CarbonSAFE Illinois
Macon County

DE-FE0029381

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U.S. Department of Energy

National Energy Technology Laboratory

Carbon Management and Oil and Gas Research Project Review Meeting – Carbon Storage

August 2 - 11, 2021

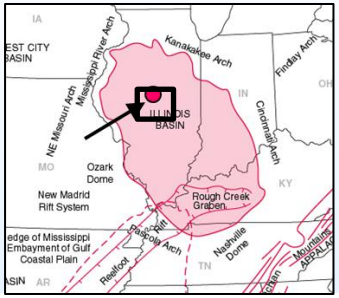
Presentation Outline

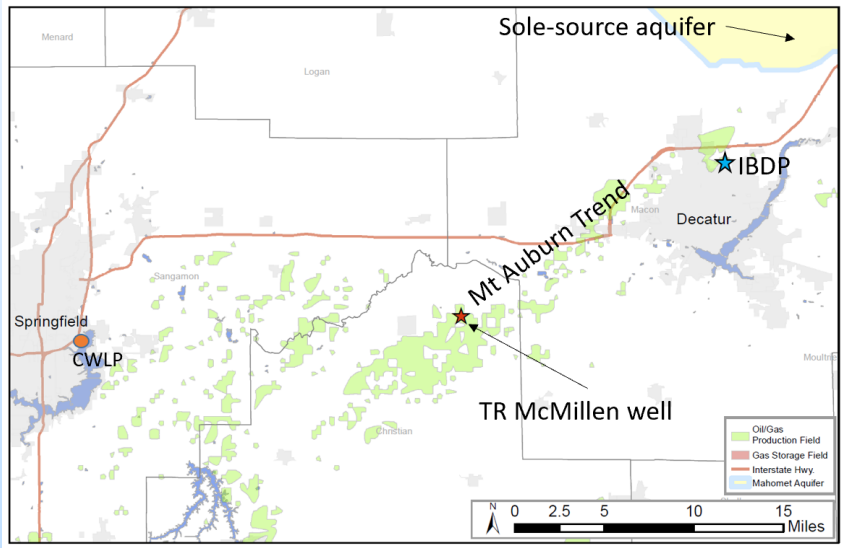
- Objectives
- Technical Status
  - Site Characterization
  - Modeling
  - Infrastructure & Future Development
- Accomplishments
- Lessons Learned
- Summary

Objectives

- Evaluate the feasibility of storage of 50 million tonnes of CO_2 injected over 30 year
- Establish workflows and generate data to assist commercial development of CCS

Site Selection





SYSTEM	GROUP	FORMATION	Storage Elements
Ordovician	Maquoketa	Brainard	Secondary Seal
		Ft. Atkinson	
		Scales	
	Galena	Kimmswick	
		Decorah	
	Plateville		
	Ancell	Joachim	
		St. Peter	Potential target
	Knox	Shakoppee	Secondary Seal/Reservoir
		New Richmond	
		Oneota	
		Gunter	
Cambrian		Eminence	
		Potosi	Potential target
		Franconia	
		Ironton-Galesville	
		Eau Claire	Primary Seal
		Mt. Simon	Target reservoir
Precambrian			

St. Peter-Knox Storage Complex

Mt. Simon Storage Complex

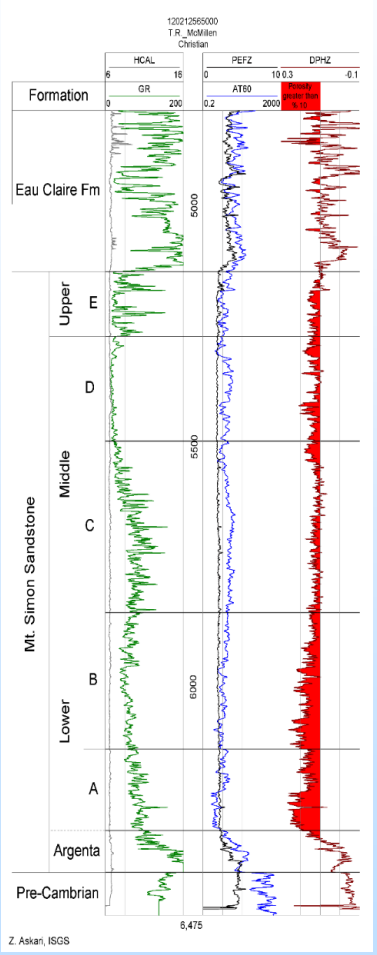
Cambro-Ordovician Storage Complex

Data Acquisition & Analyses

- Regional geological data
- Drilled stratigraphic test well
  - Full diameter, sidewall cores
  - Geological descriptions
- Geophysical logs
  - Petrophysics
  - Geomechanics
- Well Tests
- Walkaway VSP
- 2D seismic

Site Characterization

TR McMillen #2: Characterization well

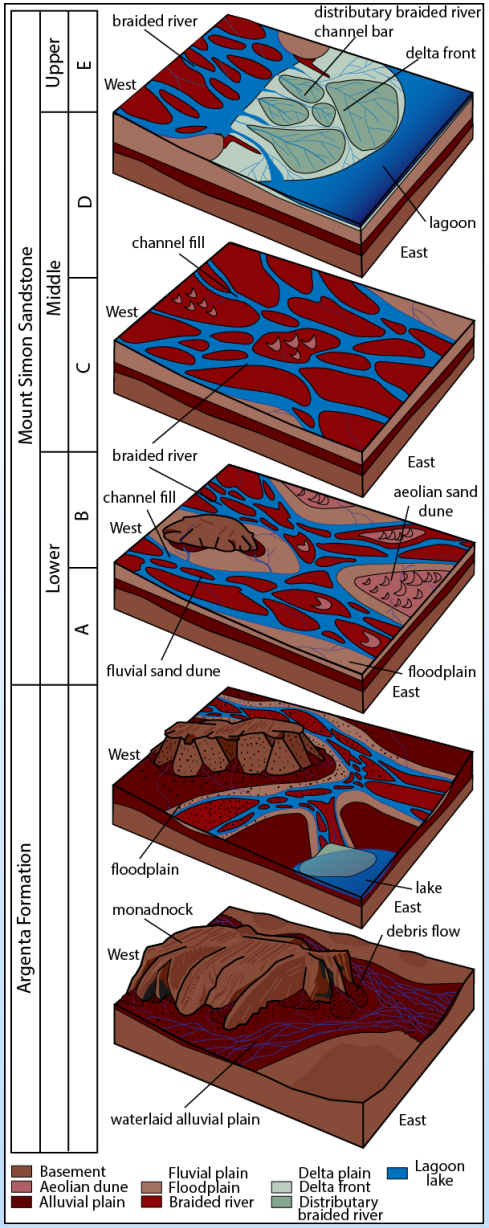


Eau Claire: Primary containment

TD at 6,469 ft
150 feet of 3.5 inch core:
- Silurian 62 ft
- Lower Mt Simon 61 ft
- Precambrian 27 ft

109 rotary sidewall cores
Extensive geophysical logs

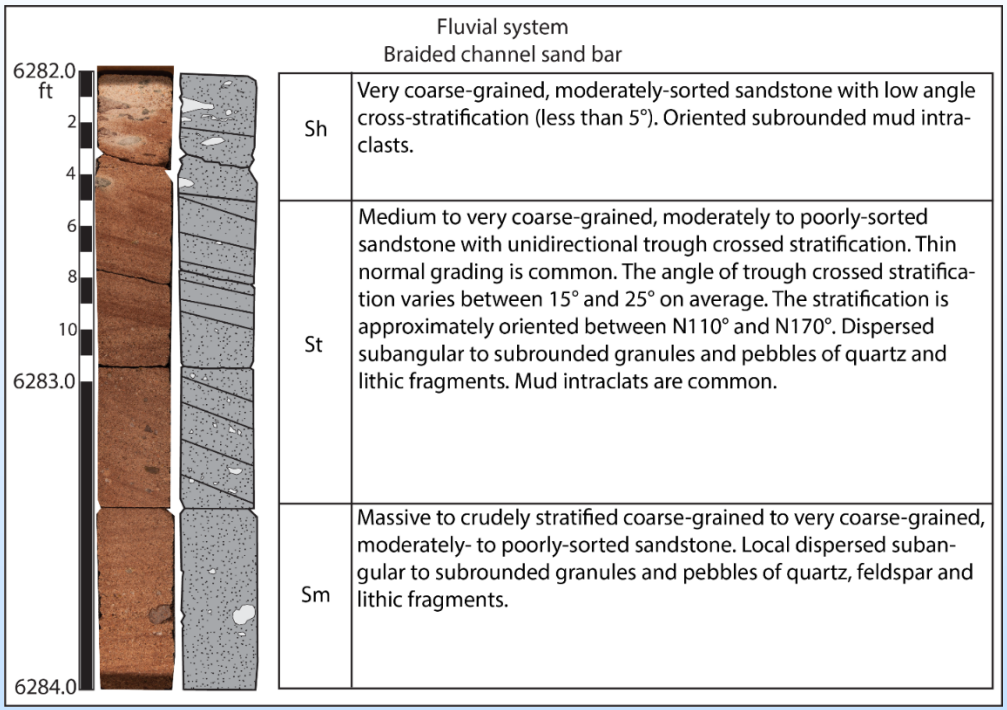
Lower Mt Simon Sandstone ("Arkose"): Primary Reservoir

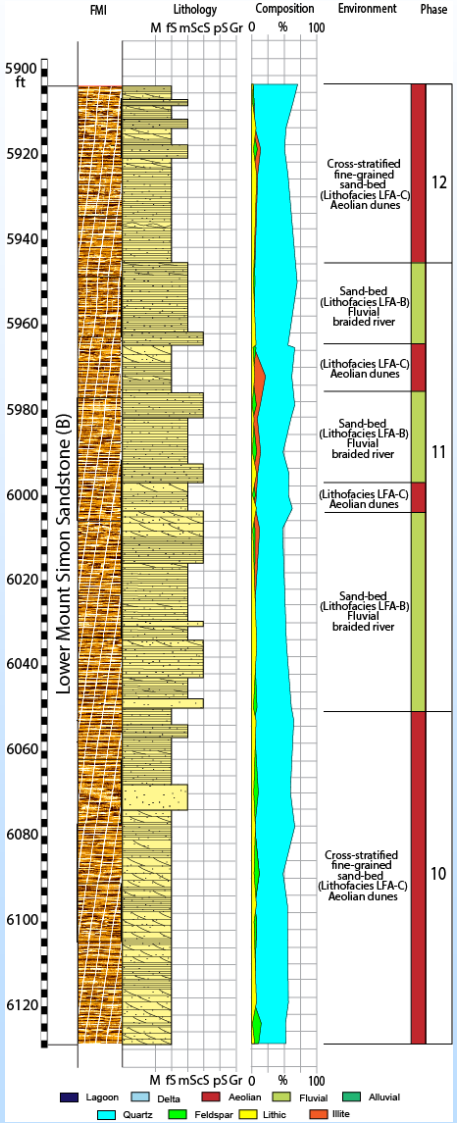


Depositional Environments

Depositional Framework

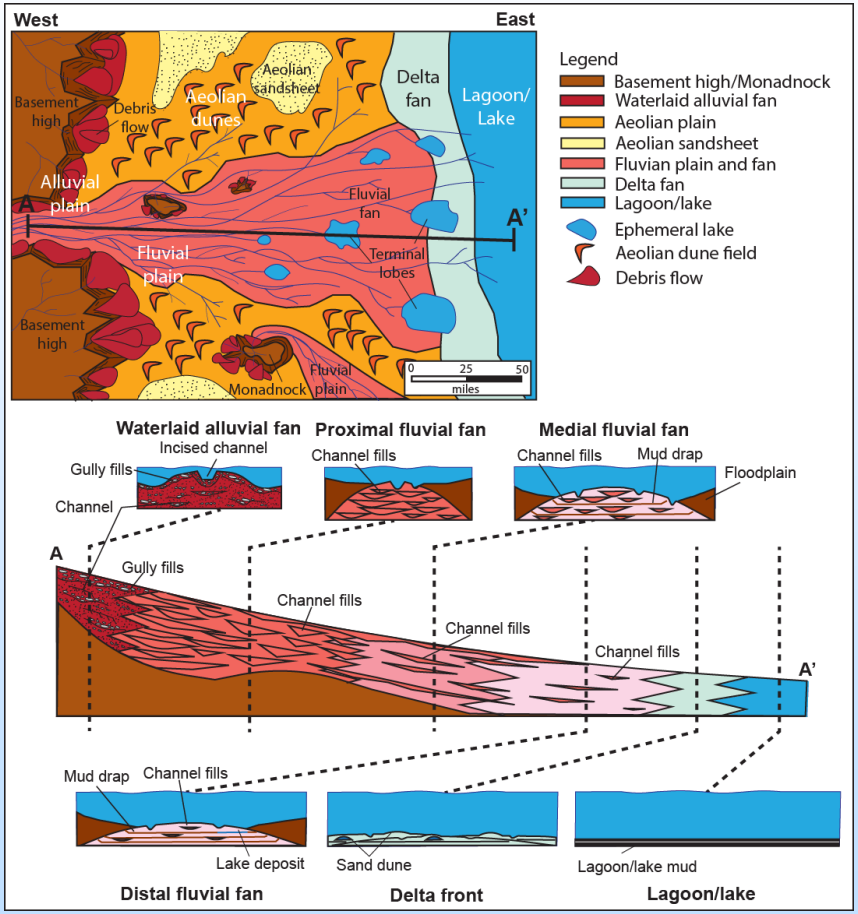
Core description and interpreted lithofacies

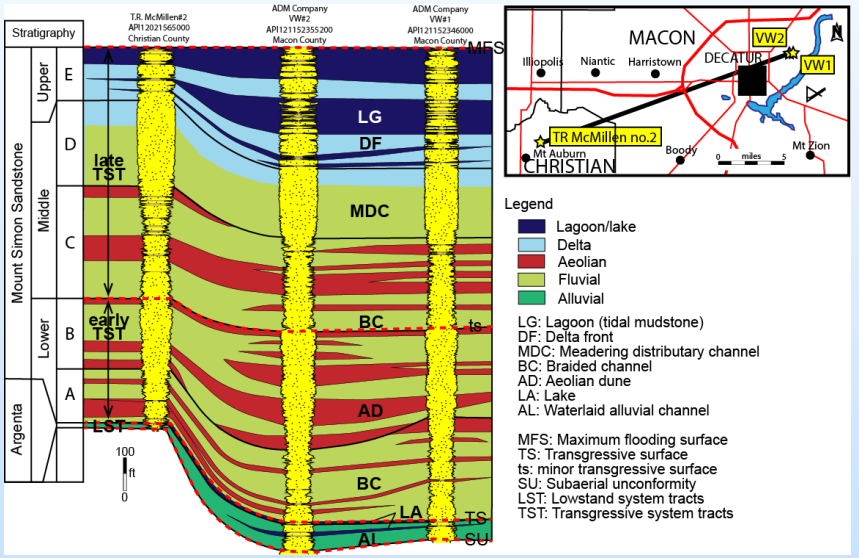




paleoenvironmental interpretation for sequence stratigraphic framework

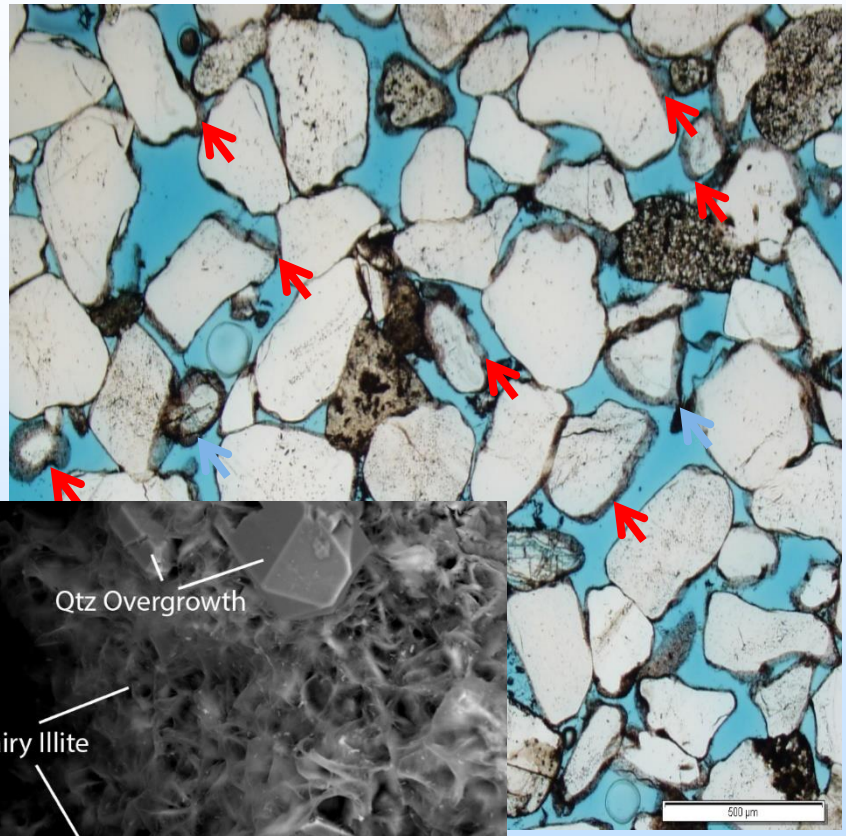
Conceptual Model



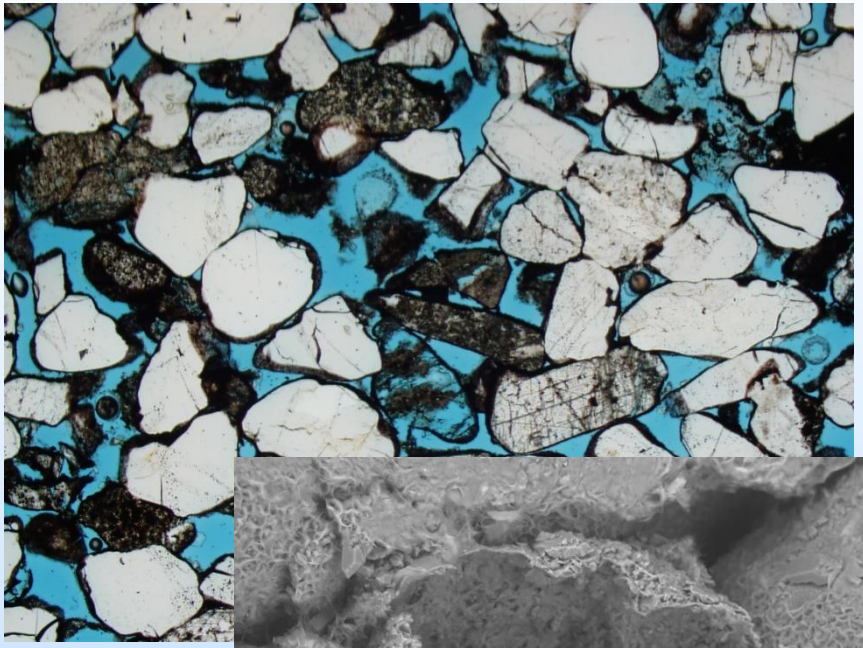


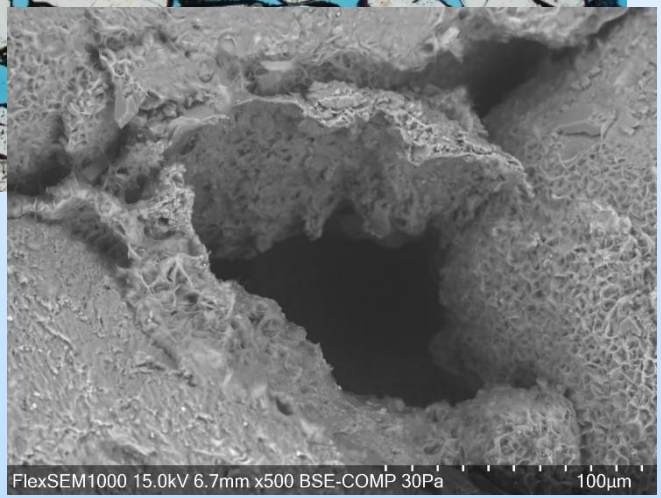
Reservoir Characterization

Role of Diagenesis



Illite linings prevent Quartz overgrowths from occluding porosity





Feldspar dissolution – 2ry porosity

Reservoir Characterization

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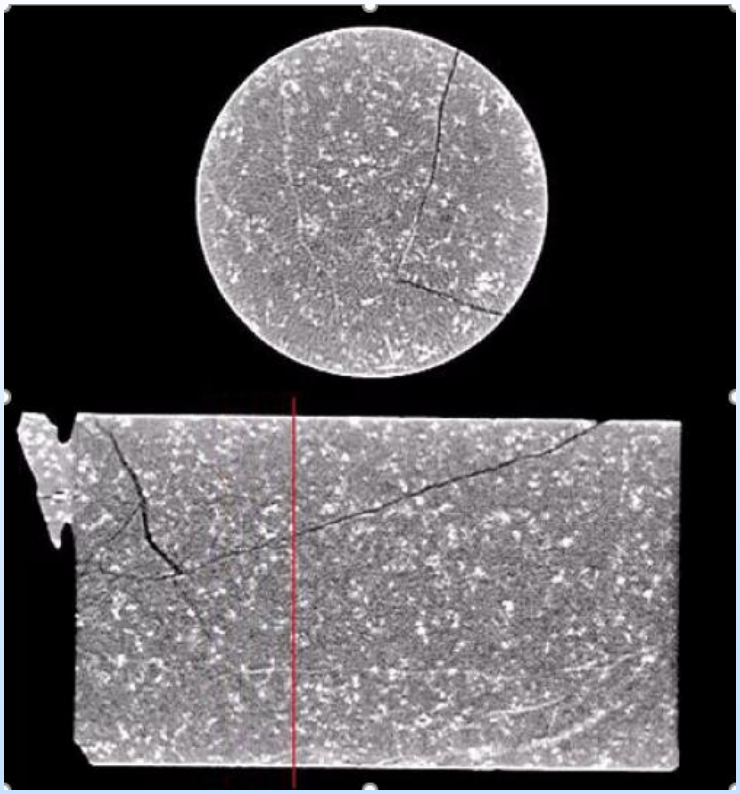
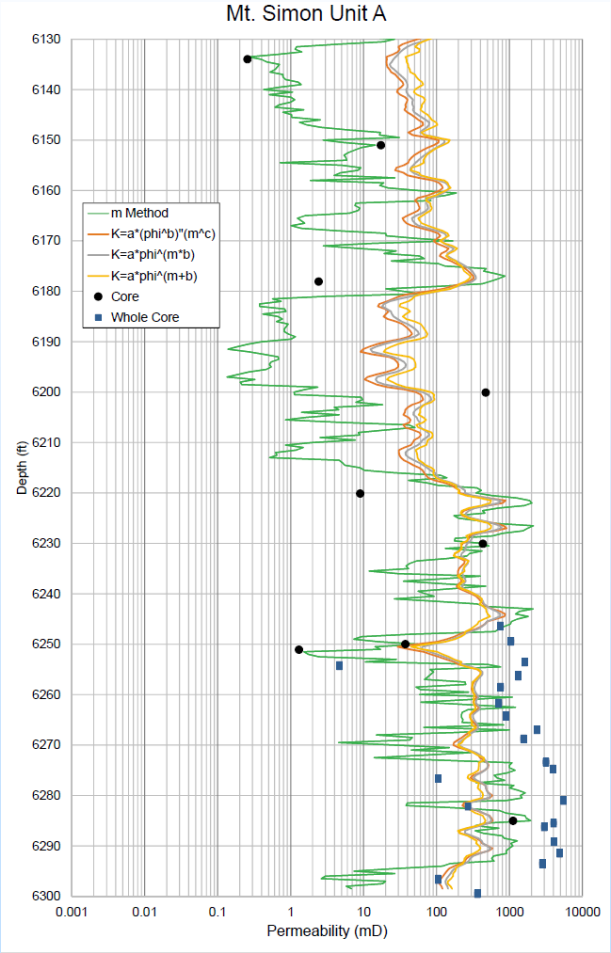
CT imaging of matrix



D. Crandell, NETL

permeability

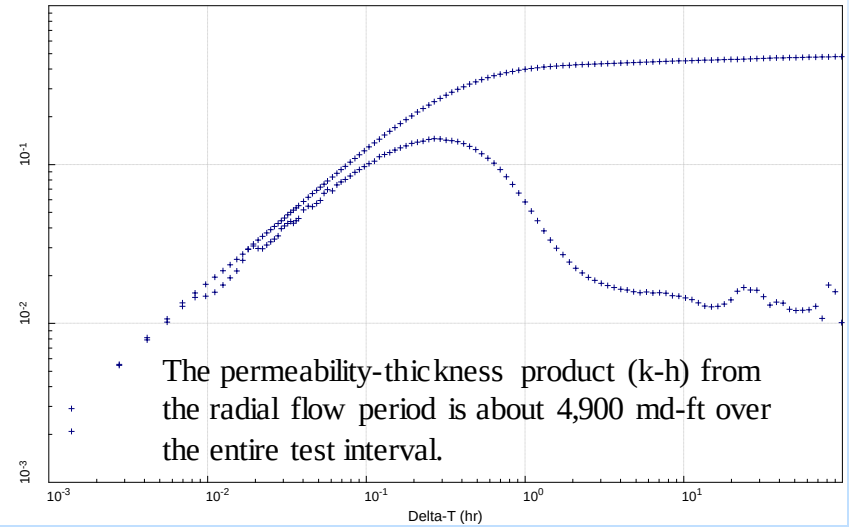


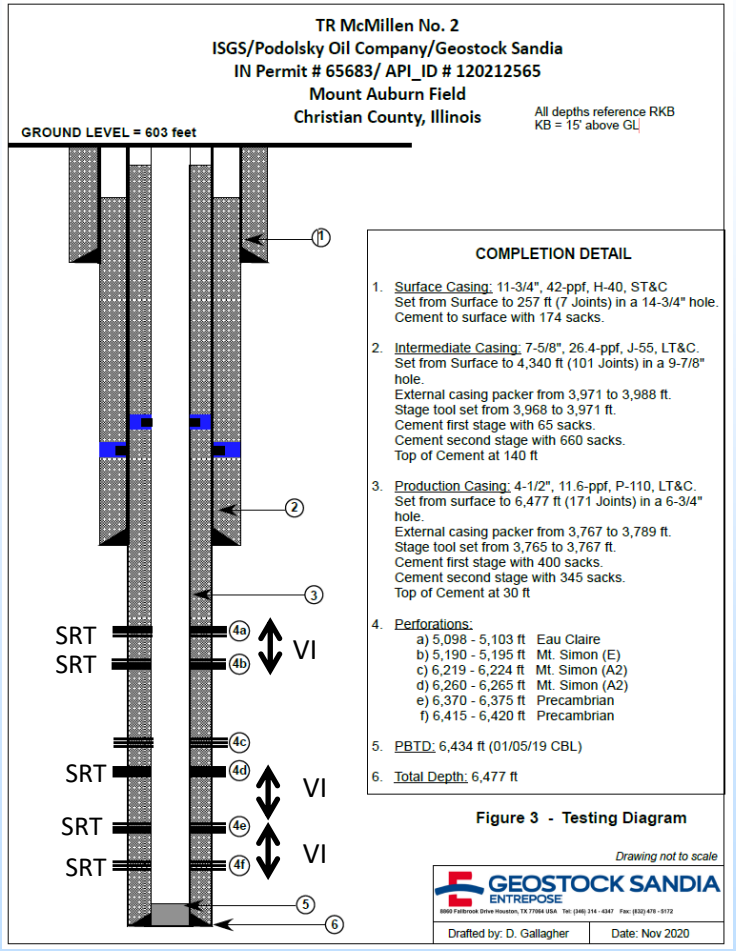
In Lower Mt Simon (Arkose)
Porosity averages ~ 20%
Permeability ca 100's of mD
Side wall and whole core samples with Darcy permeability

Well Testing

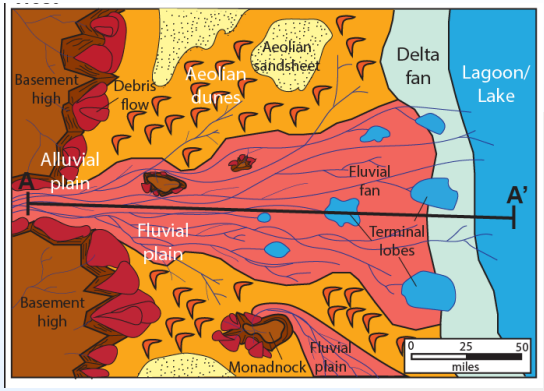
Formation Name	Abbreviation	Perforation interval, feet	Test interval depth and thickness, feet	Average porosity from log, %
Eau Claire	EC	5,098-5,103 5.0	5,098-5,103 5	8.0
Mt. Simon E	MtSE	5,190-5,195 5.0	5,175-5,219 44	13.4
Mt. Simon A2	MtSA2	6,219-6,224 5.0	6,193-6,250 47	20.2
Mt. Simon A1	MtSA1	6,260-6,265 5.0	6,252-6,300 48	23.8
Precambrian 2	PC2	6,370-6,375 5.0	6,363-6,386 23	~5
Precambrian 1	PC1	6,415-6,420 5.0	6,387-6,420 33	~3

MtSA2 derivative plot of the buildup tests' Shut In period following a 10-day flow period





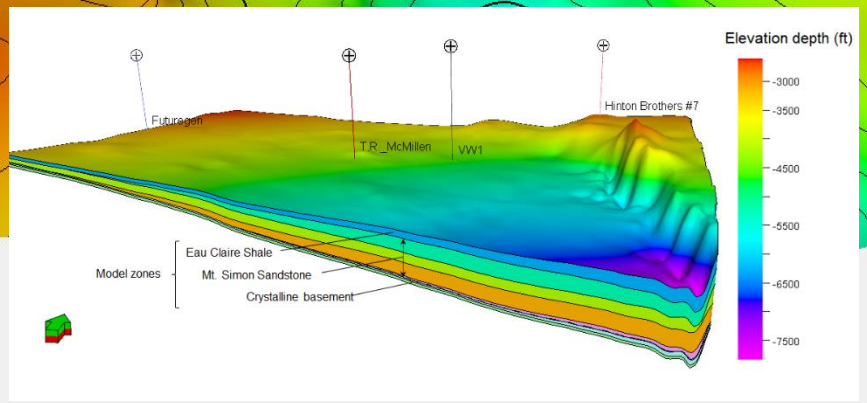
Modeling Workflow



Regional Mapping

Reservoir Simulation

Static Model



Static Model

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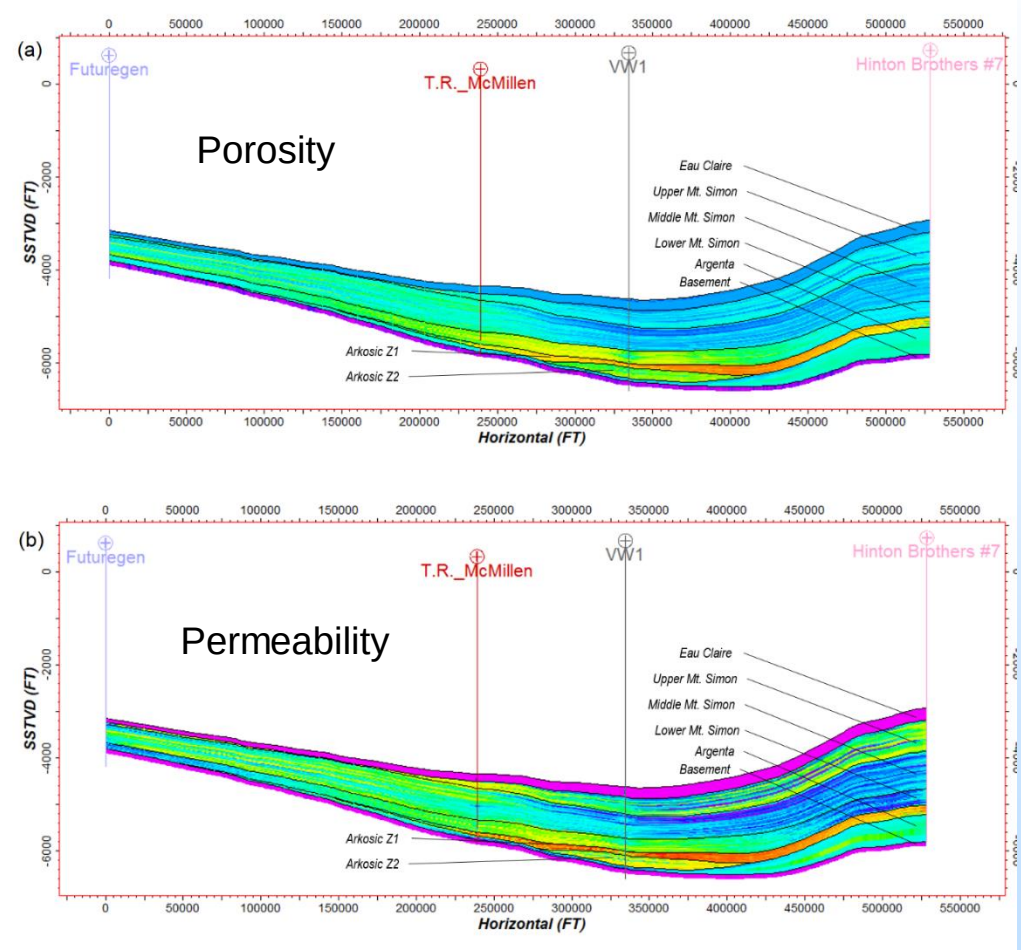

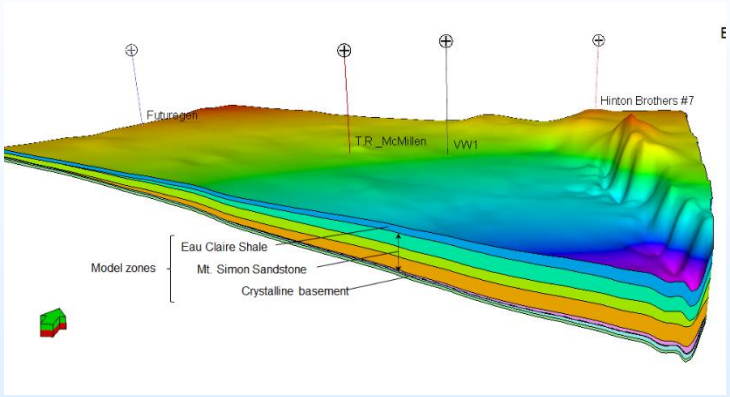

~ 100 miles

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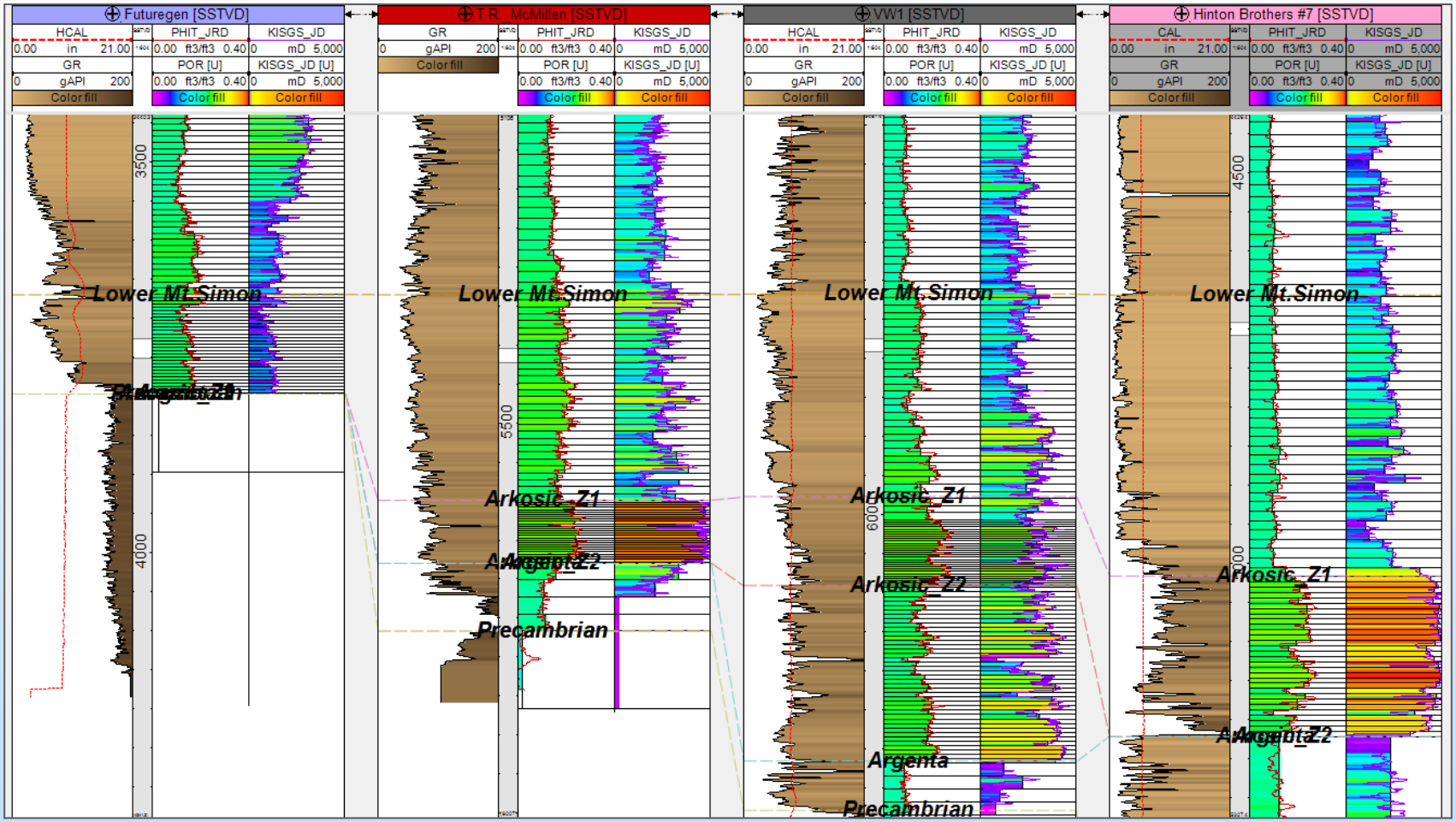
Illinois State Geological Survey
PRAIRIE RESEARCH INSTITUTE

Static Modeling

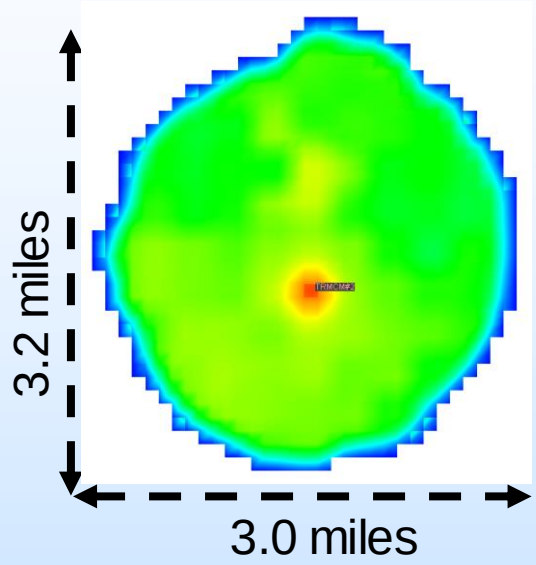
W E

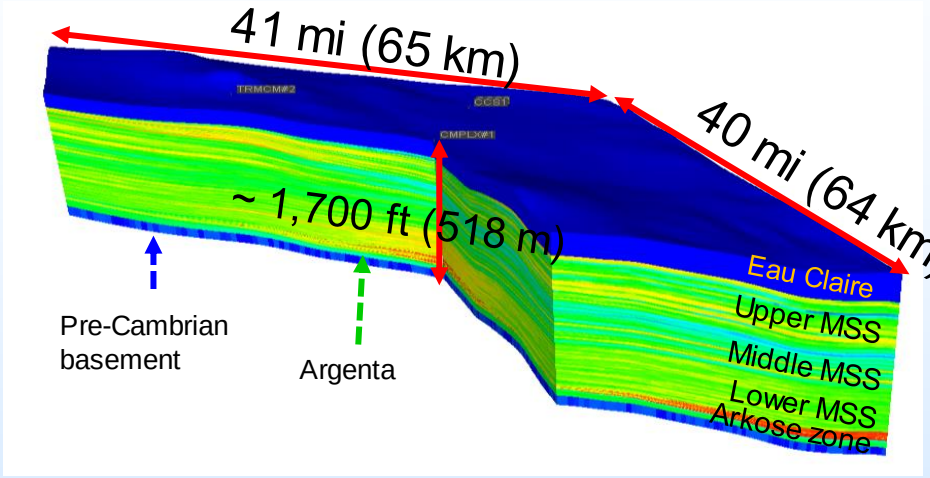


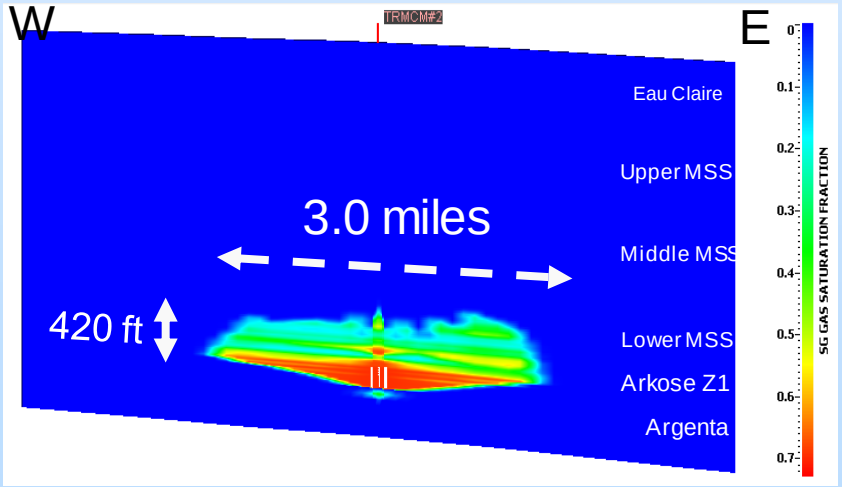
Dynamic Simulation

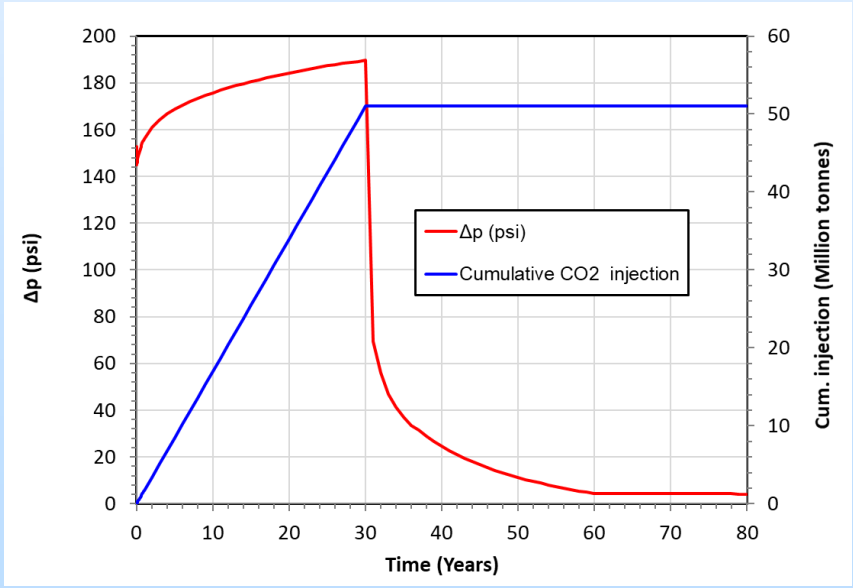
Single well scenario: 50 million tonnes CO_2 injected over 30 years

CO_2 saturation distribution (30 years injection)





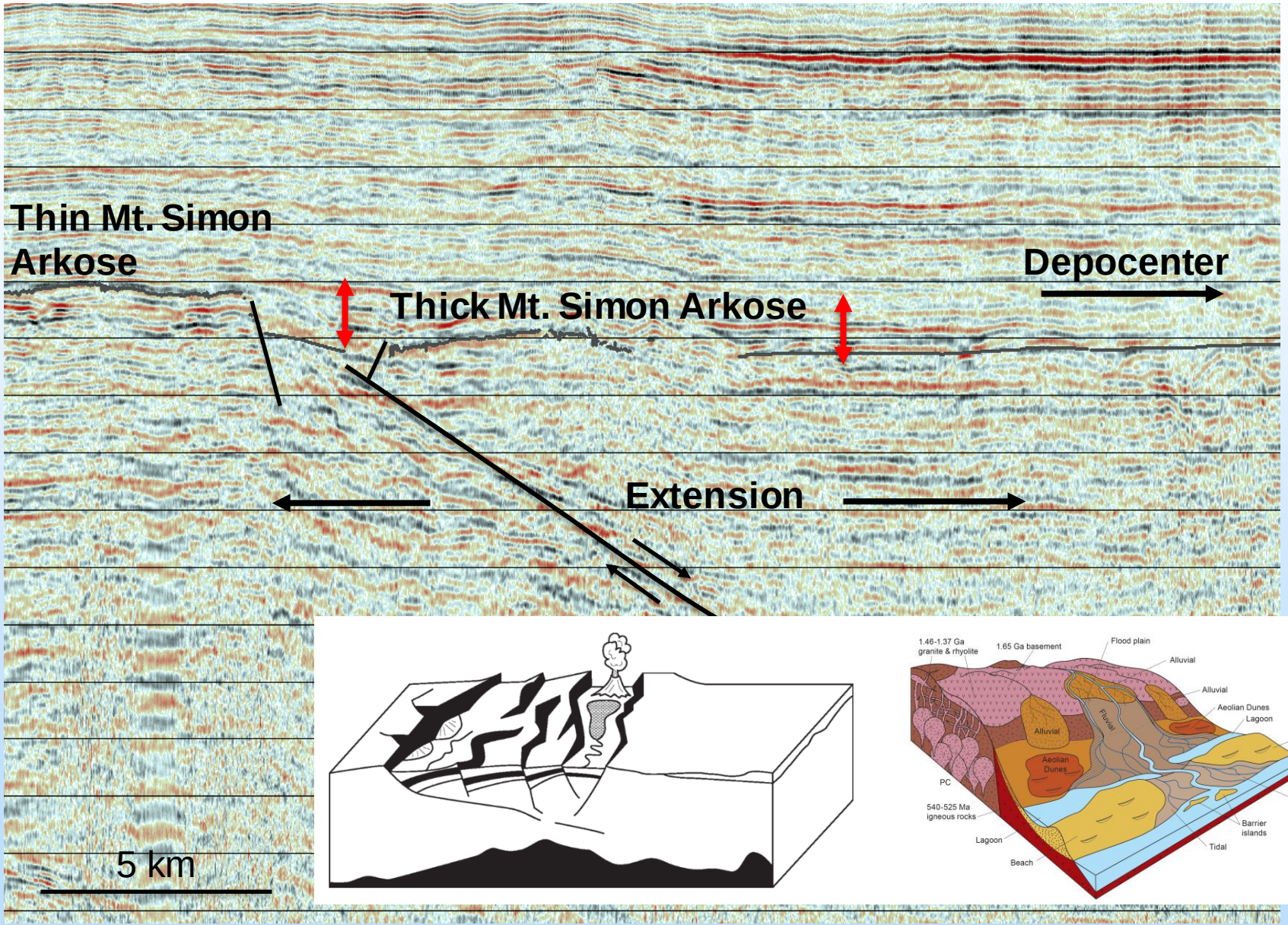




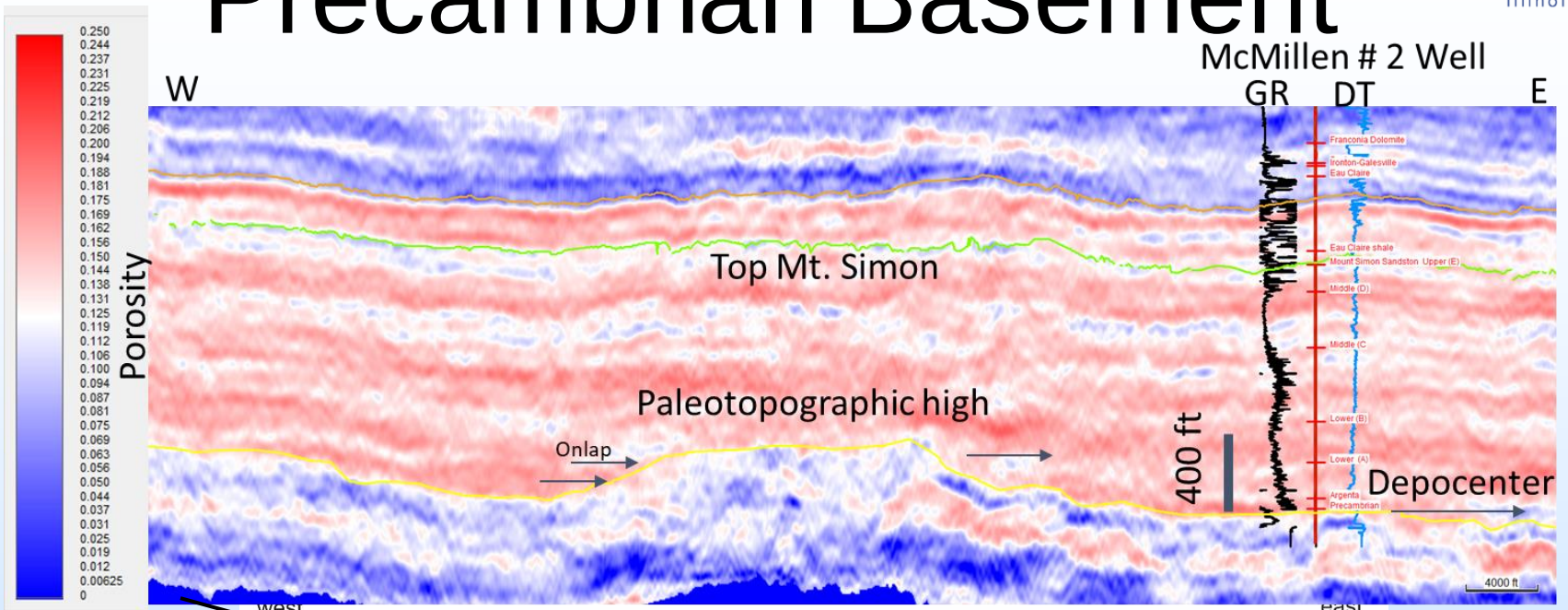
2D Seismic central Illinois

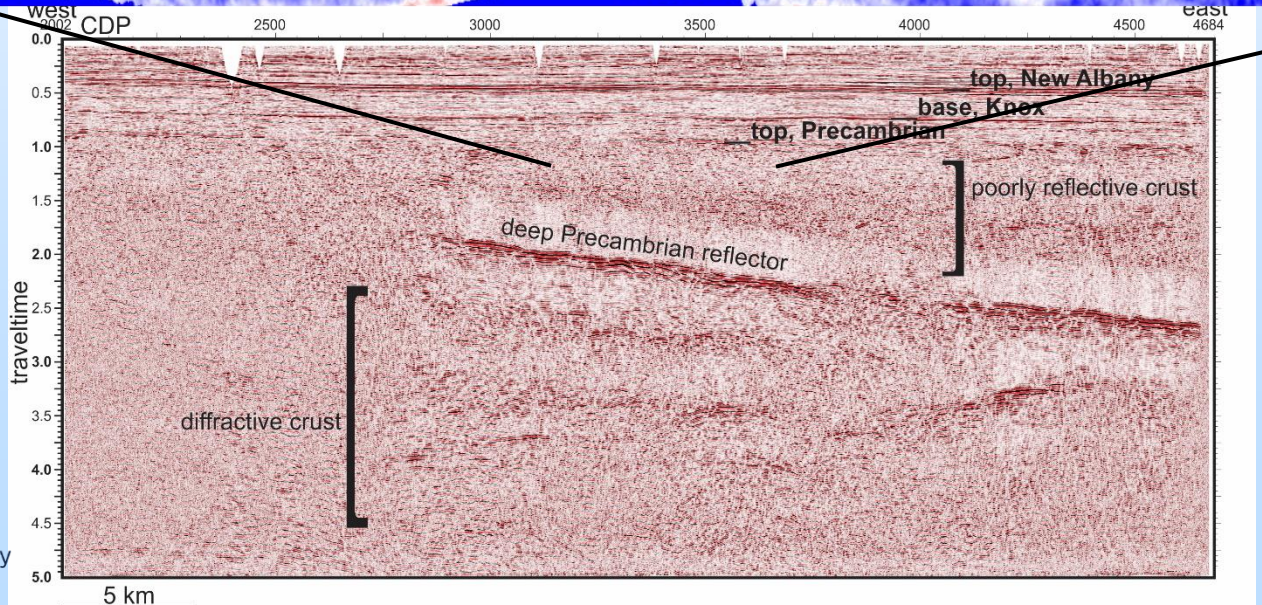
W

E

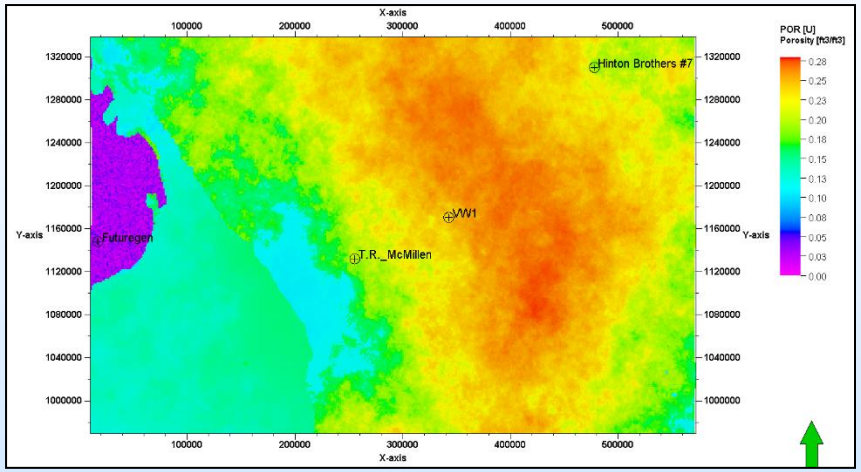


Precambrian Basement



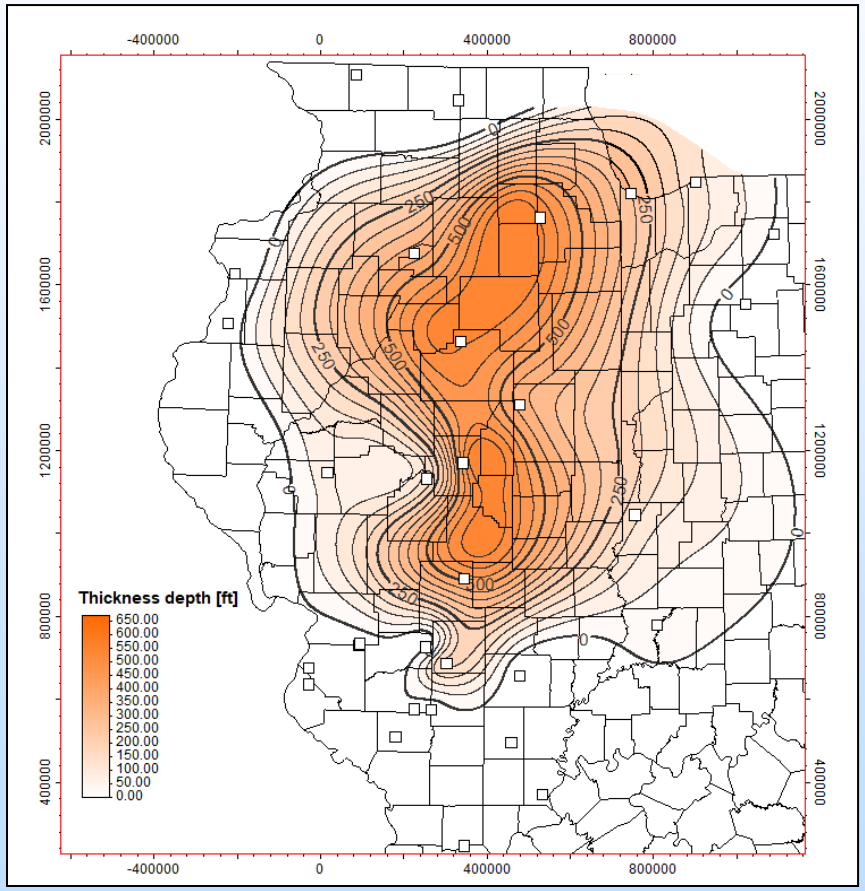


Regional Implications



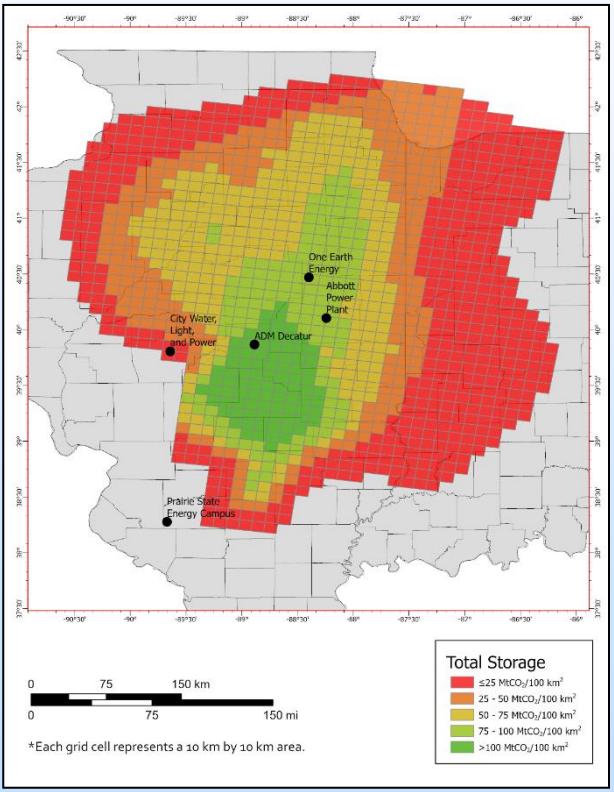
Modeled porosity distribution at top of Arkosic zone – mapped as absent in west and SW portion of map

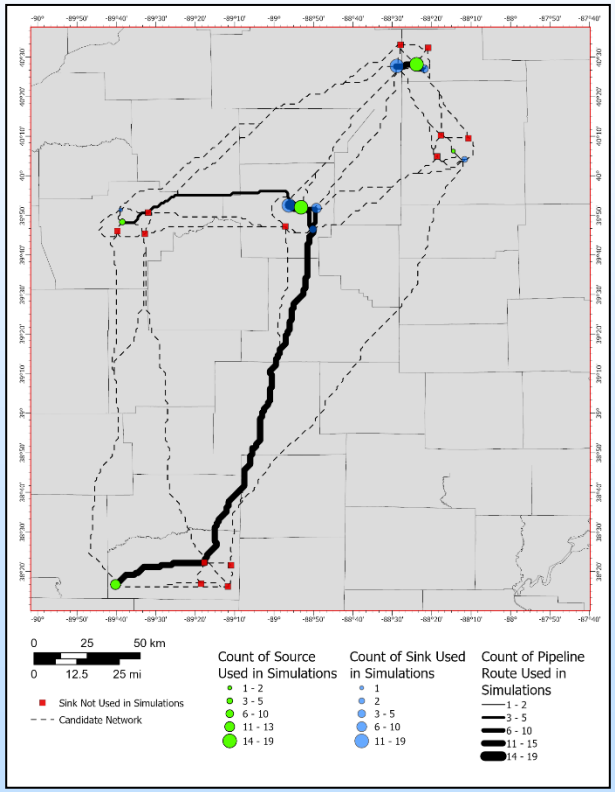
Lower Mt Simon Sandstone net thickness (10% porosity cutoff)

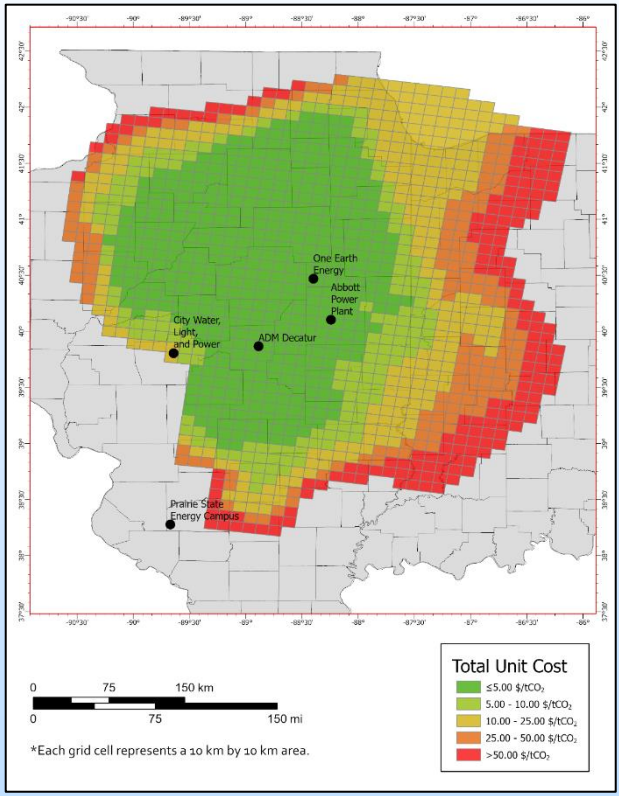


Sim CCS Gateway

SimCCS Gateway, is a decision-support tool for designing CCS infrastructure







The method used in this study for creating these estimates is the Sequestration of CO_2 Tool (*SCO_2T*)

Accomplishments to Date

- Site Characterization
  - Data Acquisition and Analysis for Feasibility Evaluation
    - Drilled stratigraphic test well
    - Collected and analyzed core, geomechanical tests,
    - In situ well tests
    - 2D seismic
- Business Case Study
- Regional Infrastructure for Development - SimCCS
- NRAP toolkit was employed and used in Risk Assessment
- Stakeholder Analysis
- Modeling site and Simulation of injection
- Establishment of feasibility of storage of 50 Mt over 30 years

Lessons Learned

- Collect as much data from the well as possible while accessible
  - Fracture gradients
  - Core from confining strata
  - Well tests – ensure there is enough time for investigation
- Following a site evaluation workflow to ensure iterative improvements to geological interpretations and modeling is important

Project Summary

- The Mt Simon Storage Complex of the Central Illinois Basin has excellent geological characteristics for CO_2 storage.
- Single injection wells are feasible for storage of 50 million tonnes CO_2 injected over 30 years
- Project has generated data that expands regional understanding of reservoir and seal characteristics
- Geologically the region is highly suitable for commercial development of CCS

CarbonSAFE Macon County Team

Appendix

– These slides will not be discussed during the presentation, but are mandatory.

Benefit to the Program

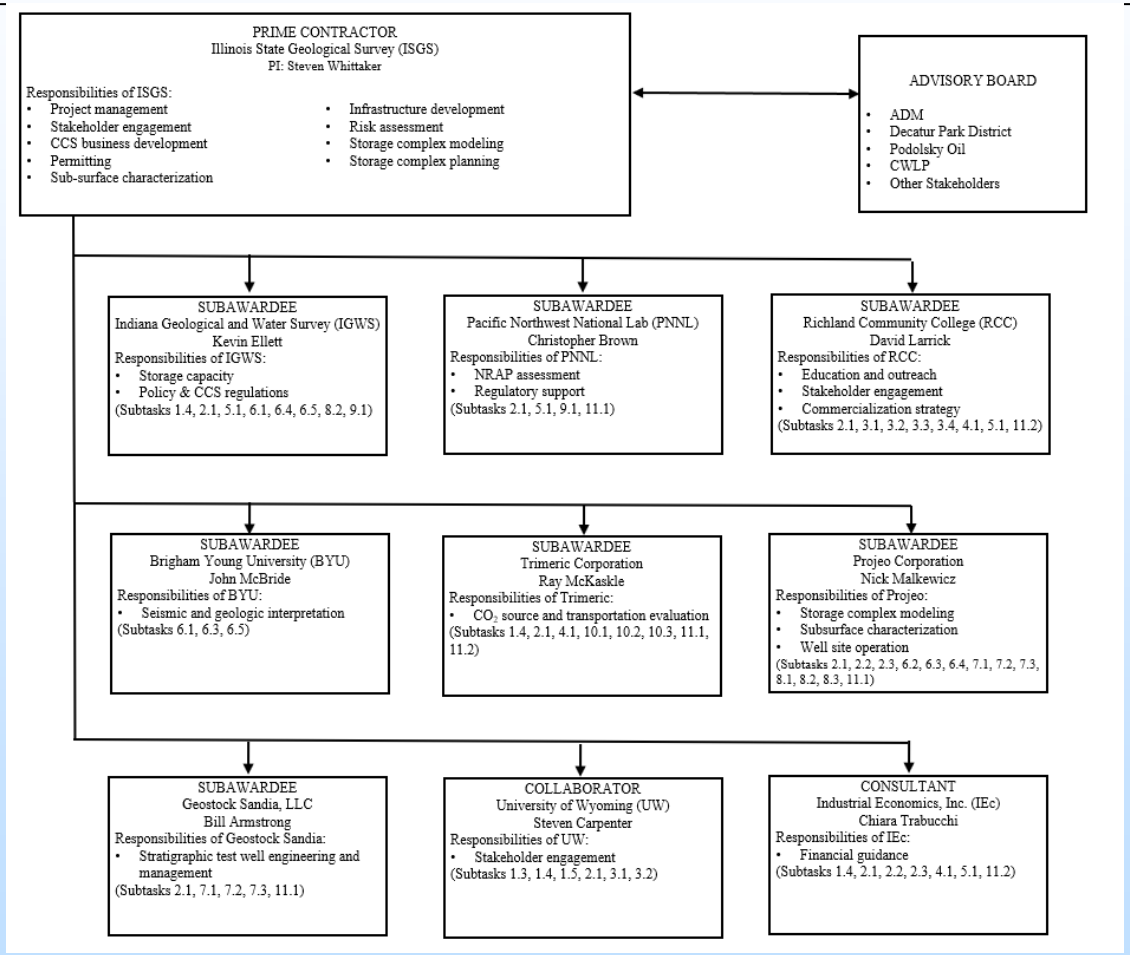
- The program goals being addressed are to improve understanding of integrated storage project site selection and characterization and to determine the feasibility of developing commercial scale geologic storage of CO_2.
- Project benefits statement.
  - Identifying geological storage sites suitable for storage of over 50 million tonnes of CO2 is essential for developing commercial-scale CCS projects to address greenhouse gas emissions from industrial sources. There are relatively few large carbon storage projects in deep saline reservoirs, and this gap in development knowledge will be addressed by the research in this project. Our work will address improving our storage capacity estimates to attain an industry standard of ±30% or better for investment decisions. The data from this study will be used within the NRAP Toolkits to move toward validating technologies to ensure storage permanence and to improve reservoir storage efficiency. The knowledge gained will contribute to best practice manuals about CCS technology and issues that will be of broad use to other sites and future commercialization efforts.

Project Overview

Goals and Objectives

- Objectives of this project (DE-FE0029381) are to establish the feasibility of developing a commercial-scale geological storage complex in east-central Illinois that could store 50 million tonnes or more of industrially sourced carbon dioxide (CO2).
  - Drill a stratigraphic test well for site characterization
  - Conduct 2D seismic surveys for site and regional characterization
- The well and seismic data were collected and contributed to overall site characterization. The project workflow has established the feasibility for storage of 50 million tonnes or more of CO_2.

Organization Chart



Gantt Chart

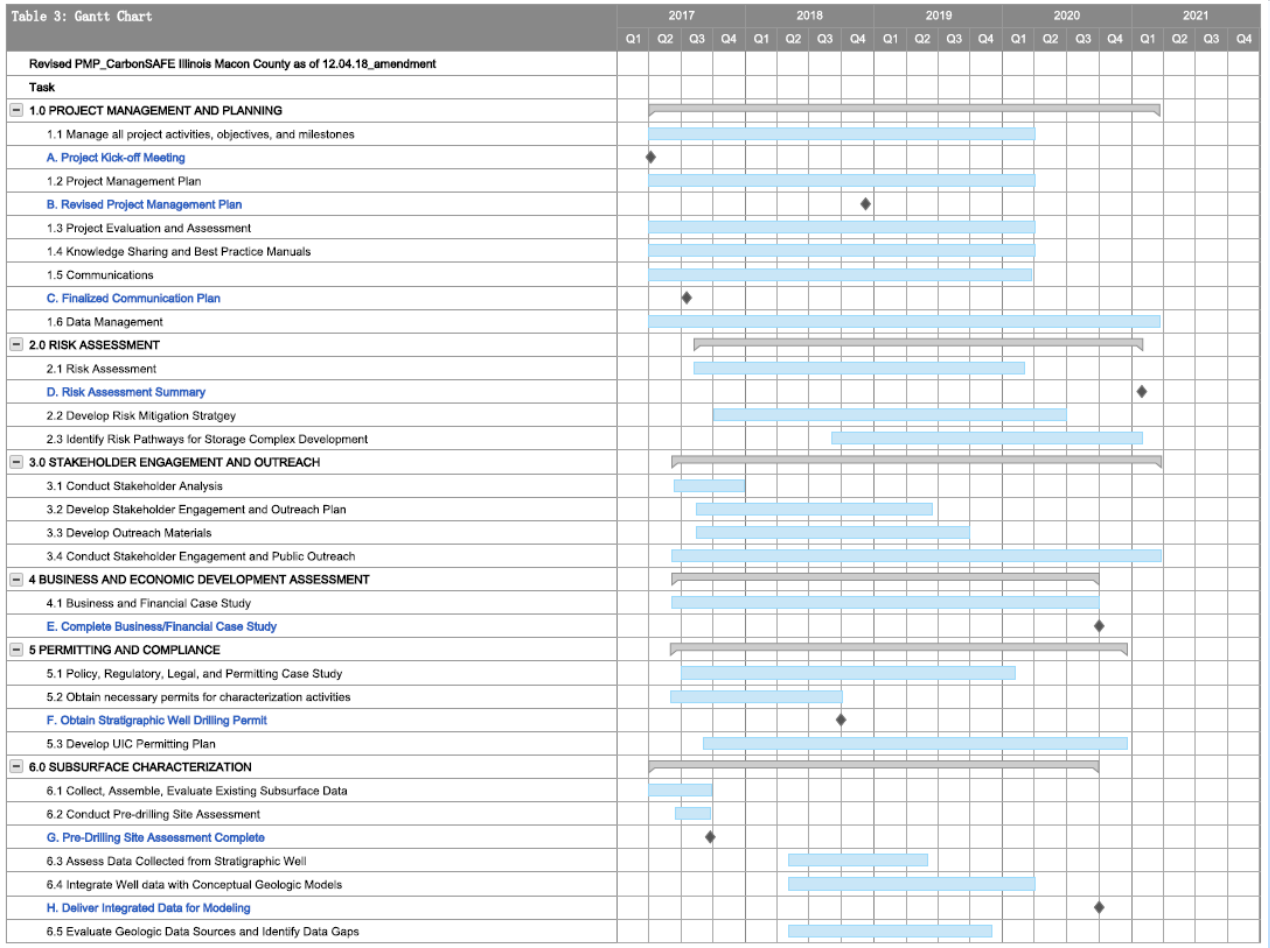
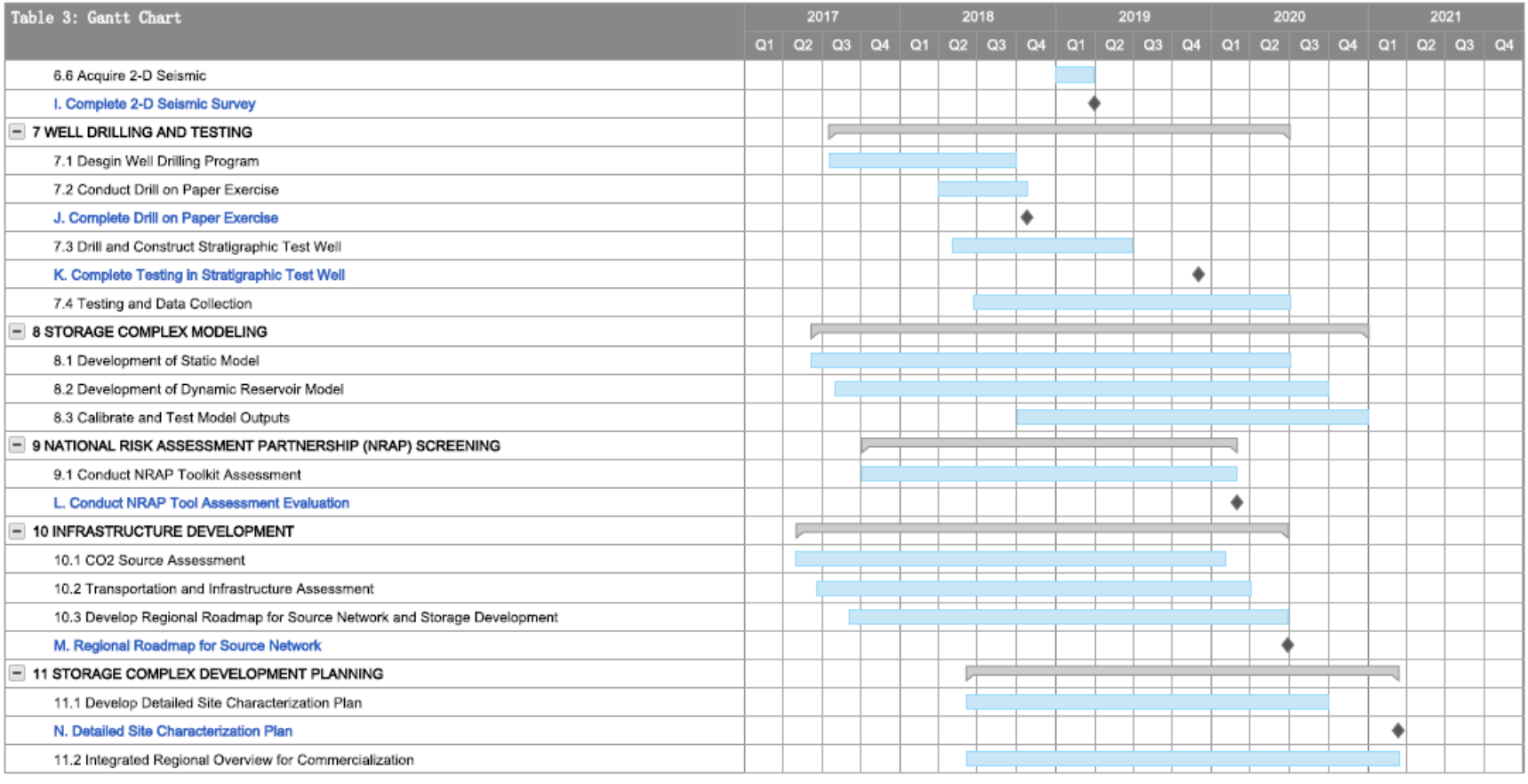


Table 3: Gantt Chart
2017
2018
2019
2020
2021
Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4
Revised PMP_CarbonSAFE Illinois Macon County as of 12.04.18_amendment
Task
1.0 PROJECT MANAGEMENT AND PLANNING
1.1 Manage all project activities, objectives, and milestones
A. Project Kick-off Meeting
1.2 Project Management Plan
B. Revised Project Management Plan
1.3 Project Evaluation and Assessment
1.4 Knowledge Sharing and Best Practice Manuals
1.5 Communications
C. Finalized Communication Plan
1.6 Data Management
2.0 RISK ASSESSMENT
2.1 Risk Assessment
D. Risk Assessment Summary
2.2 Develop Risk Mitigation Stratgey
2.3 Identify Risk Pathways for Storage Complex Development
3.0 STAKEHOLDER ENGAGEMENT AND OUTREACH
3.1 Conduct Stakeholder Analysis
3.2 Develop Stakeholder Engagement and Outreach Plan
3.3 Develop Outreach Materials
3.4 Conduct Stakeholder Engagement and Public Outreach
4 BUSINESS AND ECONOMIC DEVELOPMENT ASSESSMENT
4.1 Business and Financial Case Study
E. Complete Business/Financial Case Study
5 PERMITTING AND COMPLIANCE
5.1 Policy, Regulatory, Legal, and Permitting Case Study
5.2 Obtain necessary permits for characterization activities
F. Obtain Stratigraphic Well Drilling Permit
5.3 Develop UIC Permitting Plan
6.0 SUBSURFACE CHARACTERIZATION
6.1 Collect, Assemble, Evaluate Existing Subsurface Data
6.2 Conduct Pre-drilling Site Assessment
G. Pre-Drilling Site Assessment Complete
6.3 Assess Data Collected from Stratigraphic Well
6.4 Integrate Well data with Conceptual Geologic Models
H. Deliver Integrated Data for Modeling
6.5 Evaluate Geologic Data Sources and Identify Data Gaps

Gantt Chart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2017
2018
2019
2020
2021
Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4
6.6 Acquire 2-D Seismic
I. Complete 2-D Seismic Survey
7 WELL DRILLING AND TESTING
7.1 Desgin Well Drilling Program
7.2 Conduct Drill on Paper Exercise
J. Complete Drill on Paper Exercise
7.3 Drill and Construct Stratigraphic Test Well
K. Complete Testing in Stratigraphic Test Well
7.4 Testing and Data Collection
8 STORAGE COMPLEX MODELING
8.1 Development of Static Model
8.2 Development of Dynamic Reservoir Model
8.3 Calibrate and Test Model Outputs
9 NATIONAL RISK ASSESSMENT PARTNERSHIP (NRAP) SCREENING
9.1 Conduct NRAP Toolkit Assessment
L. Conduct NRAP Tool Assessment Evaluation
10 INFRASTRUCTURE DEVELOPMENT
10.1 CO2 Source Assessment
10.2 Transportation and Infrastructure Assessment
10.3 Develop Regional Roadmap for Source Network and Storage Development
M. Regional Roadmap for Source Network
11 STORAGE COMPLEX DEVELOPMENT PLANNING
11.1 Develop Detailed Site Characterization Plan
N. Detailed Site Characterization Plan
11.2 Integrated Regional Overview for Commercialization

Bibliography

- List peer reviewed publications generated from the project per the format of the examples below.

- Journal, one author:
  - Gaus, I., 2010, Role and impact of CO_2-rock interactions during CO_2 storage in sedimentary rocks: International Journal of Greenhouse Gas Control, v. 4, p. 73-89, available at: XXXXXXX.com.
- Journal, multiple authors:
  - MacQuarrie, K., and Mayer, K.U., 2005, Reactive transport modeling in fractured rock: A state-of-the-science review. Earth Science Reviews, v. 72, p. 189-227, available at: XXXXXXX.com.
- Publication:
  - Bethke, C.M., 1996, Geochemical reaction modeling, concepts and applications: New York, Oxford University Press, 397 p.