Wyoming Class VI Site Characterization Database

PROJECT AWARD #: DE-FE0032372 (FOA 2799)

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School of Energy Resources
University of Wyoming

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U.S. Department of Energy
National Energy Technology Laboratory

UNIVERSITY OF WYOMING | School of Energy Resources

THE WORLD NEEDS MORE COWBOYS.

Acknowledgement and Disclaimer

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

Project Overview

Project overview: Wyoming Class VI Site Characterization Database

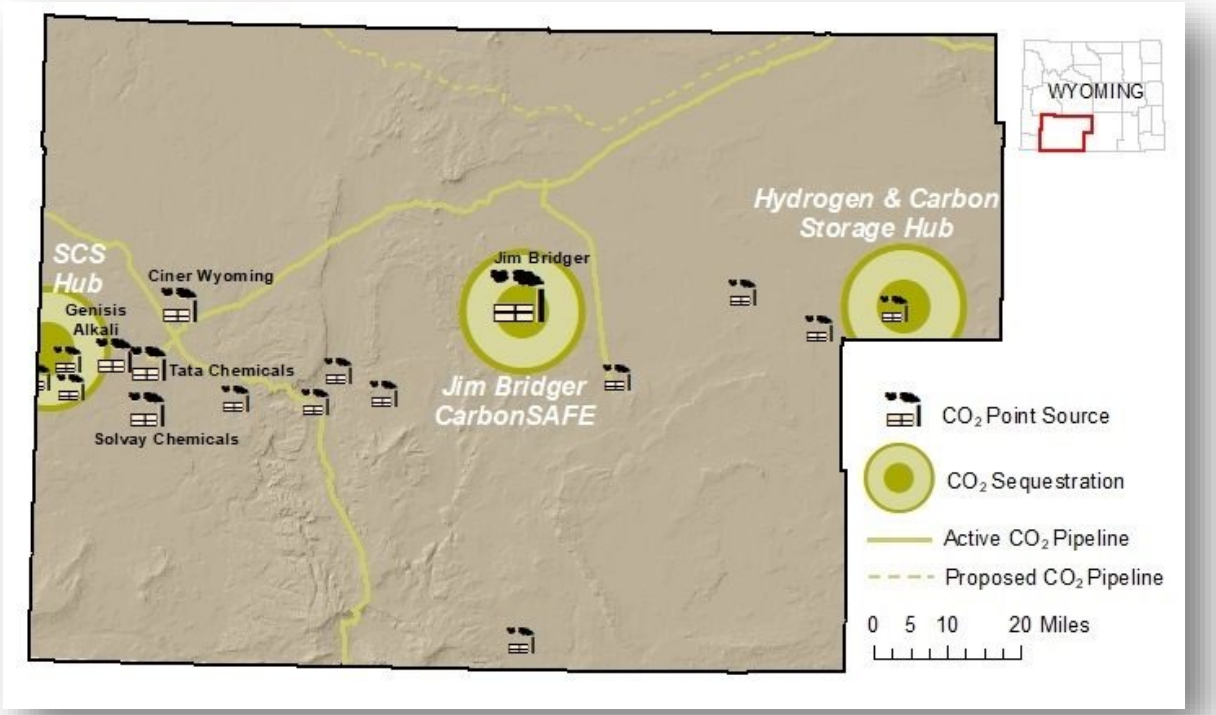
Project objective: *T*o develop a geologic site characterization database to expedite Class VI permitting for three carbon storage hubs in Sweetwater County, Wyoming within the Greater Green River Basin.

Funding summary:

Total	
DOE funds	**Cost Share**
$998,968	**$999,925**

Project/Grant Period:

March 1, 2024– February 28, 2026



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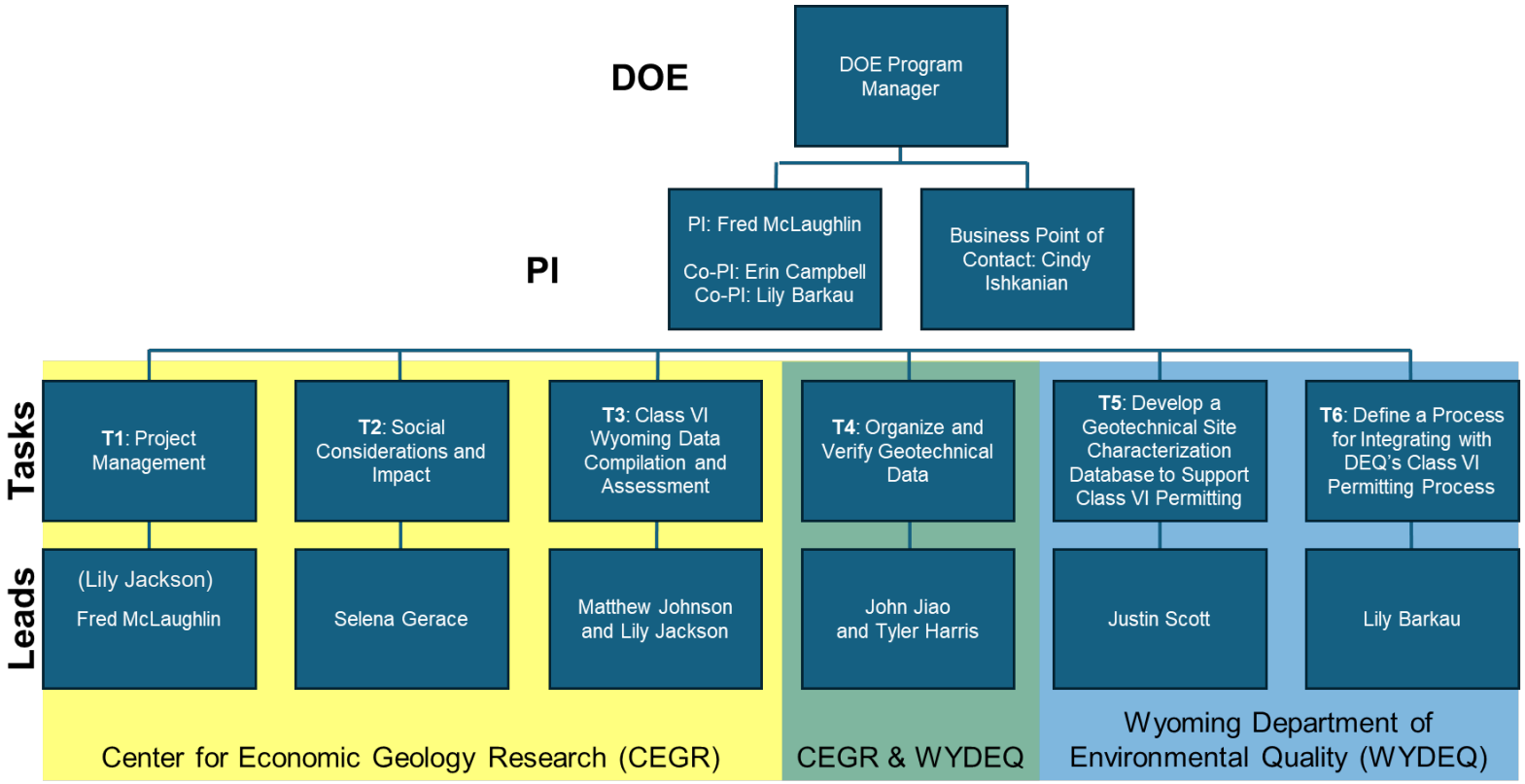
Project organization & key participants

Lead Institutions

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



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DEQ Wyoming Department of Environmental Quality

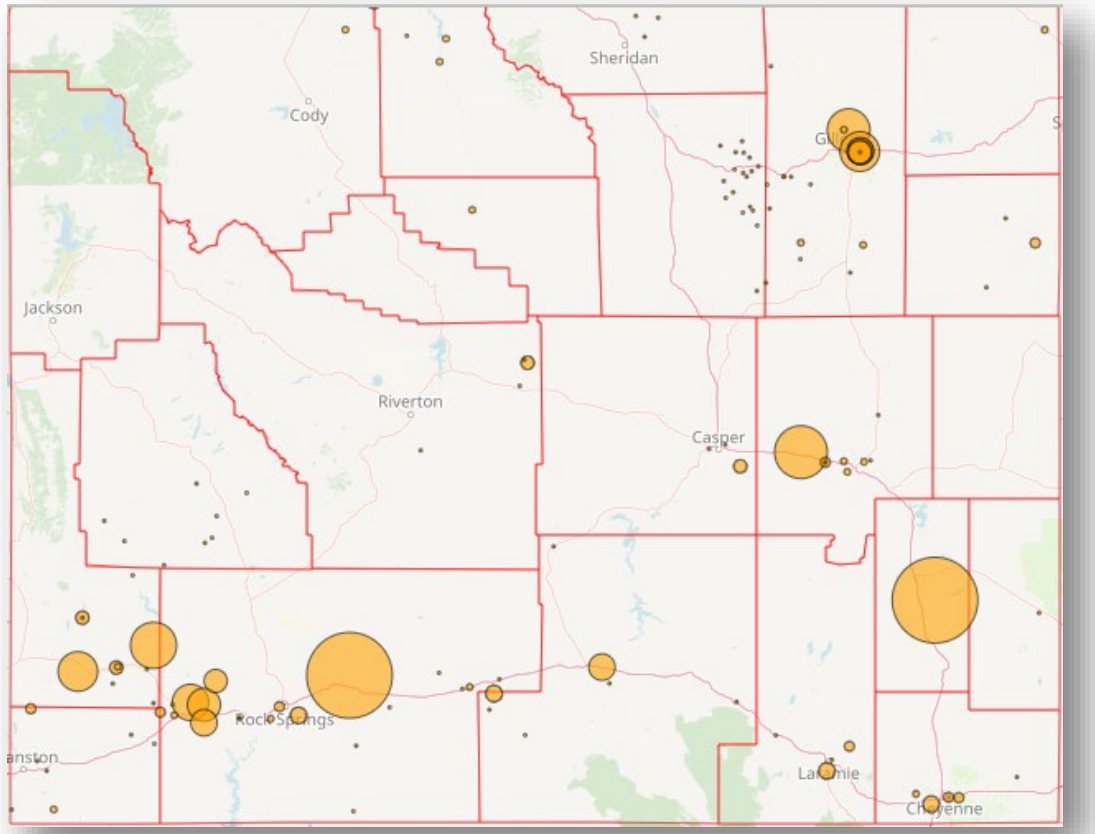
State of Wyoming Geological Survey

Project Background

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 What's this?
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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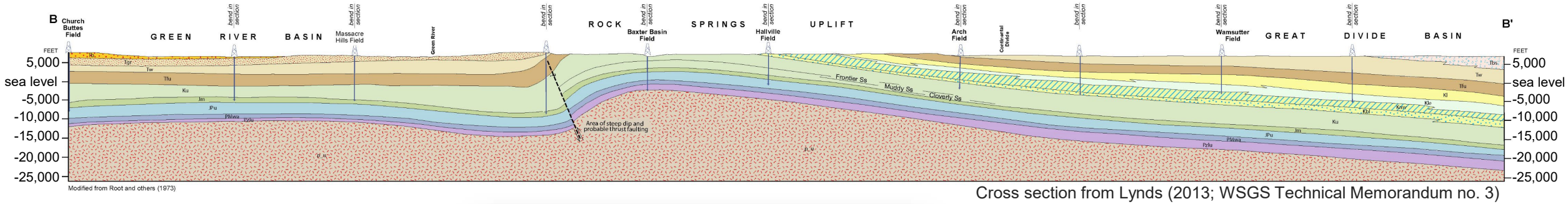
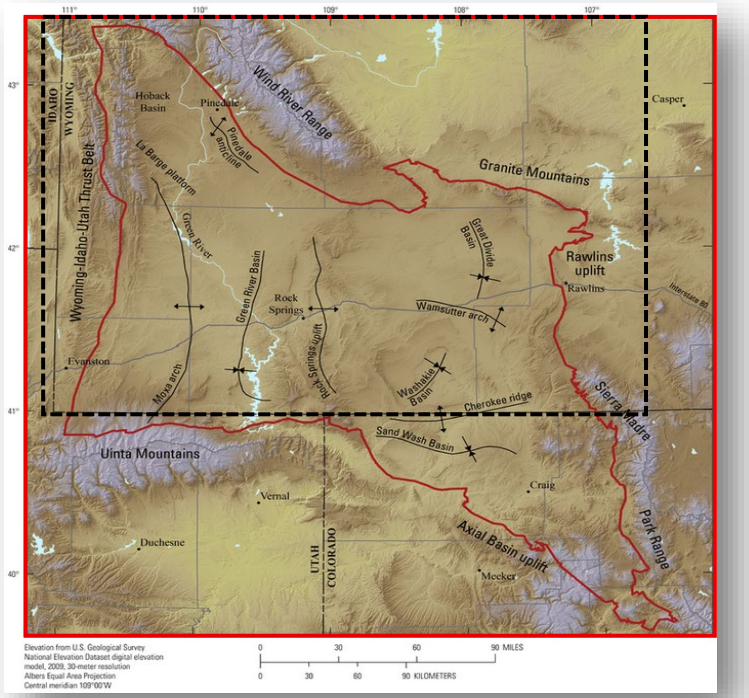
Project location - Greater Green River Basin



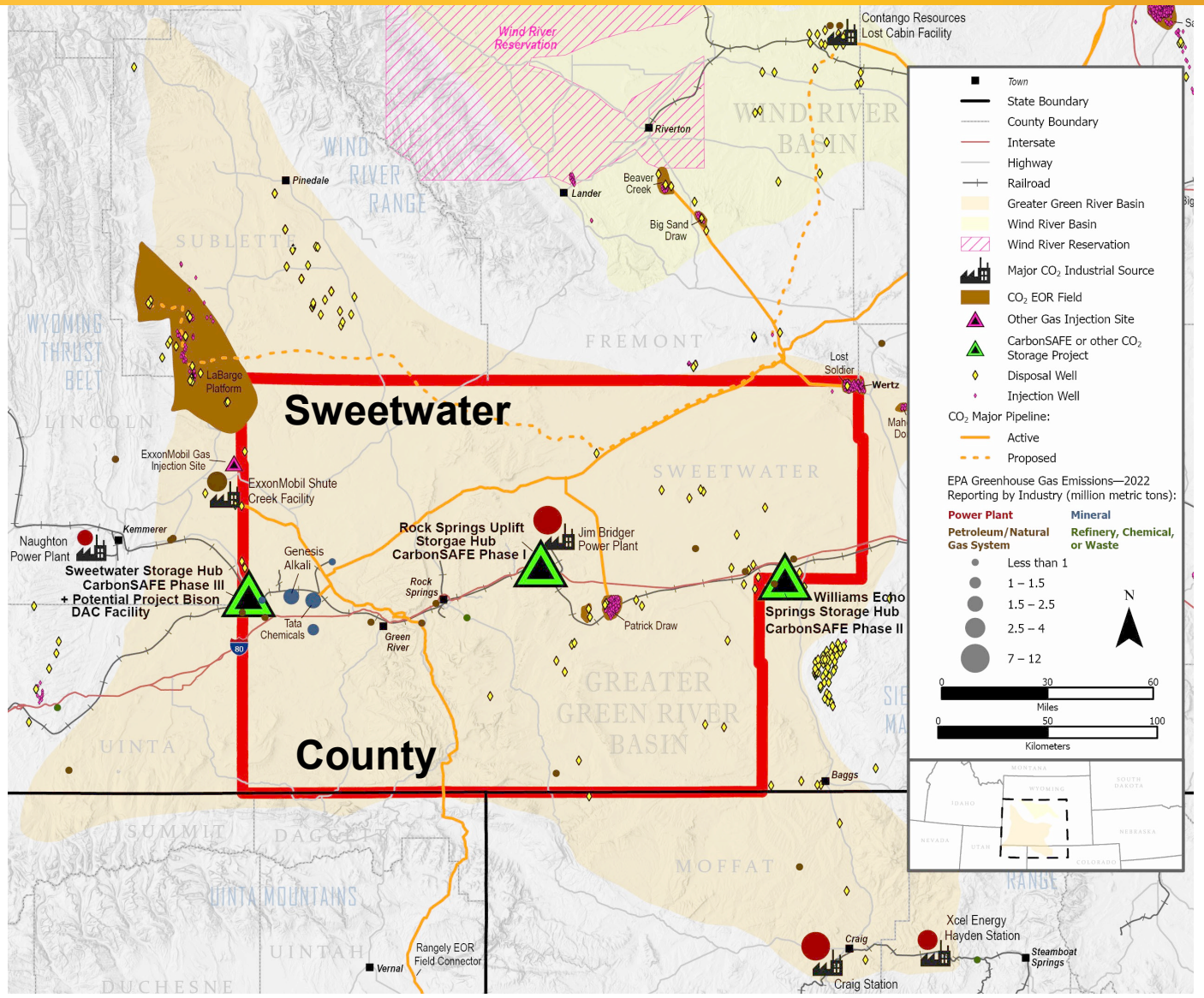
Cross section from Lynds (2013; WSGS Technical Memorandum no. 3)



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

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

Site characterization requirements for class VI permit

WATER QUALITY DIVISION

UIC Class VI Permit Application
Site Characterization Form A-1
March 28, 2024

GEOLOGIC SEQUESTRATION

CLASS VI PERMIT APPLICATION - SITE CHARACTERIZATION

Water Quality Rules, Chapter 24 Sections 10 and 12

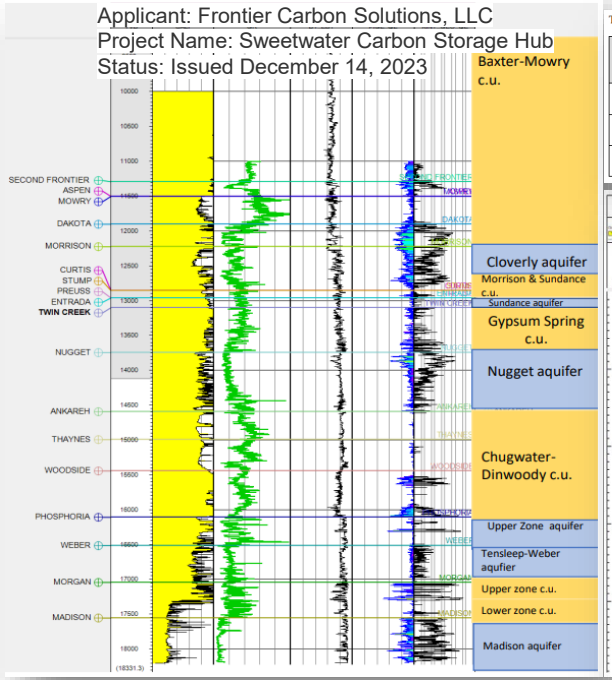
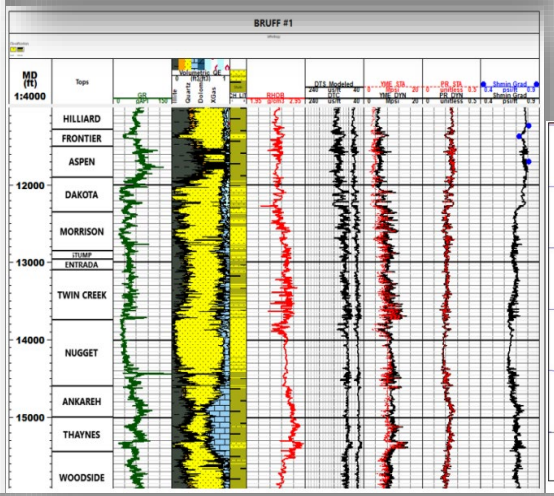


Table 8. Formations Comprising the CO2 Storage System

Formation	Purpose	Average Thickness at Project Site, feet	Average Depth at Project Site, feet	Mineralogy
Twin Creek	Upper confining zone	650	13,000 – 13,750	10-40% Clay; 40- 60% Quartz; 0-10% Calcite
Nugget	Injection zone	850	13,750 – 14,600	0-10% Clay; 70-90% Quartz; 0-10% Calcite
Ankareh	Lower confining zone	400	14,600 – 15,000	20-40% Clay; 0- 50% Quartz; 0-40% Calcite



Example images from an issued permit by applicant Frontier Carbon Solutions, LLC

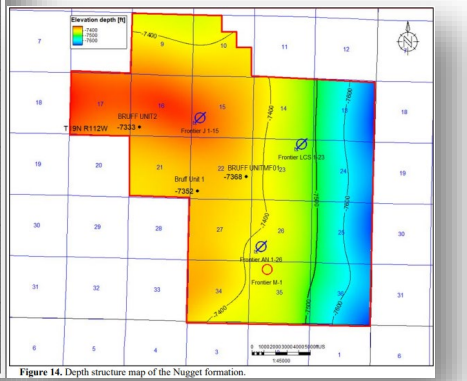
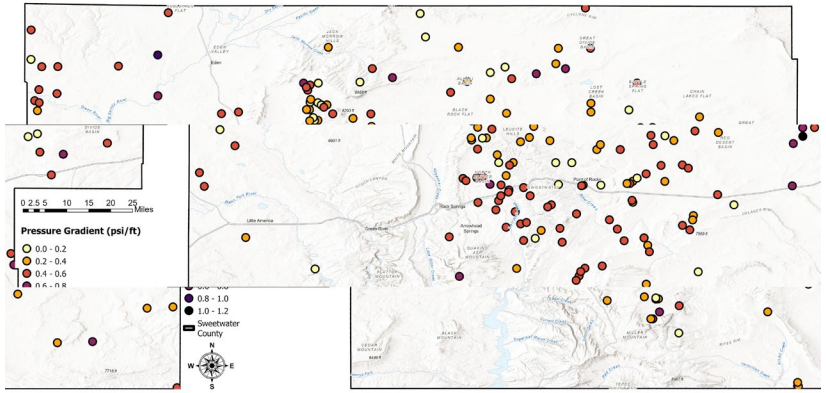


Figure 14. Depth structure map of the Nugget formation.

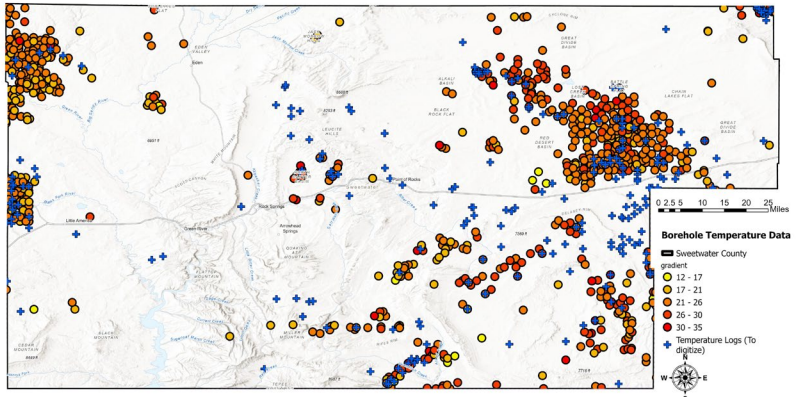
- Regional Hydrostratigraphy and Groundwater Flow
- Storage Reservoir Geology
- Geophysical Well Logs
- Core Sample Analyses
- Mineralogy
- Mechanism of Geological Confinement
- Injection Zone Storage Capacity
- Potential Geochemical Interactions
- Compatibility of the CO2 with Subsurface Fluids and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

Status of data compilation (Task 3)

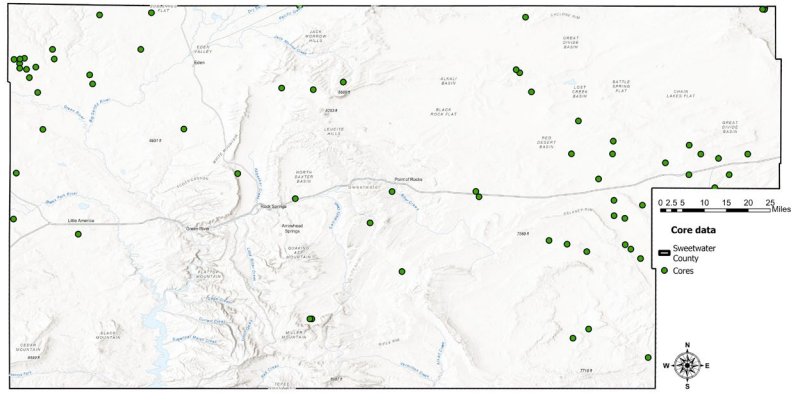
Subsurface pressure



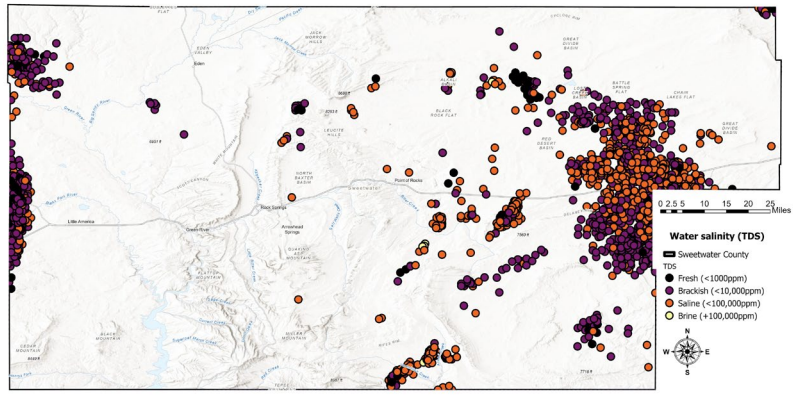
Subsurface temperature



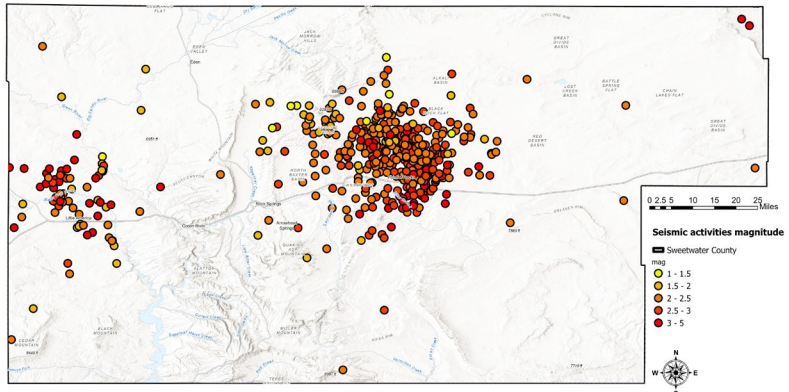
Core data (φ, k, ρ, XRD mineralogy)



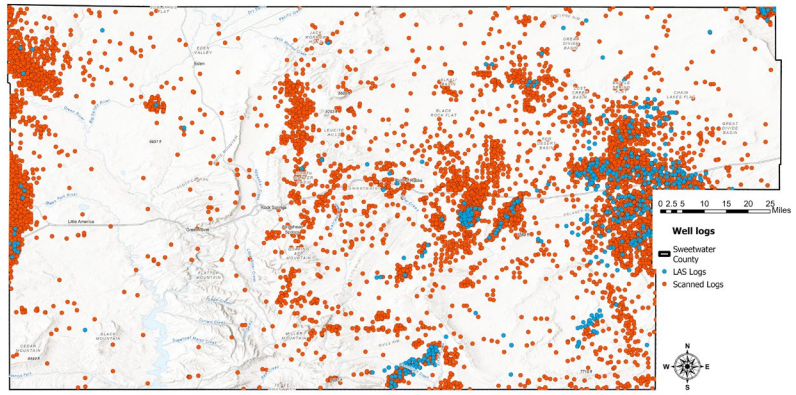
Water salinity



Seismic events



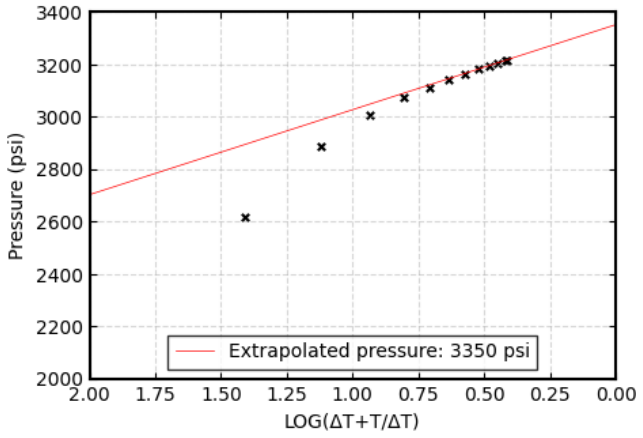
Well logs



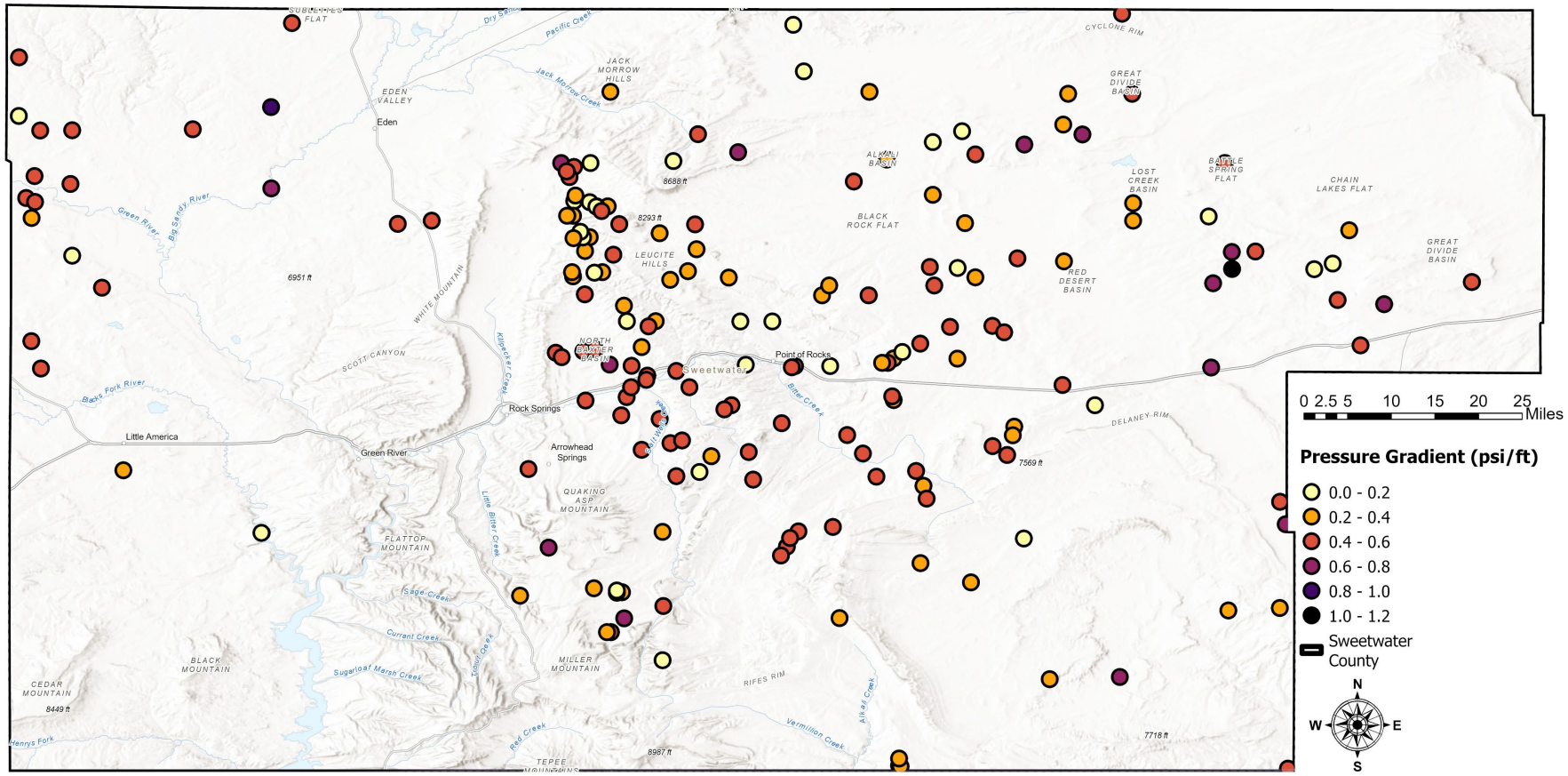
Formation pressures and pressure gradients

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

Horner analyses performed, calculated pressure gradient



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



Data: Wyoming Oil and Gas Conservation Commission

Formation pressures and pressure gradients

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

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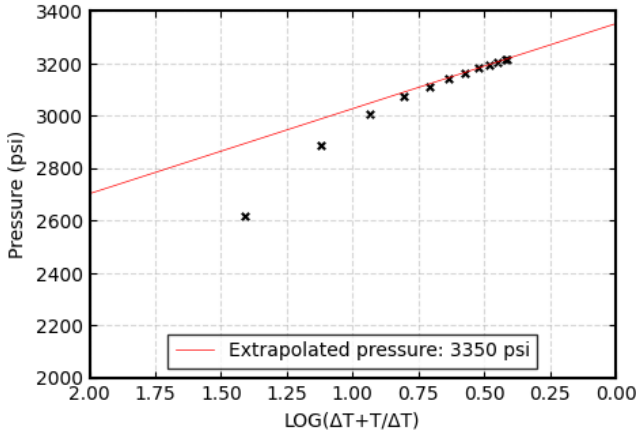
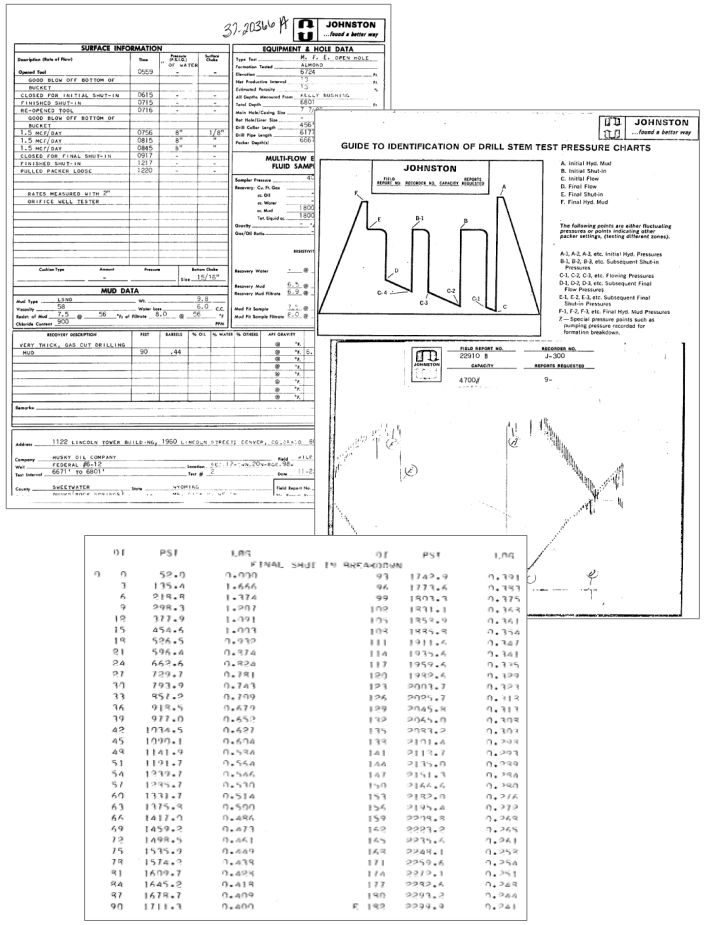
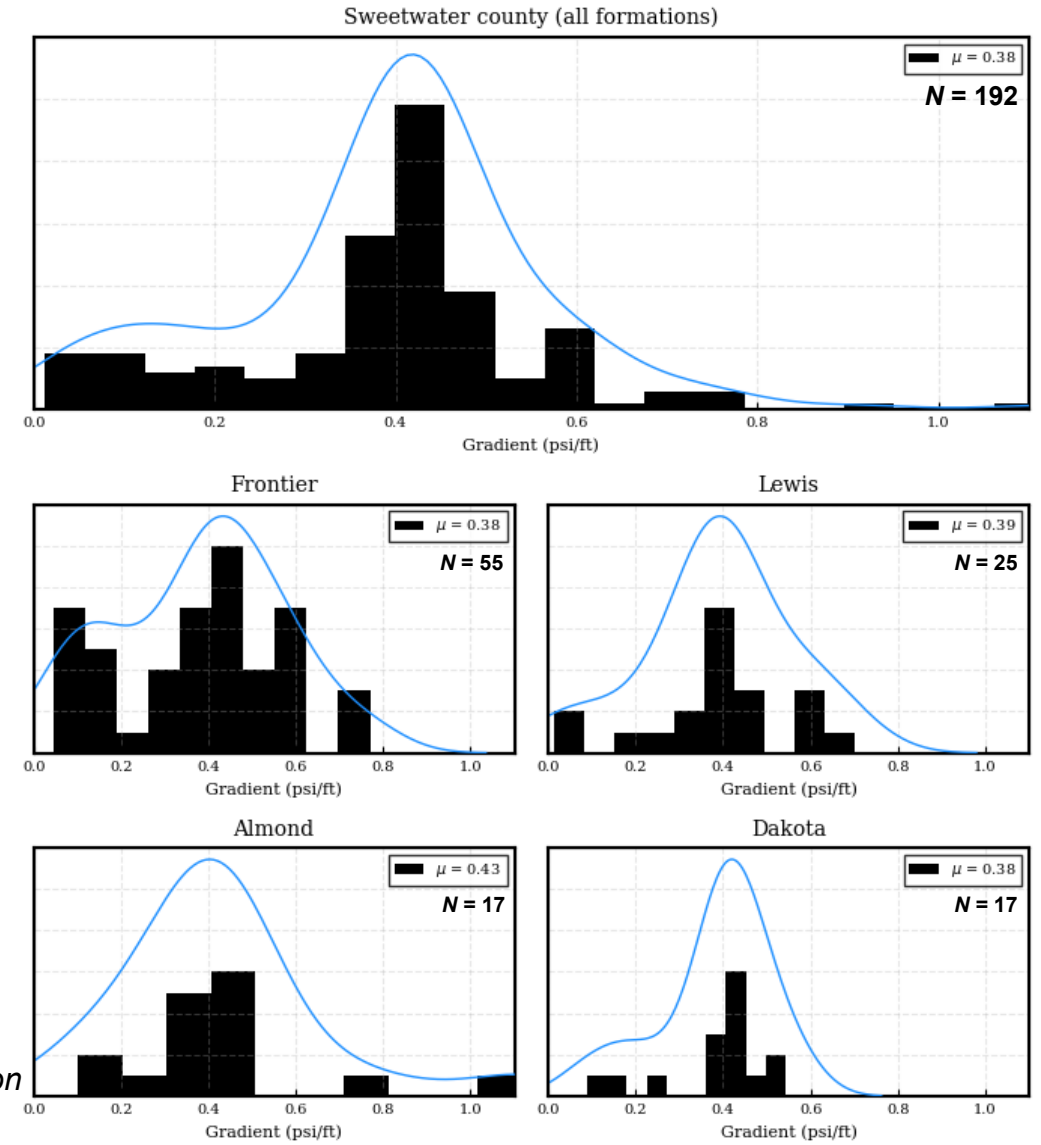






Data: Wyoming Oil and Gas Conservation Commission

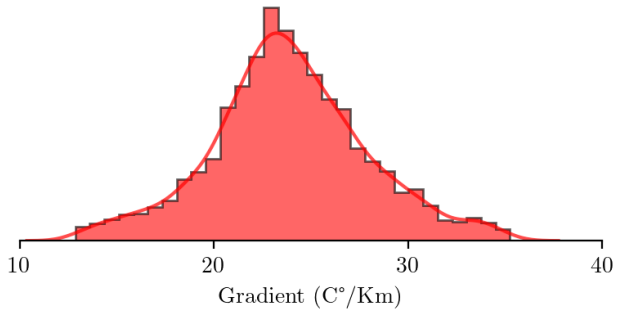
Formation temperatures and temperature gradients

N = 2764 temperature measurements compiled, gradients calculated

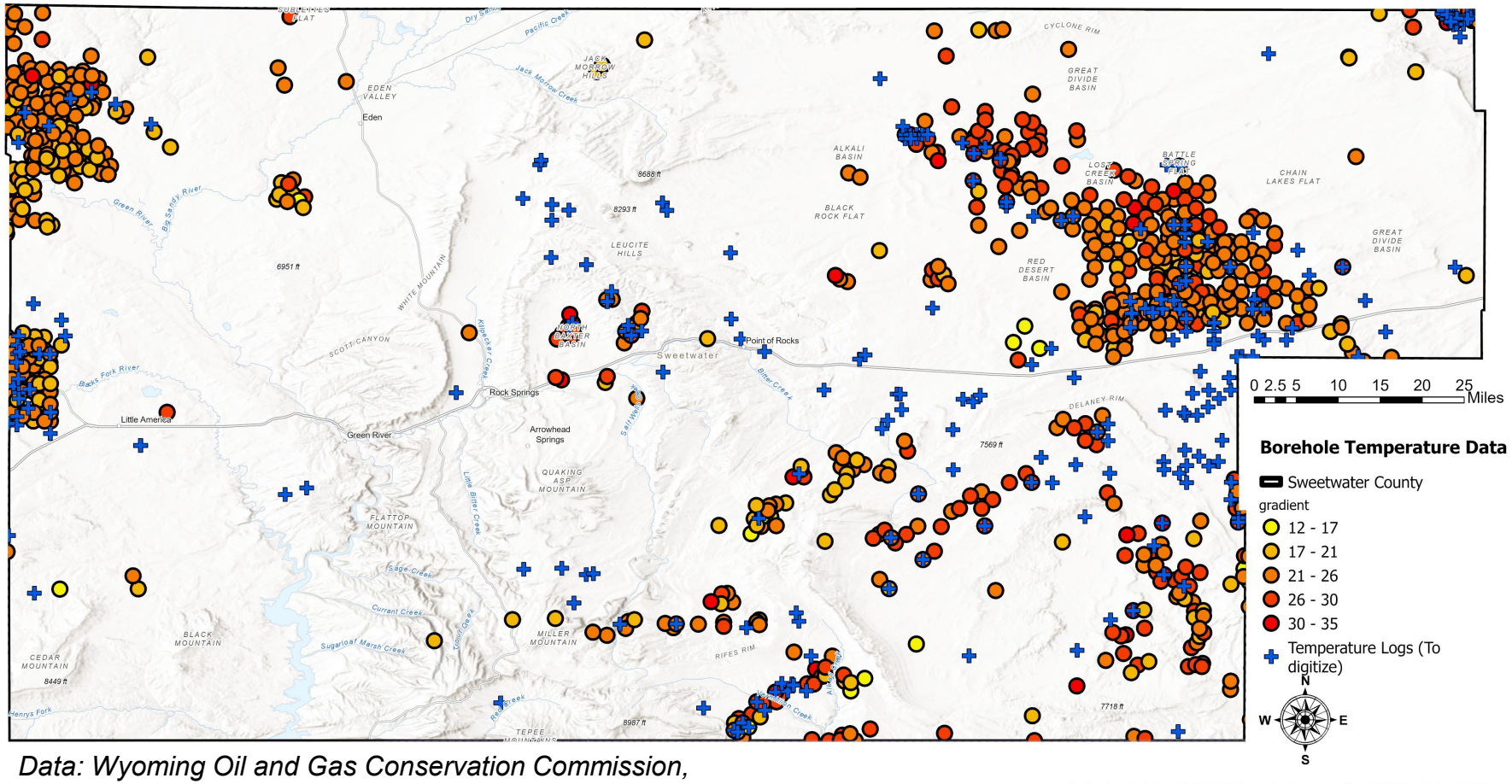
N = 245 temperature logs (to be digitized)

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

$\mu = 23.85,\ \sigma = 4.05$



Subsurface temperature gradient, and available temperature logs (raster)



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

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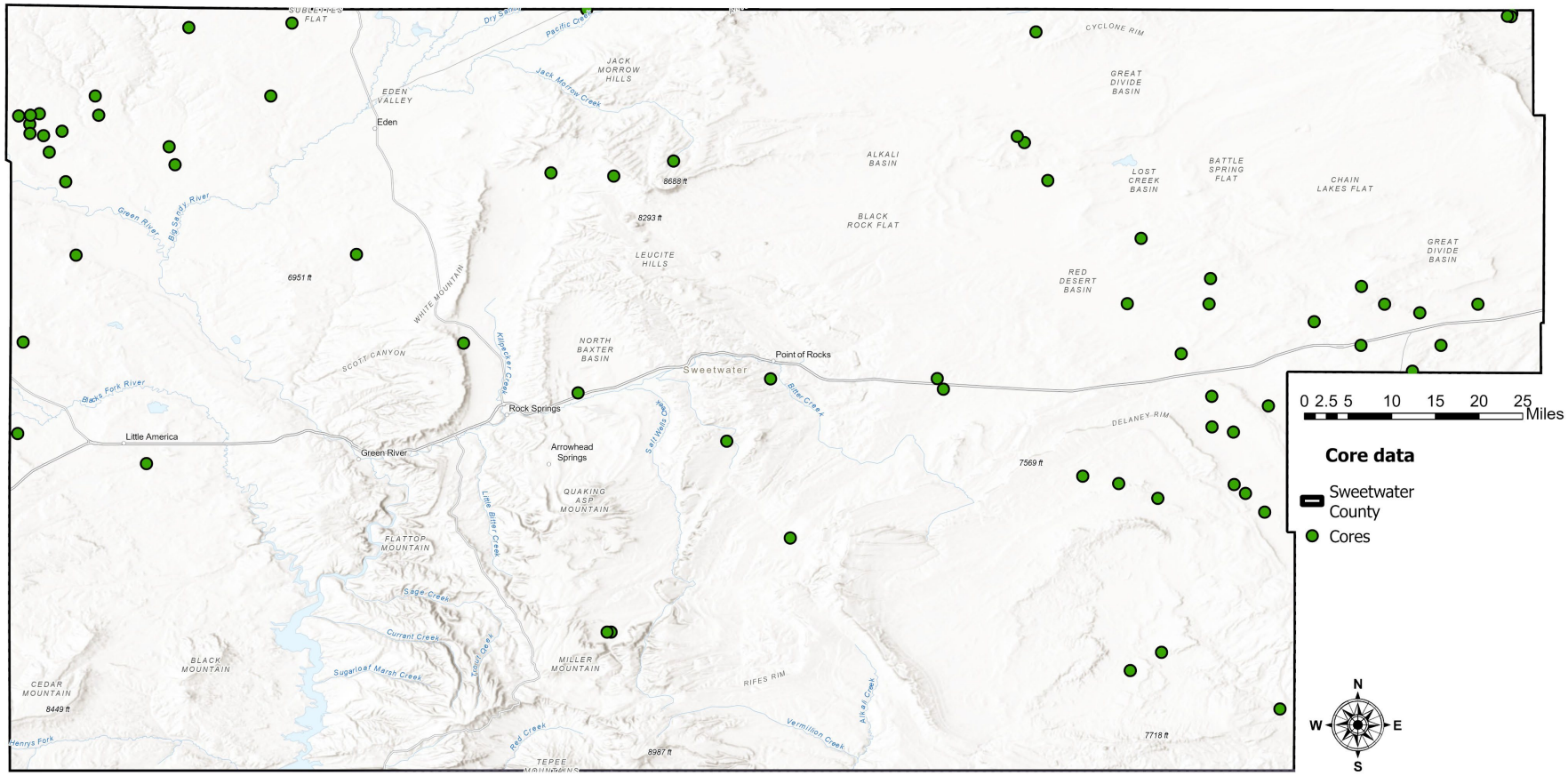
Core data

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

- Porosity (φ)
- Permeability (k)
- Grain density (ρ)
- XRD mineralogy

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



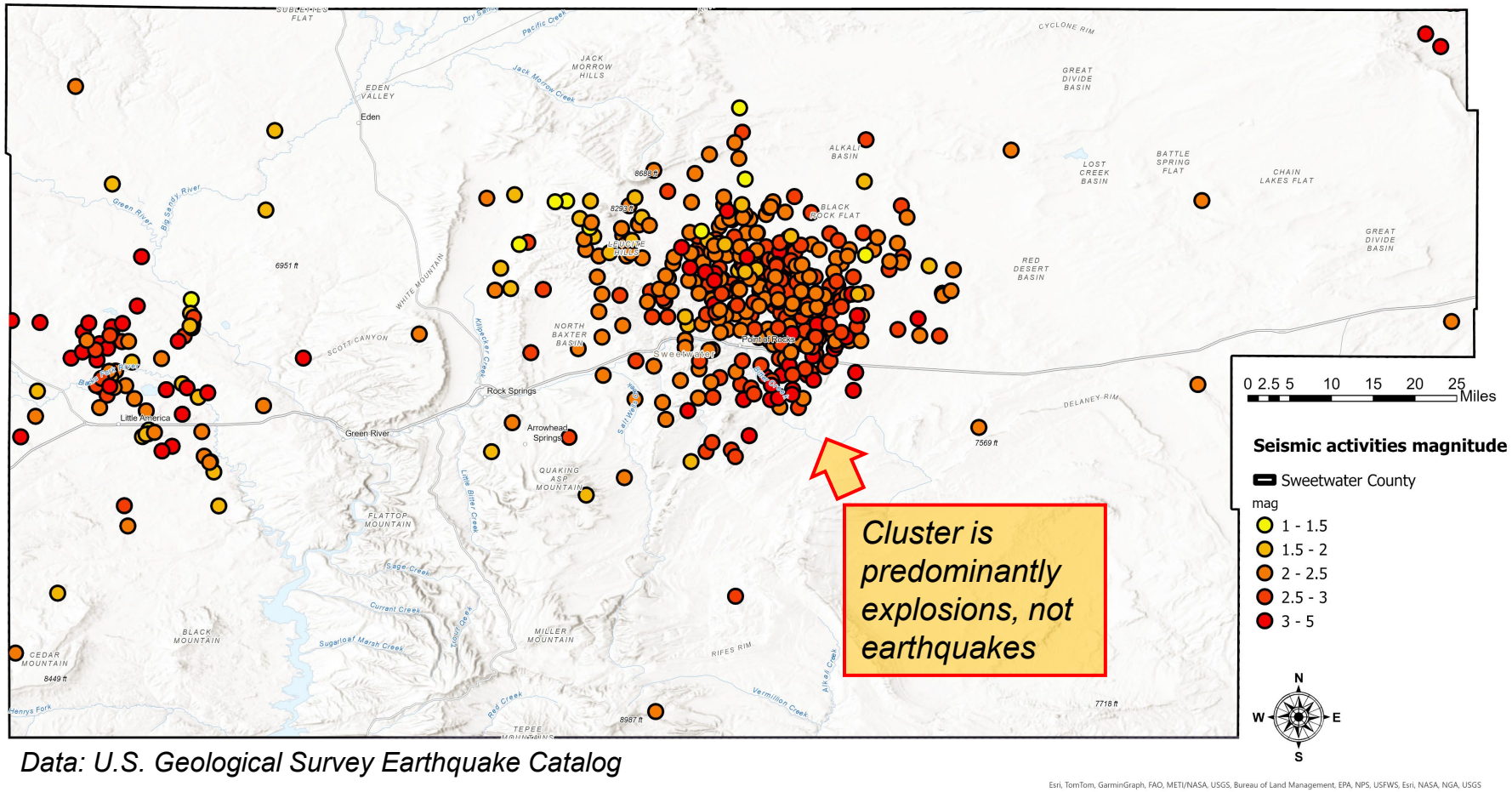
Data: United States Geological Survey Core Research Center

Seismic events

N = 743 seismic events

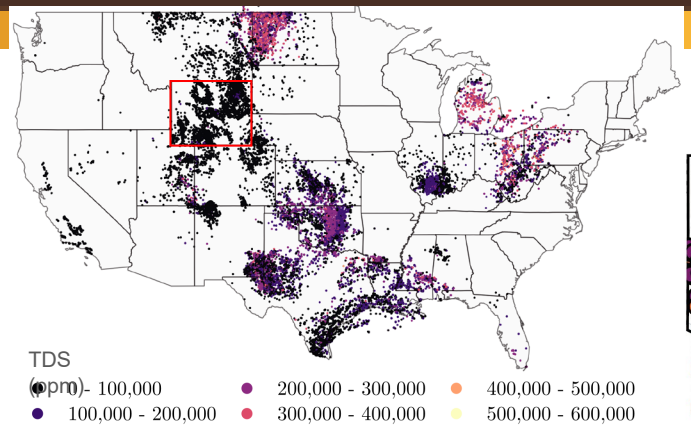
Years 1973 – 2024,
Magnitude 1.0 and above

Spatial distribution of historical seismic activities and their magnitude

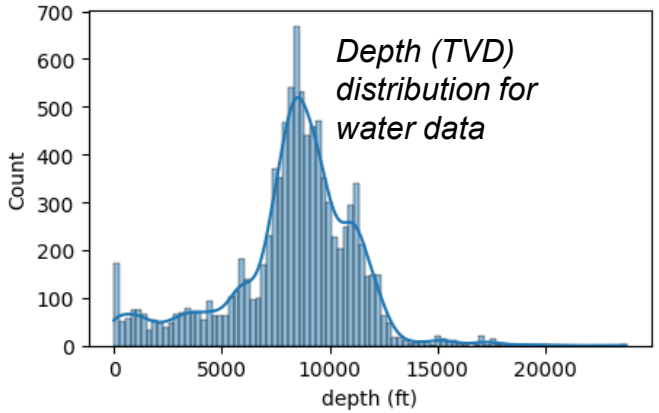


Data: U.S. Geological Survey Earthquake Catalog

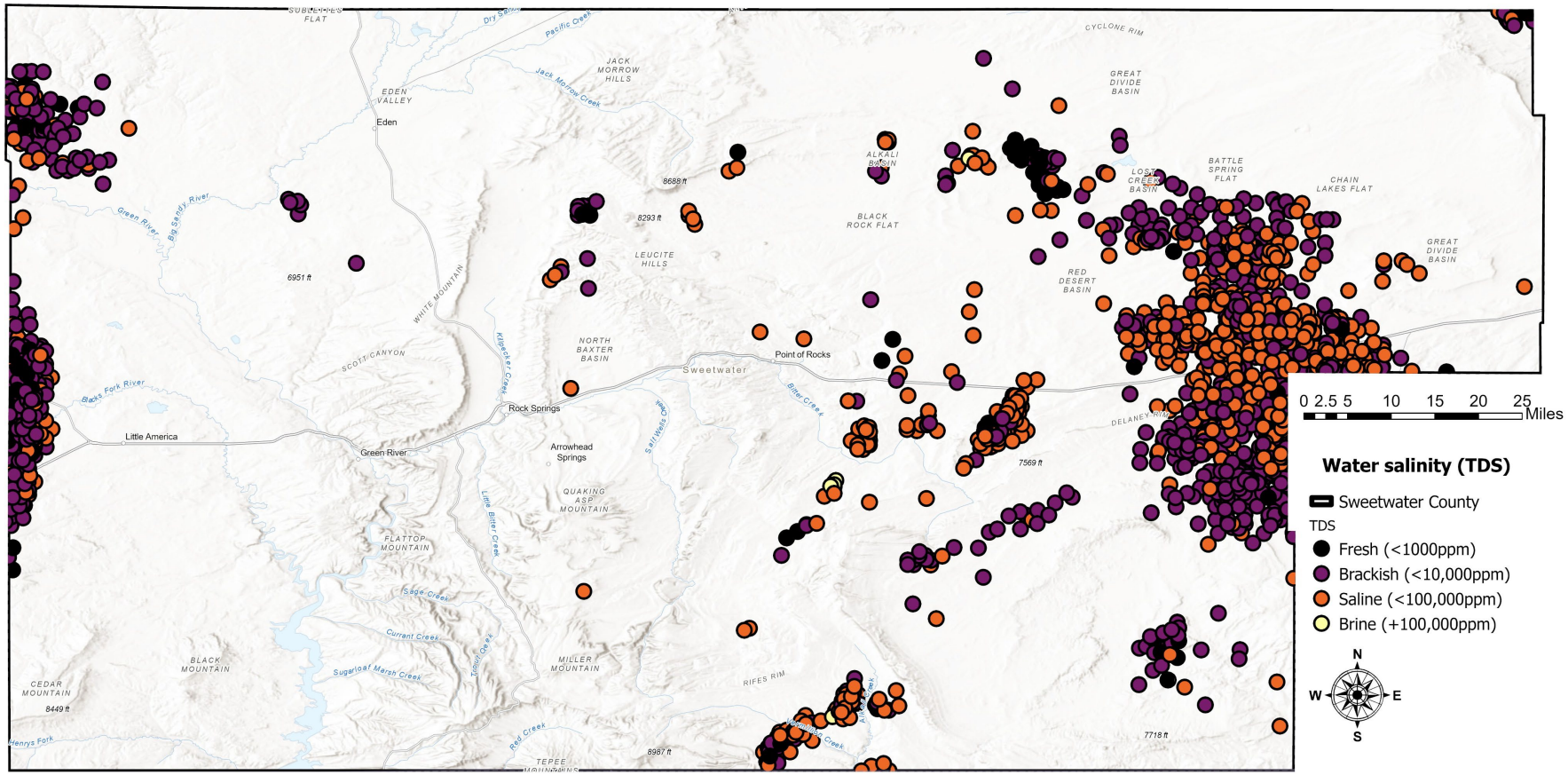
Water geochemistry



N = 2,389 data points compiled



Spatial distribution of water chemistry data, and groundwater salinity

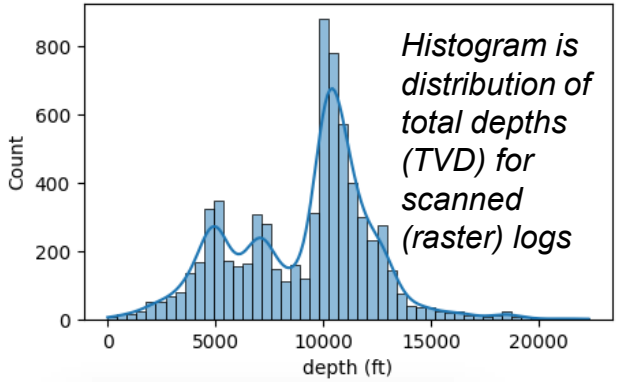


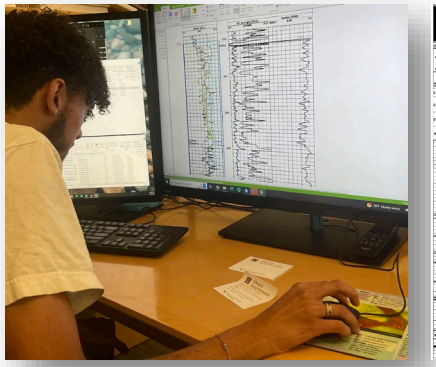
Data: U.S. Geological Survey National Produced Waters Geochemical Database, Wyoming Oil and Gas Conservation Commission

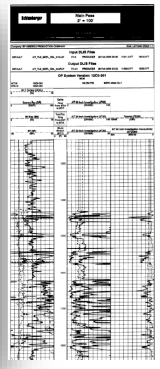
Well logs

N* = *1,070 LAS files
for ***n* = 769** wells

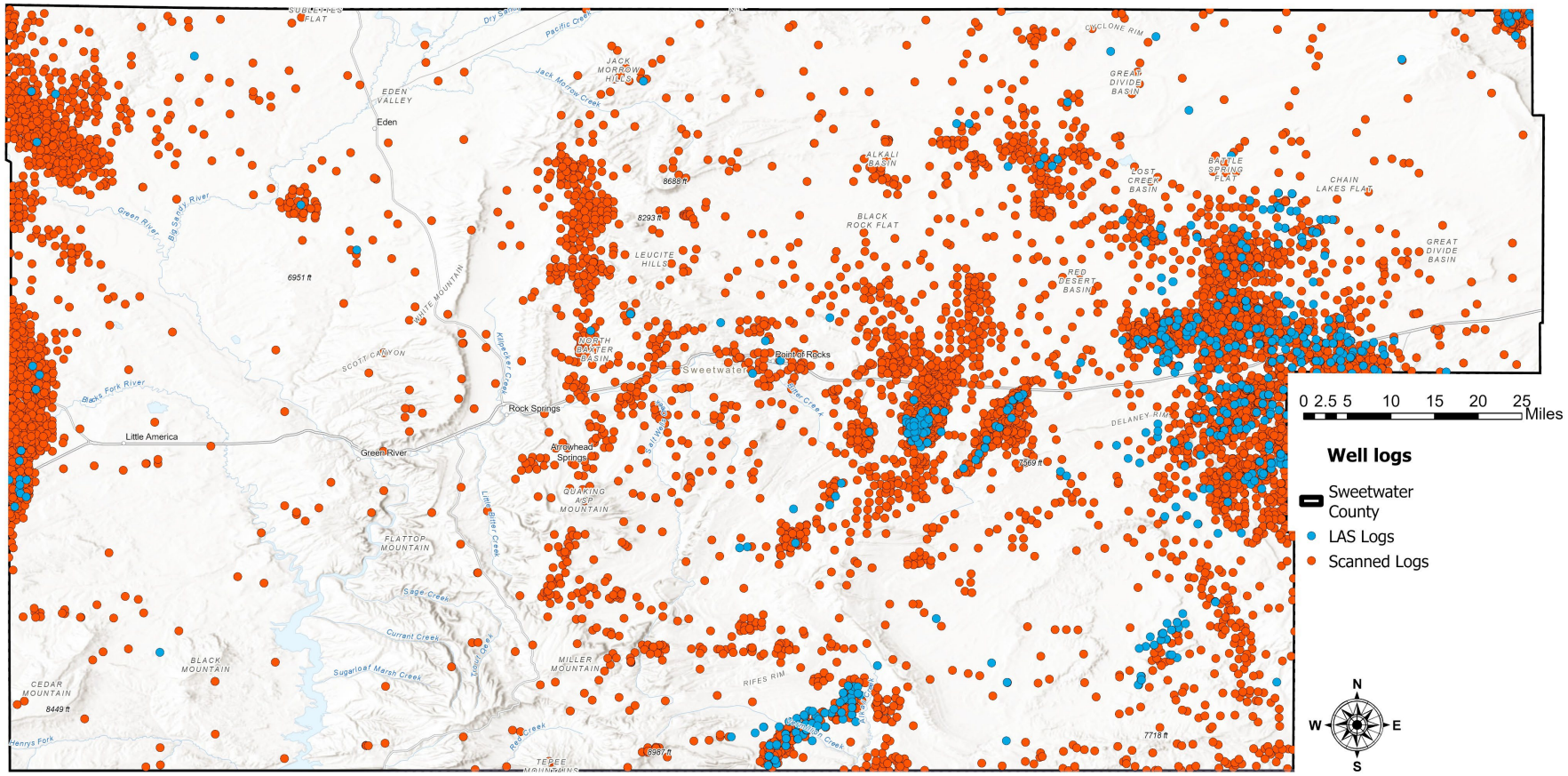
***N* = 20,807** scanned logs
for ***n* = 7,188** wells







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



Data: Wyoming Oil and Gas Conservation Commission

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WERL Wyoming Energy Resource Library

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

James Amato
CEGR Research Professional

- (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!

Enhanced Oil Recovery Institute

Student development and training

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

Junior Grimes (center)
Senior, Environmental Science and Geology

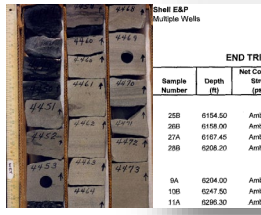
Graduate Research Assistant:
Abdeldjalil Latrach (right)
Ph.D. Candidate, Petroleum Engineering

Minerals in weight %

		Feldspars			Carbonates				Sulfide	Mafic	Clays						
Depth	Quartz	Albite	Anorthite	Orthoclase	Calcite	Dolo.	Ankerite	Siderite	Pyrite	Hornblende	Muscovite	Illite	Montmorillonite	Clinochlore	Kaolinite	Biotite	Glauconite
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	2.7	0.1	1.4
10,760.5	49.8	13.3	3.4	2.9	2.8	0.7	6.1	0.2	0.2	1.6	9.0	4.3	0.4	3.0	0.6	0.2	1.4
10,791.0	51.2	14.0	2.1	6.9	2.9	1.3	3.2	0.4	0.4	3.0	7.7	0.1	0.5	2.6	2.5	0.2	1.5
13,281.6	55.6	3.0	5.3	9.3	1.9	4.6	9.6	0.6	0.6	2.4	5.2	0.0	0.9	0.6	0.1	0.1	1.1
13,313.5	64.5	7.3	4.8	3.2	5.8	3.8	0.8	0.1	0.2	0.2	4.7	0.8	0.3	0.2	1.5	0.2	1.2
5,749.0	44.5	15.4	1.7	6.6	2.3	0.9	3.1	0.1	1.1	1.1	8.8	0.5	0.5	4.1	4.8	0.3	2.1
5,767.5	56.4	19.7	0.3	7.5	1.0	0.3	0.4	0.2	0.6	1.0	4.8	0.8	0.7	2.0	3.0	0.1	1.2
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	1.9	0.5	0.4
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	0.4	0.7	2.2
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	3.7	0.3	1.3

XRD data

Interns learning about the acquisition of XRD mineralogy data



Shell E&P
Multiple Wells
CL File No.: HOU-081208
Date: 04/06/09
Analyst(s): ML-JH

Core Lab

END TRIM POROSITY AND PERMEABILITY ANALYSIS

Sample Number	Depth (ft)	Net Confining Stress (psig)	Porosity (%)	Probe Permeability Klinkenberg (md)	Probe Permeability K90 (md)	Grain Density (g/cm3)	Footnote
Woods Steamboat Mount							
25B	6154.50	Ambient	5.79	0.025	0.061	2.[illegible]	
26B	6158.00	Ambient	3.29	<0.0001	0.0005	2.659	
27A	6167.45	Ambient	2.96	<0.0001	0.0007	2.657	
28B	6208.20	Ambient	16.29	2.54	3.28	2.723	(fl)
MFS Jacknife 2							
9A	6204.00	Ambient	5.07	0.016	0.005	2.671	(fl)
10B	6247.50	Ambient	10.81	9.83	11.7	2.675	(fl)
11A	6296.30	Ambient	6.15	0.091	0.176	2.651	(fl)

Lithology and Total Organic Carbon (TOC)

Arch Unit No.80-10-1 Sec 10/19N/98W

Sample Type	Lithology	TOC (wt%)
core	100% SILTSTONE- blk, dk gry, mod hd, slty-suc tex, carb, sme pyr	1.72
core	100% SHALE- blk, mod hd, brit, slty tex, plty, intrd coal mat, v carb	3.49

Core data

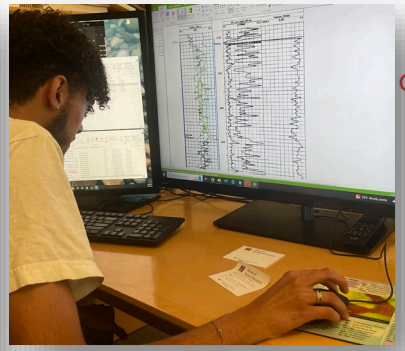
Field trip to see rock units where they are exposed at the surface (Seminoe Reservoir, WY)

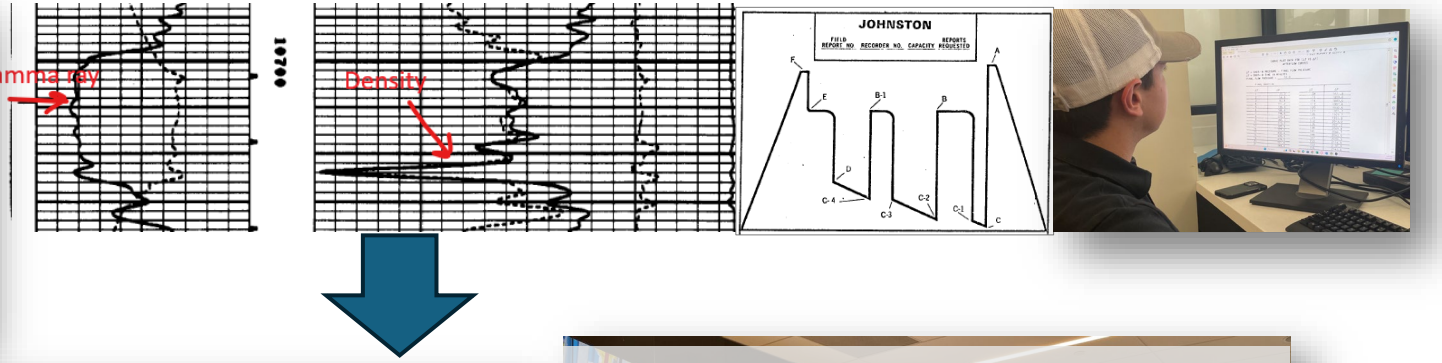
Student development and training

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

Making connections on the drilling 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[1], *JOHNSON, Matthew B.*[1], *LATRACH, Abdeldjalil*[2], *GRIMES, Demetrian*[3], *MARTINEZ, Christian*[4] *and MCLAUGHLIN, J. Fred*[1], *(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)

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Student co-authored conference abstract

Community Benefits and Impacts

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

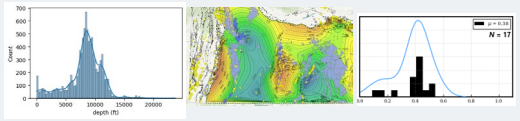
Lessons learned and next steps

Lessons learned

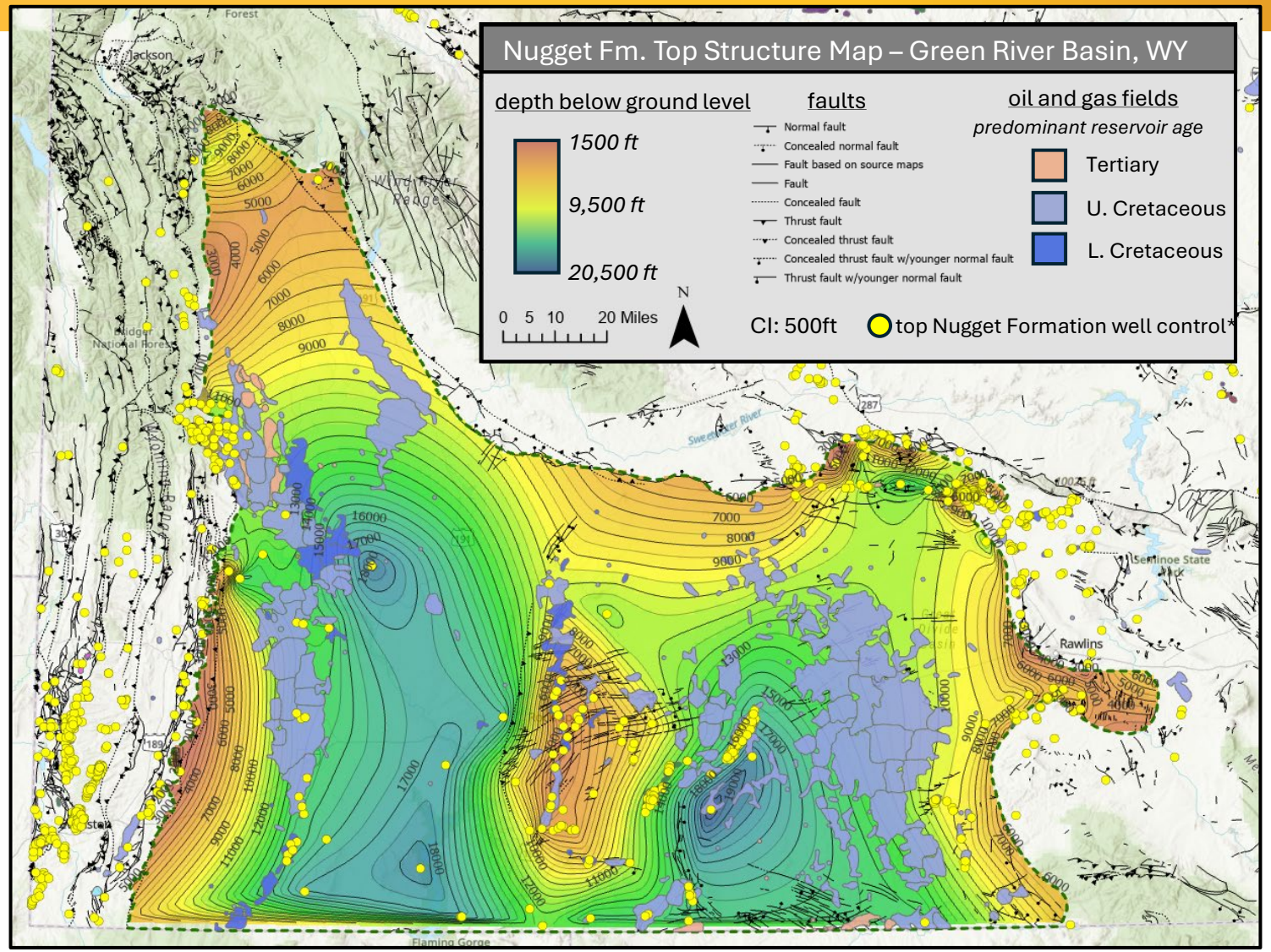
- *Data availability and quality*

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)

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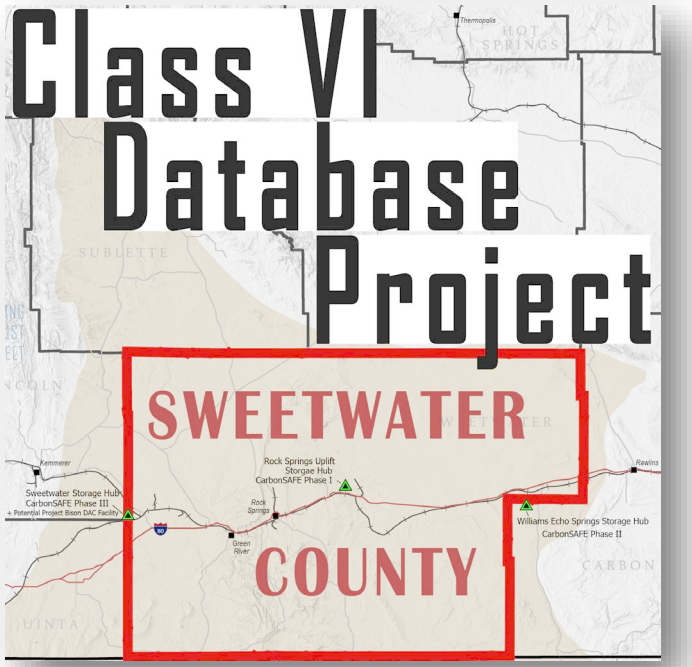
Next Steps: Wyoming Class VI Site Characterization Database

- *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.

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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 6th 2024

U.S. Department of Energy
National Energy Technology Laboratory

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THE WORLD NEEDS MORE COWBOYS.

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 7th 2024

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