

MRCSP Baseline Monitoring Results Large-Scale Injection of CO₂ in Depleted Reefs in Northern Michigan

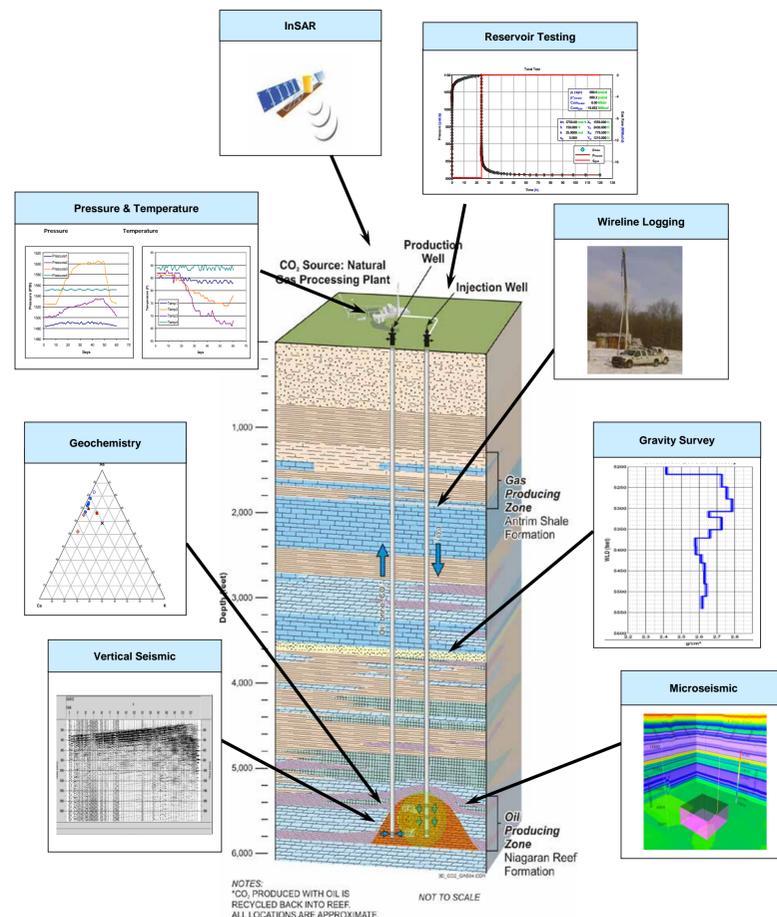
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Abstract

An evaluation of large-scale injection and utilization of CO₂ in several depleted oil bearing carbonate reefs is being performed under the Midwest Regional Carbon Sequestration Partnership (MRCSP). CO₂ for this effort is being supplied from gas processing plants located in the northern lower-peninsula of Michigan. The reef structures are in various stages of life-cycle, including highly depleted reefs that have undergone CO₂ enhanced oil recovery (EOR) in the past, currently active EOR reefs, and reefs that will start new EOR operations – thus offering opportunity to evaluate different aspects of CO₂ utilization and storage. A detailed assessment of CO₂ injection and flow in these closed reservoirs through extended site characterization, modeling, and monitoring is underway. Characterization efforts are underway to determine the structure, stratigraphy, fluid saturation, and history of individual reefs, with an initial focus on a depleted reef that has already undergone CO₂ EOR for several years and is near the end of commercial production phase.

Several monitoring technologies are being deployed to assess the fate of the CO₂, including pressure monitoring, wireline logging (e.g. pulsed neutron), vertical seismic profiling, microseismic monitoring, microgravity monitoring, and surface deformation monitoring. Results of the research are being used to improve understanding of CO₂ migration and oil production in reservoirs, interaction with surrounding media, geochemical and geomechanical impacts, and storage capacity.



Site Overview

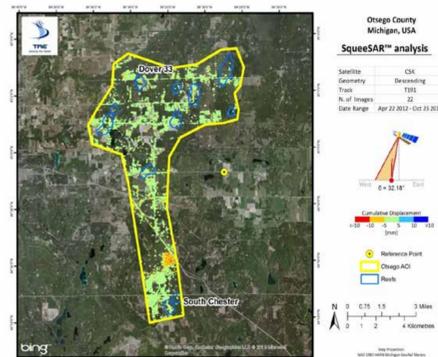


In Dover 33, there is one vertical injection well, one deviated monitoring/production well and one horizontal monitoring/production well.

The reef has a depth extending from 5400 to 5700 feet deep with a maximum height of 280 feet and a total aerial extent of 60 acres. Porosity values extend to 24%, but typically range from 3–11% with an average of 7%.

Remote Sensing (InSAR)

Historical satellite measurements were analyzed in the Dover 33 vicinity. In addition, 29 artificial corner reflectors were installed to increase data fidelity.



Both studies showed there was no significant ground motion trends off-versus-on reef. In addition, a seasonal trend was observed.

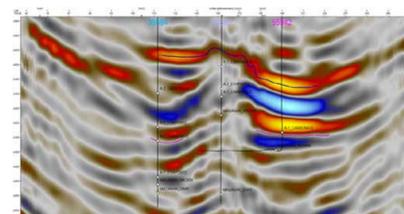
Monitoring will continue during injection period to evaluate any changes

Vertical Seismic Profile



Five walk away VSP lines were collected centered around the injection well to better image the reef.

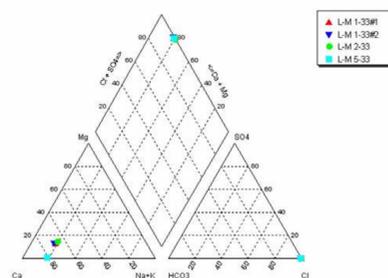
Processed data showed much higher frequency recovery than the 3D seismic survey.



Additional horizons, formation pinch out and a clearer picture of the interior of the reef have been extracted from the data.

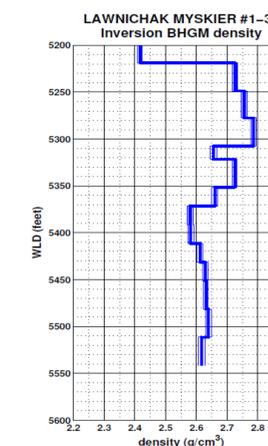
Geochemistry

Two sampling events have occurred. One samples the formation fluid and one sampled the gas in the well bore. The samples indicate that any interactions between the CO₂, native formation fluids and the rocks are nearly at equilibrium. It is likely that the effects from the earlier CO₂ injection have largely been completed. Additional isotope, organic, and inorganic analysis are underway.



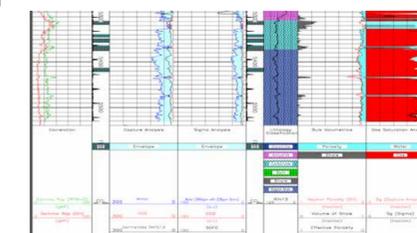
Wireline Logging and Gravity Survey

Logging was conducted to both aid in characterization and to establish a baseline measurement for repeat logging.



Well	Log	Interval (MD)
1-33 (29565)	CBL	800-5230
	PNC	3500-5553
	Sonic	800-5230
2-33 HD 4 (55942)	Gyro	0-TD
	Gravity Survey	0-TD, specific points
5-33 HD 1 (51603)	PNC	3500-7061
	Gyro	0-TD
	CBL	3300-5569
	PNC	3500-6409
	Sonic	4900-5560
	Gyro	0-TD

A gravity survey was completed using 35 depth stations in the injection well. The data was inverted for density. Repeated measurements are expected to see minute changes in the density profile due to the injection of CO₂.



PNC logs were run in all three open wells. Data was processed to show the gas-fluid profile in the near well bore environment. All wells indicated a high percentage of gas present.

Conclusions and Next Steps

A wide variety of monitoring technologies are being employed at the Dover 33 highly depleted field test site. The diversity of technologies allows for thorough testing of technologies as well as an integrated approach towards assessment of CO₂ in the subsurface.

Next steps will include the following:

- Finalize baseline interpretations of the data.
- Formally integrate results into the Static Earth Model for Dover 33.
- Determine best practices for implementing repeat monitoring events. These will be scheduled during and after injection.
- Use of field logistics, design, and performance information for developing plans for next reef site

Acknowledgements

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