Midwest Geological Sequestration Consortium

Optimization of Onshore Monitoring for Industrial CCS: Experiences from the Decatur Projects

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- Harris Corporation
- Illinois Department of Transportation*
- Lawrence Berkeley National Laboratory
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- Stanford University
- TRE Canada and the Carbon Capture Project
- University of Illinois – Department of Geology

*provided content for this presentation

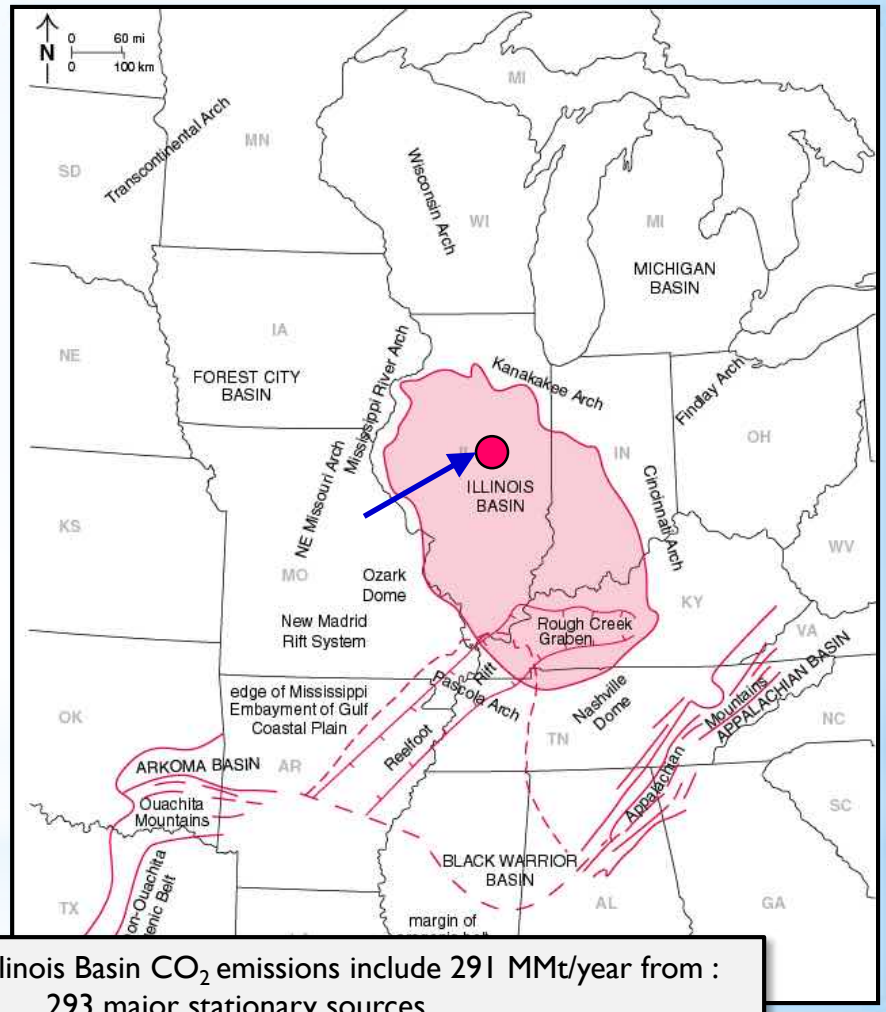
Overview

- A story of two ‘projects’ in Decatur, Illinois, USA
- First project: Research and comprehensive monitoring (demonstration scale)
- Second project: Targeted monitoring (commercial scale)
- Gaps and challenges

Illinois Basin - Decatur Project (IBDP)

- 1st saline storage project in Decatur, Illinois, USA. Led by ISGS.
- CO_2 injection began in Nov 2011 completed in Nov 2014
  999,215 tonnes total (~1,000 tpd)
- 1 million tonnes of anthropogenic CO_2 at a depth of 2,100 m (7,000 ft)
- Comprehensive monitoring program (20+ techniques); 11+ years
  - 2 years pre-injection,
  - 3 years during injection, and
  - 6 years post-injection (2014-2020)
  - Additional post-injection requirements*

*USEPA UIC Class VI permit finalized Feb 12, 2015.



Illinois Basin CO_2 emissions include 291 MMt/year from :
293 major stationary sources
84 fossil-fueled electric generators (87%)
20 ethanol plants (5%)

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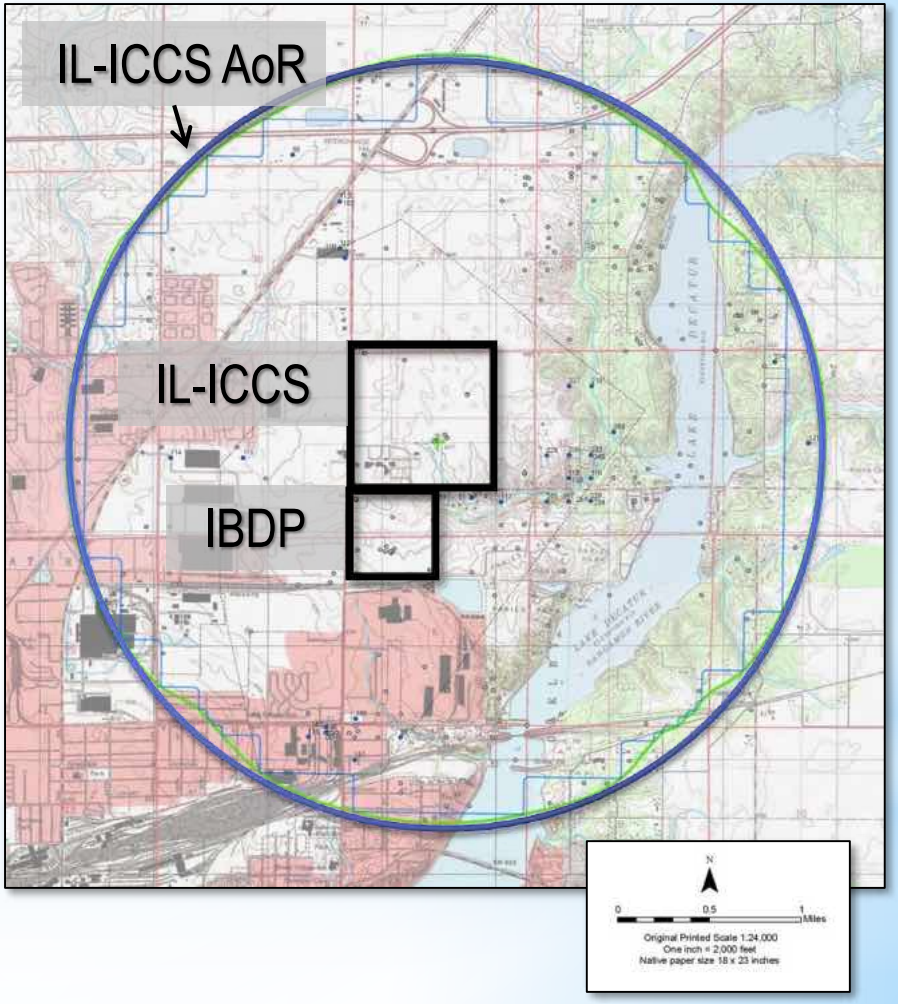
Illinois Industrial CCS (IL-ICCS) Project

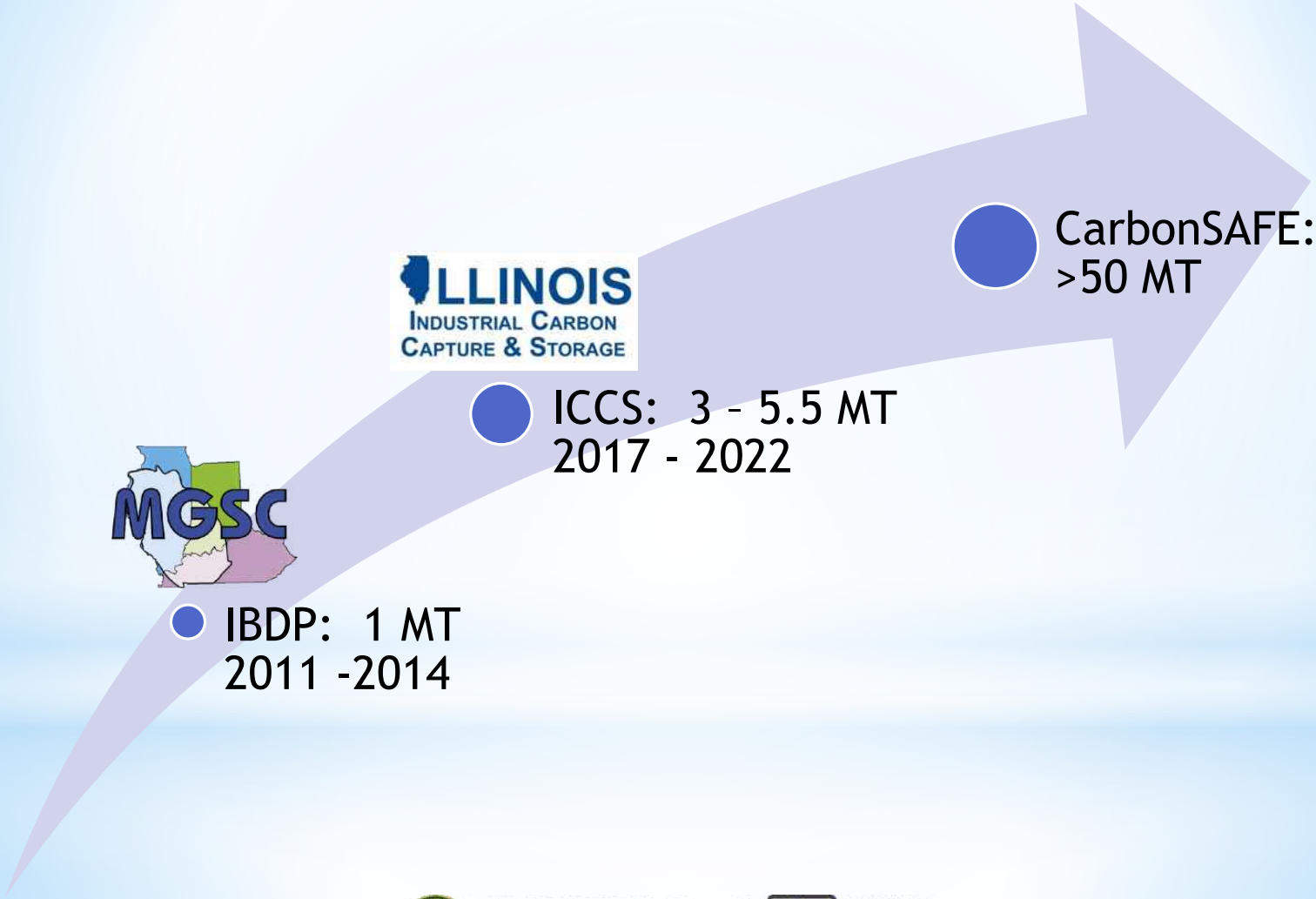
- 2nd saline storage project in Decatur, Illinois, USA. Led by ADM.
- Injection: April 2017 (up to 3,000 tpd) As of April 2018 (~670,000 tonnes)
- 3 - 5.5 million tonnes total of anthropogenic CO_2 at a depth of 2,100 m (7,000 ft)
- Targeted monitoring program with 17 years of monitoring planned;
  - 2 years pre-injection,
  - Up to 5 years during injection, and
  - 10 years post-injection*

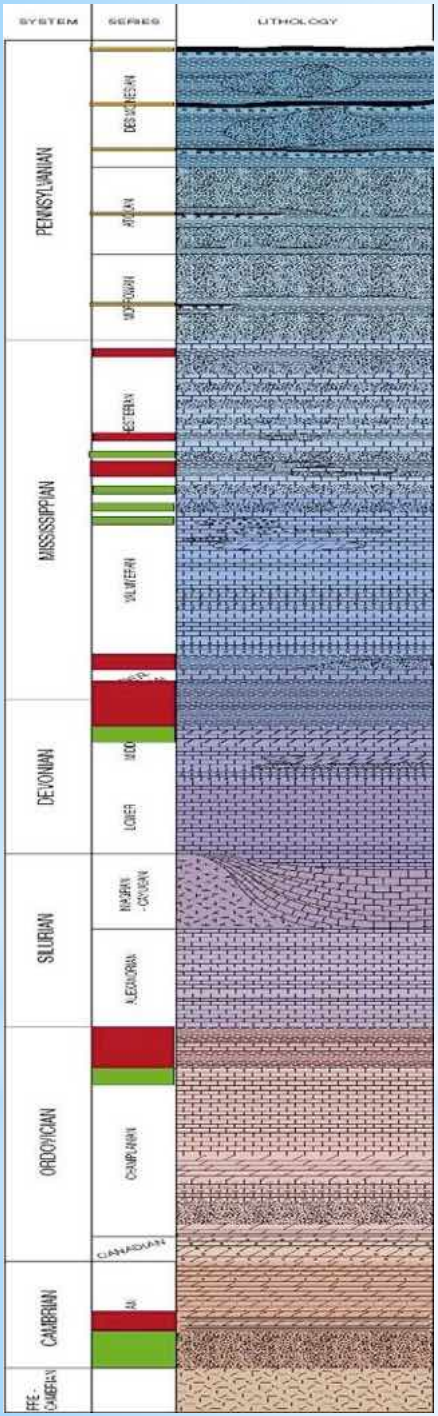


*USEPA UIC Class VI application finalized November 2014.

For a project description, see http://www.carboncapturejournal.com/ViewNews.aspx?NewsID=3346

Illinois Industrial CCS Progression





Illinois Basin Strata

Pennsylvanian coal seams

Mississippian sandstone and carbonate oil reservoirs

New Albany Shale (seal)

Maquoketa Shale (seal)

Saint Peter Sandstone

Ironton-Galesville Formation

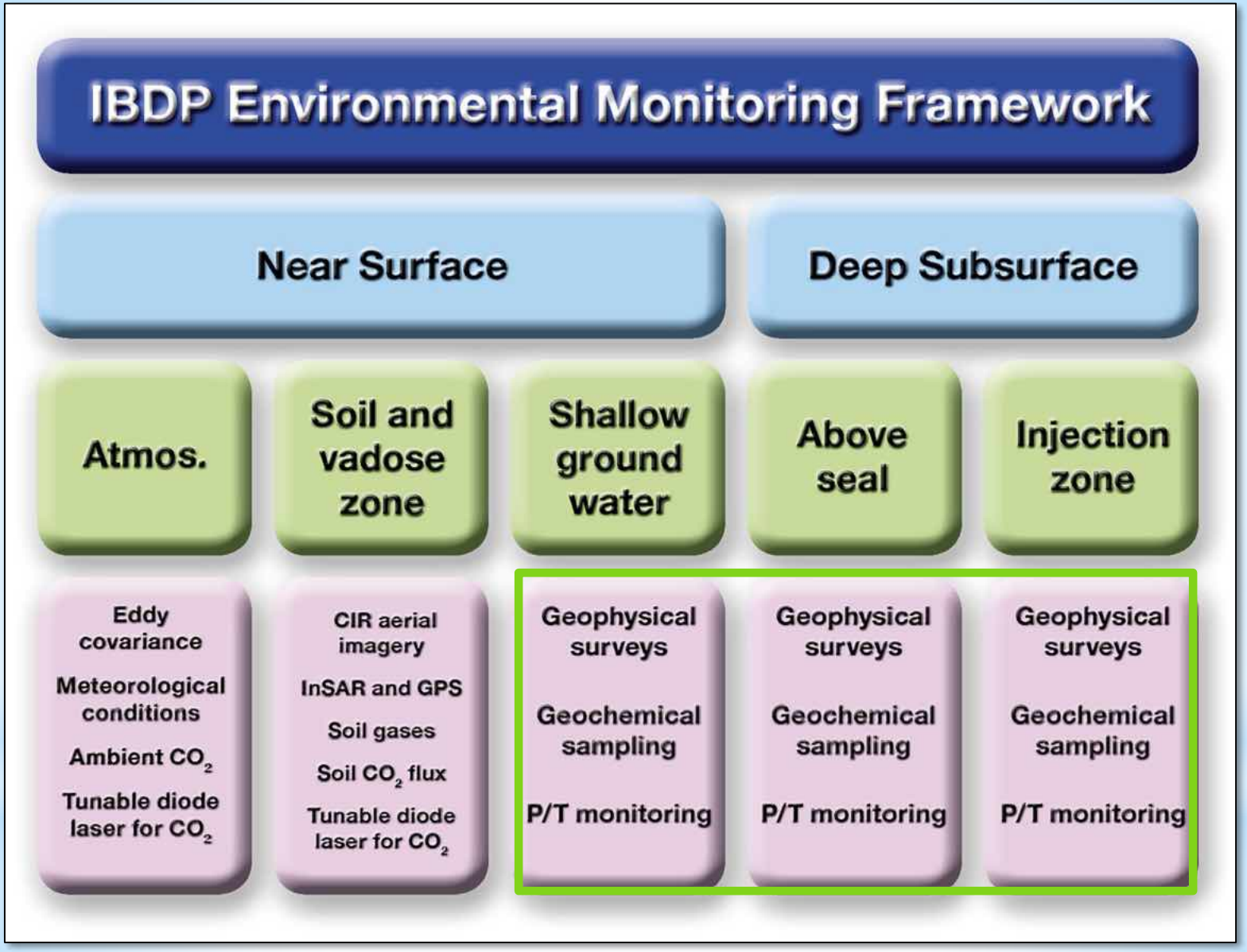
Eau Claire Shale (seal)

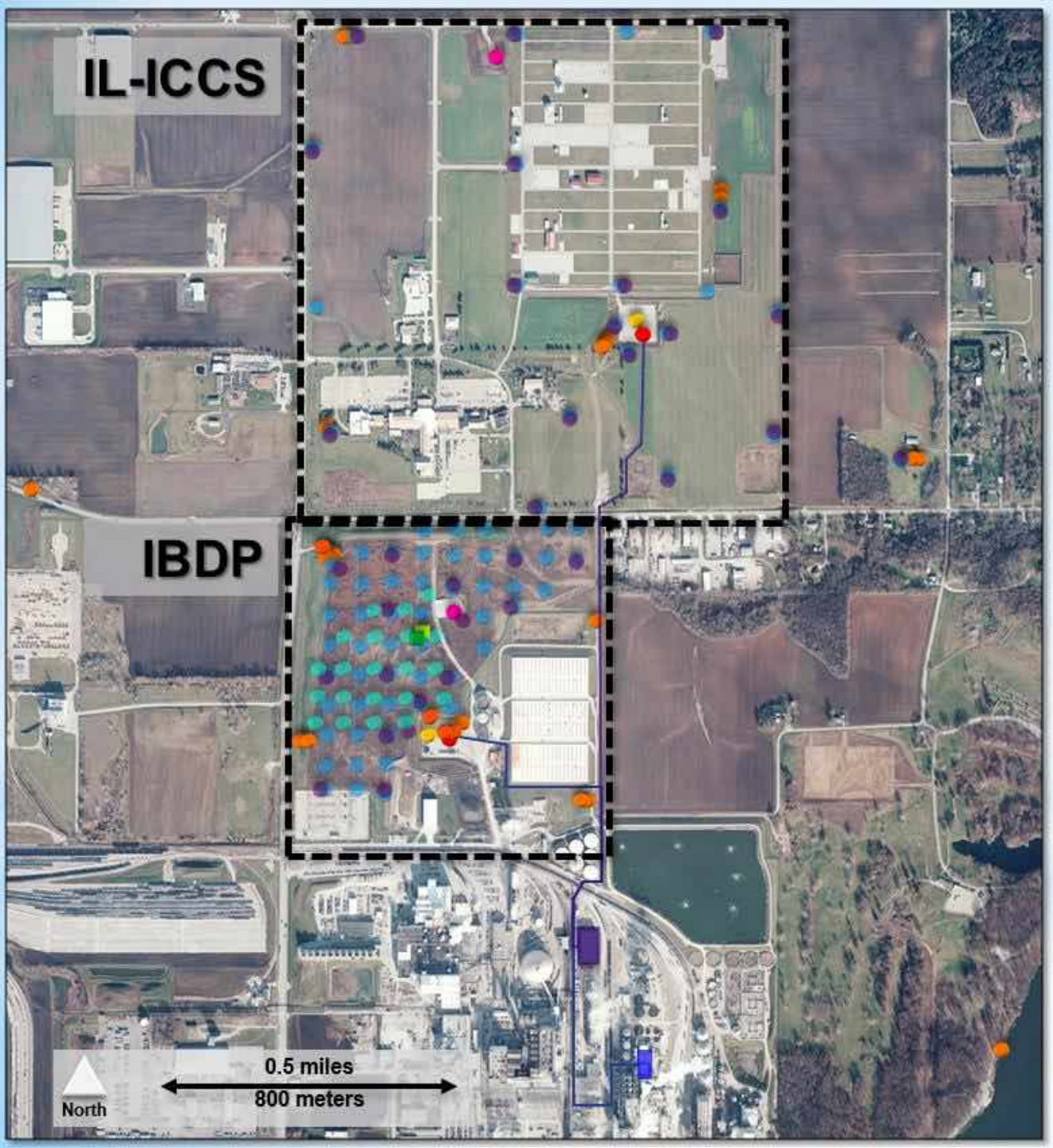
Mount Simon Sandstone (reservoir)

= key monitoring zones

Mount Simon Sandstone:

- Regionally most significant sequestration resource in the Midwestern USA
- 11 to 151 Gtonnes capacity (US DOE Atlas, 3rd edition)
- IBDP = 0.001 Gtonne test
- IB emission= 0.291 Gtonne/yr
- 37 to 519 years of capacity


IBDP Environmental Monitoring Framework
Near Surface
Deep Subsurface
Atmos.
Soil and vadose zone
Shallow ground water
Above seal
Injection zone
Eddy covariance
Meteorological conditions
Ambient CO_2
Tunable diode laser for CO_2
CIR aerial imagery
InSAR and GPS
Soil gases
Soil CO_2 flux
Tunable diode laser for CO_2
Geophysical surveys
Geochemical sampling
P/T monitoring
Geophysical surveys
Geochemical sampling
P/T monitoring
Geophysical surveys
Geochemical sampling
P/T monitoring



Monitoring Summary

- Injection wells (2)
- Verification wells (2)
- Geophysical wells (2)
- Compliance wells (4)
- Research wells (24)
- Soil gas points (35)
- Soil flux points (145)
- Eddy covariance station (1)
- Continuous GPS station (1)
- InSAR artificial reflectors (21)

IBDP Monitoring Summary

	Monitoring Activity	Freq.	Pre-injection			Injection				Post-Injection					
			2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Surface	Aerial imagery	SA		x	x	x	x	x	x	x	x	x	x	x	x
	Eddy covariance	C					x	x	x						
	Soil flux - network*	W-Q		x	x	x	x	x	x	x					
	Soil flux - multiplexer*	C			x	x	x	x	x	x					
	Tunable diode laser- single path	C					x	x							
	Tunable diode laser- multi path *	C								x					
	InSAR *	BW				x	x								
	Continuous GPS *	C					x	x	x						
Near-Surface	Soil gas sampling	Q-A				x	x	x	x	x	x				
	Shallow groundwater sampling	M-Q-SA		x	x	x	x	x	x	x	x	x	x	x	x⟶
	Shallow electrical earth resistivity*	A	x	x	x										
Subsurface	Pressure/temp. - VW1 and CCS1	C				x	x	x	x	x	x	x	x	x	x⟶
	Pulsed neutron (CCS1, VW1, GM1)	Q-A		x		x	x	x	x	x			x		x⟶
	Deep fluid sampling (VW1)	SA				x	x	x	x	x		x	x	x	
	Passive seismic monitoring (GM1)	C			x	x	x	x	x	x	x	x	x	x	x⟶
	Seismic/3D VSP imaging	SA-A			x	x	x	x	x	x					x⟶
	Mechanical integrity (CCS1, VW1)	A			x	x	x	x	x	x					x

Abbreviations: C = Continuous, W = Weekly, BW = Biweekly, M = Monthly, Q = Quarterly, SA = Semi-Annually, A = Annually,
x = planned, not permit required; * = experimental technique or deployment; x = planned, permit required;
x⟶ = permit activity required beyond 2020; yellow box highlights decrease in monitoring activity during PISC phase

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Gaps and Challenges

- First of all, don't forget the basics!
  - Well-defined data quality objectives.
  - Frequent data integration.
  - Anticipate that monitoring methods will change during the span of your project.

- Key Project and Regulatory Needs:
  - Shorter permitting timeframes.
  - Ability to more definitively track/image the CO_2 plume, calibrate and update numerical models, and verify containment.
  - Well-defined closure and non-endangerment criteria.
  - Adaptive monitoring programs that are part of approved permits.

Gaps and Challenges

- Technical Issues: Subsurface Monitoring
  - Seismic imaging
    (decreasing costs and lag in visualization);
    Periodic field campaigns to greater frequency methods?
  - Fluid and well condition monitoring
    (increase measurement capabilities);
    Improving indirect methods and add new direct methods?
  - Leak detection in formations above the reservoir
    (increase likelihood of detection);
    Improve pressure analysis methods?

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