CarbonSAFE Illinois – ~~Macon~~ Christian County

FE-0029381

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Illinois State Geological Survey

U.S. Department of Energy

National Energy Technology Laboratory

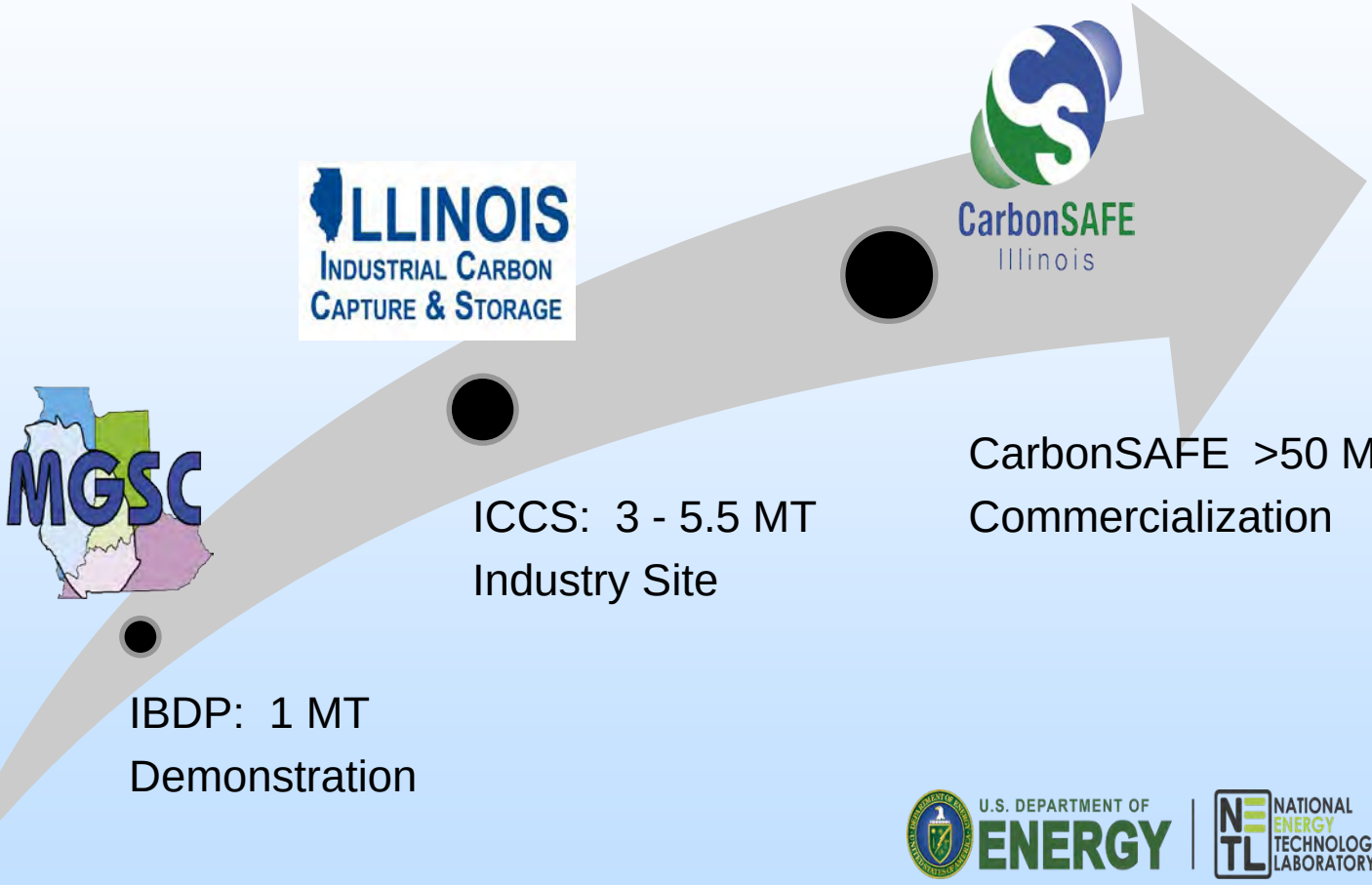
Mastering the Subsurface Through Technology Innovation, Partnerships and Collaboration:
Carbon Storage and Oil and Natural Gas Technologies Review Meeting

August 13-16, 2018

Presentation Outline

- Project Context and Changes
- Storage Play
- CO_2 sources and associated challenges
- Advantages of new well location
- Summary

CarbonSAFE Progression to CCS Commercialization



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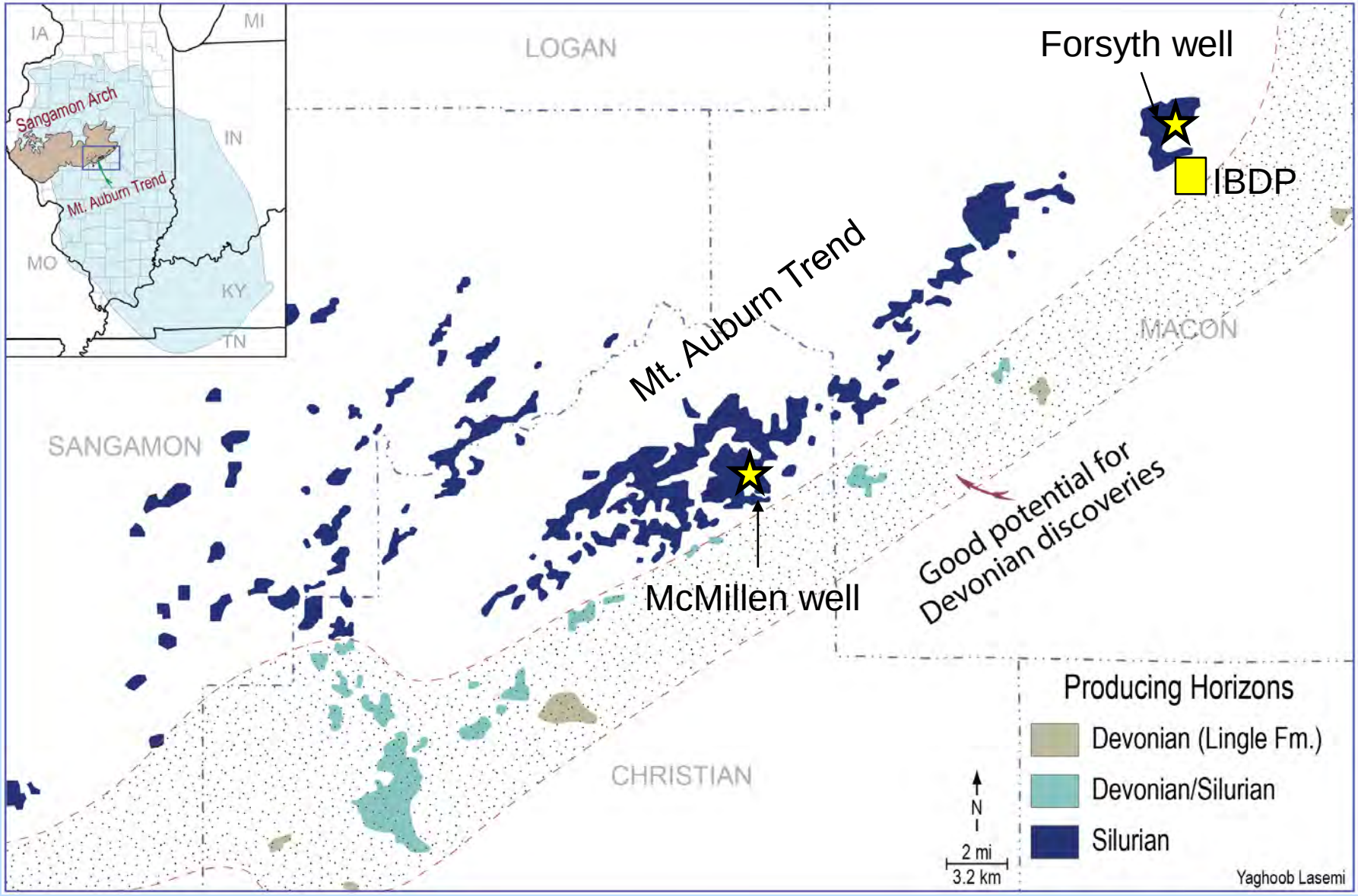
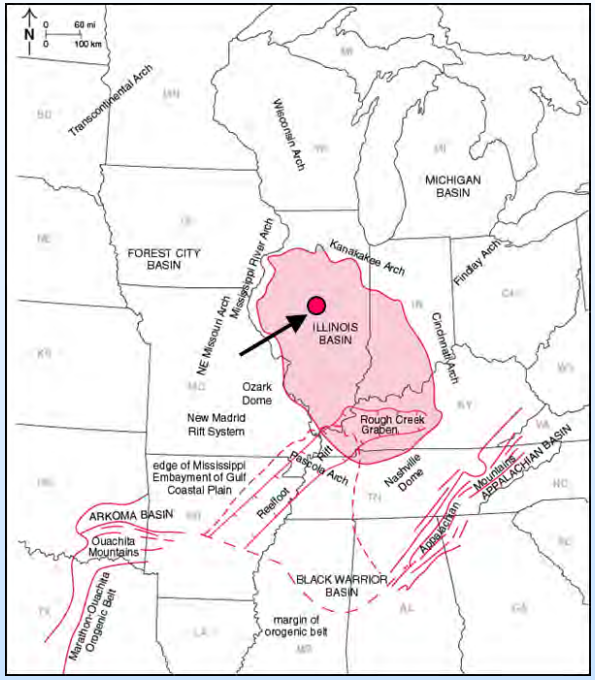
ILLINOIS

CarbonSAFE Illinois Area



CarbonSAFE Storage Complexes



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

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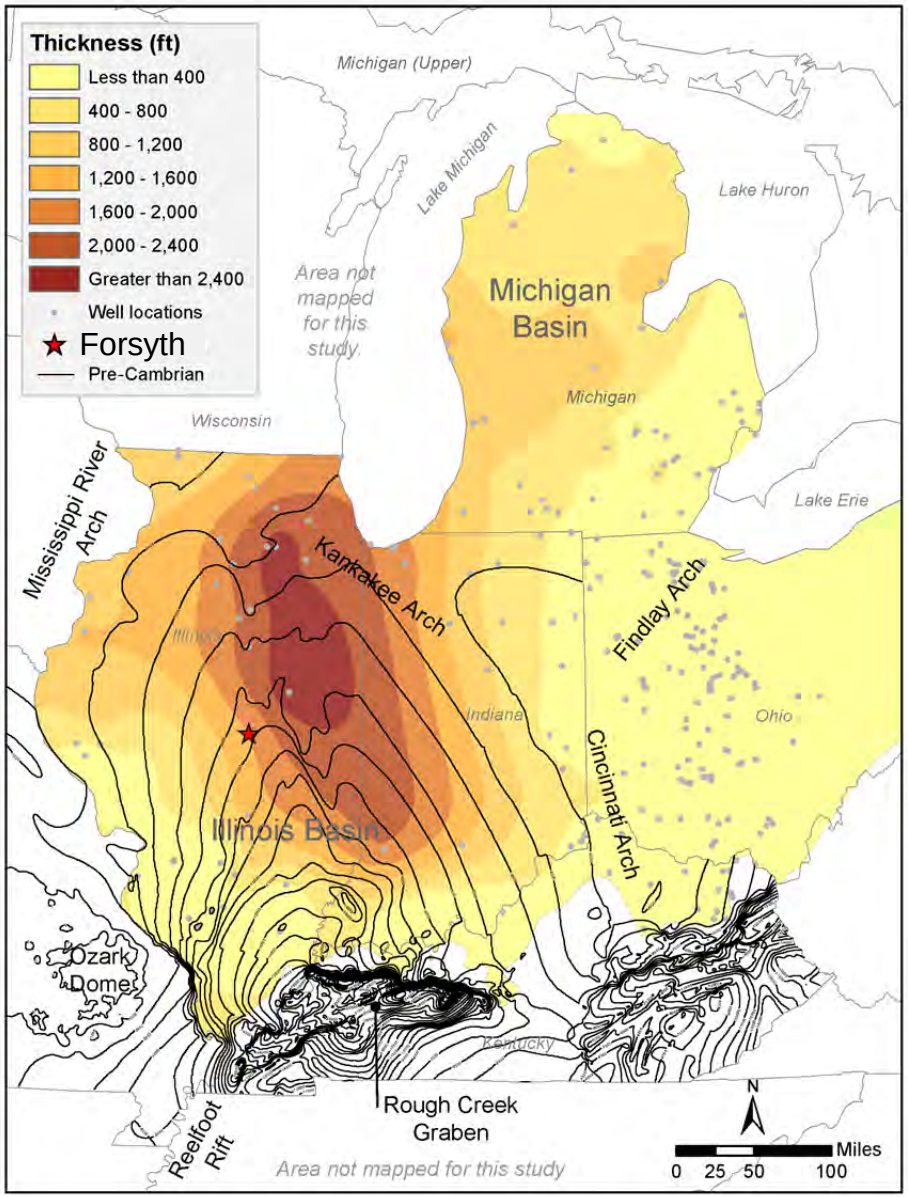
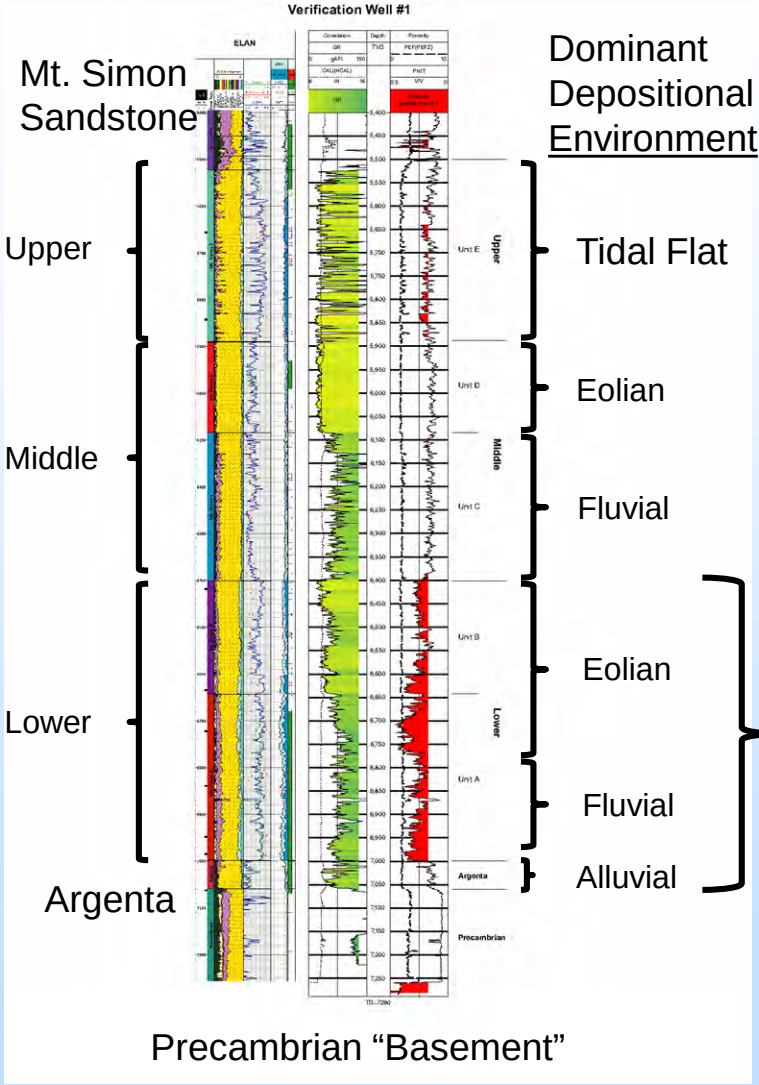
Mt Simon Sandstone

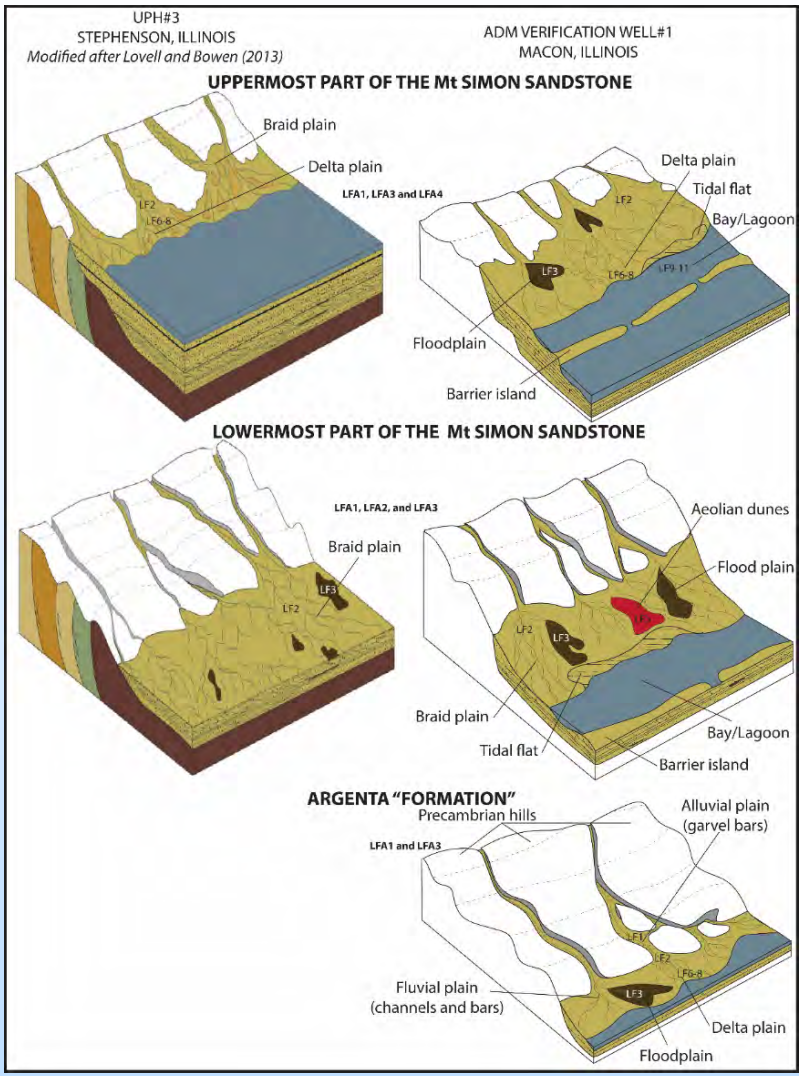


- Cambrian Mt Simon Sandstone is ~ 1500 ft thick at CarbonSAFE site
- In CarbonSAFE region the Mt Simon can be divided into three major sections
- Lower Mt Simon is preferred storage unit; Upper Mt Simon also suitable
- Lower Mt. Simon “storage play”
- Eau Claire Formation overlies Mt Simon and is regional seal

Modified from Freiburg et al., 2016

Depositional Environment





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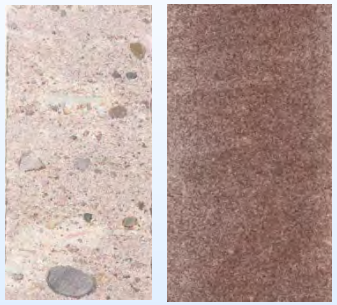
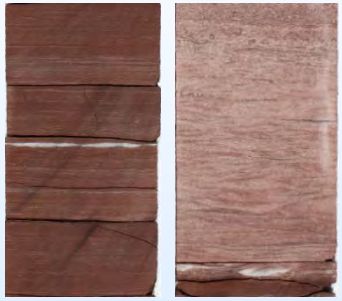
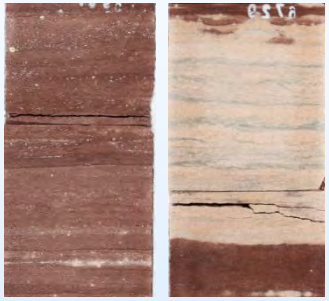
Lower Mt. Simon Depositional Environments



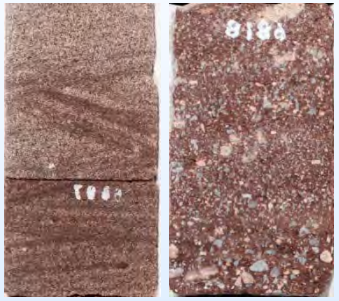
Coastal



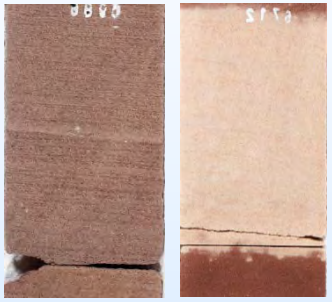
Lagoon



Plains



River



Desert

Highly heterogeneous - but average porosity around 18%!

Maximum porosity of 27.3% and permeability of 498 mD!

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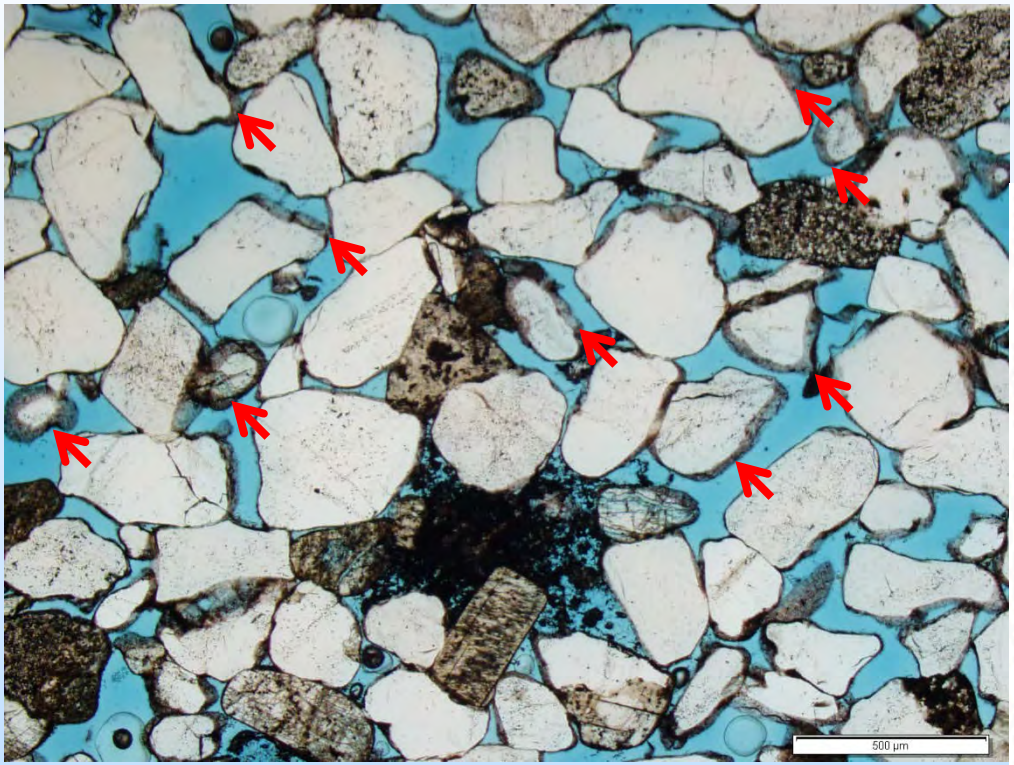
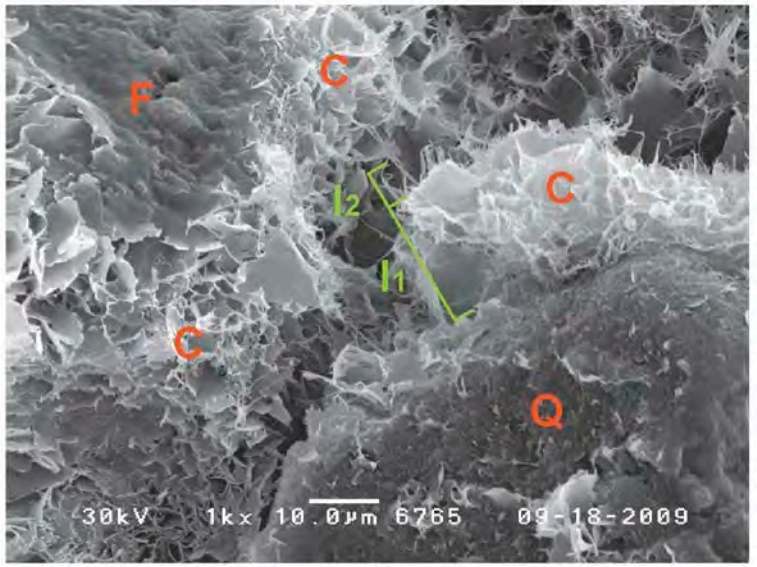
Diagenesis of Arkose

1. clay coatings



Early clay coatings prevent abundant quartz cementation



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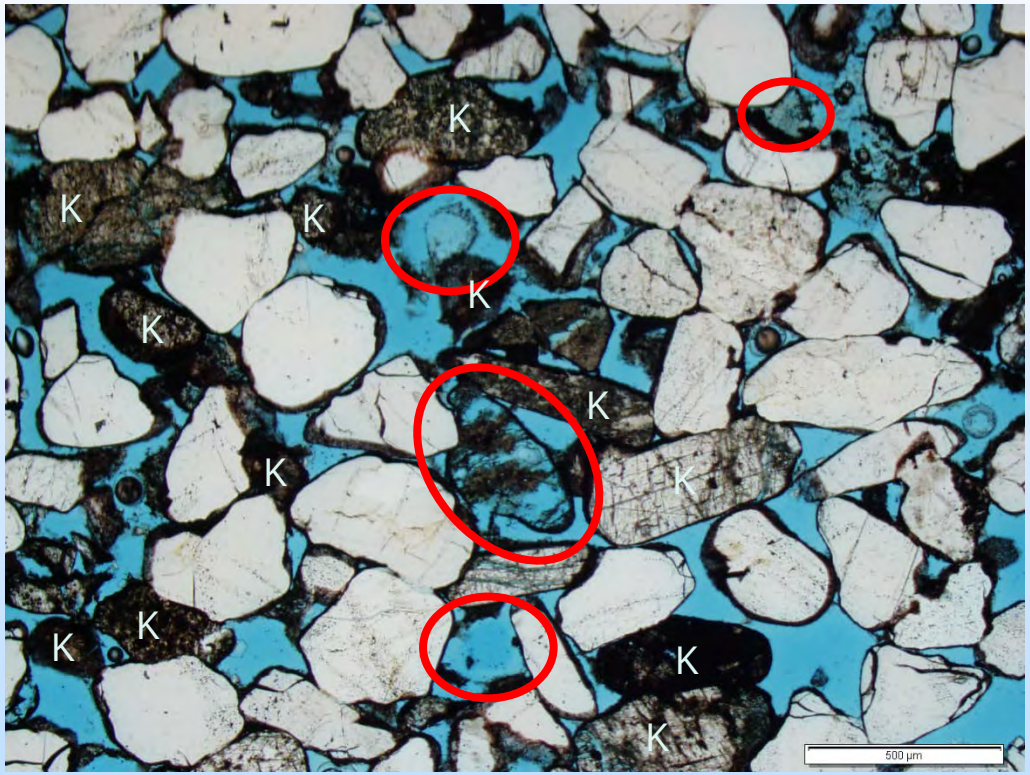
Diagenesis of Arkose

2. feldspar dissolution

Abundant secondary porosity resulting from late-stage feldspar dissolution



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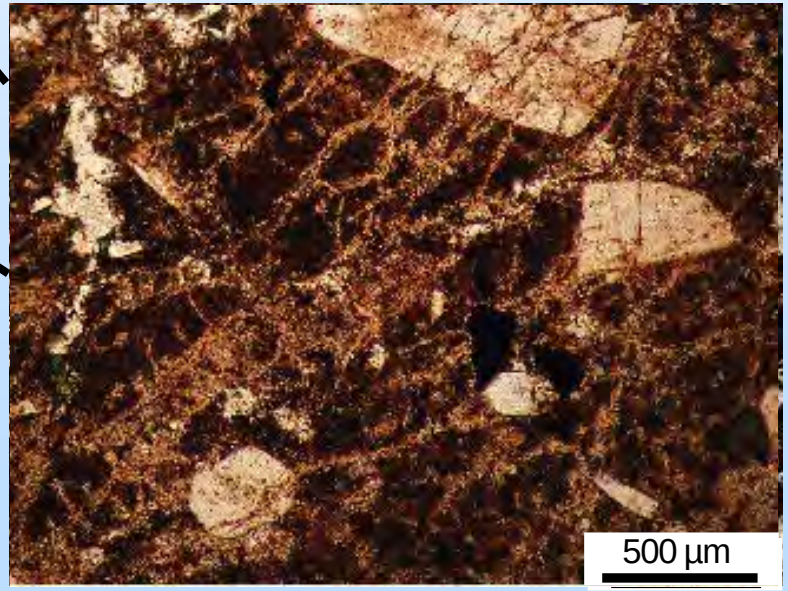
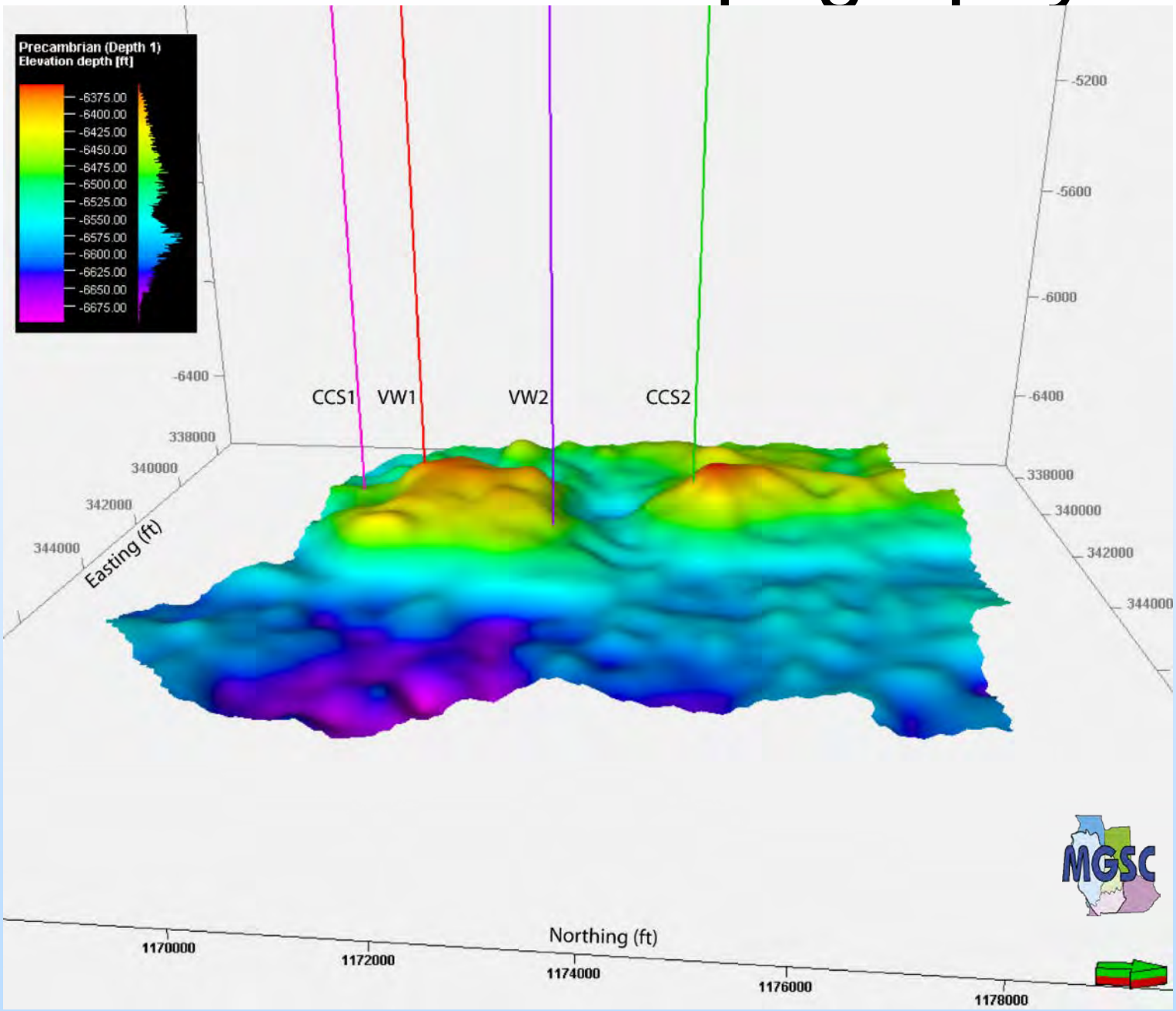
Precambrian Basement

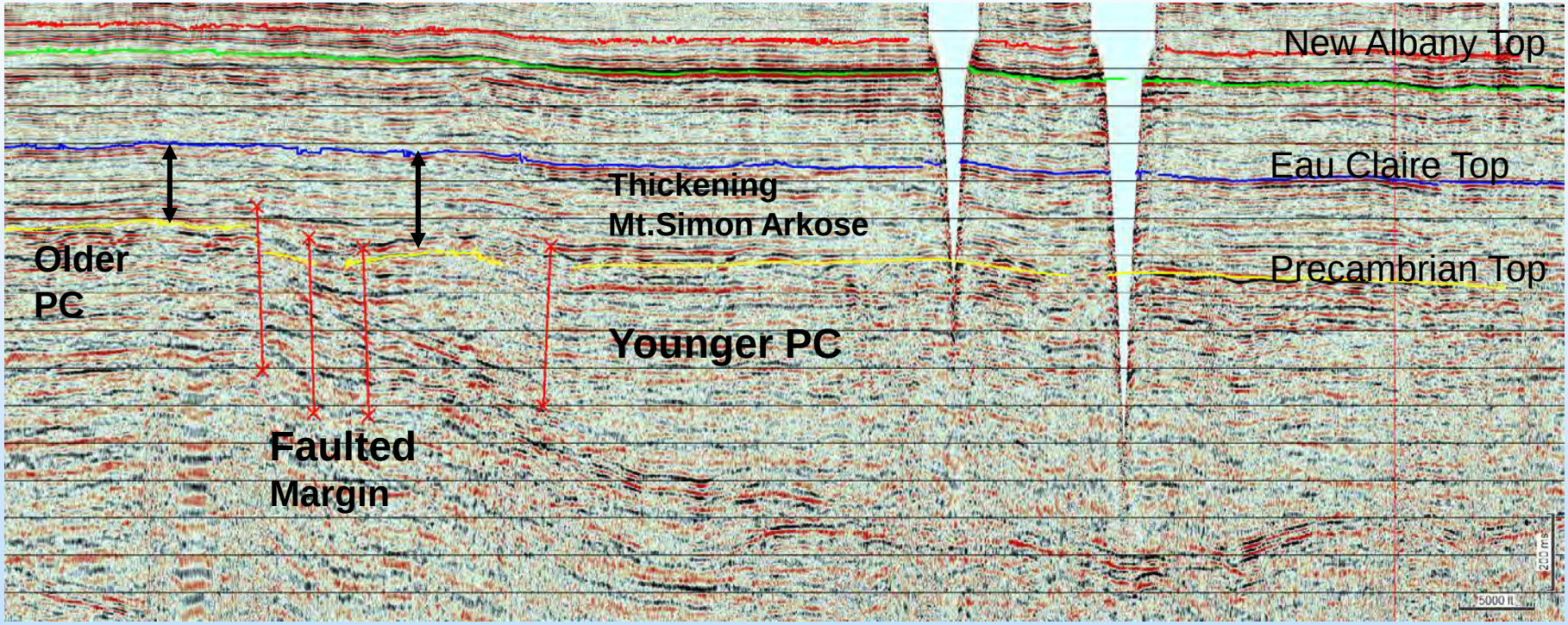
- Upper Basement is Rhyolite veneer (?) over felsic (granitic) rocks
- Distinct Weathering Profile. Fractured
- Dated at 1.45 Ga



Precambrian Topography



Proximal Precambrian Highs on structure source arkose



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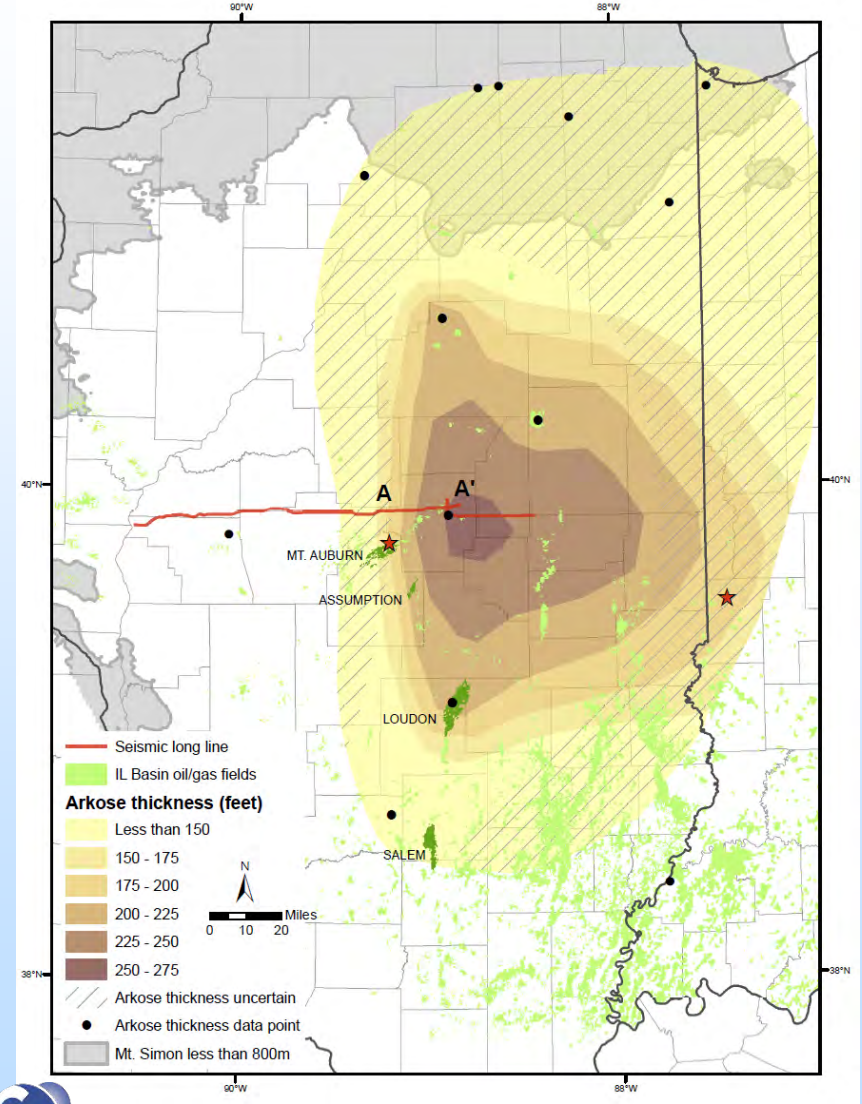
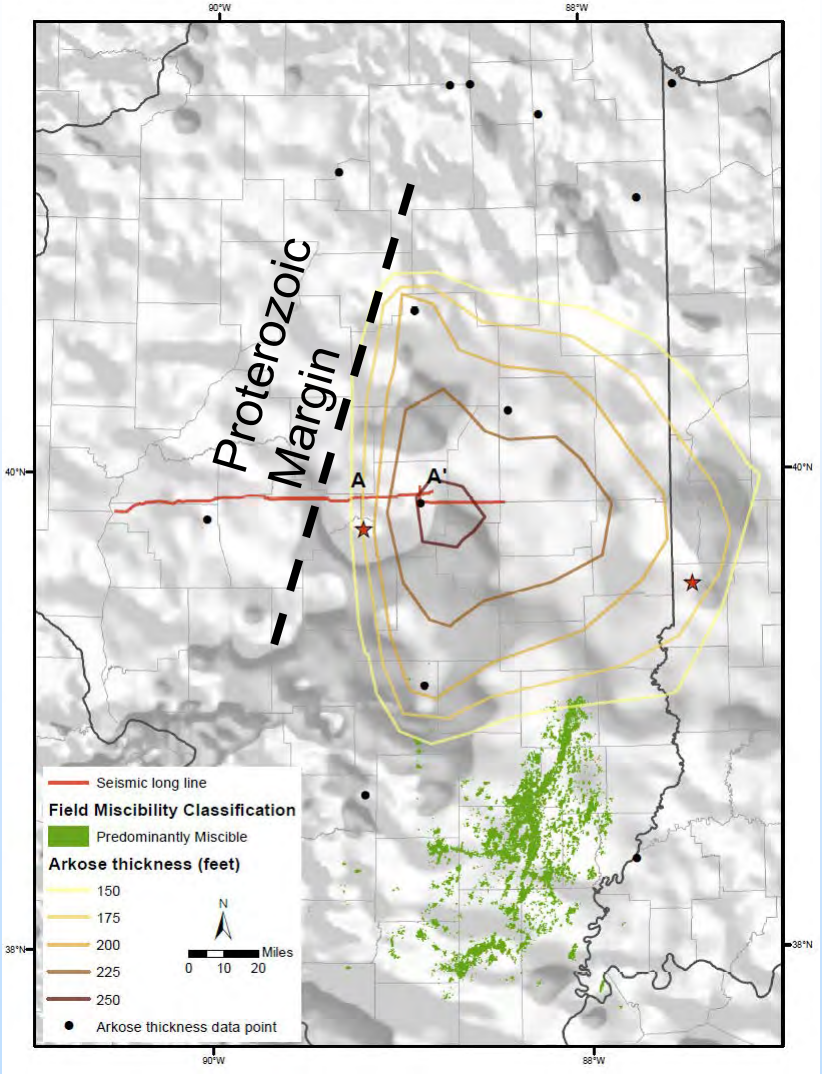
“Arkosic storage play”





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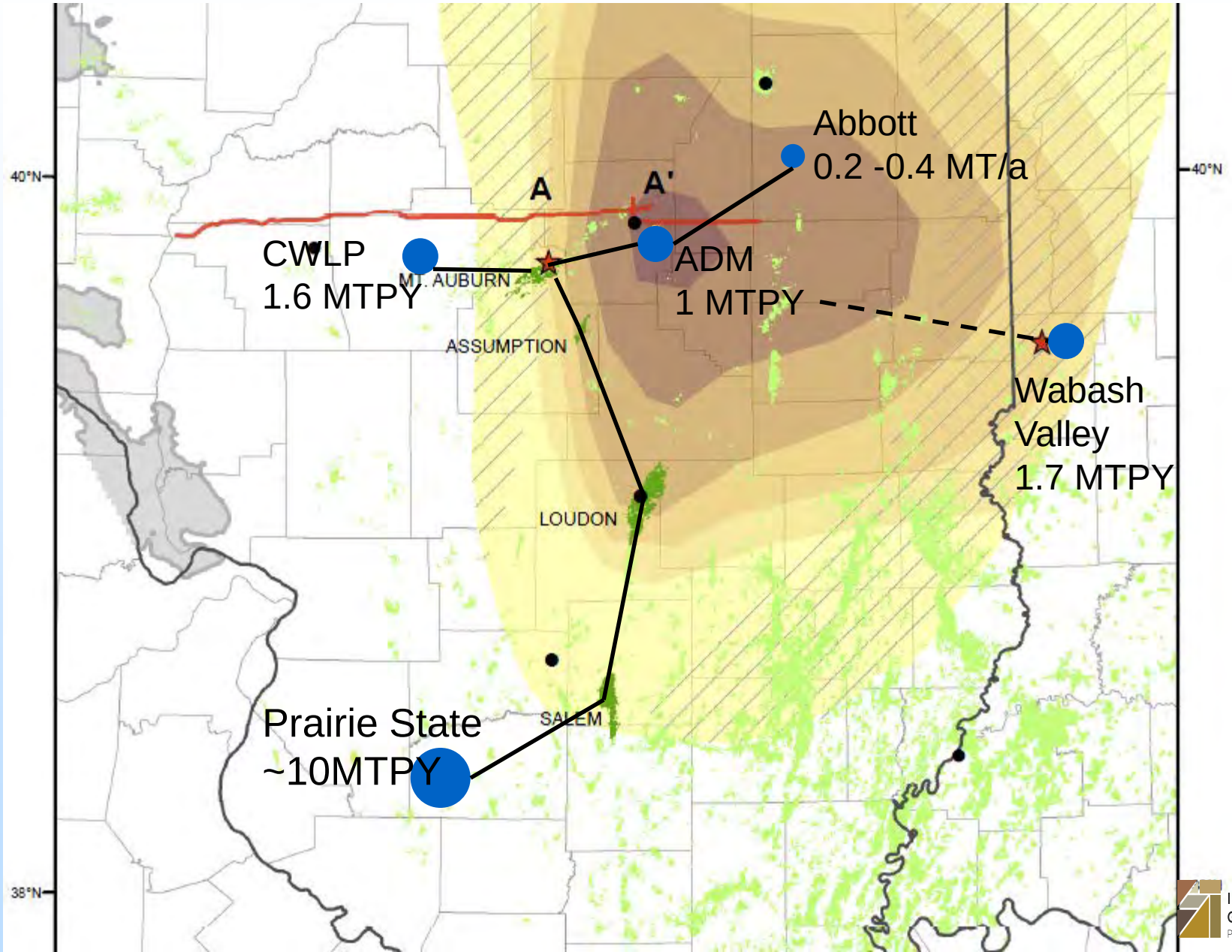
CarbonSAFE CO_2 Sources



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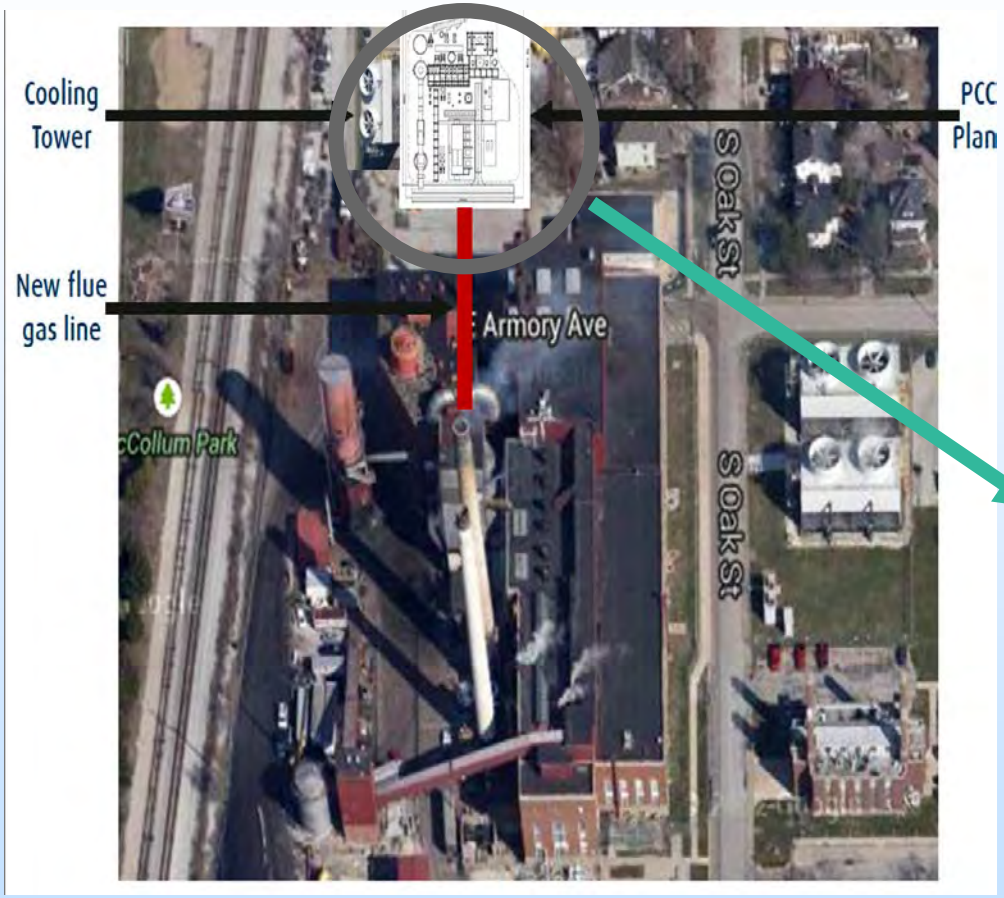
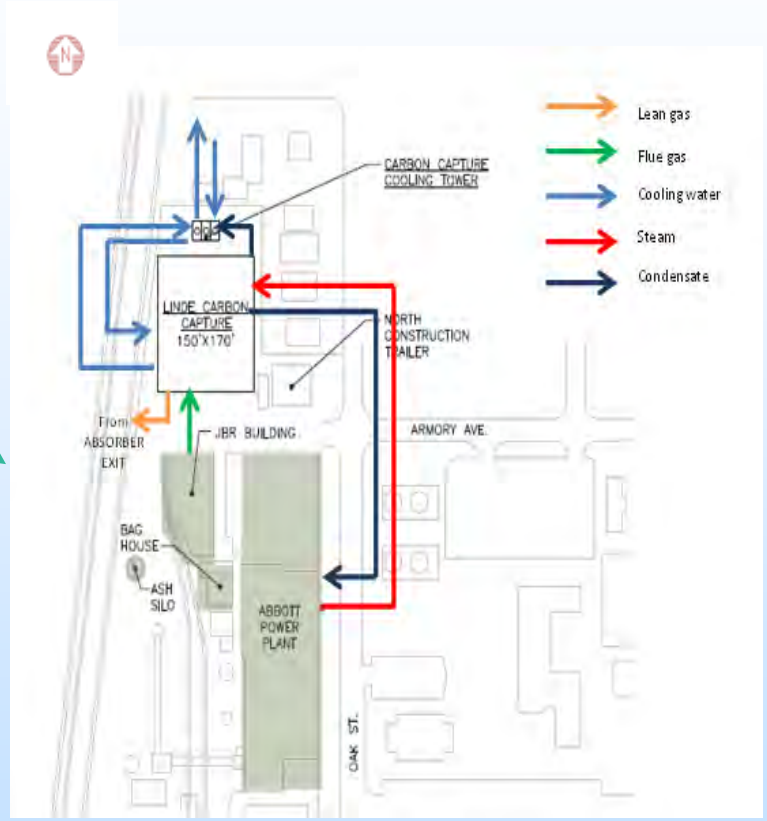
Abbott Site for Carbon Capture Plant Established and Evaluated





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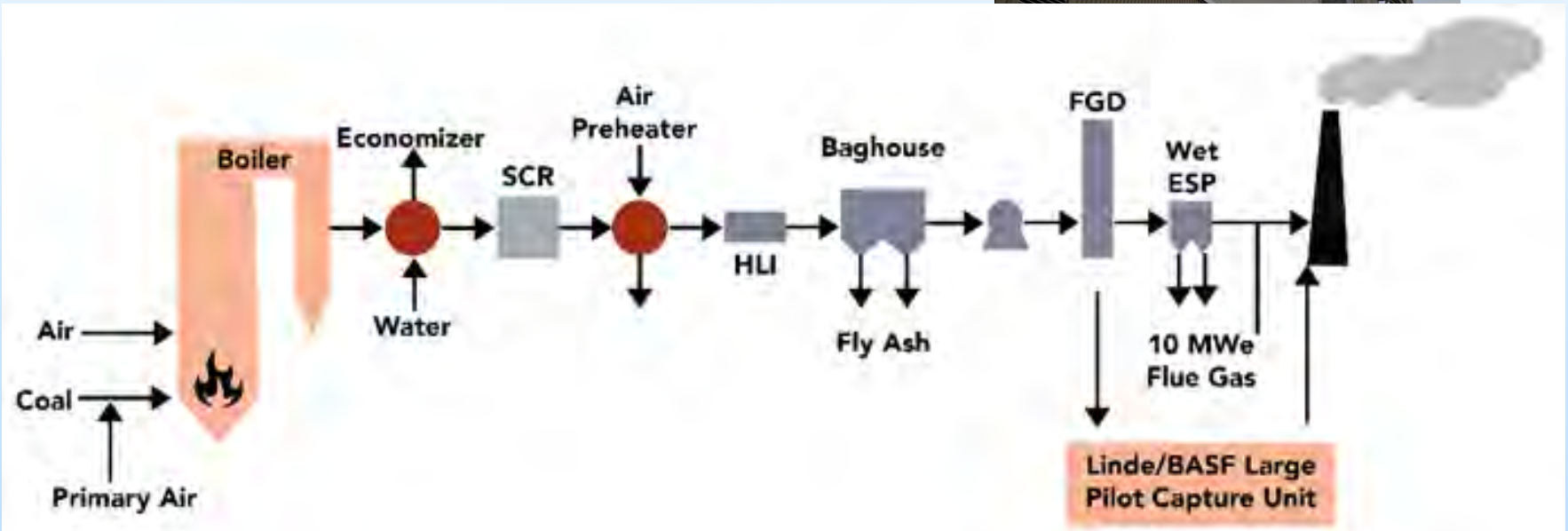
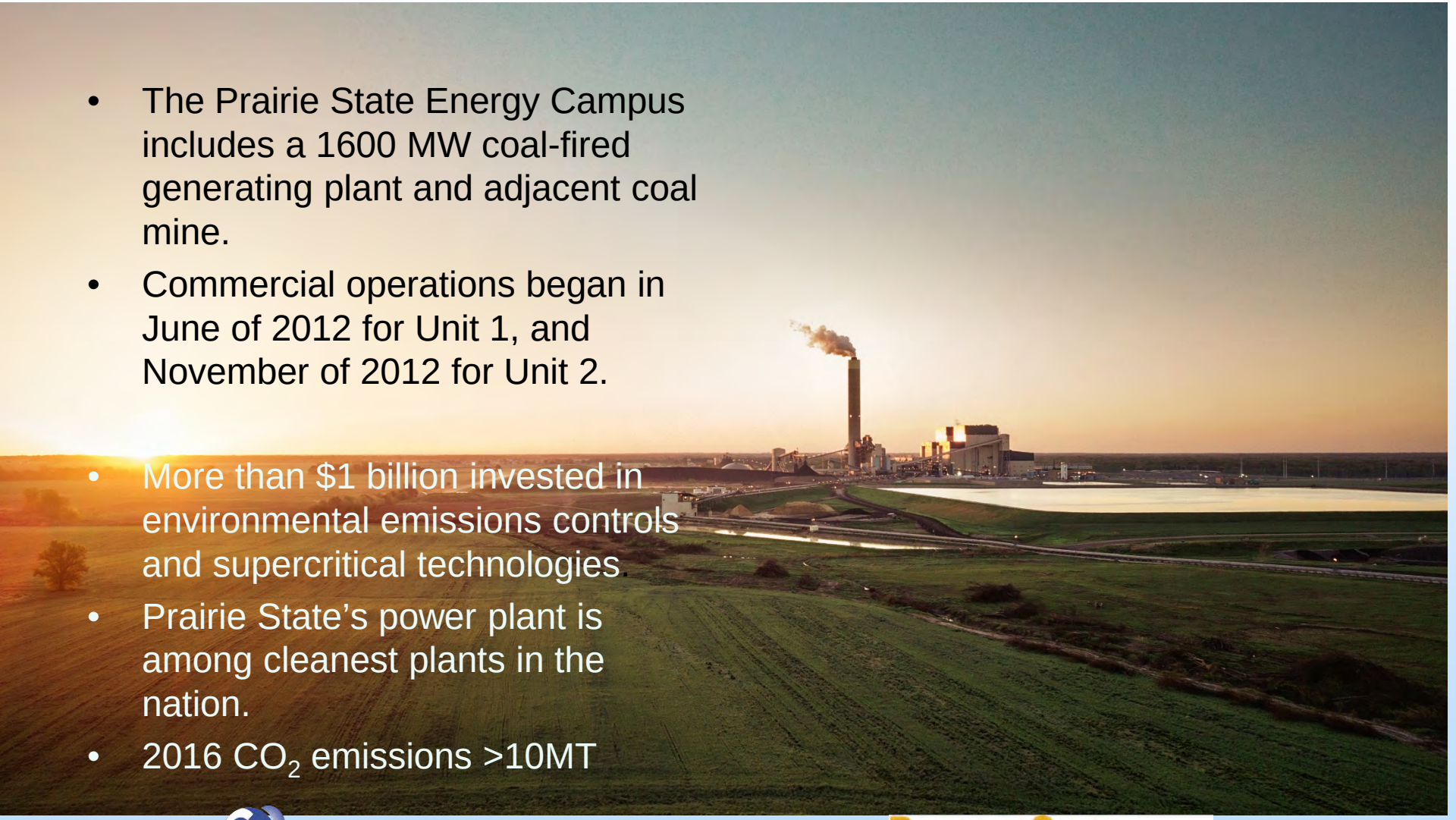
CWLP's Dalman Unit #4 : 200 MWe

- Unit #4 burned approximately 552,500 tons of Illinois coal in 2014
- Name Plate ca 1.6MT CO_2/a



ILLINOIS Prairie Research Institute

Prairie State Generating Company



- The Prairie State Energy Campus includes a 1600 MW coal-fired generating plant and adjacent coal mine.
- Commercial operations began in June of 2012 for Unit 1, and November of 2012 for Unit 2.

- More than $1 billion invested in environmental emissions controls and supercritical technologies.
- Prairie State's power plant is among cleanest plants in the nation.
- 2016 CO_2 emissions >10MT

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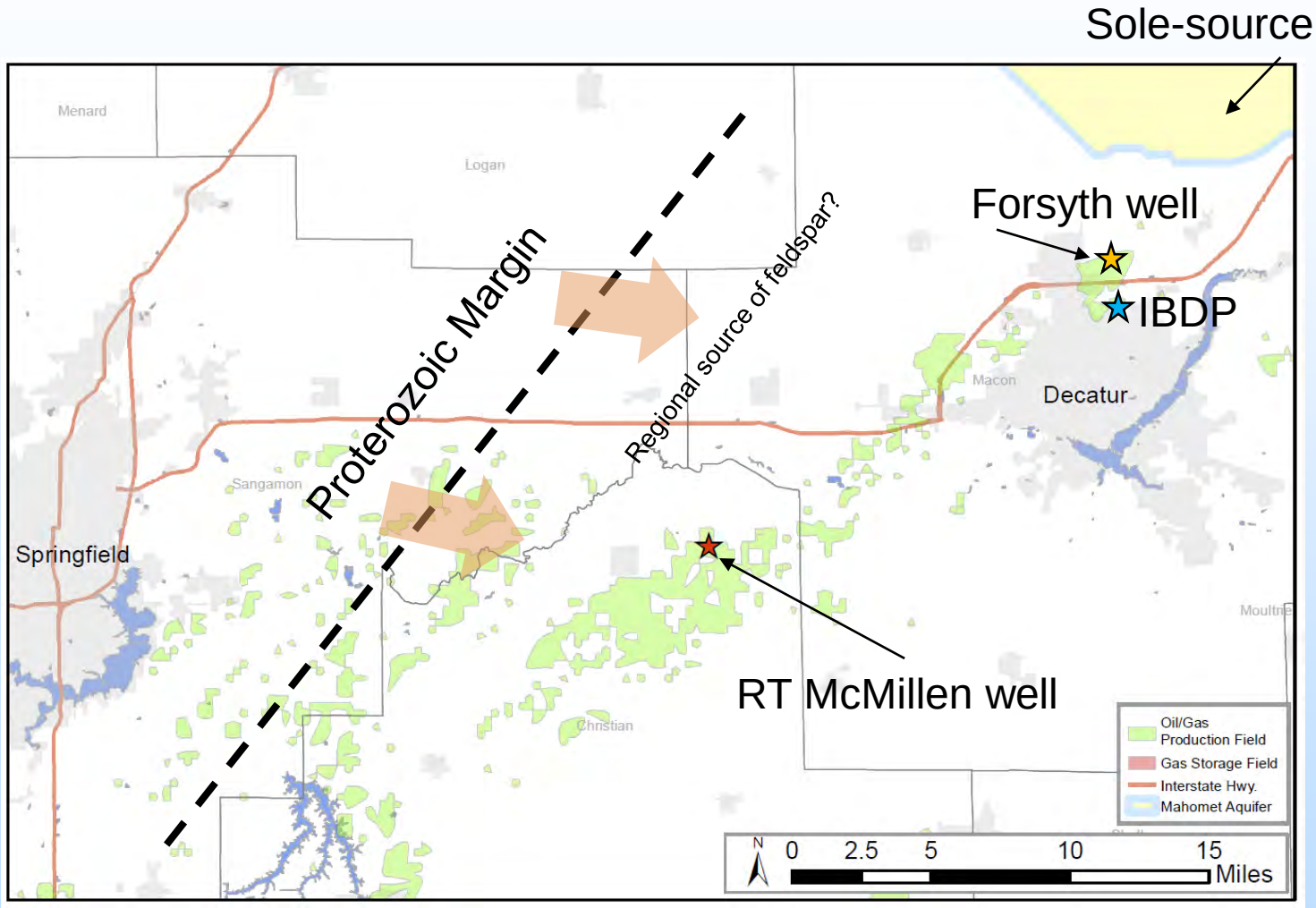
Study Area



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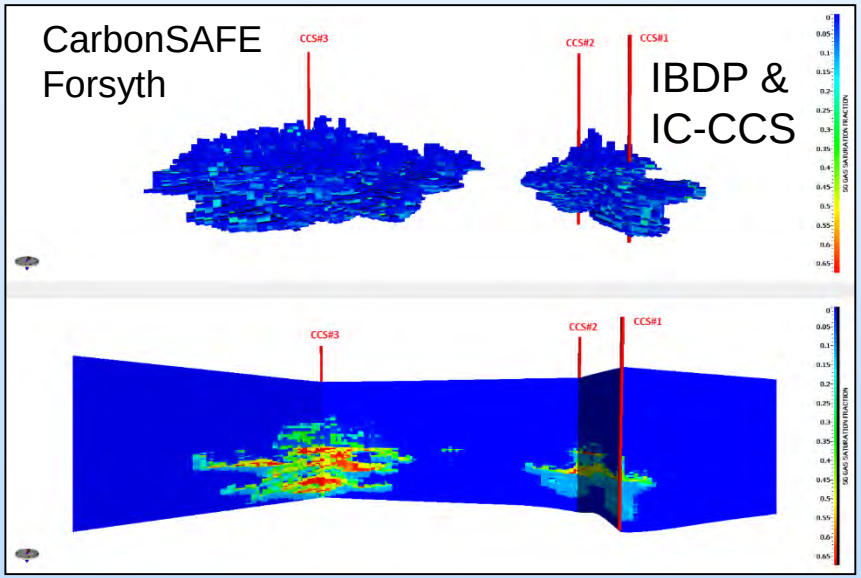
Storage Site Interaction

Injection Schedule

- CCS1: 0.33 Mt/yr for 3 years (2011-2014)
- CCS2: 1 Mt/yr for 5 years (2017-2023)
- CCS3: 2 Mt/yr for 25 years (2025-2050)
- Post-Injection Monitoring: 20 years (2050-2070)

Plume interaction

- Little plume interaction observed for sites ~ 3 miles apart.
- Injection induced reservoir pressure increase was less than 4%.



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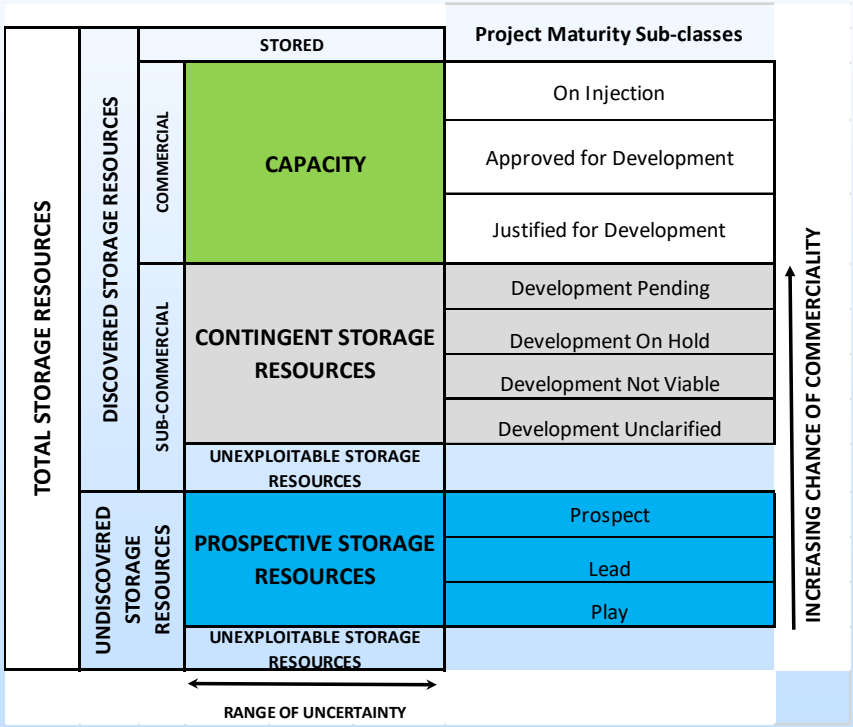
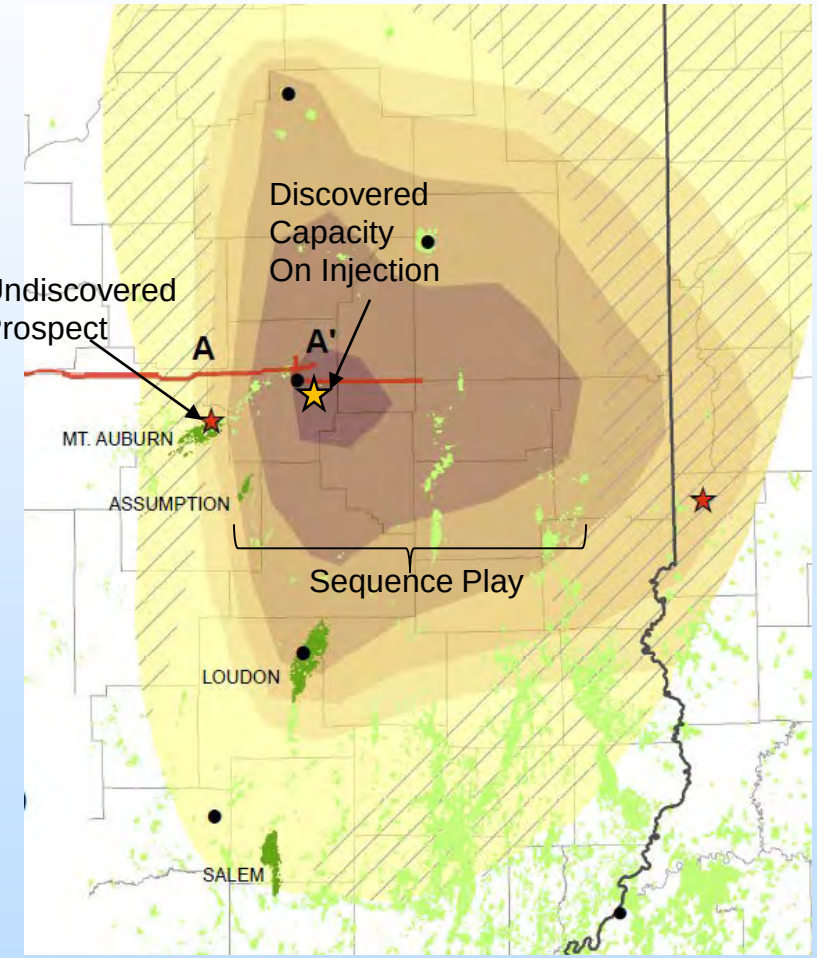
Storage Resource Management for Commerciality





Source: SPE (2017) *DRAFT* CO2 Storage Resource Management System. Society of Petroleum Engineers

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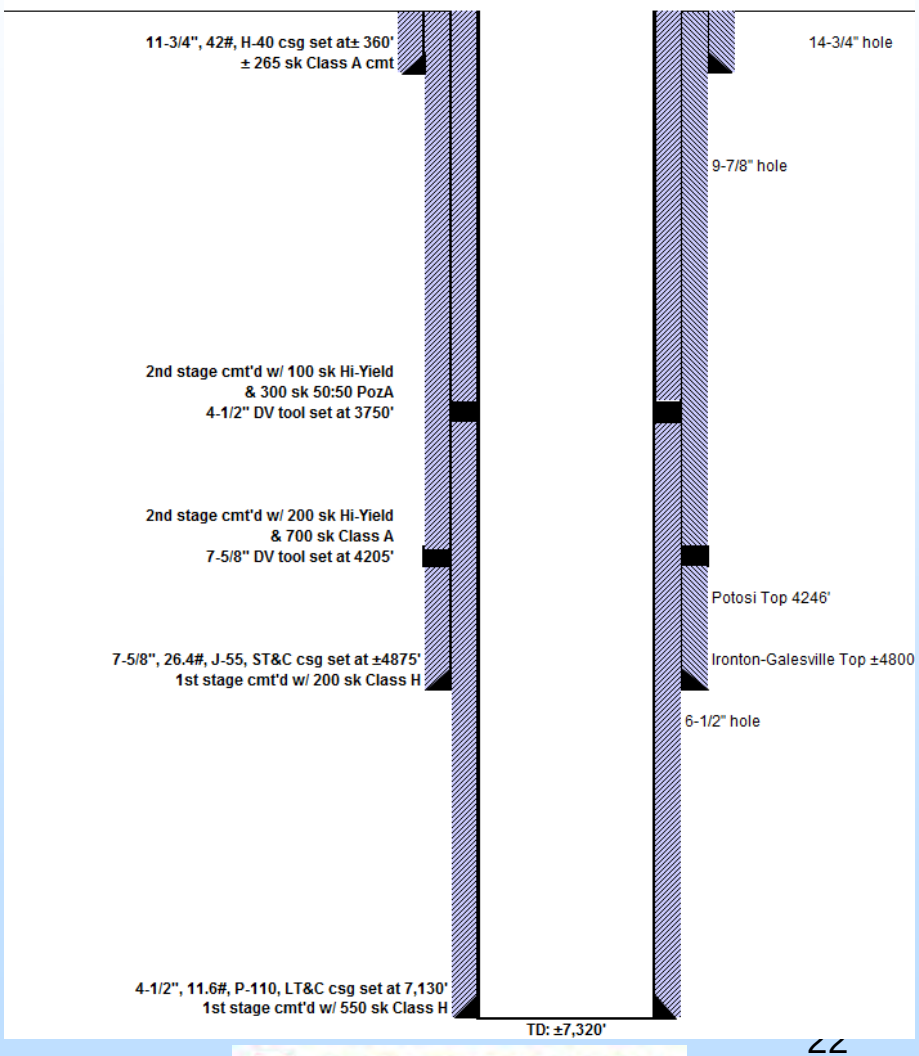
Characterization Well

Characterization Plan

- ~300’ Whole Core
- ~120 Sidewall Cores
- Evaluation
  - Triple Combo
  - Formation Images
  - Full Sonic
  - Elemental Spectroscopy
  - Magnetic Resonance
- Cased Hole Testing
  - VSP
  - Step Rate Tests
  - Sampling
  - Pressure Falloff
- Evaluate EOR Potential (Silurian)
- Drill into Precambrian for basement characterization



Projeo

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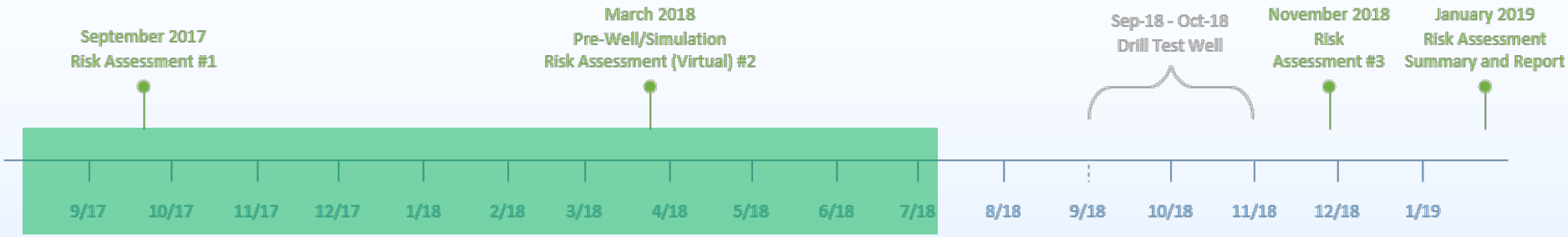
GEOSTOCK SANDIA
ENTREPOSE

CO_2 Capture and Transportation Screening-Level Cost Estimates

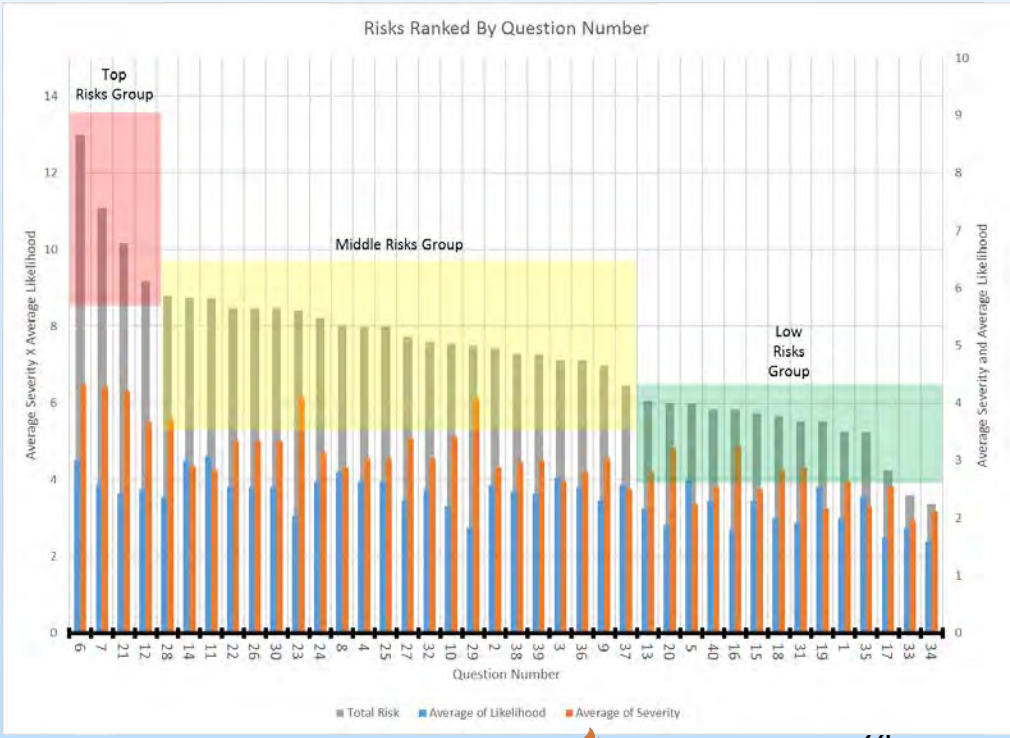
- ADM Ethanol Facility in Decatur, IL
  - 55 MMscfd or 1 million tonne per year (MTPY) of CO_2
  - \$0.30 - \$0.71 / tonne CO_2 - Estimate is for transportation only
- CWLP Dalman Unit #4
  - 75 MMscfd or 1.4 MTPY of CO_2 capture from 200 MWe coal-fired unit
  - \$63 - \$82 / tonne CO_2 - Estimate includes capture, compression, cogeneration facility (to offset parasitic load), and transportation
- Next steps
  - Revise ADM and CWLP to reflect new well site
  - Develop estimates for Prairie State and Abbott
  - Integrate with SimCCS

Risk Assessment Progress



Top 3 Ranked Risks

1. CO_2 source unwilling to participate results in no commercial viability.
2. Changes in federal project funding results in significant reduction of scope or outright cancellation of the project.
3. Unable to obtain site host results in an inability to drill a stratigraphic test well.



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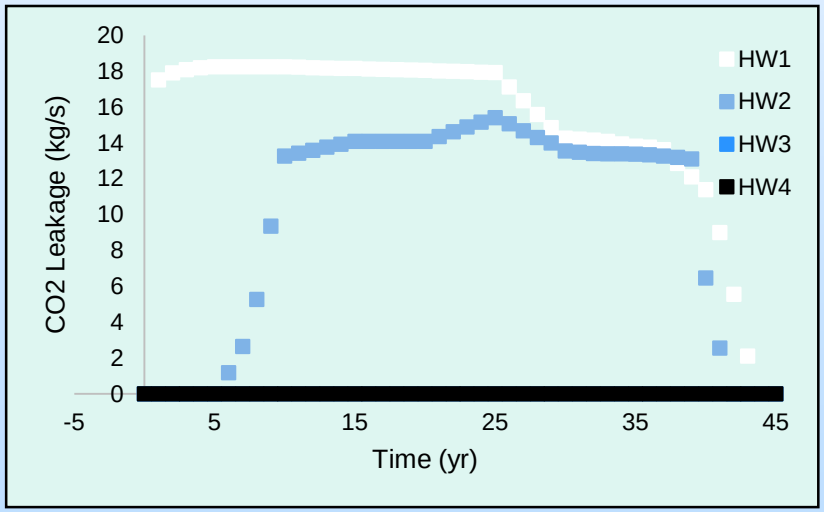
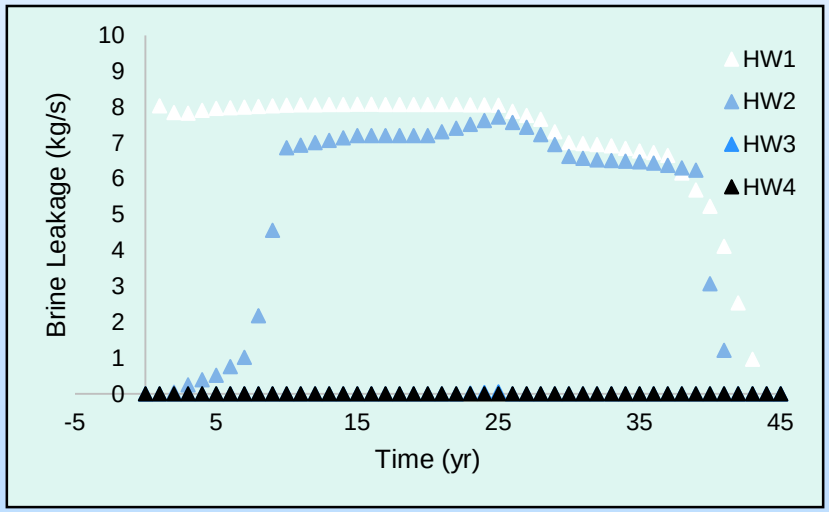
NRAP Integrated Assessment (IAM) tool

- Simulated CO_2 and brine leakage into the proximal USDW using 4 hypothetical wells modeled as open boreholes at 0*, 1, 2, and 3km south of the injection well
- Aquifer parameters derived from the St. Peter Sandstone
- Simulation indicates that the USDW was impacted at hypothetical wells only up to 1km from injection





Pacific Northwest NATIONAL LABORATORY

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Project Summary

- Identified new sources of CO_2 suitable for potential capture and transportation
  - challenge presented by scale of storage resource required for very large emitters (land access, pore space ownership, subsurface requirements)
- Revised drilling target to accommodate larger potential sources of CO_2 and reduce risks associated with initial site
- Well drilling early fall 2018
- Better define “arkosic sequence play” for moving toward commercialization of Mt. Simon storage resource – implement SRMS
- Re-evaluate stakeholder engagement requirements
- Integrate costs, SimCCS for business case evaluation

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Thank You

- Project thanks DOE for support through award FE-0029381
- And our partners in research