Detailed CO₂ storage reservoir/site characterization: the key to optimizing performance and maximizing storage capacity

Uncertainty Reduction Progression for Determining Optimal CO₂ Storage Capacity/Dynamics/Permanence.

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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
**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*
Madison biomicrite – 12,301.1 ft
Displacement Pressure - 4000 psi
Calculated CO$_2$ sealing capacity > 20,000 ft
RSU-1 well: Madison Limestone Formation lithofacies zones

Amsden Formation

Biomicroite and Biosparite facies
Brecciated limestone facies
Biomicroite and Biosparite facies

Fractured sparite facies

Porous dolosparite facies

Dolostone facies

Porous dolosparite facies

Dolostone facies

Dolostone facies

Bighorn Dolomite
Amsden

RSU-53
Porosity (Hg) = 3.06%
Permeability = 0.003 mD
Displacement pressure = 1381 psi
Calculated CO₂ sealing capacity* = 7700 ft.
Scale bar = 200 microns

*Vavra et al., 1992

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Amsden dolostone – 12,197.4 ft.
Displacement Pressure - 1380 psi
Calculated CO₂ sealing capacity > 7000 ft
Dissolved Gas Composition of Reservoir Fluids

**Weber 1**
- Nitrogen (mole %) 78.9%
- Carbon dioxide (mole %) 14.7%
- Alkanes (mole %) 6.4%

**Madison 1**
- Nitrogen (mole %) 16.7%
- Carbon dioxide (mole %) 82.9%
- Alkanes (mole %) 0.4%
Dinwoody

RSU-01
Porosity (Hg) = 0.64%
Permeability = 0.005 mD
Displacement pressure = 940 psi
Calculated CO₂ sealing capacity* = 5000 ft.
Scale bar = 200 microns

RSU-18
Porosity (Hg) = 0.85%
Permeability = 0.003 mD
Displacement pressure = 1521 psi
Calculated CO₂ 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 CO₂ sealing capacity* = 16,000 ft.
Scale bar = 200 microns

*Vavra et al., 1992

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Dinwoody – 10,656.4 ft.
Displacement Pressure - 3000 psi
Calculated CO2 sealing capacity > 16,000 ft
From Erin Campbell-Stone et al., 2010
Rock Springs Uplift hydrostratigraphic system

Cretaceous Shales

- Dp = 500-1,100 psi
- Sealing capacity = 1,000-2,000 ft
  (3 shale samples)

- Dp = 1,900 - 2,800 psi
- Sealing capacity = 3,800 - 5,700 ft
  (2 samples)
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.
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)
W.G.A.
BAXTER BASIN, MIDDLE
SWEETWATER COUNTY, WYOMING
DATUM - FRONTIER
CONTOUR INTERVAL = 100'

from WGA - Oil and Gas Fields, GGRB, 1979
The ultimate mission of the WY-CUSP program, managed by the University of Wyoming Carbon Management Institute – delivery of a certified commercial CO₂ storage site in Wyoming that could be used as a surge tank for CO₂ utilization – is being accomplished.

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

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