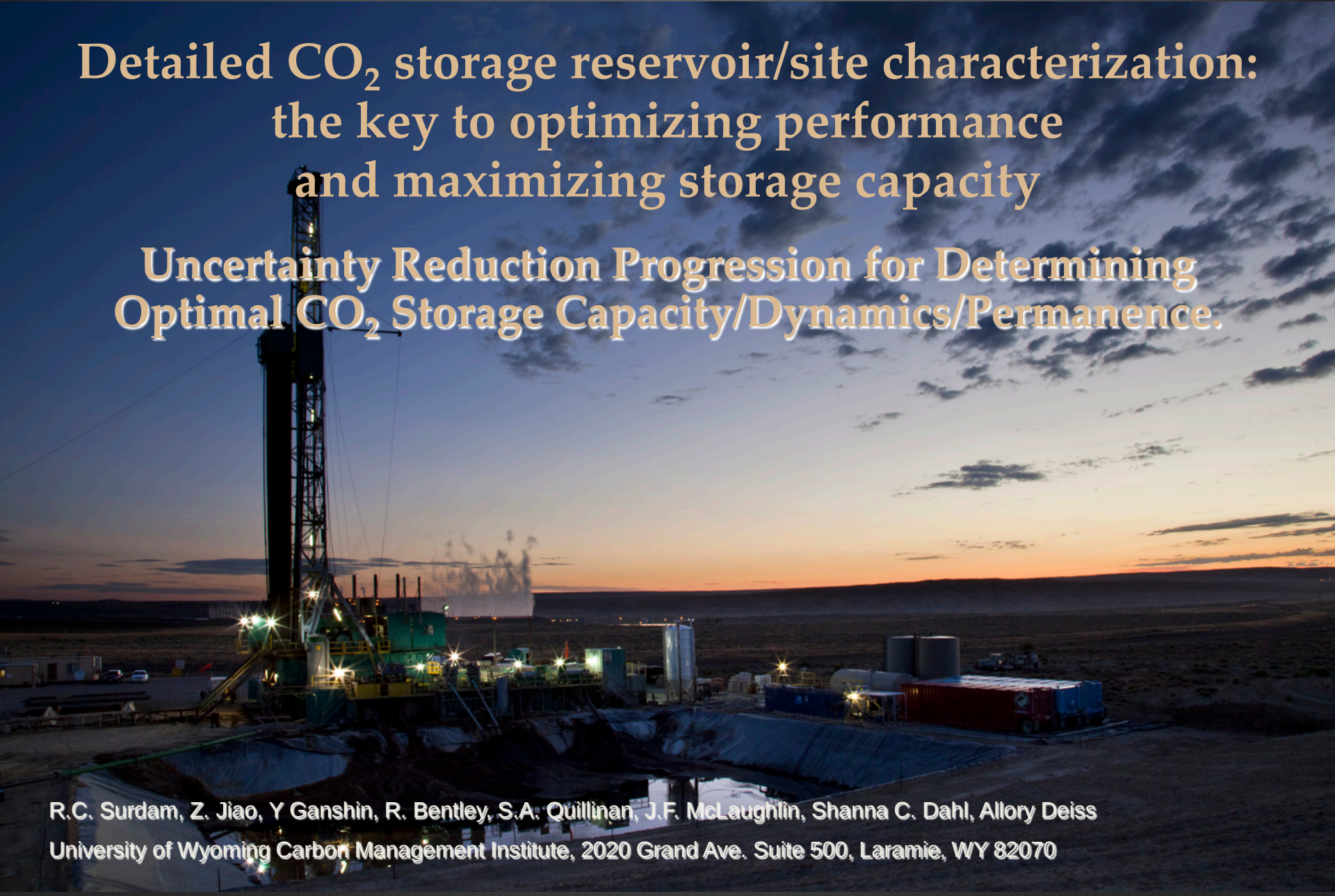
Detailed CO_2 storage reservoir/site characterization: the key to optimizing performance and maximizing storage capacity

Uncertainty Reduction Progression for Determining Optimal CO_2 Storage Capacity/Dynamics/Permanence.



R.C. Surdam, Z. Jiao, Y Ganshin, R. Bentley, S.A. Quillinan, J.F. McLaughlin, Shanna C. Dahl, Allory Deiss

University of Wyoming Carbon Management Institute, 2020 Grand Ave. Suite 500, Laramie, WY 82070

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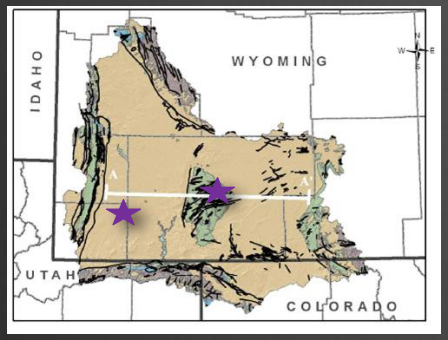
Wyoming Carbon Underground Storage Project (WY-CUSP) Goals

1. To improve estimates of CO_2 reservoir storage capacity at the premier CCUS site in Wyoming.

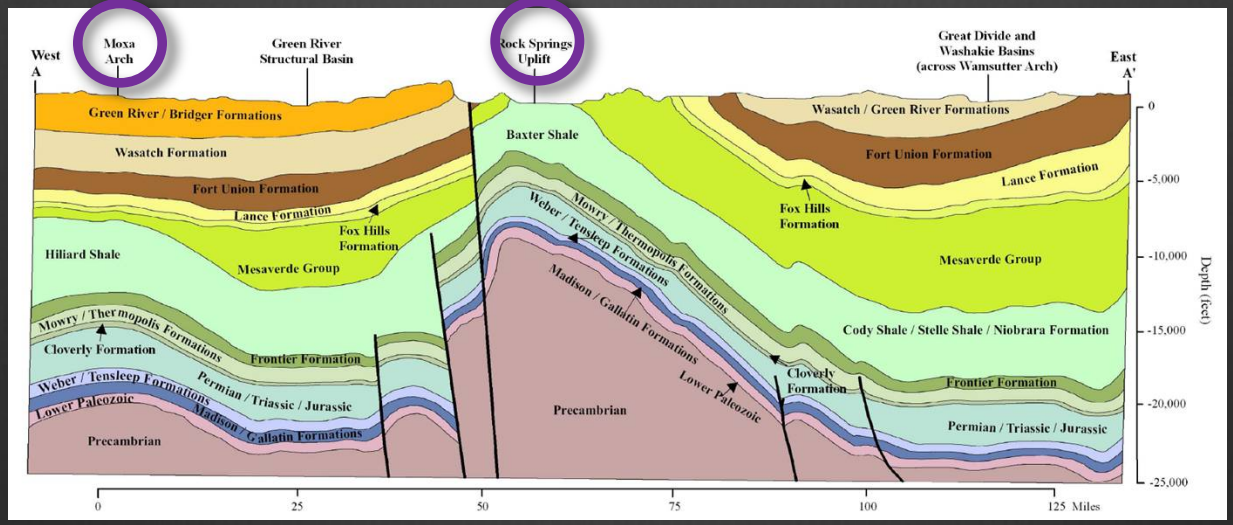
2. To evaluate the long-term integrity and permanence of confining layers at the Rock Springs Uplift.

3. To manage injection pressures and brine production in order to optimize CO_2 storage efficiency for the most significant storage reservoirs (Tensleep/Weber and Madison formations).

Carbon capture potential in southwest Wyoming



WSGS, UW, State, and DOE-funded research identified two high-capacity sites in southwest Wyoming: *Rock Springs Uplift* and *Moxa Arch*



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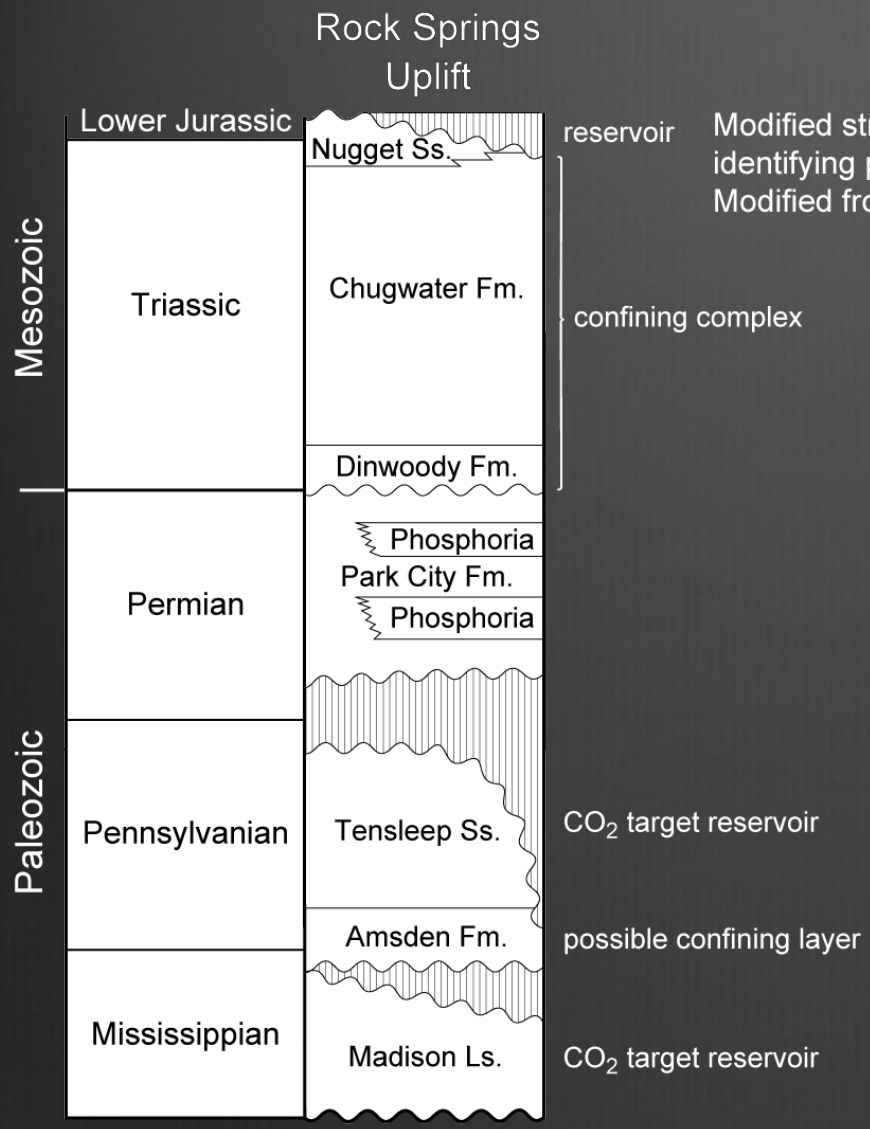

Modified stratigraphic column of the Rock Springs Uplift identifying possible confining layers and CO_2 target reservoirs. Modified from Love, Christiansen, and VerPloeg, 1993.

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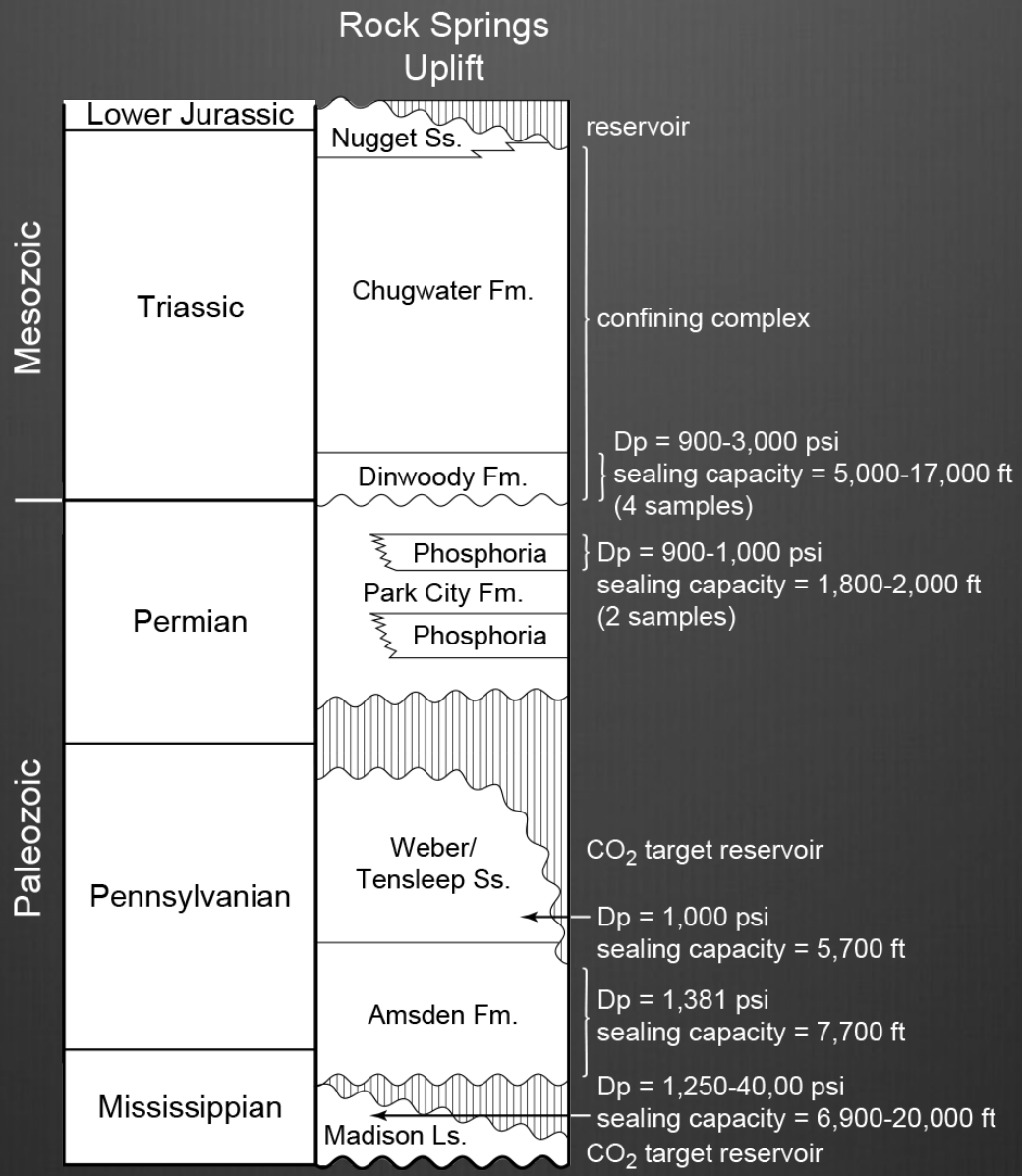
Primary Seals



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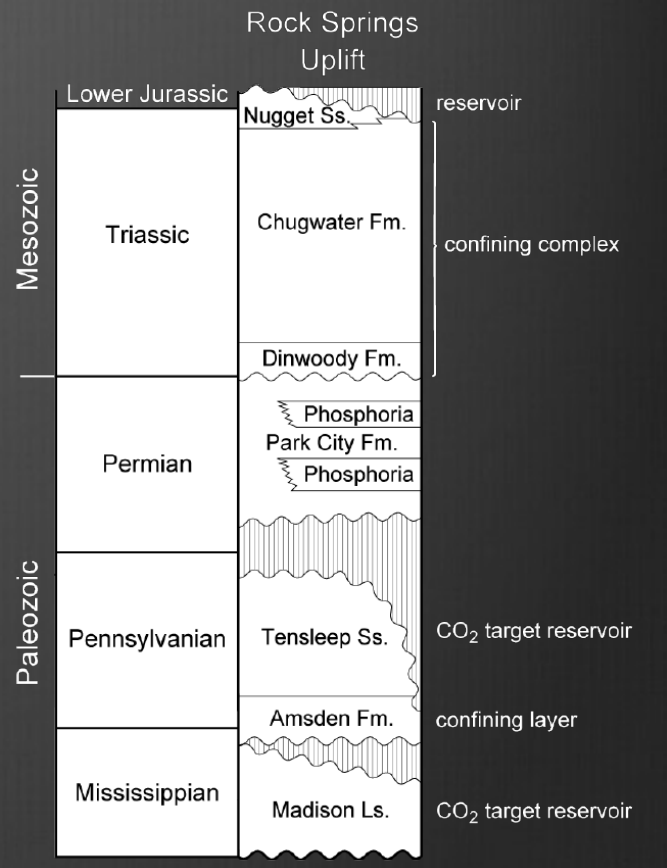
Madison

12,250.0 ft.

RSU-59

Porosity (Hg) = 0.66
Permeability = 0.001 mD
Displacement pressure = 1254 psi
Calculated CO_2 sealing capacity* = 6900 ft.
Scale bar = 200 microns

*Vavra et al., 1992



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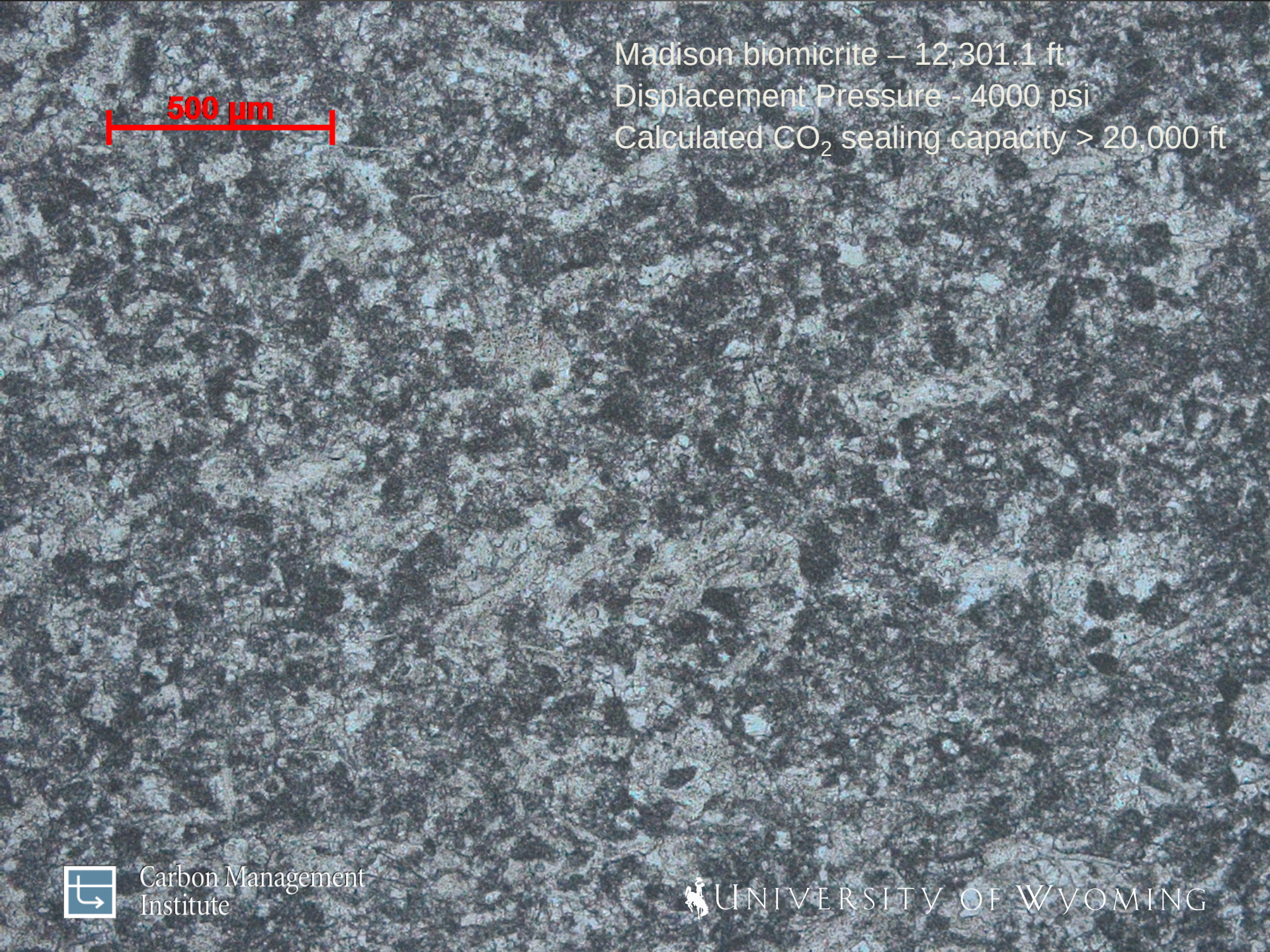

Madison biomicrite – 12,301.1 ft.
Displacement Pressure - 4000 psi
Calculated CO_2 sealing capacity > 20,000 ft

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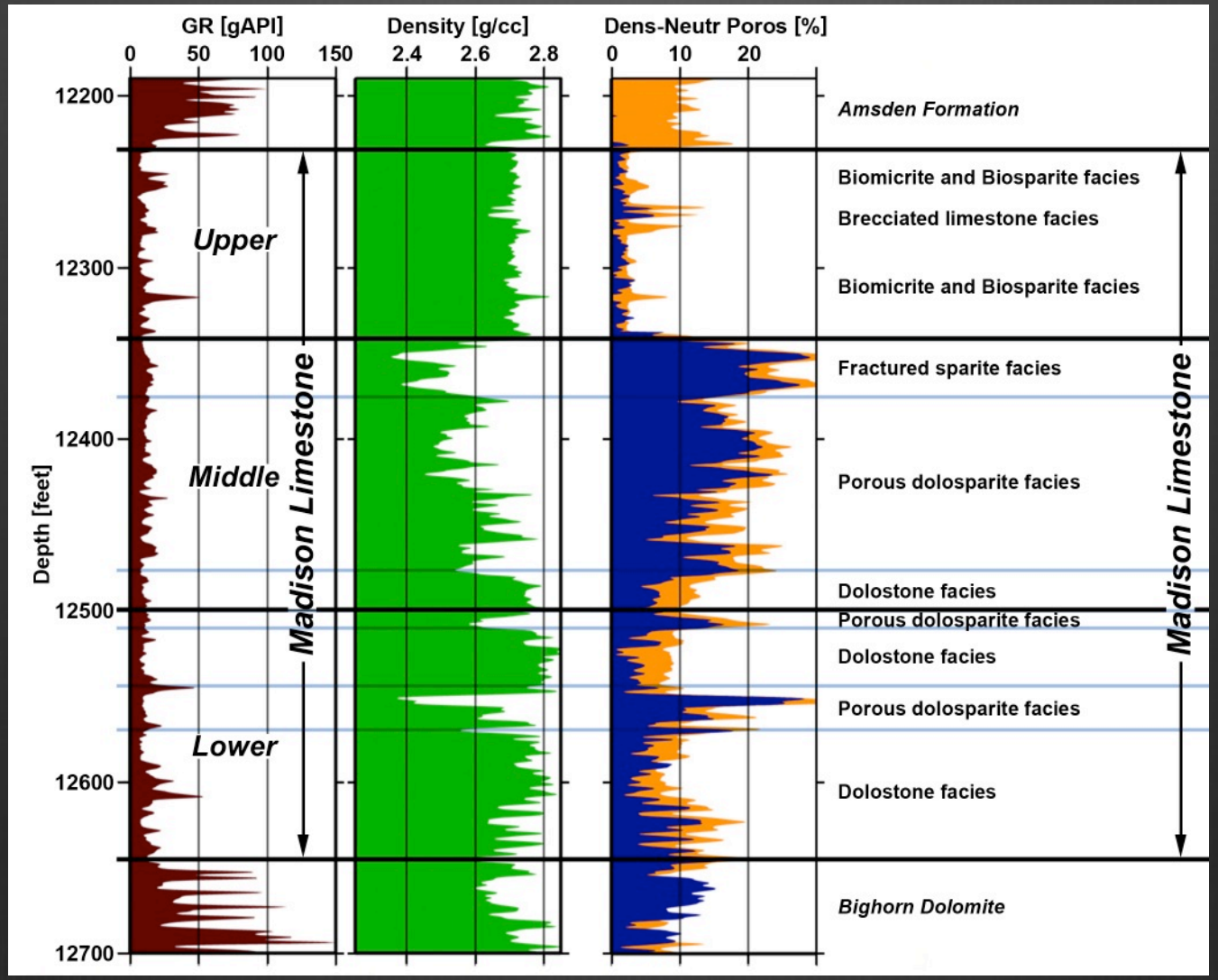
RSU-1 well: Madison Limestone Formation lithofacies zones



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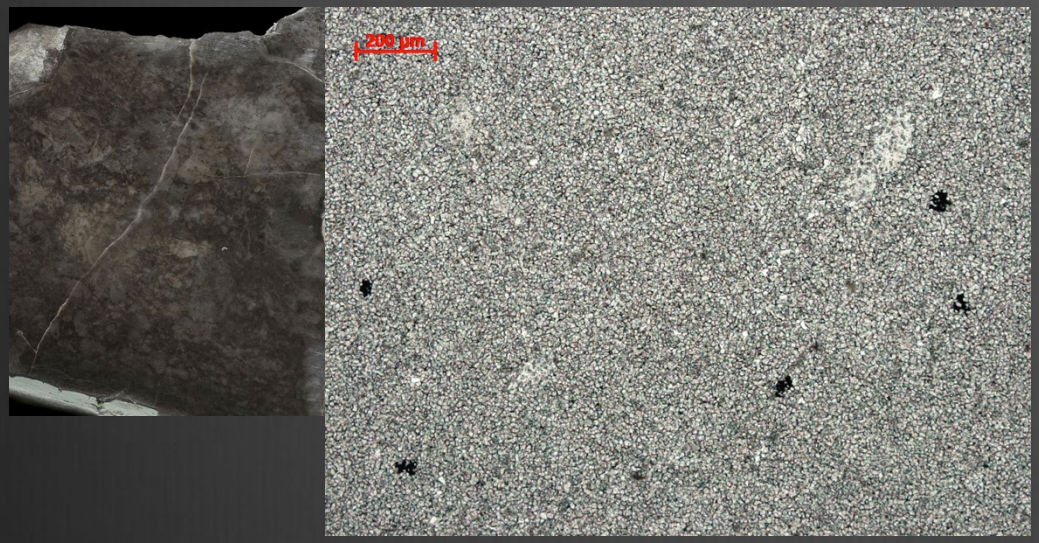
Amsden

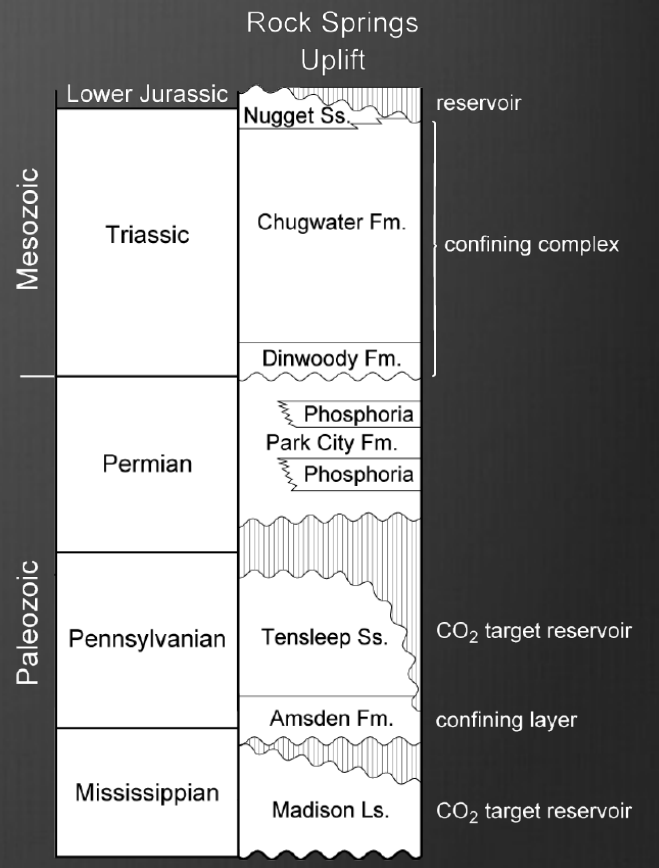
12,197.4 ft.



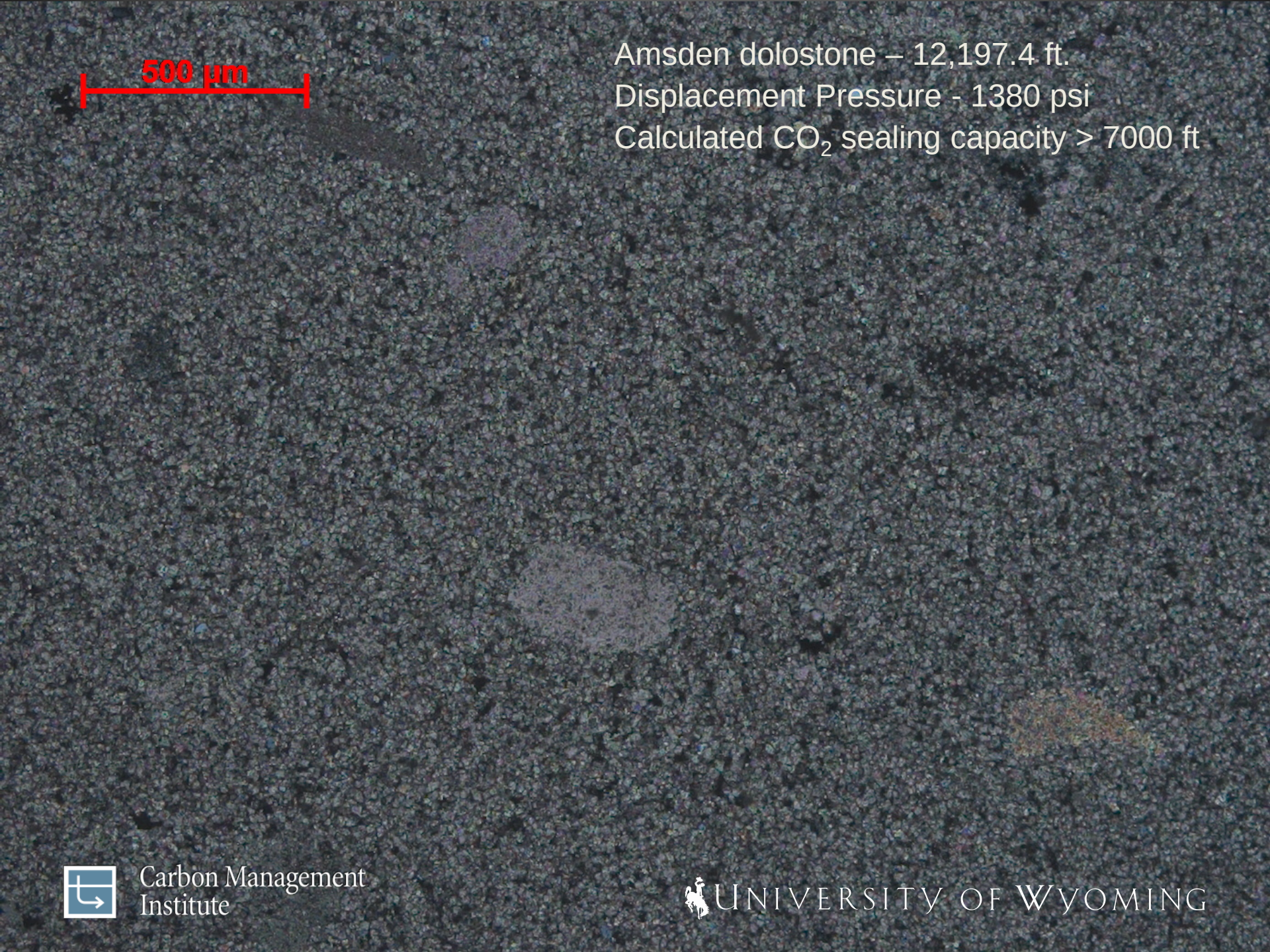
RSU-53

Porosity (Hg) = 3.06%
Permeability = 0.003 mD
Displacement pressure = 1381 psi
Calculated CO_2 sealing capacity* = 7700 ft.
Scale bar = 200 microns

*Vavra et al., 1992



Modified stratigraphic column of the Rock Springs Uplift identifying confining layers and CO_2 target reservoirs. Modified from Love, Christiansen, and VerPloeg, 1993.



Amsden dolostone – 12,197.4 ft.
Displacement Pressure - 1380 psi
Calculated CO_2 sealing capacity > 7000 ft

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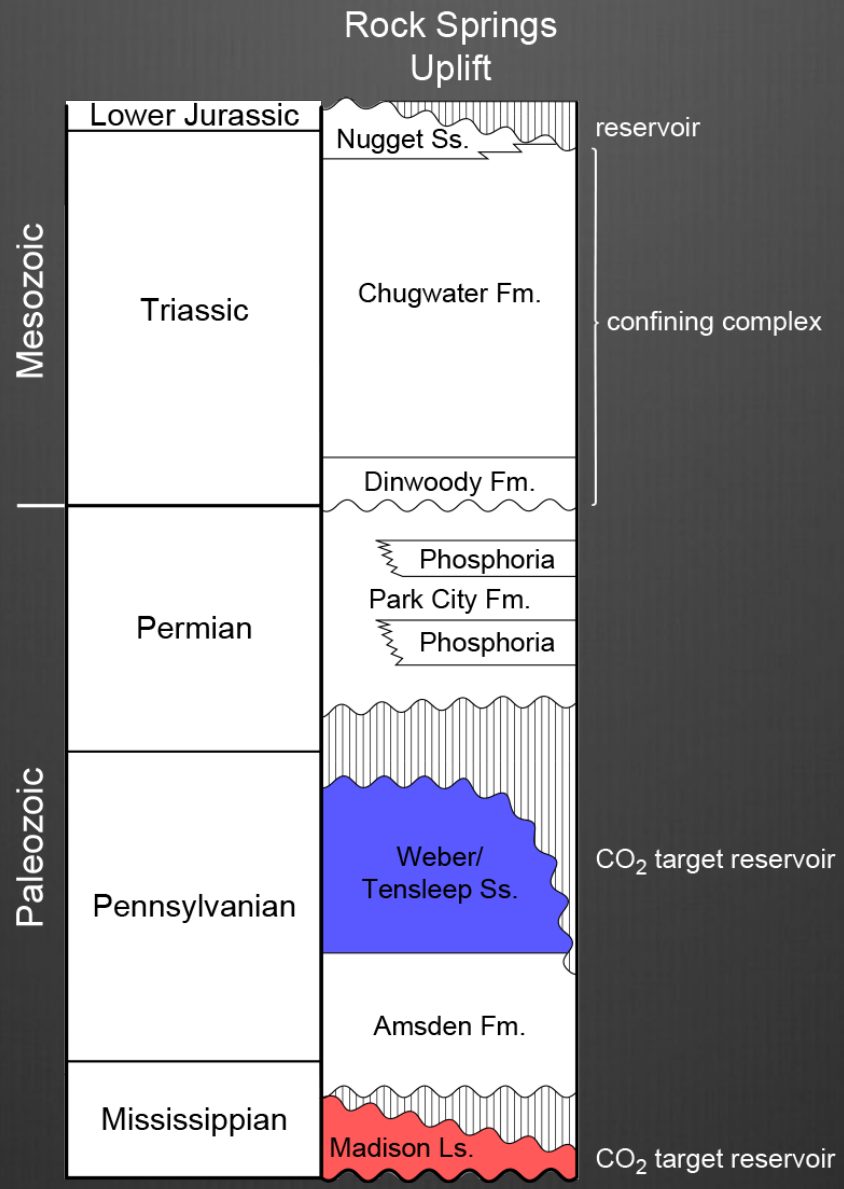
Reservoir Fluids



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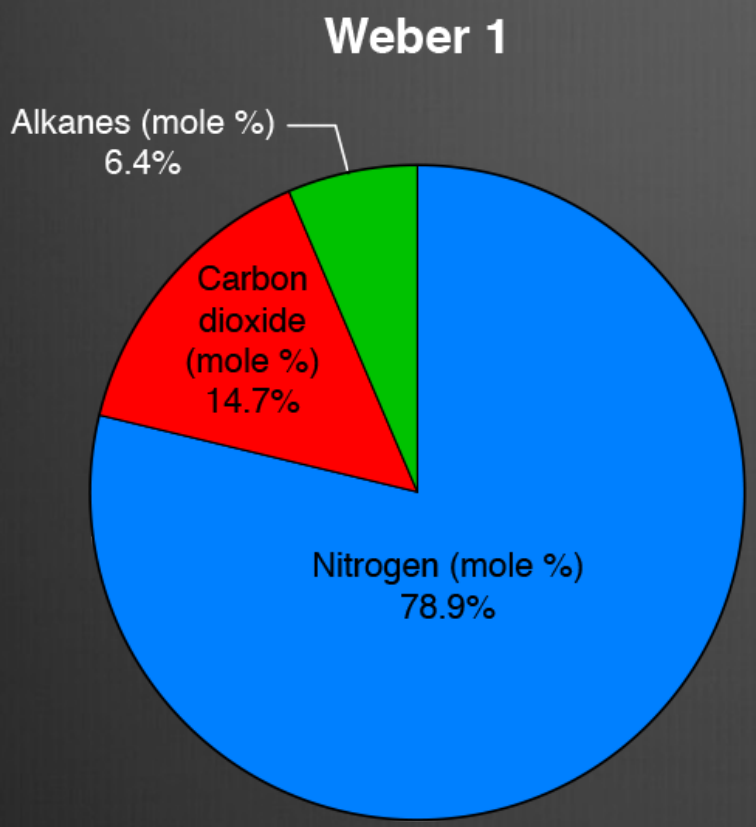
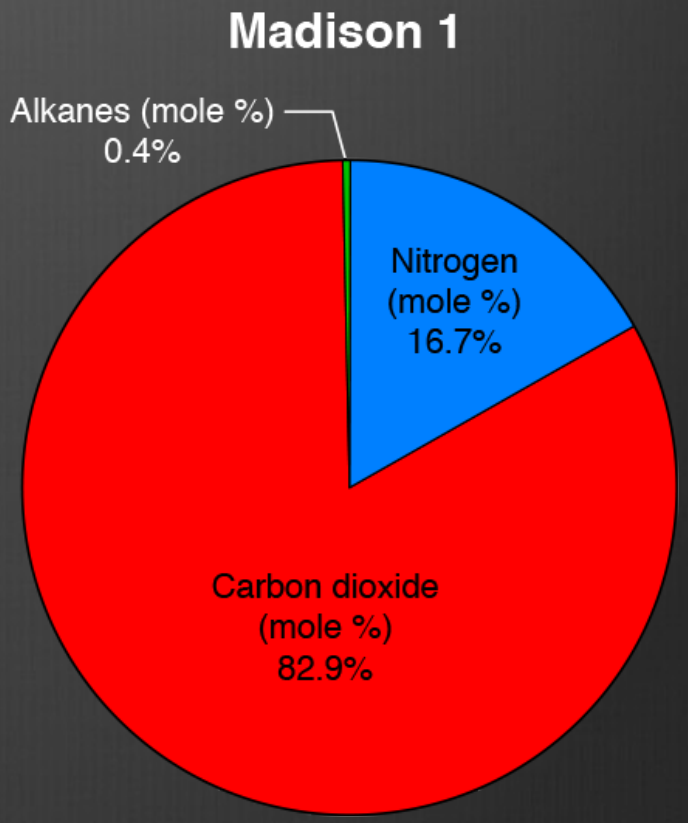
Dissolved Gas Composition of Reservoir Fluids





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Dinwoody

10,601.9 ft.

RSU-01

Porosity (Hg) = 0.64%
Permeability = 0.005 mD
Displacement pressure = 940 psi
Calculated CO_2 sealing capacity* = 5000 ft.
Scale bar = 200 microns

10,682.1 ft.

RSU-18

Porosity (Hg) = 0.85%
Permeability = 0.003 mD
Displacement pressure = 1521psi
Calculated CO_2 sealing capacity* = 8500 ft.
Scale bar = 200 microns

***Vavra et al., 1992**

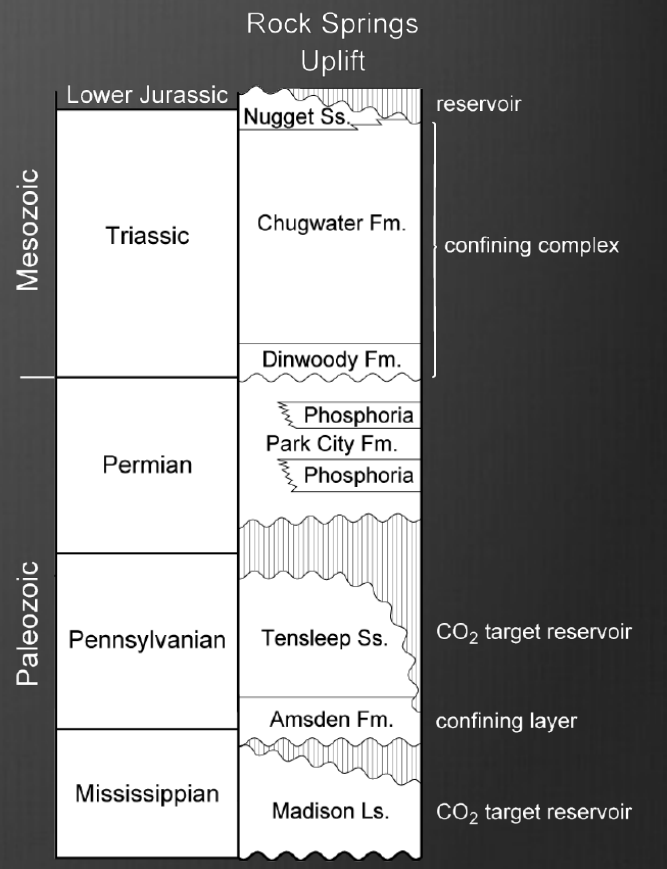
Dinwoody

10,656.4 ft.

RSU-16

Porosity (Hg) = ND
Permeability = <0.001 mD
Displacement pressure = 3000 psi
Calculated CO_2 sealing capacity* = 16,000 ft.
Scale bar = 200 microns

*Vavra et al., 1992



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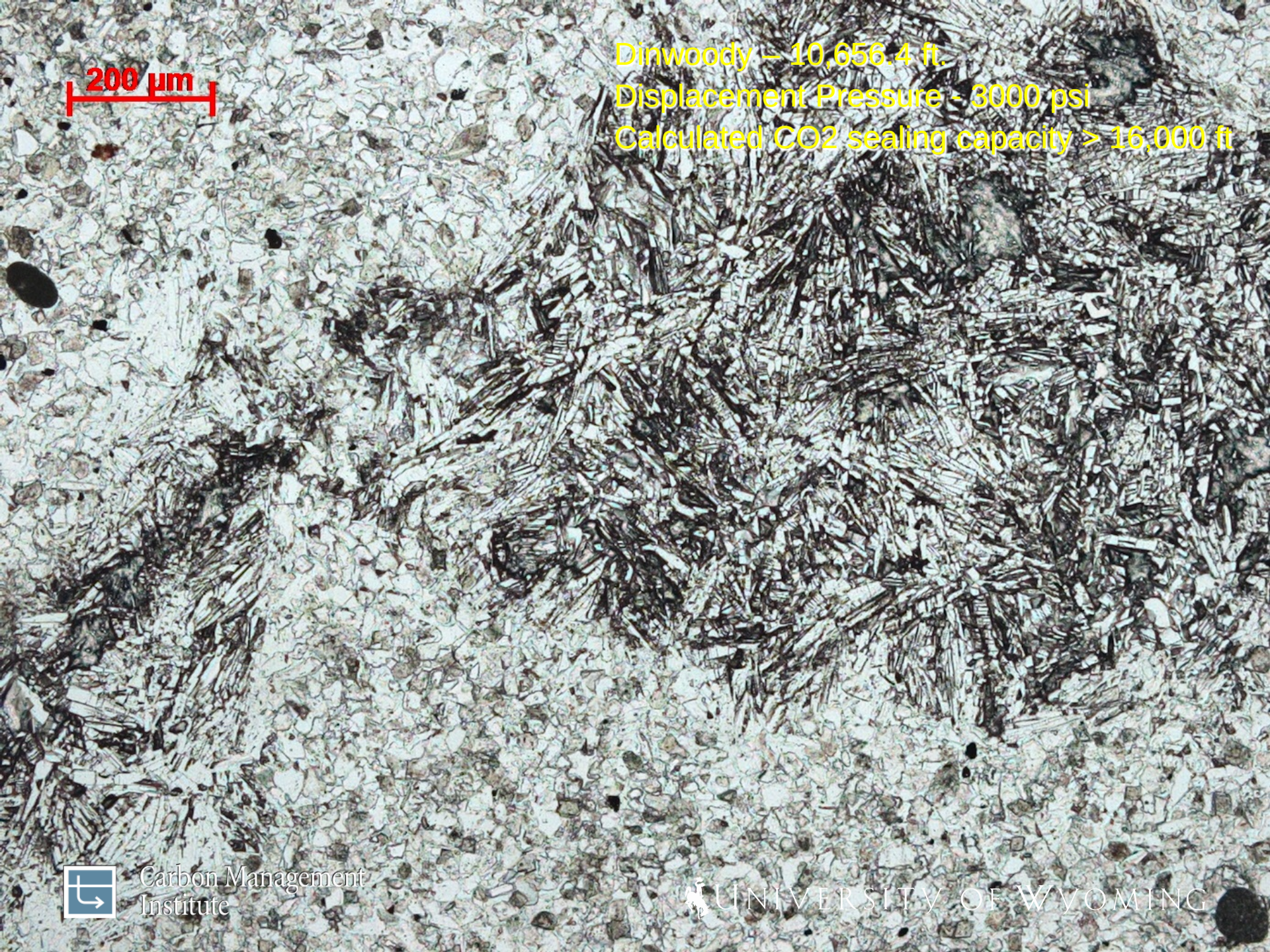

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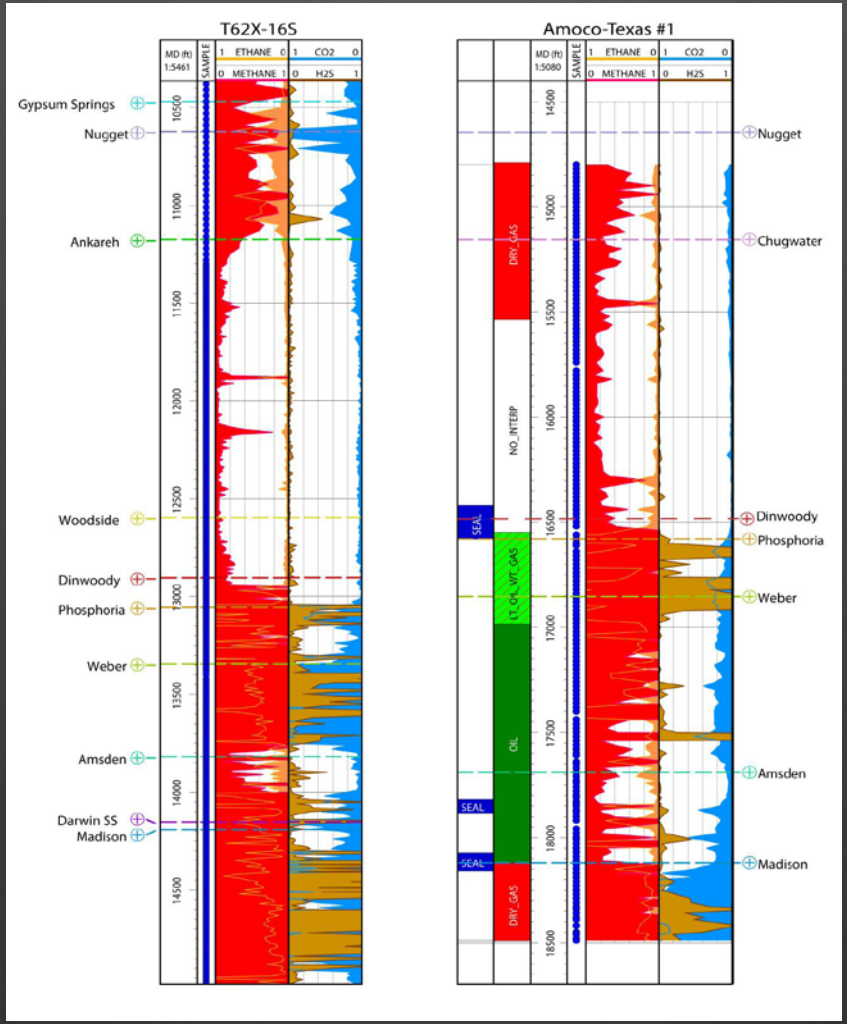
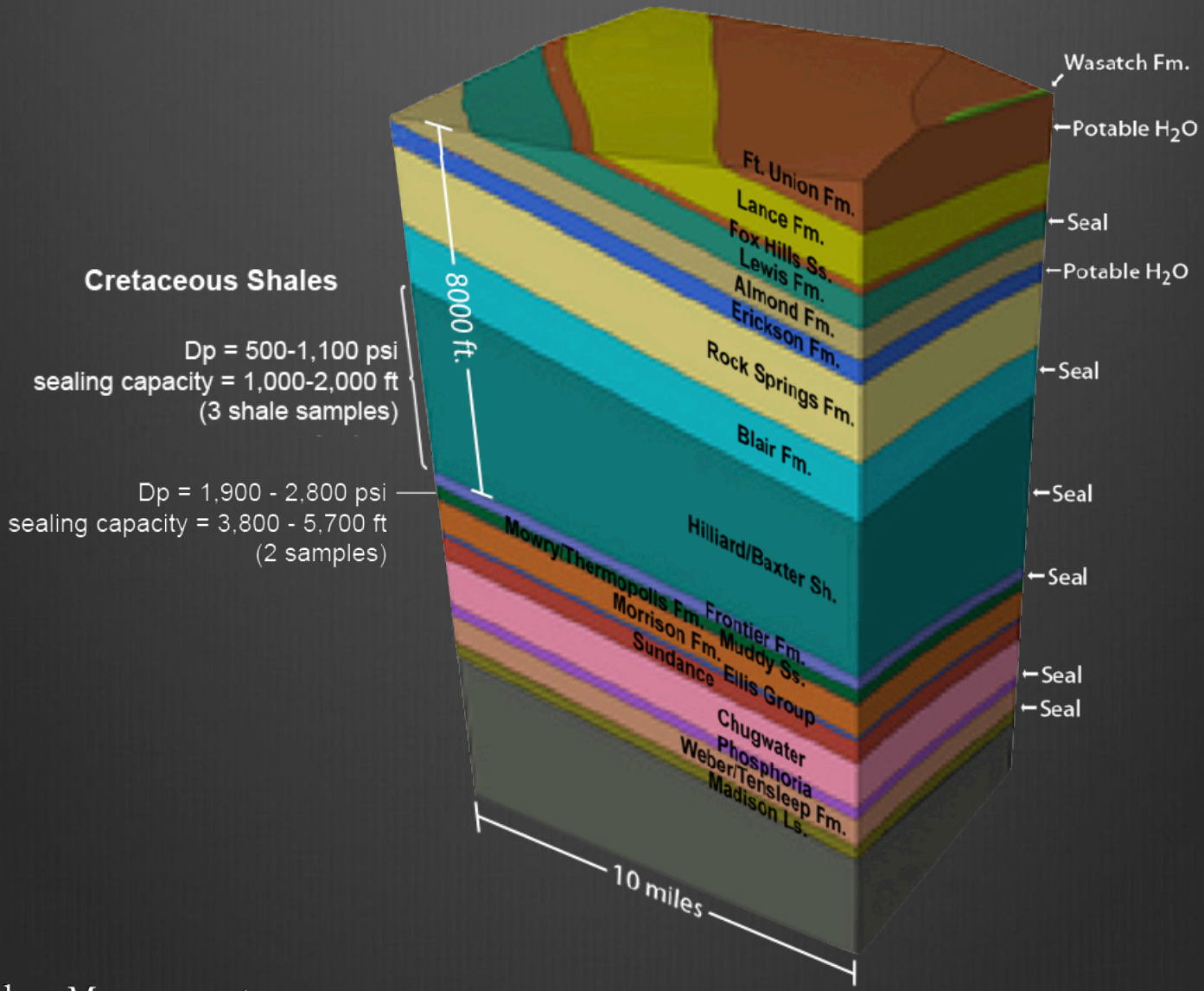


From Erin Campbell-Stone et al., 2010

Rock Springs Uplift hydrostratigraphic system



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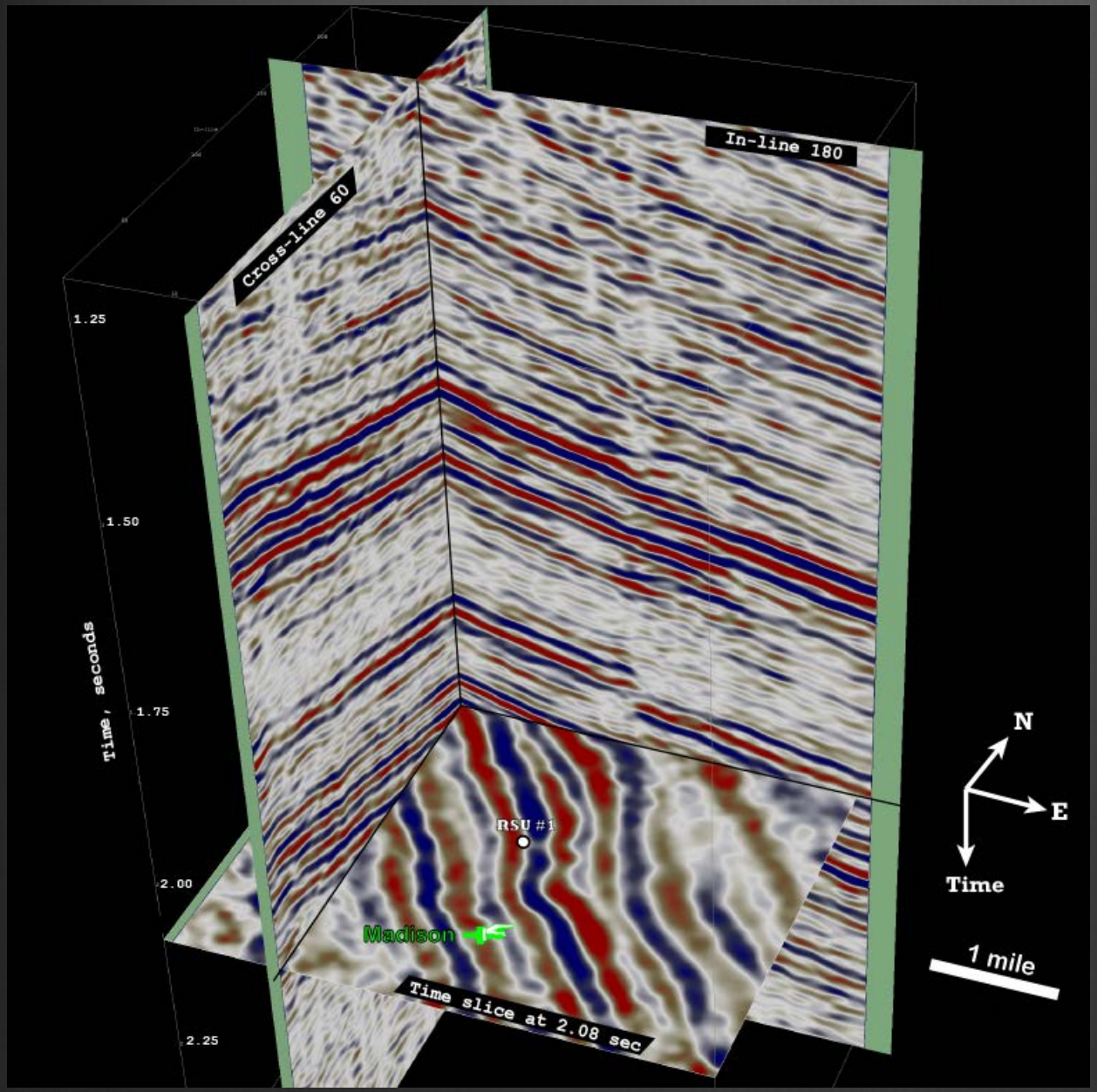
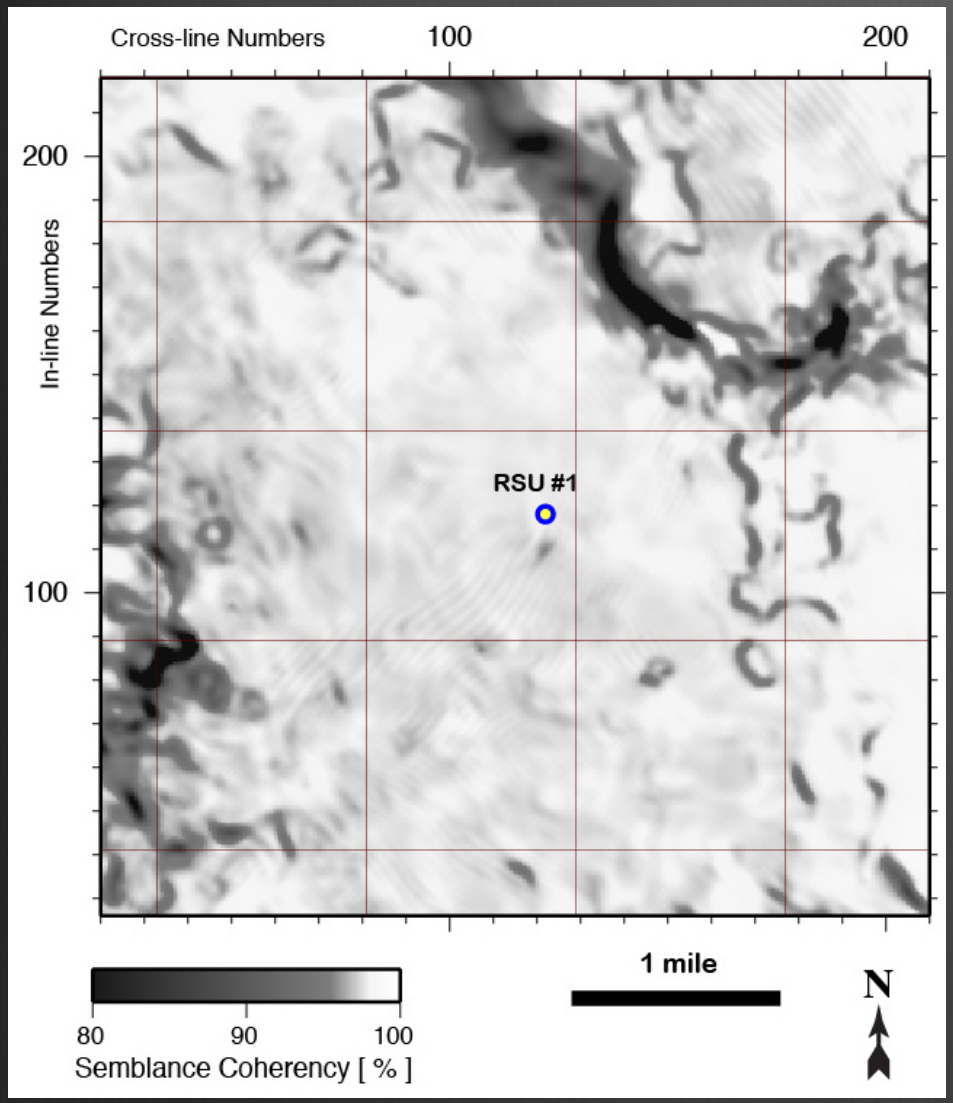


Jim Bridger 3-D seismic amplitude volume displayed in three orthogonal slices.
Note an overall northeast dip of reflectors having relatively good continuity.



Stratal slice on top of the Madison reservoir. Seismic coherency variations are displayed in shades of gray scale.

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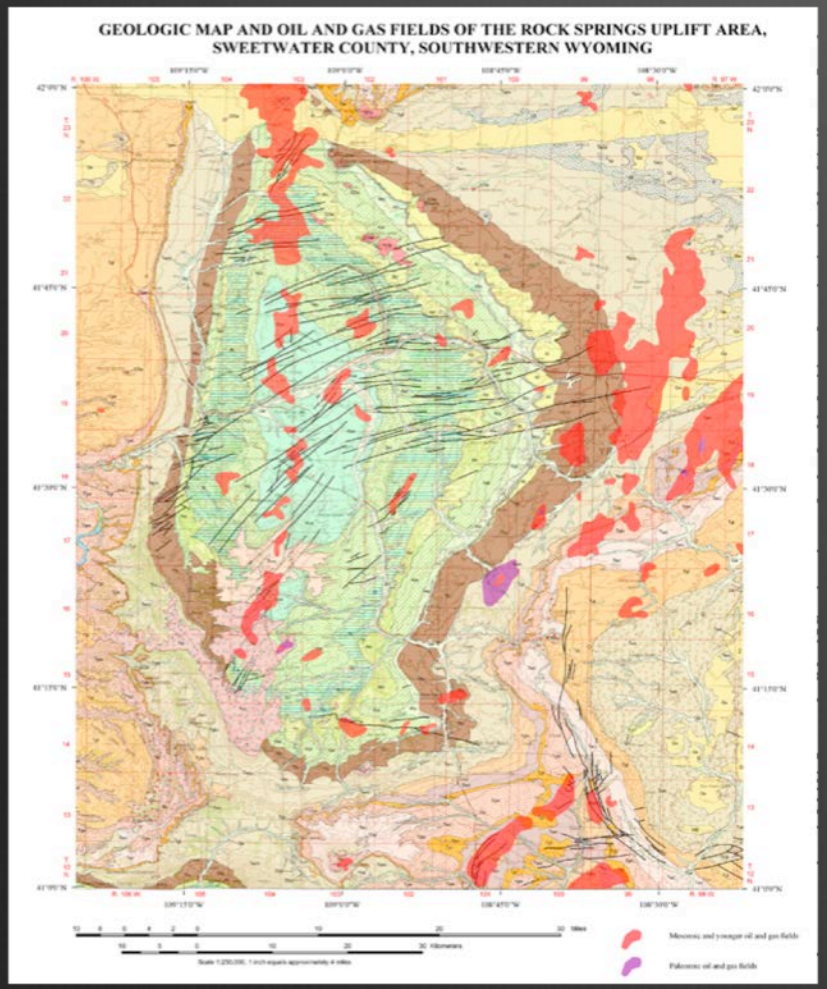
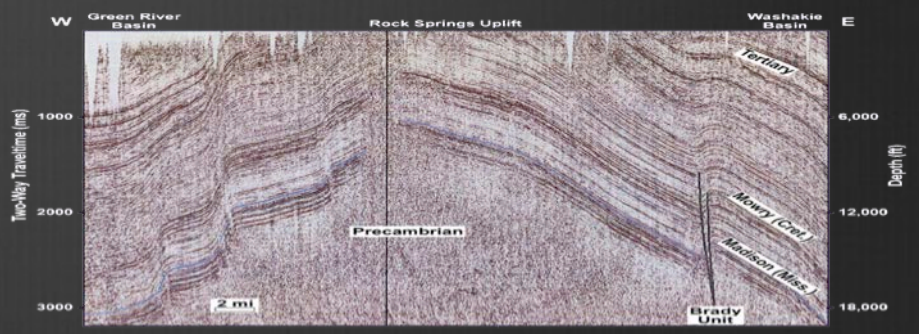
The Rock Springs Uplift: an outstanding geological CO_2 storage site in SW Wyoming



- Thick saline aquifer sequence overlain by thick sealing lithologies (8000 feet vertical separation between CO_2 storage reservoirs and fresh water aquifers)
- Doubly-plunging anticline characterized by more than 10,000 feet of closed structural relief
- Huge area (50 x 35 miles)
- Required reservoir conditions, including, but not limited to fluid chemistry, porosity (pore space), fluid-flow characteristics, temperature and pressure (i.e., regional burial history)



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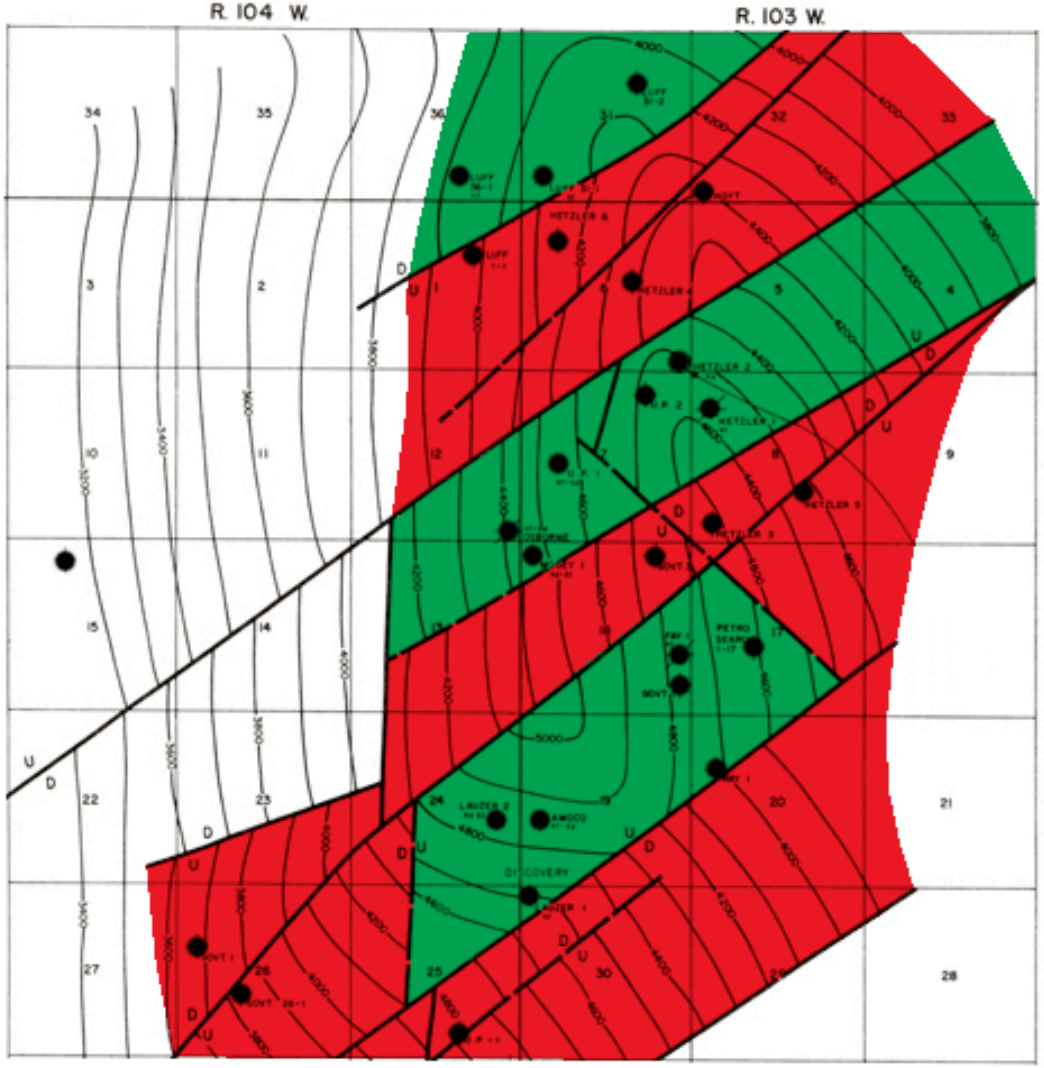


W.G.A.

BAXTER BASIN, MIDDLE

SWEETWATER COUNTY, WYOMING

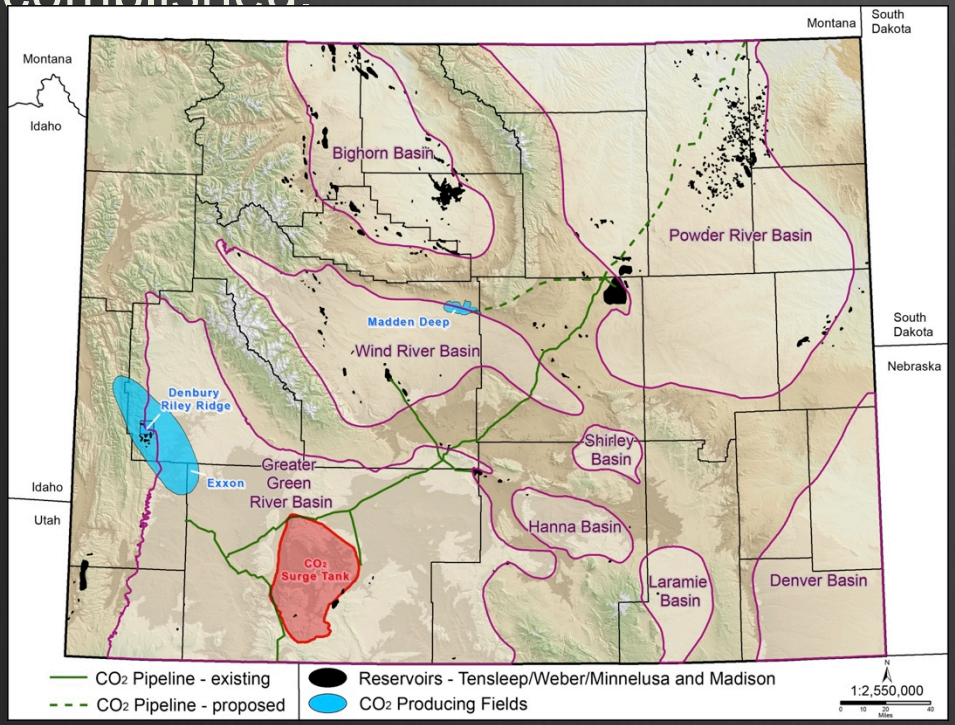
DATUM - FRONTIER

CONTOUR INTERVAL = 100'

from WGA - Oil and Gas Fields, GGRB, 1979

WY-CUSP Deliverables

The ultimate mission of the WY-CUSP program, managed by the University of Wyoming Carbon Management Institute – delivery of a certified commercial CO_2 storage site in Wyoming that could be used as a surge tank for CO_2 utilization – is being accomplished.



Tensleep and Madison oil and gas fields in Wyoming: 2 – 4 billion barrels of stranded oil

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Partners and contributors

- Thank you to the crew from Baker Hughes, Inc., including Paul Williams, Sam Zettle, Dana Dale, and Danny Dorsey
- TRUE Drilling Co. of Casper, WY provided the large rig and an excellent drilling crew.
- The WY-CUSP characterization project is funded in part by DOE NETL (Project DE-FE0009202). CMI would like to thank DOE Project Manager Karen Kluger.
- Other contributors include Los Alamos National Laboratory, Lawrence Livermore National Laboratory, PetroArc International, New England Research, Geokinetics, EMTek, and the Wyoming State Geological Survey.