Carbon Utilization and Storage Partnership of the Western USA

CUSP Iron Mountain Subsurface Characterization

CUSP Focused Project

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CUSP Iron Mountain Subsurface Characterization

Carbon Utilization and Storage Partnership of the Western USA

Project Overview

CUSP Iron Mountain Subsurface Characterization

CUSP West — Carbon Utilization and Storage Partnership of the Western USA

Iron Mountain Team

- CUSP Lead
  - New Mexico Tech (NMT)
- Project Lead
  - University of Utah (UU)
- Project Collaborators
  - Utah Geological Survey (UGS)
  - Kansas Geological Survey (KGS)
  - Oklahoma University (OU)
  - Oklahoma Geological Survey (OGS)
  - Montana State University (MSU)
  - Los Alamos National Labs (LANL)
- Industrial Partner
  - Utah Iron
  - CarbonSolutions LLC

DNR Utah Geological Survey

The University of Utah

Oklahoma Geological Survey OGS 1908

Kansas Geological Survey, University of Kansas

Los Alamos National Laboratory EST. 1943

OU – IC³

Montana State University Mountains & Minds

New Mexico Tech Science • Engineering • Research • University

Carbon Solutions LLC

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CUSP Regional Partnership

Project Goal: Improve understanding of storage systems and carbon sources

1. Focus is on collecting, synthesizing, and use of existing data sets to improve coverage, accuracy, and granularity of existing data
2. Evaluate CCUS potential and readiness
3. Strong emphasis on technology transfer

★ **CUSP Iron Mountain Subsurface Characterization Focused Project**

CUSP Member States & Organizations

CUSP Iron Mountain Subsurface Characterization

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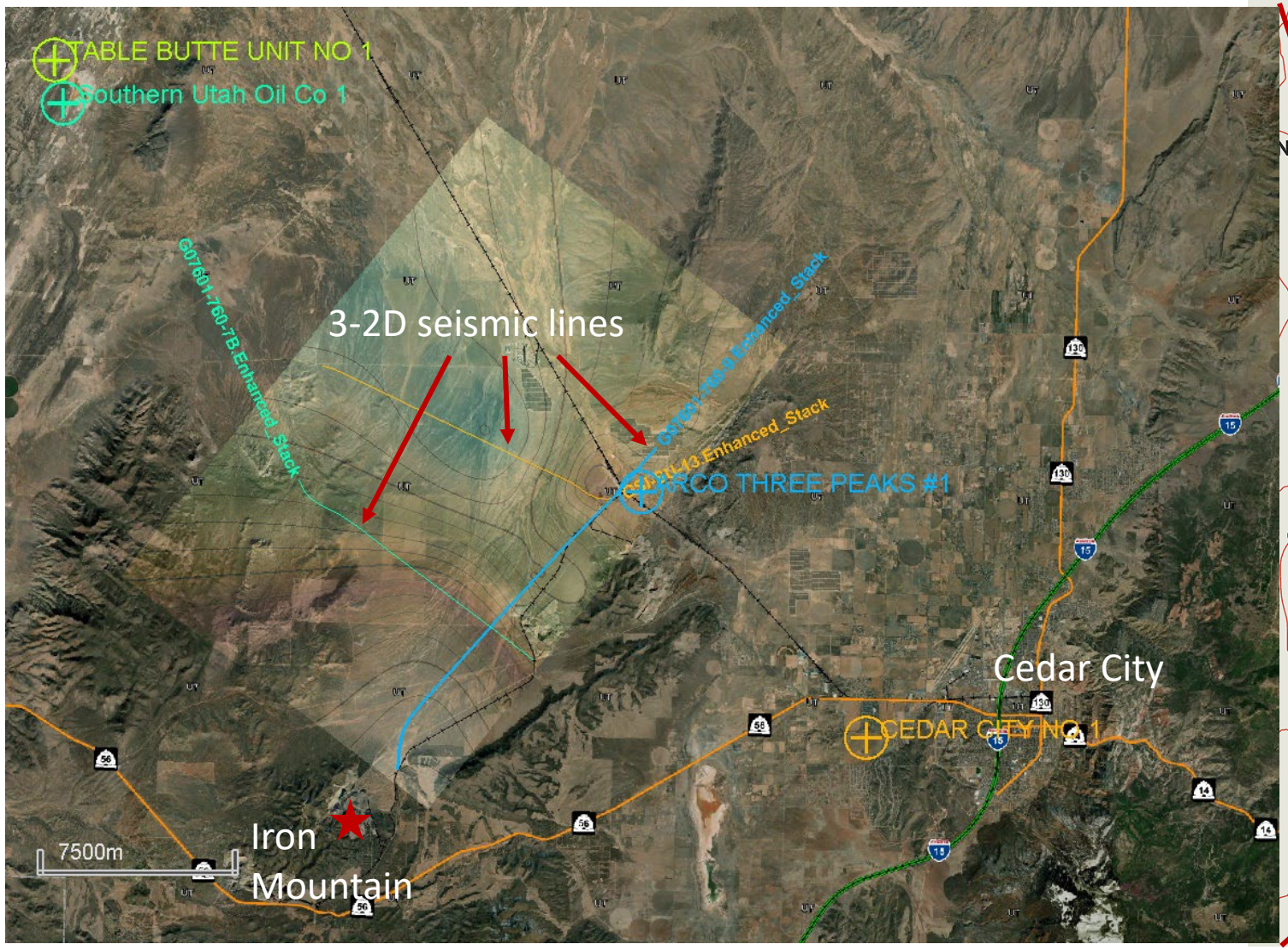
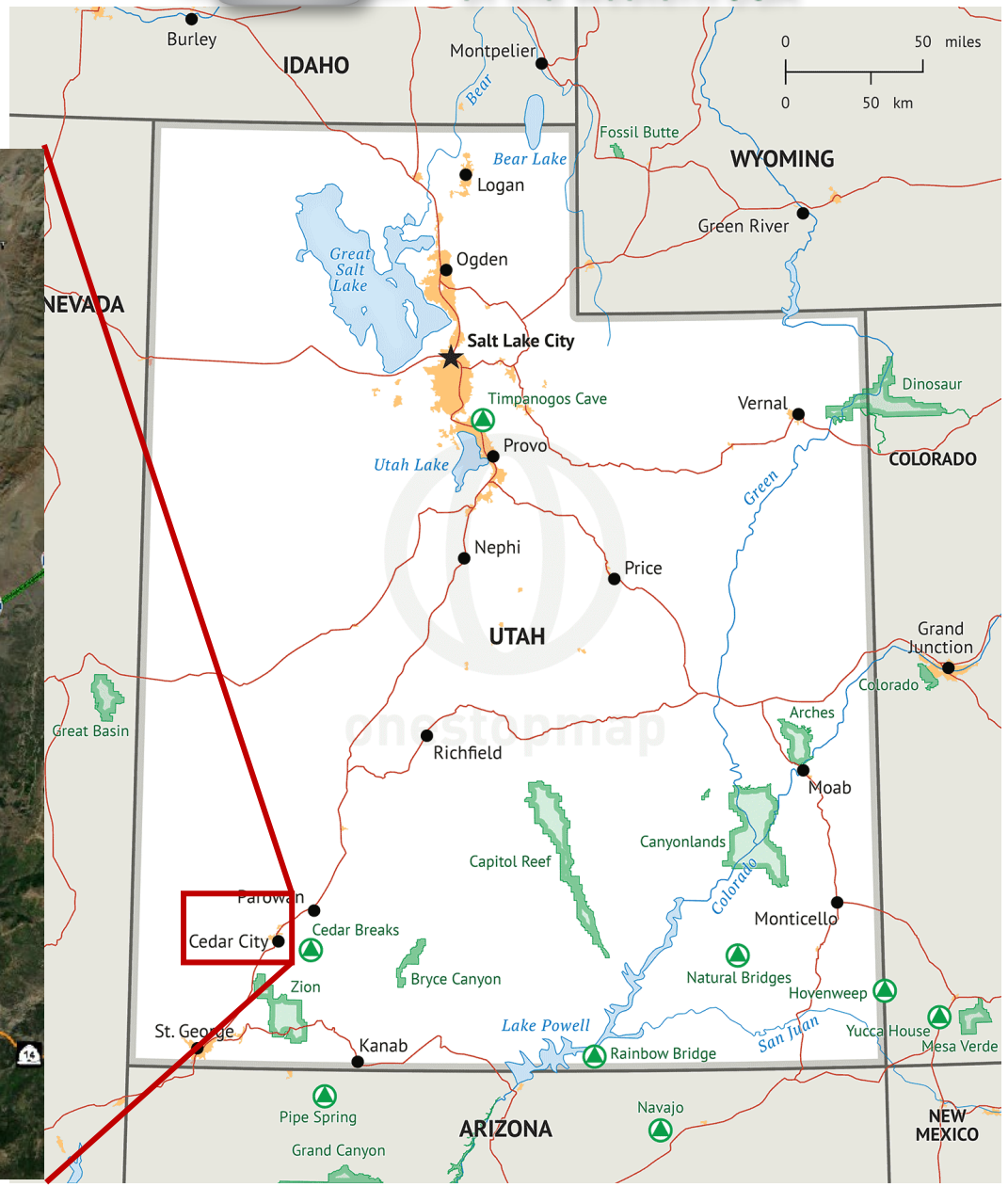
Focus Project Location





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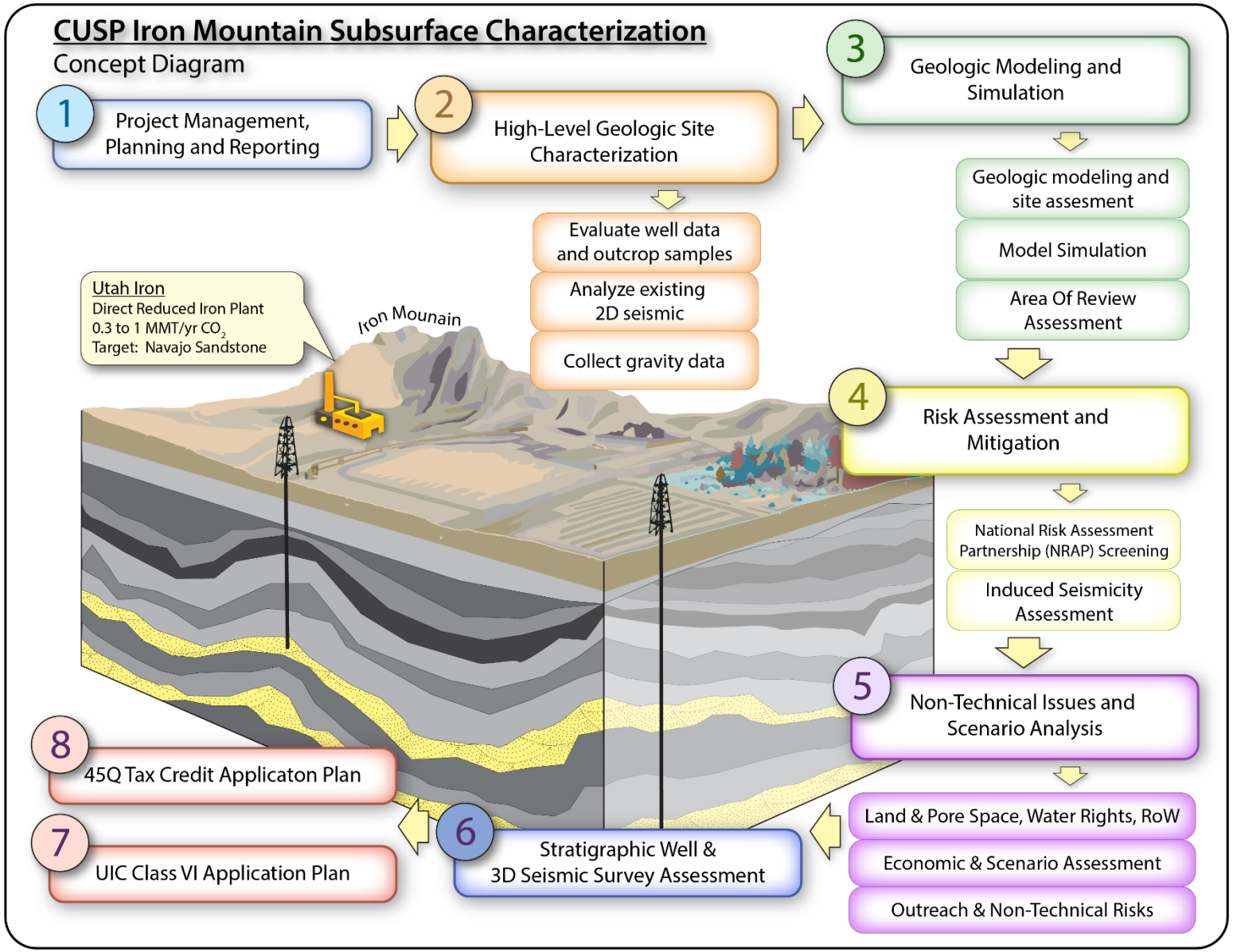
CUSP Focused Project Concept Diagram

- Utah Iron and SA Recycling
  - Commercial-scale caron capture and storage near Iron Mountain iron mine
  - Located near Cedar city, UT
- Evaluating the feasibility of storing 500,000 to 1 million metric tons of CO_2 generated from Direct Reduced Iron (DRI) process
- Two potential storage formation
  - The Navajo Sandstone and Kaibab Limestone
- Primary Project Goals
  - Characterize potential for CO_2 in the Neck of the Desert area
  - Assemble plan for data needs for a Class VI injection well(s) and 45Q tax credit



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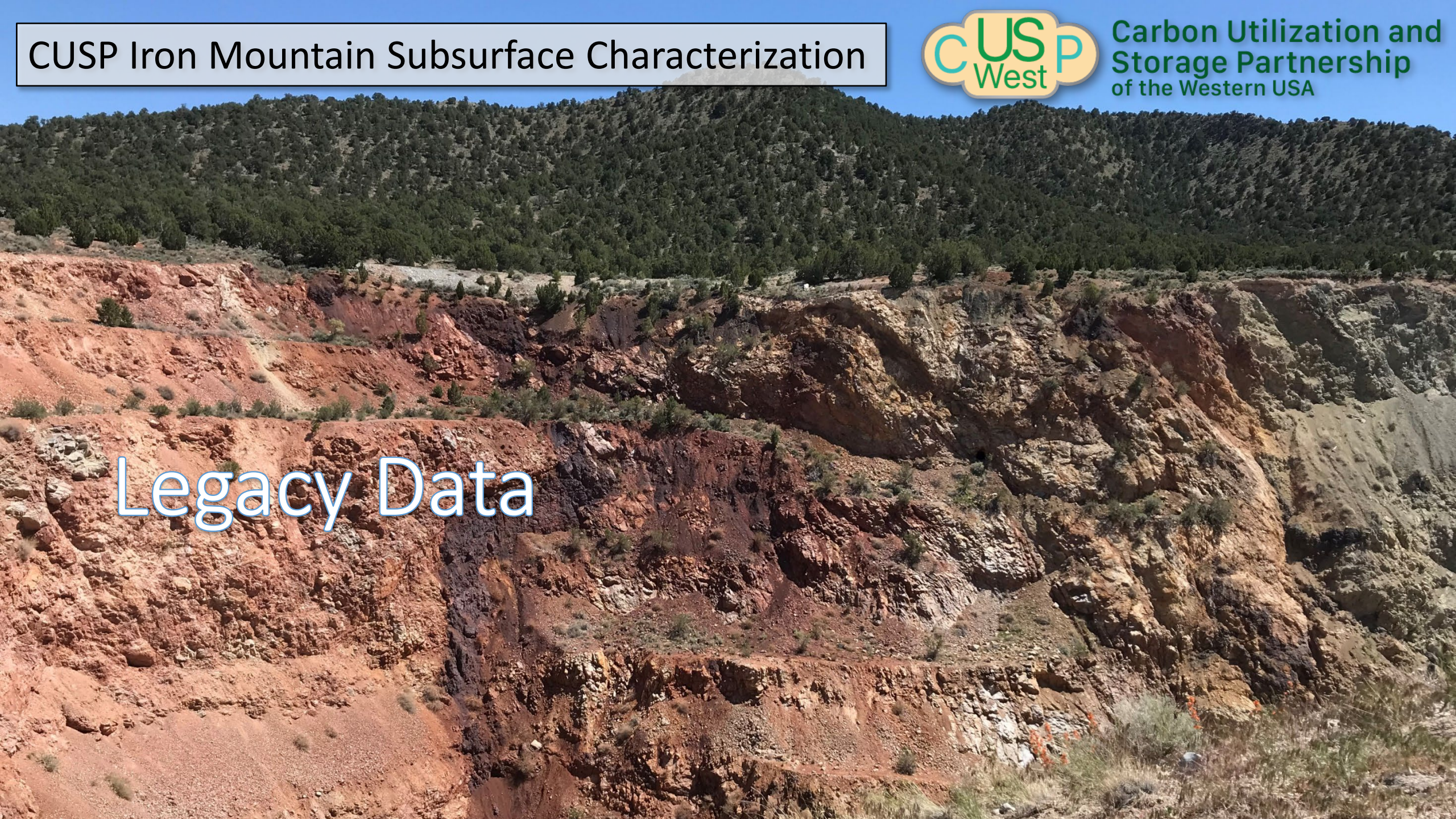

Legacy Data

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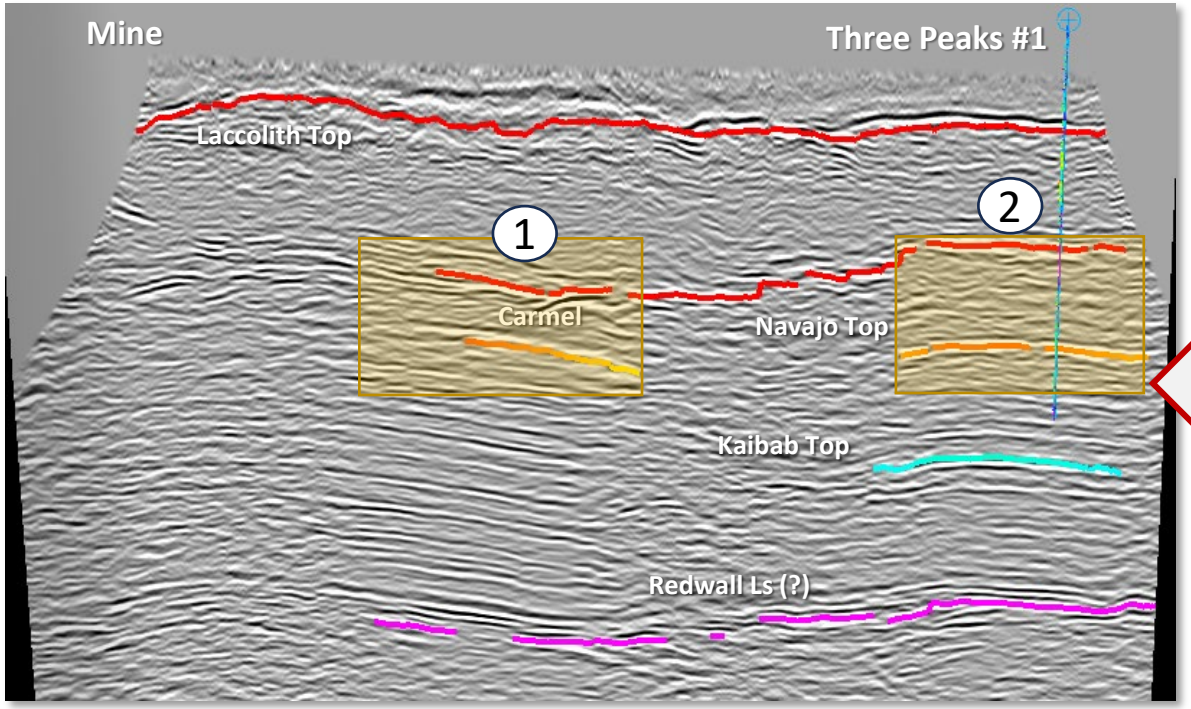
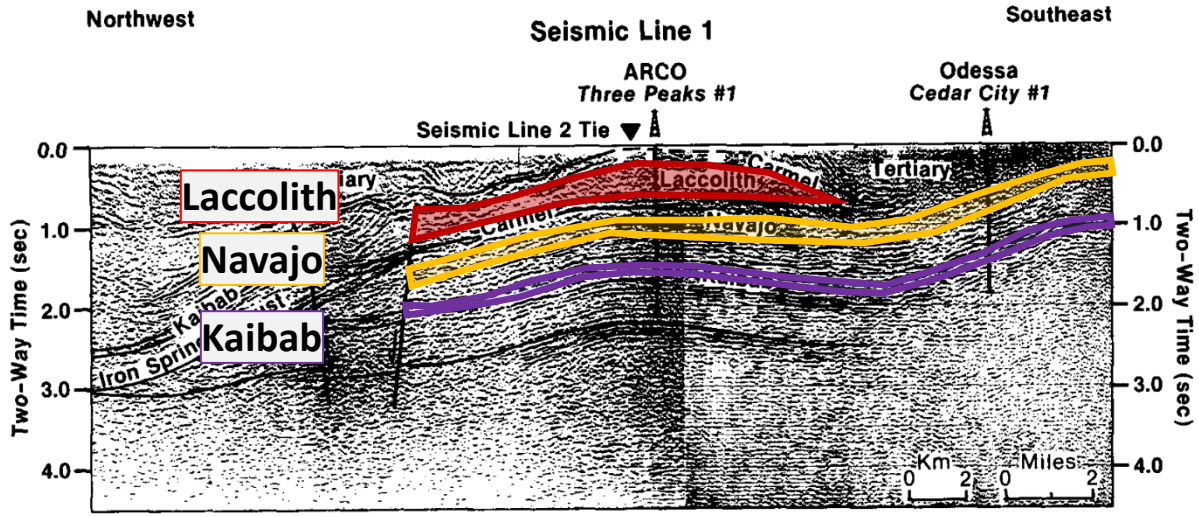
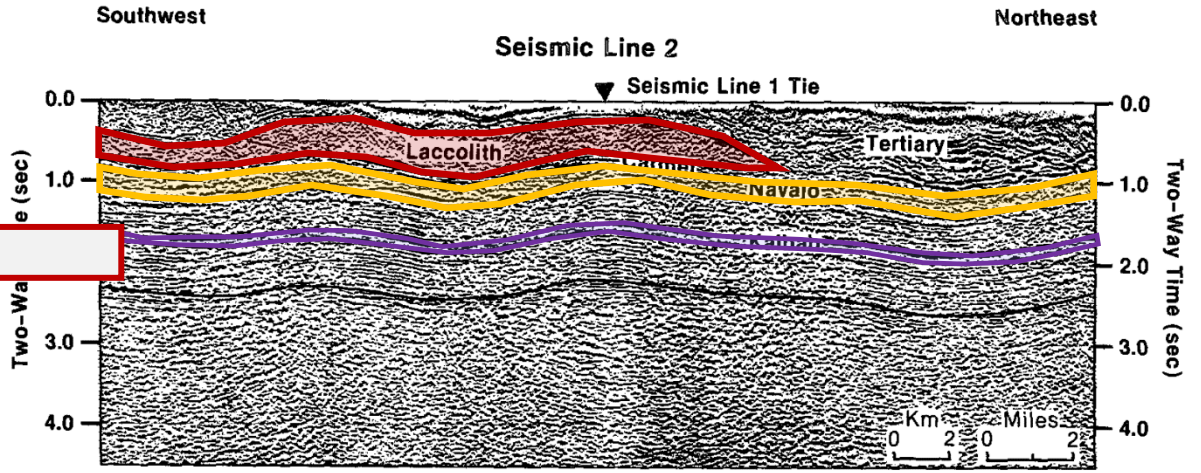
Legacy Data

- Three 2D seismic lines
  - Data has low energy and lots of noise and artifacts
  - Hard to resolve surfaces except in limited areas
  - Show potential for storage in two areas
    1. Near the mine
    2. Near the ATP #1 well







van Kooten, G. K. (1988). Structure and hydrocarbon potential beneath the Iron Springs laccolith, southwestern Utah. *Geological Society of America Bulletin*, 100(10), 1533-1540.

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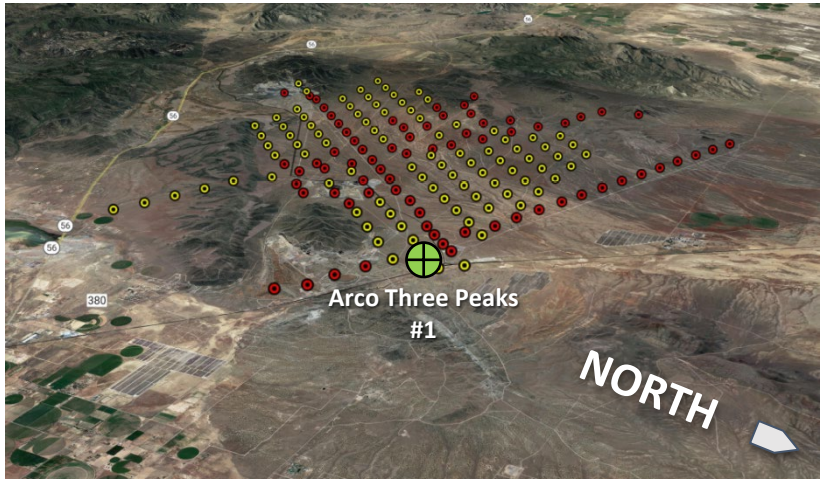
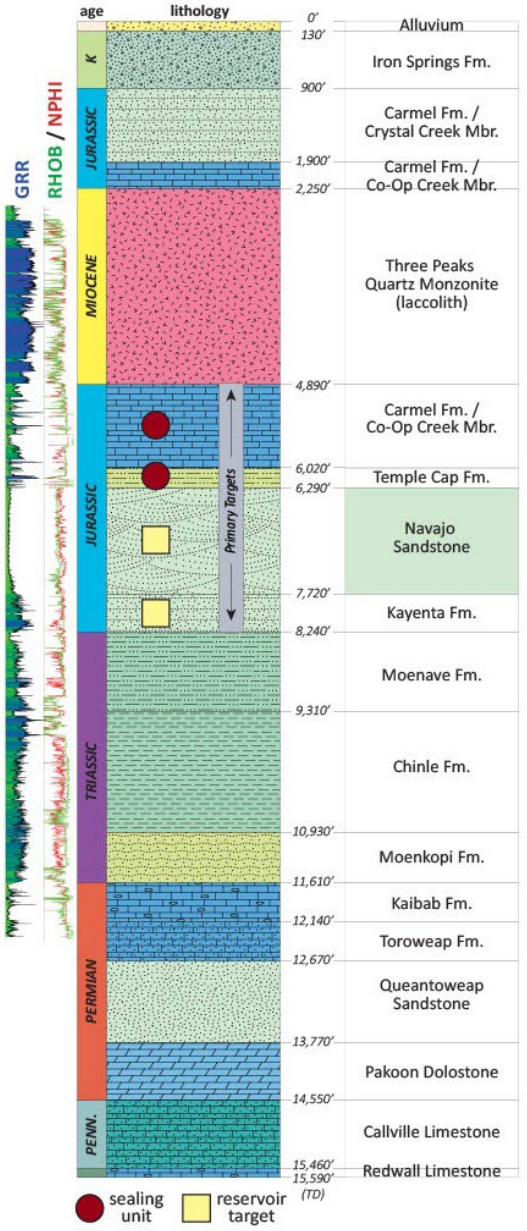
Legacy Data

- Core
  - Carmel below the Laccolith [5018 to 5033 ft]
  - Kaibab [11,646 to 11,666 ft]
  - [11,991 to 11,997 ft]
- Cuttings from potential reservoirs and seals
- Gravity data for the area
  - Data set was expanded by UGS surveys





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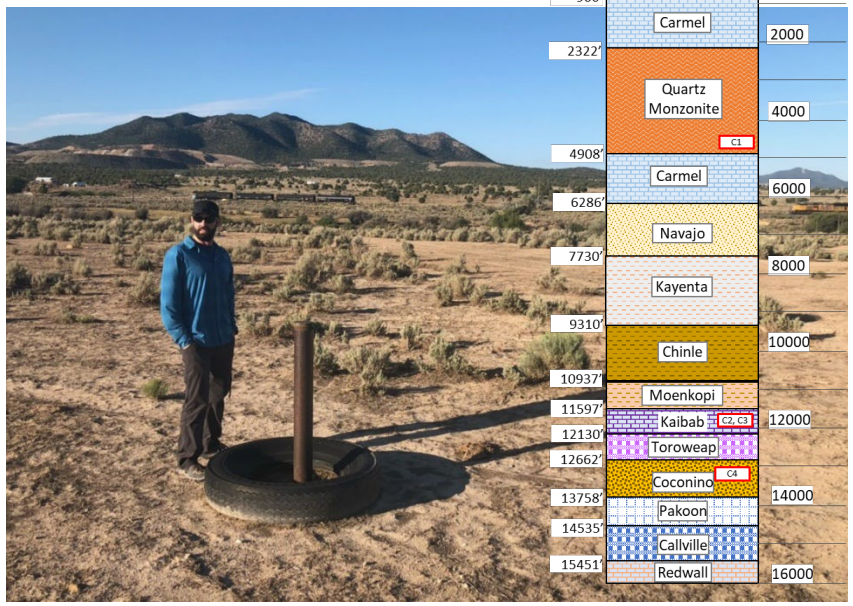
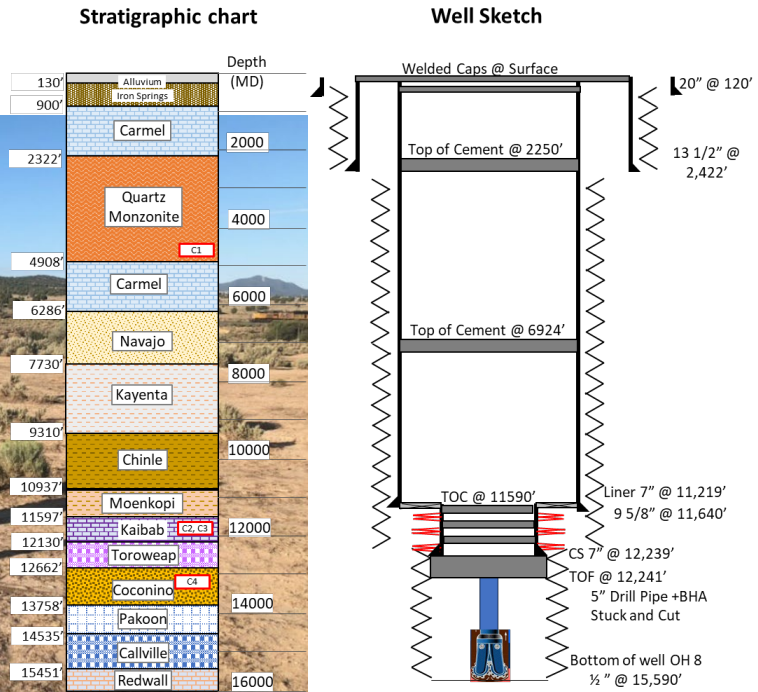
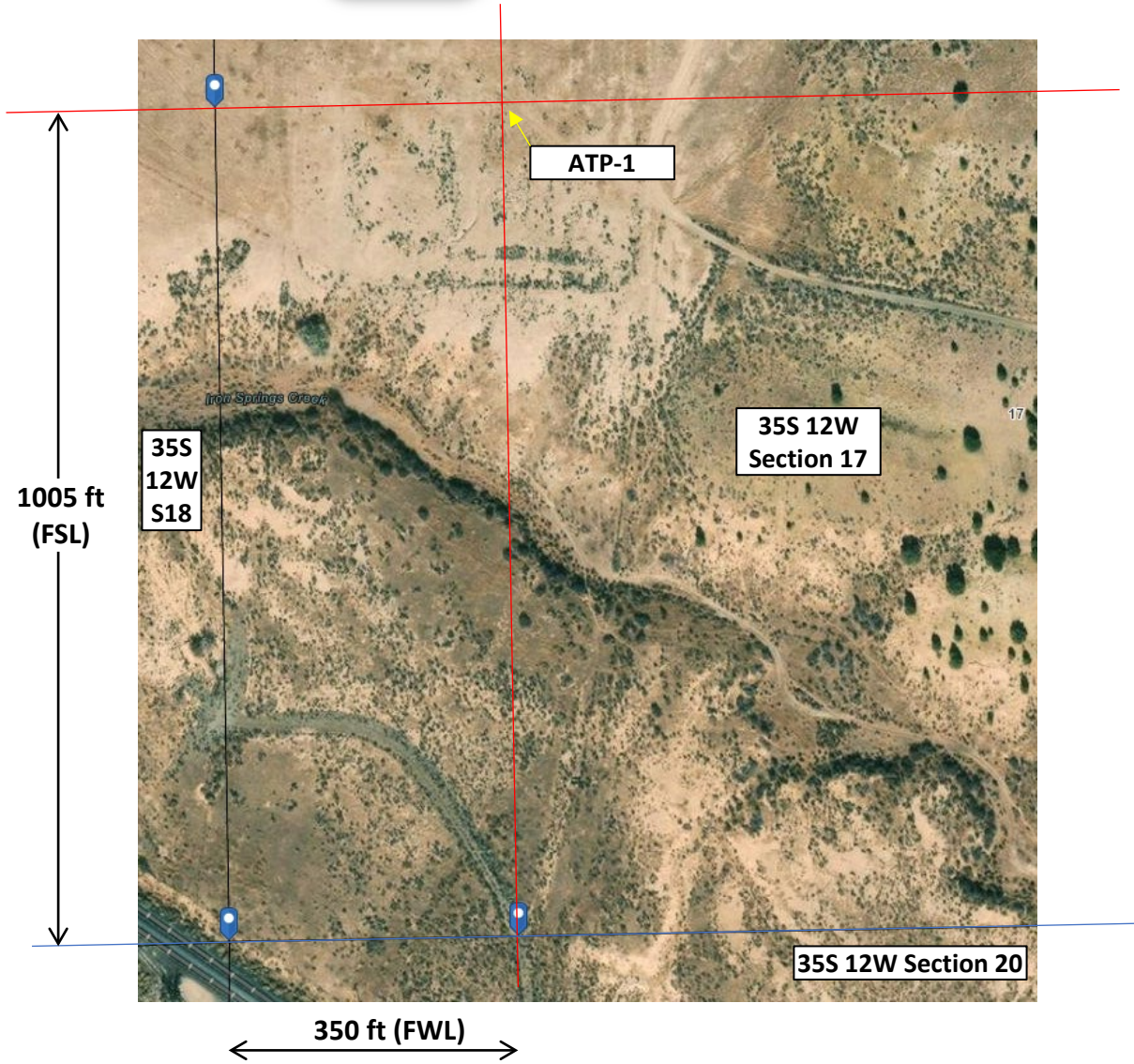
ATP-1 Well Status

- 9 5/8” Casing: Cut at 6’ from ground level. Cap Welded
- 13 1/2” Casing: Cut at 4’ from ground level. Cap Welded
- 20” Casing: Unclear. Assumed to be cut at 6’ from ground level
- Annular cemented







Source: ATP-1 Drilling Report (March 13 to 16, 1985)

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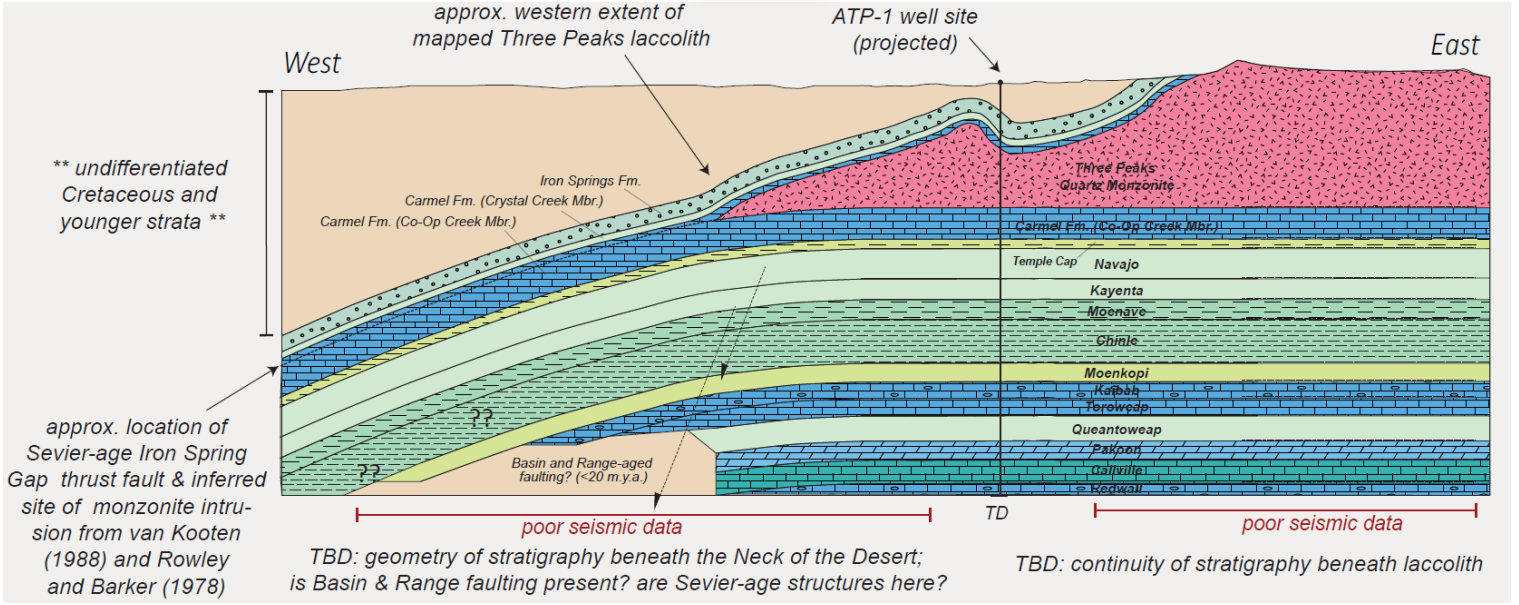
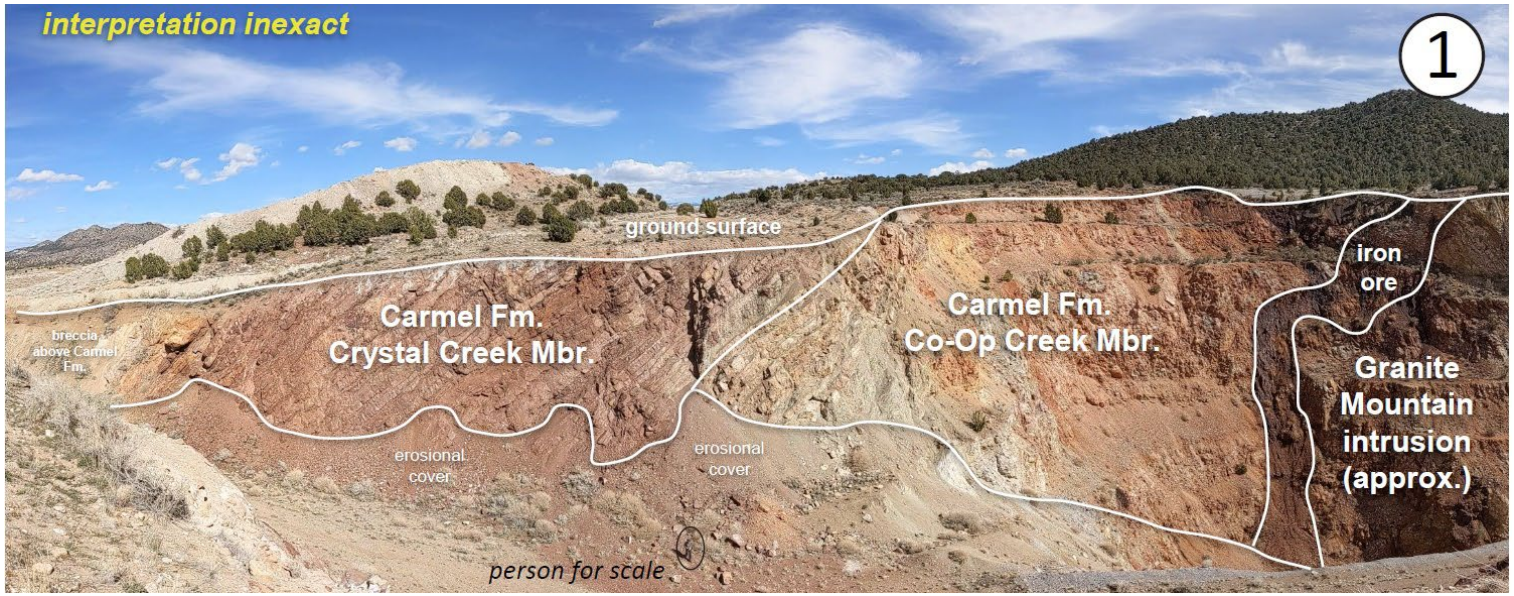
Three-Peaks Laccolith

- Historically interpreted as a continuous, sheet-like intrusion which migrated by way of an old fault plane.
- Questions remain about the orientation and extent of the laccolith due to the limitations of the legacy seismic data.
- The extent of faulting and complexities from regional tectonism are also unknown at depth and could impact seal integrity.





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CUSP West

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Data Collection and Laboratory Testing

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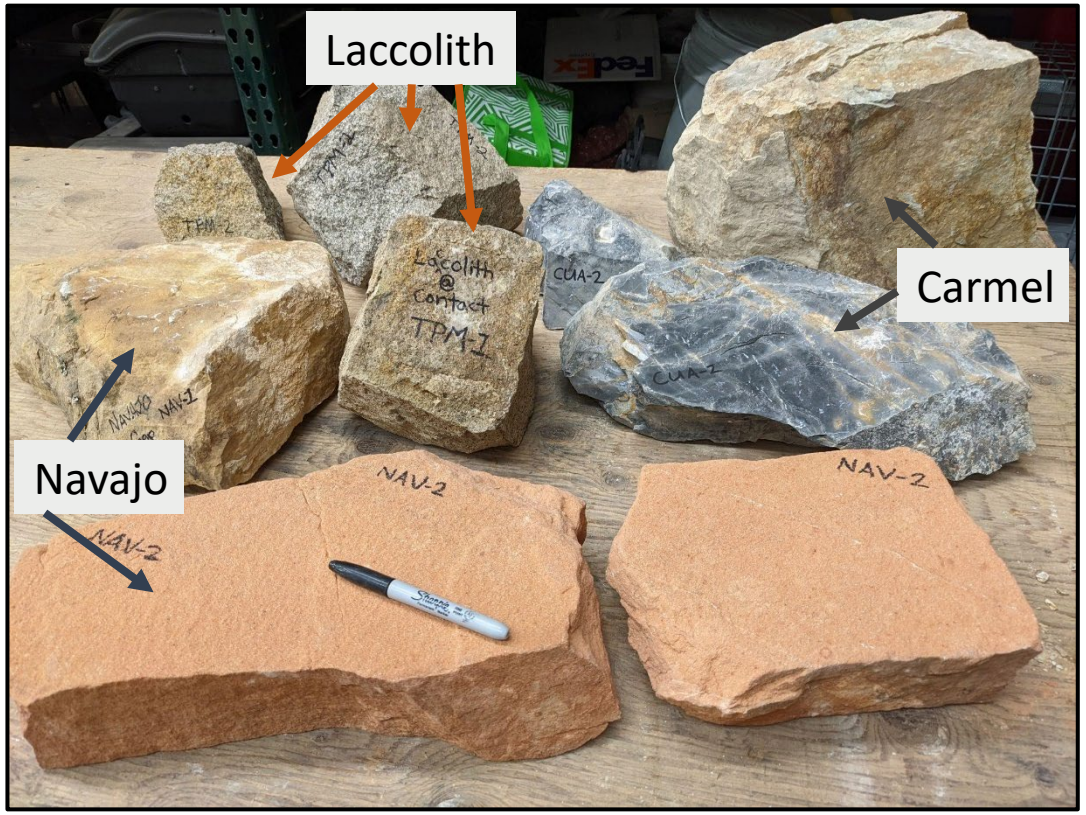
Data Collection

- Multiple field campaigns to collect outcrop samples for laboratory testing and gravity data survey for intrusion mapping



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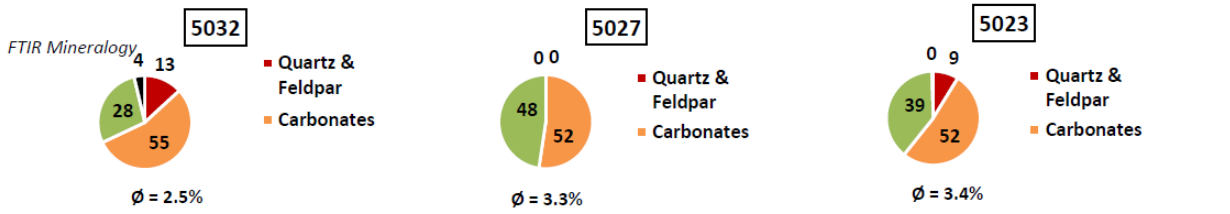
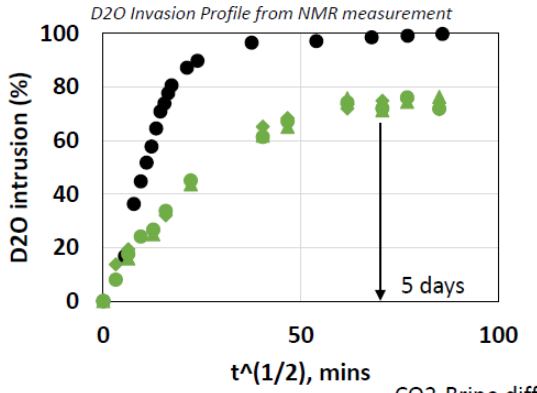
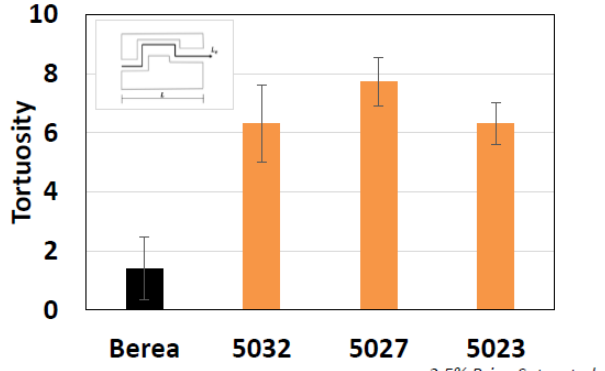
Laboratory Testing

IC3 Laboratory at OU

1. FTIR Minerology
2. NMR D2O Diffusion
3. CO2 exposure (SEM)
4. Porosity and Permeability
5. Capillary Pressure
6. Elemental Composition
7. Wettability

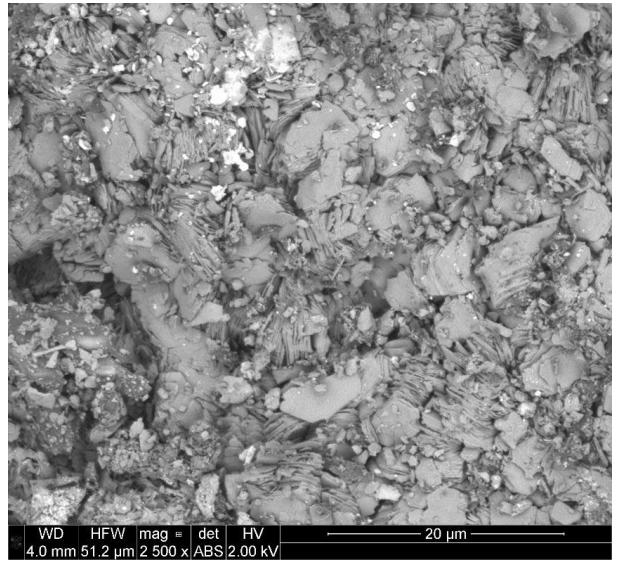




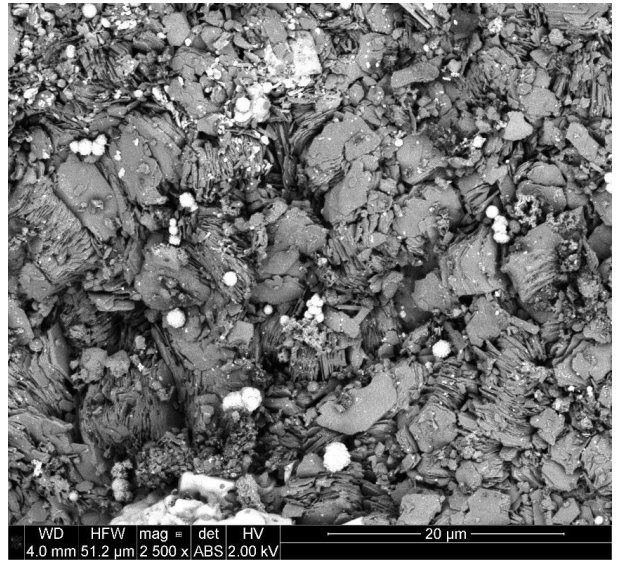


CO2-Brine diffusivity = ½ of Self-Water diffusivity
-> CO2 exposure time = 4* D2O exposure time = 20 days

NAV-2 Before CO_2 exposure



Nav-2 After 2 weeks of CO_2 exposure



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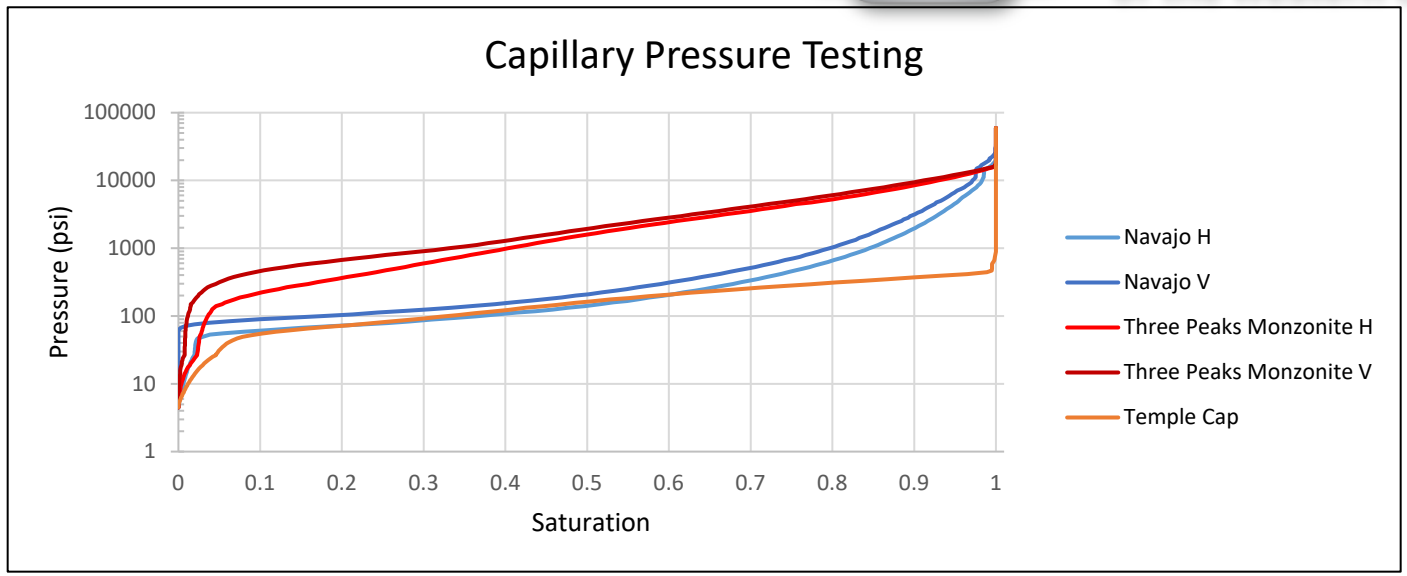
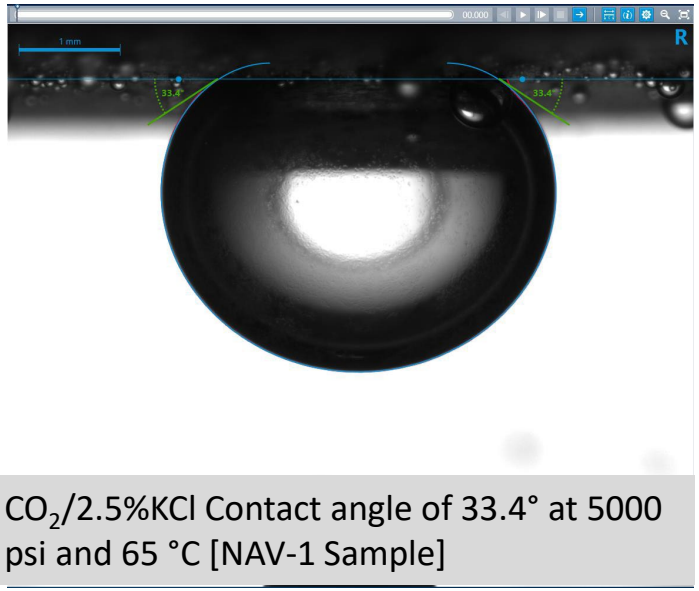
Laboratory Testing

IC3 Laboratory at OU

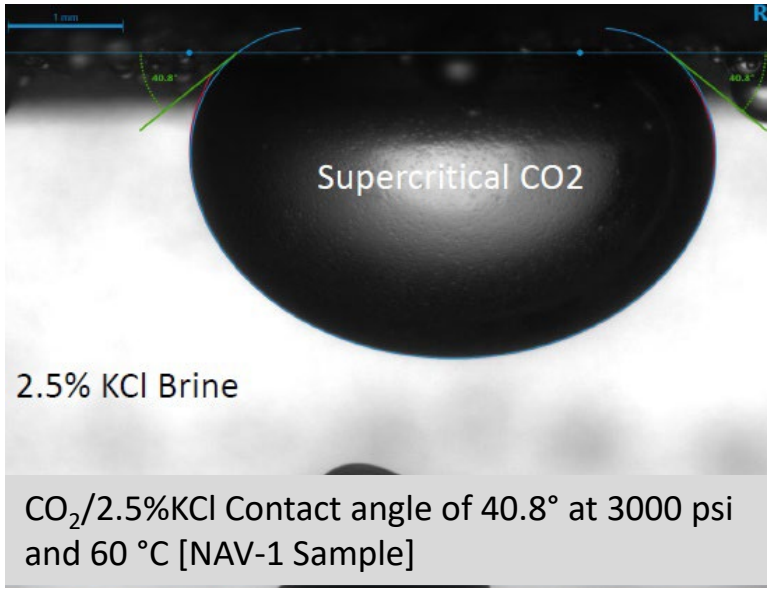
- FTIR Minerology
- NMR D2O Diffusion
- CO2 exposure (SEM)
- Porosity and Permeability
- Capillary Pressure
- Elemental Composition
- Wettability



Contact Angle



CO_2/2.5%KCl Contact angle of 33.4° at 5000 psi and 65 °C [NAV-1 Sample]



CO_2/2.5%KCl Contact angle of 40.8° at 3000 psi and 60 °C [NAV-1 Sample]

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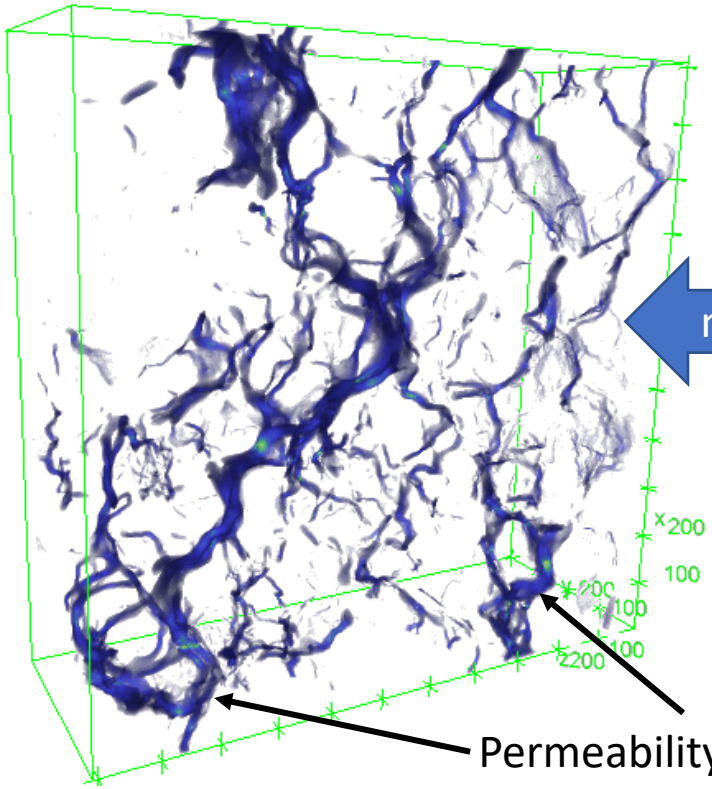
Laboratory Testing

UGS and UU

- Well cuttings used for thin section and microCT scanning

Navajo Well Cuttings

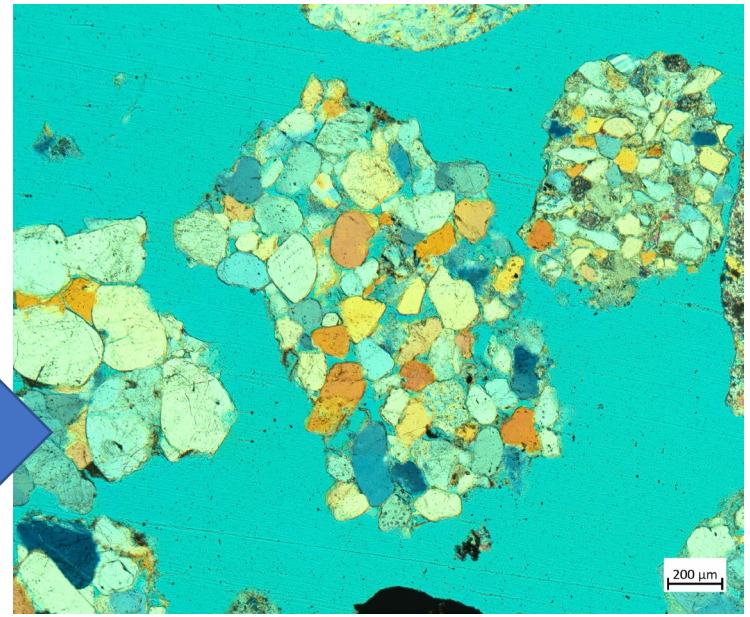
microCT



Permeability estimated in blue

Thin Section

Navajo Thin Section



Cross-polarized light (XPL) images show a range of grain sizes and shapes as well as open pore space in the central rock fragment; visual porosity estimate range: ~10-15%? (6,580'-6,590' MD)

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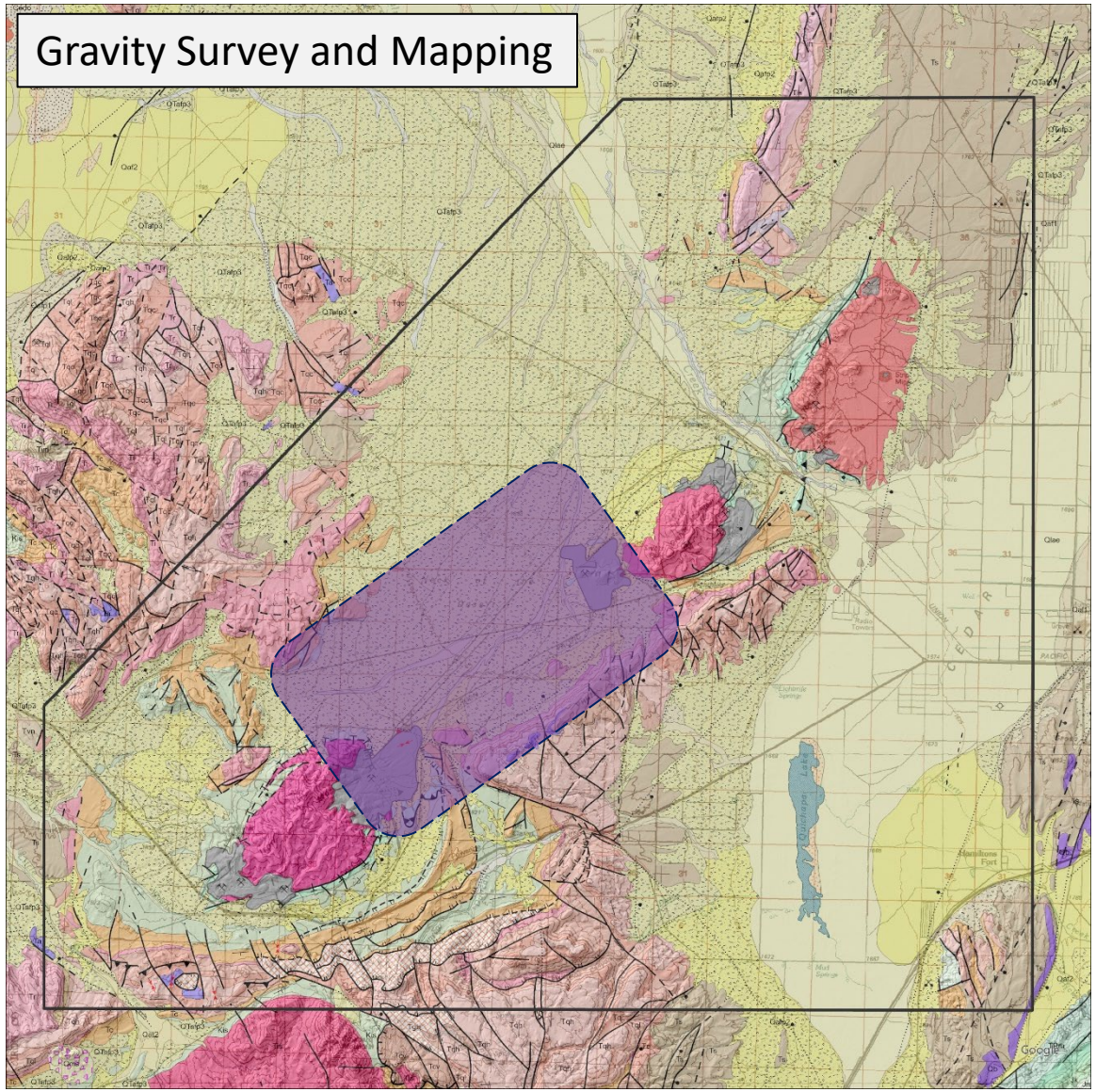
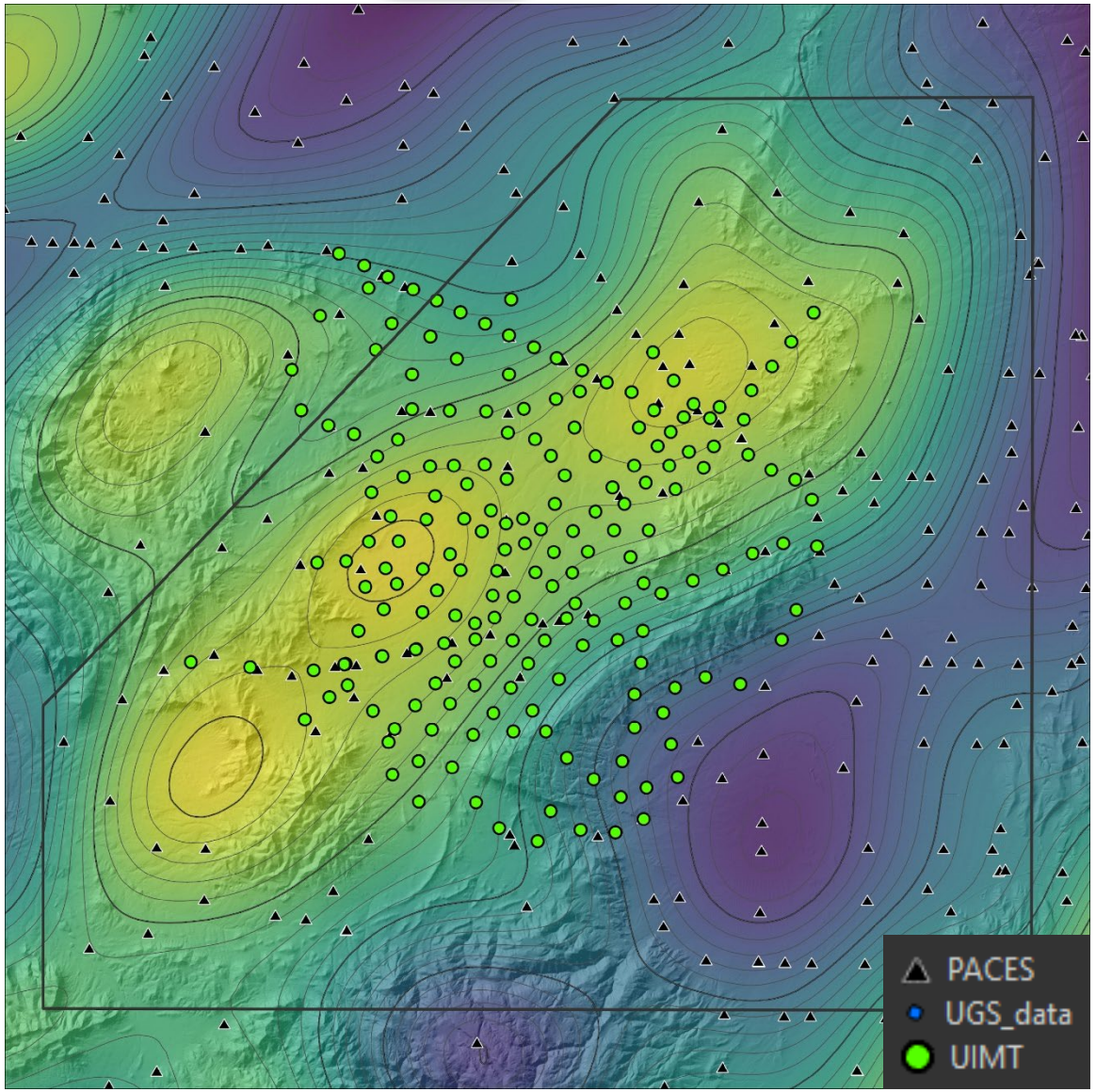
Gravity Survey and Mapping





Gravity technical work c/o Christian Hardwick, Kayla Smith, Will Hurlbut, & Austin Jensen (UGS)

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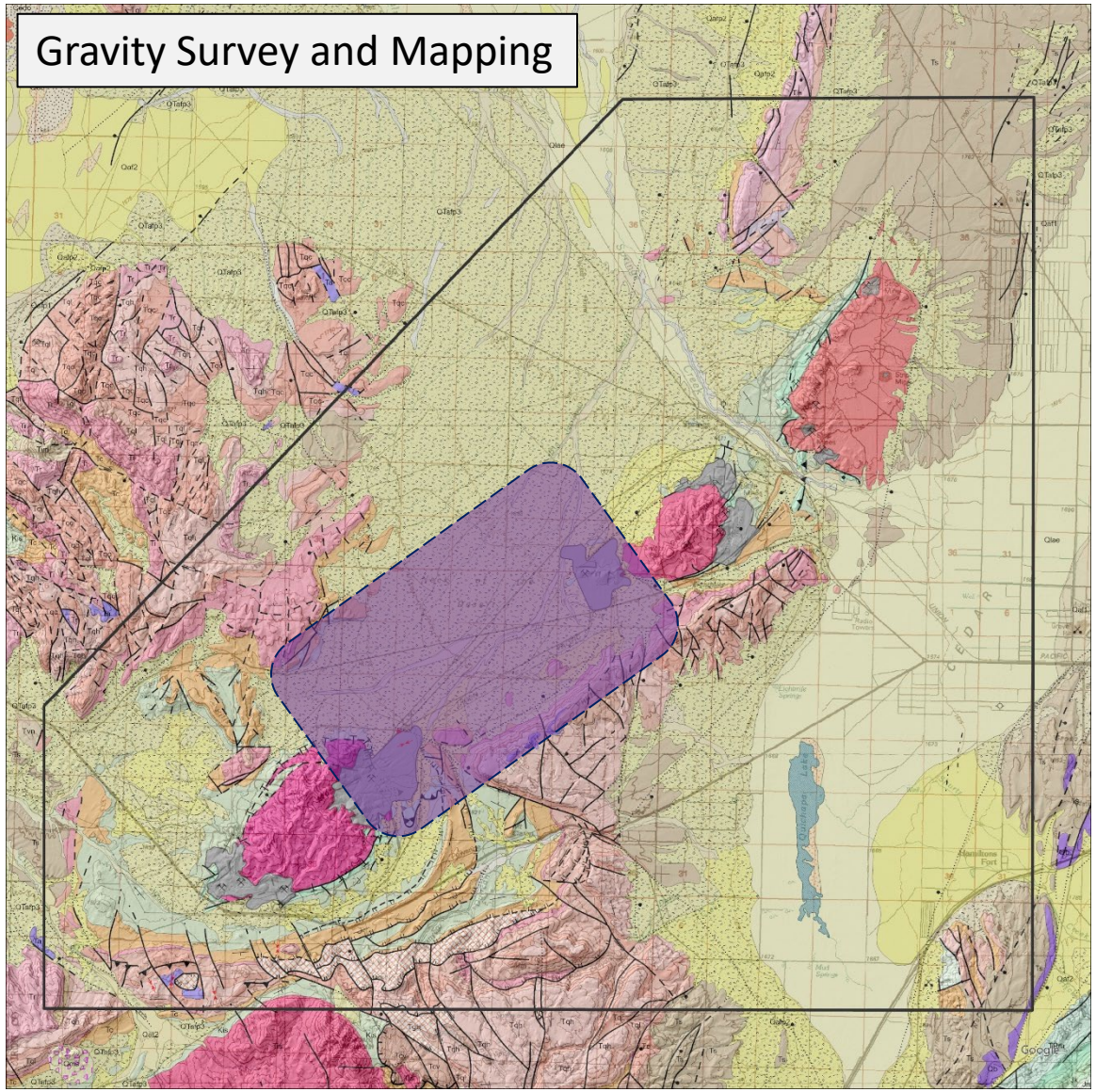

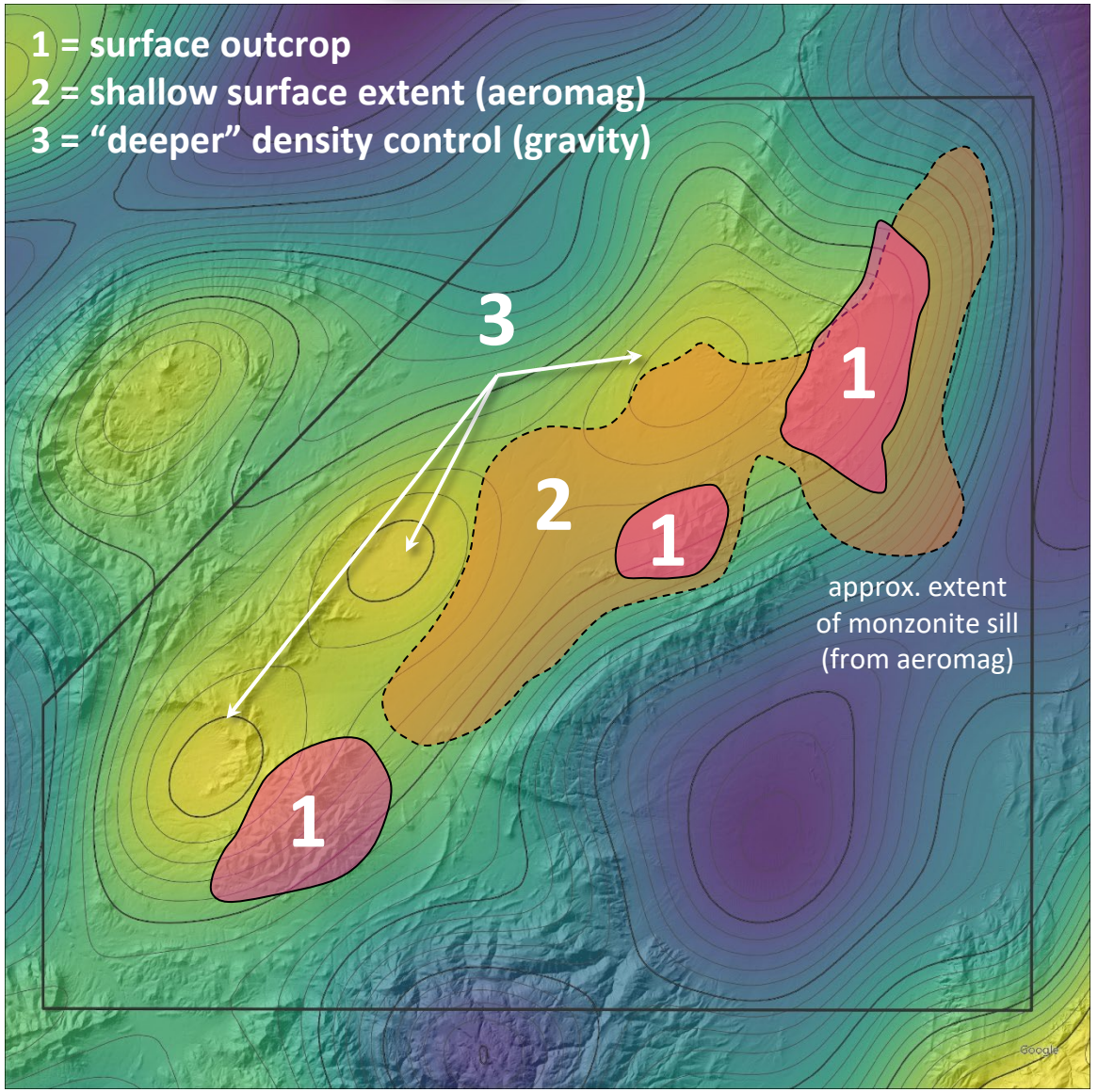

Gravity technical work c/o Christian Hardwick, Kayla Smith, Will Hurlbut, & Austin Jensen (UGS)

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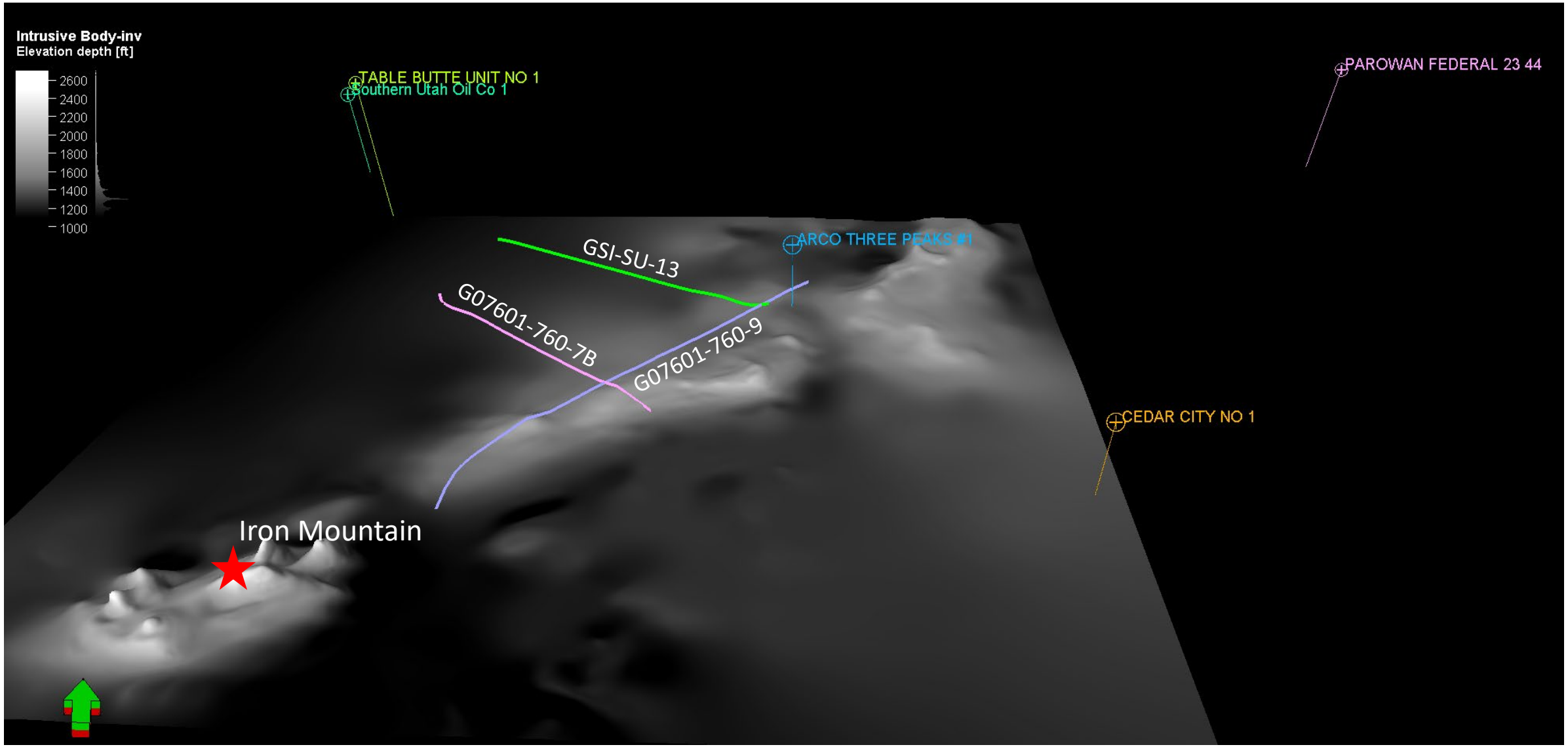
Aero-mag Data



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Modeling

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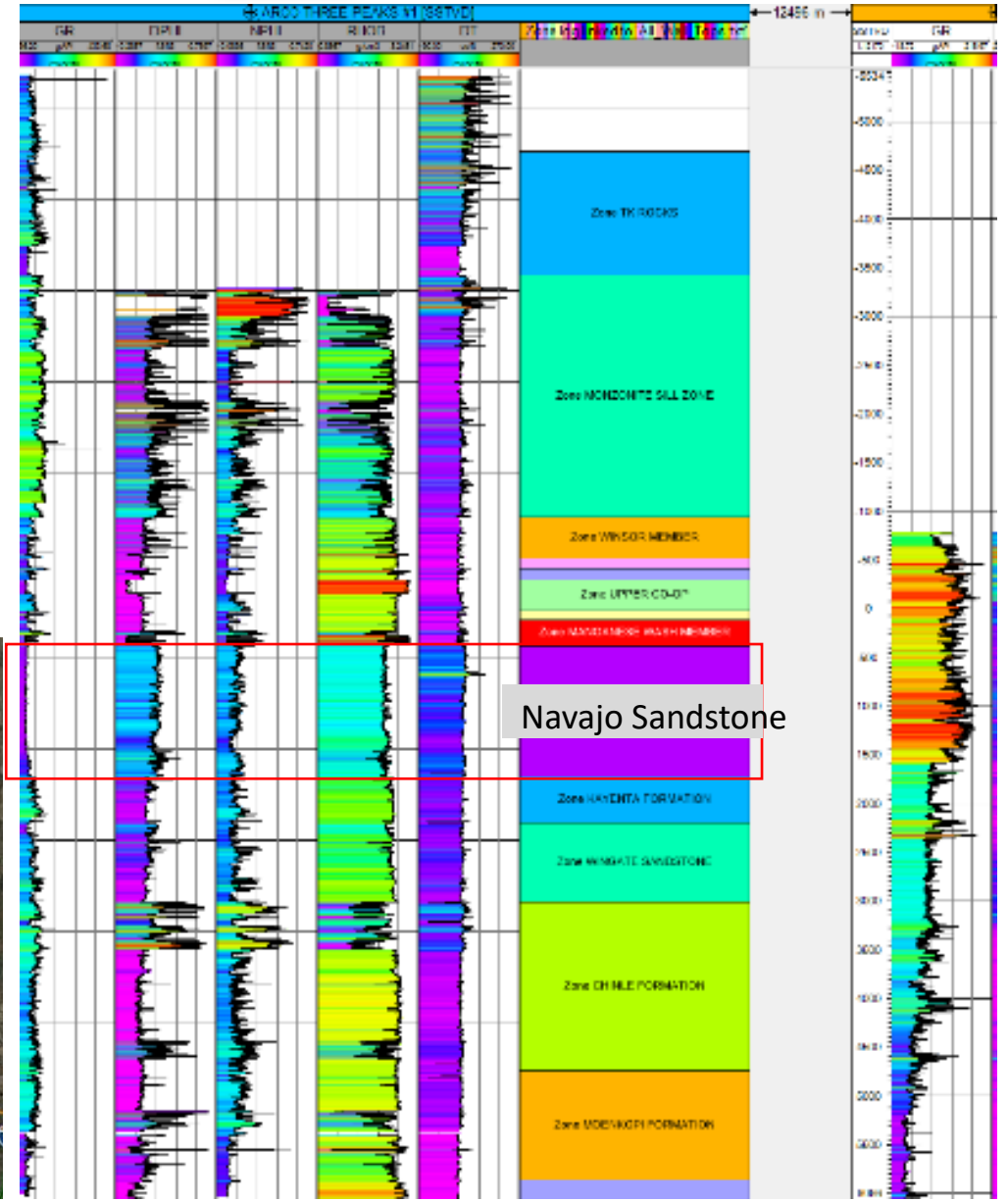
Modeling

1. The entire ARCO Three Peaks#1 well logs has been digitized.
2. The utilized curves are the GR, Deep Resistivity, Neutron Porosity, Bulk Density and Compressional Sonic
3. The Target formations (Navajo Sandstone, Carmel Limestone), overburden and under burden formation tops were picked with the digital curves' interpretation and the wells reports.



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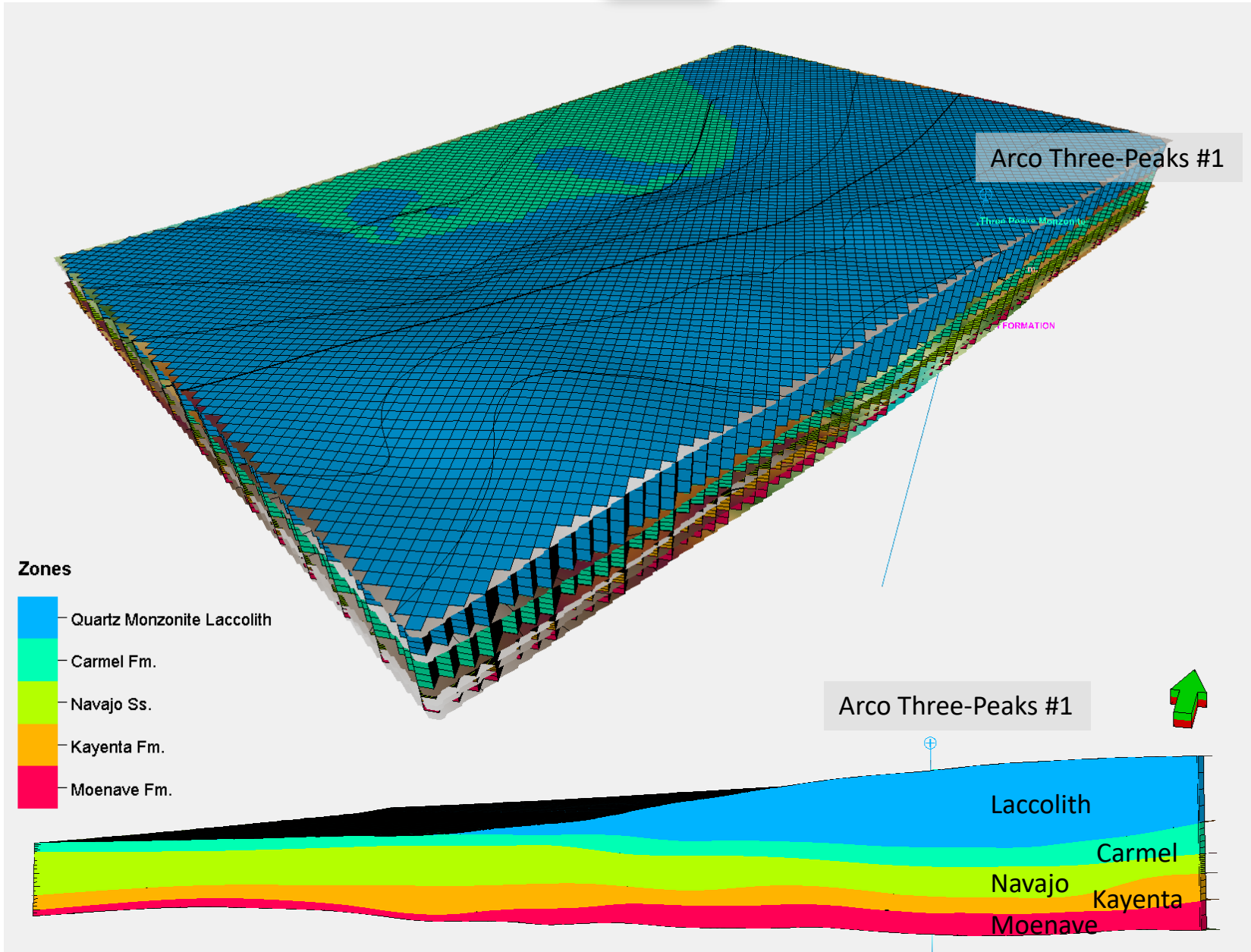
Modeling

- Sealing formations:
  - Laccolith and Carmel
- Primary reservoir:
  - Navajo Ss.
- Underlying formations:
  - Kayenta and Moenave Frm.



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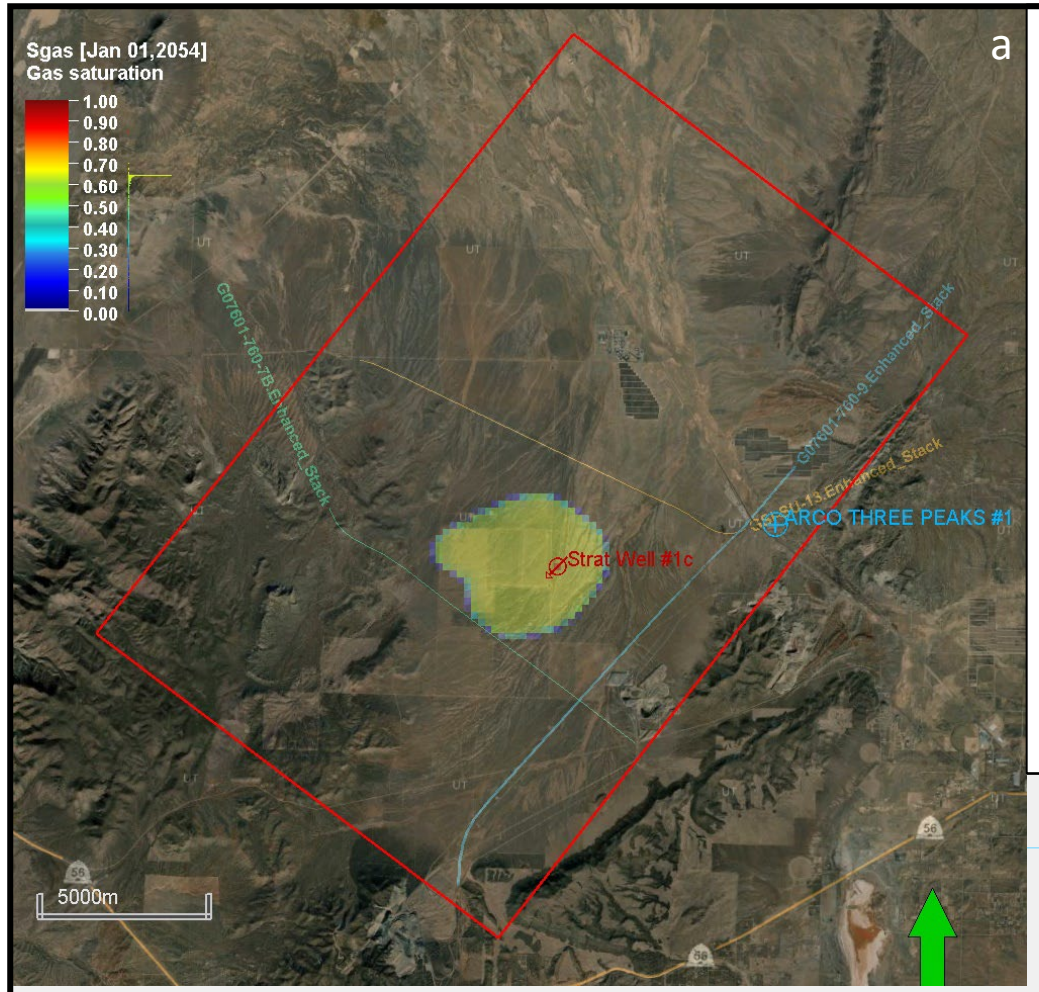

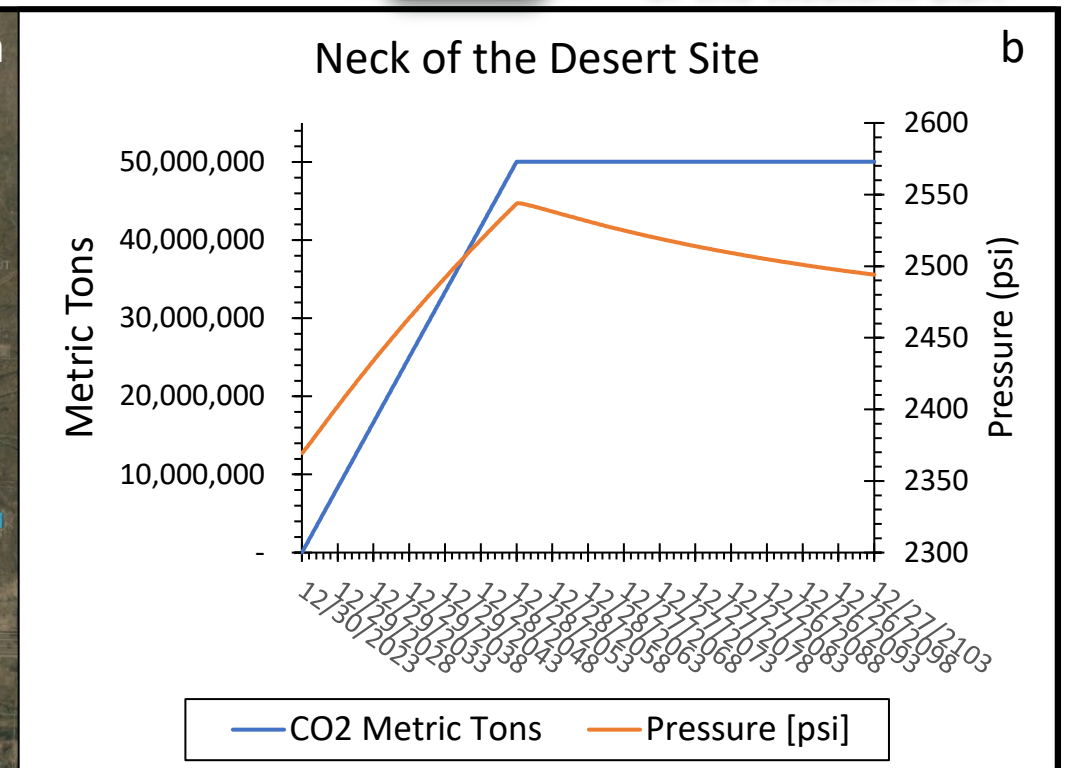

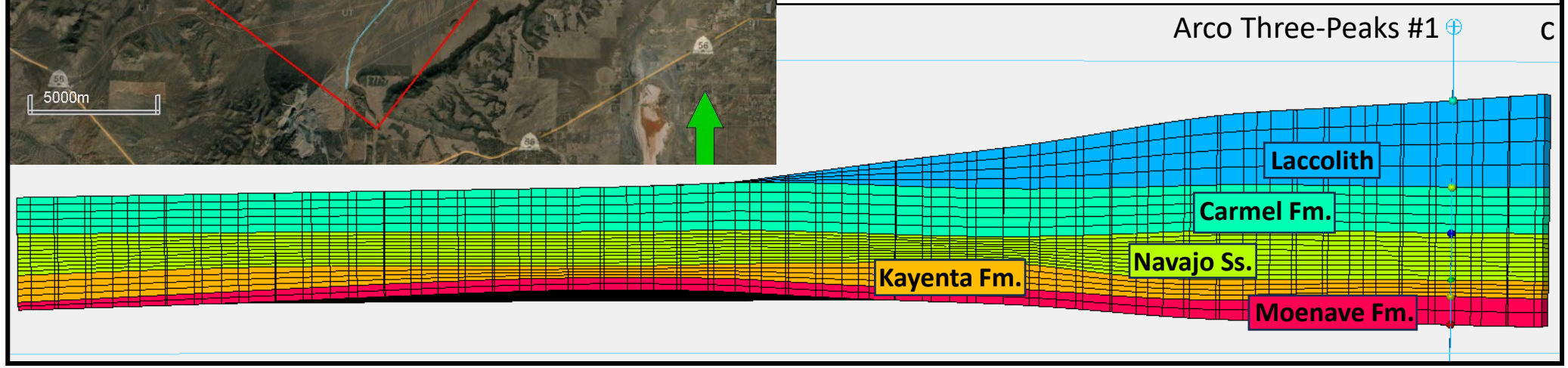

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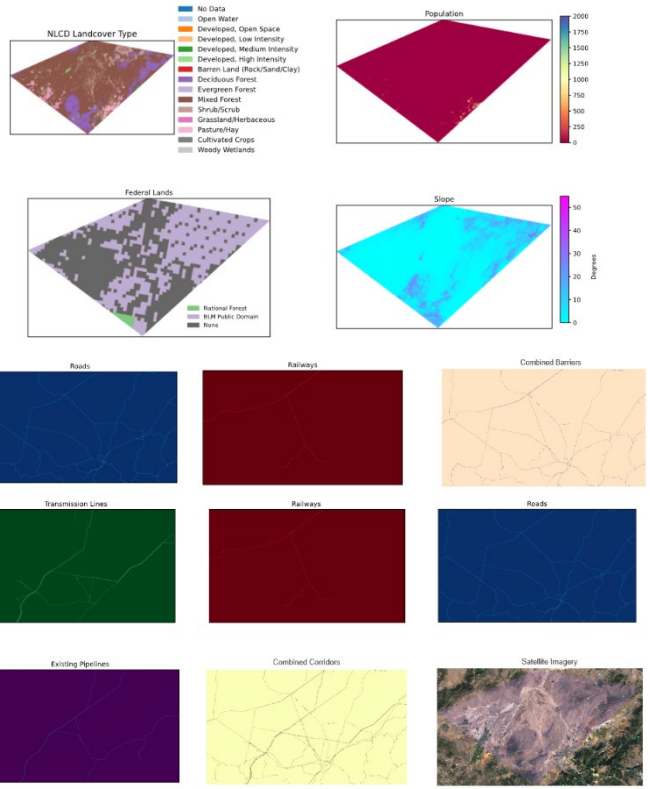
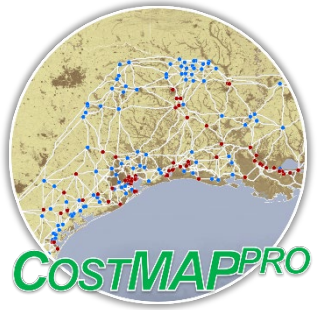
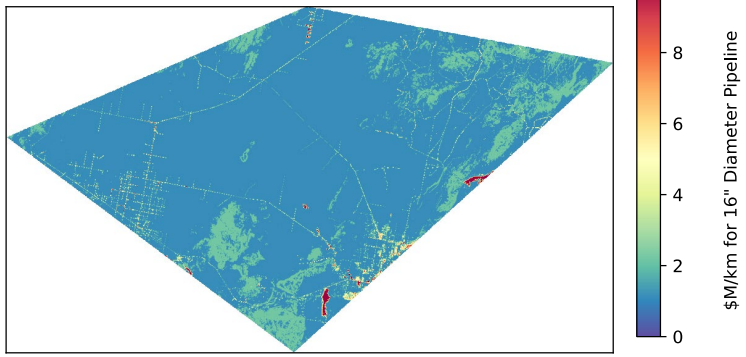
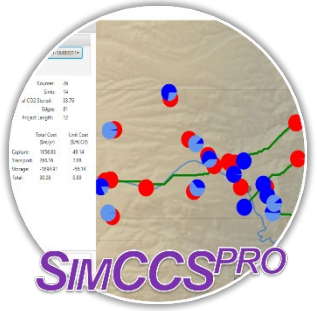


Utah Iron rights of way

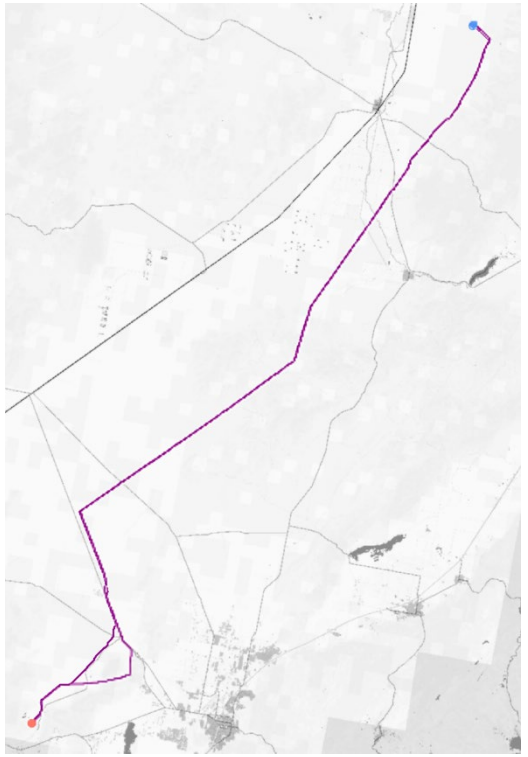


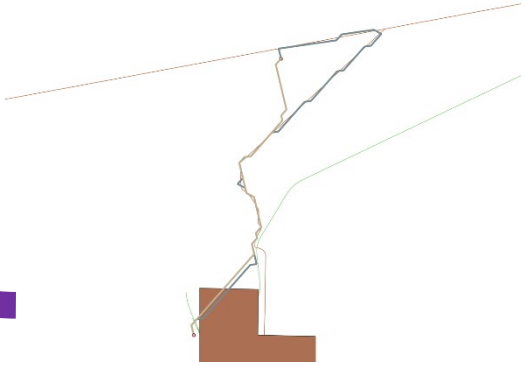
CostMAP Generated Pipeline Costs





Pipeline routing solutions





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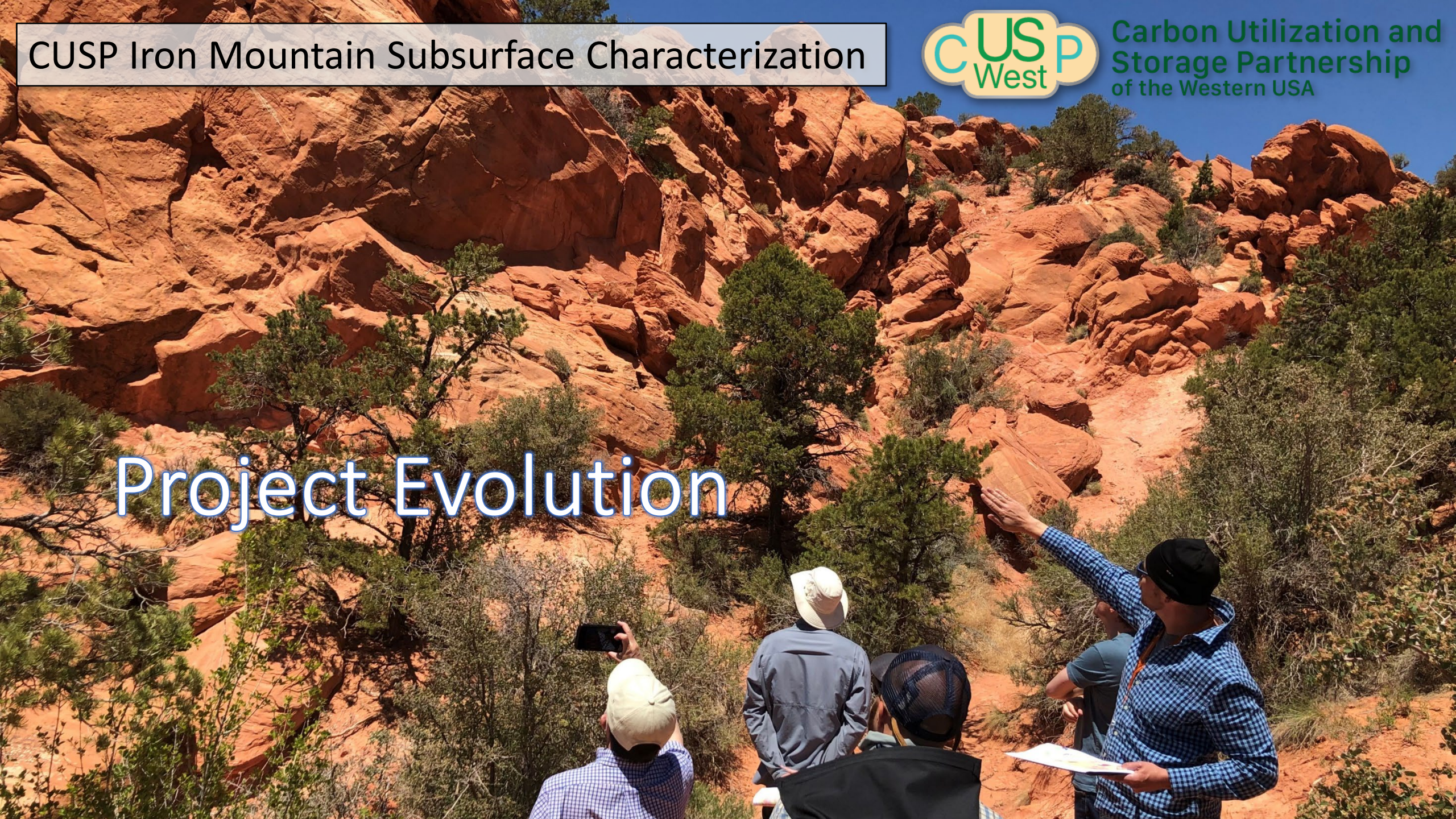
Project Evolution



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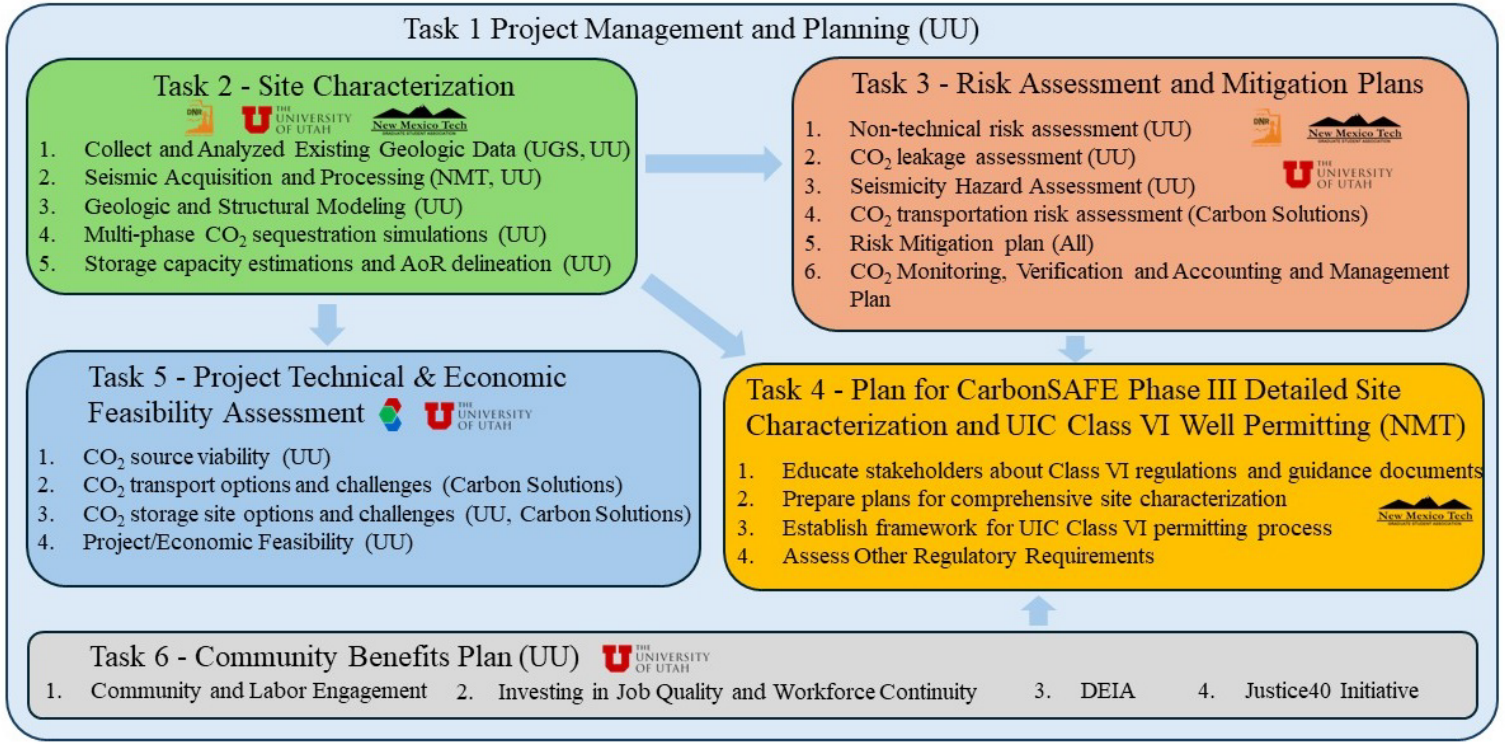
Carbon Utilization and Storage Partnership of the Western USA

CarbonSAFE Phase II: Storage Complex Feasibility Basin and Range Southwest Utah

DE-FOA-0002711:
Bipartisan Infrastructure Law (BIL): Storage Validation and Testing (Section 40305): Carbon Storage Assurance Facility Enterprise (CarbonSAFE): Phases II, III, III.5, and IV
Area of Interest 4: CarbonSAFE Phase II: Storage Complex Feasibility

Project Partners:

- Utah Iron
- Utah Geologic Survey
- Fervo Energy
- Cyrq Energy
- AirMyne
- New Mexico Tech
- University of Oklahoma
- Carbon Solutions



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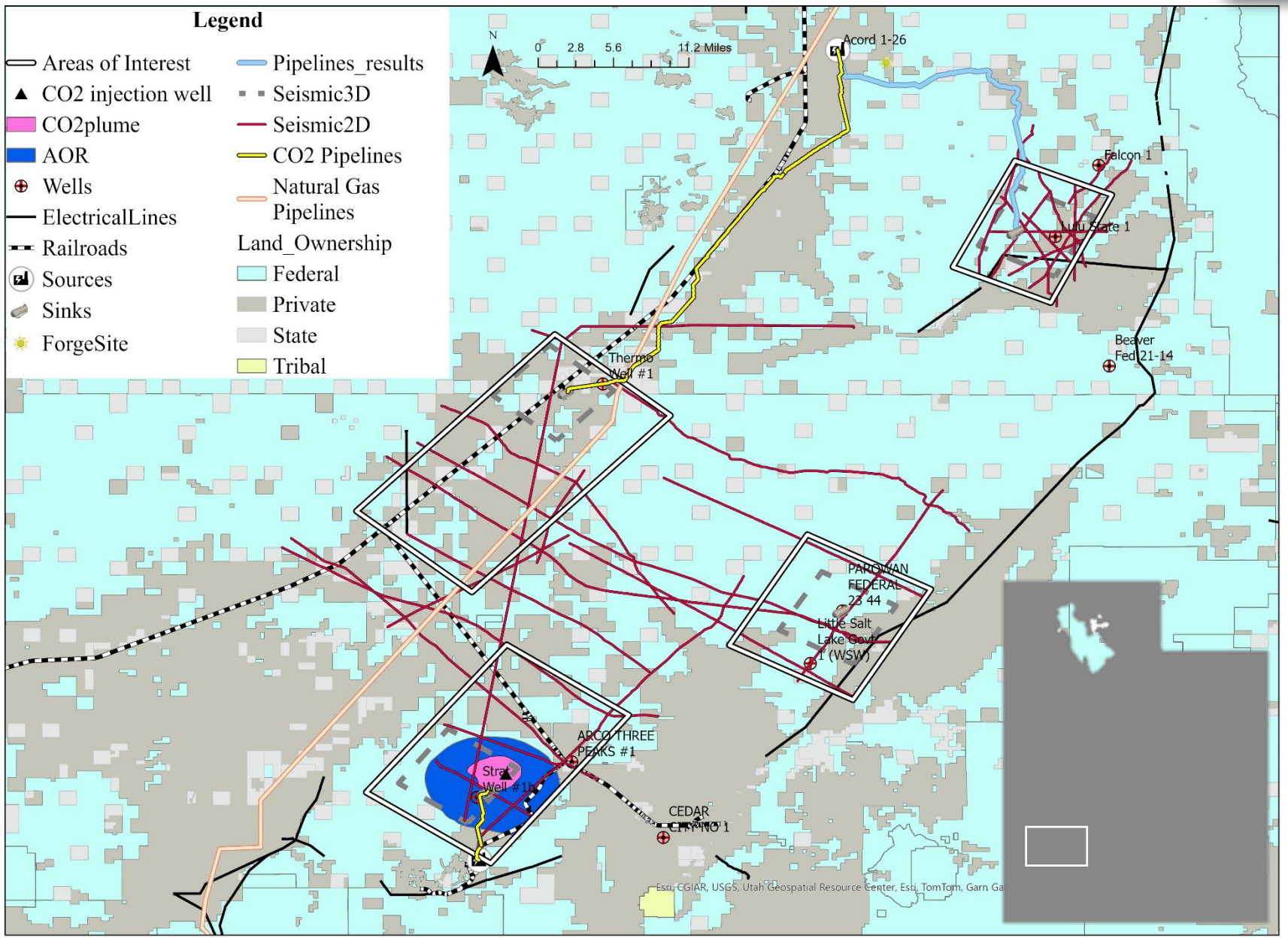

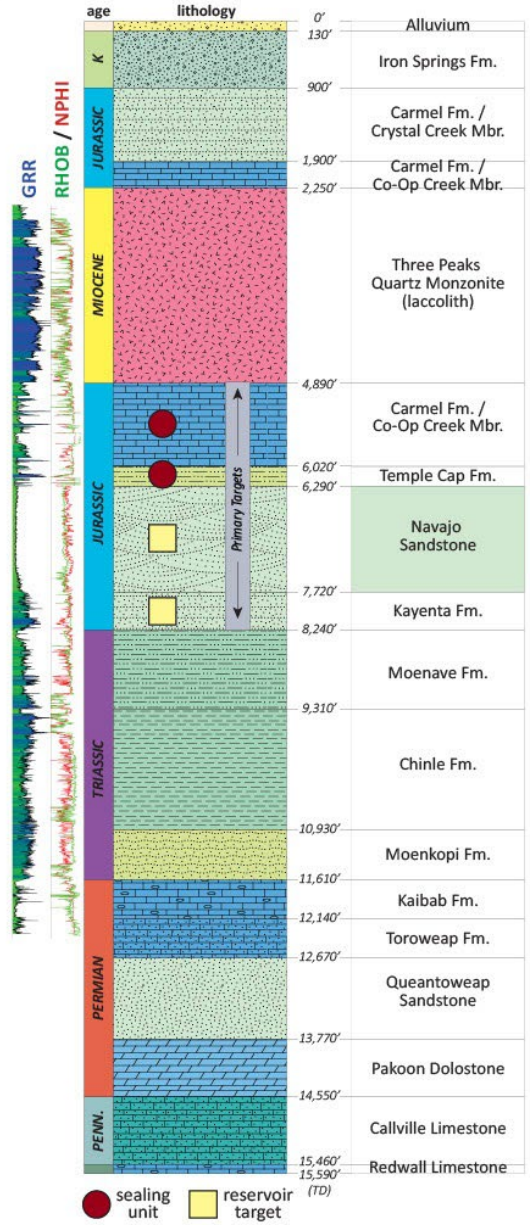

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Questions?

Acknowledgements

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