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# Midwest Regional Carbon Sequestration Partnership Update (DOE Project No. DE-FC26-05NT42589)

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**U.S. Department of Energy**

**National Energy Technology Laboratory**
**Carbon Storage R&D Project Review Meeting**
**Developing the Technologies and Building the Infrastructure for $CO_2$ Storage**

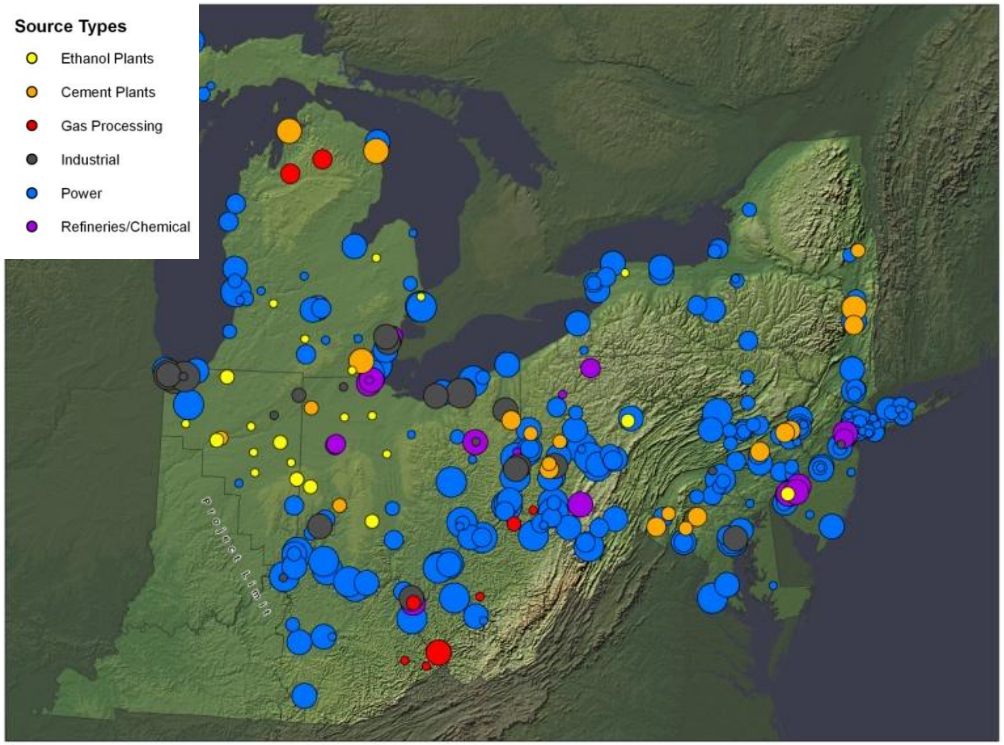
**August 21-23, 2012**

# Presentation Outline

- Quick Overview of MRSCP
- MRCSP Benefit to the DOE Program
- MRCSP Project Overview: Goals and Objectives
- Technical Status
- Accomplishments to Date
- Summary
- Appendix
  - Organization Chart
  - Bibliography

# About the Midwest Regional Carbon Sequestration Partnership

- Formed in 2003 as a public/private consortium
- Consists of nearly 40 members, led by Battelle
- Includes 9 states
- Region emits nearly 700 million metric tons $CO_2$ each year
- CCS is viewed as a key emissions reduction technology for our industrial base




***This map shows locations of large point sources – power generators, iron and steel manufacturing, refineries, cement plants, gas processing, and other industry.***

# MRCSP/DOE Program Goals Aligned

| NETL Program Goal | MRCSP Approach |
|---|---|
| 1. Develop technologies that will support industries' ability to predict $CO_2$ storage capacity in geologic formations to within ±30 percent. | MRCSP is developing validated geological and reservoir models that are correlated with field geophysical, geochemical, and $CO_2$ injection data. MRCSP regional mapping efforts further contribute to this. |
| 2. Develop technologies to demonstrate that 99 percent of injected $CO_2$ remains in the injection zones. | MRCSP will use a variety of monitoring techniques including VSP, micro seismic, wireline, tracer gas, pressure sensing, and fluid sampling to image and track plume behavior, and monitor $CO_2$ storage. |
| 3. Conduct field tests through 2030 to support the development of BPMs for site selection, characterization, site operations, and closure practices. | MRCSP will continue to contribute to the BPMs and also add to the operational best practices and assessment of a major MRCSP reservoir not previously tested in the region. |

# Benefit to the Program

- MRCSP has refocused our efforts on Carbon Capture, Utilization, and Storage (CCUS) Activities.
- Novel modeling and MVA techniques will be further validated using depleted oil fields in Northern Michigan (Niagaran Reefs)
- Plans are in place to also characterize the East Canton Oil Fields in northeastern Ohio.
- In addition, working with the Geology Teams in our nine state region, opportunities for CCUS will identified and ranked, storage potentials updated, and further geologically characterized.
- MRCSP will continue to contribute to Best Practices, and help to develop regional implementation plans.

# Project Overview: Goals and Objectives

- Primary goal is to execute a large-scale scale $CO_2$ injection to evaluate best practices and technologies required to implement carbon sequestration on a commercial scale.
- Objectives are to advance monitoring and modeling techniques needed to:
  - develop and validate reservoir models useful for commercial scale applications
  - address public concerns such as leakage and storage security
  - address other topics such as cost effectiveness and CCUS practicability

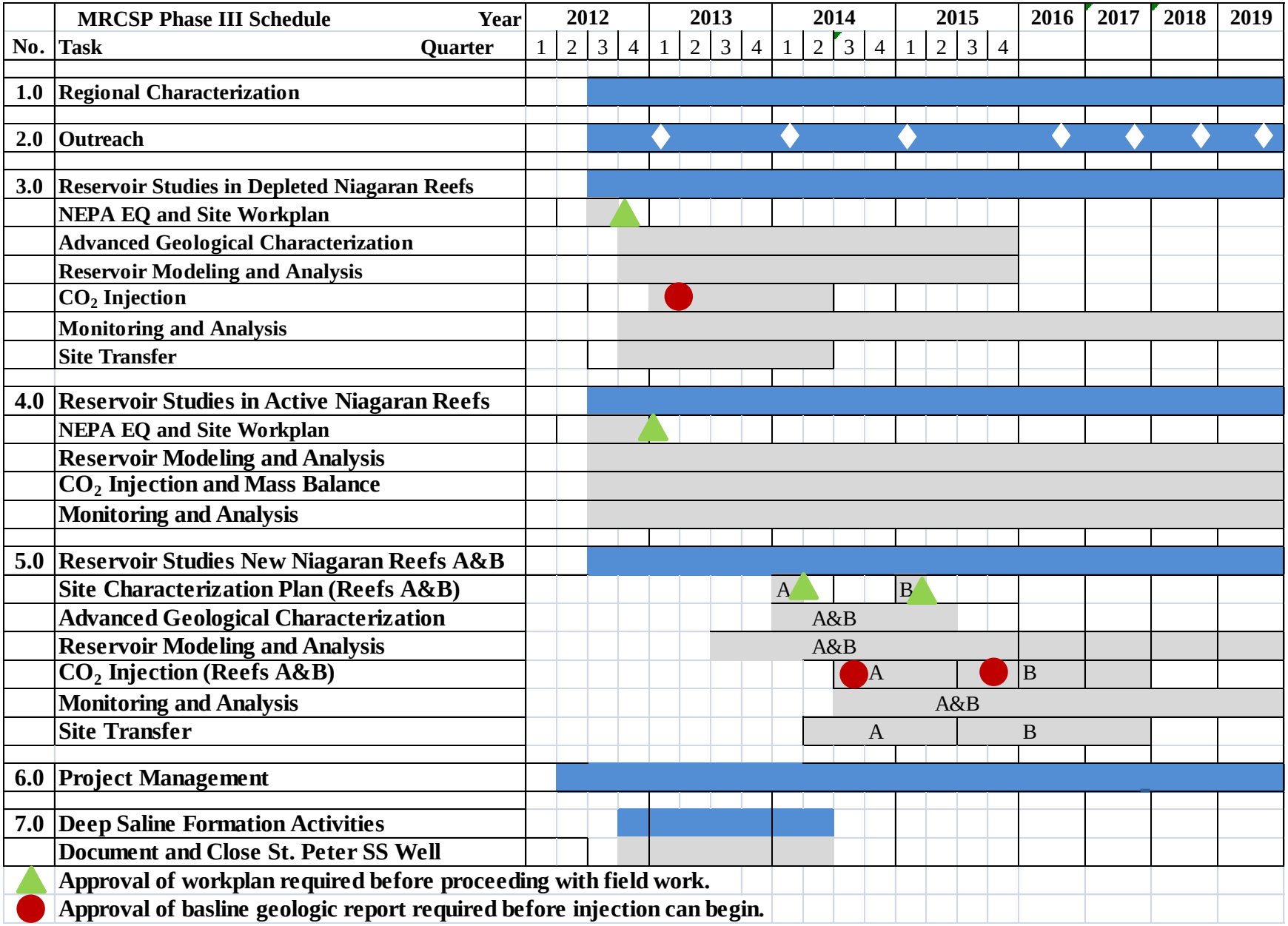
# MRCSP Success Criteria Aligned with RCSP Goals

| RCSP Goal | MRCSP Success Criteria |
| --- | --- |
| *Goal 1 - Prove Adequate Injectivity and Available Capacity* | The Niagaran Reef Trend in Northern Michigan has the potential to be a significant resource for CCUS. Success will be measured by injecting 1 million tonnes of $CO_2$ over four years within regulated reservoir pressures. Pressure monitoring and modeling will be used to evaluate system capacity |
| *Goal 2 - Prove Storage Permanence* | Phase III site carefully chosen to include good caprock, geologic structure. Test well drilling, seismic survey, and characterization will be used to evaluate storage mechanisms and containment. Deep monitoring wells and sampling will be used to measure success of containment over time. |
| *Goal 3 - Determine Aerial Extent of Plume and Potential Leakage Pathways* | Appropriate monitoring portfolio will be employed to image and track the lateral and vertical plume migration. Success will be measured by using monitoring data to compare to and validate plume models. |

# MRCSP Success Criteria Aligned with RCSP Goals

| RCSP Goal | MRCSP Approach and Success Criteria |
|---|---|
| *Goal 4 -Develop Risk Assessment Strategies* | Phase III risk assessment initiated including risk events, pathways, and mitigation planning. Success will be measured by comparing predicted to actual field experience for all stages of the project. |
| *Goal 5 - Develop Best Practices* | Phase III is expected to build on and add to Phase II best practices in siting, risk management, modeling, monitoring etc. Key emphasis will be on operation and monitoring and scale-up to commercial-scale |
| *Goal 6 - Engage in Public Outreach and Education* | Extensive outreach efforts have already taken place in support of the Phase III site and extensive experience has been gained in both Phase II and III work to date. |

# MRCSP Project Schedule



# MRCSP Membership - Progress through Collaboration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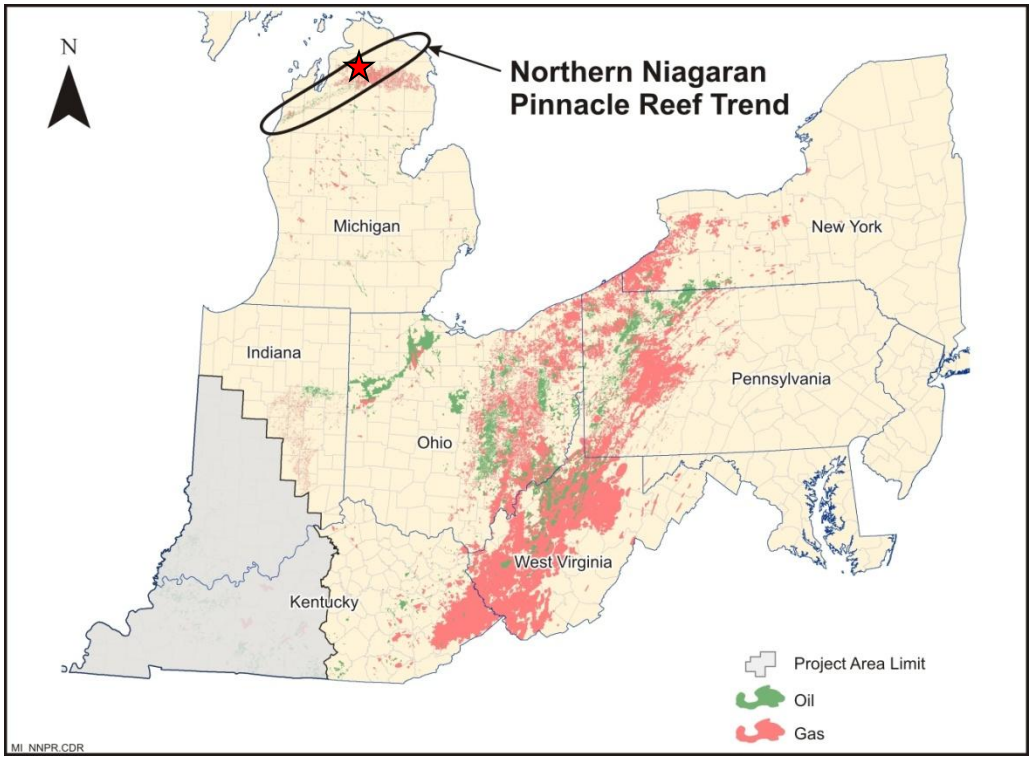
# Depleted oil and gas fields - Using $CO_2$ for Enhanced Oil Recovery

- Our region contains some of the largest historic oil-and-gas producing areas in the US
- An estimated 8500 million metric tons of $CO_2$ could be stored within depleted O&G fields (~10 years worth of emissions)*.
- Using $CO_2$ for EOR could lead to the production of an additional 1.2 billion barrels* of oil that would otherwise be stranded in the ground.




**Oil and gas fields map for region***

* Source: *Estimates developed by the Geological Surveys within the MRCSP*

# Key Oil and Gas Fields in MRCSP Potential Targets for $CO_2$ Utilization

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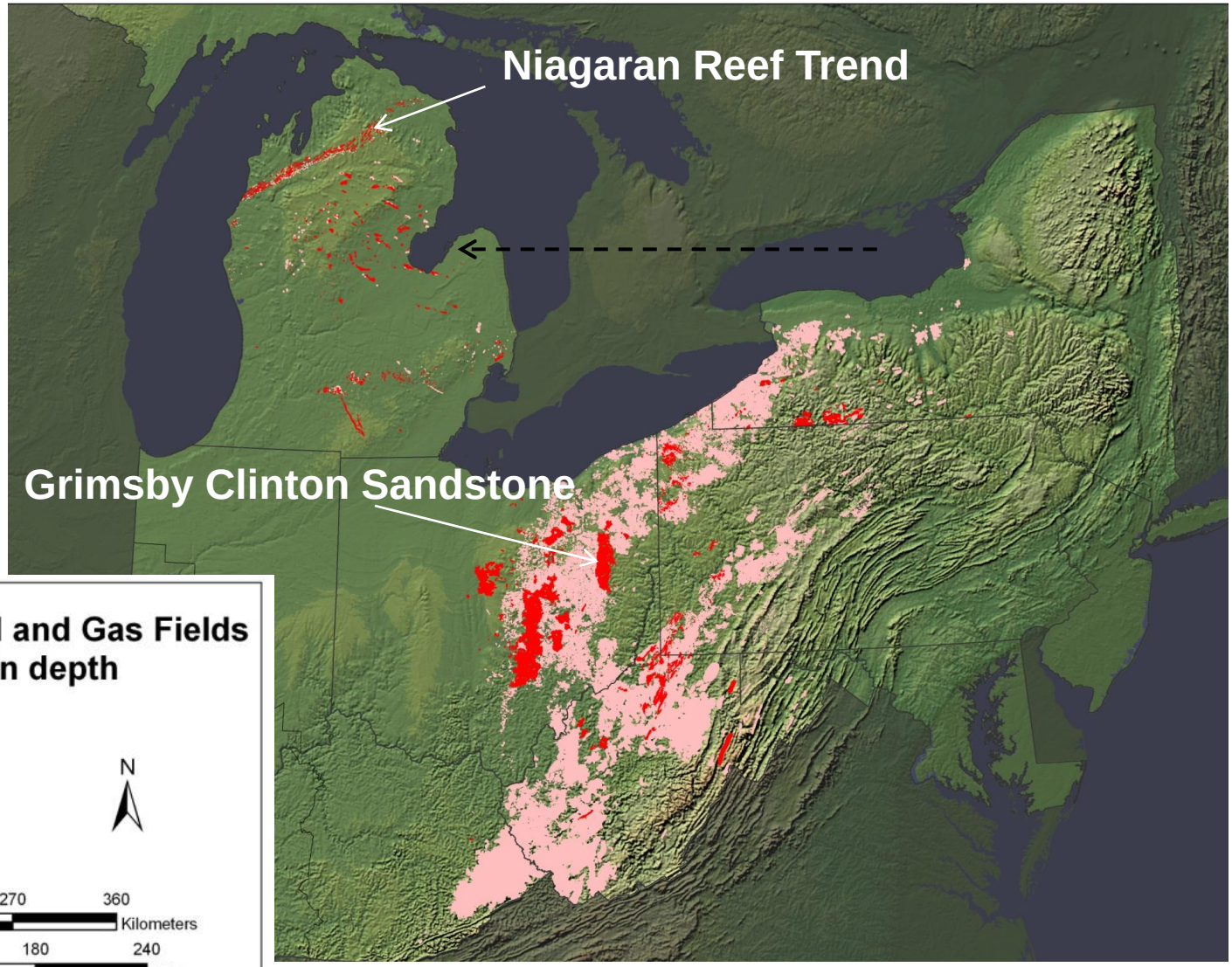
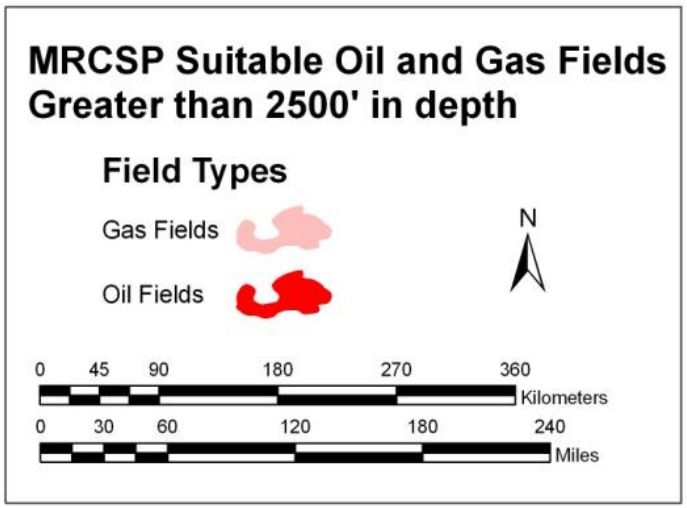
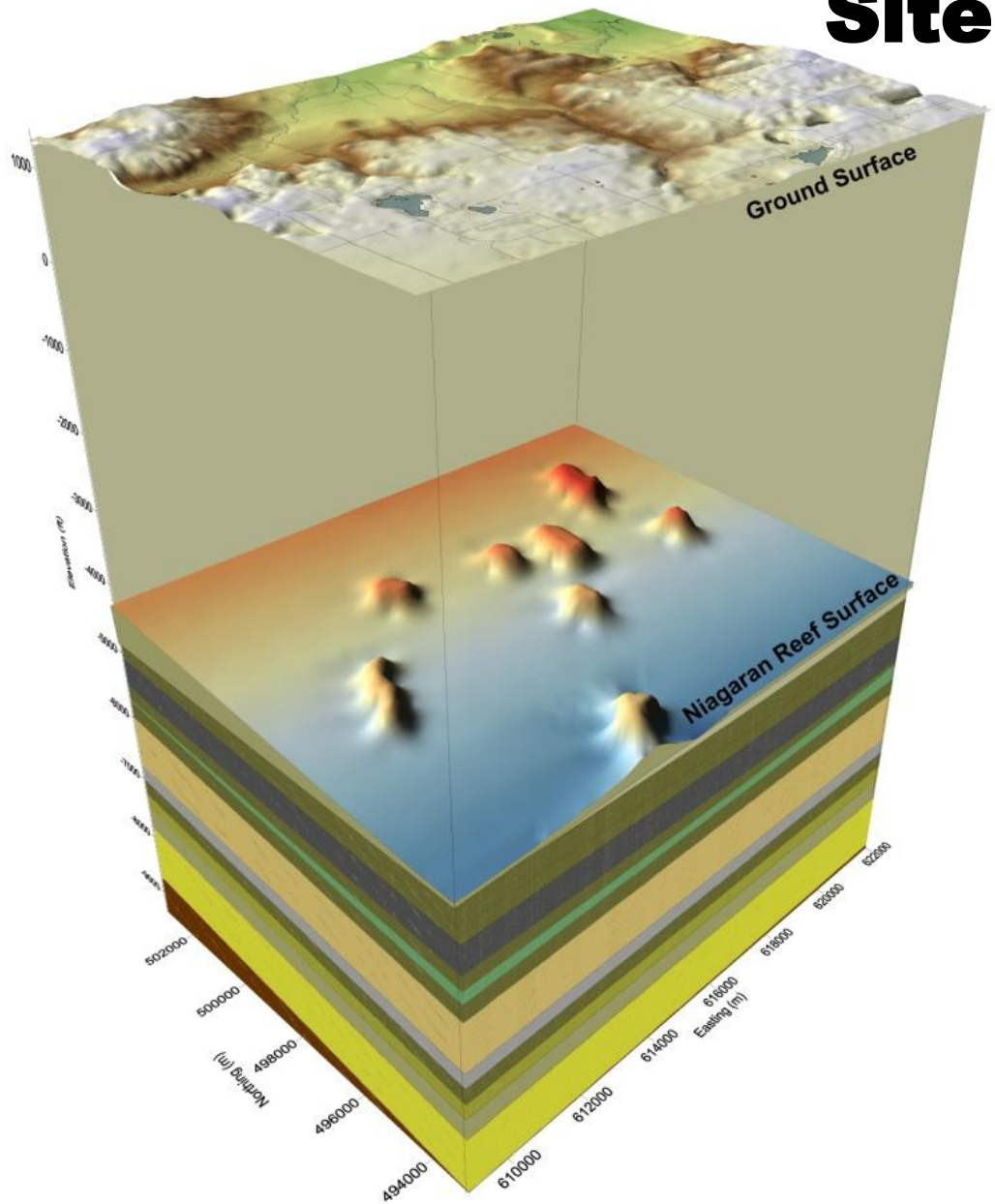
**Existing data on over 700 reefs:**

- Core and wireline logs
- Production Data
- Original Oil in Place
- Remaining Oil in Place



# Site Description



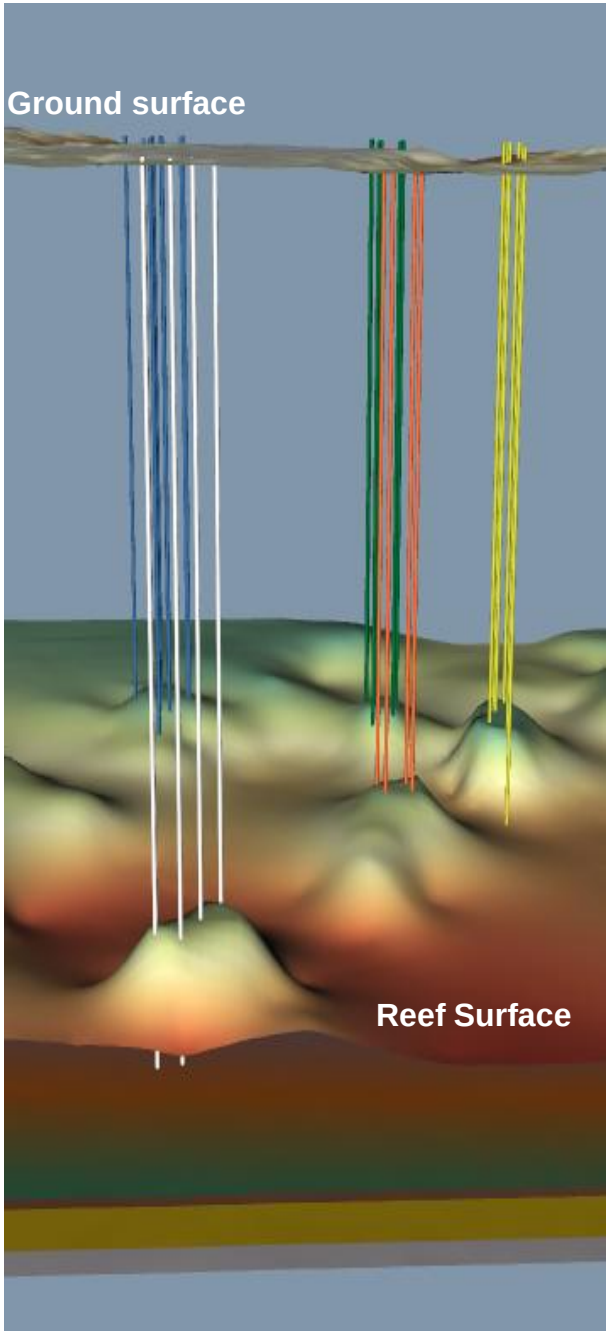

**Location:**
Otsego County, Michigan

**Source of $CO_2$:**
Local Natural Gas Processing Plant
(Antrim Shale Gas ~15% $CO_2$ content)

**Reservoir Type:**
Closely-spaced, highly compartmentalized oil & gas fields located in the Northern Michigan Niagaran Reef Trend

**Permitting:**
U.S. EPA Region 5 UIC Class II permits already in place for EOR

# Injection Strategies




• **Injection Strategies:** Evaluate reef capacity as a function of geology, well locations, operational history, geochemical reactions, etc. Test methods to promote oil production such as:

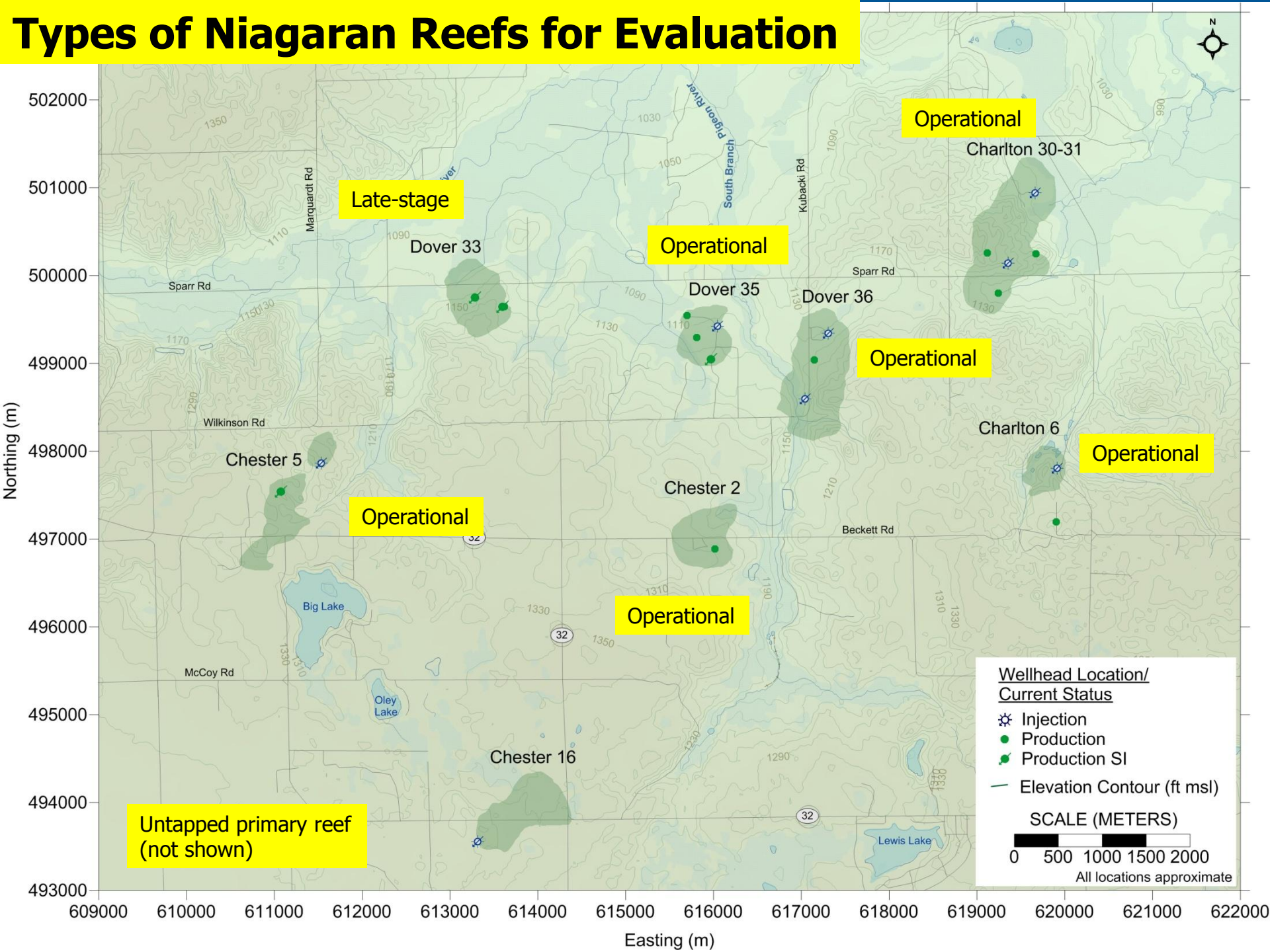
- Injecting enough $CO_2$ to pressurize reef beyond discovery pressure
- Injecting $CO_2$ into residual oil zone

•**Depleted Reef:** late-stage EOR reefs that have undergone extensive primary and secondary oil recovery, and are mostly depleted of oil

•**Active EOR Reefs:** operational EOR reefs, in which primary oil recovery is completed and secondary oil recovery is currently under way

•**Pre-EOR Reefs:** reefs that typically have undergone primary oil recovery, but where no secondary oil recovery using CO2 has been attempted.

# Types of Niagaran Reefs for Evaluation



# Core Energy LLC – EOR Operator with $CO_2$ Source

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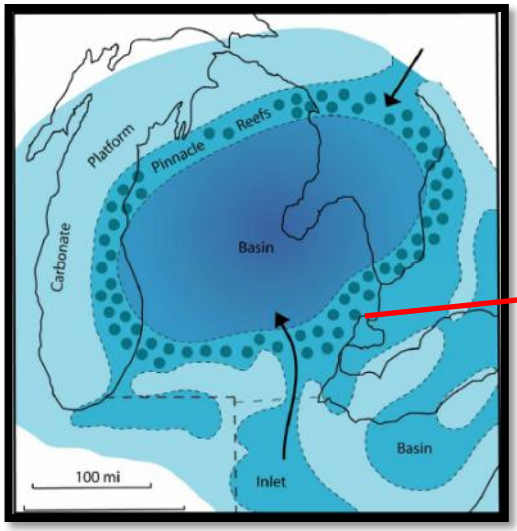
**Combination is well suited to Phase III test in addition to geological considerations**

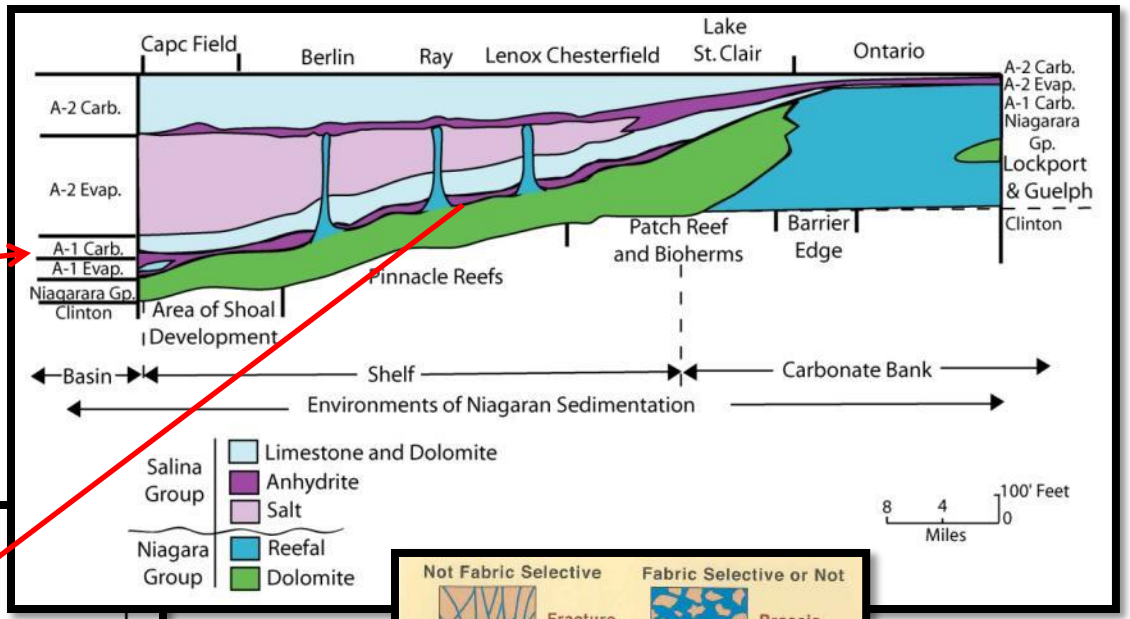

Gas Processing Plants

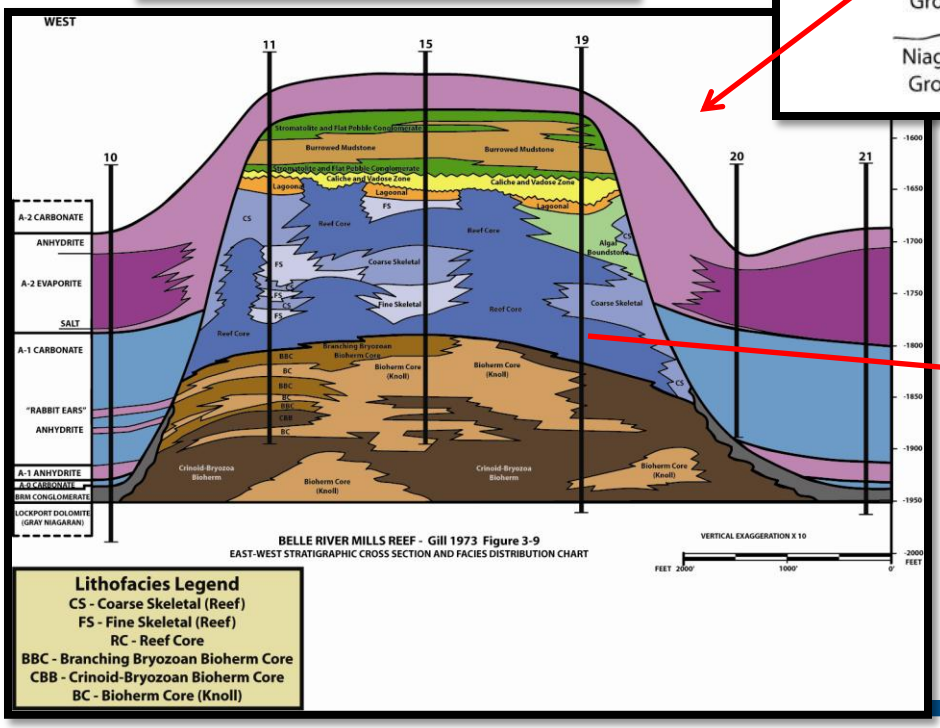
Compressor

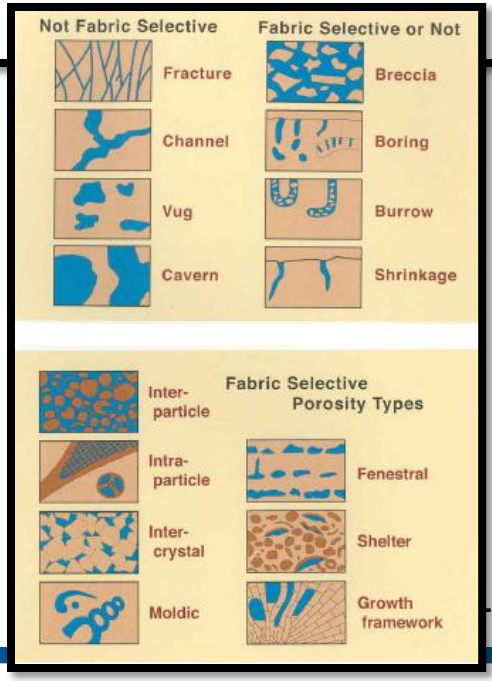
# Dover 36 Processing Facility

# Geologic Setting – More than 700 Reefs

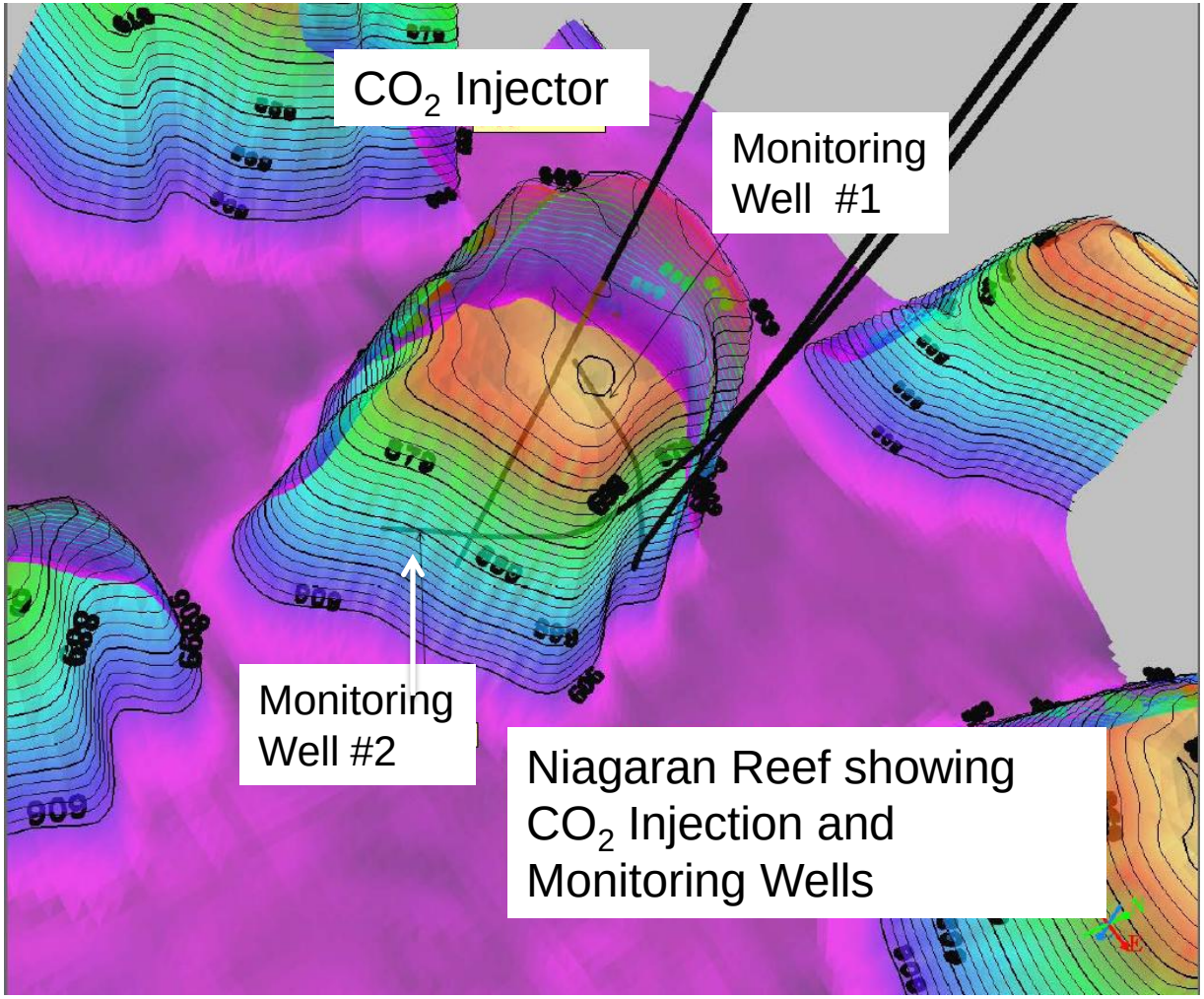


# Existing 3D Seismic for Dover 33 and Vicinity




MRCSP has also piggybacked on Core Energy's seismic survey (Over 35 Sq. Miles) by collecting three component geophone data over several reefs targeted for study.

This data will be a key contribution in better understanding the geologic environment and developing detailed models of the $CO_2$ behavior inside the Niagaran Reefs.

# Dover 33 Infrastructure Assessment

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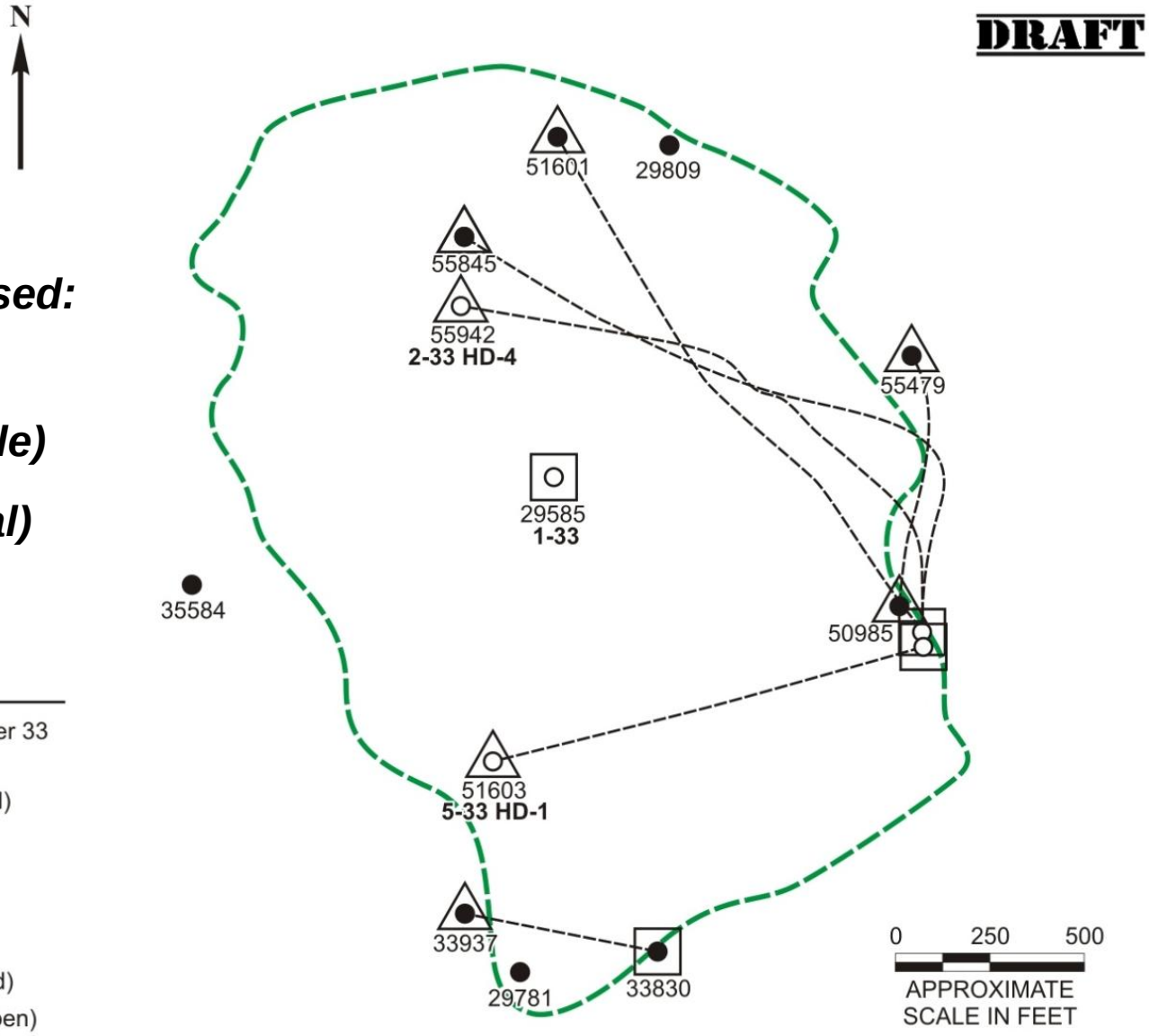
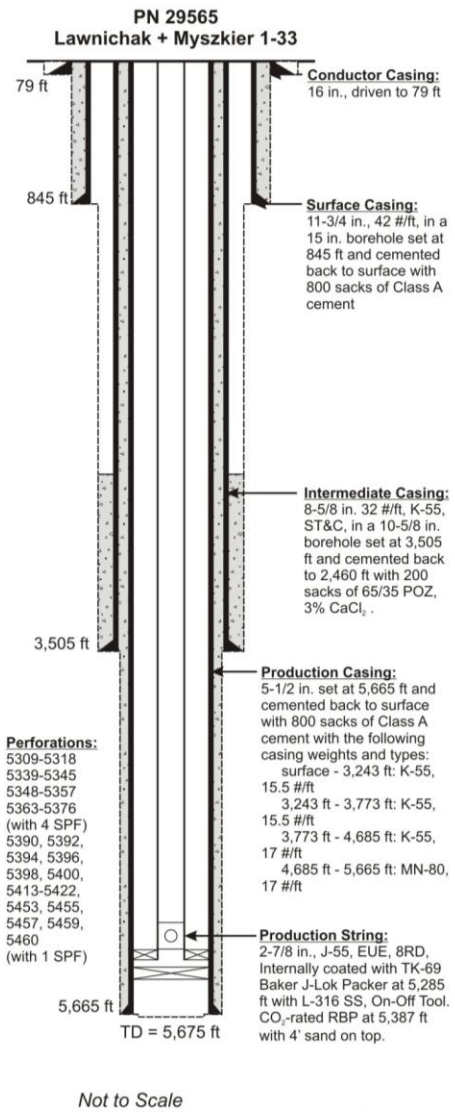
***Three wells will be used:***

- ***1-33 (vertical)***
- ***5-33 HD-1 (High angle)***
- ***2-33 HD-4 (horizontal)***

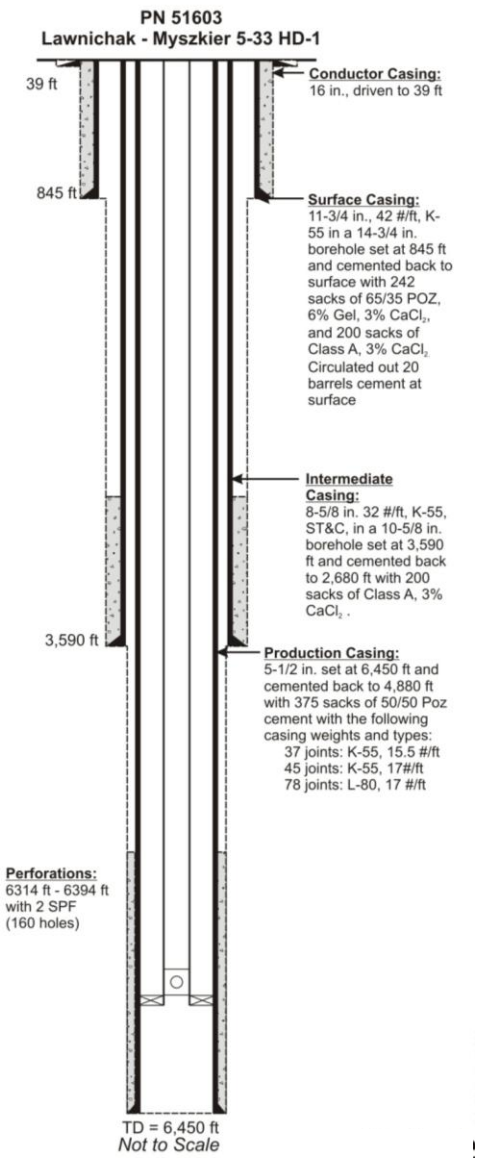


# Dover 33 Well Schematics

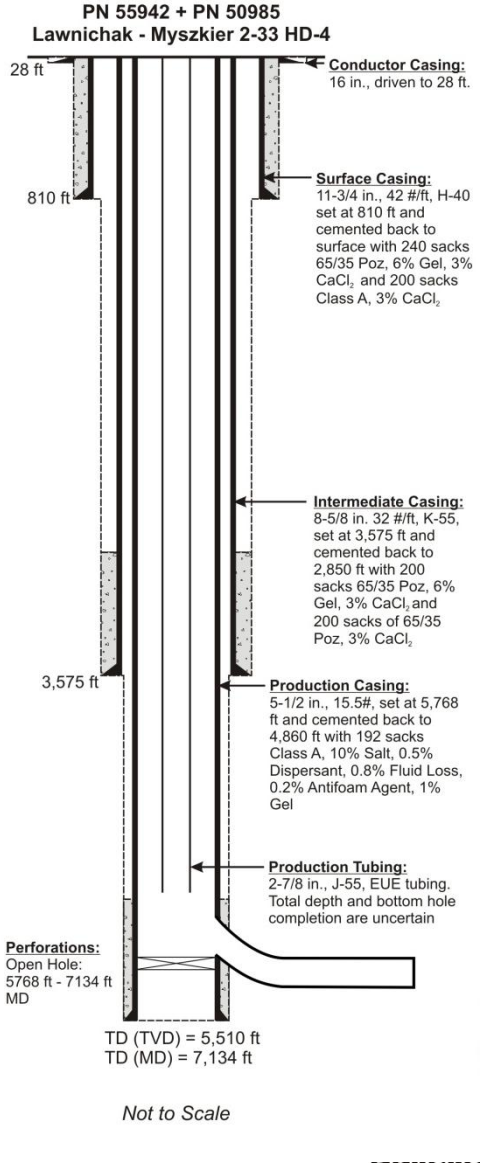
## Vertical Well




## High Angle Well




## Horizontal Well



# No New Wells Needed at Dover 33 – Limited Well Workover Planned

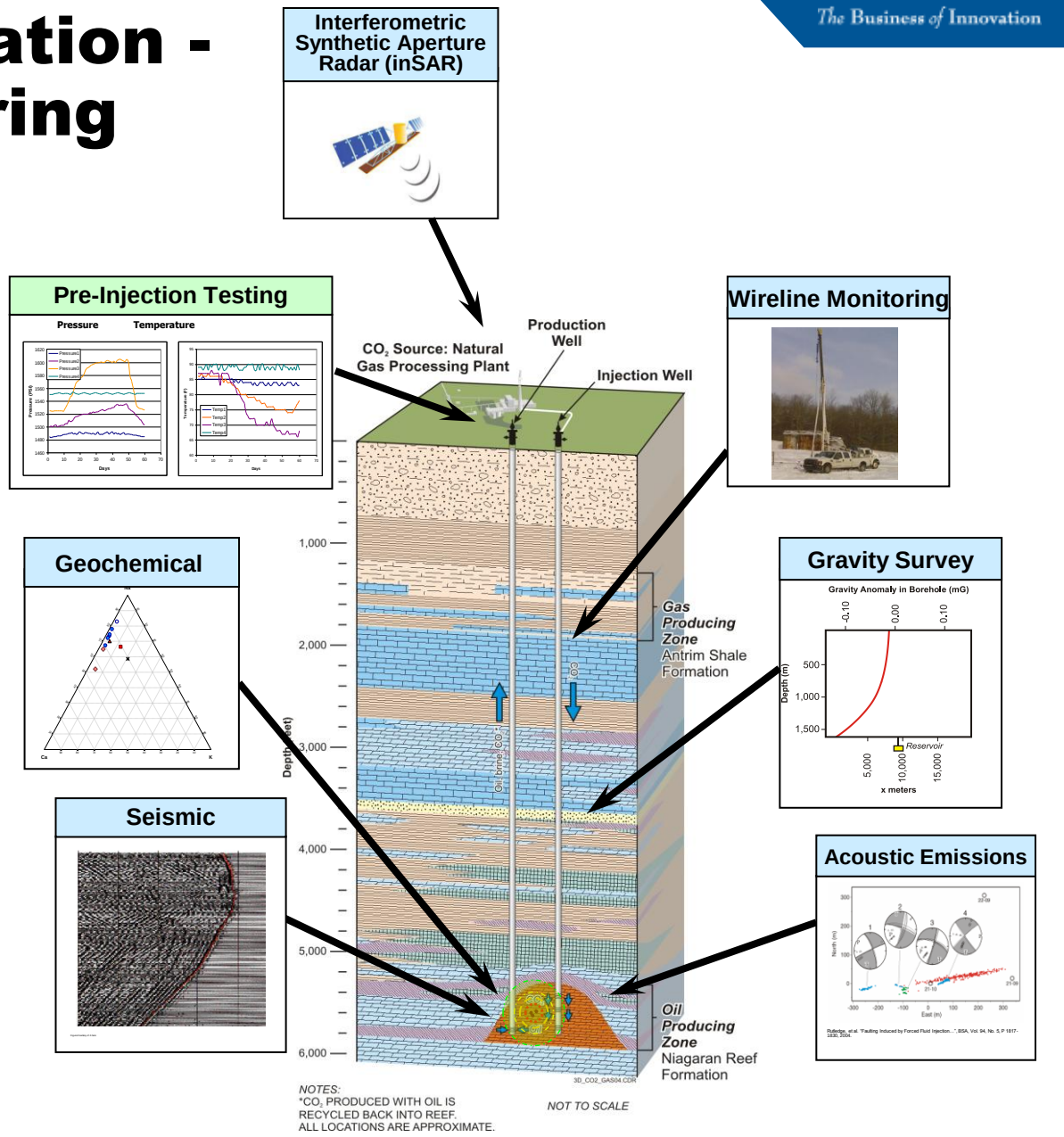
- Wells need to be reconfigured for long term injection test.
- A bridge plug needs to removed from Well 1-33
- Injection tubing and packers need to be removed from all wells to collect data
- Horizontal section of well 2-33 needs to be cleaned out and conditioned to run wireline tools and gyroscope


- *Potential Risk – removing and replacing bridge plug could take longer than expected*

# Site Characterization - Baseline Monitoring

Dover 33 provides a test bed to advance technologies for tracking $CO_2$, brine, and oil migration underground in a closed reservoir.

Multiple characterization and monitoring options possible using existing infrastructure



# Gyroscope and Wireline Logging

| Technique | Expected Outcome |
|---|---|
| Gyroscope (Deviation Survey) | • Determine the subsurface location of the horizontal and high angle wells *(risk – may not work in the entire wellbore)* |
| Cement Bond Log | • Aid in design of seismic techniques, which require good cement where geophones are placed. |
| Pulse Neutron Capture (PNS) (Saturation profiles at wells) | • Correlate to historical neutron porosity logs<br>➢ Develop a correlation between saturation-resistivity-neutron porosity with the old logs.<br>• Establish a current 'baseline' of saturation profiles.<br>• Determine ROZ depth and thickness |
| Sonic Log | • Determine potential correlation between saturation and sonic velocity<br>➢ If successful, will help in any time lapsed seismic interpretation |

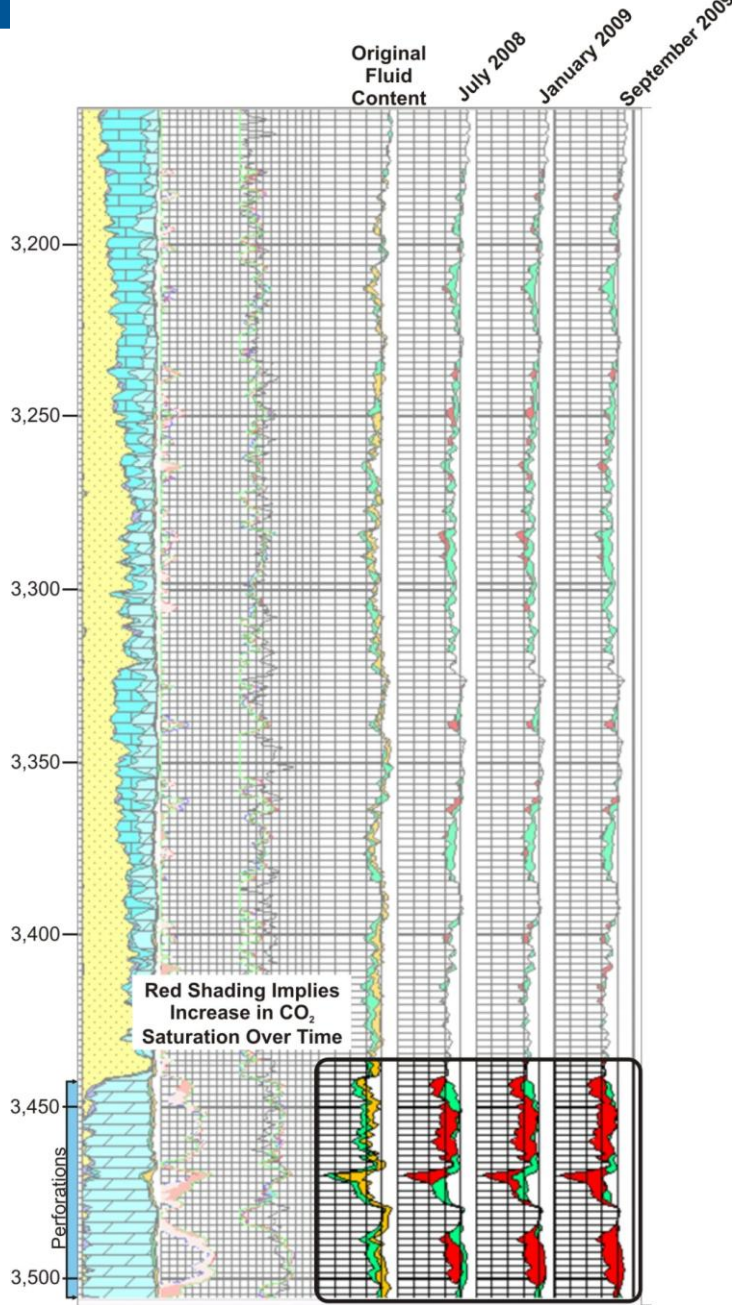
# Pressure, Temperature and Flowrate Monitoring

- Wellhead monitoring provides fundamental information necessary for UIC permitting on injection rates, wellhead pressure, annulus pressure, and the properties of the injected $CO_2$.
- Downhole P&T gauges
  - Provide data used to track reservoir behavior.
  - Temperature surveys provide direct evidence because $CO_2$ stream will be colder (60 to 65ºF) than the conditions in the storage formation (108ºF).

$CO_2$ Injection Well at Host Site

# Pulsed Neutron Capture (PNC) Logging

- PNC logging will be used to detect the vertical distribution of $CO_2$ adjacent to the logged well.
- The PNC tool can measure formation properties through well casing
- When $CO_2$ displaces native pore fluids in the formation surrounding the well, a change in response is expected to occur.
- Changes measured during repeat logging events will be used to infer the presence of $CO_2$




MRCSP Phase II Time Lapsed PNC Log

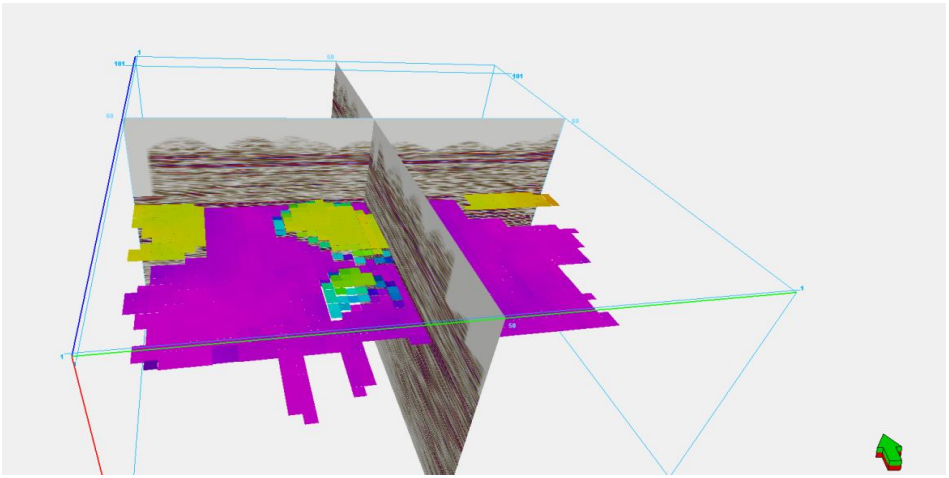
# Seismic Data Processing

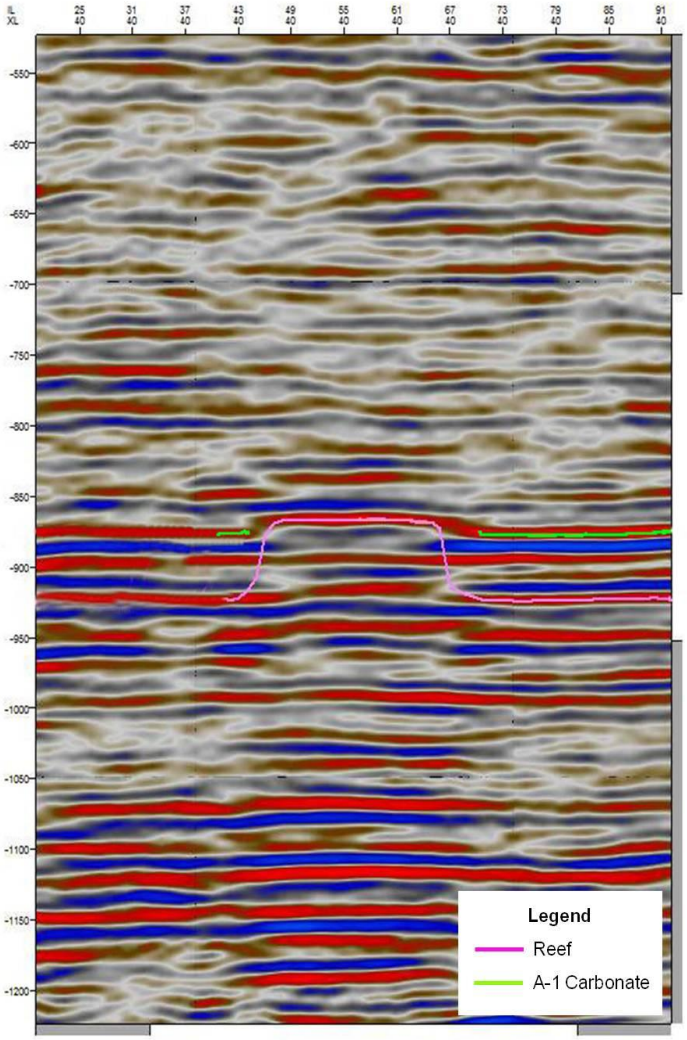
**Expected Outcome:**

- Provide input into the geologic model of the reefs and inter-reef areas

**Strategy:**

- Use 3D existing seismic data for reef, donated by Core Energy LLC
- Compile additional seismic data – tie into the proposed VSP data; use 3D-3C data from analog reef structures; perform porosity modeling of internal reef structure





# Vertical Seismic Profiling

**Expected Outcome:**

- Input for geologic models
- Track the location of the injected $CO_2$, and the potential movement of oil to the producing wells.

**Strategy**

- Time lapse VSP is considered a viable method to overcome the resolution and cost limitations of 4-D surface seismic.
- Use of surface sources in combination with receivers in a single well near the target horizon.
- Technical feasibility and timely availability to be evaluated before final deployment on this reef
- Collaboration with Tom Daley, LBNL
- Risks – cost/schedule; good cement contact; permitting; resolution

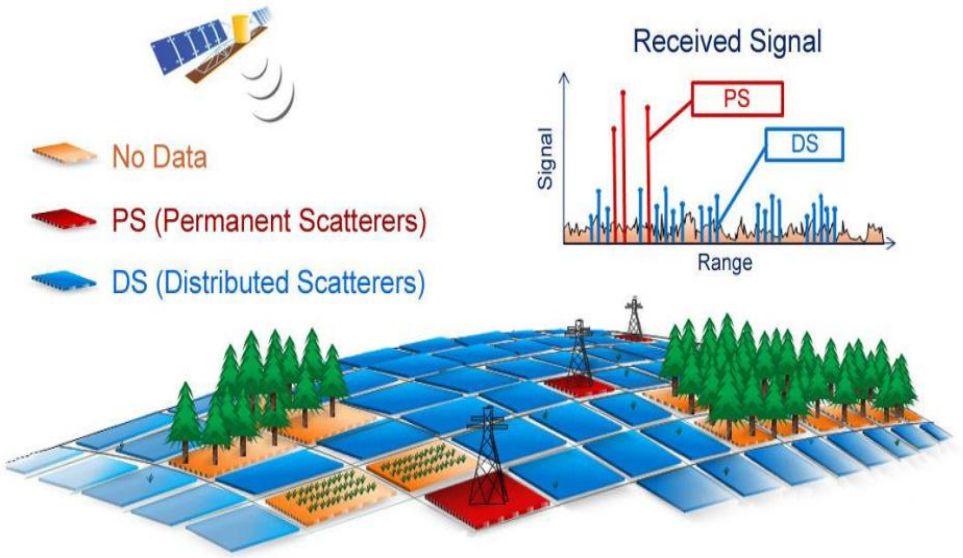


VSP survey photos, MRCSP East Bend Test, 2009

# Interferometric Synthetic Aperture Radar (InSAR)

**Expected outcome:**

- Evaluate applicability of technology
- Map $CO_2$ migration by measuring potential surface terrain deformatio
- Increased understanding of deployment of InSAR in vegetated terrain for $CO_2$ injection sites




Source: TRE

**Strategy:**

- Acquire satellite images before, during, and after injection for analysis using persistent scatter interferometry (PSI) techniques
- Assess historical deformations (e.g., between 1992 and 1999) to quantify background natural displacements and potential subsidence associated with oil extraction.
- Use artificial corner reflectors (**pending landowner permissions**) to mitigate for periods of snow coverage

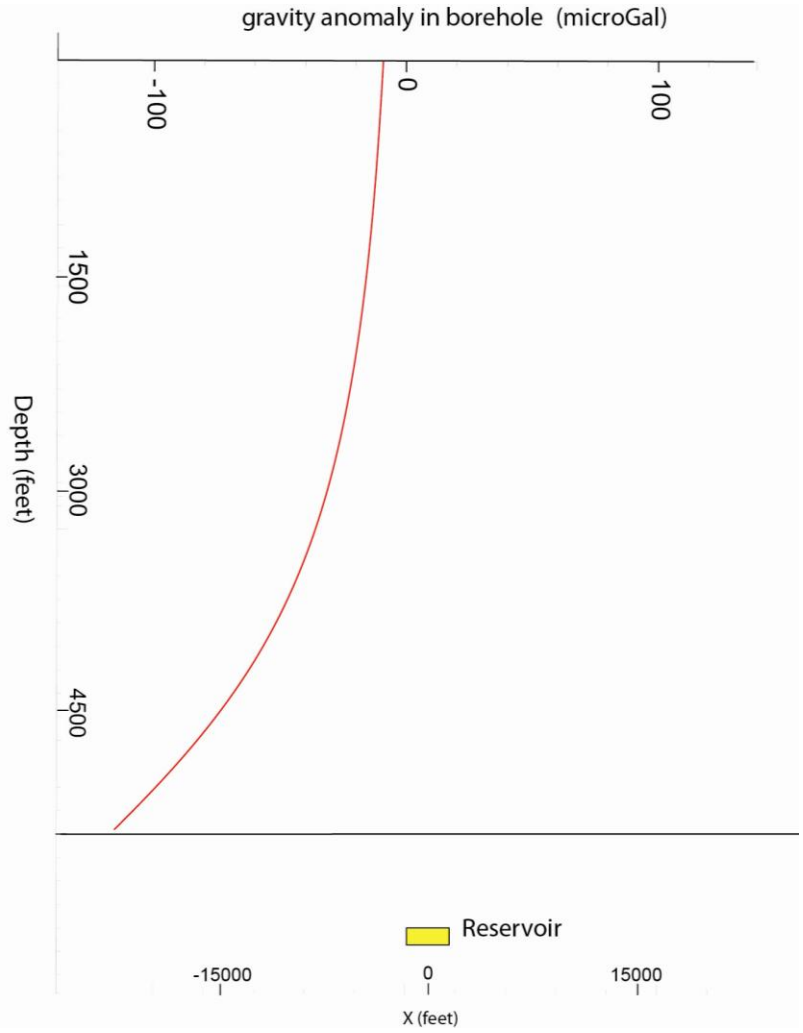
# Borehole Gravity Survey

## Expected Outcome:

- Density measurements of reservoir surrounding well
- Repeat survey useful to follow displacement of the $CO_2$ front

## Strategy:

- Use borehole gravity meter (feasibility assessment ruled out surface gravity method because gravity signal at the surface would not be detectable due to the low injection quantity of $CO_2$ and injection depth in the reef).
- Expected anomalies ~60 microgal and above with the instrument just above or in the reservoir
- Risk – Gravity response may be still below acceptable; need to extensive calibration




**Synthetic borehole for Dover 33- gravity anomaly *vs. depth after injection of 400,000 tons***

# Baseline Fluid and Gas Sampling

**Expected Outcome:**

- Provide data for:
  - calibrating transport models
  - identifying $CO_2$ breakthrough
  - identifying rock/$CO_2$/brine interactions.

**Strategy:**

- Monitoring for natural and/or induced tracers and other geochemical parameters
- Conduct base-line characterization: gas, brine, & solid (rock, oil)
- Characterize input $CO_2$ for chemistry (including nobles) and isotopes
- Collaborate with Ohio State Univ.
- Risk – Differentiating signals from past injection in Dover 33

**A number of physical and chemical changes in the reservoir will be monitored**

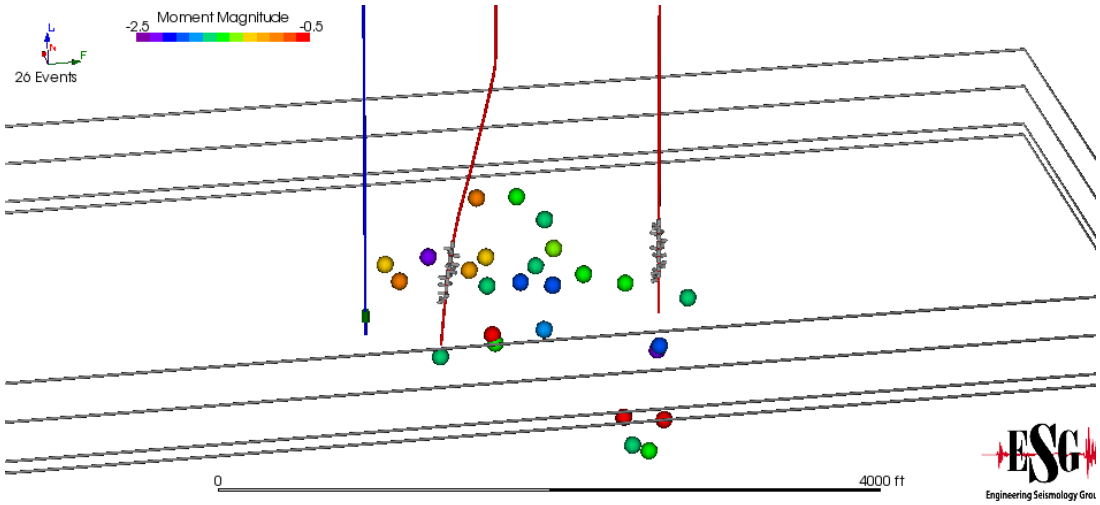
# Microseismic Monitoring

**Expected Outcome:**

- More detailed feasibility assessment of this method for future reefs

**Strategy:**

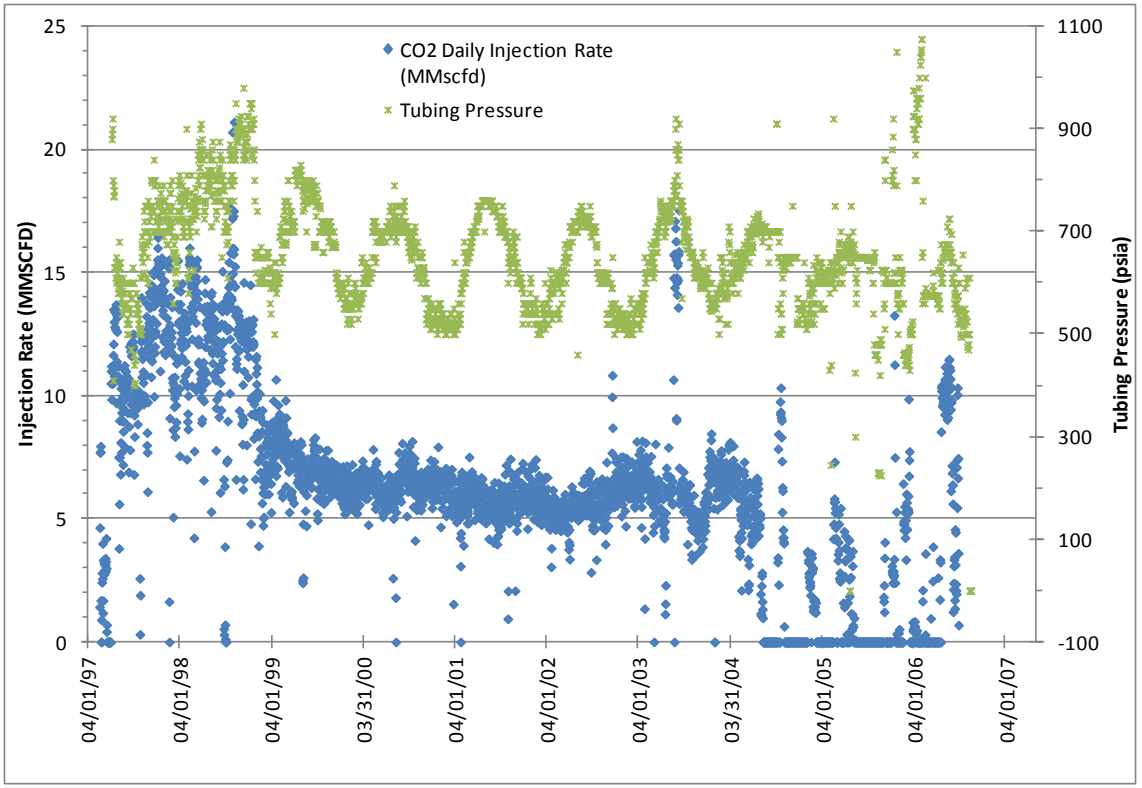
- Conduct brief monitoring in Dover 33 to help design more comprehensive plans for next reef for geomechanical changes during repressurization or $CO_2$ movement.




**Event triggers recorded during microseismic monitoring can provide both magnitude and location (in three dimensions) of each detected event**

# Evidence for Injectivity in Dover 33 Reef

- 10 year period of record (1997-2007) for Well 1-33
- Historical injection rates vary from ~6 to ~21 MMSCFD (~300 to 1,000 tonnes/day)
- Steady injection from 1997 thru late 2004, followed by a period of intermittent injection until early 2007.
- No injection since 2007, other than periodic short-term injections for performing maintenance checks.




Injection data for period of record: Well 1-33

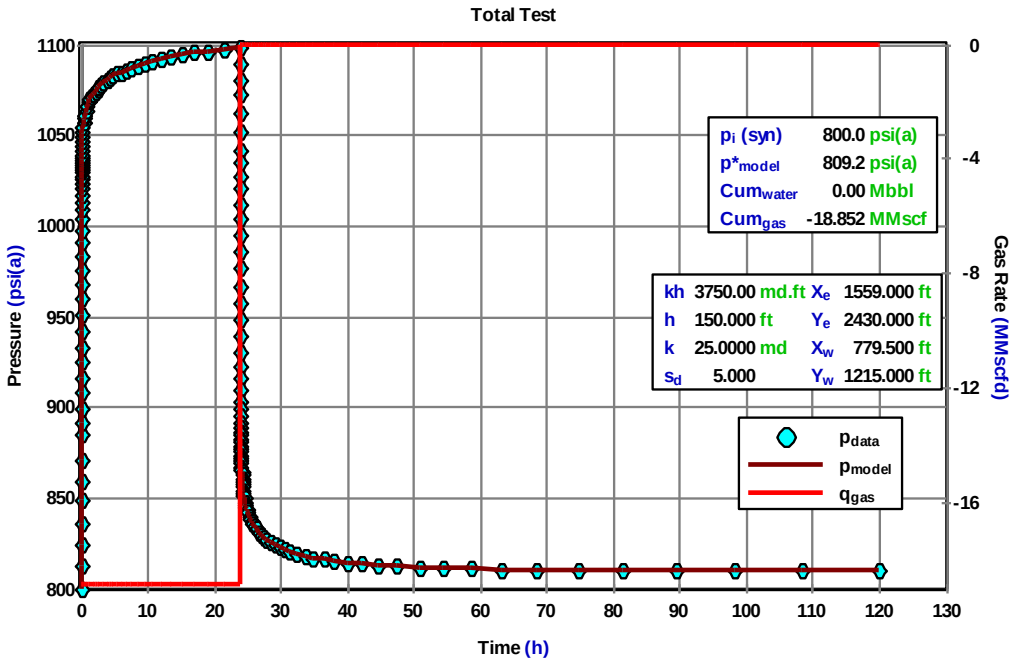
# Pre-Injection Reservoir Testing

**Expected Outcome:**

- Characterization of reservoir hydraulic properties needed to confirm injectivity.
- Results used to support numerical modeling and to aid the design of the long-term $CO_2$ injection.

**Strategy:**

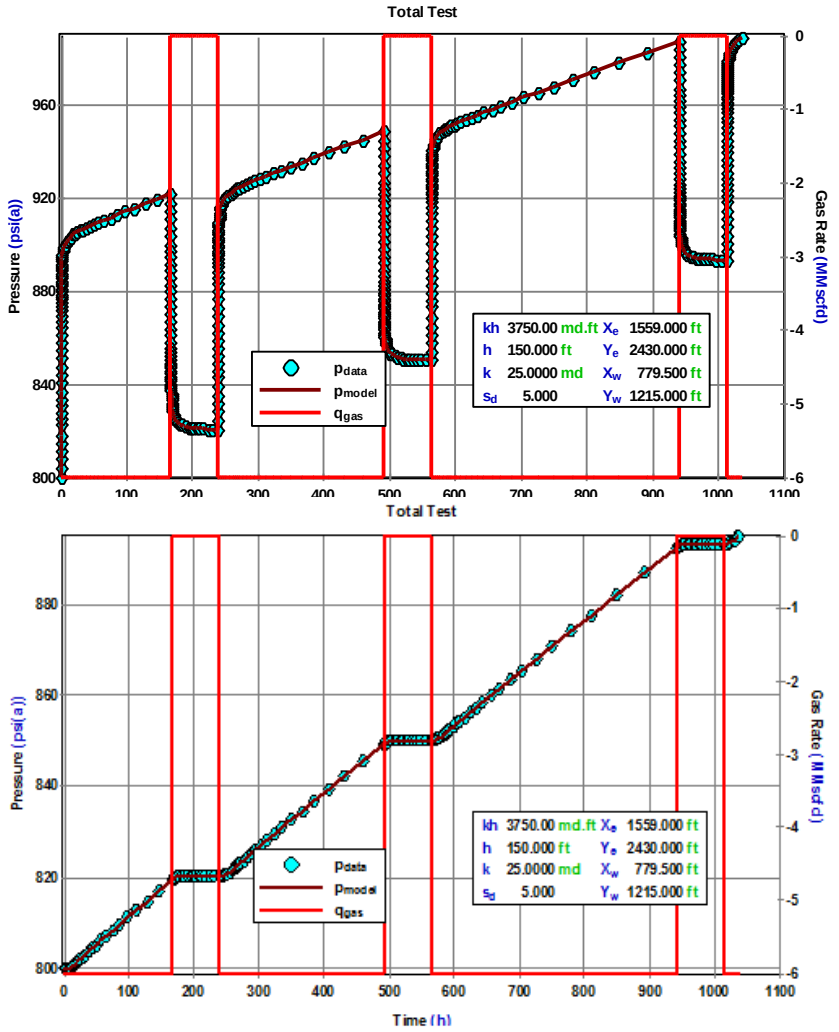
- Flow-meter logging test in the injection well using brine as the injection fluid; and, one or more short-term constant-rate injection/shut-in tests using $CO_2$ as the injection fluid.
- The flow-meter logging test will be completed prior to the $CO_2$ injection/shut-in test(s) to help design the injection/shut-in test(s).




**Anticipated pressure response in the injection well for a 24-hour injection of $CO_2$ at a rate of 1,000 tonnes/day, a reservoir permeability of 25 mD, and a 30%:40%:30% gas-oil-water reservoir saturation profile.**

# Evidence for Injectivity in Dover 33 Reef

- Design calculations were performed to estimate pressure response in the injection well (1-33) and the nearby observation well (5-33) for various short-term injection scenarios.
- This figure indicates a pressure increase of 200 psi in the injection well and 100 psi in the observation well after 3 injection/fall-off cycles of increasing duration at a rate of 318 tonnes/day, assuming reservoir permeability of 25 mD.




**Predicted Pressure Response at the Injection Well (top) and Observation Well (bottom) for Three Injection Cycles Separated by a 72-hour Recovery Period. Injection of gas @ 6 MMscfd (318 tonnes/day); k=25 mD; 30%:40%:30% gas-oil-water.**

# Dover 33 Static Earth Model (SEM) Development

## Level 1 SEM

- Geologic surfaces defined based on 3D seismic and well data
- Vertical layering represented by major geologic units (e.g., A-1 Carbonate, Brown Niagaran, Gray Niagaran)
- Layer-averaged porosity and permeability (permeability inferred from porosity and well testing)
- Oil-water contact (OWC)

### Key Data Needs

- New log data to define current OWC
- Permeability data

## Level 1A SEM

- Incorporate spatially varying porosity and permeability within the major geologic units
- Distributions constrained by geologic formation surfaces

### Key Data Needs

- Porosity/permeability spatial correlations

## Level 2 SEM

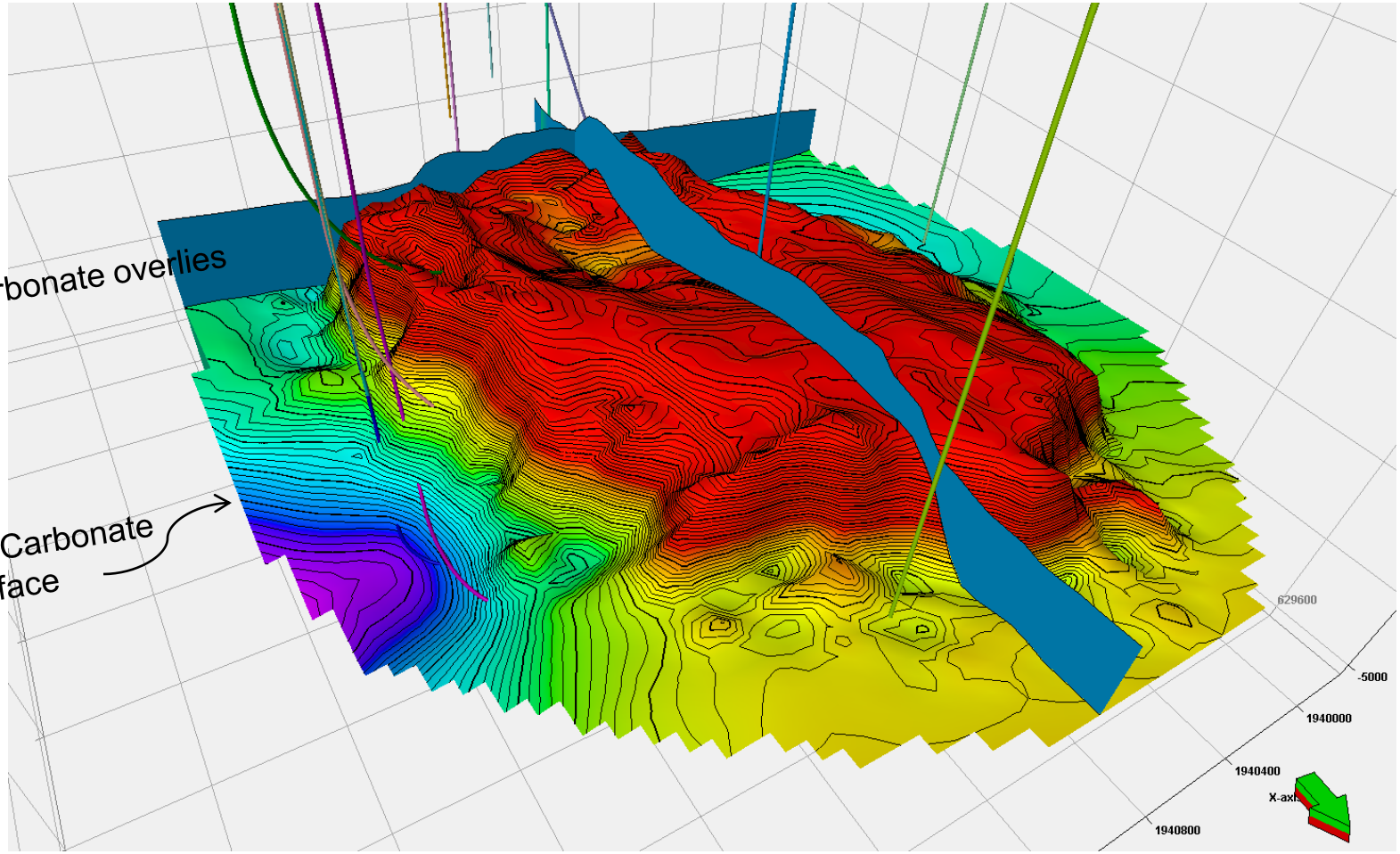
- Incorporate facies to further constrain porosity and permeability
- Geochemistry
- Geomechanics

### Key Data Needs

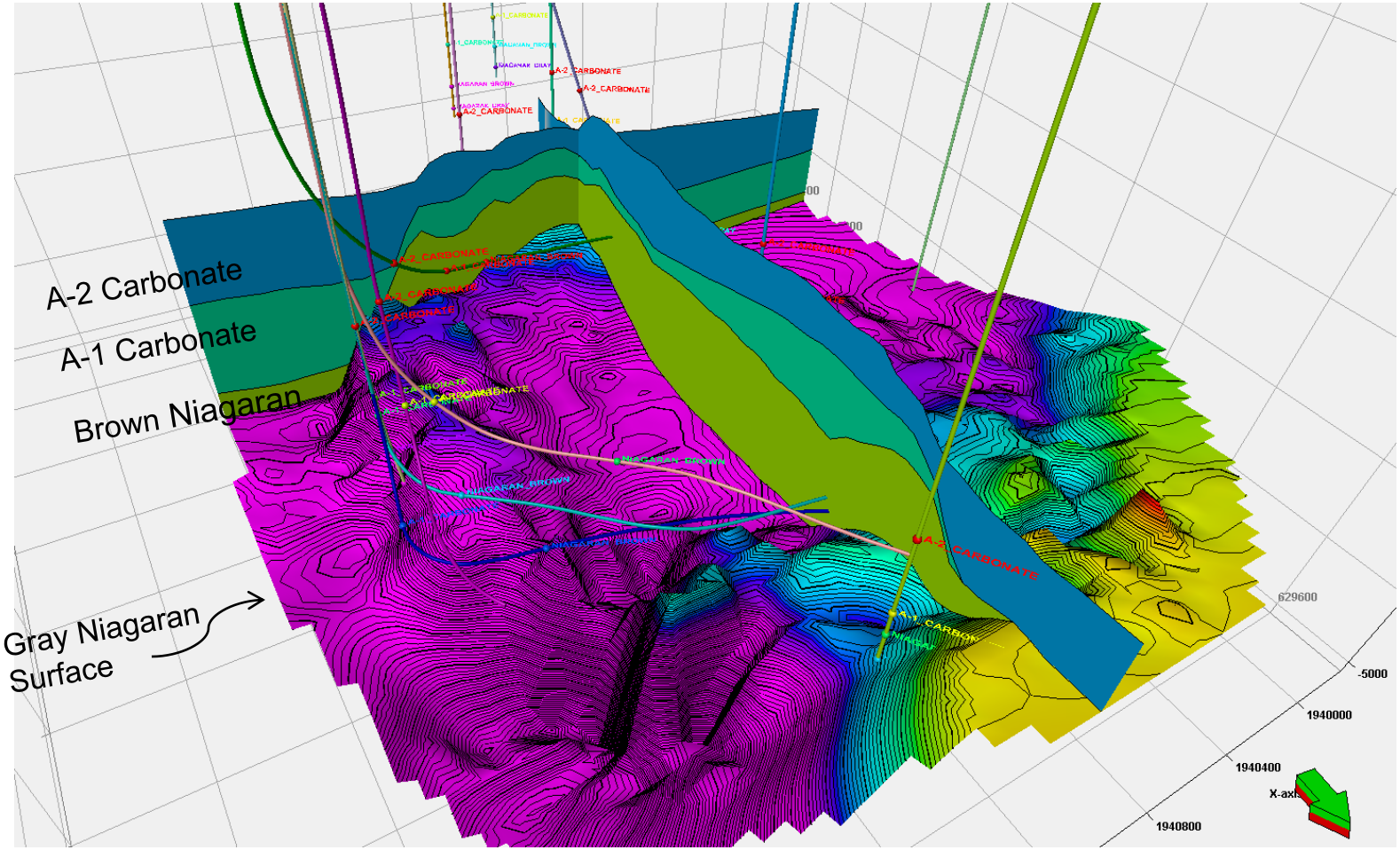
- Geologic facies
- Facies distribution
- Geochemistry data
- Geomechanical data

reservoir model complexity

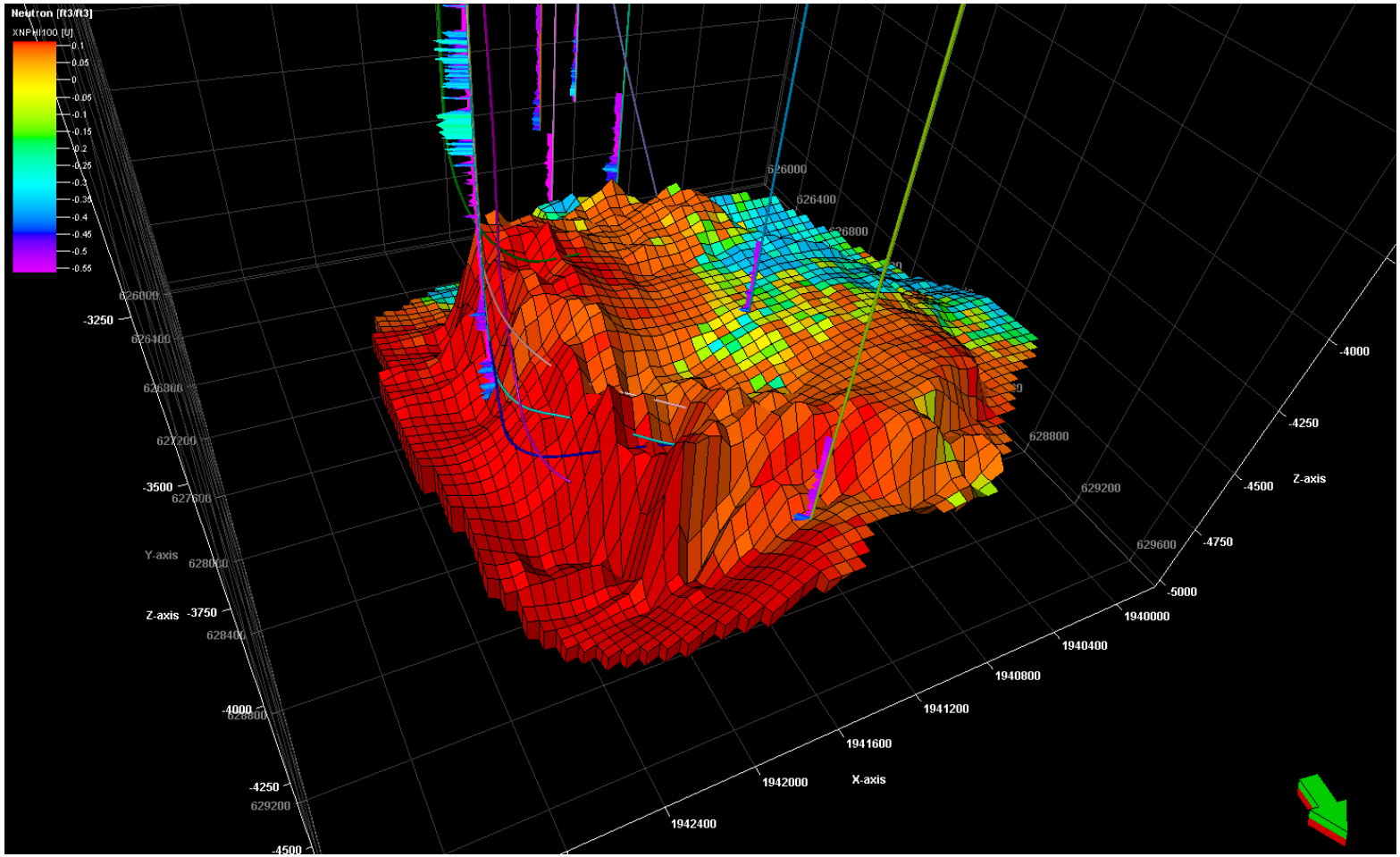
# Level 1 SEM Geologic Framework (Preliminary)
# Top of A-1 Carbonate Picked from 3-D Seismic Data



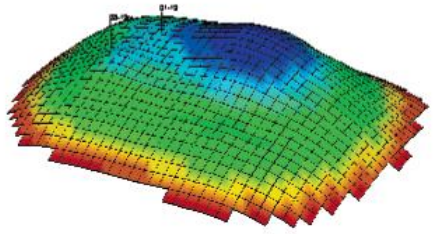
# Level 1 SEM Geologic Framework (Preliminary)
# Cut away through Dover 33 on Gray Niagaran Surface



# Example of Modeled Porosity in the Brown Niagaran in the Dover 33 Reef (Preliminary)



# Reservoir Simulations

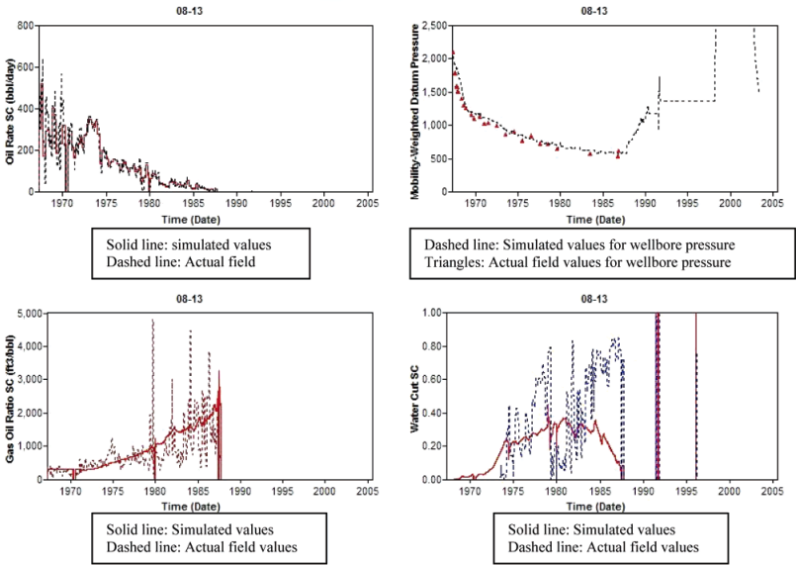


**Expected Outcome:**

- Full accounting for (1) reservoir geology and (2) compositional phase behavior

**Strategy:**

- **$CO_2$-Prophet** for initial simulations
- **GEM** (Computer Modeling Group) will used to model multiphase flows common to $CO_2$-EOR systems
- Requires detailed information about (1) rock / fluid properties and (2) production history
- Can be used for all phases of history matching (primary, $CO_2$-EOR, depleted), flood design and production forecasting
- Possible partial or full coupling of flow, geochemistry, and geomechanics



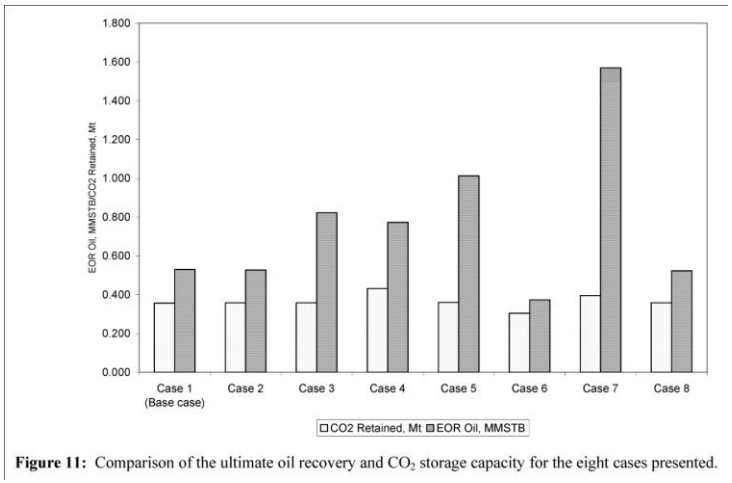



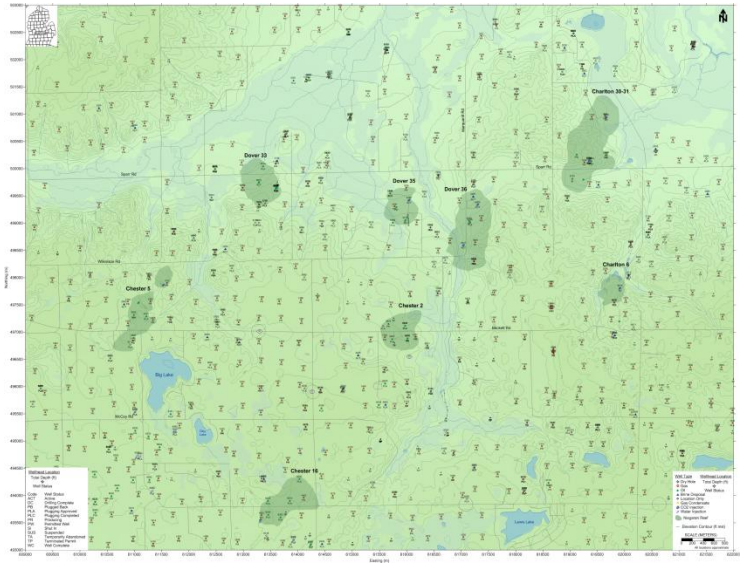

**Figure 11:** Comparison of the ultimate oil recovery and $CO_2$ storage capacity for the eight cases presented.

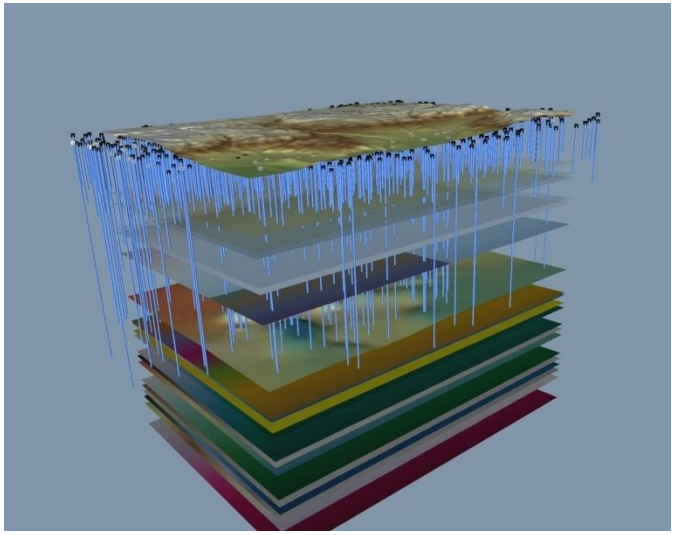
# Risk Screening for the MRCSP MI Basin Niagaran Reef Sites

- Preliminary risk screening completed for the MRCSP Phase III Michigan Basin Niagaran reef sites:
  - Features, Events, and Processes (FEP) performance and safety screening to identify possible risk items.
  - Risk pathway analysis to identify leakage pathways and other risk mechanisms to receptors in the area.
  - Initial risk matrix analysis.
- Conclusions
  - No FEP items significantly affect $CO_2$ storage project.
  - Existing plugged boreholes are a potential risk pathway present in the storage area;
- Dover 33 test will also provide valuable data for detailed risk assessment by MRCSP and others

# Risk Screening for the MRCSP MI Basin Niagaran Reef Sites

- Systematic survey of the site features to describe geologic setting, surface features, and risk pathways.
- **Well records** reviewed to identify all wells at the project sites, including active wells, abandoned wells, and groundwater wells.
- **Surface features** such as wetlands, streams, lakes, and other ecological areas will be mapped. Groundwater resources in the project area were catalogued.
- **Geologic setting** reviewed to identify confining layers, faults, fractures, and other features that may affect storage security. Geologic structures in the region were reviewed as they pertain to $CO_2$ migration and trapping.



# FEP Screening

- Few items were identified in the FEP screening, mainly due to the previous EOR work completed in the reefs.
- The main risk items were related to the fluid/gas composition in the reefs and boreholes in the area.

| Description | Rating |
|---|---|
| *Assessment Basis* | |
| Purpose of the assessment | + |
| Endpoints of Interest | + |
| Spatial Domain of Interest | + |
| Timescale of Interest | + |
| Sequestration Assumptions | + |
| Future Human Action Assumptions | + |
| Legal and Regulatory Framework | + |
| Model and Date Issues | + |
| *Geological Factors* | |
| Neotectonics | + |
| Volcanic and Magmatic Activity | + |
| Seismicity | + |
| Hydrothermal Activity | + |
| Hydrological and Hydrogeological Response | + |
| Large Scale Erosion | + |
| Bolide Impact | + |
| *Climatic Factors* | |
| Global Climate Change | + |
| Regional and Local Climate Change | + |
| Sea Level Change | + |
| Periglacial Effects | + |
| Glacial and ice sheets effects | + |
| Warm Climate Effects | + |
| Hydrological and Hydrogeological Response | + |
| Responses to Climate Changes | + |
| *Future Human Actions* | |
| Human Influences on Climate | + |
| Motivation and Knowledge Issues | + |
| Social and Institutional Developments | + |
| Technological Developments | + |
| Drilling Activities | + |
| Mining and other underground activities | + |
| Human Activities in the surface Environmen | + |
| Water Management | + |
| CO2 presence influencing future operations | + |
| Explosions and crashes | + |
| *CO2 Storage Pre-Closure* | |
| Storage Concept | + |
| CO2 quantities, injection rate | + |
| CO2 composition | + |
| Microbiological Contamination | + |
| Schedule and Planning | + |
| Pre-closure administrative control | + |
| Pre-closure monitoring of storage | + |
| Quality Control | + |
| Accidents and unplanned events | + |
| Over-pressuring | + |
| *CO2 Storage Post-Closure* | |
| Post-closure administrative control | + |
| Post-closure monitoring of storage | + |
| Records and markers | + |
| Reversibility | + |
| Remedial Actions | + |
| *CO2 Properties* | |
| Physical Properties of CO2 | + |
| CO2 phase behavior | + |
| CO2 solubility and aqueous speciation | + |

| Description | Rating |
|---|---|
| *CO2 Interactions* | |
| Effects of Pressurisation of reservoir on cap | + |
| Effects of Pressurization on reservoir fluids | + |
| Interaction with Hydrocarbons | + |
| Displacement of saline formation fluids | + |
| Mechanical Processes and conditions | + |
| Induced seismicity | + |
| Subsidence or uplift | + |
| Thermal effects on injection point | + |
| Water Chemistry | + |
| Interaction of CO2 with chemical barriers | + |
| Sorption and Desorption of CO2 | + |
| Heavy metal release | + |
| Mineral phase | + |
| Gas Chemistry | +++ |
| Gas Stripping | +++ |
| Gas Hydrates | + |
| Biogeochemistry | + |
| Microbial Processes | + |
| Biomass Uptake of CO2 | + |
| *CO2 Transport* | |
| Advection of free CO2 | + |
| Buoyancy-driven flow | + |
| Displacement of formation fluids | + |
| Dissolution in formation fluids | + |
| Water mediated transport | + |
| CO2 release processes | + |
| Co-migration of other gases | + |
| *Geology* | |
| Geographical Location | + |
| Natural Resources | +++ |
| Reservoir Type | + |
| Reservoir geometry | + |
| Reservoir exploitation | +++ |
| Cap rock or sealing formation | + |
| Additional Seals | ++ |
| Lithology | ++ |
| Unconformities | ++ |
| Heterogeneities | ++ |
| Faults and Fractures | + |
| Undetected features | + |
| Vertical Geothermal Gradient | + |
| Formation Pressure | + |
| Stress and Mechanical Properties | ++ |
| Petrophysical Properties | ++ |
| *Fluids* | |
| Fluid Properties | +++ |
| Hydrogeology | + |
| Hydrocarbons | + |
| *Drilling and Completion* | |
| Formation Damage | + |
| Well lining and completion | +++ |
| Workover | + |
| Monitoring wells | + |
| Well Records | + |
| *Borehole Seals and Abandonments* | |
| Closure and Sealing of Boreholes | +++ |
| Seal Failure | ++ |
| Blowouts | + |
| Orphan wells | ++ |
| Soil Creep around Boreholes | + |

| Description | Rating |
|---|---|
| *Terrestrial Environment* | |
| Topography and Morphology | + |
| Soils and Sediments | + |
| Erosion and Deposition | + |
| Atmosphere and meterology | + |
| Hydrological regime and water balance | ++ |
| Near-surface aquifers and surface water bo | + |
| Terrestrial Flora and Fauna | + |
| Terrestrial Ecological Systems | + |
| *Marine Environment* | |
| Coastal Features | + |
| Local Oceanography | + |
| Marine Sediments | + |
| Marine flora and fauna | + |
| Marine ecological systems | + |
| *Human Behavior* | |
| Human Characteristics | + |
| Diet and Food Processing | + |
| Lifestyles | + |
| Land and water Use | + |
| Community Characteristics | + |
| Buildings | + |
| System Performance | |
| Loss of Containment | + |
| *Impacts on the Physical Environment* | |
| Contamination of Groundwater | + |
| Impacts on soils and sediments | + |
| Release to the atmosphere | + |
| Impacts on exploitation of natural resources | + |
| Modified Hydrology and Hydrogeology | + |
| Modified Geochemistry | + |
| Modified Seismicity | + |
| Modified Surface Topography | + |
| *Impacts on Flora and Fauna* | |
| Asphyxlation effects | + |
| Effect of CO2 on plants and algae | + |
| Ecotoxicology of contaminants | + |
| Ecological Effects | + |
| Modification of microbiological systems | + |
| *Impacts on Humans* | |
| Health Effects of CO2 | + |
| Toxicity of Contaminants | + |
| Impacts from Physical Disruption | + |
| Impacts from Ecological Modification | + |

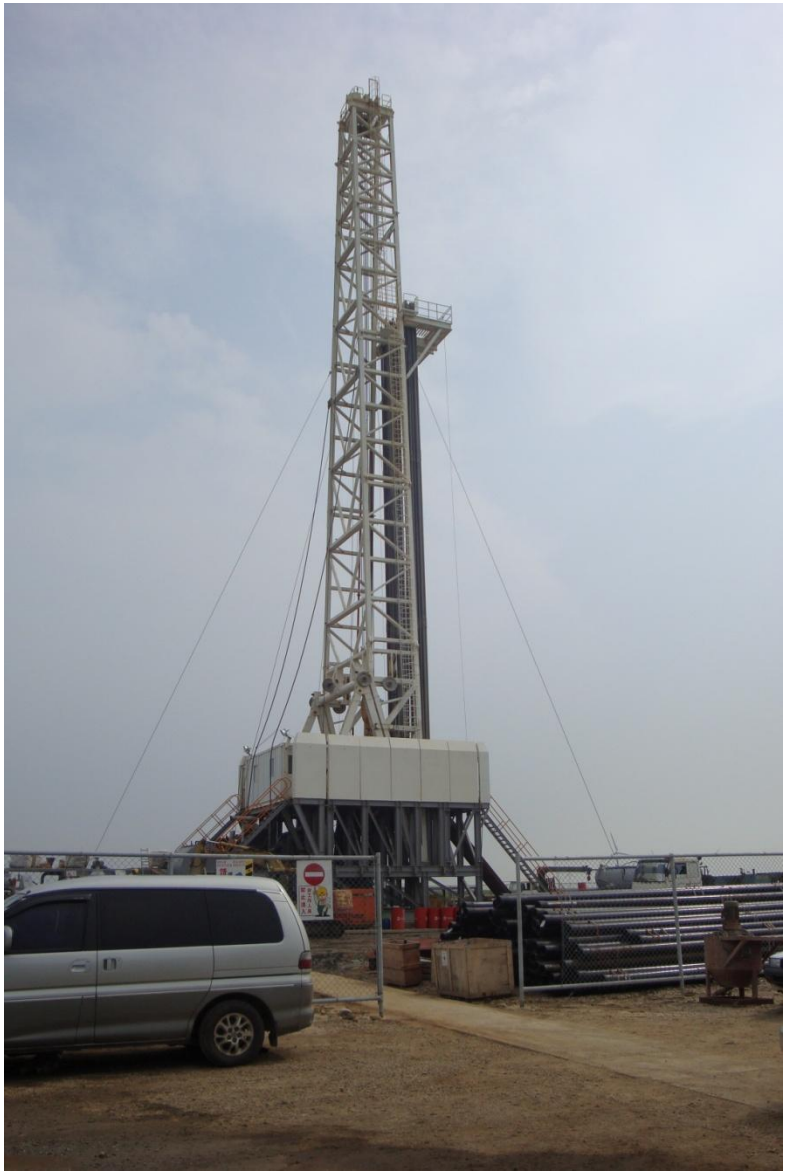
| Likelihood | Rating |
|---|---|
| Improbable | + |
| Unlikely | ++ |
| Possible | +++ |
| Likely | ++++ |
| Probable | +++++ |

# MRCSP Outreach Activities

- **Support the large volume injection test**
- **Maintain reputation of MRCSP** as a neutral and credible source of scientific information on CCUS
  - Over 20 Topical Reports available
  - Over 30 Presentations and Briefings available on MRCSP Website
- **Improve public understanding** and acceptance of carbon capture, utilization, and sequestration
  - Hosting site visits for key groups and local officials
- **Increase public understanding** of enhanced oil recovery, subsurface activities, and their role in the larger energy mix
  - Speaking at conferences and meeting with trade associations

# MRCSP Partner Outreach

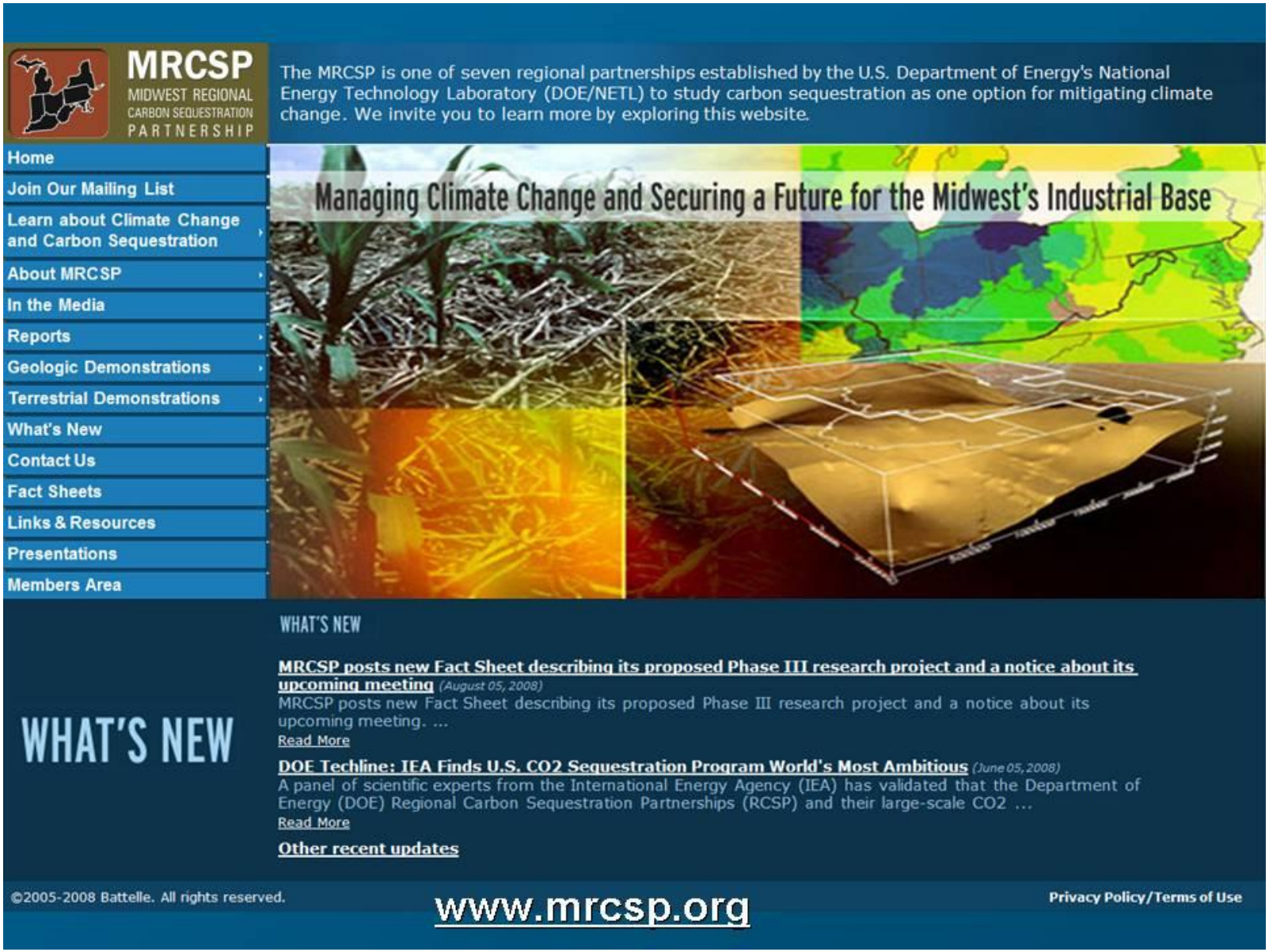
- Taiwan Power – Sino-Tech Visit, August 2012
- Technical Transfer
- Drilling site visit

# MRCSP Accomplishments to Date

- Successfully completed Phase I (Sources and Sinks) and Phase II (Small Scale Field Tests)
- Finalized plans for redesigned Phase III Large Scale Injection Tests in Northern Michigan:
  - Site agreements with Core Energy LLC, an EOR operator, to use existing infrastructure and $CO_2$ delivery operations.
  - NEPA Categorical Exclusions approved
  - Site Characterization Workplan approved
  - Vendor selection completed
  - Static model development started
  - Workplans for active and new reefs under development
- Working on getting nine state geology team under subcontract for the Phase III activities.

# Visit MRCSP.ORG



# APPENDICES

PROJECT ORGANIZATION CHART

PROJECT SCHEDULE

BIBLIOGRAPHY

# MRCSP Organization Chart

# Bibliography