DOE Award No.: DE-FE0023919

Quarterly Research Performance Progress Report

(Period Ending 12/31/21)

Deepwater Methane Hydrate Characterization & Scientific Assessment

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

Submitted by:

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U.S. DEPARTMENT OF ENERGY | NATIONAL ENERGY TECHNOLOGY LABORATORY

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 Vessel Procurement**
  UT entered into contract discussions with a vessel operator for the UT-GOM2-2 field program. UT is in the final stage of securing an agreement for a 2023 UT-GOM2-2 field program. The contract terms and conditions have been vetted and approved by all entities.

- **UT-GOM2-2 Permit Approvals**
  Three UT-GOM2-2 Expedition permit applications were approved this quarter:
  1. The Louisiana Department of Natural Resources (LDNR) found the Exploration Plan to be consistent with the LDNR Coastal Zone Monitoring (CZM) program and cleared the Exploration Plan for approval by the Bureau of Ocean Energy Management (BOEM).
  2. BOEM approved the UT-GOM2-2 Exploration Plan (N-10162).
  3. BOEM granted UT a Right-of-Use and Easement (RUE) in Walker Ridge Block 313 (OCS-G 30392).

- **Special Sponsor meeting**
  UT hosted a special sponsor meeting featuring the work of the GOM2 subcontractors, postdocs, and students. Presentations were made by The Ohio State University, University of Washington, University of New Hampshire, Columbia University, Oregon State University, and Tufts University.

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	Oct-21	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

- **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:**
  - In the previous performance period (Y7Q4), DOE informed UT that the UT-GOM2-2 field program could be delayed due to insufficient funding and schedule/resource conflicts with a DOE-sponsored hydrates production test in Alaska.
  - In this performance period (Y8Q1), UT initiated a two-pronged risk management approach to manage the UT-GOM2-2 schedule uncertainty:
    1. UT continued to plan, prepare, and contract for a 2022 UT-GOM-2 field program to the extent feasible and without committing unrecoverable funds, so that UT could maintain the ability to perform UT-GOM2-2 in 2022 if funding and resources could be secured.
    2. In addition, UT began to plan, prepare, and develop contractual options to perform the UT-GOM2-2 expedition in 2023, under the assumption that UT-GOM2-2 could be delayed.
  - In December, 2021, UT and US DOE made a final decision to proceed with contracting for a 2023 field program only. This decision was based on the following facts:
    1. On December 3, 2021, the U.S. Federal Government passed a stopgap spending bill to extend the continuing resolution through February 18, 2021 (H.R. 6119). As a result, the final FY 2022 project budget for the GOM2 project will most likely not be known until February.
    2. UT entered into contract negotiations with a vessel operator with the option for a 2022 or 2023 UT-GOM2-2 field program. The opportunity for a 2022 field program required a commencement date of May 1, 2022. After contract execution, if UT terminated or rescheduled the field program within 90 days of the May 1, 2022 start date (January 31, 2022) UT would incur a minimum penalty of $2.03M.
  - UT and DOE agreed that an uncertain FY 2022 budget, the continuing resolution through February 18, and a possible $2.03M contractual penalty presented too great of a risk to continue to maintain the option for a possible 2022 UT-GOM2-2 drilling program. UT has now transitioned all 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 and will communicate changes to the DOE project manager. See further discussion in Section 3.

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

- **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.
- Managed SharePoint sites, email lists, and archive/website.

- **Coordinate and supervise service agreements:**
  - UT initiated contract negotiations with a vessel operator on the basis of a best-value determination. UT is now in the process of finalizing the contract with the vessel operator for a 2023 field program. The contract has been vetted and approved by UT Purchasing, Business Contracts, and Legal Services.
  - UT initiated contract negotiations with Geotek for the UT-GOM2-2 scope of work and services.
  - UT 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.

- **Coordinate subcontractors:**
  - UT hosted a special sponsor meeting featuring the GOM2 subcontractors, postdocs, and students. Presentations were made by The Ohio State University, University of Washington, University of New Hampshire, Columbia University, Oregon State University, and Tufts University.
  - Worked individually with each of the six subcontracted universities to Amend their contract with UT.

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 continues the characterization of pressure core samples from UT-GOM2-1 at high effective stresses (~ 20 MPa). This extended stress capability is the result of systematic improvements in our measurements program, which have reduced problems with seal leakage.
- In this quarter, we characterized the sample 8FB3-1. Figure 1-1 shows the evolution of porosity *n* and lateral stress ratio K_0 with effective vertical stress σ'_a. The compression trend (i.e., the slope of *n* vs. log σ'_a curve - Figure 1-1a) agrees with previously measured values in similar hydrate-bearing sediments up to effective stresses of $\sigma'_a \approx 4$ MPa. Further stress increments cause the sediment to become more

compressible at approximately σ'_a = 8 MPa (i.e., higher slope of the *n* vs. log σ'_a curve). In terms of the lateral stress ratio (Figure 1-1b), the values of the sample 8FB3-1 are larger in the effective stress range 1 to 4 MPa. In both cases where samples were subjected to large stresses, i.e., 2FB2-1 (previous quarter) and 8FB3-1 (this quarter), the K0 ratio monotonically increases after 8 MPa of effective stress. The higher compressibility and K_0 values at high stress are being further investigated.

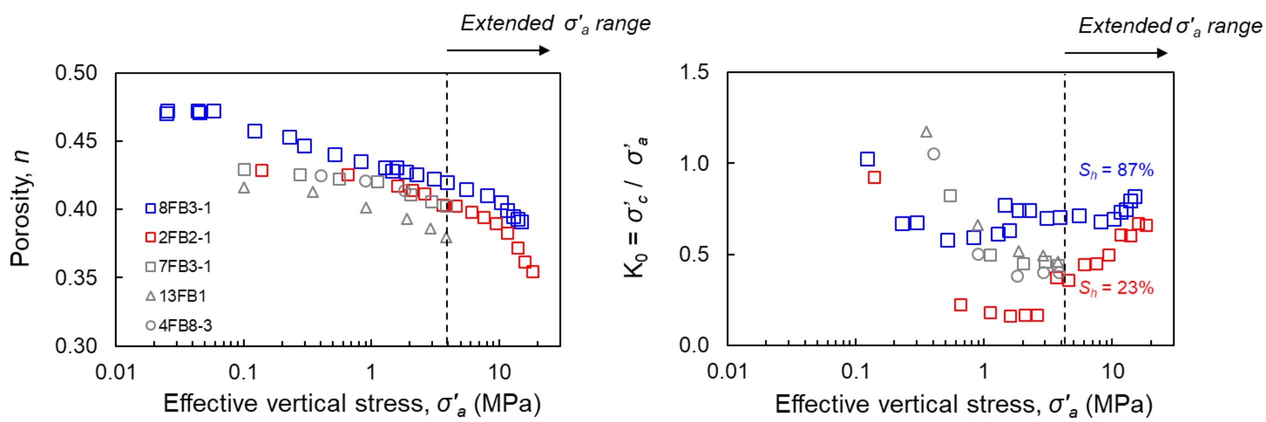
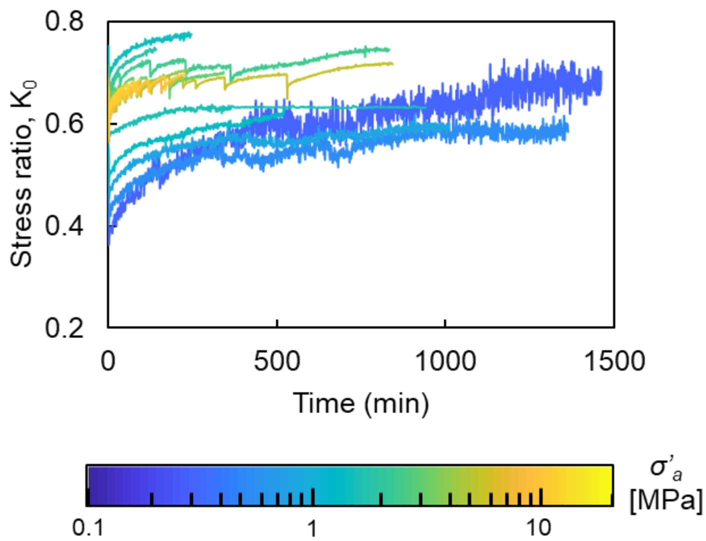


Figure 1-1. Characterization of sample 8FB3-1 at high effective stress. For completeness, we superimpose the 2FB2-1 data gathered in the last quarter. The compression (a) and lateral stress ratio (b) data at high stresses (shown as blue and red squares) agrees with previously measured values shown as gray markers for similar samples (Fang, in press). The new measurements at higher stresses suggest different trends after ~8MPa. 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.

- Previous analyses have suggested that the hydrate in the sediment pores behaves as a viscoelastic material that carries a fraction of the vertical load and laterally transfers the applied stress (Fang, in press). The proposed rheological behavior explains the increased stiffness and the higher K0 ratio with hydrate saturation. New K0 versus time data for creep tests in the sample 8FB3-1 suggests a gradual increase of K0 with time for the entire effective stress range (Figure 1-2). This time-dependent behavior agrees with the hypothesis of hydrate behaving as a viscoelastic material over experimental timescales.



A

Figure 1-2. Lateral to vertical effective stress ratio K_0 with time for the sample 8FB3-1 during creep tests (i.e., total vertical stress is constant). The color in the lines represent vertical effective stress values at the end of each creep test.

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. Residence times are being estimated using accumulations of radiogenic helium-4. The abundance of ^{4}He in the hydrate likely reflects a combination of different sources. Constraining the inputs from these various sources gives the potential to quantify the in situ generation of [^{4}He], which can be estimated to quantify release rates and residence time.

1.2.2.2.2 Subtask 10.6 – Additional Analysis Capabilities

- UT implemented a slow-speed actuator mode in the Hydrate Core Effective Stress Chamber with help from Geotek. This added capability allows us to conduct Constant Rate of Strain (CRS) tests that can potentially expedite testing times while gathering the same geomechanical and petrophysical information of hydrate-bearing sediment samples. We plan to test this new capability in the next quarter.
- UNH new Elementar CHNS Elemental Analyzer is now fully up and running. This instrument will be utilized extensively on samples collected during the GOM2-2 expedition.

1.2.2.2.3 Subtask 10.7 – Hydrate Modeling

- UT developed a new quantitative model to describe microbial methane generation in coarse-grained marine sediments (sands/silts) during burial (Figure 1-4). In this model, methanogens live in sand/silt beds and are fed by dissolved organic carbon that is generated in the bounding muds. Dissolved organic carbon is transported from muds to the interbedded sands/silts by diffusion within a saturated liquid phase.
- This methanogenesis model provides an additional source of microbial methane in marine sediments besides the shallow source in marine muds, and sheds new light on methane budget and distribution and carbon cycle under the seafloor.
- This new methanogenesis model is integrated into a hydrate simulator we developed (You and Flemings, 2021) which 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. The predicted methane hydrate distribution and saturation matches field observations from the Cascadia Margin.

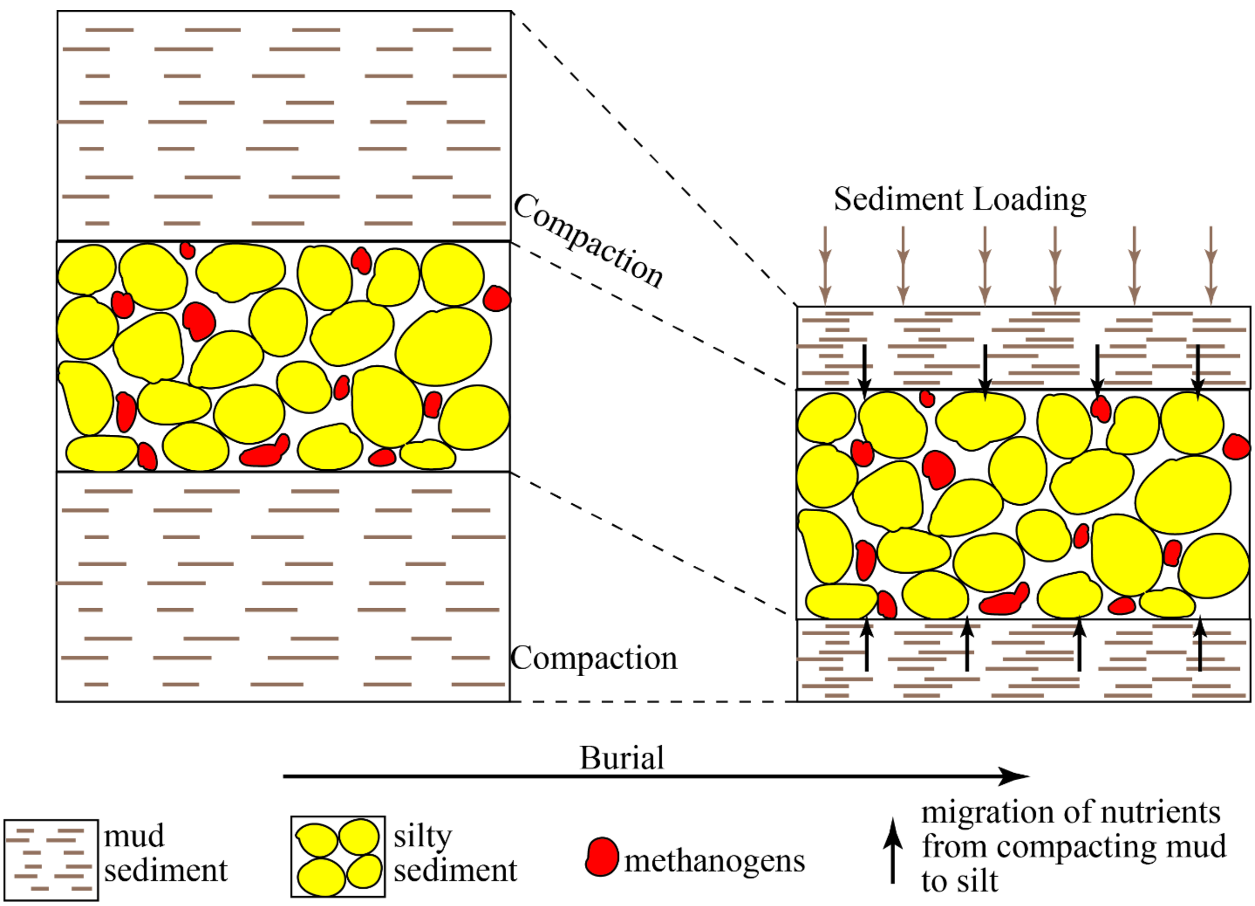


Figure 1-4: We envision a silty layer (yellow grains) bounded by a fine-grained muddy layer. Methanogens (red, prokaryotes) live within the pores of the silt. As burial occurs by sedimentation, the mud undergoes dramatic compaction and its fluids are expelled toward the silt

layer, which does not undergo significant compaction. Blue arrows record migration of organic carbon-rich fluids (by diffusion and compaction-driven advection) from the mud to the silt.

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

- A paper on the full data analyses/interpretations of 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 from the University of New Hampshire was published in Marine Geology Johnson, J.E., MacLeod, D.R., Phillips, S.C., Purkey Phillips, M., Divins, D.L., 2022. 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, Volume 444, 2022, 106718, https://doi.org/10.1016/j.margeo.2021.106718.
- Gabrielle Varona of UT Austin presented in person at an AGU poster session. Her poster "Channel Evolution Of Methane-Hydrate Bearing Sands in WR313, deepwater Gulf of Mexico" summarized the paleogeographic evolution of the Green Sand channel.
- Alejandro Cardona of UT Austin presented in person at AGU. His presentation "Validation of hydro-geomechanical properties in high pressure triaxial device for hydrate-bearing core analysis" summarized our efforts over the past year to accurately measure geomechanical and petrophysical properties in hydrate-bearing sediments.
- Fawz Naim of Ohio State presented his machine learning results in person at AGU which included predicting Vp and bulk density logging data at WR313. His model uses LWD data from Cascadia Margin and the Gulf of Mexico to predict Vp and bulk density logs at WR313 with a high degree of accuracy. These results could be important for areas where these logs were not measured or the data is poor quality. Naim and Cook are working on a manuscript with this work for JGR Solid Earth.
- AAPG Editors continued working on the AAPG Bulletin GC 955 dedicated Volume 2 and volume 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).
- One data report was published. See Expedition Research Results under UT-GOM2-1 proceedings.
    - Solomon, E.A., Phillips, S.C., 2021, Data Report: Pore Water Geochemistry at Green Canyon 955, deepwater Gulf of Mexico, In Flemings, P.B., Phillips, S.C, Collett, T., Cook, A., Boswell, R., and the UT-GOM2-1 Expedition Scientists, UT-GOM2-1 Hydrate Pressure Coring Expedition Report: Austin, TX (University of Texas Institute for Geophysics, TX), http://dx.doi.org/10.2172/1838142, 14 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
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 (Milestones 5C, 5E)

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

Status: Ongoing

- UT entered into contractual negotiations with a vessel operator on the basis of a Best-Value Determination.
- Contract terms were developed with the option for a 2022 or 2023 UT-GOM2-2 field program, with appropriate cost adjustments for either scenario. The opportunity for a 2022 field program required a commencement date of May 1, 2022. After contract execution, if UT terminated or rescheduled the field program within 90 days of the May 1, 2022 start date (January 31, 2022), UT would have incurred a minimum penalty of $2.03M. UT requested that the 90 day notification term be reduced to 60 days, providing the option to reschedule until March 2, 2022 without incurring the penalty charge. However, the vessel operator declined UT's proposal. As a result, UT and US DOE made the decision to proceed with contracting for a 2023 field program only.
- UT is now in the final stage of finalizing the contract with the vessel operator for a 2023 field program. The contract terms and conditions have been reviewed by UT Business Contracts, Legal Services, and Purchasing. We expect to finalize and execute the contract in the next performance period (Y8Q2).

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 continues 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.
- The equipment to allow UT to create and exchange methane-charged water is being manufactured and will be delivered in Y8Q2.

1.2.2.5.1 Subtask 13.1 – Hydrate Core Manipulator and Cutter Tool

- Geotek made a service visit during this quarter for inspection and to perform software updates on the mini-PCATS system. The mini-PCATS computer system was updated to a Windows 10 operating system.
- The mini-PCATS system underwent a full mechanical maintenance teardown. Seals and bearings were replaced and mini-PCATS sediment traps were cleaned.
- The X-ray system underwent quarterly calibration.
- The mechanical drive system of mini-PCATS underwent full cleaning and lubrication.

1.2.2.5.2 Subtask 13.2 – Hydrate Core Effective Stress Chamber

- Geotek made a service visit during this quarter for inspection and software updates on the Hydrate Core Effective Stress Chamber. The Hydrate Core Effective Stress Chamber computer system was updated to a Windows 10 operating system.
- We continued to improve our approach to correct for possible radial strain in our experiments due to the system compressibility (the compressibility in the water of the confining system and the cell itself). We validated our approach using two samples with different diameters to reflect pressure core conditions. Sample RBBC-1 has a diameter smaller than the membrane while sample RBBC-2 (data gathered in this quarter) has a diameter equal to the membrane. The validation uses the fluid volume expelled during consolidation of the clay sample as a proxy for volumetric deformation. Figure 1-3 shows that the volumetric ε_v and axial ε_a strains are equivalent; therefore, the calculated radial strain is negligible. These results confirm our compressibility correction.

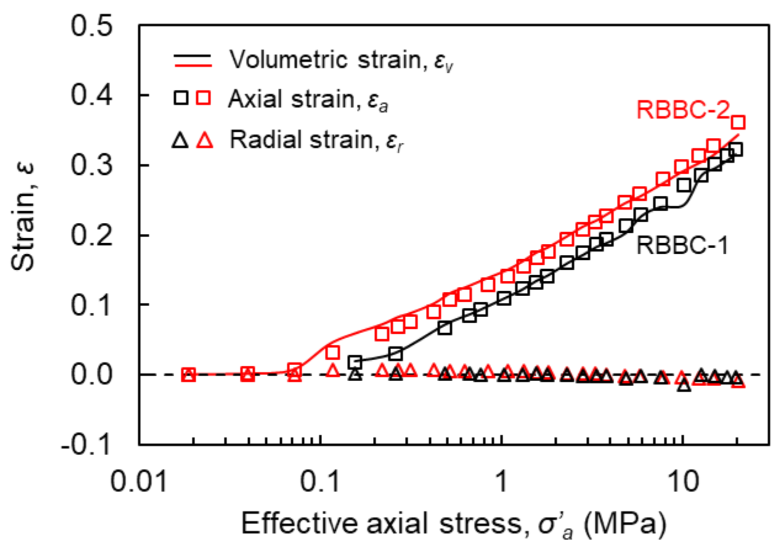


Figure 1-3. Resedimented Boston Blue Clay (RBBC) strain data for sample RBBC-1 and RBBC-2 (this quarter). The volumetric and axial strain during consolidation overlap. This indicates zero-radial strain conditions.

1.2.2.5.3 Subtask 13.3 – Hydrate Core Depressurization Chamber

- 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. UT continues to evaluate how to streamline the expansion of the pressure maintenance system and venting system.
- 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

- Geotek Ltd made a service visit during this quarter for inspection, calibration, and to perform software updates on the X-ray CT scanner. The computer system was updated to a Windows 10 operating system.
- The X-Ray CT continues to operate as designed.
- During this period, the system was calibrated.
- The Dell Image Reconstruction computer was found to have a faulty motherboard/memory interaction. The computer was evaluated by UT ITS and submitted to Dell for warranty repair which will occur in Y8Q2.

1.2.2.5.8 Subtask 13.8 – Pre-Consolidation System

- Geotek made a service visit during this quarter for inspection and repair of the Pre-Consolidation system bladder that was determined to be leaking in the previous quarter.
- The hydraulic accumulator bladder was replaced and then a nitrogen leak/pressure test was conducted and pressure was maintained.

- A long-term dummy sample test will be run in the future with an Effective Stress Chamber Test Section to ensure that each hydraulic accumulator can provide a different pressure to ensure proper axial loading of a sample in long-term storage.

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
- On Nov. 5, the Louisiana Department of Natural Resources (LDNR) found the UT-GOM2-2 Exploration Plan to be consistent with the LDNR Coastal Zone Management (CZM) program.
- On Nov 10, UT submitted a request to the BOEM Adjudication Section for a change in Name and Title for UT's Authorized Official from Dr. Alison Preston, Interim Vice President for Research to Dr. Daniel Jaffe, Vice President for Research.
- On Nov. 12, BOEM approved UT-GOM2-2 Exploration Plan (N-10162).
- On Nov. 12, BOEM approved the Right-of-Use (RUE) request (OCS-G 30392), and sent approval notification to UT for acceptance.

- UT completed the BOEM Permit for Geological and Geophysical Explorations or Scientific Research on the outer Continental Shelf (BOEM 0327/0329).
- UT is deferring work on specific 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 (Milestones M5C, 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 execute contracts with third party contractors including Geotek and a vessel operator to perform UT-GOM2-2 in 2023.
- 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 execute a contract with a vessel operator to perform UT-GOM2-2 in 2023.

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 run a dummy sample test in the Pre-Consolidation system to assess hydraulic accumulators after repair.
- 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/software developed to compensate for K0 apparatus compressibility.
- UT will work with Geotek to evaluate an Effective Stress Chamber modification to use the system actuator to gain a more accurate displacement measurement of the sample.

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 continue work on the NEPA Environmental Questionnaire.
- UT will evaluate what amendments or modifications to currently approved permits will be required by BOEM as a result of shifting the UT-GOM2-2 expedition schedule from 2022-2023.

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

- No update; Future Task.

2 PRODUCTS

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

2.1 Publications

Boswell, R., Collet, T.C., Cook, A.E., Flemings, P.B., 2020, Introduction to Special Issue: Gas Hydrates in Green Canyon Block 955, deep-water Gulf of Mexico: Part I: AAPG Bulletin, v. 104, no. 9, p. 1844-1846, http://dx.doi.org/10.1306/bltnintro062320.

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Cook, A. E., and Sawyer, D. E., 2015, The mud-sand crossover on marine seismic data: Geophysics, v. 80, no. 6, p. A109-A114. https://doi.org/10.1190/geo2015-0291.1

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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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Meazell, K., Flemings, P., Santra, M., and Johnson, J. E., 2020, Sedimentology and stratigraphy of a deepwater gas hydrate reservoir in the northern Gulf of Mexico: AAPG Bulletin, v. 104, no. 9, p. 1945–1969, https://doi.org/10.1306/05212019027

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Meyer, D. W., Flemings, P. B., DiCarlo, D., You, K. H., Phillips, S. C., and Kneafsey, T. J., 2018b, Experimental Investigation of Gas Flow and Hydrate Formation Within the Hydrate Stability Zone: Journal of Geophysical Research-Solid Earth, v. 123, no. 7, p. 5350-5371. https://doi.org/10.1029/2018jb015748

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2.2 Conference Presentations/Abstracts

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Cook. A., Waite, W. F., Spangenberg, E., and Heeschen, K.U., 2018, Petrophysics in the lab and the field: how can we understand gas hydrate pore morphology and saturation? Invited talk presented at the American Geophysical Union Fall Meeting, Washington D.C.

Cook, A.E., and Waite, B., 2016, Archie's saturation exponent for natural gas hydrate in coarse-grained reservoir. Presented at Gordon Research Conference, Galveston, TX.

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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.

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2.3.2 Prospectus

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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

UT Austin, the Subawards (Ohio State, Oregon State, LDEO, UNH, UW, and Tufts), and the project science & engineering contractors (Geotek and Pettigrew Engineering) have been working toward planning and executing a Spring 2022 UT-GOM2-2 drilling program since 2019. In the previous performance period (Y7Q4), DOE informed UT that UT-GOM2-2 may be delayed until 2023 due to insufficient funding, and schedule and resource conflicts with a hydrate production test that the DOE is performing on the Alaska North Slope in 2022. See Section 3.2 and 3.3 for further discussion.

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

To mitigate the risk introduced by the potential UT-GOM2-2 delay (Section 3.1), UT initiated a two-pronged UT-GOM2-2 planning approach:

1. UT continued to plan, prepare, and contract for a 2022 UT-GOM-2 field program to the extent feasible and without committing unrecoverable funds, so that UT could maintain the ability to perform UT-GOM2-2 in 2022 if funding could be secured.
2. In addition, UT began to plan, prepare, and develop contractual options to perform UT-GOM2-2 in 2023 under the assumption that UT-GOM2-2 could be delayed.

In December, 2021, UT and US DOE determined that performing UT-GOM2-2 in 2022 was no longer a viable possibility, and made a final decision to proceed with contracting for a 2023 field program only. This decision was based on the following facts:

1. On September 30, 2021, the U.S. Federal Government passed a continuing resolution for FY 2022 appropriations through December 3, 2021 (H.R. 5305). On December 3, 2021, U.S. President Joe Biden signed a stopgap spending bill, extending the continuing resolution through February 18, 2021 (H.R. 6119). As a result, the FY2022 project budget for the GOM2 project will most likely not be known until mid-February.
2. UT initiated contract negotiations with a vessel operator, which included the option for a 2022 or 2023 UT-GOM2-2 field program. The opportunity for a 2022 field program required a commencement date of May 1, 2022. After contract execution, if UT terminated or rescheduled the field program within 90 days of the May 1, 2022 start date (January 31, 2022) UT would incur a minimum penalty of $2.03M.

UT has now transitioned all UT-GOM2-2 preparation and planning efforts towards performing the expedition in 2023, with the expectation that the expedition will be funded at this time.

3.3 Changes That Have A Significant Impact On Expenditures

UT is evaluating budget implications for the project as a result of the delayed UT-GOM2-2 field program to 2023. We anticipate numerous financial impacts to the current budget and spending projections:

- Current trends in the offshore drilling market indicate that rates are increasing.
- Some large contractual expenditures planned for 2021-2022 must be shifted to 2022-2023.
- A delayed UT-GOM2-2 will require expanding the GOM2 program by adding one additional year.

3.4 Change Of Primary Performance Site Location From That Originally Proposed

None.

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	$ 466,675	$ 33,330,806						
Non-Federal Share	$ 254,642	$ 25,022,184						
Total Incurred Cost	$ 721,317	$ 58,352,990						
Variance								
Federal Share	$ (3,967,208)	$ (9,705,280)						
Non-Federal Share	$ (445,590)	$ (1,244,581)						
Total Variance	$ (4,412,798)	$ (10,949,860)						

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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
CRS	Constant Rate of Strain
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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