Midwest Regional Carbon Sequestration Partnership

DOE/NETL cooperative agreement # DE-FC26-05NT42589

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U.S. Department of Energy
National Energy Technology Laboratory
Mastering the Subsurface Through Technology Innovation, Partnerships and Collaboration:
Carbon Storage and Oil and Natural Gas Technologies Review Meeting
August 1-3, 2017

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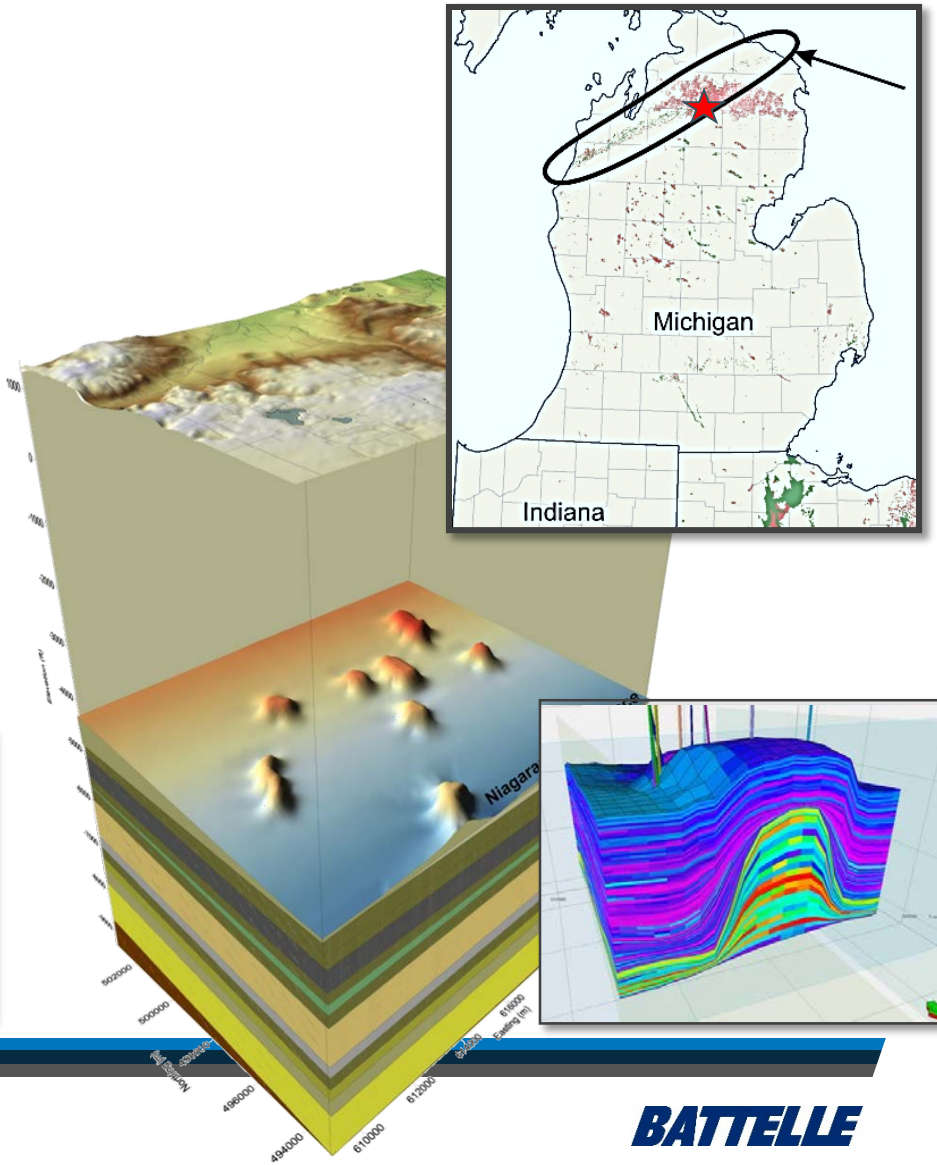
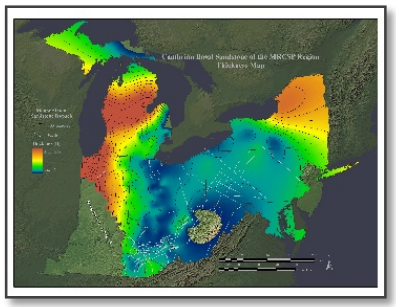
Presentation Outline

- Technical Status
- Accomplishments
- Lessons Learned
- Synergy Opportunities
- Project Summary and Overview





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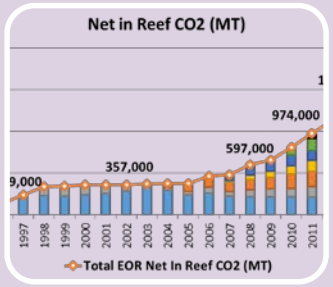
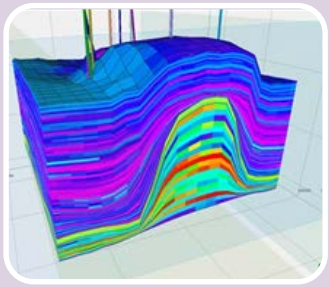
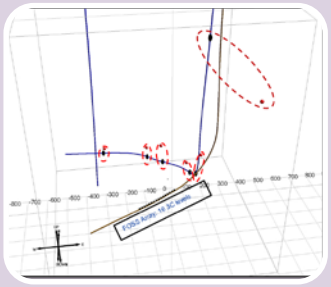
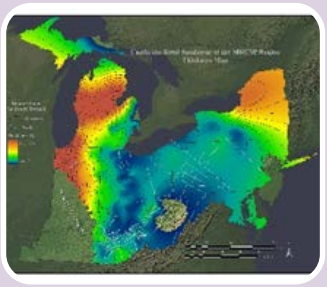
Technical Status

Technical updates grouped into five categories









1	2	3	4	5
Injection Test	Modeling	Monitoring	Regional Characterization	Outreach

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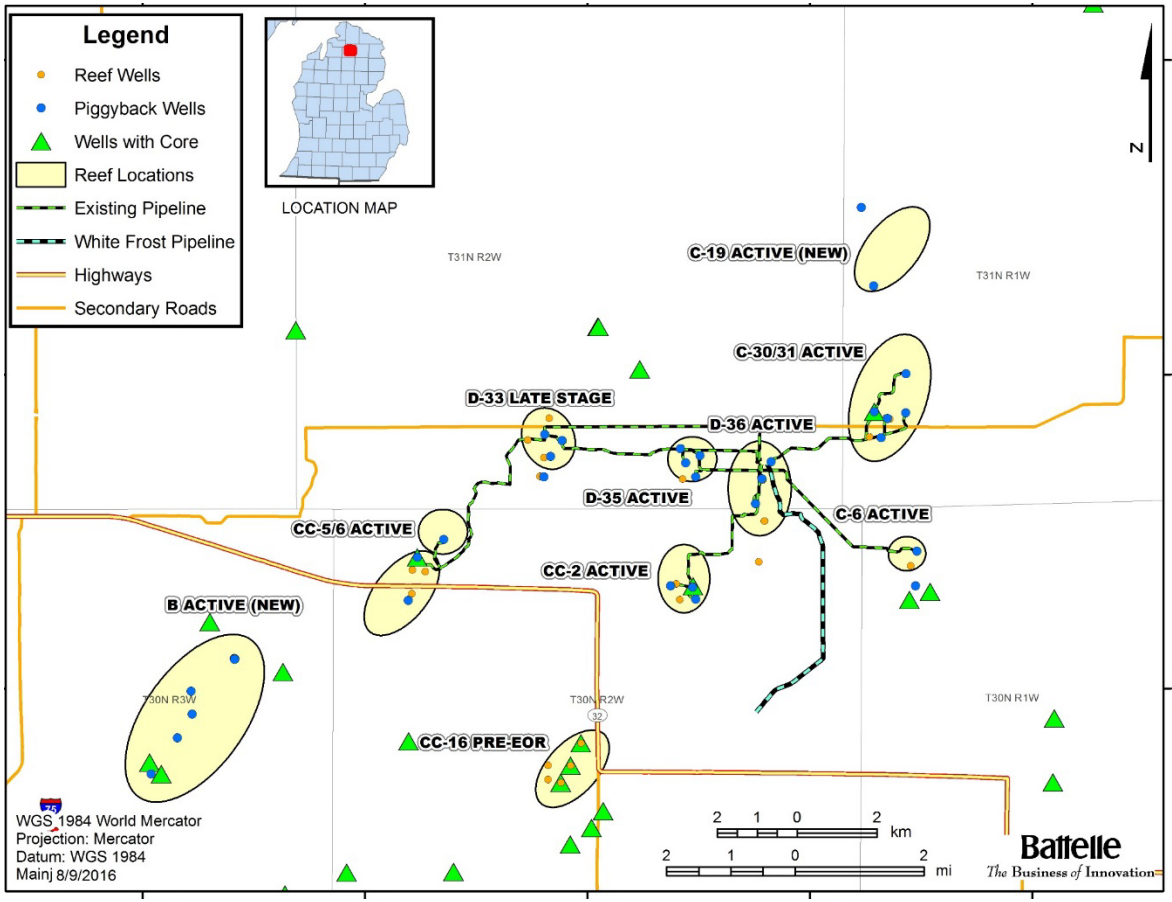
Accounting for CO_2 Mass Balance

- 10 reefs in Northern Michigan [Otsego County] in various stages of EOR
- EOR still ongoing, with a new reef (CC-16) added
- ~780K tonnes net injection



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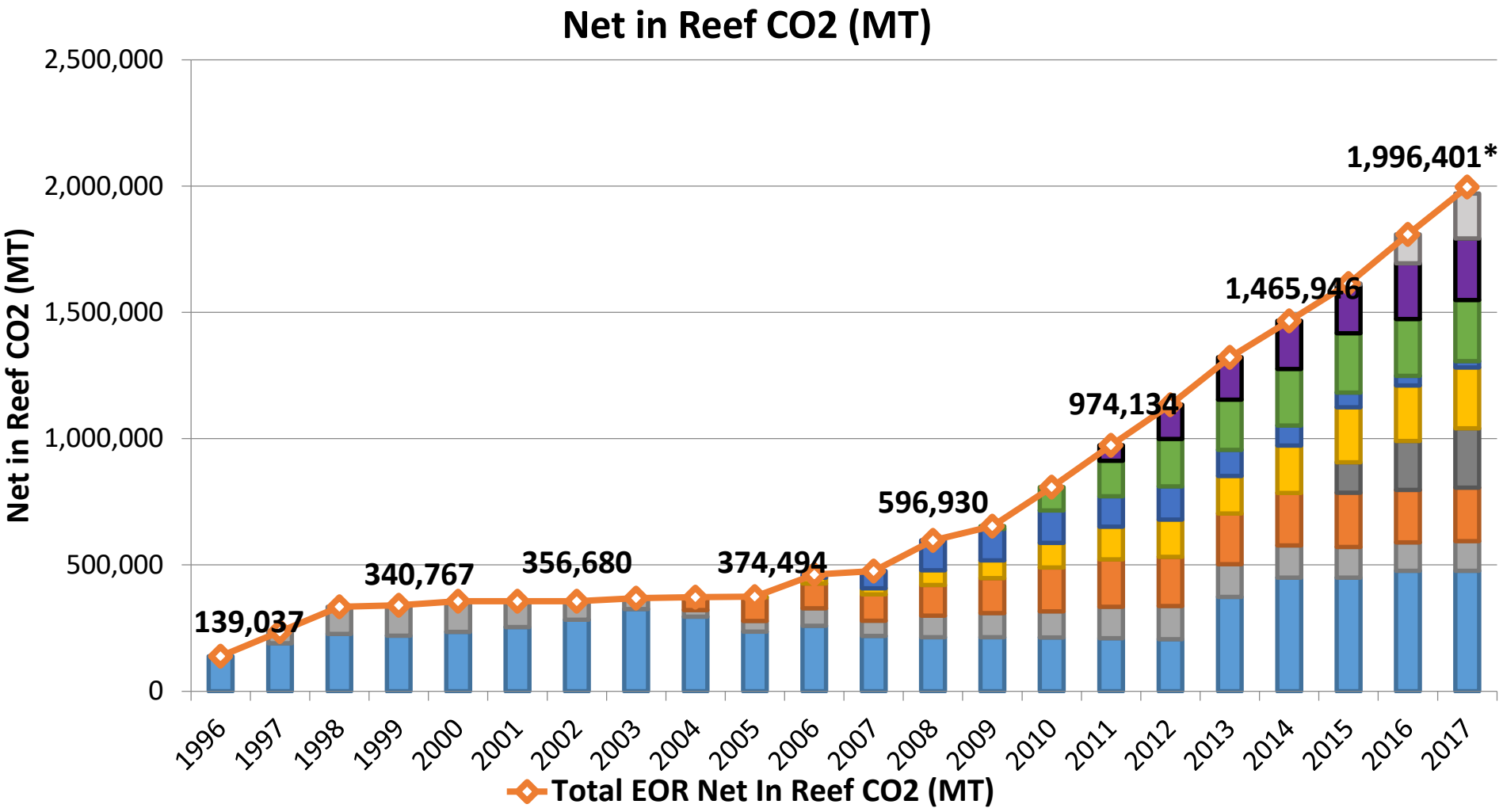
Cumulative Storage Assessment



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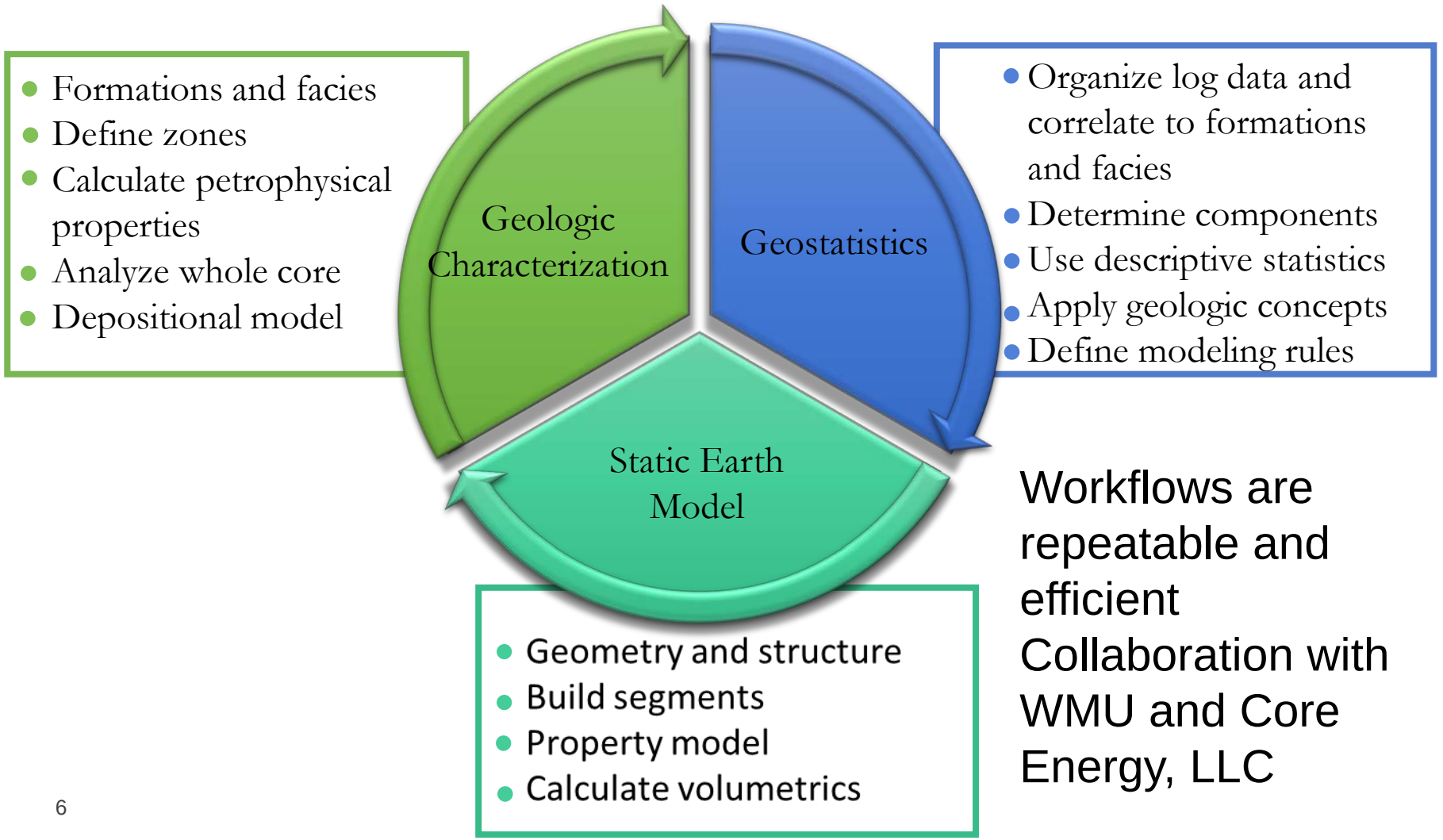
Modeling- geologic and static earth models

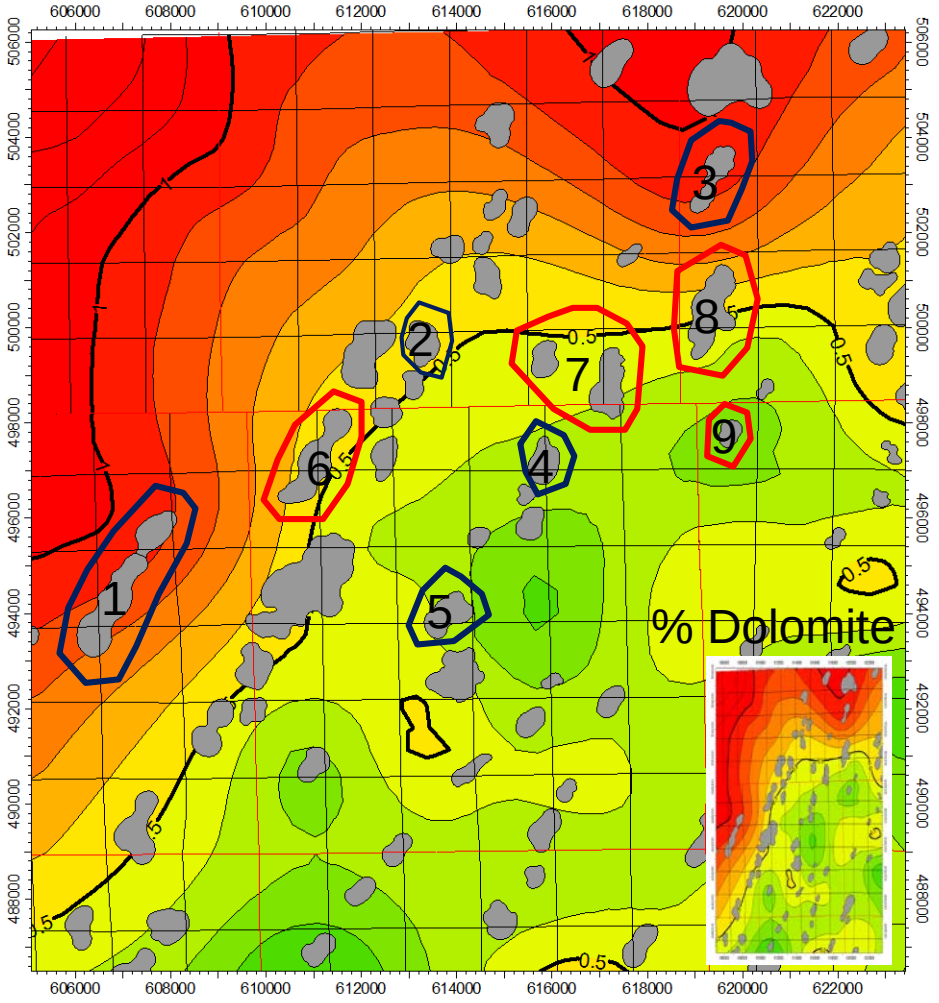
- Developed approach to integrate data and to simplify SEMs



Workflows are repeatable and efficient
Collaboration with WMU and Core Energy, LLC

Modeling- geologic and static earth models

- Niagaran reefs effectively used for EOR
- Diverse geology of reefs makes characterization and SEMs challenging
- Key issues include:
  - Limestone vs dolomite
  - Salt plugging
  - Multi-pods
  - Diagenesis
  - Data availability
  - Geologic heterogeneity



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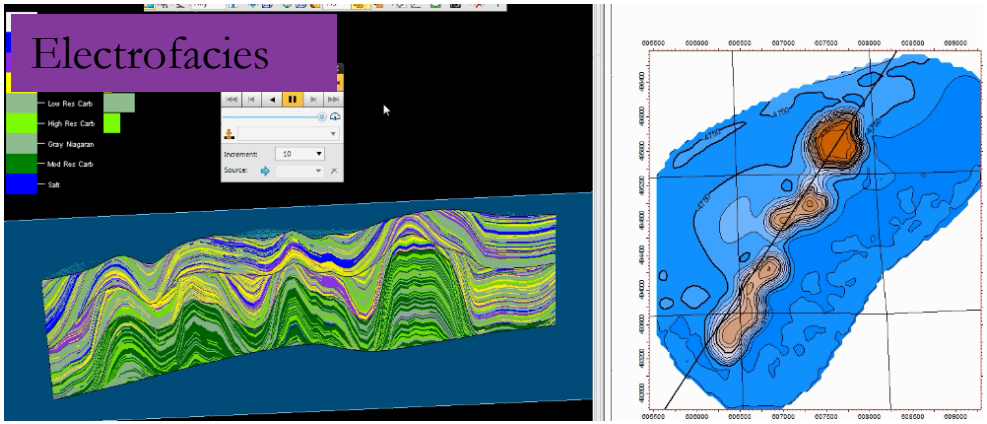
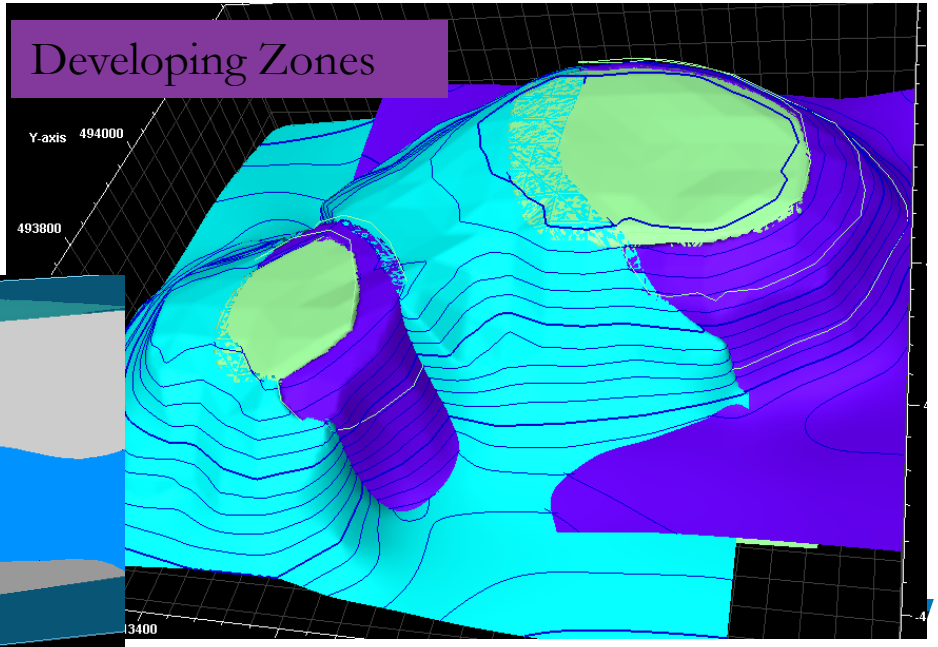
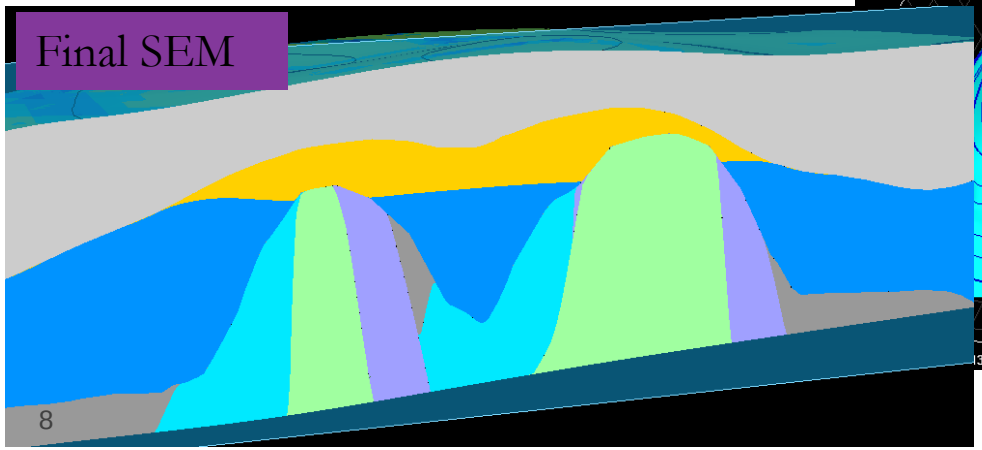
Modeling- static earth models

- Salt plugging can be extensive and traceable
- Definition of reef geometry with 3D seismic is critical
- Geostatistics can assist with modeling decisions and be used to predict electrofacies
- Increased dolomitization often leads to better quality reservoirs
- **Geologic conceptual model important to establish pre-SEM**







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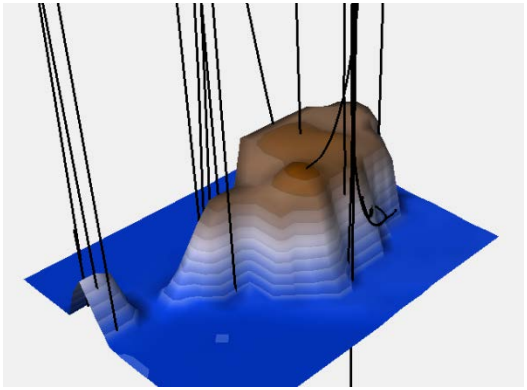
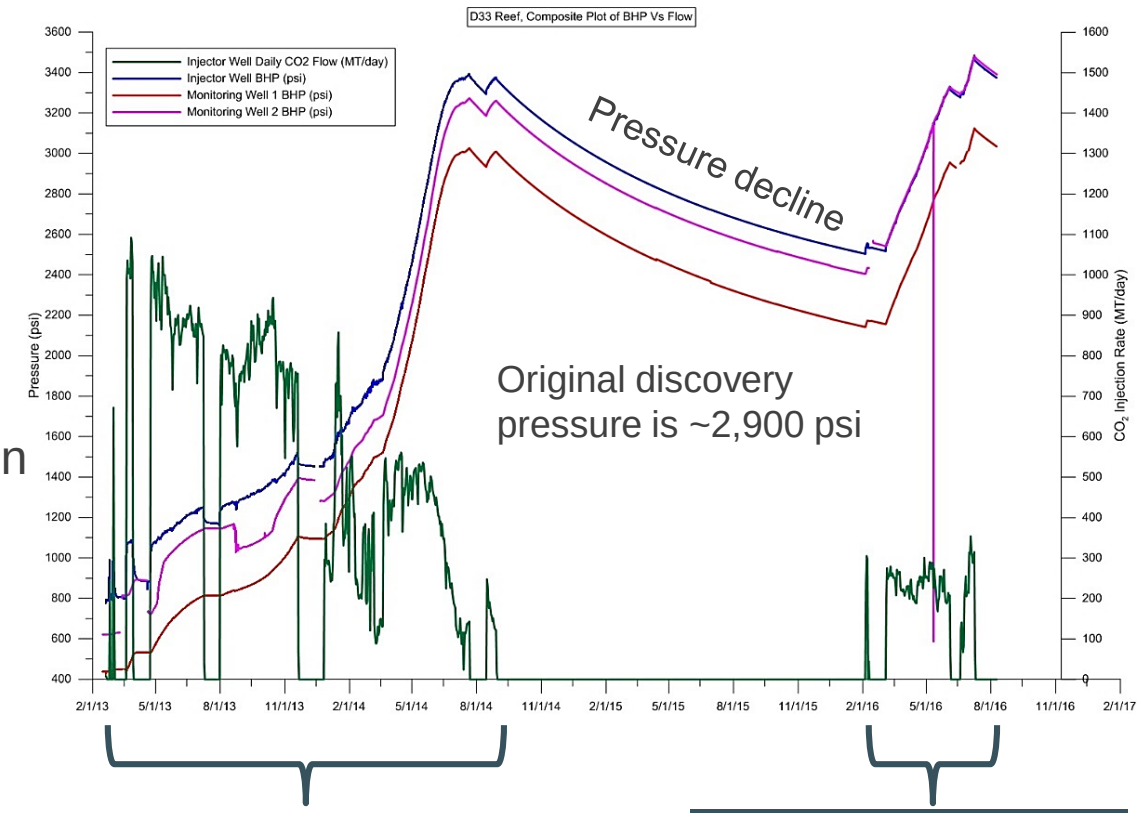
Modeling- pressure response in late-stage reef

- MRCSP injection followed past EOR and several years in “dormant” status
- Steepening of pressure curve observed part way through injection period
- Pressure in all 3 wells declined continuously after halting injection in Sept. 2014



Study Reef (right) and Annex (left)

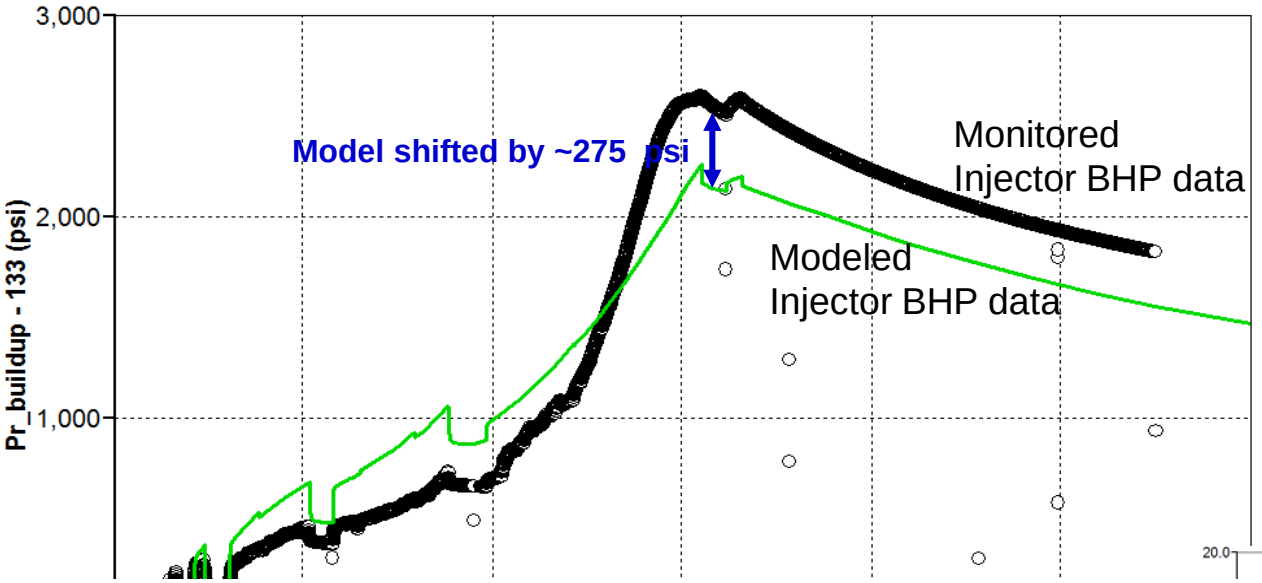


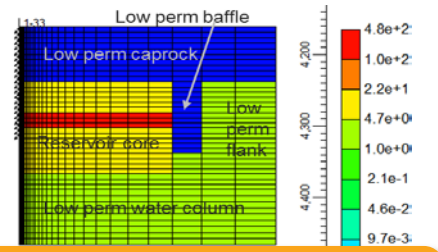
Main CO_2 Injection Period ~250,000 tonnes CO_2 injected

Microseismic Monitoring Test ~15,000 tonnes CO_2 injected

Modeling- dynamic modeling

Validating Injection Phase Pressure Buildup in Late-Stage Reef

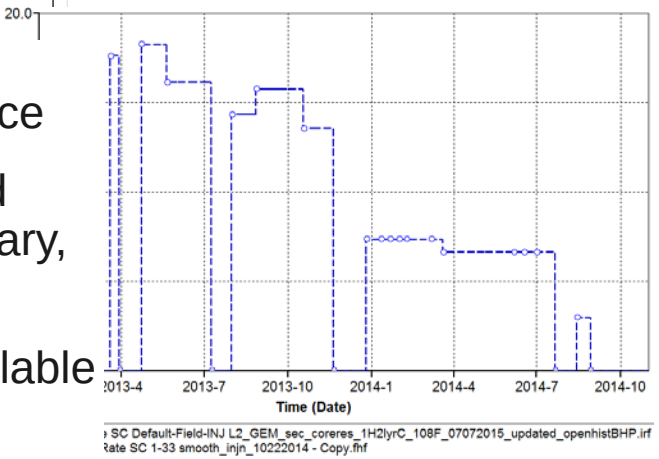




Equivalent Radial Single-well CMG-GEM® Model

Simpler Zonation, Simpler Geometry
MRCSP Injection Modeled

CO_2 Injection Schedule



- Alternative reef model conceptualizations with simpler zonation, simpler geometry for computational convenience
- Model CO_2 injector pressure response predictions tested successfully with mini (3day)- injection test during February, 2016
- Investigation of saturation-associated constraints to available pore-volume in progress to improve model match

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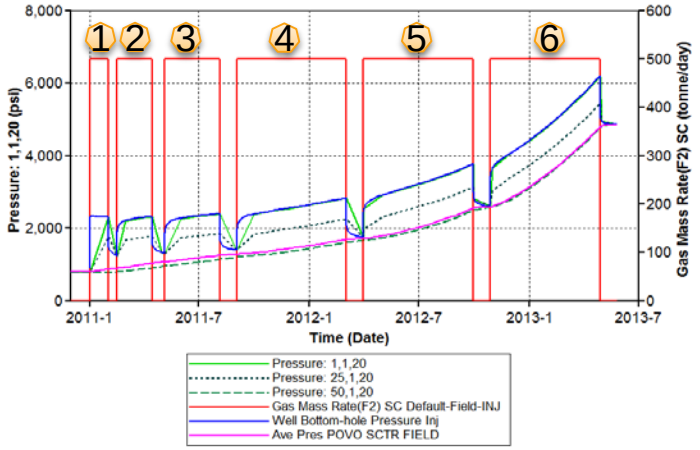
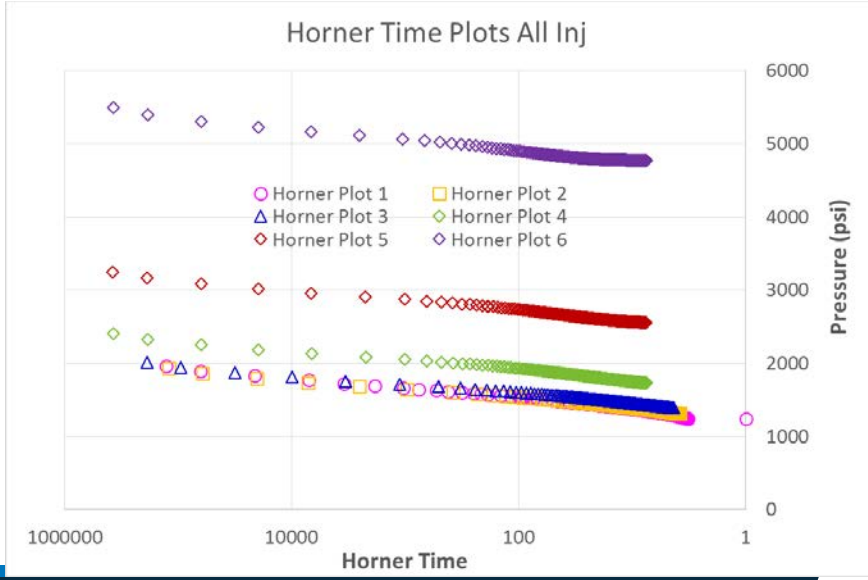
Modeling - Synthetic Models

Using known numerical models representing typical depleted reef reservoir with simulated primary production followed by CO_2 injection

- Synthetic datasets from analyzing injection well response to CO_2 injection:
  - Pressure falloff data ⇨ Horner analysis
    - To estimate reservoir properties and identify boundaries
  - Injectivity index
    - Commonly-used oil-field metric of well performance
- [Q] What to expect in a multiphase environment?



Upward shift in time-lapse Horner plots → boundary effects



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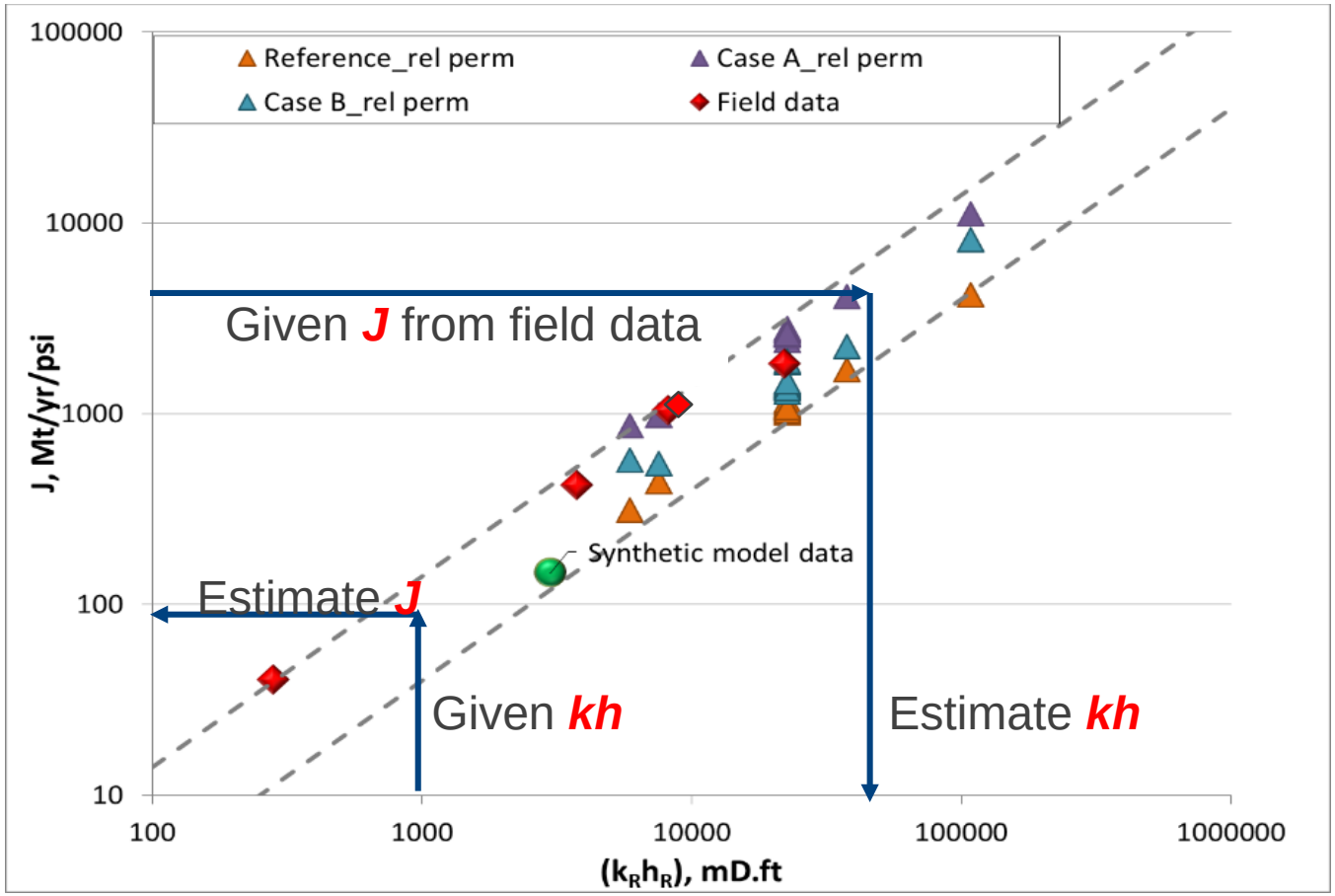
Modeling - Injectivity Index

MRCSP and other field and synthetic model data **show** correlation of injectivity index with transmissivity



Modeling- dynamic modeling key points

Learning from Synthetic Models

Pressure fall-off tests analyses

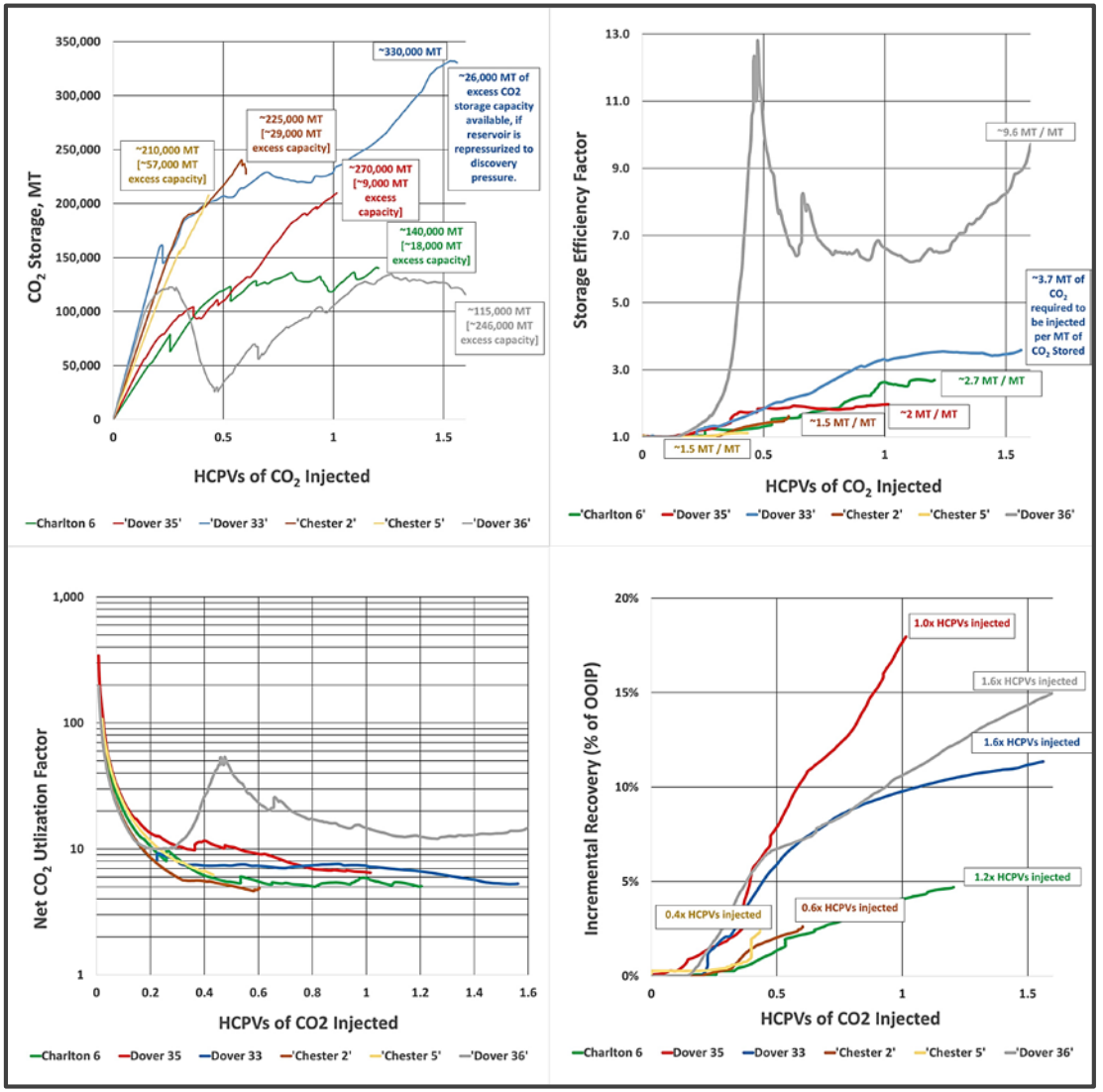
- Inner zone total mobility (permeability divided by viscosity) related to gas-phase mobility in the vicinity of CO_2 front
- Outer zone total mobility related to oil-phase mobility in the undisturbed reservoir
- Cannot determine absolute permeability from mobility, due to complex unknown multiphase viscosity

Injectivity analyses

- Injectivity index behavior during transient and boundary dominated periods different
- Empirical correlation found between injectivity and permeability-thickness product (helpful for screening analysis and quick-look estimation of absolute permeability)

Performance Metrics Dashboard

- 4-panel dashboard used to compare storage and recovery performance across all reefs
- Normalized to %HCPV (hydrocarbon pore volume) injected
- After CO_2-EOR, around ~45% of oil still remains unrecovered in the reservoirs
- D-35 is the best performing reef by oil recovery performance, and likely will have most incidental CO_2-storage at the end of CO_2-EOR



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Monitoring- late stage reef

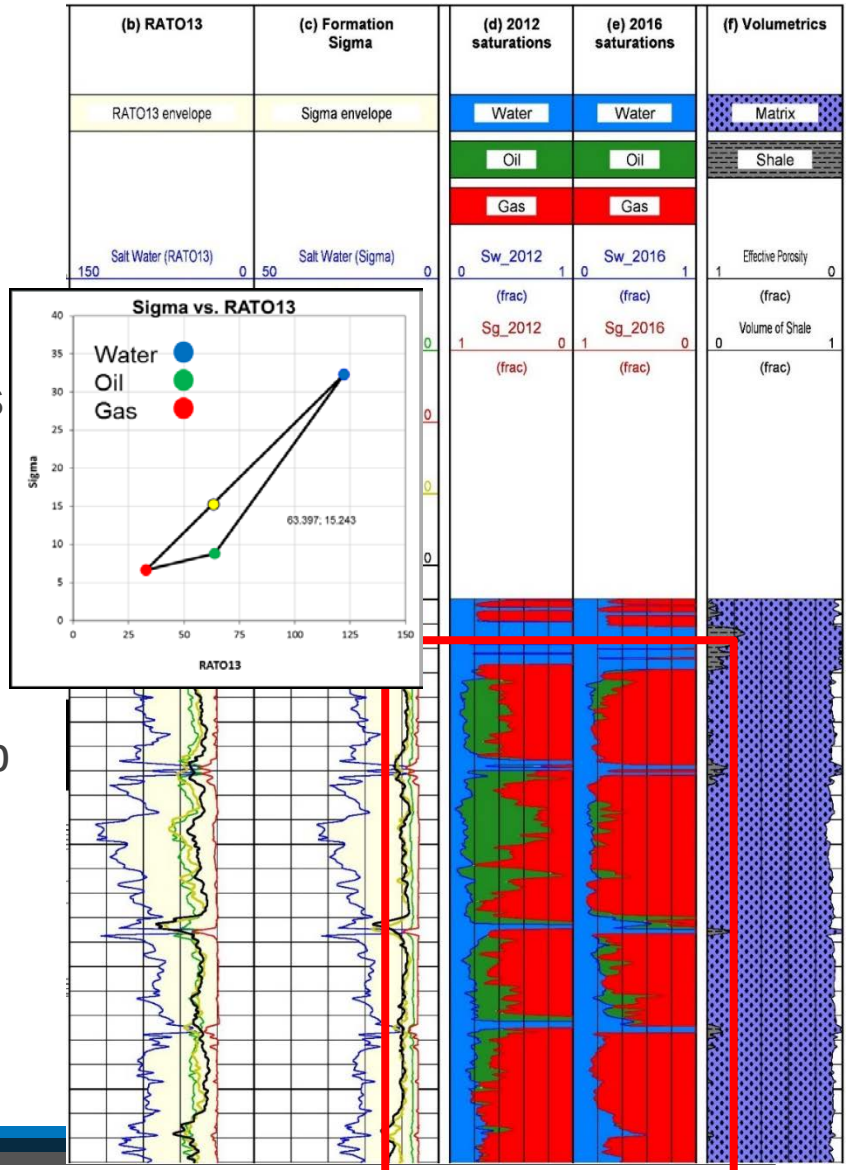
All primary field activities completed- data analysis underway

Activity	Before Injection	Early Injection	Mid Injection	Late Injection	After Injection
CO_2 flow accounting		X	X	X	Ongoing
Pressure and temperature	X	X	X	X	Ongoing
PNC logging	X		X		Complete
Borehole gravity	X				Complete
Fluid sampling	X		X		X
Vertical seismic profile	X				Complete
Microseismic	X			X	Complete
InSAR (Satellite radar)	X	X	X	Complete	
Characterization Well Drilling					Complete

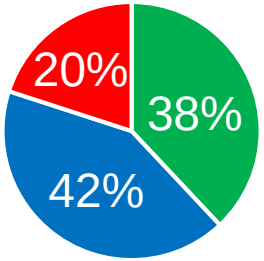
Monitoring- pulsed neutron capture

Saturation Estimation Analysis

- Water, oil, and gas saturations are of interest for CO_2 EOR and CO_2 storage
  - Better estimations of saturations using triangulation method
  - Baseline and repeat logging show changes in saturations

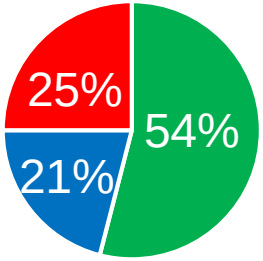


Baseline A1 Carb Saturations



Water
Gas
Oil

Repeat A1 Carb Saturations



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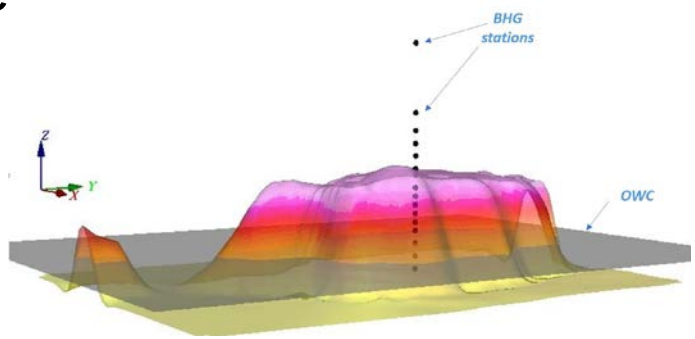
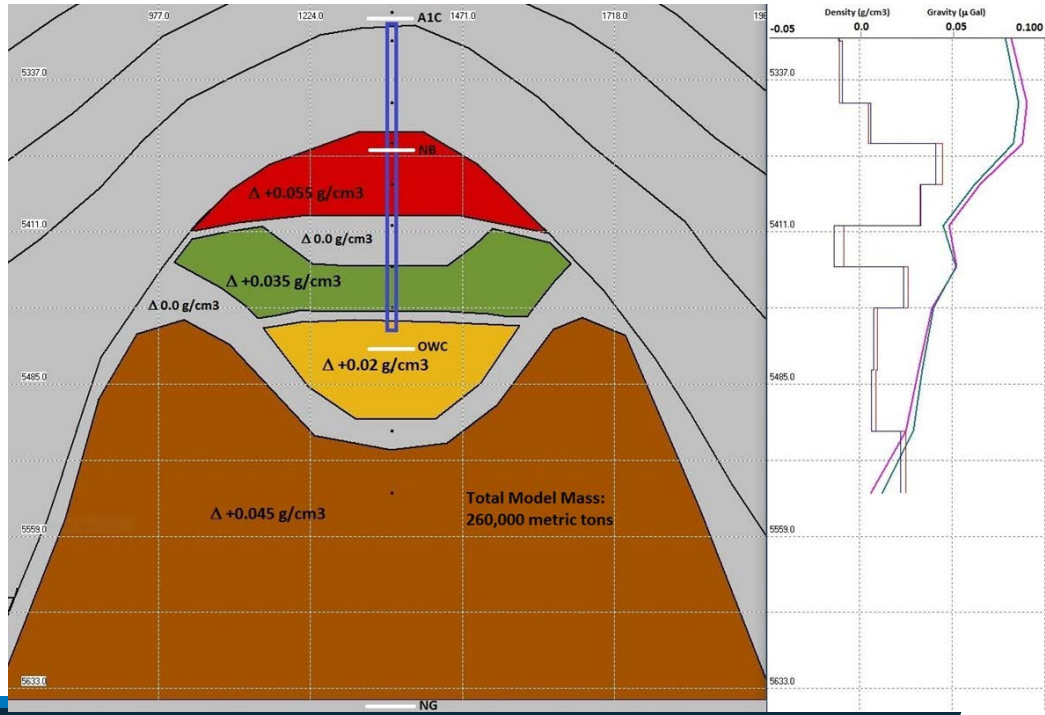
Monitoring- borehole microgravity

Time-lapsed BHG in late-stage reef

- Borehole gravity survey collected in 2013 and repeated in 2016
  - 35 stations divided into 3 sections
  - GR log used to check depths
- Measures very small, time-variable density changes
- May also be used with VSP to better resolve plume density and shape
- Changes in borehole gravity correlate with changes in wireline logs





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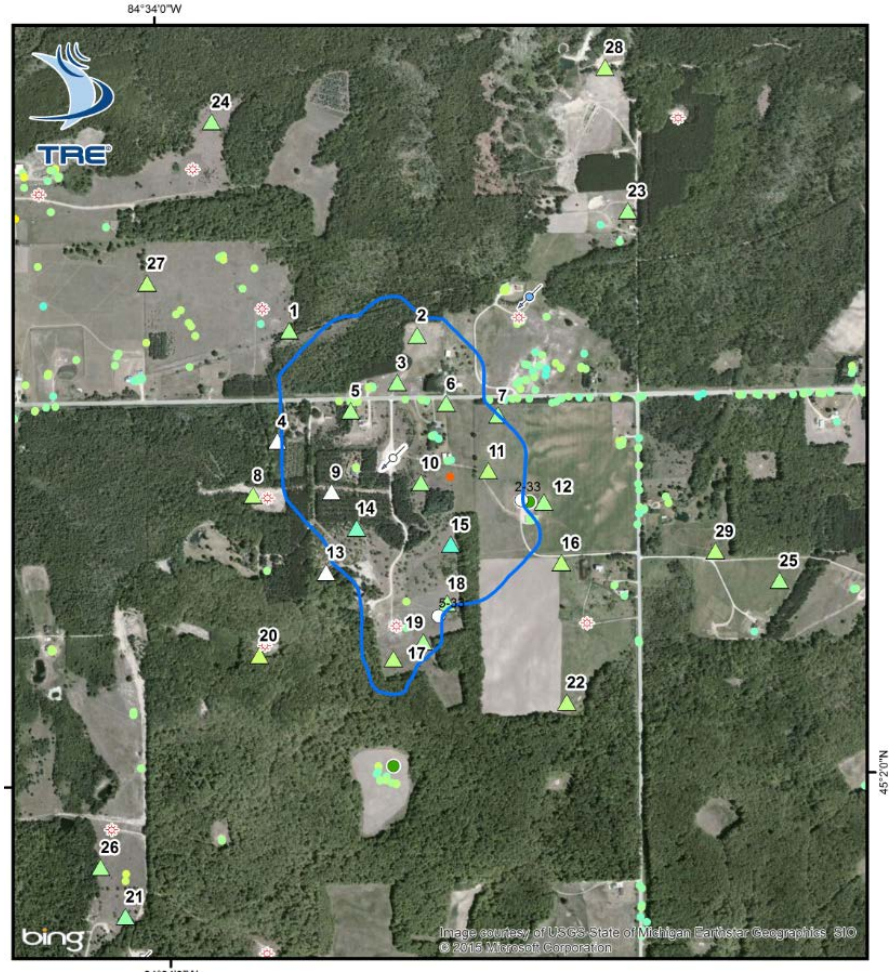
Monitoring- INSAR

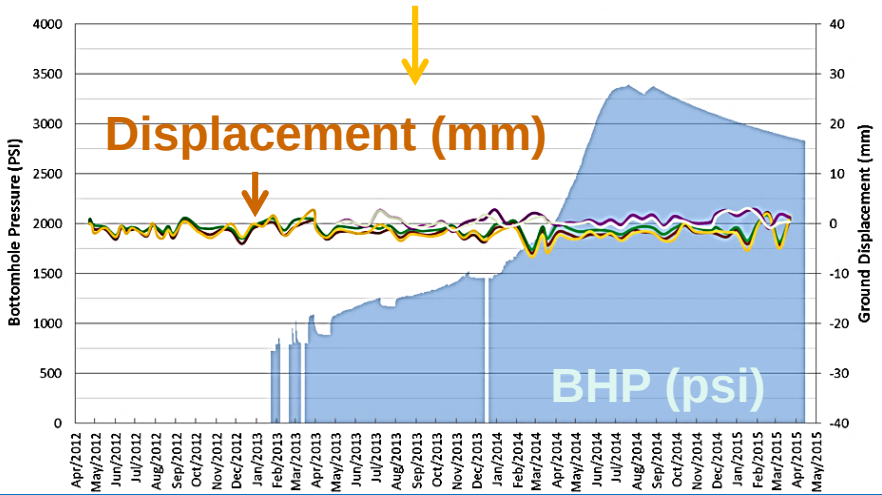
No Meaningful Displacement Observed



Vegetation and snow are challenging for radar, but there were a reasonable number of natural reflectors

Artificial reflectors augmented the data for injection monitoring

Time series displacement data show no correlation to injection



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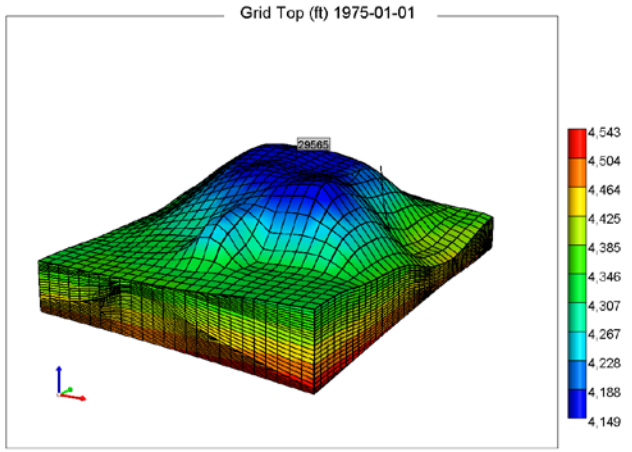
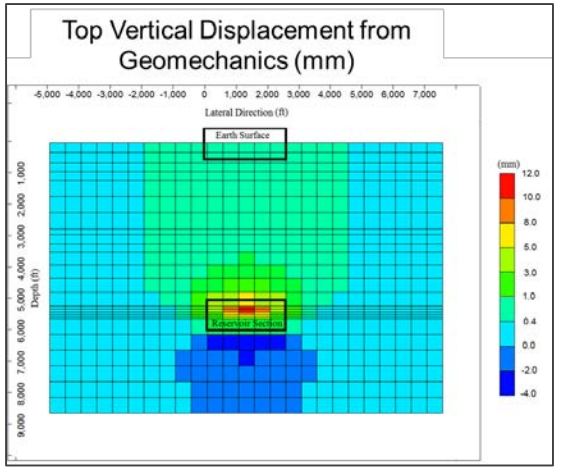
Monitoring- INSAR

Geomechanical modeling to validate INSAR results

- Consolidated carbonate reservoir; limited boundary; one injection well; several carbonate layers in overburden; presence of overlying salina salt
- Used surrogate data to build the model
  - Elastic parameters estimated from log data in place of core triaxial compression test data
  - Dynamic Young Modulus and Poisson Ratio calculated using dipole sonic and density log from analogous reefs
- Used two phase flow to model surface uplift
  - 3-D fluid flow simulator used to model the pressure rise following fluid injection
  - Simulated the poroelastic response during injection periods and predict reservoir and overburden deformation
  - Predicted surface displacement is less than 1 mm (insignificant)





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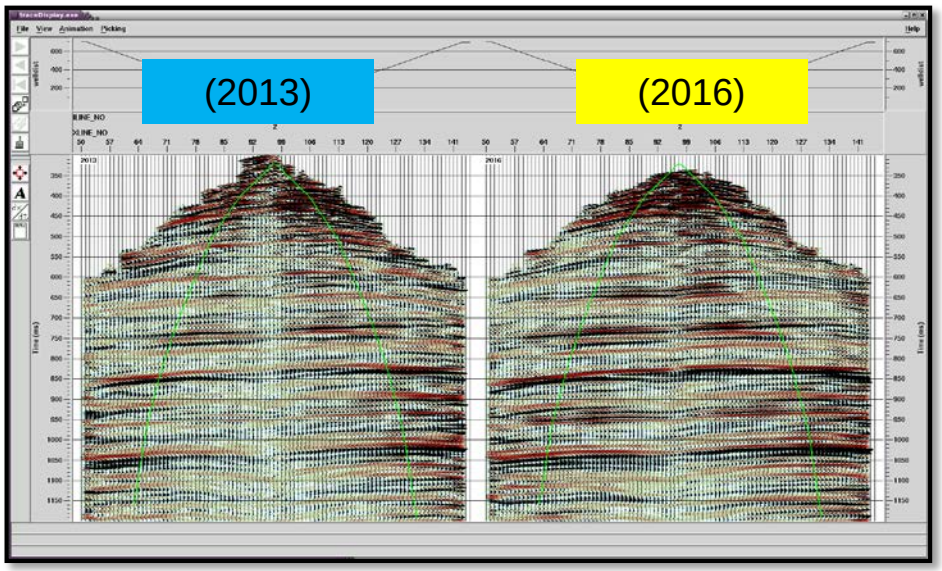
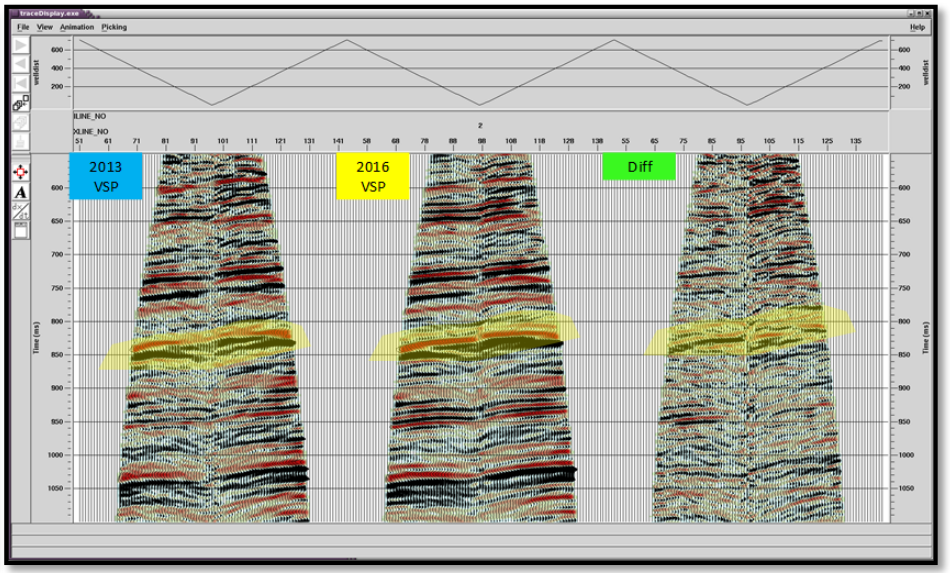
Monitoring- vertical seismic profile

Using time-lapse VSP to monitor the CO_2 plume in the Late Stage Reef

- P-wave data processed and the PS-wave processing ongoing
- Amplitude difference within reef to be evaluated with P and PS waves
- Fluid substitution modeling underway includes effects of CO_2 saturation, phase, and pressures changes.
- Further work will improve the difference images and provide an evaluation of using VSP for CO_2 monitoring





VSP Preliminary Stack Difference Images

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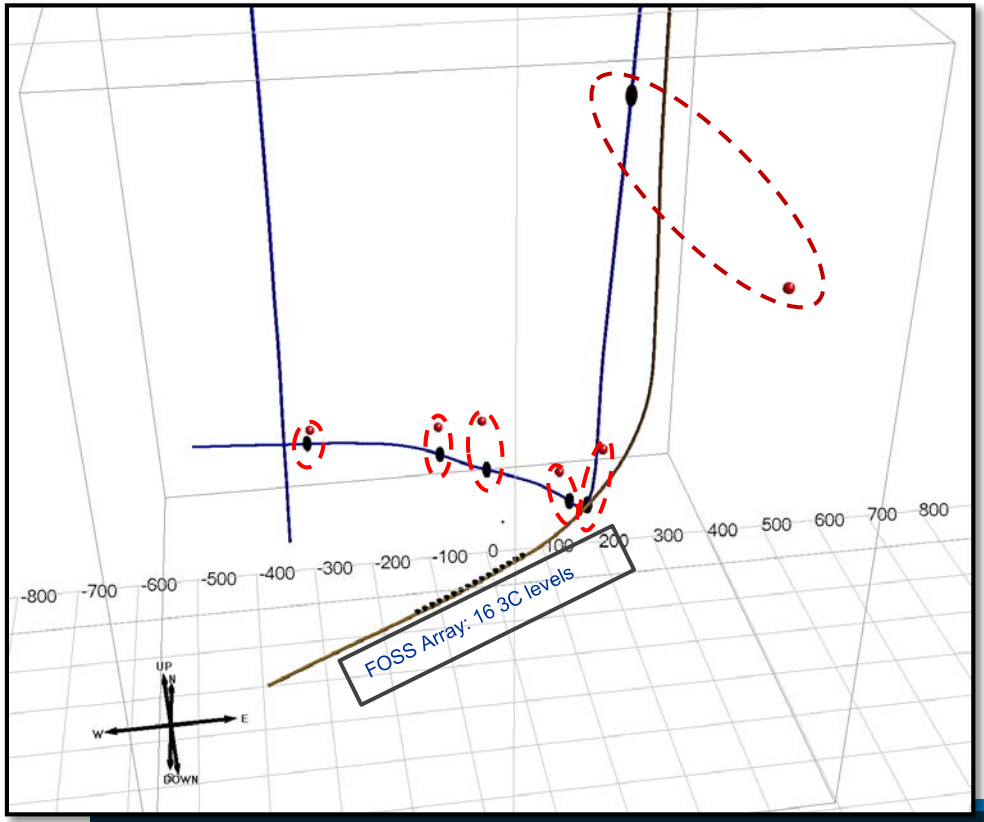
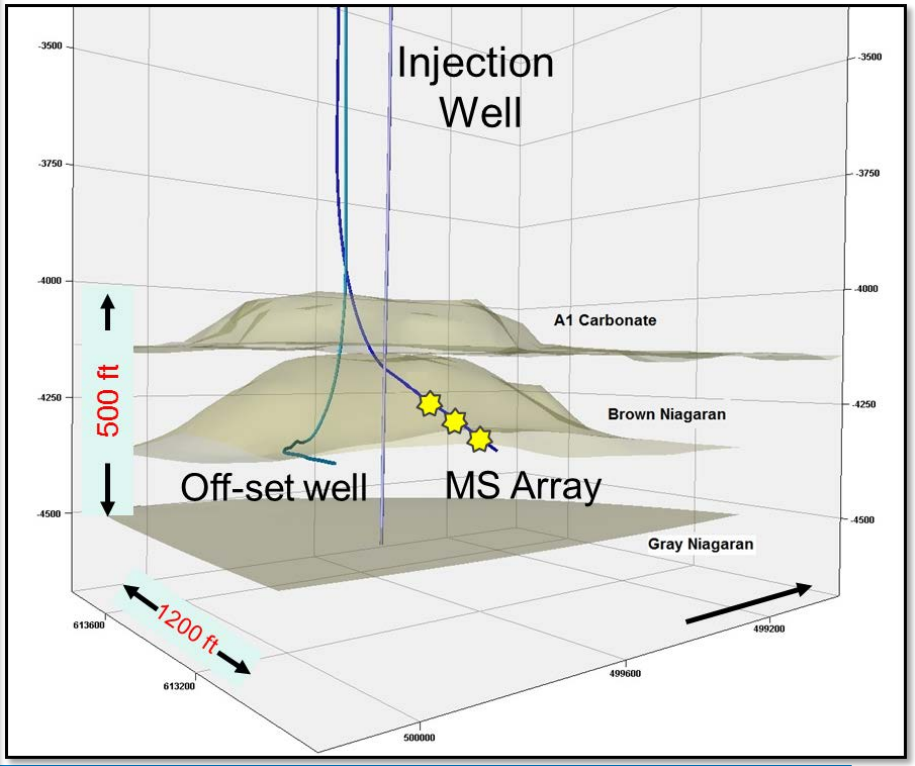
Monitoring- microseismic

String shots in off-set well used to “calibrate” microseismic

- 5 of 6 string shots located with “good” accuracy
- 16-level 3C Fiber Optic Seismic Sensor (FOSS™) array placed in monitoring well
- Deployment depth: 5,572 – 5,947 ft.





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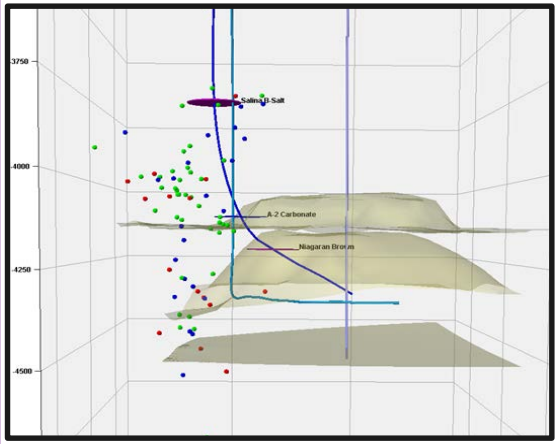
Monitoring- microseismic

Three types of events identified

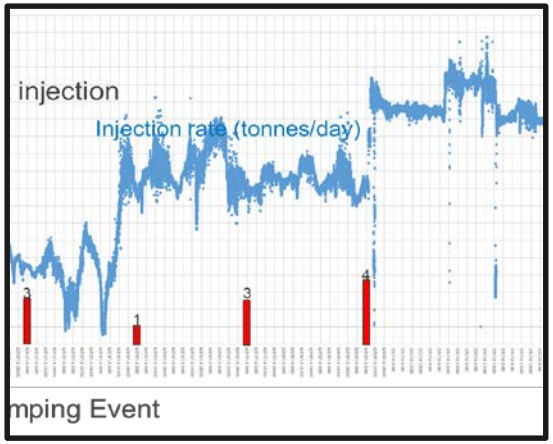
Type 1



Work in nearby well

M<-2.0

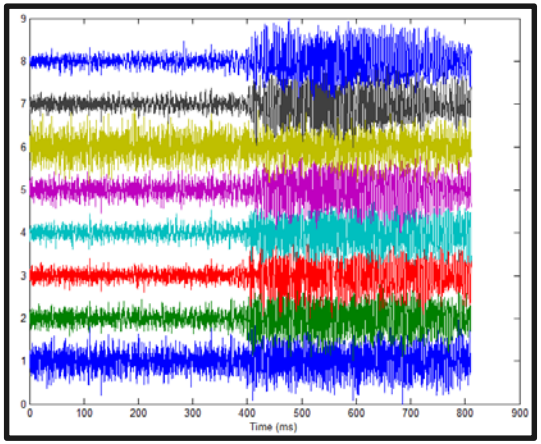
Type 2



FOSS clamp mechanism

M<-2.0

Type 3



Fluid movement and noise?

M<-3.0

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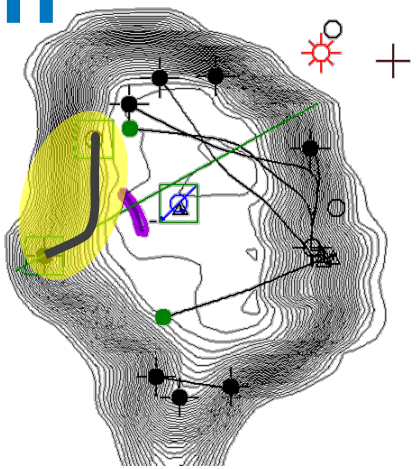
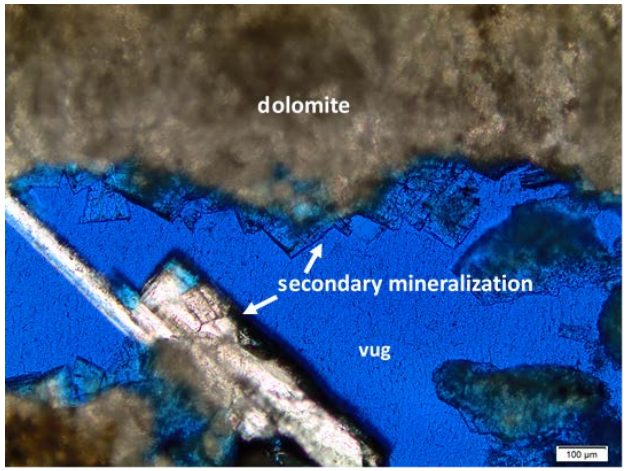
Late stage reef – post injection characterization well drilled

- Well completed November, 2016
- Core samples, wireline logging data, fluid properties, and monitoring information
- Preliminary analyses show potential CO_2 near top of reef





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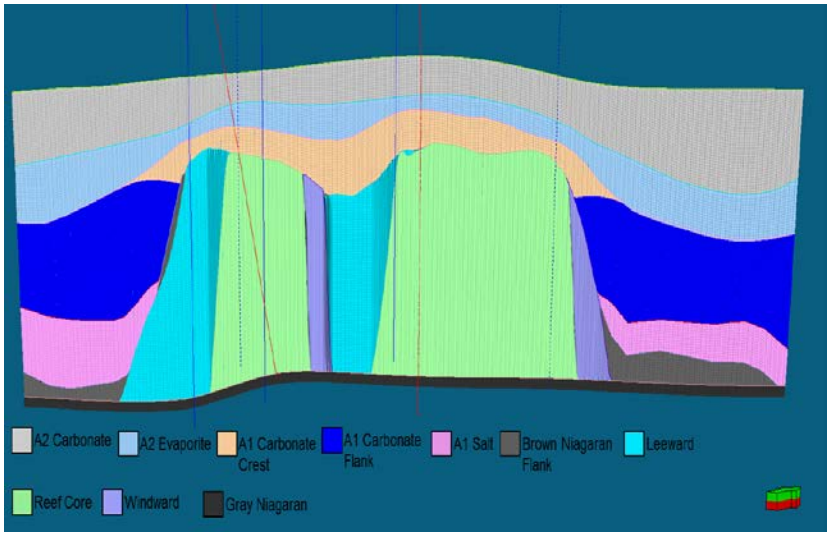
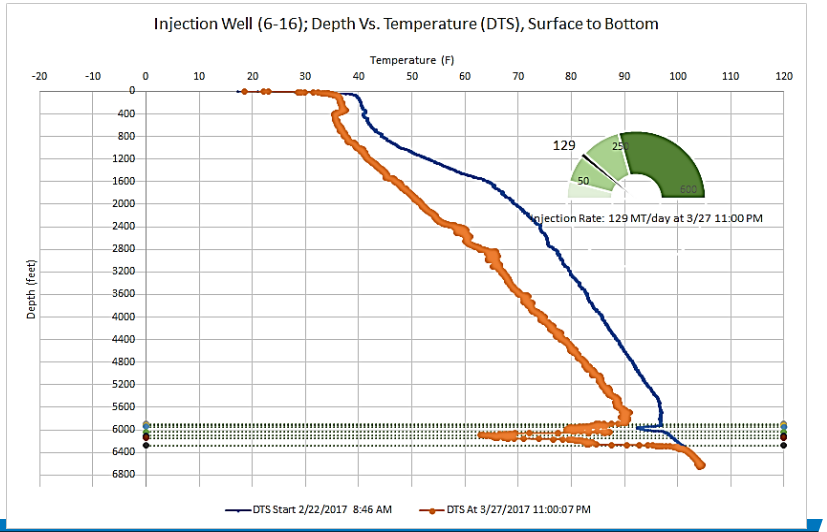
New EOR reef- drilling of two new wells

- Two new wells drilled
  - CO_2 Injection well
  - Monitoring Well
- Core, wireline logging, and monitoring information collected
- New monitoring technologies installed
  - DTS
  - DAS with VSP capabilities





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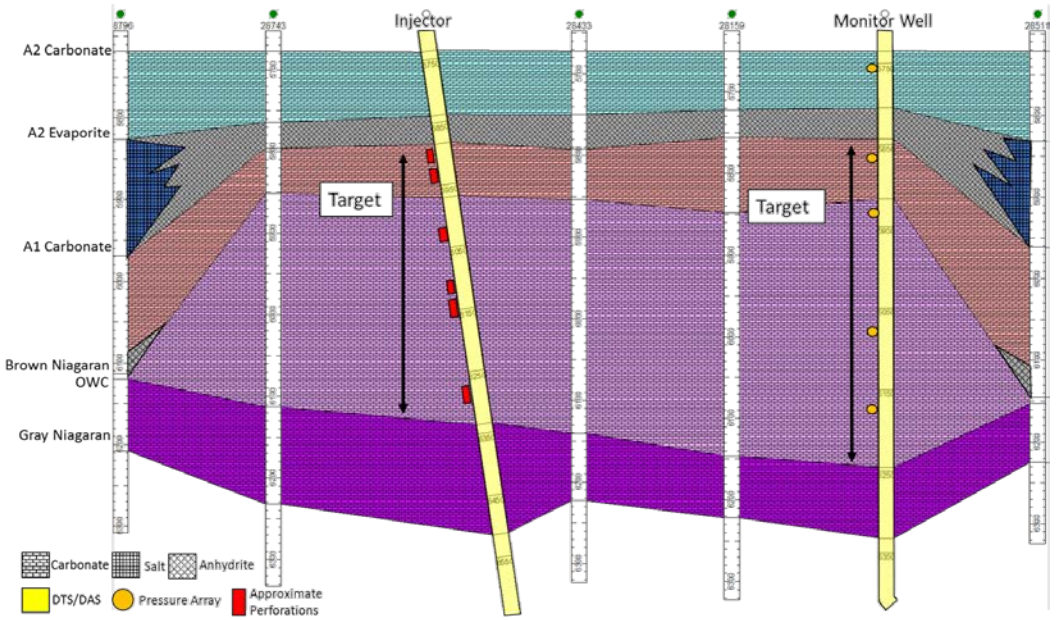
Monitoring- new EOR reef

Planned

Activity	Position	Before Injection	Early Injection	Mid Injection	Late Injection	After Injection
CO_2 flow accounting	Surface		X	X	X	X
Pressure and temperature	Surface and borehole	X	X	X	X	X
PNC logging	Borehole	X		X		X
Fluid sampling[a]	Borehole and wellhead	X	X	X	X	X
DTS	Borehole	X	X	X	X	X
DAS-VSP	Borehole	X			X	

a. tentative

Injection Month	CO_2 Injected (MT)
Jan-17	804
Feb-17	3,648
Mar-17	4,749
Apr-17	2,077
May-17	6,294
Total	17,572

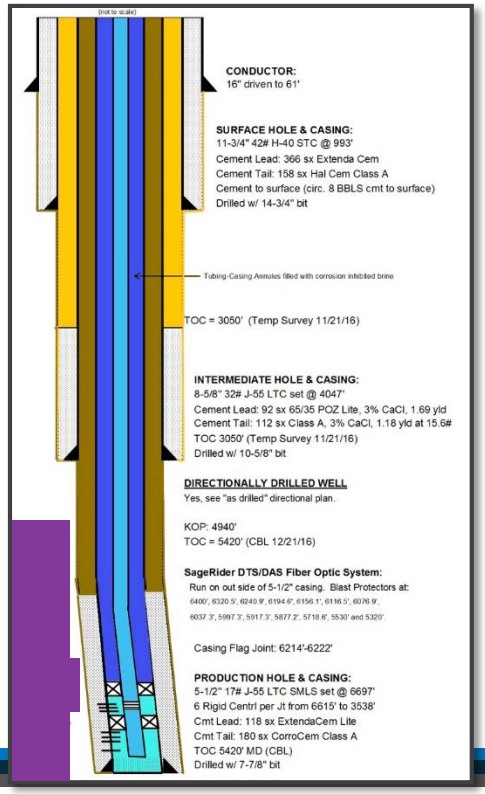


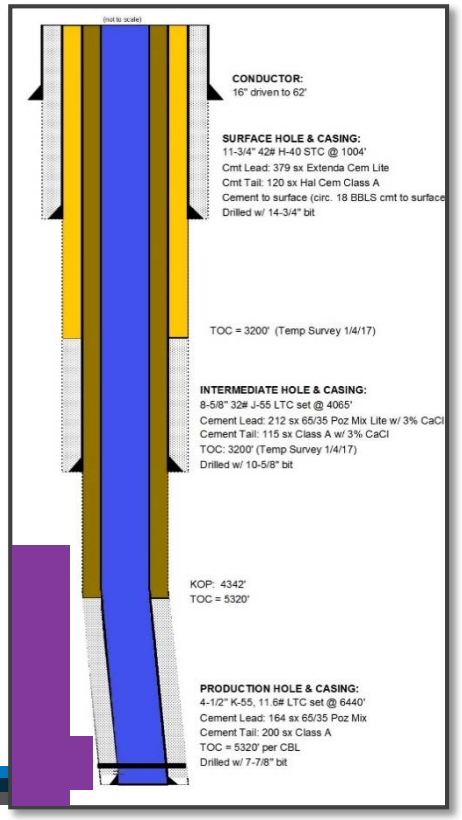
Monitoring- DAS VSP

- Conduct a pre-CO_2 injection DAS VSP that can serve as baseline for future VSPs during the CO_2 injection period
- Determine quality of DAS VSP that is possible in Niagaran reef/carbonate rock in light of potential issues (thick glacial till, well construction)

TIMELINE

- 2 wells (and fiber optic system) installed Dec. 2016 – Feb 2017
- Baseline VSP was conducted Feb. 17-20
- CO_2 injection began Feb. 22





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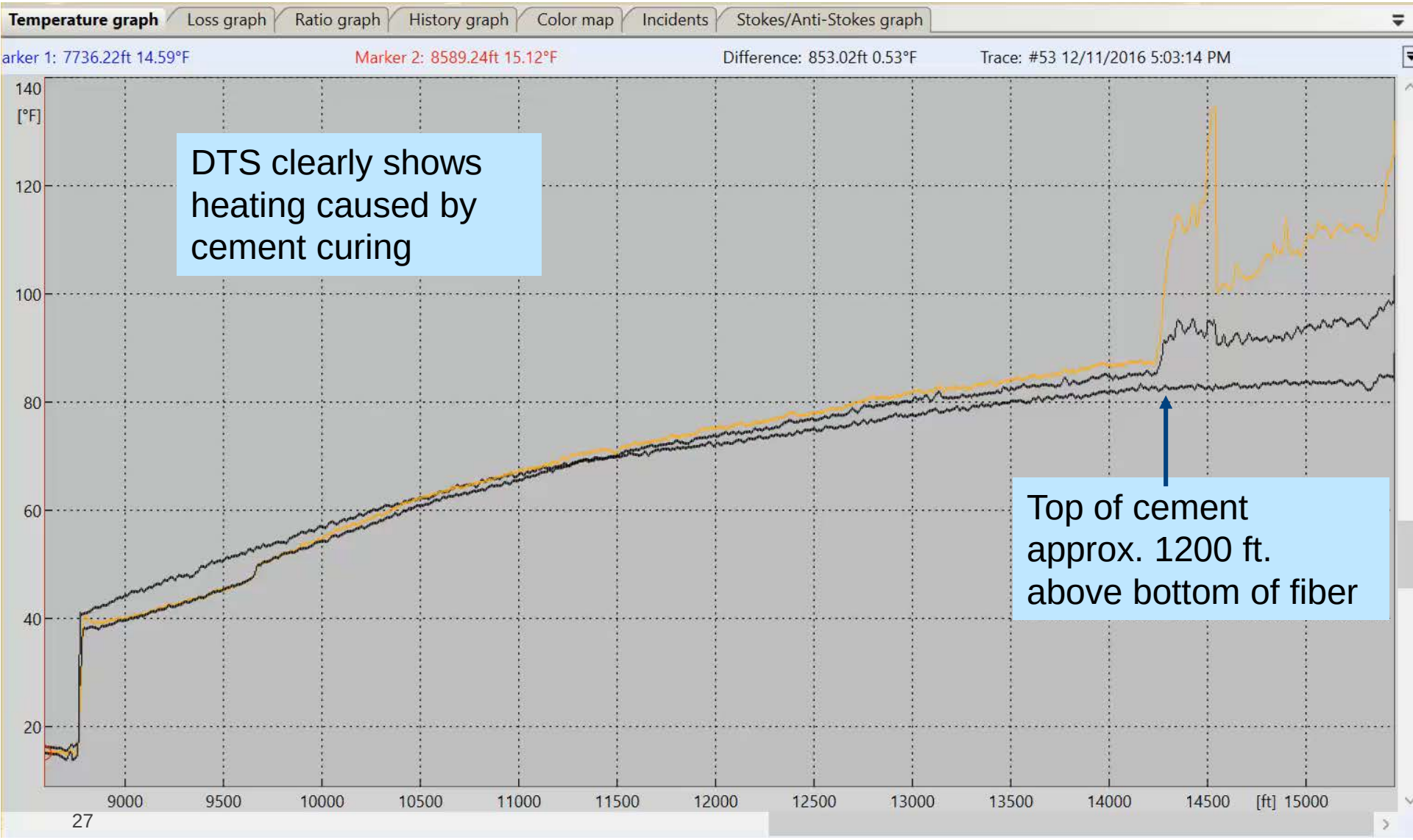
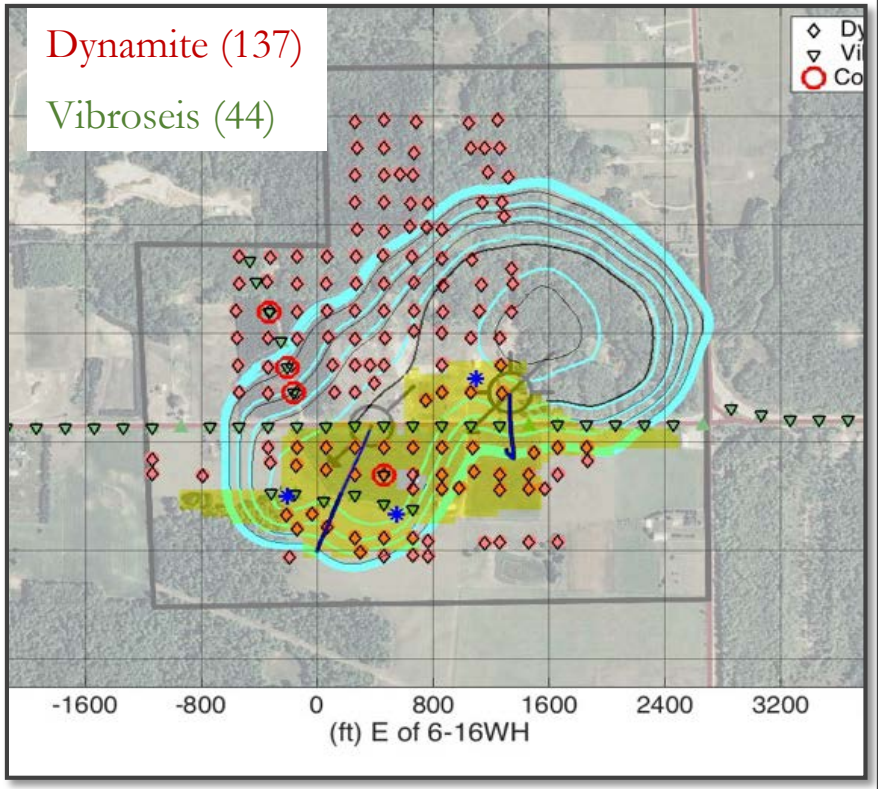
Monitoring- New EOR Reef

Using DTS Fiber to evaluate cementing

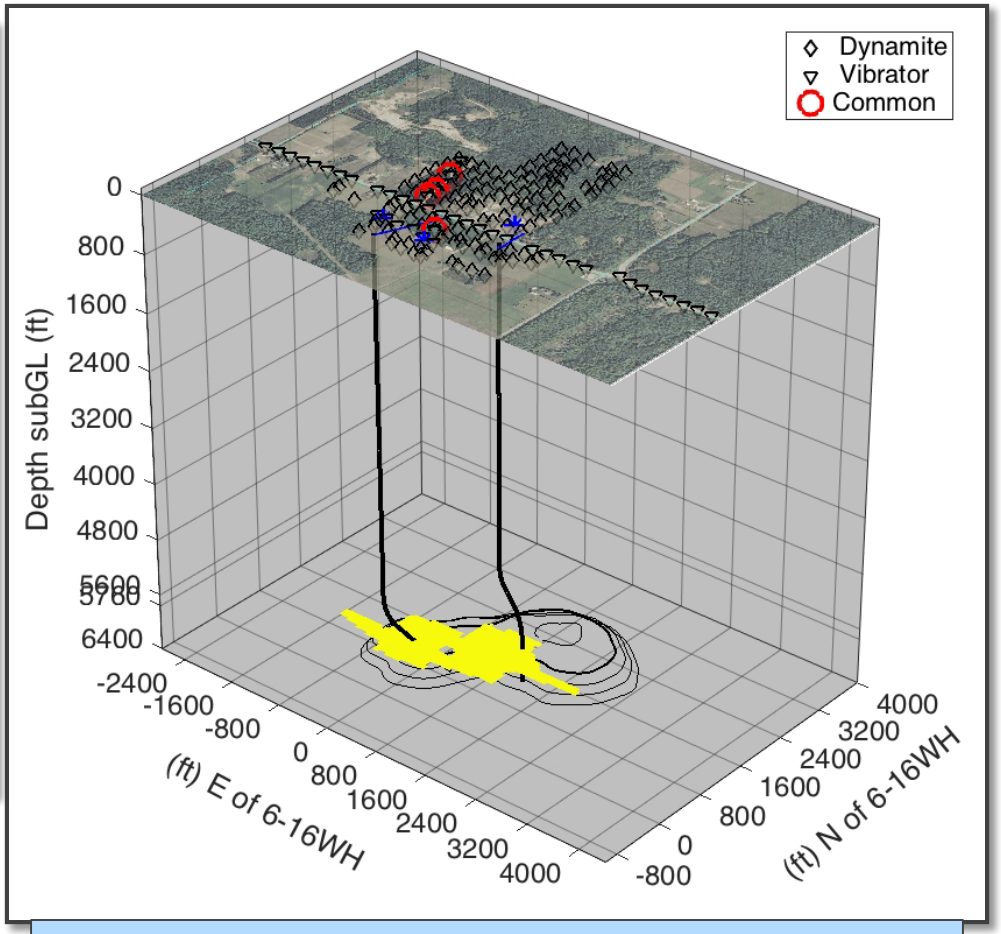


Monitoring- DAS VSP

Source layout to capture region between wells



Source layout is a grid



Region between wells will be imaged

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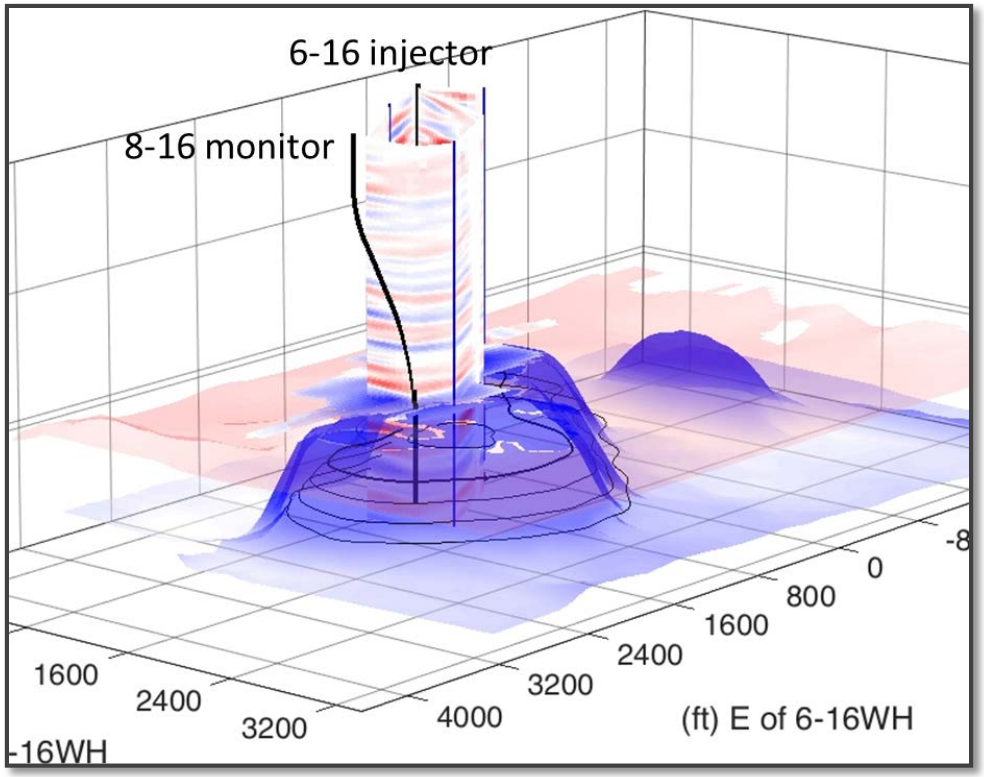
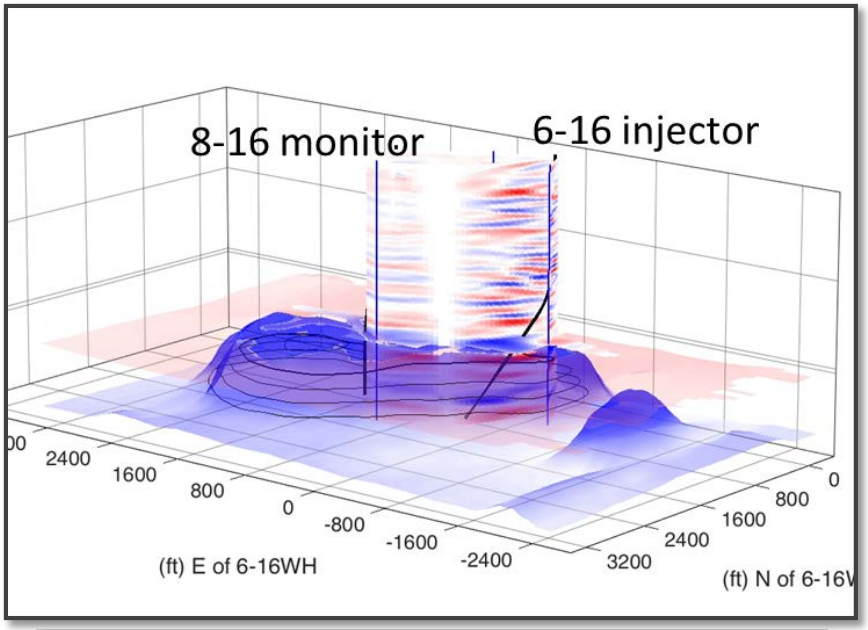
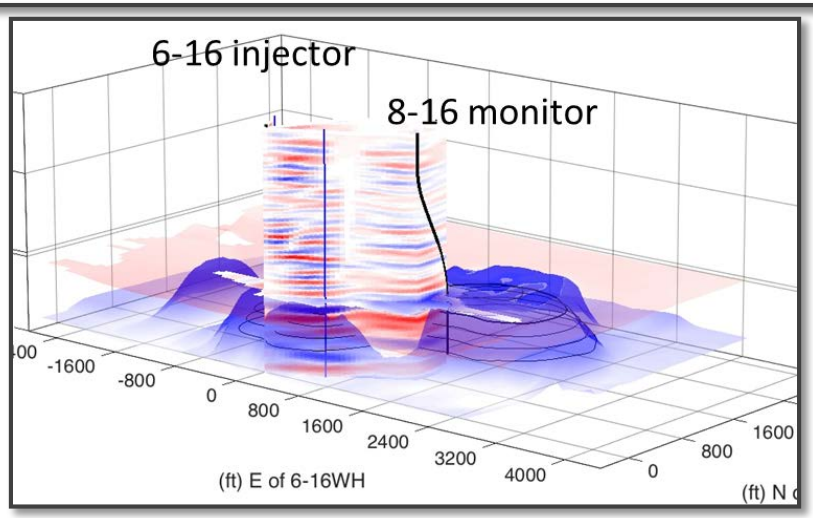
Monitoring- DAS VSP

3D perspectives of data showing area of coverage







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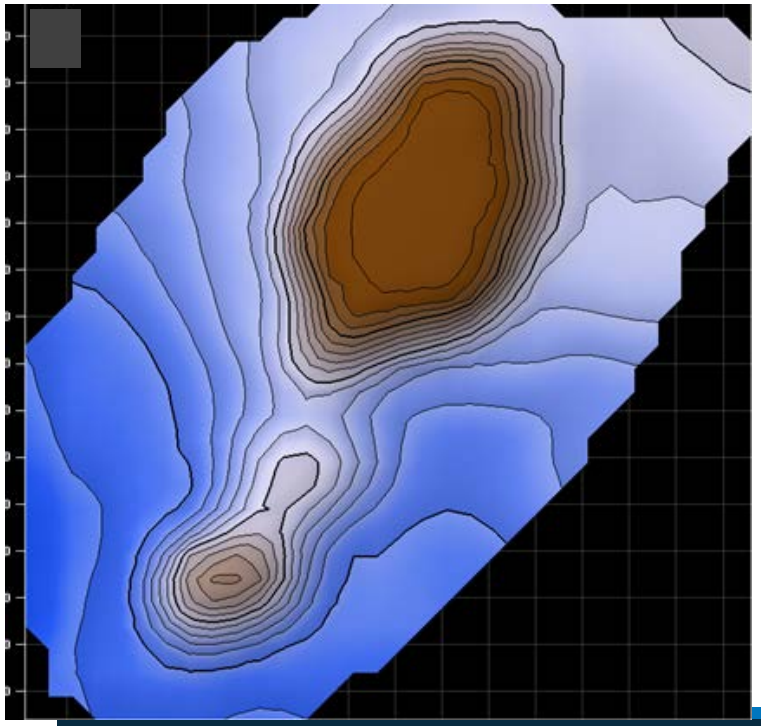
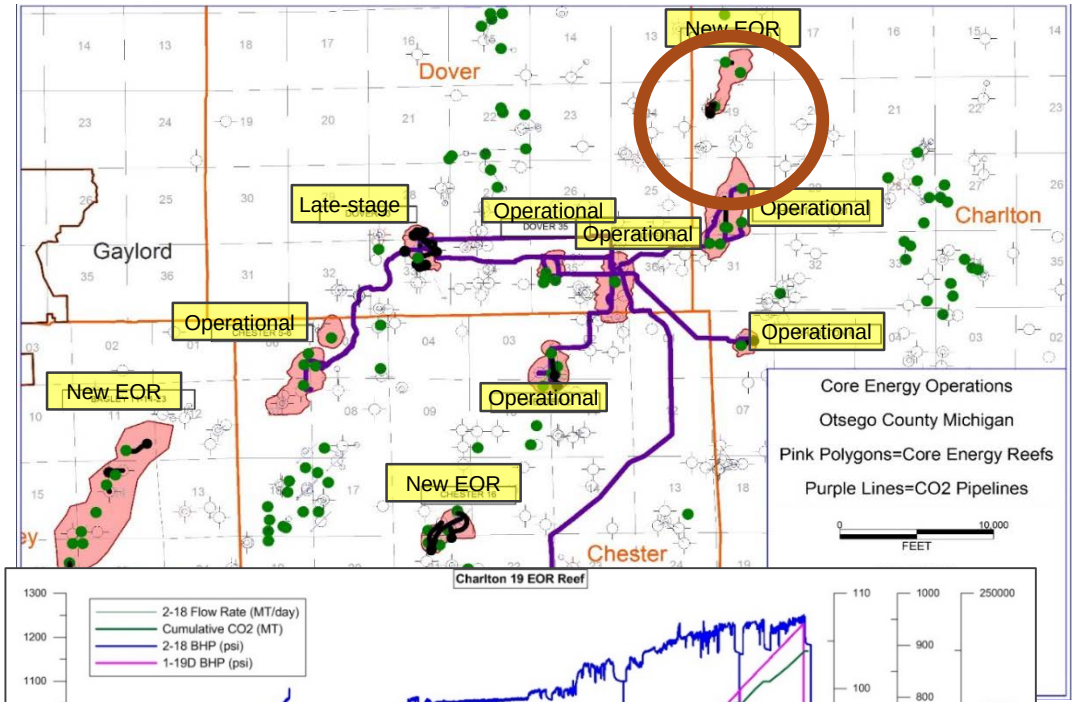
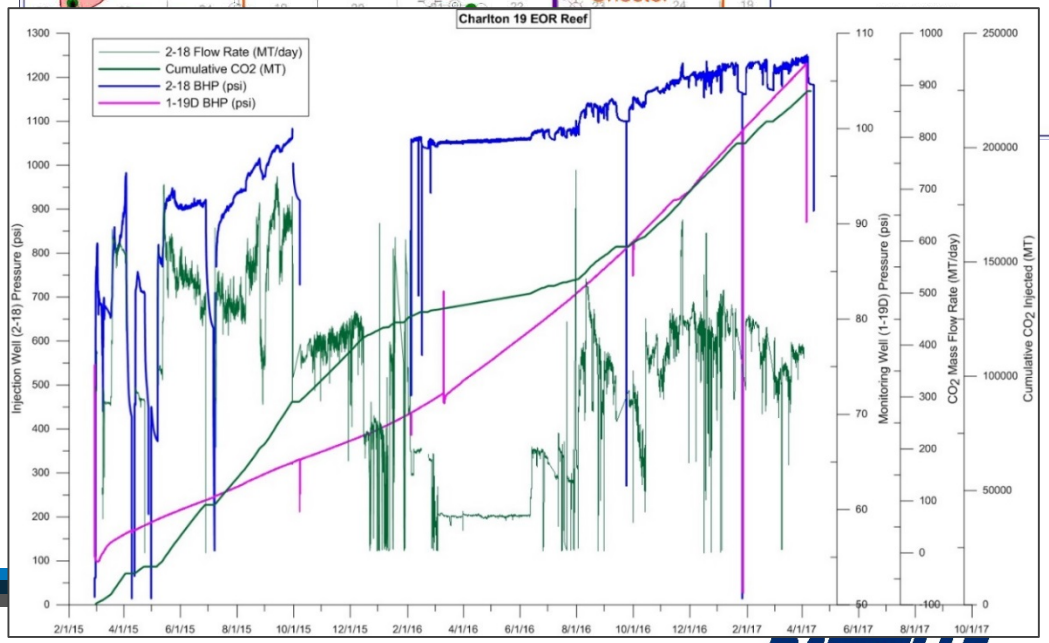
Monitoring - injection in a new reef

- Two partly connected lobes
  - 1 injection well
  - 1 monitoring well
  - 1 old well plugged
  - One new drilled







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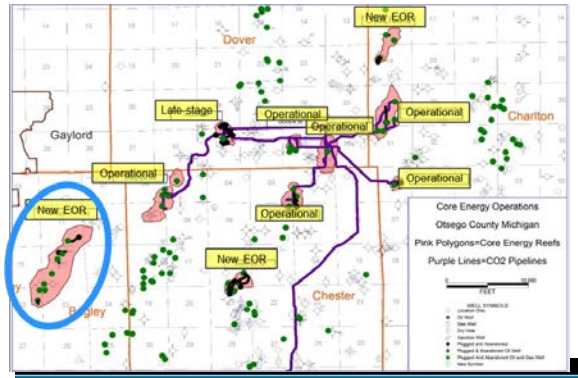
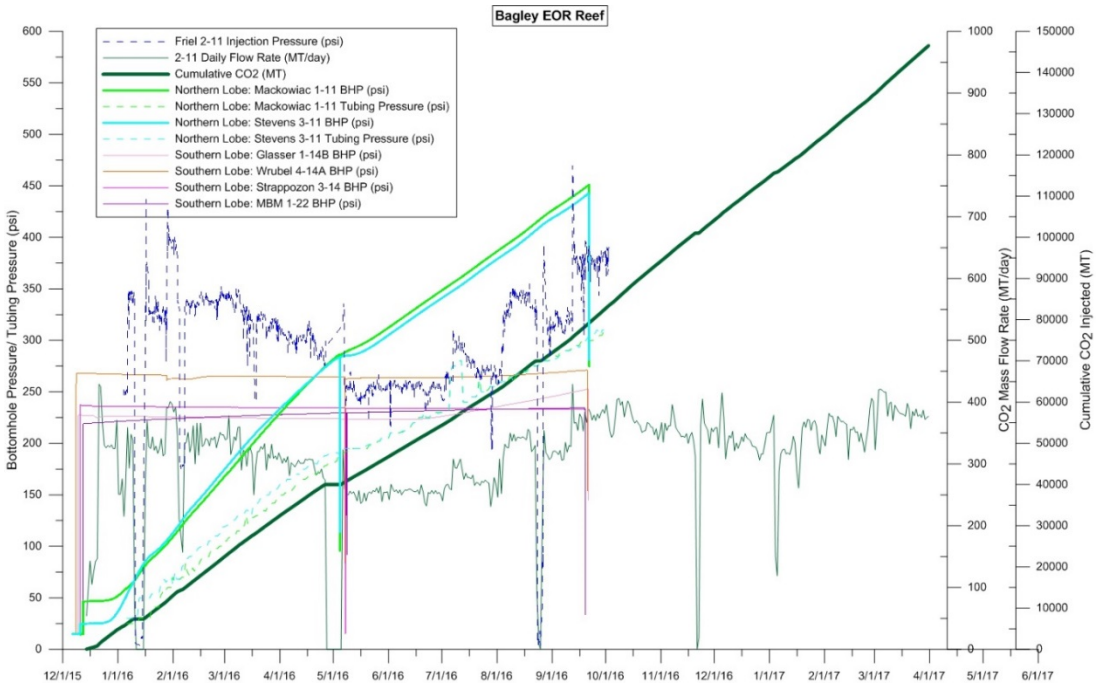
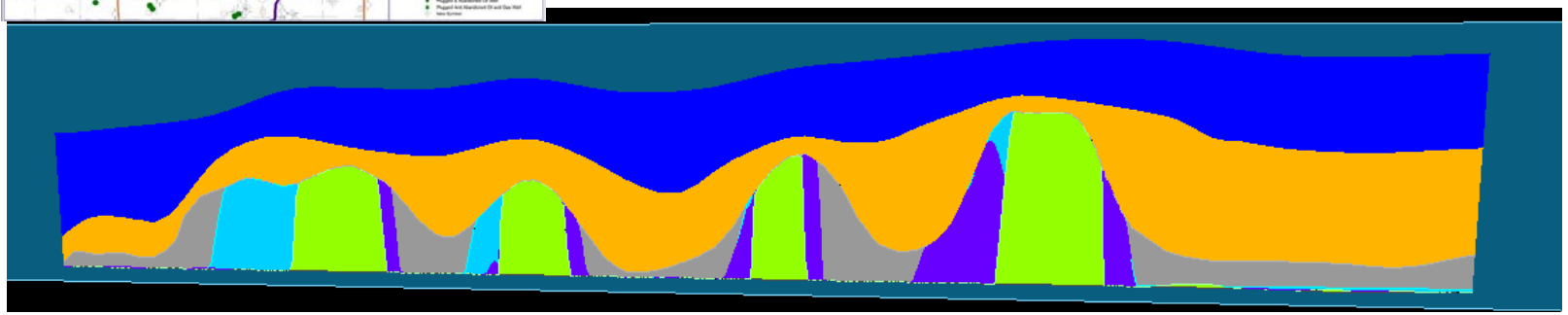
Monitoring - injection in a new reef

- 3-4 reef pods with varying connectivity
- 6 monitoring wells







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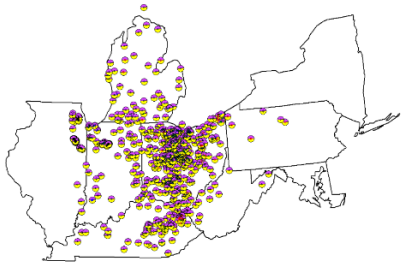
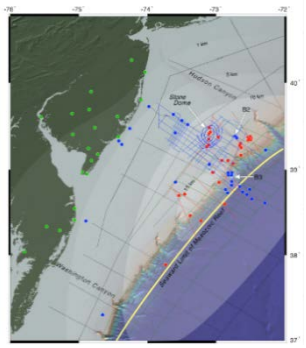
Regional characterization

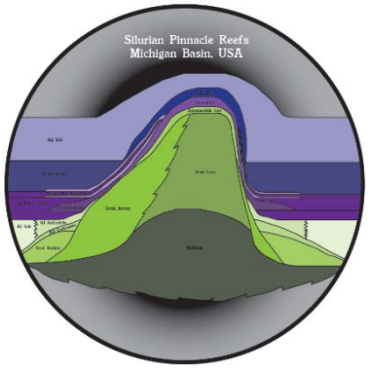
MRCSP 10-State team conducting regional studies



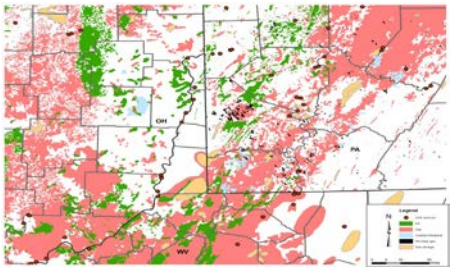
Cambro-Ordovician Storage Potential
Led by Indiana



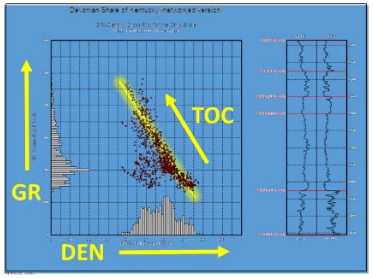
East Coast Offshore and Onshore Storage Targets
Led by Rutgers



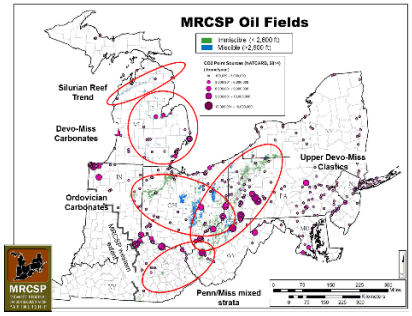
Silurian Pinnacle Reef Reservoirs
Led by W. Michigan University



CCS Opportunities in Appalachian Basin
Led by Pennsylvania



Storage and Enhanced Gas Recovery for Organic Shale
Led by Kentucky



Reservoirs for CO_2-EOR, EGR, and other Commercial Uses
Led by West Virginia

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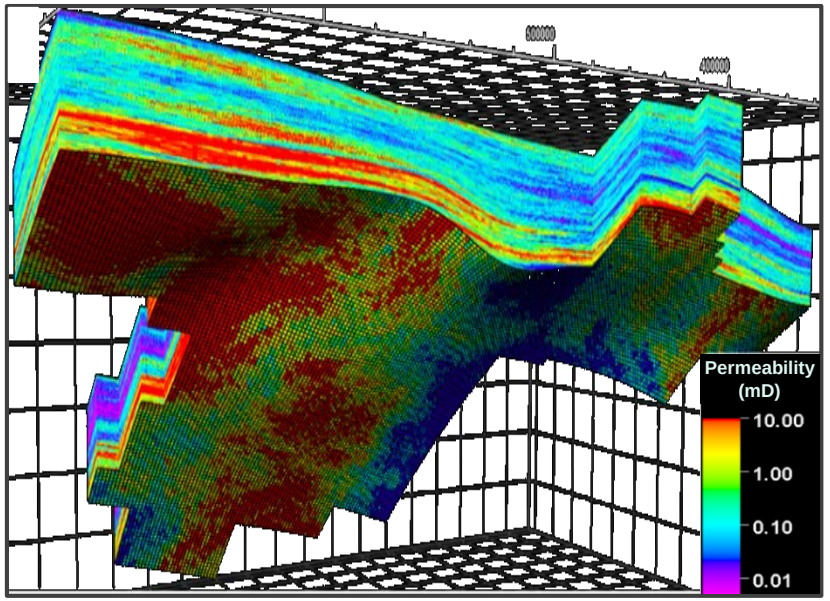
Regional characterization in the Upper Ohio River Valley - storage resource calculations

SEM: 3D model of subsurface geology and pore volume for Cambrian-Ordovician deep saline formations in the study area

- Formation Structure
  (depth, thickness, lateral continuity)
- Petrophysical Properties
  (porosity, permeability)



Portion of the SEM developed for the eastern OH study area clipped to show the basal Cambrian sandstone interval at a selected site. The entire SEM has a total of 145,413,098 grid cells with X-Y-Z dimensions of 1,875 x 1,875 x 3ft (Battelle, 2017).

2D map grids from SEM coarsened & used as input for CO_2-SCREEN

CO_2 Storage Resource calculated deterministically directly in model using DOE-NETL equation & E_{saline} from CO_2-SCREEN

$$G_{CO2} = A_t\, h_g\, \phi_t\, \rho_{CO2res}\, E_{saline}$$

Prospective Storage Resource

Theoretical Maximum Storage Resource

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Regional characterization in the Upper Ohio River Valley - storage resource calculations

A systematic workflow of static modeling exercises is used to help define the regional geologic storage framework of the eastern Ohio study area

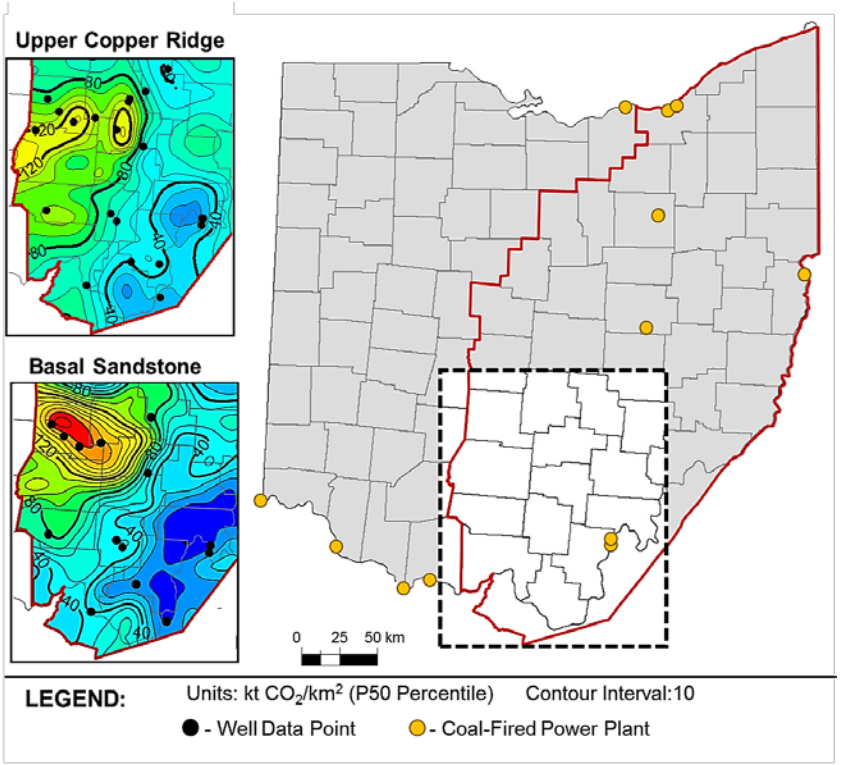
Calculation of CO_2 Storage Resource for 2 major deep saline formations

- Theoretical Storage Resource: 111-155 Gt
- Prospective Storage Resource: 3.4 Gt (P50)
- CO_2 storage efficiency: 2.2 – 3.0% (P50)

Less than 1% difference between SEM & CO_2-SCREEN results

Generation of Storage Resource maps

- Spatial distribution of storage resource
- Help guide site selection for dynamic models
- Potential for stacked storage in some areas



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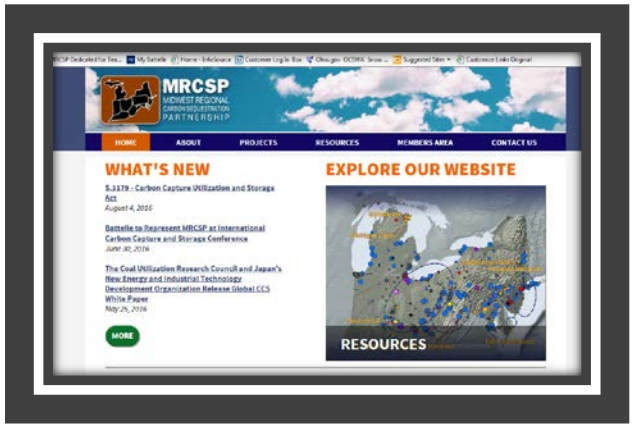
MRCSP Outreach Status

Knowledge Sharing is the main focus

- Communicating results to a broad audience via site visits, fact sheets, conference and meetings, and the website
- Topical highlights:
  - CO_2 accounting in closed reservoirs
  - Performance Measures
  - Numerical Modeling
  - Monitoring-Modeling Loop
  - Regional Storage Opportunities



www.mrcsp.org

- Convening/participating in the Outreach Working Group
- MRCSP hosted IEAGHG Monitoring Workshop in June 2017
- Results shared in Mexico, China, South Africa, etc.

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MRCSP Outreach Status

Knowledge Sharing is the main focus

Presentations given at regional, national and international meetings, conferences and workshops in 2016 and 2017

- Annual CCUS Conference
- Eastern Section American Association of Petroleum Geologists
- American Institute of Chemical Engineers (AIChE) Annual Meeting
- SPE Eastern Regional Meeting
- IEAGHG Workshop in Edinburgh, Scotland
- 13th Conference on Greenhouse Gas Control Technologies (GHGT-13)

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MRCSP outreach status

Knowledge Sharing is the main focus

Multiple Stakeholder Engagements

- US Technical Advisory Group (TAG)
- US-Japan CCS Collaboration Meeting
- North American Energy Ministers (NAEM) Trilateral dialogue
- CSLF International Offshore Storage Meeting
- MGSC Annual Meeting in Champaign
- Mission Innovation Meeting hosted by WVU
- Seminar at Penn State University
- CURC's Coal Technology Showcase at the US Capitol
- **MRCSP Annual Meeting**

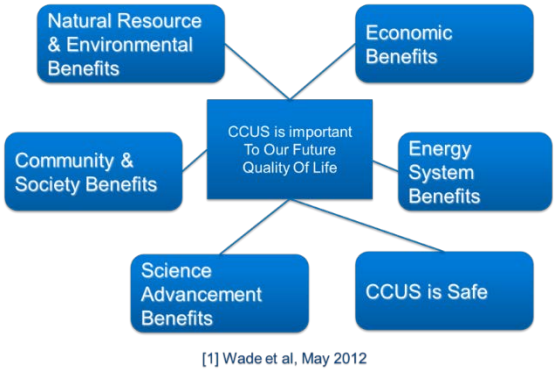
2016 Annual MRCSP Partners meeting held November 1-2, 2016 was attended by nearly 100 representatives from Industry and Research Partners, regulatory entities, other stakeholders, as well as Battelle and NETL personnel.

MRCSP Outreach Status

Knowledge Sharing is the main focus

Participation in RCSP Initiatives

- Convene/participate in the Outreach Working Group
  - A group of outreach coordinators working to better understand and respond to questions about CCS
- Participate in Water Working Group
  - Working to address stakeholder concerns regarding CCS potential interactions with water resources
- Contribute to DOE/NETL Best Practices Manuals: MVA, Risk Assessment and Simulation, Site Characterization, and Carbon Storage and Well Management
- Contribute to NATCARB Database, NRAP efforts



[1] Wade et al, May 2012

Message Mapping

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Accomplishments to date

All Critical Milestones and Objectives on track

- 780,000 metric tons stored across all reefs; ~1.6M metric tons injected across all reefs (through June 30, 2017).
- Completed injection at main test bed in late-stage Reef
  - Performed microseismic monitoring in final injection stage
  - Post-injection PNC, microgravity, and VSP completed
  - Post-injection test well drilled and characterized
  - Field returned to normal EOR operations, with continued access for accounting and pressure monitoring
- Advancements in static and numeric modeling processes
- Developed performance metrics to assess storage capacity
- Added two new EOR reefs for active monitoring
- Task 5 drilling and monitoring underway, after delays due to oil price decline

Accomplishments to date

All Critical Milestones and Objectives on track

- Collaborative regional assessments across ten states
  - Continued research on regional storage resources and opportunities
  - Final capstone report will include (1) synopsis of regional characterization findings; (2) concise summaries of CCUS potential in ten partnership states; and (3) advancements in CCUS resource estimate methodologies
- Technology transfer is focus of outreach
  - Presentations at regional, national and international meetings, conferences and workshops
  - Multiple stakeholder engagements
  - Contributing to RCSP Initiatives – working groups, NRAP, NatCARB

Lessons learned

- CO_2 measurement and accounting can be performed with high level of confidence in a inter-connected multifield complex
- Storage potential in closed EOR reservoirs evaluated
- Significant complexity within and across reefs affects CO_2 injection, migration, and storage
- Pressure monitoring remains the mainstay for managing injection operations and monitoring reservoir response
- Monitoring technologies still require testing/validation across for confident assessment of plume development
- Characterization-monitoring-modeling loop requires more research for cross-validation over the life-cycle
- CO_2-EOR regulatory/policy framework is well developed and essential for enhanced associated storage. But EOR to storage to credits link may needs more clarity and policy support.

Synergy opportunities

- CarbonSafe projects in Ohio, Michigan, and Nebraska
- Mid-Atlantic Offshore storage assessment
- Well integrity and risk management
- Brine disposal and induced seismicity research
- Knowledge share with RCSPs on monitoring and modeling
- Testing NRAP models and CO_2Screen tools
- Collaboration with international projects on modeling and CO_2 EOR to Storage transitions – South Africa, China, Mexico
- IEAGHG monitoring/Modeling Networks
- Input to DOE Best Practices Manuals

Project summary

- MRCSP Large-Scale Test ~75% completed with diverse EOR field setting and variety of monitoring options
- Multiple monitoring options are being tested
- Both monitoring and modeling are essential for understanding performance – imperative to be able to do much with limited data
- Regional characterization helping identify new storage zones and estimate storage resources – setting stage for commercial scale CCS
- Results will contribute to developing standards and best practices, NRAP tools, CO_2 capacity estimate tools

Acknowledgements

Battelle's MRCSP Current Contributors – Mark Kelley, Srikanta Mishra, Matt Place, Lydia Cumming, Sanjay Mawalkar, Charlotte Sullivan, Priya Ravi Ganesh, Autumn Haagsma, Samin Raziperchikolaee, Amber Conner, Glen Larsen, Caitlin Holley, Joel Main, Jacob Markiewicz, Isis Fukai, Ashwin Pasumarti, Jackie Gerst, Rod Osborne, and others

DOE/NETL – Agreement # DE-FC26-0NT42589, Andrea McNemar (PM)

Core Energy, LLC – Bob Mannes, Rick Pardini, Allen Modroo, Bob Tipsword, Kim Sanders, Kathy Dungey, and several others

Ohio Development Services Agency's **Ohio Coal Development Office**

MRCSP's technical **partners, sponsors, and host sites**

The MRCSP Region's State **Geology Survey and University team members**

Partners over 15 years have helped make MRCSP successful

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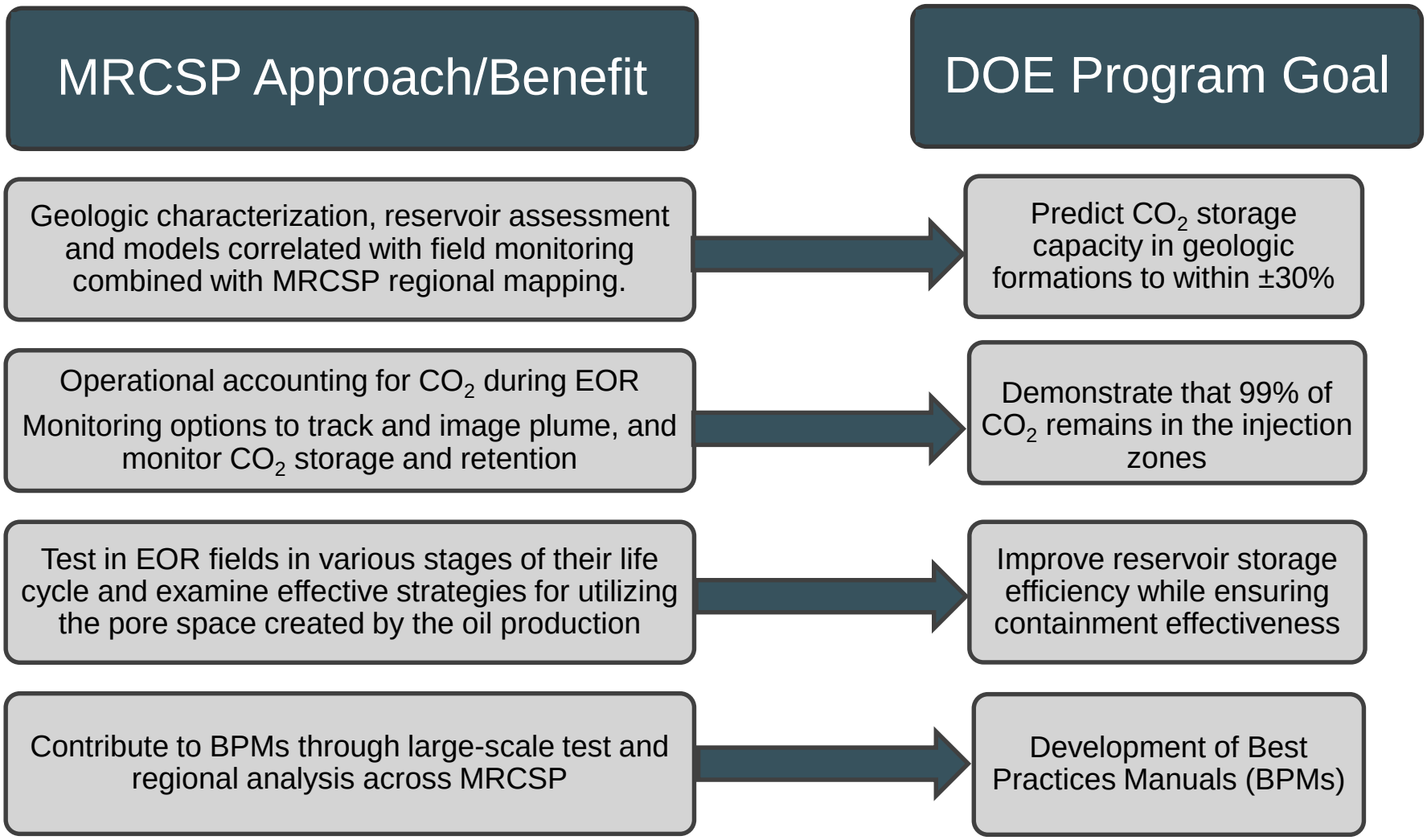
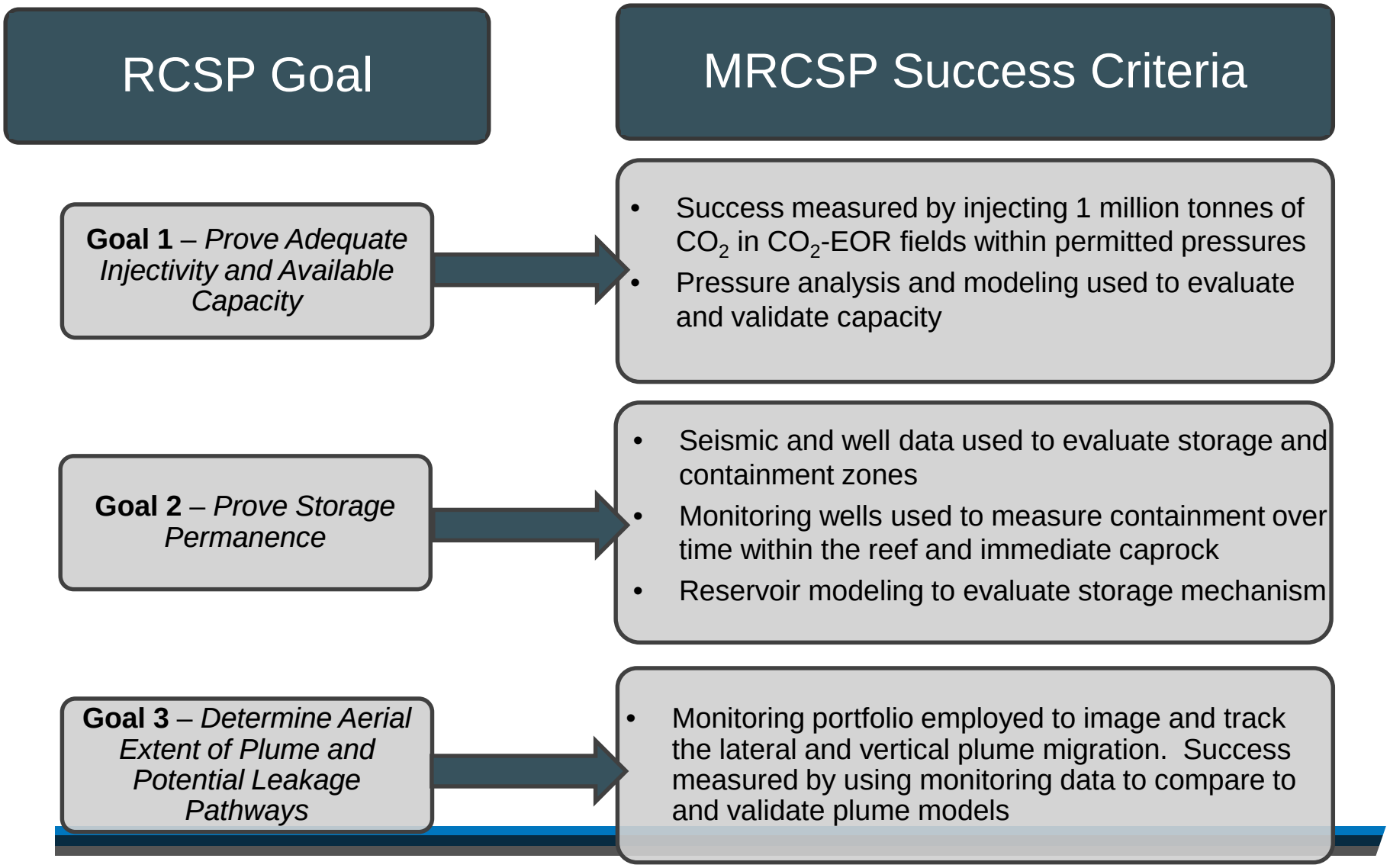
Appendix

Project Overview

MRCSP supports DOE program goals



MRCSP addresses RCSP goals



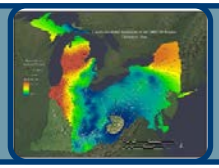
MRCSP addresses RCSP goals

RCSP Goal	MRCSP Success Criteria
Goal 4 – *Develop Risk Assessment Strategies*	• Risk assessment for 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 builds on Phase II best practices in siting, risk management, modeling, monitoring, etc. • Key emphasis is on operation and monitoring and scale-up to commercial-scale
Goal 6 – *Engage in Public Outreach and Education*	• Extensive outreach efforts for both Phase II and Phase III sites as well as technology transfer and sharing • Phase III lessons learned contribute directly to the RSCP Best Practice Manual updates

MRCSP goals and objectives

- Primary goal: To execute a large-scale scale CO_2 injection test to evaluate best practices and technologies required to implement carbon storage
- Objectives are to advance operational, 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 CCS practicability

MRCSP scope of work structured around six tasks



Task 1

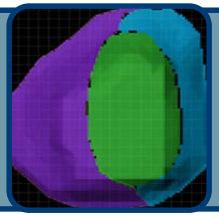
Regional Characterization: *Develop a detailed actionable picture of the region's geologic CO_2 storage resource base*

Task 2

Outreach: *Raise awareness of regional CO_2 storage opportunities and provide stakeholders with information about CO_2 storage*

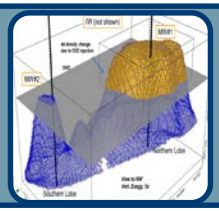
Task 3

Field Laboratory Using Late-Stage EOR Field: *Pressurize a depleted oil field with CO_2 injection to test monitoring technologies and demonstrate storage potential*



Task 4

CO_2 Storage Potential in Active EOR Fields: *Monitor CO_2 Injection and recycling in active EOR operations with different scenarios*



Task 5

CO_2 Injection in New EOR Field(s): *Monitor CO_2 injection into an oil field that has not undergone any CO_2 EOR to test monitoring technologies and demonstrate storage potential*

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Task 6

Program Management

MRCSP organization

DOE/NETL
Andrea McNemar
MRCSP Program Manager

Battelle
The Business of Innovation

Prime Contractor
Neeraj Gupta, PI/PM
M. Kelley, Characterization/Monitoring
L. Cumming, Outreach & Regional Geology
A. Haagsma and A. Conner, Geology
S. Mishra and P. Ravi Ganesh, Modeling
J. Walker, C. Holley, Deputy PM
M. Place, J. Holley, J. Markiewicz, Fieldwork

Pacific Northwest NATIONAL LABORATORY

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Characterization Monitoring Support

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Regional Characterization Task Coordinators

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Sarah Wade
Outreach Working Group Coordinator

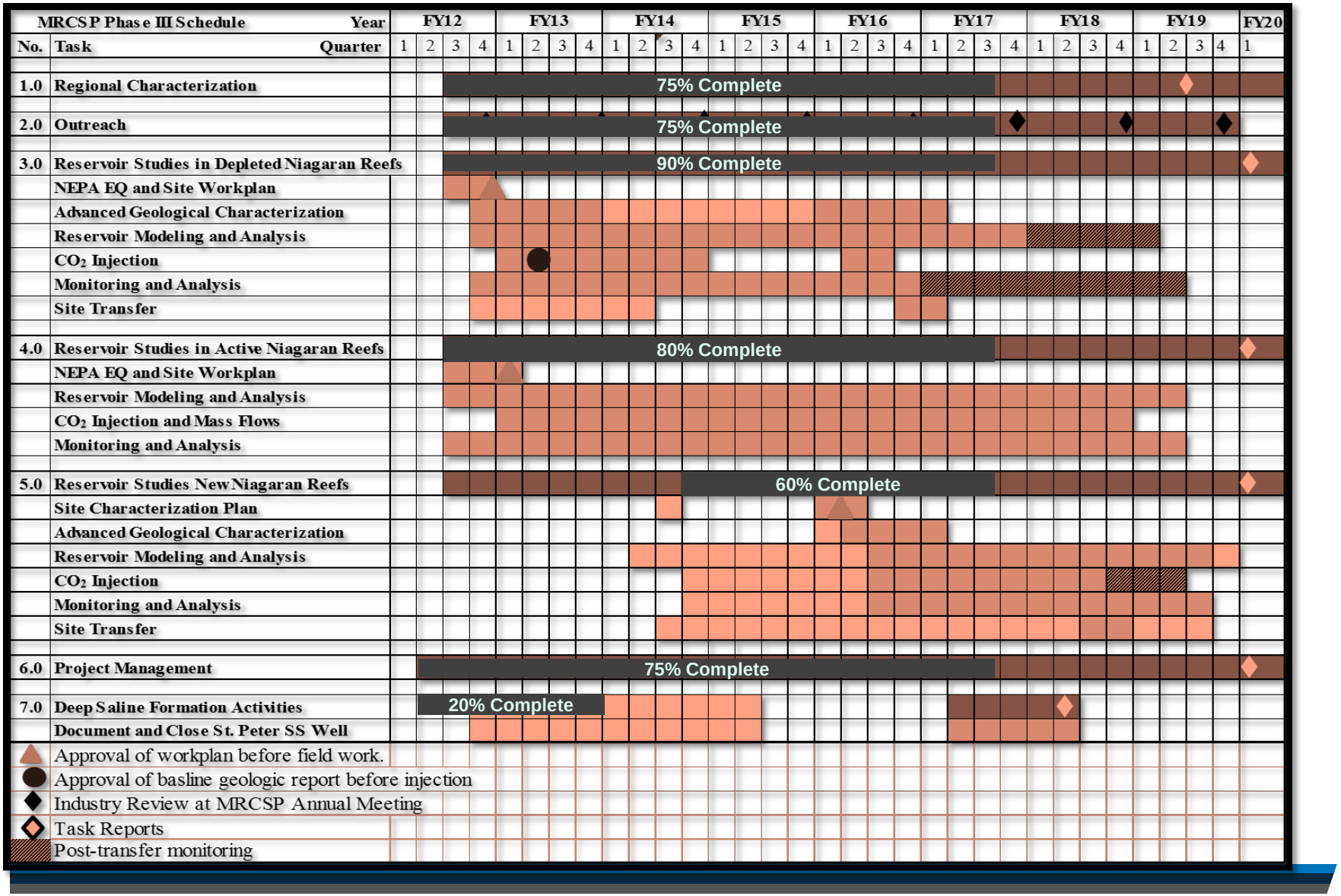
The Ohio State University

David Cole
Geochemical Monitoring
LLNL

CORE ENERGY, LLC

Robert Mannes
Rick Pardini
Large-Scale Test Host

MRCSP task schedule



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Recent Publications and Presentations

- Conner A., Chace, D., Abou-Saleh, J., Kim, Y., McNeil, C., Gerst, J., Kelley, M., Place, M., Pardini, R., and Gupta, N. Developing best practices for evaluating fluid saturations with pulsed neutron capture logging across multiple active CO_2-EOR fields. In Press. Energy Procedia 2017
- Cumming, L., Gupta, N., Miller, K., Lombardi, C., Goldberg, D., ten Brink, U., Schrag, D., Andreasen, D., and Carter, K. 2017. Mid-Atlantic U.S., Offshore Carbon Storage Resource Assessment. In Press. Energy Procedia 2017
- Fukai, I., Mishra, S., and Pasumarti, A. 2017. Technical and Economic Performance Metrics for CCUS Projects: Example from the East Canton Consolidated Oil Field, Ohio, USA. In Press. Energy Procedia 2017
- Gupta, N., Haagsma, A., Howat, E., Kelley, M., Hawkins, J., Fukai, I., Conner, A., Larsen, G., Main, J., McNeil, C., and Sullivan, C. 2017. Integrated Sub-Basin Scale Exploration for Carbon Storage Targets: Advanced Characterization of Geologic Reservoirs and Caprocks in the Upper Ohio River Valley. In Press. Energy Procedia 2017
- Gupta, N., Kelley, M., Place, M., Cumming, L., Mawalkar, S., Mishra, M., Haagsma, A., Mannes, R., and Pardini, R. 2017. Lessons Learned from CO_2 Injection, Monitoring, and Modeling Across a Diverse Portfolio of Depleted Closed Carbonate Reef Oil Fields – the Midwest Regional Carbon Sequestration Partnership Experience. In Press. Energy Procedia 2017
- Haagsma, A., Rine, M., Sullivan, C., Conner, A., Kelley, M., Modroo, A., Larsen, G., and Gupta, N. 2017. Static Earth Modelling of Diverse Michigan Niagaran Reefs and the Implications for CO_2 Storage, Energy Procedia 114C (2017) pp.3336-3346
- Hawkins, J., Mishra, S., Stowe R., Makwana, K., Main J. CO2 storage capacity and potential CO2-EOR in oilfields of Ohio. Environmental Geosciences. March. 2017

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- Miller, K.G., Browning, J.V., Sugarman, P.J., Monteverde, D.H., Andreasen, D.C., Lombardi, C., Thornburg, J., Reinfelder, Y., and Kopp, R.E., 2017, Lower to mid-Cretaceous sequence stratigraphy and characterization of CO2 storage potential in the Mid-Atlantic U.S. Coastal Plain. Journal of Sedimentary Research, v. 87, p. 609-629, available at: http://eps.rutgers.edu/images/17-MillerCCS.full.pdf
- Miller, K.G., Lombardi, C., Browning, J.V., Schmelz, W.J., Gallegos, G., and Mountain, G.S., Back to basics of sequence stratigraphy: Early Miocene and Mid Cretaceous examples from the New Jersey paleoshelf. Journal of Sedimentary Research (provisionally accepted June 27, 2017).
- Mishra, S., Ravi Ganesh, P., Kelley, M., and Gupta, N. 2017. Analyzing the Performance of Closed Reservoirs Following CO_2 Injection in CCUS Projects. In Press. Energy Procedia 2017
- Mishra, S. and Ravi Ganesh, P. 2017. Developing and Validating Simplified Predictive Models for CO_2 Geologic Sequestration. In Press. Energy Procedia 2017
- Rine, M., Garrett, J., and Kaczmarek, S.E., 2017, A new facies architecture model for the Silurian Niagara-Lower Salina “Pinnacle” Reef Complexes of the Michigan Basin, in MacNeil, A., Lonnee, J., and Wood, R., eds., Advances in Characterization and Modeling of Complex Carbonate Reservoirs: SEPM Special Publication.
- Rine, M., Garrett, J., and Kaczmarek, S., (in review), A new sequence stratigraphic model for the Silurian A-1 Carbonate (Ruff Formation) of the Michigan Basin: GSA Special Publication: Michigan Basin.
- Sminchak, J., Babarinde, O., and Gupta, N. Integrated Analysis of Geomechanical Factors for Geologic CO_2 Storage in the Midwestern United States. In Press. Energy Procedia 2017