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Leveraging Research, Datasets, and Legacy Seismic to Support CCS in the MRCI

Partners and Stakeholders Meeting
September 28th, 2022
Columbus, OH

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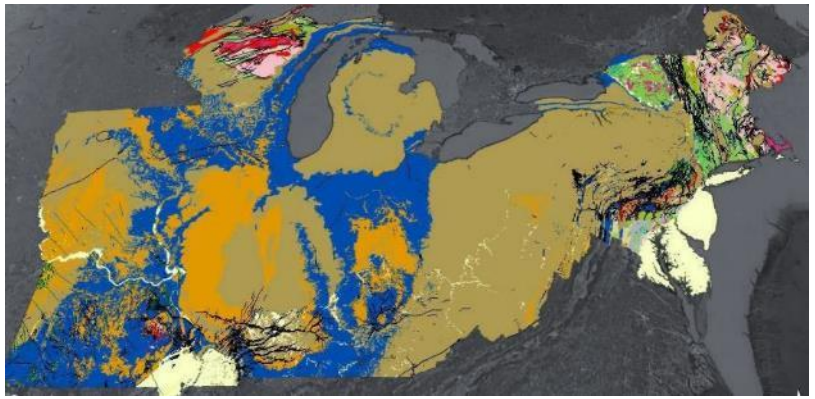
Midwest Regional Carbon Initiative

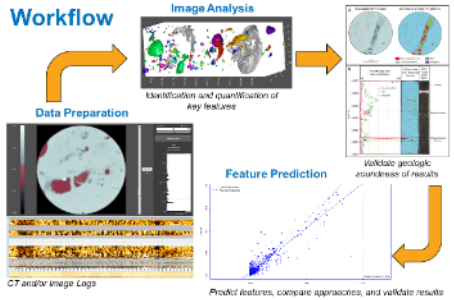
U.S. DEPARTMENT OF ENERGY | NATIONAL ENERGY TECHNOLOGY LABORATORY | BATTELLE | ILLINOIS

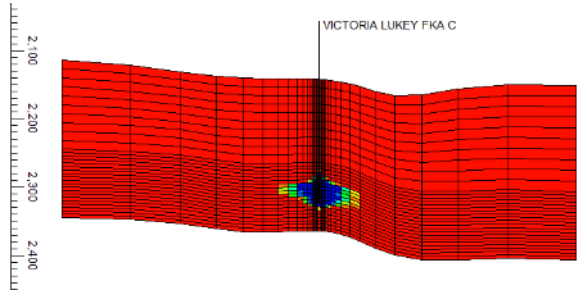
MRCI Research, Projects, Datasets



Objective: facilitate CCUS development through collection and sharing of existing and new technical data on from CCUS projects for possible further analysis and for assessment of tools by the project team and other DOE research programs.

- Inventory & Compile Data from MGSC, MRCSP, State initiatives: completed summarizing 1000+ reports, datasets, projects completed in MRCI over the past 20+ years!
- Additional Data Analysis: completed topical studies for key CCS challenges in MRCI region.
- Collaborate with DOE-NETL, NRAP, Nat. Labs.





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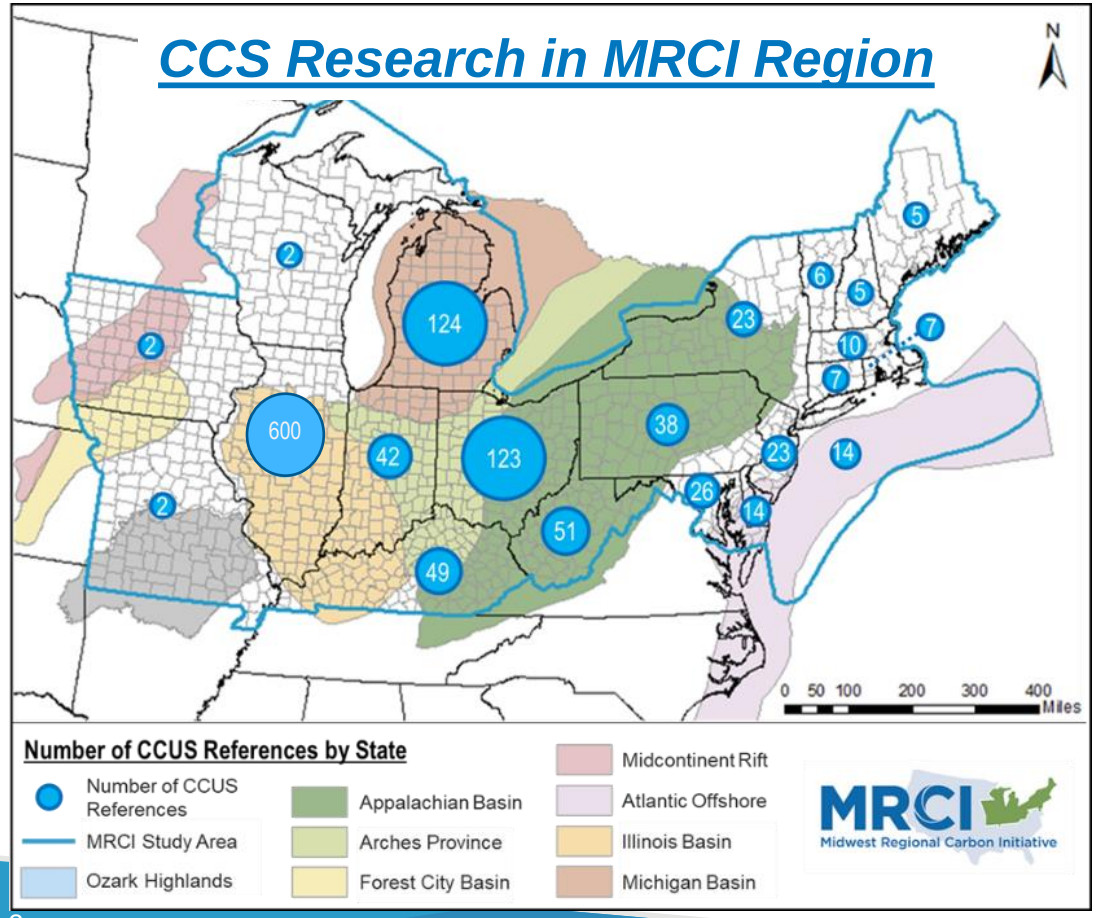
MRCI Research, Projects, Datasets

- Over 1,000 reports, presentations, posters, technical papers, datasets inventoried from previous research on carbon storage in MRCI region.
- Research supports CCS technology development in the MRCI.

CCS Research in MRCI Region



Technology Development in MRCI Region

Applied Research: TRL 2–4
- Proof-of-concept testing
- Lab/bench-scale
- Integration of components
- Short duration, low–moderate cost
- Simulated conditions

Development: TRL 5–6
- Evaluation of performance
- Pilot field testing
- Small-scale CO_2 injection
- Longer duration, higher cost
- In situ operating conditions
- Relevant to a project lifecycle

Demonstration: TRL 7–9
- Full-scale commercial application
- Large-scale CO_2 Injection
- Extended duration, major costs
- Variable operating conditions
- Relevant to all phases of a project's full lifecycle

Characterization & Feasibility CCS Projects
- MGSC Phase I
- MRCSP Phase I
- Mid-Atlantic Offshore
- OCDO
- CarbonSAFE Phase I

Pilot-Scale CCS Projects
- MGSC Phase II Tests
- MRCSP Phase II Tests
- AEP Mountaineer
- Southern MI Advanced CO_2-EOR

Large-Scale CCS Projects
- MGSC Phase III Illinois Basin Decatur Project
- MRCSP Phase III Michigan Basin
- CarbonSAFE IL Phase III

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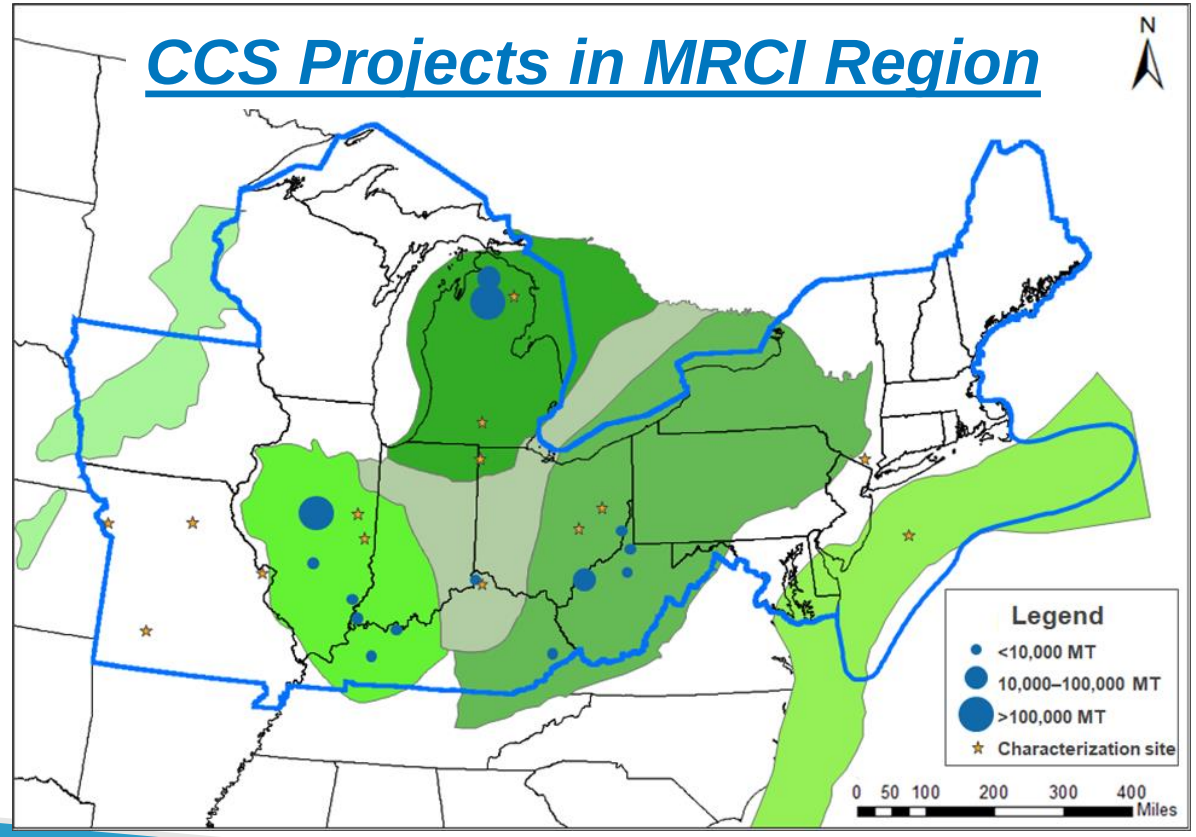
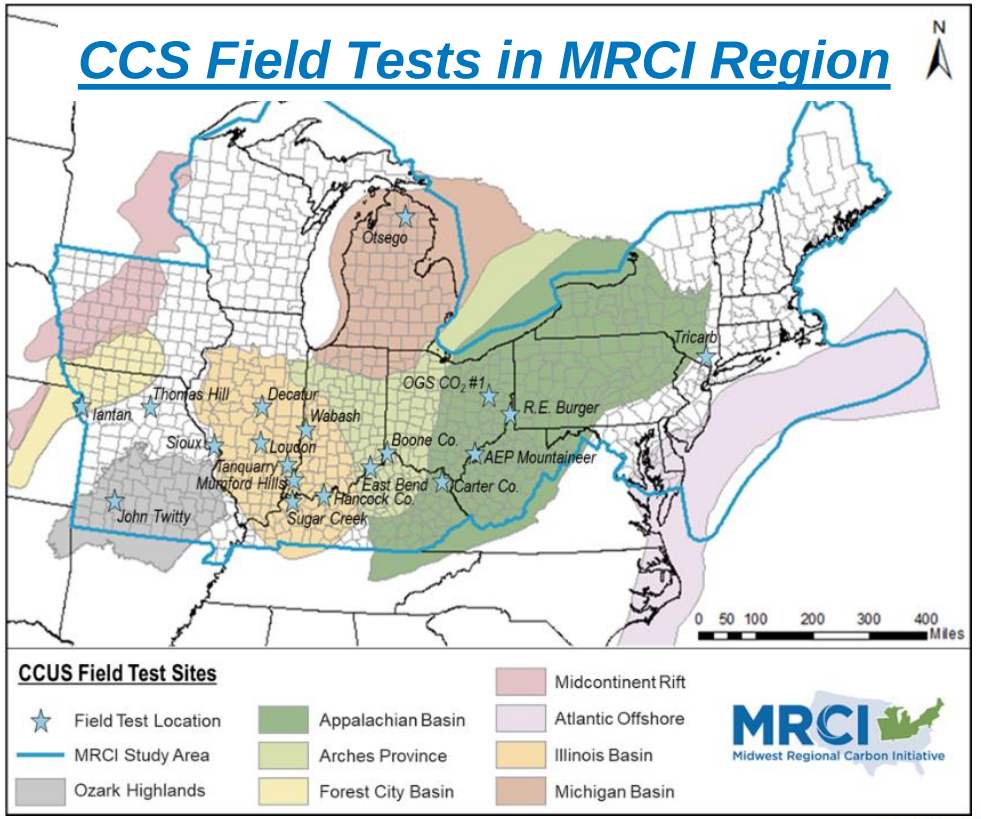
- CCS projects and field tests provide foundation for CCS development in MRCI.
- More than 3,000,000 metric tons CO_2 injected, 10+ deep test wells, CO_2 injection tests, 100s kms of seismic surveys, 1000s rock core tests.





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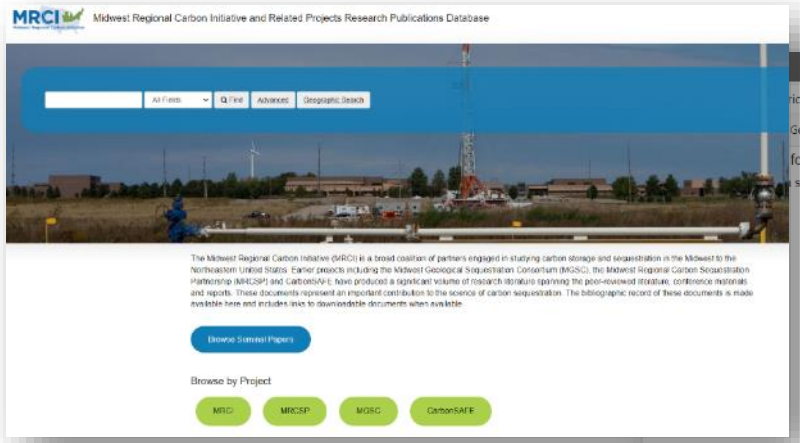
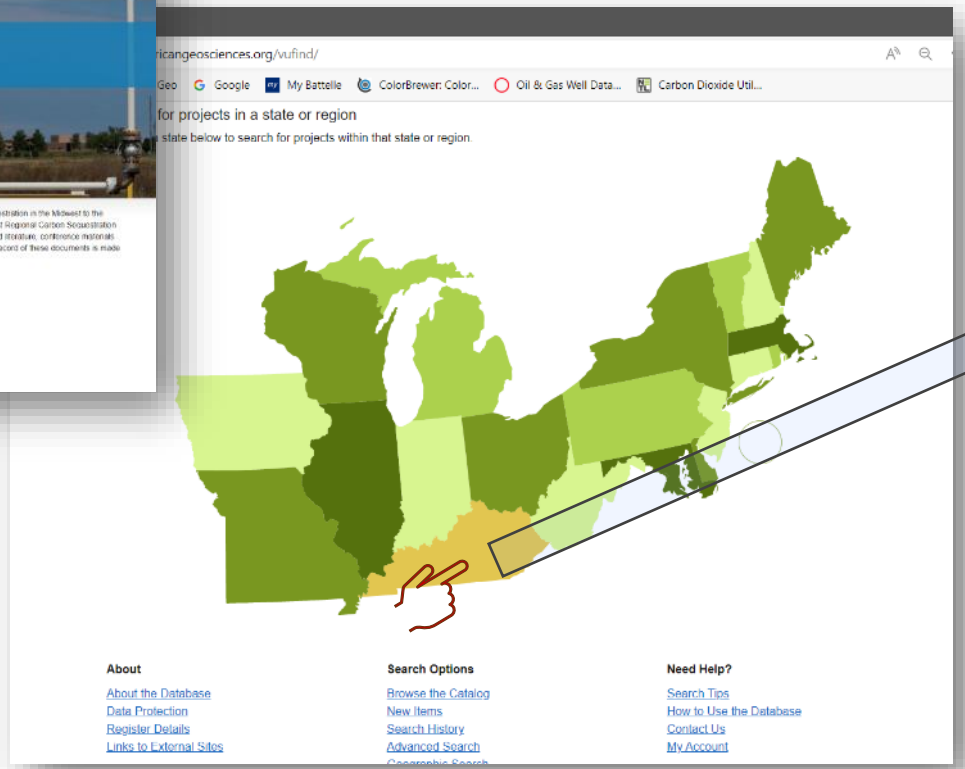
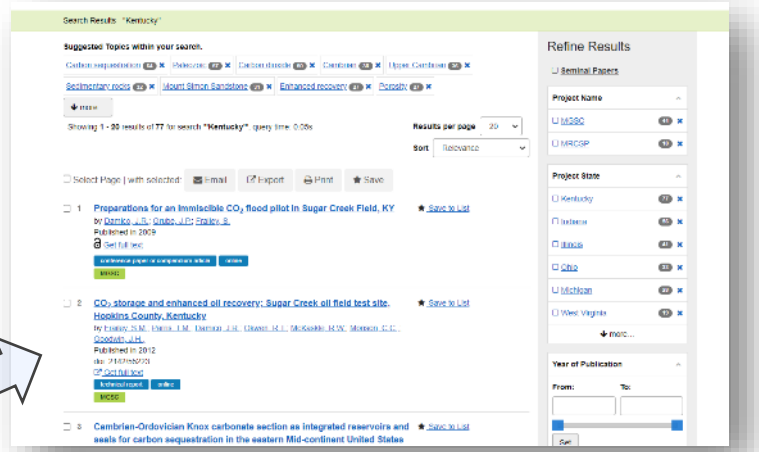
MRCI Data Sharing

- Information on geological storage provided to project developers in Illinois, Indiana, Ohio, Maryland, Michigan, Pennsylvania, West Virginia, & Ontario, CAN.
- Online database developed by American Geosciences Institute for MRCI website.







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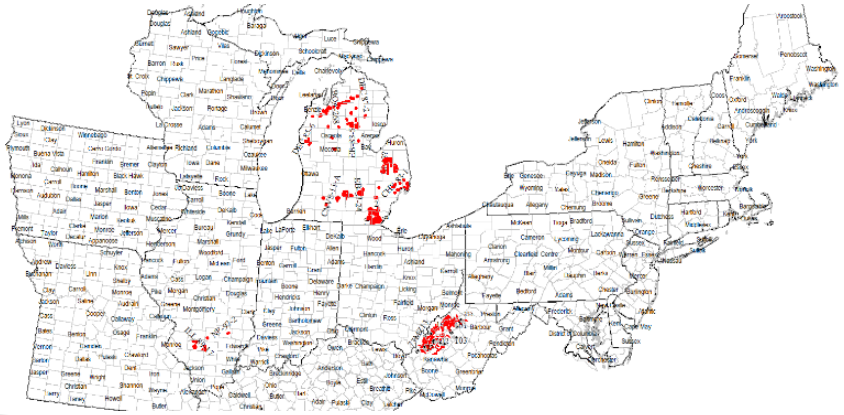
Leveraging Legacy Seismic Datasets

- Legacy seismic data was obtained, organized, summarized, and digitized so that it may support CCS in the MRCI region:
  - 832 linear miles of 2D seismic data
  - 43 square miles of 3D seismic data
  - 57 boxes containing reels, tape cartridges, CD's, DVD's, floppy disks, paper plots, and mylars
  - 6 Oil & Gas Operators with data from Illinois, Michigan, Ohio, and West Virginia
- The seismic lines were cataloged in terms of acquisition parameters, vintage, quality, location, and resolution.



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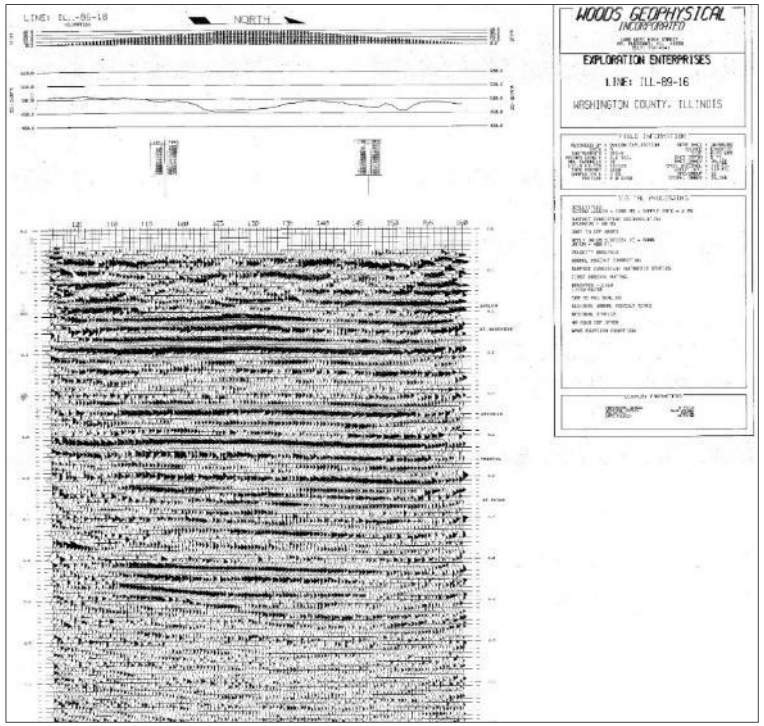
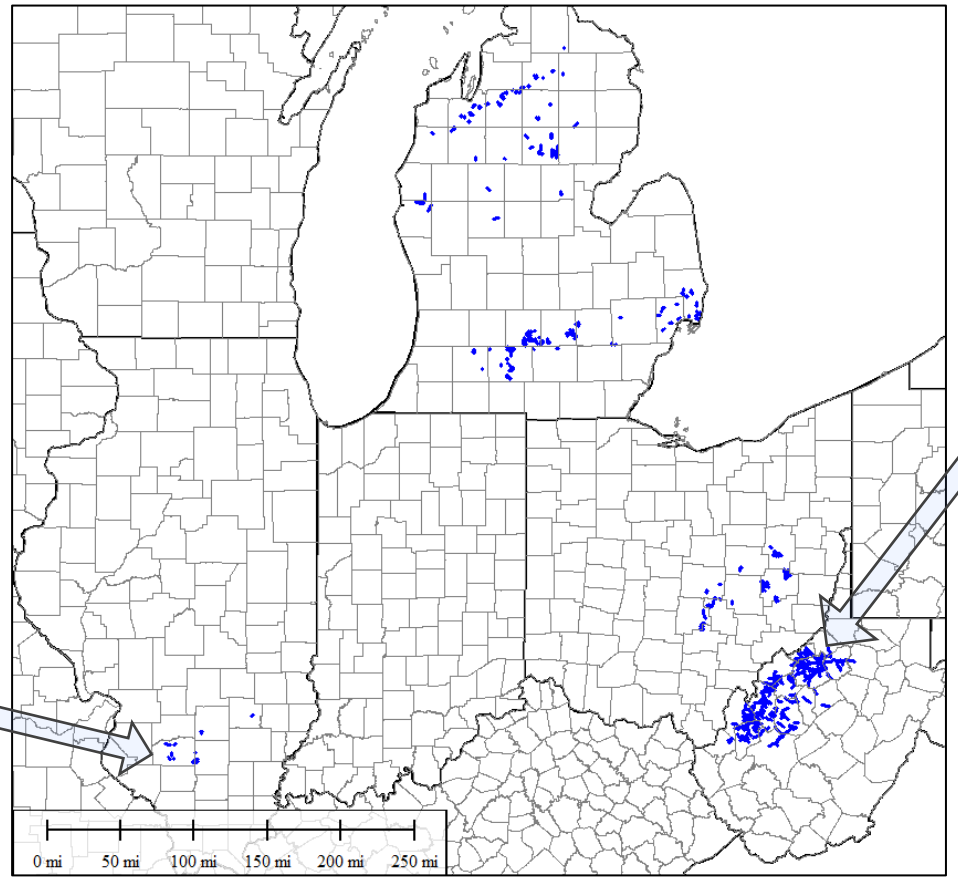
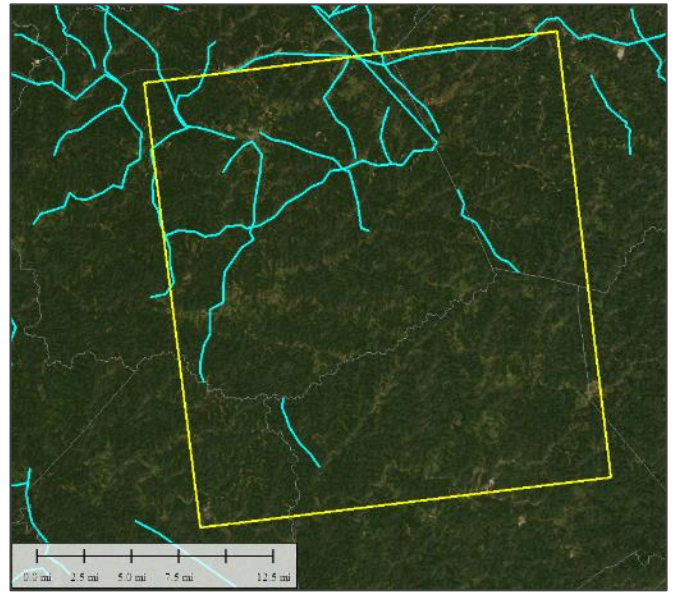
Leveraging Legacy 2D Seismic Datasets

2D seismic line in southern Illinois scanned from mylar to digital format







Legacy seismic lines (blue) in relation to the model area in West Virginia developed under Task 2

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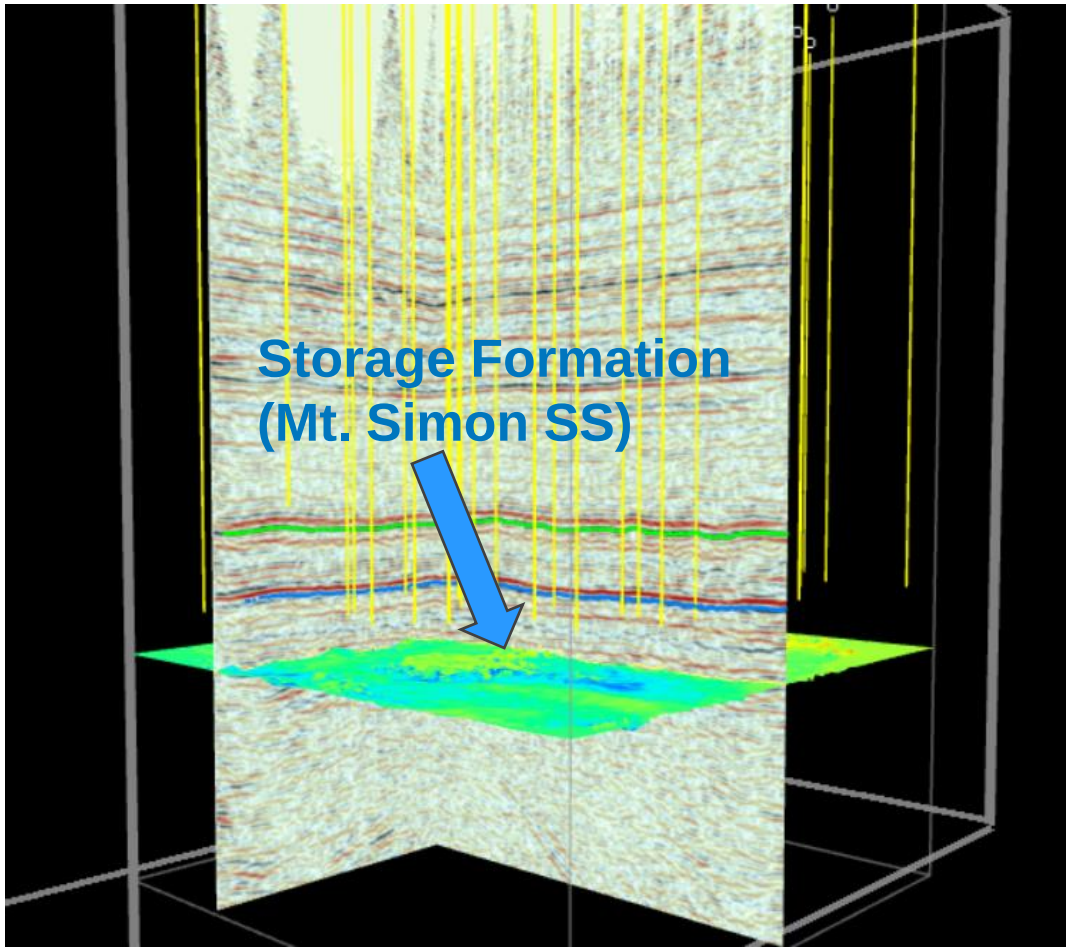
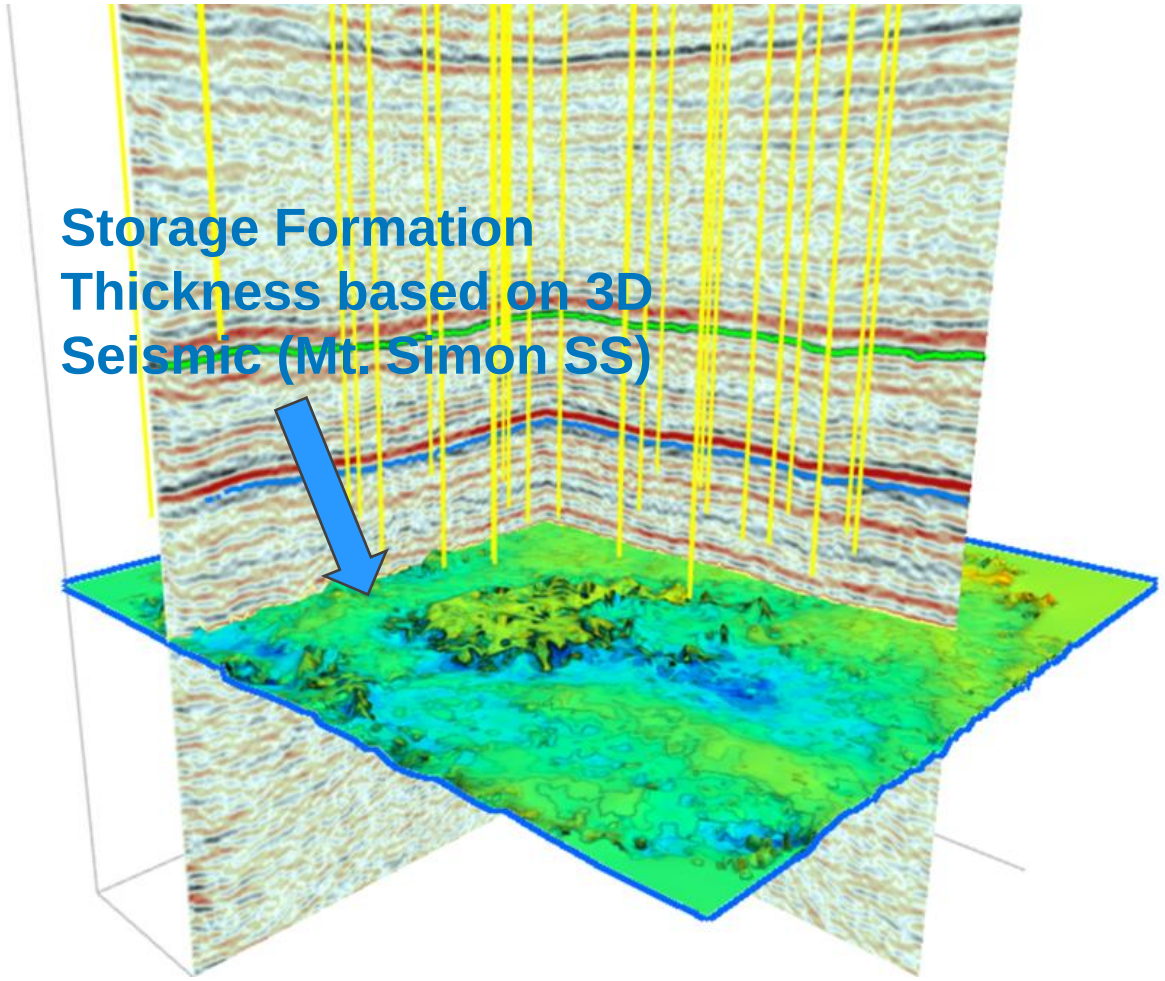
Leveraging Legacy 3D Seismic Datasets





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MRCI- Additional Data Analyses

Additional analysis completed with existing CCS datasets for MRCI:

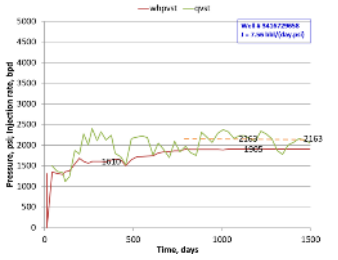
- *Class I & II Underground Injection Control well injectivity analysis*
- *Central MRCI Ethanol Plant CCS Screening Study*
- *Greenhouse Gas Emissions Life Cycle Analysis for MRCI Sources*
- *ACT collaboration for micro-seismicity*
- *Machine learning for downhole pressure/temperature prediction*
- *CT scan for carbonate porosity zones*
- *NRAP tool validation with field data in MRCI*

Effective mo**n**itoring of long-term site **s**tability for transparent carbon captu**r**e and storage hazar**d** ass**e**ssment (ENSURE)

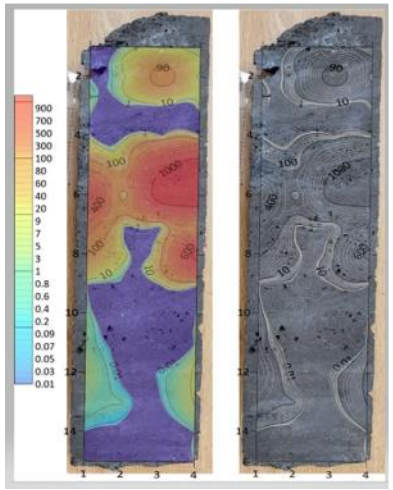
NORSAR

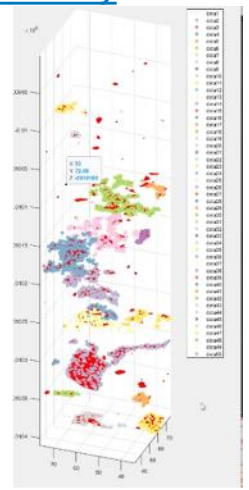
Accelerating CCS Technologies

Class II UIC Well Injectivity Analysis

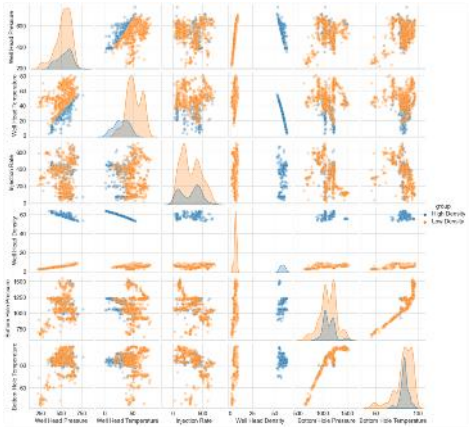


CT Scan of Carbonate Porosity



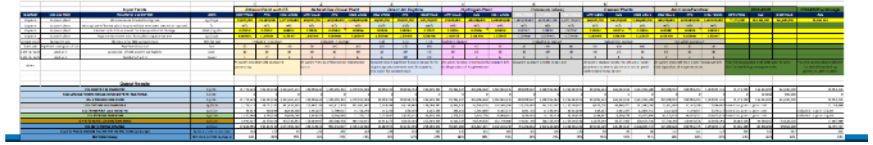


Machine Learning for Bottomhole Pressure/Temp



GHG LCA Net CO_2 Storage

- Ethanol Plant with CS (82-90%)
- Direct Air Capture Plant (59-90%) (depending on energy source for capture)
- Petroleum refinery (NA)
- Fertilizer/Ammonia Plant (87-88%)
- Natural Gas Power Plant (71-76%) (accounting for displaced electricity)
- Hydrogen Plant (88-90%)
- Cement Plant (90-91%) (new facility)
- CO2-EOR (59-66%) (not including downstream combustion of fuel products)



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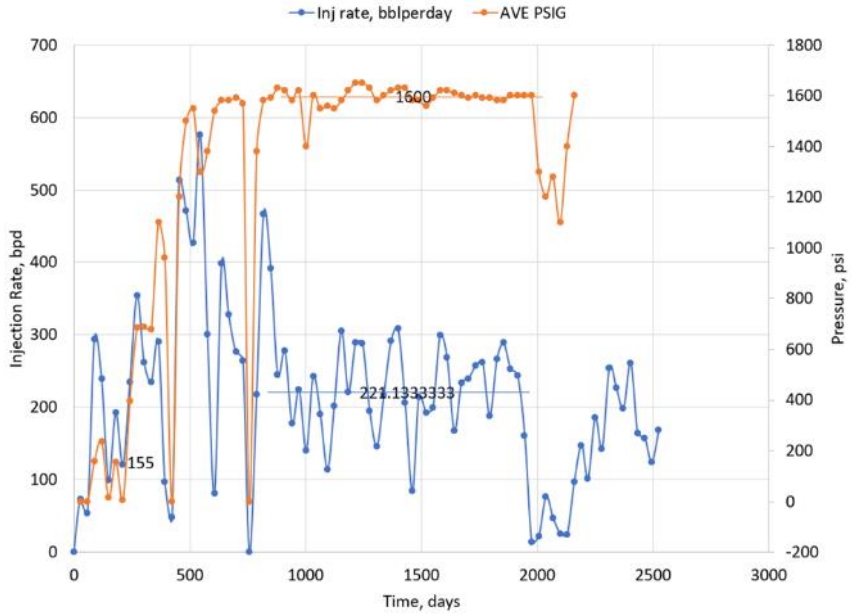
Class I & II Underground Injection Control well injectivity analysis

- A key question for CO_2 storage projects in the MRCI is the ability to maintain high injection rates necessary for large scale CCS projects
- Operational data from Class I and Class II UIC injection wells was analyzed to understand injection performance (rate and pressures) in relation to CO_2 storage.

Plot of q, WHP vs time for well PAS2D215BWAR. Calculated injectivity index is 0.15 bbl/day/psi



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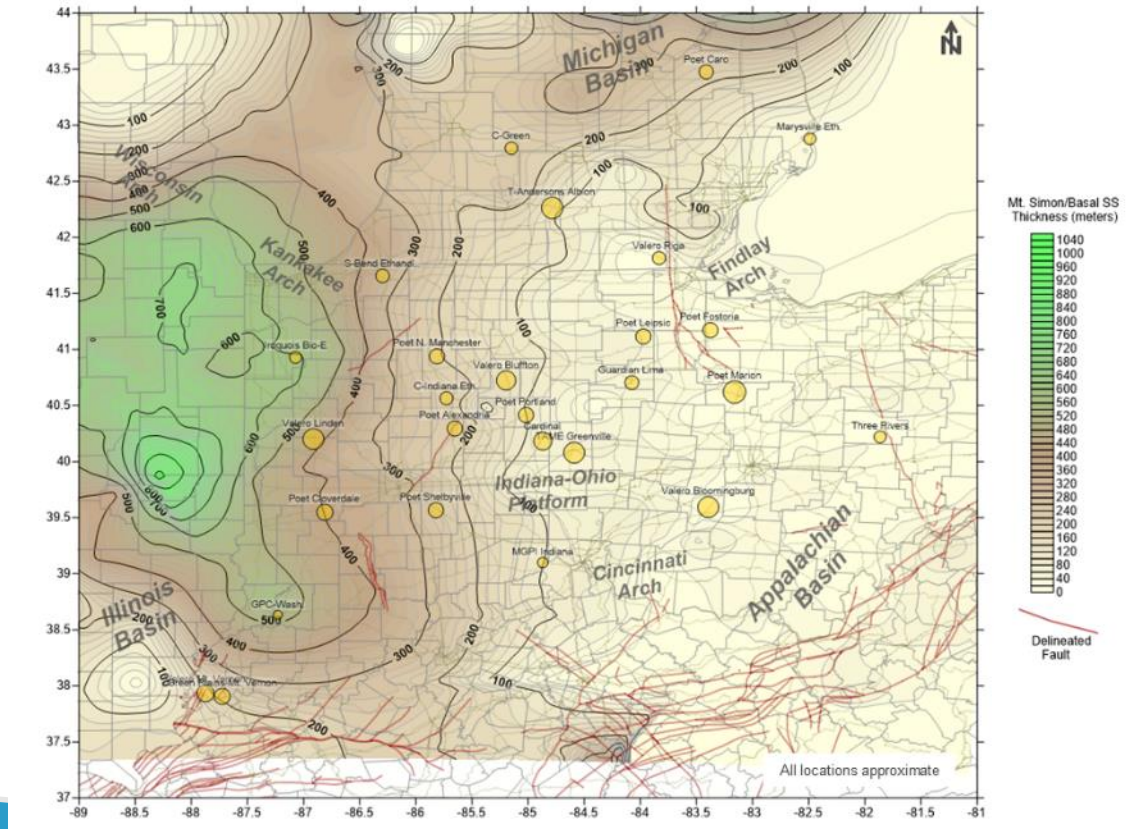
Example: Central MRCI Ethanol Plant CCS Screening

- Numerous ethanol plants in central MRCI wanted to understand CO_2 storage feasibility at their facilities (mainly after 45Q policy clarifications).
- Screening study outlined key factors for CO_2 storage at plant locations.

Mt. Simon/Basal Sandstone Thickness (meters)



Central MRCI Ethanol Plants
Preliminary CO2 Storage Screening

Plant	Formation	Caprock	Seismic/ Faults	Injectivity	Source/Sink	Economics	Surface Factors	Ranking
Poet Biorefining-Marion	Favorable	Favorable	Marginal	Favorable	Favorable	Favorable	Favorable	Favorable
The Andersons Albion Ethanol, LLC	Favorable	Favorable	Favorable	Favorable	Favorable	Favorable	Favorable	Favorable
Valero Renewable Fuels-Linden	Favorable	Favorable	Favorable	Marginal	Favorable	Favorable	Favorable	Favorable
The Andersons Marathon Ethanol, LLC	Fair	Marginal	Favorable	Marginal	Favorable	Marginal	Marginal	Marginal
Valero Renewable Fuels-Bloomingburg	Marginal	Favorable	Favorable	Marginal	Favorable	Favorable	Favorable	Fair
Valero Renewable Fuels-Bluffton	Favorable	Favorable	Favorable	Marginal	Favorable	Favorable	Favorable	Favorable
Cardinal Ethanol, LLC	Fair	Favorable	Favorable	Marginal	Favorable	Favorable	Favorable	Fair
Valero Renewable Fuels-Mount Vernon	Favorable	Favorable	Low	Marginal	Marginal	Favorable	Favorable	Marginal
Poet Biorefining-Cloverdale	Favorable	Favorable	Favorable	Marginal	Favorable	Favorable	Favorable	Favorable
Green Plains-Mt. Vernon	Favorable	Favorable	Low	Marginal	Marginal	Favorable	Favorable	Marginal
Poet Biorefining-Alexandria	Favorable	Marginal	Low	Favorable	Favorable	Favorable	Favorable	Fair
Poet Biorefining-North Manchester	Favorable	Marginal	Favorable	Favorable	Favorable	Favorable	Favorable	Favorable
Poet Biorefining-Portland	Favorable	Favorable	Favorable	Marginal	Favorable	Favorable	Favorable	Favorable
Poet Biorefining-Leipsic	Fair	Marginal	Low	Favorable	Favorable	Favorable	Favorable	Fair
Poet Biorefining-Fostoria	Low	Marginal	Marginal	Marginal	Favorable	Favorable	Favorable	Low
Poet Biorefining-Shelbyville	Favorable	Favorable	Favorable	Marginal	Favorable	Favorable	Favorable	Favorable
Poet Biorefining-Caro	Marginal	Favorable	Marginal	Low	Favorable	Marginal	Favorable	Marginal
Guardian Lima, LLC	Marginal	Marginal	Marginal	Fair	Fair	Marginal	Marginal	Marginal
South Bend Ethanol, LLC	Marginal	Marginal	Fair	Favorable	Marginal	Marginal	Marginal	Marginal
Central Indiana Ethanol, LLC	Favorable	Favorable	Favorable	Marginal	Favorable	Marginal	Favorable	Fair
Valero Renewable Fuels-Riga	Low	Marginal	Marginal	Marginal	Marginal	Marginal	Favorable	Low
Carbon Green BioEnergy, LLC	NA	NA	NA	NA	NA	Low	NA	NA
Iroquois Bio-Energy Company, LLC	NA	NA	NA	NA	NA	Low	NA	NA
Marysville Ethanol, LLC	NA	NA	NA	NA	NA	Low	NA	NA
Three Rivers Energy, LLC	NA	NA	NA	NA	NA	Low	NA	NA
MGPI of Indiana	NA	NA	NA	NA	NA	Low	NA	NA
Grain Proc. Corp.-Washington wet mill	NA	NA	NA	NA	NA	Low	NA	NA

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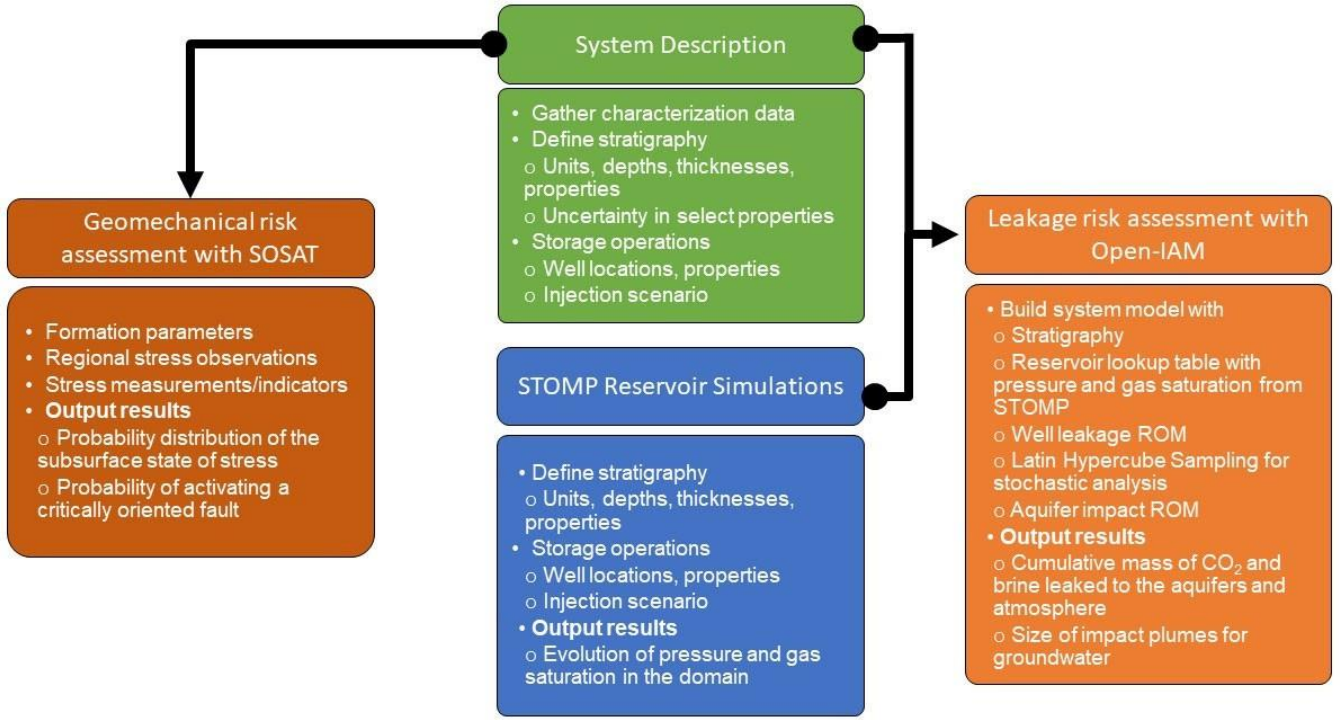
Working with NETL National Risk Assessment Partnership

- The Illinois State Geological Survey worked with PNNL in support of the Wabash CarbonSAFE project, including STOMP reservoir simulations for the Potosi Dolomite, and assessments of well leakage risk and subsurface stresses using the NRAP-Open-IAM (Integrated Assessment Model) and a new version of the SOSAT (State-of-Stress Analysis Tool).

- The CarbonSAFE Illinois Storage Corridor project is currently in progress and leveraging NRAP tools (SOSAT, NRAP-Open-IAM and Designs for Risk Evaluation and Management [DREAM]) for site characterization and to support UIC Class VI permit applications for the project's two site hosts.

General workflow for assessing leakage and geomechanical risks associated with the injection of carbon dioxide using two NRAP tools



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