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Impact of Geologic Diversity on Static Earth Models in a CO_2-EOR Reef Complex

MRCSP
MIDWEST REGIONAL CARBON SEQUESTRATION PARTNERSHIP

Carbon Management Technology Conference-Houston, Texas
July 17-20, 2017

DOE/NETL Coop. Agreement # DE-FC26-0NT42589

BATTELLE

Acknowledgements

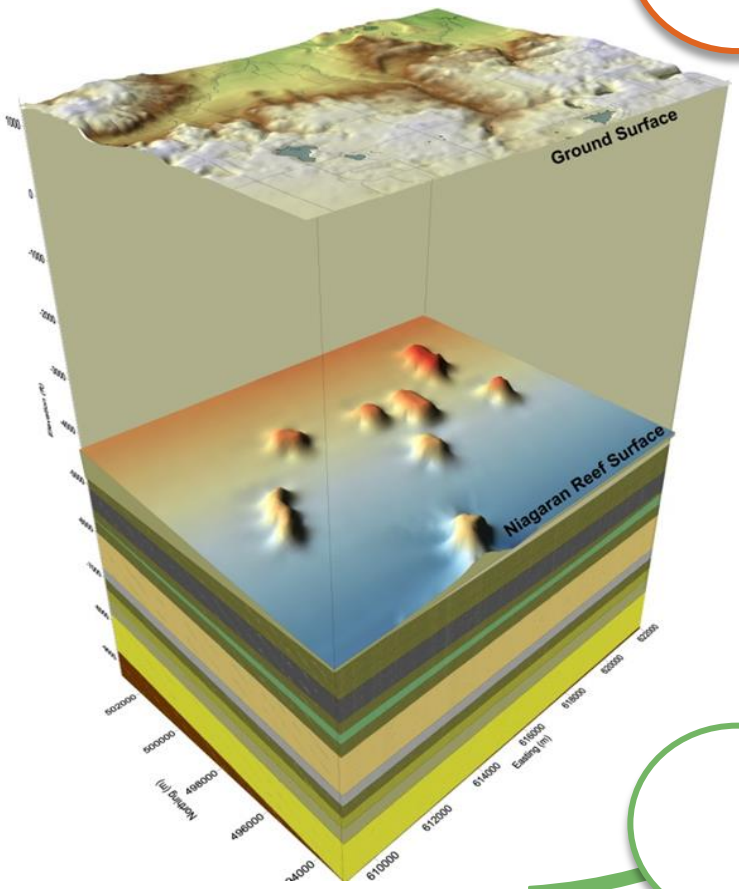
Battelle's MRCSP team members for work shown here

DOE/NETL has worked with us and our partners to structure a program that adds to the knowledge base and extends the state-of-the-art research.

Core Energy, LLC our host site and CO_2 supplier for 10 years of collaboration under Phase II and Phase III

Western Michigan University has worked closely with us to develop geologic interpretations and static earth models and provided access to the core database

Presentation Outline



- Project Background
- Geologic Characterization
- Conceptual Model
- Static Earth Modeling
- Key Findings/Conclusions

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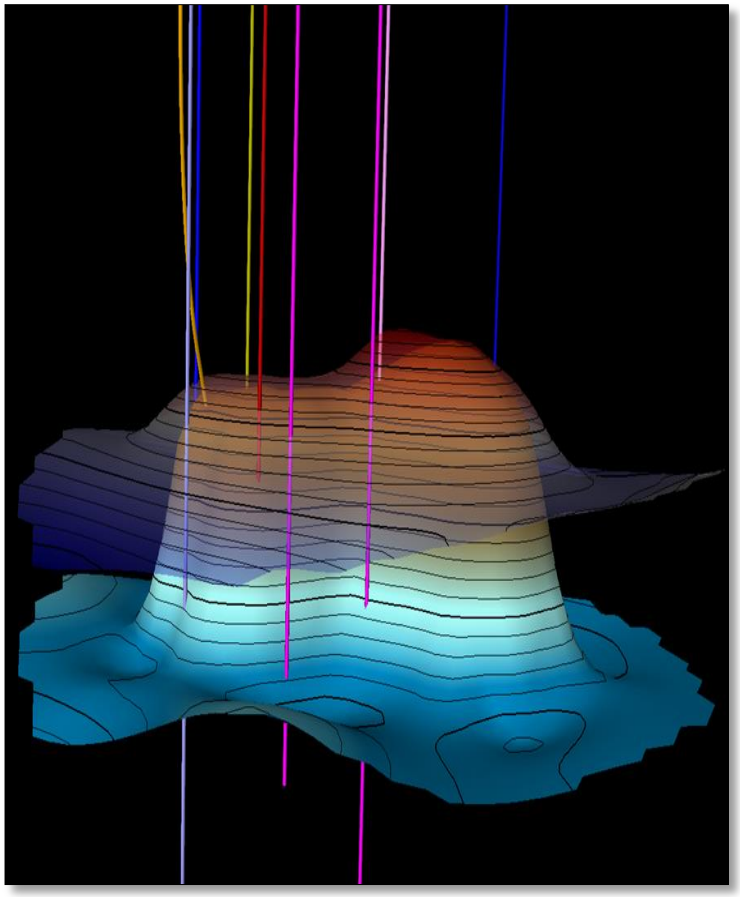
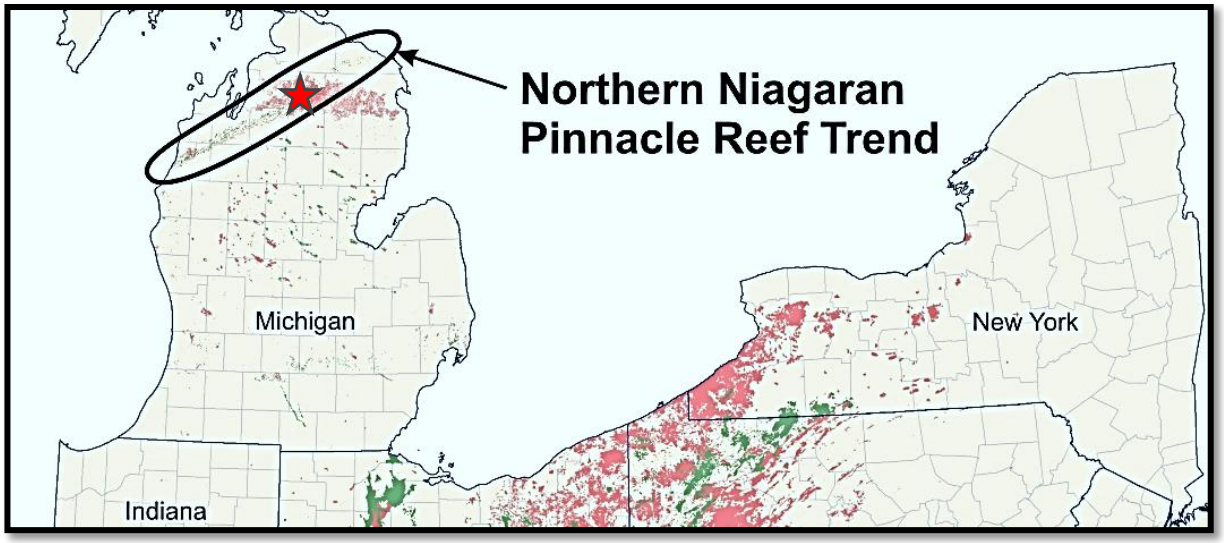
MRCSP Project Overview: Goals and Objectives

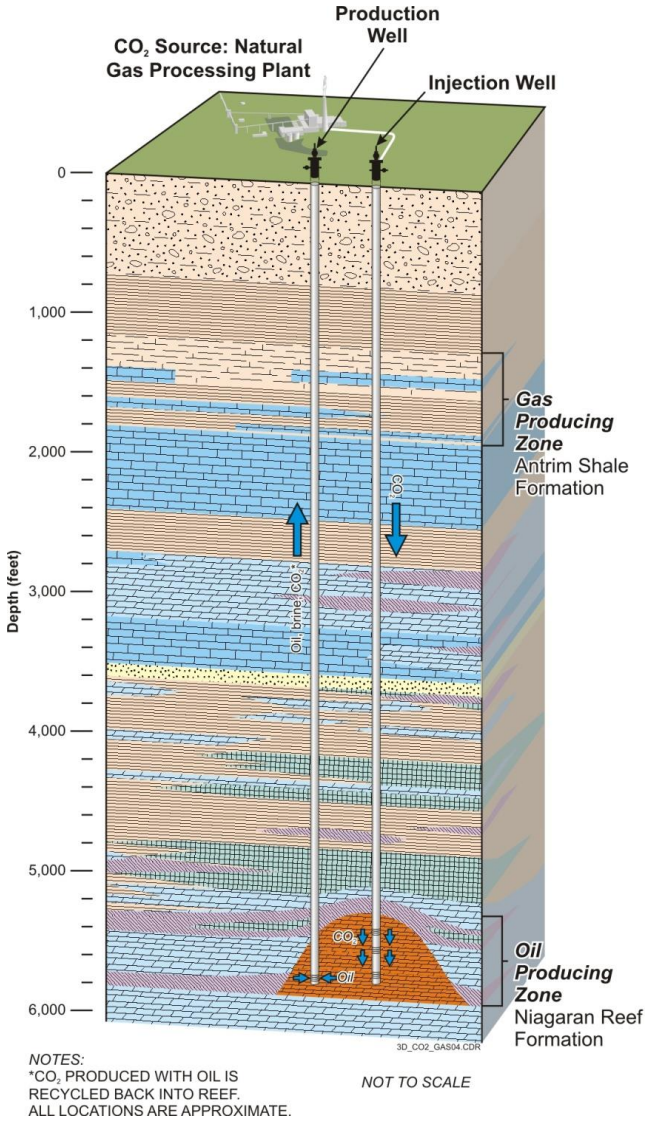
- Primary goal: To execute a large-scale CO_2 injection test to evaluate best practices and technologies required to implement carbon sequestration
- Objectives are to advance operational, monitoring, and modeling techniques needed to:
  - Develop and validate reservoir models
  - Address public concerns such as leakage and storage security
  - Address other topics such as cost effectiveness and CCUS practicability



MRCSP Large-Scale Test Site



- **Location**: Otsego County, Michigan
- **Source of CO_2**:
  - Local natural gas processing plant
- **Reservoir Type**:
  - Closely spaced, highly compartmentalized oil & gas fields located in the Northern Michigan's Niagaran Reef Trend



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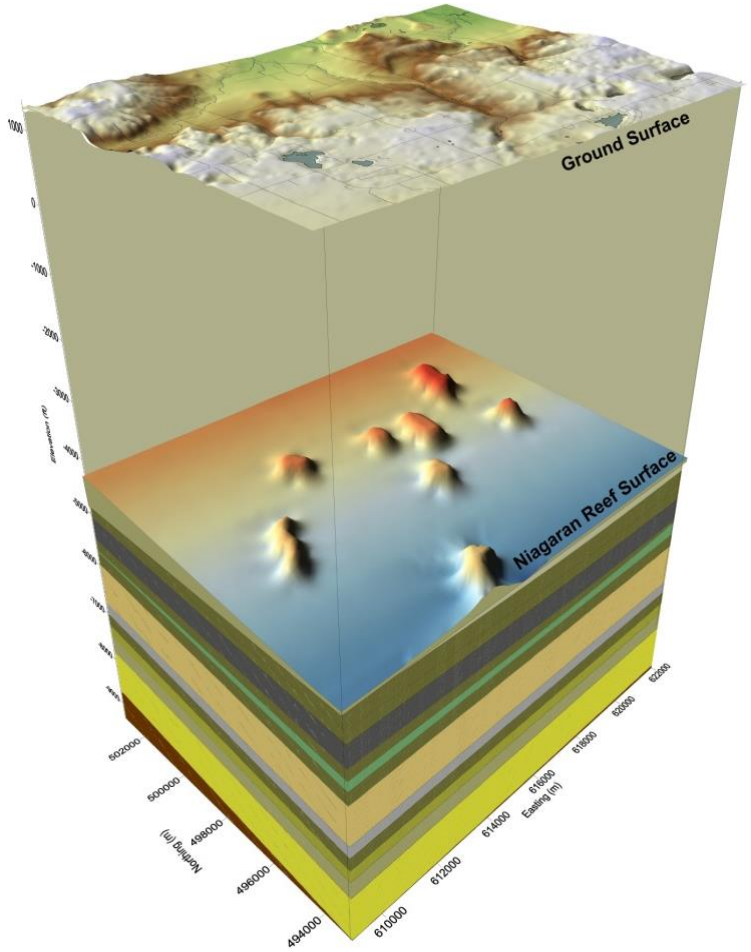
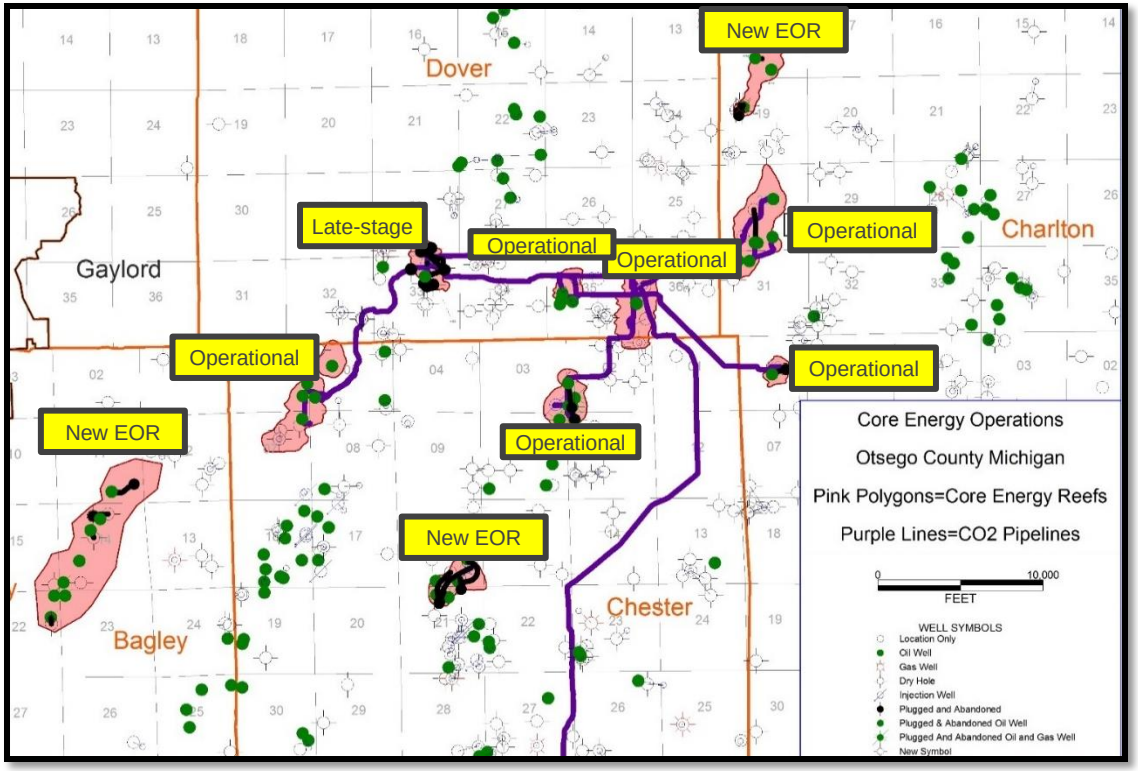
MRCSP Large-Scale Test Site

3D Representation of Study Area



Map of Study Area



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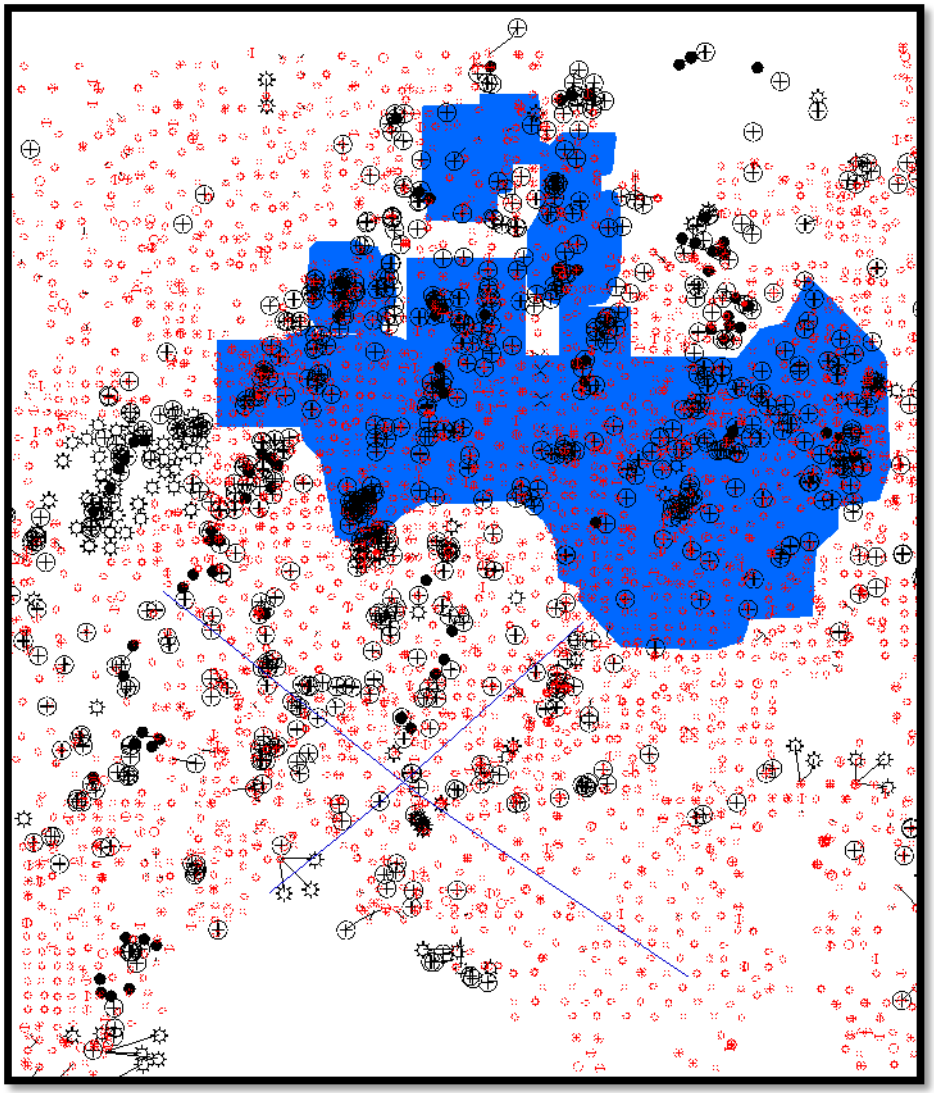
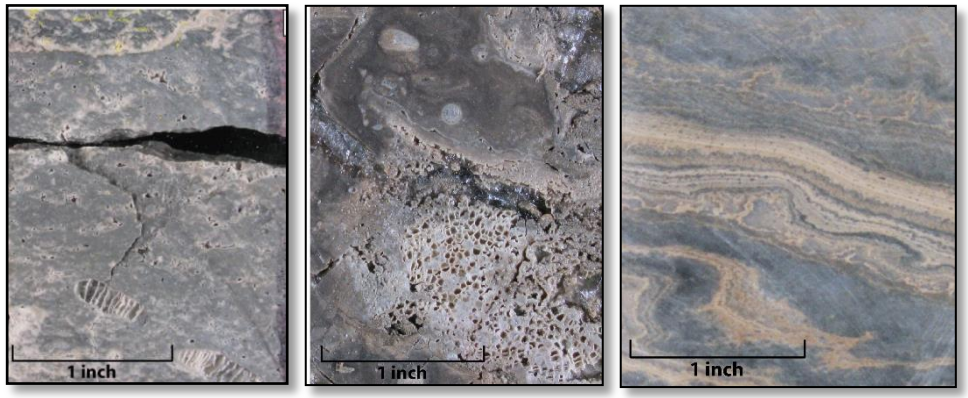
Compiled Dataset

- Working closely with Core Energy, LLC and WMU
- >4200 wells in study area
  - Many shallow (<3000 ft)
  - Many missed the reefs
- 60+ sq miles of 3D seismic
- 2 2D lines
- ~ 20 Whole core
  - Many missed the reefs
- **Recently drilled 4 new wells and collected advanced data**

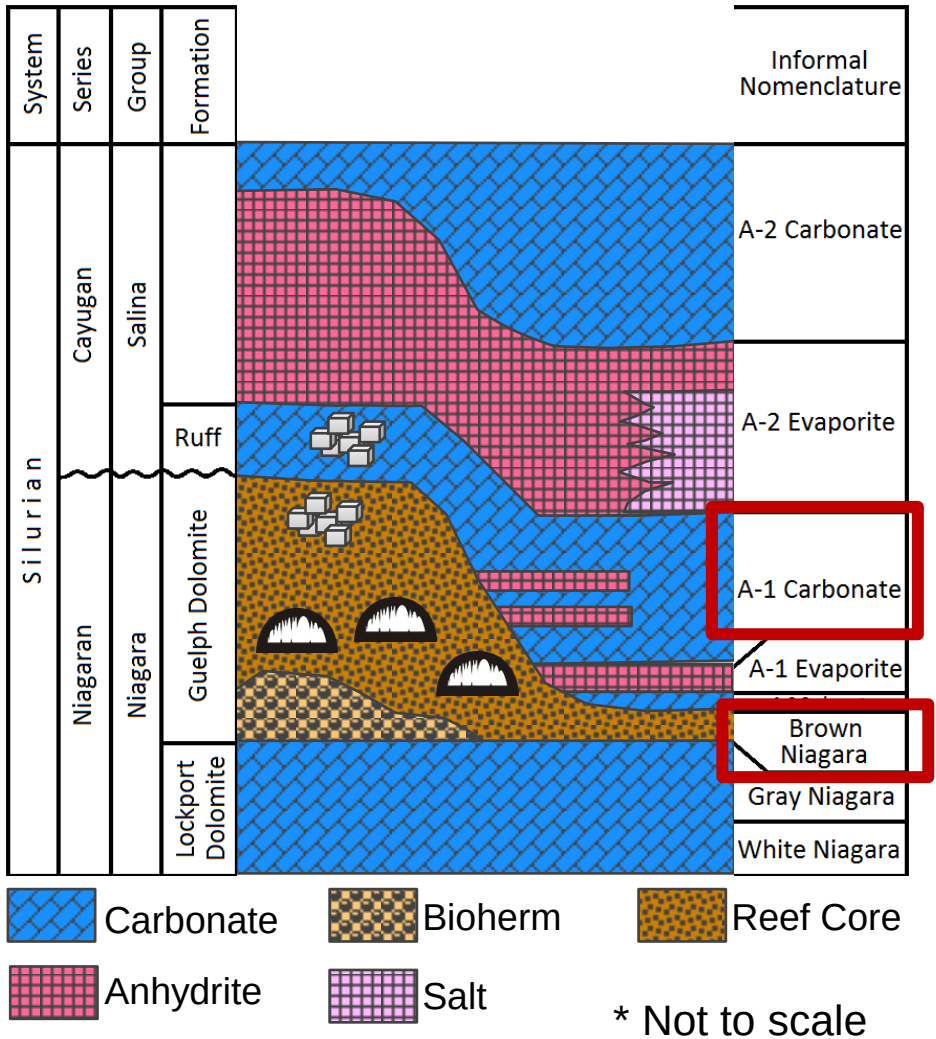


Reef Building and Diagenesis Leads to Complex Geology

- Silurian-age, Niagaran group reef
- Sealed by overlying Salina group
  - Carbonates and evaporites



Bioherm Reef Core Evaporite



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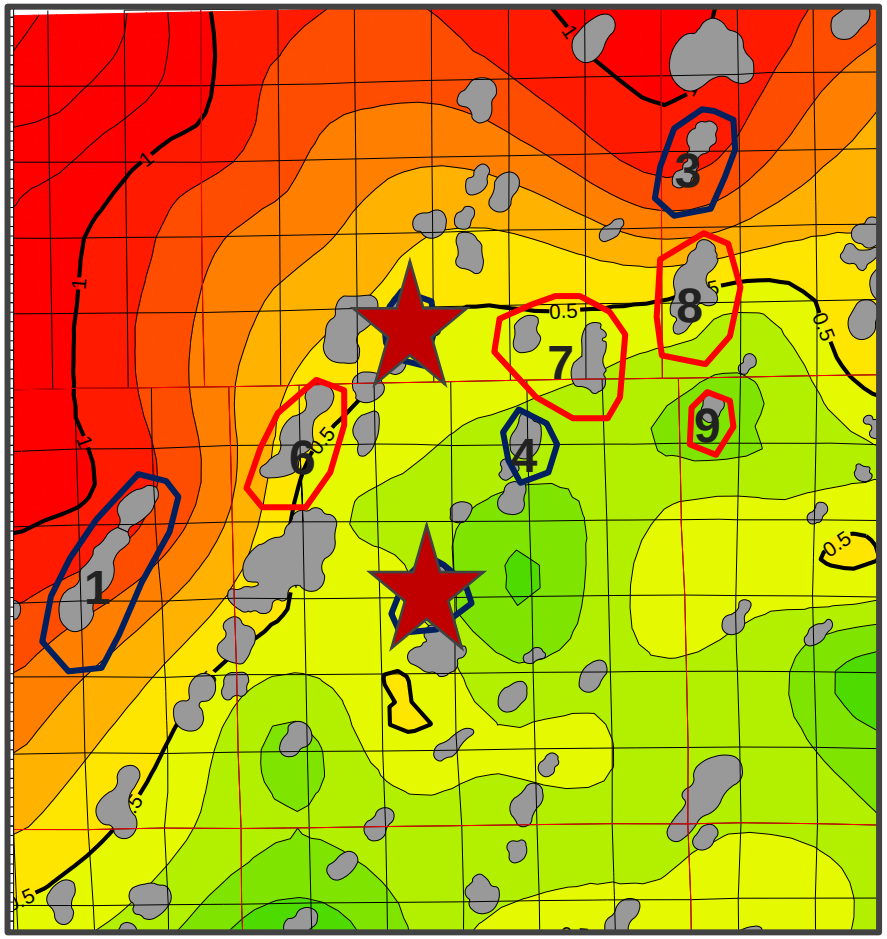
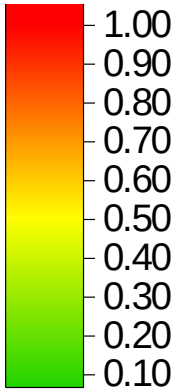
Current Reefs of Study are Diverse



1) B
2) D33
3) CH9
4) C2
5) C16
6) C5-6
7) D35 and D36
8) CH30-31
9) CH6

% Dolomite



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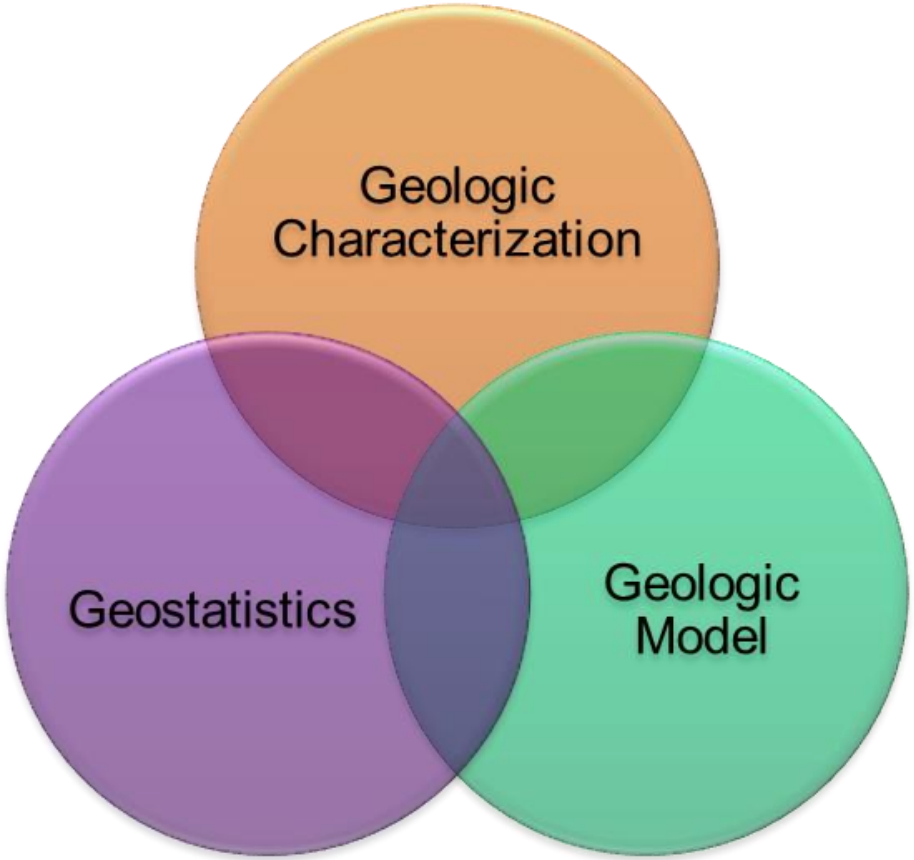
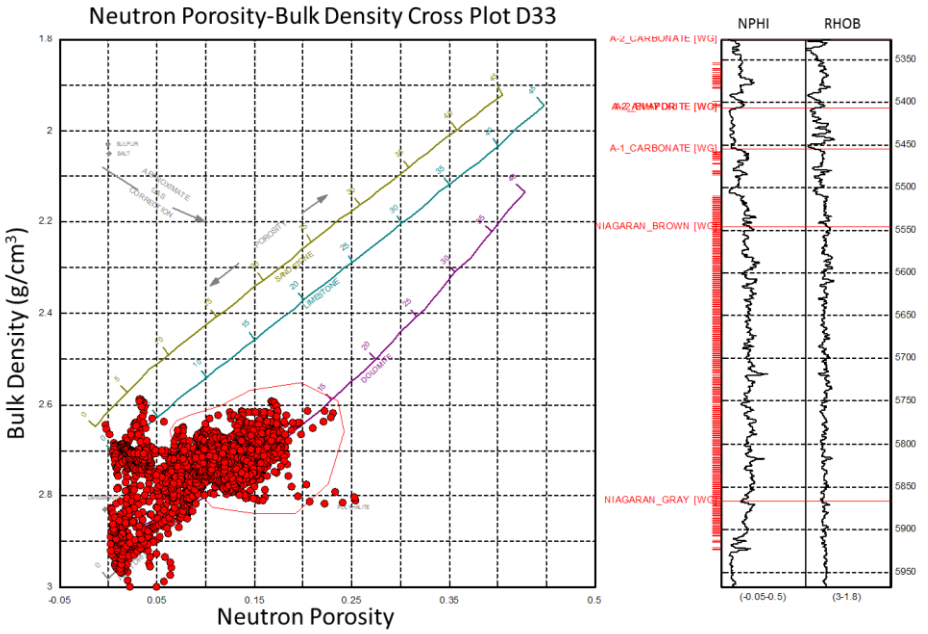
Developing Workflows for Static Earth Models

- Building comprehensive database
- Collaboration with WMU and Core Energy, LLC
- Simple and efficient workflows
  - Characterize reefs
  - Justify decisions
  - Build geologic models
  - Scale from site to regional

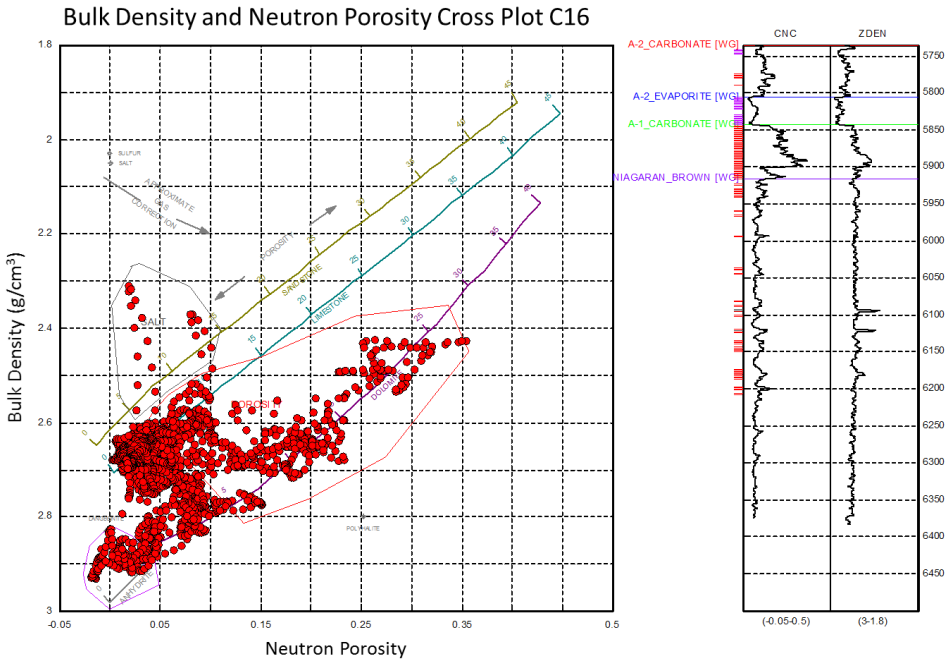


Basic Log Analysis to Identify Porosity and Lithology

D33



C16



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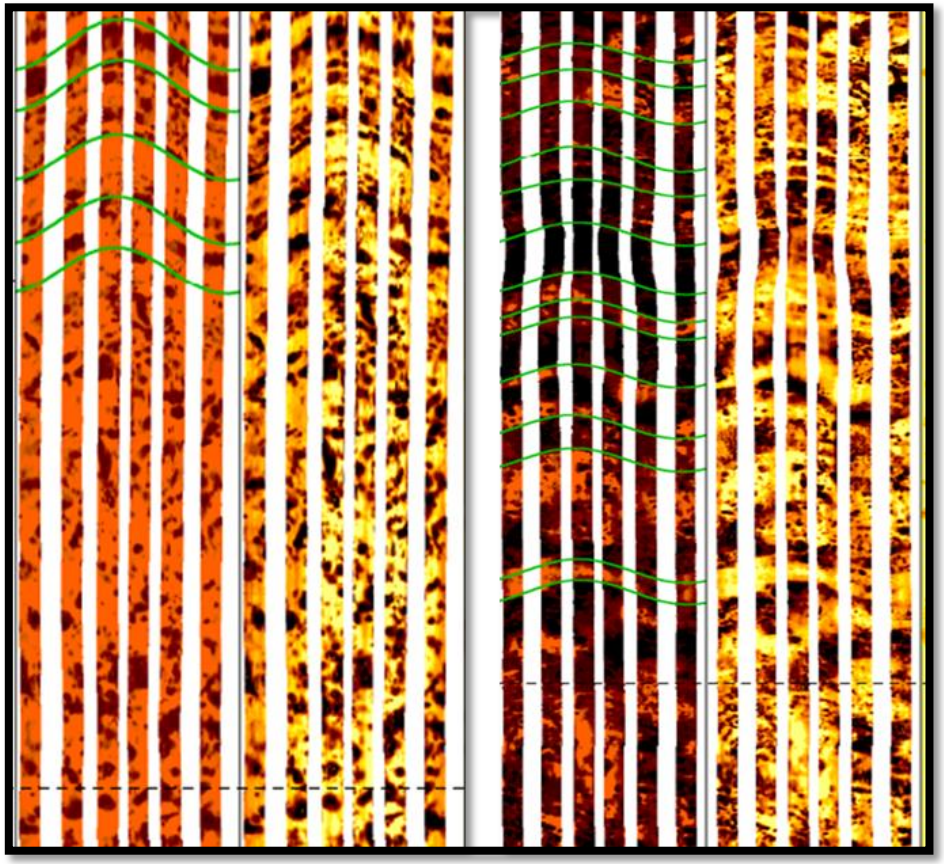
Advanced Log Analysis to Identify Changes in Texture and Structures

D33



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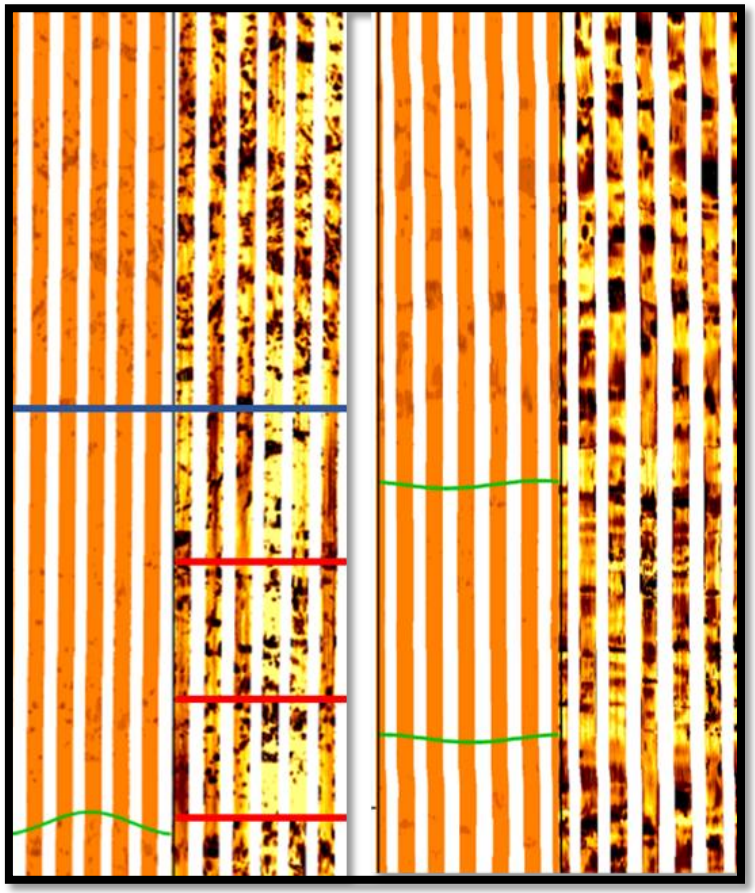


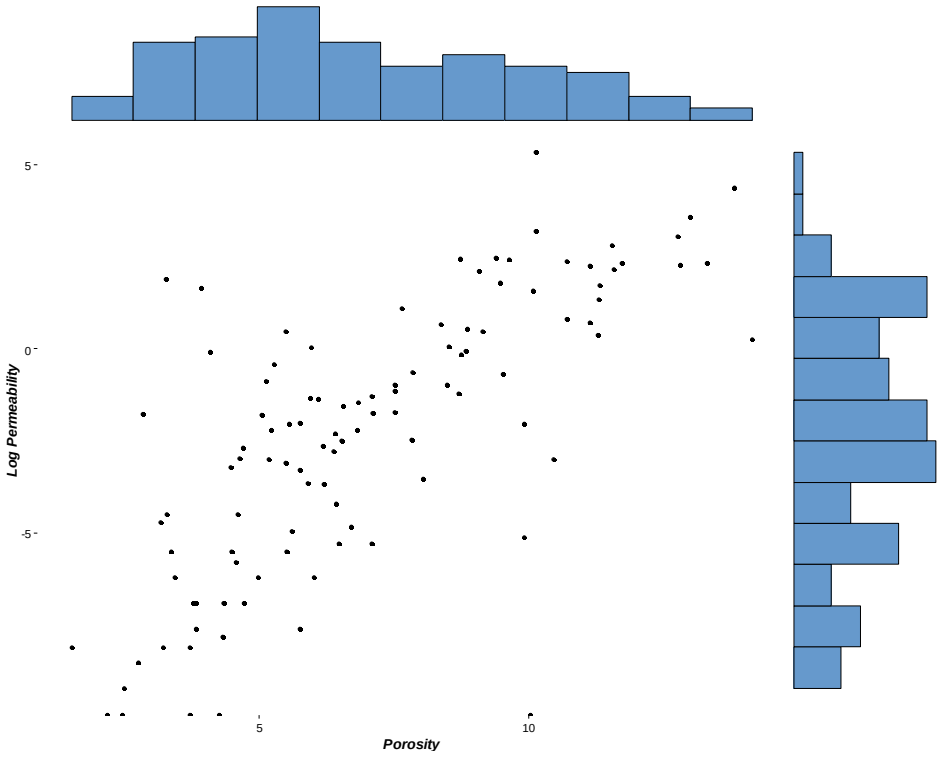
Whole Core Analysis to Analyze Reservoir and Caprock Properties

D33

C16

Whole Core Analysis to Analyze Reservoir and Caprock Properties

D33



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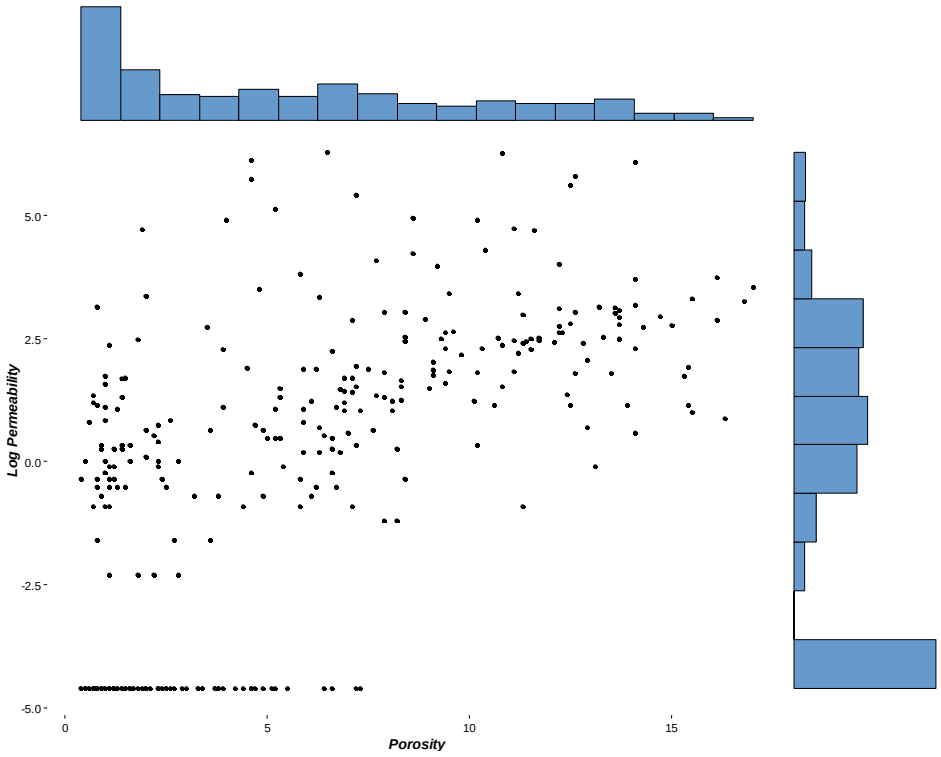

*New data not yet available from new wells

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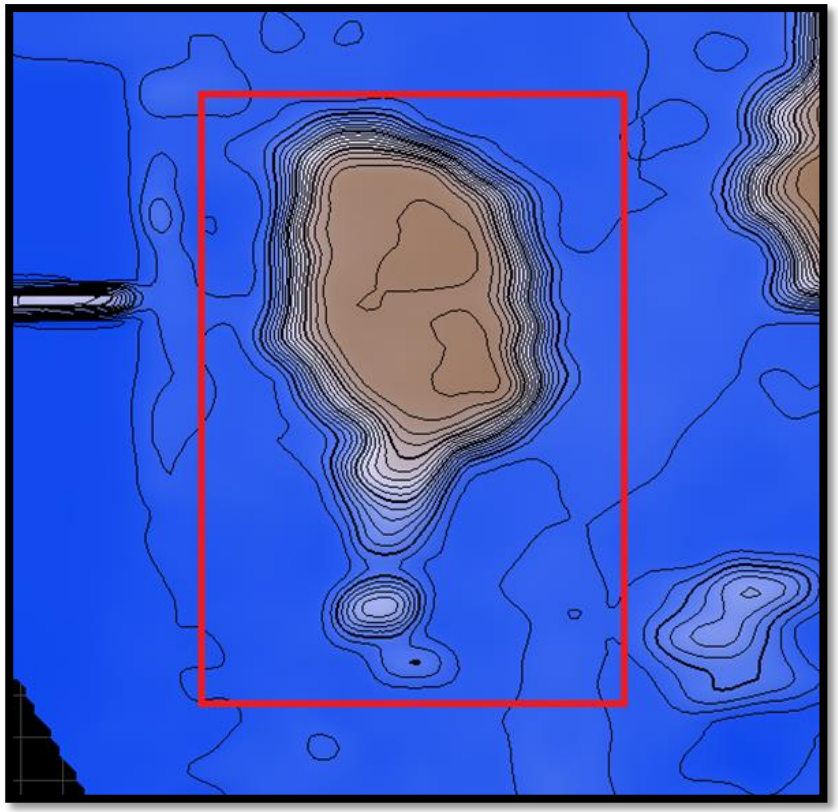
3D Seismic to Determine Reef Geometry

D33



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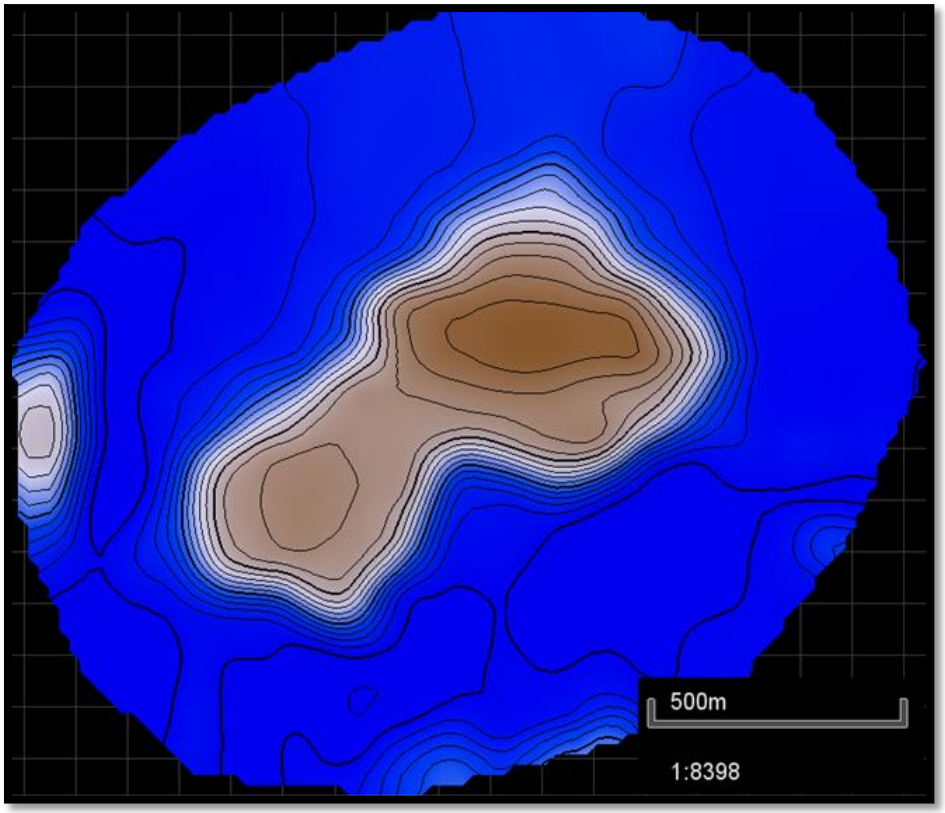

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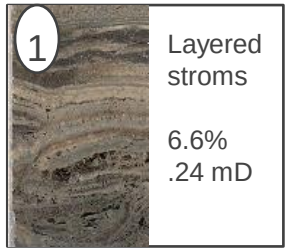
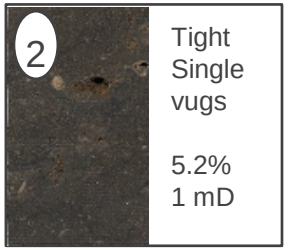
Integration of Data to Develop Conceptual Models- D33



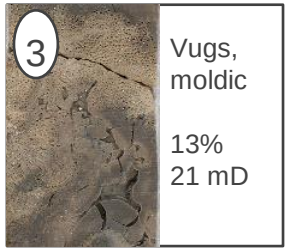
1 Layered stroms

6.6%
.24 mD



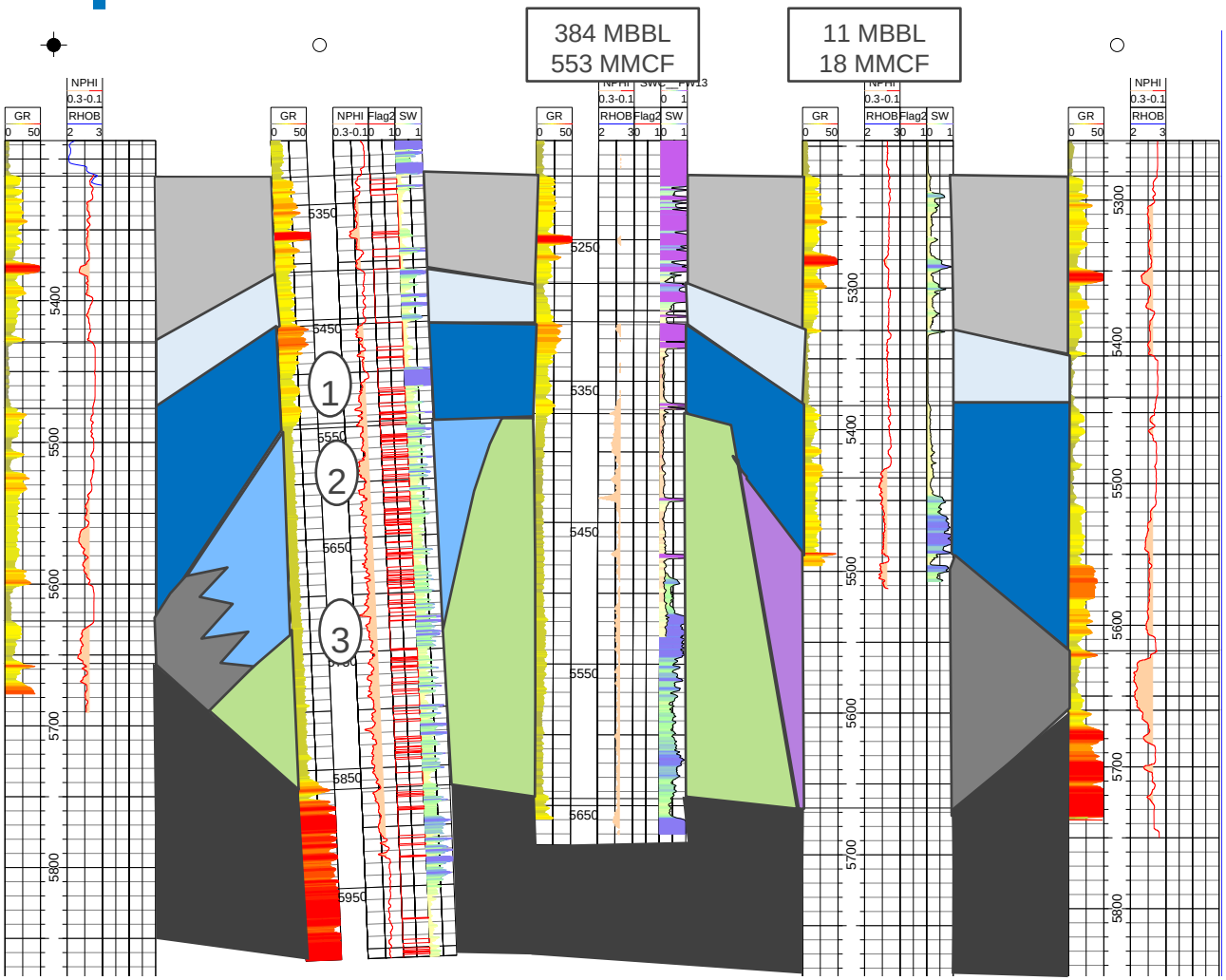
2 Tight Single vugs

5.2%
1 mD



3 Vugs, moldic

13%
21 mD



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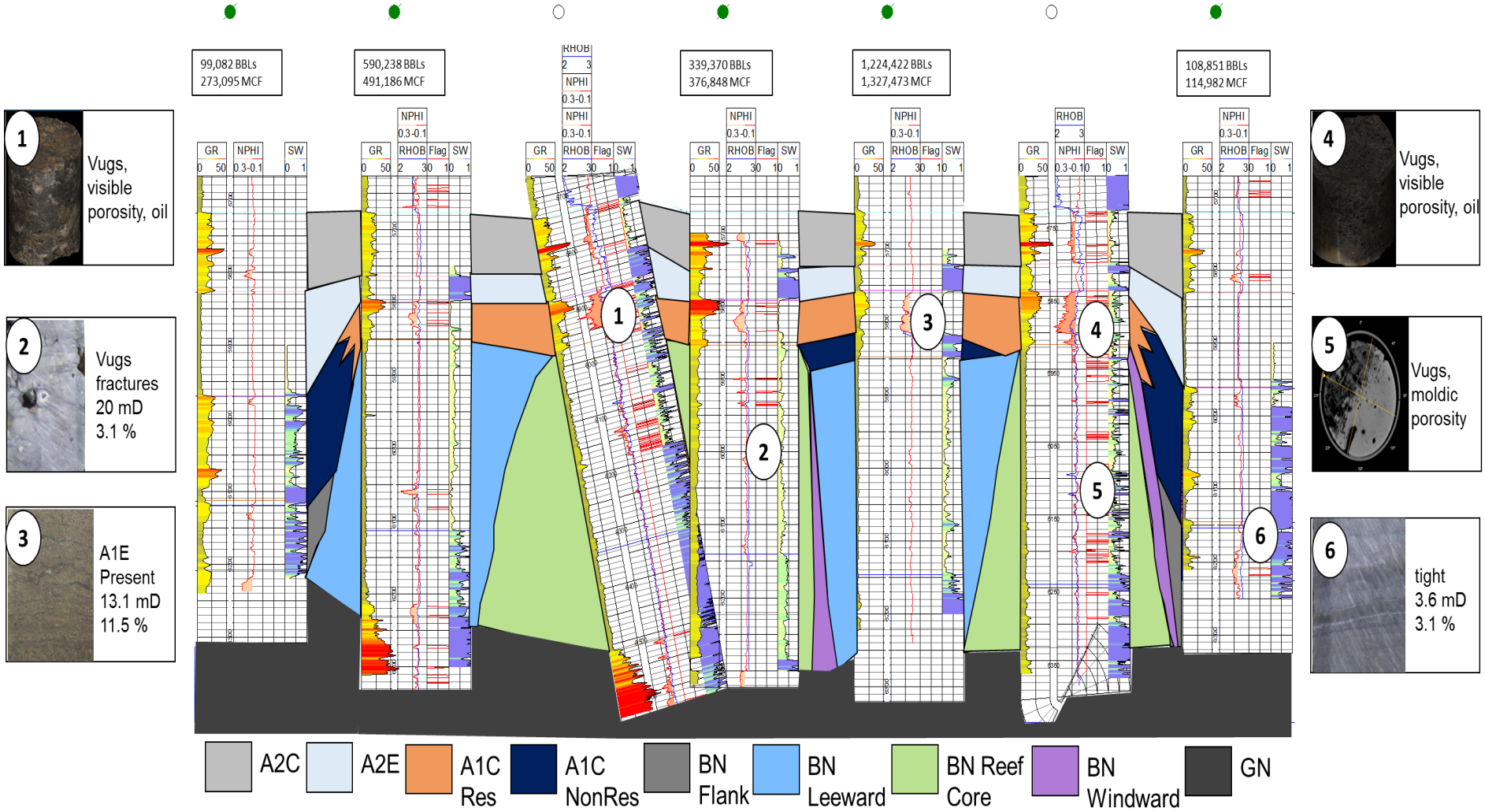
Integration of Data to Develop Conceptual Models- C16



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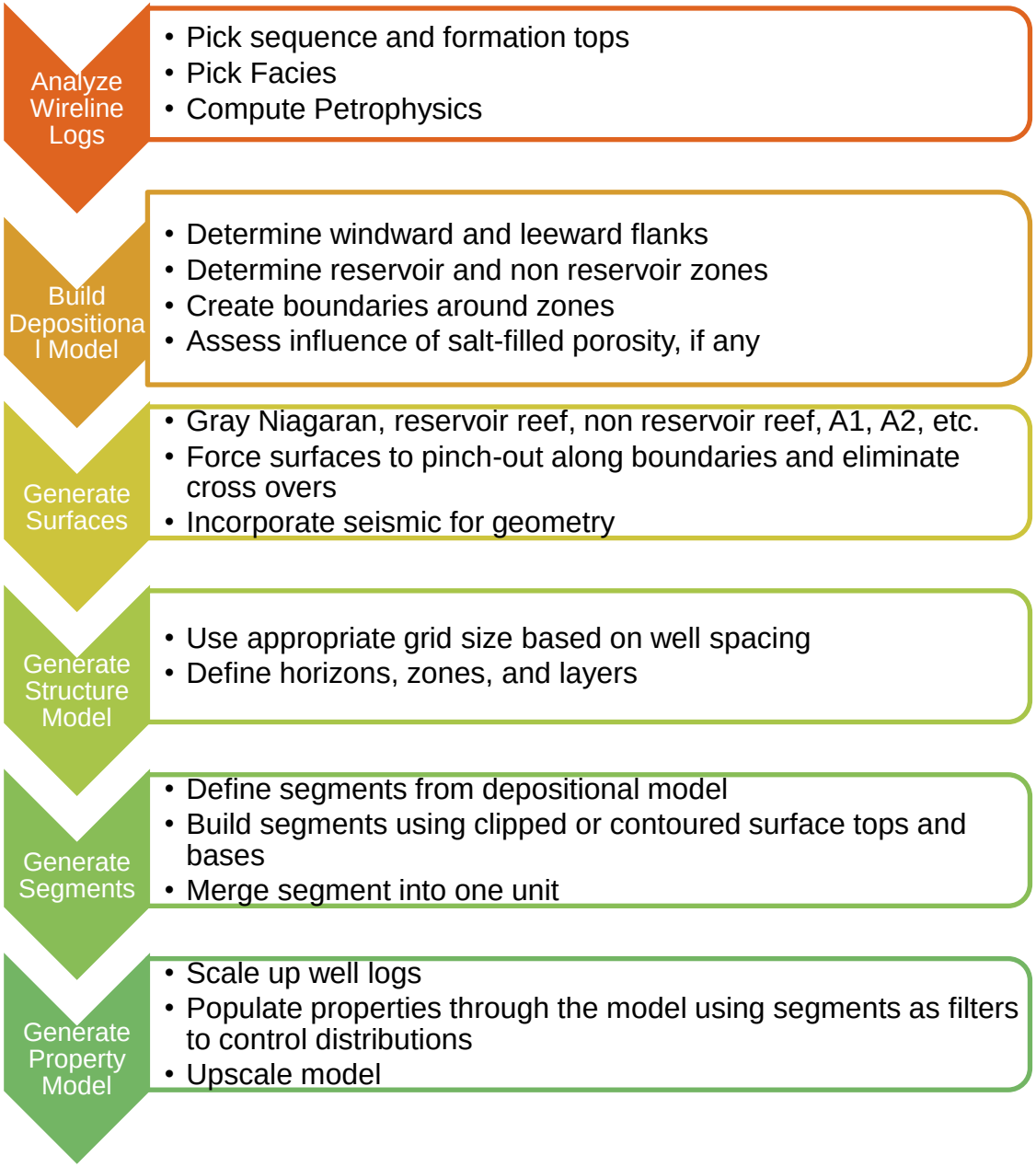
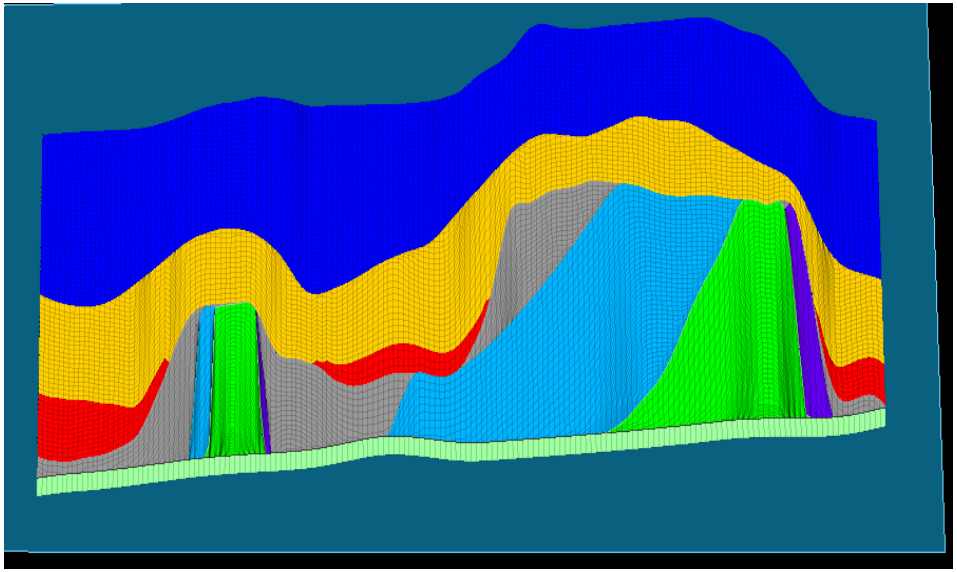
Static Earth Modeling

- Goals
  - Develop efficient workflow
  - Incorporate WMUs work
  - Suitable for dynamic
- Combine simple structure model with advanced model
- Keep interpretations consistent across the team



Application of Conceptual Model to Guide SEM

D33



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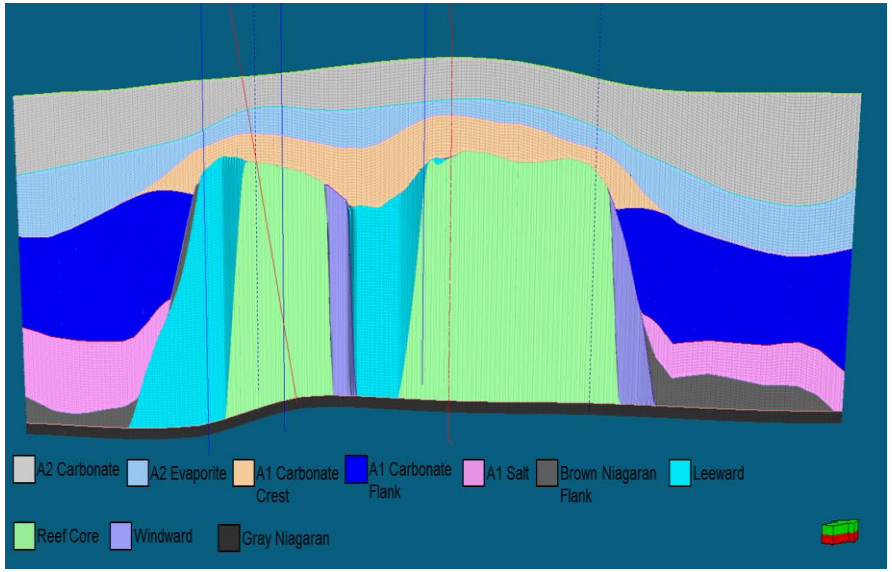
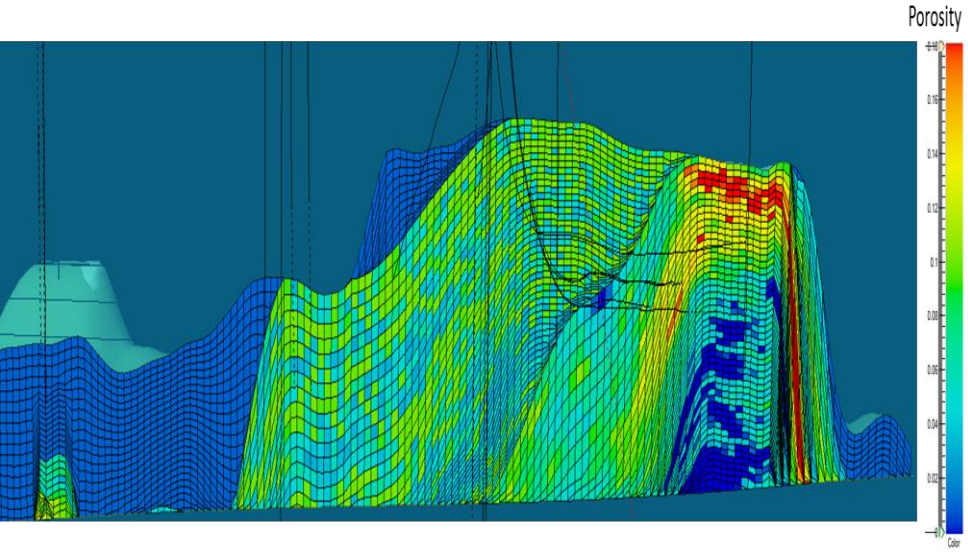


Porosity Distribution is Significantly Different between Reefs

D33



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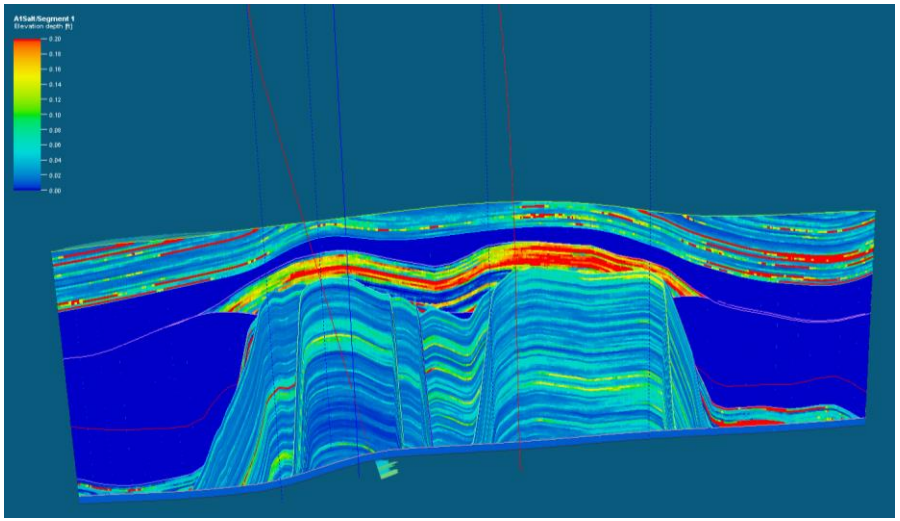
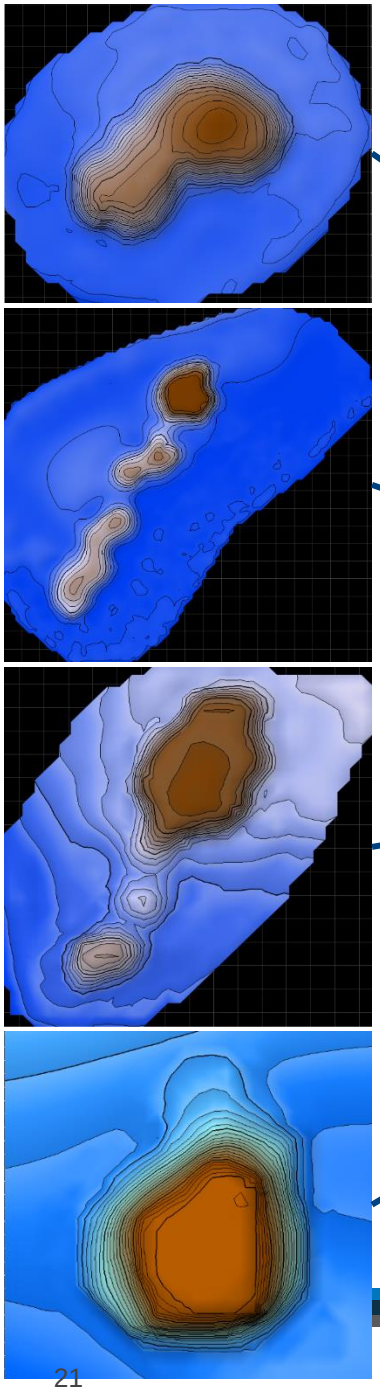


Diversity of Niagaran Reefs



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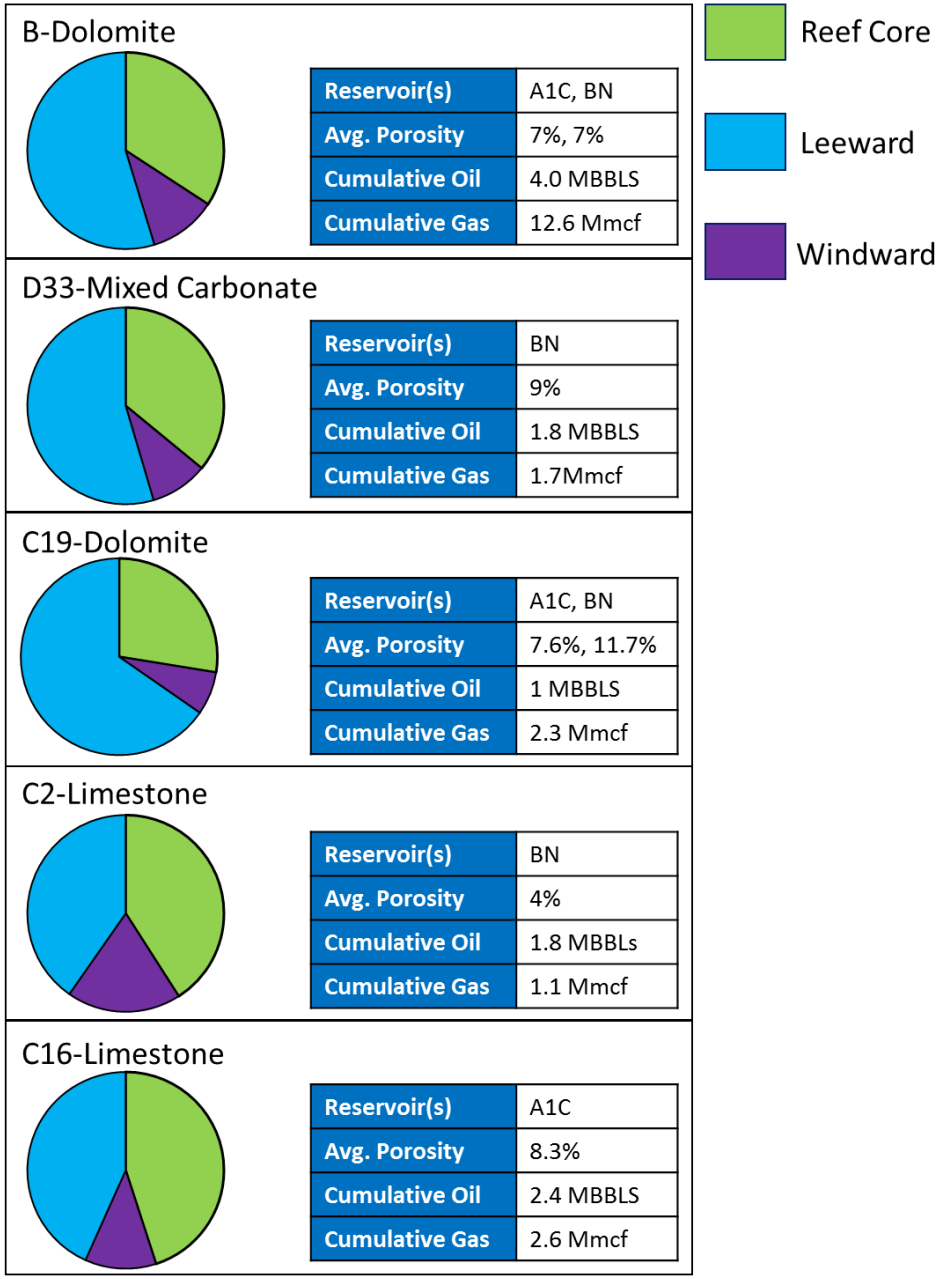
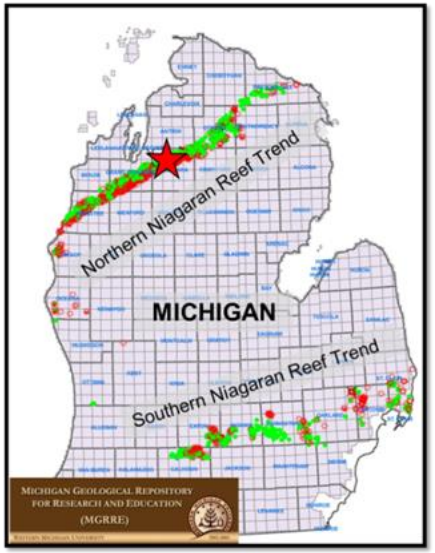
Conclusions

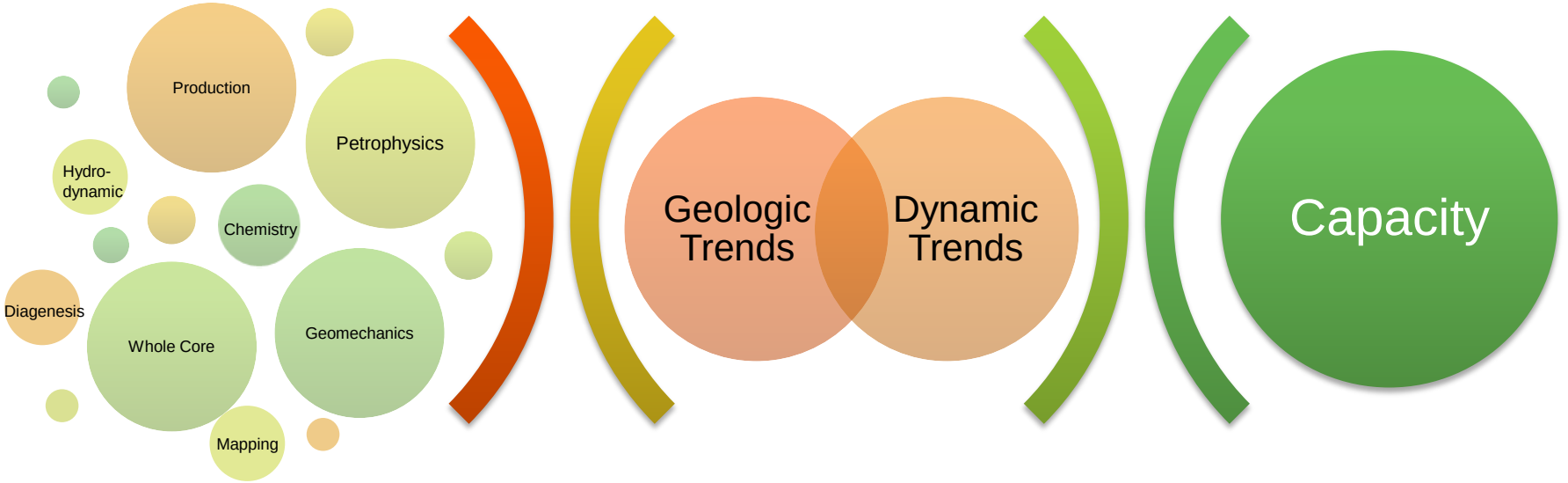
- Standard analyses provide initial geologic interpretations
- Integration of data types is needed to fully understand geologic diversity
- Development of conceptual models are crucial to guide SEMs
- Geologic variability between reefs influences the reservoir position and distribution



Expanding to Regional Characterization and Capacity Estimations

- Continued collaboration between Battelle, Core Energy, and WMU
- Expand datasets to northern reef trend (NRT)
- Identify trends and/or predictors for capacity





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Questions?

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It can be done