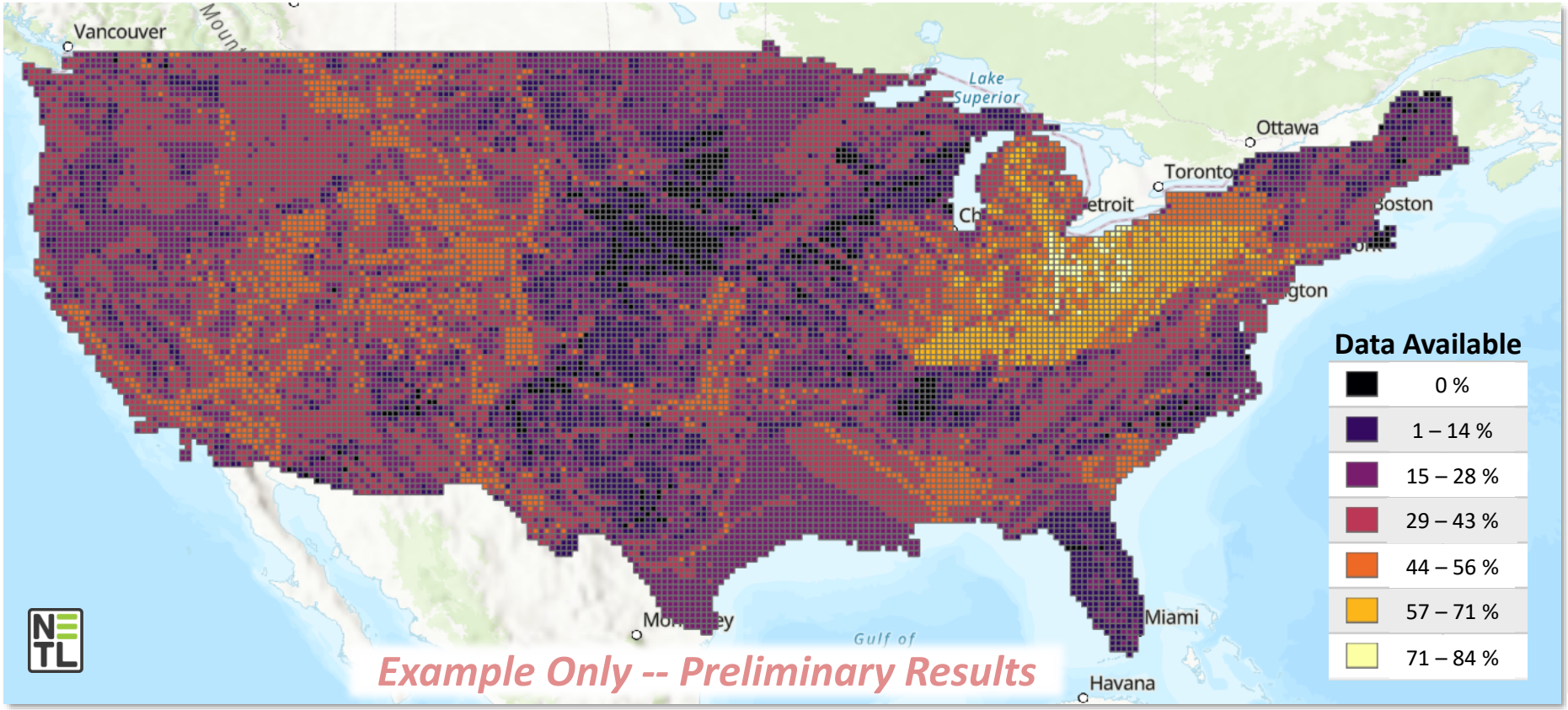
# Where are the Data? Automating a Workflow for Carbon Storage Data Gap Analyses

***Gabe Creason***

*National Energy Technology Laboratory*

***2024 FECM/NETL Carbon Management Research Project Review Meeting***




***August 2024***

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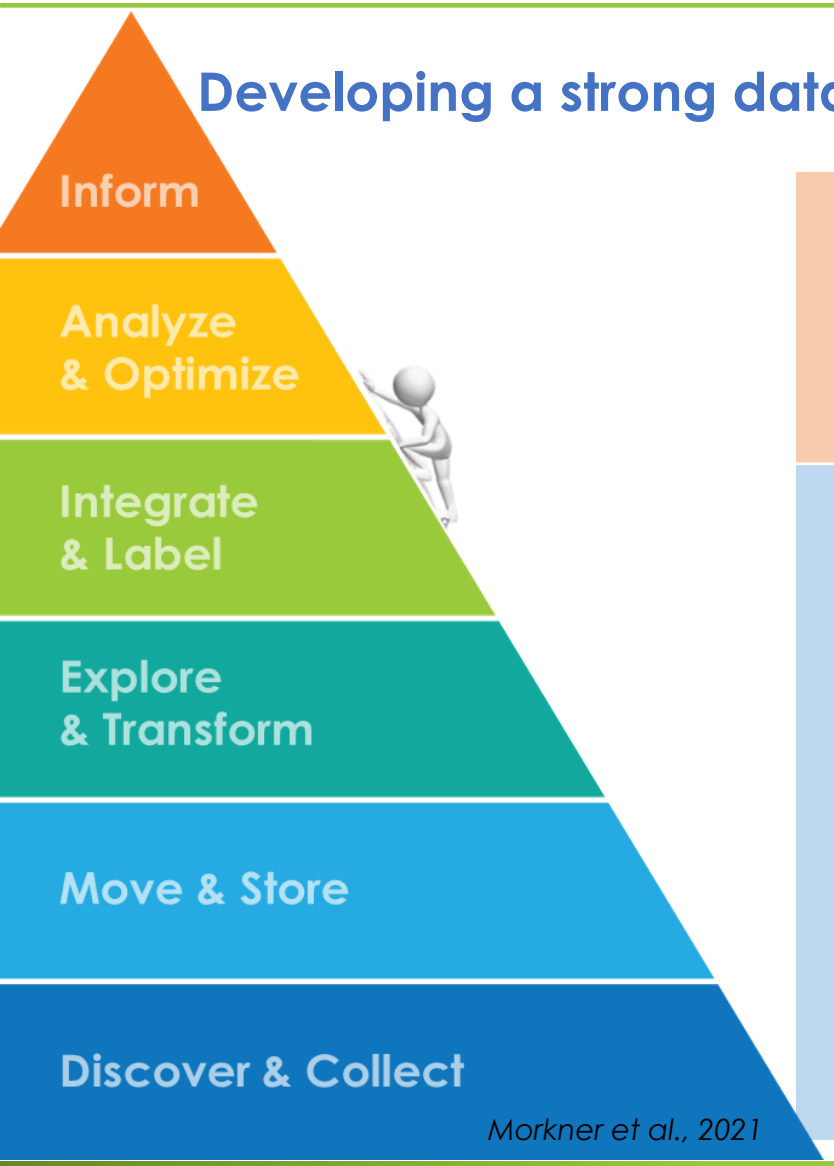
# Data are the *Energy* for Analysis & Inquiry

NATIONAL ENERGY TECHNOLOGY LABORATORY

## Developing a strong data foundation is key to any program/project's success




*Morkner et al., 2021*

**20%**

**80%**

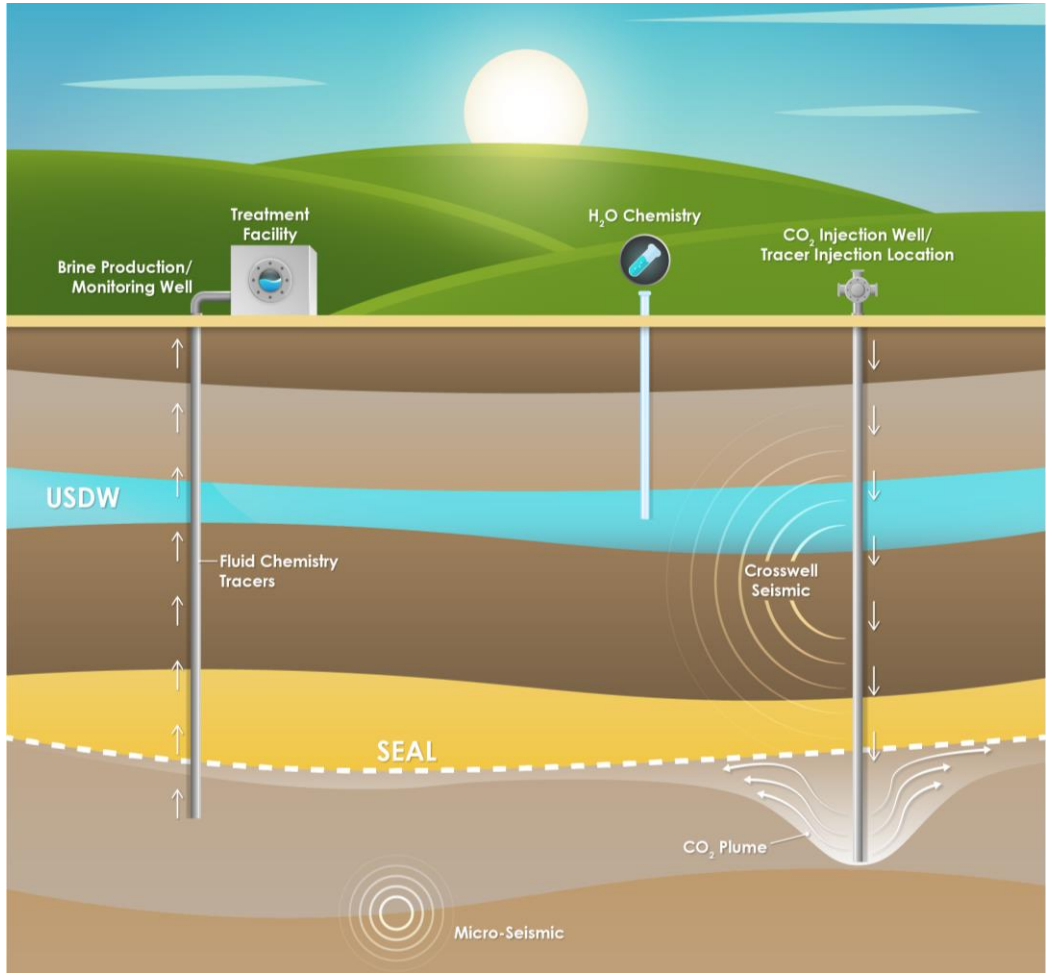
Data-driven teams can spend up to ~80% of their time addressing the bottom components of the "data pyramid"

*Crowdflower 2016*

# A Workflow for Carbon Storage Data Gap Analyses

## Motivation:

- **Need data** to inform $CO_2$ storage resource assessments
- Carbon storage technical viability **determined by more than geological factors**:
  - *environmental*
  - *socio-economic*
  - *infrastructure*




## Overview:

1. **Define an ontology of components** of carbon storage technical viability
2. **Collect and label data** with appropriate components/categories
3. **Spatially assess** the availability of different components/categories

***Where are the data?? Are they useful?***

# 1. Ontology for CS Technical Viability

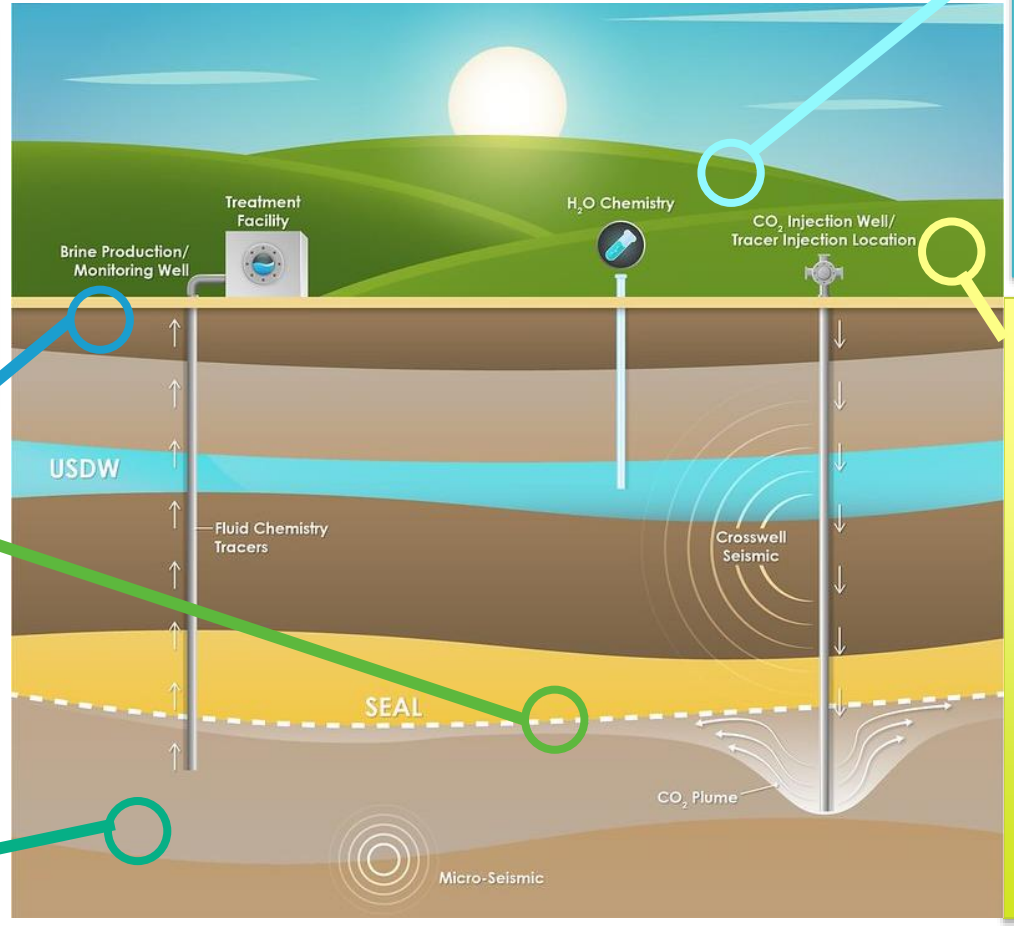
## *5 Categories → 14 Subcategories*

- Reflects **multidisciplinary requirements** of carbon storage projects

**Retention and Geomechanical Risk**
- Seals and Pressure
- Trap
- Faulting

**Hazards**
- Subsurface Hazards
- Surface Hazards

**Reservoir Suitability**
- Reservoir Quality
- Reservoir Geometry
- Reservoir Conditions

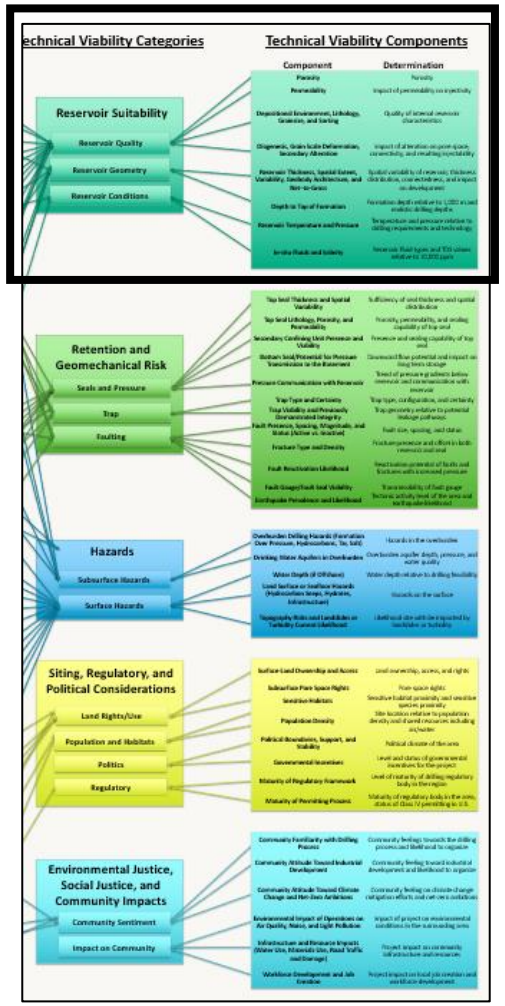


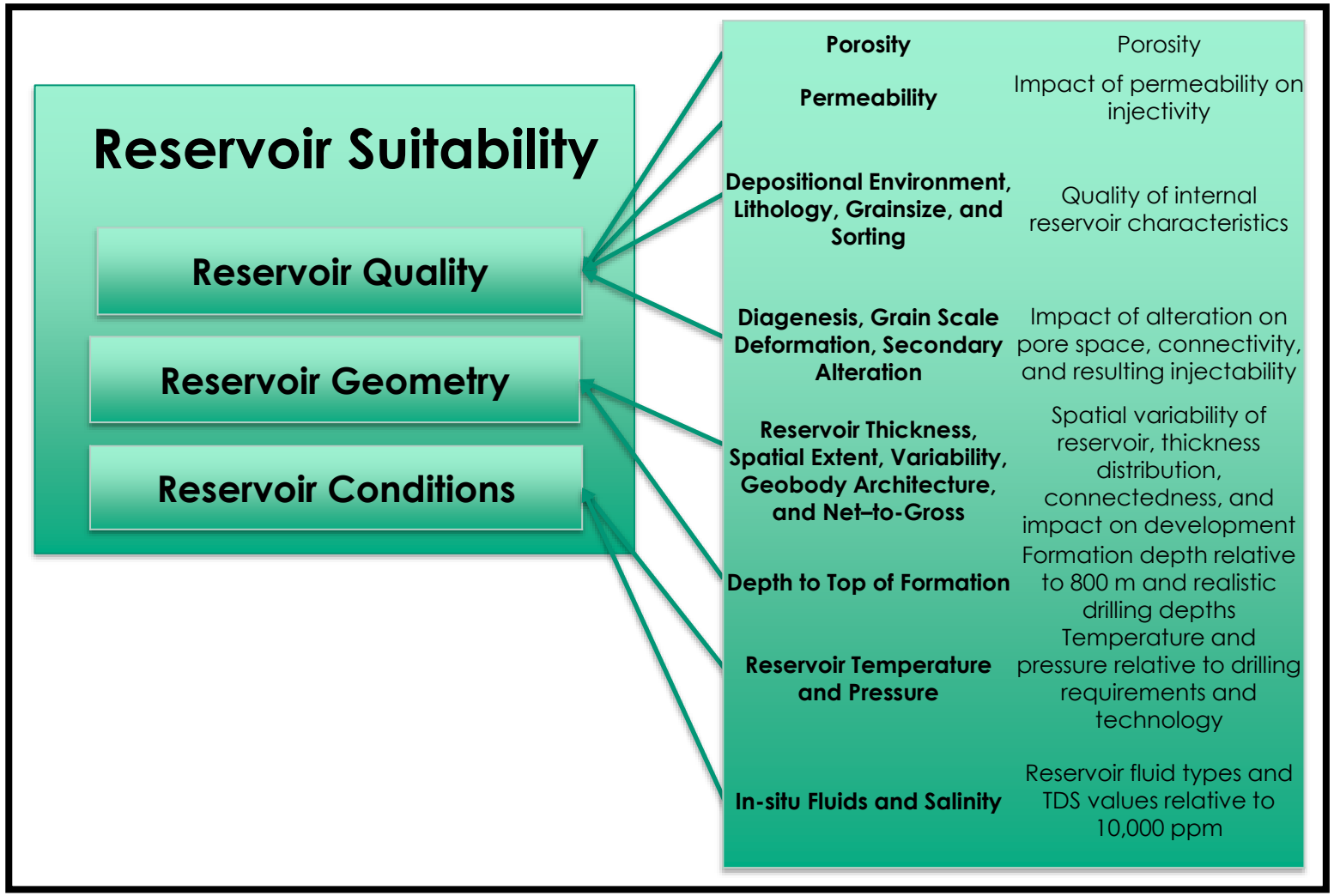

**Environmental Justice, Social Justice, and Community Impacts**
- Community Sentiment
- Impact on Community

**Siting, Regulatory, and Jurisdiction Considerations**
- Land Rights/Use
- Population and Habitats
- Jurisdiction
- Regulatory

# 1. Ontology for CS Technical Viability

## *5 Categories → 14 Subcategories → 46 Components*



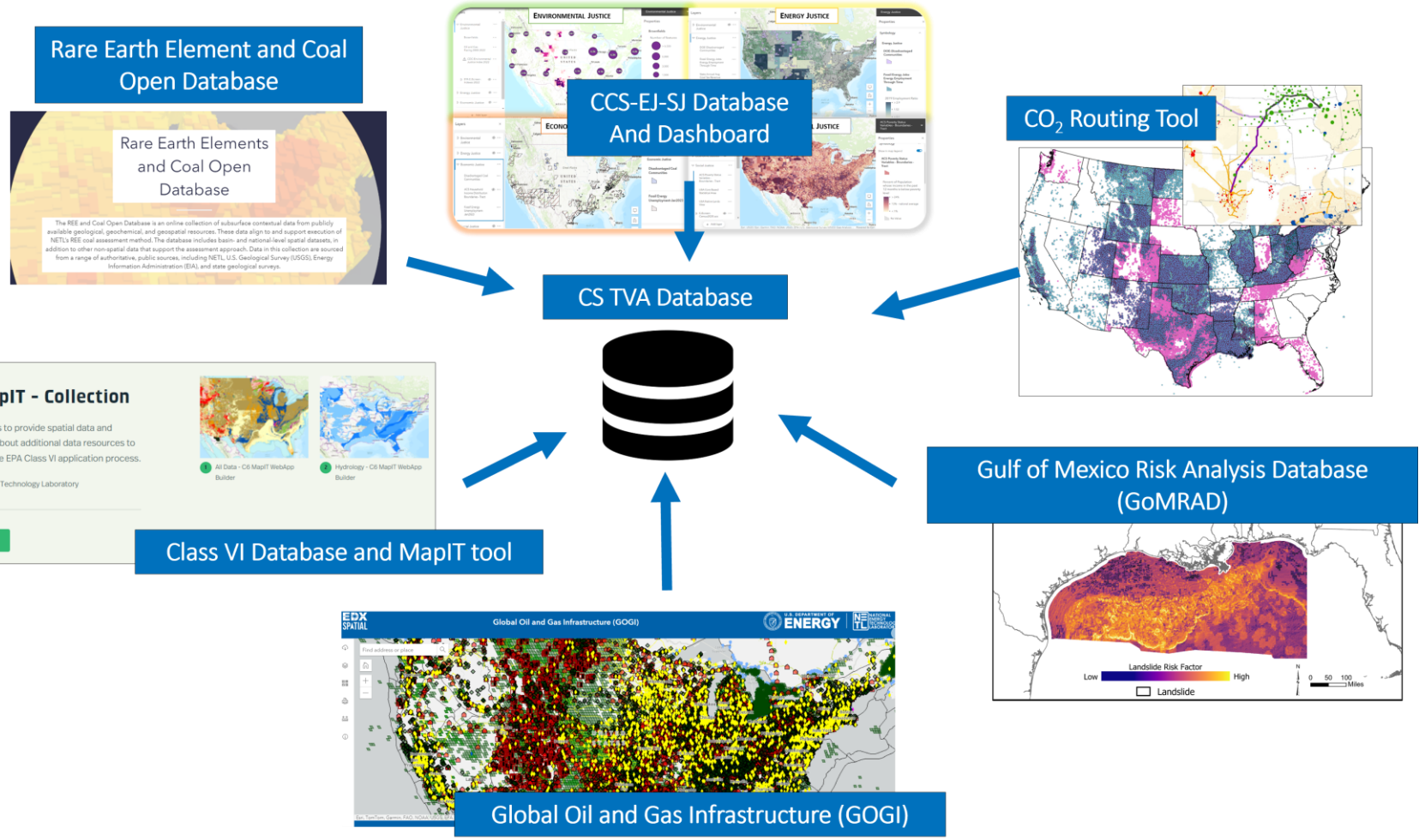
# 2. Collect and Label Data

## *Aggregated public data from across EDX4CCS and other NETL efforts*

- **1400+ files**
- **120 GB**
- **Removed duplicates**

- **Published July 2024**

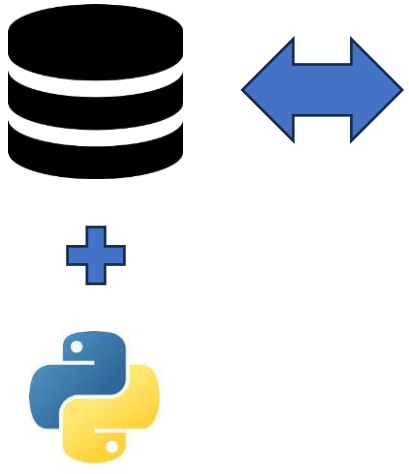
***Mulhern et al., Carbon Storage Technical Viability Approach (CS TVA) Database***
**DOI: 10.18141/1984655**



# 2. Collect and Label Data

## *Defined relationships*

### Database



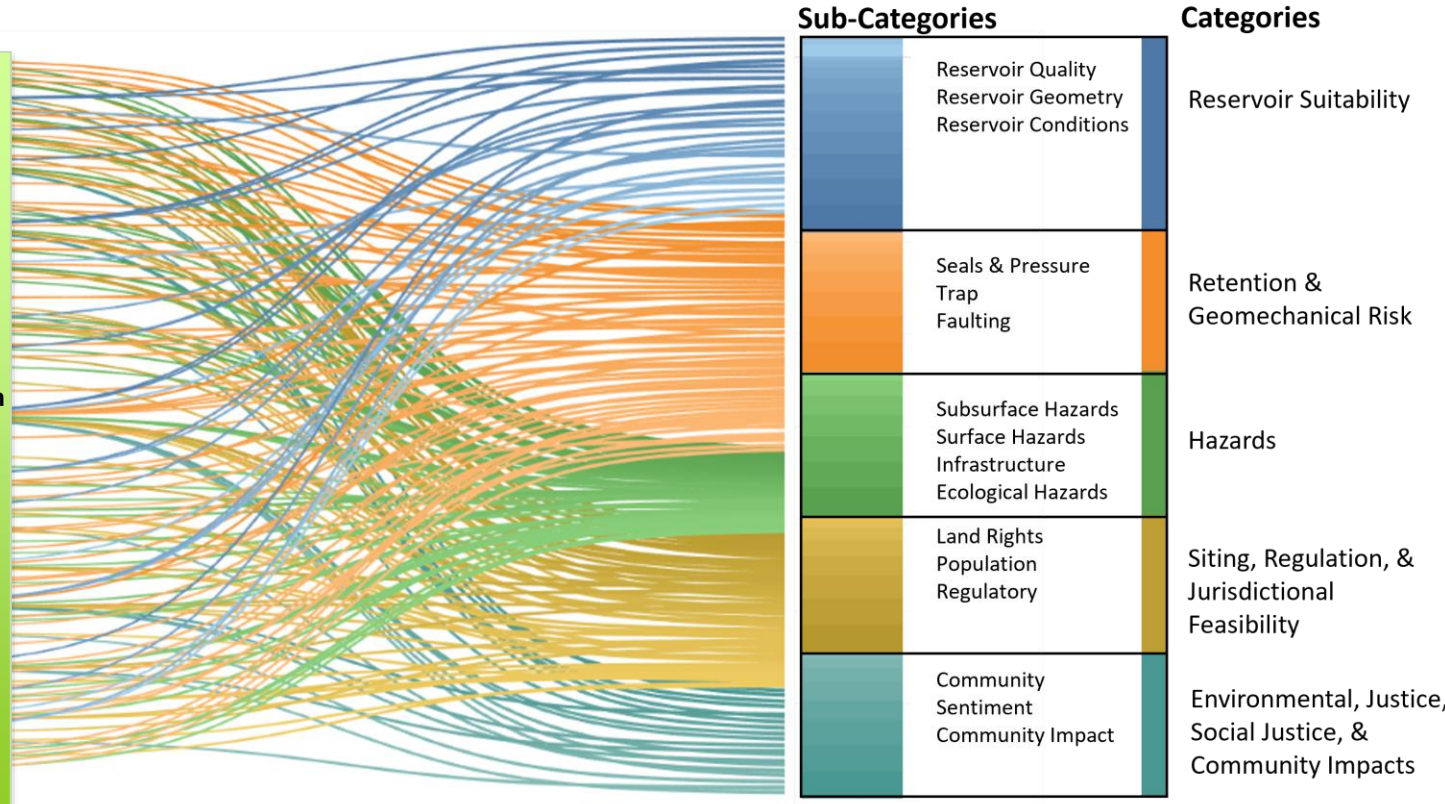
*Developed script to **query database** contents for keywords **to assign data labels***

### Data Types

**Subsurface**

- Porosity
- Permeability, Rel. Permeability, Anisotropy Ratio
- Well Logs, Down-Hole Logs, Log Interp
- Core, Core Logs, Core Samples, Core Analysis
- Petrographic Analysis, Thin Sections
- Paleontology, Micro-Paleontology
- Well Image Logs, Image Log Interpretations
- Secondary Alteration, Diagenetic History, Basin History Model
- Seismic Data, Derived Data Volumes, Horizons & Surfaces, Interpretations (2D/3D)
- Geomodels, Well Correlations, Cross-Sections, Stratigraphic Columns, Sedimentary Facies, Lithology, Geobody Interpretations, V-Shale/Clay
- Reservoir Depth
- Reservoir Thickness
- …
- …
- etc.

### CS Technical Viability Components




***"One-to-many" relationship** where data types relate to multiple components*

# 3. Spatial Analysis

## *Presence/absence of each dataset*

**Aggregate:**

- Data types
- Data types per component
- Components per category

**Data Type 1**

| | | | |
|---|---|---|---|
| 1 | 0 | 0 | 1 |
| 0 | 1 | 1 | 1 |
| 0 | 0 | 1 | 1 |
| 0 | 0 | 1 | 1 |
| 0 | 1 | 1 | 0 |
| 1 | 1 | 1 | 0 |

+

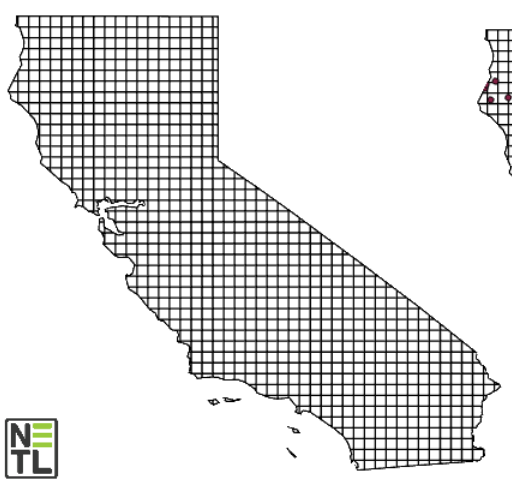
**Data Type 2**

| | | | |
|---|---|---|---|
| 1 | 1 | 0 | 0 |
| 0 | 1 | 1 | 0 |
| 0 | 0 | 1 | 1 |
| 0 | 0 | 1 | 0 |
| 0 | 0 | 1 | 0 |
| 0 | 1 | 1 | 0 |

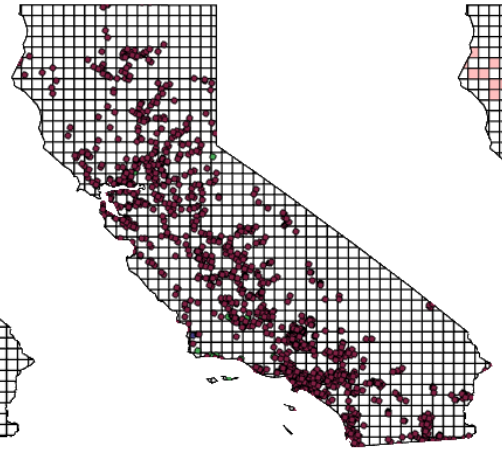
=

**Component A**

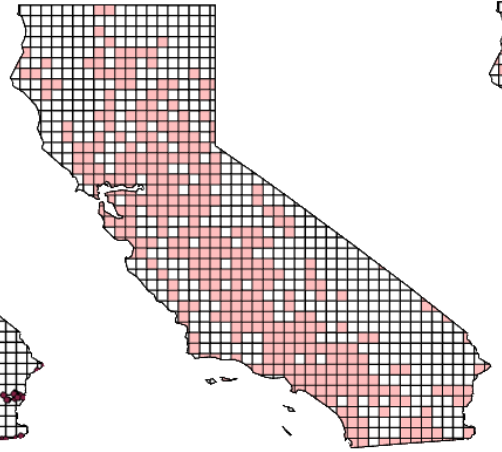
| | | | |
|---|---|---|---|
| 100% | 50% | 0% | 50% |
| 0% | 100% | 100% | 50% |
| 0% | 0% | 100% | 100% |
| 0% | 0% | 100% | 50% |
| 0% | 50% | 100% | 0% |
| 50% | 100% | 100% | 0% |



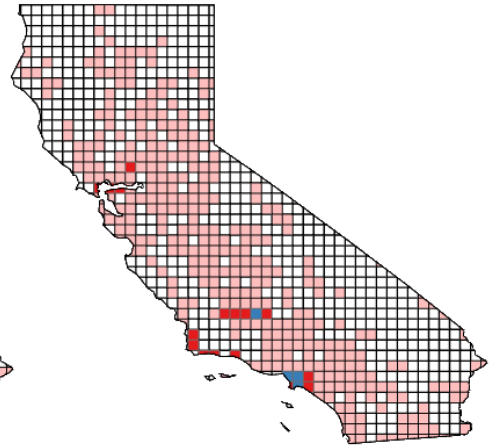
**Empty Grid**



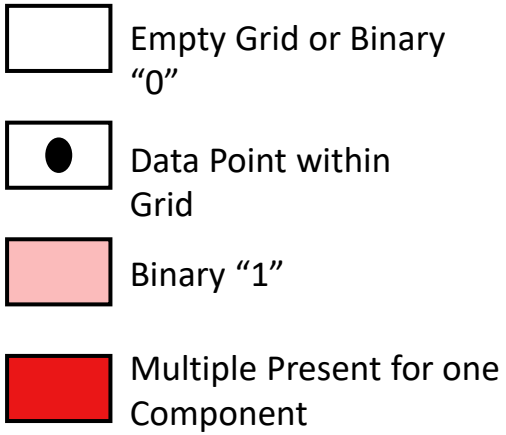
**Power Plants**
**- Data -**



**Power Plants**
**- Results -**



**Power Plants +**
**Processing Plants**



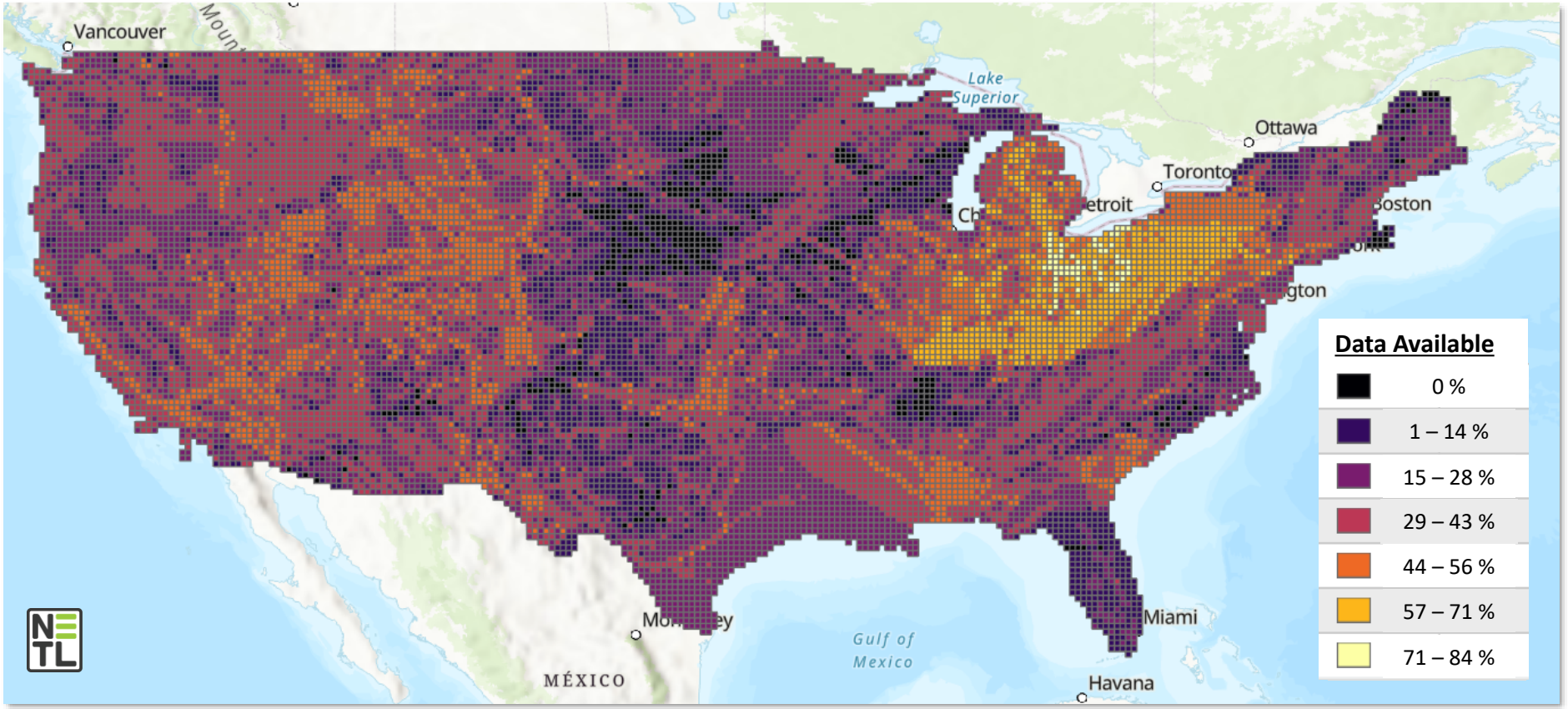
# 3. Spatial Analysis

## *Example Results: Bottom Seal, Induced Seismicity*

- **Category:** Retention and Geomechanical Risk
  - **Sub-category:** Seals and Pressure
    - **Component:** Bottom Seal, Induced Seismicity

**Component Context:** Information about downward flow potential, impact on long term storage, and risk for induced seismicity in crystalline basement.

| Data Types |
|---|
| Seismic Data |
| Pressure Measurements |
| Well Logs |
| Faults - Basement |
| Faults - Undifferentiated |
| Derived 3D Volumes |
| Bedrock Geology |
| Faults - 3D |
| Extent - Basement |
| Depth - Basement |

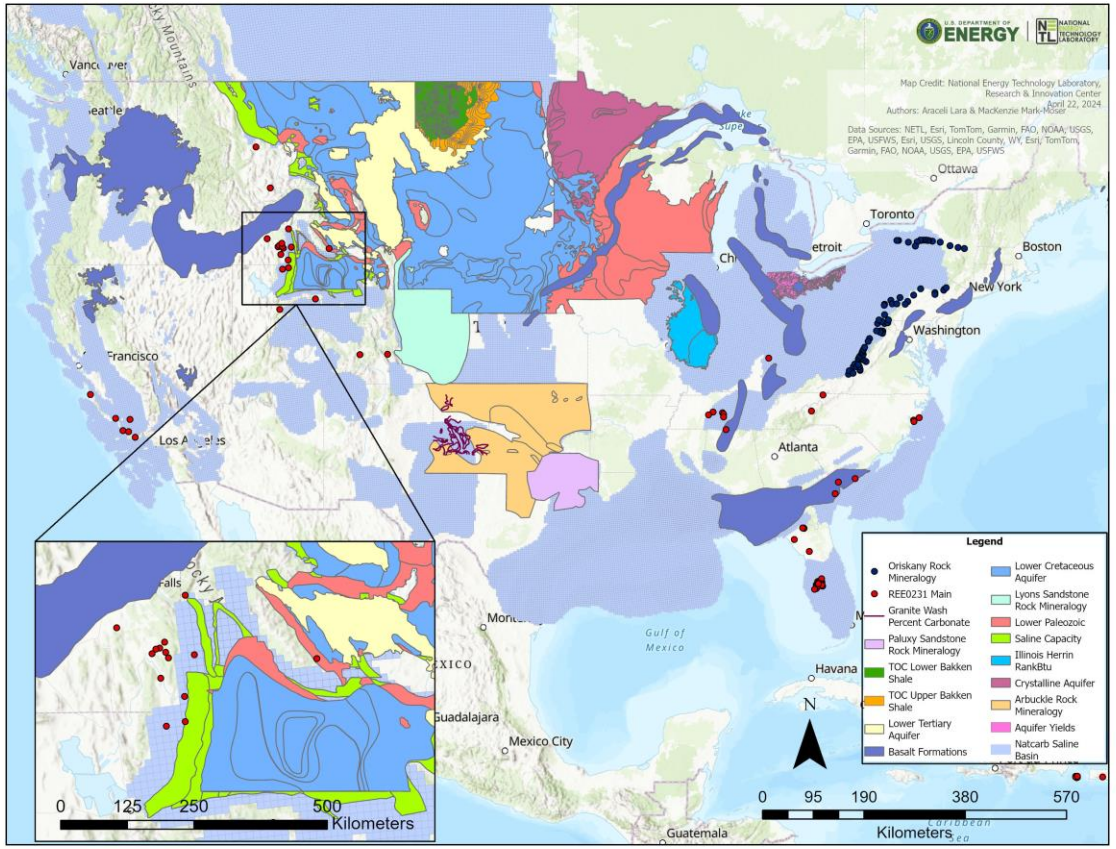


# Next Steps

## *Improved usability and advanced labeling*

1. Develop into **online tool hosted on disCO2ver** platform
   - Improve user accessibility

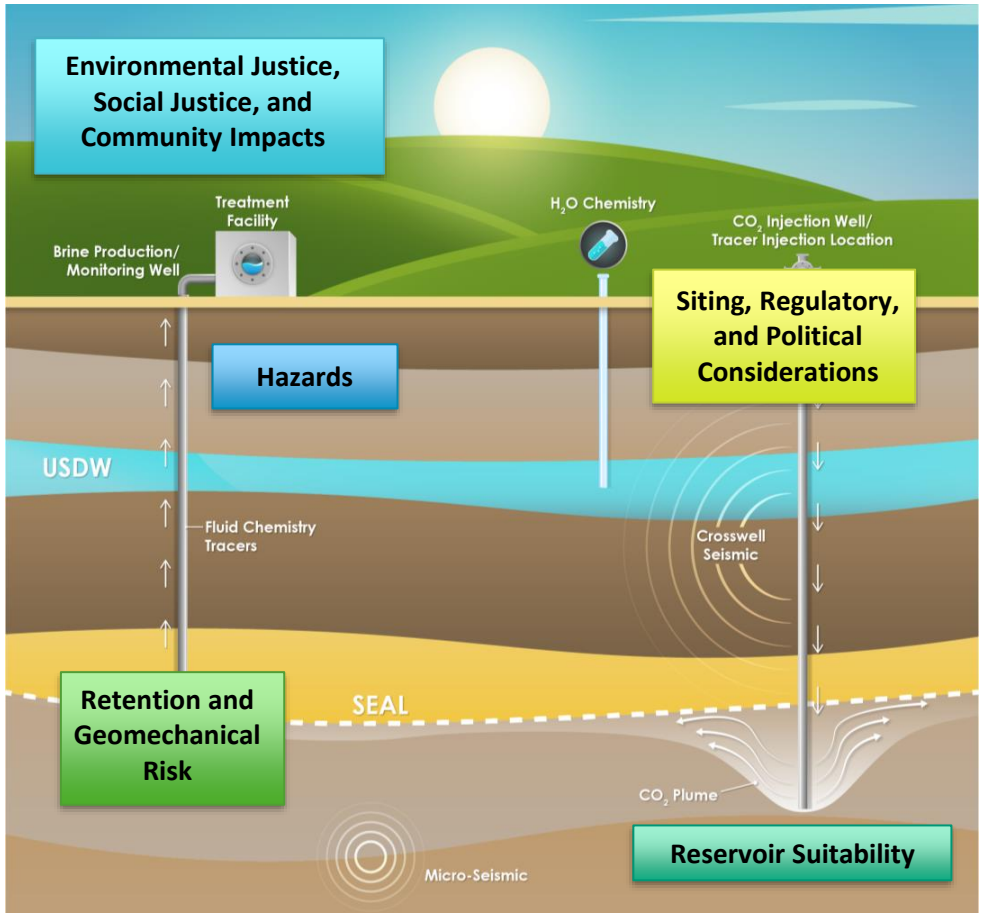
2. **Augment results** using available NETL tools and **NLP/GenAI**
   - **Assigning weights** to different data types
   - **NLP/GenAI assisted classification** of datasets
     - More robust labeling
     - Streamline analysis of new datasets
   - **AI/ML** Subsurface Trend Analysis Tool **for data collection**
     - e.g., Image recognition, image embedding, table extraction




***Where are the data?? Are they useful?***

# Key Takeaways

- Produced a **workflow** for assessing data availability *and* utility for **technically viable carbon storage assessments**
- Considers **multiple factors** beyond reservoir and caprock viability
- **Contextualizes** the available **data**
- **Identifies** areas with **limited data** availability




***Where are the data?? Are they useful?***

# the stats

**54** RIC PRESENTATIONS

**22** POSTERS

**30** TOOL DEMOS

## MONDAY

### Presentations
(10:30AM - 5:25PM)

- 16 disCO2ver presentations

## TUESDAY

### Presentations
(10:30AM - 5:45PM)

- 17 SMART presentations
- 2 disCO2ver presentations
- 2 Geographic focus/tool presentations

### Posters
(5:45PM - 7:45PM)

- 18 CTS Posters
- 2 PSCC Posters
- 1 CDR Poster
- 1 MLEF Poster

### Tool Demos
(5:45PM - 7:45PM)

- 30 Tool Demos
  - SMART
  - NRAP
  - EDX
  - EDX4CCS

## WEDNESDAY

### Presentations
(2:10PM - 4:30PM)

- 3 transport, research, development, and demonstration activities presentations
- 1 transport modeling presentation
- 1 secure storage (basalts/mafic) presentation

## THURSDAY

### Presentations
(10:30AM - 5:20PM)

- 8 NRAP presentations
- 2 NETL RIC Presentations
- 2 Offshore presentations

NETL Research · Carbon Storage Program

NRAP National Risk Assessment Partnership

SMART

EDX disco2ver

https://edx.netl.doe.gov/disco2ver

# Acknowledgments

This work was performed in support of the U.S. Department of Energy's (DOE) Office of Fossil Energy and Carbon Management's EDX4CCS Project, in part, from the Bipartisan Infrastructure Law.

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