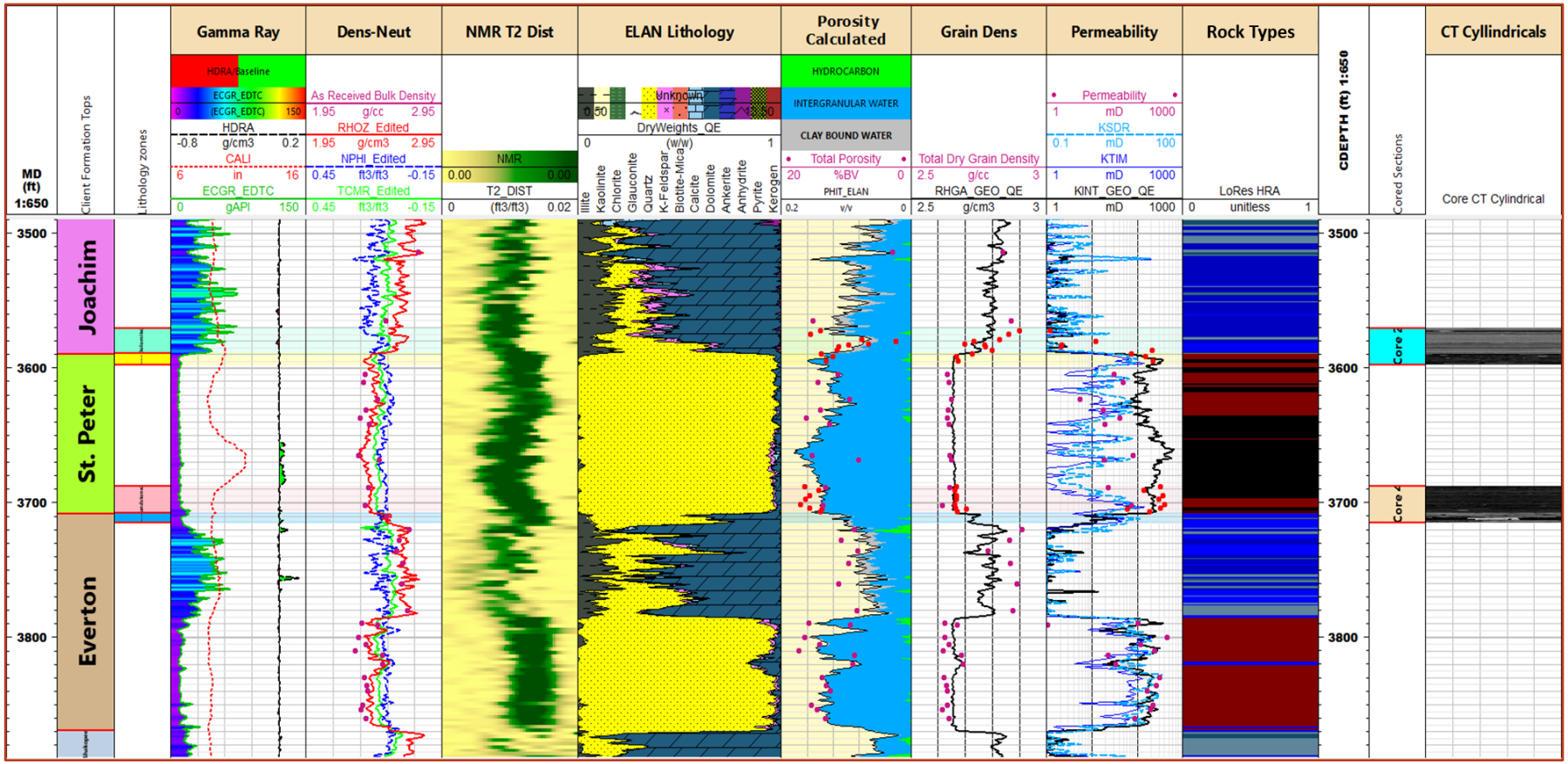
- Prairie State – coal fired power station commissioned 2012 1600 MW – 2 units
- St Peter-Everton Storage Complex (ca 8.125 MTPA CO_2 from 1 unit)
- Storage near site location

- One Earth Energy – ethanol plant
- Mt Simon Storage Complex – Storage HUB (0.5 to 4.5 MTPA CO_2)
- Storage near site location
- Onshore Hub Storage facility

Prairie State Generating Company (PSGC) site Updates

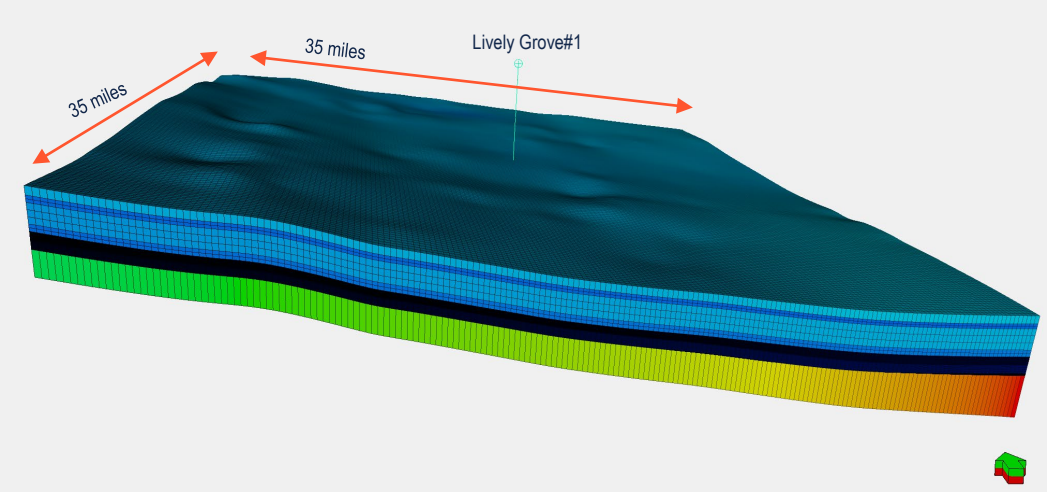
- Targeted injection zones: St. Peter and Everton Sandstones
- Characterization well: Lively Grove #1 (LG #1)
- Storage requirement:
  - Inject 8.125 MMTA of CO_2 for a period of 20 years in a storage complex around PSGC property (total of 162.5 MMtonnes of CO_2)
- Simulation study objectives:
  - Determine number of wells and well spacing required to inject 8.125 MMTA for 20 years
  - Determine CO_2 plume size and pressure front distribution vs. time
  - Determine Area of Review (AoR)
  - Provide input to the Class VI permit preparation

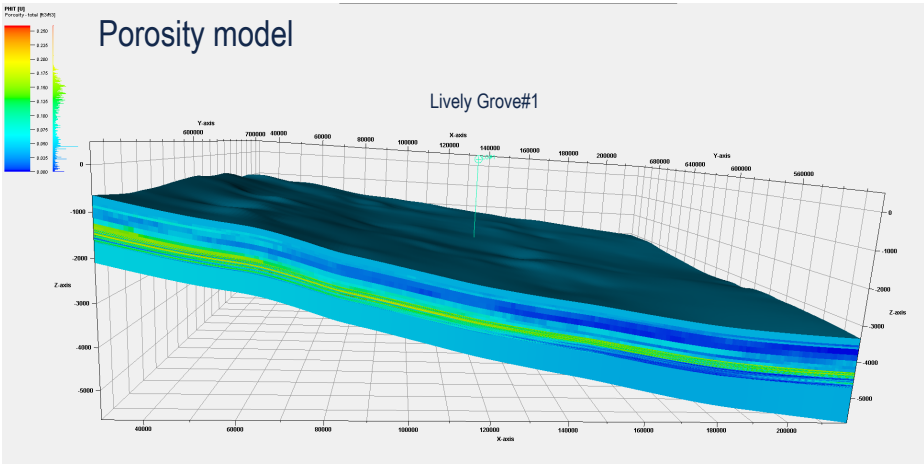
LIVELY GROVE #1: Integrated Petrophysical Analysis - Main Reservoir Section

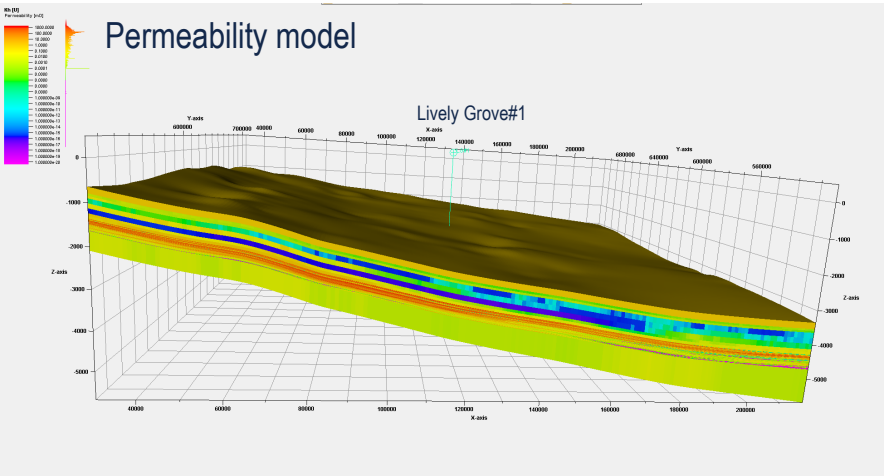


Lively Grove#1 geocellular Model

Grid dimensions(X and Y): 1000 by 1000 ft
Number of layers:149 layers
Number of grid cells: 5,154,804
Number of zones: 8
Including: Maquoketa Group, Trenton, Platteville, Joachim, St Peter Sandstone, Everton Dolomite, Everton Sandstone, and Shakopee



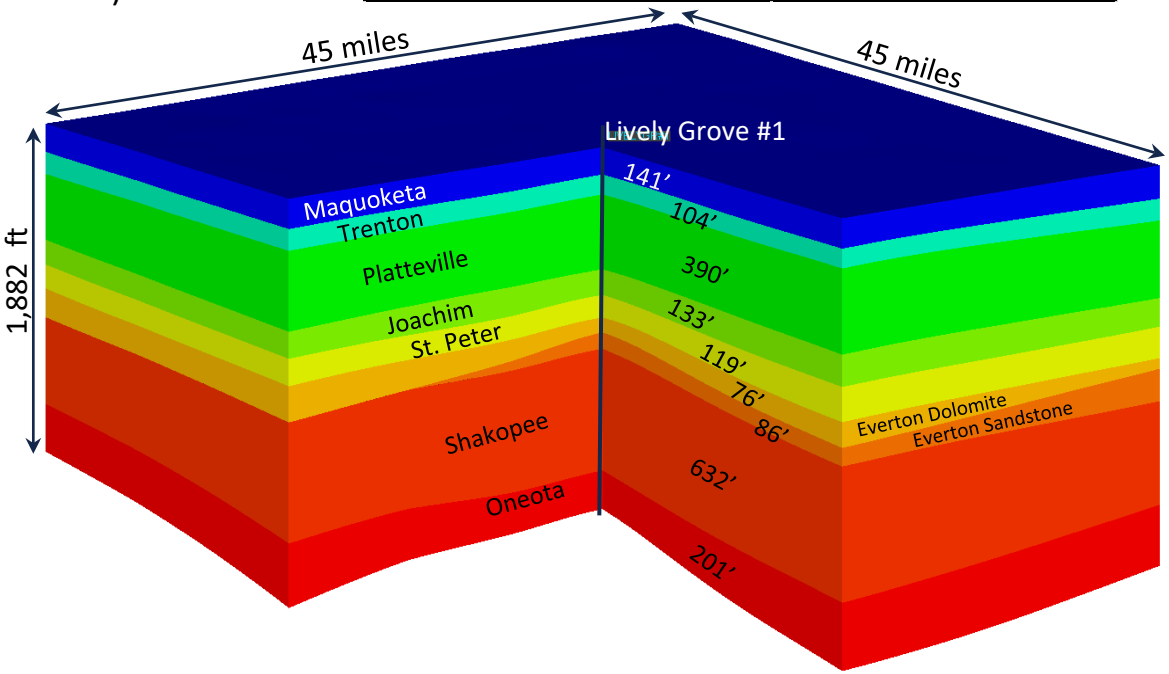




St Peter/Everton: Model Description

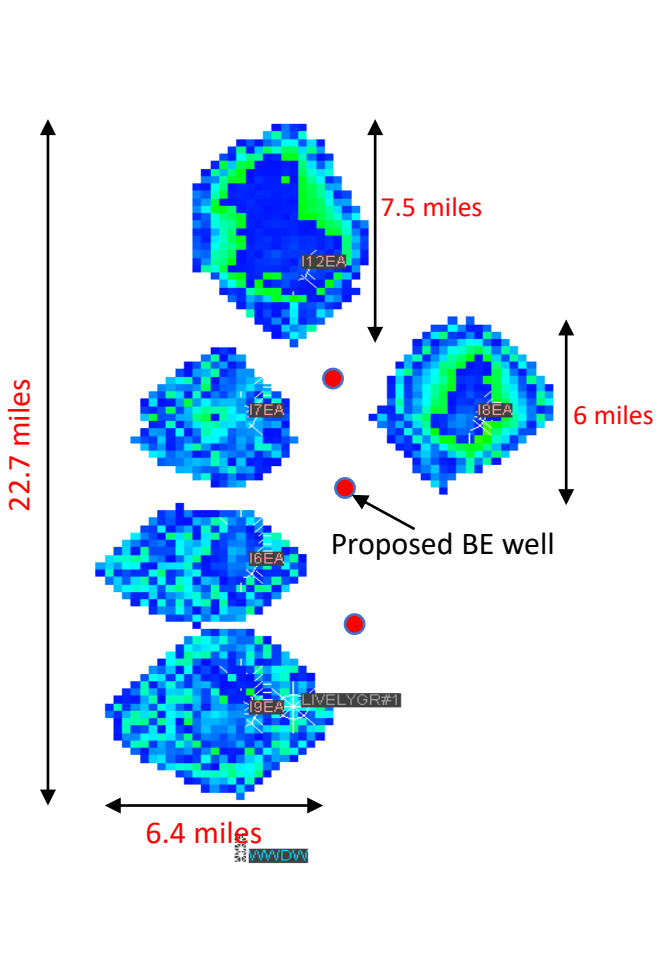
- Nexus Simulation model: 45 x 45 miles
  - Based on geologic model, 3-D heterogeneity
  - Includes overburden/underburden formations
- Model Size
  - Grid cells: 1320’ x 1320’ areally
  - Cell thickness varies: 2.5 ft in St Peter and Everton
  - 182 layers (113 within St Peter and Everton)
  - Total blocks: 6 million
- Boundary Conditions
  - Infinite-acting aquifer on edges
  - Top and Bottom sealed (no flow)
- Injection Constraint
  - P_{max} = 0.9 * 0.58 psi/ft*depth + 15
  - Applied at top of perf interval
- Includes WWDW#1
  - Injects into St. Peter sandstone

Parameter	Value
Initial Pressure	1,607 psia at 3,693', MD
Reservoir Temperature	98 °F at 3,693' MD
Salinity	50,745 ppm
Frac Gradient: St Peter Ss	0.58 psi/ft
Frac Gradient: Everton Ss	0.66 psi/ft



Recap: CO_2 Saturation after 20 years of Injection

CO2 saturation: 10 Slanted wells

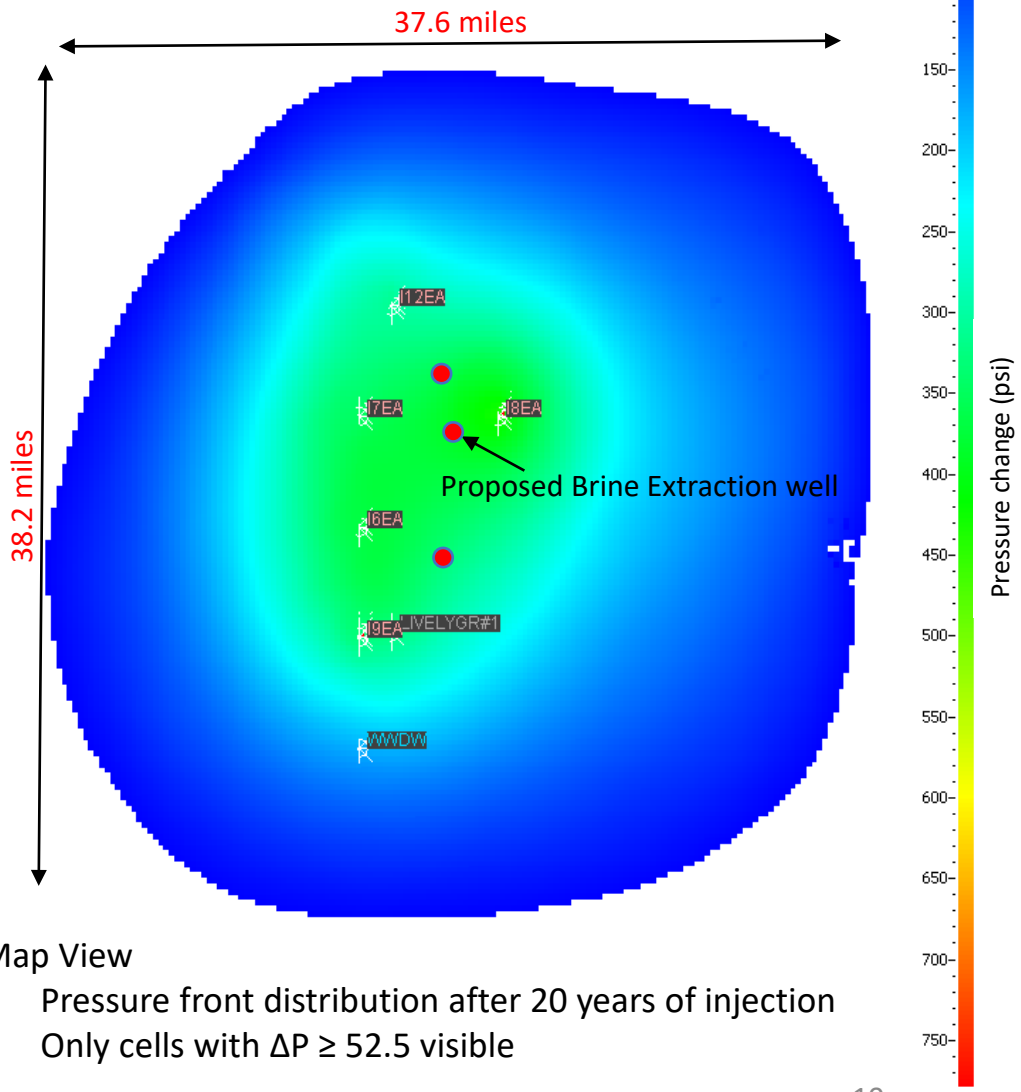


Map View

- Gas Saturation after 20 years at 7.7 Mta
- Only cells with Sg ≥ 1% visible

Pressure change (top of St Peter) : 10 Slanted wells

AoR : 1,436 square miles

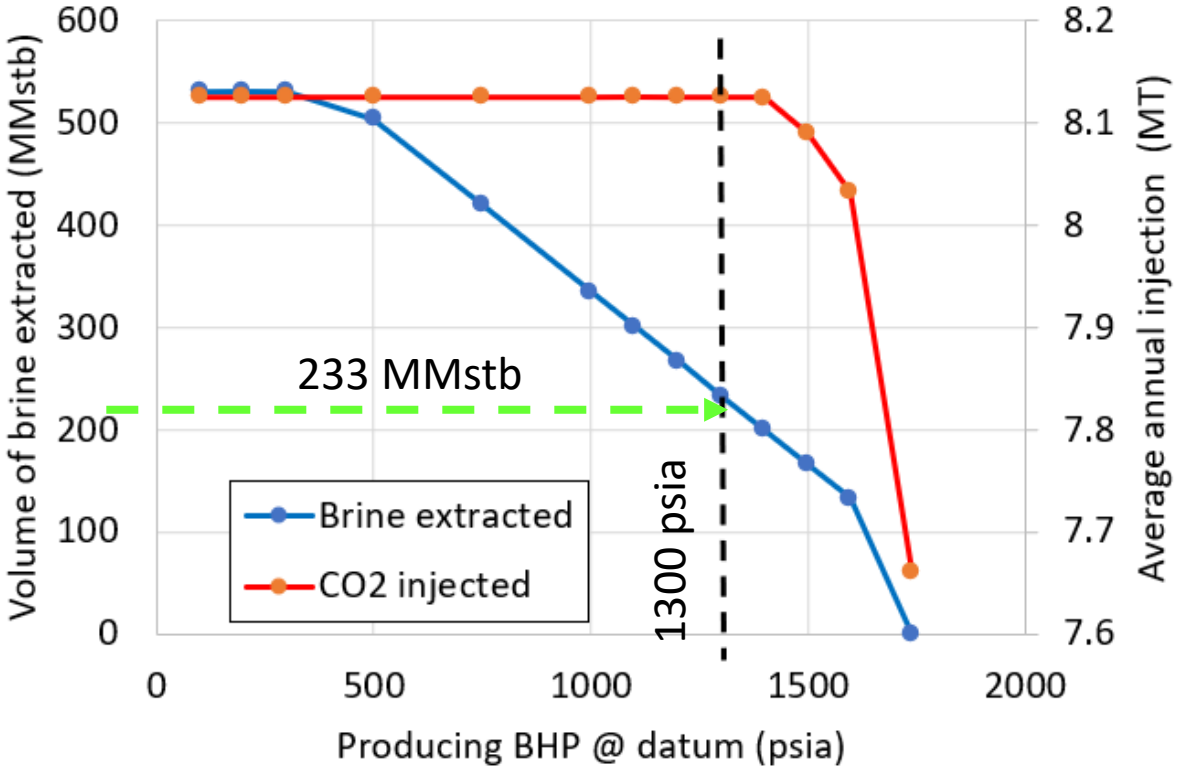


Map View

- Pressure front distribution after 20 years of injection
- Only cells with ΔP ≥ 52.5 visible

Producing BHP sensitivity

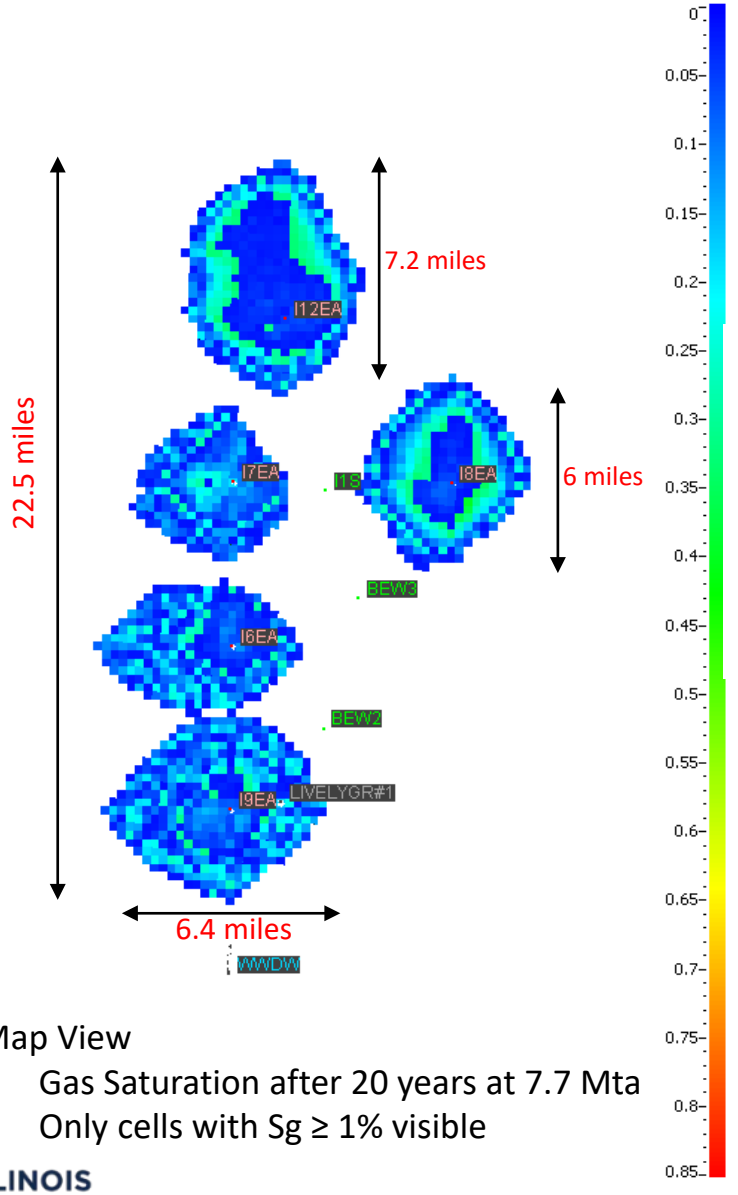
- Range: 100 – 1,565 psia at datum (3,056 - 3,167 ft, ss)
- Objective: Minimize volume of produced brine required to meet injection target (8.125 million tonnes per year)
- Assumption: Extracted brine and wastewater from WWDW1 are injected into the Knox
- Three brine extraction wells



AoR is decreases by about 70 sq miles when 233 million barrels of brine is extracted

CO_2 Saturation after 20 years of Injection

CO2 saturation: 10 Slanted wells



Map View

- Gas Saturation after 20 years at 7.7 Mta
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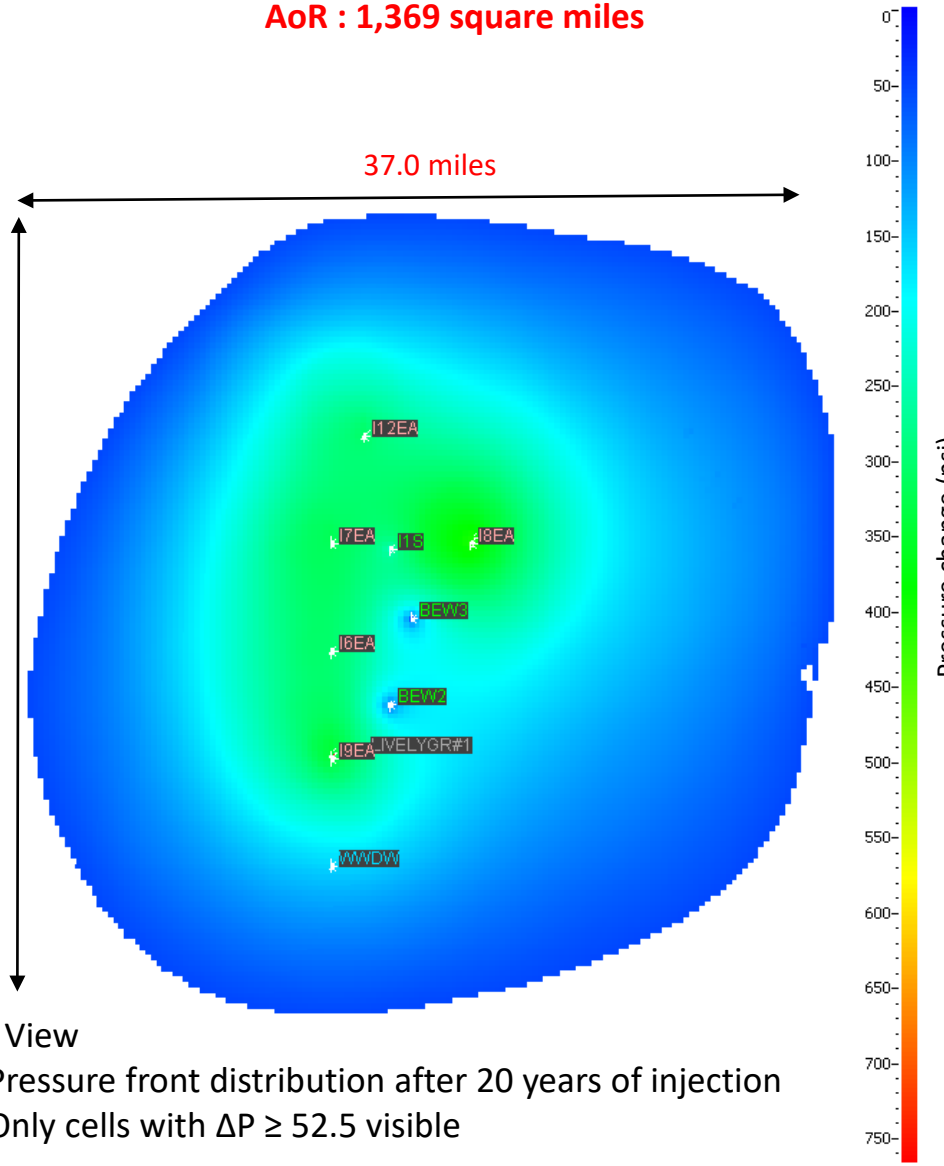
Pressure change (top of St Peter) : 10 Slanted wells

AoR : 1,369 square miles



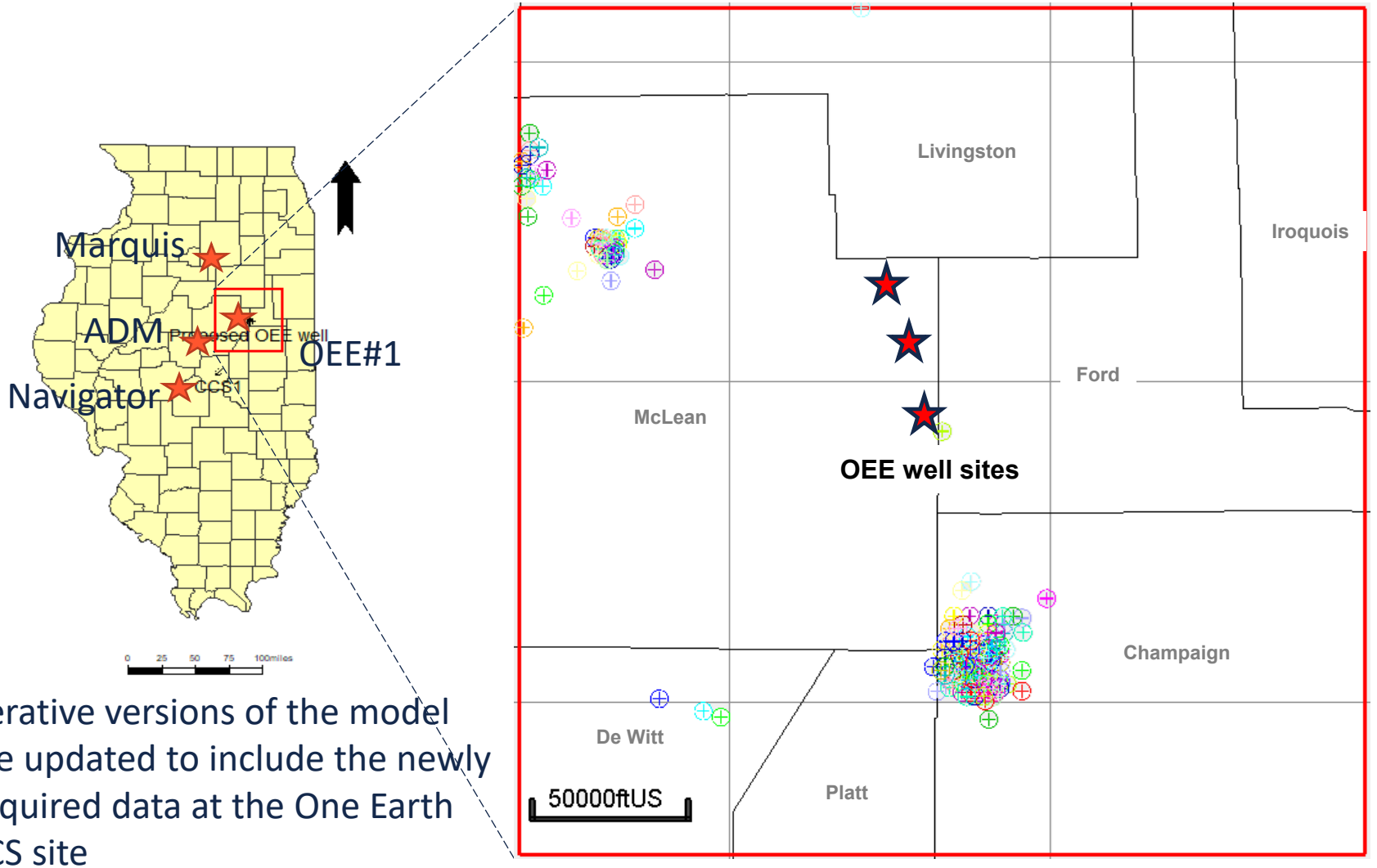
Map View

- Pressure front distribution after 20 years of injection
- Only cells with ΔP ≥ 52.5 visible

One Earth Energy (OEE) site Updates

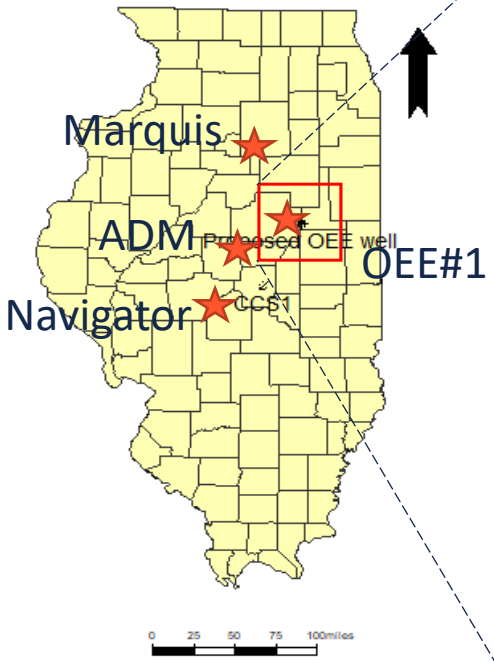
- Targeted injection zones: Mt. Simon Sandstone
- Characterization well: OEE #1
- Storage target:
  - Inject 4.5 MMTA of CO_2 for a period of 20 years in a storage complex near One Earth Energy ethanol facility (total of 90 MMtonnes of CO_2)
- Simulation study objectives:
  - Determine the number of wells and well spacing required to inject 4.5 MMTA for 20 years
  - Determine CO_2 plume size and pressure front distribution vs. time
  - Determine Area of Review (AoR)
  - Provide input to the Class VI permit preparation

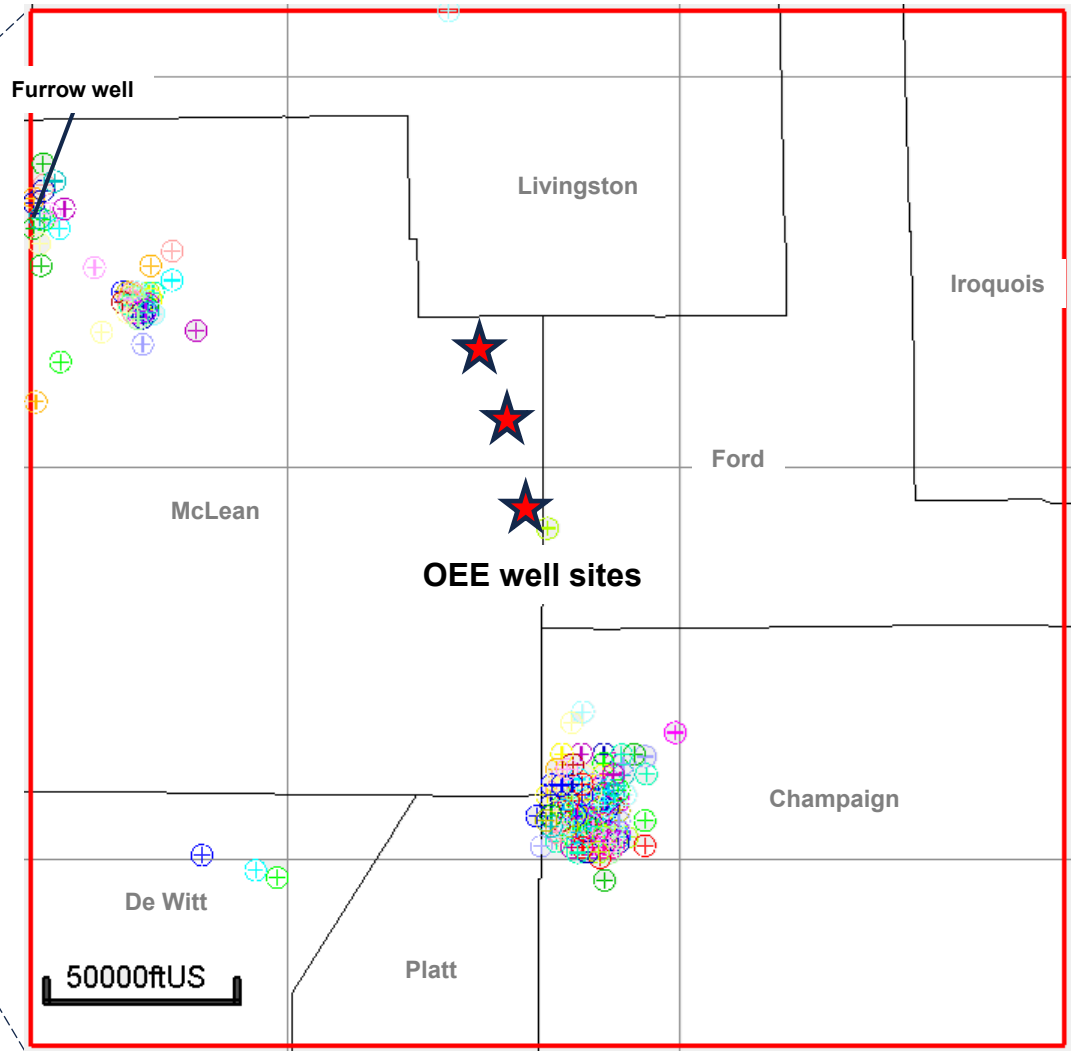
Model area



Iterative versions of the model are updated to include the newly acquired data at the One Earth CCS site

Model area





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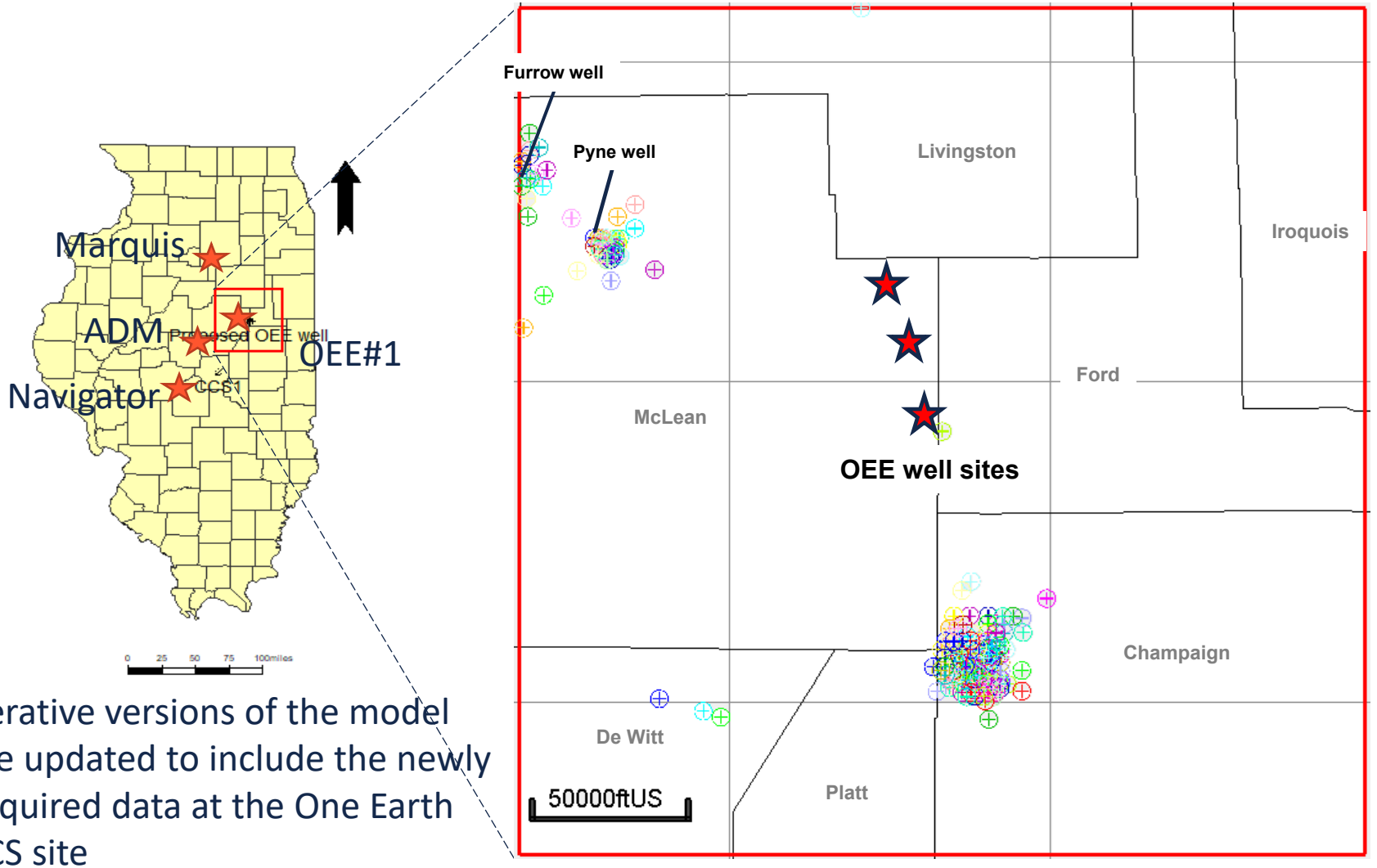

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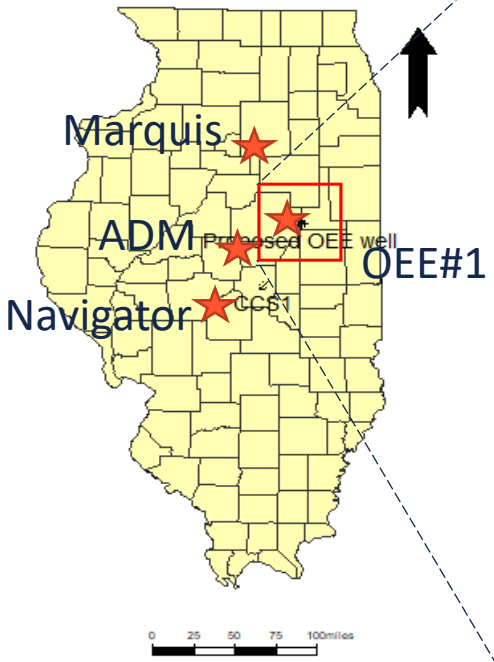

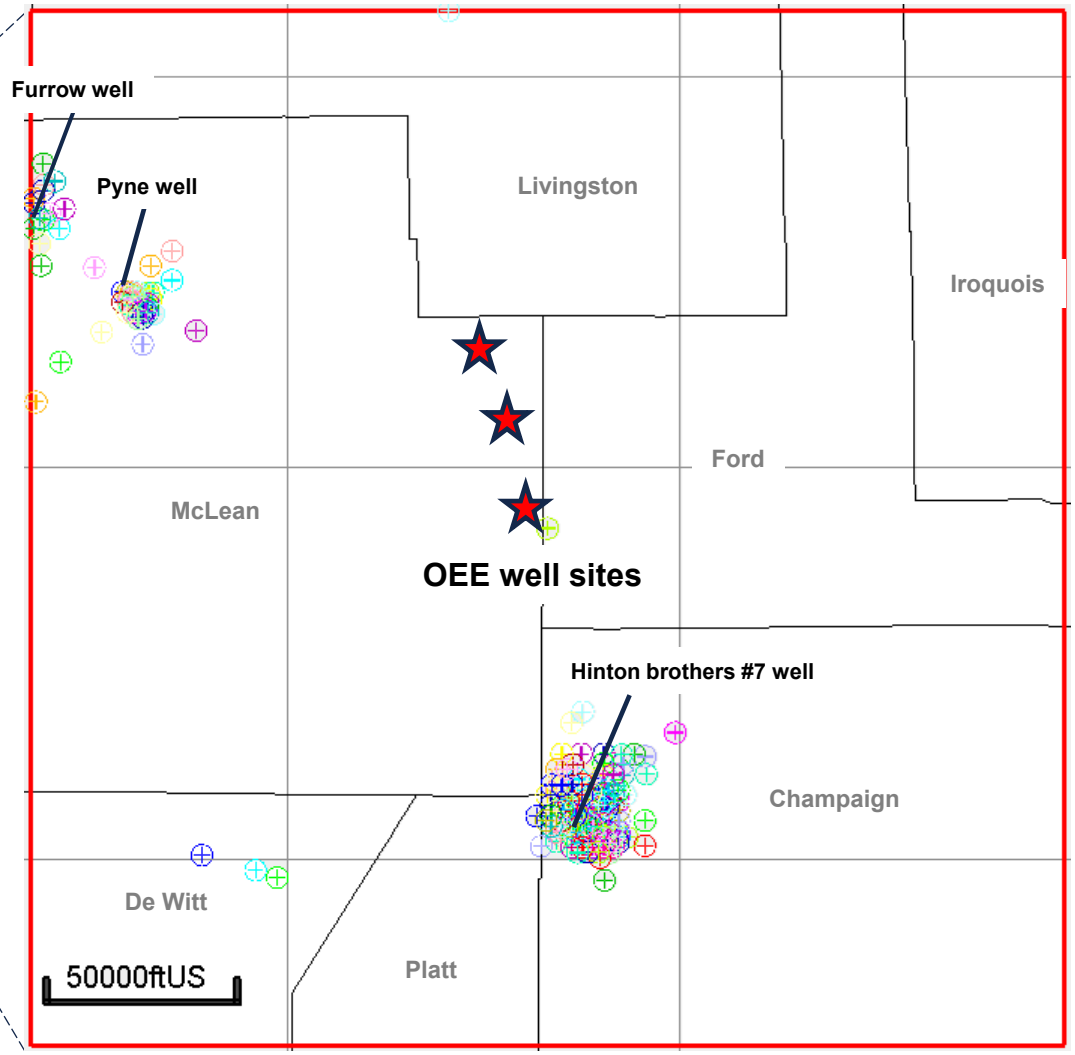

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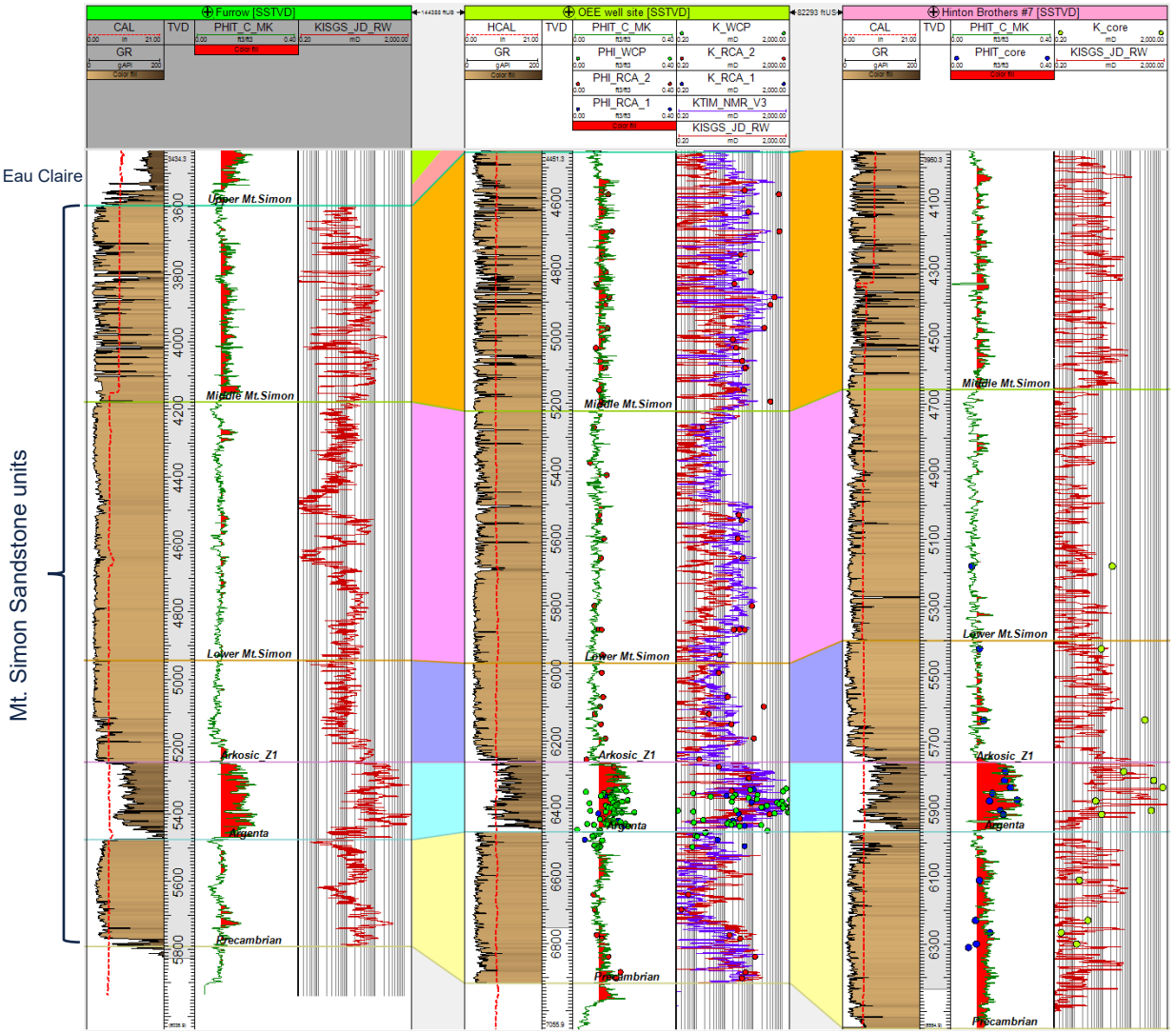
Lithostratigraphy/ Well log X-section

SYSTEM	GROUP	FORMATION
Cambrian	Knox	Eminence
		Potosi
		Franconia
		Iron-Galesville
		Eau Claire
		Mt. Simon
		Pre-Mt. Simon
Precambrian		

*Simplified lithostratigraphic chart



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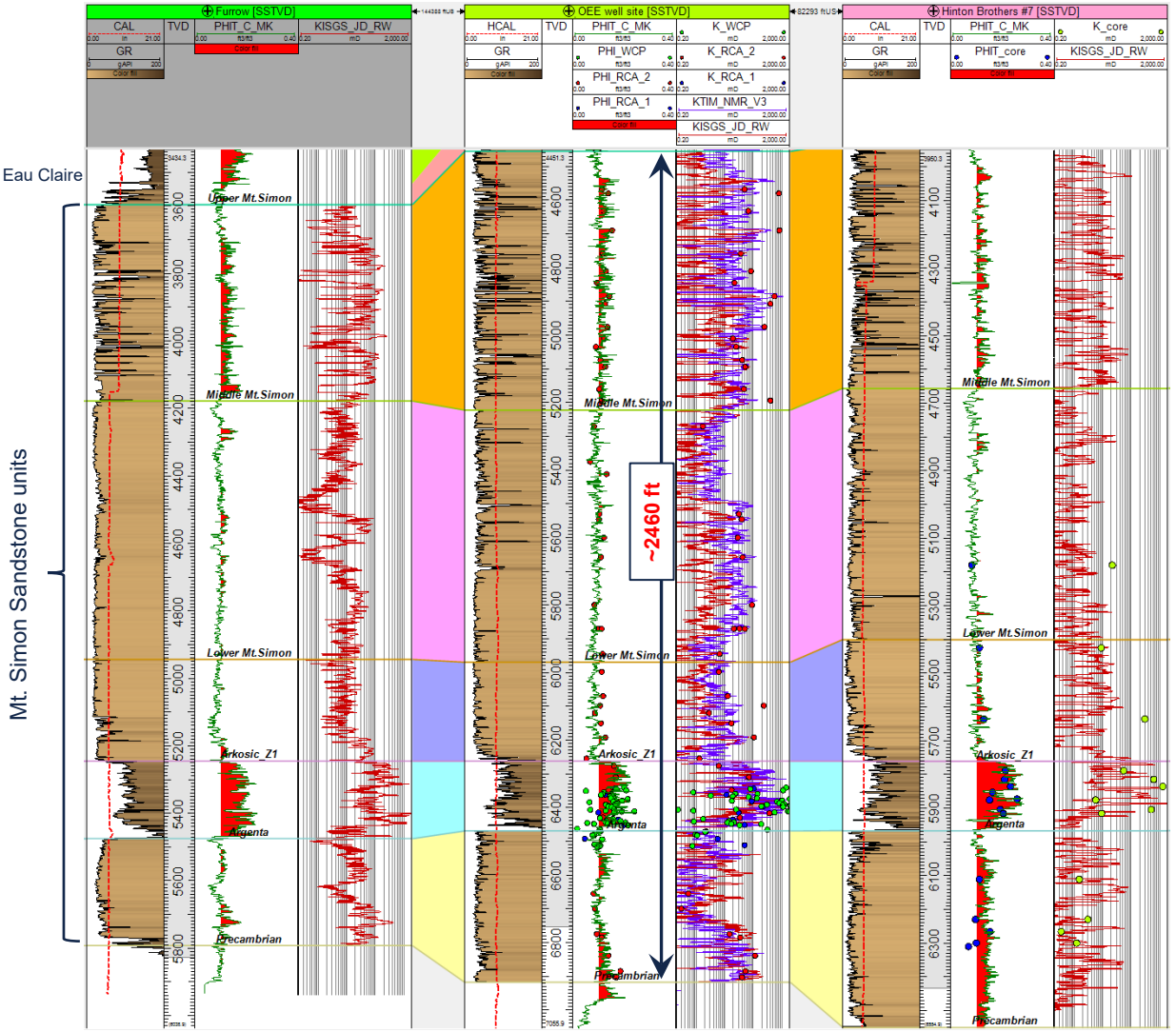

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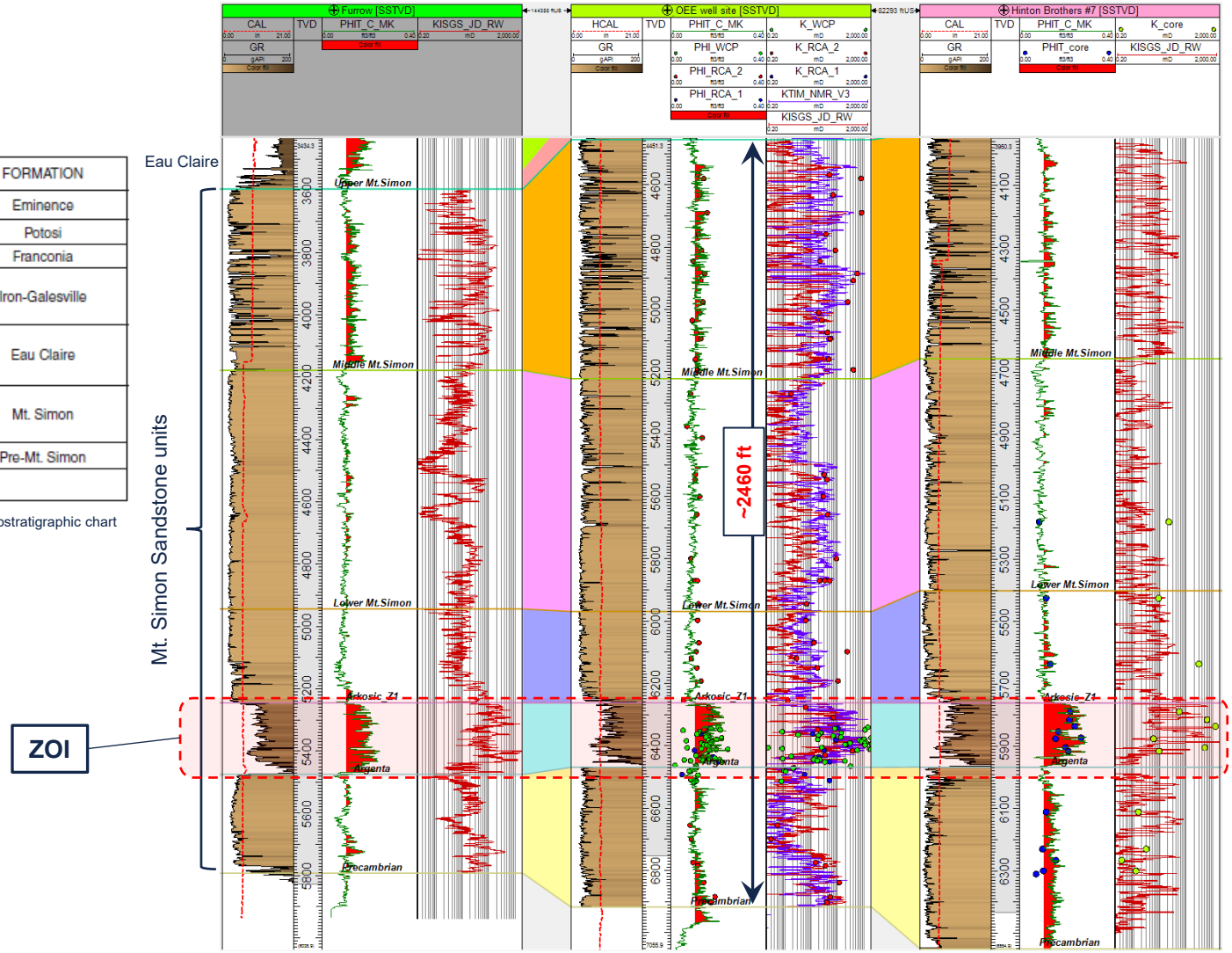
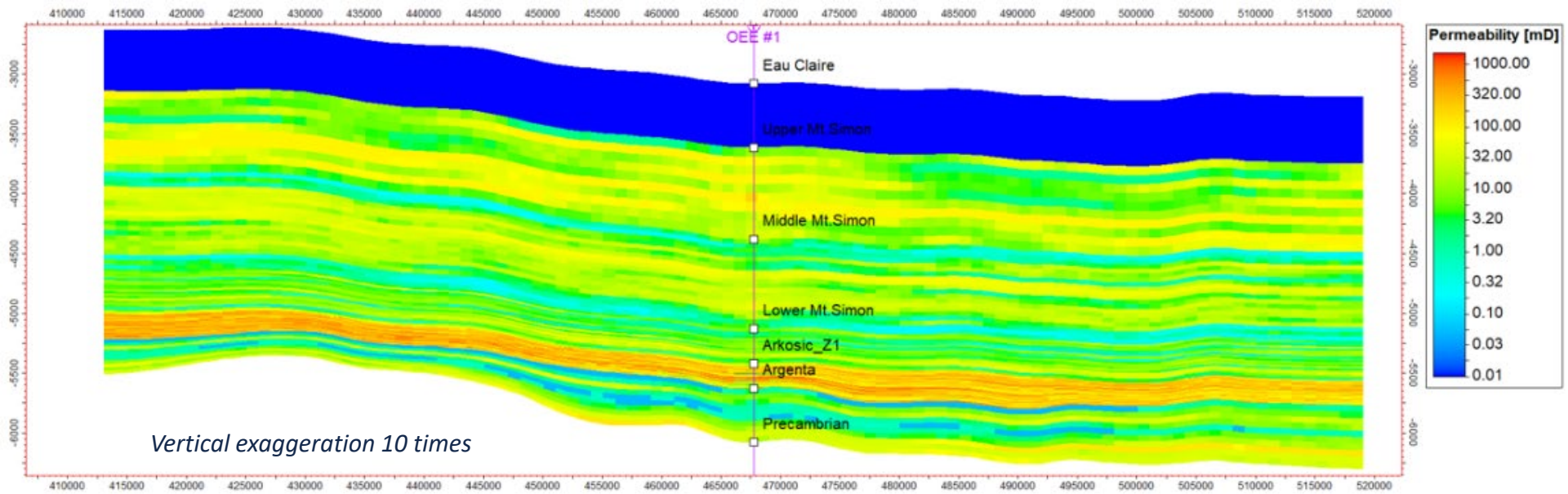


OEE geocellular model

Heterogeneous model, MS+ Argenta averaging 11%, 44 md

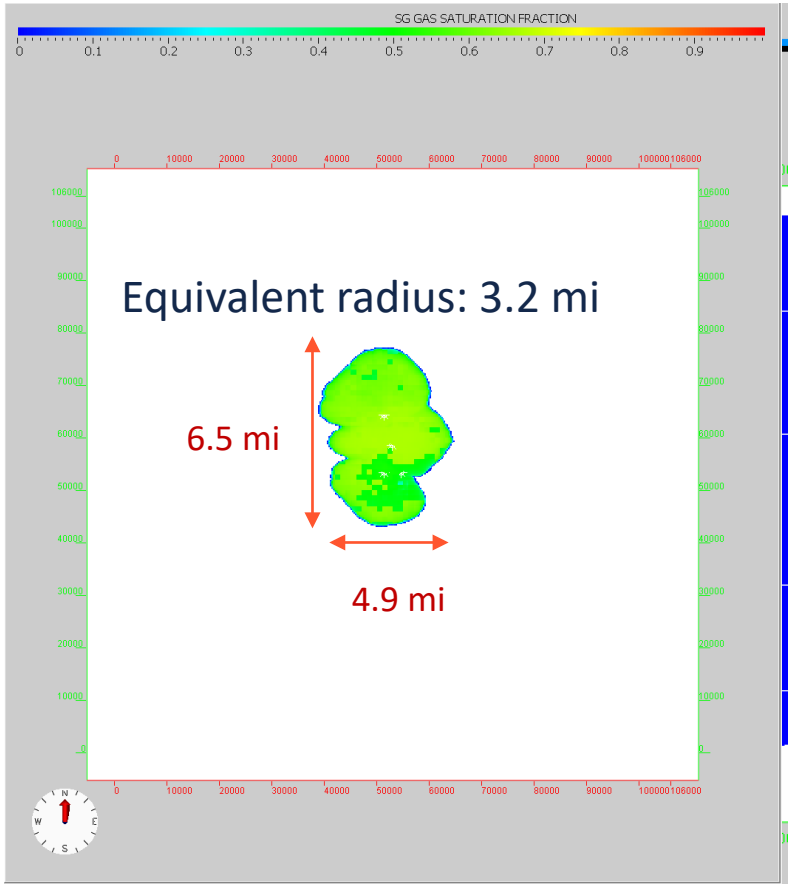


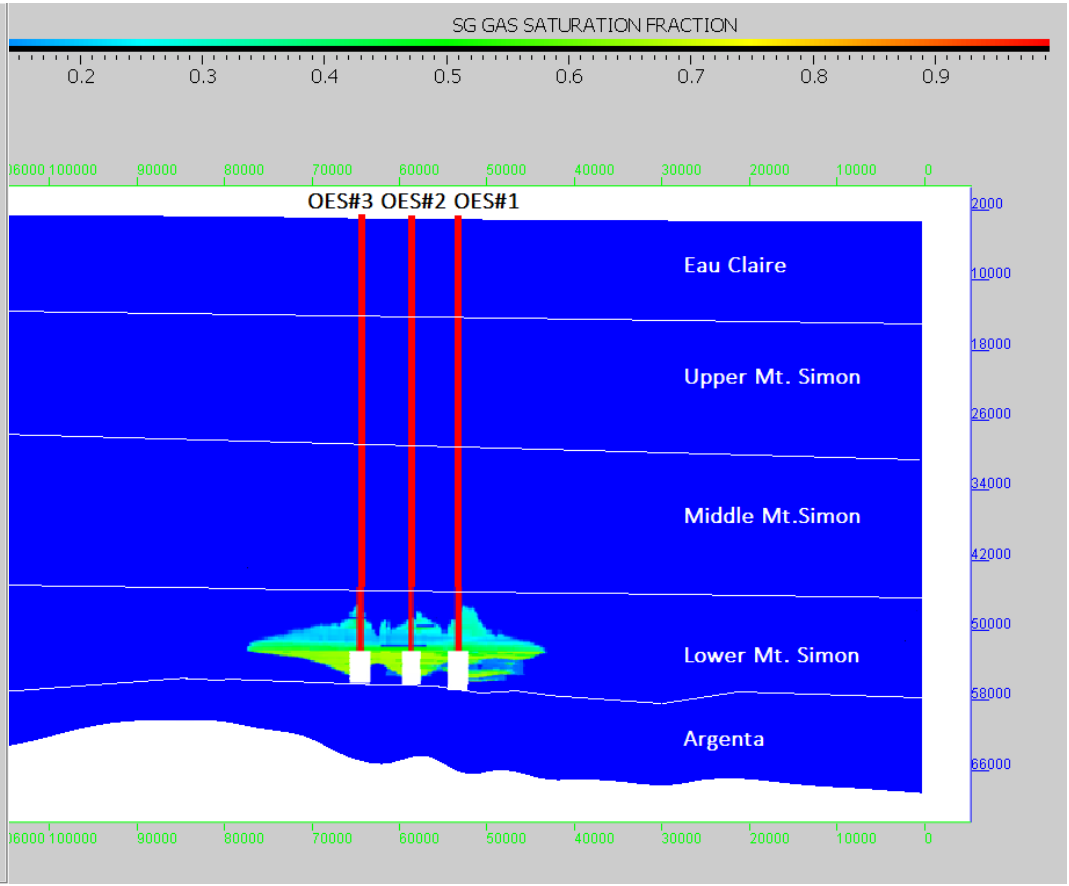
Average Cell size:

- 1000 ft x 1000 ft x 21 ft
- Around injection wells
  - 250 ft x 250 ft x 21 ft

Unit	Thickness, ft	Porosity, %	Permeability, mD
Eau Claire	537	5	0.0001
Upper MS	720	11	31
Middle MS	740	9	15
Lower MS	320	9	12
LMS Arkose	200	16	308
Argenta	460	12	18

CO_2 plume distribution at 20yr-injection

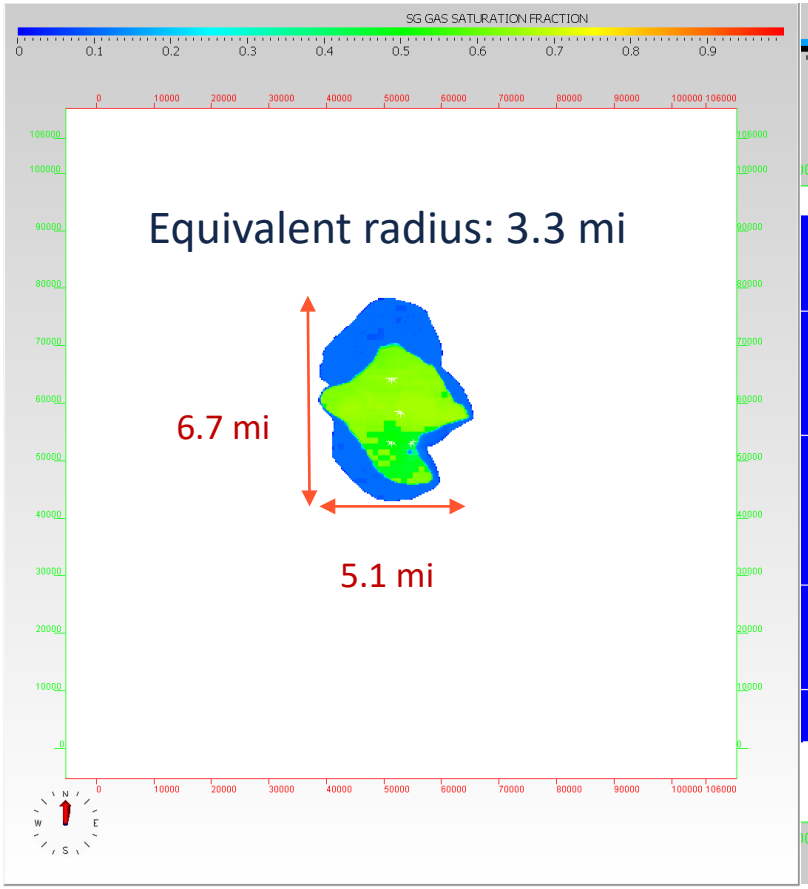


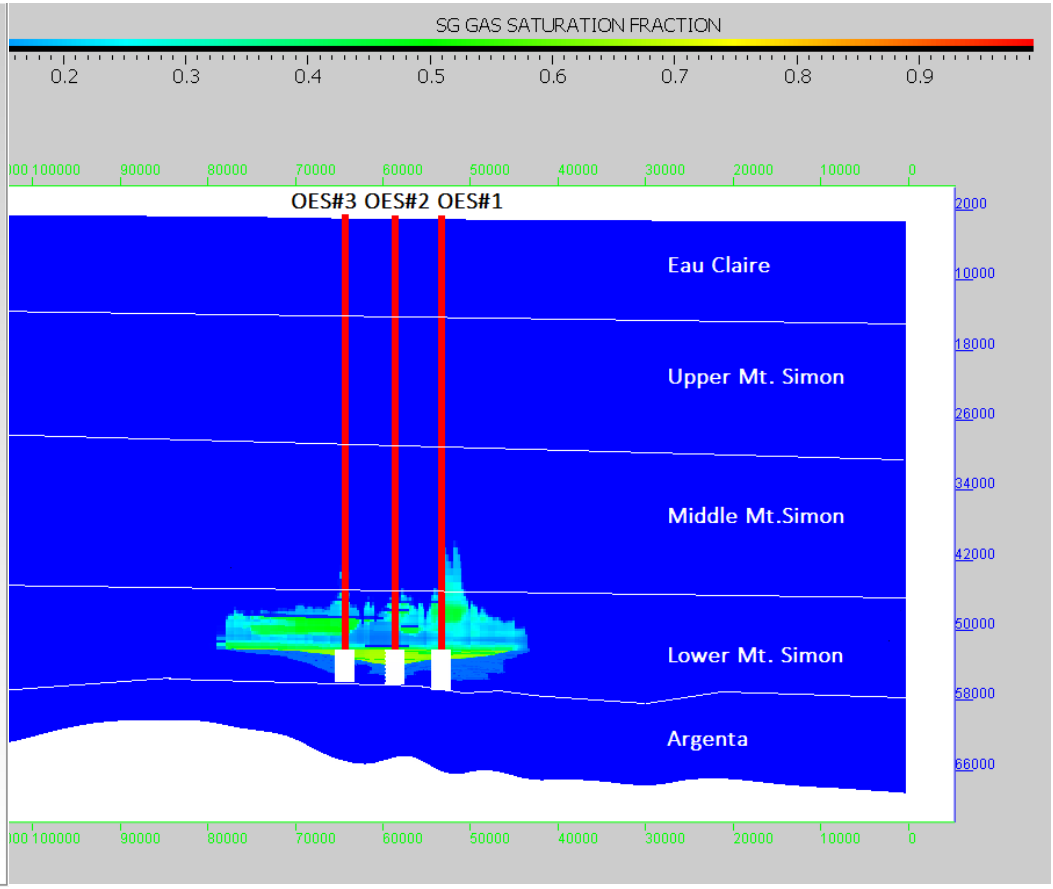


Sg>1%

Vertical exaggeration 20 times

CO_2 plume distribution at 50yr-post injection





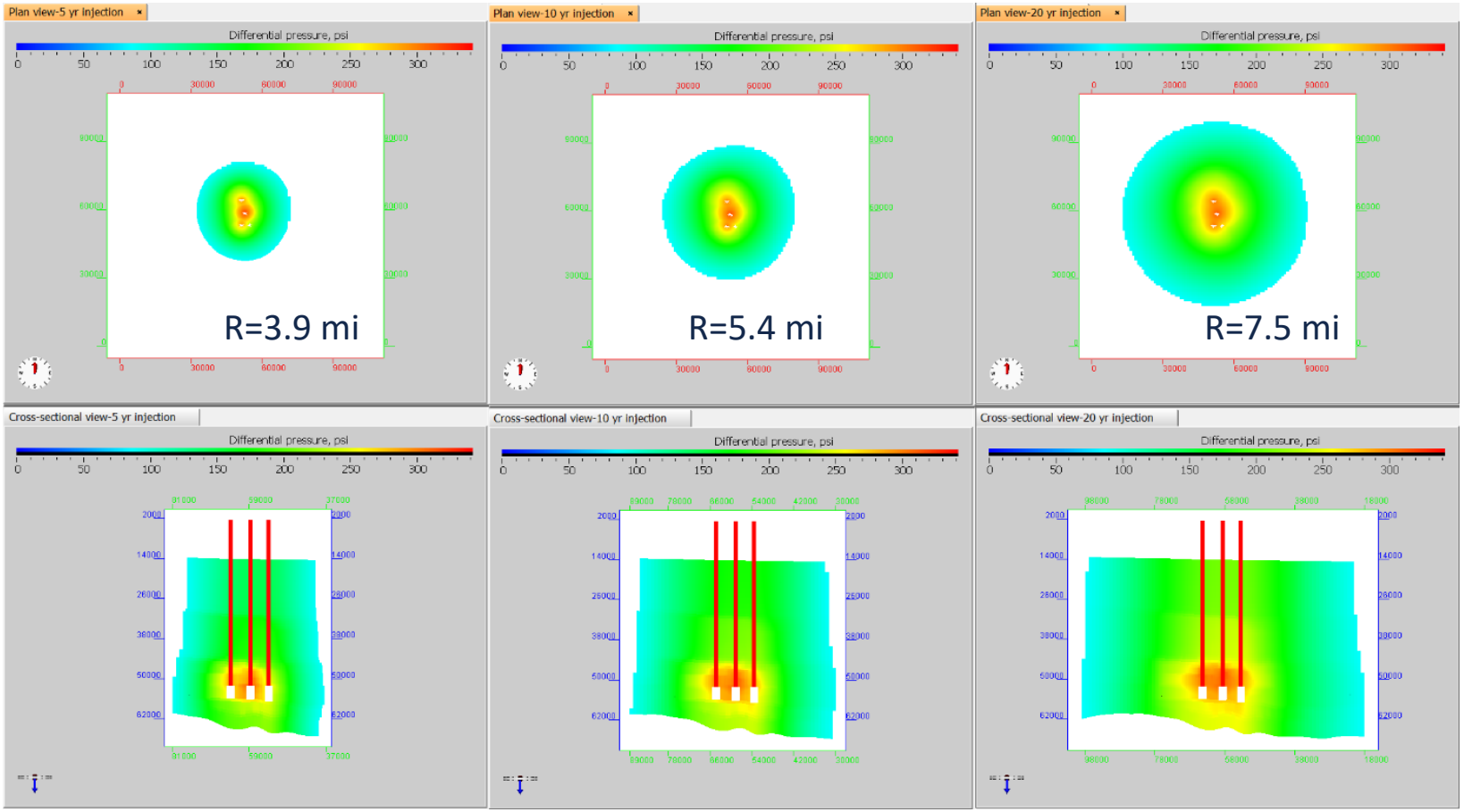
Sg>1%

Vertical exaggeration 20 times

Pressure front during injection

Based on a threshold differential pressure of 86 psi

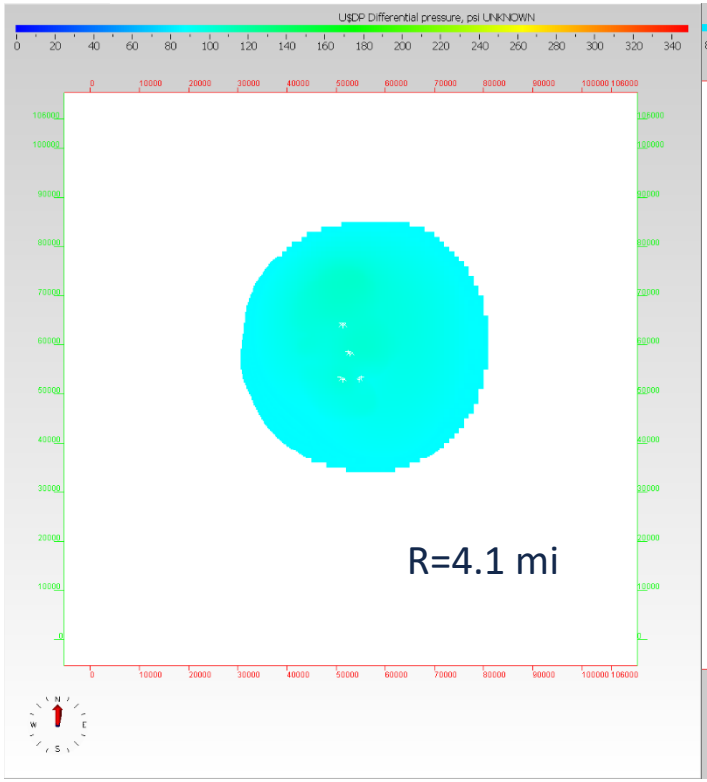
5-year injection *10-year injection* *20-year injection*



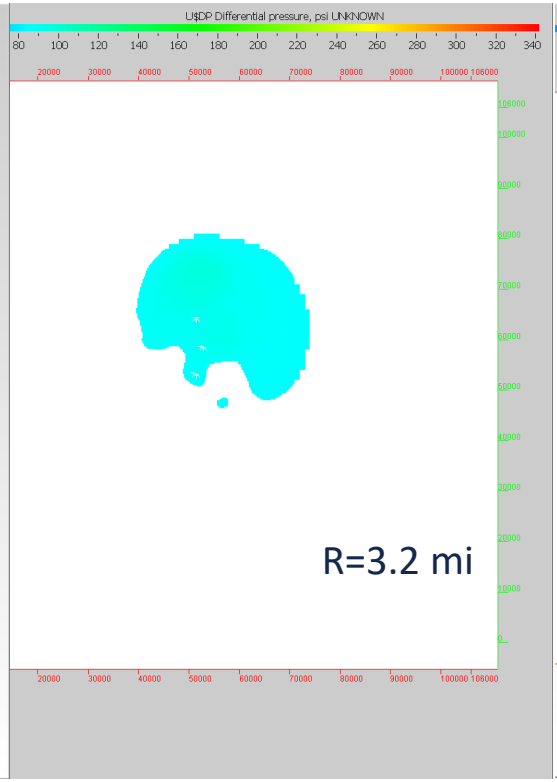
Pressure front post injection

Based on a threshold differential pressure of 86 psi

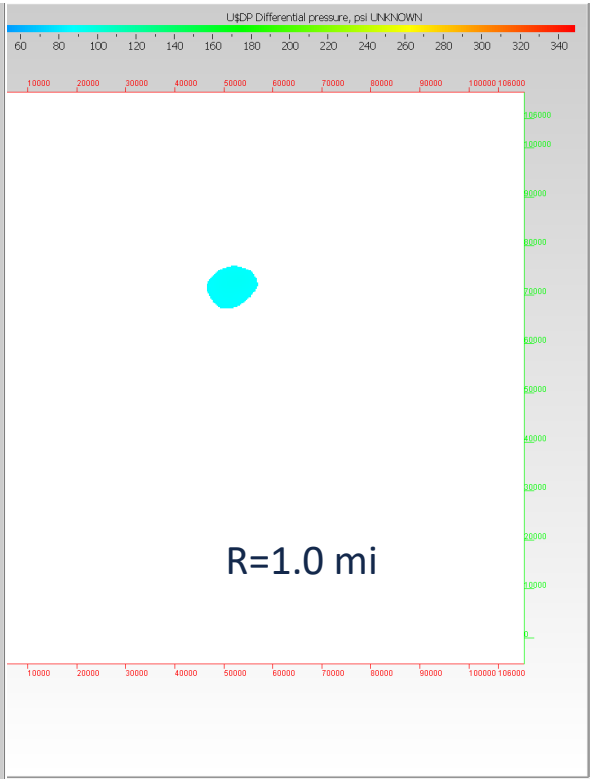
5-year post injection



6-year post injection

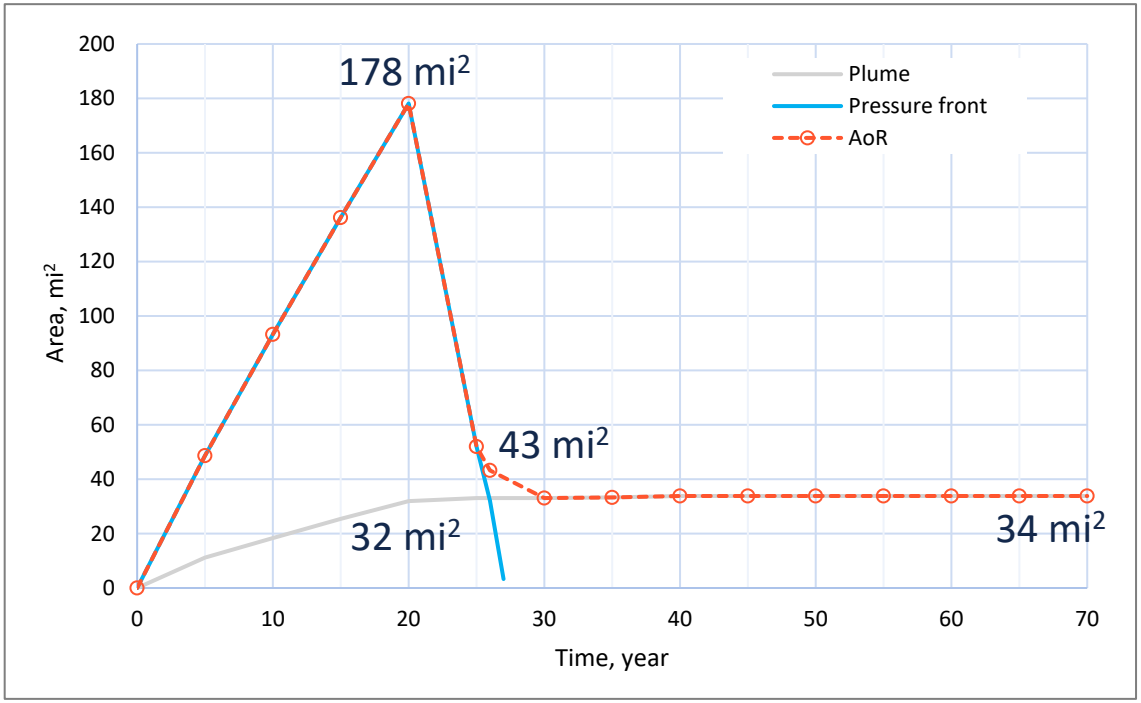


7-year post injection



Area-of-Review (AoR)

- The larger between the plume area and pressure front.



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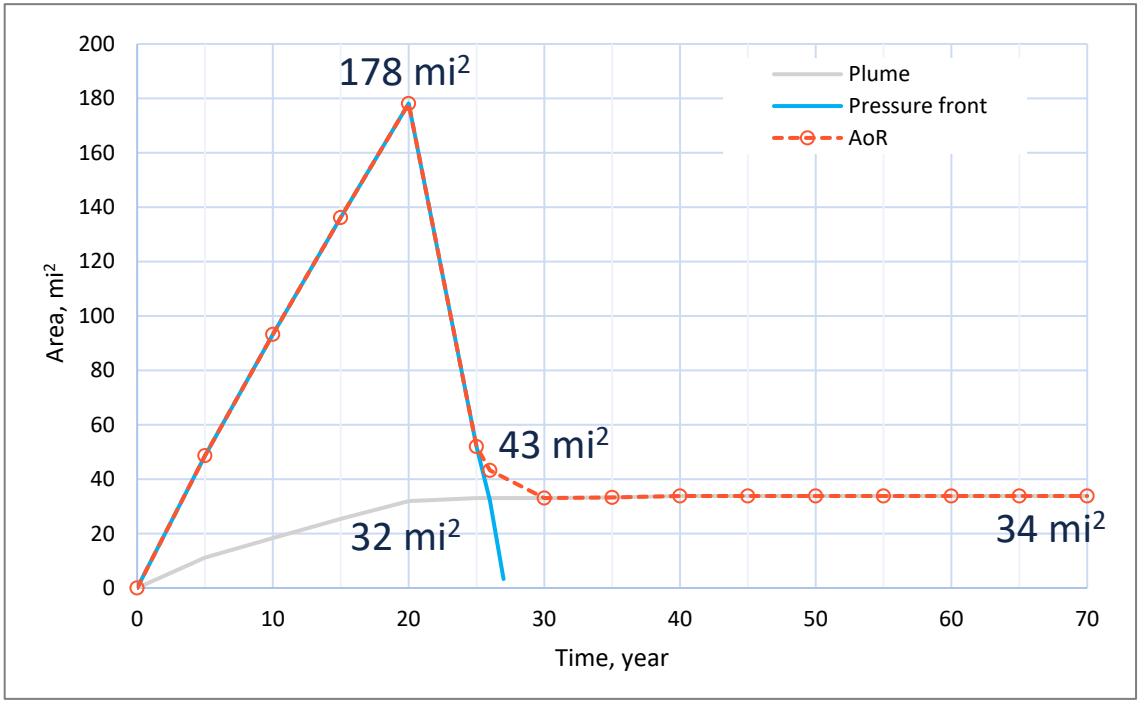

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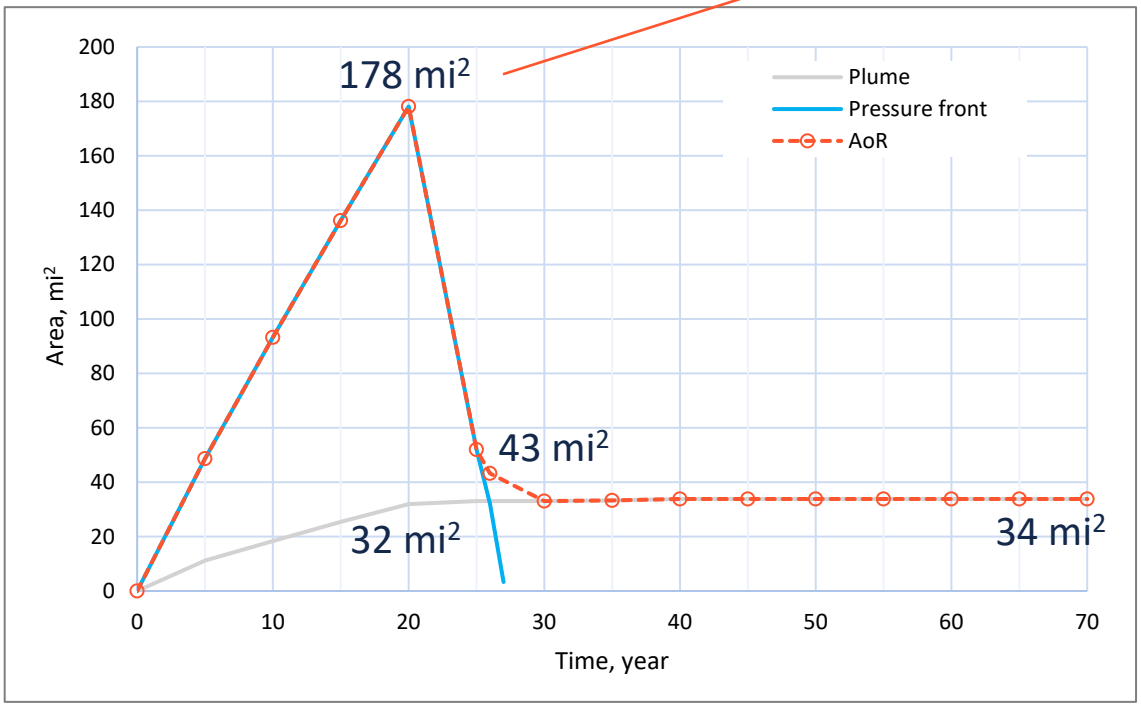

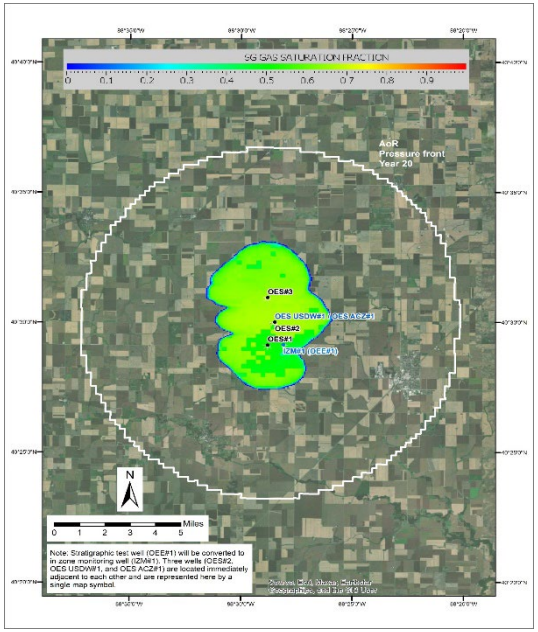

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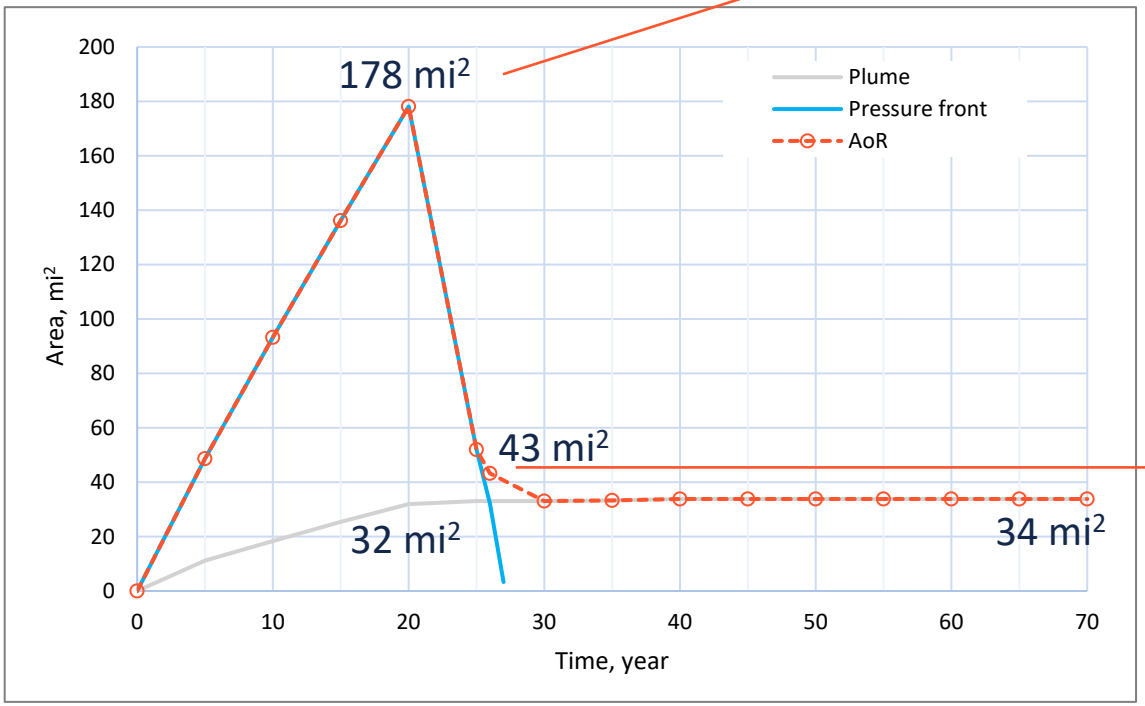

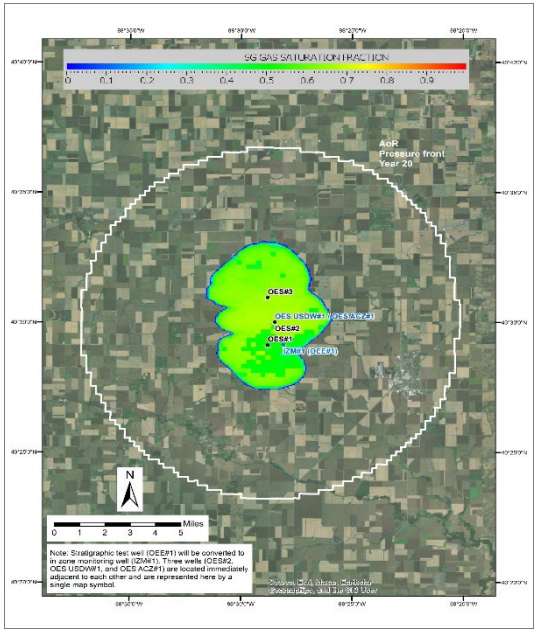

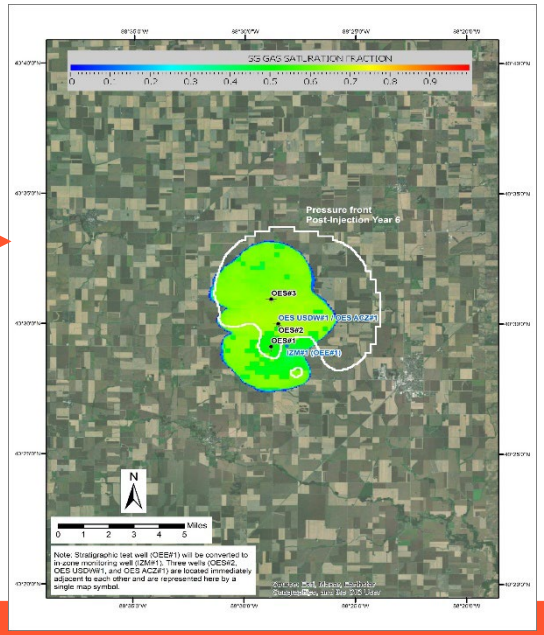

UIC Class VI permit status

PSGC site

- Two Class VI permit applications prepared and submitted to PSGC
- PSGC's executive board will select a third-party operator that will submit UIC Class VI permits for the site.
- Lively Grove #1 has been plugged.

One Earth Sequestration site

- Three Class VI permit applications were submitted to the US EPA on October 28, 2022.
- Uploads to GSDT completed Completeness review by US EPA dated November 23, 2022.
- Received first comments from US EPA on May 31st, 2023.
- Responses to US EPA's comments: June 20th, 2023.
- OEE#1 well will be converted to monitoring well

Future tasks

- Environmental Assessment (EA) based on Environmental Information Volume (EIV) determination
- Storage field development plans
- Community Benefit Plans (CBPs)
- CO_2 pipeline FEED studies
- Regional CO_2 point sources assessment and pipeline network
- Monitoring: Statistical optimization approach
- Research work:
  - Regional study of St. Peter Sandstone
  - Smart brine extraction and disposal approach
    - Centrifugal Packer-Type Downhole Separator (prototype)

Key accomplishments to date

1. Characterized both OEE and PSGC sites
2. Completed quantitative risk assessment for both sites
3. Plugged Lively Grove #1 well (PSGC site)
4. Prepared UIC Class VI permit documents for the PSGC site
5. Submitted three UIC Class VI permits for the OEE site
6. Coordinating with Environmental Assessment (EA) at OEE and PSGC sites.
7. Completed 13 technical reports and counting

Announcement

ISC Project All-Hands Meeting

Dates: September 26 –27, 2023
Location: Champaign, Illinois

Agenda

- Presentations
- Roundtable discussions
- Site visit to One Earth Sequestration/OEE site

Registration is still open
https://forms.illinois.edu/sec/465698360

Prairie Research Institute
UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN

Project Team

Acknowledgement

This material is based upon work supported by the Department of Energy

Award Number DE-FE0031892

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UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN

End