Spatial Seal Database for Prospective Storage Resources in the USA

Scott Pantaleone
Computational Geo-scientist/NETL Support Contractor

2024 FECM/NETL Carbon Management Research Project Review Meeting
Aug. 6, 2024

Disclaimer

This project was funded by the U.S. Department of Energy, National Energy Technology Laboratory, in part, through a site support contract.

Authors and Contact Information

Scott Pantaleone[1,2]; Abigail Martin[1,2]; Olivia Marcelli[3,4]; Paige Morkner[1]; Kelly Rose[1]

[1]National Energy Technology Laboratory, 1450 Queen Avenue SW, Albany, OR 97321, USA

[2]NETL Support Contractor, 1450 Queen Avenue SW, Albany, OR 97321, USA

[3]National Energy Technology Laboratory, 3610 Collins Ferry Road, Morgantown, WV 26505, USA

[4]NETL Support Contractor, 3610 Collins Ferry Road, Morgantown, WV 26505, USA

Collecting Prospective Caprock and Seal Data

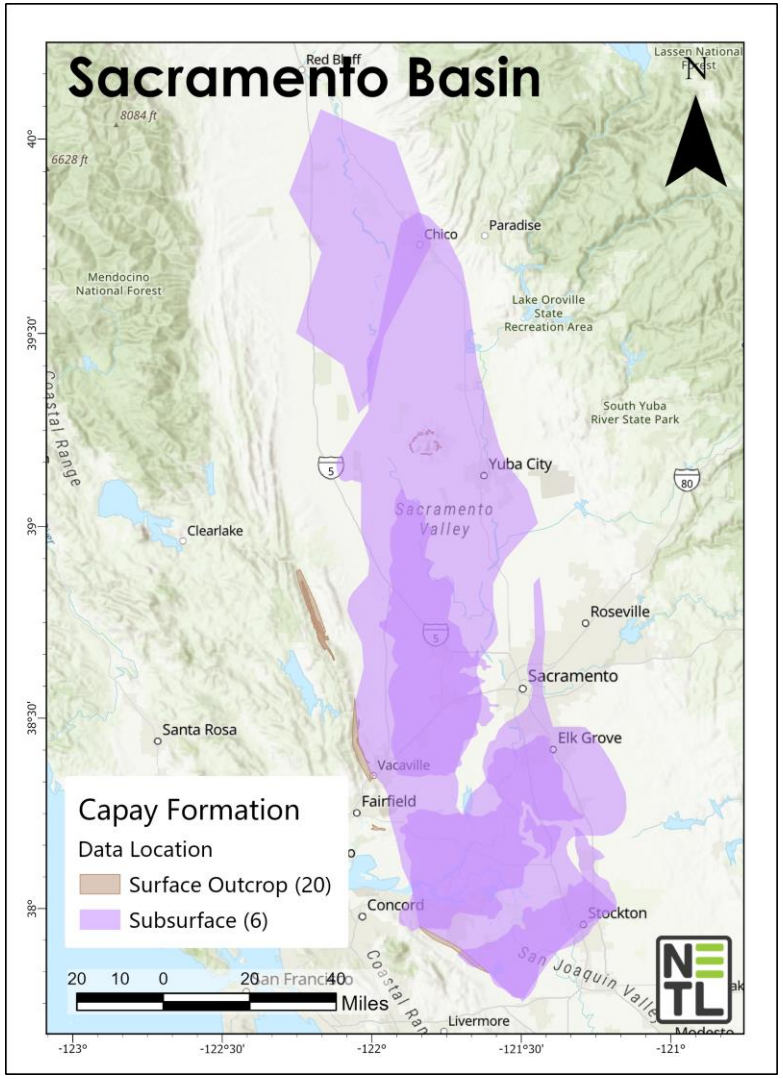
Challenge

- EPA Class VI permits requires an assessment of the confining zone (seal "caprock" unit)
- A lack of aggregated information is readily available that focuses on the caprock and seal units

Objective:
Help guide stakeholders to relevant information on prospective confining units for carbon storage projects

1. Develop a data catalog of **seal unit names** and relevant **properties**
2. Develop a **spatial extent** database for seal rock units

Benefits: Carbon storage site selection, permitting, and risk modeling



Key Terminology

Confining zone

- Geologic formation, group of formations, or part of a formation stratigraphically overlying the injection zone(s) that acts as barrier to fluid movement
- For Class VI wells operating under an injection depth waiver, confining zone means a geologic formation, group of formations, or part of a formation stratigraphically overlying and underlying the injection zone

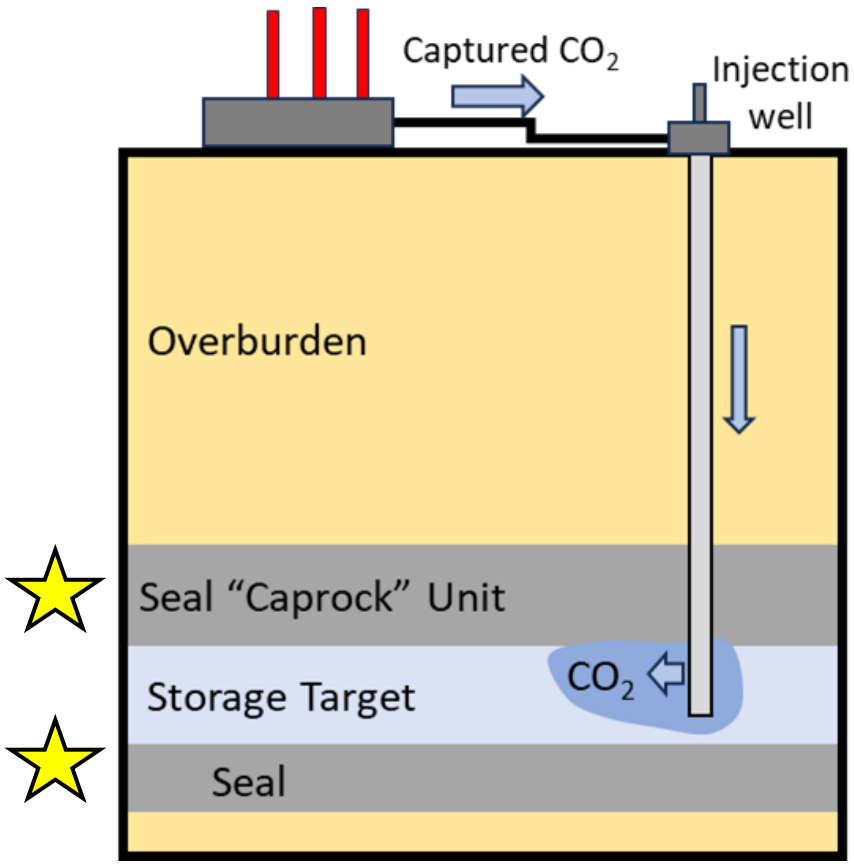
Source: EPA UIC Program Class VI Well Site Characterization Guidance, 2013

Seal (also referred to as Caprock)

- A relatively impermeable rock unit (commonly shale, anhydrite, or salt) that forms a barrier or **seal** above and around the reservoir rock so that fluid cannot migrate beyond the reservoir

Source: Schlumberger Energy Glossary, 2024

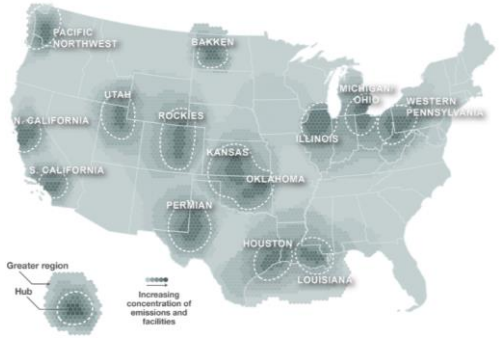
Injection and Confining Zones Diagram



Where to Search for Seal Data?

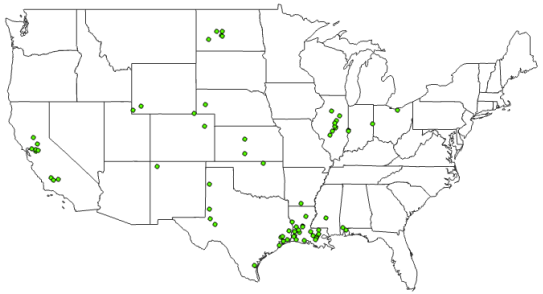
High-priority areas

- Basins with current Class VI well projects
- Proximity to the Great Plains Institue (GPI) Hydrogen and CO_2 hubs



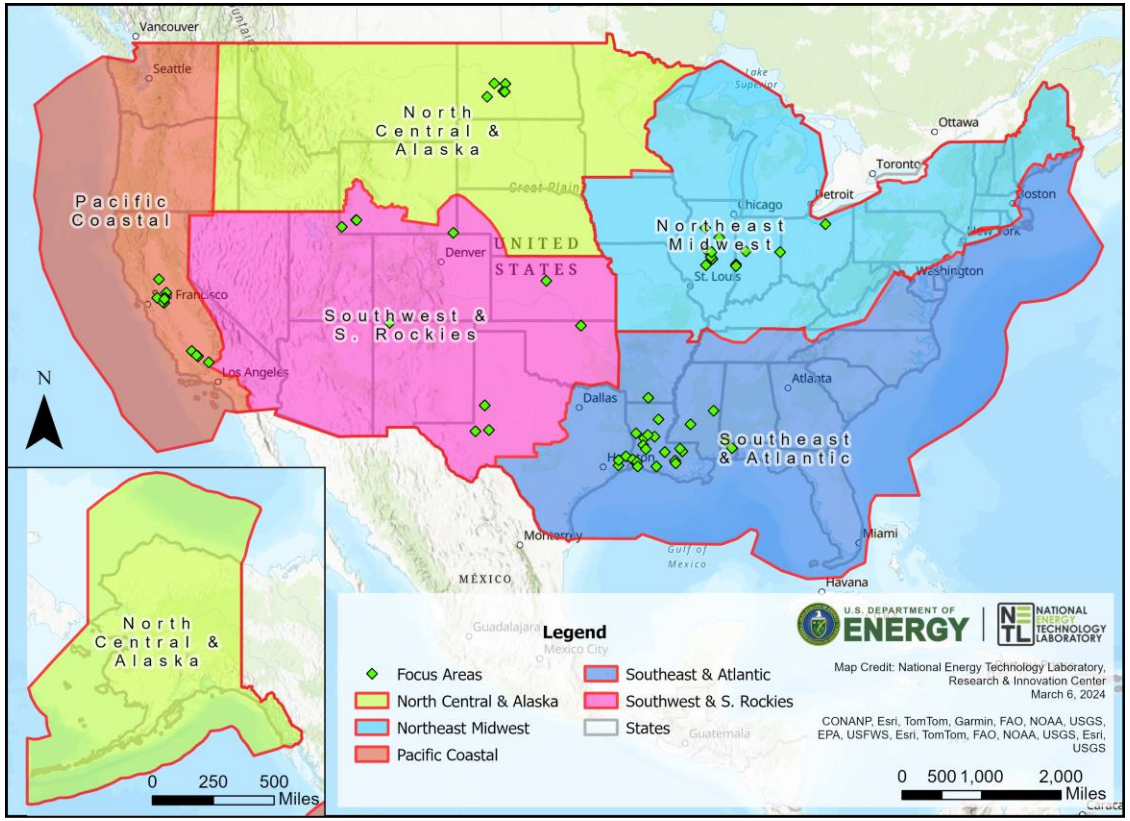
Atlas of Carbon and Hydrogen Hubs (Great Plains Institue, 2022).

+



EPA Class VI Project locations (Permit Applications July 2024).

=

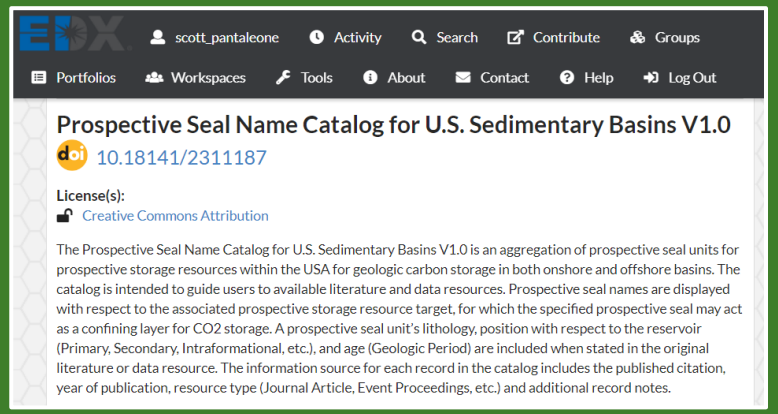


Regional areas of high-priority basins for literature search.

Ultimate Outcome

Prospective Seal Name Catalog

February 2024



Benefits:

- Guides stakeholders to seal unit names, relevant properties, data resources publicly available
- Helps identify the gaps in data knowledge

Prospective Seal Spatial Extent Database

August 2024

Coming Soon…

Benefits:

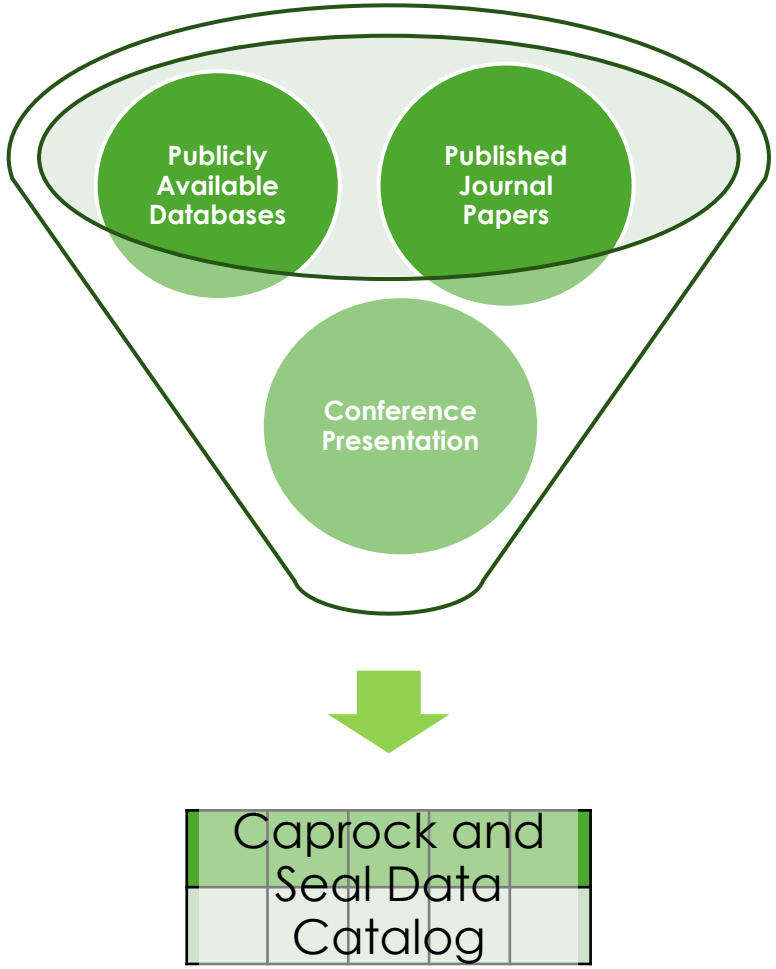
- Guide stakeholders to the publicly available spatial seal data that overlaps various areas of interest
- Provides new seal maps georeferenced from literature figures

Stakeholder Benefits: Providing critical data for increased confidence in long-term carbon storage security

Aggregating Caprock and Seal Data for Data Catalog

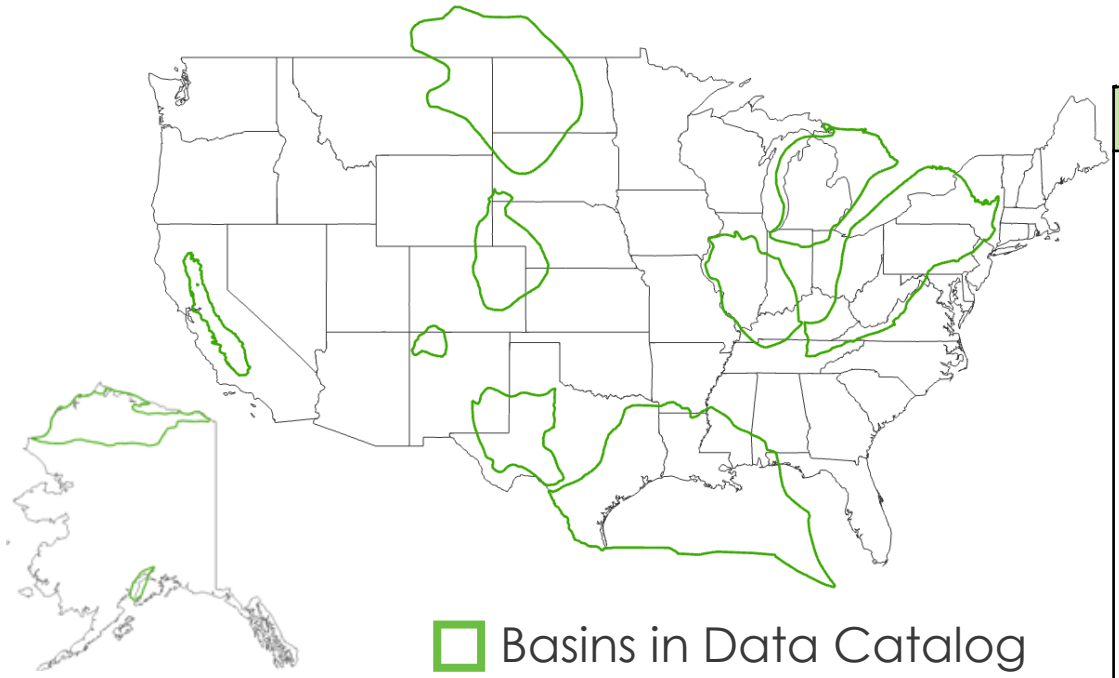
Method Overview

1. Assign high-priority regions to each member of the team for literature search and data collection
2. Leverage publicly available information on storage resources to help form the initial seal unit name list
   - NATCARB
   - USGS National Assessment of Geologic Carbon Dioxide Storage Resources
3. Define rock properties most relevant to stakeholders
4. Conduct literature search for data collection

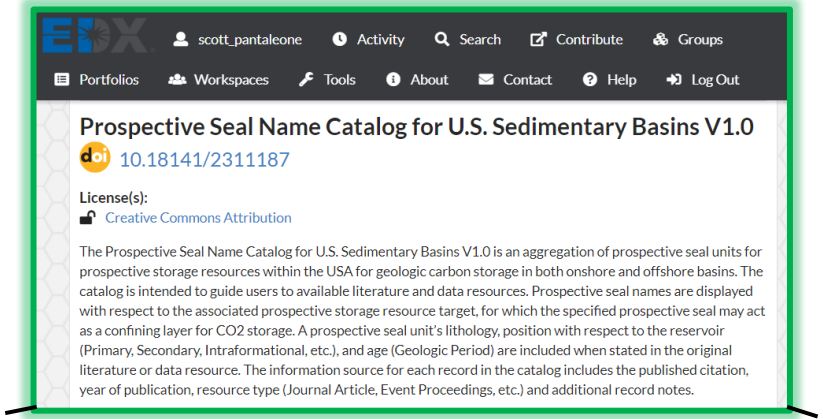


Accomplishments to Date

- **Published** "Prospective Seal Name Catalog for U.S. Sedimentary Basins V1.0" on EDX
  - Describes **seal unit names** and **key properties**
  - Documents all **data citations** to guide stakeholders to original source



Basins in Data Catalog



EDX Energy Data exchange

(February 2024)

Seal Rock Properties

• Seal Unit Names	• Seal Lithology	• Field Test Data and Location	• Trap Type
• Associated Reservoir	• Seal Position (Overlying, underlying, etc.)	• Monitoring Zone (Min/Max)	• Capillary Pressure
• Basin	• Proximity (Primary/Secondary)	• Depth (Min, Average, Max)	• Porosity
• **Data Source** (Citation, Date, Type)	• Seal Age	• Thickness (Min, Average, Max)	• Permeability (Min, Average, Max)

Project Timeline

Prospective Seal Name Catalog for U.S. Sedimentary Basins V1.0 published to EDX

Benefits:

Helps stakeholders who are looking for information when establishing risk analysis, scoping potential sites, etc.

Helps identify the gaps in seal unit names, properties, and data resources publicly available

February 2024

August 2024

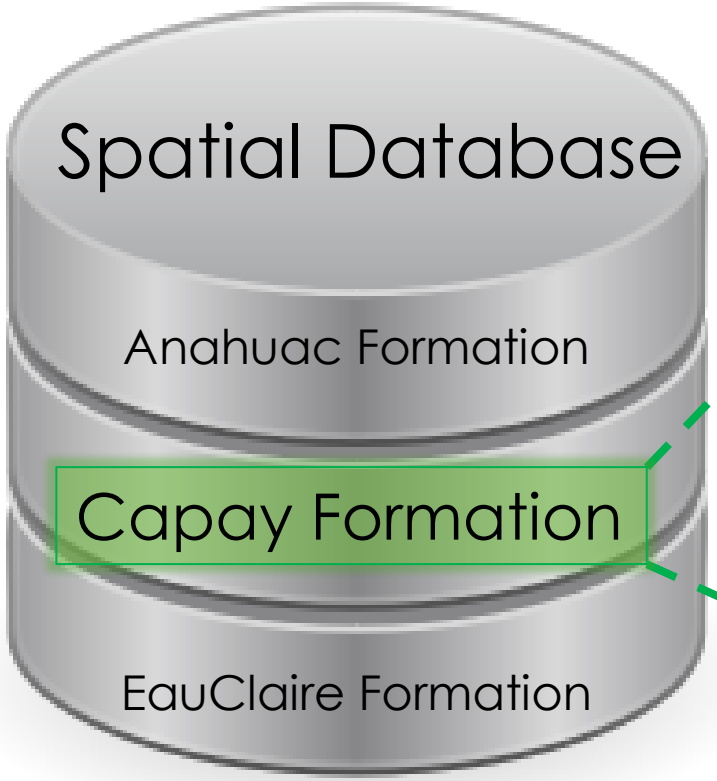
Early 2025

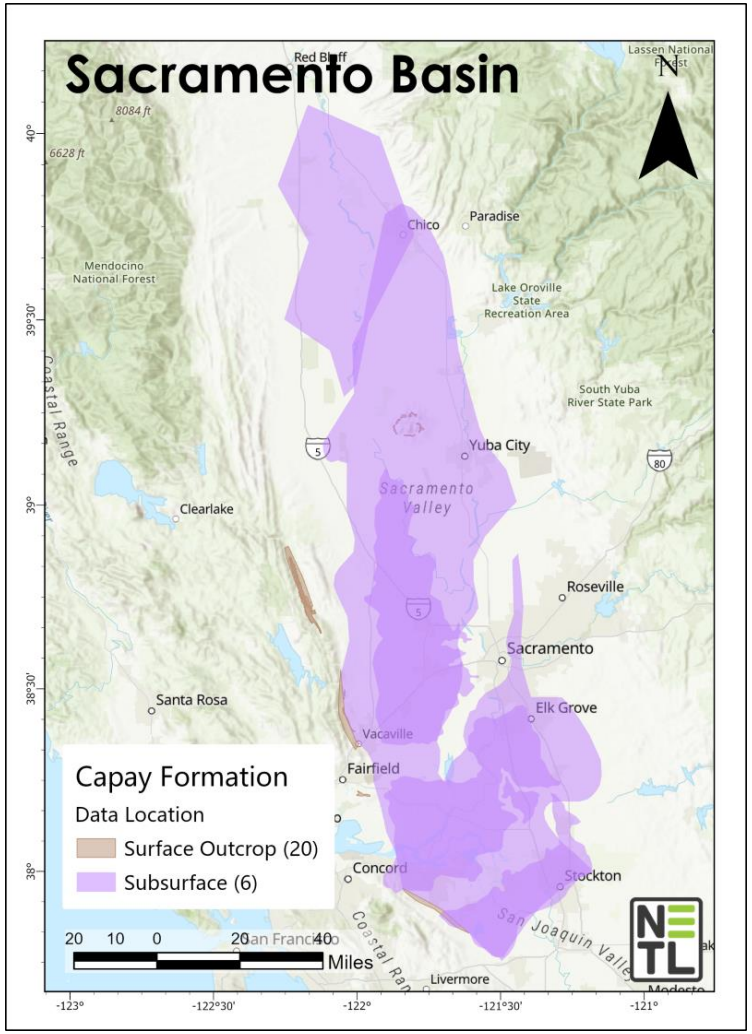
Publish updated Catalog and Spatial Dataset

Prospective Seal Unit Spatial Database for U.S. Sedimentary Basin V1.0 (ready to publish to EDX)

Continue to complete data extraction from literature and resources for derivative analysis in high-priority regions

Prospective Seal Unit Spatial Database V1.0

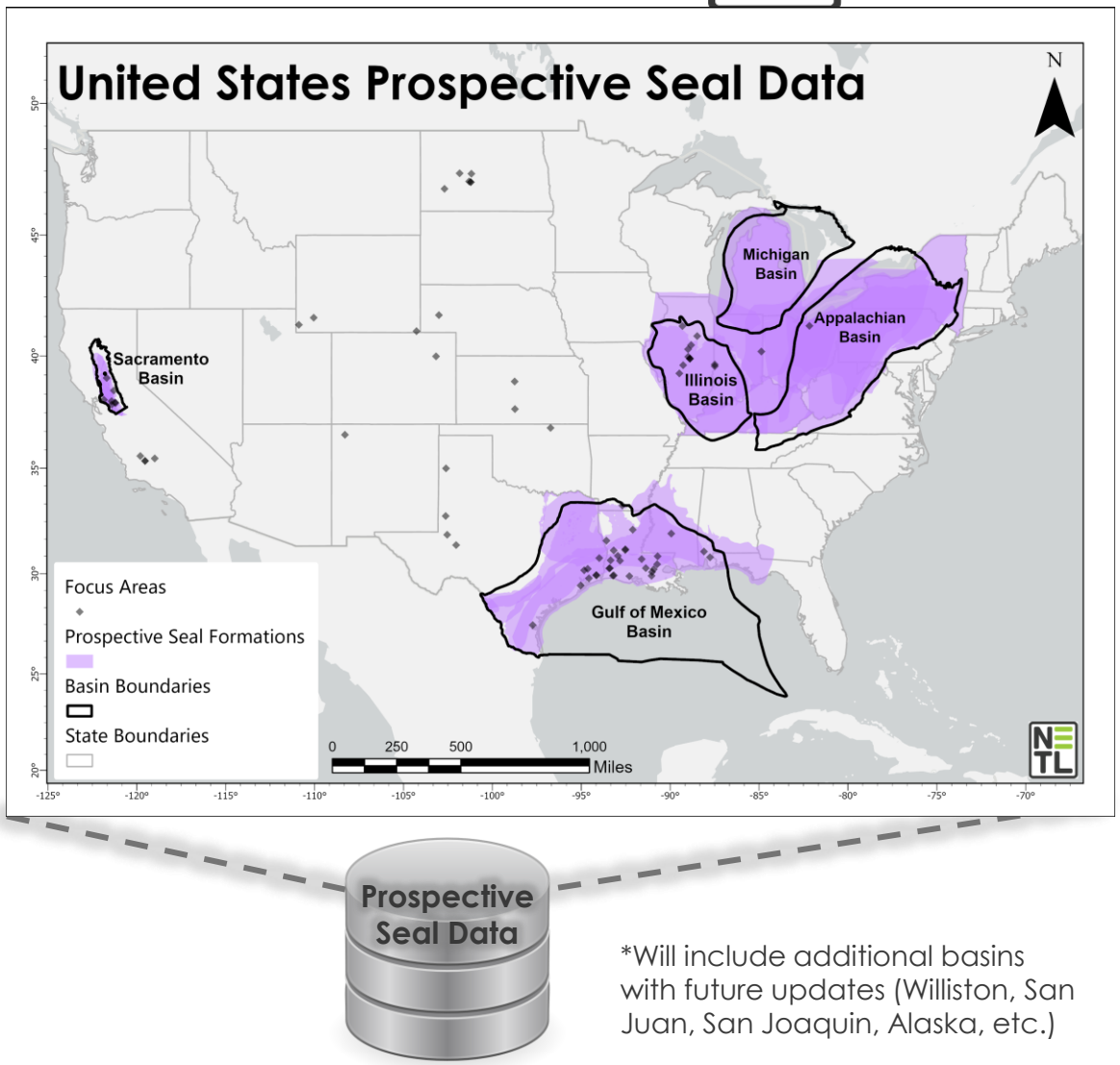




Prospective Seal Unit Spatial Database V1.0

Building a Multi-Source Seal Spatial Database

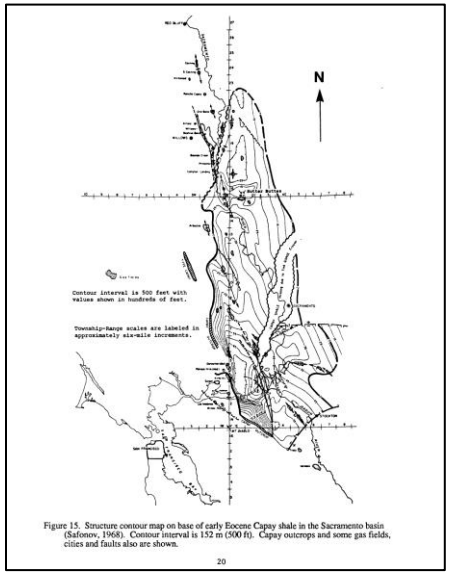
- Prospective Seal Formations
  - Combines all individual spatial extent datasets together by geologic formation
- Enables users to select a spatial dataset to view:
  - **Data type** of the original source
    - Known spatial data published
      - DOE+EDX, USGS, etc.
    - Georeferenced maps from literature (Depth to top, Thickness, etc.)
    - Georeferenced cross-sections from literature
  - **Citation** of the original source
- Database can guide stakeholders to the original data source to view, conduct further research, and download supplementary data (if applicable)



*Will include additional basins with future updates (Williston, San Juan, San Joaquin, Alaska, etc.)

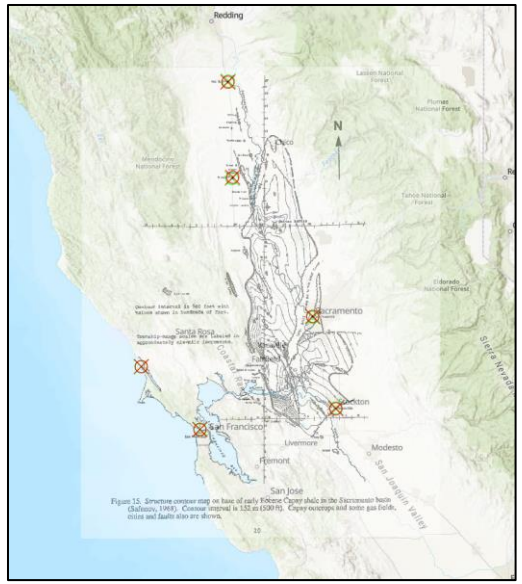
Georeferenced Data Workflow

Capay Formation Example



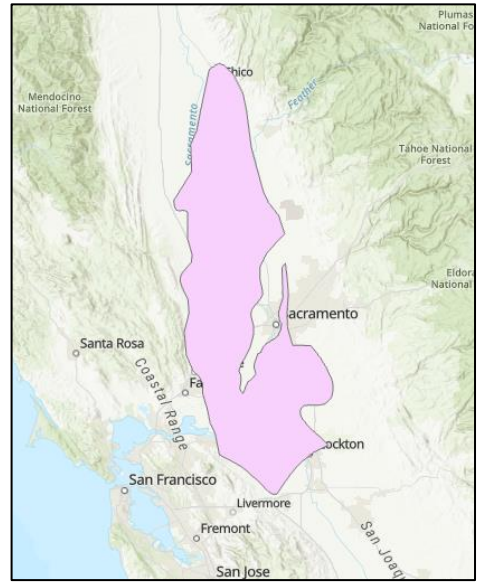
Raw data from literature

1. Extract map figure from source report



Georeferencing step

2. Import into ArcGIS Pro and "georeference" image using spatial reference information and anchor points



Turn map into a polygon layer

3. Generate feature outline representing spatial extent of formation
4. Combine layer with spatial extents for the same formation

Guiding Stakeholders Back to the Original Source

Original Source

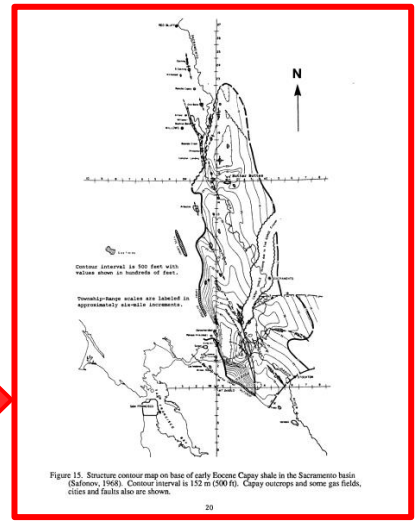


Figure 15. Structure contour map on base of early Eocene Capay shale in the Sacramento basin (Safonov, 1968). Contour interval is 152 m (500 ft). Capay outcrops and some gas fields, cities and faults also are shown.

3.

How the database can act as a guide:

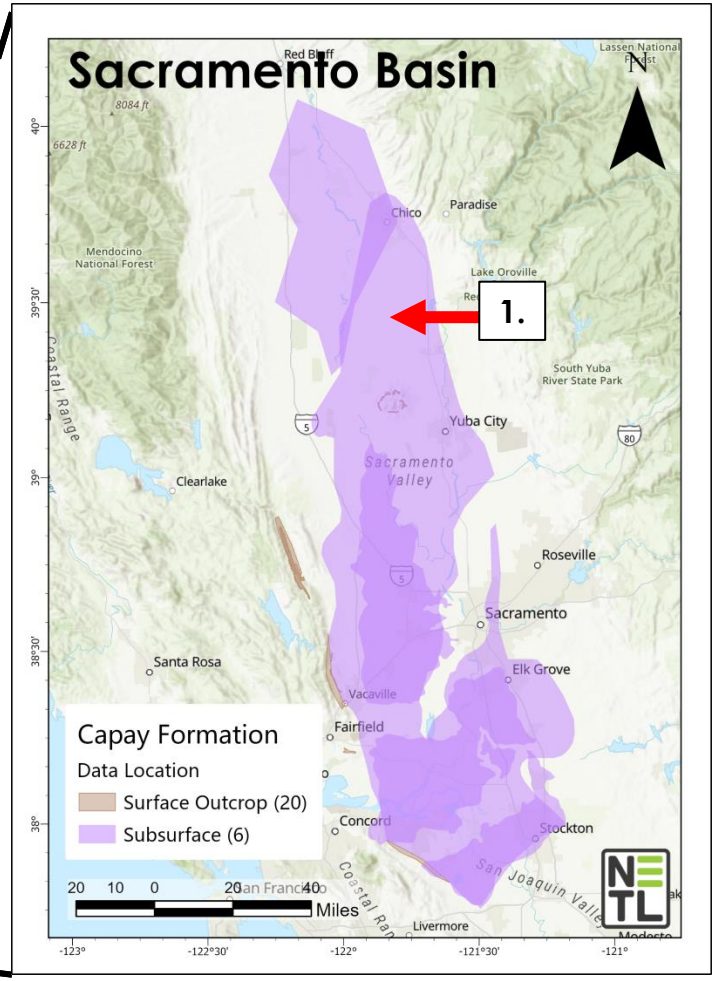
1. Select an individual layer within a formation
2. View attribute table
   (selected layer is highlighted)
   a. Formation Name
   b. Is the data subsurface or outcrop
   c. Data Type
   d. Spatial Quality
   e. Geologic Age
   f. Original **Source Link** and **Citation**
3. Visit original data source

Attribute table showing individual layers for the Capay Formation

Shape *	Formation	Basin	SubBasin	SubsurfaceData	Data_Type	Spatial_Quality	Sources_Table	GeoAge
Polygon	Lower Princeton and C...	Sacramento Basin	N/A	Yes	Cross-Section	Approximate Georefer...	Data_Sources.csv	Eocene
Polygon	Capay Shale	Sacramento Basin	N/A	Yes	Map Figure	Approximate Georefer...	Data_Sources.csv	Eocene
Polygon	Capay Shale	Sacramento Basin	N/A	Yes	Map Figure	Approximate Georefer...	Data_Sources.csv	Eocene
Polygon	Capay Shale	Sacramento Basin	N/A	Yes	Map Figure	Approximate Georefer...	Data_Sources.csv	Eocene
Polygon	Capay Shale	Sacramento Basin	N/A	Yes	Map Figure	Approximate Georefer...	Data_Sources.csv	Eocene
Polygon	Capay Formation	Sacramento Basin	N/A	Yes	Structure Contour Map	Approximate Georefer...	Data_Sources.csv	Early Eocene
Polygon	Capay Formation	Sacramento Basin	N/A	No	Field Data	Approximate Georefer...	Data_Sources.csv	Eocene
Polygon	Capay Formation	Sacramento Basin	N/A	No	Quadrangle	Approximate Georefer...	Data_Sources.csv	Eocene

2.

Processed Combined Layer



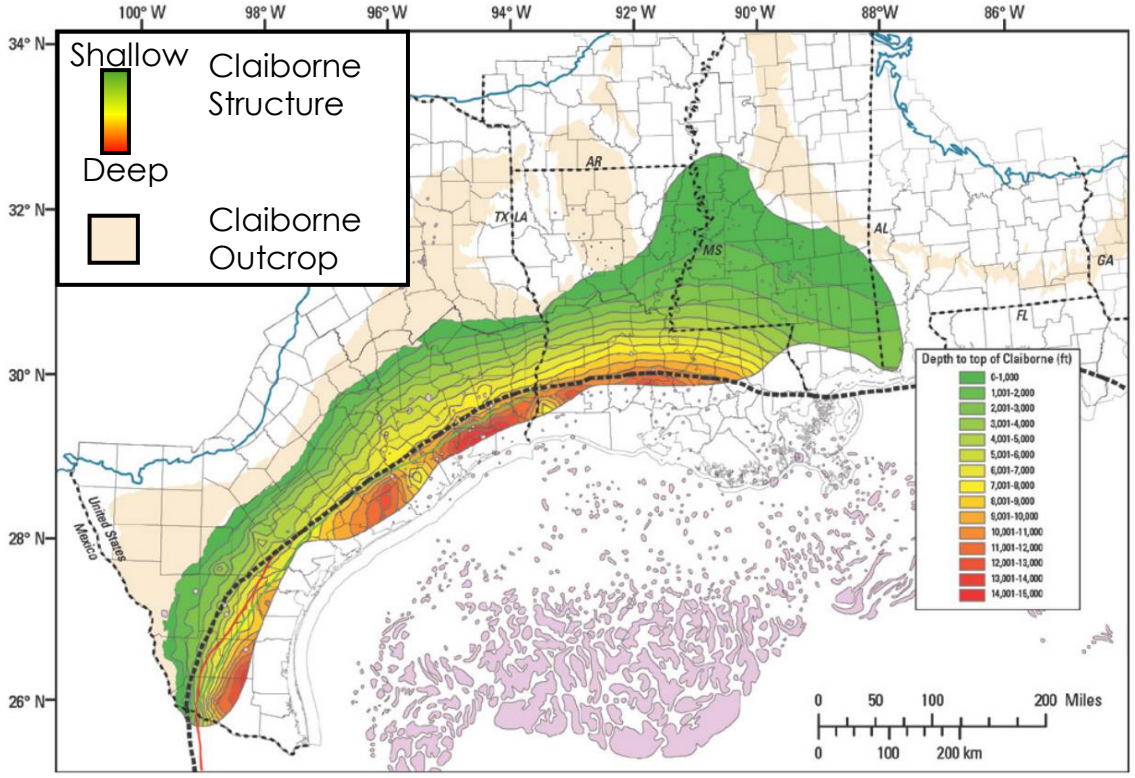
Spatial Data Types

Subsurface Data

- Seal unit extent meeting criteria for confining fluids (when a seal is a seal)
- Seal unit formation overall spatial extent
- Depth to top of formation structural map
- Isopach (thickness) of seal formation map

Surface Data

- Spatial extent of formation in outcrop
- Surface representation provides contextual information valuable to geo modelers
  - Outcrop provides higher resolution than remotely sensed or wellbore data and is a better proxy for dynamics associated with depositional environment



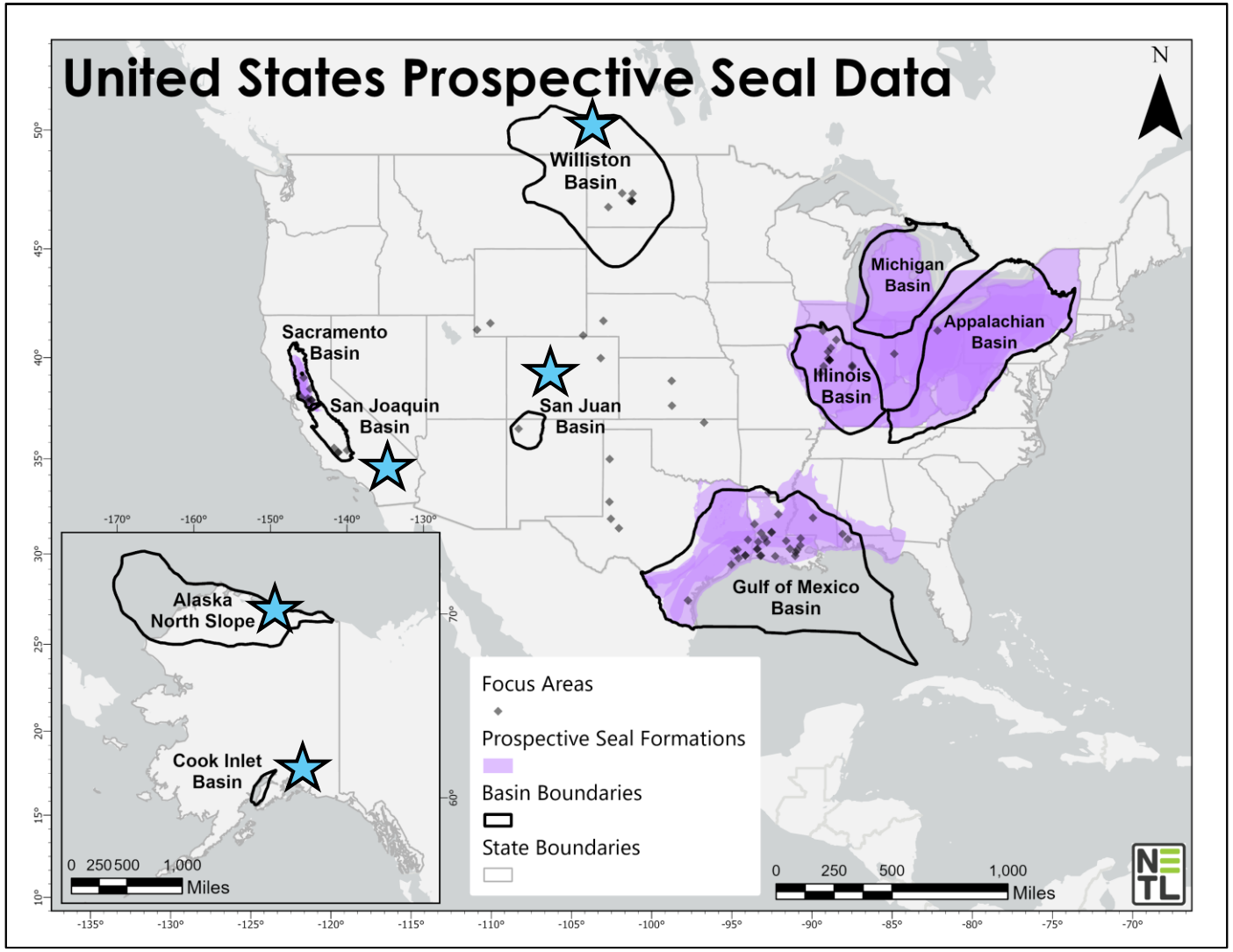
Modified from Hackley, 2012

Prospective Seal Spatial Extent Database V1.0

Next Steps

- Publish Prospective Seal Spatial Extent Database V1.0 to EDX (8/31/2024)

- Update the database with datasets from additional areas of interest
  - Williston
  - San Juan
  - San Joaquin
  - Alaska North Slope
  - Cook Inlet



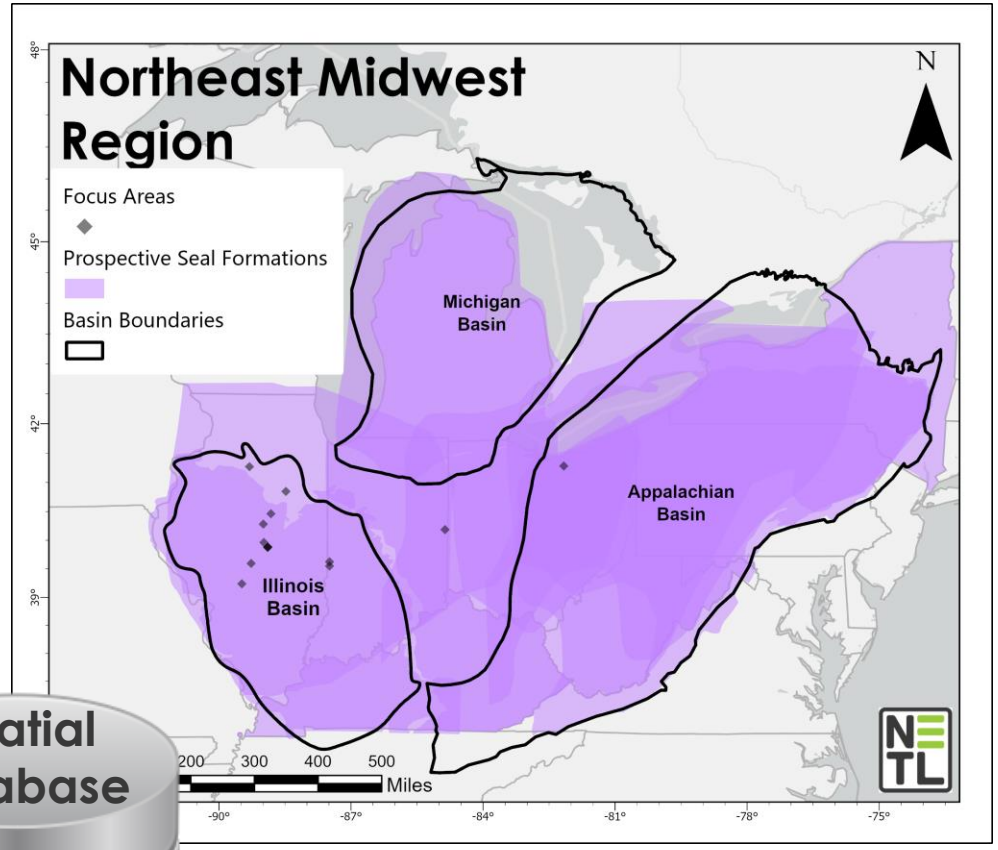
Prospective Seal Spatial Extent Database V1.0

Ultimate Outcomes

- Providing **seal and caprock data** for sedimentary basins
  - **Data Catalog** of seal names and key properties
  - **Database** showing seal unit spatial extent
- Publish an updated database to the EDX DisCO_2ver platform
  - Access and explore seal data within an interactive web application

Benefits to Stakeholders

- Provide information about **caprock and seal rock units** within high-priority sedimentary basins, guiding stakeholders to the original data sources
- Insights from the data can aid in carbon storage feasibility assessments
- Assists with the identification of data gaps for seal rocks



Spatial Database

Caprock and Seal Data Catalog

References

- Geologic Sequestration of Carbon Dioxide; Underground Injection Control (UIC) Program Class VI Well Area of Review Evaluation and Corrective Action Guidance, EPA 2013
- Hackley, P.C., 2012, Geologic assessment of undiscovered conventional oil and gas resources—Middle Eocene Claiborne Group, United States part of the Gulf of Mexico Basin: U.S. Geological Survey Open–File Report 2012–1144, 87 p., available only at http://pubs.usgs.gov/of/2012/1144/.
- Schlumberger Energy Glossary, 2024 https://glossary.slb.com/en/terms/s/seal.

Acknowledgments

This work was performed in support of the U.S. Department of Energy's Office of Fossil Energy and Carbon Management's Geo-Analysis and Monitoring Team and was developed jointly through the U.S. DOE Office of Fossil Energy and Carbon Management's EDX4CCS Project, in part, from the Bipartisan Infrastructure Law.

This research was supported in part by an appointment to the U.S. Department of Energy (DOE) Postgraduate Research Program at the National Energy Technology Laboratory (NETL) administered by the Oak Ridge Institute for Science and Education (ORISE).

DEMO & POSTER SESSION

TUESDAY, AUGUST 6, 2024
5:45 PM - 7:45PM
BALLROOM GALLERY

EDX discover

CARBON TRANSPORT & STORAGE DATA AND INNOVATION TO BRIDGE THE DIGITAL DIVIDE

NETL RESOURCES

VISIT US AT: **www.NETL.DOE.gov**

@NETL_DOE

@NETL_DOE

@NationalEnergyTechnologyLaboratory

CONTACT:
Scott Pantaleone, Scott.Pantaleone@netl.doe.gov
Paige Morkner, Paige.Morkner@netl.doe.gov