Regional EOR Potential of the Utica/Point Pleasant in Ohio

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Abstract

Over the past decade, the Utica Shale/Point Pleasant Formation unconventional shale play has been a prolific oil, gas, and natural gas liquids producer, primarily in the Ohio portion of the Appalachian Basin. As part of the Utica Consortium Playbook, Hickman and others (2015) delineated an oil assessment area for the Utica/Point Pleasant unconventional shale play. Current oil production from the Point Pleasant Formation is in the extreme southeastern portion of the oil assessment area, showing that most of the oil assessment area first delineated in 2015 is nonproductive. This study is a regional characterization of the Utica/Point Pleasant interval for enhanced oil recovery (EOR) techniques. EOR techniques may allow for the opening of the oil assessment area, extending the life of the play, and possibly play a role in usage of CO_2 EOR techniques.

The methods employed in this study include new mapping of the geologic units in the Utica/Point Pleasant interval, along with examining existing and newly submitted data for the rock and reservoir properties since the publication of the Utica Consortium Playbook. The new structure and isopach maps show much more detail than was published previously. Using the mineralogy data, Mineral Brittleness Indices (MBI) were computed for each of the geologic units in Utica/Point Pleasant interval. New reservoir pressure mapping by Trotter (2018) shows that the primary production is from the overpressure area. Most of the oil assessment area is slightly above or at hydrostatic pressure. Any EOR activity will require additional energy being added to the reservoir, through repressurizing of the reservoir, for oil to be driven to collection wellbores. These new maps and analyses provide guidance to operators for future EOR operations in the Utica/Point Pleasant unconventional shale play.

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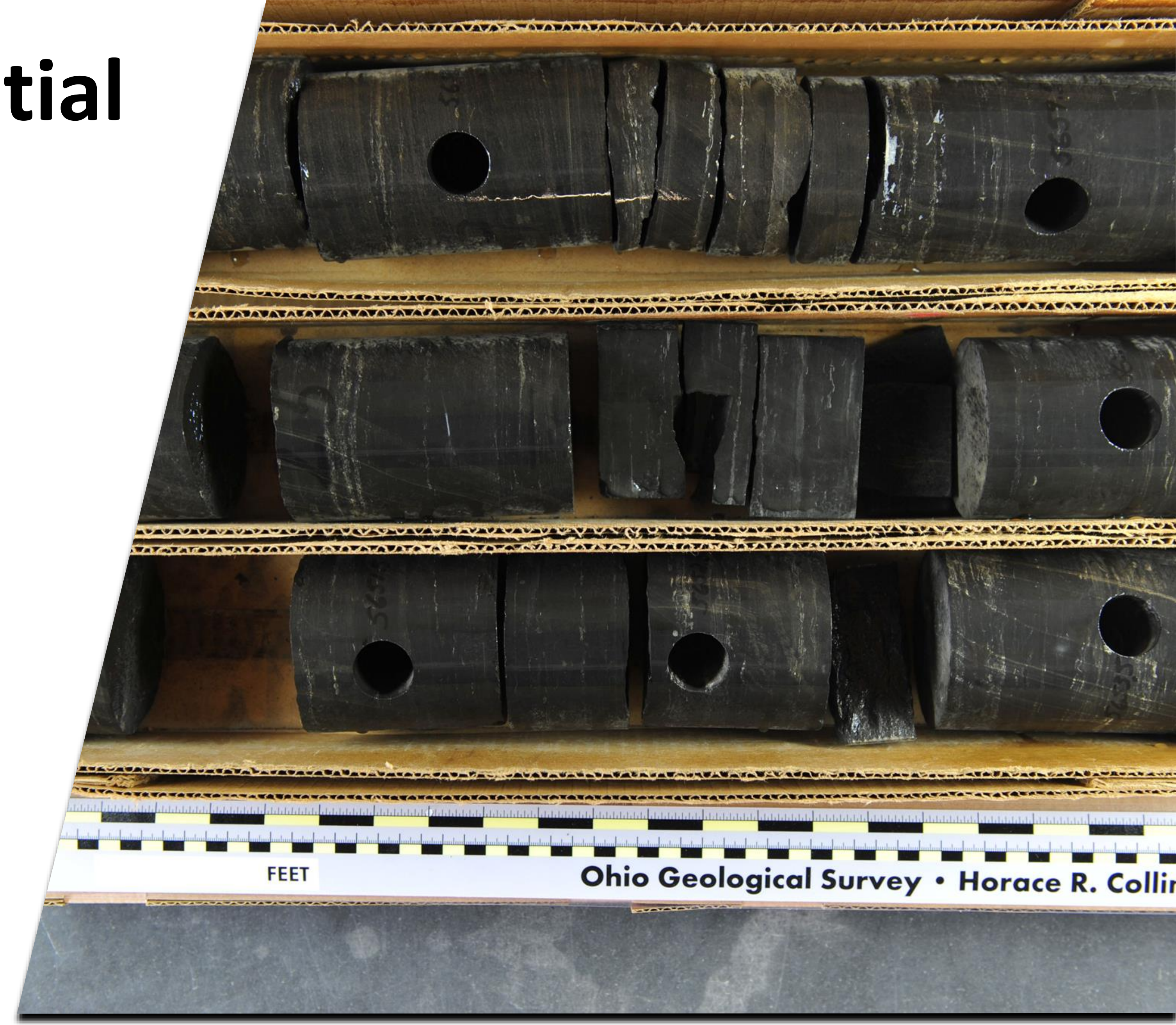

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Outline

- Purpose
- Geologic Framework
- Structure and Isopach Mapping
- Rock Properties
- Reservoir Properties
- Results

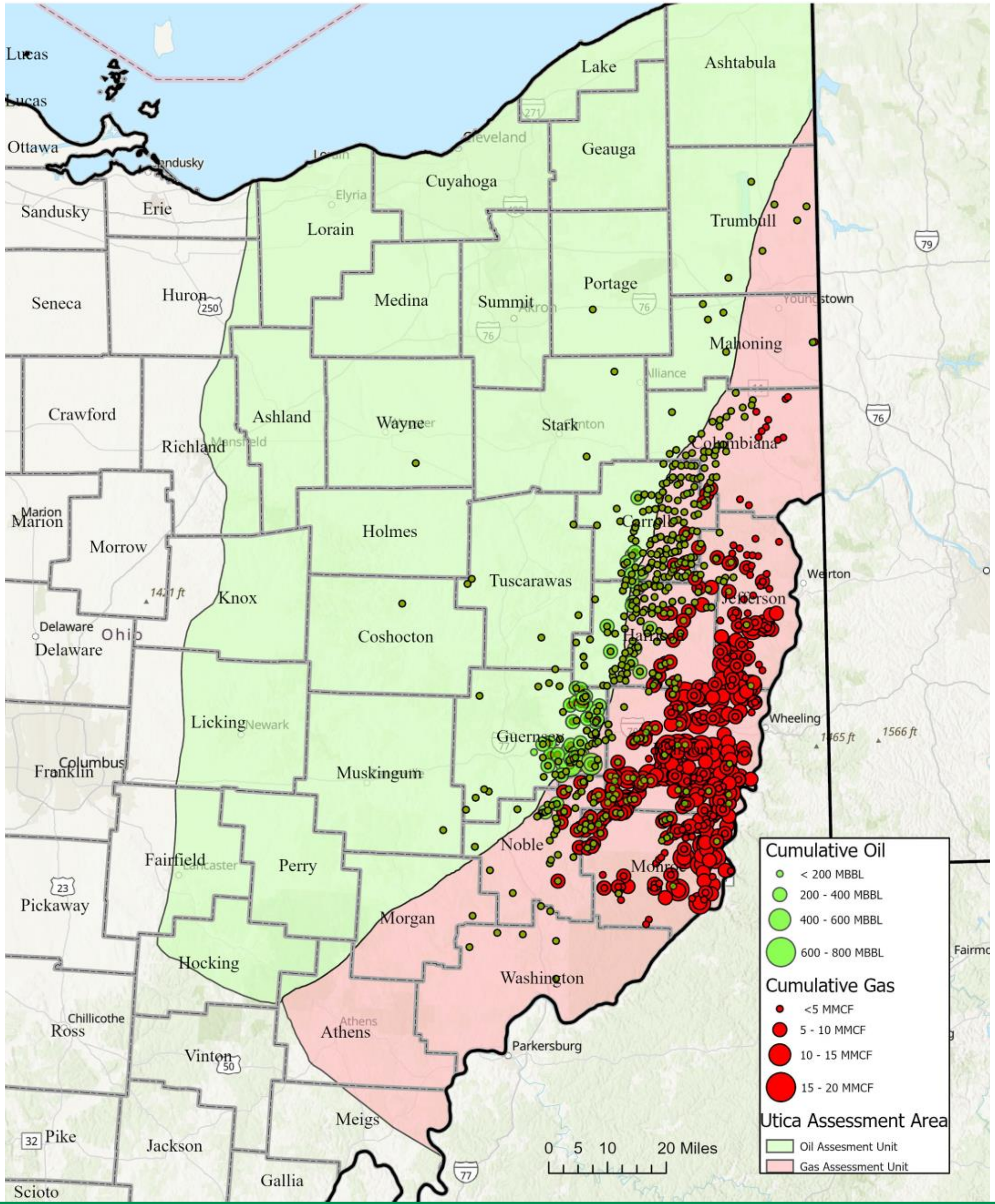
Purpose - Why Enhanced Oil Recovery in the Utica/Point Pleasant?

- **Most of the Oil Assessment Unit is Non-Productive**
  - Utica Consortium (2015) defined an Oil Assessment and Gas Assessment Units
  - Oil Assessment Unit is Non-Productive
  - Open up the Non-Productive Oil Assessment Unit
- **Reverse Production Decline/Extend the Life of a Well**
- **Application of Novel EOR Techniques**
  - U.S. DOE grant to Battelle Memorial Institute
  - Pilot Project by Battelle in Coshocton County using NGL as Injection Fluid
- **Possible Application of CO_2 EOR and Carbon Capture, Utilization and Storage (CCUS)**

Point Pleasant Oil/NGL/Gas Production

- **Most Production is NGL and Gas**
- **Oil production is limited**
  - SE Border of the Oil Assessment Unit
- **EOR techniques can be used to open the Oil Assessment Unit**

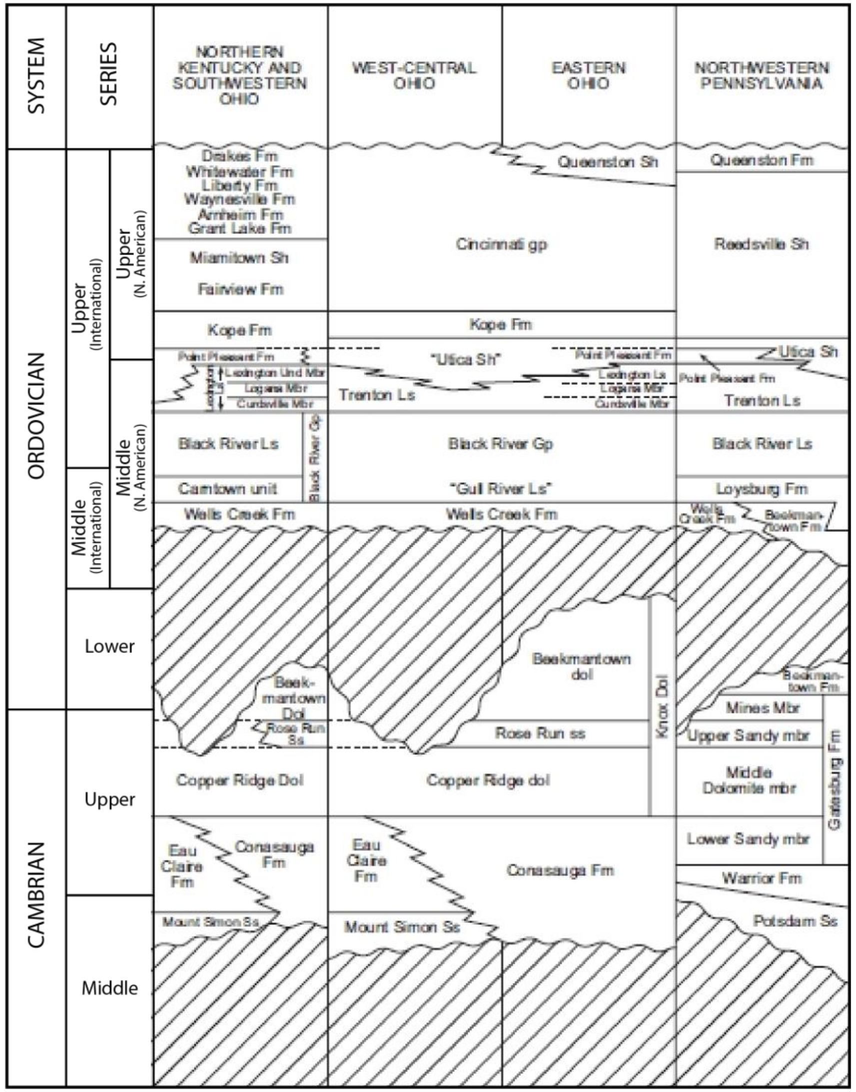
Point Pleasant Cumulative Production



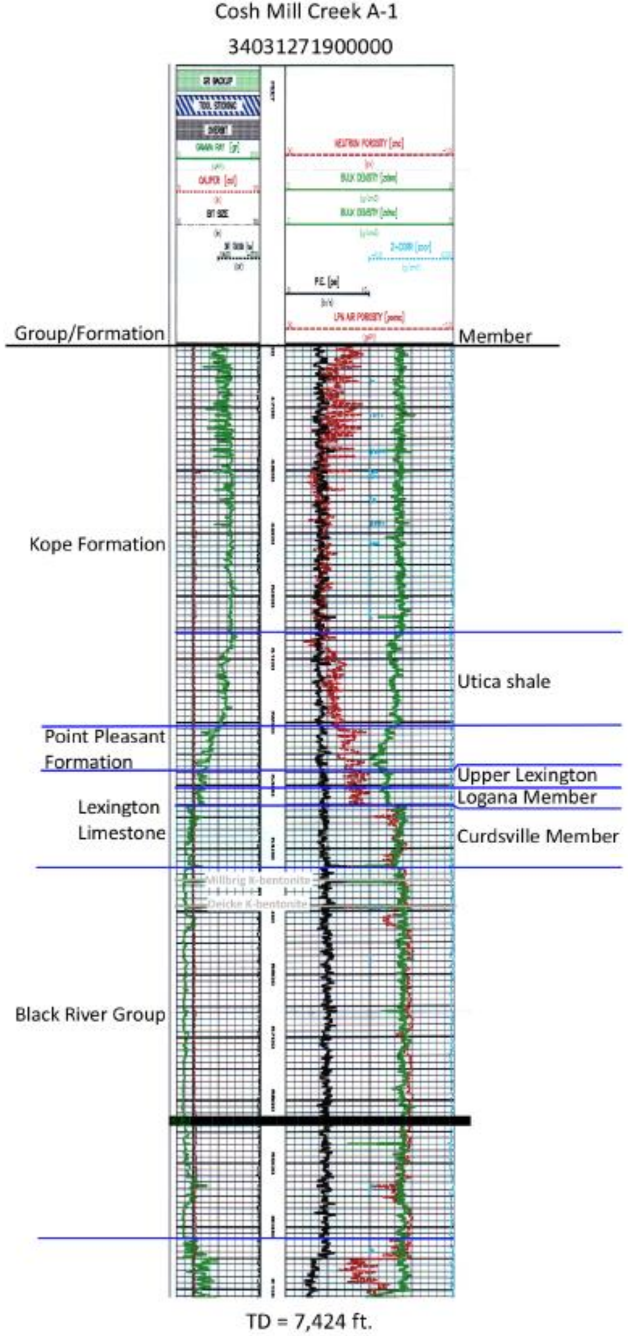
Geologic Framework

- **Data and Stratigraphic Framework**
  - Approach – Build upon the Utica Consortium Playbook (Hickman and others, 2015) and Trenton/Black River Consortium (Patchen and others, 2006)
  - Start with existing Ohio data
  - Add new data submitted to the State of Ohio/Literature since 2015
- **Construct New Network of Cross Sections**
- **Densify the Stratigraphic Well Database**
- **Construct New Structure and Isopach Maps**

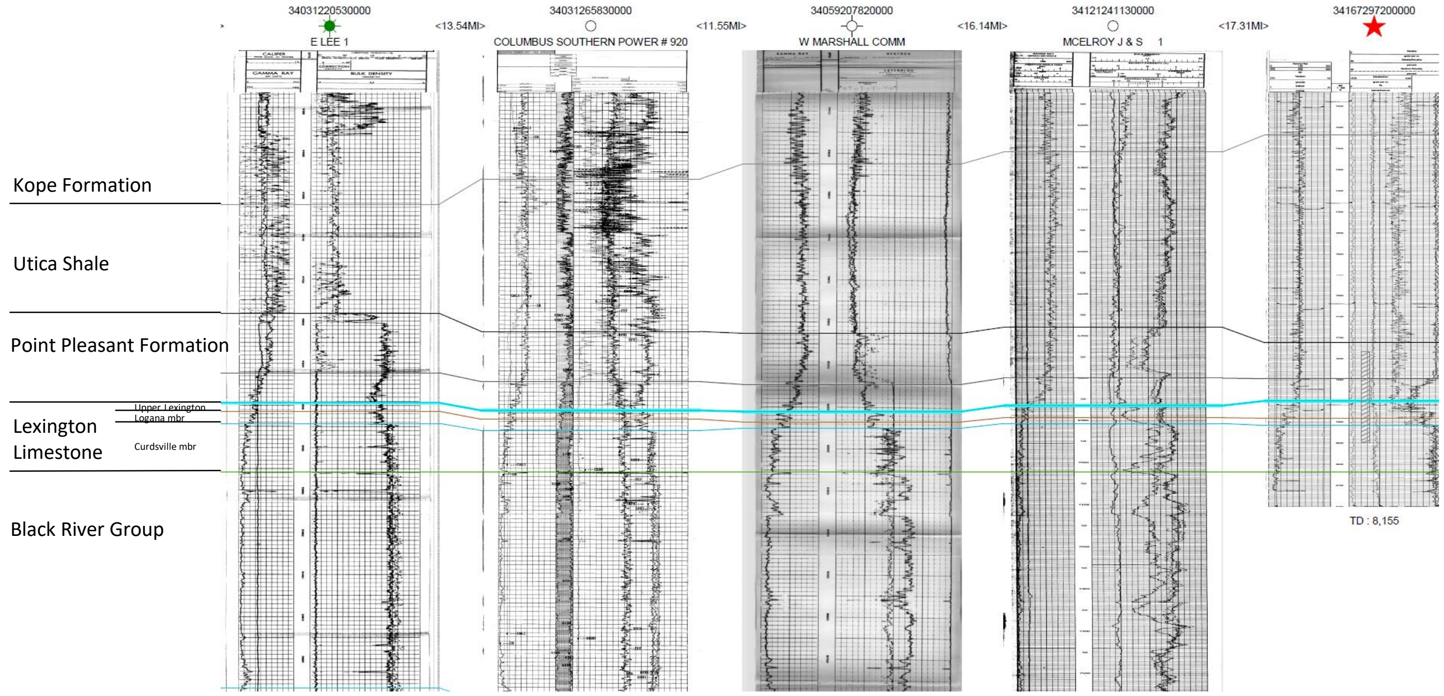
Stratigraphic Framework

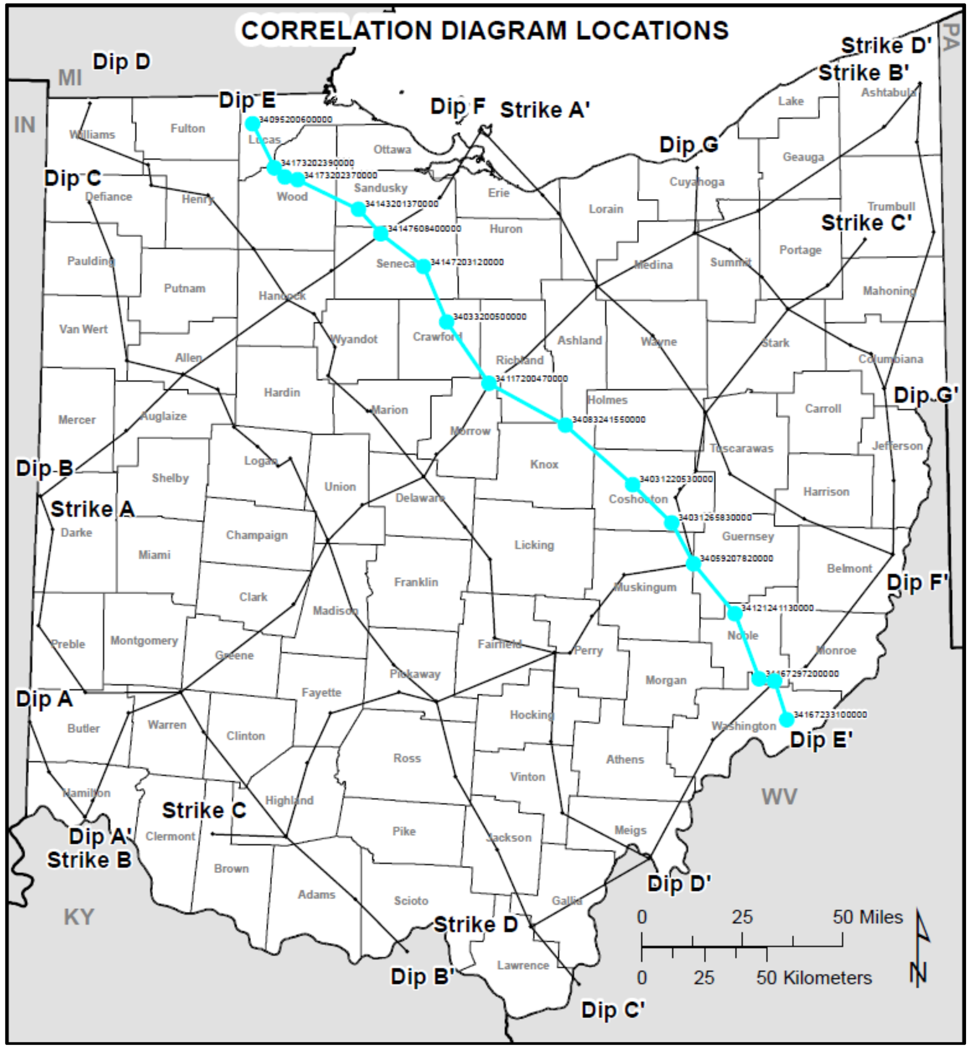


(Patchen and others, 2006; Hickman and others, 2015)



Cross Section Network

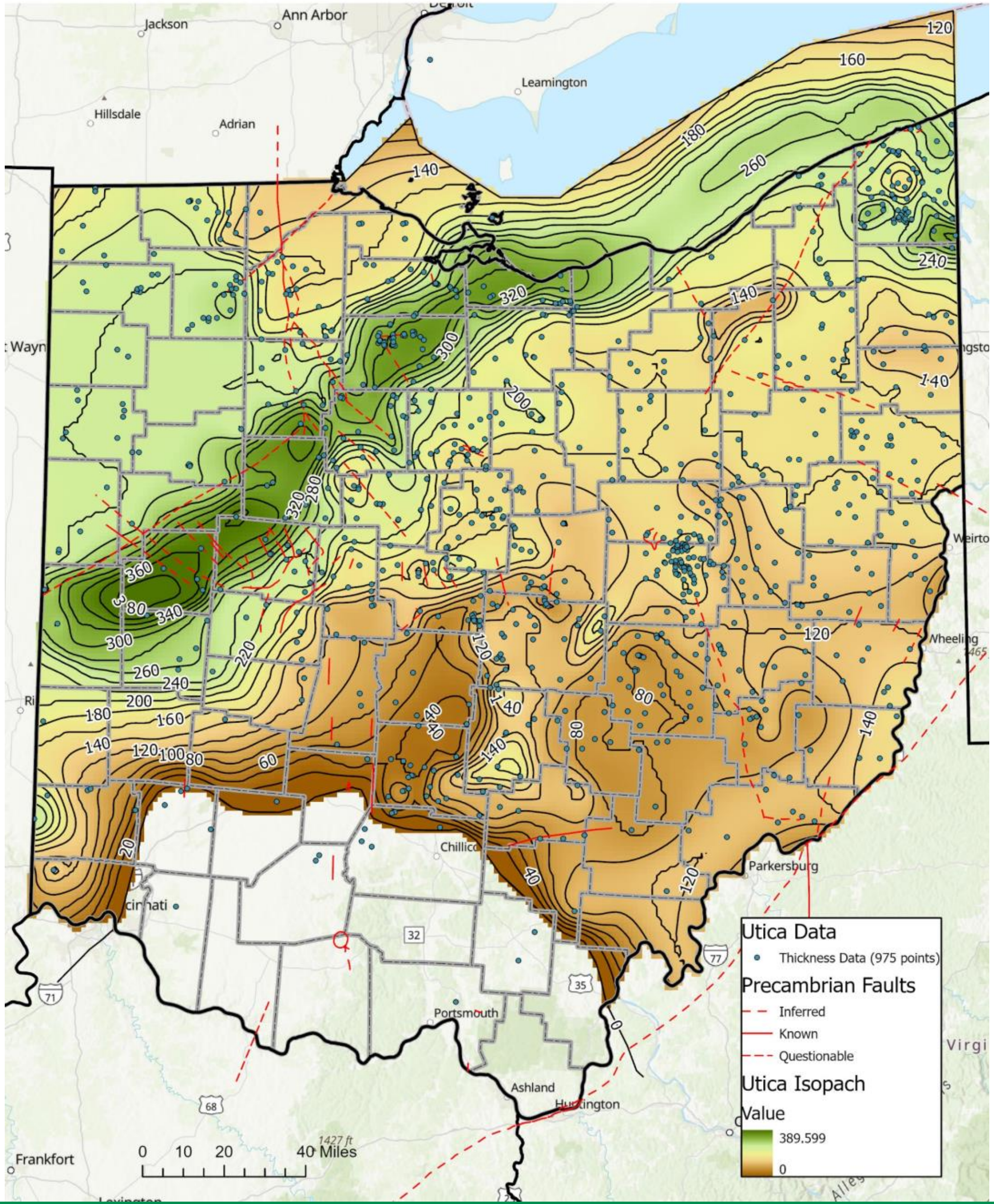




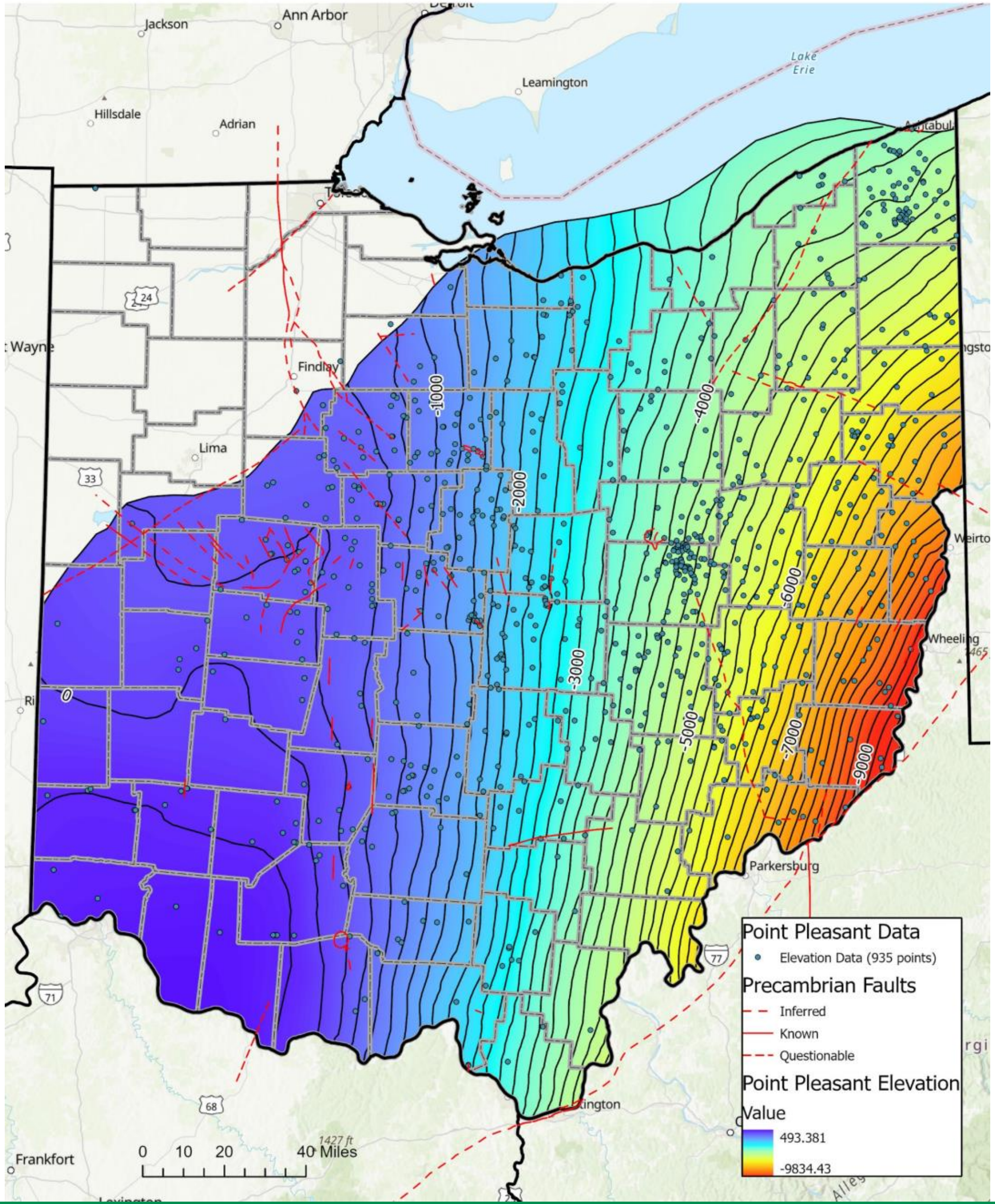
New Structure and Isopach Mapping

- **Mapped Formations**
  - Kope Formation
  - Utica shale
  - Point Pleasant Formation
  - Upper Trenton/Lexington member
  - Logana Member
  - Curdsville Member
  - Black River Group
- **Increased Map Resolution**
  - Increased by 67% the number of wells used in mapping

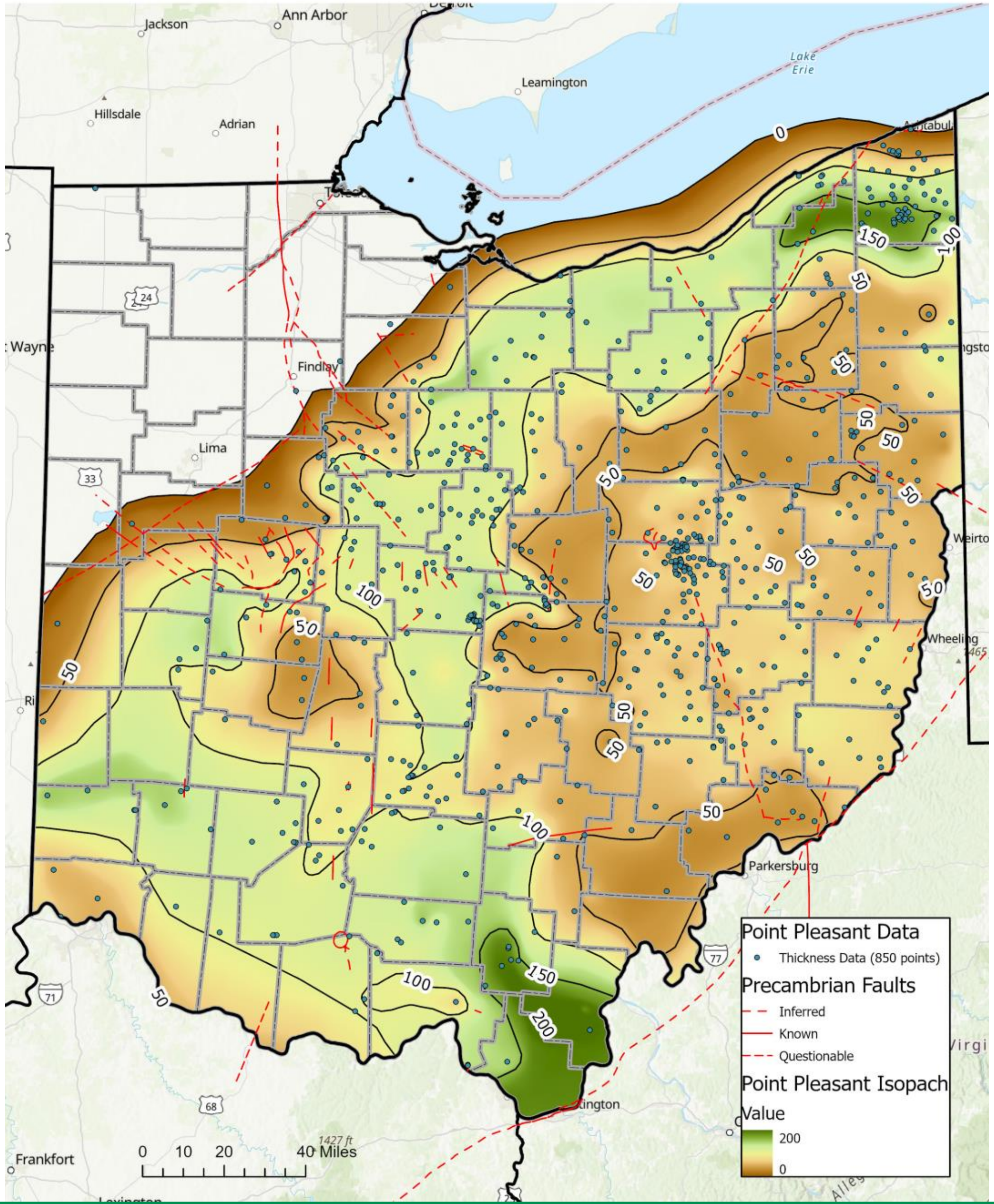
Utica Shale Isopach



Point Pleasant Structure Contours



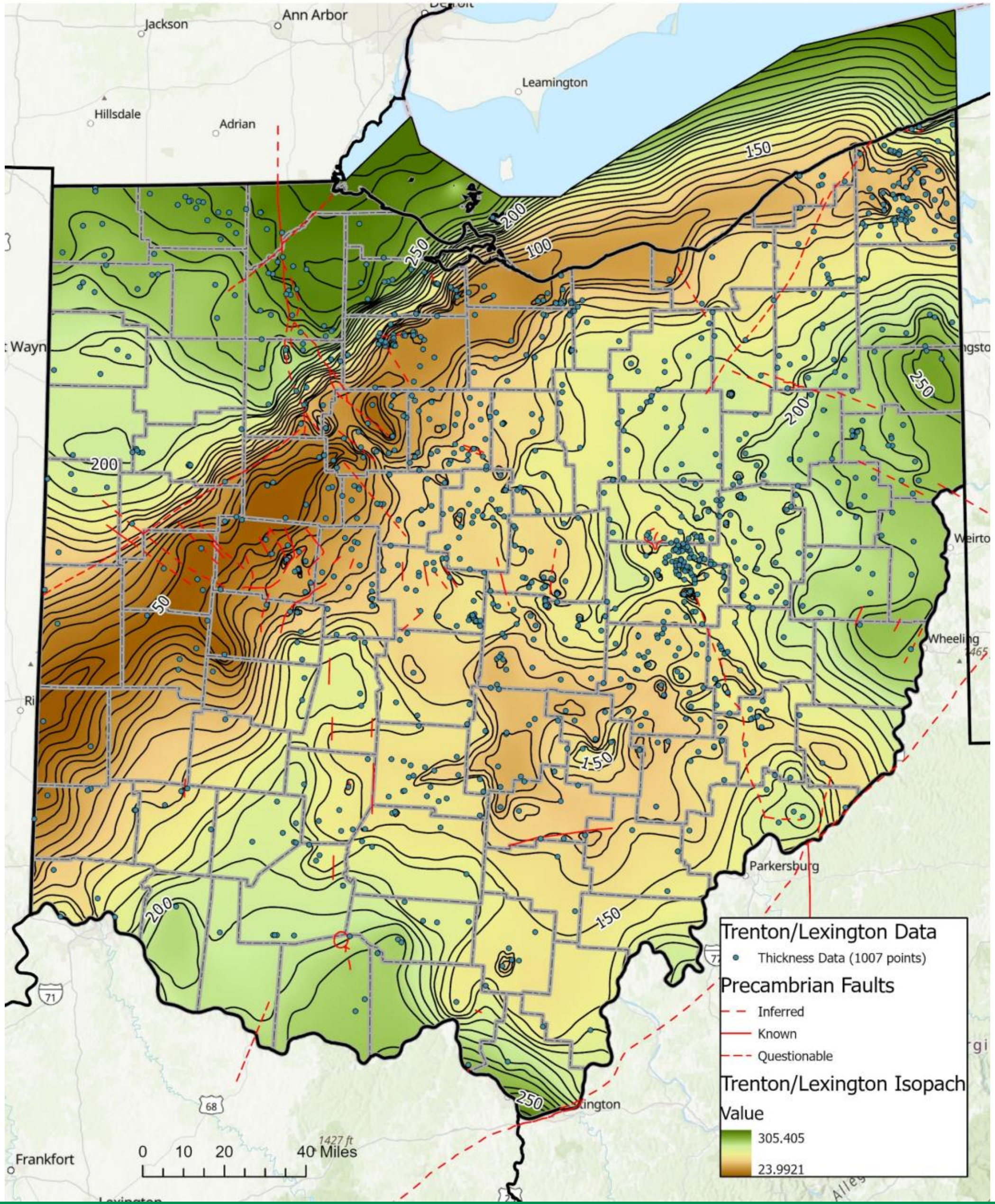
Point Pleasant Isopach



Mapping Results

- **Increased Data Density/Finer Resolution of Maps**
- **Sebree Trough Extends Through Northern Ohio**
  - Confirms Bloxson's mapping (2017)
- **Some Influence of Basement Structures**
  - Bowling Green/Outlet Faults in NW Ohio are affecting the Sebree Trough

Trenton/Lexington Isopach

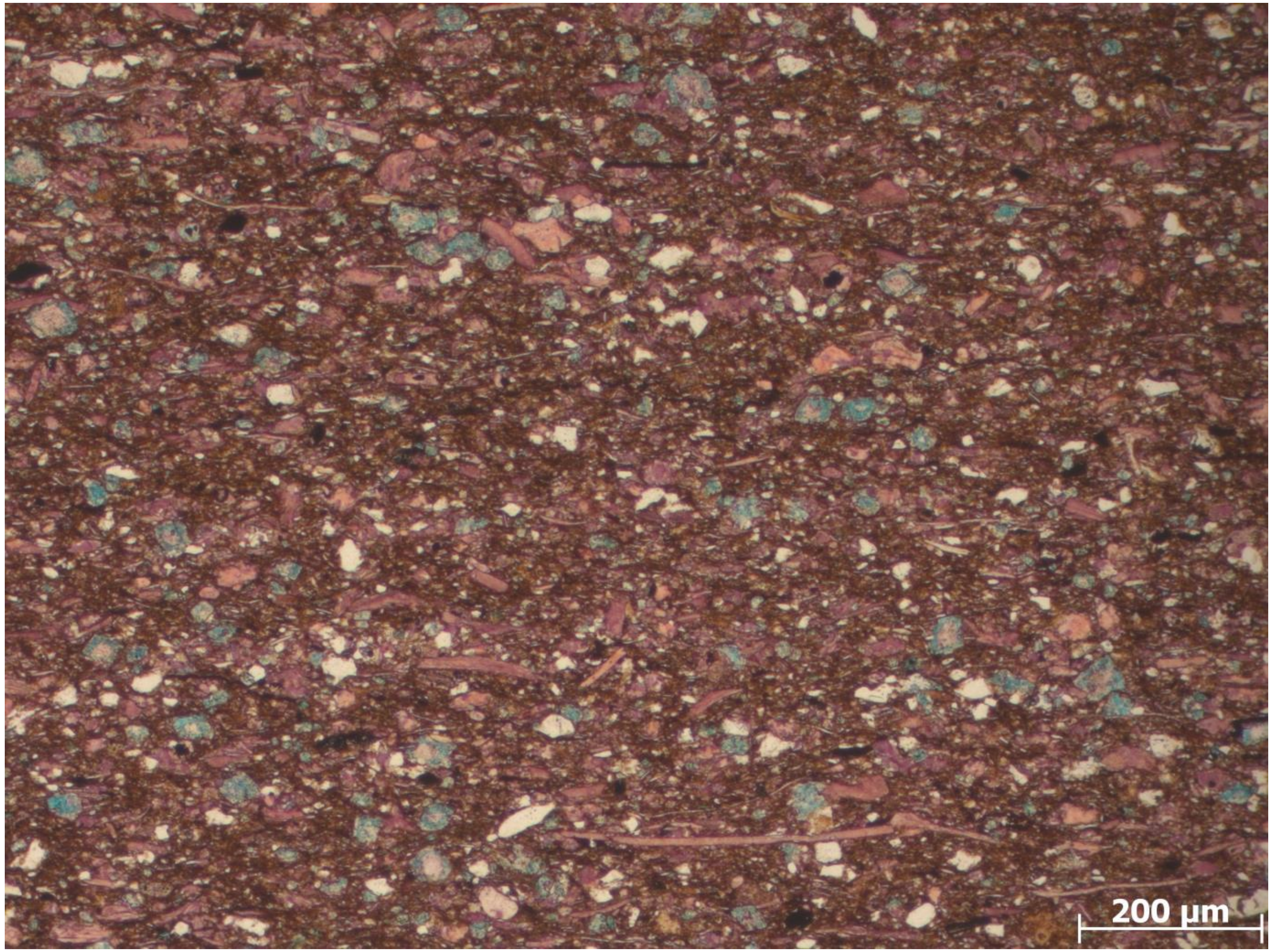


Rock and Reservoir Properties

- Mineralogy
- Total Organic Carbon
- Thermal Maturity
- Porosity
- Density
- Reservoir Pressure

Mineralogy

- Data from X-Ray Diffraction (XRD)
- Mineral Brittleness Indices
- Dolomitization



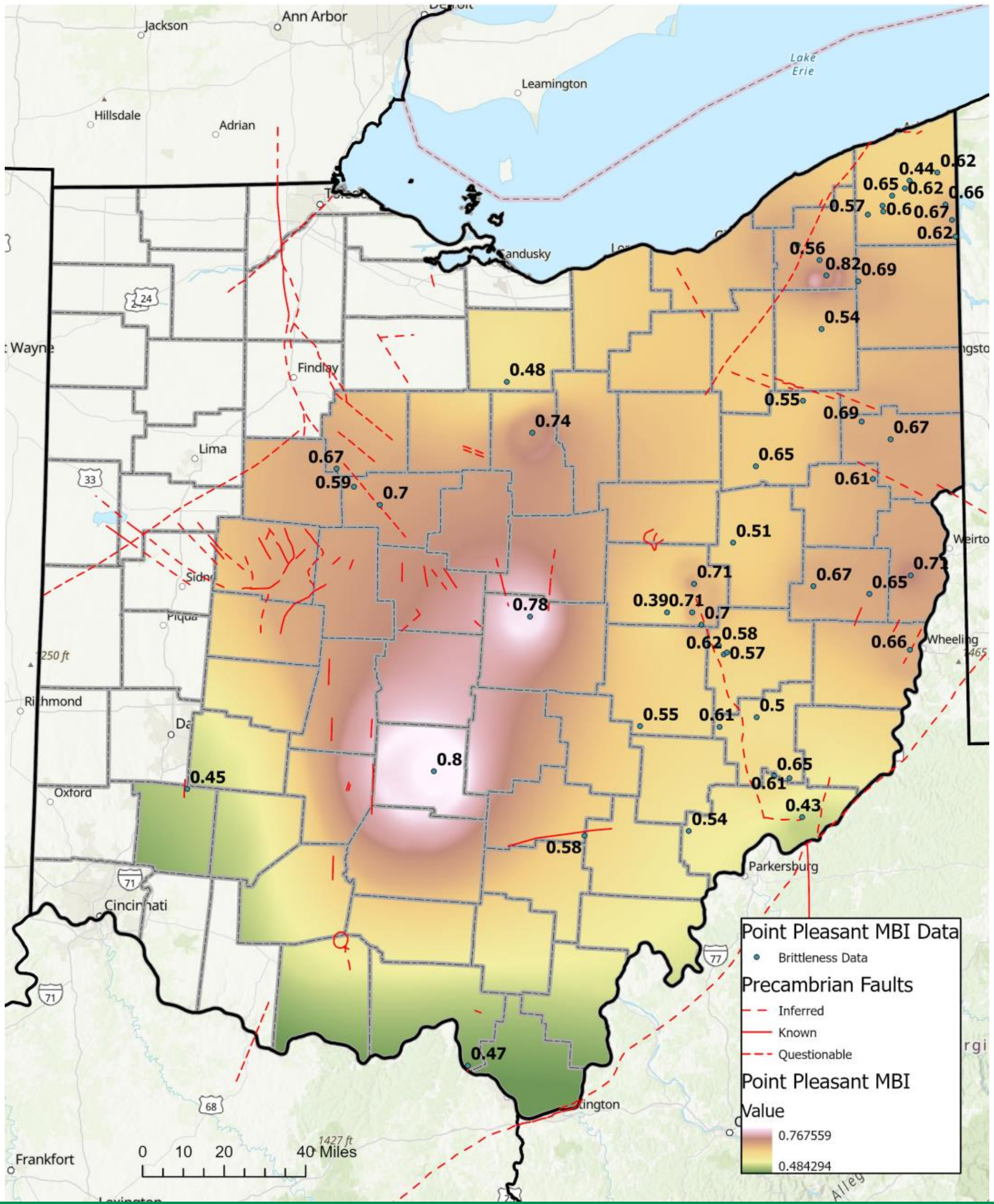
Barth #3, 34031228380000, Depth 5684.5 ft

Mineral Brittleness Indices

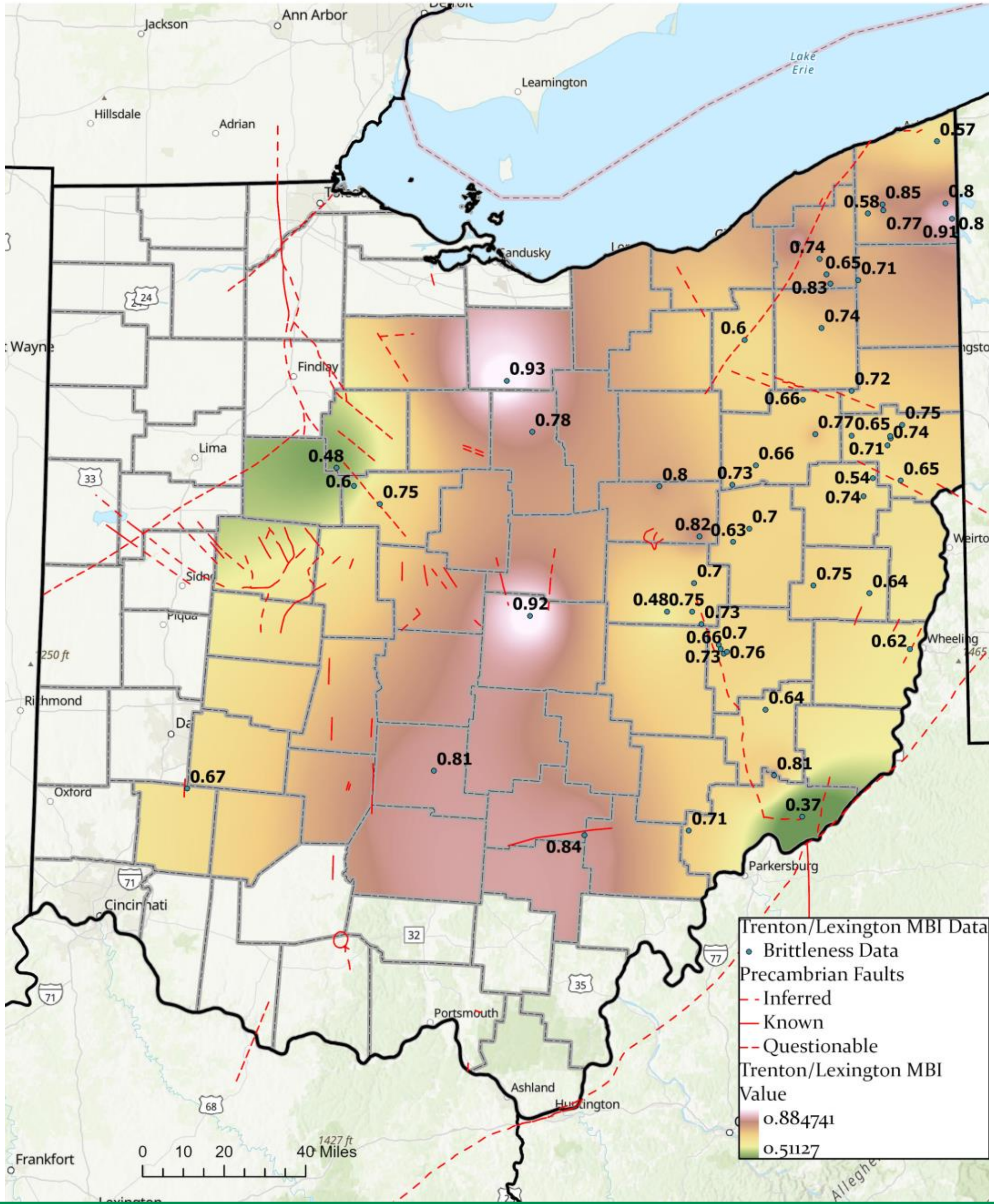
- **Rock Fracturing is Necessary**
  - Primary production
  - EOR
- **Geomechanical data**
  - Modeling - Data is lacking in Ohio
  - Existing point data not representative regionally
- **Regional Characterization/MBI**
  - Use XRD data
  - MBI= $\frac{W(QF)+W(Cal)+W(Dol)}{W(Tot)}$

(Modified from Jin and others, 2014)

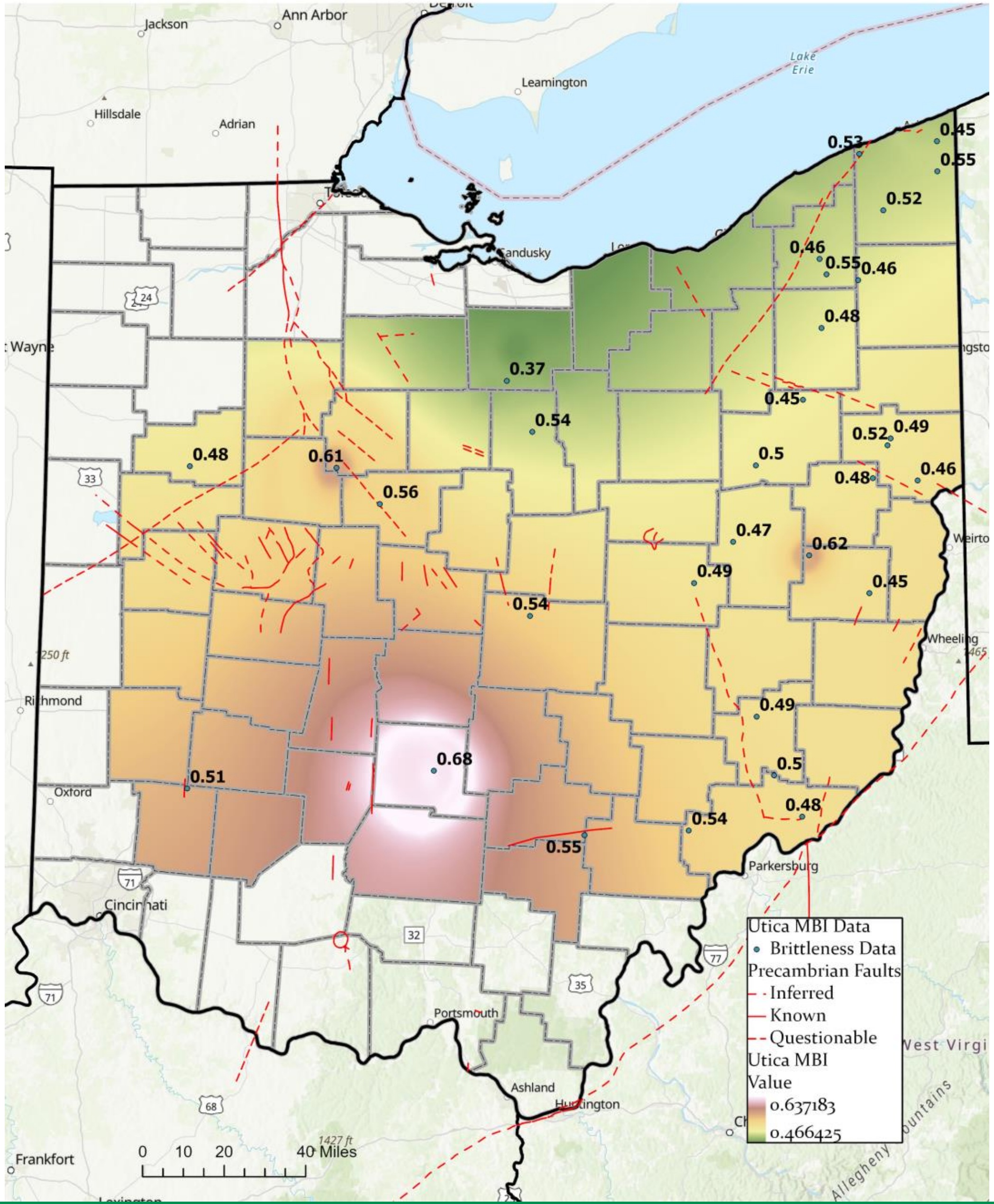
Point Pleasant MBI



Trenton/Lexington MBI



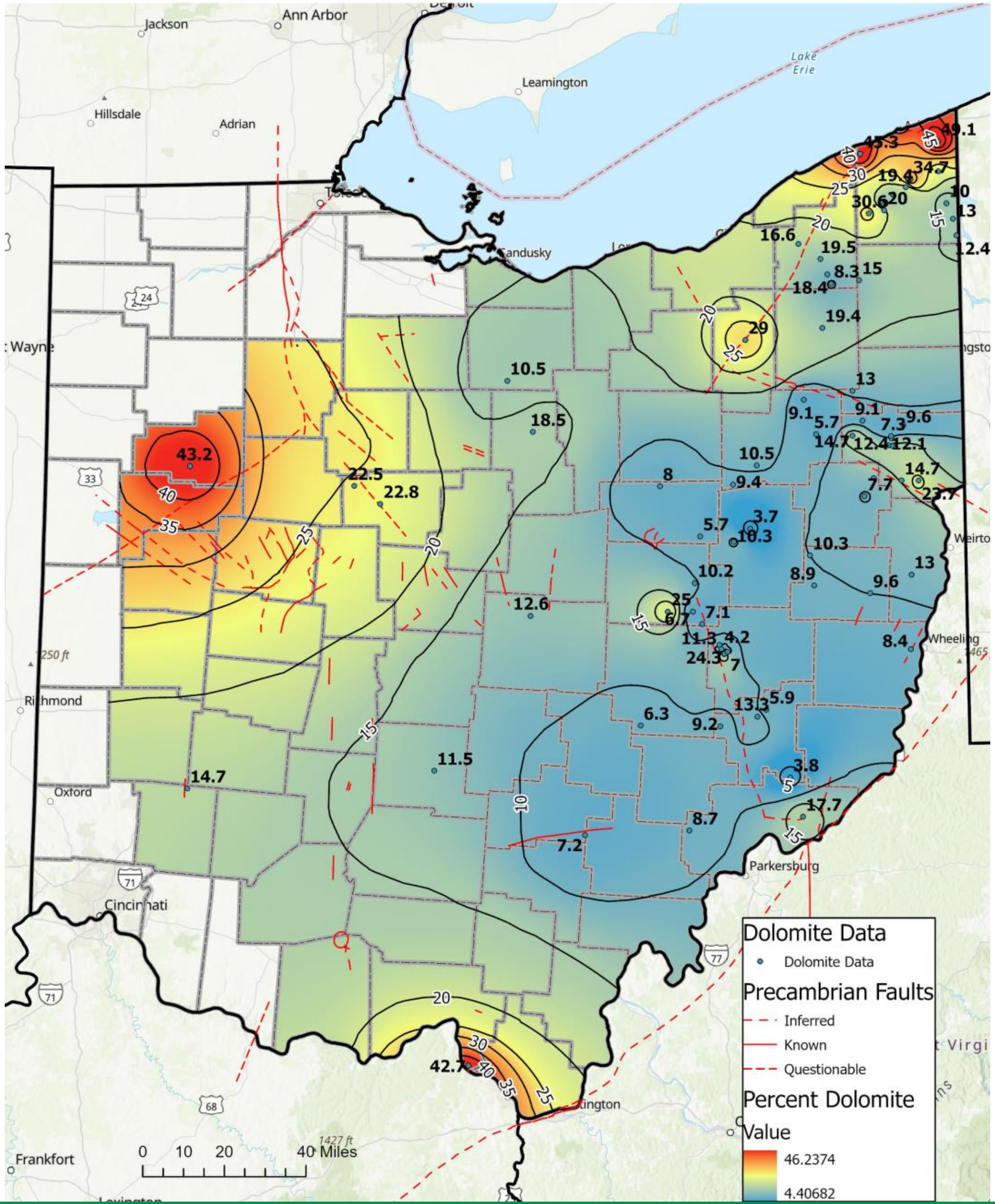
Utica MBI



Dolomitization

- **Low/Medium Levels of Dolomitization**
- **Basement faults and higher levels of dolomitization**
  - Cambridge CCSD
  - Akron/Suffield/Smith Township/Highlandtown Faults
  - Western Ohio
- **Hydrothermal Dolomite**
  - Hydrothermal fluids flowing along fractures and faults – Increase porosity

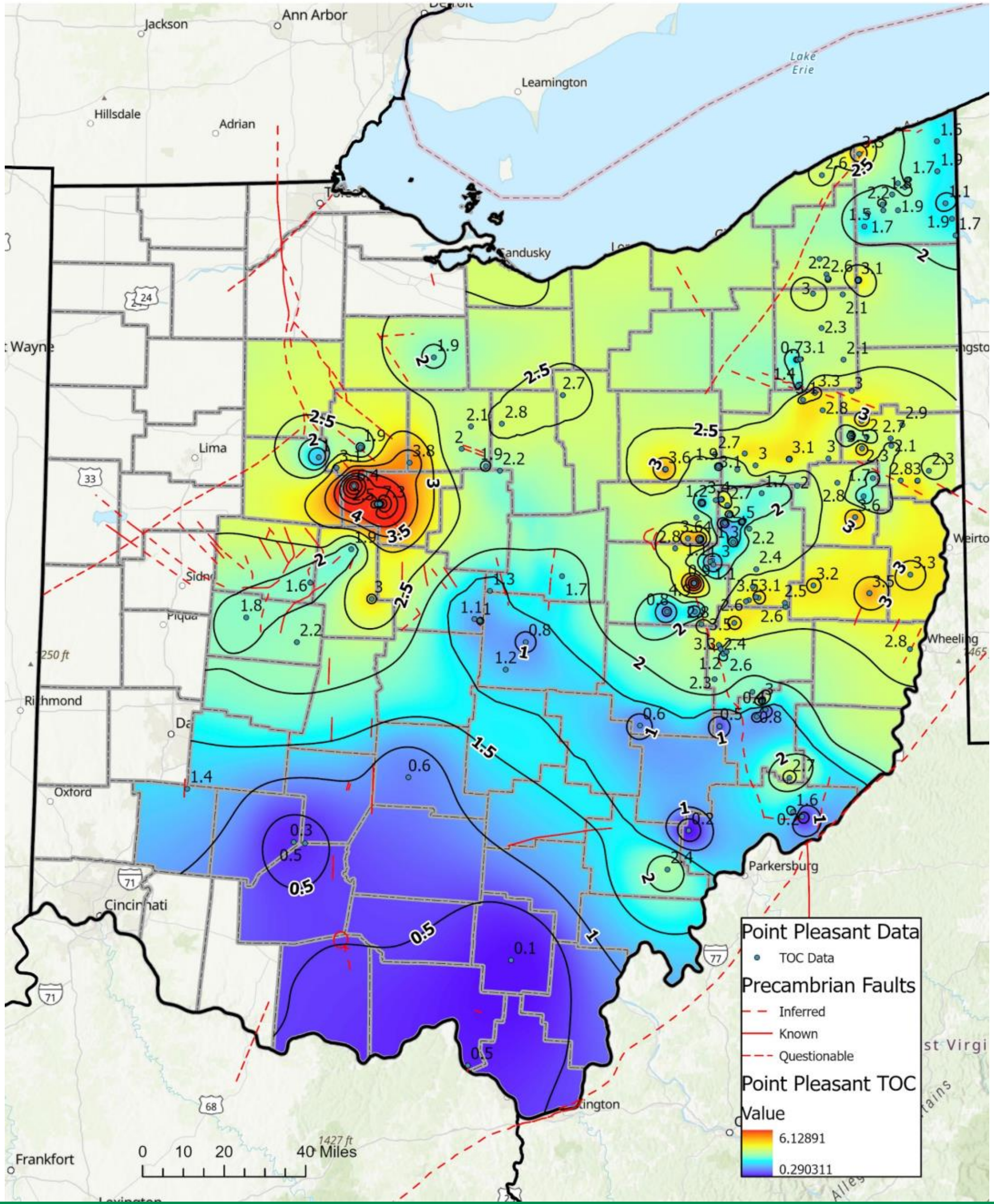
Dolomitization



Total Organic Carbon (TOC)

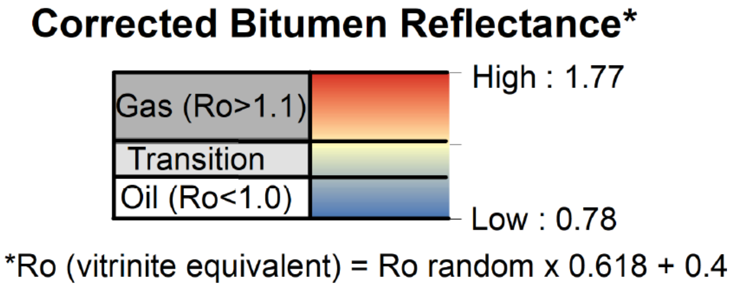
- **New Mapping**
  - Used existing data
  - Used new data submitted since 2015
- **Results**
  - Higher TOC values from south to north
  - Persistent trend - Concentration of high TOC values in the Wyandot-Marion county area in all units
  - Possible Structural control
    - Sebree Trough
    - Bowling Green Fault/Outlet Fault

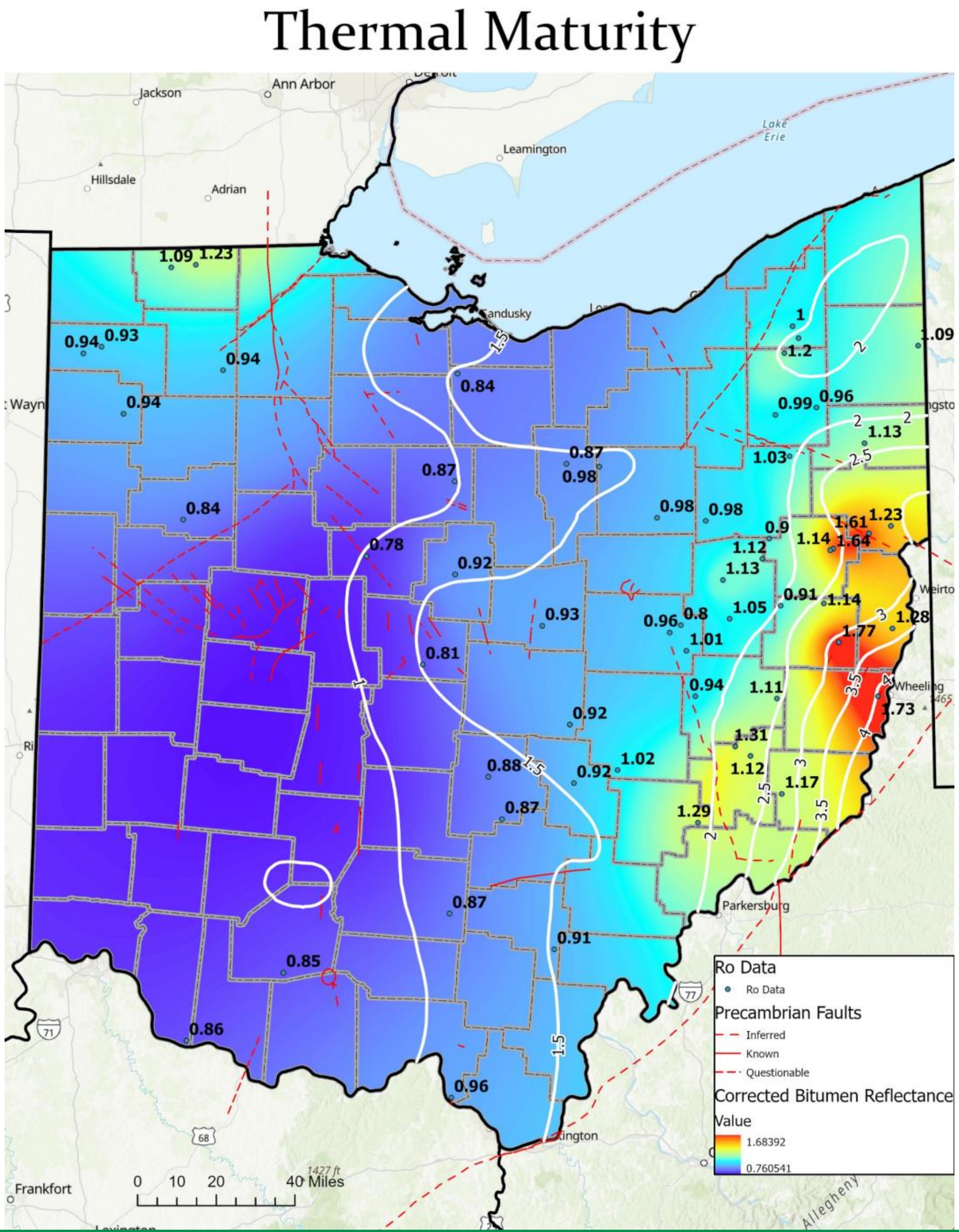
Point Pleasant TOC



Thermal Maturity

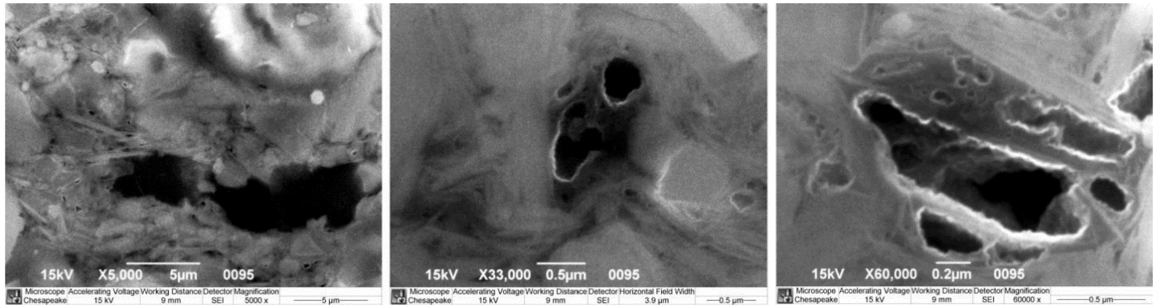
- **New Mapping**
  - Used existing data
  - Used new data submitted since 2015
- **Bitumen Reflectance and CAI**
  - Calculated Bitumen Reflectance
  - Mapped Conodont Alteration Index (CAI)
- **Oil Assessment Area is Thermally Mature/Oil Window**





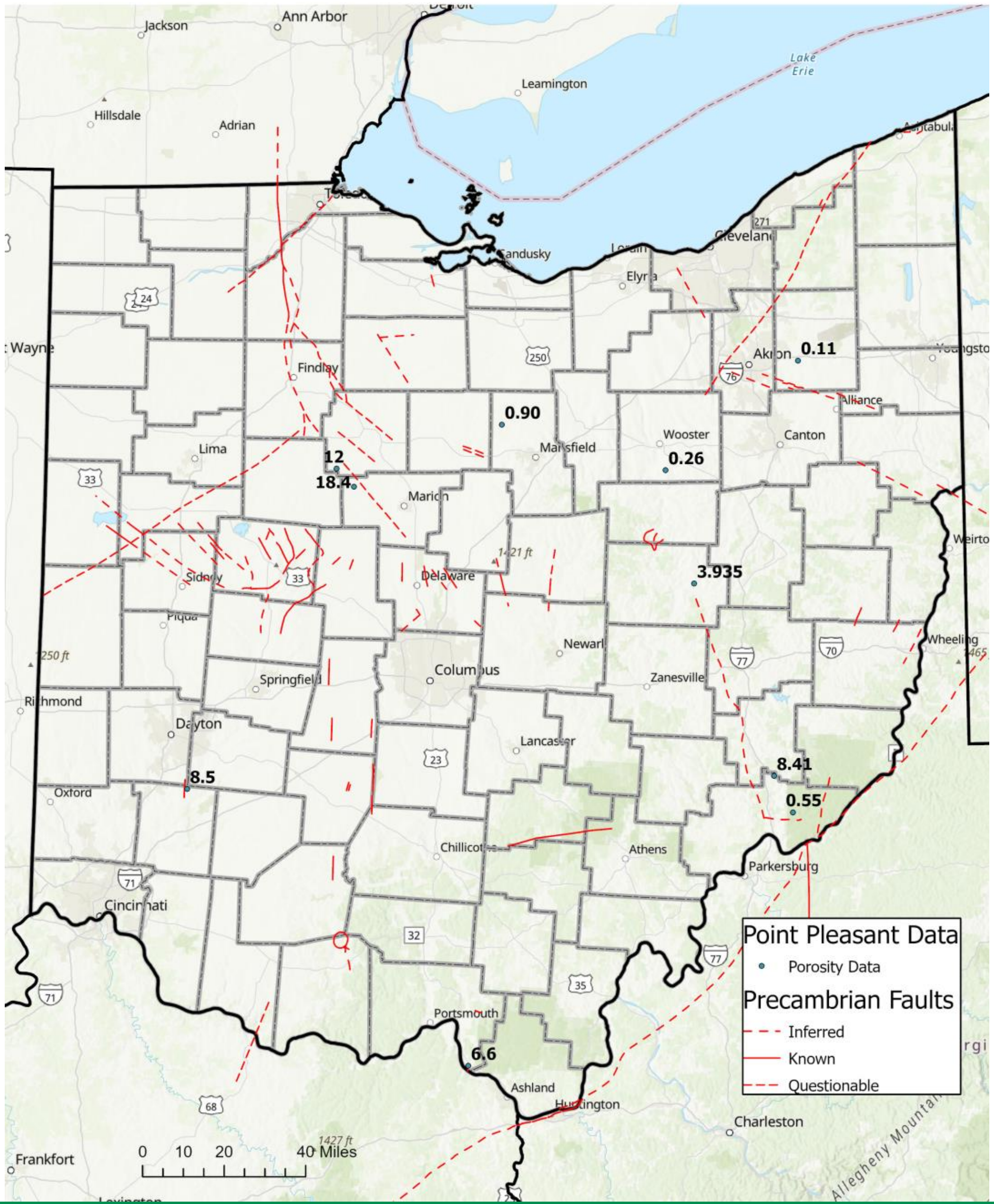
Porosity

- **Primary Porosity**
  - Organic matter porosity (Hickman and others, 2015)
- **Lab analyses**
  - Most lab analyses below detection limit
  - Limited data/small relationship to basement structures

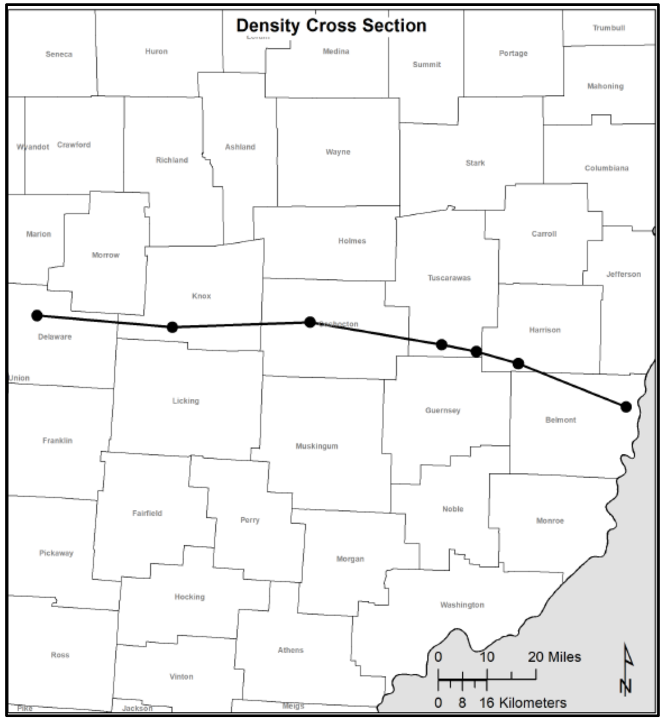


Organic Matter Porosity (Hickman and others, 2015)

Point Pleasant Porosity



Rock and Bulk Density



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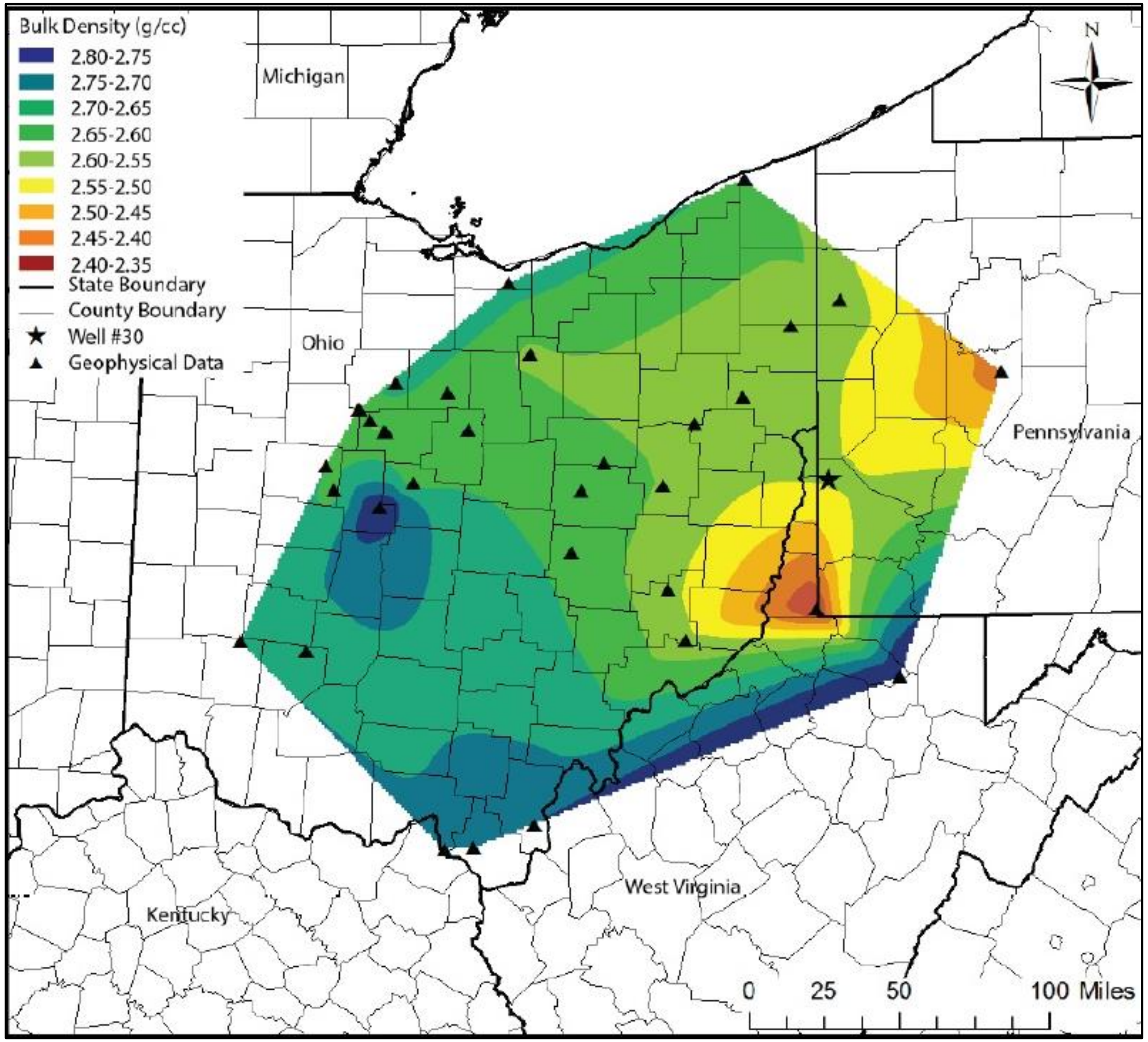
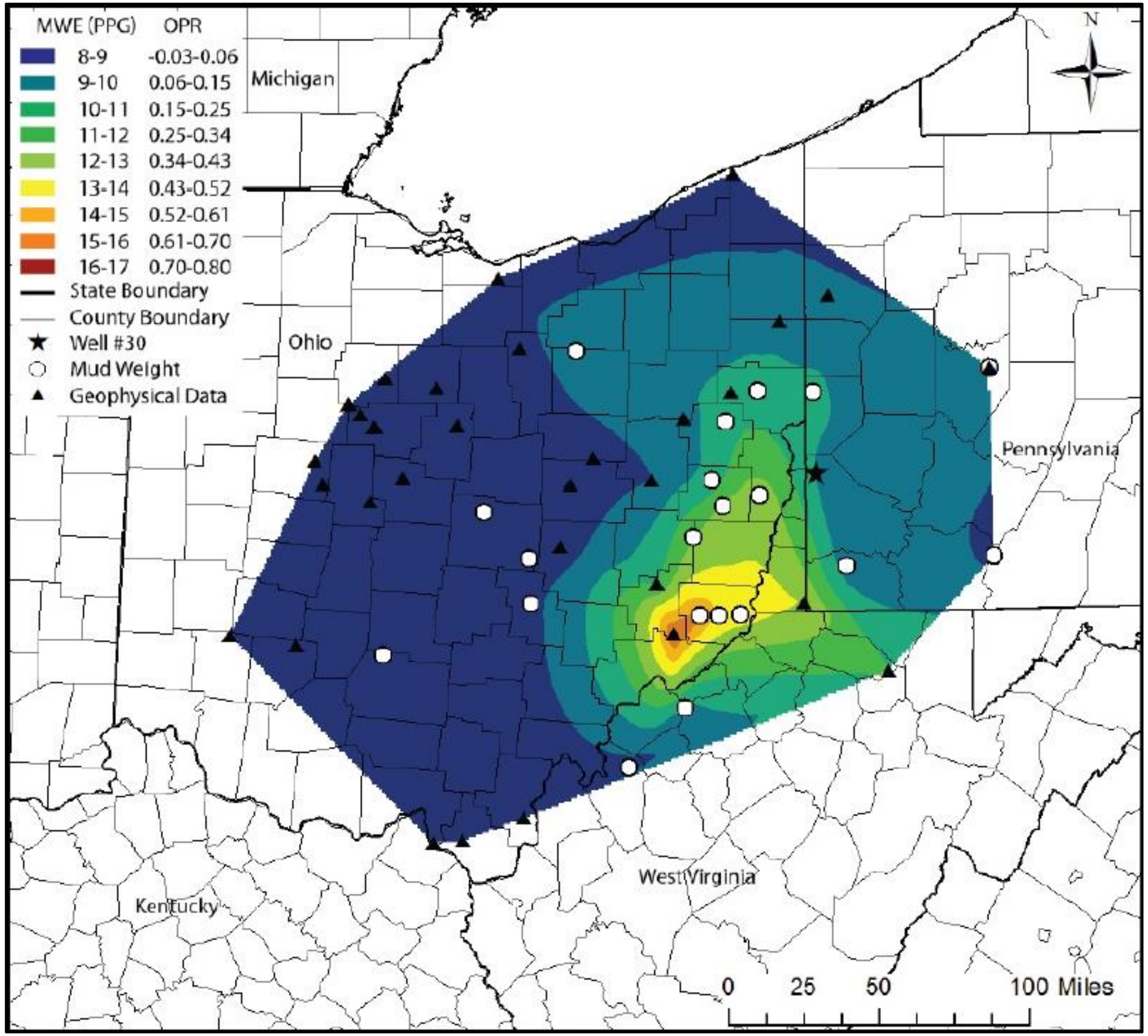
Kope Fm.	2.612*	2.702	2.071	2.538	2.721	2.641	2.699
Utica Sh.	2.652	2.692	2.637	2.575	2.687	2.602	2.699
Point Pleasant Fm.	2.602	2.657	2.627	2.525	2.599	2.556	2.496
Trenton/Lexington upper mbr.	2.612	2.623	2.640	2.565	2.619	2.556	2.603
Logana Mbr.	2.598	2.632	2.631	2.566	2.619	2.548	2.688
Curdsville Mbr.	2.682	2.681	2.700	2.630	2.691	2.619	2.669



(Trotter, 2018)

Reservoir Pressure/Overpressure

- **2011 - Initial drilling encountered overpressure conditions**
- **New study by Trotter (OSU M.S. Thesis, 2018)**
  - Mapped reservoir pressure
  - Used sonic logs and mud weights
  - Calculated overpressure conditions in SE Ohio
  - Most of the oil assessment area is slightly above or at hydrostatic pressure



(Trotter, 2018)

Characterization Study Results

- **New Structure and Isopach Maps**
  - Increased data density/show finer details
  - Sebree Trough – Extends through Northern Ohio
- **Mineralogy**
  - Mineral Brittleness Index Maps
  - Dolomitization Maps – Shows some influence of basement structures
- **Porosity**
  - Conventional lab porosity measurements show some influence of basement structures
- **Density**
  - Density inversion with depth – Related to gas charge and overpressure
- **Reservoir Pressure**
  - New understanding of the reservoir pressure

Conclusions

- **Oil Assessment Unit - Organically rich & thermally mature**
- **Interval is brittle enough for fracturing**
- **Basement structures enhance natural fractures and porosity – May affect EOR operations**
- **EOR in the Oil Assessment Unit will require injection to raise reservoir pressure**

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