Deploying a National Well Database to Support CS Reuse and Risk Work

CO_2-Locate: A Dynamic Database & Tool

NATIONAL ENERGY TECHNOLOGY LABORATORY

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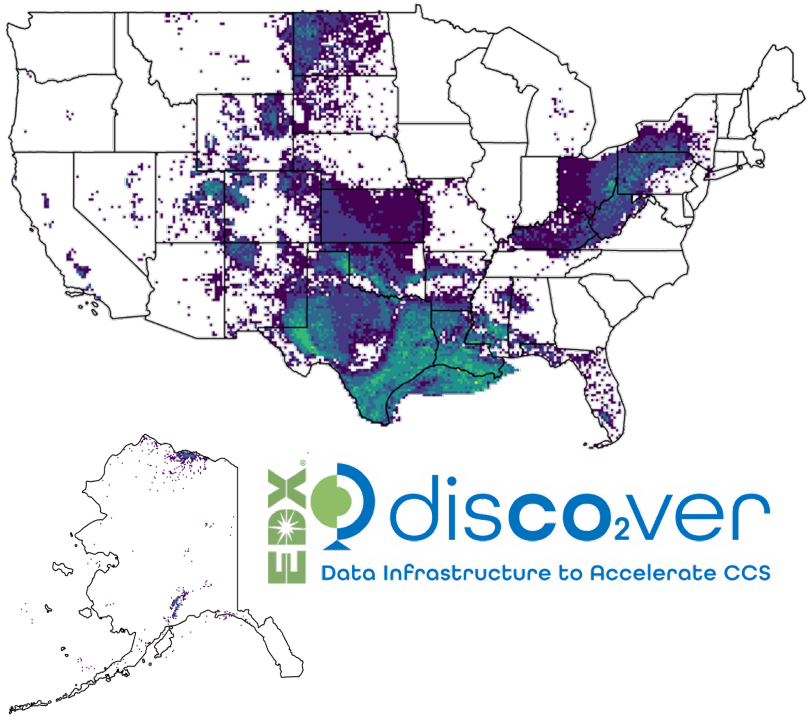

EDX discover
Data Infrastructure to Accelerate CCS

Carbon Management Research Program Review Meeting

August 28, 2023

Disclaimer

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Overview

Problem: ***Safe*** **geologic carbon storage requires well information, but data are siloed and disparate.**

Solution:

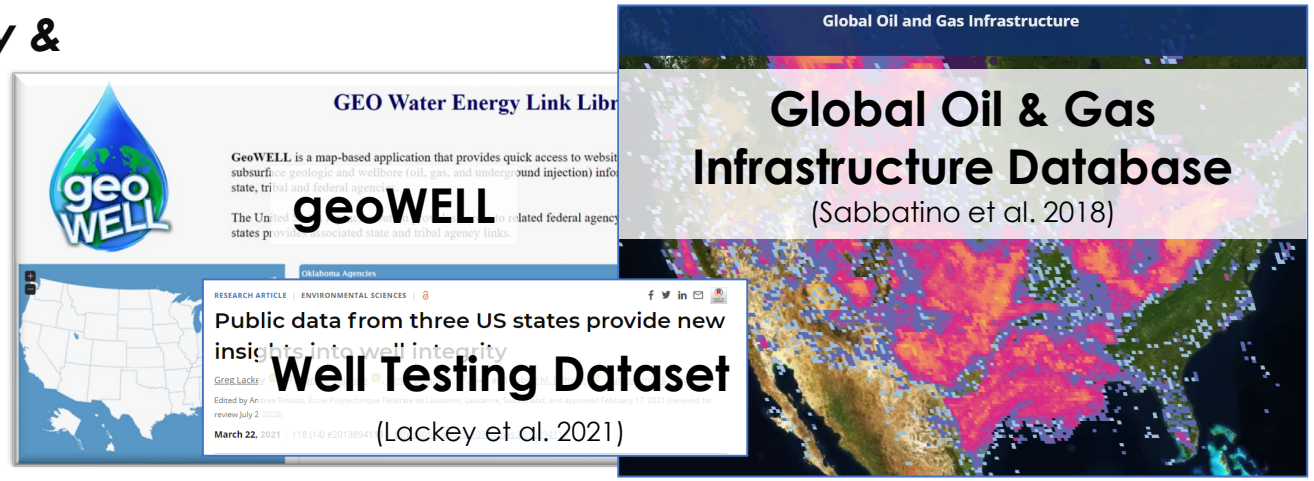
- Acquire & integrate wellbore data from across the country
- Perform analytics to highlight potential opportunities or risk
  (Dilmore et al. 2015; Glosser et al. 2016; Rose 2016)
- Automate methods to create a *dynamic database*
- Deliver data & insights through an intuitive web mapping tool

Values Delivered:

- Provide an up-to-date, national, integrated resource
- Support CS site selection and risk prevention
- Meets stakeholder request supporting CCS R&D

*Stakeholders include commercial and government entities.

Leverages NETL Technology & Resources:



Dilmore, R.M. et al., 2015. Spatial and temporal characteristics of historical oil and gas wells in Pennsylvania: Implications for new shale gas resources. *Environmental science & technology*, 49(20), pp.12015-12023.
Glosser, D. et al., 2016. "Spatio-Temporal Analysis to Constrain Uncertainty in Wellbore Datasets: An Adaptable Analytical Approach in Support of Science-Based Decision Making," Journal of Sustainable Energy Engineering, Vol. 3 (4), pp. 299–317.
Lackey, G. et al., 2021. Public data from three US states provide new insights into well integrity. *Proceedings of the National Academy of Sciences, 118*(14), p.e2013894118.
Rose, K., "Signatures in the Subsurface – Big & Small Data Approaches for the Spatio-Temporal Analysis of Geologic Properties & Uncertainty Reduction," 2016, http://hdl.handle.net/1957/59459.
Sabbatino, M. et al., 2017. Global Oil & Gas Features Database, https://edx.netl.doe.gov/dataset/global-oil-gas-features-database, DOI: 10.18141/1427300

Building a National Well Database

Developing a Method to Support Dynamic Databases

Acquire

Data & metadata were pulled from a **subset** of public **state** and **federal entities & NETL R&D papers**

Public data from three US states provide new insights into well integrity

Well Testing Dataset

(Lackey et al. 2021)

Process

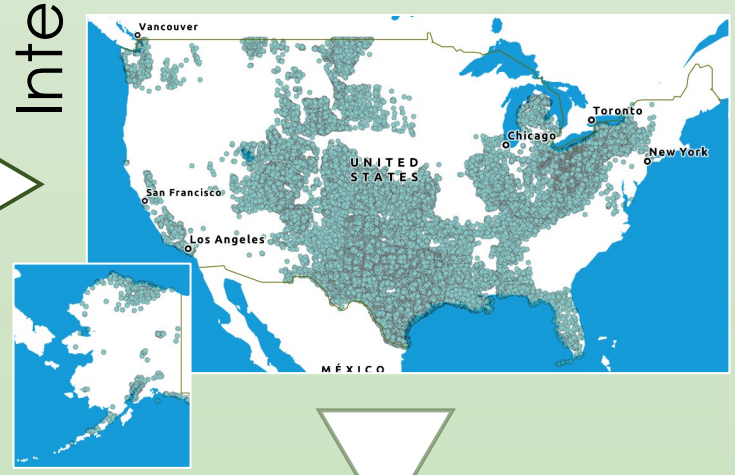
Transform tabular data to spatial layers

Develop **attribute mapping schema** based on common attributes among datasets

Common Attributes & Definitions		Public Well Layers													
Field Names	Field Definitions	Well Test	New York	Alabama	Florida	Virginia	Washington	Utah	South Dakota	Texas	Alaska	HFLD	West Virginia DEP	West Virginia	Dataset Coverage per Field
Abstract Number	The abstract number for the surface location of the well.									x					1
Additional Documents	Indicates the availability of scanned documents pertaining to the permitted borehole, either geophysical logs or permit documents.						x								1
Alternate Well Name	The alternate name for a well, if any.						x							x	2
API UWI	The API (American Petroleum Institute) number is a unique oil and gas well identifier. API number is formatted to include a state identifier (2 digit), county identifier (3 digit), and unique well identifier (5 digit). The unique well identifier (UWI) is a unique number (up to 16 digits) that defines the bottom-hole location and each significant drilling or completion event in the well.	x			x		x	x	x		x	x	x	x	9
API UWI 12	The API (American Petroleum Institute) number is a unique oil and gas well identifier. API number is formatted to include a state identifier (2 digit), county identifier (3 digit), and unique well identifier (5 digit). The unique well identifier (UWI) is a unique number (up to 12 digits) that defines the bottom-hole location and each significant drilling or completion event in the well.									x					1
API UWI 12 Unformatted	API (American Petroleum Institute) unique well identifier (UWI) 12 with dashes and slashes removed.									x					1
API UWI 14	The API (American Petroleum Institute) number is a unique oil and gas well identifier. API number is formatted to include a state identifier (2 digit), county identifier (3 digit), and unique well identifier (5 digit). The unique well identifier (UWI) is a unique number (up to 14 digits) that defines the bottom-hole location and each significant drilling or completion event in the well.			x						x					2
API UWI 14 Unformatted	API (American Petroleum Institute) unique well identifier (UWI) 14 with dashes and slashes removed.		x												1
Avg Time Between CVF or SCP Tests	Average number of days between sustained casing pressure (SCP) or casing vent flow (CVF) tests.	x													1
Basin	Basin in which the well is located.	x									x				2
Best Analysis Date	The best date available for well installation. It is equivalent to the well spud date if available. If no spud date is available, the first production date was used. If no first production date or spud date were available, the completion date was used.	x													1
Block	Subdivision indicating the location of an offshore well.									x					1
Bottom Hole Distance	Bottom-hole distance in feet from the closest drilling unit boundaries.				x										1
Bottom Hole Formation	The name of the bottom-hole formation or stratigraphic unit.								x						1
Bottom Hole Temperature	Temperature at the bottom of the well measured in degrees Fahrenheit.				x										1
Casing Base Formation Fluid Pressure	Estimated formation fluid pressure at the base of the surface casing (in pounds per square inch).	x													1

Integrate

Compile layers and attributes into a **uniform public wells dataset**



Publish

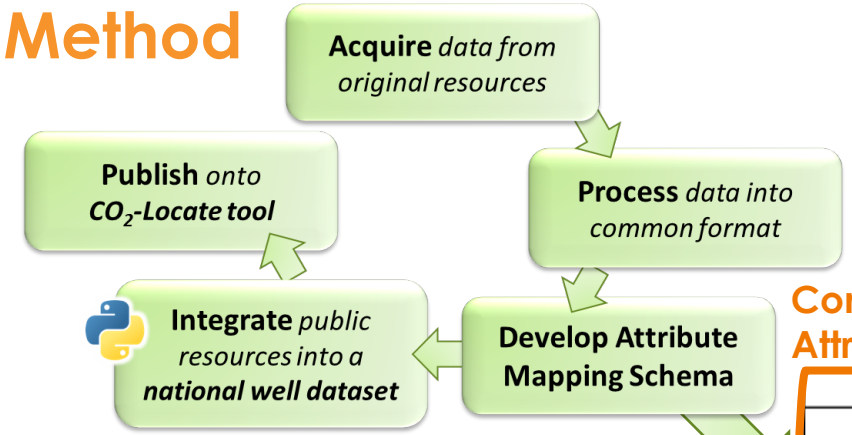
Romeo et al. 2023. **CO_2-Locate.** https://edx.netl.doe.gov/dataset/co2-locate, DOI: 10.18141/1964068

CO_2-Locate (v1)

Database Highlights & Method

- **3.5+ million** well surface hole locations
- **11 credible sources**
- **Analytical spatial layers** developed with proprietary data
- Updated **Global Oil and Gas Infrastructure (GOGI)** U.S. data

100+ downloads



Developed **method** for **integrating multiple, disparate datasets** into **one resource**

Common Attributes

Original Public Resources

Field Names	Well Test	New York	Alabama	Florida	Virginia	Washington	Utah	South Dakota	Texas	Alaska	HIFLD	West Virginia DEP	West Virginia	Dataset Coverage per Field
Abstract Number									x					1
Additional Documents						x								1
Alternate Well Name						x							x	2
API UWI	x			x		x	x	x		x	x	x	x	9

Method being adapted for other NETL projects:

NEWTS DATABASE

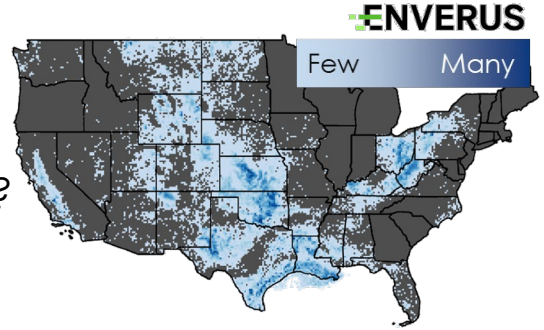
CATALOG Consortium Advancing Technology for Assessment of Lost Oil & Gas Wells.

Additional Features of CO_2-Locate

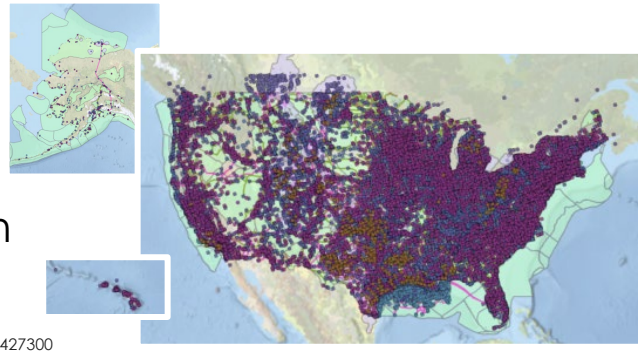
Leveraging NETL R&D and Technologies

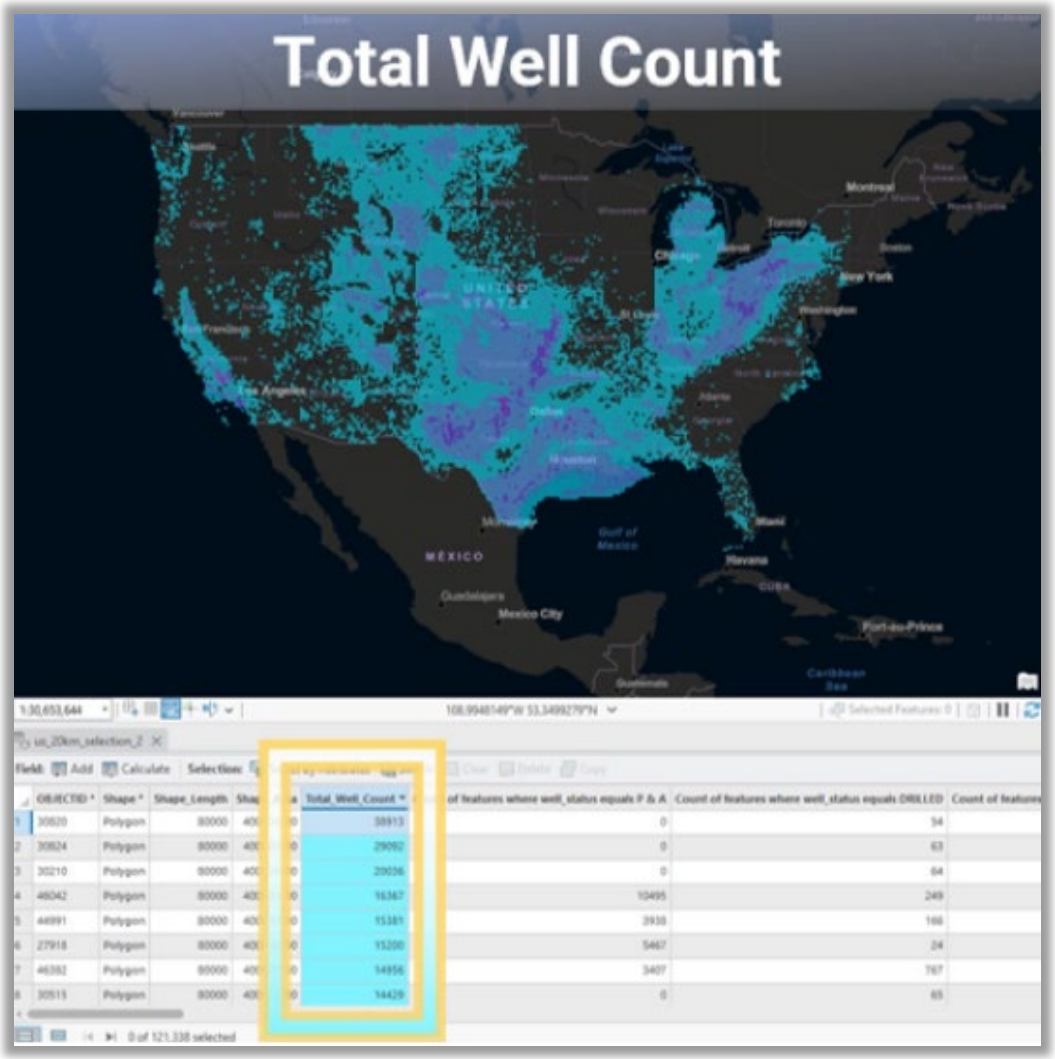
- **High-level analytics** of wells by **age**, **total vertical depth**, and **status**
  - *Where are concentrations of old wells at multiple depths?*
  - *Where are younger, active wells?*

Density of wells > 50 years old

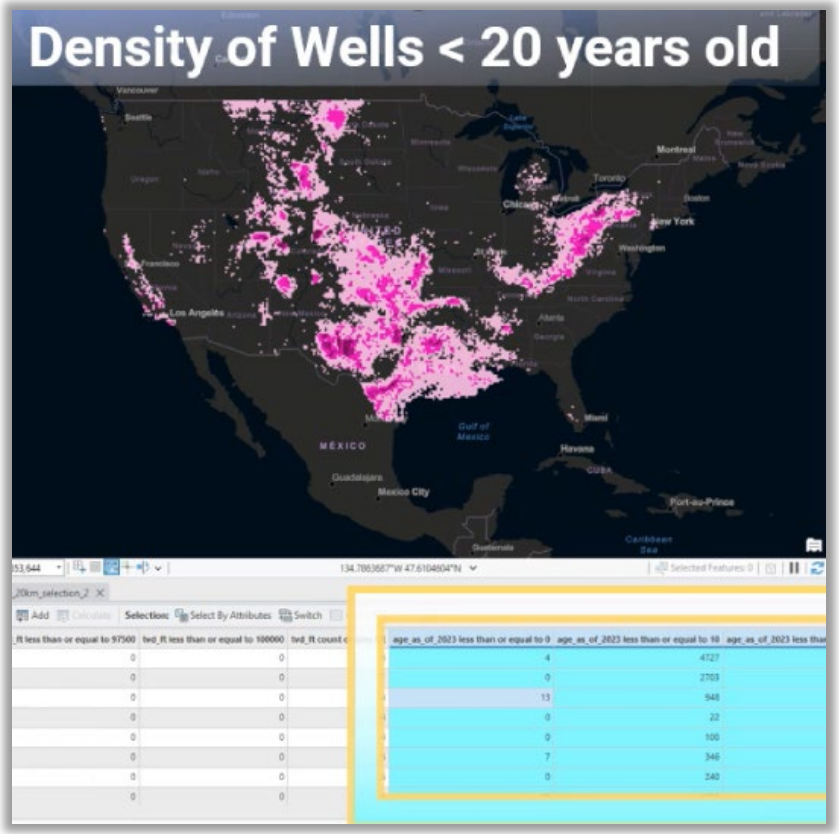


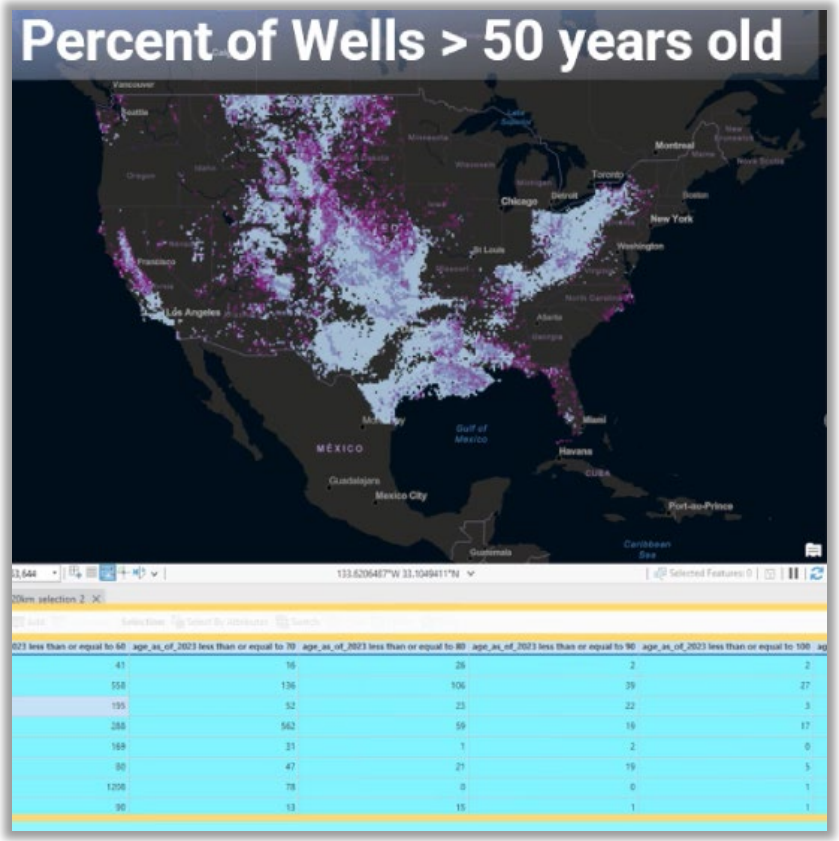
- Updates to U.S. features in NETL's award-winning **GOGI Database** (Sabbatino et al. 2017)
  - Transportation
  - Facilities & Installation
  - Production & Extraction

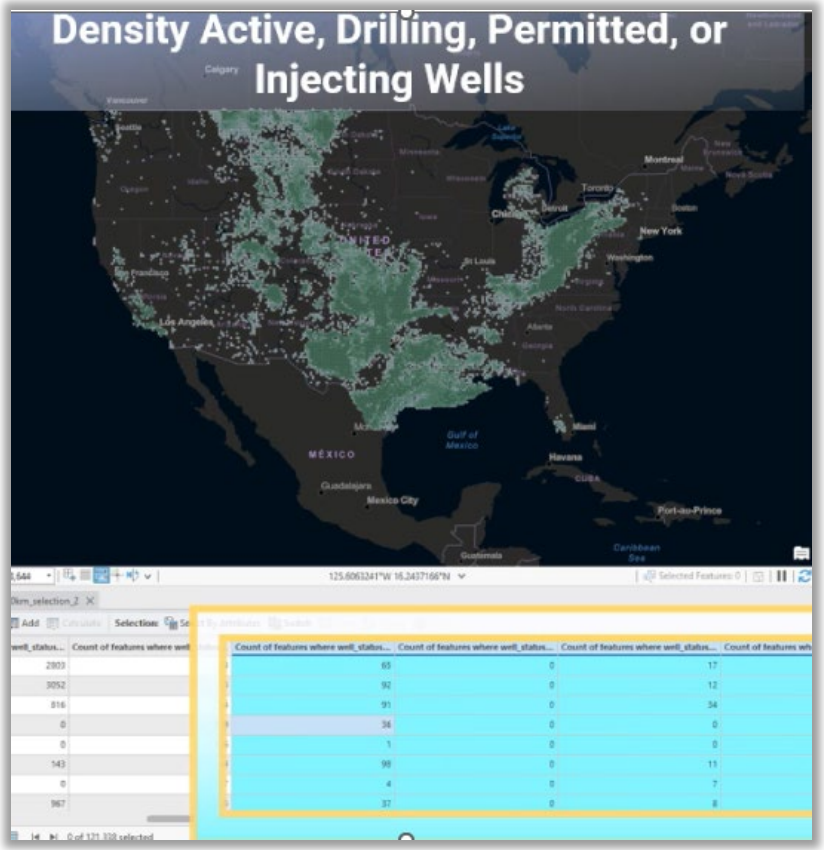


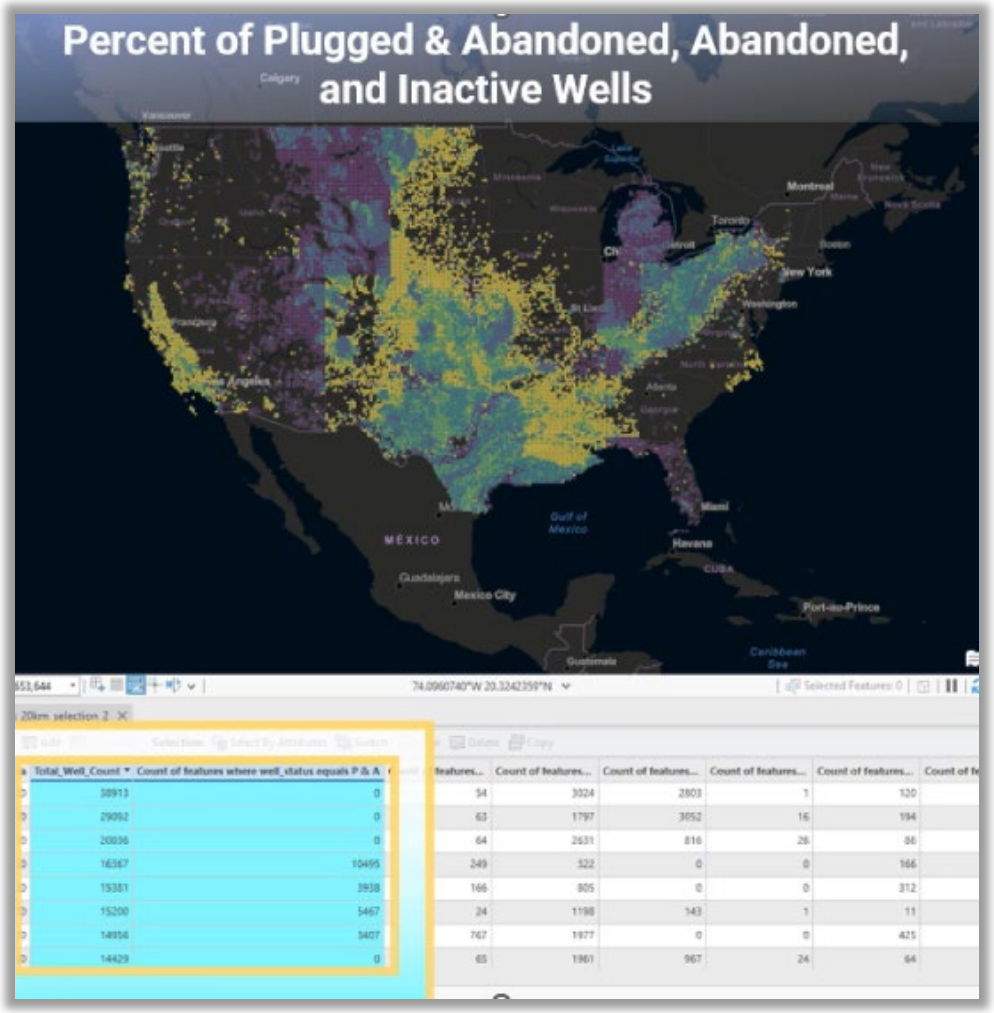


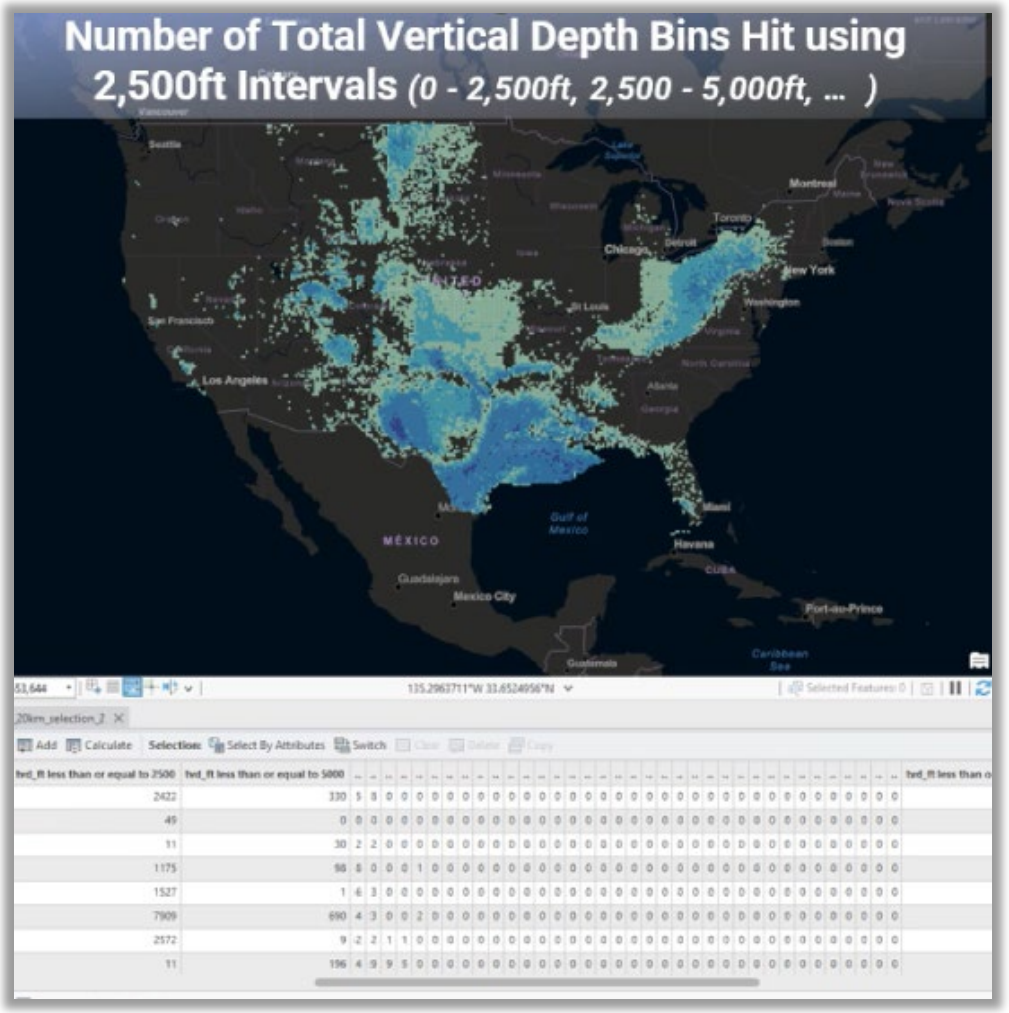
Sabbatino et al., 2017. **Global Oil & Gas Features Database**, https://edx.netl.doe.gov/dataset/global-oil-gas-features-database, DOI: 10.18141/1427300


Density of Wells < 20 years old


Percent of Wells > 50 years old


Density Active, Drilling, Permitted, or Injecting Wells


Percent of Plugged & Abandoned, Abandoned, and Inactive Wells
Montreal
Toronto
New York
Washington
Miami
Havana
CUBA
MÉXICO
Gulf of Mexico
Guadalajara
Mexico City
Port-au-Prince
Caribbean Sea
Guatemala


Number of Total Vertical Depth Bins Hit using 2,500ft Intervals (0 - 2,500ft, 2,500 - 5,000ft, ...)
Montreal
Toronto
Chicago
New York
Washington
Miami
Havana
CUBA
MÉXICO
Gulf of Mexico
Guadalajara
Mexico City
Port-au-Prince
Caribbean Sea
Guatemala

The Future of CO_2-Locate

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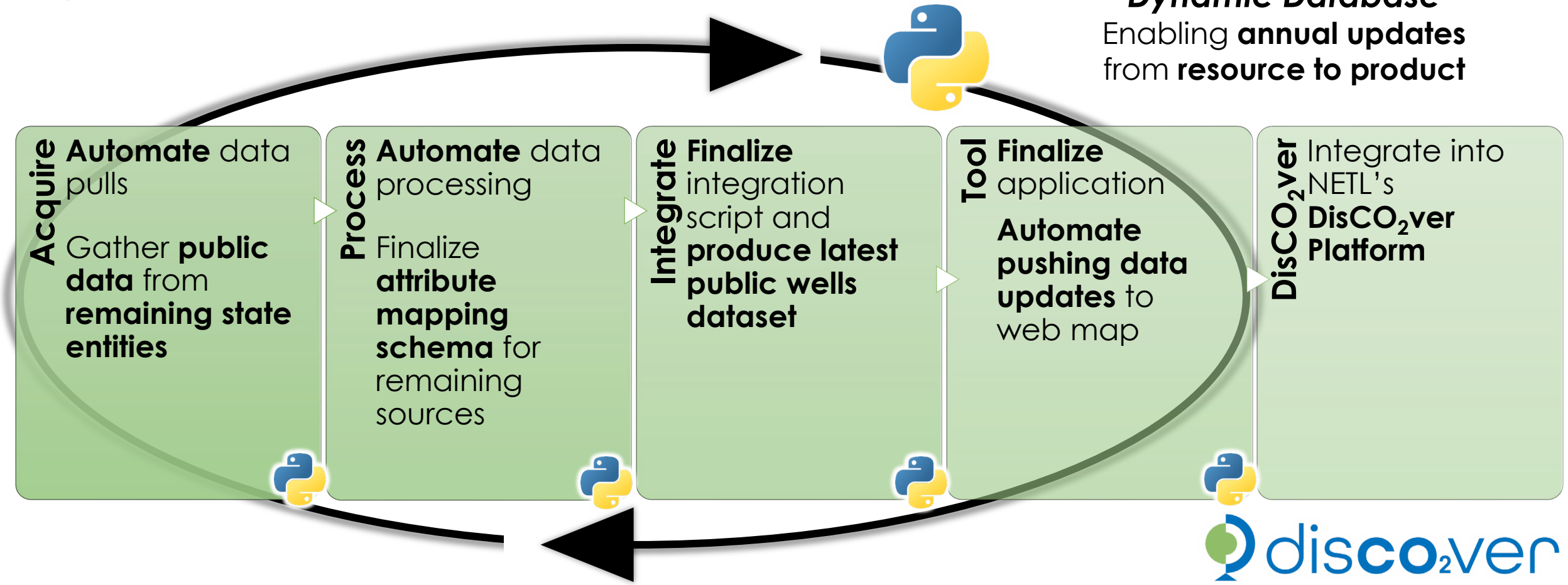
Current Automation Efforts

Dynamic Database
Enabling **annual updates** from **resource to product**



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Data Infrastructure to Accelerate CCS

Expanding Resources

Current CO_2-Locate Database Efforts

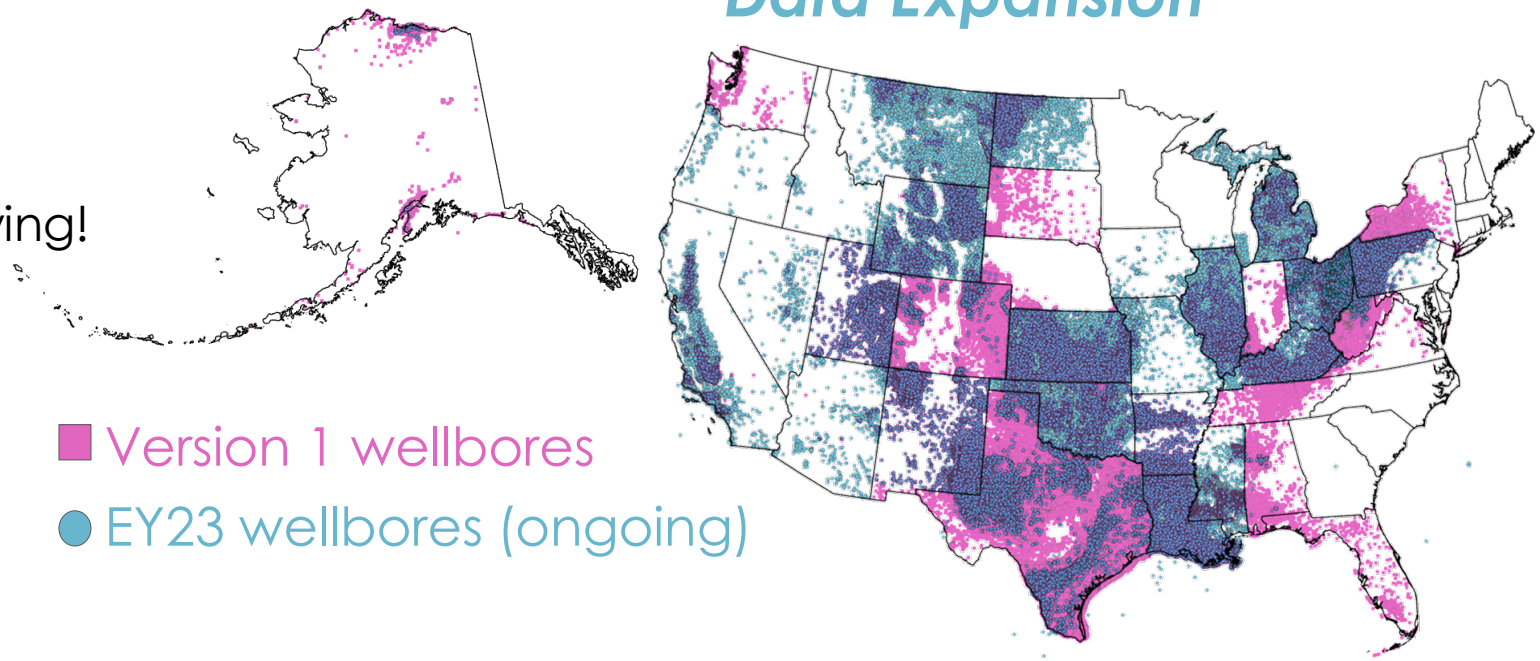
Acquiring & processing public resources from **more** state, tribal, and federal entities

- **30+ additional resources** and growing!
- **3.5+ million additional well records**

Expanding **analytical summary layers**

- **4.6+ million wells** (IHS, 2015)
- Summarizing additional **well characteristics**
- Developing **redundancy handling** method

EY23 Public Wellbore Record Data Expansion



Currently contains 7+ million public well records

800+ attributes identified & integrated

Class II Well Reuse Methodology & Tool

A Cross-Cutting Effort

Problem: ***Currently unknown if Class II wells are candidates to be reused for CS.***

Solution:

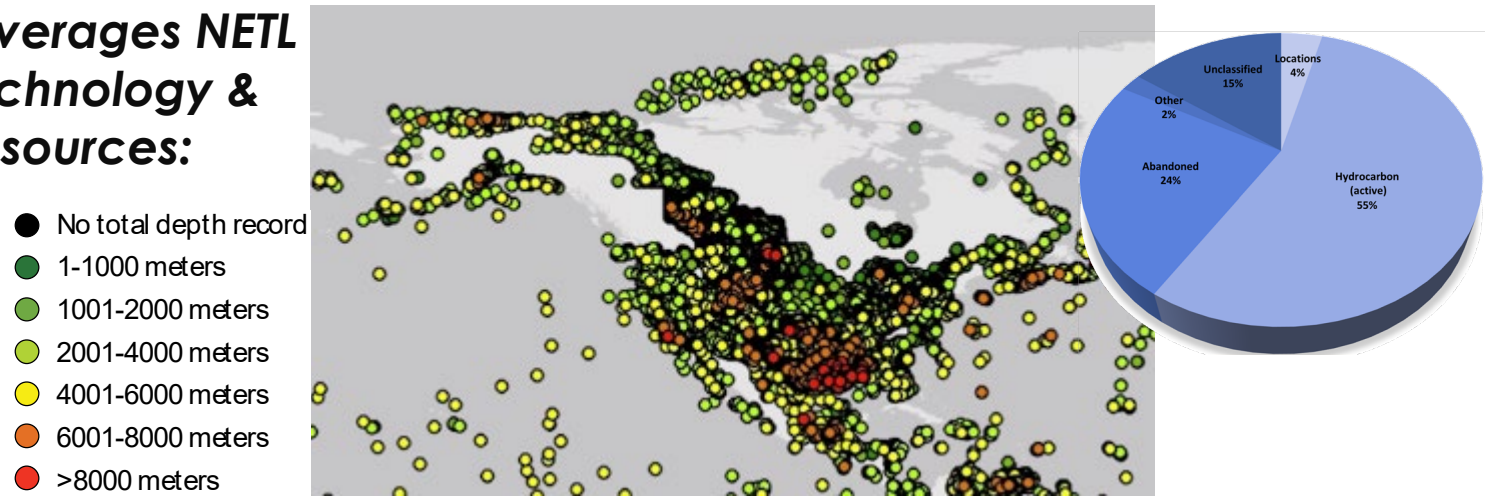
- Develop a technically-informed method to rank Class II wells for reuse
- Evaluate well characteristics and proximity to potential hazards
- Leverage CO_2-Locate database & methodology derived insights to support tool development

Values Delivered:

- Publish a standardized method to review existing Class II wells and characterize safe CS reuse potential
- Provide stakeholders critical information that can help ensure efficient evaluation of Class II wells for CS

*Stakeholders include researchers, industry, regulators

Leverages NETL Technology & Resources:



Rose, K., 2016, Signatures in the Subsurface – Big & Small Data Approaches for the Spatio-Temporal Analysis of Geologic Properties & Uncertainty Reduction, 162 pgs, http://hdl.handle.net/1957/59459
Bauer, J., Justman, D., Mark-Moser, M., Romeo, L., Creason, C.G., and Rose, K., Exploring beneath the basemap, in Wright, D.J. and Harder, C. (Ed.), GIS for Science: Applying Mapping and Spatial Analytics: Volume 2, Redlands, CA: Esri Press, pp. 51-67, 2020
Glosser, D., Rose, K., and J. R. Bauer, 2016. Spatio-Temporal Analysis to Constrain Uncertainty in Wellbore Datasets: An Adaptable Analytical Approach in Support of Science-Based Decision Making. Journal of Sustainable Energy Engineering, 3(4): 299-317.

Class II Well Reuse Methodology

Evaluating Adequate Wellbore Integrity as Defined by EPA

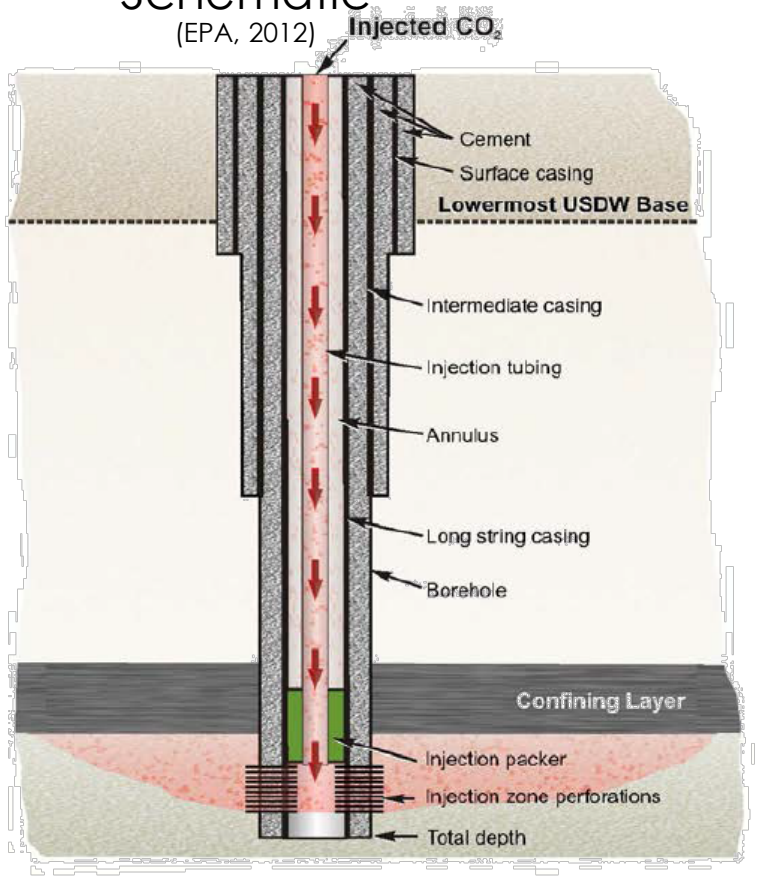
Class VI Rule
(76 FR 56982)

- Internal & External Mechanical Integrity

Relevant components:

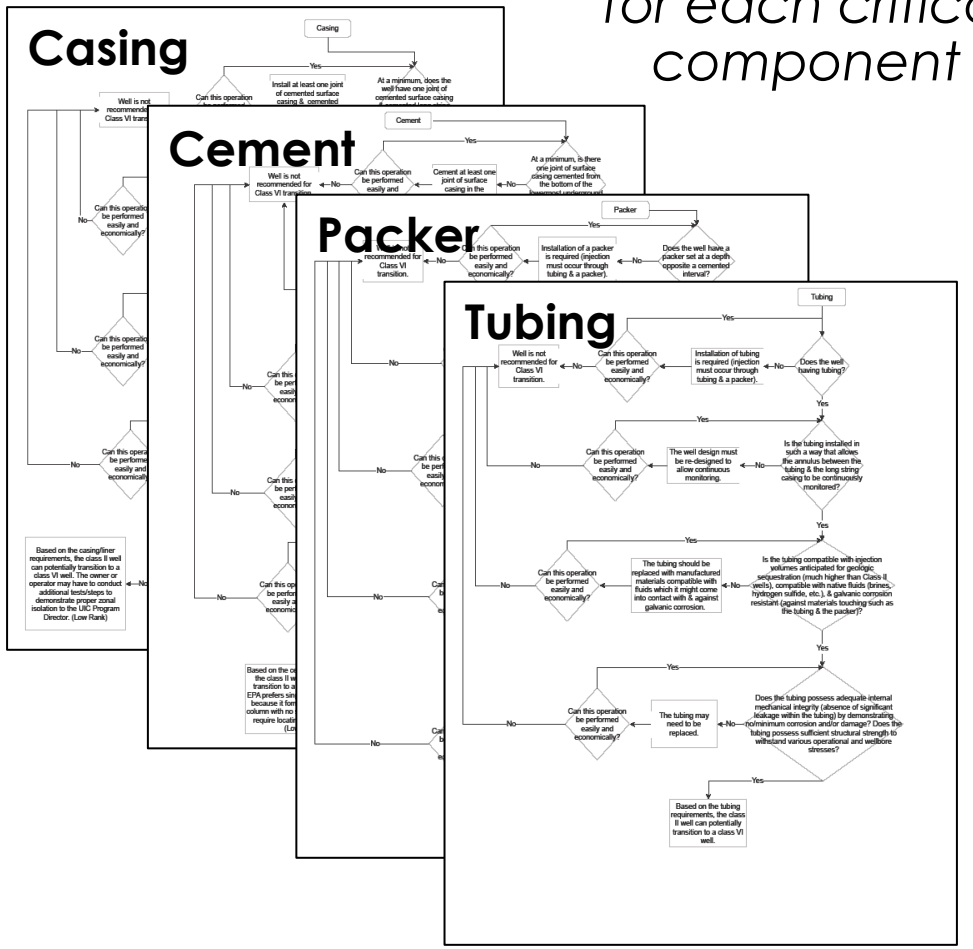
1. Casing
2. Tubing
3. Cement
4. Packer

Class VI Injection Well Schematic
(EPA, 2012)



United States Environmental Protection Agency (EPA), (2012, May). Underground Injection Control (UIC) Program Class VI Well Construction Guidance. Geologic Sequestration of Carbon Dioxide. https://www.epa.gov/sites/default/files/2015-07/documents/epa816r11020.pdf

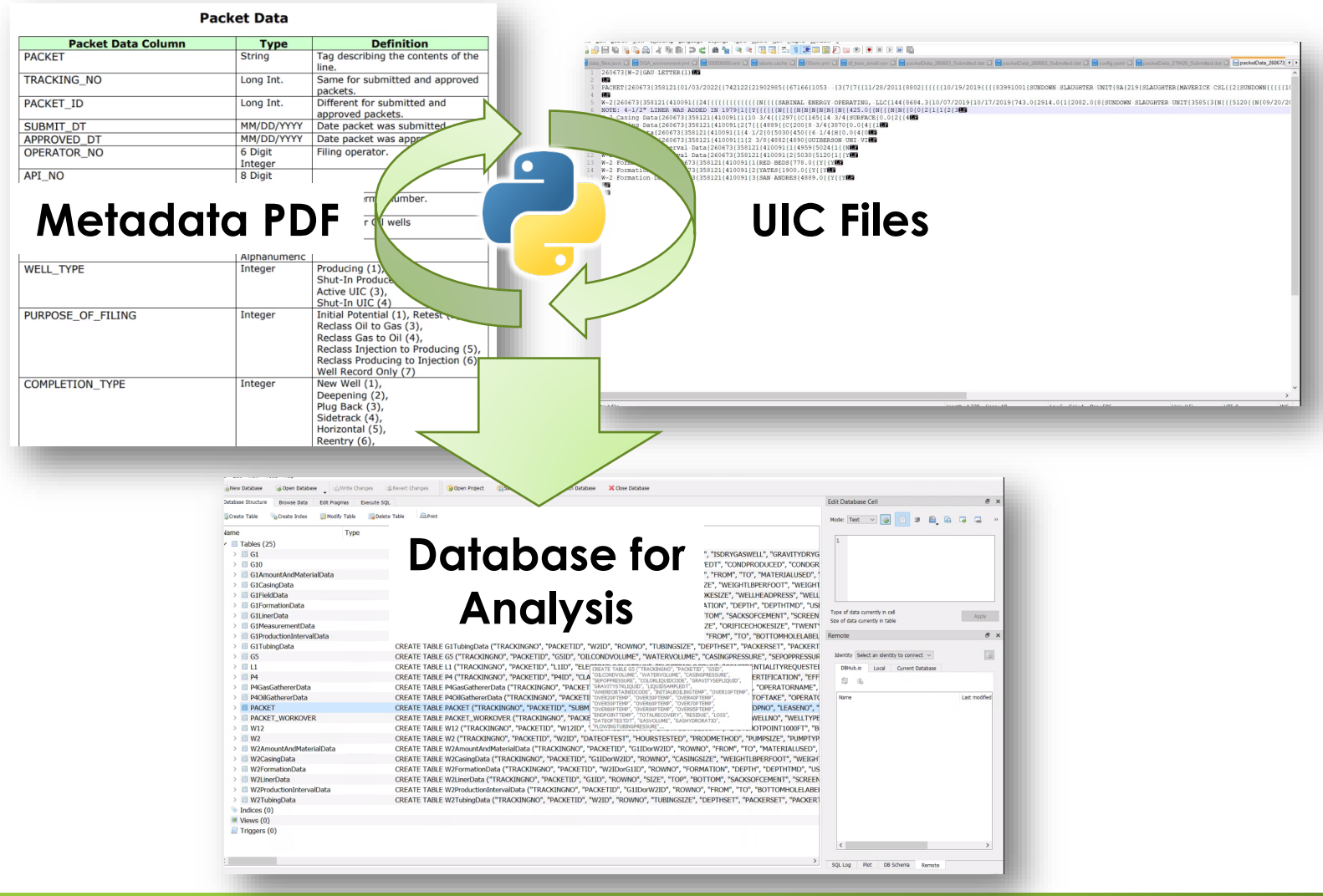
Developed workflows for each critical component



Applying Methodology with Well Data

Acquisition & Standardization of Data

- Underground injection control (UIC) files for injection, disposal, storage, geothermal, and brine wells
- Digitized data into Completion Database (SQLite)
- Applying methodology to evaluate Texas wells
- Publishing results in upcoming manuscript (McElroy et al. in preparation)



CO_2-Locate: Class II Well Reuse & Regional Evaluation Tool

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Access to & Visualization of Key Well Characteristics & Insights

- Currently contains **public well layer & analytical summary layers**
- **Expanding functionality**
  - Adding **CO_2-Locate layers**
  - Integrating **reuse methodology** key characteristics
  - Enabling **on-the-fly queries**
  - Supporting **help documentation**
- Plugging into **DisCO_2ver Platform**

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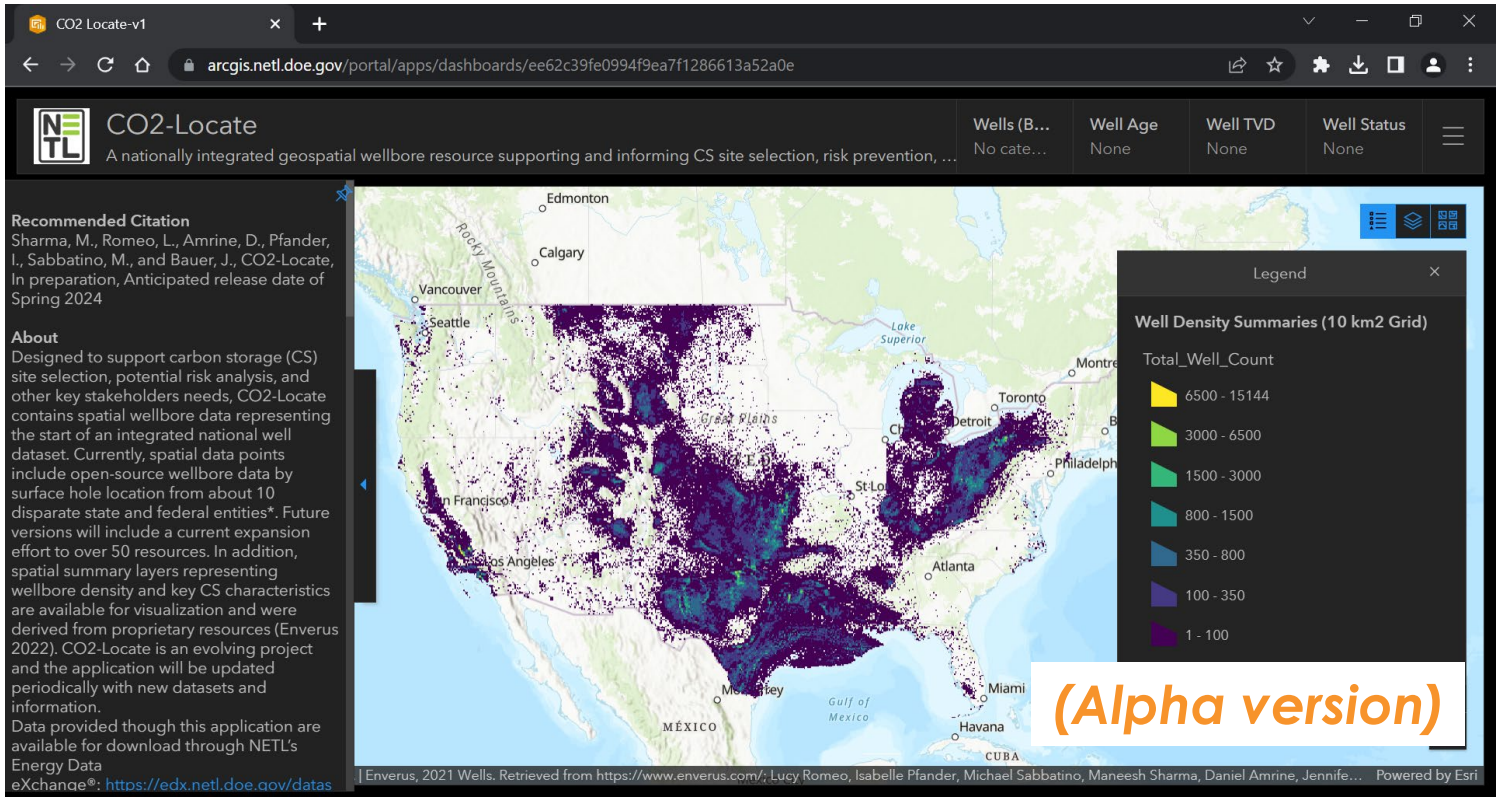


Stakeholder Benefit: ***Meets stakeholder requests of an integrated and up-to-date resource to support CCS R&D and offer critical insights for safe CS site selection and well reuse.***

Next Steps & Opportunities

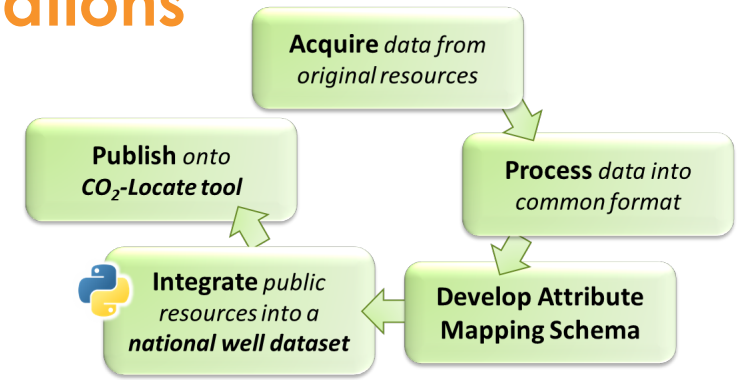
Research Products & Applications

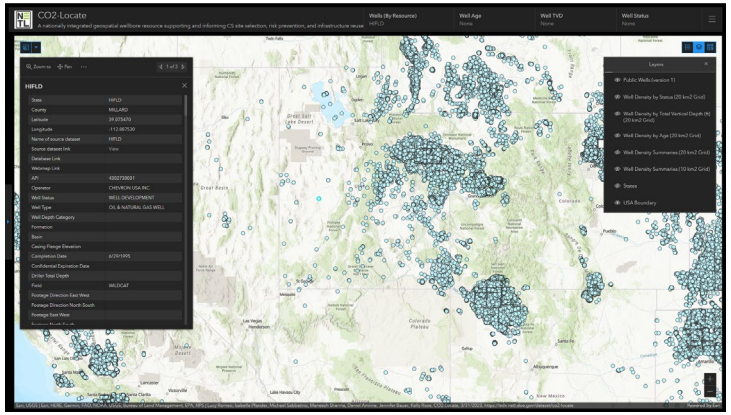
Auto-update algorithms
- Anticipated completion January 2024

Publish CO_2-Locate Database (*v2*)
- Anticipated completion March 2024

Submit Class II Well Reuse Methodology for Publication
- Anticipated completion March 2024

Release CO_2-Locate Tool (*beta*)
- Anticipated completion March 2024
- Supporting ***Class II Well Reuse & Regional Evaluations***





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Data Infrastructure to Accelerate CCS

Opportunities

- Utilize integration method to produce databases

NEWTS DATABASE

Consortium Advancing Technology for Assessment of Lost Oil & Gas Wells. CATALOG

- Update **geoWELL** using sources found in CO_2-Locate

geoWELL

- Apply NETL's **Advanced Infrastructure Integrity Models** to perform integrity assessments

AIIM

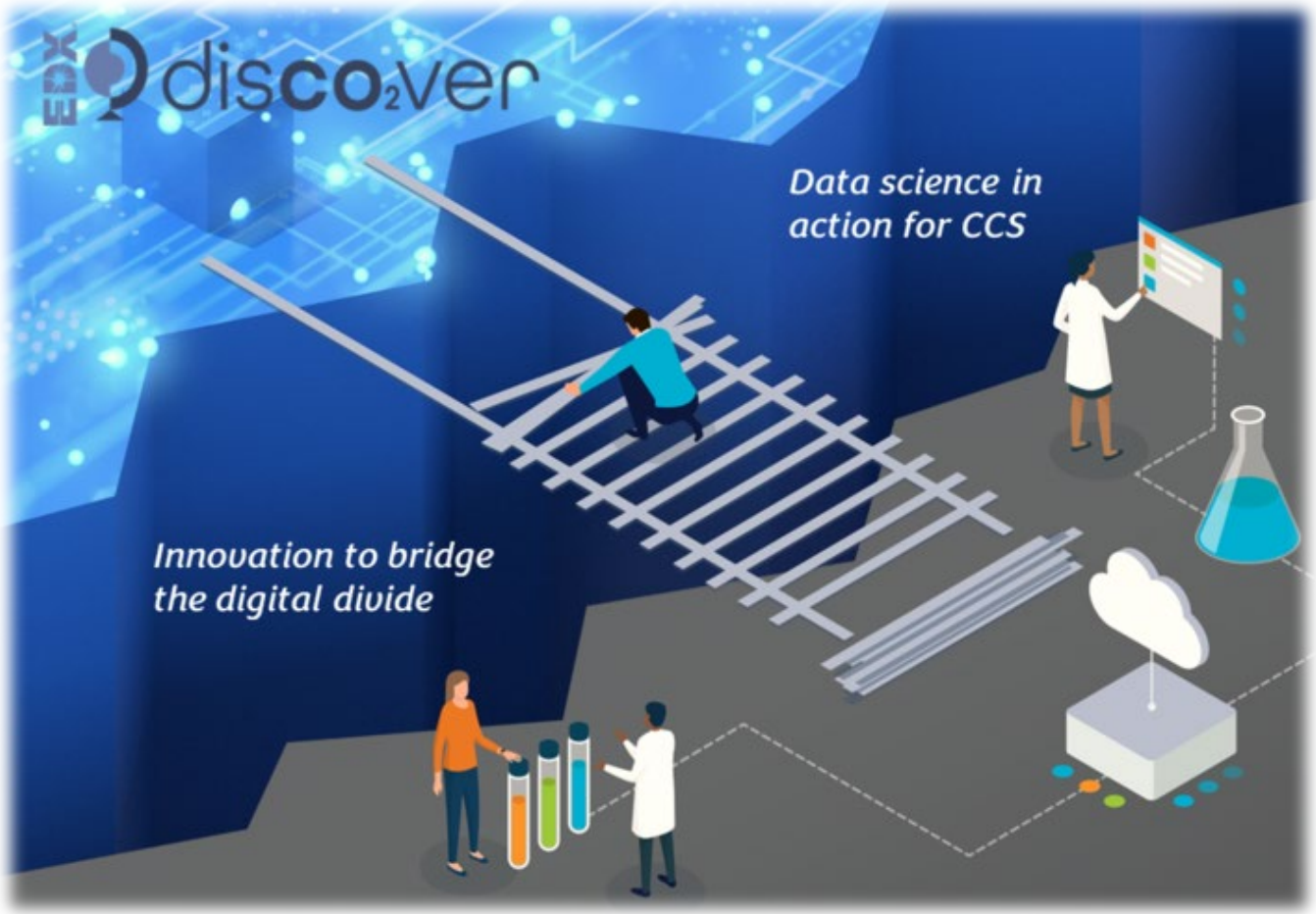
Join us Tuesday evening for live Tool Demos!

When: **5:45 - 7:45 p.m.**

Where: **The Ballroom Foyer and East/West Atriums**

What:

- **Environmental Justice and Social Justice** for CS Systems
- The **international offshore CS** and web-database and tool
- RokBase, Virtualizing **CS Rock Property Data** platform
- **Class VI Data Support Tool** for regulatory requirements
- **CO_2 Pipeline Routing** Smart Tool
- **Co_2Locate - Class II Well Reuse and Regional Evaluation Tool**
- C**arbon Storage Planning Framework Dashboard**
- **3D Data Viewer** and Preview Capability
- AIIM Model, **Assessing Infrastructure Reuse Potential** for CS
- **EDX disCO_2ver,** a one-stop tool for CO_2 digital resources



In demo "theater room" EDX Energy Data eXchange **support team** will offer **in person demos & Q&A**

Acknowledgments

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