

# Wyoming Class VI Site Characterization Database

PROJECT AWARD #: DE-FE0032372 (FOA 2799)

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U.S. Department of Energy  
National Energy Technology Laboratory



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## ***Acknowledgement and Disclaimer***

***Acknowledgment:** This material is based upon work supported by the Department of Energy under Award Number DE-FE0032372*

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# Project Overview

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# Project overview: Wyoming Class VI Site Characterization Database

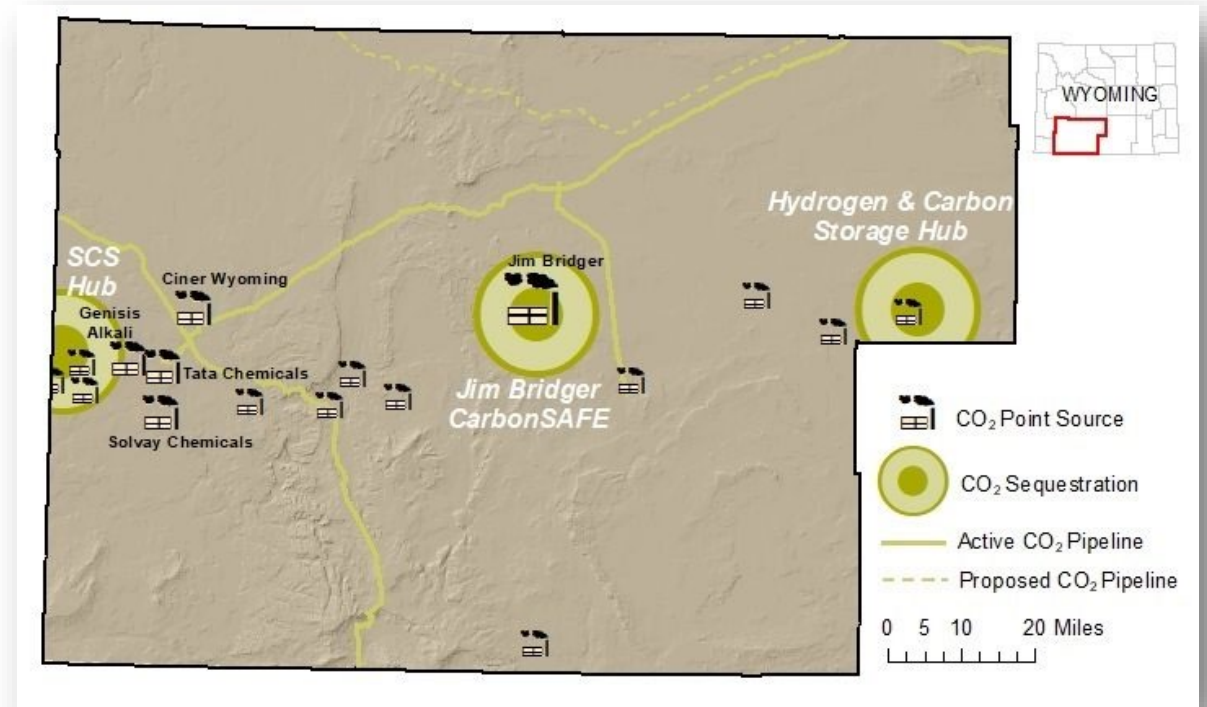
**Project objective:** To develop a geologic site characterization database to expedite Class VI permitting for three carbon storage hubs in Sweetwater County, Wyoming within the Greater Green River Basin.

## Funding summary:

|           |            |
|-----------|------------|
| Total     |            |
| DOE funds | Cost Share |
| \$998,968 | \$999,925  |

## Project/Grant Period:

March 1, 2024– February 28, 2026



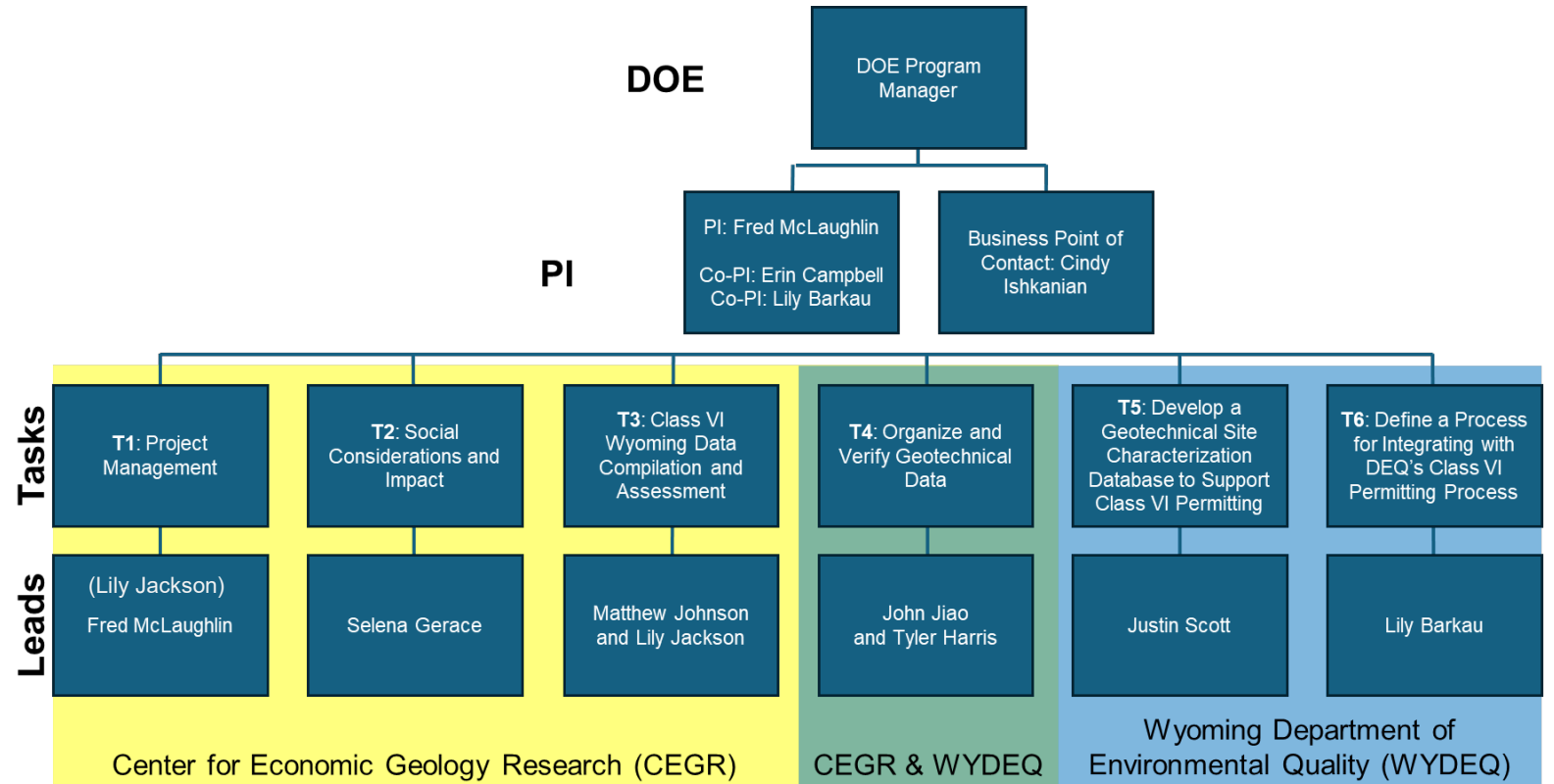
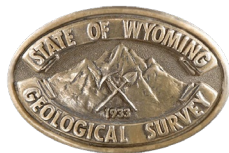
# Project organization & key participants

## Lead Institutions

- *University of Wyoming  
School of Energy Resources*
- *Wyoming Department of  
Environmental Quality*
- *Wyoming State Geological  
Survey*



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Energy Resources



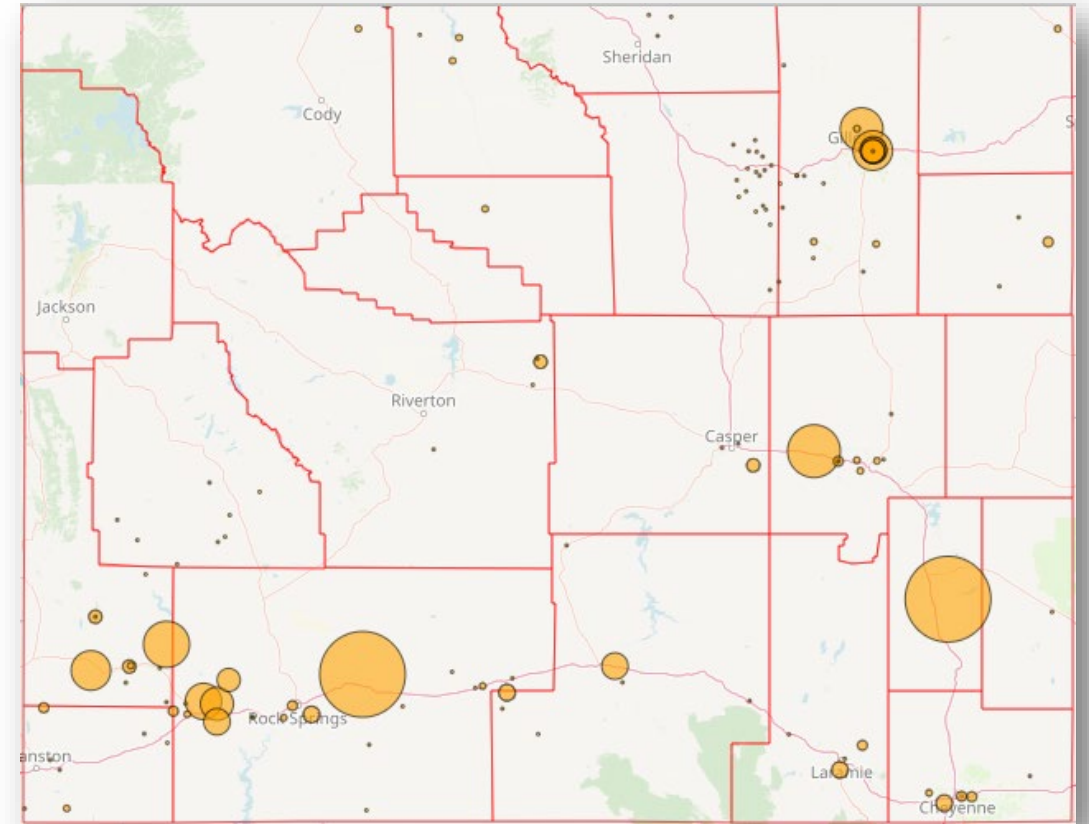
# Project Background

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# Project background: history and goals

**Project Goals:** This project will develop a verified geotechnical database for Sweetwater County in Wyoming's Greater Green River Basin (GGRB) to help **facilitate and expedite Class VI permit *compilation and review***

**Project Benefit:** This project aims to *accelerate* the commercialization of regional CCS storage hubs to help reduce emissions from hard to mitigate industrial sources as well as energy facilities.



<https://deq.wyoming.gov/water-quality/groundwater/uic/class-vi/>

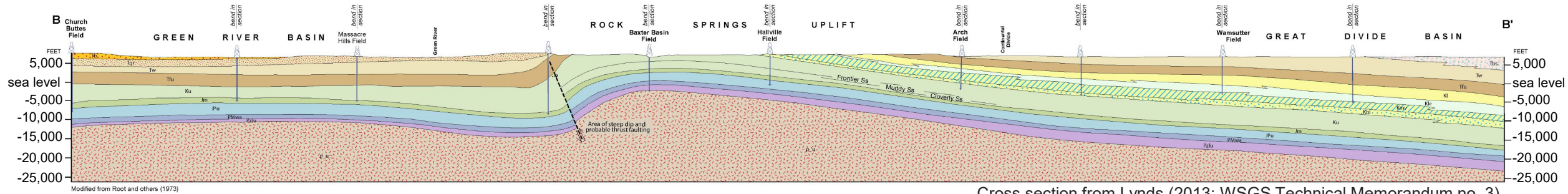
Data and map from EPA Flight website, July 2024

| Power Plants | Petroleum and Natural Gas Systems | Refineries | Chemicals | Other | Minerals | Waste | Metals | Pulp and Paper | Total Reported Emissions<br><small>What's this?</small> |
|--------------|-----------------------------------|------------|-----------|-------|----------|-------|--------|----------------|---------------------------------------------------------|
| 38           | 5.8                               | 1.3        | 1.4       | 0.1   | 6.4      | 0.1   | 0      | 0              | 53                                                      |
| 13           | 30                                | 4          | 4         | 3     | 10       | 3     | 0      | 0              | 66                                                      |

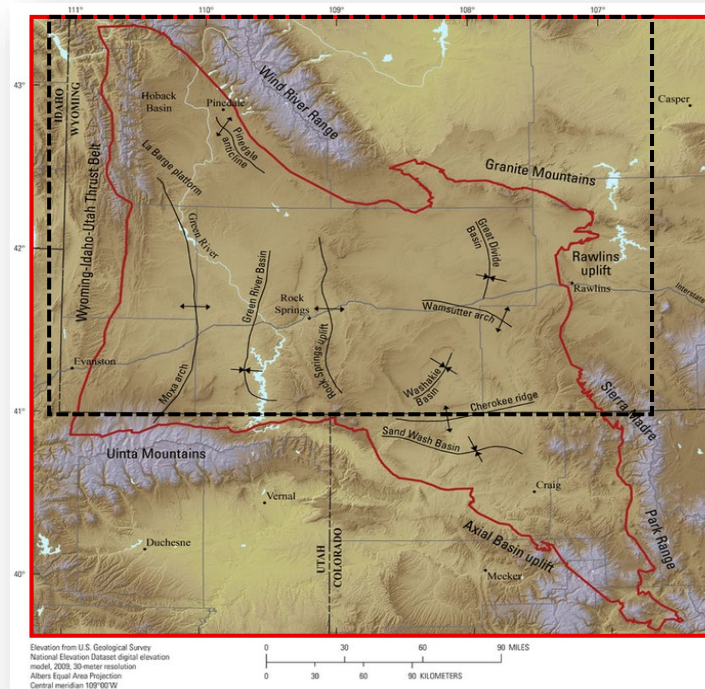


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# Project location - Greater Green River Basin



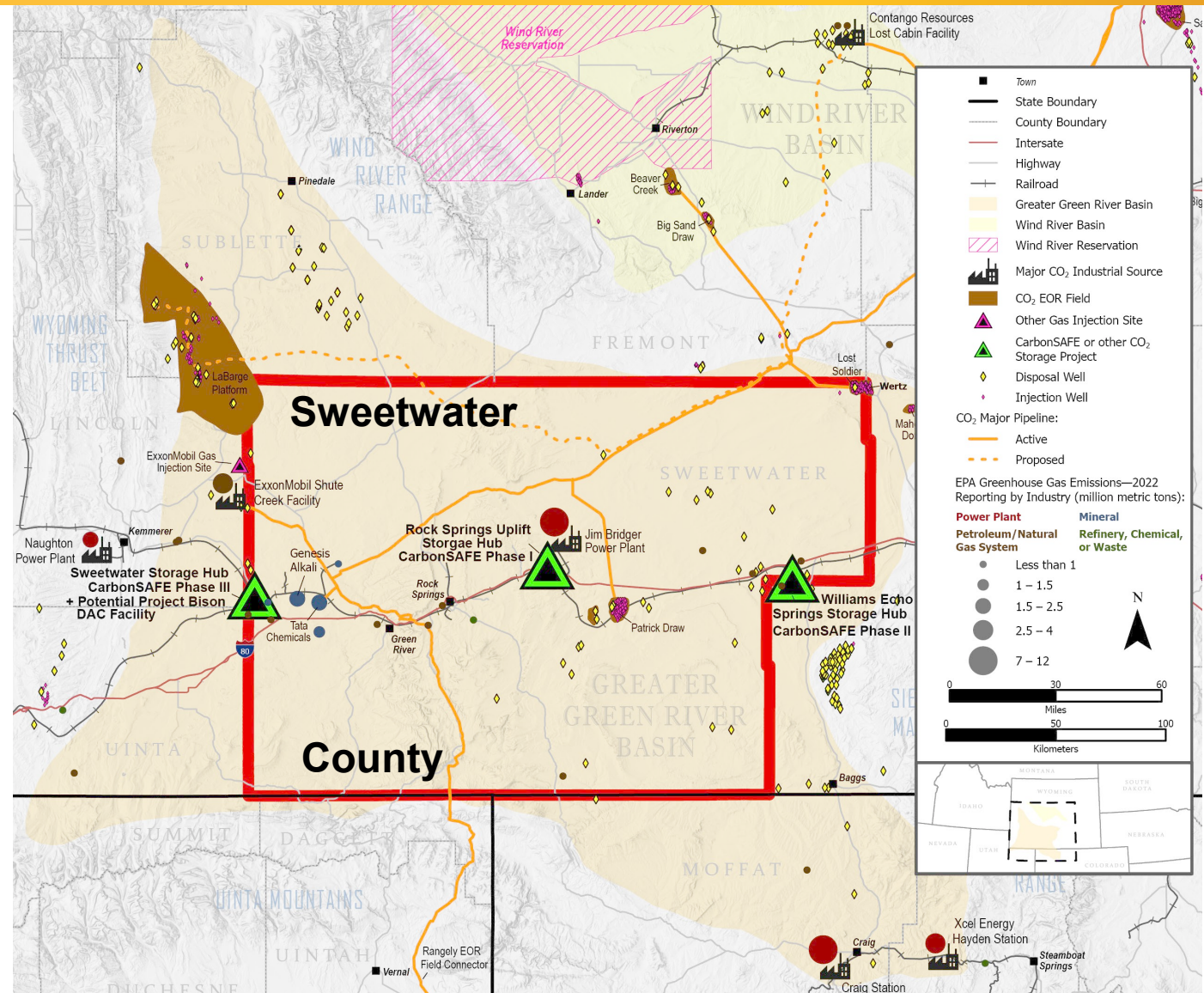
Cross section from Lynds (2013; WSGS Technical Memorandum no. 3)



# Project background: advancing goals

## Advancing DOE program goals - Accelerate CCUS in Sweetwater County

- Sweetwater Storage Hub CarbonSAFE Phase III
- Rock Springs Uplift Storage Hub CarbonSAFE Phase I
- Williams Echo Springs CarbonSAFE Phase II
- *future projects*
- *“template” for other counties and basins*



# Technical Approach & Project Scope

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# Wyoming Class VI Site Characterization Database scope and tasks

## Scope of Work

The scope of work contains five (5) technical tasks in addition to Task 1.0 - Project Management and Planning.

*The technical tasks are:*

Task 1 – Project Management and Planning

Task 2 – Develop Societal Considerations and Impacts Plans

Task 3 – Compile Class VI Wyoming Geotechnical Data

Task 4 – Organize and Verify Geotechnical Data

Task 5 – Develop a Geotechnical Site Characterization Database to Support Class VI Permitting

Task 6 – Define a Process for Integrating with DEQs Class VI Permitting Process

# Success Criteria and outcomes

| Decision Point                                             | Go / No-Go? | Circumstances Affecting the Decision                                                                | Objective Success Criteria                                                                                                                                           |
|------------------------------------------------------------|-------------|-----------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Public has a negative view of the project/is not accepting | No          | Negative project reception at outreach event, negative media, lack of public cooperation.           | Project team builds all public data/responses into its assessments for better outreach strategies and/or educational materials to inform and address all perceptions |
| Database design is not completed                           | Yes         | Failure to hire developer, failure to agree and produce final design and user interface parameters. | Database design is finalized                                                                                                                                         |

## ***Anticipated outcomes:***

- A database of geotechnical information which has been compiled and verified from established, public geologic databases/entities
- A record of key social considerations and community benefits which developers should address or consider when preparing applications to the Wyoming DEQ
- A methodology to expand the Class VI database to other regions in Wyoming that are current focus areas of carbon storage hubs.

# Project Status and Accomplishments

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# Site characterization requirements for class VI permit



WATER QUALITY DIVISION

GEOLOGIC SEQUESTRATION

CLASS VI PERMIT APPLICATION - SITE CHARACTERIZATION

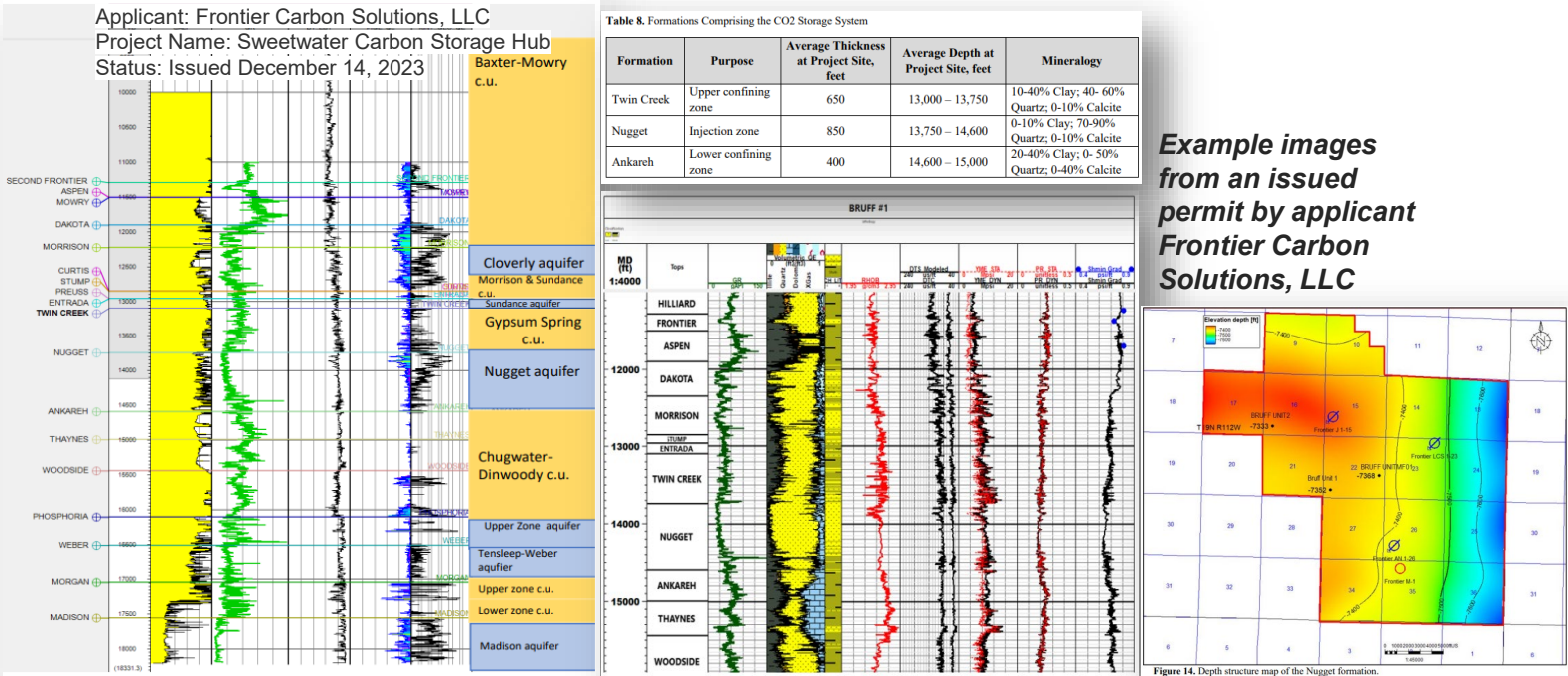
Water Quality Rules, Chapter 24 Sections 10 and 12

UIC Class VI Permit Application

Site Characterization Form A-1

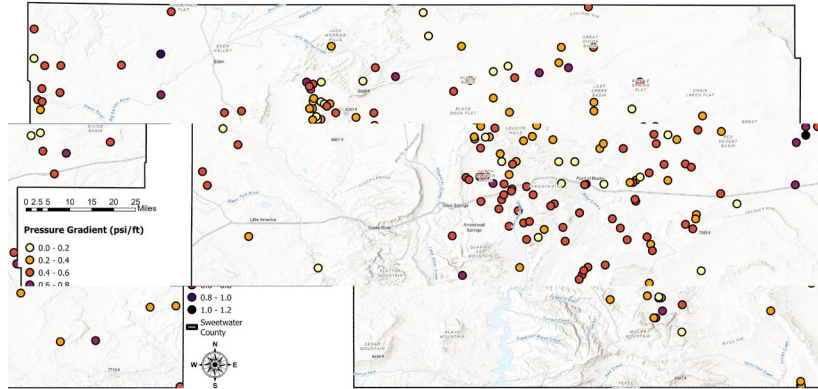
March 28, 2024

- Regional Hydrostratigraphy and Groundwater Flow
- Storage Reservoir Geology
- Geophysical Well Logs
- Core Sample Analyses
- Mineralogy
- Mechanism of Geological Confinement
- Injection Zone Storage Capacity
- Potential Geochemical Interactions
- Compatibility of the CO2 with Subsurface Fluids and Minerals
- Geomechanical Information of Confining Zone
- Confining Zone Integrity
- Faults, Fractures, and Seismic Activity

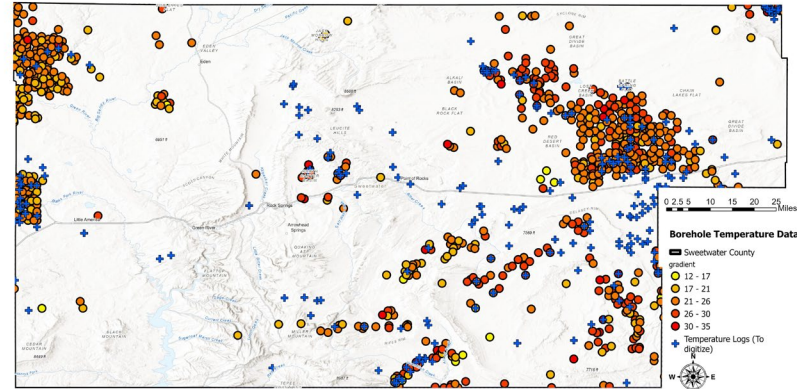


# Status of data compilation (Task 3)

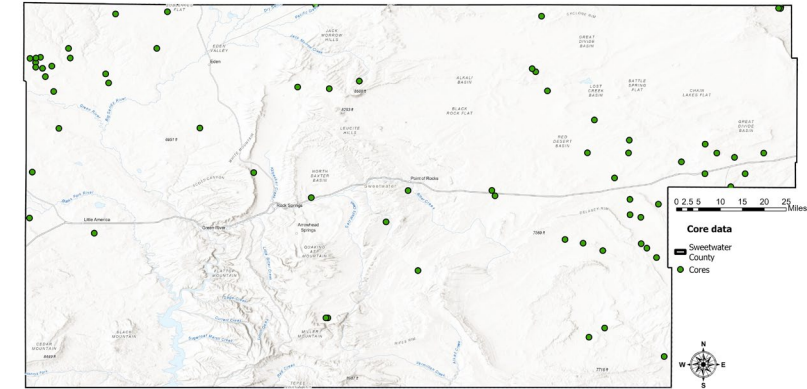
## Subsurface pressure



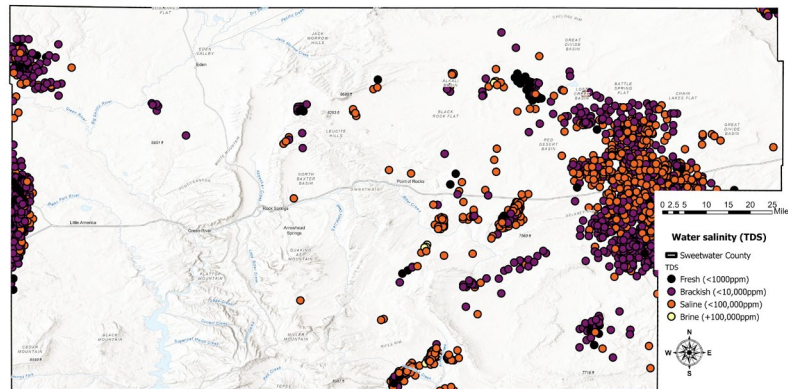
## Subsurface temperature



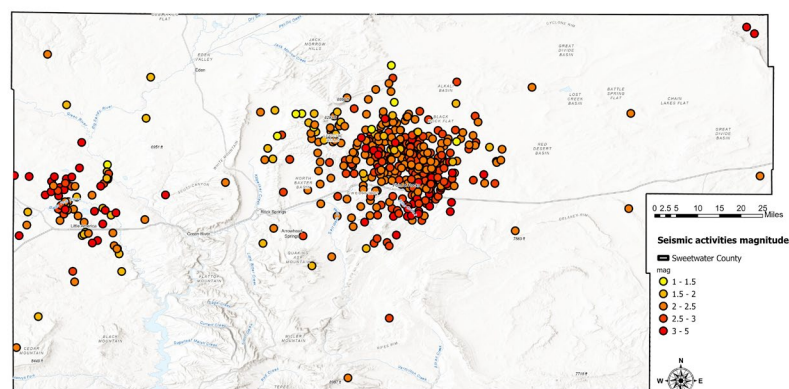
## Core data ( $\phi$ , $k$ , $\rho$ , XRD mineralogy)



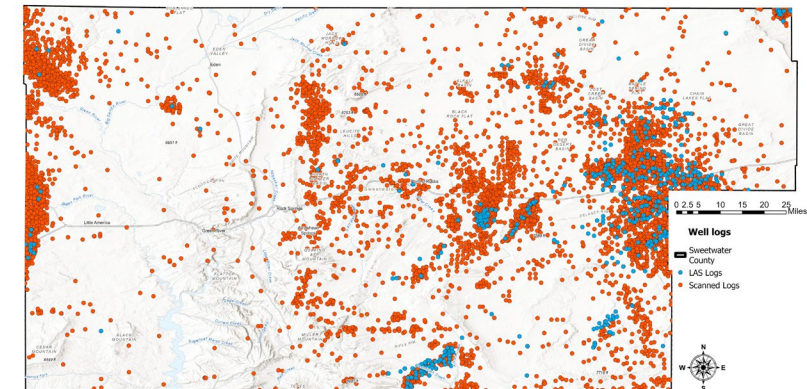
## Water salinity



## Seismic events



## Well logs

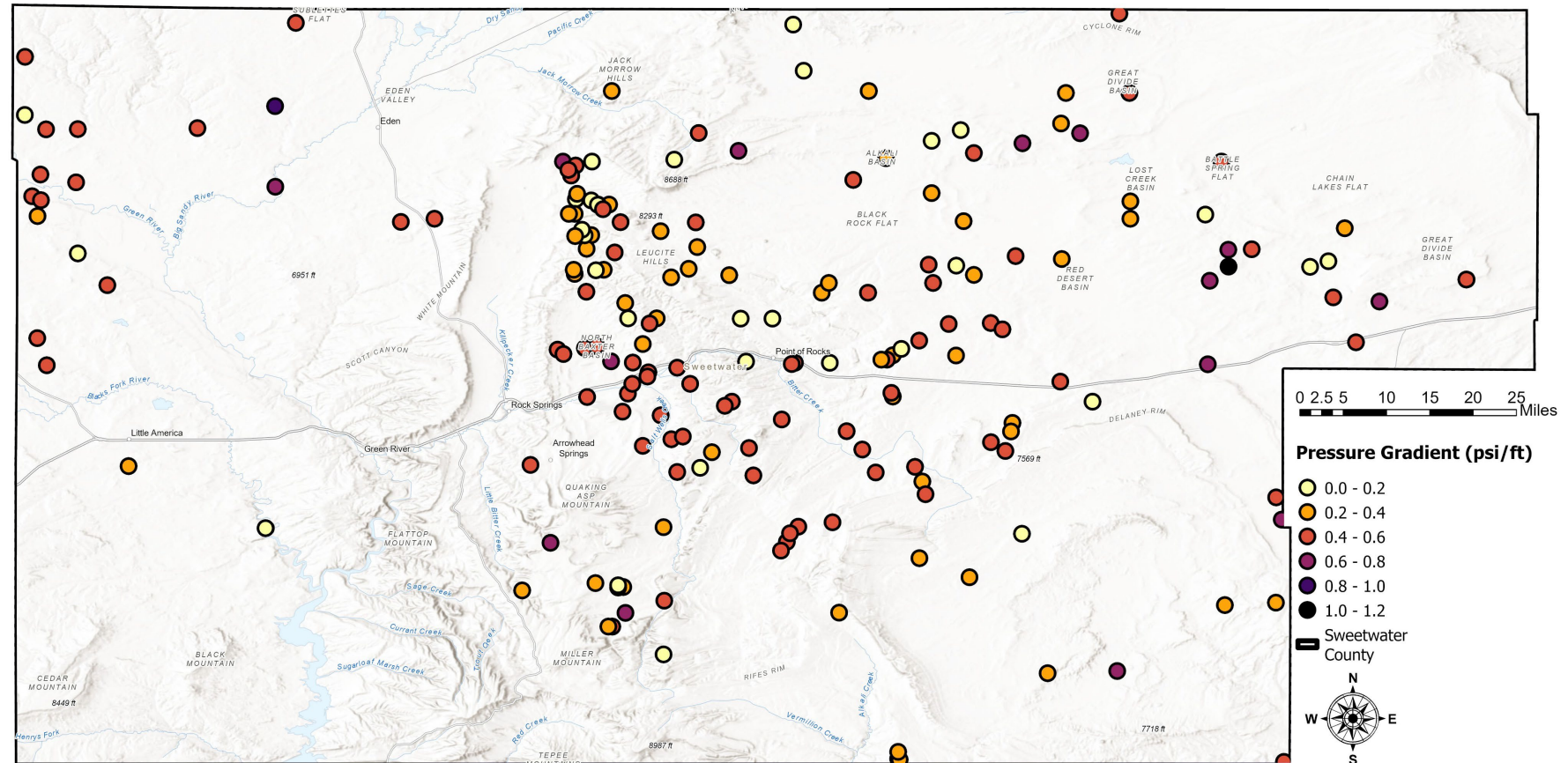
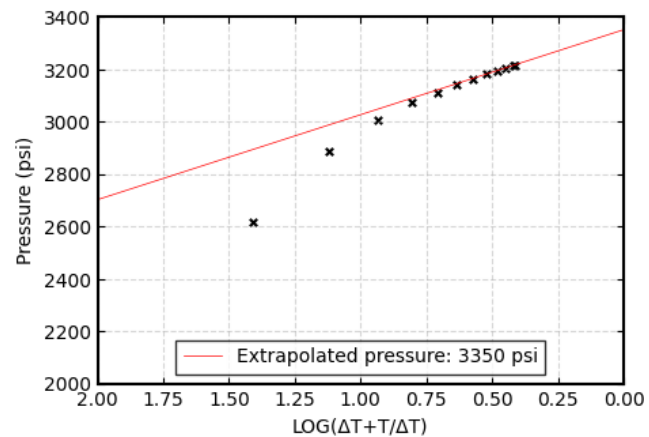


# Formation pressures and pressure gradients

Spatial distribution of the pressure gradient in Sweetwater county, obtained from drill-stem test and Horner analysis

Drill stem test (DST) data  
digitized for **192 wells**

Horner analyses  
performed, calculated  
pressure gradient



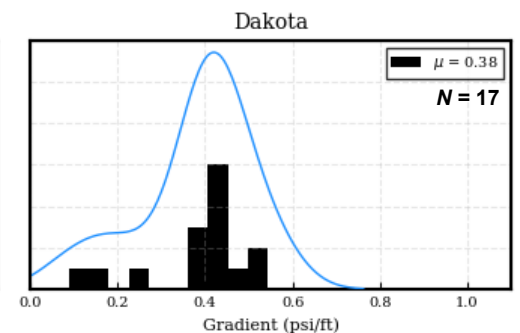
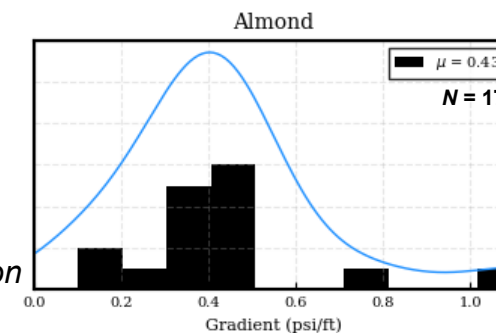
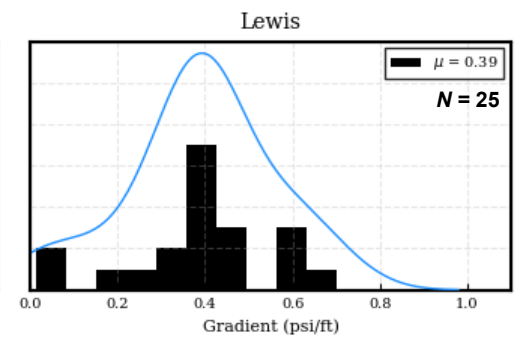
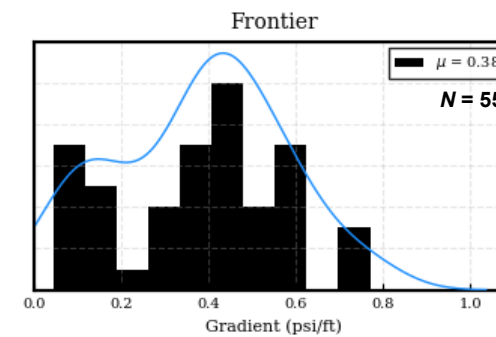
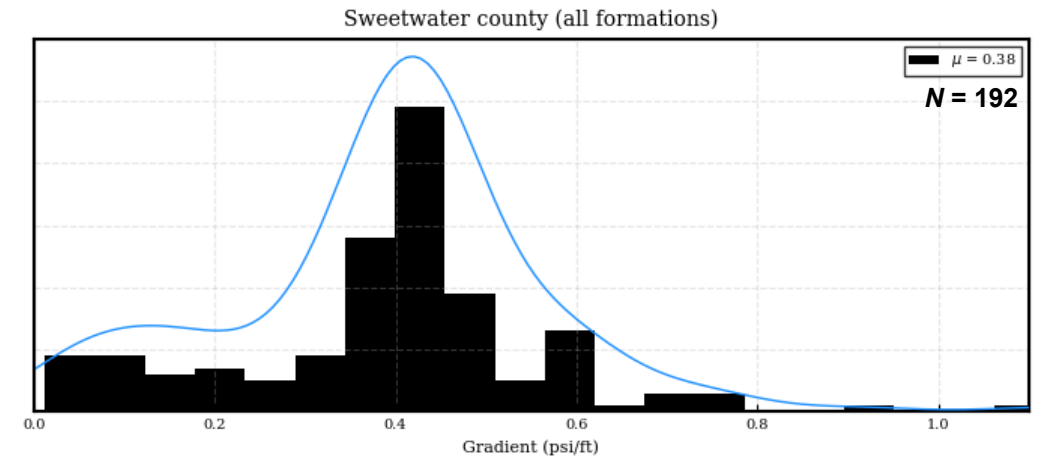
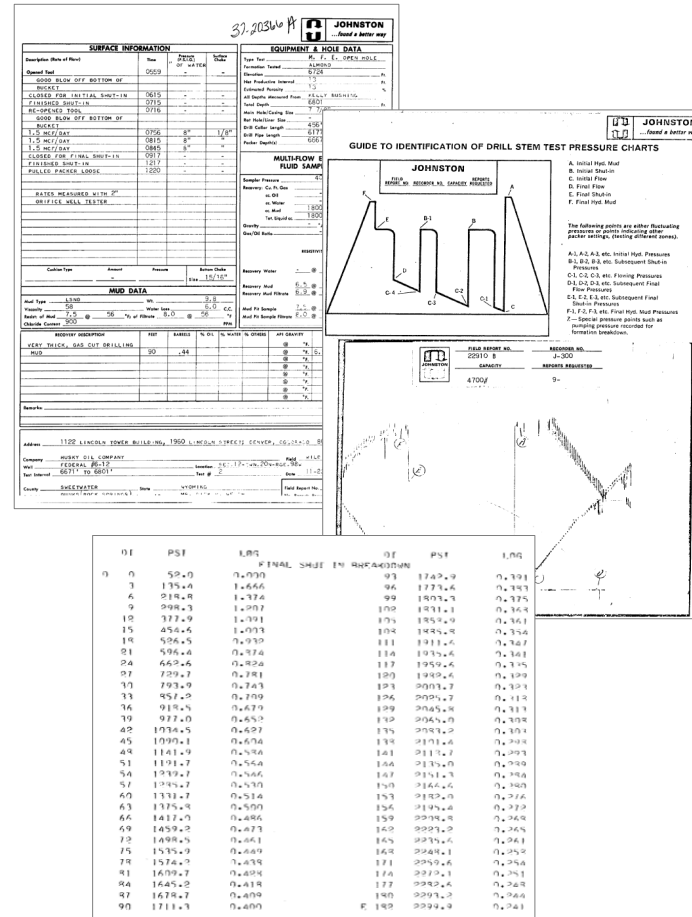
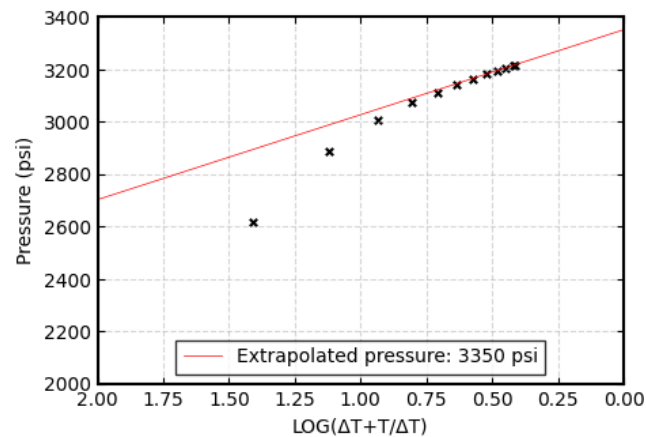
Data: Wyoming Oil and Gas Conservation Commission

Esri, TomTom, Garmin, SafeGraph, FAO, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USFWS, NASA, NGA, USGS

# Formation pressures and pressure gradients

Drill stem test (DST) data digitized for **192 wells**

Horner analyses performed, calculated pressure gradient



Data: Wyoming Oil and Gas Conservation Commission

# Formation temperatures and temperature gradients

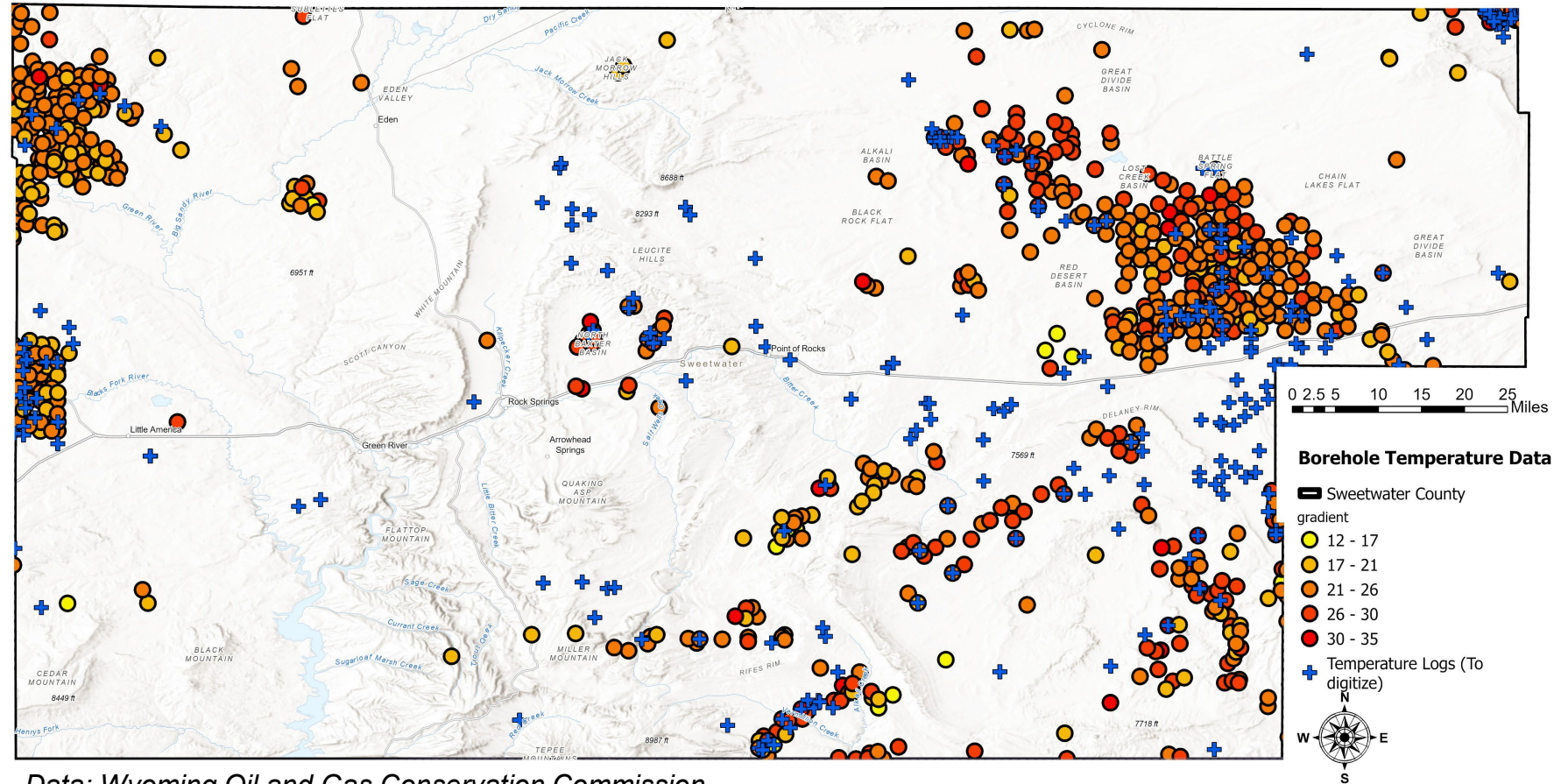
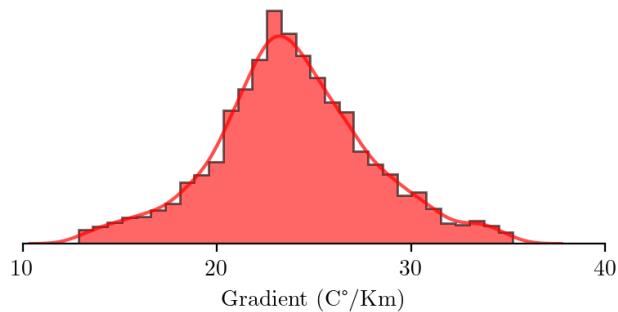
Subsurface temperature gradient, and available temperature logs (raster)

**$N = 2764$**  temperature measurements compiled, gradients calculated

**$N = 245$**  temperature logs (to be digitized)

$$\text{gradient} = \frac{\text{BH temperature} - \text{surface temperature}}{\text{depth}}$$

$\mu = 23.85, \sigma = 4.05$



Data: Wyoming Oil and Gas Conservation Commission,  
Wyoming State Geological Survey, AASG/SMU, Latrach et al. (2024)

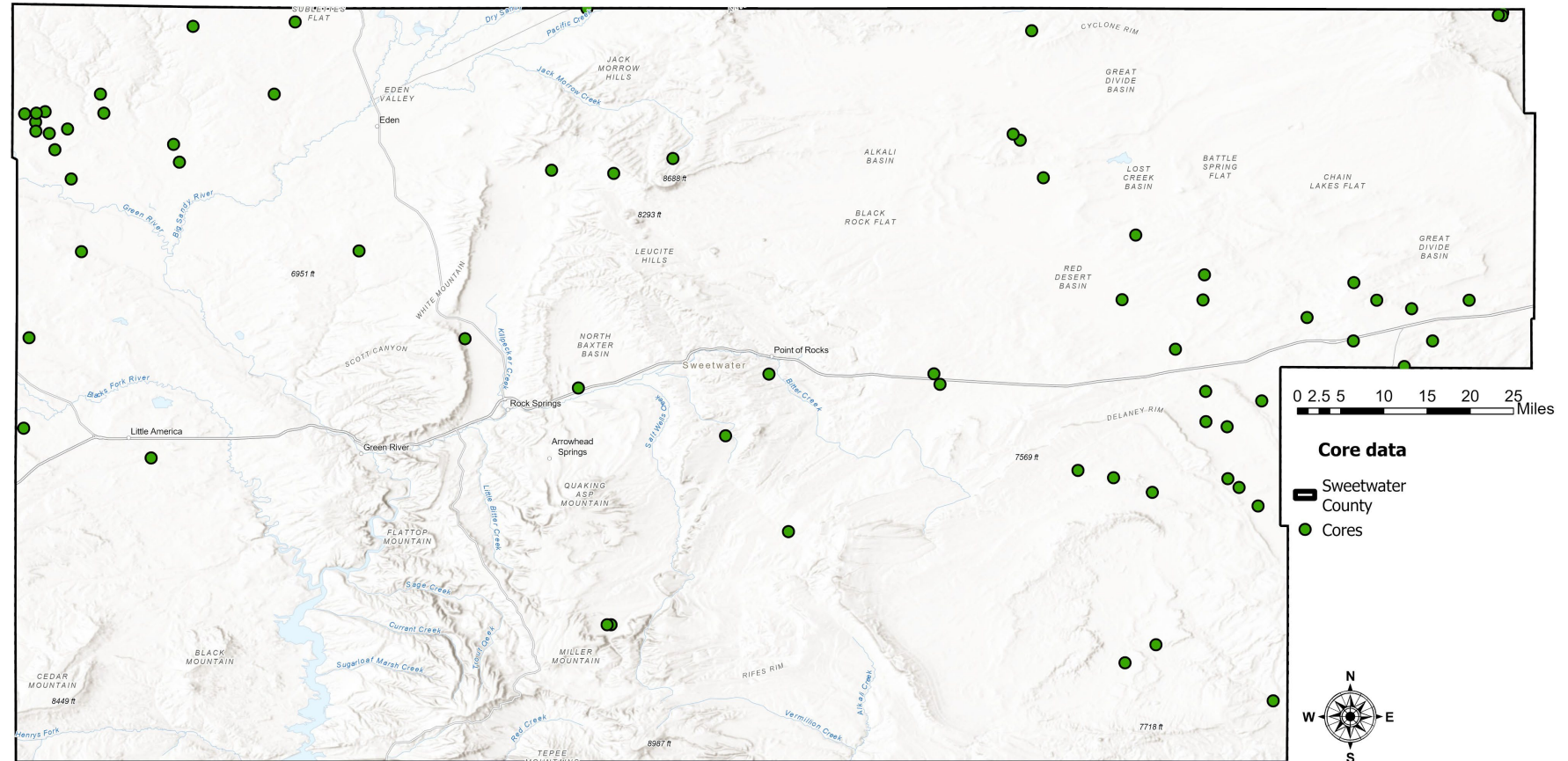
Esri, TomTom, GarminGraph, FAO, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USFWS, Esri, NASA, NGA, USGS

# Core data

Data compiled and digitized for  **$N = 64$  cores**

- Porosity ( $\phi$ )
- Permeability ( $k$ )
- Grain density ( $\rho$ )
- XRD mineralogy

Spatial distribution of core data (routine core analysis and XRD data).



Data: United States Geological Survey Core Research Center

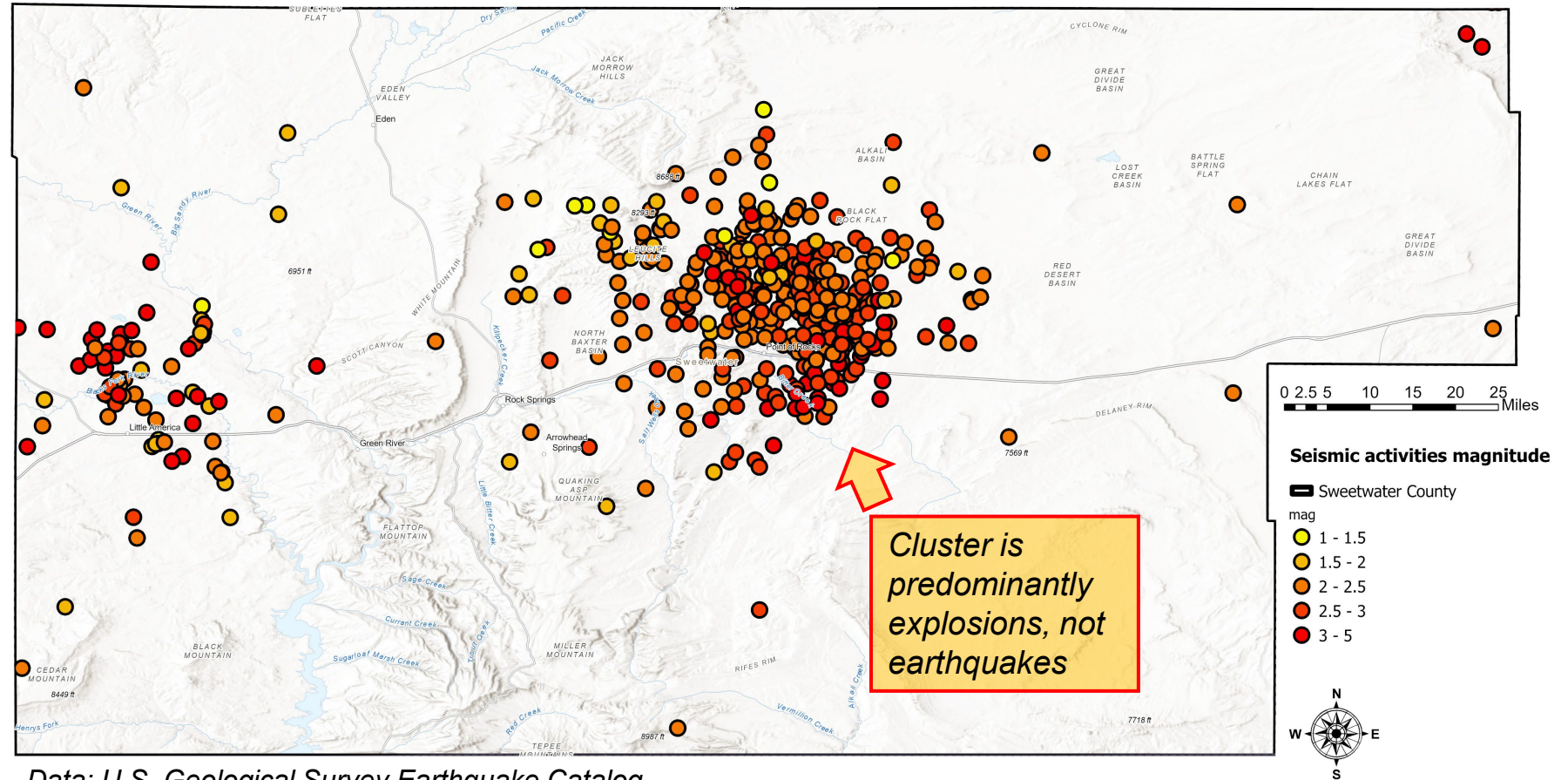
Esri, TomTom, Garmin, SafeGraph, FAO, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USFWS, NASA, NGA, USGS

# Seismic events

Spatial distribution of historical seismic activities and their magnitude

**$N = 743$**  seismic events

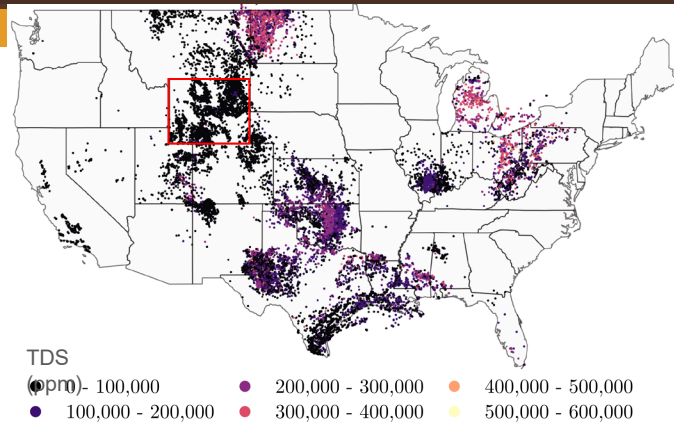
Years 1973 – 2024,  
Magnitude 1.0 and above



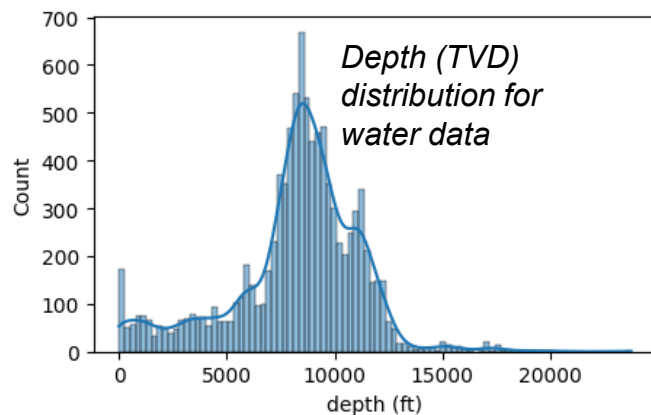
Data: U.S. Geological Survey Earthquake Catalog

Esri, TomTom, GarminGraph, FAO, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USFWS, Esri, NASA, NGA, USGS

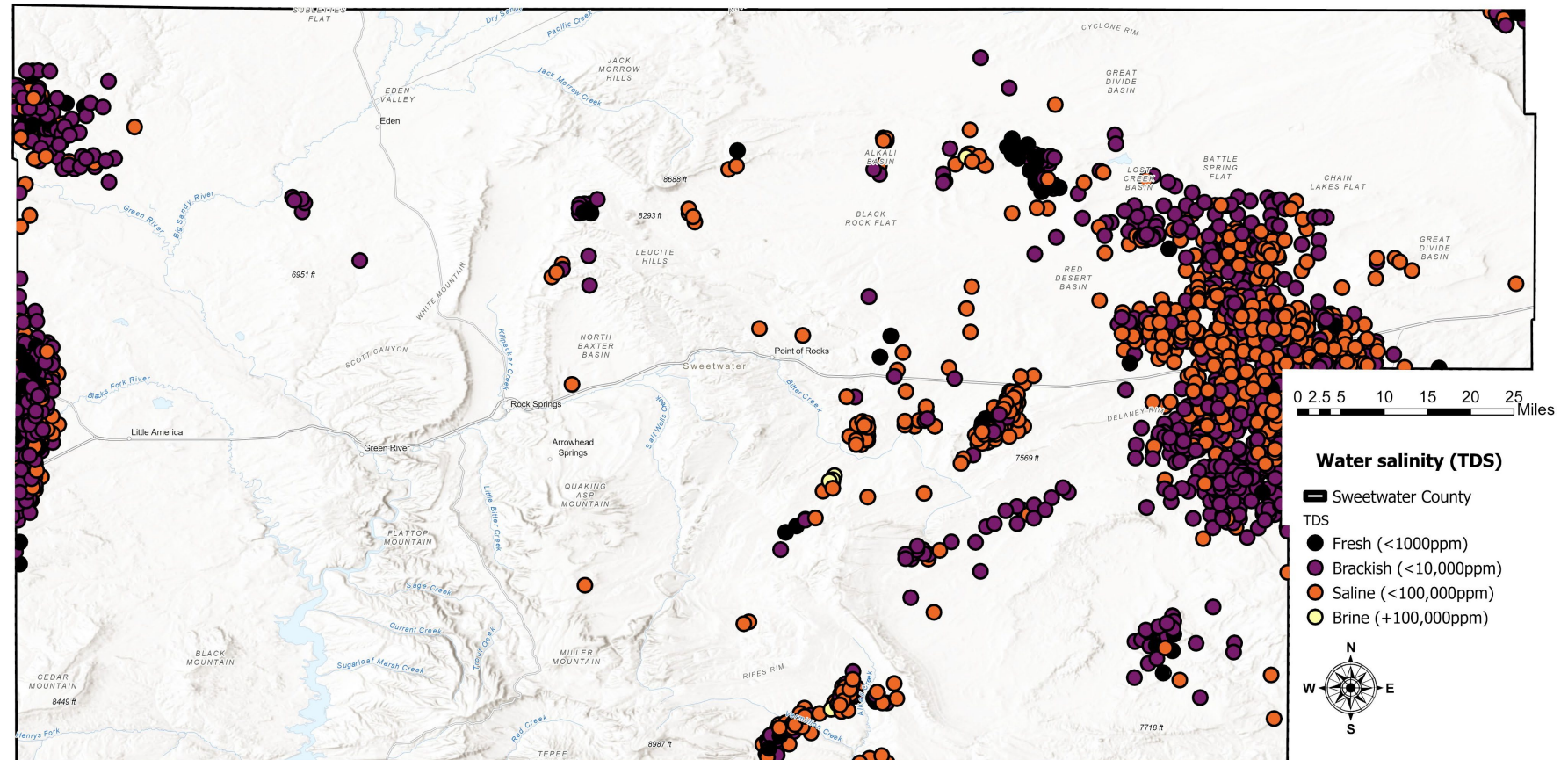
# Water geochemistry



**$N = 2,389$**  data points compiled



Spatial distribution of water chemistry data, and groundwater salinity

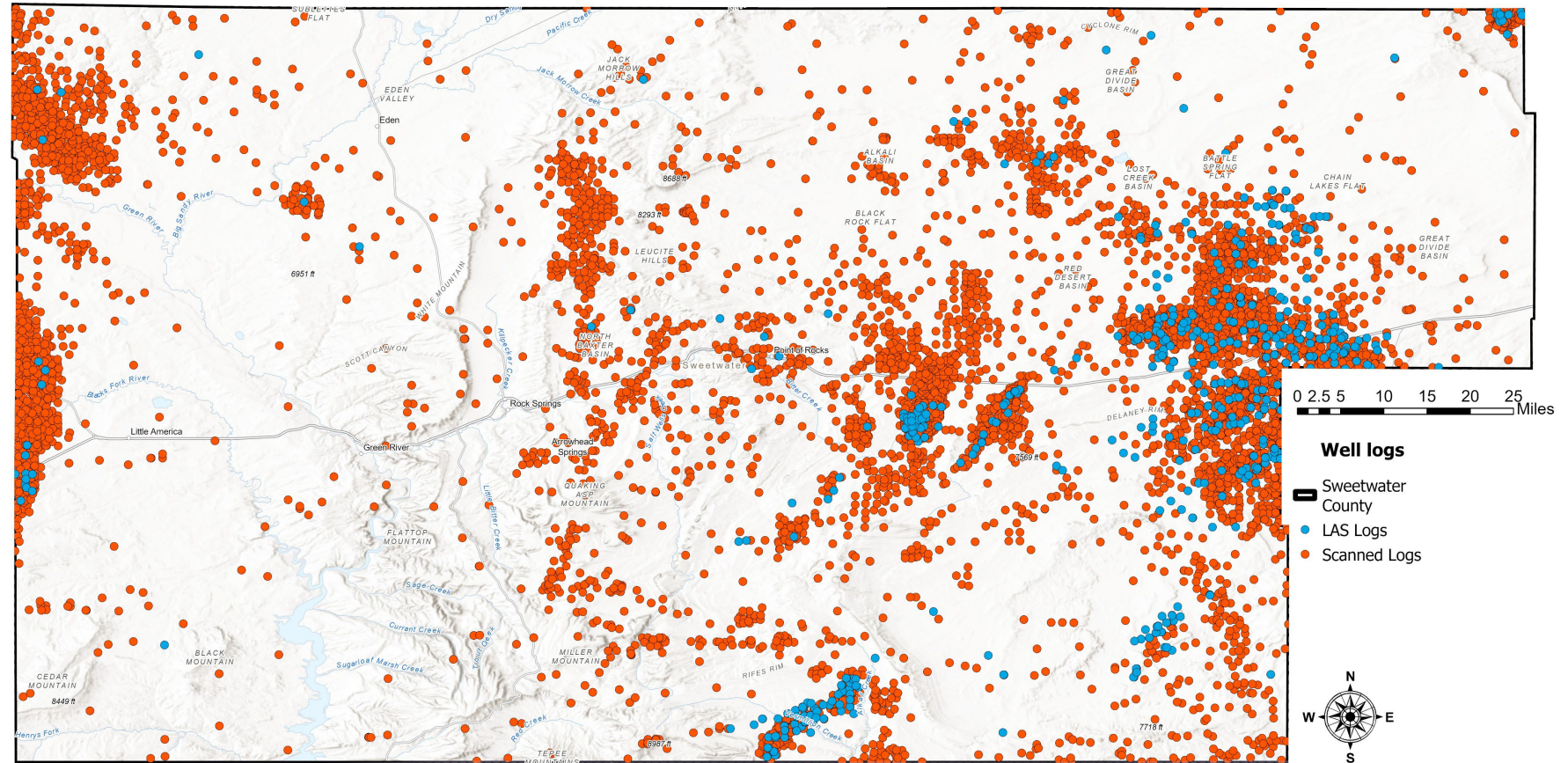
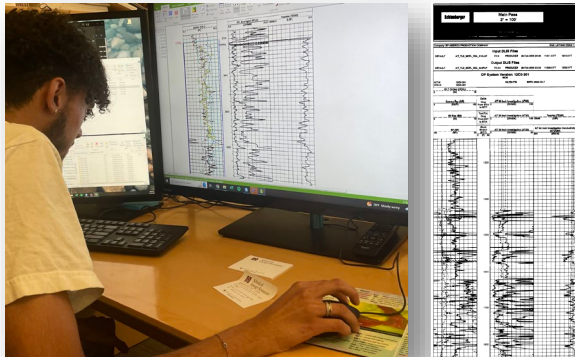
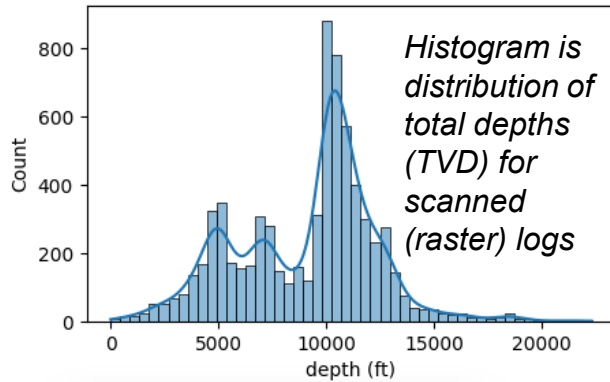


Data: U.S. Geological Survey National Produced Waters Geochemical Database, Wyoming Oil and Gas Conservation Commission

Esri, TomTom, GarminGraph, FAO, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USFWS, Esri, Esri, CGIAR, USGS

Spatial distribution of well logs, both LAS files and scanned logs.

**$N = 20,807$**  scanned logs  
for  **$n = 7,188$**  wells



*Data: Wyoming Oil and Gas Conservation Commission*

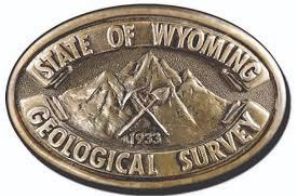
Esri, TomTom, Garmin, Safe, SafeGraph, FAO, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USFWS, NASA, NGA, USGS



# Wyoming Energy Resource Library

*A digital collection of energy-related spatial datasets from State and Federal sources*

James Amato  
CEGR Research  
Professional



Enhanced Oil  
Recovery Institute

(16) Administrative

(9) Coal

(4) Geology

(12) Geothermal

(20) Hydrology

(9) Hazards

Infrastructure (7)

Mineral Resources (22)

Nuclear Energy (22)

Oil & Gas (17)

Carbon Capture (2)

Wind Energy (1)

Total GIS Layers (to date) = 139

Elevation Data (coming soon)

Request Layers!



# Student development and training



Summer '24 undergraduate interns:  
**Christian Martinez (left)**  
*Senior, Finance*

**Junior Grimes (center)**  
*Senior, Environmental Science and Geology*

Graduate Research Assistant:  
**Abdeldjalil Latrach (right)**  
*Ph.D. Candidate, Petroleum Engineering*

| Depth    | Minerals in weight % |        |           |            |            |       |          |          |        |            |           |        |                 |             |
|----------|----------------------|--------|-----------|------------|------------|-------|----------|----------|--------|------------|-----------|--------|-----------------|-------------|
|          | Feldspars            |        |           |            | Carbonates |       | Sulfide  | Mafic    | Clays  |            |           |        |                 |             |
|          | Quartz               | Albite | Anorthite | Orthoclase | Calcite    | Dolo. | Ankerite | Siderite | Pyrite | Hornblende | Muscovite | Illite | Montmorillonite | Clinochlore |
| 10,744.0 | 52.6                 | 14.9   | 0.9       | 5.1        | 3.1        | 0.9   | 4.2      | 0.2      | 0.6    | 0.1        | 5.0       | 5.6    | 0.6             | 2.1         |
| 10,760.5 | 49.8                 | 13.3   | 3.4       | 2.9        | 2.8        | 0.7   | 6.1      | 0.2      | 1.6    | 9.0        | 4.3       | 0.4    | 3.0             | 0.6         |
| 10,791.0 | 51.2                 | 14.0   | 2.1       | 6.9        | 2.9        | 1.3   | 3.2      | 0.4      | 3.0    | 7.7        | 0.1       | 0.5    | 2.6             | 2.5         |
| 13,281.6 | 55.6                 | 3.0    | 5.3       | 9.3        | 1.9        | 4.6   | 9.6      | 0.1      | 0.6    | 2.4        | 5.2       | 0.0    | 0.9             | 0.6         |
| 13,313.5 | 64.5                 | 7.3    | 4.8       | 3.2        | 5.8        | 3.8   | 0.8      | 0.1      | 0.6    | 0.2        | 4.7       | 0.8    | 0.3             | 0.2         |
| 5,749.0  | 44.5                 | 15.4   | 1.7       | 6.6        | 2.3        | 0.9   | 3.1      | 0.1      | 1.1    | 8.8        | 0.5       | 0.5    | 4.1             | 4.8         |
| 5,767.5  | 56.4                 | 19.7   | 0.3       | 7.5        | 1.0        | 0.3   | 0.4      | 0.2      | 0.6    | 4.8        | 0.8       | 0.7    | 2.0             | 3.0         |
| 8,600.2  | 46.9                 | 16.0   | 2.6       | 4.2        | 3.7        | 1.6   | 2.7      | 0.8      | 0.3    | 0.1        | 7.5       | 6.5    | 0.2             | 3.4         |
| 8,606.3  | 27.5                 | 4.9    | 7.1       | 2.4        | 7.7        | 24.0  | 10.1     | 0.5      | 1.1    | 1.0        | 4.5       | 4.5    | 1.2             | 0.6         |
| 9,393.5  | 44.5                 | 15.4   | 2.9       | 5.0        | 16.8       | 0.0   | 0.7      | 1.0      | 1.6    | 0.7        | 4.5       | 0.3    | 0.9             | 0.6         |



Interns learning about the acquisition of XRD mineralogy data

| END TRIM POROSITY AND PERMEABILITY ANALYSIS |            |                             |              |                   |                      |          |                                          |                                                                       |                |
|---------------------------------------------|------------|-----------------------------|--------------|-------------------|----------------------|----------|------------------------------------------|-----------------------------------------------------------------------|----------------|
| Sample Number                               | Depth (ft) | Net Confining Stress (psig) | Porosity (%) | Permeability (md) | Grain Density (g/cc) | Footnote | Lithology and Total Organic Carbon (TOC) |                                                                       |                |
| 25B                                         | 6154.50    | Ambient                     | 5.79         | 0.025             | 0.061                |          | Sample Type                              | Arch Unit No.80-10-1                                                  | Sec 10/19N/98W |
| 26B                                         | 6158.00    | Ambient                     | 3.29         | <0.0001           | 0.0006               | 2.659    | core                                     | 100% SILTSTONE- blk, dk gry, mod hd, slty-suc tex, carb, sme pyr      | TOC (wt%)      |
| 27A                                         | 6157.45    | Ambient                     | 2.96         | <0.0001           | 0.0007               | 2.857    |                                          |                                                                       | 1.72           |
| 28B                                         | 6206.30    | Ambient                     | 16.29        | 2.84              | 3.28                 | 2.723    | core                                     | 100% SHALE- blk, mod hd, brit, slty tex, pity, intrd coal mat, v carb | 3.49           |



Field trip to see rock units where they are exposed at the surface (Seminole Reservoir, WY)

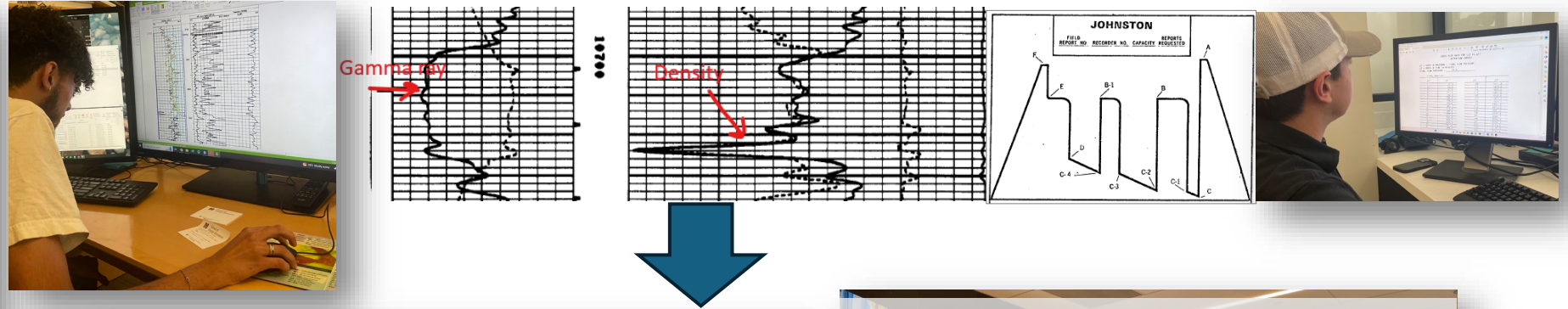
# Student development and training



Summer '24 undergraduate interns:  
**Christian Martinez (left)**  
*Senior, Finance*

**Junior Grimes (center)**  
*Senior, Environmental Science and Geology*

Graduate Research Assistant:  
**Abdeldjalil Latrach (right)**  
*Ph.D. Candidate, Petroleum Engineering*



**Running logging tools down hole on the simulator**



🕒 4:20 PM

53-10: MULTIDISCIPLINARY GEOTECHNICAL DATA COLLECTION, CURATION, AND ANALYSIS FOR CONFORMITY WITH THE REGULATORY FRAMEWORK FOR GEOLOGIC CARBON STORAGE IN WYOMING, USA

JACKSON, Lily<sup>1</sup>, JOHNSON, Matthew B.<sup>1</sup>, LATRACH, Abdeldjalil<sup>2</sup>, GRIMES, Demetrian<sup>3</sup>, MARTINEZ, Christian<sup>4</sup> and MCLAUGHLIN, J. Fred<sup>1</sup>, (1)Center for Economic Geology Research, School of Energy Resources, University of Wyoming, Laramie, WY 82071, (2)Department of Energy & Petroleum Engineering, University of Wyoming, Laramie, WY 82071, (3)Haub School of Environment and Natural Resources, University of Wyoming, Laramie, WY 82071, (4)Department of Accounting and Finance, College of Business, University of Wyoming, Laramie, WY 82071

📍 207D (Anaheim Convention Center)

**Student co-authored conference abstract**

# Community Benefits and Impacts

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# Community Benefits and Impacts

## ***Community and Labor Engagement***

**Commitment 1:** Community engagement event in Sweetwater County, WY. Event will occur within the first year of the project (Q4).

**Commitment 2:** Community outreach event in collaboration with Wyoming State Geological Survey. Event will occur within the second year of the project (Q8).

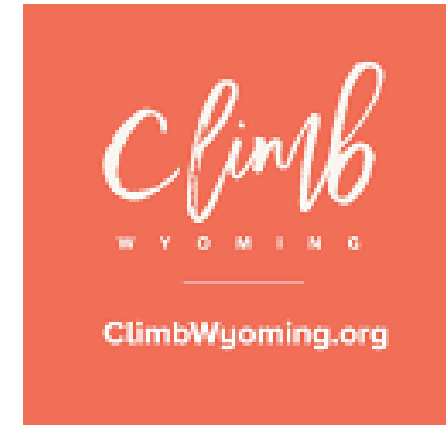
## ***Diversity, Equity, Inclusion, and Accessibility***

**Commitment 3:** Partner with Wyoming organization to identify pathways for inclusion of diverse groups. Partnership will be established within the first year of the project (Q4) and will occur throughout the project.

## ***Justice40 Initiative***

**Commitment 4:** Environmental Justice Assessment. Environmental justice assessment will be ongoing throughout the project (Q8).

## **Progress towards SMART milestones**



# The UW School of Energy Resources Energy ELC

## The Energy Engagement, Leadership, and Careers (ELC) Program

**MISSION:** *To lead in the development of a skilled energy workforce, engage industry stakeholders, empower communities by incorporating local knowledge into program development and research, advance social science capacity building, and inspire the next generation of leaders through innovative education.*



### ENERGY WORKFORCE DEVELOPMENT

Pioneer workforce development strategies that align with the evolving needs of existing and emerging energy sectors.



### ENERGY EDUCATION AT ALL LEVELS

Develop innovative and forward-thinking education programs at all levels to cultivate future leaders in the energy sector.



### ENGAGEMENT WITH ENERGY COMMUNITIES

Empower energy communities to embrace and benefit from emerging energy technologies.



### SOCIAL SCIENCE RESEARCH

Lead in the application of social science methodologies to address the societal dimensions of emerging energy technologies and inform capacity building for energy communities.



### ENERGY LEADERSHIP

Develop and train the next generation of innovative, forward-thinking, and conscientious energy leaders.

# Lessons Learned

## Next Steps

*THE WORLD NEEDS  
MORE COWBOYS.*

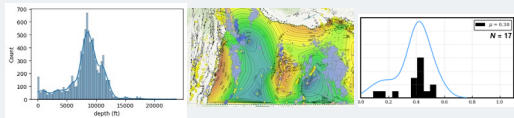
# Lessons learned and next steps

## Lessons learned

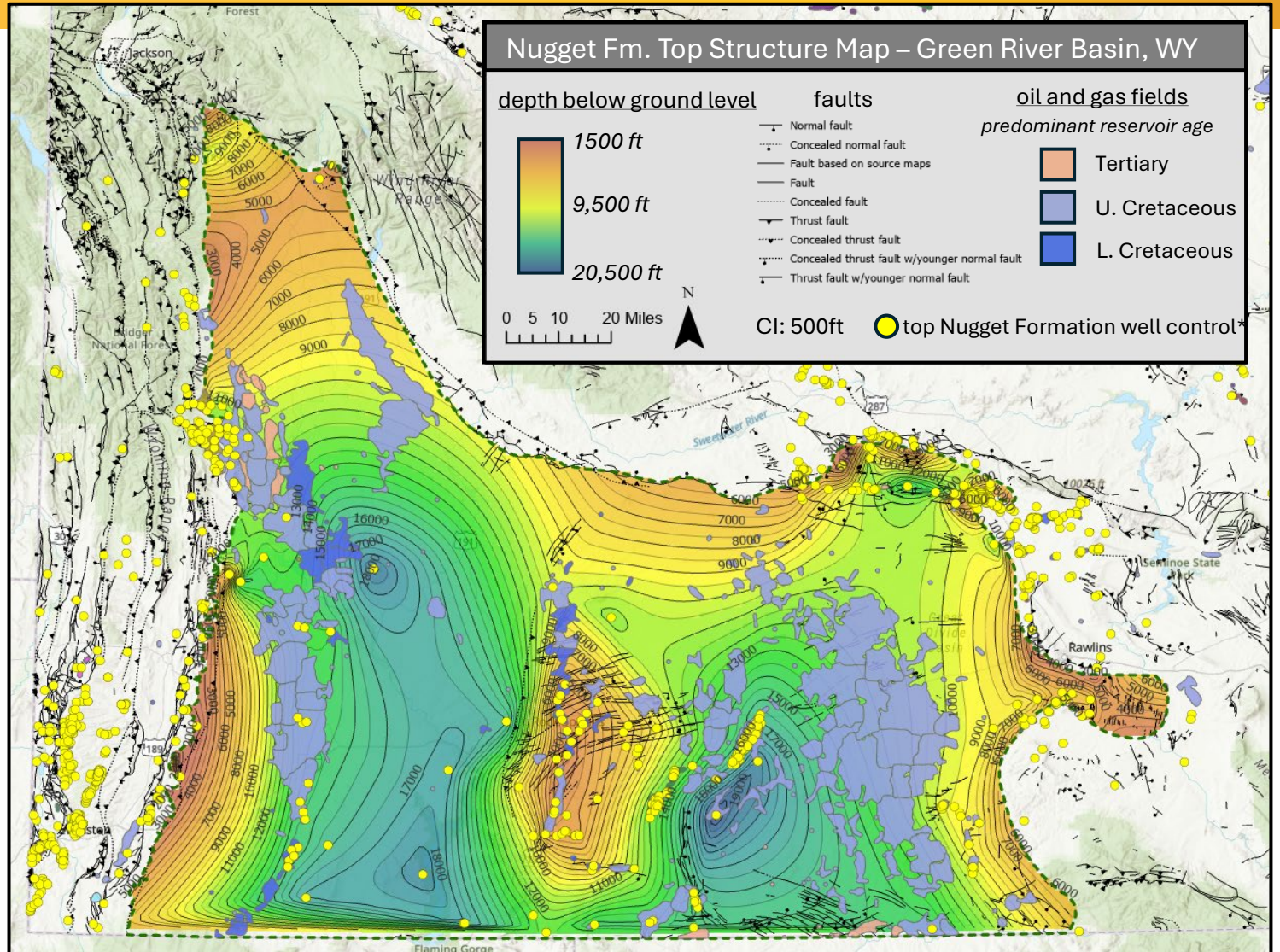
- *Data availability and quality*

## Next steps

- *Define uncertainties and data gaps*
- *Statistics and visual representations*



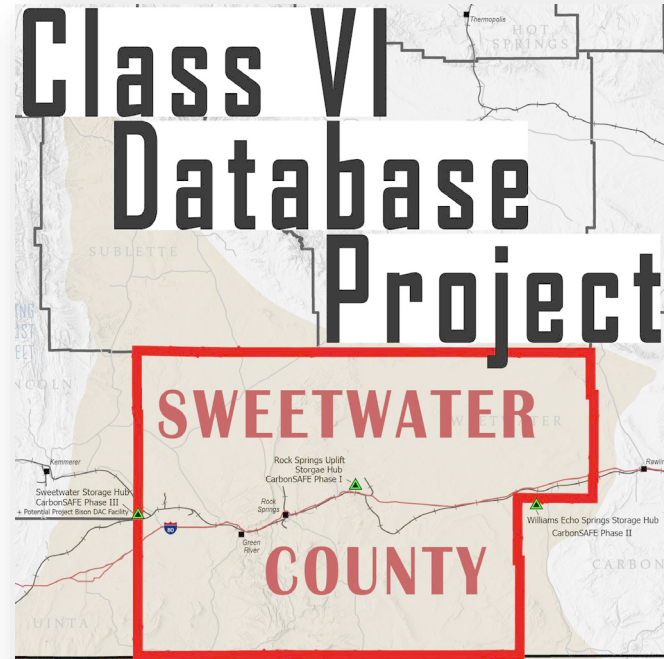
- *Develop type logs across the county*



\*depth to top formation from WOGCC well files; depths are ft below ground level or Kelly Bushing (where noted)

# Next Steps: Wyoming Class VI Site Characterization Database

- *Data verification and organization*
- *Database development*
- *Define a Process for Integrating with DEQs Class VI Permitting Process*



*The Class VI Database is a geo-enabled enterprise relational database using PostgreSQL and ArcGIS enabled feature services.*

*The web application (map interface and web dashboard) will be developed using ArcGIS Experience Builder.*

# Wyoming Class VI Site Characterization Database

PROJECT AWARD #: DE-FE0032372 (FOA 2799)

**Lily J. Jackson, Ph.D.**

Center for Economic Geology Research  
School of Energy Resources  
University of Wyoming

August 6<sup>th</sup> 2024

U.S. Department of Energy  
National Energy Technology Laboratory



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# Wyoming Class VI Site Characterization Database

PROJECT AWARD #: DE-FE0032372 (FOA 2799)

**Greatest challenges so far in data  
compilation efforts**

*for*

**Workshop on Consistency in Geologic  
Data Collection and Reporting for  
Storage Resources**

August 7<sup>th</sup> 2024

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