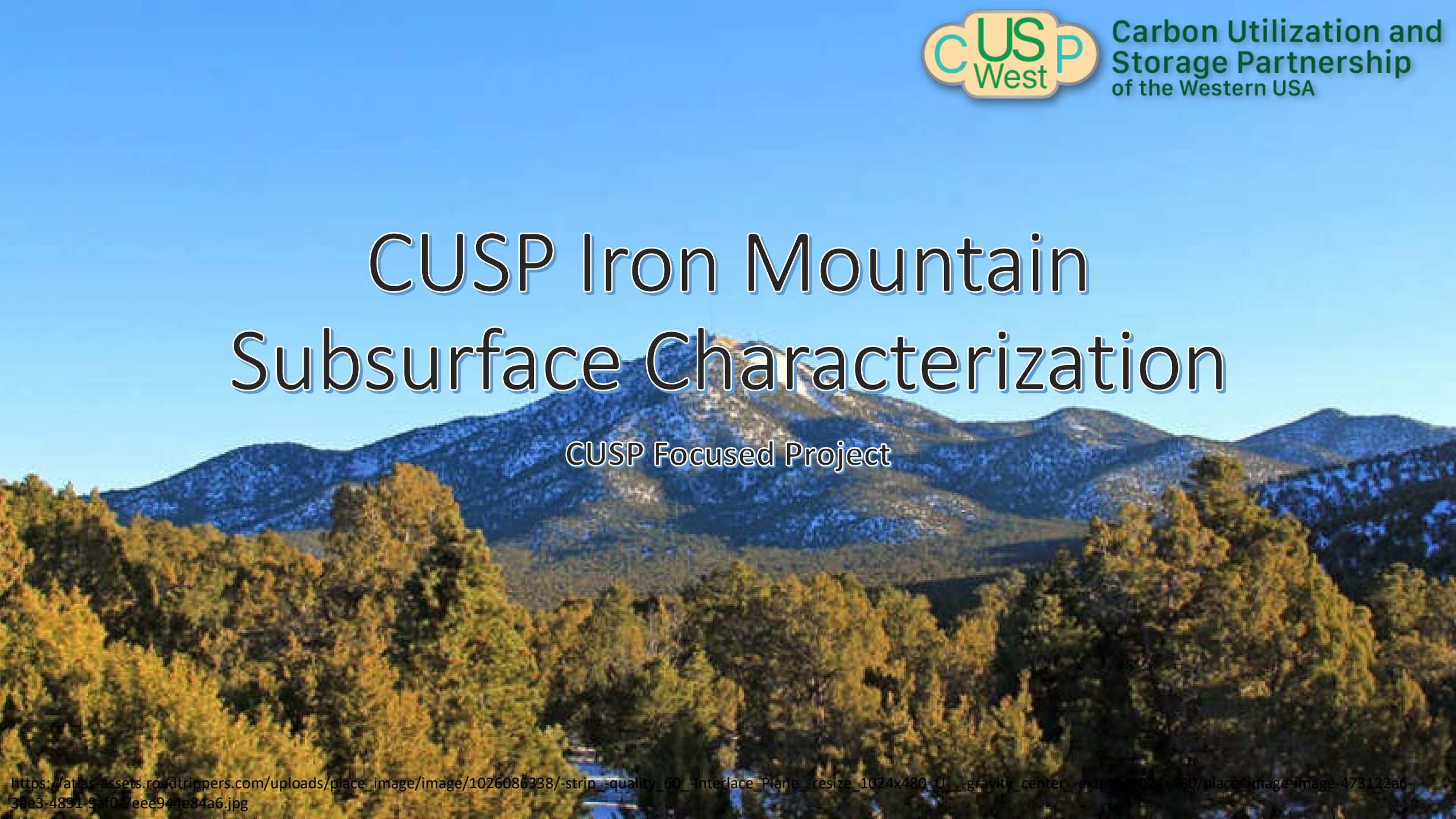
Carbon Utilization and Storage Partnership of the Western USA

# CUSP Iron Mountain Subsurface Characterization

CUSP Focused Project



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# Acknowledgements

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# CUSP Iron Mountain Subsurface Characterization

Carbon Utilization and Storage Partnership of the Western USA

## Presentation Outline

- CUSP sub-team
- CCS potential in the Wester US and CUSP Partnership
- Iron Mountain Subsurface Characterization project and goals
- DRI Process and Impact on Carbon Storage development
- Legacy geologic data
- Project information and timeline

# CUSP Iron Mountain Subsurface Characterization

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

## CUSP sub-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
  - CandaceCadyConsulting LLC

New Mexico Tech — Science • Engineering • Research • University

Utah DNR — Utah Geological Survey

The University of Utah


Oklahoma University

Oklahoma Geological Survey — OGS — 1908

Kansas Geological Survey — University of Kansas

Los Alamos National Laboratory — Est. 1943

Montana State University — Mountains & Minds

CandaceCCadyConsulting, LLC

Carbon Solutions LLC

# CUSP Iron Mountain Subsurface Characterization

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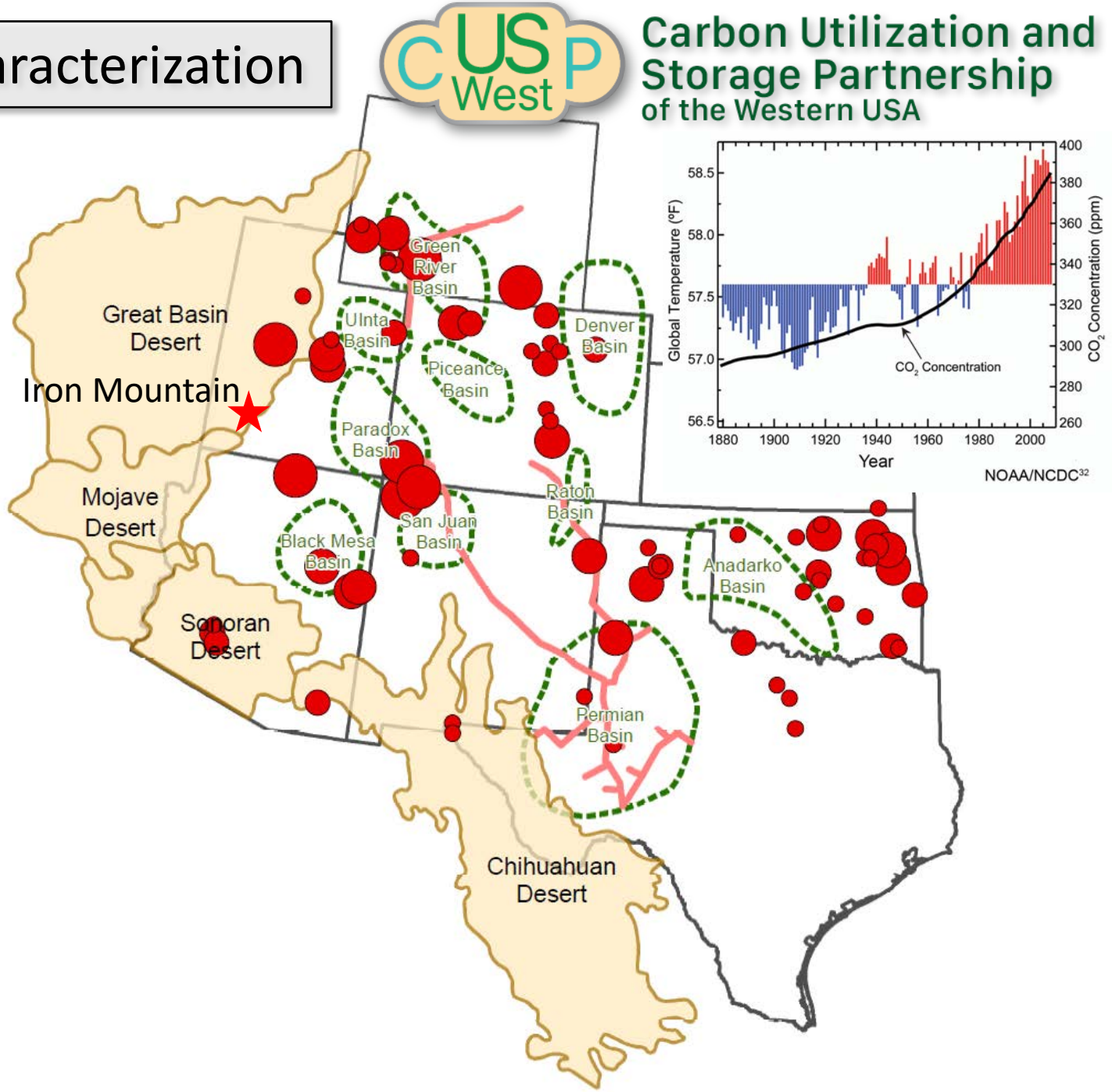
## Region sources and sinks of the Western US

1. Why CCS?
2. String of pearls
    1. We need to link sources and sinks to create a regional CCS ‘economy’
3. Major point sources are easier to Identify
4. Suitable GCS sites are much more work identify and characterize
    1. The Great Basin is one such poorly characterized potential carbon sink



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## CUSP Regional Partnership

- ***Project Goal: Improve understanding of storage systems and carbon sources***
  - Identifying best prospects for commercial CCUS
  - Quantifying potential economic impacts
  - Developing Readiness Indices (w/ SimCCS) to identify best areas for short-term, mid-term, and long-term CCUS projects
- Focus is on collecting, synthesizing, and use of existing data sets to improve coverage, accuracy, and granularity of existing data
- Evaluate CCUS potential and readiness
  - Incorporate data into analytical and optimization models to. geological storage complexes (saline, stacked storage, ROZs)
  - $CO_2$ emission sources
  - existing infrastructure
- Strong emphasis on technology transfer


*CUSP Member States & Organizations*

# CUSP Iron Mountain Subsurface Characterization

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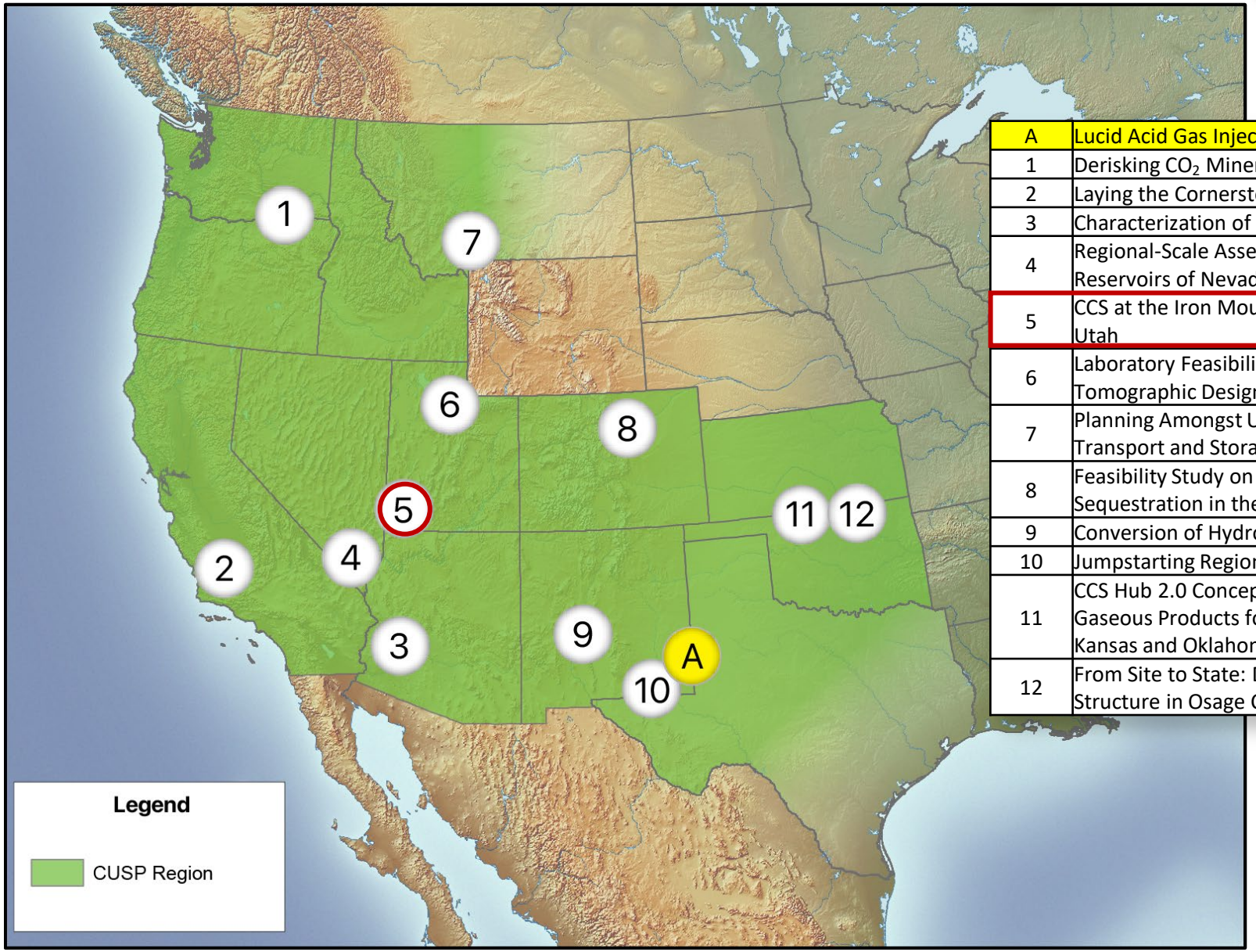


| | |
|---|---|
| A | Lucid Acid Gas Injection Project |
| 1 | Derisking $CO_2$ Mineralization Storage in Basalt Reservoirs |
| 2 | Laying the Cornerstones of a Regional Storage Hub in California |
| 3 | Characterization of $CO_2$ storage potential in Harquahala basin western central Arizona |
| 4 | Regional-Scale Assessment of $CO_2$ Geological Storage in Sedimentary Basin Geothermal Reservoirs of Nevada |
| 5 | CCS at the Iron Mountain Iron Mine and Direct Reduced Iron Processing Plant, Southern Utah |
| 6 | Laboratory Feasibility Study for Eventual Field Deployment of a Downhole Source Tomographic Design for $CO_2$ Plume Detection |
| 7 | Planning Amongst Uncertainty Designing CCS Infrastructure Resilient to Capture, Transport and Storage Uncertainty |
| 8 | Feasibility Study on a Potential CCS Project in Colorado $CO_2$ Capture from a Refinery and Sequestration in the DJ Basin |
| 9 | Conversion of Hydrogen from Natural Gas and Integration with $CO_2$ Capture and Storage |
| 10 | Jumpstarting Regional CCS Through Co-optimized $CO_2$ and Water Disposal |
| 11 | CCS Hub 2.0 Concept for ONEOK Infrastructure Development for Handling of New Gaseous Products for Natural Gas Liquids Fractionation and Gas Processing Plants in Kansas and Oklahoma |
| 12 | From Site to State: Design of an Integrated CCS Operation in a Complex Geological Structure in Osage County, Oklahoma |

# CUSP Iron Mountain Subsurface Characterization

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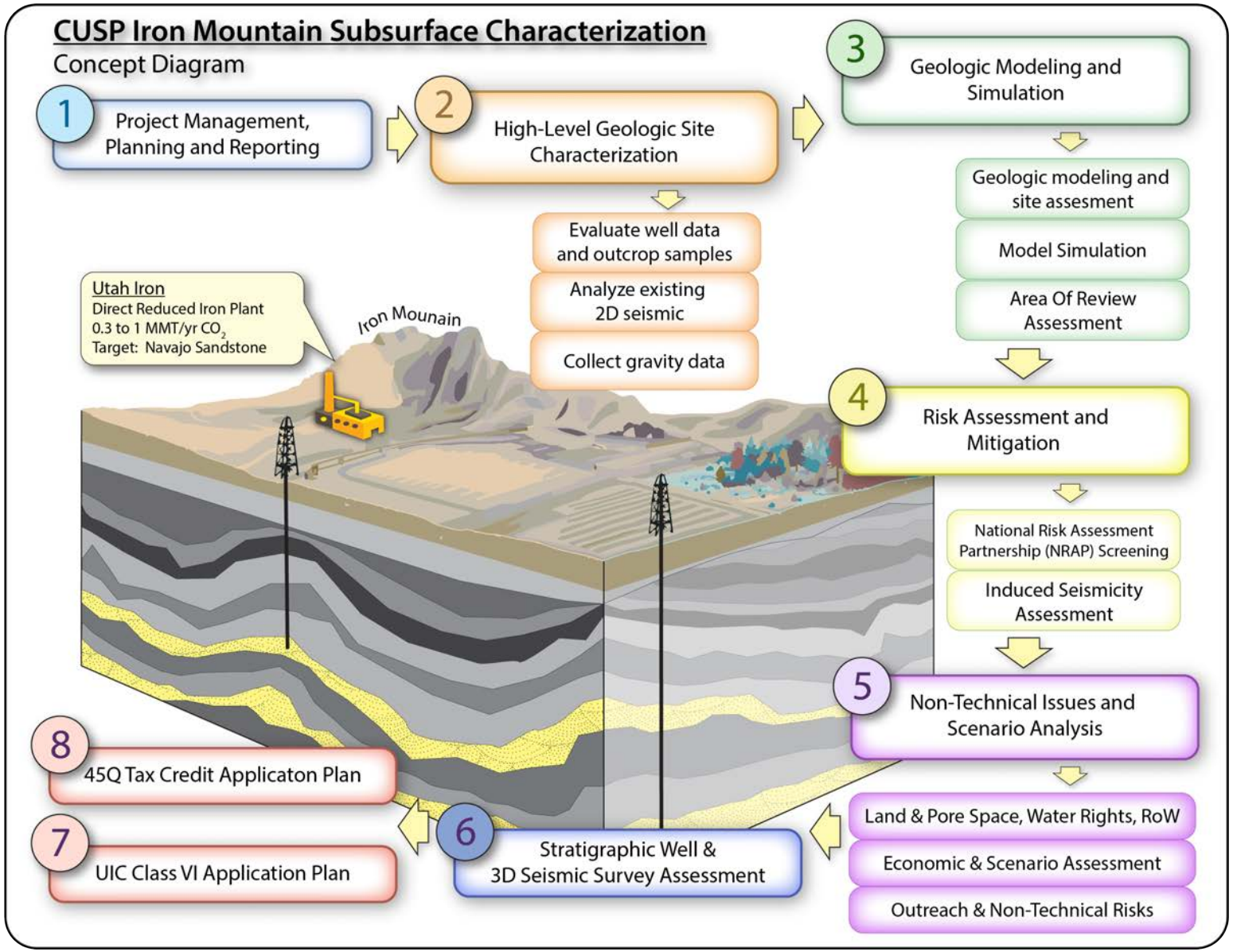
## CUSP Focused Project Concept Diagram

- 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 300,000 to 1 million metric tons of $CO_2$ generated from Direct Reduced Iron (DRI) process
- Three potential storage formation
  - The Navajo Sandstone, the Wingate Sandstone, and Kaibab Limestone



# CUSP Iron Mountain Subsurface Characterization

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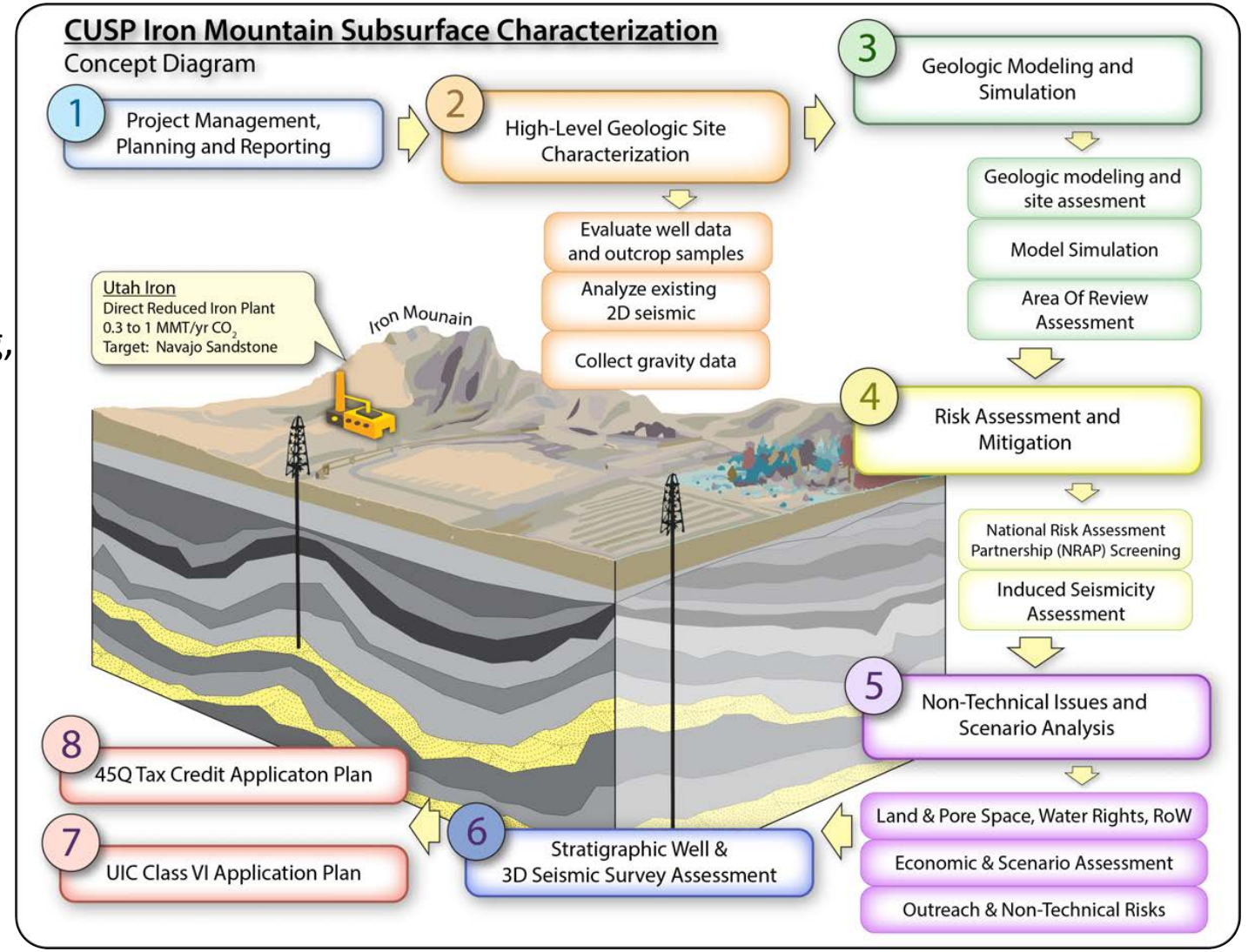
## Primary goals

1. Rigorous site characterization and analysis of storage capacity, risks and economic options for CCUS at Iron Mountain
2. Comprehensive plan for developing a monitoring, reporting, and verification (MVA) plan
3. Comprehensive plan for 3D seismic survey and stratigraphic well
4. Comprehensive plans for assembling UIC Class VI and 45Q tax credit applications

The nature and success of these objectives depend explicitly on the target storage formation and its specific geologic setting



# CUSP Iron Mountain Subsurface Characterization

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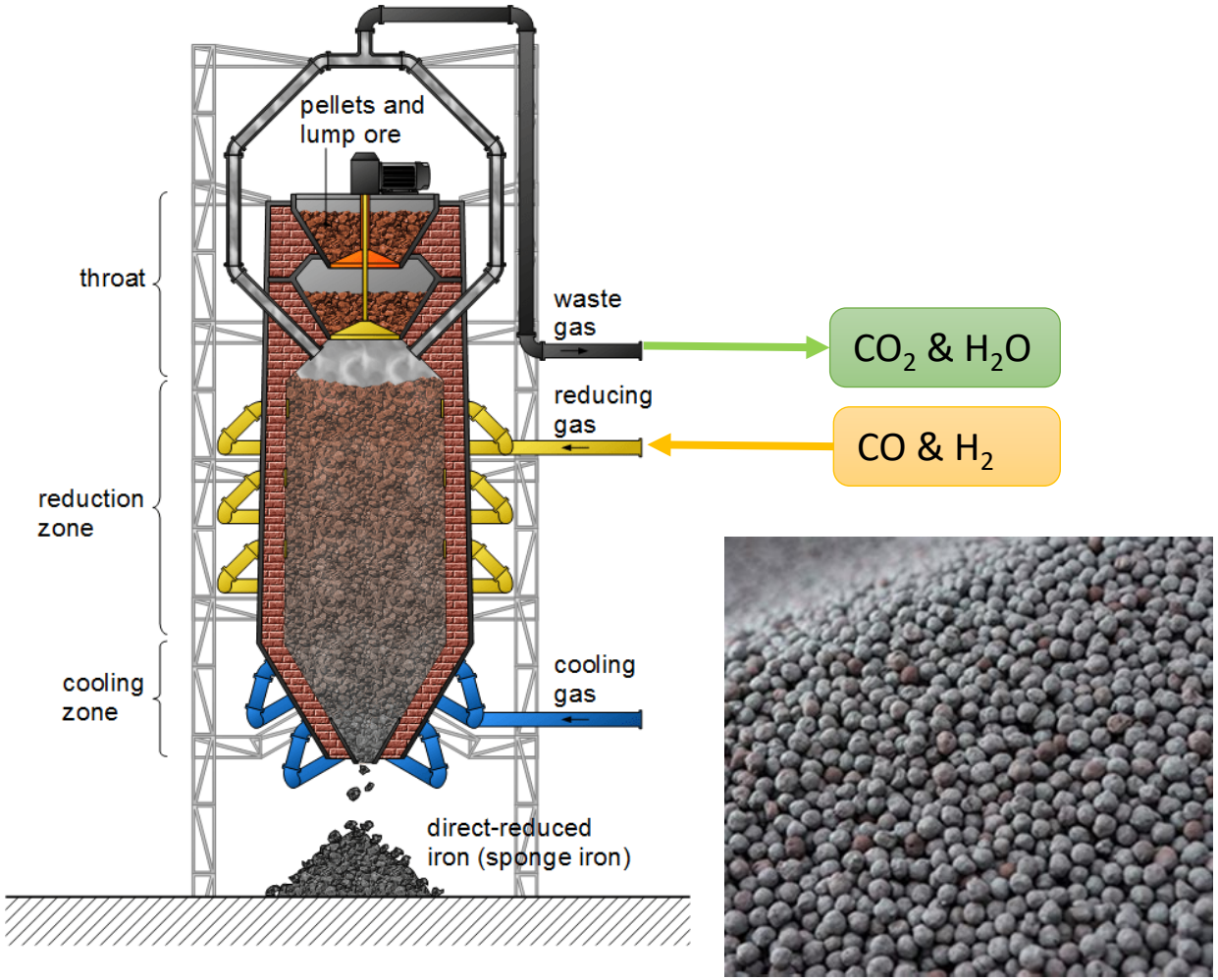
## Direct Reduced Iron (DRI) Process

- Direct Reduced Iron refers to the solid-state processes of reducing iron oxides to metallic iron at temperatures below the melting point of iron
  - Lower temp than blast furnace <1,000 °C
- CO and $H_2$ are produced by $CH_4$ catalysis and heated before entering the reactor
- Iron reduction reactions occur producing $CO_2$ and water
- $CO_2$ can then be stripped, compressed, and stored
- Iron is cooled and sent for further processing into steal

Iron reduction reactions

$$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$$

$$Fe_2O_3 + 3H_2 \rightarrow 2Fe + 3H_2O$$




https://www.lmmgroupcn.com/direct-reduced-iron-process/

# CUSP Iron Mountain Subsurface Characterization

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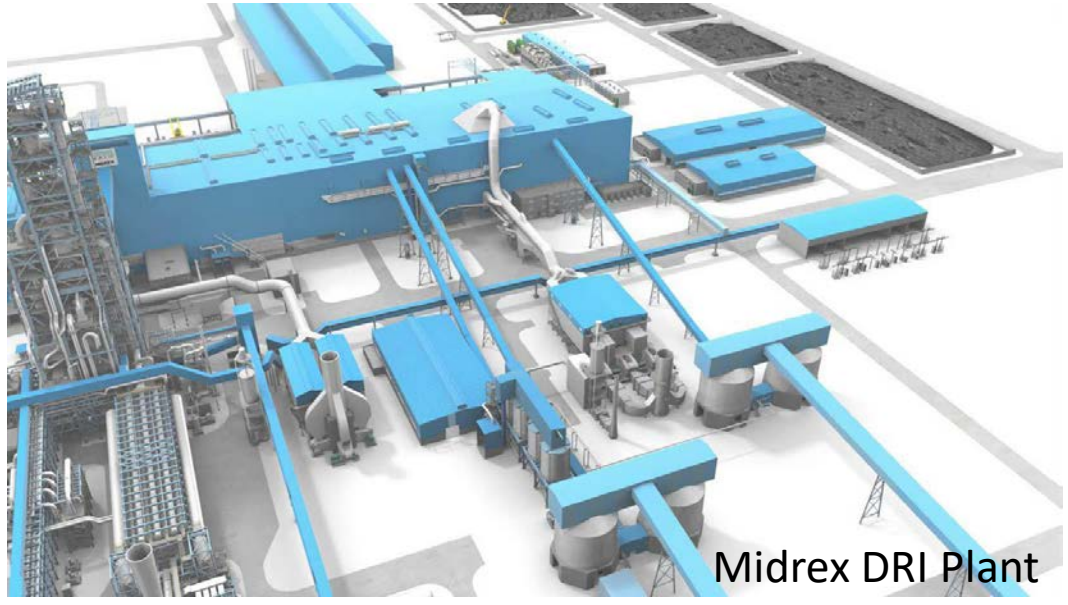
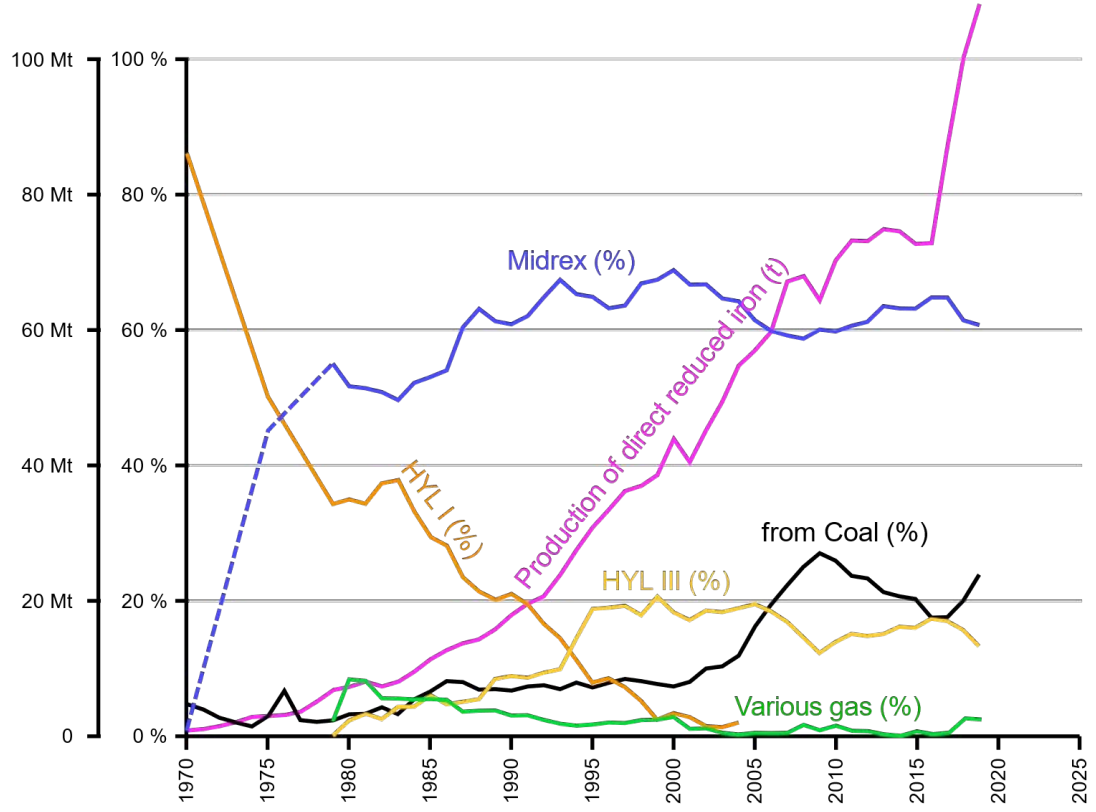
## Impact on Carbon Storage

- First of its kind commercial-scale iron ore processing + CCS. It will prove the viability of using CCS to make green steal.
  - New innovations may also result in H2 production
- First commercial-scale CCS operation in Utah
- Characterization of a potential $CO_2$ storage complex that may serve as an analog for other potential basin and range storage sites.



Midrex DRI Plant



# CUSP Iron Mountain Subsurface Characterization

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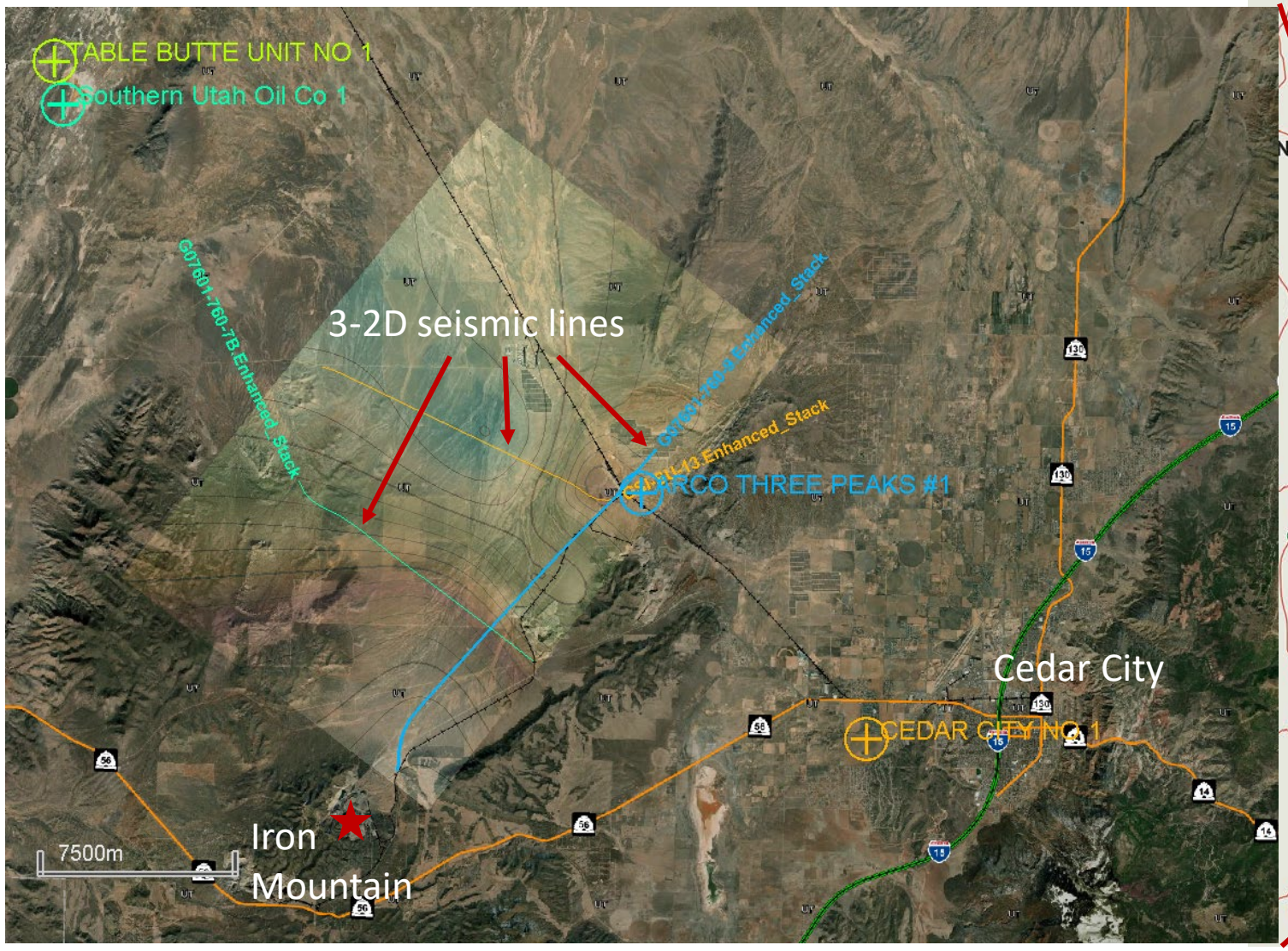
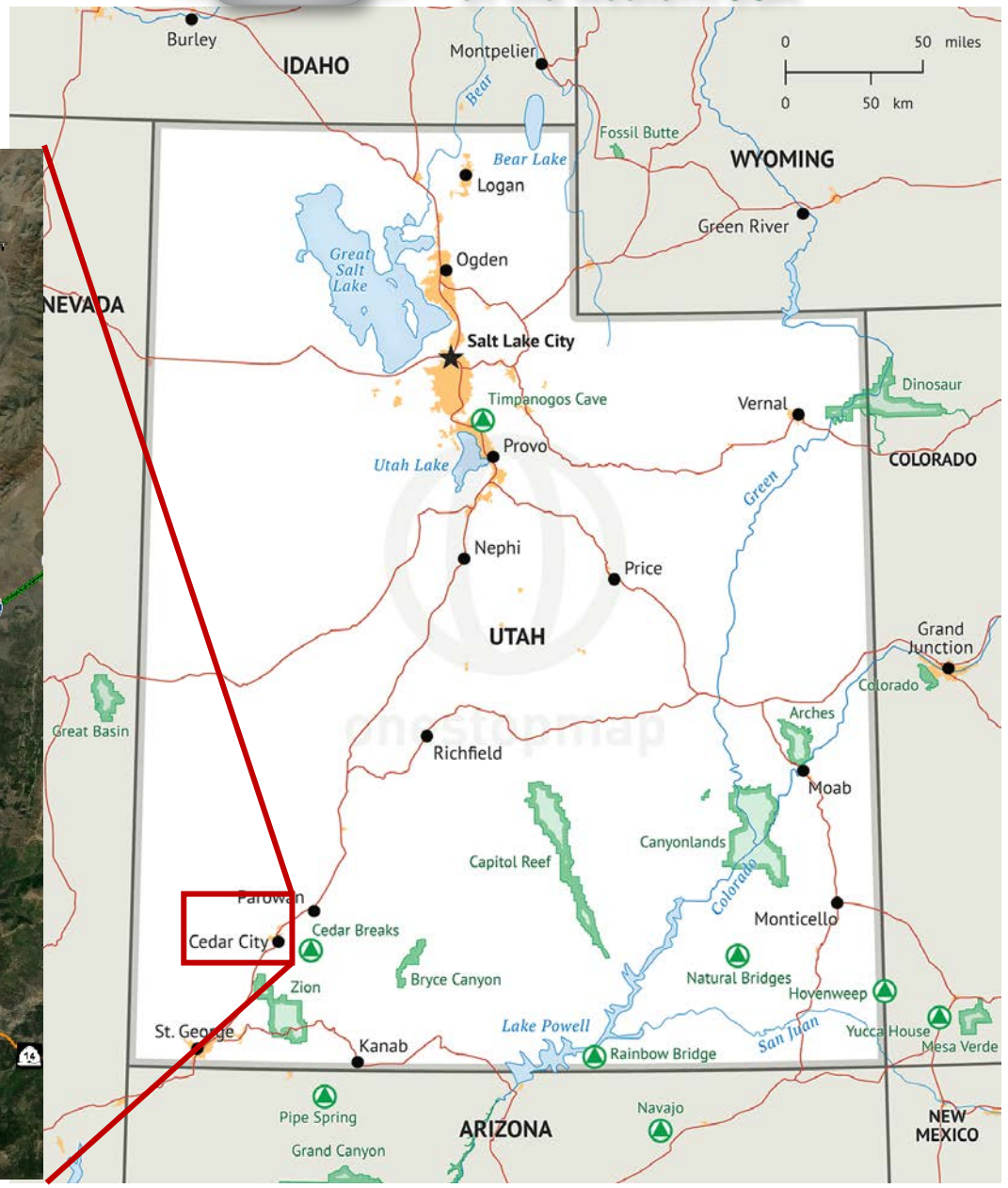
## CUSP Focus Project Location



# CUSP Iron Mountain Subsurface Characterization

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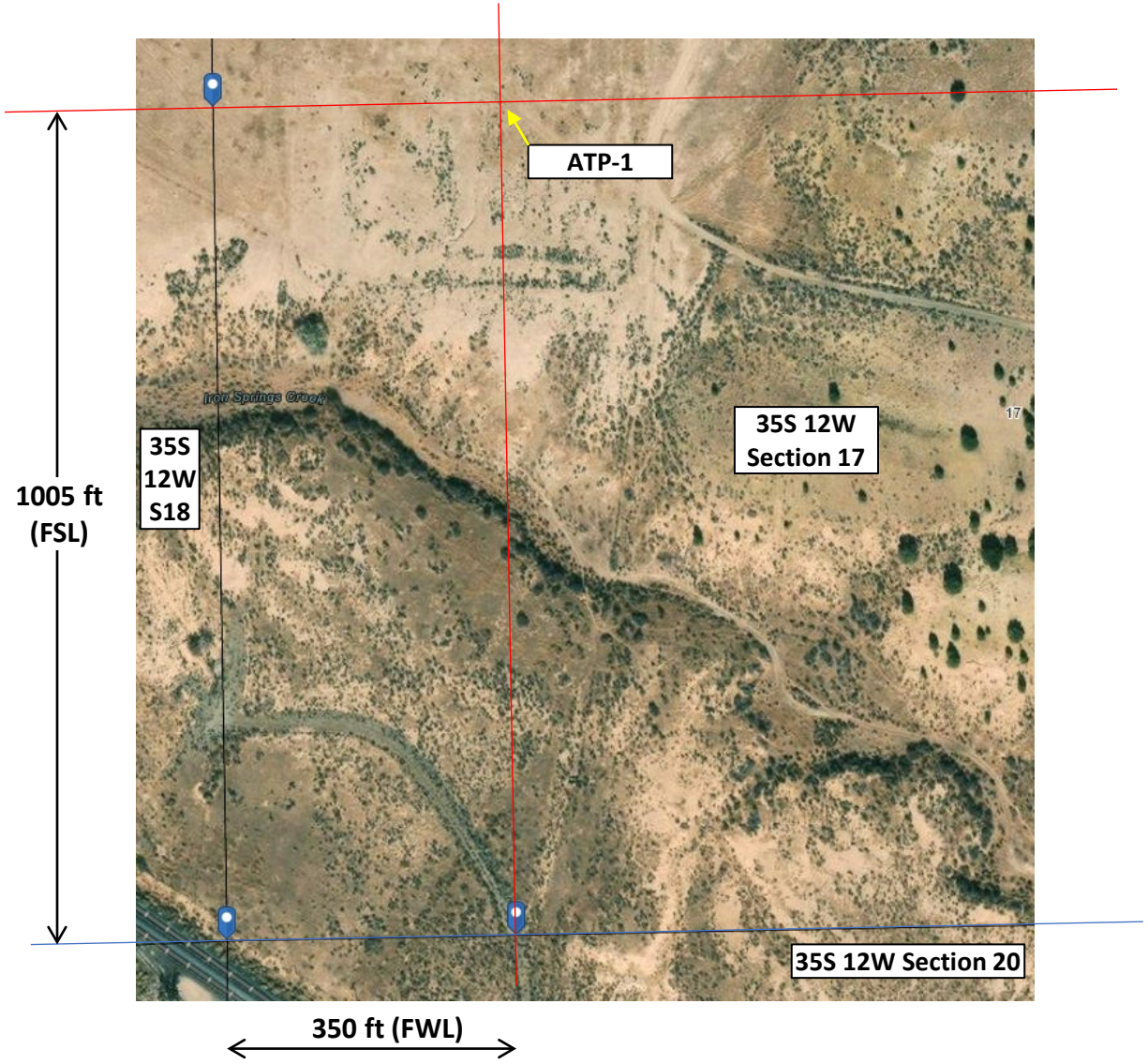
## Legacy Data

- Arco Three-Peeks #1 (ATP-1)
  - LAS well logs
  - Cutting and core
  - Formation tops
- Three 2D Seismic lines
  - Old lines, not the best quality
- Aeromag data for the area
- Gravity data for the area
  - Data set is being expanded with another survey planned for June



# CUSP Iron Mountain Subsurface Characterization

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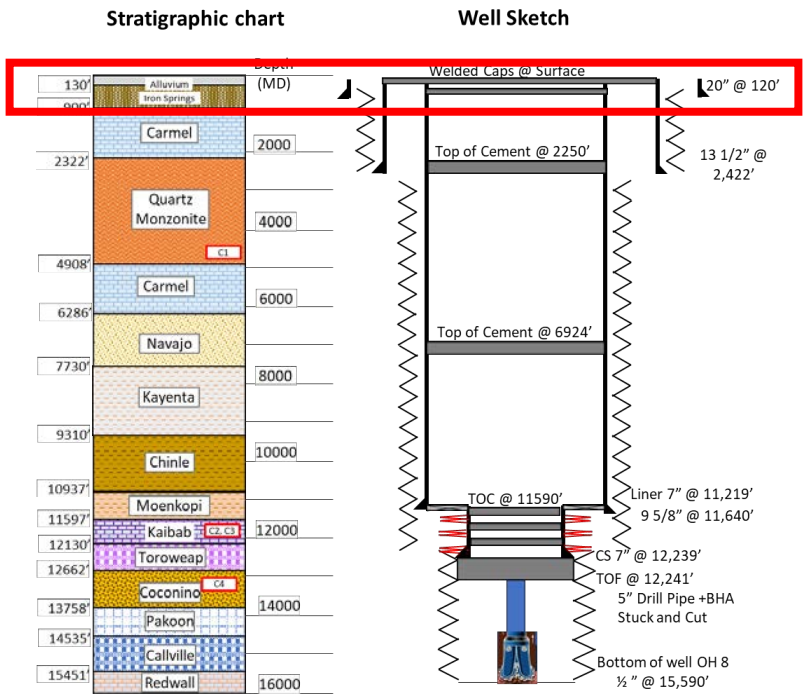
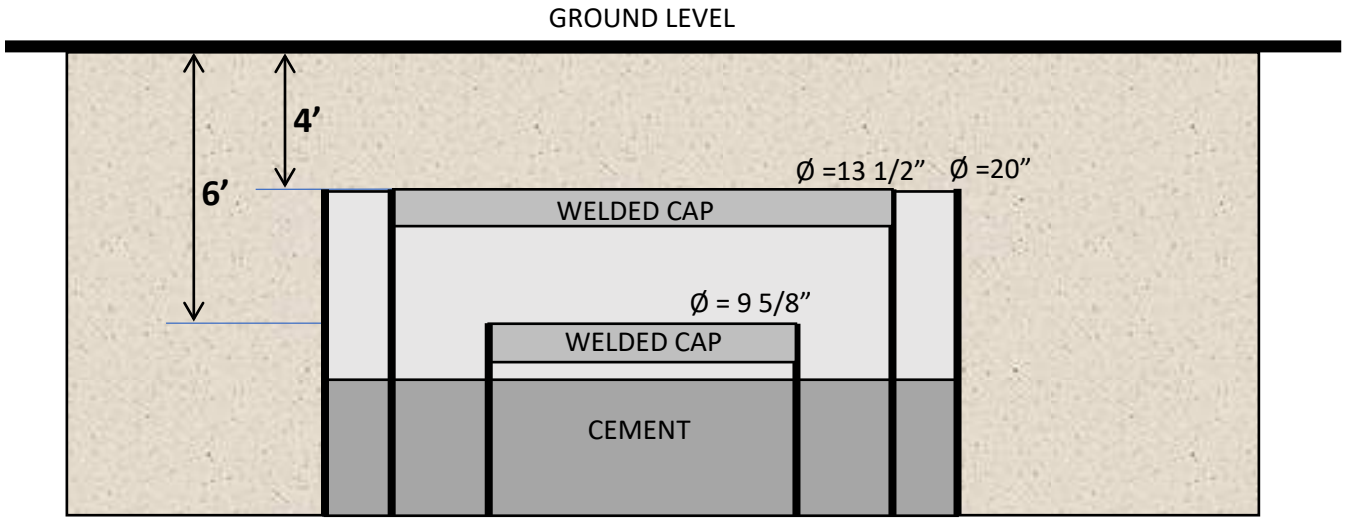
## ATP-1 Well Status at Surface

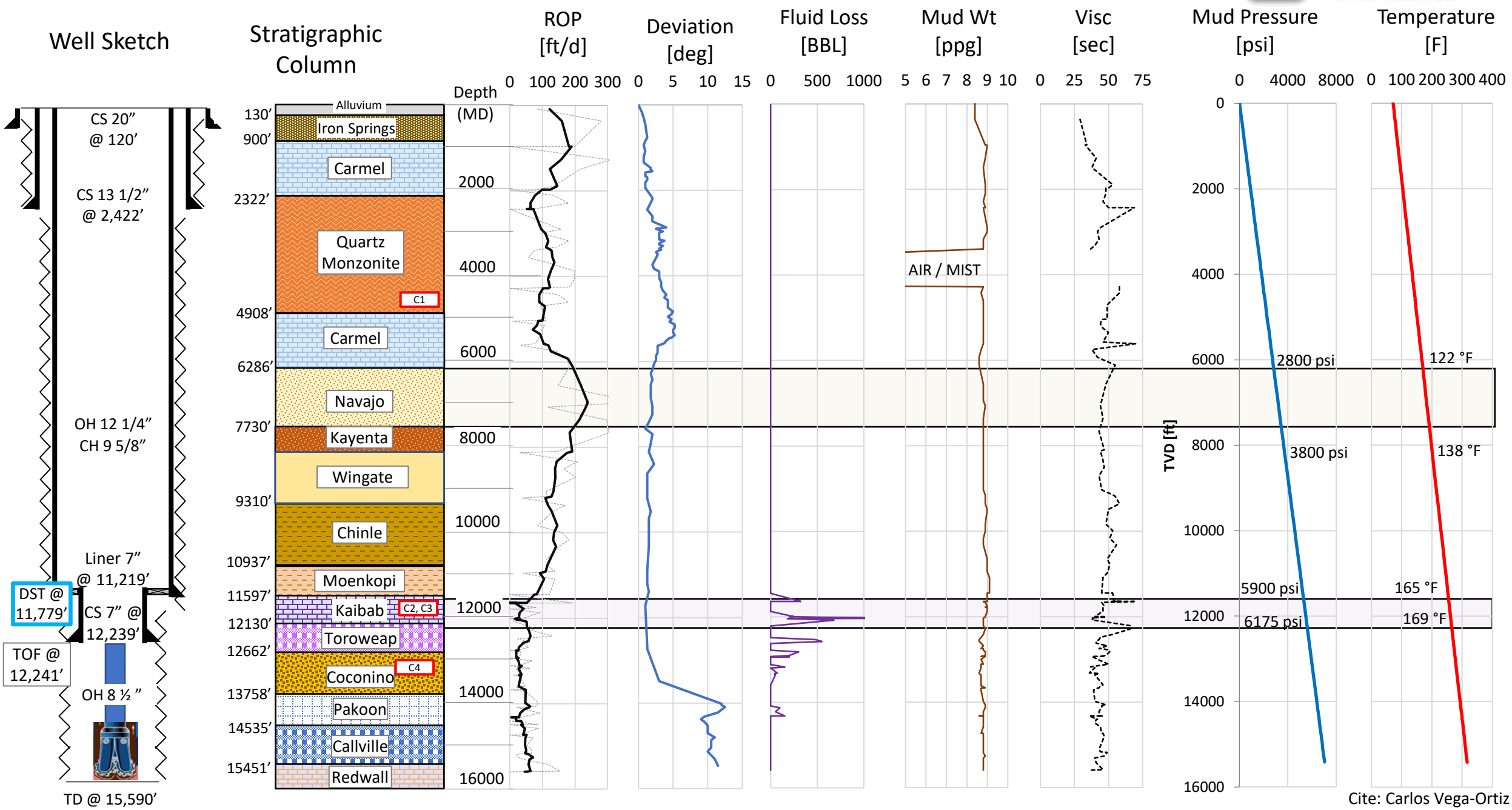
- 9 5/8” Casing: Cut at 6’ from ground level. Cap Welded
- 13 1/2” Casing: Cut at 4’ from ground level. Cap Welded
- 20” Casing: Unclear. Assumed to be cut at 6’ from ground level
- Annulars cemented




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

# ATP-1 Strat Column




Cite: Carlos Vega-Ortiz

# CUSP Iron Mountain Subsurface Characterization

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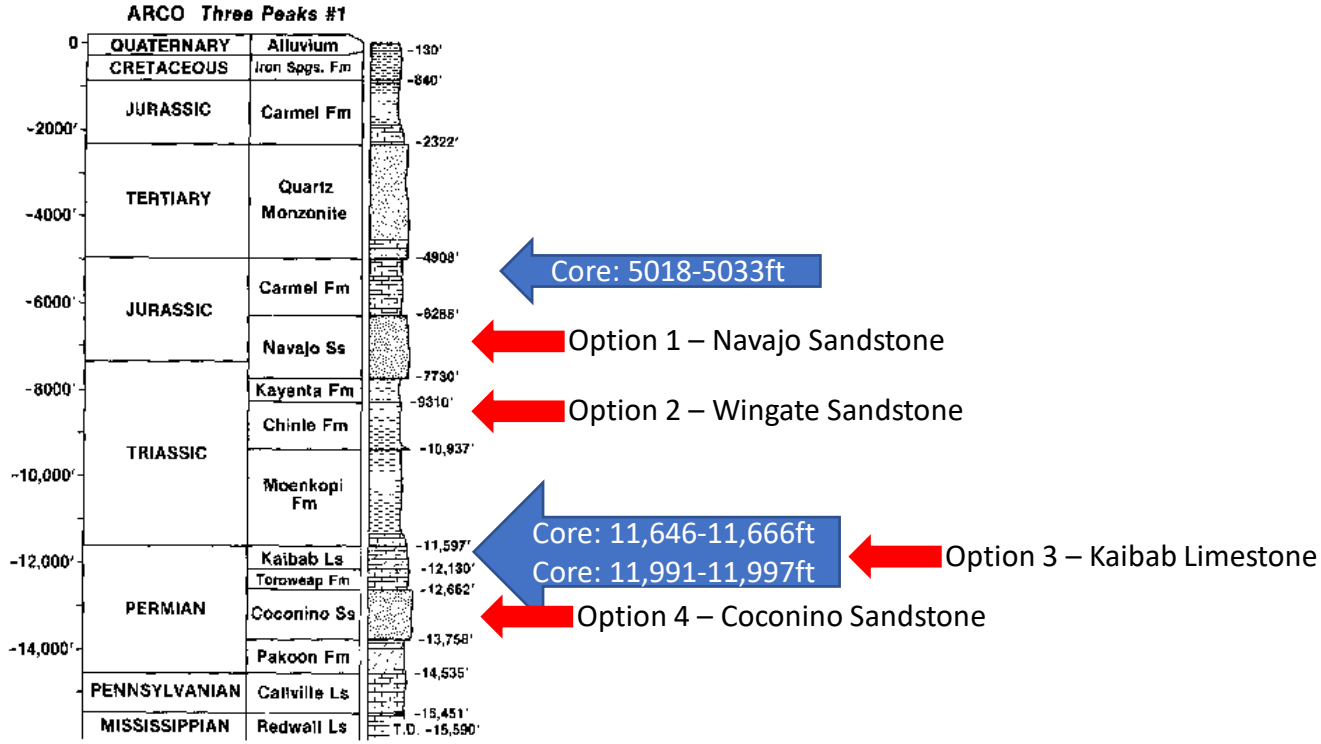
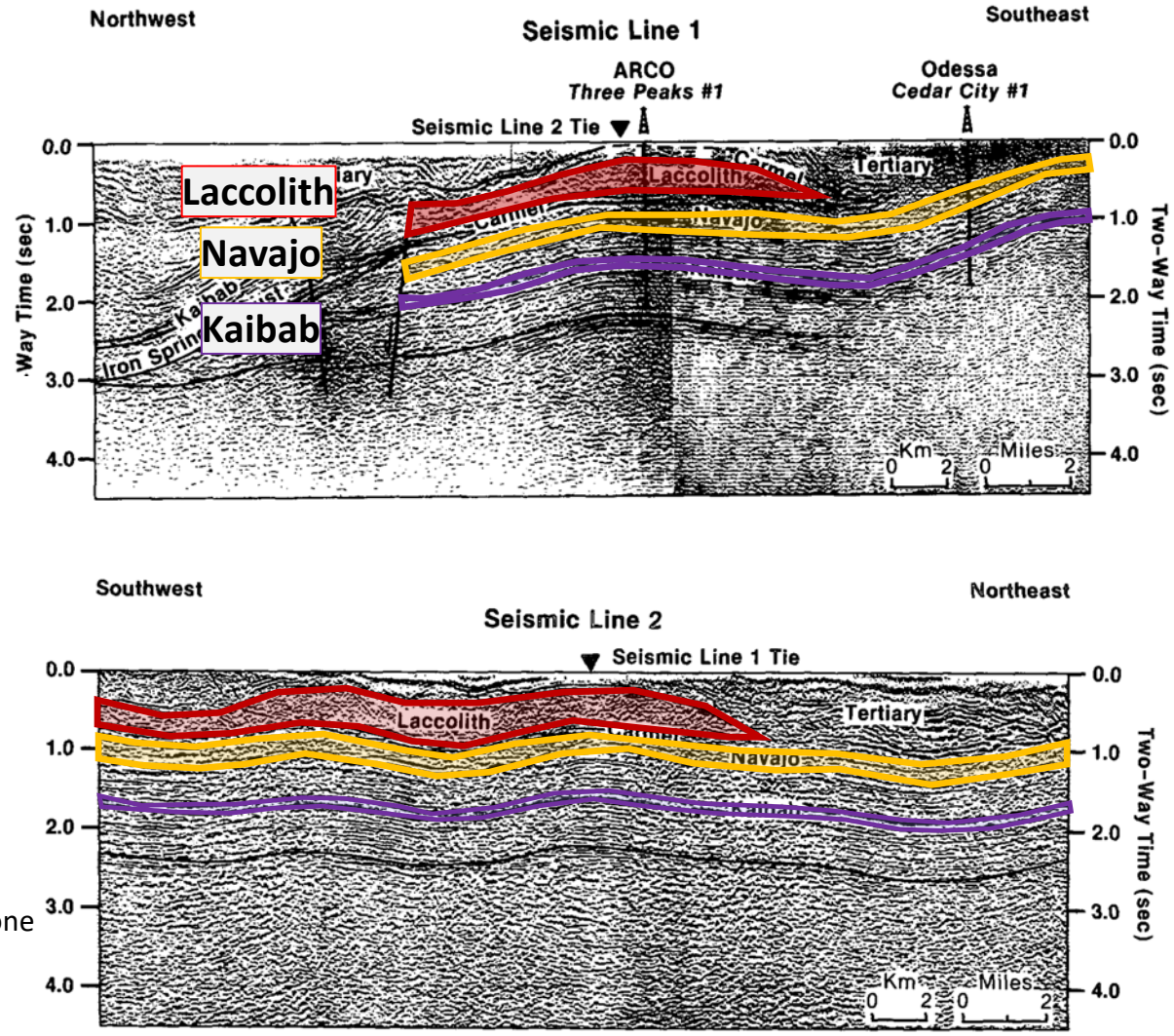
## Geologic Structure of Iron Mountain Valley

- Primary CCS target is the Navajo Sandstone at 6,200 ft
- Secondary CCS target Wingate Sandstone at 9,3000 ft
- Tertiary CCS target is the Kaibab Limestone at 11,600 ft




Van Kooten, 1988

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## Seismic Lines and Aeromag Data

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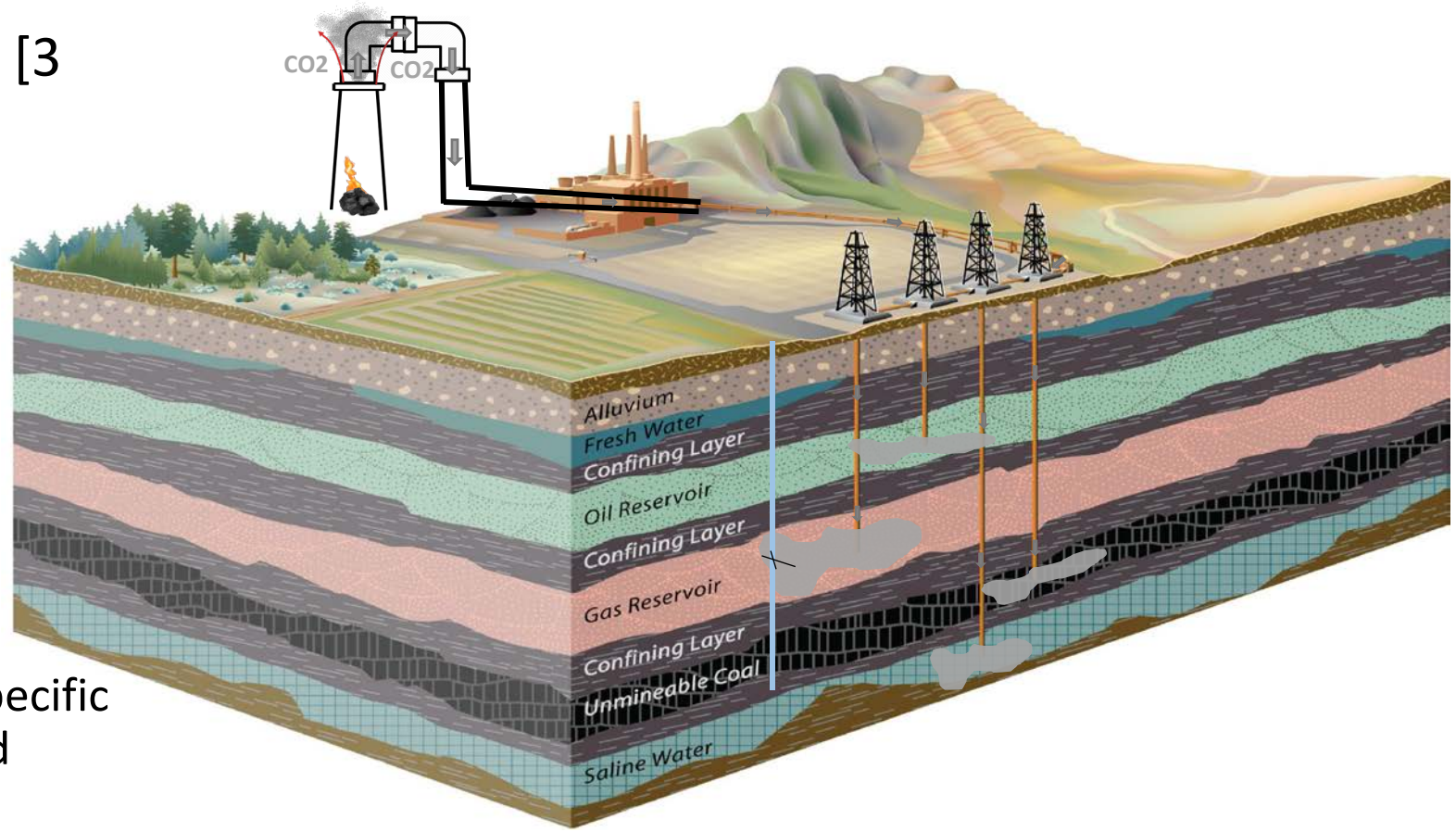
## Additional CUSP Focused Project Information

- Project duration
  - Jan 1st, 2022 to Dec 31st, 2024 [3 years]
- Anticipated time to CCS implementation
  - 5 to 8 years
- Anticipated volume/year
  - 0.3 to 1.0 Mt/yr over 30 yrs
  - Estimated 9 to 30 million tons
    - Emissions targets depend on specific DRI process being implemented



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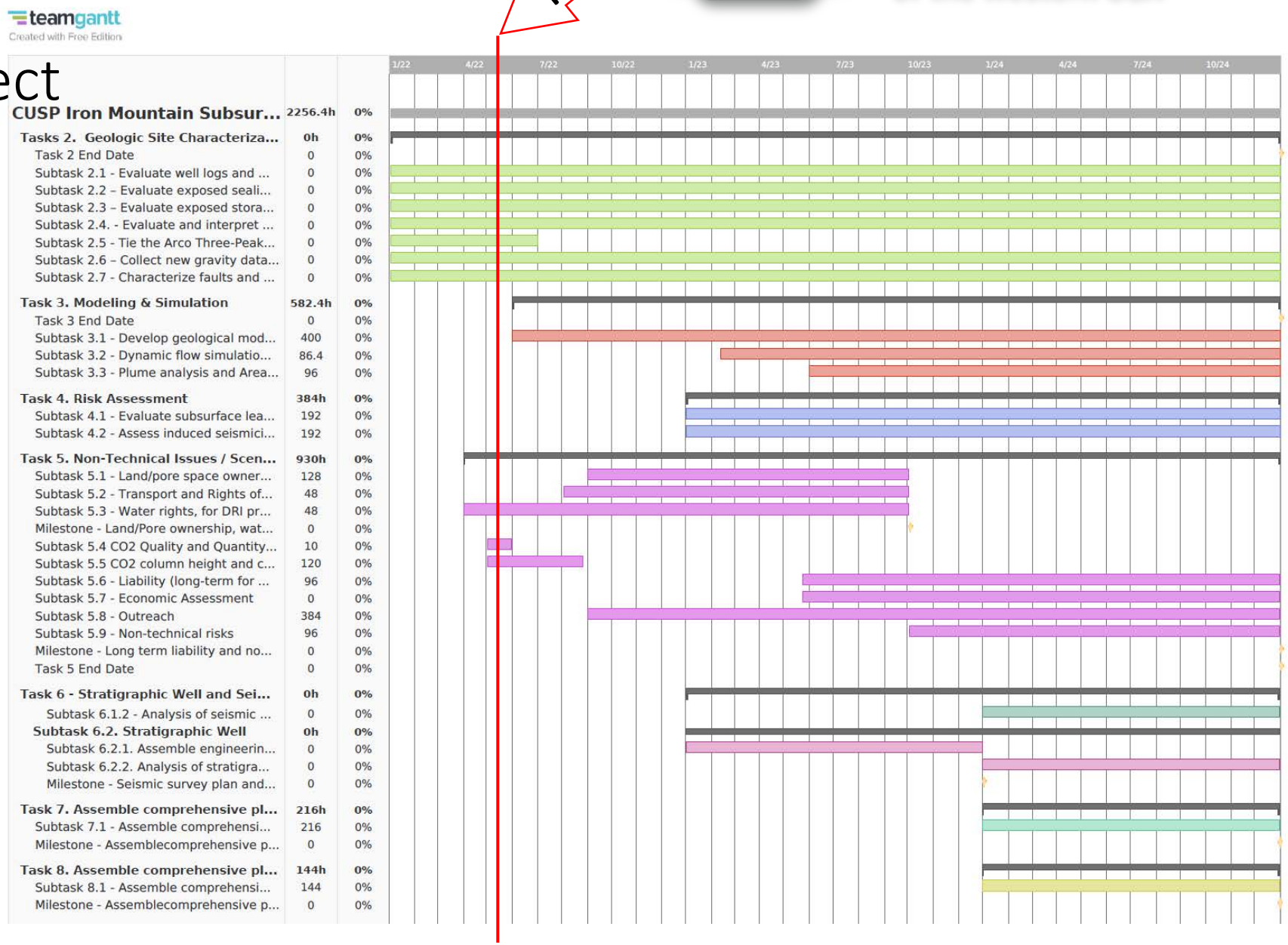
## CUSP Focused Project Gant Chart

What we have already started

1. Acquired well cuttings and core for Arco Three-Peaks well
2. UGS began work on cuttings
3. Cuttings samples sent to OGS
   Analysis started
4. Gravity survey is underway
   June planned for final survey
5. Outcropping survey and sample collection
6. Seismic well tie and fault analysis are underway



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