DOE Award No.: DE-FE0023919

Quarterly Research Performance Progress Report

(Period Ending 09/30/21)

Deepwater Methane Hydrate Characterization & Scientific Assessment

Project Period 5: 10/01/20 - 09/30/22

Submitted by:

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Signature

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Office of Fossil Energy

DISCLAIMER

1 ACCOMPLISHMENTS

This report outlines the progress of the fourth quarter of the seventh fiscal year of the project (Budget Period 5, Year 1). Highlights from this period include:

- **UT-GOM2-2 Prospectus Published:**
  The UT-GOM2-2 Expedition Prospectus was completed and published. This is the scientific plan for the acquisition, storage, analysis, and distribution of core and other collected samples for the expedition. See Section 1.2.2.3.

- **UT-GOM2-2 Operations Plan**
  The UT-GOM2-2 Operations Plan was updated to incorporate information from the prospectus, and is now considered final (Milestone M5E). The updated Operations Plan (version 2.1) was published on the UT-GOM2-2 website and is attached as Appendix A.

- **AAPG / SEG Annual Meeting**:
  GOM2 made four presentations at the joint Society of Exploration Geophysicists (SEG) & American Association of Petroleum Geologists (AAPG) meeting: "Gas hydrates - hydrocarbons of the future" and "Gas Hydrates and Rare Earth Resources". See Section 1.2.2.2.7

1.1 Major Project Goals

The primary objective of this project is to gain insight into the nature, formation, occurrence and physical properties of methane hydrate-bearing sediments for the purpose of methane hydrate resource appraisal. This will be accomplished through the planning and execution of a state-of-the-art drilling, coring, logging, testing and analytical program that assess the geologic occurrence, regional context, and characteristics of marine methane hydrate deposits in the Gulf of Mexico Continental Shelf. Project Milestones are listed in Table 1-1, Table 1-2, and Table 1-3.

Table 1-1: Previous Milestones

Budget Period	Milestone	Milestone Description	Estimated Completion	Actual Completion	Verification Method
1	M1A	Project Management Plan	Mar-15	Mar-15	Project Management Plan
	M1B	Project Kick-off Meeting	Jan-15	Dec-14	Presentation
	M1C	Site Location and Ranking Report	Sep-15	Sep-15	Phase 1 Report
	M1D	Preliminary Field Program Operational Plan Report	Sep-15	Sep-15	Phase 1 Report
	M1E	Updated CPP Proposal Submitted	May-15	Oct-15	Phase 1 Report
	M1F	Demonstration of a Viable Pressure Coring Tool: Lab Test	Sep-15	Sep-15	Phase 1 Report
2	M2A	Document Results of BP1/Phase 1 Activities	Dec-15	Jan-16	Phase 1 Report
	M2B	Complete Updated CPP Proposal Submitted	Nov-15	Nov-15	QRPPR
	M2C	Scheduling of Hydrate Drilling Leg by IODP	May-16	May-17	Report directly to DOE PM
	M2D	Demonstration of a Viable Pressure Coring Tool: Land Test	Dec-15	Dec-15	PCTB Land Test Report, in QRPPR
	M2E	Demonstration of a Viable Pressure Coring Tool: Marine Test	Jan-17	May-17	QRPPR
	M2F	Update UT-GOM2-2 Operational Plan	Feb-18	Apr-18	Phase 2 Report
3	M3A	Document results of BP2 Activities	Apr-18	Apr-18	Phase 2 Report
	M3B	Update UT-GOM2-2 Operational Plan	Sep-19	Jan-19	Phase 3 Report
4	M4A	Document results of BP3 Activities	Jan-20	Apr-20	Phase 3 Report
	M4B	Demonstration of a Viable Pressure Coring Tool: Lab Test	Feb-20	Jan-20	PCTB Lab Test Report, in QRPPR
	M4C	Demonstration of a Viable Pressure Coring Tool: Land Test	Mar-20	Mar-20	PCTB Land Test Report, in QRPPR

Table 1-2: Current Milestones

Budget Period	Milestone	Milestone Description	Estimated Completion	Actual Completion	Verification Method
5	M5A	Document Results of BP4 Activities	Dec-20	Mar-21	Phase 4 Report
	M5B	Complete Contracting of UT-GOM2-2 with Drilling Vessel	May-21	-	QRPPR
	M5C	Complete Project Sample and Data Distribution Plan	Jul-22	-	Report directly to DOE PM
	M5D	Complete Pre-Expedition Permitting Requirements for UT-GOM2-2	Dec-21	-	QRPPR
	M5E	Complete UT-GOM2-2 Operational Plan Report	May-21	Sep-21	QRPPR
	M5F	Complete UT-GOM2-2 Field Operations	Jul-22	-	QRPPR

Table 1-3: Future Milestones

Budget Period	Milestone	Milestone Description	Estimated Completion	Actual Completion	Verification Method
6	M6A	Document Results of BP5 Activities	Dec-22	-	Phase 5 Report
	M6B	Complete Preliminary Expedition Summary	Dec-22	-	Report directly to DOE PM
	M6C	Initiate comprehensive Scientific Results Volume	Jun-23	-	Report directly to DOE PM
	M6D	Submit set of manuscripts for comprehensive Scientific Results Volume	Sep-24	-	Report directly to DOE PM

1.2 What Was Accomplishments Under These Goals

1.2.1 Previous Project Periods

Tasks accomplished in previous project periods (Phase 1, 2, 3, and 4) are summarized in Table 1-4, Table 1-5, Table 1-6, and Table 1-7.

Table 1-4: Tasks Accomplished in Phase 1

PHASE 1/BUDGET PERIOD 1	
Task 1.0	**Project Management and Planning**
Task 2.0	**Site Analysis and Selection**
Subtask 2.1	*Site Analysis*
Subtask 2.2	*Site Ranking / Recommendation*
Task 3.0	**Develop Operational Plan for UT-GOM2-2 Scientific Drilling Program**
Task 4.0	**Complete IODP Complimentary Project Proposal**
Task 5.0	**Pressure Coring and Core Analysis System Modifications and Testing**
Subtask 5.1	*PCTB Scientific Planning Workshop*
Subtask 5.2	*PCTB Lab Test*
Subtask 5.3	*PCTB Land Test Prep*

Table 1-5: Tasks Accomplished in Phase 2

PHASE 2/BUDGET PERIOD 2	
Task 1.0	**Project Management and Planning**
Task 6.0	**Technical and Operational Support of Complimentary Project Proposal**
Task 7.0	**Continued Pressure Coring and Core Analysis System Modifications and Testing**
Subtask 7.1	*Review and Complete NEPA Requirements for PCTB Land Test*
Subtask 7.2	*PCTB Land Test*
Subtask 7.3	*PCTB Land Test Report*
Subtask 7.4	*PCTB Modification*
Task 8.0	**UT-GOM2-1 Marine Field Test**
Subtask 8.1	*Review and Complete NEPA Requirements for UT-GOM2-1*
Subtask 8.2	*UT-GOM2-1 Operational Plan*
Subtask 8.3	*UT-GOM2-1 Documentation and Permitting*
Subtask 8.4	*UT-GOM2-1 Marine Field Test of Pressure Coring System*
Subtask 8.5	*UT-GOM2-1 Marine Field Test Report*
Task 9.0	**Develop Pressure Core Transport, Storage, and Manipulation Capability**
Subtask 9.1	*Review and Complete NEPA Requirements for Core Storage and Manipulation*
Subtask 9.2	*Hydrate Core Transport*
Subtask 9.3	*Storage of Hydrate Pressure Cores*
Subtask 9.4	*Refrigerated Container for Storage of Hydrate Pressure Cores*

Subtask 9.5	*Hydrate Core Manipulator and Cutter Tool*
Subtask 9.6	*Hydrate Core Effective Stress Chamber*
Subtask 9.7	*Hydrate Core Depressurization Chamber*
Task 10.0	**Core Analysis**
Subtask 10.1	*Routine Core Analysis (UT-GOM2-1)*
Subtask 10.2	*Pressure Core Analysis (UT-GOM2-1)*
Subtask 10.3	*Hydrate Core-Log-Seismic Synthesis (UT-GOM2-1)*
Task 11.0	**Update Science and Operational Plans for UT-GOM2-2 Scientific Drilling Program**
Task 12.0	**UT-GOM2-2 Scientific Drilling Program Vessel Access**

Table 1-6: Tasks Accomplished in Phase 3

PHASE 3/BUDGET PERIOD 3	
Task 1.0	**Project Management and Planning**
Task 6.0	**Technical and Operational Support of CPP Proposal**
Task 9.0	**Develop Pressure Core Transport, Storage, and Manipulation Capability**
Subtask 9.8	*X-ray Computed Tomography*
Subtask 9.9	*Pre-Consolidation System*
Task 10.0	**Core Analysis**
Subtask 10.4	*Continued Pressure Core Analysis (UT-GOM2-1)*
Subtask 10.5	*Continued Hydrate Core-Log-Seismic Synthesis (UT-GOM2-1)*
Subtask 10.6	*Additional Core Analysis Capabilities*
Task 11.0	**Update Science and Operational Plans for UT-GOM2-2 Scientific Drilling Program**
Task 12.0	**UT-GOM2-2 Scientific Drilling Program Vessel Access**
Task 13.0	**Maintenance and Refinement of Pressure Core Transport, Storage, and Manipulation Capability**
Subtask 13.1	*Hydrate Core Manipulator and Cutter Tool*
Subtask 13.2	*Hydrate Core Effective Stress Chamber*
Subtask 13.3	*Hydrate Core Depressurization Chamber*
Subtask 13.4	*Develop Hydrate Core Transport Capability for UT-GOM2-2 Scientific Drilling Program*
Subtask 13.5	*Expansion of Pressure Core Storage Capability for UT-GOM2-2 Scientific Drilling Program*
Subtask 13.6	*Continued Storage of Hydrate Cores from UT-GOM2-1*
Task 14.0	**Performance Assessment, Modifications, and Testing of PCTB**
Subtask 14.1	*PCTB Lab Test*
Subtask 14.2	*PCTB Modifications/Upgrades*
Task 15.0	**UT-GOM2-2 Scientific Drilling Program Preparations**
Subtask 15.1	*Assemble and Contract Pressure Coring Team Leads for UT-GOM2-2 Scientific Drilling Program*
Subtask 15.2	*Contract Project Scientists and Establish Project Science Team for UT-GOM2-2 Scientific Drilling Program*

Table 1-7: Tasks Accomplished in Phase 4

PHASE 4/BUDGET PERIOD 4	
Task 1.0	**Project Management and Planning**
Task 10.0	**Core Analysis**
Subtask 10.4	*Continued Pressure Core Analysis (GOM2-1)*
Subtask 10.5	*Continued Hydrate Core-Log-Seismic Synthesis (UT-GOM2-1)*
Subtask 10.6	*Additional Core Analysis Capabilities*
Subtask 10.7	*Hydrate Modeling*
Task 11.0	**Update Science and Operational Plans for UT-GOM2-2 Scientific Drilling Program**
Task 12.0	**UT-GOM2-2 Scientific Drilling Program Vessel Access**
Task 13.0	**Maintenance and Refinement of Pressure Core Transport, Storage, and Manipulation Capability**
Subtask 13.1	*Hydrate Core Manipulator and Cutter Tool*
Subtask 13.2	*Hydrate Core Effective Stress Chamber*
Subtask 13.3	*Hydrate Core Depressurization Chamber*
Subtask 13.4	*Develop Hydrate Core Transport Capability for UT-GOM2-2 Scientific Drilling Program*
Subtask 13.5	*Expansion of Pressure Core Storage Capability for UT-GOM2-2 Scientific Drilling Program*
Subtask 13.6	*Continued Storage of Hydrate Cores from UT-GOM2-1*
Subtask 13.7	*X-ray Computed Tomography*
Subtask 13.8	*Pre-Consolidation System*
Task 14.0	**Performance Assessment, Modifications, and Testing of PCTB**
Subtask 14.1	*PCTB Lab Test*
Subtask 14.2	*PCTB Modifications/Upgrades*
Subtask 14.3	*PCTB Land Test*
Task 15.0	**UT-GOM2-2 Scientific Drilling Program Preparations**
Subtask 15.3	*Permitting for UT-GOM2-2 Scientific Drilling Program*

1.2.2 Current Project Period

Current project period tasks are shown in Table 1-8.

Table 1-8: Current Project Tasks

PHASE 5/BUDGET PERIOD 5	
Task 1.0	**Project Management and Planning**
Task 10.0	**Core Analysis**
Subtask 10.4	*Continued Pressure Core Analysis (UT-GOM2-1)*
Subtask 10.5	*Continued Hydrate Core-Log-Seismic Synthesis (UT-GOM2-1)*
Subtask 10.6	*Additional Core Analysis Capabilities*
Subtask 10.7	*Hydrate Modeling*
Subtask 10.8	*Routine Core Analysis (UT-GOM2-2)*
Subtask 10.9	*Pressure Core Analysis (UT-GOM2-2)*
Subtask 10.10	*Core-log-seismic Integration (UT-GOM2-2)*
Task 11.0	**Update Science and Operational Plans for UT-GOM2-2 Scientific Drilling Program**
Task 12.0	**UT-GOM2-2 Scientific Drilling Program Vessel Access**
Task 13.0	**Maintenance and Refinement of Pressure Core Transport, Storage, and Manipulation Capability**
Subtask 13.1	*Hydrate Core Manipulator and Cutter tool*
Subtask 13.2	*Hydrate Core Effective Stress Chamber*
Subtask 13.3	*Hydrate Core Depressurization Chamber*
Subtask 13.4	*Develop Hydrate Core Transport Capability for UT-GOM2-2 Scientific Drilling Program*
Subtask 13.5	*Expansion of Pressure Core Storage Capability for UT-GOM2-2 Scientific Drilling Program*
Subtask 13.6	*Continued Maintenance and Storage of Hydrate Pressure Cores from UT-GOM2-1*
Subtask 13.7	*Maintain X-ray CT*
Subtask 13.8	*Maintain Preconsolidation System*
Subtask 13.9	*Transportation of Hydrate Core from UT-GOM2-2 Scientific Drilling Program*
Subtask 13.10	*Storage of Hydrate Cores from UT-GOM2-2 Scientific Drilling Program*
Subtask 13.11	*Hydrate Core Distribution*
Task 14.0	**Performance Assessment, Modifications, and Testing of PCTB**
Subtask 14.4	*PCTB Modifications/Upgrades*
Subtask 14.5	*PCTB Land Test III*
Task 15.0	**UT-GOM2-2 Scientific Drilling Program Preparations**
Subtask 15.3	*Permitting for UT-GOM2-2 Scientific Drilling Program*
Subtask 15.4	*Review and Complete NEPA Requirements*
Subtask 15.5	*Finalize Operational Plan for UT-GOM2-2 Scientific Drilling Program*
Task 16.0	**UT-GOM2-2 Scientific Drilling Program Field Operations**
Subtask 16.1	*Mobilization of a Scientific Ocean Drilling and Pressure Coring Capability*
Subtask 16.2	*Field Project Management, Operations and Research*
Subtask 16.3	*Demobilization of Staff, Labs, and Equipment*

1.2.2.1 Task 1.0 – Project Management & Planning

Status: Ongoing

1. **Compared identified risks with those documented in the Project Management Plan to ensure all risks are identified and monitored. Communicated risks and possible outcomes to project team and stakeholders:**
    - The US DOE is performing a methane hydrate production test on the Alaska North Slope that is scheduled to commence in 2022. Common contractors, equipment, and resources are required for both the Alaska program and UT-GOM2-2; therefore, both programs cannot be conducted concurrently.
    - DOE has also informed UT that it is unable to fund both the Alaska North Slope hydrate production test and the UT-GOM2-2 field program in the same fiscal year.
    - As a result of these issues, DOE informed UT that UT-GOM2-2 would most likely have to be delayed, and that a decision should be made by late summer based, in part, on Congressional Appropriations Committee marks.
    - In September, 2021, UT determined that the schedule and resource conflicts and DOE's inability to commit funds presented unacceptable risk to the continued possibility of performing the UT-GOM2-2 field program in 2022. UT has transitioned UT-GOM2-2 preparation and planning efforts with the assumption that the expedition will be funded in 2023.
    - UT is evaluating budget implications for the project as a result of the delayed UT-GOM2-2 field program. We anticipate numerous financial impacts to the current budget and spending projections due to extending the project one additional year, and increasing costs in the offshore market.
    - See further discussion in Section 3.

2. **Coordinate the overall scientific progress, administration and finances of the project:**
    - Monitored and controlled project scope, costs, and schedule.

3. **Communicate with project team and sponsors:**
    - Organized sponsor and stakeholder meetings.
    - Organized task-specific working meetings to plan and execute project tasks per the Project Management Plan and Statement of Project Objectives (e.g. PCTB development, UT-GOM2-2 science and sample distribution planning, UT-GOM2-2 permitting, and UT-GOM2-2 vessel access).
    - Managed SharePoint sites, email lists, and archive/website.

4. **Coordinate and supervise service agreements:**
    - Procured ANCO Insurance to broker a $200,000 general lease bond with RLI Insurance Company. This bond meets a regulatory requirement of the Bureau of Ocean Energy Management (BOEM) for the UT-GOM2-2 research permit.

- Organized recurring technical/science meetings with Geotek to identify and address science and engineering challenges pertaining to UT Pressure Core Center and field science program for the UT-GOM2-2 Scientific Drilling Program.
- Extended the Geotek service agreement through FY22.
- Executed a contract amendment with Geotek to test the Temperature-2-Pressure Probe Deployment Tool at the Geotek facility in Salt Lake City, Utah.
- Executed a license agreement with IHS Markit for the Petrodata™ "Rigbase" and "ConstructionVesselBase" databases, in support of Task 12.0 – UT-GOM2-2 Scientific Drilling Program Vessel Access. These databases provide a comprehensive source of data on the mobile offshore drilling rig and construction vessel fleet.

5. **Coordinate subcontractors:**
    - Worked individually with each of the six subcontracted universities to rework budgets to perform a 2023 expedition. Costs for FY22 were reduced to a minimum while upholding commitments to students and post-doctoral scientists and making sure we can still execute the expedition in 2023. Expedition costs that could be deferred were moved to FY23.
    - All subcontracted institutions contributed to the UT-GOM2-2 Prospectus and participated in the UT-GOM2-2 Science Planning meetings.

1.2.2.2 Task 10.0 – Core Analysis

Status: Ongoing

1.2.2.2.1 Subtask 10.4 – Continued Pressure Core Analysis (UT-GOM2-1)

A. Pressurized Core Analysis

A1. Compression behavior of pressure core

- UT characterized the compression behavior of one pressure core sample from UT-GOM2-1 (2FB2-1) to an effective stress of 20 MPa. This is the first test that we have performed at effective stresses greater than 4 MPa and it is direct result of our efforts over the last 9 months to improve our experimental approach by successfully sealing the core at high confining stress. Our new characterization extends previous effective stress ranges and new trends emerges after ~5 MPa.
  Figure 1-1 shows the evolution of void ratio and lateral stress ratio K0 with effective stress. The compression behavior agrees with previously measured values for similar hydrate-bearing sediments (Figure 1-1a) at lower effective stresses. The measured lateral stress ratio for these new data is lower within the effective axial stress range σ'_a = 0.1 to 3 MPa (Figure 1-1b). Hydrate-bearing sediments exhibit higher compressibility and K0 values at high stresses; the break in slope at 5 MPa (Figure 1-1a) and the increase in lateral stress (Figure 1-1b) is being further investigated.

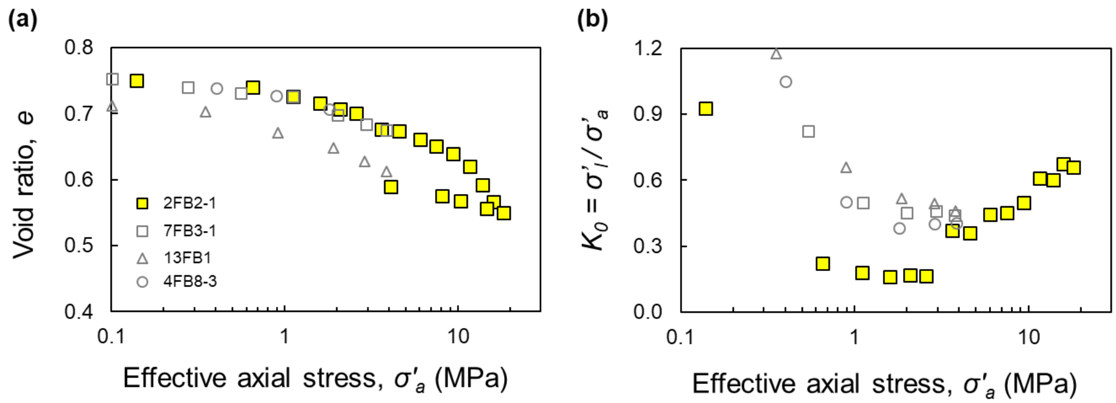

Figure 1-1. Characterization of sample 2FB2-1 at high effective stress. The compression (a) and lateral stress ratio (b) data (shown as yellow squares) agrees with previously measured values for similar samples (Fang, in press). The new measurements at higher stresses suggest different trends after ~5MPa. We are investigating why the compression coefficient (the slope of the data in Fig. 1-1a) becomes greater at effective stresses above this threshold. The stress ratio also increases at higher effective stresses.

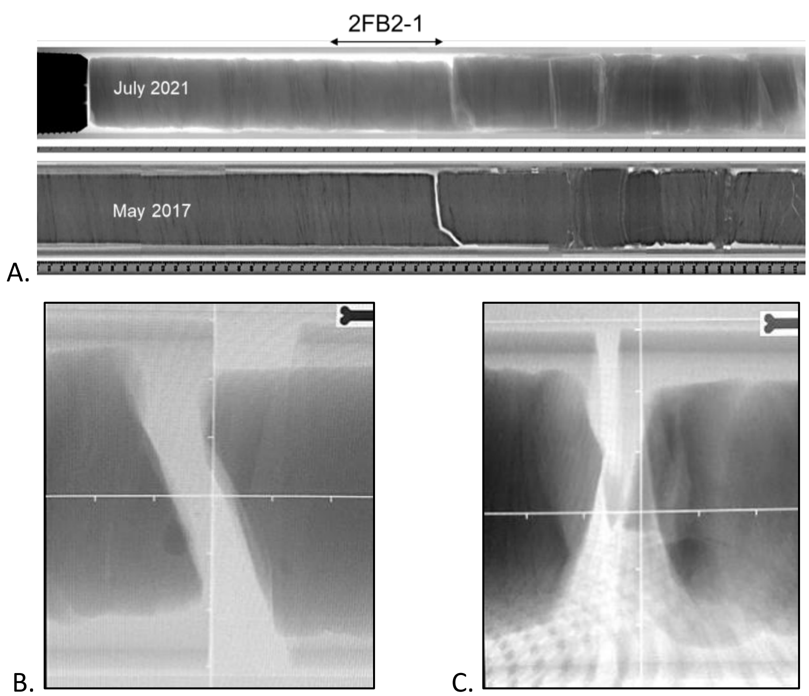

Figure 1-2. A. Comparison of 2FB2-1 now (July 2021 X-ray image) and before storage (X-ray image May 2017) showing the reduction of the core diameter over time due to dissolution. The tested sample 2FB2-1 shows degradation near core boundaries which together with uneven sample cuts add uncertainty to the measured values. The sample diameter D_{sample} = 4.9 cm is smaller than the core liner inner diameter $D_{core\text{-}liner}$ = 5.3 cm. B and C are examples of cuts that are not flush with the end of the core liner. B. initiation of the core cutting causes the core to break along an existing weak-angled plane. C. Cut surface is rough, possibly from natural or induced weakness in the core, or core degradation.

A2. Gas Analysis from Pressure Cores

- Ohio State (PhD student Gus Wilson with PI Darrah) continues to analyze results from analysis of gas produced during quantitative degassing of pressure cores from UT-GOM2-1 with a goal of age dating the hydrate accumulations at GC955 using noble gas geochemistry.

B. Conventional Core Analysis

B1. Microbiology

- DNA extraction, purification, quantification, and sequencing on a finite set of UT-GOM2-1 samples collected at UT-Austin in the summer of 2019 has been resumed at Exxon Mobil after delays associated with the COVID-19-related work restrictions. Discussion with Oregon State on the results and how to prepare a manuscript that describes the synoptic changes in microbial communities has started. The team hopes to submit an abstract for presentation at the Gordon Conference in March 2022.
- Oregon state continued to refine core sampling strategies needed for the UT-GOM2-2 expedition. Experiments to determine the primary contaminants and the source of those contaminants in the Colwell Geomicrobiology lab at OSU were initiated by sampling air and lab benches, while following carefully prescribed protocols for maintaining sterility and minimizing sources of lab contamination. Data showed that lab air and pipetting of samples and reactants during experimental amplification were minimal sources of contamination. As soon as we have enough samples we will be able to conduct a DNA sequencing run to identify the contaminant taxa that might be anticipated from our lab protocols, and contrasted the taxa with authentic microbes in samples.
- Oregon State explored ways to optimize the extraction of DNA from fine-grain materials typical of GOM sediments. Extraction of DNA from fine-grain sediment is a longstanding problem for environmental microbiologists. Recent progress at Oregon State has been shown by treating model sediments with two reagents: G2 and linear polyacrylamide (LPA). G2 DNA/RNA Enhancer (a mutagenized salmon sperm DNA produced by Ampliqon Inc.) increases the yield of microbial DNA during DNA extraction from difficult matrices such as clays by “relieving” inhibitory DNA - particle complexes. Addition of LPA to a DNA solution allows co-precipitation and concentration of the nucleic acid with the LPA. At Oregon State, electrophoretic gel images performed on DNA extracted from Eugene Island model clays amplified with both G2 and LPA, showed the highest concentrations of DNA were over all other individual methods (Figure 1-3). This protocol holds the promise of extracting and amplifying vanishingly small levels of DNA in samples, as already experienced in samples from GOM2-1 and as expected in samples from GOM2-2.

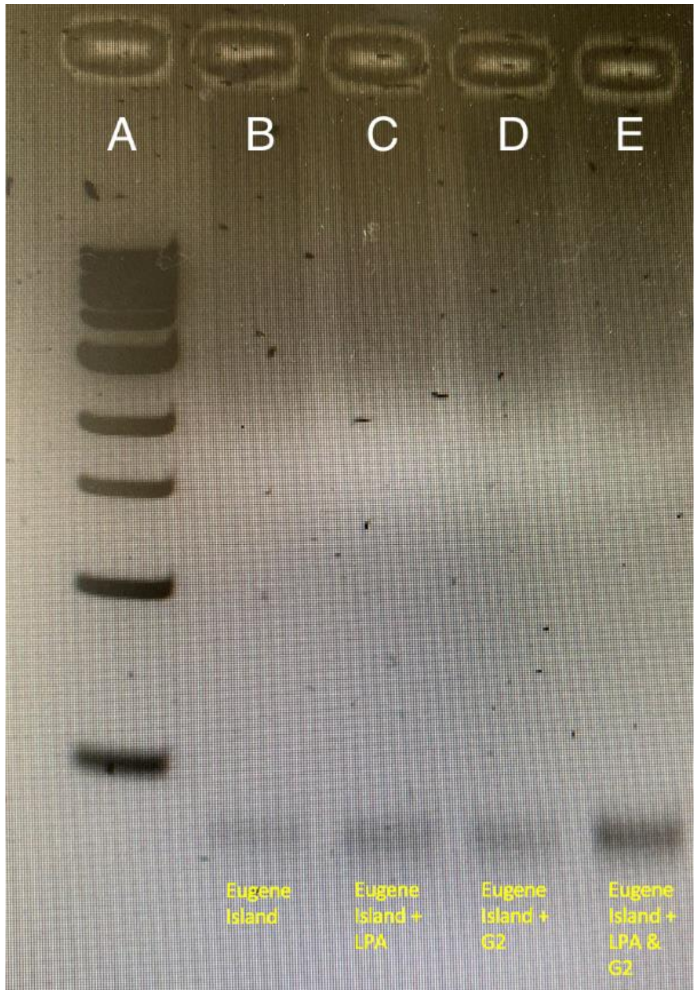

Figure 1-3 Dark bands of DNA extracted from Eugene Island clay appearing at the bottom of an electrophoretic gel. The darker the band the higher the concentration of DNA. A) Reference links of DNA. B) Eugene Island clay with no treatment, C) Eugene Island clay with LPA, D) Eugene Island clay with G2, E) Eugene Island clay with both LPA and G2.

B2. Bulk sediment CHNS elemental analysis, Bulk sediment TOC, N, and S isotopes and Grain size

- UNH finished drafting and submitted a paper to Marine Geology on the full data analyses/interpretations on Bulk sediment CHNS elemental analysis, Bulk sediment TOC, N, and S isotopes and Grain size for all of the UNH derived UT-GOM2-1 samples. Johnson, J.E., MacLeod, D.R., Phillips, S.C., Purkey Phillips, M., Divins, D.L., submitted 9/30/2021. Primary Deposition and Early Diagenetic Effects on the High Saturation Accumulation of Gas Hydrate in a Silt Dominated Reservoir in the Gulf of Mexico. Marine Geology.

1.2.2.2.2 Subtask 10.6 – Additional Analysis Capabilities

- UT increased the K0 permeameter (i.e., effective stress chamber) capacity from ~4 to 20 MPa of effective vertical stress. The load is now applied using a hydraulic loading scheme instead of the screw-drive system. To accomplish this procedural change, engineering testing conducted at UT identified optimal protocols and hydraulic seals that resulted in higher effective stresses while monitoring sample compression under zero-lateral strain condition (see section 1.2.2.5.2 for details)

- UNH continued running calibration and internal lab standards on the new Elementar CHNS Elemental Analyzer. This instrument will be utilized extensively on samples collected during the GOM2-2 expedition.

1.2.2.2.3 Subtask 10.7 – Hydrate Modeling

- Li Wei completed her PhD at Ohio State and began work as a post-doctoral research scientist at Columbia LDEO. Wei will focus on using GOM physical properties data to constrain reaction-transport models and investigate hydrate-forming processes.
- UT developed a model that systematically describes the generation, migration, phase partitioning and accumulation of methane as the sediment is deposited from the seafloor and buried through the base of hydrate stability zone (Figure 1-4) (You et al., In Review).
- With three-dimensional focused free gas flow, microbial methane that is generated from a much larger fetch area of the entire basin, both above and below the BHSZ, is concentrated into coarse-grained layers at structural closures to form high-concentration methane hydrate reservoirs (Figure 1-4).
- This model illuminates highly-concentrated hydrate reservoirs along the continental margins are formed including: Green Canyon 955 and Walker Ridge 313 of northern Gulf of Mexico, the first offshore gas production site of eastern Nankai Trough, Area B and Area C of NGHPE-02, and New Zealand's southern Hikurangi subduction margin.
- This model provides a systematic view of the development and evolution of a hydrate system. We link the generation, migration, phase portioning and accumulation of microbial methane into a closed loop during sediment deposition and burial.

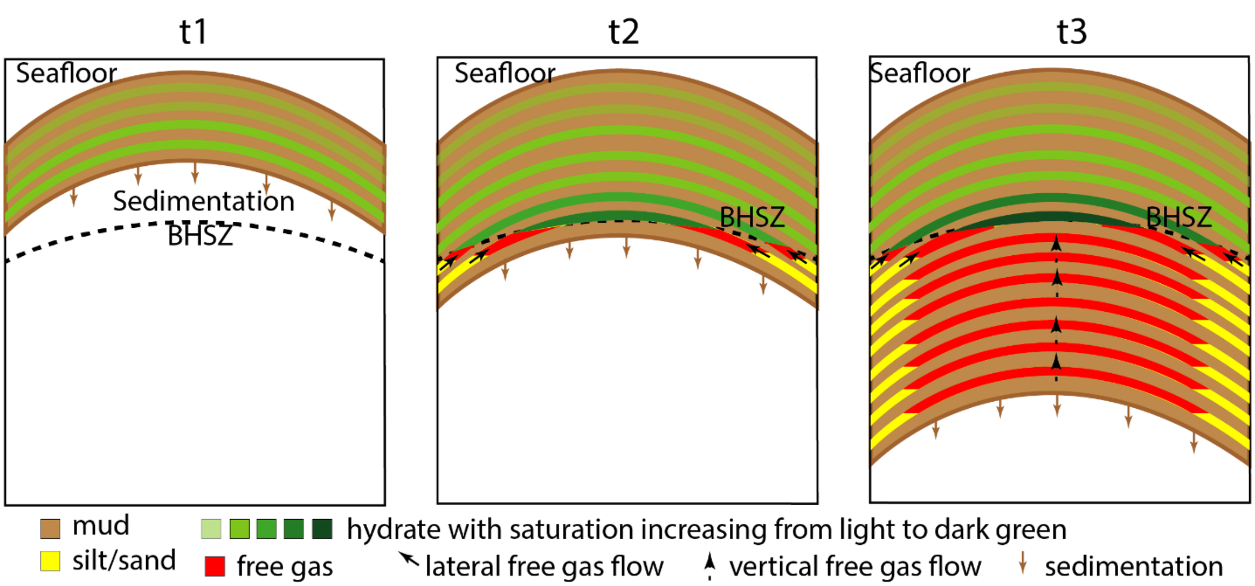

Figure 1-4: A schematic of the generation, migration, phase partitioning and accumulation of microbial methane in an evolving sedimentary system from t1 to t2 and then to t3. Methane is generated in muds, focused into sands/silts and

forms concentrated methane hydrate as a sand-mud interbedded system is deposited from the seafloor and passes through the BHSZ from t1 to t2 and t3. In this model, methane is generated by biodegradation of organic carbon in muds. Hydrate does not form and methane is not trapped until a coarse-grained layer is deposited, because the nm-scale pores prevent hydrate formation in muds. Instead, methane diffuses into sands/silts where methane solidifies into hydrate. As hydrate-bearing sands/silts pass through the base of hydrate stability zone (BHSZ) during sediment burial, methane hydrate dissociates and releases free gas. The released and the newly generated free gas below the BHSZ concentrates into a vertical/dipping zone with low capillary entry pressure and high permeability and flows upward driven its buoyancy. When free gas reaches the hydrate stability zone (HSZ), capillary forces drive free gas to flow laterally, preferentially enter sands/silts, feed hydrate growth and elevate hydrate saturation

1.2.2.2.4 Subtask 10.8 – Routine Core Analysis (UT-GOM2-2)

- Future Task.

1.2.2.2.5 Subtask 10.9 – Pressure Core Analysis (UT-GOM2-2)

- Future Task.

1.2.2.2.6 Subtask 10.10 – Core-log-seismic Integration (UT-GOM2-2)

- Ohio State is editing logging-while-drilling (LWD) curves and developing reference hydrate saturation curves for WR313-H and WR313-G from the 2009 LWD data to provide to UT-GOM2-2 participants before, during and after the expedition. These curves will allow non-logging experts to have quality reference curves with depth to compare to new datasets as they are generated during UT-GOM2-2. We plan to publish these curves in the Expedition Proceedings.

1.2.2.2.7 Other – Publication and Presentation Work

- Fawz Naim of Ohio State, and Abby Varona, Kevin Meazell and Alexey Portnov of the UT presented at the joint American Association of Petroleum Geologists (AAPG) and Society of Exploration Geophysicists (SEG) meeting. The talks presented new geophysical data analyses for the Gulf of Mexico gas hydrate systems from regional to basin and reservoir scales.
- Alexey Portnov and Kevin Meazell convened both hybrid sessions and an on-line session "Gas hydrate and helium sources" at the joint American Association of Petroleum Geologists (AAPG) and Society of Exploration Geophysicists (SEG) meeting.
- AAPG Editors continued working on the AAPG Bulletin GC 955 dedicated Volume 2 and started writing the introduction.
- GOM2 participants continued working on their AAPG Vol 2 submissions. Table 1-9 shows the current status. All papers except one and the volume introduction are now available on-line (ahead of print).
- Several data reports were published. See Expedition Research Results under UT-GOM2-1 proceedings.
    - Johnson, J.E., MacLeod, D.R., Divins, D.L., 2020. Data Report: UT-GOM2-1 Sediment Grain Size Measurements at Site GC 955, Holes H002 and H005. In Flemings, P.B., Phillips, S.C, Collett, T., Cook, A., Boswell, R., and the UT-GOM2-1 Expedition Scientists, Proceedings of the UT-GOM2-1

Hydrate Pressure Coring Expedition: Austin, TX (University of Texas Institute for Geophysics, TX). http://dx.doi.org/10.2172/1823030, 87 p.

- Johnson, J.E., Divins, D.L., 2020, Data Report: UT-GOM2-1 Lithostratigraphic Core Description Logs at Site GC 955, Holes H002 and H005. In Flemings, P.B., Phillips, S.C, Collett, T., Cook, A., Boswell, R., and the UT-GOM2-1 Expedition Scientists, Proceedings of the UT-GOM2-1 Hydrate Pressure Coring Expedition: Austin, TX (University of Texas Institute for Geophysics, TX)., http://dx.doi.org/10.2172/1823034, 30 p.
- Purkey Phillips, M., 2020, Data Report: UT-GOM2-1 Biostratigraphy Report Green Canyon Block 955, Gulf of Mexico. In Proceedings of the UT-GOM2-1 Hydrate Pressure Coring Expedition: Austin, TX (University of Texas Institute for Geophysics, TX)., http://dx.doi.org/10.2172/1823039, 15 p.

Table 1-9: AAPG Vol 2 submissions

Primary Author	Working Title	Status
Flemings, Cook	Volume Introduction	In prep
Oti	Using X-ray Computed Tomography (XCT) to Estimate Hydrate Saturation in Sediment Cores from Green Canyon 955, northern Gulf of Mexico	Ahead of Print
Moore	Integrated geochemical approach to determine the source of methane in gas hydrate from Green Canyon Block 955 in the Gulf of Mexico	Ahead of Print
Daigle	Pore structure of sediments from Green Canyon 955 determined by mercury intrusion	Ahead of Print
Wei	Methane migration mechanisms for the Green Canyon Block 955 gas hydrate reservoir, northern Gulf of Mexico	Ahead of Print
Santra	Occurrence of High-Saturation Gas Hydrate in a Fault-Compartmentalized Anticline and the Role of Seal- Green Canyon, Abyssal Gulf of Mexico	Ahead of Print
Yoneda	Comprehensive pressure core analysis for hydrate-bearing sediments from Gulf of Mexico Green Canyon Block 955, including assessments of geomechanical viscous behavior and NMR permeability	Ahead of Print
Fang	Permeability of methane hydrate-bearing sandy silts in the deepwater Gulf of Mexico (Green Canyon block 955)	Ahead of Print
Fang	Compression behavior of hydrate-bearing sediments	Accepted, final edits submitted
Phillips	Thermodynamic insights into the production of methane hydrate reservoirs from depressurization of pressure cores	Ahead of Print

1.2.2.3 Task 11.0 – Update Science and Operations Plans for UT-GOM2-2 Scientific Drilling Program

Status: Complete (Milestone 5E)

Prospectus: Science and Sample Distribution Plan

The UT-GOM2-2 Science and Sample Plan V2 was completed and published as the UT-GOM2-2 Prospectus on the UT-GOM2-2 Expedition website (Figure 1-5) and on OSTI.

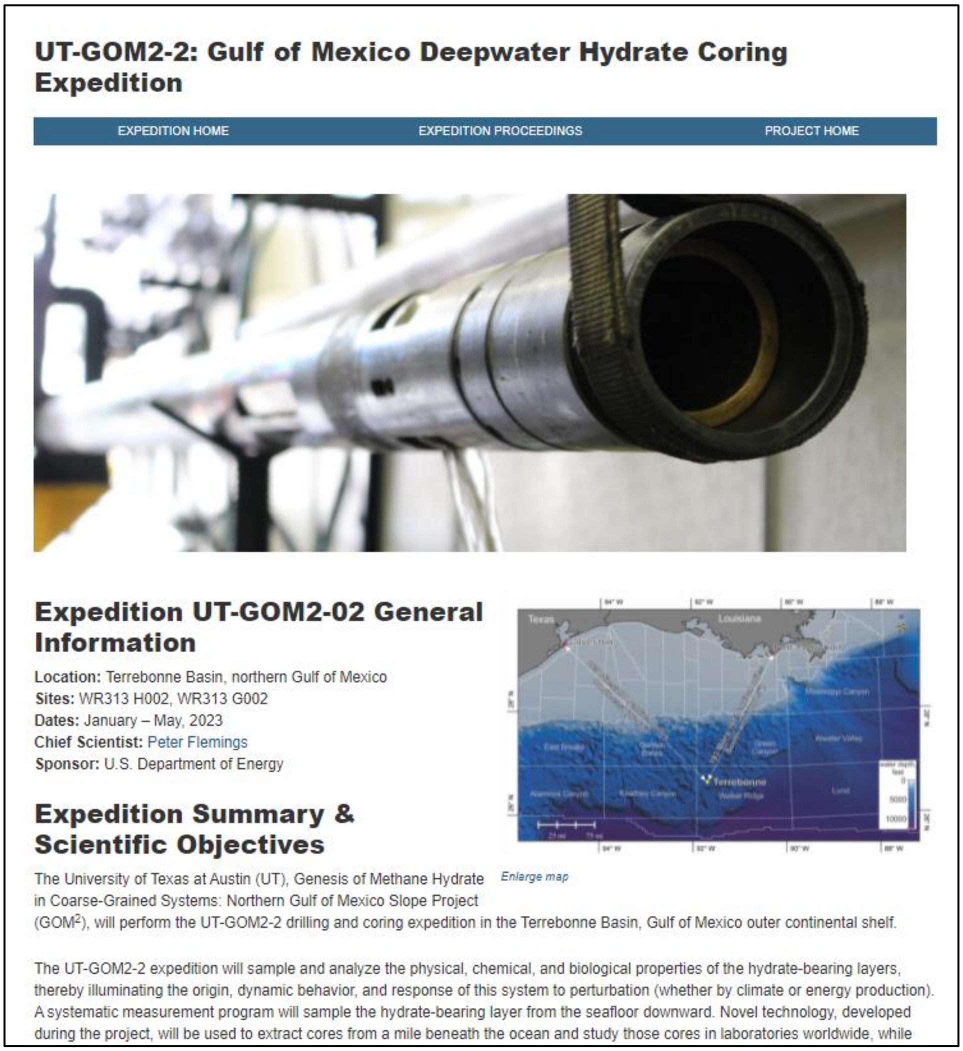

Figure 1-5. Snapshot of the UT-GOM2-2 Expedition website home page. See UT-GOM2-2.

- The prospectus details the scientific objectives, acquisition, storage, analysis, and distribution of core and other collected samples for the expedition. It includes the following:
- The core sampling frequency as a function of depth for all required samples and generated an estimate of the total number of each kind of sample.

A detailed pore water sampling plan for the science plan detailing the prioritization of pore water analyses and allocation of pore water samples dependent on the amount of pore water acquired from each whole round sample and sample depth. See

- Table 1-10 and Table 1-11.
- A split core sampling plan for CHNS, TOC, and isotopes, grain size distribution, biostratigraphy, rock magnetism, XRPD, MAD, and XRD.
- Final edits to the science plan including a rework of the outline to pull together one high level section detailing the measurements required to inform the scientific objectives and a rewording of the pressure core processing steps to better clarify the requires steps.
- The work is a compilation of writing from many of members of the GOM research team led by Carla Thomas (UT) and including Peter Flemings, Manasij Santra, Jaime Morrison, Jesse Houghton, Kehua You, Kevin Meazell, Alexey Portnov, and Aaron Price (UT), Rick Colwell (Oregon State), Evan Solomon (University of Washington), Ann Cook, Derek Sawyer, and Tom Darrah (Ohio State University), David Divins and Joel Johnson (University of New Hampshire), Alberto Malinverno (Lamont-Doherty Earth Observatory), John Germaine (Tufts University), and Steve Phillips (USGS); and others including Peter Schultheiss and Melanie Holland (Geotek); members of the GOM2 Advisory Group including Tim Collett (USGS); and Tom Pettigrew (Pettigrew Engineering, Ltd).
- Reference: Peter Flemings, Carla Thomas, Tim Collett, Fredrick Colwell, Ann Cook, John Germaine, Melanie Holland, Jesse Houghton, Joel Johnson, Alberto Malinverno, Kevin Meazell, Tom Pettigrew, Steve Phillips, Alexey Portnov, Aaron Price, Manasij Santra, Peter Schultheiss, Evan Solomon, Kehua You, UT-GOM2-2 Prospectus: Science and Sample Distribution Plan, Austin, TX (University of Texas Institute for Geophysics, TX). http://dx.doi.org/10.2172/1827729, 141 p.

Table 1-10. Pore Water sampling plan for on-board and routine geochemical analysis. Zoom in to read table.

Pore Water Allocation - APC/XCB/PCTB Routine Pore Water Geochemistry										
					Personal Samples					
			glass				**plastic**		**shipboard**	
	O/H	**Halogens**	**DIC Isotopes**	**DIC**	**DOC/VFAs**	**Majors, Minors, Isotopes**	**SO4/H2S**	**Cl+B Isotopes**	**Alkalinity**	**Alkalinity residue**
code	**IWOH**	**IWHAL**	**IWDI13C**	**IWDIC**	**IWDOC**	**IWMAJ**	**IWSO4**	**IWCLISO**	**IWS**	**IWALK**
subsample container	2 ml glass vial	2ml glass vial	2 ml agilent vials	2 ml agilent vials	5 ml amber bottles, pre-combusted	4-15 ml Acid-Cleaned Nalgene Bottles	15 ml Corning Centristar Tubes	4-15 ml Acid-Cleaned Nalgene Bottles	14 ml Falcon tubes	5 ml cryovials
treatment	**Nothing**	**Nothing**	**HgCl2 10 ul**	**HgCl2 10 ul**	**Frozen -20C**	**Acidified to pH2 with Optima HNO3**	**0.1 ml sample in 10 ml of 0.5 mM Zn-Acetate**	**Nothing**	**Nothing**	**Nothing**
45 ml	2.0	2.0	2.0	2.0	5.0	15.0	0.1	14.0	3.0	3.0
40 ml	2.0	2.0	2.0	2.0	5.0	15.0	0.1	8.0	3.0	3.0
35 ml	2.0	2.0	2.0	2.0	5.0	11.0	0.1	8.0	3.0	3.0
30 ml	2.0	2.0	2.0	2.0	5.0	8.0	0.1	6.0	3.0	3.0
25 ml	2.0	2.0	2.0	2.0	2.0	8.0	0.1	4.0	3.0	3.0
20 ml	2.0	2.0	2.0	1.0	2.0	4.0	0.1	4.0	3.0	3.0
15 ml	2.0	1.0	2.0		1.0	4.0	0.1	2.0	3.0	3.0
10 ml	2.0	1.0	1.0			4.0	0.1	2.0		
5 ml	2.0					3.0	0.1			
3 ml	1.0					2.0	0.1			
1 ml	1.0									
Note - APC DOC samples are collected with APC Organic Geochem Whole-Round, Only Collect DOC Samples for XCB and PCTB Cores										

Table 1-11. APC core Pore Water sampling plan for organic geochemical analysis. Zoom in to read table

Pore Water Allocation - APC Organic Geochemistry				
	glass	plastic		
	DOC/VFAs	Ligands	Trace Metals and Isotopes	SO4/H2S
code	IWDOC	IWLIG	IWTRACE	IWSO4
subsample container	5 ml Amber Glass Bottle (pre-combusted)	4-15 ml Acid-Cleaned LDPE Bottle	4-20 ml Acid-Cleaned LDPE Bottle	15 ml Corning Centristar Tubes
treatment	Frozen -20C	Frozen -20C	Acidified with Optima Nitric to pH 2	0.1 ml sample in 10 ml of 0.5 mM Zn-Acetate
40 ml	5.0	15.0	20.0	0.1
35 ml	5.0	15.0	15.0	0.1
30 ml	5.0	12.0	13.0	0.1
25 ml	5.0	12.0	8.0	0.1
20 ml	5.0	10.0	5.0	0.1
15 ml	2.0	10.0	4.0	0.1
10 ml	2.0	4.0	4.0	0.1
5 ml	2.0	2.0	1.0	0.1

Operations Plan

The Operations Plan was updated to version 2.1 and published on the UT-GOM2-2 Expedition website (Figure 1-5). Updates were made to the schedule, coring program, and field program logistics to reflect updates made in the Science and Sample Distribution Plan V2. Tufts University was also added to the organizational profile as the physical and petrophysical properties lead.

1.2.2.4 Task 12.0 – UT-GOM2-2 Scientific Drilling Program Vessel Access

Status: Ongoing

- UT identified three possible vessel contracting paths:
    1. Best value determination through UT
    2. Competitive bid through UT
    3. Competitive bid through Geotek
- UT has made a preliminary decision which contracting strategy we will pursue, and is taking steps to pursuing this strategy. However, this does imply UT has committed to a final decision
- UT has completed internal reviews for UT's proposed contractual terms and conditions.
- UT is shifting focus to the 2023 UT-GOM2-2 field program. We are working to understand the offshore market outlook for 2023 and working with our contacts in industry to understand external

forces on the market and rig availability. UT has also achieved means of having independent (3rd party) assessment of drilling rig and construction rig rates, utilization, and availability.

- UT executed a license agreement with IHS Markit for the Petrodata™ Rigbase and ConstructionVesselBase (CVBase) databases.
    1. Petrodata™ Rigbase and CVBase provide a comprehensive source of data on the mobile offshore drilling rig and construction vessel fleet. The license agreement provides near-real-time raw data, statistics, and analytical tools to assess rig availability, rig locations, rig contracts, rig utilization rates, current and historical day rates, technical specifications and drilling equipment.
    2. UT will use Petrodata™ Rigbase and CVBase database to evaluate offshore rig market conditions, utilization, and availability. This provides UT with the ability to independently verify proposed cost schedules against market conditions.

1.2.2.5 Task 13.0 – Maintenance & Refinement of Pressure Core Transport, Storage, & Manipulation Capability

Status: Ongoing

- UT continues to make progress on understanding the mechanisms and extent of core degradation during high pressure storage in fresh water.
    - Work continued on extracting samples of storage fluid from high pressure chambers. Previous simulations of core degradation have modeled a change in storage fluid salinity and dissolved methane concentration as a function of time and space (see Y7Q1 (Flemings, 2021a) or Y7Q2 (Flemings, 2021b)). These modeled changes are a result of salt diffusion and advection from the pore space into the fresh storage fluid, and loss of hydrate in the pore space of the exposed surfaces of the core. The method of extraction needs to be refined as gas chromatography of the gases from UT-GOM2-1-H005-08FB-1 was inconclusive due to too high a level of water vapor in the samples. Longer times for the samples to equilibrate may be required.
- Equipment was ordered that should allow UT to create and exchange storage fluid with methane-charged water.

1.2.2.5.1 Subtask 13.1 – Hydrate Core Manipulator and Cutter Tool

- The system underwent cutter mechanism maintenance teardown. Seals and bearings were replaced and mini-PCATS sediment traps were cleaned.
- The x-ray system underwent quarterly calibration.
- The following pressure cores were sampled for K0 Testing.
    - H005-02FB-2
        - 2 K0 samples
    - H005-08FB-3

- Began X-ray scanning. 2 K0 samples are projected to be cut in the next quarter.

1.2.2.5.2 Subtask 13.2 – Hydrate Core Effective Stress Chamber

- In the last three quarters, UT implemented multiple test protocols that extended the capabilities of the Hydrate Core Effective Stress Chamber. Proper understating of sealing now allows us to impose effective stresses up to 20 MPa, and instantaneous undrained loading measures sample deformation in an actuator-free loading system.
- We documented a benchmark study that evaluates the accuracy of our measurement system in the previous quarter. We compared properties derived from our pressure core tool and classical geotechnical devices using a resedimented clay sample. Compression, permeability, and lateral stress measurements are validated in a wide range of effective stresses.
- Reviews of the manuscript Fang et al. (in review) brought up the fact that a limitation of our early experiments is that there was some radial strain in our experiments due to the system compressibility (the compressibility in the water of the confining system and the cell itself). We developed an approach to correct for this system compressibility by having the confining pump supply additional fluid volume as the effective stresses increase to correct for this system compressibility. We validated this approach in the following manner. We used the fluid volume expelled during consolidation of the clay sample as an approximation of the volumetric deformation. Figure 1-6 shows that the volumetric ε_v and axial ε_a strains are equivalent; therefore, the lateral deformation is negligible. These results confirm our compressibility correction.

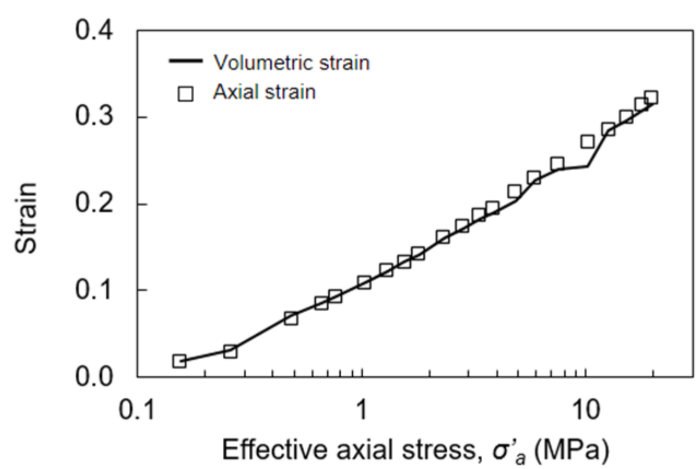

Figure 1-6. Resedimented Boston Blue Clay (RBBC) strain data. The volumetric and axial strain during consolidation overlap. This indicates zero-lateral strain conditions.

1.2.2.5.3 Subtask 13.3 – Hydrate Core Depressurization Chamber

- The system was used to quantify dissociated methane hydrate from small remainder samples of pressure cores.
- The system underwent maintenance and cleaning.

1.2.2.5.4 Subtask 13.4 – Develop Hydrate Core Transport Capability for UT-GOM2-2

- No update this period.

1.2.2.5.5 Subtask 13.5 – Expansion of Pressure Core Storage Capability for UT-GOM2-2

- UT has obtained a quote to manufacture new core chamber orientation support bases. After obtaining a single example of the design, UT continues to evaluate the quad base design for long-term feasibility in terms of pressure maintenance access and pressure relief.
- Expansion of pressure maintenance system is required to increase storage capability sufficient to receive UT-GOM2-2 cores. UT has obtained a finalized quote for additional pressure maintenance manifolds. Expansion of pressure safety venting system will also be required. UT has obtained a finalized quote for additional venting lines.
- Evaluation and maintenance testing of methane monitoring system and possible expansion being explored.

1.2.2.5.6 Subtask 13.6 – Continued Storage of Hydrate Cores from UT-GOM2-1

- Core storage expansion in the PCC is anticipated to accommodate any remaining pressure cores acquired from UT-GOM2-1, even when additional cores are collected during UT-GOM2-2 and transferred to the PCC.

1.2.2.5.7 Subtask 13.7 – X-ray Computed Tomography

- Improvements were made for processing 2D X-Ray and 3D CT scans. UT image quality continues to be on par with Geotek.
    - The new version of Geotek imaging software continues to operate well on the new image processing computer.
- The X-Ray CT continues to operate as designed.
- During this period, the system was calibrated.

1.2.2.5.8 Subtask 13.8 – Pre-Consolidation System

Replacement parts for a leaking Pre-Consolidation System hydraulic accumulator were installed and tested in Q1, 2021. After a long-term nitrogen leak test was conducted during Q2 and Q3, it was discovered that one of the hydraulic accumulators has a leak at the bladder seal. UT is working with the manufacturer to obtain and install the replacement bladder in Q1, 2022.

1.2.2.5.9 Subtask 13.9 – Transportation of Hydrate Core from UT-GOM2-2 Scientific Drilling Program
Future Task.

1.2.2.5.10 Subtask 13.10 – Storage of Hydrate Cores from UT-GOM2-2 Scientific Drilling Program
Future Task.

1.2.2.5.11 Subtask 13.11 – Hydrate Core Distribution
Future Task.

1.2.2.6 Task 14.0 – Performance Assessment, Modifications, And Testing Of PCTB

Status: Complete

1.2.2.6.1 Subtask 14.4 – PCTB Modifications/Upgrades
Status: Complete

1.2.2.6.2 Subtask 14.5 – PCTB Land Test III
Status: Complete

1.2.2.7 Task 15.0 – UT-GOM2-2 Scientific Drilling Program Preparations

Status: In Progress

1.2.2.7.1 Subtask 15.3 – Permitting for UT-GOM2-2 Scientific Drilling Program
- UT procured the services of ANCO Insurance to broker the required $200,000 bond with RLI Insurance Company. The bond was submitted to BOEM Leasing and Financial Responsibility Section, and subsequently approved.
- UT is now focused on completing the BOEM Permit for Geological and Geophysical Explorations or Scientific Research on the outer Continental Shelf (BOEM 0327/0329).
- We are deferring further work on certain UT-GOM2-2 permits due to the high potential for a delayed UT-GOM2-2 field program schedule. A number of permit submissions are only valid for a limited term, or must be submitted closer to a confirmed field schedule. These includes the Bureau of Safety and Environmental Enforcement (BSEE) Application for Permit to Drill (APD), the National Pollutant Discharge Elimination System (NPDES) Notice of Intent (NOI), and the US Coast Guard (USCG) Letter of Determination (LOD).

1.2.2.7.2 Subtask 15.4 – Review and Complete NEPA Requirements

Status: In Progress

1.2.2.7.3 Subtask 15.5 – Finalize Operational Plan for UT-GOM2-2 Scientific Drilling Program

Status: Complete (Milestone M5E)

UT has completed the UT-GOM2-2 Prospectus: Science and Sample Distribution Plan V.2 and the UT-GOM2-2 Operations Plan version 2.1 (see Section 1.2.2.3). The Operational Plan for the UT-GOM2-2 Scientific Drilling Program is now complete (Milestone M5E).

1.2.2.8 Task 16.0 – UT-GOM2-2 Scientific Drilling Program Field Operations

Status: Future Task

1.2.2.8.1 Subtask 16.1 – Mobilization of Scientific Ocean Drilling and Pressure Coring Capability

Future Task.

1.2.2.8.2 Subtask 16.2 – Field Project Management, Operations, and Research

Future Task.

1.2.2.8.3 Subtask 16.3 – Demobilization of Staff, Labs, and Equipment

Future Task.

1.3 What Will Be Done In The Next Reporting Period To Accomplish These Goals

1.3.1 Task 1.0 – Project Management & Planning

- UT will continue to execute the project in accordance with the approved Project Management Plan and Statement of Project Objectives.
- UT will continue to manage and control project activities in accordance with their established processes and procedures to ensure subtasks and tasks are completed within schedule and budget constraints defined by the Project Management Plan.
- UT will continue to manage the risk introduced to the project by the UT-GOM2-2 schedule uncertainty. We will continue to be prepared to perform the UT-GOM2-2 program in 2022, to the extent feasible should funding somehow become available. However, we have transitioned our primary efforts towards planning a 2023 UT-GOM2-2 field program.
- UT will review and analyze project budget and schedule implications for delaying the UT-GOM2-2 field program, and will notify the DOE Project Manager of findings and proposed a plan forward.

1.3.2 Task 10.0 – Core Analysis

- UT will continue analyzing the petrophysical and geomechanical properties of pressure cores using the UT K0 permeameter at high vertical effective stresses ~20MPa.
- UT will continue to assess the impact of core degradation during storage.
- Oregon State will continue working on improving DNA extraction techniques for UT-GOM2-2
- Ohio State with UT will continue developing reference hydrate saturation curves for UT-GOM2-2
- UT, Ohio State, UW, UNH, Oregon State, and Tufts will continue working on UT-GOM2-2 protocols and supply lists
- AAPG Editors will continue working on the publication of the second special volume of our findings from GC 955.

1.3.3 Task 11.0 – Update Operations Plan for UT-GOM2-2 Scientific Drilling Program

- Task Complete

1.3.4 Task 12.0 – UT-GOM2-2 Scientific Drilling Program Vessel Access

- UT will evaluate proposals and cost estimates, and evaluate against independent, third-party, source of vessel rates, utilization, and schedules.

1.3.5 Task 13.0 – Maintenance And Refinement Of Pressure Core Transport, Storage, & Manipulation Capability

- The Mini-PCATS, PMRS, analytical equipment, and storage chambers will undergo continued observation and maintenance at regularly scheduled intervals and on an as-needed basis. Installation of new or replacement parts will continue to ensure operational readiness.
- UT will work with Geotek to implement monitoring of the temperature of a sample in the Effective Stress Chamber.
- UT will replace a leaking component in the Pre-Consolidation hydraulic accumulator.
- Geotek will conduct a service visit in November, 2021. The primary focus will be software and firmware updates of Mini-PCATS and the K0 Effective Stress Chamber as well as inspection and potential replacement of high-wear parts.
- UT will perform continued operational evaluation of the single, quad-configuration support base for core storage expansion.
- UT will continue to evaluate the new pump modes developed to compensate for K0 apparatus compressibility.

1.3.6 Task 14.0 – Performance Assessment, Modifications, And Testing Of PCTB

- Task complete.

1.3.7 Task 15.0 – UT-GOM2-2 Scientific Drilling Program Preparations

- UT will complete the BOEM permit application for Geological and Geophysical (G&G) research in the Outer Continental Shelf (OCS)
- UT will continue work on the NEPA Environmental Questionnaire.

1.3.8 Task 16.0 – UT-GOM2-2 Scientific Drilling Program Field Operations

- No update.

2 PRODUCTS

Project publications webpage: https://ig.utexas.edu/energy/gom2-methane-hydrates-at-the-university-of-texas/gom2-publications/

2.1 Publications

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Flemings, P. B., Phillips, S. C., Boswell, R., Collett, T. S., Cook, A. E., Dong, T., Frye, M., Guerin, G., Goldberg, D. S., Holland, M. E., Jang, J., Meazell, K., Morrison, J., O'Connell, J., Pettigrew, T., Petrou, E., Polito, P. J., Portnov, A., Santra, M., Schultheiss, P. J., Seol, Y., Shedd, W., Solomon, E. A., Thomas, C., Waite, W. F., and You, K., 2020, Pressure coring a Gulf of Mexico Deepwater Turbidite Gas Hydrate Reservoir: Initial results from the UT-GOM2-1 hydrate pressure coring expedition: AAPG Bulletin, v. 104, no. 9, p. 1847-1876. https://doi.org/10.1306/05212019052

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Hillman, J. I. T., Cook, A. E., Daigle, H., Nole, M., Malinverno, A., Meazell, K., and Flemings, P. B., 2017a, Gas hydrate reservoirs and gas migration mechanisms in the Terrebonne Basin, Gulf of Mexico: Marine and Petroleum Geology, v. 86, no. Supplement C, p. 1357-1373. https://doi.org/10.1016/j.marpetgeo.2017.07.029

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2.3 Proceeding of the UT-GOM2-1 Hydrate Pressure Coring Expedition

Volume contents are published on the [UT-GOM2-1 Expedition website] and on [OSTI.gov].

2.3.1 Volume Reference

Flemings, P.B., Phillips, S.C, Collett, T., Cook, A., Boswell, R., and the UT-GOM2-1 Expedition Scientists, Proceedings of the UT-GOM2-1 Hydrate Pressure Coring Expedition, Austin, TX (University of Texas Institute for Geophysics, TX), https://dx.doi.org/10.2172/1646019

2.3.2 Prospectus

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2.3.3 Expedition Report Chapters

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2.3.4 Data Reports

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2.4 Processing of the UT-GOM2-2 Hydrate Coring Expedition

Volume contents will be published on the UT-GOM2-2 Expedition Proceedings website and on OSTI.gov.

2.4.1 Prospectus

Peter Flemings, Carla Thomas, Tim Collett, Fredrick Colwell, Ann Cook, John Germaine, Melanie Holland, Jesse Houghton, Joel Johnson, Alberto Malinverno, Kevin Meazell, Tom Pettigrew, Steve Phillips, Alexey Portnov, Aaron Price, Manasij Santra, Peter Schultheiss, Evan Solomon, Kehua You, UT-GOM2-2 Prospectus: Science and Sample Distribution Plan, Austin, TX (University of Texas Institute for Geophysics, TX). http://dx.doi.org/10.2172/1827729, 141 p.

2.5 Websites

- Project Website:

https://ig.utexas.edu/energy/genesis-of-methane-hydrate-in-coarse-grained-systems/

- UT-GOM2-2 Expedition Website

https://ig.utexas.edu/energy/gom2-methane-hydrates-at-the-university-of-texas/gom2-2-expedition/

- UT-GOM2-1 Expedition Website:

https://ig.utexas.edu/energy/genesis-of-methane-hydrate-in-coarse-grained-systems/expedition-ut-gom2-1/

- Project SharePoint:

https://sps.austin.utexas.edu/sites/GEOMech/doehd/teams/

- Methane Hydrate: Fire, Ice, and Huge Quantities of Potential Energy:

https://www.youtube.com/watch?v=f1G302BBX9w

- Fueling the Future: The Search for Methane Hydrate:

https://www.youtube.com/watch?v=z1dFc-fdah4

- Pressure Coring Tool Development Video:

https://www.youtube.com/watch?v=DXseEbKp5Ak&t=154s

2.6 Technologies Or Techniques

Nothing to report.

2.7 Inventions, Patent Applications, and/or Licenses

Nothing to report.

3 CHANGES/PROBLEMS

3.1 Changes In Approach And Reasons For Change

Since 2019, UT, the project Subawards (Ohio State, Oregon State, LDEO, UNH, UW, and Tufts), and project science & engineering contractors (Geotek and Pettigrew Engineering) have been working toward planning and executing the UT-GOM2-2 scientific drilling program in 2022. In September, 2021, UT determined that this is no longer feasible, and transitioned planning efforts with the expectation that UT-GOM2-2 will be performed in 2023. The delayed UT-GOM2-2 field program is a result of budget, schedule, and resource conflicts with the hydrate production test that the DOE is performing on the Alaska North Slope in 2022. See further discussed in the section below.

3.2 Actual Or Anticipated Problems Or Delays And Actions Or Plans To Resolve Them

The US DOE is performing a methane hydrate production test on the Alaska North Slope that is scheduled to commence in 2022. Common contractors, equipment, and resources are required for both the Alaska program and UT-GOM2-2, therefore both programs cannot be conducted concurrently. Furthermore, DOE is unable to fund both the Alaska program and the UT-GOM2-2 field program in the same fiscal year.

DOE informed UT that UT-GOM2-2 would most likely have to be delayed, and that a decision should be made by late summer based, in part, on Congressional Appropriations Committee marks. In September, 2021, UT determined that the schedule and resource conflicts and DOE's inability to commit required funds presented unacceptable risk to the continued possibility of performing the UT-GOM2-2 field program in 2022.

UT is now transitioning UT-GOM2-2 preparation and planning efforts with the assumption that the expedition will be funded in 2023. UT is evaluating the schedule and budget implications for the project resulting from the delayed UT-GOM2-2 field program. See further discussed in the section below.

3.3 Changes That Have A Significant Impact On Expenditures

As a direct result of delaying the UT-GOM2-2 field program, there will have significant financial impacts to the current budget and spending projections:

- Current trends in the offshore drilling market indicate that rates are increasing. UT will be unable to lock in vessel rates and offshore service rates until Federal funds are committed, and the UT-GOM2-2 expedition schedule is confirmed.
- Some large contractual expenditures planned for 2021-2022 must be shifted to 2022-2023. These include large lump sum payments for the drilling vessel, offshore service providers, and Geotek.
- A delayed UT-GOM2-2 will require expanding the GOM2 program by adding one additional year.

Under the current project agreement, DOE was scheduled to obligate $26.7M to the DE-FE0023919 project between July 2021 and January 2022, for the execution of the UT-GOM2-2 field program. As of October, 2021, $5M of this sum has been allocated to the program, but has not yet been distributed.

3.4 Change Of Primary Performance Site Location From That Originally Proposed

Nothing to report.

4 SPECIAL REPORTING REQUIREMENTS

4.1 Current Project Period

Task 1.0 – Revised Project Management Plan

Subtask 15.5 – Final UT-GOM2-2 Scientific Drilling Program Operations Plan

4.2 Future Project Periods

Task 1.0 – Revised Project Management Plan

Subtask 17.1 – Project Sample and Data Distribution Plan

Subtask 17.3 – UT-GOM2-2 Scientific Drilling Program Scientific Results Volume

5 BUDGETARY INFORMATION

The Budget Period 5 cost summary is provided in Table 5-1.

Table 5-1: Phase 5 / Budget Period 5 Cost Profile

Baseline Reporting Quarter	Budget Period 5							
	Y1Q1		Y1Q2		Y1Q3		Y1Q4	
	10/01/20-12/31/20		01/01/21-03/31/21		04/01/21-06/30/21		07/01/21-09/30/21	
	Y1Q1	Cumulative Total	Y1Q2	Cumulative Total	Y1Q3	Cumulative Total	Y1Q4	Cumulative Total
Baseline Cost Plan								
Federal Share	$ 587,651	$ 31,973,595	$ 581,151	$ 32,554,746	$ 5,466,306	$ 38,021,052	$ 581,151	$ 38,602,203
Non-Federal Share	$ 150,293	$ 23,871,255	$ 148,630	$ 24,019,885	$ 1,398,018	$ 25,417,903	$ 148,630	$ 25,566,533
Total Planned	$ 737,944	$ 55,844,850	$ 729,781	$ 56,574,631	$ 6,864,324	$ 63,438,955	$ 729,781	$ 64,168,736
Actual Incurred Cost								
Federal Share	$ 589,548	$ 29,766,294	$ 426,667	$ 30,192,961	$ 2,072,269	$ 32,265,230	$ 598,900	$ 32,864,131
Non-Federal Share	$ 220,056	$ 23,547,000	$ 374,124	$ 23,921,124	$ 623,736	$ 24,544,860	$ 222,682	$ 24,767,542
Total Incurred Cost	$ 809,604	$ 53,313,294	$ 800,791	$ 54,114,085	$ 2,696,006	$ 56,810,091	$ 821,582	$ 57,631,673
Variance								
Federal Share	$ 1,897	$ (2,207,301)	$ (154,484)	$ (2,361,785)	$ (3,394,037)	$ (5,755,822)	$ 17,750	$ (5,738,072)
Non-Federal Share	$ 69,763	$ (324,255)	$ 225,493	$ (98,761)	$ (774,281)	$ (873,043)	$ 74,052	$ (798,991)
Total Variance	$ 71,661	$ (2,531,556)	$ 71,010	$ (2,460,546)	$ (4,168,318)	$ (6,628,864)	$ 91,801	$ (6,537,063)
Baseline Reporting Quarter	Budget Period 5							
	Y2Q1		Y2Q2		Y2Q3		Y2Q4	
	10/01/21-12/31/21		01/01/22-03/31/22		04/01/22-06/30/22		07/01/22-09/30/22	
	Y2Q1	Cumulative Total	Y2Q2	Cumulative Total	Y2Q3	Cumulative Total	Y2Q4	Cumulative Total
Baseline Cost Plan								
Federal Share	$ 4,433,883	$ 43,036,085	$ 749,973	$ 43,786,058	$ 20,274,089	$ 64,060,147	$ 710,837	$ 64,770,984
Non-Federal Share	$ 700,232	$ 26,266,765	$ 118,441	$ 26,385,206	$ 3,201,835	$ 29,587,040	$ 112,261	$ 29,699,301
Total Planned	$ 5,134,114	$ 69,302,850	$ 868,414	$ 70,171,264	$ 23,475,924	$ 93,647,188	$ 823,097	$ 94,470,285
Actual Incurred Cost								
Federal Share								
Non-Federal Share								
Total Incurred Cost								
Variance								
Federal Share								
Non-Federal Share								
Total Variance								

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7 ACRONYMS

Table 7-1: List of Acronyms

ACRONYM	DEFINITION
AAPG	American Association of Petroleum Geologists
APC	Advanced Piston Corer
APD	Application for Permit to Drill
BHSZ	Base of Hydrate Stability Zone
BOEM	Bureau of Ocean Energy Management
BSEE	Bureau of Safety and Environmental Enforcement
CFR	Code of Federal Regulation
CHNS	Carbon, Hydrogen, Nitrogen, Sulfur
CPP	Complimentary Project Proposal
CT	Computed Tomography
CZM	Coastal Zone Management
DOE	U.S. Department of Energy
EP	Exploration Plan
G&G	Geologic and Geophysical
GC	Green Canyon
HSZ	Hydrate Stability Zone
IODP	International Ocean Discovery Program
LOI	Letter of Intent
LPA	Linear Polyacrylamide
LWD	Logging While Drilling
MAD	Moisture and Density
NEPA	National Environmental Policy Act
NETL	National Energy Technology Laboratory
NMR	Nuclear Magnetic Resonance
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
OCS	Outer Continental Shelf
OSTI	Office of Scientific and Technical Information
PCATS	Pressure Core Analysis and Transfer System
PCC	Pressure Core Center
PCTB	Pressure Core Tool with Ball Valve
PI	Principle Investigator
PM	Project Manager
PMP	Project Management Plan
PMRS	Pressure Maintenance and Relief System
QRPPR	Quarterly Research Performance and Progress Report

RBBC	Resedimented Boston Blue Clay
RPPR	Research Performance and Progress Report
RUE	Right-of-Use-and-Easement
SEG	Society of Exploration Geophysicists
SMT	Sulfate-Methane Transition
SOPO	Statement of Project Objectives
TN	Total Nitrogen
TOC	Total Organic Carbon
UNH	University of New Hampshire
USCG	United States Coast Guard
UT	University of Texas at Austin
UW	University of Washington
XRD	X-ray Diffraction
XRPD	X-ray Power Diffraction

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