RESEARCH PERFORMANCE PROGRESS REPORT

U.S. Department of Energy National Energy Technology Laboratory

Cooperative Agreement: DE-FE0031558

Project Title: Partnership for Offshore Carbon Storage Resources and Technology Development in the Gulf of Mexico

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AMENDED

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DUNS Number: 170230239

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Project Period: April 1, 2018 – March 31, 2022

Reporting Period End Date: September 30, 2018

Report Frequency: Quarterly

Signature Submitting Official: _____

EXECUTIVE SUMMARY OF RESEARCH DEVELOPMENTS DURING THIS QUARTER

Subcontracts with sub-recipients Fugro, TDI-Brooks, Inc. Trimeric, LLC and USGS were negotiated. The subcontract with Lamar University was fully executed on July 10, 2018. The Trimeric subcontract was fully executed on August 21, 2018. The USGS subcontract was fully executed on September 13, 2018. The subcontracts for Fugro and TDI-Brooks were pending/awaiting actions and/or signatures from the sub-recipients at the end of the reporting quarter. Negotiations related to augmenting the Partnership's scope commensurate with projected additional funding of between $4 million and $10 million continued between NETL and The University of Texas at Austin (UT). At the end of the reporting quarter (i.e., also the Federal fiscal year), unofficial communications were received from NETL PM indicating that the Partnership's scope and funding augmentation had been approved.

A WebEx (conference call / videoconference) meeting of the Partnership advisory committee occurred on July 23, 2018. This was the second meeting of the committee. The first occurred early in the award negotiation phase, on December 14, 2017. The Partnership PI presented a summary and overview of the project at the first-day plenary session of NETL's "MASTERING THE SUBSURFACE THROUGH TECHNOLOGY INNOVATION, PARTNERSHIPS & COLLABORATION" meeting. In addition, there was an informal face-to-face meeting on August 14, 2018 of some advisory committee members and researchers at the same meeting. An EDX workspace was created for the Partnership, and Partners were encouraged to utilize it to share data, text products, etc. with each other.

The Louisiana Geological Survey sub-recipient reported updating the Louisiana offshore (State waters) database.

Initial assessment of the Chandeleur Sound 3D seismic survey revealed the data was post stack time migrated necessitating a conversion to depth to tie biostratigraphically constrained well tops and surface picks from the GBDS database. A preliminary velocity model for Chandeleur Sound was created by identifying three ION GulfSPAN 2D lines that intersected the 3D survey and utilizing their interval velocity data to interpolate a model with full coverage over the Chandeleur area.

Although, no Partnership-supported activity occurred for subtask 2.1.3 during the reporting quarter, corresponding geological interpretation did occur in the geographic area of interest under the auspices of another NETL grant, DE-FE0026083, "Offshore CO2 Storage Resource Assessment of the Northern Gulf of Mexico (Texas-Louisiana)." The resulting geologic characterization will be useful to several other Tasks in the Partnership (e.g., Task 3) such as input for geomechanical assessment.

Task 1.0 – Project Management, Planning, and Reporting

With the hiring of a new contracts specialist at the Bureau of Economic Geology (BEG), subcontracts with sub-recipients Fugro, TDI-Brooks, Inc. Trimeric, LLC and USGS were negotiated. The subcontract with Lamar University was fully executed on July 10, 2018. The Trimeric subcontract was fully executed on August 21, 2018. The USGS subcontract was fully executed on September 13, 2018. The subcontracts for Fugro and TDI-Brooks were pending/awaiting actions and/or signatures from the sub-recipients at the end of the reporting quarter.

An internal UT LoA (letter of agreement) between the Bureau of Economic Geology (BEG) and the UT Institute for Geophysics (UTIG) was finalized. The LoA will facilitate participation in the Partnership by the Gulf Basin Depositional Synthesis (GBDS) group, which will provide the Partnership with longstanding regional geologic expertise of the Gulf of Mexico (GoM) and will focus on the Chandeleur Sound, Louisiana area.

Negotiations related to augmenting the Partnership's scope commensurate with projected additional funding of between $4 million and $10 million continued between NETL and The University of Texas at Austin (UT). Augmentation of the Partnership would include: 1) expanding most of the original sub-recipients' research and project objectives and 2) engaging three new organizations, Aker Solutions, Texas A&M Geochemical and Environmental Research Group (GERG), (vendor) GfK, and a consultant, Dr. Rob Finley. At the end of the reporting quarter (i.e., also the Federal fiscal year), unofficial communications were received from NETL PM indicating that the Partnership's scope and funding augmentation had been approved. The NETL project manager agreed that it would be most efficient to wait to update the Partnership PMP until after the augmented scope and funding are in place.

Preparing the augmentation proposal and budget required extensive communications and interactions with the original sub-recipients and proposed new sub-recipients. The efforts necessarily diverted time and energy away from usual early-project start-up activities and somewhat slowed progress on the original scope and project management.

A WebEx (conference call / videoconference) meeting of the Partnership advisory committee occurred on July 23, 2018. This was the second meeting of the committee. The first occurred early in the award negotiation phase, on December 14, 2017. During the July meeting, one of the co-PI's and the PI presented, respectively, 1) a high level overview of the Partnership and 2) aspirational goals. The ongoing Partnership scope and funding augmentation negotiations were confidentially shared with the advisory committee members. Dates for the first annual Partnership meeting were discussed. The week of February 11, 2019 was proposed.

On August 13, 2018, the Partnership PI presented a summary and overview of the project at the first-day plenary session of NETL's "MASTERING THE SUBSURFACE THROUGH TECHNOLOGY INNOVATION, PARTNERSHIPS & COLLABORATION" meeting. In addition, there was an informal face-to-face meeting on August 14, 2018 of some advisory committee members and researchers at the same NETL meeting.

Dr. Rob Finley, former leader of a $100 million project on carbon sequestration in the Illinois Basin, the Midwest Geological Sequestration Consortium (one of the U.S. Department of Energy's Regional Carbon Sequestration Partnerships) also participated in the NETL meeting on behalf of the GoMCarb Partnership. Dr. Finley is also a former Associate Director of the BEG and provided valuable feedback to the GoMCarb Partnership PIs about his interactions at the meeting.

An EDX workspace was created for the Partnership, and Partners were encouraged to utilize it to share data,

text products, etc. with each other.

An improved version of the Partnership's area of interest map (including that of the sister Partnership) was generated (Figure 1.1).

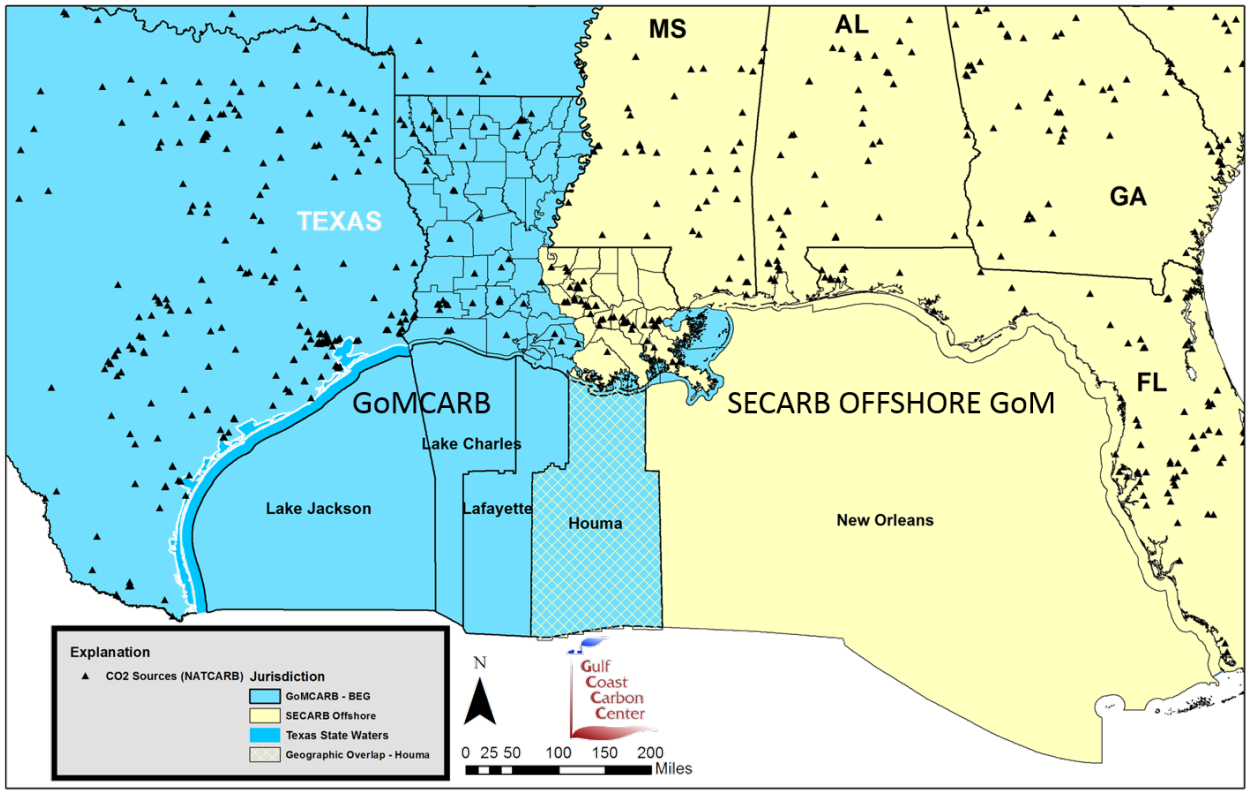

Figure 1.1 – Updated and improved map version of the GoMCARB and SECARB Offshore GoM Partnerships', respective, areas of interest.

On September 13, the Partnership held the first in a series of periodic Research – Outreach (RO) meetings via WebEx. The purpose of the meetings was to be sharing updates with each other across the Partnership. This first meeting included a review by the PI, Dr. Hovorka, of the Partnership overview she presented during the 2018 "Mastering the Subsurface through Technology Innovation, Partnerships & Collaboration: Carbon Storage & Oil & Natural Gas Technologies Review" meeting in Pittsburgh.

In addition, the PI shared and discussed coordination rules for GoMCarb partners as follows:

Coordination rules for GOMCarb

Draft for Research – Outreach (RO) webinar 9/13/2018

We will use NETL EDX for providing data

- Sign up as a user. Each person on your team can get his/her own logon, or one person be lead.
- We will start simple – BEG post for RO to use
- As we build skills, RO can start to post data sets
- We will keep the data private, *only for GoMCarb RO use* (do not provide to others)
- As we progress, we will make data public (via publication process), as required by DOE.

Data control

- We (and soon you) will be uploading unpublished data to facilitate collaborative use
- Please observe publication rules below. Please enforce rules to your collaborators.
- Critical to not "scoop" data generators. People generating data need time to publish: ***be very careful with ownership of shared data***.

Publication – subcontractors must enforce rules though your whole team.

- All publications planned and in process must undergo peer review from project collaborators and project PI's or delegates.
    - Protect authorship
    - Correct errors that damage project credibility
    - Increase collaboration
- Peer review process:
    - When you are *first considering* a publication (including externally, peer-reviewed submissions, conference presentations/posters) that is partly funded by GoMCarb or uses any GoMcarb data, you must begin a file on EDX with title, venue, date, authors, and general content planned. Inform the entire RO team of the EDX doi . This will let any review needs be worked out and protect ownership and authorship of data. **At least one week notice.**
- When a draft (abstract, poster, talk, paper, open file) is prepared, you must post a draft on EDX and let those who want to review, and the PI's (Sue Tip and Ramon) know. Need at least a day, more is kinder.
- Post final version (abstract, poster, talk, submitted and authors final paper) on EDX to comply with DOE reporting requirements. Comply with copyright by using author's versions.

Task 2.0 – Offshore Storage Resource Assessment

Subtask 2.1 – Database development:

Subtask 2.1.1 – Geographic Focus Area A - Lake Jackson, Lake Charles, and Lafayette (OCS) districts

The Louisiana Geological Survey sub-recipient is currently updating the Louisiana offshore (State waters) database.

Subtask 2.1.2 – Geologic Characterization of Chandeleur Sound, LA

Initial assessment of the Chandeleur Sound 3D seismic survey revealed that the dataset was post stack time migrated necessitating a conversion to depth to tie biostratigraphically constrained well tops and surface picks from the GBDS database. A preliminary velocity model for Chandeleur Sound was created by 1) identifying three GulfSPAN 2D lines (from ION Geophysical) that intersected the 3D survey and 2) utilizing their interval velocity data to interpolate a model with full coverage over the Chandeleur area. Due to the significant distance between the 2D lines there are noticeable portions of the model that are slightly misaligned, but overall the converted seismic presented an approximate fit to the existing tops (Figure 2.1.2.1 and 2.1.2.2).

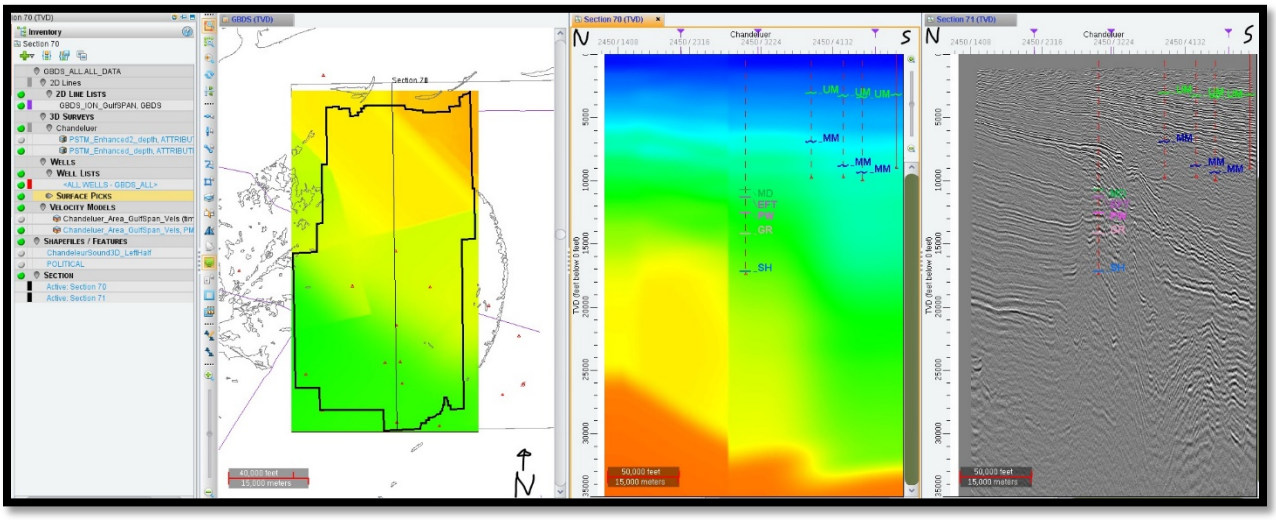

Figure 2.1.2.1 – North to South interpreted velocity model with section with wells and tops

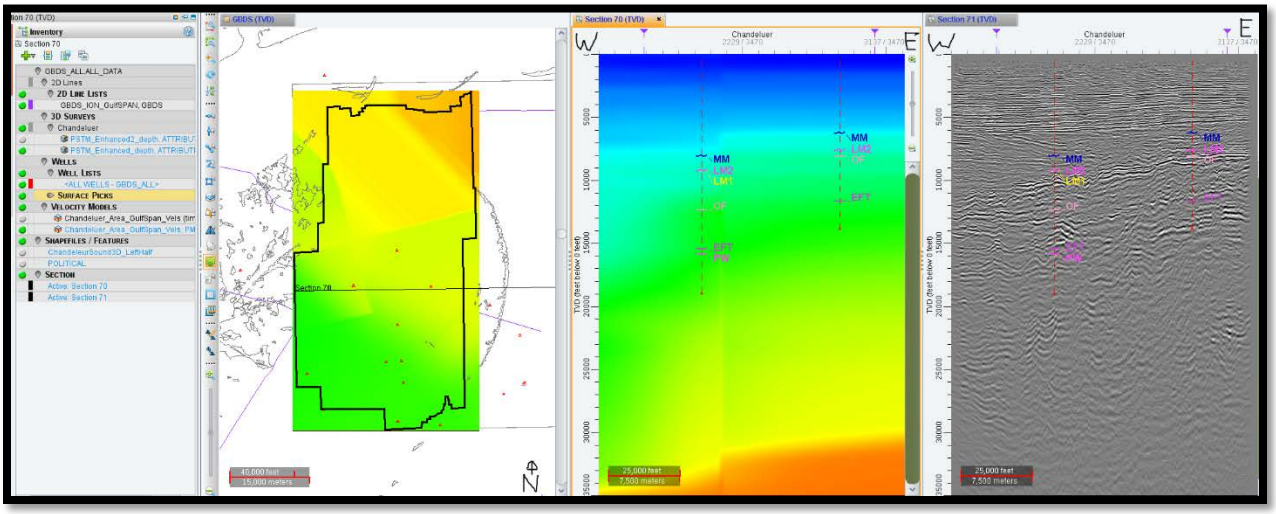

Figure 2.1.2.2 – West to East interpreted velocity model with section with wells and tops

Well Data Mining and Interpreted Tops

Micropaleontological (aka “paleo”) data acquired from Paleo Data, Inc. was searched for well locations within and close to the Chandeleur Sound 3D seismic survey. Using the API numbers for wells with paleo data (Figure 2.1.2.3A and Table 2.1.2.1) associated geophysical logs were downloaded from The Louisiana Department of Natural Resources SONRIS website. Biostratigraphically constrained tops (Table 2.1.2.2) were then interpreted using this data and entered into GBDS GIS and Landmark seismic databases. It should be noted that there are additional wells in the area with logs for which, however, no paleo is available (Figure 2.1.2.3B).

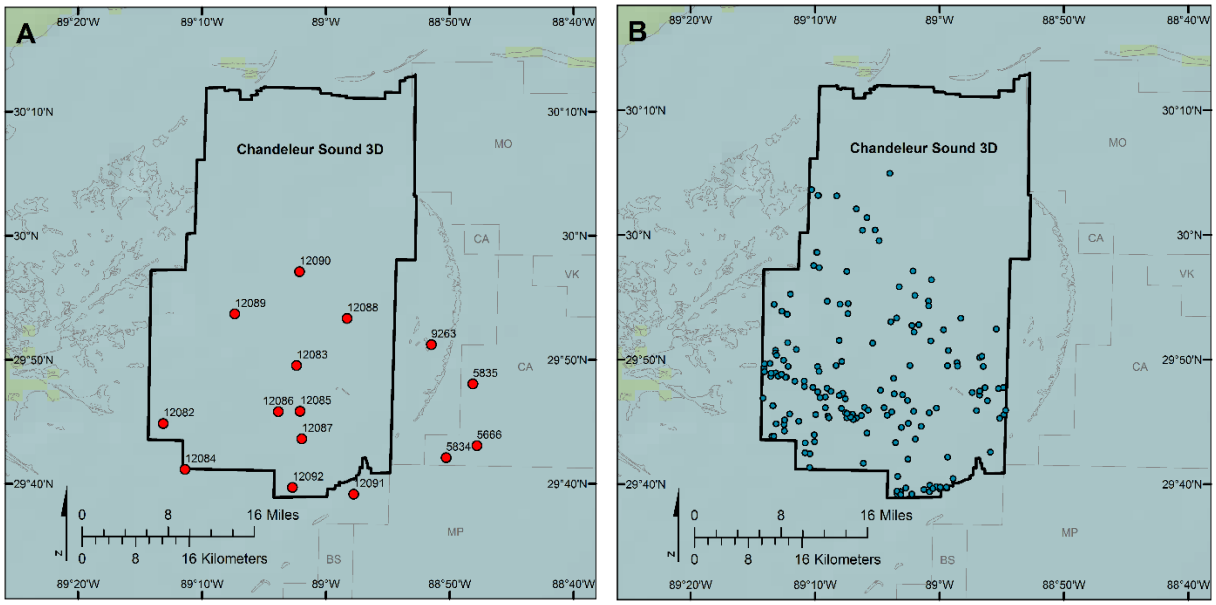

Figure 2.1.2.3 Well location maps. (A) Wells in Chandeleur with paleo data and (B) wells with available geophysical well logs.

Table 2.1.2.1 Well location and header information

GBDS Well Id	API	Operator	Lease	Latitude	Longitude	TVD (ft)	TVD Date	Kelly Bushing (ft)
5666	177284001500	Tenneco	Chandeleur 29 #A001	29.717962	-88.796593	5250	12/15/2003	68
5834	177282000600	Exxon	Chandeleur Sound Blk 28 No 1	29.70174	-88.83789	16140	2/9/1983	100
5835	177280000200	Chevron	Chandeleur Sound 6 #1	29.800798	-88.802002	13947	1/4/1967	
9263	177300000600	Shell	State Lease 4898 #1	29.853602	-88.857926	20123	3/10/1968	31
12082	177272049000	Coastal Oil and Gas	State Lease 16164 #1	29.747548	-89.218734	8290	1/4/1999	49
12083	177270015600	British American Oil	State Lease 4548 #1	29.825402	-89.039438	9775	11/22/1965	26
12084	177262034600	Prairie Producing	State Lease 10761 #4	29.685883	-89.189487	11224	3/1/1985	32
12085	177270012800	British American Oil	State Lease 4558 #1	29.764101	-89.034537	9731	11/4/1965	25
12086	177270012900	British American Oil	State Lease 4556 #1	29.763501	-89.063938	9991	10/19/1965	25
12087	177270017300	Gulf Oil	State Lease 4566 #1	29.727003	-89.03224	9995	4/14/1966	33
12088	177270023600	Gulf Oil Corporation	State Lease 5114 Well #1	29.8888	-88.971332	13894	8/1/1936	54
12089	177272012900	Phillips Petroleum Company	State Lease 8244 #1	29.894835	-89.122567	19013	11/24/1980	40
12090	177302001400	Pel-Tex Oil Co.	State Lease 11778 #1	29.951649	-89.035336	17412	9/14/1985	34
12091	177260023100	Chevron	State Lease 4125 #2	29.652604	-88.962535	9924	7/5/1965	23
12092	177262002000	Placid	State Lease 5384 #1	29.661703	-89.044941	9006	4/24/1970	57

Table 2.1.2.2 Well tops, unit thickness, and penetration data

GBDS Well Id	Unit Id	Top Elevation (ft TVDSS)	Interval Thickness (ft)	Penetration
5666	UM	-3180	2160	Base unit, partial penetration
5835	UM	-2950	3625	Single genetic unit
5835	MM	-6575	1350	Single genetic unit
5835	LM2	-7925	825	Single genetic unit
5835	LM1	-8750	750	Single genetic unit
5835	OF	-9500	1050	Single genetic unit
5835	JS	-10550	NA	Base unit, inconsequential penetration
9263	NT	-10599	1087	Cover unit, top known
9263	AC	-11686	223	Single genetic unit
9263	EFT	-11909	394	Single genetic unit
9263	PW	-12303	4197	Single genetic unit
9263	GR	-16500	920	Single genetic unit
9263	FL	-17420	849	Single genetic unit
9263	RD	-18269	680	Single genetic unit
9263	BP	-18949	325	Single genetic unit
9263	SH	-19274	818	Base unit, partial penetration
5834	UM	-3800	5700	Single genetic unit
5834	MM	-9500	1950	Single genetic unit
5834	LM2	-11450	900	Single genetic unit
5834	LM1	-12350	1250	Single genetic unit
5834	OF	-13600	1600	Base unit, partial penetration
12082	UM	-2481	NA	Base unit, inconsequential penetration
12083	UM	-3074	3850	Single genetic unit
12083	MM	-6924	NA	Base unit, inconsequential penetration
12084	UM	-3768	6070	Single genetic unit
12084	MM	-9838	NA	Base unit, inconsequential penetration
12085	UM	-3295	5530	Single genetic unit
12085	MM	-8825	NA	Base unit, inconsequential penetration
12086	MM	-8175	920	Single genetic unit
12086	LM2	-9095	180	Single genetic unit
12086	LM1	-9275	NA	Base unit, inconsequential penetration
12087	UM	-3417	5950	Single genetic unit
12087	MM	-9367	NA	Base unit, inconsequential penetration
12088	MM	-6246	1370	Single genetic unit
12088	LM2	-7616	510	Undifferentiated unit
12088	LM1	-7616	510	Undifferentiated unit
12088	OF	-8126	3520	Undifferentiated unit
12088	EFT	-11646	NA	Base unit, inconsequential penetration
12089	MM	-8060	1180	Single genetic unit
12089	LM2	-9240	50	Single genetic unit
12089	LM1	-9290	3075	Single genetic unit
12089	OF	-12365	3085	Undifferentiated unit
12089	EFT	-15450	440	Single genetic unit
12089	PW	-15890	NA	Base unit, inconsequential penetration
12090	MD	-10696	640	Undifferentiated unit
12090	NT	-10696	640	Undifferentiated unit
12090	AC	-10696	640	Undifferentiated unit
12090	EFT	-11336	1200	Single genetic unit
12090	PW	-12536	1670	Single genetic unit
12090	GR	-14206	2960	Undifferentiated unit
12090	SH	-17166	NA	Base unit, inconsequential penetration
12091	UM	-3327	5970	Single genetic unit
12091	MM	-9297	NA	Base unit, inconsequential penetration
12092	UM	-3213	NA	Base unit, inconsequential penetration

Seismic Interpretation

Seismic interpretation began with the mapping of the top Cretaceous so to constrain the Cenozoic stratigraphy in the Chandeleur survey area. The top of the Cretaceous ranges from ~8,000' TVD to ~19,000' TVD. The shelf edge is represented by the bright green color (Figure 2.1.2.4). Once the top Cretaceous was picked across the entire area, the surface was converted to a color-contoured grid (Figure 2.1.2.5). The interpretation of the top Cretaceous was completed in Q3 2018.

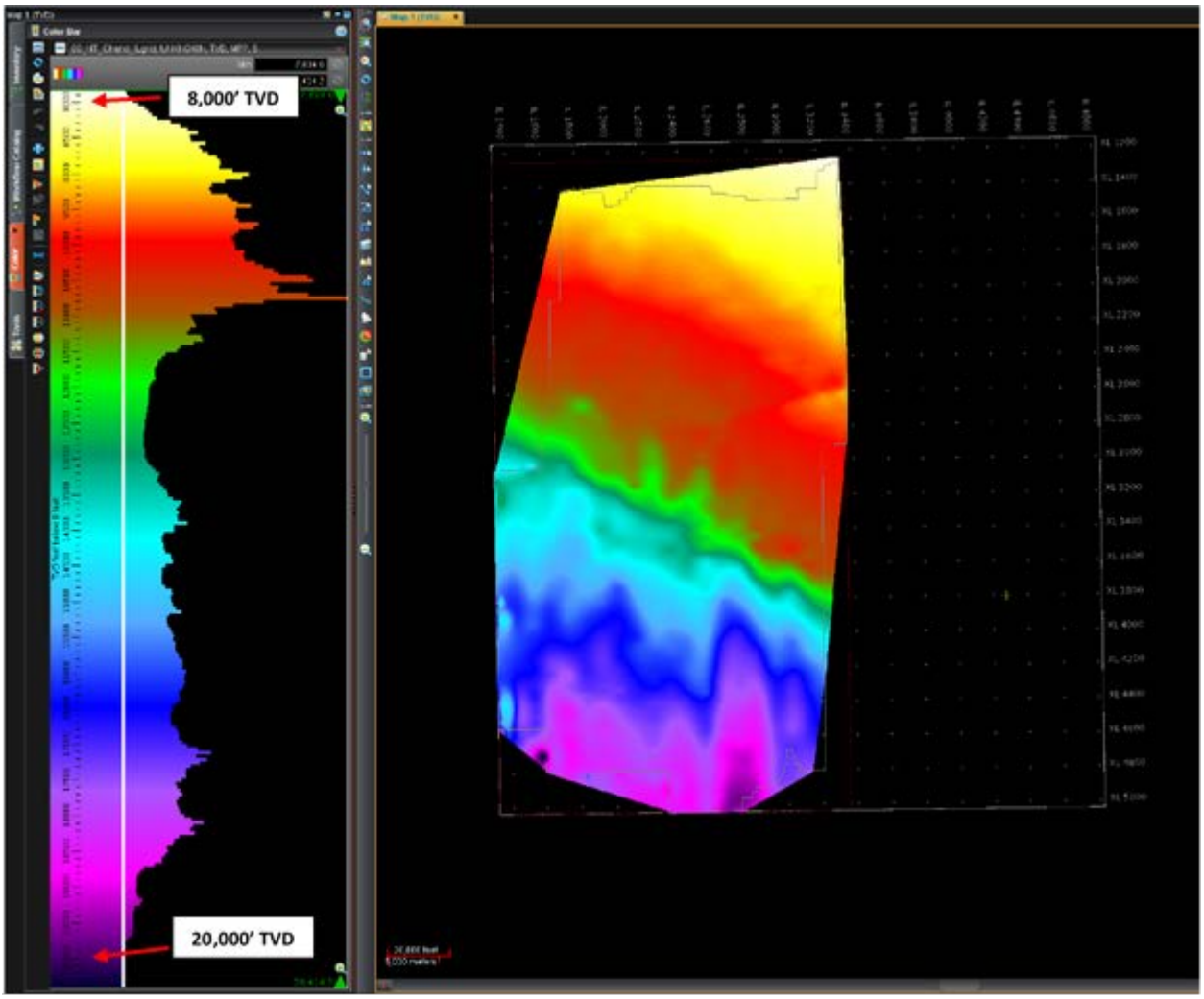

Figure 2.1.2.4 Interpolated surface of top Cretaceous

Figure 2.1.2.5 Cross section (A-A') showing top Cretaceous pick (bright blue). *Figure with proprietary data removed.*

Subtask 2.1.3 Geologic Characterization of High Island, TX

No activity this quarter. Although, no Partnership-supported activity occurred for this subtask during the reporting quarter, corresponding geological interpretation did occur in the area under the auspices of another NETL grant, DE-FE0026083, "Offshore CO2 Storage Resource Assessment of the Northern Gulf of Mexico (Texas-Louisiana)." Specifically, geologic characterization informally known as the "High Island 10-L Field extension" involves interpretation of a conventional 3D seismic dataset ("TexLa Transition Zone Merge" aka "TexLa Merge") located offshore from the southern extent of the Bolivar Peninsula of Texas to the southwestern corner of Louisiana. The TexLa Merge is shown in orange with red-dashed polygon border outline in Figure 2.1.3.1. Similarly, Figure 2.1.3.2 is a close-up of the TexLa Merge showing the

extent of the High Island 10-L Field extension interpretation task (i.e., for DE- FE0026083), and Figure 2.1.3.3 is a close-up detailing the current depth-structure interpretation of the 10-L field itself at the MFS09 level, which is equivalent to the base of the middle Miocene age biochronozone, *Amphistegina B.* The objective of the 10-L extension interpretation is to extend the geologic interpretation from the area in Figure 2.1.3.3 to throughout the red-dashed polygon area in Figure 2.1.3.2. The result will be useful to several other Tasks in the Partnership (e.g., Task 3) such as input for geomechanical assessment.

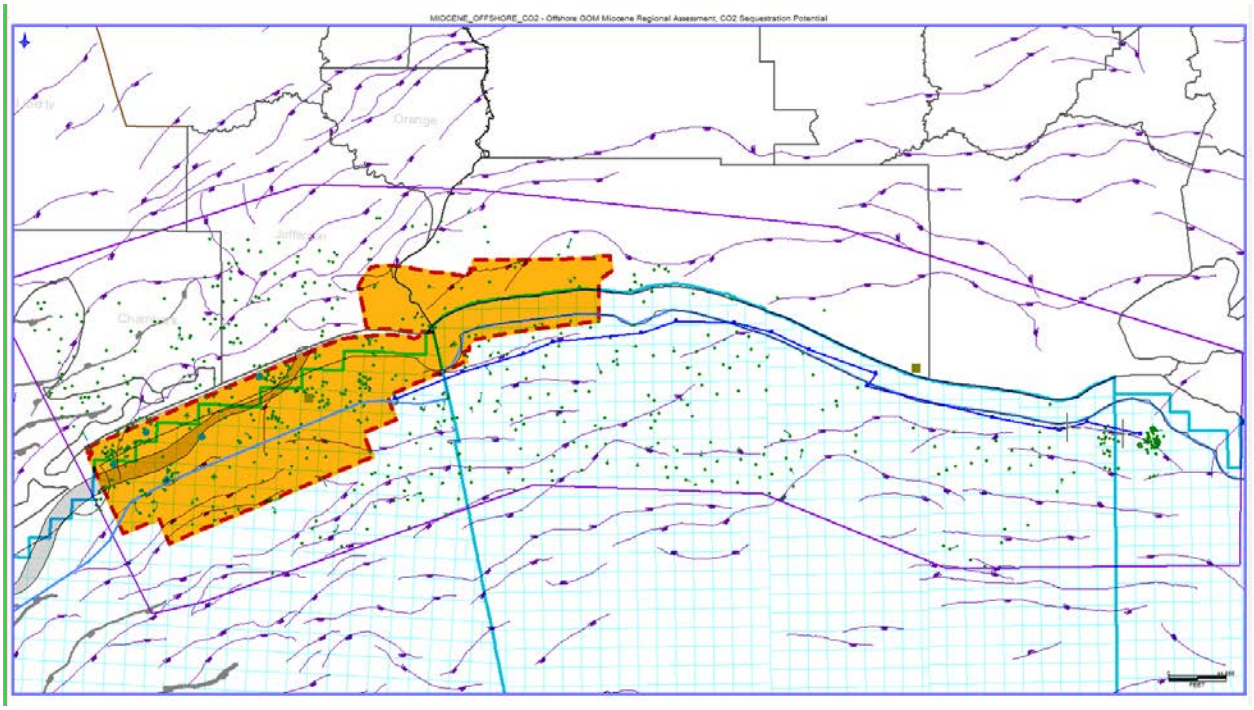

Figure 2.1.3.1 – Map of the northwestern Gulf of Mexico coastline. Note the orange-colored polygon with red-dashed line border, which shows the extent of the "TexLa Transition Zone Merge" (TexLa Merge) 3D seismic dataset, a key seismic dataset for the GoMCarb Partnership.

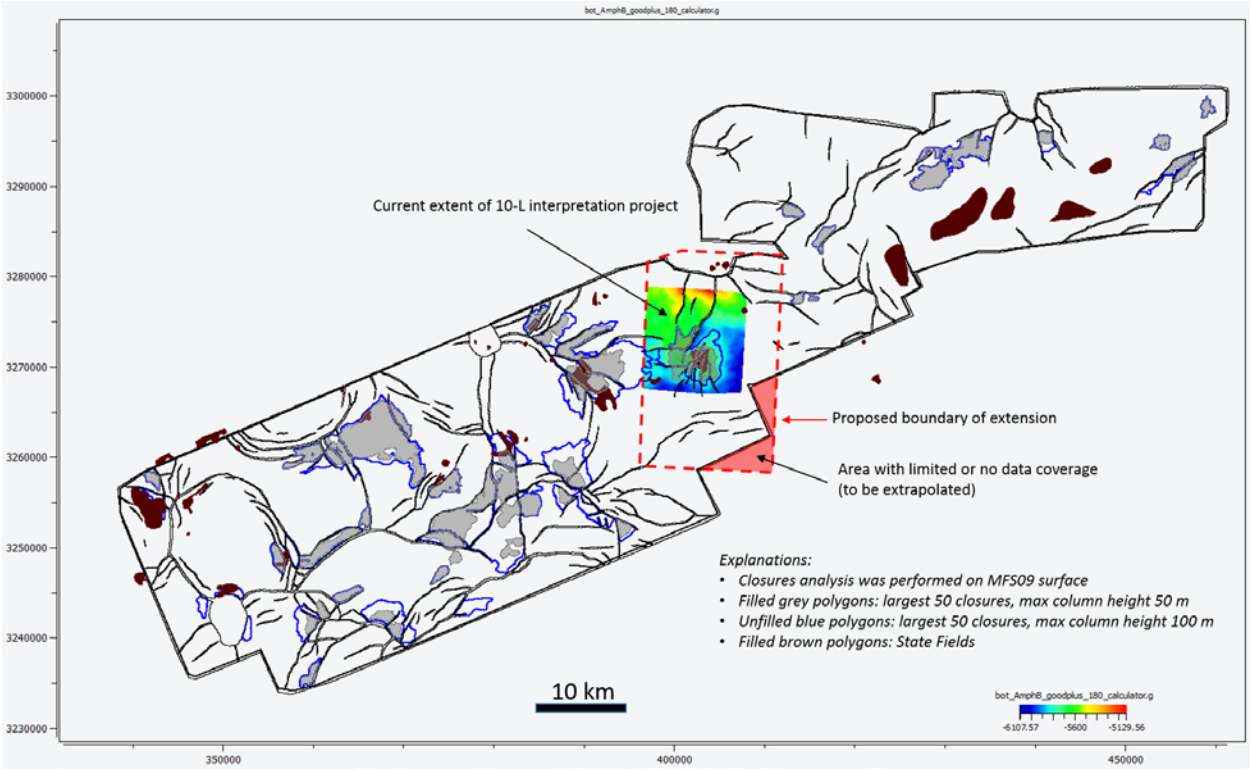

Figure 2.1.3.2 – Fault map of the TexLa Merge 3D dataset at the MFS09 surface, which is approximately equivalent to the base of the middle Miocene age biochronozone, *Amphistegina B*. Note the red-dashed polygon with the multi-colored square within it. The red-dashed polygon defines the High Island 10-L extension, currently being geologically characterized in project DE- FE0026083.

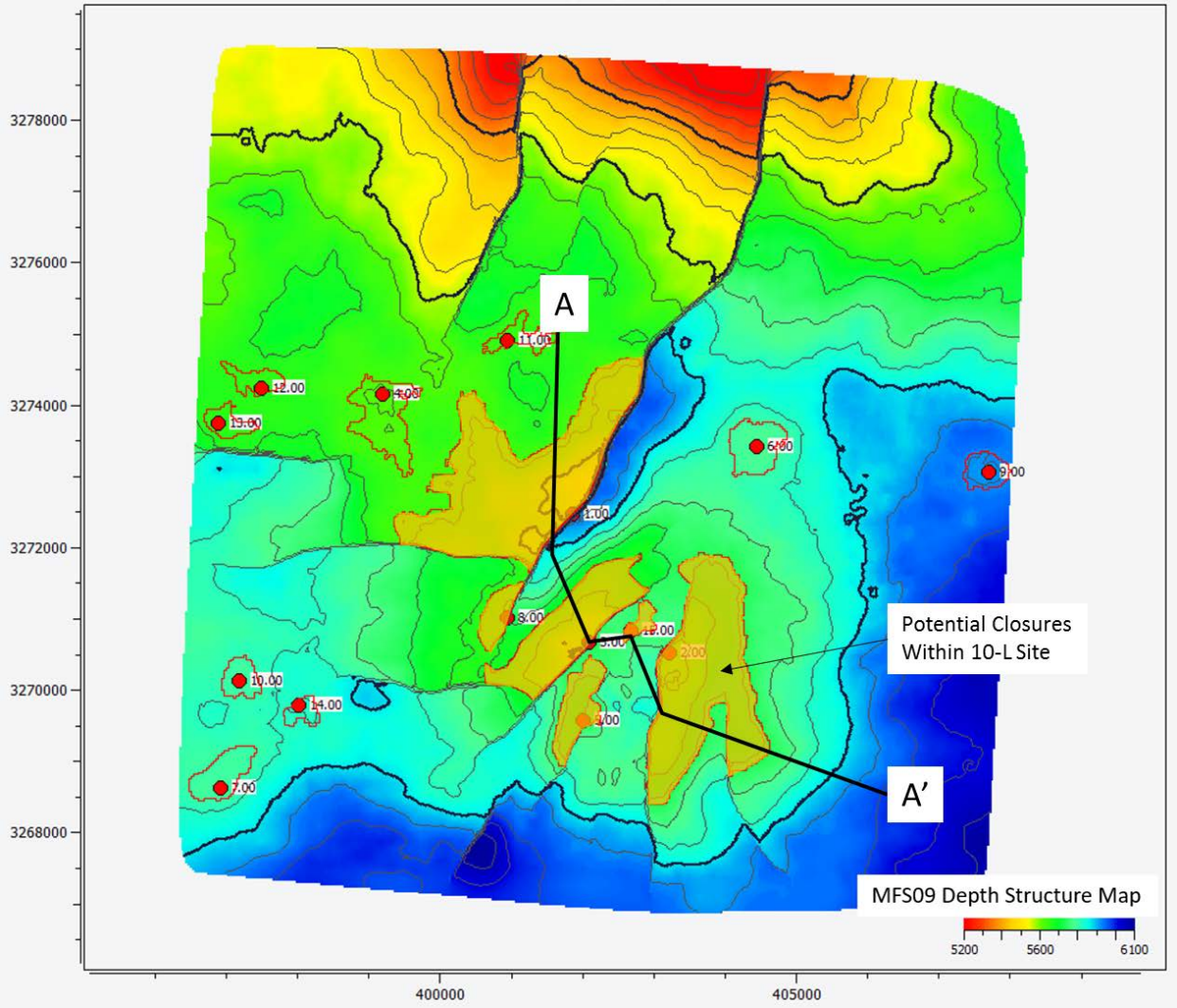

Figure 2.1.3.3 – Current structural interpretation, in depth, of the High Island 10-L Field at the MFS09 (*Amphistegina B*) seismic surface.

Subtask 2.2 – Data Gap Assessment

No activity this quarter

Subtask 2.2.1: Data gap assessments will focus on regionally relevant analog settings

No activity this quarter

Subtask 2.3 – Offshore and reservoir storage Enhanced Oil Recovery (EOR) Potential

No activity this quarter

Subtask 2.3.1 Texas (High Island area of Lake Jackson district) and Louisiana (Lake

Charles and Lafayette districts)

Task 3.0 – Risk Assessment, Simulation and Modeling

Subtask 3.1 – Risk Assessment and Mitigation Strategies

No activity this quarter.

Subtask 3.1.1 Assess the adaptation of existing tools to offshore settings

No activity this quarter.

Subtask 3.2 – Geologic Modeling

No activity this quarter.

Subtask 3.2.1 – Reservoir modeling

No activity during this quarter.

TASK 4.0: Monitoring, Verification, and Assessment (MVA)

Subtask 4.1: MVA Technologies and Methodologies

No activity during this quarter.

Subtask 4.1.1 Geochemical Monitoring of Seabed Sediments

No activity during this quarter.

Subtask 4.1.2 UHR3D Seismic

No activity during this quarter.

Subtask 4.1.3 Distributed Acoustic Sensors

No activity during this quarter.

Subtask 4.1.4 Pipeline MVA

No activity during this quarter.

Subtask 4.2: Plans for Testing of MVA Technologies

Subtask 4.2.1 Priority list for MVA Technologies and testing methods

No activity during this quarter.

TASK 5.0: Infrastructure, Operations and Permitting

Subtask 5.1: CO_2 Transport and Delivery

No activity during this quarter

Subtask 5.1.1 Data assessment near-shore sites

Subtask 5.2: Scenario Optimization

No activity during this quarter

Subtask 5.2.1 Analog Site Optimization

Subtask 5.3: Communication

No activity during this quarter

TASK 6.0: Knowledge Dissemination

No activity during this quarter

Subtask 6.1: Stakeholder Outreach

Subtask 6.2: Technical Outreach

Subtask 6.3: Advisory Committee

In late June planning began for an Advisory committee meeting to be held via conference or video-conference call sometime in July.

PLANS FOR THE NEXT PROJECT QUARTER

In the next quarter, work will continue on:

Task 1

- Revise / update PMP (project management plan) as needed.
- Revise TMP (technology maturation plan) as needed
- Revise DMP (data management plan) as needed
- Implement augmented Partnership SOPO and funding.
- Implement remaining sub-recipient awards from the original SOPO and funding.
- Establish an LoA (letter of agreement) with the UT Petroleum and Geosystems Engineering Department.
- Continue Research and Outreach WebEx video-conference calls.

Task 2 Build well and seismic databases.

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Task 6 Initiate plans for stakeholder and technical outreach.

STATUS OF PROJECT SCHEDULE AND MAJOR GOALS/MILESTONES OF PROJECT

Schedule/Timeline

The project schedule/timeline is shown in the following Gantt chart. The Gantt will be revised in the next quarter as part of revising the PMP (project management plan) to incorporate the project's funding and scope augmentation. (See Task 1 for details of the project augmentation.)

MAJOR GOALS / MILESTONES

To date, the following materials have been uploaded to the Partnership's EDX workspace in partial fulfillment of Milestone M18-2:

List of GoMCarb resources that have been uploaded to EDX

1. Offshore Technology Conference 2019 abstract (not yet accepted): Monitoring Stores CO2 to Document Permanence
2. GHGT-14 poster: Overview of future USGS Gulf of Mexico buoyant storage assessment project
3. Statement of purpose: On the Effect of Flow Instabilities and Heterogeneity in Aquifer with Partially Sealing Boundaries

Task/ Subtask	Milestone Number and Title	Planned Completion Date	Verification method
1.0	M18-1: Partnership Fact Sheet	8/30/2018	Fact Sheet file
2.0	M18-2: Data submitted to NETL-EDX	12/15/2018	List of data submitted
2.0	M19-1: Identification of geologic storage prospects & data gaps	5/30/2019	Summary Report
3.0	M19-2: Risk assessment, simulation and modeling of prospects	10/31/2019	Summary Report

3.0	M20-1: Modified risk assessment, simulation and modeling of prospects	10/31/2020	Summary Report
4.0	M20-2: Modified MVA technologies and testing plan identified for prospects	11/30/2020	Summary Report
2.0	M21-1: Refinement of geologic storage prospects & data gaps	5/30/2021	Summary Report
6.0	M21-2: Summary of Advisory Committee recommendations	12/15/2021	Letter Report

3. PRODUCTS

Publications, conference papers, and presentations.

Several abstracts were submitted to the May, 2019 Offshore Technology Conference to be held in Houston, TX.

From the University of Texas, BEG-GCCC:

"Offshore Co2 Storage: Technical Challenges For New Business Opportunities - What Offshore Ccs Will Look Like In The Gulf Of Mexico - Perspectives From Texas" by Timothy Meckel

Abstract

Since 2009, the Gulf Coast Carbon Center at the Bureau of Economic Geology (UT-Austin) has undertaken multiple integrated geologic and geophysical studies to evaluate the continental shelf in the Gulf of Mexico for CO_2 storage. Funding for this has come primarily from the U.S. Department of Energy (NETL), but also from the State of Texas General Land Office, which administers the State offshore resources. A recent award-winning publication (BEG Report of Investigations No. 283) compiles the diverse topics explored during this long history of characterization: *Geological CO_2 Sequestration Atlas for Miocene Strata Offshore Texas State Waters*. This is the first attempt to comprehensively address CO_2 storage topics for the near offshore in the Gulf Coast. Topics addressed in the volume that will be summarized in this presentation include Miocene stratigraphy and depositional systems with regional cross sections, implications of petroleum systems for CO_2 storage, microscopic and stratigraphic evaluation of anticipated primary seals, regional static capacity estimates, and field-scale examples of storage reservoirs (including modelling and simulation). Detailed stratigraphic and structural interpretation of hundreds of wells and faults using integrated 3D seismic data is now continuous over an area greater than 5,000 square kilometres (2,000 square miles). In three localities a total of 137 square kilometres (53 square miles) of novel high-resolution 3D seismic data has been acquired to understand technological capabilities for imaging the overburden and shallow injection reservoirs, and to address characterization, risk reduction, and monitoring needs. General conclusions from this work are that the inner shelf of the Gulf of Mexico presents superb geology for CCS with ample storage capacity and that sources and developing pipeline infrastructure are well located for development of offshore storage hubs. The thick and relatively young and porous clastic Miocene stratigraphy has multiple regional confining intervals deposited during regional sea level transgressions. Static CO_2 storage capacity estimates beneath the Texas State waters between Mexico and Louisiana total more than 30 Gt, including both depleted hydrocarbon reservoirs and saline intervals. This offshore geologic CO_2 storage resource is regionally and nationally significant, is available for both CO_2 sequestration and enhanced oil recovery (EOR), and is likely to be the most appropriate region for giga-tonne scale storage in the United States.

From Lamar University:

"Literature search for monitoring, Verification and Assessment technologies for Large-scale CO2 storage projects" by Daniel H. Chen, Vijaya Damodara, and Arokiaraj Alphones

Abstract

Geological storage of CO_2 has been gaining attention over the past few years as a crucial strategy for meeting CO_2 emission reduction targets from industrial sources. In this survey various technologies for monitoring CO_2 storage and pipeline transportation are reviewed based on the available literatures. Tools are available to monitor CO_2 in the atmosphere, in the near-surface region, and in the subsurface. Reflection seismic imaging and well-logging have been commercially used and well-adapted in CO_2 storage projects. Use of sub-surface and surface sensors and Unmanned Aerial Vehicles (UAV) to detect and quantify CO_2 leakage into the soil and atmosphere have shown promising results in pilot-scale tests. The value of a comprehensive approach to site characterization, computational modeling, and monitoring has been proven in several storage projects over the years across the world. Several geophysical and geochemical methods, which includes time lapse seismic, micro-seismic, wellhead sampling, tracers, down-hole logging, core analysis, surface gas monitoring, groundwater aquifer monitoring and satellite data were some of the monitoring techniques used in the well-known In-Salah CO_2 storage project in Algeria where 3.8 million metric tons of CO_2 were stored between 2004 and 2011. In another study of monitoring seabed sediments, chemical tracers were proposed as viable means of detecting, attributing, and quantifying CO_2 leaks to surface from geological CO_2 storage sites. A suite of chemicals that could fulfil these criteria has been proposed in this study for different Carbon Capture and Storage (CCS) monitoring objectives. To achieve safe and cost-effective design of CO_2 transport, understanding of the thermodynamics of the CO_2/impurities corrosion mechanism is important to avoid the formation of free water in the pipe-line. Pipeline fracture mitigation involves measures such as the use of fracture arrestors placed at regular intervals along the pipeline length, the selection of appropriate pipeline materials, or operating conditions which are less likely to lead to such failures. A sensor based autonomous monitoring of pipe-lines called SPAMMS, which is probably a novel cost effective, scalable, customizable has been reviewed. It has combined robot agent-based technology with sensing technology for efficiently locating health related events and allows dynamic and corrective monitoring and maintenance of the pipelines. Proposed methods to optimize the design of pipelines and analysis of growth rate of a crack during its lifetime for assessment and scheduling efficient maintenance plan have been reviewed. Subsea pipeline plays an important role in transporting oil and gas. Existing pipeline free span detecting technologies mainly include underwater diver detection, sensing and monitoring, side-scan sonar, multi-beam, sub-bottom profiler and underwater vehicle detection. In a recent study, two evaluation indicators are used to identify the free span and results show that free-spanning segment can be detected by this method. A plethora of technologies have been developed in recent times and the experimental and modeling results seem to be very promising to achieve an efficient site-specific monitoring strategy.

From Lawrence Berkeley National Laboratory:

"Offshore CO2 storage: technical challenges for a new business opportunity: Simulation study comparing offshore versus onshore CO2 well blowouts" Curtis M. Oldenburg, Lehua Pan, Quanlin Zhou

Abstract

1. Objectives/Scope

Wells are widely recognized as potential leakage pathways for carbon dioxide (CO_2) and other fluids at geologic carbon sequestration (GCS) sites. Most studies of well leakage in the GCS context focus on long-term leakage, rather than acute blowout, through onshore wells. In this study, we simulated high flow-rate well blowout scenarios involving CO_2 and water from individual wells at both onshore and offshore GCS sites. The purpose of the modeling is to understand dynamic two-phase non-isothermal flow phenomena in the wells, to estimate leakage rates, and to consider potential effectiveness of blowout kill strategies.

2. Methods, Procedures, Process

We use T2Well which simulates transient two-phase flow in the wellbore using the drift-flux model (DFM) and couples the well flow with porous media flow in reservoirs and aquifers through wellbore-reservoir connections (e.g., perforations). We simulate a variety of prototypical onshore and offshore GCS well-reservoir systems to capture a range of flow phenomena representative of flows at actual sites.

3. Results, Observations, Conclusions

For an onshore well that loses integrity either at the well head or in the shallow part of the well, large pressure gradients arise from reservoir to the leakage point. For an offshore well, the pressure near the top of the well is somewhat larger than for an onshore well because of the presence of the sea water column. Because of the changes in CO_2 solubility in water, higher pressure at the well-failure point affects the flow in complex ways. But regardless of whether the well is onshore or offshore, non-trivial gaps and breaches in the well at shallow depths will allow high blowout flow rates and these flows are characterized by rapid expansion of supercritical CO_2 starting at the perforations to the reservoir. The expansion is accompanied by cooling in the well. Depending on compartmentalization and permeability structure of the reservoir, the blowout flow rate may quickly stabilize or flow-rate may decrease continuously as the reservoir is depressurized. Comparisons of onshore vs. offshore and for various other well- and reservoir-type combinations will be presented.

4. Novel/Additive Information

We are developing three-phase DFM modeling capabilities to handle situations where cooling is severe and liquid CO_2 is present.

Websites

None generated to date.

Technologies or techniques

None generated to date.

Inventions, patent applications, and/or licenses

None generated to date.

Other products

None to date.

4. PARTICIPANTS & OTHER COLLABORATING ORGANIZATIONS

The University of Texas at Austin

Bureau of Economic Geology, GCCC (Gulf Coast Carbon Center)
Name: Susan Hovorka, PhD
Project Role: Principal Investigator
Nearest person month worked: 1
Contribution to Project: Leadership in planning and negotiating

Name: Tip Meckel, PhD
Project Role: Co-Principal Investigator
Nearest person month worked: 1
Contribution to Project: Dr. Meckel presented the overview at the kick-off meeting

Name: Ramón Treviño
Project Role: Co-Principal Investigator (project manager)
Nearest person month worked: 1
Contribution to Project: Mr. Treviño provided project management and project reporting; he acted at the primary contact for the DOE project manager and contracting specialist.

Name: Michael DeAngelo
Project Role: Researcher (geophysicist seismic interpreter)
Contribution to Project: Mr. DeAngelo conducted structural interpretation of the "TexLa Merge" and "Texas OBS" regional 3D seismic datasets.

Name: Katherine Romanak, PhD
Project Role: sediment geochemist
Nearest person month worked: 1
Contribution to Project: Liaison with Texas A&M GERG

UT Institute for Geophysics, GBDS (Gulf Basin Depositional Synthesis) Industrial Associates Program

Name: John Snedden
Project Role: Senior Research Scientist
Nearest person month worked: 1
Contribution to Project: Dr. Snedden provided expertise in seismic stratigraphy and siliciclastic depositional systems.

Name: Jon Virdell
Project Role: Project Manager
Nearest person month worked: 1
Contribution to Project: Mr. Virdell provided project and GIS data management support.

Name: Penelope Parr
Project Role: Research Engineer (geophysicist)
Nearest person month worked: 1
Contribution to Project: Ms. Parr contributed seismic data expertise and data management.

Name: Marcie Purkey Phillips
Project Role: Biostratigrapher
Nearest person month worked: 1
Contribution to Project: Mrs. Purkey Phillips contributed expertise in biostratigraphy and integrated well and seismic data in the Chandeleur 3D survey area.

Lamar University

Louisiana Geological Survey

Trimeric Corp.

U.S. Geological Survey (USGS)

Lawrence Berkeley National Laboratory

Lawrence Livermore National Laboratory

5. IMPACT:

6. CHANGES/PROBLEMS

Changes in approach and reasons for change: **None**

Actual or anticipated problems or delays and actions or plans to resolve them:

1. **Lack of staff in the BEG contracts department had caused delays in sub-contracting sub-recipients. A new contract specialist started early in the quarter, and the backup in subcontracting diminished.**
2. **Negotiations related to augmenting the Partnership's scope commensurate with projected additional funding of between $4 million and $10 million continued between NETL and The University of Texas at Austin (UT). Preparing the augmentation proposal and budget required extensive communications and interactions with the original sub-recipients and proposed new sub-recipients. The efforts necessarily diverted time and energy away from usual early-project start-up activities and somewhat slowed progress on the original scope and project management.**

Changes that have a significant impact on expenditures: **Per item #2 above, expenditures were less than planned.**

Change of primary performance site location from that originally proposed: **None**.

7. SPECIAL REPORTING REQUIREMENTS

Respond to any special reporting requirements specified in the award terms and conditions, as well as any award specific requirements.

8. BUDGETARY INFORMATION

Cost Plan Status Report

Financial Status				
University of Texas at Austin				

Baseline Reporting Quarter	Budget Period 1			
	4/1/2018-06/30/2018		7/1/2018-9/30/2018	
	Q2	Cummulative Total	Q3	Cummulative Total
Baseline Cost Plan				
Federal Share	$562,499	$562,499	$562,499	$1,124,998.00
Non-Federal Share	$147,166	$147,166	$147,156	$294,321
Total Planned	$709,665	$709,665	$709,655	$1,419,319
Actual Incurred Costs				
Actual Federal Share	$12,650.50	$12,650.50	$338,105.17	$350,755.67
Actual non-Federal Share	$588,662.00	$588,662.00	$0.00	$588,662.00
Total Incurred Costs	$601,312.50	$601,312.50	$338,105.17	$939,417.67
Variance				
Variance Federal Share	$549,848.50	$549,848.50	$224,393.83	$774,242.33
Variance non-Federal Share	($441,496.50)	($441,496.50)	$147,155.50	($294,341.00)
Total Variance Cumulative	$108,352.00	$108,352.00	$371,549.33	$479,901.33