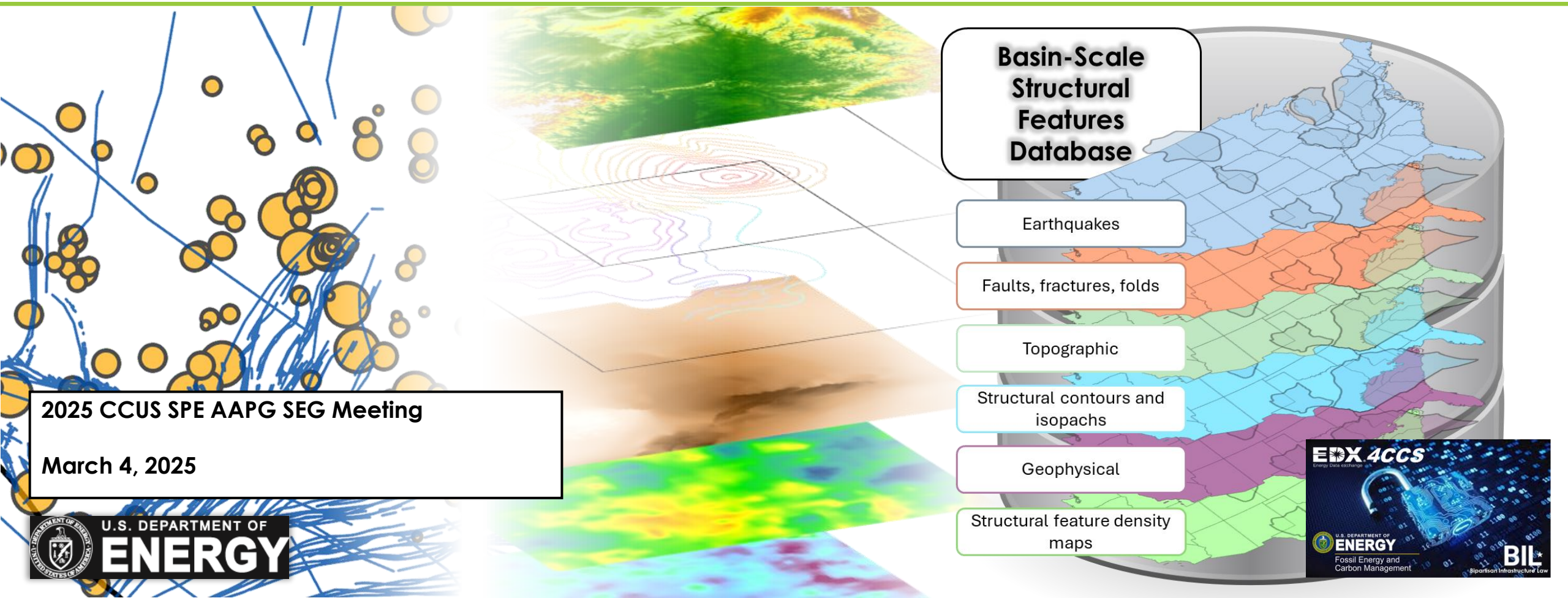
Basin-Scale Structural Features Database

Spatial Datasets to Support Carbon Storage Resource Assessments

Gabe Creason

Geo-Data Scientist



2025 CCUS SPE AAPG SEG Meeting

March 4, 2025

U.S. DEPARTMENT OF ENERGY

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Structural Features….

What are they?

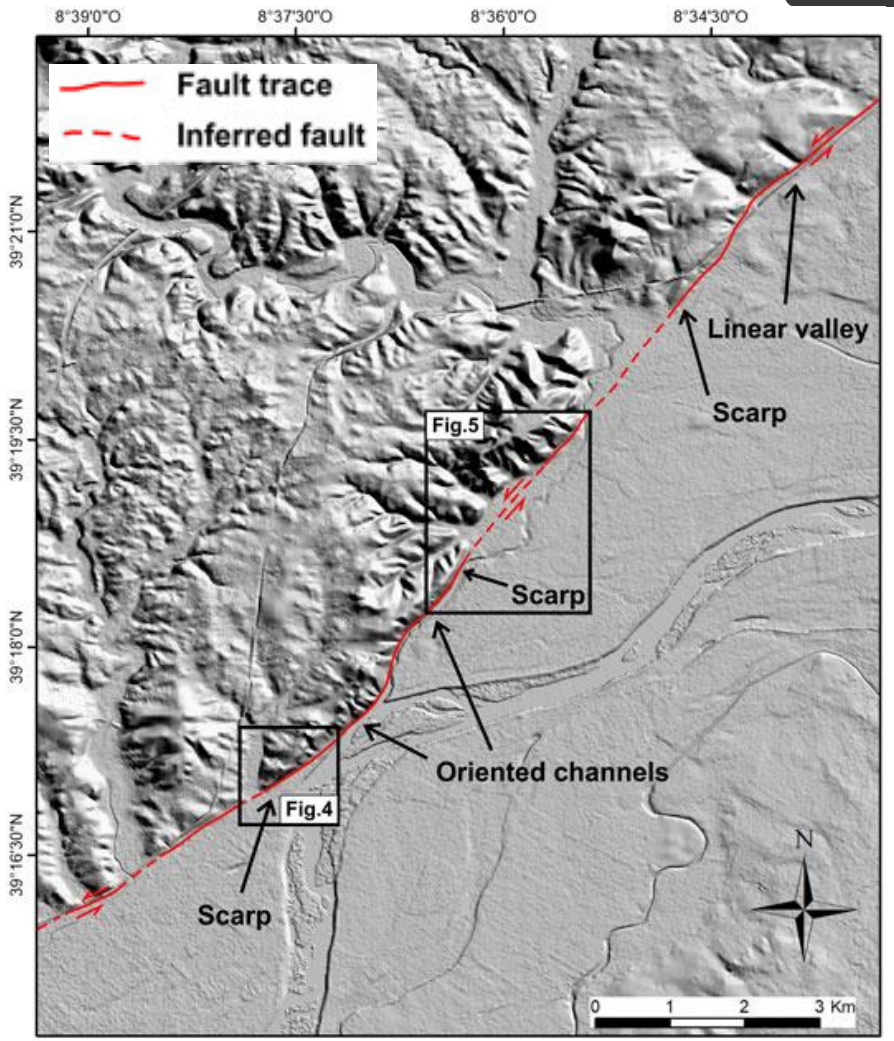
- Faults, fractures, folds…

How are they represented?

- Measured
- Inferred

Why do they Matter?

- CO_2 storage, geothermal, mineral resources…
- Seismic/Induced seismic hazards….

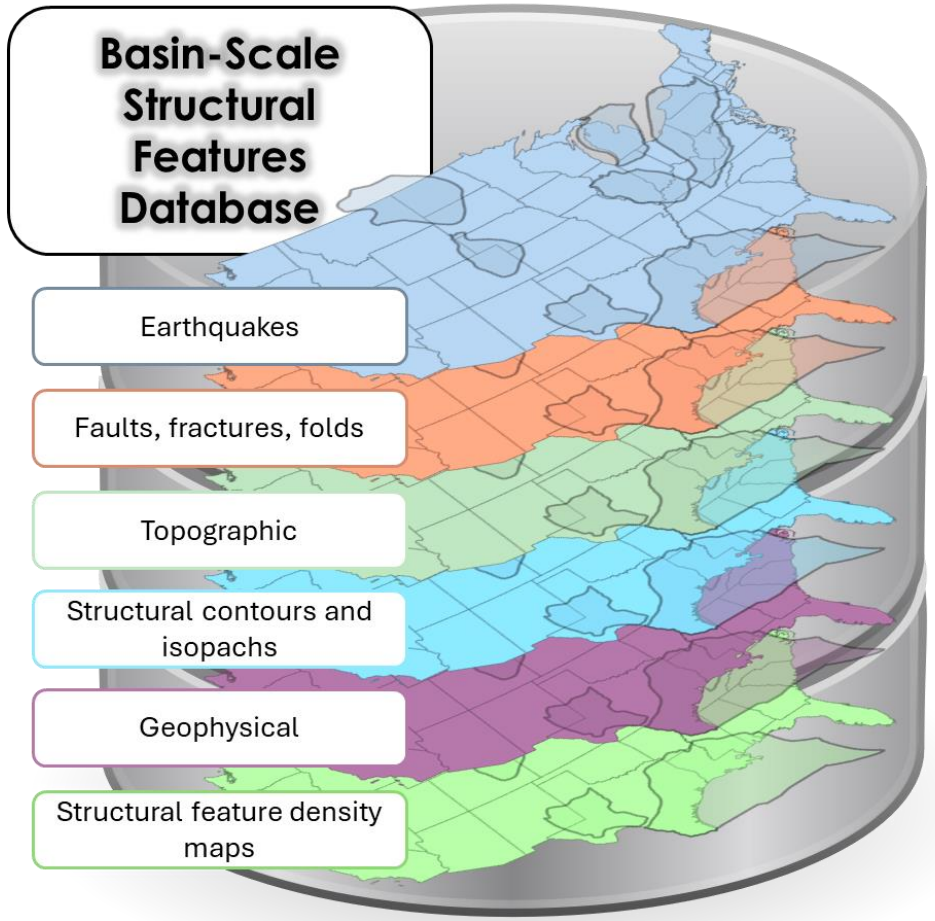


Canora et al., 2021

Basin-Scale Structural Features Database

Purpose:

- Produce an integrated database of **basin-scale structural feature datasets**, for use in **carbon storage-based assessments**



Challenge:

- Readily, publicly available structural data are multi-sourced, multi-format
- A lack of **unified** information to better understand the influence that **basin-scale structure** will have on **long-term carbon storage security**

User community:

- Researchers, external company project leads, and policy makers
- EDX4CCS and other BIL-funded projects

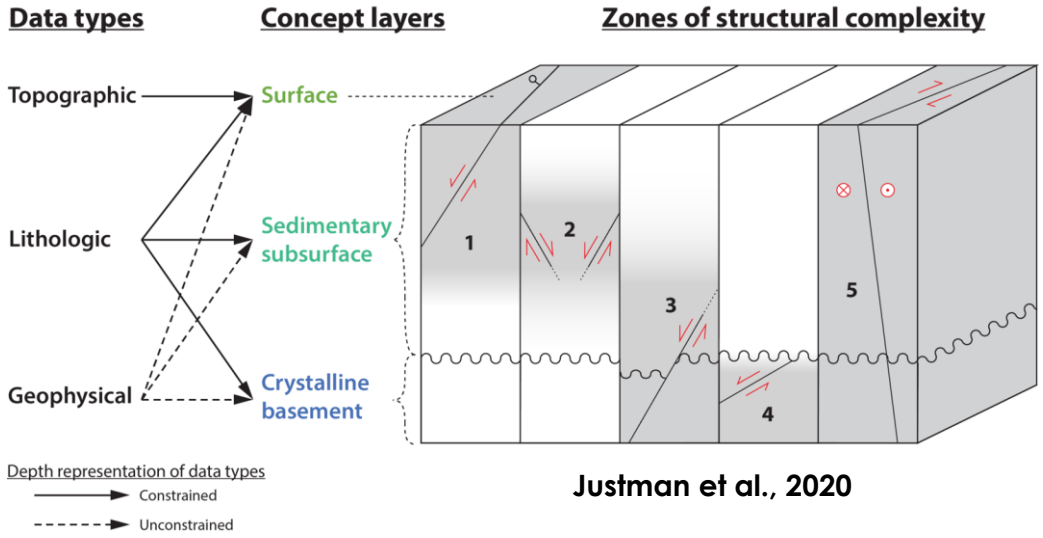
Potential insights for a given basin:

- Provide information about areas with limited structural feature information
- **Multiple datasets** = **multiple perspectives** on structural feature representation

Developing a Basin-Scale Structural Features Database

Method Overview

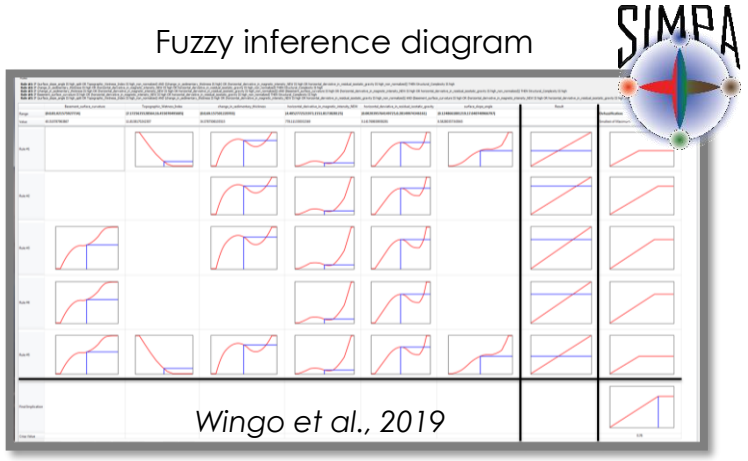
- **Screening method and approach to predict the potential for complex structural features to exist**
  - To better understand geo-hazards linked with faults and fractures
  - Mitigate risks associated with human-subsurface interactions



Justman et al., 2020

- **Tested and validated method in Oklahoma**
  - SIMPA tool- Spatially Integrated Multivariate Probabilistic Assessment (**Wingo et al., 2019**)

Fuzzy inference diagram

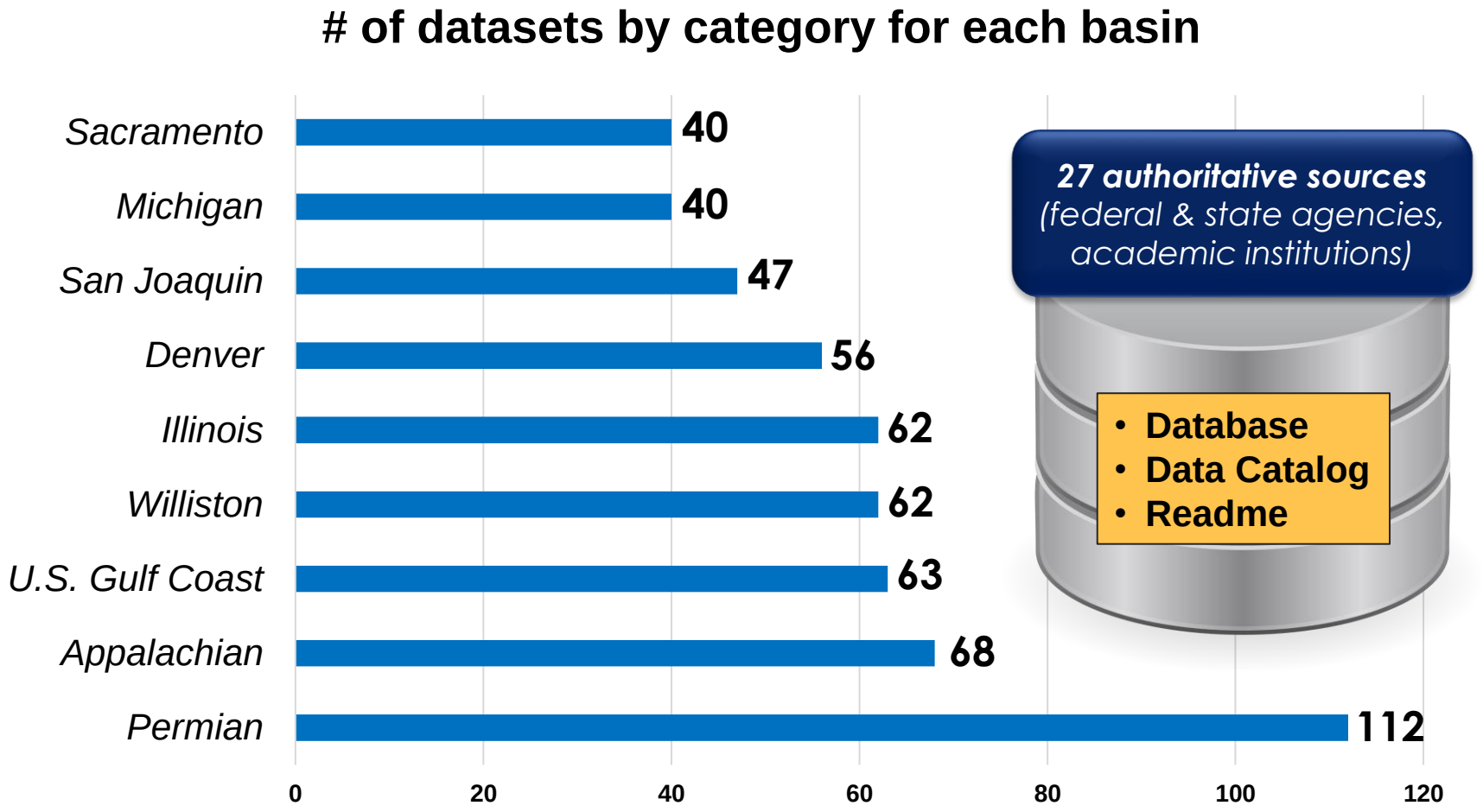


Justman, D., Creason, C. G., Rose, K., & Bauer, J. (2020). A knowledge-data framework and geospatial fuzzy logic-based approach to model and predict structural complexity. **Journal of Structural Geology**, 141, 104153.

Basin-Scale Structural Features Database v1.0

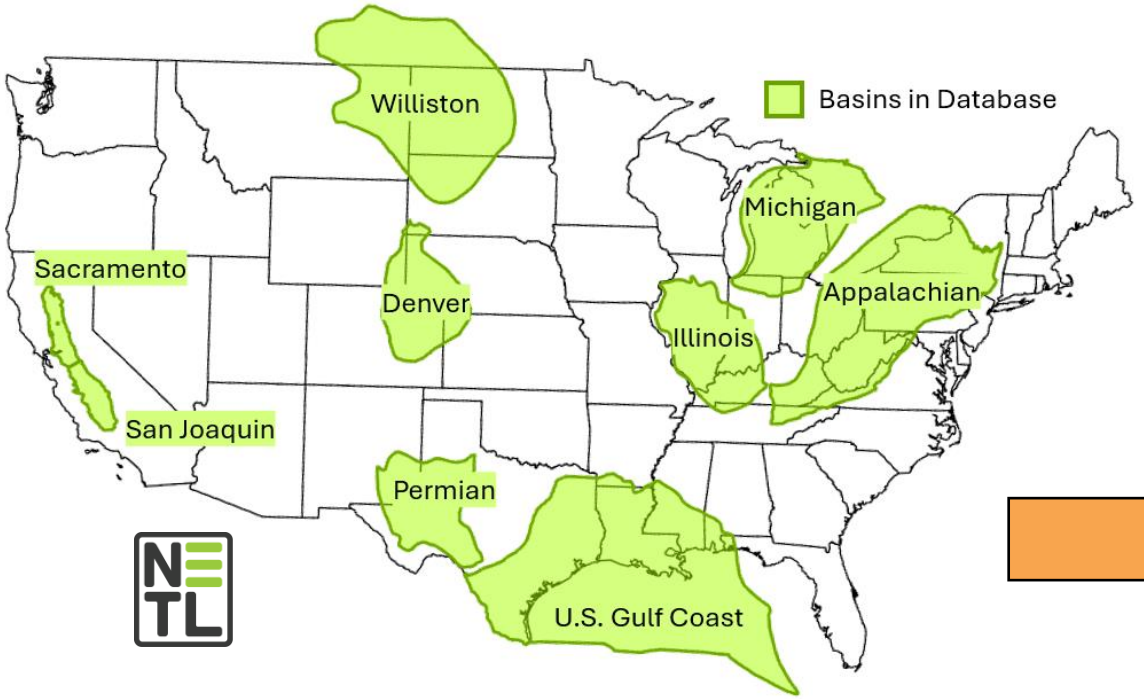
What does it contain?

- **550 spatial datasets** for **9 saline basins**
  - Datasets organized by basin and category
- **Data catalog-** source and key metadata information
- **ReadMe-** Background information, metadata, and key explanations

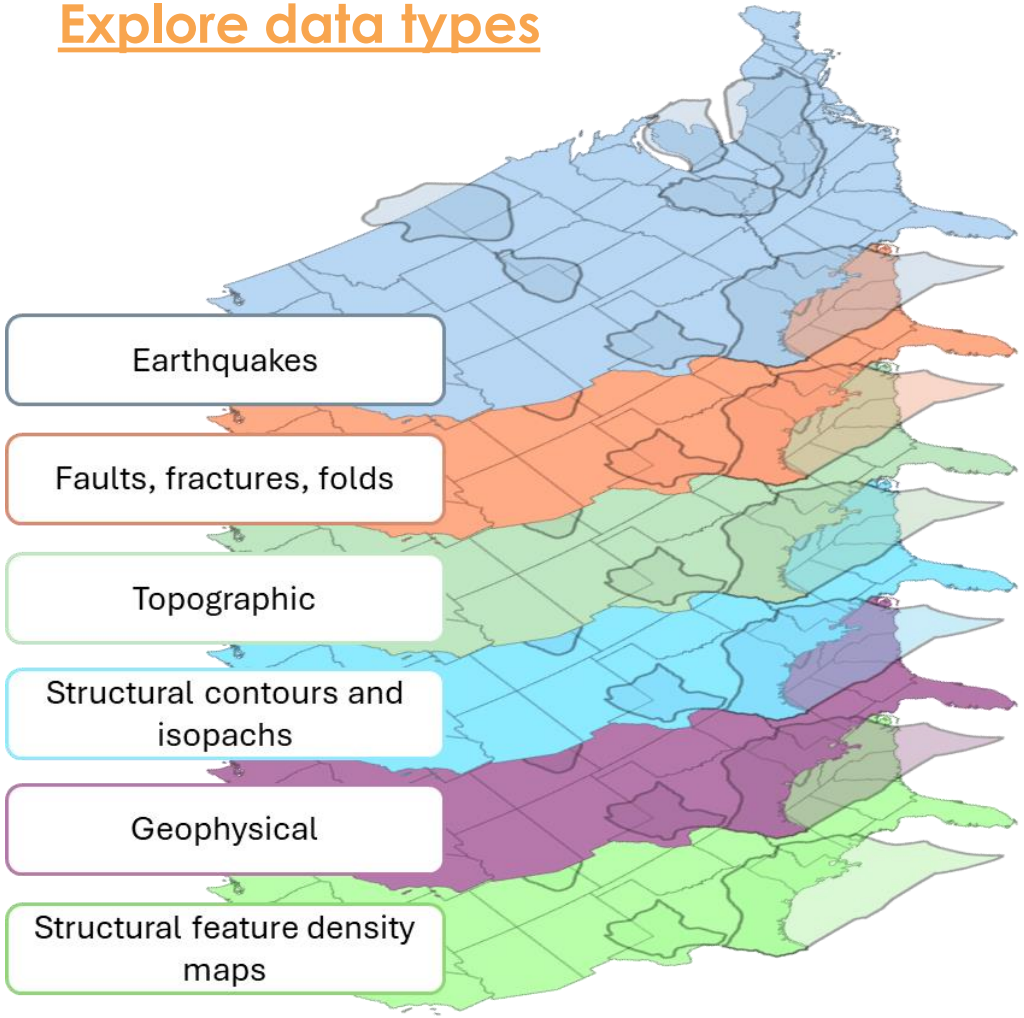


Database Content

Choose a Basin

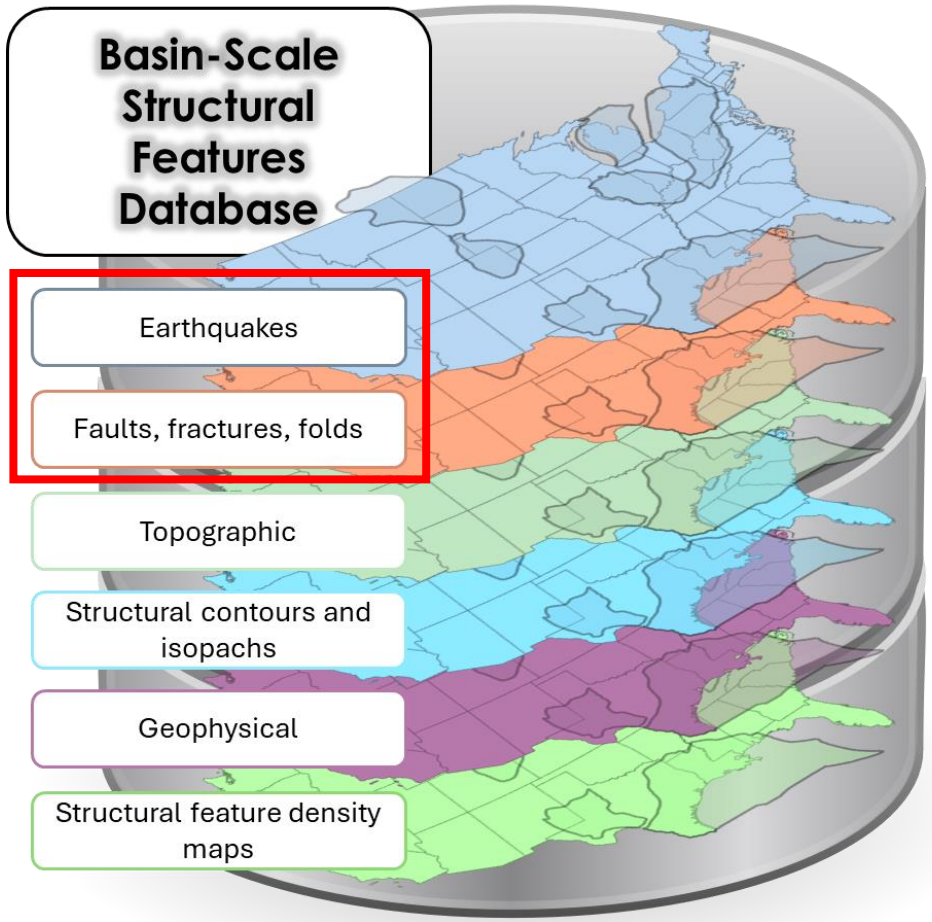


Explore data types

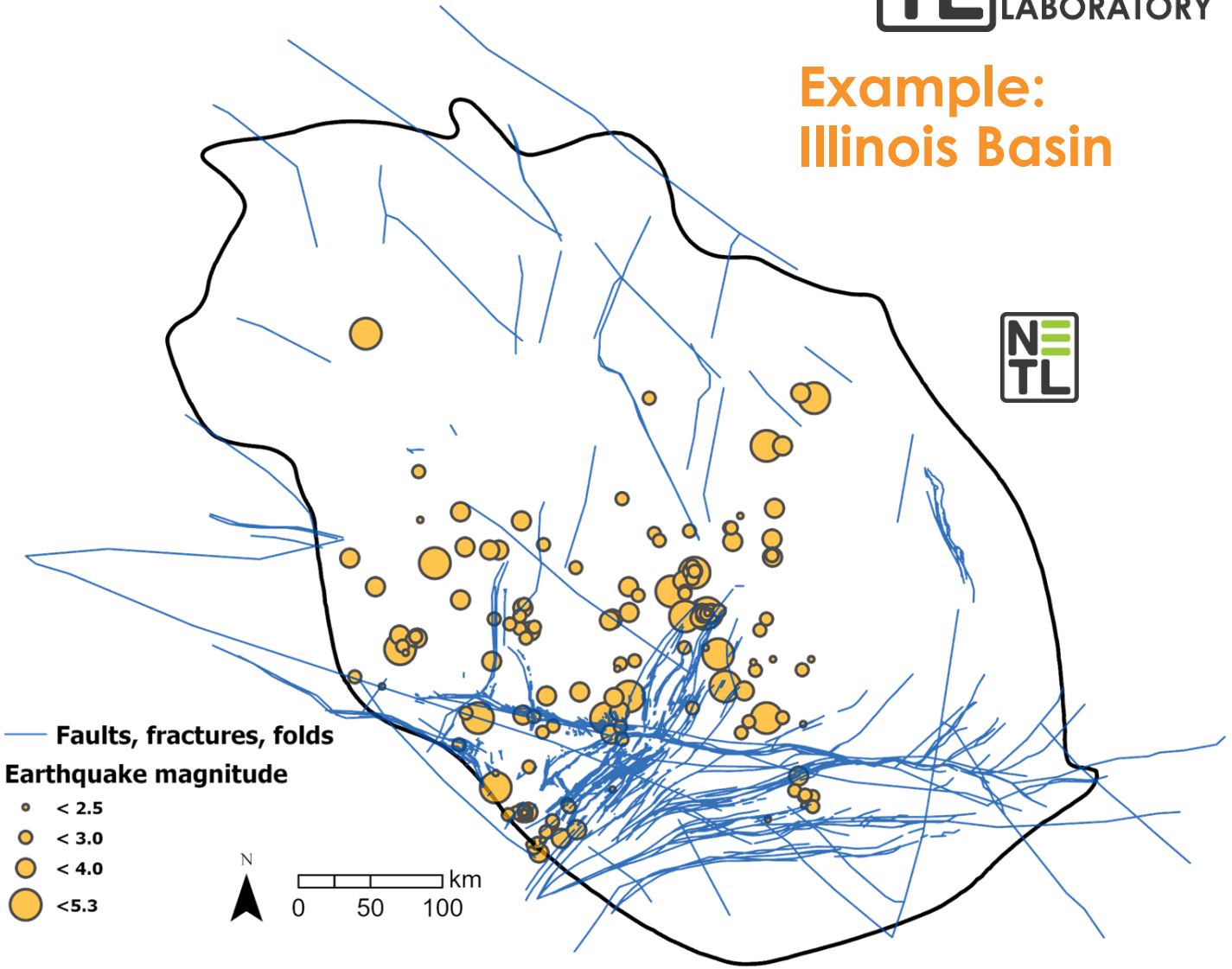


- Provides stakeholders with multiple structural data types for multiple perspectives on geologic structure within single unified database to view, conduct further research, and download

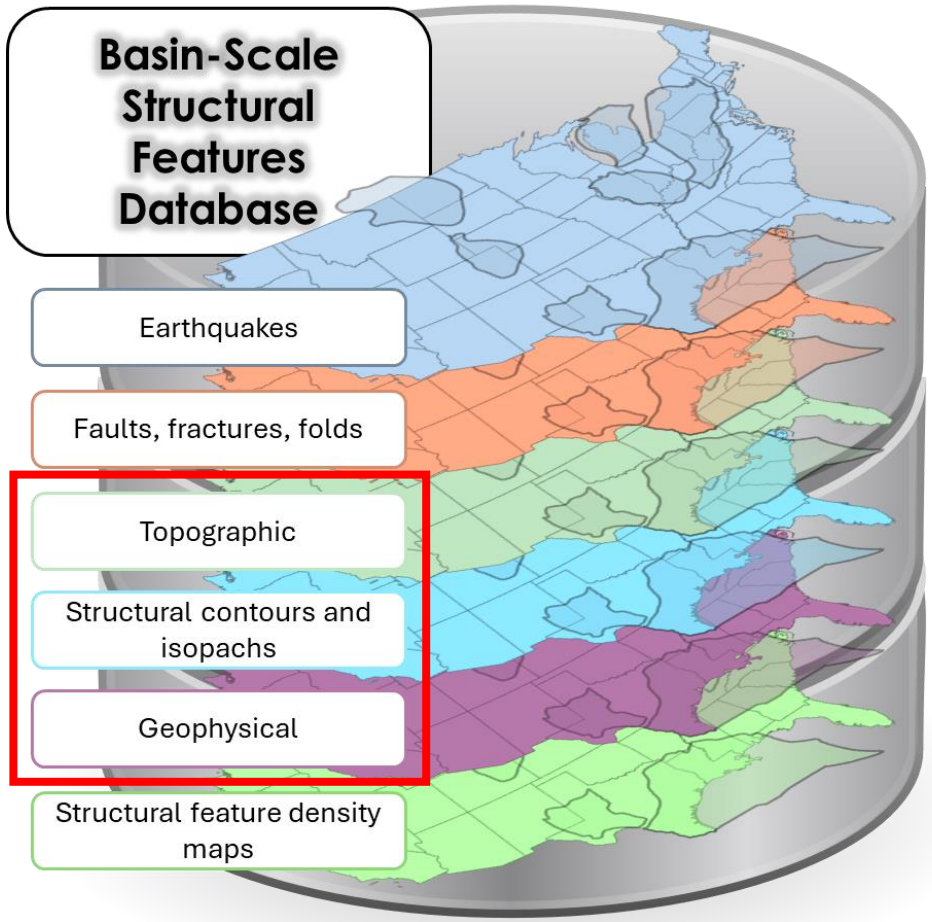
Measured structural feature data



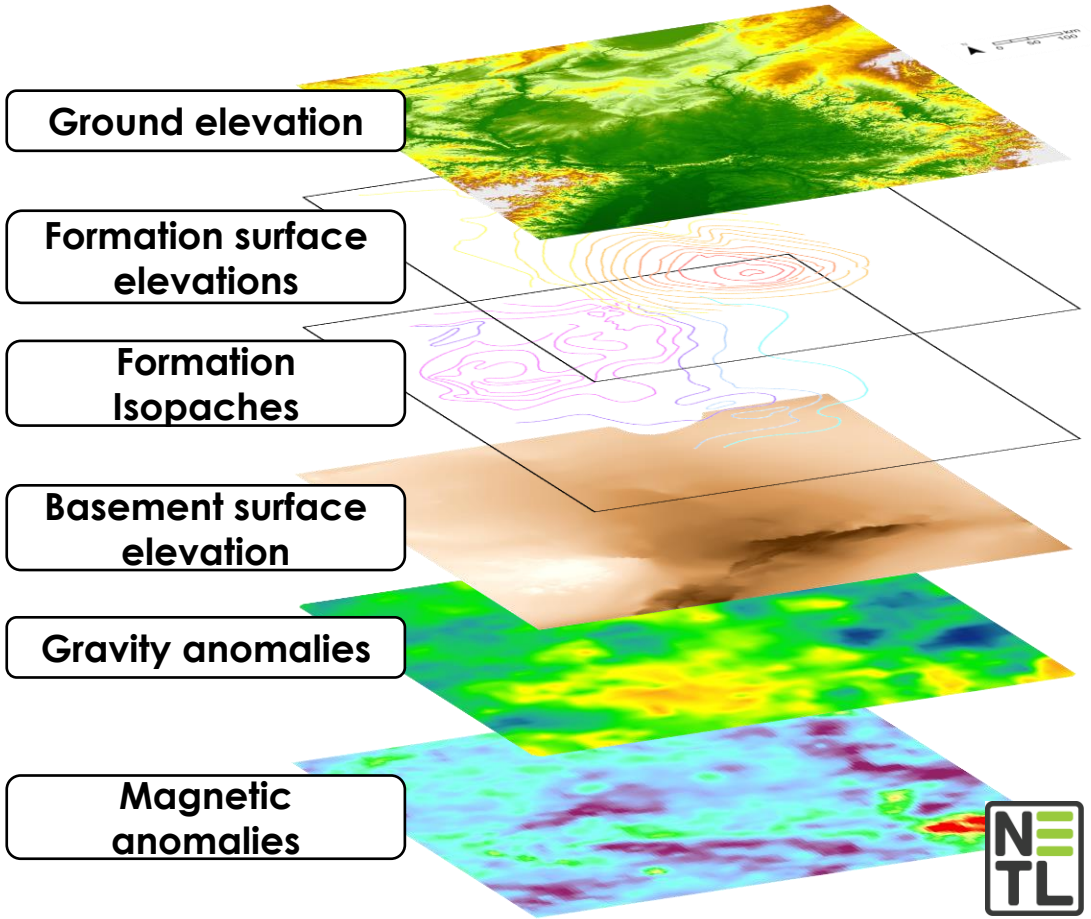
Example: Illinois Basin



Inferred structural feature data



Example: Illinois Basin



Inferred structural feature data derivatives

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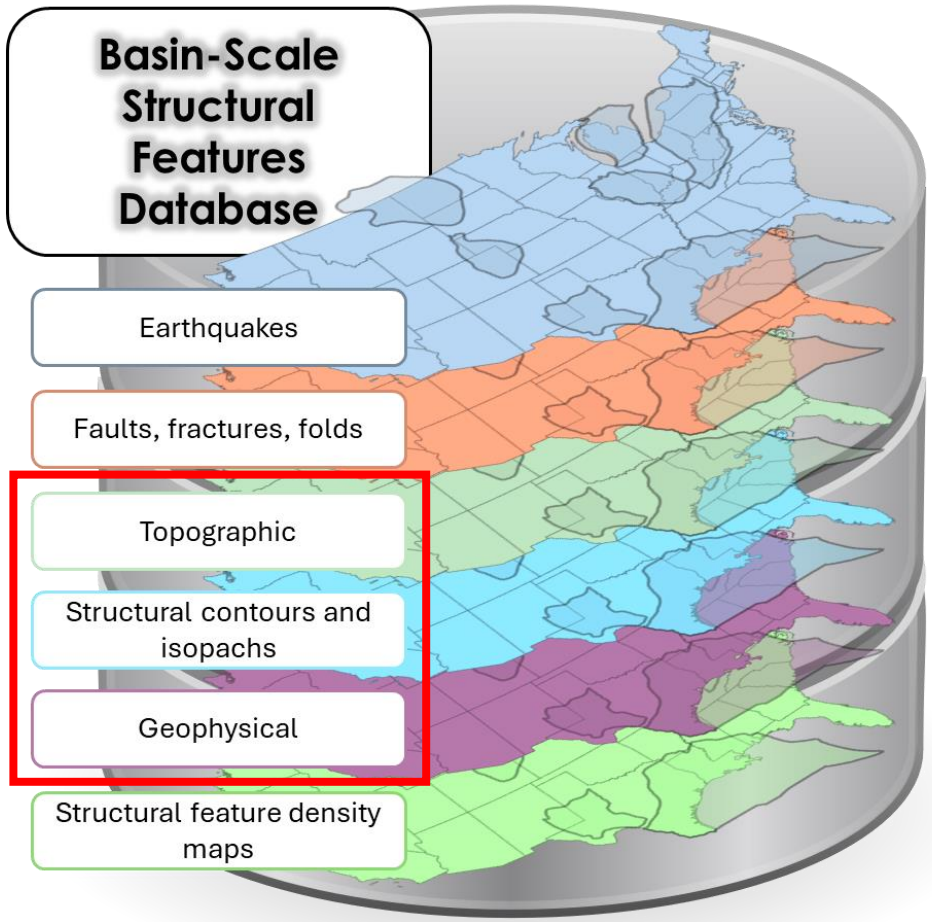
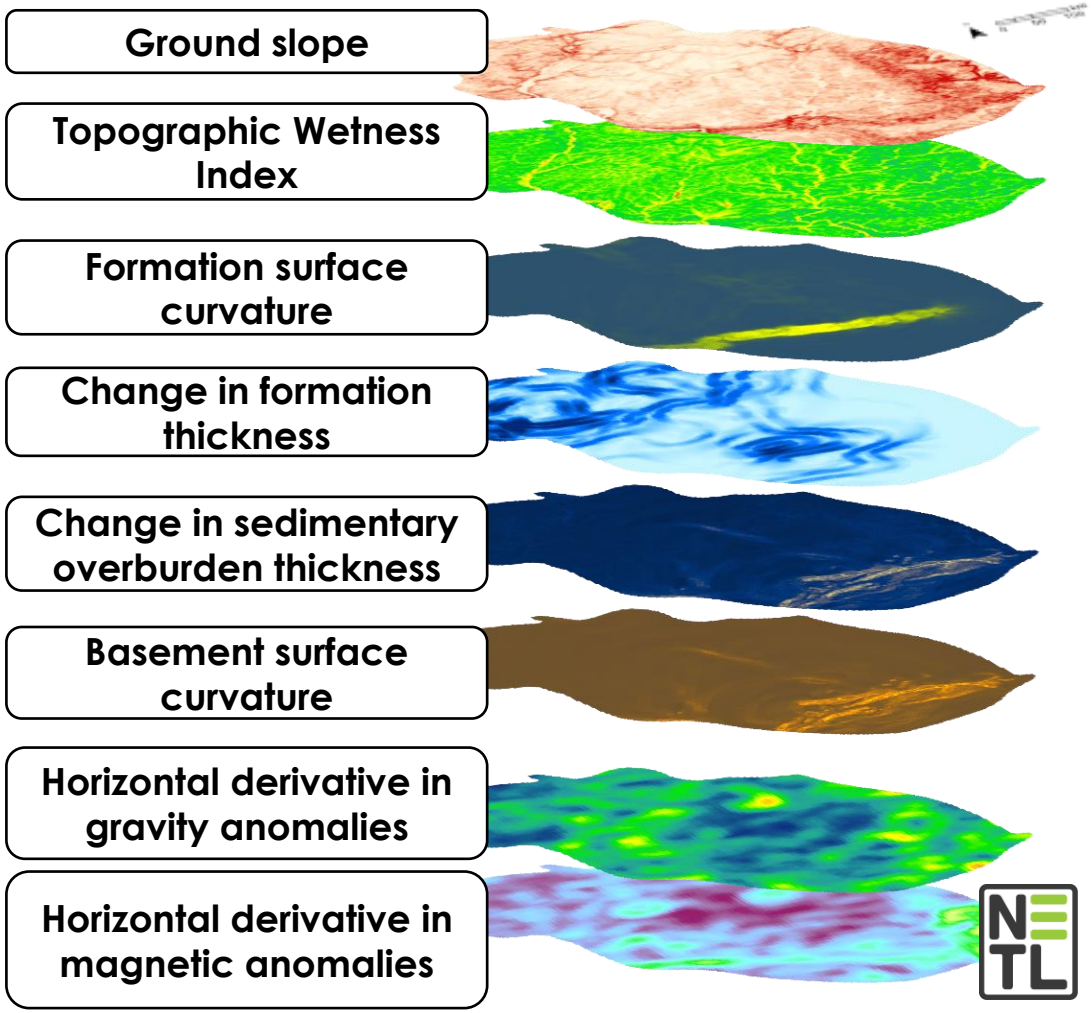
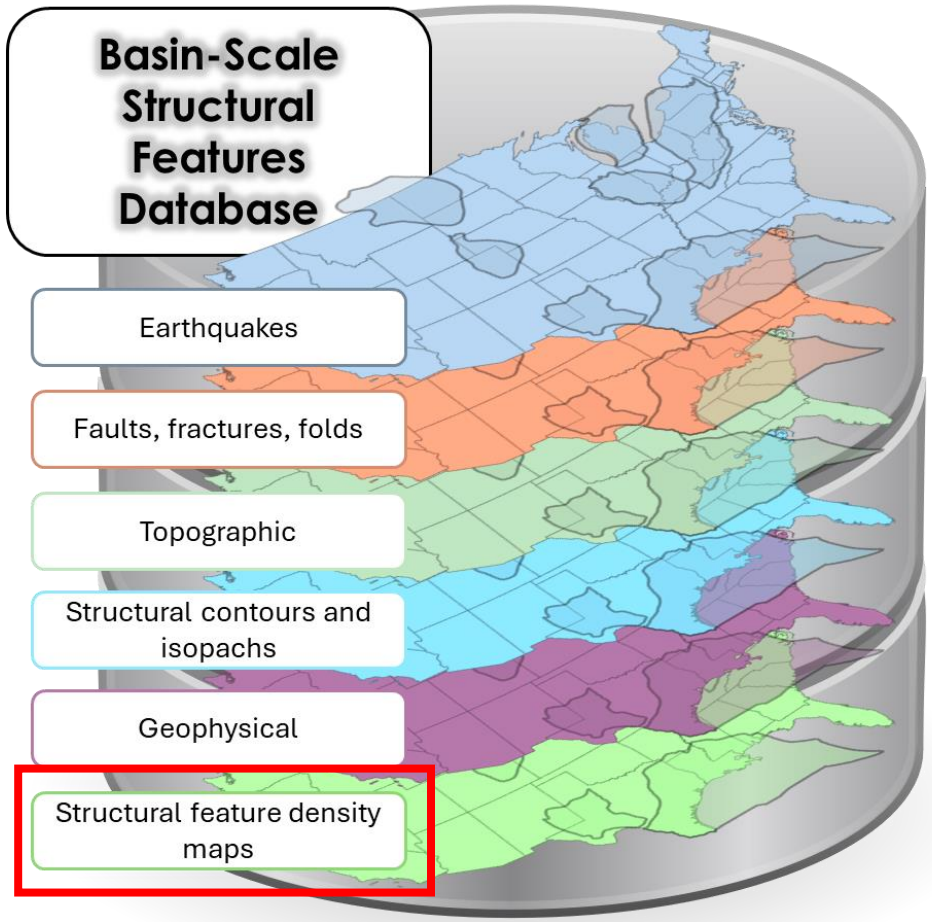


Example: Illinois Basin



Structural feature density assessment data



Measured structural data

Inferred structural data

Structural Feature Density (SFD) scores

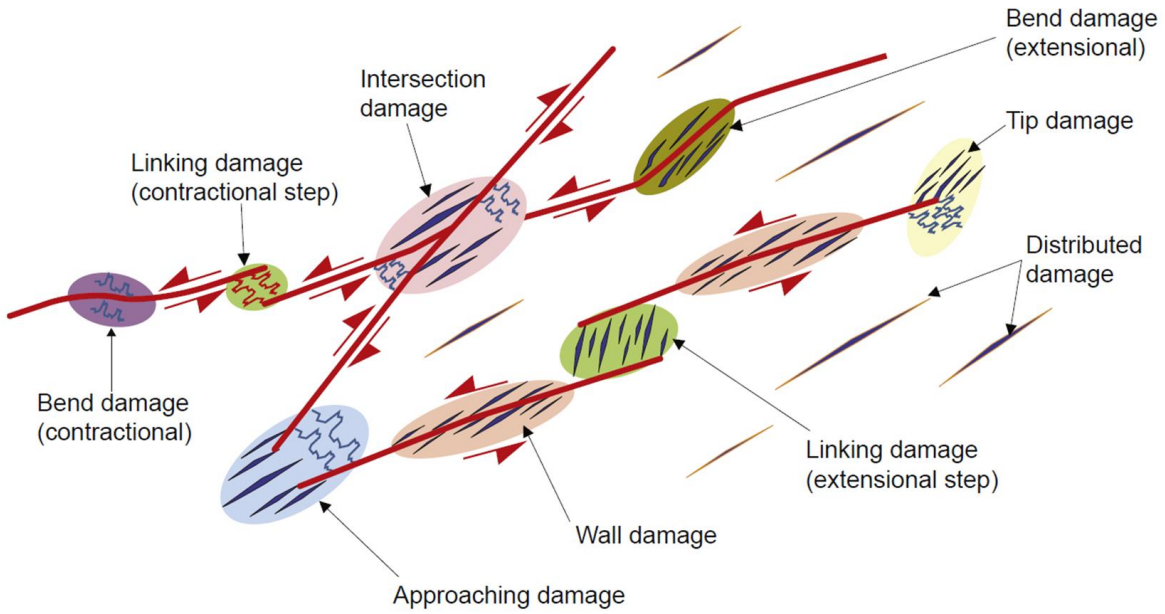
- A score describing the **relative spatial density of structural features** for each basin ranging from 0 (lower density) to 1 (higher density).

Measured SFD score maps

Predicted SFD score maps

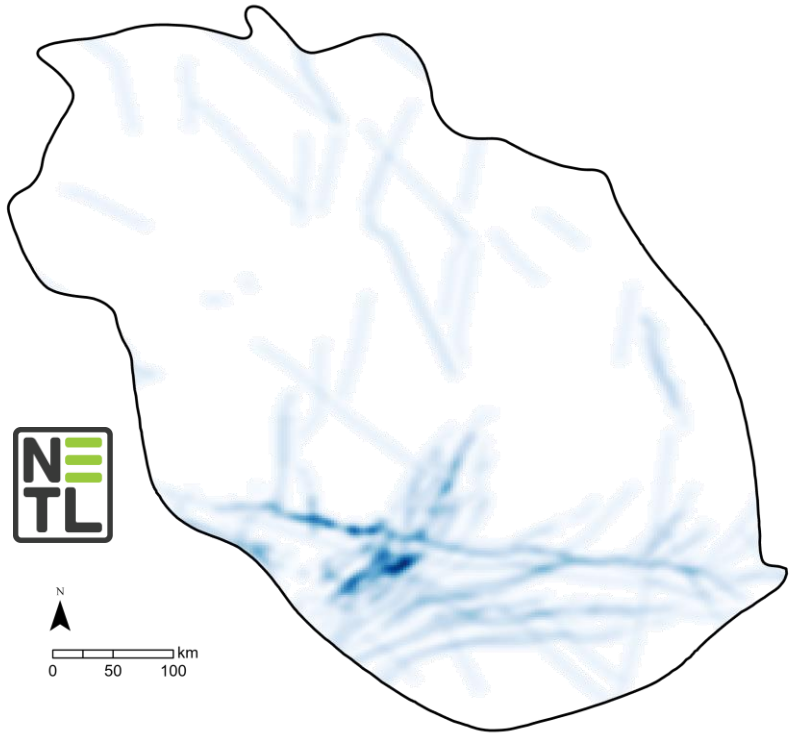
Measured structural feature density assessment data

Types of structural feature density



"Complex zones" or "damage zones" are areas with high fracture intensity/linkage and high variation in fracture orientations in contrast with surrounding areas and occur across a variety of tectonic setting, lithologies and scales.
Peacock et al. (2017)

Example: Illinois Basin



Measured Structural Feature Density Score

Lower **Higher**

Predicted structural feature density assessment data

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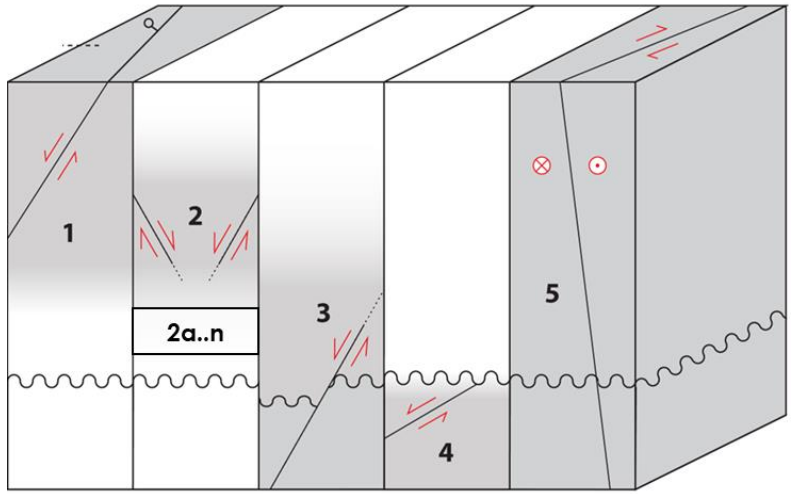
Example: Illinois Basin

Subsurface zones



1) Surface

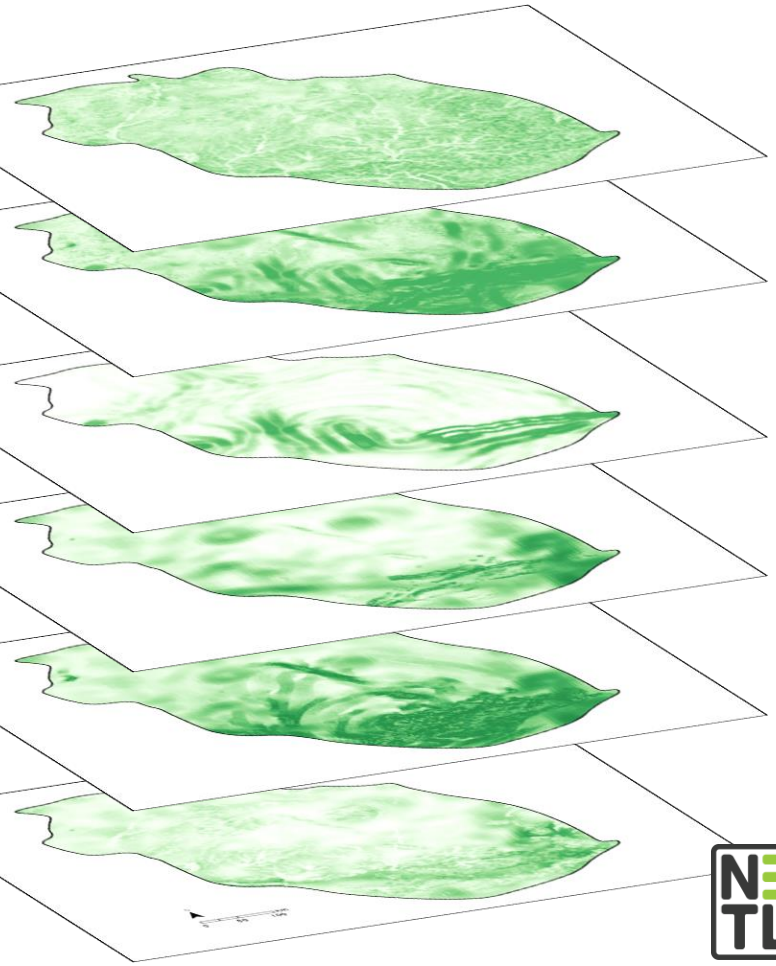
2) Sedimentary subsurface

2a..n) Sedimentary formations

3) Crystalline basement interface

4) Crystalline basement

5) Entire subsurface crosscut



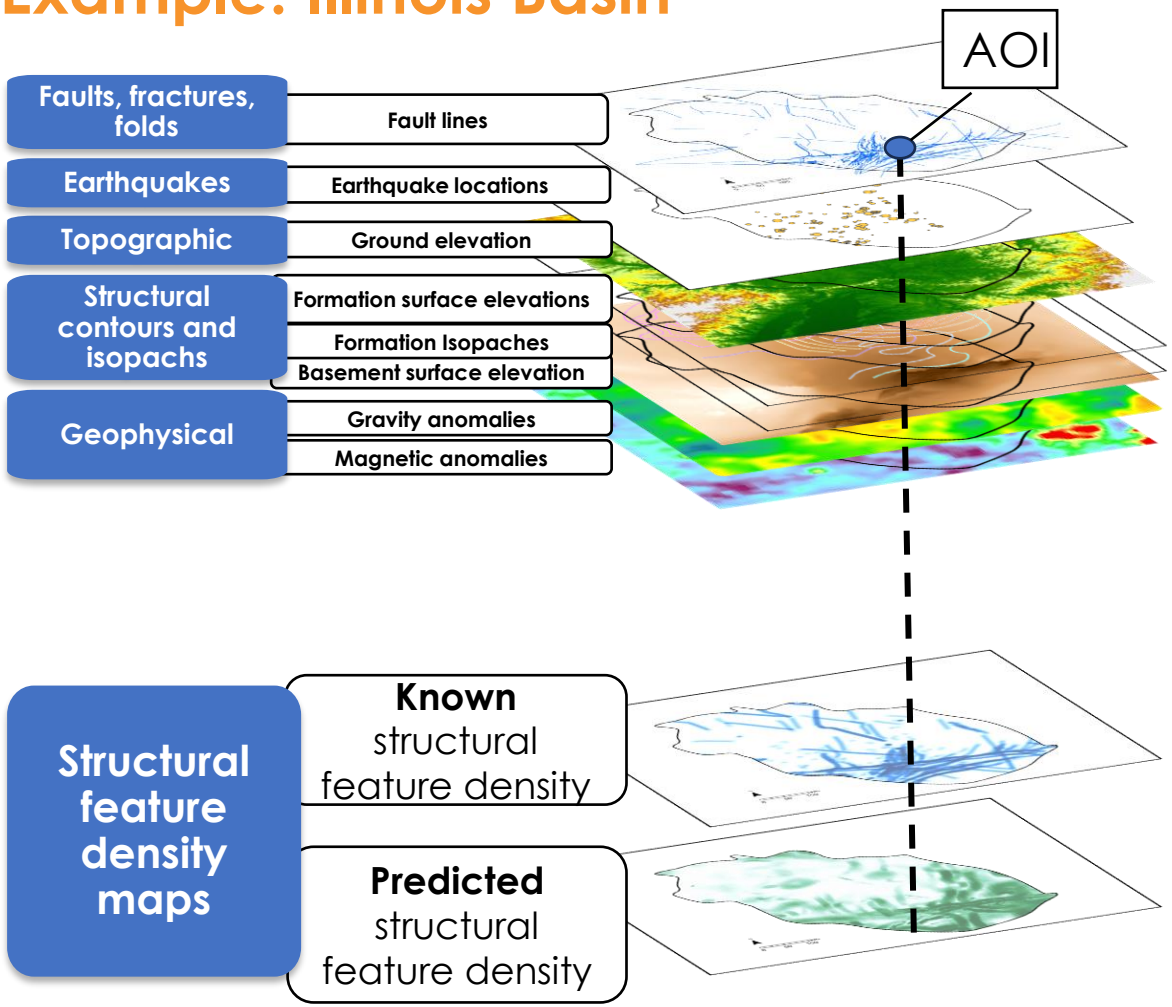
Predicted Structural Feature Density Score

Higher

Lower

Multiple Data Perspectives

Example: Illinois Basin



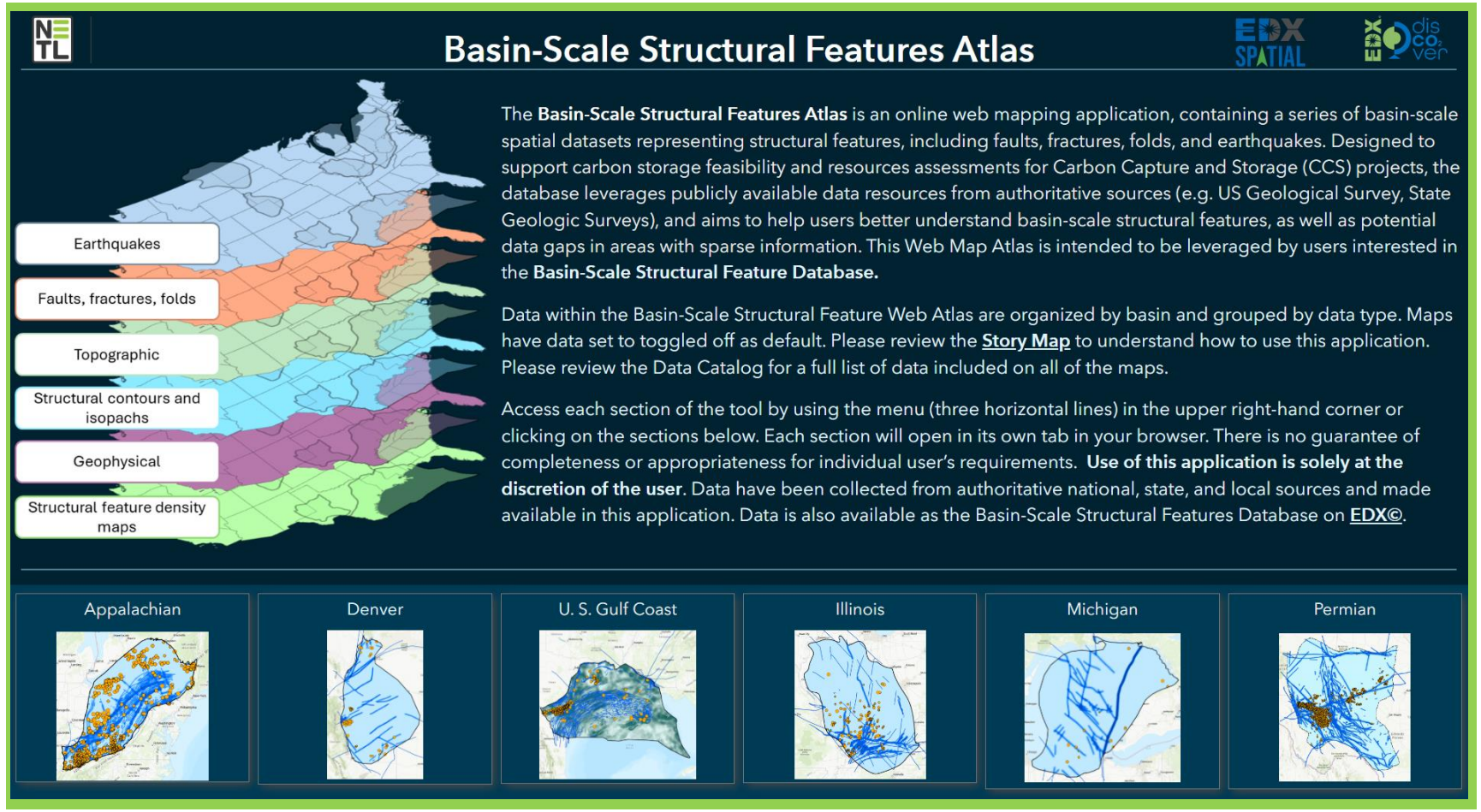
- At any given location, users can explore multiple data types representing structural features for a variety of use cases
  - Potential CS site locations, CS technical viability, etc.
- Raw data are processed to develop new datasets to represent **measured** and **predicted** structural feature density based on published methods (*Journal of Structural Geology; Justman et al., 2020*)
- Provides users with synthesized results to gain new insights into where potential structural features may exist

Basin-Scale Structural Feature Atlas

Next steps

- **Basin-Scale Structural Feature digital web atlas**
  - Host, visualize, and explain the database for improved stakeholder engagement
  - Public release is **3/31/2025**

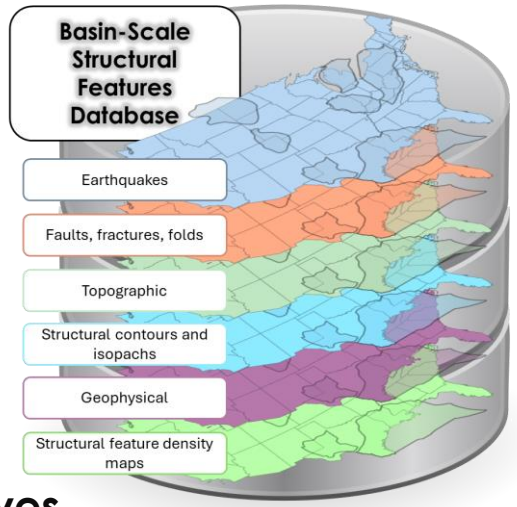
- Updated database is set to be publish on EDX **(3/31/2025)**
  - Includes Sacramento and San Joaquin Basins



Basin-Scale Structural Feature Database

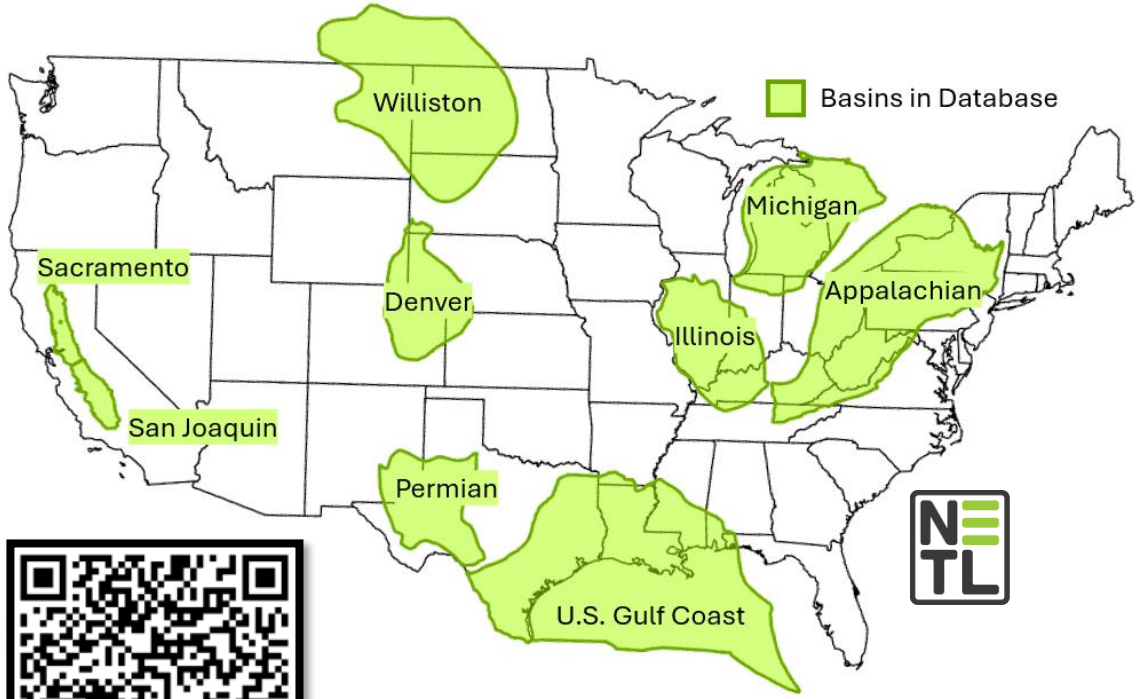
Ultimate Outcomes

- A database of *basin-scale* structure datasets for selected saline basins
- Digital atlas of structural features
- Published on **EDX DisCO$_2$ver Platform**



Stakeholder Benefit

- Provide information about areas with limited structural feature information
- **Multiple datasets = multiple perspectives** on structural feature representation
- Results can be leveraged to inform carbon storage resource and feasibility assessments and many other subsurface applications



https://edx.netl.doe.gov/dataset/basin-scale-structural-features-database

disco2ver Data Infrastructure to Accelerate CCS https://edx.netl.doe.gov/sites/disco2ver-alpha/

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Acknowledgments

This work was performed in support of the U.S. Department of Energy's Fossil Energy and Carbon Management's Geo-Analysis and Monitoring Team and was developed jointly through the U.S. DOE Office of Fossil Energy and Carbon Management's EDX4CCS Project, in part, from the Bipartisan Infrastructure Law.

This research was supported in part by an appointment to the U.S. Department of Energy (DOE) Postgraduate Research Program at the National Energy Technology Laboratory (NETL) administered by the Oak Ridge Institute for Science and Education (ORISE).

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Developing a Basin-Scale Structural Features Database

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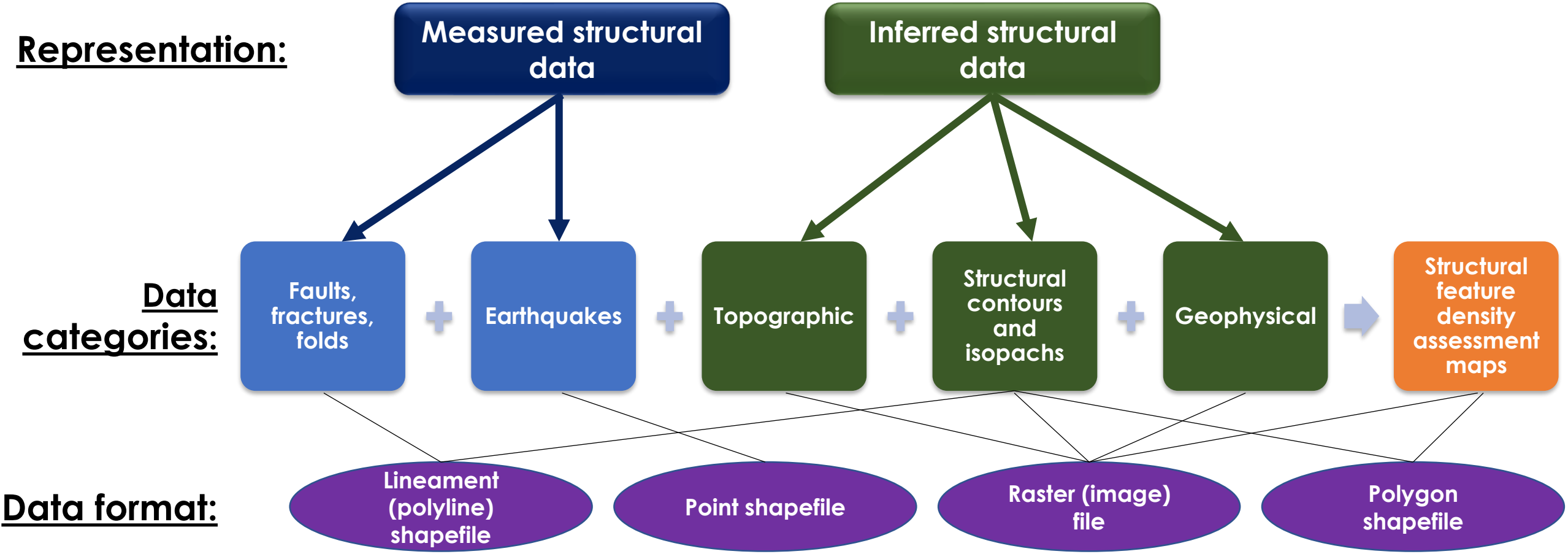
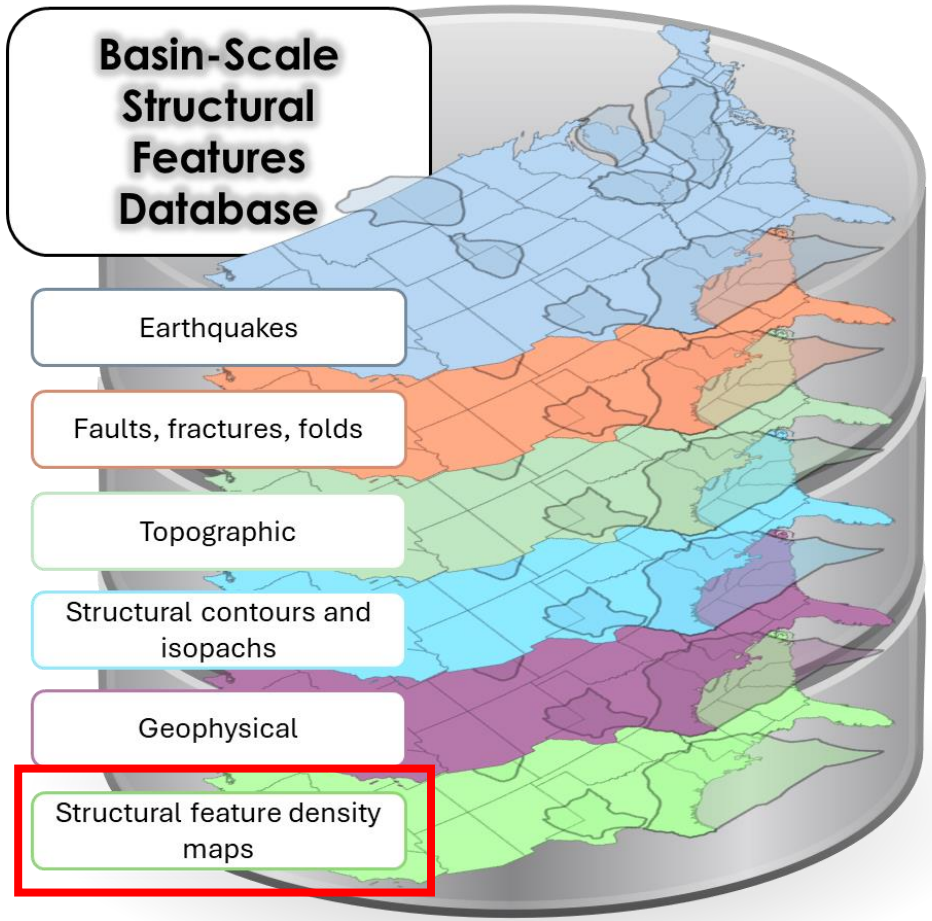
Applied Framework



Structural feature density assessment data



Measured structural data

Inferred structural data

Structural Feature Density (SFD) scores

- A score describing the **relative spatial density of structural features** for each basin ranging from 0 (low density) to 1 (high density).
  - A score of 1 represents the highest relative spatial density of **known** (available fault, fracture, fold, and earthquake data) or **predicted** structural features.
  - A score of 0 represents the absence of **known** (available fault, fracture, fold, and earthquake data) or **predicted** structural features or where data aren't readily available.

Measured SFD score maps

Predicted SFD score maps